PREVOST®

COACH MANUFACTURER

MAINTENANCE MANUAL

X3-45 COACH
X3-45 VIP
LE MIRAGE XLII BUS SHELL

PA1580

(Revision 01)

PA1580 revision 01

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Featuring: EPA 2010

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01	Sections modified: 00 General 01 Engine 04 Exhaust 06 Electrical 10 Front Axle 16 Suspension 18 Body 23 Accessories 24 Lubrication 24A Lubrication And Servicing Schedule	July 2012

SECTION 00: GENERAL INFORMATION

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1. FOREWORD

This manual includes procedures for diagnosis, service, maintenance and repair for components of the X3 series coaches and VIP and Le Mirage XLII Bus Shells listed on the front cover page. This manual should be kept in a handy place for ready reference by the technician. If properly used, it will meet the needs of the technician and owner.

Information provided in Section 1 through 26 pertains to standard equipment items, systems and components as well as the most commonly used optional equipment and special equipment offered on the vehicle models covered by this manual. At the beginning of each section: a Table of Contents and a list of illustrations give the page number on which each subject begins and where each figure is located. Vehicle operating information is provided in a separate Manual. Audio/Video system operator instructions are also included in a separate manual.

More specific information on engine and transmission operating, maintenance, and overhaul information is contained in the applicable engine or transmission service manual published by the engine or transmission manufacturer. Engine and transmission parts information is contained in the applicable engine or transmission parts catalog published by the engine or transmission manufacturer. All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication approval. The right is reserved to make product changes at any time without notice.

NOTE

Typical illustrations may be used; therefore minor illustration difference may exist when compared to actual parts or other publications.

Prevost occasionally sends Maintenance Information, Warranty Bulletins, Safety Recalls or other literature to update users with the latest service procedures. They are issued, when required, to supplement or supersede information in this manual. Update sheet should be filled out and bulletins should be filed at the end of their respective section for future reference.

2. SCHEMATICS

Vehicle Air Schematics are provided at the end of Section 12, "Brake". SUSPENSION AIR SCHEMATICS are provided at the end of Section 16: "Suspension". Moreover, Electrical Schematics are provided in the technical publications box. Refer to those schematics for detailed circuit information or during diagnosis.

3. PRECAUTIONS TO BE OBSERVED BEFORE WELDING

CAUTION

Precautions are to be observed before welding to minimize the risk of major and costly damage caused to the vehicle electronic components.

NOTE

*For **X3 Series Coaches & VIP and Le Mirage XLII Bus Shells Multiplex** vehicles, also execute procedure no: PR060041 "MULTIPLEX MODULES DISCONNECTION PROCEDURE PRIOR TO WELDING" included at the end of this section.*

CAUTION

For vehicles equipped with a WCL system, disconnect electronic controller connector.

CAUTION

Cover electronic control components and wiring to protect from hot sparks, etc.

CAUTION

Position welding machine ground clamp as close as possible to the work. Ensure that the welding machine ground return clamp is well secured and makes a good electrical contact with a large metallic area of the chassis located as close as possible to the welding point.

CAUTION

Do not use TIG welding process on the vehicle. This high frequency current process can seriously damage the electronic components.

STEEL – STEEL WELDING

CAUTION

Before welding, perform multiplex modules disconnection procedure.

NOTE

Welding surfaces must be free of scale, slag, rust, paint, grease, humidity or other foreign material that would render welding impossible.

DANGER

Only a qualified and experienced person must do welding.

- FCAW (Flux Cored Arc Welding) process ;
- Electrode wire conforms to A5.20 AWS (American Welding Society) specifications ;
- E4801T-9-CH, type electrode wire with 0,045“ diameter (1,14 mm) ;

Material Thickness	Voltage	Current	Wire Feed Rate	Shielding Gas
1/8” to ½”	26 ± 2 volts	260 Amps	450 ipm. approx.	75% argon – 25% CO2 or 100% CO2

If necessary and with great care to prevent perforating the material, it is possible to use a conventional electric arc welding machine according to the following specifications:

- SMAW (Shielded Metal-Arc Welding) process ;
- Welding rod conforms to A5.1 of AWS (American Welding Society) specifications; E 7018 type welding rod with 1/8” diameter (3,2 mm).
- Current: 100 amperes to 150 amperes; optimum at 120 amps.

It is important to grind weld bead starts and stops and also to grind arc strikes from surfaces.

STEEL - STAINLESS STEEL OR STAINLESS STEEL - STAINLESS STEEL WELDING

CAUTION

Before welding, perform multiplex modules disconnection procedure.

NOTE

Welding surfaces must be free of scale, slag, rust, paint, grease, humidity or other foreign material that would render welding impossible.

DANGER

Only a qualified and experienced person must do welding.

- GMAW (Gas Metal-Arc Welding) process;
- Welding wire conforms to AWS (American Welding Standards) A5.9 specifications;
- 308LSi type welding wire with 0.035" diameter (0,9 mm);

STEEL - STAINLESS STEEL WELDING

Steel Thickness	SS Thickness	Voltage	Current	Wire Feed Rate	Shielding Gas
Less than 1/8”	Any type	20±1.5 volts	130±15 Amps	290 ipm approx.	90% He, 7.5% Ar, 2.5% CO2
1/8” and more	Any type	22±1.5 volts	160±15 Amps	330 ipm approx.	90% He, 7.5% Ar, 2.5% CO2

STAINLESS STEEL - STAINLESS STEEL WELDING

SS Thickness	Voltage	Current	Wire Feed Rate	Shielding Gas
Any type	20 ± 1.5 volts	130 ± 15 Amps	290 ipm approx.	90% He – 7.5% Ar, 2.5% CO2

If necessary and with great care to prevent perforating the material, it is possible to use a conventional electric arc welding machine according to the following specifications:

- SMAW (Shield Metal-Arc Welding) process;
- Welding rod conforms to AWS (American Welding Standards) A5.4 specifications; 308L-17 type welding rod with 3/32" diameter (2,4 mm);
- Current: - 50 amperes to 90 amperes, optimum at 60 amperes.

It is important to grind weld bead starts and stops and also to grind arc strikes from surfaces.

4. SAFETY NOTICE

This maintenance manual has been prepared in order to assist skilled mechanics in the efficient repair and maintenance of PREVOST vehicles.

This manual covers only the procedures as of manufacturing date.

Safety features may be impaired if other than genuine PREVOST parts are installed.

Torque wrench tightening specifications must be strictly observed. Locking devices must be installed or replaced by new ones, where specified. If the efficiency of a locking device is impaired, It must be replaced.

This manual emphasizes particular information outlined by the wording and symbols:

DANGER

Directs the operator's attention to unsafe practices which could result in serious personal injury or death.

WARNING

Directs the operator's attention to unsafe practices which could result in serious personal injury or severe damage to the vehicle.

CAUTION

Directs the operator's attention to unsafe practices where personal injury is not likely but damage to vehicle components could occur.

NOTE

Indicates supplementary information essential to the proper operation of the vehicle. Although, the mere reading of such information does not eliminate the hazard, understanding of the information will promote its correct use.

4.1 DATA PLATES AND CERTIFICATIONS

Delay and confusion can be avoided by placing the complete vehicle identification number of the vehicle and the serial numbers of the engine on parts orders and correspondence. Also, the transmission, axles, power steering pump chassis and other major components are identified by serial numbers.

4.1.1 Engine

- **Volvo D13 Engine**

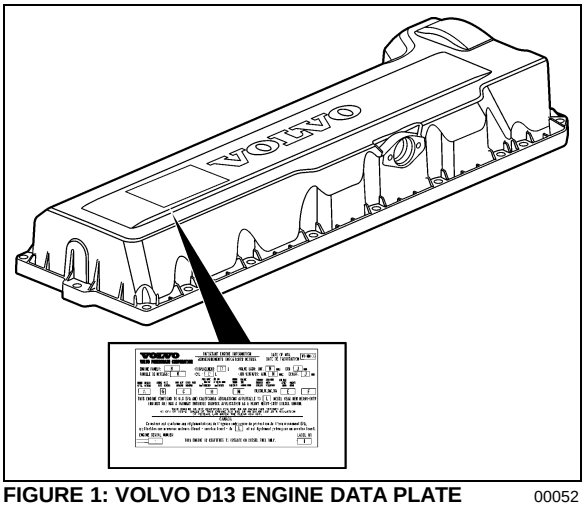


FIGURE 1: VOLVO D13 ENGINE DATA PLATE 00052

Volvo D13 engine serial and model numbers are stamped on the cylinder head (Fig. 1). Also, the

engine data plate certifies that the engine conforms to federal and any state exhaust emission regulations. It gives the operating conditions under which certification was made.

4.1.2 Transmission

The transmission identification plate is located on the oil level dipstick side of the transmission (WT) or on transmission (I-Shift) (Fig. 2 & 3). The identification plate shows the transmission serial number, part number (assembly number), and model number. Use all three numbers when ordering parts.

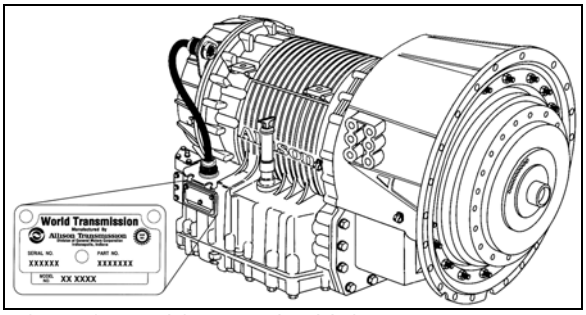


FIGURE 2: ALLISON TRANSMISSION 07076

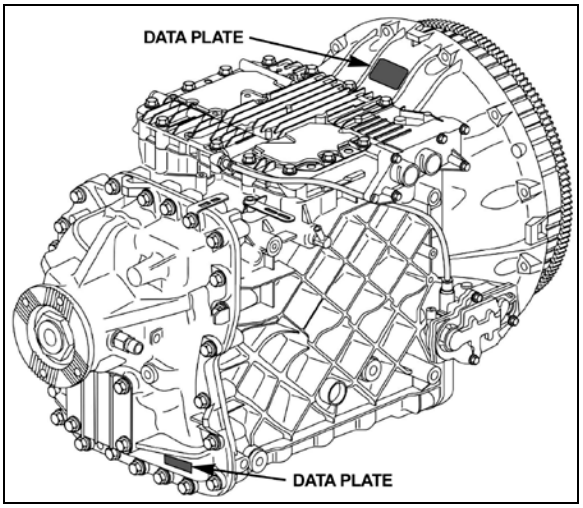


FIGURE 3: I-SHIFT TRANSMISSION

4.1.3 Drive Axle

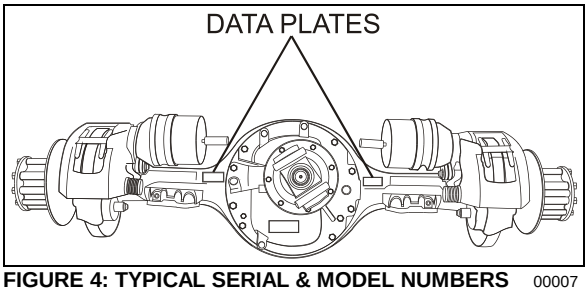


FIGURE 4: TYPICAL SERIAL & MODEL NUMBERS 00007

4.1.4 Front Axle

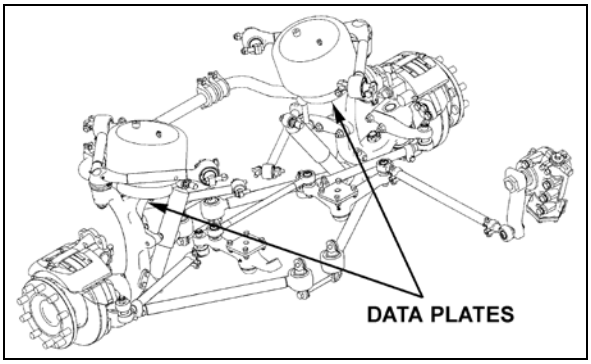


FIGURE 5: ISS TYPICAL SERIAL & MODEL NUMBERS 16136

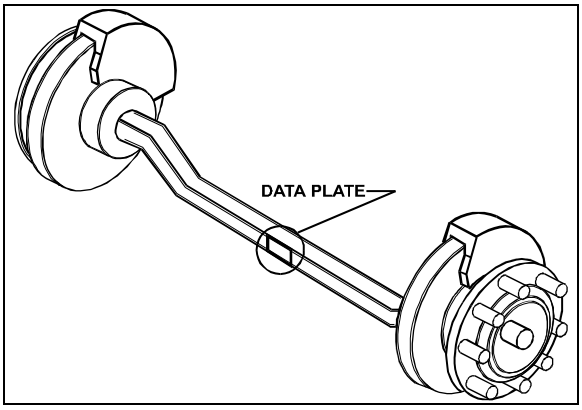


FIGURE 6: I-BEAM AXLE TYPICAL SERIAL & MODEL NUMBERS 00008

4.1.5 Power Steering Pump

- **Volvo D13 Engine**

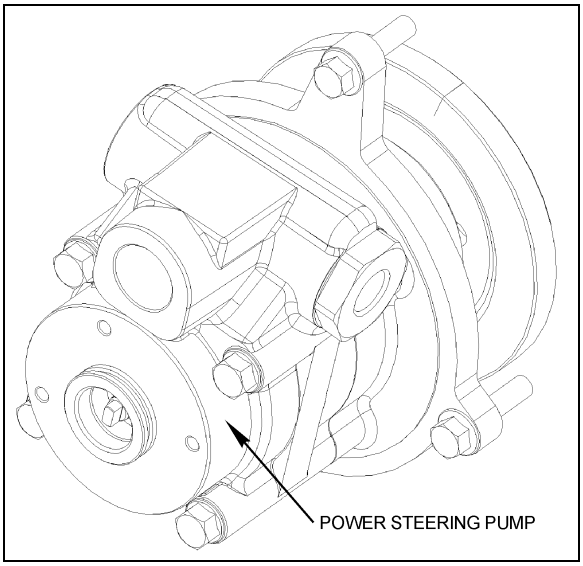


FIGURE 7: POWER STEERING PUMP

The power steering pump is mounted on the engine and located underneath the air compressor (Fig. 7).

4.1.6 Coach Final Record

The Coach Final Record is a record of all data pertaining to the assembly of the vehicle. This record is shipped to the new customer via a courier company. Retain this record in the company records office for reference and safe-keeping.

4.1.7 Safety Certification

Vehicle components meet specifications and standards as follows:

- Material and parts conform to ASTM and/or SAE standards in effect at the time of manufacture.

- All factory-installed interior materials meet FMVSS 302 for fire resistance.

- Certified according to Provincial, State and Federal Safety standards (Canadian and US) BMCSS, FMVSS, and CMVSS.

Other applicable certification labels are affixed to the component.

4.1.8 DOT Certification Label

This certifies that vehicles manufactured by Prevost Car Inc., comply with all Federal Motor Vehicle Safety Standards at the time of manufacture. Information such as date of manufacture, model year, gross vehicle weight rating, tire types and inflation pressure is also etched on this plate. The DOT Certification plate is affixed behind the driver's seat.

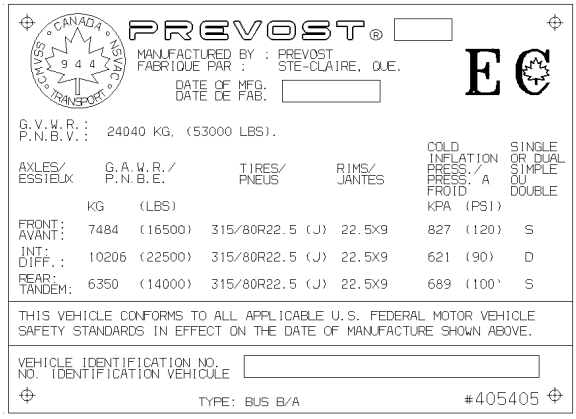


FIGURE 8: DOT CERTIFICATION PLATE 00016

4.1.9 Fuel Tank Label

The fuel tank label is molded on the side of the fuel tank. To read this label, unscrew the fuel tank access panel nuts located at the left in the condenser compartment.

4.1.10 Vehicle Identification Number (VIN)

The seventeen digit vehicle identification number (VIN) is located on a plate (Fig. 9 & 10) located on the windshield frame pillar (driver's side). The VIN is visible from the outside of the vehicle. Make sure the correct vehicle identification number is given when ordering replacement parts. Using the VIN when ordering parts will facilitate processing.

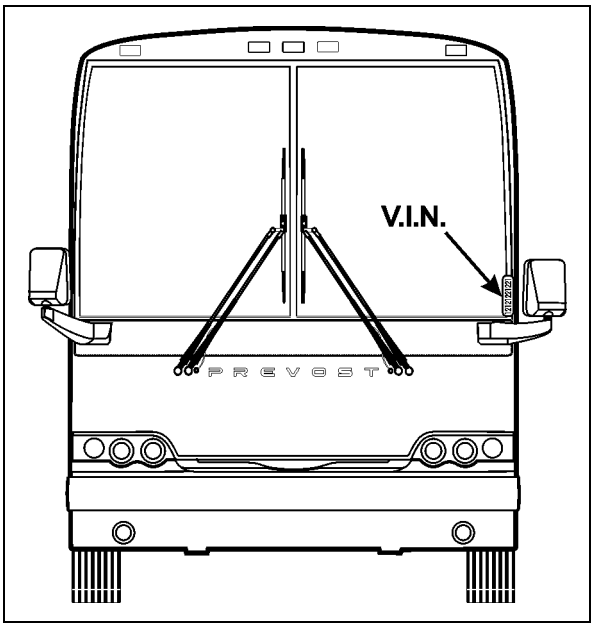
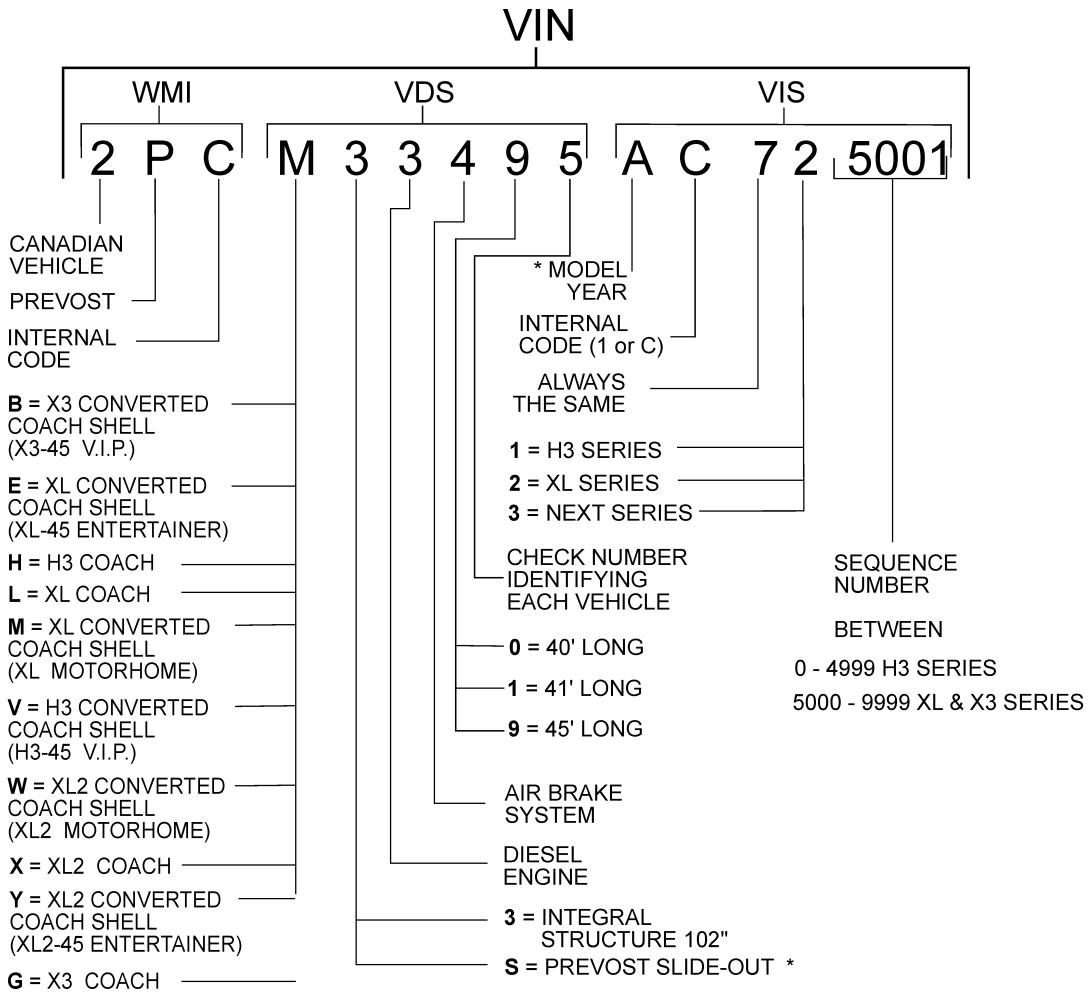


FIGURE 9 : VEHICLE I.D. 00048

NOTE

Record the VIN in the vehicle documentation and keep with company records. The VIN will normally be used for vehicle registration and for obtaining vehicle insurance coverage.



VIN Vehicle Identification Number: A structured combination of characters assigned to a vehicle by the manufacturer for identification purposes.

WMI World Manufacturer Identifier: Designating the manufacturer of the vehicle.

VDS Vehicle Descriptor Section: Provides information describing the general attributes of the vehicle.

VIS Vehicle Indicator Section: Combination of characters assigned by the manufacturer to distinguish one vehicle from another.

* Since A-1600 & A-9885

FIGURE 10 : VEHICLE IDENTIFICATION NUMBER 00056

YEAR	CODE	YEAR	CODE	YEAR	CODE
2000	Y	2006	6	2012	C
2001	1	2007	7	2013	D
2002	2	2008	8	2014	E
2003	3	2009	9	2015	F
2004	4	2010	A	2016	G
2005	5	2011	B	2017	H

5. FASTENER STRENGTH IDENTIFICATION

Most commonly used metric fastener strength property classes are 9.8 and 10.9 with the class identification embossed on the head of each bolt. Customary (inch) strength classes range from grade 2 to 8 with radial line identification embossed on each bolt head actual grade (i.e., a grade 7 bolt will have 5 embossed radial lines on the bolt head). Some metric nuts will be marked with single digit strength identification numbers on the nut face. Fig. 12 shows the different strength markings. When replacing metric fasteners, be careful to use fasteners of the same or greater strength than the original fasteners (the same number marking or higher). It is also important to select replacement fasteners of the correct size. Correct replacement fasteners are available through the parts division. Some metric fasteners available in after-market parts sources were designed to metric standards of countries other than the United States and may be of a lower strength, may not have the numbered head marking system, and may be of a different thread pitch.

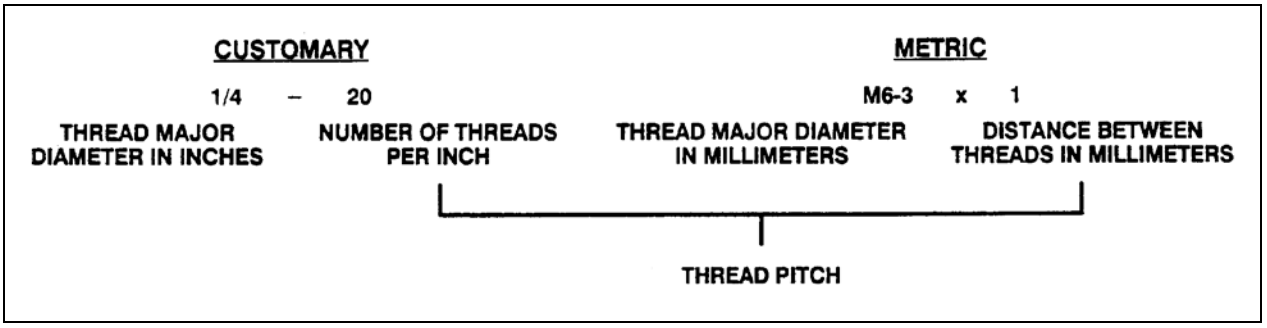


FIGURE 11 : THREAD NOTATION 00002

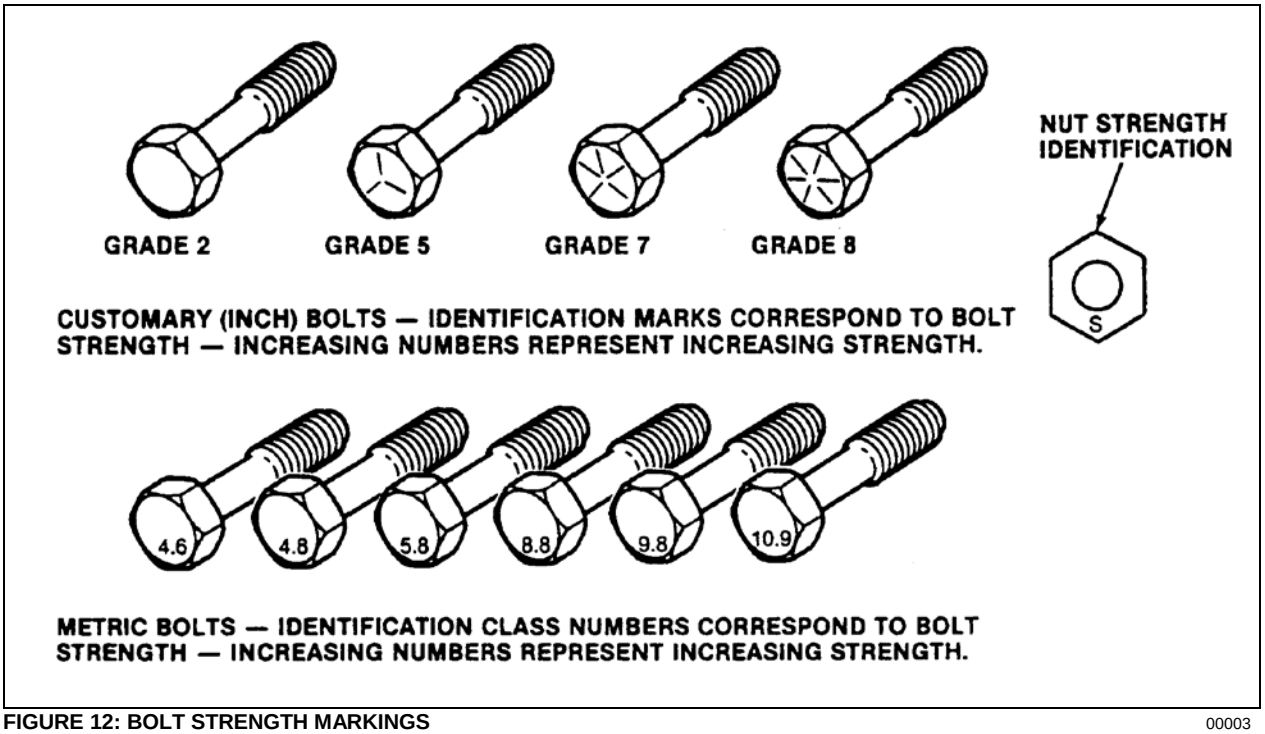


FIGURE 12: BOLT STRENGTH MARKINGS 00003

The metric fasteners used on the coach are designed to new standards and may not yet be manufactured by some non-domestic fastener suppliers. In general, except for special applications, the common sizes and pitches are:

- M 8 X 1.25;
- M 10 X 1.5;
- M 12 X 1.75;
- M 14 X 2;

5.1 STANDARD TORQUE SPECIFICATIONS

The following table lists the standard tightening torques for bolts and nuts, relating tightening torque to thread diameter. Use the following table as a general guide for tightening torques. Use this table only for the bolts and nuts which do not require a specific torque value. All of the values are for use with dry solvent-cleaned threads.

TYPE	DESCRIPTION	THREAD	GRADE	RECOMMENDED TORQUE, ±10% lbf-ft (dry) otherwise specified	
SAE	1/4-20	unc	5	100	lbf-in (dry)
SAE	1/4-20	unc	8	143	lbf-in (dry)
SAE	1/4-28	unf	5	115	lbf-in (dry)
SAE	1/4-28	unf	8	163	lbf-in (dry)
SAE	5/16-18	unc	5	210	lbf-in (dry)
SAE	5/16-18	unc	8	305	lbf-in (dry)
SAE	5/16-24	unf	2	120	lbf-in (dry)
SAE	5/16-24	unf	5	230	lbf-in (dry)
SAE	5/16-24	unf	8	325	lbf-in (dry)
SAE	3/8-16	unc	5	31	
SAE	3/8-16	unc	8	44	
SAE	3/8-24	unf	5	35	
SAE	3/8-24	unf	8	50	
SAE	7/16-14	unc	5	50	
SAE	7/16-14	unc	8	70	
SAE	7/16-20	unf	5	55	
SAE	7/16-20	unf	8	78	
SAE	1/2-13	unc	5	75	
SAE	1/2-13	unc	8	107	
SAE	1/2-20	unf	5	85	
SAE	1/2-20	unf	8	120	
SAE	9/16-12	unc	5	109	
SAE	9/16-12	unc	8	154	
SAE	9/16-18	unf	5	122	
SAE	9/16-18	unf	8	172	
SAE	5/8-11	unc	5	151	
SAE	5/8-11	unc	8	211	
SAE	5/8-18	unf	5	170	
SAE	5/8-18	unf	8	240	

TYPE	DESCRIPTION	THREAD	GRADE	RECOMMENDED TORQUE, ±10% lbf-ft (dry) otherwise specified
SAE	3/4-10	unc	5	266
SAE	3/4-10	unc	8	376
SAE	3/4-16	unf	5	298
SAE	3/4-16	unf	8	420
SAE	7/8-9	unc	5	430
SAE	7/8-9	unc	8	607
SAE	7/8-14	unf	5	470
SAE	7/8-14	unf	8	670
METRIC	M6 X 1		nut 9 / screw 8.8	7
METRIC	M6 X 1		nut 10 / screw 10.9	9
METRIC	M8 X 1.25		nut 9 / screw 8.8	16
METRIC	M8 X 1.25		nut 10 / screw 10.9	22
METRIC	M10 X 1.5		nut 9 / screw 8.8	32
METRIC	M10 X 1.5		nut 10 / screw 10.9	43
METRIC	M12 X 1.75		nut 9 / screw 8.8	60
METRIC	M12 X 1.75		nut 10 / screw 10.9	74
METRIC	M14 X 2		nut 9 / screw 8.8	90
METRIC	M14 X 2		nut 10 / screw 10.9	120
METRIC	M16 X 2		nut 9 / screw 8.8	140
METRIC	M16 X 2		nut 10 / screw 10.9	190
METRIC	M16 X 1.5		nut 10 / screw 10.9	230
METRIC	M20 X 2.5		nut 9 / screw 8.8	275
METRIC	M20 X 2.5		nut 10 / screw 10.9	450
METRIC	M20 X 1.5		nut 10 / screw 10.9	465
METRIC	M22 X 2.5		nut 9 / screw 8.8	345
METRIC	M22 X 2.5		nut 10 / screw 10.9	493
METRIC	M24 X 3		nut 9 / screw 8.8	475
METRIC	M24 X 3		nut 10 / screw 10.9	640

5.2 SELF-LOCKING FASTENERS

A self-locking fastener is designed with an interference fit between the nut and bolt threads. This is most often accomplished by distortion of the top thread of an all-metal nut or bolt or by using a nylon patch on the threads. A nylon insert or the use of adhesives may also be used as a method of interference between nut and bolt threads (Fig. 13).

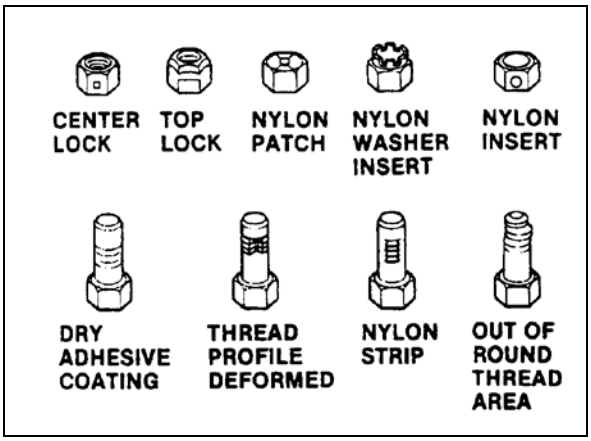


FIGURE 13 : SELF-LOCKING FASTENERS 00004

5.3 RECOMMENDATIONS FOR REUSE

Clean, rust-free self-locking fasteners may be reused as follows:

a) Clean dirt and other foreign matter from the fastener;

b) Inspect the fastener to ensure there is no crack, elongation, or other sign of fatigue or overtightening. If there is any doubt, replace with a new self-locking fastener of equal or greater strength;

c) Assemble parts and hand start fastener;

d) Observe that, before the fastener seats, it develops torque per the chart in table two. If there is any doubt, replace with a new self-locking fastener of equal or greater strength;

e) Tighten the fastener to the torque specified in the applicable section of this manual;

Fasteners which are rusty or damaged should be replaced with new ones of equal or greater strength.

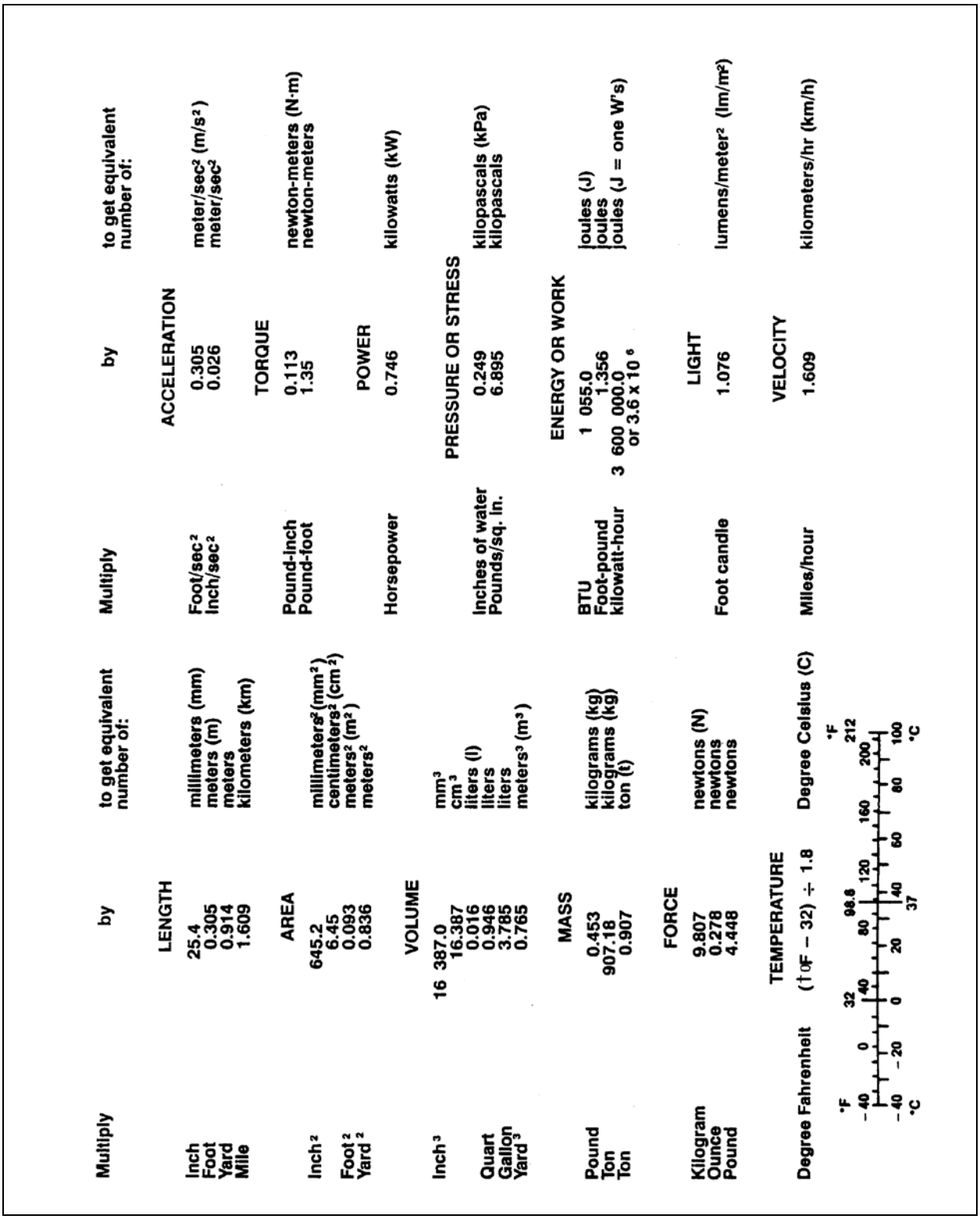
SELF-LOCKING FASTENER TORQUE CHART

METRIC		6 & 6.3	8	10	12	14	16	20
NUTS AND	Nm	0.4	0.8	1.4	2.2	3.0	4.2	7.0
ALL-METAL BOLTS	Lbf-in	4.0	7.0	12	18	25	35	57
ADHESIVE OR NYLON	Nm	0.4	0.6	1.2	1.6	2.4	3.4	5.6
COATED BOLTS	Lbf-in	4.0	5.0	10	14	20	28	46

US STANDARD		¼	5/16	3/8	7/16	½	9/16	5/8	¾
NUTS AND	Nm	0.4	0.6	1.4	1.8	2.4	3.2	4.2	6.2
ALL-METAL BOLTS	Lbf-in	4.0	5.0	12	15	20	27	35	51
ADHESIVE OR NYLON	Nm	0.4	0.6	1.0	1.4	1.8	2.6	3.4	5.2
COATED BOLTS	Lbf-in	4.0	5.0	9.0	12	15	22	28	43

5.4 SIX LOBED SOCKET HEAD

Six lobed socket head (Torx) fasteners are used in some applications on vehicles covered in this manual. The tools designed for these fasteners are available commercially. However, in some cases, if the correct tool is not available, a hex socket head wrench may be used.



Multiply	by	to get equivalent number of:
LENGTH		
Inch	25.4	millimeters (mm)
Foot	0.305	meters (m)
Yard	0.914	meters
Mile	1.609	kilometers (km)
AREA		
Inch²	645.2	millimeters² (mm²)
	6.45	centimeters² (cm²)
Foot²	0.093	meters² (m²)
Yard²	0.836	meters²
VOLUME		
Inch³	16 387.0	mm³
	16.387	cm³
	0.016	liters (l)
Quart	0.946	liters
Gallon	3.785	liters
Yard³	0.765	meters³ (m³)
MASS		
Pound	0.453	kilograms (kg)
Ton	907.18	kilograms (kg)
Ton	0.907	ton (t)
FORCE		
Kilogram	9.807	newtons (N)
Ounce	0.278	newtons
Pound	4.448	newtons
TEMPERATURE		
Degree Fahrenheit	(†°F – 32) ÷ 1.8	Degree Celsius (C)

Multiply	by	to get equivalent number of:
ACCELERATION		
Foot/sec²	0.305	meter/sec² (m/s²)
Inch/sec²	0.026	meter/sec²
TORQUE		
Pound-inch	0.113	newton-meters (N·m)
Pound-foot	1.35	newton-meters
POWER		
Horsepower	0.746	kilowatts (kW)
PRESSURE OR STRESS		
Inches of water	0.249	kilopascals (kPa)
Pounds/sq. in.	6.895	kilopascals
ENERGY OR WORK		
BTU	1 055.0	joules (J)
Foot-pound	1.356	joules
kilowatt-hour	3 600 000.0 or 3.6 x 10 ⁶	joules (J = one W's)
LIGHT		
Foot candle	1.076	lumens/meter² (lm/m²)
VELOCITY		
Miles/hour	1.609	kilometers/hr (km/h)

FIGURE 14: METRIC - US STANDARD CONVERSION TABLE

00005

DECIMAL AND METRIC EQUIVALENTS

FRACTIONS	DECIMAL IN.	METRIC MM	FRACTIONS	DECIMAL IN.	METRIC MM
1/64	.015625	.39688	33/64	.515625	13.09687
1/32	.03125	.79375	17/32	.53125	13.49375
3/64	.046875	1.19062	35/64	.546875	13.89062
1/16	.0625	1.58750	9/16	.5625	14.28750
5/64	.078125	1.98437	37/64	.578125	14.68437
3/32	.09375	2.38125	19/32	.59375	15.08125
7/64	.109375	2.77812	39/64	.609375	15.47812
1/8	.125	3.1750	5/8	.625	15.87500
9/64	.140625	3.57187	41/64	.640625	16.27187
5/32	.15625	3.96875	21/32	.65625	16.66875
11/64	.171875	4.36562	43/64	.671875	17.06562
3/16	.1875	4.76250	11/16	.6875	17.46250
13/64	.203125	5.15937	45/64	.703125	17.85937
7/32	.21875	5.55625	23/32	.71875	18.25625
15/64	.234375	5.95312	47/64	.734375	18.65312
1/4	.250	6.35000	3/4	.750	19.05000
17/64	.265625	6.74687	49/64	.765625	19.44687
9/32	.28125	7.14375	25/32	.78125	19.84375
19/64	.296875	7.54062	51/64	.796875	20.24062
5/16	.3125	7.93750	13/16	.8125	20.63750
21/64	.328125	8.33437	53/64	.828125	21.03437
11/32	.34375	8.73125	27/32	.84375	21.43125
23/64	.359375	9.12812	55/64	.859375	21.82812
3/8	.375	9.52500	7/8	.875	22.22500
25/64	.390625	9.92187	57/64	.890625	22.62187
13/32	.40625	10.31875	29/32	.90625	23.01875
27/64	421875	10.71562	59/64	.921875	23.41562
7/16	.4375	11.11250	15/16	.9375	23.81250
29/64	.453125	11.50937	61/64	.953125	24.20937
15/32	.46875	11.90625	31/32	.96875	24.60625
31/64	.484375	12.30312	63/64	.984375	25.00312
1/2	.500	12.70000	1	1.00	25.40000

FIGURE 15: CONVERSION CHART 00006

PREVOST

MULTIPLEX MODULES DISCONNECTION PROCEDURE PRIOR TO WELDING

PROCEDURE NO: PR060041	REVISION 01 2010-12-01

Material: N/A

Equipment(s): Phillips-head screwdriver
Ratchet handle
3/8" socket
Electric tape
Long nose pliers

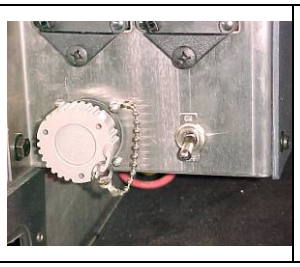
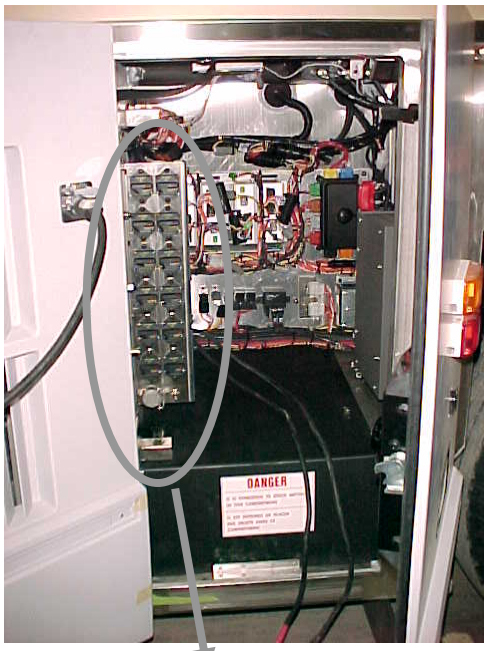
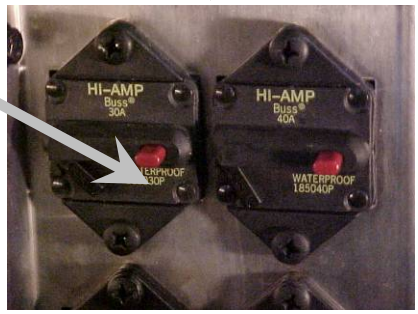
Reference schematics: N/A

Safety rules: - Wear safety goggles
- Set the battery master switch to the OFF position first

Recommendations: **This procedure should be performed by qualified personnel only.**

	Effective
Revision 00 : New procedure for cooling 2007 **Revision 01 : Modified for EPA 2010**	

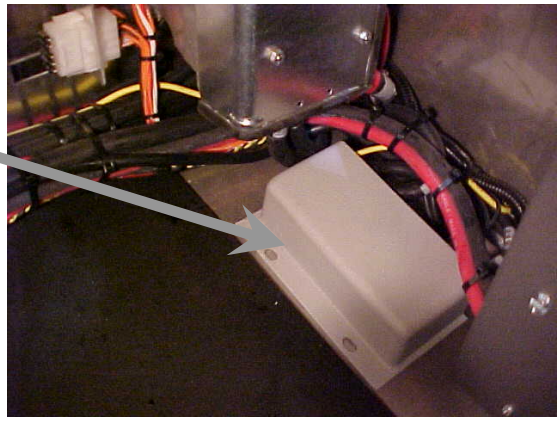
SECTION 1 H3 Coaches & VIP

1.00	**Location: Main power compartment and dashboard.** Set the battery master switch to the OFF position. Place the ignition switch to the OFF position.	 
1.05	**Location: Main power compartment** Trip rear junction box circuit breakers CB2, CB4, CB6 Push the red button to open the circuit	 

1.10

Location: Main power compartment

Remove the protective cover

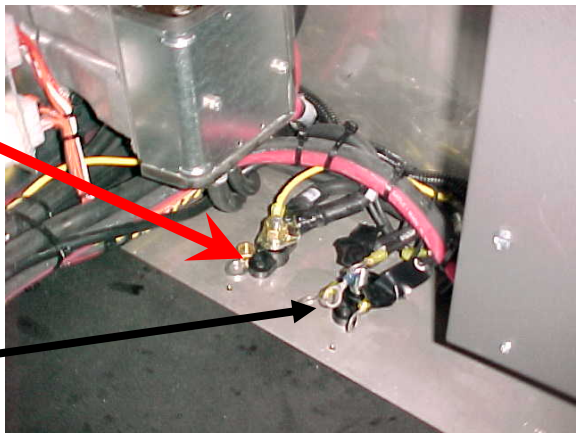


⚠ WARNING ⚠

LIVE WIRE

This 12-volt terminal remains energized

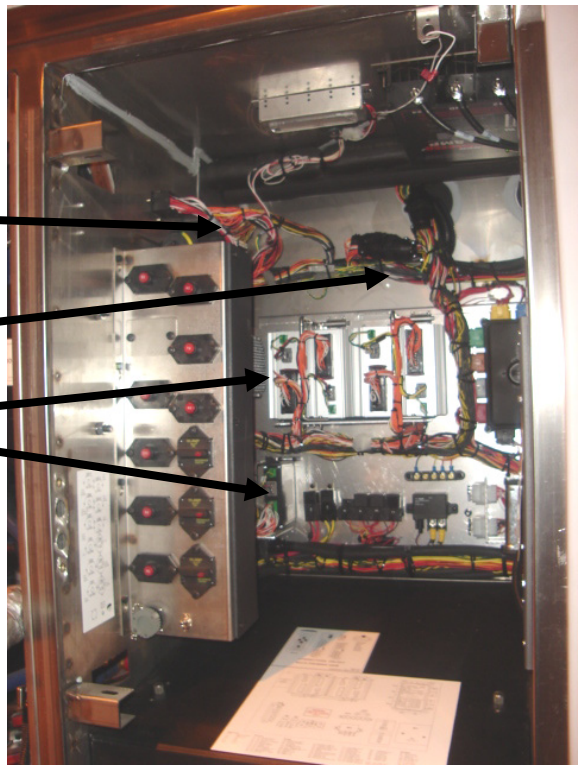
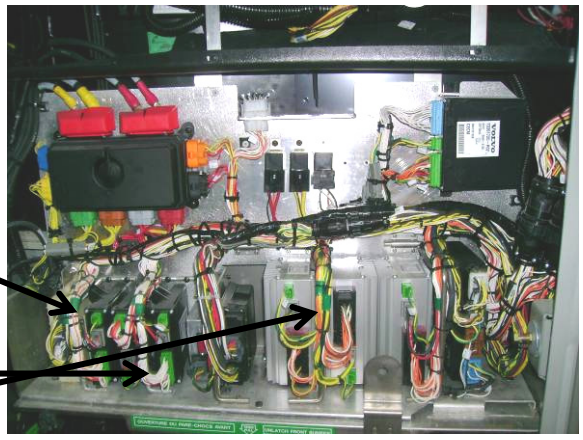
Disconnect the electronic ground terminals from the stud.

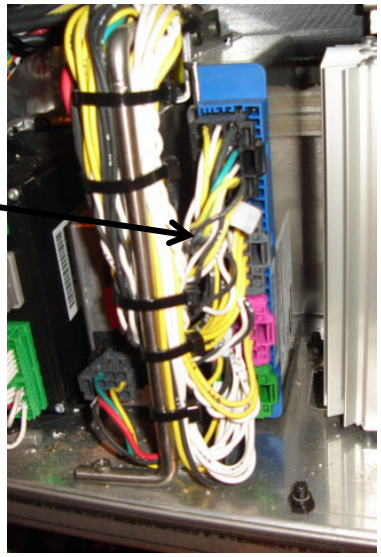
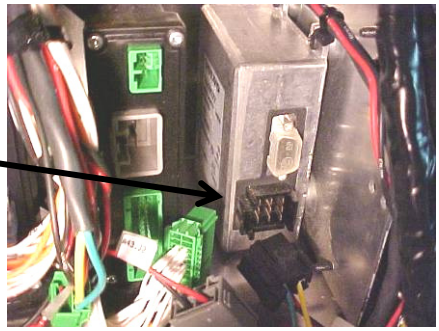
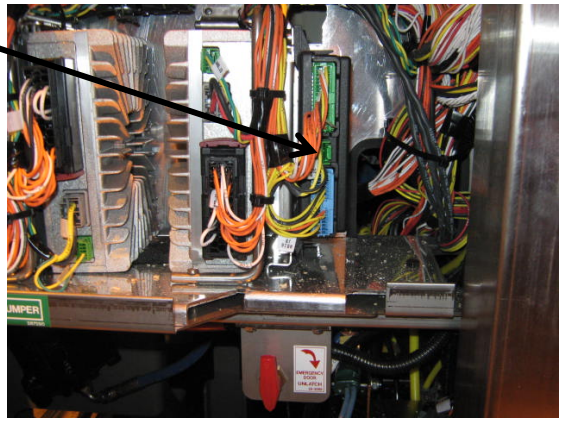


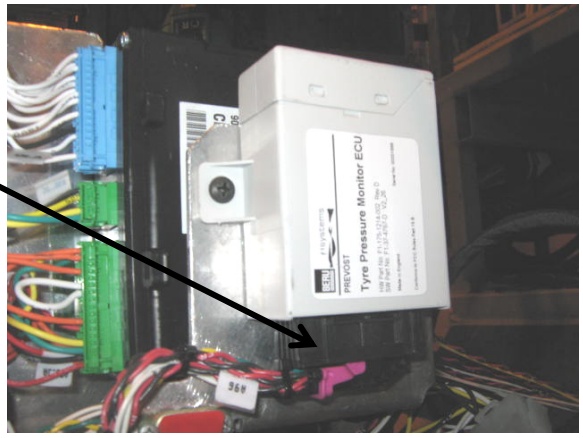
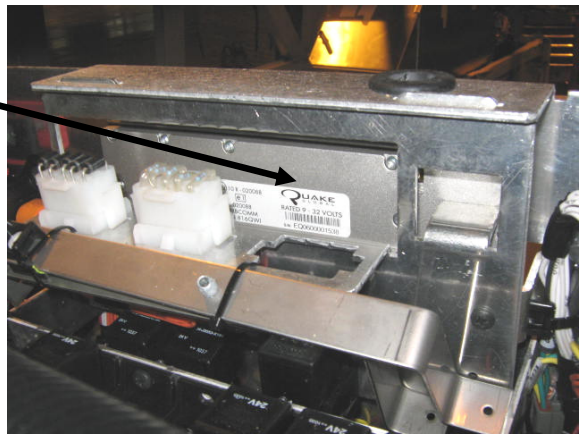
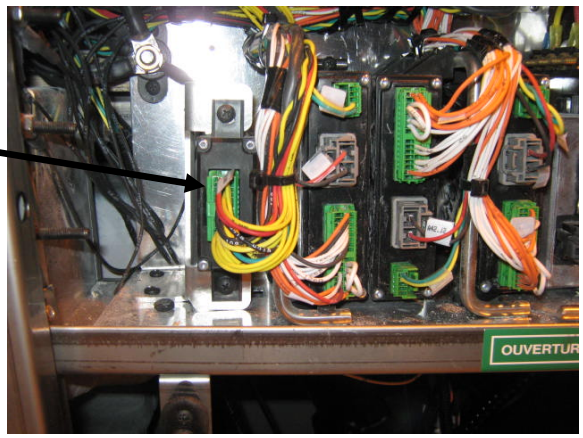
Using electric tape, insulate the 2 largest gage wires. Make sure the ring terminals do not touch each others and the vehicle body.

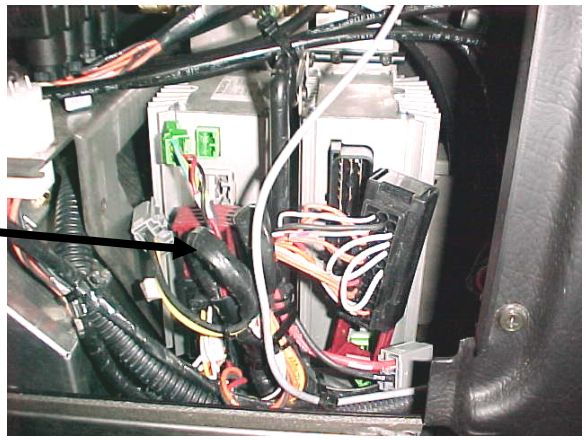
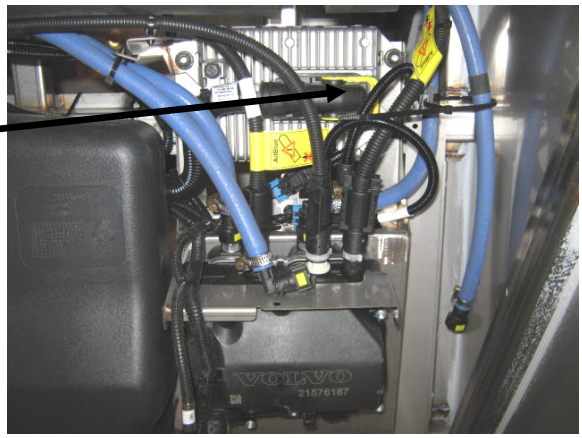
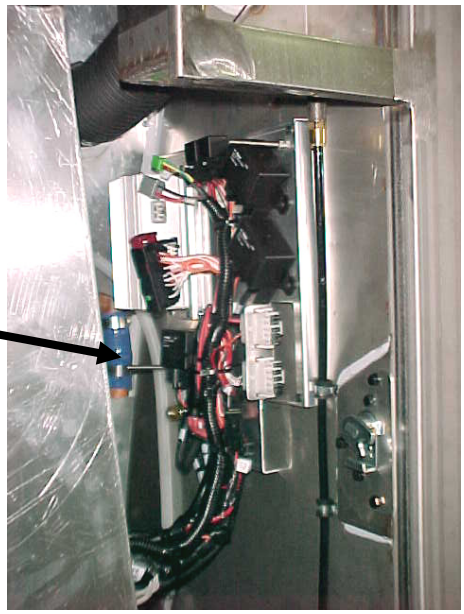
Note :

With disconnection of the electronic ground terminals, disconnecting the engine ECM, transmission TCM and the dashboard electronic components (telltale module, HVAC module, radio, control head …) is not required.

1.15	**Location: Main power compartment** Disconnect the electronic modules : Disconnect I/O A, I/O B modules Disconnect C397 Disconnect connector C717 Disconnect 3 connectors from I/O B and I/O A modules.	
1.20 *	**Location: Front electrical compartment** **VIP + COACH:** Disconnect the I/O A, I/O B, ABS, master ID, VECU, CECM, BERU, Volvo Link, Gsecu modules. **VIP:** Disconnect all keyless module connectors. Disconnect 3 connectors from I/O B and I/O A modules	

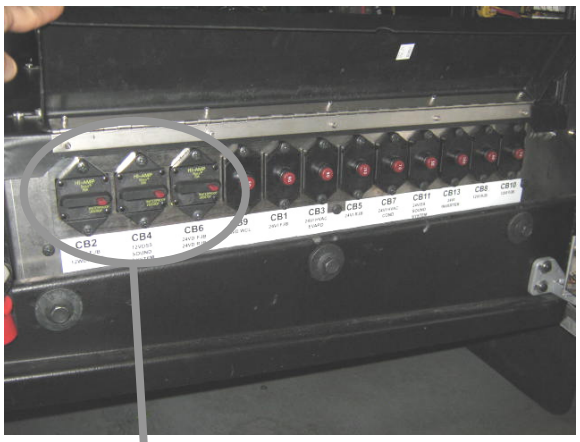
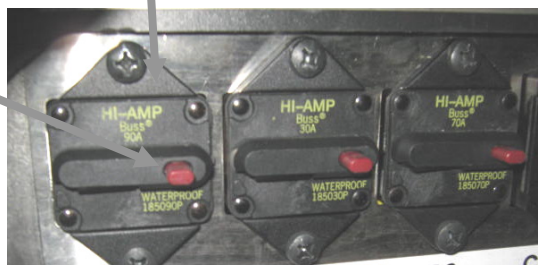
	Disconnect 4 connectors from the ABS module	
	Disconnect connector from master ID	
	Disconnect 3 connectors from VECU	
	Disconnect 3 connectors from CECM	

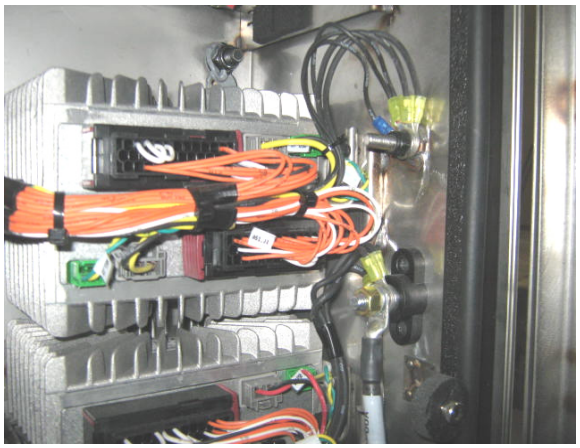
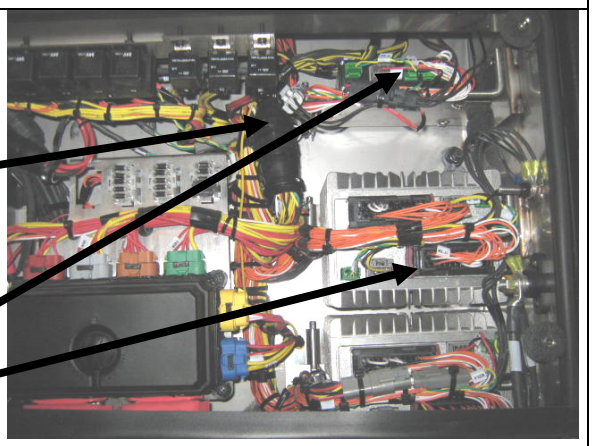
	Disconnect connector A 96 from BERU (OPTION)	
	Disconnect connector A 83 under Volvo Link module	
	I shift Disconnect connector A 108 from Gsecu module (OPTION)	

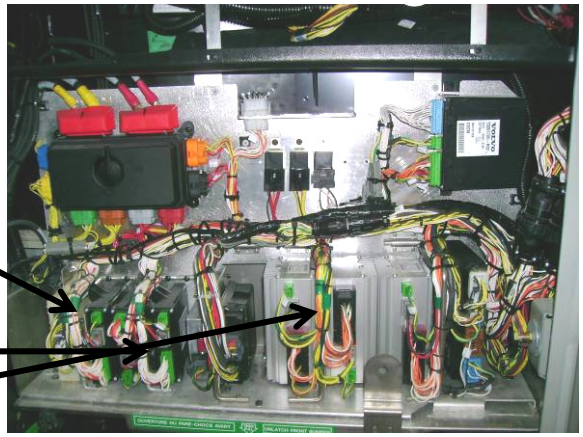
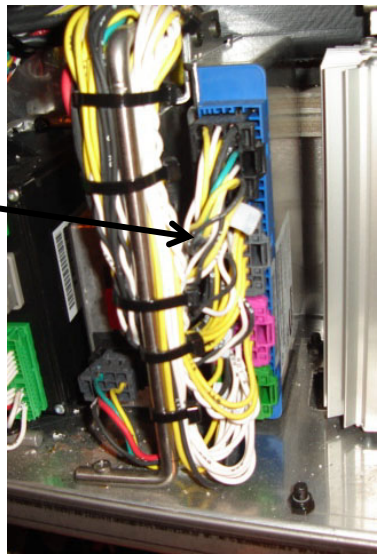
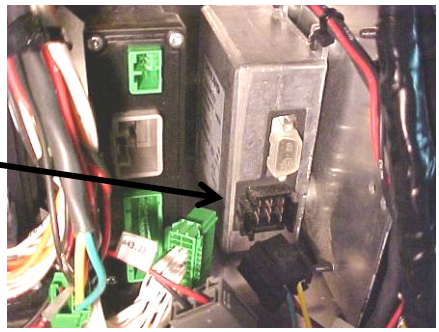
1.25	**Location: Pneumatic accessory panel inside right console** Remove the access panel on the right console (R.H. side of dashboard) Disconnect both I/O B modules	
1.30 *	**Location: Condenser Compartment** Disconnect connector A 137	
1.35	**Location: Evaporator compartment** Remove the protective cover and disconnect I/O B module	

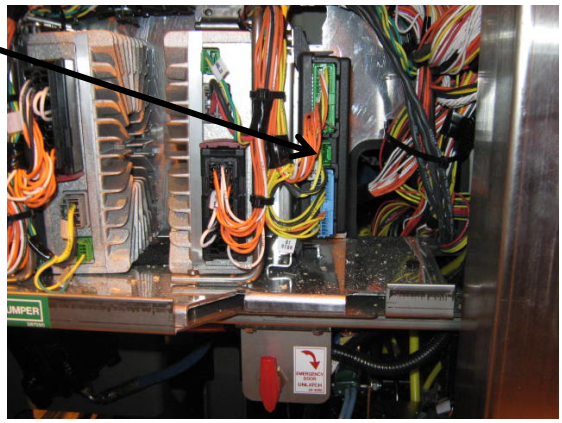
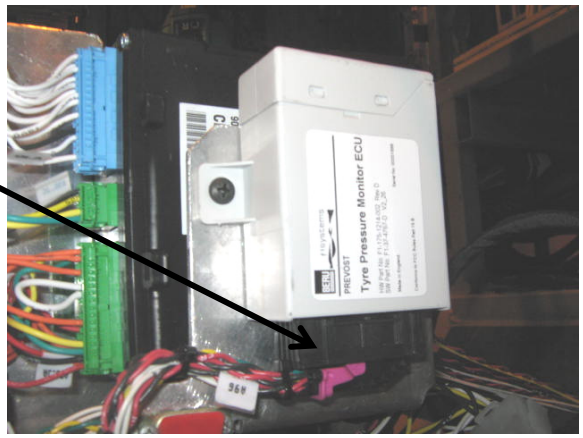
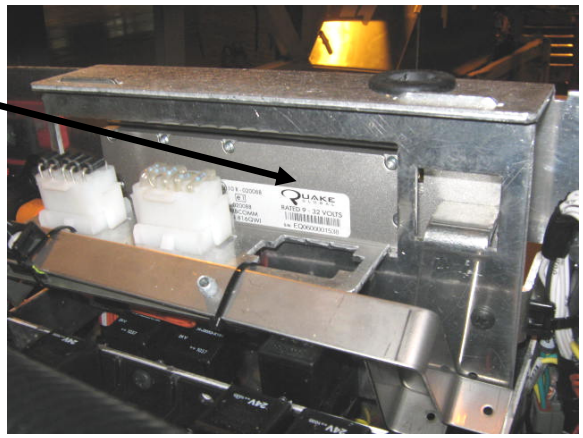
1.40	**Kidde Automatic Fire Detection and Suppression System (optional)**	
	Disconnect C466 Kidde AFSS module is located on the lateral control panel.	
1.45	When all the previous steps are done, you can do welding on the vehicle.	**ENSURE THAT THE WELDING GROUND RETURN CLAMP IS WELL SECURED AND MAKES A GOOD ELECTRICAL CONTACT WITH A LARGE METALLIC AREA OF THE CHASSIS LOCATED NEAR THE WELDING POINT AS MUCH AS POSSIBLE.**
1.50	**When welding is completed, reconnect all the modules.** Make sure that the connectors locking tab are well engaged!	**BE CAREFUL TO MAKE THE PROPER CONNECTIONS, IF NOT, SOME SYSTEMS OR COMPONENTS MAY NOT BE USABLE.**

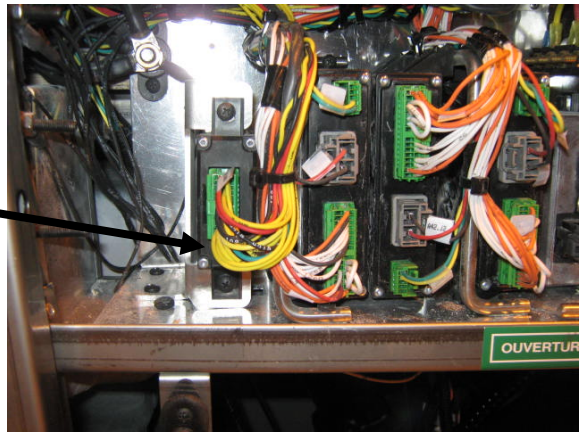
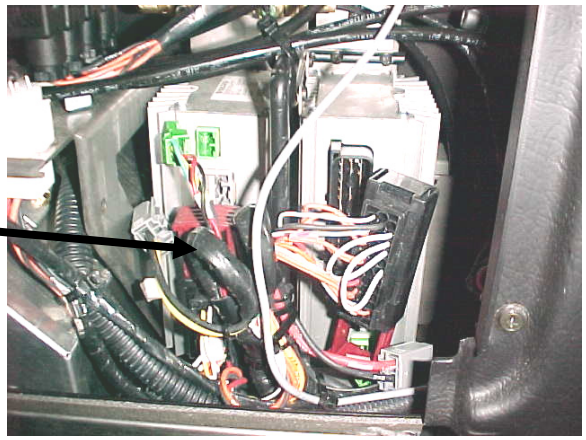
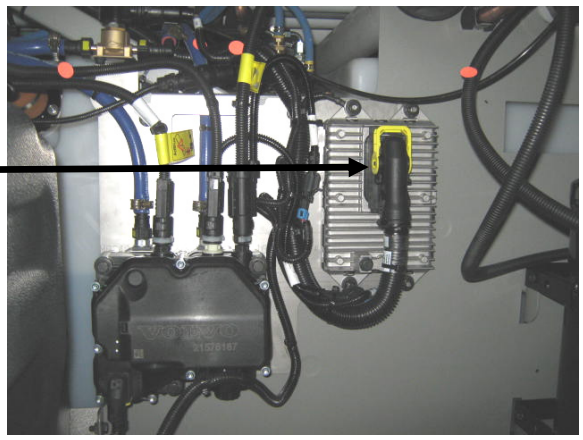
SECTION 2 X3 Coaches, X3-45 VIP & XLII Bus Shells

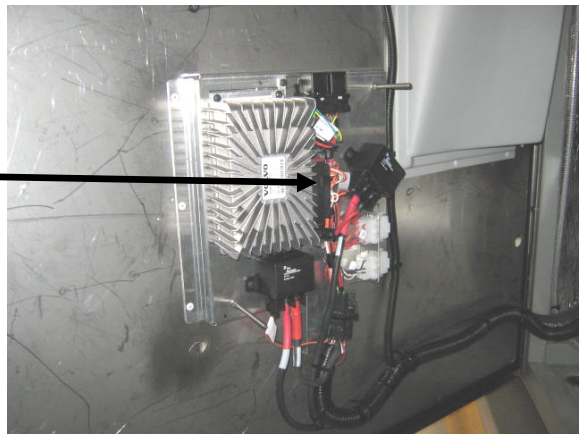
2.00*	**Location: Rear Electrical Panel and Dashboard** Set the battery master switch to the OFF position **(X3 Coaches only)** Place the ignition switch to the OFF position.	 
2.05*	**Location: Rear Junction Panel** Lift cover, trip circuit breakers CB2-CB4-CB6 located on junction panel. Push the red button to open the circuit	 

2.10*	**Location: Rear Electrical Panel** Disconnect the electronic ground terminals from this stud. Use electric tape; make sure that cables do not touch each others and the vehicle body. ***Note :*** ***With disconnection of the electronic ground terminals, disconnecting the engine ECM, transmission TCM and the dashboard electronic components (telltale module, HVAC module, radio, control head …) is not required.***	
2.15*	**Location: Rear Electrical Panel** Disconnect the electronic modules: Disconnect all I/O A, I/O B modules. Disconnect C717 Disconnect 3 connectors from each I/O A module Disconnect 3 connectors from each I/O B module Disconnect C397	 

2.20 *	**Location: Front Electrical Compartment** **VIP + BUS:** Disconnect the I/O A, I/O B, ABS, master ID, VECU, CECM, BERU, Volvo Link, Gsecu modules. **VIP :** Disconnect all keyless module connectors Disconnect 3 connectors from I/O B and I/O A modules	
	Disconnect 4 connectors from the ABS module	
	Disconnect connector from master ID	

	Disconnect 3 connectors from VECU	
	Disconnect 3 connectors from CECM	
	Disconnect connector A 96 from BERU (option)	
	Disconnect connector A 83 under Volvo Link module	

	Location: Front Electrical Compartment **I shift** Disconnect connector A 108 from Gsecu module (OPTION)	
2.30	**Location: Pneumatic accessory panel inside right console** Remove the access panel on the right console (R.H. side of dashboard) Disconnect both I/O B modules	
2.40	**Location: Condenser Compartment** Disconnect connector A 137	

2.50	**Location: Evaporator Compartment** Disconnect A 54 module located inside the evaporator compartment, on the door.	
2.60	When all the previous steps are done, you can do welding on the vehicle.	**ENSURE THAT THE WELDING GROUND RETURN CLAMP IS WELL SECURED AND MAKES A GOOD ELECTRICAL CONTACT WITH A LARGE METALLIC AREA OF THE CHASSIS LOCATED NEAR THE WELDING POINT AS MUCH AS POSSIBLE.**
2.70	**When welding is completed, reconnect all the modules.** Make sure that the connectors locking tab are well engaged!	**BE CAREFUL TO MAKE THE PROPER CONNECTIONS, IF NOT, SOME SYSTEMS OR COMPONENTS MAY NOT BE USABLE**.

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1. VOLVO D13 ENGINE

1.1 SYSTEM OVERVIEW

NOTE
The "Premium Tech Tool" (PTT) is the preferred tool for performing diagnostic work. Contact your local dealer for more information.

The Engine Management System (EMS) controls many engine functions such as: fuel timing and delivery, engine protection functions, engine brake operation, EGR valve function and the turbocharger nozzle function. The Engine Electronic Control Unit (EECU) along with other supporting control units and sensors are responsible for monitoring and controlling these functions. These control units communicate through the J1939 high speed serial data line to share data.

In addition to their control functions, the modules have on-board diagnostic capabilities. The on-board diagnostics are designed to detect faults or abnormal conditions that are not within their operating parameters. When the system detects a fault or abnormal condition, the fault will be logged in one or both of the modules' memory. The vehicle operator will be advised that a fault has occurred by the illumination of a malfunction indicator lamp and a message in the driver information display, if equipped. The module may initiate the engine shutdown procedure if the system determines that the abnormal condition could damage the engine. In some situations, the system will enter the "limp home" mode. Limp home mode allows continued vehicle operation but, the system may substitute a sensor or signal value that may result in reduced engine performance.

Fault codes logged in the system memory, can later be read to aid in diagnosing the fault. These faults can be read via a diagnostic computer or through the instrument cluster display, if equipped. The "Premium Tech Tool" (PTT) is the preferred tool for performing diagnostic work. Using a diagnostic computer (or PTT) connected to the Serial Communication Port, expands the technicians diagnostic capabilities with additional data and tests.

For diagnostic software, contact your local dealer.

The following is a list of engine sensors that provide input to the EMS:

- Ambient Air Temperature Sensor
- Ambient Pressure sensor
- Boost Air Pressure (BAP) Sensor
- Camshaft Position (Engine Position) Sensor
- Crankshaft Position (Engine Speed) Sensor
- Differential Pressure DPF Sensor
- EGR Differential Pressure Sensor
- EGR Temperature Sensor
- Engine Coolant Level (ECL) Sensor
- Engine Coolant Temperature (ECT) Sensor
- Engine Oil Pressure (EOP) Sensor
- Engine Oil Level (EOL) Sensor
- Engine Oil Temperature (EOT) Sensor
- Exhaust Temperature Sensor (DPF Sensors)
- Fuel Pressure Sensor
- Intake Air Temperature And Humidity (IATH) Sensor
- Intake Manifold (Boost) Temperature Sensor
- Throttle Position (TP) Sensor
- Turbo Speed Sensor
- Variable Geometry Turbocharger (VGT) Position Sensor

Sensors

Ambient Air Temperature Sensor

The Ambient Air Temperature Sensor is used to detect the outside air temperature. The sensor modifies a voltage signal from the ECM. The modified signal returns to the ECM as the ambient air temperature. The sensor uses a thermistor that is sensitive to the change in temperature. The electrical resistance of the thermistor decreases as temperature increases.

The Ambient Air Temperature Sensor is located in the front of the vehicle.

Ambient (Atmospheric) Pressure Sensor

The Ambient (Atmospheric) Pressure Sensor contains a pressure sensitive diaphragm and an electrical amplifier. Mechanical pressure applied to the diaphragm causes the diaphragm to deflect and the amplifier to produce an electrical signal proportional to the deflection.

The Ambient (Atmospheric) Pressure Sensor is built into the Engine Management System (EMS) Module.

Camshaft Position Sensor

The Camshaft Position (Engine Position) Sensor is located in the rear face of the timing gear cover at the rear of the engine, near the bottom of the valve cover. It uses magnetic induction to generate a pulsed electrical signal. It senses the passage of seven (7) timing bumps on the edge of the camshaft dampener. Six of the holes correspond to the phasing of the electronic unit injectors, while the seventh hole indicates the top dead center position.

Crankshaft Position (Engine Speed) Sensor

The Crankshaft Position (Engine Speed) Sensor uses magnetic induction to generate a pulsed electrical signal. Notches are machined into the edge of the flywheel. When one of the notches passes close to the sensor, electric pulses result.

The Crankshaft Position (Engine Speed) Sensor also indicates when the crankshaft is at the top dead center position.

Differential Pressure DP Sensor

The differential pressure sensor is used for flow measurement of the Diesel Particulate Filter (DPF). This sensor has two pressure ports and senses the difference in pressure between the two ports. Measurement of the pressure before and after the DPF is used to calculate diesel filter regeneration.

The Differential Pressure DPF Sensor is located on the side of the Diesel Particulate Filter (DPF).

EGR Differential Pressure Sensor

The EGR differential pressure sensor is used for flow measurement of the Exhaust Gas Recirculation (EGR) valve. This sensor has two pressure ports and senses the difference in pressure between the two ports. Measurement of the pressure before and after the EGR valve is used to calculate EGR flow.

The EGR Differential Pressure Sensor is located on the left or right side of the engine.

EGR Temperature Sensor

The EGR temperature sensor detects exhaust gas temperature for EGR system. The sensor modifies a voltage signal from the control unit. The modified signal returns to the control unit as the exhaust temperature of the EGR system to confirm EGR operation. The sensor uses a thermistor that is sensitive to the change in temperature.

The EGR Temperature Sensor is located near the EGR valve.

Engine Coolant Level (ECL) Sensor

The Engine Coolant Level (ECL) Sensor is a switch. If engine coolant level falls below a calibrated point the contacts open and the driver will be notified of the low coolant level.

The Engine Coolant Level (ECL) Sensor is located in the cooling system reservoir tank.

Engine Coolant Temperature (ECT) Sensor

The Engine Coolant Temperature Sensor is located at the front of the engine. The sensor will indicate a high coolant temperature caused by problems like radiator blockage, thermostat failure, heavy load, or high ambient temperatures. This sensor is also used for cold start enhancement and for fan clutch engagement.

Engine Oil Pressure (EOP) Sensor

The Engine Oil Pressure Sensor contains a pressure sensitive diaphragm and a electrical amplifier. Mechanical pressure applied to the diaphragm causes the diaphragm to deflect and the amplifier to produce an electrical signal proportional to the deflection.

The Engine Oil Pressure Sensor is located on the oil filter assembly. The sensor monitors engine oil pressure to warn of lubrication system failure.

Engine Oil Level (EOL) Sensor

The Engine Oil Level Sensor is located in the oil pan.

Engine Oil Temperature (EOT) Sensor

The Engine Oil Temperature Sensor is a thermistor whose resistance varies inversely to temperature. The sensor has a negative temperature coefficient, which means the sensor resistance will decrease as the engine oil temperature increases.

The Engine Oil Temperature Sensor is located in the oil pan.

Exhaust Temperature Sensor (DPF Sensors)

The exhaust gas temperature sensor detects exhaust gas temperature for DPF protection as well as DPF regeneration control. The sensor modifies a voltage signal from the control unit. The modified signal returns to the control unit as the exhaust temperature at that specific location of the exhaust. The sensor uses a thermistor that is sensitive to the change in temperature.

The Exhaust Temperature Sensors are located in the DPF assembly.

Fuel Pressure Sensor

The fuel pressure sensor contains a diaphragm that senses fuel pressure. A pressure change causes the diaphragm to flex, inducing a stress or strain in the diaphragm. The resistor values in the sensor change in proportion to the stress applied to the diaphragm and produces an electrical output.

The Fuel Pressure Sensor is located on top of the fuel filter housing.

Intake Air Temperature and Humidity (IATH) Sensor

The Intake Air Temperature and Humidity (IATH) Sensor contains a thermistor and a capacitive sensor. The resistance of the thermistor varies inversely to temperature. The output of the capacitive sensor increases as the humidity of the surrounding air increases. By monitoring the signals from both portions of the sensor, the Engine Management System (EMS) Module calculates the temperature and humidity of the air passing through the air filter housing.

The Intake Air Temperature and Humidity (IATH) Sensor is located in the air intake tube just downstream from the air filter canister.

Intake Manifold (Boost) Temperature Sensor

The Intake Manifold (Boost) Temperature Sensor is a thermistor whose resistance varies inversely to temperature. The sensor has a negative temperature coefficient, which means the sensor resistance will decrease as the inlet air temperature increases.

The Intake Manifold (Boost) Temperature Sensor is located in the intake manifold.

Intake Manifold Pressure Sensor

The Intake Manifold Pressure Sensor contains a pressure sensitive diaphragm and an electrical amplifier. Mechanical pressure applied to the diaphragm causes the diaphragm to deflect and the amplifier to produce an electrical signal proportional to the deflection.

The Intake Manifold Pressure Sensor is located on the air inlet pipe before the intake manifold.

Throttle Position (TP) Sensor

The Throttle Position Sensor is a potentiometer that is mechanically linked to the accelerator pedal. A potentiometer is a variable resistor whose resistance will change as the pedal is pressed. As the resistance changes, the signal voltage of the sensor changes indicating the accelerator pedal position.

The Throttle Position Sensor is located above the accelerator pedal. The sensor is designed to improve the driver's control by reducing sensitivity to chassis motion. This sensor provides the driver's fuel request input to the VECU.

Turbo Speed Sensor

The Turbo Speed Sensor informs the EMS of the turbo shaft speed. The sensor does not read from the vanes, but reads from the shaft. The Engine Management System (EMS) Module uses this signal in conjunction with the VGT position sensor signal to control the speed of the turbocharger and therefore optimize the intake manifold pressure.

The Turbo Speed Sensor is mounted in the center of the turbocharger.

Variable Geometry Turbocharger Smart Remote Actuator (VGT SRA)

The Variable Geometry Turbocharger Smart Remote Actuator (VGT SRA) takes the position commands from the EMS, moves the nozzle of the turbocharger to the desired position, and performs all of the diagnostics and self checks on the actuator.

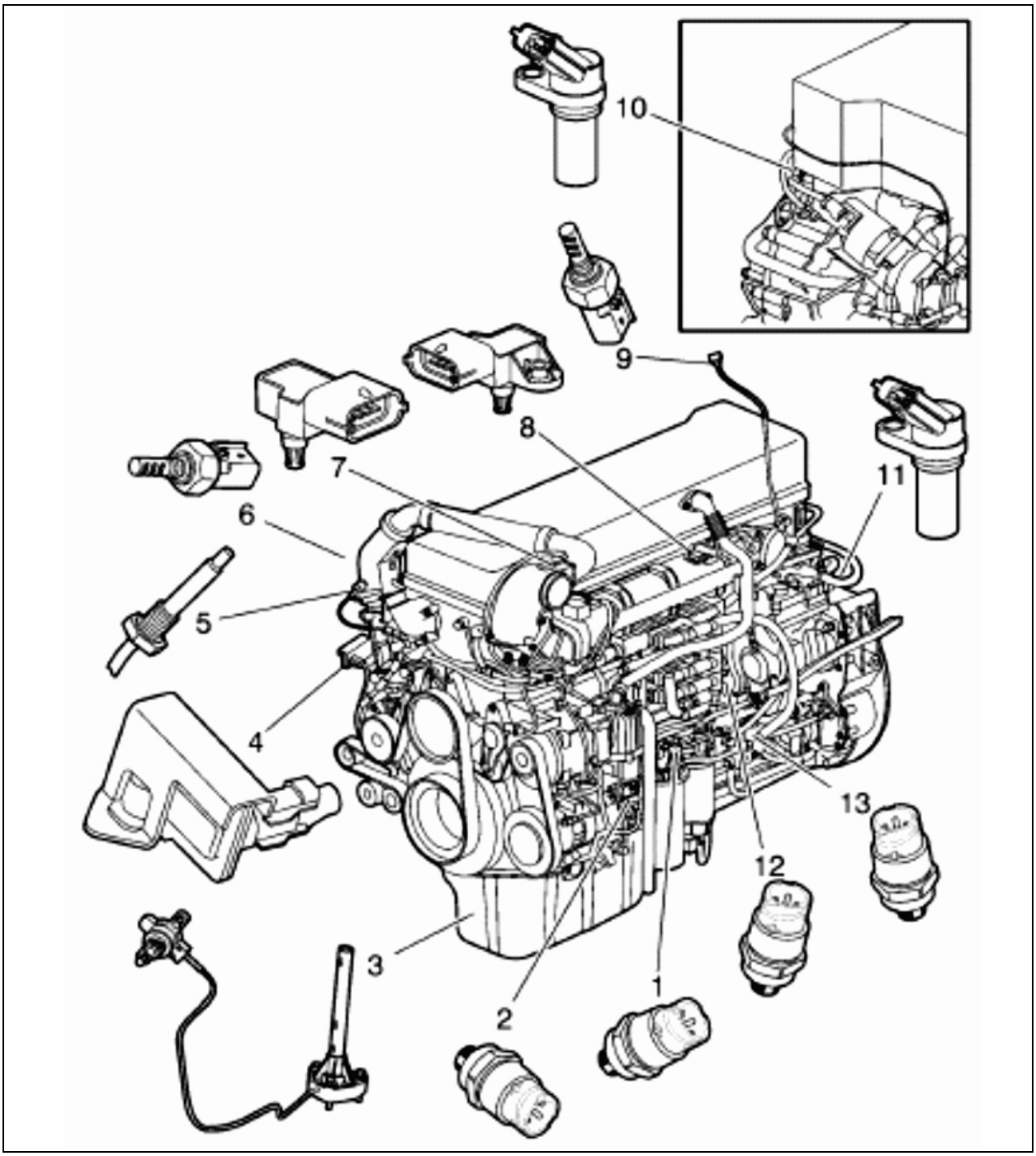


FIGURE 1: ENGINE SENSORS LOCATION

1	Fuel Pressure	8	Air Temperature
2	Crankcase Pressure	9	Humidity/Ambient Air Temperature
3	Oil Level/Temperature	10	Camshaft Speed
4	EGR Differential Pressure	11	Crankshaft Speed
5	EGR Temperature	12	Oil Pressure
6	Coolant Temperature	13	AFI Fuel Pressure
7	Boost Pressure		

1.2 ENGINE OVERVIEW

NOTE
For maintenance on or repair of engine components or engine-related components, please refer to Volvo Trucks Canada or Volvo Trucks North America Web Site under: Parts & Service, purchase engine literature, D13F engine.

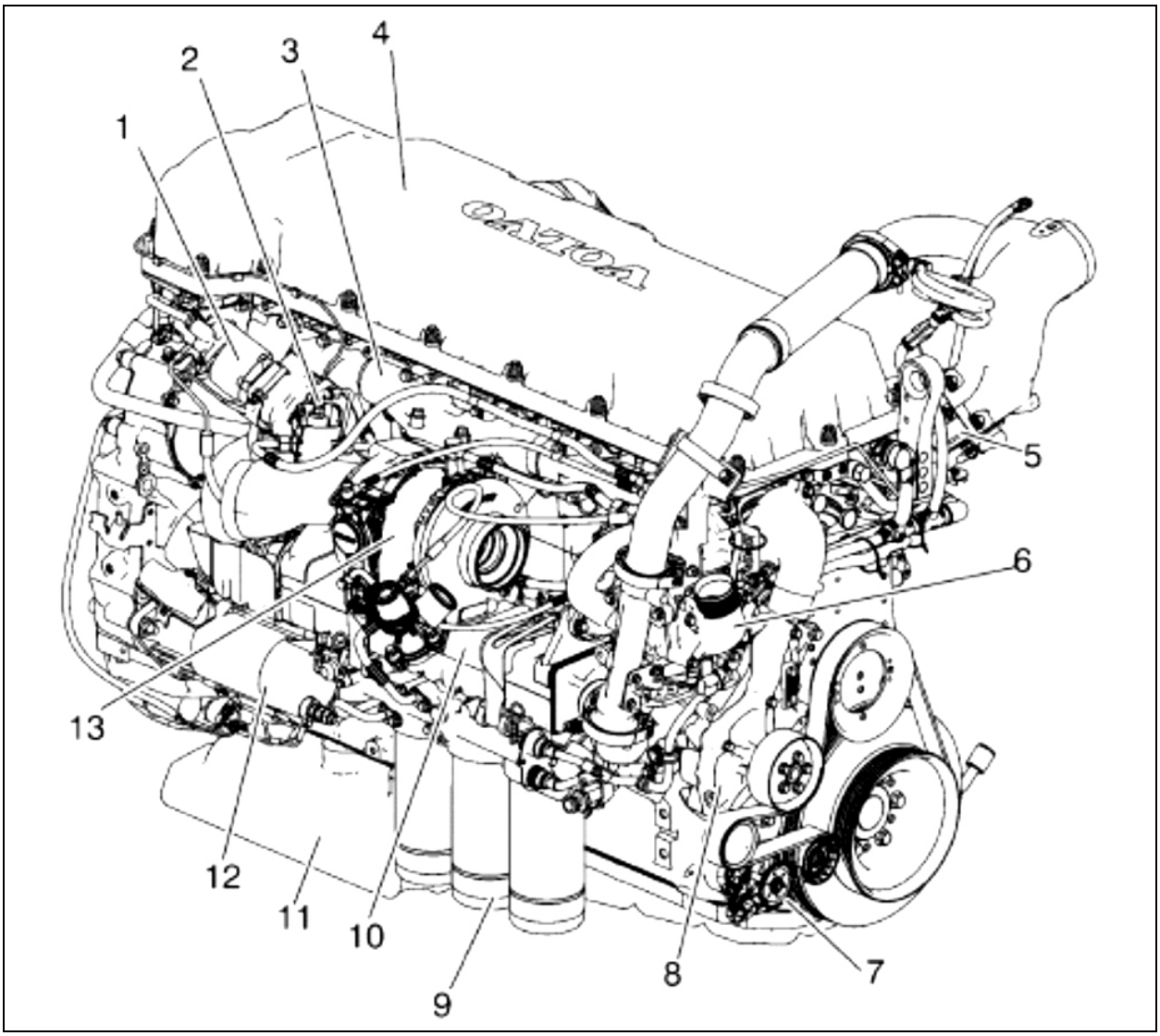


FIGURE 2: D13F ENGINE, TURBO SIDE (TYPICAL)

1. EGR Valve	**8. Coolant Pump**
2. Aftertreatment Fuel Injector	**9. Oil Filters**
3. Exhaust Manifold	**10. EGR Cooler**
4. Valve Cover	**11. Oil Pan**
5. Engine Preheater Element	**12. Starter Motor**
6. Thermostat Cover	**13. Turbocharger**
7. Belt Tensioner	

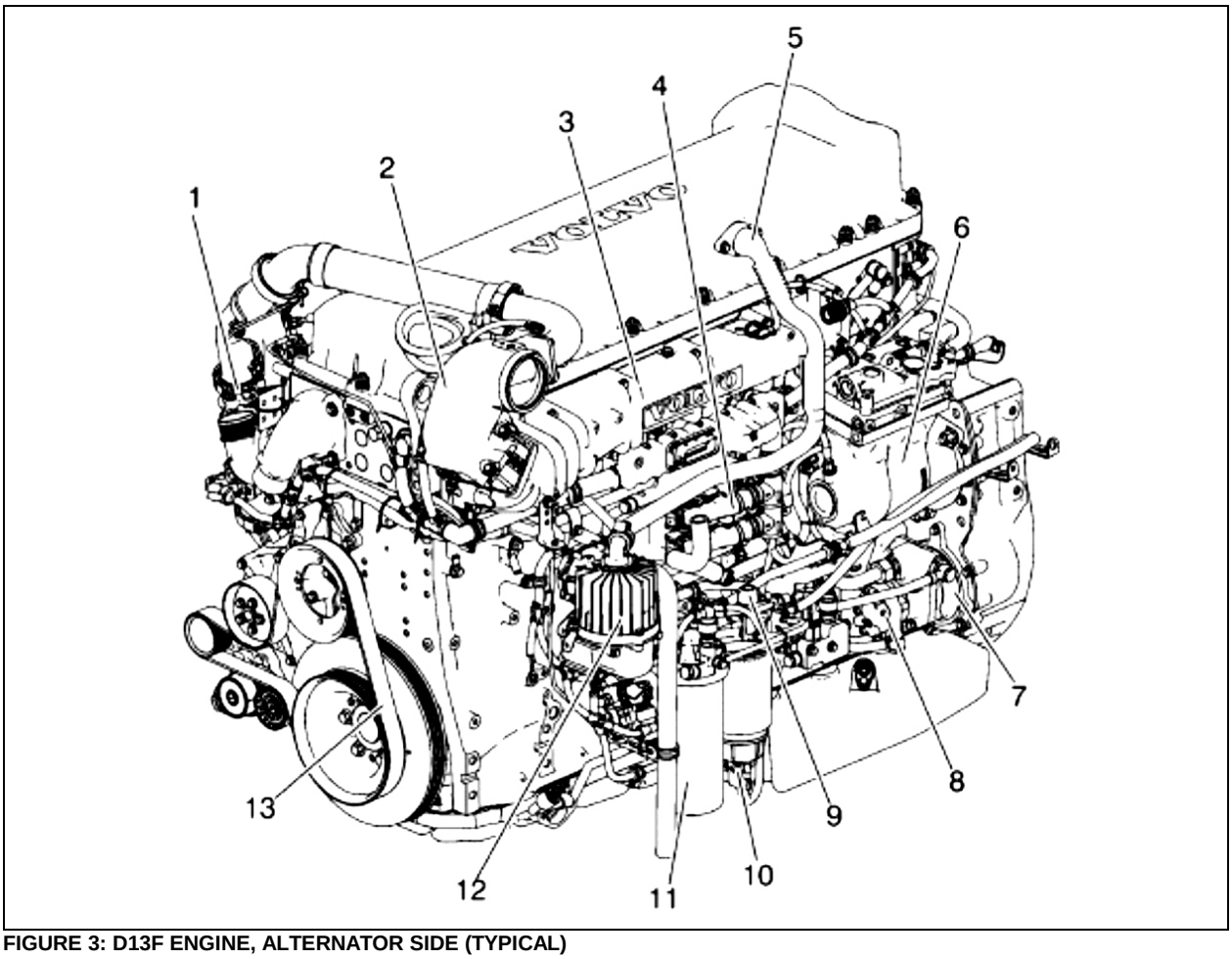


FIGURE 3: D13F ENGINE, ALTERNATOR SIDE (TYPICAL)

1. Venturi Pipe	**8. Fuel Pump**
2. EGR Mixing Chamber	**9. Hand Primer**
3. Intake Manifold	**10. Fuel/Water Separator**
4. Engine Electronic Control Unit (EECU)	**11. Fuel Filter**
5. Breather Tube	**12. Crankcase Ventilator**
6. Air Compressor	**13. Fan/Coolant Pump Belt**
7. Power Steering Pump	

1.3 ENGINE OIL

1.3.1 General

Keep the engine oil at the proper level and change it at the recommended intervals. Always replace the oil filters at the same time as when the oil is changed.

1.3.2 Oil Quality

Volvo North America recognizes engine oils that meet or exceed the standards given by American Petroleum Institute (API) for the oil classifications listed in this manual. Only oils licensed to carry the API symbol should be used. Lubricants meeting API standards have provided maximum engine life when used together with the recommended oil and oil filter change intervals.

EO-O Premium Plus (or VDS-4) diesel engine oil is mandatory for use in all 2010 emission compliant Volvo engines. These engines, which can be identified by the presence of an exhaust aftertreatment system using Selective Catalytic Reduction (SCR), also require the use of Ultra Low Sulfur Diesel (ULSD) fuel. EO-O Premium Plus oils exceed the new API service category CJ-4.

CAUTION

DO NOT add extra oil additives. Additives such as break-in oils, top oils, graphitizers, and friction-reducing liquids are not necessary and can harm the engine.

1.3.3 Oil Change Intervals

The length of time an engine can operate before an oil change depends on the quality oil used, the type of fuel used, fuel consumption, engine oil consumption, vehicle application, level of dust in the air, and fuel consumption. The change intervals given in this manual are maximum intervals. If the vehicle is operating in heavy-duty operation, dusty or off-road conditions, etc., reduce the intervals for more frequent oil changes.

NOTE

Use the information in the table below to determine the operating condition and usage applicable to your vehicle.

Engine Operating Condition	Medium	Heavy	Severe
Total Fuel Consumption (mpg)	More than 6	More than 4.7	More than 3.7
Total Fuel Consumption (L/100 KM)	Less than 39	Less than 50	Less than 64
Engine Oil and Filter Change Interval, miles (km) – 41 U.S. quarts (39L) Oil capacity	35,000 (55 000)	25,000 (40 000)	15,000 (24 000)
NOTE: If idle time is greater than 25%, use the next lower drain interval.			

NOTE

Oil filters should always be changed when changing the oil.

1.3.4 Oil Filters

There are three filters on the engine, one of which is a bypass filter. This should be changed at the same time as the full-flow filter(s).

CAUTION

Volvo branded oil filters are designed to provide the proper level of filtration and protection for Volvo engines. Filters that do not meet the same stringent requirements may void engine warranty.

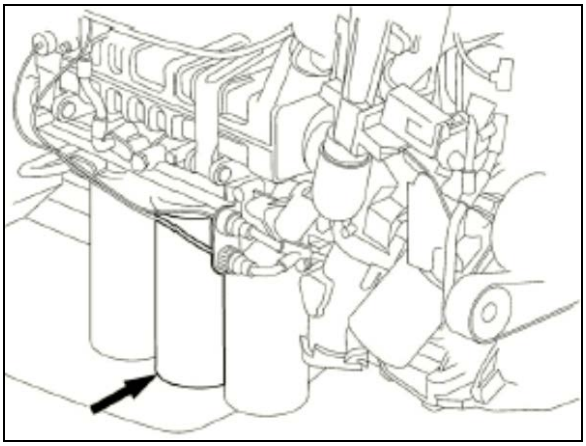


FIGURE 4: D13F OIL FILTERS

1.3.5 Synthetic Lubrication

Synthetic oils are offered by some oil suppliers as an alternative to the traditional, petroleum based oils for engines. These oils may be used in Volvo engines, provided they meet the quality levels specified on the previous pages, that is: both VDS-4 and EO-O Premium Plus.

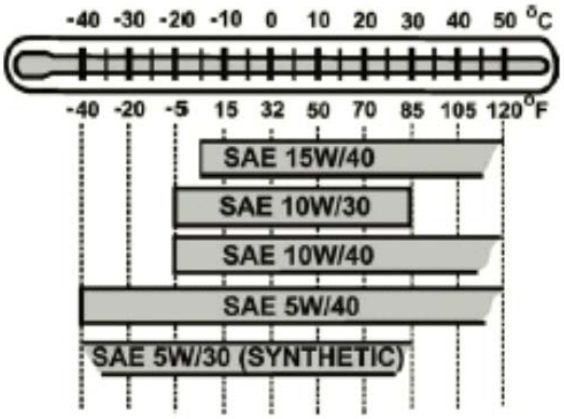
The use of synthetic oils does not permit the extension of the recommended oil change intervals.

1.3.6 Oil Viscosity

The viscosity grade defines the thickness of the oil. The oil must be thin enough at low temperatures for easy cold starts and thick enough to protect at high temperatures. An oil is not fully defined until both the API quality classification and the viscosity grade are specified.

Choose the viscosity grade for the typical ambient temperature for the application. Multigrade oils have a broad range that suit operation in changing temperature.

Volvo North America recommends the viscosities shown in the viscosity/temperature table for Volvo engines.



1.3.7 Oil Additives

CAUTION

Extra oil additives must never be added to any engine oil used. Additives such as break-in oils, top oils, graphitizers, and friction reducing liquids are not necessary and may even harm the engine.

Using oils to the quality standards recommended in this manual makes the use of extra oil additives unnecessary, as these oils already contain a balanced treatment of additives.

1.3.8 Oil Consumption

Once the engine is stopped, check the oil level daily. If the engine has just been stopped and it is warm, wait approximately five minutes to allow the oil to drain back to the oil pan before checking. Add oil as necessary.

CAUTION

DO NOT overfill engine with oil.

All diesel engines are designed to consume some oil, so it is normal to add oil periodically. An engine used in heavy-duty operation will consume more oil than one in normal operation.

1.3.9 Oil Change

WARNING

A hot engine or engine oil can be dangerous. Serious burns can result from contact with a hot engine or oil. Take precautions when draining the oil. Wear gloves or let the engine cool down before draining.

WARNING

When draining the oil, use the proper tools and keep away as far as possible. Raise the elbow so the forearm is parallel to the ground to prevent oil running down the arm, causing burns.

CAUTION

Always dispose of all lubricants (motor oil, coolant, gear box oils, etc) and filters according to Federal or local regulations. Used oil disposed of in nature or waterways contaminates our drinking water and kills wildlife.

WARNING

Prolonged contact with used engine oil may be harmful. Use rubber gloves when handling used oil. Wash skin thoroughly if it comes in contact with used oil.

It is important to drain as much oil as possible. Try to change oil immediately after driving, when the oil is warm. Always replace the oil filters when changing the oil.

Component	Capacity (L)
Oil pan	24 (min) – 32 (max)
Engine block	1
Filters (3)	6
Total oil fill (empty)	39

NOTE

Since about 1 liter of oil remains in the engine after draining, approximately 38 liters will be needed for a complete oil change.

1.3.10 Oil Filters Change

WARNING

Hot oil can cause severe burns. DO NOT allow hot oil to contact the skin. When changing oil, wear protective gloves.

CAUTION

Volvo-branded oil filters are designed to provide the proper level of filtration and protection for Volvo engines. Filters that do not meet the same stringent requirements may cause unsatisfactory results.

- Clean around the oil filter housing and remove the filters using the oil filter wrench or the oil filter socket.

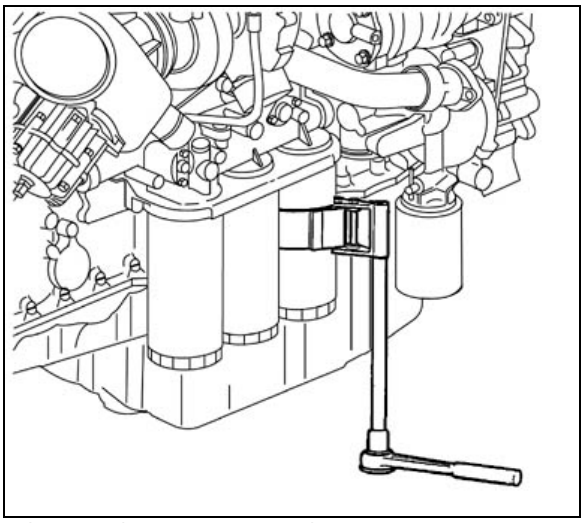


FIGURE 5: OIL FILTER WRENCH

- Prefill the new oil filters with approved engine oil. Also, lubricate the filter gaskets with engine oil (1). Hand tighten the oil filters until they contact the sealing surface of the oil filter housing (2). Manually tighten the oil filters an additional ¾ to 1 full turn (3).

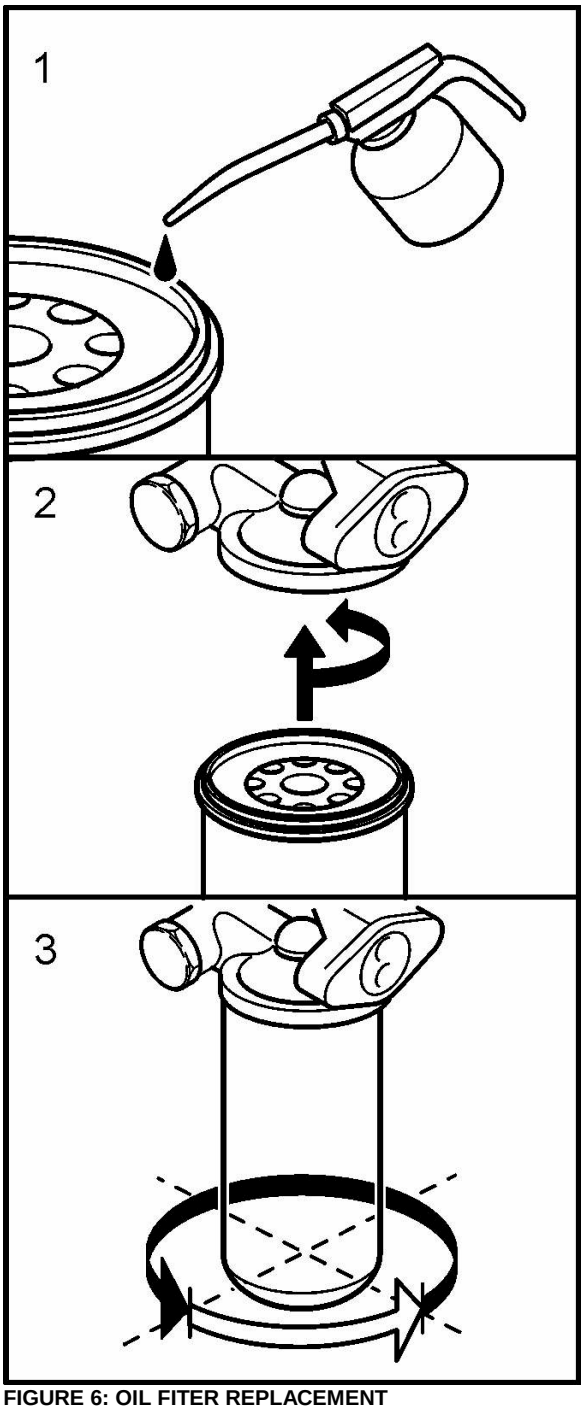


FIGURE 6: OIL FITER REPLACEMENT

- Start the engine and check for leaks around the oil filter housing and filters.
- Check the oil level. Add approved engine oil to the recommended level, if necessary. Do not overfill.

1.3.11 Checking the Oil Level

Ensure that the vehicle is parked on level ground before checking the oil level. Wait five minutes after shutting off the engine and then proceed with checking the oil.

CAUTION

DO NOT let the oil level fall below the marking on the dipstick. **DO NOT** overfill so the level is above the upper marking on the dipstick. This could lead to excessive oil temperature and/or poor crankcase breather performance. Add oil through the oil filler pipe as required in order to maintain level within the safe range.

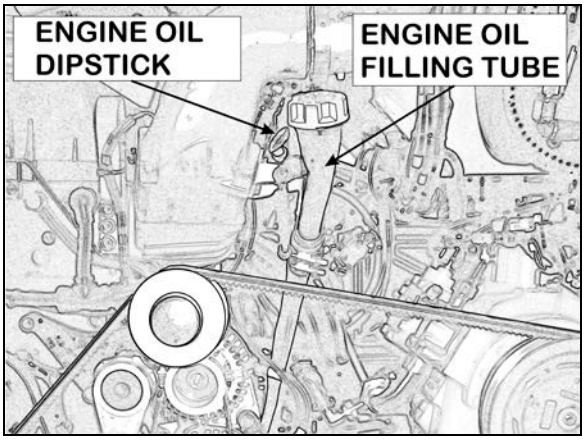


FIGURE 7: ENGINE OIL FILLING TUBE

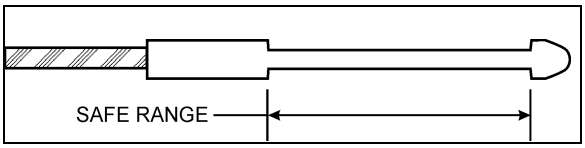


FIGURE 8: ENGINE OIL LEVEL DIPSTICK

1.4 POWER PLANT ASSEMBLY REMOVAL

To access the engine or engine-related components, the vehicle power plant assembly must be removed as a whole unit by means of a slide-out cradle. The power plant assembly includes the engine, transmission (including retarder if so equipped), air compressor, alternator and transmission oil cooler.

Remove the power plant assembly as follows:

CAUTION

Tag hoses and cables for identification before disconnecting in order to facilitate reinstallation. Plug all openings to prevent dirt from entering the system.

NOTE

No parts within the EECU are serviceable. If found defective, replace the EECU as a unit.

- **First**

1. Shut off the heater line shut-off valves.
2. Disconnect the battery or batteries from the starting system by removing one or both of the battery cables from each battery system. With the electrical circuit disrupted, accidental contact with the starter button will not produce an engine start.

WARNING

Due to the heavy load of the rear bumper assembly, it must be adequately supported before attempting to remove it.

3. Remove the rear bumper assembly complete with hitch if applicable from the vehicle. Refer to Section 18, BODY, under "REAR BUMPER REMOVAL".
4. Using the quick-connect drain hose, drain the engine cooling system. Refer to Section 05, COOLING under "DRAINING COOLING SYSTEM".
5. If applicable, disconnect the block heater connector located near the EGR mixing chamber.

- **With Vehicle Raised**

1. Using a vehicle lift or jack, raise vehicle to access transmission fasteners and wire harness.
2. Disconnect propeller shaft.
3. Partially remove L.H. side transmission protective panel to access connectors.
4. On vehicles equipped with an automatic transmission provided with a hydraulic output retarder, disconnect steel-braided airline from pressure regulator output. The pressure regulator is mounted in the upper section of engine compartment backwall and is accessible through the engine compartment R.H. side door.
5. Untighten bolts A and C. Remove bolts B and D and pivot oil cooler towards transmission. Reinstall bolts B and D.

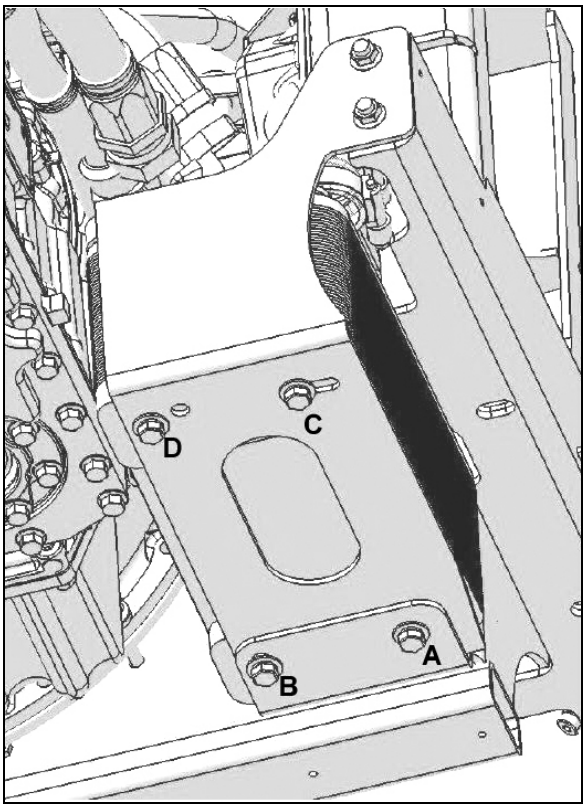


FIGURE 9: COOLER POSITION DURING ENGINE CRADLE INSERTION OR REMOVAL

6. From underneath, unfasten the bolts fixing the engine cradle.
7. Disconnect the engine coolant hose near the starter.
8. Disconnect air compressor suction and discharge hoses.

- **With Vehicle Lowered**

Lower the vehicle enough to access all components.

➢ Engine Compartment R.H. side

- If applicable, remove auxiliary sump tank to ease access.
- Disconnect cables from two chassis grounds located on diagonal member.
- Inside engine compartment, disconnect starter, alternators and heater cables. Also disconnect AFSS cable if applicable.
- Disconnect from engine, connector C398 and vehicle interface harness connector located above EECU connectors. Also disconnect DPF cable.
- Disconnect power steering pump hoses.
- Shut off fuel line shut-off valve.
- Close engine fuel supply shut-off valve on primary fuel filter or Fuel Pro. Disconnect the fuel line located above fuel filters and connected to inlet port. On vehicles equipped with the optional water-separator-fuel-filter, disconnect the connector and remove cable ties from cradle.
- Disconnect fuel return line located above fuel filters.
- Disconnect alternators cooling duct and put aside.

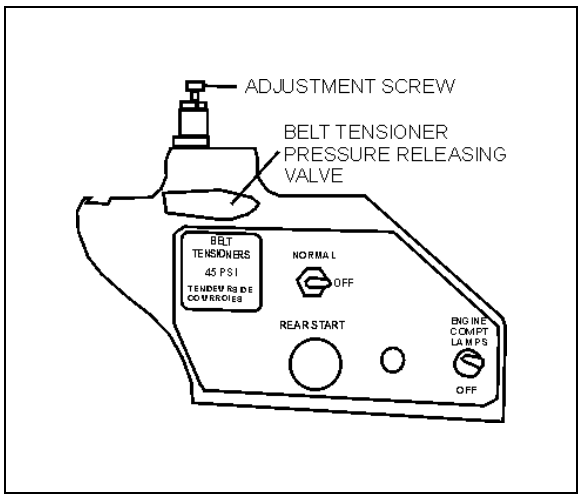


FIGURE 10: BELT TENSIONER VALVE 12200

- Locate the A/C compressor belt tensioner pressure releasing valve (Fig. 10). Turn pressure releasing valve handle counterclockwise in order to release pressure in belt-tensioner air bellows and loosen belts. Remove the belts.
- Disconnect and remove the engine-air intake duct mounted between air cleaner housing and turbocharger inlet.

⚠ CAUTION

To avoid damage to turbocharger, cover the turbocharger inlet opening to prevent foreign material from entering.

- Disconnect and remove the exhaust pipe mounted between the flexible coupling and the pipe going to the Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPF) assembly. If

necessary, refer to Section 4: EXHAUST SYSTEM under "EXHAUST AFTERTREATMENT SYSTEM OVERVIEW".

- Disconnect and remove the air intake duct mounted between the charge air cooler outlet and the engine intake.

➢ Engine Compartment L.H. side

- Disconnect fan driving shaft from radiator fan drive mechanism support.

⚠ CAUTION

To avoid damage to cooling fan right angle gearbox, make sure the power plant cradle clears the gearbox when pulling the engine out.

- Disconnect and remove section of coolant pipe assembly mounted between the radiator outlet and the water pump inlet.
- Disconnect and remove a section of coolant pipe assembly mounted between the thermostat housing and the radiator inlet.
- Disconnect the electric fan-clutch connector located near the cooling fan right angle gearbox.
- Disconnect and remove the air intake duct mounted between the turbocharger outlet and the air cooler inlet.
- Disconnect and remove surge tank hose connected to pump inlet pipe and hose connected to engine.
- Unfasten and put aside engine compartment lighting fixture and turbocharger fire suppression nozzle if applicable.
- Disconnect Exhaust Aftertreatment System control cable.

- **Last**

1. Inspect the power plant assembly to ensure that nothing will interfere when sliding out the cradle. Check for connections or hoses not mentioned in this list as some vehicles are equipped with special or aftermarket components.
2. Make sure the ten retaining bolts, washers and nuts securing the power plant cradle to the vehicle rear subframe are removed (Fig. 13).

NOTE

Check if any spacer(s) have been installed between power plant cradle and vehicle rear subframe, and if so, note position of each washer for reinstallation purposes.

3. Using a suitable equipment with a minimum capacity of 4,000 lbs (1 800 kg), slightly raise the power plant cradle.
4. Pull engine out slowly from the engine compartment. Make sure all lines, wiring and accessories are disconnected and are not tangled.

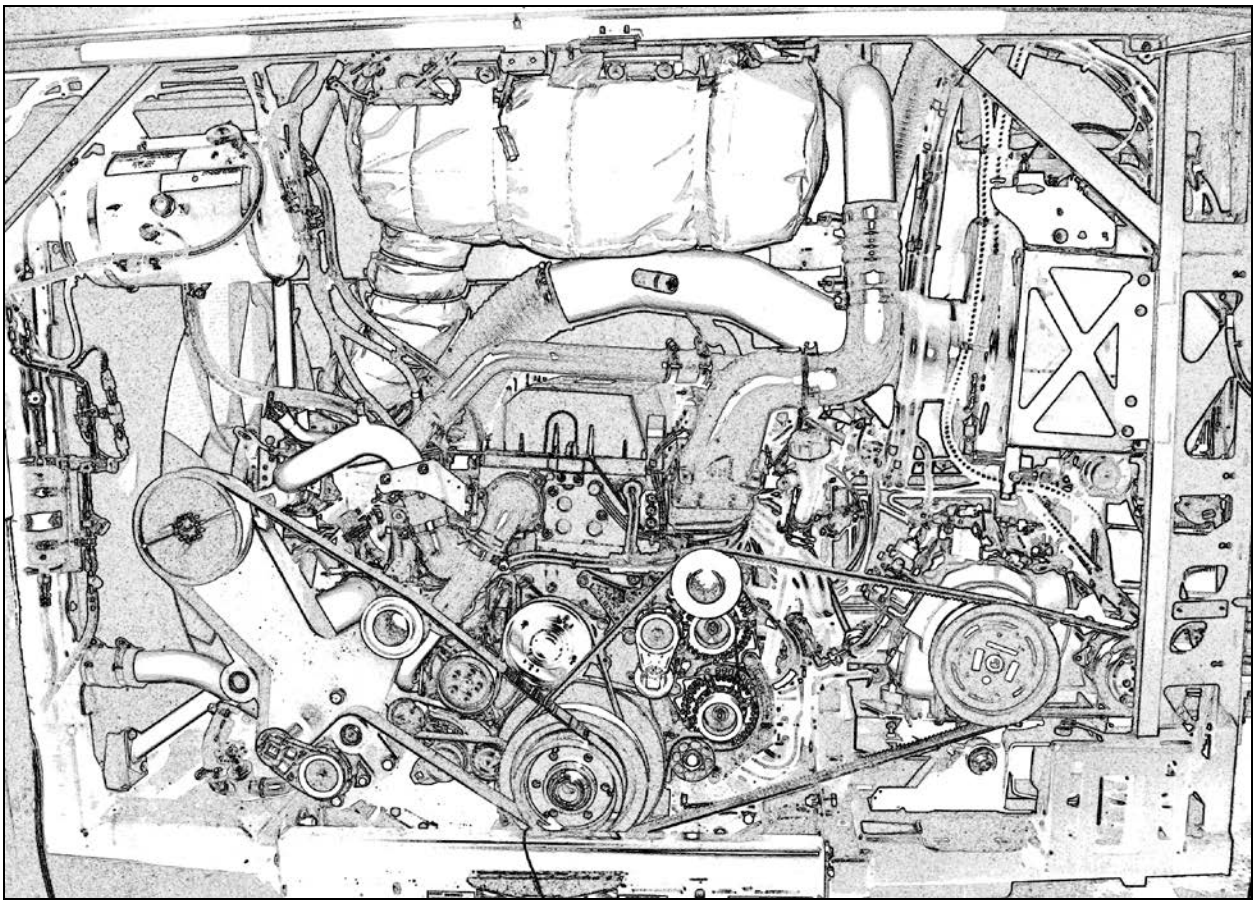


FIGURE 11: ENGINE COMPARTMENT X3 COACHES (TYPICAL) 01184_A

1.5 POWER PLANT ASSY. INSTALLATION

To install a power plant assembly, follow the same procedure as in "Power Plant Assembly Removal" except in reverse order, then proceed with the following:

1. Torque the power plant cradle mounting bolts to 190 lbf-ft (258 Nm).
2. Remove bolts B and D. Untighten bolts A and C then pivot oil cooler as per figure 12. Install bolts B and D and tighten all bolts.
3. Refill cooling system with saved fluid (refer to Section 05, COOLANT SYSTEM).
4. Once engine fuel system has been drained, it will aid restarting if fuel filters are filled with fuel oil (refer to Section 03, FUEL SYSTEM).
5. Start engine for a visual check. Check fuel, oil, cooling, pneumatic and hydraulic system connections for leakage. Test operation of engine controls and accessories.

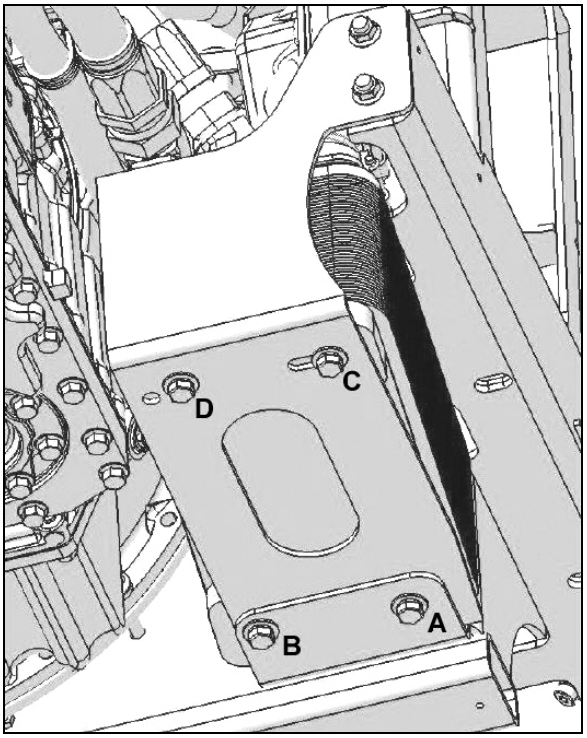


FIGURE 12: NORMAL OIL COOLER POSITION

1.6 ENGINE MOUNTS

The power plant assembly is mounted to the cradle by means of rubber mounts and supports.

Two engine support brackets are used at the front of the engine while two rubber mounts are mounted underneath the engine & radiator fan drive mechanism support and the engine & alternator support (Fig. 13).

It is recommended that new rubber mounts be installed at each major overhaul.

NOTE
Refer to the table on the following page for engine cradle tightening torques.

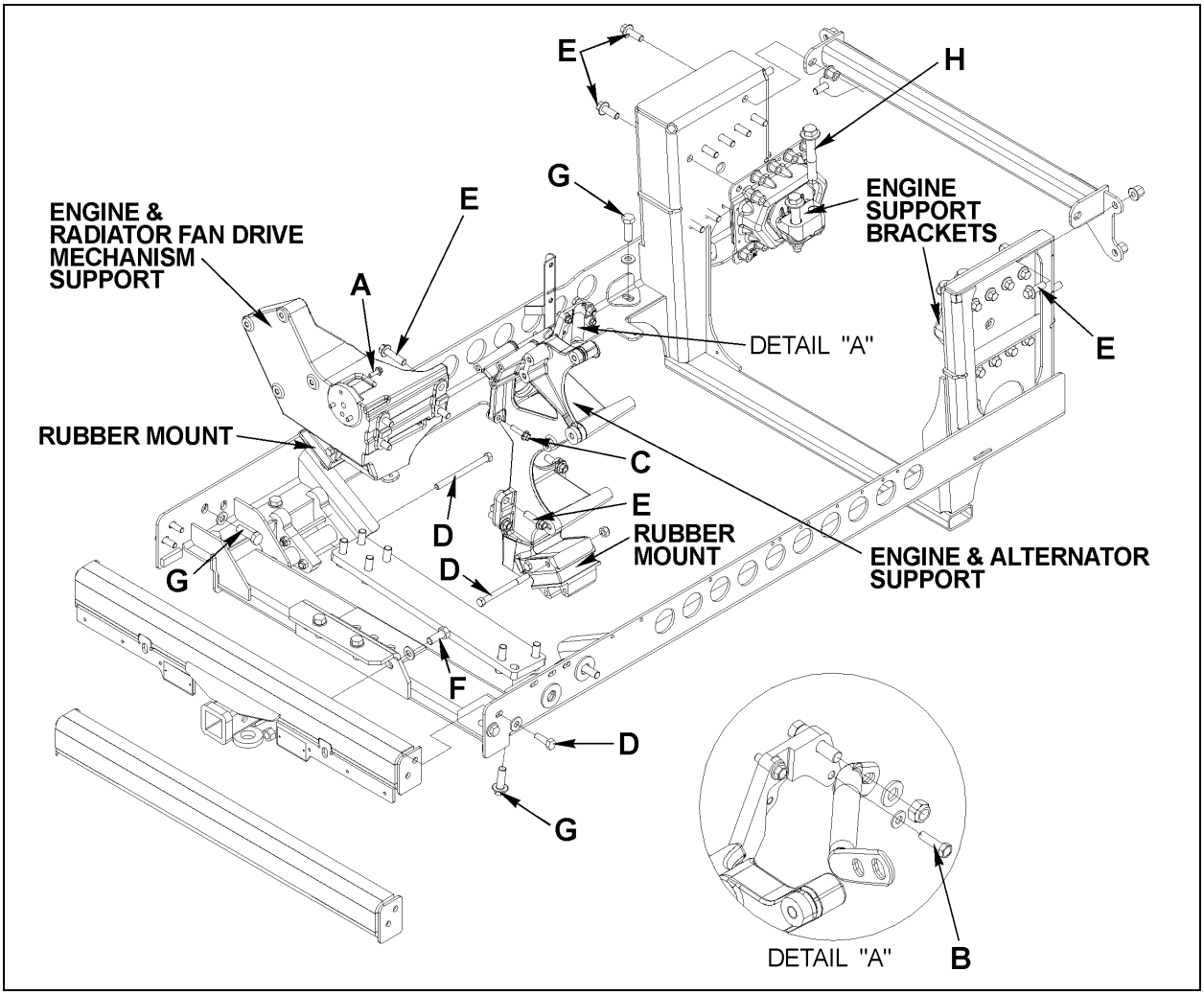


FIGURE 13: VOLVO ENGINE POWER PLANT CRADLE INSTALLATION

DRY TORQUES			
REFERENCE	DESCRIPTION	Lbf-Ft	Nm
A	SCREW, CAP HEXAGONAL HEAD M8 – 1.25 G8.8	16	22
B	SCREW, CAP HEXAGONAL HEAD M8 – 1.25 G10.9	22	30
C	SCREW, CAP HEXAGONAL HEAD M10 – 1.5 G10.9	43	58
D	SCREW, CAP HEXAGONAL HEAD M12 – 1.75 G8.8	60	81
E	SCREW, CAP HEXAGONAL HEAD M14 – 2.0 G8.8	90	122
F	SCREW, CAP HEXAGONAL HEAD M16 – 2.0 G8.8	140	190
G	SCREW, CAP HEXAGONAL HEAD M16 – 2.0 G10.9	190	258
H	SCREW, CAP HEXAGONAL HEAD M20 – 2.5 G10.9	450	610

2. ELECTRONIC FOOT PEDAL ASSEMBLY (EFPA) & THROTTLE POSITION SENSOR

The Electronic Foot Pedal Assembly (EFPA) connects the accelerator pedal to a Throttle Position Sensor (TPS). The (TPS) is a device, which sends an electrical signal to the Motor Control Module (MCM). The TPS varies in voltage depending on how far the pedal is depressed. The system is installed in the space normally occupied by a mechanical foot pedal. The (EFPA) has maximum and minimum stops that are built into the unit during manufacturing (Fig. 14). The (TPS) converts the operator's foot pedal input into a signal for the MCM.

When installed by the equipment manufacturer, the TPS should not require adjustment. If the TPS is suspected of being misadjusted, confirm that the sensor is installed in accordance with the manufacturer's specifications. It is recommended that the idle count be at 50 or higher with a full throttle count of up to 200.

The TPS is self-calibrating and therefore has no optimum closed throttle or wide open throttle count value. If the counts are within the 50 to 200 range, the sensor is properly set.

Monitor the (TPS) at the controls as you move it through its full stroke. Be sure there is no misalignment or obstruction preventing the smooth movement of the TPS through the full stroke. Using a diagnostic data reader, check that the idle and full throttle position counts do not fall within the error zones. The error zones occur when the idle position is less than 14 counts, or when the full throttle position is more than 233 counts. Should these conditions occur, the CPC will signal diagnostic codes of 21-12 for idle error and 21-23 for wide-open throttle error.

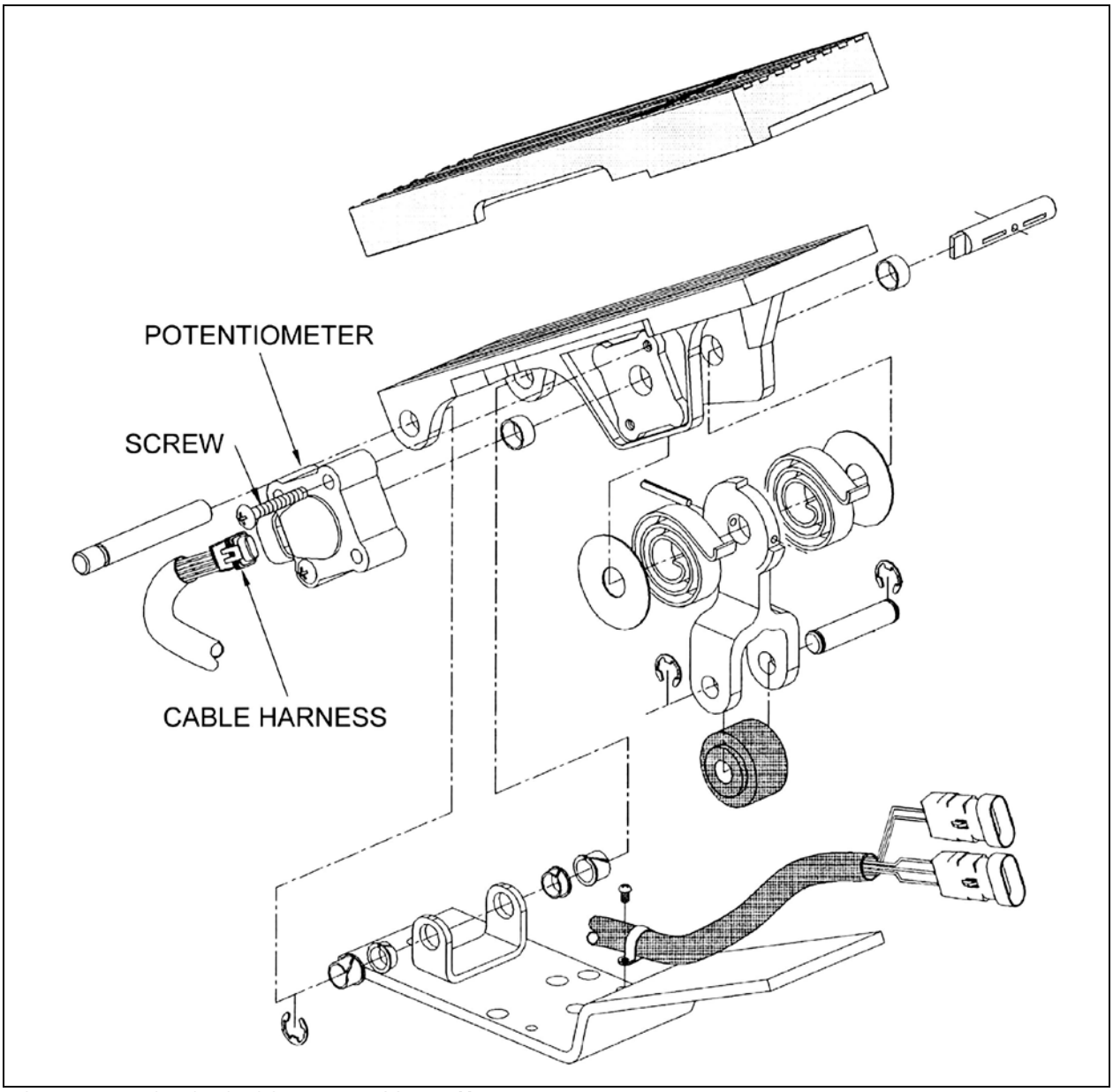


FIGURE 14: ELECTRONIC FOOT PEDAL ASSEMBLY 03035

3. SPECIFICATIONS

Volvo D13 Engine

Make ..... Volvo

Type ..... Diesel four cycle/in-line direct injection engine

Description ..... Turbo/Air to air charge cooled

No. of cylinders 6

Operating range ..... 1400-1800 RPM

X3-45 Coaches Peak Power Rating ..... 435 HP (324 kW)

X3-45 Coaches Peak Torque Rating ..... 1700 Ft-lb (2304 Nm)

Le Mirage XLII Entertainer Bus Shells and X3-45 VIP Peak Power Rating ..... 500 HP (373 kW)
Le Mirage XLII Entertainer Bus Shells and X3-45 VIP Peak Torque Rating ..... 1770 Ft-lb (2400 Nm)
Low Idle ..... 600 rpm
Fast Idle ..... 2150 rpm
Maximum full load revolutions ..... 1900 rpm

Engine oil level quantity

Oil Pan Capacity, Low Limit ..... 25 quarts/24 liters
Oil Pan Capacity, High Limit ..... 34 quarts/32 liters
Total Engine Oil Capacity with Filters ..... 41 quarts/39 liters

Lubricating oil filter elements

Type ..... By-pass
Prevost number 510938
Type ..... Full Flow
Prevost number 488736

Torque specification

Engine oil filter ..... Tighten ¾ of a turn to 1 full turn after gasket contact

Filters

Engine Air Cleaner Filter
Prevost number 530197

Engine Coolant Filter/Conditioner
Prevost number 20458771

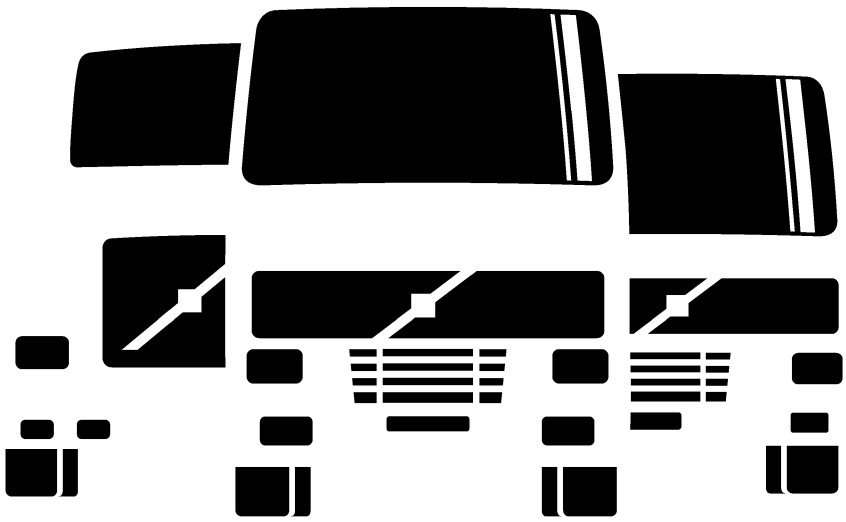
Service Manual
Trucks

Group **28**

Engine Control Module (ECM), Diagnostic Trouble Code (DTC), Guide

2010 Emissions

B13R, PREVH, PREVX



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VOLVO

Foreword

The descriptions and service procedures contained in this manual are based on designs and methods studies carried out up to August 2010.

The products are under continuous development. Vehicles and components produced after the above date may therefore have different specifications and repair methods. When this is believed to have a significant bearing on this manual, supplementary service bulletins will be issued to cover the changes.

The new edition of this manual will update the changes.

In service procedures where the title incorporates an operation number, this is a reference to an V.S.T. (Volvo Standard Times).

Service procedures which do not include an operation number in the title are for general information and no reference is made to an V.S.T.

Each section of this manual contains specific safety information and warnings which must be reviewed before performing any procedure. If a printed copy of a procedure is made, be sure to also make a printed copy of the safety information and warnings that relate to that procedure. The following levels of observations, cautions and warnings are used in this Service Documentation:

Note: Indicates a procedure, practice, or condition that must be followed in order to have the vehicle or component function in the manner intended.

Caution: Indicates an unsafe practice where damage to the product could occur.

Warning: Indicates an unsafe practice where personal injury or severe damage to the product could occur.

Danger: Indicates an unsafe practice where serious personal injury or death could occur.

Volvo Bus Corporation
Göteborg, Sweden

Order number: 88985784
Repl:

USA43530

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Engine Control Module (ECM) Diagnostic Trouble Codes (DTCs) 3

Troubleshooting

Engine Control Module (ECM) Diagnostic Trouble Codes (DTCs)

The manufacturer scan tool is the preferred tool for performing diagnostic work. Contact your local dealer for more information or visit “www.premiumtechtool.com”.

Note: The use of a scan tool is necessary to perform diagnostic work as well as clearing of any diagnostic trouble codes (DTCs). DTC(s) can no longer be cleared using the vehicles instrument cluster digital display and stalk switch control.

System Overview

Six electronic control units (ECUs) are used; the engine control module (ECM), instrument control module (ICM), Vehicle Electronic Control Unit (VECU), transmission control module (TCM), the gear selector control module (GSCM) and the aftertreatment control module (ACM). Together, these modules operate and communicate through the SAE J1939 (CAN 1) data link to control a variety of engine and vehicle cab functions. The ECM controls such things as fuel timing and delivery, fan operation, engine protection functions, engine brake operation, the exhaust gas recirculation (EGR) valve and the turbocharger nozzle. The VECU controls cruise control functions, accessory relay controls and idle shutdown functions. The ICM primarily displays operational parameters and communicates these to the other ECUs. All have the capability to communicate over the SAE J1587 data link primarily for programming, diagnostics and data reporting.

In addition to their control functions, the modules have on board diagnostic (OBD) capabilities. The OBD is designed to detect faults or abnormal conditions that are not within normal operating parameters. When the system detects a fault or abnormal condition, the fault will be logged in one or both of the modules’ memory, the vehicle operator will be advised that a fault has occurred by the illumination of the malfunction indicator lamp (MIL) and a message in the driver information display, if equipped. The module may initiate the engine shutdown procedure if the system determines that the fault could damage the engine.

In some situations when a fault is detected, the system will enter a "derate" mode. The derate mode allows continued vehicle operation but the system may substitute a sensor or signal value that may result in reduced performance. In some instances, the system will continue to function but engine power may be limited to protect the engine and vehicle. Diagnostic trouble codes (DTCs) logged in the system memory can be read later, to aid in diagnosing the problem using a diagnostic computer or through the instrument cluster display, if equipped. When diagnosing an intermittent DTC or condition, it may be necessary to use a scan tool connected to the communication port.

The use of a scan tool is necessary to perform diagnostic work as well as clearing of any diagnostic trouble codes (DTCs). DTC(s) can no longer be cleared using the vehicles instrument cluster digital display and stalk switch control. Additional data and diagnostic tests are available when a scan tool is connected to the Serial Communication Port.

For diagnostic software, contact your local dealer.

The ECM is a microprocessor based controller programmed to perform fuel injection quantity and timing control, diagnostic fault logging, and to broadcast data to other ECUs. The fuel quantity and injection timing to each cylinder is precisely controlled to obtain optimal fuel economy and reduced exhaust emissions in all driving situations.

The ECM controls the operation of the injectors, engine brake solenoid, EGR valve, turbocharger nozzle position, and cooling fan clutch based on inputs from many sensors and information received over the data links from other ECUs.

The VECU and ECM are dependent on each other to perform their specific control functions. In addition to switch and sensor data, the broadcast of data between modules also includes various calculations and conclusions that each module has developed, based on the input information it has received.

System Electronic Control Unit (ECU) Overview

The engine control module (ECM) monitors and models (using physical principles) engine parameters to monitor the engine system's performance in real time. This is performed to aid the ECM with its self diagnostic capabilities. Many sensors are used for input to the emission control system.

The system contains the following "emission critical" ECUs that are monitored;

- Engine Control Module (ECM)
- Vehicle Electronic Control Unit (VECU)
- Aftertreatment Control Module (ACM)
- Aftertreatment Nitrogen Oxides (NOx) Sensors
- Engine Variable Geometry Turbocharger (VGT) Smart Remote Actuator (SRA)

These ECUs all communicate with the ECM via data links. The VECU communicates across the SAE J1939 (CAN1) data link while the others use the SAE J1939-7 (CAN2) data link. The OBD systems use SAE J1939 data link protocol for communication with scan tools but, still are capable of communicating via the SAE J1587 data link for diagnostics. The use of a scan tool is necessary to perform diagnostic work as well as clearing of any diagnostic trouble codes (DTCs). DTC(s) can no longer be cleared using the vehicles instrument cluster digital display and stalk switch control.

There are other ECUs such as the Instrument Control Module (ICM), Transmission Control Module (TCM) and Anti-lock Brake System (ABS) Module that provide data to the emission control system or the diagnostic system but are not "emission critical".

Malfunction Indicator Lamp (MIL), Description and Location

A MIL located in the instrument cluster. This amber colored lamp is used to inform the driver that a "emission critical" malfunction signal has occurred.

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SAE J1939 Data Link Communication

The electronic control units (ECUs) that communicate on the SAE J1939 data link, communicate according to the SAE J1587 standard. The diagnostic trouble codes (DTCs) set by the ECUs contain information that is described by the following abbreviations.

SA	Source Address: Identification of a control module.
SPN	Suspect Parameter Number: Identification of a parameter (value).
FMI	Failure Mode Identifier: Identification of fault types.

SAE J1939 FMI Table

FMI	SAE Text
0	Data valid but above normal operational range - Most severe level
1	Data valid but below normal operational range - Most severe level
2	Data erratic, intermittent or incorrect
3	Voltage above normal, or shorted to high source
4	Voltage below normal, or shorted to low source
5	Current below normal or open circuit
6	Current above normal or grounded circuit
7	Mechanical system not responding or out of adjustment
8	Abnormal frequency or pulse width or period
9	Abnormal update rate
10	Abnormal rate of change
11	Root cause not known
12	Bad intelligent device or component
13	Out of calibration
14	Special instructions
15	Data valid but above normal operating range - Least severe level
16	Data valid but above normal operating range - Moderately severe level
17	Data valid but below normal operating range - Least severe level
18	Data valid but below normal operating range - Moderately severe level
19	Received network data in error
20	Reserved for SAE assignment
21	Reserved for SAE assignment
22	Reserved for SAE assignment
23	Reserved for SAE assignment
24	Reserved for SAE assignment
25	Reserved for SAE assignment
26	Reserved for SAE assignment
27	Reserved for SAE assignment
28	Reserved for SAE assignment
29	Reserved for SAE assignment
30	Reserved for SAE assignment
31	Condition exists

SAE J1587 Data Link Communication

The electronic control units (ECUs) also communicate on the SAE J1587 data link. These ECUs communicate according to the SAE J1587 standard. This standard has been extended with proprietary supplements (PPID, PSID). The diagnostic trouble codes (DTCs) set by the ECUs contain information that is described by the following abbreviations.

MID — Message Identification Description: Identification of a control module.

PID — Parameter Identification Description: Identification of a parameter (value).

PPID — Proprietary Parameter Identification Description: Unique identification of a parameter (value).

SID — Subsystem Identification Description: Identification of a component.

PSID — Proprietary Subsystem Identification Description: Unique identification of a component.

FMI — Failure Mode Identifier: Identification of fault types.

SAE J1587 FMI Table

FMI	SAE Text
0	Data valid, but above the normal working range
1	Data valid, but below the normal working range
2	Intermittent or incorrect data
3	Abnormally high voltage or short circuit to higher voltage
4	Abnormally low voltage or short circuit to lower voltage
5	Abnormally low current or open circuit
6	Abnormally high current or short circuit to ground
7	Incorrect response from a mechanical system
8	Abnormal frequency
9	Abnormal update rate
10	Abnormally strong vibrations
11	Non-identifiable fault
12	Faulty module or component
13	Calibration values outside limits
14	Special instructions
15	Reserved for future use

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ECM SPN 84, Wheel-Based Vehicle Speed – MID 128 PID 84

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Missing signal from VECU	• Engine derate	• SAE J1587 data link vehicle speed message does not exist, (VECU error) • VECU
FMI 10	• Abnormal rate of change	• Vehicle speed deemed inaccurate by VECU	• MIL illuminated	• Vehicle speed sensor (VSS) • VECU
FMI 13	• Out of calibration	• No vehicle speed available to VECU	• MIL illuminated	• Vehicle speed sensor (VSS) • VECU
FMI 19	• Received network data in error	• Vehicle speed deemed inaccurate by VECU	• MIL illuminated	• Vehicle speed sensor (VSS) • VECU

ECM SPN 91, Accelerator Pedal Position 1 – MID 128 PID 91

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Missing signal from VECU	• N/A	• SAE J1587 data link pedal information not available
FMI 10	• Abnormal rate of change	• Pedal position deemed inaccurate by VECU	• MIL illuminated	• Accelerator pedal sensor fault
FMI 13	• Out of calibration	• Pedal not connected to VECU	• MIL illuminated	• Accelerator pedal sensor fault
FMI 19	• Received network data in error	• Pedal position deemed inaccurate by VECU	• MIL illuminated	• Accelerator pedal sensor fault

ECM SPN 94, Engine Fuel Delivery Pressure – MID 128 PID 94

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Low fuel pressure sensor signal line voltage	• N/A	• Damaged contacts in harness • Faulty fuel pressure sensor • Open circuit.
FMI 5	• Current below normal or open circuit	• Low fuel pressure sensor signal line voltage	• N/A	• Damaged contacts in harness • Faulty fuel pressure sensor

FMI 7	• Mechanical system not responding properly	• Drop in fuel pressure	• Engine derate	• Clogged fuel filter • Faulty fuel pressure sensor • Leaking fuel line or fitting • Poor fuel pump response
FMI 13	• Out of Calibration	• Sensor indicates a invalid value	• N/A	• Wiring harness • Faulty fuel pressure sensor • Clogged fuel filter
FMI 15	• Data valid but above normal operating range - Least severe level	• Sensor indicates a invalid value	• N/A	• Wiring harness • Faulty fuel pressure sensor
FMI 17	• Data valid but below normal operating range - Least severe level	• Sensor indicates a invalid value	• N/A	• Wiring harness • Faulty fuel pressure sensor • Clogged fuel filter
FMI 18	• Data valid but below normal operating range - Moderately severe level	• Drop in fuel pressure	• Engine derate	• Clogged fuel filter • Faulty fuel pressure sensor • Leaking fuel line or fitting • Poor fuel pump response

ECM SPN 97, Water in Fuel Indicator – MID 128 PID 97

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Water in fuel is indicated	• Uneven running • Engine stalling	• Water in fuel
FMI 3	• Voltage above normal, or shorted to high source	• N/A	• Undetected water in fuel supply • Uneven running • Engine stalling	• Open circuit
FMI 4	• Voltage below normal, or shorted to low source	• N/A	• Undetected water in fuel supply • Uneven running	• Short to ground • Open circuit • Faulty sensor

ECM SPN 98, Engine Oil Level – MID 128 PID 98

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 1	• Data valid but above normal operational range	• Critically below range	• Red Stop or yellow Check lamps illuminated dependent of severity	• Low oil level leakage • Critically low oil level

FMI 4	• Voltage below normal, or shorted to low source	• Short Circuit - Positive side	• Oil level can not be measured	• Engine Oil Level (EOL) sensor failure • Faulty harness
FMI 5	• Current below normal or open circuit	• Short Circuit +, Positive side • Open Circuit +, Positive side • Open Circuit- Negative side	• Oil level can not be measured	• Engine Oil Level (EOL) sensor failure • Faulty harness
FMI 18	• Data valid but below normal operating range - Moderately severe level	• Moderately below range • Critically below range	• Red Stop or yellow Check lamps illuminated dependent of severity	• Low oil level leakage • Moderately low oil level

ECM SPN 100, Engine Oil Pressure – MID 128 PID 100

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 1	• Data valid but below normal operational range	• Critically below range	• Engine derate • Low pressure • Red Stop lamp illuminated	• Oil leakage • Broken oil pump • Clogged oil system
FMI 3	• Voltage below normal or shorted low	• Short Circuit +, Measuring line • Open Circuit, Ground line	• Oil pressure shows 0 in the cluster, engine is running • Yellow Check lamps illuminated	• Engine Oil Pressure (EOP) sensor failure • Faulty harness
FMI 5	• Current below normal or open circuit	• Open Circuit +, 5V Supply line • Short Circuit -, Measuring line • Open Circuit, Measuring line	• Oil pressure shows 0 in the cluster, engine is running • Yellow Check lamps illuminated	• Engine Oil Pressure (EOP) sensor failure • Faulty harness
FMI 13	• Out of Calibration	• Sensor indicates a invalid value	• Oil pressure shows 0 in the cluster, engine is running	• Engine Oil Pressure (EOP) sensor failure • Faulty harness
FMI 15	• Data valid but above normal operating range - Least severe level	• Sensor indicates a invalid value	• Oil pressure shows 0 in the cluster, engine is running	• Engine Oil Pressure (EOP) sensor failure • Faulty harness
FMI 17	• Data valid but below normal operating range - Least severe level	• Sensor indicates a invalid value	• Oil pressure shows 0 in the cluster, engine is running	• Engine Oil Pressure (EOP) sensor failure • Faulty harness

ECM SPN 102, Engine Intake Manifold 1 Pressure – MID 128 PID 102

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent or incorrect	• Intake Manifold Pressure Sensor output is too high or too low	• Engine derate • MIL lamp illuminated	• Faulty harness • Intake Manifold Pressure sensor
FMI 3	• Voltage above normal, or shorted to high source	• A short to battery in the metering circuit • An open in the ground circuit of the Intake Manifold Pressure Sensor	• Engine derate • MIL lamp illuminated	• Faulty harness • Harness connectors • Intake Manifold Pressure sensor
FMI 5	• Current below normal or open circuit	• A short to ground in the harness • An open in the 5 volt supply circuit • An open in the metering circuit	• Engine derate • MIL lamp illuminated	• Faulty harness • Harness connectors • Intake Manifold Pressure sensor
FMI 12	• Bad intelligent device or component	• Intake Manifold Pressure sensor output is too high • Sensor indicates a invalid value	• Engine derate • MIL lamp illuminated	• Faulty harness • Intake Manifold Pressure sensor
FMI 13	• Out of Calibration	• Sensor indicates a invalid value	• Engine derate • MIL lamp illuminated	• Faulty harness • Harness connectors • Intake Manifold Pressure sensor
FMI 14	• Special instructions	• Intake Manifold Pressure sensor output is too low • Sensor indicates a invalid value	• Engine derate • MIL lamp illuminated	• Faulty harness • Intake Manifold Pressure sensor • Inlet air leakage
FMI 15	• Data valid but above normal operating range - Least severe level	• Intake Manifold Pressure sensor output is too high	• Engine derate • MIL lamp illuminated	• Faulty harness • Harness connectors • Intake Manifold Pressure sensor
FMI 17	• Data valid but below normal operating range - Least severe level	• Sensor indicates a invalid value	• Engine derate • MIL lamp illuminated	• Faulty harness • Harness connectors • Intake Manifold Pressure sensor

ECM SPN 103, Engine Turbocharger 1 Speed – MID 128 PID 103

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• A fault is logged if the Turbocharger Speed Sensor signal is lost	• Engine derate • MIL illuminated	• Faulty harness • Faulty harness connector • Turbocharger Speed Sensor

ECM SPN 105, Engine Intake Manifold 1 Temperature – MID 128 PID 105

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Sensor indicates a invalid value	• Engine derate • MIL illuminated	• Poor cooling • Extreme running conditions
FMI 2	• Data erratic, intermittent or incorrect	• The Intake Manifold Temperature sensor output is too high or too low	• Engine derate • MIL illuminated	• Poor cooling • Extreme running conditions • Engine Intake Manifold sensor • Faulty harness • Faulty harness connector • Ambient Air Temperature sensor
FMI 4	• Voltage below normal, or shorted to low source	• N/A	• Difficult to start in cold climates • Minor cold engine smoke • Engine derate • MIL illuminated	• Engine Intake Manifold sensor • Faulty harness • Faulty harness connector
FMI 5	• Current below normal or open circuitt	• Possible short to sensor	• Difficult to start in cold climates • Engine derate • MIL illuminated	• Engine Intake Manifold sensor • Faulty harness • Faulty harness connector
FMI 13	• Out of Calibration	• The sensor output is showing a constant value	• Engine derate • Minor cold engine smoke • MIL illuminated	• Engine Intake Manifold sensor • Faulty harness • Faulty harness connector
FMI 17	• Data valid but below normal operating range - Least severe level	• The sensor output is showing a constant value	• Engine derate • Minor cold engine smoke • MIL illuminated	• Engine Intake Manifold sensor • Faulty harness • Faulty harness connector

ECM SPN 108, Barometric Pressure – MID 128 PID 108

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent or incorrect	• Barometric Pressure sensor output is too high or too low	• Minor engine derate • MIL illuminated	• Faulty Sensor • Faulty Engine Control Module
FMI 3	• Voltage above normal, or shorted to high source	• Short to battery on the metering side	• MIL illuminated	• Internal fault in the Engine Control Module • Faulty Sensor
FMI 4	• Voltage below normal, or shorted to low source	• A short to ground on the metering side	• MIL illuminated	• Internal fault in the Engine Control Module • Faulty Sensor

ECM SPN 110, Engine Coolant Temperature – MID 128 PID 110

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Coolant temperature indicates critical limit	• Engine derate • Red Stop or yellow Check lamps illuminated dependent of severity	• Extreme driving condition • Faulty coolant thermostat • Malfunctioning fan • Blocked radiator
FMI 2	• Data erratic, intermittent or incorrect	• Engine Coolant Temperature sensor output is too high or too low	• May affect driveability in extreme cases • MIL illuminated	• Faulty Sensor • Faulty harness • Faulty coolant thermostat
FMI 4	• Voltage below normal or shorted low	• Engine Coolant Temperature sensor voltage too low	• Difficult to start in cold climates • Idle run regulation is deteriorated • MIL illuminated	• Faulty Sensor • Faulty harness
FMI 5	• Current below normal or open circuit	• N/A	• Difficult to start in cold climates • Idle run regulation is deteriorated • MIL illuminated	• Faulty Sensor • Faulty harness
FMI 10	• Abnormal rate of change	• Engine Coolant Temperature sensor output is showing a constant value	• May affect vehicle driveability • MIL illuminated	• Faulty Sensor • Faulty harness
FMI 13	• Out of Calibration	• Sensor out of range • Sensor indicates a invalid value	• MIL illuminated	• Faulty Sensor

FMI 16	• Data valid but above normal operating range - Moderately severe level	• Coolant temperature indicates moderate upper limit	• Engine derate • Yellow Check lamp illuminated	• Extreme driving condition • Faulty coolant thermostat • Malfunctioning fan • Blocked radiator
FMI 17	• Data valid but below normal operating range - Least severe level	• Sensor out of range • Sensor indicates a invalid value	• MIL illuminated	• Faulty Sensor

ECM SPN 111, Engine Coolant Level – MID 128 PID 111

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 1	• Data valid but below normal operational range - Most severe level	• Critically below range • Coolant level can not be detected	• Engine derate • Red Stop lamp illuminated • Coolant level can not be detected	• Coolant level below range • Faulty harness
FMI 3	• Voltage above normal, or shorted to high source	• Short Circuit +, measuring line • Coolant level can not be detected	• Coolant level can not be detected • Yellow Check lamp illuminated	• Faulty harness • Faulty harness connector • Faulty level sensor
FMI 4	• Voltage below normal, or shorted to low source	• Short Circuit -, measuring line • Coolant level can not be detected	• Coolant level can not be detected • Yellow Check lamp illuminated	• Faulty harness • Faulty harness connector • Faulty level sensor
FMI 5	• Current below normal or open circuit	• Open Circuit • Coolant level can not be detected	• Coolant level can not be detected • Yellow Check lamp illuminated	• Faulty harness • Faulty harness connector • Faulty level sensor
FMI 14	• Special instructions	• Sensor out of range • Sensor indicates a invalid value	• Coolant level can not be detected • Yellow Check lamp illuminated	• Faulty harness • Faulty harness connector • Faulty level sensor
FMI 18	• Data valid but below normal operating range - Moderately severe level	• Sensor out of range • Sensor indicates a invalid value	• Coolant level can not be detected • Yellow Check lamp illuminated	• Faulty harness • Faulty harness connector • Faulty level sensor

ECM SPN 153, Engine High Resolution Crankcase Pressure – MID 128 PID 153/PSID 23

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Out of range, max voltage, illegal • Critically Above Range	• Red Stop lamp illuminated • Forced idle • Engine shut down	• Piston ring blow-by
FMI 2	• Data erratic, intermittent or incorrect	• Crankcase pressure indication to high or to low a value	• MIL illuminated	• Faulty Crank Case Pressure senor • Faulty harness
FMI 3	• Voltage above normal or shorted to high source	• Short Circuit +, Measuring line • Open Circuit, Ground line	• MIL illuminated • Yellow Check lamp illuminated	• Faulty Crank Case Pressure senor • Faulty harness
FMI 5	• Current below normal or open circuit	• Open Circuit +, 5V Supply Line • Short Circuit -, measuring line • Open Circuit, measuring line	• MIL illuminated • Yellow Check lamp illuminated	• Faulty Crank Case Pressure senor • Faulty harness
FMI 7	• Mechanical system not responding or out of adjustment	• Leakage detected in the crankcase ventilation system	• MIL illuminated	• Faulty separator, hoses or pipes
FMI 13	• Out of Calibration	• Sensor out of range • Sensor indicates a invalid value	• MIL illuminated	• Faulty Sensor
FMI 15	• Data valid but above normal operating range - Least severe level	• Sensor out of range • Sensor indicates a invalid value	• MIL illuminated	• Faulty Sensor
FMI 17	• Data valid but below normal operating range - Least severe level	• Sensor out of range • Sensor indicates a invalid value	• MIL illuminated	• Faulty Sensor

ECM SPN 158, Keyswitch Battery Potential – MID 128 PID 158/PSID 124

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range	• Aftertreatment control module (ACM) battery voltage too high	• N/A	• Charging system fault • External charger • ACM

FMI 1	• Data valid but below normal operational range	• Aftertreatment control module (ACM) battery voltage too low	• Starter will not crank	• Charging system fault • Battery • Ground connection
FMI 3	• Voltage above normal, or shorted to high source	• Engine control module (ECM) battery voltage too high	• N/A	• Charging system fault • External charger • ECM
FMI 4	• Voltage below normal, or shorted to low source	• Engine control module (ECM) battery voltage too low	• Starter will not crank	• Charging system fault • Battery • Ground connection
FMI 16	• Data valid but above normal operating range - Moderately severe level	• Aftertreatment control module (ACM) battery voltage too high	• N/A	• Charging system fault • External charger • ACM
FMI 18	• Data valid but below normal operating range - Moderately severe level	• Aftertreatment control module (ACM) battery voltage too low	• Starter will not crank	• Charging system fault • Battery • Ground connection

ECM SPN 171, Ambient Air Temperature (AAT) – MID 128 PID 171

Type of fault:	**FMI Description:**	**Fault Condition:**	**Possible Symptoms:**	**Possible Cause:**
FMI 2	• Data erratic, intermittent or incorrect	• Key ON, AAT message missing on SAE J1939 and SAE J1587 data links	• N/A	• Faulty instrument cluster • Faulty harness
FMI 9	• Abnormal Update Rate	• Key ON, AAT message missing on SAE J1587 data link	• N/A	• Faulty instrument cluster • Faulty harness
FMI 10	• Abnormal rate of change	• AAT sensor signal fault	• MIL illuminated	• Faulty instrument cluster
FMI 12	• Bad intelligent device or component	• Loss of SAE J1939 data link communication between engine control module (ECM) and instrument cluster control module	• MIL illuminated	• Faulty instrument cluster • Faulty harness

FMI 13	• Out of calibration	• AAT sensor signal fault • No AAT calculated by Vehicle ECU • No valid ambient temperature received by Engine Control Module	• MIL illuminated	• Faulty instrument cluster/harness or cluster harness connectors
FMI 14	• Special instructions	• AAT sensor signal fault	• MIL illuminated	• AAT sensor signal missing from Vehicle ECU
FMI 19	• Received network data in error	• AAT sensor signal fault	• MIL illuminated	• Faulty instrument cluster

ECM SPN 173, Engine Exhaust Gas Temperature (EGT) – MID 128 PID 173

Type of fault:	**FMI Description:**	**Fault Condition:**	**Possible Symptoms:**	**Possible Cause:**
FMI 0	• Data valid but above normal operational range - Most severe level	• EGT is critically high	• Engine derate • Poor driveability • Aftertreatement regeneration is not possible	• Faulty harness • Faulty harness connector • Intake air leak
FMI 2	• Data erratic, intermittent or incorrect	• Sensor is not rational	• MIL illuminated • Aftertreatement regeneration is not possible	• Faulty harness • Faulty harness connector • Exhaust leak • Intake air leak • Sensor failure
FMI 4	• Voltage below normal, or shorted to low source	• Short to ground on the metering side of the circuit	• MIL illuminated • Aftertreatement regeneration is not possible	• Sensor failure • Faulty harness • Faulty harness connector • Aftertreatment control module (ACM)
FMI 5	• Current below normal or open circuit	• Short to battery on the metering side of the circuit • Open in the metering side of the circuit • Open in the ground side of the circuit	• MIL illuminated	• Faulty harness • Sensor failure • Faulty harness connector

FMI 15	• Data valid but above normal operating range - Least severe level	• Sensor out of range • Sensor indicates a invalid value	• MIL illuminated	• Sensor failure • Faulty harness
FMI 16	• Data valid but above normal operating range - Moderately severe level	• EGT is moderately too high	• Engine derate • Poor driveability	• Faulty harness • Faulty harness connector • Intake air leak

ECM SPN 175, Engine Oil Temperature (EOT) 1 – MID 128 PID 175

Type of fault:	**FMI Description:**	**Fault Condition:**	**Possible Symptoms:**	**Possible Cause:**
FMI 0	• Data valid but above normal operational range - Most severe level	• Extreme driving conditions • EOT critically above range	• Red Stop or yellow Check lamps illuminated dependent of severity • Engine derate	• Extreme driving conditions • Engine cooling fan • Oil thermostat • Coolant system • Clogged oil cooler
FMI 2	• Data erratic, intermittent or incorrect	• EOT sensor indicating too high or too low a value (abnormal value)	• MIL illuminated • In some cases may have an effect on driveability	• EOT sensor failure • Faulty harness
FMI 4	• Voltage below normal, or shorted to low source	• Short circuit -, measuring line	• MIL illuminated • Yellow Check lamp illuminated	• EOT sensor failure • Faulty harness
FMI 5	• Current below normal or open circuit	• Short circuit +, measuring line • Open circuit	• MIL illuminated • Yellow Check lamp illuminated	• EOT sensor failure • Faulty harness
FMI 13	• Out of Calibration	• Sensor out of range • Sensor indicates a invalid value	• MIL illuminated	• EOT sensor failure
FMI 16	• Data valid but above normal operating range - Moderately severe level	• Extreme driving conditions • EOT is moderately too high	• Yellow Check lamp illuminated • Engine derate	• Extreme driving conditions • Engine cooling fan • Oil thermostat • Coolant system • Clogged oil cooler
FMI 17	• Data valid but below normal operating range - Least severe level	• Sensor out of range • Sensor indicates a invalid value	• MIL illuminated	• Engine Oil Temperature (EOT) sensor failure

ECM SPN 177, Transmission Oil Temperature – MID 128 PID 177

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Oil temperature critically above range	• Red Stop or yellow Check lamps illuminated dependent of severity	• Transmission oil cooler • Coolant system
FMI 16	• Data valid but above normal operating range - Moderately severe level	• Oil temperature is moderately too high	• Yellow Check lamp illuminated	• Extreme driving conditions • Engine cooling fan • Oil thermostat • Coolant system • Clogged oil cooler

ECM SPN 188, Engine Speed At Idle, Point 1 (Engine Configurations) – MID 128 PID 188

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Engine idle speed above desired speed	• MIL illuminated • High engine oil consumption • High fuel consumption	• Engine oil entering cylinders • Leaking or faulty fuel injector
FMI 1	• Data valid but below normal operational range - Most severe level	• Engine idle speed below desired speed	• MIL illuminated • High fuel consumption	• Low engine torque production • Faulty fuel injector • Low cylinder compression • Engine friction is too high

ECM SPN 190, Engine Speed – MID 128 PID 190

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Engine is/was overspeeding	• Red Stop lamp illuminated	• Engine oil entering cylinders • Faulty crankcase oil filter • Possible engine brake engaged causing engine overspeeding • Possible transmission downshift causing engine overspeeding

ECM SPN 228, Speed Sensor Calibration – MID 128 PID 228

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• SAE J1587 data link calibration factor message does not exist. (vehicle ECU (VECU) error).	• Your trip data	• VECU
FMI 11	• Failure mode not identifiable	• SAE J1587 data link calibration factor message does not exist. (vehicle ECU (VECU) error).	• Your trip data	• VECU

ECM SPN 237, Vehicle Identification Number (VIN) – MID 128 PSID 161

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent or incorrect	• No answer from VIN	• Yellow Check lamp illuminated • Engine will not start	• Data link error • Engine control module (ECM) • Missing VIN in other electronic control units (ECUs) commonly vehicle electronic control unit (VECU), light control module (LCM)
FMI 12	• Bad intelligent device or component	• Bad answer from VIN	• Yellow Check lamp illuminated • Engine will not start	• Engine control module (ECM) • Mismatched VIN sent from other electronic control units (ECUs) commonly vehicle electronic control unit (VECU), light control module (LCM))

ECM SPN 245, Total Vehicle Distance – MID 128 PID 245

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• SAE J1587 data link total vehicle distance message does not exist. (vehicle ECU (VECU) error).	• N/A	• VECU

ECM SPN 251, Time – MID 128 PID 251

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent or incorrect	• Time data message missing on SAE J1587 and J1939 data links. (Cluster error). • Time stamp from cluster isn't available.	• N/A	• Instrument Cluster
FMI 9	• Abnormal update rate	• Time data message didn't arrive when expected. (Cluster error). • Time stamp from cluster isn't available.	• N/A	• Instrument Cluster
FMI 10	• Abnormal rate of change	• Soak time too long. • Time data fault, data deemed inaccurate.	• MIL illuminated	• Instrument Cluster
FMI 12	• Bad intelligent device or component	• Time and date data missing on J1939 data link.	• MIL illuminated	• Instrument Cluster • Faulty harness • Faulty harness connector
FMI 13	• Out of calibration	• Time/date fault	• MIL illuminated	• Instrument Cluster • Faulty harness • Faulty harness connector
FMI 19	• Received network data in error	• Soaktime too long. • Time data fault, data deemed inaccurate.	• MIL illuminated	• Instrument Cluster

ECM SPN 252, Date – MID 128 PID 252

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Time stamp from cluster isn't available. • Date data message missing on SAE J1587 data link. (Cluster error).	• N/A	• Instrument Cluster

ECM SPN 411, Engine Exhaust Gas Recirculation (EGR) Differential Pressure – MID 128 PID 411

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• EGR differential pressure sensor output reading too high. (abnormal value)	• MIL illuminated • Engine derate	• Faulty harness • Faulty harness connector • Faulty sensor • EGR leakage • Clogged EGR cooler
FMI 2	• Data erratic, intermittent or incorrect	• Only used to control EGR valve.	• N/A	• N/A
FMI 3	• Voltage above normal or shorted to high source	• Short to battery in metering line • Open in the ground circuit	• MIL illuminated • Engine derate	• Faulty EGR differential pressure sensor connector • Faulty EGR differential pressure sensor harness • Faulty EGR differential pressure sensor
FMI 5	• Current below normal or open circuit	• Open in the 5 volt supply line • Short to ground in metering line • Open in the metering line	• MIL illuminated • Engine derate	• Faulty EGR differential pressure sensor connector • Faulty EGR differential pressure sensor harness • Faulty EGR differential pressure sensor
FMI 7	• Mechanical system not responding or out of adjustment	• EGR differential pressure sensor is read either to high or too low. (Abnormal value).	• MIL illuminated • Engine derate	• Faulty EGR differential pressure sensor connector • Faulty EGR differential pressure sensor harness • Faulty EGR differential pressure sensor • EGR valve • EGR valve leak • Clogged venturi

FMI 10	• Abnormal rate of change	• EGR differential pressure sensor out of range (too high)	• N/A	• Faulty EGR differential pressure sensor
FMI 14	• Special instructions	• EGR differential pressure sensor out of range (too low)	• N/A	• Faulty EGR differential pressure sensor
FMI 16	• Data valid but above normal operating range - Moderately severe level	• EGR differential pressure sensor out of range (too high)	• N/A	• Faulty EGR differential pressure sensor
FMI 18	• Data valid but below normal operating range - Moderately severe level	• EGR differential pressure sensor out of range (too low)	• N/A	• Faulty EGR differential pressure sensor

ECM SPN 412, Engine Exhaust Gas Recirculation (EGR) Temperature – MID 128 PID 412

Type of fault:	**FMI Description:**	**Fault Condition:**	**Possible Symptoms:**	**Possible Cause:**
FMI 0	• Data valid but above normal operational range - Most severe level	• Engine EGR Temperature is above range	• Engine derate	• Extreme driving conditions • EGR cooler failure
FMI 2	• Data erratic, intermittent or incorrect	• EGR temperate signal, believed to be not valid (plausibility fault)	• MIL illuminated • Engine derate	• Faulty sensor
FMI 4	• Voltage below normal, or shorted to low source	• Short to ground on the metering side of the EGR Sensor circuit	• MIL illuminated • Engine power will be derated according to the error torque map	• Faulty EGR temperature sensor connector • Faulty EGR temperature sensor harness • Faulty EGR temperature sensor
FMI 5	• Current below normal or open circuit	• Short to battery in the metering side of the EGR Sensor circuit • Open in the metering side of the EGR Sensor circuit • Open circuit in the ground line of the EGR Sensor circuit	• MIL illuminated • Engine derate	• Faulty EGR temperature sensor connector • Faulty EGR temperature sensor harness • Faulty EGR temperature sensor

FMI 13	• Out of calibration	• Engine EGR temperature sensor is out of range (low) • Sensor indicates a invalid value	• MIL illuminated	• Faulty EGR temperature sensor connector • Faulty EGR temperature sensor harness • Faulty EGR temperature sensor
FMI 13	• Out of calibration	• Engine EGR temperature sensor is above range	• Engine derate	• Extreme driving conditions • EGR cooler failure
FMI 15	• Data valid but above normal operating range - Least severe level	• Engine EGR temperature sensor is out of range (high) • Sensor indicates a invalid value	• MIL illuminated	• Faulty EGR temperature sensor connector • Faulty EGR temperature sensor harness • Faulty EGR temperature sensor
FMI 16	• Data valid but above normal operating range - Moderately severe level	• Engine EGR temperature is above range	• Engine derate	• Extreme driving conditions • EGR cooler failure
FMI 17	• Data valid but below normal operating range - Least severe level	• Engine EGR temperature is out of range (low) • Sensor indicates a invalid value	• MIL illuminated	• Faulty EGR temperature sensor connector • Faulty EGR temperature sensor harness • Faulty EGR temperature sensor

ECM SPN 558, Accelerator Pedal 1 Idle Validation Switch (IVS) – MID 128 SID 230

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• IVS signal shorted to voltage	• Yellow Check lamp illuminated	• Faulty harness or connector
FMI 5	• Current below normal or open circuit	• IVS signal shorted to ground or open	• Yellow Check lamp illuminated	• Faulty harness or connector

ECM SPN 626, Intake Air Heater (IAH) Relay – MID 128 PID 45

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Short Circuit +, Measuring line	• IAH relay not activated • White smoke for cold start • Start problems in cold climate	• IAH relay solenoid shorted

FMI 4	• Voltage below normal, or shorted to low source	• Short Circuit -, Measuring line	• Yellow Check lamp illuminated • Induction air is hot • IAH relay is impossible to turn off	• Faulty harness
FMI 5	• Current below normal or open circuit	• Open Circuit	• Preheat relay not activated • White smoke for cold start • Start problems in cold climate	• Faulty IAH relay • Faulty harness

ECM SPN 628, Program Memory – MID 128 SID 240

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent or incorrect	• Check sum error	• Red Stop lamp illuminated • Engine will not start	• Engine Control Module (ECM) software
FMI 11	• Root cause not known	• Bad software configuration	• MIL illuminated • Engine will not start	• Engine Control Module (ECM) software
FMI 12	• Bad intelligent device or component	• Error on code-part of flash RAM or erased vendor area	• Red Stop lamp illuminated • Nothing functions	• Engine Control Module (ECM) software • Engine Control Module (ECM)
FMI 14	• Special instructions	• VIN not loaded yet	• Flashing MIL • Engine will not start	• Vehicle identification number (VIN) missing

ECM SPN 629, Electronic Control Unit (ECU) 1 – MID 128 SID 254

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 8	• Abnormal frequency or pulse width or period	• Self test failure	• Red Stop lamp illuminated • Not possible to program Engine Control Module (ECM)	• ECM
FMI 12	• Bad intelligent device or component	• Self test failure	• Red Stop lamp illuminated • Engine will not start	• ECM

ECM SPN 630, Calibration Memory – MID 128 SID 253

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent or incorrect	• Check sum error	• Red Stop lamp illuminated • Engine will not start	• Engine Control Module (ECM) software
FMI 12	• Bad intelligent device or component	• Check sum error	• Red Stop lamp illuminated • Engine will not start	• Engine Control Module (ECM)
FMI 14	• Special instructions	• Vehicle identification number (VIN) not loaded yet	• Loss of log data and some user configurable data	• Engine Control Module (ECM) software

ECM SPN 631, Calibration Module – MID 128 PSID 77/PSID 124

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Check sum error	• Engine will not start	• Aftertreatment control module (ACM) software error
FMI 8	• Abnormal frequency or pulse width or period	• Reset of ECM does not work	• Engine will not start	• Aftertreatment control module (ACM) software error

ECM SPN 633, Engine Fuel Actuator 1 Control Command – MID 128 SID 18

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted +	• Yellow Check lamp illuminated • Valve constantly shut	• Faulty solenoid • Faulty harness • Faulty engine control module (ECM) driver
FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted –	• Yellow Check lamp illuminated • High fuel consumption due to fuel leakage	• Faulty solenoid • Faulty harness • Faulty engine control module (ECM) driver
FMI 5	• Current below normal or open circuit	• Open circuit	• Yellow Check lamp illuminated • Valve constantly shut	• Faulty solenoid • Faulty harness

ECM SPN 636, Camshaft Position (CMP) Sensor – MID 128 SID 21

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent or incorrect	• Phase Error - Incorrect correlation between CMP and crankshaft position (CKP) sensor	• MIL illuminated • Increase in fuel consumption	• Engine timing

FMI 3	• Voltage above normal, or shorted to high source	• Missing Signal from CMP sensor • Open in the CMP sensor circuit • Short to battery in the CMP sensor circuit • Short to ground in the CMP sensor circuit	• MIL illuminated • Possible loss of engine power • Increased engine start time	• Faulty harness
FMI 8	• Abnormal frequency or pulse width or period	• Noisy Signal from CMP sensor • Open in the CMP sensor circuit	• MIL illuminated • Possible loss of engine power • Increased engine start time	• Faulty CMP sensor • Faulty harness

ECM SPN 637, Crankshaft Position (CKP) Sensor – MID 128 SID 22

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent or incorrect	• Intermittent or weak signal	• MIL illuminated • Yellow Check lamp illuminated • Increased fuel consumption • Imprecise engine timing • Increased fuel consumption • Uneven cylinder balancing • Power loss • Smoke	• Faulty CKP sensor harness • Faulty CKP sensor
FMI 3	• Voltage above normal, or shorted to high source	• Missing signal CKP sensor • Open in the CKP sensor circuit • Short to battery in the CKP sensor circuit • Short to ground in the CKP sensor circuit	• MIL illuminated • Yellow Check lamp illuminated • Possible loss of engine power • Increased fuel consumption	• Faulty CKP sensor harness • Faulty CKP sensor
FMI 8	• Abnormal frequency or pulse width or period	• Erratic or intermittent signal from CKP sensor • Open in the CKP sensor	• MIL illuminated • Yellow Check lamp illuminated • Possible loss of engine power • Increased engine start time • Increased fuel consumption • Uneven cylinder balancing • Power loss • Smoke	• Faulty CKP sensor harness • Faulty CKP sensor mounting

ECM SPN 639, SAE J1939 Data Link 1 – MID 128 SID 231

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent or incorrect	• SAE J1939 high or low circuit shorted + • SAE J1939 high or low circuit shorted – • SAE J1939 high or low circuit open	• MIL illuminated	• Faulty harness or connector

ECM SPN 641, Engine Variable Geometry Turbocharger (VGT) Actuator 1 – MID 128 SID 27

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Engine VGT actuator temperature out of range	• Yellow Check lamp illuminated • Possible engine derate	• N/A
FMI 2	• Data erratic, intermittent or incorrect	• Engine VGT actuator has not seen a valid command on SAE J1939 (CAN2) data link • Incorrect data	• MIL illuminated • Yellow Check lamp illuminated • Low boost • Low power • Nozzle opens • Smoke from engine	• Disturbance on SAE J1939 (CAN2) data link
FMI 4	• Voltage below normal, or shorted to low source	• Short to ground	• MIL illuminated • Yellow Check lamp illuminated • Nozzle will open resulting in low power and low boost • Engine VGT actuator will continue to attempt and maintain target nozzle position	• Faulty engine VGT actuator connector • Faulty engine VGT actuator harness • Low battery voltage

FMI 7	• Mechanical system not responding or out of adjustment	• Mechanical problem with the engine VGT actuator	• MIL illuminated • Yellow Check lamp illuminated • Low boost and smoke • Possible engine derate • Power loss in some cases when actuator motor has been disabled	• Engine VGT actuator motor effort is temporarily limited to prevent overheating • Restrictions detected when running learn sequence • Engine VGT actuator is slow to follow commands • Engine VGT actuator position is not tracking command
FMI 9	• Abnormal update rate	• Data from the engine VGT actuator has been missing for 2-seconds	• MIL illuminated • Yellow Check lamp illuminated • Engine derated (major) • EGR valve closed	• Data link harness • No supply to engine VGT actuator • Engine VGT actuator • Engine VGT actuator connector
FMI 12	• Bad intelligent device or component	• Engine VGT disabled by internal diagnostics	• MIL illuminated • Yellow Check lamp illuminated • Nozzle will open resulting in low power, low boost and smoke	• Loss of communication • Internal diagnostic failures • Data storage failure • Over rotation • Engine VGT actuator • Engine VGT actuator connector
FMI 13	• Out of calibration	• Failed self-calibration	• Yellow Check lamp illuminated	• VGT actuator

ECM SPN 642, Engine Variable Geometry Turbocharger (VGT) Actuator 2 – MID 128 PPID 89

Type of fault	**FMI Description:**	**Fault Condition:**	**Possible Symptoms:**	**Possible Cause**
FMI 0	• Data valid but above normal operational range - Most severe level	• VGT actuator temperature is critically high	• Red Stop or yellow Check lamps illuminated dependent of severity • Engine derate	• Coolant system malfunction • Extreme driving conditions • Overheated engine VGT actuator
FMI 16	• Data valid but above normal operating range - Moderately severe level	• VGT actuator temperature is moderately too high	• Yellow Check lamp illuminated • Engine derate	• Coolant system malfunction • Extreme driving conditions • Overheated engine VGT actuator

ECM SPN 647, Engine Fan Clutch Output Device Driver – MID 128 SID 33

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Short to positive in the cooling fan control circuit	• Yellow Check lamp illuminated • Increased fuel consumption • Fan runs at full speed	• Faulty cooling fan actuator • Faulty cooling fan actuator harness or connector
FMI 4	• Voltage below normal, or shorted to low source	• Short to ground in the cooling fan control circuit • Output voltage is 1/3 the supply voltage	• Yellow Check lamp illuminated • Fan always deactivated or always activated if fault is intermittent	• Faulty cooling fan actuator • Faulty cooling fan actuator harness or connector
FMI 5	• Current below normal or open circuit	• Open in the cooling fan control circuit	• Increased fuel consumption • Fan runs at full speed	• Faulty cooling fan actuator • Faulty cooling fan actuator harness or connector

ECM SPN 651, Engine Injector Cylinder 1 – MID 128 SID 1

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Harness shorted + low side circuit	• MIL illuminated • Yellow Check lamp illuminated • Engine power loss • Engine running uneven (misfire)	• Faulty harness
FMI 5	• Current below normal or open circuit	• Harness shorted +, – or open high side circuit • Harness shorted – low side circuit	• MIL illuminated • Yellow Check lamp illuminated • Engine power loss • Engine running uneven (misfire)	• Faulty harness • Faulty engine injector

FMI 7	• Mechanical system not responding properly	• Cylinder balancing data above limit	• MIL illuminated	• PTO engaged without engine control module (ECM) knowing • Faulty engine injector • Low cylinder compression • Damaged or flywheel
FMI 13	• Out of calibration	• Cylinder balancing data above limit	• MIL illuminated	• PTO engaged without ECM knowing • Faulty engine fuel injector • Low cylinder compression • Damaged or flywheel

ECM SPN 652, Engine Injector Cylinder 2 – MID 128 SID 2

Type of fault:	**FMI Description:**	**Fault Condition:**	**Possible Symptoms:**	**Possible Cause:**
FMI 3	• Voltage above normal, or shorted to high source	• Harness shorted + low side circuit	• MIL illuminated • Yellow Check lamp illuminated • Engine power loss • Engine running uneven (misfire)	• Faulty harness
FMI 5	• Current below normal or open circuit	• Harness shorted +, – or open high side circuit • Harness shorted – low side circuit	• MIL illuminated • Yellow Check lamp illuminated • Engine power loss • Engine running uneven (misfire)	• Faulty harness • Faulty engine injector
FMI 7	• Mechanical system not responding properly	• Cylinder balancing data above limit	• MIL illuminated	• PTO engaged without engine control module (ECM) knowing • Faulty engine injector • Low cylinder compression • Damaged or flywheel
FMI 13	• Out of calibration	• Cylinder balancing data above limit	• MIL illuminated	• PTO engaged without engine control module (ECM) knowing • Faulty engine fuel injector • Low cylinder compression • Damaged or flywheel

ECM SPN 653, Engine Injector Cylinder 3 – MID 128 SID 3

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Harness shorted + low side circuit	• MIL illuminated • Yellow Check lamp illuminated • Engine power loss • Engine running uneven (misfire)	• Faulty harness
FMI 5	• Current below normal or open circuit	• Harness shorted +, – or open high side circuit • Harness shorted – low side circuit	• MIL illuminated • Yellow Check lamp illuminated • Engine power loss • Engine running uneven (misfire)	• Faulty harness • Faulty engine injector
FMI 7	• Mechanical system not responding properly	• Cylinder balancing data above limit	• MIL illuminated	• PTO engaged without engine control module ECM knowing • Faulty engine fuel injector • Low cylinder compression • Damaged or flywheel
FMI 13	• Out of calibration	• Cylinder balancing data above limit	• MIL illuminated	• PTO engaged without engine control module ECM knowing • Faulty engine injector • Low cylinder compression • Damaged or flywheel

ECM SPN 654, Engine Injector Cylinder 4 – MID 128 SID 4

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Harness shorted + low side circuit	• MIL illuminated • Yellow Check lamp illuminated • Engine power loss • Engine running uneven (misfire)	• Faulty harness
FMI 5	• Current below normal or open circuit	• Harness shorted +, – or open high side circuit • Harness shorted – low side circuit	• MIL illuminated • Yellow Check lamp illuminated • Engine power loss • Engine running uneven (misfire)	• Faulty harness • Faulty engine injector

FMI 7	• Mechanical system not responding properly	• Cylinder balancing data above limit	• MIL illuminated	• PTO engaged without engine control module (ECM) knowing • Faulty engine injector • Low cylinder compression • Damaged or flywheel
FMI 13	• Out of calibration	• Cylinder balancing data above limit	• MIL illuminated	• PTO engaged without engine control module (ECM) knowing • Faulty engine fuel injector • Low cylinder compression • Damaged or flywheel

ECM SPN 655, Engine Injector Cylinder 5 – MID 128 SID 5

Type of fault:	**FMI Description:**	**Fault Condition:**	**Possible Symptoms:**	**Possible Cause:**
FMI 3	• Voltage above normal, or shorted to high source	• Harness shorted + low side circuit	• MIL illuminated • Yellow Check lamp illuminated • Engine power loss • Engine running uneven (misfire)	• Faulty harness
FMI 5	• Current below normal or open circuit	• Harness shorted +, – or open high side circuit • Harness shorted – low side circuit	• MIL illuminated • Yellow Check lamp illuminated • Engine power loss • Engine running uneven (misfire)	• Faulty harness • Faulty engine injector
FMI 7	• Mechanical system not responding properly	• Cylinder balancing data above limit	• MIL illuminated	• PTO engaged without engine control module (ECM) knowing • Faulty engine fuel injector • Low cylinder compression • Damaged or flywheel
FMI 13	• Out of calibration	• Cylinder balancing data above limit	• MIL illuminated	• PTO engaged without engine control module (ECM) knowing • Faulty engine injector • Low cylinder compression • Damaged or flywheel

ECM SPN 656, Engine Injector Cylinder 6 – MID 128 SID 6

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Harness shorted + low side circuit	• MIL illuminated • Yellow Check lamp illuminated • Engine power loss • Engine running uneven (misfire)	• Faulty harness
FMI 5	• Current below normal or open circuit	• Harness shorted +, – or open high side circuit • Harness shorted – low side circuit	• MIL illuminated • Yellow Check lamp illuminated • Engine power loss • Engine running uneven (misfire)	• Faulty harness • Faulty engine injector
FMI 7	• Mechanical system not responding properly	• Cylinder balancing data above limit	• MIL illuminated	• PTO engaged without engine control module (ECM) knowing • Faulty engine fuel injector • Low cylinder compression • Damaged or flywheel
FMI 13	• Out of calibration	• Cylinder balancing data above limit	• MIL illuminated	• PTO engaged without engine control module (ECM) knowing • Faulty engine injector • Low cylinder compression • Damaged or flywheel

ECM SPN 677, Engine Starter Motor Relay – MID 128 SID 39

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted +	• Yellow Check lamp illuminated • Engine will not start	• Faulty starter relay • Fault harness
FMI 5	• Current below normal or open circuit	• Open circuit	• Yellow Check lamp illuminated • Engine will not start	• Faulty starter relay • Fault harness

ECM SPN 729, Intake Air Heater (IAH) 1 – MID 128 SID 70

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted +, measuring line	• Yellow Check lamp illuminated	• Faulty IAH relay • Faulty IAH 1
FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted –, measuring line	• Yellow Check lamp illuminated	• Faulty IAH relay • Faulty IAH 1
FMI 5	• Current below normal or open circuit	• Open circuit	• Yellow Check lamp illuminated	• Faulty IAH 1

ECM SPN 730, Intake Air Heater (IAH) 2 – MID 128 SID 71

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted +, measuring line	• Yellow Check lamp illuminated	• Faulty IAH relay • Faulty IAH 2
FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted –, measuring line	• Yellow Check lamp illuminated	• Faulty IAH relay • Faulty IAH 2
FMI 5	• Current below normal or open circuit	• Open circuit	• Yellow Check lamp illuminated	• Faulty IAH 2

ECM SPN 931, Engine Fuel Supply Pump Actuator – MID 128 SID 78

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Fuel priming pump circuit shorted +	• Fuel priming or drain aborted and inhibited	• Faulty actuator • Faulty harness
FMI 4	• Voltage below normal, or shorted to low source	• Fuel priming pump circuit shorted –,	• Fuel priming pump permanently on	• Faulty actuator • Faulty harness
FMI 5	• Current below normal or open circuit	• Open circuit fuel priming pump	• Fuel priming or drain inhibited	• Faulty actuator • Faulty harness

ECM SPN 970, Engine Auxiliary Shutdown Switch – MID 128 PPID 6

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Engine shutdown switch circuit shorted +	• Engine shutdown switch can not be activated	• Engine shutdown switch
FMI 5	• Current below normal or open circuit	• Open circuit in engine shutdown switch	• Engine shutdown switch can not be activated	• Engine shutdown switch

ECM SPN 975, Estimated Percent Fan Speed – (MID 128 PID 26)

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Missing signal from Fan Speed Sensor • Short Circuit +, Measuring line • Short Circuit -, Measuring line • Open Circuit, Measuring line • Open Circuit, Ground line	• Higher fuel consumption • Will work as on/off fan, 100%fan speed if cooling is needed	• Cooling Fan Speed (CFS) sensor failure • Faulty Cooling Fan Speed (CFS) sensor harness

ECM SPN 1072, Engine Compression Brake Output #1 – MID 128 PPID 122

Type of fault	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause
FMI 1	• Data valid but below normal operational range - Most severe level	• Below range	• Info lamp illuminated • No engine compression brake	• Low engine oil temperature
FMI 3	• Voltage above normal, or shorted to high source	• Short Circuit +	• Yellow Check lamp illuminated • Engine compression brake can not be turned on • Engine brake function derated • Gear shift performance derated for some automatic transmissions	• Faulty engine compression brake actuator • Faulty harness
FMI 4	• Voltage below normal, or shorted to low source	• Short Circuit -	• Yellow Check lamp illuminated • Engine compression brake can not be turned off • Engine stops running • Engine impossible to restart	• Faulty engine compression brake actuator • Faulty harness
FMI 5	• Current below normal or open circuit	• Open Circuit	• Yellow Check lamp illuminated • Engine compression brake can not be turned on • Engine brake function derated • Gear shift performance derated for some automatic transmission boxes	• Faulty engine compression brake actuator • Faulty harness

ECM SPN 1127, Engine Turbocharger Intake Manifold Pressure (IMP) – MID 128 PSID 98

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range	• Engine turbocharger boost pressure is too high	• MIL illuminated • Turbocharger surge	• Exhaust gas recirculation (EGR) system failure • Faulty engine turbocharger oulet pressure sensor
FMI 1	• Data valid but below normal operational range	• Engine turbocharger boost pressure is too low	• MIL illuminated • Engine derate • Engine slow to respond	• Air leak in turbocharger hoses, pipes, brackets, cooler or components • EGR system fault
FMI 10	• Abnormal rate of change	• Poor engine turbocharger boost pressure response	• MIL illuminated • Engine power loss/re-sponse/drivability	• Engine turbocharger inlet air system leak • Faulty engine turbocharger
FMI 11	• Root cause not known	• Engine variable geometry turbocharger (VGT) control mode fault	• MIL illuminated	• Engine VGT fault
FMI 14	• Special instructions	• Poor engine turbocharger boost pressure response	• MIL illuminated	• Air leak in engine turbocharger hoses, pipes, brackets, cooler or components • Engine variable geometry turbocharger (VGT) fault • Oil pressure fault
FMI 16	• Data valid but above normal operating range - Moderately severe level	• Engine turbocharger boost pressure is too high	• MIL illuminated • Engine turbocharger surge	• Exhaust gas recirculation (EGR) system failure • Faulty sensor
FMI 18	• Data valid but below normal operating range - Moderately severe level	• Engine turbocharger boost pressure is too low	• MIL illuminated • Engine derate • Engine slow to respond	• Air leak in engine turbocharger hoses, pipes, brackets, cooler or components • Exhaust gas recirculation (EGR) system failure

ECM SPN 1136, Engine Control Module (ECM) Temperature – MID 128 PPID 55

Type of fault	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause
FMI 4	• Voltage below normal, or shorted to low source	• Short to ground on the metering circuit	• N/A	• ECM

FMI 5	• Current below normal or open circuit	• Short to battery in the metering circuit • Open in the metering circuit • Open circuit in the ground circuit	• N/A	• ECM

ECM SPN 1198, Anti–theft Random Number – MID 128 PID 224

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent or incorrect	• Engine control module (ECM) and instrument cluster control module security codes do not match	• Yellow Check lamp illuminated • Can start engine	• Security system failure
FMI 12	• Bad intelligent device or component	• Security system not installed	• Yellow Check lamp illuminated • Can start engine	• Security system failure

ECM SPN 1231, SAE J1939 Data Link 2 – MID 128 PSID 229

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent or incorrect	• Circuit shorted + • Circuit shorted – • Open circuit	• MIL illuminated • Engine power loss • No Aftertreatment Diesel Exhaust Fluid (DEF) dosing • No engine variable geometry engine turbocharger (VGT) control	• Faulty harness
FMI 9	• Abnormal update rate	• Missing signal from transmission control module (TCM)	• MIL illuminated • Yellow Check lamp illuminated • No Aftertreatment Diesel Exhaust Fluid (DEF) dosing	• SAE J1939 data link • Faulty harness or connectors • DEF pump • DEF control module

ECM SPN 1265, Engine Piston Cooling Oil Pressure Actuator – MID 128 SID 85

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted +	• Yellow Check lamp illuminated • Possible smoke during start up	• Faulty harness • Faulty actuator
FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted –	• Red Stop lamp illuminated • Engine damage can occur without piston cooling	• Faulty harness • Faulty actuator
FMI 5	• Current below normal or open circuit	• Open circuit	• Yellow Check lamp illuminated • Possible smoke during start up	• Faulty harness • Faulty actuator

ECM SPN 1322, Engine Misfire for Multiple Cylinders – MID 128 PSID 27

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 8	• Abnormal frequency or pulse width or period	• Cylinder misfires detected in multiple cylinders	• MIL illuminated • Rough idle	• Engine injectors
FMI 31	• Condition exists	• Cylinder misfires detected in multiple cylinders	• MIL illuminated • Rough idle	• Engine injectors

ECM SPN 1323, Engine Misfire Cylinder #1 – MID 128 SID 1

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 8	• Abnormal frequency or pulse width or period	• Cylinder misfires detected in cylinder 1	• MIL illuminated • Rough idle	• Engine injector
FMI 31	• Condition exists	• Cylinder misfires detected in cylinder1	• MIL illuminated • Rough idle	• Engine injector

ECM SPN 1324, Engine Misfire Cylinder #2 – MID 128 SID 2

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 8	• Abnormal frequency or pulse width or period	• Cylinder misfires detected in cylinder 2	• MIL illuminated • Rough idle	• Engine injector
FMI 31	• Condition exists	• Cylinder misfires detected in cylinder 2	• MIL illuminated • Rough idle	• Engine injector

ECM SPN 1325, Engine Misfire Cylinder #3 – MID 128 SID 3

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 8	• Abnormal frequency or pulse width or period	• Cylinder misfires detected in cylinder 3	• MIL illuminated • Rough idle	• Engine injector
FMI 31	• Condition exists	• Cylinder misfires detected in cylinder 3	• MIL illuminated • Rough idle	• Engine injector

ECM SPN 1326, Engine Misfire Cylinder #4 – MID 128 SID 4

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 8	• Abnormal frequency or pulse width or period	• Cylinder misfires detected in cylinder 4	• MIL illuminated • Rough idle	• Engine injector
FMI 31	• Condition exists	• Cylinder misfires detected in cylinder 4	• MIL illuminated • Rough idle	• Engine injector

ECM SPN 1327, Engine Misfire Cylinder #5 – MID 128 SID 5

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 8	• Abnormal frequency or pulse width or period	• Cylinder misfires detected in cylinder 5	• MIL illuminated • Rough idle	• Engine injector
FMI 31	• Condition exists	• Cylinder misfires detected in cylinder 5	• MIL illuminated • Rough idle	• Engine injector

ECM SPN 1328, Engine Misfire Cylinder #6 – MID 128 SID 6

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 8	• Abnormal frequency or pulse width or period	• Cylinder misfires detected in cylinder 6	• MIL illuminated • Rough idle	• Engine injector
FMI 31	• Condition exists	• Cylinder misfires detected in cylinder 6	• MIL illuminated • Rough idle	• Engine injector

ECM SPN 1659, Engine Coolant System Thermostat – MID 128 PSID 109

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 7	• Mechanical system not responding or out of adjustment	• Thermostat stuck closed	• Possible poor drivability	• Coolant thermostat
FMI 12	• Bad intelligent device or component	• Thermostat is leaking or stuck open	• MIL illuminated • Longer engine warm up time • Poor heat in cab	• Coolant thermostat

ECM SPN 1675, Engine Starter Mode – MID 128 SID 39

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Starter overheating	• Engine will not start	• Starter is deactivated due to overheating
FMI 7	• Mechanical system not responding or out of adjustment	• Transmission not in neutral	• Engine will not start	• Starter is deactivated due to overheating
FMI 10	• Abnormal rate of change	• Starter gear is stuck, engaged with engine	• Engine will not start	• Starter is deactivated due to overheating
FMI 14	• Special instructions	• PTO is engaged or switch on	• Engine will not start	• Starter is deactivated due to overheating

ECM SPN 1677, Aftertreatment Diesel Particulate Filter (DPF) Auxiliary Heater Mode – MID 128 PSID 25

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range — most severe level	• Truck has idled too long without completing a periodic heat mode	• Red Stop lamp illuminated • Engine derate • High temperature spikes in DPF when driving is resumed or during stationary regeneration	• Extremely cold ambient temperatures • PTO operated with limited exhaust temperatures • Engine turbocharger • Engine turbocharger compressor bypass valve
FMI 7	• Mechanical system not responding or out of adjustment	• Truck has idled too long without completing a periodic heat mode	• Yellow Check lamp illuminated • White exhaust smoke • High temperature spikes in DPF when driving is resumed or during stationary regeneration	• Extremely cold ambient temperatures • PTO operated with limited exhaust temperatures • Engine turbocharger • Engine turbocharger compressor bypass valve
FMI 16	• Data valid but above normal operating range - Moderately severe level	• Truck has idled too long without completing a periodic heat mode	• Yellow Check lamp illuminated • White exhaust smoke • High temperature spikes in DPF when driving is resumed or during stationary regeneration	• Extremely cold ambient temperatures • PTO operated with limited exhaust temperatures • Engine turbocharger • Engine turbocharger compressor bypass valve

ECM SPN 1761, Aftertreatment Diesel Exhaust Fluid (DEF) Tank Level – PPID 278

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Short circuit high side	• N/A	• Aftertreatment DEF tank pickup assembly/sensor failure
FMI 5	• Current below normal or open circuit	• Short circuit + • Open circuit	• Yellow Check lamp illuminated	• Aftertreatment DEF tank pickup assembly/sensor failure
FMI 11	• Root cause not known	• Aftertreatment DEF tank level low (driver warning)	• Low aftertreatment DEF fluid lamp illuminated	• N/A

FMI 14	• Special Instructions	• Aftertreatment DEF tank almost empty (driver warning)	• Low aftertreatment DEF fluid lamp illuminated • No Aftertreatment DEF dosing	• N/A
FMI 18	• Data valid but below normal operating range - Moderately severe level	• Aftertreatment DEF tank almost empty (driver warning)	• Low aftertreatment DEF fluid lamp illuminated • No aftertreatment DEF dosing	• N/A

ECM SPN 2017, Cruise Control Status – MID 128 PID 85

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Missing cruise control signal from vehicle electronic control unit (VECU)	• Cruise control does not work	• No clutch information to engine control module (ECM) from SAE J1939 data link

ECM SPN 2023, Invalid or Missing Data From Instrument Cluster – MID 128 PSID 202

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 8	• Abnormal frequency or pulse width or period	• Missing signal from instrument cluster via SAE J1939 (CAN 1) data link (CM1 signal)	• Yellow Check lamp illuminated	• Faulty harness or connections

ECM SPN 2029, Invalid or Missing Data from Vehicle ECU – MID 128 PSID 201

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Missing signal from cluster	• MIL illuminated	• Faulty harness

ECM SPN 2629, Engine Turbocharger Compressor Outlet Temperature – MID 128 PID 404

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Estimated engine turbocharger discharge temperature error.	• Engine derate	• High ambient air temperature (AAT) • Low barometric pressure • Leak in engine turbocharger inlet tube
FMI 2	• Data erratic, intermittent or incorrect	• Engine turbocharger outlet temperature signal believed to be not valid (high) (plausibility fault)	• Engine derate • MIL illuminated	• Engine turbocharger outlet temperature sensor
FMI 4	• Voltage below normal, or shorted to low source	• Short circuit –, measuring line	• MIL illuminated • Yellow Check lamp illuminated	• Engine turbocharger outlet temperature sensor • Faulty harness
FMI 5	• Current below normal or open circuit	• Short circuit +, measuring line • Open circuit	• MIL illuminated • Yellow Check lamp illuminated	• Engine turbocharger outlet temperature sensor • Faulty harness
FMI 13	• Out of calibration	• Sensor out of range	• MIL illuminated	• Engine turbocharger outlet temperature sensor
FMI 15	• Data valid but above normal operating range - Least severe level	• Sensor out of range	• MIL illuminated	• Engine turbocharger outlet temperature sensor
FMI 17	• Data valid but below normal operating range - Least severe level	• Sensor out of range	• MIL illuminated	• Faulty Engine turbocharger outlet temperature sensor

ECM SPN 2659, Engine Exhaust Gas Recirculation (EGR) Mass Flow Rate – MID 128 PPID 35

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0 (J1587 only)	• Data valid but above normal operational range	• EGR flow is too high	• MIL illuminated • Exhaust smoke	• Faulty EGR system
FMI 1	• Data valid but below normal operational range	• EGR flow is too low	• MIL illuminated	• Faulty EGR system • Clogged EGR cooler

FMI 16	• Data valid but above normal operating range - Moderately severe level	• EGR flow is too high	• MIL illuminated • Exhaust smoke	• Faulty EGR system • Faulty harness or connector
FMI 18	• Data valid but below normal operating range - Moderately severe level	• EGR flow is too low	• MIL illuminated	• Faulty EGR system • Clogged EGR cooler • Faulty harness or connector

ECM SPN 2791, Engine Exhaust Gas Recirculation (EGR) Valve Control – MID 128 SID 146

Type of fault:	**FMI Description:**	**Fault Condition:**	**Possible Symptoms:**	**Possible Cause:**
FMI 3	• Voltage above normal, or shorted to high source	• Stuck EGR valve • EGR valve circuit shorted + • EGR valve circuit shorted to –	• MIL illuminated • Engine derate	• Faulty harness or connector • Faulty EGR valve
FMI 5	• Current below normal or open circuit	• Open EGR valve circuit	• MIL illuminated • Engine derate	• Faulty harness or connector • Faulty EGR valve

ECM SPN 3031, Aftertreatment Diesel Exhaust Fluid (DEF) Tank Temperature – MID 128 PPID 274

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Aftertreatment DEF tank temperature too high • Date data message missing on SAE J1587 data link. (cluster error).	• MIL illuminated • No Aftertreatment DEF dosing	• Aftertreatment DEF tank pickup assembly/sensor failure
FMI 4	• Voltage below normal, or shorted to low source	• Short Circuit -	• MIL illuminated	• Aftertreatment DEF tank pickup assembly/sensor failure • Aftertreatment DEF tank pickup asssembly/sensor wiring or connectors
FMI 5	• Current below normal or open circuit	• Short Circuit + • Open Circuit	• MIL illuminated	• Aftertreatment DEF tank pickup assembly/sensor failure • Aftertreatment DEF tank pickup assembly/sensor wiring or connectors
FMI 8	• Abnormal frequency or pulse width or period	• Sensor ripple is not too high	• N/A	• Aftertreatment DEF tank pickup assembly/sensor failure • Aftertreatment DEF tank pickup ‘assembly/sensor wiring or connectors

ECM SPN 3064, Aftertreatment Diesel Particulate Filter (DPF) System Monitor – MID 128 PPID 326

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Moderately high soot load	• Yellow Check lamp illuminated • Medium to high engine derate	• Aftertreatment DPF clogged • Aftertreatment hydrocarbon doser clogged • Aftertreatment regeneration disabled by driver or other component
FMI 10	• Abnormal rate of change	• Soot loading high due to heavy load or use (no problem)	• Yellow Check lamp illuminated • Engine derate	• No error, condition occurs during heavy load or use with high soot loading
FMI 11	• Root cause not known	• Critically high soot load	• Red Stop lamp illuminated • High engine derate • Engine derate	• Aftertreatment DPF clogged • Aftertreatment hydrocarbon doser • Aftertreatment regeneration disabled by driver or other component

ECM SPN 3216, Aftertreatment Intake NOx – MID 128 PPID 348

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent or incorrect	• Aftertreatment intake NOx sensor error (plausibility) • Mismatch between aftertreatment intake NOx sensor and aftertreatment outlet NOx sensor	• MIL illuminated	• Engine outlet NOx high • Faulty aftertreatment intake NOx sensor
FMI 3	• Voltage above normal, or shorted to high source	• Short Circuit, aftertreatment intake NOx signal	• MIL illuminated	• Faulty wiring between aftertreatment intake NOx sensor and sensor electronic control module • Faulty aftertreatment intake NOx sensor
FMI 5	• Current below normal or open circuit	• Open Circuit, aftertreatment intake NOx signal	• MIL illuminated	• Faulty wiring between aftertreatment intake NOx sensor and sensor electronic control module • Faulty aftertreatment intake NOx sensor
FMI 9	• Abnormal update rate	• Missing signal from aftertreatment intake NOx sensor	• MIL illuminated • Yellow Check lamp illuminated	• Loss of communication from aftertreatment intake NOx sensor electronic control module and engine control module (ECM)
FMI 11	• Root cause not known	• Aftertreatment intake NOx sensor measures near zero for long time with high load	• MIL illuminated	• Faulty aftertreatment intake NOx sensor
FMI 12	• Bad intelligent device or component	• Aftertreatment intake NOx sensor, signal corrupt (incorrect value)	• MIL illuminated	• Faulty aftertreatment intake NOx sensor
FMI 13	• Out of calibration	• Aftertreatment intake NOx, sensor activation (incorrect value)	• MIL illuminated	• Faulty aftertreatment intake NOx sensor
FMI 14	• Special instructions	• Missing signal from aftertreatment intake NOx sensor due to battery voltage	• MIL illuminated	• Voltage to aftertreatment intake NOx sensor is too high or too low • Faulty aftertreatment intake NOx sensor

ECM SPN 3226, Aftertreatment Outlet NOx – MID 128 PPID 270/ PSID 90

MID 233 Fault code sent by MID 128 engine control module (ECM)

Type of fault	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause
FMI 2	• Data erratic, intermittent or incorrect	• Aftertreatment intake NOx sensor error (plausibility) • Mismatch between aftertreatment intake NOx sensor and aftertreatment outlet NOx sensor	• MIL illuminated	• Engine outlet NOx high • Faulty aftertreatment outlet NOx sensor • Aftertreatment diesel exhaust fluid (DEF) quality
FMI 3	• Voltage above normal or shorted to high source	• Short Circuit, aftertreatment outlet NOx signal	• MIL illuminated	• Faulty wiring between aftertreatment outlet NOx sensor and sensor electronic control module • Faulty aftertreatment outlet NOx sensor
FMI 5	• Current below normal or open circuit	• Open Circuit, aftertreatment outlet NOx signal	• MIL illuminated	• Faulty wiring between aftertreatment outlet NOx sensor and sensor electronic control module • Faulty aftertreatment outlet NOx sensor
FMI 9	• Abnormal update rate	• Missing signal from aftertreatment outlet NOx sensor	• MIL illuminated • Yellow Check lamp illuminated	• Loss of communication from aftertreatment outlet NOx sensor electronic control module and engine control module (ECM)
FMI 11	• Root cause not known	• Aftertreatment outlet NOx sensor measures near zero for long time with high load	• MIL illuminated	• Faulty aftertreatment outlet NOx sensor
FMI 12	• Bad intelligent device or component	• Aftertreatement outlet NOx sensor, signal corrupt (incorrect value)	• MIL illuminated	• Faulty aftertreatment outlet NOx sensor
FMI 13	• Out of calibration	• Aftertreatement outlet NOx sensor, activation (incorrect value)	• MIL illuminated	• Faulty aftertreatment outlet NOx sensor
FMI 14	• Special instructions	• Missing signal from aftertreatment outlet NOx sensor due to battery voltage	• MIL illuminated	• Voltage to aftertreatment outlet NOx sensor is too high or too low • Faulty harness to aftertreatement outlet NOx sensor

ECM SPN 3245, Aftertreatment Diesel Particulate Filter (DPF) Outlet Temperature – MID 128 PPID 436

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Aftertreatment DPF outlet temperature critically too high	• Low engine power	• Restricted Catalyst • Intake air leak • Faulty aftertreatment DPF outlet temperature sensor
FMI 2	• Data erratic, intermittent or incorrect	• Aftertreatment DPF outlet temperature sensor is not rational (plausibility)	• MIL illuminated • Aftertreatment regeneration not possible	• Faulty aftertreatment DPF outlet temperature sensor • Exhaust system leak • Faulty harness connectors or connections
FMI 4	• Voltage below normal, or shorted to low source	• Short to ground on the metering side of the circuit	• MIL illuminated • Aftertreatment regeneration not possible	• Faulty harness • Faulty aftertreatment DPF outlet temperature sensor • Aftertreatment control module (ACM)
FMI 5	• Current below normal or open circuit	• Short to battery on the metering side of the circuit • Open in the metering side of the circuit • Open in the ground side of the circuit	• MIL illuminated	• Faulty harness • Faulty aftertreatment DPF outlet temperature sensor • Aftertreatment control module (ACM)
FMI 15	• Data valid but above normal operating range - Least severe level	• Aftertreatment DPF outlet temperature sensor is out of range (high) • Aftertreatment DPF outlet temperature sensor indicates a invalid value	• MIL illuminated	• Faulty harness • Faulty aftertreatment DPF outlet temperature sensor

ECM SPN 3249, Aftertreatment Diesel Particulate Filter (DPF) Intake Temperature – MID 128 PPID 387

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent or incorrect	• Aftertreatment DPF intake temperature sensor is not rational (plausibility)	• MIL illuminated • Aborted aftertreatment regeneration	• Faulty harness • Faulty harness connectors or connections • Exhaust system leak • Faulty aftertreatment DPF intake temperature sensor
FMI 4	• Voltage below normal, or shorted to low source	• Short to ground on the metering side of the circuit	• MIL illuminated • Aborted aftertreatment regeneration	• Faulty harness • Faulty aftertreatment DPF intake temperature sensor • Aftertreatment control module (ACM)
FMI 5	• Current below normal or open circuit	• Short to battery on the metering side of the circuit • Open in the metering side of the circuit • Open in the ground side of the circuit	• MIL illuminated • Aftertreatment regeneration not possible	• Faulty harness • Faulty aftertreatment DPF intake temperature sensor • Aftertreatment control module (ACM)
FMI 15	• Data valid but above normal operating range - Least severe level	• Aftertreatment DPF intake temperature sensor is out of range (high) • Aftertreatment DPF intake temperature sensor indicates a invalid value	• MIL illuminated	• Faulty harness • Faulty aftertreatment DPF intake temperature sensor

ECM SPN 3251, Aftertreatment Diesel Particulate Filter (DPF) Differential Pressure – MID 128 PID 81

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range	• Critically high pressure	• Engine derate • Red Stop lamp illuminated	• Aftertreatment DPF differential pressure sensor failure
FMI 2	• Data erratic, intermittent or incorrect	• Aftertreatment DPF differential pressure sensor is not rational	• MIL illuminated	• Aftertreatment DPF differential pressure sensor failure

FMI 3	• Voltage above normal, or shorted to high source	• Short to battery on the metering side • Open in the ground line	• MIL illuminated	• Aftertreatment DPF differential pressure sensor failure • Faulty aftertreatment DPF differential pressure sensor connector • Faulty harness
FMI 5	• Current below normal or open circuit	• Open in 5 volt supply line • Short to ground in metering line • Open in metering line	• MIL illuminated	• Aftertreatment DPF differential pressure sensor failure • Faulty harness
FMI 16	• Data valid but above normal operating range - Moderately severe level	• Moderately high pressure	• Engine derate	• Aftertreatment DPF differential pressure sensor failure

ECM SPN 3363, Aftertreatment Diesel Exhaust Fluid (DEF) Tank Heater – MID 128 PSID 75

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent or incorrect	• Commanded valve position is not plausible	• N/A	• Faulty harness or connectors • Aftertreatment DEF tank temperature sensor • Aftertreatment DEF tank heating valve
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted +	• N/A	• Aftertreatment DEF pump assembly
FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted – • Open circuit	• N/A	• Aftertreatment DEF pump assembly
FMI 5	• Current below normal or open circuit	• Open circuit	• N/A	• Aftertreatment DEF pump assembly

ECM SPN 3471, Aftertreatment Fuel Pressure Control Actuator – MID 128 PPID 328

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted to battery	• MIL illuminated • Yellow Check lamp illuminated • Aborted aftertreatment regeneration	• Faulty harness • Aftertreatment fuel pressure control actuator failure

FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted to ground	• MIL illuminated • Yellow Check lamp illuminated • Aborted aftertreatment regeneration	• Faulty harness • Aftertreatment fuel pressure control actuator failure
FMI 5	• Current below normal or open circuit	• Open circuit	• MIL illuminated • Yellow Check lamp illuminated • Aborted aftertreatment regeneration	• Faulty harness • Aftertreatment fuel pressure control actuator failure
FMI 7	• Mechanical system not responding or out of adjustment	• Aftertreatment hydrocarbon doser fuel pressure too low	• MIL illuminated • Yellow Check lamp illuminated • Aftertreatment regeneration not possible	• Aftertreatment fuel shut off valve stuck open • Faulty fuel pressure sensor
FMI 14	• Special instructions	• Aftertreatment hydrocarbon doser fuel pressure too high	• MIL illuminated • Yellow Check lamp illuminated • Aftertreatment regeneration not possible	• Aftertreatment fuel shut off valve leakage

ECM SPN 3480, Aftertreatment Diesel Particulate Filter (DPF) Fuel Pressure – MID 128 PPID 437/PSID 108

Type of fault:	**FMI Description:**	**Fault Condition:**	**Possible Symptoms:**	**Possible Cause:**
FMI 2	• Data erratic, intermittent or incorrect	• DPF fuel pressure sensor is not rational (plausibility) • Aftertreatment hydrocarbon doser fuel pressure too low	• MIL illuminated • Yellow Check lamp illuminated • Aftertreatment regeneration not possible	• Faulty aftertreatment fuel shut off valve • Faulty aftertreatment DPF fuel pressure sensor • Air in fuel • Fuel filter • Aftertreatment fuel pump
FMI 3	• Voltage above normal or shorted to high source	• Short to battery on the metering side • Open in the ground line	• MIL illuminated • Yellow Check lamp illuminated • Aftertreatment regeneration not possible	• Faulty harness • Faulty aftertreatment DPF fuel pressure sensor

FMI 5	• Current below normal or open circuit	• Open circuit in the 5 volt supply • Short circuit to ground in the metering line • Open circuit in the metering line	• MIL illuminated • Yellow Check lamp illuminated • Aftertreatment regeneration not possible	• Faulty harness • Faulty aftertreatment DPF fuel pressure sensor
FMI 7	• Mechanical system not responding or out of adjustment	• Mechanical problem	• MIL illuminated • Engine derate • Possible engine shutdown • Aftertreatment regeneration not possible	• Faulty aftertreatment hydrocarbon doser system • Aftertreatment hydrocarbon doser • Faulty aftertreatment fuel shut off valve • Aftertreatment fuel pump
FMI 10	• Abnormal rate of change	• Aftertreatment hydrocarbon doser fuel pressure sensor stuck • Aftertreatment hydrocarbon doser fuel pressure too high	• MIL illuminated • Yellow Check lamp illuminated • Aftertreatment regeneration not possible	• Faulty fuel pressure sensor • Faulty shut off valve • Aftertreatment hydrocarbon doser
FMI 15	• Data valid but above normal operating range - Least severe level	• Fuel pressure sensor is out of range • Sensor indicates a invalid value	• MIL illuminated	• Faulty fuel pressure sensor

ECM SPN 3483, Aftertreatment Regeneration Status – MID 128 PSID 47

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Unable to achieve needed aftertreatment temperature	• MIL illuminated • Possible incomplete aftertreatment regeneration	• Aftertreatment hydrocarbon doser clogged • Aftertreatment hydrocarbon doser fuel pressure too low
FMI 1	• Data valid but below normal operational range	• Aftertreatment system temperature too high	• MIL illuminated • Possible incomplete aftertreatment regeneration	• Aftertreatment hydrocarbon doser clogged • Aftertreatment hydrocarbon doser fuel pressure too high
FMI 12	• Bad intelligent device or component	• Regeneration efficiency too low	• N/A	• Aftertreatment hydrocarbon doser clogged • Aftertreatment diesel particulate filter (DPF) catalyst damaged • Aftertreatment diesel particulate filter (DPF) catalyst clogged

FMI 15	• Data valid but above normal operating range - Least severe level	• Unable to achieve needed temperature	• MIL illuminated • Possible incomplete aftertreatment regeneration	• Aftertreatment hydrocarbon doser clogged • Aftertreatment hydrocarbon doser fuel pressure too low
FMI 17	• Data valid but below normal operating range - Least severe level	• Aftertreatment temperature too high	• MIL illuminated • Possible incomplete aftertreatment regeneration	• Aftertreatment hydrocarbon doser clogged • Aftertreatment hydrocarbon doser fuel pressure too high

ECM SPN 3509, Sensor Supply Voltage 1 – MID 128 SID 232

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Sensor supply voltage out of range (high)	• MIL illuminated • Incorrect sensor values	• Faulty harness or connector
FMI 4	• Voltage below normal, or shorted to low source	• Sensor supply voltage out of range (low)	• MIL illuminated • Incorrect sensor values	• Faulty harness or connector

ECM SPN 3510, Sensor Supply Voltage 2 – MID 128 SID 211

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted +	• MIL illuminated • Incorrect sensor values	• Faulty harness or connector
FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted –	• MIL illuminated • Incorrect sensor values	• Faulty harness or connector

ECM SPN 3511, Sensor Supply Voltage 3 – MID 128 PSID 113

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted +	• MIL illuminated	• Faulty harness
FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted –	• MIL illuminated	• Faulty harness

ECM SPN 3512, Sensor Supply Voltage 4 – MID 128 PSID 126

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Sensor supply circuit shorted +	• MIL illuminated • Incorrect sensor values	• Faulty harness
FMI 4	• Voltage below normal, or shorted to low source	• Sensor supply circuit shorted –	• MIL illuminated • Incorrect sensor values	• Faulty harness

ECM SPN 3522, Aftertreatment Total Fuel Used – MID 128 PSID 91

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range	• Aftertreatment Diesel Exhaust Fluid (DEF) level change too much	• N/A	• Aftertreatment DEF system leak • Wrong aftertreatment DEF tank • Aftertreatment DEF dosing module failure or wrong module
FMI 1	• Data valid but below normal operational range	• Aftertreatment Diesel Exhaust Fluid (DEF) level change too little	• N/A	• Aftertreatment DEF tank level sensor stuck • Aftertreatment DEF system clog • Wrong aftertreatment DEF tank • Aftertreatment DEF dosing module failure or wrong module
FMI 16	• Data valid but above normal operating range - Moderately severe level	• Aftertreatment Diesel Exhaust Fluid (DEF) level change too much	• N/A	• Aftertreatment DEF system leak • Wrong aftertreatment DEF tank • Aftertreatment DEF dosing module failure or wrong module
FMI 18	• Data valid but below normal operating range - Moderately severe level	• Aftertreatment Diesel Exhaust Fluid (DEF) level change too little	• N/A	• Aftertreatment DEF tank level sensor stuck • Aftertreatment DEF system clog • Wrong aftertreatment DEF tank • Aftertreatment DEF dosing module failure or wrong module

ECM SPN 3556, Aftertreatment Hydrocarbon Doser – MID 128 PPID 329

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted to battery	• MIL illuminated • Yellow Check lamp illuminated • Aftertreatment regeneration not possible	• Faulty harness • Aftertreatment hydrocarbon doser failure

FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted to ground	• MIL illuminated • Yellow Check lamp illuminated • Aftertreatment regeneration not possible	• Faulty harness • Aftertreatment hydrocarbon doser failure
FMI 5	• Current below normal or open circuit	• Open circuit	• MIL illuminated • Yellow Check lamp illuminated • Aftertreatment regeneration not possible	• Faulty harness • Aftertreatment hydrocarbon doser failure
FMI 13	• Out of calibration	• Aftertreatment hydrocarbon doser clogged	• MIL illuminated	• Aftertreatment hydrocarbon doser failure • Aftertreatment fuel shut off valve • Aftertreatment fuel supply failure
FMI 14	• Special instructions	• Aftertreatment hydrocarbon doser leaking	• MIL illuminated • Yellow Check lamp illuminated • Aftertreatment regeneration not possible	• Aftertreatment hydrocarbon doser failure

ECM SPN 3597, Aftertreatment Diesel Particulate Filter (DPF) Regeneration too Frequent – MID 128 PSID 119

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted +	• MIL illuminated	• Faulty harness • Faulty connector • Aftertreatment Control Module (ACM)
FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted –	• MIL illuminated	• Faulty harness • Faulty connector • Aftertreatment Control Module (ACM)

ECM SPN 3675, Engine Turbocharger Compressor Bypass Valve Position – MID 128 PPID 330

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted + • On/off valve can't be activated	• MIL illuminated • Yellow electronic malfunction lamp illuminated • Aftertreatment regeneration not possible • High engine braking without request • Driveability affected	• Faulty bypass valve solenoid • Faulty harness • Faulty harness connector
FMI 4	• Voltage below normal, or shorted to low source	• Short circuit - • Valve constantly activated	• MIL illuminated • Yellow Check lamp illuminated • Major engine derate • Exhaust manifold overheating • Engine shut down	• Faulty bypass valve solenoid • Faulty harness • Faulty harness connector
FMI 5	• Current below normal or open circuit	• Open circuit • On/off valve can't be activated	• MIL illuminated • Yellow Check lamp illuminated • Aftertreatment regeneration not possible • High engine braking without request • Driveability affected	• Faulty bypass valve solenoid • Faulty harness • Faulty harness connector
FMI 7	• Mechanical system not responding or out of adjustment	• Mechanically Stuck • On/off valve can't be activated	• MIL illuminated • Yellow Check lamp illuminated • Aftertreatment regeneration not possible • High engine braking without request • Driveability affected • Valve constantly activated	• Leaking pipes • Faulty bypass valve solenoid

			• Major engine derate • Exhaust manifold overheating • Engine shut down	

ECM SPN 3936, Aftertreatment Diesel Particulate Filter (DPF) System – MID 128 PSID 28

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Aftertreatment DPF differential pressure sensor value too high	• MIL illuminated	• Aftertreatment DPF differential pressure sensor • Aftertreatment DPF
FMI 1	• Data valid but below normal operational range - Most severe level	• Aftertreatment DPF differential pressure sensor value too low	• MIL illuminated	• Aftertreatment DPF differential pressure sensor • Aftertreatment DPF

ECM SPN 4094, NOx Limits Exceeded Due to Insufficient Diesel Exhaust Fluid (DEF) Quality – MID 128 PSID 90

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 1	• Data valid but below normal operational range - Most severe level	• Aftertreatment DEF dosing too low	• Yellow Check lamp illuminated • Engine derate	• DEF quality • Aftertreatment DEF line clogged • Aftertreatment DEF doser • Aftertreatment control module failure
FMI 14	• Special Instructions	• Aftertreatment DEF dosing too low	• Yellow Check lamp illuminated • Engine derate	• DEF quality • Aftertreatment DEF line clogged • Aftertreatment DEF doser • Aftertreatment control module failure
FMI 18	• Data valid but below normal operating range - Moderately severe level	• Aftertreatment DEF dosing too low	• Yellow Check lamp illuminated • Engine derate	• DEF quality • Aftertreatment DEF line clogged • Aftertreatment DEF doser • Aftertreatment control module failure

ECM SPN 4095, NOx Limits Exceeded Due to Interrupted Diesel Exhaust Fluid (DEF) Dosing – MID 128 PSID 90

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 7	• Mechanical system not responding or out of adjustment	• Dosing failure	• MIL illuminated • Aftertreatment DEF low usage	• DEF level • Faulty DEF pump • Leak in DEF hose

ECM SPN 4334, Afterteatment Diesel Exhaust Fluid (DEF) Dosing Absolute Pressure – MID 128 PPID 273

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 1	• Data valid but below normal operational range - Most severe level	• DEF system leakage detected	• MIL illuminated • No Aftertreatment DEF dosing	• DEF pump assembly • DEF hose • Aftertreatment DEF dosing valve
FMI 4	• Voltage below normal, or shorted to low source	• Short Circuit -	• MIL illuminated • No Aftertreatment DEF dosing	• Aftertreatment DEF pump assembly
FMI 5	• Current below normal or open circuit	• Short Circuit + • Open Circuit	• MIL illuminated • Yellow Check lamp illuminated • No Aftertreatment DEF dosing	• Aftertreatment DEF pump assembly

ECM SPN 4354, Aftertreatment Diesel Exhaust Fluid (DEF) Line Heater 1 – MID 128 PSID 103

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted +	• N/A	• Faulty harness • Faulty connector • Aftertreatment DEF line heater 1 failure
FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted –	• N/A	• Faulty harness • Faulty connector • Aftertreatment DEF line heater 1 failure
FMI 5	• Current below normal or open circuit	• Open circuit	• N/A	• Faulty harness • Faulty connector • Aftertreatment DEF line heater 1 failure

ECM SPN 4356, Aftertreatment Diesel Exhaust Fluid (DEF) Line Heater 3 – MID 128 PSID 102

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted +	• N/A	• Faulty harness • Faulty connector • Aftertreatment DEF line heater 3 failure

FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted –	• N/A	• Faulty harness • Faulty connector • Aftertreatment DEF line heater 3 failure
FMI 5	• Current below normal or open circuit	• Open circuit	• N/A	• Faulty harness • Faulty connector • Aftertreatment DEF line heater 3 failure

ECM SPN 4375, Aftertreatment Diesel Exhaust Fluid Pump (DEF) Drive Percentage – MID 128 PSID 121

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Circuit shorted +	• MIL illuminated • No aftertreatment DEF dosing	• Faulty harness • Faulty connector • Aftertreatment DEF pump assembly failure
FMI 1	• Data valid but below normal operational range - Most severe level	• Circuit shorted – • Open circuit	• MIL illuminated • No aftertreatment DEF dosing	• Faulty harness • Faulty connector • Aftertreatment DEF pump assembly failure
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted +	• MIL illuminated • No aftertreatment DEF dosing	• Faulty harness • Faulty connector • Aftertreatment DEF pump assembly failure
FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted –	• MIL illuminated • No aftertreatment DEF dosing	• Faulty harness • Faulty connector • Aftertreatment DEF pump assembly failure
FMI 5	• Current below normal or open circuit	• Open circuit	• MIL illuminated • No aftertreatment DEF dosing	• Faulty harness • Faulty connector • Aftertreatment DEF pump assembly failure
FMI 11	• Root cause not known	• Aftertreatment DEF filter full	• Yellow Check lamp illuminated	• Aftertreatment DEF filter

FMI 12	• Bad intelligent device or component	• Open circuit	• MIL illuminated • No aftertreatment DEF dosing	• Faulty harness • Faulty connector • Aftertreatment DEF pump assembly failure
FMI 14	• Special instructions	• Voltage to pump out of range	• MIL illuminated • No aftertreatment DEF dosing	• Faulty harness • Faulty connector • Aftertreatment DEF pump assembly failure
FMI 16	• Data valid but above normal operating range - Moderately severe level	• Aftertreatment DEF filter full	• Yellow Check lamp illuminated	• Aftertreatment DEF filter

ECM SPN 4376, Aftertreatment Diesel Exhaust Fluid (DEF) Return Valve – MID 128 PSID 105

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted – • Open circuit	• MIL illuminated • Not possible to perform afterrun	• Faulty harness • Faulty connector • Aftertreatment DEF pump assembly failure
FMI 5	• Current below normal or open circuit	• Open circuit	• MIL illuminated • Not possible to perform afterrun	• Faulty harness • Faulty connector • Aftertreatment DEF pump assembly failure
FMI 7	• Mechanical system not responding or out of adjustment	• Possible mechanical problem with aftertreatment DEF return valve	• MIL illuminated • Not possible to perform afterrun	• Mechanical fault – aftertreatment DEF return line restricted between DEF pump and DEF tank • Aftertreatment DEF pump assembly

ECM SPN 4752, Engine Exhaust Gas Recirculation (EGR) Cooler Efficiency – MID 128 SID 282

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 7	• Mechanical system not responding or out of adjustment	• Low EGR cooler efficiency	• MIL illuminated	• EGR cooler clogged or damaged

ECM SPN 4811, Engine Piston Cooling Oil Pressure – MID 128 PPID 8

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 1	• Data valid but below normal operational range - Most severe level	• Pressure below range	• Red Stop lamp illuminated	• N/A
FMI 2	• Data erratic, intermittent or incorrect	• Sensor rationality fault	• Yellow Check lamp illuminated	• Faulty sensor • Faulty valve
FMI 3	• Voltage above normal or shorted to high source	• Short to battery in metering line	• Yellow Check lamp illuminated	• Faulty harness
FMI 5	• Current below normal or open circuit	• Open in the metering side sensor circuit • Open circuit in the ground line sensor circuit	• Yellow Check lamp illuminated	• Faulty sensor • Faulty harness

ECM SPN 4813, Engine Oil Thermostat Bypass Valve Opening – MID 128 PSID 72

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted +	• Yellow Check lamp illuminated • Oil thermostat is always open	• Faulty actuator • Faulty harness

FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted –	• Yellow Check lamp illuminated • Oil thermostat is always closed • Engine may overheat	• Faulty actuator • Faulty harness
FMI 5	• Current below normal or open circuit	• Open circuit	• Yellow Check lamp illuminated • Oil thermostat is always open • May have increased fuel consumption	• Faulty actuator • Faulty harness

ECM SPN 4815, Engine Cooling Fan Thermal Switch Position – MID 128 PPID 333

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal, or shorted to high source	• Circuit shorted to battery	• Yellow Check lamp illuminated	• Faulty harness • Faulty harness connector • Faulty sensor
FMI 4	• Voltage below normal, or shorted to low source	• Short circuit -	• Yellow Check lamp illuminated	• Faulty harness • Faulty harness connector • Faulty sensor
FMI 5	• Current below normal or open circuit	• Open circuit	• Yellow Check lamp illuminated	• Faulty harness • Faulty harness connector • Faulty sensor

ECM SPN 5246, Aftertreatment SCR Operator Inducement Severity – MID 128 PSID 46

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 0	• Data valid but above normal operational range - Most severe level	• Severe SCR system fault detected – Warning fault	• Severe engine derate	• N/A
FMI 15	• Data valid but above normal operating range - Least severe level	• Moderate SCR system fault detected – Warning fault	• Moderate engine derate	• N/A
FMI 16	• Data valid but above normal operating range - Moderately severe level	• SCR system fault detected – Warning fault	• Engine derate	• N/A

ECM SPN 5298, Aftertreatment Diesel Oxidation Catalyst (DOC) Conversion Efficiency – MID 128 PSID 99

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 7	• Mechanical system not responding properly	• Hydrocarbon conversion is too low in the DOC	• MIL illuminated	• Aftertreatment DOC catalyst failure • Aftertreatment DOC temperature sensor
FMI 18	• Data valid but below normal operating range - Moderately severe level	• Hydrocarbon conversion is too low in the DOC	• MIL illuminated	• Aftertreatment DOC catalyst failure • Aftertreatment DOC temperature sensor

ECM SPN 5319, Aftertreatment 1 Diesel Particulate Filter (DPF) Incomplete Regeneration – MID 128 PSID 47

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 13	• Calibration values outside limits	• Incomplete aftertreatement regeneration	• MIL illuminated	• Aftertreatment fuel line clogged • Aftertreatment hydrocarbon doser
FMI 31	• Condition exists	• Incomplete aftertreatement regeneration	• MIL illuminated	• Aftertreatment fuel line clogged • Aftertreatment hydrocarbon doser

ECM SPN 5392, Aftertreatment Diesel Exhaust Fluid (DEF) Dosing Valve Loss of Prime – MID 128 PSID 121

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 7	• Mechanical system not responding properly	• Aftertreatment DEF pressure build up failure	• MIL illuminated • Yellow Check lamp illuminated • No Aftertreatment DEF dosing	• Empty aftertreatment DEF tank • Aftertreatment DEF filter clogged • Aftertreatment DEF inlet pipe leak or blockage • Aftertreatment DEF pump assembly
FMI 31	• Condition exists	• Aftertreatment Diesel Exhaust Fluid (DEF) pressure build up failure	• MIL illuminated • Yellow Check lamp illuminated • No Aftertreatment DEF dosing	• Empty aftertreatment DEF tank • Aftertreatment DEF filter clogged • Aftertreatment DEF inlet pipe leak or blockage • Aftertreatment DEF pump assembly

ECM SPN 5394, Aftertreatment Diesel Exhaust Fluid (DEF) Dosing Valve – MID 128 PSID 89/90

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 1	• Data valid but below normal operational range	• Dosing failure • Aftertreatment DEF dosing amount too low or DEF quality	• MIL illuminated • Aftertreatment outlet NOx emissions too high	• Aftertreatment outlet NOx sensor • Selective catalytic reduction (SCR) catalyst malfunction • Exhaust gas recirculation (EGR) mass flow failure • Selective catalytic reduction (SCR) inlet temperature sensor
FMI 4	• Voltage below normal, or shorted to low source	• Circuit shorted –	• MIL illuminated	• Aftertreatment DEF dosing pump assembly
FMI 5	• Current below normal or open circuit	• Open circuit	• MIL illuminated • Yellow Check lamp illuminated	• Aftertreatment DEF dosing valve • Aftertreatment DEF dosing pump assembly
FMI 14	• Special instructions	• Aftertreatment DEF Dosing valve clogged or hose clogged	• MIL illuminated • Yellow Check lamp illuminated	• Aftertreatment DEF dosing valve clogged • Hose clogged
FMI 17	• Data valid but below normal operating range - Least severe level	• Dosing failure • Aftertreatment DEF dosing amount too low or DEF quality	• MIL illuminated • Aftertreatment outlet NOx emissions too high	• Aftertreatment outlet NOx sensor • Selective catalytic reduction (SCR) catalyst malfunction • Exhaust gas recirculation (EGR) mass flow failure • Selective catalytic reduction (SCR) inlet temperature sensor

ECM SPN 5397, Aftertreatment 1 Diesel Particulate Filter (DPF) Regeneration Too Frequent – MID 128 PSID 47

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 10	• Abnormally strong vibrations	• Aftertreatment regenerations frequency too high	• MIL illuminated • Too frequent aftertreatment regenerations	• Engine out soot too high • Exhaust gas recirculation system fault • Engine injectors • Air leak
FMI 31	• Condition exists	• Aftertreatment regenerations frequency too high	• MIL illuminated • Too frequent aftertreatment regenerations	• Engine out soot too high • Exhaust gas recirculation system fault • Engine injectors • Air leak

ECM SPN 5485, Aftertreatment Diesel Exhaust Fluid (DEF) Pump Orifice – MID 128 PSID 121

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 11	• Root cause not known	• Aftertreatment DEF bleed orifice clogged	• MIL illuminated • Yellow Check lamp illuminated • No Aftertreatment DEF dosing	• Bleed orifice • Aftertreatment DEF pressure sensor

Volvo Trucks North America
P.O. Box 26115, Greensboro, NC 27402-6115

Volvo Trucks Canada, Ltd.
5600A Cancross Court, Missisauga, Ontario L5R 3E9
http://www.volvotrucks.com

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Vehicle Electronic Control Unit (VECU) MID 144, Diagnostic Trouble Code (DTC), Guide

Contents

- "MID 144 Vehicle Electronic Control Unit (VECU)", page 2
- "MID 144 Vehicle Electronic Control Unit, Diagnostic Trouble Codes (DTCs)", page 3

Information is subject to change without notice.
Illustrations are used for reference only and may differ slightly from the actual vehicle being serviced. However, key components addressed in service information are represented as accurately as possible.

MID 144 Vehicle Electronic Control Unit (VECU)

The manufacturer scan tool is the preferred tool for performing diagnostic work. Contact your local dealer for more information or visit “www.premiumtechtool.com”.

System Overview

The VECU is a microprocessor based controller, programmed to perform several functions, these include:

- Driver controls
- Vehicle and engine speed controls
- Starter control
- Cab power
- Broadcasting data on the serial data lines
- Trip data logging
- Diagnostic trouble code (DTC) logging and password processing

The VECU performs these functions by monitoring the signals from sensors and switches, and data received over the data link from the other modules. The VECU directly monitors the throttle position (TP) sensor and vehicle speed sensor (VSS).

The VECU also monitors the position or state of multiple switches, to perform its control and diagnostic functions. The following is a list of some of the inputs that are monitored:

- A/C Pressure Switch
- Air Suspension Height Control Switch
- Differential Lock Switch
- Engine Brake Switches
- Ignition Key Switch
- Service and Park Brake Switches
- Speed Control Switches (Set/Decel, Resume/Accel)

The VECU communicates with other modules and shares its inputs through the SAE J1939 and SAE J1587 data links.

The SAE J1587 data link is primarily used for programming, diagnostics and data reporting.

In addition to switch and sensor data, the broadcast between modules also includes various calculations and conclusions each module has developed, based on the input information it has received. These calculations and conclusions are part of the modules on board diagnostic (OBD) capability. The OBD is designed to detect faults or abnormal conditions that are not within normal operating parameters. When the system detects a fault or abnormal condition, a DTC will be logged in one or both of the modules’ memory. The vehicle operator will be advised that a fault has occurred by the illumination of a instrument panel telltale lamp and a message in the driver information display, if equipped.

For diagnostic software, contact your local dealer or visit “www.premiumtechtool.com”.

MID 144 Vehicle Electronic Control Unit, Diagnostic Trouble Codes (DTCs)

The manufacturer scan tool is the preferred tool for performing diagnostic work. Contact your local dealer for more information or visit “www.premiumtechtool.com”.

The electronic control units (ECUs) on the SAE J1587 data link communicate according to the SAE J1587 standard. The standard has been extended with supplements (PPID, PSID). The diagnostic trouble codes (DTCs) set by the ECUs contain information that is described by the following abbreviations.

MID	Message Identification Description: Identification of a ECU.	SID	Subsystem Identification Description: Identification of a component.
PID	Parameter Identification Description: Identification of a parameter (value).	PSID	Proprietary Subsystem Identification Description: Unique identification of a component.
PPID	Proprietary Parameter Identification Description: Unique identification of a parameter (value).	FMI	Failure Mode Identifier: Identification of fault types.

FMI Table

FMI	SAE Text
0	Data valid, but above the normal working range
1	Data valid, but below the normal working range
2	Intermittent or incorrect data
3	Abnormally high voltage or short circuit to higher voltage
4	Abnormally low voltage or short circuit to lower voltage
5	Abnormally low current or open circuit
6	Abnormally high current or short circuit to ground
7	Incorrect response from a mechanical system
8	Abnormal frequency
9	Abnormal update rate
10	Abnormally strong vibrations
11	Non-identifiable fault
12	Faulty module or component
13	Calibration values outside limits
14	Special instructions
15	Reserved for future use

MID 144 Vehicle ECU, Fault Codes

PID

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"MID 144 PID 91 Accelerator Pedal Position (APP) (Percentage)", page 5
"MID 144 PID 152 Vehicle Electronic Control Unit (VECU), Number of Resets", page 6
"MID 144 PID 191 Output Shaft Speed (OSS)", page 6

PPID

"MID 144 PPID 69 Buffered Idle Validation (IV) Switch", page 6
"MID 144 PPID 70 Pedal Switches, Supply", page 7
"MID 144 PPID 71 Cruise Control and Engine Brake, Switch Supply", page 7
"MID 144 PPID 72 Accelerator Pedal Position (APP) and Engine Brake, Sensors Supply", page 7
"MID 144 PPID 74 Vehicle Electronic Control Unit (VECU), Power Supply", page 8
"MID 144 PPID 265 Vehicle Speed Sensor (VSS) Supply", page 8

SID

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"MID 144 SID 231 SAE J1939 Data Link", page 9
"MID 144 SID 240 Program Memory", page 9
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"MID 144 SID 250 SAE J1587 Data Link", page 9
"MID 144 SID 253 Calibration Memory EEPROM", page 10

PSID

"MID 144 PSID 1 Retarder Control Set Switch", page 10
"MID 144 PSID 14 DataMax General Error", page 10

"MID 144 PSID 200 Communication Interference, Data Link, Engine Control Module (ECM)", page 10
"MID 144 PSID 202 Communication Interference, Data Link, Instrumentation", page 10
"MID 144 PSID 204 Communication Interference, Data Link, Brake Control Module", page 11
"MID 144 PSID 205 Communication Interference, Data Link, Transmission Control Module (TCM)", page 11
"MID 144 PSID 206 Communication Interference, Data Link, Retarder Control Module", page 11
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"MID 144 PSID 211 SAE J1939 Data Link Interruption, Collision Avoidance Control Module", page 11
"MID 144 PSID 230 Software Fault", page 12

MID 144 PID 84 Vehicle Speed

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Intermittent or incorrect data	• Speed signal from speedometer and anti lock brake system (ABS) differs too much	• Gauge drops/inoperable	• Vehicle speed sensor (VSS) Harness • VSS sensor
FMI 14	• Special instructions	• Intermittent faulty data • Speed signal from vehicle speed sensor (VSS) was updated incorrectly	• N/A	• SAE J1587 data link • Wiring harness

MID 144 PID 86 Cruise Control, Set Speed

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 14	• Special Instructions	• Timeout on adaptive cruise control (ACC) 1 message with ACC installed	• N/A	• Faulty or no information from ACC (VORAD) • Wiring harness

MID 144 PID 91 Accelerator Pedal Position (APP) (Percentage)

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Abnormally high voltage or short circuit to higher voltage	• Voltage above 4.3V	• Yellow Check lamp illuminated • Engine will not supply requested fuel to engine	• APP harness shorted high • Faulty APP sensor
FMI 4	• Abnormally low voltage or short circuit to lower voltage	• Voltage below 0.4V	• Yellow Check lamp illuminated • Engine will not supply requested fuel to engine	• APP harness shorted low • Faulty APP sensor
FMI 5	• Abnormally low current or open circuit	• Input too low compared to IV switch 1 and 2	• Yellow Check lamp illuminated • Engine will not supply requested fuel to engine	• Faulty APP sensor

FMI 6	• Abnormally high current or short circuit to ground	• Input too low compared to IV switch 1 and 2	• Yellow Check lamp illuminated • Engine will not supply requested fuel to engine	• Faulty APP sensor
FMI 14	• Special Instructions	• Supply Error from PPID 72	• Yellow Check lamp illuminated • Engine will not supply requested fuel to engine	• APP harness

MID 144 PID 152 Vehicle Electronic Control Unit (VECU), Number of Resets

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 12	• Faulty module or component	• Internal software fault causing a reset	• System restarted	• VECU

MID 144 PID 191 Output Shaft Speed (OSS)

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 5	• Abnormally low current or open circuit	• Lower current then expected	• N/A	• Faulty vehicle speed sensor (VSS) • Wiring harness
FMI 6	• Abnormally high current or short circuit to ground	• Higher current then expected	• N/A	• Faulty vehicle speed sensor (VSS) • Wiring harness

MID 144 PPID 69 Buffered Idle Validation (IV) Switch

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Abnormally high voltage or short circuit to higher voltage	• Buffered IV switch 1 too high compared to IV switch 2 signal	• Yellow Check lamp illuminated	• Signal shorted high • Faulty harness
FMI 4	• Abnormally low voltage or short circuit to lower voltage	• Buffered IV switch 1 too low compared to IV switch 2 signal	• Yellow Check lamp illuminated	• Signal shorted low • Faulty harness

MID 144 PPID 70 Pedal Switches, Supply

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 4	• Abnormally low voltage or short circuit to lower voltage	• Voltage below 3V	• Yellow Check lamp illuminated	• Idle Validation (IV) switch shorted low • Faulty connector • Faulty harness • Supply voltage shorted low

MID 144 PPID 71 Cruise Control and Engine Brake, Switch Supply

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 4	• Abnormally low voltage or short circuit to lower voltage	• Voltage below 3V	• Yellow Check lamp illuminated • Engine will not supply requested fuel increase	• Cruise control switch shorted low • Faulty connector • Faulty harness • Supply voltage shorted low

MID 144 PPID 72 Accelerator Pedal Position (APP) and Engine Brake, Sensors Supply

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Abnormally high voltage or short circuit to higher voltage	• Voltage above 5.7V	• Yellow Check lamp illuminated • Requested fuel not supplied to engine • Engine brake retarder is disabled	• APP sensor harness shorted high • APP sensor
FMI 4	• Abnormally low voltage or short circuit to lower voltage	• Voltage below 4.7V	• Yellow Check lamp illuminated • Requested fuel not supplied to engine • Engine brake retarder is disabled	• Accelerator pedal position sensor harness shorted low • Accelerator pedal position sensor

MID 144 PPID 74 Vehicle Electronic Control Unit (VECU), Power Supply

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 4	• Abnormally low voltage or short circuit to lower voltage	• Voltage below 4.7V	• Yellow Check lamp illuminated • Engine will not supply requested fuel to engine • Display show minimum wet tank pressure	• VECU power supply relay • Signal shorted low • Faulty harness

MID 144 PPID 265 Vehicle Speed Sensor (VSS) Supply

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Abnormally high voltage or short circuit to higher voltage	• Voltage above 9V	• Yellow Check lamp illuminated	• VSS harness shorted high • Faulty VSS
FMI 4	• Abnormally low voltage or short circuit to lower voltage	• Voltage below 6.5V	• Yellow Check lamp illuminated	• VSS harness shorted low • Faulty VSS

MID 144 SID 230 Idle Validation (IV) Switch 1

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 7	• Incorrect response from a mechanical system	• Faulty readout from IV switch 1	• Yellow Check lamp illuminated • Engine will not supply requested fuel to engine	• IV switch • IV switch connector • IV switch harness

MID 144 SID 231 SAE J1939 Data Link

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Intermittent or incorrect data	• Vehicle electronic control unit (VECU) doesn't get acknowledgement on sent messages	• Yellow Check lamp illuminated	• CAN communication • SAE J1939 data link down/shorted

MID 144 SID 240 Program Memory

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Intermittent or incorrect data	• Check sum calculated at startup differs from the stored one	• Yellow Check lamp illuminated • Vehicle electronic control unit (VECU) keeps resetting • Vehicle not drivable	• Software error • Faulty flash hardware • VECU

MID 144 SID 243 Cruise Control Set Switch

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 7	• Incorrect response from a mechanical system	• Signals SET+ and SET- received at the same time	• Yellow Check lamp illuminated • Cruise control deactivated	• Faulty harness • Connector

MID 144 SID 246 Brake Pedal Position (BPP) Switch

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 4	• Abnormally low voltage or short circuit to lower voltage	• Voltage lower than expected or shorted to –	• N/A	• Faulty harness • Faulty BPP switch

MID 144 SID 250 SAE J1587 Data Link

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Intermittent or incorrect data	• Faulty messages on the link received	• Some functional disturbances may occur	• SAE J1587 data link down/shorted

MID 144 SID 253 Calibration Memory EEPROM

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Intermittent or incorrect data	• Datasets have incorrect checksum	• Yellow Check lamp illuminated • Some functions may be deactivated	• Faulty EEPROM • Vehicle electronic control unit (VECU)
FMI 14	• Special instructions	• Incorrect data found in datasets • Error when programming	• Yellow Check lamp illuminated • Some functions may be deactivated	• Faulty EEPROM • VECU

MID 144 PSID 1 Retarder Control Set Switch

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 7	• Incorrect response from a mechanical system	• Signals SET+ and SET- received at the same time	• Yellow Check lamp illuminated • Retarder Control deactivated	• Faulty harness • Connector

MID 144 PSID 14 DataMax General Error

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Clock or other data missing	• N/A	• Clock or other data missing

MID 144 PSID 200 Communication Interference, Data Link, Engine Control Module (ECM)

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Expected ECM message(s) not received	• Yellow Check lamp illuminated	• SAE J1939 data link down/shorted

MID 144 PSID 202 Communication Interference, Data Link, Instrumentation

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Expected instrument cluster message(s) not received	• Yellow Check lamp illuminated	• SAE J1939 datalink down/shorted

MID 144 PSID 204 Communication Interference, Data Link, Brake Control Module

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Expected anti lock brake system (ABS) message(s) not received	• Yellow Check lamp illuminated	• SAE J1939 datalink down/shorted

MID 144 PSID 205 Communication Interference, Data Link, Transmission Control Module (TCM)

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Expected TCM message(s) not received	• Yellow Check lamp illuminated	• SAE J1939 datalink down/shorted

MID 144 PSID 206 Communication Interference, Data Link, Retarder Control Module

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Expected retarder message(s) not received	• Yellow Check lamp illuminated	• SAE J1939 datalink down/shorted

MID 144 PSID 207 Communication Interference, Data Link, Gear Selector Control Module

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Expected gear selector control module message(s) not received	• Yellow Check lamp illuminated	• SAE J1939 datalink down/shorted

MID 144 PSID 211 SAE J1939 Data Link Interruption, Collision Avoidance Control Module

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Expected adaptive cruise control (ACC) message(s) not received	• Yellow Check lamp illuminated	• SAE J1939 datalink down/shorted

MID 144 PSID 230 Software Fault

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 4	• Abnormally low voltage or short circuit to lower voltage	• Uncontrolled software reset	• Yellow Check lamp illuminated	• Wiring harness – loss or interruption of supply voltage to vehicle electronic control unit (VECU) • Faulty software • VECU

SECTION 03: FUEL SYSTEM

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1. FUEL SYSTEM WITH VOLVO D13 ENGINE

1.1 DESCRIPTION

NOTE
For additional information concerning Volvo D13 engine components or engine-related components, consult Volvo Trucks Canada or Volvo Trucks North America Web Site under: Parts & Service. On Volvo web site, you will find detailed service procedures for parts replacement, repair and maintenance.

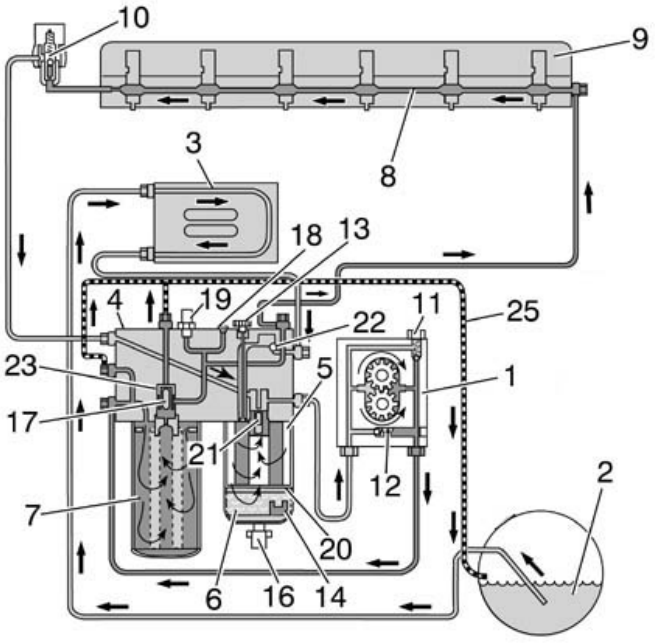


FIGURE 1: FUEL SYSTEM SCHEMATIC (VOLVO D13 ENGINE) 03086

Fuel is drawn up the fuel lines by the supply pump (1) through the pickup tube in the tank (2) and through the Engine Electronic Control Unit (EECU) cooling coil (3) and into the fuel filter housing (4). The fuel housing is equipped with a primary fuel filter (fuel/water separator) consisting of a filter cartridge and a water separation bowl.

The supply pump (1) forces the fuel into the fuel filter housing through the secondary filter (main) to a cylinder head longitudinal gallery (8). This channel supplies each unit injector (9) with pressurized fuel by a circular groove around each unit injector in the cylinder head. The overflow valve (10) controls the fuel supply pressure to the unit injectors.

The return fuel from the overflow valve (10) is returned back to the fuel filler housing and is mixed with the fuel from the fuel tank in a channel within the fuel filter housing (4).

Supply Pump Valves

Two valves are located in the supply pump (1). The safety valve (11) allows fuel to flow back to the suction side when the pressure becomes too high, e.g., if the fuel filter is blocked or is too restricted. The non-return valve (12) opens when the hand-priming pump is used.

Automatic Bleeding

If air gets into the system, it is bled when the engine starts. During bleeding, air is pressed out through the fuel filter housing over to the fuel tank through the return line (25). Bleeding for the filter replacement is controlled by valves (17) and (23).

Other

The fuel filter housing eliminates the need to drain the fuel when replacing the filter. The valve pegs (17) and (21) close when the fuel filter is removed. It is not necessary to bleed the fuel system after replacing the filter, since this is performed automatically when the engine is started and runs for more than 2 minutes.

The plugged outlet (18) is fitted on the fuel filter housing. This outlet is used when measuring supply pressure after the fuel filter with an external pressure gauge. The pressure sensor (19) on the fuel filter housing monitors the supply pressure after the fuel filter. A fault code is displayed on the instrument cluster if the fuel supply pressure is less than the specified value.

Hand Priming Pump

The hand priming pump (13) is located on the fuel filter housing and is used to pump fuel (when engine is not running) after the fuel system has been drained for repair, etc. The non-return valve (22) for the hand priming pump is also located in the fuel filter housing.

1.2 FUEL VALVES

The manual shut-off valve on engine fuel-supply line is located on the R.H. side of engine compartment. A manual shut-off valve is located at the inlet side of the primary fuel filter or at the inlet side of Davco Fuel Pro 382 fuel filter.

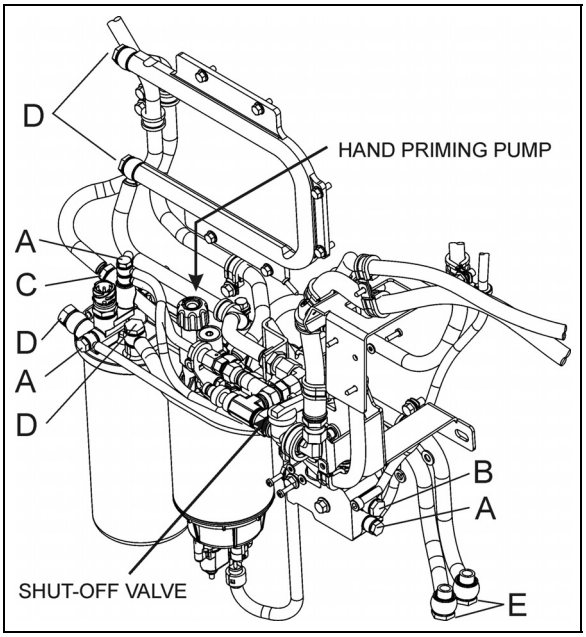


FIGURE 2: MANUAL SHUT-OFF VALVE (VOLVO D13 ENGINE) 03088

Shut-off valve is designed to prevent loss of fuel prime. No manual valve is required on preheater fuel-supply line, since the positive-displacement fuel pump (located close to the fuel tank) prevents fuel flow when not activated.

FUEL LINE FITTINGS – VOLVO D13 ENGINE	
A	13 ± 2 ft-lb (18 ± 3 Nm)
B	20.5 ± 3 ft-lb (28 ± 4 Nm)
C	22 ± 3 ft-lb (30 ± 4 Nm)
D	26 ± 4 ft-lb (35 ± 5 Nm)
E	29.5 ± 4 ft-lb (40 ± 5 Nm)
F	35 ± 4 ft-lb (48 ± 5 Nm)

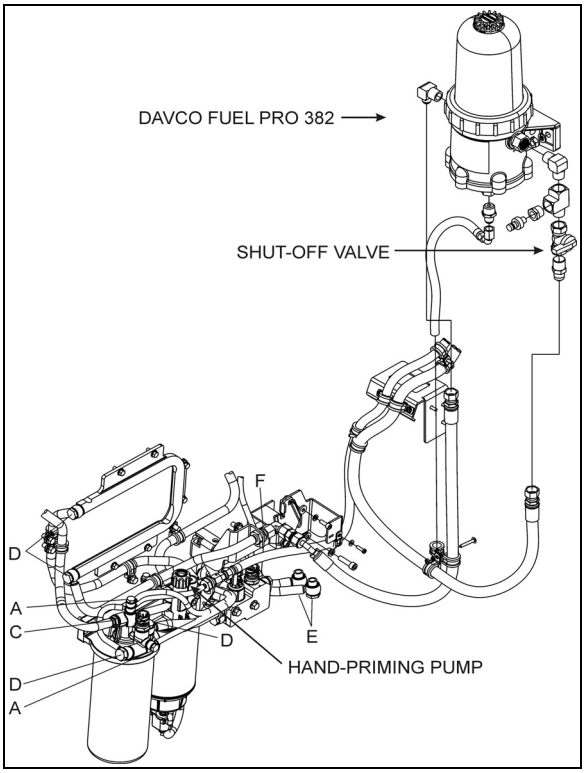


FIGURE 3: MANUAL SHUT-OFF VALVE LOCATION WITH DAVCO FUEL PRO 382 (VOLVO D13 ENGINE) 03087

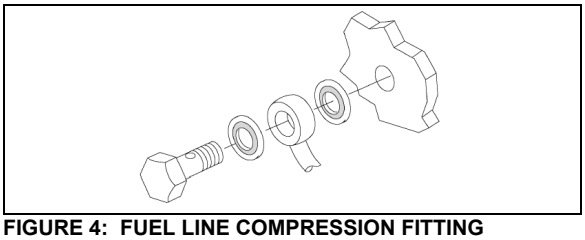


FIGURE 4: FUEL LINE COMPRESSION FITTING

⚠ CAUTION

Always replace the fuel line compression sealing washers when troubleshooting for fuel aeration or performing any service procedure that requires the removal of engine fuel lines.

1.3 FUEL FILTERS

A primary fuel filter is installed on the engine. This filter consists of a filter cartridge, a water separation bowl with a drain valve. It is used to prevent water from entering the fuel system.

MAINTENANCE

The primary and secondary fuel filters are of a spin-on type and must be replaced at **every engine oil change**.

The primary fuel filter should be drained periodically or when the telltale light on the dashboard illuminates if equipped with this system. To drain water, loosen the drain valve below the separator. Place an appropriate container under the filter. Close the drain valve when finished.

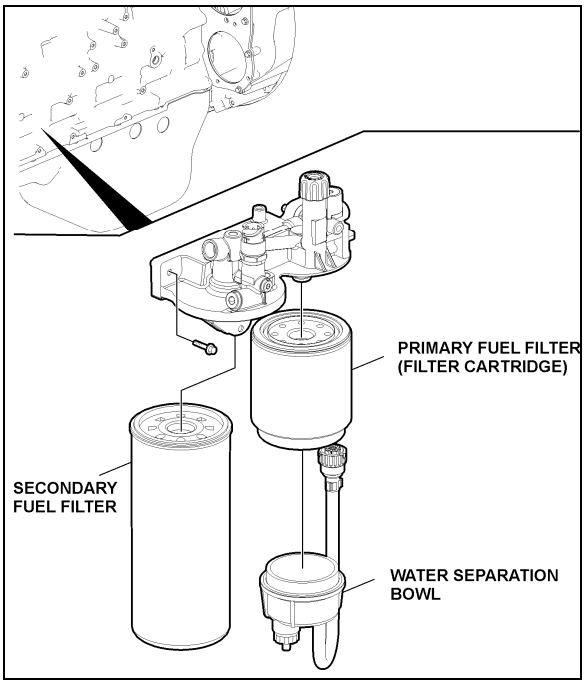
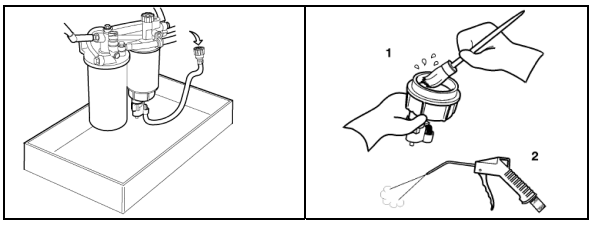


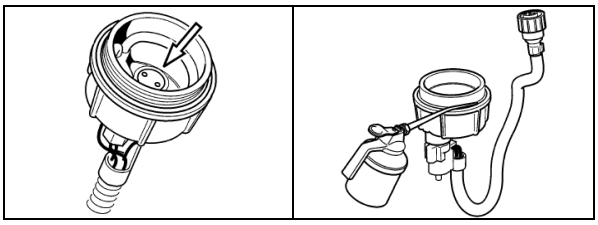
FIGURE 5: FUEL FILTERS WITH VOLVO D13 ENGINE
03085

1.3.1 Primary Fuel Filter Replacement

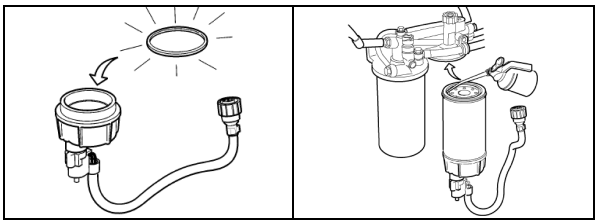
1. Stop engine, close the fuel supply line shut-off valve.
2. Place an appropriate container under the fuel filter housing, then drain the water from the water separation bowl.
3. Disconnect the fuel/water separator indicator electrical connector.



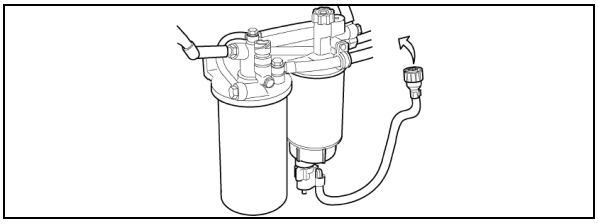
4. Unscrew and remove the primary fuel filter from the fuel filter housing. Drain filter.
5. Unscrew and remove the separation bowl from the filter cartridge.
6. Remove and discard the old gasket from the water separation bowl. Clean the bowl thoroughly and then blow dry with filtered compressed air.



7. Check that the drainage hole in the water separator bowl is not blocked.
8. Apply a thin coating of clean engine oil to the surface of the water separation bowl.



9. Install a new gasket to the water separation bowl and then reinstall the separation bowl to the new primary fuel filter cartridge.
10. Apply a thin coating of clean engine oil to the surface of the primary fuel filter, install the primary fuel filter to the fuel filter housing, then tighten the primary fuel filter 1/2-3/4 turn.

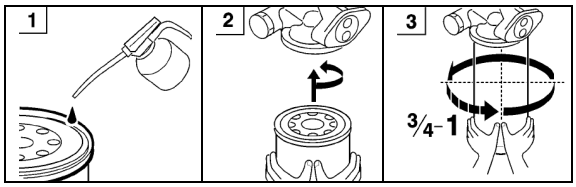


11. Connect the electrical connector for the water/fuel separation bowl indicator.

12. Open the fuel supply line shut-off valve.
13. Purge air from the filter by operating the priming pump to draw fuel and fill the filter. When using the hand priming pump, approximately 100 strokes will be required.
14. Start the engine and carry out a fuel-tightness check. Let the engine run for about 5 minutes to remove air pockets from the fuel system.

1.3.2 Secondary Fuel Filter Replacement

1. Stop engine, close the fuel supply line shut-off valve. Place an appropriate container under the fuel filter housing.
2. Clean around sealing area on fuel filter and housing.
3. Unscrew and remove the secondary fuel filter from the fuel filter housing.
4. Apply a thin coating of clean engine oil to the gasket of the secondary fuel filter. Screw the fuel filter into position. Tighten the filter ¾ to 1 turn after the gasket makes contact with the fuel filter housing.



CAUTION

Fuel in the old filter **must absolutely not** be poured into the new filter. This kind of contaminated fuel can damage the unit injectors.

5. Prime the fuel system by pumping the hand priming pump on the fuel filter housing until resistance is felt indicating that the system is full of fuel.
6. Start the engine and carry out a fuel-tightness check. Let the engine run for about 5 minutes to remove air pockets from the fuel system.

1.4 PRIMING THE FUEL SYSTEM

The fuel system will need to be bled if:

- The vehicle has run out of fuel.
- The engine has not been running for an extended period of time.
- Service work has been done on the fuel system, (tank, fuel lines, filters, valves, etc.) for example cleaning or replacing fuel filter cartridges.
- The engine is new or rebuilt.

CAUTION

When priming the system, movement of the primer pump should be as up and down as possible. Avoid putting any side load on the pump or causing a binding condition. Failure to follow these instructions could prematurely damage the primer pump.

NOTE

When the fuel system is empty, 200 or more pump strokes may be needed to properly prime system. There are no bleed nipples to be opened to prime the fuel system.

1. Stop engine;
2. Unlock the hand pump by turning the handle counterclockwise.
3. Prime the system by moving the primer pump in an up and down pumping motion. Avoid putting any side load on the pump or causing a binding condition.

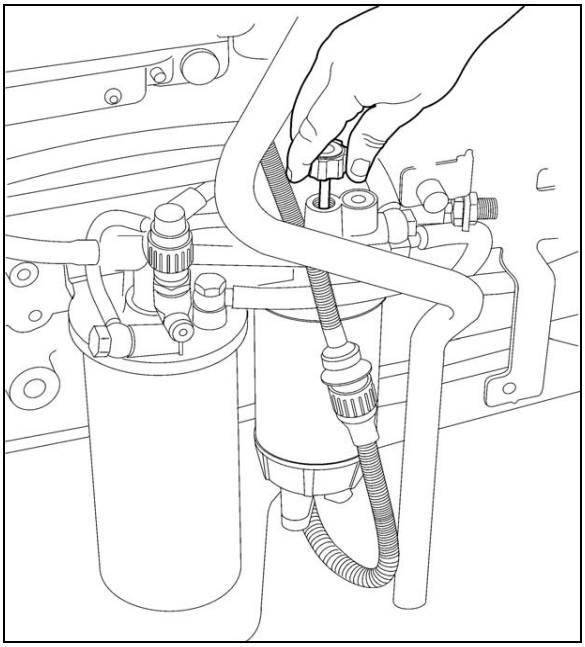


FIGURE 6: HAND PRIMING PUMP

4. Lock the hand primer pump by retracting it into the housing and turning it clockwise.
5. Start the engine and run it at an increased idle speed for approximately 5 minutes to remove any remaining air in the system. Check the fuel system for leaks.

1.5 FUEL PUMP REMOVAL AND INSTALLATION

The pump is located underneath the air compressor and is accessible through the engine compartment R.H. access door.

To remove the pump, proceed as follows:

- Clean around the fuel pump and fuel lines. Position a container to catch any fuel that might drain from the pump or lines.
- Remove the fuel pump.

NOTE
Only unfasten the bolts marked with arrows.

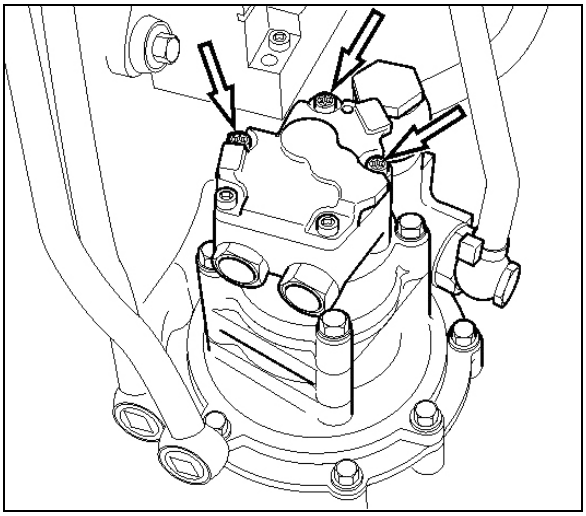


FIGURE 7: FUEL PUMP REMOVAL

CAUTION
Ensure to clean around the head of the bolts. Debris will prevent the tool from fitting properly and cause damage to the fasteners..

- Check that the adapter and fuel pump drive axle are not damaged.

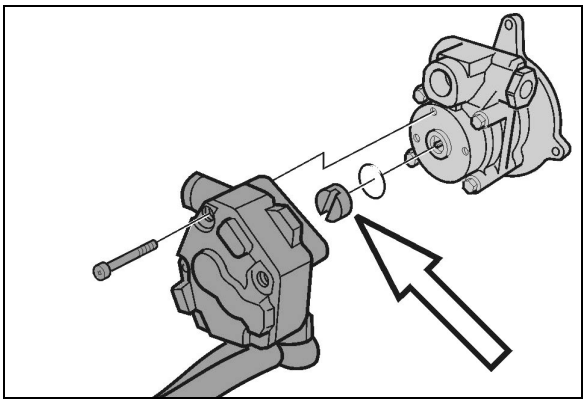


FIGURE 8: FUEL PUMP DRIVE AXLE

- Install the fuel pump. Torque-tighten bolts to specification.

NOTE
Use a new sealing ring. Check that the fuel pump drive axle sits correctly in the power steering pump.

- Using the hand primer on the fuel filter housing, prime the fuel system.
- Start the engine and let run for 5 minutes. Make sure that there are no leaks.

2. DAVCO FUEL PRO 382

The optional Fuel Pro 382 diesel fuel filter system consists of a permanently mounted fuel processor, a replaceable filter element, a filter element cover and collar and a fluid filter base assembly. This system is installed between the fuel tank and the fuel pump and is designed to be the only fuel filter in the fuel system. The filter serves as a water separator as well as a fuel filter (refer to figure 9).

The filter fibers used in the Davco Fuel Pro 382 element may cause the fuel level to read artificially high when the filter is first installed. Over the first few days, the filter fibers eventually become fully saturated and the fuel level will drop to normal levels. Do not be concerned about an abnormally high fuel level when a new Davco element is installed.

When new, the fuel level as seen through the clear cover in the 382 filter is very low. It rises as dirt collects on the filter from the bottom up. Restriction remains consistently low because fuel always flows through clean, new media.

MAINTENANCE

Replace Fuel Pro 382 filter element when the fuel level in the see-thru filter cover reaches the top of the filter element or after one year of service, whichever comes first.

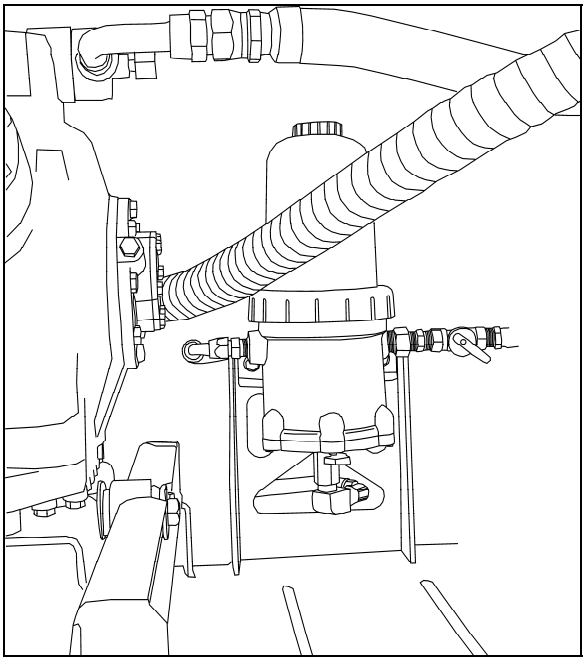


FIGURE 9: DAVCO FUEL PRO 382 FUEL FILTER 03062

Filter replacement:

1. Stop engine;
2. Place a suitable container under the fuel processor;
3. Close the shut-off valve at the inlet side of the fuel filter;
4. Open the drain valve at the base of the fuel processor and drain the fuel until it is below the level of the filter;
5. Untighten upper collar, remove cover, filter hold down spring, filter element and cover seal;
6. Dispose of used filter element;
7. Ensure the filter grommet is included at the base of the new filter element and then install the element onto the center stud;
8. Ensure the filter spring is installed at the top of the cover. If missing, the spring must be replaced to insure proper filter operation.
9. Wipe the cover lid and seal clean. After ensuring the seal is properly positioned at the base of the cover, install the cover and collar onto the fuel processor. Tighten the collar by hand until secure;
10. Fill the cover full of clean fuel through spin off cap located on top of cover. Install vent cap seal and then reinstall the cap and tighten by hand only;

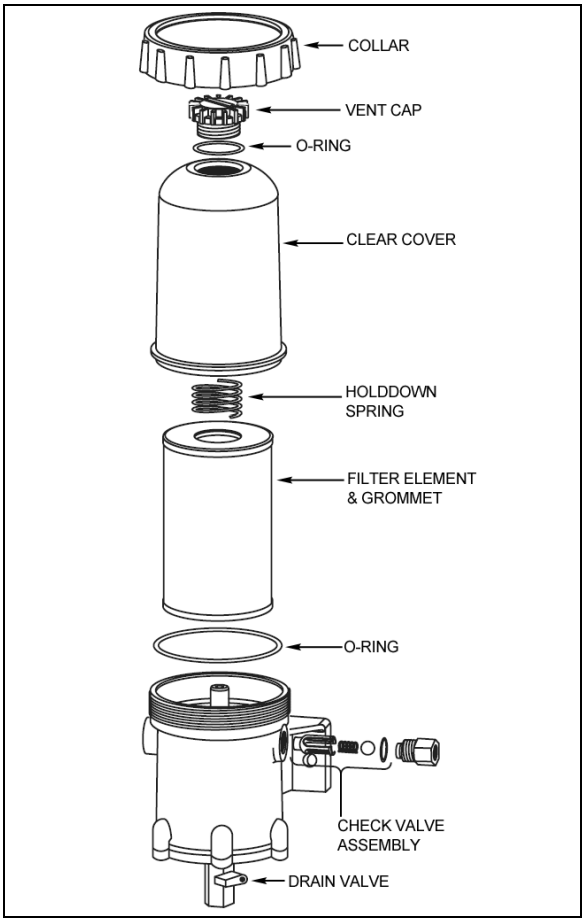


FIGURE 10: DAVCO FUEL PRO 382 EXPLODED VIEW03034

11. Open the shut-off valve;
12. Start engine, raise rpm for 2-3 minutes, hand tighten collar again;
13. After the air is purged and with the engine still running, slowly loosen the vent cap on the filter cover. The fuel level in the cover will start falling. When the fuel level falls to the top of the collar, tighten the vent cap quickly by hand;
14. Shut down the engine and hand-tighten the collar again.

NOTE

Fuel Pro 382 also accepts standard secondary spin-on fuel filters.

ENVIRONMENTAL NOTICE

Diesel fuel is an environmentally hazardous product. Dispose in an environmentally friendly manner.

3. FUEL LINES AND FLEXIBLE HOSES

Make a visual check for fuel leaks at all engine-mounted fuel lines and connections and at the fuel tank suction and return lines. Since fuel tanks are susceptible to road hazards, leaks in this area may best be detected by checking for accumulation of fuel under the tank. Engine performance and auxiliary equipment is greatly dependent on the ability of flexible hoses to transfer lubricating oil, air, coolant and fuel oil. Diligent maintenance of hoses is an important step in ensuring efficient, economical and safe operation of engine and related equipment.

MAINTENANCE

Check hoses daily as part of the pre-start-up inspection. Examine hoses for leaks and check all fittings, clamps and ties carefully. Make sure that the hoses are not resting on or touching shafts, couplings, and heated surfaces, including exhaust manifolds, any sharp edges or other obviously hazardous areas.

Since all machinery vibrates and moves to a certain extent, clamps and ties can fatigue with age. To ensure continued proper support, inspect fasteners frequently and tighten or replace them as necessary. Refer to the schematic diagram of the fuel system (Fig. 1).

CAUTION

Oil level above the dipstick full mark or a decrease in lube oil consumption may indicate internal fuel leaks. Check oil level frequently.

4. PREHEATER FUEL FILTER

The preheater fuel filter is located beside the preheater in the engine coolant heater compartment, and is accessible by opening the evaporator compartment door.

MAINTENANCE

Replace preheater fuel filter every 50,000 miles (80 000 km) or once a year, whichever comes first.

5. FUEL TANK

X3-45 coaches & VIP and also XLII Entertainer Bus Shells are equipped with a high-density cross-link polyethylene fuel tank with a capacity of 208 US gallons (787 liters).

The fuel filling access door is located on the R.H. side of vehicle providing easy fuel filling.

A pressure relief valve on the fuel tank connection-panel relieves high-pressure buildup and an overflow tube allows offset air in the tank to escape during filling. For 95% of the tank volume, 5% of tank inside space is kept filled with air with no exit opening, allowing for a fuel expansion safety margin. A drain plug, accessible from under the vehicle, is fitted at the bottom of the tank.

5.1 TANK REMOVAL

DANGER

Park vehicle safely, apply parking brake, stop engine and set battery master switch(es) to the OFF position prior to working on the vehicle.

Before working under an air-suspended vehicle, it is strongly recommended to support the body at the recommended jacking points.

NOTE

Before removal, the fuel tank should be completely drained by unscrewing the drain plug. Ensure that the container used has a capacity equal to the amount of fuel remaining in the tank.

1. Open the condenser door and remove the fuel tank access panel. The rear baggage compartment fuel tank access panel may also be removed to facilitate access to components.
2. Unscrew clamps retaining R.H. side filler tube to fuel tank and filler neck. Disconnect tube and remove it.

3. If applicable, unscrew preheater supply line, preheater return line, auxiliary return line and/or auxiliary return line from fuel tank connection-panel.
4. Unscrew engine supply and return lines from fuel tank connection-panel, identify them for reinstallation.
5. Disconnect electrical wiring from tank on connection plate.

DANGER

Before removing the bolts securing the tank support to the frame, make sure the tank is supported adequately. Failure to do so could result in injury as well as damage to the tank.

6. From under the vehicle, on R.H. side, unscrew the 4 bolts (2 in front, 2 in back) retaining the tank support to the frame.
7. From under the vehicle, on the L.H. side, unscrew the 2 bolts (1 in front, 1 in back) retaining the tank support to the frame.
8. Carefully remove tank from under the vehicle.

5.2 TANK INSTALLATION

To install tank, simply reverse the *"Tank Removal"* procedure.

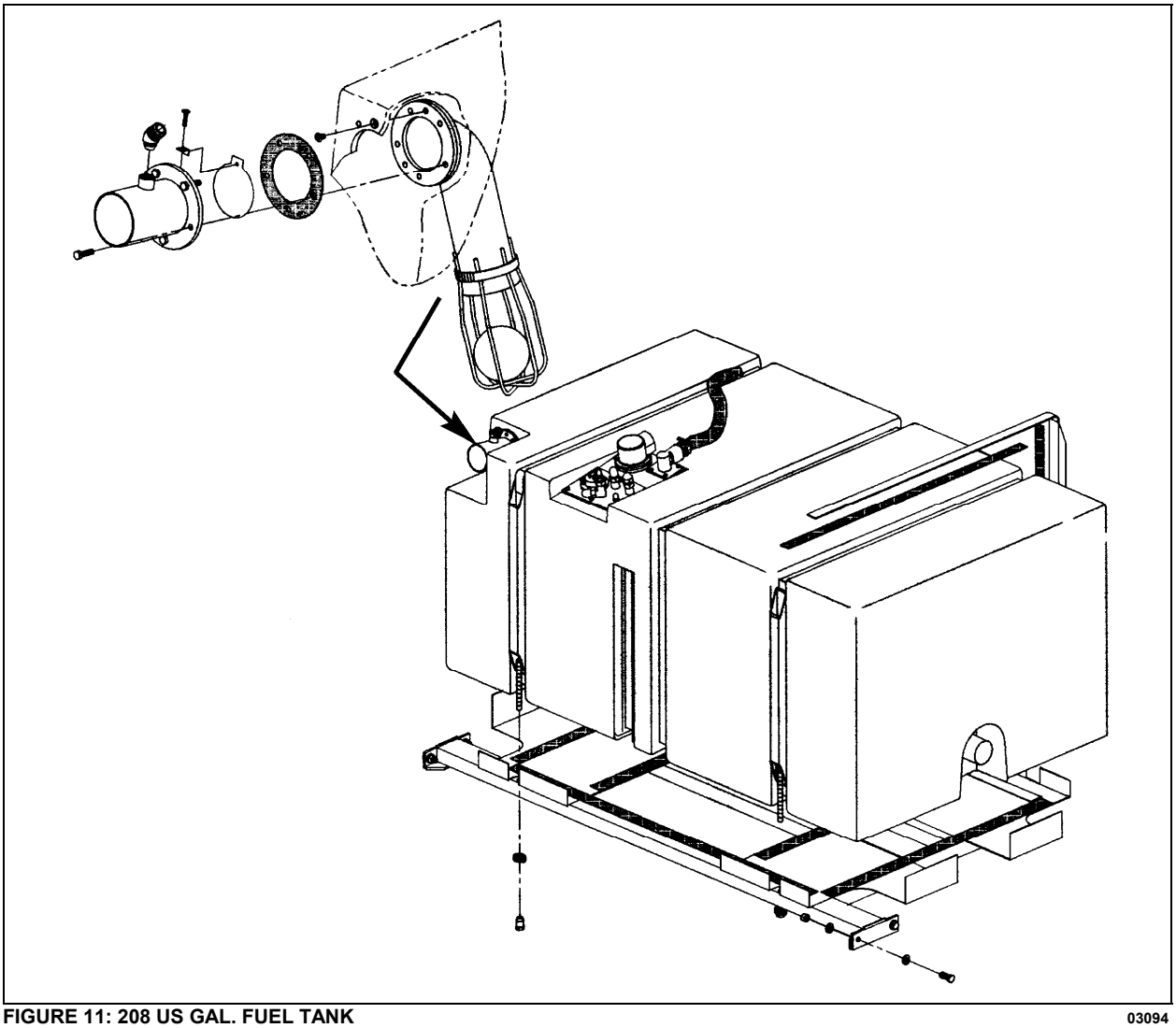


FIGURE 11: 208 US GAL. FUEL TANK 03094

5.3 FUEL TANK VERIFICATION

Inspect fuel tank from under vehicle for leaks or fuel traces. If a leak is detected, repair immediately as per "Polyethylene Fuel Tank Repair" in this section.

DANGER

Park vehicle safely, apply parking brake, stop engine and set battery master switch(es) to the OFF position prior to working on the vehicle.

Before working under an air-suspended vehicle, it is strongly recommended to support the body at the recommended jacking points.

5.4 POLYETHYLENE FUEL TANK REPAIR

NOTE

Fuel level must be lower than perforation to carry out this procedure.

DANGER

Park vehicle safely, apply parking brake, stop engine and set battery master switch(es) to the OFF position prior to working on the vehicle.

1. Locate perforation on fuel tank.
2. If necessary, remove fuel tank as per instructions in this section.
3. Drill perforation with a 23/64" bit. Make sure drill hole is perfectly round.
4. Insert a screw (Prevost #500196) and a washer (Prevost #5001244) into anchor nut (Prevost #500331).
5. Place assembly in drill hole. Tighten screw by 10 complete turns. Refer to Fig. 12.
6. Apply sealant on head plug (Prevost #507300) and seal hole with the head plug.

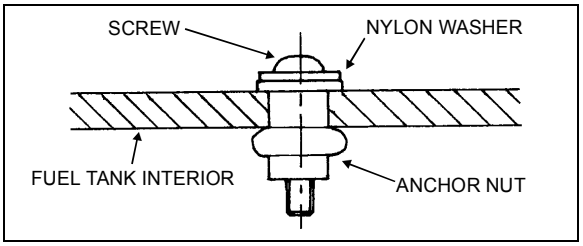


FIGURE 12: FUEL TANK REPAIR 03014

6. FUEL SPECIFICATIONS

The quality of fuel oil used for high-speed diesel engine operation is a very important factor in obtaining satisfactory engine performance, long engine life and acceptable exhaust emission levels.

The U.S. Environmental Protection Agency (EPA) has issued new standards to improve air quality by significantly reducing emissions through a combination of cleaner-burning diesel engines and vehicles.

To meet EPA standards, the petroleum industry produces **Ultra Low Sulfur Diesel** (ULSD) fuel, also referred to as S15, containing a maximum 15ppm (parts-per-million) sulfur.

On-highway diesel engines meeting 2010 emission regulations are designed to operate **ONLY** with ULSD fuel. ULSD fuel will enable the use of cleaner technology diesel engines and vehicles with advanced emissions control devices, resulting in significantly improved air quality.

6.1 FUEL TYPE

EPA-10 engines like the Volvo D13 are designed to run on **Ultra Low Sulfur Diesel** (ULSD) fuel, which can contain no more than 15 ppm sulfur.

Fuel used must meet engine manufacturer's specification. Refer to Volvo engine specifications.

CAUTION

ULSD fuel is necessary to avoid fouling the engine's Exhaust Aftertreatment System. Improper fuel use will reduce the efficiency of the engine's Aftertreatment System and may permanently damage the system.

CAUTION

Owners of 2010 and later model year on-highway diesel engine must refuel only with ULSD fuel.

NOTE

Burning Low Sulfur Diesel fuel (instead of ULSD fuel) in 2010 and later model year diesel engines is illegal and punishable with civil penalties.

NOTE

Engine and vehicle manufacturers expect ULSD fuel to be fully compatible with the existing fleet, including 2006 and earlier model year vehicles. In some instances, the introduction of ULSD fuel to older vehicles may affect fuel system components or loosen deposits in fuel tanks. As part of a good maintenance program, owners and operators of existing cars, trucks and buses are encouraged to monitor their diesel-powered vehicles closely for potential fuel system leaks or premature fuel filter plugging during the change-over to ULSD fuel.

NOTE

Like Low Sulfur Diesel fuel, ULSD fuel requires good lubricity and corrosion inhibitors to prevent unacceptable engine wear. As necessary, additives to increase lubricity and to inhibit corrosion will be added to ULSD fuel ***prior*** *to its retail sale.*

6.2 BLENDING

Only ultra low sulfur kerosene – No.1 diesel with no more than 15ppm sulfur may be blended with ULSD fuel to improve cold weather performance. With so many kerosene formulations on the market, care must be taken to select kerosene with a maximum of 15ppm sulfur.

Blend rates remain the same as with Low Sulfur Diesel fuel.

6.3 BIODIESEL FUELS

ULSD-B5 biodiesel may be used. B5 tells you the percentage of biodiesel mixed in with ULSD. B5 is 5% biodiesel and 95% ULSD.

Fuel used must meet engine manufacturer's specification for biodiesel fuel. Refer to Volvo engine specifications.

Biodiesel fuels are alkyl esters of long chain fatty acids derived from renewable resources. Volvo highly recommends biodiesel fuels made from soybean or rapeseed oil through the proper transesterification reaction process. Other feedstock source of biodiesel fuels such as animal fat and used cooking oils are not recommended by Volvo. Failures attributed to the use of biodiesel fuel will not be covered by Volvo or Prevost product warranty. Also, any engine performance problem related to the use of biodiesel fuel would not be recognized nor considered as Volvo or Prevost's responsibility.

7. AIR CLEANER (DRY TYPE)

The vehicle is equipped with a dry-type replaceable element air cleaner, located in the engine compartment. Access the air cleaner through the engine R.H. side door. Engine air enters the air cleaner through (1) one intake duct located just above engine R.H. side door. It then flows through a pre-cleaner and finally through the air cleaner. The pre-cleaner removes dust and moisture by means of a discharge tube at the bottom of the element. It is in series with a replaceable impregnated paper filter element (air cleaner).

7.1 PRE-CLEANER SERVICING

MAINTENANCE

The pre-cleaner is designed to be self-cleaning; however, it should be inspected and any accumulated foreign material removed during the periodic replacement of the impregnated paper filter element.

7.2 AIR CLEANER SERVICING

Stop the engine, open the R.H. side engine compartment door, and loosen the wing nut retaining the air cleaner element to the air cleaner. Remove the element by pulling on the handle in the center of the air cleaner element.

Install cleaner element as follows:

1. Inspect the gasket-sealing surface inside the air cleaner. It must be smooth, flat and clean;
2. Install the air cleaner element;
3. Make sure that the element seals securely;
4. Inspect element cover gasket and replace if necessary.

Whenever it becomes necessary to remove the air cleaner assembly (dry type) for maintenance or other repair in this area, great care should be taken when installing air cleaner assembly.

The pre-filter should be installed snugly in the air duct and clamped tightly to the air cleaner inlet to prevent any dust infiltration into the air cleaner.

7.3 GENERAL RECOMMENDATIONS

The following maintenance procedures will ensure efficient air cleaner operation:

1. Keep the air cleaner housing tight on the air intake pipe;
2. Make sure the correct filters are used for replacement;
3. Keep the air cleaner properly assembled so the joints are air-tight;
4. Immediately repair any damage to the air cleaner or related parts;
5. Inspect, clean or replace the air cleaner or elements as operating conditions warrant. Whenever an element has been removed from the air cleaner housing the inside surface of the housing must be cleaned with a soft clean cloth;
6. Periodically inspect the entire system. Dust-laden air can pass through an almost invisible crack or opening which may eventually cause damage to an engine;
7. Never operate the engine without an element in the air cleaner assembly;

⚠ CAUTION

Do not ignore the Warning given by the air restriction indicator. This could result in serious engine damage.

8. Store new elements in a closed area free from dust and possible damage.

7.4 AIR CLEANER RESTRICTION INDICATOR

A resettable restriction indicator may be installed on the engine air-intake duct, clearly visible from the rear engine compartment. The indicator monitors the vacuum level between the air filter and the engine. A red marker is displayed when the air filter is clogged and must be replaced. Reset by pressing on the indicator's extremity.

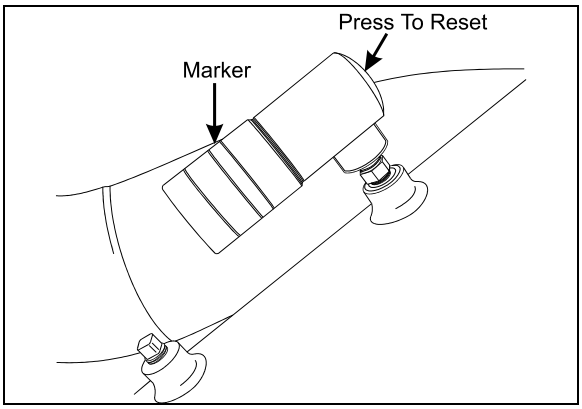


FIGURE 13: RESTRICTION INDICATOR 01052

8. FUEL PEDAL

The EFPA (Electronic Foot Pedal Assembly) connects the accelerator pedal to a potentiometer (a device that sends an electrical signal to the ECM, which varies in voltage, depending on how far down the pedal is depressed). The EFPA is installed in the space normally occupied by a mechanical foot pedal. It has maximum and minimum stops that are built into the unit during manufacturing.

8.1 FUEL PEDAL ADJUSTMENT

The EFPA contains a throttle position sensor that varies the electrical signal sent to the ECM. The sensor must be adjusted whenever an EFPA is serviced. In addition, the sensor should be adjusted any time codes 21 and 22 are flashed.

With the ignition "ON" and the proper diagnostic tool (DDR) (for information regarding the DDR, see *"01 ENGINE"* in this manual), check the throttle counts at idle and full throttle positions.

Proper pedal output should be 20/30 counts at idle and 200/235 at full throttle. If adjustment is necessary, remove the potentiometer retaining screws and rotate the potentiometer clockwise to increase counts or counterclockwise to decrease. When correct output is confirmed, tighten retaining screws.

8.2 POTENTIOMETER REPLACEMENT

1. Disconnect cable harness connector.
2. Loosen the two screws and remove potentiometer. Retain for re-assembly.
3. Discard potentiometer (Fig. 14).

CAUTION

Note the routing and clamping locations of the cable before disassembly. Proper cable routing and fastening is critical to the operation of this system. Marking the foot pedal assembly to record cable routing is recommended.

2. Position new potentiometer. Press potentiometer onto the potentiometer shaft, matching cutouts in shaft to drive tangs of potentiometer. Apply hand pressure until potentiometer has bottomed out in housing. Reinstall screws (Fig. 14) and tighten just enough to secure potentiometer lightly. Tighten screws to 10 - 20 Lbf-in (1.13 - 2.26 Nm).
3. Reconnect electronic foot pedal assembly's cable harness to the ECM connector. If potentiometer calibration is necessary (see *"FUEL PEDAL ADJUSTMENT"* in this section).

CAUTION

Make sure the cable harness is routed correctly, and securely installed so that it does not become pinched, stretched, or otherwise damaged during vehicle operation.

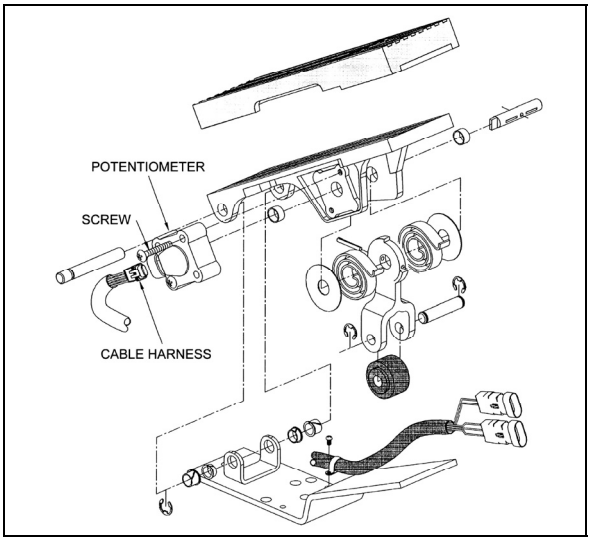


FIGURE 14: ELECTRONIC FOOT PEDAL ASSEMBLY 03035

9. SPECIFICATIONS

Davco Fuel Pro 382 Fuel Filter / Water Separator Element

Prevost number 510795

Primary Fuel Filter (Fuel/Water Separator) With Volvo D13 Engine

Part number 21380475

Filter torque ..... ½-¾ turn after gasket contact

Secondary Fuel Filter With Volvo D13 Engine

Part number 20972293

Filter torque ..... ¾- 1 turn after gasket contact

Fuel tank Capacity

Standard (All vehicles) ..... 208 US gallons (787 liters)

Air Cleaner

Make ..... Nelson

Prevost Number 530206

Service Part No 7182 8N

Prevost number (element cartridge) 530197

Air Cleaner Restriction Indicator

Make ..... Donaldson

Model RBX00-2220

Indicates .....at 20" (508 mm) of water

Prevost number 530161

Preheater Fuel Filter

Make ..... Spheros

Prevost number 871037

SECTION 04: EXHAUST AND AFTERTREATMENT SYSTEM

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1. EXHAUST AFTERTREATMENT SYSTEM OVERVIEW

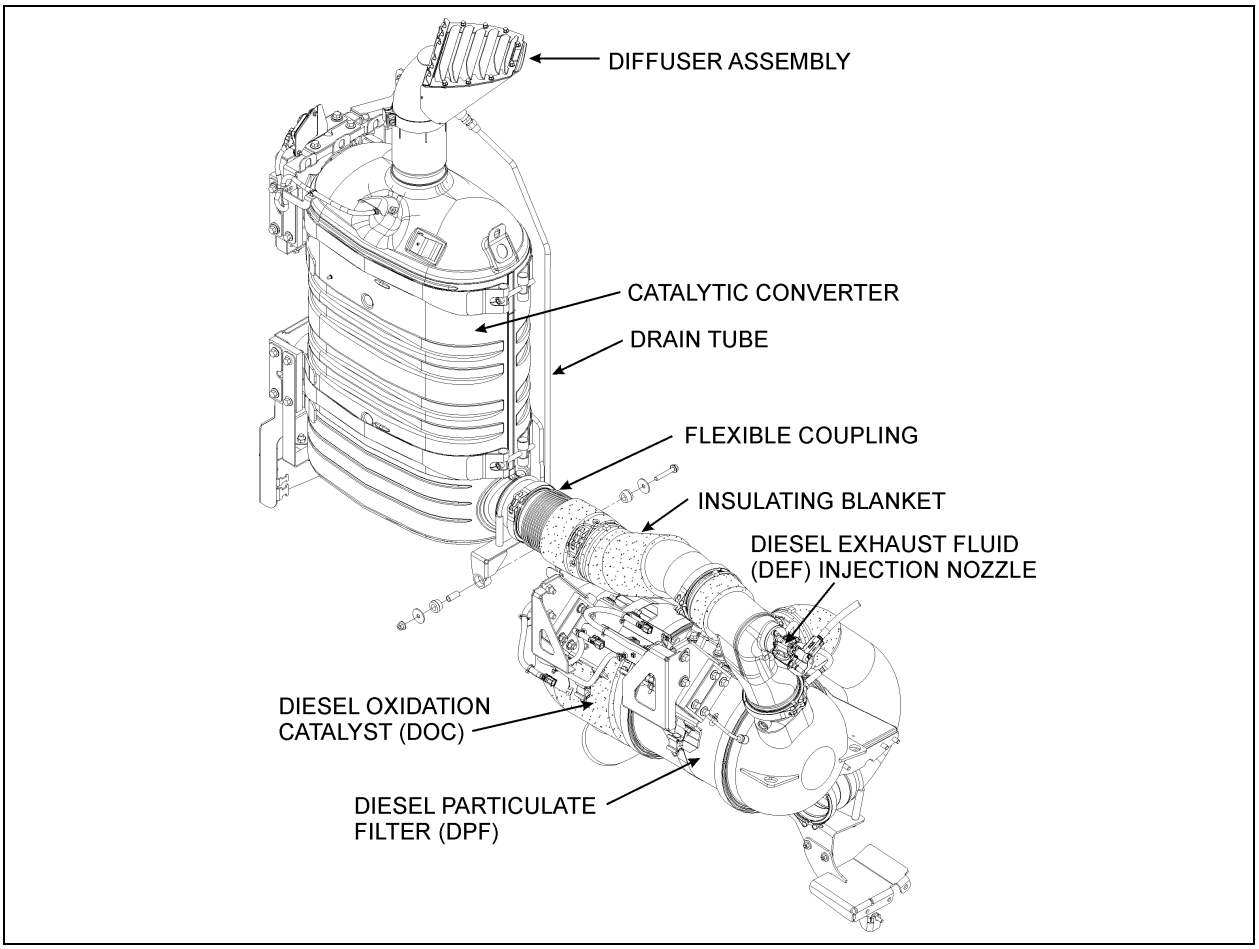


FIGURE 1: EXHAUST SYSTEM

The technology behind clean emissions is through the immediate aftertreatment of engine exhaust. The process for reducing NOx via aftertreatment is called Selective Catalytic Reduction (SCR). It requires a catalytic converter into which is injected Diesel Exhaust Fluid (DEF). The primary component of DEF is water; the active component is urea. Urea is a nitrogen compound that turns to ammonia when heated. When a urea-and-water solution is injected into the exhaust stream and passed over a catalyst, the urea reacts with the NOx to form nitrogen and water vapor – two clean and harmless components of the air we breathe. The aftertreatment system primary function is to capture and oxidize (regenerate) the particulate matter (soot) in the engine exhaust gases and to reduce NOx. To achieve this goal, the exhaust aftertreatment system is split into two main sections: the exhaust gases first enter the **Diesel Oxidation Catalyst (DOC)** and **Diesel Particulate Filter (DPF)** assembly to capture and regenerate the soot on a regular or passive basis, then the exhaust gases flow through the **catalytic converter** to reduce NOx to minimum level. Through constant monitoring of the exhaust gas temperature and the system back pressure, the engine management system (EMS) is able to manage regeneration.

The exhaust aftertreatment system is rubber mounted to the vehicle structure. This feature reduces the transmission of vibrations to the exhaust aftertreatment system thus resulting in extended life of the system, brackets and also noise reduction.

1.1 MAINTENANCE

Inspect the exhaust system periodically for restrictions and leaks. Figure 1 presents the major components of the exhaust system. Exhaust leaks are commonly the result of loose

clamp bolts, corroded or punctured pipes. In addition to excessive noise, a leaking exhaust system could allow toxic gases to enter the vehicle. Damage to surrounding components from hot gases could result as well. Replace damaged or corroded exhaust components immediately.

Inspect the exhaust system as follows:

- At vehicle inspection intervals ;
- Whenever a change is noticed in the sound of the exhaust system ;
- When components close to the exhaust system get unnaturally dirty ;
- Whenever the exhaust system is damaged.

Replace damaged or corroded exhaust system components without delay.

When operating the engine in a service garage or in a closed area, the exhaust must be vented to the outside. Place the shop vent hose over the exhaust outlet pipe.

DANGER

Avoid breathing exhaust gases since they contain carbon monoxide which is odorless and colorless but harmful. Carbon monoxide is a dangerous gas that can cause unconsciousness and can be lethal. If, at any time you suspect that exhaust fumes are entering the vehicle, locate and correct the cause(s) as soon as possible.

NOTE

The key to successful regeneration is high exhaust temperature for an extended period of time. For this reason, insulating blankets must remain permanently on the exhaust system.

If insulating blankets are removed from the system, the exhaust gases temperature may not be high enough to permit efficient particulate oxidation during passive regeneration, resulting in increased fuel consumption due to overuse of active or stationary regeneration.

1.2 FLEXIBLE COUPLING INSTALLATION

The flexible coupling contains a rigid interior pipe (Fig. 2). To allow appropriate flexibility once installed, be sure interior pipe is concentric to flexible part and that the flexible coupling is straight when installed. This piece of equipment handles vibration and thermal expansion.

CAUTION

Adequately support the exhaust system line. The load of the exhaust line **must not** be transferred to the turbocharger.

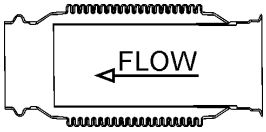


FIGURE 2: FLEXIBLE COUPLING 04022

2. DIESEL PARTICULATE FILTER (DPF)

Besides trapping soot, the **DPF** (**Diesel Particulate Filter**) also traps the ash that has been generated when additives in engine oil are burned. However, unlike soot, ash cannot be oxidized. The ash that accumulates in the filter will eventually cause an increase in exhaust back pressure. EMS will constantly monitor the ash accumulation and forecast the approximate time until DPF ash cleaning is required. This allows you the opportunity to plan for the DPF ash cleaning interval. If ash cleaning is not performed proactively, and the back pressure increases beyond the system limit, EMS will flag the amber warning light on the telltale panel, notifying the operator that an ash cleaning is required. Clean remanufactured DPF cartridge will be available through Prevost on an exchange basis. For most commuter vehicle applications and duty cycle, this will occur after approximately 4500 hours of operation.

WARNING

HOT SURFACES

Keep yourself clear of hot Aftertreatment System surfaces, particularly during and after active or stationary regeneration. Hot surfaces can cause serious burns.

Make sure Aftertreatment System components are cold before handling.

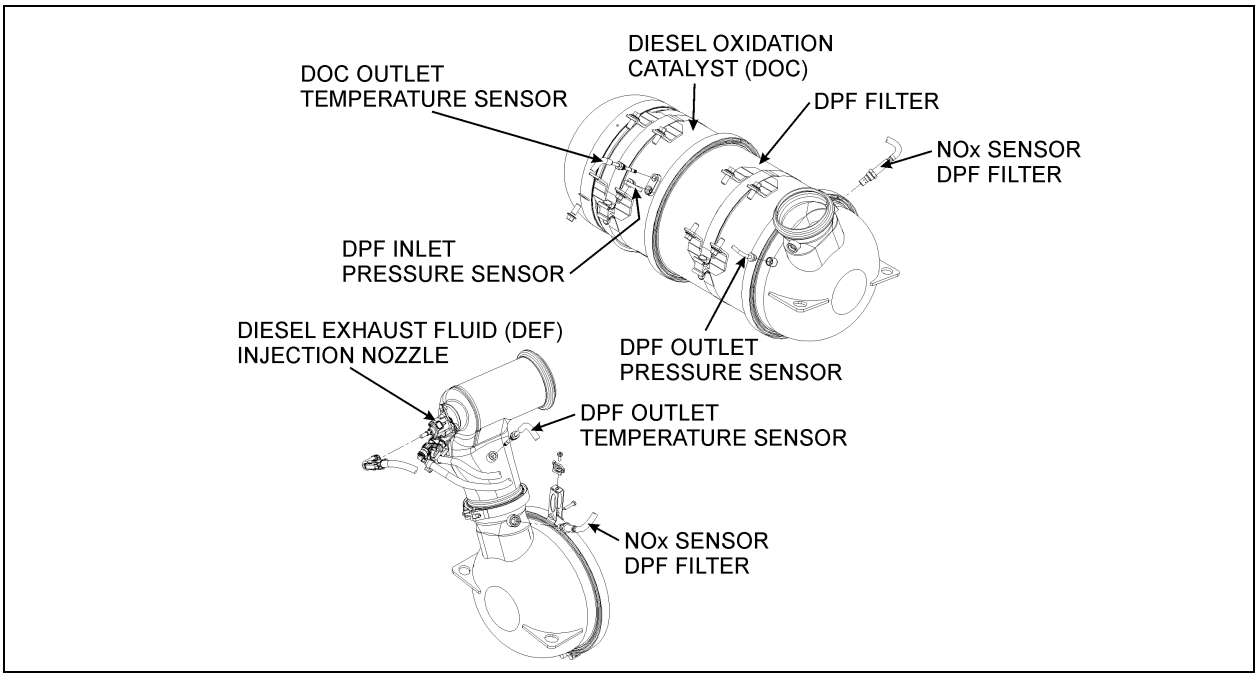


FIGURE 3: DIESEL OXIDATION CATALYST (DOC) & DIESEL PARTICULATE FILTER (DPF) ASSEMBLY 04016

WARNING

HOT EXHAUST

During stationary regeneration, exhaust gases temperature may get very hot at the diffuser outlet. Do not direct diffuser at combustible materials. Before initiating stationary regeneration, make sure that the diffuser outlet is clear of objects and that no one is working near the diffuser outlet. Stationary regenerations must be undertaken outdoors only.

Never initiate regeneration when exhaust gas collection system is in place.

WARNING

TOXICITY

Do not initiate a stationary regeneration in a closed area like a garage. **Stationary regeneration must be undertaken outdoors only.**

2.1 DIESEL PARTICULATE FILTER ASSEMBLY REMOVAL

To remove the DPF, proceed as follows:

CAUTION

External and internal temperatures remain hot long after engine has been shut down. Allow the Exhaust Aftertreatment System to cool before handling. Wear protective clothing and glove while servicing.

1. First, open the engine compartment doors;
2. Put insulating blanket aside;
3. Disconnect pressure, temperature and NOx sensors;
4. Support Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPF) assembly;

CAUTION

HEAVY DEVICE

A suitable lifting or holding device is required. Properly support and attach lifting equipment to prevent the DOC and DPF assembly from falling when servicing.

5. Unfasten straps holding DOC and DPF assembly;
6. Carefully lower DOC and DPF assembly;
7. To make sure components are reinstalled in the same position, mark position of DOC,

DPF and V-band clamps in relation with one another before taking apart;

CAUTION

FRAGILE - HANDLE WITH CARE

Use extreme care when handling DPF cartridge as it could be damaged or destroyed by dropping or sudden impact.

Clean remanufactured DPF cartridge will be available on an exchange basis. For this reason, it is very important to maintain the cartridge in perfect condition. Damaged cartridge may not be refunded.

8. Also replace V-band clamps and gaskets when replacing DPF filtration module;

NOTE

When replacing the DPF cartridge, refer to the specifications on the DPF attached tag for proper replacement DPF selection.

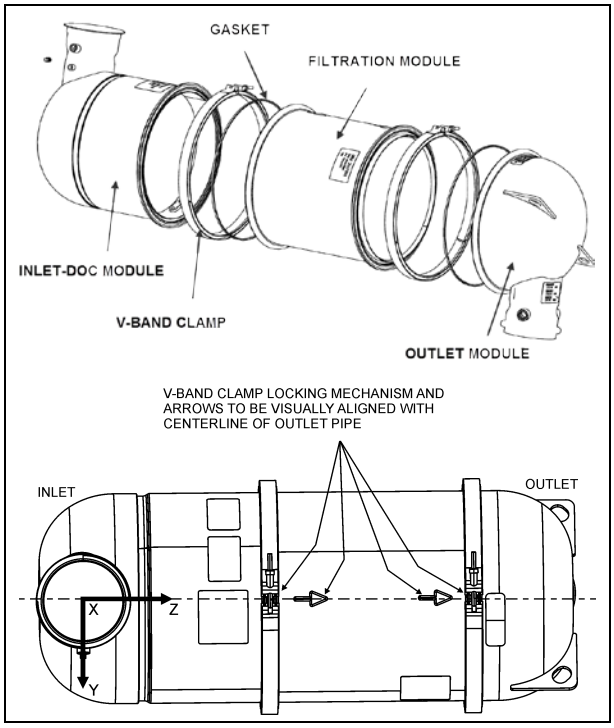
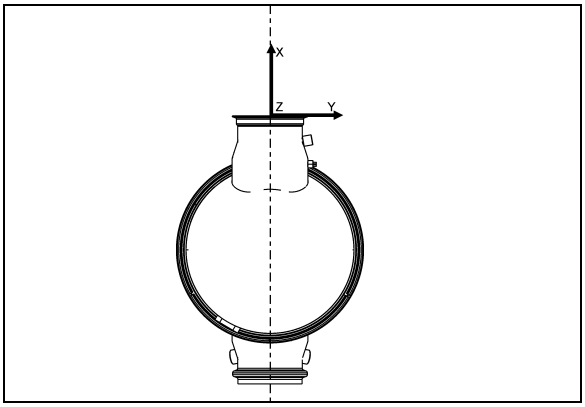


FIGURE 4: TAKING DOC AND DPF APART

9. Always put DOC and DPF filtration module back together again in a vertical position to facilitate gaskets positioning;

   For proper DPF assembly installation, inlet and outlet alignment is important. When reassembling the DPF, a straight edge must be used to align inlet and outlet.



10. Torque V-band clamps to 20 lbf-ft;

CAUTION

Always torque clamps by hand.

11. With a rubber mallet, hit clamps forcefully around circumference to make sure gasket is fully seated;
12. Support Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPF) assembly during reinstallation;
13. Reconnect pressure, NOx and temperature sensors;
14. Fasten straps holding DOC and DPF assembly;
15. Put insulating blanket back.

3. CATALYTIC CONVERTER

In the first instance, the catalytic converter of the Selective Catalytic Reduction (SCR) does not need any maintenance. Unless an accident or damage occurs in the vicinity of the engine compartment; the catalytic converter will not have to be replaced.

However if the catalytic converter must be replaced, use one of the two following procedures:

3.1 REMOVAL

Procedure # 1

Radiator must be removed in order to lower the catalytic converter for replacement.

- Set the starter selector switch to the *OFF* position.
- Shut off the heater line shut-off valves.
- Using the quick-connect drain hose, drain the engine cooling system. Refer to Section 05, COOLING under "DRAINING COOLING SYSTEM".

CAUTION

Tag hoses and cables for identification before disconnecting in order to facilitate re-installation. Plug all openings to prevent dirt from entering the system.

- Disconnect and remove section of coolant pipe assembly mounted between the radiator outlet and the water pump inlet.

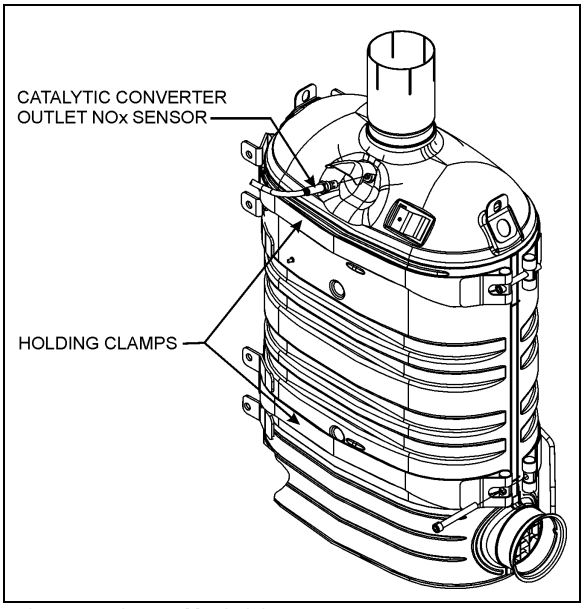


FIGURE 5: CATALYTIC CONVERTER

- Disconnect and remove a section of coolant pipe assembly mounted between the thermostat housing and the radiator inlet.
- Disconnect the electric fan-clutch connector located near the cooling fan right angle gearbox.
- Disconnect and remove the air intake duct mounted between the turbocharger outlet and the air cooler inlet.
- Open radiator door. Unfasten bolts and screws fixing radiator sealing frame.
- Remove radiator and air cooler assembly.

WARNING

Due to the heavy load of the radiator assembly, it must be adequately supported before attempting to remove it.

- Safely support catalytic converter from the top.
- Disconnect catalytic converter outlet NOx sensor.
- Remove clamps holding catalytic converter then lower.
- Remove or disconnect any piece of equipment or component that might be in the way or that might prevent removing the catalytic converter.

Procedure # 2

- Set the starter selector switch to the *OFF* position.
- Shut off the heater line shut-off valves.
- Remove DOC and DPF assembly (Refer to paragraph 2.1 in this Section).
- Remove pipe connecting DOC & DPF assembly to catalytic converter.
- Using the quick-connect drain hose, drain the engine cooling system. Refer to Section 05, COOLING under "DRAINING COOLING SYSTEM".

CAUTION

Tag hoses and cables for identification before disconnecting in order to facilitate re-installation. Plug all openings to prevent dirt from entering the system.

- Disconnect and remove section of coolant pipe assembly mounted between the radiator outlet and the water pump inlet.
- Disconnect and remove a section of coolant pipe assembly mounted between the thermostat housing and the radiator inlet.
- Disconnect and remove a section of air intake duct mounted between the air cooler outlet and the engine.
- Remove coolant surge tank.

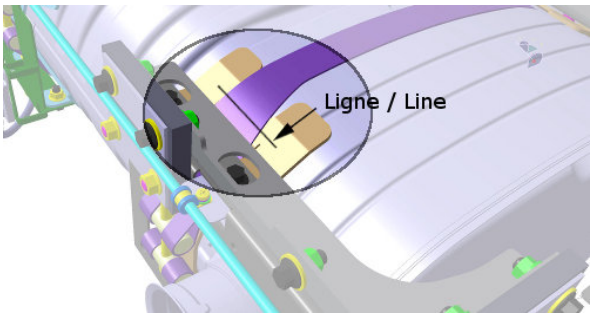
- Release tension from drive belt (Refer to paragraph 12.1 and 15.1 in Section 05: Cooling System).
- Cut cable ties and disconnect electrical connector from fan clutch. Remove fan drive shaft fasteners at the gear box.
- Remove radiator fan drive mechanism support.
- Safely support catalytic converter from the top.
- Disconnect catalytic converter outlet NOx sensor.
- Remove clamps holding catalytic converter then lower.
- Remove or disconnect any piece of equipment or component that might be in the way or that might prevent removing the catalytic converter.

3.2 ASSEMBLING CATALYTIC CONVERTER

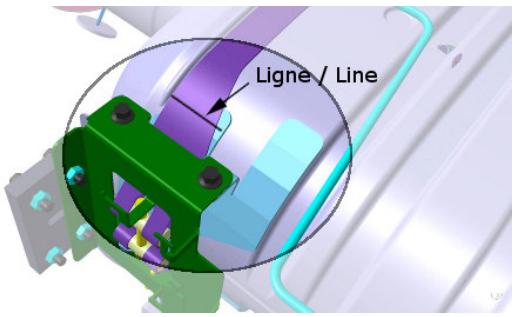
Before removing

- Mark, with a vertical line the angular position of the lower (both sides) and upper clamps with regard to the clamps support located on the catalytic converter.

Lower

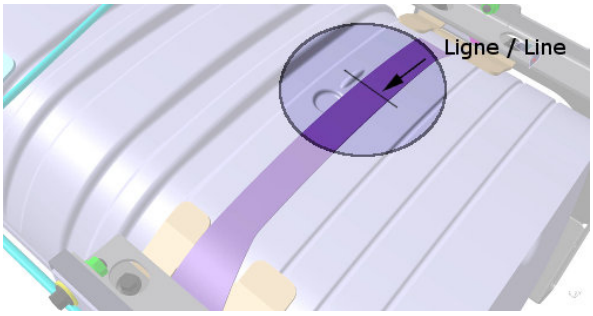


Upper

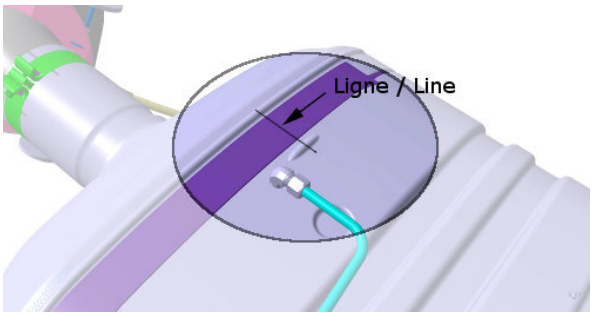


- Mark, with a vertical line the central position of the lower and upper clamps with regard to the emboss located at the bottom and at the top of the catalytic converter.

Lower



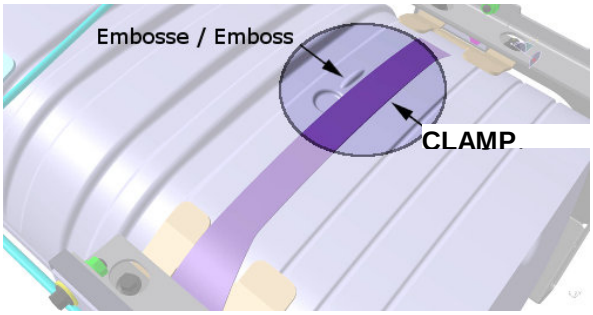
Upper



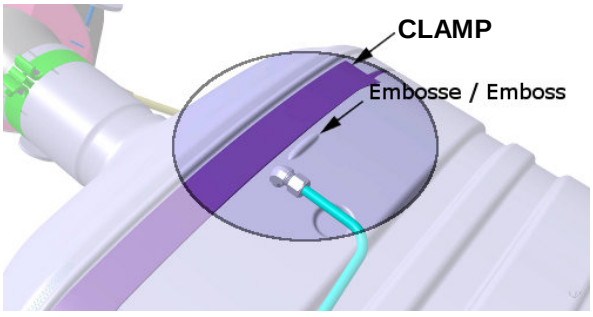
Assembling

- Position the upper clamps above the upper emboss and the lower clamps below the lower emboss of the catalytic converter.

Lower

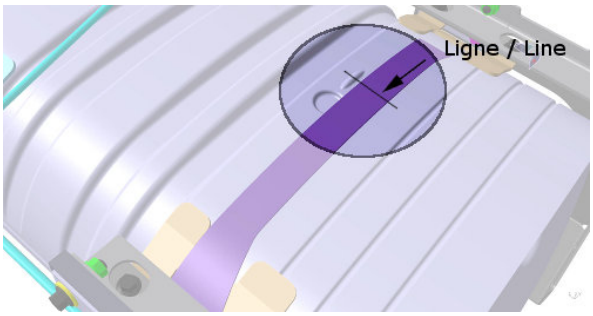


Upper

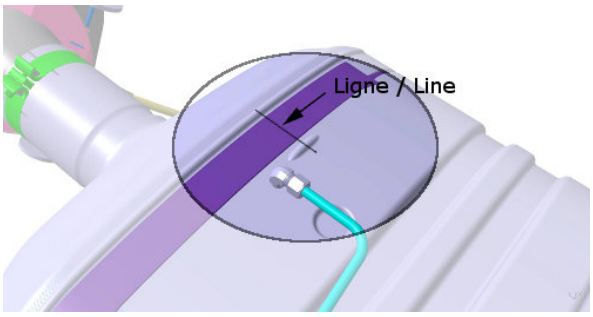


- Using the lines made earlier, line up the lower and upper clamps with regard to the emboss of the converter and afterward, line up the lines made earlier on the clamps with regard to the clamp supports on the catalytic converter.

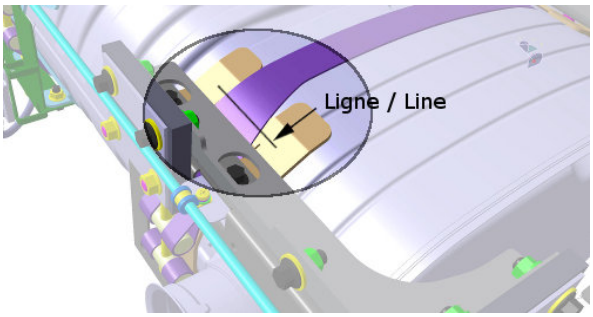
Lower



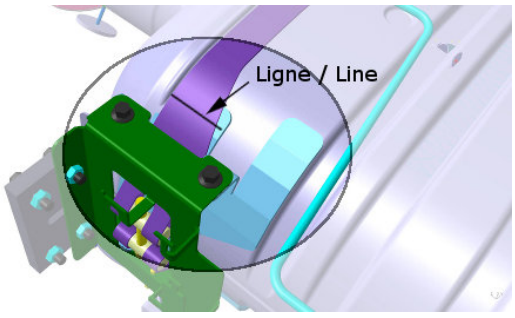
Upper



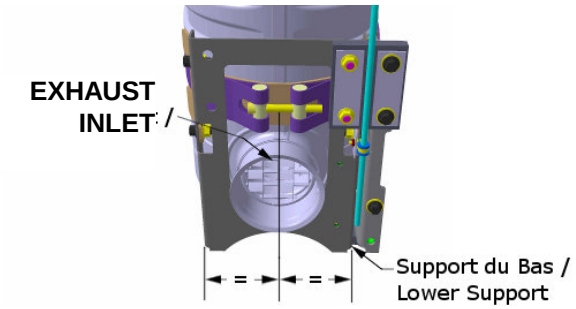
Lower



Upper



- Before tightening the parts, make sure that the catalytic converter lower support is well centered with the exhaust inlet of the catalytic converter.



- While tightening the bolts, keep in mind to respect the alignment of the parts and keep the lower support as centered as possible with the catalytic converter exhaust inlet.

4. DIFFUSER ASSEMBLY

During stationary regeneration, exhaust gases temperature may get very hot at the DPF outlet. The diffuser decreases the exhaust gasses temperature by about half approximately, at 6 inches above the diffuser. The diffuser is an important component of the exhaust system and must remain on the vehicle at all times. Operating the vehicle without the diffuser may seriously damage the vehicle.

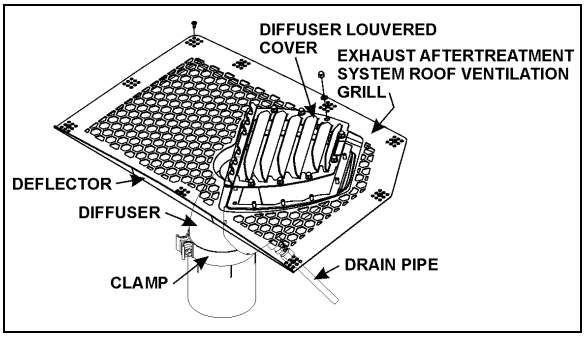


FIGURE 6: DIFFUSER ASSEMBLY 04014

4.1 DIFFUSER ADJUSTMENT

Should an adjustment of the diffuser position be necessary, first remove the exhaust aftertreatment roof ventilation grill.

CAUTION

To prevent paint damage and fiberglass overheating caused by hot exhaust gases, the diffuser louvered cover must be flush with the roof surface or may exceed the roof surface not more than 3/32" (2mm).

CAUTION

Tighten clamps properly in order to prevent any movement of the diffuser assembly. An impact wrench is necessary.

1. Loosen the clamp securing the diffuser assembly to the catalytic converter.

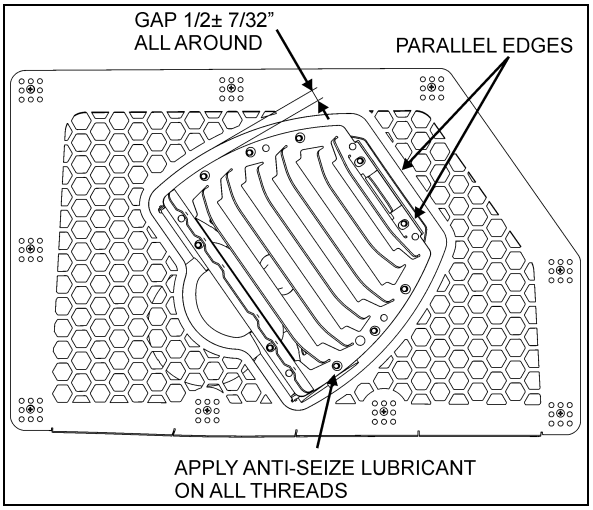


FIGURE 7: DIFFUSER POSITION ADJUSTMENT 04015_1

2. For proper angular position, make sure that the two edges shown on figure 7 are parallel with each other.
3. Using a straightedge, adjust the diffuser assembly level. The top surface of the warning plate fixed on the diffuser louvered cover must be flush with the roof surface or may exceed about 3/32".
4. Tighten the clamp securing the diffuser assembly to the catalytic converter.
5. Reinstall the exhaust aftertreatment system roof ventilation grill and deflector.

4.2 MAINTENANCE

At vehicle inspection intervals, inspect the diffuser assembly as follows:

- Inspect diffuser grille for stress cracking;
- Check for presence of foreign matter and debris inside the diffuser housing, remove and clean if applicable;
- Check for proper functioning of the rain cap inside the diffuser housing, make sure that it moves freely;
- Make sure that the water drain tube is not clogged. Pour a cup of water into the diffuser housing and assure that all the water is drained at once at the other end of the drain tube. If tube is clogged, remove tube and blow compressed air inside in reverse flow;
- Check that the warning plate "THIS DIFFUSER SURFACE MUST BE FLUSH WITH THE ROOF SURFACE" is still in place.

5. DIESEL EXHAUST FLUID (DEF) TANK AND INJECTION SYSTEM

The DEF tank and injection system control unit continuously vary the amount of DEF injected in response to the engine's current load conditions.

Diesel Exhaust Fluid (DEF) is stored in a 16 gallons plastic tank located aft of the condenser compartment.

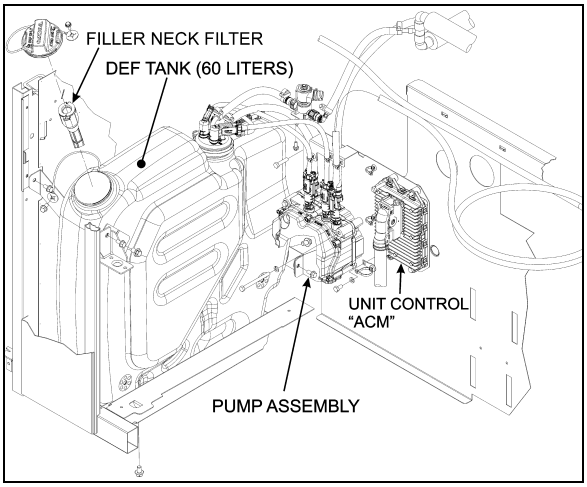


FIGURE 8: DEF TANK AND PUMP LOCATION

A pump located beside the DEF tank is used to pressurize the system and deliver the fluid.

A heating coil located inside the tank use engine coolant to keep the DEF warm during cold season.

DEF is injected into the exhaust gases through an injection nozzle located between the DPF and the catalytic converter (refer to figure 1).

In the catalytic converter, nitrogen oxides are transformed into harmless nitrogen gas and water.

The system notifies the driver when it is time to top up with DEF.

5.1 DIESEL EXHAUST FLUID

When handling DEF solution, it is important that electrical connectors to be connected or well encapsulated, otherwise there is a risk that the DEF will cause oxidation that cannot be removed. Water or compressed air will not help, since DEF quickly oxidizes certain metals. If a disconnected connector comes into contact with the DEF solution, it must be replaced immediately to prevent the DEF solution from creeping further into the copper wiring, which takes place at a speed of about 2.4 in (60 mm) per hour.

CAUTION

Diesel Exhaust Fluid (DEF) is a nontoxic aqueous solution of urea (32.5%) and ultra-pure water (67.5%). Urea is a compound of nitrogen that turns to ammonia when heated. The fluid is non-flammable, and is not dangerous when handled as recommended. However, it is highly corrosive to certain metals, especially copper and brass.

When detaching hoses and components, do not spill DEF on disconnected or unsealed connectors. If DEF is spilled on a disconnected or unsealed connector, the connector must be removed immediately and replaced.

Things to know about spilt diesel exhaust fluid (DEF):

- If urea solution comes into contact with the skin, rinse with plenty of water and remove contaminated clothing.
- If urea solution comes into contact with the eyes rinse for several minutes and call for medical help if necessary.
- If inhaled breathe fresh air and call for medical help if necessary.
- Do not allow the DEF solution to come into contact with other chemicals.
- The DEF solution is not flammable. If the DEF solution is exposed to high temperatures, it breaks down into ammonia and carbon dioxide.
- The DEF solution is highly corrosive to certain metals, including copper and aluminum.
- If the DEF solution is spilled onto the vehicle, wipe off the excess and rinse with water. Spilled DEF solution can form concentrated white crystals on the vehicle. Rinse off these crystals with water.

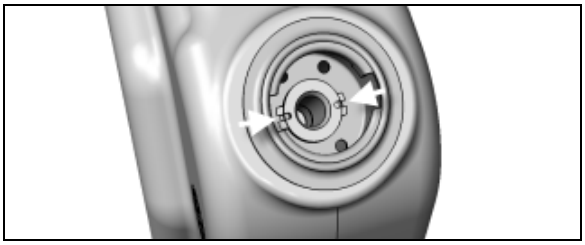
WARNING

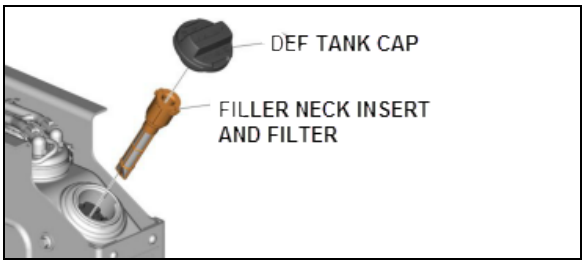
DEF spilt onto hot components will quickly vaporize. Turn your face away!

5.2 DEF TANK CLEANING

Removing the DEF tank for cleaning is not necessary.

1. Put a suitable container under the DEF tank.
2. Remove the DEF tank drain plug through the DEF tank support pan access hole.
3. Let all of the DEF drain from the tank. Discard the used DEF according to local regulations.
4. Remove the DEF tank filler neck insert. To do so, release the retaining tab and remove filler neck insert. Replace old seal if damaged.





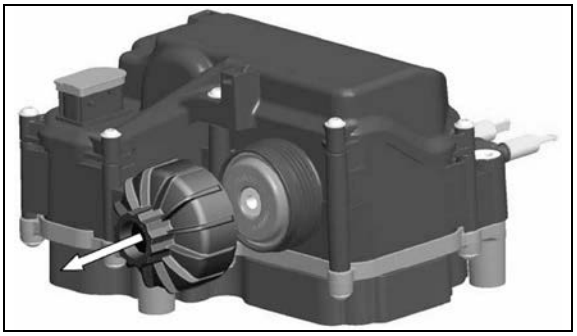
5. Flush the tank with hot water. Let all of the water drain from the tank.
6. Clean the filler neck insert screen with hot water.
7. Reinstall the filler neck insert until the retaining tabs snap into filler neck. Reinstall DEF tank drain plug.

MAINTENANCE

Drain and clean DEF tank and filler neck insert filter with hot water every 175,000 miles or once a year, whichever comes first.

5.3 PUMP ASSEMBLY FILTER ELEMENT REPLACEMENT

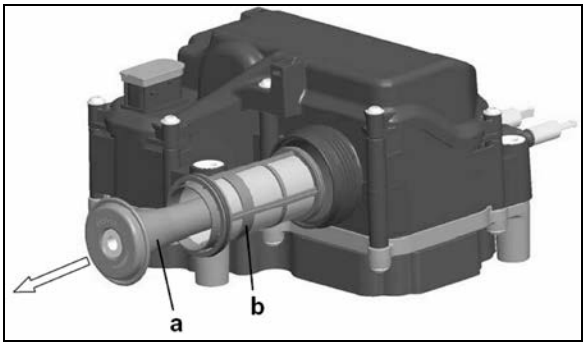
- Remove filter cover.



CAUTION

Contamination or damage of the sealing surface on the housing is not acceptable.

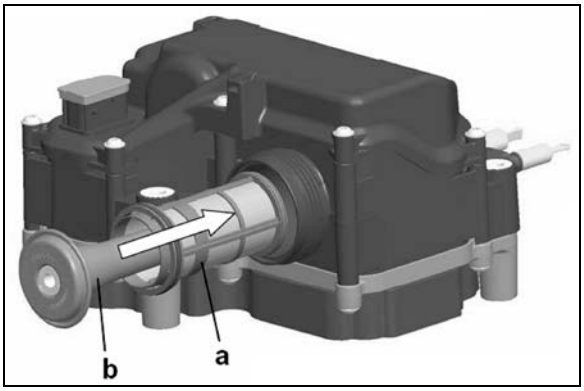
- Remove the equalizing element (a) and the filter element (b).



CAUTION

Protect filter area in the housing from contamination.

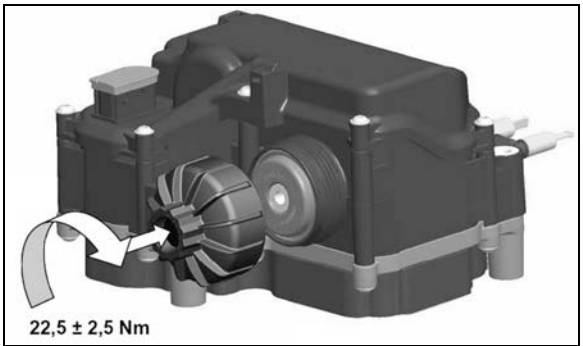
- Replace the filter element (a) and the equalizing element (b).



CAUTION

The sealing surfaces on the housing must be clean. No contamination or particles acceptable.

- Install filter cover. Torque to 16.5 lbf-ft.



CAUTION

It must be checked if there are cracks around the area of the filter cover. No cracks in the material are allowed. If there are cracks in the housing, the entire Supply Module must be replaced! If there are cracks in the filter cover, the filter cover must be replaced.

MAINTENANCE

Replace pump assembly filter element every 150,000 miles or every three years, whichever comes first.

6. AFTERTREATMENT FUEL INJECTOR CLEANING

Proper functioning of the aftertreatment fuel injector a.k.a. aftertreatment hydrocarbon injector (AHI) is required in order to obtain efficient regeneration process of the DPF. Clogged aftertreatment fuel injector will result in clogged DPF.

In addition to the activation of the CHECK telltale, emission of diagnostic troubleshooting codes (DTC) by the engine ECM (MID128) will indicate malfunction of the aftertreatment system and/or aftertreatment fuel injector. DTC may be accessed through the Driver Information Display. Select DIAGNOSTICS menu then FAULT DIAGNOSTICS and ENGINE ECU submenus.

In the Driver Information Display, you can check the status of the aftertreatment system. Select AFTERTREATMENT menu then ATS STATUS. Then check the DPF soot level with SOOT LEVEL GAUGE.

6.1 REPLACEMENT

1. Remove fastener and p-clamp securing the line to the mounting bracket on the diffuser pipe.

WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire and result in component damage and serious personal injury.

2. Disconnect the line from the aftertreatment hydrocarbon injector fitting. Collect any residual fuel that might be in the line in a suitable container.

CAUTION

Do not kink the line. Kinking the line may result in leakage.

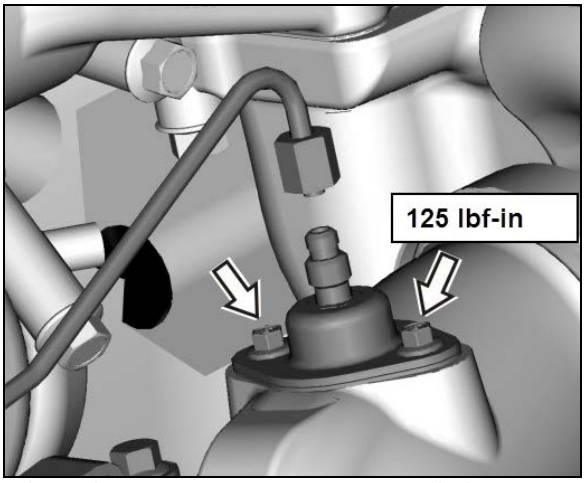


FIGURE 9: AFTERTREATMENT FUEL INJECTOR

3. Remove the aftertreatment hydrocarbon injector mounting fasteners. Remove the aftertreatment hydrocarbon injector from the diffuser pipe (which attaches to the turbocharger outlet).
4. Clean the sealing surface on the diffuser pipe before mounting the aftertreatment hydrocarbon injector.
5. Install the aftertreatment hydrocarbon injector onto the diffuser pipe (which attaches to the turbocharger outlet). Tighten the fasteners to **125 lbf-in**.

NOTE
The fasteners already include pre-applied high-temperature anti-seize compound.

6. Connect the line to the aftertreatment hydrocarbon injector. Tighten the line fitting to**135 lbf-in**.

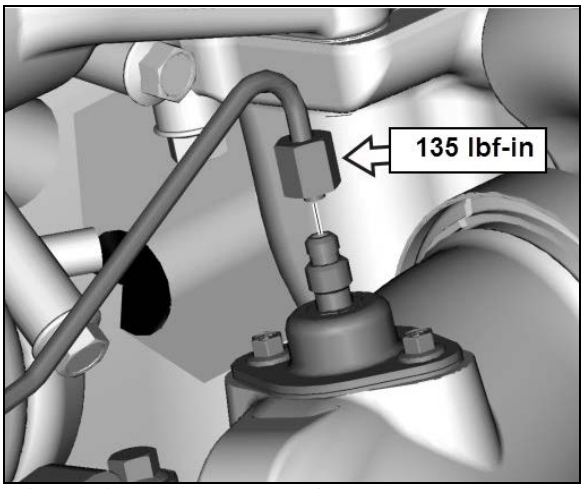
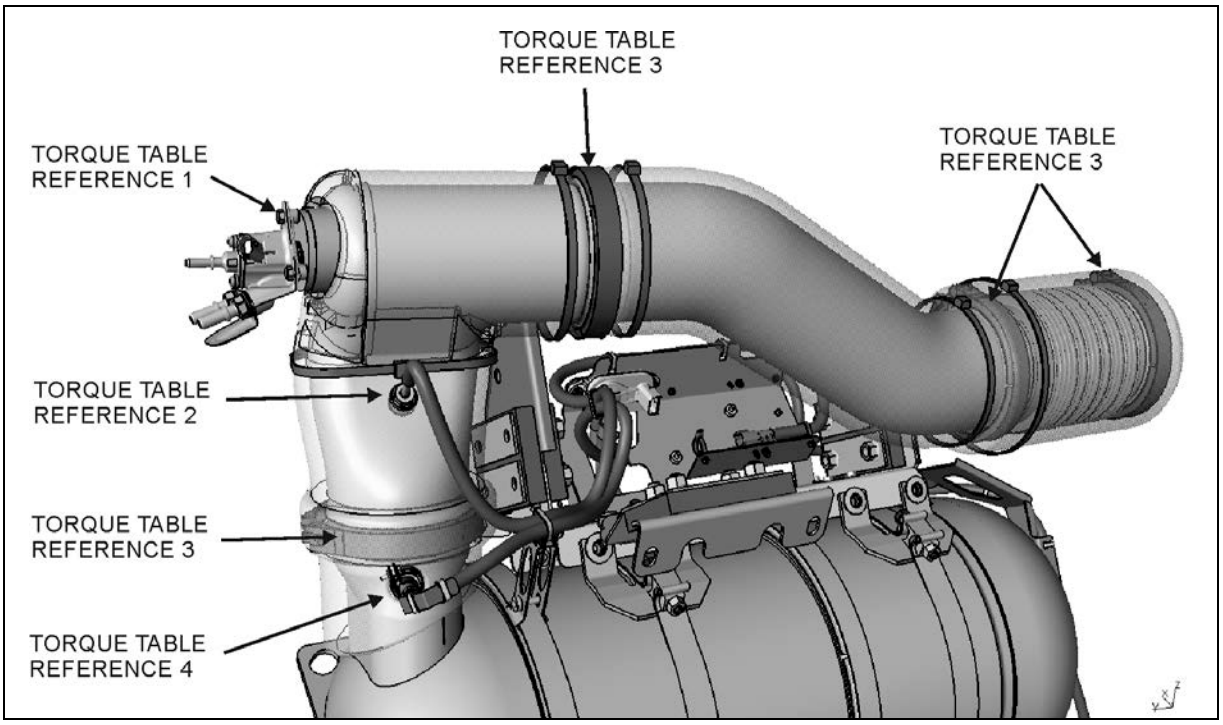


FIGURE 10: FUEL LINE FITTING

7. Install the P-clamp and fastener to secure the line to the mounting bracket on the diffuser pipe.
8. Start the service regeneration process. When fuel dosing starts, check for leaks starting on the hot side of the engine. Clear any diagnostic trouble codes, if needed.

NOTE
If fault tracing was performed using Guided Diagnostics, return to Guided Diagnostics for repair verification.

7. TORQUE SPECIFICATIONS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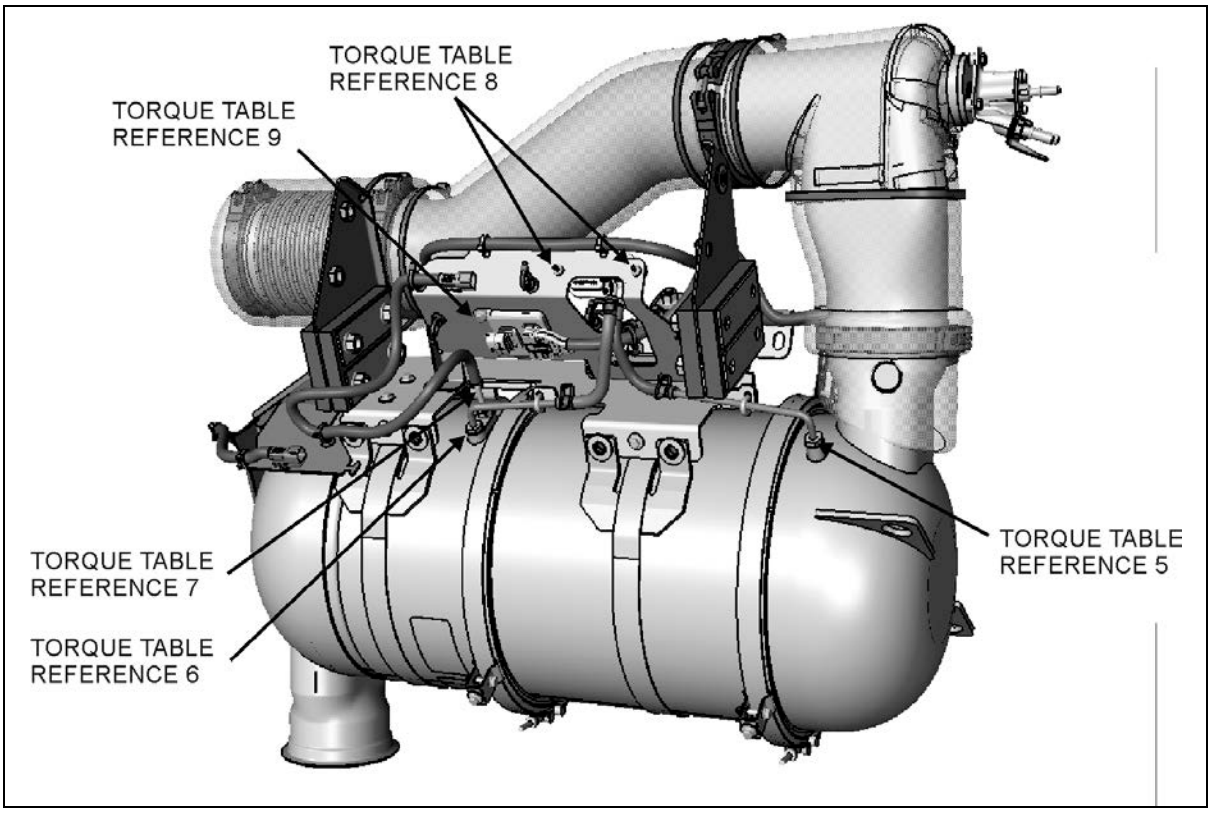
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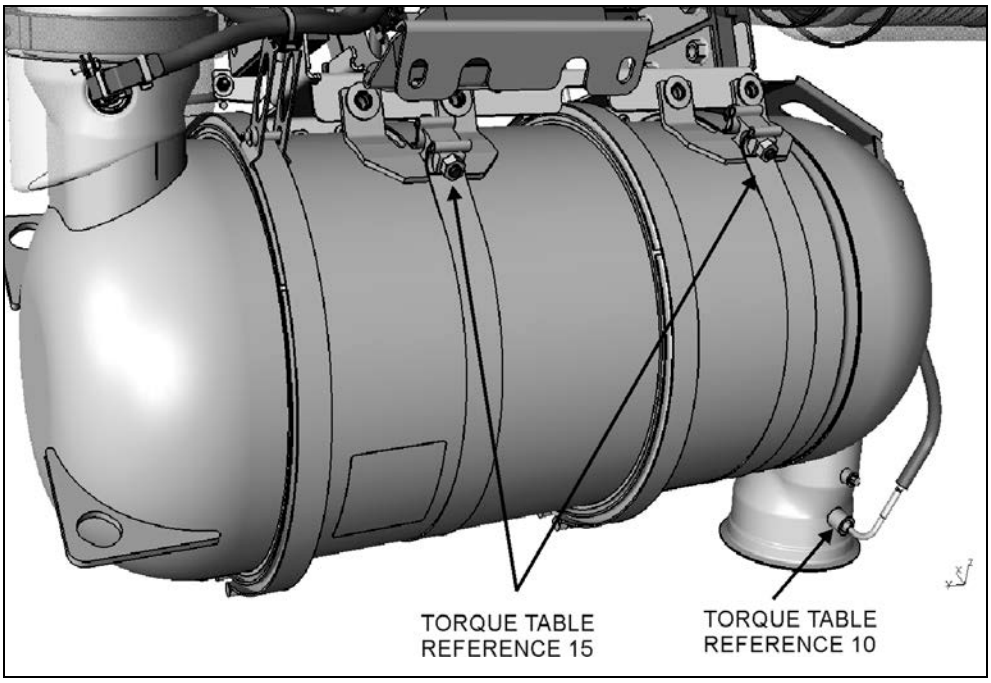
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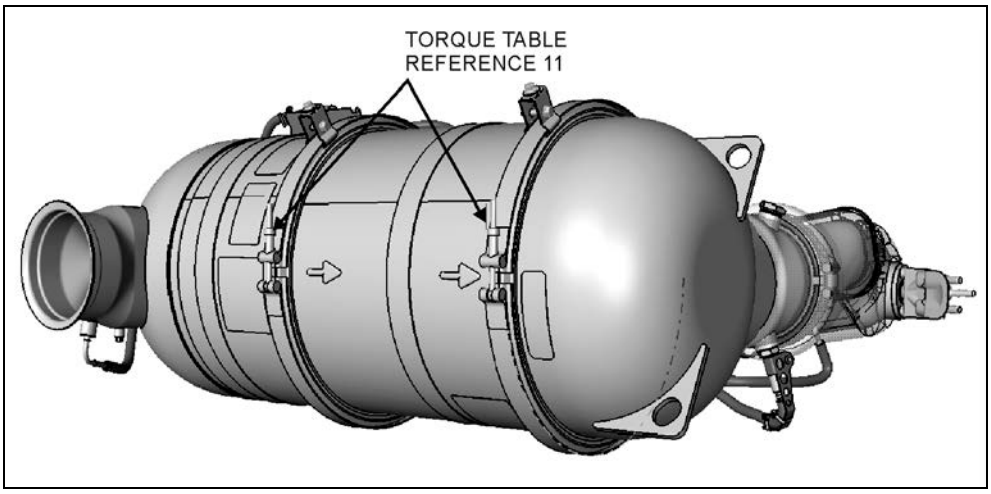
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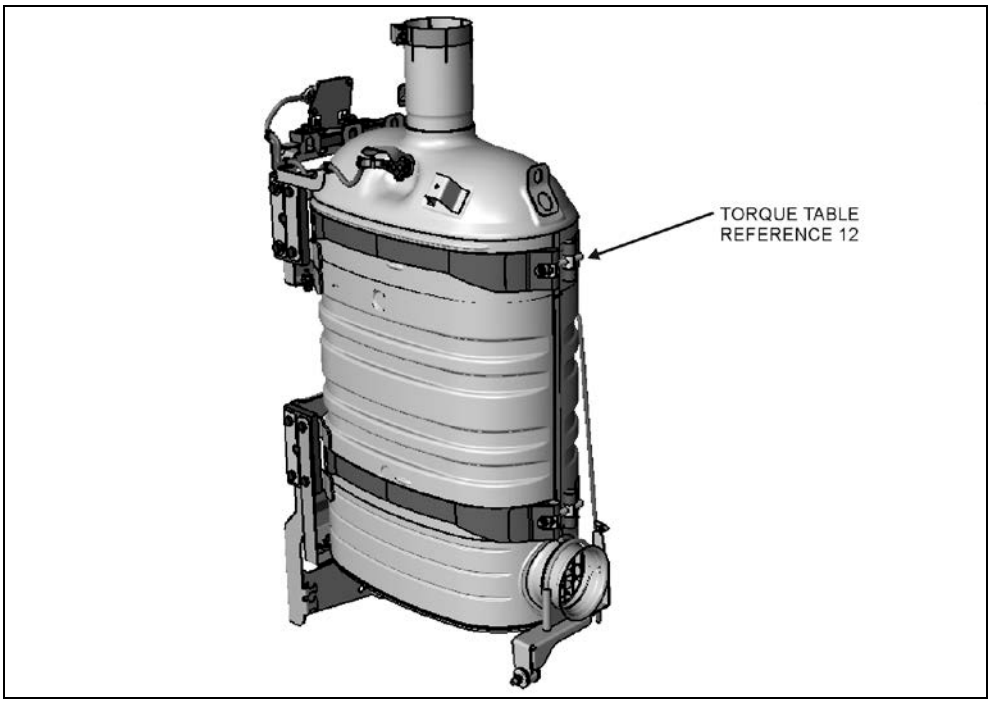
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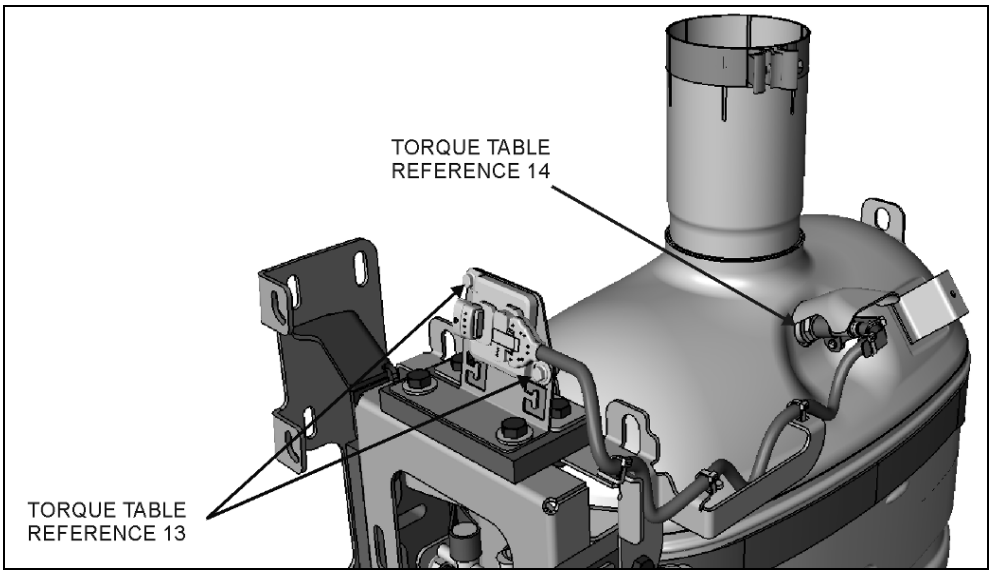
TORQUE TABLE
REFERENCE 14
TORQUE TABLE
REFERENCE 13

The following table lists the tightening torques for the bolts, nuts, etc. on the DPF assembly which do require a specific torque value. When no torque specifications are indicated, use the Standard Torque Specifications table found in Section 00: General Information of the Maintenance Manual.

SPECIFIC TORQUE TABLE			
DESCRIPTION	***QTY***	***REFERENCE***	***TORQUE DRY*** *(±10 lbf-ft)*
DEF injection nozzle mounting bolt	*3*	*1*	*7.5*
*DPF outlet temperature sensor **	*1*	*2*	*33*
V-band clamp 5 inch	*7*	*3*	*8*
*NOx sensor **	*1*	*4*	*37*
*DPF outlet pressure sensor **	*1*	*5*	*4*
*DPF inlet pressure sensor **	*1*	*6*	*4*
*Diesel Oxidation Catalyst (DOC) temperature sensor **	*1*	*7*	*33*
Cap screw	*2*	*8*	*4.5*
Cap screw	*-*	*9*	*7.5*
*DPF inlet temperature sensor **	*1*	*10*	*33*
V-band clamp	*2*	*11*	*20*
Strap – SCR tank	*4*	*12*	*33*
NOx sensor – SCR tank	*1*	*13*	*37*
Bolts – SCR tank	*2*	*14*	*7.5*
Strap – DPF tank	*2*	*15*	*20*

* Use Permatex 454G anti-seize lubricant or Loctite 76764 silver grade anti-seize

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V-band clamp	*2*	*11*	*20*
Strap – SCR tank	*4*	*12*	*33*
NOx sensor – SCR tank	*1*	*13*	*37*
Bolts – SCR tank	*2*	*14*	*7.5*
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* Use Permatex 454G anti-seize lubricant or Loctite 76764 silver grade anti-seize

SECTION 05: COOLING SYSTEM

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1. DESCRIPTION

A radiator and thermo-modulated fan are used to effectively dissipate the heat generated by the engine. A centrifugal-type water pump is used to circulate the engine coolant.

One full blocking-type thermostat is used in the water outlet passage to control the flow of coolant, providing fast engine warm-up and regulating coolant temperature.

The engine coolant is drawn from the lower portion of the radiator by the water pump and is forced through the transmission cooler before going through the oil cooler and into the cylinder block.

From the cylinder block, the coolant passes up through the cylinder head and, when the engine is at normal operating temperature, it goes through the thermostat housing and into the upper portion of the radiator. The coolant then passes through a series of tubes where its heat is dissipated by air streams created by the revolving fan and the motion of the vehicle.

Upon starting a cold engine or when the coolant is below normal operating temperature, the closed thermostat directs coolant flow from the thermostat housing through the by-pass tube to the water pump. Coolant is recirculated through the engine to aid engine warm up.

When the thermostat opening temperature is reached, coolant flow is divided between the radiator inlet and the by-pass tube. When the thermostat is completely open, all of the coolant flow is to the radiator inlet.

The cooling system is filled through a pressure & filler cap on the surge tank (Fig. 1), the cap is also used to maintain pressure within the system. When system exceeds normal pressure rating (14 psi - 96.53 kPa), the cap releases air and if necessary, coolant through the overflow tube (Fig. 1). The thermostat is located in the housing bolted to the engine on the L.H. side.

The engine cooling system also provides hot coolant fluid for the vehicle heating system. Refer to section 22, *""HEATING AND AIR CONDITIONING"* in this manual for information relating to heating system water circulation.

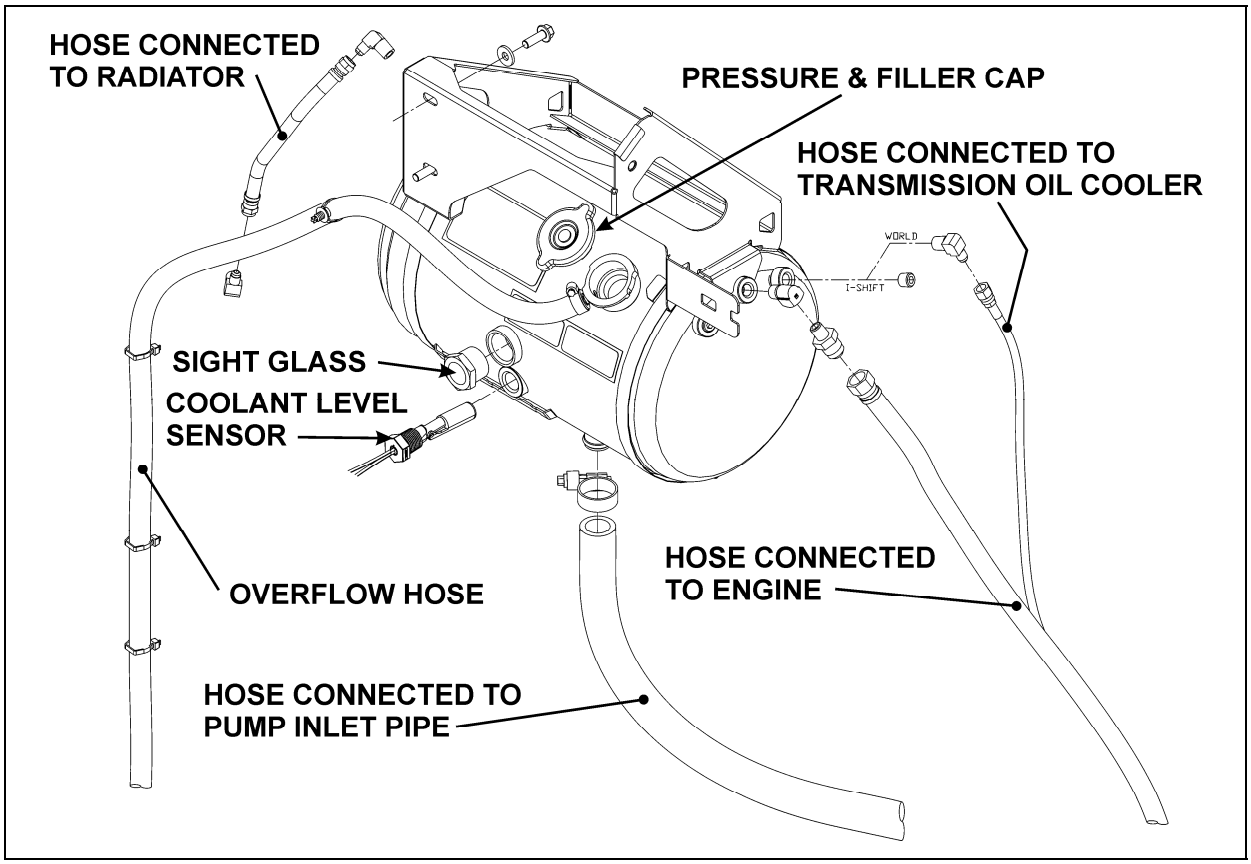


FIGURE 1: COOLANT SURGE TANK 05132

2. MAINTENANCE

2.1 GENERAL RECOMMENDATIONS

A systematic routine inspection of cooling system components is essential to ensure maximum engine and heating system efficiency.

- Check coolant level in the surge tank daily, and correct if required. Test antifreeze strength.
- Check belts for proper tension; adjust as necessary and replace any frayed or badly worn belts.
- Check radiator cores for leaks and make sure the cores are not clogged with dirt or insects. To avoid damaging the fins, clean cores with a low-pressure air hose. Steam clean if required.
- Inspect the water pump operation. A leaky pump sucks in air, increasing corrosion.
- Repair all leaks promptly. Unrepaired leaks can lead to trouble. Inspect and tighten radiator mounts periodically. Test and replace thermostat regularly.

NOTE

In order to ensure the integrity of the system, it is recommended that a periodic cooling system pressure check be made. Pressurize the cooling system to 103-138 kPa (15-20 psi) using Radiator and Cooling System Tester, J24460-1. Do not exceed 138 kPa (20 psi).

Any measurable drop in pressure may indicate a leak. Whenever the oil pan is removed, the cooling system should be pressure checked as a means of identifying any incipient coolant leaks. Make sure the cause of the internal leak has been corrected before flushing the contaminated system.

Leaks at the thermostat housing hose connections may be caused by deformation of connections or by rough surfaces on the castings of the hose mounting surfaces. It is recommended that *"Dow Corning RTV-102 Compound"* or any equivalent product be applied on cast surfaces prior to hose installation.

CAUTION

Castings should be clean and free of oil and grease before applying compound. No other sealer should be used with RTV-102 compound.

2.2 VEHICLES EQUIPPED WITH VOLVO D13 ENGINE

NOTE

For additional information concerning Volvo D13 engine components or engine-related components, consult Volvo Trucks Canada or Volvo Trucks North America Web Site under: Parts & Service. On Volvo web site, you will find detailed service procedures for parts replacement, repair and maintenance.

MAINTENANCE

Drain, flush, thoroughly clean and refill the system with Extended Life Coolant (ELC) every four years or every 600,000 miles (1 000 000 km), whichever comes first. Change the coolant filter once a year or every 150,000 miles (240 000 km), whichever comes first. When using ELC, **do not** use a filter that contains Supplemental Coolant Additives (SCA).

3. HOSES

Rotten, swollen, and worn out hoses or loose connections are frequent causes of cooling system problems.

Serious overheating is often caused by an old hose collapsing or from rotten rubber shedding from hoses and clogging the coolant passages.

Connections should be inspected periodically and hose clamps tightened. Replace any hose found to be cracked or swollen.

When installing a new hose, clean pipe connections and apply a thin layer of a non-hardening sealing compound. Replace worn out clamps or clamps that pinch hoses.

3.1 CONSTANT-TORQUE HOSE CLAMPS ON COOLANT LINES –VOLVO D13

All hose clamps of 1 3/8" ID and over, used on the heating and cooling systems, are of the *"Constant-torque"* type. These clamps are worm-driven, made of stainless steel, and supplied with a series of Belleville spring washers. They also feature an extended integral liner that covers the band slots to protect soft/silicone hoses from damage, and help maintain consistent sealing pressure.

This type of clamp is designed to automatically adjust its diameter to compensate for the normal expansion/contraction of a hose and metal connection that occurs during vehicle operation and shutdown. The constant-torque clamp virtually eliminates coolant losses due to *"Cold flow"* leakage and greatly minimizes clamp maintenance.

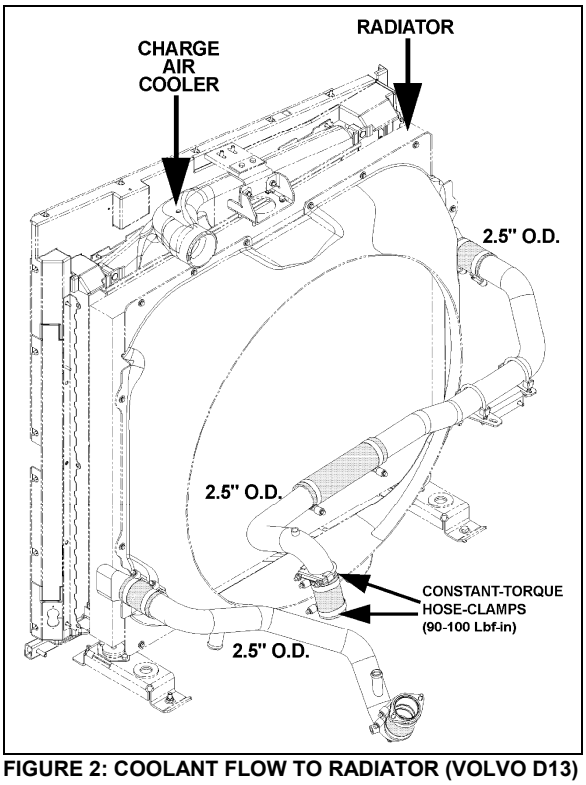


FIGURE 2: COOLANT FLOW TO RADIATOR (VOLVO D13)

3.1.1 Installation

A torque wrench should be used for proper installation. The recommended torque is 90 to 100 lbf-in. (10 to 11 Nm). The Belleville spring washer stacks should be nearly collapsed flat and the screw tip should extend ¼" (6 mm) beyond the housing (Fig. 3).

⚠ CAUTION

The hose clamps will break if over-torqued. Do not over-tighten, especially during cold weather when hose has contracted.

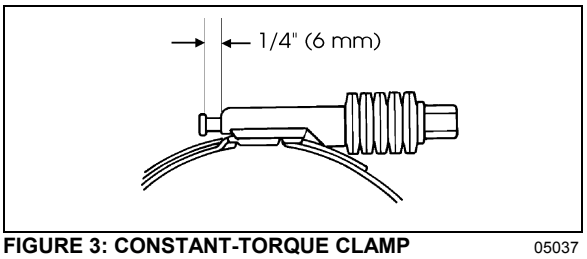


FIGURE 3: CONSTANT-TORQUE CLAMP 05037

3.1.2 Maintenance

The constant-torque clamps contain a *"Visual torque check" feature.* When the tip of the screw is extending ¼" (6 mm) out of the housing, the clamp is properly installed and maintains a leak-proof connection. Since the constant-torque clamp automatically adjusts to keep a consistent sealing pressure, there is no need to re-torque hose clamps on a regular basis. During vehicle operation and shutdown, the screw tip will adjust according to the temperature and pressure changes.

Checking for proper torque should be done at room temperature.

3.2 CONSTANT-TORQUE HOSE CLAMPS ON CHARGE AIR COOLER (CAC)

If for any reason such as an accident, hose clamps need to be changed; install and tighten hose clamps to 10±1 lbf-ft (dry) (Fig. 4).

⚠ CAUTION

The hose clamps will break if over-tighten. Do not over-tighten, especially during cold weather when hose has contracted.

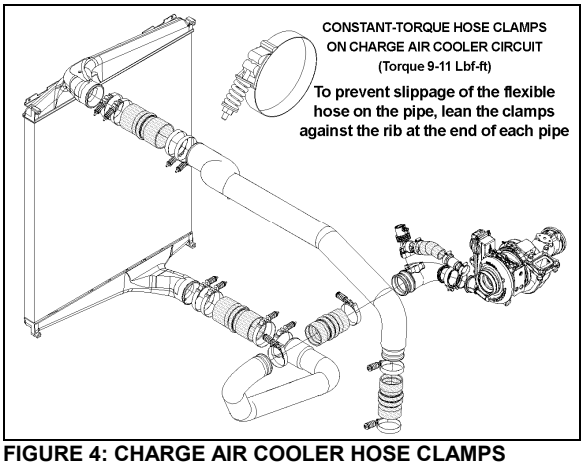


FIGURE 4: CHARGE AIR COOLER HOSE CLAMPS

3.2.1 Maintenance

Since the constant-torque clamp automatically adjusts to keep a consistent sealing pressure, there is no need to retorque hose clamps on a regular basis. During vehicle operation and shutdown, the screw tip will adjust according to the temperature and pressure changes.

Checking for proper torque should be done at room temperature.

4. THERMOSTAT OPERATION

4.1 THERMOSTAT REPLACEMENT

1. Drain the cooling system.
2. Remove the bolts, the thermostat housing and the thermostat. Carefully clean the thermostat seat and all cylinder head-to-thermostat housing mating surfaces.

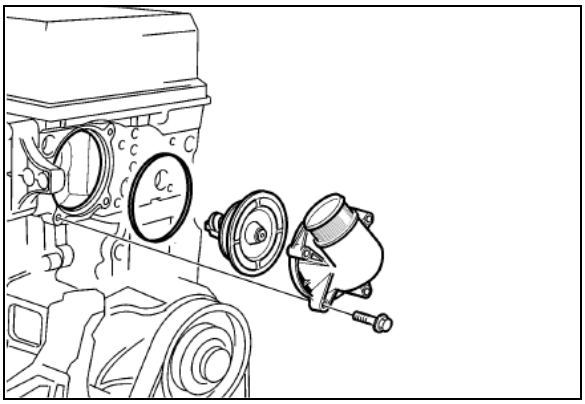


FIGURE 5: VOLVO D13 THERMOSTAT HOUSING

3. Install the new thermostat. Make sure that the rubber seal remains properly seated.
4. Position the thermostat housing to the cylinder head, install the bolts and torque-tighten to 24 ± 4 Nm (18 ±3 ft-lb).
5. Install the rubber radiator hose to the thermostat housing. Position the clamp and tighten to secure.
6. Fill the system with the recommended coolant.
7. Start the engine, check for leaks and proper operation. After shutdown, replenish fluids as necessary.

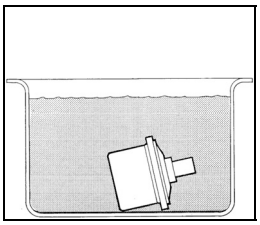
4.2 CHECKING THERMOSTAT

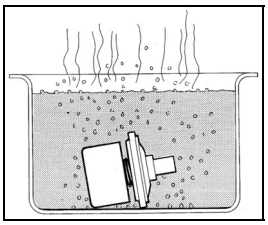
A function check must be carried out before installing a new thermostat.

NOTE

Check to be sure that the thermostat closes fully. This can be done by holding it up to the light to check that there is no visible gap at the opening point. If the thermostat does not close properly, replace it.

1. Warm up water in a receptacle to 75°C (167°F) and immerse the thermostat in the water. Use a piece of wire attached to the thermostat.





2. After at least 30 seconds, check that the thermostat is still closed.
3. Now warm the water to 100°C (212°F). After at least 30 seconds at the boiling point, check that the thermostat has opened at least 7mm (9/32in). If the thermostat has not opened, it must be replaced. A good thermostat starts to close at 95°C (203°F) and is fully closed at approximately 85°C (185°F).

5. COOLANT

5.1 COOLANT LEVEL VERIFICATION

Coolant level is correct when cold coolant is visible through the surge tank sight glass (Fig. 1). If coolant level is low, fill cooling system.

5.2 COOLANT LEVEL SENSOR

This warning device consists of a fluid level probe mounted on the surge tank. The probe sends a signal to the engine control module to indicate coolant level. If the coolant level drops below the probe, the *"Check Engine"* light flashes and a diagnostic code is registered (see section 01*" ENGINE"*).

⚠ CAUTION

Do not run engine with the “Check Engine” light flashing.

The level probe is mounted on the front of the surge tank.

5.3 THAWING COOLING SYSTEM

If the cooling system becomes frozen solid, place the coach in a warm area until the ice is completely thawed.

CAUTION

Under no circumstances should the engine be operated when the cooling system is frozen, as it will result in engine overheating due to insufficient coolant.

Once thawed, check engine, radiator and related components for damage caused by expansion of frozen coolant fluid.

5.4 COOLING SYSTEM RECOMMENDATIONS

Always maintain cooling system at the proper coolant level. Check daily.

The cooling system must be pressurized to prevent localized boiling of coolant. The system must be kept clean and leak-free. The filler and pressure caps must be checked periodically for proper operation.

The coolant provides a medium for heat transfer and controls the internal temperature of the engine during operation. In an engine having proper coolant flow, some of the combustion heat is conveyed through the cylinder walls and the cylinder head into the coolant. Without adequate coolant, normal heat transfer cannot take place within the engine, and engine temperature rapidly rises. Coolant must therefore be carefully selected and properly maintained.

Select and maintain coolant in order to meet the following basic requirements:

- Provide for adequate heat transfer.
- Provide protection from cavitation damage.
- Provide a corrosion and erosion resistant environment within the cooling system.
- Prevent formation of scale or sludge deposits in the cooling system.
- Be compatible with the cooling system hose and seal materials.
- Provide adequate freeze protection during cold weather operation.

When freeze protection is required, a mixture of suitable water and antifreeze containing adequate inhibitors will provide a satisfactory coolant fluid.

Freeze protection down to:	percentage of antifreeze in mixture
-13°F (-25°C)	40%
-22°F (-30°C)	46%
-36°F (-38°C)	54%
-51°F (-46°C)	60%

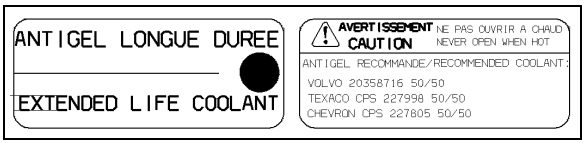
5.5 COOLANT RECOMMENDATIONS FOR VOLVO D13 ENGINE

Coolant mixture consisting of 50/50 antifreeze and deionized water solution should be used year-round to provide freeze and boil-over protection as well as providing a stable environment for seals and hoses.

When topping up coolant, use the same coolant mixture type as the mixture already in the cooling system. Do not mix two different types of coolant.

Do not use antifreeze formulated for automobile gasoline engines, these have a very high silicate content that will clog the radiator and leave unwanted deposits in the engine.

A decal (053487) located on the surge tank provides information on recommended coolants.



Recommended coolants for Volvo D13 engine:

- Prevost #685241 (pre-diluted 50/50 mixture);
- Texaco CPS#227998 (pre-diluted 50/50 mixture);
- Chevron CPS#2227805 (pre-diluted 50/50 mixture);
- Volvo 20358716 (pre-diluted 50/50 mixture);

CAUTION

On Volvo D13 engine, use **only** Extended Life Coolant (ELC). **Do not** add supplemental coolant additives (SCA) to extended life coolant. **Do not** use a coolant filter containing Supplemental Coolant Additives (SCA).

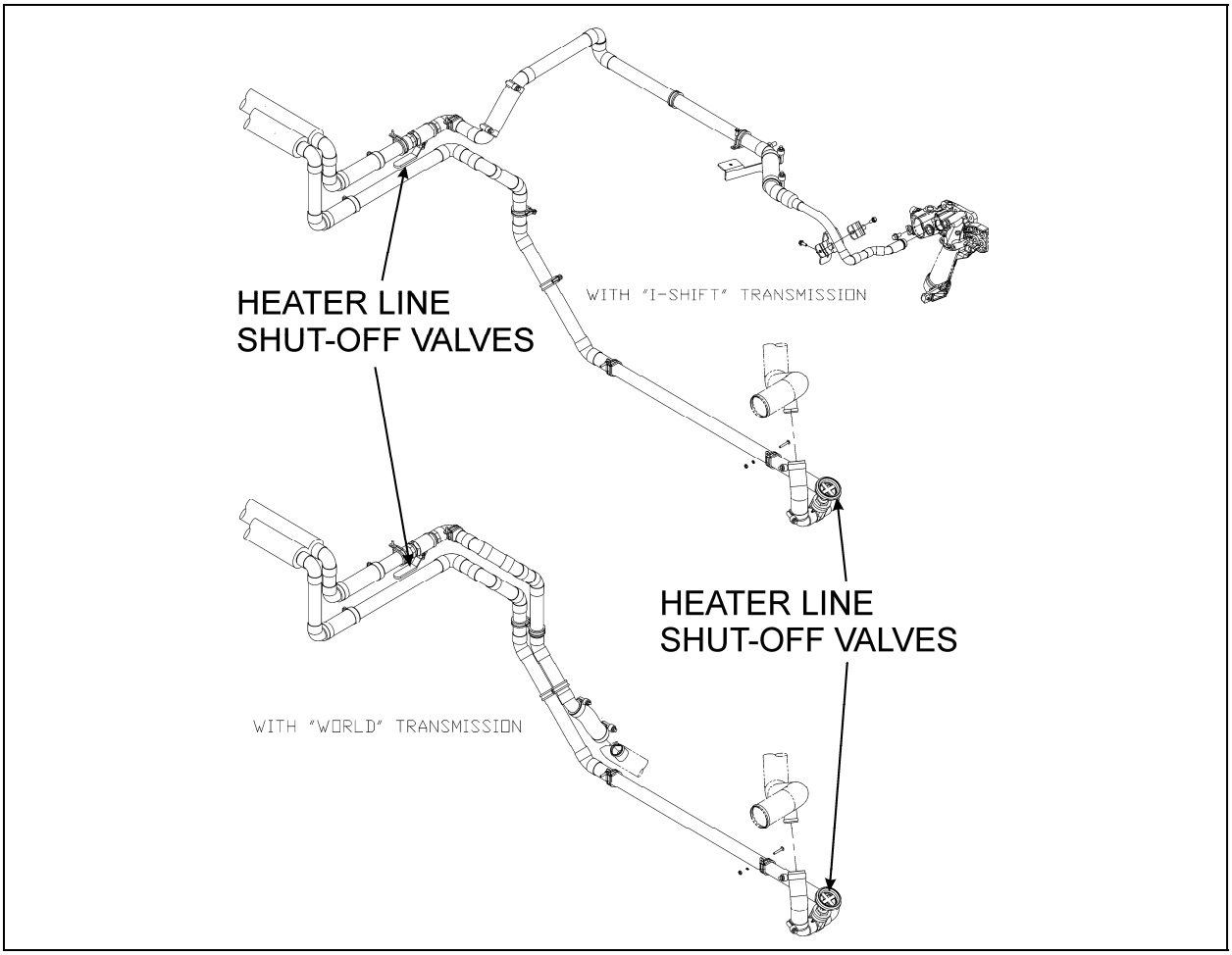


FIGURE 6: LOCATION OF HEATER LINE SHUT-OFF VALVES IN ENGINE COMPARTMENT 05105

⚠ CAUTION

Extended Life Coolant (ELC) will test as out of additives (SCA), but SCA should not be added. Shortened engine life may be the result of adding SCA.

6. DRAINING COOLING SYSTEM

Use the following procedures to drain the cooling system partially or completely.

To drain engine and related components:

1. Stop engine and allow engine to cool. Close both heater line shutoff valves.

On X3- 45 coaches & VIP, and also on XLII Entertainer Bus Shells, the valves are located in the engine compartment. One is located under the radiator fan drive mechanism support; another valve is on the L.H. side of the engine compartment in front of the radiator (Fig. 6).

NOTE

Refer to section 22 under "Preheating System" for information about preheater access and heater line shutoff valve.

WARNING

Before proceeding with the following steps, make sure the coolant has cooled down. The sudden release of pressure from a heated cooling system can result in loss of coolant and possible personal injury (scalding) from the hot liquid.

2. Close the shut-off valve on the coolant filter mounting head and remove filter (perform only if filter as to be replaced).
3. Open the shut-off valve on the coolant filter mounting head and drain the coolant into a suitable container. Close the shut-off valve.

4. Unscrew the surge tank pressure cap counterclockwise, ¼ turn to let air enter the system and permit the coolant to drain completely from system.
5. Connect coolant extractor (Fig. 7). Use coolant extractor to drain the coolant from the engine. An alternate method is to drain the coolant into a suitable container using the drain hose.

DANGER

Coolant is toxic; risk of poisoning. Do not drink coolant. Use proper hand protection when handling. Keep coolant out of reach of children and animals. Failure to follow these precautions can cause serious illness or death.

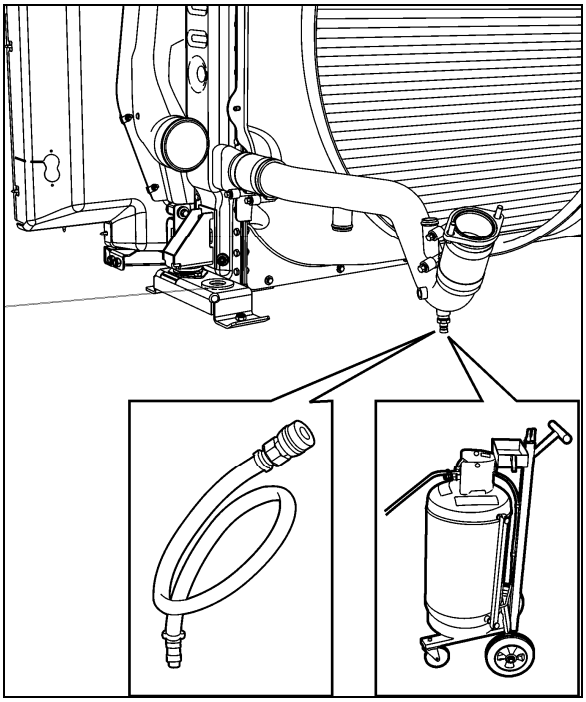


FIGURE 7: EXTRACTING COOLANT 05093

6. Open the radiator drain cock.
7. Remove the transmission oil cooler. Drain, flush and inspect. Refer to Section 7, "TRANSMISSION" for oil cooler maintenance or preventive replacement.

CAUTION

Drain water pump completely before extended storage to avoid possible water pump damage.

If freezing weather is anticipated and the engine is not protected with antifreeze, drain the cooling system completely when vehicle is not in use. Trapped water in the cylinder block, radiator or other components may freeze and expand resulting in damages. Leave the drain plugs open until the cooling system can be filled with coolant fluid. Do not run engine with cooling system empty.

To drain the entire system, do the previous steps while maintaining the shutoff valves in the open position; then follow the procedure under *"Draining Heating System"* in Section 22.

7. FILLING COOLING SYSTEM

If only the engine and related components were drained, maintain the two heater line shutoff valves in their closed position, then proceed as follows:

1. Close radiator drain cock.
2. Open the shut-off valve on the coolant filter mounting head.
3. Refill cooling system from the surge tank filler cap inlet with the recommended ethylene glycol-based antifreeze and water solution of the required concentration using the coolant extractor.

NOTE

Make sure the purge lines are properly connected and not obstructed. The purge lines (thermostat housing dome, radiator top tank, transmission oil cooler or delivery line) are required to ensure complete engine fill and proper purging of air in the system.

NOTE

The coolant level should remain within two inches of the surge tank filler neck.

4. Install the filler and pressure cap, then start the engine and run it at fast idle until reaching normal operating temperature. Check for leaks.

NOTE

If for any reason, the coolant level drops below the surge tank level probe, the Check Engine warning light will illuminate.

5. Stop engine and allow cooling.

6. Open the two heater line shutoff valves, check the coolant level in the surge tank, and then add as required.

> **CAUTION**
>
> Never pour cold coolant into a hot engine. The sudden change in temperature may cause the cylinder head or block.

If the entire system has been drained, redo the previous steps while maintaining the two heater line shutoff valves in the "Open" position. With engine running, activate the driver's and central heating systems to permit coolant circulation. Complete the procedure by bleeding the heater cores as explained in Section 22, under *"Bleeding Heating System".*

8. FLUSHING

If the cooling system is contaminated, flush the cooling system as follows:

1. Drain the coolant from the engine.
2. Refill with clean water.

> **CAUTION**
>
> If the engine is hot, fill slowly to prevent rapid cooling and distortion of the engine castings.

3. To thoroughly circulate the water, start and run the engine for 15 minutes after the thermostats have opened.
4. Fully drain system.
5. Refill with clean water and operate for 15 minutes after the thermostats have opened.
6. Stop engine and allow cooling.
7. Fully drain system.

Vehicles without coolant filters:

Fill with a 50/50-antifreeze/water solution and add required inhibitors.

Vehicles with coolant filters:

Fill with a 50/50-antifreeze/water solution. Replace coolant filter as per the Lubrication and Servicing Schedule in section 24 if required.

Dispose of spent fluids in an environmentally responsible manner according to regulations in effect in your area.

COOLING SYSTEM CAPACITY (approximation)
Includes heating system: 24 US gal (91 liters)

8.1 COOLING SYSTEM DESCALERS

If the engine overheats and the fan belt tension, coolant level and thermostat operation have been found to be satisfactory, it may be necessary to de-scale and flush the entire cooling system.

Remove scale formation by using a reputable and safe de-scaling solvent. Immediately after using the de-scaling solvent, neutralize with a neutralizing agent. It is important that product directions be thoroughly read and followed.

After using the solvent and neutralizer, fully drain the system, and then reverse flush the engine and radiator (see *"Reverse Flushing" in this section)* before filling the system with coolant solution.

8.2 REVERSE FLUSHING

After the engine and radiator have been thoroughly de-scaled, they should be reverse-flushed. The water pump should be removed and the radiator and engine reverse-flushed separately to prevent dirt and scale deposits from clogging the radiator tubes or being forced through the pump. Reverse flushing is accomplished by hot water, under pressure, being forced through the cooling system in a direction opposite to the normal flow of coolant, loosening and forcing deposits out.

The radiator is reverse flushed as follows:

1. Remove the radiator inlet and outlet hoses and replace existing radiator cap with a new one.
2. Attach a hose to the top of the radiator to lead water away from the engine.
3. Attach a hose at the bottom of the radiator and insert a flushing gun in the hose.
4. Connect the water hose of the gun to the water outlet and the air hose to the compressed air outlet.
5. Turn on the water and when the radiator is full, turn on the air in short blasts, allowing the radiator to fill between blasts.

NOTE

Apply air gradually. Do not exert more than 138 kPa (20 psi) air pressure. Too great a pressure may rupture a radiator tube.

6. Continue flushing until only clean water is expelled from the radiator.

The cylinder block and cylinder head water passages are reverse flushed as follows:

1. Remove the thermostats and the water pump.
2. Attach a hose to the water inlet of oil cooler housing to drain water away from engine.
3. Attach a hose to the water outlet at the top of the cylinder head (thermostat housing) and insert the flushing gun in the hose.
4. Turn on the water until the jackets are filled, and then turn on the air in short blasts. Allow jackets to fill with water between air blasts.
5. Continue flushing until the water from the engine runs clean.

If scale deposits in the radiator cannot be removed by chemical cleaners or reverse flushing as outlined above, it may be necessary to remove the upper tank and rod out the individual radiator tubes with flat steel rods. Circulate the water through the radiator core from the bottom to the top during this operation.

9. SPIN-ON COOLANT FILTER

The optional engine cooling system filter is used to filter out impurities such as scale or sand from the coolant and it also eliminates the process of adding inhibitors to the antifreeze/water solution. The filter is mounted onto the cooling fan drive mechanism aluminum casting (Fig. 8).

To replace a filter:

1. Close the filter shutoff cock on the filter mounting head and unscrew the old filter from mounting.

WARNING

Failure to relieve cooling system pressure may result in personal injury.

2. Remove and discard the filter. Recover the coolant remaining in the filter with a suitable container.
3. Clean the filter adapter with a clean, lint-free cloth.
4. Coat surface of gasket with clean antifreeze, tighten 2/3 to 1 turn after gasket makes contact with head.
5. Open the filter shutoff cock.
6. Start engine and check for leaks.

CAUTION

Do not exceed recommended service intervals.

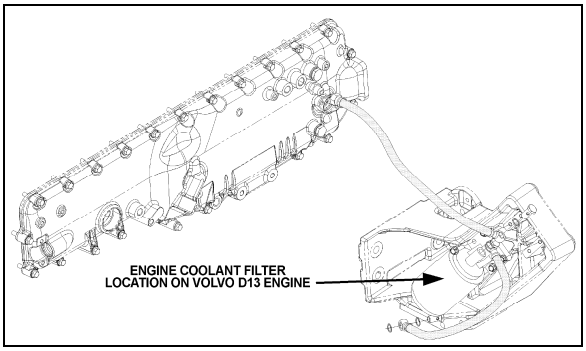


FIGURE 8: COOLANT FILTER (VOLVO D13) 05145

MAINTENANCE

VOLVO D13 ENGINE

Replace the coolant filter cartridge after 150,000 miles (240 000 km) or one year to prevent external rust damage to the filter walls. **Do not** use a coolant filter containing Supplemental Coolant Additives (SCA).

Coolant filter cartridge (Volvo D13): #20458771

10. RADIATOR

The radiator is mounted on the L.H. side of engine compartment. It is designed to reduce the temperature of the coolant under all operating conditions. It is essential that the radiator core be kept clean and free from corrosion and scale at all times.

10.1 MAINTENANCE

MAINTENANCE

Inspect the exterior of the radiator core every 25,000 miles (40 000 km) or once a year, whichever comes first. Clean with a quality grease solvent, such as a mineral spirits and dry with compressed air. Do not use fuel oil, kerosene, gasoline, or any caustic material. It may be necessary to clean the radiator more frequently if the vehicle is operated in extremely dusty or dirty areas. Refer to coolant system flushing and reverse flushing in this section for maintenance of radiator interior.

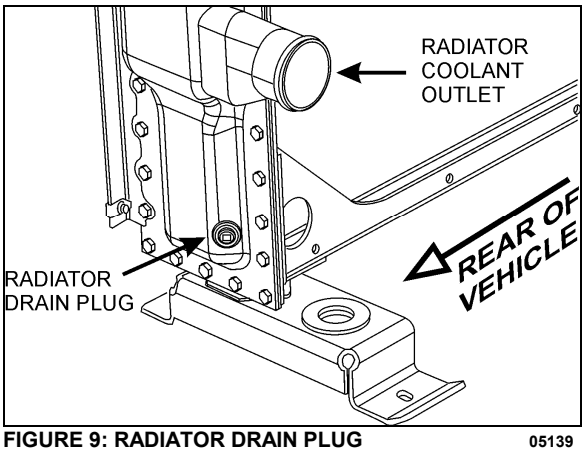


FIGURE 9: RADIATOR DRAIN PLUG 05139

10.2 RADIATOR REMOVAL & INSTALLATION

1. Apply the parking brake and shift the transmission to neutral. Shut off all electrical loads. Turn the ignition key to the OFF position.
2. Open engine compartment doors.
3. Set starter selector switch to the OFF position.
4. Connect coolant extractor (Fig. 7). Use coolant extractor to drain the coolant from the engine. An alternate method is to drain the coolant into a suitable container using the drain hose.
5. Raise L.H. side hinged rear fender.
6. Remove tag axle L.H. side wheel.

DANGER

Coolant is toxic; risk of poisoning. Do not drink coolant. Use proper hand protection when handling. Keep coolant out of reach of children and animals. Failure to follow these precautions can cause serious illness or death.

7. Unfasten 4 cap screws and remove access panel located behind tag axle L.H. side wheel (refer to figure 10).

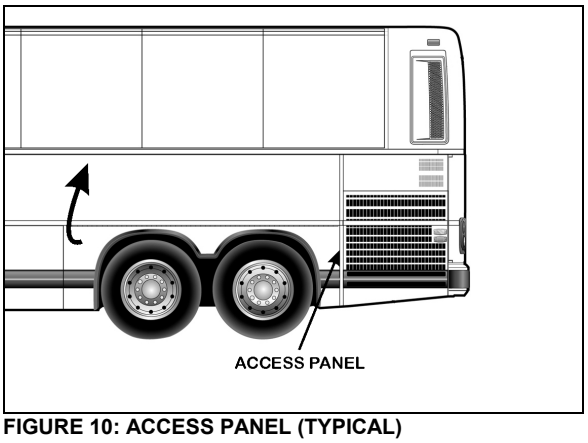


FIGURE 10: ACCESS PANEL (TYPICAL)

8. Open radiator door to access radiator assembly. Unfasten upper arm assembly.
9. Remove radiator sealing frame.

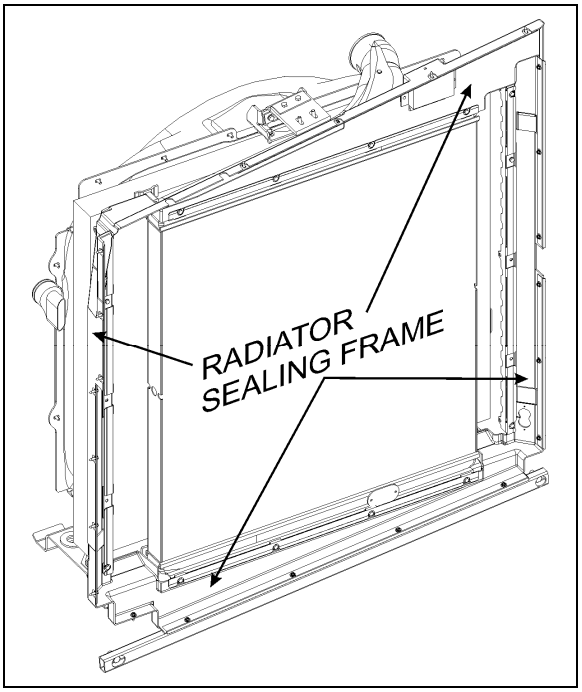


FIGURE 11: RADIATOR SEALING FRAME

10. Remove clamps and then break hoses from the front coolant and charge air pipes (Fig. 12 & 13).

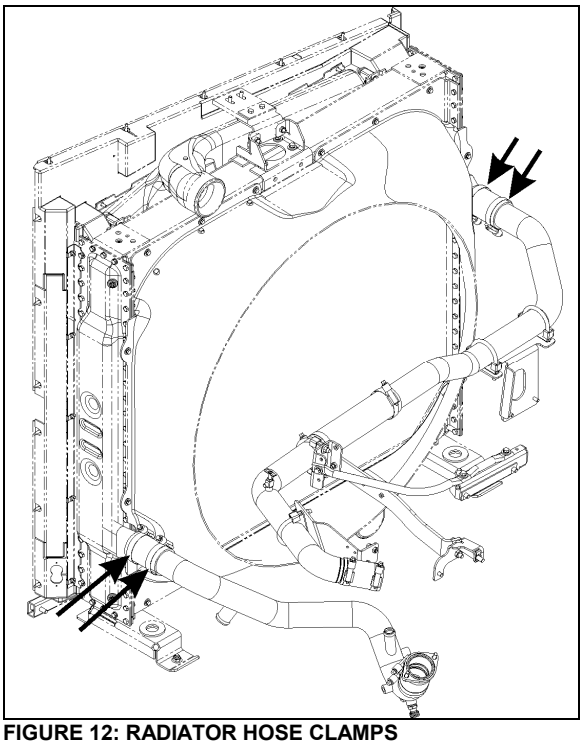


FIGURE 12: RADIATOR HOSE CLAMPS

11. Remove rear coolant and charge air hose clamps then break hoses loose (Fig. 12 & 13).

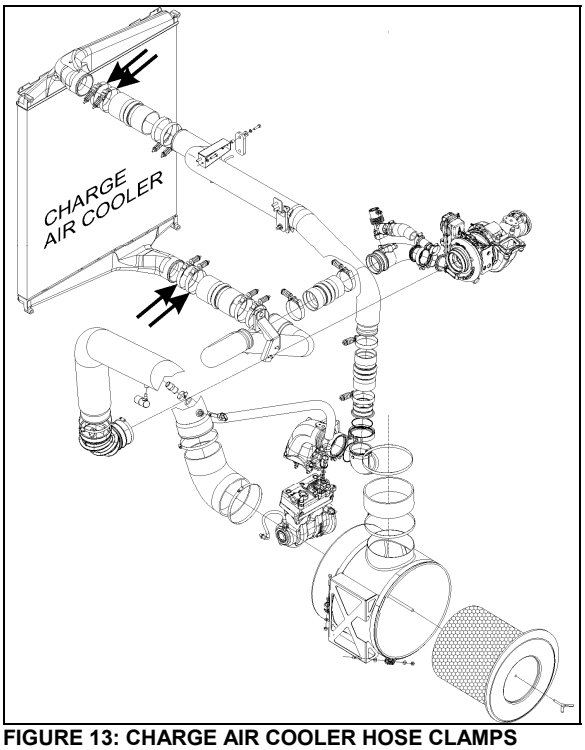


FIGURE 13: CHARGE AIR COOLER HOSE CLAMPS

12. Remove the upper radiator assembly support bracket (Fig. 14).

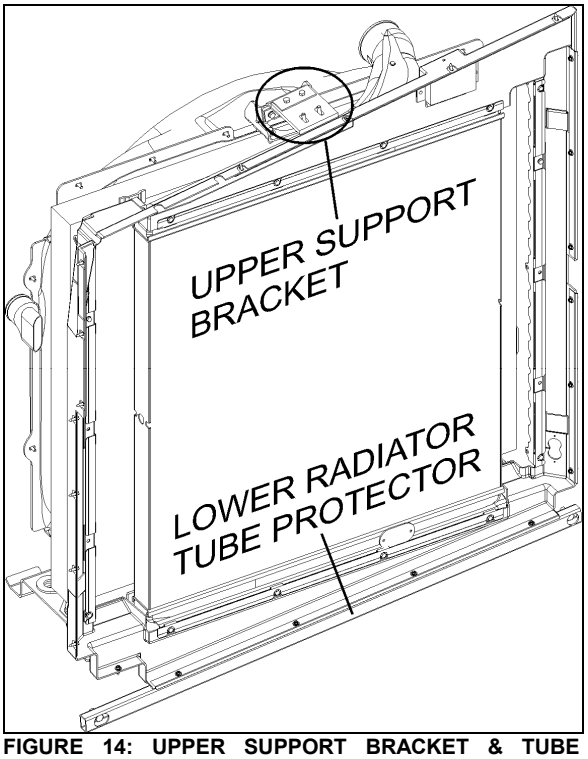


FIGURE 14: UPPER SUPPORT BRACKET & TUBE PROTECTOR

13. Remove the lower radiator assembly tube protector from the lower section (Fig. 14).

14. Remove all lower radiator assembly mounting fasteners.

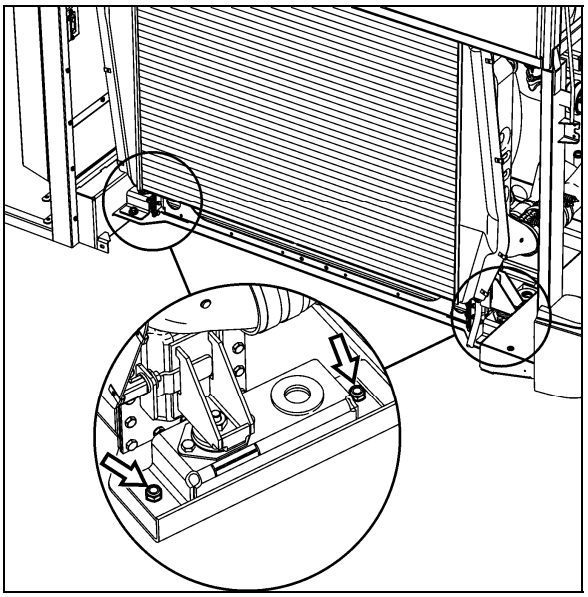


FIGURE 15: RADIATOR ASSEMBLY LOWER MOUNTING FASTENERS

15. Cut cable tie and disconnect electrical connector from fan clutch. Remove fan drive shaft fasteners at the gear box.

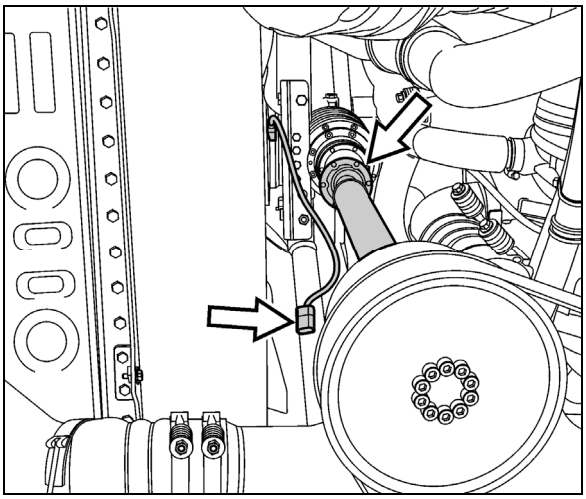


FIGURE 16: DISCONNECTING FAN DRIVE SHAFT

16. Position a forklift under the radiator assembly that is capable of safely lifting the radiator.

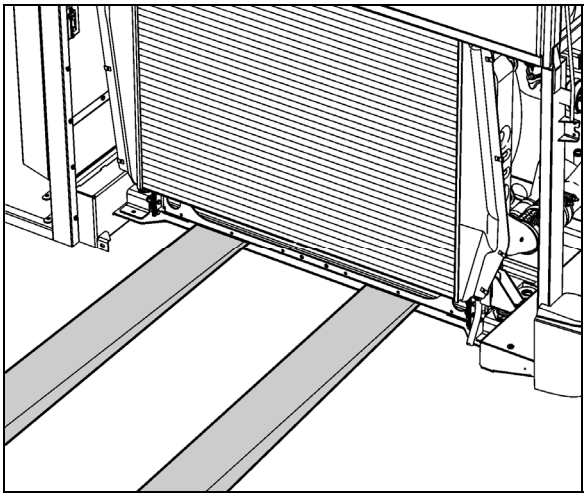


FIGURE 17: POSITIONING FORKLIFT

17. With assistance, slide radiator assembly out and onto the forklift. Transfer radiator assembly to a secure location.
18. Separate charge air cooler from radiator.
19. Lay radiator face down. Remove the fasteners that connect lower radiator mounts to radiator.

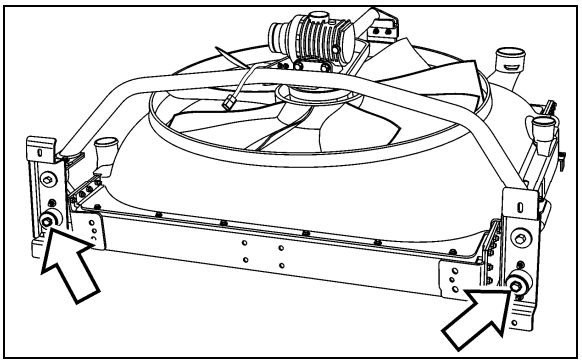


FIGURE 18: REMOVING FASTENERS

20. Remove upper fan drive support bracket from the upper section of the radiator.

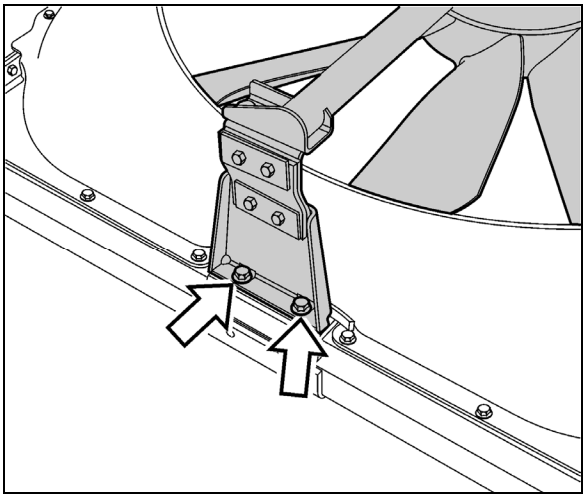


FIGURE 19: REMOVING UPPER FAN DRIVE SUPPORT BRACKET

21. With assistance, remove fan drive and drive frame from radiator.
22. Remove fan shroud from radiator.

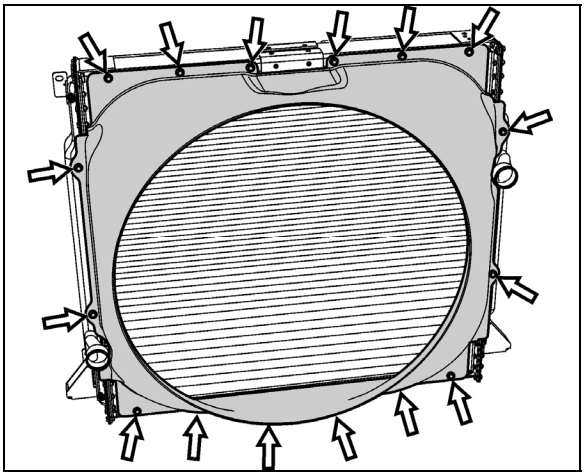


FIGURE 20: REMOVING FAN SHROUD FROM RADIATOR

23. Reverse removal procedure to reinstall radiator assembly.

11. CHARGE AIR COOLER LEAKAGE

Spec for CAC acceptable leakage:

"The CAC is considered acceptable if it can hold 30 psi (206 kpa) gauge pressure with less than 5 psi (34.5 kpa) loss in 15 seconds after turning off the hand valve."

NOTE

This spec does not apply if there is any evidence that the leak was caused by a foreign object impact.

12. COOLING FAN DRIVE MECHANISM

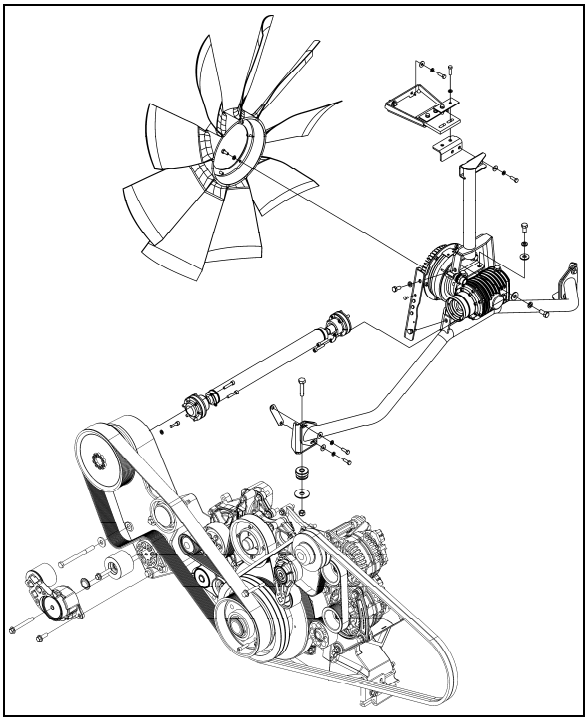


FIGURE 21: COOLING FAN DRIVE MECHANISM

12.1 DRIVE PULLEY AND UNIVERSAL JOINT SHAFT

To disconnect the universal shaft, proceed as follow:

WARNING

Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine.

1. Unwrap the drive belt from around the pulley (see paragraph MOUNTING THE DRIVE BELT).
2. Dismount the drive pulley. Gain access to the 6 mounting bolts from behind the pulley, through the opening in the cast aluminum support (Fig. 22).
3. Unscrew and remove the universal joint shaft mounting bolts (6) at the right angle gearbox.
4. Slowly, move the shaft toward the rear of the vehicle.
5. Finally, dismount the universal joint shaft from the drive pulley (6 bolts).

Installation of the universal joint shaft is the same as removal, but in reverse order.

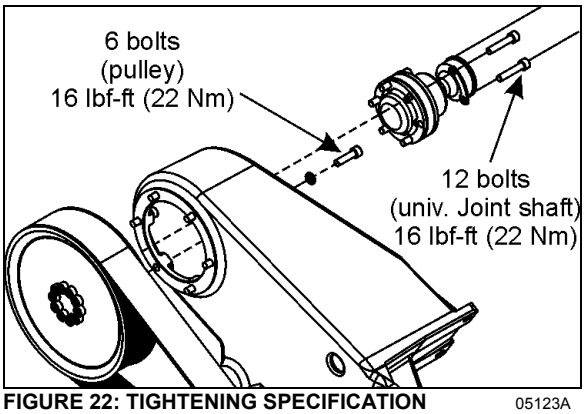


FIGURE 22: TIGHTENING SPECIFICATION 05123A

12.2 IDLER REPLACEMENT

If an idler is defective, replace as follow:

WARNING

Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine.

1. Remove the protective cap (replace with a new one).
2. Unscrew the idler mounting bolt.
3. Replace idler with a new one.

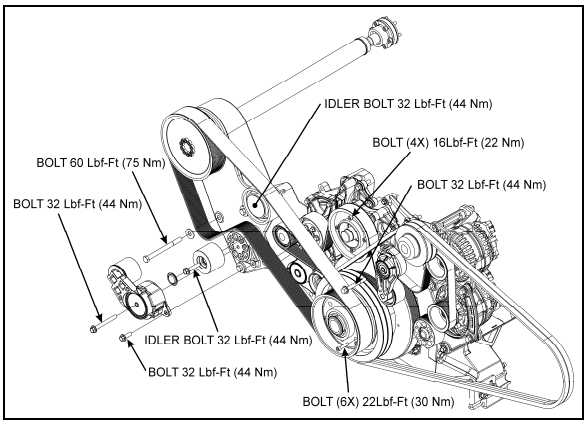


FIGURE 23: TIGHTENING SPECIFICATION (VOLVO D13 ENGINE)

CAUTION

When installing the idler, make sure it rests perfectly against the bearing surface on the cast aluminum support. If not, the drive belt may slip of the idler. See following figure.

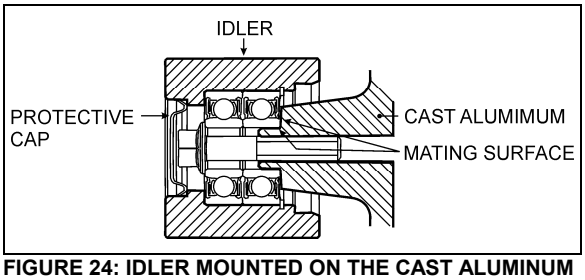


FIGURE 24: IDLER MOUNTED ON THE CAST ALUMINUM SUPPORT

4. Bolt the new idler on the cast aluminum support. Tighten to 32 lbf-ft (44 Nm).
5. Place a new protective cap.

13. VARIABLE SPEED COOLING FAN

The cooling fan clutch has two thermostatically controlled speeds, plus a neutral (clutch disengaged). The engine control module controls the speed by comparing data from engine coolant temperature, charge air temperature, Allison transmission oil temperature (if applicable) and small A/C High side pressure to a set of calibration data. The fan drive clutch is electromagnetic; the engine control module sends an electric current to regulate speed by activating one magnetic coil for the first speed and two magnetic coils for the second speed.

The settings are:

	Engine coolant temp.	Air intake temp.	Allison trans. oil temp.
temperature rising ⇧	208°F: fan engages in HIGH SPEED	194°F: fan engages in HIGH SPEED	230°F: fan engages in HIGH SPEED
	203°F: fan engages in LOW SPEED	176°F: fan engages in LOW SPEED	216°F: fan engages in LOW SPEED
temperature dropping ⇩	203°F: fan HIGH SPEED disengages	189°F: fan HIGH SPEED disengages	225°F: fan HIGH SPEED disengages
	198°F: fan LOW SPEED disengages	170°F: fan LOW SPEED disengages	210°F: fan LOW SPEED disengages

	Small A/C high side pressure
pressure rising ⇧	170 psi: fan engages in HIGH SPEED
	120 psi: fan engages in LOW SPEED
pressure dropping ⇩	130 psi: fan HIGH SPEED disengages
	90 psi: fan LOW SPEED disengages

WARNING

DO NOT work near the fan with the engine running or the ignition in the ON position. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured.

13.1 LOCKING RADIATOR FAN FOR EMERGENCY OPERATION

13.1.1 Electrical Locking

If the cooling fan clutch does not function due to an electrical control system malfunction and the engine is overheating, execute the following procedure:

1. Set the ignition key to the ON position.
2. Activate the dashboard Telltale Light Test switch 3 times within 4 seconds.
3. In the engine compartment, set the starter selector switch to REAR START and then start the engine from the rear.

WARNING

Potential Accident Risk. Always use extreme caution when working in the vicinity of hot, rotating or moving parts.

While in this mode, the rear start push-button can be used to manually engage the fan clutch. The multiplex system knows when the engine is already running, and it will not activate the starter.

4. Press the push-button one time to engage the clutch to 1st speed, press a second time to engage to 2nd speed, press a third time to stop the fan, press once again to return to 1st speed.

NOTE

If the fan clutch does not engage using this procedure then the clutch is faulty or the wiring between the multiplex module and the clutch is faulty. Mechanically lock the fan as described hereafter in section 13.1.2.

13.1.2 Mechanical Locking

Once mechanically locked, the fan is rigidly connected to the drive mechanism and will rotate continuously, with no considerations for the cooling needs. This is an emergency situation and the vehicle shall not be operated in that situation for an extended period.

In case of a magnetic clutch malfunction:

1. Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine.
2. Disconnect the fan clutch electrical connector.
3. Unscrew and remove the 4 spare bolts screwed to the angle on the fan gearbox mounting support.
4. Turn the fan blades in order to position the locking plate bores over the rotor's threaded sockets.
5. Screw in and tighten the spare bolts (Fig. 25).
6. Using the automatic belt tensioner, release tension on the drive belt in order to be able to rotate the fan clutch drive mechanism by hand.
7. Rotate the shaft to get access to the second locking plate and rotor threaded sockets.
8. Screw in and tighten the spare bolts.

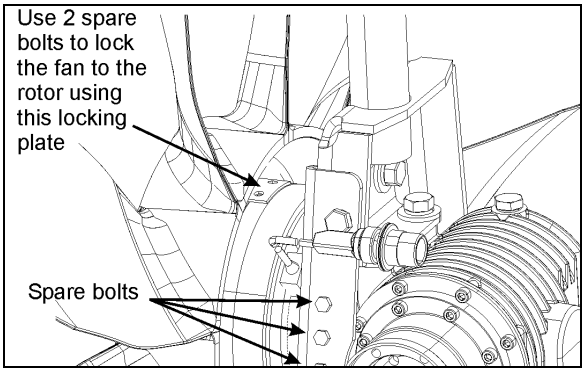


FIGURE 25: MECHANICAL LOCKING 05124

13.2 MAINTENANCE

1. Clean the fan and related parts with clean fuel oil and dry them with compressed air. Do not clean with steam or high-pressure jet.
2. Check the fan blades for cracks or other damage. Replace the fan if the blades are cracked or deformed.
3. Remove any rust or rough spots in the grooves of the fan pulley. If the grooves are damaged or severely worn, replace the pulley.
4. Do not restrict fan rotation during engine operation for any reason.
5. Do not operate fan-driving mechanism with a damaged fan assembly. Replace a damaged fan as soon as the fault is noted.
6. Immediately investigate and correct any operator complaint involving driving mechanism or cooling system performance.
7. When questions arise, obtain answers before proceeding. Assistance is available through the Prevost After-Sales Service Support serving your area.

13.3 INSPECTION

DANGER

Set the starter selector switch in engine compartment to the "Off" position to prevent accidental starting of the engine.

- Check security of fasteners securing fan blade assembly to fan clutch.
- Visually inspect fan driving mechanism, fan blade assembly, shroud, radiator, and surrounding area for evidence of contact between rotating and non-rotating parts.
- Check drive belt for fraying, cracking, and proper tension.
- Turn fan through at least 360° of rotation. It should turn smoothly with no resistance.

13.4 FAN REMOVAL / INSTALLATION

The fan is bolted to the magnetic clutch. To remove the fan:

- Unscrew and remove the mounting bolts and washers.

To reinstall the fan:

- If the fan is still in the radiator fan shroud, place 2 of the mounting bolts on the opposite side of the clutch, in reverse direction, in order to use them as guide pins to position the fan.
- Once properly positioned, screw the 4 remaining bolts back in and tighten properly (16 lbf-ft; 22 Nm).
- Finally, take the 2 bolts that were used as guide pins and screw them back in on the proper side of the clutch and tighten properly.

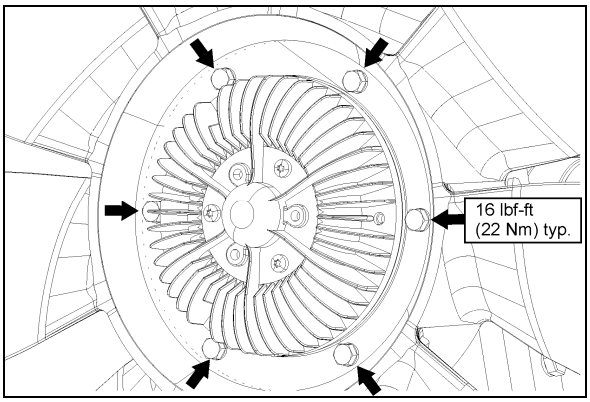


FIGURE 26: RADIATOR FAN MOUNTING BOLTS 05125

14. FAN RIGHT ANGLE GEARBOX

The radiator fan is belt driven from the engine crankshaft pulley through a drive belt, a universal joint shaft, a right angle gear and clutch assembly.

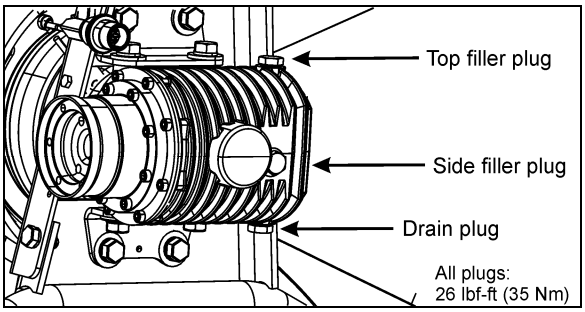


FIGURE 27: RIGHT ANGLE GEARBOX 05118

14.1 MAINTENANCE

MAINTENANCE

Change the right angle gearbox oil every 56,000 miles (90,000-km). Replace seals at every oil change.

Use **Shell transmission oil MA 75W90**.

14.2 OIL CHANGE

1. Stop engine and make sure that all engine safety precautions have been observed.
2. Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine or set the rear start panel selector switch to the OFF position.
3. Remove the drain plug located underneath the right angle gearbox case and allow the oil to drain into a suitable container.
4. Replace the seal and screw the drain plug back in (torque: 26 lbf-ft).
5. Unscrew and remove the side filler plug.
6. Unscrew and remove the top filler plug.
7. Add gear lubricant. The oil level is correct once the top of the oil has reached the bottom of the side filling point.
8. Replace the seals and screw side and top filler plug back in (torque: 26 lbf-ft).
9. Clean gear case carefully.
10. Start the engine and allow running a few minutes. Stop the engine and check for leaks.

WARNING

Note that warranty may be voided if proper maintenance at oil change intervals is not respected.

14.3 REMOVAL / INSTALLATION

To remove the right angle gearbox, proceed as follow:

1. Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine.
2. Disconnect the fan clutch electrical connector.
3. Dismount the fan and lean it against the radiator (refer to previous paragraph).
4. Disconnect the universal joint shaft.

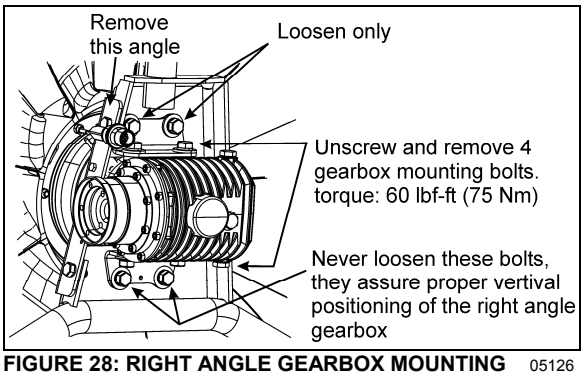


FIGURE 28: RIGHT ANGLE GEARBOX MOUNTING 05126

5. Dismount the angle (see fig. 28).
6. Loosen the gearbox support bracket top bolts.
7. Unscrew and remove 4 gearbox mounting bolts.
8. Slide the gearbox out of the support assembly.

Installation procedure is the same as removal but in reverse order. Tighten the 4 mounting bolts as specified.

15. COOLING FAN DRIVE BELT

15.1 MOUNTING THE DRIVE BELT

To install the cooling fan drive belt, proceed as follow:

WARNING

Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine.

WARNING

Potential Accident Risk. Always use extreme caution when working in the vicinity of hot, rotating or moving parts.

1. Wrap the new drive belt around the fan drive mechanism pulley, the idlers and the automatic tensioner idler as shown on figure 29.
2. Using the special tool included with your vehicle (see inside the Warning Reflectors box located in the first curb-side baggage bay), rotate the automatic tensioner in clockwise direction to relieve tension on the belt and hold the tensioner in that position (Fig. 29).
3. Finally, place the drive belt around the engine crankshaft pulley.

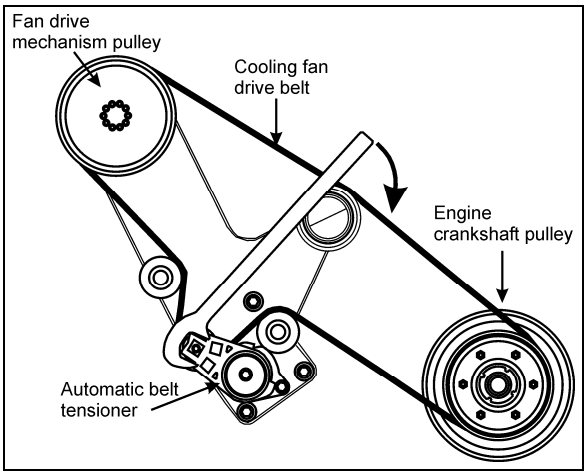


FIGURE 29: DRIVE BELT ROUTING (VOLVO D13 ENGINE)

4. Release the tensioner slowly and let it return to its natural position.

COOLING FAN DRIVE BELT

With Volvo D13 engine

Type: 14PK2526

Prevost number: 5060097

16. SPECIFICATIONS

Cooling System Capacity (Approximation)

Includes heating system ..... 24 US gal (91 liters)

Thermostat - Volvo D13 Engine

Number used 1
Start to close ..... 203°F (95°C)
Fully closed ..... 185°F (85°C)

Cooling Fan Drive Belt – Volvo D13 Engine

Type ..... Poly-Rib 14PK2526
Qty 1
Prevost number 5060097

Coolant - Volvo D13 Engine

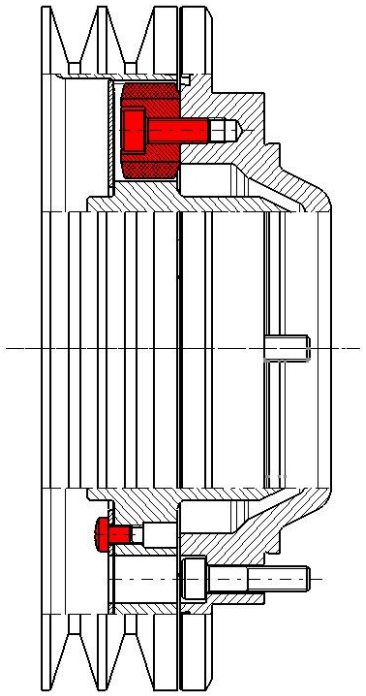
Prevost Number 685241
Texaco CPS 227998
Chevron CPS 2227805

Coolant Filter Cartridge – Volvo D13 Engine

Number used 1
Type ..... Spin-on
Prevost number 20458771

LINNIG®
Antriebstechnik

Postfach / P.O.Box 1430
D - 88672 Markdorf
Tel.: + 49 7544 / 964 0
Fax: + 49 7544 / 6218
Internet: http://www.linnig.com
Mail: webinfo@linnig.com

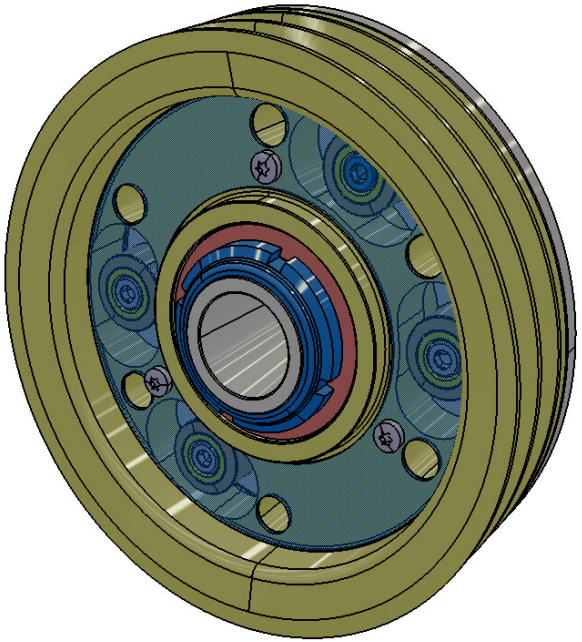


Reparaturanleitung

LINNIG Drehschwingungsdämpfer LDD (außer LDD12)
Austausch Gummidämpfer 127.032 mit EB0112

Repair instructions

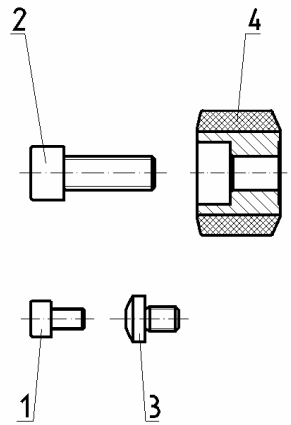
LINNIG Torsional vibration damper LDD (except LDD12)
Replacement of the rubber damper 127.032 with EB0112



Instrucciones de servicio

LINNIG Polea antivibratoria LDD (excepto LDD12)
Reemplazo de amortiguadores de goma 127.032 con EB0112

Lieferumfang / Delivery / Volumen de suministro



Schrauben 50.002 (Pos.1), 50.099 (Pos.2) und 65.003 (Pos.3) zusammen mit Gummidämpfer 127.032 (Pos.4) und Reparaturanleitung 142.219 (Pos.6) in Minigripbeutel 141.018 (Pos.5) verpacken.

Pos.5 und 6 nicht dargestellt.

	Pos.	Menge	Einheit	Benennung	Sachnummer/Norm-Kurzbezeichnung	Bemerkung
	1	2	3	4	5	6
"1"	6	1	Stk	Reparaturanleitung LDD	Austausch Gummidämpfer 127.0	142.219
	5	1	Stk	Minigripbeutel	220×150×0.050	141.018
"2"	4	6	Stk	Gummidämpfer		127.032
"2"	3	3	Stk	IN-STAR LIKO-Schraube	M6×8-8.8-A3C-P80	65.003
"2"	2	6	Stk	Zyl.-Schraube	DIN 912-M8×22-8.8-A3C	50.099
	1	4	Stk	Zyl.-Schraube	DIN 912-M5×8-8.8-A3C	50.002

LINNIG Markdorf — Fuer diese Zeichnung behalten wir uns alle Rechte nach DIN 34 vor

Index	Änderungsnummer	Datum	Name
2	3168	27.Mar.2006	Met
1	3130	26.Jan.2006	Kre

	Datum	Name
Bearb.	17.06.04	Meckes
Gepr.		
Freig.		

27704

Gew.: 0.360 kg

Maßstab 1:1 | DIN A4

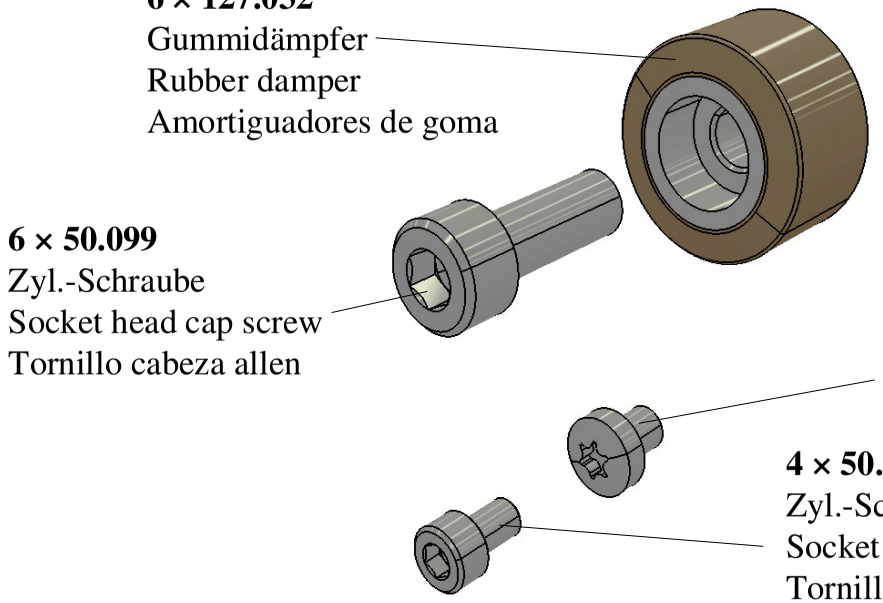
Werkst.:

Ersatzteilbaugruppe für LDD (außer LDD12)

EB0112 | Blatt Bl.

Ers.f.Zg. EB0103/EB0112/EB01 | Entst. aus EB0103

Ersatzteilbaugruppe / Assembly group / Juego de refacciones EB0112



Achtung:

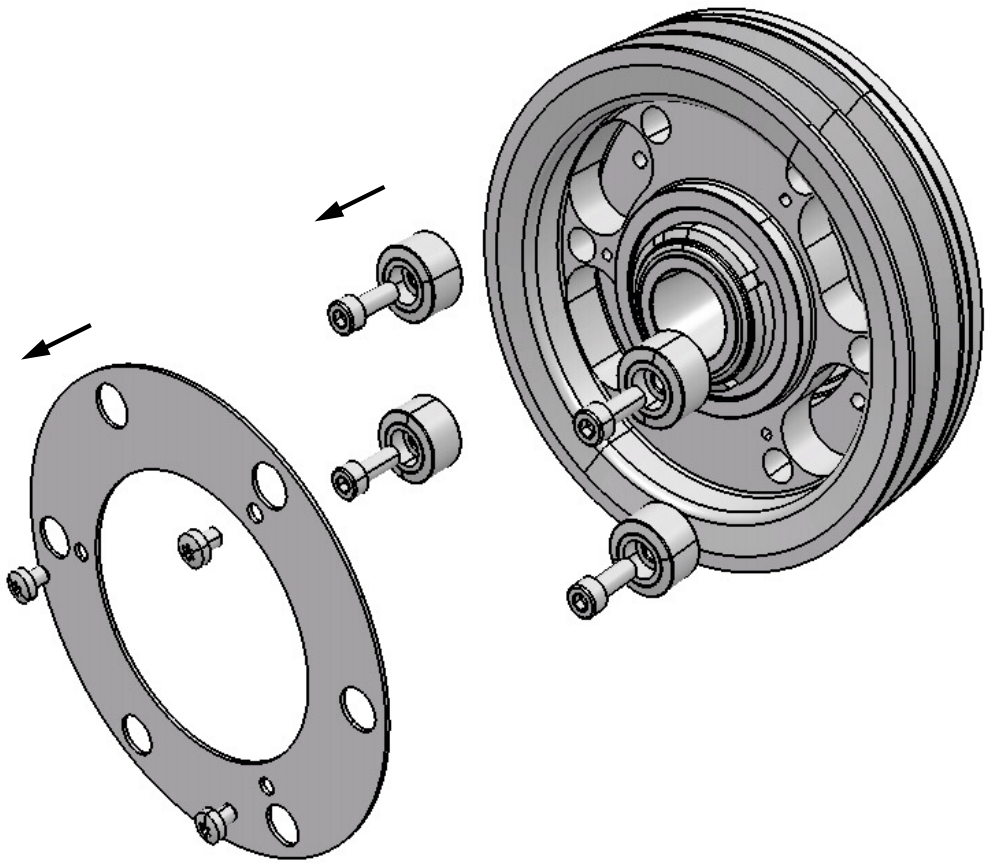
Je nach Ausführung des Drehschwingungs-dämpfers können evtl. Schrauben bzw. Gummidämpfer übrig bleiben !

Attention:

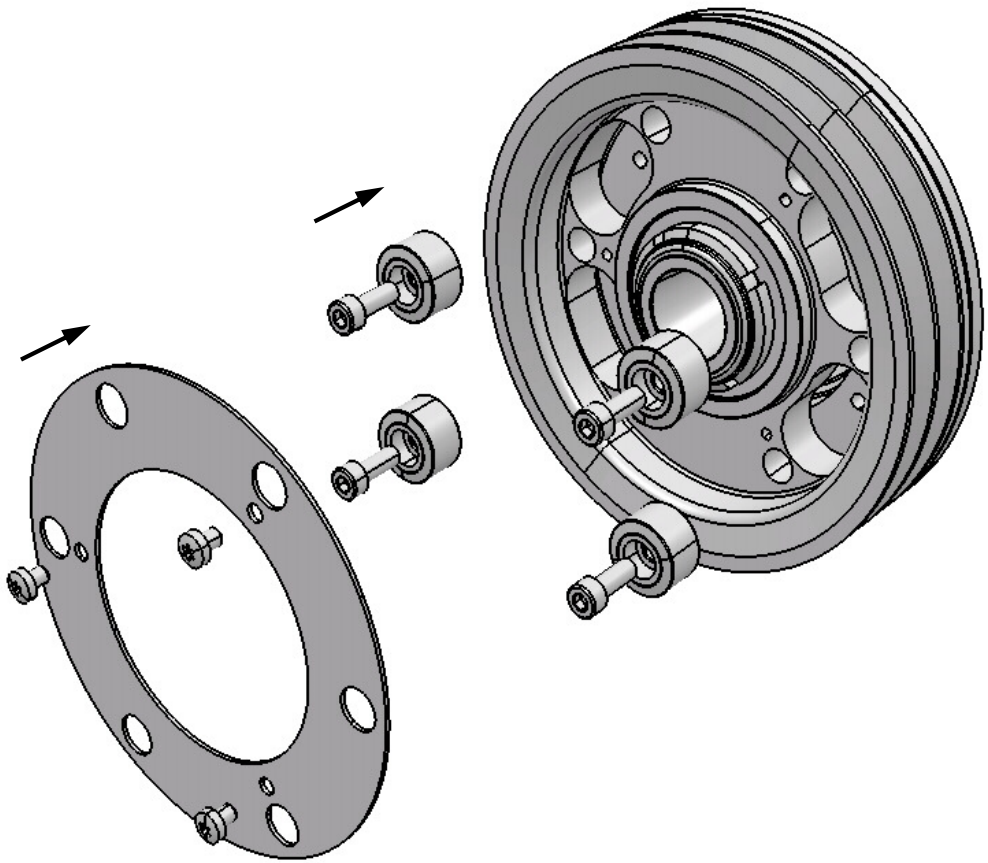
Beause of differnt versions of the torsional vibration damper, it is possible that some of the delivered screws and rubber damper are not be used !

Atención:

Debido a las diferentes versiones de Poleas antivibratorias, es posible que algunos de los tornillos y amortiguadores de goma no se utilizen!



1. 4 Zyl.-Schrauben M5 bzw. 3 IN-STAR LIKO-Schrauben M6 am Deckel entfernen.	**1.** Remove 4 socket head cap screws M5 resp. 3 IN-STAR LIKO-screws M6 on the cover.	**1.** Retire los 4 tornillos M5 o 3 tornillos M6 IN-STAR LIKO de la tapa de la polea.
2. Deckel entfernen.	**2.** Remove cover.	**2.** Retire la tapa.
3. 4 bzw. 6 Zyl.-Schrauben M8 der Gummidämpfer entfernen.	**3.** Remove 4 resp. 6 socket head cap screws M8 of the 4 resp. 6 rubber damper.	**3.** Retire los 4 o 6 tornillos M8 de los amortiguadores de goma de la polea.
4. 4 bzw. 6 Gummidämpfer entfernen.	**4.** Remove 4 resp. 6 rubber damper.	**4.** Retire los 4 o 6 amortiguadores de goma de la polea.
5. Nach Entfernen der Gummidämpfer alle 4 bzw. 6 Gewinde M8 reinigen.	**5.** After removing of the rubber damper clean all of the 4 resp. 6 threads.	**5.** Después de retirar los amortiguadores de goma de la polea, limpiar las 4 o 6 roscas.



6.

4 bzw. 6 neue Zyl.-Schrauben 50.099 mit Loctite 270 versehen und 4 bzw. 6 neue Gummidämpfer 127.032 an Nabe anschrauben.

Anzugsmoment

Ma = 25 Nm

6.

Protect 4 resp. 6 new socket head cap screws 50.099 with Loctite 270 and attach the 4 resp. 6 new rubber damper on the hub.

Tightening torque

Ma = 25 Nm
(18,5 lbs.ft)

6.

Aplicar Loctite 270 o equivalente a los 4 o 6 tornillos M8 nuevos (50.099), y sujetar los 4 o 6 nuevos amortiguadores de goma a la polea.

Torque de apriete

Ma = 25 Nm
(18,5 lbs.ft)

7.

Deckelmontage:

Bei LK 4×90°:
4 neue Zyl.-Schrauben 50.002 (M5) mit Loctite 270 versehen und Deckel an Riemenscheibe anschrauben.

Anzugsmoment

Ma = 6 Nm

Bei LK 3×120°:
Mit 3 neuen IN-STAR LIKO-Schrauben 65.003 (M6) Deckel an Riemenscheibe anschrauben.

Anzugsmoment

Ma = 10 Nm

7.

Mounting the cover:

Pitch circle 4×90°:
Protect 4 new socket head cap screws 50.002 with Loctite 270 and attach the cover on the pulley.

Tightening torque

Ma = 6 Nm
(4,5 lbs.ft)

Pitch circle 3×120°:
Attach cover with 3 new IN-STAR LIKO-screws 65.003 (M6) on the pulley.

Tighening torque

Ma = 10 Nm
(7,5 lbs.ft)

7.

Montaja de la tapa:

Tapa con 4 tornillos:
Aplicar Loctite 270 o equivalente a los tornillos M5 nuevos (50.002) y colocar la tapa de la polea.

Torque de apriete

Ma = 6 Nm
(4,5 lbs.ft)

Tapa con 3 tornillos:
Con los 3 tornillos M6 IN-STAR LIKO nuevos (65.003) colocar la tapa de la polea.

Torque de apriete

Ma = 10 Nm
(7,5 lbs.ft)

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1. GENERAL DESCRIPTION

These vehicles use a dual voltage system to obtain two different voltages (12 and 24 volts) for various electrical controls and accessories. The main power source incorporates four maintenance-free “Volvo” model 20359831 batteries connected in parallel-series. All batteries are kept uniformly charged by means of a 100 amp battery equalizer (standard), giving a maximum possible output supply of 100 amps on the 12 volt system. Both the 12 and 24 volt systems are controlled through individual main battery relays. Usually two 28 volt self-regulated alternators are installed and are belt driven from the engine, and can be reached through the engine compartment doors.

1.1 WIRING DIAGRAMS

A master wiring diagram of the electric circuits, covering standard and optional accessories and systems, is located in the technical publications box. Usually, a separate wiring diagram page is provided for each major function or system. In some cases, more than one circuit may appear on one wiring diagram page; when this occurs, each circuit covered in this page is listed in the wiring diagram index. Moreover, a circuit may appear on several pages; in such case, the number(s) at the extremity of the diagram title will indicate the sheet reference number. Refer to the *"Wiring Diagram Index*" to ensure that the correct diagram is being used to trace the circuit in question. In addition to the major functions page reference, the wiring diagram index contains the following information pages.

- The Multiplexed Device Index,
- The Arrangement-Harness drawing showing the harnesses arrangement and harness number on the vehicle,
- Glossary,
- Circuit number listing,
- Circuit breaker code,
- Connector code,
- Diode number code,
- Resistor number code,
- Fuse code.

1.1.1 Using Wiring Diagrams

Three methods are used to *"work"* with electric wiring diagrams.

Situation: You have identified the defective part (breaker, diode, relay, etc.), and you wish to locate its corresponding circuit.

Problem: Circuit breaker CB12 is released (open circuit) and you don't know which circuit is affected.

a) Refer to wiring diagram index, and look for *"Circuit breaker code"*, pages **F**.

b) At item CB12, you will find the location, the Prevost number, the breaker function, the breaker ampere rating and the page on which to find the corresponding diagram.

c) Refer to page 3.1.

d) When you have located CB12, follow the wiring up to the end and find the diagram page number and function on which the circuit continues.

Situation: You have a problem with a specific system and you want to find the corresponding diagram.

Problem: The last three (3) speakers on the R.H. side of vehicle are inoperative and you must trace the electric circuit.

a) Refer to wiring diagram index and look for *“Sound system”.*

b) You will find on page 35.1 & 35.2 the components as well as the electric wiring, thus providing you with a complete understanding of this circuit.

Situation: Using the message center display (MCD), you check on arrival if there are active errors in the vehicle electrical system. With the SYSTEM DIAGNOSTIC menu, highlight FAULT DIAGNOSTIC, highlight ELECTRICAL SYSTEM to request a diagnostic of the electrical system and then press the enter key. If applicable, the MCD shows the fault messages or fault codes recorded. When more than one fault is recorded, an arrow pointing down appears on the right of the display. Use the down arrow to see all the fault messages.

Problem: MCD displays the fault "Elec. Horn SW61 SW62; shorted to ground" as being active.

a) Refer to wiring diagram index, and look for *"Multiplexed Device Index"*, pages B1-B8.

b) In first column DEVICE ID, look for device SW61, SW62.

c) At device SW61,SW62, find the fault message, the minimum condition to activate, other inputs involved in logic, the multiplex module related to switch 61 and switch 62, the connector and pin number on the module and the page on which to find the corresponding diagram.

d) Once the problem corrected, the MCD still shows the fault as being active. You have to leave the FAULT DIAGNOSTIC menu, wait approximately 20 to 30 seconds and then return to FAULT DIAGNOSTIC to request a new diagnostic of the ELECTRICAL SYSTEM from the CECM. The MCD should display the fault as being inactive.

1.1.2 Testing Circuits

A careful study of the wiring diagrams should be made to determine the source and flow of current through each circuit. When a circuit is thoroughly understood, a point-to-point check can be made with the aid of the applicable wiring diagrams. Any circuit can be tested for continuity or short circuits with a multimeter or a suitable voltmeter.

All electrical connections must always be kept clean and adequately tight. Loose or corroded connections can result in discharged batteries, difficult starting, dim lights and improper functioning of other electric circuits. Inspect all wiring connections at regular intervals. Make sure knurled nuts on all amphenol-type plugs are securely tightened. Knurled nuts on the plastic amphenol-type connectors will click into a detent when properly tightened. Line connectors, who have the side locking tabs, must have the locks latched in place to ensure a proper electrical connection.

1.2 WIRE SIZES AND COLORS

Each wire in the electrical system has a specific size as designated on the wiring diagram. When replacing a wire, the correct size must be used. Never replace a wire with one of a smaller size. The vehicle electrical system is provided with different voltages. The insulation on each wire is distinctly colored in order to determine visually the wiring voltage and to assist in making connectors. The wires are color coded as follows:

Yellow	Multiplex modules communication CAN-H (twisted with green)
Green	Multiplex modules communication CAN-L (twisted with yellow)
Orange	Connected to multiplex outputs
White	Connected to multiplex inputs
Red	24 volt system
Yellow	12 volt system
Black	grounded wire
Blue	110 V ac system (live)
White	110 V ac system (neutral)
Green	110 V ac system (ground)
Orange	speakers (+) (**Coaches Only)**
Brown	speakers (-) (**Coaches Only)**
Grey	spare wire

NOTE

Wires are identified at each 2-4 inch (5-10 cm) intervals by a printed number.

Each wire on a diagram is patterned to assist in tracing and testing circuits. The wire number identifies the voltage rating, the wire identification number and the basic wire gauge as illustrated in figure 1.

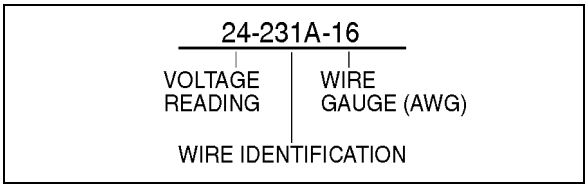


FIGURE 1: WIRE IDENTIFICATION 06048

1.3 SPARE WIRES

When the vehicle leaves the factory, and even in the case of a fully-equipped vehicle, an important number of unconnected spare wires are routed between the junction boxes. Consequently, for any connection of an additional accessory, refer to page D *"Spare wires"* in master wiring diagram to determine the number, the gauge and location of these wires.

⚠ CAUTION

Wire size is calibrated according to the breaker or fuse that protects it. When using a spare wire to replace a damaged wire, assure that the spare wire size is equal or larger than the wire being replaced. Using a wire too small for the breaker or fuse amperage might cause overheating of the wire.

NOTE

Spare wires are identified by a wire identification number and by the letters "SP", to designate "spare".

1.4 CLEANING CONNECTORS

When the pins and sockets of connectors become dirty, clean them with a good quality solvent containing HFC 134A refrigerant as its active ingredient. HFC 134A has two qualities that recommend it. First, it does not conduct electricity and therefore, will not cause shorting between connector pins and sockets. Second, it evaporates quickly, eliminating the possibility of condensation within the connectors.

Always shake out or gently blow out any excess HFC 134A before assembling a connector to its mating connector or hardware. HFC 134A trapped in the connector can affect the connector seal.

DANGER

HFC 134A is toxic. HFC 134A bases compounds should always be used in a well-ventilated area, never in a confined space. Use outdoor whenever possible.

1.5 CIRCUIT BREAKERS

Most electric circuits are protected by circuit breakers of the "Manual Reset" type. The main circuit breakers, as well as those protecting the A/C system, are located on the rear electrical junction panel and are accessible from the engine compartment curb-side door, on R.H. side of the vehicle.

This type of circuit breaker deenergizes the circuit without disconnecting any wire.

1.5.1 X3-45 Coaches

Circuit breakers CB2, CB4 & CB6 are different in the fact that you may open the circuit manually, to do so simply press down the red tab on breaker to open the circuit, repair defective circuit, and afterwards depress black button in center of breaker to close the circuit.

Smaller circuit breakers may be located in the VECF of the front service compartment.

CIRCUIT BREAKERS			
CB1	Front distribution	24 VI	90 amps
CB2	Distribution	12 VD	90 amps
CB3	HVAC - evaporator	24 VI	90 amps
CB4	Sound system	12 VD	30 amps
CB5	Rear distribution	24 VI	150 amps
CB6	Distribution	24 VD	70 amps
CB7	HVAC - condenser	24 VI	70 amps
CB8	Rear distribution	12 VI	40 amps
CB9	WCL or other option	24VD	50 amps
CB10	Front distribution	12 VI	70 amps
CB11	Sound system	24 VD	50 amps
CB13	Galley or other option	24 VI	90 amps

VD= volts direct. The electrical components connected to these circuit breakers are direct-connected to the battery.

VI= volts indirect. Electrical power is supplied via master relay R1 which engages when ignition key is in the ON or ACC position and battery master switch (master cut-out) is set to ON.

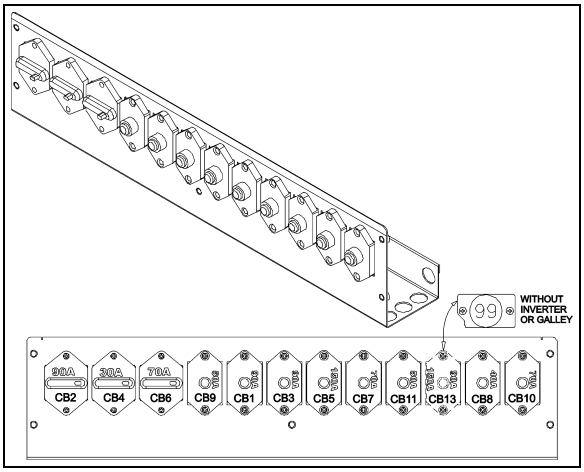


FIGURE 2: REAR ELECTRICAL JUNCTION PANEL 06621

1.5.2 X3-45 VIP & XLII Bus Shells

Circuit breakers CB1 & CB2 are different in the fact that you may open the circuit manually, to do so simply press down the blue tab on breaker to trip the circuit breaker, repair defective circuit, and afterwards toggle yellow lever upwards to reset the circuit breaker and close the circuit.

CIRCUIT BREAKERS			
CB1	Distribution	12 VD	150 amps
CB2	Distribution	24 VD	50 amps
CB3	Front distribution	24 VI	70 amps
CB4	HVAC - evaporator	24 VI	90 amps
CB5	HVAC - condenser	24 VI	70 amps
CB6	Slide-Out	24 VI	35 amps
CB7	Distribution	24 VI	60 amps
CB8	HVAC - condenser	12 VI	40 amps

CIRCUIT BREAKERS			
CB9	Distribution	12VI	70 amps

VD= volts direct. The electrical components connected to these circuit breakers are direct-connected to the battery.

VI= volts indirect. Electrical power is supplied via master relay R1 which engages when ignition key is in the ON or ACC position.

1.6 MULTIPLEX FUSES

The multiplex outputs are protected in current by an internal “soft-fuse”. Each output has programmed specific maximum amperage. When an output is shorted, the current gets above the limit and the soft-fuse intervenes to turn the output OFF. The output stays OFF until the "soft-fuse" is reset.

Turn the ignition key to the OFF position and turn to the ON position again. This resets all "soft-fuses".

There is also hardware fuses used to protect the incoming power to the multiplex modules. These fuses are located inside the VECF (Vehicle Electrical Center Front) and VECR (Vehicle Electrical Center Rear).

1.7 RELAYS

Relays are used to automatically energize or deenergize a circuit from a remote location. The relay draws a very low current to energize its coil. Once the coil is energized, it develops a magnetic field that pulls a switch arm closed or open, to either energize or deenergize a given component. As the control current required for the coil is very low, the relay allows a remote station to control a high energy circuit without running great lengths of costly high capacity cable, and also eliminates the need for high amperage switches and heavy connectors.

NOTE

Each relay is identified with “12V” or “24V” printed on its casing in order to identify the coil operating voltage.

CAUTION

The Multiplex vehicle uses a VF4 relay designed specially for Volvo that has different internal characteristics than the current VF4 relay. It is important to use only the new part marked Volvo as a replacement in Multiplex vehicles. Regular relays have an inadequate lifespan for Multiplex vehicles.

1.8 PRECAUTIONS

DANGER

Prior to working on a system inside vehicle, make sure to cut electrical power and air supply. A component could be supplied with electricity even if the ignition switch is set to the OFF position and/or a component could be pressurized even if air tanks are emptied. Always refer to the appropriate wiring and pneumatic diagrams prior to working on electrical and/or pneumatic systems.

NOTE

When the ignition switch is set to the OFF position, the electrical components are not energized except for the CECM (Chassis Electronic Control Module), engine MCM, transmission ECU, instrument cluster module, the battery equalizer, the preheater system, the wheelchair lift system and some Multiplex modules which are energized during 15 minutes after the ignition has been set to the OFF position. Prior to working on one of these electrical components, set the master cut-out switch located above the rear electrical panel to the OFF position.

If the vehicle will not be operated for a long period (more than 2 weeks), it is recommended, in order to prevent the batteries from discharging, to trip main circuit breakers (2, 4 and 6) located on the rear junction panel to stop the small current drawn by the radio preset station memory, the CECM memory and the instrument cluster clock. Note that the radio station presets will be erased, same thing for the diagnostic codes history and the instrument cluster clock will have to be reset.

CAUTION

Prior to arc welding on the vehicle, refer to "Multiplex Modules Disconnection Procedure Prior To Welding" in section 00 GENERAL of this manual to avoid serious damage to the vehicle components.

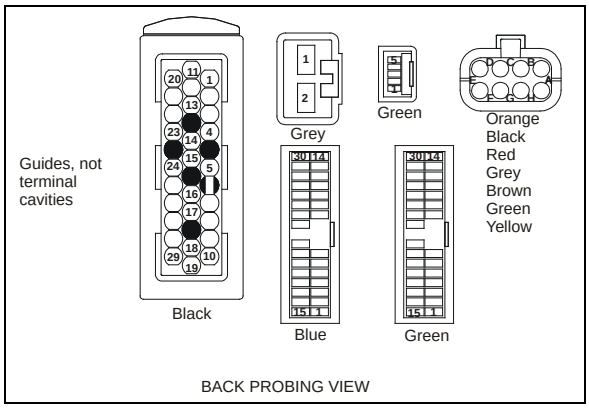
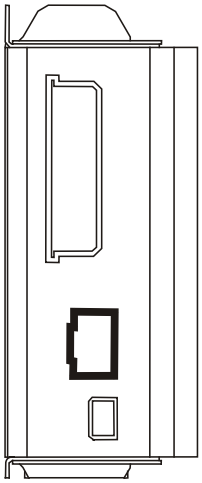
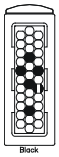
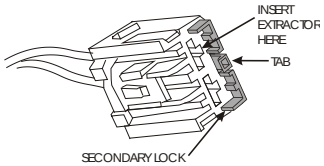
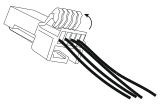
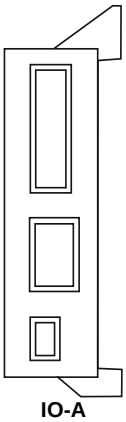
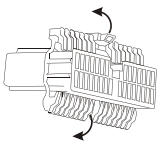
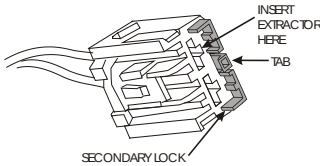
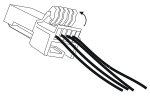
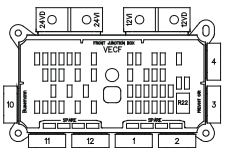
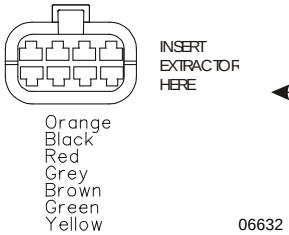


FIGURE 3: MULTIPLEX MODULE CONNECTORS PIN-OUT

06624

Multiplex modules	Connector type	Terminal removal
 **IO-B** 06625	 Black **AMP** 06628	EXTRACTOR/TOOL: Prevost #683594 Insert the extractor on the front of the connector. Remove the terminal by disengaging the flexible lock tabs on the terminal. Gently remove the terminal from the connector by pulling on the wire.
	 INSERT EXTRACTOR HERE TAB SECONDARY LOCK grey 06629 **YAZAKI**	EXTRACTOR/TOOL: Packard #12094430 Using a small flat blade screwdriver, open the hinged secondary lock. Insert the extractor on the front of the connector, over the terminal cavity. Remove the terminal by disengaging the flexible lock tab on the terminal. Gently remove the terminal from the connector by pulling on the wire.
	 green 06630 **JAE**	EXTRACTOR/TOOL: Prevost #683766 Using a small flat blade screwdriver, open the hinged secondary lock. Insert the extractor on the front of the connector, over the terminal cavity. Remove the terminal by disengaging the flexible lock tab on the terminal. Gently remove the terminal from the connector by pulling on the wire.
 **IO-A** 06626	 green, blue (CECM) **JAE** 06631	EXTRACTOR/TOOL: Prevost #683766 Using a small flat blade screwdriver, open both hinged secondary locks. Insert the extractor on the front of the connector, over the terminal cavity. Remove the terminal by disengaging the flexible lock tab on the terminal. Gently remove the terminal from the connector by pulling on the wire.
	 INSERT EXTRACTOR HERE TAB SECONDARY LOCK grey 06629 **YAZAKI**	EXTRACTOR/TOOL: Packard #12094430 Using a small flat blade screwdriver, open the hinged secondary lock. Insert the extractor on the front of the connector, over the terminal cavity. Remove the terminal by disengaging the flexible lock tab on the terminal. Gently remove the terminal from the connector by pulling on the wire.
	 green 06630 **JAE**	EXTRACTOR/TOOL: Prevost #683766 Using a small flat blade screwdriver, open the hinged secondary lock. Insert the extractor on the front of the connector, over the terminal cavity. Remove the terminal by disengaging the flexible lock tab on the terminal. Gently remove the terminal from the connector by pulling on the wire.
 **VECF** 06627	 INSERT EXTRACTOR HERE Orange Black Red Grey Brown Green Yellow 06632 **BUSSMAN**	EXTRACTOR/TOOL: Prevost #682256 (Packard 12094429) Remove the terminal by disengaging the flexible lock tab on the terminal. Gently remove the terminal from the connector by pulling on the wire.

2. X3 SERIES COACH, VIP & XLII ENTERTAINER BUS SHELL ELECTRICAL COMPARTMENTS

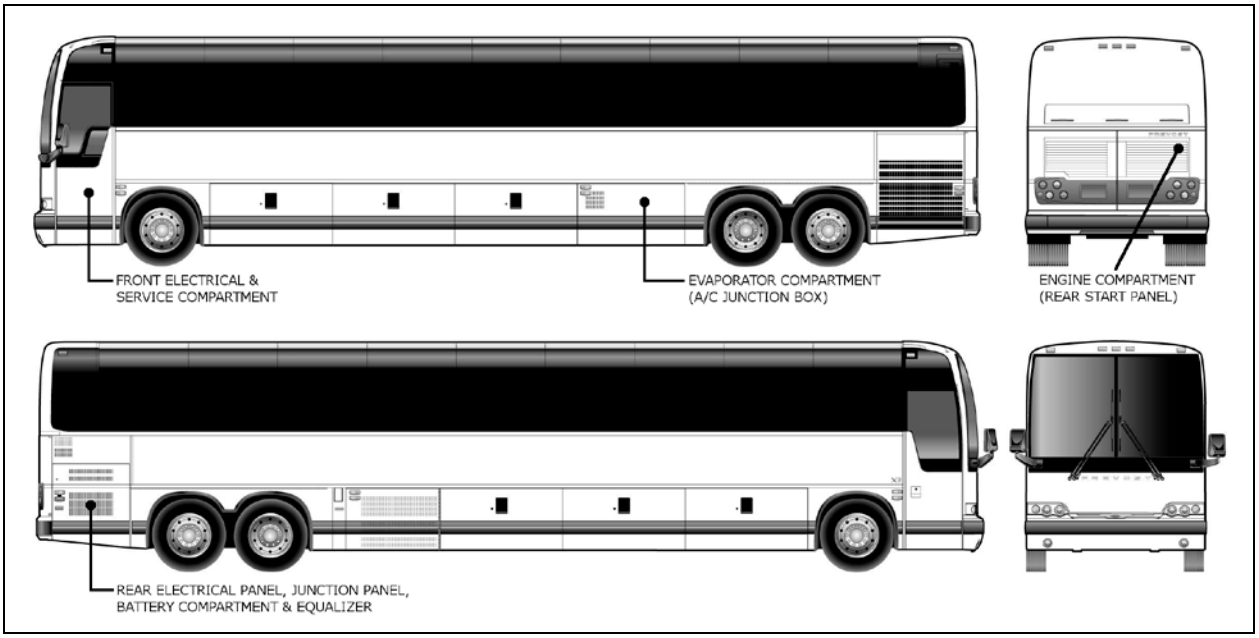


FIGURE 4: ELECTRICAL COMPARTMENTS (X3-45 COACH) 06672

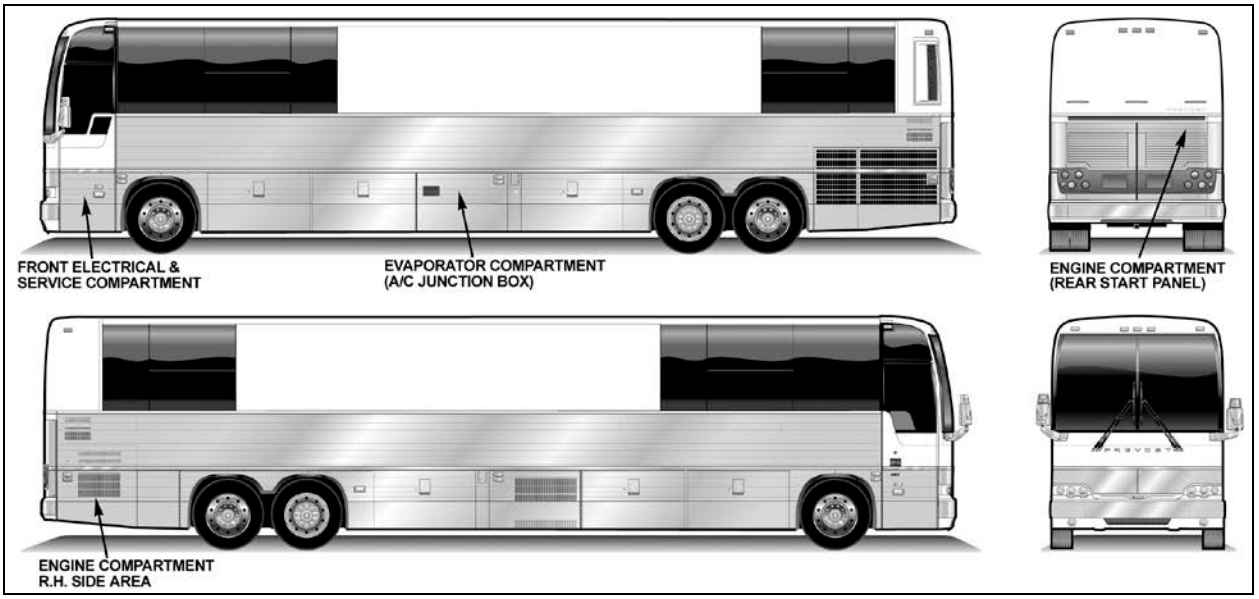


FIGURE 5 ELECTRICAL COMPARTMENTS (X3-45 VIP))

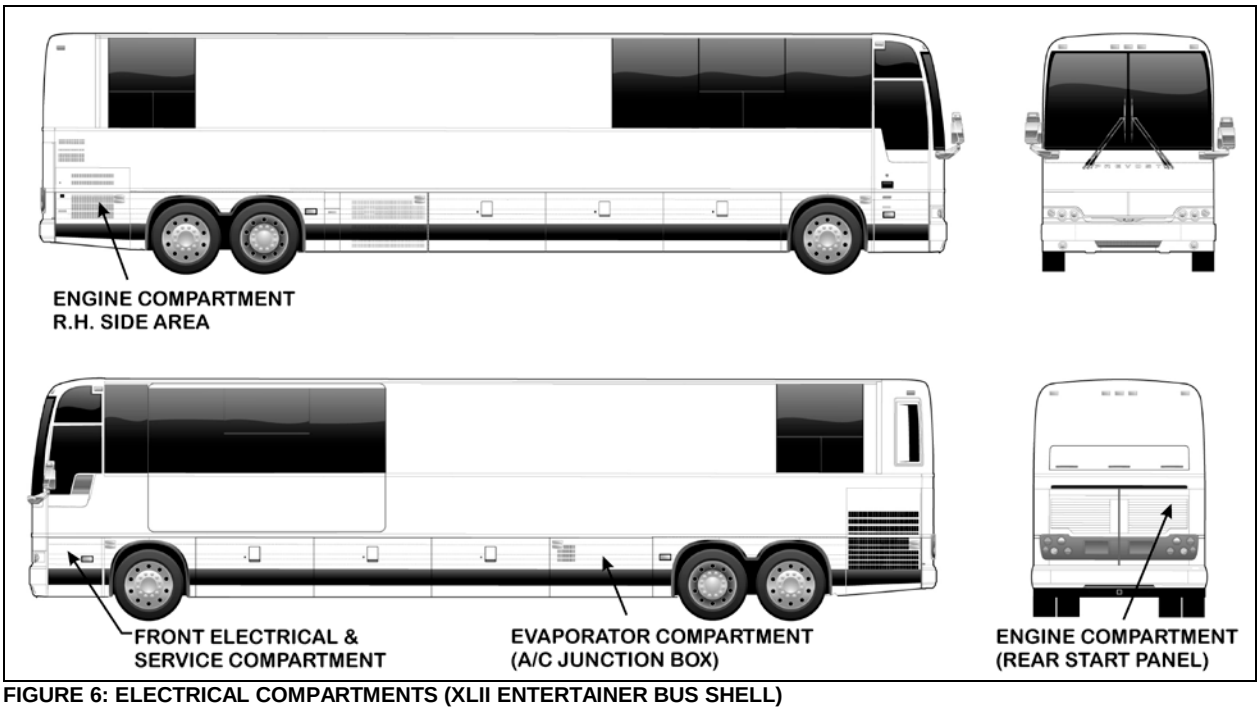


FIGURE 6: ELECTRICAL COMPARTMENTS (XLII ENTERTAINER BUS SHELL)

2.1 MAINTENANCE

A corrosion inhibitor has been sprayed on certain electrical components in order to protect them from corrosion. Refer to procedure SAV00002E at the end of this section for recommended products and where they are used.

CAUTION

Never put grease or other product on the multiplex modules connector terminals.

DANGER

Use sprayed sealer in a well ventilated area. Do not smoke. Avoid prolonged contact with skin and breathing of spray mist.

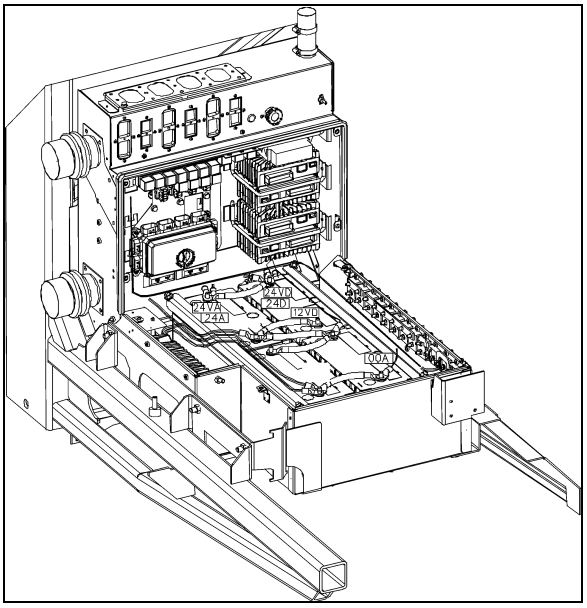


FIGURE 7: REAR ELECTRICAL PANEL, JUNCTION PANEL & BATTERY COMPARTMENT

2.2 REAR ELECTRICAL PANEL, JUNCTION PANEL, BATTERY COMPARTMENT & EQUALIZER

The rear electrical panel, junction panel, battery compartment & battery equalizer are located on the R.H. side of the engine compartment and are accessible from the engine compartment curb-side door.

2.3 REAR ELECTRICAL PANEL

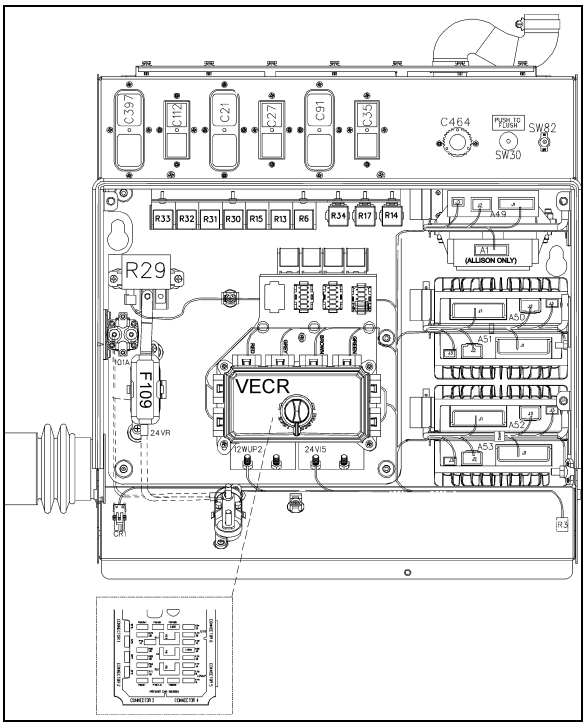


FIGURE 8: REAR ELECTRICAL PANEL

The rear electrical panel provides access to the following:

- Rear terminal block;
- Multiplex modules;
- Vehicle Electrical Center Rear (VECR)
- Relays and fuses;
- Transmission TCM;
- Battery master switch (Master cut-out);
- Diagnostic Data Reader (DDR) receptacle, (refer to “Other Features” chapter).

Rear Electrical Panel			
Multiplex Modules			
A49	I/O-A	A52	I/O-B
A50	I/O-B	A53	I/O-B
A51	I/O-B		

Relays			
R3	12V IGN & A/C (under CB4)	R21	24V Emergency cut-out
R5	24V Preheat / Charger	R29	Engine Air Heater
R6	24V Direct lights	R30	24V Lugg. Door Lock
R13	24V Indirect lights	R31	24V Luggage Door Lock
R14	24V Reading lights	R32	24V Luggage Door Unlock
R15	24V Aisle & Emerg. Lts	R33	24V Luggage Door Unlock
R17	24V 12V Rr wake-up	R34	12V 12VI Engine ECU

Fuses			
F50	Engine Pre-heating	F71	Hat Rack Lighting L & R
F51	Engine Pre-heating	F72	Power Mux A50
F52	Spare fuse	F73	Trailer / Urea
F53	HVAC Passenger	F74	ECU engine IGN
F54	Customer (24VD)	F75	Engine Door
F55	Aisle & emergency lights	F76	Customer (12VI)
F56	Indirect lights	F77	ECU transmission wake-up
F57	Indirect lights	F78	Spare fuse
F58	Direct lights	F79	Spare fuse
F59	Direct lights	F80	Power Mux A51
F60	Reading Lamp RH	F81	Excitation
F61	Reading Lamp LH	F85	Urea System
F62	Lavatory night light	F86	Air Dryer
F63	Engine Pre-heater	F87	Door Lock
F64	Galley	F88	Door lock
F65	Power Mux Module RJB	F89	Spare fuse
F66	Radiator Fan Clutch	F90	Urea System
F67	Power Mux A54	F91	Engine ECU
F68	Power Mux A54	F99	Engine ECU
F69	Retarder	F109	Engine Air Heater
F70	Customer (24VI)		

Resistors	
RES16	Rear marker lights : 100 ohms
RES17	Rear marker lights : 100 ohms

Diodes			
D6	Master relay	D37	Fan Clutch 1
D15	Wake-up mode	D49	Parcel Rack
D28	Unloader LH	D67	Rear Lights
D29	Unloader RH	D68	Rear Lights
D31	Main A/C Clutch	D69	Rear Lights
D33	Toilet flush pump	D70	Rear Lights
D36	Fan Clutch 2	DXX	Not used

2.4 REAR JUNCTION PANEL

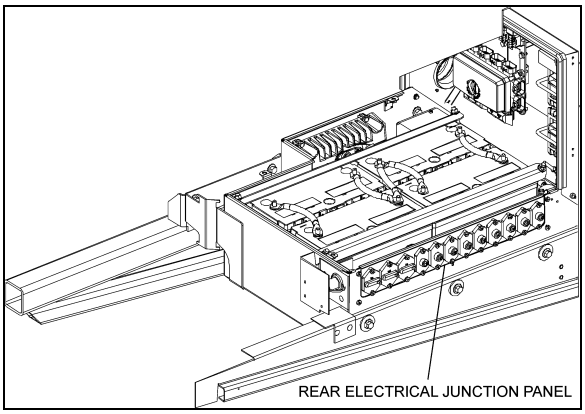


FIGURE 9: REAR ELECTRICAL JUNCTION PANEL 06634

2.5 BATTERY COMPARTMENT

The Battery Compartment provides access to the batteries (4), battery equalizer and master relay (R1).

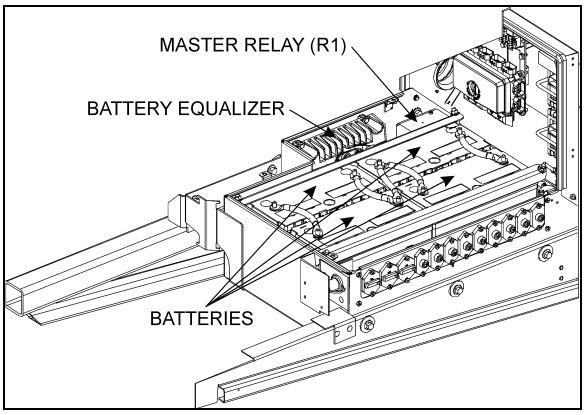


FIGURE 10: BATTERY COMPARTMENT

2.6 FRONT ELECTRICAL AND SERVICE COMPARTMENT

The front electrical and service compartment is located on L.H. side of vehicle, under the driver's window. It contains the following components (Fig. 9):

- Front terminal block;
- CECM;
- Vehicle Electrical Center Front (VECF) and Multiplex Modules;
- Relays and fuses;
- ABS Electronic Control Unit (ECU);
- Common Powertrain Controller (CPC);
- VECU with Volvo D13 engine;

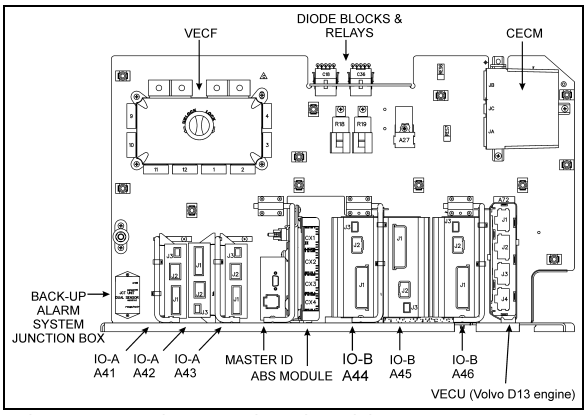


FIGURE 11: FRONT ELECTRICAL COMPARTMENT 06673

Front Electrical & Service Compartment			
Modules			
VECF	Vehicle Electrical Center Front	A43	I/O-A
A9	ABS-ECU	A44	I/O-B
A13	MASTER ID	A45	I/O-B
A36	CECM	A46	I/O-B
A41	I/O-A	A72	CPC
A42	I/O-A		
Relays			
R18	Wake-up 24V	R22	Engine brake
R19	Wake-up 12V	A27	Steering Control soft module
Fuses			
F1	CECM Power	F23	ABS
F2	Front start main switch	F24	Mirror
F3	Pre-heating & driver liquid solenoid valve	F25	Back-up camera
F4	Wireless microphone	F26	Spare fuse
F5	Wake-up mode 24V	F27	Customer
F6	Free/customer	F28	Driver's power window
F7	ABS & pre-heat control	F29	Instrument cluster & data reader
F8	Air horn	F30	Cigarette lighter & 12-volt accessory outlet
F9	Spare fuse	F31	Keyless entry module
F10	Spare fuse	F32	Spare fuse
F11	Sun visor	F33	Wake-up mode 12VD
F12	Power multiplex A41	F34	Wake-up mode 12VD
F13	Power multiplex A41	F35	12-volt accessory outlet
F14	Customer	F36	HVAC & telltale panel

F15	R22	F37	Spare fuse
F16	Defroster unit	F38	Digital Clock
F17	Spare	F39	Spare fuse
F18	Upper Defroster	F40	Spare fuse
F19	Pro Driver	F41	Spare fuse
F20	Witness red LED	F82	Lower wipers
F21	Power Mux A44	F83	Sound system
F22	ZF Steering Control	F84	Customer
Diodes			
D1	Accessories	D44	Ignition
D2	Driver Liq Sol Vlve	Dxx	Not used

2.7 A/C JUNCTION BOX

The A/C junction box is located inside the evaporator compartment on the X3-45 coach.

A/C Junction Box			
Multiplex Module			
A54	I/O-B		
Relays			
R10	Condenser Fan Sp. 2		
R12	Evaporator Fan		
R20	Water Pump Relay		
R26	Water Pre-heater Relay		
Diodes			
D9	HVAC	D10	Pre-Heater
D11	Pass. Liq. Sol.	D17	Lugg. 5th Compt
D19	Lugg. 2nd Compt	D20	Lugg. 1st Compt
D25	Evap. Fan	D30	Water Pump
D73	Opt.	D80	Opt.

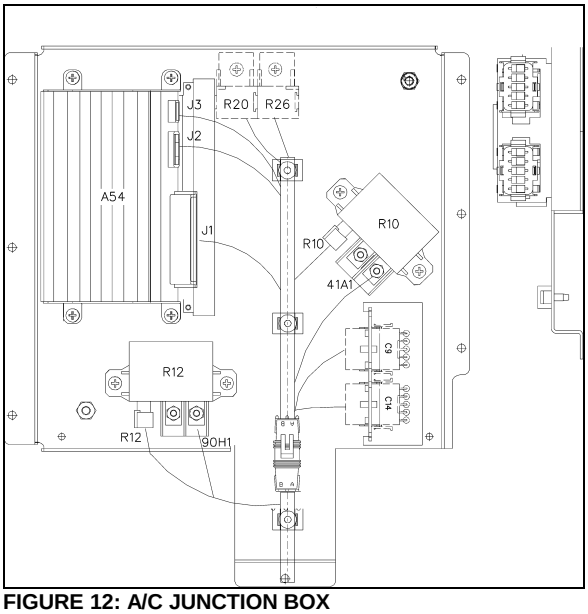


FIGURE 12: A/C JUNCTION BOX

2.8 ENGINE REAR START PANEL

This control panel is located in the R.H. side of engine compartment above the engine air filter. This control panel includes the engine starter selector switch, the rear start push button switch to start engine from engine compartment as well as the engine compartment lights switch.

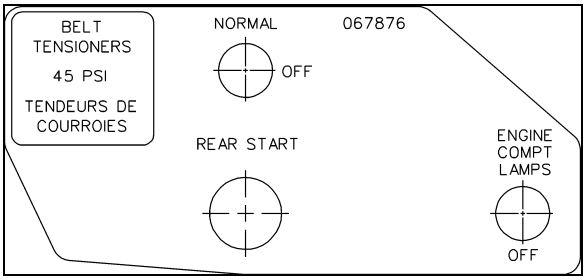


FIGURE 13: REAR START PANEL

NOTE

When the ignition key switch is set to the "OFF" position, the electrical supply from the batteries is cut off, with the exception of the Fire Detection System, the Engine & Transmission Electronic Controls, the Auxiliary Heating System, the Battery Equalizer and the Digital Clock.

2.9 ENTRANCE DOOR & WIPER CONTROL PANEL

To access the entrance door & wiper control panel of the right console, remove the panel under the larger utility compartment at the base of the windshield.

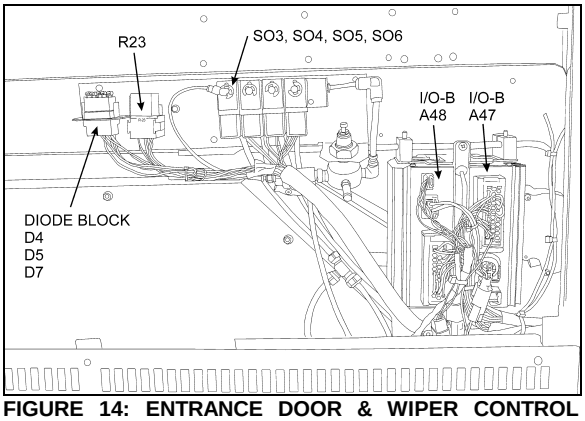


FIGURE 14: ENTRANCE DOOR & WIPER CONTROL PANEL 06619

Entrance Door & Wiper Control Panel			
Multiplex Modules			
A47	I/O-B	A48	I/O-B
Relays			
R23	Windshield wipers		

Solenoids			
SO3	Door unlock solenoid valve	SO5	Door opening solenoid valve
SO4	Door unlock solenoid valve	SO6	Door closing solenoid valve
Diodes			
D4	Windshield wipers speed 2	D7	Entrance door
D5	Windshield wipers speed 1		

3. BATTERIES

The vehicle is provided with four (4) maintenance-free 12 volt heavy-duty batteries connected in series-parallel (Fig. 4 & 8). The top-mounted negative and positive terminals are tightly sealed to prevent leaks. Water never needs to be added to this type of battery. There are no filler caps in the cover. The battery is sealed, except for small vent holes in the cover. The vents must not be restricted as they allow small amounts of gases produced in the battery to escape. The special chemical composition inside the battery reduces gassing to a very small amount at normal charging voltages. Besides reducing gassing, the special chemistry greatly reduces the possibility of overcharge damage.

The vents require keeping the battery in an upright position to prevent electrolyte leakage. Tipping the battery beyond a 45° angle in any direction can allow a small amount of electrolyte to leak out of the vent holes.

WARNING

DO NOT tip battery by more than 45° when carrying or installing the battery.

NOTE

Evidence of electrolyte leakage does not necessarily mean the battery is defective.

With special cables properly attached to batteries, the metal surfaces that carry the current are completely sealed from the atmosphere. This prevents terminal oxidation and corrosion that may cause starting and charging problems. If new cables are required, sealed terminal cable replacements should be used to retain the reliability of the original maintenance-free connections.

DANGER

All lead-acid batteries generate hydrogen gas, which is highly flammable. If ignited by a spark or flame, the gas may explode violently, causing spraying of acid, fragmentation of the battery, which may result in severe personal injuries. Wear safety glasses and do not smoke when working near batteries. In case of contact with acid, flush immediately with water.

The battery has four (4) major functions:

1. Providing a source of current for starting the engine;
2. Stabilizing the voltage in the electrical system;
3. Supplying current for a limited time, when electrical demands of the equipment exceed the power output of the alternator;
4. Providing a limited source of power for connected accessories, when the engine is not running.

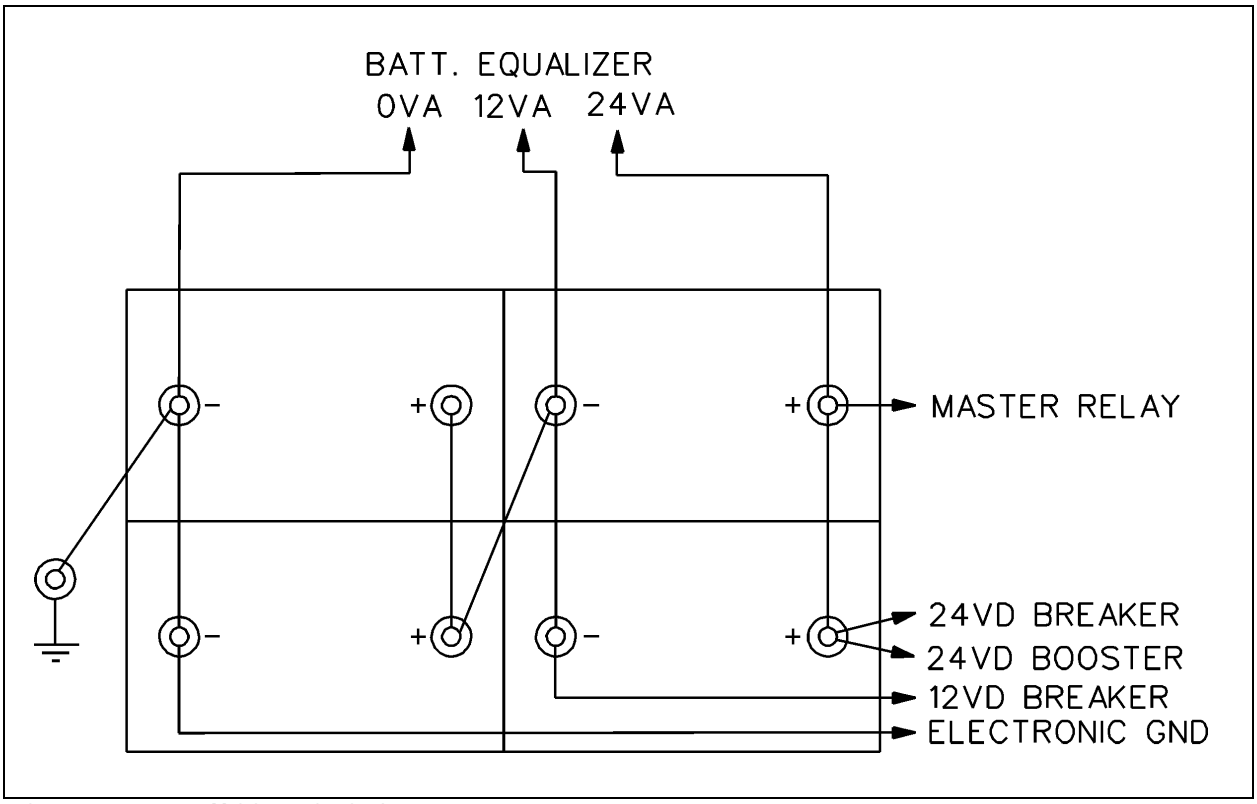


FIGURE 15: BATTERY CONNECTIONS

3.1 BATTERY DISCHARGE PROTECTION

To prevent discharge of the batteries when the engine in not running, some functions are automatically switched off if the batteries voltage drops below 24.4 volts for more than 30 seconds. The "BAT" telltale light blinks while this protection mode is active. Set the ignition key to the OFF position and then turn the ignition key to the ON position to reactivate the functions for a period of 30 seconds before they switch off again.

If a prolonged use of the functions with the engine not running is necessary, connect the battery to a charger.

3.2 MAIN BATTERY RELAYS

Main battery (master) relays (12V and 24V) are provided for this vehicle. The relays are located in the battery compartment and on the rear electrical panel. The 24-volt battery relay (R1) engages when ignition key is in the ON or ACC position and battery master switch (master cut-out) is flipped ON.

When the main battery relays (R1 & R3) are turned to the *OFF* position, all electrical supply from the batteries is cut off, with the exception of the following items.

- Battery equalizer check module;
- MCM;
- TCM (World transmission);
- Preheater electronic timer;
- Preheater and water recirculating pump;
- Sedan entrance door;
- Radio memory;
- CECM;
- Cluster memory.

3.3 BATTERY REMOVAL AND INSTALLATION

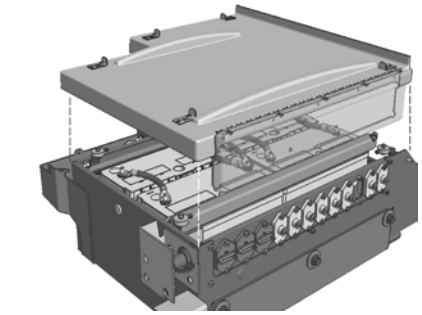
The batteries are located in the battery compartment on the R.H. side of the engine compartment and are accessible from the engine compartment curb-side door.

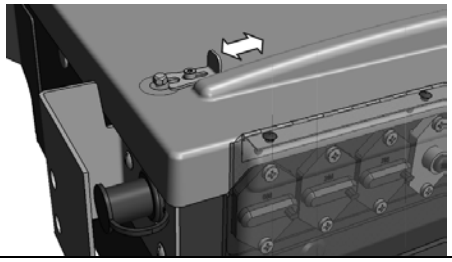
1. Remove the battery compartment protective cover.

⚠ CAUTION

To protect battery terminals and circuit breaker

bus bars against mist and corrosion, make sure that the battery protective cover is properly fitted and latched (five latches).





DANGER

To prevent possible electric shocks or sparking, the battery master switches should be in the "Off" position before disconnecting cables from the batteries.

2. Remove the supports, and unscrew terminal nuts of each defective battery.
3. Remove battery cables from the batteries.
4. Remove batteries.
5. Installation is the reverse of removal.

NOTE

When the battery cables have been removed from the batteries, wrap the battery terminals and cable ends with electric tape to prevent accidental grounding. The ground cables should always be disconnected first and replaced last.

NOTE

In replacing batteries, only batteries of the same specification should be used. Refer to "Specifications" at the end of this section for further details.

CAUTION

Ensure that connections are not reversed when reinstalling batteries, since damage to electrical system components will result.

NOTE

When reinstalling batteries, battery connections must be tightened to 13-15 lbf-ft (18-20) Nm). A torque wrench is required to ensure an accurate tightening torque.

DANGER

To prevent possible electric shock or sparking, the battery master switch must be set to the "Off" position before tightening an electrical connection.

NOTE

A protective coating should be applied on certain power connections that have been disconnected. Refer to Procedure PR00002E included at the end of this section to know the recommended products and where they are used.

3.4 BATTERY RATING

Each of the 12 volt batteries used on the vehicle has the following rating:

- Reserve capacity: 195 minutes
- Cold cranking (amps): 950 @ 0°F (-18°C)
- Cold cranking (amps): 745 @ -20°F (-29°C)
- Weight (filled): 59 lb (26,7 kg)

The reserve capacity is defined as the number of minutes a new, fully charged battery at 80°F (26,6°C) can be discharged at 25 amperes and maintain a minimum of 1.75 volts per cell (10.5 volts total for one 12 volts battery). This rating can be used as a basis for determining how long a vehicle might run after an alternator failure. The cold cranking rating is defined as the minimum discharge current a battery will deliver in amperes for 30 seconds at 0°F (-18°C) while maintaining a minimum of 1.2 volts per cell (7.2 volts total for one 12 volts battery). This rating

can be used as a basis for comparing starting performance.

3.5 BATTERY TESTING

The maintenance-free battery has a strong ability to withstand the damaging effects of overcharge. The test indicator in the cover is used only to determine if the battery can be tested in case of a cranking problem.

The test indicator in the battery cover is to be used with accepted diagnostic procedures only. It must not be used to determine if the battery is good or bad, charged or discharged. The test indicator is a built-in hydrometer in one cell that provides visual information for battery testing (Fig. 14).

It is important when observing the test indicator, that the battery be relatively level and has a clean indicator top to see the correct indication. Some lighting may be required in poorly lit areas. Under normal operation, two indications can be observed.

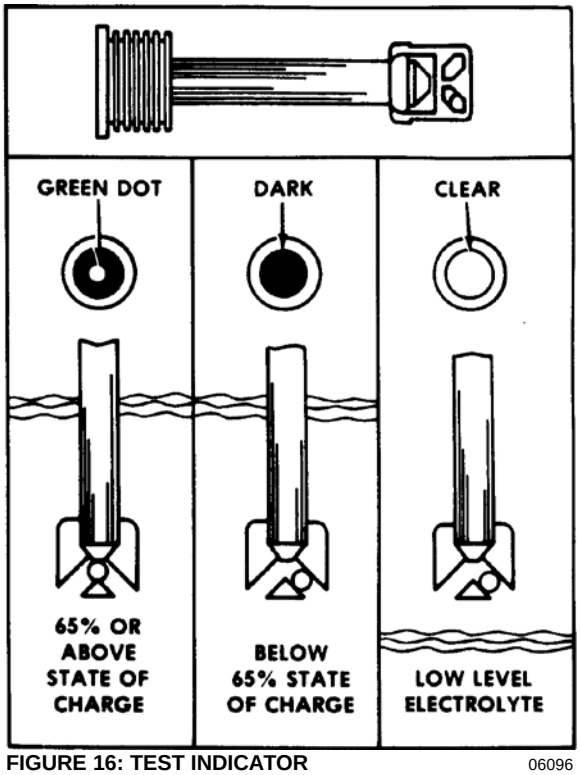


FIGURE 16: TEST INDICATOR 06096

Green Dot Visible

Any green appearance is interpreted as a *"green dot"*, and the battery is ready for testing. On rare occasions, following prolonged cranking, the green dot may still be visible when the battery is obviously discharged. Should this occur, charge the battery as described under *"Charging Procedure"* in *"Battery Charging"* later in this section.

Dark - Green Dot Not Visible

If there is difficulty cranking the engine, the battery should be tested as described in this section. On rare occasions, the test indicator may turn light yellow. In this case, the integral charging system should be checked. Normally, the battery is capable of further service; however, if difficult start has been reported, replace the battery. **DO NOT CHARGE, TEST, OR JUMP-START.**

3.5.1 Visual Inspection

1. Check the outside of the battery for a broken or cracked cover or case that could permit loss of electrolyte. If obvious physical damage is noted, replace the battery.
2. Check for loose terminal posts, cable connections, damaged cables, and for evidence of corrosion. Correct conditions as required before proceeding with tests.

3.5.2 Removing Surface Charge

Disconnect cables from the battery and attach alligator clamps to the contact lead pad on the battery as shown in figure 16. Connect a 300 ampere load across the terminal for 15 seconds to remove surface charge from the battery.

3.5.3 Load Test

This test is one means of checking the battery to determine its ability to function as required in the vehicle.
To make this test, use test equipment that will withstand a heavy electrical load from the battery, such as a carbon pile resistor or other suitable means.

1. Connect a voltmeter, ammeter, and a variable load resistance as illustrated in figure 15.

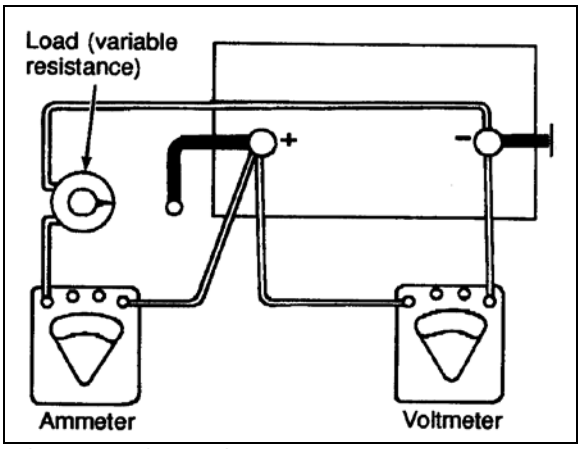


FIGURE 17: LOAD TEST 06064

CAUTION

Observe polarity of the meters and the battery when making connections, and select the correct meter range.

2. Apply a 290 amperes load to the battery for 15 seconds.
3. With an ammeter reading specified load, read voltage. The voltage should be at least 9.6 volts. Disconnect the load. If the voltmeter indicates 9.6 volts or more, the battery is good. If the voltmeter reading is less than 9.6 volts, replace the battery. This voltage is to be used for battery ambient temperatures of 70ºF (21ºC) and above. For temperatures below 70ºF (21ºC), refer to the following *"Voltage and Temperature Chart"*.

Voltage and Temperature Chart

Ambient Temperature	Minimum Voltage
70ºF (21ºC) and above	9.6
60ºF (16ºC)	9.5
50ºF (10ºC)	9.4
40ºF (4ºC)	9.3
30ºF (-1ºC)	9.1
20ºF (-7ºC)	8.9
10ºF (-12ºC)	8.7
0ºF (-18ºC)	8.5

NOTE

The accuracy of this test procedure is dependent upon close adherence to the proper load, time and temperature specifications.

3.5.4 Testing Battery Cables

Check all cable ring terminals and connections to determine if they are in good condition. Excessive resistance, generally caused by poor connections, produces an abnormal voltage drop which may lower voltage at the starter to such a low value that normal operation of the starter will not be obtained. An abnormal voltage drop can be detected with a low-reading voltmeter as follows:

DANGER

To prevent the engine from starting during these tests, remove fuses F78 and F79 located in the VECR of the rear electrical compartment. Once the tests are completed, reinstall F78 and F79.

1. Check voltage drop between grounded (negative) battery terminal and vehicle frame by placing one prod of the voltmeter on the battery terminal and the other on a good ground (unpainted surface) on the vehicle. With the starter cranking the engine at a temperature of 70ºF (21ºC), voltage reading should be less than 0.3 volt. If the voltage reading exceeds 0.3 volt, there is excessive resistance in this circuit.
2. Check voltage drop between the positive battery terminal and the starter positive terminal stud while the motor is operated. If the reading is more than 2.5 volts, there is excessive resistance in this circuit.

NOTE

If it is necessary to extend the voltmeter lead for this test, use a #16 (AWG) or larger wire.

3. Check voltage drop between the starter housing and a good ground on the vehicle. The reading should be less than 0.2 volt.

DANGER

Any procedure other than the following could cause personal injury or damages to the charging system resulting from battery explosion or electrical burns.

Wear adequate eye protection when working on or near the batteries. Ensure that metal tools or jumper cables do not contact the positive battery terminal (or a metal surface in contact with it) as a short circuit will result. Do not attempt to jump start a vehicle suspected of having a frozen battery because the battery may rupture or explode. Both the booster and discharged batteries must be treated carefully when using jumper cables. Follow exactly the

procedure outlined later in this section, being careful not to cause sparks.

3.6 BATTERY CHARGING

The batteries used on this vehicle can be charged either on or off the vehicle; however, when they are removed from the vehicle, it is recommended that an adapter kit, which is available from any "A/C DELCO" dealer, be used in charging sealed-terminal batteries. Use the booster block to charge the batteries when they are left on vehicle and **make sure that the main battery disconnect switch is set to the *"On"* position.**

DANGER

During charging of the batteries, an explosive gas mixture forms in each cell. Part of this gas escapes through the vent holes and may form an explosive atmosphere around the battery itself if ventilation is poor. This explosive gas may remain in or around the battery for several hours after it has been charged. Sparks or flames can ignite this gas causing an internal explosion, which may shatter the battery.

1. Do not smoke near a battery which is being charged or which has been recently charged.
2. Do not break live circuits at battery terminals because a spark usually occurs at the point where a live circuit is broken. Care must always be taken when connecting or disconnecting booster leads or cable clamps on chargers. Poor connections are a common cause of electric arcs, which cause explosions.
3. The electrical system on this vehicle is negative ground. Installing the batteries with the positive terminals grounded or incorrect use of the booster battery and jumper cables will result in serious damage to the alternator, batteries and battery cables.

The alligator clamps of the tester or charger must be placed between the terminal nuts and the lead pads of the terminal studs (Fig. 16) after the vehicle cables are detached. The alligator clamps should make firm contact with the lead pads.

NOTE

If this connection cannot be made because of the alligator clamp design, the load value for testing must be reduced from 290 to 260 amperes.

On rare occasions, such as those that occur following prolonged cranking, the green dot in the test indicator may still be visible when the battery is obviously discharged. Should this occur, a boost charge of 20 amperes-hour is recommended. Under normal operating conditions, do not charge battery if the green dot is visible. The battery should never be charged if the test indicator (hydrometer) is clear or light yellow. If this occurs, replace the battery.

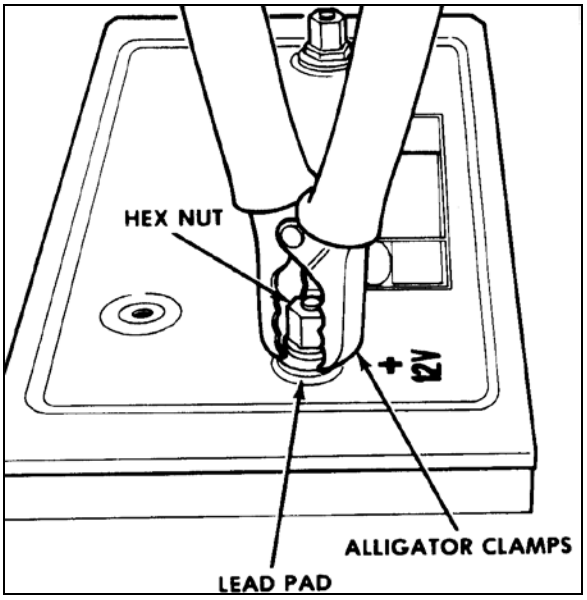


FIGURE 18: ALLIGATOR CLAMPS AND BATTERY 06065

A charge rate between 3 and 50 amperes is generally satisfactory for any maintenance-free battery as long as spewing of electrolyte does not occur or the battery does not feel excessively hot (over 125ºF (52ºC)). If spewing or violent gassing of electrolyte occurs or battery temperature exceeds 125ºF (52ºC), the charging rate must be reduced or temporarily stopped to allow cooling and to avoid damaging the battery. Battery temperature can be estimated by touching or feeling the battery case. The battery is sufficiently charged when the green dot in the built-in hydrometer is visible. No further charging is required. Shake or tilt the battery at hourly intervals during charging to mix the electrolyte and see if the green dot appears.

WARNING

Always turn off the charger before connecting or disconnecting to a battery.

NOTE

The charge rate must be doubled when the batteries are charged by the booster block, because of the series-parallel circuit.

Battery charging consists of a charge current in amperes for a period of time in hours. Thus, a 25 ampere charging rate for 2 hours would be a 50 ampere-hour charge to the battery. Most batteries, whose load test values are greater than 200 amperes, will have the green dot visible after at least a 75 ampere-hour charge. In the event that the green dot does not appear, replace the battery.

3.6.1 Battery Charging Guide

Fast Charging Rate

20 amps @ 3-¾ hours
30 amps @ 2-½ hours
40 amps @ 2 hours
50 amps @ 1-½ hours

Slow Charging Rate

5 amps @ 15 hours
10 amps @ 7-½ hours
The time required for a charge will vary according to the following factors:

Size of Battery

For example, a completely discharged large heavy-duty battery requires more than twice the recharging time of a completely discharged small passenger car battery.

Temperature

For example, a longer time will be needed to charge any battery at 0°F (-18°C) than at 80°F (27°C). When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first, and then in time, the battery will accept a higher rate as it warms.

State of Charge

For example, a completely discharged battery requires more than twice as much charge than a half-charged battery. Since the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will likewise increase.

Charger Capacity

For example, a charger which can supply only 5 amperes will require a much longer period of charging than a charger that can supply 30 amperes or more.

3.6.2 Emergency Jump Starting With Auxiliary (Booster) Battery.

DANGER

Off-board battery charger with a start boost facility must not be used to jump start the vehicle. This could damage the electrical system. Do not jump start vehicles equipped with maintenance-free batteries if the test indicator is light yellow.

Booster Block

On X3-45 coaches, booster block is located near the batteries in the engine compartment on the R.H. side and is accessible through engine R.H. side door (Fig. 17).

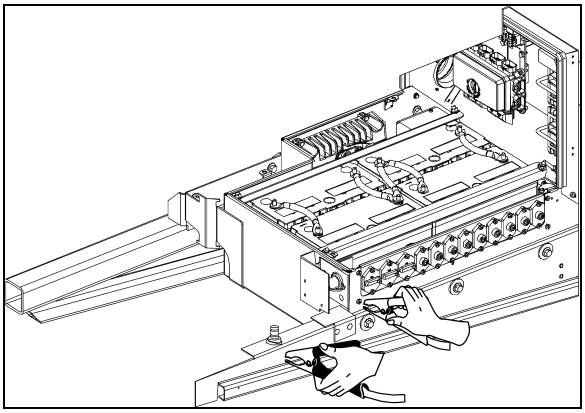


FIGURE 19: BOOSTER BLOCK

Both booster and discharged batteries should be treated carefully when using jumper cables. A vehicle with a discharged battery may be started by using energy from a booster battery or the battery from another vehicle.

DANGER

Jump starting may be dangerous and should be attempted only if the following conditions are met:

The booster battery or the battery in the other vehicle must be of the same voltage as the battery in the vehicle being started, and must be negative grounded.

If the booster battery is a sealed-type battery without filler openings or caps, its test indicator must be dark or a green dot must be visible. Do not attempt jump starting if the test

indicator of the booster battery or the discharged battery has a light or bright center.

DANGER

Follow the procedure exactly as outlined hereafter. Avoid making sparks.

Wear eye protection and remove rings, watches with metal bands and other metal jewelry.

Apply parking brake and place the transmission shift lever or push-button pads in Neutral (N) position in both vehicles. Turn off lights, heater and other electrical loads. Observe the charge indicator. If the indicator in the discharged battery is illuminated, replace the battery. **Do not** attempt jump starting when indicator is illuminated. If the test indicator is dark and has a green dot in the center, failure to start is not due to a discharged battery and the cranking system should be checked. If charge indicator is dark but the green dot does not appear in center, proceed as follows:

1. Connect one end of one red jumper cable to the positive (+) terminal of the booster power source and the other end to the positive (+) post of the booster power block, located on the R.H. side of the engine compartment (refer to fig. 17).
2. Connect one end of the remaining negative jumper cable (black) to the negative (-) terminal of the booster power source, and the other end of the black jumper cable to the negative (-) post of the booster power block.
3. Make sure the clips from one cable do not inadvertently touch the clips on the other cable. Do not lean over the battery when making connections. The ground connection must provide good electrical conductivity and current carrying capacity.
4. Start the engine in the vehicle that is providing the jump start. Let the engine run for a few minutes, then start the engine in the vehicle that has the discharged batteries.
5. When removing the jumper cables, perform the above procedure exactly in reverse order, and replace protective caps on booster block terminals.

DANGER

Any procedure other than the above could result in personal injury, property damage due to battery explosion, or damage to the charging system of the booster vehicle or of the boosted vehicle.

NOTE

Jumper cables must withstand 500 cranking amperes. If cable length is 20 feet (6m) or less, use 2/0 (AWG) gauge wires. If cable length is between 20-30 feet (6-9m), use 3/0 (AWG) wires.

3.7 CLEANING AND INSPECTION

The external condition of the battery and the battery cables should be checked periodically. The top of the battery should be kept clean and the battery hold-down clamp bolts should be kept properly tightened. For best results when cleaning the battery, wash first with a diluted solution of ammonia or soda to neutralize any acid present then wash out with clean water. The battery hold-down bolts should be kept tight enough to prevent the batteries from moving, but they should not be tightened to the point that excessive strain is placed on the battery hold-down cover (proper tightening torque: 45-55 lbf-in (5-6 Nm).

To insure good contact, the battery cable ring terminals should be tight on the battery posts. If the posts or cable ring terminals are corroded, the cables should be disconnected and the posts and clamps cleaned separately with a soda solution and a wire brush. Install cable ring terminals on battery posts and tighten to a torque of 10-15 lbf-ft (13-20 Nm). Replace protective caps to prevent corrosion and sparks.

3.8 COMMON CAUSES OF BATTERY FAILURE

When a battery fails, the cause of failure may be related to something other than the battery. For this reason, when a battery failure occurs, do not be satisfied with merely recharging or replacing the battery. Locate and correct the cause of the failure to prevent recurrence. Some common external causes of battery failure are as follows:

1. A defect in charging system such as high resistance or a faulty alternator or regulator. The dashboard ALTERNATOR telltale light illuminates if one of the alternators is defective.

ALTERNATOR telltale

2. A malfunction within the 12 volts system (equalizer).
3. Overloads caused by a defective starter or excessive use of accessories.
4. Dirt and electrolyte on top of the batteries causing a constant drain.
5. Hardened battery plates, due to battery being in a low state of charge over a long period of time.
6. Shorted cells, loss of active material from plates.
7. Driving conditions or requirements under which the vehicle is driven for short periods of time.
8. A constant drain caused by a shorted circuit such as an exposed wire or water infiltration in junction boxes causing ground fault.
9. Extended operation of preheating system with engine not running.
10. Failing to close disconnect switches during the night.

3.9 TROUBLESHOOTING

If a battery is known to be good and then has not performed satisfactorily in service for no apparent reason, the following factors may reveal the cause of trouble:

1. Vehicle accessories and disconnect switches inadvertently left on overnight.
2. Defects in the charging system, such as high wiring resistance, faulty alternator, regulator or battery equalizer.
3. A vehicle electrical load exceeding the alternator (or battery equalizer) capacity, with the addition of electrical devices, such as CB radio equipment, a cellular phone or additional lighting systems.
4. Defects in the electrical system, such as shorted or pinched wires.
5. Extended driving at a slow speed while using many accessories.
6. Loose or poor battery cable-to-post connections, previous improper charging of a run-down battery, or loose hold-down clamp bolts.
7. High-resistance connections or defects in the cranking system.

3.10 "BATTERY VOLTAGE WARNING" PICTOGRAM

If the "BATTERY VOLTAGE WARNING"  (battery voltage incorrect) pictogram shows up in the DID (Driver Information Display), check the voltmeter gauge to determine if the battery voltage is too high or too low.

3.10.1 Voltage Gauge Definitions

Voltmeter drops below 24.4 volts dc

- o Check alternator output.
- o Check voltage regulator.
- o Check battery connections.
- o Check battery cells.
- o Check battery equalizer connections.

Voltmeter exceeds 30 volts dc

- o Check alternator output.
- o Check voltage regulator.
- o Check battery connections.

Battery Balance

NOTE
Allow at least 15 minutes to balance batteries after any corrective measure has been taken.

1. Batteries out of balance (difference greater than 1.5 volts between the two battery banks).
   - o Check battery equalizer connections.
   - o Check equalizer cables for proper gauge.
   - o Check battery connections.
2. Demand for 12-volt power exceeding rated amperage output of battery equalizers causing batteries to go out of balance.
   - o Reduce 12-volt load or install additional battery equalizer(s).

4. TROUBLESHOOTING AND TESTING THE MULTIPLEX VEHICLES

4.1 ELECTRICAL SYSTEM DIAGNOSTIC

Using the message center display (MCD), check if there are active errors in the vehicle electrical system. With the SYSTEM DIAGNOSTIC menu, highlight FAULT DIAGNOSTIC and then

highlight ELECTRICAL SYSTEM to request a diagnostic of the electrical system from the CECM. Press the enter key. If applicable, the MCD shows the multiplex device ID, the fault messages or fault codes recorded. When more than one fault is recorded, an arrow pointing down appears on the right of the display. Use the down arrow to see all the fault messages.

Once the problem corrected, the MCD still shows the fault as being active. You have to leave the FAULT DIAGNOSTIC menu, wait approximately 20 to 30 seconds and then return to FAULT DIAGNOSTIC to request a new diagnostic of the ELECTRICAL SYSTEM from the CECM. The MCD should display the fault as being inactive. The CECM can store up to 20 faults, i.e. the first 10 and the last 10. Middle faults will be erased. If the breakers are tripped, the fault history will be erased from the CECM memory.

NOTE
It is of the utmost importance to have a MCD (message center display) in working condition because it is the most important tool to achieve troubleshooting on a multiplex vehicle.

4.2 PROBING VOLTAGE ON THE MULTIPLEX CIRCUITS

Some Multiplex modules are supplied by 12 volts while others are supplied by 24 volts. The 12-volt or 24-volt information is found on the modules symbol in the wiring diagram. Before taking voltage readings to track the source of a problem, first verify if the module is supplied by 12V or 24V, if not, residual voltage on the module inputs/outputs can draw an erroneous conclusion.

Inactive Multiplex output = Residual voltage of 18% to 33% of supply voltage.

Inactive Multiplex input = Residual voltage of 50% of supply voltage.

NOTE
o *Verify on the wiring diagram whether the voltage is 12V or 24V,* o *For a 12V module: an active voltage would be 12V or 0V but not in between. If you measure the intermediate tensions (ex. 6V, 2V, or 4V) this must be interpreted as if the input or the output is inactive.*
o *For a 24V module: an active voltage would be 24V or 0V but not in between. If you measure the intermediate tensions (ex. 12V, 4V, or 8V) this must be interpreted as if the input or the output is inactive.*

4.3 CAN NETWORK

The CAN network wiring is separated in sections and uses connectors that are not shared with other circuits. This allows sections of the network to be isolated to help locate short-circuit on the CAN.

In case of a short-circuit on the CAN network, this affects all the modules and they all act as “No response” in the error messages of the “ELECTRICAL SYSTEM” menu. To locate a short-circuit, proceed by disconnecting one module zone at a time while verifying if this makes inactive the errors in the modules still connected. Connector C1 (front electrical & service compartment) disconnects all the modules at the rear of the vehicle from the network. Connector C5 (front electrical & service compartment) disconnects all the modules from the entrance door & wiper control panel. Connector C3 (rear electrical panel) disconnects all the modules at the rear of the vehicle from the network.

Example: Disconnect C5 and C1 and then verify the status of the errors. If the front modules (A41 to A46) now give inactive errors, which means short-circuit is elsewhere than in the front electrical & service compartment.

4.3.1 CAN Connection On The Telltale Panel And The Hvac Control Unit

The telltale panel module and HVAC module are linked to the CECM by a CAN connection. In case of a CAN connection default, the telltale panel LCD display shows "CAN", and on the HVAC control unit, the temperature display indicates "---". To confirm a CAN connection default, check that the fan speed on the driver's section HVAC control unit cannot be adjusted.

Moreover, specific error messages from these 2 modules can be read in the ELECTRICAL SYSTEM menu.

NOTE
While downloading a new vehicle program in the CECM from a computer, the CAN network is temporarily interrupted and therefore a CAN reference appears in the telltale panel LCD

display.

4.3.2 Spare CAN

A spare CAN network is installed between the front and the rear of the vehicle. It has connectors installed at each end to facilitate swapping from the regular CAN network to the spare CAN network. Refer to the vehicle wiring diagram and section 4.6 for more information.

4.4 TEST MODE FOR SWITCHES AND SENSORS

The switch/sensor test mode provides useful information to diagnose problems complimentary to the electrical system diagnosis.

To enter this mode, activate the dashboard "Telltale Light Test" switch 3 times within 4 seconds. To exit the switch/sensor test mode, reactivate the test switch 1 time or turn OFF the ignition.

4.4.1 Information Available And Impact On The Functions In Switch/Sensor Test Mode

Telltale panel audible alarm emits a *beep* each time an OFF/ON transition is detected on a multiplex input. This allows quick verifying if the switches and sensors are detected or seen by the multiplex modules. When the vehicle is parked, the back-up alarm also emits a sound that allows verification of the sensors at the rear of the vehicle.

Certain inputs are doubled (ex. turn signal switch on multi-function lever, door operating buttons) and also other inputs activate at the same time (ex. kneeling switch and Kneeling proximity sensor switch). For these inputs, 2 *beeps* are emitted. If only one *beep* is heard, one of the inputs is defective.

SWITCHES AND SENSORS SUPPORTED BY THE SWITCH/SENSOR TEST MODE
HVAC control unit driver's section ON/OFF
A/C door ajar open sensor
HVAC control unit driver recirculate switch
HVAC overhead compartment fan switch
HVAC control unit passenger's section ON/OFF
Engine ether start switch
Radiator fan clutch switch
Engine front start enable switch
Engine rear start enable switch
Engine ignition front switch
Engine ignition rear switch
Entrance door inside closing switch
Entrance door outside opening /closing switch
Entrance door electric window down switch
Entrance door electric window up switch
Electric horn button
Kneeling down switch
Kneeling up switch
Lavatory emergency switch
Interior lighting switch, 2 positions
Driver's area lighting switch
Reading lights switch
Multi-function lever LH turn signal
Multi-function lever RH turn signal
Fog lights switch
Hazard warning flashers switch
Multi-function lever courtesy blinkers switch
Headlights switch, 2 positions
Multi-function lever headlights beam toggle switch
Baggage compartment door lock/unlock switch
Tag axle signal
Wheelchair lift activation switch
Windshield lower wiper
Multi-function lever windshield wipers intermit.
Multi-function lever windshield wipers speed 1,2
Windshield wipers backup switch
Windshield washer switch

The following inputs, either certain options or sensors which are difficult to activate, are not supported by the switch/sensor test:

- Low-Buoy switch,
- Starter Sensor,
- ABS Warning input,
- WCL switch,
- Driver's Power Window Switch (up & down),
- Fog Lights Switch,
- Alternator Sensors 1 & 2,
- Retarder Active Signal,
- Radiator fan speed 1 & 2 signals.

When in switch/sensor test mode, the A/C compressor HI and LO pressure values are displayed one after the other instead of the outside temperature in the telltale panel LCD display. This feature can be used when the vehicle is traveling to check the A/C compressor pressure values, but no *beep* can be heard.

In test mode, with the parking brake applied and the passenger set point set to a value higher than 64°F (18°C), the circulator pump is not set to OFF as it would normally do when the outside temperature gets above 50°F (10°C). This feature allows verification of the pump when inside a garage. This is also useful when working on the heating system to remove air pockets trapped in the system.

When performing an A/C cooling test and having the water pump shut off in switch/sensor test mode is required, just set the passenger set point temperature to the minimum 64°F (18°C) to shut off the pump.

4.5 TEST MODE FOR ELECTRIC MOTORS

The test mode allows testing the motors and electric contactors without the need to have the engine running. Note that while in test mode, the engine cannot be started.

Prerequisite conditions for the motor test mode:

A. The battery charger must be connected to a 110-120 volt power supply. If not, the test will be interrupted when the voltage drops below 24.4 volts,

B. Engine not running,

C. Parking brake applied,

DANGER

Before starting the test sequence, make sure nobody is working in the evaporator or condenser compartment.

NOTE

A delay of 15 seconds during which the back-up alarm will sound is introduced prior the test start to advise people that may be working on the vehicle.

To enter this mode:

- Activate the dashboard Telltale Light Test switch 3 times within 4 seconds;
- Push the ON/OFF button on the driver's side HVAC control unit 5 times (that makes 3 transitions from OFF to ON),
- A *beep* can be heard indicating the motor test mode has started.

Using the test mode:

- During the entire test, the telltale panel audible alarm gives a signal each second to remind that the motor test mode is underway.

4.5.1 Test Sequence

Go to the condenser compartment.

- The condenser fans runs for 3 seconds at speed 1.
- 1 second delay.
- Speed 2 activates for 3 seconds.
- 3 seconds delay.
- Passenger's unit refrigerant solenoid valve activates 3 times at 1 second interval.

Then 5 *beeps* can be heard from the back-up alarm to indicate to go to the engine compartment (15 SECONDS DELAY).

In the engine compartment, the sequence is as follows:

- Toilet fan motor runs for 3 seconds.
- 1 second delay.
- A/C compressor clutch activates 3 times at 1 second interval.
- 1 second delay.
- Left compressor unloader activates 3 times at 1 second interval.
- 1 second delay.
- Right compressor unloader activates 3 times at 1 second interval.

5 *beeps* from the back-up alarm indicate to go to the engine radiator fan (5 SECONDS DELAY).

- Fan clutch is disengaged for 3 seconds (fan can be turned freely by hand).
- Fan clutch engages for 3 seconds in speed 1 (fan can be turned by hand but with a certain resistance).
- 3 seconds delay.
- Fan clutch engages for 3 seconds in speed 2 (cannot be turned but hand).
- 10 seconds delay.
- Auxiliary A/C clutch (parcel rack cooling system) activates 3 times at 1 second interval.

5 *beeps* from the back-up alarm indicate to go to the evaporator compartment (10 SECONDS DELAY).

In the evaporator compartment:

- Evaporator fan motor runs at speed 1 for 3 seconds then runs at speed 2 for 3 seconds.
- Hot water pump starts running for 5 seconds and hot water pneumatic valve activates 3 times at 1 second interval.

5 *beeps* from the back-up alarm indicate to go to the spare wheel compartment (20 SECONDS DELAY).

Inside the compartment:

- Driver's refrigerant solenoid valve activates 3 times at 1 second interval.
- 1 second delay.
- Driver's water solenoid valve activates 3 times at 1 second interval.

5 *beeps* from the back-up alarm indicate to go to inside the vehicle (10 SECONDS DELAY).

Inside the vehicle:

- Upper section defroster fan motor runs for 5 seconds.
- 10 seconds delay.
- Left and right overhead compartment fans start running one after the other for 5 seconds.
- 1 second delay.
- Overhead storage compartment refrigerant solenoid valve activates 3 times at 1 second interval.

This ends the test. Activate the dashboard Telltale Light Test switch one time to leave the motor test mode.

4.6 CAN NETWORK LAYOUT AND TROUBLESHOOTING

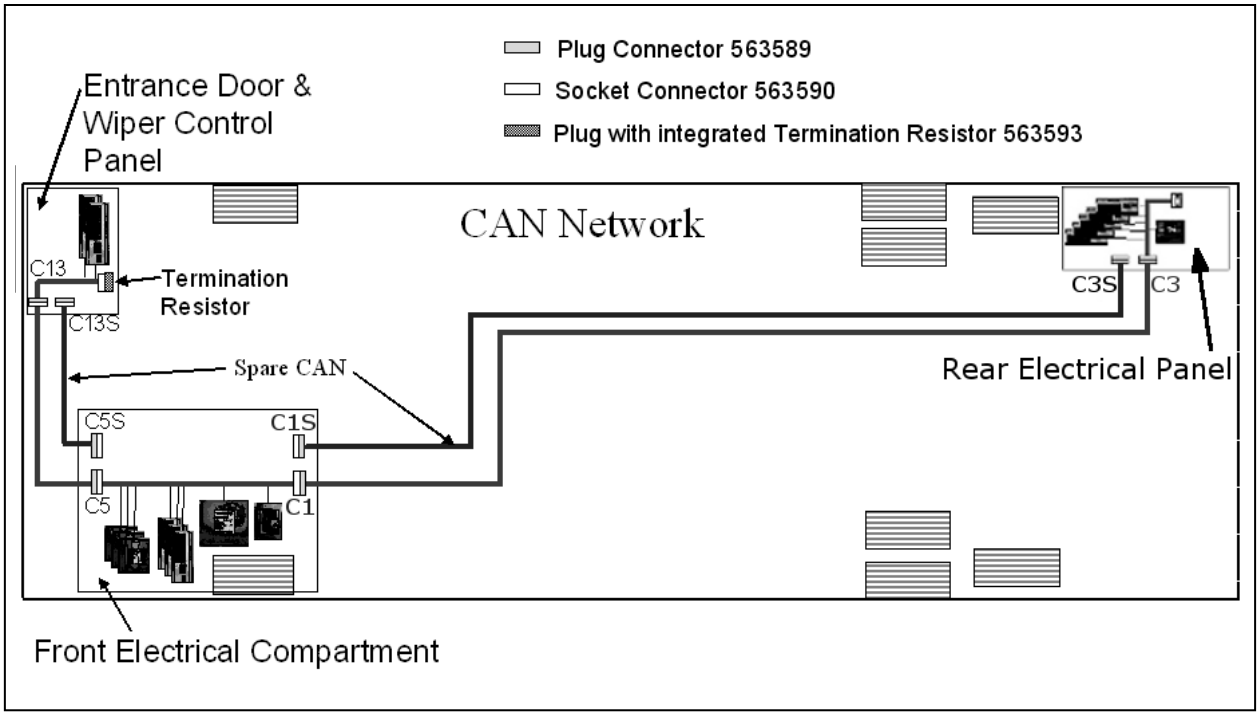


FIGURE 20: X3-45 COACHES CAN NETWORK LAYOUT 06637

4.7 TROUBLESHOOTING

Problem/Symptom	Probable Causes	Actions
Vehicle does not Start	Rear Start selector switch is not in the NORMAL position Master cut-out switch on the rear electrical panel is in the OFF position (down)	1. Check that the rear start selector switch is flipped up to NORMAL start position and master cut-out switch is flipped up to ON and retry cranking 2. Flip the rear start selector switch to "Rear Start" and start the vehicle from the rear
	CAN network problem (Multiplex) Module A53 not powered or is defective Engine ECM does not receive the ignition signal Engine ECM is not powered	If the vehicle does not start from the rear: 1. Verify that module A53 is powered: a) Check the SYSTEM DIAGNOSTIC menu of Driver Information Display (DID). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message "No Response ModA53, Active", indicates a power problem on the module or a CAN network problem. b) Check / reset circuit breaker CB5 c) Check / replace fuse F65 d) Probe gray connector on module to see if it is powered. 2. Verify that the engine ECM is powered and get the ignition signal a) Check / reset circuit breaker CB8 Check / replace fuse F74 b) Check / reset circuit breaker CB2 Check / replace fuse F78
None of the Multiplexed functions are operating, including the basic limp-home functions (door opening, flashers, wipers in speed 1) Three dashes "---" appear in the telltale panel instead of the outside temperature *Note: The sunshades are still functioning since these are not multiplexed*	The program version in the CECM is different than the program in the I/O modules and the CECM is forcing all I/O modules to stay inactive	1. Engage the auto-programming of the I/O modules: Turn the ignition key to the OFF position, flip the master cut-out switch on the rear electrical panel to OFF and ON and then turn the ignition key ON. The letters CAN will appear in the telltale LCD panel for about 3 minutes Everything shall get back to normal once the letters CAN are replaced with outside temperature display 2. Try disconnecting the green connector on the CECM and reconnect 3. If step 1 and 2 are ineffective, try disconnecting the Master ID module completely and repeat step 1 4. Try disconnecting the CECM

Problem/Symptom	Probable Causes	Actions
		completely, leave it disconnected and see if the limp-home functions (start of the vehicle from the engine compartment, wipers speed 1, flashers, etc) are functioning
Many secondary functions (not essential for driving) not functioning (interior lighting, driver's area lighting, wiper speed 2 and intermittent). Outside temperature display in the telltale LCD panel displays three dashes "---" Marker lights and clearance lights are turned ON when setting ignition to the ON position.	The CECM module does not receive 24 V power. The CAN network is not working. It could be caused by a short on the network, an open circuit, a problem with the CECM or the CECM being disconnected from the network.	1. Check / reset circuit breaker CB6 (3rd from the left on the junction panel) Check / replace fuse F1 2. Operate in limp-home mode by starting the vehicle from the engine compartment (REAR START). All functions essential to drive are available To close and lock the door, pull the door manually up to its closed position and it will lock by itself. The door opening button is still functioning
No temperature control in the passenger area Passenger temperature display indicates two dashes "--"	Problem with the temperature sensor located in the evaporator compartment air intake or the sensor wiring	Instruct the driver to manually control the temperature by playing with the passenger set point. Set above 22°C (72°F) to heat and below 22° C (72°F) to cool
Entrance door does not open nor close using the control buttons Defroster fan not functioning Windshield wipers not functioning in speed 1 or intermittent	Module A47 is not powered or is faulty	1. Check the SYSTEM DIAGNOSTIC menu of Driver Information Display (DID). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message “No Response ModA47, Active” indicates a power problem on the module. (A CAN network problem would show the same message but doesn't produce these symptoms). 2. Check / reset circuit breaker CB6 3. Check / replace fuse F5 4. Probe gray connector on module to see if it is powered. 5. Use the air release valves near the entrance door and in the front service compartment to lock / unlock the door
Windshield wipers not functioning in speed 1 or intermittent	No power on R23	Check / replace fuse F82
HVAC condenser fans not functioning in speed 1	Circuit breaker CB7 was manually tripped and not	Check / reset circuit breaker CB7

Problem/Symptom	Probable Causes	Actions
	reset	
HVAC condenser fans not functioning in speed 2	Circuit breaker CB7 was manually tripped and not reset	Check / reset circuit breaker CB7
Windshield washer not functioning Windshield upper section de-icing system not functioning Defroster fan is functioning but no heat or cooling available in the driver area.	Module A46 is not powered or is faulty	1. Check the SYSTEM DIAGNOSTIC menu of Driver Information Display (DID). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message “No Response ModA46, Active” indicates a power problem on the module. (A CAN network problem would show the same message but doesn't produce these symptoms). 2. Check / reset circuit breaker CB1 3. Check / replace fuse F12 or F13 4. Probe gray connector on module to see if it is powered.
Low beam headlights and front flasher on left side not functioning Electric horn not functioning	Module A45 is not powered or is faulty	1. Check the SYSTEM DIAGNOSTIC menu of Driver Information Display (DID). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message “No Response ModA45, Active” indicates a power problem on the module. (A CAN network problem would show the same message but doesn't produce these symptoms). 2. Check / reset circuit breaker CB2 3. Check / replace fuse F33 and F34 4. Probe gray connector on module to see if it is powered.
Low beam headlights and flasher on right side not functioning	Module A48 is not powered or is faulty	1. Check the SYSTEM DIAGNOSTIC menu of Driver Information Display (DID). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message “No Response ModA48, Active” indicates a power problem on the module. (A CAN network problem would show the same message but doesn't produce these symptoms). 2. Check / reset circuit breaker CB2 3. Check / replace fuse F33 and F34 4. Probe gray connector on module to see if it is powered.
Rear flashers not functioning	Module A51 is not powered or is faulty	1. Check the SYSTEM DIAGNOSTIC menu of Driver Information Display

Problem/Symptom	Probable Causes	Actions
Stoplights and center stoplights not functioning		(DID). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message “No Response ModA51, Active” indicates a power problem on the module. (A CAN network problem would show the same message but doesn't produce this symptom). 2. Check / reset circuit breaker CB2 3. Check / replace fuse F80 4. Probe gray connector on module to see if it is powered.
Engine is overheating and radiator fan clutch does not engage The A/C compressor clutch does not engage	Module A52 is not powered or is faulty	1. Check the SYSTEM DIAGNOSTIC menu of Driver Information Display (DID). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message “No Response ModA52, Active” indicates a power problem on the module. (A CAN network problem would show the same message but doesn't produce this symptom). 2. Check / reset circuit breaker CB5 3. Check / replace fuse F65 4. Probe gray connector on module to see if it is powered.
Evaporator fan not functioning	Circuit breaker CB3 tripped Module A54 is not powered or is faulty	1. Check / reset circuit breaker CB3 2. Check the SYSTEM DIAGNOSTIC menu of Driver Information Display (DID). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message “No Response ModA54, Active” indicates a power problem on the module. (A CAN network problem would show the same message but doesn't produce this symptom). 3. Check / reset circuit breaker CB5 4. Check / replace fuse F67 , F68 5. Probe gray connector on module to see if it is powered.
HVAC condenser fans not functioning in speed 1	Module A54 is not powered or is faulty	1. Check the SYSTEM DIAGNOSTIC menu of Driver Information Display (DID). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message “No Response ModA54, Active” indicates a power problem on the module. (A CAN network problem would show the same message but

Problem/Symptom	Probable Causes	Actions
		doesn't produce this symptom). 2. Check / reset circuit breaker CB5 3. Check / replace fuse F67 , F68 4. Probe gray connector on module to see if it is powered.
Sound system not functioning	Circuit breaker CB4 or CB11 was manually tripped and not reset	Check / reset circuit breaker CB4 or CB11
Fire alarm telltale light and audible alarm always ON and there is no fire or high temperature in the engine compartment	Short-circuited fire sensor or defective sensor	Prior to start the vehicle, cycle the ignition key to the ON position, OFF position and then ON position again and then start the vehicle. This will deactivate the fire alarm function. This has to be repeated each time the vehicle is re-started
The vehicle is parked and the electrical horn is activated to indicate a fire in the engine compartment but there is no fire	Short-circuited fire sensor or defective sensor	Cycle the ignition key between the ON and OFF position twice within 3 seconds. This will deactivate the fire alarm function. This has to be repeated each time the vehicle is parked
A single light, a group of LED lights or another function of the vehicle is not functioning	The multiplex outputs are protected in current by an internal “soft-fuse”. When an output is shorted, it turns OFF and stays OFF until the "soft-fuse" is reset	Turn the ignition key to the OFF position and turn to the ON position again. This resets all "soft –fuses"
No backlighting in the instrument cluster	Circuit breaker CB10 is tripped or fuse F20 blown	Check / reset circuit breaker CB10 Check / replace fuse F20
The radiator fan clutch does not function and the engine is overheating		1. Set the ignition key to the ON position. 2. Activate the dashboard Telltale Light Test switch 3 times within 4 seconds. 3. In the engine compartment, set the starter selector switch to REAR START and then start the engine from the rear. While in this mode, the rear start push-button can be used to manually engage the fan clutch. The Multiplex system knows when the engine is already running, and it will not activate the starter. 4. Press the push-button one time to engage the clutch in 1st speed, press a second time to engage in 2nd speed,

Problem/Symptom	Probable Causes	Actions
		press a third time to stop the fan, press once again to return to 1st speed. If the fan clutch does not engage using this procedure then the clutch is faulty or the wiring between the multiplex module and the clutch is faulty. Mechanically lock the fan clutch as described in section 05: COOLING SYSTEM of the maintenance manual.

4.8 ESSENTIAL FUNCTIONS TO OPERATE THE VEHICLE

Even with a defective CECM (Chassis Electronic Control Module) or a CAN network problem, essential base functions are maintained to rear start the vehicle from the engine compartment and drive in a secure manner.

However, many secondary functions are lost. In this case, the following directives must be followed.

- Never connect a battery charger when the ignition is at the ON position on a vehicle with a CAN defective or certain functions will start up by themselves,
- Disconnect the charger before starting the vehicle, if not the default functions will not activate,
- If the default mode does not activate, try to turn the ignition OFF while ensuring that no charger is connected and then restart the vehicle.

4.8.1 Available Functions

- Startup: Turn on the ignition in the driver's area and rear start the vehicle from the engine compartment,
- Opening the door: Functions normally,
- Closing the door: Manually pull on the door and it will lock automatically,
- Windshield wipers: Wipers functions at 1st speed only,
- Headlights: Low beams only,
- Directional signals: Rear and front only,
- Stoplights: 2 upper stoplights + high-mounted stoplight are functional,
- HVAC: Functional with set point fixed at 70°F (22°C), evaporator and condenser fixed at speed 1, defroster fixed at speed 4.

4.9 LOWER PRIORITY MODULES FOR BREAKDOWN SERVICE

Modules A43 (IO-A) and A44 (IO-B) affect lower priority functions. These modules can therefore be used as spare parts for breakdown service while on the road.

Functions lost if A43 is removed and used as spare part:

- High beams,
- Ability to turn on the parking lights only,
- “Watch your step” sign,
- Driver's area lighting,
- Tag axle activation,
- Courtesy lights.

Functions lost if A44 is removed and used as spare part:

- Fresh air damper mix trap control,
- Driver's area and entrance overhead light,
- Front clearance lights.

4.10 MULTIPLEX MODULES

4.10.1 CECM

The CECM plays the role of interface between the engine ECM, the transmission ECU, the telltale panel module and other IO-A, IO-B modules. When a multiplex module is being replaced, the CECM will inform the new module

of its role and function accordingly to the vehicle options.

4.10.2 MASTER ID

The Master ID works in conjunction with the CECM. It keeps the specific back-up program of the vehicle. So, a specific Master ID cannot be removed from a vehicle and installed on another vehicle.

4.10.3 IO-A

IO-A modules receive inputs and control outputs. IO-A's are used for all outputs of 1 amp or less.

4.10.4 IO-B

IO-B modules receive inputs and control outputs. IO-B's are used for outputs up to 30 amps.

4.11 MULTIPLEX MODULES REPLACEMENT

IO-A, IO-B and CECM multiplex modules can be replaced and reprogrammed without having to connect a computer to the vehicle.

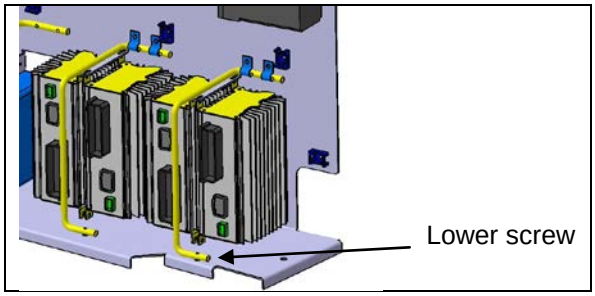


FIGURE 21: IO-B MODULE REMOVAL 06638

4.11.1 Replacing IO-A Or IO-B Modules

- Set the ignition key to the ON position and leave it in that position at all time while performing this procedure.
- On rear electrical junction panel, trip circuit breaker CB6.
- Replace the module (for IO-B modules, disconnect the green connector first, then the grey one and finish with the black connector. To disconnect the black connector, slide downwards the red latch. Remove the lower screw that holds the cable attachment rod onto the floor portion of the panel and flip the rod up, this will relieve the IO-B module, (see Fig. 17).
- Reset circuit breaker CB6. This engages the automatic reprogramming.
- The telltale panel LCD display indicates "CAN" until the reprogramming is complete. Once completed, "CAN" disappears and the temperature reappears.
- Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. Verify the fault message to be certain the module is reprogrammed. If the module is not reprogrammed, the message « Axx Not Responding » appears where Axx is the module number (Ex: A41, A42…etc).

4.11.2 Replacing The CECM Module

- Set the ignition key to the ON position and leave it in that position at all time while performing this procedure.
- On rear electrical junction panel, trip circuit breaker CB6.
- Replace the module.
- Reset circuit breaker CB6. This engages the program transfer from the Master ID to the CECM module (the back-up program is inside the Master ID. The Master ID will identify the CECM as being new and will send the correct program to it). The telltale panel LCD display indicates "CAN" during 3 minutes approximately. "CAN" disappears and "---" is displayed alternately with "CAN" (during that sequence, "---" will be displayed up to 6 times and the audible alarm will ring). Wait until "CAN" is replaced by "---" that remains for more than 10 seconds. At this point the MasterID module has finished loading the program in the CECM.
- Go to the rear electrical junction panel and trip circuit breaker CB6 once again. Wait 1 second and reset it. This engages I/O's modules automatic reprogramming.
- The telltale panel LCD display indicates "CAN" until the reprogramming is completed. Once completed, "CAN" disappears and the temperature reappears. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. Check the error messages. All modules appear in error but are not active. If an active error appears for a module, this one was not reprogrammed. In this case, trip CB6 once again. Wait 1 second and reset CB6. Re-verify the error messages when "CAN" disappears from the telltale panel LCD display.

o Do an error reset to remove all errors (requires Password) from non-active modules, leave the SYSTEM DIAGNOSTIC menu and reopen to verify there are no more errors.

5. BOSCH ALTERNATORS

Two 28 volt 120A, self regulated, belt driven, air-cooled HD 10 BOSCH alternators are used in the 24 volt electrical system.

If the alternators needed to be removed, reinstall as follows. Refer to figure 20 for installation and to figure 21 for tightening specifications:

1. If necessary, tighten screws (6) fixing alternators support assembly onto engine (1, figure 21). Torque tighten to 43 Lb-Ft, use some Loctite 243 blue (680038) onto the threads. Also tighten screw (1) fixing belt tensioner onto alternators support assembly (1, figure 21). Torque tighten to 43 Lb-Ft, use some Loctite 243 blue (680038) onto the threads.
2. If removed, reinstall screw (1) fixing alternators support assembly onto engine (2, figure 21). Torque tighten to 22 Lb-Ft, use some Loctite 243 blue (680038) onto the threads.
3. Mount the A/C compressor idler pulley onto alternators support assembly (3, figure 21). Torque tighten to 150 Lb-Ft, use some Loctite 243 blue (680038) onto the threads.

MAINTENANCE

On-highway applications

Replace Bosch HD10 alternator brushes after every 125,000 miles (200 000 km).

Other than on-highway applications

Check Bosch HD10 alternator brushes condition once a year and replace if necessary.

Brush length when new= 9/16 in (15 mm)

4. Install alternators arched support (1) onto engine (4, figure 21), torque tighten to 43 Lb-Ft. If removed, install alternators idler pulley (1) (4, figure 21) onto alternators arched support, torque tighten to 43 Lb-Ft. Also, mount the lower alternator and upper alternator onto alternators arched support, torque tighten to 43 Lb-Ft. If removed install stone guard below lower alternator.
5. Fix lower and upper alternators to alternators support assembly using bolts (2) (5, figure 21), torque tighten to 80 Lb-Ft.
6. Mount pulleys (6, figure 21) onto alternators. Torque tighten to 58 Lb-Ft.
7. Install alternators belt (figure 20).

NOTE

Final tightening of the pulleys can be performed once the belt is installed. This will help keep the pulley from turning when tightening.

5.1 ALTERNATOR DRIVE BELT

Removal

1. Insert a ¾'' socket drive into the automatic belt tensioner opening (Fig. 20).
2. Twist the tensioning arm to slacken belt.
3. Remove belt.

NOTE

Belts specifications may vary. For proper belt selection, always consult your vehicle Coach Final Record.

Installation

Installation of the alternator drive belt is the reverse of removal.

5.2 ADJUSTMENT

Correct belt tension is required to maximize belt life. The tensioning arm maintains proper belt tension, no adjustment is required.

MAINTENANCE

Check for wear and proper tension every 6,250 miles (10 000 km) or twice a year, whichever comes first.

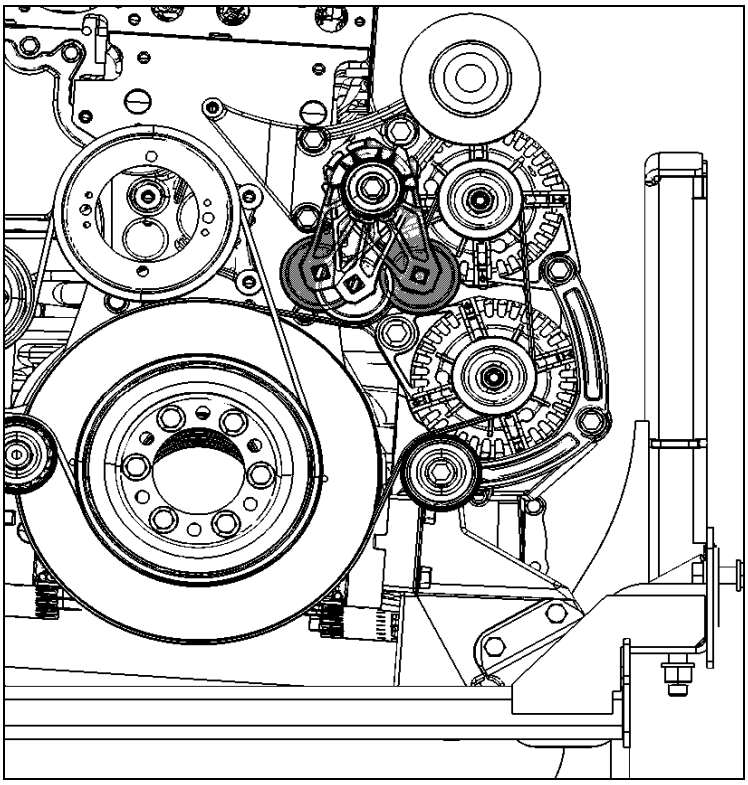


FIGURE 22: ALTERNATOR DRIVE BELT

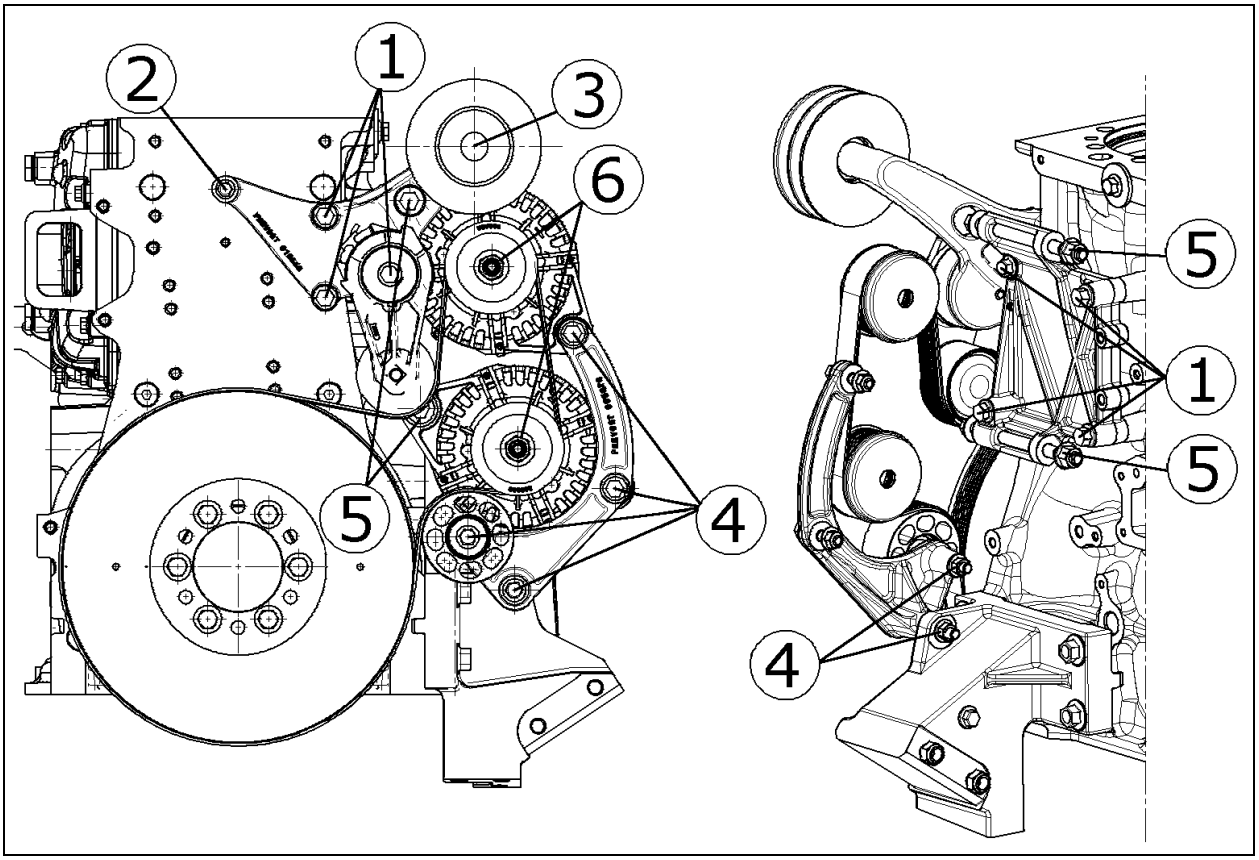
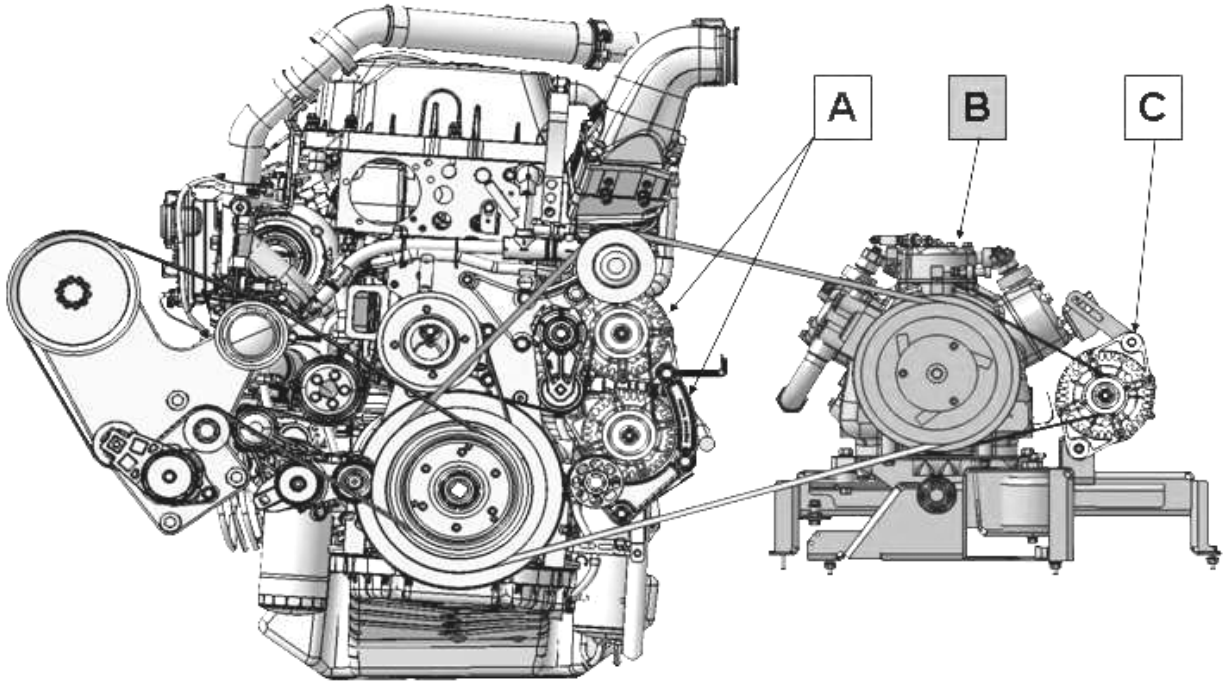
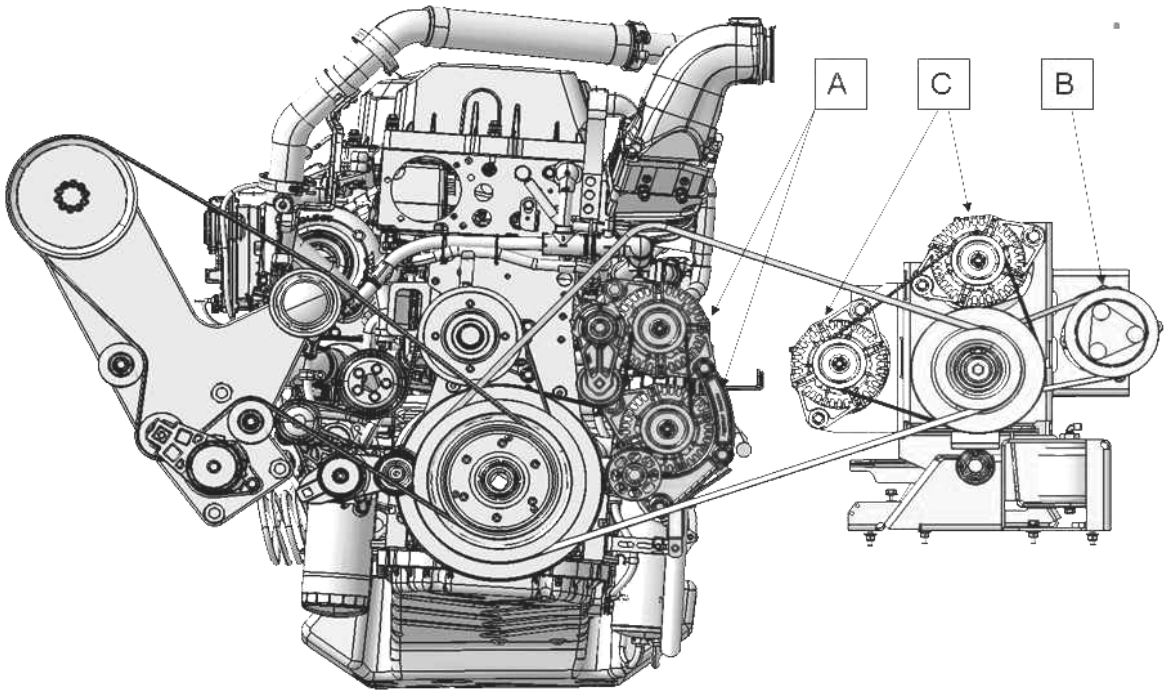


FIGURE23: TWIN BOSCH ALTERNATORS INSTALLATION (X3-45 COACH)

EPA 2010 ALTERNATORS AND COMPRESSORS LAYOUT		
X3-45 COACH		
2 X : HD-10 BOSCH ALTERNATOR 28V – 120 A – PART # 564119		LOCATION A
1 X : CENTRAL A/C SYSTEM CARRIER COMPRESSOR 05G		LOCATION B
(OPTIONAL WITH PARCEL RACK A/C) 1 X : AUXILIARY A/C SYSTEM ICE COMPRESSOR TM-16HD – PART # 950436		LOCATION C
X3-45 VIP & XLII BUS SHELL WITH CENTRAL A/C SYSTEM		
1ST OPTION	2 X : HD-10 BOSCH ALTERNATOR 28V – 120 A – PART # 564119	LOCATION A
	1 X : CENTRAL A/C SYSTEM CARRIER COMPRESSOR 05G	LOCATION B
2ND OPTION	2 X : HD-10 BOSCH ALTERNATOR 28V – 120 A – PART # 564119	LOCATION A
	1 X : CENTRAL A/C SYSTEM CARRIER COMPRESSOR 05G	LOCATION B
	1 X : HD-10 BOSCH ALTERNATOR 28V – 120 A - PART # 564119	LOCATION C
3RD OPTION	2 X : HD-10 BOSCH ALTERNATOR 28V – 120 A – PART # 564119	LOCATION A
	1 X : CENTRAL A/C SYSTEM CARRIER COMPRESSOR 05G	LOCATION B
	1 X : HD 10E BOSCH ALTERNATOR 14V – 200 A – PART # 564492	LOCATION C



X3-45 VIP & XLII BUS SHELL WITH SMALL AUXILIARY A/C SYSTEM		
1ST OPTION	1 X : HD-10 BOSCH ALTERNATOR 28V – 120 A – PART # 564119	LOCATION A
	1 X : SMALL A/C SYSTEM ICE COMPRESSOR TM-16HD – PART # 950436	LOCATION B
2ND OPTION	2 X : HD-10 BOSCH ALTERNATOR 28V – 120 A – PART # 564119 (ONLY TOP ALTERNATOR CONNECTED)	LOCATION A
	1 X : SMALL A/C SYSTEM ICE COMPRESSOR TM-16HD – PART # 950436	LOCATION B
3RD OPTION	2 X : HD-10 BOSCH ALTERNATOR 28V – 120 A – PART # 564119 (ONLY TOP ALTERNATOR CONNECTED)	LOCATION A
	1 X : SMALL A/C SYSTEM ICE COMPRESSOR TM-16HD – PART # 950436	LOCATION B
	1 X : HD 10 BOSCH ALTERNATOR 28V – 120 A - PART # 564119	LOCATION C
4TH OPTION	2 X : HD-10 BOSCH ALTERNATOR 28V – 120 A – PART # 564119 (ONLY TOP ALTERNATOR CONNECTED)	LOCATION A
	1 X : SMALL A/C SYSTEM ICE COMPRESSOR TM-16HD – PART # 950436	LOCATION B
	2 X : HD 10 BOSCH ALTERNATOR 28V – 120 A - PART # 950436	LOCATION C
5TH OPTION	2 X : HD-10 BOSCH ALTERNATOR 28V – 120 A – PART # 564119 (ONLY TOP ALTERNATOR CONNECTED)	LOCATION A
	1 X : SMALL A/C SYSTEM ICE COMPRESSOR TM-16HD – PART # 950436	LOCATION B
	1 X : HD 10E BOSCH ALTERNATOR 14V – 200 A	LOCATION C



6. BATTERY EQUALIZER

Vanner "Vann-Guard 70-Series" Battery equalizer is located beside the batteries in battery compartment. Battery Equalizer Owner's Manual (100 amps) is annexed at the end of this section.

7. STARTER

Refer to Mitsubishi Electric Corporation (MELCO) Service bulletin ME003-P annexed at the end of this section for information and maintenance instruction on MELCO 105P70 starter.

⚠ CAUTION

Do not engage starter for more than 15 seconds at a time. If engine does not start within 15 seconds, release ignition key and let starter cool for one minute before attempting to restart.

8. ENGINE BLOCK HEATER

The vehicle may be equipped with an engine immersion-type electric block heater to assist cold weather starting. The heater male electric plug is easily accessible through the engine compartment R.H. side door (Fig. 22). To use it, connect the female plug of an electrical extension cord to the heater plug. The extension cord must be plugged into a 110-120 V AC power source only. The engine block heater should be used whenever the vehicle is parked for an extended period of time in cold weather and a suitable power source is available.

8.1 MAINTENANCE

This heater is non-serviceable except for the cord, and if faulty, must be replaced as a unit.

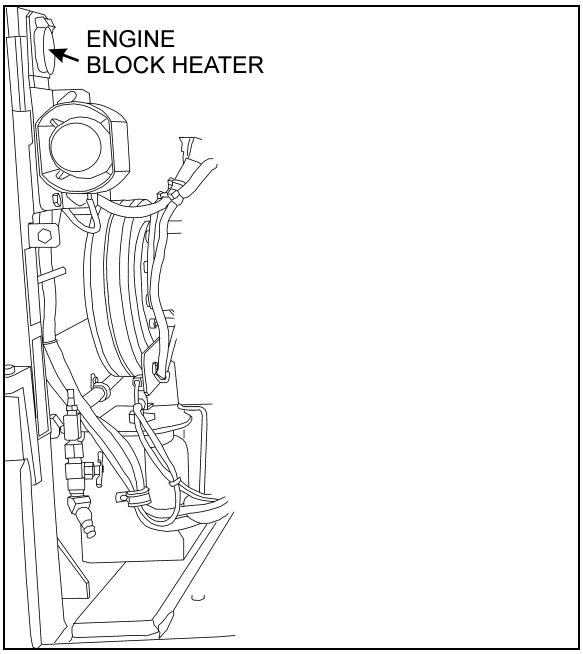


FIGURE 24: ELECTRIC HEATER PLUG LOCATION 06639

9. EXTERIOR LIGHTING

The circuit for exterior lights, as well as their control switches, relays and circuit breakers are shown on the applicable wiring diagrams. Wiring diagrams are located in the technical publication box.

9.1 HEADLIGHTS

Each headlight assembly consists of two headlamp module 90 mm (3½ inch) equipped with a 12-volt halogen bulb and one 100 mm (4 inch) 12-volt LED turn/signal lamp. Outer lamps have a double function (both low and high beam). Inner lamps are used for high beam or daytime running light. The inner or outer lamp uses the same single filament halogen bulb part number.

NOTE

If vehicle is equipped with optional Xenon headlamps, refer to paragraph 9.1.6.

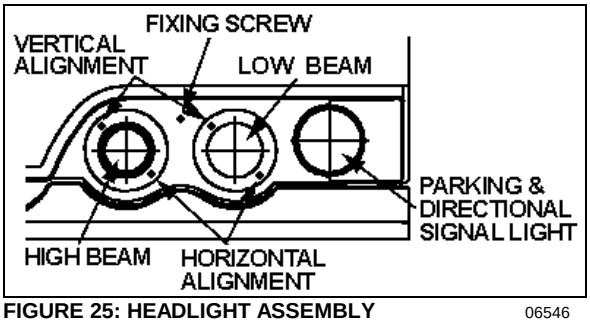


FIGURE 25: HEADLIGHT ASSEMBLY 06546

9.1.1 Headlight Beam Toggle Switch

The multifunction lever located on the steering column is used to select proper lighting. High beams or low beams can be selected by pulling the lever rearward. A high beam indicator on the central dashboard panel is illuminated when the high beam circuit is energized.

NOTE
Pulling the lever rearward while the lights are off will flash the headlights.

9.1.2 Maintenance

Clean headlights with soap and water and a good glass cleaner whenever dirty. For maximum illumination, headlight connections must be coated with a dielectric grease to prevent oxidation and proper voltage must be maintained. Low battery voltage, loose or dirty contacts in wiring system and poor ground contribute to a decrease in voltage. Check wiring and connections regularly and keep battery properly charged. When a headlight burns out, a new bulb must be installed. Headlights must be properly aimed to provide maximum allowable road illumination. When using mechanical aiming devices, follow manufacturer's instructions.

Headlight aim should be checked after installing a new bulb. Aiming can be performed without opening headlight assembly. Horizontal and vertical aiming of each module is provided by two adjusting screws that pivot the module in the housing for proper alignment (fig. 24). There is no adjustment for focus since the module is set for proper focus during manufacturing assembly.

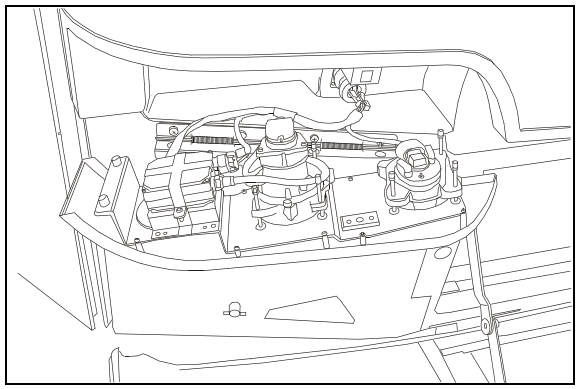


FIGURE 26: OPENING HEADLIGHT ASSEMBLY 06547

NOTE
Make sure headlight assembly is properly positioned into its housing before securing using fixing screw.

CAUTION
Use a soft cloth to clean the parking and front turn signal lamp.

9.1.3 Headlight Adjustment

1. Headlight aiming and inspection can be accomplished by visual means. This is done on a screen located at a distance of 25 feet (7,6 m) of the headlights. It should be of adequate size with a matte-white surface well shaded from extraneous light and properly adjusted to the floor area on which the vehicle stands. Provisions should be made for moving the screen or its vertical centerline so that it can be aligned with the vehicle axis. In addition to the vertical centerline, the screen should be provided with four laterally adjustable vertical tapes and two vertically adjustable horizontal tapes.
2. The four movable vertical tapes should be located on the screen at the left and right limits called for in the specification with reference to centerlines ahead of each headlight assembly.
3. The headlight centerlines shall be spaced either side of the fixed centerline on the screen by ½ the lateral distance between the light source centers of the pertinent headlights. The horizontal tapes should be located on the screen at the upper and lower limits called for in the specification with reference to the height of beam centers and the plane on which the vehicle rests, not the floor on which the screen rests (Fig. 25).

TABLE 1 – VERTICAL BEAM AIM GUIDELINES

Headlight (centerline) Mounting Height	Nominal Vertical Aim	Aim Inspection Limits for Vertical Aim
56 to 90 cm (22 to 36 inch)	0 Vertical	10 cm (4 inch) up to 10 cm (4 inch) down
90 to 120 cm (36 to 48 inch)	5 cm (2 inch) down	5 cm (2 inch) up to 15 cm (6 inch) down
120 to 140 cm (48 to 54 inch)	6.4 cm (4 inch) down	4 cm (1.5 inch) up to 16.5 cm (6.5 inch) down

4. The nominal vertical aim position on lower beam headlights shall be adjusted based on the headlight mounting height, from the

ground to the light source center of the headlight, according to table1.

5. High beam headlights are aimed so that the center of the high-intensity zone is located at the horizontal and straight ahead vertically (Fig. 26).
6. Low beam headlights are aimed so that the top edge (the cutoff) of the high-intensity zone is at the vertical location as per Table 1 and the left edge of the high-intensity zone is at the vertical centerline of the headlight (Fig. 27).
7. The inspection limits for high-beam headlights shall be with the center of the high-intensity zone from 10 cm (4 in) up to 10 cm (4 in) down; and, from 10 cm (4 in) left to 10 cm (4 in) right on a screen at 7.6 m (25 ft) (Fig. 28).

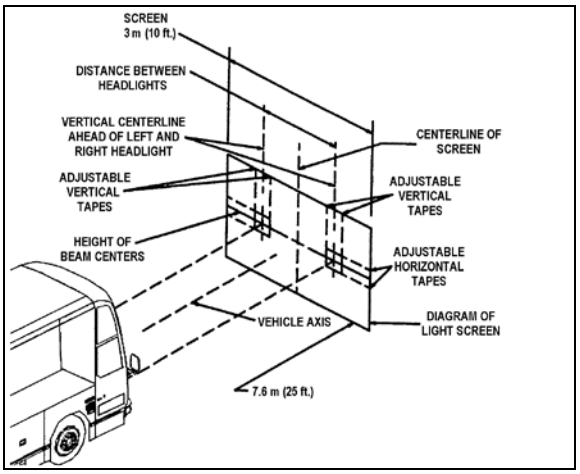


FIGURE 27: ALIGNMENT OF HEADLIGHT AIMING SCREEN 06502

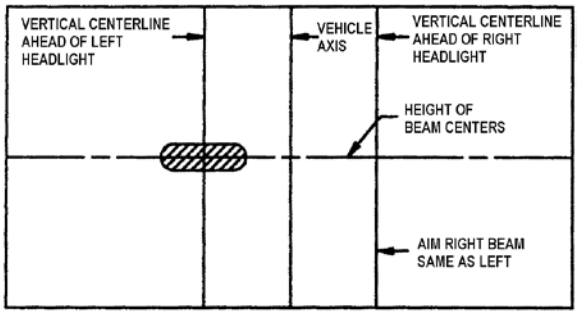


FIGURE 28: HIGH-INTENSITY ZONE (SHADED AREA) OF A PROPERLY AIMED UPPER BEAM ON THE AIMING SCREEN 7.6 M (25FT) IN FRONT OF VEHICLE 06503

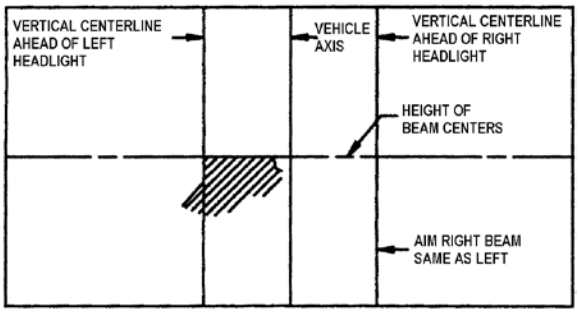


FIGURE 29: HIGH-INTENSITY ZONE (SHADED AREA) OF A PROPERLY AIMED LOWER BEAM ON THE AIMING SCREEN 7.6 M (25FT) IN FRONT OF VEHICLE 06504

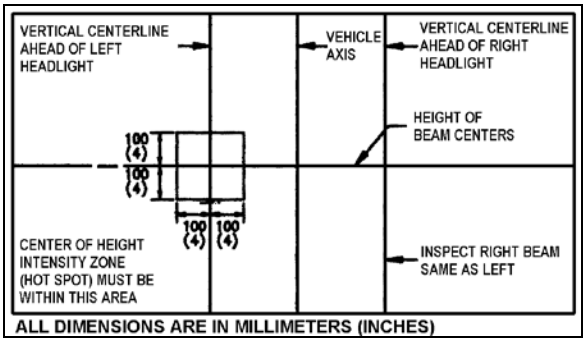


FIGURE 30: AIM INSPECTION LIMITS FOR UPPER-BEAM HEADLIGHTS 06505

7. The inspection limits in the vertical direction for low-beam headlights or the low beam of a dual-beam headlight, shall be as described in Table 1. In the horizontal direction, the left edge of the high-intensity zone shall be located from 10 cm (4 in) left to 10 cm (4 in) right of the vertical centerline of the beam. The viewing screen shall be located 7.6 m (25 ft) in front of the vehicle (Fig. 29).

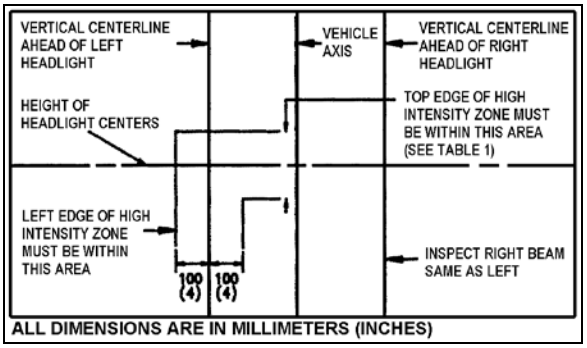


FIGURE 31: AIM INSPECTION LIMITS FOR LOWER-BEAM HEADLIGHTS 06506

9.1.4 Sealed-Beam Unit

Bulb Removal and Replacement

1. Pull the release handle located inside the front service compartment to tilt down the entire bumper assembly.
2. Remove the headlight screw fixing the headlight assembly, then tilt headlight assembly down (Fig. 23 and 24).
3. Remove connector from headlight bulb.
4. Remove the bulb by pushing and rotating it out of the socket.
5. Install the new bulb by reversing the previous procedure.

⚠ CAUTION

During this step, avoid contacting the bulb with the fingers not to alter the bulb life.

NOTE

Do not disrupt headlight adjustment screws.

Module Replacement

1. Pull the release handle located inside the front service compartment to tilt down the entire bumper assembly.
2. Remove the headlight screw fixing the headlight assembly, then tilt headlight assembly down (Fig. 23 and 24).
3. Remove connector from headlight bulb.
4. Unfasten three metal clips attaching headlight unit to support.
5. Install new module and fasten metal clips.
6. Install wiring connector on back of new sealed beam unit.
7. Tilt headlight assembly up into its housing then secure using fixing screw.

NOTE

Make sure headlight assembly is properly positioned into its housing before securing using fixing screw.

8. Perform alignment procedure.

NOTE

The headlight aim must be checked and adjusted even if it was properly adjusted before the sealed beam unit was replaced.

9.1.5 Front Turn Signal

The front turn signal is part of the front headlight assembly. The turn signal is a sealed unit (LED) located on each front corner and should be replaced as an assembly. Turn signal is visible from both front and side.

Removal and Replacement

1. Pull the release handle located inside the front service compartment to tilt down the entire bumper assembly.
2. Remove the headlight screw fixing the headlight assembly, then tilt headlight assembly down (Fig. 23 and 24).
3. Partially unfasten back plate fixing screws, then remove signal lamp.
4. Remove socket from signal lamp.
5. Install wiring connector on back of new signal lamp then install signal lamp.
6. Fasten back plate fixing screws then tilt headlight assembly up into its housing then secure using fixing screw.

NOTE

Make sure headlight assembly is properly positioned into its housing before securing using fixing screw.

9.1.6 Optional Xenon Headlamp

The outer lamps of each headlight assembly may be equipped with the optional Xenon lamps. These lamps improve visibility and provide better lifespan.

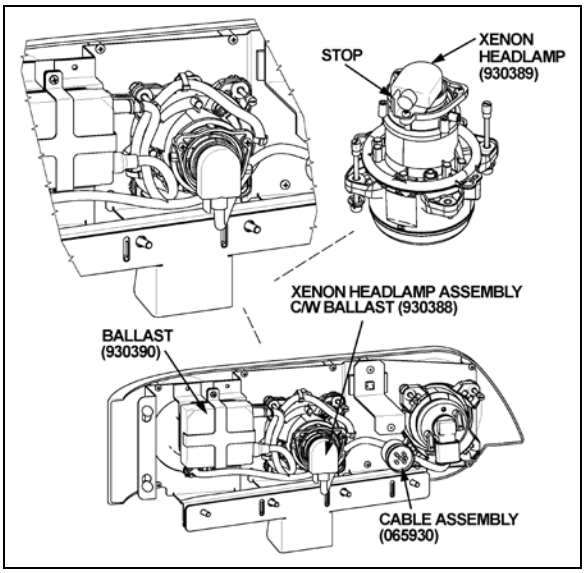


FIGURE 32: XENON HEADLAMP LOCATION 06549

Bulb Removal and Replacement

1. Pull the release handle located inside the front service compartment to tilt down the entire bumper assembly.
2. Remove the headlight screw fixing the headlight assembly, then tilt headlight assembly down (Fig. 23 and 24).
3. Remove main cable connector (066011).
4. Remove connector from headlamp bulb by turning counterclockwise.
5. Unscrew the three Phillips head screws, pull the retainer and bulb out.

⚠ CAUTION

To avoid breaking the bulb, make sure the socket is in proper position against the stop.

6. Install the new bulb by reversing the previous procedure.

⚠ CAUTION

During this step, avoid contacting the bulb with the fingers not to alter the bulb life.

NOTE

Do not disrupt headlight adjustment screws.

⚠ CAUTION

Never connect a voltmeter or V.O.M. to measure bulb voltage as instrument will be destroyed.

Troubleshooting and Safety

When switching on the Xenon headlamp using the rocker switch, a lamp short-circuit test is performed.

Current is detected in the lamp circuit before the ignition time and ignition prevented. Connection of the "hot" lamp to the body mass also prevents ignition. In both cases, the system is cut off within < 0.2 s and can only be restarted via the rocker switch.

In general, the maximum ignition time is < 0.2 s, which period is followed by cutoff. This would happen if a lamp was defected.

Lamp missing: system is cut off after < 0.2 s.

If lamp components or cables are damaged by force (accident) so that contact with hazardous parts is possible, the current in these lines is earthed by the vehicle body and - as with a defective household appliance - switched off when 30 mA are reached within < 0.2 s. the cutoff time is shortened by a more powerful defect current.

To protect the ballast, a counter in the electronic safety system ensures that a defective lamp can only be switched off 7 times consecutively after a successful ignition, after which the device is cut off. This prevents flutter and flashing. This counter is put out of action when the lamp cutoff time repetition interval is longer than 1.3 s so that temporary non-defect disturbances that result in immediate invisible re-ignition do not cause lamp cutoff.

A warning notice on the lamp plug makes you aware of the fact that the lamp is operated in this system on a higher voltage (you should therefore switch off the lamp before working on this part).

After taking out the lamp, the contact pins are in a practically idle state (< 34 Volt) after < 0.5 seconds so that there is no immediate danger of electric shock even if the warning is disregarded.

With this safety concept there is no danger to check the ballast with a new bulb. There is a

very high probability that the ballast is OK if the ballast can ignite the bulb.

One simple test to check the ballast would be to measure the Nominal current of 1.58 A after one minute for the 24V ballast.

9.2 STOP, TAIL, DIRECTIONAL, BACK-UP, AND HAZARD WARNING LIGHTS

A combination stoplight, taillight, directional signal light and back-up light assembly is mounted at the rear, on each side of the vehicle. Furthermore, when braking, two center stoplights (LED) and a cyclops light (LED) will illuminate simultaneously with the stoplights on the sides for increased safety. The L.H. and R.H. side center stop lights are also used as directional signal and marker lights.

The stop, tail, directional signal and back-up lights consist of individual LED lights mounted on the engine rear door, and each light is serviced individually as a complete unit. The back-up light uses a regular tungsten bulb.

The hazard warning flashing system uses the front, side and rear directional lights simultaneously. This system is energized by a switch on the L.H. dashboard.

9.2.1 Lamp Removal and Replacement

1. Open engine compartment rear door.
2. Remove the lamp support retaining screws (2), and then from the outside, remove the lamp and its support.
3. From the outside, install the new lamp with its support then fasten the retaining screws.

9.2.2 Center Stoplights and Cyclops Light Removal and Replacement

These (LED) lights are sealed unit and should be replaced as an assembly in accordance with the following procedure:

1. Unscrew both “Phillips” light screws then remove the light assembly.
2. Install new light assembly and secure using screws.

9.3 LICENSE PLATE LIGHT

Two LED units are mounted above the rear license plate(s) of vehicle. In case of burn out, the LED unit must be changed according to the following procedure.

1. Pry out the rubber seal with a small screwdriver. Pull on the LED unit and disconnect it.
2. Reconnect new LED unit, place rubber seal, and press on it until it is seated in position.

9.4 CLEARANCE, IDENTIFICATION AND MARKER LIGHTS

The vehicle is equipped with marker, identification and clearance lights (LED). The clearance lights are mounted at each corner of the coach near the top and the identification lights are in the upper center of rear and front sections.

The rear clearance and identification lights are red and the front ones are amber.

The amber marker lights are mounted along the sides of vehicle.

The side marker light is a sealed unit (LED) and should be replaced as an assembly in accordance with the following procedure:

1. Unscrew both *“Phillips”* light screws, and then remove the light assembly.
2. Position the new light assembly and install the “Phillips” screws.

9.4.1 Clearance and Identification Light Removal and Replacement

The clearance and identification light are sealed units (LED) and can be replaced in accordance with the following procedure:

1. Unscrew both “Phillips” light screws, and then remove the light assembly.
2. Position the new light assembly, and then install the “Phillips” screws.

9.5 FOG LIGHTS

Optional halogen fog lights can be mounted on this vehicle to give the driver better visibility in foggy weather, or to improve the range of vision just ahead of the coach.

9.5.1 Bulb Removal and Replacement

1. Pull on the release handle located in the front service compartment, near the door lower hinge. The bumper will lower gradually.
2. Unscrew the wing nut and pivot assembly upwards.
3. Unscrew the outer ring. Disconnect the light unit connection and remove the bulb.

4. Install the new bulb, reconnect the light unit and replace in its proper position.

> **CAUTION**
>
> During this step, avoid contacting the bulb with your fingers. This could alter the bulb life.

5. Reinstall the outer ring, pivot the assembly downwards.

Fasten the wing nut and securely close the bumper.

10. INTERIOR LIGHTING EQUIPEMENT

10.1 CONTROL PANEL LIGHTING

The instrument gauges and switches mounted on all control panels are energized whenever the exterior light switch is pushed to the first position. A control dimmer located on the dashboard is used to vary the brightness of the panel gauges, switches and indicator lights.
The gauge lights, panel lights, switch lights and indicator lights have a different bulb arrangement. Thus, the procedure to change a defective bulb can vary according to the application.

10.1.1 Switch Lighting

1. Slightly pull the switch with a defective LED away from the control panel.
2. Disconnect the electric cable from the switch.
3. To install a new switch, reverse the procedure (Fig. 31).

> *NOTE*
>
> *Switches are lighted by the use of LED. When lighting on a switch fails, replace defective switch as a unit.*

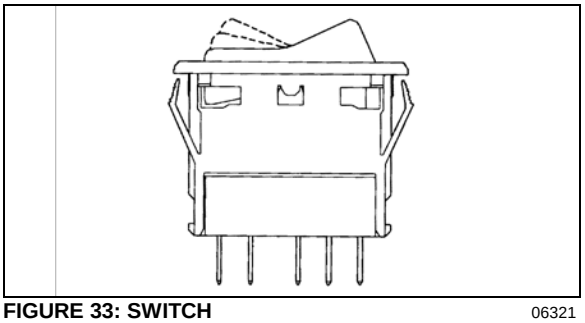


FIGURE 33: SWITCH 06321

10.1.2 Telltale Light Replacement

Telltale module is non-serviceable and must be replaced as a unit.

1. Unscrew and remove the top dashboard panel.
2. Remove the telltale back wire electric connectors.
3. Unscrew and remove the telltale module.
4. To replace the telltale module, reverse the procedure.

10.1.3 Gauge Light Bulb Replacement

1. For any gauge light bulb replacement, the dashboard panel must be removed in order to have access to the rear of gauges.
2. Remove bulb socket from the gauge, turn the defective bulb counterclockwise and pull it out of the gauge.
3. Push a new bulb and socket ASM and turn clockwise to lock in place.
4. Replace the rear dashboard housing.

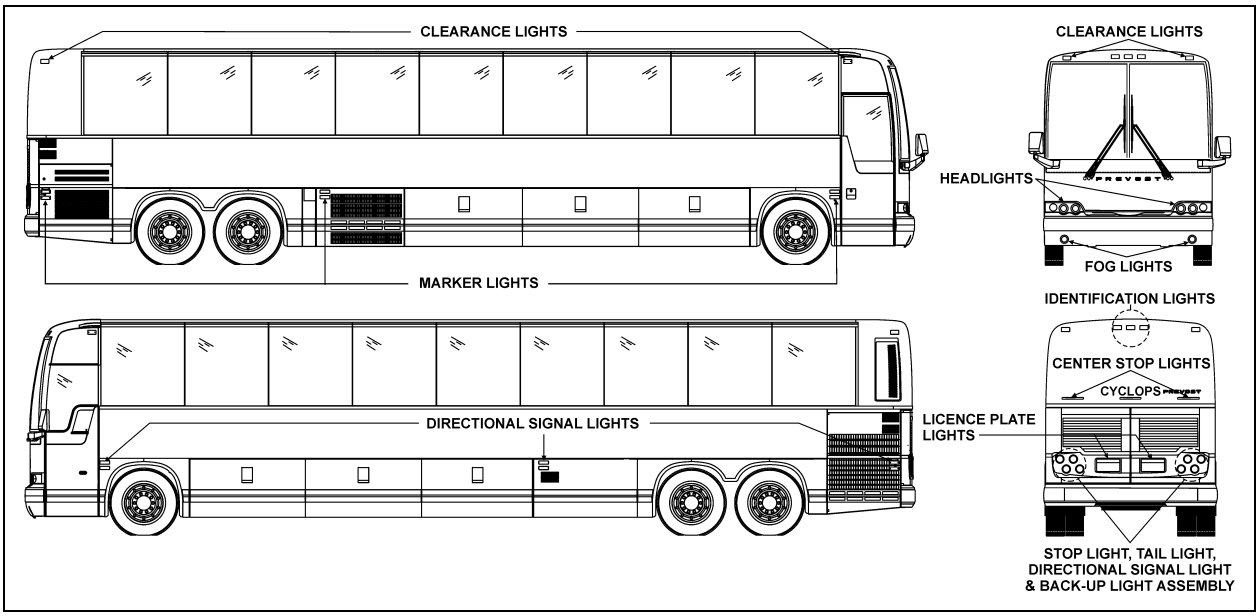


FIGURE 34: VARIOUS LIGHTS LOCATION 06640

10.2 STEPWELL LIGHTS

Two Stepwell lights are illuminated when the door opening system is activated.

10.2.1 Bulb Removal and Replacement

Proceed as follows to replace a defective bulb:

1. Unscrew the two Phillips-head screws retaining the lens to the wall, and remove it.
2. With the light lens removed, pull bulb from the lamp while applying lateral pressure.
3. Install the new bulb into the lamp.
4. Position the light lens and install it.

10.3 LAVATORY NIGHT-LIGHT

The lavatory night-light is illuminated as soon as the ignition switch is set to the *"ON"* position.

10.3.1 Bulb Removal and Replacement

1. Unscrew the two Phillips-head screws retaining the lens to the wall, and remove it.
2. With the light lens removed, pull bulb from the lamp while applying lateral pressure.
3. Install the new bulb into the lamp.
4. Position the light lens and install it.

10.4 DRIVER'S AREA LIGHTS

Two halogen ceiling lights are installed over the stepwell and the driver's area. These lights are frequently used for night-time operation when passengers board or leave coach.

10.4.1 Bulb Removal and Replacement

1. Unsnap the lamp with a flat head screwdriver and remove it.
2. Pull the defective bulb out of the socket.
3. Install the new bulb by pushing it in position.
4. Replace the lamp by snapping it back in place.

⚠ CAUTION

Do not touch halogen bulbs with bare hands as natural oils on skin will shorten bulb life span.

10.5 PASSENGER SECTION LIGHTING

The passenger section of coach is lit by two types of fluorescent tube lamps installed on the parcel racks. The aisle or indirect lights are located on front of parcel racks, and provide soft, indirect cabin lighting and parcel rack interior lighting. More powerful lighting for general and in-station applications is provided by fluorescent tubes located under the parcel racks, close to the windows. A dual power system is available for this lighting either from the 24 volt vehicle

power supply or from a 110 volt outlet supply. In order to save batteries during extended periods of in-station lighting, no current is drawn from the batteries as soon as the 110 volt circuit is connected.

Moreover, adjustable reading lamps are installed under the parcel racks for passenger accommodation.

10.5.1 Fluorescent Tube Replacement

Indirect Fluorescent Light

1. Open the parcel rack access door, if so equipped, unscrew the two Phillips screws (one each end). Let the hinged cover down.
2. Remove fluorescent tube from light socket.
3. Install a new fluorescent tube.
4. Lift the hinged cover and replace the two retaining screws (Fig. 33).

Parcel Rack Interior Lighting

1. Open the parcel rack access door, if so equipped, unscrew the two Phillips screws (one each end). Pull the hinged cover down.
2. Push on the bulb, turn and then, pull it from the socket.
3. Install a new bulb.
4. Lift the hinged cover and replace the two retaining screws.

10.5.2 Removal and Replacement of In-Station Fluorescent Tubes

1. Start by pulling out the corner of the lens then delicately peeling it out of its seat.

CAUTION

The lens is fragile. Be very careful when removing and handling.

2. Rotate and pull the fluorescent tube from its sockets.
3. Install a new fluorescent tube, rotating the tube to secure it in the sockets.
4. Replace the screen lens by first inserting one side in the seat, then push the other side in and snap it in place by running it in from one corner to the next.

10.5.3 Removal and Replacement of Reading Lamp Bulb

1. Engage the tool (#830164) over the lamp and turn one quarter turn counterclockwise. Then, remove the tool slowly.
2. Pull the bulb socket off the reading lamp unit.
3. Push and turn bulb counterclockwise, then pull it out of the socket.
4. Install new bulb in the socket, then push and turn clockwise to lock bulb in position.
5. Push the bulb socket in the reading lamp unit.
6. Position the reading lamp with the tool (#830164), turn one quarter turn clockwise.

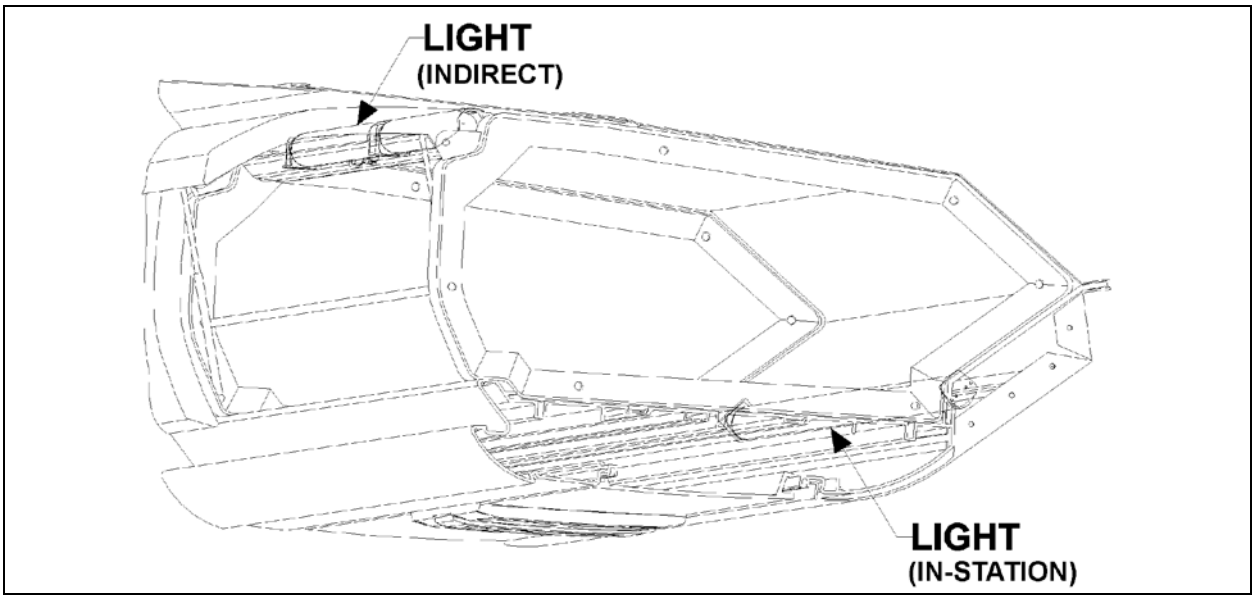


FIGURE 35: PARCEL RACK LIGHTING 06419

10.6 ENGINE COMPARTMENT LIGHTING

Two 24-volts LED module illuminate the engine compartment when the following conditions are met:

1. The engine compartment rear door or curbside door is open.
2. Ignition switch in ON or ACC position.
3. Engine compartment lighting switch on rear engine start panel in ON position.

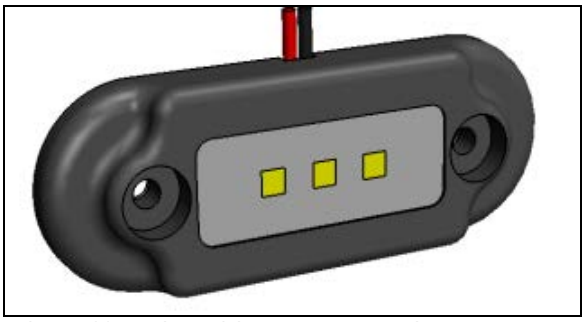


FIGURE 36: ENGINE COMPARTMENT LIGHT

Each light is sealed and can be replaced as follows:

4. Disconnect the light unit connection.
5. Remove the lamp.
6. Position new lamp.
7. Connect the light unit.
8. Make sure the retaining ring is installed properly.

10.7 LAVATORY LIGHT

The halogen lavatory light is installed on ceiling. A microswitch, mounted in the door exterior frame, is activated by the door lock mechanism upon locking to energize the circuit. This switch is readily serviced by removing the two Phillips-head screws securing the mounting plate to the door exterior frame.

Bulb removal and replacement:

1. Unsnap the lamp with a flat head screwdriver and remove it.
2. Pull the defective bulb out of the socket.
3. Install the new bulb by pushing it into position.
4. Replace the lamp by snapping it back in place.

⚠ CAUTION

Do not touch halogen bulbs with bare hands as natural oils on skin will shorten bulb life span.

11. LIGHT BULB DATA

When replacing a light bulb, special attention must be paid to the voltage rating (refer to light bulb data hereafter).

LIGHT BULB DATA					
APPLICATION	**PREVOST PART NO.**	**TRADE OR SAE NUMBER**	**WATTS OR CANDLE POWER**	**VOLTS**	**QTY**
EXTERIOR LIGHTING					
Hi/Lo-beam	930291	9004	65/45 W	12	2
Lo-Beam Xenon (optional)	930388	D2S	35 W	12	2
Docking & cornering	930319	9415	37.5W	12	4
Fog	930361	H3	55 W	12	2
License plate (sealed)	930266	TL 15206	---	12	2
Marker Light (red)	930340	Grote 47072-3	---	12	2
Marker Light (amber)	930341	Grote 47073	---	12	10
Identification (red)	930334	TL 25420R	---	12	3
Clearance (red)	930334	TL 25420R	---	12	4
Identification (amber)	930337	TL 25450Y	---	12	3
Clearance (amber)	930337	TL 25450Y	---	12	4
Front directional (hazard & marker)	562135	3057	32/3W	12	2
Rear directional	560589	1156	32 W	12	4
Stop	560589	1156	32 W	12	8
Back-up	560589	1156	32 W	12	4
Center stop	930330	HELLA 96208	---	12	2
Cyclops	930330	HELLA 96208	---	12	1
Tail	560123	67	4 W	12	4
Exterior compartment (except engine)	562278	6429	10 W	24	12
Engine compartment	930383	SEALED	25 W	12	2

LIGHT BULB DATA					
APPLICATION	**PREVOST PART NO.**	**TRADE OR SAE NUMBER**	**WATTS OR CANDLE POWER**	**VOLTS**	**QTY**
INTERIOR LIGHTING					
Instrument cluster lights	562838	2721 MFX	---	12	---
Telltale panel assy.	563333	---	---	---	1
Step light	562278	6429	10 W	24	2
Lavatory	830176	Q20MR16	20 W	12	1

LIGHT BULB DATA					
APPLICATION	**PREVOST PART NO.**	**TRADE OR SAE NUMBER**	**WATTS OR CANDLE POWER**	**VOLTS**	**QTY**
Parcel rack	560144	1820	1.6 W	12	A R
Driver's area	830176	Q20MR16	20 W	12	2
"EMERGENCY EXIT" decal	560601	456	2 W	24	A R
"LAVATORY OCCUPIED"	563108	168	3 W	12	1
"WATCH YOUR STEP"	561166	1820	1.6 cp	24	2
Aisle	560141	1251	3 W	24	A R
Reading	563349	303	6 W	24	A R
Fluorescent (In-Station)	830153	F32T8/SP41	32 W	---	A R
Destination sign fluorescent	830120	F30T8CW4	30 W	---	1
Fluorescent (Indirect)	830152	F13T5/CW	13 W	---	A R
Baggage Compartment	562411	#6424	5 W	24VDC	AR

12. SPECIFICATIONS

Battery

Make..... Volvo
Model..... 20359831
Type ..... Maintenance-free
Terminal type.....Top Stud
Group size 31
Volts 12
Load test amperage 290
Reserve capacity (minutes)..... 195

Cold cranking (in amps)
-At 0°F (-18°C)..... 950 (each battery)

Maximum dimensions (inches/mm)
-Length (including flange)..... 13.0/330,2
-Width..... 6.7/169,3
-Height (including top posts)..... 9.3/237,0
-Approximate weight (lbs/kg)..... 59/26,7

* *Battery tester cable clamps should be between terminal nuts and lead pads of terminals. If not possible, load value should be 210 amperes.*

Torque specifications

Battery cable to post.....10-15 Ft-lbs (13-20 Nm)

Alternator

Make..... BOSCH
Series ..... HD 10
Amperes..... 120
Volts 28.4
Output Power ..... 3 Kw
Ground .....negative
Prevost Number 564119

Battery equalizer

Make.....Vanner
Model..... Vann-Guard 70-Series
Amperes..... 100 amps

Starter

Make..... Mitsubishi Electric Corporation (MELCO)
Model Number..... M009T82479
Type 105P70
Voltage 24
Prevost Number 510752

No-load test
-Volts 23.5
-Max. current draw ..... 125 amperes
-Min. rpm .....3000 rpm

Starter solenoid

Make..... Mitsubishi Electric Corporation (MELCO)
Model Number..... 1115557
Pull In Voltage .....16 volts max.

Mitsubishi Electric Corporation (MELCO)

Service Bulletin ME003-P

STARTER MOTORS (105P70)

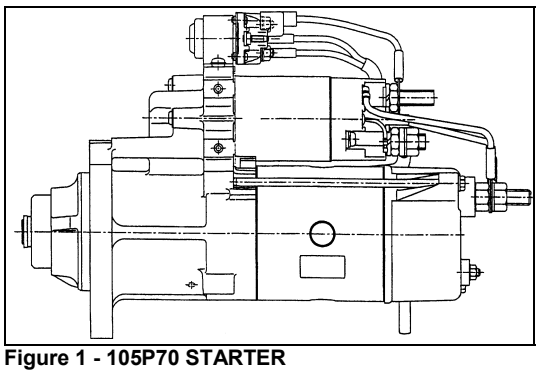


Figure 1 - 105P70 STARTER

A starter is one of the parts installed to the flywheel housing. MELCO's 105P70 starter uses the planetary gear reduction system, actualizing a compact and high-power starter. This starter weighs approximately 30 pounds (13.5 kg), extremely lightweight, and excels in handling.

In addition, this starter uses an overhung mechanism in the output shaft supporting structure designated to protect the inner starter parts from dust or water/oil splash.

1. Principle of operation

* When handling the starting system, be sure to refer to the wiring diagrams issued by the vehicle manufacturer to insure an understanding of the whole starting circuit.

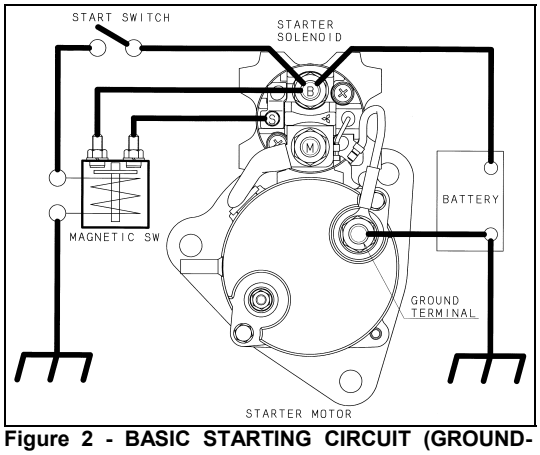


Figure 2 - BASIC STARTING CIRCUIT (GROUND-FLOAT TYPE)

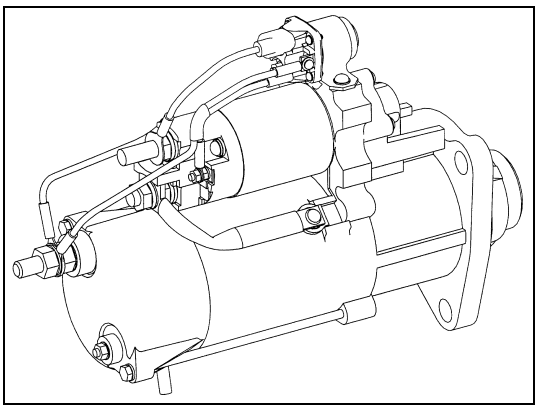


Figure 2 shows the circuit diagram for the 105P70 Ground-float type (sometimes referred to as Insulated or Isolated Ground).

The circuit diagram contains a start switch, a magnetic switch, and a starter solenoid.

When the start switch is closed, the current flows through the magnetic switch windings. The magnetic switch contacts are closed, enabling the current to flow through the windings in the starter solenoid. The clutch is thrust forward with the movement of the plunger and the lever (shown in figures 3), the pinion starts to rotate slowly by the above-mentioned current to engage with the ring gear. When the secure engagement is made, the main contacts in the starter solenoid are closed, and cranking takes place.

When the engine does not start during the initial cranking attempt, the start switch must be turned off within 30 seconds to protect the starter from excessive heat. If the starter motor is operated continuously for 30 seconds, it is necessary to allow the starter motor to be cooled off for at least 2 minutes before the next operation.

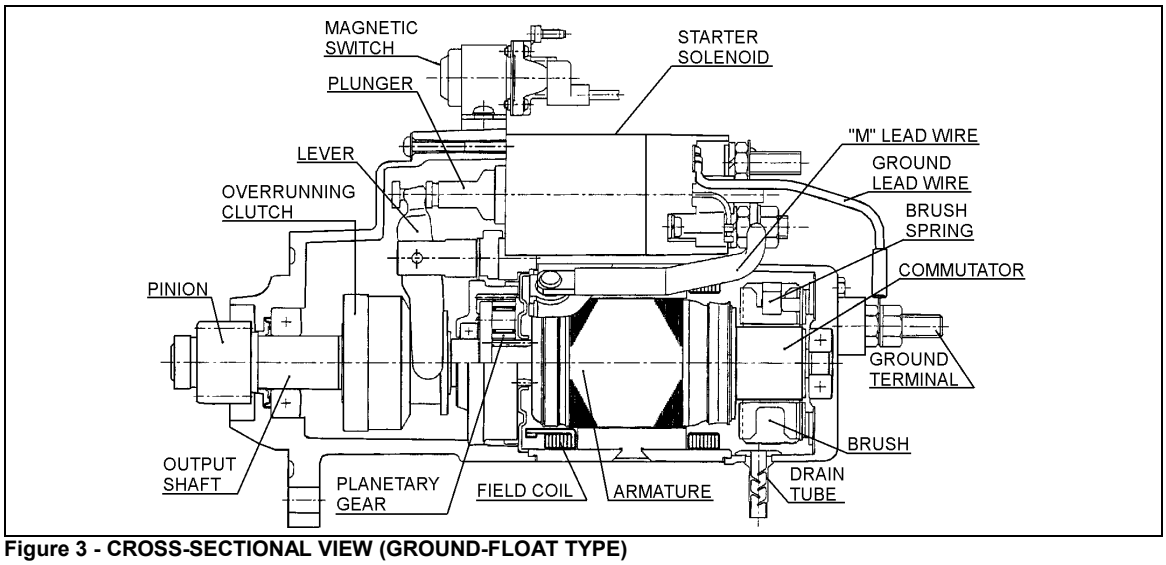


Figure 3 - CROSS-SECTIONAL VIEW (GROUND-FLOAT TYPE)

When the engine starts, the clutch prevents excessive overrun of the armature. Because the clutch is for a short-time rating, the start switch must be turned off immediately after the engine starts.

2. Troubleshooting the starting circuit

If the starting system is not functioning correctly, the following checks will assist in determining which part of the circuit is at fault.

2.1 Battery

To determine the condition of the battery, follow the testing procedure specified by the vehicle manufacturer. Ensure that the battery is fully charged. (If the battery is faulty, the other starting systems cannot be checked.)

2.2 Wiring

Inspect the wiring relating to the starting system for damage. Inspect all connections to the battery, start switch, magnetic switch, and starter solenoid for contact failure due to looseness or rust.

2.3 Magnetic switch (Directly attached to the starter)

Inspect the magnetic switch for its function with the start switch closed (i.e. key switch in the start position) by measuring the voltage between the S-terminal in the starter solenoid and the ground. The switch should not be closed for more than 3 seconds. If this time is exceeded, the starter solenoid may be damaged.

2.4 Ring gear and pinion

If the battery, wiring, and magnetic switch are in satisfactory condition, it is assumed that a "stuck" condition may be found (this condition is the phenomenon caused when the pinion is caught by the ring gear, thereby resulting in neither pinion rotation nor thrust movement). This only occurs in very rare cases when the ring gear and pinion teeth are damaged on their end faces. Therefore, remove the starter and check the end faces on the ring gear and pinion for damage (burr). If necessary, replace the ring gear and starter.

2.5 Starter

2.5.1 Pinion movement and starter solenoid operation test

As described in figure 4, inspect that the pinion advances forward (no rotation will occur) when a voltage of 16 to 24 V is applied to between the S-terminal in the starter solenoid and the ground. Inspection must be done within 3 seconds for voltage application. If the pinion does not advance forward, replace the starter. The P-coil in the starter solenoid may be layer-shorted, or the pinion sliding area may be clogged.

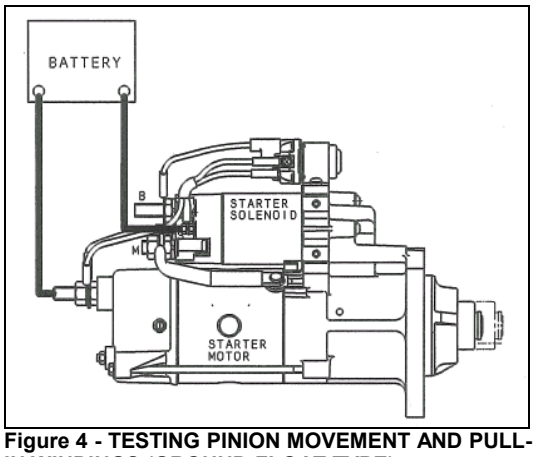


Figure 4 - TESTING PINION MOVEMENT AND PULL-IN WINDINGS (GROUND-FLOAT TYPE)

For the starter switch coils, refer to the switch circuit diagrams for the ground-wire type (ground-float type) shown in figures 5.

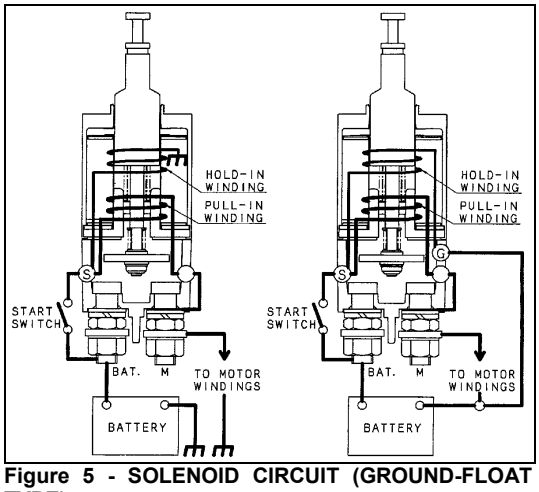


Figure 5 - SOLENOID CIRCUIT (GROUND-FLOAT TYPE)

If the pinion is performing properly, follow the procedure as described below to inspect the H-coil in the starter solenoid.
Remove the M-terminal nut as described in figure 6 and keep the lead wire end in contact with the M-terminal. Apply voltage between the S-terminal and the ground to let the pinion advance forward. Immediately after that, separate the lead wire from the M-terminal and check if the pinion stays in the advanced forward position while voltage is applied to the H-coil only. If the pinion returns, replace the starter. The H-coil is assumed to be layer-shorted.

* M-terminal nut tightening torque: 20 to 30 N·m

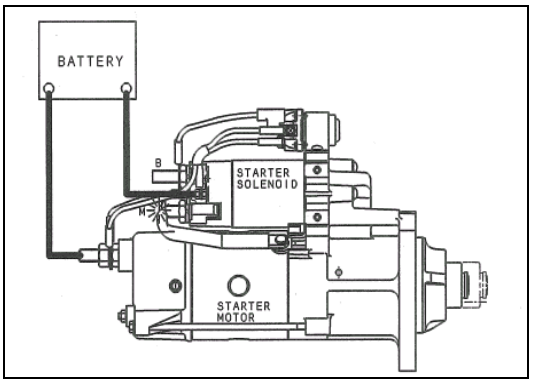


Figure 6 - TESTING HOLD-IN WINDINGS (GROUND-FLOAT TYPE)

Below are the resistance values for the P- and H-coils for reference.

Coil	Resistance (reference)
P-coil	0.072ohm at 68° F
H-coil	1.300 ohm at 68° F

2.5.2 No-load test

The no-load test makes it easy to inspect the starter for functional failure without disassembling. This test can also identify an open/short circuit that is difficult to check when disassembled.

As shown in figure 7, connect the starter, fully charged battery, ammeter, and voltmeter. If possible, connect a resistor suitable for voltage control in parallel with the battery. In addition, use an rpm indicator to measure the revolution speed of the output shaft.

Note: *Attention should be given to the output shaft which advances forward to approximately 0.8" (20 mm) and rotates at that position when the starter is operated.*

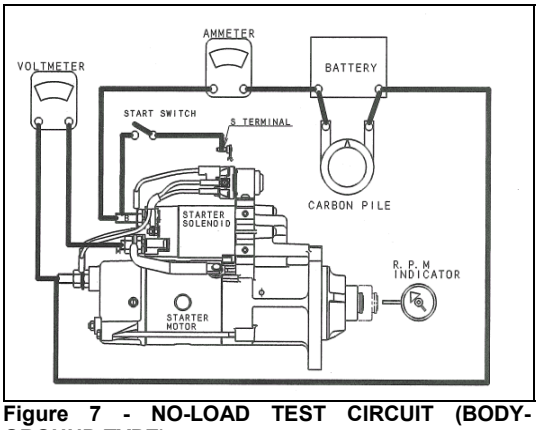


Figure 7 - NO-LOAD TEST CIRCUIT (BODY-GROUND TYPE)

* If the output shaft does not move, stop voltage application. If voltage continues to be applied, excessive heat will occur in the starter solenoid and give thermal damage to the coil, thereby making it unserviceable.

Inspect that the current and revolution speed satisfy the following standards when the start switch is closed.

Voltage	Current	Speed
23.5 V	125 A max.	3000 rpm min.

It is not necessary to adjust the voltage to the exact value of 23.5 V. If the voltage is slightly higher, the rpm will be proportionately higher, while if the voltage is lower, the rpm will be proportionately lower. The current is independent of the voltage, and can be judged using the above standard.

* Note that the starter solenoid will not operate unless the voltage between the S-terminal and the ground exceeds 16 V.

Test result and possible cause

1. Rated current draw and revolution speed indicate normal condition of the starter.
2. Low revolution speed and high current draw indicate:
   a. Too much friction inside starter motor such as clogging, dirt, wearing, faulty bearings
   b. Shorted circuit inside starter
3. No revolution of the output shaft indicates:
   a. Grounded M-lead wire or field coils
   b. Frozen bearings
4. No current draw indicates:
   a. Open field coils
   b. Open armature coils
   c. Broken brush springs, worn brushes, or high insulation resistance between brushes and commutator
5. Extremely low revolution speed and low current draw indicate:

   Poor connection between M-terminal and lead wire, or between bracket and brush holder screws (body-ground type only), damaged M-lead wire, damaged brush pig tails, or poor contact between commutator and brushes
6. High revolution speed and high current draw indicate:

   Shorted field coils

* In case of symptoms 2 to 6, replace the starter, because of the possible failures mentioned above.

2.5.3 Output shaft play

Before reinstalling the starter to the engine, follow the procedure below to inspect the output shaft clearance.

1. Remove the M-terminal nut and keep the lead wire end in contact with the M-terminal.
2. Apply voltage to between the S-terminal and the ground to let the pinion advance forward. Immediately after that, separate the lead wire from the M-terminal. The pinion stays in the advanced forward position until the battery is disconnected.
3. As described in figure 8, measure the distance between the shaft pressed-in and pulled-out positions. The play should be within 0.004" to 0.118" (0.1 to 3.0 mm). If the measured value does not satisfy the standard, replace the starter.

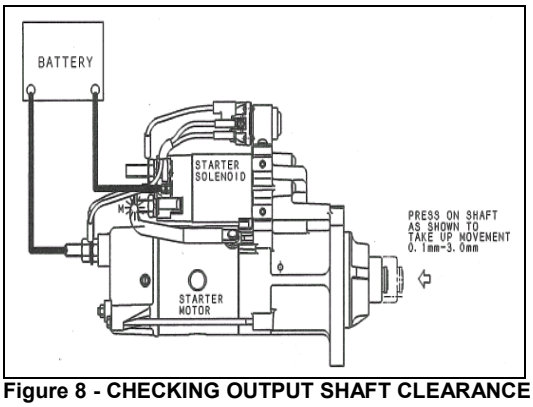


Figure 8 - CHECKING OUTPUT SHAFT CLEARANCE (GROUND-FLOAT TYPE)

VANN-Guard 70-Series

Battery Equalizer

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Theory of Operation…… 4

Typical Applications…… 5

Installation Instructions…… 7

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Introduction

Thank you for purchasing a Vanner *VANN-Guard Battery Equalizer*. We are confident that you will be very pleased with its performance because our 70-Series are designed and manufactured by skilled professionals using the highest standards in workmanship. With minimum maintenance and care, you can be assured of many years of trouble free service.

General Description

The Vanner *VANN-Guard Battery Equalizer* is an efficient and highly reliable method of obtaining a 12 volt DC power source from a 24 volt DC electrical system. The VANN-Guard makes the batteries look like they are in series and parallel at the same time. In addition to providing regulated 12 volt power, the system ensures that battery voltages remain equal which significantly extends battery life. Ideally suited for vehicle and alternate energy applications, the *VANN-Guard* is designed to save your batteries and the money you would spend replacing them. Users of the Vanner *VANN-Guard* know that it is the most cost effective and dependable solution for dual voltage systems.

A typical system would include a 24VDC power source, such as an alternator or solar array, two 12 volt battery banks in series, and the *VANN-Guard*. The *VANN-Guard* connects to the 24 volt, 12 volt and ground terminals of the battery system. When the 12 volt loads require power, the *VANN-Guard* ensures that the current is taken equally from both batteries, and that the voltages of the two batteries are kept equal. This equalization ensures extended battery life and provides a stable 12 volt supply for operating accessories.

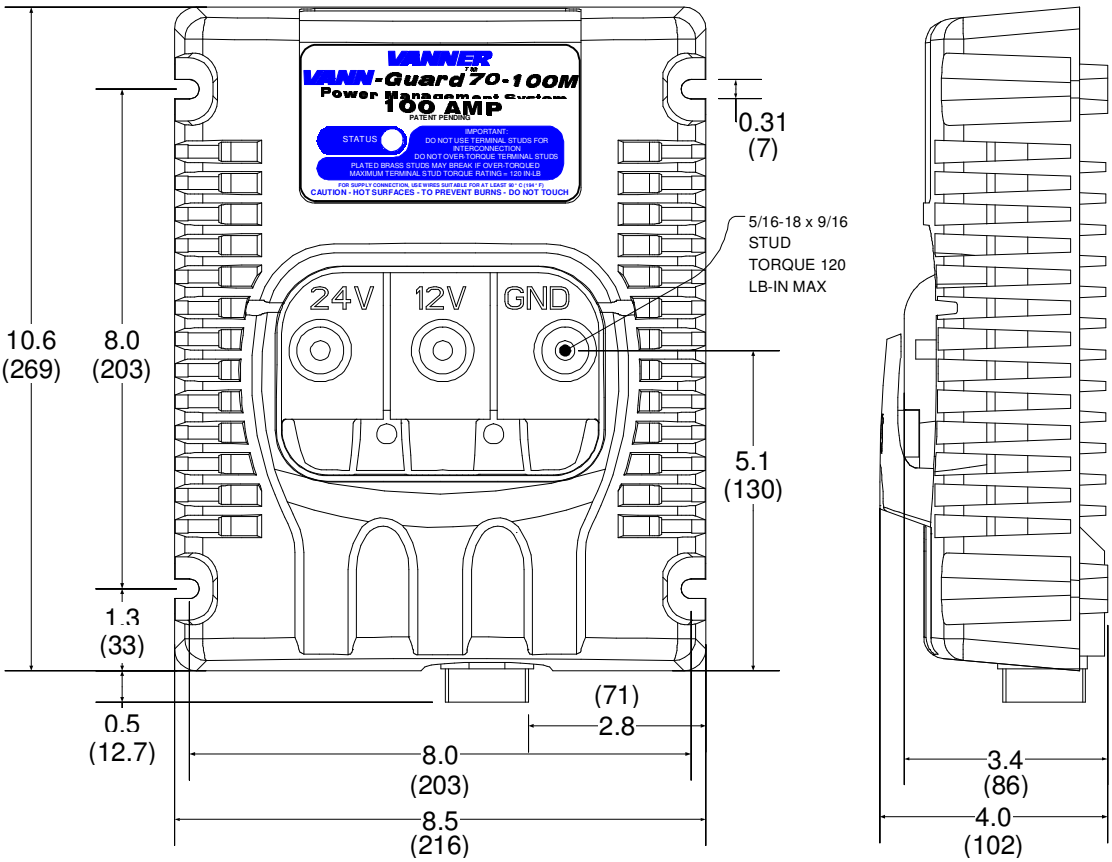
Paralleling VANN-Guard: Models are available which provide 60, 80 and 100 amps of 12 volt DC power. *VANN-Guard Battery Equalizers* may also be operated in parallel to provide more power. For example, two 60 amp units can be installed to provide 120 amps of 12 volt DC power.

NOTE: The Vanner *VANN-Guard Battery Equalizer* is an extremely reliable device and, when installed according to the instructions, will provide reliable operation for an indefinite period of time. However, if a system abnormality should develop that would cause a *VANN-Guard* malfunction, damage to the battery system could result if 12 volt loads are present.

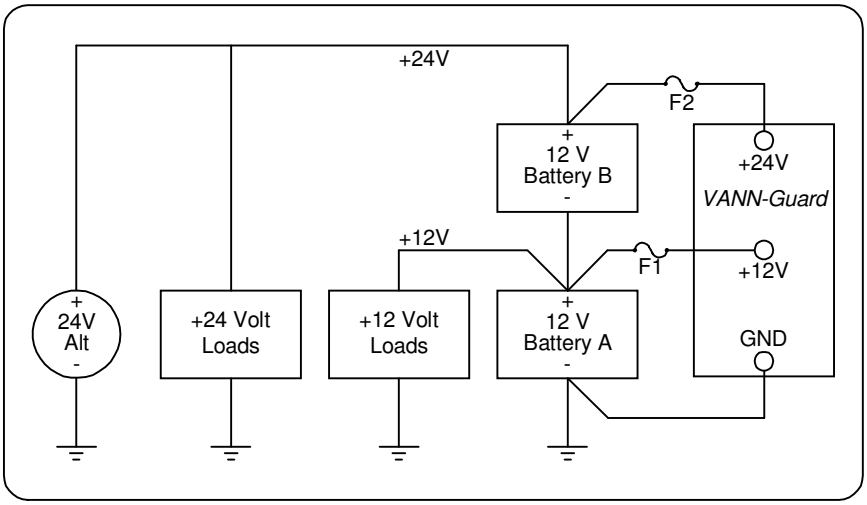
Specifications

70-Series Equalizers			
Model Number	70-60	70-80	70-100
Input Voltage 24v	18 to 32 v		
Efficiency (Peak)	>97%	>97%	>97%
Max 24v Input Amps	32	43	53
Output Voltage	(Input Voltage/2) ±2%		
Output Amps (12v)	0-60	0-80	0-100
Standby Current	17 milliamps nominal at 28.4V		
Operating Temp.	-40°C to +75°C (-40°F to 167°F)		
Storage Temp.	-54°C to +95°C (-65°F to 203°F)		
Serviceable	Yes	Yes	Yes
Environmental Considerations	Cast aluminum enclosure provides protection against salt, fungus, dust, water, fuel vapors and all fluids associated with commercial and off-highway vehicle operations.		
Mounting Location	Mount on a flat surface close to the batteries to allow short cable runs. Location should be protected from battery acid and gases.		
Weights	7.0 lbs.	7.3 lbs.	7.3 lbs.

70-Series Dimensional Specifications



Theory of Operation



In many 24 volt electrical systems it is desirable to tap into the battery system to obtain power for 12 volt loads. This method, while seemingly simple, causes a charge imbalance resulting in Battery B (see diagram) being overcharged, and possibly boiling, while Battery A discharges.

To solve this application problem the Vanner *VANN*-Guard is connected to the battery system at the +24 volt, +12 volt, and ground points. The *VANN-Guard* makes the batteries look like they are in series and in parallel at the same time. The *VANN-Guard* maintains the voltage balance and therefore the charge acceptance rate of each battery. The *VANN-Guard* hold Battery A and B voltages to within 0.05 volts under light loads and to within 0.1 volts at full rated load.

When the voltage of Battery A is higher than or equal to Battery B the *VANN-Guard* is in the standby mode, i.e., it is not transferring power from its 24 volt input to its 12 volt output. When a 12 volt load is present, and Battery A's voltage decreases to just below the voltage of Battery B, the *VANN-Guard* activates and transfers sufficient current from Battery B to Battery A to satisfy the load and maintain an equal voltage and charge in both batteries.

A key advantage of a system containing a Vanner *VANN-Guard*, compared to a DC to DC converter, is that if the 12 volt load requires a momentary surge current which exceeds the rated capacity of the *VANN-Guard*, Battery A will supply the extra current to the load. The *VANN-Guard* will then replenish the energy to Battery A after the surge has passed.

The following scenarios describe the *VANN-Guard Battery Equalizer* operation.

Scenario #1 - 24 volt load present, no 12 volt load present. The system operates as a system would without the *VANN-Guard* whether the alternator is ON or OFF. The *VANN-Guard* is in the standby mode except for making small adjustments to keep the batteries in balance.

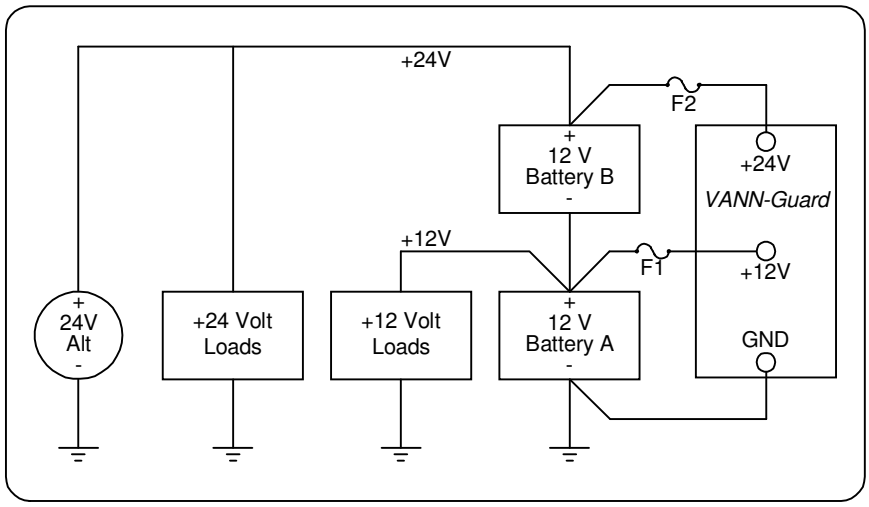
Scenario #2 - Both 24 volt and 12 volt loads present, alternator is OFF. The *VANN-Guard* will insure that both batteries will discharge at the same rate even if different loads are present.

Scenario # 3 - Both 24 volt and 12 volt loads present, alternator is ON. The alternator provides 24 volt power to the battery system and to the 24 volt loads. The *VANN-Guard* transfers power from the 24 volt source to the 12 volt load by converting 24 volt power to 12 volts. It will supply sufficient 12 volt power to satisfy the 12 volt load and to maintain battery voltage balance.

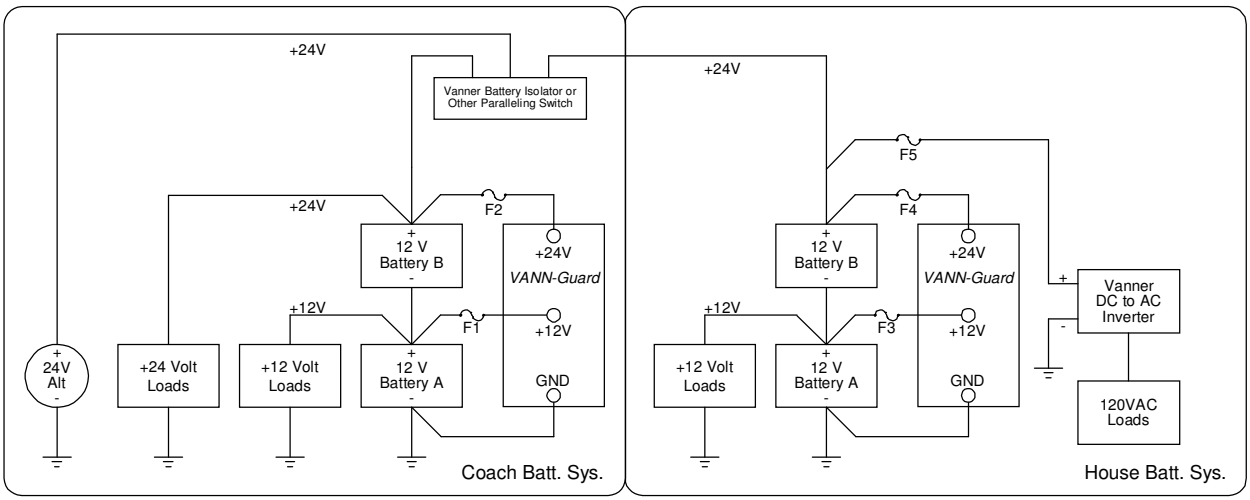
Typical Applications

Vanner *VANN-Guard Battery Equalizers* are used in many types of applications including transit and tour buses, private coaches, heavy trucks and off highway equipment, yachts, and alternative energy systems such as solar powered homes. In addition to *VANN-Guards*, Vanner manufactures a wide range of complementary products such as DC to DC converters, DC to AC inverters, battery charger/conditioners, and battery isolators. The following system diagrams illustrate how these products are used in various applications.

TRANSIT BUS

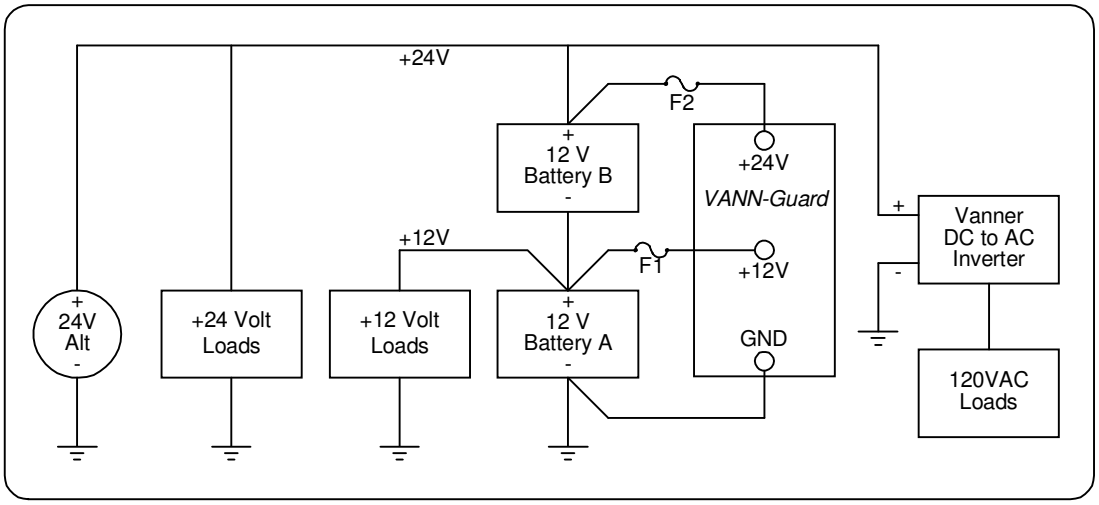


PRIVATE COACH

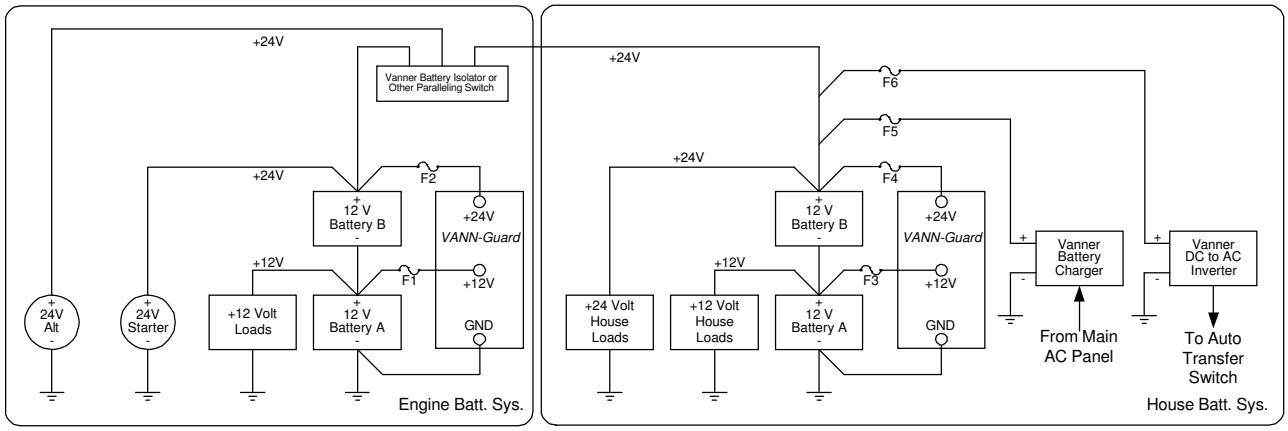


Typical Applications continued:

TOUR/CHARTER COACH



MARINE



Installation Instructions

Do not exceed the specified torque of 120 in-lbs. *when connecting cables to the terminal posts (+24, GND, +12) during installation of all the VANN-Guard Models. Torque values higher than specified may damage the product, reduce performance, and/or create hazardous conditions. Products damaged by improper torque are not covered by the warranty.*

Do not connect more than one conductor per terminal post on any Vanner VANN-Guard*. Multiple wires and cables may overstress internal components, resulting in poor performance or creating hazardous conditions. Products damaged by the installation of multiple conductors per post are not covered by the warranty.*

Fault protection devices must be installed between the VANN-Guard and the power source (battery*). A fault protection device would be any fuse or circuit breaker properly rated for the maximum DC current obtainable. This advisory is in accordance with SAE, NEC and UL, for mobile power applications. Install per applicable codes or within 18" of the battery. See Wire and Fuse Sizing Chart on page 10 of this manual or contact Vanner at 1-800-227-6937 or pwrsales@vanner.com if assistance is needed in sizing fault protection devices.*

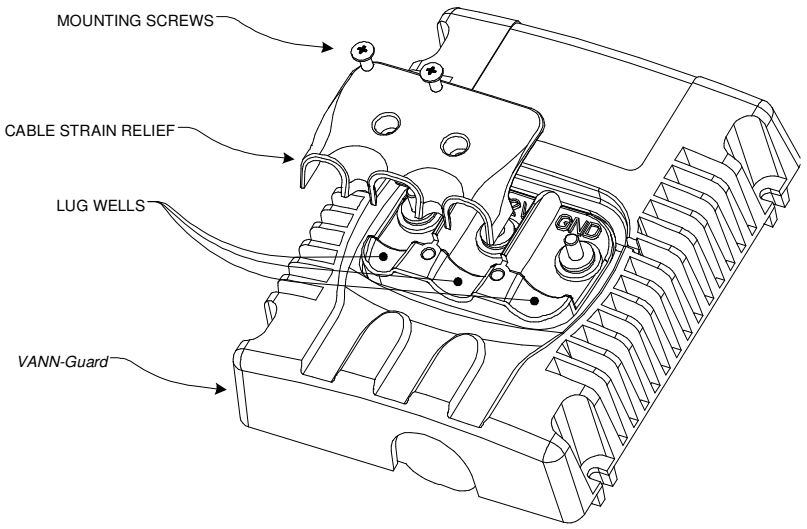
Caution: This equipment tends to produce arcs and sparks during installation. To prevent fire or explosion, compartments containing batteries or flammable materials must be properly ventilated. Safety goggles should always be worn when working near batteries

Mounting Location –The *VANN-Guard* may be mounted in any orientation, on a flat mounting surface suitable to support the *VANN-Guard* during application. Do not mount in zero-clearance compartment that may result in the *VANN-Guard* overheating. Locate so that contact by people is unlikely.

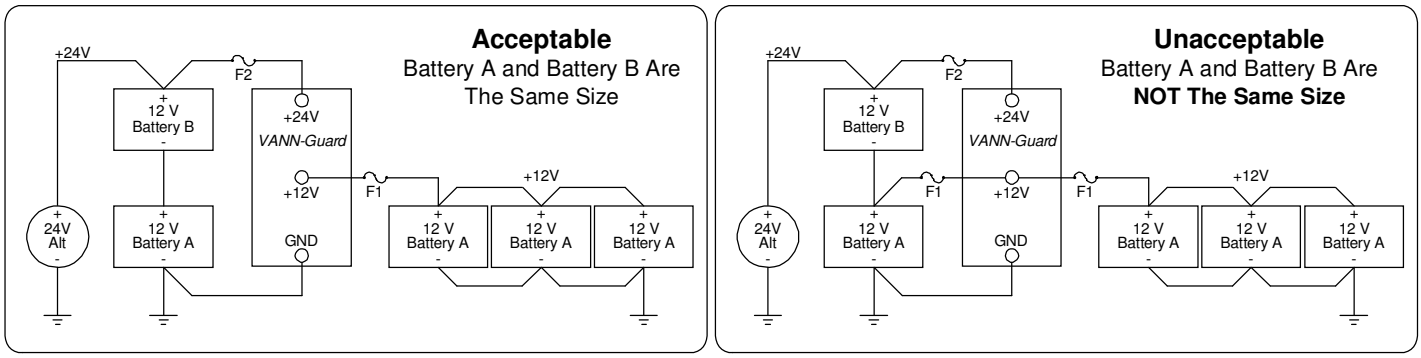
Environmental Protection – Your *VANN-Guard* has been designed to withstand direct exposure to rain and moisture. The *VANN-Guard* has also been tested for exposure to direct pressure spray, but continual exposure to direct pressure spraying may reduce the *VANN-Guard* serviceable life. Any damage due to water contamination is covered by Vanner only through the terms of our factory warranty.

Wiring Sequence– The *VANN-Guard* is internally protected for reverse polarity. The wiring sequence is not an issue with the *VANN-Guard* products.

Strain Relief – The *VANN-Guard* has an integral strain relief. The *VANN-Guard* is designed with wells for the lug to sit into to resist bolt loosening from cable movement, and the strain relief is designed to further inhibit cable movement. The diagram below shows the proper orientation for the attachment of the strain relief and the #10-32 mounting hardware that is supplied.



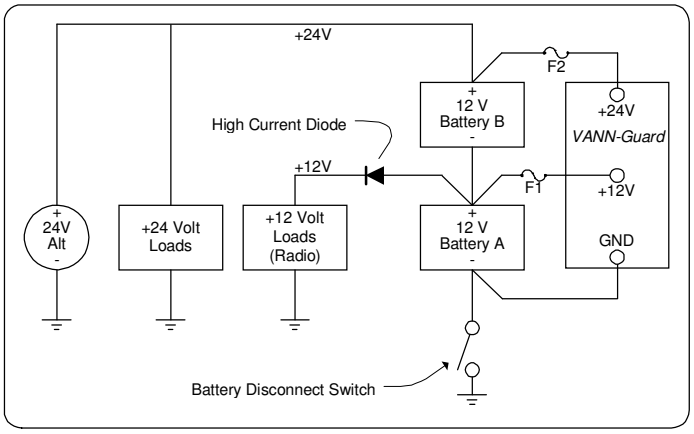
Caution adding 12volt batteries



In certain applications, such as private coach or alternate energy applications, it may be desirable to have additional 12 volt "House Batteries" to operate heavy 12 volt (inverter) loads. Use the *VANN-Guard* to charge the additional batteries.

Connect the *VANN-Guard* 12V terminal to the additional batteries only. Do not connect the *VANN-Guard* 12V terminal to both battery banks as this would make Battery A larger than Battery B. **Damage to Battery B may occur during charging** due to overcharging, if the VANN-Guard cannot keep up with the charging system.

Caution using a Ground-Side Battery Disconnect Switch



The system must be wired as shown to prevent Reverse Polarity Damage to polarity sensitive12 volt loads while the ground-side disconnect switch is open. The *VANN-Guards* GND terminal must be wired to the battery side of the ground-side disconnect switch circuit for the *VANN-Guard* to work properly.

Install the external High Current Diode, such as Vanner Model 52-75 (45 amp continuous rating) to protect polarity sensitive 12 volt loads if these loads do not already contain input diode protection. This prevents a reverse polarity on the 12 volt equipment when the battery switch is open. The reverse polarity does not come from the *VANN-Guard,* but from any 24 volt equipment that may be turned ON.

Wire Size and temperature rating

Cables connecting the *VANN-Guard* to the batteries must be sufficiently sized to prevent unwanted voltage drops. These voltage drops (loss) must be less than 0.05 VDC between the *VANN-Guard's* +24 volt terminal and the battery +24 volt terminal (Battery B positive terminal), less than 0.10 VDC between the *VANN-Guard's* +12 volt terminal and the battery +12 volt terminal (the jumper between Battery A and Battery B), and less than 0.05 VDC between the *VANN-Guard's* GND terminal and the battery ground terminal (Battery A negative terminal that is connected to chassis ground). In most installations, the *VANN-Guard's* terminals are wired directly to the battery terminals (reference fault protection) to prevent voltage loss that could occur in switch contacts, connections, and long wire runs. Since the *VANN-Guard* can be operated in temperatures up to 75º C, use wire rated at least 90º C. See Wire and Fuse Size Chart.

Wire and Fuse Size Chart

Wire Size AWG	Ring Terminal AMP or UL recognized equal	Max wire length, in feet, between *VANN-Guard* and battery to keep voltage drop under 0.1 volt. The chart assumes wire carries no other load and wire temperature is below 80º C.			
		70-60	70-80	70-100	2 X 70-100
#8	33462	2.1	XXX	XXX	XXX
#6	33466	3.2	2.4	XXX	XXX
#4	33470	5.9	4.4	3.5	XXX
#2	322870	8.7	6.5	5.2	2.6
#1	321867	10.9	8.2	6.5	3.3
#1/0	321867	13.8	10.4	8.3	4.1
#2/0	321870	17.6	13.2	10.5	5.3
Fuse F1		80 amp	100 amp	125 amp	250 amp
Fuse F2		40 amp	50 amp	80 amp	150 amp

Crimp the ring terminals using ***AMP*** ROTA-CRIMP 600850 (2/0 - 8ga).
AMP Product Information Center: 800-522-6752
AMP Tooling Assistance Center: 800-722-1111

Testing and Troubleshooting

Before testing the equalizer, be sure all battery connections are good and that fuses F1 and F2 are good.

CAUTION
Servicing of electrical systems should only be performed by trained and qualified technical personnel.

Equipment Required

- VoltMeter having 0.01 volt resolution. (Fluke Model 87 Multimeter recommended).
- Clamp-on amp meter (Fluke Model 36 Clamp-on Meter recommended).

Vanner Repair Service

Vanner offers a quick turn around factory repair service. Send the unit to the address below with a note instructing us to repair it. Include your name, phone number, shipping address (not a P.O. Box Number), and your purchase order number.

Test Procedure for *VANN-Guard* 70-Series Battery Equalizer

The VANN-Guard is working properly if:

1. The 12 volt DC loads are being operated continuously and are within the rated capacity of the VANN-Guard and;
2. Battery A voltage is lower than Battery B by no more than 0.05 to 0.10 volts (measured at the VANN-Guard's +24, +12 and GND terminals).

Vanner *VANN-Guards* are electronically protected against reverse polarity damage therefore the DC connection sequence is not an issue.

Vanner *VANN-Guards* will not function properly unless all three battery connections are made. Battery A and Battery B voltages both must be above 8 volts for the unit to turn ON.

Vanner *VANN-Guards* may be used in parallel with other *VANN-Guards* and Vanner Equalizer models.

Please note that the 24V, 12V and GND stud position and orientation are different on *VANN-Guard* 70-Series than on other Vanner Equalizers.

VANN-Guard Test Procedure:

1. Field-test the equalizer while fully connected to the vehicle batteries. For bench testing, two 12 volt batteries, or two 12 volt power supplies are required. The *VANN-Guard* must be connected to the batteries at GND, 12V and 24V to function properly.
2. If battery voltage is below 24 volts start the vehicle or apply a 24 volt battery charger to the batteries.
3. Turn ON 12 volt DC loads up to the *VANN-Guard's* rated capacity. Measure DC amps on the VANN-Guard +12 cable to verify load amperages.
4. **At the *VANN-Guard*** measure and record:
    a. Battery A voltage (voltage between the *VANN-Guard's* +12 and GND terminals)
    b. Battery B voltage (voltage between the *VANN-Guard's* +24 and +12 terminals)
5. Subtract Battery A voltage from Battery B voltage and compare readings.

Voltage Comparison		*VANN-Guard* Status	
a.	Battery A is lower than Battery B but within 0.05 volt.	OFF	Stand-by Mode. The *VANN-Guard* will not turn ON until Battery A is lower than Battery B by more than 0.05 volts.
b.	Battery A is lower than Battery B by 0.05 to 0.10 volts.	ON	Normal Operating Mode
c.	Battery A is lower than Battery B by more than 0.10 volts	ON	Self-Protection Mode due to Overload Condition. See below.
d.	Battery A is lower than Battery B by more than 0.10 volts	OFF	The *VANN-Guard* is not functioning properly.
e.	Battery A is higher than Battery B	Abnormal condition. Suspect Battery B is defective or a 12 volt load is connected to Battery B.	

Overload Condition

An overload condition exists when the 12 volt loads exceed the *VANN-Guard's* rated capacity. The overload condition will not damage the *VANN-Guard,* but may cause damage to the batteries.

During the overload, the *VANN-Guard's* output is limited by internal protection circuits to its Rated Output Amps. The 12 volt amps exceeding the *VANN-Guard's* output are drawn from Battery A which will begin to draw the batteries out of balance. The *VANN-Guard's* full Rated Output Amps are maintained as long as Battery A and Battery B remain balanced within 0.10 volt. The internal protection circuits will reduce the *VANN-Guard's* output as the batteries become further out-of-balance. If Battery A voltage falls below approximately 8 volts the *VANN-Guard* will shut itself OFF.

To correct the overload condition the 12 volt load must be reduced, or the *VANN-Guard's rated* capacity must be increased.

Trouble Shooting an Engine No-Start Situation

Situation:
A coach has dead batteries and won't start while jump starting. The coach is equipped with a 24 volt starting and charging system, a 12 volt electronic diesel engine control, a *VANN-Guard*, and a moderate 12 volt load which cannot be turned OFF. The coach sits for several days and the batteries run completely dead. During jump-starting the engine cranks but does not start due to low voltage on the 12 volt supply. Electrical testing reveals there is no 12 volt output from the *VANN-Guard* while jump starting even though the *VANN-Guard* separately tests OK.

Cause:
The 12 volt load which could not be turned OFF first ran both batteries down until the *VANN-Guard* shut itself OFF due to low voltage. (The *VANN-Guard* will shut OFF if system voltage falls below 16 volts or if voltage on either battery falls below 8 volts.) Then Battery A alone was drained to near zero volts.
As the bus is being jumped, 12 volt loads hold Battery A voltage too low for the *VANN-Guard* to turn ON and Battery A is too weak to support the 12 volt electronic engine control.

Solution:
Turn OFF all 12 volt loads (turning the battery disconnect switch OFF may accomplish this). Connect the jumper cables but do not crank the engine for two or three minutes. (Both batteries must rise above 8 volts.) The battery disconnect switch can then be turned ON and the bus should have adequate 12 volt power to start.

Vanner Incorporated
4282 Reynolds Drive
Hilliard, Ohio 43026

1-800-AC POWER
(1-800-227-6937)
Tel: 614-771-2718
Fax: 614-771-4904

www.vanner.com
e-mail: pwrsales@vanner.com

Part Number xxxxxxx
August 18, 2004 Printed in U.S.A.

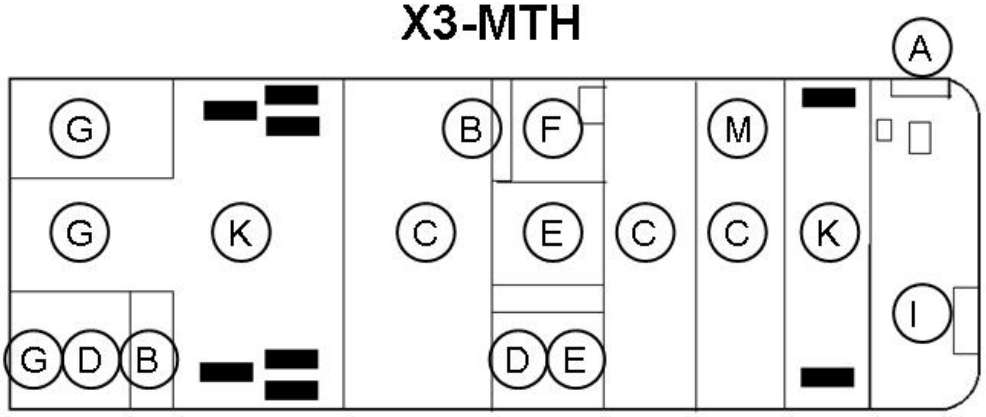
ELECTRICAL CONNECTORS PROTECTION

PROCEDURE NO SAV00002E	NOVEMBER 2009 REVISION 02

Kent Sealer	
Sprayed sealer. It is used for structure ground connections. It prevents corrosion and ensures maximum contact. Refer to table for proper use. Apply this product once installation is finished. ***Warning**: It is very important to be in a well ventilated area when applying this product.*	 680324
Nyogel Grease	
Grease-type product. It is used to facilitate connectors or terminals insertion. Refer to table for proper use of Nyogel grease. It is preferable to apply Nyogel into the female part of connector. Apply this product as the last assembling operation.	 3 Oz. tube: 681095 Container 500g: 683409
"Color Guard" black rubber coating	
This product may be applied with a brush. It is used for structure ground connections or other connections that will most likely not be disconnected later on. Apply this product once installation is finished. ***Warning** : Wear goggles and rubber gloves.*	 684013

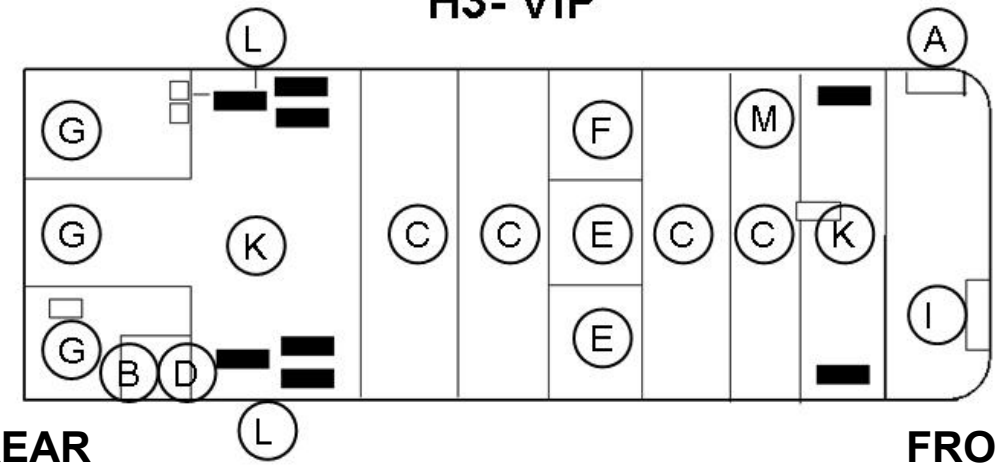
Vehicle Zoning

X3-MTH



REAR FRONT

H3- VIP



REAR FRONT

Electrical Connectors Protection Procedure Table

Zone	Component	Model				Product	Note
		MTH	X3	H3	VIP		
A- Front Elect. Compt	Diode Block	X	X	X	X	Nyogel	Accepted to ease connection
A- Front Elect. Compt	Customer Terminal Block	X	X	X	X	Nothing	
A Front Elect. Compt	Terminal Block Electronic Ground	X	X	X	X	Kent	
A- Front Elect. Compt	Structure Ground	X	X	X	X	Kent	
A- Front Elect. Compt	Electronic Module	X	X	X	X	Nothing	
A- Front Elect. Compt	VEC Power	X	X	X	X	Nothing	
A- Front Elect. Compt	70A Relay	X	X	X	X	Nyogel	Accepted to ease connection
A- Front Elect. Compt	Control Relay	X	X	X	X	Nyogel	Accepted to ease connection
A- Front Elect. Compt	All connectors except those specified in this zone	X	X	X	X	Nothing	
A- Front Service Compt	All connectors except those specified in this zone	X	X	X	X	Nothing	
B- Rear Elect. Compt/panel	Customer Terminal Block	X	X	X	X	Nothing	
B- Rear Elect. Compt/panel	Power Terminal Block		X			Nothing	
B- Rear Elect. Compt/panel	Circuit Breaker		X	X	X	Nothing	
B- Rear Elect. Compt/panel	Circuit Breaker	X				Kent	Surface only
B- Rear Elect. Compt/panel	Volvo Air Heater Fuse			X		Nothing	
B- Rear Elect. Compt/panel	Structure Ground		X	X	X	Kent	
B- Rear Elect. Compt/panel	Electronic Module	X	X	X	X	Nothing	
B- Rear Elect. Compt/panel	VEC Power		X	X	X	Nothing	
B- Rear Elect. Compt/panel	VEC Power	X				Kent	Surface only
B- Rear Elect. Compt/panel	70A Relay	X	X	X	X	Nyogel	Accepted to ease connection
B- Rear Elect. Compt/panel	Master Switch Relay		X	X	X	Nothing	
B- Rear Elect. Compt/panel	Master Switch Relay	X				Kent	Surface only
B- Rear Elect. Compt/panel	Control Relay	X	X	X	X	Nyogel	Accepted to ease connection
B- Rear Elect. Compt/panel	200A Power Relay	X	X	X	X	Nothing	
B- Rear Elect. Compt/panel	Power Relay Stud		X			Nothing	
B- Rear Elect. Compt/panel	All connectors except those specified in this zone	X	X	X	X	Nothing	
B- Rear Elect. Compt/panel	Vanner			X	X	Kent	

Zone	Component	Model				Product	Note
		MTH	X3	H3	VIP		
C- Baggage Compt	Structure Ground	X	X	X	X	Color Guard or Kent	
C- Baggage Compt	Door Switch	X	X	X	X	Nyogel	Accepted to ease connection
C- Baggage Compt	Door lock Actuator Module (switch and solenoid)	X	X	X	X	Nyogel	Accepted to ease connection
C- Baggage Compt	Electronic Module	X	X	X	X	Nothing	
C- Baggage Compt	Slide-out Motor	X			X	Nyogel	Accepted to ease connection
C- Baggage Compt	WCL Junction Panel		X	X		Nothing	
C- Baggage Compt	120V Inverter Connector	X	X	X	X	Nothing	
C- Baggage Compt	Stud inverter		X	X		Color Guard or Kent	
C- Baggage Compt	WCL Remote Control		X	X		Nyogel	Accepted to ease connection
C- Baggage Compt	All connectors except those specified in this zone	X	X	X	X	Nothing	
D- Battery Compt	Battery	X	X	X	X	Nyogel	
D- Battery Compt	Structure Ground	X	X			Color Guard or Kent	
D- Battery Compt	Electronic Module	X	X	X	X	Nothing	
D- Battery Compt	All connectors except those specified in this zone	X	X	X	X	Nothing	
D- Battery Compt	Battery Equalizer	X	X			Kent	
E- Condenser Compt	Fuel sender	X	X	X	X	Kent	
E- Condenser Compt	Structure Ground	X	X	X	X	Color Guard or Kent	
E- Condenser Compt	Door Switch	X	X	X	X	Nyogel	Accepted to ease connection
E- Condenser Compt	Condenser Motor	X	X	X	X	Nothing	
F- Evaporator Compt	Diode Block	X		X	X	Nyogel	Accepted to ease connection
F- Evaporator Compt	Structure Ground	X	X	X	X	Color Guard or Kent	
F- Evaporator Compt	Electronic Module	X		X	X	Nothing	
F- Evaporator Compt	Evaporator Motor	X	X	X	X	Color Guard or Kent	
F- Evaporator Compt	200A Power Relay	X		X	X	Nothing	
F- Evaporator Compt	All connectors except those specified in this zone	X		X	X	Nothing	

Zone	Component	Model				Product	Note
		MTH	X3	H3	VIP		
G- Engine Compt	120A Alternator	X	X	X	X	Color Guard	
G- Engine Compt	Booster Block (+)		X	X	X	Color Guard	
G- Engine Compt	Starter Terminal	X	X	X	X	Color Guard	
G- Engine Compt	Volvo Air Element Terminal	X	X	X	X	Color Guard	
G- Engine Compt	Customer Terminal Block	X				Nothing	
G- Engine Compt	Power Terminal Block		X			Color Guard	
G- Engine Compt	Breaker	X				Kent	
G- Engine Compt	Air Heater Fuse & Relay	X	X			Nyogel	Accepted here
G- Engine Compt	Engine Ground	X	X	X	X	Color Guard	
G- Engine Compt	Structure Ground	X	X	X	X	Color Guard	
G- Engine Compt	VEC Power	X				Kent	
G- Engine Compt	Master Switch Relay	X				Kent	
G- Engine Compt	Starter Relay	X	X			Color Guard	
G- Engine Compt	All connectors except those specified in this zone	X	X	X	X	Nothing	
H- Vehicle Exterior	ABS Sensor	X	X	X	X	Nothing	
H- Vehicle Exterior	Docking & Cornering Lamps	X	X	X	X	Nyogel	Accepted to ease connection
H- Vehicle Exterior	Marker Light	X	X	X	X	Nothing	
H- Vehicle Exterior	Mirror	X	X	X	X	Nothing	
H- Vehicle Exterior	Light Module	X	X	X	X	Nothing	
H- Vehicle Exterior	Stop light, Backup light, Directional Signal Light	X	X	X	X	Nothing	
I- Vehicle Interior	Diode Block	X	X	X	X	Nyogel	Accepted to ease connection
I- Vehicle Interior	Junction Block		X	X		Nothing	
I- Vehicle Interior	A3 & A4 Transmission Retarder Hand lever	X	X	X	X	Nyogel	Accepted to ease connection
I- Vehicle Interior	C258 & C259 Multi-function Lever Connector	X	X	X	X	Nyogel	Accepted to ease connection
I- Vehicle Interior	Audio - video Connection		X	X		Nothing	
I- Vehicle Interior	Defrost Compt Ground	X	X	X	X	Kent	
I- Vehicle Interior	Video Plate Direct Ground		X	X		Nothing	
I- Vehicle Interior	Structure Ground		X	X		Kent	
I- Vehicle Interior	Terminal Block Ground		X	X		Nothing	

Zone	Component	Model				Product	Note
		MTH	X3	H3	VIP		
I- Vehicle Interior	Dashboard Switch	X	X	X	X	Nothing	
I- Vehicle Interior	Electronic Module	X	X	X	X	Nothing	
I- Vehicle Interior	Slide-out Motor	X			X	Nyogel	Accepted to ease connection
I- Vehicle Interior	Wiper Motor	X	X	X	X	Nyogel	Accepted to ease connection
I- Vehicle Interior	200A Power Relay	X	X	X	X	Nothing	
I- Vehicle Interior	70A Relay	X	X	X	X	Nyogel	Accepted to ease connection
I- Vehicle Interior	Control Relay	X	X	X	X	Nyogel	Accepted to ease connection
I- Vehicle Interior	All connectors except those specified in this zone	X	X	X	X	Nothing	
I- Vehicle Interior	All components except those specified in this zone	X	X	X	X	Nothing	
K- Front & Rear Wheelhousing	All connectors except those specified in this zone	X	X	X	X	Nothing	
K- Front & Rear Wheelhousing	All components except those specified in this zone	X	X	X	X	Nothing	
L- Compartment above rear wheelhousing	All connectors except those specified in this zone			X	X	Nothing	
L- Compartment above rear wheelhousing	All components except those specified in this zone			X	X	Nothing	
M- Slide-out Panel	All connectors except those specified in this zone	X			X	Nothing	
M- Slide-out Panel	All components except those specified in this zone	X			X	Nothing	

SECTION 07: TRANSMISSION

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1. DESCRIPTION

X3 Series coaches may be provided with either an Allison automatic transmission or a Volvo I-Shift transmission while X3-45 VIP and XLII Bus Shells are provided with an Allison automatic transmission.

1.1 ALLISON AUTOMATIC TRANSMISSION

The B500 and B500R (with retarder) Allison Transmissions have 6 speeds with two top range (fifth and sixth) overdrives. Total coverage is determined by dividing the highest gear ratio by the lowest gear ratio. Total coverage expresses the transmission gear ratio versatility. Transmissions with larger total coverage number have a wider variety of available ratios.

An electronic control allows the transmission to shift at exactly the right point on the engine's fuel consumption curve for best economy. Early lockup maintains the highest possible mechanical efficiency through the closely-spaced gear steps, culminating in two overdrive ratios. This combination allows progressive shifting techniques, where engine speeds are reduced for higher efficiency and lower fuel consumption.

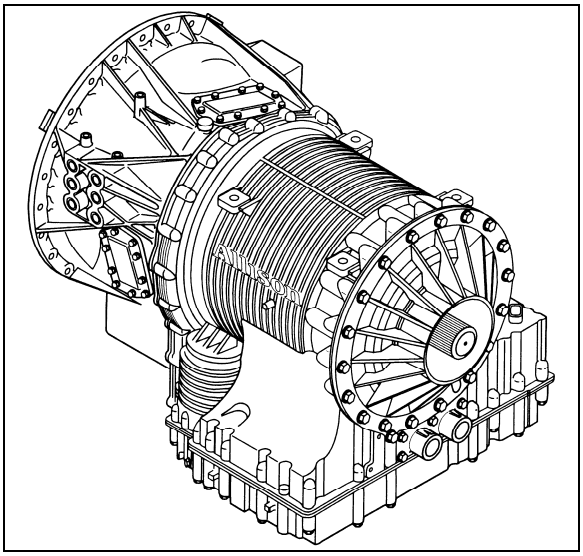


FIGURE 1: ALLISON TRANSMISSION 07136

Gear selection and torque converter modes are controlled by a microcomputer-based electronic transmission management system. It is fed information regarding throttle position, operator range selection, engine speed, turbine speed, transmission output speed and various system pressures from special electronic sensors. With this information, it computes shift points and clutch pressures to meet immediate needs. Using closed loop adaptive logic; the electronic control looks at a number of parameters during the shift, and makes minute adjustments to match the shift to desired profile stored in its memory. It then looks at these adjustments and resets the parameters, which allow the transmission to quickly compensate for variations in load, terrain or environment and to adjust for clutch wear and engine power changes. A Diagnostic Data Reader can be connected to the electronic control unit to provide a self-check of all systems in the transmission. Five-digit trouble codes greatly reduce the time it takes to pinpoint potential problems. (Refer to paragraph *"8. TROUBLESHOOTING"* in this section).

1.1.1 Retarder (if applicable)

This optional auxiliary braking device for the automatic transmission is integrated into the basic envelope of the transmission and transmits its braking force directly to the propeller shaft. It requires no additional length and adds only 75 pounds (34 kg) of weight. Operation of the retarder is controlled electronically by the driver's use of the brake and/or by hand control lever.

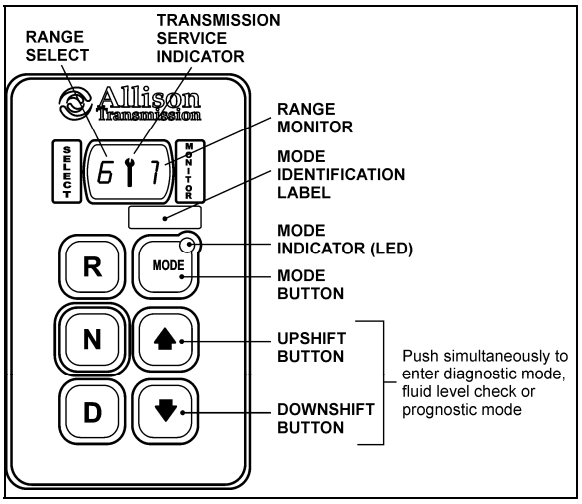


FIGURE 2: ALLISON TRANSMISSION CONTROL PAD 07142

When activated, fluid enters a cavity and provides resistance to the turning of rotor blades revolving with the output shaft. This effectively slows the vehicle to the point where the service brakes are needed only for final stopping. The retarder is fully modulated and is compatible with ABS.

1.2 VOLVO I-SHIFT TRANSMISSION

The Volvo I-Shift transmission is a single countershaft transmission with 12 forward gears and two reverse gears. The I-Shift is an automated mechanical transmission.

If the I-Shift transmission system is to be used, the vehicle must have an electronic engine control unit as well as CAN communication. Since the clutch is automated (clutch pedal no longer fitted), the driver no longer has to activate the clutch.

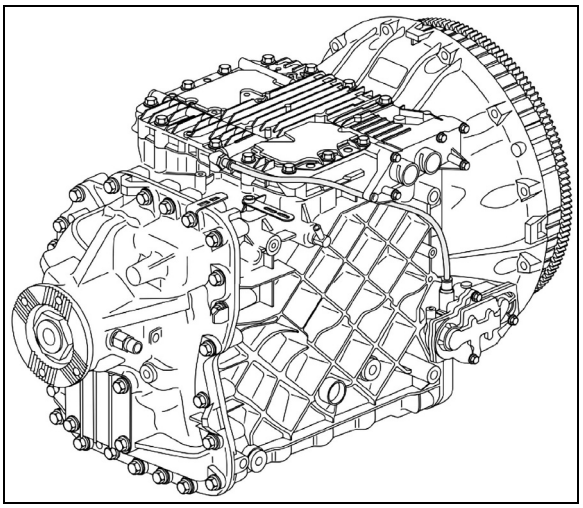


FIGURE 3: VOLVO I-SHIFT TRANSMISSION 07XXX

The transmitted torque (both engine and braking) will be interrupted during gear shifting, in both driving and coasting conditions. There is no clutch pedal and the gear shifting is controlled by the transmission or the driver through the pushbutton shift selector.

When in fully automatic mode, gears are selected and shifts made by the electronic control unit. The driver can still intervene if he wishes to. All system functions required are shown on the display, e.g. neutral, gear change, clutch overload and diagnosis information.

2. WELDING PROCEDURES

These procedures are intended only for vehicles equipped with transmission electronic controls. When frame or other welding is required on the vehicle, precautions are to be taken to protect the electronic control components. Refer to section 00: GENERAL INFORMATION, paragraph 3: “Precautions to be observed before welding” for complete procedure.

3. MAINTENANCE

3.1 ALLISON TRANSMISSION

To gain access to the dipstick, open the engine compartment rear doors; dipstick is located on the radiator side of the engine (Fig. 4).

3.1.1 Manual Fluid Level Check

DANGER

When checking the oil level, be sure that the parking brake and/or emergency brakes are set and properly engaged, and the wheels are chocked. Unexpected and possible sudden vehicle movement may occur if these precautions are not taken.

- Special care must be taken not to touch the engine coolant tubing and/or exhaust pipe, since this could cause severe burns.
- Do not wear loose clothing and, stay away from rotating parts during procedure; personal injury could occur.

Clean all dirt from around the end of the oil filler tube before removing the dipstick. Dirt or foreign matter must not be permitted to enter the oil system since it will cause valves to stick, undue wear of transmission parts, and clogged passages. Check the oil level using the procedures in Cold Check and Hot Check. Record any abnormal level on your *"Maintenance Records".*

Always check the oil level reading at least twice when the engine is running. Consistency is important in maintaining the accuracy of the reading. If inconsistent readings persist, check the transmission breather to ensure it is clean and free of debris.

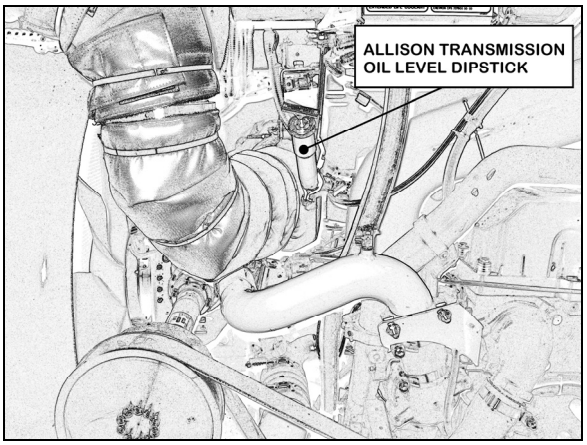


FIGURE 4: OIL LEVEL DIPSTICK (AUTO. TRANS.) 07113

3.1.2 Cold Check

The purpose of the **Cold Check** is to determine if the transmission has enough fluid to be operated safely until a **Hot Check** can be made.

1. If the engine has been shut down for an extended period of time, park the vehicle on a level surface and apply the parking brake.

> **CAUTION**
>
> The oil level rises as sump temperature increases. DO NOT fill above the "Cold Run" band if the transmission oil is below normal operating temperature. During operation, an overfull transmission can become overheated, leading to transmission damage.

2. Run the engine at idle in «N» (Neutral) for about one minute.
3. Shift to Drive (D) and operate the engine for 30 seconds at 1000-1500 rpm; then shift to Reverse (R) to clear the hydraulic system of air.
4. Move the vehicle to a level surface, put transmission in «N» (Neutral), and set the parking brake.
5. Finally shift to Neutral (N) and allow the engine to idle (500 - 800 rpm).
6. While the engine is running, remove the dipstick from the tube and wipe it clean (Figs. 4 & 5). Insert the dipstick into the fill tube, pushing down until it stops.

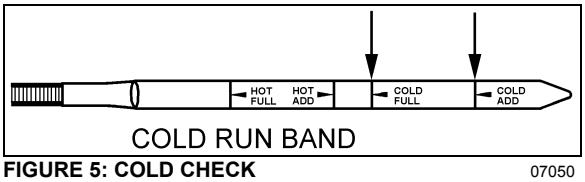


FIGURE 5: COLD CHECK 07050

7. Remove the dipstick and observe the fluid level. Repeat the check procedure to verify the reading. If the fluid on the dipstick is within the COLD CHECK band, the level is satisfactory for operating the transmission until the oil is hot enough to perform a **Hot Check**. If the fluid level **is not** within this band, add or drain fluid as necessary to bring the level within the COLD CHECK band.
8. Perform a **Hot Check** at the first opportunity after the normal operating temperature of 160ºF (71ºC) to 200ºF (93ºC) is attained.

> **CAUTION**
>
> **DO NOT** operate the transmission for extended periods of time until a **Hot Check** has verified proper fluid level. Transmission damage can result from extended operation at improper fluid level conditions.

> **CAUTION**
>
> Obtain an accurate fluid level by imposing the following conditions:
>
> - Engine is idling (500-800 rpm) in «N» (Neutral).
> - Transmission fluid is at normal operating temperature.
> - The vehicle is on a level surface.

3.1.3 Hot Check

> **CAUTION**
>
> The oil **must be hot** to ensure an accurate check for this procedure. The oil level rises as temperature increases.

To perform a **Hot Check**, do the following:

1. The **Hot Check** can be performed when the transmission oil reaches the normal operating temperature (160ºF to 200ºF / 71ºC to 93ºC). The transmission oil temperature can be checked with the dashboard message center display (MCD) when selecting the Gauge Mode (refer to the ''Operator's Manual'' for added information).
2. Park the vehicle on a level surface and shift to Neutral (N). Apply the parking brake and allow the engine to idle (500 - 800 rpm).
3. Remove the dipstick from the tube and wipe it clean. Insert the dipstick into the fill tube, pushing down until it stops.
4. Remove the dipstick and observe the fluid level. The safe operating level is anywhere within the HOT RUN band on the dipstick. Repeat the check procedure to verify the reading.
5. If the level **is not** within this band, add or drain fluid as necessary to bring the level within the HOT RUN band. (Fig. 6).

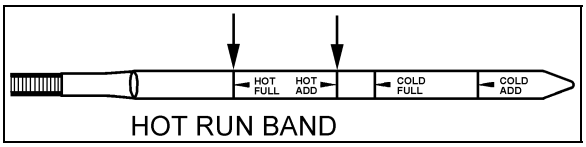


FIGURE 6: HOT CHECK 07049

6. Be sure fluid level checks are consistent. Check level more than once and if readings are not consistent, check to be sure the transmission breather is clean and not clogged. If readings are still not consistent, contact your nearest Allison dealer or distributor.

NOTE
The Cold Check is more appropriate for verifying the oil level after the first fill-up. In case of conflict, the Hot Check has priority over the Cold Check; ***the fluid level check using the pushbutton shift selector has priority over the Hot Check.***

3.1.4 Fluid Level Check Using the Pushbutton Shift Selector

Oil level codes are obtained as follows:

1. Park vehicle on a level surface, select «N» (neutral) on the pushbutton shift selector and apply parking brake.
2. Press simultaneously the ▲ (Up) and ▼ (Down) arrow buttons once.
3. Oil level codes are displayed in 2 minutes (e.g. display will flash and 8, 7, 6, 5, ...; countdown will occur during the 2 minutes) once the following parameters are met:

- **Waiting time, vehicle must be stationary for at least 2 minutes to allow the oil to settle;**
- **Engine at idle;**
- **Oil at normal operating temperature, between 140°F (60°C) and 220°F (104°C);**
- **Transmission in «N» (Neutral);**
- **Transmission output shaft stopped;**
- **Oil level sensor present and working.**

After 2 minutes, the display will flash one of the codes shown below:

CODE	CAUSE OF CODE
O L…O K	Oil level is correct
O L…L O… 1	Oil Level is LOw 1 quart
O L…L O… 2	Oil Level is LOw 2 quart
O L…L O… 3	Oil Level is LOw 3 quarts
O L…L O… 4	Oil Level is LOw 4 or more quarts
O L…H I… 1	Oil Level is HIgh 1 quart
O L…H I… 2	Oil Level is HIgh 2 quarts
O L…H I… 3	Oil Level is HIgh 3 or more quarts
O L… – (fc)	Oil Level is invalid. Source of invalid reading is defined by a two-character fault code (fc)

NOTE
Note that the quantities LO 4 and HI 3 are the largest values displayed and that the actual variation in oil level may exceed these numbers.

NOTE
Failure to meet one of the above parameters will stop the two minute countdown. One of the codes shown hereafter will indicate the cause of the countdown interruption. Once all parameters are met, the countdown will continue from where it left off.

If the fluid level check cannot be completed, an Invalid for Display fault is reported. This condition is reflected by the display of "OL", followed by "–", followed by one or two additional characters. The displayed characters define the cause of the fault, which may be either a system malfunction or an improper condition for conducting the check.

CODE	CAUSE OF CODE
OL…-…0X	Waiting period is not complete
OL…-…EL	Engine speed (rpm) too low
OL…-…EH	Engine speed (rpm) too high
OL…-…SN	N (neutral) must be selected
OL…-…TL	Sump oil temperature too low
OL…-…TH	Sump oil temperature too high
OL…-…SH	Output shaft rotation
OL…-…FL	Sensor failure

To exit the Oil Level Display Mode, press any range button: «R», «N» or «D» at any time.

3.1.5 Importance of Proper Fluid Level

It is important that the proper fluid level be maintained at all times because the transmission fluid cools, lubricates, and transmits hydraulic power. If the fluid level is too low, the converter and clutches do not receive an adequate supply of fluid. If fluid level is too high, the fluid can aerate, causing the transmission to shift erratically or overheat.

3.1.6 Keeping Oil Clean

Oil must be handled in clean containers, fillers, etc., to prevent foreign material from entering the transmission. Place the dipstick on a clean surface area while filling the transmission.

⚠ CAUTION

Containers or fillers that have been used to handle antifreeze or engine coolant must NEVER be used for handling transmission fluid. Antifreeze and coolant solutions contain ethylene glycol that, if introduced into the transmission, can cause the clutch plates to fail.

3.1.7 Recommended Automatic Transmission Fluid

Hydraulic fluids used in the transmission are important influences on transmission performance, reliability and durability. **Castrol TranSynd™ Synthetic Fluid** and **DEXRON-III®** fluids are recommended for on-highway applications.

- **TranSynd™** is a full synthetic transmission fluid developed by Allison Transmission and Castrol Ltd. This fluid meets Allison specifications for Severe Duty and Extended Drain Intervals. TranSynd™ is fully qualified to the Allison TES295 specifications and is available through Prevost Parts.

NOTE

*The prognostics package requires the use of TranSynd™ or an Allison approved TES-295 licensed fluid in the transmission and Allison High Capacity filters. If any other fluids or filters are used, Prognostic mode **must be disabled**. Prognostic information will not be accurate with any other fluids or filters and could result in missed maintenance activities resulting in transmission damage.*

- To be sure a fluid is qualified for use in Allison transmission, check for the **DEXRON-III®** license number on the container or consult the lubricant manufacturer. Consult your Allison Transmission dealer or distributor before using other fluid types.

Customers may use TranSynd™/TES 295 equivalent and extend drain intervals. Equivalent TranSynd™ fluid must meet or exceed TES 295 requirements. Customers may choose from a wide variety of approved Dexron-III® fluids.

Customers may choose from a wide variety of approved non-TES 295 like Dexron-III® or approved Schedule 1 TES-389 fluids.

The Transmission Fluid Operating Temperature Requirements table lists the minimum fluid temperatures at which the transmission may be safely operated without preheating. Preheat with auxiliary heating equipment or by running the equipment or vehicle with the transmission in «N» (Neutral) for a minimum of 20 minutes before attempting range operation.

Transmission Fluid Operating Temperature Requirements

Fluid type	Minimum operating temperature	
	Celsius	Fahrenheit
TranSynd™	-30	-22
DEXRON-III®	-25	-13

⚠ CAUTION

Disregarding minimum fluid temperature limits can result in transmission malfunction or reduced transmission life.

NOTE

The use of an arctic preheat kit is recommended at temperatures below -25ºF (-32ºC). If a preheat kit is not available, the TCM will restrict full operation until the sump temperature is increased.

3.1.8 Oil Contamination

At each oil change, examine the drained oil for evidence of dirt or water. A nominal amount of condensation will emulsify during operation of the transmission. However, if there is evidence of water; check the cooler (heat exchanger) for other signs of leakage. This, however, may also indicate leakage from the engine oil system.

3.1.9 Metal Particles

Metal particles in the oil (except for minute particles normally trapped in the oil filter) indicate damage has occurred in the transmission. When these particles are found in the sump, the transmission must be disassembled and closely inspected to find the source. Metal contamination will require complete disassembly of the transmission and cleaning of all internal and external circuits, coolers, and all other areas where the particles could lodge.

⚠ CAUTION

If excessive metal contamination has occurred, replacement of the oil cooler and replacement of all bearings within the transmission is recommended.

3.1.10 Coolant Leakage

If engine coolant leaks into the transmission oil system, immediate action must be taken to prevent malfunction and possible serious damage. The transmission must be completely disassembled, inspected, and cleaned. All traces of the coolant contamination must be removed. Friction clutch plates contaminated with ethylene glycol must be replaced.

3.1.11 Control System Prognostics

The transmission control system includes the provision for the user to monitor various transmission operating parameters. Transmission operating parameters monitored by the prognostics feature are:

- Oil Life Monitor
- Filter Life Monitor
- Transmission Health Monitor

NOTE

The prognostics package requires the use of TranSynd™ or an Allison approved TES-295 licensed fluid in the transmission and Allison High Capacity filters. If any other fluids or filters are used, Prognostic mode ***must be disabled****. Prognostic information will not be accurate with any other fluids or filters and could result in missed maintenance activities resulting in transmission damage.*

Refer to TES 295 Approved Fluids list, found under the Service/Fluids heading on the home page of the Allison Transmission web site.

www.allisontransmission.com

When a specified threshold is detected for any of the serviceable conditions, the TRANSMISSION SERVICE indicator is illuminated to alert the operator. Failure to attend to the service condition and reset the TRANSMISSION SERVICE indicator within a defined operating period will result in illumination of the CHECK TRANS light on the dashboard telltale panel, indicating the increased probability that the service condition will develop into a more serious condition.

To access the Prognostic Mode functions, simultaneously press the ▲ (Up) and ▼ (Down) arrow buttons repeatedly. See the reference table at the end of this section.

- Oil Life Monitor

The display message denotes the calculated remaining life of the transmission fluid. This value is based on the established life for the required baseline fluid, and then is continuously adjusted for cumulative effects of such operating parameters as operating time, retarder operation, output shaft revolutions and shift frequency.

Display: The display is a two-digit number, denoting percentage of the fluid life which remains. New fluid is displayed as 99%.

The TRANSMISSION SERVICE indicator will be illuminated, denoting a required change of transmission fluid, when the remaining fluid life reaches approximately 1–2 %. The indicator will be lit steadily upon each initialization of the TCM, and will remain on steady for approximately 1–2 minutes after the first selection of “D” (drive) range each time, until service is performed and the indicator is reset.

Failure to perform maintenance and reset the TRANSMISSION SERVICE indicator within a defined period will result in the illumination of the CHECK TRANS light on the dashboard telltale panel and diagnostic code P0897 Transmission Fluid at Limit will be set.

Reset: The TRANSMISSION SERVICE indicator can be reset by a message over the SAE J1939 communication interface, with the Allison DOC™ for PC diagnostic program, or by depressing and holding the MODE button for ten (10) seconds while the Oil Life Monitor function is displayed. It may also be reset by selecting N-D-N-D-N-R-N on the shift selector, pausing briefly (less than 3 seconds) between each

selector movement, with the ignition on and the engine not running.

> **CAUTION**
>
> Required calendar-based oil & filter change intervals (based on month) still apply because Oil Life Monitor function cannot measure time while ignition power is OFF.
>
> If the Oil Life Monitor function has not indicated the need for a fluid change before 60 month (five years) have passed, it will be necessary to change the fluid and filters per calendar requirements and reset the system.

- Filter Life Monitor

The display message denotes operating status of the transmission main fluid filter, based on the measured pressure drop across the filter. The feature is not functional at transmission sump temperatures below 40 ºC (105 ºF). Both the main and lube filters **must be** changed when the TRANSMISSION SERVICE indicator shows the main filter should be changed.

Display: An acceptable filter life status is displayed as "OK". An unacceptable filter life status is displayed as "LO".

Once the programmed threshold for maximum filter pressure drop has been observed and verified, the diagnostic code P088A Transmission Filter At/Over Limit will be recorded to indicate that the filter has reached the end of its designed life. At the next initialization of the TCM, the TRANSMISSION SERVICE indicator will flash for approximately 1–2 minutes after the first selection of “D” (drive) range. Thereafter, the indicator will illuminate and flash upon each TCM initialization, continuing to flash for 1–2 minutes after the first selection of a drive range each time, until service is performed and the indicator is reset.

Failure to perform maintenance and reset the monitor after a calibration-defined number of warnings will result in the illumination of the CHECK TRANS light on the dashboard telltale panel and diagnostic code P088B will be recorded to indicate a highly deteriorated filter.

Reset: The feature will reset automatically when the main fluid filter has been changed and the pressure drop across the filter no longer exceeds the threshold value. A manual reset can be performed by depressing and holding the MODE button for ten (10) seconds while the Filter Life Monitor function is displayed. It may also be reset by selecting N-R-N-R-N-D-N on the shift selector, pausing briefly (less than 3 seconds) between each selector movement, with the ignition on and the engine not running.

- Transmission Health Monitor

The display message denotes clutch life status, as determined by monitored changes and the calculated running clearance of the transmission clutches C1, C2, C3, C4 & C5.

Display: An acceptable clutch life status is displayed as "OK". An unacceptable clutch life status is displayed as "LO". The specific clutch(es) for which the function indicates "LO" cannot be identified with the shift selector. Allison DOC™ for PC-Service Tool displays clutch condition as OK or NOT OK for each clutch, C1 through C5.

The TRANSMISSION SERVICE indicator will be illuminated, indicating the need for clutch maintenance, when the remaining clutch life reaches approximately 10%, or if the running clearance exceeds a maximum value which may indicate a non-wear-related issue. Thereafter, the indicator will be lit upon each initialization of the TCM, and will remain on steady during all vehicle operation until service is performed and the indicator is reset.

Failure to perform maintenance and reset the monitor after a number of warnings will result in the illumination of the CHECK TRANS light on the dashboard telltale panel and diagnostic code P2789 Clutch Adaptive learning at Limit will be set.

Reset: The feature will reset automatically upon elimination of the clutch clearance condition which initiated it. The indicator can also be manually reset using the Allison DOC™ for PC diagnostics program if necessary.

The following table illustrates how to access Oil Level Check, Prognostics & Diagnostic Troubleshooting Codes functions on the Allison pushbutton shift selector.

▲ (up) & ▼ (down) arrow buttons pressed simultaneously	Description	SELECT	MONITOR
1st press	**Allison transmission oil level check**	" - "	" - "
	Other codes will be displayed		
2nd press	**Oil Life Monitor**	**" O "**	**" M "**
	Oil life remaining will range from 99% down to 00%	Some number from 9 to 0	Some number from 9 to 0
3rd press	**Filter Life Monitor**	**" F"**	**" M "**
	Present life of filter is OK	" O "	" K"
	Present life of filter is low	" L"	" O"
4th press	**Transmission Health Monitor**	**" O "**	**" K"**
	Shows "OK" until remaining life of one or more of the clutch(es) wear enough so that the programming changes	" O "	" K"
	One or more of the clutches C1 through C5 have worn enough to change the program	" L"	" O"
5th press	**Display of diagnostic codes**	**" d "**	**" 1"**
	Other codes will be displayed		

TABLE 1

Recommended Fluid and Filter Change Intervals Using Dexron-III / Non-TranSynd™/Non-TES 295/Mixture							
Severe[3] All vehicles equipped with retarder				General[4] All vehicles without retarder			
Fluid	Filters			Fluid	Filters		
	Main	Internal	Lube/ Auxiliary		Main	Internal	Lube/ Auxiliary
12,000 Miles (20 000 km) 6 Months/ 500 Hrs	12,000 Miles (20 000 km) 6 Months/ 500 Hrs	Overhaul	12,000 Miles (20 000 km) 6 Months/ 500 Hrs	25,000 Miles 40 000 km 12 Months/ 1000 Hrs	25,000 Miles 40 000 km 12 Months/ 1000 Hrs	Overhaul	25,000 Miles (40 000 km) 12 Months/ 1000 Hrs

2 inch Control Module (1.75 approximately) – Requires High-Capacity Filter kit Allison P/N 571709

TABLE 2

Recommended Fluid and Filter Change Intervals[1] Using 100% TranSynd™/TES 295 Approved Fluid[2]							
Severe[3] All vehicles equipped with retarder				General[4] All vehicles without retarder			
Fluid	Filters			Fluid	Filters		
	Main	Internal	Lube/ Auxiliary		Main	Internal	Lube/ Auxiliary
150,000 Miles (240 000 km) 48 Months/ 6000 Hrs	75,000 Miles (120 000 km) 36 Months/ 3000 Hrs	Overhaul	75,000 Miles (120 000 km) 36 Months/ 3000 Hrs	300,000 Miles 480 000 km 48 Months/ 6000 Hrs	75,000 Miles (120 000 km) 36 Months/ 3000 Hrs	Overhaul	75,000 Miles (120 000 km) 36 Months/ 3000 Hrs

[1] Extended TrandSynd™/TES 295 fluid and filter change intervals are only allowed with Allison High-Capacity filters.

[2] Less than 100% concentration of TranSynd™/TES 295 approved fluid is considered a mixture and should utilize non-TES 295 change intervals. If the customer replaces non-TranSynd™/non-TES 295 fluid with TranSynd™/TES 295 equivalent, the change interval recommendations of non-TranSynd™/non-TES 295/mixture must be followed. Upon the next oil change, if the customer reinstall TranSynd™/TES 295 equivalent, the fluid & filter change recommendation outlined in 100% TES 295 approved fluids must be followed.

[3] Severe vocation= All retarder, On/Off highway, transit and intercity coach with duty cycle greater than one (1) stop per mile.

[4] General vocation= intercity coach with duty cycle less than or equal to one (1) stop per mile and all other vocations not listed in severe vocation.

TABLE 3

Recommended Fluid and Filter Change Intervals Using 100% TranSynd™/TES 295 Approved Fluid And Gold Series Filters							
Coaches equipped with retarder				Coaches without retarder			
Fluid	Filters			Fluid	Filters		
	Main Initial Break-in 5,000 miles (8,000 km)/ 200 Hrs	Internal	Lube/ Auxiliary		Main Initial Break-in 5,000 miles (8,000 km)/ 200 Hrs	Internal	Lube/ Auxiliary
50,000 Miles (80 000 km) 24 Months/ 2000 Hrs	50,000 Miles (80 000 km) 24 Months/ 2000 Hrs	Overhaul	50,000 Miles (80 000 km) 24 Months/ 2000 Hrs	150,000 Miles 240 000 km 48 Months/ 4000 Hrs	50,000 Miles 80 000 km 24 Months/ 2000 Hrs	Overhaul	50,000 Miles (80 000 km) 24 Months/ 2000 Hrs

3.1.12 Oil And Filter Change Interval

- Oil and Filter Change interval With Prognostics Mode Disabled

Allison transmissions are factory fill with **Castrol TranSynd**™ fluid. Oil change must be performed with the vehicle on a flat and level surface and with parking brake applied. Oil and oil filter change frequency is determined by the severity of service and operating conditions of the transmission and by the filter equipment installed. See *"TABLE 1, TABLE 2 or TABLE 3"* for oil and filter change intervals. More frequent changes may be required when operations are subject to high levels of contamination or overheating. Filters must be changed at or before recommended intervals.

IMPORTANT NOTE

Allison Transmission recommends that customers use fluid analysis as the primary method for determining fluid change intervals. Many customers have a systematical annual transmission fluid change while, in many cases, fluid analysis could demonstrate that the transmission fluid is still in good condition and a fluid change is not required. In the absence of a fluid analysis program, the fluid change interval listed in TABLE 1, TABLE 2 & TABLE 3 should be used.

IMPORTANT NOTE

*Your transmission is equipped with **High Capacity filters**. High Capacity filters allow for increased fluid and filter change intervals in transmissions utilizing TES 295 approved fluid/TranSynd™. High Capacity filters eliminate the requirement of the initial 5000 miles (8000km) main filter change.*

Former Gold Series filter kits are completely cancelled and serviced with current High Capacity filter kits. However, if you are using stocked Gold Series filter kits with TES 295 approved fluid/TranSynd™, use TABLE 3 for oil and filter change intervals.

- Oil And Filter Change Interval With Prognostics Mode Enabled

Oil Life Monitor and Filter Life Monitor of the Prognostics mode provide indicators of required maintenance actions. They are designed to maximize fluid and filter utilization. **Prognostics enabled requires the use of 100% TranSynd™ or an Allison approved TES-295 transmission fluid and Allison High Capacity filters**. If any other fluids or filters are used, Prognostic mode **must be disabled**. Prognostic information will not be accurate with any other fluids or filters and could result in missed maintenance activities resulting in transmission damage.

IMPORTANT NOTE

The following schedule is to be used with Prognostics enabled.

*100% concentration of TES-295 Allison approved fluids and Allison High Capacity Filters is **required**. Less than 100% concentration of TES-295 Allison approved fluids are considered a mixture and shall not be used with Prognostics mode or this change schedule. Utilization of previous Non-TES 295 fluid/filter change intervals (Table 1) is required.*

	General or Severe Vocation
FLUIDS Prognostics enabled	Change fluid when indicated by TRANSMISSION SERVICE indicator or 60 month (five years) whichever occurs first. In addition, change filters with fluid.
FILTERS Prognostics enabled	Change filters (Main & Lube) when indicated by TRANSMISSION SERVICE indicator between fluid change or 60 month (five years) whichever occurs first.

- Changing The Transmission Oil And Oil Filters

The procedure for changing the transmission oil and oil filters is as follows:

Drain

1. The transmission should be at an operating temperature of 160ºF (71ºC) to 200ºF (93ºC) when the oil is drained. This will ensure quicker and more complete fluid drainage.

NOTE

Remove transmission protective panel located underneath transmission for easier access.

2. Remove the drain plug from under the transmission (Fig. 7) and allow the oil to drain into a suitable container. Check the condition of the oil as described previously.
3. To replace the integral filters, remove twelve bolts (6 on each cover), two filter covers, two O-rings, two square cut seals and the two filters from the bottom of the control module (Fig. 7).
4. To install filters, pre-lube and install the two O-rings, the two square cut seals followed by the filters (lube the O-ring in filter cartridge only) into the filter compartment. Index each filter/cover assembly to holes in channel plate/sump. Push the cover assembly in by hand to seat the seals.

⚠ CAUTION

Do not use bolts to draw the cover to sump. This can damage the cover, seal, or sump.

5. Install twelve bolts and both covers, and then tighten to 38-45 lbf-ft (51-61 Nm).

6. Inspect the drain plug and O-ring. Replace if necessary. Reinstall the drain plug and tighten to 18-24 lbf-ft (25-32 Nm).
7. Reinstall transmission protective panel

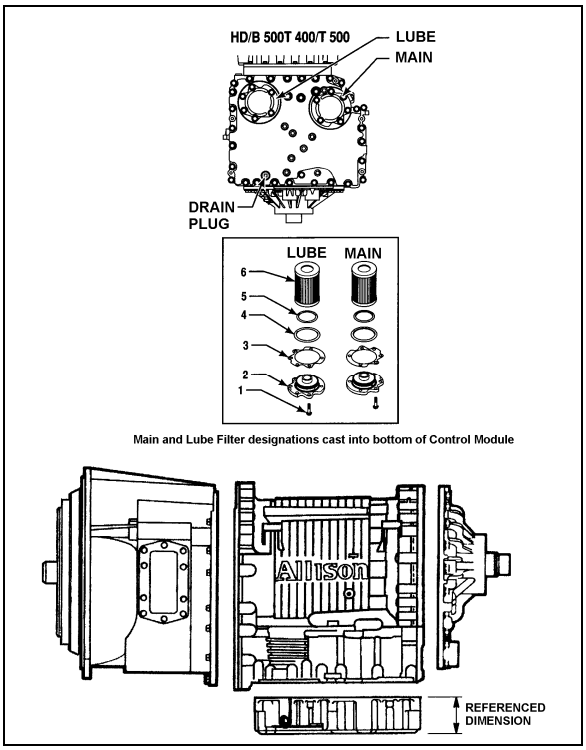


FIGURE 7: DRAIN PLUG AND FILTERS 07074

Fluid loss with filter change only

When changing main and lube filters at recommended intervals, approximate fluid loss for each filter as follows:

Main filter = 2 quarts (1.9 liters)
Lube filter =8 quarts (7.6 liters)

Refilling Transmission

The amount of refill fluid is less than the amount used for the initial fill. Fluid remains in the external circuits and transmission cavities after draining the transmission.

NOTE
Quantities listed above are approximations and do not include external oil cooler lines.

Using the oil level dipstick filler tube, refill with 24 US qts (23 liters) [28 US qts (26.5 liters) if equipped with retarder] and check the oil level using the **Fluid Level Check Using Pushbutton Shift Selector** procedure in this section.

3.2 VOLVO I-SHIFT TRANSMISSION

All information needed for the removal /installation or maintenance of the Volvo I-Shift transmission is included in the documents annexed at the end of this section.

3.2.1 Transmission Oil

⚠ **CAUTION**
Only use Castrol Syntrans SAE 75W85 (Prevost #684516) gearbox oil in the I-Shift transmission. Using non-approved oil can result in damage to transmission components.

⚠ **CAUTION**
Never reuse drained I-Shift oil. The oil must be replaced along with the oil filter. Reusing drained oil can result in damage to transmission components.

Keep the transmission oil at the proper level and change it at the Volvo recommended intervals. Always replace the oil filter when the oil is changed (#20779040). Always use the Volvo approved synthetic oil whenever adding or changing the transmission oil.

3.2.2 Checking Oil Level

Check the transmission oil level at each service interval. Park the vehicle on a level surface. Check the oil level through the sight glass on the side of the transmission. Add oil as necessary. Always use the correct Volvo approved synthetic oil (Castrol Syntrans SAE 75W85).

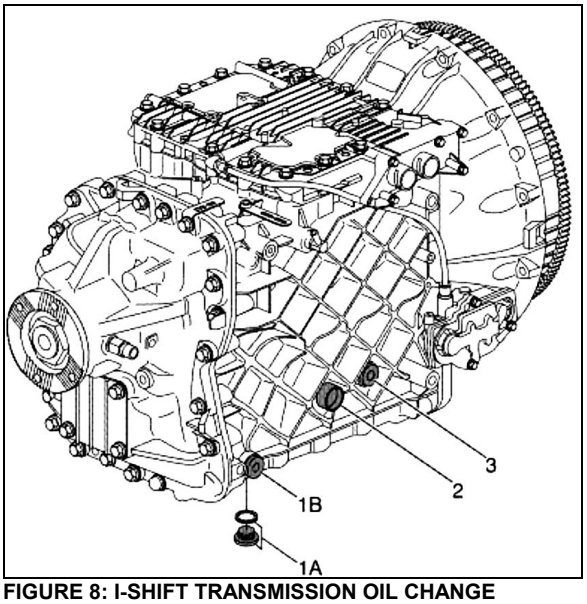


FIGURE 8: I-SHIFT TRANSMISSION OIL CHANGE

- Vehicle should be on horizontal ground when oil is changed;
- Do not check oil level straight after a journey (incorrect measurement). Undertake the check once the transmission oil has cooled down (lower than 104°F or 40 °C);
- Check oil level using transmission sight glass (2, Fig. 8) ;

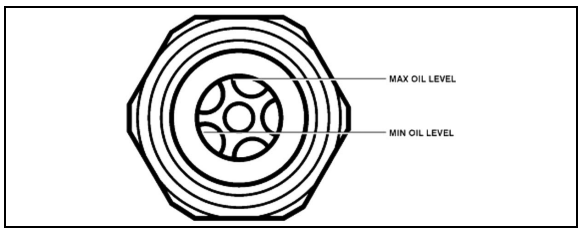


FIGURE 9: SIGHT GLASS FOR CHECKING OIL LEVEL

- Add oil through the oil filling point if necessary (3, Fig. 8) ;
- Torque tighten fill plug to 26±4 Lb-Ft (35±5 Nm).

3.2.3 Oil Change Interval

The length of time a transmission can operate before an oil change is required depends on the quality of the oil used and the vehicle application.

For on-highway applications, change the transmission oil every 800 000 km (500,000 miles) or every 5 years. This extended oil change interval only applies when using Castrol Syntrans SAE 75W85. Always replace the oil filter when the oil is changed. For all other vehicle applications or if not using Castrol Syntrans SAE 75W85, change the transmission oil every 400 000 km (250,000 miles) or every 3 years.

3.2.4 Oil Change

Approximately 15 liters (16 quarts) is needed for a complete oil change.

WARNING

Hot oil can cause burns. DO NOT allow hot oil to contact the skin. When changing oil, wear protective gloves.

Remove the drain plug from under the transmission (1A or 1B, Fig. 8) and allow the oil to drain into a suitable container.

Inspect the drain plug and O-ring. Replace if necessary. Reinstall the drain plug and tighten to 26±4 Lb-Ft (35±5 Nm).

CAUTION

Always dispose of all lubricants (engine oil, coolant, transmission oil, etc) and filters according to Federal or local regulations.

Change the oil filter (#20779040) at every oil change. Drain the oil filter housing before you remove the filter.

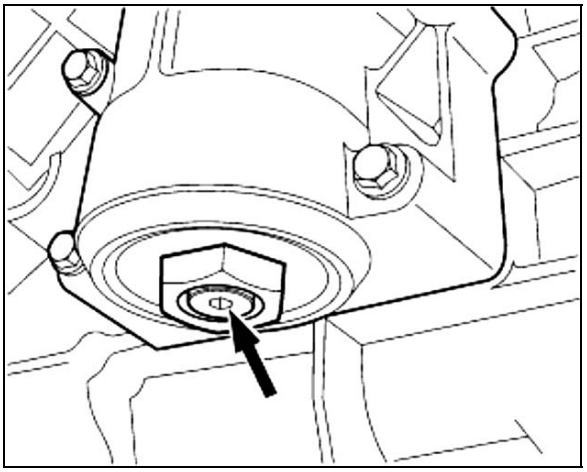


FIGURE 10: OIL FILTER HOUSING DRAIN PLUG

NOTE

Torque tighten oil filter housing drain plug to 12±1 Lb-Ft (16±2 Nm).

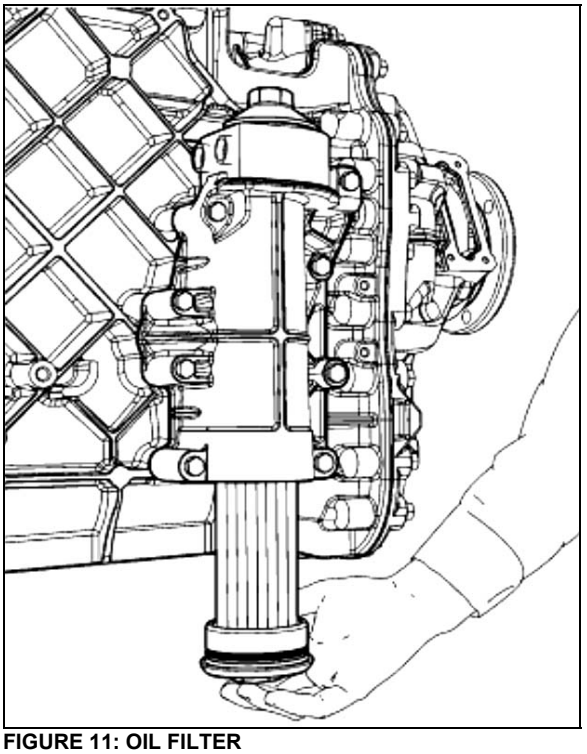


FIGURE 11: OIL FILTER

4. ALLISON TRANSMISSION REMOVAL

The following procedure deals with the removal of the Allison transmission without removing the power plant cradle from vehicle. The methods used to support the transmission and engine depend upon conditions and available equipment.

1. Select transmission's "NEUTRAL" position, apply parking brake, then set battery master switch to the "OFF" position.
2. Jack up vehicle, then place safety supports underneath body.

CAUTION

Only the recommended jacking points must be used as outlined in Section 18, "BODY".

NOTE

For more clearance between the tag axle and transmission, the tag axle may be unloaded and jacked up or retracted (if applicable).

3. Remove engine splash guards and protective panels surrounding transmission.
4. Remove cross member from under transmission.
5. Remove the transmission drain plug and allow oil to drain. Inspect the drain plug washer and replace it if necessary. Reinstall the drain plug and tighten to 33-41 lbf-ft (45-56 Nm) (see *"3.1.12 Oil and Filter Change"* in this section.

WARNING

It is better to drain oil when it is still warm. Avoid contact with oil since it can be very hot and cause personal injury.

6. Remove transmission dipstick and filler tube.
7. Disconnect propeller shaft from transmission and remove its safety guard. Refer to Section 09, *"PROPELLER SHAFT".*
8. Disconnect the two oil cooler hoses from transmission. Cover hose ends and fittings to prevent fluid contamination.

WARNING

A significant amount of oil may drain from oil lines when they are disconnected.

9. Disconnect all sensors on L.H. side of the transmission.
10. Disconnect main wiring harness.
11. Disconnect the air supply line (steel-braided hose) from retarder control valve (if applicable).
12. Remove any locking tie, clamp and bracket that may interfere with the removal of transmission.
13. Support transmission using a suitable transmission jack.

NOTE

Remove starter motor located on engine L.H. side. Removing the starter motor will allow access to unfasten the 12 converter-to-flexible plate attaching screws. Remove the plug located below starter motor and install cranking tool (88800014). Cranking the engine to gain access to the attaching screws may be done by turning the cranking tool using a suitable adapter (fig. 12).

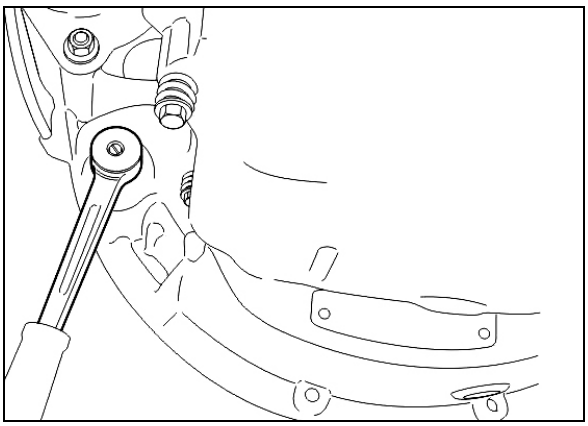


FIGURE 12: VOLVO ENGINE CRANKING POSITION

CAUTION

Do not rotate alternator shaft clockwise to avoid removing tension on belt.

14. Remove the 12 screws retaining the torque converter housing to the flywheel housing.

CAUTION

Make sure transmission-to-engine alignment is maintained when removing screws to avoid damaging torque converter housing.

15. Slowly pull transmission straight out to clear the engine.

16. Remove the transmission.

5. TRANSMISSION OIL COOLER REMOVAL

5.1 TRANSMISSION WITHOUT RETARDER

Stop engine and allow engine to cool. Close both heater line shutoff valves (refer to Section 05 *''Cooling''*).

To drain the cooling system, proceed as per Section 05 *''Cooling''*, paragraph 5: Draining. If the cooling system is contaminated, flush system as per Section 05 *''Cooling''*, paragraph 7: Flushing.

1. Remove the rear L.H. side tag axle wheel, then remove the rear L.H. side fender panel.
2. Disconnect the two transmission hoses from oil cooler. Cover hose ends and fittings to prevent fluid contamination (Refer to fig.13).

WARNING

A significant amount of oil may drain from oil lines when they are disconnected.

3. Unfasten the constant-torque hose clamps and remove the two hoses.
4. Unscrew the four holding nuts and remove the U-bolts, remove the oil cooler from engine compartment.
5. Reinstall transmission oil cooler by using reverse procedure.

5.2 TRANSMISSION WITH RETARDER

Stop engine and allow engine to cool. Close both heater line shutoff valves (refer to Section 05 *''Cooling''*).

1. To drain the cooling system, proceed as per Section 05 *''Cooling''*, paragraph 5: Draining. If the cooling system is contaminated, flush system as per Section 05 *''Cooling''*, paragraph 7: Flushing.
2. Remove the rear L.H. side tag axle wheel, then remove the rear L.H. side fender panel.
3. Disconnect the transmission hoses from oil cooler. Cover hose ends and fittings to prevent fluid contamination.

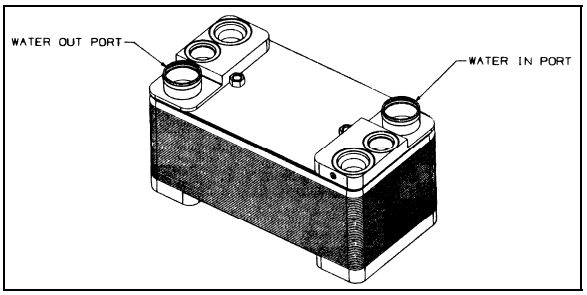


FIGURE 13: ALLISON OIL COOLER

WARNING

A significant amount of oil may drain from oil lines when they are disconnected.

4. Unfasten the constant-torque hose clamps and remove the two hoses.
5. Unscrew the holding bolts and nuts and remove the oil cooler from engine compartment.

6. CLEANING AND INSPECTION OF ALLISON AUTOMATIC TRANSMISSION

The exterior of the transmission should be cleaned and inspected at regular intervals. The length of service and severity of operating conditions will determine the frequency of such inspections. Inspect the transmission for:

1. Loose bolts (transmission and mounting components);
2. Oil leaks (correct immediately);
3. Loose, dirty, or improperly adjusted throttle sensor linkage;
4. Damaged or loose oil lines;
5. Worn or frayed electrical harnesses, improper routing;
6. Worn or out of phase drive line U-joint and slip fittings.

CAUTION

DO NOT pressure wash the transmission electrical connectors. Water and detergent will cause the contacts to corrode or become faulty.

6.1 BREATHER

The breather is located on the engine, flywheel side near the valve cover. It serves to prevent pressure build-up within the transmission and

must be cleaned to keep the passage opened. The prevalence of dust and dirt will determine the frequency at which the breather requires cleaning. Use care when cleaning the engine. Spraying steam, water or cleaning solution directly at the breather can force the water or solution into the transmission. Always use care when removing the hose connector from transmission to prevent the entry of foreign matter.

7. ALLISON TRANSMISSION INSTALLATION

NOTE

For more clearance between the tag axle and transmission, the tag axle may be unloaded and jacked up, or retracted (if applicable).

1. With the starter motor removed, align one of the 12 attaching screw holes in the flexible plate with the access opening.
2. Place the transmission on a transmission jack.
3. Install a headless guide bolt into one of the 12 threaded holes for flexible plate attaching screws in the flywheel.
4. Lubricate the flywheel center pilot boss with molybdenum disulfide grease (Molycote G, or equivalent).
5. Raise transmission and position the flywheel pilot boss into the flexible plate adapter. Align the guide bolt previously installed in the flywheel with the flexible plate hole facing the access opening in the flywheel housing.

DANGER

Severe damages and/or personal injury can occur if transmission is not adequately supported.

5. Seat the transmission against the engine flywheel housing. NO FORCE IS REQUIRED. If interference is encountered, move the transmission away from engine, then investigate the cause.

CAUTION

The torque converter housing must be seated against the flywheel housing prior to tightening any screws. DO NOT USE SCREWS TO SEAT THE HOUSING.

6. Start all torque converter housing screws, and then tighten four of them gradually and in a criss-cross sequence around the housing. Tighten the 12 remaining screws. Recommended torque is between 42-50 lbf-ft (57-68 Nm).
7. Remove the guide bolt through the access opening in the flywheel housing. Replace it with a self-locking screw, finger-tighten then start the remaining screws; tighten to 17-21 lbf-ft (23-28 Nm).

NOTE

Remove the plug located below starter motor and install cranking tool (88800014). Crank the engine to gain access to the threaded holes by turning the cranking tool using a suitable adapter (Refer to fig. 12).

Reinstall starter motor and connect cables.

Reinstall access plug below starter motor.

8. Remove jack from under transmission.
9. Connect all sensors.
10. Connect the main wiring harness.
11. Connect the air supply line (steel-braided hose) to the retarder control valve (if applicable).
12. Connect the two transmission oil cooler hoses as they were previously.
13. Reinstall clamps and brackets, and replace locking ties previously removed during removal procedure.
14. Install propeller shaft and its safety guard. Refer to Section 09, *"PROPELLER SHAFT".*
15. Install transmission dipstick and filler tube.
16. Install cross member under transmission.
17. Install engine splash guards.
18. Adjust the retarder pressure to 85 ± 3 psi with the air pressure regulator. For more information refer to Section 12, *"BRAKE AND AIR SYSTEM*", under heading *"AIR PRESSURE REGULATOR".* The air pressure regulator is located in the engine compartment, on engine cradle R.H. side (Fig. 14).
19. Make sure that the drain plug is in place, and then remove the transmission dipstick and pour approximately 24 US quarts (23 L) of

automatic transmission fluid through the filler tube. Check and adjust oil level.

> **⚠ CAUTION**
>
> Do not overfill the transmission. Overfilling can cause oil aeration (milky appearance) and overheating. If overfilling occurs, drain oil as required to bring it to the proper level.

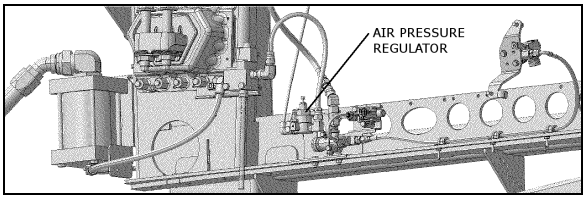


FIGURE 14: AIR PRESSURE REGULATOR (TYPICAL) 07130

8. ALLISON AUTOMATIC TRANSMISSION TROUBLESHOOTING

For complete information about Allison transmission troubleshooting, refer to ''Allison 4th Generation Controls – Troubleshooting Manual: 3000 and 4000 Product families (TS3989)".

8.1 4TH GENERATION TRANSMISSION CONTROL MODULE

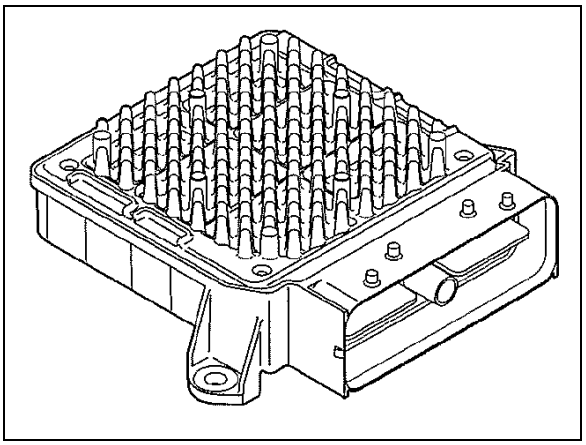


FIGURE 15: TRANSMISSION CONTROL MODULE 07140

The Allison transmission has a new Transmission Control Module (TCM) which involves specific diagnostic incident codes. The TCM unit is located in the coach rear electrical compartment.
TCM Replacement

The TCM is a non-serviceable electronic device. When it fails, it must be replaced using the following procedure:

- Open the coach rear baggage compartment then remove the rear electrical compartment door in order to get access to the TCM;
- Remove the electrical cable connectors;
- Unscrew the TCM unit;
- Replace by reversing the procedure.

> **⚠ CAUTION**
>
> Place the battery master switch to the ''OFF'' position.

8.2 DIAGNOSTIC TROUBLESHOOTING CODES (DTC) — ALLISON 4TH GENERATION CONTROLS

Diagnostic codes (DTC) are numerical indications relating to a malfunction in transmission operation. These codes are logged in a list in the TCM memory with the most severe or most recent code listed first. A maximum of five codes (numbered d1 to d5) may be listed in memory at one time. As codes are added, the oldest inactive code is dropped from the list. If all codes are active, the code with the lowest priority that is not included on the severity list is dropped from the list.

Diagnostic codes (DTC) and code information may be accessed through the pushbutton shift selector or using an Allison DOC™ diagnostic tool.

The TCM separately stores the active and inactive codes. An active code is any code that is current in the TCM decision-making process. Inactive codes are codes that are retained in the TCM memory and will not necessary affect the TCM decision-making process. Inactive codes are useful in determining if a problem is:

- Isolated ;
- Intermittent ;
- Result from a previous malfunction.

The TCM may automatically delete a code from memory if it has not recurred. If the MODE INDICATOR (LED) is not illuminated, the displayed code is not active. An illuminated MODE INDICATOR (LED) during normal operation signifies secondary shift mode operation.

8.3 DIAGNOSTIC CODES – ALLISON 4TH GENERATION CONTROLS

When the diagnostic mode is entered, the first code (position d1) is displayed as follows:

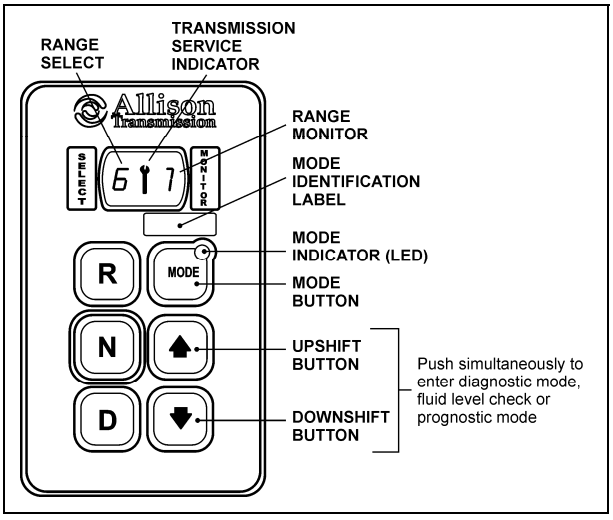
Example: Code P0722

Displayed as: **d1**…**P**…**07**…**22**

The code list position is the first item displayed, followed by the DTC. Each item is displayed for about one second. The display cycles continuously until the next code list position is accessed by pressing the **MODE** button. The following example shows how DTC P0722 is displayed on the pushbutton shift selector.

SELECT			MONITOR
	d	1	
		P	
	0	7	
	2	2	

- d1 (code list position) – The position which a code occupies in the list. Positions are displayed as « d1 » through « d5 » (code list position 1 through code list position 5).
- P0722 (DTC) – The diagnostic troubleshooting code number referring to the general condition or area of fault detected by the TCM.



8.4 DIAGNOSTIC CODE DISPLAY AND CLEARING PROCEDURE – ALLISON 4TH GENERATION CONTROLS

Diagnostic codes can be read and cleared by two methods:

- Using an Allison DOC™ diagnostic tool. For specific instructions on how to use an Allison DOC™ diagnostic tool, refer to the User Guide.
- Using the pushbutton shift selector.

To begin the diagnostic process:

1. Bring the vehicle to a stop at a safe location.
2. Apply the parking brake.

To display stored codes:

1. Simultaneously press the ▲ (Up) and ▼ (Down) arrow buttons twice to access the Diagnostic Display Mode.

NOTE
To access the Oil Level Display Mode, simultaneously press the ▲ *(Up) and* ▼ *(Down)* arrow buttons *once. Consult paragraph: « ALLISON TRANSMISSION OIL LEVEL CHECK USING THE PUSHBUTTON SHIFT SELECTOR » at the end of this section.*

2. Observe the digital display for code (d1).
3. Press the MODE button to see the next code (d2) – repeat for subsequent codes (d3, d4 & d5).

NOTE
Be sure to record all codes displayed before they are cleared. This is essential for troubleshooting.

NOTE
The Diagnostic Display Mode can be entered for viewing codes at any speed. Codes can only be cleared when the output speed = 0 and no output speed sensor failure is active

Active indicators (MODE INDICATOR LED) and inactive codes can be cleared manually, while in the diagnostic display mode, after the condition causing the code is identified.

To clear active indicators and inactive codes:

1. While in Diagnostic Display Mode, press and hold the MODE button for 10 seconds to clear both active indicators and inactive codes.
2. Begin operating as normal. Have the transmission checked at the earliest opportunity by an Allison Transmission distributor or dealer.

NOTE
All active indicators are cleared at TCM power down. *Some codes will clear their active indicator when the condition causing the code is no longer detected by the TCM.*

The Diagnostic Display Mode can be exited by any of the following methods:

- Press simultaneously the ▲ (Up) and ▼ (Down) arrow buttons at the same time on the pushbutton shift selector.
- Press any range button «D», «N» or «R» on the pushbutton shift selector (the shift will be commanded if it is not inhibited by an active code).
- Wait until the calibrated time (approximately 10 minutes) has passed. The system will automatically return to the normal operating mode.
- Turn off power to the TCM (shut off the engine using the ignition key).

NOTE
If clearing a code while locked in a «D» (Drive) or «R» (Reverse) position (fail-to-range), the transmission will still be in «D» (Drive) or «R» (Reverse) when the clearing procedure is completed. «N» (Neutral) must be manually selected.

8.5 DIAGNOSTIC CODE RESPONSE

The following responses are used in the "Diagnostic Troubleshooting Code List and Inhibited Operation Description" table to command safe operation when diagnostic codes are sent.

DNS - Do Not Shift Response

Release lock up clutch and inhibit lock up operation.

Inhibit all shifts.

Turn *ON* the CHECK TRANS light.

Display the range attained.

Ignore any range selection inputs from the shift selector.

DNA - Do Not Adapt Response

The TCM stops adaptive shift control while the code is active.

SOL OFF - SOLenoid OFF Response

All solenoids are commanded *OFF* (turning solenoids “A” and “B” off electrically cause them to be on hydraulically).

RPR - Return to Previous Range Response

When the speed sensor ratio or C3 pressure switch test associated with a shift not successful, the TCM commands the same range as commanded before the shift.

NNC - Neutral No Clutches Response

When certain speed sensor ratio or C3 pressure switch tests are not successful, the TCM commands a neutral condition with no clutches applied.

8.6 DIAGNOSTIC TROUBLESHOOTING CODES (DTC) LIST - ALLISON 4TH GENERATION CONTROLS

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
C1312	Retarder Request Sensor Failed Low	No	May inhibit retarder operation if not using J1939 datalink
C1313	Retarder Request Sensor Failed High	No	May inhibit retarder operation if not using J1939 datalink
P0122	Pedal Position Sensor Low Voltage	No	Use default throttle values. Freezes shift adapts.
P0123	Pedal Position Sensor High Voltage	No	Use default throttle values. Freezes shift adapts.
P0218	Transmission Fluid Over Temperature	No	Use hot mode shift schedule. Holds fourth range. TCC is inhibited. Freezes shift adapts.
P0561	System Voltage Performance		
P0562	System Voltage Low		
P0563	System Voltage High		
P0602	TCM Not Programmed	Yes	Lock in Neutral
P0610	TCM Vehicle Options (Trans ID) Error	Yes	Use TID A calibration
P0613	TCM Processor	No	All solenoids off
P0614	Torque Control Data Mismatch - ECM/TCM	Yes	Allows operation only in reverse and second range.
P0634	TCM Internal Temperature Too High	Yes	SOL OFF (hydraulic default)
P063E	Auto Configuration Throttle Input Not Present	Yes	Use default throttle values
P063F	Auto Configuration Engine Coolant Temp Input Not Present	No	None
P0658	Actuator Supply Voltage 1 (HSD1) Low	Yes	DNS, SOL OFF (hydraulic default)
P0659	Actuator Supply Voltage 1 (HSD1) High	Yes	DNS, SOL OFF (hydraulic default)
P0667	TCM Internal Temperature Sensor Circuit Range / Perform		
P0668	TCM Internal Temperature Sensor Circuit Low		
P0669	TCM Internal Temperature Sensor Circuit High		
P0701	Transmission Control System Performance		
P0702	Transmission Control System Electrical (TransID)	Yes	Use TID A calibration
P0703	Brake Switch Circuit Malfunction	No	No Neutral to Drive shifts for refuse packer. TCM inhibits retarder operation if a TPS code is also active.
P0708	Transmission Range Sensor Circuit High Input	Yes	Ignore defective strip selector inputs
P070C	Transmission Fluid Level Sensor Circuit – Low Input	No	None
P070D	Transmission Fluid Level Sensor Circuit – High Input	No	None
P0711	Transmission Fluid Temperature Sensor Circuit Performance	Yes	Use default sump temp
P0712	Transmission Fluid Temperature Sensor Circuit Low Input	Yes	Use default sump temp
P0713	Transmission Fluid Temperature Sensor Circuit High Input	Yes	Use default sump temp
P0716	Turbine Speed Sensor Circuit Performance	Yes	DNS, Lock in current range
P0717	Turbine Speed Sensor Circuit No Signal	Yes	DNS, Lock in current range
P0719	Brake Switch ABS Input Low	No	TCM assumes ABS is OFF

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
P071A	RELS Input Failed On	Yes	Inhibit RELS operation
P071D	General Purpose Input Fault	Yes	None
P0720	Output Speed Sensor Circuit		
P0721	Output Speed Sensor Circuit Performance	Yes	DNS, Lock in current range
P0722	Output Speed Sensor Circuit No Signal	Yes	DNS, Lock in current range
P0726	Engine Speed Sensor Circuit Performance	No	Default to turbine speed
P0727	Engine Speed Sensor Circuit No Signal	No	Default to turbine speed
P0729	Incorrect 6th Gear Ratio	Yes	DNS, Attempt 5th, then 3rd
P0730	Incorrect Neutral Gear ratio		
P0731	Incorrect 1st Gear ratio	Yes	DNS, Attempt 2nd, then 5th
P0732	Incorrect 2nd Gear ratio	Yes	DNS, Attempt 3rd, then 5th
P0733	Incorrect 3rd Gear ratio	Yes	DNS, Attempt 4th, then 6th
P0734	Incorrect 4th Gear ratio	Yes	DNS, Attempt 5th, then 3rd
P0735	Incorrect 5th Gear ratio	Yes	DNS, Attempt 6th, then 3rd, then 2nd
P0736	Incorrect Reverse Gear ratio	Yes	DNS, Lock in Neutral
P0741	Torque Converter Clutch System Stuck Off	Yes	None
P0776	Pressure Control Solenoid 2 Stuck Off	Yes	DNS, RPR
P0777	Pressure Control Solenoid 2 Stuck On	Yes	DNS, RPR
P0796	Pressure Control Solenoid 3 Stuck Off	Yes	DNS, RPR
P0797	Pressure Control Solenoid 3 Stuck On	Yes	DNS, RPR
P0842	Transmission Pressure Switch 1 Circuit Low	Yes	DNS, Lock in current range
P0843	Transmission Pressure Switch 1 Circuit High	Yes	DNS, Lock in current range
P0847	Transmission Pressure Switch 2 Circuit Low		
P0848	Transmission Pressure Switch 2 Circuit High		
P088A	Transmission Fluid Filter Deteriorated		
P088B	Transmission Fluid Filter Very Deteriorated		
P0880	TCM Power Input Signal	No	None
P0881	TCM Power Input Signal Performance	No	None
P0882	TCM Power Input Signal Low	Yes	DNS, SOL OFF (hydraulic default)
P0883	TCM Power Input Signal High	No	None
P0894	Transmission Component Slipping	Yes	DNS, Lock in first
P0960	Pressure Control Solenoid Main Mod Control Circuit Open	Yes	None
P0961	Pressure Control Solenoid (PCS) MM System Performance		
P0962	Pressure Control Solenoid Main Mod Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P0963	Pressure Control Solenoid Main Mod Control Circuit High	Yes	None
P0964	Pressure Control Solenoid 2 (PCS2) Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P0965	Pressure Control Solenoid (PCS) 2 System Performance		
P0966	Pressure Control Solenoid 2 (PCS2) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P0967	Pressure Control Solenoid 2 (PCS2) Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P0968	Pressure Control Solenoid 3 (PCS3) Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P0969	Pressure Control Solenoid (PCS) 3 System Performance		
P0970	Pressure Control Solenoid 3 (PCS3) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
P0971	Pressure Control Solenoid 3 (PCS3) Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P0973	Shift Solenoid 1 (SS1) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P0974	Shift Solenoid 1 (SS1) Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P0975	Shift Solenoid 2 (SS2) Control Circuit Open	Yes	7-speed: Allow 2 through 6, N, R
P0976	Shift Solenoid 2 (SS2) Control Circuit Low	Yes	7-speed: Allow 2 through 6, N, R Inhibit TCC operation
P0977	Shift Solenoid 2 (SS2) Control Circuit High	Yes	7-speed: Allow 2 through 6, N, R
P0989	Retarder Pressure Sensor Failed Low	No	None
P0990	Retarder Pressure Sensor Failed High	No	None
P1739	Incorrect Low Gear Ratio	Yes	Command 2nd and allow shifts 2 through 6, N, R
P1891	Throttle Position Sensor PWM Signal Low Input	No	Use default throttle values
P1892	Throttle Position Sensor PWM Signal High Input	No	Use default throttle values
P2184	Engine Coolant Temperature Sensor Circuit Low Input	No	Use default engine coolant values
P2185	Engine Coolant Temperature Sensor Circuit High Input	No	Use default engine coolant values
P2637	Torque Management Feedback Signal (SEM)	Yes	Inhibit SEM
P2641	Torque Management Feedback Signal (LRTP)	Yes	Inhibit LRTP
P2670	Actuator Supply Voltage 2 (HSD2) Low	Yes	DNS, SOL OFF (hydraulic default)
P2671	Actuator Supply Voltage 2 (HSD2) High	Yes	DNS, SOL OFF (hydraulic default)
P2685	Actuator Supply Voltage 3 (HSD3) Low	Yes	DNS, SOL OFF (hydraulic default)
P2686	Actuator Supply Voltage 3 (HSD3) High	Yes	DNS, SOL OFF (hydraulic default)
P2714	Pressure Control Solenoid 4 (PCS4) Stuck Off	Yes	DNS, RPR
P2715	Pressure Control Solenoid 4 (PCS4) Stuck On	Yes	DNS, SOL OFF (hydraulic default)
P2718	Pressure Control Solenoid 4 (PCS4) Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P2719	Pressure Control Solenoid (PCS) 4 System Performance		
P2720	Pressure Control Solenoid 4 (PCS4) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P2721	Pressure Control Solenoid 4 (PCS4) Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P2723	Pressure Control Solenoid 1 (PCS1) Stuck Off	Yes	DNS, RPR
P2724	Pressure Control Solenoid 1 (PCS1) Stuck On	Yes	DNS, RPR
P2727	Pressure Control Solenoid 1 (PCS1) Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P2728	Pressure Control Solenoid (PCS) 1 System Performance		
P2729	Pressure Control Solenoid 1 (PCS1) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P2730	Pressure Control Solenoid 1 (PCS1) Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P2736	Pressure Control Solenoid 5 (PCS5) Control Circuit Open	Yes	Inhibit retarder operation
P2737	Pressure Control Solenoid (PCS) 5 System Performance		
P2738	Pressure Control Solenoid 5 (PCS5) Control Circuit Low	Yes	Allow 2 through 6, N, R. Inhibit retarder and TCC operation
P2739	Pressure Control Solenoid 5 (PCS5) Control Circuit High	Yes	Inhibit retarder operation
P2740	Retarder Oil Temperature Hot	No	None
P2742	Retarder Oil Temperature Sensor Circuit – Low Input	No	Use default retarder temp values
P2743	Retarder Oil Temperature Sensor Circuit – High Input	No	Use default retarder temp values
P2761	TCC PCS Control Circuit Open	Yes	Inhibit TCC operation

9. VOLVO I-SHIFT TRANSMISSION TECU FAULT CODES

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
Brake switch	**PID65**	FMI14	Brake interlock active	***Activate:*** The gearlever is moved from neutral without prior application of the service brake ***Deactivate:*** The gearlever is returned to neutral or the vehicle speed is above 5km/h	White lamp is sent together with a pop-up message The transmission will not engage the selected gear (stays in neutral)	***Conditions for activation: (and)*** The brake interlock function is activated (VTNA vehicles only) The vehicle speed is below 5km/h The gear lever is moved from neutral or in folded position without prior activation of the service brake or parking brake ***Conditions for deactivation: (either)*** The vehicle speed is above 5km/h The gearlever is returned to neutral or folded position
Calibration memory	**SID253**	FMI13	Out of range	***Active:*** Flash CS dataset error or program code missing ***Deactivate:*** Flash CS OK	Yellow lamp is sent Cranking is inhibited Engine can not start	
Clutch cylinder slip point position	**PPID51**	FMI13	Calibration value out of range	***Activate:*** 1. The CS in NVRAM is not correct, or 2. The slip point has not been calibrated ***Deactivate:*** Slip point has been successfully calibrated	Yellow lamp is sent The vehicle can not drive	
Clutch load on plates	**PID50**	FMI0	Data valid but above normal operational range	***Activate:*** The calculated stored energy is above 200kJ. The energy calculation is time-based for VTNA and physical for others. ***Deactivate:*** 7.0s after activation and, energy below 180 kJ or neutral, or driving without clutch slip	Yellow lamp is sent Start gear changed to gear 1 in A/D, for RTC also in M The clutch is overheated The clutch is slowly engaged	Clutch load on plates are set without any filtering
Clutch load on plates		FMI11	Clutch protection active (unidentifiable error)	***Activate:*** Only activated for VTNA. Clutch slip more than 8.0s with vehicle movement less than 0.8m (e.g. hill holding event) ***Deactivate:*** 7.0s after activation and, acc pedal released more than 6.0s or neutral, or driving without clutch slip	Yellow lamp is sent Start gear changed to gear 1 in A/D, for RTC also in M There has been unnecessary clutch slip The clutch is slowly engaged	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
Clutch load on plates		FMI14	Special instructions	***Activate:*** If there is an attempt to start on a high range gear or above gear 4 in VTNA in manual mode ***Deactivate:*** The start gear is changed to an allowed gear	White lamp is sent Not possible to start	This fault code is not saved
Clutch plate wear condition	**PID36**	FMI0	Data valid but above normal operational range	***Activate:*** The clutch wear is more than or equal to "Service due position" ***Deactivate:*** The clutch disc is replaced and calibrated	Yellow lamp is sent If active during a long time the clutch may wear out and become damaged	
Clutch position sensor supply (SEPoC5V)	**PPID54**	FMI0	Data valid but above normal operational range	***Activate:*** Voltage is above normal range ***Deactivate:*** Voltage is within normal range	Yellow lamp is sent Reduced clutch performance Reduced gearbox comfort at start and marshalling Gear changes are slow	
Clutch position sensor supply (SEPoC5V)		FMI1	Data valid but below operational range	***Activate:*** Voltage is below normal range ***Deactivate:*** Voltage is within normal range	Yellow lamp is sent Reduced clutch performance Reduced gearbox comfort at start and marshalling Gear changes are slow	
Clutch system	**PSID27**	FMI0	Unintentional disengagement of the clutch	***Activate:*** 1. The clutch disengages when not commanded and, 2. There is no active fault code on the SEPoC and, 3. There is no active fault code for low air pressure and, 4. There is no active fault code on any of the clutch cylinder valves and, 5. The PCB temperature is above a specific limit ***Deactivate:*** The	Yellow lamp is sent Slow gear changes Low clutch performance	***Detailed conditions to activate/deactivate*** The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row in order to set the fault code: - The clutch has been engaged for less than 10s with inactive engagement valves - The clutch cylinder position has been at least 1mm below the engaged limit at some point during this time - The clutch leaves the engaged state - The clutch disengagement valves are inactive - There is no active fault code on any of the clutch

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
				clutch response is OK		cylinder position sensor (SEPoC) the clutch valves - There is no active fault code for low air pressure - The PCB temperature is above 10 dgC *The fault is deactivated if any of the following conditions are fulfilled:* - The clutch has been engaged for more than 20s with inactive engagement valves - There is an active fault code for the clutch cylinder position sensor (SEPoC)
Clutch system		FMI1	Unintentional engagement of the clutch	***Activate:*** 1. The clutch engages when not commanded and, 2. There is no active fault code on the SEPoC and, 3. There is no active fault code for low air pressure and, 4. There is no active fault code on any of the clutch cylinder valves and, 5. The PCB temperature is above a specific limit ***Deactivate:*** The clutch response is OK	Yellow lamp is sent Slow gear changes Low clutch performance	***Algorithm for activation/deactivation*** The following sequence must be passed three times (only once if the fault code-filter is switched OFF) in order to activate: - The clutch is near the disengaged position - All clutch valves are deactivated - The initial average clutch position is calculated during 0.1s - Wait for 3s - The final average clutch position is calculated during 0.1s - If the position has moved more than 1mm in the engagement direction, the FMI is set, else if the clutch has moved less than 0.2mm in the engagement direction the FMI is reset. *Additional conditions for activation:* *- There is no active fault code on any of the clutch cylinder position sensor (SEPoC) the clutch valves low air pressure* *- The PCB temperature is above 10dgC*
Clutch system		FMI7	Mechanical system not responding properly	***Activate:*** 1. The clutch does not disengage/engage properly when commanded 2. There is no active fault code on the SEPoC and, 3. There is no active fault code for low air pressure and, 4. There is no active fault code on any of the	Yellow lamp is sent Slow gear changes Low clutch performance	***Detailed conditions to activate/deactivate*** One of the following conditions must be fulfilled three times in a row in order to activate the fault: - The clutch position is more than 2mm from the disengaged position, after control of the clutch to the disengaged position during 1.0 s - The clutch position is not in the interval [set point +3mm; set point -1mm] after control of the clutch to near the slip

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
				clutch cylinder valves and, 5. The PCB temperature is above 10 dgC ***Deactivate:*** The clutch response is OK		point position during 1.0s - The clutch position is more than 2.5mm from the engaged position, after control of the clutch to the engaged position during 1.0s *The fault is deactivated after three successful occurrences, of control of the clutch to the requested position in 0.5s* The fault is also deactivated if - There is an active fault on the clutch position sensor - There is an active fault on any of the clutch valves - There is an active fault code for low air pressure - The PCB temperature is below 10 dgC
Clutch system		FMI12	Unintentional clutch slip	***Activate:*** The clutch can not transfer a specific torque without slipping ***Deactivate:*** The clutch can transfer a specific torque without slipping	Yellow lamp is sent The engine torque is reduced so that the clutch does not continue to slip	***Detailed conditions Activation:*** - Clutch slip is detected when the engine torque is already reduced below the "Clutch slip warning torque level" in an attempt to prevent clutch slip. The clutch slip warning level is 2500Nm for MD16 (TMF) variants and 2000Nm for other variants (SMF) - There is no active fault on any of: the sensor for the countershaft speed (SECS) the sensor for the clutch position (SEPoC) and the engine torque & engine speed is received from the engine ECU ***Deactivation:*** The clutch can transfer the maximum engine torque without slipping the fault is also deactivated at startup of the system
Clutch system		FMI11	Clutch drag	***Activate:*** The clutch transfers too much torque in disengaged position ***Deactivate:*** The clutch transfers no torque in disengaged position	Yellow lamp is sent The clutch wear is high	***Algorithm for activation/deactivation*** - Start the check when the counter shaft has been stopped with the brake during slip point calibration when the gearlever is in neutral during normal operation. - Release the brake and check the input shaft speed after 0.5s if input shaft speed > 300rpm, activate this fault code if input shaft speed < 300rpm, deactivate this fault code - Continue with the slip point calibration

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
Digital input flash NVRAM programming enable (DIEE)	**PSID254**	FMI3	Voltage above normal or shorted high	***Activate:*** The voltage level for DIEE-pin is high ***Deactivate:*** The voltage for the DIEE-pin is low	Yellow lamp is sent Cranking is inhibited Engine can not start All communication with the control unit is disabled except from programming of MSW	The boot-program does not save any fault codes
Digital input flash NVRAM programming enable (DIEE)		FMI3	Voltage above normal or shorted high	***Active:*** The voltage level for DIEE-pin is high ***Deactivate:*** The voltage for the DIEE-pin is low	Yellow lamp is sent	If the DIEE-pin is high during normal operation the fault code is saved.
Fast clutch valves low side (VAF-)	**PSID5**	FMI3	Voltage above normal or shorted high	***Activate:*** The low-side drive is short circuit to Ubatt ***Deactivate:*** The low-side drive is OK	Yellow lamp is sent Fast engagement/disengagement disabled Reduced clutch performance Gear changes are slow	
Fast clutch valves low side (VAF-)		FMI6	Current above normal or grounded circuit	***Activate:*** 1. The low-side drive is short circuit to Gnd and 2. There is no active fault code for short circuit to Gnd on VAFE or VAFD ***Deactivate: T***he low-side drive is OK	Yellow lamp is sent Fast engagement/disengagement disabled Reduced clutch performance Gear changes are slow	
Gearbox brake	**PSID28**	FMI7	Mechanical system not responding properly	***Activate:*** The gearbox brake does not brake when the valve is activated	Yellow lamp is sent Slow gear changes at standstill	***Detailed conditions*** The following conditions must be fulfilled for five activations (only one with the fault code-filter switched OFF) of the gearbox brake in order to activate the fault code: - The activation must last for at least 0.2s - There is no active fault code on the sensor for the split cylinder position (SEPoS) - The minimum valve of the derivative of the input shaft speed during activation is greater than -500 rpm/s - There is no active fault on any of the gearbox brake valve (VAGB) the sensor for the counter

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
						shaft speed (SECS) the sensor for the split cylinder position (SEPoS) low air pressure. The following conditions must be fulfilled for one activation of the gearbox brake ***in order to deactivate:*** - The minimum value of the derivative of the countershaft speed during the activation is greater than -1000rpm/s The fault is also deactivated if there is an active fault on the countershaft speed sensor (SESC), on the gearbox brake valve (VAGB), or the split position sensor (SEPoS)
Gears 1/R engagement system	**PSID25**	FMI0	Unintentional disengagement of 1:st gear	***Conditions to set the fault code:*** -The 1/R cylinder leaves the 1:st position -The 1:st cylinder valves are inactive	Yellow lamp is sent Loss of torque	***Detailed conditions to activate/deactivate*** The following conditions must be fulfilled three times (only one time if the fault code filter is switched OFF) in a row in order to set the fault code: (engagement of another gear will reset the count) - The 1/R cylinder position indicates that the 1/R gear leaves the 1:st position - The 1:st cylinder valves are inactive - There is no active fault on any of the sensor for the position of the 1/R cylinder (SEPo1R) the valve for shift to 1:st gear the valve for shift to reverse gear - There is no active fault code for low air pressure *Note: T*he fault will always have the state inactive. Check the fault count and last occurrence to get more information.
Gears 1/R engagement system		FMI1	Unintentional disengagement of reverse gear	***Conditions to set the fault code:*** -The 1/R gear leaves the reverse position -The 1/R cylinder valves are inactive	Yellow lamp is sent Loss of torque	***Detailed conditions to activate/deactivate*** The following conditions must be fulfilled three times (only one time if the fault code-filter is switched OFF) in a row in order to set the fault code: (engagement of another gear will reset the count) - The 1/R cylinder position indicates that the 1/R gear leaves the reverse position - The 1/R cylinder valves are inactive - There is no active fault on any of the sensor for the position of the 1/R cylinder

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
						(SEPo1R) the valve for shift to 1:st gear the valve for shift to reverse gear - There is no active fault code for low air pressure *Note: T*he fault will always have the state inactive. Check the fault count and last occurrence to get more information.
Gears 1/R engagement system		FMI2	Unintentional disengagement of neutral gear (1:st and reverse gear cylinder)	***Conditions to set the fault code:*** -The 1/R gear leaves the neutral position -The 1/R cylinder valves are inactive	Yellow lamp is sent Loss of torque	***Detailed conditions to activate/deactivate*** The following conditions must be fulfilled three times (only one time if the fault code-filter is switched OFF) in a row in order to set the fault code: (engagement of another gear will reset the count) - The 1/R cylinder position indicates that the 1/R gear leaves the neutral position - The 1/R cylinder valves are inactive - There is no active fault on any of the sensor for the position of the 1/R cylinder (SEPo1R) the valve for shift to 1:st gear the valve for shift to reverse gear - There is no active fault code for low air pressure *Note: T*he fault will always have the state inactive. Check the fault count and last occurrence to get more information.
Gears 1/R engagement system		FMI11	Blocked engagement of 1:st gear	***Conditions to set the fault code:*** -The 1:st gear can not engage -There is no active fault code on the SEPo1R -There is no active fault code for low air pressure -There is no active fault code on any of the 1:st and reverse gear cylinder valves	Yellow lamp is sent Loss of torque The 1:st gears will not be selected by the system for a short while. After five successful gear changes a new attempt to use 1:st gear may be made	***Detailed conditions to activate/deactivate*** The following conditions must be fulfilled three times (only one time if the fault code-filter is switched OFF) in a row in order to set the fault code:(engagement of another gear will reset the count) - The valve for reaching 1:st gear is activated for at least 0.8s - The 1/R cylinder position sensor indicates that 1:st position is not engaged - There is no active fault on any of the 1/R position sensor (SEPo1R) the valve for shift to 1:st gear the valve for shift to reverse gear - There is no active fault code for low air pressure The fault is deactivated if any of the following conditions are fulfilled:

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
						- The 1/R position sensor indicates that 1:st position is engaged - There is an active fault code on any of the 1/R position sensor (SEPo1R) the valve for shift to 1:st gear the valve for shift to reverse gear
Gears 1/R engagement system		FMI12	Blocked engagement of reverse gear	***Conditions to set the fault code:*** -The reverse gear can not engage	Yellow lamp is sent The R gear can not engage, but the system will try to engage it as long as the gearlever is in the reverse position	***Detailed conditions to activate/deactivate*** The following conditions must be fulfilled three times (only one time if the fault code filter is switched OFF) in a row in order to set the fault code: (engagement of another gear will reset the count) - The valve for reaching the reverse gear is activated for at least 0.8s - The 1/R cylinder position sensor indicates that R position is not engaged - There is no active fault on any of the 1/R position sensor (SEPo1R) the valve for shift to 1:st gear the valve for shift to reverse gear - There is no active fault code for low air pressure. The fault is deactivated if any of the following conditions are fulfilled: - The 1/R position sensor indicates that R position is engaged - There is an active fault code on any of the 1/R position sensor (SEPo1R) the valve for shift to 1:st gear the valve for shift to reverse gear
Gears 1/R engagement system		FMI7	Blocked engagement of neutral gear (1:st and reverse gear cylinder)	***Conditions to set the fault code:*** -The neutral gear (1:st and reverse gear cylinder) can not engage	Yellow lamp is sent	***Detailed conditions to activate/deactivate*** The following conditions must be fulfilled three times (only one time if the fault code-filter is switched OFF) in a row in order to set the fault code: (engagement of another gear will reset the count) - The valve for reaching the reverse gear is activated for at least 0.8s - The 1/R cylinder position sensor indicates that neutral position is not engaged - There is no active fault code on any of the 1/R position sensor (SEPo1R) the valve for shift to 1:st gear the valve for shift to

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
						reverse gear - There is no active fault code for low air pressure The fault is deactivated if any of the following conditions are fulfilled: - The 1/R position sensor indicates that neutral position is engaged - There is an active fault code on any of the 1/R position sensor (SEPo1R) the valve for shift to 1:st gear the valve for shift to reverse gear
Gears 2/3 engagement system	**PSID26**	FMI0	Unintentional disengagement of 2:nd gear	***Conditions to set the fault code:*** -The 2/3 cylinder position indicates that the 2/3 gear leaves the 2:nd position - The 2:nd cylinder valves are inactive	Yellow lamp is sent Loss of torque	***Detailed conditions to activate/deactivate*** The following conditions must be fulfilled three times (only one time if the fault code-filter is switched OFF) in a row in order to set the fault code: (engagement of another gear will reset the count) - The 2/3 cylinder position indicates that the 2/3 gear leaves the 2:nd position - The 2:nd cylinder valves are inactive - There is no active fault on any of the sensor for the position of the 2/3 cylinder (SEPo23) the valve for shift to 2:nd gear the valve for shift to 3:rd gear - There is no active fault code for low air pressure *Note:* The fault will always have the state inactive. Check the fault count and last occurrence to get more information.
Gears 2/3 engagement system		FMI1	Unintentional disengagement of 3:rd gear	***Conditions to set the fault code:*** -The 2/3 cylinder leaves the 3:rd position - The 3:rd cylinder valves are inactive	Yellow lamp is sent Loss of torque	***Detailed conditions to activate/deactivate*** The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row in order to set the fault code: (engagement of another gear will reset the count) - The 2/3 cylinder position indicates that the 2/3 gear leaves the 3:rd position - The 3:rd cylinder valves are inactive - There is no active fault on any of the sensor for the position of the 2/3 cylinder (SEPo23) the valve for shift to 2:nd gear the valve for shift to 3:rd gear - There is no active fault code for low air pressure

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
						Note: The fault will always have the state inactive. Check the fault count and last occurrence to get more information.
Gears 2/3 engagement system		FMI2	Unintentional disengagement of neutral gear (2:nd and 3:rd gear cylinder)	***Conditions to set the fault code:*** -The 2/3 cylinder leaves the neutral position - The 2/3 cylinder valves are inactive	Yellow lamp is sent	***Detailed conditions to activate/deactivate*** The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row in order to set the fault code: (engagement of another gear will reset the count) - The 2/3 cylinder position indicates that the 2/3 gear leaves the neutral position - The 2/3 cylinder valves are inactive - There is no active fault on any of the sensor for the position of the 2/3 cylinder (SEPo23) the valve for shift to 2:nd gear the valve for shift to 3:rd gear - There is no active fault code for low air pressure *Note:* The fault will always have the state inactive. Check the fault count and last occurrence to get more information.
Gears 2/3 engagement system		FMI11	Blocked engagement of 2:nd gear	***Conditions to set the fault code:*** -The 2:nd gear can not engage	Yellow lamp is sent Loss of torque The 2:nd gear will not be selected by the system for a short while. After five successful gearshifts a new attempt to use 2:nd gear may be made	***Detailed conditions to activate/deactivate*** The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row in order to set the fault code: (engagement of another gear will reset the count) - The valve for reaching 2:nd gear is activated for at least 0.8s - The 2/3 cylinder position sensor indicates that 2:nd position is not engaged - There is no active fault on any of the 2/3 position sensor (SEPo23) the valve for shift to 2:nd gear the valve for shift to 3:rd gear - There is no active fault code for low air pressure *The fault is deactivated if any of the following conditions are fulfilled:* - The 2/3 position sensor indicates that 2:nd 2;nd position is engaged - There is an active fault code on any of the 2/3 position sensor (SEPo23) the valve for shift to 2:nd

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
						gear the valve for shift to 3:rd gear
Gears 2/3 engagement system		FMI12	Blocked engagement of 3:rd gear	***Conditions to set the fault code:*** -The 3:rd gear can not engage	Yellow lamp is sent Loss of torque The 3:rd gear will not be selected by the system for a short while. After five successful gearshifts a new attempt to use 3:rd gear may be made	***Detailed conditions to activate/deactivate*** The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row in order to set the fault code: (engagement of another gear will reset the count) - The valve for reaching 3:rd gear is activated for at least 0.8s - The 2/3 cylinder position sensor indicates that 3:rd position is not engaged - There is no active fault on any of the 2/3 position sensor (SEPo23) the valve for shift to 2:nd gear the valve for shift to 3:rd gear - There is no active fault code for low air pressure *The fault is deactivated if any of the following conditions are fulfilled:* - The 2/3 position sensor indicates that 3:rd position is engaged - There is an active fault code on any of the 2/3 position sensor (SEPo23) the valve for shift to 2:nd gear the valve for shift to 3:rd gear
Gears 2/3 engagement system		FMI7	Blocked engagement of neutral gear (2:nd and 3:rd gear cylinder)	***Conditions to set the fault code:*** -The neutral gear (2:nd 3:rd gear cylinder) can not engage	Yellow lamp is sent	***Detailed conditions to activate/deactivate*** The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row in order to set the fault code: (engagement of another gear will reset the count) - The valve for reaching gear (2:nd and 3:rd gear cylinder) is activated for at least 0.8s - The 2/3 cylinder position sensor indicates that neutral position is not engaged - There is no active fault code on any of the 2/3 position sensor (SEPo23) the valve for shift to 2:nd gear the valve for shift to 3:rd gear - There is no active fault code for low air pressure *The fault is deactivated if any of the following conditions are fulfilled:* - The 2/3 position sensor

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
						indicates that neutral position is engaged - There is an active fault code on any of the 2/3 position sensor (SEPo23) the valve for shift to 2:nd gear the valve for shift to 3:rd gear
J1708/J1587	**SID250**	FMI9	Abnormal update rate	***Activate:*** The FMI shall be set if any of the messages* have not been received on the bus for 30s ***Deactivate:*** The FMI shall be cleared if all messages* are sent on the bus *PID190, PID85 and PPID212	Yellow lamp is sent Fault codes can not be read On-vehicle tests can not be performed	
J1939	**SID231**	FMI2	Data erratic, intermittent or incorrect	***Active:*** This FMI shall be set if the CAN transceiver signals "bus-off" ***Deactivate:*** FMI cleared if CAN-transceiver does not signal "bus-off	Yellow lamp is sent Much reduced gear selection and gear change performance	
Missing data on J1939 form BECU	**PSID204**	FMI8	Abnormal frequency, pulse width or period	***Activate:*** The FMI shall be set if the wheel speeds from the BECU (MID136) are incorrect ***Deactivate:*** The FMI shall be cleared if the wheel speeds from the BECU (MID136) are correct	Yellow lamp Automatic gear selection enters backup mode with gear changes only at certain vehicle speeds	
Missing data on J1939 form BECU		FMI9	Abnormal update rate	***Activate:*** The FMI shall be set if message WSI from BECU (MID136) is not received within 1s ***Deactivate:*** The FMI shall be cleared if message WSI is received at normal rate	Yellow lamp Automatic gear selection enters backup mode with gear changes only at certain vehicle speeds	
Missing data on J1939 form GECU	**PSID207**	FMI9	Abnormal update rate	***Activate:*** The FMI shall be set if message VP6 from GECU (MID223) is not received within 1s ***Deactivate:*** The FMI shall be cleared if message VP6 is received at normal rate	Yellow lamp Slow response on manual gear changes and slow response when buttons are pressed on the gear lever.	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
Missing data on J1939 from the adaptive cruise control	**PSID211**	FMI9	Abnormal update rate	***Activate:*** The FMI shall be set if message ACC1 from ACC (MID219) is not received within 1s, and ACC is installed ***Deactivate:*** The FMI shall be cleared if message ACC1 is received at normal rate	Yellow lamp The retarder ACC function does not work	
Missing data on J1939 from the EMS	**PSID200**	FMI9	Abnormal update rate	***Activate:*** The FMI shall be set if message EEC1 from EECU is not received within 200ms ***Deactivate:*** The FMI shall be cleared if message EEC1 is received at normal rate	Yellow lamp is sent If there is no POWERTRAIN_CAN, automatic gear selection enters backup mode with gear changes only at certain vehicle speeds If there is no Powertrain_CAN and the engine does not receive any messages from the TECU, the gear changes will be slow	
Missing data on J1939 from the light control module (LCM)	**PSID210**	FMI9	Abnormal update rate	***Activate:*** The FMI shall be set if message VP37 from LCM (MID216) is not received within 10s ***Deactivate:*** The FMI shall be cleared if message VP37 is received at normal rate	Yellow lamp The start gear might be wrong Automatic gear selection performance might be reduced a certain time after start Automatic gear selection performance might be reduced a certain time after a trailer has been connected/disconnected	
Missing data on J1939 from the suspension ECU (ECS)	**PSID208**	FMI9	Abnormal update rate	***Activate:*** The FMI shall be set if message VW from ECS (MID150) is not received within 10s, and ECS is installed	Yellow lamp The start gear might be wrong after loading and unloading	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
				Deactivate: The FMI shall be cleared if message VW is received at normal rate		
Missing data on J1939 from VECU	**PSID201**	FMI8	Abnormal frequency, pulse width or period	***Activate:*** The FMI shall be set if the acc pedal pos or service brake-switch from the VECU (MID144) is incorrect ***Deactivate:*** The FMI shall be cleared if the acc pedal pos and service brake-switch from the VECU (MID144) are correct	Yellow lamp If pedal pos is undefined, automatic gear selection enters backup mode with gear changes only at certain vehicle speeds If pedal pos is undefined, gearbox comfort at start and marshalling might be reduced If service brake is undefined, automatic gear selection enters backup mode with gear changes only at certain vehicle speeds	
Missing data on J1939 from VECU		FMI9	Abnormal update rate	***Activate:*** The FMI shall be set if message VP2 from VECU (MID144) is not received within 100ms ***Deactivate:*** The FMI shall be cleared if message VP2 is received at normal rate	Yellow lamp Automatic gear selection enters backup mode with gear changes only at certain vehicle speeds Gearbox comfort at start and marshalling might be reduced	
Powertrain CAN	**PSID232**	FMI2	Data erratic, intermittent or incorrect	***Activate****:* The FMI shall be set if the CAN transceiver signals "busOFF" ***Deactivate****:* The FMI shall be cleared if the CAN-transceiver does not signal "busOFF"	Yellow lamp is sent Reduced automatic gear selection and gear change performance	This fault code is only valid for vehicles where a Pwertrain_CAN link exist between the TECU and the engine.
Powertrain CAN		FMI9	Abnormal update rate	***Activate:*** The FMI shall be set if message VP24/MID128 is not received	Yellow lamp is sent Reduced automatic gear selection	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
				within 100ms ***Deactivate:*** The FMI shall be cleared if message VP24/MID128 is received at normal rate	and gear change performance	
Program memory	**SID240**	FMI2	Data erratic, intermittent or incorrect	***Activate:*** Flash CS error or program code missing ***Deactivate***: Flash CS OK	Yellow lamp is sent Cranking is inhibited Engine can not start	
Range engagement system	**PSID24**	**FMI0**	Unintentional disengagement of low range	***Conditions to set the fault code:*** -The range cylinder leaves the low range position -The range cylinder valves are inactive	Yellow lamp is sent Loss of torque	***Detailed conditions to activate/deactivate***: The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row, in order to set the fault code: (engagement of another gear will reset the count) - The range cylinder position indicates that range gear leaves the low range position - The range cylinder valves are inactive - There is no active fault on any of the sensor for the position of the range cylinder (SEPoR) the valve for shift to high range the valve for shift to low range - There is no active fault code for low air pressure note: The fault will always have the state inactive. Check fault-count and last occurrence to get more information
Range engagement system		FMI1	Unintentional disengagement of high range	***Conditions to set the fault code:*** -The range cylinder leaves the high range position -The range cylinder valves are inactive	Yellow lamp is sent Loss of torque	***Detailed conditions to activate/deactivate***: The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row, in order to set the fault code: (engagement of another gear will reset the count) - The range cylinder position indicates that the range gear leaves the high range position - The range cylinder valves are inactive - There is no active fault on any of the sensor for the position of the range cylinder (SEPoR) the valve for shift to high range the

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
						valve for shift to low range - There is no active fault code for low air pressure *note*: The fault will always have the state inactive. Check fault-count and last occurrence to get more information
Range engagement system		FMI11	Blocked engagement of low range	***Conditions to set the fault code:*** -The low range gear can not engage	Yellow lamp is sent Loss of torque	***Detailed conditions to activate/deactivate***: The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row, in order to set the fault code: (engagement of another gear will reset the count) - The low range can not engage within 3.8s - The gearbox oil temperature is above 10dgC - There is no active fault code on any of the sensor for the position of the range cylinder (SEPoR) low air pressure the range cylinder valves ***The fault is deactivated if any of the following conditions are fulfilled:*** - The range cylinder position sensor indicates that low range is engaged - The gearbox oil temperature is below 10dgC - There is an active fault on any of the sensor for the position of the range cylinder (SEPoR) low air pressure the range cylinder valves
Range engagement system		FMI12	Blocked engagement of high range	***Conditions to set the fault code:*** -The high range gear can not engage	Yellow lamp is sent Loss of torque	***Detailed conditions to activate/deactivate***: The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row, in order to set the fault code: (engagement of another gear will reset the count) - The high range gear can not engage within 3.8s - The gearbox oil temperature is above 10dgC - There is no active fault on any of the range position sensor (SEPoR) low air pressure the range cylinder valves - There is no active fault code for low air pressure ***The fault is deactivated if***

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
						any of the following conditions are fulfilled: - The range cylinder position sensor indicates that high range is engaged - The gearbox oil temperature is below 10dgC - There is an active fault code on any of the range position sensor (SEPoR) low air pressure the range cylinder valves
Sensor for the 1:st and reverse gear cylinder (SEPo1R)	**PPID10**	FMI2	Data erratic, intermittent or incorrect	***Activate:*** The position sensor is distributing a temperature-signal from the sensor ASIC, if the value from this sensor deviates too much this fault code is triggered. ***Deactivate:***	Yellow lamp is sent Slow gear changes	***Detailed conditions to activate / deactivate:*** ***Activate:*** The position sensor is distributing a temperature-signal from the sensor ASIC, if the value from this sensor deviates too much this fault code is triggered, the diagnostics are based upon cross-reference between all four position-sensors. This means that if the value differs more than +/- 20dgC from the average-temp, if the temperature is out of boundary -60dgC to +160dgC or if the temperature changes at a rate higher than 10dgC during 15s, then this fault code is set. ***Deactivate:*** Fault code stays until a clear DTC command is received
Sensor for the 1:st and reverse gear cylinder (SEPo1R)		FMI3	Voltage above normal or shorted high	***Activate:*** Status from the ASIC is short circuit to Ubatt ***Deactivate***: Status is OK	Yellow lamp is sent Slow gear changes	
Sensor for the 1:st and reverse gear cylinder (SEPo1R)		FMI5	Current below normal or open circuit	***Activate:*** Status from the ASIC is open circuit ***Deactivate:*** Status is OK	Yellow lamp is sent Slow gear changes	
Sensor for the 1:st and reverse gear cylinder (SEPo1R)		FMI6	Current above normal or grounded circuit	***Activate:*** Status from the ASIC is short circuit to Gnd ***Deactivate:*** Status is OK	Yellow lamp is sent Slow gear changes	
Sensor for the 1:st and reverse gear cylinder (SEPo1R)		FMI13	Calibration value out of range	***Activate:*** The Checksum of the NVRAM is not correct, or the sensor has not been calibrated ***Deactivate:*** Sensor signal has been successfully calibrated	Yellow lamp is sent Cranking is inhibited Engine can not start	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
Sensor for the inclination of the gearbox (SEIG)	**PPID140**	FMI2	Data erratic, intermittent or incorrect	***Activate:*** 1. The sensor signal is above or below normal range and 2. The vehicle has been standing still for a specific time ***Deactivate:*** The sensor signal is in the normal range	Yellow lamp is sent The start gear might be wrong Gear selection performance might be reduced Downhill and uphill gear change performance may be reduced	
Sensor for the PCB temperature	**PPID55**	FMI0	Data valid but above normal operational range	***Activate***: temp above 125dgC ***Deactivate:*** temp below 125dgC	Yellow lamp is sent	
Sensor for the position of the 2:nd and 3:rd gear cylinder (SEPo23)	**PPID11**	FMI2	Data erratic, intermittent or incorrect	***Activate:*** The position sensor is distributing a temperature-signal from the sensor ASIC, if the value from this sensor deviates too much this fault code is triggered. ***Deactivate:***	Yellow lamp is sent Slow gear changes	***Detailed conditions to activate / deactivate:*** ***Activate:*** The position sensor is distributing a temperature-signal from the sensor ASIC, if the value from this sensor deviates too much this fault code is triggered, the diagnostics are based upon cross-reference between all four position-sensors. This means that if the value differs more than +/- 20°C from the average-temp, if the temperature is out of boundary -60°C to +160°C or if the temperature changes at a rate higher than 10°C during 15s, then this fault code is set. ***Deactivate:*** Fault code stays until a clear DTC command is received
Sensor for the position of the 2:nd and 3:rd gear cylinder (SEPo23)		FMI3	Voltage above normal or shorted high	***Activate:*** Status from the ASIC is short circuit to Ubatt ***Deactivate:*** Status is OK	Yellow lamp is sent Slow gear changes	
Sensor for the position of the 2:nd and 3:rd gear cylinder (SEPo23)		FMI5	Current below normal or open circuit	***Activate***: Status from the ASIC is open circuit ***Deactivate:*** Status is OK	Yellow lamp is sent Slow gear changes	
Sensor for the position of the 2:nd and 3:rd gear cylinder (SEPo23)		FMI6	Current above normal or grounded circuit	***Activate***: Status from the ASIC is short circuit to Gnd ***Deactivate***: Status is OK	Yellow lamp is sent Slow gear changes	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
Sensor for the position of the 2:nd and 3:rd gear cylinder (SEPo23)		FMI13	Calibration value out of range	***Activate:*** The Checksum of the NVRAM is not correct, or the sensor has not been calibrated ***Deactivate:*** Sensor signal has been successfully calibrated	Yellow lamp is sent Cranking is inhibited Engine can not start	
Sensor for the position of the range (SEPoR)	**PID31**	FMI2	Data erratic, intermittent or incorrect	***Activate:*** The position sensor is distributing a temperature-signal from the sensor ASIC, if the value from this sensor deviates too much this fault code is triggered. ***Deactivate:***	Yellow lamp is sent Slow gear changes	***Detailed conditions to activate / deactivate:*** ***Activate:*** The position sensor is distributing a temperature-signal from the sensor ASIC, if the value from this sensor deviates too much this fault code is triggered, the diagnostics are based upon cross-reference between all four position-sensors. This means that if the value differs more than +/- 20°C from the average-temp, if the temperature is out of boundary -60°C to +160°C or if the temperature changes at a rate higher than 10°C during 15s, then this fault code is set. ***Deactivate:*** Fault code stays until a clear DTC command is received
Sensor for the position of the range (SEPoR)		FMI3	Voltage above normal or shorted high	***Activate***: Status from the ASIC is short circuit to Ubatt ***Deactivate***: Status is OK	Yellow lamp is sent Slow gear changes	
Sensor for the position of the range (SEPoR)		FMI5	Current below normal or open circuit	***Activate***: Status from the ASIC is open circuit ***Deactivate***: Status is OK	Yellow lamp is sent Slow gear changes	
Sensor for the position of the range (SEPoR)		FMI6	Current above normal or grounded circuit	***Activate***: Status from the ASIC is short circuit to Gnd ***Deactivate***: Status is OK	Yellow lamp is sent Slow gear changes	
Sensor for the position of the range (SEPoR)		FMI13	Calibration value out of range	***Activate***: The Checksum of the NVRAM is not correct, or the sensor has not been calibrated ***Deactivate***: Sensor signal has been successfully calibrated	Yellow lamp is sent Cranking is inhibited Engine can not start	
Sensor for the position of the Split (SEPoS)	**PID32**	FMI2	Data erratic, intermittent or incorrect	***Activate:*** The position sensor is distributing a temperature-signal from the	Yellow lamp is sent Slow gear changes	***Detailed conditions to activate / deactivate:*** ***Activate:*** The position sensor is distributing a temperature-signal from the

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
				sensor ASIC, if the value from this sensor deviates too much this fault code is triggered. ***Deactivate:***		sensor ASIC, if the value from this sensor deviates too much this fault code is triggered, the diagnostics are based upon cross-reference between all four position-sensors. This means that if the value differs more than +/- 20°C from the average-temp, if the temperature is out of boundary -60°C to +160°C or if the temperature changes at a rate higher than 10°C during 15s, then this fault code is set. ***Deactivate:*** Fault code stays until a clear DTC command is received
Sensor for the position of the Split (SEPoS)		FMI3	Voltage above normal or shorted high	***Activate:*** Status from the ASIC is short circuit to Ubatt ***Deactivate:*** Status is OK	Yellow lamp is sent Slow gear changes	
Sensor for the position of the Split (SEPoS)		FMI5	Current below normal or open circuit	***Activate***: Status from the ASIC is open circuit ***Deactivate***: Status is OK	Yellow lamp is sent Slow gear changes	
Sensor for the position of the Split (SEPoS)		FMI6	Current above normal or grounded circuit	***Activate:*** Status from the ASIC is short circuit to Gnd. ***Deactivate***: Status is OK	Yellow lamp is sent Slow gear changes	
Sensor for the position of the Split (SEPoS)		FMI13	Calibration value out of range	***Activate:*** The Checksum of the NVRAM is not correct, or the sensor has not been calibrated ***Deactivate:*** Sensor signal has been successfully calibrated	Yellow lamp is sent Cranking is inhibited Engine can not start	
Sensor for the pressure of the supply air (SEPrSA)	**PID37**	FMI0	Data vaild but above normal operational range	***Activate:*** 1. Sensor signal is in normal range 2. Pressure is above 10.0 [bar] ***Deactivate:*** 1. Sensor signal is in normal range 2. Pressure is below 10.0 [bar]	Yellow lamp is sent reduced clutch performance	
Sensor for the pressure of the supply air (SEPrSA)		FMI1	Data valid but below operational range	***Activate:*** 1. Sensor signal is in normal range 2. Pressure is below 5.0 [bar] ***Deactivate:*** 1. Sensor signal is in normal range 2. Pressure is above 5.0 [bar]	Yellow lamp is sent. The symbol for compressed air, gearbox is sent. Gear changes may be absent. Reduced clutch performance	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
Sensor for the pressure of the supply air (SEPrSA)		FMI3	Voltage above normal or shorted high	***Activate:*** The sensor signal is above normal range ***Deactivate:*** The sensor signal is in normal range	Yellow lamp is sent	
Sensor for the pressure of the supply air (SEPrSA)		FMI5	Current below normal or open circuit	***Activate:*** The sensor signal is below normal range ***Deactivate:*** The sensor signal is in normal range	Yellow lamp is sent	
Sensor for the speed on the counter shaft (SESC)	**PID161**	FMI1	Data valid but below operational range	***Activate:*** 1. The sensor signal is within normal range and, 2. The counter shaft speed differs from both the main shaft speed (SESM) and the vehicle speed received from the vehicle ECU when the counter shaft is rotating ***Deactivate:*** 1. The sensor signal is within normal range 2. The counter shaft speed and the main shaft speed are equal when the counter shaft is rotating	Yellow lamp is sent Reduced gear change performance Gearbox brake up shifts can not be used Slip point can not be updated which will give reduced performance at starts Start gear engagement only possible at standstill and when the vehicle speed is high enough to synchronize the main box with the engine	Detailed condition to activate: The following conditions must be fulfilled for a time of 2.0s in order to activate: A gear (not neutral) is engaged in the gearbox The value of the input shaft speed calculated from the main shaft speed sensor (SESM) is more than 300rpm, or the value of the input shaft speed calculated from the counter shaft speed sensor (SESC) is more than 300rpm -The values of the input shaft speed calculated from the counter shaft speed sensor (SESC) and the main shaft speed sensor (SESM) differ more than 50rpm -The values of the input shaft speed calculated from the counter shaft speed sensor (SESC) and the vehicle speed received from the vehicle ECU differ more than 30rpm -The values of the input shaft speed calculated from the main shaft speed sensor (SESM) and the vehicle speed received from the vehicle ECU differ less than 30rpm -There is no active fault on any of -The sensor for the main shaft speed (SESM) -The sensor for the position of the split cylinder (SEPoS) -The sensor for the position of the shift cylinder1R (SEPo1R) -The sensor for the position of the shift cylinder 23 (SEPo23) -The sensor for the position of teh range cylinder (SEPoR)

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
						The fault is deactivated if the following conditions are fulfilled for a time of 2.0s: -A gear (not neutral) is engaged in the gearbox -The value of the input shaft speed calculated from the countershaft speed sensor (SESC) is more than 300rpm, or -the value of the input shaft speed calculated from the main shaft speed sensor (SESM) is more than 300rpm -The values of the input shaft speed calculated from the countershaft speed sensor (SESC) and the main shaft speed sensor (SESM) differ less than 50rpm The fault is also deactivated if the following conditions are fulfilled for a time of 2.0s: -A neutral gear is engaged in the gearbox -The engine speed is above 400rpm -The clutch is engaged -Direct or indirect split is engaged -The values of the input shaft speed is calculated from the counter shaft speed sensor (SESC) and the engine speed received from the engine ECU differ less than 50 rpm The fault is also deactivated if the signal from the countershaft speed sensor (SESC) is not within normal range or if there is an active fault code on any of: -The clutch position sensor (SEPoC) -The sensor for the position of the split cylinder (SEPoS) -The sensor for the position of the shift cylinder1R (SEPo1R) -The sensor for the position of the shift cylinder 23 (SEPo23) -The sensor for the position of teh range cylinder (SEPoR)
Sensor for the speed on the counter shaft (SESC)		FMI4	Voltage below normal or shorted low	***Activate:*** The sensor signal is below normal range. ***Deactivate:*** The sensor signal is within normal range	Yellow lamp is sent Reduced gear change performance Gearbox brake up shifts can not be used	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
					Slip point cannot be updated which will give reduced performance at starts Start gear engagement only possible at standstill and when the vehicle speeds is high enough to synchronize the main box with the engine	
Sensor for the speed on the counter shaft (SESC)		FMI5	Current below normal or open circuit	***Activate:*** The sensor signal is above normal range ***Deactivate:*** The sensor signal is within normal range	Yellow lamp is sent Reduced gear change performance Gearbox brake up shifts can not be used Slip point cannot be updated which will give reduced performance at starts Start gear engagement only possible at standstill and when the vehicle speed is high enough to synchronize the main box with the engine	
Sensor for the speed on the main shaft (SESM)	**PID160**	FMI1	Data valid but below operational range	***Activate:*** 1. Sensor signal is within normal range and 2. The main shaft speed differs from both the value of the countershaft speed and the vehicle speed received from the vehicle ECU ***Deactivate:*** *1. Sensor signal is within normal range and,* *2. The main shaft speed and the counter shaft speed are equal*	Yellow lamp is sent Reduced gear change performance Reduced gear change comfort	Detailed condition to activate: The following conditions must be fulfilled for a time of 2.0s in order to activate: A gear (not neutral) is engaged in the gearbox The value of the input shaft speed calculated from the main shaft speed sensor (SESM) is more than 300rpm, or the value of the input shaft speed calculated from the counter shaft speed sensor (SESC) is more than 300rpm. The values of the input shaft speed calculated from the main shaft speed sensor (SESM) and the counter shaft speed sensor

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
				when the main shaft is rotating		(SESC) differ more than 50rpm The values of the input shaft speed calculated from the main shaft speed sensor (SESM) and the vehicle speed received from the vehicle ECU differ more than 30rpm. The values of the input shaft speed calculated from the counter shaft speed sensor (SESC) and the vehicle speed received from the vehicle ECU differ less than 30rpm. There is no active fault on any of the sensor for the countershaft speed (SECS) The sensor for the position of the split cylinder (SEPoS) The sensor for the position of the shift cylinder1R (SEPo1R) The sensor for the position of the shift cylinder 23 (SEPo23) The sensor for the position of teh range cylinder (SEPoR) The following conditions must be fulfilled for a time of 2.0s in order to deactivate: A gear (not neutral) is engaged in the gearbox The value of the input shaft speed calculated from the main shaft speed sensor (SESM) is more than 300rpm, or the value of the input shaft speed calculated from the counter shaft speed sensor (SESC) is more than 300rpm. The value of the input shaft speed calculated from the main shaft speed sensor (SESM) and the counter shaft speed sensor (SESC) differ less than 50rpm. The fault is also deactivated if The sensor signal (SESM) is not within normal range. There is an active fault on any of The sensor for the countershaft speed (SECS) The sensor for the position of the split cylinder (SEPoS) The sensor for the position of the shift cylinder1R (SEPo1R) The sensor for the position of the shift cylinder 23 (SEPo23) The sensor for the position of teh range cylinder (SEPoR)

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
Sensor for the speed on the mainshaft (SESM)		FMI2	Data erratic, intermittent or incorrect	***Activate:*** The sensor indicates wrong traveling direction ***Deactivate:*** The sensor indicates correct traveling direction	Yellow lamp is sent Reduced gear change performance	Detailed conditions to activate The following conditions must be fulfilled for a time of 2.0s in order to activate: The input shaft speed calculated from the countershaft speed sensor (SESC) is above 300 rpm and the clutch is engaged or The input shaft speed calculated from the countershaft speed sensor (SECS) is above 600 rpm, the clutch position is more engaged than the slip point and the engine speed is received from the engine ECU and above 600rpm. A forward gear is engaged in the gearbox and the main shaft speed sensor (SESM) indicates reverse movement or a reverse gear is engaged and the main shaft speed sensor (SESM) indicates forward movement There is no other active fault on the sensor for the main shaft speed (SESM) There is no active fault on any of: -The sensor for the countershaft speed (SECS) -The sensor for the clutch position (SePoC) -The sensor for the position of the split cylinder (SePoS) -The sensor for the position of the shift cylinder (1R SEPo1R) -The sensor for the position of the shift cylinder (23 SEPo23) -The sensor for the range cylinder (SEPoR) The fault is deactivated if the following conditions are fulfilled for a time of 2,0s: The input shaft speed calculated from the counter shaft speed sensor (SECS) is above 300 rpm and the clutch is engaged or The input shaft speed calculated from the counter shaft speed sensor (SECS) is above 600 rpm, the clutch position is more engaged than the slip point and the engine speed is received from the engine ECU and above 600rpm A forward gear is engaged in the gearbox and the main shaft speed sensor (SESM) indicates forward movement

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
						or A reverse gear is engaged and the main shaft speed sensor (SESM) indicates reverse movement. The fault is also deactivated if the main shaft speed sensor (SESM) signal is not within normal range, or if there is an active fault on any of the sensors: -The sensor for the countershaft speed (SECS) -The sensor for the clutch position (SePoC) -The sensor for the position of the split cylinder (SePoS) -The sensor for the position of the shift cylinder (1R SEPo1R) -The sensor for the position of the shift cylinder (23 SEPo23) -The sensor for the range cylinder (SEPoR)
Sensor for the speed on the main shaft (SESM)		FMI3	Voltage above normal or shorted high	***Activate***: Signal or supply voltage is above normal range ***Deactivate***: Signal and supply voltage is in normal range.	Yellow lamp is sent Reduced gear change performance Reduced gear change comfort	
Sensor for the speed on the main shaft (SESM)		FMI4	Voltage below normal or shorted low	***Activate:*** Signal and supply voltage is below normal range. ***Deactivate:*** Signal and supply voltage is within normal range	Yellow lamp is sent Reduced gear change performance Reduced gear change comfort	
Sensor for the speed on the main shaft (SESM)		FMI5	Current below normal or open circuit	***Activate: 1.***Signal voltage is below normal range and, 2. Supply voltage is in the normal range ***Deactivate:*** Signal and supply voltage is in the normal range	Yellow lamp is sent Reduced gear change performance Reduced gear change comfort	
Sensor for the temperature of the gearbox oil (SETeGO	**PID177**	FMI0	Data valid but above normal operational range	***Activate low:*** 1.The sensor signal is in normal range 2. Temperature is above 100dgC during 18000s ***Deactivate low:*** 1. The sensor signal is in normal range 2. Temperature is below 100dgC ***Activate medium:*** 1. The	***Low:*** Yellow lamp is sent Symbol for high gearbox oil temperature is lit ***Medium:*** Yellow lamp is sent Symbol for high gearbox oil temperature is	Gearbox oil temperature fault codes are only set if the vehicle has oil temperature sensor functionality installed

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
				sensor signal is in normal range 2. Temperature above 120dgC during 600s ***Deactivate medium:*** 1. The sensor signal is in normal range 2. Temperature is below 120dgC ***Activate high:*** 1. The sensor signal is in normal range 2. Temperature is above 140dgC during 30s ***Deactivate high:*** 1. The sensor signal is in normal range Temperature is below 140dgC	lit ***High:*** Red lamp is sent Symbol for high gearbox oil temperature is lit	
Sensor for the temperature of the gearbox oil (SETeGO		FMI4	Voltage below normal or shorted low	***Activate:*** The sensor signal is below normal range ***Deactivate:*** The sensor signal is in normal range	Yellow lamp is sent	
Sensor for the temperature of the gearbox oil (SETeGO		FMI5	Current below normal or open circuit	***Activate:*** The sensor signal is above normal range ***Deactivate:*** The sensor signal is in normal range	Yellow lamp is sent	
Sensor position of the clutch (SEPoC and SEPoCINV)	**PID33**	FMI2	Data erratic, intermittent or incorrect	***Activate:*** The difference between clutch positions indicated by the sensor signal (SEPoC) and the inverted sensor signal (SEPoC INV) is to large and both signals is within normal range ***Deactivate:*** The difference between clutch positions indicated by the sensor signal (SEPoC) and the inverted sensor signal (SEPoC INV) is normal	Yellow lamp is sent Reduced clutch performance Reduced gearbox comfort at start and marshalling Gear changes are slow	The PID 33 fault code should not be set if there is an active fault code on the clutch position sensor supply (PPID 54) The clutch position sensor has four connectors: one supply, one ground and two connectors for the sensor signal. With correct input the input voltage of the sensor signal, the inverted sensor signal and the sensor supply, they will follow the nominal relation (Usepoc + Usepoc_inv) / Usepoc5V = 100%
Sensor position of the clutch		FMI3	Voltage above normal or shorted high	***Activate:*** Sensor signal is short circuit to Ubatt or sensor supply,	Yellow lamp is sent Reduced clutch	The PID 33 fault code should not be set if there is an active fault code on the clutch position sensor

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
(SEPoC and SEPoCINV)				when at least one of the sensor signals is above normal range. ***Deactivate:*** No sensor signal is above normal range	performance Reduced gearbox comfort at start and marshalling Gear changes are slow	supply (PPID 54)
Sensor position of the clutch (SEPoC and SEPoCINV)		FMI5	Current below normal or open circuit	***Activate:*** 1. Open circuit on any of the sensor signals is detected when: one of the sensor signals is within normal range and the other sensor signal is below normal range 2. Open circuit on ground, detected when both the sensor signals are within the normal range and the sum of the sensor signals is above a specific value ***Deactivate: No*** activation condition is no longer fulfilled	Yellow lamp is sent Reduced clutch performance Reduced gearbox comfort at start and marshalling gear changes are slow	The PID 33 fault code should not be set if there is an active fault code on the clutch position sensor supply (PPID 54)
Sensor position of the clutch (SEPoC and SEPoCINV)		FMI12	Faulty device or component	***Activate:*** Both sensor signals are below normal when: 1. Status of the sensor ASIC reports internal fault on the sensor, or 2. Short circuit to Gnd on any of the sensor signals, or 3. Open circuit on supply, or 4. Short circuit between the two sensor signals ***Deactivate:*** Both sensor signals are not below normal level	Yellow lamp is sent Reduced clutch performance Reduced gearbox comfort at start and marshalling gear changes are slow	The PID 33 fault code should not be set if there is an active fault code on the clutch position sensor supply (PPID 54)
Sensor position of the clutch (SEPoC and SEPoCINV)		FMI13	Calibration value out of range	***Activate:*** 1. The CS in NVRAM is not correct 2. The cylinder has not been calibrated ***Deactivate:*** Sensor signal has been successfully calibrated	Yellow lamp is sent Cranking is inhibited Engine can not start	The PID 33 fault code should not be set if there is an active fault code on the clutch position sensor supply (PPID 54)
Slow clutch valves low side (VAS-)	**PSID6**	FMI3	Voltage above normal or shorted high	***Activate:*** The low-side drive is short circuit to Ubatt	Yellow lamp is sent Slow engagement/d	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
				Deactivate: The low-side drive is OK	isengagement disabled Reduced clutch performance, especially at start and marshalling	
Slow clutch valves low side (VAS-)		FMI6	Current above normal or grounded circuit	***Activate:*** 1. The low-side drive is short circuit to Gnd and 2. There is no active fault code for short circuit to Gnd on VASE or VASD ***Deactivate: T***he low-side drive is OK	Yellow lamp is sent Slow engagement /disengagement disabled Reduced clutch performance, especially at start and marshalling	
Split engagement system	**PSID23**	FMI0	Unintentional disengagement of indirect split	***Conditions to set the fault code:*** -The split cylinder position leaves the indirect position -The split cylinder valves are inactive	Yellow lamp is sent Loss of torque	***Detailed conditions to activate/deactivate***: The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row, in order to set the fault code: (engagement of another gear will reset the count) - The split cylinder position indicates that split gear leaves the indirect position - The split cylinder valves are inactive - There is no active fault on any of the sensor for the position of the split cylinder (SEPoS) the valve for shift to direct split the valve for shift to indirect split - There is no active fault code for low air pressure n*ote:* The fault will always have the state inactive. Check fault-count and last occurrence to get more information
Split engagement system		FMI1	Unintentional disengagement of direct split	***Conditions to set the fault code:*** -The split cylinder position leaves the direct position -The split cylinder valves are inactive	Yellow lamp is sent Loss of torque	***Detailed conditions to activate/deactivate***: The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row, in order to set the fault code: (engagement of another gear will reset the count) - The split cylinder position indicates that split gear leaves the direct position - The split cylinder valves are inactive - There is no active fault on

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
						any of the sensor for the position of the split cylinder (SEPoS) the valve for shift to direct split the valve for shift to indirect split - There is no active fault code for low air pressure Note: The fault will always have the state inactive. Check fault-count and last occurrence to get more information
Split engagement system		FMI2	Unintentional disengagement of neutral split	***Conditions to set the fault code:*** -The split cylinder position leaves the neutral position -The split cylinder valves are inactive	Yellow lamp is sent	***Detailed conditions to activate/deactivate***: The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row, in order to set the fault code: (engagement of another gear will reset the count) - The split cylinder position indicates that split gear leaves the neutral position - The split cylinder valves are inactive - There is no active fault on any of the sensor for the position of the split cylinder (SEPoS) the valve for shift to direct split the valve for shift to indirect split - There is no active fault code for low air pressure *Note*: The fault will always have the state inactive. Check fault-count and last occurrence to get more information
Split engagement system		FMI11	Blocked engagement of indirect split	***Conditions to set the fault code:*** -The indirect split gear can not engage	Yellow lamp is sent Loss of torque Only direct split gears will be selected by the system for a short while. After five successful gearshifts a new attempt to use indirect split may be made	***Detailed conditions to activate/deactivate***: The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row, in order to set the fault code: - The split valve for reaching indirect split is activated for at least 0.8s - The split cylinder position sensor indicates that indirect position is not engaged - There is no active fault on any of the sensor for the position of the split cylinder (SEPoS) the valve for shift to direct split the valve for shift to indirect split - There is no active fault code for low air pressure ***The fault is deactivated if any of the following***

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
						conditions are fulfilled: - The split cylinder position sensor indicates that indirect position is engaged - There is an active fault code on any of the sensor for the position of the split cylinder (SEPoS) the valve for shift to direct split the valve for shift to indirect split
Split engagement system		FMI12	Blocked engagement of direct split	***Conditions to set the fault code:*** -The direct split gear can not engage	Yellow lamp is sent Loss of torque Only indirect split gears will be selected by the system for a short while. After five successful gearshifts a new attempt to use direct split may be made	***Detailed conditions to activate/deactivate***: The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row, in order to set the fault code: - The split valve for reaching direct split is activated for at least 0.8s - The split cylinder position sensor indicates that direct position is not engaged - There is no active fault on any of the sensor for the position of the split cylinder (SEPoS) the valve for shift to direct split the valve for shift to indirect split - There is no active fault code for low air pressure ***The fault is deactivated if any of the following conditions are fulfilled:*** - The split cylinder position sensor indicates that direct position is engaged - There is an active fault code on any of the sensor for the position of the split cylinder (SEPoS) the valve for shift to direct split the valve for shift to indirect split
Split engagement system		FMI7	Blocked engagement of neutral split	***Conditions to set the fault code:*** -The neutral split gear can not engage	Yellow lamp is sent Eco roll is not available	***Detailed conditions to activate/deactivate***: The following conditions must be fulfilled three times (only once if the fault code-filter is switched OFF) in a row, in order to set the fault code: - The split valve for reaching neutral split is activated for at least 0.8s - The split cylinder position sensor indicates that neutral position is not engaged - There is no active fault on any of the sensor for the position of the split cylinder (SEPoS) the valve for shift to direct split the valve for shift to indirect split

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
						- There is no active fault code for low air pressure ***The fault is deactivated if any of the following conditions are fulfilled:*** - The split cylinder position sensor indicates that neutral position is engaged - There is an active fault code on any of the sensor for the position of the split cylinder (SEPoS) the valve for shift to direct split the valve for shift to indirect split
TECU Power supply	**PID158**	FMI0	Data valid but above normal operational range	***Activate:*** 24V system: above 36V 12V system: above 19V ***Deactivate:*** 24V system: below 36V. 12V system: below 19V	Yellow lamp is sent	
TECU Power supply		FMI1	Data valid but below normal operational range	***Activate:*** 24V system: below 17V. 12V system: below 9V ***Deactivate:*** 24V system: above 17V 12V system: above 9V	Yellow lamp is sent Reduced gearbox performance	
Valve for activating the PTO number 1 (VAP1)	**PSID20**	FMI3	Voltage above normal or shorted high	***Activate***: The high side drive is short circuit to Ubatt ***Deactivate***: The high side drive is OK	Yellow lamp is sent The valve is activated The PTO can not be deactivated Reduced gear change comfort	PTO fault codes are only set if the PTO exists
Valve for activating the PTO number 1 (VAP1)		FMI5	Current below normal or open circuit	***Activate***: The high side drive is open circuit ***Deactivate***: The high side drive is OK	Yellow lamp is sent The valve can not be activated The PTO does not work	
Valve for activating the PTO number 1 (VAP1)		FMI6	Current above normal or grounded circuit	***Activate***: The high side drive is short circuit to Gnd ***Deactivate***: The high side drive is OK	Yellow lamp is sent The valve can not be activated The PTO does not work	
Valve for activating the PTO number 2 (VAP2)	**PSID21**	FMI3	Voltage above normal or shorted high	***Activate***: The high side drive is short circuit to Ubatt ***Deactivate***: The high side drive is OK	Yellow lamp is sent The valve is activated The PTO can not be deactivated Reduced gear change comfort	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
Valve for activating the PTO number 2 (VAP2)		FMI5	Current below normal or open circuit	***Activate***: The high side drive is open circuit ***Deactivate***: The high side drive is OK	Yellow lamp is sent The valve can not be activated The PTO does not work	
Valve for activating the PTO number 2 (VAP2)		FMI6	Current above normal or grounded circuit	***Activate:*** The high side drive is short circuit to Gnd ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated The PTO does not work	
Valve for fast disengagement of the clutch (VAFD)	**PSID3**	FMI3	Voltage above normal or shorted high	***Activate:*** 1. The high-side drive is short circuited to Ubatt and 2. there is no active fault code for short circuit to Ubatt on VAF- ***Deactivate:*** The high-side drive is OK	Yellow lamp is sent Fast engagement/disengagement disabled Reduced clutch performance Gear changes are slow	
Valve for fast disengagement of the clutch (VAFD)		FMI5	Current below normal or open circuit	***Activate:*** The high-side drive is open circuit ***Deactivate:*** The high side drive is OK	Yellow lamp is sent Fast disengagement disabled Reduced clutch performance Gear changes are slow	
Valve for fast disengagement of the clutch (VAFD)		FMI6	Current above normal or grounded circuit	***Activate:*** The high-side drive is short circuit to Gnd ***Deactivate:*** The high-side drive is OK	Yellow lamp is sent Fast disengagement disabled Reduced clutch performance Gear changes are slow	
Valve for fast engagement of the clutch (VAFE)	**PSID1**	FMI3	Voltage above normal or shorted high	***Activate:*** 1. The high-side drive is short circuited to Ubatt and, 2. there is no active fault code for short circuit to Ubatt on VAF- ***Deactivate:*** The high-side drive is OK	Yellow lamp is sent Fast engagement/disengagement disabled Reduced clutch performance Gear changes are slow	
Valve for fast engagement of the clutch (VAFE)		FMI5	Current below normal or open circuit	***Activate:*** The high-side drive is open circuit ***Deactivate:*** The high side drive is OK	Yellow lamp is sent Fast engagement disabled Reduced clutch performance Gear changes are slow	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
Valve for fast engagement of the clutch (VAFE)		FMI6	Current above normal or grounded circuit	***Activate:*** The high-side drive is short circuit to Gnd ***Deactivate:*** The high-side drive is OK	Yellow lamp is sent Fast engagement disabled Reduced clutch performance Gear changes are slow	
Valve for shifting to direct split (VADS)	**SID37**	FMI3	Voltage above normal or shorted high	***Activate:*** The high side drive is short circuit to Ubatt ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve is activated Indirect and neutral split gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to direct split (VADS)		FMI5	Current below normal or open circuit	***Activate:*** The high side drive is open circuit ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Split gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to direct split (VADS)		FMI6	Current above normal or grounded circuit	***Activate:*** The high side drive is short circuit to Gnd ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Split gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to gear 1 (VAG1)	**PSID12**	FMI3	Voltage above normal or shorted high	***Activate:*** The high side drive is short circuit to Ubatt ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve is activated Gears are missing Automatic	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
					gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to gear 1 (VAG1)		FMI5	Current below normal or open circuit	***Activate:*** The high side drive is open circuit ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to gear 1 (VAG1)		FMI6	Current above normal or grounded circuit	***Activate:*** The high side drive is short circuit to Gnd ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to gear 2 (VAG2)	**PSID14**	FMI3	Voltage above normal or shorted high	***Activate:*** The high side drive is short circuit to Ubatt ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to gear 2 (VAG2)		FMI5	Current below normal or open circuit	***Activate:*** The high side drive is open circuit ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Gears are missing Automatic gear selection enters faulty	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
					gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to gear 2 (VAG2)		FMI6	Current above normal or grounded circuit	***Activate:*** The high side drive is short circuit to Gnd ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to gear 3 (VAG3)	**PSID15**	FMI3	Voltage above normal or shorted high	***Activate:*** The high side drive is short circuit to Ubatt ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to gear 3 (VAG3)		FMI5	Current below normal or open circuit	***Activate:*** The high side drive is open circuit ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to gear 3 (VAG3)		FMI6	Current above normal or grounded circuit	***Activate:*** The high side drive is short circuit to Gnd ***Deactivate:*** The high side drive is OK	Yellow lamp is sent. The valve can not be activated Gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
					at certain vehicle speeds	
Valve for shifting to gear reverse (VAGR)	**PSID13**	FMI3	Voltage above normal or shorted high	***Activate:*** The high side drive is short circuit to Ubatt ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve is activated Gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to gear reverse (VAGR)		FMI5	Current below normal or open circuit	***Activate:*** The high side drive is open circuit ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to gear reverse (VAGR)		FMI6	Current above normal or grounded circuit	***Activate:*** The high side drive is short circuit to Gnd ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to high range (VAHR)	**SID35**	FMI3	Voltage above normal or shorted high	***Activate:*** The high side drive is short circuit to Ubatt ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve is activated Low range gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
Valve for shifting to high range (VAHR)		FMI5	Current below normal or open circuit	***Activate:*** The high side drive is Open circuit ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Range gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to high range (VAHR)		FMI6	Current above normal or grounded circuit	***Activate:*** The high side drive is short circuit to Gnd ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Range gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to indirect split (VAIDS)	**SID38**	FMI3	Voltage above normal or shorted high	***Activate:*** The high side drive is short circuit to Ubatt ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve is activated Direct and neutral split gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to indirect split (VAIDS)		FMI5	Current below normal or open circuit	***Activate:*** The high side drive is open circuit ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Split gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
Valve for shifting to indirect split (VAIDS)		FMI6	Current above normal or grounded circuit	***Activate:*** The high side drive is short circuit to Gnd ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Split gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to low range (VALR)	**SID36**	FMI3	Voltage above normal or shorted high	***Activate:*** The high side drive is short circuit to Ubatt ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve is activated High range gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to low range (VALR)		FMI5	Current below normal or open circuit	***Activate:*** The high side drive is open circuit ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Range gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for shifting to low range (VALR)		FMI6	Current above normal or grounded circuit	***Activate:*** The high side drive is short circuit to Gnd ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Range gears are missing Automatic gear selection enters faulty gearbox mode with gear changes only at certain vehicle speeds	
Valve for slow	**PSID4**	FMI3	Voltage above normal or	***Activate:*** 1. The high-side drive is	Yellow lamp is sent Slow	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
disengage-ment of the clutch (VASD)			shorted high	short circuit to Ubatt and 2. There is no active fault code for short circuit to Ubatt on VAS- ***Deactivate:*** The high-side drive is OK	engagement/dis-engagement disabled Reduced clutch performance, especially at start and marshalling	
Valve for slow disengage-ment of the clutch (VASD)		FMI5	Current below normal or open circuit	***Activate:*** The high-side drive is open circuit ***Deactivate:*** The high-side drive is OK	Yellow lamp is sent Slow disengagement disabled Reduced clutch performance	
Valve for slow disengage-ment of the clutch (VASD)		FMI6	Current above normal or grounded circuit	***Activate:*** The high-side drive is short circuit to Gnd ***Deactivate: T***he high-side drive is OK	Yellow lamp is sent Slow disengagement disabled Reduced clutch performance	
Valve for slow engagement of the clutch (VASE)	**PSID2**	FMI3	Voltage above normal or shorted high	***Activate:*** 1. The high-side drive is short circuit to Ubatt and 2. There is no active fault code for short circuit to Ubatt on VAS- ***Deactivate:*** The high-side drive is OK	Yellow lamp is sent Slow engagement/dis-engagement disabled Reduced clutch performance, especially at start and marshalling	
Valve for slow engagement of the clutch (VASE)		FMI5	Current below normal or open circuit	***Activate:*** The high-side drive is open circuit ***Deactivate:*** The high-side drive is OK	Yellow lamp is sent Slow engagement disabled Reduced clutch performance, especially at start and marshalling	
Valve for slow engagement of the clutch (VASE)		FMI6	Current above normal or grounded circuit	***Activate:*** The high-side drive is short circuit to Gnd ***Deactivate: T***he high-side drive is OK	Yellow lamp is sent Slow engagement disabled Reduced clutch performance, especially at start and marshalling	
Valve for the gearbox brake (VAGB)	**PSID22**	FMI3	Voltage above normal or shorted high	***Activate:*** The high side drive is short circuit to Ubatt ***Deactivate:*** The high side drive is OK	Red lamp is sent. The valve and the brake are activated The gearbox will be damaged if the vehicle	

FUNCTION	PID/SID	FMI J1587	ERROR	CONDITION	SYMPTOM	COMMENT
					drives. The prop shaft has to be removed to move the vehicle	
Valve for the gearbox brake (VAGB)		FMI5	Current below normal or open circuit	***Activate:*** The high side drive is open circuit ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Shifting to the start gear takes long time	
Valve for the gearbox brake (VAGB)		FMI6	Current above normal or grounded circuit	***Activate:*** The high side drive is short circuit to Gnd ***Deactivate:*** The high side drive is OK	Yellow lamp is sent The valve can not be activated Shifting to the start gear takes long time	

10. VOLVO I-SHIFT TRANSMISSION GSECU FAULT CODES

PID/PPID SID/PSID	FMI	LAMP	CONTENT	TEXT	COMMENT	CONSEQUENCES
SID231	2	None	SAE J1939 Data Link	-	-	Redundancy on J1587
SID237	3	CHECK	Start enable device	Check Gear Selector System at next stop	Only for EMS1.xx vehicles	Start relay not working
SID240	2	CHECK	Program memory	Gear Selector System failure	Boot	Not possible to engage gear
SID250	9	None	SAE J1708 /J1587 data link	-	-	-
SID253	2	CHECK	Program memory	Gear Selector System failure	-	Not possible to engage gear
SID254	12	CHECK	Controller #1	Gear Selector System failure	-	Not possible to engage gear
PSID9	12	CHECK	Gear level position sensors	Check Gear Selector System at next stop	-	Not possible to engage/change gear
PSID36	7	CHECK	Output actuator (REPS)	Check Gear Selector System at next stop	-	Fault displayed after ignition OFF. Risk of battery discharge if main circuit breaker is not opened when vehicle is not used
PSID36	12	CHECK	Output actuator (REPS)	Check Gear Selector System at next stop	-	Gearbox not supplied

PID/PPID SID/PSID	FMI	LAMP	CONTENT	TEXT	COMMENT	CONSEQUENCES
PSID42	2	None	Ignition signals	-	-	Power supply always on
PSID200	9	None	Data Link, MID128	Check Gear Selector System at next stop	Only for AMT-C, Boot	Affects RT only (can be sent for VT)
PSID201	9	None	Data Link, MID144	Check Gear Selector System at next stop	Only for AMT-C, Boot	Affects RT only (can be sent for VT)
PSID205	9	None	Data Link, MID130	Check Gear Selector System at next stop	Boot	Affects RT only (can be sent for VT)
PSID214	9	None	Data Link, MID249	-	Only when second gear selector is installed, Boot	Not possible to switch to/from secondary gear lever

11. SPECIFICATIONS

ALLISON AUTOMATIC TRANSMISSION WITH OR WITHOUT RETARDER

X3-45 Coaches
Gross input power (maximum).....500 HP (373 kW)
Gross input torque (maximum) .....1525 Lbf-ft- (2068 Nm)
Rated input speed (minimum-maximum) .....1600-2300 rpm

X3-45 VIP & XLII BUS SHELLS
Gross input power (maximum).....525 HP (392 kW)
Gross input torque (maximum) .....1650 Lbf-ft (2237 Nm)
Rated input speed (minimum-maximum) .....1600-2300 rpm

Mounting:
Engine.....SAE #1 flywheel housing, flex disk drive

Torque converter:
Type ..... One stage, three element, polyphase
Stall torque ratio .....TC 551-1.8
Lockup clutch with torsional damper ..... Integral/standard

Gearing:
Type ..... Patented, constant mesh, helical, planetary

Ratio:
First 3.51:1
Second.....1.91:1
Third.....1.43:1
Fourth.....1.00:1
Fifth 0.74:1
Sixth 0.64:1
Reverse 4.80:1

Ratio coverage:
6 speed 5.48:1

*** Gear ratios do not include torque converter multiplication.**

Oil System:
Oil type ..... TRANSYND, DEXRON-III
Capacity (excluding external circuits) ..... Initial fill 47 US qts (45 liters)
Oil change ..... 24 US qts (23 liters)
Oil change (with retarder) ..... 27.6 US qts (26 liters)

Oil Filters:
Make ..... Allison Transmission
Type ..... Disposable cartridge
Prevost Part Number (2-filter replacement kit) 571709

VOLVO I-SHIFT TRANSMISSION

Oil System:
Oil type ..... CASTROL SYNTRANS 75W85
Oil change ..... 16 US qts (15 liters)

Oil Filter:
Make ..... Volvo
Type ..... Disposable cartridge
Prevost Part Number 20779040

Gear Selector Control Module (GSCM) MID 223, Diagnostic Trouble Code (DTC), Guide

Contents

- "MID 223 Gear Selector Control Module", page 2
- "Gear Selector Control Module (MID 223), Diagnostic Fault Codes (DTC)", page 3

Information is subject to change without notice.
Illustrations are used for reference only and may differ slightly from the actual vehicle being serviced. However, key components addressed in service information are represented as accurately as possible.

MID 223 Gear Selector Control Module

The manufacturer scan tool is the preferred tool for performing diagnostic work. Contact your local dealer for more information or visit “www.premiumtechtool.com”.

System Overview

A gear selector control module (GSCM) located under the dash board receives operator input signals from the gear selector that is mounted to the left of the drivers seat, along with steering wheel mounted gear selector buttons. The GSCM interpret these signals and communicates the information to the transmission control module (TCM) via the SAE J1939 data link. The GSCM also communicates on the SAE J1587 data link for diagnostic purposes and serve as a redundancy to the SAE J1939 data link in case of data link failure.
The selector includes gear positions of R (reverse), N (neutral), D (drive), and M (manual). The drive and manual are both used for selecting the forward gears in the transmission. With the selector in the drive position the transmission will shift as an automatic, performing gear selections and shifting without driver input. When the manual position is selected, the driver can use the steering wheel selector buttons to choose gears.
In situations where the I-Shift is unintentionally left in gear with the parking brake applied, the TCM will automatically go to neutral when the ignition switch is turned off. This is done to avoid the transmission getting stuck in gear due to drive line "torque up".

Limp Home Mode

Note: Limp Home Mode should only be used to get a vehicle to a safe or secure location. It is not meant for driving any distance.

In the event the that a transmission malfunction occurs, "Limp Home Mode" can be activated. This mode is only meant to get a vehicle to a safe or secure location. To activate, press the ??????? button on the gear selector and then select the D position on the gear selector to active "Limp Home Mode". When activated, L is displayed as the driving mode in the instrument panel digital information display (DID). In "Limp Home Mode", only forward gears 1, 3 and 5 are available. To selector or change a gear while in this mode the vehicle has to be stationary. The "Limp Home Mode", will automatically be deactivated when the ignition is turned off.

Gear Selector Control Module (MID 223), Diagnostic Fault Codes (DTC)

The manufacturer scan tool is the preferred tool for performing diagnostic work. Contact your local dealer for more information or visit “www.premiumtechtool.com”.

The electronic control units (ECUs) on the SAE J1587 data link communicate according to the SAE J1587 standard. The standard has been extended with supplements (PPID, PSID). The diagnostic trouble codes (DTCs) set by the ECUs contain information that is described by the following abbreviations.

MID	Message Identification Description: Identification of a control unit.	SID	Subsystem Identification Description: Identification of a component.
PID	Parameter Identification Description: Identification of a parameter (value).	PSID	Proprietary Subsystem Identification Description: Unique identification of a component.
PPID	Proprietary Parameter Identification Description: Unique identification of a parameter (value).	FMI	Failure Mode Identifier: Identification of fault types.

FMI Table

FMI	Display Text	SAE Text
0	Too high value	Data valid, but above the normal work range
1	Too low value	Data valid, but below the normal work range
2	Incorrect data	Data erratic, Intermittent or incorrect
3	Electrical fault	Voltage above normal or shorted high
4	Electrical fault	Voltage below normal or shorted low
5	Electrical fault	Current below normal or open circuit
6	Electrical fault	Current above normal or grounded circuit
7	Mechanical fault	Mechanical system not responding properly
8	Mechanical or electrical fault	Abnormal frequency, pulse width or period
9	Communication fault	Abnormal update rate
10	Mechanical or electrical fault	Abnormal rate of change
11	Unknown fault	Failure mode not identifiable
12	Component fault	Bad intelligent device or component
13	Incorrect calibration	Out of calibration
14	Unknown fault	Special instructions
15	Unknown fault	Reserved for future assignment by SAE Data Formal Subcommittee

Diagnostic Trouble Code (DTC) List

PSID

“MID 223 PSID 9, Gear Selector, Position”, page 5

“MID 223 PSID 36, Relay Power Supply”, page 5

“MID 223 PSID 42, Signals Key”, page 6

“MID 223 PSID 200, Communication Interference, Data Link, Engine Control Module (ECM)”, page 6

“MID 223 PSID 201, Communication Interference, Data Link, Vehicle Electronic Control Unit (VECU)”, page 7

“MID 223 PSID 205, Communication Interference, Data Link, Transmission Control Module (TCM)”, page 7

“MID 223 PSID 214, No Data From Bodybuilders Module (BBM)”, page 8

SID

“MID 223 SID 231, SAE J1939 Data Link”, page 8

“MID 223 SID 237, Relay, Starter Motor”, page 8

“MID 223 SID 240, Program Memory”, page 9

“MID 223 SID 250, SAE J1587 Data Link”, page 9

“MID 223 SID 253, Calibration Memory EEPROM”, page 9

“MID 223 SID 254, Hardware Fault”, page 9

MID 223 PSID 9, Gear Selector, Position

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 12	• Faulty device or component	• The sensor signals do not correspond with valid value	• Yellow check lamp illuminated • Some or all stalk actions are not working • It is not possible to select gear	• Wiring harness or connectors • Gear position sensor

MID 223 PSID 36, Relay Power Supply

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 7	• Mechanical system not responding properly	• The relay does not release	• Yellow check lamp illuminated • Fault displayed after ignition OFF • Risk of battery discharge if main circuit breaker is not opened when vehicle is not used	• Relay
FMI 12	• Faulty device or component	• 0 voltage at Pin 1	• It is not possible to drive the vehicle	• Short circuit of output to ground when relay is active

MID 223 PSID 42, Signals Key

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent, or incorrect	• Inconsistency between hard-wired ignition signal and ignition signal read on network	• Transmission supplied and Optidriver fully functional until main circuit breaker is opened • Risk of battery discharge if main circuit breaker not opened when vehicle not used • Transmission not supplied and vehicle immobilized after main circuit breaker has been cycled	• Wiring harness or connectors • Blown fuse

MID 223 PSID 200, Communication Interference, Data Link, Engine Control Module (ECM)

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Message missing on SAE J1939 data link from the ECM	• Downhill help disabled	• Open circuit in SAE J1939 data link between gear selector control module (GSCM) and ECM

MID 223 PSID 201, Communication Interference, Data Link, Vehicle Electronic Control Unit (VECU)

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Message missing on SAE J1939 data link from the VECU	• Temporary manual mode disabled • Downhill help disabled • Return to drive disabled	• Open circuit in SAE J1939 data link between gear selector control module (GSCM) and VECU

MID 223 PSID 205, Communication Interference, Data Link, Transmission Control Module (TCM)

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Message missing on SAE J1939 data link from the TCM	• No memorization during 1.5 sec of direction change requests when vehicle is moving • Temporary manual mode disabled	• Open circuit in SAE J1939 data link between gear selector control module (GSCM) and TCM

MID 223 PSID 214, No Data From Bodybuilders Module (BBM)

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• Message missing on SAE J1939 data link from the BBM	• N/A	• N/A

MID 223 SID 231, SAE J1939 Data Link

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent, or incorrect	• SAE J1939 data link communication does not work	• Gear lever commands slower (SAE J1587 data link) • No memorization during 1.5 sec of direction change requests when vehicle is moving • Temporary manual mode disabled • Downhill help disabled • Return to drive disabled	• Wiring harness or connectors

MID 223 SID 237, Relay, Starter Motor

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 3	• Voltage above normal or shorted high	• Vehicle won't start	• Yellow check lamp illuminated • Vehicle won't start	• Relay • Wiring harness or connectors

MID 223 SID 240, Program Memory

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent, or incorrect	• Fault data in program memory • The control unit is not programmed	• Yellow check lamp illuminated • Gear selector control module (GSCM) no function except supply the relay • Unable to shift out of neutral position	• GSCM not programmed • Program memory

MID 223 SID 250, SAE J1587 Data Link

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 9	• Abnormal update rate	• The SAE J1587 data link is not working	• N/A	• A control module is being programmed • Wiring harness or connectors

MID 223 SID 253, Calibration Memory EEPROM

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 2	• Data erratic, intermittent, or incorrect	• Fault in main software	• Yellow check lamp illuminated • Use of default values of parameters	• The gear selector control module (GSCM) is not programmed • Software

MID 223 SID 254, Hardware Fault

Type of fault:	FMI Description:	Fault Condition:	Possible Symptoms:	Possible Cause:
FMI 12	• Faulty device or component	• Internal fault in control unit	• Yellow check lamp illuminated • It is not possible to drive the vehicle	• Gear selector control module (GSCM)

SECTION 09: PROPELLER SHAFT

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FIGURE 1: PROPELLER SHAFT ASSEMBLY 3

1. PROPELLER SHAFT

1.1 DESCRIPTION

The propeller shaft transmits power from the transmission to the differential (Fig. 1). Refer to paragraph *"6. SPECIFICATIONS"* at the end of this section for propeller shaft length. The propeller shaft is "Dana Spicer Life Series SPL250" type with tubular shafts. It is provided with two heavy-duty universal joints (Fig. 1).

The propeller shaft has a half round end yoke at each end. The slip yoke is connected to the differential by a half round end yoke with two needle bearings.

The other extremity (tube yoke assembly) is connected to the transmission by a half round end yoke with two needle bearings (Allison transmission) or a flange yoke and companion flange with two needle bearings (I-Shift Transmission).

Furthermore, a slip joint on the propeller shaft compensates for variations in distance between the transmission and the differential, or between the output retarder (optional on the automatic transmission) and differential.

The rise and fall of the drive axle bring about these variations as the vehicle passes over uneven surfaces. The slip joint also eases removal of the transmission or the drive axle.

2. REMOVAL, DISASSEMBLY, REASSEMBLY AND INSTALLATION

Refer to *"SPICER LIFE SERIES DRIVESHAFTS Service Manual"* annexed to this section.

Where applicable:

- Remove or install propeller shaft safety guard.
- Screw bolts to the specified torque (Fig. 1).

3. CLEANING, INSPECTION AND LUBRICATION

3.1 CLEANING AND INSPECTION

Thoroughly clean grease from bearings, journal, lubricating grease fittings and other parts. Needle bearing assemblies may be soaked in a cleaning solution to soften hard grease particles.

It is extremely important that bearing assemblies be absolutely clean and blown out with compressed air, since small particles of dirt or grit can cause rapid bearing wear. Do not attempt to disassemble needle bearings.

Bearing journal areas should be inspected for roughness or grooving. If light honing does not remove roughness, the entire bearing assembly should be replaced. Excessive wear of the needle bearing is indicated if the needles drop out of the retainer, or if marks are present on the journal bearing surface. In such case, replace bearing assembly. Finally, inspect yokes for cracks, wear or distortion.

NOTE
Repair kits are available for overhaul of the propeller shaft assembly. Refer to Parts Manual, Section 9.

3.2 LUBRICATION

Lubricate propeller shaft universal joints periodically, every 100,000 miles (160 000 km) or every 6 months, whichever comes first. Apply grease gun pressure to the lube fitting. Use a good quality lithium-base grease such as: NLGI No.2 E.P. Grease (suitable for most temperatures). Refer to "Spicer Life Series Driveshafts Service Manual", under heading, "Lubrication Procedures – Universal Joints".

NOTE
Do not assume that bearing cavities have been filled with new grease unless it has expelled around all seals.

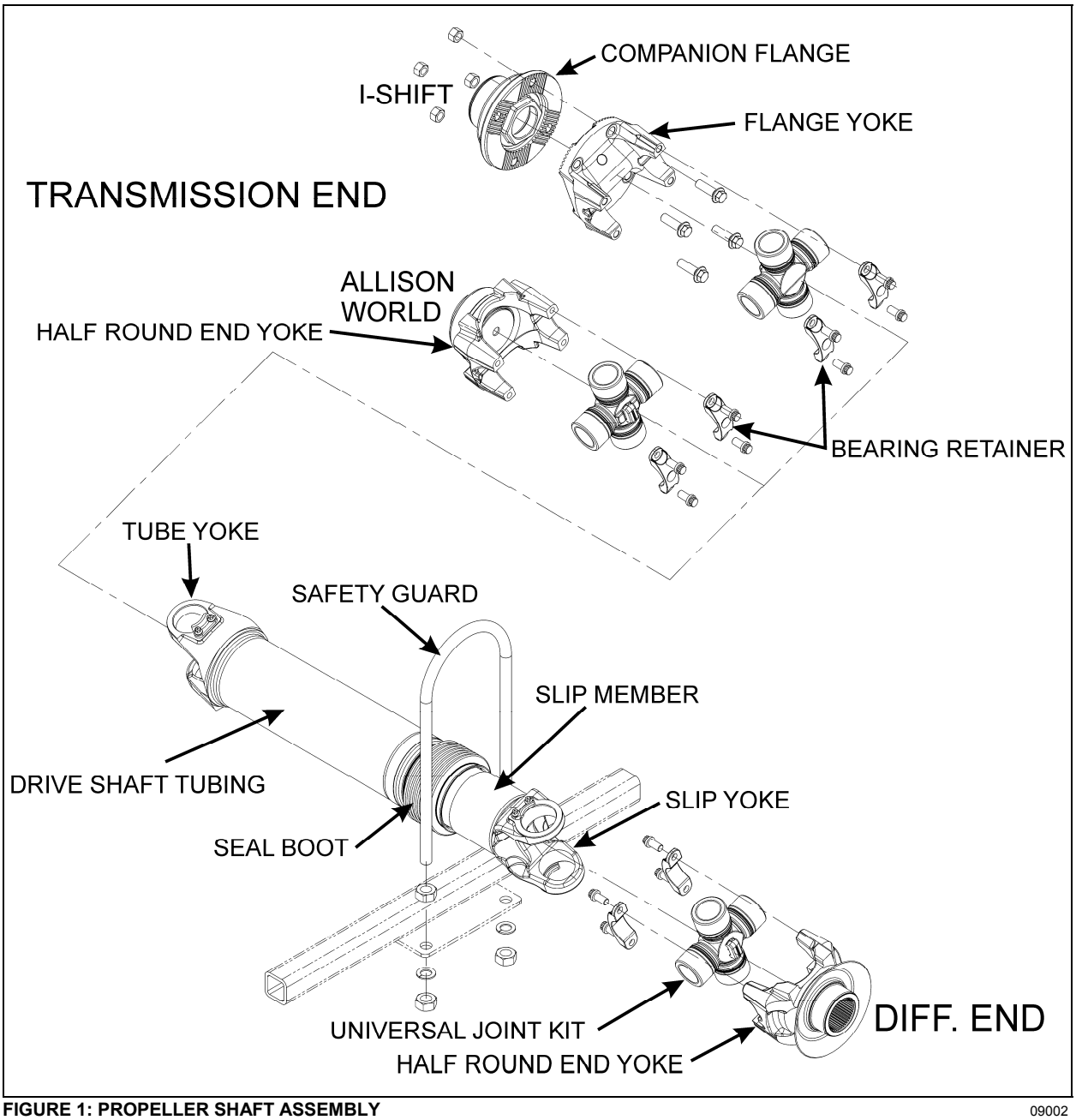

FIGURE 1: PROPELLER SHAFT ASSEMBLY 09002

4. EXPLANATION OF COMMON DAMAGES

1. Cracks: Stress lines due to metal fatigue. Severe and numerous cracks will weaken the metal until it breaks.

2. Galling: Scraping off of metal or metal displacement due to friction between surfaces. This is commonly found on trunnion ends.

3. Spalling (surface fatigue): Breaking off of chips, scales, or flakes of metal due to fatigue rather than wear. It is usually found on splines and U-joint bearings.

4. Pitting: Small pits or craters in metal surfaces due to corrosion. If excessive, pitting can lead to surface wear and eventual failure.

5. Brinelling: Surface wear failure due to the wearing of grooves in metal. It is often caused by improper installation procedures. Do not confuse the polishing of a surface (false brinelling), where no structural damage occurs, with actual brinelling.

6. Structural Overloading: Failure caused by a load greater than the component can stand. A structural overload may cause propeller shaft tubing to twist under strain or it may cause cracks or breaks in U-joints and spline plugs.

5. TROUBLESHOOTING

Refer to *"Spicer Life Series Driveshafts Service Manual".*

6. SPECIFICATIONS

PROPELLER SHAFT

ALL VEHICLES EQUIPPED WITH ALLISON WORLD TRANSMISSION

Make	Hayes-Dana Inc.
Series	SPL250
Prevost number	580090
Length	485 mm

X3-45 COACHES EQUIPPED WITH I-SHIFT TRANSMISSION

Make	Hayes-Dana Inc.
Series	SPL250
Prevost number	580086
Length	373 mm

Spicer Life Series® Driveshafts

Roadranger® More time on the road™

Service Manual

3264-SPL

Spicer Life Series

March 2008

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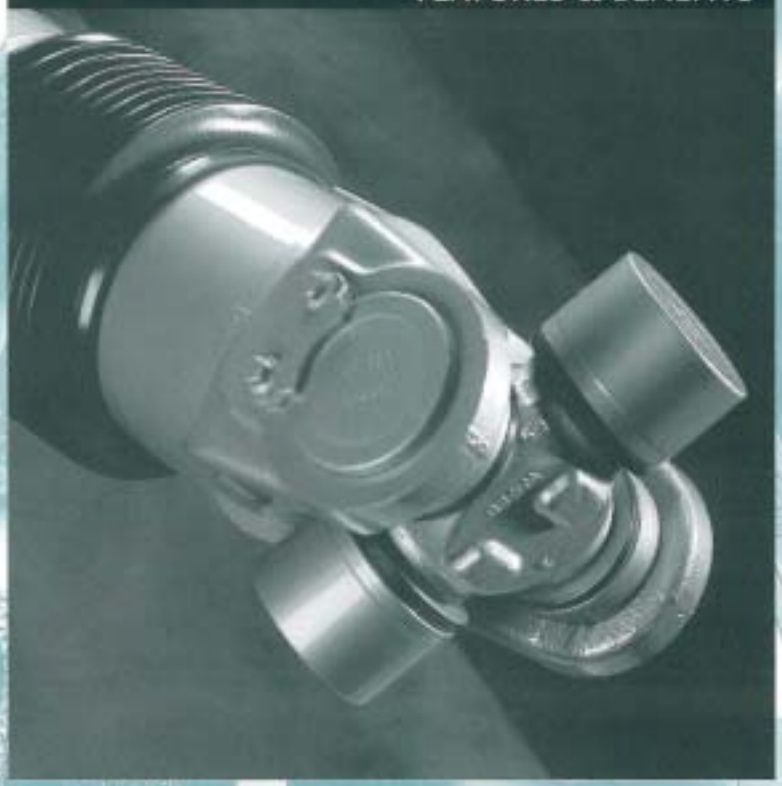
FEATURES & BENEFITS



People Finding A Better Way

SPICER LIFE SERIES™ FEATURES & BENEFITS

Note – Spicer Life Series™ driveshafts are found on vehicles throughout the world. Therefore, this manual includes worldwide terminology. These terms have been highlighted in teal.

This manual encompasses inspection, lubrication, removal and installation procedures for Spicer Life Series™ 55, 70, 90, 100, 140, 170 and 250 driveshaft assemblies.

IMPORTANT FEATURES OF A SPICER LIFE SERIES™ DRIVESHAFT

Spicer offers a complete range of driveshaft solutions to meet the full spectrum of needs in medium and heavy duty applications. The Spicer Life Series™ driveshafts have been designed and developed to stand up to the wear and tear of heavy hauling tasks. They are the first driveshafts in the industry to be compatible with advancing powertrain specifications for higher engine torque and lower axle ratios. No one does more than Spicer in meeting the needs of the marketplace.

Spicer Life Series™ driveshafts offer:

- Longer life
- Lower lifetime maintenance
- Increased strength for higher engine torque and lower axle ratios
- Smaller driveshaft rotating diameter

A driveshaft that transmits high torque loads must be durable and strong. Spicer uses forged steel and high strength cast yokes to provide the necessary rigidity to maintain bearing alignment under torque loads. Spicer Life Series Quick Disconnect™ end yokes reduce the time to remove or install the driveshaft, equating up to a 75% labor savings for service. Applications requiring flange connections, S.A.E., DIN and cross-serrated T-Flanges are available. A new cold-formed, bearing retainer provides structural rigidity and reduces bearing movement which may result from overloading. New patented spring tabs, found on heavy duty Spicer Life Series™ assemblies and bearing retainers, increase bearing retention, reduce wear and optimize bearing capacity.

Spicer Life Series™ award winning* universal joint kits are specifically designed to give extended driveshaft life. Flat-ended needle bearings are used to withstand oscillating loads while the driveshaft is rotating and to eliminate skewing in the bearing cup. Thrust washers significantly reduce end galling on trunnion ends and lower universal joint operating temperature. Synthetic rubber seals and plastic seal guards provide lubricant retention and help prevent the entry of foreign material, significantly increasing universal joint life. The centrally located grease zerk (nipple) fitting increases the strength of the journal cross and allows more torque carrying capacity.

High-strength steel tubing is used to provide maximum torque carrying capacity at minimum practical weight. Increased tube diameter allows a higher critical speed and longer one-piece driveshafts. This increased stiffness also improves noise, vibration and harshness. New slip member booting or alternative seal can offers better protection against environmental contaminants, increases component life, and is lubricated for the life of the product.

The new integral tube sleeve and yoke shaft design, found on heavy duty Spicer Life Series™ designs, along with larger diameter involute splines, creates greater strength and torsional stiffness with less weight. This new design leads to improved balance and less slip effort, resulting in reduced noise and vibration for the entire driveshaft system. Spicer Glidecote,® found in all slip member assemblies, reduces friction, thereby lowering thrust loads under high torque. This nylon coating also prevents spline wear and extends life.

Automotive News PACE AWARD

**Spicer Driveshaft Division won the Automotive News PACE award for this bearing's innovative design, product and process technology.*

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INSPECTION

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SPICER LIFE SERIES™ INSPECTION

Before You Get Started

Note – Spicer Life Series™ driveshafts are found on vehicles throughout the world. Therefore, this manual includes worldwide terminology. These terms have been highlighted in teal.

Caution – Under no circumstances should individuals attempt to perform driveline service and/or maintenance procedures for which they have not been trained or do not have the proper tools and equipment. ▲ See warning, below.

▲ ***WARNING***

Failure to take commonsense, precautionary measures when working on a vehicle or other machinery could result in property damage, serious personal injury or death. In order to avoid property damage, serious personal injury or death, you must:

1. **ALWAYS** wear safety glasses when performing maintenance or service. Failure to wear safety glasses can result in personal injury and/or partial or complete vision loss.

2. **NEVER** go under a vehicle while the engine is running. Be sure the vehicle's engine is off, and keys are removed from ignition.

3. **NEVER** go under or work on a vehicle that is not on a level or flat surface.

4. **NEVER** work on a driveshaft without blocking the vehicle's wheels and releasing all parking brakes. ▲ See warning, below.

▲ ***WARNING***

Failure to release all parking brakes and failure to place transmission in neutral can result in torque being applied to the driveshaft. Disconnecting a driveshaft with applied torque can result in property damage, serious personal injury or death.

5. **NEVER** lift a vehicle without the appropriate weight-rated, vehicle-support equipment.

6. **NEVER REMOVE** a driveshaft from the vehicle without keeping the vehicle's transmission in neutral. ▲ See warning, step 4.

7. **CAUTION** – Spicer Life Series™ driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Be sure to use proper lifting techniques when handling Spicer Life Series™ driveshafts. More than one person may be needed when handling driveshaft assemblies.

8. **ALWAYS** use support straps to prevent the driveshaft from falling out of vehicle during the removal and installation process.

9. **NEVER** heat components or use sledgehammers or floor jacks to remove the driveshaft from vehicle.

Note – For driveshaft applications that have pillow blocks, dampers, parking brakes or retarders, refer to these component manufacturers' or the original equipment vehicle manufacturers' service manuals for proper procedures.

Note – Spicer Life Series™ 140, 170 and 250 driveshaft assemblies and components are metric. To eliminate any confusion between S.A.E. and metric threaded fasteners, the metric fasteners have been color coded gold. Spicer Life metric fasteners include spring tab bolts, bearing retainer bolts and midship nuts.

DRIVESHAFT ASSEMBLY INSPECTION PROCEDURES

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

Spicer Life Series™ driveshafts should be carefully inspected at recommended original equipment vehicle manufacturers' service intervals and/or at Spicer recommended lubrication intervals as shown in Table A, below.

Note – The following procedures are to be performed **prior to** any lubrication of universal joints or slip members. The addition of lubricant can mask the looseness in a component that is beginning to show wear and may be in need of replacement.

END FITTINGS

1. Visually inspect all input and output end-fitting retaining nuts or bolts for any gaps between mating surfaces. If gaps are present, consult transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for proper fastener specifications. ▲ See warning, below.

▲ ***WARNING***

A loose end-fitting retaining nut or bolt can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 1

2. Check all input and output end fittings for looseness or broken back. Take hold of the end fitting with both hands. Try to move it vertically and horizontally to feel any looseness. (See photo 1, above.)

There should **NOT** be any movement in the end fittings

UNIVERSAL JOINT MAXIMUM LUBRICATION INTERVALS

SERIES	CITY	ON-HWY.	LINEHAUL	OFF-HWY.*	INDUSTRIAL*
SPL 250, 170 & 140	25,000 Mi. 40,000 Km. or 3 Months (whichever comes first)	100,000 Mi. 160,000 Km. or 6 Months (whichever comes first)	100,000 Mi. 160,000 Km. or 6 Months (whichever comes first)	25,000 Mi. 40,000 Km. or 3 Months (whichever comes first)	500 Hrs.
SPL 100, 90, 70 & 55	8,000 Mi. 12,800 Km. or 3 Months (whichever comes first)	15,000 Mi. 24,000 Km. or 3 Months (whichever comes first)	15,000 Mi. 24,000 Km. or 3 Months (whichever comes first)	8,000 Mi. 12,800 Km. or 3 Months (whichever comes first)	500 Hrs.

City *is defined as all applications that require a minimum of 90% of operation time within city limits.*

On-highway *is defined as all applications requiring less than 10% of operating time on gravel, dirt or unpaved roads.*

Off-highway *is defined as all applications requiring more than 10% of operating time on gravel, dirt or unpaved roads.*

Linehaul *is defined as 100% of operation time on smooth concrete or asphalt.*

** Relubrication intervals for off-highway and industrial use vary depending on the application and operating conditions. In general, to obtain maximum life, relubrication on industrial applications should occur every 500 hours for normal service and every 250 hours for continuous service or severe environmental conditions.*

Table A

relative to the output or input shafts to which they are connected. ▲ See warning, below.

▲ ***WARNING***

A loose end fitting can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If looseness is evident, consult transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for proper end fitting specifications.

3. If the end fittings are tight, check for excessive radial looseness of the transmission output shaft and axle input and output shaft splines relative to the end fitting.

Take hold of the end fitting with both hands, rotate left to right, feeling for play or backlash. If radial looseness is evident, end fittings or input or output shafts may be in need of replacement. (See photo 2, below.) ▲ See warning, below.

▲ ***WARNING***

A loose end fitting, due to transmission or axle input and/or output shaft spline wear or end fitting spline wear, can result in driveline failure. Driveline failure can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 2

4. Visually inspect for damaged bearing retainers or stamped straps, loose bearing retainer bolts or strap bolts, loose companion flange bolts and nuts, loose or missing spring tabs or spring tab bolts, damaged tangs on end fittings, damaged or missing snap rings, and rotating bearing cups. ▲ See warning, below.

If any of these situations are evident, replacement of the components is necessary. Refer to the removal and installation sections of this manual for proper replacement procedures.

▲ ***WARNING***

Loose, missing or damaged bearing retainers or stamped straps, retaining nuts, bolts, spring tabs or spring tab bolts, end-fitting tangs, snap rings, or rotating bearing cups can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 3

Photo 4, Relubable Style

UNIVERSAL JOINTS

5. Check for excessive looseness across the ends of the universal joint bearing cup assemblies and trunnions. Take hold of the inboard yoke on the driveshaft with both hands. Try to move yoke vertically and horizontally. (See photo 3, above.)

There should be less than .006 in. (.15mm) movement in the universal joint kit relative to the inboard or outboard yokes. If looseness is greater than .006 in. (.15mm), the universal joint kit must be replaced. ▲ See warning, below.

▲ *WARNING*

Excessive looseness across ends of universal joint bearing cup assemblies can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

6. Visually inspect all universal joint kits in the driveshaft assembly.

Relubable Style

7. Check for the presence of all grease zerk (nipple) fittings. (See photo 4, above). Grease zerk (nipple) fittings should not be missing, loose or fractured. ▲ See warning, below.

▲ *WARNING*

A missing, loose or fractured grease zerk (nipple) fitting eliminates the ability to relubricate the universal joint. Neglecting to properly relubricate or inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If grease zerk (nipple) fitting is loose, tighten to required specifications. (See Table B, below.)

If grease zerk (nipple) fitting is fractured, replace grease zerk (nipple) fitting and tighten to required specifications. (See Table B, below.)

UNIVERSAL JOINT GREASE ZERK (NIPPLE) FITTING SPECIFICATIONS

SERIES	GREASE ZERK P/N	MIN. ZERK TORQUE Nm	MIN. ZERK TORQUE FT. LB.
SPL90, SPL100, SPL140, SPL170 SPL250	232830	20.5	15.0

Table B

Photo 5, Permanently Lubricated Plug Style

Photo 6, Permanently Lubricated Net-Form Style

If grease zerk (nipple) fitting is missing, the entire universal joint kit needs to be replaced. Refer to the removal and installation sections of this manual for proper replacement procedures.

Permanently Lubricated Plug Style

8. Permanently lubricated plug style universal joint kits do not contain grease zerk (nipple) fittings, only a plug. (See photo 5, above.) Make sure plug is not missing, loose or fractured.

If the plug is loose, tighten to required specifications. (See Table B, step 7.) ▲ See warning, below.

▲ ***WARNING***

A missing, loose or fractured plug allows contaminants to invade the universal joint kit. Invasion of contaminants into the universal joint kit can degrade lubricant and can cause universal joint damage, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If a plug is missing or fractured, the entire universal joint kit needs to be replaced. Refer to the removal and installation sections of this manual for proper replacement procedures. ▲ See warning, step 8.

Permanently Lubricated Net-Formed Style

9. Net-formed universal joints do not contain grease zerk (nipple) fittings or plugs and are not relubable. (See photo 6, above.)

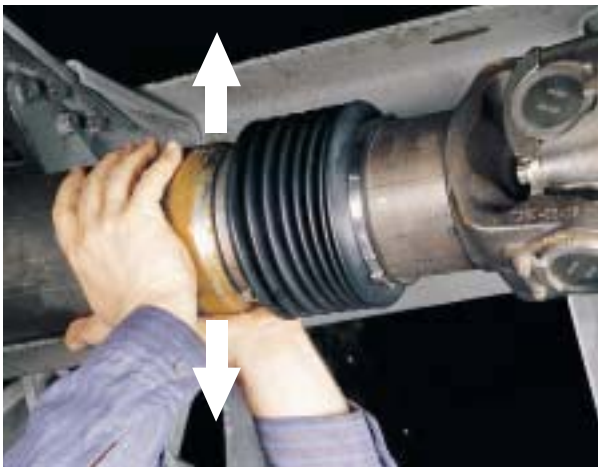

Photo 7

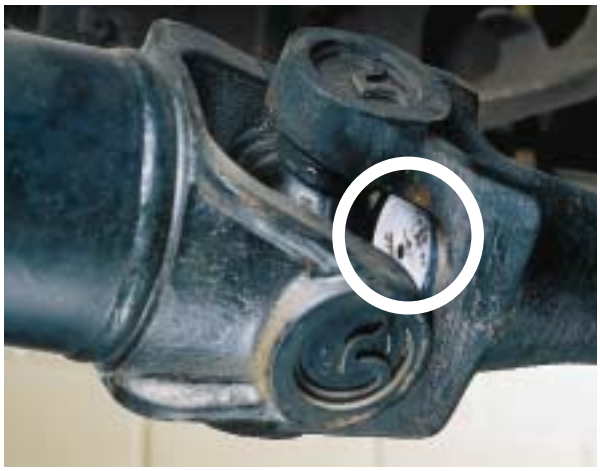

Photo 8

SLIP MEMBER ASSEMBLY

10. Check the slip member assembly for excessive radial looseness. Using a dial indicator, take hold of the tubing near the slip member with both hands and try to move vertically, up and down relative to the ground. There should be limited looseness in the slip member assembly. (See photo 7, above.) See warning, below.

If looseness is greater than .012 in. (.30mm) or greater as read on dial indicator, replacement of the slip member assembly is necessary. Refer to the removal and installation sections of this manual for proper replacement procedures.

WARNING

Excessive radial looseness can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Relubable Style

11. For an inboard and outboard slip yoke assembly design, check to be sure the slip yoke welch plug is not loose, missing or damaged. (See photo 8, above.) See warning, below.

If any of these situations are evident, replacement of the slip yoke and professional rebalancing of the driveshaft is necessary. Refer to the removal and installation sections of this manual for proper replacement procedures for slip members.

WARNING

A loose, missing or damaged welch plug allows contaminants to invade the slip member assembly. Invasion of contaminants into the slip member assembly can degrade the lubricant and cause slip member component damage, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 9

Photo 10

12. Visually inspect for the presence of the grease zerk (nipple) fitting, if applicable, on the slip yoke. (See photo 9, above.) Grease zerk (nipple) fittings should not be missing, loose or fractured. ▲ See warning, below.

▲ *WARNING*

A missing, loose or fractured grease zerk (nipple) fitting eliminates the ability to relubricate the slip member assembly. Neglecting to properly relubricate or inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If grease zerk (nipple) fitting is loose, tighten to required specifications. (See Table C, below.)

SLIP MEMBER GREASE ZERK (NIPPLE) FITTING SPECIFICATIONS

SERIES	GREASE ZERK P/N	THREAD SIZE	ZERK TORQUE Nm	ZERK TORQUE IN. LB.
SPL90	500174-1	0.25"-28	3.5-6.2	31-55

Table C

If grease zerk (nipple) fitting is missing or fractured, the slip members may need to be replaced. Be sure to follow step 10 for inspection of radial looseness in slip member assembly.

If slip member assembly is within acceptable limits as stated in step 10, (page 14) install new grease zerk (nipple) fitting and tighten to required specifications. (See Table C, below). Be sure to completely relubricate slip member assembly with recommended lubricant. See lubrication section of this manual for proper procedures.

Refer to the removal and installation sections of this manual for proper replacement procedures for slip members.

13. Check the slip yoke seal. (See photo 10, above.) Make sure the seal is properly attached to the slip yoke and is not loose or damaged. ▲ See warning, below.

If any of these situations are evident, replacement of slip member assembly is necessary. Refer to the removal and installation sections of this manual for proper replacement procedures for slip members.

▲ *WARNING*

A loose or damaged slip yoke seal allows contaminants to invade the slip member assembly. Invasion of contaminants into the slip member assembly can degrade the lubricant and cause slip member component damage, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Permanently Lubricated Style

14. Check yoke shaft boot (see photo 11, below) or seal can. Make sure the boot or seal can is properly attached to the yoke shaft and tube sleeve and no damage or looseness is apparent. Visually inspect boot for tears. Inspect boot or seal can for punctures. Inspect boot clamps for damage. See warning, below.

Photo 11

If any of these situations are evident, replacement of slip member assembly is necessary. Refer to the removal and installation sections of this manual for proper replacement procedures for permanently lubricated slip members.

WARNING

A loose or damaged slip member boot or seal can allows contaminants to invade the slip member assembly. Invasion of contaminants into the slip member assembly can degrade the lubricant and can cause slip member component damage, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

TUBING

15. Check the driveshaft for bent or dented tubing. If either of these situations is evident, replacement of the complete driveshaft assembly or tube is necessary. See warning, below.

WARNING

Bent or dented tubing can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

16. Make certain there is no buildup of foreign material on the driveshaft. See warning, below.

WARNING

Buildup of foreign material on a driveshaft can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If found, buildup should be removed carefully to avoid damaging the driveshaft. (See Table D, below.)

REMOVAL OF FOREIGN MATERIAL

FOREIGN MATERIAL TYPE	REMOVAL METHOD
Asphalt, Tar or Undercoating	Mineral spirits or any appropriate solvent
Mud	Rinse off with water

Table D

Photo 12

CENTER BEARINGS

17. Visually inspect all center bearings, end-fitting midship nuts for any gaps between the mating surfaces. (See photo 12, above.) ▲ See warning, below.

Be sure to repeat steps 2 and 3, for all center bearing end fittings for broken back and backlash.

▲ *WARNING*

A loose center bearing end-fitting midship nut can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If gaps are present and steps 2 and 3 have been followed, see Table E, top right, for proper torque specifications and refer to the removal section of this manual for proper driveshaft removal procedures.

MIDSHIP NUT SPECIFICATIONS

SERIES	NUT P/N	WASHER P/N	HEAD SIZE	NUT TORQUE Nm	NUT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	231502	N/A	1 5/8"	644-712	475-525
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	250-74-11	230123-6	41mm*	644-712	475-525
SPL170	250-74-11	230123-6	41mm*	644-712	475-525
SPL250	250-74-11	230123-6	41mm*	644-712	475-525

** A 1 5/8" socket may be used.*

Table E

18. Inspect the center bearing bracket bolts for looseness. (See photo 13, below.) ▲ See warning, below.

Photo 13

If looseness is evident, retighten center bearing bracket bolts. Consult the vehicle manufacturers' specifications for proper bolt torque. Check the alignment of the bracket before tightening the bolts. Bracket should not be skewed.

▲ *WARNING*

Loose center bearing bracket bolt(s) can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

19. Visually inspect the center bearing rubber cushion for damage. Make sure the slingers are not rubbing against the rubber cushion. Verify that the rubber cushion is properly seated in the metal bracket. ▲ See warning, below.

If any of these situations are evident, replacement of the center bearing assembly is necessary. Refer to the removal and installation sections in this manual for proper center bearing replacement instructions.

▲ ***WARNING***

Damaged center bearings or center bearing components can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

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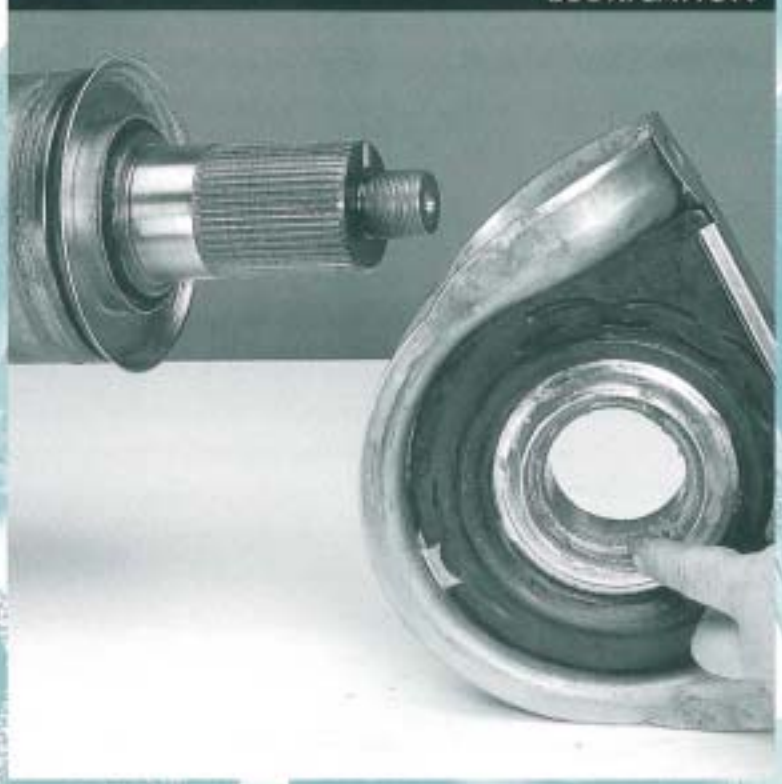
LUBRICATION



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SPICER LIFE SERIES™
LUBRICATION OF U-JOINTS, SLIP MEMBERS & CENTER BEARINGS

Before You Get Started

Note – Spicer Life Series™ driveshafts are found on vehicles throughout the world. Therefore, this manual includes worldwide terminology. These terms have been highlighted in teal.

Caution – Under no circumstances should individuals attempt to perform driveline service and/or maintenance procedures for which they have not been trained or do not have the proper tools and equipment. ▲ See warning, below.

▲ ***WARNING***

Failure to take commonsense, precautionary measures when working on a vehicle or other machinery could result in property damage, serious personal injury or death. In order to avoid property damage, serious personal injury or death, you must:

1. **ALWAYS** wear safety glasses when performing maintenance or service. Failure to wear safety glasses can result in personal injury and/or partial or complete vision loss.

2. **NEVER** go under a vehicle while the engine is running. Be sure the vehicle's engine is off, and keys are removed from ignition.

3. **NEVER** go under or work on a vehicle that is not on a level or flat surface.

4. **NEVER** work on a driveshaft without blocking the vehicle's wheels and releasing all parking brakes. ▲ See warning, below.

▲ ***WARNING***

Failure to release all parking brakes and failure to place transmission in neutral can result in torque being applied to the driveshaft. Disconnecting a driveshaft with applied torque can result in property damage, serious personal injury or death.

5. **NEVER** lift a vehicle without the appropriate weight-rated, vehicle-support equipment.

6. **NEVER REMOVE** a driveshaft from the vehicle without keeping the vehicle's transmission in neutral. ▲ See warning, step 4.

7. **CAUTION** – Spicer Life Series™ driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Be sure to use proper lifting techniques when handling Spicer Life Series driveshafts. More than one person may be needed when handling driveshaft assemblies.

8. **ALWAYS** use support straps to prevent the driveshaft from falling out of vehicle during the removal and installation process.

9. **NEVER** heat components or use sledgehammers or floor jacks to remove the driveshaft from vehicle.

Note – For driveshaft applications that have pillow blocks, dampers, parking brakes or retarders, refer to these component manufacturers' or the original equipment vehicle manufacturers' service manuals for proper procedures.

Note – Spicer Life Series™ 140, 170 and 250 driveshaft assemblies and components are metric. To eliminate any confusion between S.A.E. and metric threaded fasteners, the metric fasteners have been color coded gold. Spicer Life metric fasteners include spring tab bolts, bearing retainer bolts and midship nuts.

LUBRICATION

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

Lack of proper lubrication is one of the most common causes of universal joint and slip member problems. When properly applied, relubable Spicer Life™ universal joints which are adequately relubricated at recommended intervals will meet or exceed vehicle operation requirements.

Note – Spicer Life Series™ replacement universal joint kits contain only enough grease to provide needle roller bearing protection during storage. It is therefore necessary to completely lubricate each replacement kit prior to assembly into the yokes.

Inadequate relubrication intervals and failure to properly lubricate the universal joints will cause universal joint failures. Proper relubrication flushes the universal joints, thus removing abrasive contaminants from the bearings. Relubable slip members must also be adequately relubricated to prevent slip member failure. ▲ See warning, below.

▲ ***WARNING***

Inadequate lubrication can cause driveline failure which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death. In order to avoid driveline failure, including driveline separation, you must:

1. Carefully review the lubrication specifications found in this manual.
2. Be sure that you relubricate at the recommended intervals.
3. Be sure that you use only recommended lubricants that meet the criteria listed.
4. Carefully follow driveshaft inspection procedures as outlined in this manual.

RECOMMENDED LUBRICANTS FOR RELUBABLE UNIVERSAL JOINTS AND SLIP MEMBERS

Standard Application

Spicer recommends that the following requirements be met for any lubricant that will be used to service most vehicular, industrial and all auxiliary driveshaft applications.

- Use a good quality **E.P. (extreme pressure)** grease
- Timkin Test Load - 50 Lbs./23 Kg. **minimum**
- Meeting N.L.G.I.* E.P., **Grade 2** specifications
- Grease must have an operating range of +325˚F to -10˚F (+163˚C to -23˚C)

**National Lubricating Grease Institute*

Consult your local lubricant source for greases that meet these specifications.

Note – There are numerous instances when special lubrication is required by vehicle specifications or customer request. The lubrication recommendations listed in this manual are prescribed by Spicer Driveshaft Division engineering. Any alternate lubricants, or lubrication procedures, are the responsibility of the user.

GREASE COMPATIBILITY*

When greases made from different thickeners are mixed, the mixture may result in lower service performance or physical properties than either of the original component products. This reduction in lubricant performance is called incompatibility. It may show up in any of several areas, such as:

1. Lower heat resistance;
2. Change in consistency, usually softening; or
3. Decrease in shear stability.

Mixtures which show none of these changes are considered compatible. Incompatibility is not always caused by the thickener, since each of the greases in the mixture is a complete package – thickener, fluid, and additives. Sometimes the thickener of one grease is incompatible with the fluid or the additives present in the second grease. If the mixture proves to be significantly softer, less shear stable, or less heat resistant than the original grease, the mixture shall be deemed incompatible. ▲ See warning, below.

▲ ***WARNING***

Incompatible lubricants/greases which are applied to universal joints and/or slip members, can result in failure of the driveline and can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Incompatibility is best determined in service or in service-related tests; it is not predictable. Certain thickener combinations often have been found unsatisfactory and are generally so recognized. These would include lithium and sodium greases and organo-clay and most soap greases. **Contact your local lubricant supplier for grease compatibility information.**

To help reduce the effects of incompatible greases, make sure to thoroughly purge all four bearing seals on each universal joint with the new grease. Purge seals until the **fresh** grease is visible on the outside of all four bearing seals.

It is recommended that all purged grease be wiped clean to prevent discharge into the general environment.

** Grease compatibility information – from National Lubricating Grease Institute*

LUBRICATION INTERVALS FOR RELUBABLE UNIVERSAL JOINTS

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

Lubrication intervals vary depending on the service requirements and operating conditions of the vehicle or machine. Table F, below, shows the recommended universal joint lubrication intervals for various types of service.

UNIVERSAL JOINT MAXIMUM LUBRICATION INTERVALS

SERIES	CITY	ON-HWY.	LINEHAUL	OFF-HWY.*	INDUSTRIAL*
SPL 250, 170 & 140	25,000 Mi. 40,000 Km. or 3 Months (which ever comes first)	100,000 Mi. 160,000 Km. or 6 Months (which ever comes first)	100,000 Mi. 160,000 Km. or 6 Months (which ever comes first)	25,000 Mi. 40,000 Km. or 3 Months (which ever comes first)	500 Hrs.
SPL 100, 90, 70 & 55	8,000 Mi. 12,800 Km. or 3 Months (which ever comes first)	15,000 Mi. 24,000 Km. or 3 Months (which ever comes first)	15,000 Mi. 24,000 Km. or 3 Months (which ever comes first)	8,000 Mi. 12,800 Km. or 3 Months (which ever comes first)	500 Hrs.

City *is defined as all applications that require a minimum of 90% of operation time within city limits.*

On-highway *is defined as all applications requiring less than 10% of operating time on gravel, dirt or unpaved roads.*

Off-highway *is defined as all applications requiring more than 10% of operating time on gravel, dirt or unpaved roads.*

Linehaul *is defined as 100% of operation time on smooth concrete or asphalt.*

** Relubrication intervals for off-highway and industrial use vary depending on the application and operating conditions. In general, to obtain maximum life, relubrication on industrial applications should occur every 500 hours for normal service and every 250 hours for continuous service or severe environmental conditions.*

Table F

LUBRICATION PROCEDURE FOR UNIVERSAL JOINTS

SPICER LIFE SERIES™ 55,70, 90, 100, 140, 170 & 250

Required Tools

- N.L.G.I. Grade-2, E.P. Grease
- Grease Gun

May Need – If bearing(s) will not purge

- Ratchet or Air Gun
- Appropriate 12-Point Socket
- C-Clamp
- Extra Bearing Retainer or Stamped Strap Bolts
- Extra Stamped Straps
- Brass Hammer or Soft-Faced Hammer

1. Use the recommended lubricant to purge **all** four seals of each universal joint. This flushes abrasive contaminants from each bearing assembly and assures proper filling of all four bearings.

Make sure **fresh** grease is evident at all universal joint bearing seals. (See photo 14, below.)

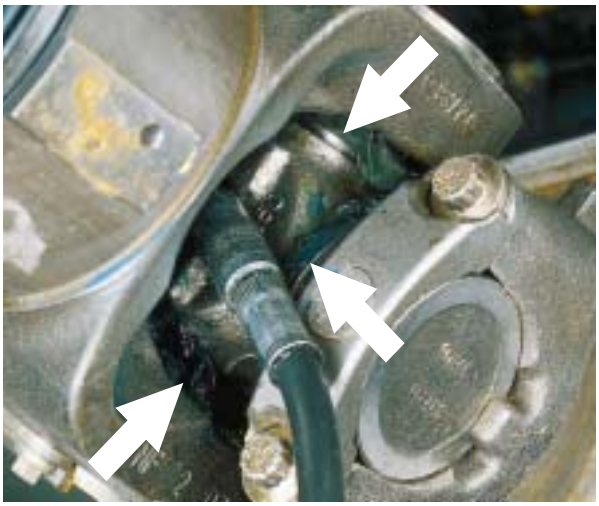

Photo 14

2. If any of the seals fail to purge, try to move the driveshaft from side to side while applying grease gun pressure. On two-headed zerk (nipple) fittings, try greasing from the opposite lube fitting.

Note – Due to the superior sealing capability of the Spicer Life design, there will occasionally be one or more bearing assembly seals that will not purge.

3. If any bearing cup assemblies fail to purge, releasing seal tension may be necessary. See table of contents for page listings for releasing seal tension of Quick Disconnect,™ Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) or Snap Ring Styles.

PROCEDURE FOR RELEASING UNIVERSAL JOINT BEARING SEAL TENSION

QUICK DISCONNECT™ – SPRING TAB STYLE

Note – It will be necessary to have additional bearing retainer or stamped strap bolts and stamped straps in order to complete the following instructions. It may also be necessary to have additional spring tabs and spring tab bolts.

1. Utilizing a brass hammer and wearing safety glasses, sharply strike inboard yoke on lug ear **once**, to firmly seat bearing against spring tab and relieve tension across span. ▲ See warning, below. Rotate shaft 180 degrees and repeat procedure on opposite lug ear.

Apply grease gun pressure and purge **all** four bearings until **fresh grease** is seen at **all** four bearing seals.

▲ ***WARNING***

To prevent serious eye injury, always wear safety glasses when performing maintenance or service. Failure to wear safety glasses can result in serious personal injury, partial or complete vision loss.

2. If striking lug ears does not cause purging, remove and discard spring tab bolts and spring tabs. ▲ See warning, below. Repeat step 1.

▲ ***WARNING***

Failure to properly tighten bolts, reuse of spring tabs, reuse of spring tab bolts, or use of inferior grade bolts can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If **all** four bearings purge fresh grease, **replace used spring tabs and spring tab bolts with new**. Torque spring tab bolts to required specifications. (See Table G, below.) ▲ See warning, step 2.

SPRING TAB BOLT SPECIFICATIONS

SERIES	THREAD SIZE	HEAD SIZE	BOLT TORQUE* Nm	BOLT TORQUE* LB. FT.	KIT P/N
SPL 140	8mm-1.00	8mm, 6 point	35-40	20-25	211941X
SPL 170	8mm-1.00	8mm, 6 point	35-40	20-25	211941X
SPL 250	8mm-1.00	8mm, 6 point	35-40	20-25	211941X

**Spicer bolts are specially heat-treated.*
***DO NOT** substitute with inferior grade bolts.*

Table G

If bearings still do not purge, removal of the universal joint kit from the end yoke is needed to determine cause of blockage. Follow steps 3-10 for proper removal of universal joint kit from end yoke.

Mark Driveshaft ("Phasing Marks")

3. With a marking stick, paint marker or other legible marking device, mark all bearing positions in relation to yokes and bearing retainers at the effected universal joint. (See figure A, page 27.) This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

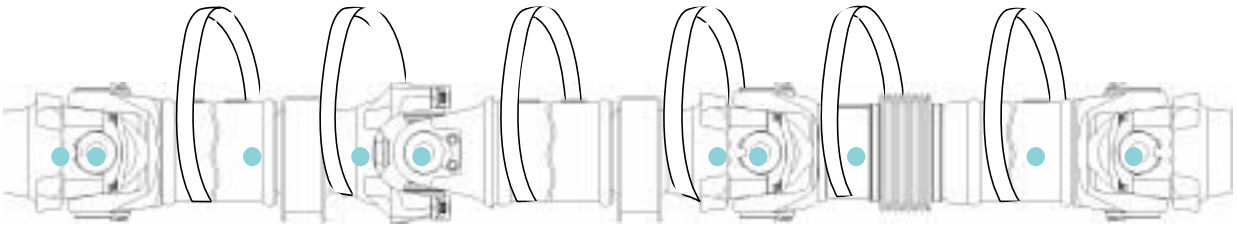

Figure A

Position Support Strap

4. Working at the effected universal joint, support the driveshaft with a support strap at the appropriate location, as illustrated in Figure A. Attach support straps to frame rails or some structural part of the vehicle. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use a support strap can cause damage to driveshaft or result in property damage, serious personal injury or death.*

DO NOT attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle which can result in property damage, serious personal injury or death.

Disconnect Driveshaft

5. Remove the bearing retainers and bolts at the effected universal joint. Reference bolt specifications, Table H, page 28. (See photo 15, below.) Bearing retainer bolts with nylon lock patch **CANNOT** be reused. Loosening or removing bearing retainer bolts requires replacement of used bolts with new. ▲ See warning, below.

Photo 15

▲ ***WARNING***

DO NOT *reuse spring tabs, spring tab bolts, bearing retainer bolts, or use inferior grade bolts. Reuse of spring tabs, spring tab bolts, bearing retainer bolts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Note – New cold formed bearing retainers **DO NOT** need to be replaced. (See photo 16, below.) Replace only if damaged.

Photo 16, Bearing Retainers

BOLT SPECIFICATIONS – QUICK DISCONNECT™

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL 140	12-73-125M	12mm - 1.25	12mm, 12 point	135-160	100-120
SPL 170	12-73-125M	12mm - 1.25	12mm, 12 point	135-160	100-120
SPL 250	12-73-125M	12mm - 1.25	12mm, 12 point	135-160	100-120

** Spicer bolts are specially heat-treated.*
***DO NOT** substitute with inferior grade bolts.*

Table H

Photo 17

6. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. (See photo 17, above.) Once the bearing cup assemblies are free, allow the driveshaft to rest on support strap.

Purging Inboard Bearings

7. Apply a c-clamp around the outboard bearings. Apply grease gun pressure. Completely purge both inboard bearings. (See photo 18, below.)

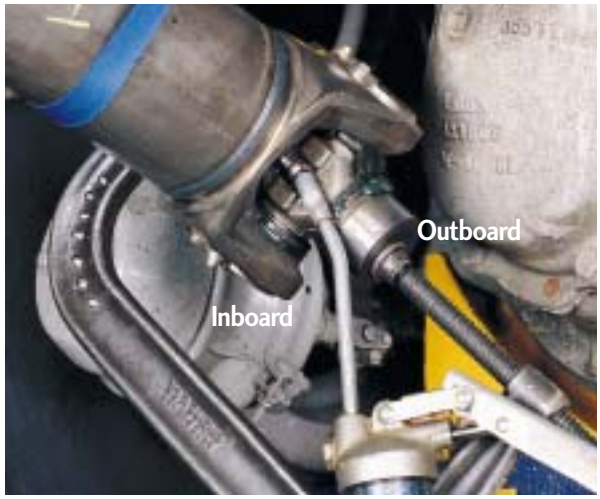

Photo 18

Purging Outboard Bearings

8. If outboard bearings fail to purge, slightly loosen c-clamp and reapply grease gun pressure until both outboard bearings purge.

9. After **all** four bearings purge fresh grease, re-tighten c-clamp to squeeze out excess grease and wipe clean. This will ease installation of universal joint kit back into yoke. Install universal joint kit in the yoke using new bearing retainer bolts, and torque bolts to the required specifications. Reference bolt torque specifications (Table H, page 28). ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts or use inferior grade bolts. Reuse of bearing retainer bolts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

10. If the bearings still will not purge, complete removal of the universal joint kit is needed to determine cause of blockage. See removal section of this manual for proper procedures on removing Spicer Quick Disconnect™ style driveshaft assemblies and spring tab style universal joints.

COMPANION FLANGE/FLANGE YOKE STYLE S.A.E., DIN AND T-TYPE

Note – It will be necessary to have additional flange bolts, nuts and washers (if applicable) in order to complete the following instructions. It may also be necessary to have additional spring tabs and spring tab bolts.

1. Utilizing a brass hammer and wearing safety glasses, sharply strike yoke on inboard and outboard lug ears **once**, to firmly seat bearings against spring tabs and relieve tension across span. ▲ See warning, below. Rotate shaft 180 degrees and repeat procedure on opposite inboard and outboard lug ears. (See photos 19 & 20, below.)

Apply grease gun pressure and purge **all** four bearings until **fresh grease** is seen at **all** four bearing seals.

▲ ***WARNING***

To prevent serious eye injury, always wear safety glasses when performing maintenance or service. Failure to wear safety glasses could result in serious personal injury, and/or partial or complete vision loss.

Photo 19

Photo 20

2. If striking lug ears does not cause purging, remove and discard spring tab bolts and spring tabs. Repeat step 1.

If **all** four bearings purge fresh grease, **replace used spring tabs and spring tab bolts with new.** Torque spring tab bolts to proper specifications. (See Table J, below.)
▲ See warning, below.

▲ ***WARNING***

Failure to properly tighten spring tab bolts, reuse of spring tabs, reuse of spring tab bolts, or use of inferior grade bolts, can cause the driveline to loosen and separate from the vehicle or machine. A separated driveline can result in property damage, serious personal injury or death.

SPRING TAB BOLT SPECIFICATIONS

SERIES	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.	KIT P/N*
SPL140	8mm - 1.00	8mm, 6 point	35-40	25-30	211941X
SPL170	8mm - 1.00	8mm, 6 point	35-40	25-30	211941X
SPL250	8mm - 1.00	8mm, 6 point	35-40	25-30	211941X

** Spicer bolts are specially heat-treated.*
***DO NOT** substitute with inferior grade bolts.*

Table J

3. If the bearings still do not purge, complete removal of the universal joint kit is needed to determine cause of blockage. See removal section of this manual for proper procedures on removing companion flange/flange yoke (S.A.E., DIN and T-Type) spring tab style driveshaft assemblies and universal joints.

SNAP RING STYLE

Note – For Quick Disconnect™ snap ring style driveshaft assemblies, it will be necessary to have additional stamped straps and stamped strap bolts to complete the following instructions. It may also be necessary to have additional snap rings.

Note – For companion flange/flange yoke, (S.A.E., DIN and T-Type), snap ring style driveshaft assemblies, it will be necessary to have additional flange bolts, nuts and washers (if applicable) to complete the instructions on page 33. It may also be necessary to have additional snap rings.

Quick Disconnect™ Style

1. Utilizing a brass hammer and wearing safety glasses, sharply strike inboard yoke on lug ear once to try to firmly seat bearing against spring tab and relieve tension across span. ▲ See warning, below. Rotate shaft 180 degrees and repeat procedure on opposite lug ear.

Apply grease gun pressure and purge **all** four bearings until **fresh grease** is seen at **all** four bearing seals.

▲ ***WARNING***

To prevent serious eye injury, always wear safety glasses when performing maintenance or service. Failure to wear safety glasses can result in serious personal injury, and/or partial or complete vision loss.

If striking lug ears does not cause purging, removal of the universal joint kit from the end yoke is needed to determine cause of blockage. Follow steps 2-9 for proper removal of universal joint kit from end yoke.

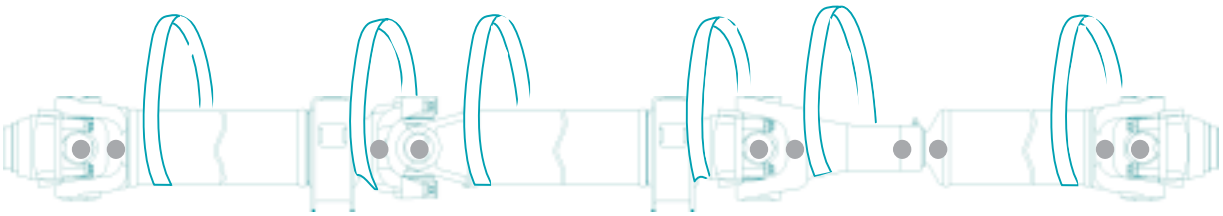

Figure B

Mark Driveshaft ("Phasing Marks")

2. With a marking stick, paint marker or other legible marking device, mark all bearing positions in relation to yokes at the effected universal joint as illustrated in figure B. This assures proper reassembly of the driveshaft into the vehicle, in its original position. See warning, below.

WARNING

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Position Support Strap

3. Working at the effected universal joint, support the driveshaft with a support strap at the appropriate location, as illustrated in Figure B, above. See warning, below.

WARNING

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use a support strap can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines or wiring in the support straps. See warning, below.

WARNING

Attaching support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle which can result in property damage, serious personal injury or death.

Disconnect Driveshaft

4. Remove bearing retainers or stamped straps (if applicable) at the effected universal joint. Discard bolts. Reference bolt specifications. (See Table K, right.) Stamped straps and stamped strap bolts or bearing retainer bolts **CANNOT** be reused. Loosening or removing bolts requires replacement of used bolts with new. Torque new bolts to required specifications. Reference bolt specifications. (See Table K, right.) ▲ See warning, below.

Note – New cold formed bearing retainers **DO NOT** need to be replaced. (See photo 21, below.) Replace only if damaged.

Note – Stamped straps **MUST BE** replaced. (See photo 22, below.) ▲ See warning, below.

Photo 21, Bearing Retainers

Photo 22, Stamped Straps

▲ ***WARNING***

DO NOT *reuse bearing retainer or stamped strap bolts, stamped straps, or use inferior grade bolts. Reuse of bearing retainer or stamped strap bolts, stamped straps and the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL 55	TBD	TBD	TBD	TBD	TBD
SPL 70	TBD	TBD	TBD	TBD	TBD
SPL 90	6-73-412	0.375" - 24	3/8" 12 point	61-81	45-60
SPL 100	TBD	TBD	TBD	TBD	TBD

** Spicer bolts are specially heat-treated.*

Table K

5. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the bearing cup assemblies are free, allow the driveshaft to rest on support strap.

Purging Inboard Bearings

6. Apply a c-clamp around the outboard bearings. Apply grease gun pressure. Completely purge both inboard bearings.

Purging Outboard Bearings

7. If outboard bearings fail to purge, slightly loosen c-clamp and reapply grease gun pressure until both outboard bearings purge.

8. After **all** four bearings purge fresh grease, re-tighten c-clamp to squeeze out excess grease and wipe clean. This will ease installation of universal joint kit back into yoke. Install universal joint kit, with new bolts, in the yoke and torque bolts to the required specifications. Reference bolt specifications. (See Table K, above.) ▲ See warning, step 4.

9. If bearings still will not purge, complete removal of the universal joint kit is needed to determine cause of blockage. See removal section of this manual for proper procedures on removing Spicer Quick Disconnect™ snap ring style driveshaft assemblies and universal joints.

Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) Style

1. Utilizing a brass hammer and wearing safety glasses, sharply strike yoke on inboard and outboard lug ears **once**, to firmly seat bearings against snap rings and relieve tension across span. ▲ See warning, below. Rotate shaft 180 degrees and repeat procedure on opposite inboard and outboard lug ears.

Apply grease gun pressure and purge **all** four bearings until **fresh grease** is seen at **all** four bearing seals.

▲ ***WARNING***

To prevent serious eye injury, always wear safety glasses when performing maintenance or service. Failure to wear safety glasses can result in serious personal injury, and/or partial or complete vision loss.

2. If striking lug ears does not cause purging, remove snap rings in lug ears of the bearing(s) that are not purging. Repeat above instructions. If **all** four bearings purge fresh grease, replace snap rings.

Note – Spicer snap rings can be reused if they **ARE NOT** severely corroded or distorted. If corroded or distorted, replace used snap rings with new. (See Table L, below.)

OUTSIDE SNAP RINGS

	P/N
SPL 55	TBD
SPL 70	TBD
SPL 90	5-7-29
SPL 100	TBD

Table L

3. If the bearings still do not purge, complete removal of the universal joint kit is needed to determine cause of blockage. See removal section of this manual for proper procedures on removing companion flange/flange yoke (S.A.E., DIN and T-Type) style driveshaft assemblies and snap ring style universal joints.

LUBRICATION INTERVALS FOR RELUBABLE SLIP MEMBERS

SPICER LIFE SERIES™ 90

Lubrication cycles vary depending on the service requirements and operating conditions of the vehicle or machine. Table M, below, shows a recommended lubrication cycle for slip members for various types of service.

SLIP MEMBER MAXIMUM LUBRICATION INTERVALS

SERIES	CITY	ON-HWY.	LINEHAUL	OFF-HWY.*	INDUSTRIAL*
SPL 90	8,000 Mi. 12,800 Km. or 3 Months (which ever comes first)	15,000 Mi. 24,000 Km. or 3 Months (which ever comes first)	15,000 Mi. 24,000 Km. or 3 Months (which ever comes first)	8,000 Mi. 12,800 Km. or 3 Months (which ever comes first)	500 Hrs.

City *is defined as all applications that require a minimum of 90% of operation time within city limits.*

On-highway *is defined as all applications requiring less than 10% of operating time on gravel, dirt or unpaved roads.*

Off-highway *is defined as all applications requiring more than 10% of operating time on gravel, dirt or unpaved roads.*

Linehaul *is defined as 100% of operation time on smooth concrete or asphalt.*

** Lubrication intervals for off-highway and industrial use vary depending on the application and operating conditions. In general, to obtain maximum life, lubrication on industrial applications should occur every 500 hours for normal service and every 200 hours for continuous service or severe environmental conditions.*

Table M

LUBRICATION PROCEDURE FOR RELUBABLE SLIP MEMBERS

SPICER LIFE SERIES™ 90

1. Apply grease gun pressure to the lube fitting until lubricant appears at the seal. Always use a E.P., Grade 2 specification, N.L.G.I grease, on Glidecote® and steel splines. Spicer recommends the same lubricant used for universal joints. Lubricate slip members at the lubrication intervals prescribed in Table M, page 34.

Caution – In cold temperatures, be sure to activate the slip member by driving the vehicle sufficiently to cause displacement of the grease prior to its stiffening. Failure to do so could cause the excess lubricant to stiffen in the cold weather and force the welch plug out. The end of the spline would then be open to collect contaminants and can result in driveline failure. ▲ See warning, below.

▲ ***WARNING***

A contaminated slip member can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

LUBRICATION FOR CENTER BEARINGS

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

All Spicer manufactured center bearings are permanently lubricated. No attempt should be made to add or change grease within the bearing itself.

However, when replacing a center bearing assembly, it is necessary to fill the entire cavity around the bearing with waterproof grease to shield the bearing from water and contaminants. The quantity of lubricant should be sufficient to fill the cavity to the extreme edge of the slinger surrounding the bearing. (See photo 23, below.)

Lubricants must be waterproof. See recommended lubricant Table N, below.

Photo 23

RECOMMENDED CENTER BEARING LUBRICANTS

LUBRICANT	SOURCE
Rykon Premium No. 3	Amoco Oil Company
Amolith 8516	Amoco Oil Company
Van Talgar No. 4	Exxon Company

Table N

Note – For relubable center bearings (pillow block) use original component manufacturer's recommended lubricants and lubrication intervals.

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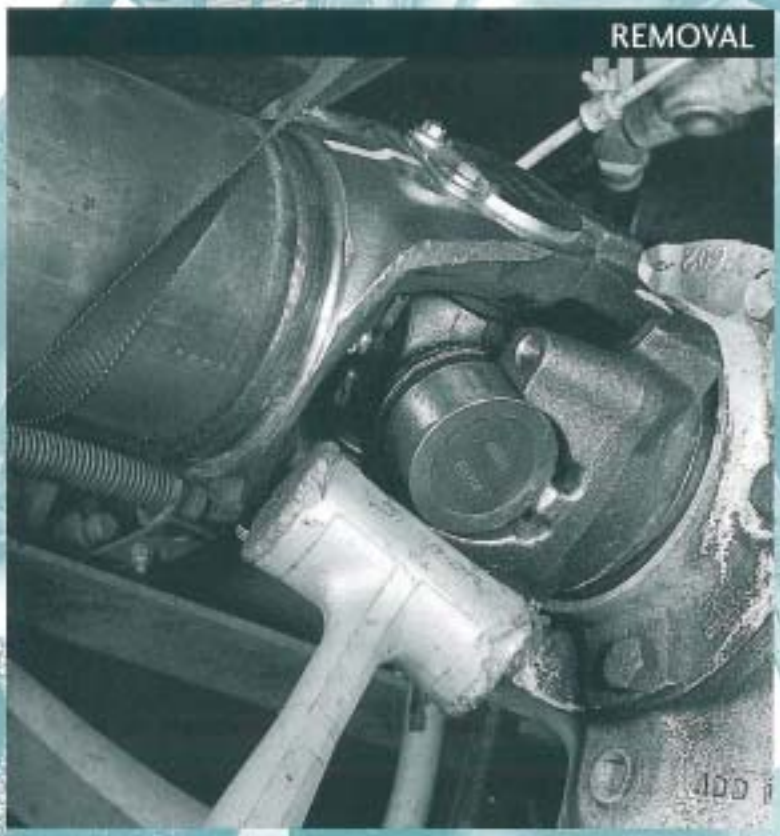
SPICER®

DANA



People Finding A Better Way

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SPICER LIFE SERIES™ DRIVESHAFT REMOVAL

Before You Get Started

Note – Spicer Life Series™ driveshafts are found on vehicles throughout the world. Therefore, this manual includes world-wide terminology. These terms have been highlighted in teal.

Caution – Under no circumstances should individuals attempt to perform driveline service and/or maintenance procedures for which they have not been trained or do not have the proper tools and equipment. ▲ See warning, below.

▲ ***WARNING***

Failure to take commonsense, precautionary measures when working on a vehicle or other machinery could result in property damage, serious personal injury or death. In order to avoid property damage, serious personal injury or death, you must:

1. **ALWAYS** wear safety glasses when performing maintenance or service. Failure to wear safety glasses can result in personal injury and/or partial or complete vision loss.

2. **NEVER** go under a vehicle while the engine is running. Be sure the vehicle's engine is off, and keys are removed from ignition.

3. **NEVER** go under or work on a vehicle that is not on a level or flat surface.

4. **NEVER** work on a driveshaft without blocking the vehicle's wheels and releasing all parking brakes. ▲ See warning, below.

▲ ***WARNING***

Failure to release all parking brakes and failure to place transmission in neutral can result in torque being applied to the driveshaft. Disconnecting a driveshaft with applied torque can result in property damage, serious personal injury or death.

5. **NEVER** lift a vehicle without the appropriate weight-rated, vehicle-support equipment.

6. **NEVER REMOVE** a driveshaft from the vehicle without keeping the vehicle's transmission in neutral. ▲ See warning, step 4.

7. **CAUTION** – Spicer Life Series™ driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Be sure to use proper lifting techniques when handling Spicer Life Series driveshafts. More than one person may be needed when handling driveshaft assemblies.

8. **ALWAYS** use support straps to prevent the driveshaft from falling out of vehicle during the removal and installation process.

9. **NEVER** heat components or use sledgehammers or floor jacks to remove the driveshaft from vehicle.

Note – For driveshaft applications that have pillow blocks, dampers, parking brakes or retarders, refer to these component manufacturers' or the original equipment vehicle manufacturers' service manuals for proper procedures.

Servicing a Spicer Life Series™ Driveshaft

The following components are serviceable:

- Universal Joint Kits
- Boot Kits
- Quick Disconnect™ End Yokes
- S.A.E., DIN and T-Type Flange Yokes
- S.A.E., DIN and T-Type Companion Flanges
- Bearing Retainers and Bolts or Stamped Straps and Bolts
- Spring Tabs and Bolts
- Center Bearing Assemblies
- Grease Zerk (Nipple) Fittings

Note – Spicer Life Series™ 140, 170 and 250 driveshaft assemblies and components are metric. To eliminate any confusion between S.A.E. and metric threaded fasteners, the metric fasteners have been color coded gold. Spicer Life metric fasteners include spring tab bolts, bearing retainer bolts and midship nuts.

REMOVAL PROCEDURE FOR END FITTINGS

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedure.

Refer to the Table of Contents for removal of center bearing end fittings.

REMOVAL PROCEDURE FOR DRIVESHAFT ASSEMBLIES

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

Required Tools

- Ratchet or Air Gun
- Appropriate 12-Point Sockets
  - English 3/8"
  - Metric 12mm
- Bench Vice
- Soft-Faced Hammer
  Brass, Plastic or Rubber
- Support Straps
- Appropriate Spicer Alignment Bar (See photos 24 or 25)
- Emery cloth and/or fine-toothed file

Photo 24, Spicer Alignment Bar, Quick Disconnect Style

Photo 25, Spicer Alignment Bar, Companion Flange/Flange Yoke Style (S.A.E., DIN and T-Type)

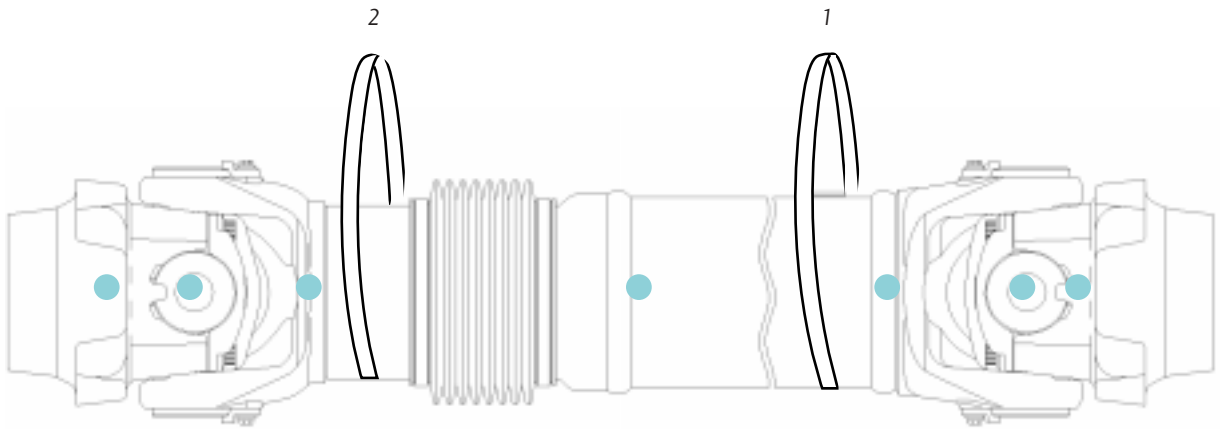

Figure C

QUICK DISCONNECT™ YOKE STYLE

One-Piece Driveshaft

Caution – Be sure to carefully read all information on page 39 before proceeding.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all the mating components of a driveshaft, as illustrated in Figure C, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all bearing positions, spline positions, shaft locations and all bearing retainers. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end, support the driveshaft with support straps, as illustrated in Figure C, above. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Photo 26

Disconnect Driveshaft

3. **Be sure first support strap is in place as illustrated in figure C, page 41.** Remove the bearing retainers or stamped straps and bolts at rear end. Discard bolts. Discard stamped straps (if applicable). (See photo 26, above.) Reference bolt specifications, Table P, below.

QUICK DISCONNECT BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table P

Bearing retainers **CAN** be reused **if there is no damage**. (See photo 27, below.) If damaged, replace.

Photo 27, Bearing Retainers

Stamped straps **CANNOT** be reused. (See photo 28, below.) See warning, below.

Photo 28, Stamped Straps

WARNING

***DO NOT** reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 29

4. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. (See photo 29, above.) Once the bearing cup assemblies are free, collapse the driveshaft until both bearing assemblies clear the open end yoke cross holes. Allow the driveshaft to rest on support strap.

Remove Driveshaft

5. **Be sure second support strap is in place as illustrated in Figure C, page 41**. Remove bearing retainers or stamped straps and bolts at the **front** end. Discard bolts. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the driveshaft is free, remove the driveshaft from the support straps and take it to a work bench area. ▲ See warning, below. Be sure to follow the end yoke inspection steps.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Inspect End Yokes

7. Check all end yokes for looseness. Take hold of end yoke with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any looseness in the end yokes relative to the input or output shafts to which they are connected. ▲ See warning, below.

▲ ***WARNING***

A loose end yoke can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If looseness is evident, the end yoke needs to be replaced. Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

8. Visually inspect all end yoke retaining nuts or bolts for any gaps between mating surfaces. ▲ See warning, below.

▲ ***WARNING***

A loose end yoke retaining nut or bolt can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If gaps are present, consult transmission, axle or transfer case original equipment manufacturers' specifications for proper fastening.

9. Inspect all end yoke cross hole surfaces and bolt hole threads for damage. If the bolt hole threads are damaged, the yoke must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

Photo 30

Raised metal or fretting on open yoke cross holes can be removed with a fine-toothed file and/or emery cloth. (See photo 30, above.) ▲ See warning, below.

▲ ***WARNING***

DO NOT *deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can be a cause of cross and bearing failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 31

10. Inspect the end yoke cross holes for distortion using the appropriate Spicer alignment bar. (See photo 31, above.) Slide alignment bar through both cross holes simultaneously. If alignment bar will not pass through both cross holes simultaneously, cross holes are distorted and end yoke must be replaced. ▲ See warning, below.

▲ *WARNING*

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, personal injury or death.

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

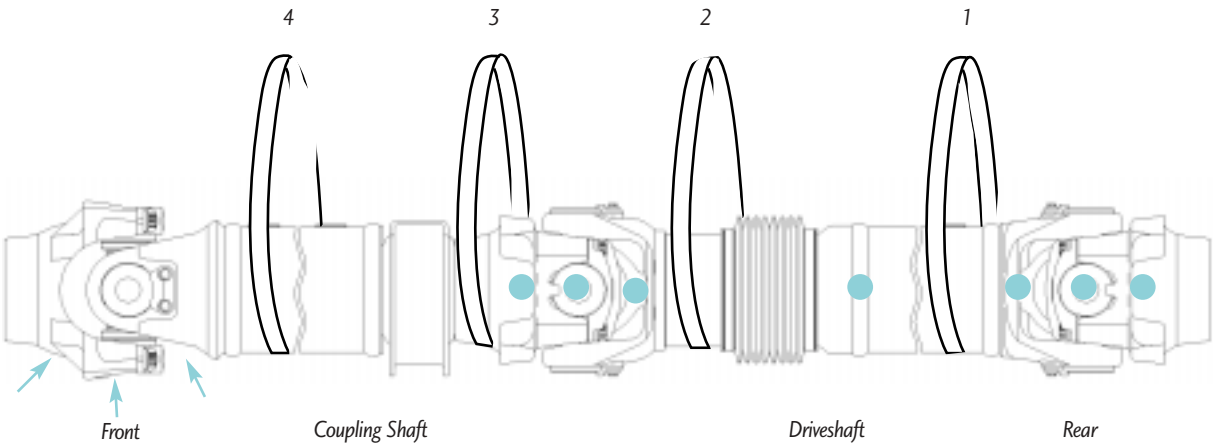

Figure D

QUICK DISCONNECT™ YOKE STYLE

Two-Piece Driveshaft

Caution – Be sure to carefully read all information on page 39 before proceeding.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all the mating components of a driveshaft, as illustrated in Figure D, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all bearing positions, spline positions, shaft locations and all bearing retainers. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end, support the driveshaft with support straps as illustrated in Figure D, above. Be sure to support the shaft assembly at the rear, at the slip member, behind the center bearing end fitting and in front of center bearing, with support straps. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Photo 32

Disconnect Driveshaft

3. **Be sure first support strap is in place as illustrated in figure D, page 46.** Remove the bearing retainers or stamped straps and bolts at **rear** end. Discard bolts. Discard stamped straps (if applicable). (See photo 32, above.) Reference bolt specifications, Table Q, below.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table Q

Bearing retainers **CAN** be reused **if there is no damage**. (See photo 33, below.) If damaged, replace.

Photo 33, Bearing Retainers

Stamped straps **CANNOT** be reused. (See photo 34, below.) ▲ See warning, below.

Photo 34, Stamped Straps

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 35

4. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. (See photo 35, above.) Once the bearing cup assemblies are free, collapse the driveshaft until both bearing assemblies clear the open end yoke cross holes. Allow the driveshaft to rest on support strap.

Remove Driveshaft

5. **Place the second support strap as illustrated in Figure D, page 46.** Remove the bearing retainers or stamped straps and bolts at center bearing yoke position. Reference bolt specifications, Table Q, page 47. Discard bolts. Discard stamped straps (if applicable). ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once driveshaft is free, collapse the driveshaft until both bearing assemblies clear the open yoke cross holes. Allow the driveshaft to rest on support strap. Remove the driveshaft from the support straps and take it to a work bench area. ▲ See warning, below. Be sure to follow end yoke inspection (steps 10-13, page 49).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Remove Coupling Shaft

7. **Be sure the third support strap is in place, as illustrated in Figure D, page 46.** Remove the center bearing bracket bolts and allow the shaft to rest on the support strap. (See photo 36, below.)

Photo 36

8. **Be sure the fourth support strap is in place, as illustrated in Figure D, page 46.** Remove bearing retainers or stamped straps and bolts at front end. Reference bolt specifications Table Q, page 47. Discard bolts. Discard stamped straps (if applicable). ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

9. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the coupling shaft is free, remove the coupling shaft from the support straps and take it to a work bench area. ▲ See warning, below. Be sure to follow end yoke inspection (steps 10-13).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Inspect End Yokes

10. Check all end yokes for looseness. Take hold of end yoke with both hands. Try to move it vertically and horizontally to feel any looseness. There should **not** be any looseness in the end yokes relative to the input or output shafts to which they are connected. ▲ See warning, below.

▲ ***WARNING***

A loose end yoke can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If looseness is evident, the end yoke needs to be replaced. Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

11. Visually inspect all end yoke retaining nuts or bolts for any gaps between mating surfaces. ▲ See warning, below.

▲ ***WARNING***

A loose end yoke retaining nut or bolt can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If gaps are present, consult transmission, axle or transfer case original equipment manufacturers' specifications for proper fastening.

12. Inspect all end yoke cross hole surfaces and bolt hole threads for damage. If the bolt hole threads are damaged, the yoke must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

Photo 37

Raised metal or fretting on open yoke cross holes can be removed with a fine-toothed file and/or emery cloth. (See photo 37, above.) ▲ See warning, below.

▲ ***WARNING***

DO NOT *deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can be a cause of cross and bearing failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 38

13. Inspect the end yoke cross holes for distortion using the appropriate Spicer alignment bar. (See photo 38, above.) Slide alignment bar through both cross holes simultaneously. If alignment bar will not pass through both cross holes simultaneously, cross holes are distorted and yoke must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

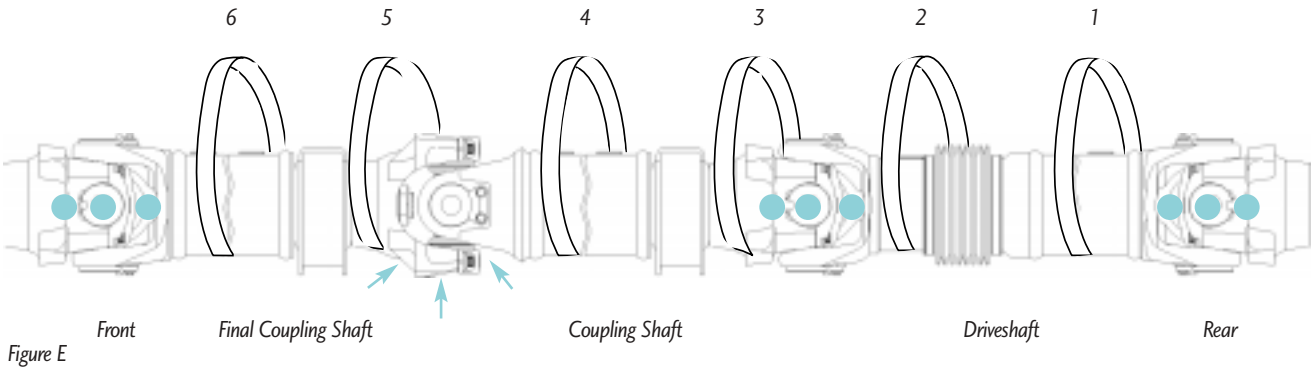

Figure E

QUICK DISCONNECT™ YOKE STYLE

Multiple-Piece Driveshaft

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire driveline assembly. Work from the **rear** end forward. The driveshaft will need to be disconnected, **first**, in order to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position the support straps as illustrated in Figure E, above.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all the mating components of a driveshaft, as illustrated in Figure E, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all bearing positions, spline positions, shaft locations and all bearing retainers. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end, support the driveshaft at the rear, at the slip member, behind the center bearing end fittings and in front of center bearings, with support straps, as illustrated in Figure E, above. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Photo 39

Disconnect Driveshaft

3. **Be sure first support strap is in place as illustrated in Figure E, page 51.** Remove the bearing retainers or stamped straps and bolts at **rear** end. Discard bolts. Discard stamped straps (if applicable). (See photo 39, above.) Reference bolt specifications, Table R, below.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table R

Bearing retainers **CAN** be reused **if there is no damage**. (See photo 40, below.) If damaged, replace.

Photo 40, Bearing Retainers

Stamped straps **CANNOT** be reused. Discard bolts. (See photo 41, below.) ▲ See warning, below.

Photo 41, Stamped Straps

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 42

Photo 43

4. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. (See photo 42, above.) Once the bearing cup assemblies are free, collapse the driveshaft until both bearing assemblies clear the open yoke cross holes. Allow the driveshaft to rest on support strap.

Remove Driveshaft

5. **Be sure second support strap is in place as illustrated in Figure E, page 51**. Remove bearing retainers or stamped straps and bolts at the center bearing position yoke. Reference bolt specifications Table R, page 52. Discard bolts. Discard stamped straps (if applicable). ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once driveshaft is free, collapse the driveshaft until both bearing assemblies clear the open yoke cross holes. Allow the driveshaft to rest on support strap. Remove the driveshaft from the support straps and take it to a work bench area. ▲ See warning, below. Be sure to follow end yoke inspection (steps 13-16, page 55).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Remove Coupling Shaft(s)

7. **Position third support strap as illustrated in Figure E, page 51.** Remove the center bearing bracket bolts and allow the shaft to rest on the support strap.
(See photo 43, above.)

8. **Be sure the fourth support strap is in place as illustrated in Figure E, page 51.** Remove bearing retainers or stamped straps and bolts at next center bearing position yoke. Reference bolt torque specifications Table R, page 52. Discard bolts. Discard stamped straps (if applicable). ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

9. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once coupling shaft is free, remove from support straps and take to a workbench area. ▲ See warning, below. Be sure to follow the end yoke inspection (steps 13-16, page 55).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

10. For driveline assemblies with more than two coupling shafts, repeat steps 7 through 9 as necessary. Place support straps on additional coupling shafts as previously described.

Removal of Final Coupling Shaft

11. **Be sure the final support strap is in place as illustrated in Figure E, page 51.** Remove bearing retainers or stamped straps and bolts at front end. Reference bolt specifications, Table R, page 52. Discard bolts. Discard stamped straps (if applicable). ▲ See warning, step 8.

12. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once final coupling shaft is free, remove from support straps and take it to a work bench area. ▲ See warning, below. Be sure to follow the end yoke inspection (steps 13-16, pages 55 and 56).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Inspect End Yokes

13. Check end yokes for looseness. Take hold of end yoke with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any looseness in the end yokes relative to the input or output shafts to which they are connected. ▲ See warning, below.

▲ ***WARNING***

A loose end yoke can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If looseness is evident, the end yoke needs to be replaced. Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

14. Visually inspect end yoke retaining nuts or bolts for any gaps between mating surfaces. ▲ See warning, below.

▲ ***WARNING***

A loose end yoke retaining nut or bolt can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If gaps are present, consult transmission, axle or transfer case original equipment manufacturers' specifications for proper fastening.

15. Inspect all end yoke cross hole surfaces and bolt hole threads for damage. If the bolt hole threads are damaged, the yoke must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

Raised metal or fretting on open yoke cross holes can be removed with a fine-toothed file and/or emery cloth. (See photo 44, below.) ▲ See warning, below.

▲ ***WARNING***

DO NOT *deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can be a cause of cross and bearing failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 44

Photo 45

16. Inspect the end yoke cross holes for distortion using the appropriate Spicer alignment bar. (See photo 45, above.) Slide alignment bar through both cross holes simultaneously. If alignment bar will not pass through both cross holes simultaneously, cross holes are distorted and yoke must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

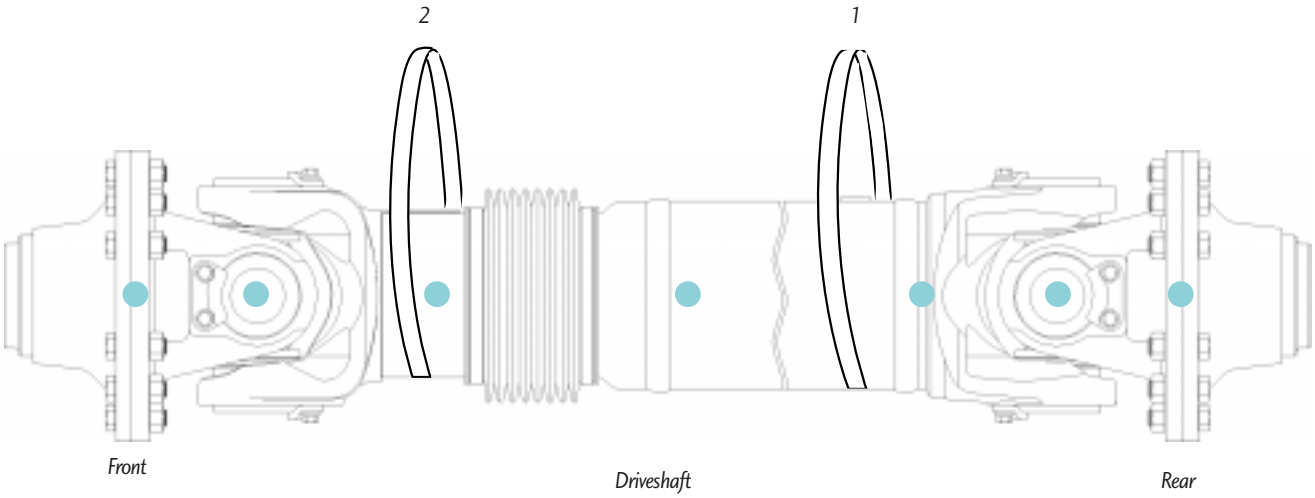

Figure F, S.A.E.

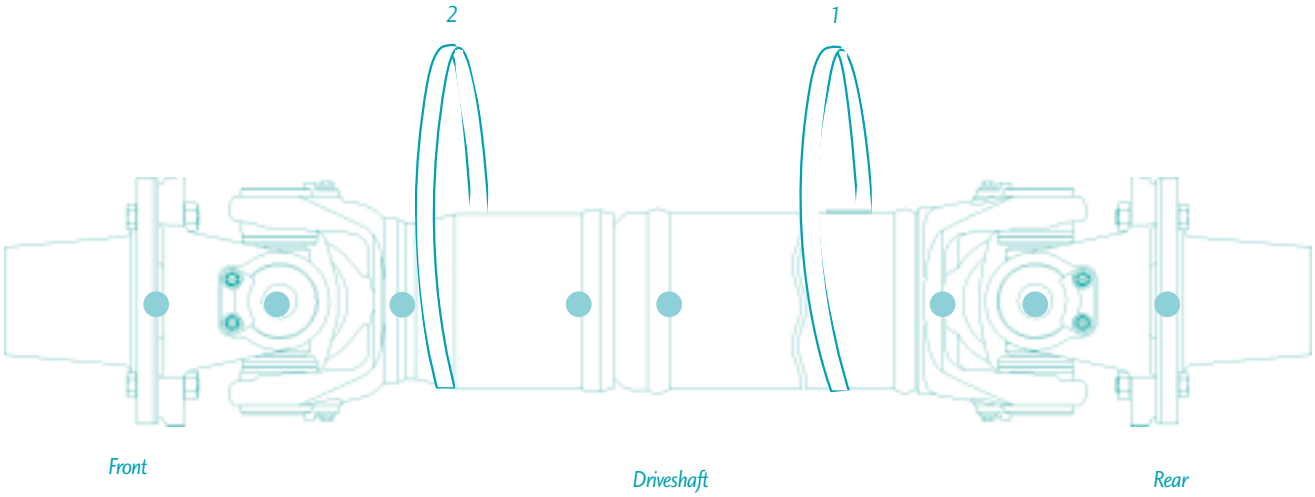

Figure G, DIN/T-Type

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE)

One-Piece Driveshaft

Caution – Be sure to carefully read all information on page 39 before proceeding.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of a driveshaft, as illustrated in Figure F or G, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all bearing positions, spline positions, and shaft locations. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*

† Approved Spicer hardware.

***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table S

Position Support Straps

2. Working from the **rear** end, support the driveshaft with support straps, as illustrated in Figure F or G, page 57.

▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps.

▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Disconnect Driveshaft

3. **Be sure first support strap is in place as illustrated in Figure F or G, page 57.** Remove and discard flange bolts, washers and nuts at **rear** end. Reference hardware specifications, Table S, above. (See photo 46, below.)

▲ See warning, below.

▲ ***WARNING***

***DO NOT** reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or*

Photo 46

nuts or use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

4. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, collapse the driveshaft and allow it to rest on support strap.

Remove Driveshaft

5. **Be sure to use the second support strap as illustrated in Figure F or G, page 57.** Remove and discard flange bolts, washers and nuts at **front** end. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once the connection is free, remove the driveshaft from the support straps and take it to a work bench area. ▲ See warning, below. Be sure to follow the flange inspection (steps 7-10).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Inspect Companion Flanges/Flange Yokes (S.A.E., DIN and T-Type Style)

7. Inspect all flange bolt hole threads or through holes for damage. If the bolt hole threads or through holes are damaged, the flange must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

For removal procedures for companion flanges, refer to the original equipment manufacturers' service and maintenance manuals. For removal procedures for flange yokes, see removal of universal joints in this manual.

8. Inspect all flange faces for galling or damage. If damaged, the flange must be replaced. ▲ See warning, above.

For removal procedures for companion flanges, refer to the original equipment manufacturers' service and maintenance manuals. For removal procedures for flange yokes, see removal of universal joints in this manual.

9. Visually inspect all companion flange retaining nuts or bolts for any gaps between mating surfaces. ▲ See warning, below.

▲ ***WARNING***

A loose companion flange retaining nut or bolt can result in driveline failure which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If gaps are present, consult transmission, axle or transfer case original equipment manufacturers' specifications for proper fastening.

10. Check all companion flanges for looseness. Take hold of companion flange with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any looseness in the companion flanges relative to the input or output shafts to which they are connected. ▲ See warning, below.

▲ ***WARNING***

A loose companion flange can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If looseness is evident, the companion flange needs to be replaced. Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

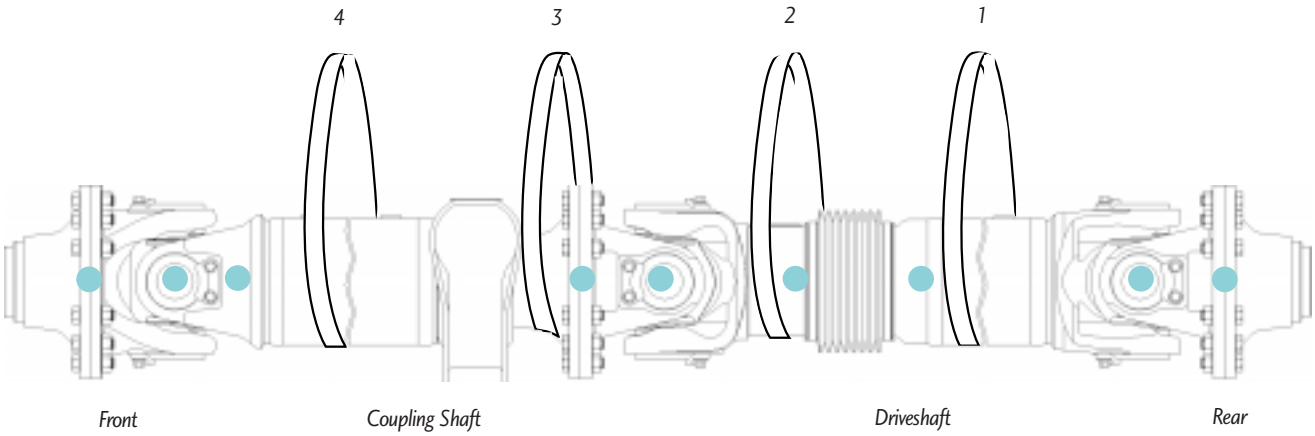

Figure H, S.A.E.

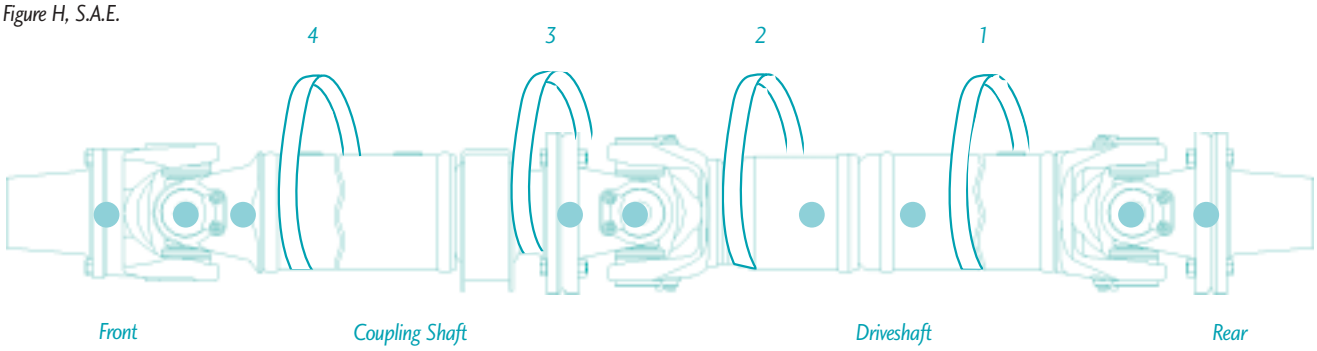

Figure J, DIN/T-Type

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE)

Two-Piece Driveshaft

Caution – Be sure to carefully read all information on page 39 before proceeding.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all the mating components of a driveshaft, as illustrated in Figure H or J, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all bearing positions, spline positions, and shaft locations. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, above right.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end, support the driveshaft with support straps as illustrated in Figure H or J, above. Be sure to support the shaft assembly at the slip member, behind the center bearing end fitting and in front of center bearing, with support straps. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table T

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ *WARNING*

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Photo 47

Disconnect Driveshaft

3. **Be sure first support strap is in place as illustrated in Figures H or J, page 61.** Remove and discard flange bolts, washers and nuts at **front** end. (See photo 47, right.) Reference hardware specifications, Table T, above. ▲ See warning, below.

▲ *WARNING*

***DO NOT** reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

4. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, collapse the driveshaft and allow it to rest on support strap.

Remove Driveshaft

5. **Place the second support strap as illustrated in Figure H or J, page 61.** Remove and discard flange bolts, washers and nuts at center bearing end fitting position. Reference hardware specifications, Table T, page 62. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, remove the driveshaft from the support straps and take it to a work bench area. ▲ See warning, below. Be sure to follow the flange inspection (steps 10-13).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Remove Coupling Shaft

7. **Be sure the third support strap is in place as illustrated in Figures H or J, page 61.** Remove the center bearing bracket bolts and allow shaft to rest on support strap.

8. **Be sure the fourth support strap is in place as illustrated in Figures H or J, page 61.** Remove and discard flange bolts, washers and nuts at **front** end. Reference hardware specifications, Table T, page 62. ▲ See warning, step 5.

9. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, remove the coupling shaft from the support straps and take it to a work bench area. ▲ See warning, step 6. Be sure to follow the flange inspection (steps 10-13).

Inspect Companion Flanges/Flange Yokes (S.A.E., DIN and T-Type Style)

10. Inspect all flange bolt hole threads or through holes for damage. If the bolt hole threads or through holes are damaged, the flange must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

For removal procedures for companion flanges, refer to the equipment manufacturers' service and maintenance manuals. For removal procedures for flange yokes, see removal of universal joints in this manual.

11. Inspect all flange faces for galling or damage. If damaged, the flange must be replaced. ▲ See warning, step 10.

For removal procedures for companion flanges, refer to the equipment manufacturers' service and maintenance manuals. For removal procedures for flange yokes, see removal of universal joints in this manual.

12. Visually inspect all companion flange retaining nuts or bolts for any gaps between mating surfaces. ▲ See warning, below.

▲ ***WARNING***

A loose companion flange retaining nut or bolt can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If gaps are present, consult transmission, axle or transfer case original equipment manufacturers' specifications for proper fastening.

13. Check all companion flanges for looseness. Take hold of companion flange with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any looseness in the companion flanges relative to the input or output shafts to which they are connected. ▲ See warning, below.

▲ ***WARNING***

A loose companion flange can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If looseness is evident, the companion flange needs to be replaced. Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

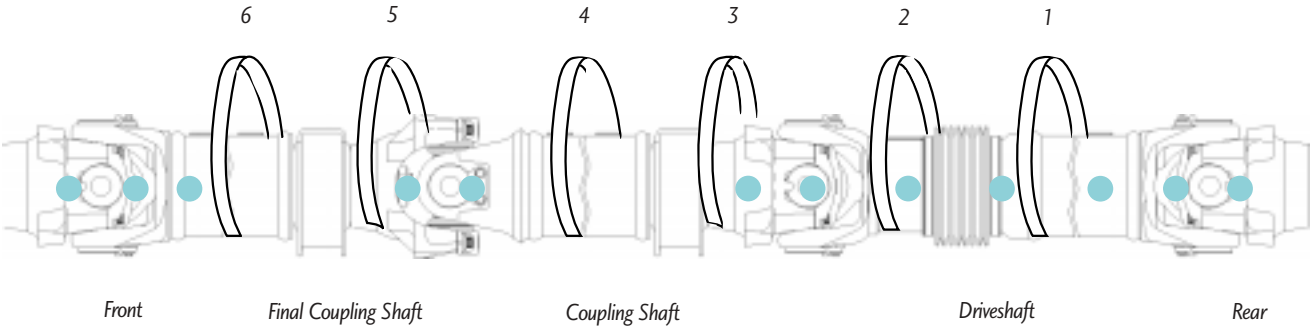

Figure K, S.A.E.

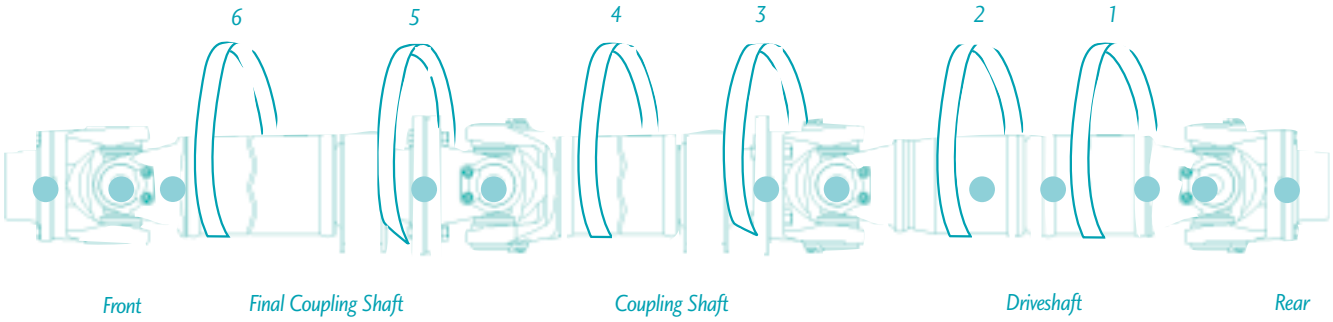

Figure L, DIN/T-Type

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE)

Multiple-Piece Driveshaft

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire assembly. Work from **rear** end forward. The driveshaft will need to be disconnected **first** in order to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position the support straps as illustrated in Figure K or L, above.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of a driveshaft, as illustrated in Figure K or L, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all bearing positions, spline positions, and shaft locations. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle which can result in property damage, serious personal injury or death.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table U

Position Support Straps

2. Working from the **rear** end forward, support the driveshaft with support straps as illustrated in Figure K or L, page 65. Be sure to support the shaft assembly at the slip member, behind the center bearing end fitting, and in front of center bearing, with support straps. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, above right.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Disconnect Driveshaft

3. **Be sure the first support strap is in place as illustrated in Figure K or L, page 65.** Remove and discard flange bolts, washers and nuts at **rear** end. (See photo 48, page 67.) Reference hardware specifications, Table U, above. ▲ See warning, below.

▲ ***WARNING***

***DO NOT** reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 48

4. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, collapse the driveshaft and allow it to rest on support strap.

Remove Driveshaft

5. **Place the second support strap as illustrated in Figure K or L, page 65.** Remove and discard flange bolts, washers and nuts at center bearing end fitting position. Reference hardware specifications, Table U, page 66. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, remove the driveshaft from the support straps and take it to a work bench area. ▲ See warning, above right. Be sure to follow the flange inspection (steps 13-16, pages 68-69).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Remove Coupling Shaft(s)

7. **Be sure the third support strap is in place as illustrated in Figures K or L, page 65.** Remove the center bearing bracket bolts and allow shaft to rest on support strap.

8. **Be sure the fourth support strap is in place as illustrated in Figures K or L, page 65.** Remove and discard flange bolts, washers and nuts at next center bearing end fitting. Reference hardware specifications, Table U, page 66. ▲ See warning, step 5.

9. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, remove the coupling shaft from the support straps and take it to a work bench area. ▲ See warning, step 6. Be sure to follow the flange inspection (steps 13-16, pages 68-69).

10. For driveline assemblies with more than two coupling shafts, repeat steps 7 through 9 as necessary. Place support straps on additional coupling shafts as previously described.

Removal of Final Coupling Shaft

11. **Be sure the final support strap is in place as illustrated in Figures K or L, page 65.** Remove flange bolts, washers and nuts at front end. Reference hardware specifications Table U, page 66. ▲ See warning, below.

▲ ***WARNING***

Do not reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

12. It may be necessary to unseat pilot or serrated connection by tapping on one side of flange with a soft-faced hammer. Once the connection is free, remove the final coupling shaft from the support straps and take it to a work bench area. ▲ See warning, below. Be sure to follow the flange inspection (steps 13-16).

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Inspect Companion Flanges/Flange Yokes (S.A.E., DIN and T-Type Style)

13. Inspect all flange bolt hole threads or through holes for damage. If the bolt hole threads or through holes are damaged, the flange must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

For the removal of companion flanges, refer to the equipment manufacturers' service and maintenance manuals. For the removal of the flange yokes, see removal of universal joints in this manual.

14. Inspect all flange faces for galling or damage. If damaged, the flange must be replaced. ▲ See warning, above.

For the removal of companion flanges, refer to the equipment manufacturers' service and maintenance manuals. For the removal of the flange yokes, see removal of universal joints in this manual.

15. Visually inspect all companion flange retaining nuts or bolts for any gaps between mating surfaces. ▲ See warning, below.

▲ ***WARNING***

A loose companion flange retaining nut or bolt can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If gaps are present, consult transmission, axle or transfer case original equipment manufacturers' specifications for proper fastening.

16. Check all companion flanges for looseness. Take hold of companion flange with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any looseness in the companion flanges relative to the input or output shafts to which they are connected. ▲ See warning, below.

▲ ***WARNING***

A loose companion flange can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If looseness is evident, the companion flange needs to be replaced. Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for removal procedures.

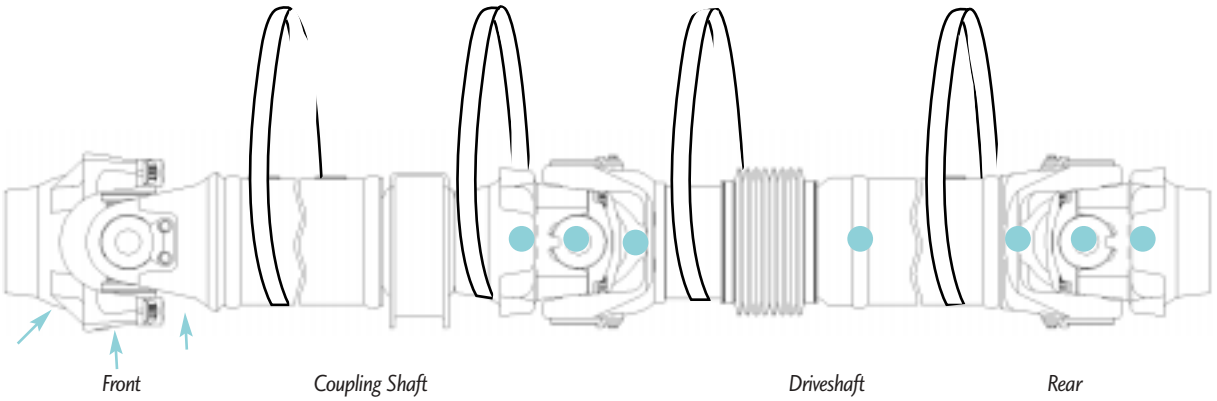

Figure M

REPLACEMENT PROCEDURE FOR GREASE ZERK (NIPPLE) FITTINGS OR PLUGS

SPICER LIFE SERIES™ 90,100,140,170 & 250

Caution – Be sure to carefully read all information on page 39 before proceeding.

Required Tools

- Open-ended wrench or pliers

UNIVERSAL JOINTS

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire assembly. Work from **rear** end forward. The driveshaft will need to be disconnected to allow clearance for the disconnection of any coupling shaft. Work on only one connection at a time. Be sure to properly position the support straps.

Follow removal procedures for the appropriate style driveshaft being serviced. (See page listings at right.) Follow steps until reaching effected universal joint grease zerk (nipple) fitting or plug. Then proceed to step one in this section.

Quick Disconnect Style
One-Piece.....41
Two-Piece.....46
Multiple-Piece 51

Companion Flange/Flange Yoke Style
One-Piece 57
Two-Piece.....61
Multiple-Piece 65

Remove Effected Grease Zerk (Nipple) Fitting or Plug

1. Tilt the universal joint kit or flange yoke and universal joint kit to allow access to effected grease zerk (nipple) fitting or plug. Using pliers or an open-ended wrench, turn grease zerk (nipple) fitting or plug counter-clockwise, until it is removed from the journal cross. (See photo 49, below.) Discard the grease zerk (nipple) fitting or plug.

Photo 49

Grease Zerk (Nipple) Fitting Only

Check for threads in the journal. If threads are present, proceed to next step. If threads are not present, replacement of universal joint kit is necessary. See disassembly procedure for universal joint kits:

- Spring Tab Style, pages 73 to 81.
- Snap Ring Style, pages 82 to 88.

Note – Pressed-in style grease zerk fittings are **NOT** serviceable. Replacement of universal joint kit is required. Press-in grease zerk (nipple) fittings were discontinued in August, 1997.

2. Thoroughly wipe clean the grease zerk (nipple) fitting or plug threaded hole.

Install New Grease Zerk (Nipple) Fitting or Plug

3. Install new grease zerk (nipple) fitting (Spicer part number 232830) or plug. Tighten to minimum 15 ft. lbs. (20 Nm). Then continue to turn only until grease zerk (nipple) fitting is correctly positioned. (See photo 49 for correct grease zerk (nipple) fitting position.) ▲ See warning, below.

▲ ***WARNING***

*Hand tightening of grease zerk (nipple) fittings or plugs is **NOT** recommended. Grease zerk (nipple) fittings or plug will eventually vibrate loose and fall out of journal. Prolonged operation with missing grease zerk (nipple) fittings or plug allows contaminants into the universal joint. Invasion of contaminants into the universal joint can degrade the lubricant and cause universal joint damage, which can result in separation of the driveline from the vehicle. A separated driveline can cause property damage, serious personal injury or death.*

Reconnect Driveshaft or Coupling Shaft

Follow installation procedures for the appropriate style driveshaft being serviced. (See page listings, top right.)

Note – Be sure to completely lubricate the universal joint kit following lubrication procedures on page 25.

Quick Disconnect Style

One-Piece 136
Two-Piece 138
Multiple-Piece.....142

Companion Flange/Flange Yoke Style

One-Piece 146
Two-Piece 149
Multiple-Piece.....152

SLIP MEMBER ASSEMBLY SPICER LIFE SERIES™ 90

Remove Effected Grease Zerk (Nipple) Fitting

1. Using pliers or an open-ended wrench, turn grease zerk (nipple) fitting counter-clockwise, until it is removed from the slip yoke seal. Discard the grease zerk (nipple) fitting.

2. Thoroughly wipe clean the grease zerk (nipple) fitting threaded hole.

Install New Grease Zerk (Nipple) Fitting

3. Install new grease zerk (nipple) fitting (Spicer part number 500174-1). Tighten to 31-55 in. lbs. (3.5-6.2 Nm). ▲ See warning, below.

▲ ***WARNING***

*Hand tightening of slip member grease zerk (nipple) fittings is **NOT** recommended. Grease zerk (nipple) fittings will eventually vibrate loose and fall out of slip member. Prolonged operation with missing grease zerk (nipple) fittings allows contaminants into the slip member. Invasion of contaminants into the slip member can degrade the lubricant and cause slip member damage, which can result in separation of the driveline from the vehicle. A separated driveline can cause property damage, serious personal injury or death.*

REMOVAL PROCEDURE FOR UNIVERSAL JOINT KITS

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

Required Tools

- Support Straps
- Ratchet or Air Gun
- Appropriate Spicer Alignment Bar
  (See photo 50 or 51, right.)

Spicer Life Series™ 140, 170 & 250

- 12-Point Sockets
  English 3/8"
  Metric 12mm
- 6-Point, 8mm Socket

Spicer Life Series™ 55, 70, 90 &100

- Pliers for Snap Rings

One of the following is recommended:

- Three-ton (minimum) Arbor Press
  (for Spicer Life Series™ 55, 70, 90, 100, 140, 170 & 250) and
  Bearing Cup Spacer, and
  Push Rod
  or
- J & J Universal Joint Puller 4LIFE (see photo 52, right)
  (for Spicer Life Series™ 140, 170 & 250)
  1-800-221-4903
  Outside U.S. and Canada 215-256-9300
  or
- Tiger Tool MARK 1A (see photo 53, right)
  or TGLS-597 (not shown)
  (for Spicer Life Series™ 140, 170 & 250)
  1-800-661-4661
  Outside U.S. and Canada 604-855-1133

Photo 50, Spicer Alignment Bar Kit Quick Disconnect Style

Photo 51, Spicer Alignment Bar, Full Round Style

Photo 52

Photo 53

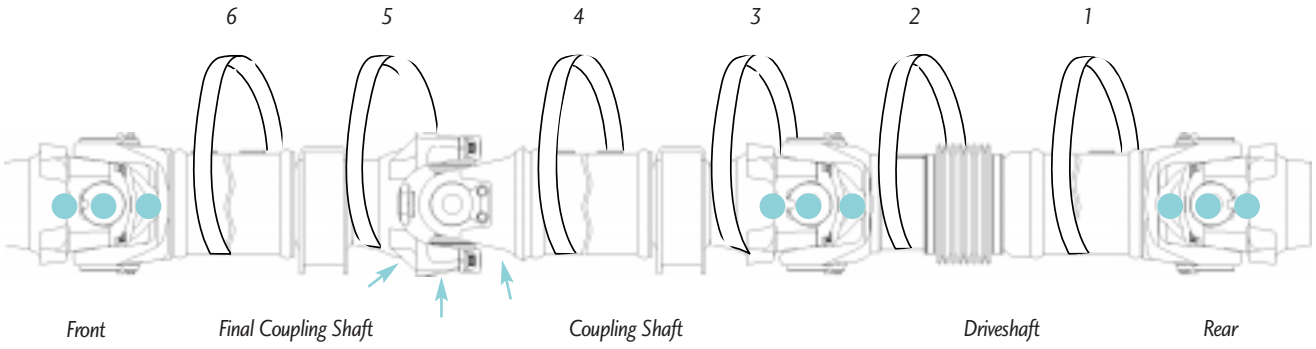

Figure N Quick Disconnect

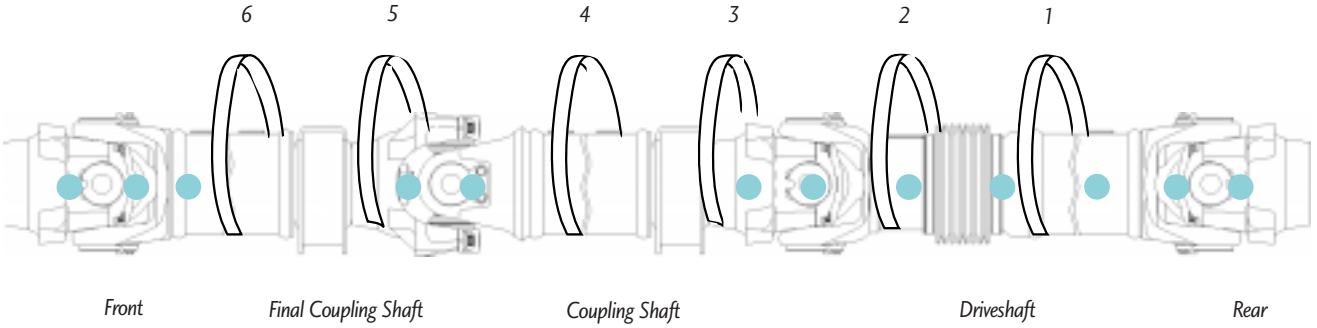

Figure P, S.A.E.

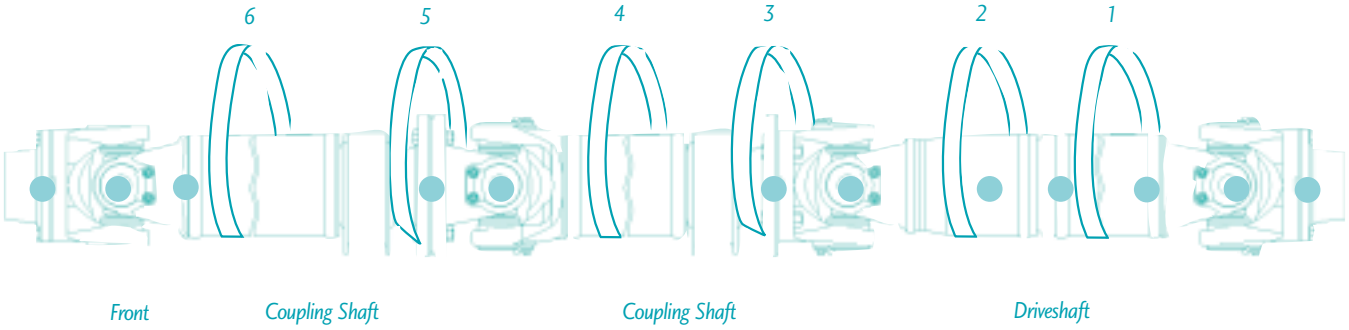

Figure Q, DIN/T-Type

SPRING TAB STYLE SPICER LIFE SERIES™ 140, 170 & 250

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire driveline assembly to reach the effected universal joint. Work from the rear end forward. The driveshaft will need to be disconnected to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position support straps.

Note – For more detailed driveshaft assembly removal procedures, see removal procedure for driveshaft assemblies in table of contents.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of the driveshaft or coupling shaft with the effected universal joint(s). Mark the driveshaft or coupling shaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark bearing positions. This assures

proper reassembly of the driveshaft or coupling shaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working on the driveshaft assembly section with the effected universal joint(s), place support straps as illustrated in Figure N, P or Q, page 73, for the appropriate style driveshaft being serviced.

Driveshaft

Be sure to position support straps 1 and 2. ▲ See warning, below.

Coupling Shaft(s)

Be sure to position support straps 2, 3 and 4. ▲ See warning, below.

Final Position Coupling Shaft

Be sure to position support straps 4, 5 and 6. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

For removal of a **driveshaft** with an effected universal joint, follow steps 3-6.

For removal of **coupling shaft(s)** with an effected universal joint, follow steps 3-11.

For removal of the **final position coupling shaft** with an effected universal joint, follow steps 3-15.

Disconnect Driveshaft

3. Remove bearing retainers and bolts or companion flange bolts, washers and nuts at the effected universal joint. Reference bolt specifications Table V, below, or hardware specifications Table W, page 75.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table V

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table W

Bearing retainers **CAN** be reused **if there is no damage**. (See photo 54, below.) If damaged, replace with new. See warning, below.

Photo 54, Bearing Retainers

Bearing retainer bolts or companion flange bolts, washers and nuts **CANNOT** be reused. Discard bolts and/or hardware, replace with new. See warning, below.

WARNING

***DO NOT** reuse bearing retainer bolts, damaged bearing retainers, companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of bearing retainer bolts, damaged bearing retainers, companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

4. It may be necessary to unseat bearing cup assemblies, pilot or serrated connection by tapping on tube yoke or bearing cup with a soft-faced hammer. (See photo 55, below.) Once the bearing cup assemblies or connections are free, collapse the driveshaft until both bearing cup assemblies clear the open cross holes or flange yoke pilot is disconnected. Allow the driveshaft to rest on support strap.

Photo 55

Remove Driveshaft

5. **Be sure the second support strap is in place as illustrated in Figure N, P or Q, page 73.** Remove bearing retainers and bolts or companion flange bolts, washers and nuts at the opposite end of the driveshaft. Reference bolt specifications, Table V, page 74, or hardware specifications, Table W, page 75. Discard bearing retainer bolts or companion flange bolts, washers and nuts.

Bearing retainers **CAN** be reused **if there is no damage**. If damaged, replace with new. ▲ See warning, below.

Bearing retainer bolts or companion flange bolts, washers and nuts **CANNOT** be reused. Discard bolts and/or hardware replace with new. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, damaged bearing retainers, companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of bearing retainer bolts, damaged bearing retainers, companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. Remove driveshaft from support straps and take it to a work bench area. ▲ See warning, below. If the driveshaft was the section of the driveline assembly with the effected universal joint, proceed to step 15, page 78.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Disconnect Coupling Shaft(s)

7. **Be sure the third and fourth support straps are in proper position as illustrated in Figure N, P or Q, page 73.**

8. Remove bearing retainers and bolts or companion flange bolts, washers and nuts at the center bearing end fitting. Discard bearing retainer bolts or companion flange bolts, washers and nuts.

Bearing retainers **CAN** be reused **if there is no damage**. If damaged, replace. ▲ See warning, step 5.

Bearing retainer bolts or companion flange bolts, washers or nuts **CANNOT** be reused. Discard bolts, washers and nuts and replace with new. ▲ See warning, step 5.

Remove Coupling Shaft(s)

9. Remove center bearing bracket bolts. Allow shaft to rest on support straps.

10. Remove bearing retainers and bolts or companion flange bolts, washers and nuts at next center bearing end fitting. Discard bearing retainer bolts or companion flange bolts, washers and nuts. ▲ See warning, step 5.

11. It may be necessary to unseat bearing cup assemblies, pilot or serrated connections by tapping on tube yokes or bearing cups with a soft-faced hammer. Once bearing cup assemblies or connections are free, remove coupling shaft from support straps and take it to a work bench area. ▲ See warning, below. If the coupling shaft was the section of the driveline assembly with the effected universal joint, proceed to step 15, page 78.

Note – It may be necessary to repeat steps 7-11 in order to access the coupling shaft with the effected universal joint.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Disconnect Final Position Coupling Shaft

12. **Be sure the fifth and sixth support straps are in place as illustrated in Figure N, P, or Q, page 73.** Remove final center bearing bracket bolts. Allow shaft to rest on support straps.

Remove Final Position Coupling Shaft

13. Remove bearing retainer bolts or companion flange bolts, washers and nuts from front end fitting. Discard bearing retainer bolts or companion flange bolts, washers and nuts. ▲ See warning, below.

Bearing retainers **CAN** be reused **if there is no damage**. If damaged, replace. ▲ See warning, below.

Bearing retainer bolts or companion flange bolts, washers or nuts **CANNOT** be reused. Discard bolts, washers and nuts and replace with new. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, damaged bearing retainers, companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of bearing retainer bolts, damaged bearing retainers, companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

14. It may be necessary to unseat bearing cup assemblies, pilot or serrated connections by tapping on tube yokes or bearing cups with a soft-faced hammer. Once bearing cup assemblies or connections are free, remove final position coupling shaft from support straps and take it to a work bench area. ▲ See warning, step 11.

Photo 56, Quick Disconnect Style

Photo 57, Companion Flange Style

Remove Universal Joint Kit

15. Remove and discard spring tabs and bolts. Reference bolt specifications, Table X, right. (See photos 56 or 57, above). ▲ See warning, below.

Companion Flange/Flange Yoke Style (S.A.E., DIN and T-Type)

If using an arbor press, proceed to step 16.

Quick Disconnect™ Style

If using an arbor press, proceed to step 20.

If using a universal joint puller, follow manufacturer's instructions.

▲ ***WARNING***

DO NOT *reuse spring tabs, spring tab bolts or use inferior grade bolts. Reuse of spring tabs, spring tab bolts and use of inferior grade bolts, can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

SPRING TAB BOLT SPECIFICATIONS

SERIES	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.	KIT P/N*
SPL140	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X
SPL170	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X
SPL250	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table X

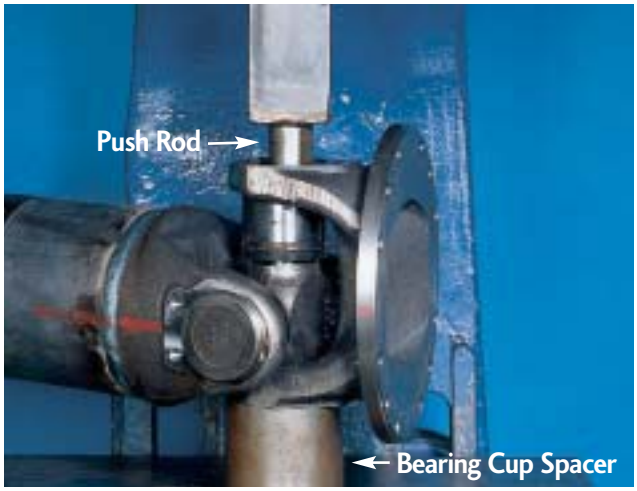

Photo 58, Companion Flange Style

Companion Flange/Flange Yoke Style (S.A.E., DIN and T-Type) Style

16. To remove flange yoke, place bearing cup spacer onto the base of the arbor press and under flange yoke. (See photo 58, above.) If the arbor is larger than the bearing cup diameter, a smaller diameter push rod will be needed to avoid damaging the yoke or bearing.

Using an arbor press, press down on the upper bearing cup assembly until the shoulder of the journal cross makes contact with the inside of flange yoke ear. (See photo 58, above.)

Caution – DO NOT over press the bearing cup and journal cross. This can damage the inside of the yoke ear.

17. Bearing cup is not designed to drop out of flange yoke. It will be necessary to use a soft-faced hammer to tap the partially pressed-out bearing cup from side to side, to "walk" the bearing cup out of flange yoke ear. (See photo 59, top right.)

Photo 59, Companion Flange Style

Remove the bearing cup from flange yoke ear and trunnion.

18. Place flange yoke in arbor press with remaining bearing cup face down. Using a push rod, press on end of the journal cross trunnion until the shoulder of the journal cross makes contact with the inside of flange yoke ear. (See photo 60, below.) Repeat step 17.

19. Remove flange yoke from journal cross. Continue to Quick Disconnect™ style, step 21, for complete removal of universal joint.

Photo 60

Photo 61, Correct Positioning

Photo 62, Incorrect Positioning

Quick Disconnect™ Style

20. Remove the outboard bearing cup assemblies.

21. Make sure universal joint cross assembly is not tilted in the yoke. (See photos 61 and 62, above.) Place bearing cup spacer onto the base of the arbor press and under the yoke. If the arbor is larger than the bearing cup diameter, a smaller diameter push rod will be needed to avoid damaging the yoke or bearing.

Using an arbor press, press down on the upper bearing cup assembly until the shoulder of the journal cross makes contact with the inside of the yoke ear. (See photo 63, below.)

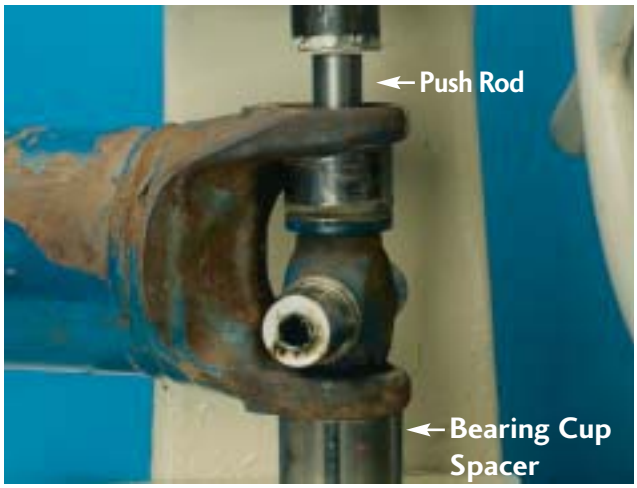

Photo 63

Caution – **DO NOT** over press the bearing cup and journal cross. This can damage the inside of the yoke ear.

22. The bearing cup is not designed to drop out of the yoke. It will be necessary to use a soft-faced hammer to tap the partially pressed-out bearing cup from side to side, to "walk" the bearing cup out of the yoke ear. (See photo 64, below.)

Remove the bearing cup from the trunnion.

Photo 64

Photo 65

23. Place the yoke in the press, with the remaining bearing cup face down. (See photo 65, above.) Using a push rod, press on end of the journal cross trunnion. Continue to press down on the journal cross trunnion until the shoulder of the journal cross makes contact with the inside of the yoke ear.

24. Repeat step 22.

25. Remove the journal from the yoke.

Inspect Tube Yoke and Flange Yoke (if applicable)

26. Inspect the tube yoke and flange yoke (if applicable) cross hole surfaces for damage or raised metal. Raised metal or fretting can be removed from yoke cross holes with a fine-toothed file and/or emery cloth. (See photo 66, top right.) See warning, below.

WARNING

DO NOT *deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can be a cause of cross and bearing problems and can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 66

27. Inspect the tube yoke or flange yoke (if applicable) for distorted cross holes using an appropriate Spicer alignment bar. Slide alignment bar through both cross holes simultaneously. If alignment bar will not pass through both cross holes simultaneously, the cross holes are distorted and the shaft assembly must be replaced. (See photo 67, below.) See warning, below.

WARNING

Failure to replace a damaged driveline can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 67

Install New Universal Joint Kit

28. Proceed to installation of universal joint kits, spring tab style, pages 116 to 121.

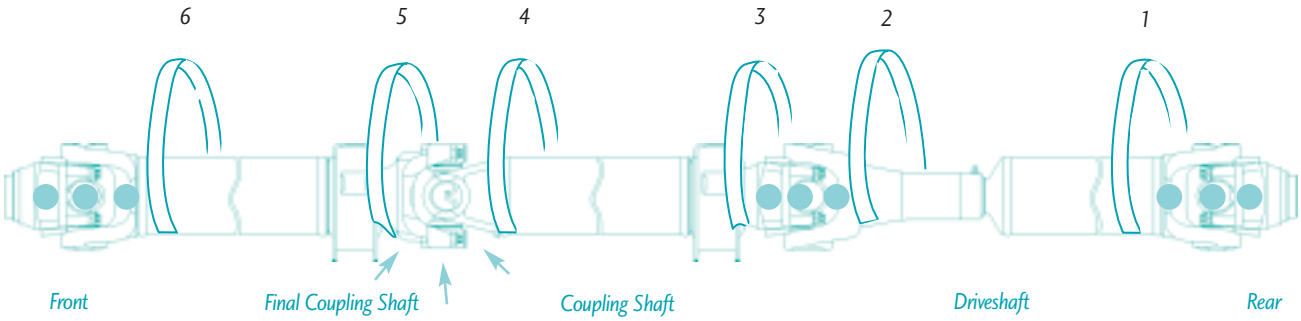

Figure R, Quick Disconnect

SNAP RING STYLE SPICER LIFE SERIES™ 55, 70, 90, AND 100

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire driveline assembly to reach the effected universal joint. Work from the rear end forward. The driveshaft will need to be disconnected to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position support straps.

Note – For more detailed driveshaft assembly removal procedures, see removal of driveshaft assemblies in table of contents.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of the driveshaft or coupling shaft with the effected universal joint(s). Mark the driveshaft or coupling shaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark bearing positions. This assures proper reassembly of the driveshaft or coupling shaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working on the driveshaft assembly section with the effected universal joint(s), place support straps as illustrated in Figure R, above.

Driveshaft

Be sure to position support straps 1 and 2. ▲ See warning, below.

Coupling Shaft(s)

Be sure to position support straps 2, 3 and 4. ▲ See warning, below.

Final Position Coupling Shaft

Be sure to position support straps 4, 5 and 6. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ *WARNING*

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

For removal of a **driveshaft** with an effected universal joint, follow steps 3-6.

For removal of **coupling shaft(s)** with an effected universal joint, follow steps 3-11.

For removal of **final position coupling shafts** with an effected universal joint, follow steps 3-14.

Disconnect Driveshaft

3. Remove bearing retainers or stamped straps. Discard stamped straps, bearing retainer bolts, stamped strap bolts or companion flange bolts, washers and nuts at the effected universal joint. Reference bolt specifications, Table Y, above right, or hardware specifications Table Z, page 84.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated. DO NOT substitute with inferior grade bolts.*

Table Y

Bearing retainers **CAN** be reused **if there is no damage**. (See photo 68, below.) If damaged, replace with new. ▲ See warning, below.

Stamped straps (see photo 69, below), bearing retainer bolts, stamped strap bolts or companion flange bolts, washers and nuts **CANNOT** be reused. Discard stamped straps and bolts or companion flange bolts, washers and nuts and replace with new. ▲ See warning, below

Photo 68, Bearing Retainers

Photo 69, Stamped Straps

▲ *WARNING*

***DO NOT** reuse bearing retainer or stamped strap bolts, stamped straps, companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of bearing retainer or stamped strap bolts, stamped straps, companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table Z

4. It may be necessary to unseat bearing cup assemblies, pilot or serrated connection by tapping on tube yoke or bearing cup with a soft-faced hammer. Once the bearing cup assemblies or connections are free, collapse the driveshaft until both bearing cup assemblies clear the open yoke cross or flange yoke pilot is disconnected. Allow the driveshaft to rest on support strap.

Remove Driveshaft

5. **Be sure the second support strap is in place as illustrated in Figure R, page 82**. Remove bearing retainers or stamped straps and bolts or companion flange bolts, washers and nuts at the opposite end of the driveshaft. Reference bolt specifications Table Y, page 83, or hardware specifications, Table Z, above. Discard stamped straps and bearing retainer or stamped strap bolts or companion flange bolts, washers and nuts.

Stamped straps, bearing retainer bolts, stamped strap bolts, or companion flange bolts, washers and nuts **CANNOT** be reused. Discard stamped straps and bolts or companion flange bolts, washers and nuts and replace with new. ⏢ See warning, below.

⏢ ***WARNING***

***DO NOT** reuse bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers, companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers, companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

6. Remove driveshaft from support straps and take it to a work bench area. ▲ See warning, below. If the driveshaft was the section of the driveline assembly with the effected universal joint, proceed to step 15, page 86.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Disconnect Coupling Shaft(s)

7. **Be sure the third and fourth support straps are in proper position as illustrated in Figure R, page 82.**

8. Remove bearing retainers or stamped straps. Discard stamped straps, bearing retainer bolts, stamped strap bolts or companion flange bolts, washers and nuts at the center bearing end fitting.

Bearing retainers **CAN** be reused **if there is no damage.** If damaged, replace. ▲ See warning, below.

Stamped straps, bearing retainer, stamped strap bolts or companion flange bolts, washers and nuts **CANNOT** be reused. Discard stamped straps and bolts or companion flange bolts, washers and nuts and replace with new. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers, companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers, companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Remove Coupling Shaft(s)

9. Remove center bearing bracket bolts. Allow shaft to rest on support straps.

10. Remove bearing retainers and bearing retainer bolts or stamped straps and bolts or companion flange bolts, washers and nuts at next center bearing position. Discard all stamped straps, bearing retainer or stamped strap or companion flange bolts, washers, and nuts. ▲ See warning, step 8.

11. It may be necessary to unseat bearing cup assemblies, pilot or serrated connections by tapping on tube yokes or bearing cups with a soft-faced hammer. Once bearing cup assemblies or connections are free, remove coupling shaft from support straps and take it to a work bench area. ▲ See warning, step 6. If the coupling shaft was the section of the driveline assembly with the effected universal joint, proceed to step 15, page 86.

Note – It may be necessary to repeat steps 7-11 in order to access the coupling shaft with the effected universal joint.

Disconnect Final Position Coupling Shaft

12. **Be sure fifth and sixth support straps are in place as illustrated in Figure R, page 82.** Remove final center bearing bracket bolts. Allow shaft to rest on support straps.

Remove Final Coupling Shaft

13. Remove and discard bearing retainers or stamped straps and bolts or companion flange bolts, washers and nuts from front end fitting. ▲ See warning, step 8.

Bearing retainers **CAN** be reused **if there is no damage.** If damaged, replace. ▲ See warning, step 8.

Photo 70

14. It may be necessary to unseat bearing cup assemblies, pilot or serrated connection by tapping on tube yoke or bearing cup with a soft-faced hammer. Once bearing cup assemblies or connection is free, remove final position coupling shaft from support straps and take it to a work bench area. ▲ See warning, below.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Remove Universal Joint Kit(s)

15. Using snap-ring pliers, remove all snap rings. (See photo 70, above.) If snap rings are severely corroded or out-of-round, snap rings must be replaced. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse severely corroded or out-of-round snap rings. Reuse of snap rings can cause universal joint failure and can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Companion Flange/Flange Yoke Style (S.A.E., DIN and T-Type)

If using an arbor press, proceed to step 16.

Quick Disconnect™ Style

If using an arbor press, proceed to step 20.

If using a universal joint puller, follow manufacturers' instructions.

Companion Flange/Flange Yoke Style (S.A.E., DIN and T-Type) Style

16. To remove flange yoke, place bearing cup spacer onto the base of the arbor press and under flange yoke. If the arbor is larger than the bearing cup diameter, a smaller diameter push rod will be needed to avoid damaging the yoke or bearing.

Using an arbor press, press down on the upper bearing cup assembly until the shoulder of the journal cross makes contact with the inside of flange yoke ear.

Caution – **DO NOT** over press the bearing cup and journal cross. This can damage the inside of the yoke ear.

17. Bearing cup is not designed to drop out of flange yoke. It will be necessary to use a soft-faced hammer to tap the partially pressed-out bearing cup from side to side, to "walk" the bearing cup out of flange yoke ear.

Remove the bearing cup from flange yoke ear and trunnion.

18. Place flange yoke in arbor press with remaining bearing cup face down. Using a push rod, press on end of the journal cross trunnion until the shoulder of the journal cross makes contact with the inside of flange yoke ear. Repeat step 17.

19. Remove flange yoke from journal cross. Continue to Quick Disconnect™ style, step 21, for complete removal of universal joint.

Photo 71, Correct Positioning

Photo 72, Incorrect Positioning

Quick Disconnect™ Style

20. Remove the outboard bearing cup assemblies.

21. Make sure the universal joint cross assembly is not tilted in yoke. (See photos 71, top left, and 72, center left.)

22. Place bearing cup spacer onto the base of the arbor press and under the yoke. If the arbor is larger than the bearing cup diameter, a smaller diameter push rod will be needed to avoid damage to the yoke or bearing.

Using the arbor press, press down on the upper bearing cup assembly until the shoulder of the journal cross makes contact with the inside of the yoke ear. (See photo 73, bottom left.) Bearing cup is not designed to drop out of yoke.

Caution – **DO NOT** over press the bearing cup and journal cross. This can damage the inside of the yoke ear.

23. Grip the bearing cup in bench vice. (See photo 74, below.) Strike the yoke ear with a soft-faced hammer until bearing is removed.

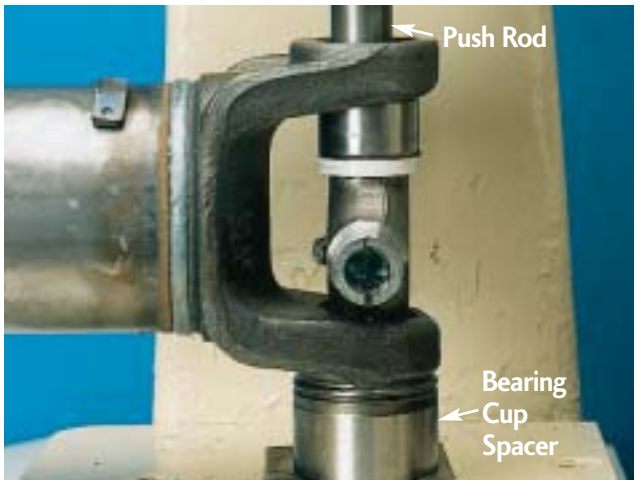

Photo 73

Photo 74

24. Place the yoke in the arbor press with remaining bearing cup face down. Using a push rod, press on the end of journal cross trunnion. (See photo 75, top right.) Continue to press down on journal cross trunnion until the shoulder of the journal cross makes contact with the inside of yoke ear. Bearing cup is not designed to drop out of yoke. Repeat step 23.

25. Remove journal cross from yoke.

Inspect Tube Yoke and Flange Yoke (if applicable)

26. Inspect the tube yoke and flange yoke (if applicable) cross hole surfaces for damaged or raised metal. Raised metal or fretting can be removed from yoke cross holes with a fine-toothed file and/or emery cloth. (See photo 76, right.) ▲ See warning, below.

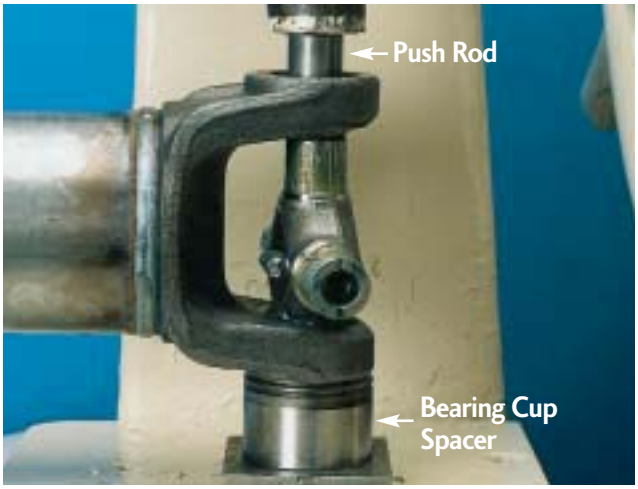

Photo 75

Photo 76

▲ ***WARNING***

DO NOT *deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can be a cause of cross and bearing problems and can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.*

27. Inspect the yoke for distorted cross holes using the appropriate Spicer alignment bar. Slide alignment bar through both cross holes simultaneously. If alignment bar will not pass through both cross holes simultaneously, cross holes are distorted and the shaft assembly must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace a damaged driveline can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Install New Universal Joint Kit

28. Proceed to installation of universal joint kits, snap ring style, pages 122 to 127.

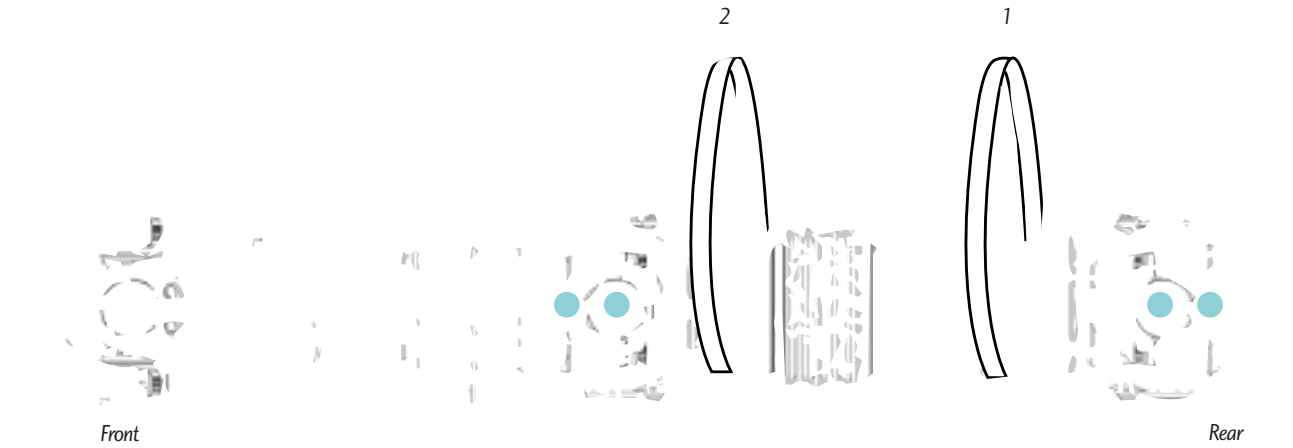

Figure S, Quick Disconnect

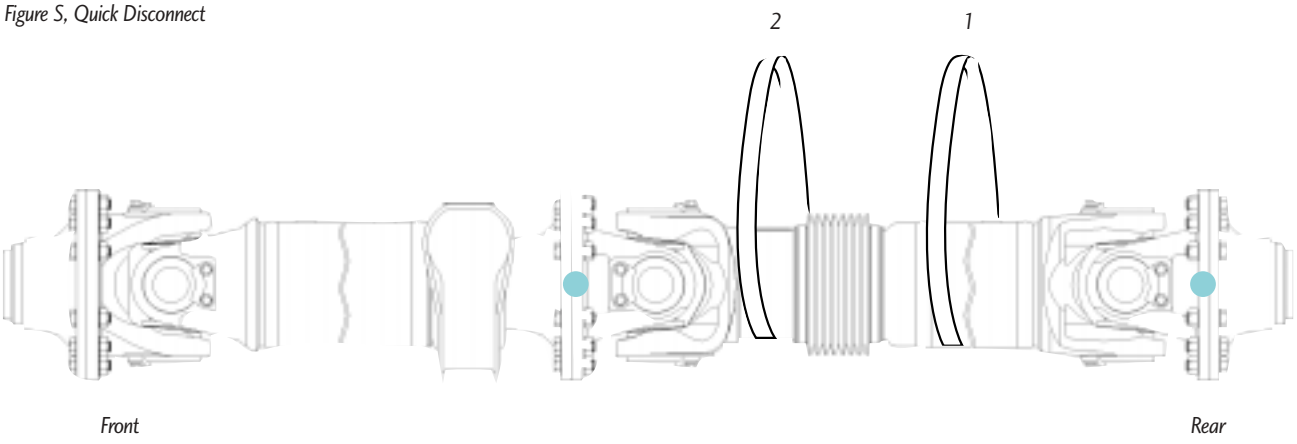

Figure T, S.A.E.

REPLACEMENT PROCEDURE FOR DAMAGED SLIP MEMBER BOOT

SPICER LIFE SERIES™ 55, 70, 100, 140, 170 & 250

Caution – Be sure to carefully read all information on page 39 before proceeding.

Required Tools

- Support Straps
- Ratchet or Air Gun
- 12-Point Sockets
  English 3/8," or
  Metric 12mm
- Soft-Faced Hammer
- Chisel

Caution – Seal can style slip member assemblies are **NOT** serviceable. If seal can or seal is damaged, replacement of the complete driveshaft assembly is necessary. (See Figure U, below.)

Figure U

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of the driveshaft, as illustrated in Figure S or T, above, for the appropriate style driveshaft being serviced. Mark the driveshaft with a marking stick, paint marker or other legible marking device.

For Quick Disconnect™ style, be sure to mark all the bearing positions, spline positions, shaft locations and bearing retainers (if applicable).

For companion flange/flange yoke (S.A.E.) style, be sure to mark all the flange positions, spline positions and shaft locations. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear**, position support straps 1 and 2 as illustrated in Figure S or T, page 89, for the appropriate style of driveshaft being serviced. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach support straps to gas lines, oil lines, brake lines, or wiring. **DO NOT** entangle gas lines, oil lines, brake lines, or wiring in support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Photo 77

Remove Boot Clamps

3. Remove and discard both boot clamps. Clamps may be separated using a chisel to disengage locking hooks. (See photo 77, above.) **DO NOT reuse clamps**. ▲ See warning, below.

▲ ***WARNING***

Reuse of boot clamps could allow intrusion of contaminants into slip member and can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Clean and Mark Spline Sleeve and Weld Ring

Caution – The following step is an additional marking process to that described in step one. Be sure to mark as directed.

4. Completely collapse the boot toward the yoke shaft to expose weld ring and spline sleeve area. Wipe weld ring and spline sleeve areas clean.

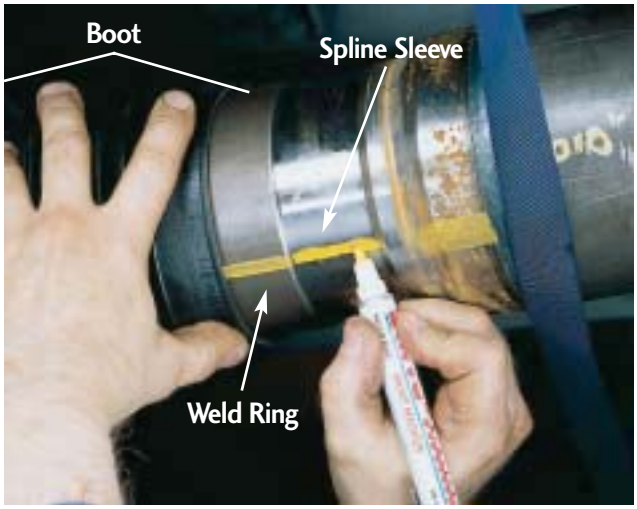

Photo 78

Photo 79

5. Mark spline sleeve and end of weld ring with a marking stick, paint marker or other legible marking device. (See photo 78, above.) This assures that the slip member can be reassembled in its original phased condition. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Disconnect Driveshaft

6. For Quick Disconnect™ style, remove bearing retainers and bolts or stamped straps and bolts at center bearing end fitting. Reference bolt specifications, Table AA, right. (See photo 79, top right.) Discard bolts.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table AA

Bearing retainers **CAN** be reused **if there is no damage**. If damaged, replace. Stamped straps **CANNOT** be reused. **DO NOT** reuse the bolts. Discard bolts. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, damaged bearing retainers, stamped straps or stamped strap bolts or use inferior grade bolts. Reuse of bearing retainer bolts, damaged bearing retainers, stamped straps or stamped strap bolts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
Note-*Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table BB

For companion flange/flange yoke (S.A.E.) style, remove and discard flange bolts, washers and nuts. Reference bolt specifications, Table BB, above. See warning, below.

WARNING

DO NOT *reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers and nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

7. For Quick Disconnect™ style, it may be necessary to unseat bearing cup assemblies by tapping on one bearing cup with a soft-faced hammer. Once the bearing cup assemblies are free, collapse the driveshaft until both bearing assemblies clear the open yoke cross holes. Allow the driveshaft to rest on support straps. See warning, below.

For companion flange/flange yoke (S.A.E.) style, it may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Allow the driveshaft to rest on support straps. See warning, below.

WARNING

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Photo 80

Remove Slip Member Boot

8. Remove the yoke shaft and boot from the spline sleeve. Discard boot. (See photo 80, above.) ▲ See warning, below.

▲ ***WARNING***

Yoke shaft assemblies can weigh in excess of 50 pounds (23 kilograms). Make sure to use proper lifting techniques when handling yoke shafts.

Inspect Yoke Shaft and Spline Sleeve

9. Inspect the yoke shaft spline surface for damage. If the splines are damaged, missing or twisted, or any Glidecote® is missing, complete driveshaft replacement is necessary. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

10. Inspect the spline sleeve for damage. If the splines are damaged, missing or twisted, complete driveshaft replacement is necessary. ▲ See warning, step 9.

11. Inspect the entire slip assembly for contaminants. If the slip assembly shows evidence of rust or the lube is severely contaminated, complete driveshaft replacement is necessary. ▲ See warning, step 9.

Reassemble Slip Member Boot

12. Proceed to installation of slip member boot, pages 133 to 135.

REMOVAL PROCEDURE FOR CENTER BEARINGS

SPICER LIFE SERIES™ 55, 70, 90, 100, 140, 170 & 250

Caution – Be sure to carefully read all information on page 39 before proceeding.

Required Tools

- Support Straps
- Bearing Puller
- Flange or Yoke Puller
- 6-Point Socket for Midship Nut
- 12-Point Sockets
  English 3/8", or
  Metric 12mm
- Spicer Alignment Bar (see photo 81 or 82, top right and right)

Photo 81, Spicer Alignment Bar Kit, Quick Disconnect Style

Photo 82, Spicer Alignment Bar, Companion Flange/Flange Yoke Style

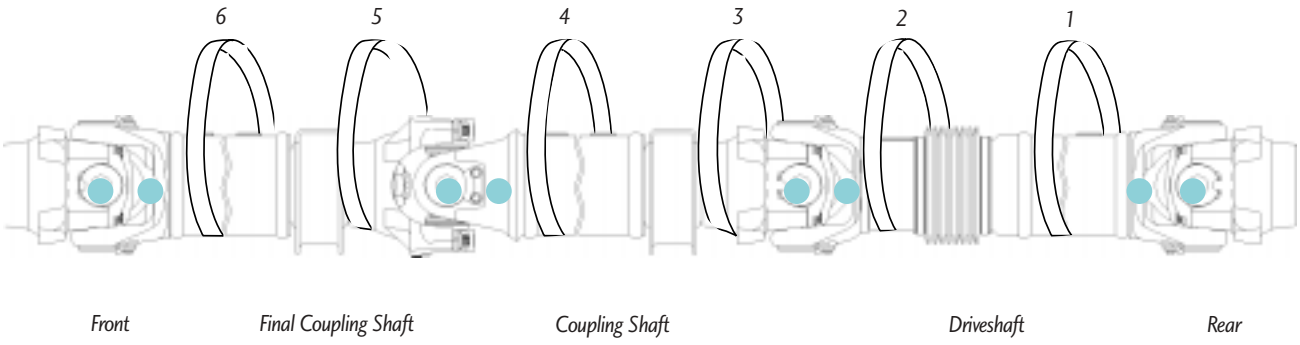

Figure V, Quick Disconnect™

QUICK DISCONNECT™ YOKE STYLE

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire driveline assembly. Work from the rear end forward. The driveshaft will need to be disconnected to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position support straps.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of the driveshaft, as illustrated in Figure V, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all bearing positions, spline positions, shaft locations and all bearing retainers. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end forward, position support straps 1 through 6 (as needed) as illustrated in Figure V, above. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach support straps to gas lines, oil lines, brake lines, or wiring. **DO NOT** entangle gas lines, oil lines, brake lines, or wiring in support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table CC

Disconnect Driveshaft

3. With all support straps securely in place, disconnect the driveshaft from the coupling shaft by removing the bearing retainers and bolts or stamped straps and bolts. Reference bolt specifications, Table CC, above. If bearing retainers are not damaged, they can be reused. Stamped straps **CANNOT** be reused. **DO NOT** reuse the bolts. Discard bolts. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts or damaged bearing retainers, stamped straps or stamped strap bolts, or use inferior grade bolts. Reuse of bearing retainer bolts or damaged bearing retainers, stamped straps or stamped strap bolts, or use of inferior grade bolts can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

4. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the bearing cup assemblies are free, collapse the driveshaft until both bearing assemblies clear the open yoke cross holes. Allow driveshaft to rest on support strap.

Photo 83

If disconnecting the driveshaft has allowed access to the effected center bearing, proceed to step 9. **DO NOT** at this point remove coupling shaft with the effected center bearing from the vehicle.

If the effected center bearing has not been reached, proceed to step 5 to remove coupling shaft(s) to reach coupling shaft with effected center bearing.

Remove Coupling Shaft(s)

5. **Be sure the third support strap is in place as illustrated in Figure V, page 95.** Remove the center bearing bracket bolts and allow the shaft to rest on the support strap. (See photo 83, above.)

6. **Be sure the fourth support strap is in place as illustrated in Figure V, page 95.** Remove bearing retainers or stamped straps and bolts on end yoke. Reference bolt specifications Table CC, left. Discard bolts. Discard stamped straps (if applicable). ▲ See warning, step 3.

7. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once coupling shaft is free, remove coupling shaft from support straps and take to a work bench area. ▲ See warning, below.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

8. Repeat steps 5-7 as necessary to obtain access to the effected center bearing. **DO NOT** at this point remove coupling shaft with the effected center bearing from the vehicle.

Inspect Center Bearing End Yoke

9. Inspect the center bearing end yoke cross hole surfaces and bolt hole threads for damage. If the bolt hole threads are damaged, the yoke must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

10. Check the center bearing end yoke for looseness, backlash and broken back. Take hold of center bearing end yoke with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any movement in the center bearing end yoke relative to the midship tube shaft to which it is connected. If any of these conditions are present, the center bearing end yoke or midship tube shaft must be replaced. ▲ See warning, below.

▲ ***WARNING***

A loose end fitting can result in driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

11. Inspect the center bearing end yoke cross hole surfaces for damage or raised metal. Raised metal or fretting can be removed from yoke cross holes with a fine-toothed file and/or emery cloth. ▲ See warning, below.

▲ ***WARNING***

***DO NOT** deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can be a cause of cross and bearing failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.*

12. Inspect the center bearing end yoke for distorted cross holes using the appropriate Spicer alignment bar. Slide alignment bar through both cross holes simultaneously. If alignment bar will not pass through both cross holes simultaneously, cross holes are distorted and yoke must be replaced. ▲ See warning, step 9.

Note – If effected center bearing was in the final coupling shaft, repeat same inspection steps on front end yoke prior to reinstallation of final coupling shaft into vehicle.

MIDSHIP NUT SPECIFICATIONS					
SERIES	NUT P/N	WASHER P/N	HEAD SIZE	NUT TORQUE Nm	LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	231502	N/A	1 5/8"	644-712	475-525 Lb.Ft.
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.
SPL170	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.
SPL250	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.

** A 1 5/8" socket may be used.*

Table DD

Remove Midship Nut on Center Bearing Yoke

13. Remove midship nut. Reference midship nut specifications Table DD, above. (See photo 84, below.) Discard nut. If washer is damaged, discard and replace. Otherwise, reuse washer. See warning, below.

WARNING

***DO NOT** reuse midship nut. Reuse of midship nut can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Photo 84

Photo 85

Mark Center Bearing End Yoke Counterbore

Caution – The following step is an additional marking process to that described in step one. Be sure to mark as directed.

14. Mark the counterbore of end yoke to midship "nose" with marking stick, paint marker or other legible marking device. This assures proper reassembly of the center bearing end yoke in its original phased position. (See photo 85, above.) See warning, below.

WARNING

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Disconnect Coupling Shaft With Effected Center Bearing

15. Remove center bearing bracket bolts. (See photo 86, page 99.) Allow coupling shaft to rest on support strap.

Remove Coupling Shaft With Effected Center Bearing

16. Remove bearing retainers or stamped straps and bolts from end yoke. Discard bolts and stamped straps. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or use inferior grade bolts. Reuse of bearing retainer bolts, stamped straps, stamped strap bolts, damaged bearing retainers or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

17. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the coupling shaft is free, remove from support straps and take it to a work bench area. ▲ See warning, below.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Remove Center Bearing End Yoke

18. Using a puller, follow the tool manufacturer's instructions to remove the Quick Disconnect™ yoke. (See photo 87, center right.) The yoke has a press fit and should **NOT** be removed with a hammer. If the yoke is loose enough to be removed by hand, the entire coupling shaft must be replaced. Remove and discard slinger from the yoke. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 86

Photo 87

Inspect Center Bearing End Yoke Splines

19. Visually inspect the splines of the center bearing end yoke. If the yoke splines are damaged, missing or twisted, the yoke must be replaced. If the yoke hub is cracked, the yoke must be replaced ▲ See warning, step 18.

Inspect Midship

20. Visually inspect the midship splines and threads. If the splines or threads are damaged, missing or twisted, replacement of the entire coupling shaft is necessary. ▲ See warning, step 18.

Photo 88

Remove Center Bearing

21. On some Spicer center bearing assemblies, a metal retainer spans the outside center bearing bracket. If present, remove metal retainer and discard. (See photo 88, above.)

22. Remove and discard center bearing bracket. (See photo 89, top right.) Remove and discard rubber cushion. (See photo 90, right.)

23. Using a puller, follow the tool manufacturer's instructions to remove the bearing assembly from the midship. (See photo 91, right.) Discard the center bearing.

Inspect Midship Bearing Diameter

24. Inspect midship for wear on the bearing diameter. If the midship is damaged from a seized bearing, replacement of the entire coupling shaft is necessary. (See photo 92, right.) ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

25. If no damage is apparent, remove slinger and proceed to installation of center bearing, Quick Disconnect™ Yoke Style, pages 128 to 132.

Photo 89

Photo 90

Photo 91

Photo 92

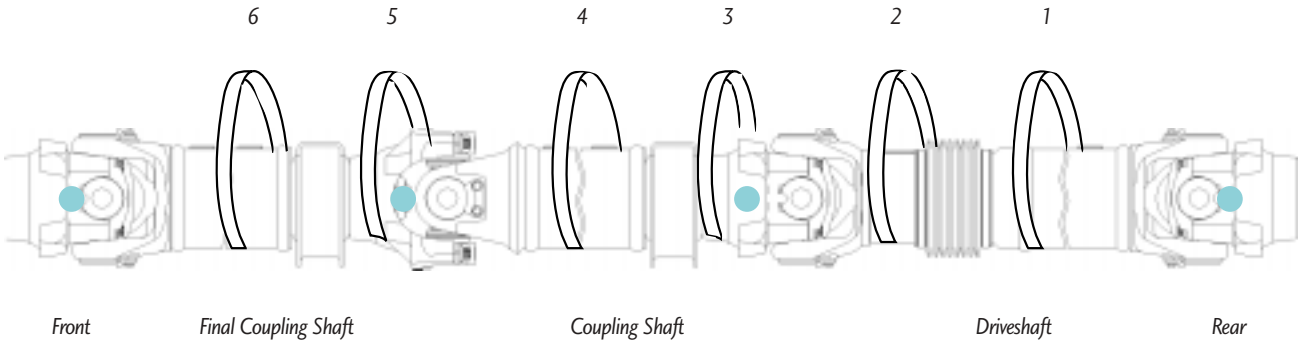

Figure W, S.A.E.

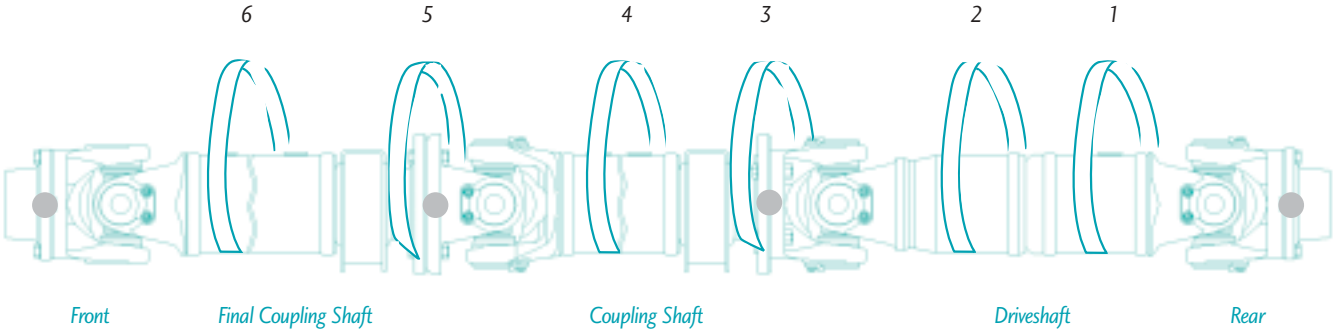

Figure X, DIN and T-Type

COMPANION FLANGE/FLANGE YOKE (S.A.E., DIN AND T-TYPE STYLE)

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire driveline assembly. Work from the **rear** end forward. The driveshaft will need to be disconnected in order to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position support straps.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of the driveshaft, as illustrated in Figure W or X, above. Mark the driveshaft with a marking stick, paint marker or other legible marking device. In addition, be sure to mark all flange positions, spline positions, and shaft locations. This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end forward, position support straps 1 through 6 (as needed) as illustrated in Figure W or X, above. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table EE

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach support straps to gas lines, oil lines, brake lines, or wiring. **DO NOT** entangle gas lines, oil lines, brake lines, or wiring in support straps. See warning, below.

WARNING

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Disconnect Driveshaft

3. With support straps securely in place, disconnect the driveshaft from the coupling shaft by removing the companion flange bolts. Reference hardware specifications, Table EE, above. **DO NOT** reuse companion flange bolts, washers or nuts. See warning, top right. Allow driveshaft to rest on the support straps.

WARNING

***DO NOT** reuse companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

4. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once the connection is free, collapse the driveshaft and allow it to rest on support strap.

If disconnecting the driveshaft has allowed access to the effected center bearing, proceed to step 9. **DO NOT** at this point remove coupling shaft with the effected center bearing from the vehicle.

If the effected center bearing has not been reached, proceed to step 5 to remove coupling shaft(s) to reach coupling shaft with effected center bearing.

Photo 93

Disconnect Coupling Shaft

5. **Be sure the third support strap is in place as illustrated in Figure W or X, page 101.** Remove the center bearing bracket bolts and allow the shaft to rest on the support strap. (See photo 93, above.)

Remove Coupling Shaft

6. **Be sure the fourth support strap is in place as illustrated in Figure W or X, page 101.** Remove companion flange, bolts, washers and nuts. Reference hardware specifications, Table EE, page 102. Discard companion flange bolts, washers and nuts. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse companion flange bolts, washers or nuts, or use inferior grade bolts. Reuse of companion flange bolts, washers or nuts, or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

7. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once coupling shaft is free, remove the coupling shaft from support straps and take to a work bench area. ▲ See warning, below.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

8. Repeat steps 5-7 as necessary to obtain access to the effected center bearing. **DO NOT** at this point remove coupling shaft, with the effected center bearing, from the vehicle.

Inspect Center Bearing Flange

9. Inspect all flange faces for galling or damage. If damaged, the flange must be replaced. ▲ See warning, step 10.

10. Visually inspect the center bearing flange. Check the flange for looseness, backlash and broken back. Take hold of center bearing flange with both hands. Try to move it vertically and horizontally to feel any looseness. There should **NOT** be any movement. If any of these conditions are present, the entire shaft must be replaced. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Note – If effected center bearing was in the final coupling shaft, repeat the same inspection steps on front flange prior to reinstallation of final coupling shaft into vehicle.

MIDSHIP NUT SPECIFICATIONS					
SERIES	NUT P/N	WASHER P/N	HEAD SIZE	NUT TORQUE Nm	NUT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	231502	N/A	1 5/8"	644-712	475-525 Lb.Ft.
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.
SPL170	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.
SPL250	250-74-11	230123-6	41mm*	644-712	475-525 Lb.Ft.

** A 1 5/8" socket may be used.*

Table FF

Remove Midship Nut on Center Bearing Flange

11. Remove and discard midship nut. Reference midship nut specifications, Table FF, above. If washer is damaged, discard and replace. Otherwise, reuse washer. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse midship nut. Reuse of midship nut can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

Mark Center Bearing Flange Counterbore

Caution – The following step is an additional marking process to that described in step 1. Be sure to mark as directed.

12. Mark the counterbore of the companion flange to midship "nose" with a marking stick, paint marker or other legible marking device. This assures proper reassembly of the companion flange in its original phased position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Disconnect Coupling Shaft With Effected Center Bearing

13. Remove center bearing bracket bolts and allow shaft to rest on support strap.

Remove Coupling Shaft With Effected Center Bearing

14. Remove and discard flange bolts, washers and nuts at end fitting. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

15. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once the connection is free, remove coupling shaft from support straps and take it to a work bench area. ▲ See warning, below.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

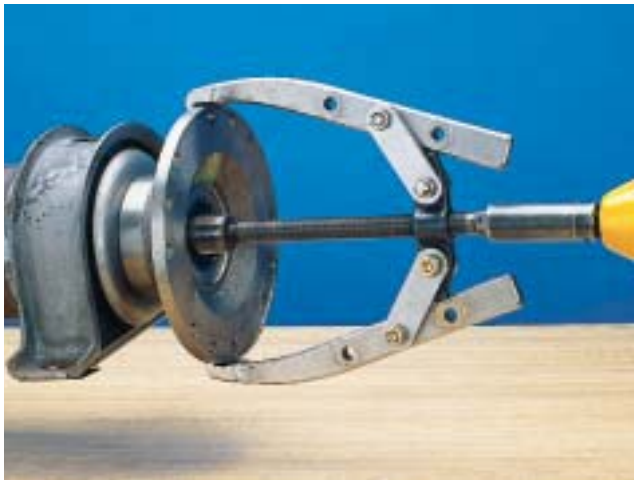

Photo 94

Photo 95

Remove Center Bearing Companion Flange

16. Using a puller, follow the tool manufacturer's instructions to remove the center bearing companion flange. (See photo 94, above.) Flange has a press fit and should **NOT** be removed with a hammer. If flange is loose enough to be removed by hand, the entire coupling shaft should be replaced. ▲ See warning, below. Remove and discard the slinger from the flange.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Inspect Center Bearing Flange

17. Visually inspect the center bearing companion flange splines and bolt hole threads or through holes. If the splines are damaged, missing or twisted, the entire coupling shaft should be replaced. If the center bearing flange hub is cracked, the pilots have damage or burrs, or bolt hole threads or through holes are damaged, replace the center bearing flange. ▲ See warning, step 16.

Inspect Midship

18. Visually inspect the midship splines and threads. If splines or threads are damaged, missing or twisted, replacement of the entire coupling shaft is necessary. ▲ See warning, below.

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Remove Center Bearing

19. On some Spicer center bearing assemblies, a metal retainer spans the outside center bearing bracket. If present, remove the metal retainer and discard. (See photo 95, above.)

Photo 96

Photo 97

Remove and discard the center bearing bracket. (See photo 96, above.) Remove and discard the rubber cushion. (See photo 97, top right.)

20. Using a puller, follow the tool manufacturer's instructions to remove the bearing assembly from the midship. (See photo 98, center right.) Discard the center bearing.

Inspect Midship Bearing Diameter

21. Inspect midship for wear on bearing diameter. If midship is damaged from a seized bearing, replacement of entire coupling shaft is necessary. (See photo 99, bottom right.) ▲ See warning, below.

Photo 98

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 99

22. If no damage is apparent, remove slinger and discard. Proceed to installation of center bearing companion flange/flange yoke (S.A.E., DIN and T-Type) style, pages 128 to 132.

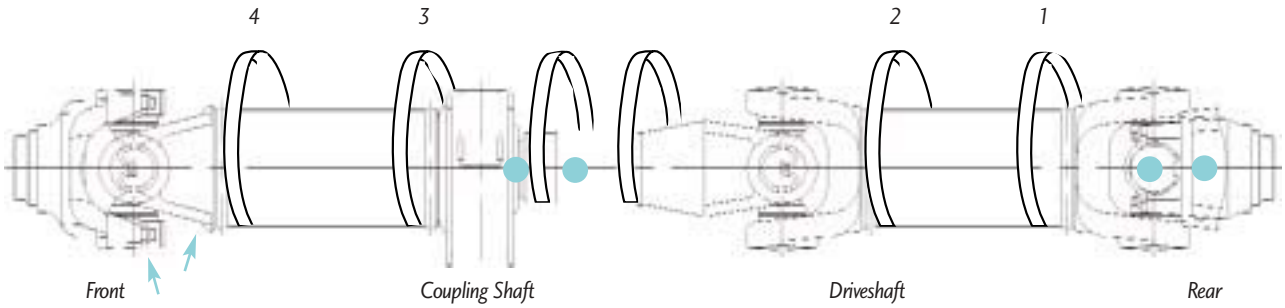

Figure Y, Quick Disconnect

OUTBOARD SLIP STYLE SPICER LIFE SERIES 55, 70, 90 & 100

Caution – Be sure to carefully read all information on page 39 before proceeding.

Note – When working with multiple-piece driveshafts, it may be necessary to remove the entire driveline assembly. Work from **rear** end forward. The driveshaft will need to be disconnected **first** in order to allow clearance for the removal of any coupling shaft. Work on only one connection at a time. Be sure to properly position support straps.

Mark Driveshaft ("Phasing Marks")

1. It is imperative to mark all mating components of a driveshaft, as illustrated in Figure Y above. Mark driveshaft with a marking stick, paint marker or other legible marking device.

Quick Disconnect™ Style

Be sure to mark all bearing positions, spline positions, shaft locations, bearing retainers (if applicable) and stamped straps.

Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) Style

Be sure to mark all flange positions, spline positions and shaft locations.

This assures proper reassembly of the driveshaft into the vehicle, in its original position. ▲ See warning, below.

▲ ***WARNING***

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from the vehicle, which can result in property damage, serious personal injury or death.

Position Support Straps

2. Working from the **rear** end forward, position support straps 1 through 4 (as needed) as illustrated in Figure Y, above. ▲ See warning, below.

▲ ***WARNING***

***ALWAYS** use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach support strap to gas lines, oil lines, brake lines, or wiring. **DO NOT** entangle gas lines, oil lines, brake lines, or wiring in support strap. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Quick Disconnect™ Style

Proceed to step 3.

Companion Flange/Flange Yoke Style (S.A.E., DIN and T-Type) Style Proceed to step 10.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in., 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm, 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute with inferior grade bolts.

Table GG

Disconnect Driveshaft Quick Disconnect™ Style

3. With support straps securely in place, remove bearing retainers or stamped straps and bolts at **rear** end. Reference bolt specifications, Table GG, above. If bearing retainers are not damaged, they can be reused. **DO NOT** reuse stamped straps or any bolts. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers or use inferior grade bolts. Reuse of bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers or use of inferior grade bolts can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

4. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the bearing cup assemblies are free, collapse the driveshaft until both bearing assemblies clear the open yoke cross holes. Allow driveshaft to rest on support strap.

Remove Driveshaft

5. Slide driveshaft off of outboard midship tube shaft at slip yoke. Remove driveshaft from vehicle and take to work bench area. ▲ See warning, below.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds *(46 kilograms)*. Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

If disconnecting the driveshaft has allowed access to the effected center bearing, proceed to step 17.

If the effected center bearing has not been reached, proceed to step 6 to remove coupling shaft(s).

Disconnect Coupling Shaft

6. **Be sure the third support strap is in place as illustrated in Figure Y, page 107.** Remove the center bearing bracket bolts and allow the shaft to rest on the support strap.

Remove Coupling Shaft

7. **Be sure the fourth support strap is in place as illustrated in Figure Y, page 107.** Remove bearing retainers or stamped straps and bolts on end yoke. Reference bolt specifications, Table GG, top left. Discard bolts. Discard stamped straps (if applicable). ▲ See warning, step 3.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer Hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table HH

8. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once coupling shaft is free, remove the coupling shaft from support straps and take it to a work bench area. ▲ See warning, below.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

9. Repeat steps 6-8 as necessary to obtain access to the effected center bearing, once the effected centering bearing has been reached. **DO NOT** at this point remove coupling shaft from vehicle. It will be necessary to continue with pages 98-100, steps 13 to 25, for Quick Disconnect™ style.

Disconnect Driveshaft – Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) Style

10. With support straps securely in place, remove and discard companion flange bolts, washers and nuts from rear end. Reference companion flange bolt torque specifications, Table HH, above. **DO NOT** reuse companion flange bolts, washers and nuts. ▲ See warning, below.

▲ ***WARNING***

***DO NOT** reuse companion flange bolts, washers or nuts or use inferior grade bolts. Reuse of companion flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

11. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once the connection is free, collapse the driveshaft and allow it to rest on support strap.

Remove Driveshaft

12. Slide driveshaft off outboard midship shaft at slip yoke. Remove driveshaft from vehicle and take to work bench area. See warning, below.

WARNING

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

If disconnecting the driveshaft has allowed access to the effected center bearing, proceed to step 17.

If the effected center bearing has not been reached, proceed to step 13 to remove coupling shaft(s).

Disconnect Coupling Shaft

13. **Be sure the third support strap is in place as illustrated in Figure Y, page 107.** Remove the center bearing bracket bolts and allow the shaft to rest on the support strap.

Remove Coupling Shaft

14. **Be sure the fourth support strap is in place as illustrated in Figure Y, page 107.** Remove companion flange bolts, washers and nuts on flange. Reference bolt specifications, Table HH, page 109. Discard bolts, washers and nuts. See warning, below.

WARNING

DO NOT *reuse companion flange bolts, washers or nuts, or use inferior grade bolts. Reuse of companion flange bolts, washers or nuts, or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

15. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once coupling shaft is free, remove the coupling shaft from support straps and take to a work bench area. See warning, step 12.

16. Repeat steps 13-15 as necessary to obtain access to the effected center bearing. Once the effected center bearing has been reached, **DO NOT** now remove coupling shaft from vehicle.

At this point it will be necessary to continue with pages 104-106, steps 11-22, for companion flanger/flanger yoke style.

Inspect Midship Tube Shaft

17. Visually inspect midship tube shaft, looking for wear on spline surface. If splines are damaged, missing or twisted, or Glidecote® is missing, replacement of entire coupling shaft is necessary. See warning, below.

WARNING

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Remove Coupling Shaft With Effected Center Bearing – Quick Disconnect Style

Proceed to step 18.

Remove Coupling Shaft With Effected Center Bearing – Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) Style

Proceed to step 20.

Quick Disconnect™ Style

18. Remove center bearing bracket bolts. Allow coupling shaft to rest on support strap.

Remove bearing retainers or stamped straps and bolts at end yoke. Discard bolts. If bearing retainers are not damaged, they **CAN** be reused. **DO NOT** reuse stamped straps or any bolts. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers, or use inferior grade bolts. Reuse of bearing retainer or stamped strap bolts, stamped straps, damaged bearing retainers, or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

19. It may be necessary to unseat bearing cup assemblies by tapping on yoke or bearing cup with a soft-faced hammer. Once the coupling shaft is free, remove from support straps and take it to a work bench area. ▲ See warning, below. Proceed to step 22.

▲ ***WARNING***

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Make sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

Companion Flange/Flange Yoke (S.A.E., DIN and T-Type) Style

20. Remove center bearing bracket bolts and allow shaft to rest on support strap.

Remove and discard flange bolts, washers and nuts at flange. ▲ See warning, below.

▲ ***WARNING***

DO NOT *reuse flange bolts, washers or nuts or use inferior grade bolts. Reuse of flange bolts, washers or nuts or the use of inferior grade bolts can cause driveline failure, which can result in separation of driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.*

21. It may be necessary to unseat pilot or serrated connection by tapping on one side of the flange with a soft-faced hammer. Once the connection is free, remove coupling shaft from support straps and take it to a work bench area. ▲ See warning, step 19. Proceed to step 22.

Photo 100

Photo 101

Remove Center Bearing

22. On some Spicer center bearing assemblies, a metal retainer spans the outside center bearing bracket. If present, remove metal retainer and discard. Remove and discard center bearing bracket. (See photo 100, above.) Remove and discard rubber cushion. (See photo 101, top right.)

23. Using a puller, follow tool manufacturer's instructions to remove the bearing assembly from the midship tube shaft. (See photo 102, center right.) Discard center bearing.

Photo 102

Inspect Midship Tube Shaft Bearing Diameter

24. Inspect the midship tube shaft for wear on the bearing diameter. If the midship tube shaft is damaged, replacement of the entire coupling shaft is necessary. (See photo 103, bottom right.) ▲ See warning, below.

Photo 103

▲ ***WARNING***

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

25. If no damage is apparent, remove slinger and discard. Proceed to installation of center bearing outboard slip style driveshafts, pages 128-132.

SPICER®

DANA

INSTALLATION

People Finding A Better Way

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SPICER LIFE SERIES™ DRIVESHAFT INSTALLATION

Before You Get Started

Note – Spicer Life Series driveshafts are found on vehicles throughout the world. Therefore, this manual includes worldwide terminology. These terms have been highlighted in teal.

Caution – Under no circumstances should individuals attempt to perform driveline service and/or maintenance procedures for which they have not been trained or do not have the proper tools and equipment. See warning, below.

WARNING

Failure to take commonsense, precautionary measures when working on a vehicle or other machinery could result in property damage, serious personal injury or death. In order to avoid property damage, serious personal injury or death, you must:

1. **ALWAYS** wear safety glasses when performing maintenance or service. Failure to wear safety glasses can result in personal injury and/or partial or complete vision loss.

2. **NEVER** go under a vehicle while the engine is running. Be sure the vehicle's engine is off, and keys are removed from ignition.

3. **NEVER** go under or work on a vehicle that is not on a level or flat surface.

4. **NEVER** work on a driveshaft without blocking the vehicle's wheels and releasing all parking brakes. See warning, below.

WARNING

Failure to release all parking brakes and placing transmission in neutral can result in torque being applied to the driveshaft. Disconnecting a driveshaft with applied torque can result in property damage, serious personal injury or death.

5. **NEVER** lift a vehicle without the appropriate weight-rated, vehicle-support equipment.

6. **NEVER REMOVE** a driveshaft from the vehicle without keeping the vehicle's transmission in neutral. See warning, step 4.

7. **CAUTION** – Spicer Life Series driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Be sure to use proper lifting techniques when handling Spicer Life Series driveshafts. More than one person may be needed when handling driveshaft assemblies.

8. **ALWAYS** use support straps to prevent the driveshaft from falling out of vehicle during the removal and installation process.

9. **NEVER** heat components or use sledgehammers or floor jacks to remove the driveshaft from vehicle.

Note – For driveshaft applications that have pillow blocks, dampers, parking brakes or retarders, refer to these component manufacturers' or the original equipment vehicle manufacturers' service manuals for proper procedures.

SERVICING A SPICER LIFE SERIES DRIVESHAFT

The following components are serviceable:

- Universal Joint Kits
- Boot Kits
- Quick Disconnect™ End Yokes
- S.A.E., DIN and T-Type Flange Yokes
- S.A.E., DIN and T-Type Companion Flanges
- Bearing Retainers and Bolts or Stamped Straps and Bolts
- Spring Tabs and Bolts
- Center Bearing Assemblies
- Grease Zerk (Nipple) Fittings

Note – Spicer Life Series 140, 170 and 250 driveshaft assemblies and components are metric. To eliminate any confusion between S.A.E. and metric threaded fasteners, the metric fasteners have been color coded gold. Spicer Life metric fasteners include spring tab bolts, bearing retainer bolts and midship nuts.

INSTALLATION PROCEDURE FOR END FITTINGS

SPICER LIFE SERIES 55, 70, 90, 100, 140, 170 & 250

Refer to the transmission, axle or transfer case original equipment manufacturers' service and maintenance manuals for proper procedures.

For center bearing fittings, refer to pages in this section for proper installation procedures for center bearings.

INSTALLATION PROCEDURE FOR UNIVERSAL JOINT KITS

SPICER LIFE SERIES 55, 70, 90, 100, 140, 170 & 250

Required Tools

- Ratchet or Air Gun
- Six-Point, 8mm Socket (Spicer Life 140, 170 & 250)
- Chisel (Spicer Life 55, 70, 90 & 100)
- Torque Wrench
- Hammer
- Pliers – For Snap Rings (Spicer Life 55, 70, 90 & 100)

One of the following is recommended:

- Three ton minimum, Arbor Press, along with
  (for Spicer Life Series 55, 70, 90, 100, 140, 170 & 250)
  Bearing Cup Spacer
  Push Rod
  Metal Plate 0.25 inches (6.4 mm) thick,

or

- J & J Tool Co., Inc. (see photo 104, right)
  Universal Joint Puller Kit 4LIFE – Basic or Complete
  (for Spicer Life Series 140, 170 & 250)
  1-800-221-4903
  Outside U. S. A. and Canada 1-215-256-9300,

or

- Tiger Tool TGLS-597 (See photo 105, right)
  or Mark 10A (not shown)
  (for Spicer Life Series 140, 170 & 250)
  1-800-661-4660
  Outside U. S.A. and Canada 1-604-855-1133

QUICK DISCONNECT™ SPRING TAB STYLE SPICER LIFE SERIES 140, 170 & 250

Caution – Be sure to carefully read all information on page 115 as well as grease recommendations and compatibility information in the lubrication section of this manual, before proceeding.

Note – Spicer Life replacement universal joint kit bearing assemblies contain only enough grease to provide needle roller bearing protection during storage. It is therefore necessary to completely lubricate each bearing assembly. It is also necessary to fully lubricate the universal joint kit after it is installed in the vehicle.

Photo 104

Photo 105

Photo 106

1. Remove needle retaining plugs from all bearing cup assemblies. Using a high-quality, N.L.G.I.*, E. P. Grade 2 lubricating grease, wipe each bearing cup assembly with grease. Fill all cavities between the needle rollers. Also apply a liberal coating of grease on the bottom of each bearing cup assembly and on the lip of the seal. (See photo 106, above.) ▲ See warning, below.

**National Lubricating Grease Institute*

▲ *WARNING*

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Caution – Spicer **DOES NOT** recommend wiping the outside of bearing cup assemblies or yoke cross holes with grease, oil or silicone-based sprays. This could result in bearing cup assembly rotation in yokes. ▲ See warning, below.

▲ *WARNING*

Rotating bearing cup assemblies can result in yoke cross hole wear and distortion. Distorted yokes can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

2. Position the journal cross into the yoke cross holes with the grease zerk (nipple) fitting inward toward tubing. The

Photo 107

double-headed, grease zerk (nipple) fitting should be perpendicular to the yoke cross holes. (See photo 107, above.)

Failure to properly position the universal joint will result in the inability to grease the universal joint. ▲ See warning, step 1, regarding inadequate lubrication.

If using an arbor press, proceed to step 3. If using a universal joint installation tool, follow the tool manufacturer's instructions, then proceed to page 136 for installation procedures for Quick Disconnect™ driveshaft assemblies.

3. Move one end of the journal cross to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke ear. Take one bearing cup assembly and position an installation height tool on the end of the bearing cup assembly. Place the bearing cup assembly over the protruding trunnion diameter and align it to the yoke cross hole. (See photo 108, below.)

Photo 108

Photo 109

Photo 110

Photo 111

4. Align the yoke in an arbor press with the bearing assembly resting on the base of the press. (See photo 109, left.) Cover the yoke ear with a metal plate that has 0.25 inch (6.4 mm) minimum thickness. Push the yoke onto the bearing cup assembly until the installation height tool is flush with the cross hole face. **Do not remove the installation height tool.**

5. Flip yoke 180 degrees. Position the remaining installation height tool on the end of another bearing cup assembly. Place bearing cup assembly over trunnion diameter and align it to the yoke cross hole. Push the bearing cup assembly until both installation height tools are flush with the cross hole face. (See photo 110, left center.) **Remove and discard both installation height tools.**

6. Install **new** spring tabs and 8mm thread bolts. Make sure that no grease or foreign material is present between the contact areas of the spring tabs, bearing cups and yoke cross hole faces. Tighten bolts to the required torque. (See photo 111, bottom left.) See spring tab bolt torque specification Table JJ below. ▲ See warning, below.

SPRING TAB BOLT SPECIFICATIONS

SERIES	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.	KIT P/N*
SPL140	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X
SPL170	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X
SPL250	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table JJ

▲ ***WARNING***

Reuse of spring tabs or spring tab bolts or failure to properly tighten spring tab bolts to required specifications can cause the driveline to loosen and separate from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

7. Proceed to page 136 for installation of the driveshaft into the vehicle.

COMPANION FLANGE/FLANGE YOKE (S.A.E., DIN AND T-TYPE) SPRING TAB STYLE SPICER LIFE SERIES 140, 170 & 250

Caution – Be sure to carefully read all information on page 115 as well as grease recommendations and compatibility information in the lubrication section of this manual, before proceeding.

Note – Spicer Life replacement universal joint kits contain only enough grease to provide needle roller bearing protection during storage. It is therefore necessary to completely lubricate each universal joint kit after it is installed in the vehicle.

1. Remove needle retaining plugs from all bearing cup assemblies. Using a high-quality, N.L.G.I.*, E. P. Grade 2 lubricating grease, wipe each bearing cup assembly with grease. Fill all the cavities between the needle rollers. Also apply a liberal coating of grease on the bottom of each bearing cup assembly and on the lip of the seal. (See photo 112, below.) ▲ See warning, below.

**National Lubricating Grease Institute.*

▲ *WARNING*

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 112

Caution – Spicer **DOES NOT** recommend wiping the outside of bearing cup assemblies or yoke cross holes with grease, oil or silicone based sprays. This could result in bearing cup assembly rotation in yokes. ▲ See warning, below.

▲ *WARNING*

Rotating bearing cup assemblies can result in yoke cross hole wear and distortion. Distorted yokes can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 113

Photo 114

2. Position the journal cross into the yoke cross holes with grease zerk (nipple) fitting inward toward tubing. The double-headed, grease zerk (nipple) fitting should be perpendicular to yoke cross holes. (See photo 113, above.)

Failure to properly position the universal joint will result in the inability to grease the universal joint. ▲ See warning, below.

▲ *WARNING*

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If using an arbor press proceed to step 3. If using a universal joint installation tool, follow the tool manufacturer's instructions, then proceed to page 147 for installation procedures for companion flange/flange yoke driveshaft assemblies.

3. Move one end of the journal cross to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke ear. Take one bearing cup assembly and position an installation height tool on the end of a bearing cup. Place the bearing cup assembly over the protruding trunnion diameter and align it to yoke cross hole. (See photo 114, top right.)

4. Align the yoke in an arbor press with the bearing cup assembly resting on the base of the press. (See photo 115, below.) Cover the yoke ear with a metal plate 0.25 inch (6.4 mm) minimum thickness. Push the yoke onto the bearing cup assembly until the installation height tool is flush with the cross hole face. **Do not remove installation height tool**.

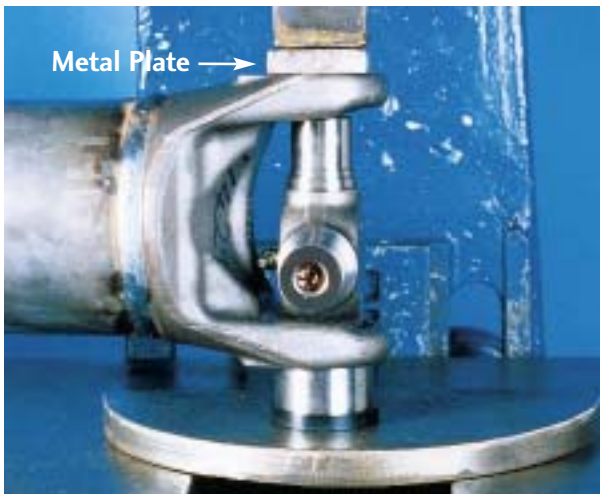

Photo 115

Photo 116

5. Flip yoke 180 degrees. Position remaining installation height tool on end of another bearing cup assembly. Place bearing cup assembly over trunnion diameter and align it to the yoke cross hole. Push the bearing cup assembly until both installation height tools are flush with cross hole face. (See photo 116, above.) **Remove both installation height tools**.

6. Position flange yoke cross holes over remaining trunnions.

7. Take one bearing cup assembly and position an installation height tool on the end of a bearing cup. Place the bearing cup assembly over one of the trunnion diameters and align it to flange yoke cross hole.

8. Align yoke in arbor press with the bearing cup assembly resting on the base of arbor press. Cover the yoke ear with a metal plate 0.25 inch (6.4mm) minimum thickness. Push the yoke onto the bearing cup assembly until the installation height tool is flush with cross hole face. **Do not remove installation height tool.**

9. Flip yoke 180 degrees. Position remaining installation height tool on last bearing cup assembly. Place bearing cup assembly over remaining trunnion diameter and align it to the flange yoke cross hole. Push the bearing cup assembly until both installation height tools are flush with cross hole face. **Remove and discard both installation height tools.**

10. Install **new** spring tabs and 8mm thread bolts, and torque to required specifications. Make sure that no grease or foreign material is present between the contact areas of the spring tabs, bearing cups and yoke cross hole faces. Tighten bolts to the required torque. See spring tab bolt specifications Table KK, below. ⏢ See warning, below.

SPRING TAB BOLT SPECIFICATIONS

SERIES	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.	KIT P/N*
SPL140	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X
SPL170	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X
SPL250	8mm x 1.00	8mm, 6 point	35-40	25-30	211941X

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table KK

⏢ ***WARNING***

Reuse of spring tab bolts or failure to properly tighten spring tab bolts to required specifications can cause the driveline to loosen and separate from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

11. Proceed to page 147 for installation of the driveshaft into the vehicle.

QUICK DISCONNECT™ SNAP RING STYLE SPICER LIFE SERIES 55, 70, 90 & 100

Caution – Be sure to carefully read all information on page 115 as well as grease recommendations and compatibility information in the lubrication section of this manual, before proceeding.

Required Tools

- Chisel
- Hammer
- Pliers – For Snap Rings

One of the following is recommended:

- Arbor Press, along with
  Bearing Cup Spacer
  Push Rod
  Metal Plate 0.25 inch (6.4 mm) thick,

or contact

- J & J Tool Co., Inc.
  Joint Puller
  1-800-221-4903
  Outside U. S. A. and Canada 1-215-256-9300,

or

- Tiger Tool Kit
  1-800-661-4660
  Outside U. S.A. and Canada 1-604-855-1133

Note – Spicer Life replacement universal joint kit bearing assemblies contain only enough grease to provide needle roller bearing protection during storage. It is therefore necessary to completely lubricate each bearing assembly. It is also necessary to fully lubricate the universal joint kit after it is installed in the vehicle.

Photo 117

1. Using a high quality N.L.G.I.*, E. P. Grade 2 lubricating grease, wipe each bearing cup assembly with grease. Fill all cavities between the needle rollers. Also apply a liberal coating of grease on the bottom of each bearing cup assembly and on the lip of the seal. (See photo 117, above.) ▲ See warning, below.

**National Lubricating Grease Institute*

▲ ***WARNING***

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Caution – Spicer **DOES NOT** recommend wiping the outside of bearing cup assemblies or yoke cross holes with grease, oil or silicone-based sprays. This could result in bearing cup assembly rotation in yokes. ▲ See warning, below.

▲ ***WARNING***

Rotating bearing cup assemblies can result in yoke cross hole wear and distortion. Distorted yokes can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 118

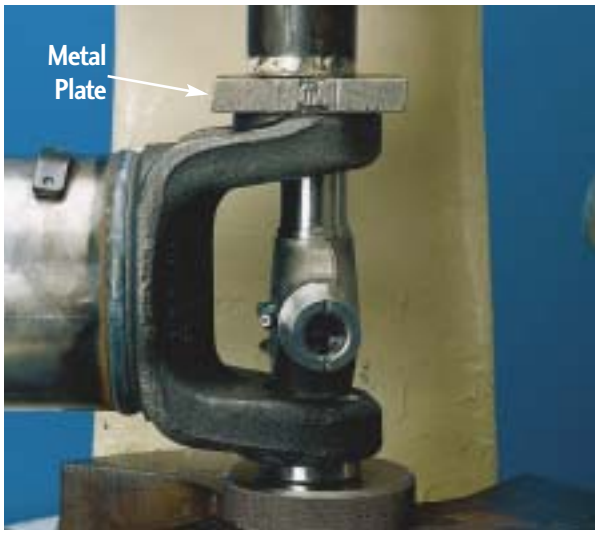

Photo 119

2. Position the journal cross into the yoke cross holes with grease zerk (nipple) fitting inward toward tubing. The double-headed, grease zerk (nipple) fitting should be perpendicular to the yoke cross holes. (See photo 118, above.)

Failure to properly position the universal joint kit will result in the inability to grease the universal joint. ▲ See warning, below.

▲ ***WARNING***

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

If using an arbor press, proceed to step 3. If using a universal joint installation tool, follow the tool manufacturer's instructions. Then proceed to page 136 for installation procedures for Quick Disconnect™ driveshaft assemblies.

3. Move one end of the journal cross to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke ear. Place the bearing cup assembly over the protruding trunnion diameter and align it to the yoke cross hole.

Align the yoke in an arbor press with the bearing assembly resting on the base of the press (see photo 119, above.) Cover the yoke ear with a metal plate that has 0.25 inch (6.4 mm) minimum thickness. Push the yoke onto the bearing cup assembly until it is flush with the cross hole face.

4. Place a push rod that is smaller than the diameter of the bearing cup assembly under the bearing cup assembly and continue pressing into the yoke cross hole until far enough to install a snap ring. (See photo 120, below.)

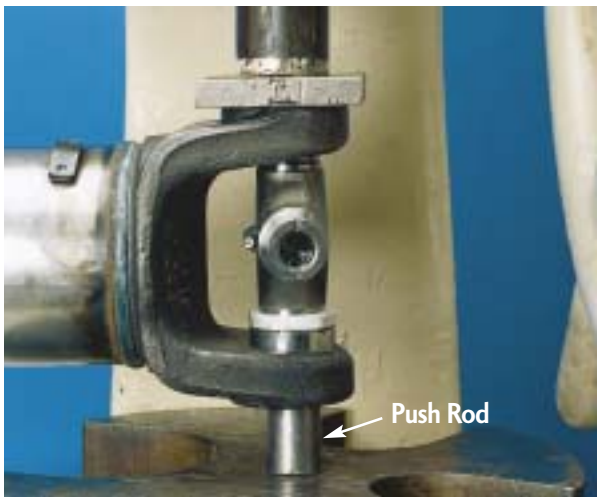

Photo 120

5. Remove yoke from arbor press. Install a snap ring using snap ring pliers.

6. Flip yoke 180 degrees. Place another bearing cup assembly over trunnion diameter and align it to yoke cross hole. Align yoke in arbor press with previously installed bearing cup assembly resting on base of press. Place a push rod that is smaller than the bearing cup assembly on top of the bearing cup assembly. Press bearing cup assembly into the yoke cross hole until far enough to install a snap ring. (See photo 121, below.)

Photo 121

7. Remove yoke from arbor press. Install a snap ring using snap ring pliers.

8. Seat installed snap rings into grooves using a small chisel or punch. (See photo 122, below.)

Photo 122

9. Flex the journal cross to make sure it moves smoothly and freely in the bearings.

If the joint is stiff, place a plate on the yoke ear and hit the plate with a hammer to seat the bearing cup assemblies. (See photo 123, below.) See warning, below.

Photo 123

WARNING

TO PREVENT *eye injury, always wear safety glasses when performing maintenance or service. Failure to wear safety glasses could result in serious personal injury and/or partial or complete vision loss.*

10. Flex the journal cross to make sure it moves smoothly and freely in the bearings. If not, disassemble and inspect the journal and bearing assemblies for skewed or dropped needle rollers. Reference removal procedures for universal joints, snap ring style, page 82.

11. Proceed to page 136 for installation of the driveshaft into the vehicle.

COMPANION FLANGE/FLANGE YOKE (S.A.E., DIN AND T-TYPE) SNAP RING STYLE SPICER LIFE SERIES 55, 70, 90 & 100

Caution – Be sure to carefully read all information on page 115 as well as grease recommendations and compatibility information in the lubrication section of this manual, before proceeding.

Note – Spicer Life replacement universal joint kit bearing assemblies contain only enough grease to provide needle roller bearing protection during storage. It is therefore necessary to completely lubricate each bearing assembly. It is also necessary to fully lubricate the universal joint kit after it is installed in the vehicle.

1. Using a high quality N.L.G.I.* Grade 2 lubricating grease, wipe each bearing cup assembly with grease. Fill all cavities between the needle rollers. Also apply a liberal coating of grease on the bottom of each bearing cup assembly and on the lip of the seal. (See photo 124, below.) ▲ See warning, below.

National Lubricating Grease Institute

▲ *WARNING*

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline could result in property damage, serious personal injury or death.

Photo 124

Caution – Spicer **DOES NOT** recommend wiping the outside bearing cup assemblies or yoke cross holes with grease, oil or silicone-based sprays. This could result in bearing cup assembly rotation in yokes. ▲ See warning, below.

▲ *WARNING*

Rotating bearing cup assemblies can result in yoke cross hole wear and distortion. Distorted yokes can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

2. Position the journal cross into the yoke cross holes with grease zerk (nipple) fitting inward toward tubing. The double-headed, grease zerk (nipple) fitting should be perpendicular to the yoke cross holes. (See photo 125, below.)

Failure to properly position the universal joint kit will result in the inability to grease the universal joint. ▲ See warning, step 1, regarding inadequate lubrication.

If using an arbor press, proceed to step 3. If using a universal joint installation tool, follow the tool manufacturer's instructions. Then proceed to page 147 for installation procedures for companion flange/flange yoke driveshaft assemblies.

Photo 125

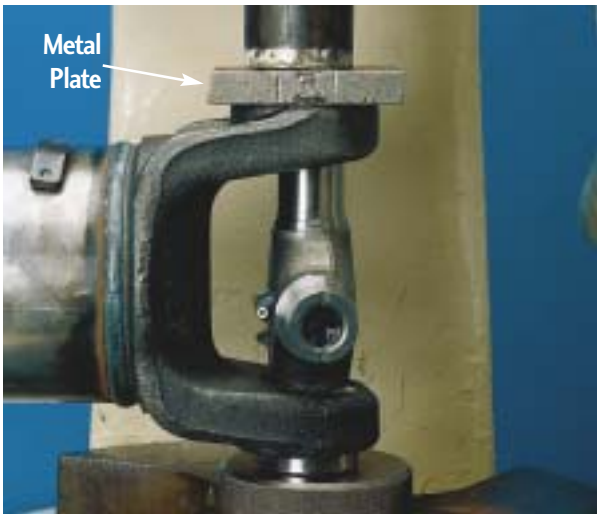

Photo 126

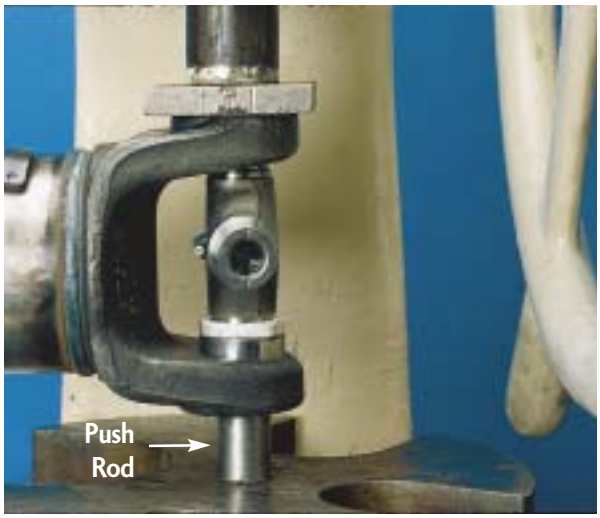

Photo 127

3. Move one end of the journal cross to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke ear. Place the bearing cup assembly over the protruding trunnion diameter and align it to the yoke cross hole.

Align the yoke in an arbor press with the bearing assembly resting on the base of the press. (See photo 126, above.) Cover the yoke ear with a metal plate that has 0.25 inch (6.4 mm) minimum thickness. Push the yoke onto the bearing cup assembly until it is flush with the cross hole face.

4. Place a push rod that is smaller than the diameter of the bearing cup assembly under the bearing cup assembly and continue pressing into the yoke cross hole until far enough to install a snap ring. (See photo 127, top right.)

5. Remove yoke from arbor press. Install a snap ring using snap ring pliers.

6. Flip yoke 180 degrees. Place another bearing cup assembly over trunnion diameter and align it to yoke cross hole. Align yoke in arbor press with previously installed bearing cup assembly resting on base of press. Place a push rod that is smaller than the bearing cup assembly on top of the bearing cup assembly. Press bearing cup assembly into the yoke cross hole until far enough to install a snap ring. (See photo 128, below.)

7. Remove yoke from arbor press. Install a snap ring using snap ring pliers.

Photo 128

Photo 129

8. Seat the snap rings into grooves using a small chisel or punch. (See photo 129, above.)

9. Position flange yoke cross holes over remaining trunnions.

10. Place a bearing cup assembly over a protruding trunnion diameter and align it to the flange yoke cross hole.

11. Align the yoke in an arbor press with the bearing assembly resting on the base of the press. Cover the yoke ear with a metal plate that has 0.25 inch (6.4 mm) minimum thickness. Push the yoke onto the bearing cup assembly until it is flush with the cross hole face.

12. Place a push rod that is smaller than the diameter of the bearing cup assembly under the bearing cup assembly and continue pressing into the flange yoke cross hole until far enough to install a snap ring.

13. Remove yoke from arbor press. Install a snap ring using snap ring pliers.

14. Flip yoke 180 degrees. Place remaining bearing cup assembly over trunnion diameter and align it to flange yoke cross hole. Align yoke in arbor press with previously installed bearing cup assembly resting on base of press. Place a push rod that is smaller than the bearing cup assembly on top of the bearing cup assembly. Press bearing cup assembly into the yoke cross hole until far enough to install a snap ring.

15. Remove yoke from arbor press. Install a snap ring using snap ring pliers.

16. Seat the snap rings into grooves using a small chisel or punch.

17. Flex the journal cross to make sure it moves freely in bearings. If the joint is stiff, place a plate on the yoke ear and hit the plate with a hammer to seat the bearing cup assemblies. ▲ See warning, below.

▲ ***WARNING***

TO PREVENT *eye injury, always wear safety glasses when performing maintenance or service. Failure to wear safety glasses could result in serious personal injury and/or partial or complete vision loss.*

18. Flex the journal cross to make sure it moves smoothly and freely in bearings. If not, disassemble and inspect the journal and bearing assemblies for skewed or dropped needle rollers. Reference removal procedures for universal joints, snap ring style, page 82.

19. Proceed to page 147 for installation of the driveshaft into the vehicle.

INSTALLATION PROCEDURE FOR CENTER BEARINGS

SPICER LIFE SERIES 55, 70, 90, 100, 140, 170 & 250

Required Tools

- Six-Point Socket
  English 1 5/8," or
  Metric 41mm
- Soft-Faced Hammer
- Section of Tubing
- Air Gun or Ratchet

QUICK DISCONNECT™ YOKE STYLE SPICER LIFE SERIES 55, 70, 90, 100, 140, 170 & 250

1. Wipe the bearing surface of the midship tube shaft with a fine emery cloth.

2. Install a new slinger (included in center bearing replacement kit) on the midship tube shaft using a section of tubing to avoid damaging slinger. Make sure the slinger is completely seated against the midship tube shaft shoulder. (See photo 130, below.)

Photo 130

Photo 131

3. Before installing the new center bearing assembly, be sure to fill the entire cavity around the bearing with waterproof lubricant. (See photo 131, above.) Enough lubricant must be applied to fill the cavity to the extreme edge of the slinger surrounding the bearing. Lubricants **must** be waterproof. See Table LL, below for recommended lubricants. ▲ See warning, below.

▲ ***WARNING***

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

RECOMMENDED CENTER BEARING LUBRICANTS

LUBRICANTS	SOURCE
Rykon Premium No. 3	Amoco Oil Company
Amolith 8516	Amoco Oil Company
Van Talgar No. 4	Exxon Company

Table LL

Photo 132

Photo 133

4. Carefully align the new center bearing assembly with the ground surface of the midship tube shaft. Physically push the center bearing onto the midship tube shaft. (See photo 132, above.)

5. Press remaining slinger on end yoke using a section of tubing to avoid damaging slinger. (See photo 133, top right.)

6. Using a soft-faced hammer, tap the yoke onto midship tube shaft, **making sure phasing marks from driveshaft removal procedure are in line**. Continue to tap the yoke until it is completely seated against the center bearing.

7. Install a washer (if required) and **new** midship nut and torque nut to specifications. See midship nut specifications, Table MM, top right. ▲ See warning, below.

▲ ***WARNING***

Failure to torque midship nut to required specifications can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

MIDSHIP NUT SPECIFICATIONS

SERIES	NUT P/N	WASHER P/N	HEAD SIZE*	NUT TORQUE Nm	NUT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	231502	N/A	1 5/8"	644-712	475-525
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	250-74-11	230123-6	41mm*	644-712	475-525
SPL170	250-74-11	230123-6	41mm*	644-712	475-525
SPL250	250-74-11	230123-6	41mm*	644-712	475-525

** A 1 5/8" socket may be used.*

Table MM

8. Proceed to page 136 for installation of the driveshaft into the vehicle.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) SPICER LIFE SERIES 55, 70, 90, 100, 140, 170 & 250

1. Wipe the bearing surface of the midship tube shaft with a fine emery cloth.

2. Install a new slinger (included in center bearing replacement kit) on the midship tube shaft using a section of tubing to avoid damaging slinger. Make sure the slinger is completely seated against the midship tube shaft shoulder. (See photo 134, below.)

Photo 134

3. Before installing the new center bearing assembly, be sure to fill the entire cavity around the bearing with a waterproof lubricant. (See photo 135, top right.) Enough lubricant must be applied to fill the cavity to the extreme edge of the slinger surrounding the bearing. Lubricants **must** be waterproof. See Table NN, top right, for recommended lubricants. ▲ See warning, below.

▲ *WARNING*

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 135

RECOMMENDED CENTER BEARING LUBRICANTS

LUBRICANTS	SOURCE
Rykon Premium No. 3	Amoco Oil Company
Amolith 8516	Amoco Oil Company
Van Talgar No. 4	Exxon Company

Table NN

4. Carefully align the center bearing assembly with the ground surface of the midship tube shaft. Physically push the center bearing onto the midship tube shaft. (See photo 136, below.)

Photo 136

Photo 137

5. Press remaining slinger onto the companion flange using a section of tubing to avoid damaging slinger. (See photo 137, above.)

6. Using a soft-faced hammer, tap the companion flange onto the midship tube shaft, **making sure phasing marks from removal procedure are in line**. Continue to tap the companion flange until it is completely seated against the center bearing.

MIDSHIP NUT SPECIFICATIONS

SERIES	NUT P/N	WASHER P/N	HEAD SIZE	NUT TORQUE Nm	NUT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	231502	N/A	15/8"	644-712	475-525
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	250-74-11	230123-6	41mm*	644-712	475-525
SPL170	250-74-11	230123-6	41mm*	644-712	475-525
SPL250	250-74-11	230123-6	41mm*	644-712	475-525

** A 1 5/8" socket may be used.*

Table PP

7. Install washer (if required) and **new** midship nut and torque nut to specifications. See midship nut specifications, Table PP, above. See warning, below.

WARNING

Failure to torque midship nut to required specifications can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

8. Proceed to page 147 for installation of the driveshaft into the vehicle.

OUTBOARD SLIP STYLE
SPICER LIFE SERIES 55, 70, 90 & 100

1. Wipe the bearing surface of the midship tube shaft with a fine emery cloth.

2. Install a new slinger (included in center bearing replacement kit) on the midship tube shaft using a section of tubing to avoid damaging slinger. Make sure the slinger is completely seated against the midship tube shaft shoulder. (See photo 138, top right.)

3. When replacing a center bearing assembly, be sure to fill the entire cavity around the bearing with a waterproof lubricant (see photo 139, center right.) Enough lubricant must be applied to fill the cavity to the extreme edge of the slinger surrounding the bearing. Lubricants **must** be waterproof. See Table QQ, bottom right for recommended lubricant.

▲ See warning, below.

▲ *WARNING*

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

4. Carefully align the center bearing assembly with the ground surface of midship tube shaft. Physically push the center bearing onto the midship tube shaft.

5. Proceed to page 136 for installation of the driveshaft into the vehicle.

Photo 138

Photo 139

RECOMMENDED CENTER BEARING LUBRICANTS

LUBRICANTS	SOURCE
Rykon Premium No. 3	Amoco Oil Company
Amolith 8516	Amoco Oil Company
Van Talgar No. 4	Exxon Company

Table QQ

INSTALLATION PROCEDURE FOR SLIP MEMBER BOOT

SPICER LIFE SERIES 55, 70, 100, 140, 170 & 250

Required Tools

- Boot Clamp Pliers
  Lisle Corporation Part Number: 30800, or
  Snap-On Part Number: YA3080
- Tape Measure or Ruler
- Soft-Faced Hammer (brass, plastic or rubber)
- Grease-Cutting Solvent

1. Clean **ALL** grease from yoke shaft and spline sleeve. Make sure grease-cutting solvent does not intrude into the tube through the vent hole in the spline sleeve plug. **Be sure the phasing marks made during disassembly are not removed.** (See photo 140, top right.)

2. After all traces of grease-cutting solvent have been removed from yoke shaft and spline sleeve, apply enough N.L.G.I*, E. P. Grade 2 grease (provided in slip member boot replacement kit) to fill the entire length of all teeth in the spline sleeve (see photo 141, right.) Wipe any excess grease on the **teeth** of the yoke shaft. ▲ See warning, below.
**National Lubricating Grease Institute*

Photo 140

Photo 141

▲ ***WARNING***

Inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

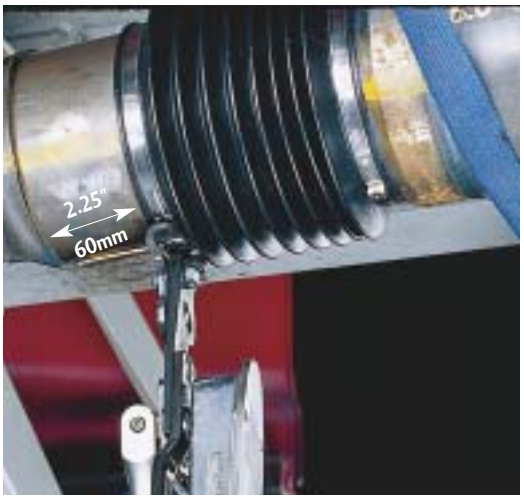

Photo 142

3. Measure and place a mark 2.25 inches (55-60mm) from yoke shaft shoulder with a marking stick, paint marker or other legible marking device. (See photo 142, above.)

4. Position a clamp on each end of the new boot. Slide the boot onto the **grease-free** yoke shaft shoulder.

5. Collapse the boot and insert the yoke shaft into the splined sleeve, **making sure phasing marks are in line.** Position the end of the boot at the 2.25 inches (55-60mm) mark made on the yoke shaft shoulder and tighten boot clamps to the specified torque. (See photo 142, above.) **Yoke shaft shoulder must be clean, dry and grease-free.** See boot clamp torque specification, Table RR, top right. See warning, below.

WARNING

Failure to properly install and tighten boot clamps could allow intrusion of contaminants and can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

BOOT CLAMP SPECIFICATIONS

SERIES	CLAMP P/N	CLAMP TORQUE Nm	LB. FT.
SPL55	TBD	TBD	TBD
SPL70	TBD	TBD	TBD
SPL100	TBD	TBD	TBD
SPL140	232757	136-180	100-130
SPL170	232493	136-180	100-130
SPL170*	232702	136-180	100-130
SPL250	232493	136-180	100-130

**high angle interaxle position only*

Table RR

6. Before the driveshaft is completely installed in the vehicle, slowly collapse and extend the driveshaft to make sure the boot clamps are stationary. If the clamps are not stationary, recheck for proper clamp torque. If clamps still are not stationary, repeat disassembly and assembly procedure. **DO NOT reuse clamps.** See warning, below.

WARNING

Reuse of boot clamps or failure to properly tighten boot clamps to required specifications could allow intrusion of contaminants onto slip member and can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Quick Disconnect™ Style

Proceed to step 7.

Companion Flange/Flange Yoke (S.A.E., DIN and T-Type Style)

Proceed to step 9.

Quick Disconnect™ Style

7. If clamps are stationary, use a soft-faced hammer to tap universal joint into the end yoke. Make sure to align universal joint in end yoke, **matching up phasing marks made during removal to ensure original driveshaft orientation.**

QUICK DISCONNECT BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*

Table SS

8. Install the bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Reference bolt specifications, Table SS, left. ▲ See warning, below. Check to make sure bearing cup assemblies are fully seated in the yoke ears.

▲ *WARNING*

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Companion Flange/Flange Yoke (S.A.E., DIN and T-Type Style)

9. Position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks.** Make sure flange yoke and companion flange are free from grease or other foreign material and are properly seated.

10. Install **new** bolts, washers (if required) and nuts. Reference hardware specifications, Table TT, below. Bolts must be torqued to required specifications. ▲ See warning, step 8.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*

† Approved Spicer hardware.

***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table TT

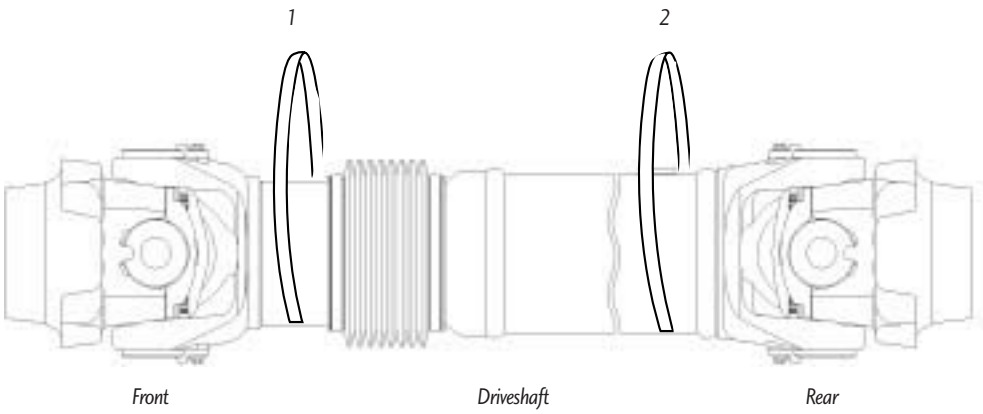

Figure Z,

INSTALLATION PROCEDURE FOR DRIVESHAFT ASSEMBLIES

SPICER LIFE SERIES 55, 70, 90, 100, 140, 170 & 250

Required Tools

- Support Straps
- Ratchet or Air Gun
- Appropriate 12-Point Socket
- Soft-Faced Hammer (Brass, Plastic or Rubber)

QUICK DISCONNECT™ YOKE STYLE

One-Piece Driveshafts

Position Support Straps

1. Position support straps as illustrated in Figure Z, above, to make sure that the driveshaft will be properly supported. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Install Driveshaft

2. Place the driveshaft in the support straps. Be sure the driveshaft is placed back in its original orientation. ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

3. Working from the **front end**, use a soft-faced hammer to tap the universal joint into the end yoke. Make sure to align

Photo 143

Photo 144

the universal joint in end yoke, **matching up the phasing marks made during removal to ensure original driveshaft orientation**. (See photo 143, above.)

4. Install the bearing retainers or **new** stamped straps and **new bolts** (see photo 144, top right.) Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in the yoke ears. ▲ See warning, below.

▲ *WARNING*

Improperly seated bearing cup assemblies can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline could result in property damage, serious personal injury or death.

Reference bolt specifications, Table UU, bottom right. Bolts must be torqued to required specifications. ▲ See warning, below.

▲ *WARNING*

Failure to install new stamped straps and new bolts and to torque bolts to specifications can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

5. **Be sure the second support strap is in place, as illustrated in Figure Z, page 136.** It may be necessary to collapse the slip member assembly to allow clearance to install driveshaft into the rear end yoke.

Use a soft-faced hammer to tap universal joint into the rear end yoke. Make sure the bearing cup assemblies are fully and properly seated. ▲ See warning, step 4, regarding improperly seated bearing cup assemblies.

6. Repeat step 4.

7. Remove **all** support straps..

8. Completely relubricate all the universal joints and the slip member assembly (if slip member assembly is relubable) as described in the lubrication section of this manual.

QUICK DISCONNECT BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table UU

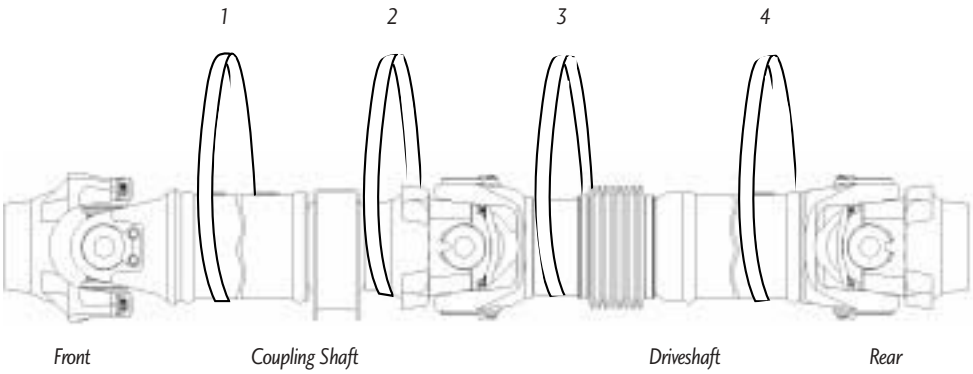

Figure AA

QUICK DISCONNECT™ YOKE STYLE

Two-Piece Driveshafts

Position Support Straps

1. Position support straps as illustrated in Figure AA, above, to make sure that the driveshaft will be properly supported at the slip member, behind the center bearing end fitting and in front of center bearing, with support straps. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Install Coupling Shaft

2. Place the coupling shaft in first and second support straps. **Be sure the coupling shaft is placed back in its original orientation.** ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

3. Working from the **front** end, use a soft-faced hammer to tap the universal joint into the front end yoke. Make sure to align the universal joint in the front end yoke, **matching up phasing marks made during removal to ensure the driveshaft is reinstalled in its original orientation.**

4. Install the bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in yoke ears. ▲ See warning, below.

▲ ***WARNING***

Improperly seated bearing cup assemblies can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline could result in property damage, serious personal injury or death.

Reference bolt specifications, Table VV, below. Bolts must be torqued to required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to install new stamped straps and new bolts and to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

QUICK DISCONNECT BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially, heat-treated.*
DO NOT substitute inferior grade bolts.

Table VV

Photo 145

5. **Be sure the second support strap is in place, as illustrated in Figure AA, page 138.** Lift the center bearing to the center bearing bracket on the cross member of the frame. Install proper center bearing bracket bolts, per vehicle manufacturer's recommendations. (See photo 145, above.) Torque bolts to vehicle manufacturer's required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Install Driveshaft

6. **Be sure the third and fourth support strap are in place, as illustrated in Figure AA, page 138.** Place the driveshaft in support straps. **Be sure the driveshaft is placed back in its original orientation.**

Center Position Yoke Style

Proceed to step 7, page 140.

Outboard Slip Style

Proceed to step 13, page 141.

Photo 146

Photo 147

Center Position Yoke Style

7. Working from the **rear end**, use a soft-faced hammer to tap the universal joint into the rear end yoke. Make sure to align the universal joint in the rear end yoke, **matching up phasing marks made during removal to ensure original driveshaft orientation**. (See photo 146, above.) See warning, below.

WARNING

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

8. Install bearing retainers or **new** stamped straps and **new** bolts. (See photo 147, above.) Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in yoke ears. Table WW, right. See warning, below.

WARNING

Failure to install new stamped straps, new bolts and torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

QUICK DISCONNECT BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table WW

9. It may be necessary to collapse slip member assembly to allow clearance to install driveshaft into center bearing end yoke. Use a soft-faced hammer to tap universal joint into center bearing end yoke, matching up phasing marks made during removal to ensure original driveshaft orientation. See warning, step 7.

WARNING

Improperly seated bearing cup assemblies can cause driveline failure which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

10. Install bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in yoke ears. Reference bolt specifications, Table WW, above. ▲ See warning, below.

▲ ***WARNING***

Failure to install new stamped straps and torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

11 Completely relubricate all the universal joints and the slip member assemblies (if slip member assembly is relubable) as described in the lubrication section of this manual.

12. Remove **all** support straps.

Outboard Slip Style

13. Guide slip yoke onto midship stub shaft, **making sure phasing marks made during removal are in line**.
▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

14. Using a soft-faced hammer, tap universal joint into rear end yoke, matching up phasing marks made during removal to ensure original driveshaft orientation. ▲ See warning, step 13.

15. Install the bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in the yoke ears.
(See warning, top right)

QUICK DISCONNECT BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table XX

▲ ***WARNING***

Improperly seated bearing cup assemblies can cause driveline failure which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Reference bolt specifications, Table XX, above. Bolts must be torqued to required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to install new stamped straps and properly tighten bearing retainer bolts can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

16. Remove **all** support straps.

17. Completely relubricate all the universal joints and the slip member assembly (if slip member assembly is relubable) as described in the lubrication section of this manual.

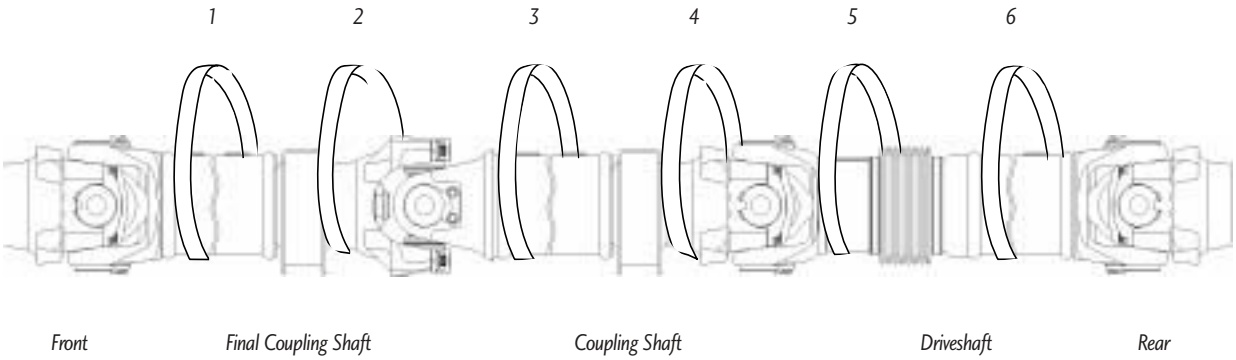

Figure BB

QUICK DISCONNECT™ YOKE STYLE

Multiple-Piece Driveshafts

Position Support Straps

1. Position support straps as illustrated in Figure BB, above, to make sure that the driveshaft will be properly supported at the slip member, behind the center bearing end fittings and in front of center bearing, with support straps. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

2. When working with multiple-piece driveshafts, start at **front** to install all **coupling shafts**.

Install Final Coupling Shaft

3. Place final **coupling shaft** in support straps. **Be sure the coupling shaft is placed back in its original orientation.** ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

4. Working from the **front** end, use a soft-faced hammer to tap the universal joint into the front end yoke. Make sure to align the universal joint in the front end yoke, **matching up phasing marks made during removal to ensure the driveshaft is reinstalled in its original orientation.**

5. Install the bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in yoke ears. ▲ See warning, below.

▲ ***WARNING***

Improperly seated bearing cup assemblies can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline could result in property damage, serious personal injury or death.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table YY

Reference bolt specifications, Table YY, above. Bolts must be torqued to required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to install new stamped straps and new bolts and to torque bolts to specifications can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

6. **Be sure the second support strap is in place, as illustrated in Figure BB, page 142.** Lift the center bearing to the center bearing bracket on the cross member of the frame. Install proper center bearing bracket bolts, per vehicle manufacturer's recommendations. (See photo 148, top right.) Torque bolts to vehicle manufacturer's required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Install Coupling Shaft(s)

7. **Be sure third and fourth support straps are in place as illustrated in figure BB, page 142.** Place coupling shaft in

Photo 148

support straps. Be sure the coupling shaft is placed back in its original orientation. ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

8. Use a soft-faced hammer to tap the universal joint into the center bearing end yoke. Make sure to align the universal joint in the center bearing end yoke, **matching up phasing marks made during removal to ensure the driveshaft is reinstalled in its original orientation.**

9. Install the bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in yoke ears. ▲ See warning, below.

▲ ***WARNING***

Improperly seated bearing cup assemblies can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline could result in property damage, serious personal injury or death.

Reference bolt specifications, Table YY, above. Bolts must be torqued to required specifications. ▲ See warning, step 6.

Photo 149

Photo 150

10. **Be sure the fourth support strap is in place, as illustrated in Figure BB, page 142.** Lift the center bearing to the center bearing bracket on the cross member of the frame. Install proper center bearing bracket bolts, per vehicle manufacturer's recommendations. (See photo 148, page 143.) Torque bolts to vehicle manufacturer's required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

11. Repeat steps 7 through 10 as necessary to install any remaining coupling shafts.

Install Driveshaft

12. **Be sure the fifth and sixth support straps are in place, as illustrated in Figure BB, page 142.** Place the **driveshaft** in support straps. **Be sure the driveshaft is placed back in its original orientation.**

Center Position Yoke Style

Proceed to step 13.

Outboard Slip Style

Proceed to step 19, page 145.

QUICK DISCONNECT™ BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table ZZ

Center Position Yoke Style

13. Working from the **rear end**, use a soft-faced hammer to tap the universal joint into the rear end yoke. Make sure to align the universal joint in the rear end yoke, **matching up phasing marks made during removal to ensure original driveshaft orientation.** (See photo 149, above.) ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

14. Install bearing retainers or **new** stamped straps and **new** bolts. (See photo 150, page 144). Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in yoke ears. Table ZZ, Page 144. ▲ See warning, below.

▲ ***WARNING***

Failure to install new stamped straps, new bolts and torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

15. It may be necessary to collapse the slip member assembly to allow clearance to install driveshaft into the center bearing end yoke. Use a soft-faced hammer to tap universal joint into center bearing end yoke, matching up phasing marks made during removal to ensure original driveshaft orientation. ▲ See warning, below.

▲ ***WARNING***

Improperly seated bearing cup assemblies can cause driveline failure which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

16. Install bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in yoke ears. Reference bolt specifications, Table AAA, above. ▲ See warnings, steps 14 and 15.

QUICK DISCONNECT BOLT SPECIFICATIONS

SERIES	BOLT P/N*	THREAD SIZE	HEAD SIZE	BOLT TORQUE Nm	BOLT TORQUE LB. FT.
SPL55	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-412	0.375 in. - 24	3/8 in. 12 point	61-81	45-60
SPL100	TBD	TBD	TBD	TBD	TBD
SPL140	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL170	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120
SPL250	12-73-125M	12mm - 1.25	12 mm 12 point	135-160	100-120

** Bolts are specially heat-treated.*
DO NOT substitute inferior grade bolts.

Table AAA

17. Completely relubricate all the universal joints and the slip member assembly (if slip member assembly is relubable) as described in the lubrication section of this manual.

18. Remove **all** support straps.

Outboard Slip Style

19. Guide slip yoke onto midship stub shaft, **making sure phasing marks made during removal are in line**. ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

20. Using a soft-faced hammer to tap universal joint into rear end yoke, match up phasing marks made during removal to ensure original driveshaft orientation. ▲ See warning, step 19.

21. Install the bearing retainers or **new** stamped straps and **new** bolts. Torque the bolts down evenly and to required specifications. Check to make sure the bearing cup assemblies are fully seated in the yoke ears. ▲ See warning, below.

▲ ***WARNING***

Improperly seated bearing cup assemblies can cause driveline failure which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Reference bolt specifications, page 145. Bolts must be torqued to required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to install new stamped straps and new bolts and to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

22. Completely relubricate all the universal joints and the slip member assembly (if slip member assembly is relubable) as described in the lubrication section of this manual.

23. Remove **all** support straps.

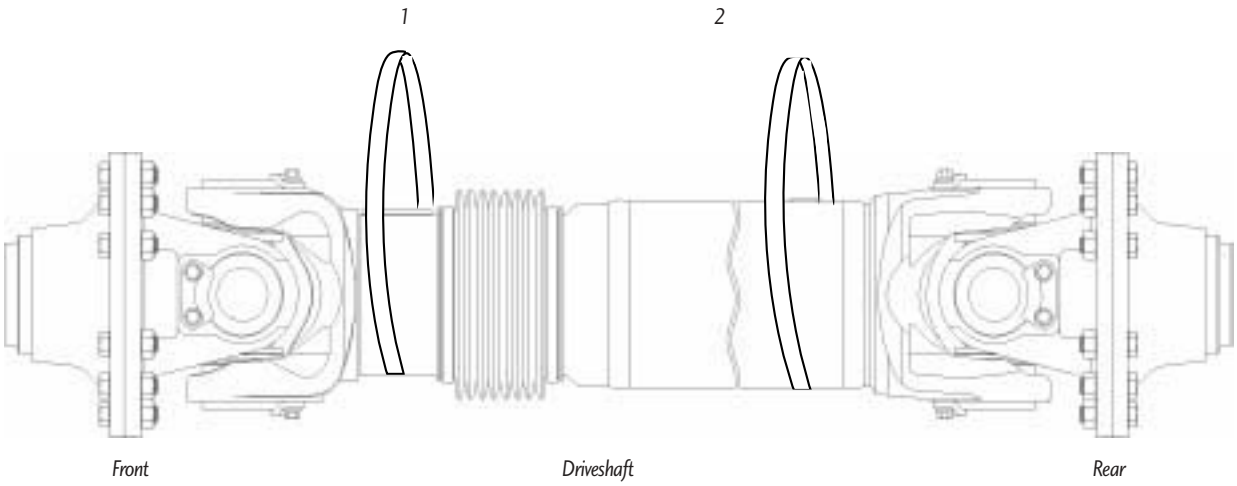

Figure CC, S.A.E.

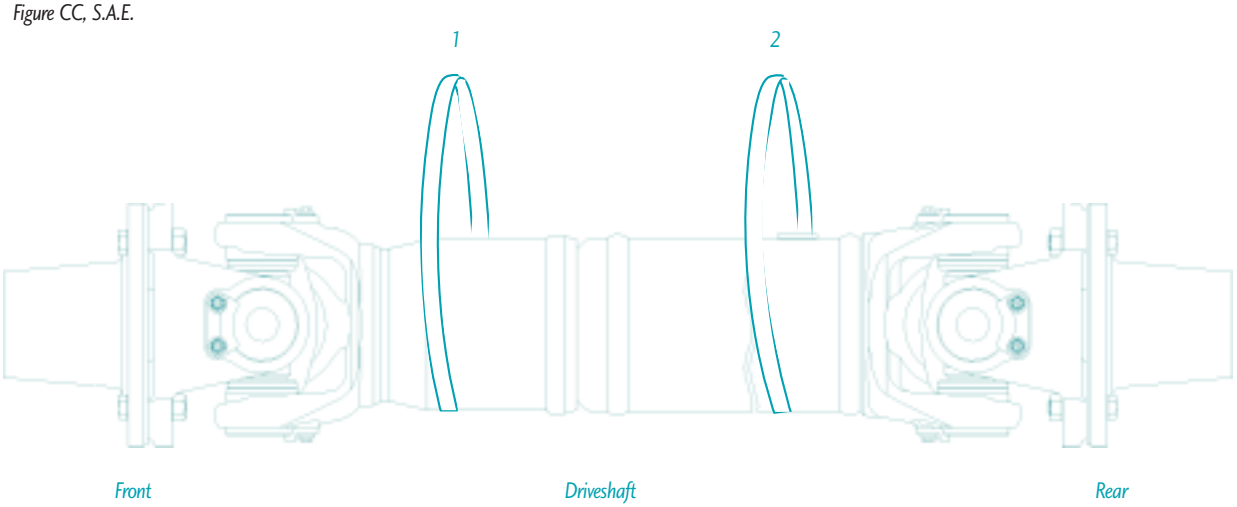

Figure DD, DIN and T-Type

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E, DIN AND T-TYPE)

One-Piece Driveshafts

Position Support Straps

1. Position support straps, as illustrated in Figure CC or DD, above, to make sure that the driveshaft will be properly supported. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table BBB

Install Driveshaft

2. Place the driveshaft in the support straps. **Be sure the driveshaft is placed back in its original orientation.** ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 151

3. Working from the **front end**, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks**. Make sure flange yoke and companion flange are **free from grease** or other foreign material and properly seated. ▲ See warning, below.

▲ ***WARNING***

Improperly seated flange yoke and companion flanges can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

4. Install **new bolts**, washers (if required) and nuts. (See photo 151, above.) Reference hardware specifications, Table BBB, above. Bolts must be torqued to required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

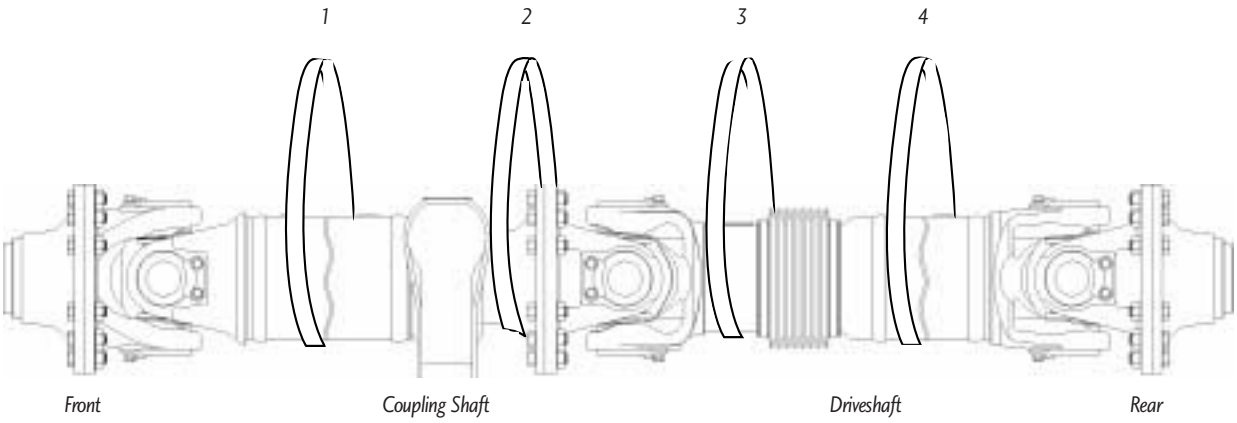

Figure EE, S.A.E.

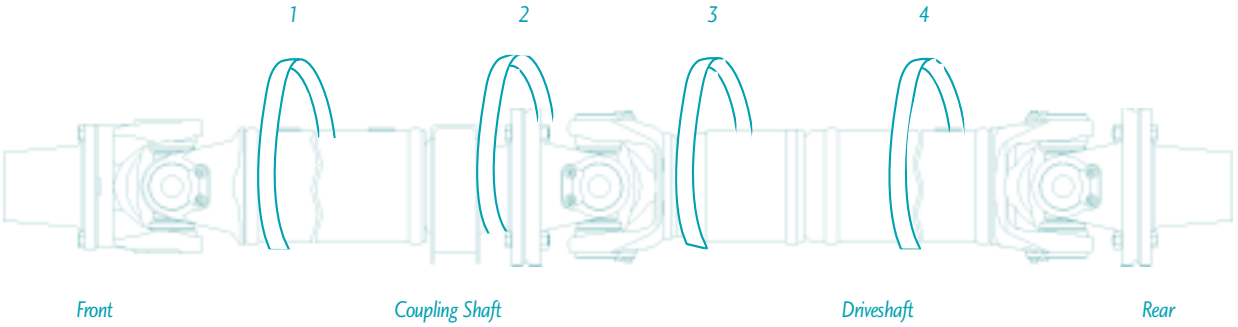

Figure FF, DIN and T-Type

5. **Be sure the second support strap is in place, as illustrated in Figure CC or DD, page 147.** It may be necessary to collapse slip member assembly to allow clearance to install the driveshaft into the front companion flange.

6. Repeat step 4.

7. Completely relubricate all universal joints and the slip member assembly (if slip member assembly is relubable) as described in the lubrication section of this manual.

8. Remove **all** support straps.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE)

Two-Piece Driveshafts

Position Support Straps

1. Position support straps, as illustrated in Figure EE or FF, above, for the appropriate style driveshaft being serviced. Make sure that the driveshaft will be properly supported at the slip member, behind the center bearing end fitting and in front of center bearing, with support straps. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table CCC

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ *WARNING*

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

Install Coupling Shaft

2. Place the **coupling shaft** in the first and second support straps. **Be sure the coupling shaft is placed back in its original orientation.** ▲ See warning, below.

▲ *WARNING*

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

3. Working from the **front** end, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks**. Make sure the flange yoke and companion flange are **free from grease** or other foreign material and properly seated. ▲ See warning, below.

▲ *WARNING*

Improperly seated flange yoke and companion flanges can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

4. Install **new** bolts, washers (if required) and nuts. (See photo 152, page 151.) Reference hardware specifications, Table CCC, above. Bolts must be torqued to required specifications. ▲ See warning, below.

▲ *WARNING*

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 152

5. **Be sure the second support strap is in place, as illustrated in Figures EE or FF, page 149**. Lift the center bearing to the center bearing bracket on the cross member of the frame. Install proper center bearing bracket bolts per vehicle manufacturer's recommendations. Torque bolts to vehicle manufacturer's specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Install Driveshaft

6. **Be sure the third and fourth support straps are in place, as illustrated in Figures EE or FF, Page 149.** Place driveshaft in support straps. **Be sure the driveshaft is placed back in its original orientation.** ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

7. Working from the **rear end**, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks**. Make sure the flange yoke and companion flange are **free from grease** or other foreign material and properly seated. ▲ See warning, below.

▲ ***WARNING***

An improperly seated flange yoke and companion flange can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

8. Install **new** bolts, washers (if required) and nuts. Reference hardware specifications, Table CCC, page 150. Bolts must be torqued to required specifications. ▲ See warning, step 5.

9. It may be necessary to collapse slip member assembly to allow clearance to install the driveshaft into the center bearing companion flange.

10. At center bearing, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks.** Make sure the flange yoke and companion flange are free from grease or other foreign material and properly seated. ▲ See warning, step 7.

11. Install **new** bolts, washers (if required) and nuts. Reference appropriate hardware specifications, Table CCC, page 150. Bolts must be torqued to required specifications. ▲ See warning, step 5.

12. Completely relubricate all universal joints and the slip member assembly (if slip member assembly is relubable) as described in the lubrication section of this manual.

13. Remove **all** support straps.

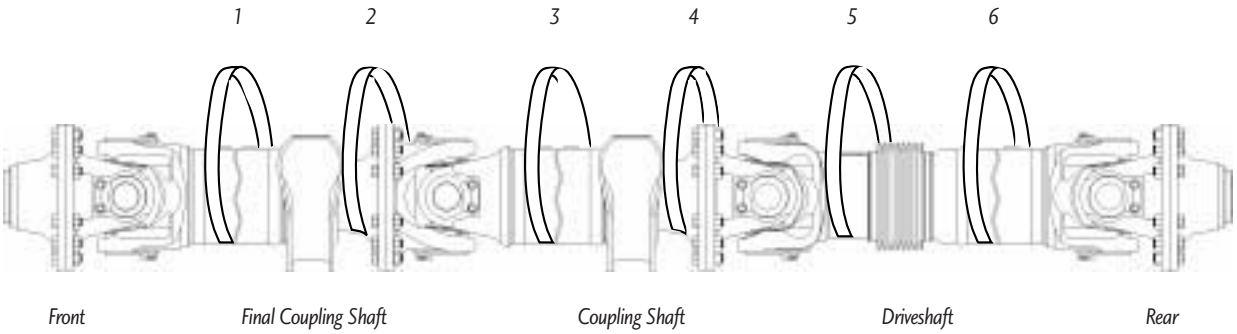

Figure GG

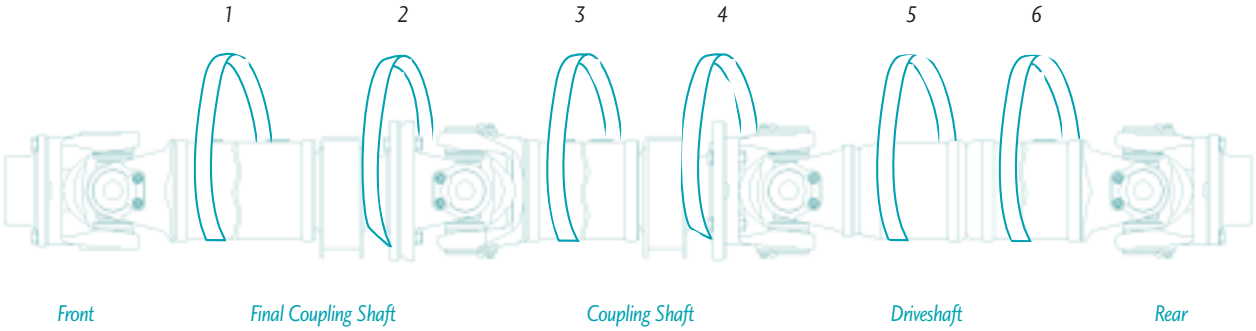

Figure HH

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E, DIN AND T-TYPE)

Multiple-Piece Driveshaft

Position Support Straps

1. Position support straps, as illustrated in Figure GG or HH, above, for appropriate style driveshaft being serviced. Make sure that the driveshaft will be properly supported at the slip member, behind the center bearing end fittings and in front of center bearings, with support straps. ▲ See warning, below.

▲ ***WARNING***

ALWAYS *use support straps to prevent driveshaft from falling out of vehicle. Failure to use support straps can cause damage to driveshaft or result in property damage, serious personal injury or death.*

Attach support straps to frame rails or some structural part of the vehicle. **DO NOT** attach the support straps to fuel lines, oil lines, brake lines, or wiring. **DO NOT** entangle fuel lines, oil lines, brake lines, or wiring in the support straps. ▲ See warning, below.

▲ ***WARNING***

Attaching or entangling support straps to fuel, oil or brake lines or wiring can result in their damage. Damaged fuel, oil or brake lines or wiring can result in failure of the vehicle, which can result in property damage, serious personal injury or death.

2. When working with multiple-piece driveshafts, start at the **front** to install all **coupling shafts**.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table DDD

Install Final Coupling Shaft

3. Place final **coupling shaft** in the first and second support straps. **Be sure the coupling shaft is placed back in its original orientation.** See warning, below.

WARNING

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

4. Working from the **front** end, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks**. Make sure the flange yoke and companion flange are **free from grease** or other foreign material and properly seated. See warning, below.

WARNING

Improperly seated flange yoke and companion flanges can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Photo 153

5. Install **new** bolts, washers (if required) and nuts. (See photo 153, above.) Reference hardware specifications, Table DDD, above. Bolts must be torqued to required specifications. See warning, below.

WARNING

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

COMPANION FLANGE/FLANGE YOKE STYLE (S.A.E., DIN AND T-TYPE) HARDWARE SPECIFICATIONS

SERIES	BOLT P/N*†	WASHER P/N	NUT P/N	DIAMETER, THREAD & LENGTH UNDER HEAD	BOLT TORQUE Nm	BOLT TORQUE FT. LBS.
SPL55	TBD	TBD	TBD	TBD	TBD	TBD
SPL70	TBD	TBD	TBD	TBD	TBD	TBD
SPL90	6-73-1219	500357-11	231421-3	.375" 24 x 1.188"	54-65	40-48
SPL100	TBD	TBD	TBD	TBD	TBD	TBD
SPL140	6-73-220	500357-11	231421-3	.375" 24 x 1.250"	54-65	40-48
	6-73-1227	500357-11	231421-3	.375" 24 x 1.688"	54-65	40-48
SPL170	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75
SPL250	7-73-122	500357-12	231421-4	.438" 20 x 1.375"	85-102	63-75
	7-73-228	500357-12	231421-4	.438" 20 x 1.750"	85-102	63-75

**Bolts are specially heat-treated. DO NOT substitute inferior grade bolts.*
† Approved Spicer hardware.
***Note**-Original equipment vehicle manufacturers' manuals may have alternate specified bolts or metric hardware. Refer to the original equipment service manual for bolt part numbers.*

Table EEE

6. **Be sure to second support strap is in place as illustrated in Figures GG or HH, page 152**. Lift the center bearing to the center bearing bracket on the cross member of the frame. Install proper center bearing bracket bolts per vehicle manufacturer's recommendations. Torque bolts to vehicle manufacturer's required specifications. See warning, below.

WARNING

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

Install Coupling Shaft(s)

7. **Be sure third and fourth support straps are in place, as illustrated in Figures GG or HH, Page 152.** Place coupling shaft in support straps. Be sure the coupling shaft is placed back in its original orientation. See warning, top right.

WARNING

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

8. Working from the center bearing end fitting, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks**. Make sure the flange yoke and companion flange are **free from grease** or other foreign material and properly seated. See warning, below.

WARNING

Improperly seated flange yoke and companion flanges can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

9. Install **new** bolts, washers (if required) and nuts. Reference hardware specifications, Table EEE, page 154. Bolts must be torqued to required specifications. ▲ See warning, below.

▲ ***WARNING***

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

10. **Be sure the fourth support strap is in place, as illustrated in Figures GG or HH, Page 152.** Lift the center bearing to the center bearing bracket on the cross member of the frame. Install and torque center bearing bracket bolts per vehicle manufacturer's recommendations. ▲ See warning, Step 12.

11. Repeat Steps 7 through 10 as necessary to install any remaining coupling shafts.

Install Driveshaft

12. Place the **driveshaft** in the fifth and sixth support straps. **Be sure the driveshaft is placed back in its original orientation.** ▲ See warning, below.

▲ ***WARNING***

Installation of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Failure of a driveline can result in separation of driveline from vehicle. A separated driveline can result in property damage, serious personal injury or death.

13. Working from the **rear end**, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks**. Make sure the flange yoke and companion flange are **free from grease** or other foreign material and properly seated. ▲ See warning, above right.

▲ ***WARNING***

An improperly seated flange yoke and companion flange can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury or death.

14. Install **new** bolts, washers (if required) and nuts. Reference hardware specifications, Table EEE, page 154. Bolts must be torqued to required specifications. ▲ See warning, step 9.

15. It may be necessary to collapse slip member assembly to allow clearance to install the driveshaft into the center bearing companion flange.

16. At center bearing, position the flange yoke face onto the companion flange, **aligning bolt holes and phasing marks**. Make sure the flange yoke and companion flange are **free from grease** or other foreign material and properly seated. ▲ See warning, step 13.

17. Install **new** bolts, washers (if required) and nuts. Reference hardware specifications, Table EEE, page 154. Bolts must be torqued to required specifications. ▲ See warning, step 9.

18. Completely relubricate all universal joints and slip member assemblies (if slip member assemblies are relubable) as described in the lubrication section of this manual.

19. Remove **all** support straps.

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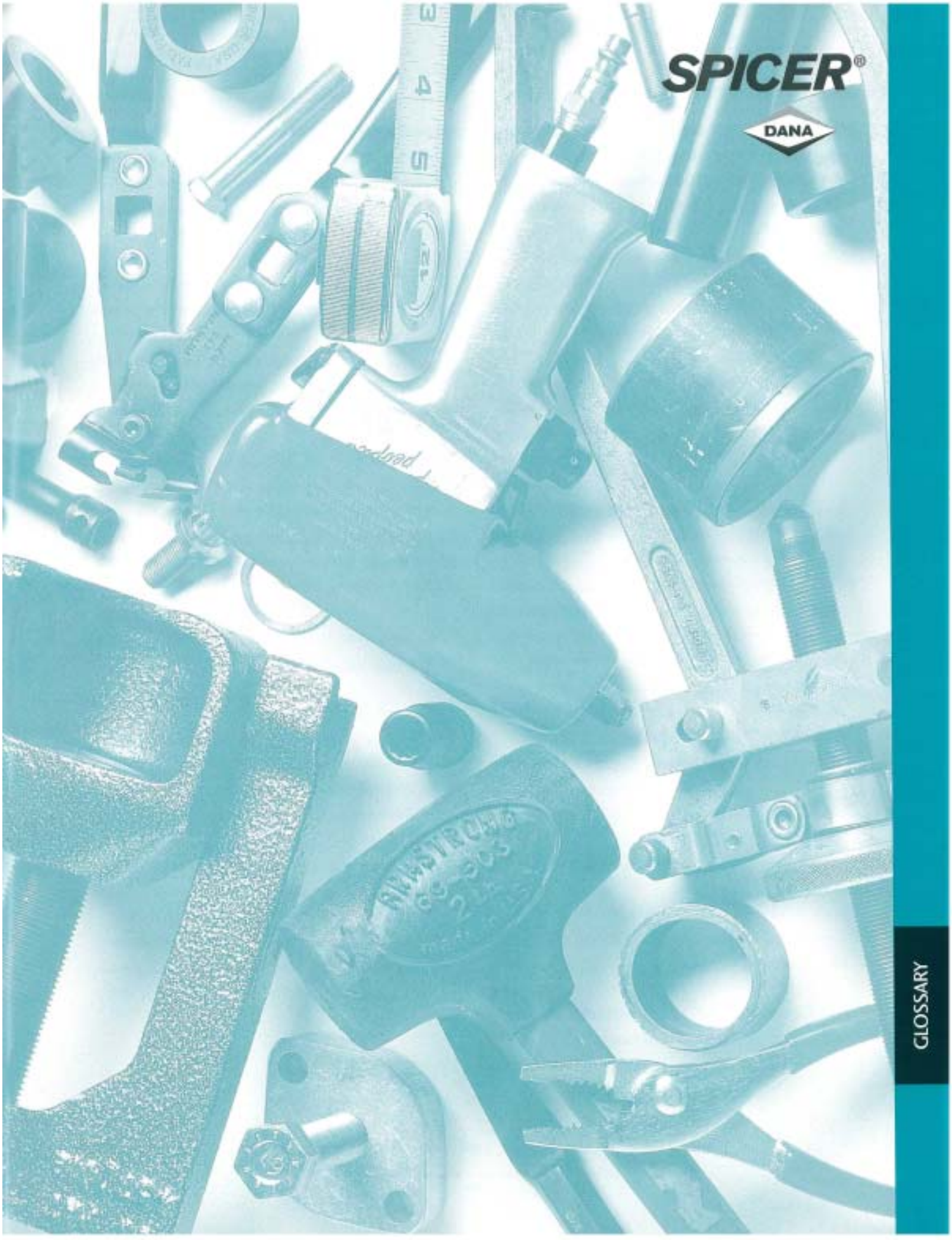

GLOSSARY

GLOSSARY

Balancing – A procedure by which the mass distribution of a rotating body is checked and, if necessary, altered in order to ensure that the vibration at a frequency corresponding to an operating speed at the supporting bearings is within specified limits.

Ball Yoke – See Tube Yoke.

Bearing Cross Hole – See Cross Hole.

Bearing Cup Assembly – Consists of a bearing cup with needle rollers generally held in place by a seal guard and bearing seal. Sometimes the assembly includes a thrust washer.

Bearing Cup – A cup-shaped member used as the bearing bore of a bearing cup assembly and for positioning a thrust end of a cross trunnion.

Bearing Retainer – A heavy, formed metal cap, used solely in Spicer Life Series,® to retain a bearing cup assembly in Quick Disconnect™ end yoke or flange yoke designs.

Bearing Seal – A flexible member of a bearing cup assembly which prevents the escape of lubricant from or entry of foreign matter into a bearing.

Bearing Strap – A narrow, stamped metal plate used to retain a bearing cup assembly in a half-round end yoke or flange yoke design.

Boot – A flexible member which prevents the escape of lubricant from or entry of foreign matter into the slip spline members.

Boot Clamp – A thin adjustable band used to hold the boot in position on the slip spline members.

Boot Seal – See Boot.

Center Bearing – Consists of a rolling element bearing isolated in rubber and a bracket configuration for attachment to the vehicle frame.

Companion Flange – A fixed flange member that attaches a driveshaft to another drivetrain component.

Coupling Shaft – The coupling member or members of a multiple-piece driveline which consists of a universal joint, tube, center bearing, and a slip or fixed spline shaft.

Coupling Shaft Length (Center Line to Center Line or ℄ to ℄) – The distance between the outermost universal joint centers on a driveshaft. Coupling shafts with fixed centers, it is the nominal dimension.

Cross – See Journal Cross.

Cross Hole– A through hole in each lug ear of a yoke used to locate a bearing cup assembly.

Deflector – See Slinger.

Driveline – An assembly of one or more coupling shafts and a driveshaft with provisions for axial movement, which transmits torque and/or rotary motion at a fixed or varying angular relationship from one drivetrain component to another.

Driveshaft – An assembly of one or two universal joints connected to a tubular shaft member which accommodates axial movement.

Driveshaft Length (Center Line to Center Line or ℄ to ℄) – The distance between the outermost universal joint centers on a driveshaft. On driveshafts with variable length centers, it is usually measured in the compressed or installed lengths.

Ear – One of two projecting parts of a yoke symmetrically located with respect to the yoke's rotational axis.

End Fitting – An end yoke or companion flange (including S.A.E., DIN and T-Type styles) that attaches a driveshaft to another drivetrain component.

End Yoke – A Quick Disconnect™ yoke that attaches a driveshaft to another drivetrain component.

Flange Yoke – A full-round or Quick Disconnect™ style yoke which attaches a driveshaft to a companion flange.

Flinger – See Slinger.

Glidecote® – The blue, nylon, wear-resistant coating on Spicer yoke shafts and tube shafts.

Grease Zerk (Nipple) Fitting – The fitting on the shoulder or center of a journal cross or on a relubable slip spline that allows for lubrication.

Quick Disconnect™ Cross Hole – A semicircular hole located on the end of each lug ear of some end yoke and flange yoke designs used to locate a bearing cup assembly.

Inboard Yokes – Yokes that make up the ends of a driveshaft or coupling shaft assembly, i.e. tube yokes, slip yokes, yoke shafts, and center bearing end yokes.

Installation Height Tools – Round, indexing tools that are supplied with all Spicer Life Series® replacement universal joint kits to ensure proper bearing cup assembly installation specifications.

Journal Cross– The core component of a universal joint which is an intermediate drive member with four equally spaced trunnions in the same plane.

Lug Ear – See Ear.

Midship Shaft – A machined element consisting of spline teeth, a pilot for a center bearing and a piloting hub that attaches to the tube of a coupling shaft assembly.

Needle Rollers – One of the rolling elements of a bearing cup assembly.

Outboard Yokes – Yokes that are not a part of a driveshaft or coupling shaft assembly, i.e. transmission, axle, transfer case end yokes and/or companion flanges.

Phase Angle – The relative rotational position of each yoke on a driveshaft or driveline.

Pillow Block – Consists usually of a rolling element bearing and a bracket configuration for attachment.

Pressure Relief Hole – A hole in the welch plug of Spicer slip yokes that allows air to escape from the slip member assembly.

Purge – The act of flushing old grease and contaminants from universal joint kits and slip member assemblies with fresh grease.

Retaining Ring – See Snap Ring.

Retaining Ring Groove – See Snap Ring Groove.

Round Bearing Assembly – See Bearing Cup Assembly.

Seal Can – A metal "can" that permanently seals the slip member on a driveshaft. Usually found on European-style driveshaft assemblies.

Seal Guard – A covering member used to protect a bearing seal on the bearing cup assembly.

Serrated Flange – See T-Flange.

Shaft Support Bearing – See Center Bearing.

Slinger – A stamped metal or non-metal ring which prevents the entry of foreign matter into a center bearing, transmission, axle or transfer case.

Slip – The total permissible length of axial travel.

Slip Yoke – A yoke which accommodates axial movement.

Slip Yoke Plug – See Welch Plug.

Slip Yoke Seal – Pop-on or threaded ring that contains a seal that protects the slip member assembly from environmental contaminants and retains lubricant.

Snap Ring – A removable member used as a shoulder to retain and position a bearing cup assembly in a yoke cross hole.

Snap Ring Groove – A groove used to locate a snap ring.

Spline – A machined element consisting of integral keys (spline teeth) or keyways (spaces) equally spaced around a circle or portion thereof.

Spline Sleeve – A patented tubular-type, machined element consisting of internal splines which is attached to a tube or tube yoke in a driveshaft assembly. Found only in Spicer Life Series® driveshaft assemblies.

Spring Tab – A patented stamped metal plate that takes the place of a bearing plate and acts as a structural member by reducing looseness in a universal joint kit. Found only on Spicer Life Series® driveshaft assemblies.

Stub Shaft – See Tube Shaft.

Tang – A nib of metal found on Quick Disconnect™ end yoke and/or flange yoke style cross holes, used to locate a bearing cup assembly.

T-Flange – A companion flange and flange yoke design which has a serrated flange face. Found most often in European applications.

T-Type Flange – See T-Flange.

Thrust Washer – A washer found in the bottom of a bearing cup assembly that reduces needle roller friction, bearing heat and guards against end galling on the journal cross trunnions.

Tube – The tubular connecting member of a driveshaft. Pipe or piping is not an equivalent.

Tubing – See Tube.

Tube O. D. (outside diameter) – The outside diameter of a tube.

Tube Yoke – A inboard yoke with a piloting hub for attachment to a tube or spline sleeve.

Tube Shaft – A machined element consisting of spline teeth and a piloting hub that attaches to the tube of a driveshaft assembly.

Trunnion(s) – Any of the four projecting journals of a cross.

Universal Joint – A mechanical device which can transmit torque and/or rotary motion from one shaft to another at fixed or varying angles of intersection of the shaft axes. Consisting usually of a journal cross, grease zerk (nipple) fitting and four bearing cup assemblies.

Universal Joint Kit – See Universal Joint.

U-Joint – See Universal Joint.

Welch Plug – A plug in the slip yoke face that seals off one end of the spline opening. Also known as a slip yoke plug.

Weld Yoke – See Tube Yoke.

Yoke Lug Ear Cross Hole – See Cross Hole.

Yoke Shaft – A slip member yoke with a male machined spline used for axial movement.

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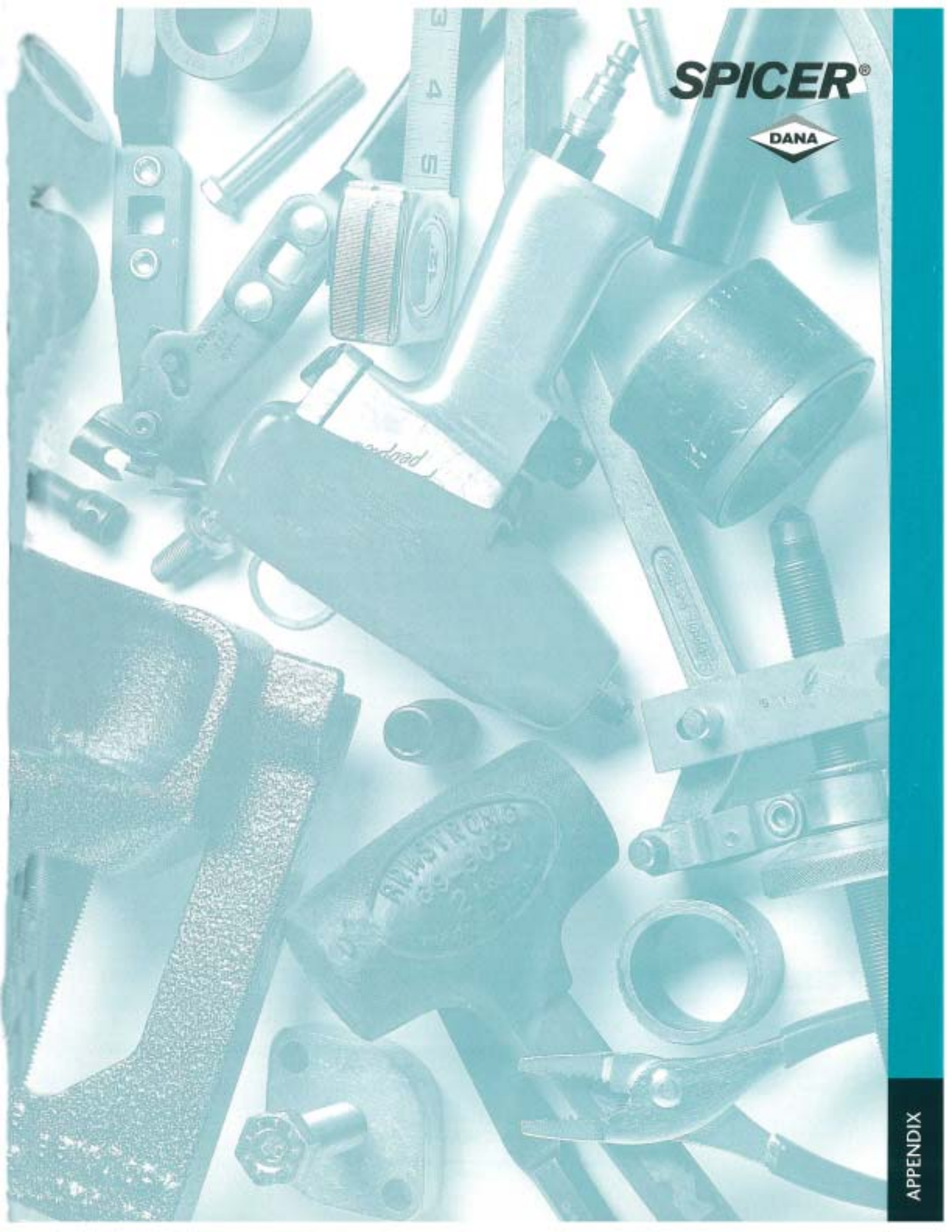
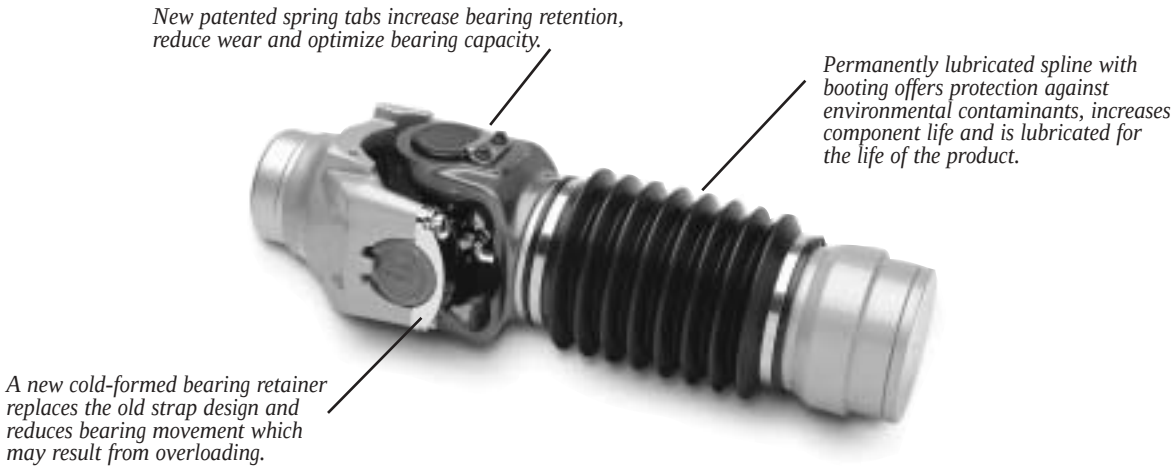


APPENDIX

Spicer Life Series™ Driveshaft – Quick Reference



Maximum Lubrication* Cycles

Type of Service	Distance	Time
City	25,000 Mi./40,000 Km	or 6 months whichever comes first
On Highway	100,000 Mi./160,000 Km	or 6 months whichever comes first
On/Off Highway	25,000 Mi./40,000 Km	or 6 months whichever comes first
Highway/Industrial	500 hours for normal service and severe environmental conditions	250 hours for continuous service or whichever comes first

*Spicer recommends use of a high quality N.L.G.I., E.P. GRADE 2 lubricating grease

Bearing Retainer* Bolt Torque Specifications

Series	Socket Size	Bolt Torque	Assembly P/N
SPL140	12mm-12 point	135-160 Nm/100-120 Lb. Ft.	140-70-18X
SPL170	12mm-12 point	135-160 Nm/100-120 Lb. Ft.	170-70-18X
SPL250	12mm-12 point	135-160 Nm/100-120 Lb. Ft.	250-70-18X

*Spicer Life Series™ bearing retainers *MAY BE RE-USED* if not damaged. Spicer Life Series bearing retainer bolts *MAY NOT BE* re-used. Order bolt P/N 12-73-125M for all series.

Spring Tab Bolt* Torque Specifications

Series	Socket Size	Bolt Torque	Assembly P/N
SPL140	8mm - 6 point	35-40 Nm/20-25 Lb. Ft.	211941X
SPL170	8mm - 6 point	35-40 Nm/20-25 Lb. Ft.	211941X
SPL250	8mm - 6 point	35-40 Nm/20-25 Lb. Ft.	211941X

*Spicer Life Series™ spring tabs and bolts *MAY NOT BE* re-used. Order assembly part number.

Midship Nut Torque Specifications

Series	Nut P/N*	Nut Torque	Washer P/N
SPL140	250-74-11	644-712 Nm/475-525 Lb. Ft.	230123-6
SPL170	250-74-11	644-712 Nm/475-525 Lb. Ft.	230123-6
SPL250	250-74-11	644-712 Nm/475-525 Lb. Ft.	230123-6

*Wrench size 41mm

Boot Clamp Torque Specifications

Series	Clamp P/N	Clamp Torque	Assembly P/N
SPL140	232757	136-180 Nm/100-130 Lb. Ft.	212046X
SPL170	232493	136-180 Nm/100-130 Lb. Ft.	211959X
SPL170*	232702	136-180 Nm/100-130 Lb. Ft.	211987X
SPL250	232493	136-180 Nm/100-130 Lb. Ft.	211959X

*Used in high angle interaxle positions only.

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Spicer Life Series™ Part Number Interchange

Description	Spicer Life Series Part Number	PACCAR	Navistar	Volvo	Freightliner	Mack
Spicer Life 170 U-Joint Kit	SPL170X		2500678C91	3947697	SP SPL170X	2104 SPL170X
Spicer Life 170 Bearing Retainer Kit	170-70-18X		2500674C91	3947699		2104 1707018X
Spicer Life Series Bearing Retainer Bolt	12-73-125M	12-73-125M	3513117C1	8082078	SP 12 73 125M	41AM7
Spicer Life Series Spring Tab Kit	211941X					
Spicer Life Series Boot Kit	211959X		2500671C91	3947801		
Spicer Life Series Boot Clip	232493			3947802		
Spicer Life Series Boot Kit	211987X		2500684C91	3947803		
Spicer Life Series Boot Clip	232702			3947804		
Spicer Life Series 170 Coupling Shaft End Yoke	170-4-11-1		2500658C1			2104 1704111
Eaton Tandem Axle	170-4-241-1X	170-4-241-X		8081933		176MU41P12 170MU51P36
Eaton Tandem Axle	170-4-161-1X					
Eaton Tandem Axle	170-4-201-1X	170-4-201-1X	3513133C91	8081927		176MU41P11 170MU51P25
Eaton Tandem Axle	170-4-221-1X	170-4-221-1X	3513134C91		SP 170-4-221-1X	
Eaton Tandem Axle	170-4-261-1X	170-4-261-1X				
Eaton Tandem Axle	170-4-281-1X	170-4-281-1X	3513135C91	8081932		176MU41P13 170MU51P37
Fuller Transmission	170-4-481-1X	170-4-481-1X	3513675C91	8081923		176MU41P20 176MU51P5
Fuller Transmission	170-4-521-1X	170-4-521-1X	3514642C91	8081924		176MU41P21 170MU51P6
Fuller Transmission	170-4-461-1X					170MU51P8
Rockwell Single Axle	170-4-671-1X	170-4-671-1X	3513842C91	8081937		176MU41P18 170MU51P31
Rockwell Single Axle	170-4-721-1X	170-4-721-1X	3514643C91	8081926		176MU41P22 170MU51P18
Spicer Single Axle	170-4-901-1X	170-4-901-1X	3517065C91			

Spicer Life Series™ Part Number Interchange

Description	Spicer Life Series Part Number	PACCAR	Navistar	Volvo	Freightliner	Mack
Spicer Life 250 U-Joint Kit	SPL250X		2500680C91	3947698	SP SPL250X	2104 SPL250X
Spicer Life 250 Bearing Retainer Kit	250-70-18X		2500675C91	3947800	SP 250 70 18X	2104 2507018X
Spicer Life Series Bearing Retainer Bolt	12-73-125M	12-73-125M	3513117C91	8082078	SP 12 73 125M	41AM7
Spicer Life Series Spring Tab Kit	211941X					
Spicer Life Series Boot Kit	211959X		2500671C91	3947801		
Spicer Life Series Boot Clip	232493			3947802		
Spicer Life Series 250 Coupling Shaft End Yoke	250-4-21-1			3947962		2104 2504211
Fuller Transmission	250-4-241-1X	250-4-241-1X	3513838C91	8081941		1NPN61008 181MU41P9 125MU53P6
Rockwell Tandem Axle	250-4-351-1X	250-4-351-1X	351839C91	3969891 8081943	SP 250 4 351 1X	181MU41P7 125MU53P16
Fuller Transmission	250-4-561-1	250-4-561-1	3519832C1			
Eaton Tandem Axle	250-4-61-1X					
Mack Transmission	250-4-621-1X					181MU41P4 125MU53P3
Eaton Tandem Axles	250-4-81-1X	250-4-81-1X	3517493C91	8081944		181MU41P5 125MU53P22

Spicer Life Series™ Part Numbering System for Driveshaft Assemblies

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Assemblies: AAABBCDEEE-FFFF

AAA	=	Series
BB	=	Description (see below)
C	=	End Fitting on Slip End (Bearing End for Coupling Shaft)
D	=	End Fitting on Tight End
EEE	=	Spicer Sequential Number
FFFF	=	Tube Length (In millimeters)

Example: 250DS25001-1234M*

Series	=	250 (SPL250)
Description	=	DS (Driveshaft)
End Fitting (Slip)	=	2 (Flange Yoke)
End Fitting (Tight)	=	5 (Journal Cross)
Sequence No.	=	001 of 999
Tube Length	=	1234 Millimeters

*M denotes millimeters

Description:

Driveshaft	=	DS
Coupling Shaft	=	CS
Short Couple	=	SC
Jack Shaft	=	JS
Steering Shaft	=	ST
Double Cardan Shaft	=	DC
System Balance	=	SB
Individual Joint	=	IJ
Double Joint	=	DJ
Dyno Shaft	=	DY
Other	=	NA

End Fittings:

No Fittings/Other	=	0
Companion Flange	=	1
Flange Yoke	=	2
Slip Yoke	=	3
End Yoke	=	4
Journal	=	5

Spicer Life Series™ Part Numbering System for Components

Components: AAA-BB-CCCC-DE*

AAA	=	Series
BB	=	Part Description (see below)
CCCC	=	Spicer Sequential Number
D	=	Denotes Half Round
E	=	Denotes Assembly

*D and/or E may or may not be present in the component part number.

Description:

Companion Flange	=	1
Flange Yoke	=	2
Slip Yoke	=	3
End Yoke	=	4
Tube Yoke	=	28
Yoke Shaft	=	82

Example: 250-4-241-1X*

Series	=	250 (SPL250)
Description	=	4 (End Yoke)
Sequence Number	=	241 (11-9999)
Half Round	=	1
Assembly	=	X

*The part number used in this example is a Spicer Life Series™ 250 half round end yoke assembly.

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SECTION 10: FRONT AXLE

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1. FRONT AXLE

1.1 DESCRIPTION

The Dana Spicer S84U front axle is of the ''Reverse Elliot'' type manufactured by Dana Spicer Europe. The front axle consists of a girder section axle bed or beam with stub axles. Each stub axle is carried on a taper kingpin, with a plain phosphor bronze bushing at the top and at the bottom. The unitized hub bearings used on the NDS range of axles, are non-serviceable items. Bearings are pre-adjusted, lubricated and have seals fitted as part of the manufacturing process. The bearings are greased for life and there is no need or facility for re-lubrication. Brakes are manufactured by KNORR-BREMSE. Steering ball joints with hardened balls and rubbing pads incorporate compression springs which automatically take up any wear.

The tie rod simplifies toe-in adjustment. The maximum turning angle is set through stop screws installed on the inner side of the knuckle.

Steering stabilizer (damper) and steering drag link which are mounted on the front axle are described in Section 14; *"Steering"* of this manual.

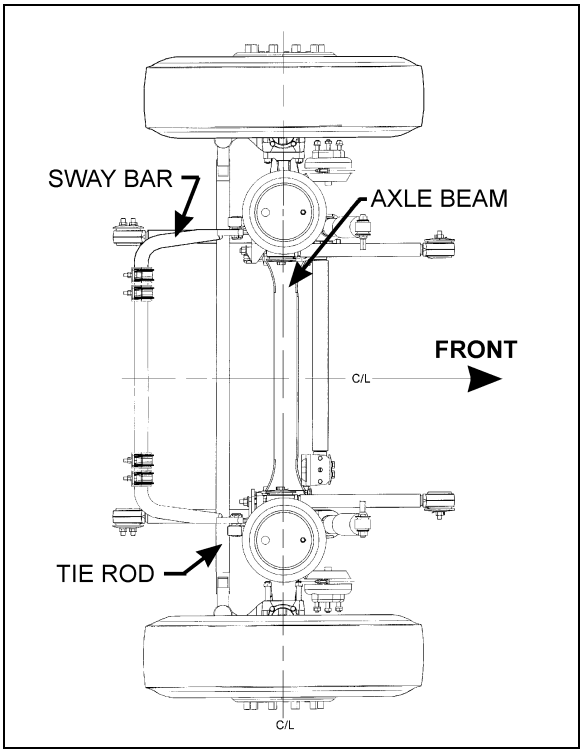


FIGURE 1: FRONT AXLE ASSEMBLY 10026

2. LUBRICATION

MAINTENANCE

Knuckle pins are provided with grease fittings for pressure lubrication. These grease fittings should be serviced every 6,250 miles (10 000 km) or every six months whichever comes first.

Good quality lithium-base roller bearing mineral grease NLGI No.1 and 2 like Shell Retinax LX are recommended.

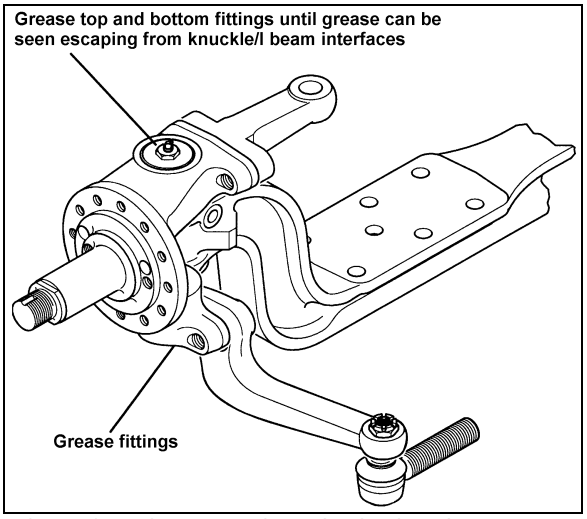
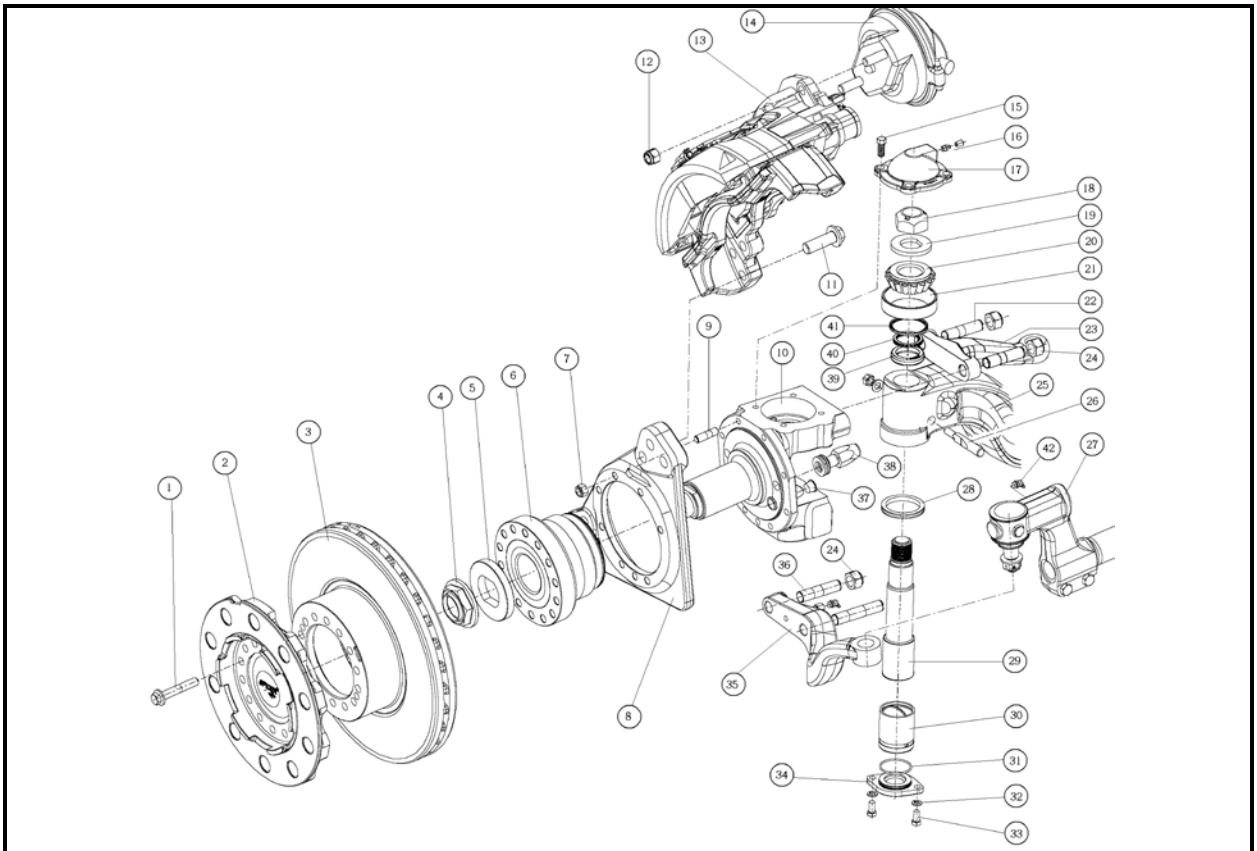


FIGURE 2: FRONT AXLE GREASING POINTS 10031



TYPICAL S84U AXLE

ITEM	DESCRIPTION		QTY	ITEM	DESCRIPTION		QTY
1	Flanged Bolt	161-197 lbf-ft	28	26	Draw key, Nut, Washer	51-62 lbf-ft	2
2	Hub		2	27	Tie Rod End		2
3	Brake Disc		2	28	V" Ring Seal		2
4	Stake Hub Nut	563-687 lbf-ft	2	29	Kingpin		2
5	Collet Washer		2	30	Kingpin - Bushing		2
6	Hub Bearing		2	31	O-Ring Seal		2
7	Nut – Self Lock	85-103 lbf-ft	16	32	Washer		4
8	Brake Mounting Bracket		2	33	Screw	26-32 lbf-ft	4
9	Stud		16	34	Cap - Knuckle Bottom		2
10	Knuckle		2	35	Bottom Steering Lever		2
11	Brake Fixing – Bolt	325-375 lbf-ft	12	36	Bottom Steering Lever - Stud		4
12	Nut – Self Lock	133-155 lbf-ft	4	37	Abs Sensor - Bush		2
13	Brake		1	38	Back Lock - Stop Bolt	85-103 lbf-ft	2
14	Brake Chamber		2		Front Lock - Stop Bolt	85-103 lbf-ft	1
15	Screw	51-62 lbf-ft	8	39	Sleeve - Knuckle Bearing		2
16	Grease Fitting		4	40	Shim .005"		8
17	Cap - Knuckle Top		2		Shim .010"		8
18	Nut – Self Lock	500-700 lbf-ft	2		Shim .015"		8
19	Washer		2		Shim .008"		4
20	Bearing Cone		2		Shim .006"		2
21	Bearing Cup		2	41	Oil Seal		2
22	Steering Lever - Stud		4	42	Grease Fitting		2
23	Steering Lever		2				
24	Nut - Self Lock		4				
25	Axle, I-Beam		1				

Additional torque specifications applicable to the front axle are grouped with information regarding the front suspension. Please refer to Section 16: SUSPENSION of this manual.

3. MAINTENANCE

A periodic inspection of the front axle assembly should be made to check that all bolts are tight, and that no damage and distortion have taken place. Suspension support stud nuts, U-bolt nuts, tie rod arms, steering arm nuts and stop screws should be checked and tightened, as required, to the torque specifications given at the end of this section. Also check the condition of the steering knuckle pins and bushings. In case of excessive looseness, the bushings and pins should be replaced.

Any looseness in the steering linkage, under normal steering loads, is sufficient cause to immediately check all pivot points for wear, regardless of accumulated mileage. Steering linkage pivot points should be checked each time the front axle assembly is lubricated. Any looseness can be visually detected while rotating the steering wheel in both directions.

Steering knuckles, knuckle pins and bushings can be overhauled or replaced without removing the axle from the vehicle. However, if extensive overhaul work is necessary, the axle assembly should be removed.

CAUTION

Should removal of a locking device be required when undergoing repairs, disassembly or adjustments, always replace with a new one.

4. REMOVAL AND REPLACEMENT

The following procedure deals with the removal of the front axle assembly. The method used to support the axle assembly and suspension components during removal and disassembly depends upon local conditions and available equipment.

4.1 REMOVAL

1. Raise the vehicle by its jacking points on the body (see Section 18, *"Body"* under heading 34; Vehicle Jacking Points) until vehicle body is approximately 20 inches (508 mm) from the floor. Place jack stands under frame. Remove the wheels (if required, refer to Section 13, *"Wheels, Hubs and Tires"*).

CAUTION

Use only the recommended jacking points as outlined in section 18 "Body".

2. Exhaust compressed air from the air supply system by opening the drain valve of each reservoir.
3. Install jacks under axle jacking points to support the axle weight.

WARNING

To help prevent injury caused by the axle rolling off the jacks, these should be equipped with U-adapters, or similar precautions must be taken.

4. Disconnect the steering drag link from the steering arm.
5. Remove the ABS sensors from their location in hubs (if applicable).
6. Disconnect the height control valve link from its support on the axle.
7. Disconnect air lines from front brake chambers, and cover line ends and fittings to prevent the entry of foreign matter.

CAUTION

Position the air lines and electric wires so they will not be damaged while removing the front axle assembly.

8. Proceed with steps a, b and c, while referring to Section 16: *"SUSPENSION".*
   a) Disconnect sway bar links from axle brackets.
   b) Remove shock absorbers.
   c) Disconnect five radius rods: one transversal and two longitudinal from subframe, and two upper rods from axle.
9. Remove the bolts and nuts fixing the axle to the left-hand and right-hand side air bellows mounting supports.
10. Using the jacks, slowly lower the axle assembly, and carefully pull away from underneath vehicle.

4.2 REPLACEMENT

Reverse front axle "*Removal"* procedure. Ensure cleanliness of air bellows support mounting plates.

NOTE

Refer to Section 16, "Suspension", Section 14, "Steering" and to paragraph 8 "Specifications" at the end of this section for applicable checks and recommended tightening torques.

5. SERVICE INSTRUCTIONS FOR STEER AXLE

5.1 STEERING KNUCKLE (KING) PIN INSPECTION

MAINTENANCE

An inspection should be made at intervals of 30,000 miles (48 000 km) or twice a year whichever comes first.

Aspects to be considered are:

- **Lateral slackness**
- **Vertical slackness**

NOTE

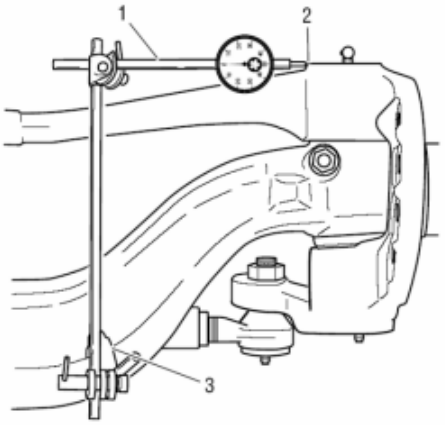
Before commencing checks, apply parking brake, raise wheels off ground and support axle on stands.

5.1.1 Checking Lateral Slackness

Following regular and thorough greasing practices will maximise bushing life. This procedure measures the upper & lower bushing wear due to side and vertical loading. While this is being carried out, the brake must be applied.

Upper Bushing Lateral Inspection

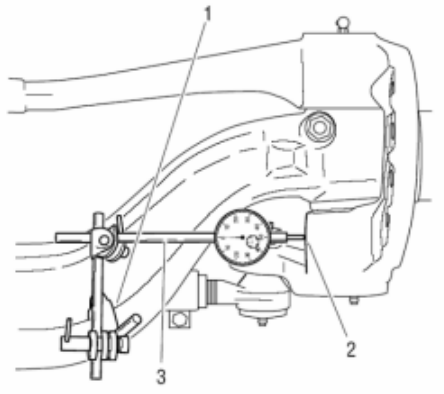
1. Mount dial indicator on the axle. Reference the upper part of the steering knuckle.
2. Move the tire and wheel assembly in and out with a push/pull motion and have an assistant record the dial indicator reading.
3. Replace the upper bushing if readings are in excess of 0.020" (0.5mm).
4. If displacement exceeds stated allowance then need for bush / bearing attention and possible renewal, is in evidence.



1 - Dial indicator
2 - Reference on top lip of steering knuckle
3 - Attach to axle beam

Lower Bushing Lateral Inspection

1. Mount dial indicator on the axle. Reference the base of the lower arm on the steering knuckle.
2. Move the tire and wheel assembly in and out with a push/pull motion and have an assistant record the dial indicator reading.
3. Replace the upper bushing if readings are in excess of 0.020" (0.5mm).
4. If displacement exceeds stated allowance then need for bush / bearing attention and possible renewal, is in evidence.



1 - Attach to axle beam
2 - Reference on lower steering knuckle
3 - Dial indicator

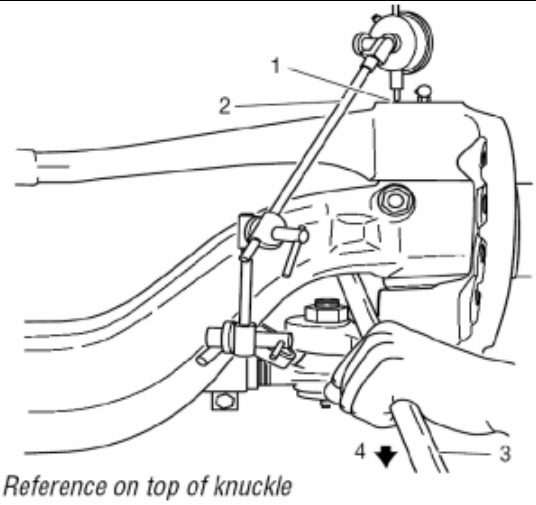
NOTE

To avoid inaccurate measurements, be careful not to let the knuckle turn while moving assembly in and out. Applying brakes will help lock wheel assembly.

Locate indicator on a smooth, flat surface for best reading.

5.1.2 Checking Vertical Slackness

1. This is measured by a dial indicator anchored to axle beam and having its pointer placed vertical against swivel top.
2. Place a jack against underside of swivel and, while applying a lifting force, observe any movement on indicator dial.
3. **If vertical movement is evident and it exceeds 0.040" (1.02mm)** then readjustment of swivel is required by adjusting thickness of bearing adjusting washers.



1 - Reference on top of knuckle
2 - Dial indicator
3 - Pry bar
4 - Pry knuckle downward

6. FRONT WHEEL ALIGNMENT

Correct front wheel alignment must be maintained for steering comfort and satisfactory tire life. Road shocks and vibrations, as well as normal stress and strains on the front-end system can, under normal operating conditions, result in loss of front wheel alignment.

Check the front wheel alignment when the following occurs:

1. Every 200,000 miles (320 000 km) or 24 months (normal maintenance);
2. When the vehicle does not steer correctly; or
3. To correct a tire wear condition.

There are two types of front wheel alignment: **minor alignment** and **major alignment**.

6.1 INSPECTION BEFORE ALIGNMENT

Check the following before doing a front wheel alignment:

1. Ensure that the vehicle is at normal riding height. See Section 16, *"Suspension"* under heading 7: *"Suspension Height Adjustment"*.
2. Ensure that front wheels are not the cause of the problem. See Section 13, *"Wheels, Hubs and Tires"*. Inspect the tires for wear patterns indicating suspension damage or misalignment.
   a. Make sure the tires are inflated to the specified pressure.
   b. Make sure the front tires are the same size and type.
   c. Make sure the wheels are balanced.
   d. Check wheel installation and straightness.
3. Check the wheel bearing adjustment. See Section 13, *"Wheels, Hubs and Tires".*
4. Check steering linkage for bending and pivot points for looseness.
5. Check knuckle pins for evidence of excessive wear.
6. Check radius rods for bending and rubber bushings for evidence of excessive wear.
7. Make sure all fasteners are tightened to the specified torque. Use a torque wrench for verification. As soon as the fastener starts to move, record the torque. Correct if necessary. Replace any worn or damaged fasteners.

6.2 MINOR FRONT WHEEL ALIGNMENT

Perform a minor front wheel alignment for all normal maintenance conditions.

Perform the minor front wheel alignment in the following sequence :

1. Inspect all the systems that affect the wheel alignment. See paragraph 6.1, *"Inspection Before Alignment"* in this section.

2. Check the hub bearings. See section 13, *"Wheels, hubs and Tires"* under heading 8: Front and Tag Axle Wheel Hubs.
3. Check and adjust the toe-in.

6.3 MAJOR FRONT WHEEL ALIGNMENT

Perform a major front wheel alignment to correct steering and tire wear conditions.

Perform the major front wheel alignment in the following sequence:

1. Inspect all systems affecting the wheel alignment. See paragraph 6.1, *"Inspection Before Alignment"* in this section.
2. Check the hub bearings. See section 13, *"Wheels, hubs and Tires"* under heading 8: Front and Tag Axle Wheel Hubs.

NOTE
If steering angle stoppers are changed, a special procedure is required for readjusting gearbox steering limiter. See paragraph 6.5 "Hydraulic Stop" in this section.

3. Check and adjust the turning angle adjustment.
4. Check the camber angle.
5. Check and adjust the caster angle.
6. Check and adjust the toe-in.

6.4 TURNING ANGLE ADJUSTMENT

The maximum turning angle is set through the two steering stop screws installed on the axle center. The turning angle is factory adjusted to accommodate the chassis design, and therefore, does not require adjustment on new vehicles. However, it should be checked and adjusted any time any component of the steering system is repaired, disassembled or adjusted.

Check if front tires rub against the frame or if the steering gear has been serviced.

Proceed with the following method to check the steering maximum turning angle :

6.4.1 R.H. Turn Adjustment

CAUTION
To prevent the steering damper from interfering with the adjustment of turning angles, make sure its fixing bracket is at the correct location on the axle center (refer to section 14 "Steering").

1. Turn steering wheel to the right until the boss on the axle center touches the right stop screw.
2. Verify the nearest point of contact of the ball socket body with the air bellows support assembly. Measure the distance between those two points.
3. The distance between these two points should be approximately 1/8 inch (3 mm). If not, the steering stop screws must be readjusted.
4. Verify the nearest point of contact of the drag link with the tire. Measure the distance between those two points.
5. The distance should be 1 inch (25 mm) or more. If not, the steering stop screws must be readjusted.
6. This must be done for a full right turn.
7. If readjustment is required:
   a. Remove the swivel stop screw.
   b. Add to the stop screw the required number of washers to obtain the proper measure, tighten the stop screw afterwards. Two washers of different thickness are available: 1/16 inch and 3/16 inch.

6.4.2 L.H. Turn Adjustment

1. Turn steering wheel to the left until the boss on the axle center touches the left stop screw.
1. Verify the nearest point of contact of the ball socket body with the air bellows support assembly. Measure the distance between those two points.
2. The distance between these two points should be approximately 1/8 inch (3 mm). If not, the steering stop screws must be readjusted.
4. Check the stroke of the steering stabilizer cylinder (damper). It should not exceed 12.59 inches (320 mm).
5. The steering stopper screw must be in contact before the steering stabilizer reaches the end of the stroke.
6. This must be done for a full left turn.
7. If readjustment is required:
   a. Remove the swivel stop screw.
   b. Add to the stop screw the required number of washers to obtain the proper

measure, tighten the stop screw afterwards. Two washers of different thickness are available: 1/16 inch and 3/16 inch.

NOTE
If steering angle stoppers are changed, a special procedure is required for readjusting gearbox steering limiter. See paragraph 6.5 "Hydraulic Stop" in this section.

6.5 HYDRAULIC STOP

NOTE
Before steering limiter readjustment, verify vehicle wheel alignment and ensure that oil level is checked and that air bleeding is done.

Refer to *'ZF-Servocom Repair Manual"* annexed at the end of Section 14 *''Steering"* under heading *'Setting and Functional Test.*

6.6 FRONT WHEEL CAMBER

Wheel camber is the number of degrees the top of the wheel tilts outward (positive) or inward (negative) from a vertical angle (Fig. 4).

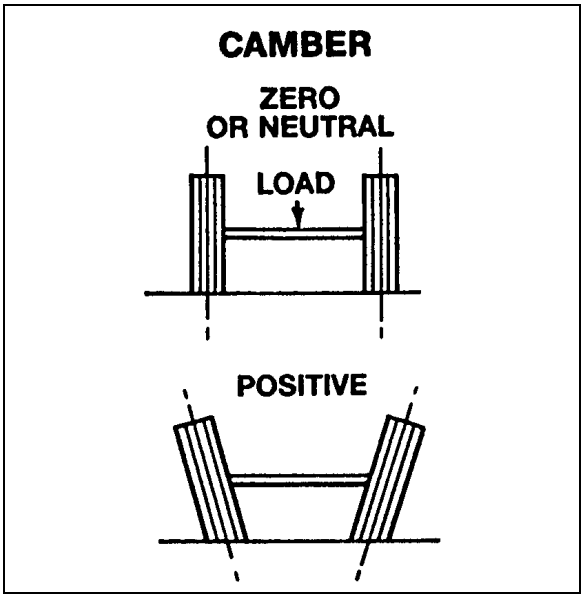


FIGURE 3: CAMBER 10006

The camber angle is not adjustable. Camber variations may be caused by wear at the wheel bearings, steering knuckle pins or by a bent knuckle or sagging axle center. Steering effort is affected by improper camber, and uneven tire wear will result. Excessive positive camber causes an irregular wear of tire at the outer shoulder and excessive negative camber causes wear at the inner shoulder.

6.6.1 Camber Check

For camber specifications, refer to paragraph 8: ''SPECIFICATIONS'' in this section

1. Use an alignment machine to check the camber angle.
2. If camber reading is not in the specifications, adjust the wheel bearings and repeat the check. If the reading is still not within specifications, verify the steering knuckle pins and axle center.
3. See instructions in "DANA SPICER Maintenance Manual Model NDS and Maintenance Manual NDS Axles" annexed at the end of this section.
4. Check the wheel lateral distortion as instructed in Section 13, *"Wheels, Hubs and Tires"* under heading, *"Checking for Distorted Wheel on Vehicle"*. If distortion is excessive, straighten or replace wheel(s).

6.7 FRONT AXLE CASTER

For caster specifications, refer to paragraph 8: ''SPECIFICATIONS'' in this section.

Positive caster is the rearward tilt from the vertical axis of the knuckle pin. Negative caster is the forward tilt from the vertical axis of the knuckle pin (Fig. 5). This vehicle is designed with a positive caster. The purpose of the caster angle is to give a trailing effect. This results in stabilized steering and a tendency for the wheels to return to the straight-ahead position after taking a turn.

Excessive caster results in hard steering around corners. A shimmy may also develop when returning to the straight ahead position (pulling out of curves).

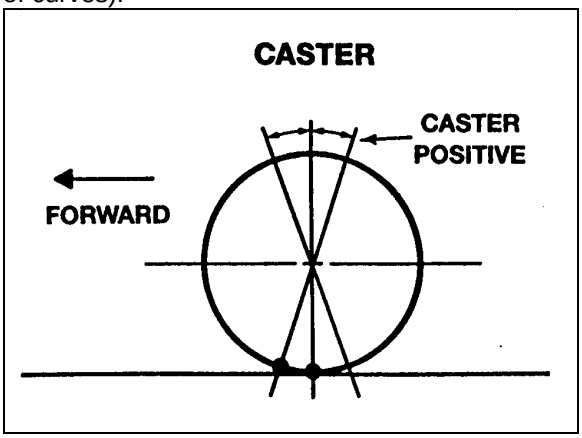


FIGURE 4: CASTER 10007

Insufficient caster will cause wandering and steering instability. Caster variations may be caused by a bent axle, tilting or distortion of the side suspension supports, damaged radius rod bushings, or unequal tightening of the front and

rear suspension support bolts. Incorrect caster must be corrected by replacing the damaged suspension parts. A precision instrument should be used to measure the caster.

NOTE

The caster of this vehicle is factory set and is not adjustable. However, if after replacing damaged parts or in case of improper caster due to irregular setting, the front axle caster needs adjustment; it can be adjusted by means of shims (Prevost #110663) on the left-hand side upper radius rod support in order to obtain minor adjustment.

6.8 FRONT WHEEL TOE-IN

Wheel toe-in is the degree (usually expressed in fractions of an inch) to which the forward part of the vehicle front wheels are closer together than the rear part, measured at wheel centerline height with the wheels in the normal ''straight-ahead'' position of the steering gear.

Incorrect toe-in results in excessive tire wear caused by side slippage and also steering instability with a tendency to wander. Toe-in may be measured from the center of tire tread or from the inside of the tires. Take measurements at both front and rear of axle (see ''A" and ''B'' in fig. 6).

When setting toe-in adjustment, the front suspension must be neutralized; that is, all component parts must be in the same relative position when marking the adjustment as they will be when in operation.

To neutralize the suspension, the vehicle must be rolled forward, approximately ten feet.

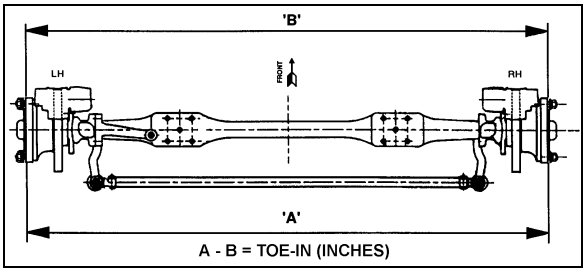


FIGURE 5: TOE-IN MEASUREMENT 10008B

For toe-in specifications, refer to paragraph 8 ''Specifications'' in this section.

By rolling the vehicle forward, all tolerances in the front suspension are taken up and the suspension is then in its normal operating position. Neutralizing the front suspension is extremely important, especially if the vehicle has been jacked up in order to mark the tires. Otherwise, the front wheels will not return to their normal operating position due to the tires gripping the floor surface when the vehicle jack is lowered.

NOTE

''Toe-in'' measurements must be taken at the horizontal axis of the wheel centerline.

6.8.1 Inspection and Adjustment

Before checking front wheel toe-in, first check the camber angles and make the necessary corrections.

1. Measure the toe-in.
2. If the toe-in measurement is not within the specified tolerance, carry out the following procedure :
   a. Loosen the pinch bolt nuts and bolts on each tie rod end.
   b. Turn the tie rod until the specified toe-in measurement is obtained.
   c. Tighten the pinch bolt nuts alternately and progressively to 65-75 lbf-ft (88-102 Nm), thus securing all tie rod joints.

FRONT WHEEL ALIGNMENT SPECIFICATIONS			
Front Wheel Alignment	**Minimal**	**Nominal**	**Maximal**
Camber, (degrees) R.H. and L.H. *	-0.250	0.125	0.375
Caster, (degrees) R.H. and L.H.	2	2.75	3.5
Toe-in (A minus B), (degrees)	0.04	0.06	0.08

Refer to Section 16: Suspension for front wheel alignment with independent front suspension

NOTE
Camber angle changes with loading. The given numbers are for an empty vehicle.

7. TROUBLESHOOTING

CONDITION	CAUSE	CORRECTION
Tires wear out quickly or have uneven tire tread wear.	1. Tires have incorrect air pressure. 2. Tires out-of-balance. 3. Incorrect tag axle alignment. 4. Incorrect toe-in setting. 5. Incorrect steering arm geometry.	1. Put specified air pressure in tires. 2. Balance or replace tires. 3. Align tag axle. 4. Adjust toe-in specified setting. 5. Service steering system as necessary.
Vehicle is hard to steer.	1. Low pressure in the power steering system. 2. Steering gear not assembled correctly. 3. Steering linkage needs lubrication. 4. King pins binding. 5. Incorrect steering arm geometry. 6. Caster improperly adjusted. 7. Tie rod ends hard to move. 8. Worn thrust bearing.	1. Repair power steering system. 2. Assemble steering gear correctly. 3. Lubricate steering linkage. 4. Replace king pins. 5. Service steering system as necessary. 6. Adjust caster as necessary. 7. Replace tie rod ends. 8. Replace thrust bearing.
Bent or broken steering arm, steering top lever or tie rod assembly.	1. Too much pressure in the power steering system. 2. Cut-off pressure of the power steering system improperly adjusted. 3. Vehicle not powered on correctly. 4. Power steering system not installed correctly.	1. Replace damaged part(s), adjust power steering system to specified pressure. 2. Make sure vehicle is powered on correctly. 3. Correctly install the power steering system. 4. Correctly install the power steering system.
Worn or broken steering ball stud.	1. Drag link fasteners tightened past specified torque. 2. Lack of lubrication or incorrect lubricant. 3. Power steering stops improperly adjusted.	1. Replace damaged part(s), tighten drag link fasteners to specified torque. 2. Lubricate linkage with specified lubricant. 3. Adjust stops to specified dimension.

Worn king pins and knuckle bushings.	1. Worn or missing seals and gaskets. 2. Incorrect lubricant. 3. Axle not lubricated at scheduled frequency. 4. Incorrect lubrication procedures. 5. Lubrication schedule does not match operating conditions.	1. Replace damaged part(s), replace seals and gaskets. 2. Lubricate axle with specified lubricant. 3. Lubricate axle at scheduled frequency. 4. Use correct lubrication schedule to match operating conditions. 5. Change lubrication schedule to match operating conditions.
Vibration or shimmy of front axle during operation.	1. Caster not adjusted properly. 2. Wheels and/or tires out-of balance. 3. Worn steering stabilizer cylinder.	1. Adjust caster. 2. Balance or replace wheels and/or tires. 3. Replace steering stabilizer cylinder.

8. SPECIFICATIONS

Front Axle

Make ..... DANA SPICER EUROPE

Model ..... NDS

Front Track ..... 84.4 inches (2 145 mm)

Rated load capacity .....16,500 lbs (7 500 kg)

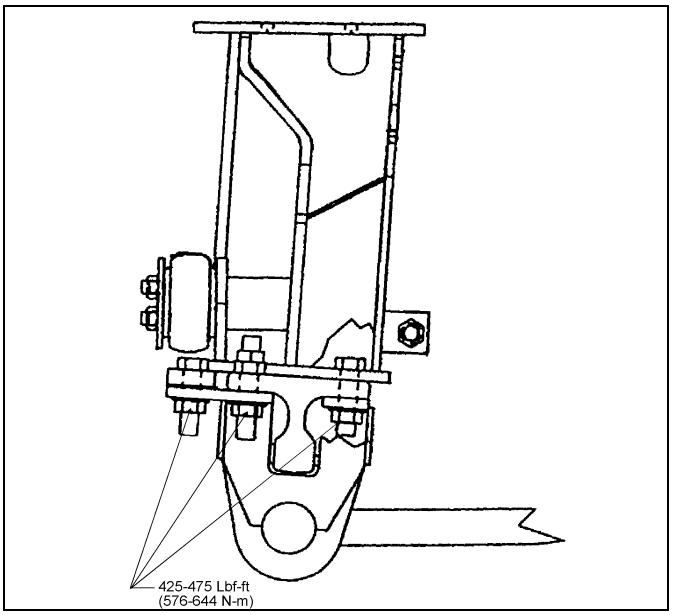
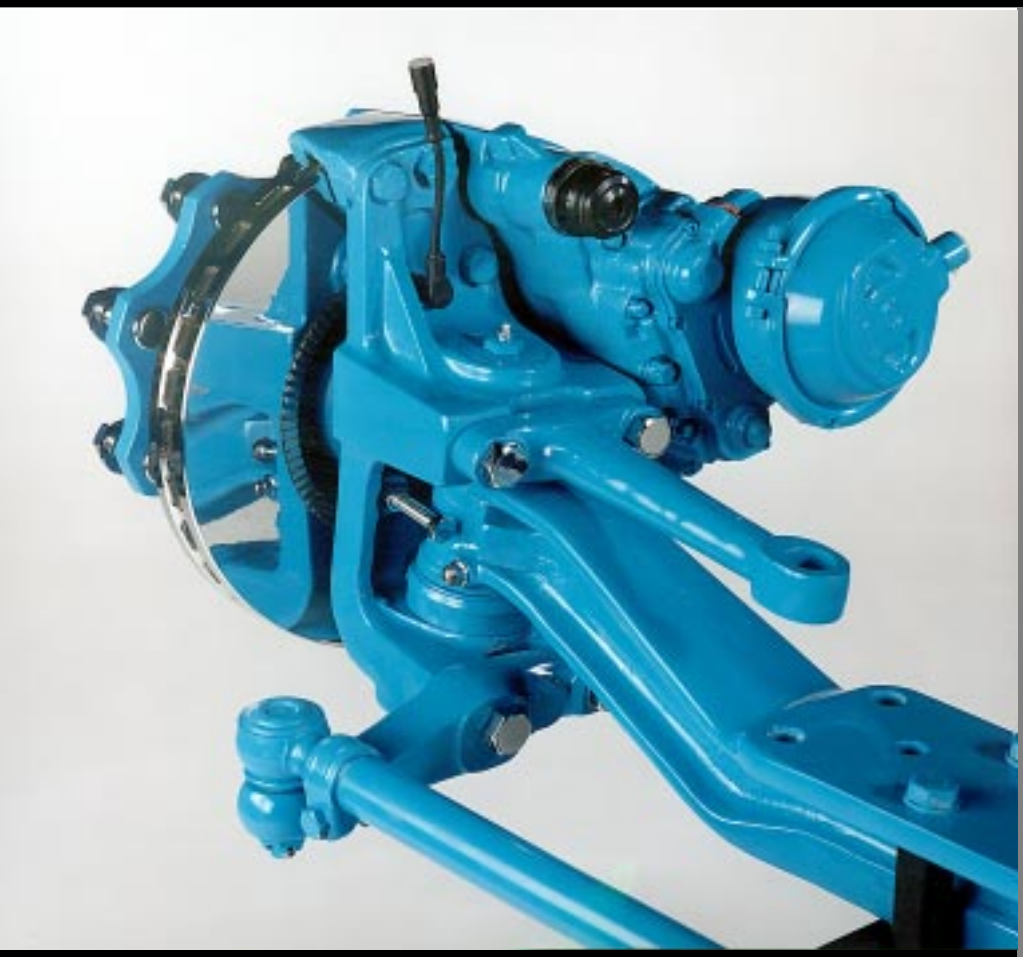


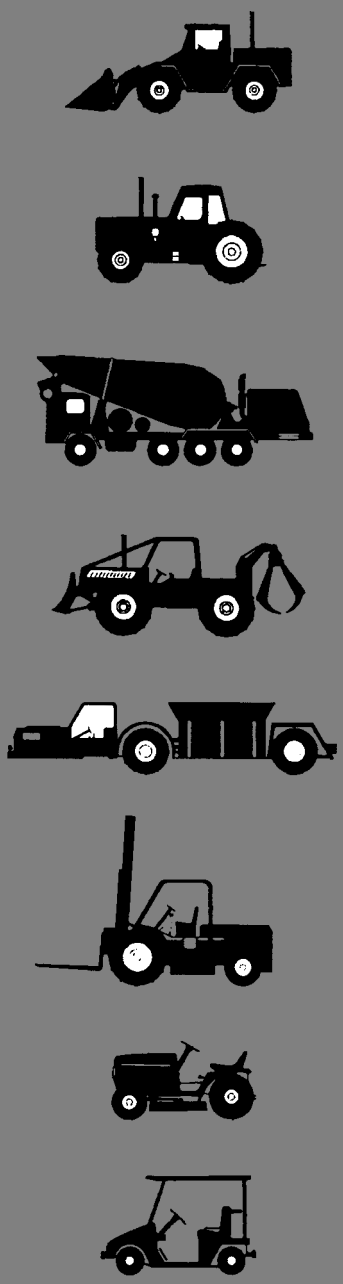
FIGURE 6: AIR BELLOWS MOUNTING SUPPORT AND AXLE 10030

9. TORQUE SPECIFICATIONS

The torque specifications applicable to the front axle are grouped with information regarding the front suspension. Please refer to Section 16: SUSPENSION of this manual.
For more torque specifications, see 'Dana Spicer Maintenance Manual NDS Axles and Maintenance Manual Model NDS'' annexed at the end of this section.

SERVICE MANUAL
GENERAL INFORMATION
NDS Axle range





SPICER SPECIALITY AXLE DIVISION

DANA

INFORMATION ABOUT THIS MANUAL.

THIS MANUAL IS DIVIDED INTO THE FOLLOWING GENERAL SECTIONS:-

1) GENERAL INFORMATION (this section)
2) LUBRICATION AND MAINTENANCE
3) REMOVAL AND REFITTING OF THE SWIVEL (KNUCKLE) ASSEMBLY
4) REMOVAL AND REFITTING OF THE BRAKE ASSEMBLY
5) PARTS IDENTIFICATION

The description, testing procedures, and specifications contained in this parts / service publication were current at time of printing. This manual will not be updated. If in doubt about any aspect of maintenance or servicing of the axle please contact the vehicle builder or our service department direct.

Spicer Speciality Axle Division products are subject to continual development and we reserve the right to modify procedures and to make changes in specifications at any time without prior notice and without incurring obligation.

The recommendations of the vehicle manufacturer should be considered as the primary source of service information regarding this *SPICER*® product. This manual is intended to be used as a supplement to such information.

Any references to brand names in this publication is made simply as an example of the types of tools and materials recommended for use and, as such, should not be considered as an endorsement.

Spicer Speciality Axle division recommends following all manufacturers recommendations for the proper handling and disposal of lubricants and solvents. For further information please contact the supplier of lubricants and solvents.

IMPORTANT NOTICE

THIS SYMBOL IS USED THROUGHOUT THIS MANUAL, TO CALL ATTENTION TO PROCEDURES WHERE CARELESSNESS OR FAILURE TO FOLLOW SPECIFIC INSTRUCTIONS MAY RESULT IN PERSONAL INJURY OR COMPONENT DAMAGE.
DEPARTURE FROM THE INSTRUCTIONS, CHOICE OF TOOLS, MATERIALS AND RECOMMENDED PARTS MENTIONED IN THIS PUBLICATION MAY JEPORDISE THE PERSONAL SAFETY OF THE SERVICE TECHNICIAN OR VEHICLE OPERATOR.

SPICER SPECIALITY AXLE DIVISION URGES CAUTION WHEN PERFORMING ANY SERVICE OR MAINTENANCE PROCEDURE

WARNING: FAILURE TO FOLLOW INDICATED PROCEDURES CREATES A HIGH RISK OF PERSONAL INJURY TO THE SERVICE TECHNICIAN.

NOTE: FAILURE TO FOLLOW INDICATED PROCEDURES MAY CAUSE COMPONENT DAMAGE OR MALFUNCTION

FOR EASE OF ASSEMBLY / DISASSEMBLY:

HELPFUL REMOVAL / INSTALLATION PROCEDURES TO AID IN THE SERVICE OF YOUR NDS AXLE

EVERY EFFORT HAS BEEN MADE TO ENSURE THE ACCURACY OF THE INFORMATION CONTAINED WITHIN THIS MANUAL.
HOWEVER, SPICER SPECIALITY AXLE DIVISION MAKES NO EXPRESSED OR IMPLIED WARRANTY OR REPRESENTATION BASED ON THE ENCLOSED INFORMATION.
ANY ERRORS OR OMISSIONS MAY BE REPORTED TO :

THE TECHNICAL PUBLICATIONS DEPARTMENT
SPICER SPECIALITY AXLE DIVISION
ABBEY ROAD
KIRKSTALL
LEEDS
LS5 3NF
TEL: 0044-113-2584611
FAX: 0044-113-2091115

WARNINGS!

NON ASBESTOS FIBRES!
ALTHOUGH NON OF THE BRAKE LININGS USED ON THE NDS RANGE OF AXLES CONTAIN ASBESTOS.
IT SHOULD BE NOTED THAT NON ASBESTOS BRAKE LININGS CAN STILL CONTAIN INGREDIENTS WHICH CAN PRESENT HEALTH RISKS IF INHALED.
ACCORDINGLY CARE SHOULD BE TAKEN TO AVOID THE CREATION AND INHALATION OF DUST WHEN BRAKES ARE SERVICED.
FURTHER DETAILS SHOULD BE OBTAINED FROM YOUR EMPLOYER OR THE BRAKE MANUFACTURER!

PERSONAL INJURY!
TO PREVENT PERSONAL INJURY, ALWAYS WEAR APPROPRIATE PERSONAL PROTECTION EQUIPMENT (P.P.E) WHEN PERFORMING ANY MAINTENANCE WORK.

SOLVENT CLEANERS!
IF SOLVENT BASED CLEANERS ARE TO BE USED, THE MANUFACTURERS INSTRUCTIONS SHOULD BE CAREFULLY FOLLOWED AS WELL AS TAKING THE FOLLOWING BASIC PRECAUTIONS:-

1) **WEAR EYE PROTECTION!**
2) **WEAR PROTECTIVE CLOTHING!**
3) **WORK IN A WELL VENTILATED AREA!**
4) **DO NOT USE PETROLIUM (GASOLINE) BASED PRODUCTS DUE TO THE RISK OF FIRE AND / OR EXPLOSION!**

ON NO ACCOUNT SHOULD SOLVENT CLEANERS BE USED ON ANY OF THE BEARING COMPONENTS CONTAINED IN YOUR NDS RANGE AXLE

NOTE:
WELDING , MACHINING OR MODIFICATION OF ANY AXLE COMPONENT IS PROHIBITED UNLESS NOTED IN THIS MANUAL, OR OTHER SPICER SPECIALITY AXLE DIVISION SERVICE LITERATURE.

GLOSSARY OF TERMS

Due to the international nature of Spicer Speciality Axle Division products certain terms and wordsrequire clarification; hence the following list:-

ENGLISH	U.S.A
SWIVEL	KNUCKLE
COTTER PIN	DRAW KEY
AXLE BED	I BEAM
STEERING LEVER	TIE ROD ARM
HUB NUT	SPINDLE NUT
SWIVEL STOP SCREW	STOP BOLT
TOP / BOTTOM CAP	KING PIN CAP
BUSHES	BUSHINGS
LUBRICATOR	ZIRC

GENUINE SPICER SERVICE PARTS

Should an axle assembly require replacement component parts, it is recommended that Spicer Speciality Axle Division service parts be used. Spicer Speciality Axle Division service parts are manufactured under the same rigid specification as are the original equipment axle components. This assures the customer who uses genuine Spicer Speciality Axle Division service parts, maximum reliability for a Spicer Speciality Axle Division assembly.
Spicer Speciality Axle Division service parts are available through either your vehicle manufacturer or through Spicer Speciality Axle Division spares department.
The use of non Spicer service parts may cause premature component failure and void the warranty.

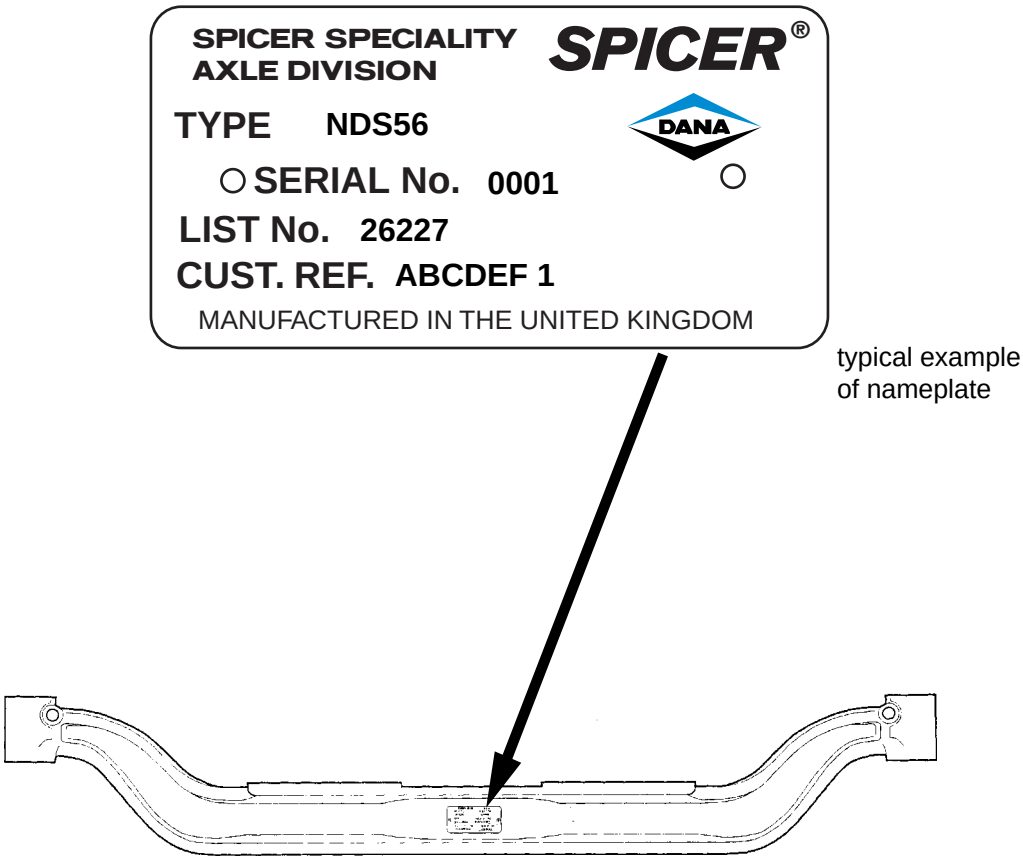
The items included in the spare parts section of this manual are currently available as service spare parts at the time of printing.
The part numbers and illustrations are provided specifically as a guide only.

ORDERING SPARE PARTS

In order to assist our spares department when ordering spare parts for your NDS range axle, please have the following information to hand.

1. Axle type
2. Axle list number
3. serial number

These can be found on the axle nameplate situated on the front of the axle bed as shown below:-



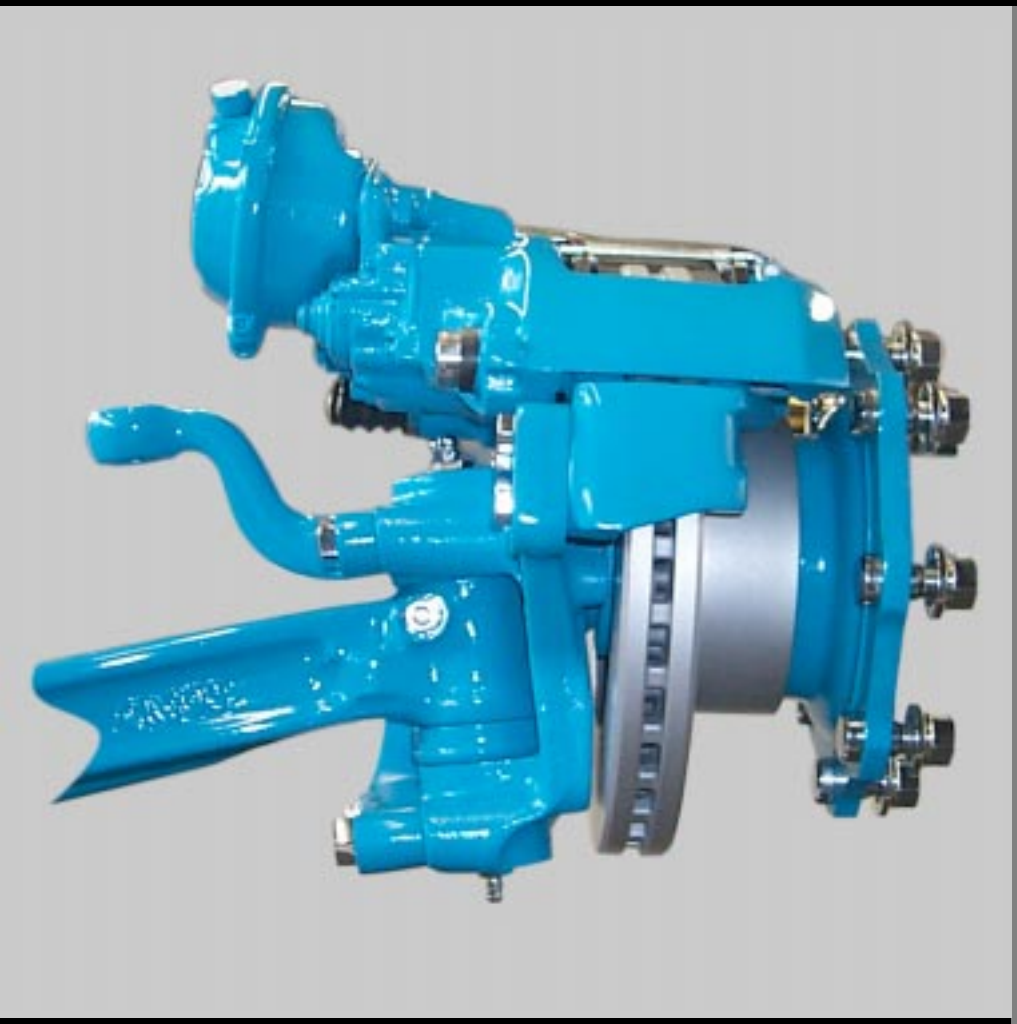
typical example of nameplate

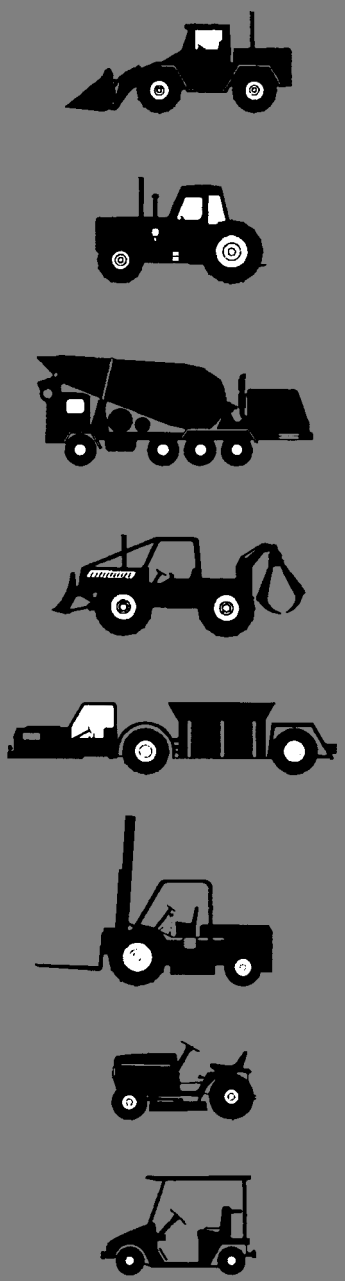
ALWAYS USE GENUINE SPICER® SPARE PARTS!

APPLICATION POLICY
Capability ratings, features and specifications vary depending upon the model type of service. Applications approvals must be obtained from Spicer Speciality axle division. We reserve the right to change or modify our product specifications, configurations, or dimensions at any time without notice.

SPICER SPECIALITY AXLE DIVISION
ABBEY ROAD
LEEDS LS5 3NF
ENGLAND
TEL (+44-113) 2584611 FAX (+44-113) 2586097

Maintenance Manual
NDS axles
Lubrication and Maintenance
NDS Axle range
Issue D





SPICER SPECIALITY AXLE DIVISION

DANA

MANUAL ISSUE SHEET

Page No.	Issue	Description / Alteration	Reason	Date
All	A	New Manual		Nov. 99
5	B	Mileage interval altered	Updated spec.	Mar.2000
9	B	Mileage interval altered	Updated spec.	Mar.2000
13	B	Tie rod torques added	New tie rod	Mar.2000
14	B	Tie rod torques added	New tie rod	Mar.2000
15	B	Air cylinder torques added	New spec	Mar.2000
18	B	Air cylinder torques added	New spec	Mar.2000
4	B	Lockstop setting info added	Clarification see SB1258	Sep.2000
3	B	Greasing period altered	Standardisation	Jan.2001
4	C	End float checking period added	Standardisation	Jan.2001

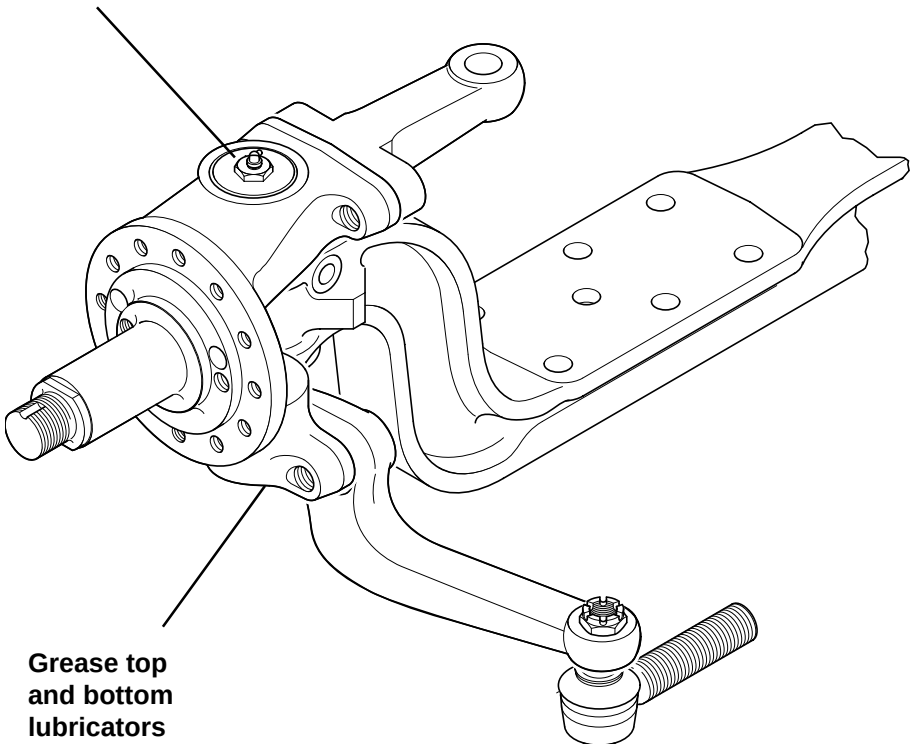
LUBRICATION AND ROUTINE MAINTENANCE FOR NDS AXLE RANGE

SECTION 1 LUBRICATION

1.1 GREASING PERIODS

1.1.1 ON HIGHWAY APPLICATIONS
Pressure lubricate every 6 months or 30000 miles (48000 km)
A more frequent lubrication cycle is required for axles used in on/off highway, refuse, or other severe service applications.

1.1.2 Grease points as shown in fig.no.1.



Greasing points
Fig.No.1

NOTE :- **ALL OTHER COMPONENTS IN THE NDS RANGE OF AXLES ARE GREASED FOR LIFE AND REQUIRE NO FURTHER LUBRICATION DURING THE LIFE OF THE COMPONENT.**

Recommended lubrication - LITHIUM BASE ROLLER BEARING GREASE NLGI NUMBER 2

1.2 Recommended Greases

Use greases to grade "F" in lubrication manual

SECTION 2 ROUTINE MAINTENANCE

2.1 Hub bearing check should be carried out every 30000 miles (48000 km)

a) Before commencing checks, apply parking brake, raise wheels off ground and support axle on stands. and remove brake drum (if fitted) .

WARNING!
NEVER WORK UNDER A VEHICLE SUPPORTED ONLY BY JACKS!
ALWAYS USE SUITABLE AXSLE STANDS!

b) Place magnetic base of a dial indicator on brake shoe / caliper and position dial indicator stem against a convenient marked spot on face of Hub flange

c) With dial indicator in position pull hard but steadily on Hub flange and oscillate at same time until a steady reading is achieved.

d) Without releasing the pressure, turn bearing so that dial indicator stem contacts marked spot and note reading on indicator.

e) Push bearing flange hard and oscillate as before until a steady reading is achieved.

f) Without releasing the pressure, turn bearing so that indicator stem again contacts the marked spot and note new reading on indicator.

g) The difference between readings is amount of mounted end play in bearing unit .

h) The mounted end play figure should not exceed 0.050mm for a new bearing.

NOTE:-
IF ORIGINAL BEARING UNIT IS RE-FITTED, AND END FLOAT IS MEASURED AT 1MM, WITH HUB NUT FULLY TIGHTENED TO CORRECT TORQUE, THEN THE RETAINING CLIP WITHIN THE UNIT IS DAMAGED / DISPLACED AND A NEW UNIT MUST BE FITTED.

To check front wheel ' Toe In '

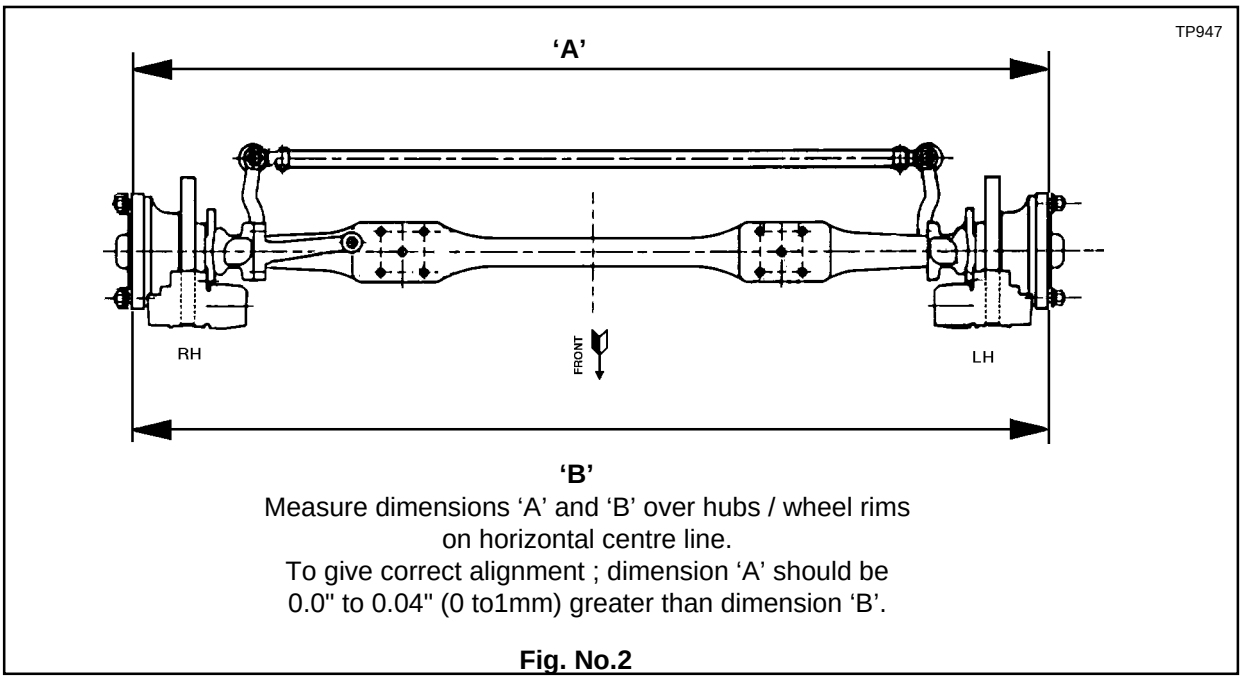
a) To preserve correct steering and avoid excessive tyre wear, tracking (or alignment) of front wheels should be checked periodically, as follows :-
Set front wheels in straight ahead position and at points level with wheel centre, measure distance over hubs / wheel rims, both in front and behind axle centre.
For correct 'Toe In' front measurement 'B' should be 0" to 0.04" (0 to1mm) smaller than rear measurement 'A' .

b) To allow for inaccuracies in wheels, same check should be made with vehicle moved an equivalent to half of a wheel revolution (180°). Any adjustment required can be effected by backing off clamp bolts in ball sockets and rotating tie (track) rod tube.
After adjustment, tighten clamp bolts to specified torque.

All steer axles supplied by Spicer Speciality Axle Division have their lockstops set to customer requirements.

It is important that when the power assisted steering is fitted, the steering gear is adjusted so that the hydraulic assistance cuts out just before the lockstops come into contact with the axle beam, to avoid excessive loads being transmitted through the steering linkages.

Incorrectly adjusted steering could lead to premature failure or shortened life of all steering components.



Measure dimensions 'A' and 'B' over hubs / wheel rims on horizontal centre line.
To give correct alignment ; dimension 'A' should be 0.0" to 0.04" (0 to1mm) greater than dimension 'B'.

Fig. No.2

2.3 Check condition of brake pads as described in relevant brake manufacturers service manual.

SECTION 2 ROUTINE MAINTENANCE Cont.

2.4 Check permissible slackness in swivel (king) pins every 30000 miles (48000 km) as follows :-

Aspects to be considered are :-

a) Lateral slackness.
b) Vertical slackness.

Before commencing checks, apply parking brake, raise wheels off ground and support axle on stands.

a) Checking lateral slackness

Whilst this is being carried out the brake must be applied.
Place a set -square with its stock on ground and its blade against tyre wall.
Place a mark on ground to indicate position of stock end.
Insert a lever through bottom cut-out of wheel and lever it upwards thus moving set-square outboard.
Mark changed position of stock end.
Maximum allowable stock displacement is given as follows:-

for 17.5" wheels	=	6mm.
for 19.5" wheels	=	7mm.
for 22.5" wheels	=	8mm.
for 24.0" wheels	=	9mm.

If displacement exceeds stated allowance then need for bush / bearing attention and possible renewal, is in evidence.

b) Checking vertical slackness

This is measured by a dial indicator anchored to axle beam and having its pointer placed vertical against swivel top.
Place a jack against underside of swivel and, whilst applying a lifting force, observe any movement on indicator dial.
If vertical movement is evident and it exceeds 0.040" (1.02mm) then re-adjustment of swivel is required by adjusting thickness of bearing adjusting washers.

2.5 Every 6 months, check for movement in ball joints as follows :-

NOTE :-
THIS TEST IS TO BE CARRIED OUT WITH VEHICLE IN LOADED CONDITION,
DO NOT JACK UP VEHICLE

a) Axial end float (axial travel)

End float in direction of axis of ball pin, as shown in fig. no.3 should be within limits of 0.4mm to 2.0mm max. using a test force of 850N.

b) Radial end float (radial travel)

Radial end float at right angles to axis of ball pin as shown in fig. no. 4 should be within limits of 0.4mm to 0.8mm max. using a test force of 6000N.

Replace ball joints if outside limits given in a) and / or b).

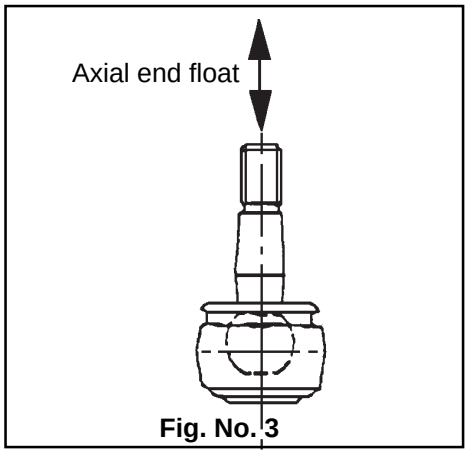


Fig. No. 3

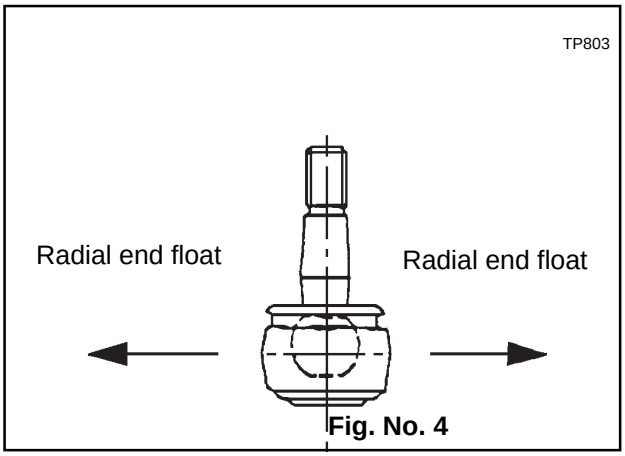


Fig. No. 4

SECTION 2 ROUTINE MAINTENANCE Cont.

2.6 Every 6 months inspect ball joints for corrosion as follows :-

NOTE:-
INSPECTION OF BALL JOINTS IS IMPORTANT, ESPECIALLY THOSE IN OLDER VEHICLES. DAMAGED SEALING BOOTS, SALT ON ROADS IN WINTER AND CLIMATIC CONDITIONS CAN CAUSE LOSS OF THE CORROSION PROTECTION COATING APPLIED DURING MANUFACTURE.

Inspection instructions:-

Ensure that ball joint is in an easy access-position.
Carefully clean the sealing boot contact area, to ensure that pollutants cannot get under the sealing boot during the following inspection procedure.
Use an appropriate inspection sheet-metal-tool, eg. spatula with cut out, (fig. no.5) to push up the sealing boot (without damaging it) until ball pin surface is visible. Degrease the ball pin surface.

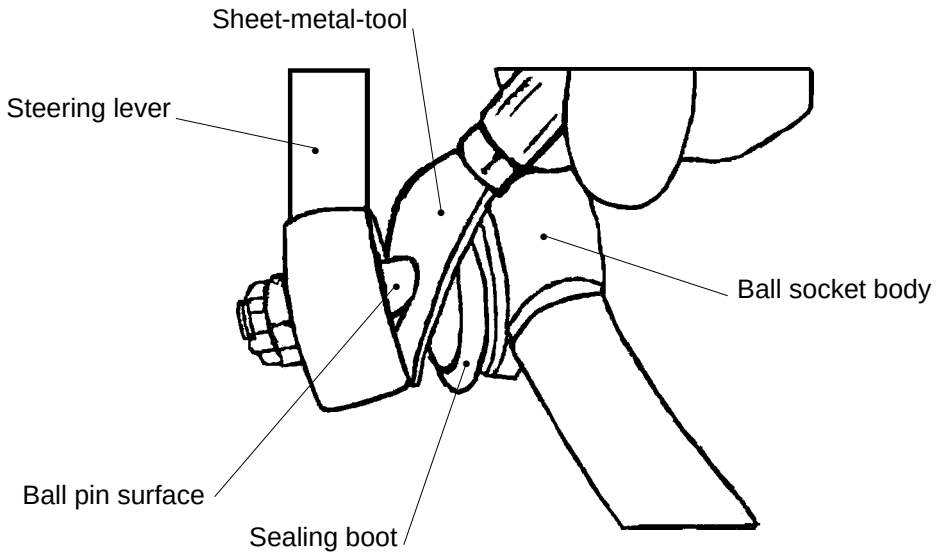


Fig. No. 5

If there is corrosion of the ball pin or the sealing boot has deteriorated through ageing or is damaged, replace the ball joint in question, or the complete tie rod or drag link as appropriate.

If there is corrosion of the steering lever area which is in contact with the sealing boot, clean and eliminate all surface irregularities.

If there is no corrosion or damage to the sealing boot, smear the steering lever surface with Lithium grease and push the sealing boot back into its properly seated position.

When dismantling tie rods, drag links or drop arms ensure that no damage is caused to the sealing boots or ball joint housings.

SECTION 3 CARE OF WHEELS AND FIXING FACES (ALL AXLES WITH SPIGOT FIXING)

At approximately 100 miles after fitting wheels, wheel nut torque should be checked with wheel ends in " cold " condition (ie not after prolonged braking.).
If any relaxation of original torque **(see specification)** has occured, re-tighten.
Relaxation of initial torque may occur because of " **Bedding Down**" of hub and wheel surfaces.

NOTE:-
TIGHTENING SHOULD NOT BE DONE IMMEDIATELY AFTER PROLONGED BRAKING I.E. WHEN WHEEL ENDS ARE HOT. A RELAXATION OF WHEEL NUT TORQUE DOES OCCUR WHEN WHEEL END IS HOT BUT SHOULD REVERT BACK TO THE ORIGINAL SETTING AS THE WHEEL END COOLS DOWN. RE- TIGHTENING WHEN HOT WILL PRODUCE A HIGHER TORQUE READING WHEN COLD!

Although this single re-tightening after first 100 miles should be sufficient to ensure wheels stay tight, extra checks are recommended within at least the first 1000 miles to check that wheel assembly is stable and that no further relaxation is occuring.

see graphic on following page for correct tightening sequence of wheel nuts

3.1 Care of wheels :-

Check for **CRACKS** in wheels, especially around the fixing holes, and in studs, nuts and washers.
If in doubt **RENEW** .
DO NOT simply re-tighten very loose wheel fixings or wheels which are continualy becoming loose.
Find out why they are loose and whether any damage has been caused.
Use **TRAINED** personnel and keep **RECORDS** of all attention to wheels and fixings, including which parts were renewed and when.

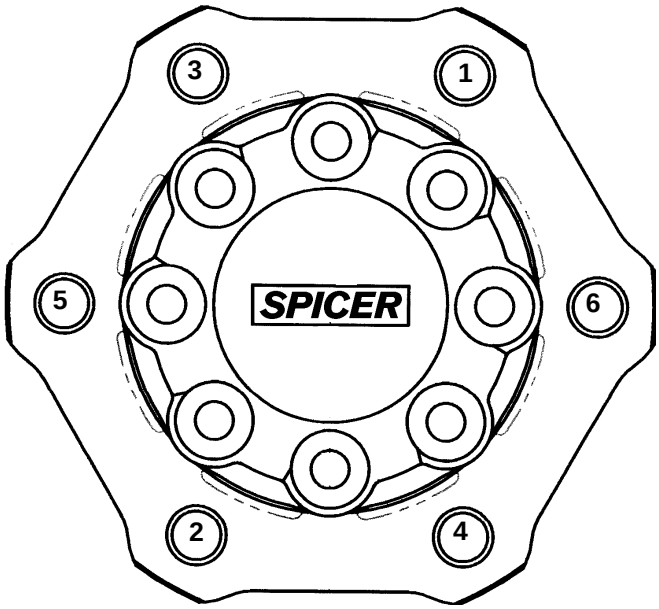
NOTE :-
FURTHER DETAILS ARE GIVEN IN BRITISH STANDARD CODE OF PRACTICE FOR THE SELECTION AND CARE OF TYRES AND WHEELS FOR COMMERCIAL VEHICLES:- BSAU50 : PART2 : SECTION 7A : 1995

3.2 PROTECTION OF SPIGOT WHEEL FIXING DIAMETERS AND PRESSURE SURFACES.

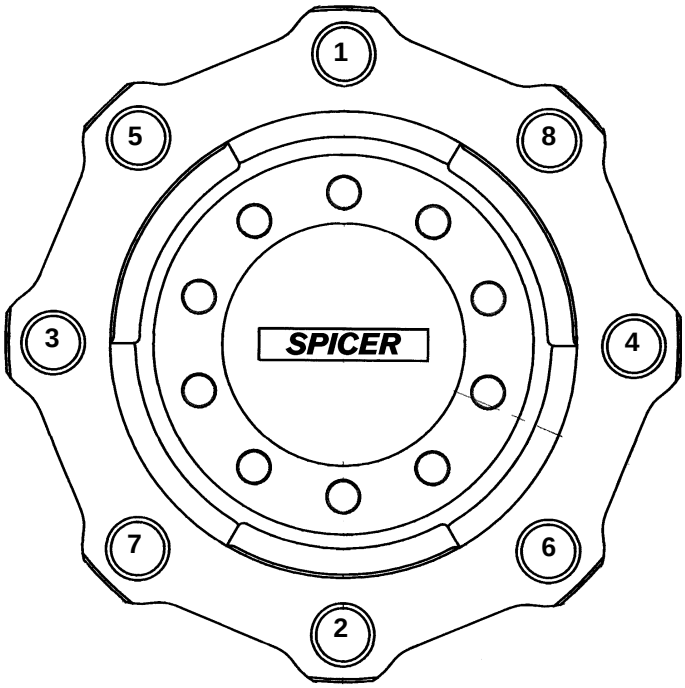
Although **Spicer Speciality Axles Division** apply an initial surface coating to wheel rim mating faces on spigot to stop rusting and facilitate easy removal of wheels. The application of P.B.C. grease such as 'Rocol Tufgear' or equivalent to wheel register is recommended.

The above P.B.C. grease is available from Rocol Ltd., Rocol House, Wakefield Road, Swillington, Leeds, UK. Phone: 44 (113) 2322600. Fax: 44 (113) 2322740.

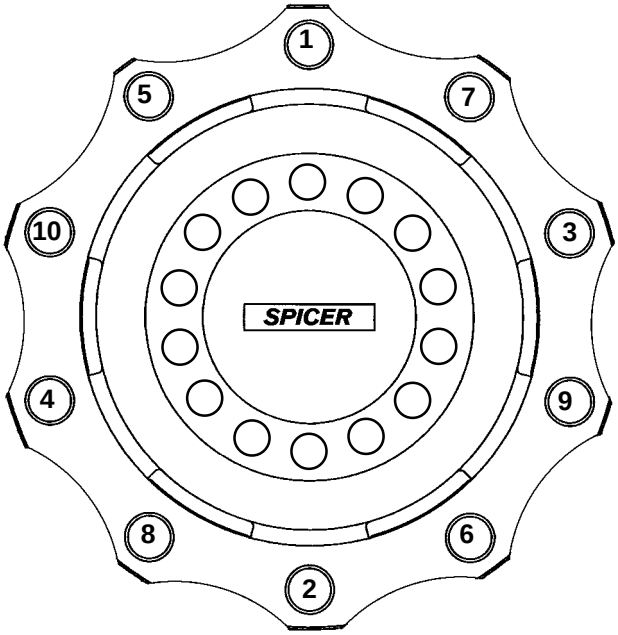
WHEELNUT TIGHTENING
TORQUE SEQUENCE
6 - STUD FIXING



WHEELNUT TIGHTENING
TORQUE SEQUENCE
8 - STUD FIXING



WHEELNUT TIGHTENING
TORQUE SEQUENCE
10 - STUD FIXING



SECTION 4 Guidance standards for acceptable brake drum crazing (if fitted).

Every 30000 miles (48000 km) or whenever brake drums are removed for axle maintenance purposes they should be checked for crazing.

Brake drums with crazing in excess of that shown in fig.6 below, and which are of Spicer Speciality axle division manufacture should not be re introduced into service.

Figs.7 & 8 show examples of unacceptable crazing.

fig.6

fig.7

fig.8

EVALUATION OF BRAKE DISC SURFACE

TP1627

Fig. 9

Upon removal of brake disc Fig. 9. It's surface should be checked for defects. Inspection should cover both sides of the braking surface as well as the outer diameter of the disc.
Brake disc thickness should be checked in accordance with manufacturers dimensional recommendations.

You should inspect for the following:-
- Heat checking
- Cracks
- Grooves - scoring
- Blue marks - Banding
- Polished discs

Heat checking can be light or heavy,

If **light heat checking** type cracks (fine and light) are found as shown in Fig.10 the disc can continue to be used.

If **heavy heat checking** type cracks (deep and wide) are found the disc **must be replaced.**

TP1628

Fig. 10

Cracks can be of 2 types **Radial or Through.**

If any **radial** cracks are found in the brake disc surface as shown in fig. 11. then the disc **must be replaced.**.

TP1629

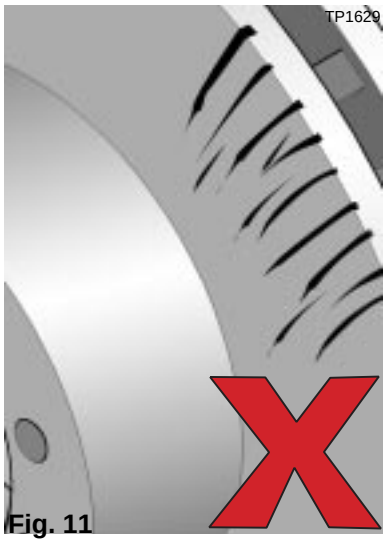


Fig. 11

If any **Through** cracks are found in the brake disc as shown in fig. 12. then the disc **must be replaced.**.

TP1630

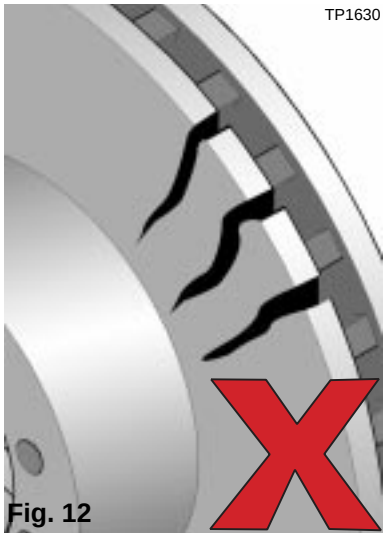


Fig. 12

EVALUATION OF BRAKE DISC SURFACE CONTINUED

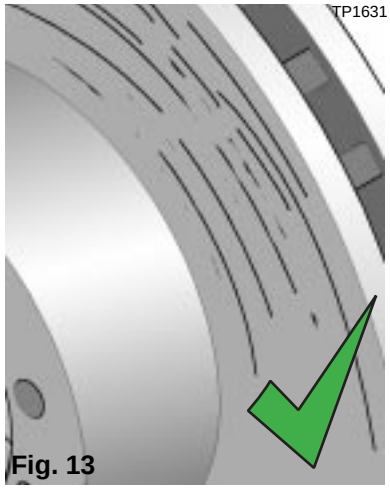


Fig. 13

Grooving - Scoring can be light or heavy,

If **light** grooving is found as shown in Fig. 13 then the disc can continue to be used.

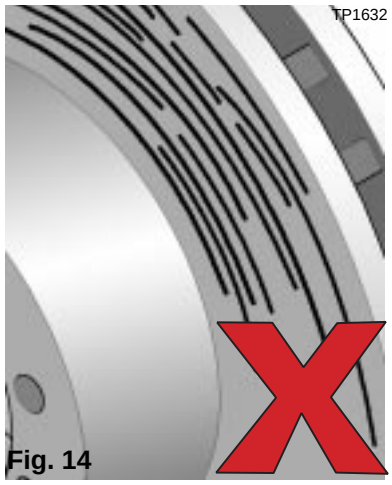


Fig. 14

If **Heavy** grooving is found as shown in Fig. 14 then the disc must be replaced.

Fig. 15

Blue marks - banding indicates that the disc has been exposed to very high temperatures.
If **Blue marks - banding** are found, the reason for the high temperatures must be investigated and corrected.
Refer to the Brake manufacturer for details.
if left uncorrected the formation of heavy heat checking / cracks will occur.

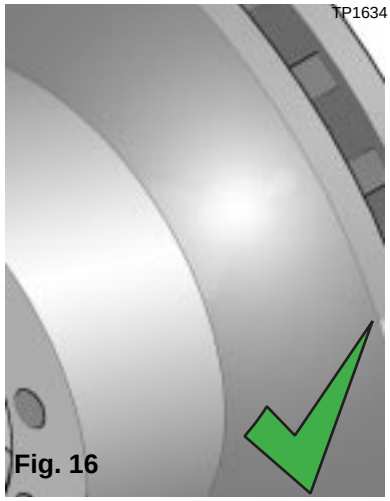


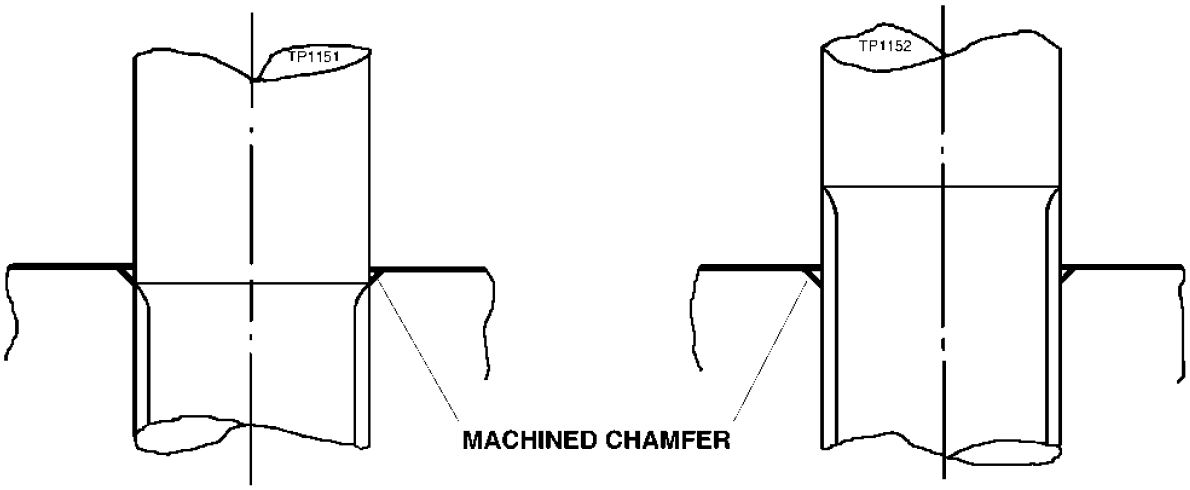
Fig. 16

Polished discs indicate the use of improper lining material or that the disc has been re- machined to too fine a surface finish.
The **Gloss / polish** should be removed using (80) grit Emery cloth and the brake manufacturer should be contacted for an alternate liner material.

SPICER SPECIALITY AXLE DIVISION

STANDARD STUDS - FITTED INTO MACHINED CHAMFERED HOLES

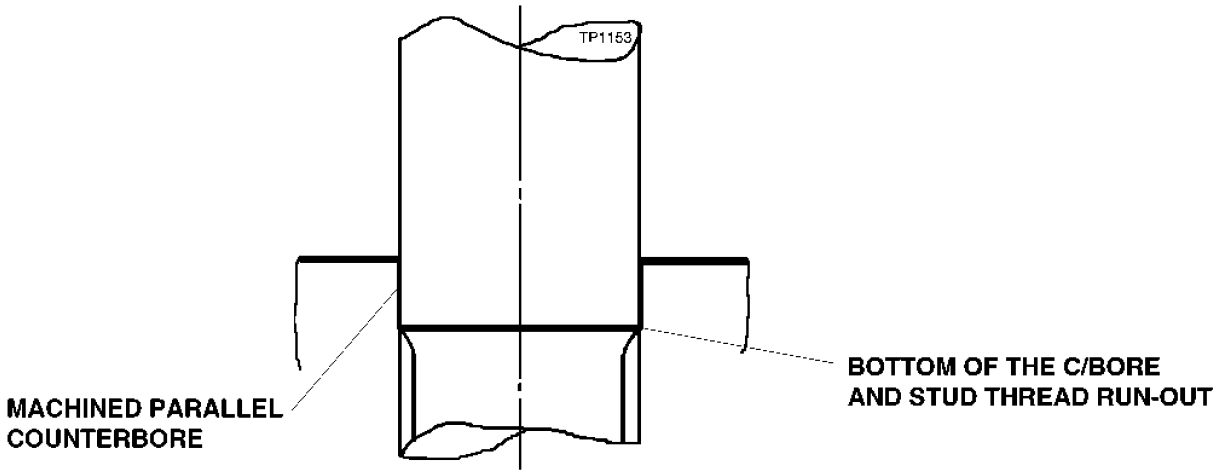
STUDS TO BE INSERTED UNTIL THREAD RUN-OUT LOCKS INTO PARENT METAL



IMPORTANT :- THIS STUD FITTING PROCEDURE IS TO BE USED IN LIEU OF STATED TORQUE VALUES ON EXISTING ARRANGEMENTS.
NEW ARRANGEMENTS WILL SPECIFY TD183/1 FROM THE DATE OF ISSUE.

SPECIAL STUDS - FITTED INTO MACHINED PARALLEL COUNTERBORE

STUDS TO BE INSERTED UNTIL CORRECT TORQUE VALUE IS OBTAINED -
AS SHOWN ON RELEVANT ARRANGEMENT DRAWING



THIS SPECIFICATION IS FOR STUD FITTING ONLY ;
NUTS & SETSCREWS MUST BE TORQUED TO VALUE SPECIFIED

Alteration Numbers									
ISSUE A									

DISTRIBUTION	STUD FITTING PROCEDURES	TD183/1
Front Axle B.U. Drive Axle B. U. Production		SHT 1 OF 1

SWIVEL / AXLE BED TIGHTENING TORQUES

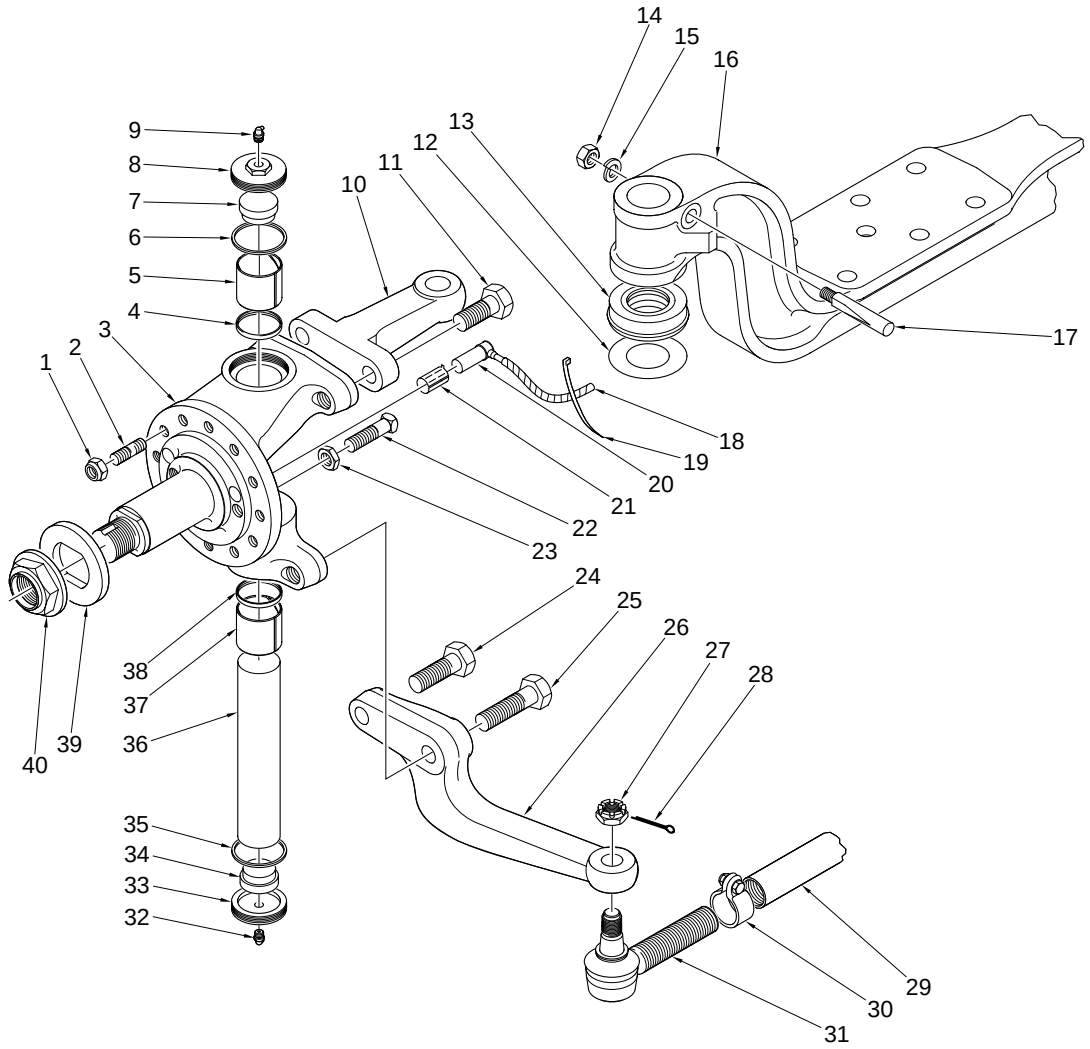


Fig.No.17

PART N°	DESCRIPTION	TIGHTENING TORQUE		
1	Brake backplate nut 1/2" UNF	85 - 103 lbs.ft	115 - 140 NM	(All axles)
2	Brake backplate stud 1/2" UNF	See TD 183/1		(All axles)
8	Swivel top cap	25 - 75 lbs.ft	34 - 102 NM	(All axles)
9	Swivel top cap lubricator	10 - 15 lbs.ft	14 - 20 NM	(All axles)
11	Top lever bolts M20 x 2.5 grade 10.9	433 - 479 lbs.ft	587 - 649 NM	(NDS 35/41/56)
	Top lever bolts M20 x 2.5 grade 12.9	520 - 575 lbs.ft	705 - 780NM	(NDS 56)
	Top lever bolts M24 x 3 grade 10.9	751 - 830 lbs.ft	1018 - 1125 NM	(NDS 80)
14	Cotter pin nut 1/2" UNF	51 - 61 lbs.ft	69 - 82 NM	(All axles)
23	Lockstop nut	90 - 120 lbs.ft	122 - 162 NM	(All axles)
24 & 25	Bottom lever bolts M20 x 2.5 grade 10.9	433 - 479 lbs.ft	587 - 649 NM	(NDS 35/41/56)
	Bottom lever bolts M20 x 2.5 grade 12.9	520 - 575 lbs.ft	705 - 780NM	(NDS 80)
	Bottom lever bolts M24 x 3 grade 10.9	751 - 830 lbs.ft	1018 - 1125 NM	(NDS 80)
27	Ball pin nut (F4845T assembly)	155 - 170 lbs.ft	210 - 230 NM	(All axles)
	Ball pin nut (F4109T assembly)	184 - 206 lbs.ft	249 - 279 NM	(All axles)
	Ball pin nut (F4779S assembly)	100 - 170 lbs.ft	135 - 230 NM	(All axles)
	Ball pin nut (F4897S assembly)	190 - 220 lbs.ft	257 - 298 NM	(All axles)
30	Socket pinch bolt (F4845T assembly)	33 - 37 lbs.ft	45 - 50 NM	(All axles)
	Socket pinch bolt (F4109T assembly)	52 - 59 lbs.ft	70 - 80 NM	(All axles)
	Socket pinch bolt (F4779S assembly)	65 - 75 lbs.ft	88 - 102 NM	(All axles)
	Socket pinch bolt (F4897S assembly)	118 - 155 lbs.ft	160 - 210 NM	(All axles)
33	Swivel bottom cap lubricator	10 - 15 lbs.ft	14 - 20 NM	(All axles)
34	Swivel bottom cap	25 - 75 lbs.ft	34 - 102 NM	(All axles)
41	Hub nut	350 - 400 lbs.ft	475 - 542 NM	(NDS 35/41/56)
	Hub nut	575 - 626 lbs.ft	778 - 849 NM	(NDS 80)

SWIVEL / AXLE BED TIGHTENING TORQUES

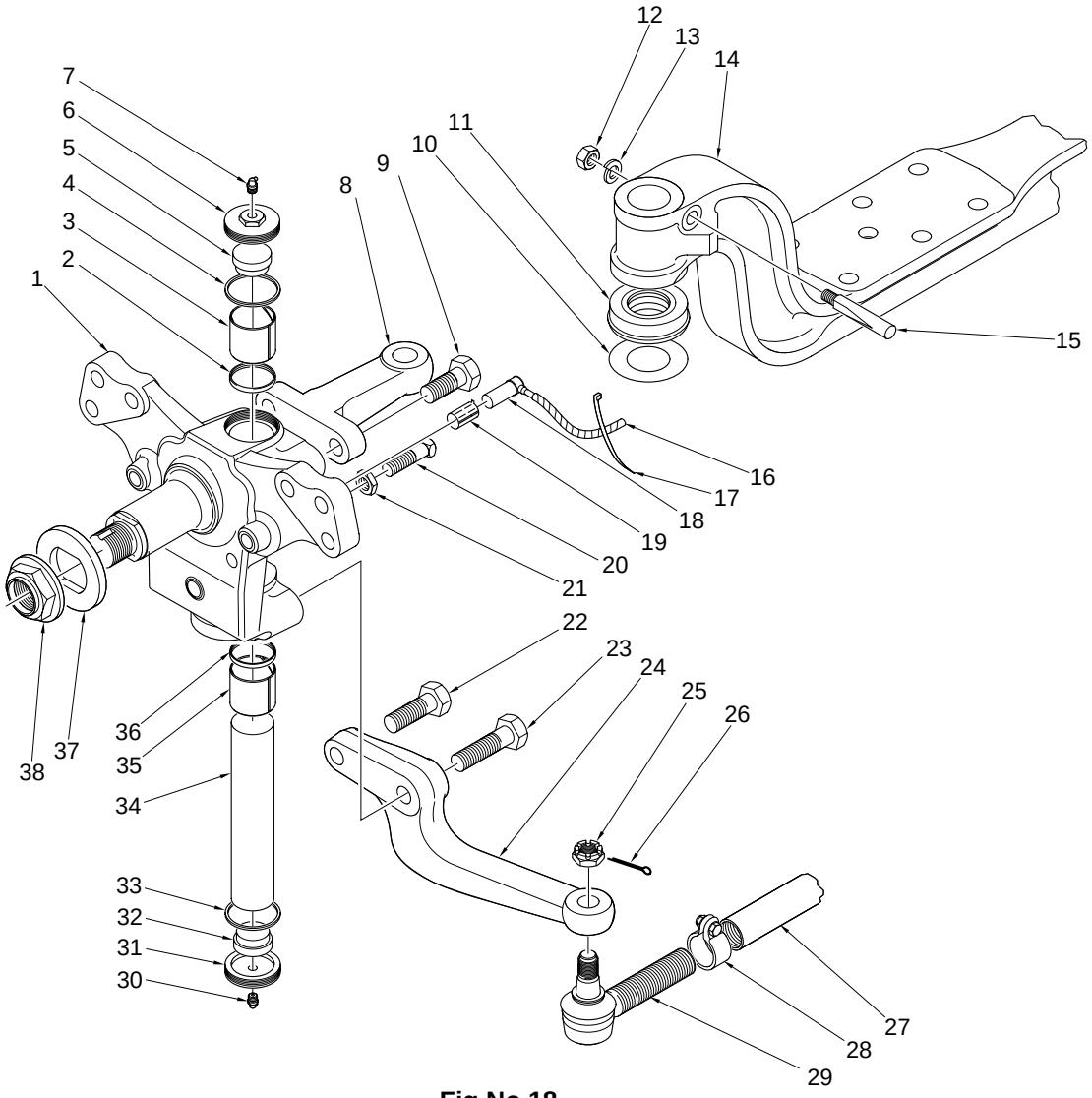


Fig.No.18

PART N^{O}	DESCRIPTION	TIGHTENING TORQUE		
6	Swivel top cap	25 - 75 lbs.ft	34 - 102 NM	(All axles)
7	Swivel top cap lubricator	10 - 15 lbs.ft	14 - 20 NM	(All axles)
9	Top lever bolts M20 x 2.5 grade 10.9	433 - 479 lbs.ft	587 - 649 NM	(NDS 35/41/56)
	Top lever bolts M20 x 2.5 grade 12.9	520 - 575 lbs.ft	705 - 780NM	(NDS 56)
	Top lever bolts M24 x 3 grade 10.9	751 - 830 lbs.ft	1018 - 1125 NM	(NDS 80)
12	Cotter pin nut 1/2" UNF	51 - 61 lbs.ft	69 - 82 NM	(All axles)
21	Lockstop nut	90 - 120 lbs.ft	122 - 162 NM	(All axles)
22 & 23	Bottom lever bolts M20 x 2.5 grade 10.9	433 - 479 lbs.ft	587 - 649 NM	(NDS 35/41/56)
	Bottom lever bolts M20 x 2.5 grade 12.9	520 - 575 lbs.ft	705 - 780NM	(NDS 80)
	Bottom lever bolts M24 x 3 grade 10.9	751 - 830 lbs.ft	1018 - 1125 NM	(NDS 80)
25	Ball pin nut (F4845T assembly)	155 - 170 lbs.ft	210 - 230 NM	(All axles)
	Ball pin nut (F4109T assembly)	184 - 206 lbs.ft	249 - 279 NM	(All axles)
	Ball pin nut (F4779S assembly)	100 - 170 lbs.ft	135 - 230 NM	(All axles)
	Ball pin nut (F4897S assembly)	190 - 220 lbs.ft	257 - 298 NM	(All axles)
28	Socket pinch bolt (F4845T assembly)	33 - 37 lbs.ft	45 - 50 NM	(All axles)
	Socket pinch bolt (F4109T assembly)	52 - 59 lbs.ft	70 - 80 NM	(All axles)
	Socket pinch bolt (F4779S assembly)	65 - 75 lbs.ft	88 - 102 NM	(All axles)
	Socket pinch bolt (F4897S assembly)	118 - 155 lbs.ft	160 - 210 NM	(All axles)
30	Swivel bottom cap lubricator	10 - 15 lbs.ft	14 - 20 NM	(All axles)
31	Swivel bottom cap	25 - 75 lbs.ft	34 - 102 NM	(All axles)
38	Hub nut	350 - 400 lbs.ft	475 - 542 NM	(NDS 35/41/56)
	Hub nut	575 - 626 lbs.ft	778 - 849 NM	(NDS 80)

SWIVEL / HUB END TIGHTENING TORQUES

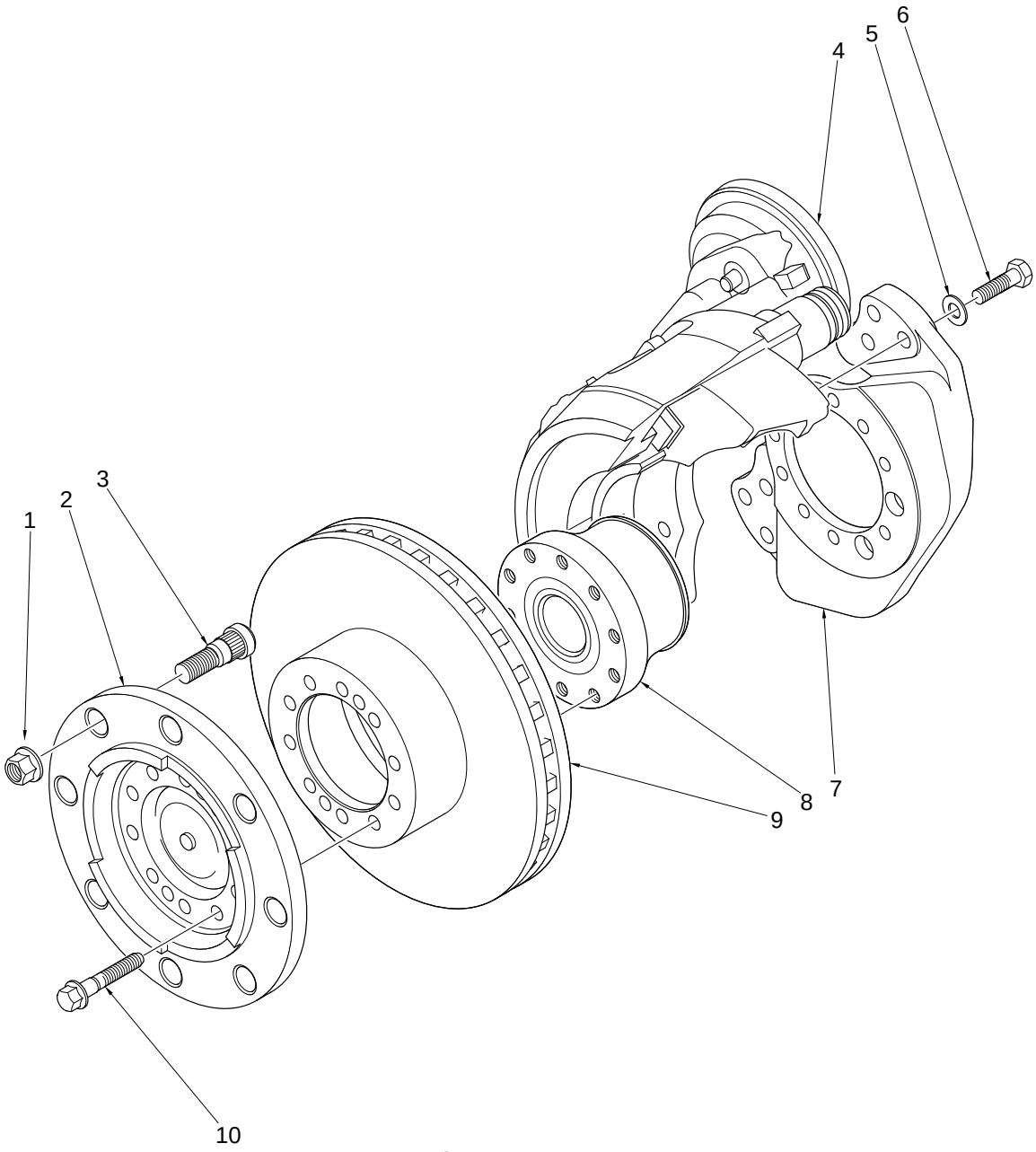


Fig.No.19

PART N^{O}	DESCRIPTION	TIGHTENING TORQUE	
1	Wheel nut M18 x 1.5	235 - 260 lbs.ft	318 - 352NM
	Wheel nut M20 x 1.5	285 - 315 lbs.ft	386 - 427NM
	Wheel nut M22 x 1.5	475 - 525 lbs.ft	644 - 712NM
6	Brake Caliper Mounting Bolt M14 x 1.5	174 - 192 lbs.ft	236 - 260NM
	Brake Caliper Mounting Bolt M16 x 1.5	266 - 294 lbs.ft	360 - 399NM
	Brake Caliper Mounting Bolt M18 x 1.5	372 - 412 lbs.ft	504 - 559NM
	Brake Caliper Mounting Bolt M20 x 1.5	520 - 574 lbs.ft	705 - 778NM
4	Brake air cylinder retaining nuts M16 X 1.5	133 - 155 lbs.ft	180 - 210NM
10	Hub flange retaining bolt M14 x 1.5	174 - 192 lbs.ft	236 - 260NM

SWIVEL / HUB END TIGHTENING TORQUES

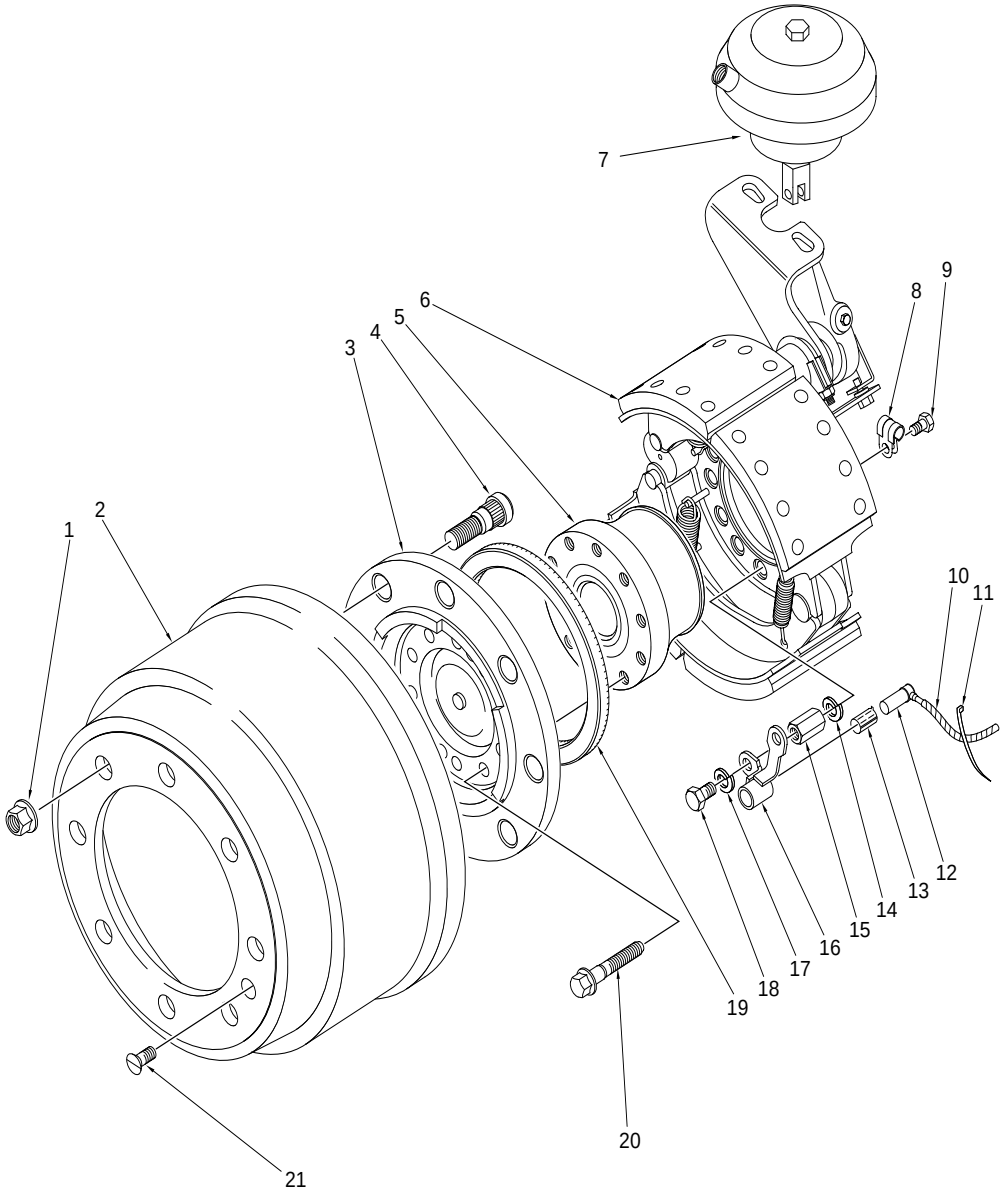


Fig.No.20

PART N^{O}	DESCRIPTION	TIGHTENING TORQUE	
1	Wheel nut M18 x 1.5	235 - 260 lbs.ft	318 - 352NM
	Wheel nut M20 x 1.5	285 - 315 lbs.ft	386 - 427NM
	Wheel nut M22 x 1.5	475 - 525 lbs.ft	644 - 712NM
8	Hub flange retaining bolt M14 x 1.5	174 - 192 lbs.ft	236 - 260NM
9	Brake drum retaining screw	26 - 32 lbs.ft	35 - 43NM

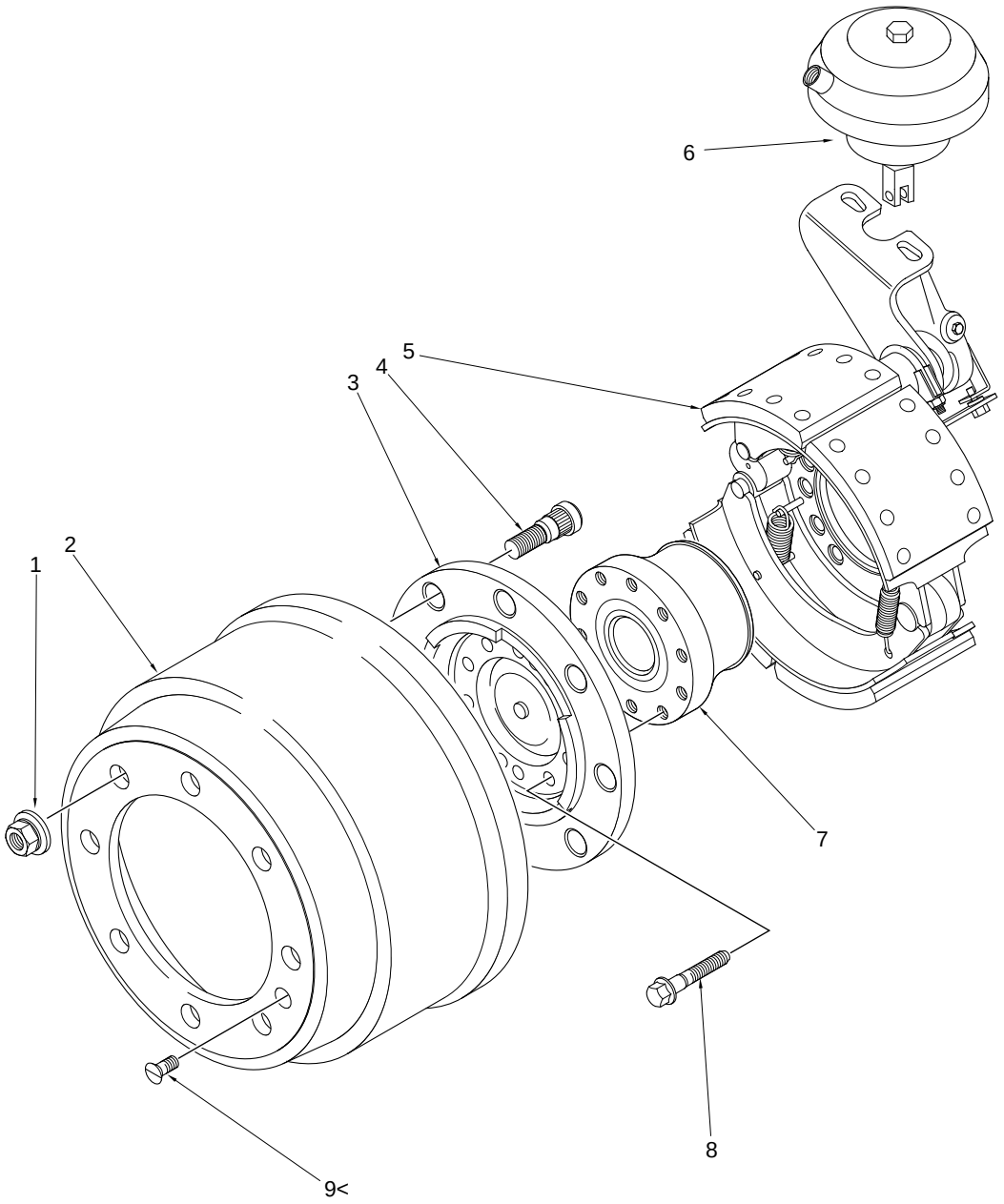


Fig.No.21

PART N^{O}	DESCRIPTION	TIGHTENING TORQUE	
1	Wheel nut M18 x 1.5	235 - 260 lbs.ft	318 - 352NM
	Wheel nut M20 x 1.5	285 - 315 lbs.ft	386 - 427NM
	Wheel nut M22 x 1.5	475 - 525 lbs.ft	644 - 712NM
20	Hub flange retaining bolt M14 x 1.5	174 - 192 lbs.ft	236 - 260NM
21	Brake drum retaining screw	26 - 32 lbs.ft	35 - 43NM

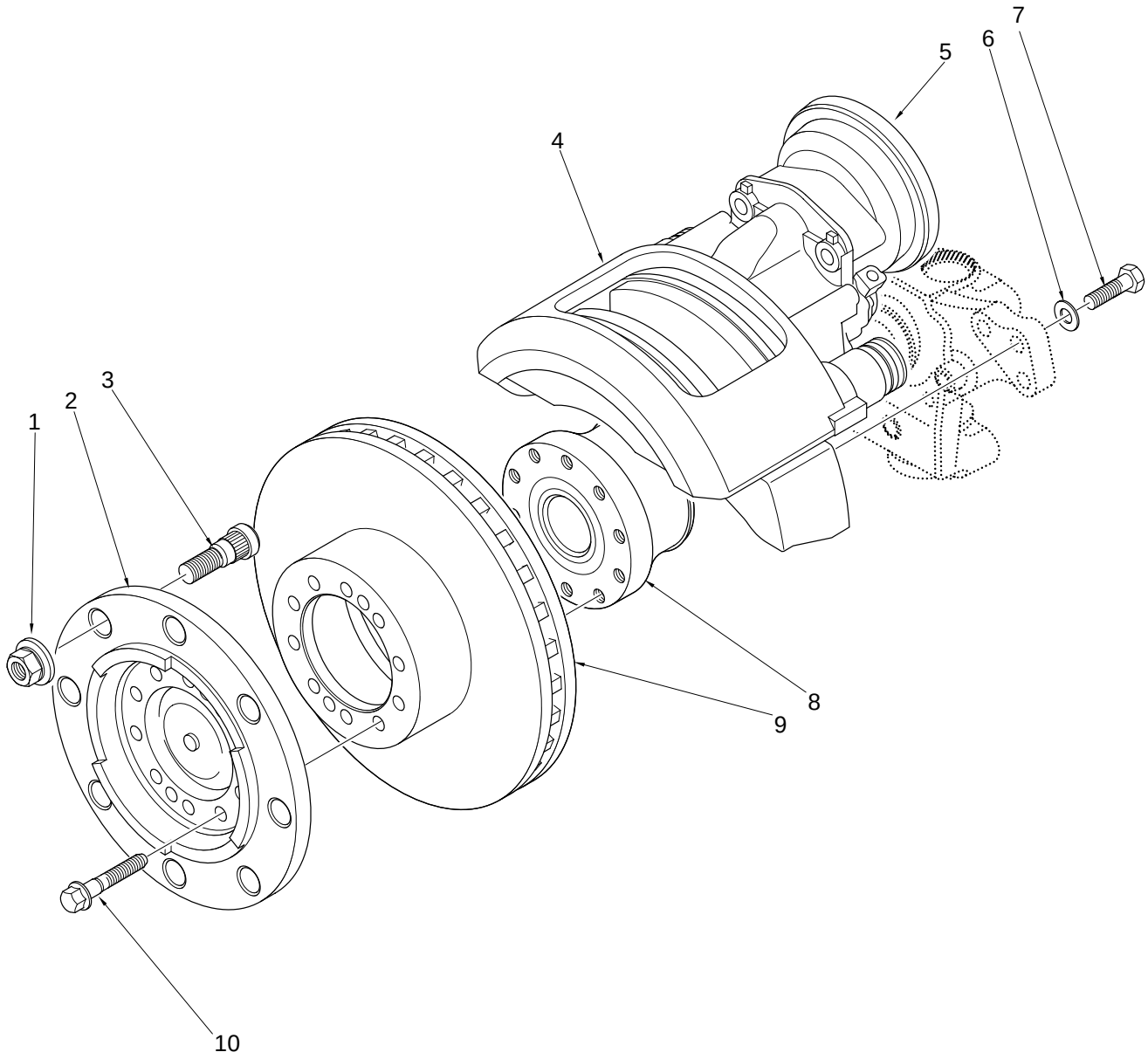


Fig.No.22

PART N^{O}	DESCRIPTION	TIGHTENING TORQUE	
1	Wheel nut M18 x 1.5	235 - 260 lbs.ft	318 - 352NM
	Wheel nut M20 x 1.5	285 - 315 lbs.ft	386 - 427NM
	Wheel nut M22 x 1.5	475 - 525 lbs.ft	644 - 712NM
5	Brake air cylinder retaining nuts M16 X 1.5	133 - 155 lbs.ft	180 - 210NM
6	Brake Caliper Mounting Bolt M14 x 1.5	174 - 192 lbs.ft	236 - 260NM
	Brake Caliper Mounting Bolt M16 x 1.5	266 - 294 lbs.ft	360 - 399NM
	Brake Caliper Mounting Bolt M18 x 1.5	372 - 412 lbs.ft	504 - 559NM
	Brake Caliper Mounting Bolt M20 x 1.5	520 - 574 lbs.ft	705 - 778NM
10	Hub flange retaining bolt M14 x 1.5	174 - 192 lbs.ft	236 - 260NM

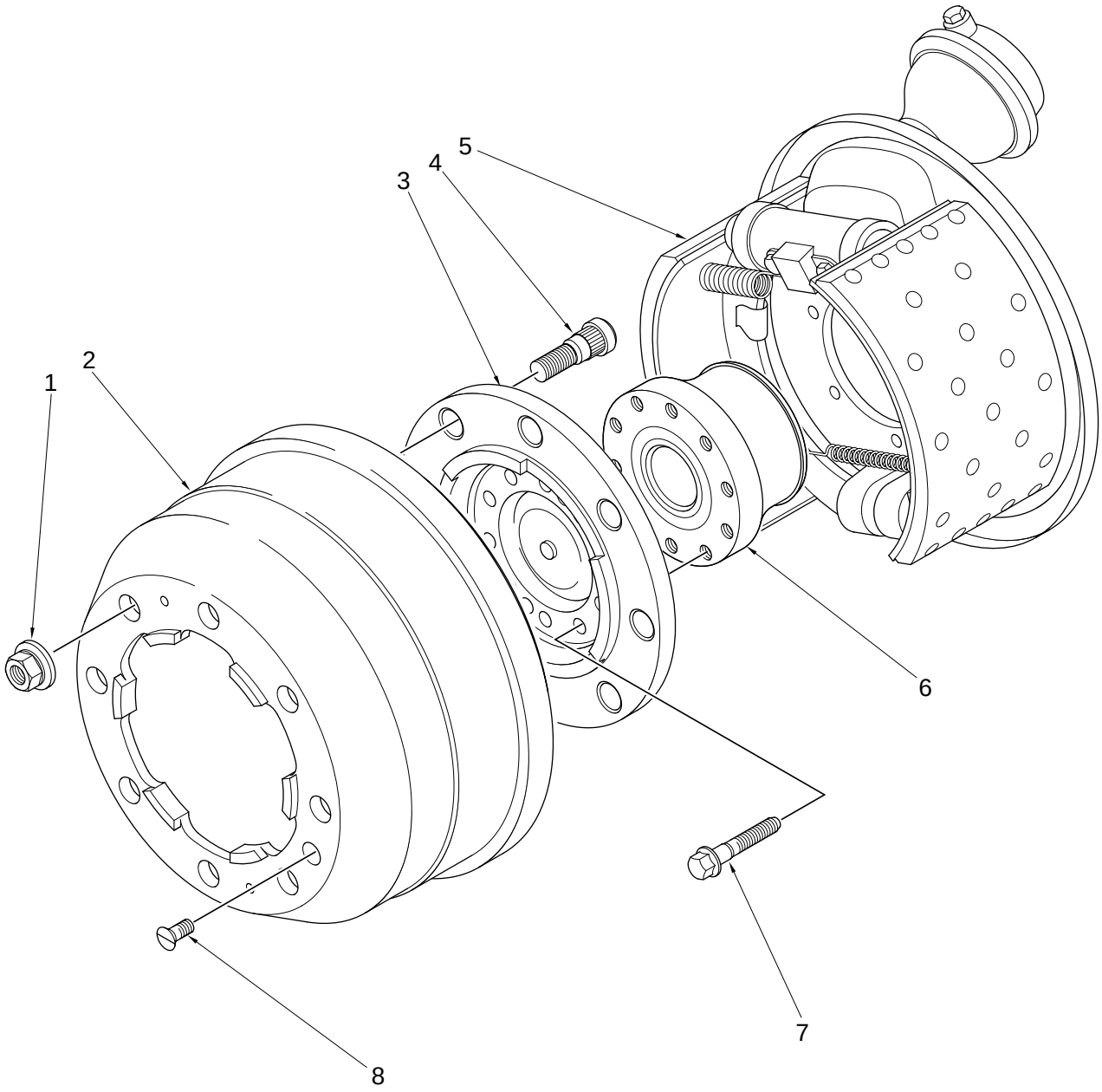


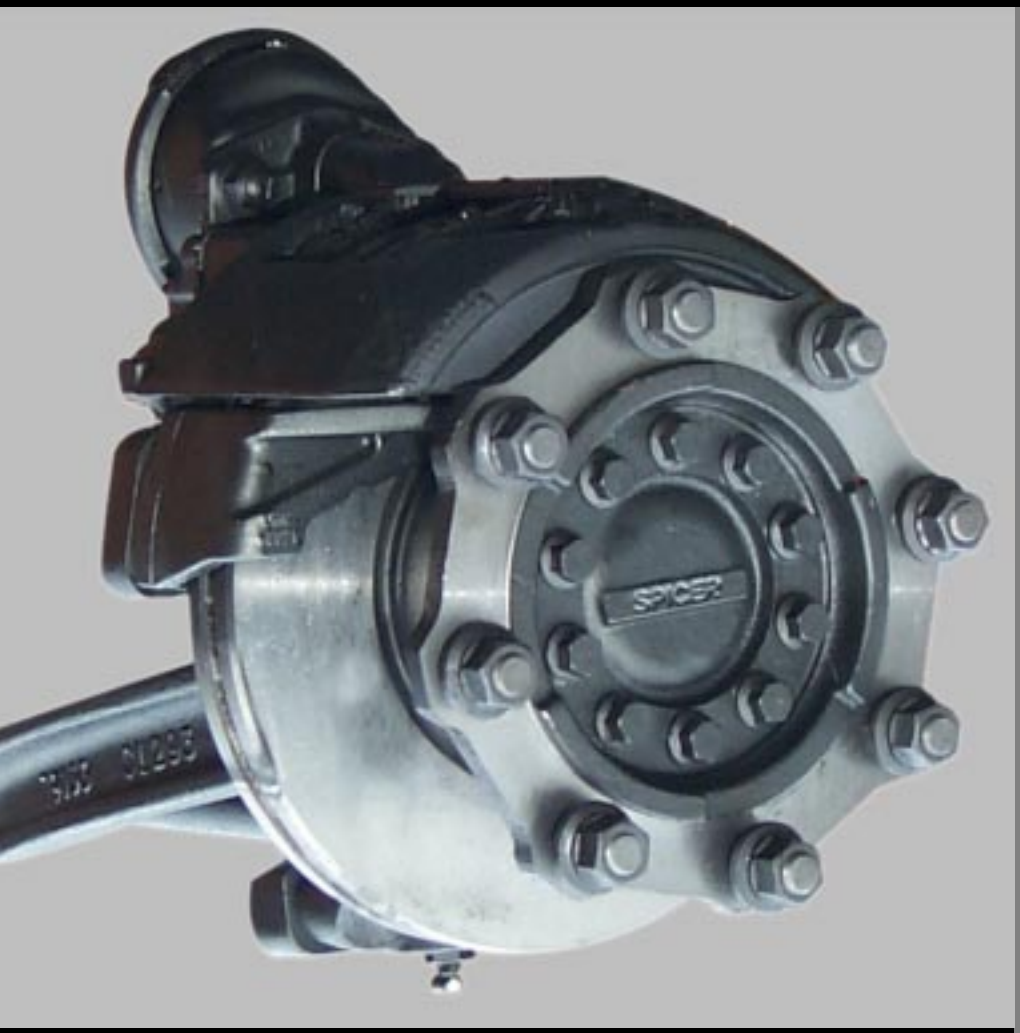
Fig.No.23

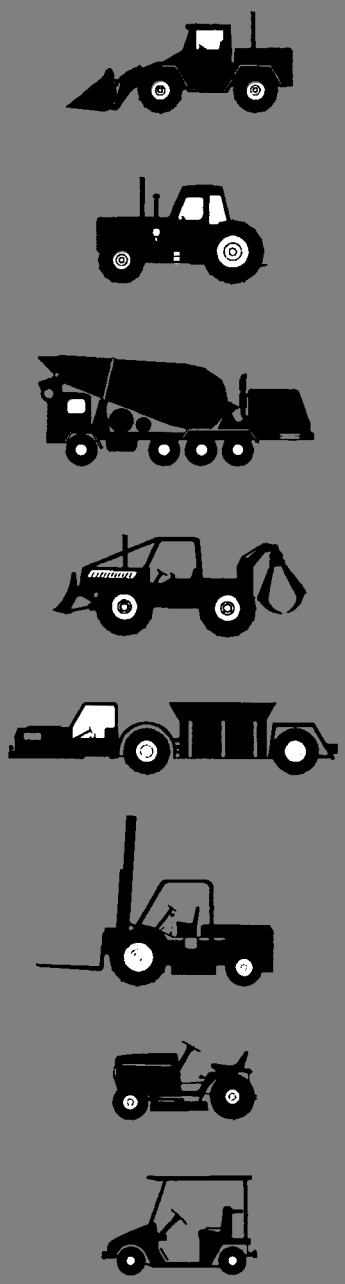
PART N^{O}	DESCRIPTION	TIGHTENING TORQUE	
1	Wheel nut M18 x 1.5	235 - 260 lbs.ft	318 - 352NM
	Wheel nut M20 x 1.5	285 - 315 lbs.ft	386 - 427NM
	Wheel nut M22 x 1.5	475 - 525 lbs.ft	644 - 712NM
7	Hub flange retaining bolt M14 x 1.5	174 - 192 lbs.ft	236 - 260NM
8	Brake drum retaining screw	26 - 32 lbs.ft	35 - 43NM

APPLICATION POLICY
Capability ratings, features and specifications vary depending upon the model type of service. Applications approvals must be obtained from Spicer Speciality Axle Division. We reserve the right to change or modify our product specifications, configurations, or dimensions at any time without notice.

SPICER SPECIALITY AXLE DIVISION
Abbey Road, Kirkstall
Leeds LS5 3NF
England
Tel: (113) 2584611 Fax: (113) 2586097

Maintenance manual
Model NDS
Hub and brake assembly
With Knorr Bremse
Disc brake
Fitted to offset barrel swivel





SPICER SPECIALITY AXLE DIVISION

MANUAL ISSUE SHEET

Page No.	Issue	Description / Alteration	Reason	Date
All	A	New Manual		Mar.2000
11	B	Page added all subsequent pages re numbered	Brake disc checking added	Oct.2000
7	C	Optimol Paste Added	To prevent fretting ECN 8695	Aug.2002

OVERHAUL PROCEDURES

PREPARATION

Prepare for axle overhaul as follows:

1 Set parking brake and block drive wheels to prevent vehicle movement.

2. Raise vehicle until tyres are off the ground. support raised vehicle with safety stands.

WARNING!

NEVER WORK UNDER A VEHICLE SUPPORTED ONLY BY A JACK. ALWAYS USE SAFETY STANDS.

HUB END DISASSEMBLY

1. Disconnect brake connections and ABS sensor from vehicle.
Fit plugs to connections to prevent dirt ingress.

2. Loosen but do not remove, brake caliper retaining bolts

3. Using suitable lifting equipment, support the brake caliper.

4. Remove brake caliper retaining bolts and remove brake caliper from axle.

WARNING!
BRAKE CALIPER IS HEAVY
ENSURE WEIGHT IS FULLY SUPPORTED BEFORE REMOVING RETAINING BOLTS.
TAKE CARE TO AVOID CALIPER SWINGING AND TRAPPING FINGERS.

NOTE:-
BRAKE CALIPERS ARE HANDED!
SPICER SPECIALITY AXLE DIVISION RECOMMENDS MARKING CALIPERS WITH PAINT OR MARKER PEN TO FACILITATE CORRECT REFITTING

BRAKE AIR CYLINDERS SHOULD ONLY BE REMOVED IF REPLACEMENT OR REPAIR IS REQUIRED.

REFER TO THE BRAKE MANUFACTURERS MANUAL FOR DETAILS OF CALIPER OR AIR CYLINDER SERVICE.

OVERHAUL PROCEDURES

HUB END DISASSEMBLY

5. Loosen but do not remove hub flange bolts.

6. Remove 2 diametrically opposed hub flange bolts.

7. Replace 2 diametrically opposed hub flange bolts with 2 studs (loosely fitted).

NOTE!
REPLACEMENT STUDS SHOULD PROTRUDE BEYOND FRONT FACE OF HUB FLANGE TO AID REMOVAL

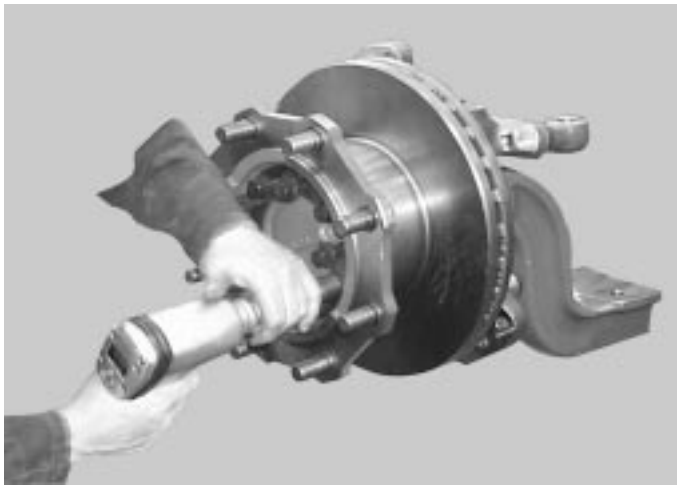
8. Gently tap hub flange outwards using a hide faced hammer.

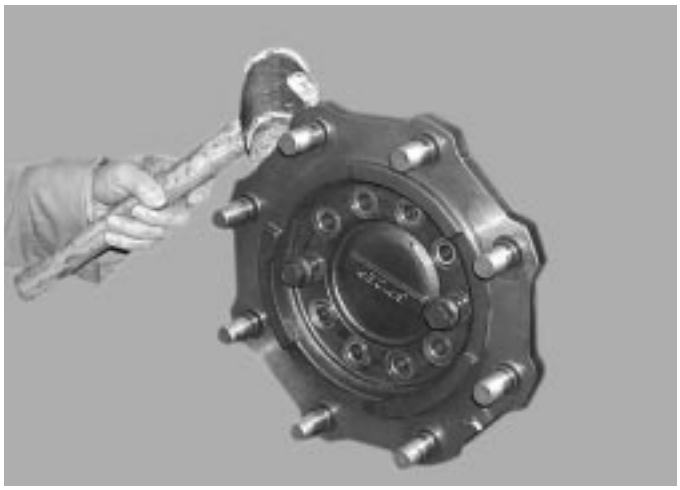
9. Support weight of hub flange and remove hub flange retaining bolts.

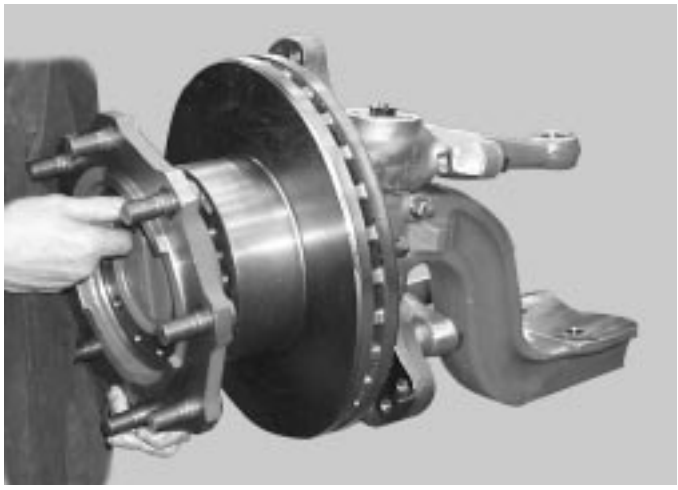
10. Remove hub flange and place on a suitable workbench.

WARNING!
COMPONENT IS HEAVY
ENSURE WEIGHT IS FULLY SUPPORTED BEFORE REMOVING RETAINING BOLTS.

11. Inspect wheel studs and remove for replacement, any that are found to be defective.







OVERHAUL PROCEDURES

HUB END DISASSEMBLY

12. Once hub flange has been removed, insert two bolts into brake disc extraction holes

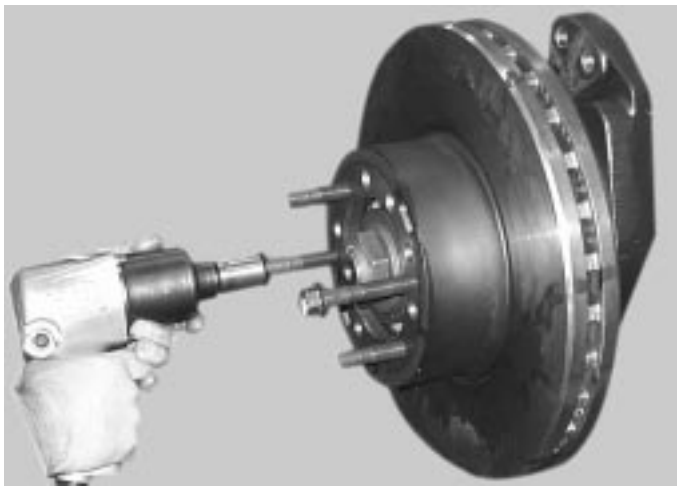
13. Tighten to free brake disc from hub bearing.

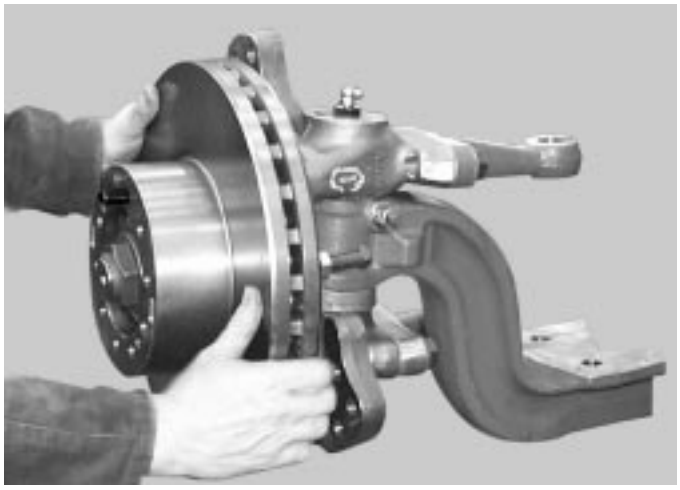
14. Support weight of brake disc and carefully slide along dummy studs to remove.

WARNING!
COMPONENT IS HEAVY
ENSURE WEIGHT IS FULLY SUPPORTED BEFORE REMOVING .

15. Place brake disc on a suitable work bench and inspect for cracks and defects, Replace if necessary.
(See Lubrication and maintenance section for details of typical defects and acceptability)
Check brake disc thickness is within manufacturers specifications.
Refer to table below for Acceptable dimensions:

WARNING!
DO NOT ALLOW BRAKE DISC TO WEAR BELOW MINIMUM THICKNESS!





Brake disc type	Original thickness	Minimum thickness
SB5000	34MM	28MM
SB6000	45MM	37MM
SB7000	45MM	37MM

OVERHAUL PROCEDURES

HUB END DISASSEMBLY

16. Using a small ended chisel, pry off the "staking" on the hub nut.

17. Remove hub nut and discard.

18. Remove bearing thrust washer.

19. Fit bearing guide sleeve onto swivel thread. (See chart at front of swivel assembly)

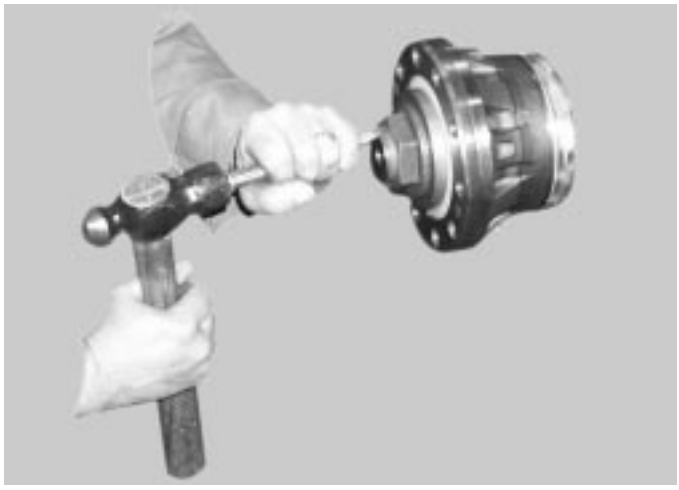
20. Carefully pull unitised hub bearing assembly towards end of swivel stub and remove.

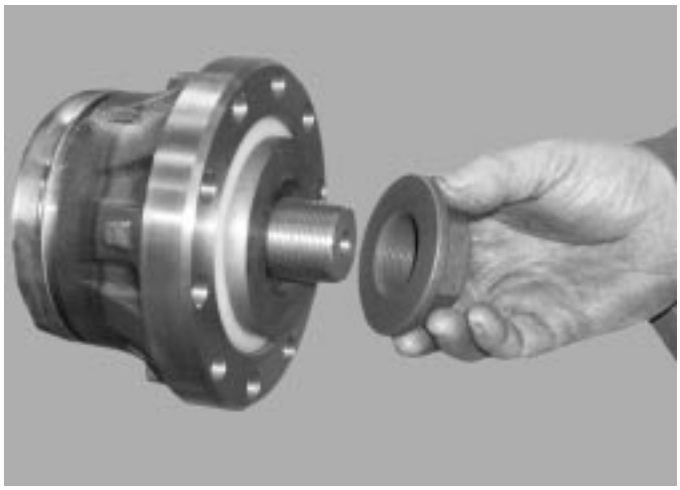
21. Place on a suitable workbench and inspect for wear / damage, taking care not to damage the ABS exciter ring in the process.

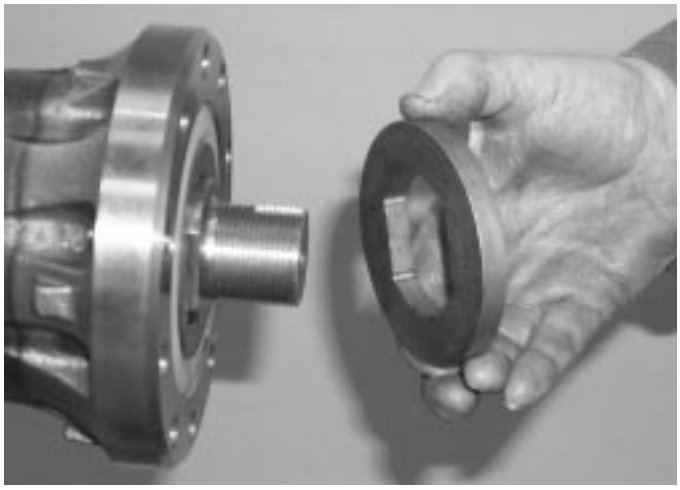
NOTE:-
THE UNITISED BEARINGS USED ON THE NDS RANGE OF AXLES, ARE NON SERVICABLE ITEMS.
BEARINGS ARE PRE ADJUSTED, LUBRICATED AND HAVE SEALS FITTED AS PART OF THE MANUFACTURING PROCESS.
THE BEARINGS ARE GREASED FOR LIFE AND THERE IS NO NEED OR FACILITY FOR RE-LUBRICATION.

22. Remove ABS sensor and sensor bush inspect for wear / damage and replace if necessary.

Stripdown remainder of axle as described in swivel assembly removal and refitting instructions.







Place bearing this way up on bench to avoid damaging pole wheel.

OVERHAUL PROCEDURES

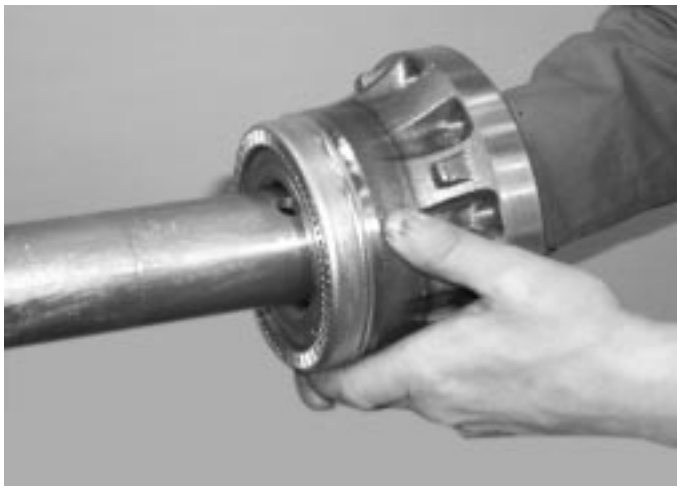
HUB END REASSEMBLY

1. Follow instructions contained in swivel / axle bed reassembly section, before attempting to reassemble hub end.

2. Fit Unitised hub bearing guide sleeve onto swivel stub .
(see chart at front of swivel section)

3. Lightly smear the axle stub bearing journal with a thin layer of anti-fretting assembly paste, white
i.e Optimol Paste White T (Castrol) or equivalent.

4. Offer new unitised bearing onto swivel stub.



OVERHAUL PROCEDURES

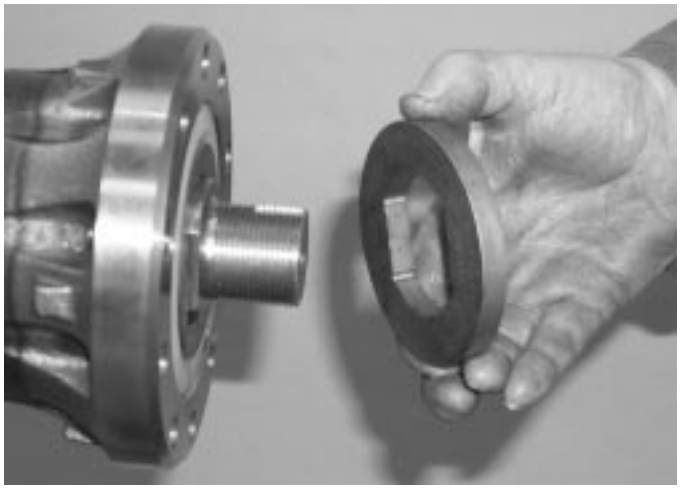
HUB END REASSEMBLY CONTINUED

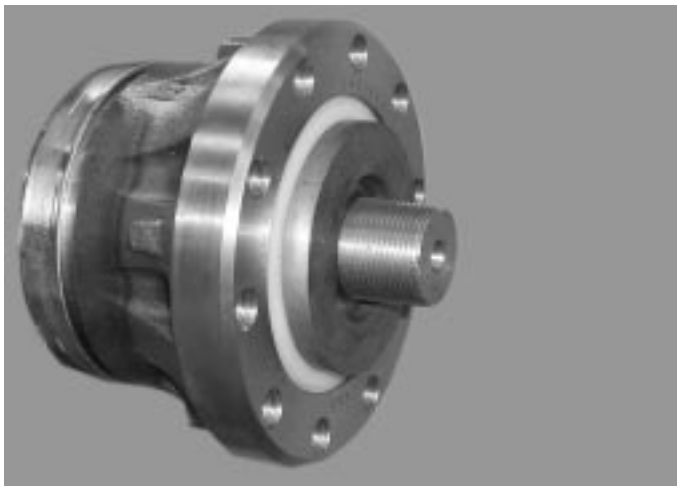
5. Place unitised hub bearing thrust washer onto axle stub.

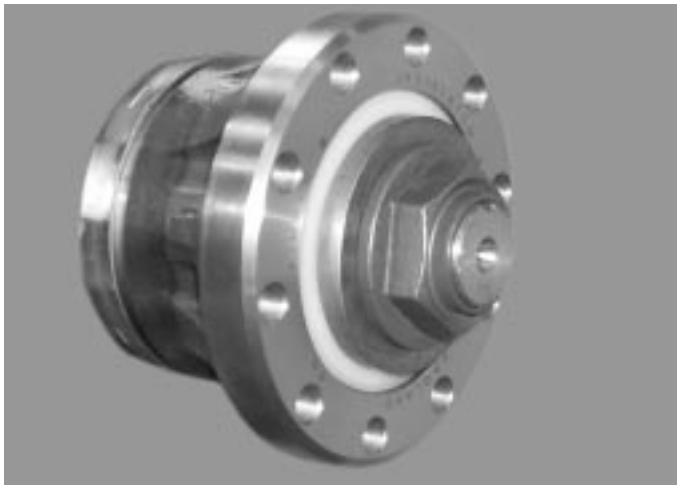
6. Fit hub nut.

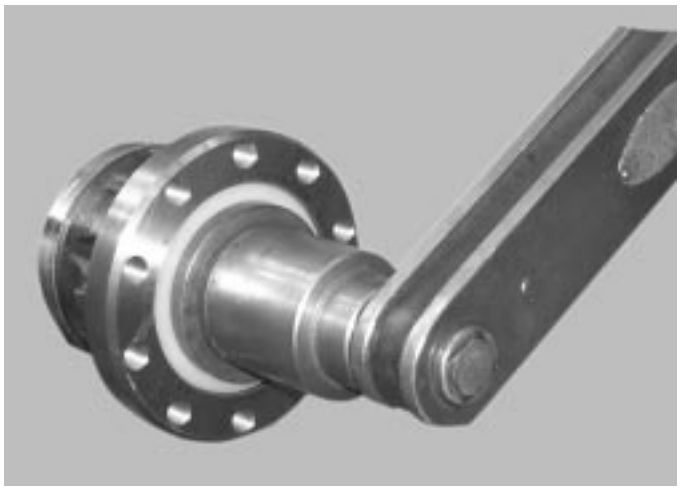
7. Tighten to specified torque.

NOTE:-
ROTATE UNITISED HUB BEARING WHILST TIGHTENING.









OVERHAUL PROCEDURES

HUB END REASSEMBLY CONTINUED

8. Stake the hub nut by deforming with a round nosed chisel.

9. Using a modified hub flange bolt as a guide. carefully position brake disc onto unitised hub bearing.

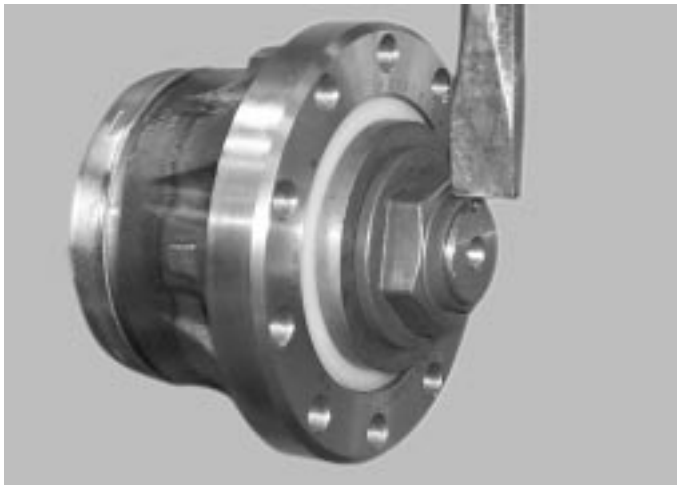
10. Tap securely home
(using a hide faced hammer to avoid damaging the brake disc itself.)

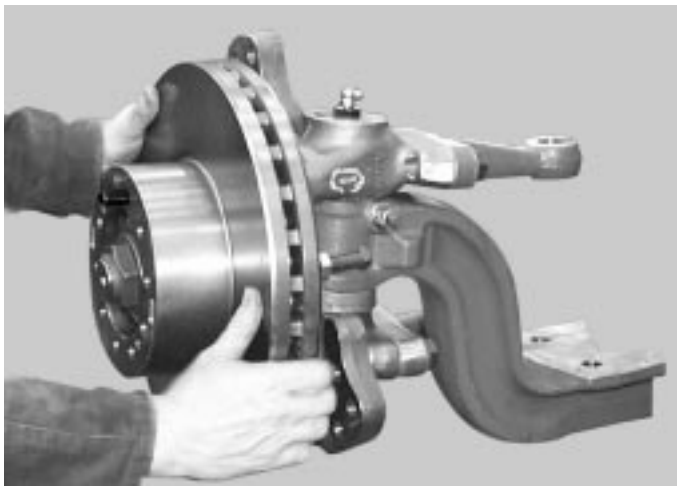
11. Remove the modified hub flange bolt at this point.

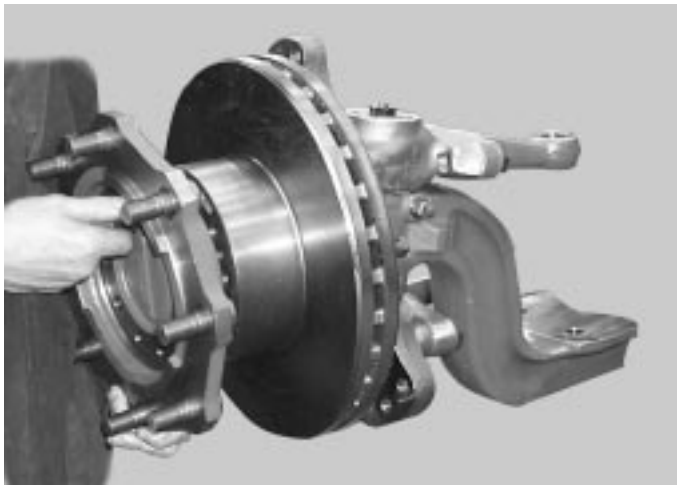
12. Carefully offer hub flange up to brake disc / unitised hub bearing assembly and hold in position by inserting 1 - off hub flange bolt and tightening hand tight.

13. Insert remainder of hub flange bolts.

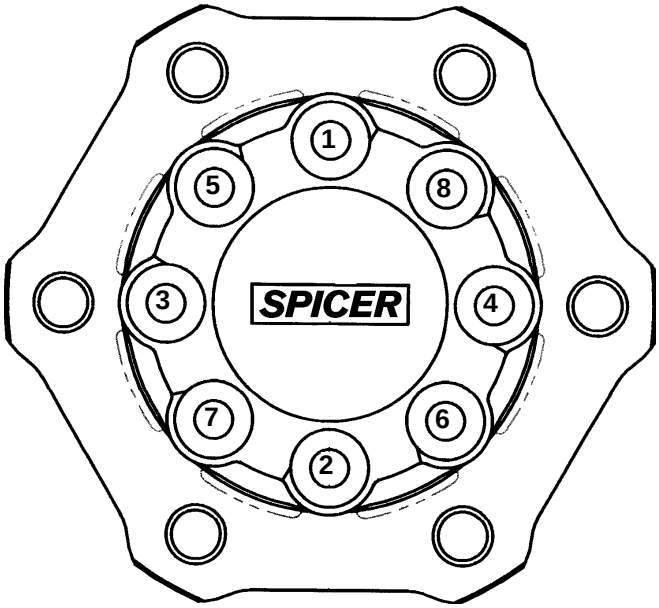
14. Tighten to correct torque using selection procedure as shown on following page.



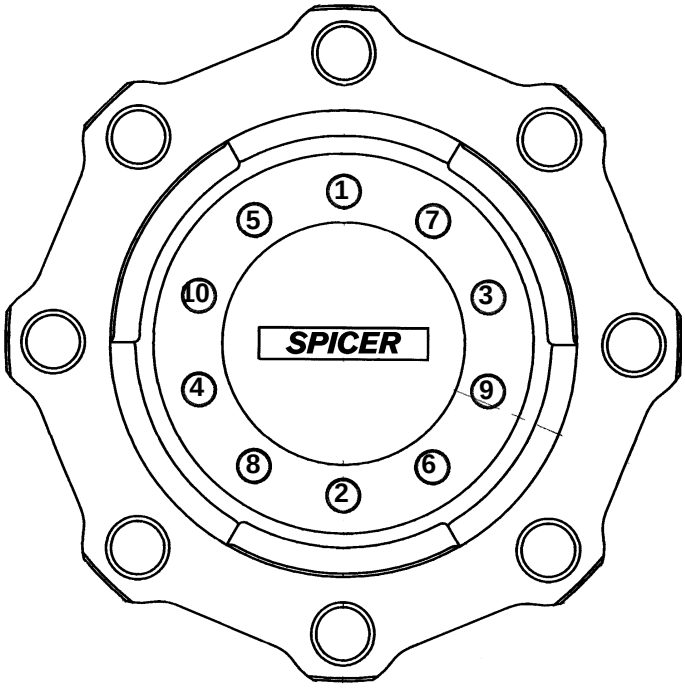




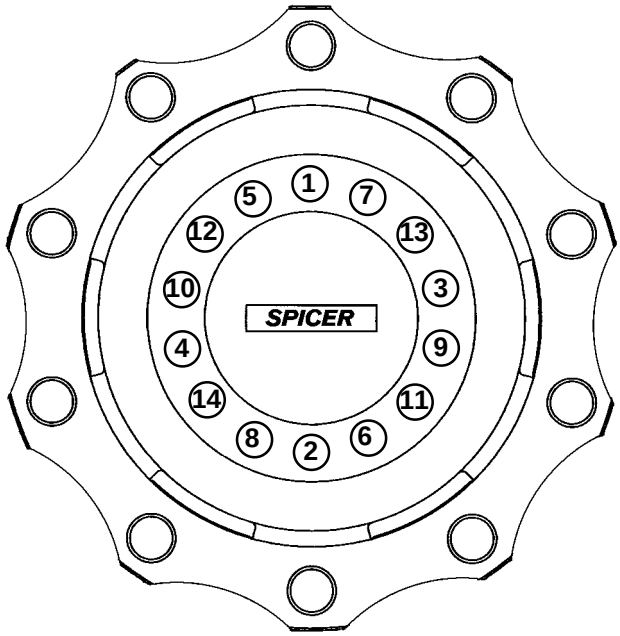
HUB FLANGE BOLT TIGHTENING TORQUE SEQUENCE FOR 8 BOLT FIXING



HUB FLANGE BOLT TIGHTENING TORQUE SEQUENCE FOR 10 BOLT FIXING

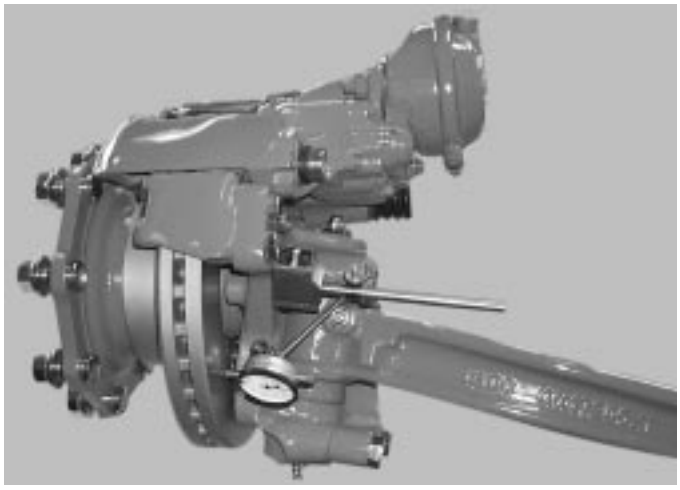


HUB FLANGE BOLT TIGHTENING TORQUE SEQUENCE FOR 14 BOLT FIXING



OVERHAUL PROCEDURES

HUB END REASSEMBLY CONTINUED



15. Once the hub flange has been correctly fitted; it is necessary to check the axial run out of the brake disc.

16. Position a metric dial test indicator onto axle in a suitable position as shown.

NOTE:-
POSITION MAY VARY DEPENDENT ON AXLE SPECIFICATION

17. Position stylus of dial test indicator onto brake disc as shown.

18. Rotate the hub through 360° and note any movement of the dial test indicator.

NOTE:-
MAXIMUM AXIAL RUNOUT IS 0.1mm

19. Should axial runout exceed 0.1mm. the brake disc is out of specification .

20. Remove and check out of specification disc to ensure no damage has occured to the mounting faces, or that no dirt is present.

21. Remove any dirt found on the mounting faces and refit and re check disc.

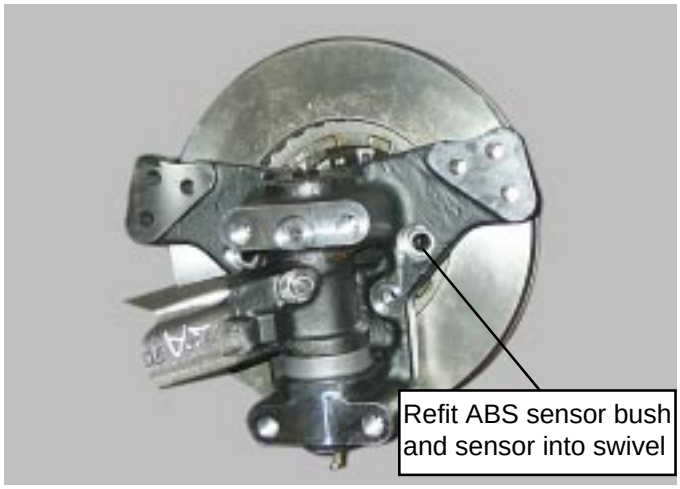
NOTE:-
DAMAGED DISCS SHOULD BE REPLACED AS A MATTER OF COURSE!

22. Should it be found that a cleaned and refitted disc is still out of specification; it must be replaced.

OVERHAUL PROCEDURES

HUB END REASSEMBLY CONTINUED

23. Refit ABS sensor bush and sensor into swivel



NOTE:-
A NEW SENSOR BUSH SHOULD BE FITTED WHENEVER A NEW SENSOR IS FITTED.
IF FITTING A NEW SENSOR AND BUSH INTO AN ABS READY AXLE. SENSOR AND BUSH SHOULD BE SUPPLIED FROM THE SAME MANUFACTURER.

24. Push sensor through bush until it comes into contact with polewheel on hub assembly.

25. Rotate hub bearing assembly through at least one revolution.

THIS SERVES TO SET THE CORRECT GAP BETWEEN SENSOR AND POLEWHEEL.

OVERHAUL PROCEDURES

HUB END REASSEMBLY CONTINUED

26. Check A.B.S. sensor performance as follows :-

Before commencement of this check It is important that the number of teeth be checked and found to be the correct, on both LH and RH hubs.

a) Insert the probes from a volt-meter into the two plugs in the sensor connector.
b) set the voltmeter to read mili-volts AC.
c) Rotate the hub in any direction at a constant speed of 60Hz (7Kph).
To determine this speed use the following calculation ;

$$RPM = \frac{60Hz}{z} \times 60 \text{ secs}$$

where z = the number of teeth on the pole wheel.

Note :- The reading may not be steady due to the possibility of pole wheel run out and the inconsistent speed of the wheel.

d) The maximum reading (Vmax) must not be more than 80% greater than the minimum reading (Vmin). ie.

$$\frac{Vmax}{Vmin} \leq 1.8$$

If the following is true then it is likely that there is excessive pole wheel runout. The pole wheel installation will therefore need to be inspected and remounted or replaced.

$$\frac{Vmax}{Vmin} > 1.8$$

e) The minimum reading must be greater than the voltage threshold (Vt) ie.

$$Vmin. > Vt$$

$$Vt. = 60mV$$

If this is not the case, then the sendsor gap is too large or there may be excessive pole wheel runout. The pole wheel will therefore need to be inspected and remounted or replaced.

f) If sections d) and e) are satisfied, then the installation can be considered as satisfactory.

Note :- The above test procedure is as recommended by A.B.S. manufacturers.

OVERHAUL PROCEDURES

HUB END REASSEMBLY CONTINUED

27. Using suitable lifting equipment, support the brake caliper.

WARNING!
BRAKE CALIPER IS HEAVY.

28. Offer brake caliper up to brake bracket. (Ensure correct hand of brake caliper is selected)

29. Insert brake caliper retaining bolts and tighten hand tight.

30. Tighten brake caliper bolts to secure assembly.

31. Remove caliper lifting equipment

WARNING!
BRAKE CALIPER IS HEAVY
ENSURE WEIGHT IS FULLY SUPPORTED BY RETAINING BOLTS BEFORE REMOVING LIFTING EQUIPMENT.

32. Tighten brake caliper bolts to correct torque.

33. If the brake caliper air chamber has been removed; Refit to caliper and tighten nuts to correct torque.

NOTE!
TAKE CARE NOT TO DAMAGE PAD WEAR SENSOR CABLE DURING REASSEMBLY OF CHAMBER TO CALIPER.

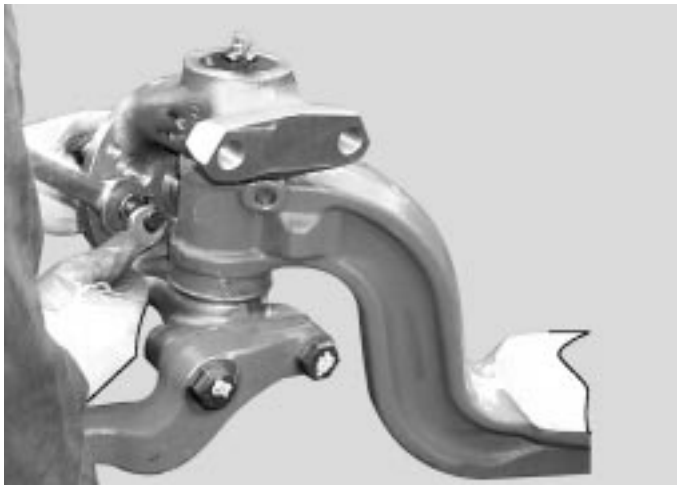
OVERHAUL PROCEDURES

HUB END REASSEMBLY CONTINUED

34. Refit lockstop screws and adjusting nuts

35. Reset lockstop screws to achieve correct lock angles as shown on installation drawing or vehicle manufacturers specifications.

NOTE:-
DO NOT ALLOW LOCKSTOP THREADS TO PROTRUDE THROUGH FRONT FACE OF SWIVEL.



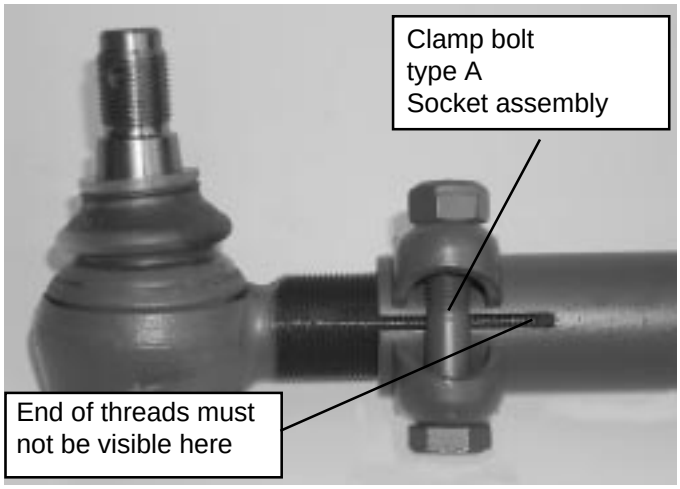
36. Check wheel alignment as follows :-

a) Set axle in straight ahead position.

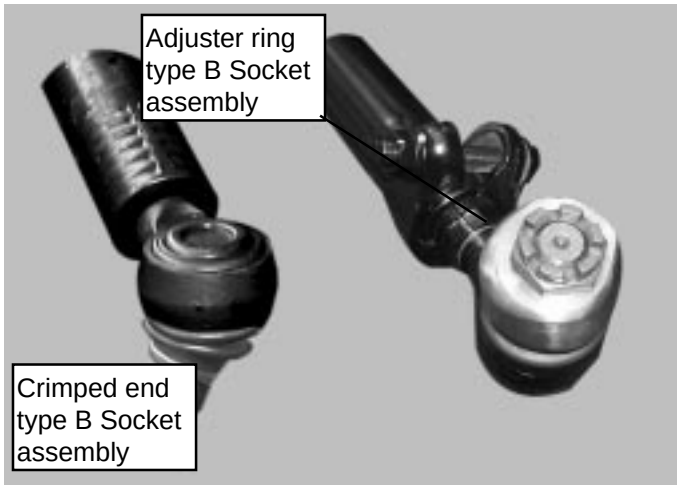
b) At a point level with wheel centre, measure distance over hubs / wheel rims, both in front and behind axle centre.

c) Front measurement 'B' should be 0.0" to 0.04" (0.0 to 1mm) **LESS** than rear measurement 'A'.

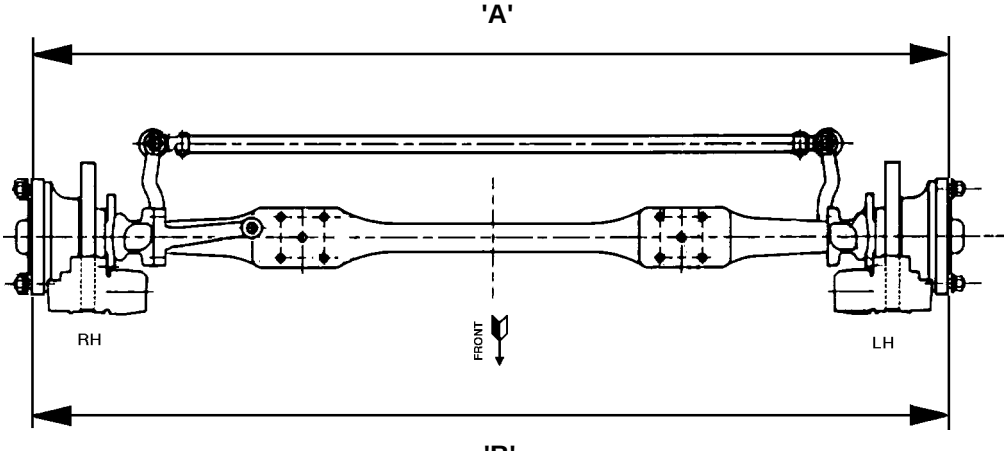
d) Any adjustment on type A socket and tie rod assemblies can be effected by slackening clamp bolts in ball sockets and rotating track rod tube.
For type B socket and tie rod assemblies, slacken the clamped end of the assembly and use the adjuster ring.



e) After adjustment, tighten clamp bolts to specified torque.



NOTE:-
WHEN ADJUSTING TYPE A TIE RODS, ENSURE SOCKET THREADS ARE EQUALLY POSITIONED IN EACH END OF THE TIE ROD AND THAT THE END OF THE SOCKET THREAD IS NOT VISIBLE THROUGH THE SAWCUT



OVERHAUL PROCEDURES

HUB END REASSEMBLY CONTINUED

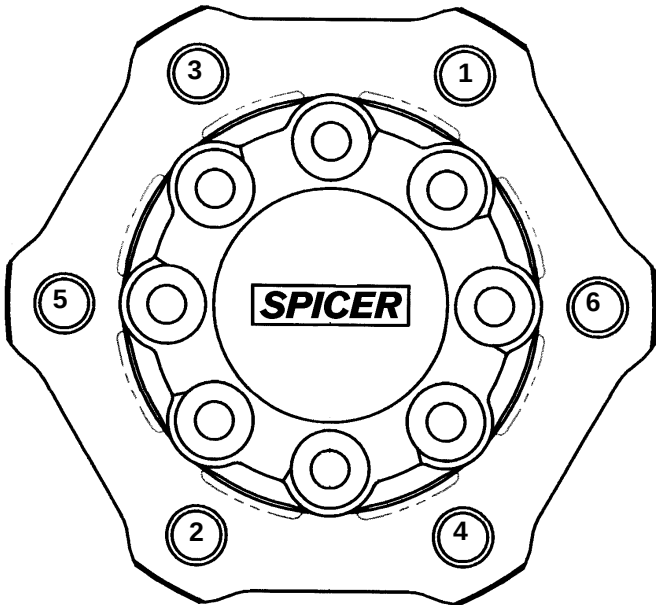
37. Re-connect brake to vehicle hydraulic system as recommended in brake manufacturer's manual.

38. Clean interfaces of wheelnuts, wheel rim & hub then re-fit road wheels securing with wheel nuts and tighten in correct sequence (as shown on following page) to specified torque.

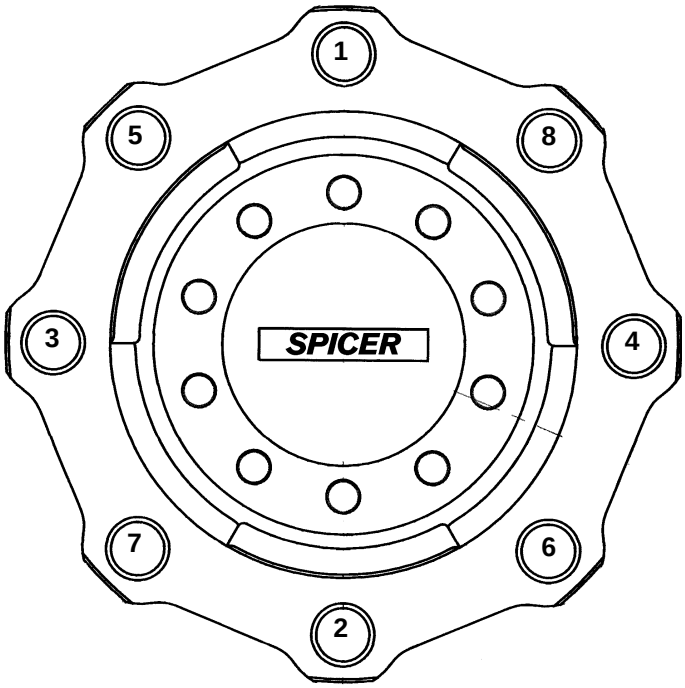
NOTE:-
INTERFACES MUST BE FREE FROM DIRT, INCLUDING BRAKE LINER MATERIAL DEBRIS, RUST AND PAINT. FAILURE TO KEEP INTERFACES CLEAN CAN AND WILL CAUSE WHEEL RIM TO DISTORT UPON TIGHTENING OF WHEEL NUTS
FOR FURTHER DETAILS SEE BS AU50 : part 2 : section 7A : 1995

39. Remove axle supports and lower vehicle to ground.

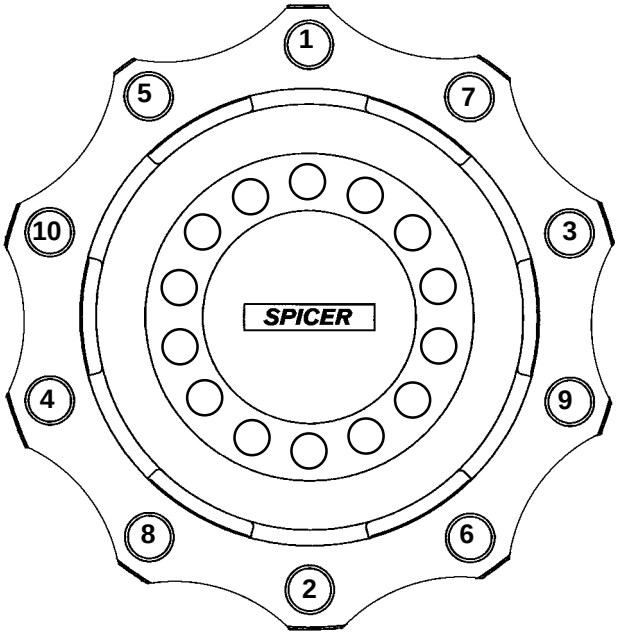
WHEELNUT TIGHTENING TORQUE SEQUENCE FOR 6 STUD FIXING



WHEELNUT TIGHTENING TORQUE SEQUENCE FOR 8 STUD FIXING



WHEELNUT TIGHTENING TORQUE SEQUENCE FOR 10 STUD FIXING

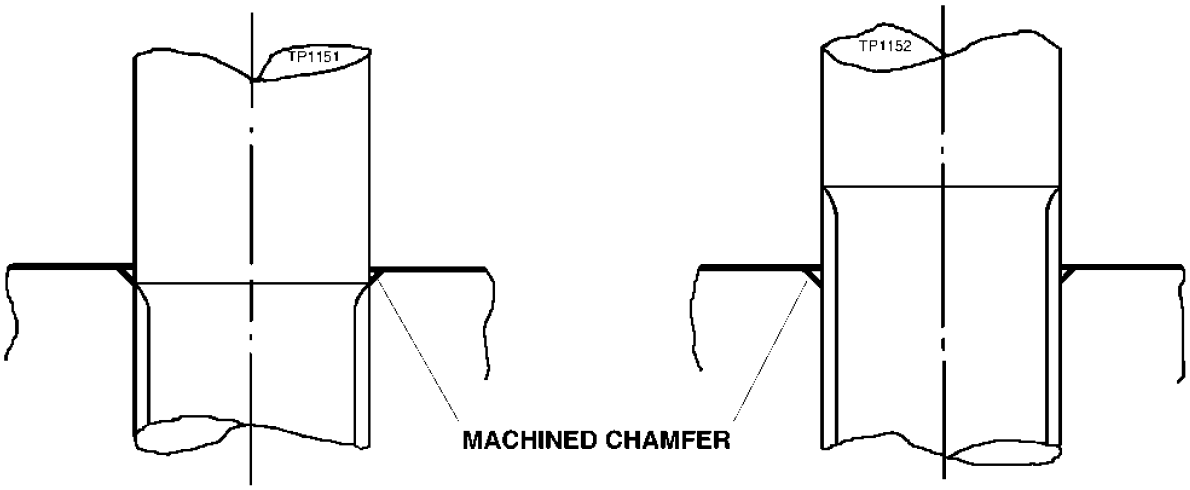


TP1193

SPICER SPECIALITY AXLE DIVISION

STANDARD STUDS - FITTED INTO MACHINED CHAMFERED HOLES

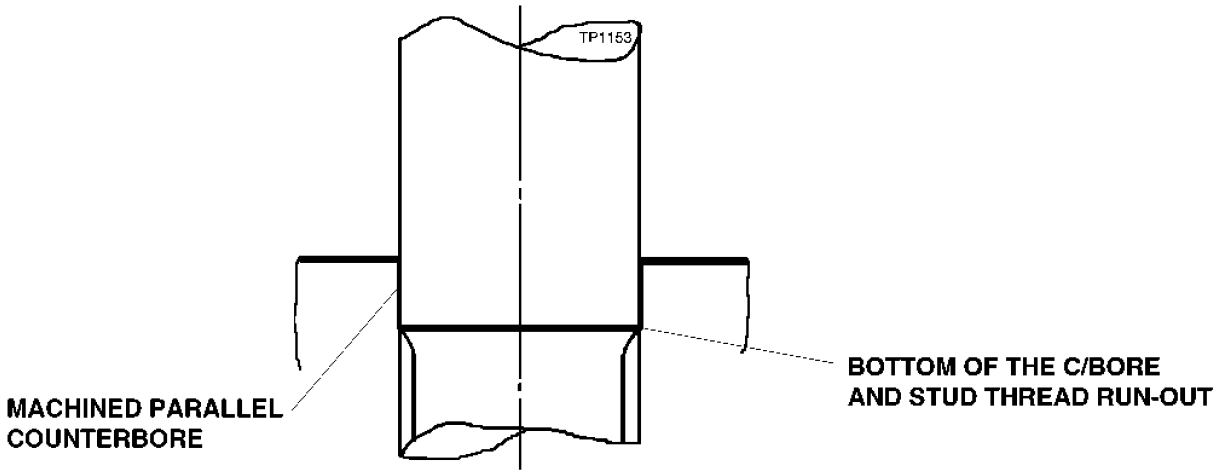
STUDS TO BE INSERTED UNTIL THREAD RUN-OUT LOCKS INTO PARENT METAL



IMPORTANT :- THIS STUD FITTING PROCEDURE IS TO BE USED IN LIEU OF STATED TORQUE VALUES ON EXISTING ARRANGEMENTS.
NEW ARRANGEMENTS WILL SPECIFY TD183/1 FROM THE DATE OF ISSUE.

SPECIAL STUDS - FITTED INTO MACHINED PARALLEL COUNTERBORE

STUDS TO BE INSERTED UNTIL CORRECT TORQUE VALUE IS OBTAINED -
AS SHOWN ON RELEVANT ARRANGEMENT DRAWING

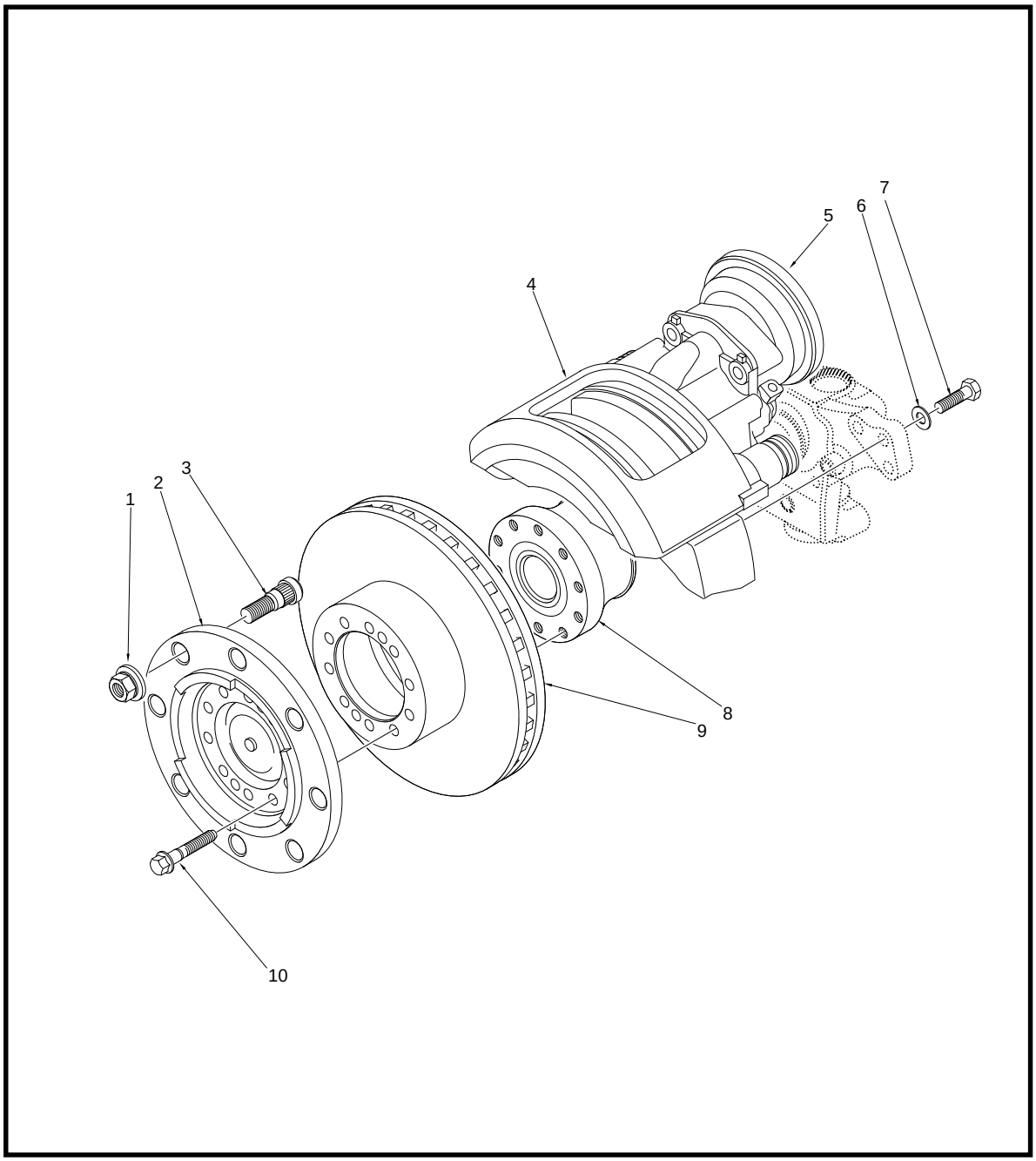


THIS SPECIFICATION IS FOR STUD FITTING ONLY ;
NUTS & SETSCREWS MUST BE TORQUED TO VALUE SPECIFIED

Alteration Numbers									
ISSUE A									

DISTRIBUTION	STUD FITTING PROCEDURES	TD183/1
Front Axle B.U. Drive Axle B. U. Production		SHT 1 OF 1

ILLUSTRATION OF NDS HUB END WITH SEPARATE BRAKE BRACKET



PART NUMBER	DESCRIPTION
1	Wheel nut (Not Supplied By Spicer Speciality Axles)
2	Hub flange
3	Wheel stud
4	Brake Caliper
5	Air chamber
6	Brake Caliper Mounting Washer
7	Brake Caliper Mounting Bolt
8	Unitised Hub Bearing
9	Brake Disc
10	Hub Flange Retaining Bolt

APPLICATION POLICY
Capability ratings, features and specifications vary depending upon the model type of service. Applications approvals must be obtained from Spicer Speciality axle division. We reserve the right to change or modify our product specifications, configurations, or dimensions at any time without notice.

SPICER SPECIALITY AXLE DIVISION
ABBEY ROAD
LEEDS LS5 3NF
ENGLAND
TEL (+44-113) 2584611 FAX (+44-113) 2586097

SECTION 11: REAR AXLES

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1. DRIVE AXLE

1.1 DESCRIPTION

The Meritor drive axle is equipped with a single reduction standard carrier mounted in front of the axle housing. The carrier consists of a hypoid drive pinion, a ring gear set and gears in the differential assembly.

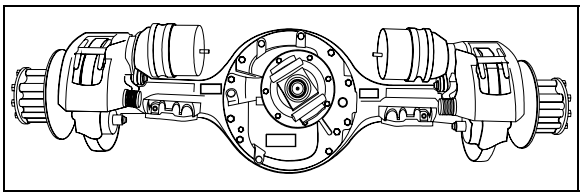

FIGURE 1: DRIVE AXLE 11019

A straight roller bearing (spigot) is mounted on the head of the drive pinion. All other bearings in the carrier are tapered roller bearings. When the carrier operates, there is a normal differential action between the wheels all the time.

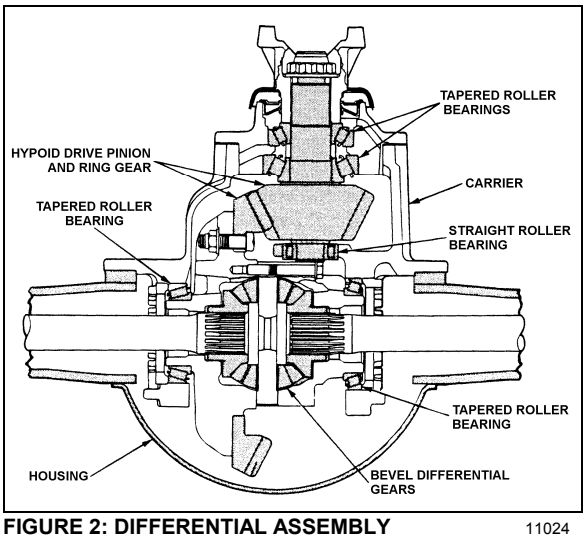

FIGURE 2: DIFFERENTIAL ASSEMBLY 11024

Several speed ratios are available for the drive axle. These ratios depend upon the motor and transmission. Also, special applications may suggest slightly different gear ratios.

1.2 DCDL (DRIVER-CONTROLLED MAIN DIFFERENTIAL LOCK)

Meritor Single-reduction carriers with driver-controlled main differential lock (DCDL) have the same type of gears and bearings as the standard-type carriers. The differential lock is operated by an air actuated shift assembly that is mounted on the carrier.

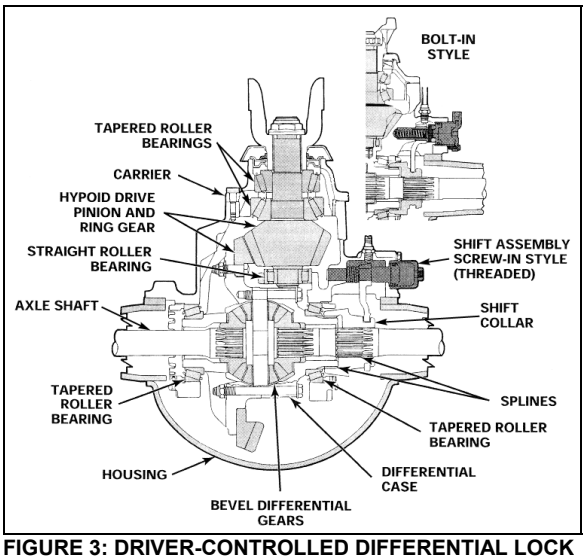

FIGURE 3: DRIVER-CONTROLLED DIFFERENTIAL LOCK 11028

1.3 DRIVE AXLE LUBRICATION

Use Multigrade gear oil 85W140 meeting MIL-PRF-2105-E, tested and approved to SAE J2360. If temperature drops below 10°F (-12°C), 80W90 should be used, and below -15°F (-26°C), 75W90 should be used. Additional lubrication information is covered in the Meritor Technical Bulletin *"Approved Rear Drive Axle Lubricants"* annexed to this section.

In extreme conditions, or for better performance, fill with synthetic gear oil.

MAINTENANCE

Check oil level and add (if necessary) every 25,000 miles (40 000 km) or according to the fleet maintenance interval, whichever comes first (Fig. 4).

MAINTENANCE

Change differential oil and clean the breathers, magnetic fill and drain plugs, every 100,000 miles (160 000 km) or once a year, whichever comes first.

If using full synthetic gear oil, change differential oil and clean the breathers, magnetic fill and drain plugs, every 250,000 miles (400 000 km) or every four years, whichever comes first.

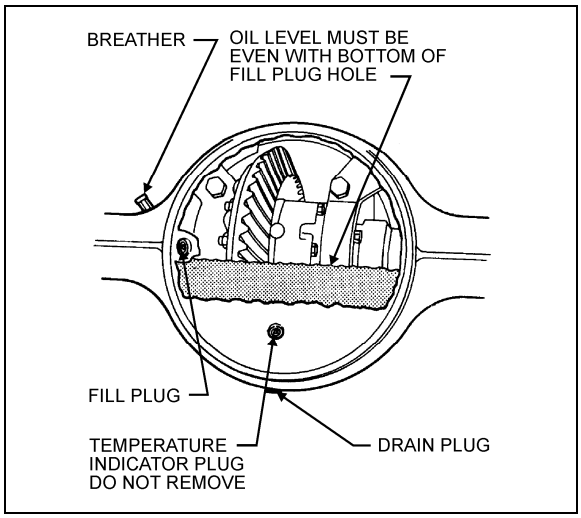

FIGURE 4: DIFFERENTIAL HOUSING BOWL 11007

1.4 MAINTENANCE

Proper vehicle operation begins with preventive maintenance, such as good differential use. The most common types of drive axle carrier failures are spinout, shock, fatigue, overheating and lubrication. Avoid neglecting these points since they would be the first steps to improper maintenance, expensive repairs, and excessive downtime.

Inspect the pinion oil seal, axle shaft flange and carrier housing gaskets for evidence of lubricant leakage. Tighten the bolts and nuts, or replace the gaskets and seals to correct leaks. Maintenance of the axle mountings consists primarily in a regular and systematic inspection of the air suspension units and radius rods, as directed in Section 16, *"Suspension".*

1.4.1 Checking and Adjusting the Oil Level

DANGER

Before servicing, park safely over a repair pit; apply parking brake, stop engine and set battery master switch to the "OFF" position.

1. Make sure the vehicle is parked on a level surface.

WARNING

Check the oil level when the axle is at room temperature. When hot, the oil temperature may be 190ºF (88ºC) or more and can cause burns. Also, a correct reading is not obtained when the axle is warm or hot.

2. Make sure the axle is "cold" or at room temperature.
3. Clean the area around the fill plug. Remove the fill plug from the differential axle housing bowl (Fig. 4).
4. The oil level must be even with the bottom of the hole of the fill plug.
   a. If oil flows from the hole when the plug is loosened, the oil level is high. Drain the oil to the correct level.
   b. If the oil level is below the bottom of the hole of the fill plug, add the specified oil.
5. Install and tighten the fill plug to 35-50 lbf-ft (48-67 Nm).

1.4.2 Draining and Replacing the Oil

DANGER

Before servicing, park safely over a repair pit, apply parking brake, stop engine and set battery master switch to the "OFF" position.

1. Make sure the vehicle is parked on a level surface. Put a large container under the axle's drain plug.

NOTE

Drain the oil when the axle is warm.

2. Remove the drain plug from the bottom of the axle. Drain and discard the oil in an environment friendly manner.
3. Install and tighten the drain plug to 35-50 lbf-ft (48-67 Nm).
4. Clean the area around the fill plug. Remove the fill plug from the differential housing bowl.
5. Add the specified oil until the oil level is even with the bottom of the hole of the fill plug. Allow the oil to flow through the axle and check the oil level again (lube capacity 41 pints [13,3 liters]).

CAUTION

The differential overheats when the oil temperature rises above 250ºF (120ºC).

6. Install and tighten the fill plug to 35-50 lbf-ft (48-67 Nm).

1.4.3 Speed Sensors (Anti-Lock Brake system, ABS)

For removing and installing the drive axle speed sensors (for anti-lock brake systems, ABS), refer to Section 12: *''Brake and Air System''* and to Rockwell WABCO Maintenance Manual: *"Anti-Lock Brake Systems For Trucks, Tractors and Buses"*, annexed at the end of section 12.

1.5 REMOVAL AND REINSTALLATION

The following procedure deals with the removal of the drive axle assembly and its attachments as a unit. The method used to support the axle during removal and disassembly depends upon local conditions and available equipment.

1. Raise vehicle by its jacking points on the body (fig. 5 or see Section 18, *"Body"* under heading *"Vehicle Jacking Points").* Place jack stands under frame. Remove drive axle wheels (if required, refer to Section 13, *"Wheels, Hubs And Tires".*

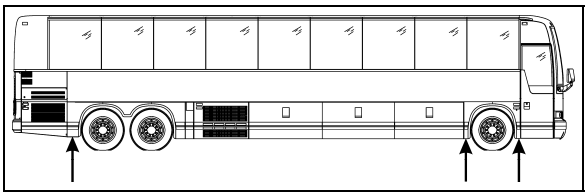

FIGURE 5: JACKING POINTS ON FRAME (TYPICAL) 18618

2. Exhaust compressed air from the air supply system by opening the drain cock on each air reservoir.
3. Disconnect the propeller shaft as directed in Section 9, *"Propeller Shaft",* in this manual.
4. On both sides of the vehicle, unscrew fasteners retaining front wheel housing plastic guards, and remove them from vehicle.
5. Disconnect both height control valve links from air spring mounting plate brackets then move the arm down to exhaust air suspension.
6. Remove cable ties securing the ABS cables (if vehicle is so equipped) to service brake chamber hoses. Disconnect the ABS cable plugs from the drive axle wheel hubs.

NOTE
When removing drive axle, if unfastening cable ties is necessary for ease of operation, remember to replace them afterwards.

7. Disconnect the brake chamber hoses.

NOTE
Position the hoses so they will not be damaged when removing the axle.

8. Install jacks under the axle jacking points to support the axle weight (refer to figure 6).

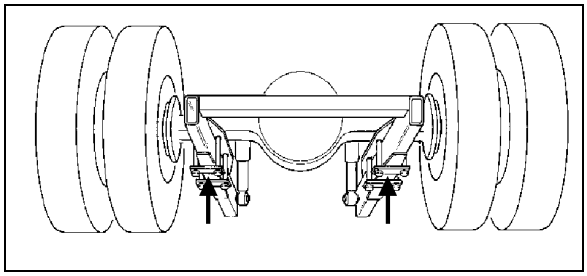

FIGURE 6: JACKING POINTS ON DRIVE AXLE 11005

9. Remove the four shock absorbers as outlined in Section 16, *"Suspension"* under heading *"Shock Absorber Removal".*
10. Remove the sway bar.
11. Remove the lower and upper longitudinal radius rod supports from vehicle sub-frame as outlined in Section 16, *"Suspension",* under heading *"Radius Rod Removal".*
12. Remove the transversal radius rod support from the vehicle sub-frame.
13. Remove the two retaining nuts from each of the four air bellows lower mounting supports.
14. Use the jacks to lower axle. Carefully pull away the jacks axle assembly from underneath vehicle.
15. Reverse removal procedure to reinstall drive axle.

NOTE
Refer to Section 16, "Suspension" for suspension components' proper tightening torques.

NOTE
Refer to section 13 "Wheels, Hubs And Tires" for correct wheel bearing adjustment procedure.

1.6 DISASSEMBLY AND REASSEMBLY

Disassembly and re-assembly procedures are covered under applicable headings in Meritor's *"MAINTENANCE MANUAL, NO. 5",* annexed to this section.

1.7 GEAR SET IDENTIFICATION

Gear set identification is covered under applicable heading in Meritor's *"MAINTENANCE MANUAL NO. 5",* annexed to this section.

1.8 ADJUSTMENTS

Adjustments are covered under applicable headings in Meritor's *"MAINTENANCE MANUAL NO. 5",* annexed to this section.

1.9 FASTENER TORQUE CHART

A differential fastener torque chart is provided in Meritor's *"MAINTENANCE MANUAL NO. 5",* annexed to this section.

1.10 TIRE MATCHING

Drive axle tire matching is covered under the applicable heading in Section 13, *"Wheels, Hubs And Tires"* in this manual.

1.11 DRIVE AXLE ALIGNMENT

NOTE
For *drive axle alignment specifications, refer to paragraph 3: ''Specifications" in this section.*

The drive axle alignment consists in aligning the axle according to the frame. The axle must be perpendicular to the frame. The alignment is achieved with the use of shims inserted between the lower longitudinal radius rod supports and the frame.

Drive axle alignment is factory set and is not subject to any change, except if the vehicle has been damaged by an accident or if there are requirements for replacement.

If the axle has been removed for repairs or servicing and if all the parts are reinstalled exactly in the same place, the axle alignment is not necessary. However, if the suspension supports have been replaced or altered, proceed with the following instructions to verify or adjust the drive axle alignment.

NOTE
When drive axle alignment is modified, tag axle alignment must be re-verified.

1.11.1 Procedure

1. Park vehicle on a level surface, then chock front vehicle wheels.
2. Using two jacking points (which are at least 30 inches [76 cm] apart) on drive axle, raise the vehicle sufficiently so that wheels can turn freely at about ½ inch from ground. Secure in this position with safety stands, and release parking brake.
3. Install wheel mount sensors on front end and drive axle wheels (fig. 7).

NOTE
See reference numbers on wheel mount sensors (fig.7).

NOTE
Select axle specifications in the appropriate chart.

DRIVE AXLE ALIGNMENT

- With the system installed as in figure 7, adjust drive axle according to specifications' chart below.

DRIVE AXLE ALL VEHICLES			
Alignment / value	Minimum value	Nominal value	Maximum value
Thrust angle (deg.)	-0.04	0	0.04
Total Toe (deg.)	0.18 Toe-in	0	0.18 Toe-out

TAG AXLE ALIGNMENT

- Remove and reinstall all wheel mount sensors on the drive and tag axles (fig. 8);

NOTE
For an accurate alignment, the tag axle must be aligned with the drive axle.

NOTE
Reinstall wheel mount sensors as shown in figure 8.

- Adjust tag axle according to specifications' chart below in reference with drive axle.

TAG AXLE ALL VEHICLES			
Alignment / value	Minimum value	Nominal value	Maximum value
Parallelism (deg.)	-0.02	0	0.02
Total Toe (deg.)	0.18 Toe-in	0	0.18 Toe-out

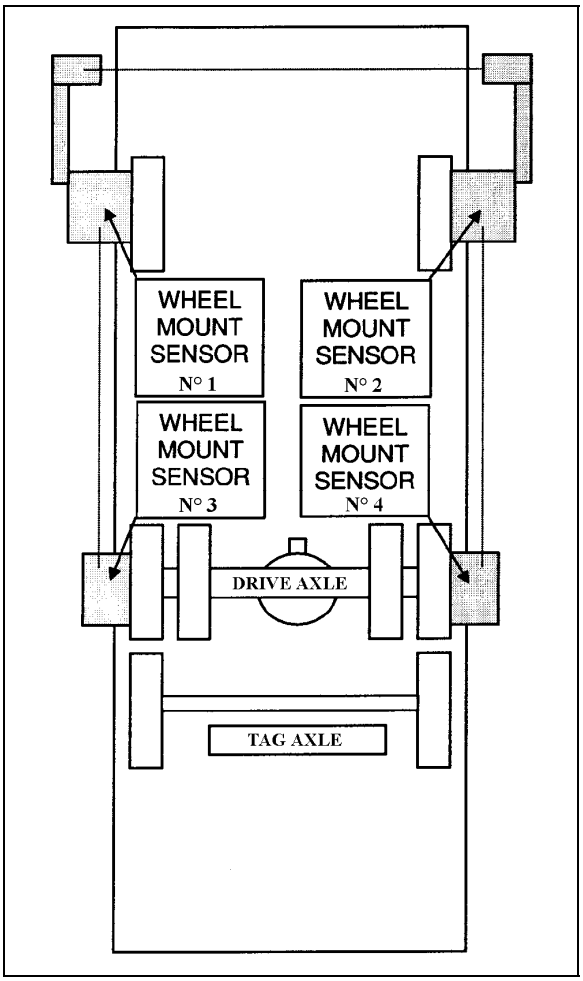

FIGURE 7: FRONT & DRIVE AXLE ALIGNMENT 11025

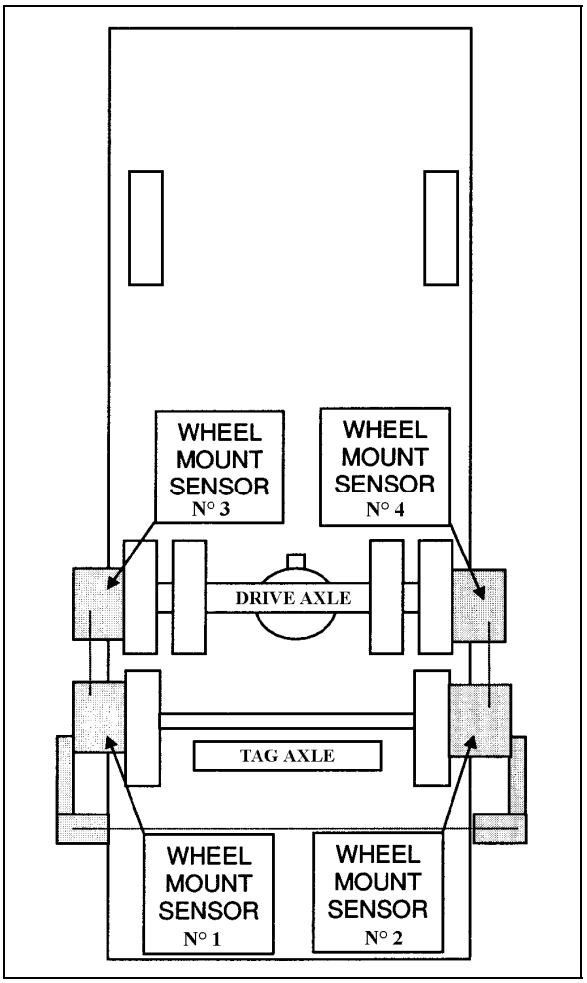

FIGURE 8: TAG AXLE ALIGNMENT 11026

NOTE
Refer to Section 16, "Suspension", for proper torque tightening of the longitudinal radius rod support nuts.

NOTE
When the drive alignment is changed, the tag alignment must also be adjusted.

1.12 AXLE SHAFT SEALING METHOD

The following method is to be used to ensure that axle shaft installation is fluid-tight:

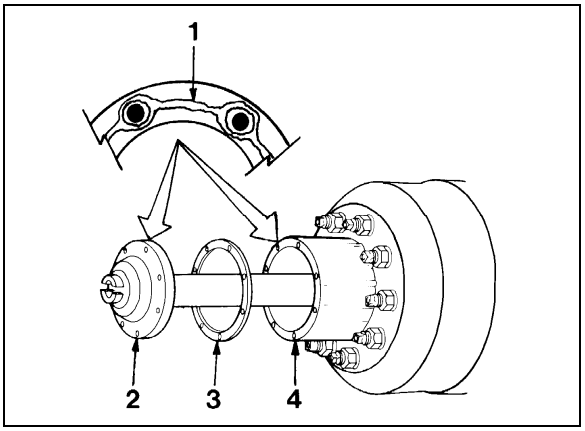

FIGURE 9: AXLE SHAFT INSTALLATION 11003

1 ..... Silicone sealant*
2 ..... Axle shaft
3 ..... Gasket
4 ..... Wheel hub

1. Clean the mounting surfaces of both the axle shaft flange and wheel hub where silicone sealant will be applied. Remove all old silicone sealant, oil, grease, dirt and moisture. Dry both surfaces.
2. Apply a continuous thin bead of silicone sealant* (Prévost P/N 680053) on the mounting surfaces and around the edge of all fastener holes of both the axle shaft flange and wheel hub.

* *GENERAL ELECTRIC Silicone Rubber Adhesive Sealant RTV 103 Black.*

⚠ WARNING

Carefully read cautions and instructions on the tube of silicone sealant and its packing.

3. Assemble components immediately to permit the silicone sealant to compress evenly between parts.
   a. Place a new gasket and then install the axle shaft into the wheel hub and differential carrier. The gasket and flange of the axle shaft must fit flat against the wheel hub.
   b. Install the tapered dowels at each stud and into the flange of the axle shaft. Use a punch or drift and hammer if needed.
   c. Install the lock washers and nuts on the studs. Tighten nuts to the correct torque value.

NOTE

Torque values are for fasteners that have a light application of oil on the threads (refer to Meritor Maintenance Manual).

9/16-18 plain nut: 110 - 165 lbf-ft (149 -224 Nm)

5/8-18 plain nut: 150 - 230 lbf-ft (203 - 312 Nm)

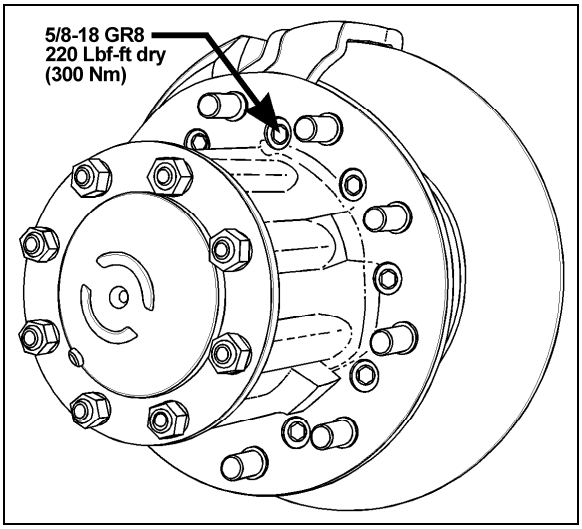

FIGURE 10: TORQUE SPECIFICATION

2. TAG AXLE

The tag axle is located behind the drive axle. It carries a single wheel and tire on each side.

2.1 UNLOADING TAG AXLE (COACH ONLY)

To reduce the turning radius, the air springs pressure will be automatically reduced by 75% when the coach is moving at speed lower than 5 mph (8 km/h) and with more than 1½ turn from the steering.

2.2 RETRACTING TAG AXLE

The standard tag axle retraction system is controlled by a valve located on the right lateral console and enables unloading and raising the tag axle (refer to the *"OPERATOR'S MANUAL"* for location of controls). This system has been designed for the following purposes:

1. Shortening of wheelbase, thus allowing tighter turning in tight maneuvering areas such as parking lots or when making a sharp turn.

2. Transferring extra weight and additional traction to the drive wheels on slippery surfaces.

The tag axle service brakes operate only when the axle is in normal driving (loaded) position.

> **⚠ CAUTION**
>
> Do not use tag axle in raised position for an extended period. Raising tag axle increases load on the drive axle, suspension and tires.
>
> Do not drive vehicle with tag axle raised when speed is exceeding 12mph (20 km/h).
>
> In order to prevent damage to the suspension, always raise the tag axle before lifting the coach.

2.3 RETRACTING TAG AXLE FOR REPAIR PURPOSES

- Connect an external air pressure line to the emergency fill valve in the engine compartment.
- Lift the axle by pushing the lever forward.

> **⚠ WARNING**
>
> Install a protective cover to prevent unfortunate lever operation while work is being carried out under the vehicle.

- Raise the vehicle using the lifts.

> **⚠ WARNING**
>
> Lift manufacturers recommend lowering the vehicle to the ground or installing some safety stands before activating the suspension to prevent the lifts from becoming unstable.

- For added safety, install nylon slings over tag axle shock absorbers.

2.4 GREASE LUBRICATED WHEEL BEARINGS

The unitized hub bearings used on the NDS range of axles, are non-serviceable items. Bearings are pre-adjusted, lubricated and have seals fitted as part of the manufacturing process. The bearings are greased for life and there is no need or facility for re-lubrication

Front and tag axle hub bearings need to be checked every 30,000 miles (48 000 km).

> *NOTE*
>
> *For more information on front and tag axle wheel hub, refer to "DANA SPICER Maintenance Manual Model NDS and Maintenance Manual NDS Axles" annexed at the end of this Section.*

2.5 REMOVAL AND INSTALLATION

2.5.1 Removing Tag Axle Only

The following procedure deals with the removal of the tag axle while keeping the air springs installed. The method used to support the axle and suspension components during removal and disassembly depends upon local conditions and available equipment.

- Connect an external air pressure line to the emergency fill valve in the engine compartment.
- Lift the axle by pushing the lever forward.

> **⚠ WARNING**
>
> Install a protective cover to prevent unfortunate lever operation while work is being carried out under the vehicle.

- Disconnect tag axle air springs pneumatic hoses and install valves or plugs.
- Raise the vehicle using the lifts.
- Dismount tag axle components.
- Before reinstalling air spring hoses, make sure there is no pressure left inside by opening the valves or unloading tag axle.

2.5.2 Removing Tag Axle Along With Suspension Components

The following procedure deals with the removal of the tag axle assembly along with the suspension components. The method used to support the axle and suspension components during removal and disassembly depends upon local conditions and available equipment.

1. Raise vehicle by its jacking points on the body (fig. 5 or see Section 18, *"Body"* under heading: *"Vehicle Jacking Points"*). Place jack under frame. Remove drive axle wheels (if

required, refer to Section 13, *"Wheels, Hubs And Tires"*).

2. Exhaust compressed air from the air supply system by opening the drain cock on each air reservoir and deplete air bags by moving leveling valve arm down.
3. Install jacks under tag axle jacking points to support the axle weight (refer to figure 11).

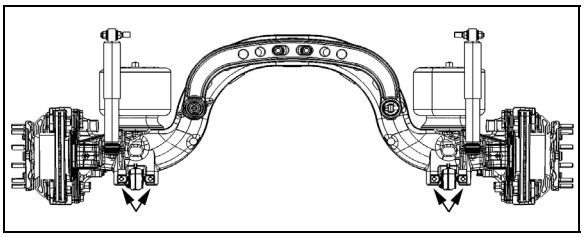

FIGURE 11: JACKING POINTS ON TAG AXLE 11029

4. Disconnect tag axle lifting chain collars from lower longitudinal radius rods.
5. Remove the propeller shaft as directed in Section 9, *"Propeller Shaft",* in this manual.
6. Disconnect the tag axle brake chamber hoses.

CAUTION

Position the hoses so they will not be damaged when removing axle.

7. Disconnect hose from the air spring upper mounting plate.
8. Remove the two shock absorbers as outlined in Section 16, *"Suspension",* under *"Shock Absorber Removal".*
9. Disconnect the lower longitudinal radius rods as outlined in Section 16, *"Suspension",* under *"Radius Rod Removal".*
10. Disconnect the transversal radius rod.
11. Disconnect the upper longitudinal radius rod.
12 Remove the air bellows retaining nuts from each of the two upper mounting plates.
13. Use the jacks to move the axle forward to clear the axle off the transmission. Lower the axle.

CAUTION

On vehicles equipped with an automatic transmission (with or without the output retarder), move tag assembly very carefully. Pay special attention to the U-shaped section, as the transmission end components may be easily damaged through a false maneuver.

14. Reverse removal procedure to reinstall tag axle.

NOTE

Refer to Section 16, "Suspension", for proper torque tightening of suspension components.

NOTE

Refer to section 13 "Wheels, Hubs And Tires" for correct wheel bearing adjustment procedure.

2.5.3 Removing Transversal radius Rod

Unfasten bolts and nuts fixing transversal radius rod ball joint to rear underframe.

Install extractor tool G32952 onto transversal rod.

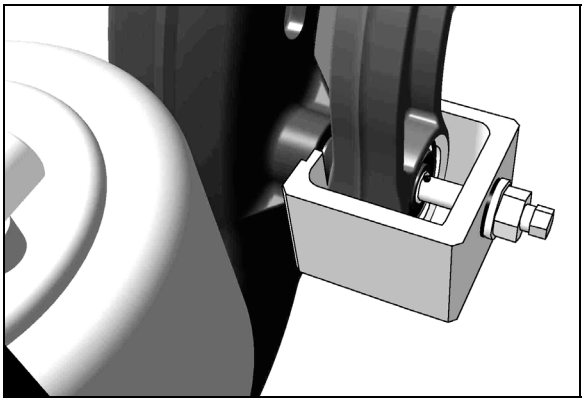

FIGURE 12: INSTALLING EXTRACTOR TOOL

CAUTION

It is strongly suggested to use the extractor tool in order to remove transversal radius rod.

Partially unscrew ball joint fixing bolt. Tighten extractor threaded rod.

Supporting the transversal radius rod at all times, gradually extract transversal radius rod from tag axle.

2.6 TAG AXLE ALIGNMENT

The tag axle alignment consists in aligning the tag axle parallel to the drive axle position. Before aligning the tag axle, proceed with the drive axle alignment (paragraph 1.11). Tag axle alignment is achieved with the use of shims inserted between the lower longitudinal radius rod supports and axle. Tag axle alignment is factory set and is not subject to any change, except if vehicle has been damaged by an accident or if there are requirements for parts replacement.

CAUTION

If this setting is altered significantly, it will cause excessive tire wear.

NOTE

It may be necessary to adjust the axle TOE as well as its alignment. In this case, insert shims (7 min. - P/N 121203 or 15 min. - P/N 121240) in between mounting plate and spindle, as required.

If axle has been removed for repair or servicing and if all parts are reinstalled exactly in their previous locations, axle alignment is not necessary. However, if the suspension supports have been replaced or have changed position, proceed with the following in structions to verify or adjust the tag axle alignment.

3. SPECIFICATIONS

Drive Axle

Make ..... Meritor
Drive track ..... 76.7 inches (1 949 mm)
Gear type ..... Hypoid
Axle type ..... Full floating
Lube capacity ..... 41 pints (19,3 liters)

Drive axle ratio

World Transmission	I-SHIFT Transmission
3.58:1	2.50:1
3.91:1	
4.10:1	

NOTE

The drive axle alignment consists in aligning the axle with reference to the frame. The axle must be perpendicular to the frame.

Tag Axle

Make ..... Prévost
Rear track ..... 83.6 inches (2 124 mm)
Axle type ..... Forged

NOTE

The tag axle alignment consists in aligning the tag axle parallel to the drive axle.

TP-9539
Revised 06-07

MERITOR®

Technical Bulletin

Approved Rear Drive Axle Lubricants

CAUTION

You must fill Meritor axles with Meritor-specified lubricants only. Do not fill an axle with non-approved lubricants, which will void Meritor's warranty. Damage to axle components also can result.

To avoid axle component damage, fill Meritor axles with approved lubricants only. Using non-approved lubricants also will void Meritor's warranty.

For complete lubrication information, refer to Maintenance Manual 1, Preventive Maintenance and Lubrication. To obtain this publication, call ArvinMeritor's Customer Service Center at 800-535-5560, or visit Literature on Demand on our website at meritorhvs.com.

Table A: Oil Change Intervals and Specifications for All Rear Drive Axles

Vocation or Vehicle Operation	Linehaul	Intercity Coach	City Delivery, School Bus, Fire Truck, Motorhome	Construction, Transit Bus, Refuse, Yard Tractor, Logging, Heavy Haul, Mining, Oil Field, Rescue
Initial Oil Change	Not required			
Check Oil Level **Add the correct type and amount of oil as required.**	Every 25,000 miles (40 000 km), or the fleet maintenance interval, whichever comes first		Every 10,000 miles (16 000 km), once a month, or the fleet maintenance interval, whichever comes first	Every 5,000 miles (8000 km), once a month, or the fleet maintenance interval, whichever comes first (1)
Petroleum-Based Oil Change on Axle with or without Pump and Filter System (2)	Every 100,000 miles (160 000 km), or annually, whichever comes first		Every 50,000 miles (80 000 km), or annually, whichever comes first	Every 25,000 miles (40 000 km), or annually, whichever comes first
Synthetic Oil Change on Axle with or without Pump and Filter System (3)	Every 500,000 miles (800 000 km), or every 4 years, whichever comes first	Every 250,000 miles (400 000 km), or every 4 years, whichever comes first	Every 250,000 miles (400 000 km), or every 3 years, whichever comes first	Every 100,000 miles (160 000 km), or every 2 years, whichever comes first (4)
Filter Change on Axle with Pump and Filter System	Every 100,000 miles (160 000 km)			

(1) For continuous heavy-duty operation, check the oil level every 1,000 miles (1600 km).

(2) All ArvinMeritor GL5 approved gear lubricants have been SAE J2360 tested and approved. A current list of approved oils is available at www.pri.sae.org/PRI/IMprograms/Lubricant.

(3) These intervals apply to approved semi-synthetic and full synthetic oils only. For a list of approved extended-drain axle oils, refer to **Table C** or **Table D**.

(4) The change interval for transit buses can be increased to **150,000** miles or **3** years, whichever comes first, contingent upon:
1) documented 10% fleet oil sampling with results below ArvinMeritor guidelines per Maintenance Manual 1,
2) minimum of six magnets in housing (61163/ 71163 drive axles come standard with six magnets in housing), and
3) use of approved extended-drain interval lubricants per **Table B**. (Drive axles excluded are: RC-26-633/634 and RC-26/27-720.)

Table B: Axle Oil Specifications

	Gear Oil Type	A.P.I. Specification	SAE Viscosity Grade	ArvinMeritor Specification	SAE Specification	Outside Temperature
Standard Drain Lubricants	Petroleum with EP additives	GL-5	85W/140	O76-A	SAE J2360 Tested and Approved	Above +10°F (–12°C)
			80W/140	O76-B		Above –15°F (–26°C)
			80W/90	O76-D		Above –15°F (–26°C)
			75W/90	O76-E		Above –40°F (–40°C)
			75W	O76-J		From –40°F (–40°C) to +35°F (+2°C)
			75W/140	O76-L		Above –40°F (–40°C)
Extended-Drain Lubricants	Petroleum with Extended-Drain Base Oils and EP additives	GL-5	75W/90, 80W/90, 80W/140 or 75W/140	O76-Q, O76-R	SAE J2360 Tested and Approved	Depends on viscosity. Refer to the viscosity grades listed above.
	Petroleum with Semi-Synthetic Base Oils and EP additives		80W/90	O76-P		Above –15°F (–26°C)
	Fully Synthetic Base Oil and EP additives		75W/140	O76-M		Above –40°F (–40°C)
	Fully Synthetic Base Oil and EP additives		75W/90	O76-N		Above –40°F (–40°C)

Table C: Extended-Drain-Approved Synthetic Axle Oil Suppliers — United States Distributors

Name of Lubricant	Viscosity	Manufacturer
Allied Mag Synthetic EP	75W/90, 80W/140	Allied Oil and Supply Incorporated
Altra Syntec GT-7	75W/90, 80W/140	Allegheny Petroleum Products
Amalie Synthetic Gear Lubricant	75W/90, 80W/140	Amalie Refining Company
Amoco Ultimate Multipurpose Gear Lube	75W/90, 80W/140	Amoco Oil Company
Archer Synthetic	75W/90, 80W/140	McCollister & Co.
Brad Penn Full Syn. Hypoid Gear Lube	75W/90, 80W/140	American Refining Group
Bulldog Syn Gear Lube	75W/90, 80W/140	Mack Truck Company
Chevron Delo Synthetic Gear Lubricant	75W/90	Chevron Global Lubricants
Chevron RPM Synthetic Gear Lubricant	75W/90, 80W/140	Chevron Global Lubricants
Citgo Synthetic Gear Lube	75W/90, 80W/140	Citgo Petroleum Corporation
Coastal HD	75W/90, 80W/140	Coastal Unilube Inc.
Dyna-Plex 21C Synzol	75W/90, 80W/140	Universal Lubricants
Dyno-Tech HD	75W/90, 80W/140	Chemtool Inc.
Emgard EP	75W/90, 80W/140	Cognis Corporation
Emgard FE Fuel Efficient Synthetic Gear Lubricant	75W/90	Cognis Corporation
Emgard Synthetic Gear Lubricant	75W/90, 80W/140	Cognis Corporation
Emgard 2986	75W/90	Cognis Corporation
Fleetrite Synthetic	75W/90, 80W/140	International Truck & Engine Group
FS Synthetic	75W/90, 80W/140	Growmark
Gear Plus Super EW	75W/90, 80W/140	Pennzoil-Quaker State

Table C: Extended-Drain-Approved Synthetic Axle Oil Suppliers — United States Distributors

Name of Lubricant	Viscosity	Manufacturer
Gibraltar Syn-Gear	75W/90, 80W/140	David Weber Oil Company
Gulf Syngear	75W/90, 80W/140	Gulf Oil
Hi-Tek Synthetic	75W/90, 80W/140	Industrial Oils Limited
Imperial SGO	75W/90, 80W/140	IPAC
Lubemaster Syn EP	75W/90, 80W/140	Lubemaster (A Division of Certified Labs)
Maxtron GL	75W/90, 80W/140	Country Energy LLC
Mobil Delvac Synthetic Gear Oil	75W/90, 80W/140	ExxonMobil Corporation
Mobilube SHC	75W/90, 80W/140	ExxonMobil Corporation
Monarch Syngear Plus	75W/90, 80W/140	Royal Manufacturing Co. Inc.
Mystik Synguard SX-7000	75W/90, 80W/140	Cato Oil and Grease Company
NEO	75W/90, 80W/140	Neo Lubricants
Pennzoil Long-Life EW	75W/90, 80W/140	Shell Oil U.S.
Quaker State FCI Synthetic	75W/90, 80W/140	Shell Oil U.S.
Raloy Transintex Plus EP	75W/90, 80W/140	Raloy Lubricantes S. A. de C.V.
Roadranger FE Fuel Efficient Synthetic Gear Lubricant	75W/90	Eaton Corporation
Roadranger Synthetic Gear Lubricant	75W/90, 80W/140	Eaton Corporation
Schaeffer Synthetic EP	75W/90, 80W/140	Schaeffer Manufacturing Company
SHP Gear Lube	75W/90, 80W/140	Kendall Lubricants
Spirax S	75W/90, 80W/140	Shell Lubricants
SYN HD Gear Oil	75W/90, 80W/140	Lyondell Lubricants
Syn. Axle Lubricant 12345841	75W/90, 80W/140	General Motors Service Parts
Syncon HP Synthetic Gear Oil	75W/90, 80W/140	Conoco Lubricants
SYN-EP Gear Lubricant	75W/90, 80W/140	Black Bear Company Incorporated
Synergy Syn. Gear Lube EP	75W/90, 80W/140	Northland Products Company
Syn-Gear	75W/90, 80W/140	Castrol Heavy Duty Lubricants, Inc.
Syngear EP	75W/90, 80W/140	American AGIP
Synolec	75W/90, 80W/140	Lubrication Engineers Incorporated
Synpro	75W/90, 80W/140	Fina Oil and Chemical Company
Syn-Star GL	75W/90, 80W/140	Texaco Lubricants Company
Synsure Synthetic Lubricant	75W/90, 80W/140	D-A Lubricant Company Incorporated
Syn-Tech EP	75W/90, 80W/140	Benz Oil
Syntex 2700	75W/90, 80W/140	Texas Refinery Corporation
Texaco Syn-Star GL	75W/90, 80W/140	Chevron Global Lubricants
Traxon E Synthetic	75W/90, 80W/140	Petro-Canada Lubricants Centre
Triton Syn Lube EP	75W/90, 80W/140	76 Lubricants
United Syn	75W/90, 80W/140	McCollister & Co.
Valvoline HD Synthetic Gear Oil EP	75W/90, 80W/140	Valvoline Incorporated

Table D: Additional Extended-Drain-Approved Axle Oil Suppliers

CANADA:

Name of Lubricant	Viscosity	Manufacturer
HDH Synthetic	75W/90, 80W/140	Irving Oil Limited
NEMCO Syngear	75W/90, 80W/140	NemCo Resources Limited
Sonic MP Gear Oil	75W/90, 80W/140	Federated Cooperatives Limited
Titan Syndrive	75W/90, 80W/140	Fuchs Lubricants Canada Limited

MEXICO:

Name of Lubricant	Viscosity	Manufacturer
Akron Axle Synthetic	75W/90, 80W/140	Mexicano de Lubricantes, S.A. de C.V.
Q.S. Synquest Gear	80W/140	Commercial Importada, S.A. de C.V.
Sun Gear Gold Syn	75W/90, 80W/140	Aceites Y Parafinas Industriales
Syn-Star GL	75W/90, 80W/140	Productos Texaco, S.A. de C.V.
Transintex Plus EP	75W/90, 80W/140	Raloy Lubricantes, S.A. de C.V.

AUSTRALIA/NEW ZEALAND:

Name of Lubricant	Viscosity	Manufacturer
Synstar GL	75W/90, 80W/140	Caltex Oil Pty. Limited
Syntrax E	75W/90, 80W/140	Castrol Australia PTY Limited
TransGear S	80W/140	BP Oil Company
Tutela Truck FE Axle	80W/140	Fiat Lubrificanti

Other Approved Extended-Drain Gear Oils

Name of Lubricant	Viscosity	Manufacturer
Delo Gear Lubricant ESI	80W/90, 85W/140	Chevron Global Lubricants
PED 6449	75W/90	Chevron Global Lubricants
Pennzoil Long-Life EW	75W/90, 80W/140	Shell Lubricants
SAF-AM	80W/90	Castrol Heavy Duty Lubricants
Shell Spirax EW	75W/90, 80W/140	Shell Lubricants
Synergyn Blended Synthetic	80W/90	Synergyn Racing Products
Texaco Star Gear Lubricant	80W/90, 85W/140	Chevron Global Lubricants
Triton Syn Lube LDO	75W/90, 80W/140	76 Lubricants
Super Three Star	75W/90, 80W/140	Kendall

For Meritor R-170 Axles Equipped With Traction Equalizer®

Meritor's R-170 axles with Traction Equalizer normally operate with either standard petroleum, semi-synthetic or full-synthetic oils.

When to Use "Limited Slip Friction Modifiers"

Occasionally the Traction Equalizer will "slip" or "stick." When this happens, you will hear intervals of shrill noises when the vehicle operates at low speed or when the vehicle makes sharp turns. You can correct this condition by adding "limited slip friction modifiers."

NOTE: "Limited slip friction modifiers" usually deteriorate more quickly than extreme pressure (EP) additives. Shorten the lubricant change schedule if you add a friction modifier.

- **At the initial lubricant change interval for an R-170 equipped with Traction Equalizer:** Replace the factory-installed lubricant with an approved lubricant and one of the additives specified in the following table.
- **After the initial change interval:** Change the lubricant and the additive at or before 50,000 miles (80 000 km).

Specifications

For all GL-5 oils (petroleum oil or synthetic), add one of the following modifiers specified in the following table.

Manufacturer	Specification
DSL-178	Guardsman Products
Equa-Torque #2411 and #2414	Sta-Lube Corporation
Lubrizol #6178	Lubrizol Corporation

Quantities for R-170 Axles With and Without Traction Equalizer

WITH Traction Equalizer	WITHOUT Traction Equalizer
40 pints oil (18.9 liters) + 3 pints additive (1.4 liters)	43 pints oil (20.3 liters)

Lubrication Analysis Recommendations

Meritor recommends using a lubricant analysis program. Perform lubricant analysis at regularly-scheduled preventive maintenance intervals. Refer to Maintenance Manual 1, Preventive Maintenance and Lubrication, for drive axle differential oil analysis guidelines.

ArvinMeritor™

Meritor Heavy Vehicle Systems, LLC
2135 West Maple Road
Troy, MI 48084 USA
800-535-5560
meritorhvs.com

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MERITOR®

Maintenance Manual Update

Applying Loctite® Ultra Grey Flange Sealant 5699/Meritor Part Number 2297-Z-7098

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

When you apply some silicone gasket materials, a small amount of acid vapor is present. To prevent serious personal injury, ensure that the work area is well-ventilated. Read the manufacturer's instructions before using a silicone gasket material, then carefully follow the instructions. If a silicone gasket material gets into your eyes, follow the manufacturer's emergency procedures. Have your eyes checked by a physician as soon as possible.

Procedures

1. Remove all old gasket material from both the axle and the carrier surfaces. Figure 1.

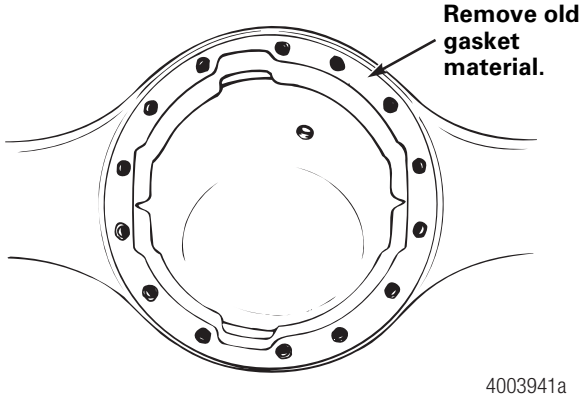

Figure 1

2. Clean the surfaces where you will apply the silicone gasket material. Remove all oil, grease, dirt and moisture. Figure 1.
3. Dry both surfaces.

⚠ CAUTION

The amount of silicone gasket material applied must not exceed a 0.125-inch (3 mm) diameter bead. Too much gasket material can block lubrication passages and result in damage to the carrier or axle components.

4. Apply a 0.125-inch (3 mm) diameter continuous bead of Loctite® Ultra Grey Flange Sealant 5699, Meritor part number 2297-Z-7098, around one surface. Also apply the gasket material around the edge of all fastener holes on that surface. Figure 2.

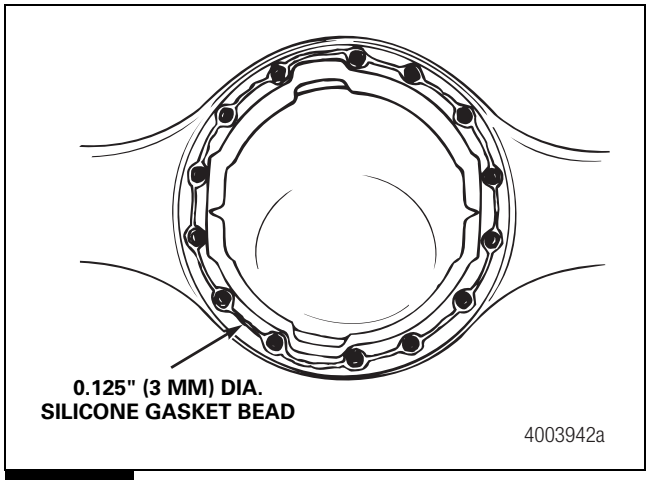

Figure 2

5. Assemble the components immediately to permit the silicone gasket material to compress evenly between the parts. Tighten the fasteners to the required torque value for that size fastener.
6. Wait 20 minutes before filling the assembly with lubricant.

Maintenance Manuals

The information in this Technical Bulletin updates the following Maintenance Manuals.

MM	Title	Date
5B	Tandem Axle Forward Rear Drive Units	09-88
5J	Single-Reduction Hypoid Drive Unit	08-79
5P	Tandem Axle Forward Rear Drive Units	03-91
6C	Double-Reduction Differential Carriers	08-84
7A	Hypoid Planetary Two-Speed Differential Carriers	08-90
12	Heavy-Duty Front Drive Steer Axles	11-98

ArvinMeritor™

Meritor Heavy Vehicle Systems, LLC
2135 West Maple Road
Troy, MI 48084 USA
800-535-5560
arvinmeritor.com

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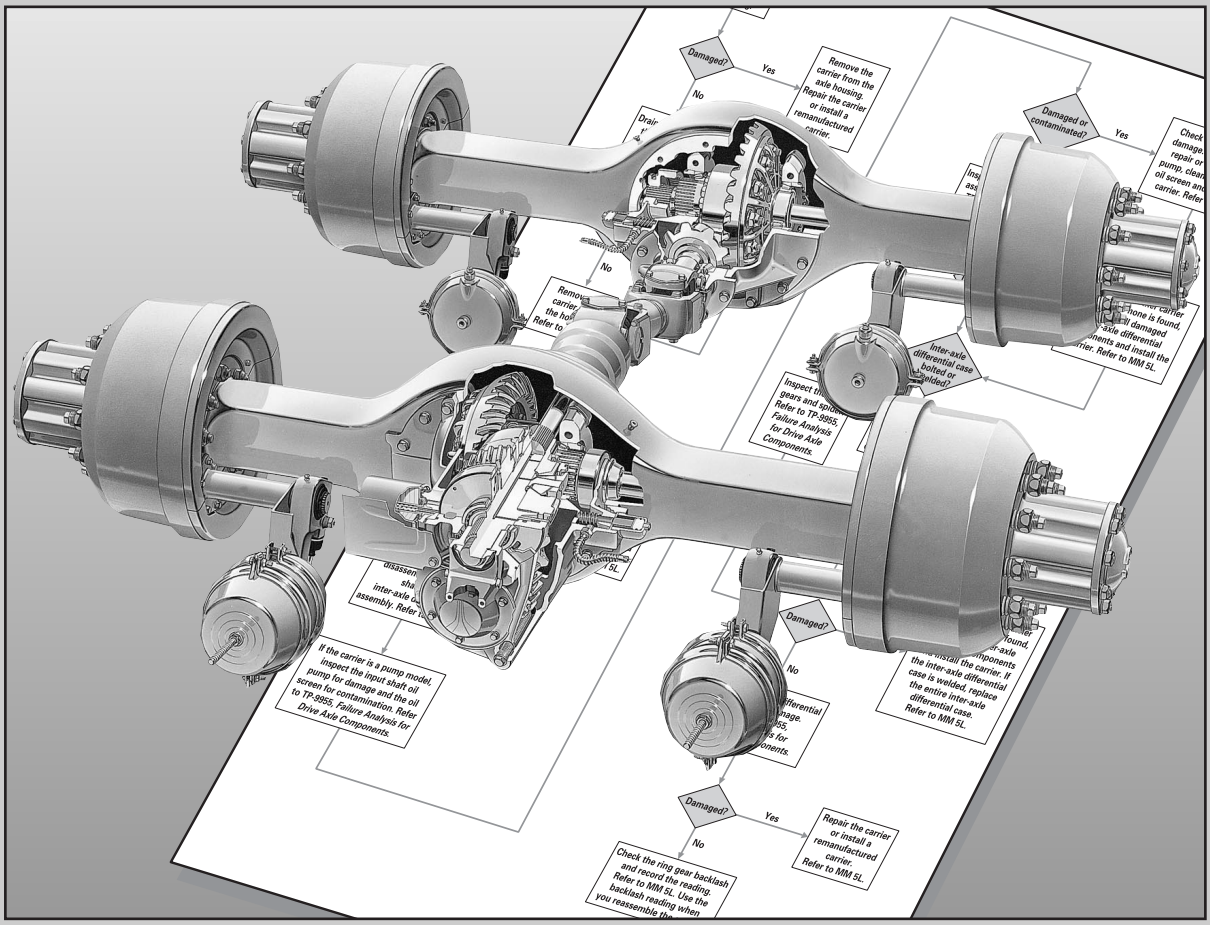
TECHNICAL BULLETIN

Forward and Rear Axle Carrier Diagnostic Flowcharts



Introduction

How to Use This Publication

Refer to the following diagnostic flowcharts to help you determine the source of axle differential carrier complaints.

Before you use the flowcharts, investigate the axle carrier complaint and confirm that the problem involves the carrier.

To locate the correct flowchart, refer to the following tables.

Forward Tandem Carrier

Flowchart	Page
Vehicle Will Not Move	2
Differential Making Noise	4
Oil Leak	6

Rear Tandem or Single Carrier

Flowchart	Page
Vehicle Will Not Move	7
Differential Making Noise	8
Oil Leak	9

All Rear Axles

Flowchart	Page
Contaminated Lubricant Found During Preventive Maintenance	10

Performing the Diagnostic Procedures in This Bulletin

Refer to the following publications when you perform the diagnostic procedures in this bulletin.

- *Lubrication*
  Maintenance Manual No. 1
- *Single Reduction Differential Carriers*
  Maintenance Manual No. 5
- *Single Reduction Rear Differential Carriers*
  Maintenance Manual No. 5A
- *Tandem Axle Forward Carriers and Single Axle Carriers* — Maintenance Manual No. 5E
- *Single Reduction Forward Differential Carriers on Tandem Axles* — Maintenance Manual No. 5L
- *Failure Analysis for Drive Axle Components*
  Manual No. TP-9955

To order copies of these publications or a CD version of the diagnostic flowcharts (TP-99113), call Meritor's Customer Service Center at 800-535-5560.

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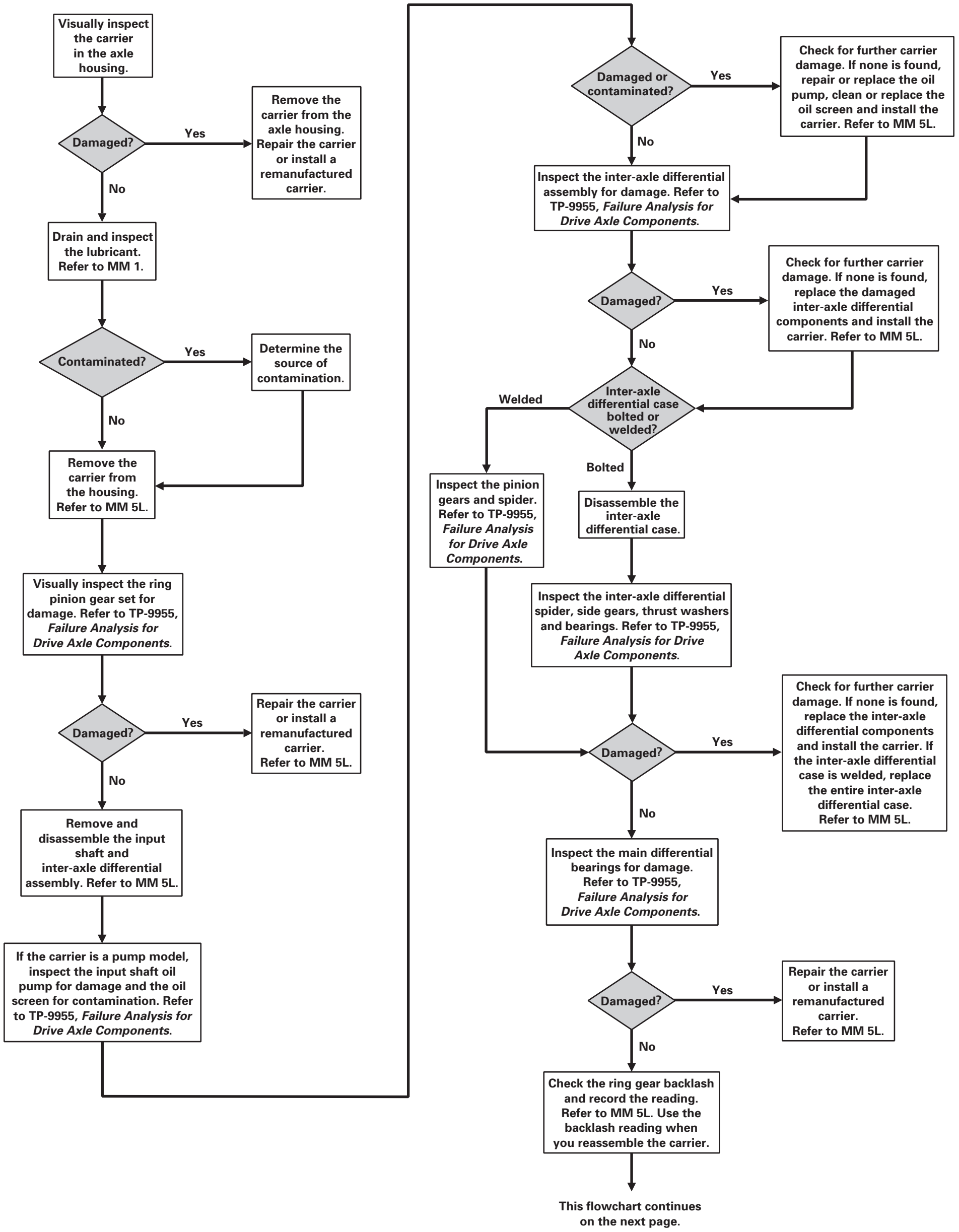
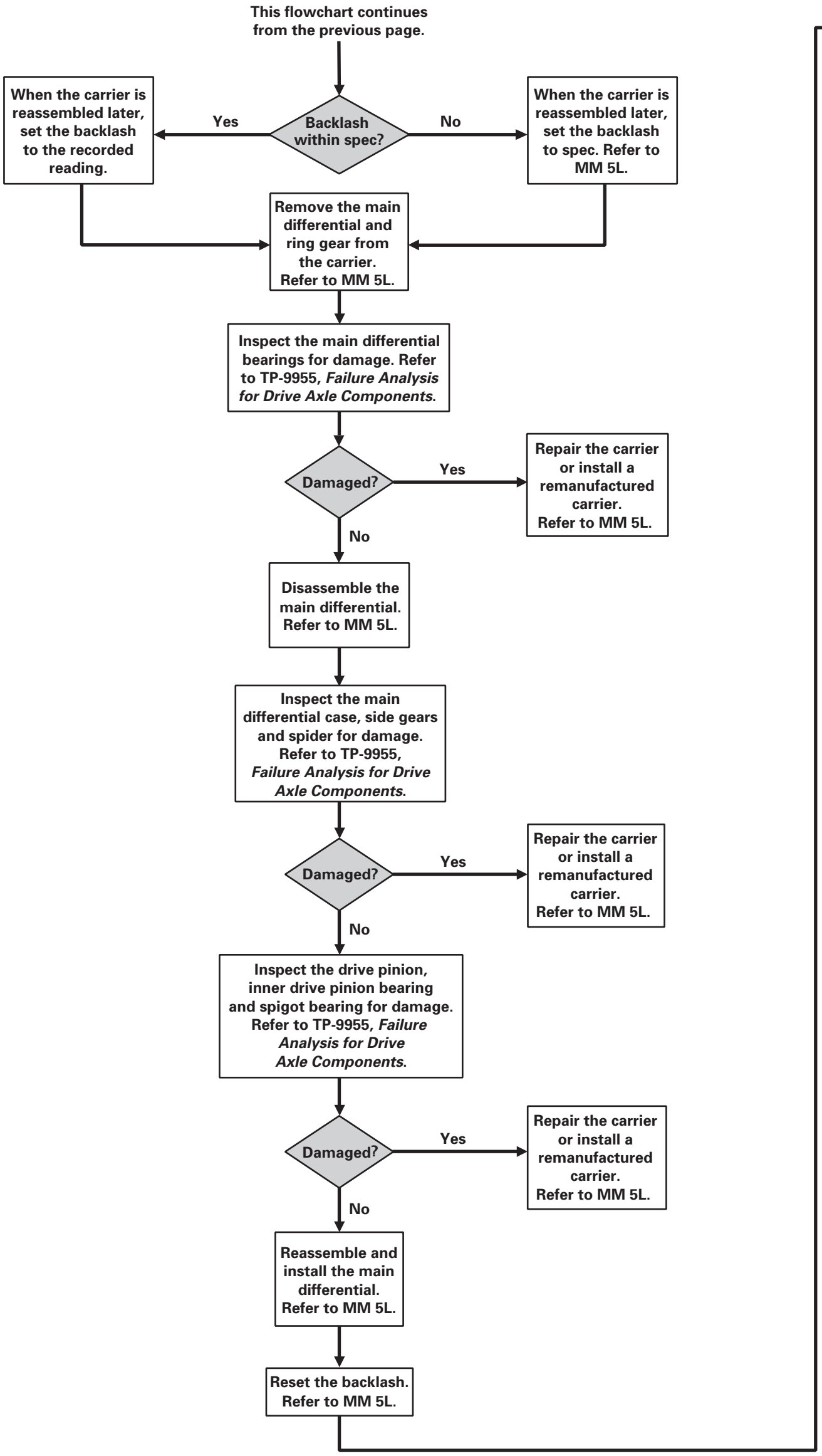
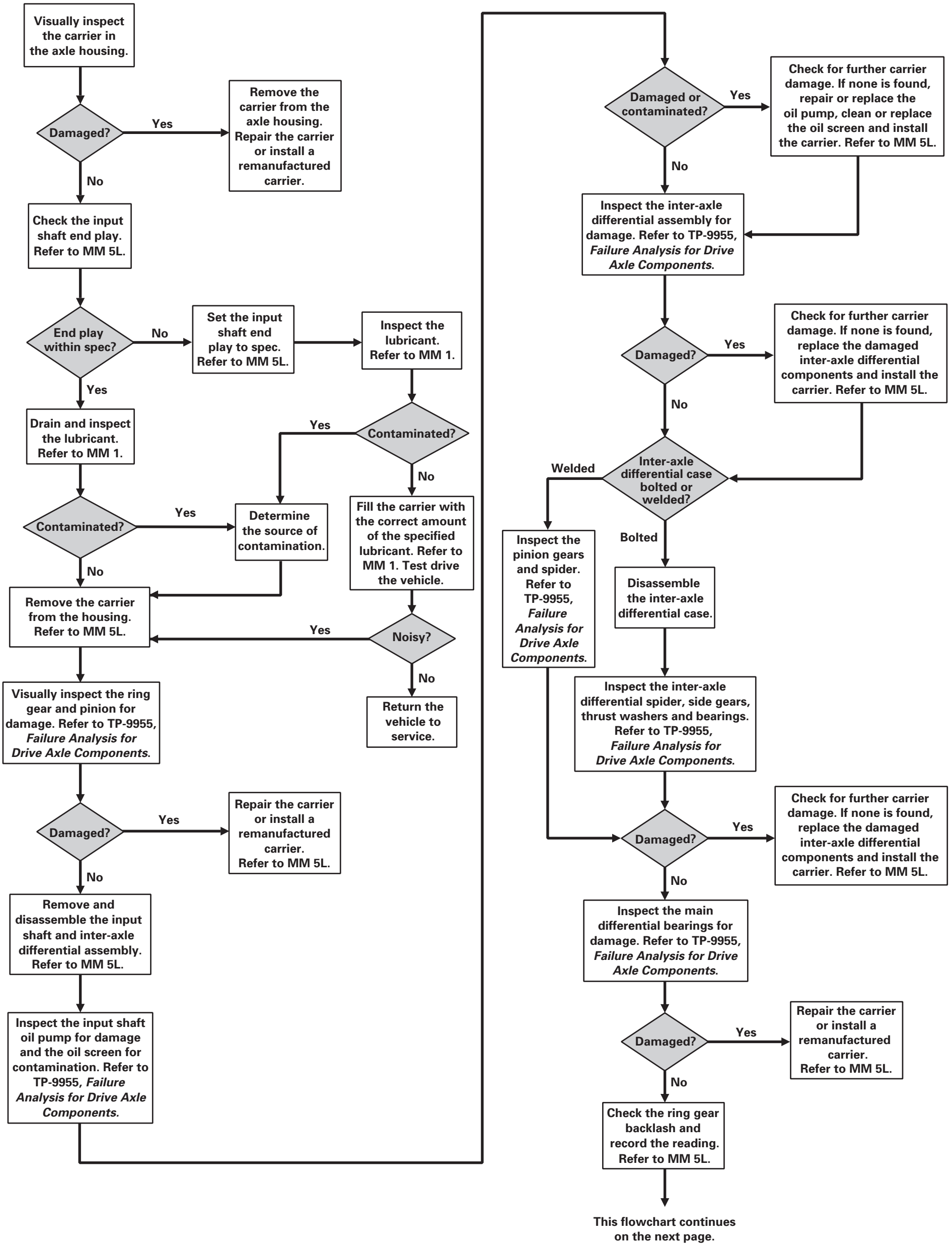
Forward Tandem Carrier
Vehicle Will Not Move



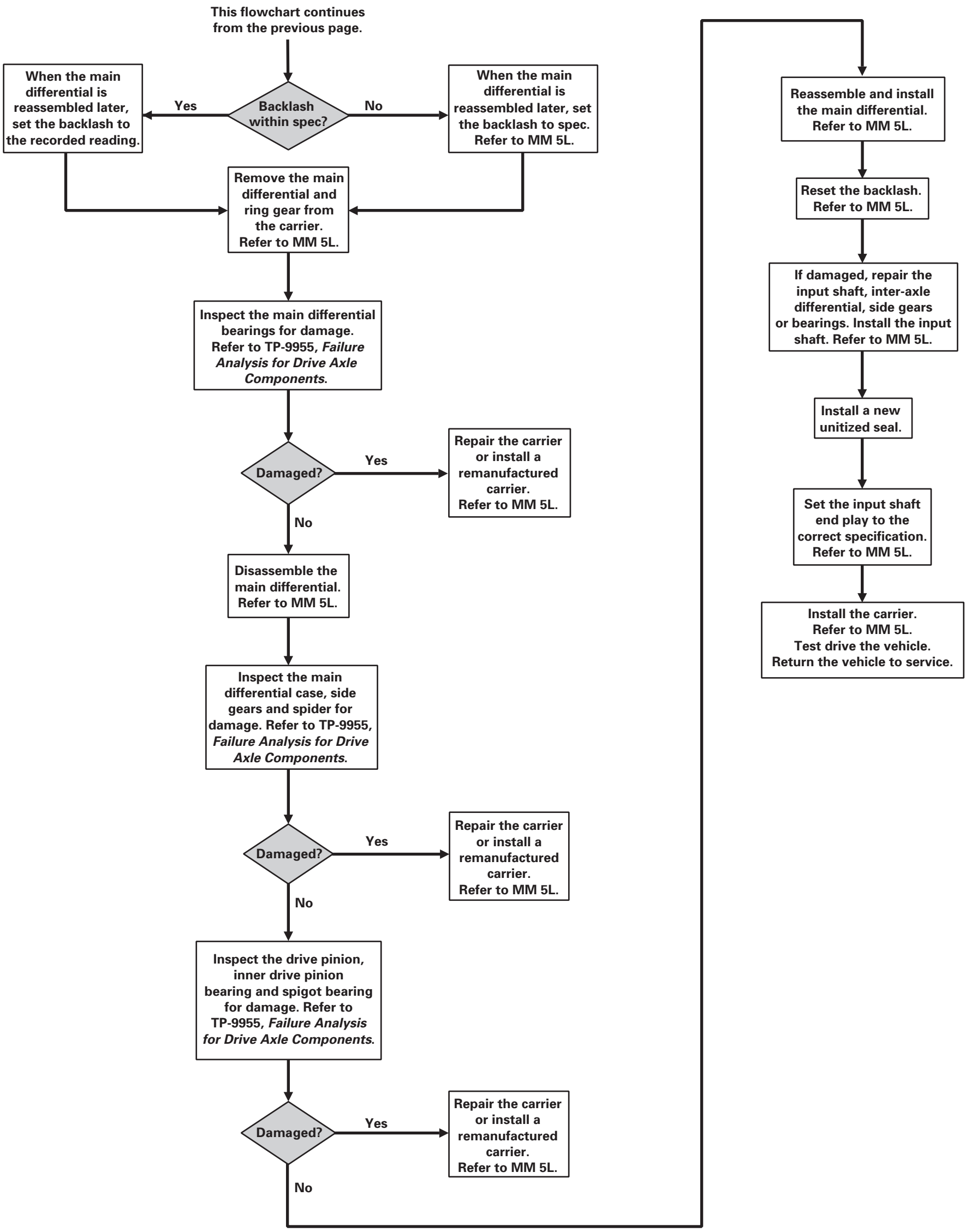
This flowchart continues on the next page.



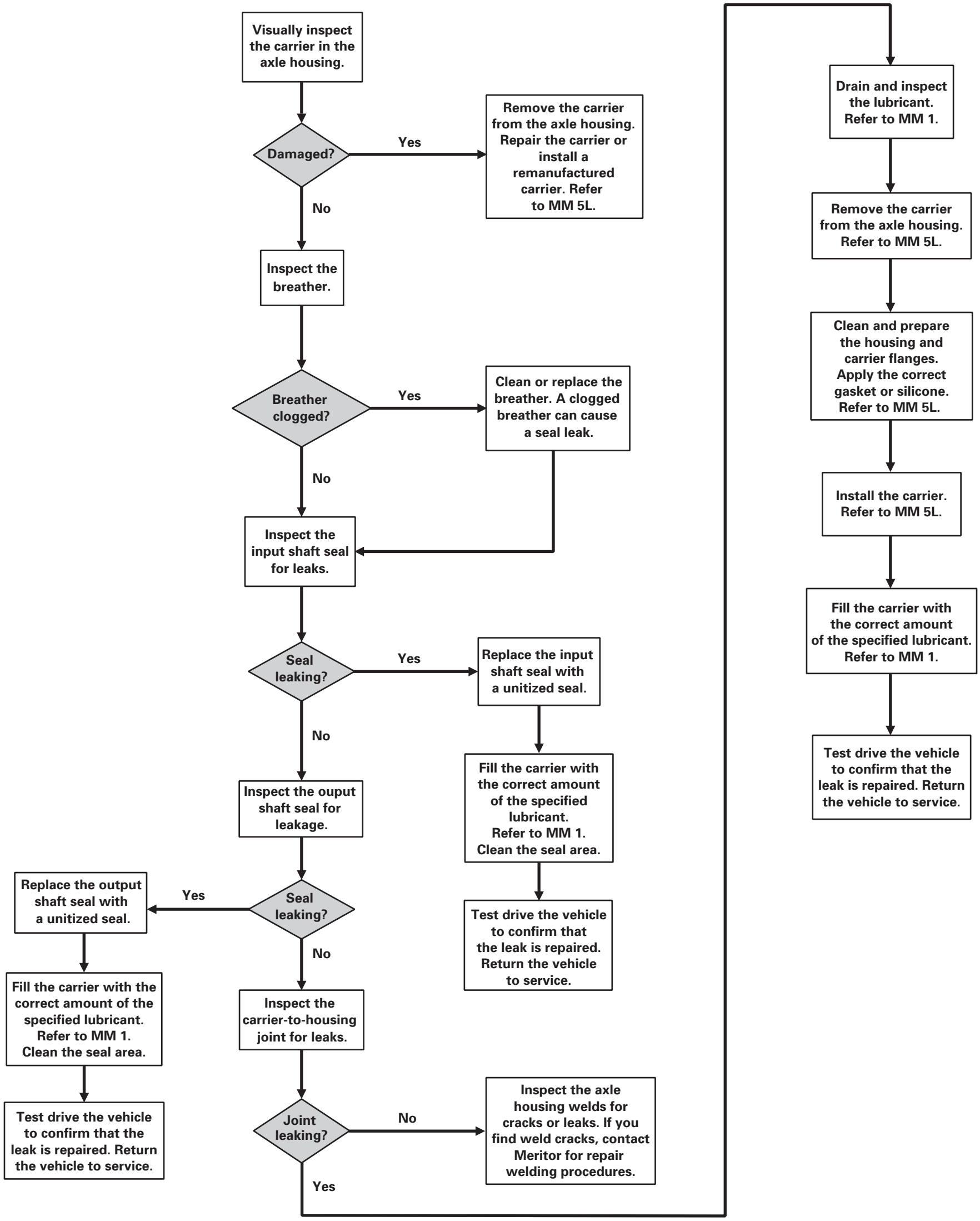
Forward Tandem Carrier
Differential Making Noise



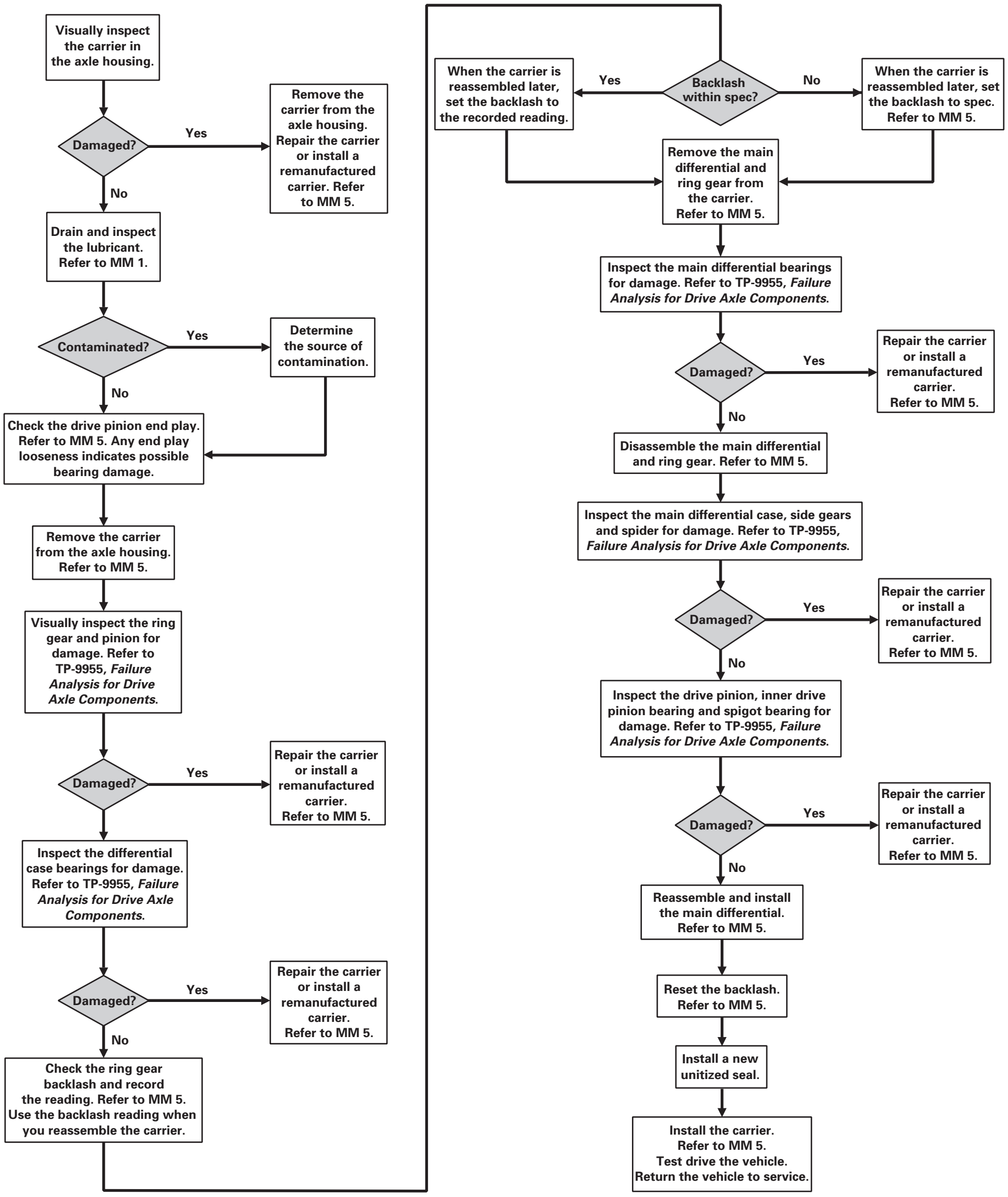
This flowchart continues on the next page.



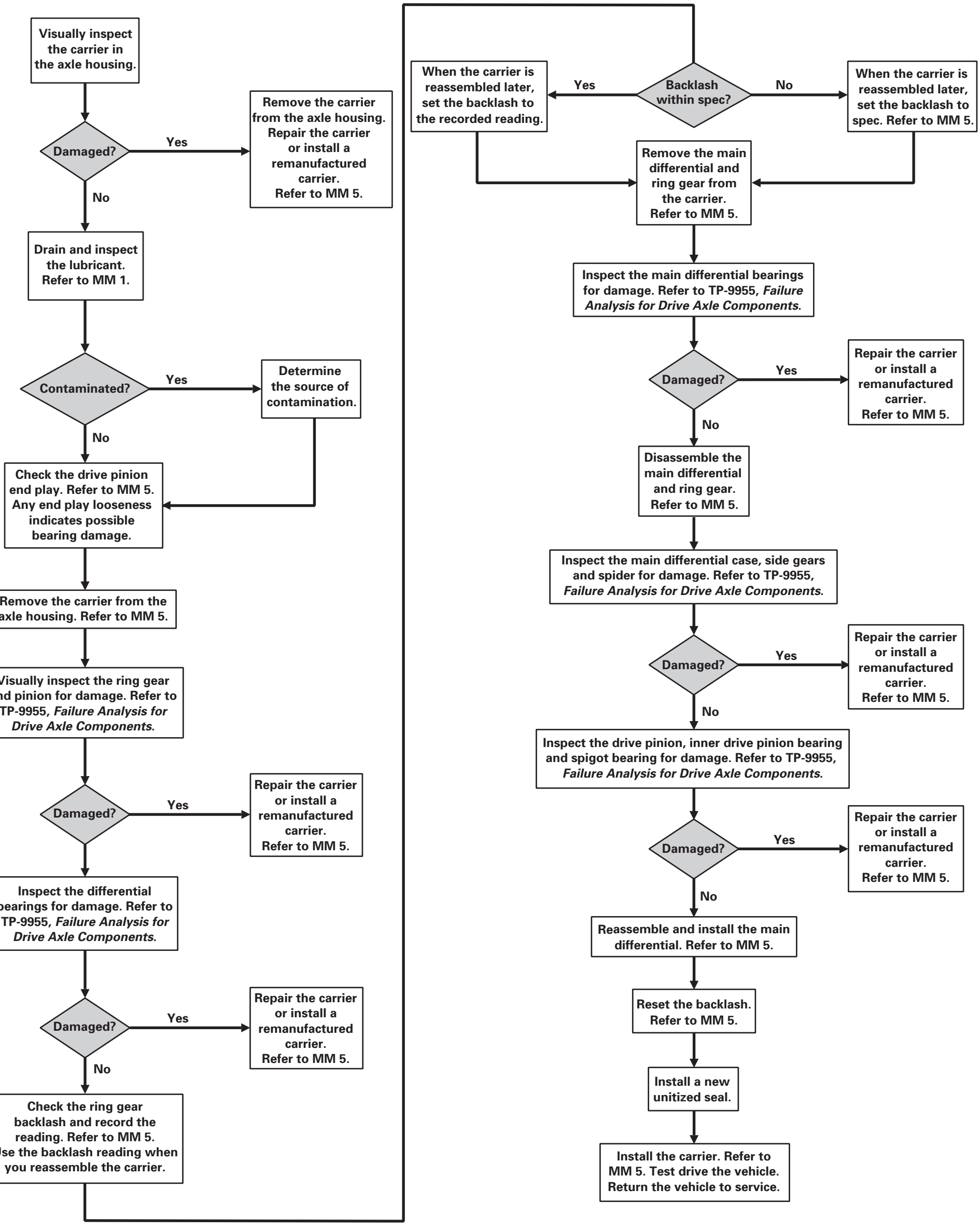
Forward Tandem Carrier
Oil Leak



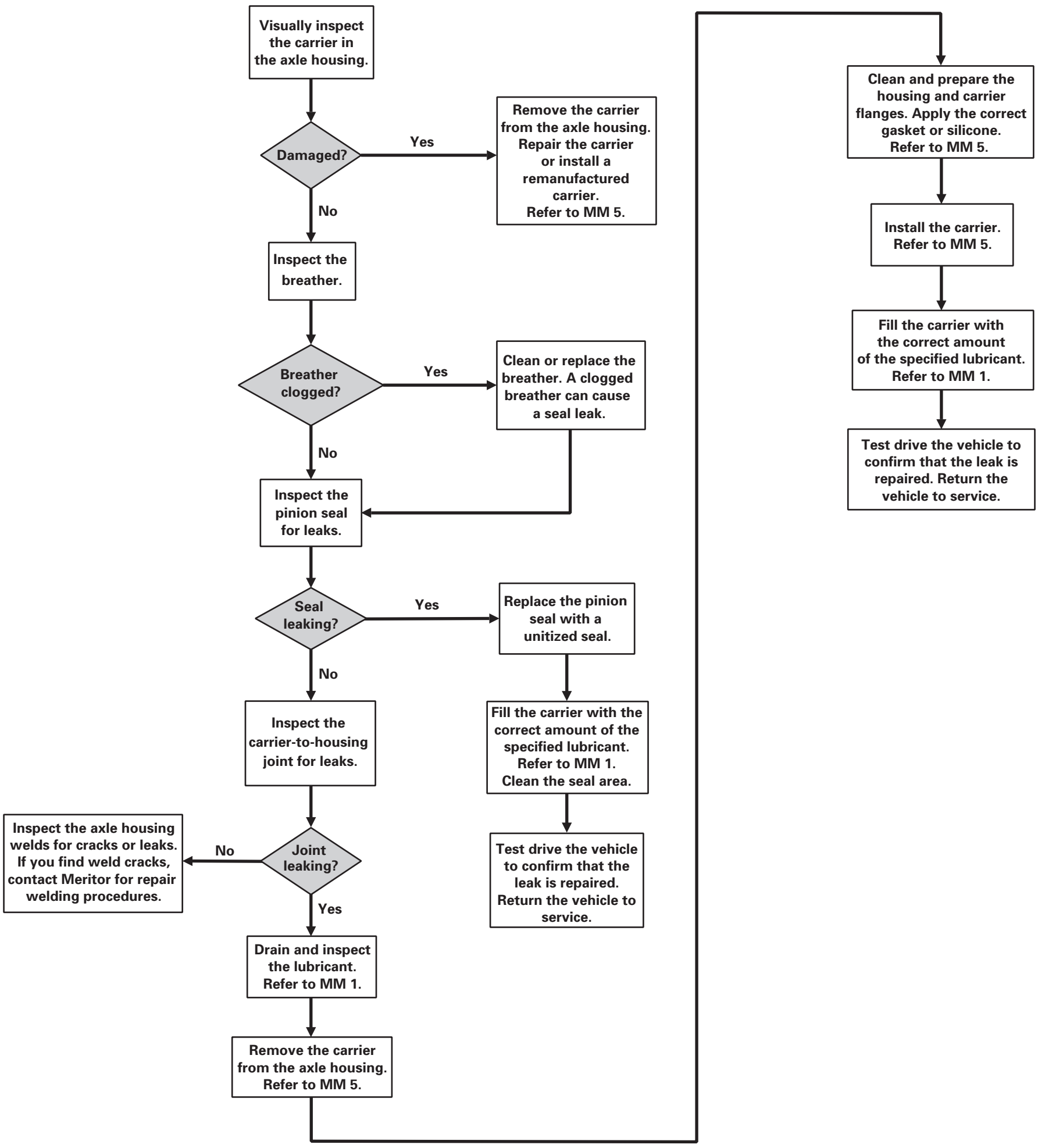
Rear Tandem or Single Carrier
Vehicle Will Not Move



Rear Tandem or Single Carrier
Differential Making Noise

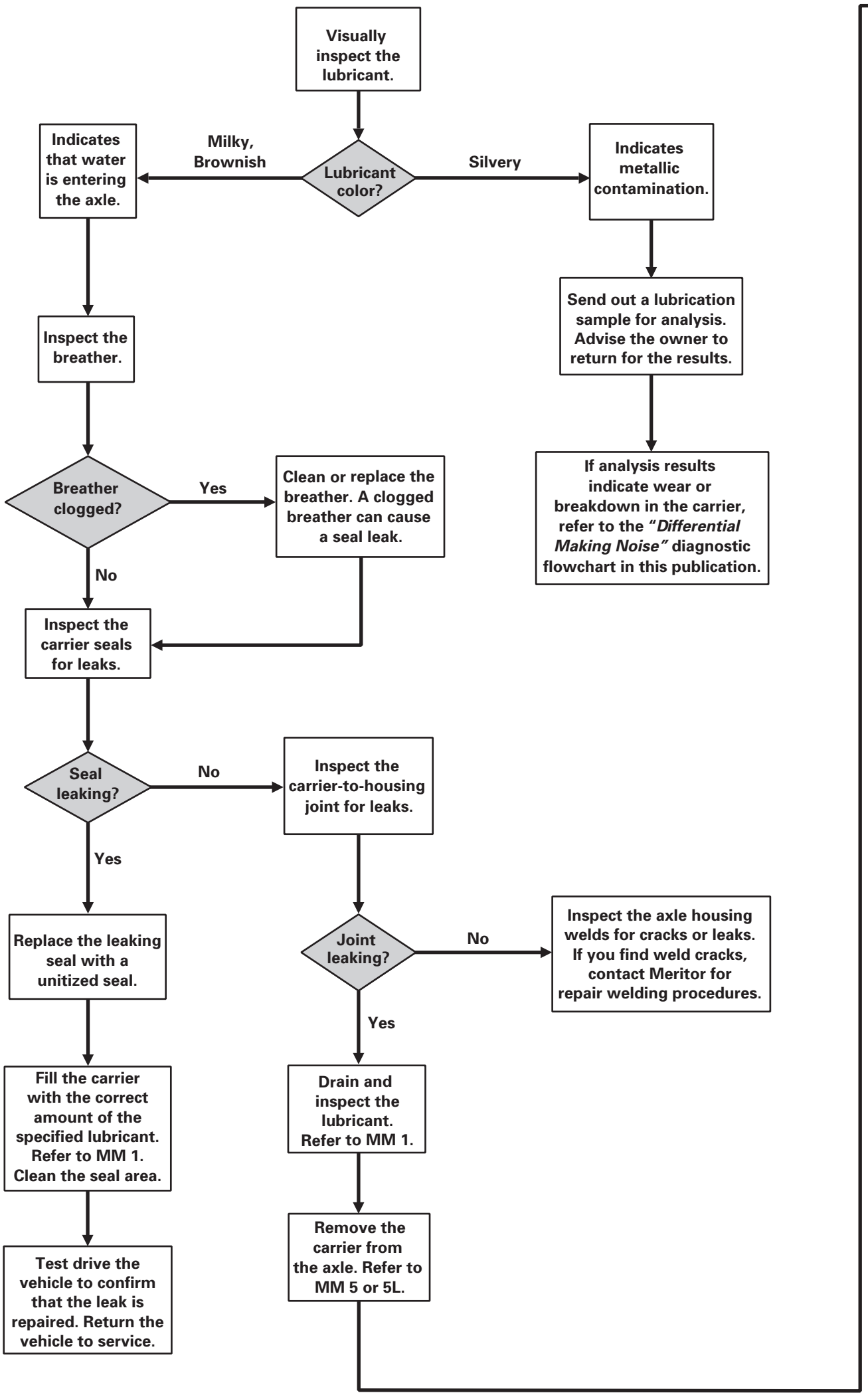


Rear Tandem or Single Carrier
Oil Leak



All Rear Axles

Contaminated Lubricant Found During Preventive Maintenance



Meritor Heavy Vehicle Systems, LLC
2135 West Maple Road
Troy, MI 48084 USA
800-535-5560
www.meritorauto.com

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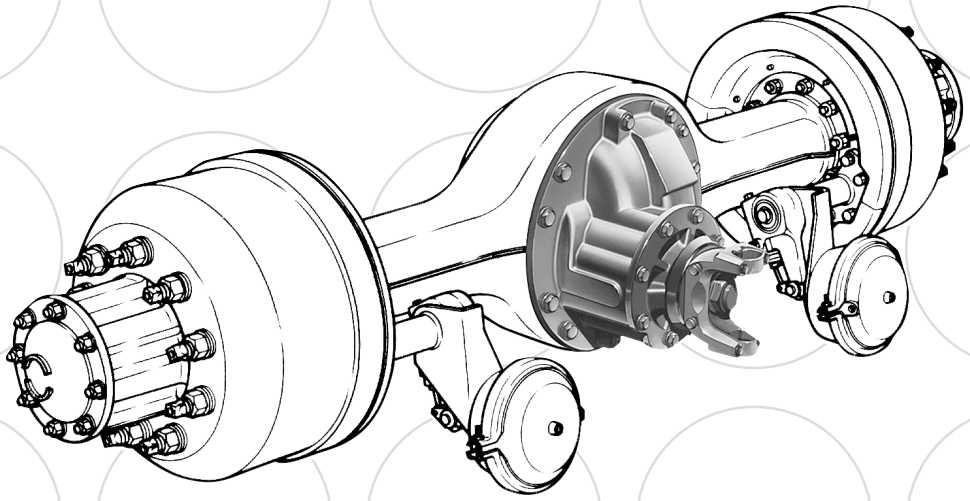
Maintenance Manual 5A

Single-Reduction Differential Carriers

Single Rear Drive Axles, Rear-Rear Tandem Drive Axles and Front Drive Steer Axles

Revised 01-08



About This Manual

This manual provides instructions for the Meritor MX, RS, RT and RF Series axles and 59000 Series angle drive carrier.

Before You Begin

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Hazard Alert Messages and Torque Symbols

⚠ WARNING

A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.

⚠ CAUTION

A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components.

This symbol alerts you to tighten fasteners to a specified torque value.

How to Obtain Additional Maintenance and Service Information

On the Web

Visit Literature on Demand at arvinmeritor.com to access and order product, service, aftermarket, and warranty literature for ArvinMeritor's truck, trailer and specialty vehicle components.

Literature on Demand DVD (LODonDVD)

The LODonDVD contains product, service and warranty information for ArvinMeritor components. To order the DVD, visit Literature on Demand at arvinmeritor.com and specify TP-0742.

How to Obtain Tools and Supplies Specified in This Manual

Call ArvinMeritor's Commercial Vehicle Aftermarket at 888-725-9355 to obtain Meritor tools and supplies.

SPX Kent-Moore, 28635 Mound Road, Warren, Michigan, 48092. Call the company's customer service center at 800-345-2233, or visit their website at spxkentmoore.com.

Kiene Diesel Accessories, Inc., 325 S. Fairbanks Street, Addison, IL 60101. Call the company's customer service center at 800-264-5950, or visit their website at kienediesel.com.

SPX/OTC Service Solutions, 655 Eisenhower Drive, Owatonna, MN 55060. Call the company's customer service center at 800-533-6128, or visit their website at otctools.com.

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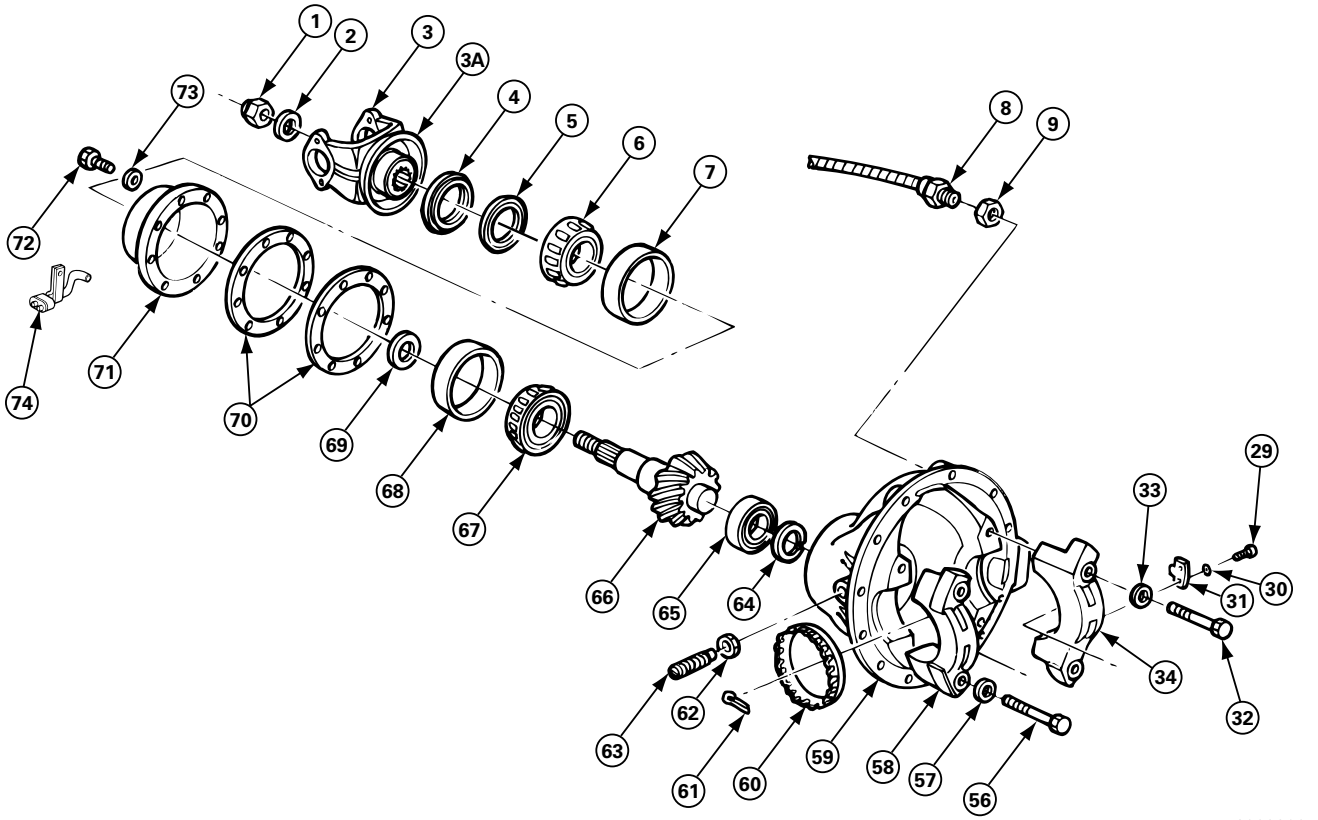
Single-Reduction Differential Carrier



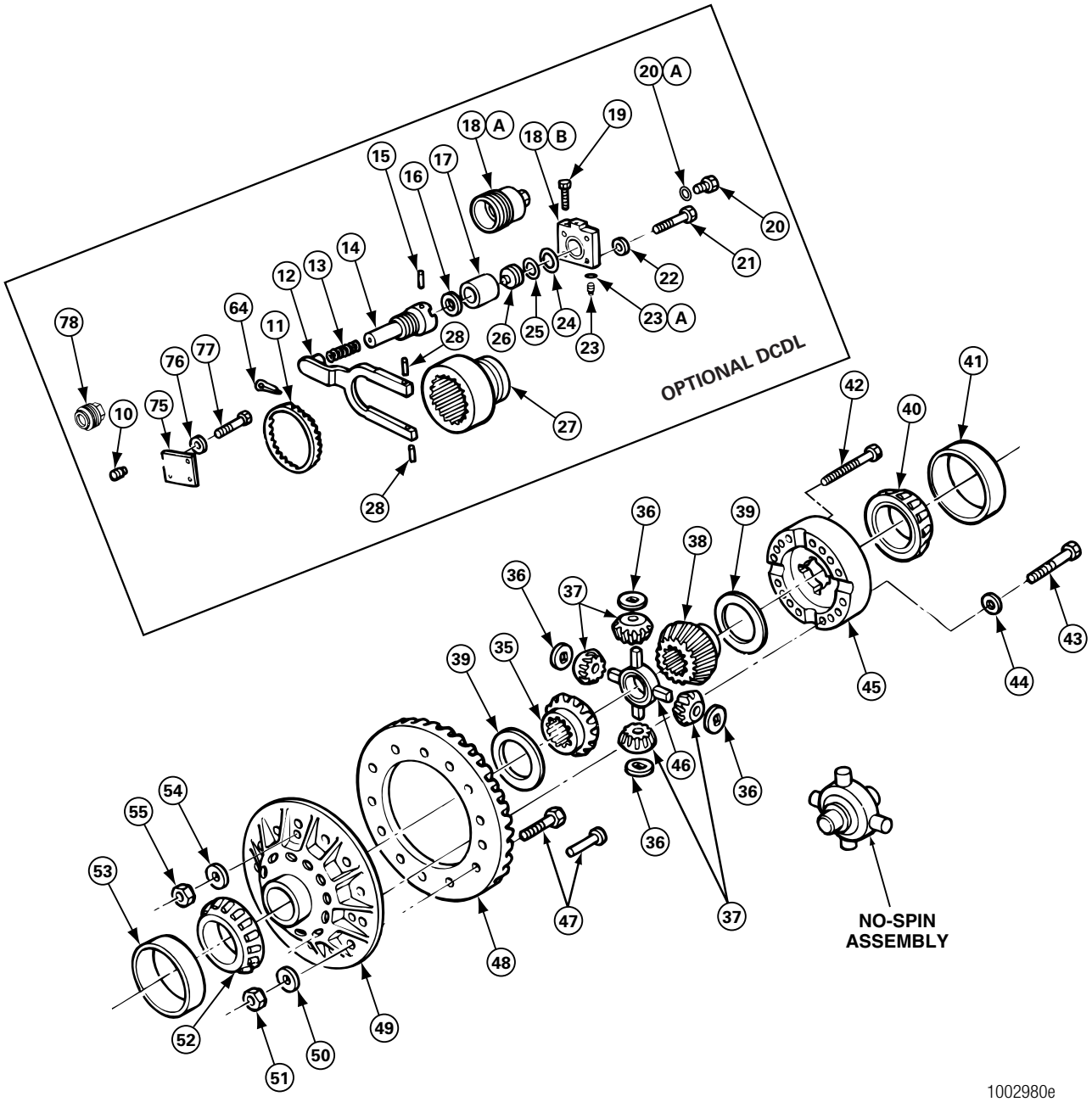
Item	Description
1	Drive Pinion Nut*
2	Drive Pinion Washer*
3	Input Yoke or Flange*
3A	Deflector
4	POSE™ Seal
5	Triple-Lip or Main Seal
6	Outer Bearing Cone
7	Inner Bearing Cup
8	Sensor Switch
9	Sensor Switch Locknut
29	Lock Plate Capscrews*
30	Lock Plate Washers*
31	Adjusting Ring Lock Plate
32	Differential Bearing Cap Capscrews

Item	Description
33	Washers
34	Differential Bearing Caps
56	Differential Bearing Cap Capscrews
57	Washers
58	Differential Bearing Cap
59	Carrier
60	Adjusting Ring
61	Adjusting Ring Cotter Pin, Spring Pin (Spirol™) or Capscrews
62	Thrust Screw Jam Nut*
63	Thrust Screw*
64	Snap Ring
65	Spigot Bearing

Item	Description
66	Drive Pinion
67	Pinion Inner Bearing Cone
68	Pinion Inner Bearing Cup
69	Pinion Bearing Spacer
70	Shims
71	Drive Pinion Bearing Cage
72	Bearing Cage Capscrew
73	Washer
74	Clip and Cable Holder
75	Bolt-On Cover
76	Washer
77	Bolt
78	Screw-In Cover

* Some Meritor carriers do not have these parts.

1 Exploded Views



Item	Description
10	Plug*
11	Right-Hand Adjusting Ring
12	Shift Fork
13	Shift Shaft Spring
14	Shift Shaft
15	Spring Retaining Pin
16	Air Cylinder Washer or Silastic*
17	Air Cylinder Tube
18A	Screw-In Differential Lock Cylinder
18B	Cylinder Cover
19	Manual Actuation Capscrew
20	Cylinder Cover Plug
20A	Cover Plug Gasket
21	Cylinder Cover Capscrews
22	Cylinder Cover Washers
23	Cylinder Cover Plug
23A	Cover Plug Gasket
24	Cylinder Cover Copper Gasket
25	Piston O-Ring
26	Piston
27	Shift Collar
28	Shift Fork Pins
35	Differential Side Gears
36	Differential Pinion Thrust Washers
37	Differential Pinions
38	Differential Side Gears
39	Differential Side Gear Thrust Washers
40	Differential Bearing Cone
41	Differential Bearing Cup
42	Thru Bolt
43	Differential Case Bolts*
44	Differential Case Washers
45	Main Differential Case Assembly
46	Differential Spider
47	Ring Gear and Case Half Bolts or Rivets*
48	Ring Gear
49	Flange Case Half
50	Case Half Washers
51	Case Half Nuts*
52	Left-Hand Differential Bearing Cone
53	Left-Hand Differential Bearing Cup
54	Thru Bolt Washer
55	Thru Bolt Nut
64	Snap Ring
75	Bolt-On Cover
76	Washer
77	Bolt
78	Screw-In Cover

* Some Meritor carriers do not have these parts.

Description

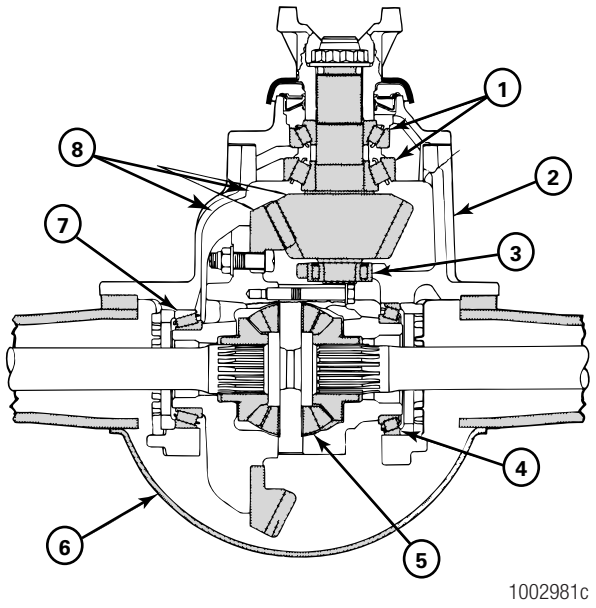
Standard Single-Reduction Carriers Without Differential Lock

Meritor single-reduction standard carriers are used in most Meritor single axles, rear of tandem axles and front drive steer axles. Figure 2.1.

The single-reduction carriers are front mounted into the axle housing. These carriers have a hypoid drive pinion and ring gear set and bevel gears in the differential assembly.

A straight roller bearing or spigot is mounted on the head of the drive pinion. All other bearings in the carrier are tapered roller bearings.

When the carrier operates, there is normal differential action between the wheels at all times.



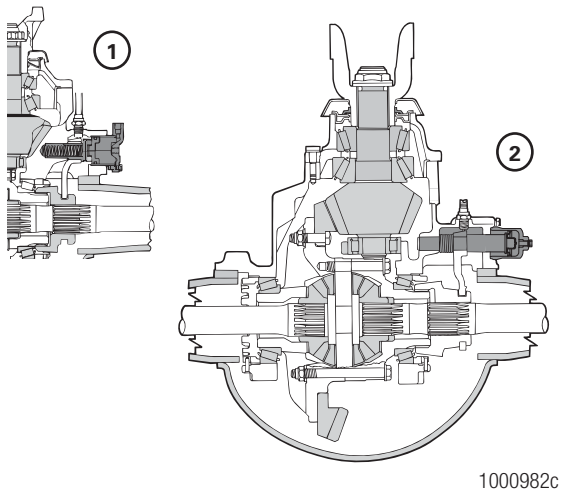
1 TAPERED ROLLER BEARINGS
2 CARRIER
3 STRAIGHT ROLLER BEARING
4 TAPERED ROLLER BEARING
5 BEVEL DIFFERENTIAL GEARS
6 HOUSING
7 TAPERED ROLLER BEARING
8 HYPOID DRIVE PINION AND RING GEAR

Figure 2.1

Single-Reduction Carriers with Driver-Controlled Main Differential Lock (DCDL)

Meritor single-reduction carriers with driver-controlled main differential lock (DCDL) have the same type of gears and bearings as the standard-type carriers. Figure 2.2. The differential lock is operated by an air-actuated shift assembly that is mounted on the carrier.

- When the differential lock is activated, the shift collar moves along the splines of the axle shaft toward the differential case.
- When the splines on the collar are engaged with splines on the differential case, the axle shafts and differential assembly are locked together.
- When the carrier operates with the DCDL in the locked position, there is no differential action between the wheels.
- When the carrier is operated in the unlocked position, there is normal differential action between the wheels at all times.



1 BOLT-IN STYLE
2 SCREW-IN OR THREADED STYLE

STANDARD CARRIER WITH DIFFERENTIAL LOCK (DCDL)

Figure 2.2

Axle Models Covered in This Manual

Table A, Table B, Table C and Table D list the axle models covered in this manual. For other models (non-MX, RS, RT and RF Series), refer to Maintenance Manual 5, Single-Reduction Differential Carriers. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

Table A: RS Series Single Drive Axles

RS-13-120	RS-17-145	RS-21-160	RS-23-186
RS-15-120	RS-17-145A	RS-21-160A	RS-25-160
RS-16-140	RS-19-144	RS-23-160	RS-25-160A
RS-16-141	RS-19-144A	RS-23-160A	RS-26-160
RS-16-145	RS-19-145	RS-23-161	RS-26-180
RS-17-140	RS-19-145A	RS-23-161A	RS-26-185
RS-17-141	RS-21-145	RS-23-180	RS-30-180
RS-17-144	RS-21-145A	RS-23-185	RS-30-185
RS-17-144A			

Table B: Bus and Coach Application Single Drive Axles

59722	59753	61052	61152
59723	59842	61053	61153
59732	59843	61063	61163
59733	61042	61142	RC-23-160
59752	61043	61143	

Table C: Rear Axle of Tandem Axles

RT-34-140	RT-40-146	RT-44-145P	RT-46-169A
RT-34-144	RT-40-149	RT-44-149	RT-46-169P
RT-34-144A	RT-40-149A	RT-46-16HEH	RT-48-180
RT-34-144P	RT-40-149P	RT-46-16HP	RT-48-185
RT-34-145	RT-40-160	RT-46-160	RT-50-160
RT-34-145P	RT-40-160A	RT-46-160A	RT-50-160P
RT-34-146	RT-40-160P	RT-46-160P	RT-52-180
RT-40-140	RT-40-169	RT-46-164	RT-52-185
RT-40-145	RT-40-169A	RT-46-164EH	RT-58-180
RT-40-145A	RT-40-169P	RT-46-164P	RT-58-185
RT-40-145P	RT-44-145	RT-46-169	

Table D: Front Drive Steer Axles

MX-10-120	RF-7-120	RF-21-160
MX-12-120	RF-9-120	RF-21-185
MX-14-120	RF-12-120	RF-21-355
MX-16-120	RF-12-125	RF-22-166
MX-21-160	RF-16-145	RF-23-180
MX-21-160R	RF-21-155	RF-23-185
MX-23-160	RF-21-156	
MX-23-160R		

Stall-Testing Can Damage a Drive Axle

Stall-testing is a procedure used to troubleshoot transmissions, evaluate vehicle performance, and test the service and park brakes.

During stall-testing, or any similar procedure, the drive axle input receives multiplied torque, which can exceed the specified torque rating. Excessive torque can damage a drive axle, which will affect axle performance and component life. A drive axle damaged by stall-testing will void Meritor's warranty.

Call ArvinMeritor's Customer Service Center at 800-535-5560 if you have questions regarding stall-testing.

Use of Traction Chains

Meritor recommends that if you are using traction chains, you should install chains on both tires on each side of all drive axles on the vehicle.

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury can result.

Use a brass or synthetic mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off. Serious personal injury and damage to components can result.

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

Removal

Axle Shafts

Before the axle shafts and differential carrier can be removed or installed, the driver-controlled differential lock (DCDL), if equipped, must be shifted into and held in the locked or engaged position. The locked position gives enough clearance between the shift collar and the axle housing to permit the removal or installation of the axle shafts and carrier. Refer to Section 6 for service information on the DCDL. If the drive axle is not equipped with DCDL, continue on with axle shaft removal in this section.

Axle Shaft Removal Methods

Use Special Tools Recommended by Meritor

To help prevent serious personal injury and damage to components when you remove the axle shaft from the housing, Meritor recommends that you use the following tools in the table below. Refer to the Service Notes page at the front inside cover of this manual for information on how to contact the manufacturers to obtain the tools.

- **If the tools are not available when you remove the axle shaft:** Follow procedures for using the Brass Drift Method or the Air Vibration Method.

Tool	Part Number	Manufacturer
Axle Shaft Remover	K-1280	Kiene Diesel Accessories, Inc.
Axle Stud Cone Plier	7077	SPX OTC

Brass Drift Method

⚠ WARNING

Do not strike the round driving lugs on the flange of an axle shaft. Pieces can break off and cause serious personal injury.

1. Hold a 1-1/2-inch diameter brass drift or brass hammer against the center of the axle shaft, inside the round driving lugs. Figure 3.1.

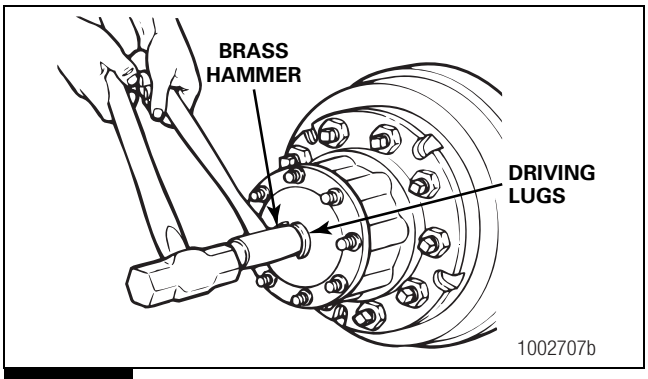


Figure 3.1

2. Strike the end of the drift with a large hammer, five to six pounds, and the axle shaft and tapered dowels will loosen.
3. Mark each axle shaft before it is removed from the axle assembly.
4. Remove the tapered dowels and separate the axle shafts from the main axle hub assembly. Figure 3.2.

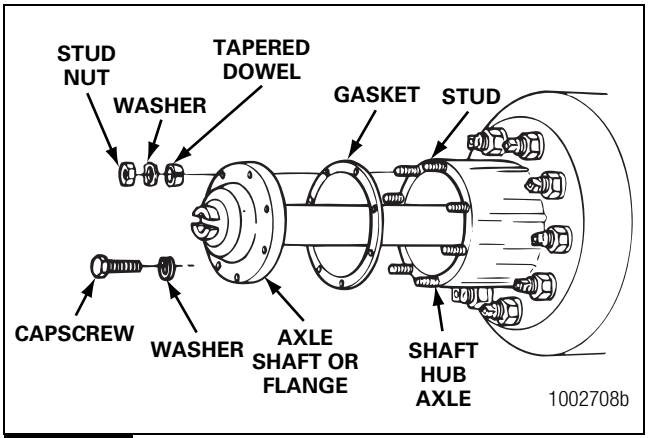


Figure 3.2

5. Install a cover over the open end of each axle assembly hub where an axle shaft was removed.

Air Hammer Vibration Method

⚠ WARNING

Wear safe eye protection when using an air hammer. When using power tools, axle components can loosen and break off causing serious personal injury.

⚠ CAUTION

Do not use a chisel or wedge to loosen the axle shaft and tapered dowels. Using a chisel or wedge can result in damage to the axle shaft, the gasket and seal, and the axle hub.

1. Use a round hammer bit and an air hammer to loosen the tapered dowels and axle shaft.
2. Place the round hammer bit against the axle shaft or flange between the hub studs. Operate the air hammer at alternate locations between the studs to loosen the tapered dowels and axle shaft from the hub. Figure 3.3.

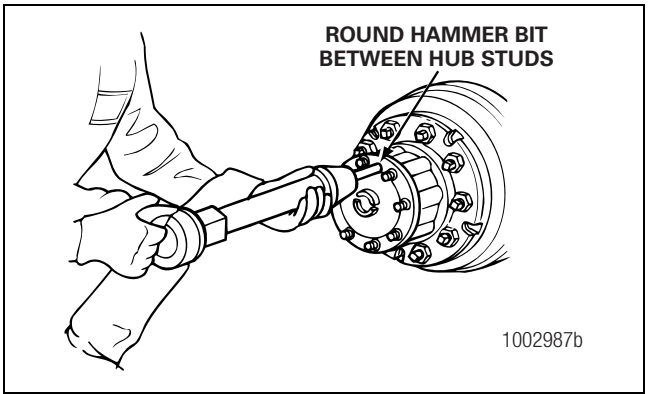


Figure 3.3

3. Mark each axle shaft before it is removed from the axle assembly.
4. Remove the tapered dowels and separate the axle shaft from the main axle hub assembly. Figure 3.2.

Axle Shafts from the Axle Housing

NOTE: If the vehicle is equipped with a driver-controlled main differential lock, the DCDL collar must be engaged before removing the axle shafts. Refer to Section 6.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Figure 3.4.

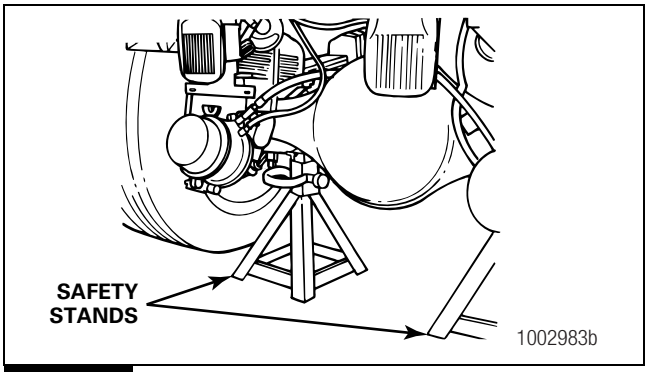
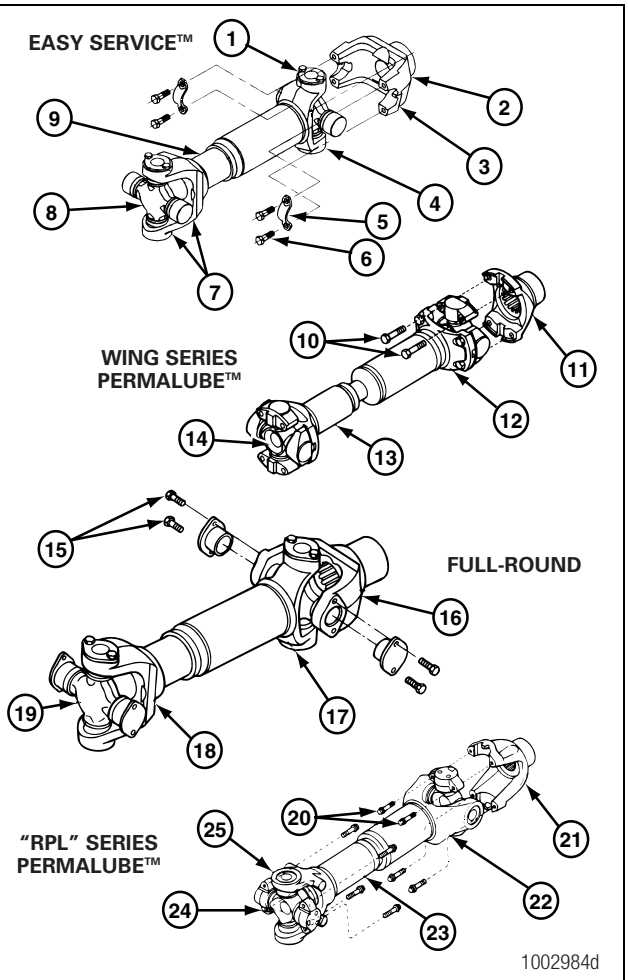


Figure 3.4

2. Use a jack or other lifting tool to raise the vehicle so that the wheels to be serviced are off the ground. Support the vehicle with safety stands. Figure 3.4.
3. Place a drain pan under the rear axle.
4. Remove the plug from the bottom of the axle housing. Drain the lubricant from the assembly.
5. Disconnect the driveline universal joint from the pinion input yoke or flange on the carrier. Figure 3.5.



1	FULL-ROUND BEARING CUPS	8	U-JOINT CROSS	17	WELD YOKE
2	END YOKE	9	SLIP YOKE	18	SLIP YOKE
3	YOKE SADDLE	10	CAPSCREWS	19	U-JOINT CROSS
4	WELD YOKE	11	END YOKE	20	CAPSCREWS
5	BEARING STRAP	12	WELD YOKE	21	END YOKE
6	CAPSCREWS	13	SLIP YOKE	22	SLIP YOKE
7	EASY SERVICE™ BEARING CUPS	14	U-JOINT CROSS	23	TUBING
		15	CAPSCREWS	24	U-JOINT CROSS
		16	END YOKE	25	WELD YOKE

Figure 3.5

6. Remove the capscrews and washers or stud nuts and washers, if equipped, from the flanges of both axle shafts.
7. Loosen the tapered dowels, if equipped, in the axle flanges of both axle shafts using one of the following methods. Refer to the procedures in this section.

Differential Carrier from the Axle Housing

1. Place a hydraulic roller jack under the differential carrier to support the assembly. Figure 3.6.

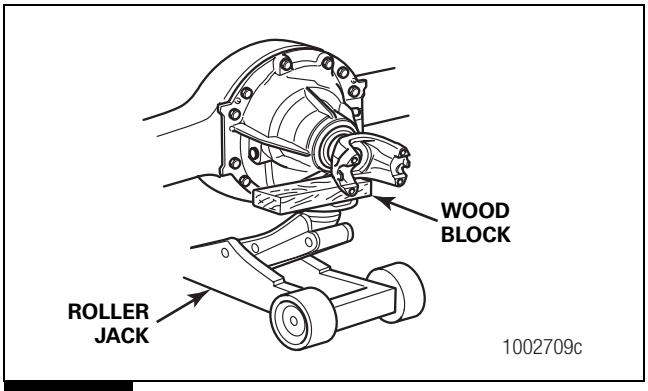


Figure 3.6

2. Remove all but the top two carrier-to-housing capscrews or stud nuts and washers.
3. Loosen the top two carrier-to-housing fasteners and leave attached to the assembly. The fasteners will hold the carrier in the housing.
4. Loosen the differential carrier in the axle housing. Use a leather mallet to hit the mounting flange of the carrier at several points.
5. After the carrier is loosened, remove the top two fasteners.

⚠ CAUTION

When you use a pry bar, be careful not to damage the carrier or housing flange. Damage to these surfaces will cause oil leaks.

6. Use the hydraulic roller jack to remove the carrier from the axle housing. Use a pry bar that has a round end to help remove the carrier from the housing.

NOTE: A carrier stand is available from SPX Kent-Moore. Refer to the Service Notes page on the front inside cover of this manual to obtain the stand.

7. Use a lifting tool to lift the differential carrier by the input yoke or flange and place the assembly in a repair stand. Figure 3.7. Do not lift by hand. A carrier stand can be built by referring to Figure 3.8.

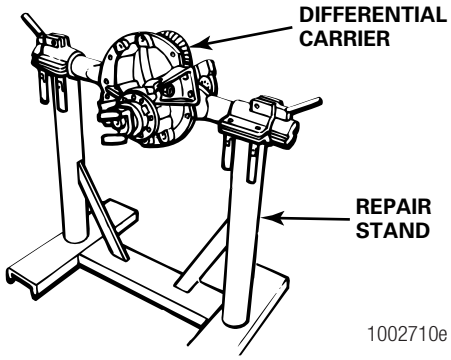
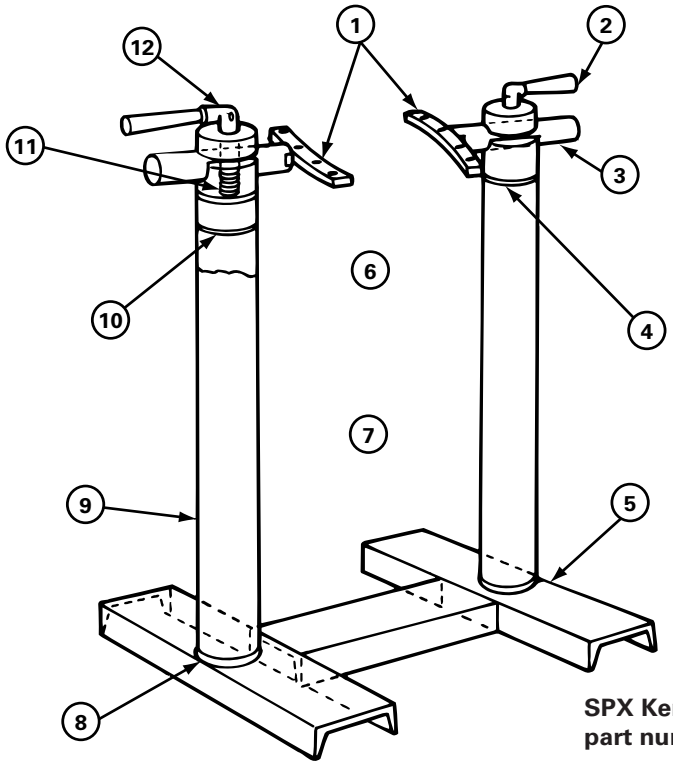


Figure 3.7



1 PLATES 8' LONG x 3/4" THICK x 1-1/4" WIDE WITH A TONGUE TO FIT SLOT IN BAR WELD PLATES TO BAR
2 HANDLE 7" LONG WITH SLOT IN ONE END TO FIT CLAMP SCREW
3 BAR 2" DIAMETER x 9" LONG WITH ONE END SLOTTED TO FIT PLATE
4 WELD ALL AROUND AFTER PRESSING PLUG IN PIPE
5 WELD
6 SHAPE AND SIZE OF HOLES TO FIT CARRIER
7 23-1/2" CENTER TO CENTER OF PIPE
8 CHAMFER END OF PIPE FOR WELDING
9 4" DIAMETER PIPE
10 PLUG 4" DIAMETER x 7" LONG WITH ONE END TURNED 3" LONG TO FIT PIPE. DRILL 2" HOLE AND MILL 3/16" WIDE SLOT 2" FROM TOP
11 SCREW 3-1/2" LONG x 5/8" DIAMETER WITH FLATS ON END TO FIT HANDLE AND 2-1/2" LENGTH OF THREAD ON OTHER END
12 DRILL 3/8" HOLE THROUGH HANDLE AND SCREW

CARRIER STAND

Figure 3.8

Measure Ring Gear Backlash

Before the differential carrier is disassembled, inspect the hypoid gear set for damage. If inspection shows no damage, the same gear set can be used again. Use a dial indicator to measure and record ring gear backlash at three locations on the ring gear. This will help you to correctly reassemble the ring gear and drive pinion.

1. Rotate the carrier in the stand to access the ring gear teeth.
2. Install a dial indicator onto the flange of the carrier. Place the tip of the indicator against the drive side of a ring gear tooth. Adjust the dial indicator to ZERO. Figure 3.9.

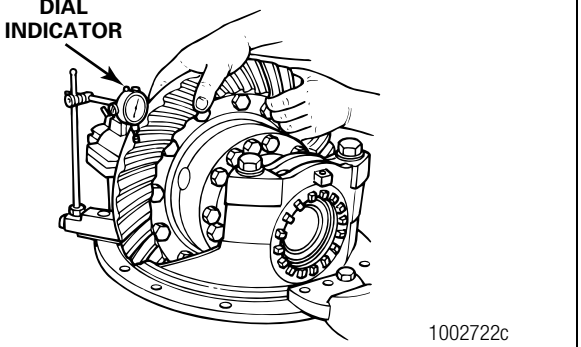


Figure 3.9

3. Read the dial indicator while you slightly rotate the ring gear in both directions. When you rotate the ring gear to measure the backlash, the drive pinion must not move. Record the reading on the dial indicator.
4. Repeat the procedure at two more locations on the ring gear.
   - **If the smallest of the three measurements is not 0.008-0.018-inch (0.20-0.46 mm) for ring gears with a pitch diameter less than 17-inches (431.8 mm) or 0.010-0.020-inch (0.25-0.51 mm) for ring gears with a pitch diameter greater than 17-inches (431.8 mm):** Replace the ring gear and drive pinion as a set.

Differential and Ring Gear from the Carrier

1. Loosen the jam nut on the thrust screw, if equipped.
2. Remove the thrust screw and jam nut, if equipped, from the differential carrier. Figure 3.10 and Figure 3.11.

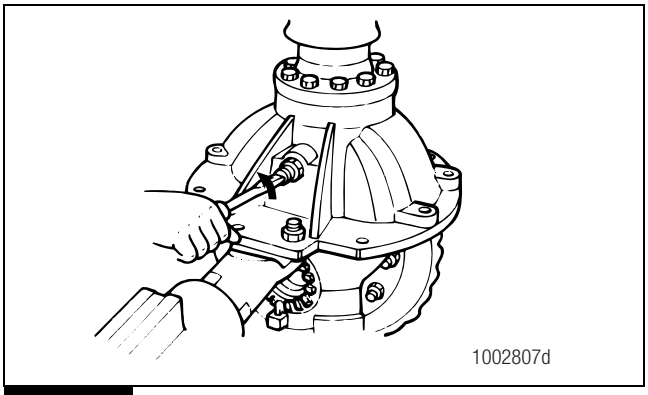


Figure 3.10

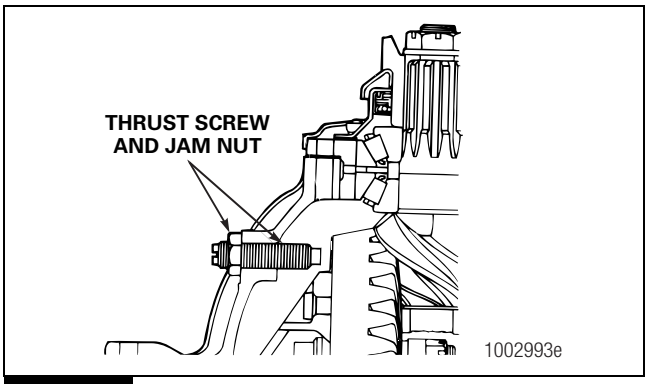


Figure 3.11

3. Rotate the differential carrier in the repair stand until the ring gear is at the top of the assembly.
4. Mark one carrier leg and bearing cap to correctly match the parts during carrier assembly. Mark the parts using a center punch and hammer. Figure 3.12.

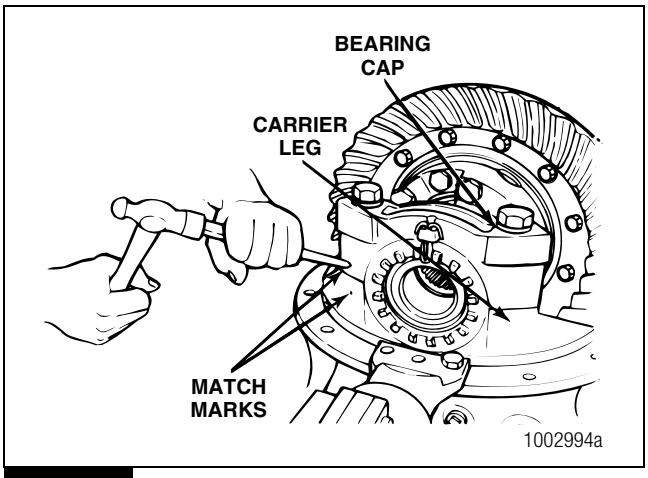


Figure 3.12

5. Remove the capscrews, cotter pins, roll pins or lock plates, if equipped, that hold the bearing adjusting rings in position. Use a small drift and hammer to remove the pins. Each lock plate is held in position by two capscrews. Figure 3.13.

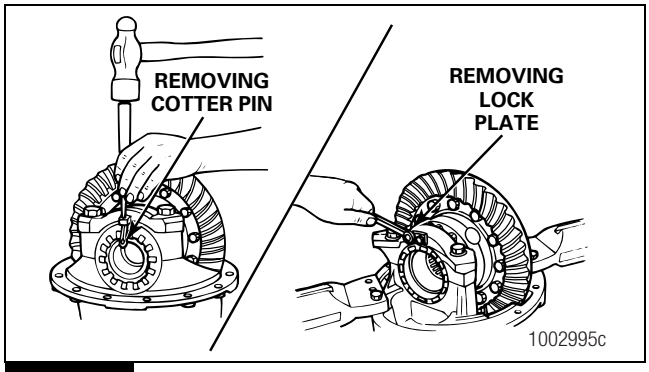


Figure 3.13

6. Remove the capscrews and washers that hold the two bearing caps on the carrier. Each cap is held in position by two capscrews and washers. Figure 3.14.

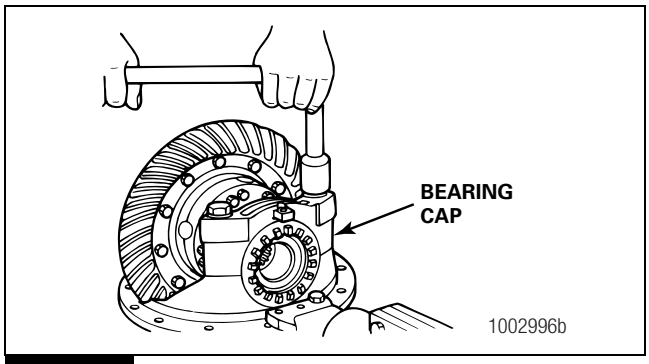


Figure 3.14

7. Remove the bearing caps and bearing adjusting rings from the carrier. Figure 3.15.

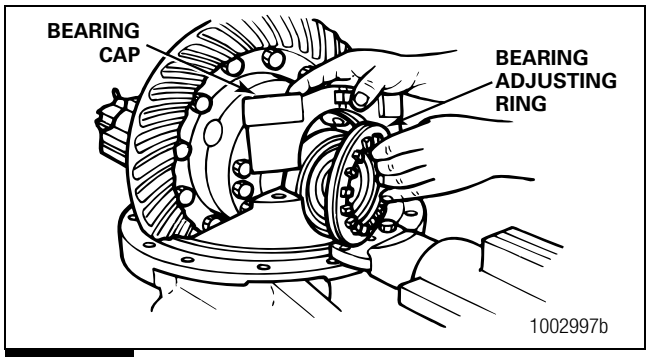


Figure 3.15

8. Safely lift the main differential and ring gear assembly from the carrier. Place the assembly on a workbench. Figure 3.16.

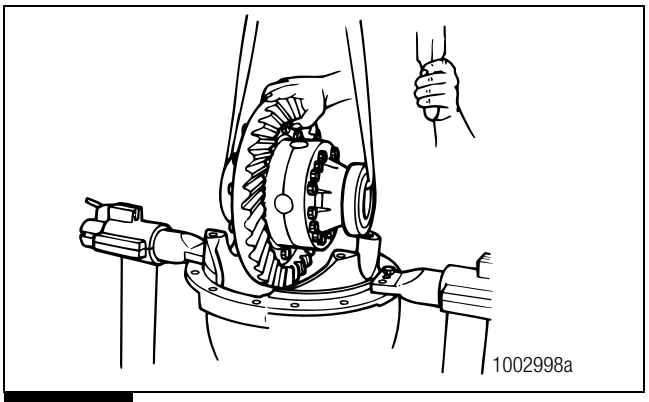


Figure 3.16

Disassembly

Differential and Ring Gear Assembly

1. If the match marks on the case halves of the differential assembly are not visible, mark each case half with a center punch and hammer. Figure 3.17.

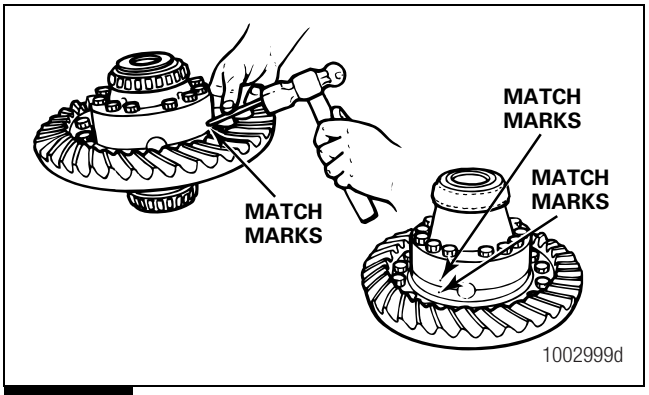


Figure 3.17

2. Remove the capscrews and washers or bolts, nuts and washers, if equipped, that hold the case halves together.
3. Separate the case halves. If necessary, use a brass, plastic or leather mallet to loosen the parts.

4. Remove the differential spider or cross, four pinion gears, two side gears and six thrust washers from inside the case halves. Figure 3.18.

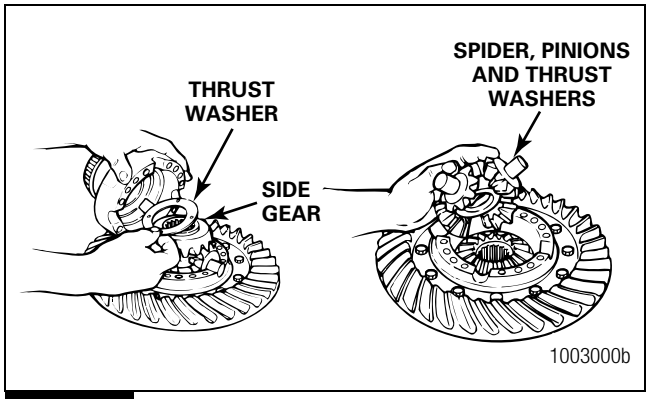


Figure 3.18

5. If the ring gear needs to be replaced, remove the bolts, nuts and washers, if equipped, that hold the gear to the flange case half.

⚠ CAUTION

Do not remove the rivets or rivet heads with a chisel and hammer. Using a flat edge tool can cause damage to the flange case.

6. If rivets hold the ring gear to the flange case half, remove the rivets as follows.

   A. Carefully center punch each rivet head in the center, on the ring gear side of the assembly. Do not use a chisel and hammer. Figure 3.19.

   B. Drill each rivet head on the ring gear side of the assembly to a depth equal to the thickness of one rivet head. Use a drill bit that is 0.03125-inch (0.79375 mm) smaller than the body diameter of the rivets. Figure 3.19.

   C. Press the rivets through holes in the ring gear and flange case half. Press from the drilled rivet head.

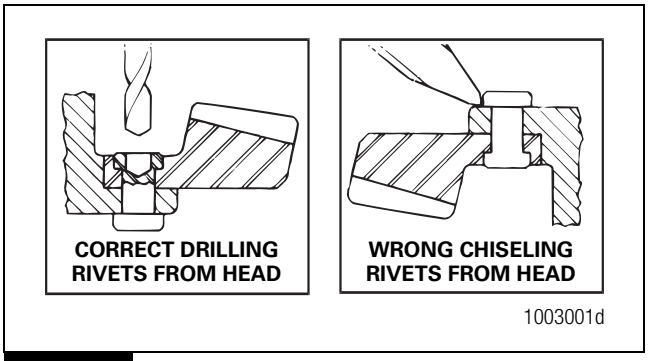


Figure 3.19

7. Use a press to separate the case half and ring gear. Support the assembly under the ring gear with metal or wood blocks. Press the case half through the gear. Figure 3.20.

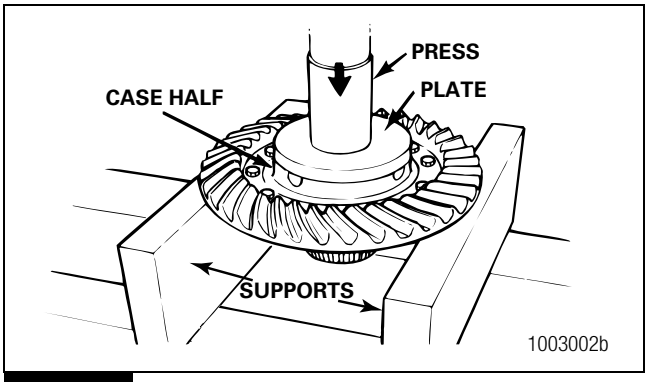


Figure 3.20

8. If the differential bearings need to be replaced, use a bearing puller or press to remove the bearing cones from the case halves. Figure 3.21.

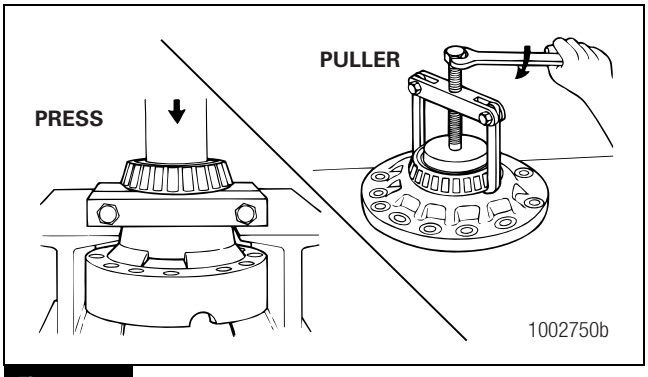


Figure 3.21

Removal

Drive Pinion and Bearing Cage from the Carrier

1. Fasten a flange bar to the input yoke or flange. When the nut is removed, the bar will hold the drive pinion in position. Figure 3.22.

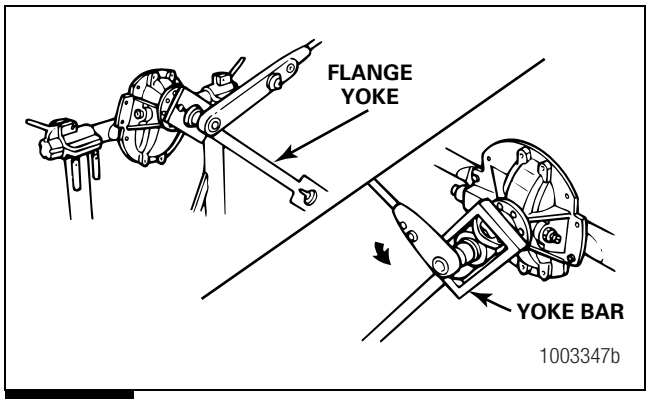


Figure 3.22

2. Remove the nut and washer, if equipped, from the drive pinion. Figure 3.22.
3. Remove the yoke or flange bar.

⚠ CAUTION

Do not use a hammer or mallet to loosen and remove the yoke or flange. A hammer or mallet can damage the parts and cause driveline runout or driveline imbalance.

4. Remove the yoke or flange from the drive pinion. Do not use a hammer or mallet.
   - **If the yoke or flange is tight on the pinion:** Use a puller for removal. Figure 3.23.

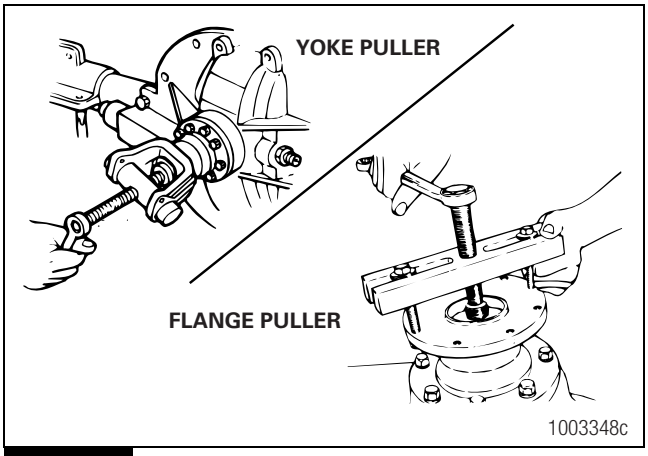


Figure 3.23

5. Remove the capscrews and washers that hold the bearing cage in the carrier. Figure 3.24.

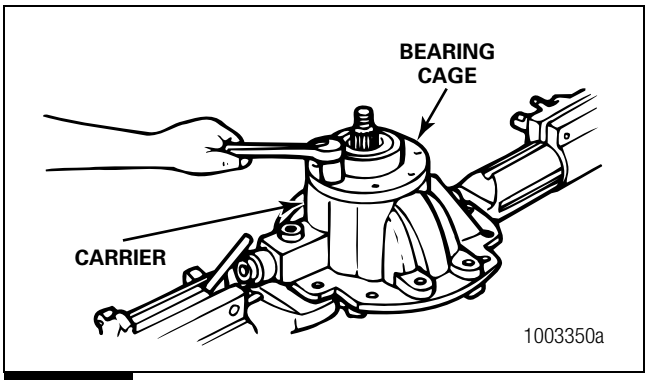


Figure 3.24

⚠ CAUTION

Do not use a pry bar to remove the bearing cage from the carrier. A pry bar can damage the bearing case, shims and carrier.

6. Remove the drive pinion, bearing cage and shims from the carrier. Do not use a pry bar.
   - **If the bearing cage is tight in the carrier:** Hit the bearing cage at several points around the flange area with a leather, plastic or rubber mallet. Figure 3.25.

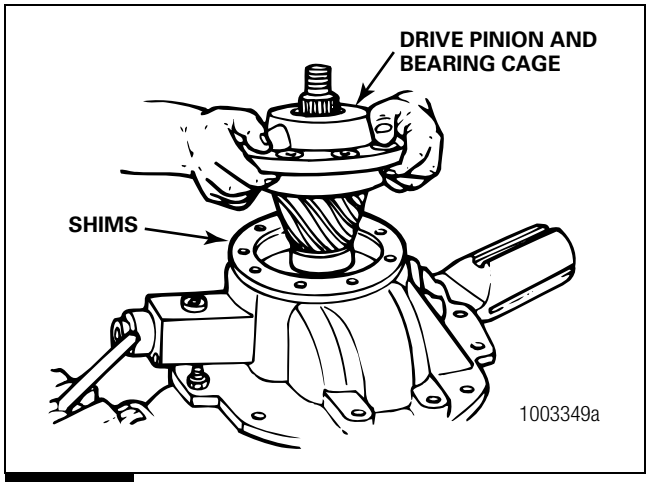


Figure 3.25

7. If the shims are in good condition, keep the shims together to use when the carrier is assembled.
8. If shims are to be discarded because of damage, first measure the total thickness of the pack. Make a note of the dimension. The dimension will be needed to calculate the depth of the drive pinion in the carrier when the gear set is installed.

Disassembly

Drive Pinion and Bearing Cage

1. Place the drive pinion and bearing cage in a press. The pinion shaft must be toward the top of the assembly. Figure 3.26.
2. Support the bearing cage under the flange area with metal or wood blocks. Figure 3.26.

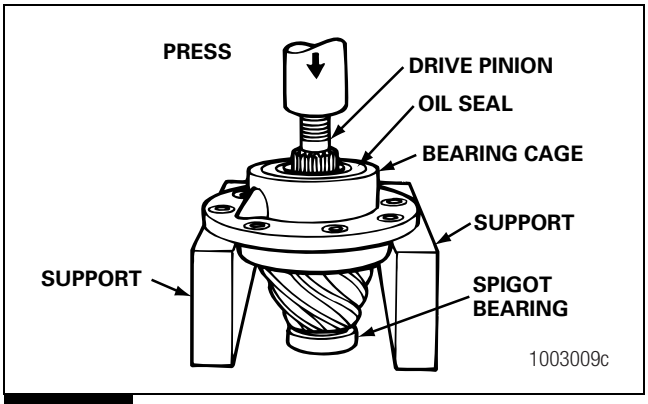


Figure 3.26

3. Press the drive pinion through the bearing cage. The inner bearing cone and bearing spacer will remain on the pinion shaft. Figure 3.26.
   - **If a press is not available:** Use a leather, plastic or rubber mallet to drive the pinion through the bearing cage.

⚠ CAUTION

Be careful when you remove the seal. Do not damage the wall of the bore. Damage to the bore wall can result in oil leaks.

4. Use a press and a sleeve to remove the triple-lip or unitized oil seal from the bearing cage.
   - **If a press is not available:** Place a tool with a flat blade under the flange to remove the oil seal from the cage. Figure 3.27.

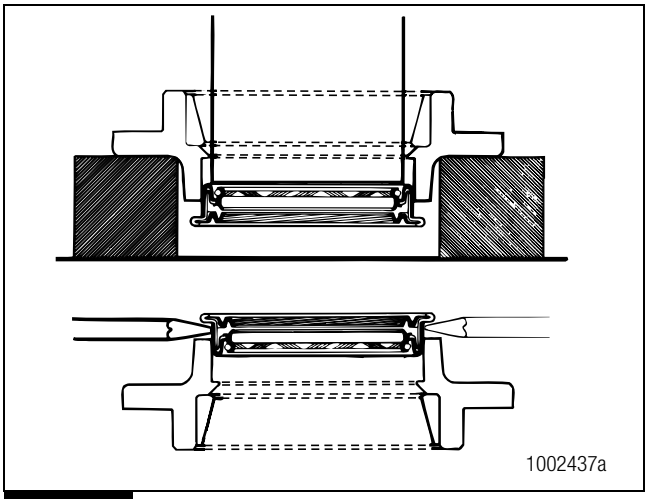


Figure 3.27

5. If the pinion bearings need to be replaced, remove the inner and outer bearing cups from the inside of the cage. Figure 3.28. Use a press and sleeve, bearing puller or a small drift hammer. The type of tool used depends on the design of the bearing cage. Figure 3.29.

   When a press is used, support the bearing cage under the flange area with metal or wood blocks.

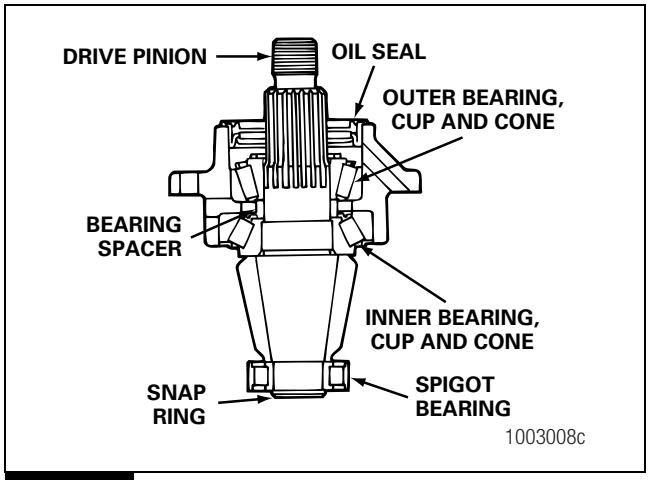


Figure 3.28

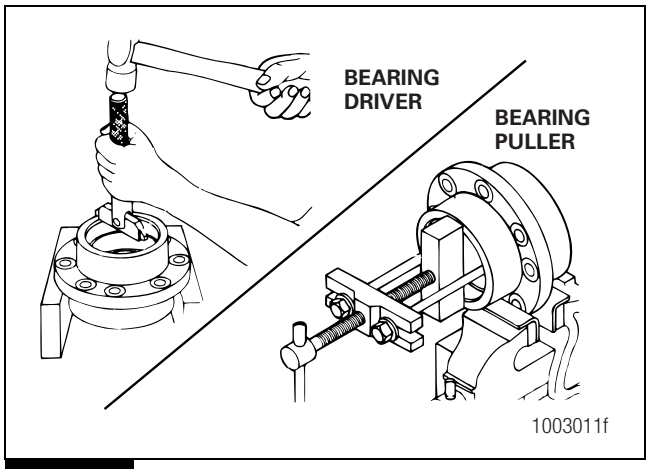


Figure 3.29

6. If the pinion bearings need to be replaced, remove the inner bearing cone from the drive pinion with a press or bearing puller. The puller must fit under the inner race of the cone to remove the cone correctly without damage. Figure 3.30.

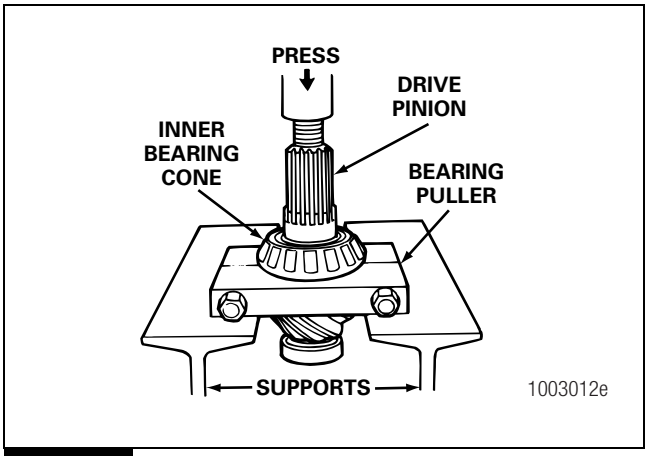


Figure 3.30

7. If the spigot bearing needs to be replaced, place the drive pinion in a vise. Install a soft metal cover over each vise jaw to protect the drive pinion.

8. Remove the snap ring, if equipped, from the end of the drive pinion with snap ring pliers that expand. Figure 3.31.

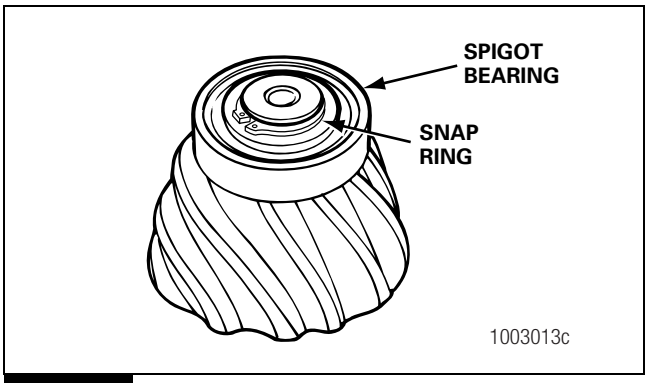


Figure 3.31

9. Remove the spigot bearing from the drive pinion with a bearing puller. Figure 3.32. Some spigot bearings are fastened to the drive pinion with a special peening tool. Figure 3.33.

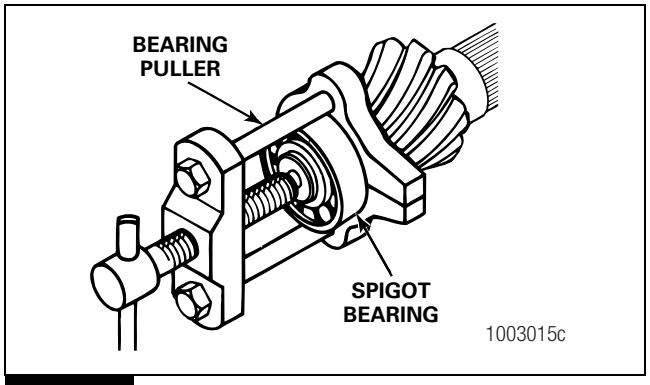


Figure 3.32

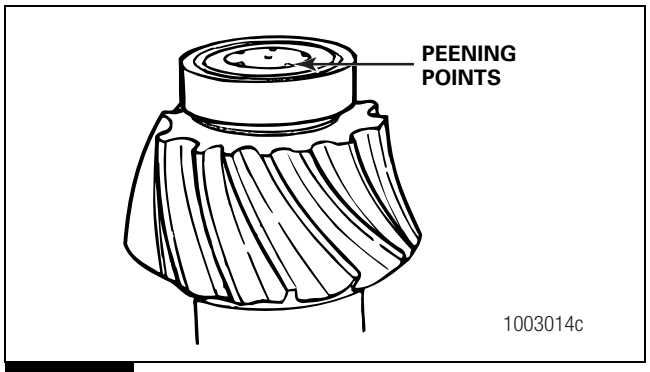


Figure 3.33

10. If the spigot bearings are a two-piece assembly, remove the inner race from the pinion with a bearing puller. Remove the outer race and roller assembly from the carrier with a drift or a press. Figure 3.34.

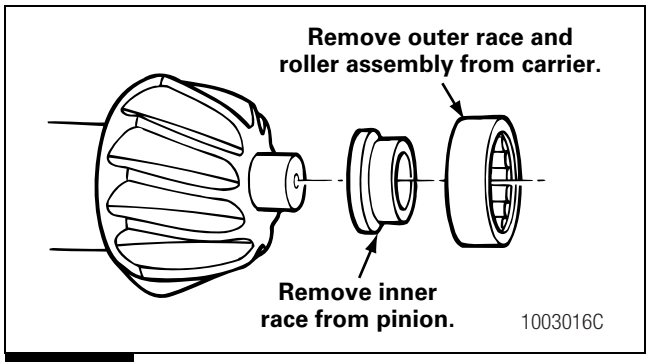


Figure 3.34

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, and emulsion-type and petroleum-base cleaners. Read the manufacturer's instructions before using a solvent cleaner, then carefully follow the instructions. Also follow the procedures below.

- **Wear safe eye protection.**
- **Wear clothing that protects your skin.**
- **Work in a well-ventilated area.**
- **Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.**
- **You must use hot solution tanks or alkaline solutions correctly. Read the manufacturer's instructions before using hot solution tanks and alkaline solutions. Then carefully follow the instructions.**

Take care when you use Loctite, adhesive to avoid serious personal injury. Read the manufacturer's instructions before using this product. Follow the instructions carefully to prevent irritation to the eyes and skin. If Loctite® adhesive material gets into your eyes, follow the manufacturer's emergency procedures. Have your eyes checked by a physician as soon as possible.

When you apply some silicone gasket materials, a small amount of acid vapor is present. To prevent serious personal injury, ensure that the work area is well-ventilated. Read the manufacturer's instructions before using a silicone gasket material, then carefully follow the instructions. If a silicone gasket material gets into your eyes, follow the manufacturer's emergency procedures. Have your eyes checked by a physician as soon as possible.

Clean, Dry and Inspect Parts

Clean and Inspect Yokes

⚠ CAUTION

Do not install a press-on shaft excluder or POSE™ seal after you install a unitized pinion seal. The use of a POSE™ seal will prevent correct seating of the unitized pinion seal on the yoke and will result in lubricant leakage at the seal. POSE™ seal installation is recommended only for triple-lip and other previous design seals.

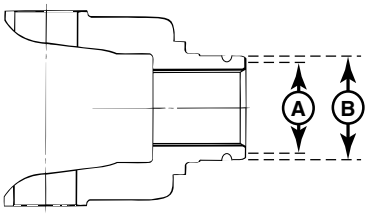
Do not use thin metal wear sleeves to refresh the yoke surface. Wear sleeves pressed onto the yoke will prevent correct seating of the pinion seal and damage the pinion seal assembly. Wear sleeve usage will cause the seal to leak.

1. Clean the ground and polished surface of the yoke journal using a clean shop towel and a safe cleaning solvent. Do not use abrasive cleaners, towels or scrubbers to clean the yoke or flange surface. Do not use gasoline.

NOTE: The unitized seal features a rubber inner sleeve that is designed to seal and rotate with the yoke. This feature allows you to reuse a yoke with minor grooves.

2. Inspect the yoke seal surface for grooves.
   - **If you find grooves on yoke hubs used with single or triple-lip seals:** Replace the yokes.
   - **If you find grooves on the yoke:** Use calipers to measure the groove diameters. If any groove diameter measures less than the dimensions shown in Figure 4.1, replace the yoke.

UNITIZED PINION SEAL (UPS)



Yoke Seal Diameter	Minimum Yoke Diameter at Groove (Inches)
3.000/3.005"	2.990"
3.250/3.255"	3.240"

1003390e

A MINIMUM GROOVE DEPTH — DIAMETER
B YOKE SEAL DIAMETER

Figure 4.1

Clean Ground and Polished Parts

1. Use a cleaning solvent, kerosene or diesel fuel to clean ground or polished parts or surfaces. Do not use gasoline.
2. Use a tool with a flat blade if required, to remove sealant material from parts. Be careful not to damage the polished or smooth surfaces.

⚠ CAUTION

Do not use hot solution tanks or water and alkaline solutions to clean ground or polished parts. Damage to parts can result.

3. Do not clean ground or polished parts with water or steam. Do not immerse ground or polished parts in a hot solution tank or use strong alkaline solutions for cleaning, or the smooth sealing surface may be damaged.

Clean Rough Parts

1. Clean rough parts with the same method as cleaning ground and polished parts.
2. Rough parts can be cleaned in hot solution tanks with a weak or diluted alkaline solution.
3. Parts must remain in hot solution tanks until heated and completely cleaned.
4. Parts must be washed with water until all traces of the alkaline solution are removed.

Clean Axle Assemblies

1. A complete axle assembly can be steam cleaned on the outside to remove dirt.
2. Before the axle is steam cleaned, close or place a cover over all openings in the axle assembly. Examples of openings are breathers or vents in air chambers.

Drying Parts After Cleaning

1. Parts must be dried immediately after cleaning and washing.
2. Dry the parts using soft, clean paper or cloth rags.

⚠ CAUTION

Damage to bearings can result when they are rotated and dried with compressed air.

3. Except for bearings, parts can be dried with compressed air.

Prevent Corrosion on Cleaned Parts

1. Apply axle lubricant to cleaned and dried parts that are not damaged and are to be assembled.
2. To store parts, apply a special material that prevents corrosion to all surfaces. Wrap cleaned parts in a special paper that will protect the parts from moisture and prevent corrosion.

Inspect Parts

It is very important to inspect all parts carefully and completely before the axle or carrier is assembled. Check all parts for wear and replace damaged parts.

1. Inspect the cup, cone, rollers and cage of all tapered roller bearings in the assembly. If any of the following conditions exist, replace the bearing.
   - The center of the large-diameter end of the rollers is worn level with or below the outer surface. Figure 4.2.
   - The radius at the large-diameter end of the rollers is worn to a sharp edge. Figure 4.2.
   - There is a visible roller groove in the cup or cone inner race surfaces. The groove can be seen at the small- or large-diameter end of both parts. Figure 4.3.
   - There are deep cracks or breaks in the cup, cone inner race or roller surfaces. Figure 4.3.
   - There are bright wear marks on the outer surface of the roller cage. Figure 4.4.
   - There is damage on the rollers and on the surfaces of the cup and cone inner race that touch the rollers. Figure 4.5.
   - There is damage on the cup and cone inner race surfaces that touch the rollers. Figure 4.6.

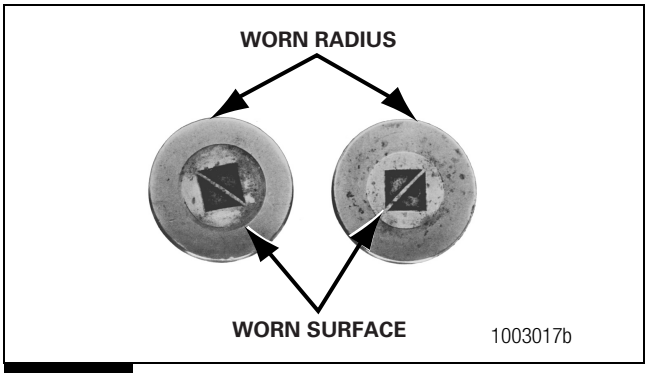


Figure 4.2

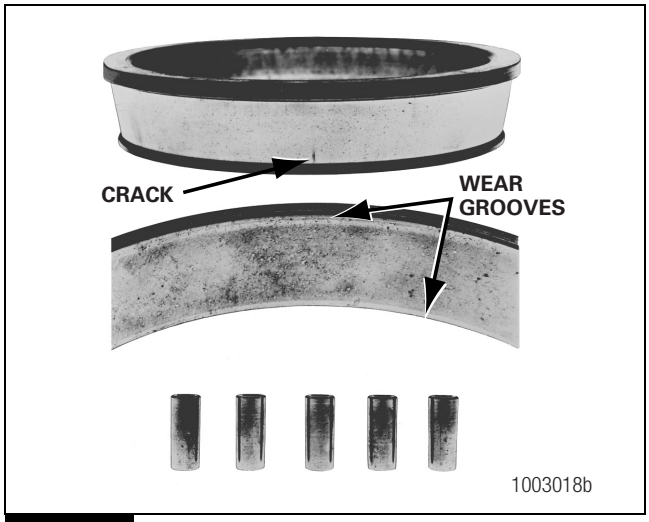


Figure 4.3

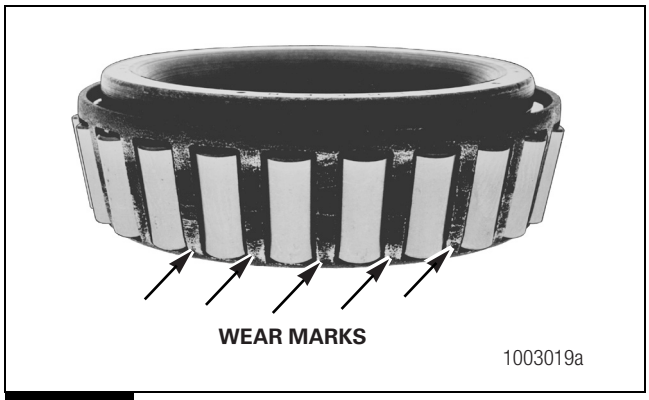


Figure 4.4

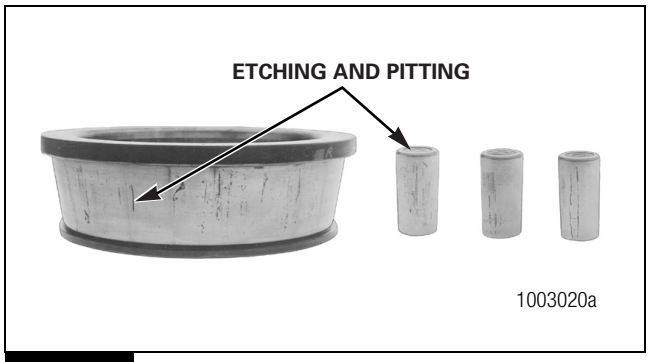


Figure 4.5

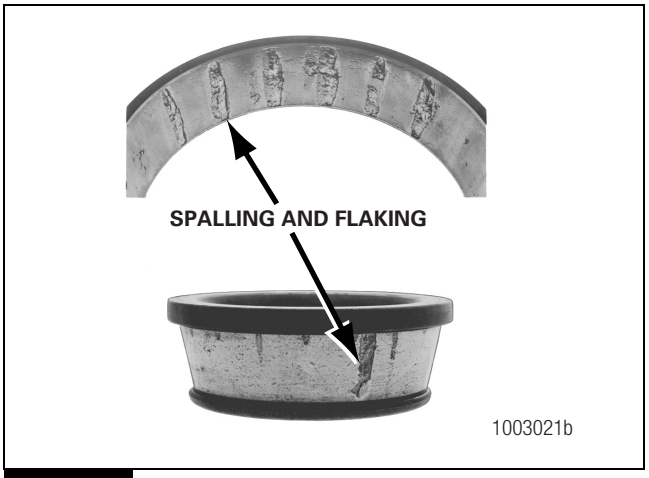


Figure 4.6

⚠ CAUTION

A drive pinion and ring gear are machined as a matched set. When you replace either a drive pinion or a ring gear, you must replace both parts as a matched set. Do not mix old and new parts. Damage to components can result.

2. Inspect hypoid pinions and gears for wear and damage. Replace gears that are worn or damaged.

⚠ CAUTION

A thrust washer, differential side gear and pinion gear are machined as a matched set. When you replace any of these parts, you must install a new matched set. Do not mix old and new parts. Damage to components can result.

3. Inspect the following main differential assembly parts for wear or stress. Replace parts that are damaged. Figure 4.7.
   - Inside surfaces of both case halves
   - Both surfaces of all thrust washers
   - The four trunnion ends of the spider or cross
   - Teeth and splines of both differential side gears
   - Teeth and bore of all differential pinions

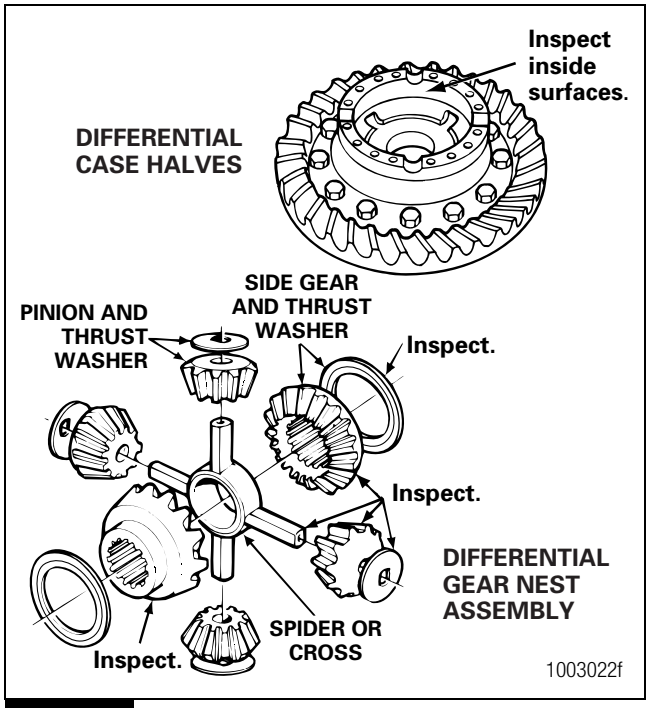


Figure 4.7

4. Inspect the axle shafts for wear and cracks at the flange, shaft and splines. Replace the axle shafts, if required.
5. Inspect the breather.
   A. Remove the breather from the axle housing.
   B. Clean the breather.
      - **If the breather remains dirty after cleaning:** Replace the breather.
   C. Apply compressed air to the breather.
      - **If compressed air does not pass through the breather:** Replace the breather.
   D. Install the breather in the axle housing.

Repair or Replace Parts

Threads must be without damage and clean so that accurate adjustments and correct torque values can be applied to fasteners and parts.

1. Replace any fastener if the corners of the head are worn.
2. Replace the washers if damaged.
3. Replace the gaskets, oil seals or grease seals at the time of axle or carrier repair.
4. Clean the parts and apply new silicone gasket material where required when the axle or carrier is assembled. Figure 4.8.

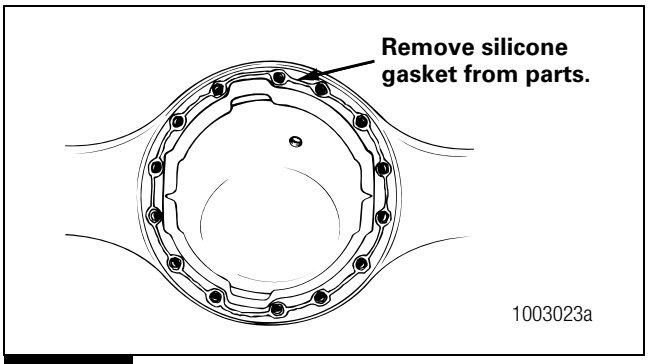


Figure 4.8

5. Remove nicks, mars and burrs from parts with machined or ground surfaces. Use a fine file, india stone, emery cloth or crocus cloth.
6. Clean and repair the threads of fasteners and holes. Use a die or tap of the correct size or a fine file.

Welding on Axle Housings

⚠ WARNING

Wear safe clothing and eye protection when you use welding equipment. Welding equipment can burn you and cause serious personal injury. Follow the operating instructions and safety procedures recommended by the welding equipment manufacturer.

Axle weld locations and welding procedures must adhere to Meritor standards. Welding at locations other than those authorized by Meritor will void the warranty and can reduce axle beam fatigue life. Serious personal injury and damage to components can result.

Refer to Maintenance Manual 8, Drive Axle Housings. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

Meritor permits drive axle housing assembly repair welding in the following locations only.

- Housing-to-cover weld joints
- Snorkel welds
- Housing seam welds between the suspension attaching brackets
- Bracket welding to the drive axle housing

Prepare the Axle

⚠ WARNING

The high temperature caused by the open flame from the cutting torch can ignite the oil in the axle housing and can cause serious personal injury.

1. Remove the oil drain plug from the bottom of the axle housing and drain the lubricant from the assembly.

⚠ CAUTION

Remove the differential carrier from the axle housing before you weld onto an axle. Do not weld onto an axle with the differential carrier installed. Electrical arcing and damage to components can result.

2. Remove the differential carrier from the axle housing. Refer to the correct Meritor carrier maintenance manual or the vehicle manufacturer's instructions.

⚠ CAUTION

Remove the brake air chambers before you weld onto an axle. Do not expose a brake air chamber to more than 250°F (121°C). Damage to the air chamber can result.

3. Remove the wheel-end components and brake air chambers from the axle. Refer to the correct Meritor brake maintenance manual or the vehicle manufacturer's instructions.
4. For housing-to-cover welds, clean the outside housing-to-cover weld area two-three-inches (50.8-76.2 mm) past each end or side of the crack. Clean the inside area where the cover mates with the housing. Clean the area completely around the cover. Use a wire brush and a cleaning solvent that will remove dirt and grease from these areas. Figure 4.9.

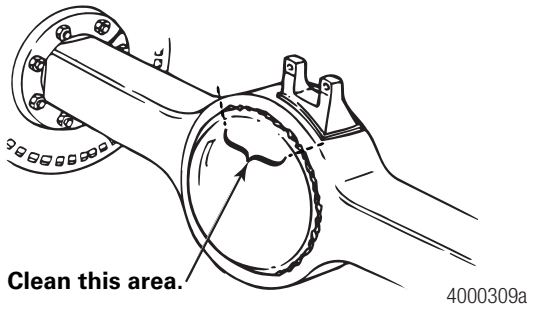


Figure 4.9

5. For suspension bracket welds, clean both lower and upper suspension brackets and the areas of the axle housing around each bracket. Use a wire brush and a cleaning solvent that will remove dirt and grease from these areas. Figure 4.10 and Figure 4.11.

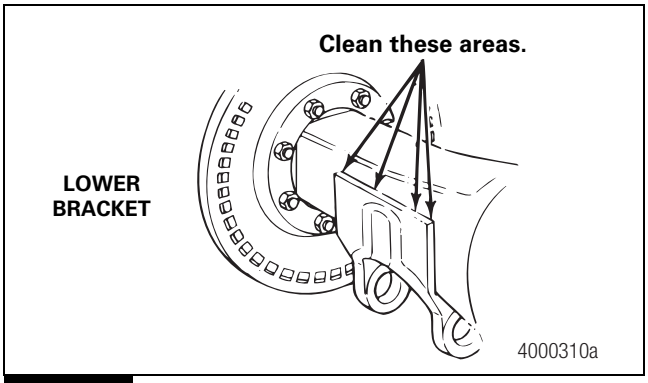


Figure 4.10

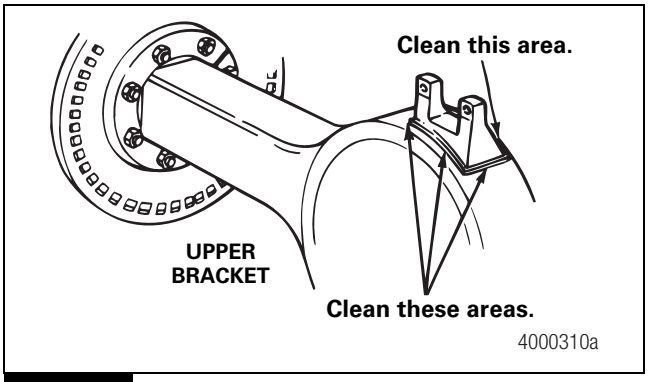


Figure 4.11

⚠ WARNING

The axle housing must be 70°F (21°C) or warmer before you weld onto the axle. Do not weld onto a cold axle or weld cold parts onto an axle. Cracks in the weld area, damage to components and serious personal injury can result.

6. Ensure that the axle housing temperature measures 70°F (21°C) or warmer.
   - **If the axle housing temperature measures less than 70°F (21°C):** Store the axle in a heated room until the housing reaches the correct temperature.

7. Heat the damaged area to approximately 300°F (149°C) before you begin welding.
8. Use suitable weld wire electrodes when you weld. Suitable weld wire electrodes include either BS EN 499 – E 42 2 B 32 H5 or BS EN 440 – G 42 2 M GSi (American Welding Society equivalents E7018 and ER70S3, respectively).
9. For complete welding instructions, refer to Maintenance Manual 8, Drive Axle Housings. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

Do Not Bend or Straighten a Damaged Drive Axle Housing

⚠ WARNING

Replace damaged or out-of-specification axle components. Do not bend, repair or recondition axle components by welding or heat-treating. A bent axle beam reduces axle strength, affects vehicle operation and voids Meritor's warranty. Serious personal injury and damage to components can result.

Always replace a damaged drive axle housing. Do not bend or straighten a damaged housing, which can misalign or weaken it, and void Meritor's warranty.

Removing Fasteners Secured with Adhesive

If it is difficult to remove fasteners secured with Dri-Loc®, Meritor adhesive or Loctite® 277 adhesive, use the following procedure.

When you remove fasteners secured with adhesive, slowly heat the fastener to 350°F (177°C). Do not exceed this temperature, or heat fasteners quickly. Damage to components can result.

1. Heat the fastener for three to five seconds. Try to loosen the fastener with a wrench. Do not use an impact wrench or hit the fastener with a hammer.
2. Repeat Step 1 until you can remove the fastener.

New Fasteners with Pre-Applied Adhesive

1. Use a wire brush to clean the oil and dirt from threaded holes.
2. Install new fasteners with pre-applied adhesive to assemble parts. Do not apply adhesives or sealants to fasteners with pre-applied adhesive, or to fastener holes.
3. Tighten the fasteners to the required torque value for that size fastener. No drying time is required for fasteners with pre-applied adhesive.

Original or Used Fasteners

1. Use a wire brush to clean the oil, dirt and old adhesive from all threads and threaded holes.
2. Apply four or five drops of Meritor liquid adhesive 2297-C-7049, Loctite® 638 or 680 liquid adhesive or equivalent inside each threaded hole or bore. Do not apply adhesive directly to the fastener threads. Figure 4.12.

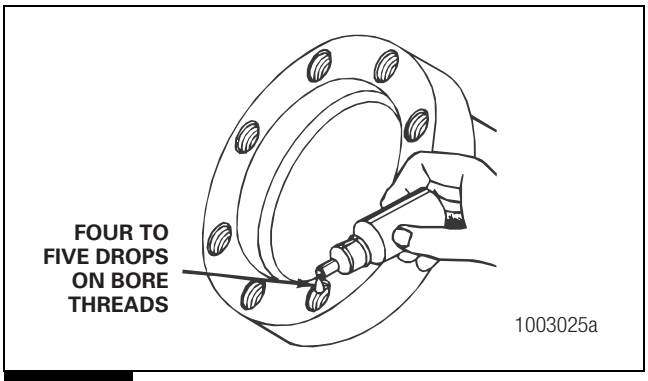


Figure 4.12

3. Tighten the fasteners to the required torque value for that size fastener. There is no drying time required for Meritor liquid adhesive 2297-C-7049, Loctite® 638 or 680 liquid adhesive or equivalent.

Meritor Specification 2297-T-4180 Adhesive in the Differential Bearing Bores

NOTE: Use Meritor specification 2297-T-4180 adhesive for all axles.

1. Clean the oil and dirt from the outer diameters of the bearing cups and bearing bores in the carrier and bearing caps. There is no special cleaning required.
2. Apply axle lubricant to the bearing cones and the inner diameters of the bearing cups of the main differential. Do not get oil on the outer diameter of the bearing cup and do not permit oil to drip onto the bearing bores.

NOTE: Meritor specification 2297-T-4180 adhesive will dry in approximately two hours. You must complete the procedure within two hours from the time you apply the adhesive. If two hours have passed since application, clean the adhesive from the parts and apply new adhesive.

3. Apply a single continuous bead of the adhesive to the bearing bores in the carrier and bearing caps. Apply the adhesive around the circumference of the smooth, ground surfaces only. Do not place the adhesive on the threaded areas. Figure 4.13.

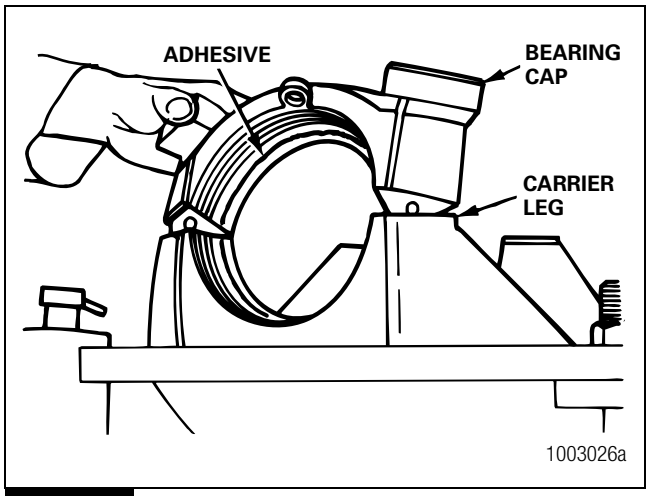


Figure 4.13

4. Install the main differential assembly, bearing cups and bearing caps into the carrier. Refer to Section 5.
5. Adjust the preload of the differential bearings, backlash and tooth contact patterns of the gear set as required. Refer to Section 5.

Carrier-to-Housing Joint Sealing Procedure

1. Remove the carrier from the housing. Refer to Section 3.
2. Remove all debris from inside the housing.
3. Use a rotary tool with a scour pad to clean all silicone residue from the housing and carrier faces. Figure 4.14. Surfaces must be clean, dry and free of foreign matter. The surfaces must not be oily to the touch.

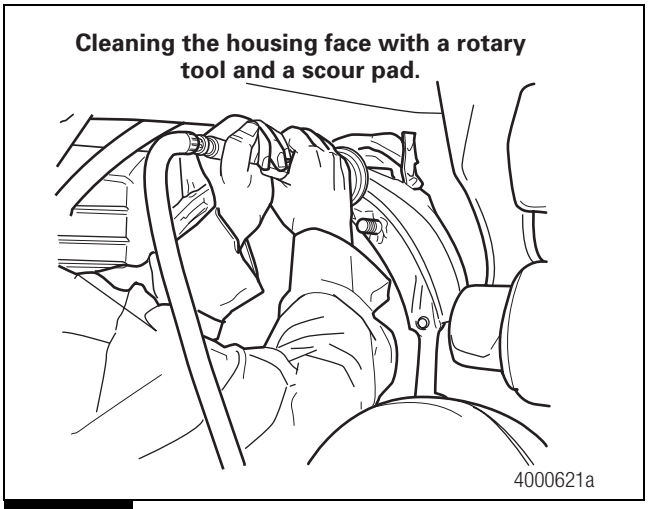


Figure 4.14

4. Remove metal filings from the magnets inside the housing.
5. Use solvent to clean the inside of the housing.
6. Use Loctite® ODC Free cleaner or brake cleaner to clean the housing and carrier faces.
7. Dry the housing and carrier faces.

⚠ CAUTION

New capscrew kits have blue Dri-Loc® STS threadlocker, an equivalent to Loctite® 242 threadlocker, applied to the capscrews. Do not remove the blue Dri-Loc® STS threadlocker from the capscrews. Damage to components can result.

8. If you reuse the carrier-to-housing capscrews, use a rotary wire brush to remove any threadlocker material and clean the capscrew threads. Use a clean cloth to wipe the threads.
9. Use a tap to clean the internal threads in the housing.

⚠ CAUTION

Apply silicone gasket material in a continuous 0.25-inch (6 mm) bead. If you use more than this amount, gasket material can break off and plug lubrication passages. Damage to components can result.

10. Apply a 0.25-inch (6 mm) bead of Loctite® 5699 silicone gasket material to the housing face. Do not use ThreeBond 1216E silicone products. Figure 4.15.

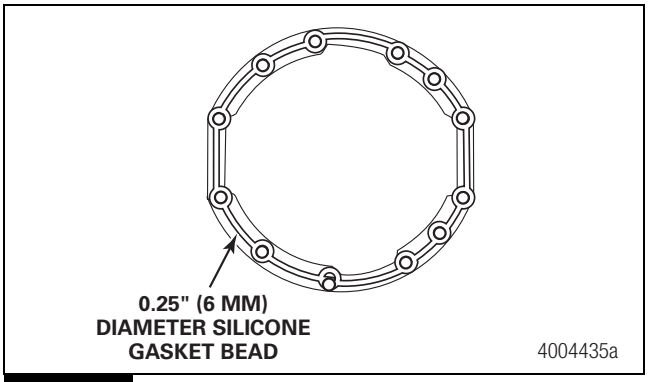


Figure 4.15

11. Install two long studs in the carrier to guide the carrier into the housing.
12. Immediately install the carrier into the housing to permit the silicone gasket material to compress evenly between the faces. If using a new capscrew kit with blue Dri-Loc® STS pre-applied threadlocker, skip the next step.
13. Apply a 0.125-inch (3 mm) bead of Loctite® 242 threadlocker around the capscrew threads approximately 0.25-inch (6 mm) from the end. Apply a 0.125-inch (3 mm) bead of Loctite® 242 threadlocker across the length of the threads. Figure 4.16.

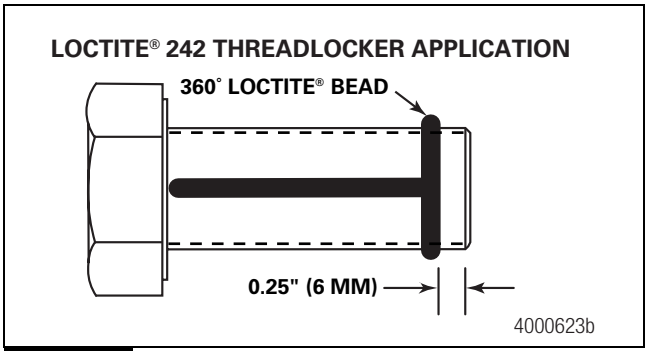


Figure 4.16

14. Install the capscrews. Use a crossing pattern to tighten the capscrews evenly. The capscrews must be tightened within 10 minutes of initial application of Loctite® 242 threadlocker.
    - Tighten the 1/2-inch capscrews to 140 lb-ft (190 N•m).
    - Tighten the 5/8-inch capscrews to 225 lb-ft (306 N•m).
15. Wait a minimum of 60 minutes before filling the assembly with lubricant. Refer to Section 7.

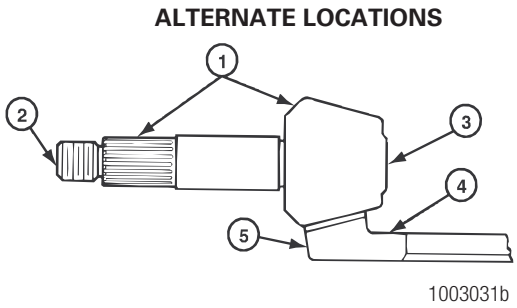
General Yoke and U-Joint Reassembly

Install the end yoke hub capscrews by hand after seating the U-joint. Tighten the capscrews according to the manufacturer's torque specifications.

Identification

Gear Sets

Refer to Table E, Table F, Table G and Table H for information on identifying gear sets with matched parts. Always check match numbers to verify that the gear set you will install has matched parts. Figure 4.17.



1 PART NUMBER, TOOTH COMBINATION NUMBER, GEAR SET MATCH NUMBER, PINION CONE VARIATION NUMBER
2 PART NUMBER, TOOTH COMBINATION NUMBER
3 GEAR SET MATCH NUMBER, PINION CONE VARIATION NUMBER
4 PART NUMBER, TOOTH COMBINATION NUMBER, GEAR SET MATCH NUMBER
5 PART NUMBER, TOOTH COMBINATION NUMBER, GEAR SET MATCH NUMBER

Figure 4.17

Examples

Table E: Gear Set Part Numbers

Part	Number	Location
Conventional ring gear	36786	On the front face or outer diameter
Conventional drive pinion	36787	At the end at threads
Generoid ring gear	36786 K or 36786 K2	On the front face or outer diameter
Generoid drive pinion	36787 K or 36787 K2	At the end at threads

Table F: Gear Set Tooth Combination Number

Gear Set Teeth	Drive Pinion Location	Ring Gear Location
5-37 = gear set has a five-tooth drive pinion and a 37-tooth ring gear	At the end at threads	On the front face or outer diameter

NOTE: Meritor drive pinions and ring gears are only available as matched sets. Each gear in a set has an alphanumeric match number.

Table G: Gear Set Match Number

Match Number	Drive Pinion Location	Ring Gear Location
M29	At the end of the gear head	On the front face or outer diameter

NOTE: Don't use the pinion cone variation number when you check for a matched gear set. Use this number when you adjust the pinion depth of the carrier. Refer to Section 5.

Table H: Pinion Cone Variation Number

Pinion Cone (PC) Variation Number	Drive Pinion Location	Ring Gear Location
PC+3 +2 +0.01 mm PC–5 –1 –0.02 mm	At the end of the pinion gear head	On the outer diameter

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

When you apply some silicone gasket materials, a small amount of acid vapor is present. To prevent serious personal injury, ensure that the work area is well-ventilated. Read the manufacturer's instructions before using a silicone gasket material, then carefully follow the instructions. If a silicone gasket material gets into your eyes, follow the manufacturer's emergency procedures. Have your eyes checked by a physician as soon as possible.

Take care when you use Loctite® adhesive to avoid serious personal injury. Read the manufacturer's instructions before using this product. Follow the instructions carefully to prevent irritation to the eyes and skin. If Loctite® adhesive material gets into your eyes, follow the manufacturer's emergency procedures. Have your eyes checked by a physician as soon as possible.

Use a brass or synthetic mallet for assembly and disassembly procedures. Do not hit steel parts with a steel hammer. Pieces of a part can break off. Serious personal injury and damage to components can result.

Observe all warnings and cautions provided by the press manufacturer to avoid damage to components and serious personal injury.

Assembly

Drive Pinion, Bearings and Bearing Cage

1. Place the bearing cage in a press. Figure 5.1.
2. Support the bearing cage with metal or wood blocks.
3. Press the bearing cup into the bore of the bearing cage until the cup is flat against the bottom of the bore. Use a sleeve of the correct size to install the bearing cup. Use the same procedure for both bearing cups. Figure 5.1.

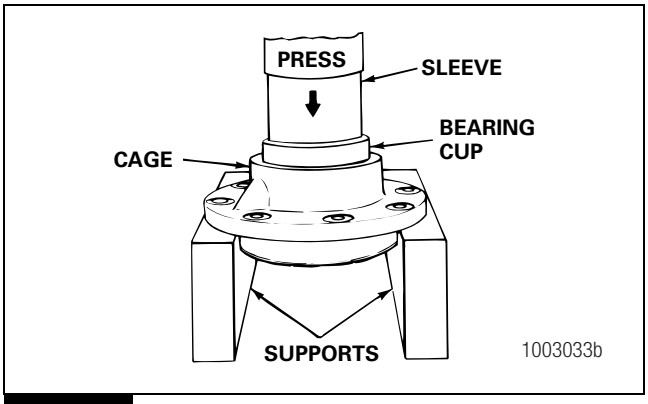


Figure 5.1

4. Place the drive pinion in a press with the gear head or teeth toward the bottom. Figure 5.2.

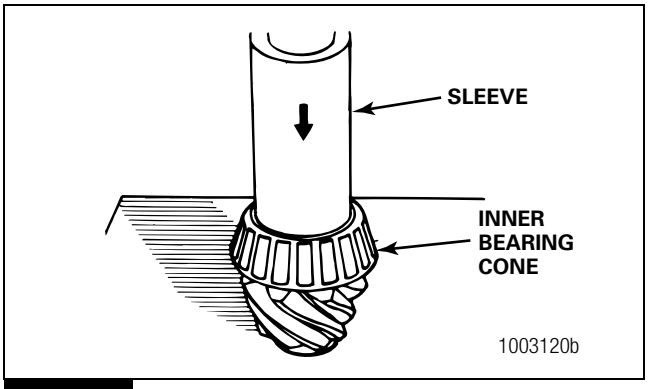


Figure 5.2

5. Press the inner bearing cone on the shaft of the drive pinion until the cone is flat against the gear head. Use a sleeve of the correct size against the bearing inner race.

NOTE: Spigot bearings are usually fastened to the drive pinion with a snap ring. Some are fastened with a peening tool, and some are a two-piece bearing assembly with the inner race pressed on the nose of the pinion and the outer race pressed into its bore in the carrier.

6. Install the spigot bearing using one of the following three procedures.

Installation

One-Piece Spigot Bearing on the Drive Pinion with a Snap Ring

NOTE: The following procedure applies to all axles except:

- Some 160 Series single axles may use snap rings.
- Some 160 and 180 Series rear-rear tandem axles may use snap rings.

1. Place the drive pinion in a press with the gear head or the teeth toward the top. Figure 5.3.

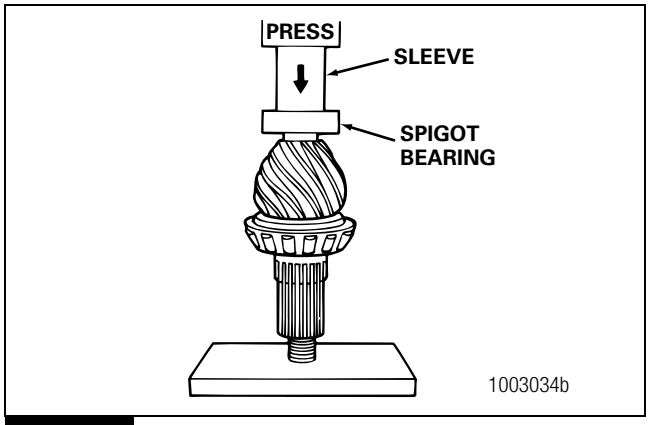


Figure 5.3

2. Press the spigot bearing on the end of the drive pinion. The bearing must be flat against the gear head. Use a sleeve of the correct size against the bearing inner race. Figure 5.3.
3. Use snap ring pliers to install the snap ring, if equipped, into the groove in the end of the drive pinion. Figure 5.4.

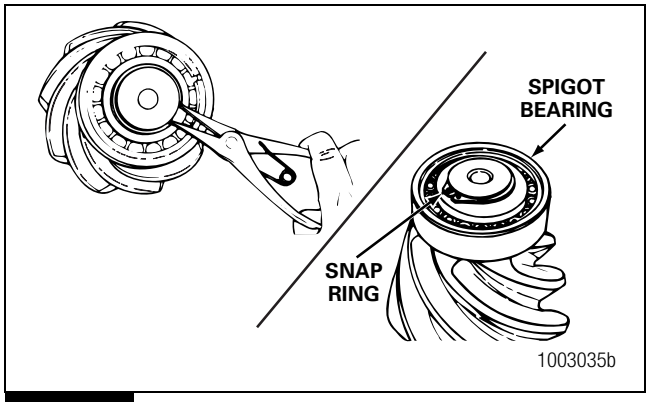


Figure 5.4

One-Piece Spigot Bearing on the Drive Pinion Without a Snap Ring

NOTE: The following procedure applies to some 180 Series rear-rear tandem axles with existing snap ring components.

To obtain the staking tool, refer to the Service Notes page on the front inside cover of this manual. Figure 5.5.

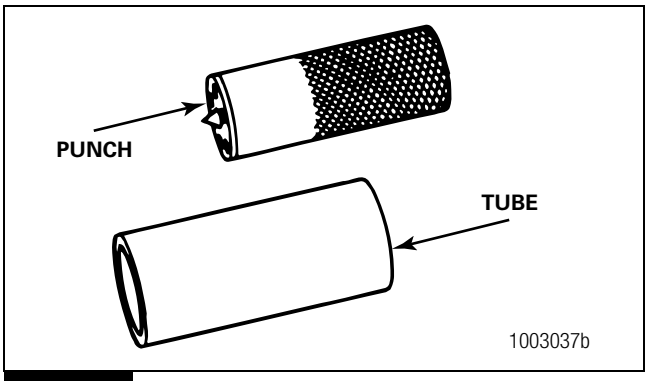


Figure 5.5

1. Place the drive pinion and the tube of the staking tool into a press with the spigot bearing toward the top. Figure 5.6.

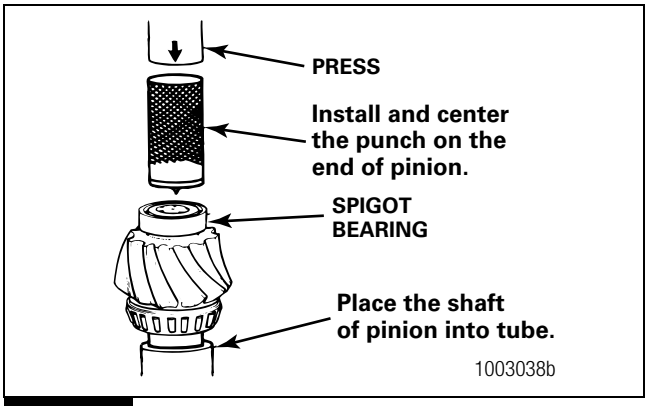


Figure 5.6

2. When you use a staking tool and press, apply 6,614 lb (3 000 kg) force on a 0.375-inch (10 mm) ball. Calculate the force required on the tool as follows.
   - 6,614 lb (3000 kg) x amount of balls in tool = pounds or kilograms
   - **Example:** 6,614 lb (3000 kg) x three balls = 19,842 pounds (9000 kg)

3. Place the punch of the staking tool over the end of the pinion and spigot bearing. Apply the required amount of force on the punch. Figure 5.6.

⚠ CAUTION

Do not align new points with the grooves in the end of the drive pinion or in old points. If the new staked points are placed in the wrong areas, the spigot bearing will not be held correctly on the pinion shaft.

NOTE: If a three-ball stake tool is used, rotate the tool 180 degrees.

4. Stake the end of the drive pinion at a minimum of five points. Figure 5.7. Rotate the punch as many times as required for a minimum of five points. Repeat Step 3 for each point.

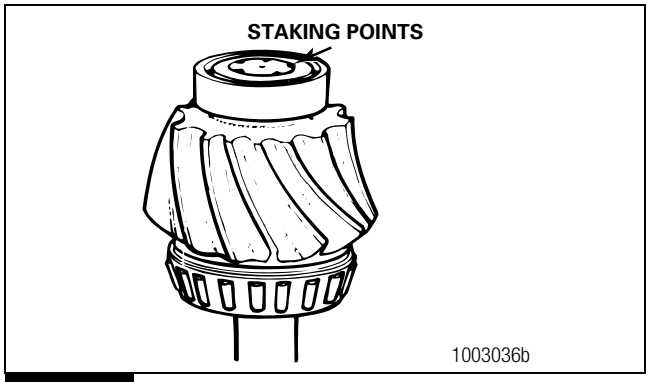


Figure 5.7

Two-Piece Spigot Bearing on the Drive Pinion

NOTE: This procedure applies to some 160 Series single rear axles and rear-rear tandem axles. These axles may also use a one-piece spigot bearing with a snap ring retainer.

NOTE: The inner race of the two-piece spigot bearings must be staked in place on RS and RR-160 Series rear axles. Before you stake the pinion, you must heat the pinion stem to soften it.

NOTE: SPX Kent-Moore kit number J-39039 includes the staking tool, temperature indicating liquid, heat shield and plastigage needed for this procedure. To obtain this kit, refer to the Service Notes page on the front inside cover of this manual.

1. Apply two stripes of temperature indicating liquid on the pinion stem from the top to the bottom. Figure 5.8. Apply a green stripe to indicate 400°F (205°C) and a blue stripe to indicate 500°F (260°C).

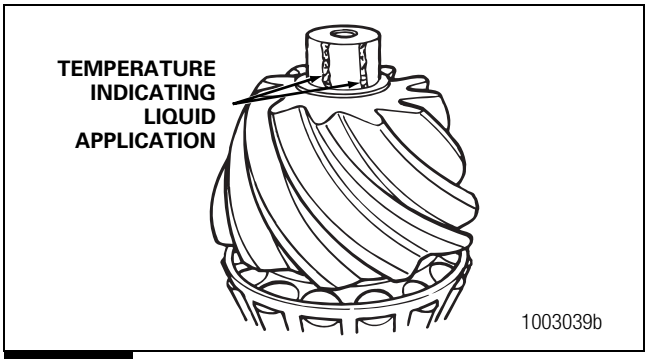


Figure 5.8

⚠ CAUTION

You must use the heat shield when you heat the pinion stem. Do not heat the pinion stem without the heat shield in place. Damage to components can result.

2. Place the heat shield over the pinion stem so that you can see the temperature indicating liquid through the hole in the shield. Figure 5.9.

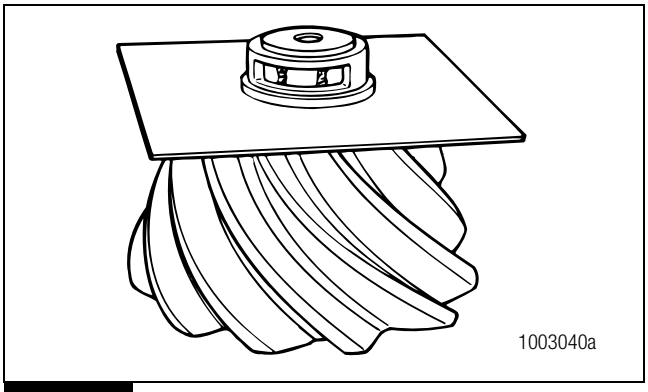


Figure 5.9

⚠ WARNING

Read the manufacturer's instructions before using a torch. Always wear safe clothing, gloves and eye protection when working with a torch for heating parts to prevent serious personal injury during assembly.

3. Put on safe clothing, gloves and eye protection.

⚠ CAUTION

Do not overheat the pinion stem or you will weaken the metal. Damage to components can result.

NOTE: Correct heating will take approximately 25-35 seconds, depending on how hot the torch is.

4. Light and adjust the torch until the white part of the flame is approximately 0.25-inch (6 mm) long. Keep the white part of the flame approximately 0.125-inch (3 mm) from the top of the stem. Figure 5.10. Move the flame around the outer diameter of the top of the pinion stem. The green temperature indicating liquid will turn black before the blue liquid does. Heat the stem until the blue liquid turns black at a point in the middle of the window.

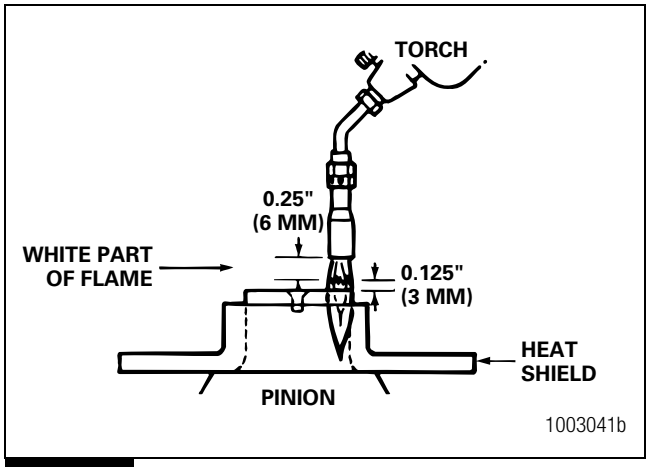


Figure 5.10

5. Remove the flame and the heat shield from the pinion. Let the pinion air cool for 10 minutes. Use a razor blade to remove the temperature indicating liquid.

⚠ CAUTION

Do not press or directly strike the new inner race. Damage to the bearing will result.

6. Use a press, if available, or a brass hammer to install the new inner race. Use the old inner race as a sleeve. The face is completely seated when you cannot fit a 0.002-inch (0.0508 mm) feeler gauge between the race and the pinion shoulder.

NOTE: To hold the races in place, use a staking tool, not the old race, to start the new race on the stem. The old race can be used to completely seat the new race.

7. Place the staking tool over the bearing race. Cut a one-inch (25 mm) piece from the green plastigage strip and place in between the punch and the staking tool. You do not need to use the plastigage for every stake. Use the plastigage until you are sure that you are hitting the punch with the correct amount of force. Figure 5.11.

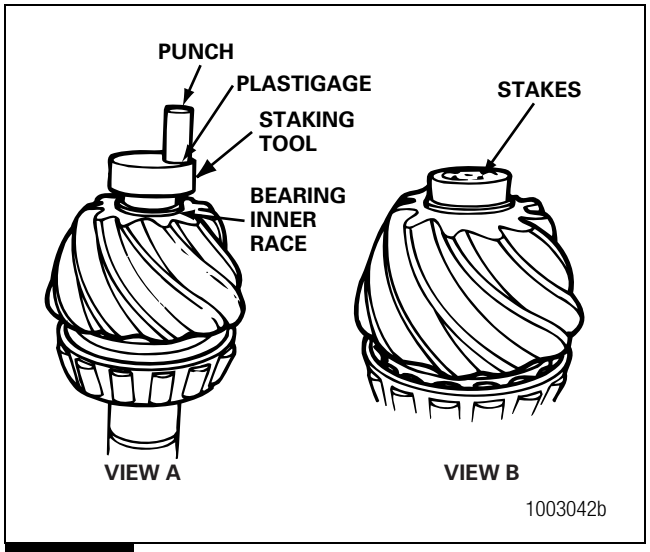


Figure 5.11

8. Strike the punch with a two-three pound (0.9-1.4 kg) brass hammer to upset the end of the pinion stem. Remove the strip and measure its thickness against the gauge on the strip's wrapper. The strip must not be less than 0.003-inch (0.0762 mm) thick. This thickness indicates that you are using enough force when you hit the punch. If the strip is too thin, then you must hit the punch harder so the stake will hold the race in place. Rotate the tool and repeat this procedure until there are six evenly spaced stake marks around the stem. Figure 5.11.

9. With a press or a soft mallet and sleeve, install the outer race and roller assembly into its bore in the carrier. Use a sleeve that is the same size as the outer race. Press the bearing until it is squarely seated against the shoulder in the bottom of its bore.

Drive Pinion

1. Apply axle lubricant to the bearing cups and to the bearing cones in the cage.
2. Install the drive pinion into the bearing cage.
3. Install the bearing spacer or spacers onto the pinion shaft against the inner bearing cone. Figure 5.12. The spacer or spacers control the preload adjustment of the drive pinion bearings.

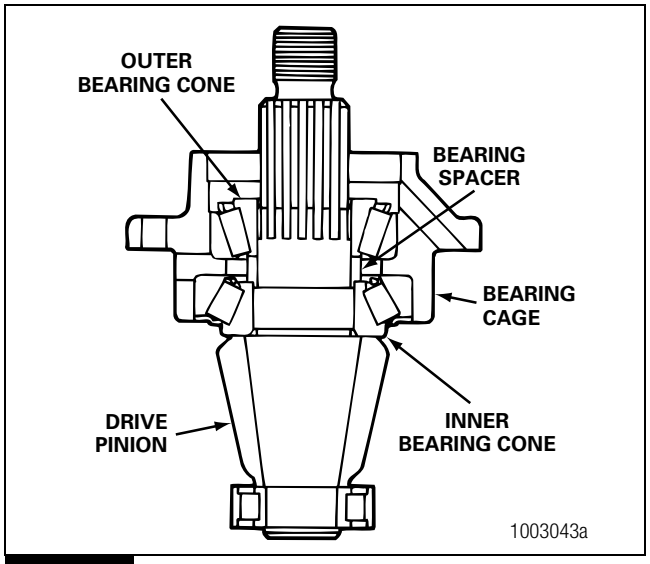


Figure 5.12

4. Install the outer bearing cone onto the pinion shaft against the spacer. Do not install the pinion seal into the bearing cage. Figure 5.12.

Adjustment

Pinion Bearing Preload

Press Method

If a press is not available, or the press does not have a pressure gauge, use the yoke or flange method to adjust the pinion bearing preload.

NOTE: Do not read the starting torque. Read only the torque value after the cage starts to rotate. The starting torque will give an incorrect reading.

1. Place the drive pinion and cage assembly into a press with the gear head or teeth toward the bottom.
2. Install a sleeve of the correct size against the inner race of the outer bearing. Figure 5.13.

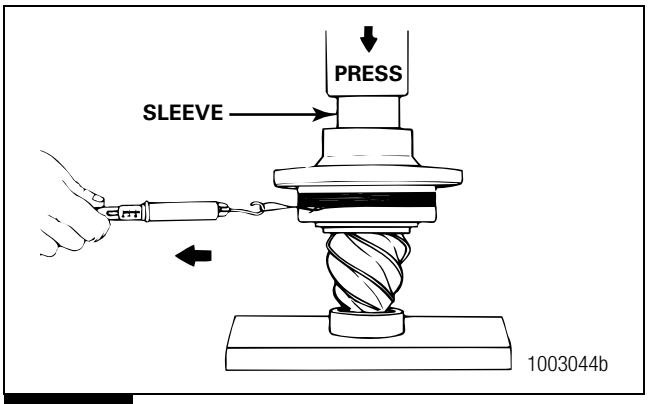


Figure 5.13

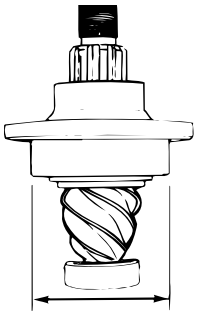
3. Apply and hold the correct amount of pressure to the pinion bearings. Refer to Table I. As pressure is applied, rotate the bearing cage several times so that the bearings make normal contact.

Table I

Thread Size of Pinion Shaft	Press Pressure Needed on Bearings for Correct Preload		Torque Value Needed on Pinion Nut for Correct Bearing Preload	
	pounds/ tons	kg/metric tons	lb-ft	N•m
7/8″-20	22,000/1	9979/10	200-275	271-373
1″-20	30,000/15	13 608/13.6	300-400	407-542
1-1/4″-12	54,000/27	24 494/24.5	700-900	949-1220
1-1/4″-18	54,000/27	24 494/24.5	700-900	949-1220
1-1/2″-12	54,000/27	24 494/24.5	800-1100	1085-1491
1-1/2″-18	54,000/27	24 494/24.5	800-1100	1085-1491
1-3/4″-12	50,000/25	22 680/22.7	900-1200	1220-1627
2″-12	50,000/25	22 680/22.7	1200-1500	1627-2034

4. While pressure is held against the assembly, wind a cord around the bearing cage several times.
5. Attach a spring scale to the end of the cord.
6. Pull the cord on a horizontal line. As the bearing cage rotates, read the value indicated on the scale. Record the reading. Figure 5.13.

7. Measure the diameter of the bearing cage where the cord was wound. Measure in inches or centimeters. Figure 5.14.



Measure diameter of cage. 1003045b

Figure 5.14

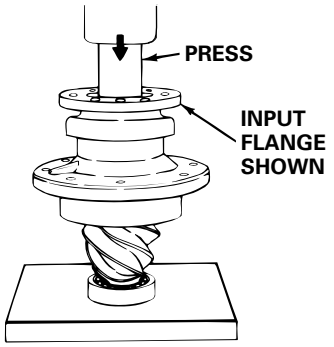
8. Divide the dimension in half to get the radius. Record the radius dimension.
9. Use the following procedure to calculate the bearing preload or torque.
   - Pounds Pulled x Radius (inches) = lb-in Preload
     — Preload x 0.113 = N•m Preload
   - Kilograms Pulled x Radius (cm) = kg-cm lb-in Preload
     — Preload x 0.098 = N•m Preload
   - Reading from spring scale = 7.5 pounds (3.4 kg)
   - Diameter of bearing cage = 6.62-inches (16.8 cm)
   - Radius of bearing cage = 3.31-inches (8.4 cm)
     — 7.5 lb x 3.31-inches = 24.8 in-lb Preload
     Preload x 0.113 = 2.8 N•m Preload
     — 3.4 kg x 8.4 cm = 28.6 kg-cm Preload
     Preload x 0.098 = 2.8 N•m Preload
10. If the preload or torque of the pinion bearings is not within 5-45 lb-in (0.56-5.08 N•m) for new pinion bearings or 10-30 lb-in (1.13-3.39 N•m) for used pinion bearings in good condition, adjust the spacer and repeat Step 1 through Step 9.
    - **To increase preload:** Install a thinner bearing spacer.
    - **To decrease preload:** Install a thicker bearing spacer.
11. Check the bearing preload with the drive pinion and cage assembly installed in the carrier. Follow the procedures to adjust the pinion bearing preload using the yoke or flange method.

Yoke or Flange Method

⚠ CAUTION

Do not install tight-fitting yokes or flanges onto shafts using a hammer or mallet. A hammer or mallet will damage the yoke or flange.

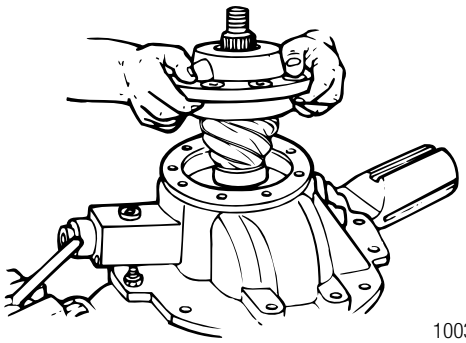
1. Use a press to install the input yoke or flange, nut and washer, if equipped, onto the drive pinion. The yoke or flange must be seated against the outer bearing. Figure 5.15.



1003046b

Figure 5.15

2. Install the drive pinion and cage assembly into the carrier. Do not install shims under the bearing cage. Figure 5.16.



1003355b

Figure 5.16

3. Install the bearing cage-to-carrier capscrews. Washers are not required at this time. Hand-tighten the capscrews.

4. Fasten a yoke or flange bar to the input yoke or flange. The bar will hold the drive pinion in position when the nut is tightened. Figure 5.17.

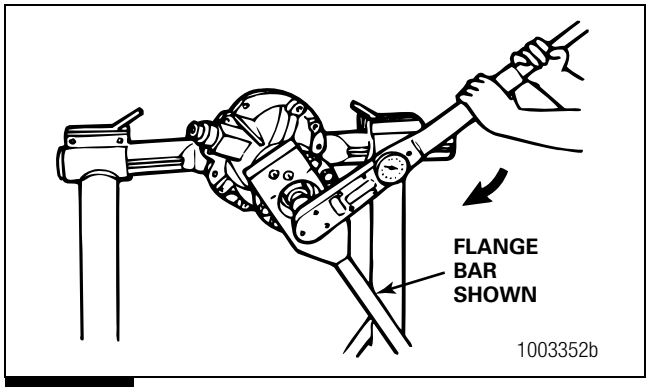


Figure 5.17

5. Tighten the drive pinion nut to the correct torque value. Figure 5.17. Refer to Table I.
6. Remove the yoke or flange bar.
7. Attach a torque wrench onto the drive pinion nut. Rotate the drive pinion and read the value indicated on the torque wrench. Figure 5.18.

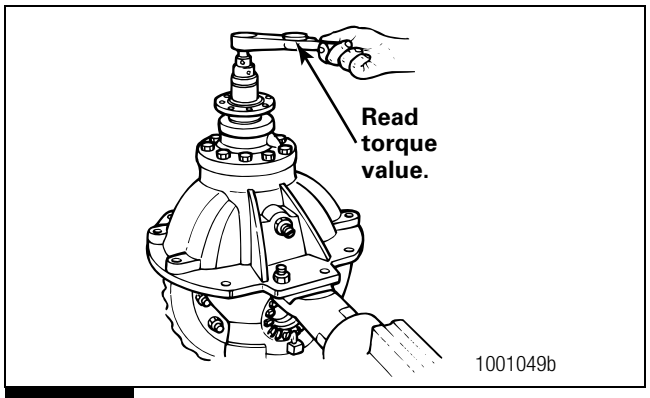


Figure 5.18

8. If the pinion bearing preload or torque is not within 5-45 lb-in (0.56-5.08 N•m) for new pinion bearings or 10-30 lb-in (1.13-3.39 N•m) for used pinion bearings in good condition, remove the pinion and cage assembly from the carrier. Adjust the spacer and repeat Step 1 through Step 7. ⓣ
   - **To increase preload:** Install a thinner bearing spacer.
   - **To decrease preload:** Install a thicker bearing spacer.
9. After adjusting the pinion bearing preload, remove the drive pinion and bearing cage from the carrier. Refer to Section 3.

Shim Pack Thickness for a New Drive Pinion

Use this procedure if you'll install a new drive pinion and ring gear set, or if you have to adjust the depth of the drive pinion. If the pinion depth shims are misplaced during carrier repair, use 0.045-inch (1.14 mm) for the initial pinion position. Figure 5.19.

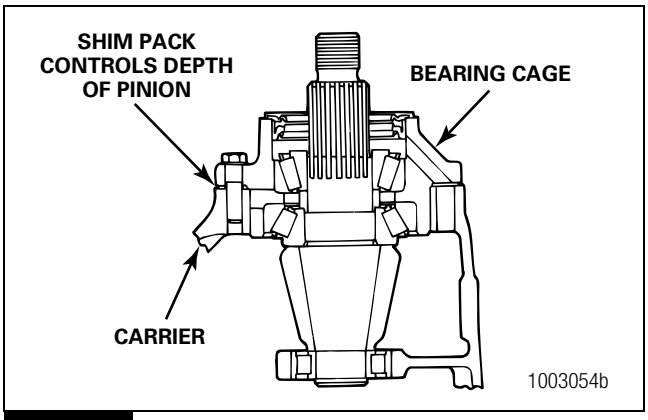


Figure 5.19

1. Use a micrometer to measure the thickness of the shim pack that was removed from under the pinion cage. Record the measurement. Figure 5.20.

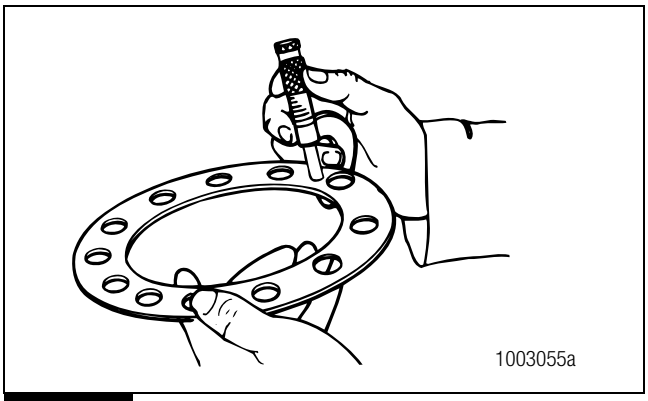


Figure 5.20

2. Find the pinion cone (PC) variation number on the drive pinion you'll replace. Figure 5.21. Record the number. The pinion cone number can be one of the following values.
   - PC +3, PC –3, +3 or –3 = 0.003-inch
   - PC +0.03, PC 0.03 mm, +0.03 mm or –0.03 = 0.03 mm

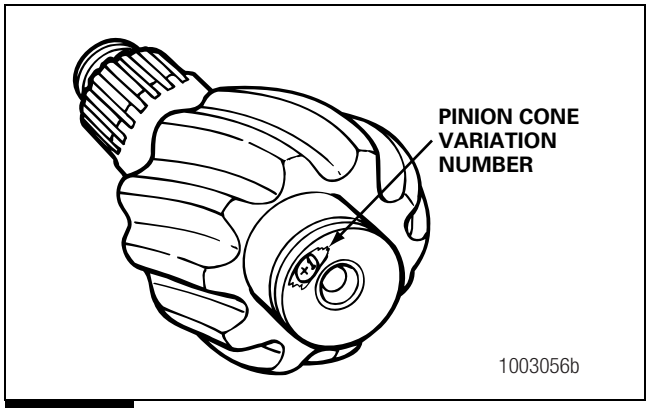


Figure 5.21

3. If you can't find the PC number or it's unreadable, install a new shim pack of the same thickness that you measured in Step 1.
4. If the old pinion cone number is a plus (+) number, subtract the number from the old shim pack thickness that was measured in Step 2.
5. If the old pinion cone number is a minus (–) number, add the number to the old shim pack thickness that was measured in Step 2.
6. Find the pinion cone (PC) variation number on the new drive pinion that will be installed. Record the number.
7. If the new pinion cone number is a plus (+) number, add the number to the standard shim pack thickness that was calculated in Step 4 or Step 5. Use new shims to make a shim pack to the correct thickness. Refer to Table J.

Table J

Examples	Inches	mm
1. Old Shim Pack Thickness. Old PC Number, PC +2-inches (+0.05 mm) Standard Shim Pack Thickness. New PC Number, PC +5-inches (+0.13 mm) New Shim Pack Thickness	0.030 – 0.002 = 0.028 + 0.005 = 0.033	0.760 – 0.050 = 0.710 + 0.130 = 0.840
2. Old Shim Pack Thickness. Old PC Number, PC –2-inches (–0.05 mm) Standard Shim Pack Thickness. New PC Number, PC +5-inches (+0.13 mm) New Shim Pack Thickness	0.030 + 0.002 = 0.032 + 0.005 = 0.037	0.760 + 0.050 = 0.810 + 0.130 = 0.940
3. Old Shim Pack Thickness. Old PC Number, PC +2-inches (+0.05 mm) Standard Shim Pack Thickness. New PC Number, PC –5-inches (–0.13 mm) New Shim Pack Thickness	0.030 – 0.002 = 0.028 – 0.005 = 0.023	0.760 – 0.050 = 0.710 – 0.130 = 0.580
4. Old Shim Pack Thickness. Old PC Number, PC –2-inches (–0.05 mm) Standard Shim Pack Thickness. New PC Number, PC –5-inches (–0.13 mm) New Shim Pack Thickness	0.030 + 0.002 = 0.032 – 0.005 = 0.027	0.760 + 0.050 = 0.810 – 0.130 = 0.680

8. If the new pinion cone number is a minus (–) number, subtract the number from the standard shim pack thickness that was calculated in Step 4 or Step 5. Use new shims to make a shim pack to the correct thickness. Refer to Table J.

Installation

Drive Pinion, Bearing Cage and Shim Pack into the Carrier

NOTE: If a new drive pinion and ring gear set is installed, or if the depth of the drive pinion has to be adjusted, calculate the thickness of the shim pack. Refer to the procedure in this section.

1. Select the correct shim pack and install it between the bearing cage and carrier. Figure 5.22.

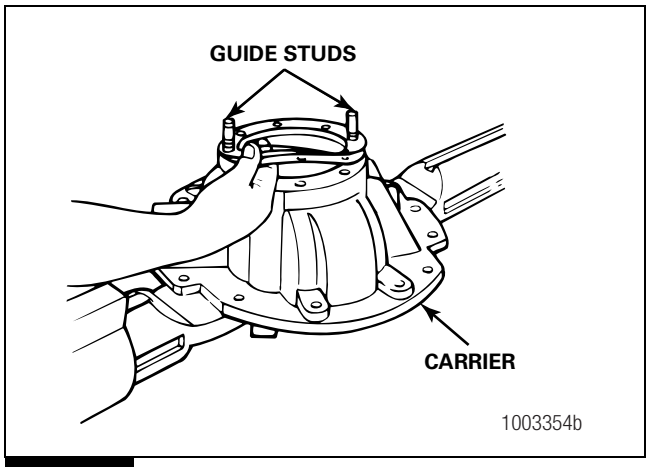


Figure 5.22

2. Apply Loctite® 518 Gasket Eliminator to the carrier face.
3. Align the oil slots in the shims with the oil slots in the bearing cage and carrier. Use guide studs to help align the shims. Figure 5.22.
4. Apply Loctite® 518 Gasket Eliminator to the top of the shim pack.
5. Install the drive pinion and bearing cage into the carrier. If necessary, use a rubber, plastic or leather mallet to hit the assembly into position. Figure 5.23.

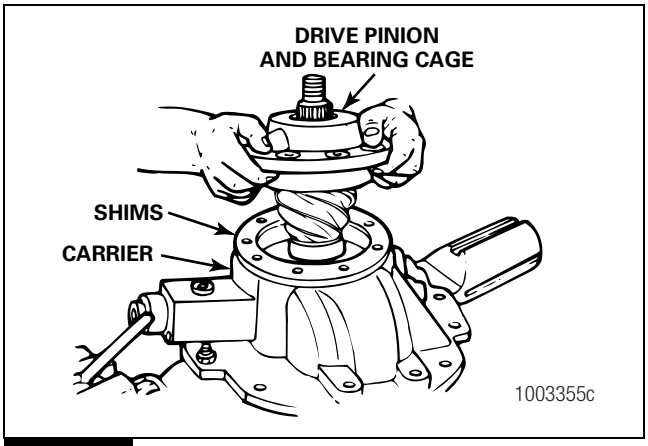


Figure 5.23

6. Install the bearing cage-to-carrier capscrews and washers. Tighten the capscrews to the correct torque value. Figure 5.24. Refer to Section 8.

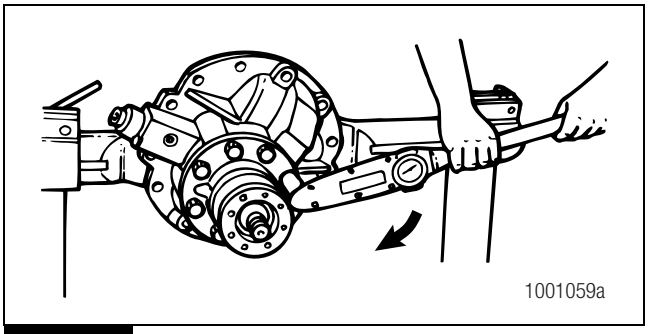


Figure 5.24

Tight Fit Yokes and POSE™ Seal

⚠ CAUTION

Do not use a hammer or mallet to install tight fit yokes onto shafts. A hammer or mallet can damage the yoke.

The seal lips must be clean. Dirt and particles may cause a leak between the yoke and the POSE™ seal.

NOTE: Do not install a POSE™ seal all the way against the yoke shoulder. This seal is designed to position itself as the yoke is installed.

1. Apply axle lubricant on the yoke seal.
2. Inspect all surfaces of the yoke hub for damage.

3. If the carrier uses a POSE™ seal element, install a new POSE™ seal.
   A. Lightly lubricate the yoke journal with the same lubricant used in the axle housing.
   B. Partially install the POSE™ seal onto the yoke 0.25-0.50-inch (6.4-12.7 mm). Figure 5.25.
   C. Before you install the yoke onto the drive pinion, lubricate the yoke with the same lubricant used in the axle housing.

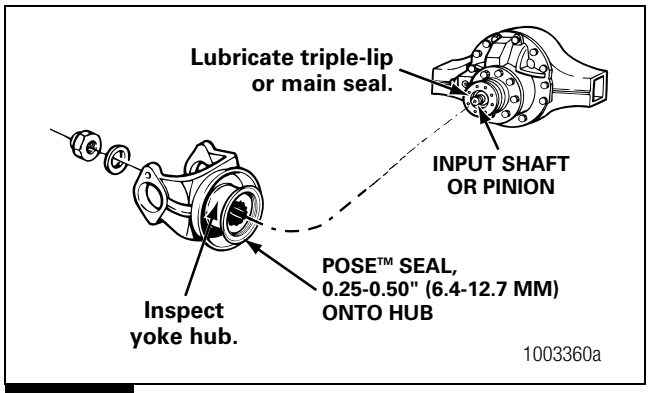


Figure 5.25

4. Slide the yoke over the input shaft pinion. Align the yoke splines with the shaft splines.

⚠ CAUTION

Do not use a hammer or mallet to install the yoke to the input pinion shaft. A hammer or mallet can damage the yoke or flange.

5. Install the input yoke flange onto the drive pinion shaft. The yoke or flange must be fully seated against the outer differential bearing before the nut is tightened to specifications.
6. Install the drive pinion nut and washer onto the input pinion shaft and against the yoke collar. Tighten the nut against yoke collar to torque specifications. Figure 5.26. Refer to Section 8.

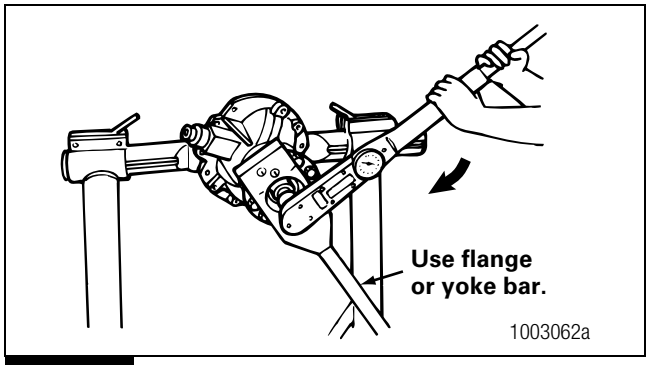


Figure 5.26

⚠ CAUTION

The seal lips must be clean. Dirt and particles may cause a leak between the yoke and the seal.

7. Install a new triple-lip seal.
   A. Apply the same lubricant used in the axle housing to the outer surface of the seal and the seal bore in the bearing cage. Figure 5.27.
   B. Place the drive pinion and cage assembly into a press with the seal bore toward the top.
   C. Press the seal into the bearing cage. The seal flange must be flat against the top of the bearing cage. Use a sleeve or seal driver of the correct size that fits against the metal seal flange. The diameter of the sleeve or driver must be larger than the flange diameter. Figure 5.28.
      - **If a press is not available:** Use a mallet and the sleeve or driver to install the seal. Figure 5.29.
   D. After the triple-lip seal is installed, a gap of approximately 0.015-0.030-inch (0.38-0.76 mm) between the flange and bearing cage is normal. Figure 5.30.
   E. Check the gap with a feeler gauge at several points around the seal. The gap must be within 0.015-0.030-inch (0.38-0.76 mm). The difference between the largest and smallest gap measurement must not exceed 0.010-inch (0.0254 mm).

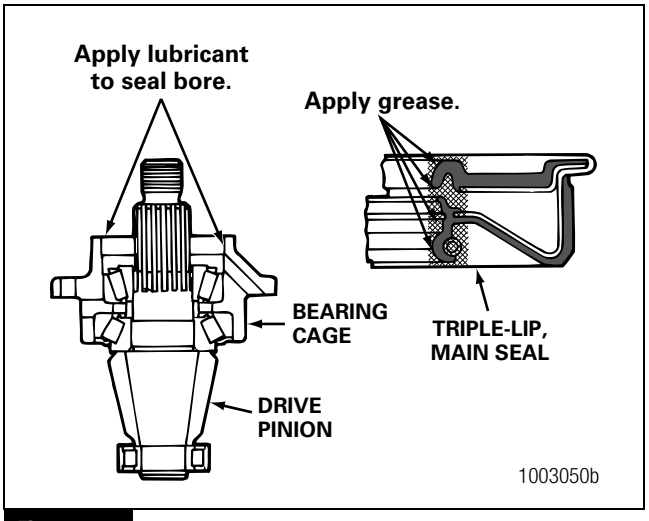


Figure 5.27

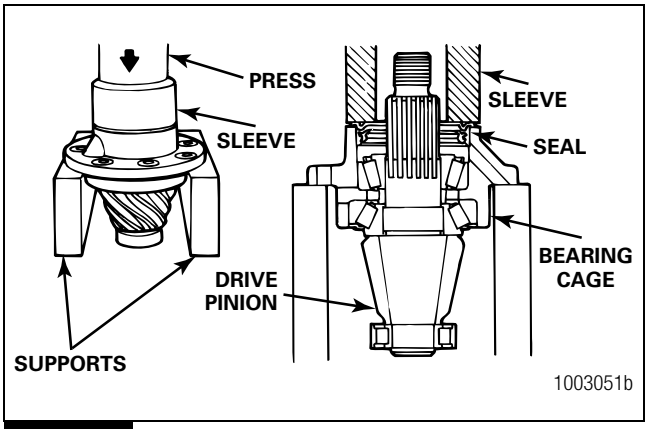


Figure 5.28

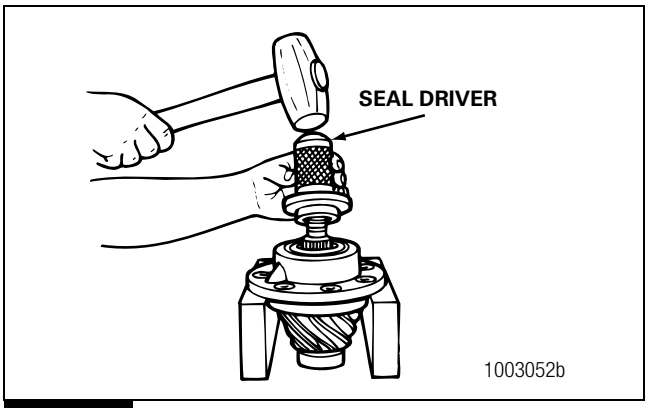


Figure 5.29

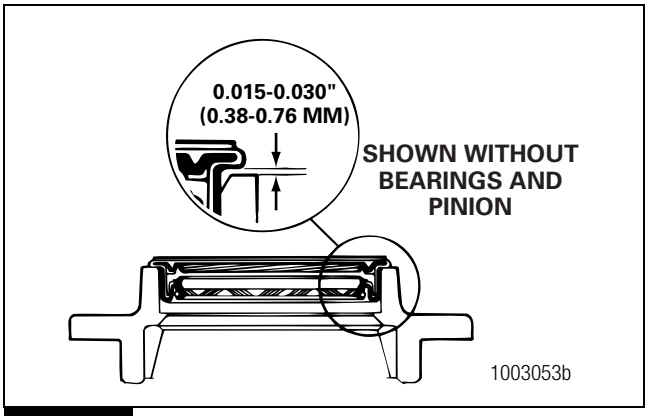


Figure 5.30

Any Type Yoke with a Unitized Pinion Seal (UPS)

1. Remove the replacement unitized seal from the package. Figure 5.31.

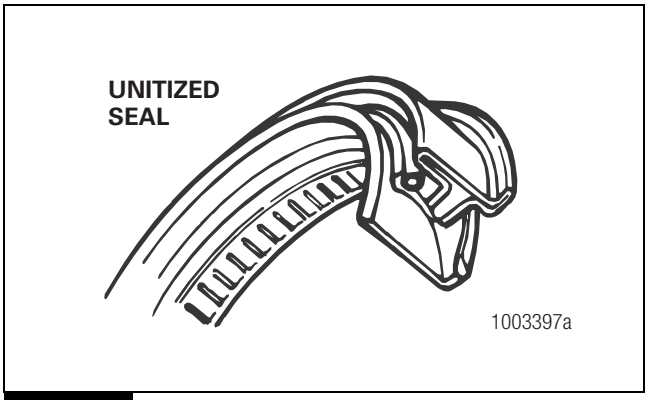


Figure 5.31

⚠ CAUTION

If a yoke is removed after it has been partially or fully installed, the unitized pinion seal will be damaged. Remove and discard the original unitized pinion seal and replace it with a new one.

If a yoke has been installed into the unitized pinion seal and then removed, the inner sleeve of the seal will be damaged. Install a new seal.

2. Select the correct seal driver from Table K. Each seal driver is designed to correctly install a specific diameter seal. To determine the yoke seal diameter, measure the yoke journal. To obtain the Meritor seal driver KIT 4454, refer to the Service Notes page on the front inside cover of this manual.
3. Position the seal on the driver.

⚠ CAUTION

Use a rubber mallet to install the seal. Do not use a steel, brass or plastic hammer. Using a steel, brass or plastic hammer can damage the seal and driver tool.

4. Use a rubber mallet to drive the seal into or against the bearing cage. The seal must fully seat into or against the bearing cage. Figure 5.32.

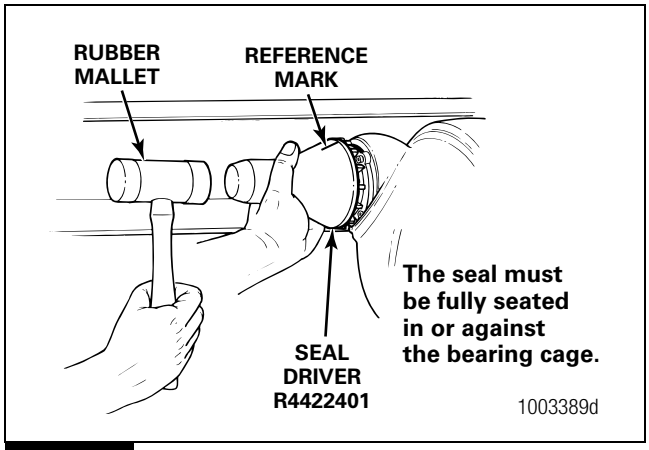


Figure 5.32

5. Visually inspect the seal to verify that it is seated correctly.

Table K: Unitized Pinion Seals and Seal Drivers

Single Models	Tandem Models	Meritor Unitized Pinion Seal	Seal Installation Location	Meritor Seal Driver	Yoke Seal Diameter Inches
RS-17-145	RT-34-144 /P	A-1205-R-2592	Tandem Forward Input — 145 models from November 1993 to present	R4422402	3.250
RS-19-145	RT-34-145 /P				3.255
RS-21-145	RT-40-145 /A /P	A-1205-P-2590	Tandem Forward Output — Tandem Forward Input 145 models before November 1993 with seal A-1205-F-2424	R4422401	3.000
RS-21-160	RT-40-149 /A /P				3.005
RS-23-160 /A	RT-44-145 /P				
RS-23-161 /A	RT-40-160 /A /P				
RS-25-160 /A	RT-40-169 /A /P	A-1205-N-2588	Tandem and Single Rear Input — 145 models	R4422401	3.000
RS-23-186	RT-46-160 /A /P				3.005
RS-26-185	RT-46-169 /A /P	A-1205-Q-2591	Tandem and Single Rear Input — 160/164/185 models	R4422402	3.250
RS-30-185	RT-46-164EH /P				3.255
	RT-46-16HEH /P				
	RT-50-160 /P				
	RT-52-185*				
	RT-58-185*				

* Forward and rear input only.

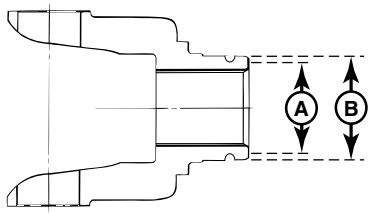
Clean, Inspect and Install the Yoke After Installing a Unitized Pinion Seal

1. Use a clean shop towel and a safe cleaning solvent to clean the ground and polished surface of the yoke journal. Do not use gasoline, abrasive cleaners, towels or scrubbers to clean the yoke. Do not attempt to polish the yoke.

NOTE: The unitized seal features a rubber inner sleeve that is designed to seal and rotate with the yoke. This feature allows you to reuse a yoke with minor grooves.

2. Inspect the yoke seal surface for grooves.
   - **If you find grooves on the yoke:** Use calipers to measure the groove diameters. If any groove diameter measures less than the dimensions shown in Figure 5.33, replace the yoke.

UNITIZED PINION SEAL (UPS)



Yoke Seal Diameter	Minimum Yoke Diameter at Groove (Inches)
3.000/3.005"	2.990"
3.250/3.255"	3.240"

1003390e

A MINIMUM GROOVE DEPTH — DIAMETER
B YOKE SEAL DIAMETER

Figure 5.33

⚠ CAUTION

Do not install a POSE™ seal after you install a unitized pinion seal. The use of a POSE™ seal will prevent correct seating of the unitized pinion seal on the yoke and can result in lubricant leakage at the seal. POSE™ seal installation is recommended only for triple-lip and other previous design seals.

Do not use thin metal wear sleeves to refresh the yoke surface. Wear sleeves pressed onto the yoke can prevent correct seating of the pinion seal, damage the pinion seal assembly and cause the seal to leak.

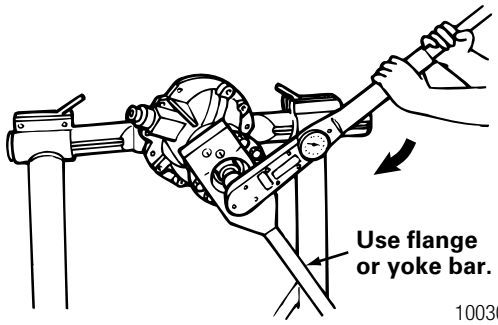
3. Before you install the yoke, lightly lubricate or coat the yoke seal journal with axle oil.

4. Align the yoke splines with the shaft splines. Slide the yoke over the shaft spline.

⚠ CAUTION

Do not use a hammer or mallet to install the yoke to the input pinion shaft. A hammer or mallet can damage the yoke or flange.

5. Install the input yoke flange onto the drive pinion shaft. The yoke or flange must be fully seated against the outer differential bearing before the nut is torqued to specifications.
6. Apply a single bead of Loctite® 277 adhesive (part number 1199Y3795) or Loctite® 270 adhesive (part number 2297M5213) at the top of the input shaft threads from inboard to outboard. The bead should be 0.120-inch wide.
7. Install the drive pinion nut, and washer if required, onto the input pinion shaft and against the yoke collar. Tighten the nut against the yoke collar to torque specifications. Figure 5.34. Refer to Section 8.

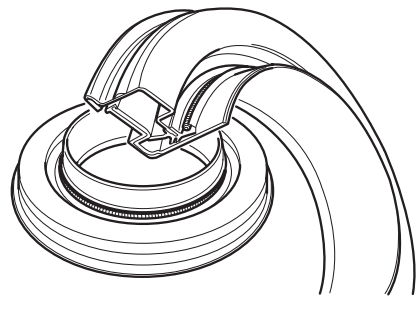


1003062a

Figure 5.34

Any Type Yoke with a Multiple Lip Seal (MLS)

1. Remove the replacement multiple lip seal from the package. Figure 5.35.



4005523a

Figure 5.35

⚠ CAUTION

If a yoke is removed after it has been partially or fully installed, the multiple lip seal will be damaged. Remove and discard the original multiple lip seal and replace it with a new one.

If a yoke has been installed into the multiple lip seal and then removed, the inner sleeve of the seal will be damaged. Install a new seal.

2. Select the correct seal driver from Table L. Each seal driver is designed to correctly install a specific diameter seal. To determine the yoke seal diameter, measure the yoke journal. To obtain the Meritor seal driver KIT 4454, refer to the Service Notes page on the front inside cover of this manual.
3. Position the seal on the driver.
4. Install the rear-rear axle input seal. Hold the seal only on the outer diameter. Position the seal into the seal driver and align it with the rear-rear axle input bearing cage. Use a dead-blow hammer and the appropriate driver to install the seal into the bearing cage. Figure 5.36.

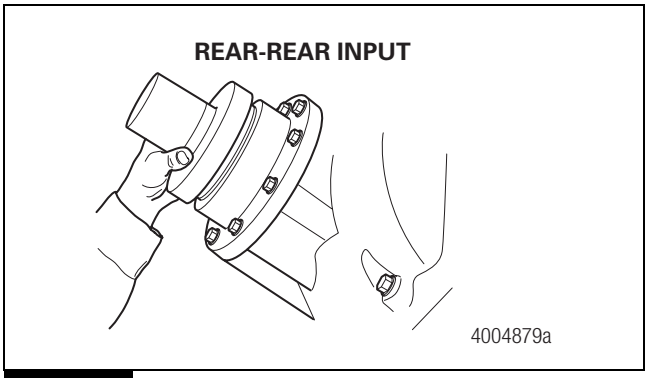


Figure 5.36

5. Use a feeler gauge to check the seal gap at all three axle positions. The seal is correctly installed if the gap is less than 0.005-inch (0.127 mm) around the circumference of the seal flange.
   - **If the gap is more than 0.005-inch (0.127 mm):** Use a dead-blow hammer and the appropriate driver to completely install the seal.

Table L: Multiple Lip Seals and Seal Drivers*

Single Models	Tandem Models	Axle Model and Position	Seal Service Part Number	Previous Seal Part Number	Seal Drivers	Sleeve Drivers
MX-21-160	RT-34-144 /P	14X/16X/18X/38X Forward-Rear Unit Input (FUI)	A1-1205X2728	A-1205R2592	2728T1	2728T2
MX-23-160R	RT-34-145 /P					
RF-16-145	MT-40-143					
RF-21-160	RT-40-145 /A /P	14X/16X Forward-Rear Unit Output (FUO)	A1-1205Y2729	A-1205P2590	2729T1	2729T2
RF-22-166	RT-40-149 /A /P					
RF-23-185	RT-44-145 /P	14X Rear-Rear Unit Input (RUI)	A1-1205Z2730	A-1205N2588	2730T1	Not Required — Sleeve is unitized
RS-17-145	RT-40-160 /A /P					
RS-19-145	RT-40-169 /A /P					
RS-21-145	RT-46-160 /A /P	16X/18X Rear-Rear Unit Input (RUI)	A1-1205A2731	A-1205Q2591	2731T1	Not Required — Sleeve is unitized
RS-21-160	RT-46-169 /A /P					
RS-23-160 /A	RT-46-164EH /P					
RS-23-161 /A	RT-46-16HEH /P					
RS-25-160 /A	RT-50-160 /P					
RS-23-186	RT-52-185*					
RS-26-185	RT-58-185*					
RS-30-185						

* Forward and rear input only.

Forward input and output seals must be serviced with the seal and sleeve. The service part number provides both when required.

If the Yoke or Inner Sleeve of the Multiple Lip Seal was Removed at Any Time During Installation

1. The original multiple lip seal will be damaged. Remove and discard the seal to prevent damage to components.
2. Install a new multiple lip seal.

Yoke

1. Before you install the yoke, lightly lubricate or coat the yoke seal journal with axle oil.
2. Align the yoke splines with the shaft splines. Slide the yoke over the shaft spline.

⚠ CAUTION

Do not use a hammer or mallet to install the yoke onto the input pinion shaft, which can damage the yoke or flange.

3. Install the input yoke flange onto the drive pinion shaft. The yoke or flange must be fully seated against the outer differential bearing before you tighten the nut.
4. Install the drive pinion nut, and washer if required onto the input pinion shaft and against the yoke collar. Use a flange or yoke bar to tighten the nut against the yoke collar to torque specifications. Figure 5.37. Refer to Section 8.

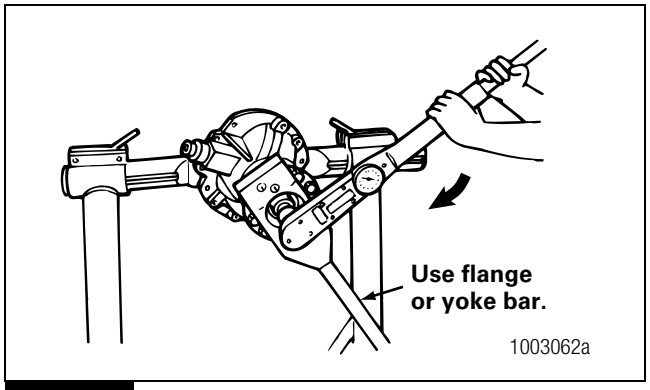


Figure 5.37

Assembly

Main Differential and Ring Gear Assembly

⚠ CAUTION

Heat the ring gear before seating it onto the differential case. Do not press a cold ring gear on the flange case half. A cold ring gear will damage the case half because of the tight fit.

1. Heat the ring gear in a tank of water to a temperature of 160-180°F (71-82°C) for 10 to 15 minutes.

⚠ WARNING

Wear safe clothing and gloves when working with the hot ring gear to prevent serious personal injury.

2. Use a lifting tool to safely lift the ring gear from the tank of water.
3. Install the ring gear onto the flange case half immediately after the gear is heated.
   - **If the ring gear does not fit easily onto the case half:** Heat the gear again.
4. Align the ring gear and the flange case half fastener holes. Rotate the ring gear as necessary.
5. Install the bolts, nuts and washers that hold the ring gear to the flange case half. Install the bolts from the gear side of the assembly. The bolt heads must be against the ring gear. Figure 5.38.
   - **If rivets were used to hold the ring gear to the flange case half:** Replace them with bolts, nuts and washers.

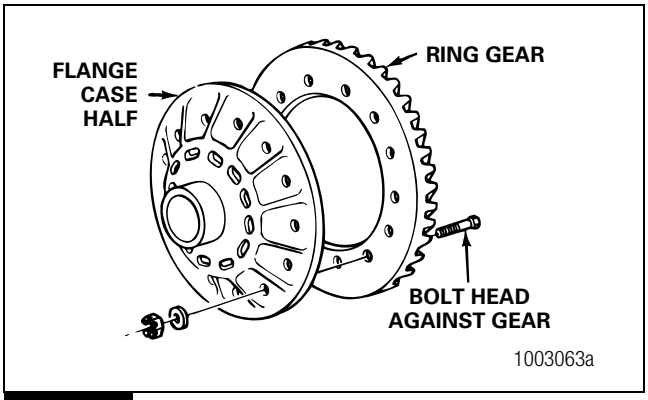


Figure 5.38

6. Tighten the bolts and nuts to the correct torque value. Refer to Section 8.

   - **For 59000 Series carriers:** Apply four to six drops of red Loctite® 277 threadlocker to the threaded holes in the ring gear. Install the capscrews. Tighten the capscrews to 360-470 lb-ft (490-639 N•m). T

7. Use a 0.003-inch (0.08 mm) feeler gauge to check for gaps between the back surface of the ring gear and the case flange. Check for gaps at four points around the assembly. Figure 5.39.

   - **If the gaps exceed specifications:** Check the flange case half and ring gear for the problem that causes the gap. Repair or replace parts. Assemble the ring gear onto the flange case half.

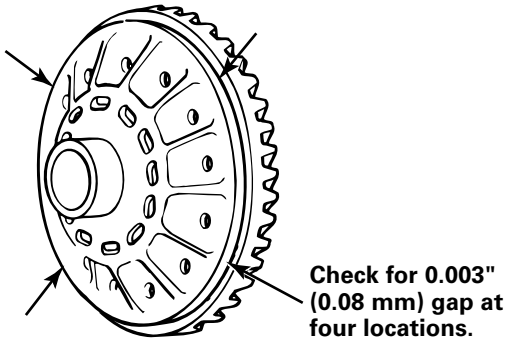


Figure 5.39

8. Use a press and the correct size sleeve to install the bearing cones on both of the case halves. Figure 5.40.

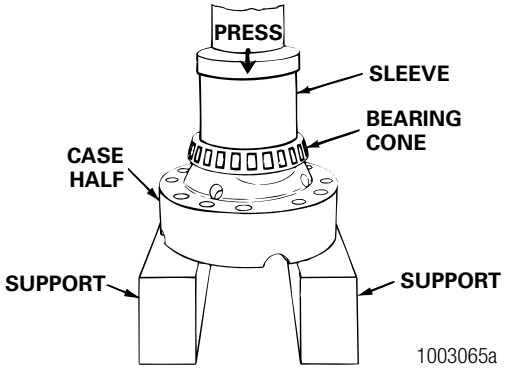


Figure 5.40

9. Apply axle lubricant on the inside surfaces of both case halves, spider or cross, thrust washers, side gears and differential pinions.

10. Place the flange case half on a bench with the ring gear teeth toward the top.

11. Install one thrust washer and side gear into the flange case half. Figure 5.41.

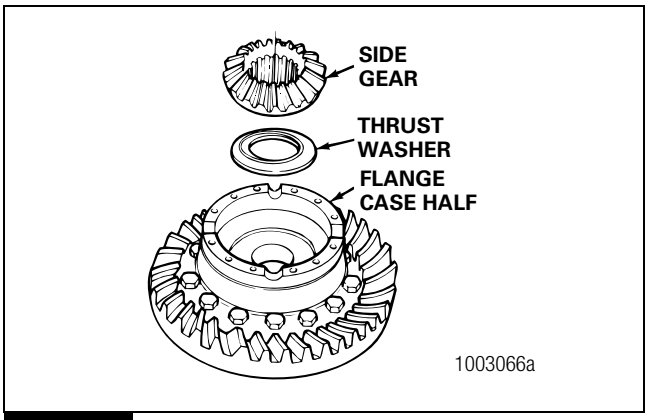


Figure 5.41

⚠ CAUTION

The side gears in some carrier models have hubs of different lengths. Install the correct length side gear into the flange case half. Damage to components can result.

12. Install the spider or cross, differential pinions and thrust washers into the flange case half. Figure 5.42.

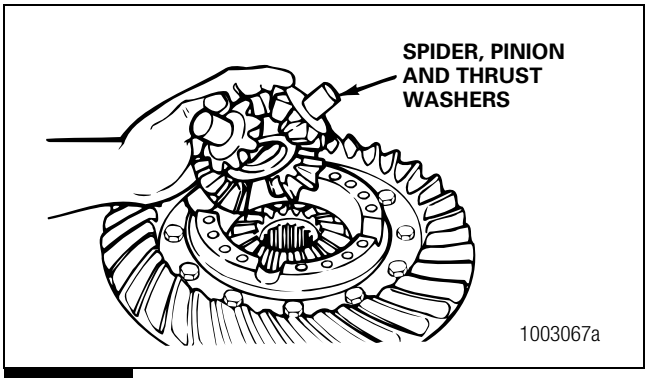


Figure 5.42

13. Install the second side gear and thrust washer over the spider and differential pinions. Figure 5.43.

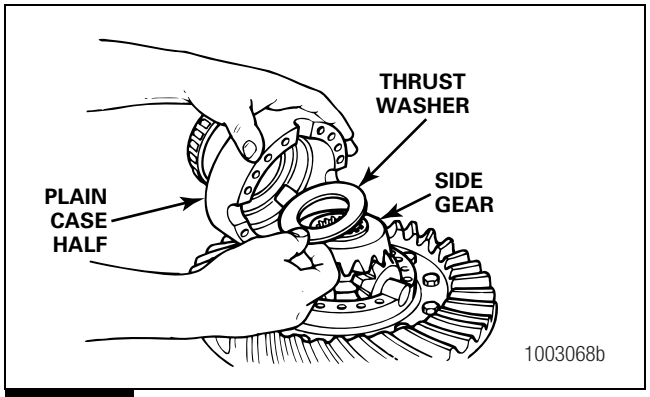


Figure 5.43

14. Place the plain half of the differential case over the flange half and gears. Rotate the plain half to align the match marks. Figure 5.43 and Figure 5.44.

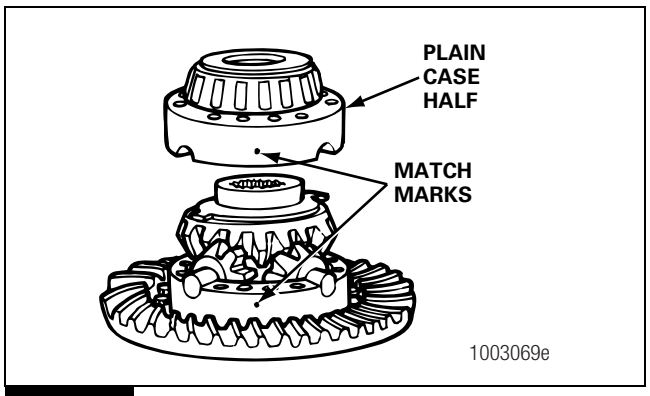


Figure 5.44

15. Install Dri-Loc® fasteners into the case halves. Refer to Section 6.
    A. Install four capscrews and washers or bolts, nuts and washers, if equipped, into the case halves. The distance between the fasteners must be equal. Tighten the fasteners to the correct torque value in a progressive crisscross pattern opposite each other. Refer to Section 8. Figure 5.45.
    B. Install the other fasteners into the case halves. Tighten the fasteners to the correct torque value. Refer to Section 8.
16. Check the differential gears rotating resistance.

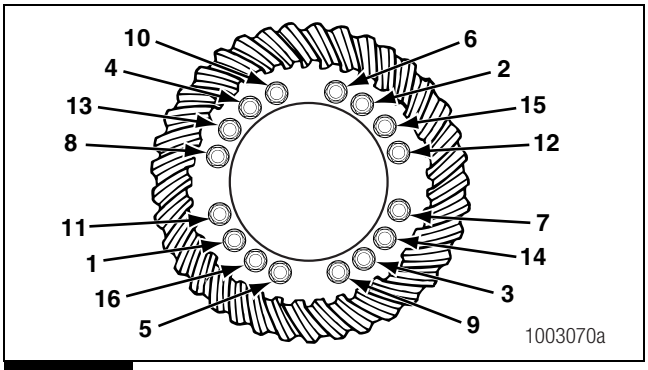


Figure 5.45

Inspection

Differential Gears Rotating Resistance

1. Make an inspection tool using an axle shaft that matches the spline size of the differential side gear. Cut the shaft to approximately 12-inches (304.8 mm). Weld a nut onto the end of the shaft. Figure 5.46.

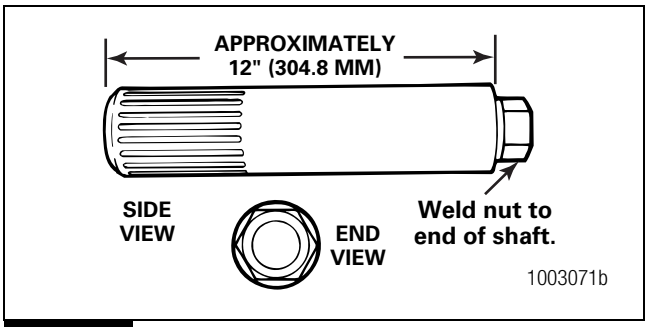


Figure 5.46

2. Place the differential and ring gear assembly in a vise. Install soft metal covers over the vise jaws to protect the ring gear. Figure 5.47.

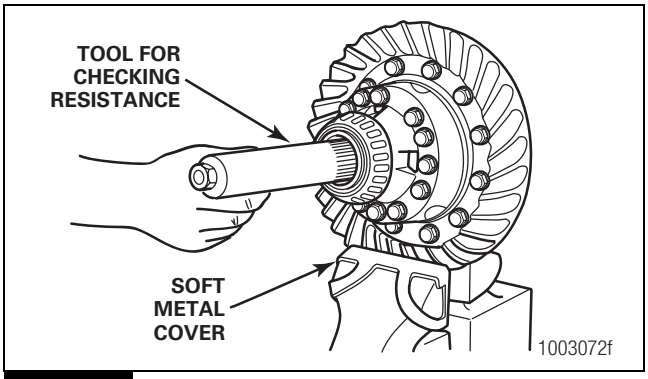


Figure 5.47

3. Install the tool into the differential until the splines of the tool are engaged with one side gear. Figure 5.47.
4. Place a torque wrench onto the nut of the tool and rotate the differential gears. As the differential gears rotate, read the value indicated on the torque wrench. Figure 5.48.
   - **If the torque value exceeds 50 lb-ft (67.8 N•m):** Disassemble the differential gears from the case halves. Inspect the case halves, spider, gears and thrust washers. Repair or replace parts. Assemble the parts and repeat Step 2 through Step 4.

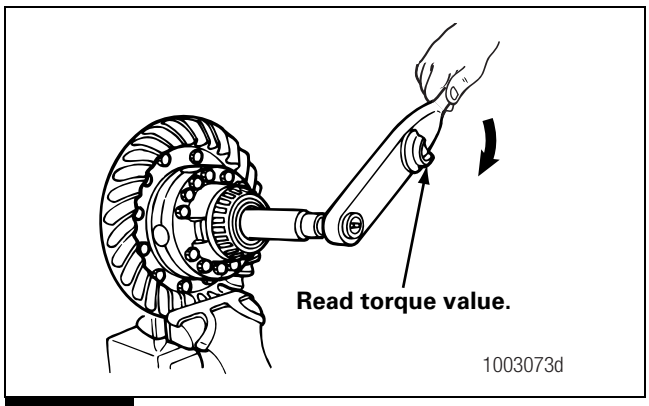


Figure 5.48

Installation

Differential and Ring Gear Assembly

1. Clean and dry the bearing cups and bores of the carrier legs and bearing caps.
2. Apply axle lubricant on the inner diameter of the bearing cups and on both bearing cones that are assembled on the case halves.
3. Apply green Loctite® 635 or 680 adhesive into the bearing bores of the carrier legs and bearing caps so that the Loctite® adhesive is spread out 360 degrees. Adhesive must not contact the adjusting ring threads. Refer to Section 6. Figure 5.49.

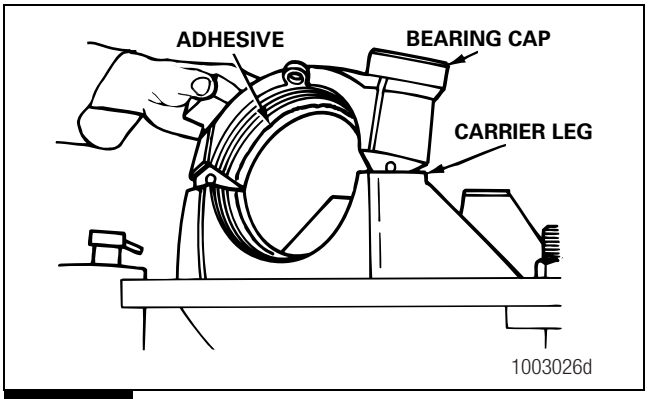


Figure 5.49

4. Install the bearing cups over the bearing cones that are assembled on the case halves. Figure 5.50.

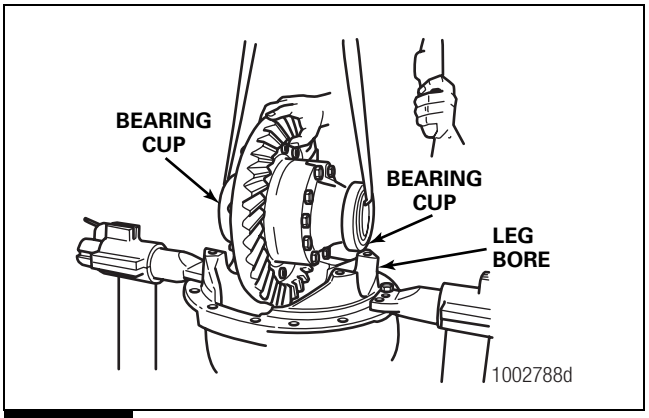


Figure 5.50

5. Safely lift the differential and ring gear assembly and install it into the carrier. The bearing cups must be flat against the bores between the carrier legs. Figure 5.50.
6. Install both of the bearing adjusting rings into position between the carrier legs. Turn each adjusting ring hand-tight against the bearing cup. Figure 5.51.
   - **For 59000 Series carriers:** Apply green Loctite® 635 or 680 adhesive to the adjusting ring threads on the carrier legs and bearing caps so that the Loctite® adhesive is spread out 360 degrees. Do not apply Loctite® adhesive between the bearing cup and adjusting ring. You must adjust the preload within the “set-time” of the Loctite® adhesive used. Refer to the manufacturer’s instructions for these set-times. Also, during and after setting the bearings, verify that no Loctite® adhesive gets into the interface between the bearing cup and the adjusting ring.

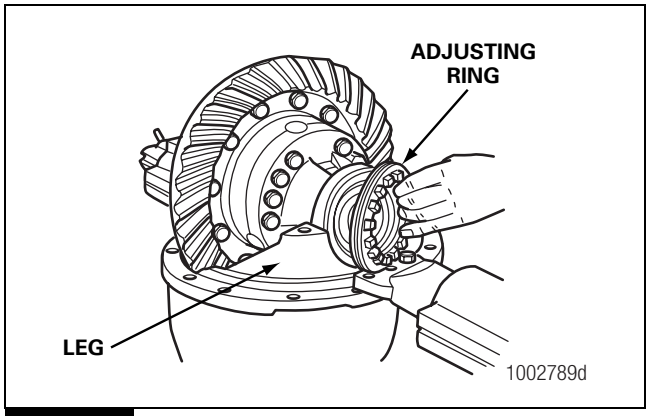


Figure 5.51

7. Install the bearing caps over the bearings and adjusting rings. Align the match marks you made when you removed the caps. Figure 5.52.

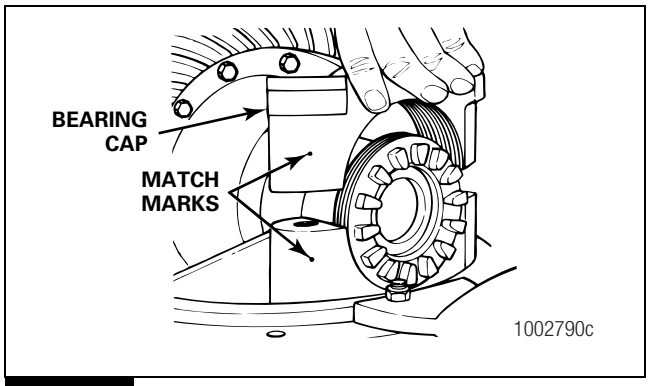


Figure 5.52

⚠ CAUTION

If the bearing caps are not installed in the correct locations, the bores and threads in the caps will not match the carrier. You will have problems assembling the caps on the carrier and damage to parts can occur. Do not force the bearing caps into position.

8. Seat each bearing cap with a light leather, plastic or rubber mallet. The caps must fit easily against the bearings, adjusting rings and carrier. Do not force the bearing caps into position.
   - **If the bearing caps do not correctly fit into position:** Check the alignment of the match marks between the caps and carrier. Remove the caps and repeat Step 6 through Step 8.
9. Install the capscrews and washers that hold the bearing caps to the carrier. Hand-tighten the capscrews four to six turns. Tighten the capscrews to the correct torque value. Refer to Section 8.

   Do not install the capscrews, cotter pins, roll pins or lock plates, if equipped, that hold the bearing adjusting rings in position.
10. Adjust the differential bearing preload and hypoid gear backlash. Check the tooth contact patterns.

Adjustment

Differential Bearing Preload

Method 1

1. Attach a dial indicator onto the carrier mounting flange so that the plunger or pointer is against the ring gear back surface. Figure 5.53.

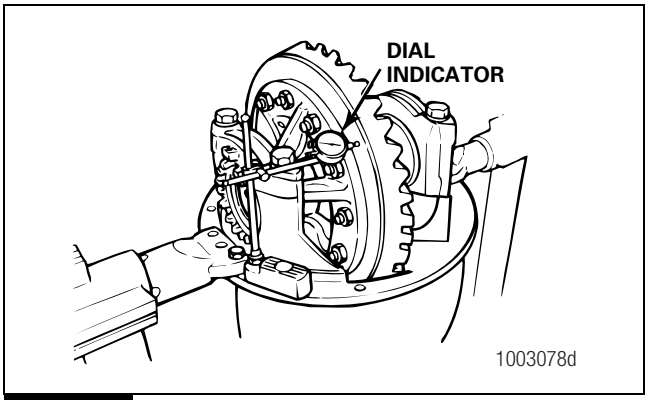


Figure 5.53

⚠ CAUTION

When you turn the adjusting rings, always use a tool that engages two or more opposite notches in the ring. A "T" bar wrench can be used for this purpose. If the tool does not correctly fit into the notches, damage to the lugs will occur.

2. Use a "T" bar wrench to loosen the bearing adjusting ring that is opposite the ring gear. A small amount of end play will show on the dial indicator. Figure 5.54.

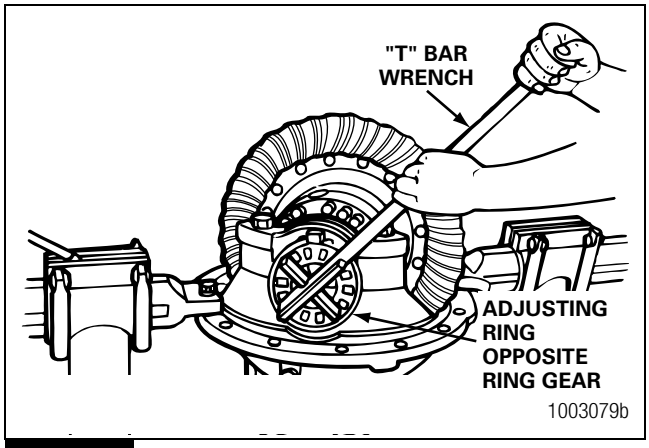


Figure 5.54

3. Use one of the following methods to move the differential and ring gear to the left and right while you read the dial indicator.

   A. Insert two pry bars between the bearing adjusting rings and ends of the differential case. The pry bars must not touch the differential bearings. Figure 5.55.

   B. Insert two pry bars between the differential case or ring gear and the carrier at locations other than described in Step A. The pry bars must not touch the differential bearings. Figure 5.56.

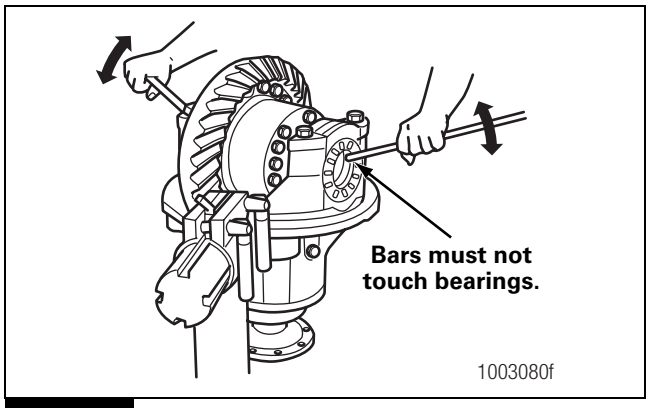


Figure 5.55

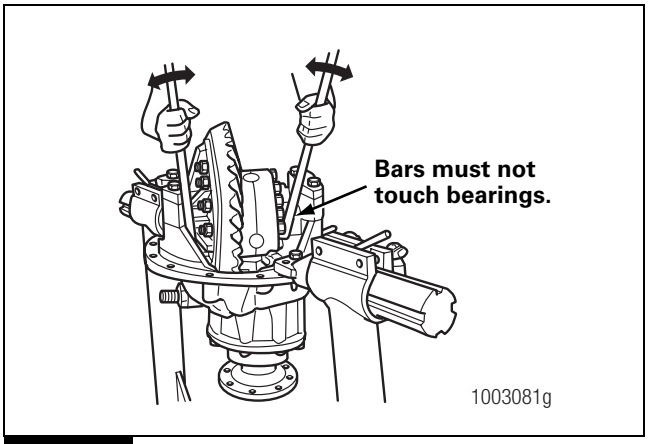


Figure 5.56

4. Tighten the bearing adjusting ring until the dial indicator reads ZERO end play. Move the differential and ring gear to the left and right as needed. If necessary, repeat Step A or Step B.
5. Tighten each bearing adjusting ring one notch from ZERO.
6. Proceed to check ring gear runout.

Method 2

1. Hand-tighten both adjusting rings against the differential bearings.
2. Use a micrometer to measure distance X or Y between the opposite surfaces of the bearing caps. Figure 5.57 and Figure 5.58. Record the measurement.

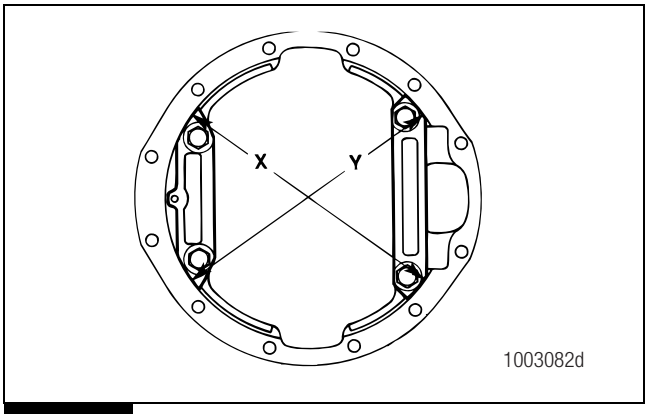


Figure 5.57

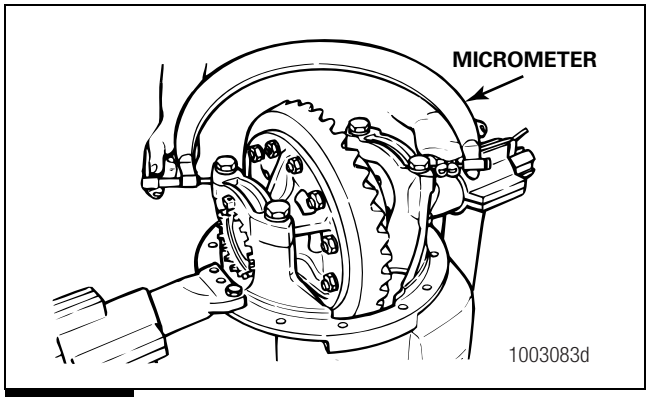


Figure 5.58

3. Tighten each bearing adjusting ring one notch.
4. Measure distance X or Y again. Compare the measurement with the one you obtained in Step 2. The difference between the two dimensions is the amount the bearing caps have expanded. Refer to the example in Table M.
   - **If the dimension is within the specification in Table N:** Continue by checking ring gear runout.
   - **If the dimension is less than the specification in Table N:** Repeat Step 3 and Step 4 as needed.

Table M: Example

RS-145 Carrier Measurements
Distance X or Y before tightening the adjusting rings = 13.927-inches (353.74 mm)
Distance X or Y after tightening the adjusting rings = 13.936-inches (353.97 mm)
13.936-inches – 13.927-inches = 0.009-inch (0.23 mm) difference

Table N: Specification

Differential Bearing Preload	Expansion Between Bearing Caps	
	RS-140, RS-145 and RS-160 carrier models	RS-120 and all other carrier models
15-35 lb-in (1.7-3.9 N•m)	0.002-0.009-inch (0.05-0.229 mm)	0.006-0.013-inch (0.15-0.33 mm)

Ring Gear Runout

1. Attach a dial indicator onto the carrier mounting flange. Figure 5.59.

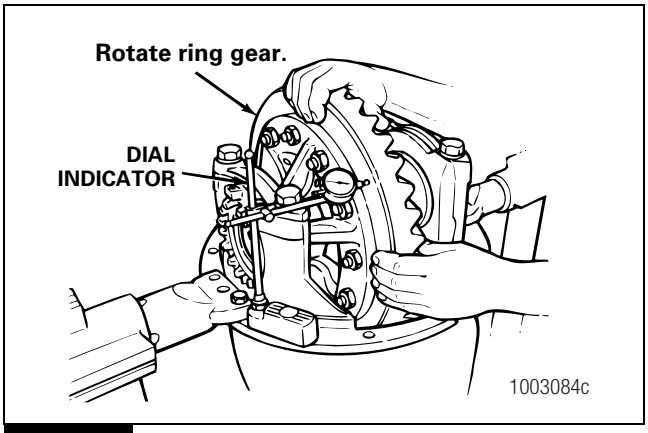


Figure 5.59

2. Adjust the dial indicator so that the plunger or pointer is against the back surface of the ring gear. Figure 5.59. Set the dial indicator to ZERO.
3. Rotate the differential and ring gear. Read the dial indicator. The ring gear runout must not exceed 0.008-inch (0.200 mm).
   - **If the ring gear runout is within the specification:** Proceed to Ring Gear Backlash.
   - **If the ring gear runout exceeds the specification:** Remove the differential and ring gear assembly from the carrier. Refer to Section 3.

   A. Inspect the differential parts, including the carrier, for wear and damage. Repair or replace parts as necessary.

   B. Install the main differential case and ring gear assembly into the carrier. Refer to the procedure in this section.

   C. Repeat the procedure for preload adjustment of the differential side bearings.

Ring Gear Backlash

Table 0: Specifications

Ring Gear Pitch Diameter	Range of Backlash Setting	Backlash Setting for New Gear Sets
Less than 17-inches (431.8 mm)	0.008-0.018-inch (0.20-0.46 mm)	0.012-inch (0.30 mm)
Greater than 17-inches (431.8 mm)	0.010-0.020-inch (0.25-0.51 mm)	0.015-inch (0.38 mm)

Measure the outer diameter of the ring gear for the approximate pitch diameter. Figure 5.60.

- **If the old gear set is installed:** Adjust the backlash to the setting that was measured before the carrier was disassembled.
- **If a new gear set is installed:** Adjust the backlash to the correct specification for new gear sets.

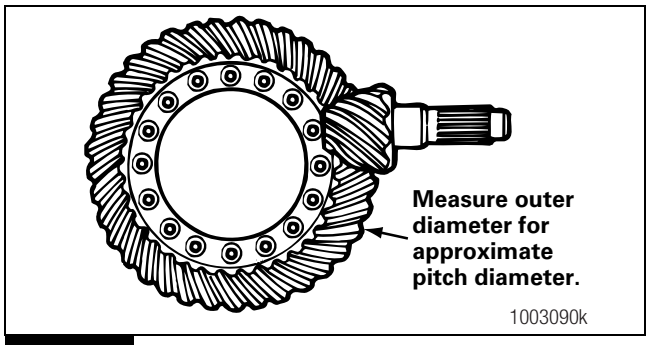


Figure 5.60

After checking the tooth contact patterns, the backlash can be adjusted within the specification limits, if needed. To change the location of the pattern, use the following procedures.

1. Attach a dial indicator onto the carrier mounting flange. Figure 5.61.
2. Adjust the dial indicator so that the plunger is against the tooth surface.
3. Adjust the dial indicator to ZERO. Hold the drive pinion in position.
4. After reading the dial indicator, rotate the differential and ring gear a small amount in both directions against the drive pinion teeth.
   - **If the backlash reading is within the specification:** Check the tooth contact patterns.
   - **If the backlash reading is not within the specification:** Adjust the backlash as needed.

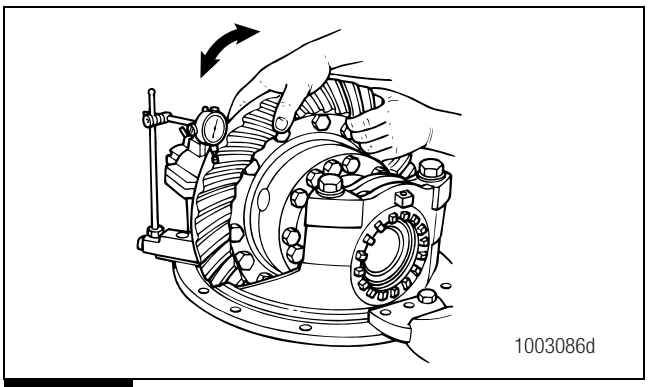


Figure 5.61

5. Loosen one bearing adjusting ring one notch. Tighten the opposite ring by the same amount.
   - **To increase the backlash:** Move the ring gear away from the drive pinion. Figure 5.62.
   - **To decrease the backlash:** Move the ring gear toward the drive pinion. Figure 5.63.

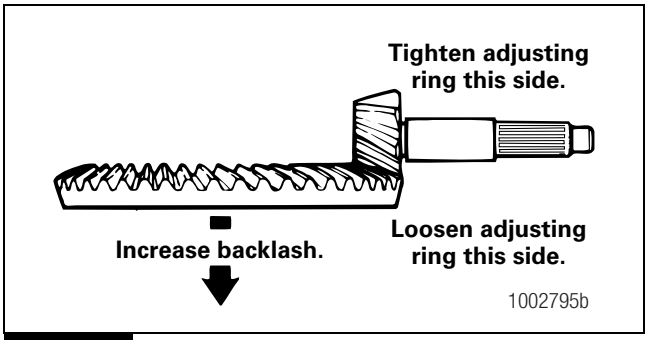


Figure 5.62

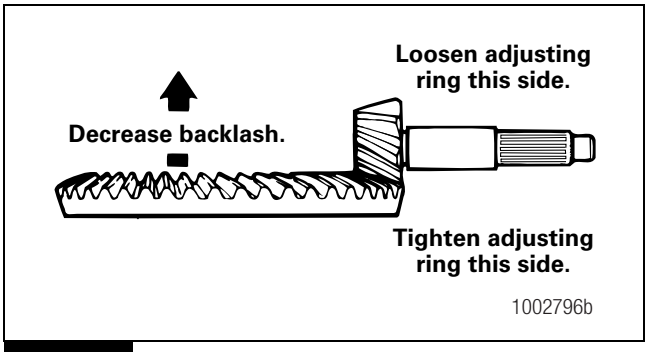


Figure 5.63

NOTE: When you adjust the backlash, only move the ring gear. Do not move the drive pinion.

6. Repeat Step 2 through Step 5 until the backlash is within specification. Record the setting for use when you adjust the pinion bearing preload.

Gear Set Tooth Contact Patterns (Backlash)

Some Meritor carriers have a generoid hypoid gear set. The tooth contact patterns for each type of gear set are different. Check the part numbers to determine what type of gear set is in the carrier. Refer to Figure 5.64 for the location of part numbers. Refer to Section 4.

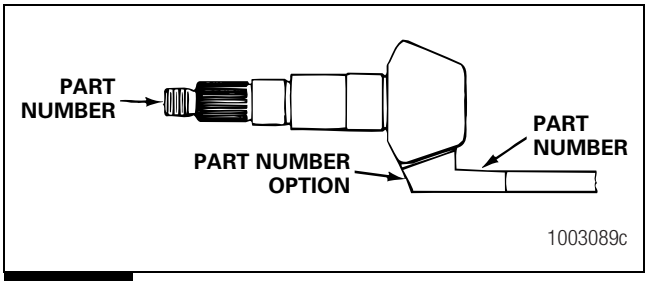


Figure 5.64

The following are examples of part numbers for generoid gear sets.

- 36786 K or 36786 K2 for the ring gear
- 36787 K or 36787 K2 for the drive pinion

In the following procedures, movement of the contact pattern in the length of the tooth is indicated as toward the heel or toe of the ring gear. Figure 5.65.

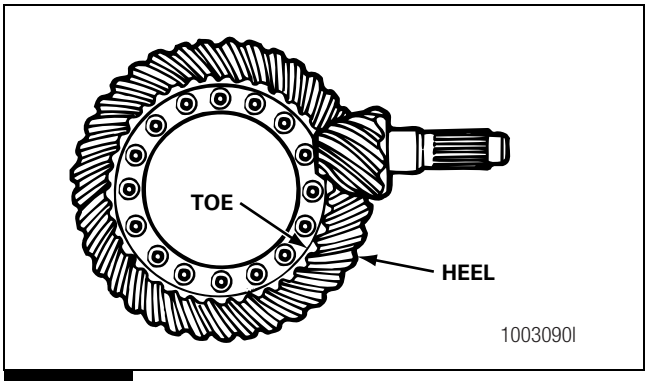


Figure 5.65

Always check the tooth contact patterns on the drive side of the gear teeth. Figure 5.66.

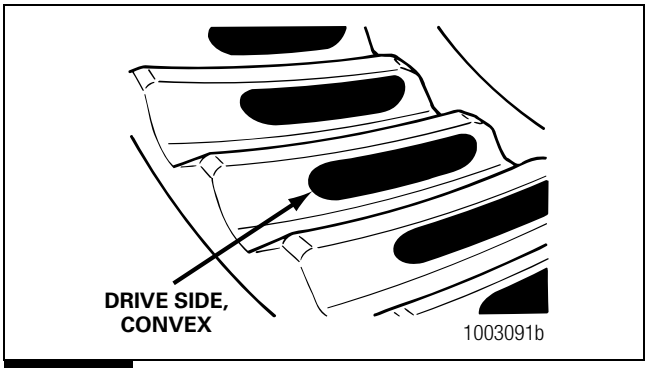


Figure 5.66

1. Adjust the backlash of a new gear set to either 0.012-inch (0.305 mm) or 0.015-inch (0.380 mm) depending on the size of the ring gear. Adjust the backlash of an old gear set to the setting that you measured before the carrier was disassembled. Refer to the procedure in this section.
2. Apply a marking compound onto approximately 12 gear teeth of the ring gear. Rotate the ring gear so that the 12 gear teeth are next to the drive pinion. Figure 5.67.

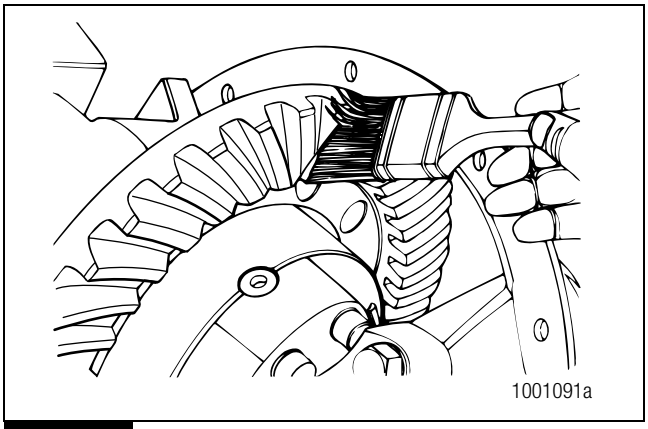


Figure 5.67

3. Rotate the ring gear forward and backward so that the 12 gear teeth go past the drive pinion six times to get the contact patterns. Repeat if needed to get a clearer pattern.

4. Look at the contact patterns on the ring gear teeth. Compare the patterns to Figure 5.68, Figure 5.69 and Figure 5.70.

   The location of good hand-rolled contact patterns for new conventional and generoid gear sets is toward the toe of the gear tooth and in the center between the top and bottom of the tooth. Figure 5.68.

   When the carrier is operated, a good pattern will extend approximately the full length of the gear tooth. The top of the pattern will be near the top of the gear tooth. Figure 5.71.

   The location of a good hand-rolled contact pattern for an old gear set must match the wear pattern in the ring gear. The new contact pattern will be smaller in area than the old wear pattern.

   A high contact pattern indicates that the drive pinion was not installed deep enough into the carrier. A low contact pattern indicates that the drive pinion was installed too deep in the carrier.

   - **If the contact patterns require adjustment:** Continue by following Step 5 to move the contact patterns between the top and bottom of the gear teeth.
   - **If the contact patterns are in the center of the gear teeth:** Continue by following Step 6.

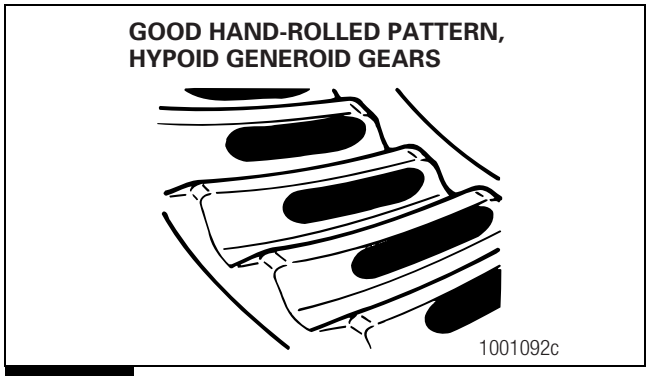


Figure 5.68

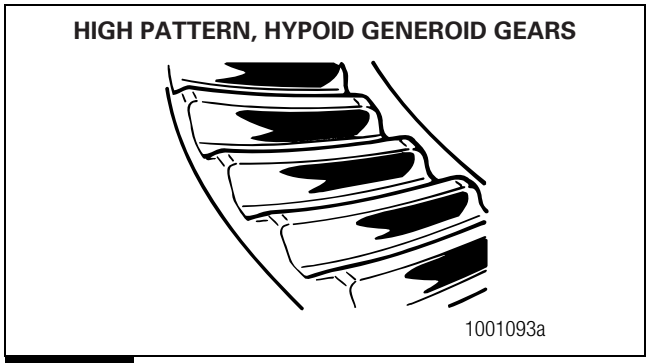


Figure 5.69

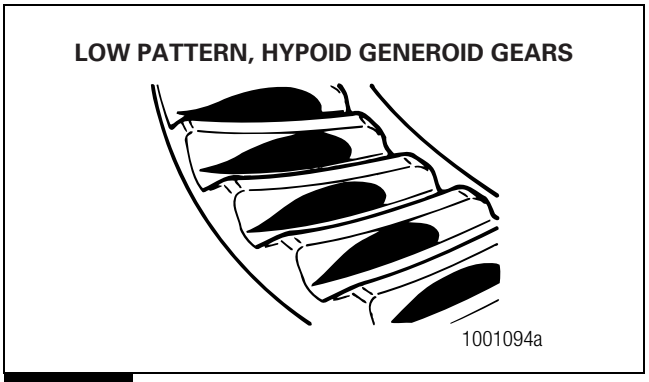


Figure 5.70

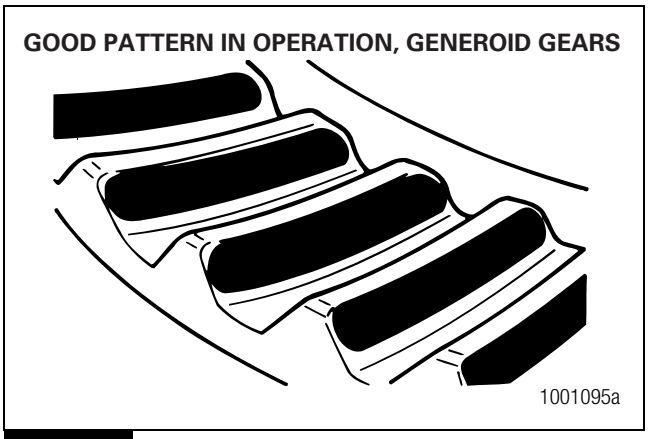


Figure 5.71

5. Change the thickness of the shim pack under the bearing cage to move the contact patterns between the top and bottom of the gear teeth. Use the following procedure.
   A. Remove the drive pinion and bearing cage from the carrier. Refer to Section 3.
      - **To correct a high contact pattern:** Decrease the thickness of the shim pack under the bearing cage. When decreasing the thickness of the shim pack, the drive pinion will move toward the ring gear. Figure 5.72.
      - **To correct a low contact pattern:** Increase the thickness of the shim pack under the bearing cage. When increasing the thickness of the shim pack, the drive pinion will move away from the ring gear. Figure 5.73.
   B. Install the drive pinion, bearing cage and shims into the carrier. Refer to the procedure in this section.
   C. Repeat Step 2 through Step 5 until the contact patterns are in the center between the top and bottom of the gear teeth.

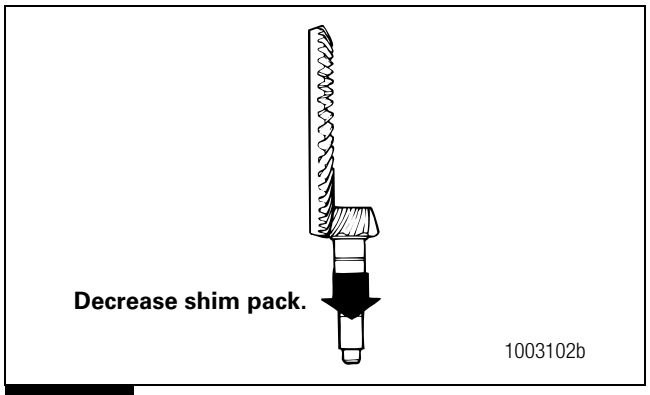


Figure 5.72

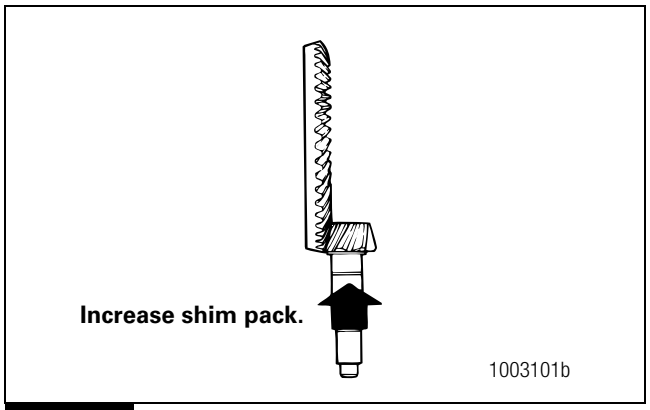


Figure 5.73

6. Adjust the backlash of the ring gear within the specification range to move the contact patterns to the correct location in the length of the gear teeth. Refer to the procedure in this section.
   A. Decrease the backlash to move the contact patterns toward the toe of the ring gear teeth. Figure 5.74.
   B. Increase the backlash to move the contact patterns toward the heel of the ring gear teeth. Figure 5.75.
   C. Repeat Step 2 through Step 4 and Step 6 until the contact patterns are at the correct location in the length of the gear teeth.

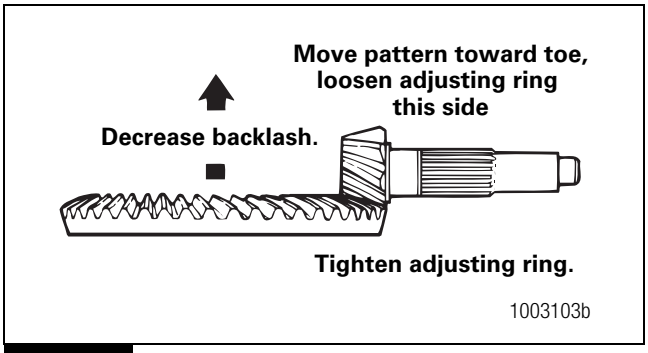


Figure 5.74

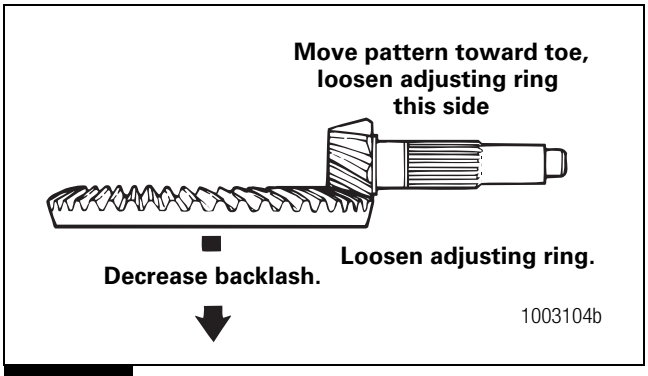


Figure 5.75

⚠ CAUTION

If the carrier has cotter pins or capscrews, lock the adjusting rings only with cotter pins or capscrews. If the carrier has roll pins, reuse the roll pins. Do not force a roll pin into a cotter pin hole. Damage to components can result.

7. Install the capscrews, cotter pins, roll pins or lock plates, if equipped, that hold the two bearing adjusting rings in position. Use the following procedures.

   A. Install capscrews between the lugs of the adjusting ring and through the boss of the bearing cap. New capscrews include a locking patch, which can only be used once. If you are installing used capscrews, apply Loctite® threadlocker to the capscrew threads before you install the capscrews. Figure 5.76.

   B. Install cotter pins between the lugs of the adjusting ring and through the boss of the bearing cap. Bend the two ends of the cotter pin around the boss. Figure 5.76.

   C. Use a drift and hammer to install the roll pin through the boss of the bearing cap until the roll pin is between the lugs of the adjusting ring. Figure 5.76.

   D. Install the lock plate onto the bearing cap so that the tab is between the lugs of the adjusting ring. Install the two capscrews and washers that hold the lock plate to the bearing cap. Tighten the capscrews to the correct torque value. Refer to Section 8. Figure 5.76.

      - **For 59000 Series carriers:** Apply two to three drops of red Loctite® 277 threadlocker to the sides of the locking tab threaded holes. Apply Loctite® 277 threadlocker even if the capscrews have a locking patch.

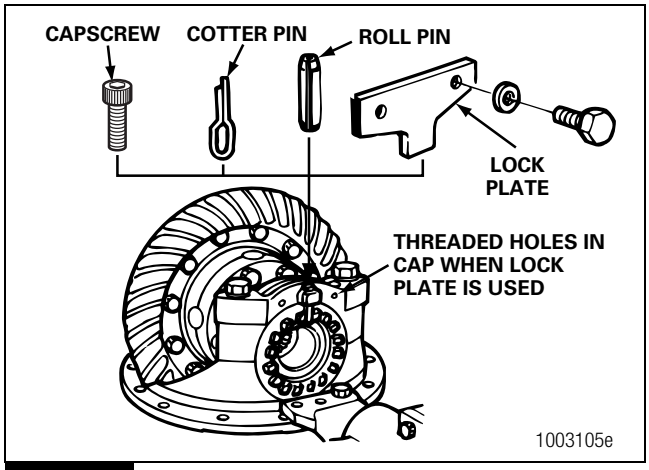


Figure 5.76

Installation

Thrust Screw (If Equipped)

1. Rotate the carrier in the repair stand until the back surface of the ring gear is toward the TOP.
2. Install the jam nut onto the thrust screw. Thread the jam nut to the middle of the thrust screw. Figure 5.77.

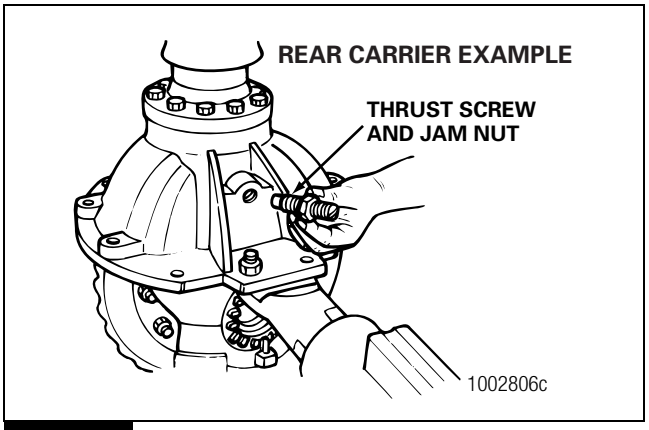


Figure 5.77

3. Install the thrust screw into the carrier. Use a feeler gauge to verify that the clearance between the thrust screw and the ring gear is 0.025-0.045-inch (0.65-1.14 mm).
4. Loosen the thrust screw one-half turn or 180 degrees. Figure 5.78.

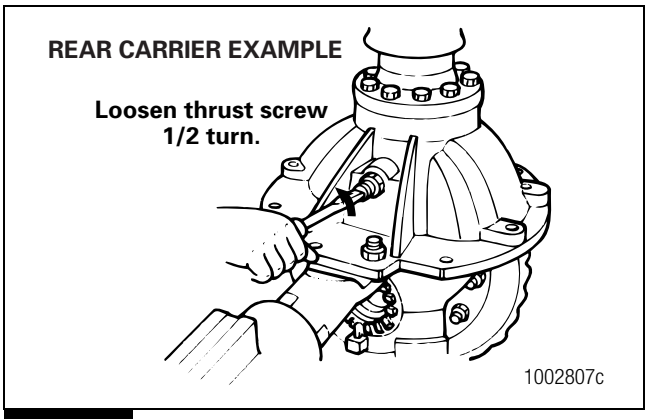


Figure 5.78

5. Tighten the jam nut, if equipped, to the correct torque value against the carrier. Refer to Section 8. Figure 5.79.

   To complete the assembly of axles equipped with driver-controlled main differential locks, refer to Section 6.

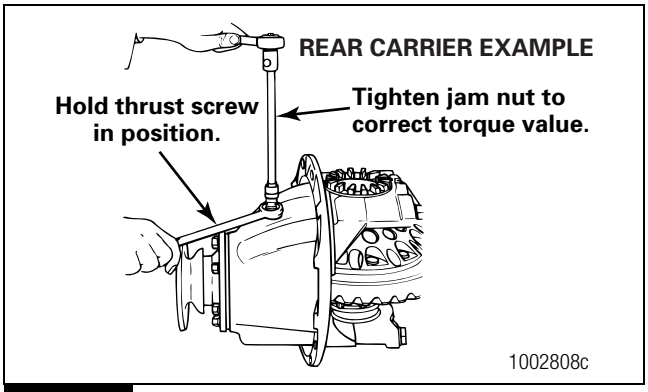


Figure 5.79

Differential Carrier into the Axle Housing

⚠ WARNING

When you apply some silicone gasket materials, a small amount of acid vapor is present. To prevent serious personal injury, ensure that the work area is well-ventilated. Read the manufacturer's instructions before using a silicone gasket material, then carefully follow the instructions. If a silicone gasket material gets into your eyes, follow the manufacturer's emergency procedures. Have your eyes checked by a physician as soon as possible.

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, and emulsion-type and petroleum-base cleaners. Read the manufacturer's instructions before using a solvent cleaner, then carefully follow the instructions. Also follow the procedures below.

- **Wear safe eye protection.**
- **Wear clothing that protects your skin.**
- **Work in a well-ventilated area.**
- **Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.**
- **You must use hot solution tanks or alkaline solutions correctly. Read the manufacturer's instructions before using hot solution tanks and alkaline solutions. Then carefully follow the instructions.**

1. Use a cleaning solvent and rags to clean the inside of the axle housing and the carrier mounting surface.
2. Inspect the axle housing for damage. Repair or replace the axle housing.
3. Check for loose studs, if equipped, in the mounting surface of the housing where the carrier fastens. Remove and clean the studs that are loose.
4. Apply liquid adhesive to the threaded holes. Install the studs into the axle housing. Tighten the studs to the correct torque value. Refer to Section 8.

⚠ CAUTION

Apply silicone gasket material in a continuous 0.25-inch (6 mm) bead. If you use more than this amount, gasket material can break off and plug lubrication passages. Damage to components can result.

5. Apply a 0.25-inch (6 mm) continuous bead of silicone gasket material to the mounting surface of the housing where the carrier fastens. Figure 5.80.

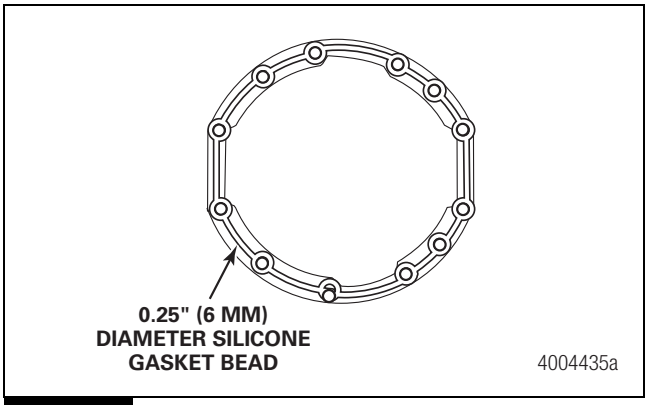


Figure 5.80

⚠ CAUTION

Do not use a hammer or mallet to install the carriers. A hammer or mallet will damage the mounting flange of the carrier and cause oil leaks.

6. Use a hydraulic roller jack or a lifting tool to install the carrier into the axle housing.
7. Install nuts and washers or capscrews and washers, if equipped, into the four corner locations around the carrier and axle housing. Hand-tighten the fasteners. Figure 5.81.

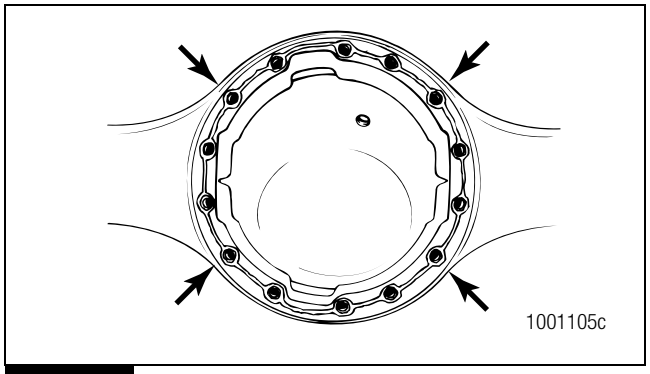


Figure 5.81

8. Carefully push the carrier into position. Tighten the four fasteners two or three turns each in a pattern opposite each other. Figure 5.81.
9. Repeat Step 8 until the four fasteners are tightened to the correct torque value. Refer to Section 8.
10. Install the other fasteners and washers that hold the carrier in the axle housing. Tighten fasteners to the correct torque value. Refer to Section 8.
11. Connect the driveline universal joint to the pinion input yoke or flange on the carrier.
12. Install the gaskets and axle shafts into the axle housing and carrier. The gasket and flange of the axle shafts must fit flat against the wheel hub. Figure 5.82.

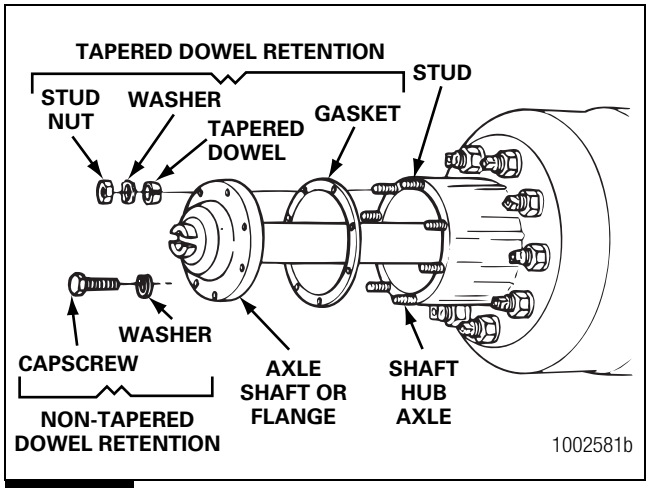


Figure 5.82

Straight Holes, Nuts and Hardened Washers

1. Clean the mating surfaces of the axle shaft and the wheel hub.
2. If silicone gasket material is used, apply a 0.125-inch (3 mm) diameter bead of the gasket material around the mating surface of the hub and around the edge of each fastener hole.
3. Install the gasket and the axle shaft into the housing. The gasket and the flange of the axle shaft must fit flat against the wheel hub. Figure 5.82.
4. Install the Grade 8 nuts and hardened washers onto the stud. Lock washers are an acceptable alternative. Tighten the stud nuts to the torque specified in Table P.

Table P: Shaft-to-Hub Torque Fastener Chart — Non-Tapered Dowel Applications

		Torque Value — Grade 8 Nuts lb-ft (N•m)	
Fastener	**Thread Size**	**Plain Nut**	**Locknut**
Stud Nut, Axle Shaft	0.62-18	150-230 (244-312)	130-190 (203-258)
	0.75-16	310-400 (420-542)	270-350 (366-475)
Studs	All	Install the coarse thread end of the stud into the hub and tighten to the last thread.	

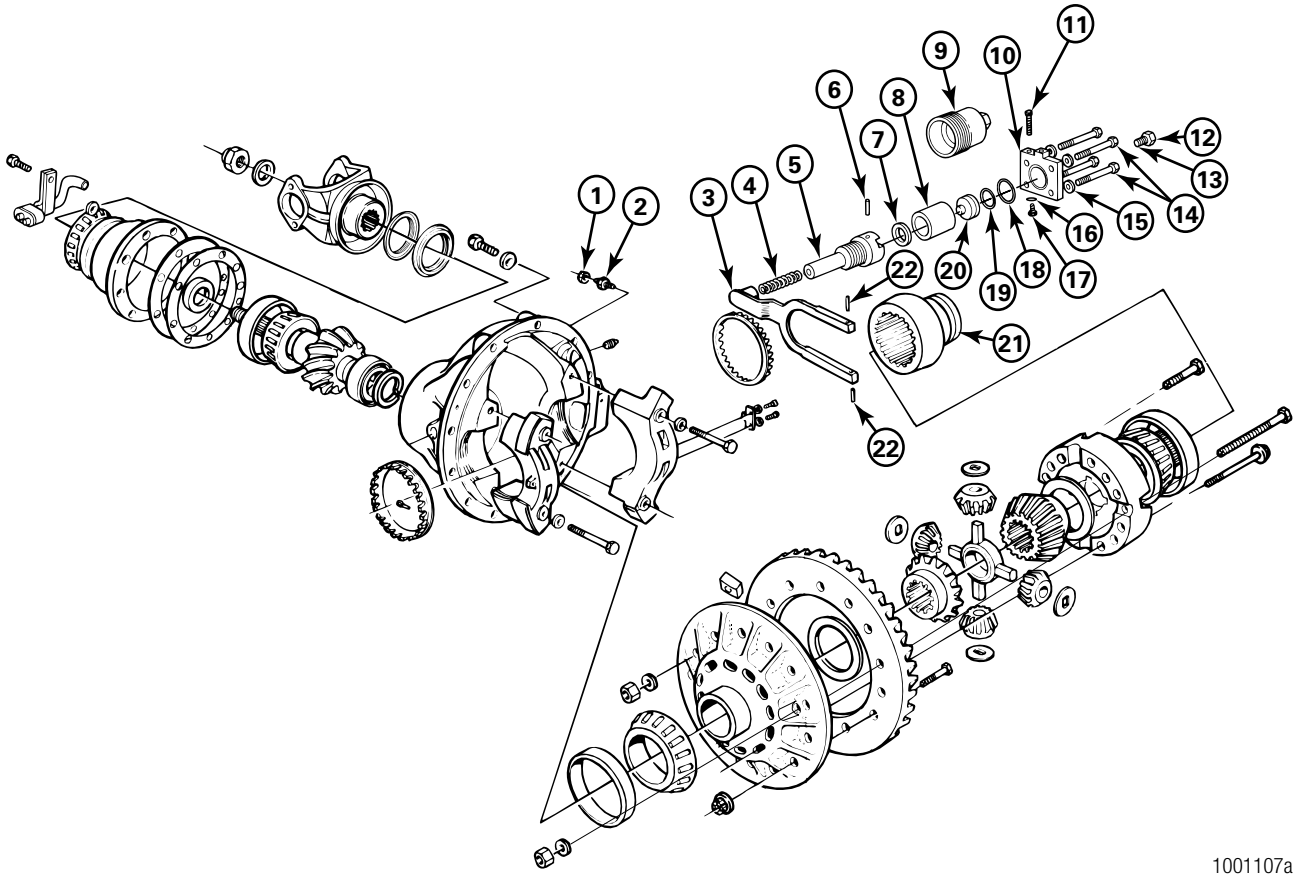
Tapered Dowel, Hardened Washer and Hardened Nut

1. Clean the mating surfaces of the axle shaft and the wheel hub.
2. If silicone gasket material is used, apply a 0.125-inch (3 mm) diameter bead of the gasket material around the mating surface of the hub and around the edge of each fastener hole.
3. Install the gasket and the axle shaft into the housing. The gasket and the flange of the axle shaft must fit flat against the wheel hub. Figure 5.82.
4. Install solid tapered dowels over each stud and into the flange of the axle shaft. Use a punch or a drift and hammer, if necessary.

5. Install the Grade 8 nuts and hardened washers onto the stud. Lock washers are an acceptable alternative. Tighten the stud nuts to the torque specified in Table Q.

Table Q: Shaft-to-Hub Torque Fastener Chart — Tapered Dowel Applications

		Torque Value — Grade 8 Nuts lb-ft (N•m)	
Fastener	**Thread Size**	**Plain Nut**	**Locknut**
Stud Nut, Axle Shaft	0.44-20	50-75 (81-102)	40-65 (67-88)
	0.50-20	75-115 (115-156)	65-100 (102-136)
	0.56-18	110-165 (176-224)	100-145 (149-197)
	0.62-18	150-230 (244-312)	130-190 (203-258)
Studs	All	Install the coarse thread end of the stud into the hub and tighten to the last thread.	



1 SENSOR SWITCH LOCKNUT
2 SENSOR SWITCH
3 SHIFT FORK
4 SHIFT SHAFT SPRING
5 SHIFT SHAFT
6 SPRING RETAINING PIN
7 FLAT WASHER, OR SILASTIC AS REQUIRED
8 AIR CYLINDER TUBE
9 SCREW-IN DIFFERENTIAL LOCK
10 CYLINDER COVER
11 MANUAL ACTUATION CAPSCREW, STORAGE POSITION
12 WASHER, OPERATING POSITION
13 PLUG GASKET, OPERATING POSITION
14 COVER CAPSCREWS
15 WASHERS
16 PLUG GASKET, STORAGE POSITION
17 COVER PLUG, STORAGE POSITION
18 COVER COPPER GASKET
19 PISTON O-RING
20 PISTON
21 SHIFT COLLAR
22 SHIFT FORK ROLL PINS

Figure 6.1

6 Driver-Controlled Main Differential Lock

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

When you apply some silicone gasket materials, a small amount of acid vapor is present. To prevent serious personal injury, ensure that the work area is well-ventilated. Read the manufacturer's instructions before using a silicone gasket material, then carefully follow the instructions. If a silicone gasket material gets into your eyes, follow the manufacturer's emergency procedures. Have your eyes checked by a physician as soon as possible.

Take care when you use Loctite® adhesive to avoid serious personal injury. Read the manufacturer's instructions before using this product. Follow the instructions carefully to prevent irritation to the eyes and skin. If Loctite® adhesive material gets into your eyes, follow the manufacturer's emergency procedures. Have your eyes checked by a physician as soon as possible.

Description

Some Meritor drive axle models have a driver-controlled main differential lock (DCDL). This differential lock is operated by a carrier-mounted, air-actuated shift unit. When activated, the shift unit moves a sliding collar that is installed on the splines of the axle shaft. When engaged, the collar locks the axle shafts together with a second set of splines on the differential case. When the DCDL is engaged, there is no differential action. Figure 6.1.

NOTE: The Meritor carrier models with driver-controlled differential lock equipment are manufactured in metric dimensions and sizes. When these carriers are serviced, it is important to use the correct metric size tools on the fasteners. Refer to Section 8.

Vehicle Towing

⚠ CAUTION

If the vehicle must be towed to a service facility with the drive axle wheels on the ground, remove the axle shafts before the vehicle is towed. Damage to components can result.

1. Remove the axle shafts before the vehicle is towed. Refer to Section 11.
2. Install the axle shafts after the vehicle is towed. Refer to Section 11.
3. If the differential carrier must be removed from the axle housing, use the following procedures.

Removal

Differential Carrier from the Axle Housing

Before the differential carrier can be removed or installed, the differential lock must be shifted into and held in the locked or engaged position. The locked position gives enough clearance between the shift collar and the axle housing to permit the removal or installation of the carrier.

NOTE: If the axle shafts were removed for towing with the differential in the unlocked or disengaged position, install the right-hand axle shaft into the housing before removing the differential carrier. Refer to Section 11.

To shift into the locked position, refer to the procedure in this section.

Axle Setup for DCDL Disassembly

⚠ WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Remove the drain plug from the bottom of the housing and drain the lubricant.

⚠ WARNING

During DCDL disassembly, when the DCDL is in the locked or engaged position and the vehicle's wheels are raised from the floor, do not start the engine and engage the transmission. The vehicle can move and cause serious personal injury. Damage to components can result.

3. Use a jack to raise the vehicle so that the wheels to be serviced are off the ground. Place safety stands under the spring seats to hold the vehicle in the raised position.

4. Disconnect the driveline from the pinion input yoke.
5. Disconnect the vehicle air line from the differential lock actuator assembly.

DCDL Assembly Manual Engaging Methods

Bolt-On Style Differential Lock Cylinder

Use the following manual engaging method to lock out the bolt-on DCDL assembly. Figure 6.2.

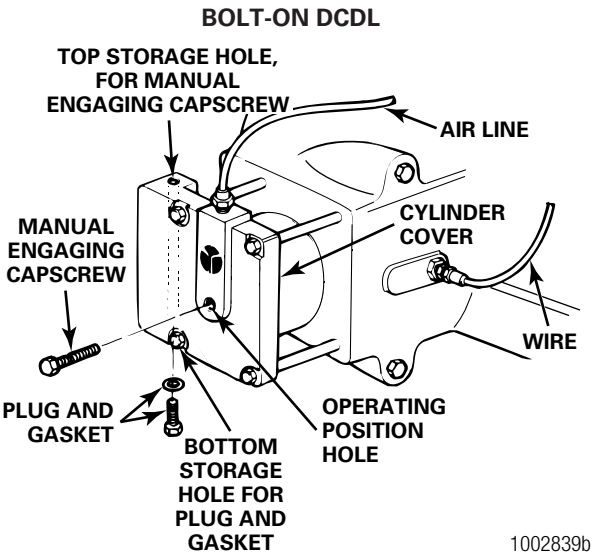


Figure 6.2

1. Follow Step 2 through Step 5 of Axle Setup for DCDL Disassembly in this section.
2. Remove the plug and gasket from the hole in the center of the cylinder cover.

NOTE: The storage hole for the plug and gasket is located on the opposite side of the cylinder cover where the storage hole for the manual engaging capscrew is located.

3. Remove the manual engaging capscrew from the top storage hole in the cylinder cover.
4. Install the plug and gasket into the bottom storage hole in the cylinder cover.
5. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover.

⚠ CAUTION

There will be a small amount of spring resistance felt when you turn in the manual engaging capscrew. If a high resistance is felt before reaching the locked or engaged position, stop turning the capscrew, or the cover and capscrew threads will be damaged.

6. Turn the manual adjusting capscrew to the right until the head is approximately 0.25-0.5-inch (6-13 mm) from the cylinder cover. Do not turn the capscrew beyond its normal stop. If the 0.25-10.5-inch (6-13 mm) service position of the capscrew is achieved, the main differential lock is completely engaged.

   A high resistance on the capscrew indicates that the splines of the shift collar and the differential case half are not aligned or engaged. To align the splines, use the following procedure.

   A. Rotate the drive pinion or right-hand wheel to align the splines of the shift collar and case half while you turn in the manual engaging capscrew.

   B. When a normal amount of spring resistance is felt on the capscrew, the splines are engaged. Continue to turn in the manual engaging capscrew until the head is approximately 0.25-inch (6 mm) from the cylinder cover.

7. Remove the carrier from the axle housing. Refer to Section 3.

Screw-In Style Differential Lock Cylinder

Use the following manual engaging method to lock out the screw-in DCDL assembly.

1. Follow Step 2 through Step 5 of Axle Setup for DCDL Disassembly in this section.
2. Remove the manual engaging capscrew from the storage hole in the carrier casting, next to the cylinder. Figure 6.3.

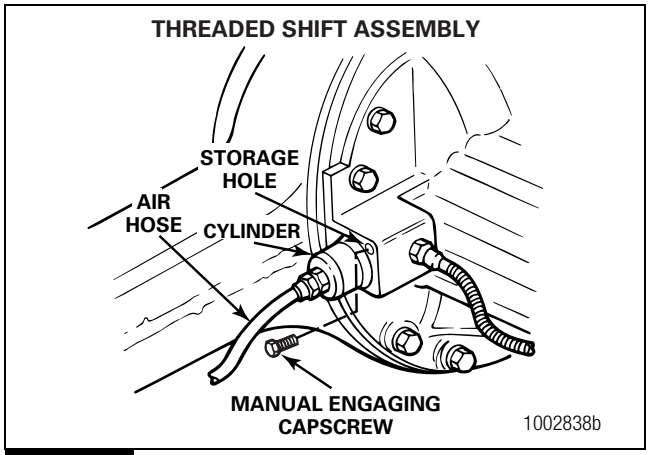


Figure 6.3

3. Remove the air line and fitting. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover.
4. Turn the manual adjusting capscrew to the right until the head is approximately 0.25-inch (6 mm) from the cylinder cover. Do not turn the capscrew beyond its normal stop. The capscrew is now in the service position and the main differential lock is completely engaged.
5. Remove the carrier from the axle housing. Refer to Section 3.

Differential and Gear Assembly

Differential Lock Sliding Collar

1. For carriers with roll pins, tap out the two retainer roll pins, if equipped, until they are level with the inner face of the shift fork. Release the differential lock if it is manually engaged. Figure 6.4.

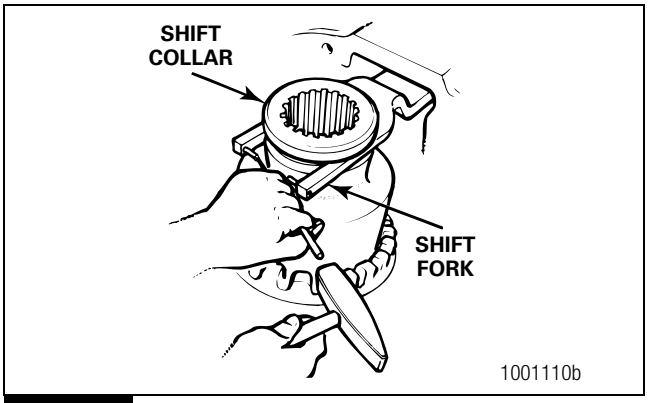


Figure 6.4

2. For carriers without roll pins, snap out the collar from the fork.
3. If required, remove the DCDL assembly at this time.

NOTE: On some bolt-on assemblies, a roll pin is installed in the shift shaft and is used as a stop for the shift shaft spring. It is not necessary to remove this roll pin during a normal disassembly.

A. **Bolt-on style differential lock cylinder:** Remove the sensor switch and locknut.

B. Remove the four capscrews and washers that hold the cylinder cover to the carrier. Remove the cylinder cover and copper gasket. Figure 6.5.

C. Remove the shift unit cylinder and piston. Remove the O-ring from the piston.

D. Remove the shift shaft from the shift fork. The shaft may be secured with liquid adhesive or pre-applied adhesive material.

E. Remove the shift shaft spring and flat washer. Some models use silastic seal instead of the flat washer.

F. Remove the shift fork.

A. **Screw-in style differential lock cylinder:** Remove the sensor switch.

B. Remove the cylinder by turning the hex nut at the top of the cylinder with a wrench. The cylinder may be secured to the carrier casting with Loctite® adhesive or equivalent pre-applied liquid adhesive.

C. Remove the shift shaft, spring and shift fork.

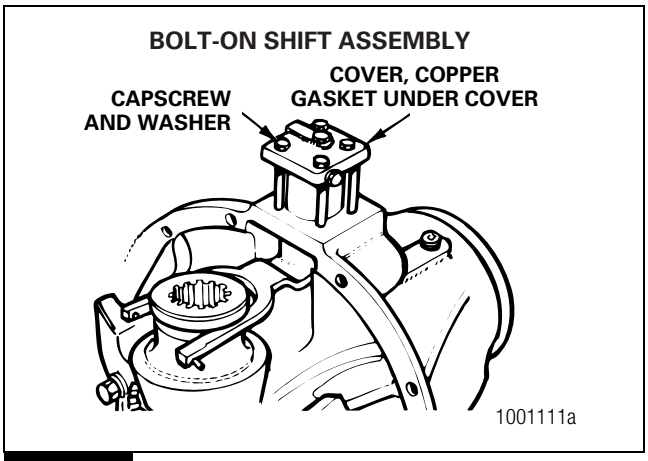


Figure 6.5

4. Remove the capscrews, cotter pins, roll pins or lock plates, if equipped, that hold the two bearing adjusting rings in position. Use a small drift and hammer to remove the pins. Each lock plate is held in position by two capscrews.

5. Mark one bearing cap and one carrier leg so that these parts will be assembled in the correct positions. Remove the bearing cap capscrews and washers, the bearing caps and the adjusting rings.
6. Lift the differential and gear assembly from the carrier. Tilt the assembly as required to permit the ring gear to clear the support for the pinion spigot bearing. Figure 6.6.

   Further disassembly of these carriers is the same as axles without the driver-controlled main differential lock. To continue disassembly, follow the procedures in Section 3.

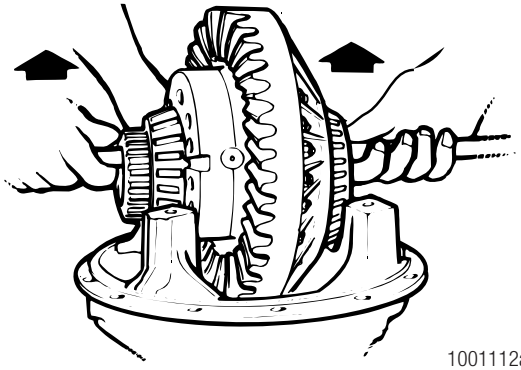


Figure 6.6

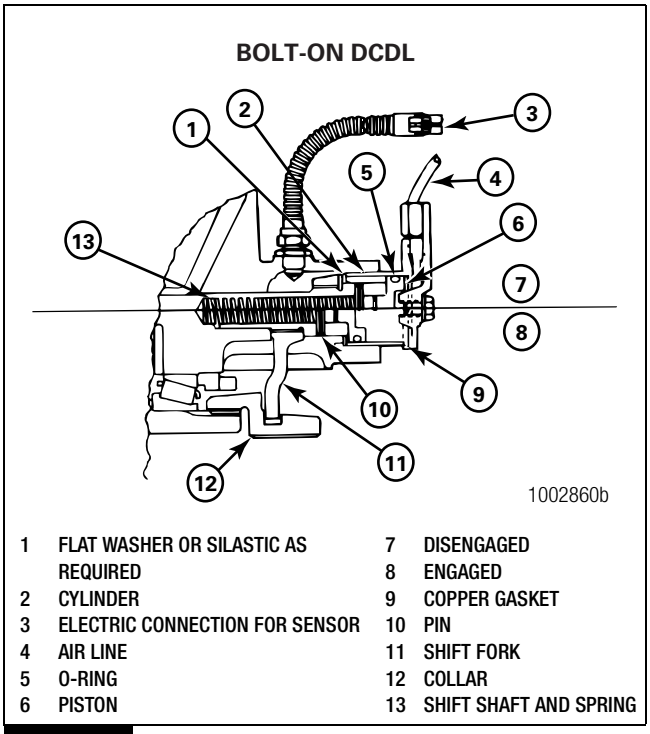
Installation

DCDL Assembly into the Carrier

Bolt-On Style Differential Lock Assembly

Install the differential shift assembly after the differential carrier is assembled and the gear and bearing adjustments are completed. Figure 6.7.

1. On carrier models with shift fork roll pins, install the two roll pins into the ends of the shift fork. Tap the pins into position until they are level with the inner yoke face. Figure 6.8. Do not install the pins completely at this time.
2. On models without roll pins, snap the fork into position.
3. Apply Loctite® 222 threadlocker, Meritor part number 2297-B-6112, to the threads of the shift shaft.
4. Install the shift fork into its correct position in the carrier case. Figure 6.9.



1	FLAT WASHER OR SILASTIC AS REQUIRED	7	DISENGAGED
2	CYLINDER	8	ENGAGED
3	ELECTRIC CONNECTION FOR SENSOR	9	COPPER GASKET
4	AIR LINE	10	PIN
5	O-RING	11	SHIFT FORK
6	PISTON	12	COLLAR
		13	SHIFT SHAFT AND SPRING

Figure 6.7

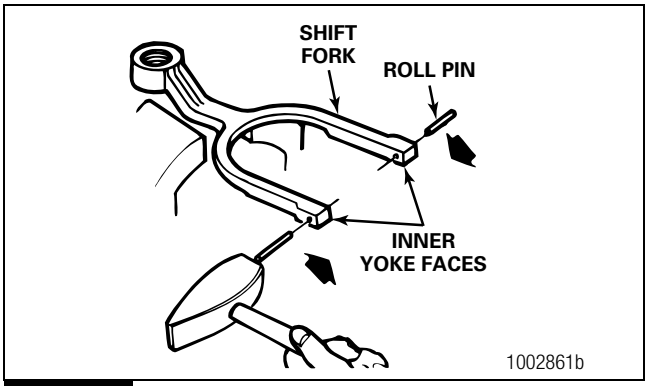


Figure 6.8

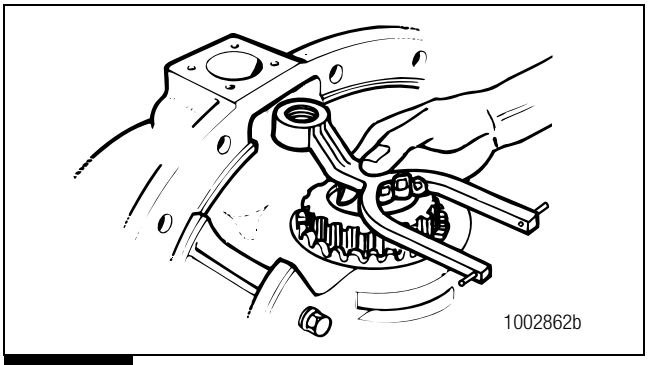


Figure 6.9

5. Hold the shift fork in position. Install the shift shaft spring into the shift shaft opening in the carrier, through the shift fork bore and into the bore for the shift shaft spring. Figure 6.10.

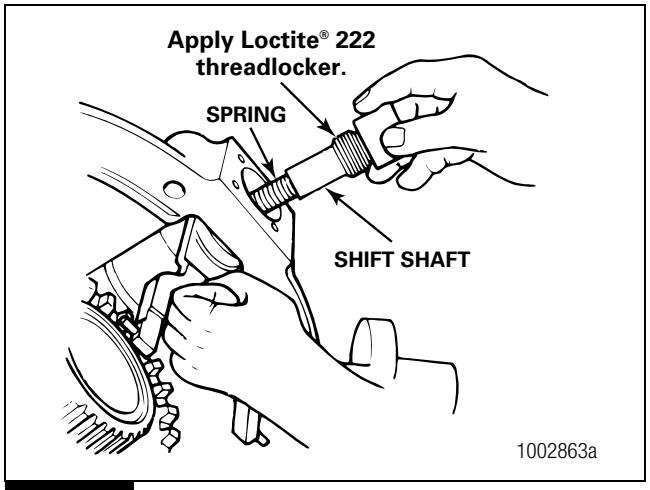


Figure 6.10

6. Slide the shift shaft over the spring. Install the shaft into the shift fork. Tighten to 20-25 lb-ft (27-34 N•m). ❶
7. Install the flat washer, when used, or apply silastic sealant, Meritor part number 1199-Q-2981, to the bottom of the cylinder bore. Figure 6.11.

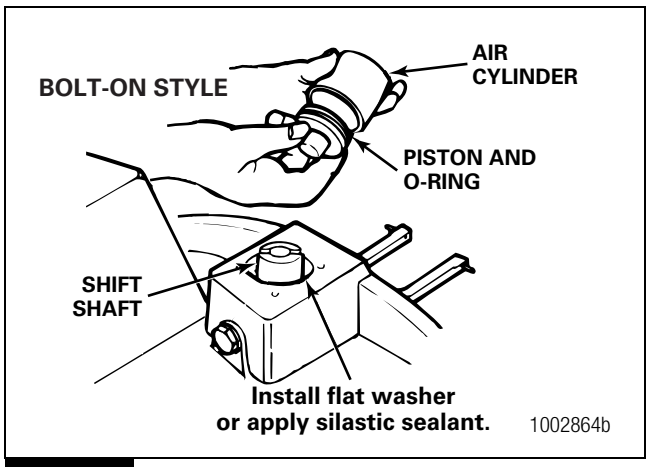


Figure 6.11

8. Install the O-ring into its groove on the piston. Lubricate the O-ring with axle lubricant. Install the piston into the air cylinder. Figure 6.11.
9. Install the cylinder into the housing bore. Verify that the pilot journal on the piston is against its bore on the shift shaft. Figure 6.12.

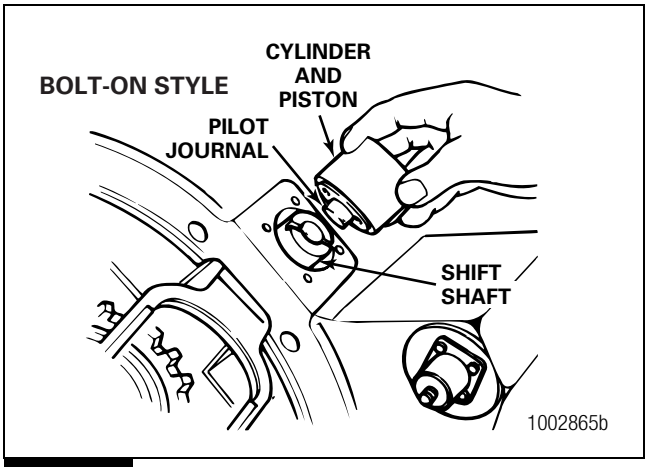


Figure 6.12

10. Install the copper gasket into its bore on the inside of the cylinder cover. Place the cover in position over the cylinder so that the air intake port will point UP when the carrier is installed into the housing. Install the cover with the four attaching capscrews and washers. Tighten the capscrews to 7.4-8.9 lb-ft (10-12 N•m). Figure 6.7 and Figure 6.13. ❶

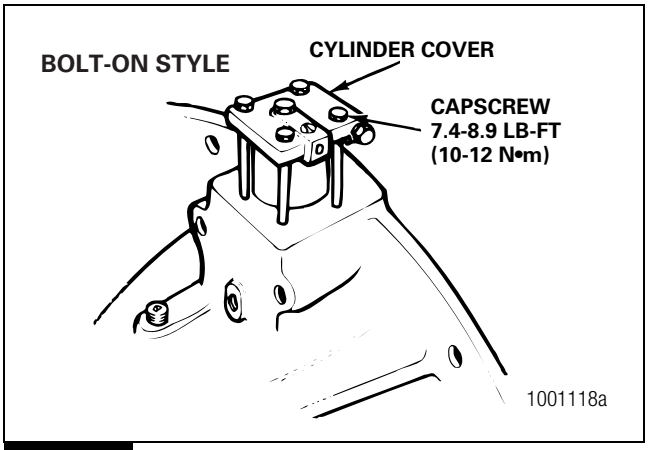


Figure 6.13

11. Slide the shift collar into the fork. Engage the shift collar splines with the splines of the differential case. Use the manual actuation capscrew to move the shift collar splines into the differential case splines. Refer to the procedure in this section.

12. Hold the shift collar in the locked or engaged position. If employed, tap the two roll pins into the shift fork ends until they are level with the outer yoke faces. Figure 6.14.

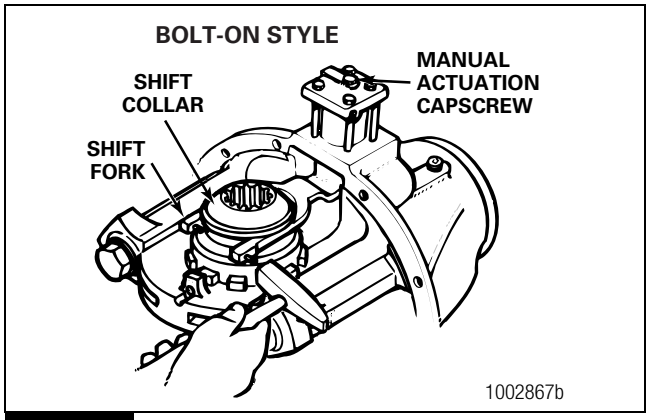


Figure 6.14

13. While the shift collar is still in the locked position, place the sensor switch, with the jam nut loosely attached into its hole.
14. Connect a volt-ohm meter to the sensor switch. Select ohms on the meter. Rotate the switch CLOCKWISE until the meter reading changes from infinity to less than one ohm. Turn the switch one additional revolution. Tighten the jam nut to 26-33 lb-ft (34-45 N•m).

Screw-In Style Differential Lock Assembly with O-Ring

Install the differential shift assembly after the differential carrier is assembled and the gear and bearing adjustments are completed. Figure 6.15.

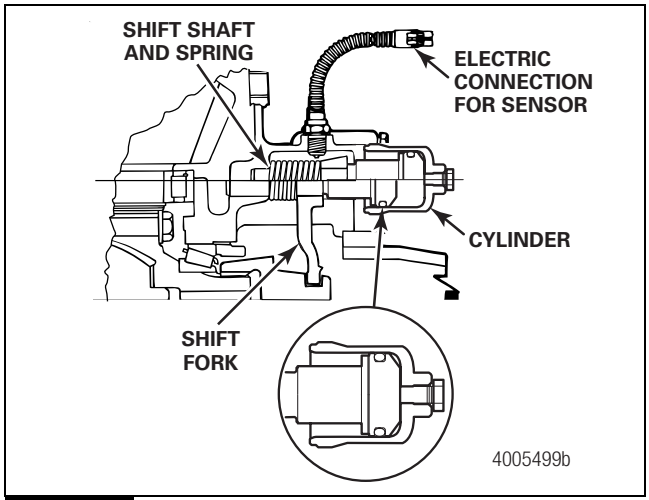


Figure 6.15

1. Install the shift spring and fork into the correct position in the carrier case. Compress the spring slightly while installing the fork.
2. Install the shift shaft into the shaft bore of the carrier. Slide the shaft through the shift fork bore and shift spring inside diameter.
3. Inspect the piston O-ring. Replace the O-ring if there is any evidence of cuts, cracks, abrasion or wear.
4. Lightly lubricate the O-ring and DCDL cylinder bore with the same lubricant used in the axle housing.
5. Install the piston and O-ring assembly into the DCDL cylinder. Slide the piston to the port end of the cylinder.
6. Apply a continuous 0.06-inch (1.5 mm) bead of Loctite® flange sealant, Meritor part number 2297-D-7076, around the DCDL cylinder threads.
7. Screw the DCDL cylinder in place. Tighten the cylinder to 80-100 lb-ft (109-136 N•m). Figure 6.16.

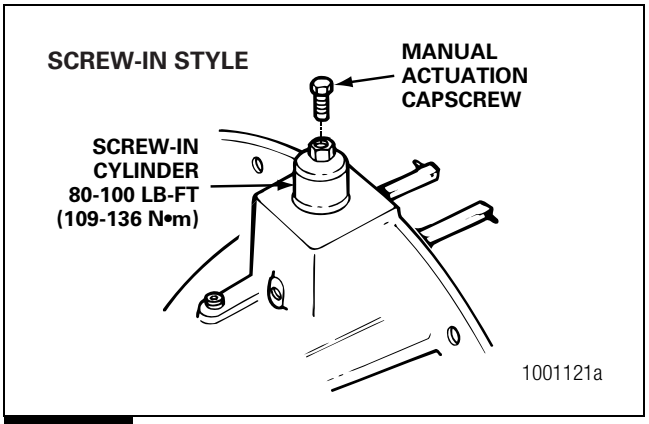


Figure 6.16

8. Snap the shift collar into the fork. Engage the shift collar splines with the splines of the differential case. Use the manual actuation capscrew to move the shift collar splines into the differential case splines. Refer to the procedure in this section.
9. Install the sensor switch into its hole. Tighten the switch to 25-35 lb-ft (35-45 N•m).

10. Connect a volt-ohm meter to the sensor switch. Select ohms on the meter. With the DCDL engaged, the circuit should be closed, showing less than one ohm resistance.
    - **If the resistance value is over one ohm:** Check the sensor.
    A. Verify that the fork is aligned with the sensor switch when it is in the engaged position.
    B. Check for a loose wiring connection. The connector must be tightly seated.
    C. Verify that the sensor switch is fully seated against the carrier.
        - **If the resistance is greater than one ohm after these checks:** Replace the sensor switch.

Screw-In Style Differential Lock Assembly with Bonded Lip Seal Piston

Install the differential shift assembly after the differential carrier is assembled and the gear and bearing adjustments are completed. Figure 6.17.

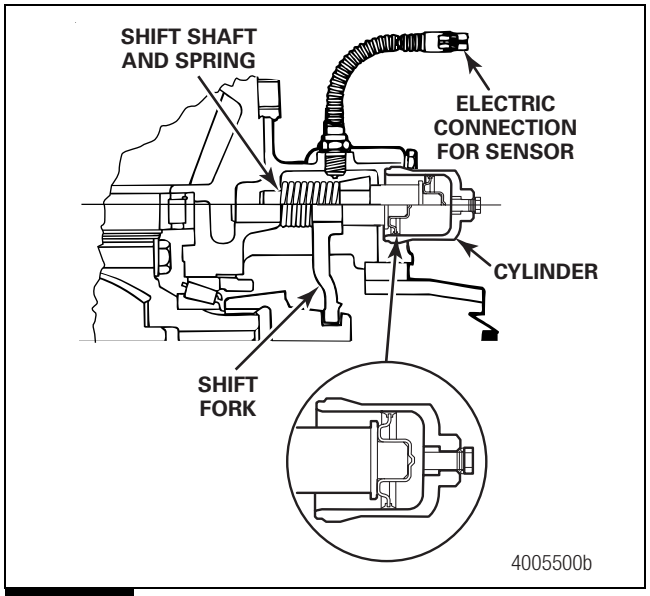


Figure 6.17

1. Install the shift spring and fork into the correct position in the carrier case. Compress the spring slightly while installing the fork.
2. Install the shift shaft into the shaft bore of the carrier. Slide the shaft through the shift fork bore and shift spring inside diameter.
3. Inspect the bonded lip seal piston. Replace the piston if there is any evidence of cuts, cracks, abrasion or wear.
4. Lightly lubricate the bonded lip seal piston and DCDL cylinder bore with the same lubricant used in the axle housing.
5. Install the bonded lip seal piston assembly into the DCDL cylinder. Slide the piston to the port end of the cylinder.
6. Apply a continuous 0.06-inch (1.5 mm) bead of Loctite® flange sealant, Meritor part number 2297-D-7076, around the DCDL cylinder threads.
7. Screw the DCDL cylinder in place. Tighten the cylinder to 80-100 lb-ft (109-136 N•m). Figure 6.18. T

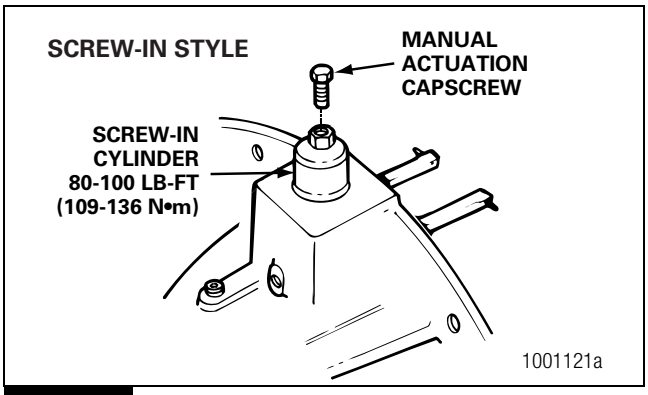


Figure 6.18

8. Snap the shift collar into the fork. Engage the shift collar splines with the splines of the differential case. Use the manual actuation capscrew to move the shift collar splines into the differential case splines. Refer to the procedure in this section.
9. Install the sensor switch into its hole. Tighten the switch to 25-35 lb-ft (35-45 N•m). T
10. Connect a volt-ohm meter to the sensor switch. Select ohms on the meter. With the DCDL engaged, the circuit should be closed, showing less than one ohm resistance.
    - **If the resistance value is over one ohm:** Check the sensor.
    A. Verify that the fork is aligned with the sensor switch when it is in the engaged position.
    B. Check for a loose wiring connection. The connector must be tightly seated.
    C. Verify that the sensor switch is fully seated against the carrier.
        - **If the resistance is greater than one ohm after these checks:** Replace the sensor switch.

Differential Lock Assembly Cover Plates

For carriers without the differential lock or air shift, assemble the sensor switch plug and cover plate as follows.

Bolt-On Cover Plate Assemblies

1. Install the washer and plug into the hole for the sensor switch. Tighten the plug to 45-55 lb-ft (60-74 N•m). Figure 6.19.

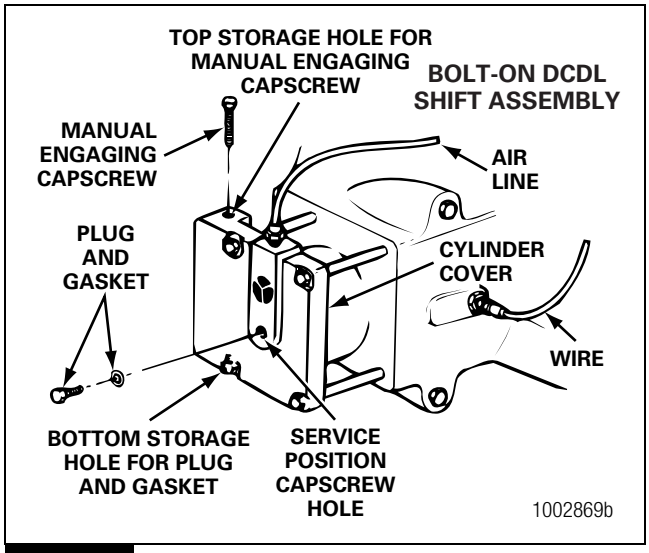


Figure 6.19

2. Apply silicone gasket material to the cover plate mounting surface on the carrier.
3. Install the four washers and capscrews. Tighten the capscrews to 7.4-8.9 lb-ft (10-12 N•m). Figure 6.20.

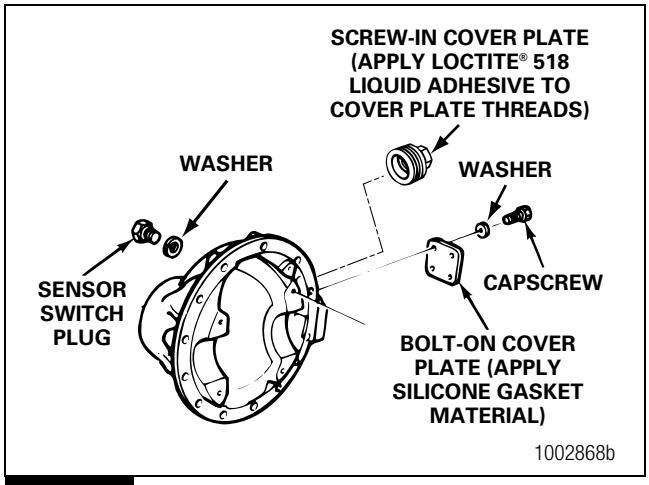


Figure 6.20

Screw-In Cover Plate Assemblies

1. Apply Loctite® 518 liquid adhesive to the plate threads.
2. Install the bolts and washers. Tighten the plate into the carrier opening to 7.5-9.0 lb-ft (10-12 N•m).

Carrier into the Axle Housing

⚠ WARNING

Solvent cleaners can be flammable, poisonous and cause burns. Examples of solvent cleaners are carbon tetrachloride, and emulsion-type and petroleum-base cleaners. Read the manufacturer's instructions before using a solvent cleaner, then carefully follow the instructions. Also follow the procedures below.

- **Wear safe eye protection.**
- **Wear clothing that protects your skin.**
- **Work in a well-ventilated area.**
- **Do not use gasoline, or solvents that contain gasoline. Gasoline can explode.**
- **You must use hot solution tanks or alkaline solutions correctly. Read the manufacturer's instructions before using hot solution tanks and alkaline solutions. Then carefully follow the instructions.**

1. Use a cleaning solvent and rags to clean the inside of the axle housing and the mounting surface. Blow dry the cleaned areas with compressed air. Refer to Section 4.
2. Inspect the axle housing for damage. If necessary, repair or replace the housing. Refer to Section 4.
3. Check for loose studs in the mounting surface of the housing where the carrier fastens. Remove and replace any studs where required.
4. Install the differential carrier into the housing, using the Manual Engaging Method.

Manual Engaging Method

1. Align the splines of the shift collar and the differential case half by hand or by installing the right-hand axle shaft through the shift collar and into the side gear.
2. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover.

⚠ CAUTION

There will be a small amount of spring resistance when you turn in the manual engaging capscrew. If a high resistance is felt before reaching the locked or engaged position, stop turning the capscrew. Damage to components can result.

3. Turn the manual adjusting capscrew to the right until the distance from the head of the capscrew is approximately 0.25-0.50-inch (6-13 mm) from the cylinder cover. Do not turn the capscrew beyond its normal stop. When the capscrew head is in the service position 0.25-0.50-inch (6-13 mm) from the top of the DCDL, the main differential lock is manually engaged.

   A high resistance on the capscrew indicates that the splines of the shift collar and the differential case half are not aligned or engaged.

   Lift the shift collar as required and rotate to align the splines of collar and case half while turning the manual engaging capscrew inward. When the normal amount of spring resistance is again felt on the capscrew, the splines are engaged. Continue to turn in the manual engaging capscrew until the 0.25-0.50-inch (6-13 mm) service position is achieved.
4. Clean both the DCDL actuator and the housing mounting surfaces.
5. Apply silicone gasket material to the cleaned housing surface for the DCDL actuator.
6. Remove the short plug and gasket from the storage hole of the DCDL.
7. Remove the long manual engaging capscrew from the service position in the center of the DCDL to disengage the main differential lock.
8. Clean the plug, gasket, cylinder cover and threaded service position hole in the center of the DCDL cylinder cover.
9. Install the manual engaging capscrew into the DCDL storage hole in the bolt-on or the screw-in DCDL assembly. Figure 6.19 and Figure 6.21. The sealing gasket must be under the head of the capscrew.
   A. On a bolt-on DCDL shift assembly, remove the short plug and gasket from the storage hole of the DCDL.

      Install the short plug and gasket into the service position hole in the center of the DCDL. Figure 6.19.

   B. On a screw-in DCDL shift assembly, install the short screw or plug into the storage hole located in the top of the screw-in DCDL shift assembly. Figure 6.21.

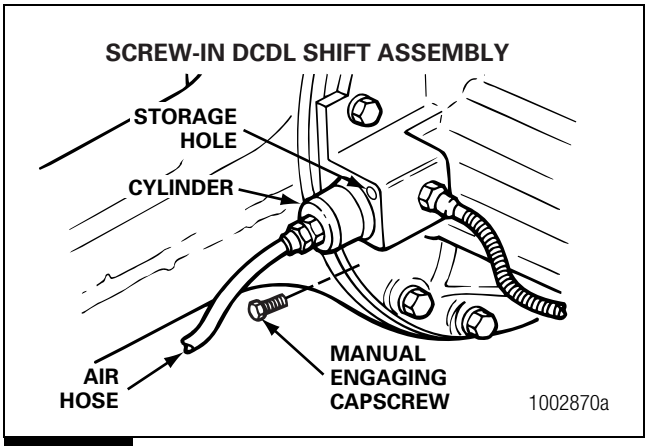


Figure 6.21

10. Tighten the plug, if equipped, to 44-55 lb-ft (60-75 N•m). Tighten the manual engaging capscrew to 22-28 lb-ft (30-38 N•m) for bolt-on style cylinders and to 7-11 lb-ft (10-15 N•m) for screw-in type reverse shifters. T
11. Connect the vehicle air line to the differential lock actuator assembly.
12. Install the electrical connection on the sensor switch located in the carrier, below the actuator assembly.
13. Install the right- and left-hand axle shafts. Refer to Section 11.
14. Remove the safety stands from under the drive axle. Lower the vehicle to the floor.
15. Proceed to Check the Differential Lock.

Check the Differential Lock

1. Shift the vehicle transmission into neutral. Start the engine to get the system air pressure to the normal level.

⚠ WARNING

During DCDL disassembly, when the DCDL is in the locked or engaged position and one of the vehicle's wheels is raised from the floor, do not start the engine and engage the transmission. The vehicle can move and cause serious personal injury and damage to components.

2. Place the differential lock switch in the cab of the vehicle in the unlocked or disengaged position.
3. Drive the vehicle at 5-10 mph (8-16 km/h) and check the differential lock indicator light. The light must be off when the switch is in the unlocked or disengaged position.

4. Continue to drive the vehicle and place the differential lock switch in the locked or engaged position. Let up on the accelerator to remove the driveline torque and permit the shift. The light must be on when the switch is in the locked position.
    - **If the indicator light remains ON with the switch in the unlocked position:** The differential is still in the locked position. Verify that the manual engaging capscrew was removed from the cylinder cover of the DCDL shift assembly. Refer to the procedure in this section.

DCDL Driver Caution Label

Verify that the driver caution label is installed in the vehicle cab. Figure 6.22. The caution label must be placed in a location that is easily visible to the driver. The recommended location is on the instrument panel, next to the differential lock switch and lock indicator light.

Figure 6.22

Technical Publications

To obtain these items, refer to the Service Notes page on the front inside cover of this manual.

- DCDL driver caution label, TP-86101
- DCDL Driver Instruction Kit (includes DCDL label and technical bulletin), TP-9579
- Traction-Control Video package, T-95125V

Capacities

Meritor recommends using a lubricant analysis program. Perform lubricant analysis at regularly-scheduled preventive maintenance intervals.

For complete information on lubricating drive axles and carriers, refer to Maintenance Manual 1, Preventive Maintenance and Lubrication. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

Refer to Table R, Table S, Table T and Table U for standard information on lubricants, schedules and capacities.

Table R: Lubricant Cross Reference (Viscosity) and Temperature Chart

Meritor Lubricant Specification	Description	Cross Reference	Minimum Outside Temperature	Maximum Outside Temperature
0-76-A	Hypoid Gear Oil	GL-5, S.A.E. 85W/140	10°F (–12.2°C)	*
0-76-B	Hypoid Gear Oil	GL-5, S.A.E. 80W/140	–15°F (–26.1°C)	*
0-76-D	Hypoid Gear Oil	GL-5, S.A.E. 80W/90	–15°F (–26.1°C)	*
0-76-E	Hypoid Gear Oil	GL-5, S.A.E. 75W/90	–40°F (–40°C)	*
0-76-J	Hypoid Gear Oil	GL-5, S.A.E. 75W	–40°F (–40°C)	35°F (1.6°C)
0-76-L	Hypoid Gear Oil	GL-5, S.A.E. 75W/140	–40°F (–40°C)	*

* There is no upper limit on these outside temperatures, but the axle sump temperature must never exceed 250°F (121°C).

Table S: Oil Change Intervals and Specifications for All Front Drive and Rear Drive Axles

Vocation or Vehicle Operation	Linehaul Intercity Coach	City Delivery School Bus Fire Truck Motorhome	Construction Transit Bus Refuse Yard Tractor Logging Heavy Haul Mining Oil Field Rescue
Initial Oil Change	No longer required as of January 1, 1993		
Check Oil Level and Breather	Every 25,000 miles (40 000 km) or the fleet maintenance interval, whichever comes first	Every 10,000 miles (16 000 km), once a month or the fleet maintenance interval, whichever comes first	Every 5,000 miles (8000 km), once a month or the fleet maintenance interval, whichever comes first[1]
Petroleum-based oil change on axle with or without pump and filter system	Every 100,000 miles (160 000 km) or annually, whichever comes first	Every 50,000 miles (80 000 km) or annually, whichever comes first	Every 25,000 miles (40 000 km) or annually, whichever comes first
Synthetic oil change on axle with or without pump and filter system[2]	Every 500,000 miles (800 000 km)	Every 100,000 miles (160 000 km) or annually, whichever comes first	Every 50,000 miles (80 000 km) or annually, whichever comes first
Filter change on axle with pump and filter system	Every 100,000 miles (160 000 km)	Every 100,000 miles (160 000 km)	Every 100,000 miles (160 000 km)

[1] For continuous heavy-duty operation, check the oil level every 1,000 miles (1600 km). Add the correct type and amount of oil as required.

[2] This interval applies to approved semi-synthetic and full-synthetic oils only. For a list of approved extended-drain axle oils, refer to TP-9539, Approved Rear Drive Axle Lubricants. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

Use the lubricant capacities in Table T and Table U as a guide only. The capacities are measured with the drive pinion in the horizontal position. When the angle of the drive pinion changes, the lubricant capacity of the axle will change.

Table T: Single Drive Axles

Axle Model	Capacity*	
	Pints	Liters
MX-10-120	16.0	7.6
MX-12-120	16.0	7.6
MX-14-120	16.0	7.6
MX-16-120	16.0	7.6
MX-21-160/160R	43.0	20.0
MX-23-160/160R	43.0	20.0
RF-7-120	15.3	7.2
RF-9-120	15.3	7.2
RF-12-120	15.3	7.2
RF-12-125	15.3	7.2
RF-16-145	36.4	17.2
RF-21-155	27.9	13.2
RF-21-156	27.9	13.2
RF-21-160	43.7	20.7
RF-21-185	39.3	18.6
RF-21-355	28.0	13.2
RF-22-166	43.7	20.7
RF-23-180	39.3	18.6
RF-23-185	39.3	18.6
RS-13-120	15.0	7.2
RS-15-120	15.0	7.2
RS-16-140	33.6	15.9
RS-16-141	33.6	15.9
RS-16-145	33.6	15.9
RS-17-140	32.0	15.4
RS-17-141	33.6	15.9
RS-17-144	32.3	15.3
RS-17-145	33.6	15.9
RS-19-144	32.3	15.3
RS-19-145	36.0	17.3
RS-21-145	35.0	16.9
RS-21-160	39.5	18.7
RS-23-160	43/41	20.7/19.5
RS-23-160A	39.5	18.7
RS-23-161/161A	37.2	17.6

Table T: Single Drive Axles

Axle Model	Capacity*	
	Pints	Liters
RS-23-180	39.0	18.6
RS-23-185	39.0	18.6
RS-23-186	39.0	18.6
RS-25-160	39.0	18.6
RS-25-160A	37.2	17.6
RS-26-160	51.0	24.2
RS-26-180	38.0	18.3
RS-26-185	38.0	18.3
RS-30-180	38.0	18.3
RS-30-185	38.0	18.3

* Includes one pint (0.97 liter) for each wheel end and with a drive pinion angle at three degrees.

Table U: Rear Axle of Tandems

Axle Model	Capacity	
	Pints	Liters
RT-34-140 (RR-17-140)	35.0	16.9
RT-34-144	25.8	12.2
RT-34-145 (RR-17-145 rear)	25.4	12.0
RT-34-145P	25.4	12.0
RT-34-146	25.4	12.0
RT-40-140 (RR-20-140)	25.8	12.2
RT-40-145/149 (RR-20-145 rear)	25.8	12.2
RT-40-145P	25.8	12.2
RT-40-146	25.8	12.2
RT-40-160	34.4	16.3
RT-40-169	34.4	16.3
RT-44-145 (RR-22-145 rear)	25.1	11.9
RT-44-145P	25.1	11.9
RT-46-160/169 (RR-23-160 rear)	34.4	16.3
RT-46-160A/160P	34.4	16.3
RT-46-164	33.2	15.7
RT-46-164EH/16HEH	33.2	15.7
RT-48-180 (RR-24-180 rear)	36.8	17.5
RT-50-160/160P	33.2	15.7
RT-52-160 (RR-26-160 rear)	41.2	19.5
RT-52-180/185 (RR-26-180 rear)	36.1	17.1
RT-58-180/185 (RR-29-180 rear)	36.1	17.1

Fasteners

The torque values in Table V are for fasteners that have a light application of oil on the threads.

- **If the fasteners are dry:** Increase the torque values by 10 percent.
- **If the fasteners have a heavy application of oil on the threads:** Decrease the torque values by 10 percent.

If you do not know the size of the fastener that is being installed, measure the fastener. Use the following procedure.

Compare the size of the fastener measured to the list of fasteners in Table V to find the correct torque value.

American Standard Fasteners

1. Measure the diameter of the threads in inches, dimension X. Figure 8.1.

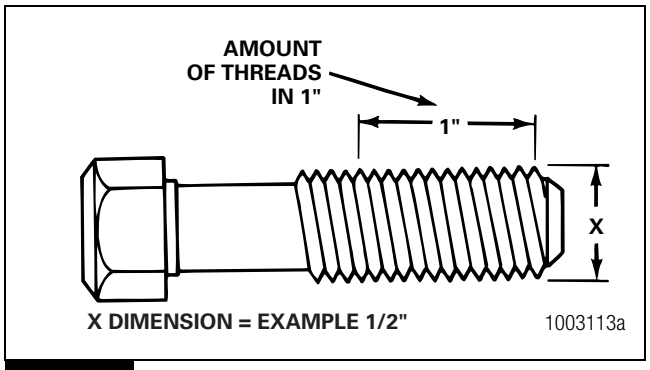


Figure 8.1

2. Count the amount of threads in one-inch. Figure 8.1.

Example

American Standard size fastener is 0.50-13.

- 0.50 is the diameter of the fastener in inches or dimension X.
- 13 is the amount of threads in one-inch.

Metric Fasteners

1. Measure the diameter of the threads in millimeters (mm), dimension X. Figure 8.2.

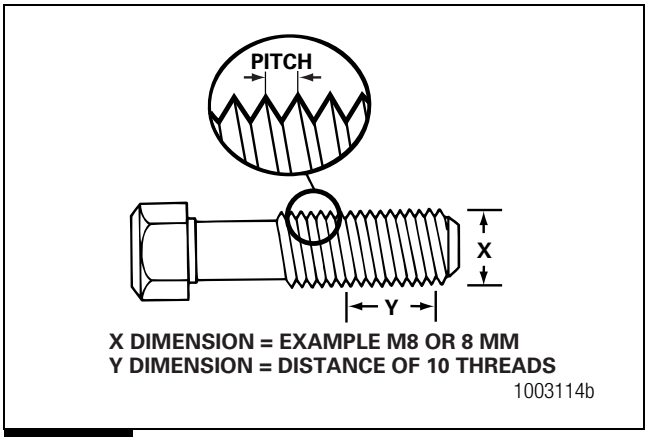


Figure 8.2

2. Measure the distance of 10 threads, point to point in millimeters (mm), dimension Y. Make a note of dimension Y. Figure 8.2.
3. Divide dimension Y by 10. The result will be the distance between two threads or pitch.

Example

Metric size fastener is M8 x 1.25.

- M8 is the diameter of the fastener in millimeters (mm) or dimension X.
- 1.25 is the distance between two threads or pitch.

Torque Specifications

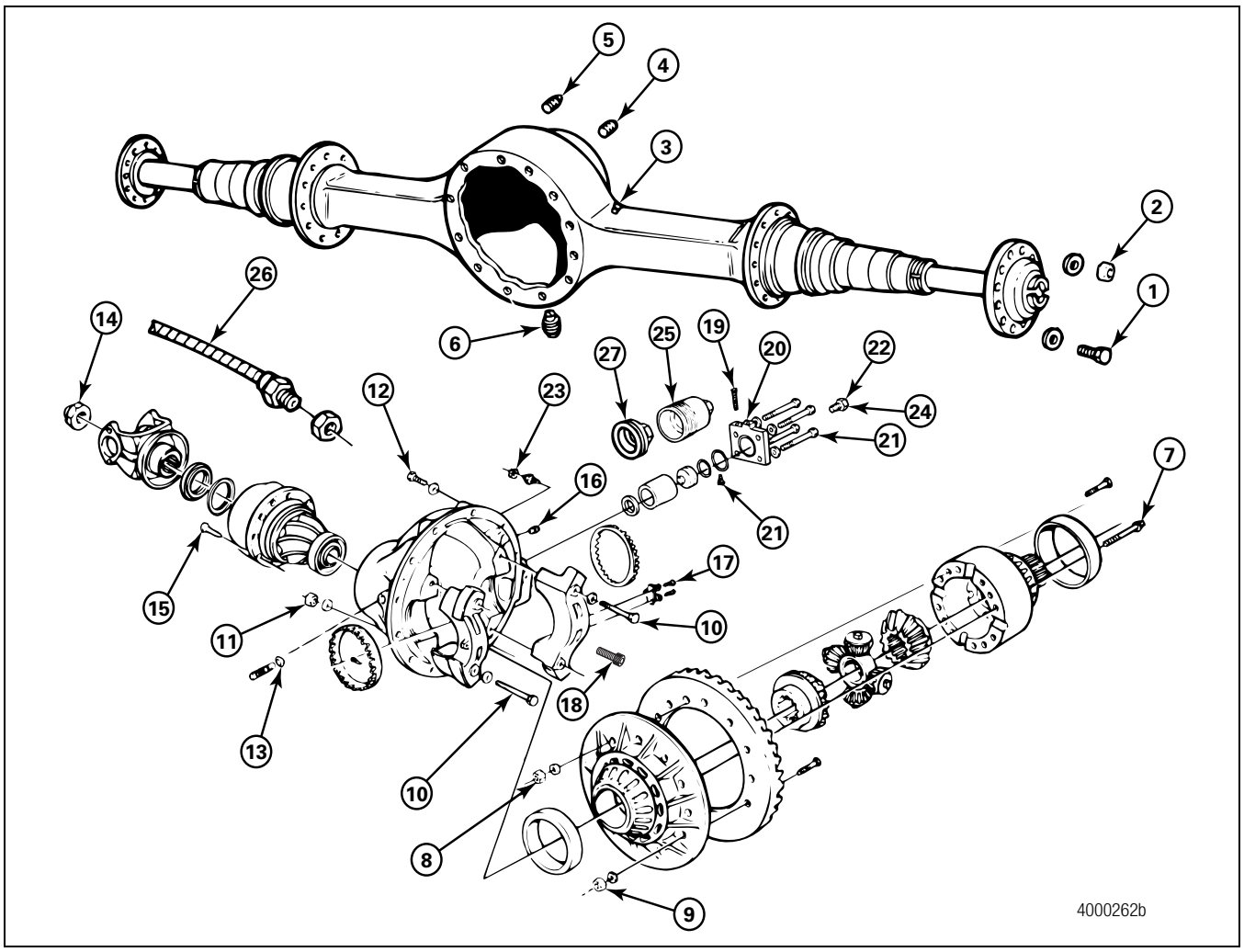


Table V: Torque Chart

Fastener		Thread Size	Torque lb-ft	Torque N•m
1	Axle Shaft Capscrew	0.31-24	18-24	24-33
		0.50-13	85-115	115-156
2	Axle Shaft Stud Nut	Plain Nut		
		0.44-20	50-75	68-102
		0.50-20	75-115	102-156
		0.56-18	110-165	149-224
		0.62-18	150-230	203-312
		Locknut		
		0.44-20	40-65	54-88
		0.50-20	65-100	88-136
		0.56-18	100-145	136-197
		0.62-18	130-190	176-258

Table V: Torque Chart

Fastener		Thread Size	Torque lb-ft	Torque N•m
3	Breather	0.38-18	20 minimum	27 minimum
4	Housing Oil Fill Plug	0.75-14	35 minimum	47.5 minimum
5	Heat Indicator Plug	0.50-14	25 minimum	34 minimum
6	Oil Drain Plug	0.50-14	25 minimum	34 minimum
7	Differential Case Capscrew	0.38-16	35-50	48-68
		0.44-14	60-75	81-102
		0.50-13	85-115	115-156
		0.56-12	130-165	176-224
		0.62-11	180-230	244-312
		M12 x 1.75, Grade 10.9 Flange Head	85-103	115-140
		M12 x 1.75, Grade 10.9 Standard Hex Head	74-96	100-130
		M12 x 1.75, Grade 12.9 Standard Hex Head	105-125	143-169
		M16 x 2, Grade 12.9 Flange Head	203-251	275-340
		M16 x 2, Grade 12.9 Standard Head	220-310	300-420
8	Differential Case Bolt Nut	0.50-13	75-100	102-136
		0.50-20	85-115	115-156
		0.62-11	150-190	203-258
		0.62-18	180-230	244-312
		0.87-14	600-700	815-950
		M12 x 1.75	74-96	100-130
		M16 x 2	220-310	300-420
9	Ring Gear Bolt Nut	0.50-13	75-100	102-136
		0.50-20	85-115	115-156
		0.62-11	150-190	203-258
		0.62-18	180-230	244-312
		0.87-14	600-700	816-952
		M12 x 1.25	66-81	90-110
		M12 x 1.75	77-85	104-115
		M16 x 1.5, Flange Head	192-214	260-190
		M16 x 1.5, Standard Hex Head	196-262	265-355
10	Bearing Cap Capscrew	0.56-12	110-145	149-197
		0.62-11	150-190	203-258
		0.75-10	270-350	366-475
		0.88-14	360-470	488-637
		0.88-9	425-550	576-746
		M16 x 2	181-221	245-300
		M20 x 2.5	347-431	470-585
		M22 x 2.5	479-597	650-810
11	Housing-to-Carrier Stud Nut	0.44-20	50-75	68-102
		0.50-20	75-115	102-156
		0.56-18	110-165	149-224
		0.62-18	150-230	203-312

Table V: Torque Chart

Fastener		Thread Size	Torque lb-ft	Torque N•m
12	Carrier-to-Housing Capscrew	0.44-14	50-75	68-102
		0.50-13	75-115	102-156
		0.56-12	110-165	149-224
		0.62-11	150-230	203-312
		0.75-10	270-400	366-542
		M12 x 1.75	74-89	100-120
		M16 x 2	181-221	245-300
13	Thrust Screw Jam Nut	0.75-16	150-190	203-258
		0.88-14	150-300	203-407
		1.12-16	150-190	203-258
		M22 x 1.5	148-210	200-285
		M30 x 1.5	236-295	320-400
14	Input Yoke-to-Input Shaft Nut	Refer to Table W.		
15	Bearing Cage Capscrew	0.38-16	30-50	41-68
		0.44-14	50-75	68-102
		0.50-13	75-115	102-156
		0.56-12	110-165	149-224
		0.62-11	150-230	203-312
		M12 x 1.75	70-110	90-150
16	Carrier Oil Fill Plug	0.75-14	25 minimum	34 minimum
		1.5-11.5	120 minimum	163 minimum
		M24 x 1.5	35 minimum	47 minimum
17	Lock Plate Capscrew	0.31-18	20-30	27-41
		M8 x 1.25	21-26	28-35
18	Adjusting Rings Capscrews	—	21-28	28-38
Torque Values for Carriers with Bolt-On Style Differential Lock Cylinders				
19	Manual Actuation Storage Position Capscrew	M10 x 1.5	15-25	20-35
20	Air Cylinder Adapter	M12 x 1.5	22-30	30-40
21	Air Cylinder Cover Capscrew	M6 x 1	7-12	10-16
22	Air Cylinder Cover Capscrew/ Plug, Operating and Storage Position	M10 x 1.5	15-25 15-25	20-35 20-35
23	Sensor Switch Locknut	M16 x 1	25-35	35-45
Torque Values for Carriers with Screw-In Style Differential Lock Cylinders				
24	Manual Actuation Storage Position Capscrew	M10 x 1.25	7-11	10-15
25	Air Cylinder	M60 x 2.0	80-100	109-136
26	Sensor Switch	M16 x 1.0	25-35	35-45
27	Screw-In DCDL Cylinder Plug or Cap	M60 x 2.0	80-100	109-136

Input and Output Yoke Pinion Nut Fastener Torque Specifications

Table W: Single and Rear of Tandem Axles

Axle Model Pinion Nut Location	RS-120, RS-125, RS-140	RS-144/145	RF-166, RS-160, RS-161, RS-185, RS-186	RS-210, RS-220, RS-230	RS-240	RS-380
Carrier Input Yoke	740-920 lb-ft (1000-1245 N•m)	920-1130 lb-ft (1250-1535 N•m)	1000-1230 lb-ft (1350-1670 N•m)	740-920 lb-ft (1000-1245 N•m)	740-920 lb-ft (1000-1245 N•m)	800-1100 lb-ft (1085-1496 N•m)
Fastener Size	M32 x 1.5	M39 x 1.5	M45 x 1.5	M32 x 1.5	M39 x 1.5	1-1/2 - 12 UNF

Table X: Drive Pinion Bearings — Preload

Specification	New bearings 5-45 lb-in (0.56-5.08 N•m) Used bearings in good condition 5-25 lb-in (1.7-2.8 N•m)
Adjustment	Preload is controlled by the thickness of the spacer between the bearings. To increase the preload, install a thinner spacer. To decrease the preload, install a thicker spacer.

Table Y: Drive Pinion — Depth in Carrier

Specification	Install the correct amount of shims between the inner bearing cup of the drive pinion and the carrier. To calculate, use the old shim pack thickness and the new and old pinion cone numbers.
Adjustment	Change the thickness of the shim pack to get a good gear tooth contact pattern.

Table Z: Hypoid Gear Set — Tooth Contact Patterns (Hand Rolled)

Specification	Conventional gear set Toward the toe of the gear tooth and in the center between the top and bottom of the tooth. Generoid gear set Between the center and toe of the tooth and in the center between the top and bottom of the tooth.
Adjustment	Tooth contact patterns are controlled by the thickness of the shim pack between the pinion bearing cage and carrier and by ring gear backlash. To move the contact pattern lower, decrease the thickness of the shim pack under the pinion bearing cage. To move the contact pattern higher, increase the thickness of the shim pack under the pinion bearing cage. To move the contact pattern toward the toe of the tooth, decrease the backlash of the ring gear. To move the contact pattern toward the heel of the tooth, increase the backlash of the ring gear.

Table AA: Main Differential Bearings — Preload

Specification	15-35 lb-in (1.7-3.9 N•m) or Expansion between bearing caps RS-140, RS-145 and RS-160 carrier models — 0.002-0.009-inch (0.05-0.229 mm) All other carrier models — 0.006-0.013-inch (0.15-0.33 mm)
Adjustment	Preload is controlled by tightening both adjusting rings after zero end play is reached.

Table AB: Main Differential Gears — Rotating Resistance

Specification	50 lb-ft (68 N•m) maximum torque applied to one side gear

Table AC: Ring Gear — Backlash

Specification	Ring gears that have a pitch diameter of less than 17-inches (431.8 mm) Range: 0.008-0.018-inch (0.20-0.46 mm) 0.012-inch (0.30 mm) for a new gear set Ring gears that have a pitch diameter of 17-inches (431.8 mm) or greater Range: 0.010-0.020-inch (0.25-0.51 mm) 0.015-inch (0.38 mm) for a new gear set
Adjustment	Backlash is controlled by the position of the ring gear. Change the backlash within specifications to get a good tooth contact pattern. To increase the backlash, move the ring gear away from the drive pinion. To decrease the backlash, move the ring gear toward the drive pinion.

Table AD: Ring Gear — Runout

Specification	0.008-inch (0.20 mm) maximum

Table AE: DCDL Sensor Switch — Installation

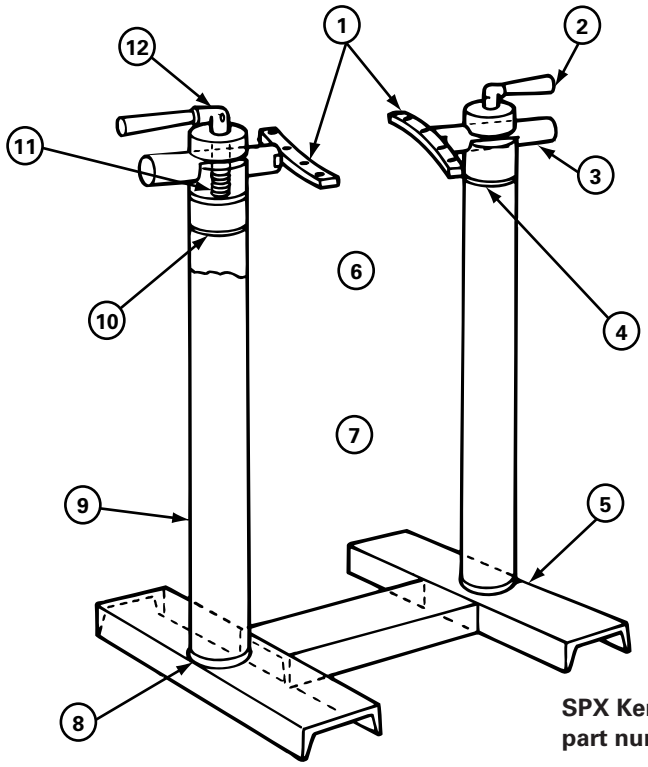
Adjustment	Shift the differential to the locked position. Tighten the sensor switch into the carrier until the test light illuminates. Tighten the sensor switch one additional turn. Tighten the jam nut to the specified torque.

Table AF: Spigot Bearing — Peening on the Drive Pinion

Specification	Apply 6,614 lb (3000 kg) load on a 0.375-inch (10 mm) ball. Peen the end of the drive pinion at a minimum of five points. Softening of the pinion stem end by heating may be required.

Specifications

Carrier Repair Stand



SPX Kent-Moore
part number J-3409-D

1002990f

1 PLATES 8′ LONG x 3/4″ THICK x 1-1/4″ WIDE WITH A TONGUE TO FIT SLOT IN BAR WELD PLATES TO BAR
2 HANDLE 7″ LONG WITH SLOT IN ONE END TO FIT CLAMP SCREW
3 BAR 2″ DIAMETER x 9″ LONG WITH ONE END SLOTTED TO FIT PLATE
4 WELD ALL AROUND AFTER PRESSING PLUG IN PIPE
5 WELD
6 SHAPE AND SIZE OF HOLES TO FIT CARRIER
7 23-1/2″ CENTER TO CENTER OF PIPE
8 CHAMFER END OF PIPE FOR WELDING
9 4″ DIAMETER PIPE
10 PLUG 4″ DIAMETER x 7″ LONG WITH ONE END TURNED 3″ LONG TO FIT PIPE. DRILL 2″ HOLE AND MILL 3/16″ WIDE SLOT 2″ FROM TOP
11 SCREW 3-1/2″ LONG x 5/8″ DIAMETER WITH FLATS ON END TO FIT HANDLE AND 2-1/2″ LENGTH OF THREAD ON OTHER END
12 DRILL 3/8″ HOLE THROUGH HANDLE AND SCREW

Figure 10.1

To obtain a repair stand, refer to the Service Notes page on the front inside cover of this manual.

How to Make a Yoke Bar

1. Measure dimensions A and B of the yoke you are servicing. Figure 10.2.

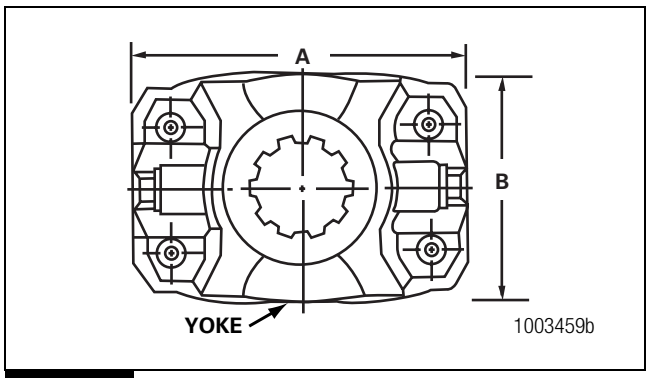


Figure 10.2

2. Calculate dimensions C and D of the yoke bar by adding 0.125-0.250-inch to dimensions A and B of the yoke. Figure 10.3.

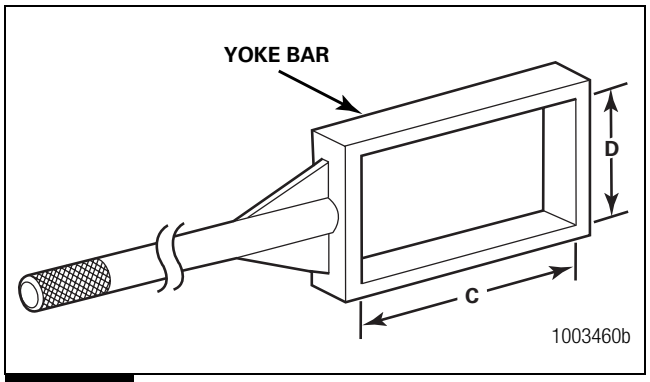


Figure 10.3

⚠ WARNING

Wear safe clothing and eye protection when you use welding equipment. Welding equipment can burn you and cause serious personal injury. Follow the operating instructions and safety procedures recommended by the welding equipment manufacturer.

3. To make the box section, cut and weld one-inch x two-inch mild steel square stock according to dimensions C and D. Figure 10.3.

4. Cut a four-foot x 1.25-inch piece of mild steel round stock to make the yoke bar handle. Center weld this piece to the box section. Figure 10.3.

   - **To increase yoke bar rigidity:** Weld two angle pieces onto the handle. Figure 10.3.

Unitized Pinion Seals and Seal Drivers

Refer to Table AG and Figure 10.4 for information on unitized pinion seals and seal drivers. To obtain Meritor seal driver KIT 4454, refer to the Service Notes page on the front inside cover of this manual.

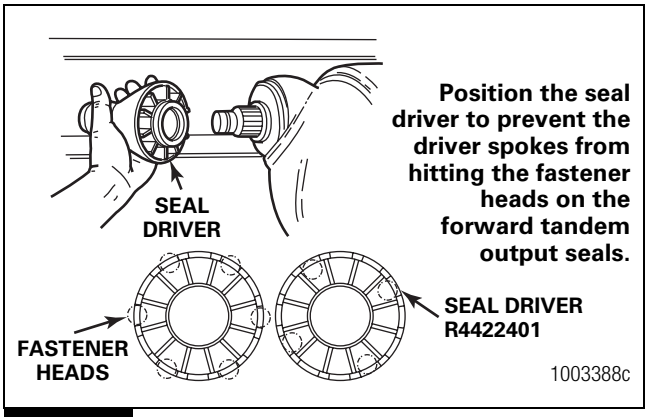


Figure 10.4

Table AG: Unitized Pinion Seals and Seal Drivers

Single Models	Tandem Models	Meritor Unitized Pinion Seal	Seal Installation Location	Meritor Seal Driver	Yoke Seal Diameter Inches
RS-17-145 RS-19-145 RS-21-145	RT-34-144 /P RT-34-145 /P RT-40-145 /A /P	A-1205-R-2592	Tandem Forward Input — 145 models from November 1993 to present	R4422402	3.250 3.255
RS-21-160 RS-23-160 /A RS-23-161 /A RS-25-160 /A	RT-40-149 /A /P RT-44-145 /P RT-40-160 /A /P RT-40-169 /A /P	A-1205-P-2590	Tandem Forward Output — Tandem Forward Input 145 models before November 1993 with seal A-1205-F-2424	R4422401	3.000 3.005
RS-23-186 RS-26-185 RS-30-185	RT-46-160 /A /P RT-46-169 /A /P RT-46-164EH /P RT-46-16HEH /P RT-50-160 /P RT-52-185* RT-58-185*	A-1205-N-2588	Tandem and Single Rear Input — 145 models	R4422401	3.000 3.005
		A-1205-Q-2591	Tandem and Single Rear Input — 160/164/185 models	R4422402	3.250 3.255

* Forward and rear input only.

Multiple Lip Seals (MLS) and Seal Drivers

Refer to Table AH for information on multiple lip seals and seal drivers. To obtain Meritor seal driver KIT 4454, refer to the Service Notes page on the front inside cover of this manual.

Table AH: Multiple Lip Seals and Seal Drivers*

Single Models	Tandem Models	Axle Model and Position	Seal Service Part Number	Previous Seal Part Number	Seal Drivers	Sleeve Drivers
MX-21-160 MX-23-160R	RT-34-144 /P RT-34-145 /P	14X/16X/18X/38X Forward-Rear Unit Input (FUI)	A1-1205X2728	A-1205R2592	2728T1	2728T2
RF-16-145 RF-21-160	MT-40-143 RT-40-145 /A /P	14X/16X Forward-Rear Unit Output (FUO)	A1-1205Y2729	A-1205P2590	2729T1	2729T2
RF-22-166 RF-23-185	RT-40-149 /A /P RT-44-145 /P	14X Rear-Rear Unit Input (RUI)	A1-1205Z2730	A-1205N2588	2730T1	Not Required — Sleeve is unitized
RS-17-145 RS-19-145 RS-21-145 RS-21-160 RS-23-160 /A RS-23-161 /A RS-25-160 /A RS-23-186 RS-26-185 RS-30-185	RT-40-160 /A /P RT-40-169 /A /P RT-46-160 /A /P RT-46-169 /A /P RT-46-164EH /P RT-46-16HEH /P RT-50-160 /P RT-52-185* RT-58-185*	16X/18X Rear-Rear Unit Input (RUI)	A1-1205A2731	A-1205Q2591	2731T1	Not Required — Sleeve is unitized

* Forward and rear input only.

Forward input and output seals must be serviced with the seal and sleeve. The service part number provides both when required.

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

Before you service a spring chamber, carefully follow the manufacturer's instructions to compress and lock the spring to completely release the brake. Verify that no air pressure remains in the service chamber before you proceed. Sudden release of compressed air can cause serious personal injury and damage to components.

Engage the parking brake to prevent the vehicle from moving before you begin maintenance or service procedures that require you to be under the vehicle. Serious personal injury can result.

⚠ CAUTION

If the vehicle is equipped with a front drive axle, tow the vehicle from the front, with the front wheels off the ground. If this is not possible, you must remove the front drive shaft before towing. Damage to components can result.

Do not use a chisel or wedge to loosen the axle shaft and tapered dowels. A chisel or wedge can result in damage to the axle shaft, the gasket and seal, and the axle hub.

NOTE: For complete towing information, refer to Technical Bulletin TP-9579, Driver Instruction Kit. To obtain this publication, refer to the Service Notes page on the front inside cover of this manual.

These instructions supersede all other instructions for the purpose of transporting vehicles for service or new vehicle drive-away dated before April 1995, including those contained in Meritor maintenance manuals.

When transporting a vehicle with the wheels of one or both drive axles on the road, it is possible to damage the axles if the wrong procedure is used before transporting begins. Meritor recommends that you use the following procedure.

Type of Axle

Single Axle with DCDL — Screw-In (Threaded) Shift Assembly, or Tandem Axle with DCDL — Screw-In (Threaded) Shift Assembly and with Inter-Axle Differential (IAD)

Before Towing or Drive-Away

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Apply the vehicle parking brakes using the switch inside the cab of the vehicle.
3. Shift the transmission into neutral and start the vehicle's engine.
4. Shift the DCDL and the IAD to the unlocked or disengaged positions using the switches inside the cab of the vehicle. The indicator lights in the cab will go off.
5. Stop the engine.

NOTE: Remove only the axle shaft(s), shown in Table AI at this time, from the axle(s) that will remain on the road when the vehicle is transported.

6. Remove the stud nuts or capscrews and washers from the flange of the axle shaft. Figure 11.1.

Table AI

Single Axles	
	Remove the left-hand, road side, axle shaft
Tandem Axles	
	Forward Axle
	Remove the right-hand, curbside, axle shaft
	Rear Axle
	Remove the left-hand, roadside, axle shaft

7. Loosen the tapered dowels, if used, in the flange of the axle shaft. Refer to Section 3 for the recommended tools and removal procedures.
8. Install a cover over the open end of each hub where an axle shaft was removed. This will prevent dirt from entering the bearing cavity and loss of lubricant.

NOTE: If an air supply will be used for the brake system of the transported vehicle, continue with Step 9 and Step 10, otherwise continue with Step 11.

9. Connect an auxiliary air supply to the brake system of the vehicle that is being transported. Before moving the vehicle, charge the brake system with the correct amount of air pressure to operate the brakes. Refer to the instructions supplied by the manufacturer of the vehicle for procedures and specifications. If an auxiliary air supply is not used, continue with Step 11.
10. When the correct amount of air pressure is in the brake system, release the parking brakes of the vehicle that is being transported. Step 11 is not required.
11. If there are spring or parking brakes on the axle(s) that will remain on the road when the vehicle is transported, and they cannot be released by air pressure, manually compress and lock each spring so that the brakes are released. Refer to the manufacturer's instructions.

After Towing or Drive-Away

1. If an auxiliary air supply was used, apply the vehicle parking brakes using the switch inside the cab of the vehicle. If an auxiliary air supply was not used, begin with Step 2.
2. Apply the vehicle spring or parking brakes by manually releasing each spring that was compressed before transporting started. Refer to the manufacturer's instructions.
3. Disconnect the auxiliary air supply, if used, from the brake system of the vehicle that was transported. Connect the vehicle's air supply to the brake system.
4. Remove the covers from the hubs.

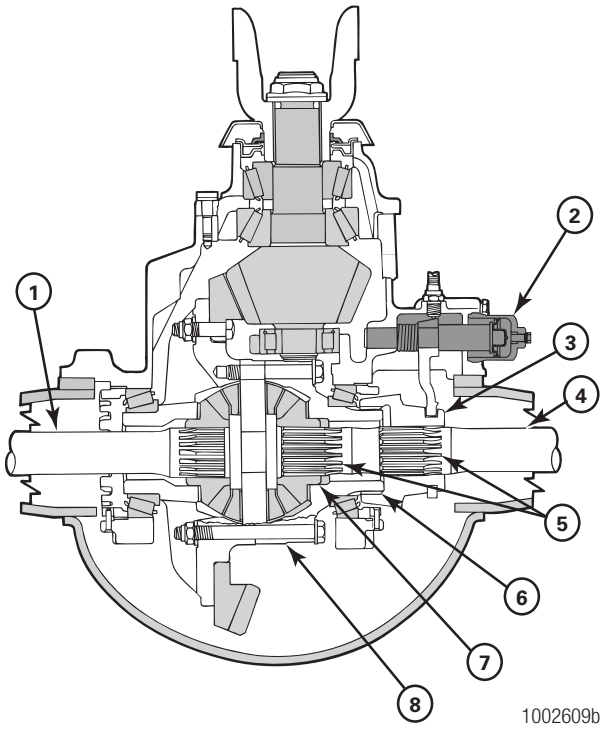
NOTE: Install only the axle shaft(s) shown in Table AJ at this time. These axle shafts have a double row of splines that engage with the splines of the side gear and shift collar in the main differential. Figure 11.1.

5. Install the gasket, if used, and axle shaft into the axle housing and carrier in the same location. The gasket and flange of the axle shaft must be flat against the hub. Rotate the axle shaft or the driveline as necessary to align the splines and the holes in the flange with the studs in the hub. Figure 11.1.

Table AJ

Single Axles	
	Install the right-hand, curbside, axle shaft
Tandem Axles	
	Forward Axle
	Install the left-hand, roadside, axle shaft
	Rear Axle
	Install the right-hand, curbside, axle shaft

SINGLE AXLE OR REAR AXLE OF TANDEM SHOWN WITH SCREW-IN DCDL SHIFT ASSEMBLY AND SHOWN IN THE LOCKED OR ENGAGED POSITION



1 LEFT-HAND, ROADSIDE, AXLE SHAFT
2 SHIFT ASSEMBLY
3 SHIFT COLLAR
4 RIGHT-HAND, CURBSIDE, AXLE SHAFT
5 DOUBLE ROW OF SPLINES
6 SHIFT COLLAR AND DIFFERENTIAL CASE SPLINES ENGAGED OR LOCKED
7 SIDE GEAR
8 DIFFERENTIAL CASE

Figure 11.1

6. Install the dowels, if used, over each stud and into the tapered holes of the flange.
7. Install the washers and capscrews or stud nuts. Determine the size of the fasteners and tighten the capscrews or nuts to the corresponding torque value shown in Table AK.

Table AK

Fastener	Thread Size	Torque Value lb-ft (N•m)
Capscrews	0.31"-24	18-24 (24-33)
	0.50"-13	85-115 (115-156)
Stud Nuts	0.44"-20	50-75 (68-102)
Plain Nut	0.50"-20	75-115 (102-156)
	0.56"-18	110-165 (149-224)
	0.62"-18	150-230 (203-312)
	0.75"-16	310-400 (420-542)
Locknut	0.44"-20	40-65 (54-88)
	0.50"-20	65-100 (88-136)
	0.56"-18	100-145 (136-197)
	0.62"-18	130-190 (176-258)
	0.75"-16	270-350 (366-475)

8. Unlock or disengage the DCDL by removing the manual engaging capscrew from the shift assembly.
9. Install the manual engaging capscrew into the storage hole. The storage hole of threaded shift assemblies is located in the shift tower of the carrier next to the cylinder. Tighten the capscrew to 15-25 lb-ft (20-35 N•m). Figure 11.2. T
10. Connect the air hose to the shift cylinder. Tighten the air hose to 22-30 lb-ft (30-40 N•m). T
11. Install the remaining axle shaft into the axle housing and carrier.
12. Check the lubricant level in the axles and hubs where the axle shafts were removed. Add the correct type and amount of lubricant if necessary. Refer to Section 7.

Single Axle with DCDL — Bolt-On Shift Assembly, or Tandem Axle with DCDL — Bolt-On Shift Assembly and with Inter-Axle Differential (IAD)

Before Towing or Drive-Away

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Apply the vehicle parking brakes using the switch inside the cab of the vehicle.
3. Shift the transmission into neutral and start the vehicle's engine.
4. Shift the DCDL and the IAD to the unlocked or disengaged positions using the switches inside the cab of the vehicle. The indicator lights in the cab will go off.
5. Stop the engine.

NOTE: Remove only the axle shaft(s), shown in Table AL at this time, from the axle(s) that will remain on the road when the vehicle is transported.

6. Remove the stud nuts or capscrews and washers from the flange of the axle shaft. Figure 11.2.

Table AL

Single Axles
Remove the left-hand, roadside, axle shaft
Tandem Axles
Forward Axle
Remove the right-hand, curbside, axle shaft
Rear Axle
Remove the left-hand, roadside, axle shaft

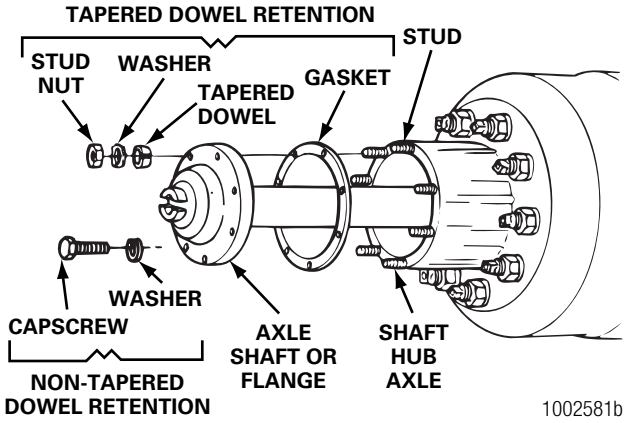


Figure 11.2

7. Loosen the tapered dowels, if used, in the flange of the axle shaft. Figure 11.2.
8. Identify each axle shaft that is removed from the axle assembly so they can be installed in the same location after transporting or repair is completed.
9. Remove the tapered dowels, gasket, if used, and the axle shaft from the axle assembly. Figure 11.2.
10. Remove the manual engaging capscrew from the storage hole. The storage hole of the bolted-on shift assemblies is located in the top side of the shift cylinder cover. Figure 11.3.

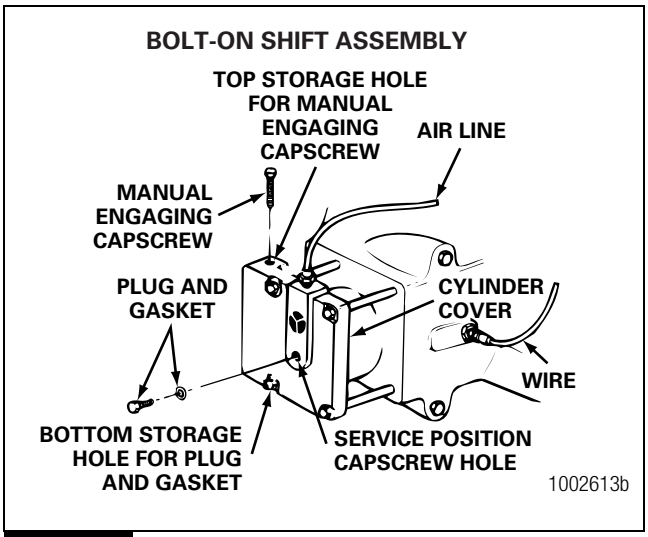


Figure 11.3

11. Remove the plug and gasket from the center of the shift cylinder cover. Install the plug and gasket into the bottom side storage hole of the shift cylinder cover, on the opposite end of the storage hole for the manual engaging capscrew. Tighten the plug to 15-25 lb-ft (20-35 N•m). Figure 11.3.
12. Lock or engage the main differential using one of the two following methods: Air Pressure Method or Manual Engaging Method.
13. Lock or engage the main differential using the air pressure method.
    A. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover. Turn the capscrew to the right three to five turns. Figure 11.4.
    B. Shift the transmission into neutral and start the vehicle's engine. Let the engine idle to increase the pressure in the air system. Do not release the parking brake.
    C. Shift the main differential to the locked or engaged position using the switch inside the cab of the vehicle. When the differential is locked, the indicator light in the cab will go on.
       - **If the light does not go on:** Rotate the main driveline or the IAD by hand until the main differential is locked and the indicator light goes on.

NOTE: When the shift collar is completely engaged with the splines of the main differential case, the differential is locked and the driveline cannot be rotated. Figure 11.5.

    D. While the differential is held in the locked position by air pressure, turn the manual engaging capscrew to the right until you feel resistance against the piston. Stop turning the capscrew.
    E. Place the main differential lock switch in the unlocked or disengaged position.
    F. Stop the engine. Proceed to Step 15.

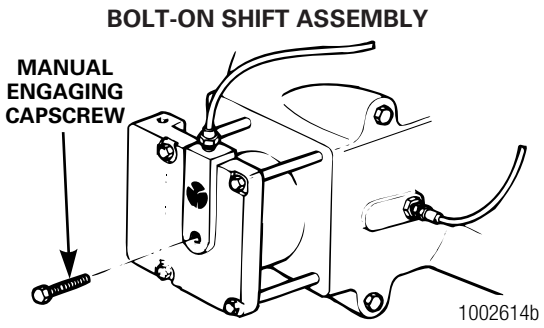
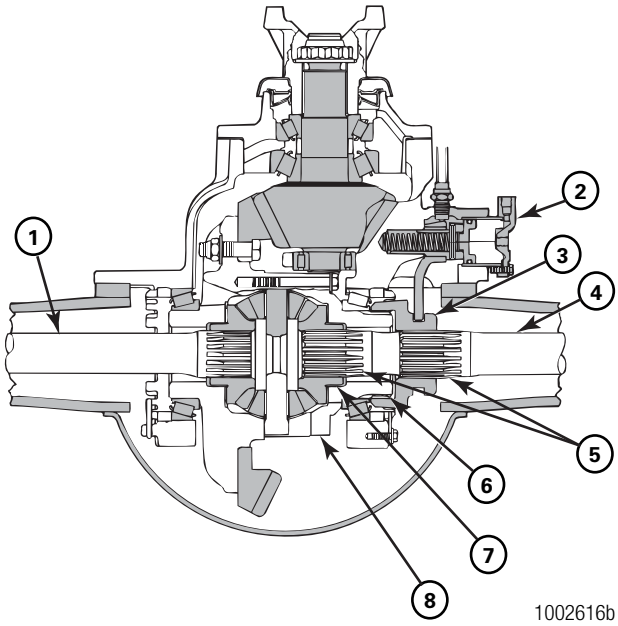


Figure 11.4



1 LEFT-HAND, ROADSIDE, AXLE SHAFT
2 SHIFT ASSEMBLY
3 SHIFT COLLAR
4 RIGHT-HAND, CURBSIDE, AXLE SHAFT
5 DOUBLE ROW OF SPLINES
6 SHIFT COLLAR AND DIFFERENTIAL CASE SPLINES ENGAGED, LOCKED
7 SIDE GEAR
8 DIFFERENTIAL CASE

Figure 11.5

14. Lock or engage the main differential using the manual engaging method.

A. Install the manual engaging capscrew into the threaded hole in the center of the cylinder cover. Figure 11.4.

⚠ CAUTION

When you turn the manual engaging capscrew and you feel a high resistance, stop turning the capscrew. A high resistance against the capscrew indicates that the splines of the shift collar and differential case are not aligned. Damage to the threads of the cylinder cover and capscrew will result.

B. Turn the capscrew to the right until the head is approximately 0.25-0.50-inch (6.4-12.7 mm) from the cylinder cover. The capscrew is now in the service position and the main differential is locked or engaged. Figure 11.6. When you turn the capscrew, you will feel a small amount of resistance. This is normal.

- **If you feel a high resistance before achieving the 0.25-0.50-inch (6.4-12.7 mm) distance between the capscrew head and cylinder:** Stop turning the capscrew, and continue with Step C, Step D and Step E.

C. Rotate the main driveline or the IAD a small amount by hand.

D. Turn the manual engaging capscrew again to the right. If you still feel a high resistance, stop turning the capscrew.

E. Repeat Step C and Step D until you feel a low resistance on the capscrew. Continue with Step B.

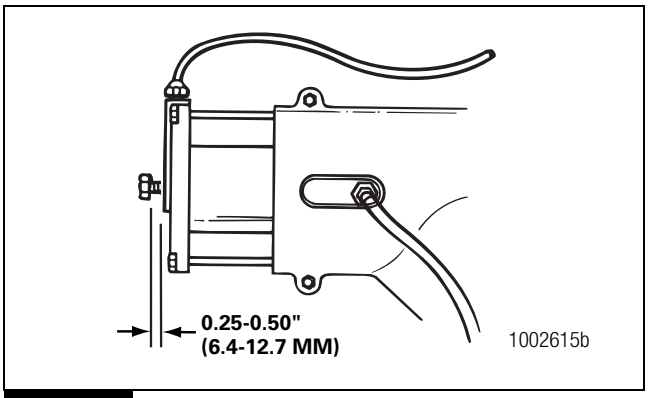


Figure 11.6

15. Remove the remaining axle shaft(s) from the axle(s) that will remain on the road when the vehicle is transported.
16. Install a cover over the open end of each hub where an axle shaft was removed. This will prevent dirt from entering the bearing cavity and loss of lubricant.

NOTE: If an air supply will be used for the brake system of the transported vehicle, continue with Step 17 and Step 18. Otherwise, continue with Step 19.

17. Connect an auxiliary air supply to the brake system of the vehicle that is being transported. Before moving the vehicle, charge the brake system with the correct amount of air pressure to operate the brakes. Refer to the instructions supplied by the manufacturer of the vehicle for procedures and specifications. If an auxiliary air supply is not used, continue with Step 19.
18. When the correct amount of air pressure is in the brake system, release the parking brakes of the vehicle that is being transported. Step 19 is not required.
19. If there are spring or parking brakes on the axle(s) that will remain on the road when the vehicle is transported, and they cannot be released by air pressure, manually compress and lock each spring so that the brakes are released. Refer to the manufacturer's instructions.

After Towing or Drive-Away

1. If an auxiliary air supply was used, apply the vehicle parking brakes using the switch inside the cab of the vehicle. If an auxiliary air supply was not used, begin with Step 2.
2. Apply the vehicle spring or parking brakes by manually releasing each spring that was compressed before transporting started. Refer to the manufacturer's instructions.
3. Disconnect the auxiliary air supply, if used, from the brake system of the vehicle that was transported. Connect the vehicle's air supply to the brake system.
4. Remove the covers from the hubs.

NOTE: Install only the axle shaft(s) shown in Table AM at this time. These axle shafts have a double row of splines that engage with the splines of the side gear and shift collar in the main differential. Figure 11.5.

5. Install the gasket, if used, and axle shaft into the axle housing and carrier in the same location. The gasket and flange of the axle shaft must be flat against the hub. Rotate the axle shaft or the driveline as necessary to align the splines and the holes in the flange with the studs in the hub. Figure 11.2.

Table AM

Single Axles	
	Install the right-hand, curbside, axle shaft
Tandem Axles	
	Forward Axle
	Install the left-hand, roadside, axle shaft
	Rear Axle
	Install the right-hand, curbside, axle shaft

6. Install the dowels, if used, over each stud and into the tapered holes of the flange.
7. Install the washers and capscrews or stud nuts. Determine the size of the fasteners and tighten the capscrews or nuts to the torque value shown in Table AN.

Table AN

Fastener	Thread Size	Torque Value lb-ft (N•m)
Capscrews	0.31"-24	18-24 (24-33)
	0.50"-13	85-115 (115-156)
Stud Nuts	0.44"-20	50-75 (68-102)
Plain Nut	0.50"-20	75-115 (102-156)
	0.56"-18	110-165 (149-224)
	0.62"-18	150-230 (203-312)
	0.75"-16	310-400 (420-542)
Locknut	0.44"-20	40-65 (54-88)
	0.50"-20	65-100 (88-136)
	0.56"-18	100-145 (136-197)
	0.62"-18	130-190 (176-258)
	0.75"-16	270-350 (366-475)

8. Unlock or disengage the DCDL by removing the manual engaging capscrew from the shift assembly.
9. Install the manual engaging capscrew into the storage hole. The storage hole of bolted-on shift assemblies is located in the top side of the shift cylinder cover. Tighten the capscrew to 15-25 lb-ft (20-35 N•m). Figure 11.3. T
10. Remove the plug and gasket from the storage hole. Install the plug and gasket into the threaded hole in the center of the shift cylinder cover. Tighten the plug to 15-25 lb-ft (20-35 N•m). T
11. Install the remaining axle shaft into the axle housing and carrier.
12. Check the lubricant level in the axles and hubs where the axle shafts were removed. Add the correct type and amount of lubricant if necessary. Refer to Section 7.

Single Axle Without DCDL or Tandem Axle Without DCDL and with Inter-Axle Differential (IAD)

Before Towing or Drive-Away

1. Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving.
2. Apply the vehicle parking brakes using the switch inside the cab of the vehicle.

NOTE: For a single axle, continue with Step 6. For a tandem axle, continue with Step 3.

3. Shift the transmission into neutral and start the vehicle's engine.
4. Shift the IAD to the unlocked or disengaged position using the switch inside the cab of the vehicle. The indicator light in the cab will go off.
5. Stop the engine.

NOTE: Remove both axle shafts from the axle(s) that will remain on the road when the vehicle is transported.

6. Remove the stud nuts or capscrews and washers from the flange of the axle shaft. Figure 11.7.
7. Loosen the tapered dowels, if used, in the flange of the axle shaft. Figure 11.7.

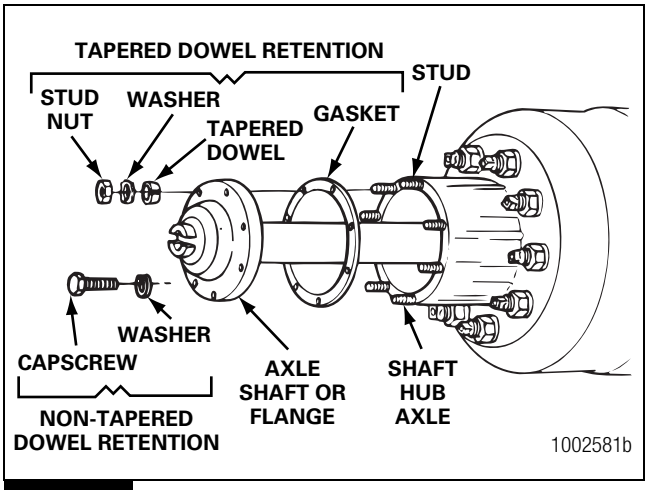


Figure 11.7

8. Identify each axle shaft that is removed from the axle assembly so they can be installed in the same location after transporting or repair is completed.
9. Remove the tapered dowels, gasket, if used, and the axle shaft from the axle assembly. Figure 11.7.
10. Install a cover over the open end of each hub where an axle shaft was removed. This will prevent dirt from entering the bearing cavity and loss of lubricant.

NOTE: If an air supply will be used for the brake system of the transported vehicle, continue with Step 11 and Step 12, otherwise continue with Step 13.

11. Connect an auxiliary air supply to the brake system of the vehicle that is being transported. Before moving the vehicle, charge the brake system with the correct amount of air pressure to operate the brakes. Refer to the instructions supplied by the manufacturer of the vehicle for procedures and specifications. If an auxiliary air supply is not used, continue with Step 13.
12. When the correct amount of air pressure is in the brake system, release the parking brakes of the vehicle that is being transported. Step 13 is not required.
13. If there are spring or parking brakes on the axle(s) that will remain on the road when the vehicle is transported and they cannot be released by air pressure, manually compress and lock each spring so that the brakes are released. Refer to the manufacturer's instructions.

After Towing or Drive-Away

1. If an auxiliary air supply was used, apply the vehicle parking brakes using the switch inside the cab of the vehicle. If an auxiliary air supply was not used, begin with Step 2.
2. Apply the vehicle spring or parking brakes by manually releasing each spring that was compressed before transporting started. Refer to the manufacturer's instructions.
3. Disconnect the auxiliary air supply, if used, from the brake system of the vehicle that was transported. Connect the vehicle's air supply to the brake system.
4. Remove the covers from the hubs.
5. Install the gasket, if used, and axle shaft into the axle housing and carrier in the same location. The gasket and flange of the axle shaft must be flat against the hub. Rotate the axle shaft or the driveline as necessary to align the splines and the holes in the flange with the studs in the hub. Figure 11.7.
6. Install the dowels, if used, over each stud and into the tapered holes of the flange.
7. Install the washers and capscrews or stud nuts. Determine the size of the fasteners and tighten the capscrews or nuts to the torque value shown in Table AO.

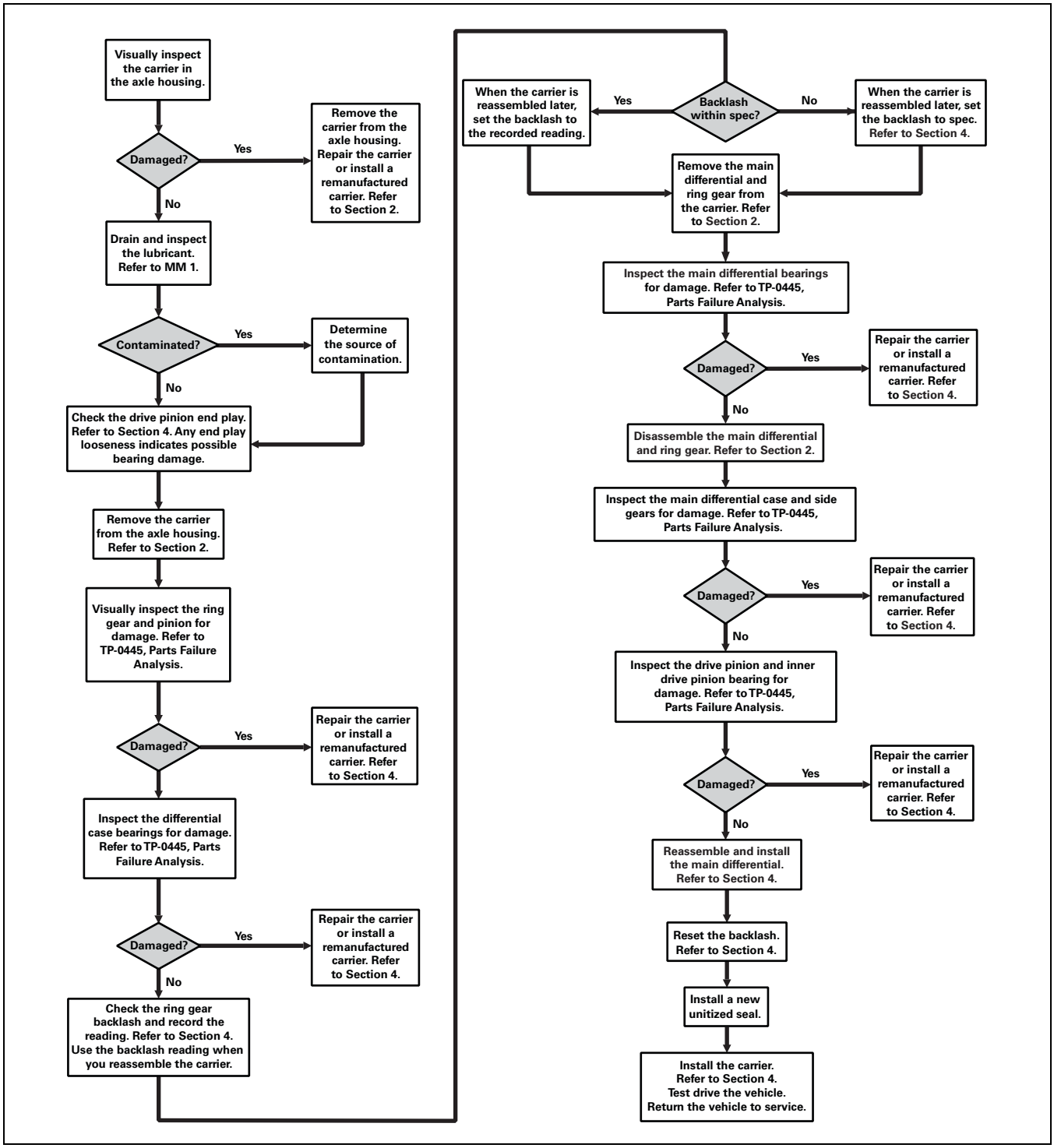
Table AO

Fastener	Thread Size	Torque Value lb-ft (N•m)
Capscrews	0.31"-24	18-24 (24-33)
	0.50"-13	85-115 (115-156)
Stud Nuts	0.44"-20	50-75 (68-102)
Plain Nut	0.50"-20	75-115 (102-156)
	0.56"-18	110-165 (149-224)
	0.62"-18	150-230 (203-312)
	0.75"-16	310-400 (420-542)
Locknut	0.44"-20	40-65 (54-88)
	0.50"-20	65-100 (88-136)
	0.56"-18	100-145 (136-197)
	0.62"-18	130-190 (176-258)
	0.75"-16	270-350 (366-475)

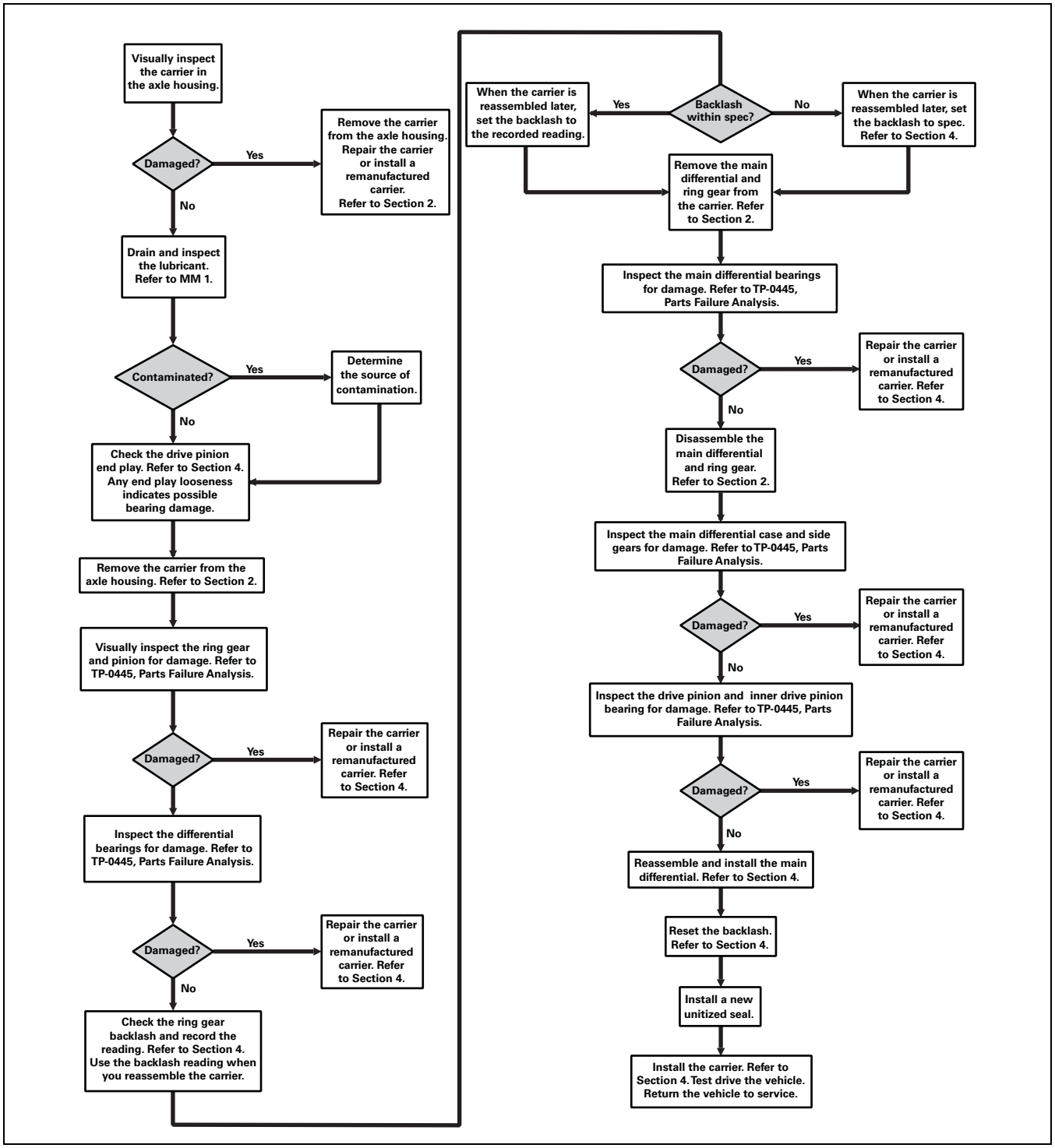
8. Check the lubricant level in the axles and hubs where the axle shafts were removed. Add the correct type and amount of lubricant if necessary. Refer to Section 7.

Troubleshooting

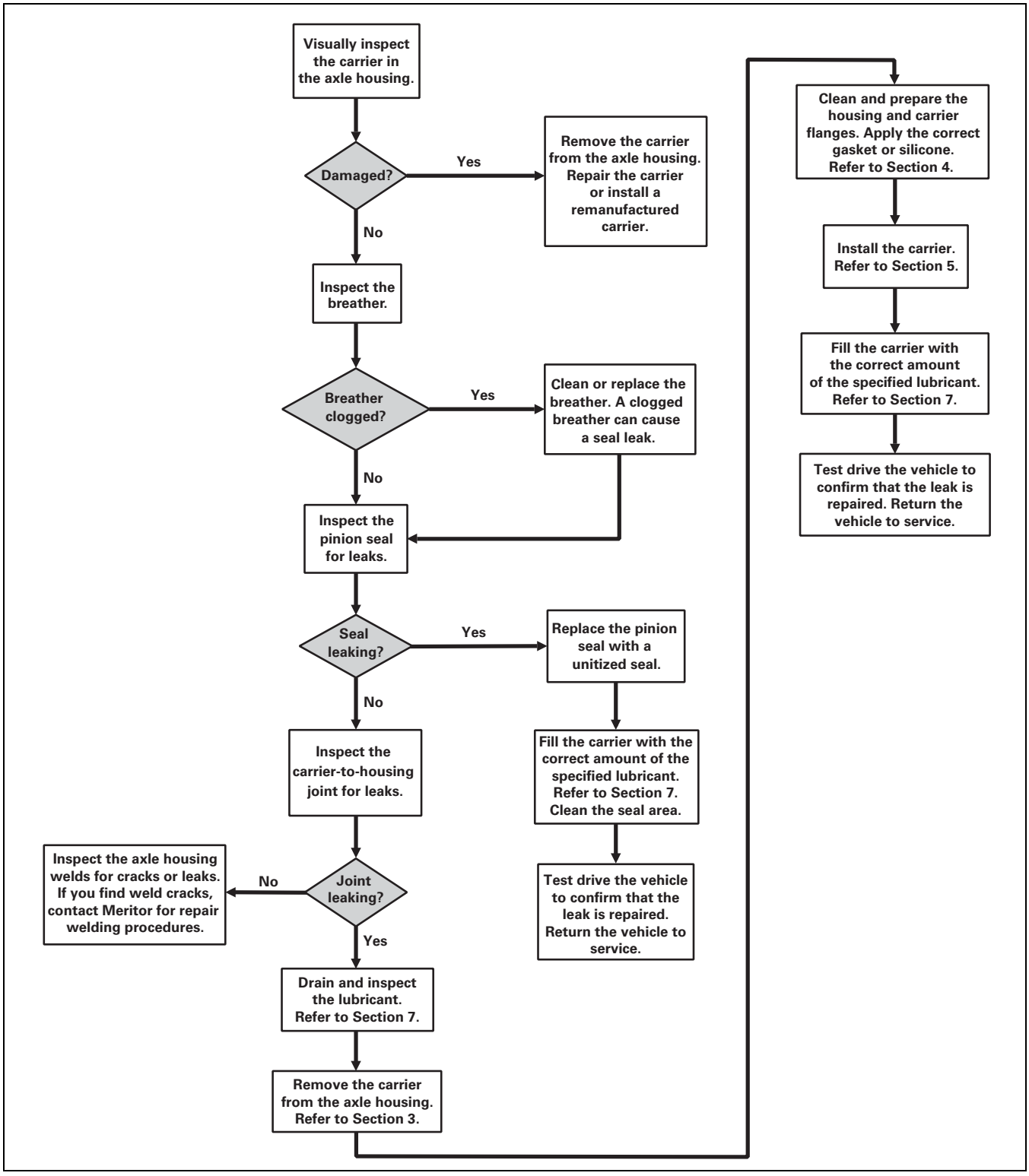
Vehicle Will Not Move



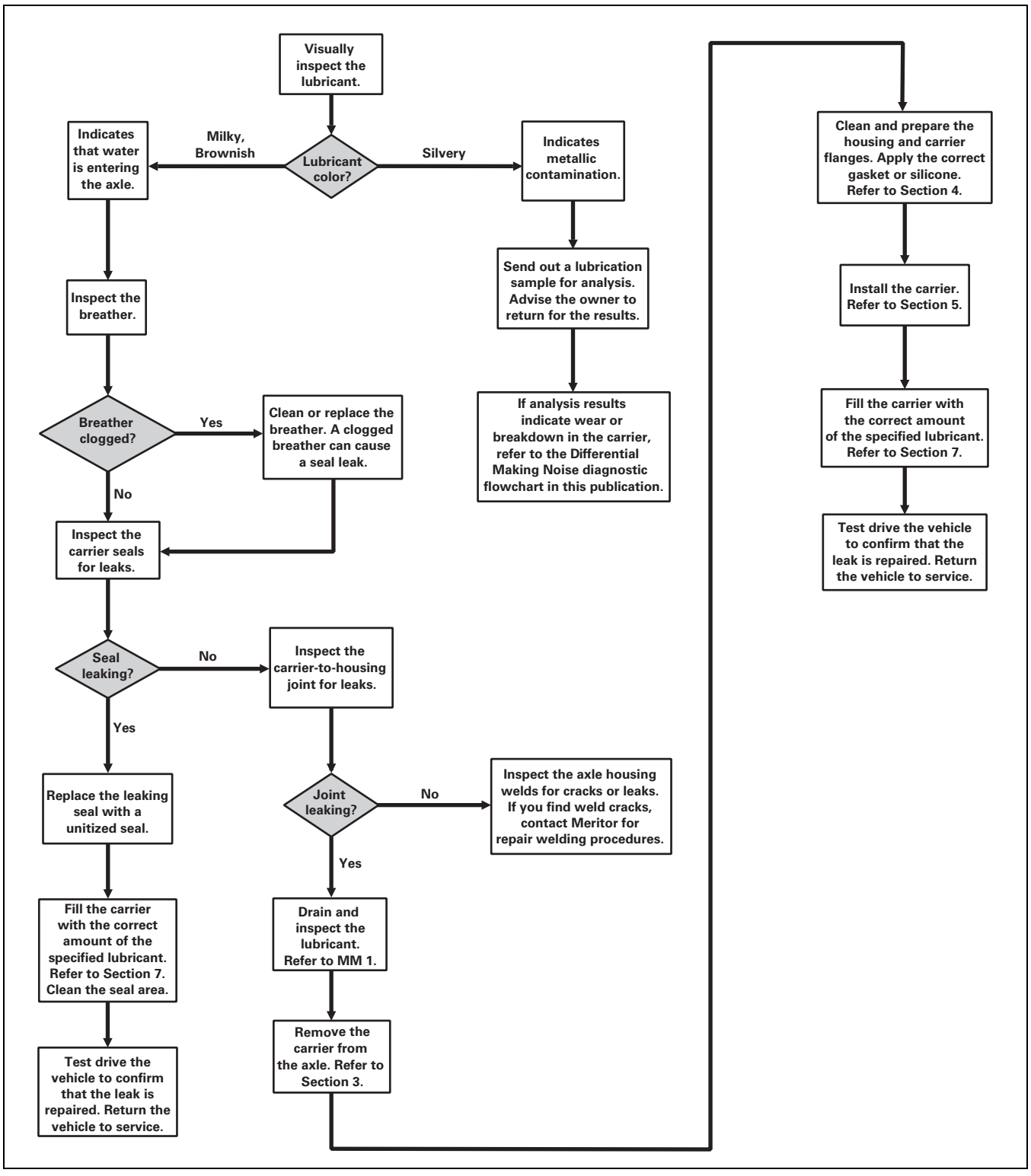
Differential Making Noise



Oil Leak


Visually inspect the carrier in the axle housing.
Damaged?
Yes
Remove the carrier from the axle housing. Repair the carrier or install a remanufactured carrier.
No
Inspect the breather.
Breather clogged?
Yes
Clean or replace the breather. A clogged breather can cause a seal leak.
No
Inspect the pinion seal for leaks.
Seal leaking?
Yes
Replace the pinion seal with a unitized seal.
No
Inspect the carrier-to-housing joint for leaks.
Fill the carrier with the correct amount of the specified lubricant. Refer to Section 7. Clean the seal area.
Test drive the vehicle to confirm that the leak is repaired. Return the vehicle to service.
Inspect the axle housing welds for cracks or leaks. If you find weld cracks, contact Meritor for repair welding procedures.
No
Joint leaking?
Yes
Drain and inspect the lubricant. Refer to Section 7.
Remove the carrier from the axle housing. Refer to Section 3.
Clean and prepare the housing and carrier flanges. Apply the correct gasket or silicone. Refer to Section 4.
Install the carrier. Refer to Section 5.
Fill the carrier with the correct amount of the specified lubricant. Refer to Section 7.
Test drive the vehicle to confirm that the leak is repaired. Return the vehicle to service.

Contaminated Lubricant Found During Preventive Maintenance



Meritor Heavy Vehicle Systems, LLC
2135 West Maple Road
Troy, MI 48084 USA
800-535-5560
arvinmeritor.com

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ArvinMeritor™

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1. AIR SYSTEM

The basic air system consists of an air compressor, reservoirs, valves, filters and interconnecting lines and hoses. It provides a means for braking; operating controls and accessories, and suspension (refer to Section 16, *"Suspension"*, for complete information on suspension description and maintenance). An air system schematic diagram is annexed in the technical publications box provided with the vehicle for better understanding of the system.

2. BRAKES

This vehicle uses both the service brake and emergency/parking brake. The service brake air system is divided into two independent circuits to isolate front brakes from rear brakes, thus providing safe braking in the event that one circuit fails. Front axle brakes operate from the secondary air system, while brakes on both the drive axle and tag axle operate from the primary air system.

NOTE
The tag axle service brake operates only when the axle is in normal ride position (loaded and down).

Furthermore, the brake application or release, which is speed up by a pneumatic relay valve (R-12), will start with the rear axles and will be followed by the front axle, thus providing uniform braking on a slippery road. The vehicle is also equipped with an Anti-Lock Braking System (ABS), which is detailed later in this section.

The drive axle is provided with spring-loaded emergency/parking brakes, which are applied automatically whenever the control valve supply pressure drops below 40 psi (275 kPa).

3. AIR RESERVOIRS

The air coming from the air dryer is first forwarded to the wet air tank, then to the primary (for the primary brake system), secondary (for the secondary brake system), and accessory (for the pneumatic accessories) air tanks (Fig. 1 & 2).

Two additional air reservoirs may be installed on the vehicle: the kneeling air tank and I-Shift transmission air tank.

3.1 MAINTENANCE

Ensure that the wet (main) air tank is purged during pre-starting inspection. In addition, it is good practice to purge this reservoir at the end of every working day. The remaining reservoirs must be purged at every 12,500 miles (or 20 000 km) or once every year, whichever comes first.

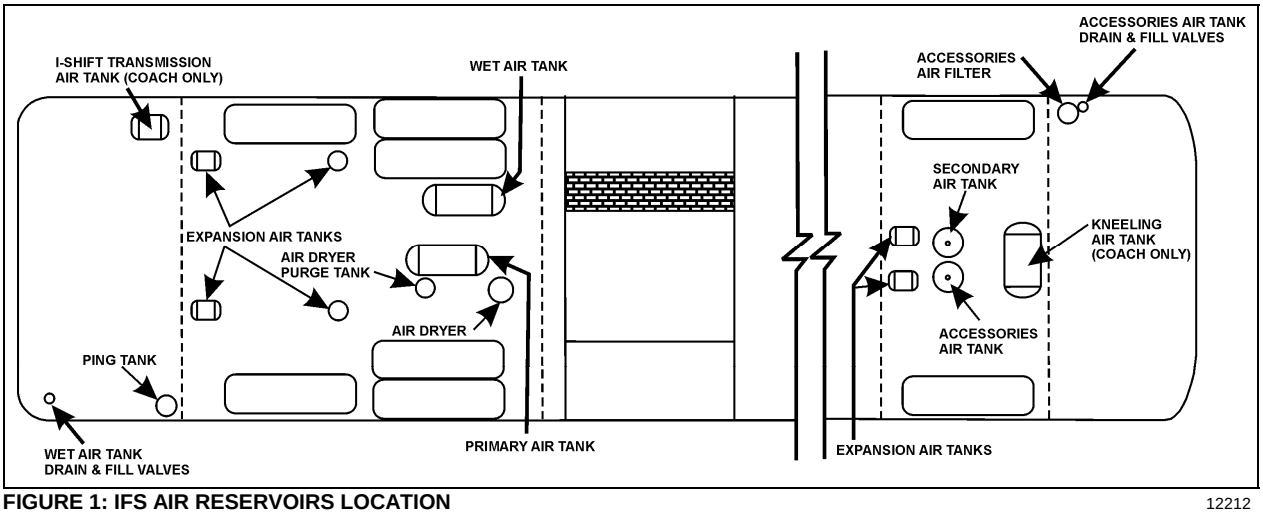


FIGURE 1: IFS AIR RESERVOIRS LOCATION 12212

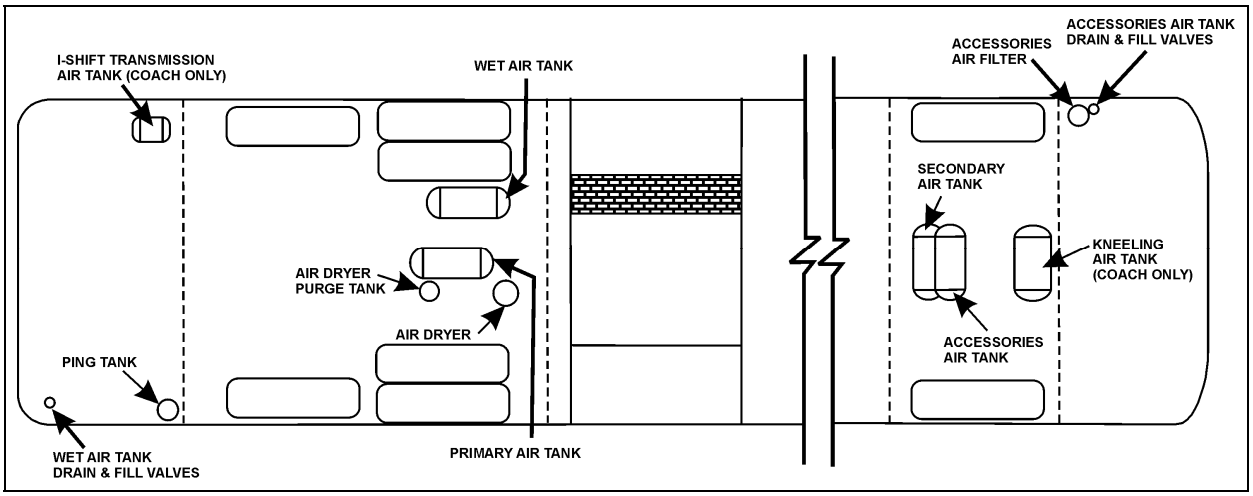


FIGURE 2: I-BEAM FRONT SUSPENSION AIR RESERVOIRS LOCATION 12213

3.1.1 Wet (Main) Air Tank

This reservoir, located above the L.H. wheel of drive axle in the rear wheelhousing, is provided with a bottom drain valve. A recommended purge using the bottom drain valve should be done every 12,500 miles (20 000 km), or once a year, whichever comes first.

3.1.2 Primary Air Tank

This reservoir is located above the R.H. wheel of the drive axle and is provided with a bottom drain valve (Fig. 1 & 2). It is recommended to purge the primary air tank every 12,500 miles (20 000 km) or once a year, whichever comes first.

3.1.3 Accessory Air Tank

The accessory air tank is installed close to the front axle and is provided with a bottom drain valve (Fig. 1 & 2).

Purge the reservoir by its drain valve every 12,500 miles (20 000 km) or once a year, whichever comes first.

3.1.4 I-Shift transmission Air Tank (Coaches Only)

Installed on vehicles equipped with this option, this reservoir is located in the engine compartment, above and in front of the radiator on the L.H. side of the vehicle (Fig. 1 & 2). It is provided with a bottom drain valve.

Purge this reservoir every 12,500 miles (20 000 km) or once a year, whichever comes first.

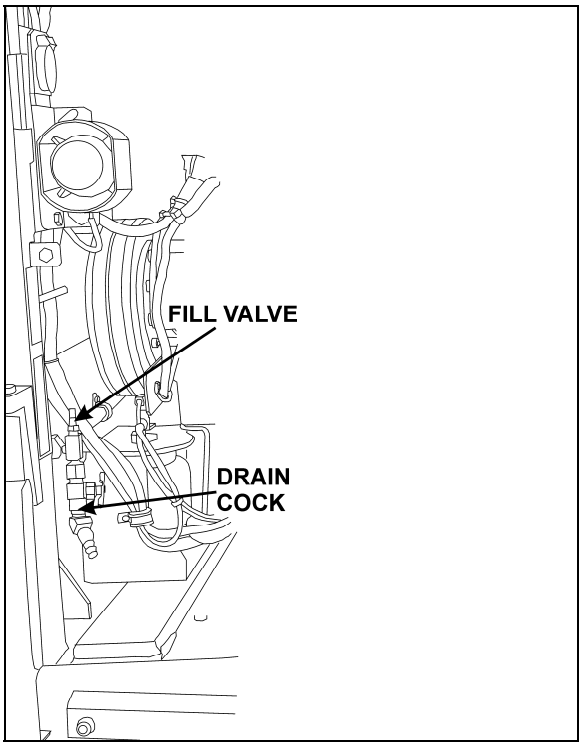


FIGURE 3: REAR VALVE LOCATION (TYPICAL) 12211

3.1.5 Secondary Air Tank

This tank is located in the front wheelhousing, behind the steering axle (Fig. 1 & 2). It is provided with a bottom drain valve.

Purge this reservoir every 12,500 miles (20 000 km) or once a year, whichever comes first.

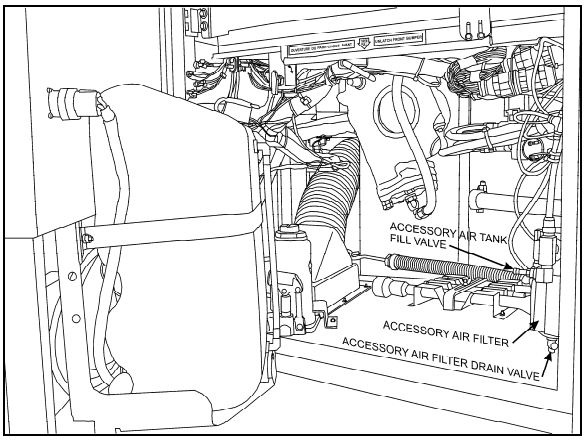


FIGURE 4: FRONT SERVICE COMPARTMENT 12210

3.1.6 Kneeling Air Tank (Coaches Only)

The kneeling air tank is installed on vehicles equipped with the Kneeling or Hi/Low-Buoy options. It is located in the front wheelhousing (Fig. 1 & 2), and is provided with a bottom drain valve.

3.2 PING TANK

The ping tank may be located behind the tag axle or in the engine compartment; in this case, it is accessible through the engine compartment R.H. side door. It is used to dissipate heat and to reduce noise produced by the air compressor cycling on and off.

4. AIR SYSTEM EMERGENCY FILL VALVES

All vehicles come equipped with two emergency fill valves that enable system pressurization by an external source such as an air compressor. The rear valve is located in the engine compartment and is accessible from engine R.H. side door (Fig 3). It is positioned close to the door opening.

⚠ CAUTION

Maximum allowable air pressure is 125 psi (860 kPa). Air filled through these two points will pass through the standard air filtering system provided by Prevost. Do not fill system by any point on the system.

The front valve is located in the front service compartment close to R.H. side of door frame (Fig. 4).

These two air system emergency fill valves are fitted with the same valve stems as standard tires, and can be filled by any standard external air supply line.

The rear air system emergency fill valve will supply air for all systems (brakes, suspension and accessories) while the front fill valve will supply air for accessories only.

5. ACCESSORY AIR FILTER

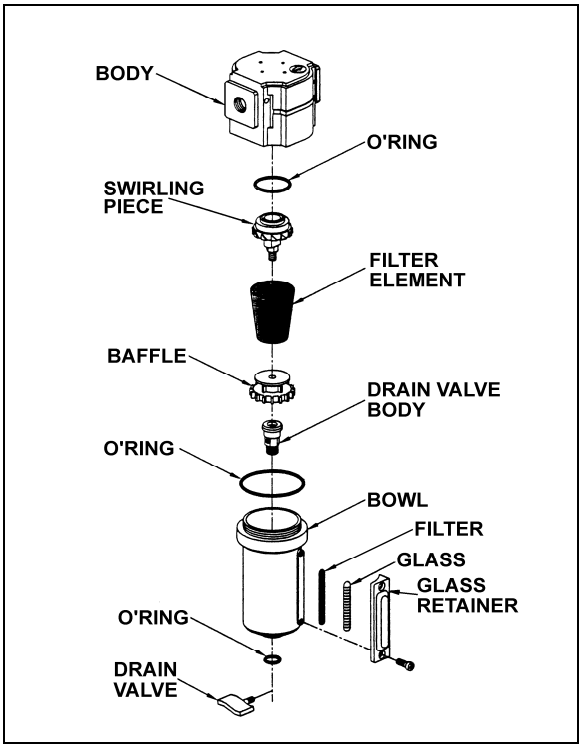


FIGURE 5: ACCESSORY AIR FILTER 12088

This filter is located inside the front service compartment (Fig. 4). Its main function consists in filtering the air supplied to the accessory air system, when connected to an external supply line. Ensure filter is purged whenever supplying the system with an external air line and at least every 12,500 miles (20 000 km). To purge, open drain valve (Fig. 4), let the moisture come out, then close the drain valve.

5.1 FILTER ELEMENT REPLACEMENT

Replace filter element whichever of the following occurs first: every 100,000 miles (160 000 km), every two years, or whenever differential pressure exceeds 15 psi (105 kPa) between filter inlet and outlet ports. Check condition of all three O'rings for damage. Replace when necessary (Fig. 5).

5.2 CLEANING

Clean filter body and bowl with a warm water and soap solution. Rinse thoroughly with clean water. Blow dry with compressed air making sure the air stream is moisture free and clean.

Pay particular attention to the internal passages. Inspect all parts for damage and replace if necessary.

6. AIR GAUGES (PRIMARY, SECONDARY AND ACCESSORY)

The air pressure gauges, located on the dashboard (see *"Operator's Manual"*), are connected to the DC-4 double check valve, located on the pneumatic accessory panel in the front service compartment.

The latter is connected to the air lines running from the primary and secondary air tanks, as shown on the pneumatic system diagram provided in the technical publications box. The accessory air gauge is connected to the accessory air tank using the drain valve connector. The vehicle should never be set in motion until the buzzer alarm and warning lights turn off, i.e. when air pressure registers at least 66 psi (455 kPa). Moreover, if pressure drops below 66 psi (455 kPa), the *"Low air pressure"* warning lights will turn on, and the *"Low air pressure"* buzzer will sound. Stop the vehicle immediately, determine and correct the cause(s) of pressure loss. Check the gauges regularly with an accurate test gauge. Replace the gauge with a new unit if there is a difference of 4 psi (27 kPa) or more in the reading.

7. AIR FILTER/DRYER

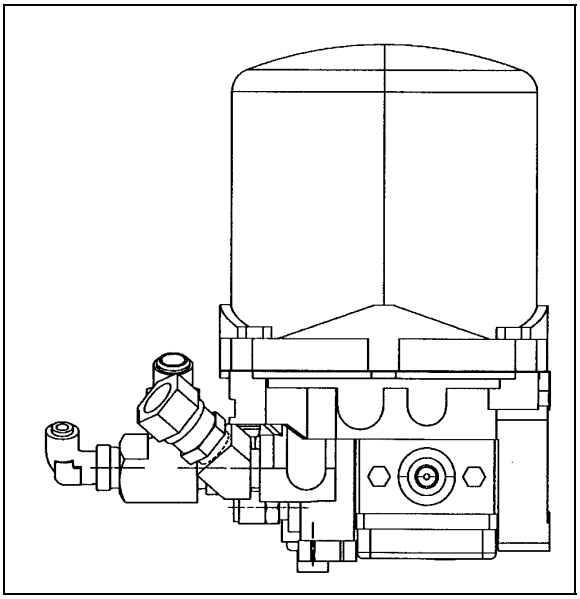


FIGURE 6: HALDEX AIR FILTER DRYER 12194

The air filter/dryer is located in front of rear wheelhousing above drive axle (Fig. 1, 2 & 6) or in the coolant heater compartment (Optional). Its purpose is to remove moisture that could damage the air system before the air enters the system reservoir. The air filter/dryer also filters the air to remove dirt, compressor oil, and other contaminants that can damage the system. Change cartridge every 100,000 miles (160 000 km) or once every two years, whichever comes first. The air dryer may be purged for maintenance purposes using the remote drain valve located in the engine compartment and accessible through the engine compartment R.H. side door. The valve is positioned close to the L.H. side of door opening (Fig. 3). The air filter/dryer has a built-in governor to maintain the system between 108 psig and 123 psig.

Maintenance and repair information is supplied in the maintenance information annexed to this section.

7.1 AIR FILTER/DRYER PURGE TANK

A tank is supplied to purge the air filter/dryer to remove moisture and contaminants.

8. AIR LINES

Copper piping, nylon-reinforced tubing, and flexible hoses are used to connect the units in the pneumatic system, including air brake system, suspension system and accessory systems such as the entrance door, fresh air damper cylinder, air horns, etc. Furthermore, the nylon tubing is color coded to ease identification. Refer to the following table for the complete color identification code. Service instructions for each type of air line are also provided under the applicable headings.

Color	Circuit
Red	Secondary
Green	Primary and Delivery
Yellow	Parking Brake
Blue	Suspension
Black	Accessory
Brown	Trailer Brake

8.1 COPPER PIPING

A heat dissipation copper piping assembly is used to dissipate the heat coming from the compressor before it enters the air filter/dryer. Connections should be checked for leakage at least every 6,250 miles (10 000 km) or twice a year, whichever comes first. Tighten or replace

when necessary. When replacing copper piping, the parts must be free of burrs, copper cuttings, and dirt. Blow out piping with compressed air. Any such particles will destroy sealing seats in air control units. Also, new piping must be the same size as the old one.

8.2 FLEXIBLE HOSES

A flexible hose is used normally where it is impractical to use copper or nylon tubing due to constant flexing during operation, such as brake chamber hoses. Hose connections should be tested for leakage at least every 6,250 miles (10 000 km) or twice a year, whichever comes first and tightened or replaced if necessary. Any hose which is chafed, worn or kinked should be replaced.

Teflon-braided stainless steel hoses used in the engine compartment must be replaced only with similar hoses.

8.3 NYLON TUBING

Nylon tubing is used for air lines in areas where usage of this material is suitable. Nylon tubing is flexible, durable, and weather resistant. When replacing an air line, use nylon tubing only where it has been used previously.

Nylon air lines must never be routed in areas where temperature could exceed 200°F (93°C).

⚠ CAUTION

Nylon air lines should be used to replace existing nylon lines only, and must comply with the color identification code to ease pneumatic system troubleshooting.

8.4 AIR LINE OPERATING TEST

If any trouble symptom such as slow brake application or slow brake release indicates a restricted or clogged air line, disconnect the suspected tube or hose at both ends and blow through it to clear the passage.

Inspect tubing and hose for partial restriction that may be caused by dents or kinks. If such a condition is found, the tubing or hose should be replaced.

8.5 AIR LINE LEAKAGE TEST

With air system fully charged and the brakes applied, coat all tubing and hose connections with a soapy solution to check for air leakage. No leakage is permitted. Leakage can sometimes be corrected by tightening the connection. If this fails to correct the leakage, new fittings, nylon tubing, copper tubing, teflon-braided stainless steel and flexible hoses must be installed as applicable.

8.6 MAINTENANCE

Inspect all lines for cuts, swelling, kinks or other damage or deterioration. Check for lines being pinched by other components. Retaining clips and ties must be in place.

Any support or bracket should be in good condition and mounted firmly in position. Hose spring guards should be in usable condition and not distorted. Particular attention should be given to long lines. Any supporting component (clips, ties, grommets, etc.) must be secured to prevent against unnecessary vibration and eventual loosening of connection. Any detected leak should be repaired. Be sure nylon lines are not near areas of intense heat. Check for any missing grommets or loose material where chafing or cutting may occur. Replace with new material as required. In general, lines should be securely located in position and free from any binding condition which would hinder air flow.

9. PRESSURE REGULATING VALVES

There is one pressure regulator for the belt tensioners, and an optional one installed on vehicles equipped with the World transmission output retarder.

The belt tensioner pressure regulating valve is located in the engine compartment above the engine air filter and is used to limit the air pressure in belt tensioners to 45 ± 2 psi (310 ± 15 kPa) (Fig. 7).

The optional regulator is located in the engine compartment, on the engine cradle R.H. side (accessible through the engine R.H. side door). It is used for transmission retarder and should be adjusted to 85 ± 3 psi (586 ± 20 kPa).

	Air Pressure (psi)	Air Pressure (kPa)
Belt Tensioner	45	310
Retarder	85	586

9.1 MAINTENANCE

Every 100,000 miles (160 000 km) or once every two years, whichever comes first, disassemble the regulating valve and wash all metal parts in a cleaning solvent (Fig. 7). Examine the diaphragm; if cracked, worn or damaged, replace with a new one. If the valve is excessively grooved or pitted, it should be replaced. Replace any other part that appears worn or damaged. After reassembly, adjust to the specified pressure setting and check for air leakage.

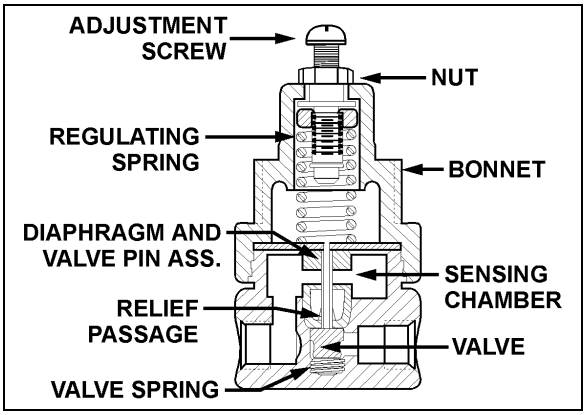


FIGURE 7: AIR PRESSURE REGULATING VALVE 12141A

9.2 PRESSURE SETTING PROCEDURE

Remove the dust cap from the pressure check valve (Fig. 8). Attach a pressure gauge at this port and check the pressure reading. If the pressure reading is incorrect, adjust as follows:

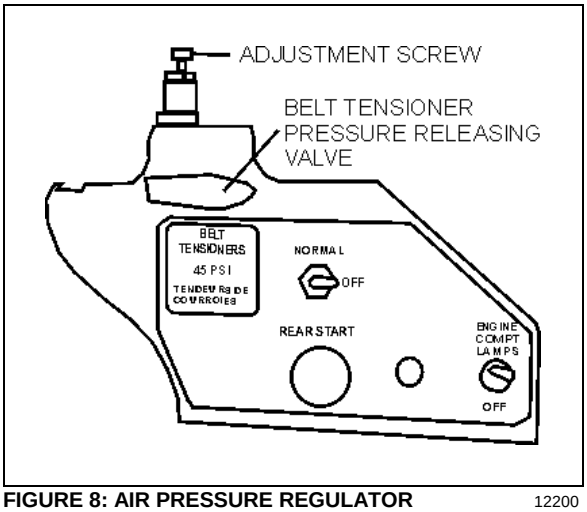


FIGURE 8: AIR PRESSURE REGULATOR 12200

1. Loosen the locking nut, turn the adjustment screw counterclockwise to decrease pressure by approximately 10 psi (70 kPa) below the required pressure.
2. Turn the adjustment screw clockwise to increase the pressure slowly until the required pressure setting is reached. Tighten the locking nut.
3. Remove pressure gauge and replace dust cap on the air pressure check valve.

10. AIR COMPRESSOR

The Wabco System Saver 636 Twin Cylinder air compressor is located on the alternator side of the engine, at the flywheel end (Fig. 9). Its function is to provide and maintain air under pressure to operate devices in brake and air systems.

The compressor is driven by the ring gear, and is water cooled. Engine coolant is fed to the compressor through a flexible hose tapped into the block water jacket and connected to the rear of the compressor. Coolant returns from the top of the compressor (governor side) through a flexible hose to the engine pump.

The air is taken from the air intake manifold and entered in the top of the compressor. The compressed air is pushed into the discharge line located on side of the compressor, which sends air to the air dryer. Lubricating oil is supplied to the compressor by a line from the cylinder block oil gallery connected to the air compressor. Lubricating oil returns to the engine crankcase through the air compressor drive assembly.

Maintenance and repair information on the Wabco 636 Twin Cylinder air compressor is supplied in the applicable booklet annexed at the end of this section.

Item	Description	Notes
1	Air Compressor	Wabco 636
2	O'Ring	
3	Stud (3)	M12
4	Flange Nut (3)	Torque to 15lb-ft (20 Nm)
5	Nipple (2)	
6	Hose Assembly	

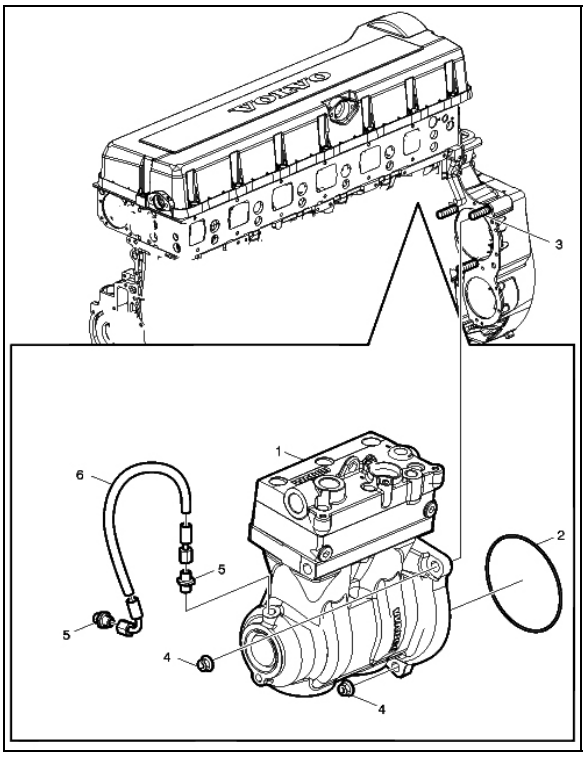


FIGURE 9: AIR COMPRESSOR LOCATION 03061

10.1 COMPRESSOR REMOVAL AND INSTALLATION

1. Exhaust compressed air from air system by opening the drain valve of each air tank.
2. Drain the engine cooling system. See Section 5: "*Cooling System*".
3. Access the compressor by the engine R.H. side compartment. Identify and disconnect all air, coolant and oil lines from the compressor assembly.
4. Remove the three compressor flange mounting nuts.
5. Slide air compressor rearward to disengage the hub from coupling. Remove the air compressor.

Remove and retain the oil supply tube that runs between the compressor and the engine

Reverse removal procedure for installation.

11. EMERGENCY/PARKING BRAKE CONTROL VALVE (PP-1)

¢lateral console is provided for parking brake application or release. The spring brakes are self-actuated whenever the control valve supply pressure drops below 60 psi (414 kPa). In the UP position, brakes are ON. In the DOWN position, brakes are RELEASED. A protective case around the knob prevents accidentally releasing the brakes.

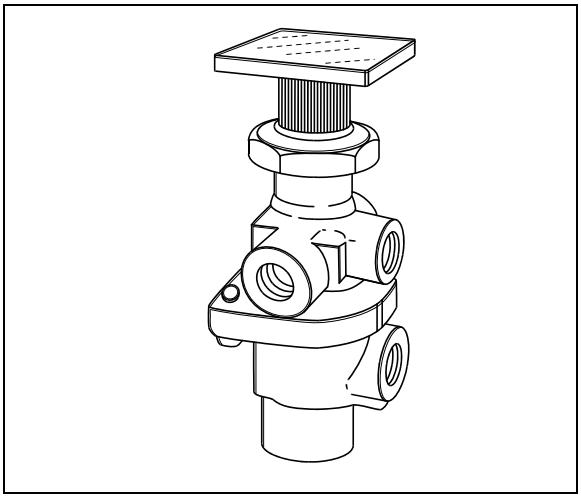


FIGURE 10: PP-1 12142

Maintenance and repair information on this valve is supplied in the applicable booklet annexed to this section under reference number SD-03-3611.

Remove the valve the following way:

1. Drain the air system.
2. Access this valve by tearing out the finishing panel, which holds the controls in place (Fig. 10).
3. Disconnect the air tubes.
4. Remove the retaining screws.
5. Service or replace the valve.
6. Installation is the reverse of removal.

12. EMERGENCY / PARKING BRAKE OVERRULE CONTROL VALVE (RD-3)

A RD-3 control valve is used with the optional parking brake overrule system. In the case of self-application of spring brakes due to a pressure drop, the brakes can be released by holding down this control valve. Maintenance and repair information on this valve is supplied in the applicable booklet annexed to this section under reference number SD-03-3611.

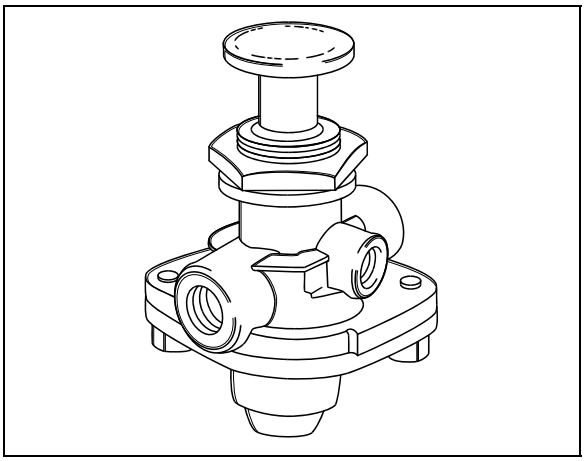


FIGURE 11: RD-3 12136

13. FLIP-FLOP CONTROL VALVE (TW-1)

A flip-flop control valve mounted on the L.H. lateral console is provided to unload tag axle air springs (and to lift tag axle if vehicle is so equipped). Another one controls the low-buoy system (coaches only). It is a manually operated "on-off" valve. Maintenance and repair information on this valve is supplied in the applicable booklet annexed to this section under reference number SD-03-3602.

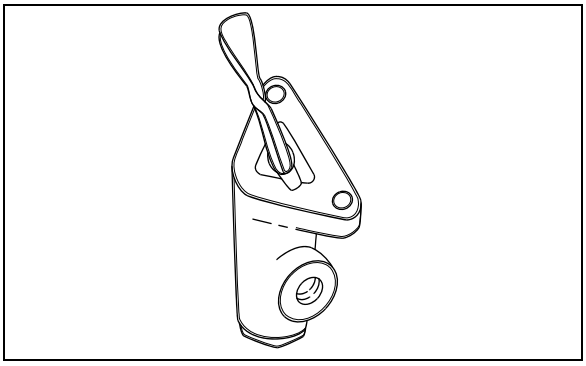


FIGURE 12: TW-1 12138

14. DUAL BRAKE APPLICATION VALVE (E-10P)

The E-10P dual brake valve is a floor mounted, foot-operated type brake valve with two separate supply and delivery circuits. This valve is located in the front service compartment (Fig. 13).

14.1 BRAKE PEDAL ADJUSTMENT

After brake pedal replacement or repair, adjust the pedal to its proper position according to the following procedure:

1. Replace the linkage, loosen threaded rod lock nuts and screw or unscrew the threaded adjustment rod in order to obtain a 45° brake pedal inclination (Fig. 13).
2. Tighten threaded rod lock nuts.

14.1.1 Maintenance

Maintenance and repair information on the E-10P dual brake application valve is supplied in the applicable booklet annexed to this section under reference number SD-03-830.

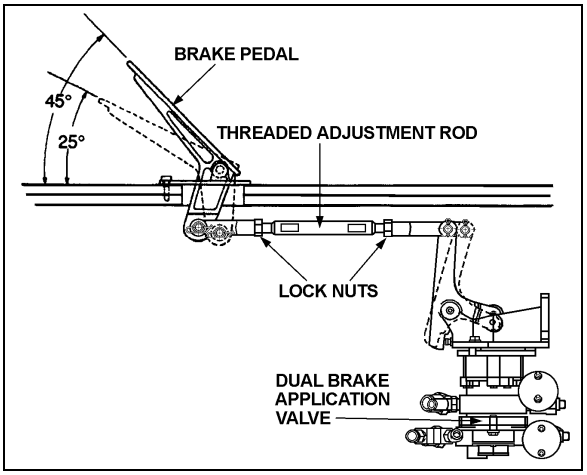


FIGURE 13: BRAKE PEDAL ADJUSTMENT 12208

15. STOPLIGHT SWITCHES

Two electro-pneumatic stoplight switches are mounted on the dual brake application valve (E-12). The upper one is used for the primary air circuit while the lower one is used for the secondary air circuit. Both switches are connected in parallel and have the same purpose, i.e. completing the electrical circuit and lighting the stoplights when a brake application is made. The upper switch (AC Delco) is designed to close its contact between 2 psi and 4 psi (14 kPa to 28 kPa) (Fig. 14), while the lower one (Bendix, SL-5) closes its contact at 4 psi (28 kPa) (Fig. 15). The switches are not serviceable items; if found defective, the complete unit must be replaced.

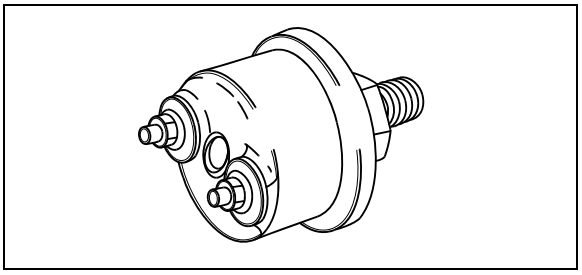


FIGURE 14: **DELCO SWITCH** 12139

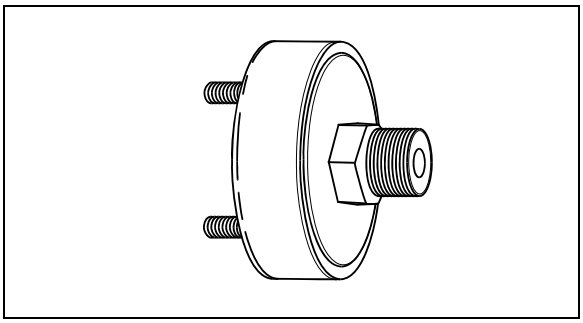


FIGURE 15: BENDIX SWITCH 12140

16. PARKING BRAKE ALARM SWITCH

Refer to the appropriate annexed booklet (Bendix, SL-5 Stop Light Switch; reference no. SD-06-2501).

The parking brake alarm uses the same switch as the stoplights. It is mounted on the spring brake valve and operates in conjunction with a NC relay to sound a warning alarm by completing the electrical circuit when the ignition key is turned OFF with parking brake released.

17. BRAKE RELAY VALVE (R-12 & R-14)

The primary air system includes three brake relay valves being supplied by the dual brake valve, and which function is to speed up the application and release of the service brakes.

One Wabco R-14 valve located in the rear underframe supplies the drive axle service brake air line, while the other two R-12 valves supply independently both the tag axle right and left service brake air line and act as interlock valves. These valves are accessible from under the vehicle at the level of the tag axle. Maintenance and repair information on these valves is supplied in the applicable booklet annexed to this section under reference number SD-03-1064.

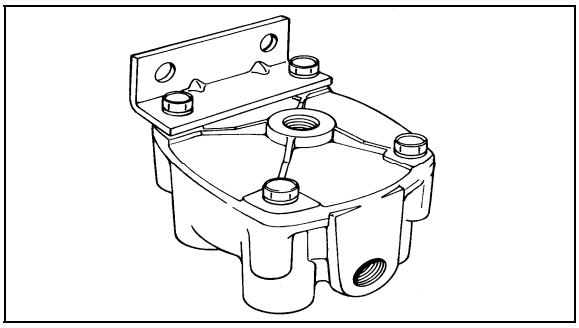


FIGURE 16: R-12 12074

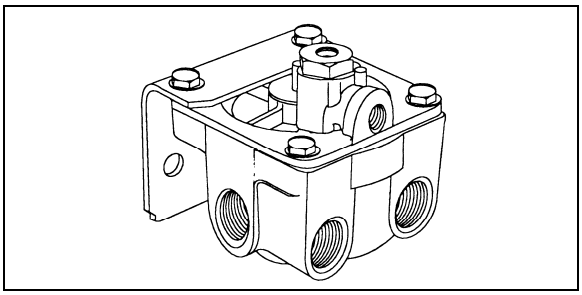


FIGURE 17: R-14 12207

18. QUICK RELEASE VALVES (QR-1)

The quick release valve is located on the front axle service brakes air line and permit rapid exhaust of air pressure from brakes, thus decreasing the brake release time.

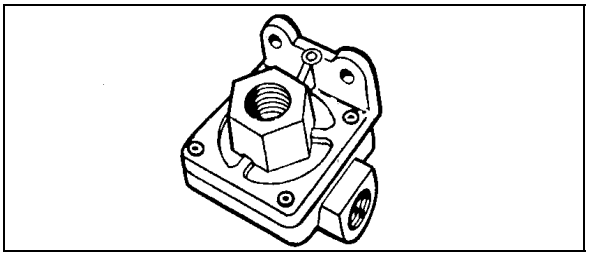


FIGURE 18: QR-1 12075

Maintenance and repair information on this valve is supplied in the applicable booklet annexed to this section under reference number SD-03-901.

19. SPRING BRAKE VALVE (SR-7)

The spring brake valve is located in the rear underframe. The SR-7 Modulating Valve is used in conjunction with a dual air brake system and spring brake actuator and performs the following functions:

- Provides a rapid application of the spring brake actuator when parking.
- Modulates the spring brake actuator application using the dual brake valve should a primary failure occur in the service brake system.
- Prevents compounding of service and spring forces.

Maintenance and repair information on the spring brake valve is supplied in the applicable booklet annexed to this section under reference number SD-03-9043.

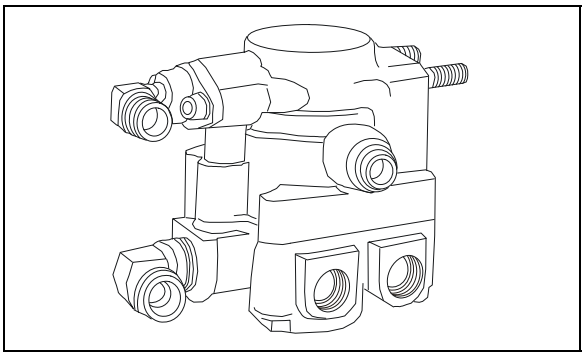


FIGURE 19: SR-7 12206

20. PRESSURE PROTECTION VALVE (PR-4)

Maintenance and repair information on the pressure protection valve is supplied in the applicable booklet annexed to this section under reference number SD-03-2010.

The air system includes two pressure protection valves (Fig. 20). One valve is installed on the manifold block, and insures at all times a minimum pressure of 70 psi (482 kPa) in the suspension air system in the event that a pressure drop occurs in either the suspension air system or accessory air system. This valve is located in the front service compartment beside the air filter.

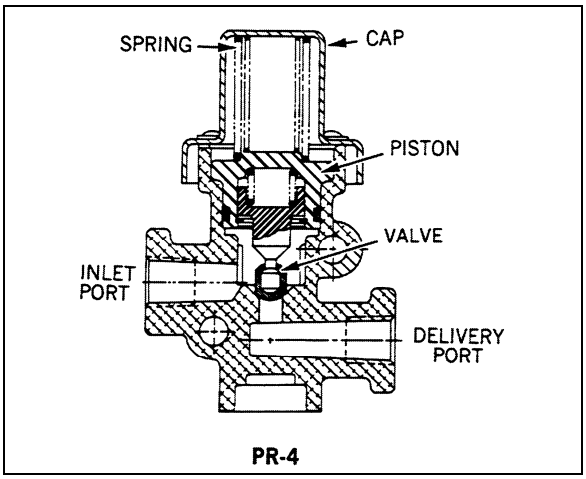


FIGURE 20: PR-4 12174

The other valve is installed on the accessory air tank, and insures a minimum pressure of 70 psi (482 kPa) in the accessory air system in the event that a pressure drop occurs in either the suspension air system or braking air system (refer to Fig. 1 & 2 for accessory air tank location).

21. LOW PRESSURE INDICATOR (LP-3)

Maintenance and repair information on the low pressure indicators is supplied in the applicable booklet annexed to this section under reference number SD-06-1600.

The air system includes two low pressure switches (Fig. 21), both located on the pneumatic accessory panel in the front service compartment. One serves for the parking brake signal, its pressure setting is 66 ± 6 psi (455 ± 40 kPa). The remaining pressure switch monitors the parking brake telltale panel indicator; its pressure setting is 30 psi (205 kPa).

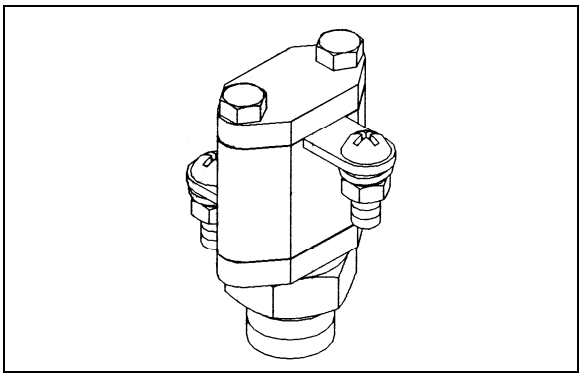


FIGURE 21: LP-3 12214

22. SHUTTLE-TYPE DOUBLE CHECK VALVE (DC-4)

Maintenance and repair information on the shuttle-type double check valve is supplied in the applicable booklet annexed to this section under reference number SD-03-2202.

The double check valve is located on the pneumatic accessory panel in the front service compartment. In the event of a pressure drop in either the primary or secondary system, this unit will protect the emergency /parking brake control valve and the intact portion of the air system from pressure loss.

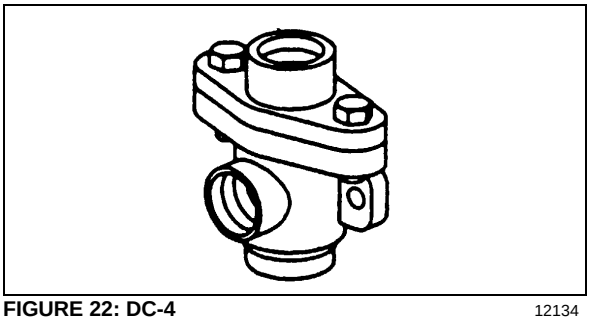


FIGURE 22: DC-4 12134

23. EMERGENCY DOOR OPENING VALVES (COACHES ONLY)

Two emergency door opening three-way valves are installed on coaches. One is in the front service compartment, readily accessible. The other one is on the R.H. side lateral console, close to the entrance door. When used, the valve releases pressure in the door locking cylinder, thus allowing the door to be manually opened.

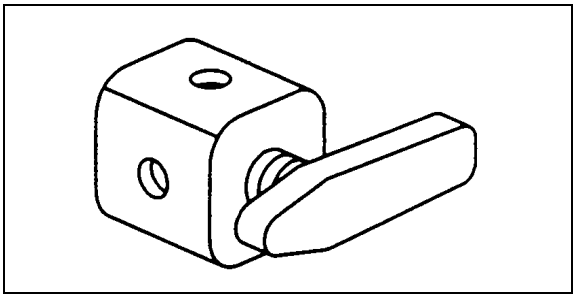


FIGURE 23: THREE-WAY VALVE 12186

24. AIR HORN VALVE

The air horn valve is located in the L.H. front service compartment. The air horn button is on the center of the steering wheel. Refer to section 23 “ACCESSORIES” for more information.

25. AIR SYSTEM TROUBLESHOOTING

The following list has been designed to help in troubleshooting some of the most common problems in the air system and main causes. For air brakes troubleshooting, refer to “*Air Brakes Troubleshooting”* in this section. For more troubleshooting information, refer to the manufacturer's brochures annexed to this section.

Air pressure doesn't rise to, or doesn't maintain, a normal setting:

- Defective air gauge (registering incorrectly).
- Excessive leaking in air system.
- Reservoir drain cock open.
- Governor poorly adjusted or defective.
- Defective compressor.
- Worn compressor or excessive wear on piston and/or ring.
- Air pressure rises to normal setting too slowly.

Excessive leaking in air system:

- Clogged engine air cleaner.
- Worn compressor or excessive wear on piston and/or ring.
- Engine speed too low.

Air pressure rises above a normal setting:

- Defective air gauge (registering incorrectly).
- Governor poorly adjusted or defective.
- Restriction in line between governor and compressor unloading mechanism.

Air pressure drops quickly when engine is stopped:

- Leaks in compressor discharge valve.
- Leaks in governor.
- Leaks in air lines.
- Leaks in air system valves.

26. BRAKE OPERATION

The vehicle braking system uses both service and parking air-operated brakes. The air system is divided into two independent circuits to isolate the front axle brakes and the rear axle brakes (drive and tag), thus providing safe brake operation in the event that one circuit of the system fails. The primary circuit is connected to the drive and tag axle brakes, while the secondary circuit is connected to the front axle brakes. The tag axle service brakes operate only when the axle is in the normal driving (loaded) position. The spring-type emergency brakes are mounted on the drive axle, and will apply automatically if primary system pressure falls below 40 psi (276 kPa).

Furthermore, brake application or release, which is speed up by a pneumatic relay valve (R-12), will start with the rear axles and be followed by the front axle, thus providing uniform braking on a slippery surface. The vehicle is also equipped with an Anti-lock Brake System (ABS), detailed later in this section.

Brake and air system maintenance consists of periodic inspections. Check all parts for damage and brake adjustment (refer to subsequent headings in this section for more details). Ensure all fasteners are tight (refer to “*Specifications”* for recommended tightening torques).

27. AIR BRAKES

DISC BRAKES

Knorr-Bremse SN7000 disc brakes are used on all axles. The front and drive axle discs are actuated by 24 square inch effective area air brake chambers, while on tag axle, the brake chambers have a 14 or 16 square inch effective area for service. The *Knorr-Bremse SN7000* brakes are supplied with automatic clearance (slack) adjusters as standard equipment for easier adjustment. For more information on disc brake components and scheduled maintenance, refer to Knorr-Bremse Service Manual at the end of this section.

27.1 CHECKING DISC BRAKE PADS

Brake pads have to be checked on a regular basis depending on the vehicle operation. The remaining thickness of the pads should never be less than 3/32 in (2 mm). When replacing brake pads, all four pads on an axle have to be changed at the same time. There is no inner or outer pad, since all pads are the same. Once removed, worn pads should be replaced in their original position.

27.1.1 Type A – Vehicles Equipped With a Rubber Bushing That is Axially Ribbed

The condition of the Pads can be visually determined, without removing the road wheel, by viewing the position of the wear marking “G” (change-over from the ribbed area to the flat area). New Condition (see “X”) Shown by the position of the wear marking ‘G’ on the Rubber Bush (6a). The wear limit (see “Z”) Shown by the new position of the wear marking “G” on the Rubber Bush (6a). This condition requires a check of the brake pad thickness and the brake disc with the wheel removed. If necessary change the Pads and/or the Disc - see Vehicle Manufacturer’s recommendations.

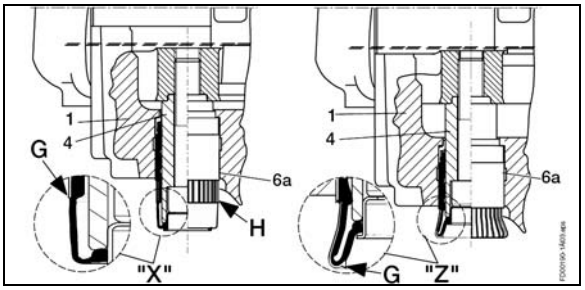


FIGURE 24: BRAKE PAD CHECK 12117

27.1.2 Type B – Vehicles Equipped With a Mechanical Wear Indicator

The condition of the pads can be visually determined without removing the road wheel by viewing the position of caliper compared to the tip of the wear indicator (A).

If the side of the caliper (flat surface around guide pin) lines up with the tip of the wear indicator, the brake pad thickness and the brake disc must be checked with the wheel removed. If necessary change the pads (refer to Knorr-Bremse Service Manual at the end of this section) and/or the disc.

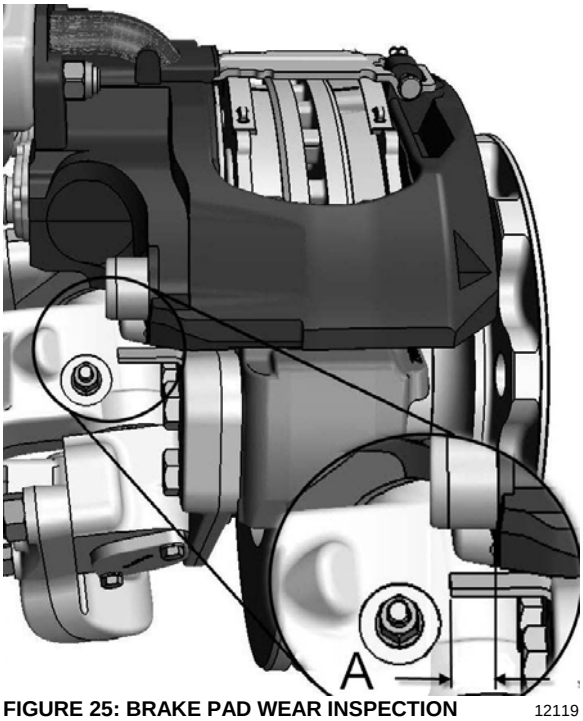


FIGURE 25: BRAKE PAD WEAR INSPECTION 12119

27.2 CALIPER RUNNING CLEARANCE

The Knorr/Bendix air disc brake is designed to move freely, with minimal force. By pushing and pulling the caliper in an axial direction by hand (see arrow A in Figure 26), a movement of 0.6 - 1.1 mm must be possible.

If, even using a high level of hand pressure (no tools), the caliper is not moveable, the caliper guidance must be further examined.

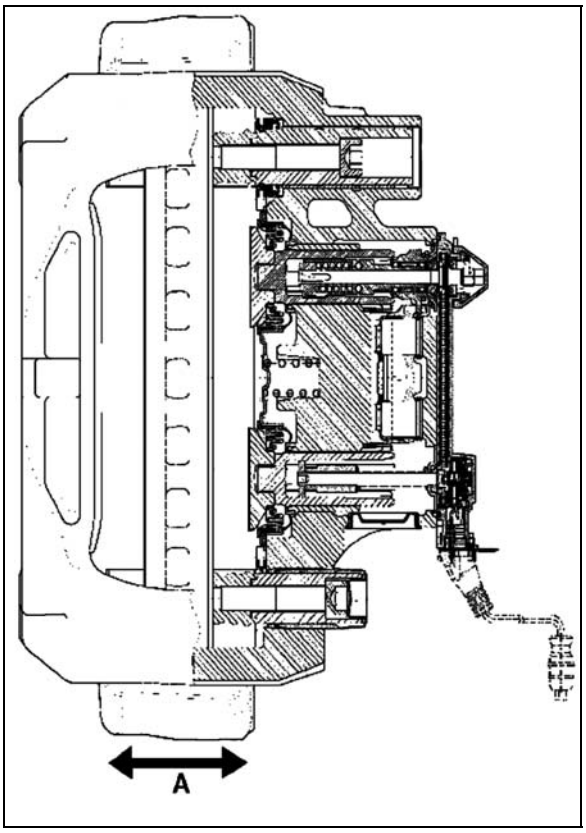


FIGURE 26: RUNNING CLEARANCE 12116

27.3 TORQUE SPECIFICATIONS

For proper caliper maintenance, refer to the following figures.

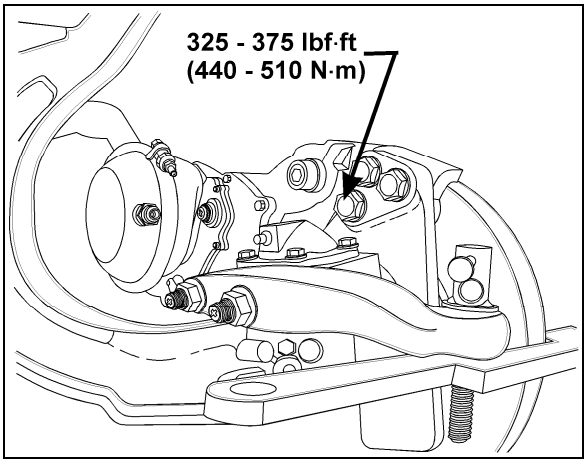


FIGURE 27: TORQUE SPECIFICATION 12145

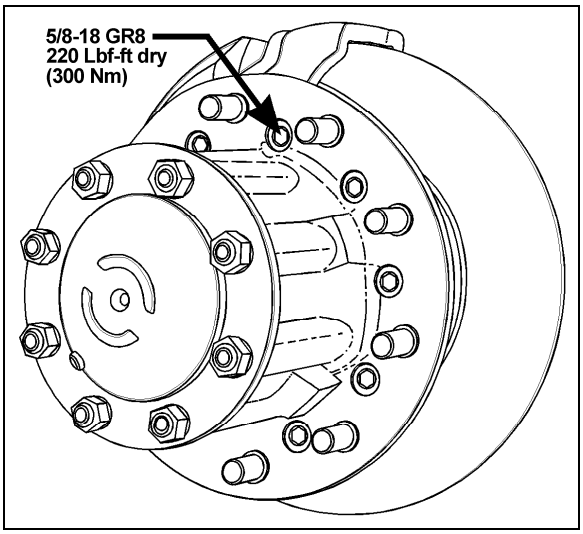


FIGURE 28: TORQUE SPECIFICATION 11030

28. SAFE SERVICE PROCEDURES

Most recently manufactured brake linings no longer contain asbestos fibers. Instead of asbestos, these linings contain a variety of ingredients, including glass fibers, mineral wool, aramid fibers, ceramic fibers, and carbon fibers. At present, OSHA (Occupational Safety and Health Administration) does not specifically regulate these non-asbestos fibers, except as nuisance dust. Medical experts do not agree about the potential long-term risks from working with and inhaling non-asbestos fibers. Nonetheless some experts think that long-term exposure to some non-asbestos fibers could cause diseases of the lung, including pneumoconiosis, fibrosis, and cancer. Therefore, lining suppliers recommend that workers use caution to avoid creating and breathing dust when working on brakes that contain non-asbestos fibers.

WARNING

Whenever possible, work on brakes in a separate area away from other operations.

Always wear a respirator approved by NIOSH (National Institute of Occupational Safety and Health) or MSHA (Mine Safety and Health Administration) during all brake service procedures. Wear the respirator from removal of the wheels through assembly.

WARNING

NEVER use compressed air or dry brushing to clean brake parts or assemblies. OSHA recommends that you use cylinders that enclose the brake. These cylinders have vacuums with high efficiency (HEPA (Health and Environment Protection Agency)) filters and workmans' arm sleeves. But, if such equipment is not available, carefully clean parts and assemblies in the open air.

Clean brake parts and assemblies in the open air. During disassembly, carefully place all parts on the floor to avoid getting dust into the air. Use an industrial vacuum cleaner with a HEPA filter system to clean dust from the brake drums, backing plates and other brake parts. After using the vacuum, remove any remaining dust with a rag soaked in water and wrung until nearly dry.

If you must grind or machine brake linings, take additional precautions because contact with fiber dust is higher during these operations. In addition to wearing an approved respirator, do such work in an area with exhaust ventilation.

When cleaning the work area, NEVER use compressed air or dry sweeping to clean the work area. Use an industrial vacuum with a HEPA filter and rags soaked in water and wrung until nearly dry. Dispose of used rags with care to avoid getting dust into the air. Use an approved respirator when emptying vacuum cleaners and handling used rags.

Wash your hands before eating, drinking or smoking. Do not wear your work clothes home. Vacuum your work clothes after use and then launder them separately, without shaking, to prevent fiber dust from getting into the air.

Material safety data sheets on this product, as required by OSHA, are available from Rockwell and Knorr-Bremse.

29. AIR BRAKE TROUBLESHOOTING

The following tests and check lists have been designed to identify the cause(s) of a sluggish performance and/or leaks in the system. These tests require very little time to perform, and give you a general idea of the system condition. Each test is provided with a corresponding check list which will guide you to the most common causes of problems.

Before performing any test, check all air lines for kinks or dents, and hoses for signs of wear, drying out or overheating.

WARNING

When working on or around a brake system and its related components, the following precautions should be observed:

Always block vehicle wheels. Stop engine when working under a vehicle. Keep hands away from chamber push rods and slack adjusters as they may apply when system pressure drops.

Never connect or disconnect a hose or line containing air pressure. It may whip as air escapes. Never remove a component or pipe plug unless you are sure all system pressure has been depleted.

Never exceed recommended air pressure and always wear safety glasses when working with air pressure. Never look into air jets or direct them at anyone.

Never attempt to disassemble a component until you have read and understood the recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to the use of those tools.

Always clean connecting piping and/or fittings, and coat pipe threads with Teflon pipe sealant before installing any air brake system component.

Pressure Build-Up / Low Pressure Warning / Cutoff Point / Air Filter/Dryer Built-in Governor Cutout

CONDITION: Vehicle leveled, parking brake applied.

1. Completely drain wet, primary and secondary air reservoirs only.
2. Start engine and run at fast idle. Low pressure warning lights should be *"On"*.
3. Start checking pressure at 50 psi (344 kPa).
4. Low pressure warning lights and buzzer should go off at or above 60 psi (415 kPa).

5. At 85 psi (586 kPa), run engine at full rpm, then check that build up time to 100 psi (690 kPa) is 30 seconds or less.
6. Air filter/dryer built-in governor cut-out. Cuts out at the correct pressure of 123 psi ±3 (847±21 kPa).
7. Air filter/dryer built-in governor cut-in. Cuts in around 110 psi (758 kPa).

For common corrections, refer to the following check list:

High or Low Warning Cutoff Point

- Perform a telltale light and gauge test. Replace entire cluster if found defective.

High or Low Air Filter/Dryer Built-in Governor Cutout Point

- Perform a telltale light and gauge test. Replace entire cluster if found defective.

OR

- Repair or replace air filter/dryer as necessary after checking that compressor unloader mechanism operates correctly.

More than 30 seconds to build-up pressure from 85 to 100 psi (585 - 690 kPa) at full engine RPM

- Perform a telltale light and gauge test. Replace entire cluster if found defective.
- Check compressor strainer or inlet line. If restricted, clean or replace element or faulty line.
- Check compressor head or discharge line for carbonization or restriction. Clean or replace as necessary.
- If discharge valves leak, pull head and correct or replace cylinder head.
- If drive is slipping, replace gear.
- If inlet valves are stuck, open or leaking severely, replace unloader kit, inlet valves and/or seats as necessary.
- If drain cock is found open, close it.
- Listen for air leaks and repair.
- Redo list to check all items repaired or replaced.

Air Supply Reservoir Leakage

CONDITION**:** Full pressure, engine stopped, parking brake applied

1. Allow at least 1 minute for pressure to stabilize.
2. Stop engine, then check air pressure gauge for 2 minutes. Note any pressure drop.
3. Pressure should not drop by more than 3 psi (20 kPa) per minute.

For common corrections, refer to the following check list:

Excessive air loss:

- With the primary air system at normal operating pressure (95 - 125 psi (655 - 860 kPa)), coat all air line connections and pneumatic components with a water and soap solution. Bubbles will indicate an air leak, and none should be permissible. Repair or replace defective parts.
- Listen for leaks and correct as required.
- Redo test to check all items repaired or replaced.

Brake System Air Leakage

CONDITION**:** Full pressure, engine stopped, parking brake released.

1. Apply service (foot) brakes, allow at least 1 minute for pressure to stabilize.
2. Hold down foot valve for 2 minutes while observing air pressure gauge on the dash-board.
3. Pressure drop should not be more than 4 psi (27 kPa) per minute.

For common corrections, refer to the following check list.

Excessive leakage on brake service side:

- With the primary air system at normal operating pressure (95 - 125 psi (655 - 860 kPa)) and foot brake applied, coat all air line connections and brake pneumatic components with a water and soap solution. Bubbles will indicate an air leak, and none should be permissible. Repair or replace defective parts.
- Listen for leaks and correct as required.
- Redo test to check all items repaired or replaced.

IMPORTANT NOTE

To maintain your vehicle's air disc brakes at their original performance standard, we strongly recommend use of only genuine, approved service replacement parts on Bendix and Knorr-Bremse air disc brake systems.

If non-approved friction materials or replacement components are used, neither Prevost Car nor Bendix Spicer Foundation Brake LLC will accept any air disc brake-related warranty returns or claims.

For more information on this policy, refer to Bendix-Prevost product notification annexed at the end of Section 12 of Maintenance Manual.

30. BRAKE AIR CHAMBER

If this vehicle is equipped with *Knorr-Bremse SN7000* disc brakes on all axles, it also uses "Knorr-Bremse" brake chambers. The drive axle chambers consist of two separate air chambers, each having its own diaphragm and push rod. They are used as a service brake chamber, an emergency brake in case of air pressure loss and a spring-applied parking brake. Refer to figures 29 and 30.

The front and tag axle brake air chambers are used only for service brake duty (Fig. 29.

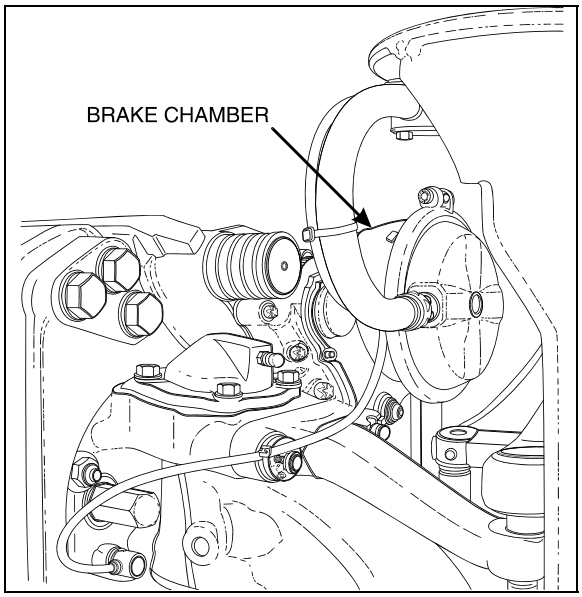


FIGURE 29: FRONT AXLE BRAKE AIR CHAMBER 12158

30.1 MAINTENANCE

Every 6,250 Miles (10 000 km) or twice a year, whichever comes first depending on type of operation:

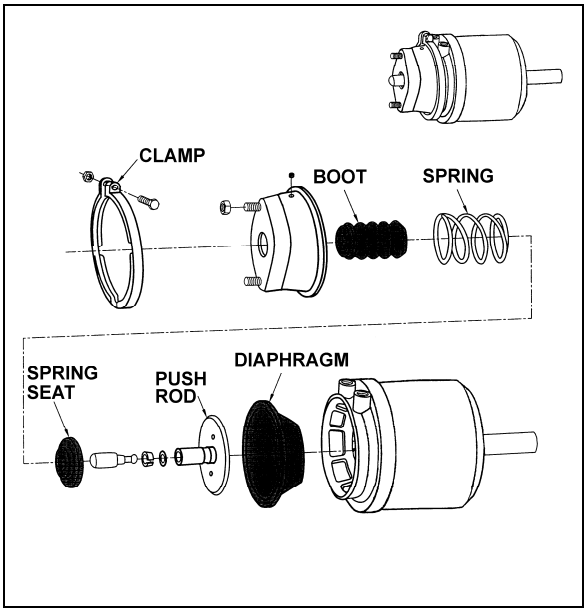


FIGURE 30: DRIVE AXLE BRAKE AIR CHAMBER 12126

Check all hoses and lines. They should be secure and in good condition.

Every 100,000 Miles (160 000 km) or once a year, whichever comes first depending on type of operation:

1. Disassemble and clean all parts.
2. Install new diaphragm or any other part if worn or deteriorated.

NOTE

When the diaphragm, spring, or both are replaced, they should be replaced in the corresponding chamber on the same axle.

3. Perform an airtighteness test:

a) Make and hold a full brake application.

b) Coat clamping ring(s) with a soapy solution. If leakage is detected, tighten clamping ring only enough to stop leakage. ***Do not overtighten*** as this can distort sealing surface or clamping ring. Coat area around push rod hole (loosen boot if necessary). No leakage is permitted. If leakage is detected, the diaphragm must be replaced.

30.2 EMERGENCY/PARKING BRAKE MANUAL RELEASE

DANGER

Never stand in the axis line of the spring brake chambers, especially when caging the spring.

Drive Axle

1. Block the wheels to prevent the vehicle from moving.
2. Remove the release stud tool from its storage place on drive axle brake air chamber.
3. Remove the access plug from the end of the spring chamber and then insert the release stud through the opening. Turn the release stud ¼ turn (clockwise) to anchor it into the spring plate. Install the flat washer and nut, then turn the nut clockwise to cage the spring. Repeat on the opposite side.

DANGER

Make sure the release stud is properly anchored in spring plate receptacle prior to caging the spring.

4. To manually reset the emergency/parking brake, turn the nut counterclockwise. Reinstall access plugs on the spring chambers, and release stud tools in their storage places.

30.3 BRAKE CHAMBER REMOVAL

WARNING

To prevent personal injuries, brakes should be inoperative prior to working on any of their components.

To prevent personal injuries, brake chambers should be made inoperative by releasing spring tension prior to disposal.

1. Block the wheels to prevent the vehicle from moving.
2. Safely support vehicle at the recommended body jacking points.
3. To gain access to a given brake air chamber, the corresponding wheel can be removed (refer to Section 13: *"Wheels, Hubs and Tires"*).
4. Exhaust compressed air from system by opening the drain valve of each reservoir.
5. For the drive axle brake chambers, manually release spring brakes (refer to "*Emergency/Parking Brake, Manual Release"* procedure in this section).
6. Disconnect air line(s) from brake chamber.
7. Remove the cotter pin connecting brake chamber and slack adjuster (drive axle).
8. Unbolt and remove the brake chamber from vehicle.

30.4 BRAKE CHAMBER INSTALLATION

Reverse removal procedure and then check brake adjustment.

CAUTION

Always clean air lines and fittings, and coat pipe threads with teflon pipe sealant before reconnecting air lines.

30.5 BRAKE CHAMBER DISASSEMBLY

DANGER

Spring brake chambers, on drive and tag axles contain an extremely high compressive force spring, which can possibly cause serious injury if special precautions are not taken when working around this area.

To avoid such injury, the following recommendations must be applied:

- Prevost recommends the installation of a new spring brake chamber if it is found to be defective.
- Spring brake chamber maintenance and/or repair must be performed by trained and qualified personnel only.
- Before manually releasing spring brakes, visually check spring brake for cracks and/or corrosion.
- On “MGM” brake chambers (drive axle), make sure the release stud is properly anchored in spring plate receptacle prior to caging the spring.
- Never stand in the axis line of the spring brake chambers, especially when caging the spring.

WARNING

To prevent personal injuries, brakes should be inoperative prior to working on any of their components.

1. Block the wheels to prevent the vehicle from moving.
2. Safely support vehicle at the recommended body jacking points.

NOTE

To gain access to a given brake air chamber, the corresponding wheel can be removed (refer to Section 13: "Wheels, Hubs and Tires").

3. Exhaust compressed air from air system by opening the drain valve of each reservoir.
4. For the drive axle brake chambers, manually release spring brakes (refer to "*Emergency/Parking Brake Manual Release"* procedure in this section).
5. Remove clamp ring, remove and discard the existing diaphragm. Install the new diaphragm squarely on body.
6. Reverse the procedure for assembly. Tap clamp ring to ensure proper seating. Check for proper operation before placing vehicle in service.

31. ANTI-LOCK BRAKING SYSTEM (ABS)

This device has been designed to ensure stability and permit steering control of vehicle during hard braking, and to minimize its stopping distance whatever the road conditions are. On slippery roads and generally in emergency situations, over-braking frequently induces wheel lock. The anti-lock braking system provides maximum braking performance while maintaining adequate steering control on slippery roads.

The ABS continuously monitors wheel behavior during braking. Sensors on each wheel of front and drive axles (tag axle is slave to drive axle) transmit data to a four channel electronic processor which senses when any wheel is about to lock. Modulator valves quickly adjust the brake pressure (up to 5 times per second) to prevent wheel locking. Each wheel is therefore controlled according to the grip available between its tire and the road.

With this device, the vehicle is brought to a halt in the shortest possible time, while remaining stable and under the driver's control.

Since the braking system has dual circuits, the ABS is also provided with a secondary system should a fault develop in the ABS. Anti-lock systems are a parallel system which does not hinder brake functioning in case of failure. Braking system functions in normal, non anti-lock controlled operation during ABS system failure.

The ABS system consists of two diagonally related circuits, only the half of the system which has sustained damage or other fault is switched off (i.e. wheels return to normal non-ABS braking). The other diagonal half remains under full ABS control.

NOTE

ABS is active on service brake, transmission retarder, Jake brake, but is inactive on emergency/parking brake.

NOTE

The ABS system is inoperative at speeds under 4 mph (6 Km/h). Illumination of ABS telltale indicator at these speeds is normal.

CAUTION

Disconnect the ECU or pull the ABS fuse before towing vehicle.

31.1 TROUBLESHOOTING AND TESTING

For troubleshooting and testing of the vehicle's anti-lock braking system, refer to Meritor Wabco Maintenance Manual MM-0112: *"Anti-Lock Braking System (ABS) for Trucks, Tractors and Buses"*, at the end of this section. Use dashboard Message Center Display (MCD) Diagnostic Mode for troubleshooting and repair.

31.2 ABS COMPONENTS

The main components of the ABS system are listed hereafter. Refer to each component for its specific function in the system and for proper maintenance.

31.2.1 Electronic Control Unit (ECU)

This control unit is located in the front electrical compartment, (refer to figure 31 for location). According to the data transmitted by the sensors (number of pulses/sec is proportional to the speed of each wheel), the electronic control unit determines which wheel is accelerating or decelerating. It then establishes a reference speed (average speed) from each wheel data, and compares the speed of each wheel with this reference speed to determine which wheel is accelerating or decelerating.

As soon as wheel deceleration or wheel slip threshold values are exceeded, the electronic control unit signals a solenoid control valve to limit the excessive brake pressure produced by the driver in the appropriate brake chamber.

Maintenance

No specific maintenance is required. The ECU is not serviceable. When found to be defective, replace.

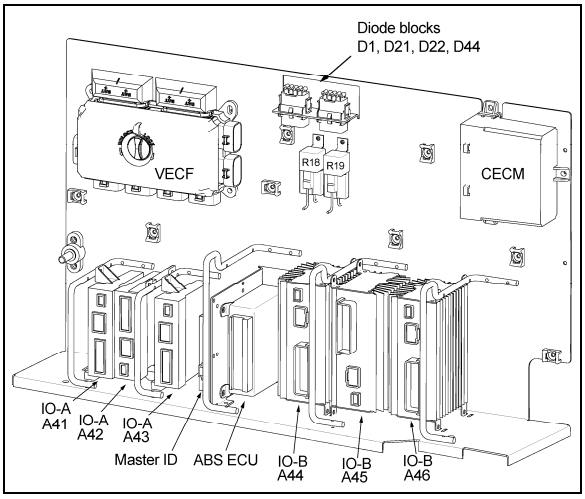


FIGURE 31: ABS ECU LOCATION 06617

CAUTION

In order to protect the ABS electronic control unit from voltage surges, always disconnect before performing any welding procedure on vehicle.

31.2.2 ABS Modulator Valve

This ABS system is equipped with four or five modulator valves, located between the brake chamber and the relay valve or quick release valve (Fig. 32). Note that on the basic ABS system, there is only one solenoid valve controlling the drive and tag axle wheels on the same side (tag axle is slave to drive axle).

This is an *"On/Off"* type valve, i.e., at brake application, the valve exhausts air from the brake chamber when the electronic unit senses that the corresponding wheel speed is decreasing in relation to the other wheels.

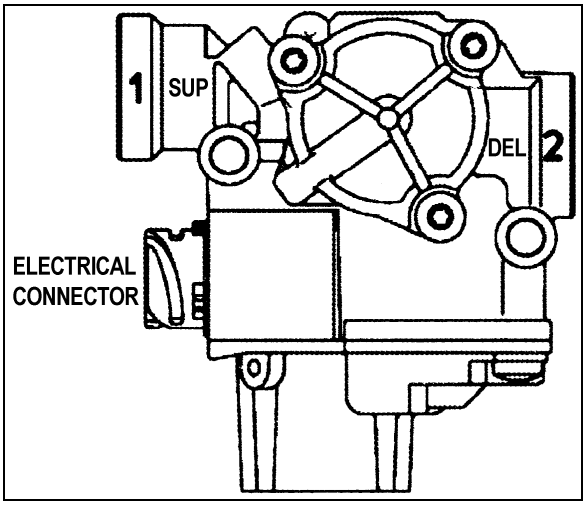


FIGURE 32: ABS MODULATOR VALVE 12221

Maintenance

Refer to Bendix Service Data sheet SD-13-4870 located at the end of this section.

31.2.3 Sensors

The sensors are mounted on the front, drive and tag axle (if applicable) wheel hubs (Fig. 33). The inductive sensors consist essentially of a permanent magnet with a round pole pin and a coil. The rotation of the toothed wheel alters the magnetic flux picked up by the coil, producing an alternating voltage, the frequency of which is proportional to wheel speed. When wheel speed decreases, magnetic flux decreases proportionately. Consequently, the electronic control unit will command the solenoid control valve to decrease the pressure at the corresponding brake chamber.

Maintenance

No specific maintenance is required for sensors, except if the sensors have to be removed for axle servicing. In such a case, sensors should be lubricated with special grease (Prevost #680460) before reinstallation. Refer to paragraph *"Sensor Installation"* for details.

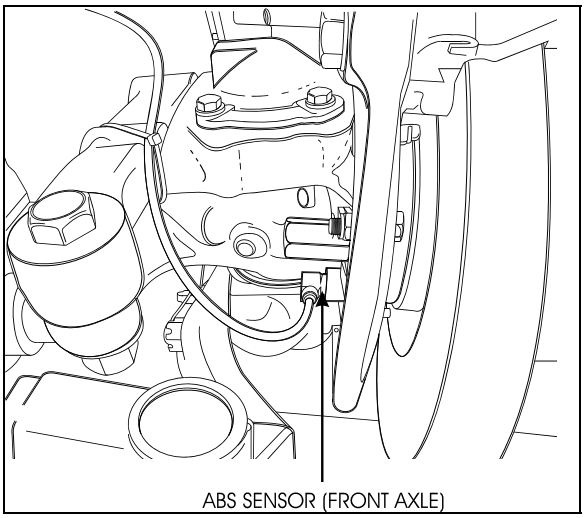


FIGURE 33: ABS SENSOR LOCATION 12153

NOTE

The resistance value, when sensors are checked as a unit, must be equal to 1,75 k ohms. To check the sensors for proper output voltage after the sensors and toothed wheels have been assembled to the axle, connect a suitable AC voltmeter across the output terminals. With the hubs rotating at 30 rpm, the output voltages should read from 50 to 1999 mV to be acceptable.

Sensor Installation

The following procedure deals with sensor installation on the axle wheel hubs. Read procedure carefully before reinstalling a sensor, as its installation must comply with operational tolerances and specifications.

1. Apply recommended lubricant (Prevost #680460) to spring clip and sensor.

CAUTION

Use only this type of grease on the sensors.

2. Insert spring clip in the holder on hub. Make sure the spring clip tabs are on the inboard side of the vehicle. Push in until the clip stops.
3. Push the sensor completely inside the spring clip until it is in contact with the tooth wheel. Ensure mounting is rigid, as it is an important criterion for adequate sensor operation.

NOTE

This installation should be of the "press fit" type.

31.2.4 Spring clip

The spring clip retains the sensor in its mounting bracket close to the toothed pulse wheel. The gap between the sensor end and teeth is set automatically by pushing the sensor in the clip hard up against the tooth wheel, and the latter knocks back the sensor to its adjusted position (Fig. 34).

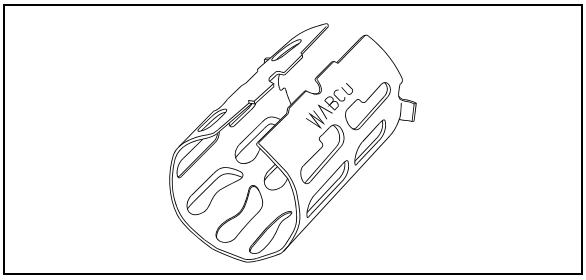


FIGURE 34: SPRING CLIP 12161

Maintenance

The spring clip requires no specific maintenance.

32. BENDIX AUTOMATIC TRACTION CONTROL (ATC) – ELECTRONIC STABILITY PROGRAM (ESP)

In addition to the ABS function, vehicle may be equipped with a Traction Control System (TCS) feature. This feature is provided by an advanced model of Bendix EC-60 controller. Bendix refers to this feature as **Automatic Traction Control (ATC®)**. Bendix ATC can improve vehicle traction during acceleration, and lateral stability while accelerating through curves. ATC utilizes **Engine Torque Limiting (ETL)** where the ECU communicates with the engine's controller and/or **Differential Braking (DB)** where individual wheel brake applications are used to improve vehicle traction.

The EC-60 advanced model controller also provides an ABS-based Electronic Stability Control (ESC) feature. Bendix refers to it as **ESP® Electronic Stability Program**.

The Bendix ESP system is an ABS-based stability system that enhances vehicle stability by both reducing engine throttle and by applying vehicle braking based on actual vehicle

dynamics. Accordingly, the ESP system is available only on specific approved vehicle platforms after vehicle application and development efforts and validation testing. Only certain limited variations of an approved vehicle platform are permitted without further validation of the ESP system application.

ESP stability system consists of Yaw Control (YC) and Roll Stability Program (RSP) features.

NOTE

Vehicles equipped with the ATC/ESP system have one more modulator valve and two additional sensors located on the tag axle wheels (6S/5M). Basic ABS consists of 4 sensors and 4 modulator valves (4S/4M).

CAUTION

Even with ESP-equipped vehicles, the driver remains responsible for ensuring vehicle stability during operation.

DANGER

ESP may reduce the vehicle speed automatically.

DANGER

ESP can make the vehicle **decelerate automatically.** ESP can slow the vehicle with or **without the operator applying the brake,** and **even when the throttle is being applied.**

32.1 COMPONENTS

32.1.1 The EC-60™ controller's ABS function utilizes the following components:

- Six (6) Bendix® WS-24™ wheel speed sensors. Each sensor is installed with a Bendix Sensor Clamping Sleeve;
- Five (5) Bendix® Pressure Modulator Valves (M-32QR™);
- Dash-mounted vehicle ABS Indicator Lamp;
- Service brake relay valve;
- Dash-mounted trailer ABS Indicator Lamp.

32.1.2 The EC-60™ controller's ATC function utilizes the following components:

- Drive axle traction control valve;
- Dash-mounted "ESC/TCS" status/indicator lamp;
- Dash-mounted "TCS" Mud/snow switch;
- J1939 serial communication to engine control module.

32.1.3 The EC-60™ controller's ESP/RSP function utilizes the following components:

- Front Axle Traction Control Valve integral to the service brake relay valve;
- Dash-mounted "ESC/TCS" status/indicator lamp (also serves as the ATC status/indicator lamp;
- Bendix SAS-60™ Steering Angle Sensor (mounted to the steering column);
- Bendix YAS-60™ Yaw Rate/Lateral Acceleration Sensor (mounted to a cross member forward of the drive axle);
- Brake Demand Sensors (installed in the primary and secondary delivery circuits);
- Load Sensor (installed in the suspension air spring);
- An additional Modulator Valve (Bendix® M-32QR™ Pressure Modulator Valve) that controls pressure applied to the trailer brakes during system intervention.

32.1.4 Bendix® M-32QR™ Pressure Modulator Valves (PMV)

This Bendix® M-32QR™ Pressure Modulator Valves (PMV) is operated by the EC-60™ controller to modify driver applied air pressure to the service brakes during ABS, ATC, RSP or YC activation. The PMV is an electro pneumatic control valve and is the last valve that air passes through on its way to the brake chamber. The modulator hold and release solenoids are activated to "modulate" or "control" the brake pressure during an antilock braking event. The hold solenoid is normally open and the release solenoid is normally closed, such that the PMV nominally allows air to flow through. This design allows for air delivery to brake chambers in the event of electrical trouble.

The Advanced EC-60™ controller also utilizes an additional PMV for control of the trailer service brakes during stability interventions.

32.2 6S/5M CONFIGURATION

Prevost vehicles utilize a 6S/5M configuration, with the additional axle (rear tag axle) having two sensors, but only one Pressure Modulator Valve. In this case, the PMV controls both wheels on the additional axle. The additional axle wheels would receive equal brake pressure, based on the wheel that is currently experiencing the most wheel slip.

32.3 ADVANCED ABS WITH ELECTRONIC STABILITY CONTROL (ESC)

Overview

Bendix ESP® stability system reduces the risk of rollovers, jackknifing and other loss of control. ESP features include Roll Stability Program (RSP) and Yaw Control. During operation, the ECU of the Bendix Advanced ABS system constantly compares performance models to the vehicle's actual movement, using the wheel speed sensors of the ABS system, as well as lateral, yaw, and steering angle sensors. If the vehicle shows a tendency to leave an appropriate travel path, or if critical threshold values are approached, the system will intervene to assist the driver.

Roll Stability Program

Bendix RSP, an element of the overall ESP system, addresses rollover conditions. In the case of a potential roll event, the ECU will override the throttle and quickly apply pressure at all wheel ends to slow the vehicle combination. The level of braking application during an RSP event will be proportional to roll risk.

Yaw Stability

Yaw stability counteracts the tendency of a vehicle to spin about its vertical axis. During operation, if the friction between the road surface and the tires is not sufficient to oppose lateral (side) forces, one or more of the tires can slide, causing the vehicle to spin. These events are referred to as either an "under-steer" situation (where there is a lack of vehicle response to steering input due to the slide on the front axle) or an "over-steer" (where the vehicle's rear end slides out due to tire slide on the rear axle) situation. Factors that influence yaw stability are: wheelbase, suspension, steering geometry, weight distribution front to rear, and vehicle track width.

Yaw Control

Yaw Control corresponds to a wide range of low to high friction surface scenarios including rollover, jackknife and loss of control. It is the recommended system for all power vehicles and especially critical for vehicles pulling trailers. In the case of vehicle slide (over-steer or under-steer situations), the system will reduce the throttle and then brake one or more of the "four corners" of the vehicle (in addition to potentially applying the trailer brakes), thus applying a counter-force to better align the vehicle with an appropriate path of travel.

For example, in an over-steer situation, the system applies the "outside" front brake; while in an under-steer condition, the "inside" rear brake is applied.

DANGER

ESP may reduce the vehicle speed automatically.

ESP can make the vehicle **decelerate automatically.** ESP can slow the vehicle with or **without the operator applying the brake,** and **even when the throttle is being applied.**

32.4 BENDIX® SAS-60™ STEERING ANGLE SENSOR

The Steering Angle Sensor (SAS) is used to provide driver steering input to the controller. It reports the steering wheel position to the controller utilizing a dedicated serial communications link that is shared with the YAS-60™ sensor. The controller supplies the power and ground inputs to the SAS-60™ sensor.

The SAS-60™ sensor installed on Prevost vehicles is the 90° connector.

32.4.1 Removal of the steering angle sensor

Service Checks:

1. Check all wiring and connectors. Some installations also include an intermediate connector from the steering angle sensor to the main vehicle wire harness. Make sure all connections are free from visible damage.

2. Examine the sensor. Make sure the sensor, its mounting screws, and the interface between the hub and the steering column are not damaged.

Diagnostics:

The steering angle sensor is only operational in conjunction with an Advanced ECU. No independent diagnostics can be performed on the sensor.

Removal:

1. Remove steering column upper, middle and lower covers.
2. The steering angle sensor is located near the universal joint.
3. Unplug sensor cable assembly from body of sensor. Squeeze the mounting tabs and pull gently on connector until it disengages.
4. Disconnect steering column upper U-joint.
5. Unscrew all three of the mounting screws that hold the body of the sensor to the steering column body.
6. Slide the sensor over the column to remove. Take note if the sensor label is facing upward or downward.

Installation:

1. Obtain a new sensor. The sensor is not repairable in the field.
2. Slide the sensor over the column. The center hub of the sensor must be aligned with the corresponding notch in the column. The sensor label should be facing in the same direction as the removed sensor.
3. Reconnect the steering column U-joint.
4. Assemble the column non-moving plate with three self-locking screws.
5. Tighten screws to 48 lbf-ft (65 Nm) to 74 lbf-ft (100 Nm).
6. Reconnect the connector. Ensure that there will be no force applied to the sensor because the connector is pulling on the sensor body.
7. If the wire harness leading to the sensor is being replaced, ensure that it is adequately tie wrapped so that the full motion of the steering column can be achieved without pulling apart the connectors.
8. Reinstall the steering column covers. The sensor is not protected against dirt or water intrusion, so care must be taken not to introduce these elements during installation.

Steering Angle Sensor Calibration

The steering angle sensor calibration can only be achieved when the sensor is powered by the Advanced ABS ECU. No stand-alone sensor calibration can be carried out. The calibration procedure is performed using Bendix® ACom™ Diagnostic V4.0 or higher. See “Troubleshooting Diagnostic Trouble Codes: Steering Angle Sensor (SAS-60)” for the calibration procedure using this tool.

The sensor **must** be recalibrated after any of these situations:

- Replacement of the steering angle sensor;
- Any opening of the connector hub from the steering angle sensor to the column;
- Any maintenance or repair work on the steering linkage, steering gear or other related mechanism;
- Adjustment of the wheel alignment or wheel track;
- After an accident that may have led to damage of the steering angle sensor or assembly.

WARNING

If the steering angle sensor is not properly recalibrated as needed, the yaw control system may not function properly, which can result in incidents leading to loss of vehicle control.

33. FITTING TIGHTENING TORQUES

45° Flare and Inverted Flare: Tighten assembly with a wrench until a solid feeling is encountered. From that point, tighten 1/6 turn (Fig. 35).

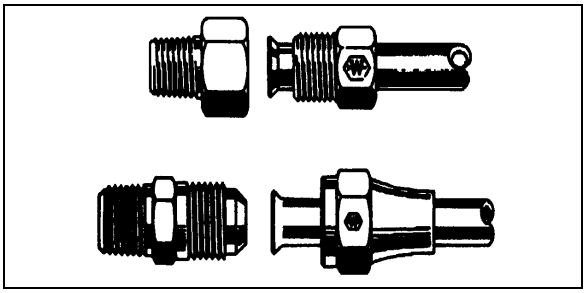


FIGURE 35: HOSE FITTINGS 12053

Compression: Tighten nut by hand (Fig. 36). From that point, tighten using a wrench the number of turns indicated in the chart hereafter.

Fitting size	Pipe diameter (inches)	Number of additional turns required following hand tightening
2	1/8	1 ¼
3	3/16	1 ¼
4	1/4	1 ¼
5	5/16	1 ¾
6	3/8	2 ¼
8	1/2	2 ¼
10	5/8	2 ¼
12	3/4	2 ¼
16	1	2 ¼

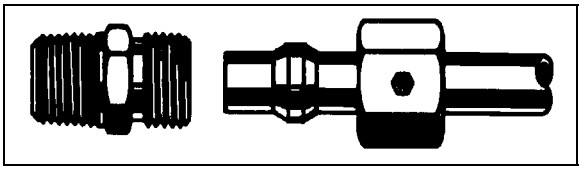


FIGURE 36: HOSE FITTING 12054

NTA-Type Plastic Tubing: Hand tighten nut (Fig. 37). From that point, tighten using a wrench the number of turns indicated in the following chart.

Tubing diameter (inches)	Number of additional turns required following hand tightening
1/4	3
3/8 to 1/2	4
5/8 to 3/4	3 ½

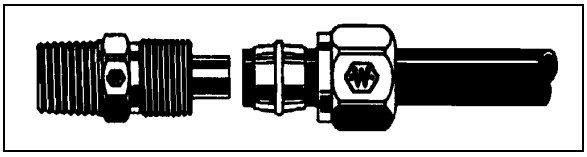


FIGURE 37: HOSE FITTING 12055

AB-Type Copper Piping: Hand tighten nut (Fig. 38). From that point, tighten with a wrench the number of turns indicated in the following chart.

Piping diameter (inches)	Number of additional turns required following hand tightening
1/4, 3/8, 1/2	2
5/8, 3/4	3

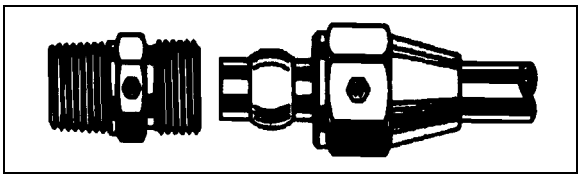


FIGURE 38: HOSE FITTING 12056

Pipe Tightening: All connections must be hand tightened. From that point, tighten a minimum of 2 ½ additional turns.

NOTE
Use Locktite (Prevost number 680098) pipe sealant to seal pipe thread.

34. SPECIFICATIONS

Air Compressor

Make....Meritor Wabco
Model....SS636
Capacity (at 1250 rpm)....37.4 cfm (1,059 m^3/min.)
Prevost number....

Air Dryer

Make....Haldex
Model....AT-87192
Prevost number....70303498
Desiccant cartridge Prevost number....3097369

Flip-Flop Control Valve

Make....Bendix Westinghouse
Model....TW-1
Type....On-Off
Prevost number....640136

Emergency/Parking Brake Control Valve

Make....Bendix Westinghouse
Model....PP-1
Automatic release pressure....60 psi (414 kPa) nominal
Prevost number....642169

Dual Brake Application Valve

Make....Bendix Westinghouse
Model....E-10P
Prevost number....641856

Stoplight Switches

Make....Bendix Westinghouse
Model....SL-5
Contact close (ascending pressure)....4 psi and more (28 kPa)
Prevost number....641462

Brake Relay Valves

Make....Bendix Westinghouse
Model....R-12
Supplier number....
Prevost number....

Brake Relay Valve

Make....Meritor Wabco
Model....R-14
Prevost number....

Quick Release Valve

Make....Bendix Westinghouse
Model....QR-1
Prevost number....641429

Spring Brake Valve

Make....Bendix Westinghouse
Model....SR-7
Prevost number....

Pressure Protection Valve

Make....Bendix Westinghouse
Model....PR-4
Nominal closing pressure....70 psi (482 kPa)
Prevost number....641137

Shuttle-Type Double Check Valve

Make....Bendix Westinghouse
Model....DC-4
Prevost number....641015

Low Pressure Indicators

Make....Bendix Westinghouse
Model....LP-3
Contact close....66 psi (455 kPa)
Prevost number....640975

Air Pressure Regulator

Make....Norgren
Adjustable output range....0-80/85 psi (0-552/586 kPa)
Recommended pressure setting....75 psi (517 kPa)
Prevost number....641472

Air Filter Element

Make....Norgren
Type....With manual drain
Prevost number....641338

Front Wheel Brake Chambers

Make....Knorr-Bremse
Type....24
Prevost number (R.H.)....641414
Prevost number (L.H.)....641413

Drive Axle Brake Chambers

Make....Knorr-Bremse
Type....24 as service -24 as emergency
Prevost number....641432

Piggy Back (On Drive Brakes)

Make....Knorr-Bremse
Type....24 as emergency
Prevost number....641433

Tag Axle Brake Chambers

Make....Knorr-Bremse
Type....14
Prevost number....642087

Tag Axle Brake Chambers

Make....Knorr-Bremse
Type....16
Prevost number....642086

Brake Lining (All Axles)

Make....Knorr-Bremse
Prevost number....611049
Prevost number....641226

ABS ANTILOCK BRAKING SYSTEM

ABS MODULATOR VALVE

Make..... Bendix
Voltage .....12 V
Prevost number..... 642077

Sensor

Prevost number..... 642085

Sensor (90°)

Prevost number..... 642084

Effective Date: 12/02/05

Subject: **Bendix Air Disc Brake Pad Replacement on Prevost Car Vehicles**

Prevost Car and Bendix Spicer Foundation Brake LLC are issuing this product notification about the potential brake performance degradation associated with use of non-approved, aftermarket replacement friction materials on Bendix® and Knorr-Bremse air disc brakes.

A compatible combination of disc pads and rotor material is essential for the safe and reliable performance of air disc brakes and also helps to extend the useful life of both parts.

Prevost Car and Bendix Spicer Foundation Brake worked together to optimize the disc pad and rotor material combination ("the friction couple") for use with Bendix® air disc brakes. Prevost Car and Bendix offer service replacement parts that maintain the same quality and compatibility as the original equipment pads and rotors.

Recent benchmarking tests by Bendix Spicer Foundation Brake with two different non-approved aftermarket brake pad brands indicate that there is a significant risk of brake performance degradation when non-approved friction materials are used with Bendix or Knorr-Bremse air disc brakes. The aftermarket pads tested demonstrated the following shortcomings:

- At high operating temperatures the non-approved pads had approximately 20% lower friction level than the original equipment friction material.
- During fade testing, brake torque was 50% to 60% of original material levels.
- Significant brake torque reduction was experienced at increased temperatures.
- Tests to replicate stops on mountain roads and other severe service conditions showed significant performance reductions.
- Insufficient pad strength caused cracking across the friction material.
- Shear testing of the friction material adhesion resulted in the friction material completely separating from the backing plate in many instances.
- Pad wear was accelerated.
- Early rotor cracking symptoms were observed much earlier that for typical genuine parts.

Based on our tests, Prevost Car and Bendix Spicer Foundation Brake LLC strongly recommend against the use of non-approved aftermarket brake pads and service parts on Bendix and Knorr-Bremse air disc brakes. Brake performance, reliability and service life can be seriously degraded if non-approved aftermarket replacement parts are used in Bendix and Knorr-Bremse air disc brake systems.

To maintain your vehicle's air disc brakes at their original performance standard, we strongly recommend use of only genuine, approved service replacement parts on Bendix and Knorr-Bremse air disc brake systems. If non-approved friction materials or replacement components are used, neither Prevost Car nor Bendix Spicer Foundation Brake LLC will accept any air disc brake-related warranty returns or claims.

BRAKE DUST WARNING:
AVOID CREATING DUST WHEN WORKING WITH BRAKE PADS DUE TO POSSIBLE CANCER AND LUNG DISEASE HAZARD.

While Bendix Spicer Foundation Brake LLC does not offer asbestos-containing brake linings or disc pads, the long-term effects of certain non-asbestos fibers have not been determined. Current OSHA Regulations cover exposure levels to some, but not all, components of non-asbestos linings and pads. The following precautions should be used when handling these materials:

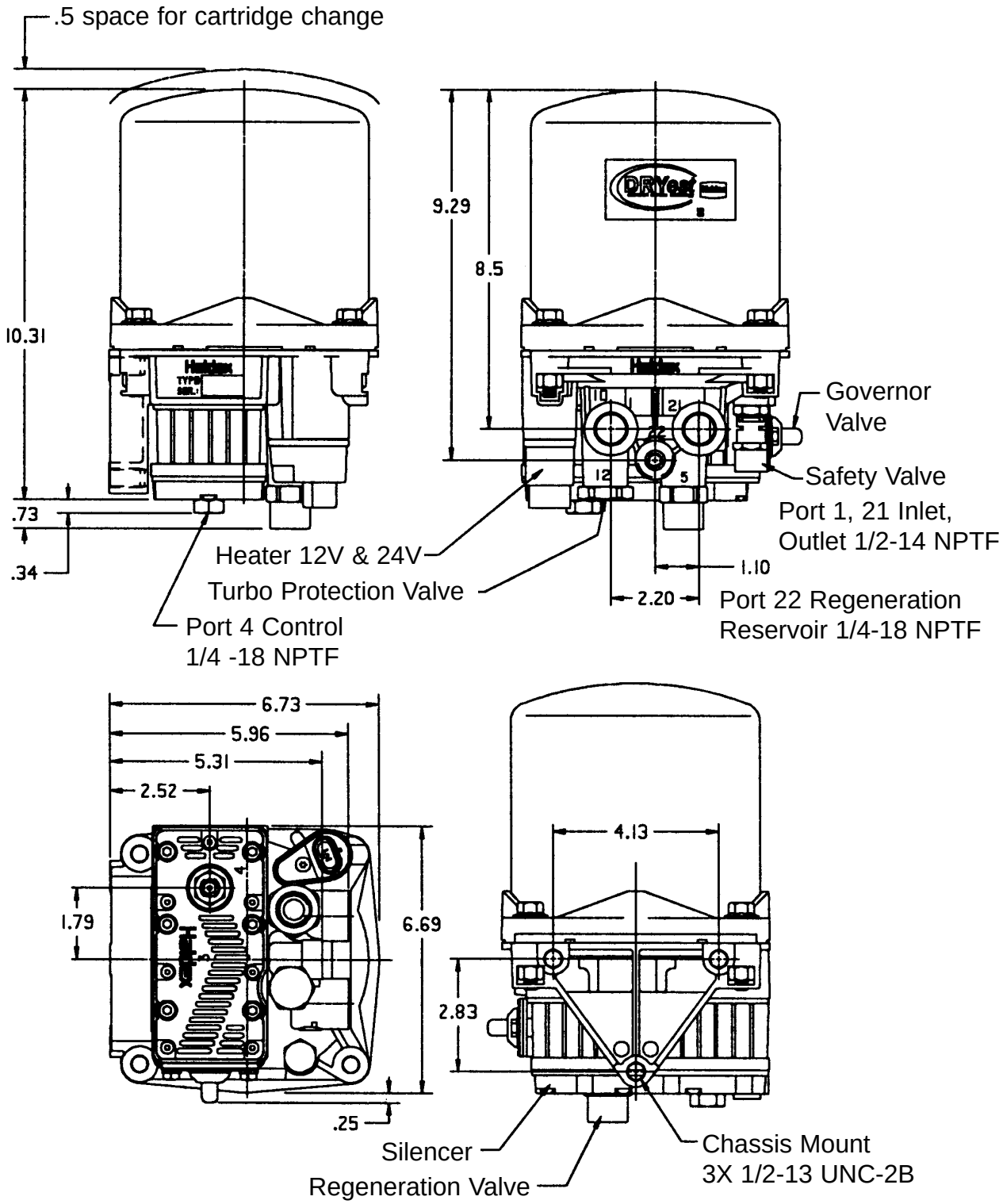
- Avoid creating dust. Compressed air or dry brushing must never be used to clean brake assemblies or the work area.

(Continued over)

- Brake workers must take steps to minimize their exposure to airborne brake lining particles. Procedures to reduce exposure include: working in a well-ventilated area, segregating areas where brake work is performed, using local filtered ventilation systems or enclosed cells with filtered vacuums for all brake work. Respirators approved by the Mine Safety and Health Administration (MSHA) or National Institute for Occupational Safety and Health (NIOSH) should be worn at all times during brake servicing.
- Workers must wash before eating or drinking, should not use tobacco products in any form, shower after working, and not wear work clothes home. Work clothes should be vacuumed using a high efficiency particulate filter (HEPA) vacuum and laundered separately without shaking.
- OSHA Regulations regarding testing, disposal of waste and methods of reducing exposure for asbestos are set forth in 29 Code of Federal Regulations §1910.001. These Regulations provide valuable information which can be utilized to reduce exposure to airborne particles.
- Material Safety Data Sheets on Bendix® air disc brake pads, as required by OSHA, are available from Bendix Spicer Foundation Brake LLC.

DRY*est* Air Dryer
Installation and Maintenance

L31166
9/02



The Haldex DRY*est* is a desiccant type dryer that effectively removes moisture, oil and contaminants from the compressed air system. This reduces the risk of freezing or corrosion of the components in the air system. When compressor cut-out is reached, dry air is allowed to flow back to regenerate the desiccant bed. The SIX (6) different applications available for the DRY*est* are illustrated on the next page.

Application Schematics

FIG. 2.A. Standard System Regeneration with Integrated Governor

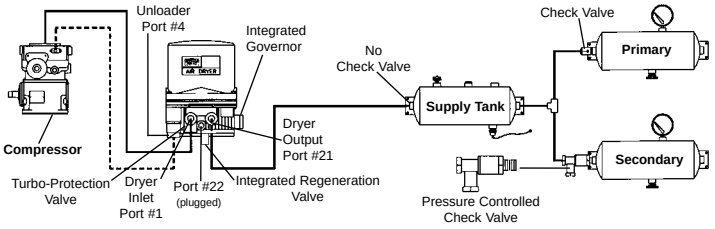


FIG. 2.B System Regeneration with External Governor

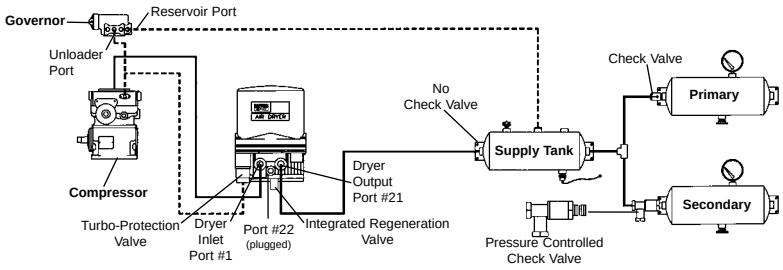


FIG. 2.C External Purge Tank Regeneration with Integrated Governor

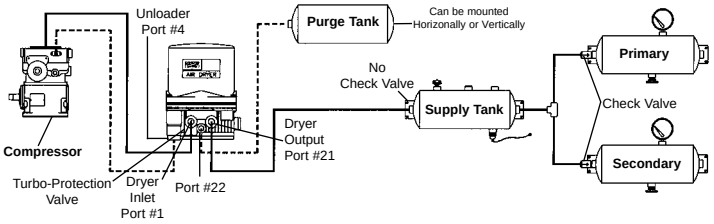


FIG. 2.D External Purge Tank Regeneration with External Governor

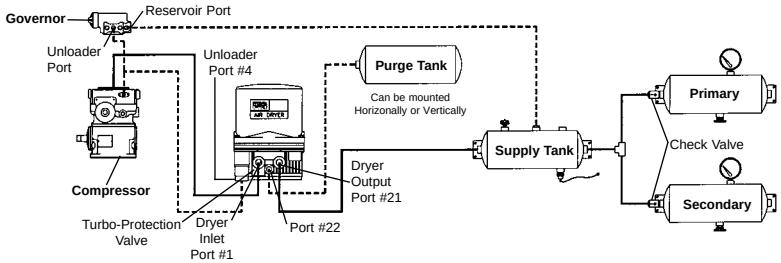


FIG. 2.E. Blow Thru: External Purge Tank with Integrated Governor

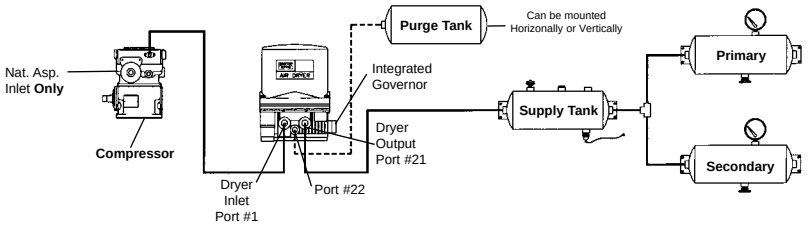
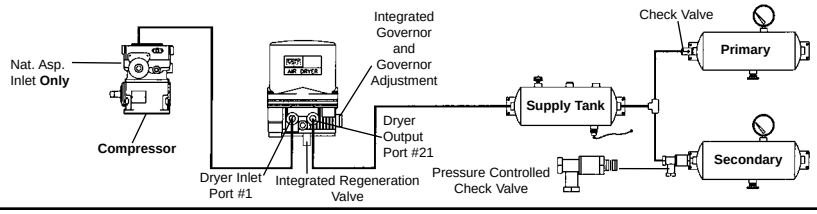


FIG. 2.F. Blow Thru: System Regeneration with Integrated Governor



Installing the DRY*est*

IMPORTANT CAUTION

1. Park the vehicle on a level surface, apply the parking brakes and always block the wheels.
2. Stop the engine when working around the vehicle.
3. Make certain to drain the air pressure from all reservoirs before beginning any work on the vehicle.
4. Following the vehicle manufacturer's recommended procedures; deactivate the electrical system in a manner that removes all electrical power from the vehicle.
5. When working in the engine compartment, the engine should be shut off. Where circumstances require that the engine be in operation, extreme caution should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.
6. Never connect or disconnect a hose or line containing pressure. Never remove a component plug unless you are certain all system pressure has been depleted.
7. Never exceed recommended pressures and always wear safety glasses.
8. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to the use of those tools.
9. Use only genuine Haldex replacement parts, components and kits. Replacement hardware, tubing, fitting, etc should be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
10. Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted unless specifically approved and stated by the vehicle or component manufacturer.
11. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.

General

The vehicle installation guidelines presented in the Application Schematic apply to all DRY*est* Air Dryer installations. Determine your system configuration and plumb accordingly. Vehicles with the Holset Type-E or QE compressor require the following additional instructions.

Haldex "isolation valve" must be mounted before the DRYest. Consult Cummins for additional plumbing requirements.

Mounting on Vehicle

1. Locate with sufficient space to facilitate service & visual access.
2. Mount away from direct tire splash.
3. Brackets, Fittings and Lines to be mounted in a protected area.
4. Exhaust port downward.
5. Mount in area to avoid excessive heat.
6. Rigid mount to avoid excess vibration.
7. Line from compressor to DRY*est* should have continuous downward slope and no dips.
8. 90° Fittings should be avoided.
9. Not to exceed 15° inclination.
10. Maintain a minimum of ½" above the dryer for access to the desiccant cartridge.
11. The dryer is equipped with an integrated mounting bracket. The enclosed template is to be used to drill three (3) 9/16" holes. If the dryer is to be bolted directly to the frame or support member, check vehicle manufacturer’s recommendations.
12. A mounting bracket can be used if necessary.
13. Install the dryer using the enclosed ½" bolts. Tighten to 45-55 ft-lb.

Heater Connection

1. Locate a circuit with the correct voltage that is "hot" when the ignition is "ON". The current draw is 8 amp@12V; 4amp@24V. A 10-15amp fuse is recommended in this line. Connect one heater lead to this wire.
2. Connect other lead to a good ground on vehicle chassis or electrical junction box.
3. For upgrade heater and connector information see " Service Information".

Installing the DRY*est* (con'd)

Compressor Discharge Line
General

While minimum diameters are specified, larger line diameters generally improve performance and life and reduce temperatures, particularly in severe applications.

1. The compressor discharge line material should be wire braided "Teflon" hose, copper tubing or a combination of both.
2. Compressor discharge line lengths and inside diameter requirements are dependent on the vehicle application.
3. The dryer inlet temperature must be less than 170°F. This can normally be accomplished with 12' to 15' of air compressor discharge line length.
4. Excessive line length should also be avoided to prevent freeze-up. The dryer inlet temperature must be greater than 40°F. If the discharge line exceeds 15', the line can be insulated as needed to prevent freeze-up.

Air Connections

1. Connect a suitable line from the compressor to the ½" NPT Inlet Port #1.
2. From the ½" NPT dryer outlet, Port #21, use a suitable line and connect to the supply tank.
3. Connect a ¼" nylon line or equivalent for control line(s).

Exhaust Line

1. If it is necessary to direct DRY*est* Air Dryer discharge contaminates away from vehicle components, it will be necessary to purchase an air dryer with special hose fitting option.

Testing the DRY*est*

Before placing the vehicle in service, perform the following tests.

1. Close all reservoir drain cocks.
2. Build up system air pressure to governor cut-out and note that the air dryer purges with an audible exhaust of air. If system 2.E or 2.F is used, the purge will be followed by a steady pulsating flow of air indicating that the system is "unloaded" and is venting to atmosphere.
3. Actuate the service brakes to reduce system air pressure to governor cut-in. Note that the system once again builds to full pressure and is followed by a purge.
4. It is recommended that the vehicle be tested for leakage using the following procedure to assure that the air dryer will not cycle excessively:
   A. Apply the parking brakes, build system pressure to governor cut-out and allow pressure to stabilize for at least 1 min.
   B. Observe the dash gauge pressures for 2 min. and note any pressure drop. Pressure drop should not exceed 4 psi with brake released and 6 psi with brakes applied. Any noticeable leakage must be repaired to avoid excessive cycling.
   C. On vehicles using "system regeneration": At cut-out pressure, system air is allowed to backflow from the secondary reservoir for desiccant regeneration. The vehicle secondary air gauge pressure will drop approximately 6 psi after the dryer purges.
5. Charge Cycle Time: During normal, daily operation the compressor should recover from governor cut-in to governor cut-out in 90 seconds or less at engine RPM's depending on vehicle vocation.
6. Purge Cycle Time: During normal vehicle operation, the air compressor must remain unloaded for a minimum of 30 seconds between charge cycles. This minimum purge time is required to insure complete regeneration of the desiccant.

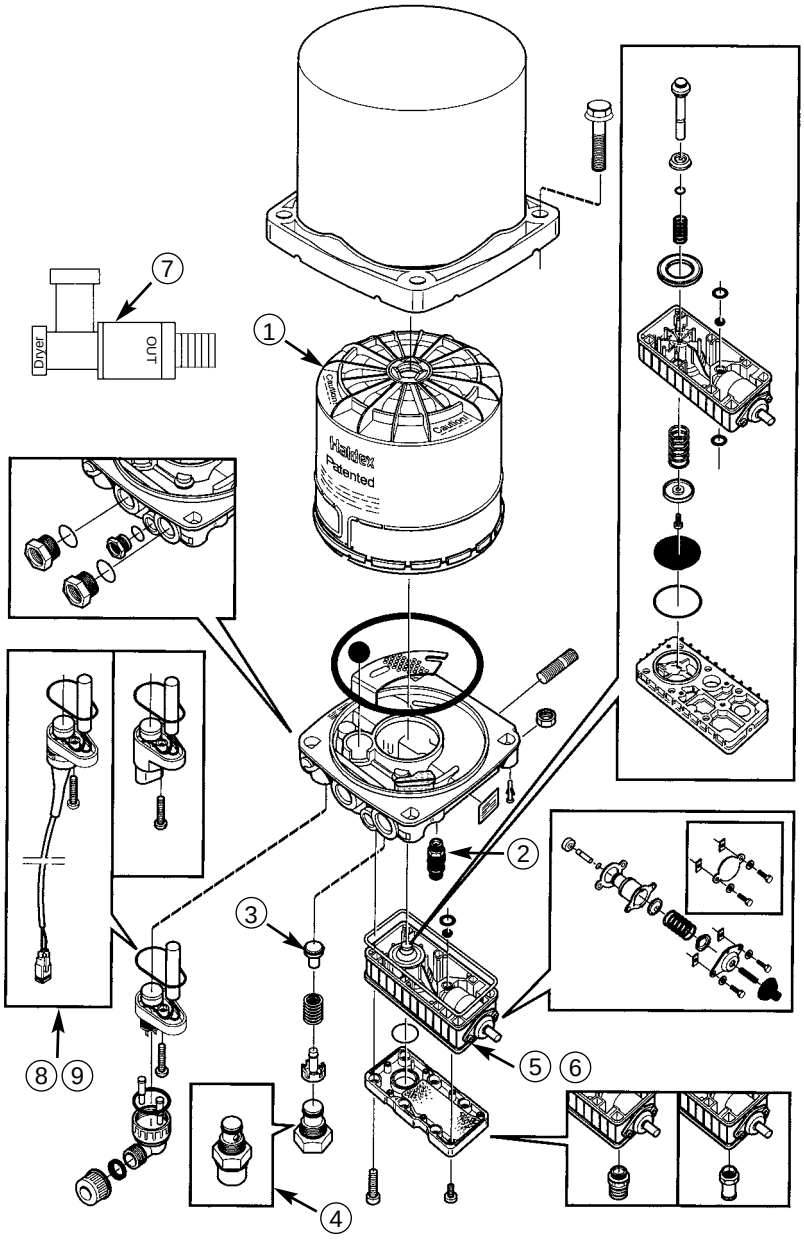
Troubleshooting

Problem	Cause	Repair
Water in air system	1. Contaminants in desiccant. 2. Leaks in air system.	1. Change desiccant cartridge. Check compressor for excessive oil passage. 2. Tighten air connections, soap connection and recheck for leaks per Testing the DRY*est* section.
Constant exhaust of air at air dryer and not Blow-Thru Type	1. Defective dryer outlet check valve. 2. Dryer unloading valve not closing.	1. Clean valve seat and replace check valve. 2. At compressor cut-out there **must** be a slight blow of regenerated air from the purge tank for approximately 30 seconds. If air flow continues, replace valve pack.
Excessive compressor cycling	1. Excessive leaks in air system. 2. Defective dryer outlet check valve. 3. Undersize compressor, duty cycle of compressor should not exceed 25%.	1. Tighten air connections, soap connection and recheck for leaks. 2. Clean valve seat and replace check valve. 3. Reduce air demand or use greater output compressor.
Safety valve is open	1. Desiccant cartridge is plugged. 2. Ice block in dryer. 3. Excessive system pressure.	1. Excessive oil passage from compressor. Check for worn compressor. Replace desiccant cartridge. 2. Check heater function. 3. Repair or replace governor.
Short life of dryer or desiccant cartridge	1. Air at inlet of dryer exceeds 170°F. 2. Duty cycle of compressor does not allow for sufficient time for desiccant regeneration.	1. Extend length of compressor discharge line; see Installing the DRY*est* section. The 170°F dryer inlet temperature can usually be accomplished with 12' to 15' of compressor discharge line. 2. During normal operation the compressor must remain unloaded for a minimum of 30 seconds to allow for sufficient purge. Lengthy loading times must be avoided. Air dryer must be "by-passed" in applications with high air use such as bulk unloading.
Poor drying efficiency	1. Air at inlet of dryer exceeds 170°F.	1. Extend length of compressor discharge line; see Installing the DRY*est* section. The 170°F dryer inlet temperature can usually be accomplished with 12' to 15' of compressor discharge line.

Service Parts

General Instructions
The following parts are available for maintenance and repair. Each service kit comes with specific repair instructions.

1. Desiccant Cartridge: 47178964
2. Safety Valve: 47178275
3. Check Valve: 47177433
4. Regeneration Valve: 47177434
5. Valve Pack with Integrated Governor: 47177343
6. Valve Pack w/o Integrated Governor: 47177442
7. Pressure Controlled Check Valve: 47110007
8. 12 V Heater: 47110020
9. 24 V Heater: 47110021
10. Integrated Turbo Protection Valve: 47189189 (Not Shown)



Haldex

Brake Systems Division
World Headquarters
10930 N. Pomona Avenue
Kansas City, MO 64153-1297
Phone: (816) 891-2470
Fax: (816) 891-9447

Brake Systems Division
North American Sales & Service Organization
10707 N.W. Airworld Drive
Kansas City, MO 64153-1215
Phone: (816) 891-2470
Fax: (816) 880-9766

Brake Systems Division
Haldex Limited
525 Southgate Drive, Unit 1
Guelph, Ontario Canada N1G 3W6
Phone: (519) 826-7723
Fax: (519) 826-9497

www.hbsna.com

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MERITOR WABCO

System Saver 636 Twin Cylinder Air Compressor for Mack E-Tech™ Engines

Maintenance Manual MM-0204
Issued 08-02

Before You Begin

This manual provides service and repair procedures for the Meritor WABCO System Saver 636 twin cylinder air compressor for Mack E-Tech™ engines. Before you begin procedures:

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Caution and Warning safety alerts that precede instructions or procedures you will perform. These alerts help to avoid damage to components, serious personal injury, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Safety Alerts, Torque Symbol and Notes

WARNING	A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury.
CAUTION	A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components.
	A torque symbol alerts you to tighten fasteners to a specified torque value.
NOTE	A Note provides information or suggestions that help you correctly service a component.

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To Order Information by Phone

Call ArvinMeritor's Customer Service Center at 800-535-5560 to order the following item.

- Drivetrain Plus™ by ArvinMeritor Technical Electronic Library on CD. Features product and service information on most Meritor, ZF Meritor and Meritor WABCO products. $20. Order TP-9853.

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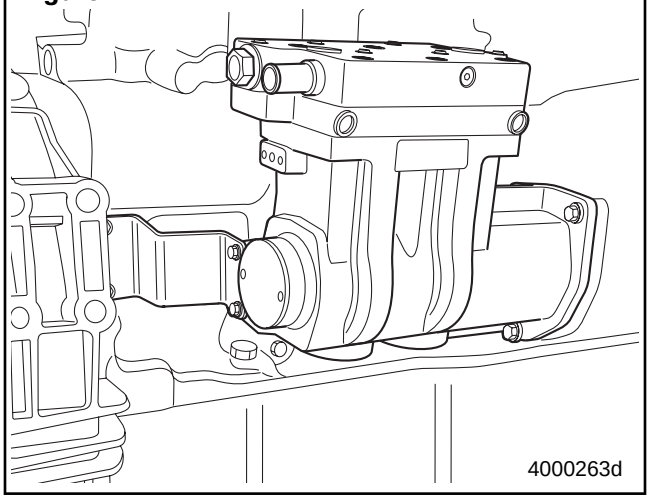
Application

- Used on Mack engines. **Figure 1.1**.
- Swept volume displacement: 37.4 cubic feet per minute.
- Flange mounted to the engine.
  - — Coupling driven through the auxiliary shaft.
  - — Inlet air, oil lubrication and coolant supplied from the engine.
- Pneumatic pressure signal from the governor controls compression:
  - — Integrated pressure relief valve protects the compressor and engine if discharge or governor lines become blocked, or if compressor cannot unload. The valve prevents the compressor from pumping more than 250 psi in the event of a blocked discharge line or other malfunction.

NOTE: This compressor has NO through drive capabilities for hydraulic power steering pumps.

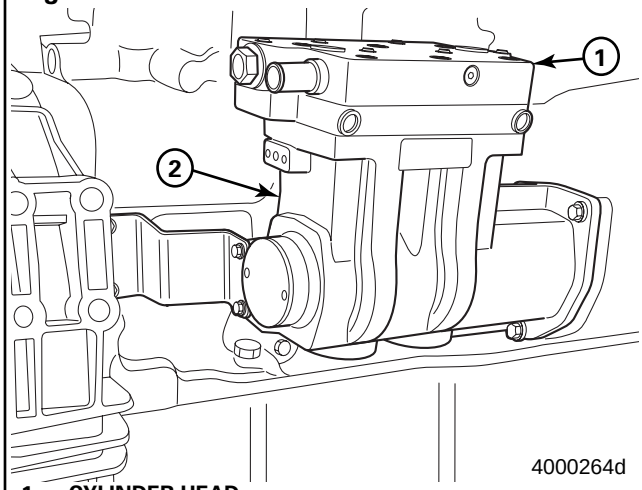
Figure 1.1



Description

The Meritor WABCO System Saver 636 twin cylinder air compressor provides and maintains air under pressure to operate devices in the air brake and auxiliary air systems of a vehicle. It consists of two major subassemblies: Cylinder head and crankcase. **Figure 1.2**.

Figure 1.2



1 CYLINDER HEAD
2 CRANKCASE

The **cylinder head** contains the inlet, discharge and unloader valving, as well as an integral relief valve. There are two water ports, marked Port 9, an air discharge port, marked Port 2, and an inlet port, marked Port 0, cast into the cylinder head to accommodate a hose connection. The cylinder head is mounted on the crankcase.

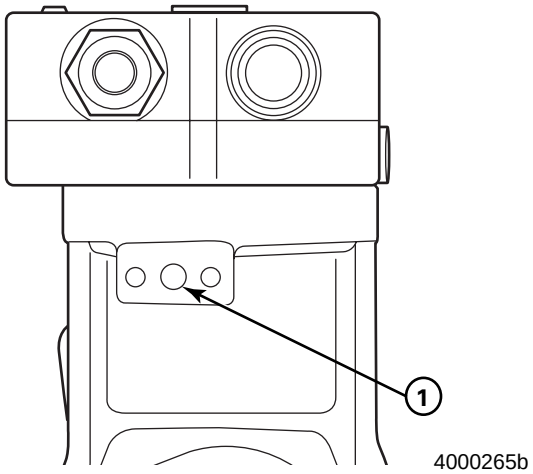
The **crankcase** contains the cylinder bores, pistons, bearings, crankshaft, governor port and connecting rods.

Operation

The compressor is driven by the engine. The compressor's crankshaft turns continuously while the engine is running. Compression of air is controlled by the **governor** and by the **compressor's unloading mechanisms**.

The **governor** maintains the brake system air pressure at preset maximum and minimum levels. The governor is mounted apart from the compressor, either horizontally or vertically. The governor port is located on the crankcase of the compressor. **Figure 1.3**.

Figure 1.3



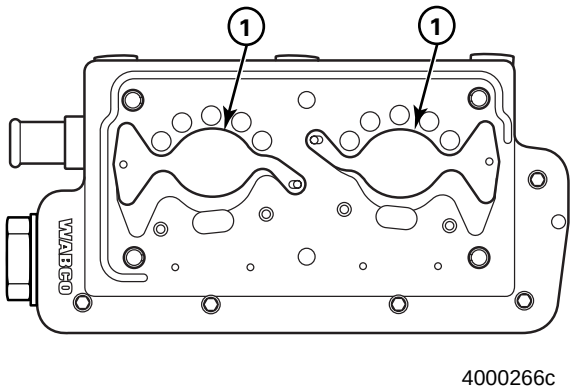
1 GOVERNOR PORT

The **unloader mechanisms** control the air compression cycle; an air compression cycle has three phases:

1. **Induction:** Air flows from the engine to the compressor, opening the inlet valves in the cylinder head of the compressor.
2. **Compression:** Air pressure is increased, causing the compressor's discharge valves to open.
3. **Unloading:** Air passes from the cylinders to the inlet chambers of the cylinder head via a port controlled by sliding leaf valves.

   When system cut-in pressure is reached, air is exhausted from the unloader ports.
4. After unloading, the unloader pistons return the sliding leaf valves to the loaded position. This seals the unloader ports and compression resumes. **Figure 1.4**.

Figure 1.4



1 SLIDING LEAF VALVES

Maintenance Intervals

The Meritor WABCO System Saver 636 twin cylinder air compressor receives inlet air, oil and coolant from the engine, so it is important to follow the engine manufacturer's recommendations and maintenance schedules regarding fluid levels, air filter and recommended change intervals.

Cylinder Head

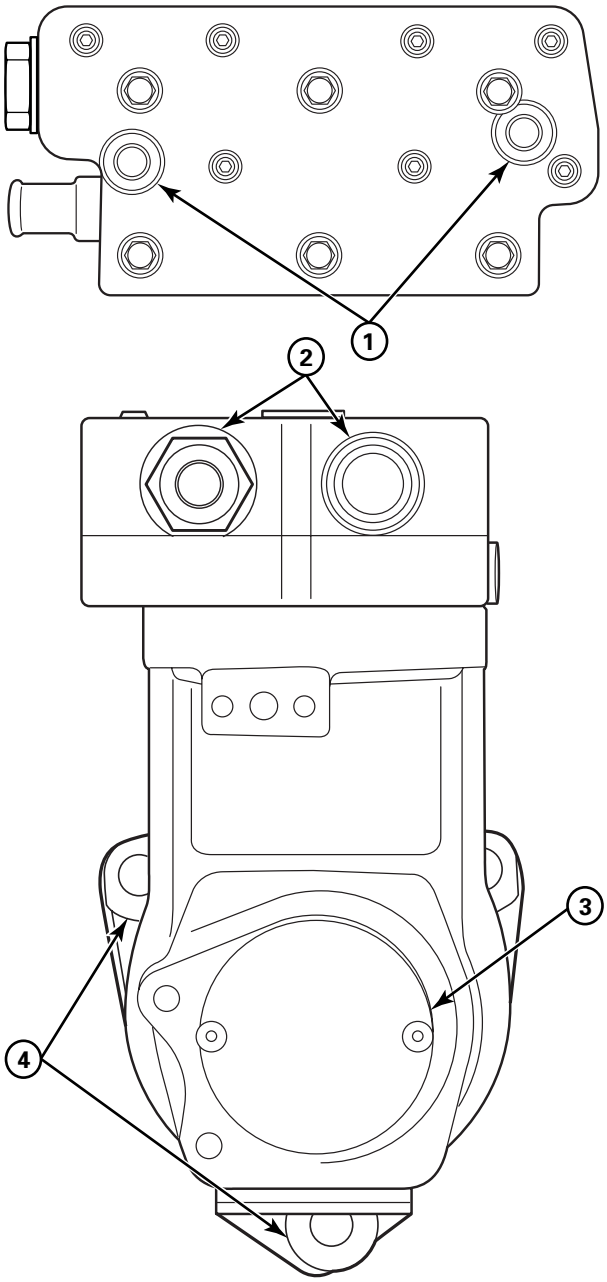
Remove carbon deposits from the discharge cavity and rust and scale from the cooling passages of the cylinder head.

Clean carbon and dirt from the inlet and unloader passages.

Visual Inspection

A visual check of the compressor can detect minor problems (see legend for examples of these problems). This check should be part of the vehicle preventive maintenance program. **Figure 1.5**.

Figure 1.5



1 Check water ports for leakage.
2 Check air inlet and discharge ports for leakage.
3 Check around end cover for oil leakage.
4 Check flanges for cracks or breaks.

Use the following chart to troubleshoot the Meritor WABCO System Saver 636 twin cylinder air compressor.

NOTE: If you have any questions or need additional information, please contact the Meritor WABCO Customer Service Center at 866-668-7221.

Table A: Compressor Troubleshooting Guide

Condition	Possible Cause	Solution
Compressor passes excessive oil (for example, the presence of oil at exhaust air brake system valves, oil in air dryer dessicant, etc.)	Blocked or restricted oil return	Clean oil drain passages in the compressor and on the engine surface. Verify proper passage alignment.
	Contaminated inlet air or oil	Replace damaged, defective or dirty engine air filter. Repair any leaking, damaged or defective compressor air intake components. Change engine lubricating oil. **NOTE:** To avoid this condition, make sure vehicle manufacturer's oil and filter maintenance schedules are followed.
	Restricted air inlet or excessive vacuum present at compressor inlet	Verify engine air cleaner is functioning properly. Replace if necessary. Repair compressor air inlet kinks or excessive bends. Check vehicle specifications to ensure air and coolant lines meet all requirements.
	Excessive engine crankcase pressure	Verify engine crankcase venting is to manufacturer's specification.
	Compressor duty cycle too high	Check system for leaks. Make necessary repairs.
	None of the above, but condition persists	Replace the compressor.
Compressor leaks oil	Physical damage or internal problems with compressor	Replace the compressor.
Compressor continuously cycles	Compressor unloader piston leaking	With compressor unloaded check for air leakage. If leaking, replace the cylinder head.
	Governor air leak	Refer to the manufacturer's manual for governor maintenance and troubleshooting procedures.
	Dryer purge valve air leakage	Check for air dryer malfunction. Refer to air dryer manufacturer's service instructions.
	Air leak at governor-compressor attachment.	Inspect connection for physical damage. Inspect and repair connection.
	Air leak at alcohol injector	Clear line of any obstructions. Inspect and repair connection.
	Excessive reservoir contamination	Drain reservoirs.
	None of the above, but condition persists	Replace the compressor.

Table A: Compressor Troubleshooting Guide (Continued)

Condition	Possible Cause	Solution
No air delivery **Low air delivery** **Low air pressure**	Discharge line blockage	Check for freeze up in the discharge line. Check low spots and eliminate any traps in the discharge line. Inspect and repair compressor discharge port and clear any line restrictions. Replace damaged lines as necessary. Check for carbon build-up. If carbon has built up, make sure cooling lines are not kinked or restricted. If carbon has built up in the discharge line, replace the line.
	Inlet line kinked or restricted	Inspect the compressor air induction line for kinks and restrictions. Repair or replace as necessary.
	Governor malfunction or misadjustment	Check for proper loader/unloader cycles of compressor. Refer to vehicle manufacturer's manual for governor maintenance and troubleshooting procedures.
	External contamination	Replace broken, defective or dirty air filters. Clean contaminants from surface of compressor.
	Air dryer purge valve stuck open or leaking	Check for air dryer malfunction. Refer to air dryer manufacturer's service instructions.
	Chafed or worn discharge line	Replace faulty sections of discharge line.
	Loose or leaking air line connections	Verify all connections are secure. Tighten to vehicle specifications where necessary. Inspect port threads for damage. If damage is extensive, replace cylinder head.
	Damage to compressor valves and/or valve seats	Replace the cylinder head.
	Leaking or malfunctioning internal pressure relief valve	Replace the cylinder head.
Noisy air compressor	Loose drive hub Loose accessory drive coupling	Check fit of drive coupling. Ensure hub is completely seated and crankshaft nut is tight. Inspect crankshaft for damage — replace compressor if crankshaft is damaged.
	None of the above, but condition persists	Replace the compressor.
Broken connecting rod or crankshaft	Oil starvation to crank pin or front main bearing	Check oil pressure. Verify oil passage is free of obstructions. Make necessary repairs.
	Failed power steering pump	Verify power steering pump is in proper operating order. Refer to the component manufacturer's service instructions.
	All of the above	Replace compressor.

Table A: Compressor Troubleshooting Guide (Continued)

Condition	Possible Cause	Solution
Compressor leaks engine coolant	Loose fitting	Check fittings at compressor and engine for leaks and verify fittings are properly torqued.
	Cracked coolant port	Replace cylinder head.
	Porosity in cylinder head	Replace cylinder head.
	Leaking of gasket internal to the cylinder head	Verify cylinder head bolts are properly torqued. Make necessary adjustments. Inspect gasket for cracks or signs of wear. Replace if necessary. Replace cylinder head.
	None of the above, but condition persists	Replace compressor.
Compressor pressurizes coolant system or coolant leakage to compressor inlet	Leaking of gasket internal to the cylinder head	Inspect gasket. Replace if necessary.
	Cavitation or corrosion in cylinder head	Replace cylinder head.
	Porosity in cylinder head or cylinder head cracked	Replace cylinder head.
	None of above, but condition persists	Replace the compressor.
Unloader leakage	Possible internal damage, including worn or damaged unloader piston O-ring, porosity in unloader piston bore, loose or leaking seal at unloader piston bore	Replace compressor cylinder head assembly.
Compressor head gasket failure	Discharge line blocked due to freezing or carbon build-up	Check for trap (low spots) in lines. Make necessary repairs. Clear discharge line. Replace line if necessary. Check for carbon build-up. If carbon build-up is present, replace the discharge line.
	Frozen or blocked line to governor	Clear blocked line. Replace line if necessary. Check for air dryer malfunction. Repair or replace as required. Refer to the air dryer manufacturer's maintenance manual for service information.
	Governor malfunction	Repair or replace the governor. Refer to governor manufacturer's maintenance manual for service information.
	Improper cylinder head bolt torque, machining defect on cylinder head or block, defective cylinder head gasket	Inspect gasket. Replace if necessary. Verify all bolts are properly torqued. If problem persists, replace cylinder head.
	None of the above, but condition persists	Replace compressor cylinder head assembly.

The cylinder head portion of the compressor is replaceable. The crankcase is not replaceable. If the crankcase is damaged or malfunctioning, replace the complete compressor.

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Remove all pressure from the air system before you disconnect any component. Pressurized air can cause serious personal injury.

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

Compressor Replacement Information

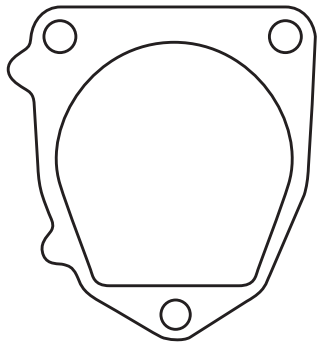
CAUTION

The removal instructions given in this manual are general. Depending on the type of vehicle involved, additional steps may be required. Refer to the vehicle manufacturer's manual for additional information.

The front of the Meritor WABCO System Saver 636 air compressor is mounted to the engine.

Before you remove the compressor, make sure you have a replacement gasket to install with the new compressor (Mack Part Number 590GB2159). Figure 3.1.

Figure 3.1



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Compressor Removal

1. Set the spring (parking) brakes and block the wheels of the vehicle.
2. Drain the air pressure from the air system.
3. Drain the engine cooling system and the cylinder head of the compressor.
4. Disconnect all air and water lines leading to the compressor.
5. Remove the discharge and coolant fittings. Note fitting locations to aid in reassembly.

   NOTE: The discharge fitting consists of a fitting and a bushing. The bushing should remain in the cylinder head.

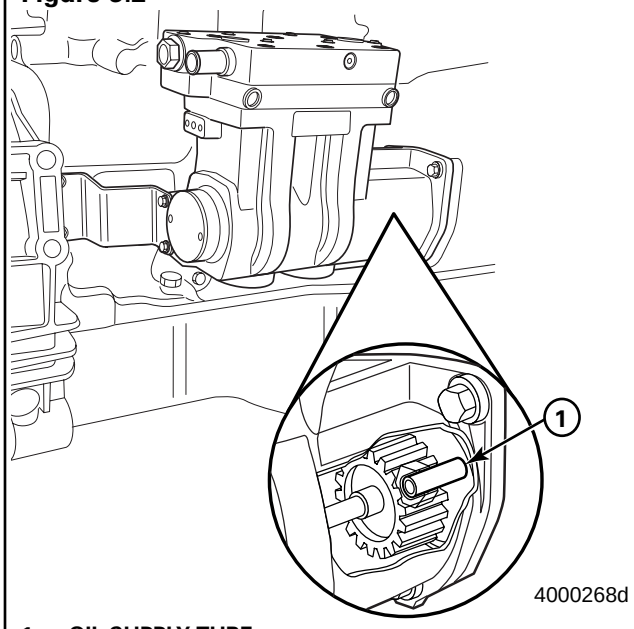
6. Loosen and remove the four bracket mounting bolts: Two bolts that hold the rear support bracket to the back of the compressor and two bolts that hold the bracket to the engine block. Retain the bolts for re-assembly.

   NOTE: This bracket supports the weight of the compressor.

7. Loosen the three flange mounting bolts that hold the compressor to the engine.
8. Remove the compressor from the engine.

   Remove and retain the oil supply tube that runs between the compressor and the engine. Figure 3.2.

Figure 3.2



1 OIL SUPPLY TUBE

Compressor Installation

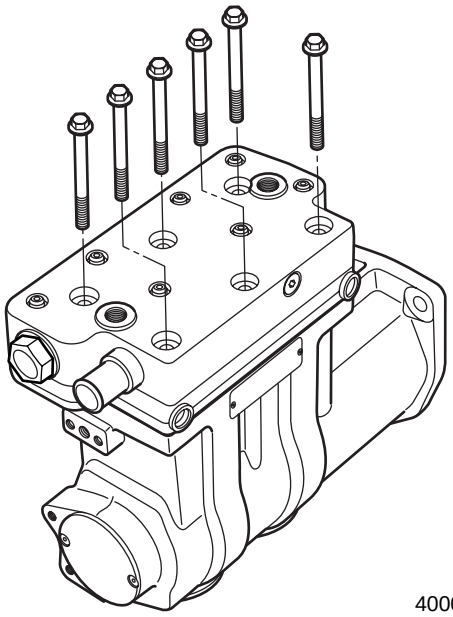
1. Reinstall the oil supply tube.
2. Install a new compressor gasket.
3. Position the compressor on the engine.
4. Install the three flange mounting bolts. Tighten to 15 lb-ft (20 N•m) +90° rotation. T
5. Install the two bolts that hold the bracket to the compressor and the two bolts that hold the bracket to the engine block. Run the bolts down finger tight at both ends of the bracket (engine and compressor). The bracket should be in contact with both surfaces; engine block and compressor rear support face. Tighten bolts to 18 lb-ft (25 N•m) maximum at compressor side. Tighten bolts at engine side per Mack specification. T
6. Attach the discharge and coolant fittings. Finger-tighten fittings and rotate 2 to 3 turns to position fitting. T
7. Connect all air and water lines leading to the compressor. Tighten per Mack specifications.
8. Add engine coolant to the cooling system. Use the coolant recommended by the engine manufacturer. Visually inspect the engine and compressor for leaks.
9. Start the engine and allow air system to build to governor cutout. Stop the engine. Use a soap and water solution at connection points to check for air leaks. Make any necessary repairs.
10. Remove the wheel blocks and release the spring (parking) brakes.

Cylinder Head Replacement

Removal

1. Follow the steps listed in Compressor Removal to remove the compressor from the engine. Take care not to damage the crankcase, since it will not be replaced.
2. Use a cleaning solvent to remove road dirt and grease from the exterior of the compressor.
3. Remove and discard the six hex head bolts that attach the cylinder head to the crankcase and remove the cylinder head valves and gaskets. **Figure 3.3**.

Figure 3.3



4. Use a mild cleaning solvent to clean the top of the crankcase.

Installation

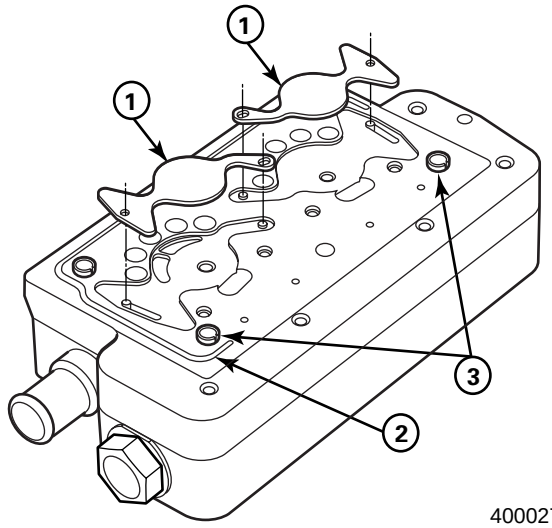
NOTE: A Torx® tool is required for this procedure.

Cylinder head valve components MUST be aligned in the proper position in order for the compressor to function.

1. Install the sliding leafs. The two holes in each sliding leaf must be installed over the two pins on the base of the cylinder head. **Figure 3.4**.

   NOTE: A light application of engine oil will hold the sliding leaves to the inlet valves. **Figure 3.4**.

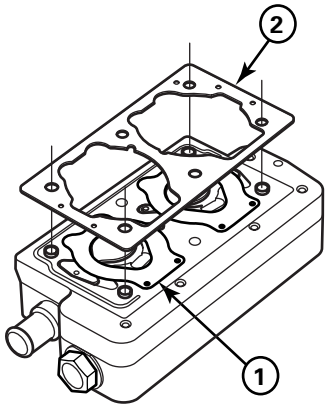
Figure 3.4



1 SLIDING LEAF VALVES
2 UNLOADER PASSAGE
3 GUIDE BUSHINGS

2. Lay the new cylinder head gasket in place, ensuring that it fits over the guide bushings and that the unloader hole allows air pressure communication from the cylinder head to the crankcase. **Figure 3.5**.
3. Place the inlet valves over the guide pins provided, ensuring that the pads are up and the valves will lie flat against the head openings. A small amount of Lubriplate grease can be used to ensure they remain in place for the remainder of the assembly. **Figure 3.5**.

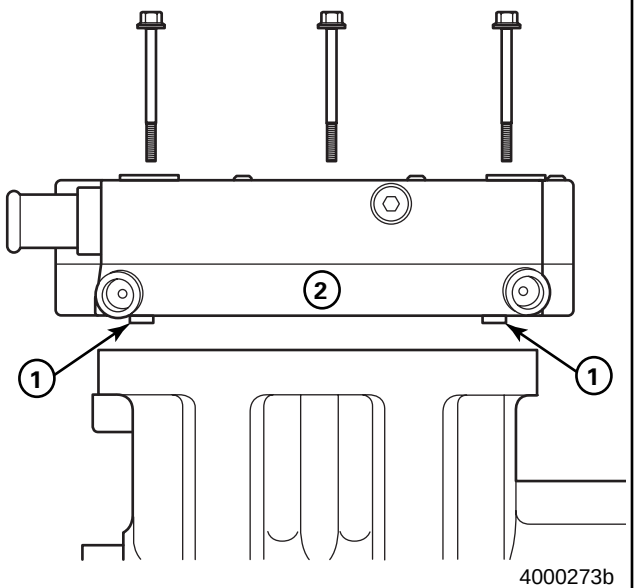
Figure 3.5



1 INLET VALVE
2 CYLINDER HEAD GASKET

4. Position the cylinder head on top of the compressor. Ensure the notched pins on the cylinder head align with the recesses in the block. Only four of the six bolt holes have notched pins. **Figure 3.6**.

Figure 3.6



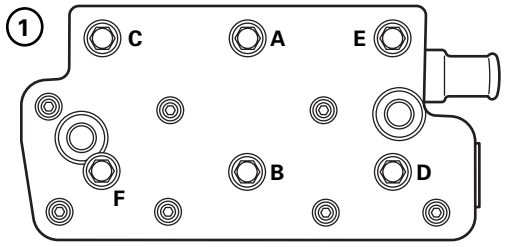
1 CYLINDER HEAD NOTCHED PINS
2 SIDE VIEW OF CYLINDER HEAD

5. Install the six hex head mounting bolts that hold the cylinder head in place. Tighten the mounting bolts in sequence per Table B, following Steps 1-12. **Figure 3.7**.
6. Use a Torx® tool to tighten the seven Torx® head screws in sequence per Table B, following Steps 13-26. **Figure 3.8**.

CAUTION

Use the proper tools to perform this torque-turn bolt tightening sequence exactly as shown in Table B. Accuracy is CRITICAL to your field service success!

Figure 3.7



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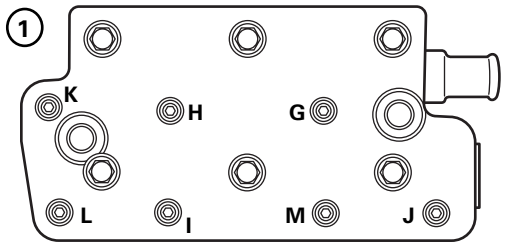
1 Tighten bolts in sequence shown.

Figure 3.8



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1 Tighten bolts in sequence shown.

Table B: Bolt Tightening Sequence

Step	Bolt	Torque (N•m)	Torque lb-ft	Rotation (Degrees)
1	A	25^{+0}_{-5}	$18.5^{+0}_{-3.7}$	
2	B	25^{+0}_{-5}	$18.5^{+0}_{-3.7}$	
3	C	25^{+0}_{-5}	$18.5^{+0}_{-3.7}$	
4	D	25^{+0}_{-5}	$18.5^{+0}_{-3.7}$	
5	E	25^{+0}_{-5}	$18.5^{+0}_{-3.7}$	
6	F	25^{+0}_{-5}	$18.5^{+0}_{-3.7}$	
7	A			$150°^{+15}_{-5}$
8	B			$150°^{+15}_{-5}$
9	C			$120°^{+15}_{-5}$
10	D			$120°^{+15}_{-5}$
11	E			$120°^{+15}_{-5}$
12	F			$120°^{+15}_{-5}$
13	G	6^{+6}_{-6}	$4.4^{+4.4}_{-4.4}$	
14	H	6^{+6}_{-6}	$4.4^{+4.4}_{-4.4}$	
15	I	6^{+6}_{-6}	$4.4^{+4.4}_{-4.4}$	
16	J	6^{+6}_{-6}	$4.4^{+4.4}_{-4.4}$	
17	K	6^{+6}_{-6}	$4.4^{+4.4}_{-4.4}$	
18	L	6^{+6}_{-6}	$4.4^{+4.4}_{-4.4}$	
19	M	6^{+6}_{-6}	$4.4^{+4.4}_{-4.4}$	
20	G			$135°^{+15}_{-5}$
21	H			$135°^{+15}_{-5}$
22	I			$135°^{+15}_{-5}$
23	J			$135°^{+15}_{-5}$
24	K			$135°^{+15}_{-5}$
25	L			$135°^{+15}_{-5}$
26	M			$135°^{+15}_{-5}$

7. Follow the steps listed in Compressor Installation to reinstall the compressor and test for leaks.

Performance Testing

Test the vehicle air system as follows:

1. Bleed the vehicle air system reservoir gauges down (apply brakes several times) to approximately 85 psig.
2. With the engine running at full governed speed (no load, no air accessories being used), the compressor should reach governor cutout pressure, then unload.

   If the compressor does not reach governor cutout pressure, check for air leaks in the system. If reservoir volume and engine RPM are per original vehicle manufacturer's specifications, system plumbing leakage must be checked and, if necessary, repaired. See air system leakage test procedures which follow.

   If the compressor fails to unload, verify proper governor operation.

Air System Leakage Test

(Conforms to North American Uniform Roadside Inspection Criteria)

1. Park the vehicle on a level surface. Apply the parking brakes. Disconnect any attached or towed vehicles (semi-trailer, full trailer, dolly, etc.). Leave engine on.
2. Chock the tires.
3. Release the parking brakes.
4. With the compressor in pumping mode, engine at idle and service brakes fully applied gauge must stay between 80-90 psi or gradually rise.

   If pressure is not maintained (pressure drops) there is an air leak in the system.

   Listen for air leaks. Soapy water or high frequency acoustic detectors may be used to detect any leaks. Make the necessary repairs.

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Commercial Vehicle Systems

Meritor WABCO
Vehicle Control Systems
3331 West Big Beaver Road, Suite 300
Troy, MI 48084 USA
800-535-5560
meritorwabco.com

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16579/24240

AlliedSignal Bendix

Service Data

LOW PRESSURE INDICATORS

*Formerly SD-06-2

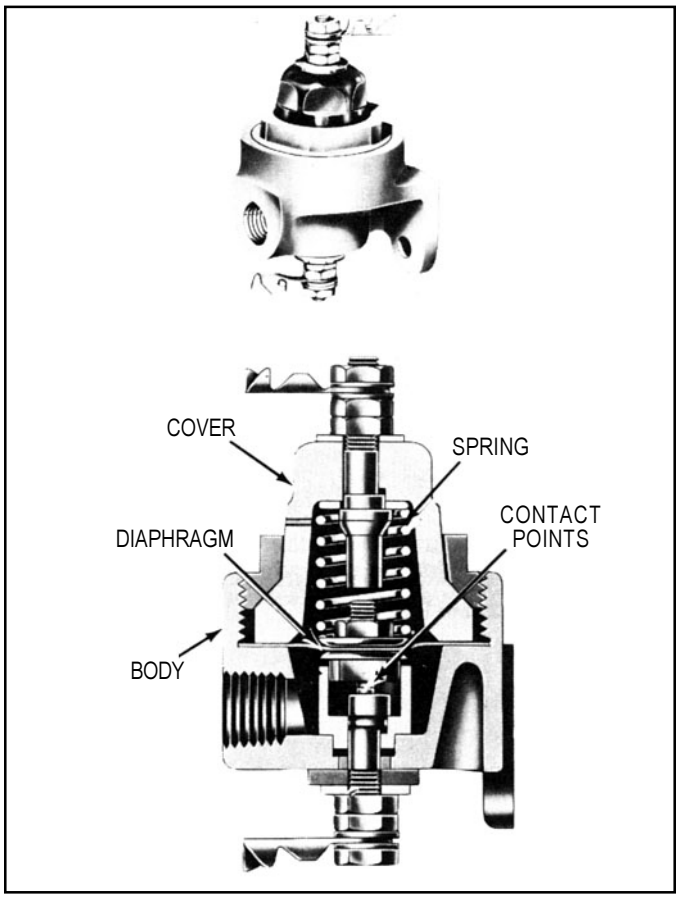

FIGURE 1 - LP-2

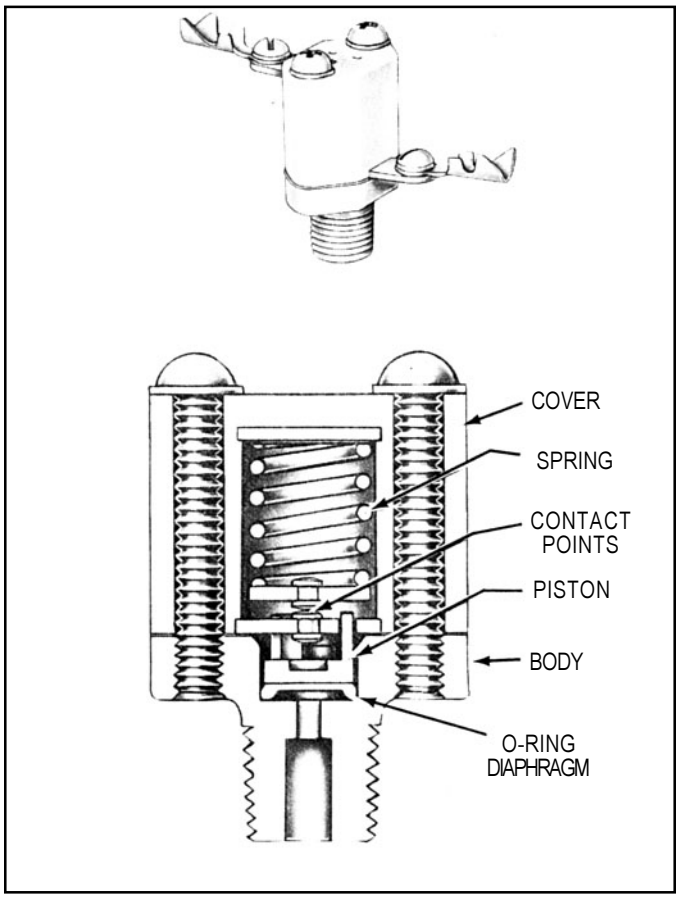

FIGURE 2 - LP-3

DESCRIPTION

The Low Pressure Indicator is a safety device designed to give an automatic warning to the driver whenever air pressure in the air brake system is below the safe minimum for normal vehicle operation. It is usually used to operate an electrical buzzer or warning light, or both, which are audible or visible to the driver.

Two styles of Low Pressure Indicators are currently manufactured.

The LP-2 Low Pressure Indicator, which is the older style and consists of a die cast body with a spring loaded diaphragm clamped between the body and the Bakelite cover.

The LP-3 Low Pressure Indicator is the newer style, consisting of a die cast body, nylon cover and employs a spring loaded O-Ring diaphragm and piston. The LP-3 is available with either one terminal or two. The single terminal unit utilizes a metallic gasket between body and case to ground the lower contract strip. The two terminal unit utilizes a phenolic insulating gasket to isolate both terminals from the vehicle frame.

The electrical contacts provided in both the LP-2 and LP-3 indicators remain closed by spring force until the air brake system pressure below the diaphragm is above the setting (force) of the Low Pressure Indicator spring. The setting of the indicator and piece number is marked on a label on the valve body. If a label is not present, then the vehicle manual should be consulted for the proper setting. The nominal setting of the indicator is 60 psi; however, pressure settings may vary depending upon the vehicle.

OPERATION

To describe the operation, we shall assume that the Low

Pressure Indicator is set for 60 psi. When air pressure at the supply port and under the diaphragm is above 60 psi, the electrical contacts remain open because the force exerted by air pressure underneath the diaphragm overcomes the force exerted by the spring above the diaphragm.

When air pressure below the diaphragm drops below 60 psi, the spring exerts a force which is greater than the force exerted by the air pressure below the diaphragm. This causes the diaphragm (and the piston in the LP-3) to move and allow the electrical contacts to close. This completes or closes the electrical circuit to the warning device, warning the driver of low air pressure in the system.

PREVENTIVE MAINTENANCE

Every six months, 1800 operating hours or 50,000 miles, check electrical connections. Low Pressure Indicator should be checked for proper operation by performing "Operating Test" as described elsewhere in this sheet.

TESTING FOR SERVICEABILITY

OPERATING TEST

1. If possible, determine the setting of the Low Pressure Indicator by referring to the label on the valve or the vehicle manual.
2. Operation of the Low Pressure Indicator may be checked with ignition switch "on" by reducing the system pressure and observing that low pressure warning occurs when system pressure drops below the setting of the Low Pressure Indicator. The contacts will be closed when the warning device operates. If the setting of the indicator is unknown, the contacts should close between approximately 70 psi and 50 psi.

LEAKAGE TEST

1. With air pressure present at the supply port, coat the indicator with soap solution. No leakage permitted.

REMOVING

1. Block the wheels. Otherwise, secure the vehicle with other than service brakes.
2. The ignition switch should be in the "off" position.
3. Drain the air from the system.
4. Disconnect the electrical connections at the Low Pressure Indicator.
5. Disconnect the air line and mounting bolts or unscrew the Indicator from the fitting and remove.

INSTALLING

1. Install in a convenient location for servicing.
2. Connect to a reservoir pressure line at a high point in the system for adequate drainage.
3. If installing an LP-2G Indicator, use a supply line of 1/4 O.D. minimum.
4. Connect the Indicator terminals in series with the ignition switch and the warning device.

DISASSEMBLY

NOTE: It is generally recommended that the Low Pressure Indicator, if faulty, be replaced with a new unit; however, service parts are available; and if repairs are necessary, the following will apply:

LP-2 Unscrew the cover retainer from the body. Remove cover and remove spring and diaphragm assembly.

LP-3. Remove cover screws, lockwashers. Remove cover, contact disc, spring, and shim(s). (Note: Shims may or may not be present.) Remove contact plate, gasket, piston, and O-Ring diaphragm.

CLEANING AND INSPECTION

Clean all metal parts in mineral spirits.

Inspect all parts for wear, cracks, or deterioration and replace all parts not considered serviceable with genuine Bendix parts.

If contact points are not pitted severely, they can be dressed with a fine file.

ASSEMBLY

LP-2

1. Place and position the diaphragm assembly in the body. Position the spring so that it rests on the upper diaphragm follower.
2. Place cover over the diaphragm and screw cover retainer to the body and tighten securely. (Torque to 110-130 inch pounds.)

LP-3

1. Lubricate bore of body and both sides of the O-Ring diaphragm with silicone lubricant BW-650-M (Bendix piece no. 291126).
2. Install O-Ring diaphragm in body. (Note: O-Ring portion of diaphragm should face supply port.)
3. Install piston in body. Flat side of piston should face O-Ring diaphragm.
4. Install gasket. (Always use a phenolic gasket in a two terminal switch and a metallic gasket in the single terminal.)
5. Position contact plate over fingers of piston. Contact plate should rest on face of gasket.
6. If shim(s) are used, place shim(s) in cover.
7. Place spring in cover.
8. Place contact point so that it rests on spring.

9. Install cover on body, using machine screws, making certain that the contact plate is in position over fingers of piston, and arm of contact plate is positioned so that it will fit in groove of cover.
10. Tighten screws securely. (Torque to 20-30 inch pounds).

TEST OF REBUILT LOW PRESSURE INDICATOR

After rebuilding, perform the leakage and operating tests as outlined in section "Testing for Serviceability."

IMPORTANT! PLEASE READ

When working on or around a vehicle, the following general precautions should be observed:

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels.
2. Stop the engine when working around the vehicle.
3. If the vehicle is equipped with air brakes, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle.
4. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that removes all electrical power from the vehicle.
5. When working in the engine compartment the engine should be shut off. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.
6. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
7. Never exceed recommended pressures and always wear safety glasses.
8. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
9. Use only genuine Bendix replacement parts, components, and kits. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.
10. Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted unless specifically approved and stated by the vehicle or component manufacturer.
11. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.

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Service Data

SD-03-3611*

PUSH-PULL TYPE CONTROL VALVES: PP-1, PP-2, PP-5, PP-8, & RD-3

*FORMERLY SD-03-61

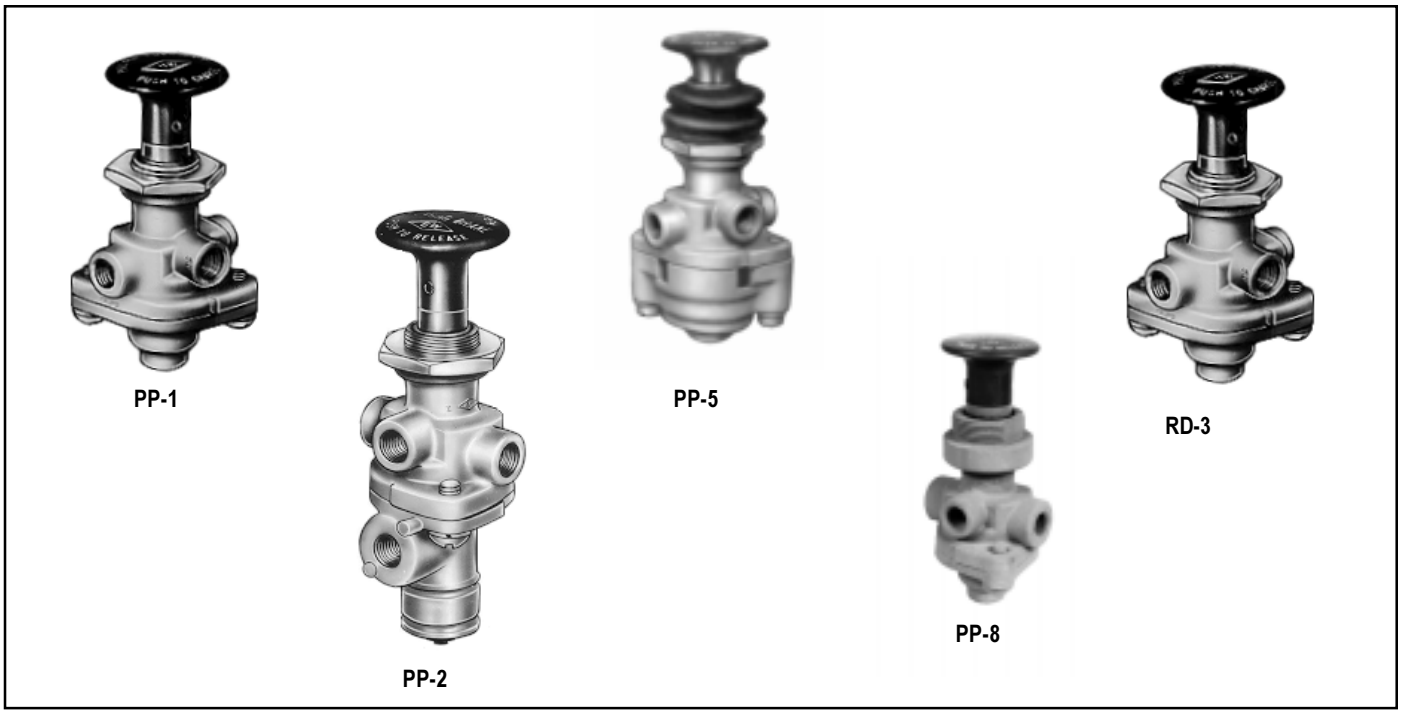


FIGURE 1 - ***PUSH-PULL TYPE CONTROL VALVES***

DESCRIPTION

The PP valves are push-pull manually operable on-off air control valves with an exhaust function. Most are pressure sensitive, so that they will automatically move from the applied to the exhaust position as supply pressure is reduced to a certain minimum, depending on the spring installed. The exception to this is the PP-8 valve and some PP-1 valves which have no spring. The PP-8 valve also has a larger diameter shaft for button mounting so that when installed on the same panel with other PP valves the buttons cannot be inadvertently mixed. The PP-8 is normally used to operate tractor spring brakes independently from the trailer.

The PP-5 is unique in having an auxiliary piston in the lower cover which, upon receiving a pneumatic signal of 18 psi or more, will cause the valve to move from the applied to the exhaust position from a 100 psi application.

The RD-3 differs slightly in that it normally remains in the exhaust position and requires a constant manual force to hold it in the applied position.

The PP-2 has an auxiliary port which may be plumbed into a service brake line to release the spring brakes if a service application is made, preventing compounding of forces on the foundation brakes.

PREVENTIVE MAINTENANCE

Every six months, 50,000 miles or 1800 operating hours, disassemble, clean and replace parts if necessary.

REMOVAL

Block and/or hold the vehicle by a means other than air brakes and drain all reservoirs.

1. Drive the Button Roll-Pin out with a punch and remove the button.
2. Mark each air supply line and its port for easy reinstallation, then disconnect them. Remove the valve from the panel by removing the Panel Mounting Nut.

	AUTOMATIC EXHUAST	MOMENTARY APPLY	PILOT TRIP FEATURE	NON-AUTOMATIC
PP-1	20,30,40 or 60 psi			
PP-2	40 psi			
PP-5	40 psi		18 psi	
RD-3		Must be held manually		
PP-8				Will remain in either position

INSTALLING

1. Install valve in panel, securing with the Panel Mounting Nut.
2. Reconnect the air lines using marks made during removal as a guide.
3. Install the operating button. Secure the operating button by installing the Button Roll Pin.

DISASSEMBLY: PP-1, PP-8 AND RD-3

1. Remove the two cap screws (3) which retain the lower cover and remove cover. Remove the sealing ring (4).
2. Insert a small punch through the roll pin hole in the stem and remove the lock nut (5).
3. Remove inlet-exhaust valve (6) and plunger (7) and spring (8) (if any).
4. Remove o-ring (9) from plunger.

DISASSEMBLY: PP-5

1. Perform same operations as for PP-1.
2. Remove inlet seal (10) in Figure 4 from lower cover. Remove the ring diaphragm (4) from the inlet seat.
3. Remove piston (11) Figure 4 and o-ring (2).

DISASSEMBLY: PP-2

1. Insert a small punch through the roll pin hole in the plunger and remove the lock nut (1) from the plunger.
2. Withdraw the plunger and remove the spring (9) and o-ring (8).
3. Remove the two machine screws (2) and remove the lower cover (3).
4. Remove the inlet-exhaust valve (4), and piston (5).
5. Remove o-rings (6 & 7) from piston.

OPERATING AND LEAKAGE TESTS

PP-1, PP-8, RD-3

1. An accurate test gauge should be tee'd into the supply line and a means of controlling the supply pressure provided. Apply a 120 psi air source to the supply port. A small volume reservoir (e.g. 90 cu. in.) with a gauge should be connected to the delivery port.
2. With 120 psi supply pressure, and the button pulled out (exhaust position), leakage at the exhaust port should not exceed a 1" bubble in five seconds; at the plunger stem a 1" bubble in five seconds. There should be no leakage between upper and lower body.
3. Push the button in (applied position). Leakage at the exhaust port should not exceed a 1" bubble in 3 seconds; at the plunger a 1" bubble in three seconds. (The RD-3 will have to be manually held in this position.)
4. Reduce the supply pressure. At a pressure from 60 to 20 psi depending on the spring installed the button should pop out automatically, exhausting the delivery volume. (This does not apply to the RD-3, PP-8 or some PP-1's).

PP-5

1. Proceed as for PP-1 through Step 3.
2. Connect a modulated source of air pressure to the pilot air inlet. With the button pushed in (applied position) with 125 psi supply pressure and a gradually increasing pressure applied at the pilot air port the valve should move to the release position with a pilot pressure of not more than 18 psi. Leakage in this mode should not exceed a 1" bubble in three seconds at the exhaust port and a 1" bubble in five seconds at the plunger stem.

PP-2

1. Proceed as for PP-1 through Step 1.
2. With the button pulled out (exhaust position), leakage at the brake valve port or at the plunger stem should not exceed a 1" bubble in five seconds.
3. Push the button in. Supply pressure should be present in the delivery volume. Leakage at the exhaust port or around the plunger stem should not exceed a 1" bubble in five seconds.
4. Pull the button out and apply supply pressure at the brake valve port. Supply pressure should be present in the delivery volume and leakage at the exhaust port should not exceed a 1" bubble in five seconds.

Note: If any of the above push-pull valves do not function as described or if leakage is excessive, it is recommended they be returned to our nearest authorized distributor for a factory rebuilt or new valve.

IMPORTANT! PLEASE READ:

When working on or around a vehicle, the following general precautions should be observed:

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels.**
2. **Stop the engine when working around the vehicle.**

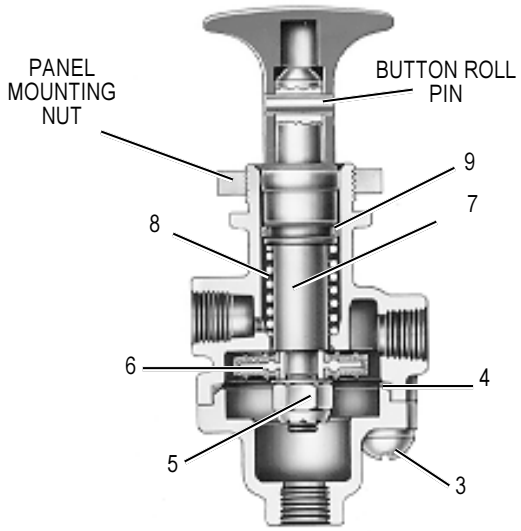


FIGURE 2 **PP-1**

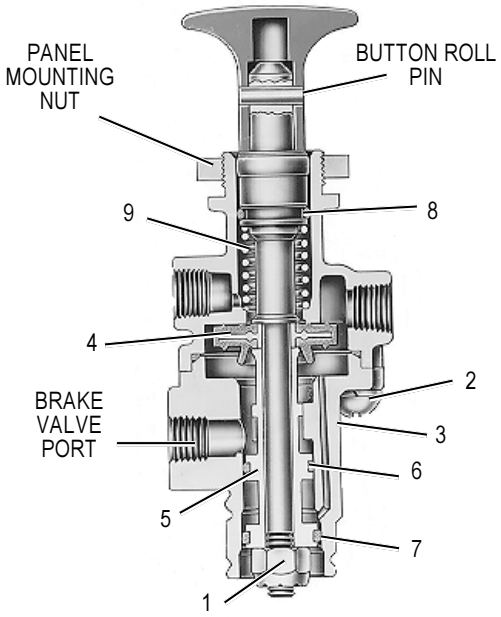
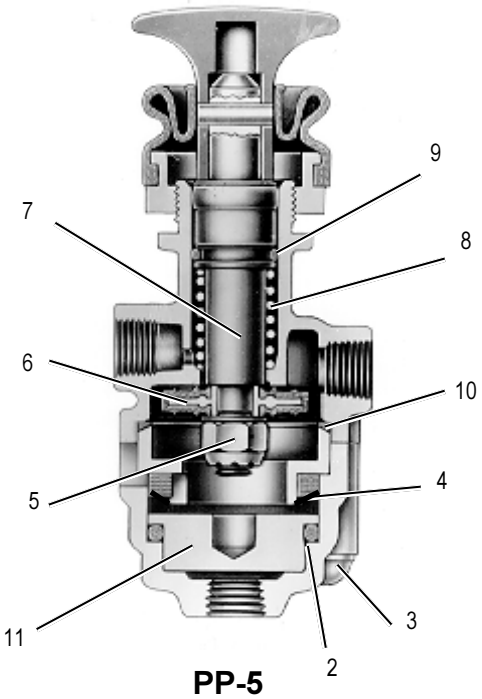
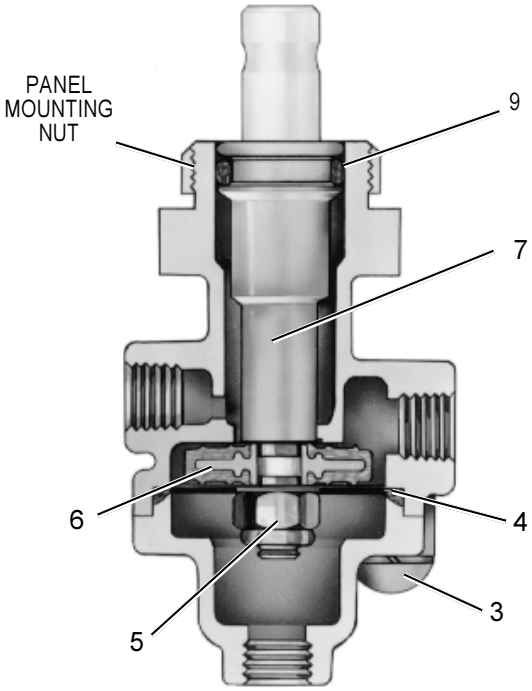


FIGURE 3 **PP-2**



PP-5

FIGURE 4

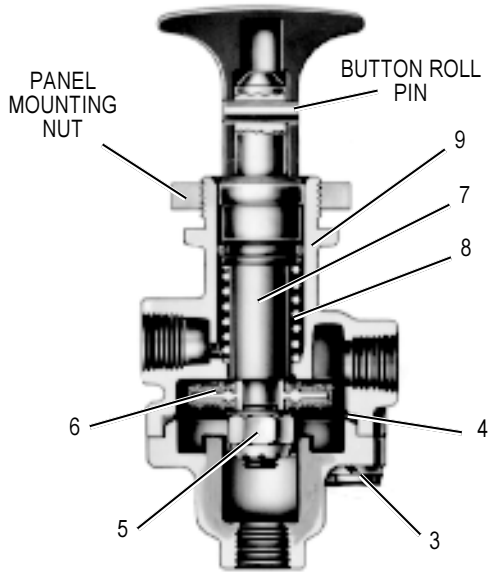


PP-8

FIGURE 5

3. **If the vehicle is equipped with air brakes, make certain to drain the air pressure from all reservoirs before beginning <u>any</u> work on the vehicle.**
4. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that removes all electrical power from the vehicle.**
5. **When working in the engine compartment the engine should be shut off. Where circumstances require that the engine be in operation, <u>extreme caution</u> should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.**

6. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
7. **Never exceed recommended pressures and always wear safety glasses.**
8. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
9. **Use only genuine Bendix replacement parts, components, and kits. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.**
10. **Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted unless specifically approved and stated by the vehicle or component manufacturer.**
11. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**



RD-3

FIGURE 6

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Service Data

SD-03-3602*

TW-1, TW-3, TW-4, TW-5 & TW-6 CONTROL VALVES

*Formerly SD-03-64

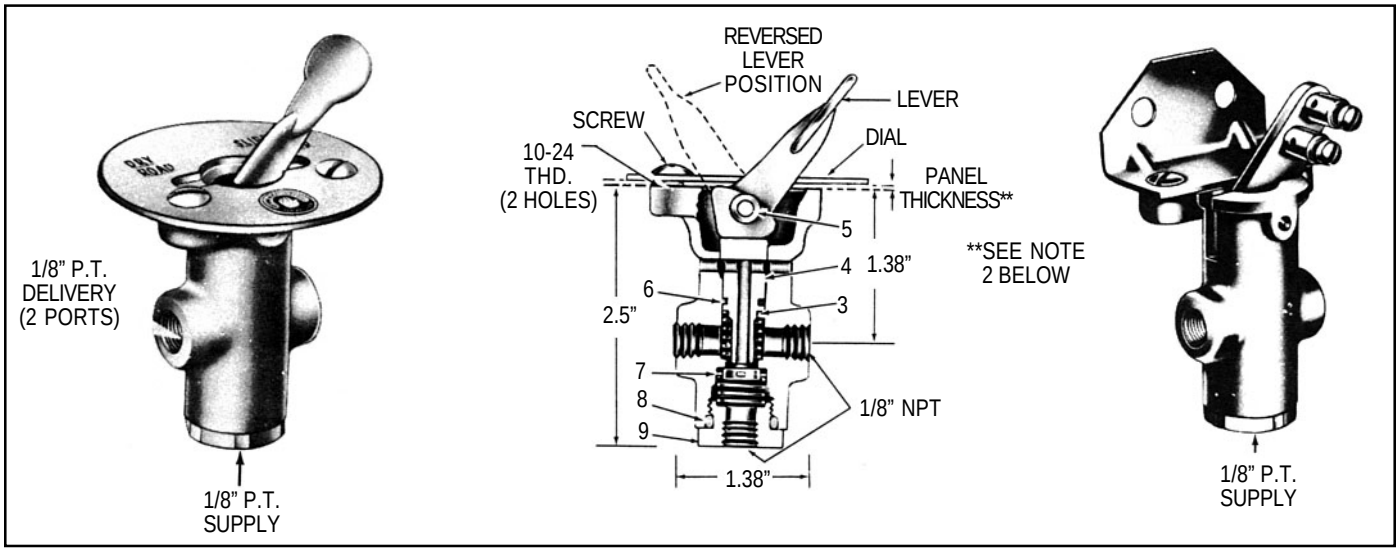

FIGURE 1 - TW-1

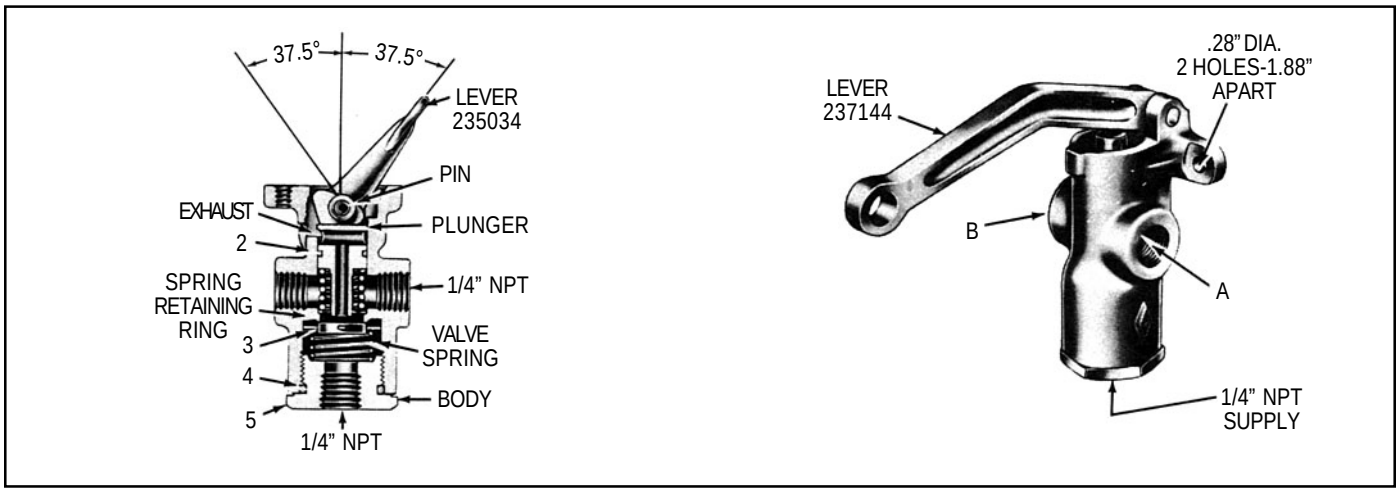

FIGURE 2 - TW-3

DESCRIPTION

The TW series valves are manually operated on-off valves. They are extensively used in air systems to control nonmodulating air controlled devices. They may be lever or button operated, direct or remote control.

The TW-1 (Figure 1) is normally panel mounted with a steel, zinc or nylon manually operated lever. Some are equipped with a steel lever with connectors for Bowden cable control. All TW-1's have 1/8" NPT ports.

The TW-3 (Figure 2) is lever operated, either direct or remote and differs from the TW-1 in having 1/4" NPT ports and larger capacity. Some versions have a heavy inlet valve spring making them suitable for vacuum control.

TW-4's and TW-5's (Figure 3) are similar to the TW-1 except the plunger is designed for a push button, giving momentary application whenever the button is depressed.

The TW-6 (Figure 4) is a TW-1 with a grounding switch included. In the exhaust position the switch is open. When the valve is applied the switch is closed.

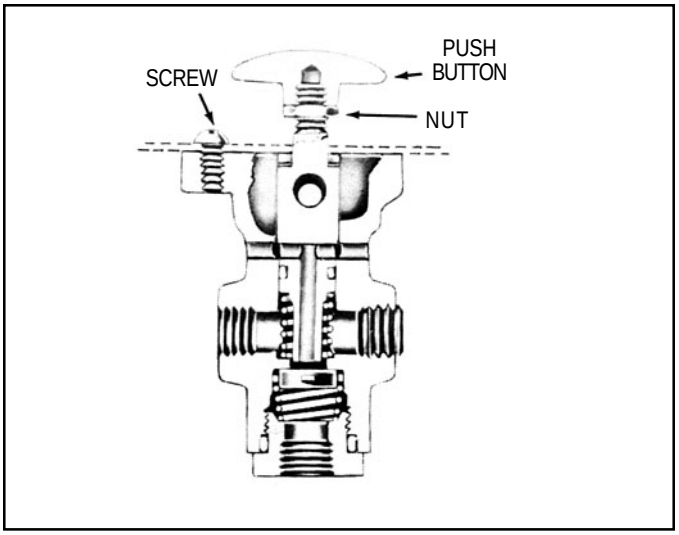

FIGURE 3 - TW-4

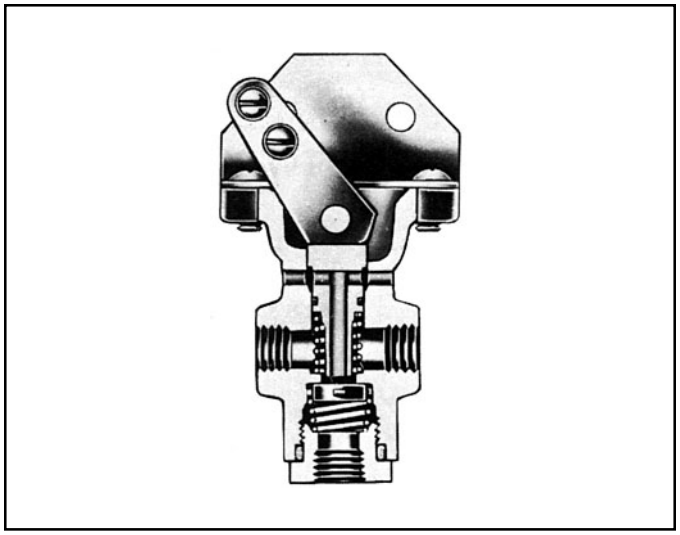

FIGURE 4 - TW-6

OPERATION

With air pressure a the supply port (Figure 1) and the plunger in the upward position the valve is in the exhaust position. The delivery ports are open to atmosphere through the exhaust passage in the center of the plunger.

When the plunger is depressed by the cam action of the lever (Figure 1) or by a direct force on a push button (Figure 3) the plunger contacts the inlet valve, closing the exhaust passage and pushes the inlet valve off the inlet seat in the body, allowing supply air to flow through the delivery ports to the controlled device.

PREVENTIVE MAINTENANCE

Every year, 100,000 miles or 1800 operating hours disassemble, clean and check all parts and replace if necessary.

SERVICE CHECKS

OPERATING AND LEAKAGE TESTS

Connect a 100 psi air pressure source to the supply port and connect delivery to an air gauge. (if there are two delivery ports, plug one.) With the valve in the released position, check for leakage at the exhaust holes with a soap solution. No leakage permitted. Place the valve in the applied position. Supply air pressure should show on the gauge. Check for leakage at the exhaust holes. No leakage permitted.

If the TW valve does not function as described or if leakage occurs, it is recommended that it be replaced with a new unit or repaired with genuine Bendix parts.

REMOVING

Secure the vehicle with other means than brakes and drain the reservoirs.

Disconnect all air lines and remove the valve.

INSTALLING

Place valve handle through appropriate hole in panel, place dial (if used) over handle and install mtg. screws. Connect air lines.

DISASSEMBLY

Remove operating handle or lever by driving the pin out of the body (Figure 1) and remove the lever, plunger and plunger spring. Remove the O-Ring from the plunger.

Remove the supply cap nut, inlet valve and spring. Remove the 0-Ring from the supply cap nut.

CLEANING AND INSPECTION OF PARTS

Wipe rubber parts clean. Clean plastic and metal parts in mineral spirits and dry thoroughly. Inspect all rubber parts for wear or deterioration and replace where necessary. Polish the inlet seat in the body if nicked or corroded. Inspect all springs for cracks, distortion or corrosion and replace if necessary.

ASSEMBLY

Prior to assembly lubricate body bore, plunger, O-Rings, and cap nut threads with Bendix silicone lubricant BW 650M Pc. No. 291126.

Place inlet valve in body.

Place inlet valve spring on inlet valve.

Place O-Ring on cap nut and install cap nut.

Install plunger spring from top of body.

Install O-Ring on plunger and install plunger.

TW-1 TW-3 & TW-6

Depress plunger, place lever cam in slot in body, line up holes in body with hole in lever and insert pin.

TW-4 & TW-5

Depress plunger with button until hole in plunger lines up with holes in body. Insert pin.

LEAKAGE TEST

Test valve per instructions in paragraph on “Service Checks.”

IMPORTANT! PLEASE READ

When working on or around a vehicle, the following general precautions should be observed:

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels.
2. Stop the engine when working around the vehicle.
3. If the vehicle is equipped with air brakes, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle.
4. Following the vehicle manufacturer’s recommended procedures, deactivate the electrical system in a manner that removes all electrical power from the vehicle.
5. When working in the engine compartment the engine should be shut off. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.
6. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
7. Never exceed recommended pressures and always wear safety glasses.
8. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
9. Use only genuine Bendix replacement parts, components, and kits. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.
10. Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted unless specifically approved and stated by the vehicle or component manufacturer.
11. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.

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Service Data

SD-03-2202*

*FORMERLY SD-03-67

DOUBLE CHECK VALVES

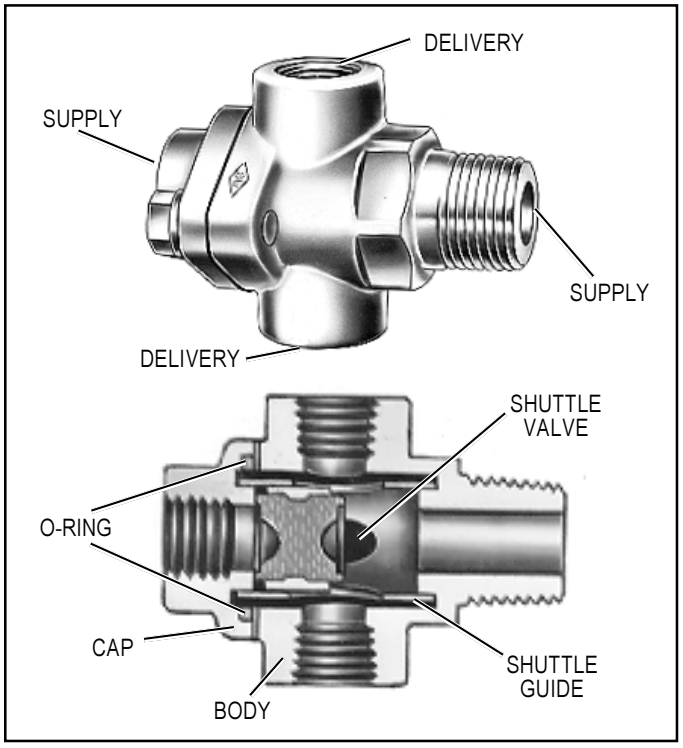


FIGURE 1 - ***DOUBLE CHECK VALVE (SHUTTLE TYPE)***

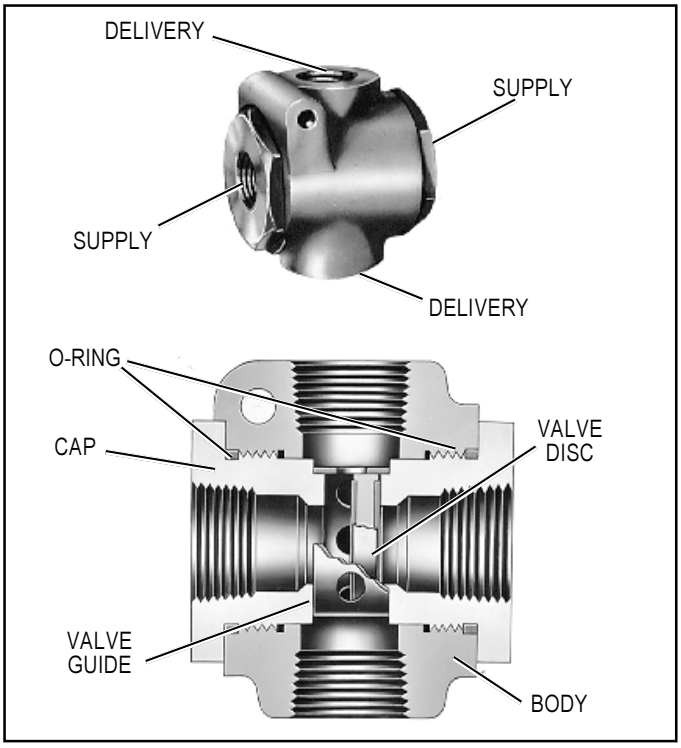


FIGURE 2 - ***DOUBLE CHECK VALVE (DISC TYPE)***

DESCRIPTION

Double Check Valves are used in an air brake system to direct a flow of air into a common line from either of two sources, whichever is at the higher pressure. They may be used for directing air flow for specific functions or to select the higher pressure of either of two sources of air as a supply source.

AlliedSignal manufactures two types of Bendix Double Check Valves: shuttle and disc. Although the valves are somewhat different physically, the same function is performed by both types. The difference in the design of the two valves is that the shuttle type has a movable shuttle to seal off the lower pressure source, whereas the disc type has a movable disc.

OPERATION

As air under pressure enters either end of the Double Check Valve (inlet port) the moving shuttle or disc responds to the pressure and seals the opposite port, assuming it is at a lower pressure level than the other. The air flow continues out the delivery port of the Double Check Valve. The position of the shuttle or disc will reverse if the pressure levels are reversed. Double Check Valves are designed so that the shuttle or disc can never impede the backflow of air in the exhaust mode.

Figure 3 (see page 2) illustrates a typical use of a Double Check Valve to control a given device, such as trailer brakes, from either of two control sources.

Figure 4 (see page 2) illustrates a typical use of a Double Check Valve to supply air to a system or systems from either of two separate sources, whichever is at the greater pressure level. In this type of installation the pressure differential to which the valve is subjected may under certain conditions be minimal. It is therefore suggested that performance of the Double Check Valve will be optimized if it is mounted in the horizontal position.

PREVENTIVE MAINTENANCE

Every 3600 operating hours, 100,000 miles, or yearly, disassemble, clean and inspect all parts. Install new parts if they show signs of wear or deterioration.

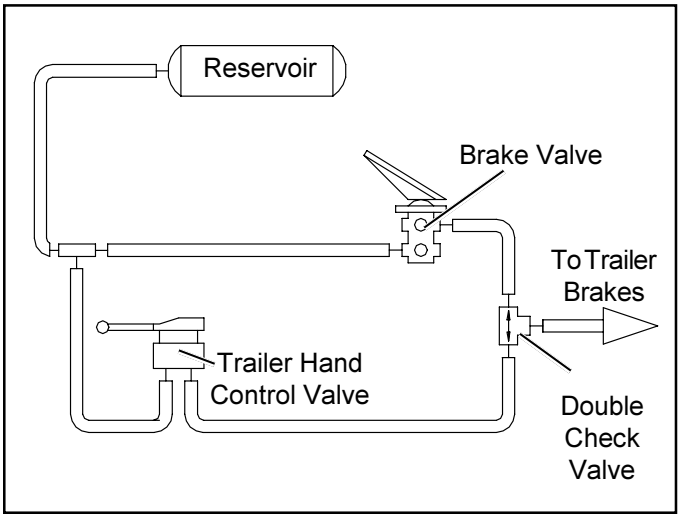


FIGURE 3 - ***DOUBLE CHECK VALVE: CONTROL OF SYSTEM FROM EITHER OF TWO CONTROL SOURCES***

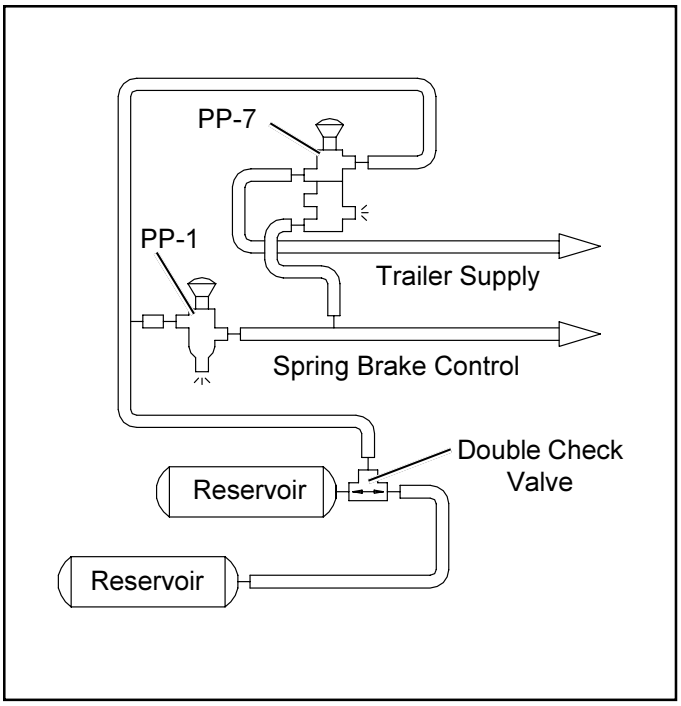


FIGURE 4 - ***DOUBLE CHECK VALVE: SYSTEM WITH TWO SUPPLY SOURCES***

SERVICE CHECKS

OPERATING AND LEAKAGE TEST

A. When the Double Check Valve is used in conjunction with a Trailer Control Valve, the following operating and leakage test can be made:

1. Apply and release foot brake valve and note that the brakes apply and release on both tractor and trailer.
2. Apply and release the Trailer Control Valve and note that only the trailer brakes apply and release. With trailer control valve applied check exhaust port of foot brake valve for leakage with soap solution. Permissible leakage is a one inch bubble in five seconds (100 sccm).
3. Apply and hold a full foot brake valve application. Check exhaust port of Trailer Control Valve for leakage with soap solution. Permissible leakage is a one inch bubble in five seconds (100 sccm). (**Note**: On some vehicles, an exhaust line is connected to the exhaust port and piped outside the cab in which case it may be necessary to disconnect this line to make leakage check.)

B. If Double Check Valve is to be bench tested or tested on the vehicle, two separately controlled air supplies must be connected to the inlet ports.

1. Install an accurate test gauge in the outlet port or in a line from outlet port.
2. Apply and release air to one inlet port and note that gauge registers application and release.
3. Repeat by applying and releasing air to other inlet port.
4. Leakage check should be performed at inlet ports of valve in the following manner:

   a. Disconnect line from one inlet port.

   b. Apply air to other inlet port and coat opposite inlet port with soap solution. Permissible leakage is a one inch bubble in five seconds (100 sccm).

   c. Repeat Step “b” applying air to other inlet port while checking opposite inlet port for leakage.

If the Double Check Valve does not function as described or if leakage is excessive, it is recommended that the valve be repaired or replaced with genuine Bendix parts. The following instructions should prove helpful:

DISASSEMBLY

1. Remove end cap(s) from valve.
2. Remove grommets (if applicable).
3. Remove shuttle and/or shuttle guide, disc and/or disc guide (depending upon type of valve).

CLEANING AND INSPECTION

1. Clean all metal parts in a cleaning solvent.
2. Inspect all metal parts for signs of cracks, wear or deterioration. Replace all parts not considered serviceable.
3. Replace all rubber parts.

ASSEMBLY

1. Install disc guide, disc and/or shuttle and shuttle guide.
2. Coat all static seals such as o-rings, grommets, etc. with BW 650M Silicone lubricant (BW 291126). It is not necessary to lubricate shuttles or discs.
3. Install grommets.
4. Install end cap(s).

TESTING OF REBUILT DOUBLE CHECK VALVE

Perform operating and leakage tests as described in “Service Checks” section.

IMPORTANT! PLEASE READ:

When working on or around a vehicle, the following general precautions should be observed:

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels.**
2. **Stop the engine when working around the vehicle.**
3. **If the vehicle is equipped with air brakes, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle.**
4. **Following the vehicle manufacturer’s recommended procedures, deactivate the electrical system in a manner that removes all electrical power from the vehicle.**
5. **When working in the engine compartment the engine should be shut off. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.**
6. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
7. **Never exceed recommended pressures and always wear safety glasses.**
8. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
9. **Use only genuine Bendix replacement parts, components, and kits. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.**
10. **Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted unless specifically approved and stated by the vehicle or component manufacturer.**
11. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**

AlliedSignal Bendix

Service Data

SD-03-2010*

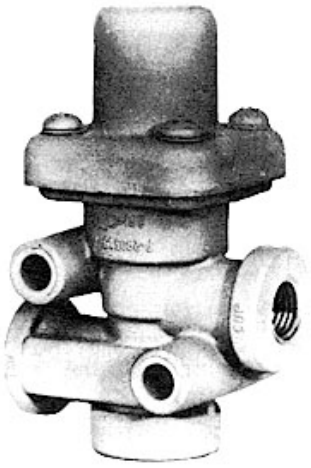
PRESSURE PROTECTION VALVES

*Formerly SD-03-55

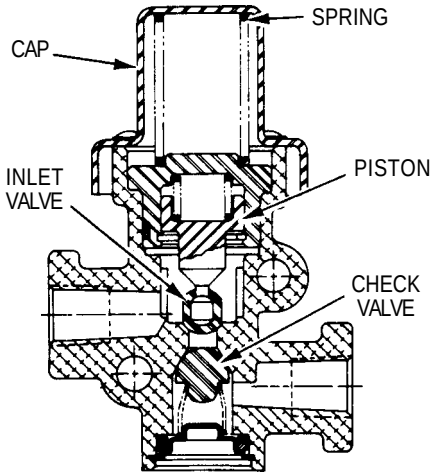
DESCRIPTION

The pressure protection valve is a normally closed, pressure control valve which can be referred to as a non-exhausting sequence valve. These valves are used in many different applications. An example would be in an air brake system to protect one reservoir, or reservoir system from another, by closing automatically at a preset pressure should a reservoir system failure occur. The valves can also be used to delay filling of auxiliary reservoirs to insure a quick build-up of brake system pressure.

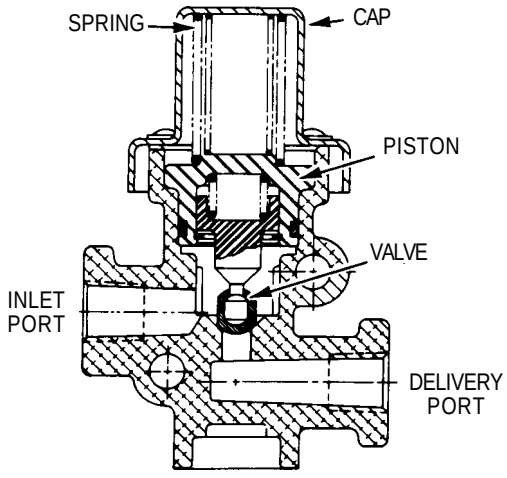
The PR-2 and PR-4 pressure protection valves have one 1/4" N.P.T.F. supply port and one 1/4" N.P.T.F. delivery port which are identified. Both valves are provided with two 9/32" mounting holes through the body. The closing pressure of the PR-2 is externally adjustable while the PR-4 has a fixed setting.



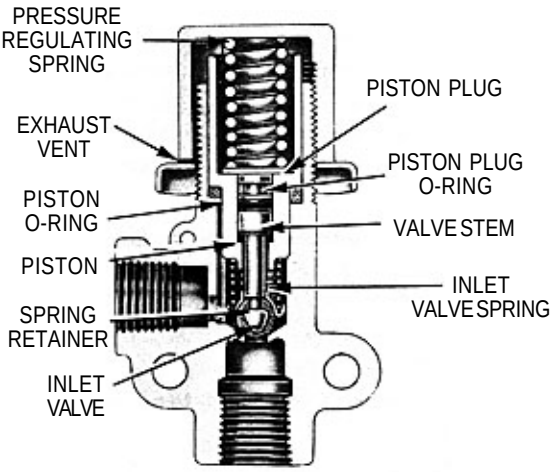
PR-3 OR PR-4



PR-3



PR-4



PR-2

OPERATION

Air entering the supply port is initially prevented from flowing out the delivery port by the inlet valve which is held closed by the pressure regulating spring above the piston. When sufficient air pressure builds beneath the piston to overcome the setting of the regulating spring, the piston will move, causing the inlet valve to unseat (open), and allow air to flow out the delivery port. As long as air pressure at the supply port and beneath the piston remains above the specified closing pressure, the inlet valve will remain open.

NOTE: The PR-2 and PR-4 closing pressure is noted on the label affixed to the valve. Opening pressures of the valves are higher than closing pressures. The pressure ranges are noted below:

PR-2-Opening pressure 15-20 psi higher than closing pressure.

PR-3 & PR-4-Opening pressure approx. 10 psi higher than closing pressure.

PR-3-Check valve will retain maximum pressure in downstream reservoir.

If for any reason system air pressure is decreased below the specified closing pressure, the regulating spring will move the piston closing the inlet valve. The remaining air pressure at either the supply or delivery side, (depending upon where the pressure drop has occurred) will be retained.

PREVENTIVE MAINTENANCE

Every three months, 900 operating hours or 25,000 miles, whichever if first, it is recommended that the operation and leakage checks described in this manual be performed.

OPERATING AND LEAKAGE CHECKS

OPERATING CHECKS

1. Provide a pressure gauge and drain valve at the supply side and delivery side of the pressure protection valve being checked.
2. Build up the air system to full pressure and shut off the engine.
3. While watching the gauges on the supply and delivery sides of the valve, slowly begin to exhaust pressure from the delivery side. Note that both gauges will show pressure loss until the closing pressure of the pressure protection valve is reached.

   The pressure protection valve should close at approximately (± 5 psi) the pressure indicated on the valve's label or in the vehicle handbook. The gauge on the delivery side of the valve should continue to show loss of pressure while the gauge on the supply side should stop at the same pressure as the setting of the valve.
4. (PR-3 only) Build pressure up again and shut off engine. Slowly exhaust air from the supply side of the PR-3. The gauge on the delivery side of the valve should remain at the highest pressure previously attained.

LEAKAGE CHECKS

1 . Build up the air system to full pressure and shut off the engine.
2. Apply a soap solution around the cap of the pressure protection valve. A one-inch bubble in three seconds or longer is acceptable. PR-3 - No leakage permissable at bottom of valve.
3. Drain the air pressure from the delivery side of the pressure protection valve and disconnect the air line to it.
4. Apply a soap solution to the delivery port. A one inch bubble in five seconds or more is acceptable.

GENERAL

If the pressure protection valve does not operate as described or leakage is excessive, it is recommended that a replacement be obtained at the nearest authorized AlliedSignal Truck Brake Systems Co. distributor.

REMOVING AND INSTALLING

REMOVING

1 . Block or hold the vehicle by means other than air brakes.
2. Drain all system reservoirs individually, to 0 psi.
3. Disconnect and identify (supply and delivery) the air lines leading to and from the pressure protection valve.
4. Remove the mounting bolts, if any, that secure the valve.

INSTALLING

1. Re-install the mounting bolts and secure the replacement valve to the vehicle.
2. Reconnect the supply delivery air lines to the proper ports of the replacement valve.

GENERAL

After installing a replacement valve, it is recommended that the operating and leakage checks be performed as outlined in this manual. If the closing pressure does not conform to that shown on the valve label or in the vehicle or a different setting is desired, the PR-2 may be adjusted by loosening the locknut and tightening or loosening the adjusting cap as required; however, if the proper setting cannot be attained by moderate adjustment of the cap, the valve may have the wrong spring and will have to be exchanged for the correct valve. The PR-3 and PR-4 are not adjustable.

IMPORTANT! PLEASE READ

When working on or around a vehicle, the following general precautions should be observed:

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels.**
2. **Stop the engine when working around the vehicle.**
3. **If the vehicle is equipped with air brakes, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle.**
4. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that removes all electrical power from the vehicle.**
5. **When working in the engine compartment the engine should be shut off. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.**
6. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
7. **Never exceed recommended pressures and always wear safety glasses.**
8. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
9. **Use only genuine Bendix replacement parts, components, and kits. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.**
10. **Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted unless specifically approved and stated by the vehicle or component manufacturer.**
11. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**

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Service Data

SD-03-1064*

R-12 & R-14 RELAY VALVES

* FORMERLY SD-03-31

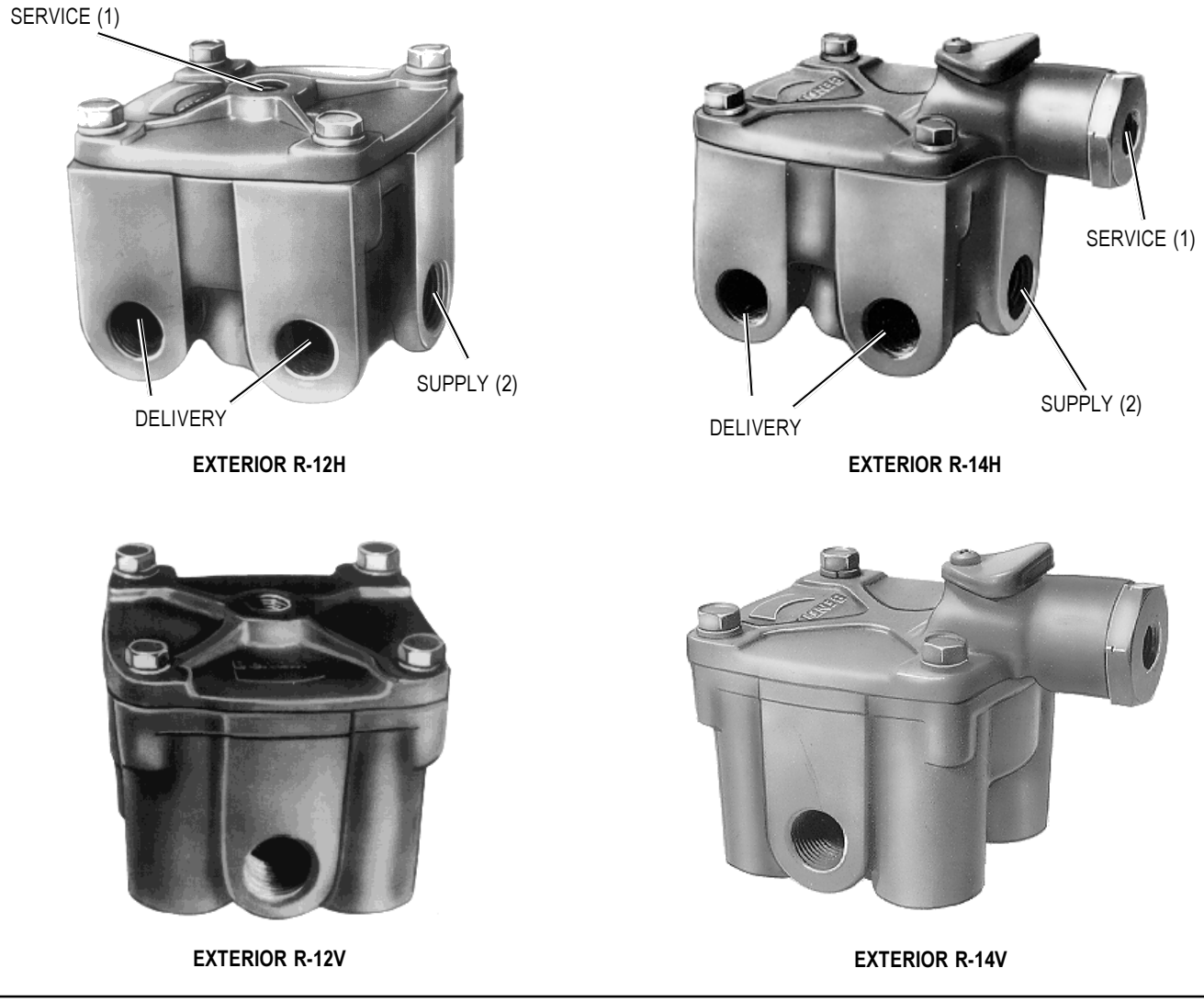

FIGURE 1 - ***EXTERIOR VIEWS***

DESCRIPTION

The Relay Valve in an air brake system functions as a relay station to speed up the application and release of the brakes. The valve is normally mounted at the rear of the vehicle in proximity to the chambers it serves. The valve operates as a remote controlled brake valve that delivers or releases air to the chambers in response to the control air delivered to it from the foot brake valve or other source.

The R-12 and R-14 Relay Valves are designed for either reservoir or frame mounting. A universal mounting bracket is furnished that permits easy interchange with other Bendix relay valves. Both valves are available in the two body styles illustrated in Figure 1. The R-14 differs from the R-12 in that it incorporates a quick release and anti-compounding feature located above its horizontal service port. The R-14's anti-compound feature allows it

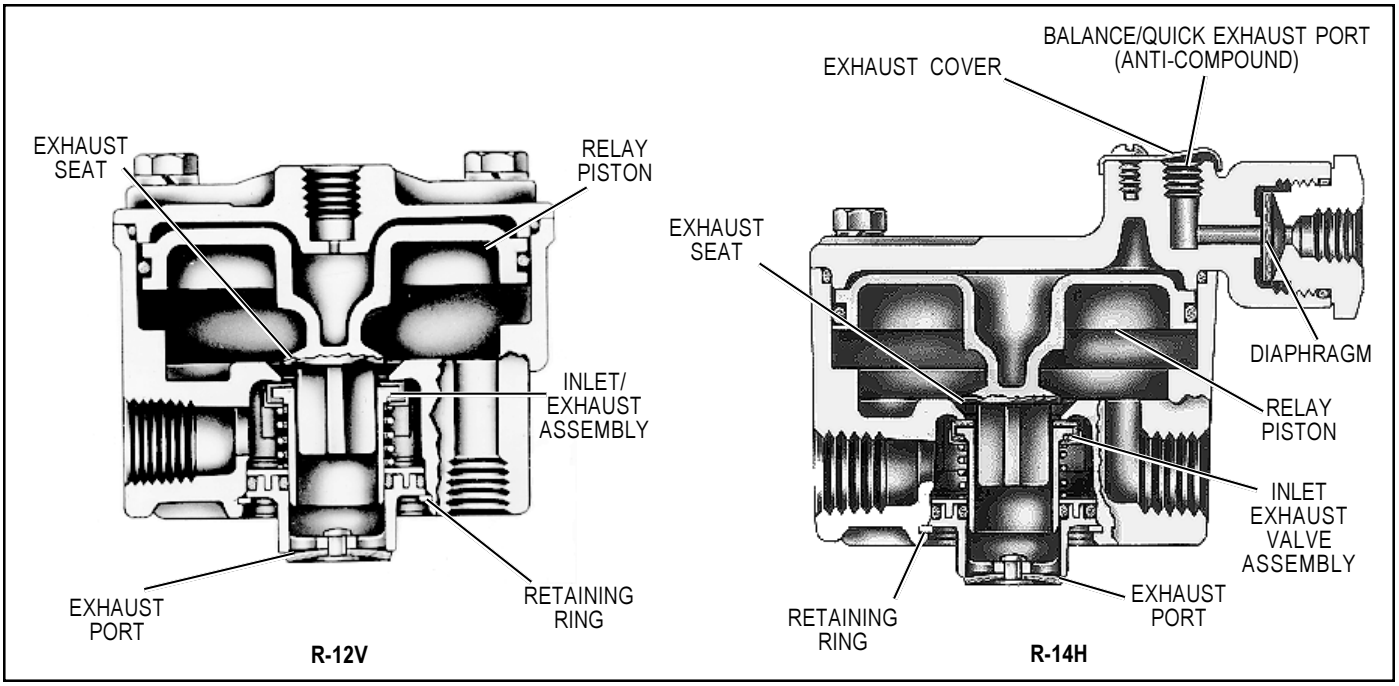

FIGURE 2 - ***SECTIONAL VIEWS***

to be conveniently used as either a service or spring brake relay valve. An exhaust cover is installed that protects the 1/8" balance port when the R-14 anti-compound feature is not in use.

All parts are interchangeable between the R-12 and R-14 with the exception of the detail components of the R-14 cover. Both valves make extensive use of non-metallic internal components. For ease of servicing, the inlet/exhaust valve can be replaced without the need for line removal.

OPERATION

APPLICATION

Air pressure delivered to the service port enters the small cavity above the piston and moves the piston down. The exhaust seat moves down with the piston and seats on the inner or exhaust portion of the inlet/exhaust valve, sealing off the exhaust passage. At the same time, the outer or inlet portion of the inlet/exhaust valve moves off its seat, permitting supply air to flow from the reservoir, past the open inlet valve and into the brake chambers.

BALANCE

The air pressure being delivered by the open inlet valve also is effective on the bottom area of the relay piston. When air pressure beneath the piston equals the service air pressure above, the piston lifts slightly and the inlet spring returns the inlet valve to its seat. The exhaust remains closed as the service line pressure balances the delivery pressure. As delivered air pressure is changed, the valve reacts instantly to the change, holding the brake application at that level.

EXHAUST OR RELEASE

When air pressure is released from the service port and air pressure in the cavity above the relay piston is exhausted, air pressure beneath the piston lifts the relay piston and the exhaust seat moves away from the exhaust valve, opening the exhaust passage. With the exhaust passage open, the air pressure in the brake chambers is then permitted to exhaust through the exhaust port, releasing the brakes.

ANTI COMPOUNDING (SIMULTANEOUS SERVICE AND PARK APPLICATION)

In those applications where the R-14 Relay Valve is used to control spring brake chambers, the anti-compound feature may be utilized. With the anti-compound feature of the R-14 connected, a service application made while the vehicle is parked is countered by a release of the parking brakes. To utilize this feature, the exhaust cover of the quick release portion of the R-14 is removed and a line is installed which is connected to the delivery of the service brake valve or relay valve. With no air pressure at the service port of the R-14, the parking brakes are applied. If a service brake application is made, air from the service brake valve enters the exhaust port of the quick release of the R-14 and moves the diaphragm, blocking the service port. Air then proceeds into the cavity above the relay piston, forces the piston down, closing the exhaust and

opening the inlet to deliver air to the spring brake cavity as described under the section of this manual entitled *Application*.

PREVENTIVE MAINTENANCE

Important: Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period.

Because no two vehicles operate under identical conditions, maintenance and maintenance intervals will vary. Experience is a valuable guide in determining the best maintenance interval for any one particular operation.

1. Every three months or 25,000 miles or 900 operating hours check for proper operation.
2. Every twelve months or 100,000 miles or 3600 operating hours: disassemble valve, clean parts with mineral spirits. Replace all rubber parts and any part worn or damaged. Check for proper operation before placing vehicle in service.

OPERATIONAL AND LEAKAGE TEST

1. Chock the wheels, fully charge air brake system and adjust the brakes.
2. Make several brake applications and check for prompt application and release at each wheel.
3. Check for inlet valve and o-ring leakage.
   A. Make this check with the service brakes released when the R-12 or R-14 is used to control the service brakes.
   B. Make the check with the spring brakes applied (PARK) when the R-14 is used to control the spring brakes. Coat the exhaust port and the area around the retaining ring with a soap solution; a 1 inch bubble in 3 seconds leakage is permitted.
4. Check for exhaust valve leakage.
   A. Make this check with the service brakes fully applied if the R-12 or R-14 control the service brakes.
   B. Make this check with the spring brakes fully released if the R-14 is used to control the spring brakes. Coat the exhaust port with a soap solution; a 1 inch bubble in 3 seconds leakage is permitted. Coat the outside of the valve where the cover joins the body to check for seal ring leakage; no leakage is permitted.
5. If the R-14 is used to control the spring brakes, place the park control in the released position and coat the balance port with a soap solution to check the diaphragm and its seat. Leakage equivalent to a 1 inch bubble in 3 seconds is permitted.

Note: If the anti-compound feature is in use, the line attached to the balance port must be disconnected to perform this test.

If the valves do not function as described above, or if leakage is excessive, it is recommended that the valves be replaced with new or remanufactured units or repaired with genuine Bendix parts, available at any authorized Bendix parts outlet.

REMOVAL AND INSTALLATION

REMOVAL

1. Block and hold vehicle by means other than air brakes.
2. Drain air brake system reservoirs.
3. If entire valve is to be removed, identify air lines to facilitate installation.
4. Disconnect air lines from valve.*
5. Remove valve from reservoir or if remotely mounted, remove mounting bolts and then valve.

*It is generally not necessary to remove entire valve to service the inlet/exhaust valve. The inlet/exhaust valve insert can be removed by removing the snap ring, exhaust cover assembly and then inlet/exhaust valve.

Caution: Drain all reservoirs before attempting to remove the inlet exhaust valve.

DISASSEMBLY

Note: Prior to disassembly, mark the location of the mounting bracket to the cover and the cover to the body.

1. Remove the four (4) cap screws and lockwashers securing the cover to the body.
2. Remove the cover, sealing ring, and mounting bracket.
3. Remove the piston and o-ring from the body.
4. While depressing the exhaust cover, remove the retaining ring and slowly relax the spring beneath the exhaust cover.
5. Remove the exhaust cover assembly and o-rings.
6. Remove the inlet/exhaust valve return spring from the body.
7. Remove the inlet/exhaust valve from the body.
8. Remove the valve retainer from the inlet/exhaust valve.
9. Remove the Phillips head screw and exhaust cover from the R-14 cover.
10. Remove the service port cap nut and o-ring from the R-14.
11. Remove the diaphragm from the R-14 cover.

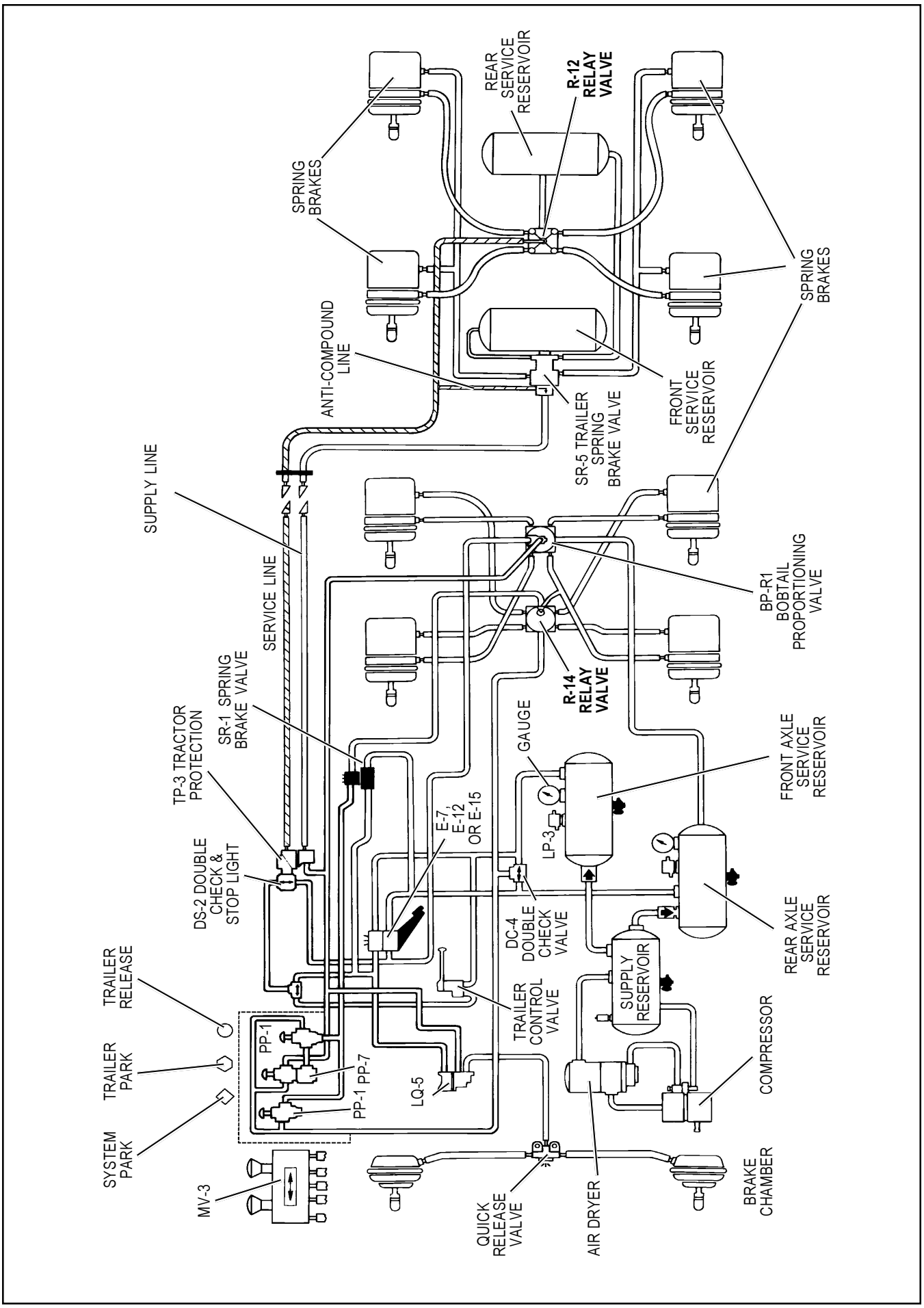

*FIGURE 3 - **TYPICAL PIPING SCHEMATIC***

CLEANING AND INSPECTION

1. Wash all metal parts in mineral spirits and dry them thoroughly.

   (**Note:** When rebuilding, all springs and all rubber parts should be replaced.)
2. Inspect all metal parts for deterioration and wear, as evidenced by scratches, scoring and corrosion.
3. Inspect the exhaust valve seat on the relay piston for nicks and scratches which could cause excessive leakage.
4. Inspect the inlet valve seat in the body for scratches and nicks, which could cause excessive leakage.
5. Inspect the exhaust seat of the quick release diaphragm in the R-14 cover and make sure all internal air passages in this area are open and clean and free of nicks and scratches.
6. Replace all parts not considered serviceable during these inspections and all springs and rubber parts. Use only genuine Bendix replacement parts, available from any authorized Bendix parts outlet.

ASSEMBLY

Note: All torque specified in this manual are assembly torque and can be expected to fall off slightly after assembly. **Do not re-torque** after initial assembly torque fall. For assembly, hand wrenches are recommended.

Prior to assembly, lubricate all o-rings, o-ring bores and any sliding surface with a silicone lubricant equivalent to Dow Corning #10.

1. Install large piston o-ring on piston.
2. Install inner and outer o-rings in the exhaust cover assembly.
3. Install the sealing ring on the cover.
4. Install piston in body, taking care not to damage the piston o-ring.
5. Noting the reference marks made during disassembly, install the cover on the valve body and the mounting bracket on the cover.
6. Secure the mounting bracket and cover to the body using the four (4) cap screws and lock washers. Torque to 80-120 inch pounds.
7. Install the valve retainer on the inlet/exhaust valve and install in the body.
8. Install the inlet/exhaust valve return spring in the body.
9. Install the exhaust cover assembly in the body, taking care not to damage the o-ring.
10. While depressing the exhaust cover, install the retaining ring. Make certain the retainer is completely seated in its groove in the body.
11. Install the R-14 service port cap nut o-ring on the cap nut. Install the diaphragm in the R-14 cover making certain it is positioned between the guide ribs in the cover.
13. Install the service port cap nut and torque to 150 inch pounds.
14. If the quick release exhaust port was protected with an exhaust cover, install the cover using the #10-24 Phillips head screw. Torque to approx. 15-25 inch pounds.
15. Test the valves as outlined in the *Operational and Leakage Test* section before returning the valve to service.

INSTALLATION

1. Clean air lines.
2. Inspect all lines and/or hoses for damage and replace as necessary.
3. Install valve and tighten mounting bolts.
4. Connect air lines to valve (plug any unused ports).
5. Test valve as outlined in *Operational and Leakage Tests*.

IMPORTANT! PLEASE READ

When working on or around a vehicle, the following general precautions should be observed:

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels.**
2. **Stop the engine when working around the vehicle.**
3. **If the vehicle is equipped with air brakes, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle.**
4. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that removes all electrical power from the vehicle.**
5. **When working in the engine compartment the engine should be shut off. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.**
6. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
7. **Never exceed recommended pressures and always wear safety glasses.**

8. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
9. **Use only genuine Bendix replacement parts, components, and kits. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.**
10. **Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be at tempted unless specifically approved and stated by the vehicle or component manufacturer.**
11. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**

AlliedSignal Bendix

Service Data

SD-03-901*

QR AND QR-1 QUICK RELEASE VALVES

*Formerly SD-03-69

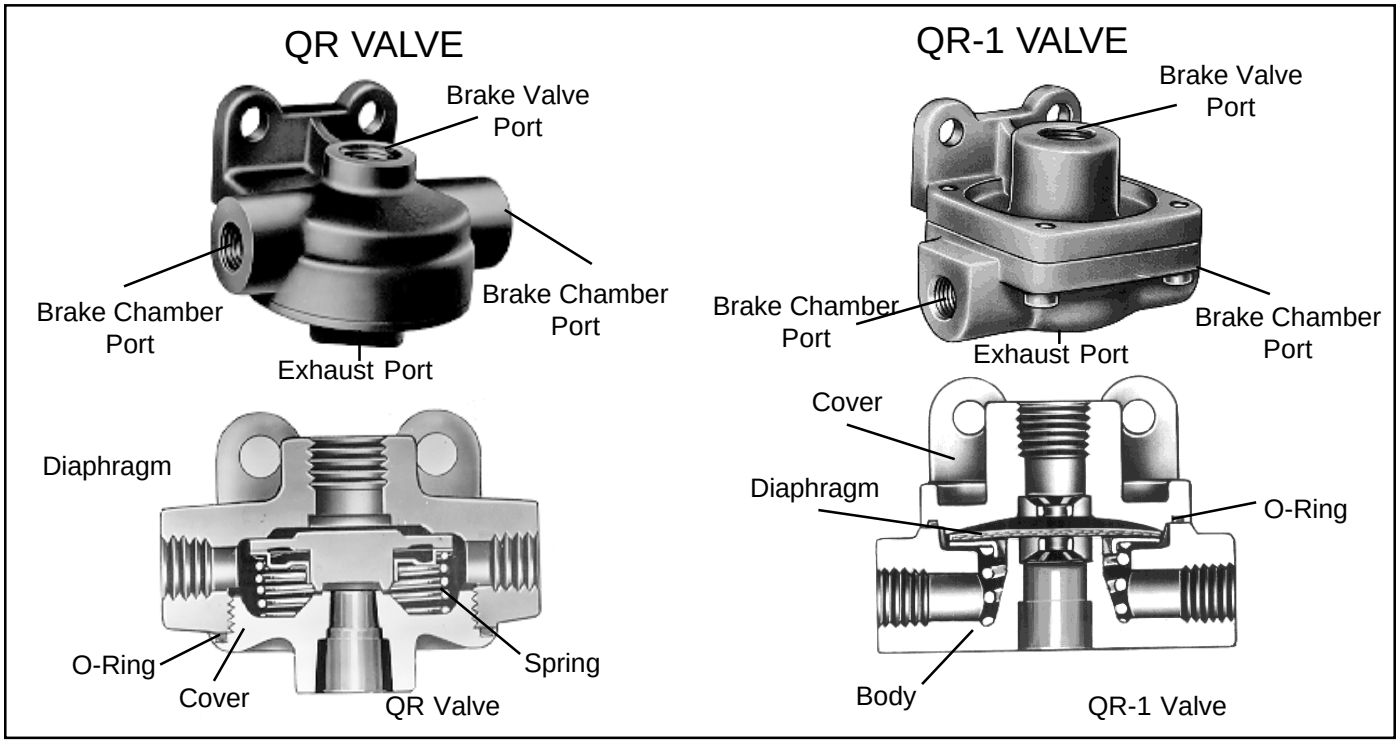

FIGURE 1

DESCRIPTION

The function of the Quick Release Valve is to speed up the exhaust of air from the air chambers. It is mounted close to the chambers it serves. In its standard configuration the valve is designed to deliver within one (1) psi of control pressure to the controlled device; however, for special applications the valve is available with greater differential pressure designed into the valve.

Reference Figure 1, two styles of Quick Release Valves are available and are functionally the same; the QR valve, which is of older design and utilizes a spring and spring seat, and the QR-1 valve, which in its standard configuration does not employ a spring or spring seat.

(Note: AR-1 Valves with a pressure differential employ a spring and spring seat.)

Porting consists of one (1) brake valve port, two (2) delivery ports and one (1) exhaust port.

OPERATION

When a brake application is made, air pressure enters the brake valve port; the diaphragm moves down, sealing the exhaust. At the same time, air pressure forces the edges of the diaphragm down and air flows out the delivery port.

When air pressure being delivered (beneath the diaphragm) equals the pressure being delivered by the brake valve (above the diaphragm), the outer edge of the diaphragm will seal against the body seat. The exhaust port is still sealed by the center portion of the diaphragm when the brake valve application is released; the air pressure above the diaphragm is released back through the brake valve exhaust; air pressure beneath the diaphragm forces the diaphragm to rise, opening the exhaust, allowing air in the chambers to exhaust.

PREVENTIVE MAINTENANCE

Every 12 months, 100,000 miles or 3600 operating hours; disassemble valve, wash metal parts in mineral spirits, wipe rubber parts dry. It is recommended that all rubber parts be replaced. Inspect all parts and replace any part showing signs of wear or deterioration.

OPERATING AND LEAKAGE TESTS

While holding a foot brake valve application:

1. Coat exhaust port with soap solution; leakage of a one (1) inch bubble in three (3) seconds is permitted.
2. Coat body and cover with soap solution. No leakage perm itted between body and cover.

If the valve does not function as described, or if leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired with genuine Bendix parts.

REMOVING AND INSTALLING

REMOVING

Block vehicle wheels and/or hold vehicle by means other than air brakes.

Drain all air brake system reservoirs.

Disconnect air lines from valve.

Remove mounting bolts, then valve.

INSTALLING

Mount valve with exhaust port pointing down; securely tighten mounting bolts.

Connect air lines to valve (brake valve application line to top port; brake chamber line to side ports.)

DISASSEMBLY

QR VALVE

1. Using wrench on square portion of exhaust port, remove cover.
2. Remove spring, spring seat and diaphragm. Remove cover O-Ring.

QR-1 VALVE

1. Remove four screws.
2. Remove spring and spring seat {if so equipped).
3. Remove diaphragm.
4. Remove cover O-Ring.

CLEANING AND INSPECTION

Clean all metal parts in mineral spirits. Wipe all rubber parts clean.

It is recommended that all rubber parts and any other part showing signs of wear or deterioration be replaced with genuine Bendix parts.

ASSEMBLY

QR VALVE

1. Position spring seat over the diaphragm and then install into body.
2. Install spring and cover O-Ring.
3. Install cover; tighten securely. (Torque to 150-400 inch pounds.)

QR-1 VALVE

1. If valve is equipped within spring and spring seat:
a. Position spring in body.
b. Position diaphragm over spring seat.
c. Install O-Ring in cover groove; install cover and tighten screws evenly and securely. (Torque to 30-60 inch pounds.)
2. If valve is not equipped with spring and spring seat:
a. Install diaphragm.
b. Install O-Ring in cover groove; install cover and tighten screws evenly and securely. (Torque to 30-60 inch pounds.)
3. Perform tests as outlined in “Operating and Leakage Tests” section.

IMPORTANT! PLEASE READ

When working on or around a vehicle, the following general precautions should be observed:

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels.
2. Stop the engine when working around the vehicle.
3. If the vehicle is equipped with air brakes, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle.
4. Following the vehicle manufacturer’s recommended procedures, deactivate the electrical system in a manner that removes all electrical power from the vehicle.
5. When working in the engine compartment the engine should be shut off. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.
6. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
7. Never exceed recommended pressures and always wear safety glasses.
8. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
9. Use only genuine Bendix replacement parts, components, and kits. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.
10. Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted unless specifically approved and stated by the vehicle or component manufacturer.
11. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.

BW1442

AlliedSignal Bendix

Service Data

E-8P & E-10P DUAL BRAKE VALVES

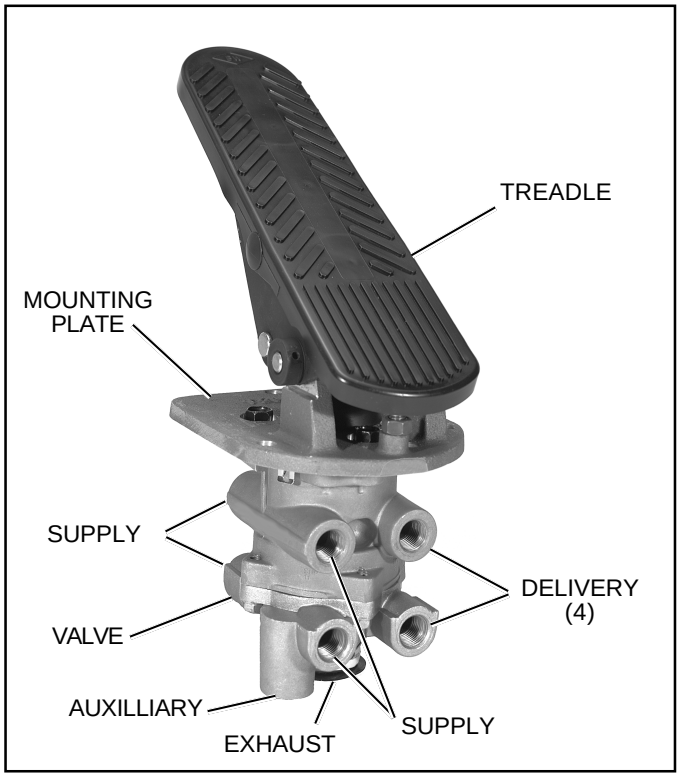

*FIGURE 1 - **E-8P***

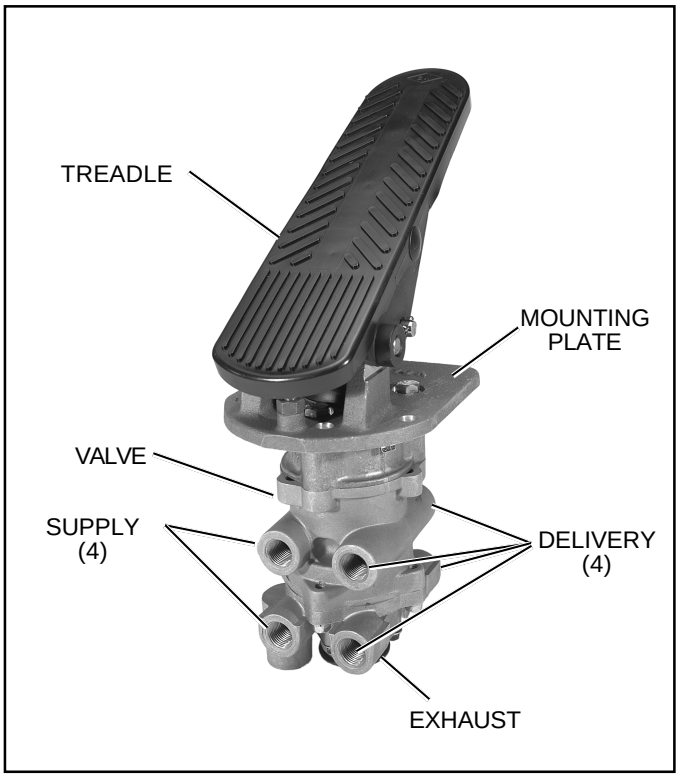

*FIGURE 2 - **E-10P***

DESCRIPTION

Refer to Figures 4, 5 and 6 for item numbers referenced in parenthesis.

The E-8P (Figure 1) and E-10P (Figure 2) Dual Brake Valves are floor mounted, treadle operated type brake valves with two separate supply and delivery circuits for service (primary and secondary) braking, which provides the driver with a graduated control for applying and releasing the vehicle brakes.

The E-10P Dual Brake Valve (Figure 2) is similar to the E-8P Dual Brake Valve except that a metal coil spring (5) housed in an upper body assembly replaces the rubber spring (27) used in the E-8P valve. The use of a metal coil spring (and the upper body assembly) provides greater treadle travel and, therefore, provides the driver with a less sensitive "feel" when making a brake application. The E-10P Dual Brake Valve is generally used on busses, where smooth brake applications contribute to passenger comfort.

The circuits in the E-8P/E-10P Dual Brake Valves are identified as follows: The No. 1 or primary circuit is that portion of the valve between the spring seat which contacts the plunger and the relay piston; the No. 2 or secondary circuit is that portion between the relay piston and the exhaust cavity.

The primary circuit of the valve is similar in operation to a standard single circuit air brake valve and under normal operating conditions the secondary circuit is similar in operation to a relay valve.

Both primary and secondary circuits of the brake valve use a common exhaust protected by an exhaust diaphragm.

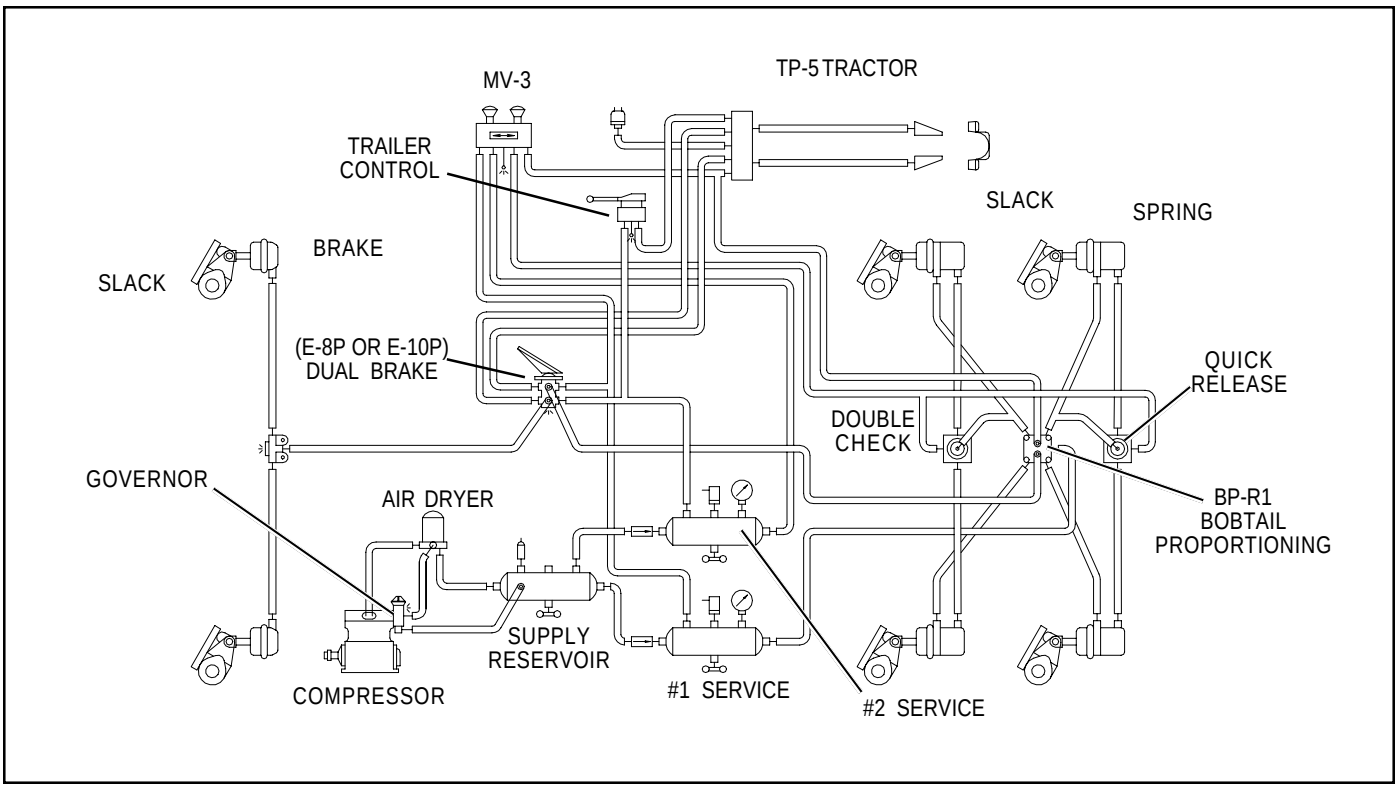

FIGURE 3 - ***TYPICAL PIPING SCHEMATIC***

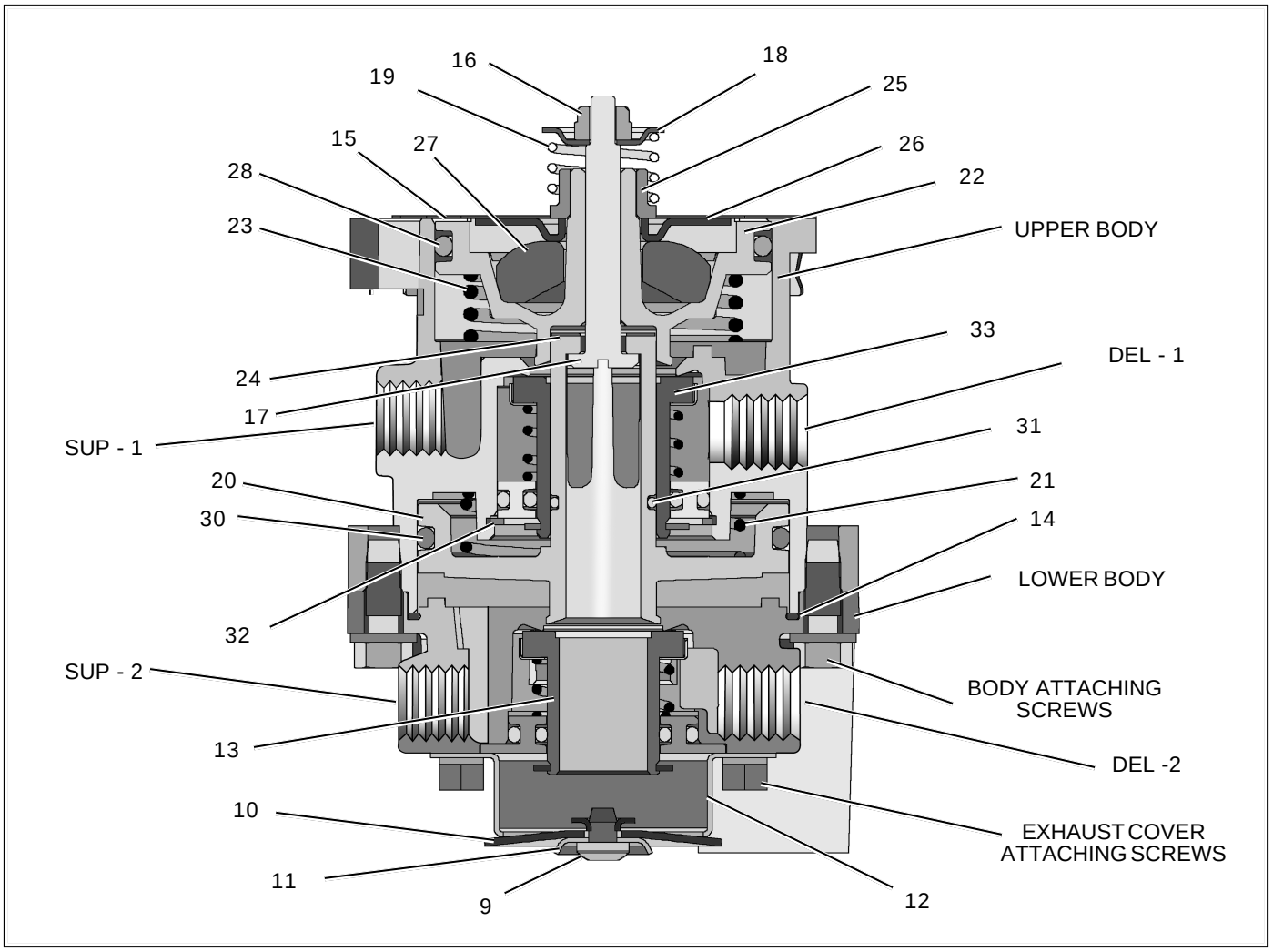

FIGURE 4 - ***E-8P SECTIONAL VIEW***

OPERATION - Refer to Figure 3

APPLYING: NORMAL OPERATION - NO. 1 OR PRIMARY CIRCUIT PORTION

When the brake treadle is depressed, the plunger exerts force on the spring seat (26), graduating spring (23), and primary piston (22). The primary piston, which contains the exhaust valve seat, closes the primary exhaust valve. As the exhaust valve closes, the primary inlet valve is moved off its seat allowing primary air to flow out the No. 1 or primary delivery port.

APPLYING: NORMAL OPERATION - NO. 2 OR SECONDARY CIRCUIT

When the primary inlet valve (33) is moved off its seat, air is permitted to pass through the bleed passage and enters the relay piston cavity. The air pressure moves the relay piston (20), which contains the exhaust seat, and closes the secondary exhaust valve. As the secondary exhaust valve closes, the inlet valve (13) is moved off its seat allowing the secondary air to flow out the delivery of the same circuit. Because of the small volume of air required to move the relay piston (20), action of the secondary circuit of the valve is almost simultaneous with the primary circuit portion.

APPLYING: LOSS OF AIR IN THE NO. 2 OR SECONDARY CIRCUIT

Should air be lost in the No. 2 or secondary circuit, the No. 1 or primary circuit will continue to function as described above under *Normal Operation: No.1 or Primary Circuit Portion*.

APPLYING: LOSS OF AIR IN THE NO. 1 OR PRIMARY CIRCUIT

Should air be lost in the primary circuit, the function will be as follows: As the brake treadle is depressed and no air pressure is present in the primary circuit supply and delivery ports, the primary piston (22) will mechanically move the relay piston (20) , allowing the piston to close the secondary exhaust valve and open the secondary inlet valve and allow air to flow out the secondary delivery port.

BALANCED: NO. 1 OR PRIMARY CIRCUIT

When the primary delivery pressure acting on the primary piston (22) equals the mechanical force of the brake pedal application, the primary piston (22) will move and the primary inlet valve (33) will close, stopping further flow of air from the primary supply line through the valve. The exhaust valve remains closed preventing any escape of air through the exhaust port.

BALANCED: NO. 2 OR SECONDARY CIRCUIT

When the air pressure on the delivery side of the relay piston (20) approaches that being delivered on the primary side of the relay piston, the relay piston moves closing the secondary inlet valve and stopping further flow of air from the supply line through the valve. The exhaust remains closed as the secondary delivery pressure balances the primary delivery pressure.

When applications in the graduating range are made, a balanced position in the primary circuit is reached as the air pressure on the delivery side of the primary piston (22) equals the effort exerted by the driver's foot on the treadle. A balanced position in the secondary portion is reached when air pressure on the secondary side of the relay piston (20) closely approaches the air pressure on the primary side of the relay piston.

When the brake treadle is fully depressed, both the primary and secondary inlet valves remain open and full reservoir pressure is delivered to the actuators.

RELEASING: NO. 1 OR PRIMARY CIRCUIT

With the brake treadle released, mechanical force is removed from the spring seat (26), graduating spring (23), and primary piston (22). Air pressure and spring load moves the primary piston, opening the primary exhaust valve, allowing air pressure in the primary delivery line to exhaust out the exhaust port.

RELEASING: NO. 2 OR SECONDARY CIRCUIT

With the brake treadle released, air is exhausted from the primary circuit side of the relay piston (20). Air pressure and spring load move the relay piston, opening the secondary exhaust valve, allowing air pressure in the secondary delivery line to exhaust out the exhaust port.

PREVENTIVE MAINTENANCE

Important: Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period.

Because no two vehicles operate under identical conditions, maintenance and maintenance intervals will vary. Experience is a valuable guide in determining the best maintenance interval for any one particular operation.

Visually check for physical damage to the brake valve such as broken air lines and broken or missing parts.

Every 3 months, or 25,000 miles or 900 operating hours:

Clean any accumulated dirt, gravel, or foreign material away from the heel of the treadle, plunger boot, and mounting plate.

Using light oil, lubricate the treadle roller, roller pin, and hinge pin.

Check the rubber plunger boot for cracks, holes or deterioration and replace if necessary. Also, check mounting plate and treadle for integrity.

Apply 2 to 4 drops of oil between plunger and mounting plate - **do not over oil!**

Every year, or 100,000 miles, or 3,600 operating hours:

Disassemble, clean parts with mineral spirits, replace all rubber parts, or any part worn or damaged. Check for proper operation before placing vehicle in service.

SERVICE CHECKS

OPERATING CHECK

Check the delivery pressure of both primary and secondary circuits using accurate test gauges. Depress the treadle to several positions between the fully released and fully applied positions, and check the delivered pressure on the test gauges to see that it varies equally and proportionately with the movement of the brake pedal.

After a full application is released, the reading on the test gauges should fall off to zero promptly. It should be noted that the primary circuit delivery pressure will be about 2 PSI greater than the secondary circuit delivery pressure with both supply reservoirs at the same pressure. This is normal for this valve.

Important: A change in vehicle braking characteristics or a low pressure warning may indicate a malfunction in one or the other brake circuit, and although the vehicle air brake system may continue to function, the vehicle should not be operated until the necessary repairs have been made and both braking circuits, including the pneumatic and mechanical devices, are operating normally. Always check the vehicle brake system for proper operation after performing brake work and before returning the vehicle to service.

LEAKAGE CHECK

1. Make and hold a high pressure (80 psi) application.
2. Coat the exhaust port and body of the brake valve with a soap solution.
3. Leakage permitted is a one inch bubble in 3 seconds. If the brake valve does not function as described above or leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired with genuine Bendix parts available at authorized Bendix parts outlets.

Refer to figures 4, 5 and 6 for item numbers referenced in parenthesis.

REMOVAL

1. Chock the vehicle wheels or park the vehicle by mechanical means. (Block and hold vehicle by means other than air brakes.) Drain all air system reservoirs.
2. Identify and disconnect all supply and delivery lines at the brake valve.
3. Remove the brake valve and treadle assembly from the vehicle by removing the three cap screws on the outer bolt circle of the mounting plate. The basic brake valve alone can be removed by removing the three cap screws on the inner bolt circle.

DISASSEMBLY (Figures 4, 5 and 6)

1. If the entire brake valve and treadle assembly was removed from the vehicle, remove the three cap screws securing the treadle assembly to the basic brake valve.
2. Remove the screw (9) securing the exhaust diaphragm (10) and washer (11) to the exhaust cover (12).
3. Remove the four screws that secure the exhaust cover (12) to the lower body.
4. Remove the secondary inlet and exhaust valve assembly (13) from the lower body.
5. Remove the four hex head cap screws securing the lower body to the upper body and separate the body halves.
6. Remove the rubber seal ring (14) from the lower body.
7. **For E-8P only:** While applying thumb pressure to the primary piston (22), lift out and up on the three lock tabs of the primary piston retainer (15).
8. **For E-10P only:** While depressing spring seat (7), remove retaining ring (8). Remove spring seat (7) and coil spring (5).

   Caution: Before proceeding with the disassembly, refer to Figures 3 and 4 and note that the lock nut (16) and stem (17) are used to contain the primary piston return spring (**for E-8P:** 23, **for E-10P:** 6), stem spring (19), and the relay piston spring (21). The combined force of these springs is approximately 50 pounds and care must be taken when removing the lock nut as the spring forces will be released. It is recommended that the primary piston and relay piston be manually or mechanically contained while the nut and stem are being removed.

9. Using a 3/8" wrench, hold the lock nut (16) on the threaded end of the stem (17). Insert a screwdriver to restrain the stem, remove the lock nut (16), spring seat, (18) and stem spring (19).
10. **For E-10P only:** Remove adapter (1) and o-ring (4). Remove the primary piston (2) from adapter (1) and o-ring (34) from the primary piston (2).

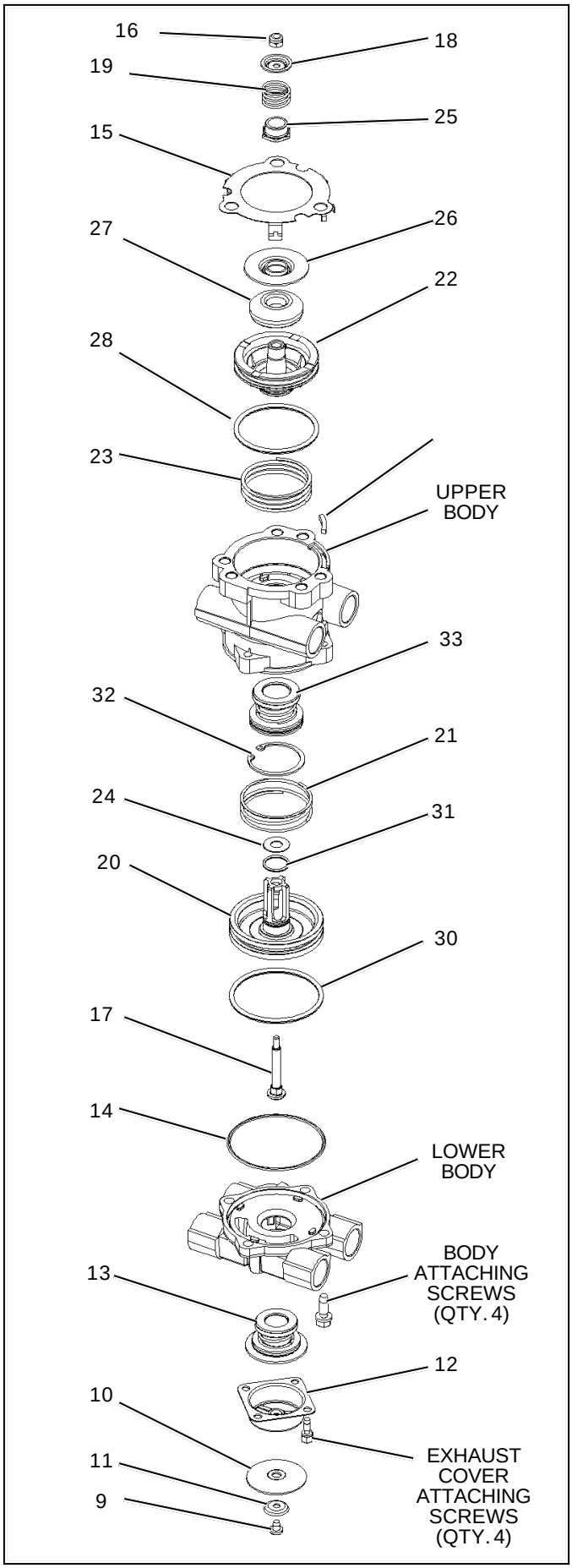

FIGURE 5 - ***E-8P BRAKE VALVE - EXPLODED VIEW***

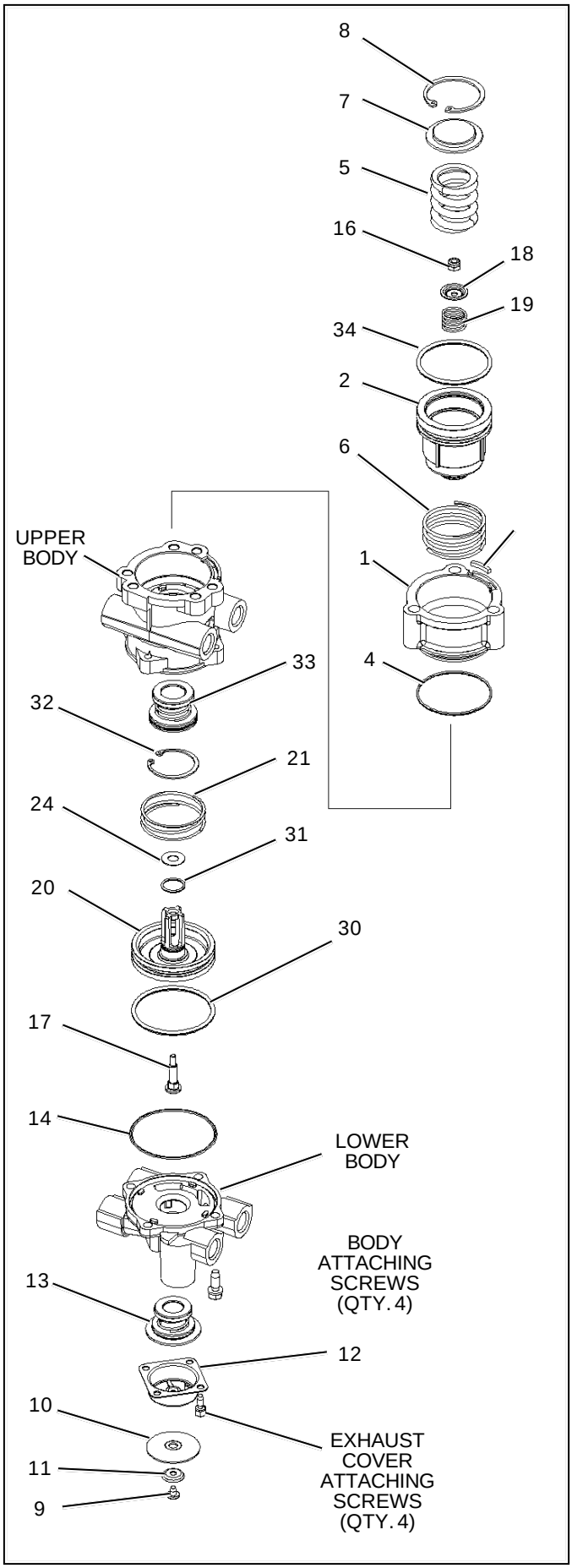

FIGURE 6 - ***E-10P BRAKE VALVE - EXPLODED VIEW***

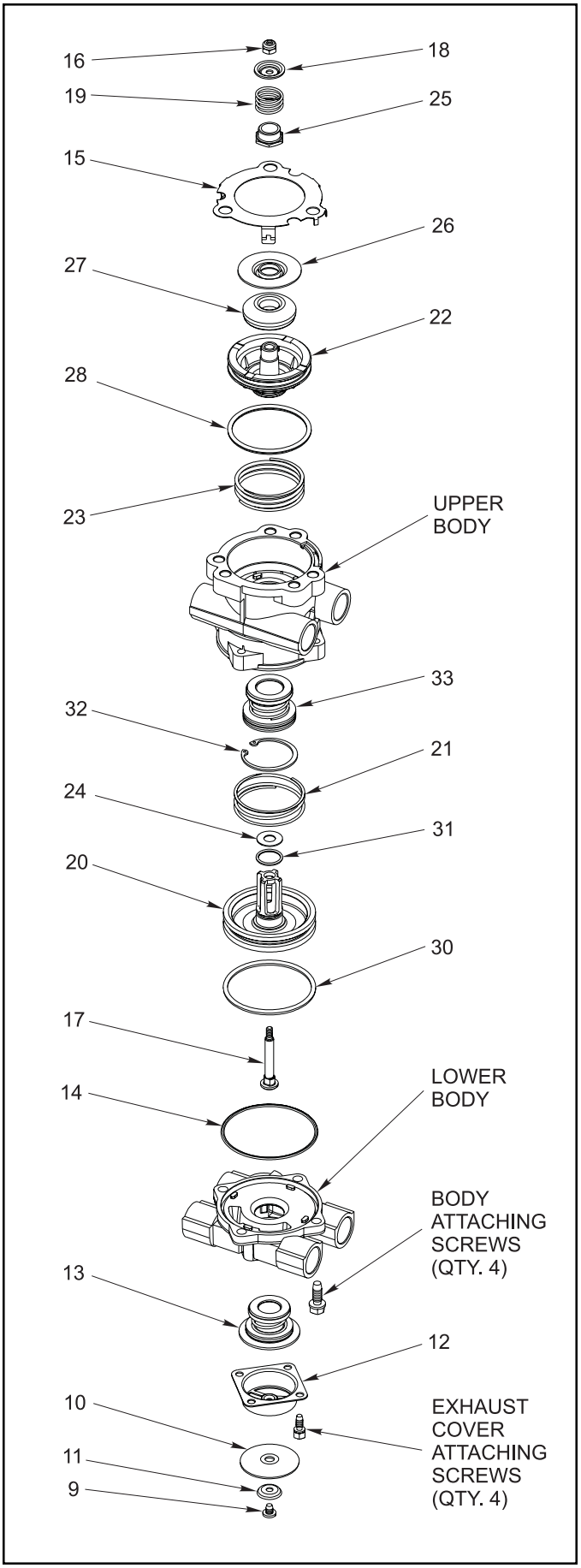

FIGURE 5 - **E-8P BRAKE VALVE - EXPLODED VIEW**

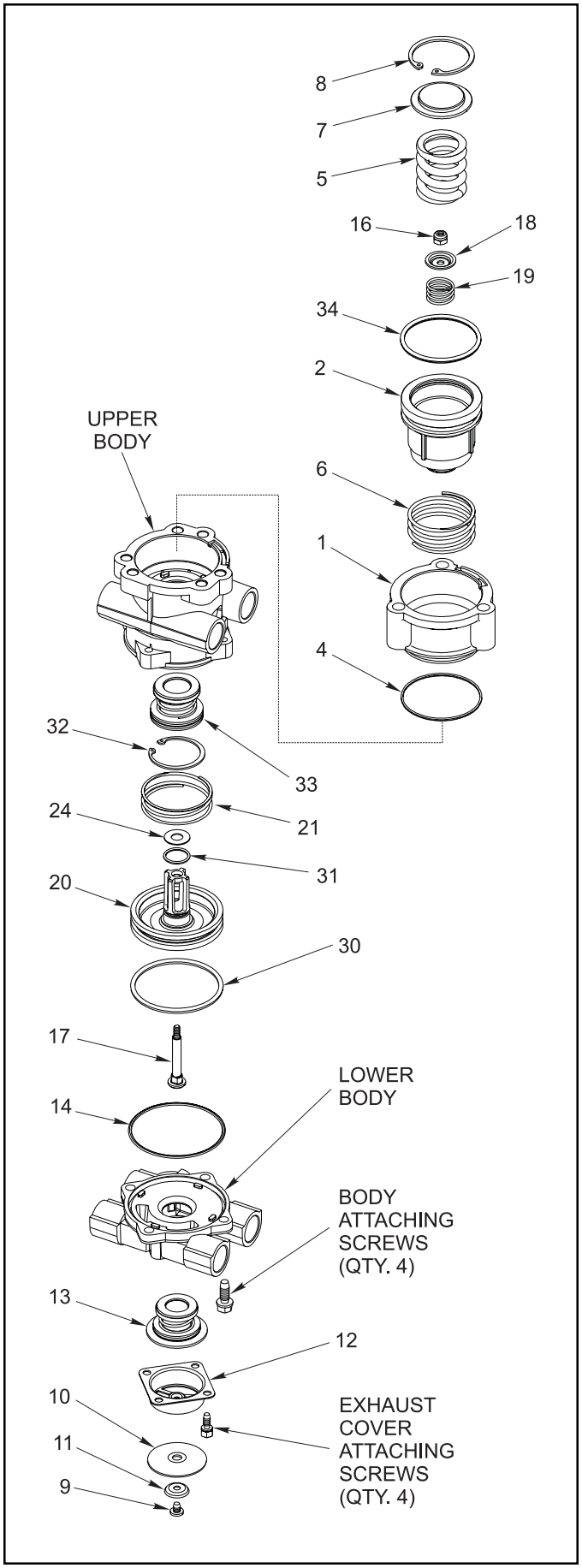

FIGURE 6 - **E-10P BRAKE VALVE - EXPLODED VIEW**

11. Remove the relay piston (20), relay piston spring (21), primary piston (**E-8P:** 22, **E-10P:** 2) and primary piston return spring (**E-8P:** 23, **E-10P:** 6) from the upper body. Use care so as not to nick seats.
12. A small washer (24) will be found in the cavity of the lower side of the primary piston (**for E-8P**: 22, **for E-10P**: 2).
13. For **E-8P only:** Disassemble the primary piston by rotating the spring seat nut (25) counterclockwise. Separate the spring seat nut, spring seat (26), and rubber spring (27) and remove the piston o-ring (28).
14. Remove the large and small o-rings (30 & 31) from the relay piston (20).
15. Remove the retaining ring (32) securing the primary inlet and exhaust valve assembly (33) in the upper body and remove the valve assembly.

CLEANING AND INSPECTION

1. Wash all metal parts in mineral spirits and dry.
2. Inspect all parts for excessive wear or deterioration.
3. Inspect the valve seats for nicks or burrs.
4. Check the springs for cracks or corrosion.
5. Replace all rubber parts and any part not found to be serviceable during inspection, use only genuine Bendix replacement parts.

ASSEMBLY

Prior to reassembling, lubricate all o-rings, o-ring grooves, piston bores, and metal to metal moving surfaces with Dow Corning 55 o-ring lubricant (Bendix piece number 291126).

Note: All torques specified in this manual are **assembly** torques and can be expected to fall off, after assembly is accomplished. **Do not retorque** after initial assembly torques fall.

1. Install the primary inlet and exhaust assembly (33) in the upper body and replace the retaining ring (32) to secure it. Be sure the retaining ring is seated completely in its groove.
2. Install the large and small o-rings (30 & 31) on the relay piston (20).
3. **For E-8P only:** Install o-ring (28) in the primary piston (22) o-ring groove.
4. **For E-8P only:** Install the rubber spring (do not lubricate) (27), concave side down in the primary piston (22) and place the spring seat (26), flat side up, over the rubber spring.
5. **For E-8P only:** Install the primary piston spring seat nut (25), with its hex closest to the spring seat, and rotate clockwise until the top surface of the spring seat is even with the top surface of the piston. Set aside.
6. Place relay piston spring (21) in concave portion of relay piston (20) and install relay piston through primary inlet/exhaust assembly (33) into under side of upper body.
7. **For E-10P only:** Install o-ring (4) on adapter (1) and install adapter on upper body. Install o-ring (34) on primary piston (2).
8. Place screwdriver, blade up, in vise. Insert stem (17) through the relay piston upper body sub assembly, slide this assembly over the blade of the secured screwdriver, engage the screwdriver blade in the slot in the head of the stem.
9. Place the washer (24) over the stem (17) and on top of the relay piston (20).
10. Install primary return spring (**E-8P**: 23, **E-10P**: 6) in upper body piston bore.
11. **For E-8P only:** Install the primary piston rubber spring sub assembly (steps 4 & 5) over the stem, into the upper body piston bore. **For E-10P:** Install primary piston sub-assembly (reference step 7).
12. Compress piston(s) (**For E-8P:** the relay piston (20), **for E-10P:** the primary and relay pistons (2 & 20)) and retaining ring into the upper body from either side and hold compressed, either manually or mechanically. **See the cautionary note under step 8 in the Disassembly section of this manual.**
13. Place the stem spring (19) (**E-8P:** place over the spring seat nut (25)), the spring seat (18) (concave side up) and lock nut (16) on the stem (17). Torque to 20 - 30 inch pounds.
14. **For E-8P only:** Install the primary piston retainer (15) over the piston, making certain all three lock tabs have engaged the outer lip of the body.
15. **For E-10P only:** Install coil spring (5), spring seat (7), and retaining ring (8) .
16. Replace the rubber seal ring (14) on the lower body.
17. Install the 4 hex head cap screws securing the lower body to the upper body. Torque to 30 - 60 inch pounds.
18. Install the secondary inlet and exhaust valve assembly (13) on the lower body.
19. Install the screws that secure the exhaust cover (12) to the lower body. Torque to 20 - 40 inch pounds.
20. Secure the screw (9) holding the exhaust diaphragm (10) and the diaphragm washer (11) to the exhaust cover (12). Torque to 5 - 10 inch pounds.
21. Install all air line fittings and plugs making certain thread sealant material does not enter valve.

VALVE INSTALLATION

1. Install the assembled brake valve on the vehicle.

2. Reconnect all air lines to the valve using the identification made during VALVE REMOVAL step 1.
3. After installing the brake valve assembly, perform the “OPERATION AND LEAKAGE CHECKS” before placing the vehicle in service.

IMPORTANT: MAINTENANCE PRECAUTIONS

When working on or around a vehicle, the following general precautions should be observed:

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels.**
2. **Stop the engine when working around the vehicle.**
3. **Drain the air pressure from all reservoirs before beginning ANY work on the vehicle.**
4. **Following the vehicle manufacturer’s recommended procedures, deactivate the electrical system in a manner that removes all electrical power from the vehicle.**
5. **When working in the engine compartment the engine should be shut off. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.**
6. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
7. **Never exceed recommended pressures and always wear safety glasses.**
8. **Do not attempt to install, remove, disassemble, or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
9. **Use only genuine Bendix replacement parts, components, and kits. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.**
10. **Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted unless specifically approved and stated by the vehicle or component manufacturer.**
11. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**

SR-7 SPRING BRAKE MODULATING VALVE

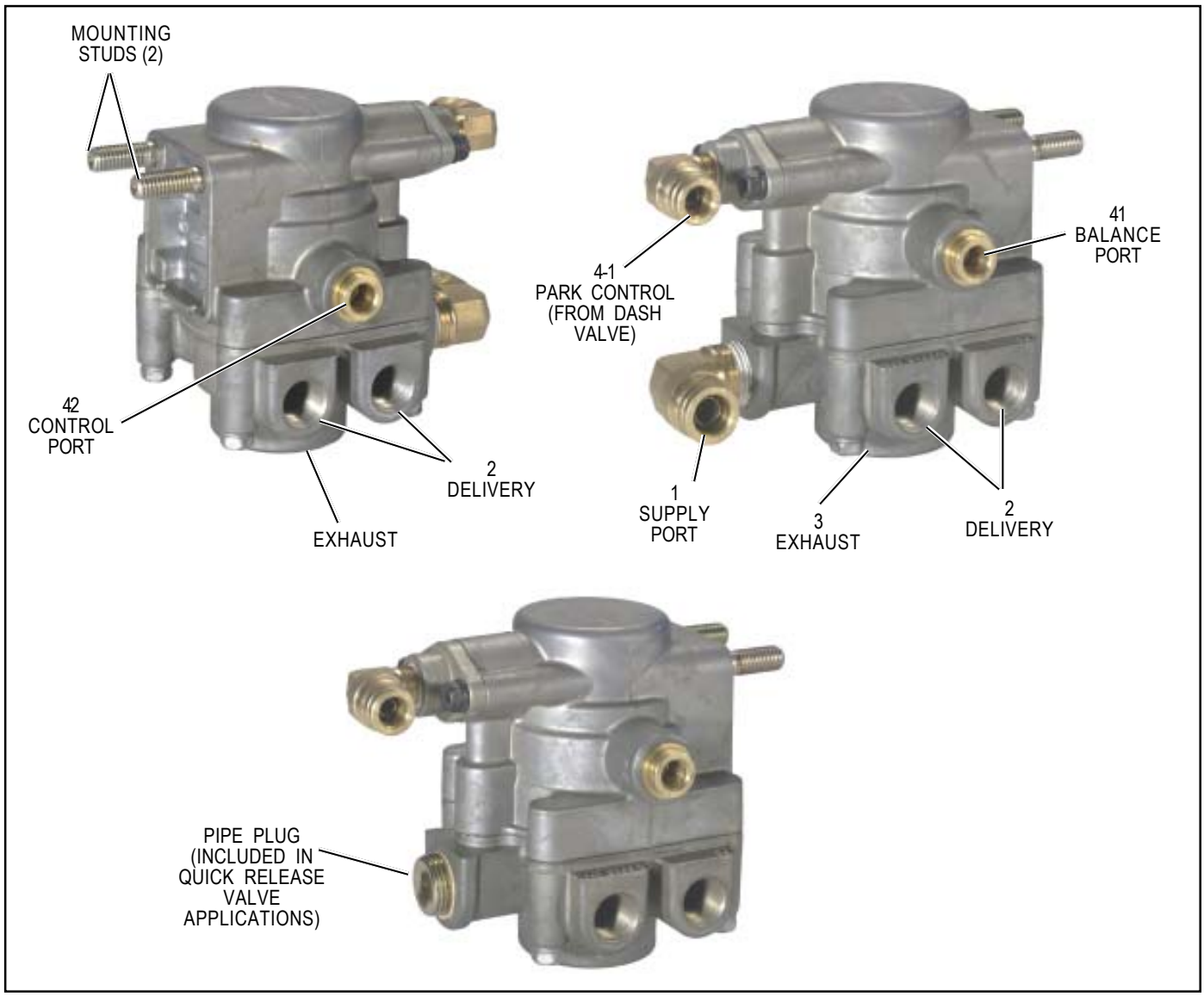

FIGURE 1 - EXTERIOR VIEW

DESCRIPTION

The SR-7 Spring Brake Modulating Valve is used in conjunction with a dual air brake system and spring brake actuator and performs the following functions:

1. Provides a rapid application of the spring brake actuator when parking.
2. Modulates the spring brake actuator application using the dual brake valve should a primary failure occur in the service brake system.
3. Prevents compounding of service and spring forces.

The valve has one park control, one service control, one supply, one balance, four delivery NPTF ports, and an exhaust port protected by an exhaust diaphragm. The valve incorporates two mounting studs for mounting the valve to the frame rail or cross member (where applicable).

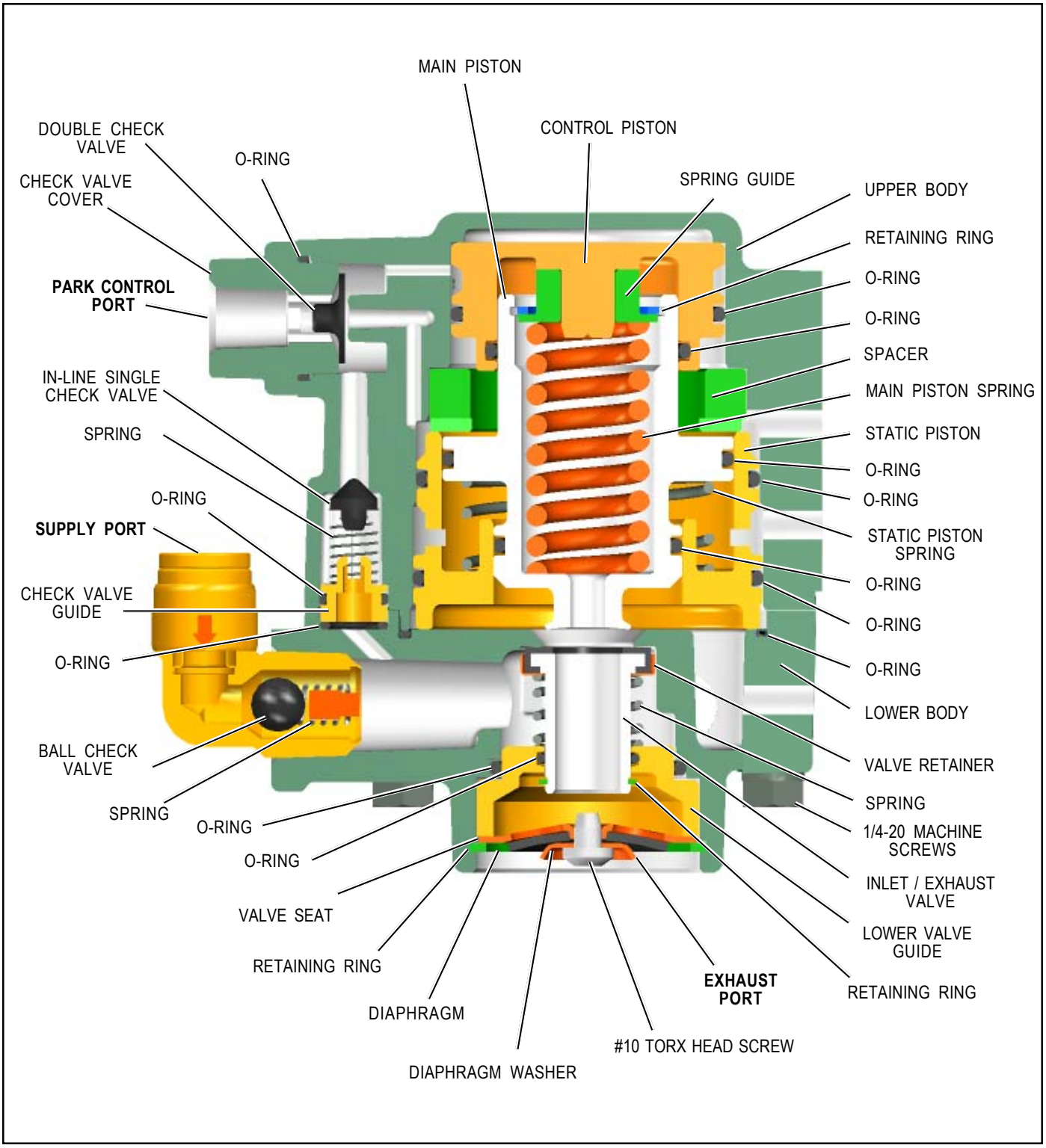

FIGURE 2 - SECTIONAL VIEW OF SR-7 USED IN RELAY VALVE APPLICATIONS

OPERATION

The operation guidelines shown in this manual represent the relay valve based SR-7 (refer to system schematic shown in figure 3). A quick release based valve functions similarly to the relay valve based version with the exception that all air delivered to spring brakes passes through the park control port through the in-line single check valve. The quick release style SR-7 can be easily identified by the pipe plug in the supply port of the valve.

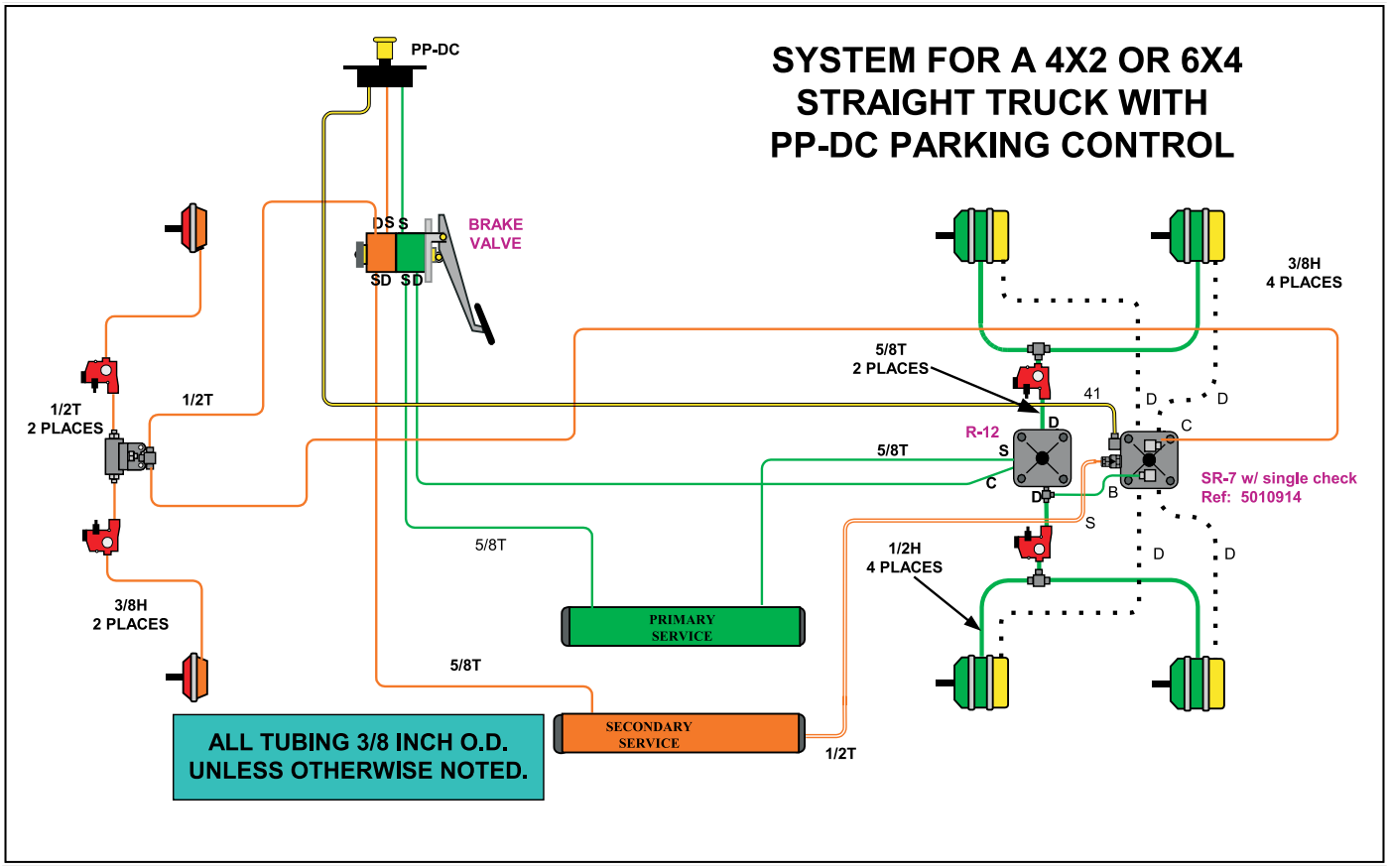

FIGURE 3 - SYSTEM SCHEMATIC WITH PP-DC PARK CONTROL

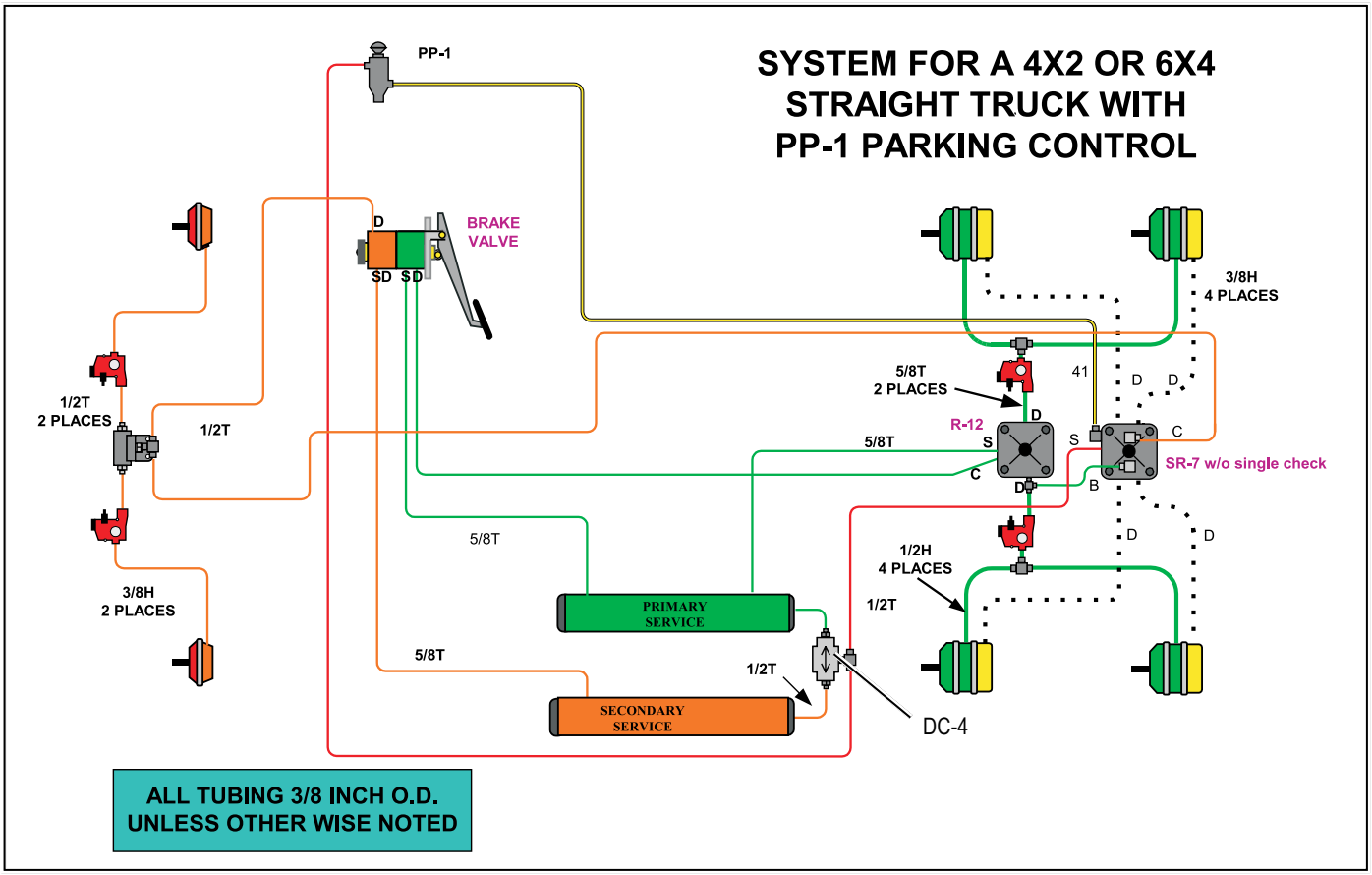

FIGURE 4 - SYSTEM SCHEMATIC WITH PP-1 PARK CONTROL AND DC-4 DOUBLE CHECK VALVE

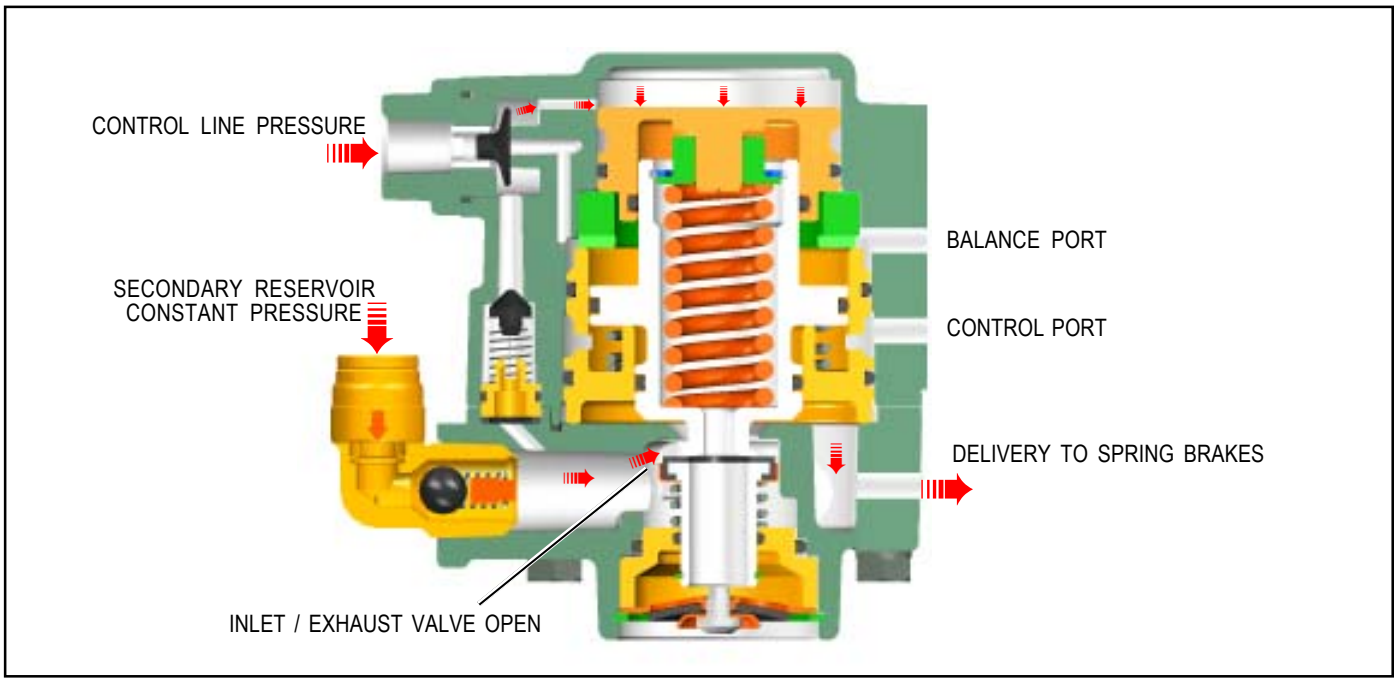

FIGURE 5 - CHARGING LESS THAN 107 PSI

CHARGING SPRING BRAKE ACTUATORS BELOW 107 PSI (FIGURE 5)

With the air brake system charged and the parking brakes released (by pushing the dash valve button in), air enters the park control port. This opens the SR-7 to supply air pressure to the spring brake chambers. As illustrated, air pressure in the chambers is below 107 psi (nominally).

CHARGING SPRING BRAKE ACTUATORS ABOVE 107 PSI (FIGURE 6)

Once the SR-7 valve delivery pressure reaches 107 psi (nominal), the inlet and exhaust are closed (valve lap position). This maintains the spring brake hold-off pressure at 107 psi (nominal).

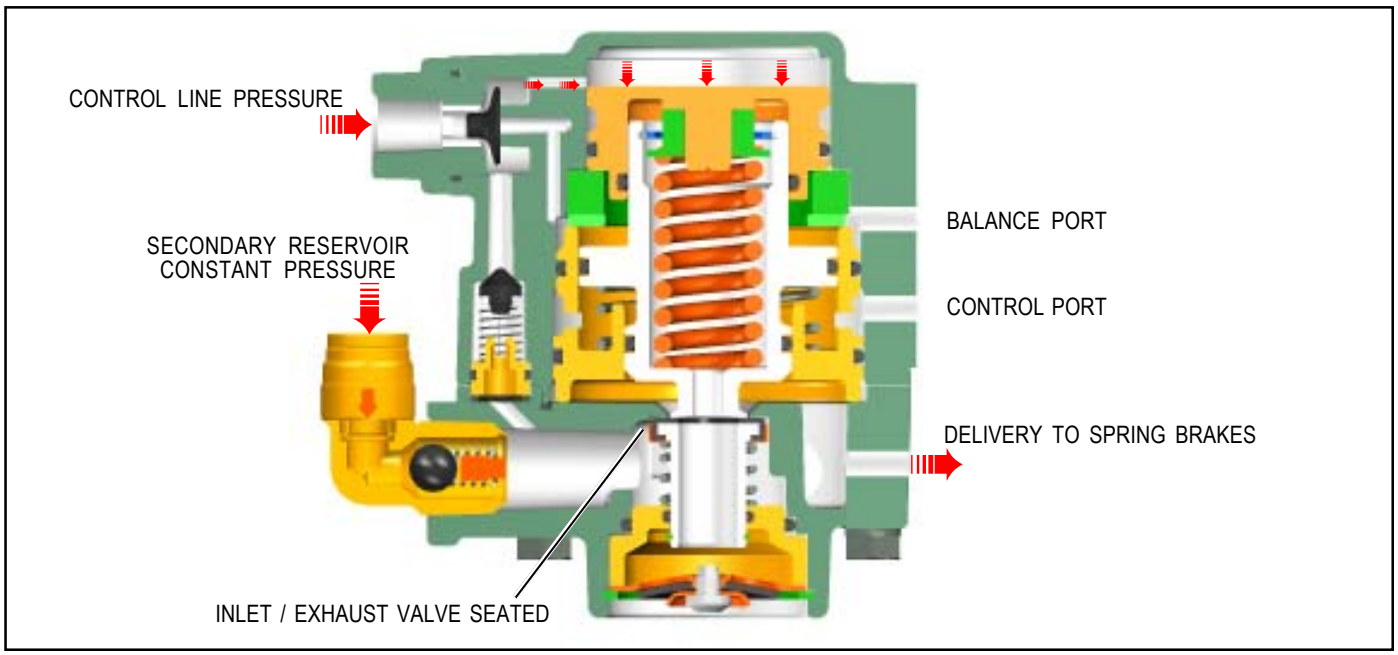

FIGURE 6 - CHARGING GREATER THAN 107 PSI

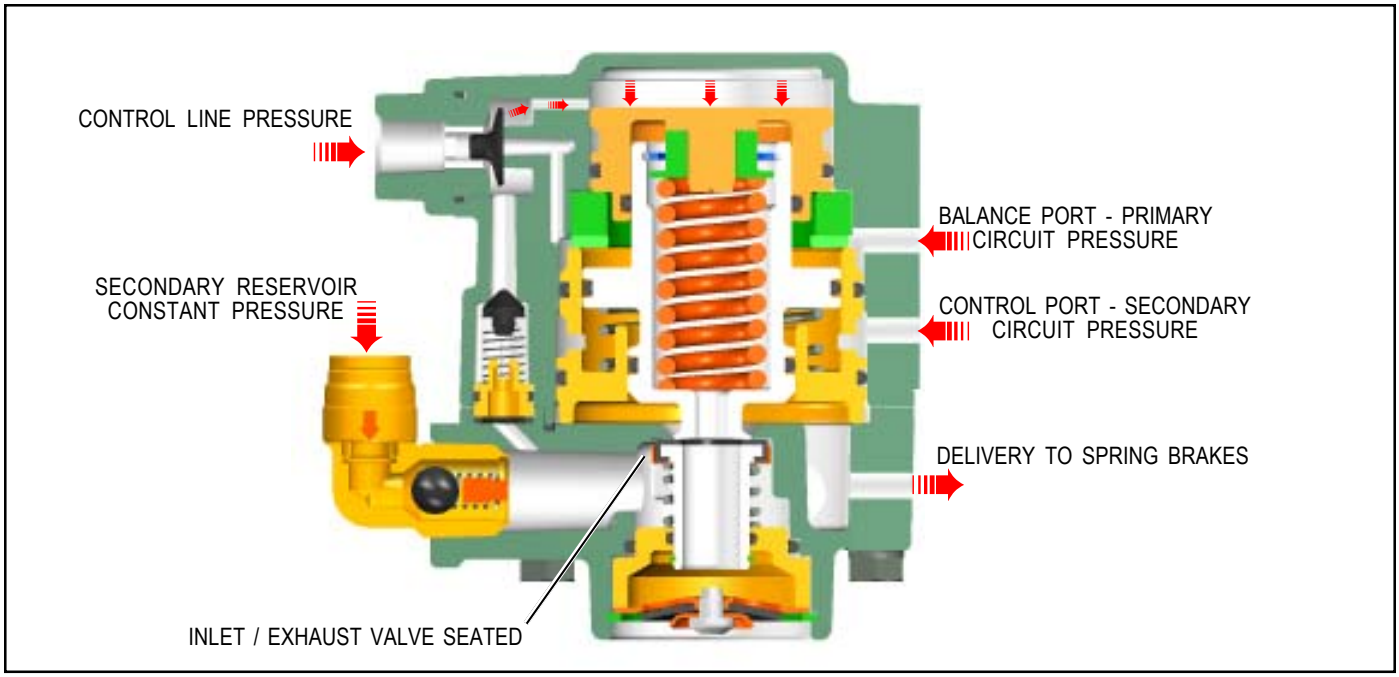

FIGURE 7 - NORMAL SERVICE APPLICATION

NORMAL SERVICE APPLICATION (FIGURE 7)

During a service brake application, the valve remains in the lap position. The SR-7 valve monitors the presence of air pressure in both primary and secondary delivery circuits.

PARKING (FIGURE 8)

Actuating the park brakes (by pulling the dash valve button out) exhausts spring brake air pressure through the SR-7 exhaust port.

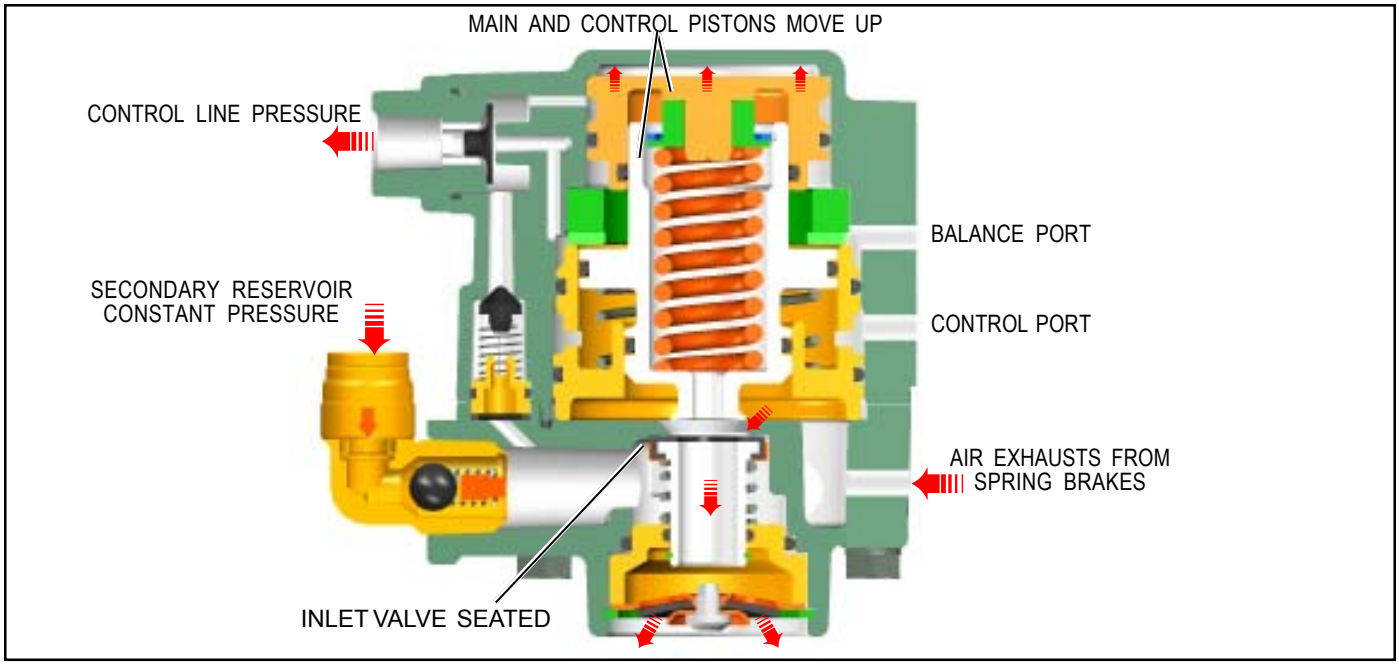

FIGURE 8 - PARKING

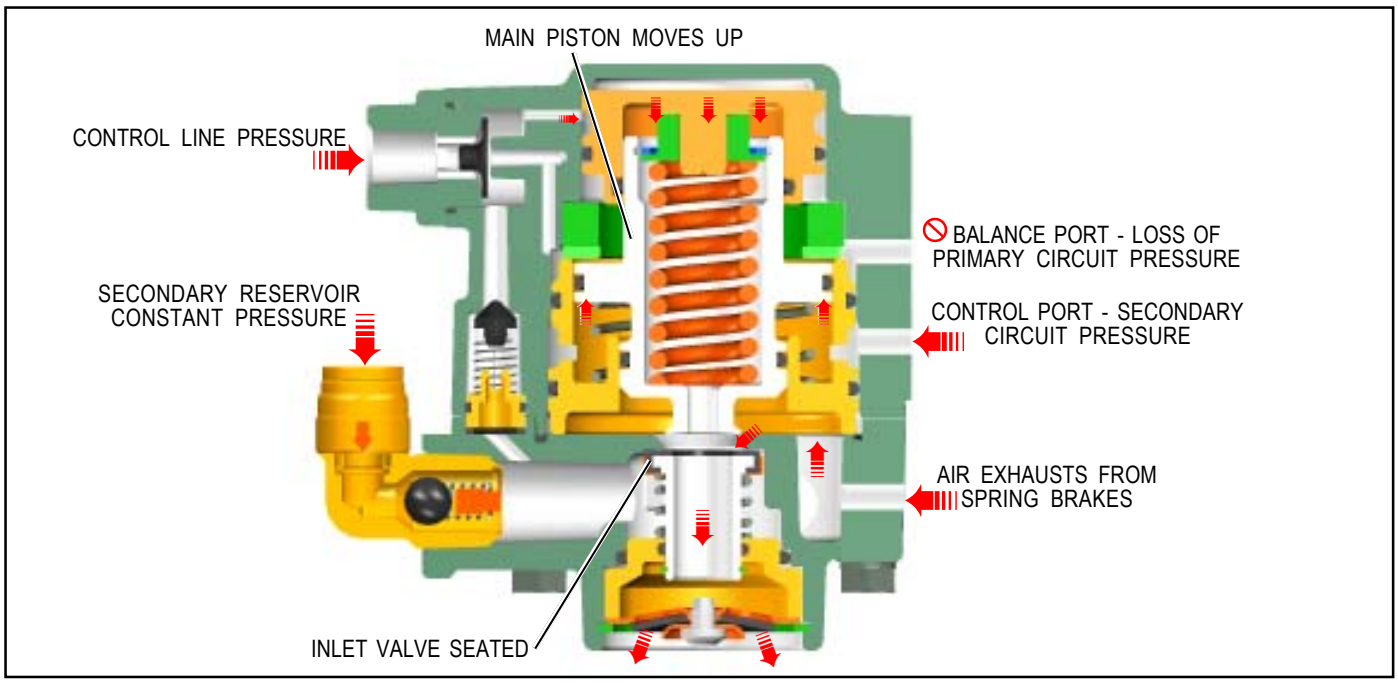

FIGURE 9 - SERVICE APPLICATION LOSS OF PRIMARY CIRCUIT

SERVICE APPLICATION WITH LOSS OF AIR IN PRIMARY CIRCUIT (FIGURE 9)

With the parking brakes released (dash valve button in) and the absence of air in the primary circuit delivery, a service brake application from the secondary circuit causes the pressure in the spring brakes to be exhausted proportionally to this application. This is known as spring brake modulation. A 30 psi service brake application will exhaust the spring brake pressure to approximately 60 psi.

SERVICE APPLICATION WITH LOSS OF AIR IN SECONDARY CIRCUIT (FIGURE 10)

With the parking brakes released (dash valve button in) and the absence of air in the secondary circuit reservoir, the external single check valve in the supply port seals to prevent air leakage to atmosphere from the SR-7 valve. The dash valve delivery air flows through the in-line single check valve and becomes SR-7 supply air. This air is delivered to maintain at least 107 psi (nominal) in the spring brake chambers.

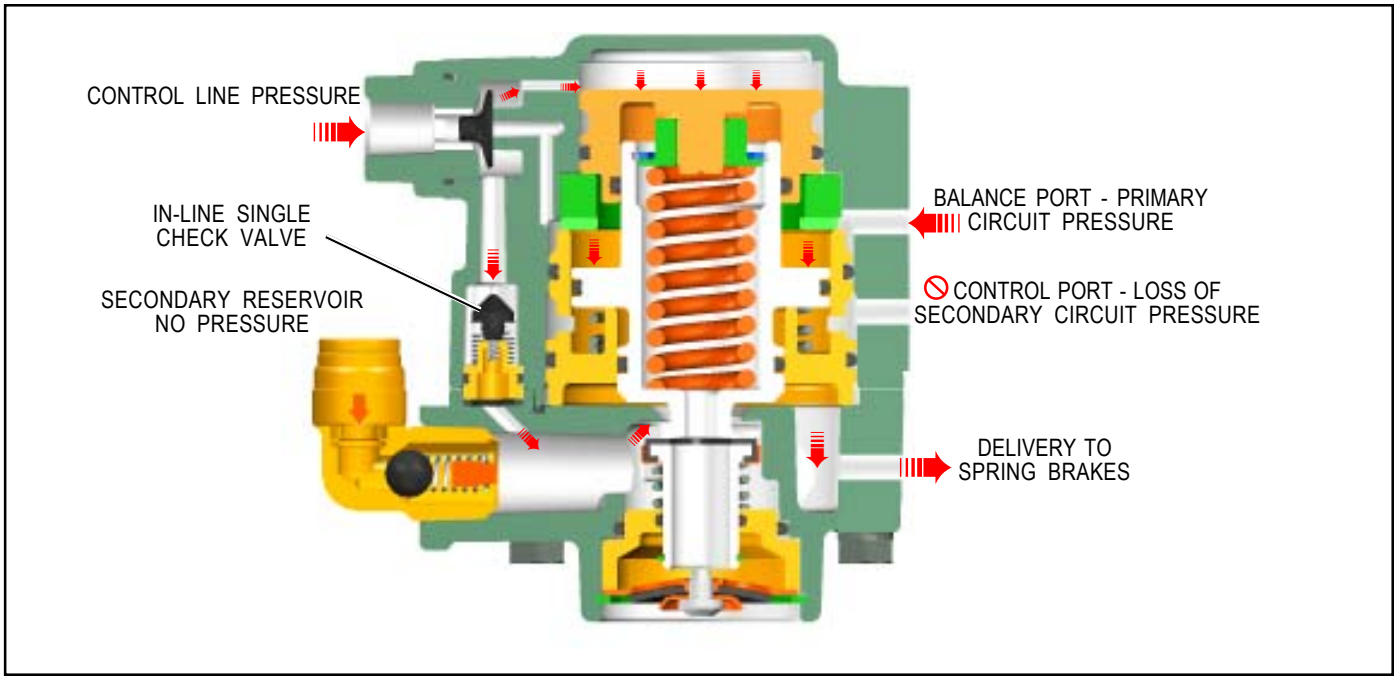

FIGURE 10 - SERVICE APPLICATION LOSS OF SECONDARY CIRCUIT

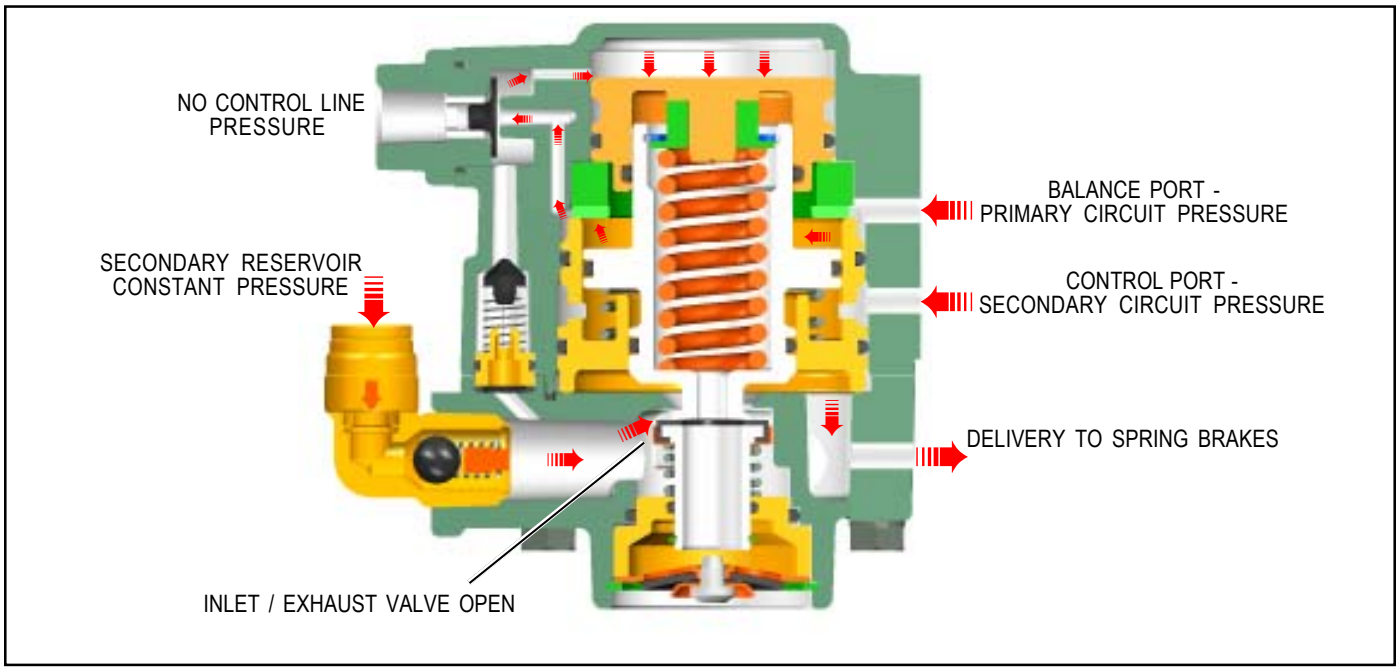

FIGURE 11 - ANTI-COMPOUNDING

ANTI COMPOUNDING (FIGURE 11)

The SR-7 provides anti-compounding of the service and spring brake forces. When the park brakes are actuated (by pulling the dash valve button out), a service brake application will cause the SR-7 to deliver air pressure to the spring brake chambers. Thus the vehicle is held stationary using a service brake application. When the service brake application is released, the delivery pressure is exhausted from the spring brake chambers and the vehicle remains parked using the spring brake actuators.

PREVENTIVE MAINTENANCE

Important: Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period.

Because no two vehicles operate under identical conditions, maintenance intervals will vary. Experience is a valuable guide in determining the best maintenance interval for a vehicle.

OPERATING TEST

Block vehicle and hold by means other than vehicle brakes. Charge air brake system to governor cut-out pressure.

1. Place parking control valve in “park” position. Observe that spring brake actuators apply promptly. Remove one line from delivery port of the SR-7 valve and install test gauge known to be accurate. Place parking control valve in “release” position. Observe that spring brake actuators release fully.
2. With parking control valve in “release” position, note gauge pressure reading. (Correct spring brake actuator hold-off pressure is 107 psi nominally.)
3. Place parking control valve in “park” position - gauge reading should drop to zero promptly. A lag (more than 3 seconds) in drop of pressure would indicate faulty operation.
4. With the parking control valve in the “park” position, gradually apply foot brake valve and note a pressure reading increase on the gauge installed in the SR-7 delivery port.
5. Place parking control valve in “release” position.
6. Drain the reservoir, which supplies the rear service brake circuit, apply the foot brake valve several times and note that pressure reading on gauge decreases each time foot brake valve is applied (spring brake modulation). After the foot brake valve has been applied several times, pressure on gauge will drop to the point where release of the spring brake actuators will no longer occur.

LEAKAGE TEST

Place the park control valve in the “release” position; using a soap solution, coat all ports including the exhaust port. A 1 inch bubble in three seconds is permitted.

If the valve does not function as described, or if leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit available from a Bendix parts outlet. **DO NOT ATTEMPT TO DISASSEMBLE THE SR-7. THE VALVE CONTAINS HIGH SPRING FORCES THAT COULD RESULT IN PERSONAL INJURY IF DISASSEMBLY IS ATTEMPTED!**

SERVICING THE SR-7

IMPORTANT! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH.

When working on or around a vehicle, the following general precautions should be observed at all times:

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels.**
2. **Stop the engine when working around the vehicle.**
3. **If the vehicle is equipped with air brakes, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle.**
4. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that removes all electrical power from the vehicle.**
5. **When working in the engine compartment the engine should be shut off. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.**
6. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
7. **Never exceed recommended pressures and always wear safety glasses.**
8. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
9. **Use only genuine Bendix replacement parts, components, and kits. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.**
10. **Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted unless specifically approved and stated by the vehicle or component manufacturer.**
11. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**

VALVE REMOVAL

1. Prior to removing the SR-7 apply the parking brakes and drain all the vehicle reservoirs.
2. Identify all air lines before disconnecting.
3. Remove the two mounting nuts that secure the valve to the frame rail and remove the valve.

VALVE INSTALLATION

1. Align the mounting studs with the mounting holes on the vehicle frame rail. Tighten the mounting nuts to 180-220 in. lbs.
2. Install the valve onto the vehicle ensuring all ports are connected as marked during disassembly.

TESTING THE REPLACEMENT SR-7 SPRING BRAKE MODULATING VALVE

Perform operating and leakage tests as outlined in "Operating Tests" section.

Bendix
Service Data
SD-13-4869

Bendix® EC-60™ ABS / ATC Controllers (Advanced Models)

See SD-13-4863 for Standard and Premium Controllers

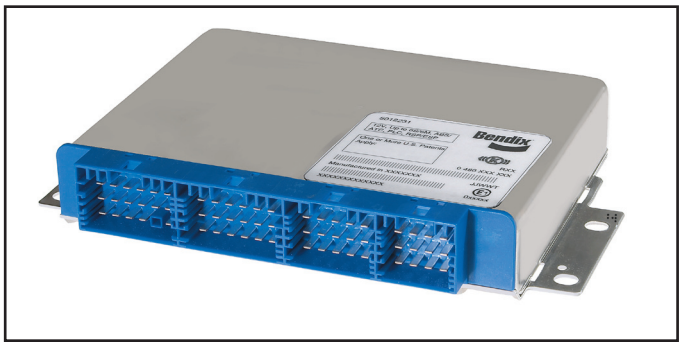

FIGURE 1 - EC-60™ ADVANCED CONTROLLER

INTRODUCTION

The Bendix® EC-60™ advanced controller is a member of a family of electronic **Antilock Braking System (ABS)** devices designed to help improve the braking characteristics of air braked vehicles - including heavy and medium duty buses, trucks, and tractors. ABS controllers are also known as **Electronic Control Units (ECUs)**.

Bendix® ABS uses wheel speed sensors, ABS pressure modulator valves, and an ECU to control either four or six wheels of a vehicle. The EC-60™ controller monitors individual wheel turning motion during braking and adjusts or modulates the brake pressure at the wheel end. When excessive wheel slip, or wheel lock-up is detected, the EC-60™ controller will activate the pressure modulator valves to automatically reduce the brake pressure at one or more of the wheel ends. By these actions, the ABS system helps to maintain the vehicle's lateral stability and steerability during heavy brake applications and during braking on slippery surfaces.

In addition to the ABS function, advanced models of the EC-60™ controller provide an **Automatic Traction Control (ATC)** feature. Bendix ATC can improve vehicle traction during acceleration, and lateral stability while accelerating through curves. ATC utilizes **Engine Torque Limiting (ETL)** where the ECU communicates with the engine's controller and/or **Differential Braking (DB)** where individual wheel brake applications are used to improve vehicle traction.

Advanced EC-60™ controllers have a drag torque control feature which reduces driven-axle wheel slip (due to driveline inertia) by communicating with the engine's controller and increasing the engine torque.

The EC-60™ advanced model provides ABS-based stability features referred to as **ESP® Electronic Stability Program**. ESP® is a registered trademark of DaimlerChrysler and is used by BCVS under license from DaimlerChrysler.

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The Bendix ESP system is an ABS-based stability system that enhances vehicle stability by both reducing engine throttle and by applying vehicle braking based on actual vehicle dynamics. Accordingly, the ESP system is available only on specific approved vehicle platforms after vehicle application and development efforts and validation testing. Only certain limited variations of an approved vehicle platform are permitted without further validation of the ESP system application.

ESP stability system consists of Yaw Control (YC) and Roll Stability Program (RSP) features.

CAUTION

Even with ESP-equipped vehicles, the driver remains responsible for ensuring vehicle stability during operation.

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The ESP system only functions within the limits of physics.

ESP functionality mitigates potential vehicle stability incidents, but cannot prevent them in all cases. Other factors such as driving too fast for road, traffic or weather conditions, oversteering, an excessively high vehicle Center of Gravity (CG), or poor road conditions can cause vehicle instability that is beyond the capability of any stability system to mitigate. In addition, the effectiveness of ESP can be greatly reduced on vehicles towing multiple trailer combinations.

CAUTION

The ESP stability system may only be used on vehicles tested and approved by Bendix engineering. ESP installations require on-vehicle testing and EC-60 parameter tuning. See "Advanced ABS with Stability Control" on page 9 for further details.

Accordingly, the EC-60 controller is provided with a corresponding parameter data set that is validated for a specific vehicle platform. Therefore, specific steps are necessary should a replacement ECU be required. See “Obtaining a New EC-60™ Controller” on page 13 for further details.

ESP-equipped vehicles should not be driven on high-banked roads – such as those found on high-speed test or race tracks. Test personnel must have ESP functionality disabled prior to operating an ESP vehicle on such tracks.

YAW CONTROL (YC)

Advanced ECU can include Yaw Control (YC) functionality, which has the ability to apply brakes to individual wheel ends, as well as applying the trailer brakes to counteract trailer “push” that, during certain maneuvers, could lead to a loss of control or a jackknife incident. See "Yaw Stability" on page 9 for further details.

ROLL STABILITY PROGRAM (RSP)

The Bendix Roll Stability Program (RSP), is an all-axle ABS solution that helps reduce vehicle speed by reducing the engine's throttle and applying all vehicle brakes as needed, reducing the vehicle's tendency to roll over. RSP focuses on reducing the vehicle’s speed below the critical roll threshold during direction-changing maneuvers such as driving on curved highway exit ramps or obstacle avoidance maneuvers on dry, high friction surfaces. See "Advanced ABS with Stability Control" on page 9 for further details.

WARNING

During an RSP system intervention, the vehicle **automatically decelerates.** RSP can slow the vehicle with or **without the operator applying the brake pedal**, and **even when the operator is applying the throttle.**

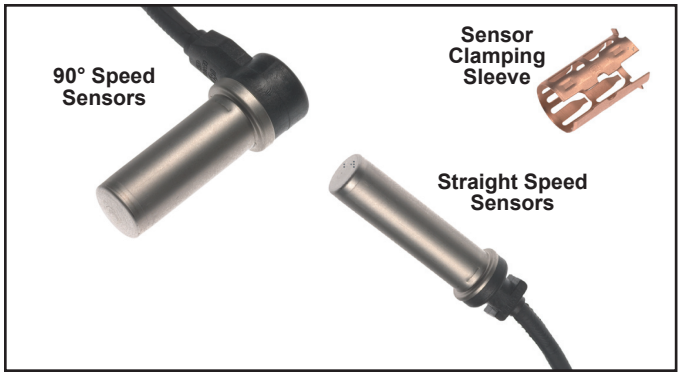

FIGURE 2 - BENDIX® WS-24™ WHEEL SPEED SENSORS

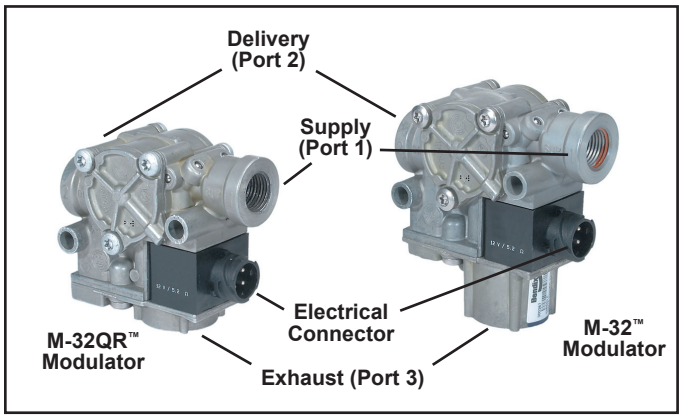

FIGURE 3 - M-32™ AND M-32QR™ MODULATORS

COMPONENTS

The EC-60™ controller’s ABS function utilizes the following components:

- Bendix® WS-24™ wheel speed sensors (4 or 6, depending on configuration). Each sensor is installed with a Bendix Sensor Clamping Sleeve
- Bendix® M-32™ or M-32QR™ Pressure Modulator Valves (4, 5, or 6 depending on configuration)
- Dash-mounted tractor ABS Indicator Lamp
- Service brake relay valve
- Dash-mounted trailer ABS Indicator Lamp
- Optional blink code activation switch
- Optional ABS off-road switch

The EC-60™ controller ATC function utilizes the following additional components:

- Drive axle traction control valve (may be integral to the service brake relay valve or a stand-alone device)
- Dash-mounted ATC status/indicator lamp
- J1939 serial communication to engine control module
- Stop lamp switch input (may be provided using the ECU hardware input or J1939)
- Optional ATC mud/snow switch (sometimes referred to as an ATC off-road switch)

Input Voltage	Sensors	PMVs	ATC	ESP/ RSP	Blink Codes	Serial Communication		PLC	ABS Off-Road	ATC Mud/Snow	Retarder Relay
						J1587	J1939				
12 VDC	4/6	4/5/6	✔	✔	✔	✔	✔	✔	✔	✔	✔

CHART 1 - EC-60™ ADVANCED CONTROLLER FEATURES

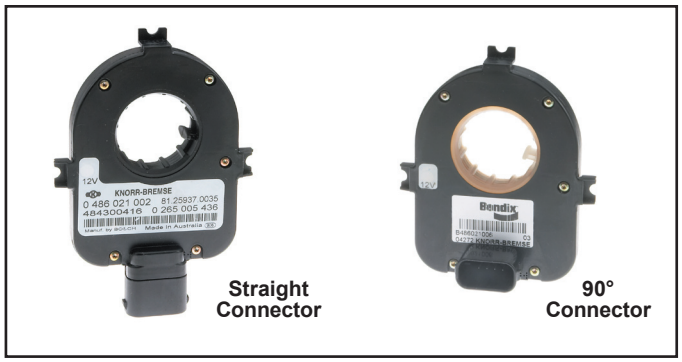

FIGURE 4 - STEERING ANGLE SENSORS

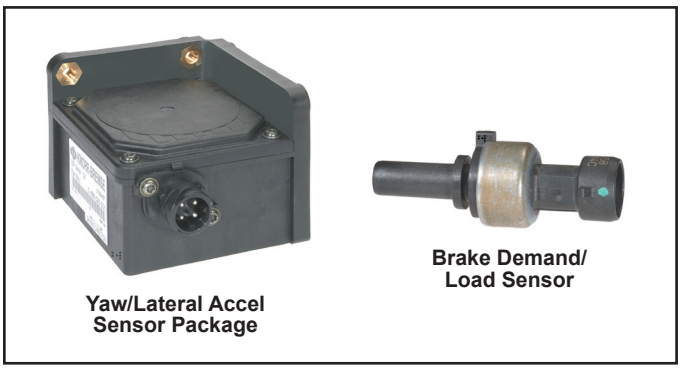

FIGURE 5 - YAW AND BRAKE DEMAND/LOAD SENSORS

The EC-60™ controller ESP/RSP function utilizes the following additional components:

- Steer Axle Traction Control Valve (may be integral to the service brake relay valve or a stand-alone device)
- Dash-mounted ESP status/indicator lamp (also serves as the ATC status/indicator lamp)
- Bendix SAS-60™ Steering Angle Sensor (mounted to the steering column)
- Bendix YAS-60™ Yaw Rate/Lateral Acceleration Sensor (typically mounted to a cross-member near the back of the vehicle cab)
- Brake Demand Sensors (installed in the primary and secondary delivery circuits)
- Load Sensor (typically installed in the suspension air bag)
- An additional Modulator Valve (Bendix® M-32™ or M-32QR™ Pressure Modulator Valve) that controls pressure apply to trailer brakes during system intervention

ECU MOUNTING

The Bendix® EC-60™ advanced cab-mounted controller is not protected against moisture, and must be mounted in an environmentally protected area.

All wire harness connectors must be properly seated. The use of secondary locks is strongly recommended.

Cab ECUs utilize connectors from the AMP MCP 2.8 product family.

HARDWARE CONFIGURATION

Advanced model EC-60™ controllers support applications up to six sensor/six modulator (6S/6M) installations with ATC and drag torque control. Available in 12 volt models, all advanced model EC-60™ controllers support PLC (See Chart 1).

ADVANCED EC-60™ CONTROLLERS USE POWER LINE CARRIER (PLC)

All new towing vehicles built since March 1, 2001 have had an in-cab trailer ABS Indicator Lamp installed.

Trailers built since March 1, 2001 transmit the status of the trailer ABS over the power line (the blue wire of the J560 connector) to the tractor using a Power Line Carrier (PLC) signal. See Figures 6 and 7. Typically the signal is broadcast by the trailer ABS ECU.

The application of PLC technology for the heavy vehicle industry in North America is known as “PLC4Trucks.”

The Advanced EC-60™ controller supports PLC communications in accordance with SAE J2497.

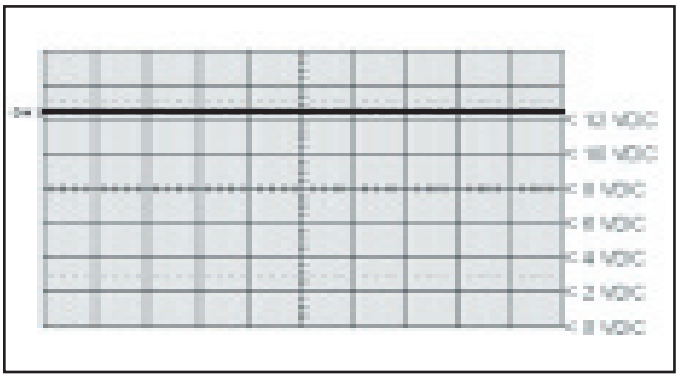

FIGURE 6 - POWER LINE WITHOUT PLC SIGNAL

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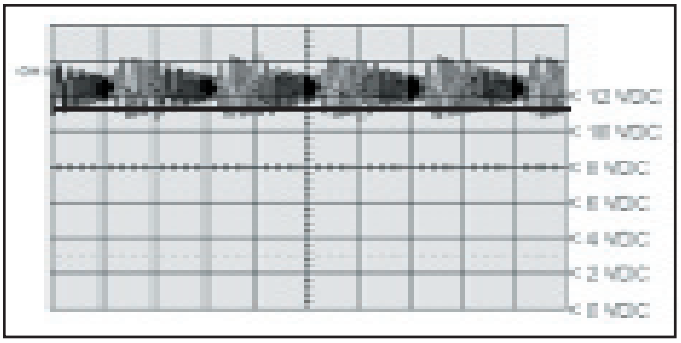


FIGURE 7 - POWER LINE WITH PLC SIGNAL

PLC SIGNAL

An oscilloscope can be used to measure or identify the presence of a PLC signal on the power line. The PLC signal is an amplitude and frequency modulated signal. Depending on the filtering and load on the power line, the PLC signal amplitude can range from 5.0mVp-p to 7.0 Vp-p. Suggested oscilloscope settings are AC coupling, 1 volt/div, 100 µsec/div. The signal should be measured at the ignition power input of the EC-60™ controller.

Note: An ABS trailer equipped with PLC, or a PLC diagnostic tool, must be connected to the vehicle in order to generate a PLC signal on the power line.

EC-60™ CONTROLLER INPUTS

Battery and Ignition Inputs

The ECU operates at a nominal supply voltage of 12 volts. The battery input is connected through a 30 amp fuse directly to the battery.

The ignition input is applied by the ignition switch circuit through a 5 amp fuse.

Ground Input

The EC-60™ controller supports one ground input. See page 42 for a system schematic.

ABS Indicator Lamp Ground Input

Advanced EC-60™ cab ECUs require a second ground input (X1-12) for the ABS indicator lamp. The X1 wire harness connector contains an ABS indicator lamp interlock (X1-15), which shorts the ABS indicator lamp circuit (X1-18) to ground if the connector is removed from the ECU.

Bendix® WS-24™ Wheel Speed Sensors

Wheel speed data is provided to the EC-60™ controller from the WS-24™ wheel speed sensor (see Figure 2). Vehicles have an exciter ring (or “tone ring”) as part of the wheel assembly, and as the wheel turns, the teeth of the exciter ring pass the wheel speed sensor, generating an AC signal. The EC-60™ controller receives the AC signal, which varies in voltage and frequency as the wheel speed changes.

Vehicle axle configurations determine the number of WS-24™ wheel speed sensors that must be used. A vehicle with a single rear axle requires four wheel speed sensors. Vehicles with two rear axles can utilize six wheel speed sensors for optimal performance.

Diagnostic Blink Code Switch

A momentary switch that grounds the ABS Indicator Lamp output is used to place the ECU into the diagnostic blink code mode and is typically located on the vehicle’s dash panel.

Optional ABS Off-Road Switch and Indicator Lamp Operation

Advanced EC-60™ controllers use an optional dash-mounted switch for the operator to place the ECU into the ABS off-road mode. See "Optional ABS Off-Road Mode" on page 7 for further details. In some cases, ECUs may also be put into the ABS off-road mode by one of the other vehicle control modules, using a J1939 message to the EC-60™ controller.

(If you need to know if this EC-60™ controller uses a J1939 message to operate the lamp, e-mail ABS@bendix.com, specifying the ECU part number, or call 1-800-AIR-BRAKE and speak to the Bendix TechTeam.)

WARNING: The ABS off-road mode should not be used on normal, paved road surfaces because vehicle stability and steerability may be affected. When the ECU is placed in the ABS off-road mode, the ABS Indicator Lamp will flash constantly (at a rate of once per 2.5 seconds) to notify the vehicle operator that the off-road mode is active.

Optional ATC Mud/Snow (Off-Road) Switch and Indicator Lamp Operation (see also page 8.)

Advanced controllers use a dash-mounted switch for the operator to place the ECU into the ATC Mud/Snow mode.

Stop Lamp Switch (SLS)

The Advanced EC-60™ controller monitors the vehicle stop lamp status. Certain vehicle functions, such as ATC and All-Wheel Drive (AWD), use the status of the stop lamp to determine when the driver makes a brake application. This can be provided to the ECU via J1939 communications, or hardware input.

Brake Demand Sensors

The brake demand sensors provide the controller with an indication of driver-applied brake pressure. One is installed in the primary air brake circuit, and another is installed in the secondary air brake circuit.

Load Sensor

The load sensor provides the controller with an indication of the vehicle load. It is typically installed in one of the suspension air bags.

Bendix® SAS-60™ Steering Angle Sensor

The Steering Angle Sensor (SAS) is used to provide driver steering input to the controller. It reports the steering wheel position to the controller utilizing a dedicated serial communications link that is shared with the YAS-60™ sensor. The controller supplies the power and ground inputs to the SAS-60™ sensor.

The SAS-60 sensor is available with two different styles of wire harness connectors. (See Figure 4)

Bendix® YAS-60™ Yaw Rate/Lateral Acceleration Sensor

The Yaw Rate/Lateral Acceleration Sensor is used to provide the controller an indication of vehicle lateral acceleration and rotation around the vertical axis. This information is provided to the controller utilizing a dedicated serial communications link that is shared with the SAS-60™ sensor. The controller supplies the power and ground inputs to the YAS-60™ sensor.

EC-60™ CONTROLLER OUTPUTS

Bendix® M-32™ and M-32QR™ Pressure Modulator Valves (PMV)

The Bendix® M-32™ and M-32QR™ pressure modulator valves (PMV) are operated by the EC-60™ controller to modify driver applied air pressure to the service brakes during ABS, ATC, RSP or YC activation (See pages 7-8). The PMV is an electropneumatic control valve and is the last valve that air passes through on its way to the brake chamber. The modulator hold and release solenoids are activated to "modulate" or "control" the brake pressure during an antilock braking event. The hold solenoid is normally open and the release solenoid is normally closed, such that the PMV nominally allows air to flow through. This design allows for air delivery to brake chambers in the event of electrical trouble.

The Advanced EC-60™ controller also utilizes an additional PMV for control of the trailer service brakes during stability interventions.

Traction Control Valve (TCV)

Advanced EC-60™ controllers use two TCVs, one on the steer axle and one on the drive axle. The TCV may be a separate valve or integrated into the rear axle relay valve.

The controller will activate the drive axle TCV during differential braking ATC events.

During stability interventions, the ECU will activate both the steer axle and drive axle TCVs as required.

Stop Lamp Output

The controller provides an output to control a relay that illuminates the vehicle stop lamps during stability interventions. This information is also available using the J1939 serial communications link.

ABS Indicator Lamp Control with Optional Diagnostic Blink Code Switch

The Advanced EC-60™ controller has internal circuitry to control the ABS Indicator Lamp on the dash panel.

The ABS Lamp Illuminates:

1. During power up (e.g. when the vehicle is started) for approximately 3 seconds and turns off after the self test is completed, providing no **Diagnostic Trouble Codes (DTCs)** are present on the ECU.
2. When full ABS operation is not available due to presence of a DTC on the ECU.
3. If the ECU is unplugged or has no power.
4. When the ECU is placed into the ABS off-road mode (the lamp flashes steadily at a rate of once per 2.5 sec.).
5. To display blink codes for diagnostic purposes after the external diagnostic switch is activated.

The EC-60™ controller may communicate with other vehicle control modules to operate the ABS Indicator Lamp using serial communications. (If you need to know if this EC-60™ controller uses serial communications to operate the lamp, e-mail ABS@bendix.com, specifying the ECU part number, or call 1-800-AIR-BRAKE and speak to the Bendix Tech Team.)

Indicator Lamp Control Using Serial Communications Links

As mentioned above, depending on the vehicle manufacturer, the dash indicator lamps (ABS, ATC, ESP and trailer ABS) may be controlled using serial communications links. In these cases, the EC-60™ controller will send a serial communications message over the J1939 or J1587 links indicating the required status of the lamp(s). Another vehicle control module receives the message and controls the indicator lamp(s).

Retarder Relay Disable Output

The retarder relay disable output may be used to control a retarder disable relay. When configured to use this output, the ECU will energize the retarder disable relay and inhibit the use of the retarder as needed.

SAE J1939 Serial Communications

A Controller Area Network (CAN) data link (SAE J1939) is provided for communication. This link is used for various functions, such as:

- To disable retarding devices during ABS operation.
- To request torque converter lock-up during ABS operation.
- To share information such as wheel speed and ECU status with other vehicle control modules.

Advanced EC-60™ controllers utilize the J1939 data link for:

- ATC and drag torque control functions.
- Vehicle stability functions.

Trailer ABS Indicator Lamp Control

The Advanced EC-60™ controller will activate a trailer ABS Indicator Lamp (located on the dash panel) that indicates the status of the trailer ABS unit on one, or more trailers, or dollies that are equipped with PLC functionality. Typically, the EC-60™ controller directly controls the trailer ABS Indicator Lamp based on the information it receives from the trailer ABS, via PLC.

Alternatively, some vehicles require the EC-60™ controller to activate the trailer ABS Indicator Lamp by communicating with other vehicle controllers using serial communications.

(If you need to know if this EC-60™ controller uses a serial communications message to operate the lamp, e-mail ABS@bendix.com, specifying the ECU part number, or call 1-800-AIR-BRAKE and speak to the Bendix TechTeam.)

SAE J1708/J1587 Serial Communications

An SAE J1708 data link, implemented according to SAE J1587 recommended practice, is available for diagnostic purposes, as well as ECU status messages.

Interaxle Differential Lock Control (AWD Transfer Case)

Advanced ECUs can control the interaxle differential lock (AWD transfer case). This is recommended on AWD vehicles, but the ECU must be specially configured to provide this feature. E-mail to ABS@bendix.com for more details.

POWER-UP SEQUENCE

NOTICE: The vehicle operator should verify proper operation of all installed indicator lamps (ABS, ATC/ESP, and trailer ABS) when applying ignition power and during vehicle operation. Lamps that do not illuminate as required when ignition power is applied, or remain illuminated after ignition power is applied, indicate the need for maintenance.

ABS Indicator Lamp Operation (Bulb Check)

The ECU will illuminate the ABS Indicator Lamp for approximately three seconds when ignition power is applied, after which the lamp will extinguish if no diagnostic trouble codes are detected.

The ECU will illuminate the ABS Indicator Lamp whenever full ABS operation is not available due to a diagnostic trouble code. In most cases, partial ABS is still available.

ATC/ESP Status/Indicator Lamp Operation

The ECU will illuminate the ATC/ESP lamp for approximately 2.5 seconds when ignition power is applied, after which the lamp will extinguish, if no diagnostic trouble codes are detected. The ECU will continuously illuminate the ATC/ESP Indicator Lamp whenever ESP or ATC is disabled due to a diagnostic trouble code.

During an ESP or ATC intervention, the lamp will flash rapidly (2.5 times per second). When the ECU is placed in the ATC Mud/Snow (off-road) mode, the lamp will flash slowly at a rate of once every 2.5 seconds

Trailer ABS Indicator Lamp Operation

The ECU will control the Trailer ABS Indicator Lamp when a PLC signal (SAE J2497) from a trailer ABS ECU is detected.

ECU Configuration Test

Within two seconds of the application of ignition power, the ECU will perform a test to detect system configuration with regards to the number of wheel speed sensors and PMVs. This can be audibly detected by a rapid cycling of the PMVs.

(Note: The ECU will not perform the configuration test when wheel speed sensors show that the vehicle is in motion.)

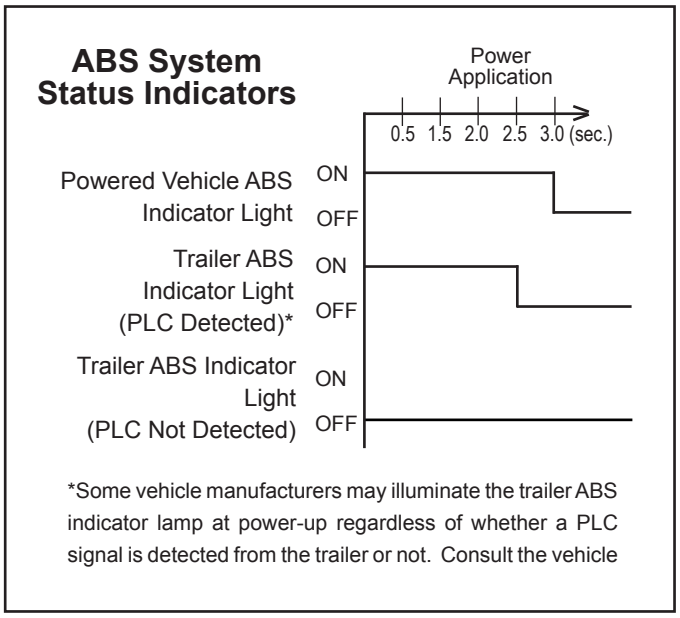


FIGURE 8 - ABS DASH LIGHTS START UP SEQUENCE

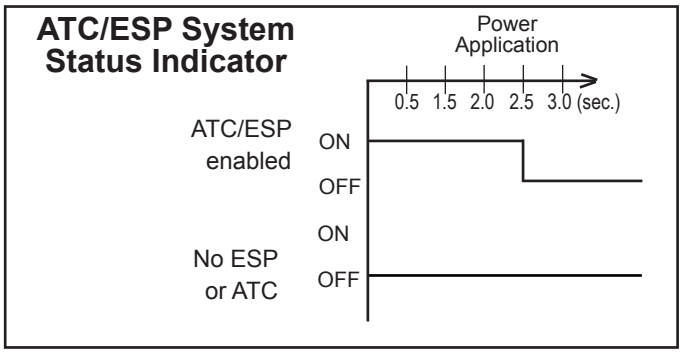


FIGURE 9 - ATC INDICATOR LIGHT START UP SEQUENCE

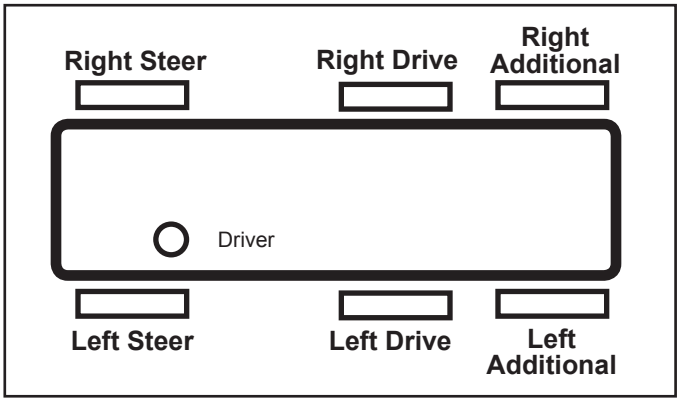


FIGURE 10 - VEHICLE ORIENTATION (TYPICAL)

Pressure Modulator Valve and Traction Control Valve Chuff Test

After the performance of the configuration test, the EC-60™ controller will perform a Bendix-patented PMV and TCV Chuff Test. The Chuff Test is an electrical and pneumatic PMV test that can assist maintenance personnel in verifying proper PMV wiring and installation.

With brake pressure applied, a properly installed PMV will perform one sharp audible exhaust of air by activating the hold solenoid twice and the release solenoid once. If the PMV is wired incorrectly, it will produce two exhausts of air or none at all.

The EC-60™ controller will perform a PMV chuff test on all installed modulators in the following order:

- Steer Axle Right PMV
- Steer Axle Left PMV
- Drive Axle Right PMV
- Drive Axle Left PMV
- Additional Axle Right PMV
- Additional Axle Left PMV
- Drive Axle TCV

The pattern will then repeat itself.

With the EC-60 advanced controller, at the completion of the second round of PMV & TCV chuff tests, the controller (if configured to do so) will perform a test to cross-check the trailer PMV operation with the vehicle stop lamps. If the trailer PMV circuit is mis-wired (including the steer axle TCV), the PMV will exhaust a large amount of air, or none at all.

NOTICE: If there are any active Diagnostic Trouble Codes, stop lamp cross-check portion of the chuff test will not be carried out until all DTCs are fully diagnosed and corresponding repairs are successfully conducted. The ESP/ATC dash indicator will also be illuminated when there are active ABS, ATC or ESP DTCs.

The ECU will not perform the PMV Chuff Test when wheel speed sensors show that the vehicle is in motion.

ABS OPERATION

Bendix® ABS uses wheel speed sensors, ABS pressure modulator valves, and an ECU to control either four or six wheels of a vehicle. The EC-60™ controller monitors individual wheel turning motion during braking and adjusts or modulates the brake pressure at the wheel end. When excessive wheel slip, or wheel lock-up is detected, the EC-60™ controller will activate the pressure modulator valves to automatically reduce the brake pressure at one or more of the wheel ends. By these actions, the ABS system helps to maintain the vehicle's lateral stability and steerability during heavy brake applications and during braking on slippery surfaces.

Steer Axle Control

Although both wheels of the steer axle have their own wheel speed sensor and pressure modulator valve, the EC-60™ controller blends the applied braking force between the two steering axle brakes. This Bendix patented brake application control, called Modified Individual Regulation (MIR), is designed to help reduce steering wheel pull during an ABS event on road surfaces with poor traction (or areas of poor traction, e.g. asphalt road surfaces with patches of ice).

Single Drive Axle Control (4x2 Vehicle)

For vehicles with a single rear drive axle (4x2), the brakes are operated independently by the EC-60™ controller, based on the individual wheel behavior.

Dual Drive Axle Control (4S/4M Configuration)

For vehicles with dual drive axles (6x4) using a 4S/4M configuration, one ABS modulator controls both right-side rear wheels and the other modulator controls both left-side rear wheels. Both wheels on each side receive equal brake pressure during an ABS stop. The rear wheel speed sensors must be installed on the axle with the lightest load.

Dual Rear Axle Control (6S/6M Configuration)

For vehicles with dual rear axles (6x4, 6x2) using a 6S/6M configuration, the rear wheels are controlled independently. Therefore, brake application pressure at each wheel is adjusted according to the individual wheel behavior on the road surface.

6x2 Vehicles with 6S/5M Configuration

6x2 vehicles can utilize a 6S/5M configuration, with the additional axle (a non-driven rear axle) having two sensors, but only one Pressure Modulator Valve. In this case, the PMV controls both wheels on the additional axle. The additional axle wheels would receive equal brake pressure, based on the wheel that is currently experiencing the most wheel slip.

Normal Braking

During normal braking, brake pressure is delivered through the ABS PMV and into the brake chamber. If the ECU does not detect excessive wheel slip, it will not activate ABS control, and normal vehicle service braking is applied.

Retarder Brake System Control

On surfaces with low traction, application of the retarder can lead to high levels of wheel slip at the drive axle wheels, which can adversely affect vehicle stability.

To prevent this, the EC-60™ controller switches off the retarder as soon as a lock-up is detected at one (or more) of the drive axle wheels.

When the ECU is placed in the ABS off-road mode (on vehicles equipped with this optional feature), it will switch off the retarder only when ABS is active on a steer axle wheel and a drive axle wheel.

Optional ABS Off-Road Mode

On some road conditions, particularly when the driving surface is soft, the stopping distance with conventional ABS may be longer than without ABS. This can occur when a locked wheel on soft ground or loose gravel plows up the road surface in front of the tire, changing the rolling friction value. Although vehicle stopping distance with a locked wheel (in the absence of ABS) may be shorter than corresponding stopping distance with conventional ABS control, vehicle steerability and stability would be reduced.

Advanced EC-60™ controllers have an optional dash switch initiated modified ABS control mode (know as "offroad ABS) that more effectively accommodates these soft road conditions to shorten stopping distance while maintaining optimal vehicle steerability and stability.

WARNING: The ABS off-road mode should not be used on normal, paved road surfaces because vehicle stability and steerability may be reduced. The ABS Indicator Lamp will flash slowly to indicate to the driver that the ABS off-road mode is engaged.

CAUTION: When ABS off-road mode is engaged, stability functions are disabled at speeds below approximately 25 mph. The ATC/ESP dash lamp will illuminate to indicate to the driver that the stability system is disabled.

The vehicle manufacturer should provide the optional ABS off-road function only for vehicles that operate on unpaved surfaces or that are used in off-road applications, and is responsible for insuring that vehicles equipped with the ABS off-road function meet all FMVSS-121 requirements and have adequate operator indicators and instructions.

The vehicle operator activates the off-road function with a switch on the dash panel. A flashing ABS Indicator Lamp indicates to the driver that the ABS off-road function is engaged. To exit the ABS off-road mode, depress and release the switch. A new ignition cycle will also cause the ECU to exit the ABS off-road mode.

All-Wheel Drive (AWD) Vehicles

AWD vehicles with an engaged interaxle differential (steer axle to rear axle)/AWD transfer case may have negative effects on ABS performance. Optimum ABS performance is achieved when the lockable differentials are disengaged, allowing individual wheel control.

Advanced EC-60™ controllers can be programmed specifically for this configuration to control the differential lock/unlock solenoid in the AWD transfer case. When programmed to do so, the ECU will disengage the locked interaxle/AWD transfer case during an ABS event and reengage it once the ABS event has ended.

ATC OPERATION

ATC Functional Overview

Just as ABS improves vehicle stability during braking, ATC improves vehicle stability and traction during vehicle acceleration. The EC-60™ controller ATC function uses the same wheel speed information and modulator control as the ABS function. The EC-60™ controller detects excessive drive wheel speed, compares the speed to the front, nondriven wheels, and reacts to help bring the wheel spin under control. The controller can be configured to use engine torque limiting and/or differential braking to control wheel spin. For optimal ATC performance, both methods are recommended.

ATC/ESP Lamp Output/ATC Mud/Snow Switch Input

Advanced ECUs control the ATC/ESP dash lamp as follows.

The ATC/ESP dash lamp illuminates:

1. During power up (e.g. when the vehicle is started) for approximately 2.5 seconds and turns off after the self test is completed, providing no diagnostic trouble codes are present.
2. When ESP or ATC is disabled for any reason.
3. During an ESP or ATC event (the lamp will flash rapidly at a rate of 2.5 per second).
4. When the ECU is placed in the ATC off-road mode (the lamp will flash steadlily at a rate of once per 2.5 seconds). This notifies the vehicle operator that the ATC Mud/Snow mode is active.
5. When the ECU is placed in the ABS off-road mode. When in this mode, ESP will be disabled below 25 mph and its inactive status will be indicated by a steadily illuminated ATC/ESP lamp.

Differential Braking

Differential braking within ATC is automatically activated when drive wheel(s) on one side of the vehicle are spinning excessively, which typically occurs on road surfaces with patches of ice. The traction system will then lightly apply the brake to the drive wheel(s) that are spinning excessively. The vehicle differential will then drive the wheels on the other side of the vehicle.

Differential braking as part of ATC functionality is available at vehicle speeds up to 25 MPH.

Disabling ATC Differential Braking

ATC differential braking is disabled under the following conditions:

1. During power up (e.g. when the vehicle is started), until the ECU detects a service brake application.
2. If the ECU receives a J1939 message indicating that the vehicle is parked.
3. When the dynamometer test mode is active. The dynamometer test mode is entered using the diagnostic blink code switch or by using a diagnostic tool (such as Bendix® ACom™ Diagnostics).
4. In response to a serial communications request from a diagnostic tool.
5. If "ATC Differential Braking" function is activated for a long time period to avoid overheating of the brakes, it would take approximately 3 continuous minutes of activation for the timeout to occur. Once timed out, approixmately 2 minutes of "cool off" time would be required before ATC Differential Braking can be used again.
6. When certain diagnostic trouble code conditions are detected.

Engine Torque Limiting with Smart ATC™ Traction Control

The EC-60™ controller uses Engine Torque Limiting to control drive axle wheel slip. This is communicated to the engine control module (using J1939), and is available at all vehicle speeds.

Bendix® Smart ATC™ Traction Control

The EC-60™ controller has an additional feature known as Smart ATC™ traction control. Smart ATC™ traction control monitors the accelerator pedal position (using J1939) to help provide optimum traction and vehicle stability. By determining the driver's throttle input and adapting the target slip of the drive wheels to the driving situation, the Smart ATC™ traction control allows higher wheel slip when the accelerator pedal is applied above a preset level.

The wheel slip allowed by Smart ATC™ is decreased when driving through a curve for improved stability.

Disabling ATC Engine Control and Smart ATC™ Traction Control

ATC Engine Control and Smart ATC™ traction control will be disabled under the following conditions:

1. In response to a serial communications request from an off-board tool.
2. At power-up until the ECU detects a service brake application.
3. If the ECU receives a J1939 message indicating that the vehicle is parked.
4. If the dynamometer test mode is active. This may be accomplished via an off-board tool or the diagnostic blink code switch.
5. When certain diagnostic trouble code conditions are detected.

Optional ATC Mud/Snow (Off-Road) Mode

In some road conditions, the vehicle operator may desire additional drive wheel slip when ATC is active. The Advanced EC-60™ controller has an optional control mode to permit this desired performance.

The vehicle operator can activate the Mud/Snow function with a switch on the dash panel. Alternately, a J1939 message may be used to place the vehicle in this mode. The ATC/ESP Indicator Lamp will flash steadily at a rate of once every 2.5 seconds to confirm that the ATC mud/snow mode is engaged.

To exit the ATC Mud/Snow mode, depress and release the ATC Mud/Snow switch.

Drag Torque Control Functional Overview

Advanced EC-60™ controllers have a feature referred to as drag torque control which reduces wheel slip on a driven axle due to driveline inertia. This condition is addressed by increasing the engine torque to overcome the inertia.

Drag torque control increases vehicle stability on low-traction road surfaces during down-shifting or retarder braking.

ADVANCED ABS WITH STABILITY CONTROL

Overview

ESP stability system reduces the risk of rollovers, jackknifing and other loss of control. ESP features include Roll Stability Program (RSP) and Yaw Control. During operation, the ECU of the Bendix Advanced ABS system constantly compares performance models to the vehicle's actual movement, using the wheel speed sensors of the ABS system, as well as lateral, yaw, and steering angle sensors. If the vehicle shows a tendency to leave an appropriate travel path, or if critical threshold values are approached, the system will intervene to assist the driver.

Roll Stability Program

Bendix RSP, an element of the overall ESP system, addresses rollover conditions. In the case of a potential roll event, the ECU will override the throttle and quickly apply brake pressure at all wheel ends to slow the vehicle combination. The level of braking application during an RSP event will be proportional to roll risk.

See Figure 11.

Yaw Stability

Yaw stability counteracts the tendency of a vehicle to spin about its vertical axis. During operation, if the friction between the road surface and the tires is not sufficient to oppose lateral (side) forces, one or more of the tires can slide, causing the truck/tractor to spin. These events

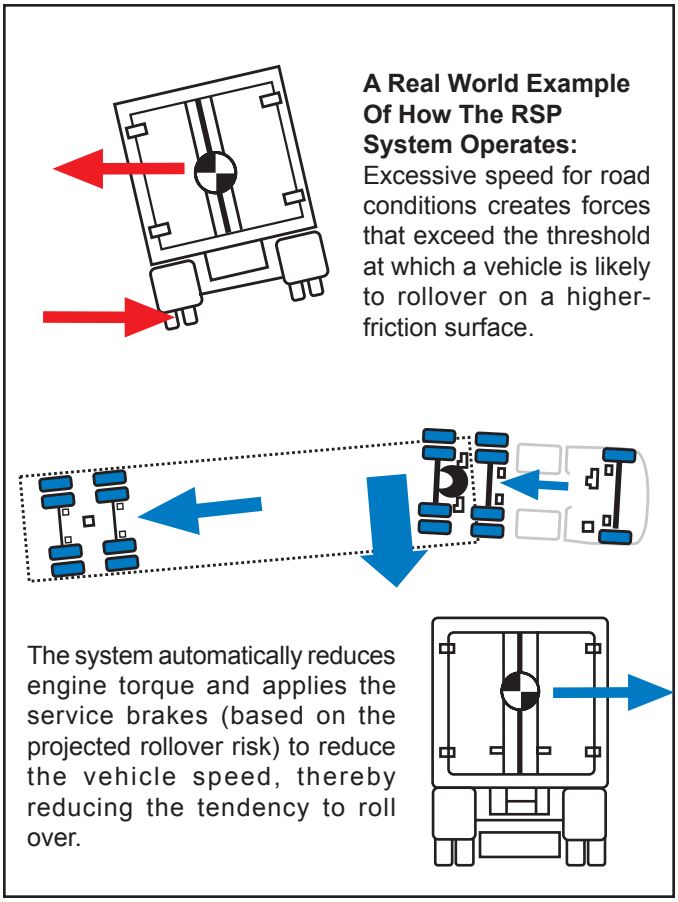
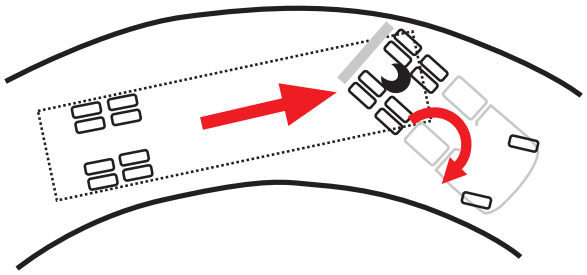
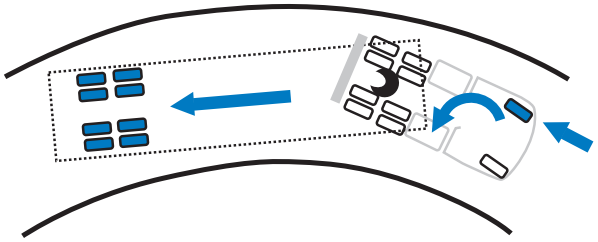


FIGURE 11 - RSP EXAMPLE



A Real World Example Of How Yaw Control Operates:
Excessive speed exceeds the threshold, creating a situation where a vehicle is likely to spin and jackknife.



The Bendix® Yaw Control system reduces engine throttle and selectively applies brakes to reduce the tendency to jackknife.

FIGURE 12 - YAW CONTROL EXAMPLE

are referred to as either an "under-steer" situation (where there is a lack of vehicle response to steering input due to tire slide on the steer axle) or an "over-steer" (where the tractor's rear end slides out due to tire slide on the rear axle) situation. Generally, shorter wheelbase vehicles (tractors, for instance) have less natural yaw stability, while longer wheelbase vehicles (straight trucks, for instance) have greater natural yaw stability. Factors that influence yaw stability are: wheelbase, suspension, steering geometry, weight distribution front to rear, and vehicle track width.

Yaw Control

Yaw Control responds to a wide range of low- to high-friction surface scenarios including rollover, jackknife and loss of control. It is the recommended system for all power vehicles and especially critical for tractors pulling trailers. In the case of vehicle slide (over-steer or under-steer situations), the system will reduce the throttle and then brake one or more of the “four corners” of the vehicle (in addition to potentially applying the trailer brakes), thus applying a counter-force to better align the vehicle with an appropriate path of travel.

For example, in an over-steer situation, the system applies the “outside” front brake; while in an under-steer condition, the “inside” rear brake is applied. (See Figure 12)

IMPORTANT SAFETY INFORMATION ABOUT THE BENDIX® ESP® STABILITY SYSTEM

ESP May Reduce The Vehicle Speed Automatically

ESP can make the vehicle **decelerate automatically.** ESP can slow the vehicle with or **without the operator applying the brake,** and **even when the throttle is being applied.**

To minimize unexpected deceleration and reduce the risk of a collision the operator must:

- Avoid aggressive driving maneuvers, such as sharp turns or abrupt lane changes at high speeds, which might trigger the stability system.
- Always operate the vehicle safely, drive defensively, anticipate obstacles and pay attention to road, weather and traffic conditions. ABS, ATC and ESP stability systems are no substitute for prudent, careful driving.

Towing Doubles Or Triples May Reduce The Effectiveness Of Stability Systems

ESP is designed and optimized for trucks and for tractors that tow single trailers. If a tractor equipped with ESP is used to power multiple trailer combinations (known as “doubles” or “triples”) **the effectiveness of the ESP system may be greatly reduced.** Extremely careful driving is always required when towing doubles or triples. Excessive speed and aggressive maneuvers, such as sharp turns, sudden steering inputs or abrupt lane changes should be avoided.

Limitations Of Stability Systems

The ESP stability system’s effectiveness may be greatly reduced if:

- The load shifts due to improper retention, accident damage or the inherently mobile nature of some loads (for example, hanging meat, live animals or partially laden tankers),
- The vehicle has an unusually high or off-set center of gravity (CG),
- One side of the vehicle drops off the pavement at an angle that is too large to be counteracted by a reduction in speed,
- The vehicle is used to haul double or triple trailer combinations,
- If very rapidly winding steering inputs are inputted at high speeds,
- There are mechanical problems with suspension leveling of the tractor or trailer resulting in uneven loads,
- The vehicle is maneuvering on a high banked road creating either additional side forces due to the weight (mass) of the vehicle or a deviation between expected & actual yaw rates,
- Gusty winds are strong enough to cause significant side forces on the vehicle and any towed vehicles.

To Maximize The Effectiveness Of ESP:

- Loads must be properly secured at all times.
- Drivers need to exercise extreme caution at all times, and avoid sharp turns, sudden steering inputs or abrupt lane changes at high speeds, particularly if:
  - › the vehicle hauls loads that could shift,
  - › the vehicle or load has a high or off-set center of gravity (CG) when loaded, or
  - › the vehicle tows doubles or triples.

Truck Chassis Modifications

If the vehicle's chassis components are altered (for example, a wheel base extension or reduction, tag axle addition or removal, a major body change such as conversion of a tractor into a truck, or an axle, suspension, or steering system component modification) the Bendix® ESP® system must be disabled. Have a qualified mechanic replace the Advanced EC-60 ECU with a Premium EC-60 ECU and secure the X4 connector which will no longer be used. The ATC/ESP indicator lamp would continue to function as an ATC indicator lamp, and should be designated as ATC only.

WARNING: If a modified vehicle does not have the ESP system disabled, serious vehicle braking and performance issues could result, including unnecessary ESP system interventions. This can lead to a loss of control of the vehicle. In addition, remove all cab signage (e.g. visor labels, etc.) used to show that Bendix ESP was installed and make any necessary notations in the vehicle manual(s), so that drivers do not misunderstand which ABS options are installed on the vehicle.

Sensor Location Modifications

The location and orientation of the Steering Angle Sensor and Yaw Rate Sensor must not be altered. When servicing, an identical component must be used in the same orientation (using OEM brackets & torque requirements). During installation follow the OEM leveling guidelines.

Steering Angle Sensor Re-Calibration

Whenever maintenance or repair work is performed to the steering mechanism, linkage, steering gear, adjustment of the wheel track, or if the steering angle sensor is replaced, a recalibration of the Steering Angle Sensor must be performed.

WARNING! If the Steering Angle Sensor is not recalibrated, the yaw control system may not function properly, which can result in incidents leading to loss of vehicle control. See page 14 of this document for more details on this procedure.

Dynamometer Test Mode

CAUTION: ATC and ESP must be disabled prior to conducting any dynamometer testing. When the Dynamometer Test Mode is engaged, ATC brake control and engine control along with drag torque control and ESP are turned off. This test mode is used to avoid torque reduction or torque increase and brake control activation when the vehicle is operated on a dynamometer for testing purpose.

The Dynamometer Test Mode may be activated by pressing and releasing the diagnostic blink code switch five times or by using a hand-held or PC-based diagnostic tool.

Advanced EC-60™ Contollers will remain engaged in the Dynamometer Test Mode even if power to the ECU is removed and re-applied. To exit the test mode, press and release the blink code switch three times, or use a hand-held or PC-based diagnostic tool.

Automatic Tire Size Calibration

The ECU requires a precise rolling circumference ratio between steer axle and drive axle tires in order for ABS, ATC, and ESP to perform in an optimal manner. For this reason, a continuously monitoring process takes place in which the precise ratio is calculated. This calculated value is stored in the ECU memory provided the following conditions are met:

1. Rolling-circumference ratio is within the permissible range.
2. Vehicle speed is greater than approximately 12 MPH.
3. No acceleration or deceleration is taking place.
4. There are no active speed sensor diagnostic trouble codes.

The ECU is provided with a ratio value of 1.00 as a default setting. If the automatic tire size alignment calculates a different value, this is used to overwrite the original figure in the memory. This process adapts the ABS and ATC function to the vehicle.

Acceptable Tire Sizes

The speed calculation for an exciter ring with 100 teeth is based on a default tire size of 510 revolutions per mile. This figure is based on the actual rolling circumference of the tires, which varies with tire size, tire wear, tire pressure, vehicle loading, etc.

The ABS response sensitivity is reduced when the actual rolling circumference is excessive on all wheels. For a 100 tooth exciter ring, the minimum number of tire revolutions per mile is 426, and the maximum is 567. The ECU will set diagnostic trouble codes if the number of revolutions is out of this range.

In addition, the size of the steer axle tires compared to the drive axle tires also has to be within the ABS system design. To avoid diagnostic trouble codes, the ratio of the effective rolling circumference of the steer axle, divided by the effective rolling circumference of the drive axle, must be between 0.85 to 1.15.

CAUTION: The ESP system effectiveness relies on the accuracy of vehicle speed. If a major change on the tire sizes occurs such that odometer setting needs to be changed, the Advanced ABS controller's setting of tire sizes must be reprogrammed to new values at the same time by a certified mechanic.

SYSTEM IMPACT DURING ACTIVE TROUBLE CODES

ABS PARTIAL SHUTDOWN

Depending on which component the trouble code is detected, the ABS, ATC, and ESP functions may be fully or partially disabled. Even with the ABS indicator lamp illuminated, the EC-60™ controller may still provide ABS function on wheels that are not affected. The ABS system controller should be serviced as soon as possible.

Steer Axle ABS Modulator Diagnostic Trouble Code

ABS on the affected wheel is disabled. ABS and ATC on all other wheels remains active. ESP is disabled.

Drive Axle/Additional Axle ABS Modulator Diagnostic Trouble Code

ATC is disabled. ABS on the affected wheel is disabled. ABS on all other wheels remains active. ESP is disabled.

Steer Axle Wheel Speed Sensor Diagnostic Trouble Code

The wheel with the diagnostic trouble code is still controlled by using input from the remaining wheel speed sensor on the steer axle. ABS remains active on the rear wheels. ATC and ESP are disabled.

Drive Axle/Additional Axle Wheel Speed Sensor Diagnostic Trouble Code

ATC and ESP are disabled. In a four sensor system, ABS on the affected wheel is disabled, but ABS on all other wheels remains active.

In a six sensor system, ABS remains active by using input from the remaining rear wheel speed sensor on the same side.

ATC Modulator Diagnostic Trouble Code

ATC and ESP are disabled. ABS remains active.

J1939 Communication Diagnostic Trouble Code

ATC and ESP are disabled. ABS remains active.

ECU Diagnostic Trouble Code

ABS, ATC, and ESP are disabled. The system reverts to normal braking.

Voltage Diagnostic Trouble Code

While voltage is out of range, ABS, ATC, and ESP are disabled. The system reverts to normal braking. When the correct voltage level is restored, full ABS and ATC function is available. Operating voltage range is 9.0 to 17.0 VDC.

Steering Angle Sensor Diagnostic Trouble Code

ESP is disabled. ABS and ATC remain active.

Yaw Rate/Lateral Acceleration Sensor Diagnostic Trouble Code

ESP is disabled. ABS and ATC remain active.

Brake Demand Pressure Sensor Diagnostic Trouble Code

ESP is disabled. ABS and ATC remain active.

Load Sensor Diagnostic Trouble Code

ESP is disabled. ABS and ATC remain active.

Steer Axle TCV Diagnostic Trouble Code

ESP is disabled. ABS and ATC remain active.

Trailer PMV Diagnostic Trouble Code

ESP is disabled. ABS and ATC remain active.

SYSTEM CONFIGURATION

The EC-60™ controller is designed to allow the technician to change the default system settings (chosen by the vehicle OEM) to provide additional or customized features.

Depending on the model, the customizable features include ABS control settings, engine module communication etc. Many of these settings can be reconfigured using a hand held or PC-based software, such as the Bendix® ACom™ Diagnostics program.

ECU RECONFIGURATION

Reconfigurating an EC-60™ controller may be carried out by using the Blink Code Switch or by using a hand-held or PC-based diagnostic tool.

Note: During the reconfiguration process, and independently from any reconfiguration being carried out by the technician, the ECU will automatically check the J1939 serial link and communicate with other vehicle modules. In particular, if the serial link shows that the vehicle has a retarder device present, the ECU will configure itself to communicate with the retarder device for improved ABS performance. For example, if the ECU detects the presence of a retarder disable relay during a reconfiguration, it will configure itself to control the relay to disable the retarding device as needed.

6S/5M Configuration

Advanced EC-60™ controllers will configure for 6S/5M operation when a reconfiguration event is initiated and the ECU detects that an additional axle PMV is wired as follows:

PMV Connector	ECU Connector
Hold	Right Additional Axle Hold
Release	Left Additional Axle Release
Common	Right Additional Axle Common

Reconfiguration Using the Blink Code Switch

With ignition power removed from the EC-60™ controller, depress the blink code switch. After the ignition power is activated, depress and release the switch seven times to initiate a reconfiguration event.

Diagnostic Tool

A reconfiguration event may be initiated using a hand-held or PC-based diagnostic tool to communicate with the ECU over the SAE J1587 diagnostic link.

Troubleshooting: General

SAFE MAINTENANCE PRACTICES

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times:

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**
2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**
3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS™ air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
8. **Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**
11. **For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.**

REMOVING THE EC-60™ CONTROLLER ASSEMBLY

1. Turn vehicle ignition off.
2. Remove as much contamination as possible prior to disconnecting electrical connections.
3. Note the EC-60™ controller assembly mounting position on the vehicle.
4. Disconnect the electrical connectors from the EC-60™ controller.
5. Remove and retain the mounting bolts that secure the EC-60™ controller.

CAUTION

The VIN of the vehicle is stored in the ECU internal memory, and is cross-checked by the ECU using information obtained from other vehicle controllers. If the VIN stored in the ECU does not match the VIN obtained from the other vehicle controller, the ECU will generate an ECU Internal VIN Mismatch DTC.

Accordingly, do not switch Advanced controllers from one vehicle to another.

OBTAINING A NEW EC-60™ ADVANCED CONTROLLER

Should the Advanced EC-60™ controller require replacement, certain steps must be followed:

1. Record the vehicle model, VIN, model year and date of manufacture from the vehicle.
2. Record the part number of the EC-60™ Advanced Controller.
3. Provide this information to your local OEM vehicle service department to obtain a new ECU. The OEM service department will install the same parameter set in the new controller that was loaded into the original ECU at the vehicle OEM assembly facility.

INSTALLING A NEW EC-60™ CONTROLLER

CAUTION! When replacing the EC-60™ controller, verify with the OEM service department that the unit you are installing has the correct parameter set. Failure to do so could result in a loss of features or degraded ESP performance.

For further information, contact either the vehicle manufacturer, Bendix or your local authorized Bendix dealer.

1. Position and secure the EC-60™ controller in the original mounting orientation using the mounting bolts retained during removal. Use no more torque than is necessary to firmly secure the ECU into position. Over-tightening the mounting hardware can cause damage to the EC-60™ controller.
2. Reconnect the electrical connectors to the EC-60™ controller.
3. Apply power and monitor the EC-60™ controller power-up sequence to verify proper system operation.

See Troubleshooting: Wiring section beginning on page 38 for more information on wire harnesses.

WARNING: Bendix ESP stability system is validated with specific Bendix® components. Always use Bendix® replacement parts to prevent compromising system performance. Bendix is not able to validate the safe and reliable use of substitute or alternate components that may be available from other manufacturers. Further, suppliers of a non-Bendix® ABS component may implement design changes in their component (without the knowledge or approval of Bendix) which could negatively affect antilock system reliability and braking performance issues.

REMOVAL OF THE STEERING ANGLE SENSOR

Service Checks:

1. Check all wiring and connectors. Some installations also include an intermediate connector from the steering angle sensor to the main vehicle wire harness. Make sure all connections are free from visible damage.
2. Examine the sensor. Make sure the sensor, its mounting screws, and the interface between the hub and the steering column are not damaged.

Diagnostics:

The steering angle sensor is only operational in conjunction with an Advanced ABS ECU. No independent diagnostics can be performed on the sensor.

Removal:

1. Remove steering column sheathing.
2. Depending upon manufacturer, the steering angle sensor could be located either near the steering wheel, necessitating the removal of the steering wheel, or near the joint to the vehicle steering mechanism, necessitating the disconnection of this linkage.
3. Unplug sensor cable assembly from body of sensor. Squeeze the mounting tabs and pull gently on connector until it disengages.
4. Unscrew all three of the mounting screws that hold the body of the sensor to the steering column body.
5. Slide the sensor over the column to remove. Take note if the sensor label is facing upward or downward.

Installation:

1. Obtain a new sensor. The sensor is not repairable in the field.
2. Slide the sensor over the column. The center hub of the sensor must be aligned with the corresponding notch in the column. Different column manufacturers may implement this hub alignment in different ways. The sensor label should be facing in the same direction as the removed sensor.
3. Assemble to column non-moving plate with three self-locking screws.
4. Tighten screws to 65N to 100N.
5. Reconnect the connector. Ensure that there will be no force applied to the sensor because the connector is pulling on the sensor body.
6. If the wire harness leading to the sensor is being replaced, ensure that it is adequately tie wrapped so that the full motion of the steering column can be achieved without pulling apart the connectors.
7. Reinstall the column sheathing. The sensor is not protected against dirt or water intrusion, so care must be taken not to introduce these elements during installation.

Steering Angle Sensor Calibration

The steering angle sensor calibration can only be achieved when the sensor is powered by the Advanced ABS ECU. No stand-alone sensor calibration can be carried out. The calibration procedure is performed using Bendix® ACom™ Diagnostic V4.0 or higher. See “Troubleshooting Diagnostic Trouble Codes: Steering Angle Sensor (SAS-60)” for the calibration procedure using this tool. The sensor must be recalibrated after any of these situations:

- Replacement of the steering angle sensor
- Any opening of the connector hub from the steering angle sensor to the column
- Any maintenance or repair work on the steering linkage, steering gear or other related mechanism
- Adjustment of the wheel alignment or wheel track
- After an accident that may have led to damage of the steering angle sensor or assembly

WARNING: If the steering angle sensor is not properly recalibrated as needed, the yaw control system may not function properly, which can result in a loss of vehicle control.

REMOVAL OF THE YAW RATE/LATERAL ACCELERATION SENSOR

Service Checks:

1. Check all wiring and connectors. Make sure all connections are free from visible damage.
2. Examine the sensor. Make sure the sensor, its mounting bolts, and the mounting bracket are not damaged.
3. Check vent hole in underbody of sensor housing. Vent hold should remain free from paint and debris at all times.

Diagnostics:

The yaw rate sensor is only operational in conjunction with an Advanced ABS ECU. No independent diagnostics can be performed on the sensor.

Removal:

1. Unplug sensor cable assembly from body of sensor. The connector must be twisted and pulled gently to release.
2. In some mounting configurations, the sensor can be removed independently from its mounting bracket. Otherwise, remove entire assembly, then remove sensor from bracket.
3. Take note of the direction in which the connector is pointed.

Installation:

1. Obtain a new sensor. The sensor is not repairable in the field. WARNING: Only Bendix-approved replacement sensors must be used to prevent negatively affecting antilock system reliability and braking performance issues.
2. Assembly yaw rate sensor housing to mounting bracket. The bracket must be the same design as used on the original vehicle configuration.
3. Using three M8 size bolts, the fixing torque should be between 18 and 22N. The connector should be facing in the same direction as the removed sensor. The unit must not be installed upside-down where there is a pressure-balancing hole.
4. The sensor should be as level as possible and parallel to the road surface when installed on the vehicle.
5. Reconnect the connector. Ensure that there will be no force applied to the sensor because the connector is pulling on the sensor body.

CAUTION: When removing or installing the sensor, care must be used to prevent damage. Do not strike or pry the sensor. Do not use an impact tool to install the mounting hardware.

Sensor Location Modifications

The location and orientation of the Yaw Rate Sensor must not be altered. When servicing, an identical component must be used in the same orientation (using OEM brackets & torque requirements). During installation follow the OEM leveling guidelines.

Yaw Rate Sensor Calibration:

The yaw rate sensor calibration can only be achieved via the Advanced ABS ECU. The sensor must be recalibrated after any of these situations:

- Replacement of the sensor
- After an accident that may have led to damage of the yaw rate sensor

The calibration procedure is preformed using Bendix® ACom™ Diagnostics V4.0 or higher.

See “Troubleshooting Diagnostic Trouble Codes: Yaw Rate Sensor” for the calibration procedure.

BRAKE DEMAND SENSOR CALIBRATION

Calibration must be performed under the following conditions:

- After servicing any pressure sensor related DTCs
- Replacement of any sensor

The calibration procedure is performed using Bendix® ACom™ Diagnostics V4.0 or newer versions.

See “Troubleshooting Diagnostic Trouble Codes: Brake Demand Sensor/Load Sensor” for the calibration procedure.

PRESSURE SENSOR INSTALLATION REQUIREMENTS

Service Checks:

1. Check all wiring and connectors. Make sure all connections are free from visible damage.
2. Examine the sensor. Make sure the sensor and its interface to the pressure location are not damaged.

Diagnostics:

The pressure sensor can be independently diagnosed when supplied with a five volt voltage supply to the B location and ground to the A location. Signal output on the C location should read approximately 0.5V if there is no pressure applied. The signal output should increase proportionately as pressure is applied, up to a maximum of 4.5V at 150 psi.

Removal:

1. Unplug sensor cable assembly from body of sensor. Pull gently on the mounting tab and connector until it disengages.
2. Remove sensor from its pressure mounting using approved air brake push in fitting tools.

Installation:

1. Obtain a new sensor. The sensor is not repairable in the field.
2. Insert sensor into pressure fitting using approved tools.
3. Reconnect the connector. Ensure that there will be no force applied to the sensor because the connector is pulling on the sensor body.
4. If the wire harness leading to the sensor is being replaced, ensure that it is adequately tie wrapped.

Pressure Sensor Calibration:

There is no need for pressure sensor calibration as long as the part replaced its identical to the part removed and a component approved for use with the Bendix Advanced ABS system. However, replacement of brake demand sensors or clearing of demand pressure sensor related DTCs require the following:

1. Use of ACom V4 or newer to clear the active p-sensor fault.
2. Carrying out the demand p-sensor initialization procedure which involves applying service brakes of 90 psi or greater for 3 sec (while stationary).

Once this procedure is carried out successfully, if there are no other active DTCs, ATC/ESP indicator will no longer illuminate.

Troubleshooting: Blink Codes and Diagnostic Modes

ECU DIAGNOSTICS

The EC-60™ controller contains self-testing diagnostic circuitry that continuously checks for the normal operation of internal components and circuitry, as well as external ABS components and wiring.

Active Diagnostic Trouble Codes

When an erroneous system condition is detected, the EC-60™ controller:

1. Illuminates the appropriate indicator lamp(s) and disengages part or all of the ABS, ATC and ESP functions. (See ABS Partial Shutdown, on page 12.)
2. Places the appropriate trouble code information in the ECU memory.
3. Communicates the appropriate trouble code information over the serial communications diagnostic link as required. Hand-held or PC-based diagnostic tools attach to the vehicle diagnostic connector, typically located on or under the dash (see Figure 13).

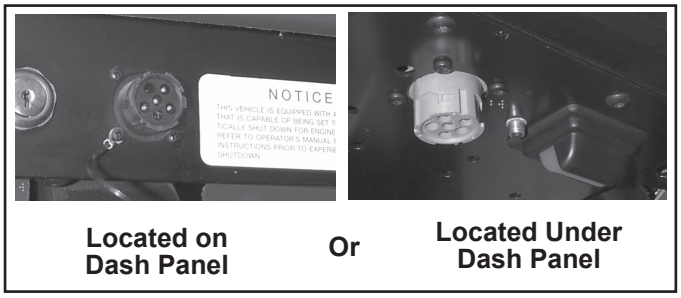


FIGURE 13 - TYPICAL VEHICLE DIAGNOSTIC CONNECTOR LOCATIONS (J1708/J1587, J1939)

BLINK CODES

Blink codes allow a technician to troubleshoot ABS problems without using a hand-held or PC-based diagnostic tool. Instead, information about the ABS system is communicated by the ECU using the ABS indicator lamp to display sequences of blinks.

Note: The ECU will not enter the diagnostic blink code mode if the wheel speed sensors show that the vehicle is in motion. If the ECU is in the diagnostic blink code mode and then detects vehicle motion, it will exit the blink code mode.

In addition, by operating the blink code switch as described below, one of several diagnostic modes can be entered. See Diagnostic Modes below.

Blink Code Switch Activation

When activating the blink code switch:

1. Wait at least two seconds after "ignition on." (Except when entering Reconfiguration Mode - see Reconfiguration section on page 12)
2. For the ECU to recognize that the switch is activated "on," the technician must press for at least 0.1 seconds, but less than 5 seconds. (If the switch is held for more than 5 seconds, the ECU will register a malfunctioning switch.)
3. Pauses between pressing the switch when a sequence is required, (e.g. when changing mode) must not be longer than 2 seconds.
4. After a pause of 3.5 seconds, the ECU will begin responding with output information blinks. See Figure 14 for an example.

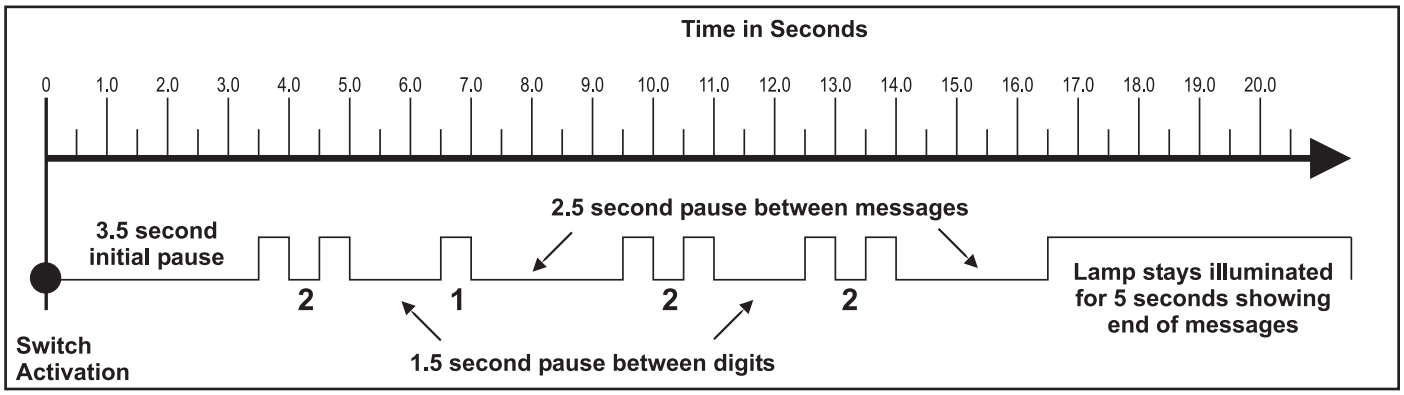


FIGURE 14 - EXAMPLE OF BLINK CODE MESSAGE

Blink Code Timing

The ECU responds with a sequence of blink codes. The overall blink code response from the ECU is called a "message." Each message includes, depending on the mode selected by the technician, a sequence of one or more groups of blinks. Simply record the number of blinks for each sequence and then use the troubleshooting index on page 21 for active or inactive trouble codes and you will be directed to the page that provides troubleshooting information.

NOTE:

1. Sequences of blinks illuminate the ABS indicator lamp for half a second, with half-second pauses between them.
2. Pauses between blink code digits are 1.5 seconds.
3. Pauses between blink code messages are 2.5 seconds.
4. The lamp remains on for 5 seconds at the end of messages.

Once the ABS indicator lamp begins displaying a sequence of codes, it continues until all blink code messages have been displayed and then returns to the normal operating mode. During this time, the ECU will ignore any additional blink code switch activation.

All trouble codes, with the exception of voltage and J1939 trouble codes, will remain in an active state for the remainder of the power cycle.

Voltage trouble codes will clear automatically when the voltage returns within the required limits. All ABS functions will be re-engaged.

J1939 trouble codes will clear automatically when communications are re-established.

DIAGNOSTIC MODES

In order to communicate with the ECU, the controller has several modes that the technician can select, allowing information to be retrieved, or other ECU functions to be accessed.

Diagnostic Modes

To enter the various diagnostic modes:

No. of Times to Press the Blink Code Switch	System Mode Entered
1	Active diagnostic trouble code retrieval
2	Inactive diagnostic trouble code retrieval
3	Clear active diagnostic trouble codes
4	System configuration check
5	Dynamometer Test Mode
7*	Reconfigure ECU

***** To enter the Reconfiguration Mode, the switch must be held in before the application of ignition power. Once the power is supplied, the switch is released and then pressed seven times.

CHART 2 - DIAGNOSTIC MODES

Active Diagnostic Trouble Code Mode

For troubleshooting, typically the Active and Inactive Diagnostic Trouble Retrieval Modes are used. The technician presses the blink code switch once and the ABS indicator lamp flashes a first group of two codes, and if there are more trouble codes recorded, this is followed by a second set of codes, etc. (See page 21 for a directory of these codes.) All active trouble codes may also be retrieved using a hand-held or PC-based diagnostic tool, such as the Bendix® ACom™ Diagnostics software.

To clear active diagnostic trouble codes (as problems are fixed), simply clear (or "self-heal") by removing and re-applying ignition power. The only exception is for wheel speed sensor trouble codes, which clear when power is removed, re-applied, and the ECU detects valid wheel speed from all wheel speed sensors. Alternately, codes may be cleared by pressing the diagnostic blink code switch 3 times (to enter the Clear Active Diagnostic Trouble Code Mode) or by using a hand-held or PC-based diagnostic tool. Hand-held or PC-based diagnostic tools are able to clear wheel speed sensor trouble codes without the vehicle being driven.

Inactive Diagnostic Trouble Code Mode

The ECU stores past trouble codes and comments (such as configuration changes) in its memory. This record is commonly referred to as "event history." When an active trouble code is cleared, the ECU stores it in the event history memory as an inactive trouble code.

Using blink codes, the technician may review all inactive trouble codes stored on the ECU. The ABS indicator lamp will display inactive diagnostic blink codes when the diagnostic blink code switch is depressed and released two times. See page 20 for the index showing trouble codes and the troubleshooting guide page to read for help.

Inactive trouble codes, and event history, may be retrieved and cleared by using a hand-held or PC-based diagnostic tool, such as the Bendix® ACom™ Diagnostics software.

Clearing Active Diagnostic Trouble Codes

The ECU will clear active trouble codes when the diagnostic blink code switch is depressed and released three times.

System Configuration Check Mode

The ABS indicator lamp will display system configuration information when the diagnostic blink code switch is depressed and released four times. The lamp will blink out configuration information codes using the following patterns. (See Chart 3). In this mode the ECU tells the technician, by means of a series of seven blink codes, the type of ABS system that the ECU has been set up to expect. For example, if the fourth blink code is a two, the technician knows that a 6S/4M sensor/modulator configuration has been set.

Dynamometer Test Mode

The Dynamometer Test Mode is used to disable ESP & ATC when needed (e.g. when performing any vehicle maintenance where the wheels are lifted off the ground and moving, including dyno testing). **For Advanced ABS controllers this mode will remain engaged even if power to the ECU is removed and re-applied.**

To exit the Dynamometer Test Mode, press and release the blink code switch three times, or use a hand-held or PC-based diagnostic tool.

Reconfigure ECU Mode

Controller reconfiguration is carried out by using the Reconfigure ECU Mode. (See page 11.)

Note: To enter the Reconfiguration Mode, the blink code switch must be held in before the application of ignition power. Once the power is supplied, the switch is released and then pressed seven times.

1st Number	System Power
1	12 Volts
2nd Number	**Wheel Speed Sensors**
4	4 Sensors
6	6 Sensors
3rd Number	**Pressure Modulator Valves**
4	4 Modulators
5	5 Modulators
6	6 Modulators
4th Number	**ABS Configuration**
1	4S/4M or 6S/6M
2	6S/4M
3	6S/5M
5th Number	**Traction Control Configuration**
2	No ATC
3	ATC Engine Control Only
4	ATC Brake Control Only
5	Full ATC (Engine Control & Brake Control)
6th Number	**Retarder Configuration**
1	No Retarder
2	J1939 Retarder
3	Retarder Relay
4	J1939 Retarder, Retarder Relay
7th Number	**Stability Configuration**
1	No Stability Program
2	Electronic Stability Program (ESP), which includes RSP
3	Roll Stability Program (RSP) Only

CHART 3 - SYSTEM CONFIGURATION CHECK

Troubleshooting: Using Hand-Held or PC-Based Diagnostic Tools

USING HAND-HELD OR PC-BASED DIAGNOSTICS

Troubleshooting and diagnostic trouble code clearing (as well as reconfiguration) may also be carried out using hand-held or PC-based diagnostic tools such as the Bendix® Remote Diagnostic Unit (RDU™), Bendix® ACom™ Diagnostics software, or the ProLink tool.

FIGURE 15 - THE BENDIX® REMOTE DIAGNOSTIC UNIT

Bendix® RDU™ (Remote Diagnostic Unit)

The Bendix® RDU™ tool provides the technician with a visual indication of Antilock Braking System (ABS) component **Diagnostic Trouble Code (DTC)** information. The RDU™ tool is specifically designed for use with Bendix® ABS systems and Bendix makes no claims for its operation and/or usability with other brands of ABS systems.

Features of the Bendix® RDU™ Tool

The RDU™ tool attaches to the 9 pin diagnostic connector in the cab of the vehicle. An adapter cable (Bendix part number 801872) is available to connect the RDU to vehicles with a 6-pin diagnostic connector.

The RDU™ tool allows the technician to:

- Troubleshoot ABS system component problems using Diagnostic Trouble Code reporting via LEDs.
- Reset Diagnostic Trouble Codes on Bendix® ABS ECUs by holding a magnet over the reset in center of RDU™ tool for less than 6 seconds.
- Enter the Self-Configuration Mode used by Bendix® ABS ECUs by holding a magnet over the reset area for greater than 6 seconds but less than 30 seconds.

How the Bendix® RDU™ Operates

See Figure 9 for typical vehicle connector locations.

When the RDU™ tool is plugged into the diagnostic connector, all the LEDs will illuminate, and the green LED will flash 4 times to indicate communications have been established.

If the ABS ECU has no active Diagnostic Trouble Codes, only the green LED will remain illuminated.

If the ABS ECU has at least one active Diagnostic Trouble Code the RDU™ tool displays the first diagnostic trouble code by illuminating the red LEDs, indicating the malfunctioning ABS component and its location on the vehicle. (See Figure 15.) If there are multiple diagnostic trouble codes on the ABS system, the RDU™ tool will display one diagnostic trouble code first, then once that Diagnostic Trouble Code has been repaired and cleared, the next code will be displayed.

- MOD red LED illuminated, shows the "Common" connection of one or more modulators is shorted to battery or ground
- VLT (Flashing indicates either over- or under-voltage condition)

Typical Combination Diagnostic Trouble Codes are:

- Right steer sensor
- Left steer sensor
- Right drive sensor
- Left drive sensor
- Right additional sensor
- Left additional sensor
- Right steer modulator
- Left steer modulator
- Right drive modulator
- Left drive modulator
- Right additional modulator
- Left additional modulator
- Rear Axle Traction modulator
- ECU
- Engine serial communication

To pinpoint the root cause and to ensure the system diagnostic trouble code is properly corrected the first time, additional troubleshooting may be necessary. Note: The RDU is not capable of diagnosing ESP-specific diagnostic trouble codes including additional sensors: steering angle sensors, yaw sensors, pressure sensors, or modulator valves (trailer pressure modulating valves or front axle traction control valves.)

Bendix® RDU™ Reset Function

The magnetic reset switch is located in the center top of the RDU™ tool. Activation requires a magnet with 30 gauss minimum.

The reset operations are:

1. If the magnet is held over the switch for less than 6 seconds the "clear current diagnostic trouble codes" command is sent.
2. If the magnet is held over the switch for more than 6 seconds, but less than 30 seconds, the Bendix® ABS "self-configuration command" is sent.

Additionally, it is recommended at the end of any inspection that the user switches off and restores the power to the ABS ECU, then check the ABS Indicator Lamp operation and RDU™ tool to see if they indicate any remaining Diagnostic Trouble Codes.

Bendix® RDU™ Communication Problems

If the ABS ECU does not respond to the RDU™ tool's request for diagnostic trouble codes, the RDU™ tool will

LED Diagnostic Trouble Codes

LFT -	Left	ECU -	ABS Controller
RHT -	Right	SEN -	Wheel Speed Sensor
DRV -	Drive Axle		
ADD -	Additional	MOD -	Pressure Modulator Valve
STR -	Steer Axle		
VLT -	Power	TRC -	Traction Control

Example: If the Diagnostic Trouble Code is "Right Steer Axle Sensor", the RDU™ unit will display one green and three red

LEDs
Green
VLT
Red
SEN
STR

FIGURE 16 - DIAGNOSTIC TROUBLE CODES

illuminate each red LED in a clockwise pattern. This pattern indicates the loss of communication and will continue until the ABS ECU responds and communication has been established.

Possible sources of communication problems are:

1. A problem with the J1587 link at the in-cab off-board diagnostic connector (9 or 6 Pin).
2. The ECU does not support PID194.
3. No power is being supplied to the ECU and/or the diagnostic connector.
4. The J1587 bus is overloaded with information and the RDU can not arbitrate access.
5. A malfunctioning RDU™ tool.

Nexiq Bendix Application Card

Nexiq provides a Bendix application card for use with the ProLink tool. It can also be used to diagnose the EC-30™, EC-17™, Gen 4™, Gen 5™, and MC-30™ ABS Controllers.

For more information on the Bendix application card visit www.bendix.com, Nexiq at www.nexiq.com, or your local authorized Bendix parts outlet.

Bendix® ACom™ Diagnostics V4.0 Software

Bendix® ACom™ Diagnostics V4.0 is a PC-based software program and is designed to meet RP-1210 industry standards developed by the Truck Maintenance Council (TMC). This software provides the technician with access to all the available ECU diagnostic information and configuration capability, including:

- ECU information
- Diagnostic trouble codes and repair information
- Configuration (ABS, ATC, and more)
- Wheel speed information
- Perform component tests
- Save and print information

ACom™ Diagnostics V4.0 software is required to calibrate the Steering Angle Sensor, the Yaw Rate/Lateral Acceleration Sensor, the Brake Demand Sensors and the Load Sensor.

Pro-Link

Heavy Duty
Multi Protocol
Cartridge

PC Card MPSI
Part Number
805013

FIGURE 17 - NEXIQ (MPSI) PRO-LINK TOOL

FIGURE 18 - BENDIX® ACOM™ DIAGNOSTICS

When using ACom™ Diagnostics V4.0 software to diagnose the EC-60™ ABS ECU, the computer's serial or parallel port needs to be connected to the vehicle's diagnostic connector.

For more information on ACom™ Diagnostics software or RP1210 compliant tools, go to www.bendix.com or visit your local authorized Bendix parts outlet.

See Page 44 for Appendix A: J1587 SID and FMI codes and their Bendix blink code equivalents.

www.bendix.com

Visit Bendix online for the latest information, and ways to find the Bendix contacts you need. Contact technical support, service engineers, Bendix account managers, and more — www.bendix.com is your complete Bendix resource.

Bendix Technical Assistance Team

For direct telephone technical support, call the Bendix technical assistance team at:

1-800-AIR-BRAKE (1-800-247-2725),

Monday through Friday, 8:00 A.M. to 6:00 P.M. EST, and follow the instructions in the recorded message.

Or, you may e-mail the Bendix technical assistance team at: tbs.techteam@bendix.com.

Active or Inactive Diagnostic Trouble Codes:

INDEX

How to interpret the first digit of messages received when Active or Inactive Diagnostic Trouble Code Mode

1st Blink Code Number	Go Here for Troubleshooting Tests
1	No faults (1,1)
2	Wheel Speed Sensors - page 22
3	Wheel Speed Sensors - page 22
4	Wheel Speed Sensors - page 22
5	Wheel Speed Sensors - page 22
6	Power Supply - page 27
7	Pressure Modulator Valves - page 24
8	Pressure Modulator Valves - page 24
9	Pressure Modulator Valves - page 24
10	Pressure Modulator Valves - page 24
11	J1939 - page 28
12	Miscellaneous - pages 30-31
13	ECU - page 29
14	Wheel Speed Sensors - page 22
15	Wheel Speed Sensors - page 22
16	Pressure Modulator Valves - page 24
17	Pressure Modulator Valves - page 24
18	Drive Axle Traction Control Valve - page 26
19	Steer Axle Traction Control Valve - page 26
20	Trailer Pressure Modulator Valve - page 24
21	Steering Angle Sensor - pages 33-33
22	Yaw Rate Sensor - pages 34-35
23	Lateral Acceleration Sensor - page 36
24	Brake Demand/Load Sensors - page 37

Example: For a message sequence of:

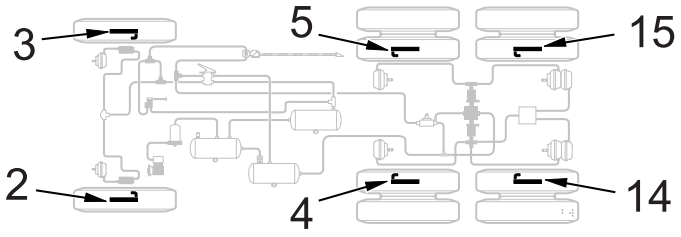
3, 2 12, 4

For the first sequence go to page 22 and
for the second sequence go to page 30.

See Page 43 for Appendix A: J1587 SID and FMI Codes and Their Bendix Blink Code Equivalents

Troubleshooting Diagnostic Trouble Codes: Wheel Speed Sensors

1st. Blink Code	Location
2	Left Steer Axle Sensor
3	Right Steer Axle Sensor
4	Left Drive Axle Sensor
5	Right Drive Axle Sensor
14	Left Additional Axle Sensor
15	Right Additional Axle Sensor



2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	Excessive Air Gap	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping.
2	Output Low at Drive-off	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping.
3	Open or Shorted	Verify 1500 – 2500 ohms across sensor leads. Verify no continuity between sensor leads and ground or voltage. Verify no continuity between sensor leads and other sensors. Check for corroded/damaged wiring or connectors between the ECU and the wheel speed sensor.
4	Loss of Sensor Signal	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping. Check for corroded/damaged wiring or connectors between the ECU and the wheel speed sensor.
5	Wheel End	Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping. Check mechanical function of brake. Check for kinked or restricted air lines.
6	Erratic Sensor Signal	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping. Check for corroded/damaged wiring or connectors between the ECU and the wheel speed sensor.
7	Tire Size Calibration	Verify correct tire size as desired. Verify proper tire inflation. Verify correct number of exciter ring teeth.
10	Configuration Error	ECU is configured for four sensors, but has detected the presence of additional sensors. Verify sensor wiring and ECU configuration.

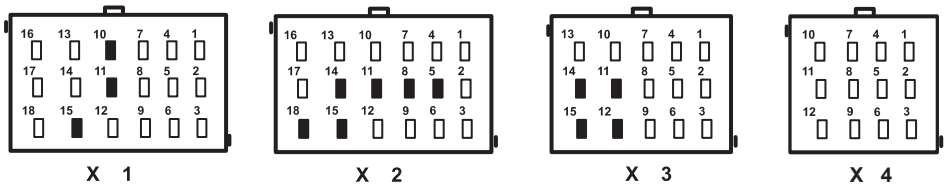
Speed Sensor Repair Tests:

1. Take all measurements at ECU harness connector pins in order to check wire harness and sensor. Probe the connector carefully so that the terminals are not damaged.
2. Wheel speed sensor measurements should read:

Location	Measurement
Sensor	1500 - 2500 Ohms
Sensor to voltage or ground	Open Circuit (no continuity)
Sensor output voltage	>0.25 of VAC sensor output at ~ 0.5 revs/sec.

3. Clear DTC after issue is corrected. The sensor DTC will remain until the power is cycled to the ABS ECU and vehicle is driven above 15 MPH or DTC was cleared using either the diagnostic blink code switch or diagnostic tool.

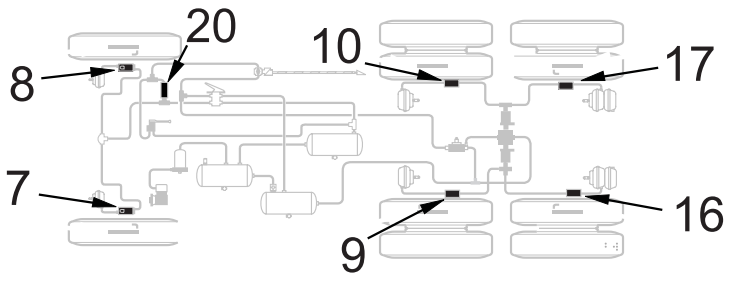
Cab-mount ECU: Looking into wire harness connector



Connector	Pin	Wheel Speed Sensor Location
X1	10	Right Drive Axle (+)
18 Way	11	Right Drive Axle (-)
	5	Left Steer Axle (+)
X2	8	Left Steer Axle (-)
18 Way	11	Right Steer Axle (+)
	14	Right Steer Axle (-)
	15	Left Drive Axle (+)
	18	Left Drive Axle (-)
X3	11	Left Additional Axle (+)
15 Way (if ECU is configured for 6 sensors)	14	Left Additional Axle (-)
	12	Right Additional Axle (+)
	15	Right Additional Axle (-)

Troubleshooting Diagnostic Trouble Codes: Pressure Modulator Valves

1st. Blink Code	Location
7	Left Steer Axle
8	Right Steer Axle
9	Left Drive Axle
10	Right Drive Axle
16	Left Additional Axle
17	Right Additional Axle
20	Trailer PMV



2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	Release Solenoid Shorted to Ground	Verify no continuity between PMV leads and ground. Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
2	Release Solenoid Shorted to Voltage	Verify no continuity between PMV leads and voltage. Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
3	Release Solenoid Open Circuit	Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
4	Hold Solenoid Shorted to Ground	Verify no continuity between PMV leads and ground. Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
5	Hold Solenoid Shorted to Voltage	Verify no continuity between PMV leads and voltage. Verify 4.9 to 5.5 ohms from REL to CMN & HLD CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
6	Hold Solenoid Open Circuit	Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between the ECU and PMV.
7	CMN Open Circuit	Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between the ECU and PMV.
8	Configuration Error	A mis-match exists between the ECU configuration and the modulator installation and wiring. Verify PMV wiring and installation. Verify ECU configuration.

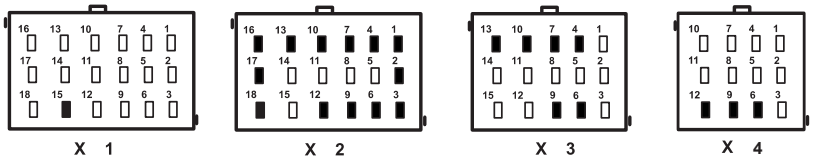
Pressure Modulator Valve Repair Tests:

1. Take all measurements at ECU harness connector pins in order to check wire harness and PMV. Probe the connector carefully so that the terminals are not damaged.
2. Pressure modulator resistance should read:

Location	Measurement
Release to Common	4.9 to 5.5 Ohms
Hold to Common	4.9 to 5.5 Ohms
Release to Hold	9.8 to 11.0 Ohms
Release, Hold, Common to Voltage or Ground	Open Circuit (no continuity)

Caution: When troubleshooting modulator trouble codes, check inactive trouble codes and event history for over-voltage or excessive noise trouble codes. If one of these is found, troubleshoot these trouble codes first before the PMV.

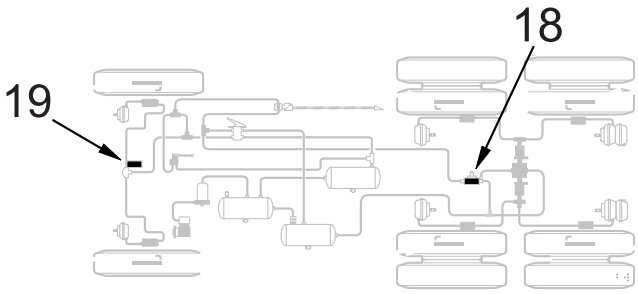
Cab-mount ECU: Looking into wire harness connector



Connector	Pin	PMV Location
X2 18 Way	1	Left Steer Axle Hold
	2	Left Steer Axle Release
	3	Left Steer Axle Common
	4	Right Steer Axle Hold
	6	Right Steer Axle Common
	7	Right Steer Axle Release
	9	Right Drive Axle Common
	10	Right Drive Axle Hold
	13	Right Drive Axle Release
	12	Left Drive Axle Common
	16	Left Drive Axle Hold
	17	Left Drive Axle Release
	4	Left Additional Axle Hold
X3 15 Way (if ECU is configured for 6 modulators)	6	Left Additional Axle Common
	7	Left Additional Axle Release
	9	Right Additional Axle Common
	10	Right Additional Axle Hold
	13	Right Additional Axle Release
X4 12 Way	6	Trailer PMV Hold
	9	Trailer PMV Release
	12	Trailer PMV Common

Troubleshooting Diagnostic Trouble Codes: Traction Control Valves

1st. Blink Code	Location
18	Drive Axle Traction Control Valve
19	Steer Axle Traction Control Valve



2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	TCV Solenoid Shorted to Ground	Verify 7 to 19 ohms between TCV and TCV common. Verify no continuity between TCV leads and ground. Check for corroded/damaged wiring or connectors between ECU and TCV.
2	TCV Solenoid Shorted to Voltage	Verify 7 to 19 ohms between TCV and TCV common. Verify no continuity between TCV leads and voltage. Check for corroded/damaged wiring or connectors between ECU and TCV.
3	TCV Solenoid Open Circuit	Verify 7 to 19 ohms between TCV and TCV common. Check for corroded/damaged wiring or connectors between ECU and TCV.
4	TCV Configuration Error	The ECU is not configured for ESP or ATC, but has detected the presence of a TCV. Verify TCV wiring. Inspect for the presence of a TCV. Verify ECU configuration.

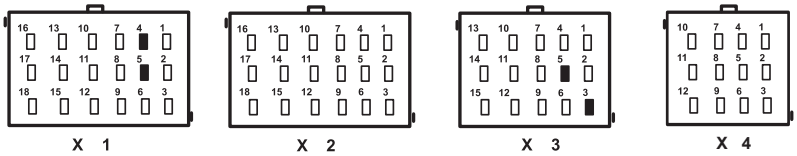
Traction Control Valve Repair Tests:

1. Take all measurements at ECU harness connector pins in order to check wire harness and traction control valve. Probe the connector carefully so that the terminals are not damaged.

Location	Measurement
TCV to TCV Common	7 to 19 Ohms
Release, Hold, Common to Voltage or Ground	Open Circuit (no continuity)

Cab-mount ECU:

Looking into wire harness connector



Connector	Pin	Traction Control Test
X1	4	Drive Axle Traction Control Valve Common
18 Way	5	Drive Axle Traction Control Valve

Connector	Pin	Traction Control Test
X3	3	Steer Axle Traction Control Valve Common
15 Way	5	Steer Axle Traction Control Valve

Troubleshooting Diagnostic Trouble Codes: Power Supply

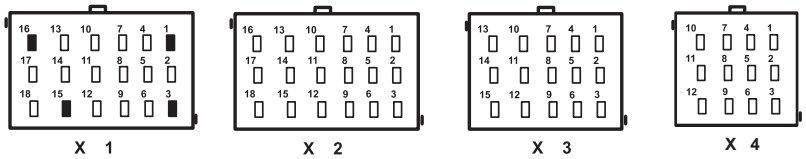
1st. Blink Code	Location
6	Power Supply

2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	Battery Voltage Too Low	Measure battery voltage under load. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
2	Battery Voltage Too High	Measure battery voltage under load. Ensure that battery voltage is correct for the model of ECU. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
3	Battery Voltage Too Low During ABS	Measure battery voltage under load. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
4	Battery Voltage Open Circuit	Measure battery voltage under load. Check condition of fuse. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
5	Ignition Voltage Too Low	Measure ignition voltage under load. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections. Check condition of fuse.
6	Ignition Voltage Too High	Measure ignition voltage. Ensure that ignition voltage is correct for the model of ECU. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
7	Ignition Voltage Too Low During ABS	Measure ignition voltage under load. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
8	Input Voltage Has Excessive Noise (Temporary)	Check alternator output for excessive noise. Check for other devices causing excessive noise.
9	Input Voltage Has Excessive Noise	Check alternator output for excessive noise. Check for other devices causing excessive noise.

Power Supply Tests:

1. Take all measurements at ECU harness connector.
2. Place a load (e.g. an 1157 stop lamp) across battery or ignition and ground connection, measure ignition and battery voltage with the load. Ignition to Ground should measure between 9 to 17 VDC. Battery to Ground should also measure between 9 to 17 VDC.
3. Check for damaged wiring, damaged or corroded connectors and connections.
4. Check condition of vehicle battery and associated components, ground connection good and tight.
5. Check alternator output for excessive noise.

Cab-mount ECU: Looking into wire harness connector



Connector	Pin	Power Supply Test
X1 18 Way	1	Ground
	3	Ignition
	16	Battery

REVISED 5/31/05

Troubleshooting Diagnostic Trouble Codes: J1939 Serial Communications

1st. Blink Code	Location
11	J1939

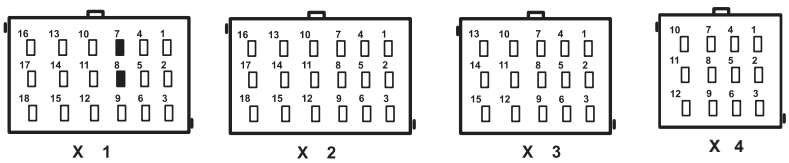
2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	J1939 Serial Link	Loss of communications between the EC-60™ controller and other devices connected to the J1939 link. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify ECU Configuration. Check for other devices inhibiting J1939 communications.
2	J1939 Retarder	Loss of communications between the EC-60™ controller and other devices connected to the J1939 link. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify presence of retarder on the J1939 link. Verify ECU Configuration. Check for other devices inhibiting J1939 communications.
3	J1939 Engine Communications	Loss of communications between the EC-60™ controller and the engine ECU over the J1939 link. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify presence of engine ECU on the J1939 link. Verify ECU Configuration. Check for other devices inhibiting J1939 communications.
4	J1939 Invalid Data (Engine Retarder)	Invalid data received from the engine or retarder. Check for damaged or reversed J1939 wiring. Check for damaged or corroded connectors. Verify presence of engine and/or retarder on J1939. Verify proper programming of engine and/or retarder. Check for other devices inhibiting J1939 communications.
5	J1939 Supply Pressure	Invalid pressure signals received from a vehicle controller. Verify proper operation of brake demand sensors. Check wiring between brake demand sensors and the vehicle controller. Verify proper programming of vehicle controller. Check for damaged or reversed J1939 wiring. Check for damaged or corroded connectors. Check for other devices inhibiting J1939 communications.
6	J1939 ESP Messages Invalid Data	Invalid ESP messages on the J1939 link. Check for damaged or reversed J1939 wiring. Check for damaged or corroded connectors. Verify presence of engine and/or retarder on J1939. Verify proper programming of engine and/or retarder. Check for other devices inhibiting J1939 communications.

J1939 Troubleshooting Tests:

1. Take all measurements at ECU harness connector
2. Check for damaged or reversed J1939 wiring
3. Check for corroded or damaged wiring connector problems such as (opens or shorts to voltage or ground)
4. Check for other J1939 devices which may be loading down (inhibiting) J1939 communication

Cab-mount ECU:

Looking into wire harness connector



Connector	Pin	J1939
X1	7	J1939 Low
18 Way	8	J1939 High

Troubleshooting Diagnostic Trouble Codes: ECU

1st. Blink Code	Location
13	ECU

2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	ECU (02)	2-24: Check for damaged or corroded connectors. Check for damaged wiring. Clear trouble codes. If diagnostic trouble codes return, replace the ECU.
2	ECU (10)	
3	ECU (11)	
4	ECU (12)	
5	ECU (13)	
6	ECU (14)	
7	ECU (15)	
8	ECU (16)	
9	ECU (17)	
10	ECU (18)	
11	ECU (1A)	
12	ECU (1B)	
13	ECU (80)	
14	ECU (04)	
15	ECU (06)	
16	ECU (0E)	
17	ECU (0D)	
18	ECU (19)	
19	ECU (1C)	
20	ECU (27)	
21	ECU (1D)	
22	ECU (1E)	
23	ECU (28)	
24	ECU (37)	
25	ECU Internal VIN Mismatch - The ECU internally-stored VIN does not match the VIN of the vehicle. Ensure that the ECU is installed on the correct vehicle. Verify ECU programming. Verify engine programming.	

Troubleshooting Diagnostic Trouble Codes: Miscellaneous

1st. Blink Code	Location
12	Miscellaneous

2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	Stop Lamp Switch Not Detected	ECU has not detected the presence of the stop lamp switch since ignition power was applied (note that stop lamp switch input may be applied to the EC-60™ controller using either hardwire input or J1939). Apply and release service brake. Check for brake switch input into ECU (see system wiring schematic). With service brake released, check for presence of the stop lamp bulb. With service brake applied, verify system voltage is now present at the stop lamp switch input to the ECU. Check for damaged wiring between ECU, stop lamp switch and bulb. Check for corroded or damaged connectors. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors on J1939 link. Verify presence of engine ECU on the J1939 link. Verify ECU configuration.
2	Stop Lamp Switch Defective	Apply and release service brake. Check for brake switch input into ECU (see system wiring schematic). With service brake released, check for presence of the stop lamp bulb. With service brake applied, verify system voltage is now present at the stop lamp switch input to the ECU. Check for damaged wiring between ECU, stop lamp switch and bulb. Check for corroded or damaged connectors. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors on J1939 link. Verify presence of engine ECU on the J1939 link. Verify ECU configuration.
3	Dynamometer Test Mode	ECU has been placed in the Dynamometer Test Mode by either the diagnostic blink code switch or a hand-held or PC-based diagnostic tool. ATC is disabled.
4	Retarder Relay Open Circuit or Shorted to Ground	Verify vehicle contains a retarder relay. Verify ECU configuration. Check wiring between ECU and retarder relay. Verify no continuity between retarder disable output of EC-60™ controller and ground. Verify condition and wiring of the retarder relay.
5	Retarder Relay Circuit Shorted to Voltage	Check wiring between ECU and retarder relay. Verify no continuity between retarder disable output of EC-60™ controller and voltage. Verify condition and wiring of the retarder relay.
6	ABS Indicator Lamp Circuit DTC	Check operation of diagnostic blink code switch. Check wiring of diagnostic blink code switch and ABS WL. Verify ABS WL ground input.
7	PMV Common Shorted to Ground	Verify no continuity between the CMN of all PMVs, TCV, and Diff Lock Solenoid and ground. Check for corroded/damaged wiring or connectors between the ECU and CMN of all PMVs, TCV, and Diff Lock Solenoid.
8	PMV Common Shorted to Voltage	Verify no continuity between the CMN of all PMVs, TCV, and Diff Lock Solenoid and voltage. Check for corroded/damaged wiring or connectors between the ECU and CMN of all PMVs, TCV, and Diff Lock Solenoid.
9	ATC Disabled to Prevent Brake Fade	ATC is temporarily disabled to prevent excessive heating of the foundation brakes.
10	Tire Size Out of Range (Front to Rear)	Verify correct tire size as desired. Verify proper tire inflation. Verify correct number of exciter ring teeth. Verify that the ECU has the proper tire size settings.
11	Wheel Speed Sensors Reversed on an Axle	Sensors are reversed (left to right) on one of the axles. Verify proper installation, connection, and wiring of the sensors.
12	Diff. Lock Solenoid Shorted to Ground or Open Circuit	Verify no continuity between the Diff Lock Solenoid and ground. Check for corroded/damaged wiring or connectors between the ECU and Diff Lock Solenoid.
13	Diff. Lock Solenoid Shorted to Voltage	Verify no continuity between the Diff Lock Solenoid and voltage. Check for corroded/damaged wiring or connectors between the ECU and Diff Lock Solenoid.
14	Sensor CAN Supply Voltage Error	Incorrect supply voltage for the SAS-60 and the YAS-60. Verify proper voltage at sensor connectors. Verify wiring between the ECU and the sensors. Verify proper output voltage from ECU.
15 - 21	Reserved	
22	ESP Sensor Voltage Out of Range	Incorrect supply voltage for the SAS-60 and the YAS-60. Verify proper voltage at sensor connectors. Verify wiring

Miscellaneous Troubleshooting (continued)

For all tests below, take all measurements at ECU harness connector pins in order to check wire harness and sensor. Probe the connector carefully so that the terminals are not damaged.

Stop Lamp Switch Test

Test	Measurement
Stop Lamp Switch to Ground	9 to 17 VDC

2. Apply and release service brake, does lamp extinguish?
3. Verify brake lamp switch is connected to ECU via hard wire or J1939.

Dynamometer Test Mode (ATC/ESP Indicator Lamp Continuously Illuminated)

1. Clear the dynamometer test mode by depressing and releasing the blink code switch three times (or use an off-board diagnostic tool).

ABS Indicator Lamp

1. Verify diagnostic blink code switch is open when not activated.

Retarder Relay

1. Measure resistance between retarder disable output of EC-60™ controller and voltage / ground.

Test	Measurement
Retarder disable to Voltage or Ground	Open Circuit (no continuity)

2. Verify vehicle has retarder relay.
3. Verify proper wiring from ECU to retarder relay.

PMV Commons

1. Measure resistance between any common (PMV, TCV, and Diff.) and voltage or ground.

Test	Measurement
Any PMV, TCV, or Diff. Common to Voltage or Ground	Open Circuit (no continuity)

Differential Lock Solenoid

1. Measure resistance between Diff lock solenoid and voltage or ground.

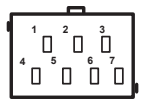
Test	Measurement
Diff. Lock Solenoid to Voltage or Ground	Open Circuit (no continuity)

Steering Angle Sensor and Yaw Rate/ Lateral Acceleration Sensor

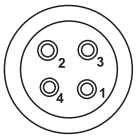
1. Measure resistance between input voltage and ground at the sensor wiring harness connector.

Test	Measurement
Power and Ground Input	8 to 16 volts

Looking into wire harness connector



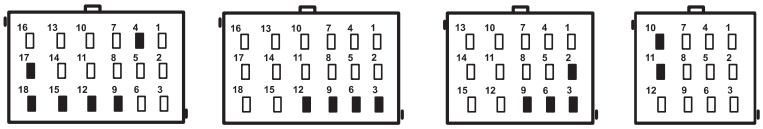
SAS Connector



Yaw Connector

Connector	Pin	PMV Location
SAS	2	Voltage Input
	1	Ground Input
YAS	1	Voltage Input
	2	Ground Input

Cab-mount ECU: Looking into wire harness connector



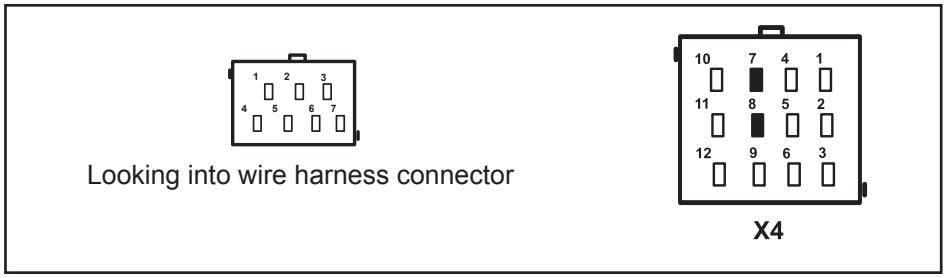
Connector	Pin	PMV Location
	4	TCV Common
X1	9	Stop Lamp Switch
18 Way	12	ABS WL Ground
	15	ABS WL Interlock
	17	Retarder
	18	ABS WL
	3	PMV Left Steer Axle Common
X2	6	PMV Right Steer Axle Common
18 Way	9	PMV Right Drive Axle Common
	12	PMV Left Drive Axle Common
	2	Diff Lock Solenoid
X3	3	Diff Lock Solenoid Common
15 Way	6	PMV Left Additional Axle Common
	9	PMV Right Additional Axle Common
X4	11	SAS-60/YAS-60 Voltage Input
12 Way	10	SAS-60/YAS-60 Ground Input

Troubleshooting Diagnostic Trouble Codes: Steering Angle Sensor (SAS-60™ sensor)

1st. Blink Code	Location
21	Steering Angle Sensor

2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	SAS Not Calibrated	SAS has not been calibrated. Perform SAS calibration procedure.
2	SAS Calibration in Progress	SAS calibration procedure is underway.
3	SAS Static Signal	SAS signal incorrect. Verify proper installation of the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output.
4	SAS Signal Out of Range	SAS signal incorrect. Verify proper installation of the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output. Perform SAS calibration procedure.
5	SAS Signal Reversed	SAS signal is reversed. Verify proper installation of the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output.
6	SAS Invalid Signal	SAS signal is invalid. Verify proper installation of the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output. Verify that correct SAS is being used.
7	SAS Gradient Error	SAS signal is invalid. Verify proper installation of the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output. Verify that correct SAS is being used.
8	SAS CAN Timeout	Loss of CAN communications between the ECU and the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output.
9	SAS Long Term Calibration Error	SAS calibration error. Verify proper installation of the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output. Verify that correct SAS is being used. Verify proper ECU programming. Perform SAS calibration procedure.
10	SAS Plausibility Check	ECU has detected incorrect SAS signal as compared to the YAS-60 signal. Verify proper installation of the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output. Verify that correct SAS is being used. Verify proper ECU programming. Perform SAS calibration procedure.

Troubleshooting Diagnostic Trouble Codes: Steering Angle Sensor (SAS-60™ sensor) (continued)



Steering Angle Sensor Tests

1. Measure resistance between input voltage and ground at the sensor wiring harness connector.

Test	Measurement
Power and Ground Input 2 = Power Input 1 = Ground Input	8 to 16 volts

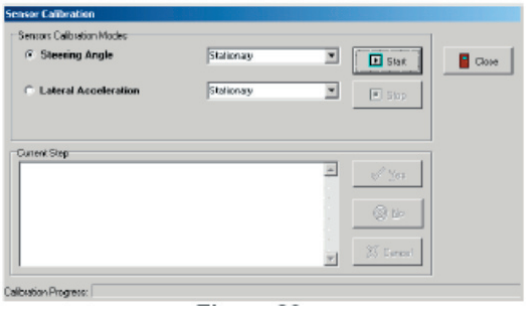
2. Verify wiring between the Steering Angle Sensor and the ECU.

SAS Wire Harness Terminal	ECU Wire Harness Terminal	Measurement
4	7	Verify Continuity
3	8	Verify Continuity

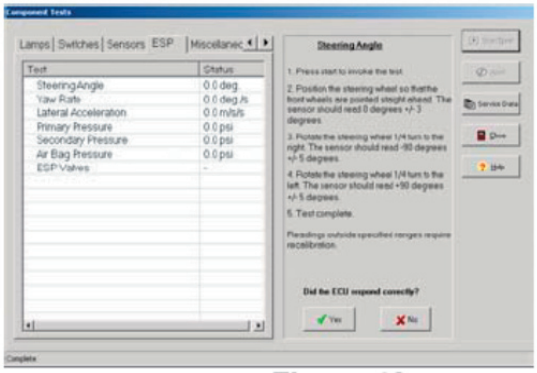
3. Verify wiring between the Steering Angle Sensor and power/ground.

SAS Wire Harness Terminal	Measurement
4 to Voltage & Ground	Verify open circuit (no continuity)
3 to Voltage & Ground	Verify open circuit (no continuity)

4. To perform a calibration procedure of the Steering Angle Sensor, ACom™ Diagnostics V4.0 is required. Using the program, select the "Configuration" option, followed by the "Calibrate" option. The following screen should be displayed.



5. Follow the prompts to perform a calibration of the Steering Angle Sensor.
6. To test the Steering Angle Sensor, ACom V4.0 is required. Using Bendix ACom V4.0, select the "Component Test" option, followed by the "ESP Test" option. The following screen should be displayed.



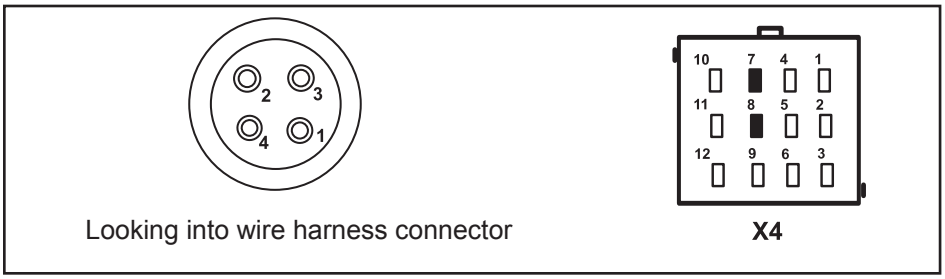
7. Follow the prompts to perform a test of the Steering Angle Sensor.

Troubleshooting Diagnostic Trouble Codes: Yaw Rate Sensor (YRS)

1st. Blink Code	Location
22	Yaw Rate Sensor

2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	YRS Signal Out of Range	YRS signal incorrect. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Perform YRS calibration procedure.
2	YRS Sensor Reversed Signal	YRS signal is reversed. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output.
3	YRS Invalid Signal	YRS signal is invalid. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used.
4	YRS Gradient Error	YRS signal is invalid. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used.
5	YRS CAN Timeout	Loss of CAN communications between the ECU and the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output.
6	YRS Static BITE Error	YRS signal fails static self-test. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
7	YRS Dynamic BITE Error	YRS signal fails self-test conducted while vehicle is in motion. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
8	YRS Fast Calibration Error	YRS calibration error. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
9	YRS Static Calibration Error	YRS calibration error. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
10	YRS Normal Calibration Error	YRS calibration error. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
11	YRS Sensitivity Calibration Error	YRS calibration error. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
12	YRS Plausibility Check (Ref Yaw Rate)	ECU has detected an incorrect YRS signal. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
13	YRS Plausibility Error (Inside Model Based Limits)	ECU has detected an incorrect YRS signal. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
14	YRS Plausibility Error (Outside Model Based Limits)	ECU has detected an incorrect YRS signal. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
15	YRS - SAS Signal Cross-check Incomplete	ECU (if configured) must confirm that YRS and SAS signals match. The vehicle must be exposed to an S-shaped driving maneuver for this DTC to automatically clear. If the DTC does not clear even after the S-shaped driving maneuver, check and correct the orientation of the YRS and repeat maneuver.

Troubleshooting Diagnostic Trouble Codes: Yaw Rate Sensor (YRS) (continued)



Yaw Rate Sensor Tests

1. Measure resistance between input voltage and ground at the sensor wiring harness connector.

Test	Measurement
Power and Ground Input	8 to 16 volts
1 = Power Input	
2 = Ground Input	

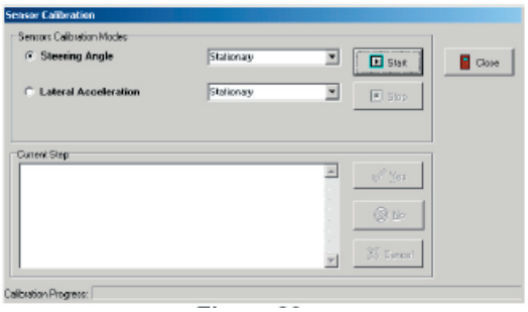
2. Verify wiring between the Yaw Rate Sensor and the ECU.

SAS Wire Harness Terminal	ECU Wire Harness Terminal	Measurement
4	7	Verify Continuity
3	8	Verify Continuity

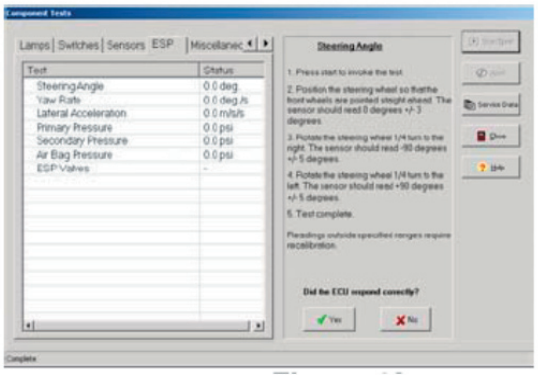
3. Verify wiring between the Yaw Rate Sensor and power/ground.

SAS Wire Harness Terminal	Measurement
4 to Voltage & Ground	Verify open circuit (no continuity)
3 to Voltage & Ground	Verify open circuit (no continuity)

4. To perform a calibration procedure of the Yaw Rate Sensor, ACom™ Diagnostics V4.0 is required. Using the program, select the "Configuration" option, followed by the "Calibrate" option. The following screen should be displayed.



5. Follow the prompts to perform a calibration of the Yaw Rate Sensor.
6. To test the Yaw Rate Sensor, ACom V4.0 is required. Using Bendix ACom V4.0, select the "Component Test" option, followed by the "ESP Test" option. The following screen should be displayed.



7. Follow the prompts to perform a test of the Yaw Rate Sensor.

Troubleshooting Diagnostic Trouble Codes: Lateral Acceleration Sensor (LAS)

1st. Blink Code	Location
23	Lateral Acceleration Sensor

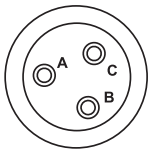
2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	LAS Signal Out of Range	LAS signal incorrect. Verify proper installation of the YRS/LAS. Verify proper wiring between the ECU and the YRS/LAS. Check YRS/LAS output. Perform LAS calibration procedure.
2	LAS Calibration in Progress	LAS calibration procedure is underway.
3	LAS Static Calibration Error	LAS calibration error. Verify proper installation of the YRS/LAS. Verify proper wiring between the ECU and the YRS/LAS. Check YRS/LAS output. Verify that correct YRS/LAS is being used. Verify proper ECU programming. Perform LAS calibration procedure.
4	LAS Long Term Calibration Error	LAS calibration error. Verify proper installation of the YRS/LAS. Verify proper wiring between the ECU and the YRS/LAS. Check YRS/LAS output. Verify that correct YRS/LAS is being used. Verify proper ECU programming. Perform LAS calibration procedure.
5	LAS Plausibility Error (Inside Model Based Limits)	ECU has detected an incorrect LAS signal. Verify proper installation of the YRS/LAS. Verify proper wiring between the ECU and the YRS/LAS. Check YRS/LAS output. Verify that correct YRS/LAS is being used. Verify proper ECU programming. Perform LAS calibration procedure.
6	LAS Plausibility Error (Outside Model Based Limits)	ECU has detected an incorrect LAS signal. Verify proper installation of the YRS/LAS. Verify proper wiring between the ECU and the YRS/LAS. Check YRS/LAS output. Verify that correct YRS/LAS is being used. Verify proper ECU programming. Perform LAS calibration procedure.
7	Erratic ESP Sensor Signal	ECU has detected an erratic signal. Verify proper installation of the YRS/LAS. Verify proper wiring between the ECU and the YRS/LAS. Check YRS/LAS output. Verify that correct YRS/LAS is being used. Verify proper ECU programming. Perform LAS calibration procedure.

1. Follow the steps shown in the Yaw Rate Sensor troubleshooting section for calibration and troubleshooting of the Lateral Acceleration Sensors.

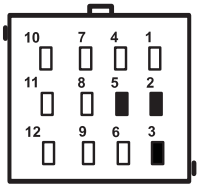
Troubleshooting Diagnostic Trouble Codes
Brake Demand/Load Sensors

1st. Blink Code	Location
24	Brake Demand/Load Sensors

2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	PS1 Open or Shorted	Check wiring between Brake Demand Sensor (primary brake circuit) and ECU. Verify operation of pressure sensor.
2	PS2 Open or Shorted	Check wiring between Brake Demand Sensor (secondary brake circuit) and ECU. Verify operation of pressure sensor.
3	PS3 Open or Shorted	Check wiring between Load Sensor and ECU. Verify operation of pressure sensor.
4	PS1/2 Plausibility Error	ECU has detected an invalid pressure sensor signal from one of the Brake Demand Sensors.
5	PS Supply Voltage Error	Incorrect supply voltage for the sensors. Verify proper voltage at sensor connectors. Verify wiring between the ECU and the sensors. Verify proper output voltage from the ECU.
6	PS Not Calibrated	Perform static sensor calibration procedure.



Looking into wire harness connector



X4

Brake Demand/Load Sensor Tests

1. Measure resistance between input voltage and ground at the sensor wiring harness connector.

Test	Measurement
Power and Ground Input B = Power Input A = Ground Input	4.75 to 5.25 volts

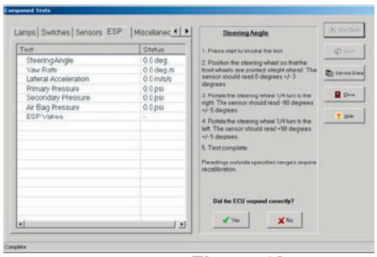
2. Verify wiring between the Load Sensor and the ECU.

Load Sensor Wire Harness Terminal	ECU Wire Harness Terminal	Measurement
C	X4 - 2 Brake Demand Sensor (primary brake circuit)	Verify Continuity
	X4 - 5 Brake Demand Sensor (secondary brake circuit)	Verify Continuity
	X4 - 3 Load Sensor	Verify Continuity

3. Verify wiring between the Load Sensor and power/ground.

Load Sensor Harness Terminal	Measurement
C to Voltage & Ground	Verify open circuit (no continuity)

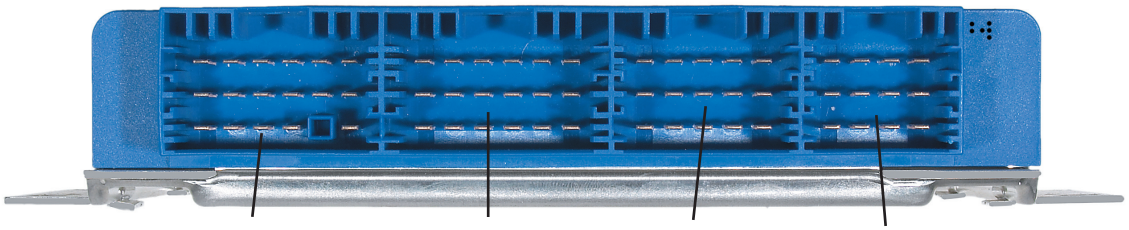
4. To perform a calibration procedure of the Brake Demand Sensor(s), ensure that the air system is fully charged. Apply ignition power, and wait 30 seconds. Perform a full application of the service brake and hold for 5 seconds. Release the service brake.
5. To test the Brake Demand Sensor and/or the Load Sensor, ACom V4.0 is required. Using the program, select the “Component Test” option, followed by the “ESP Test” option. The following screen should be displayed.



6. Follow the prompts to test of the Brake Demand Sensor(s) and/or the Load Sensor.

EC-60™ Controller Wire Harness Connector Part Numbers and Pin Assignments:

ADVANCED CAB



Advanced Cab Model EC-60™ Controller

Advanced cab models utilize four AMP connectors for wire harness connections.

X1 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	Ground	7	J1939 Low	13	J1587 (B)
2	Trailer ABS Indicator	8	J1939 High	14	J1587 (A)
3	Ignition	9	SLS Input	15	ABS Indicator Interlock
4	TCV CMN (DA)	10	WSS DA Right (+)	16	Battery
5	TCV (DA)	11	WSS DA Right (-)	17	Retarder
6	ATC/ESP Indicator and ATC ORS	12	ABS Indicator Ground	18	ABS Dash Indicator

X2 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	PMV SA Left HLD	7	PMV SA Right REL	13	PMV DA Right REL
2	PMV SA Left REL	8	WSS SA Left (-)	14	WSS SA Right (-)
3	PMV SA Left CMN	9	PMV DA Right CMN	15	WSS DA Left (+)
4	PMV SA Right HLD	10	PMV DA Right HLD	16	PMV DA Left HLD
5	WSS SA Left (+)	11	WSS SA Right (+)	17	PMV DA Left REL
6	PMV SA Right CMN	12	PMV DA Left CMN	18	WSS DA Left (-)

X3 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	ABS ORS	6	PMV AA Left CMN	11	WSS AA Left (+)
2	Diff. Lock SOL[1]	7	PMV AA Left REL	12	WSS AA Right (+)
3	TCV CMN (SA)	8	Stop Lamp Output	13	PMV AA Right REL
4	PMV AA Left HLD	9	PMV AA Right CMN	14	WSS AA Left (-)
5	TCV (SA)	10	PMV AA Right HLD	15	WSS AA Right (-)

X4 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	Pressure Sensor CMN	5	Brake Demand Secondary CKT Signal	9	PMV Trailer REL
2	Brake Demand Primary CKT Signal	6	PMV Trailer HLD	10	Sensor CAN Common
3	Load Sensor Signal	7	Sensor CAN Low	11	Sensor CAN Supply
4	Pressure Sensor Supply	8	Sensor CAN High	12	PMV Trailer CMN

[1]AWD vehicles only. (AWD Transfer Case)

Troubleshooting: Wiring

ABS/ATC WIRING

ECU Wiring Harness Connectors

The Advanced EC-60™ controller is designed to interface with AMP MCP 2.8 connectors as referenced in Chart 4. Follow all AMP requirements for the repair of wire harnesses.

All wire harness connectors must be properly seated. The use of secondary locks is strongly advised.

CAUTION: All unused ECU connectors must be covered and receive proper environmental protection.

ABS Wiring Requirements

As a matter of good practice and to ensure maximum system robustness, always use the maximum size wire supported by the wire harness connectors for battery, ignition, ground, PMV, TCV, Interaxle Differential Lock and indicator lamp circuits.

All sensor and serial communications circuits (J1587 and J1939) must use twisted pair wiring (one to two twists per inch). See the appropriate SAE document for additional details.

WARNING: All wires must be carefully routed to avoid contact with rotating elements. Wiring must be properly secured approximately every 6 to 12 inches using UV stabilized, non-metallic hose clamps or bow-tie cable ties to prevent pinching, binding or fraying.

It is recommended that wires be routed straight out of a connector for a minimum of three inches before the wire is allowed to bend.

Battery and ground wires should be kept to a minimum length.

If convoluted tubing is used, its I.D. must match the size of the wire bundle as closely as possible.

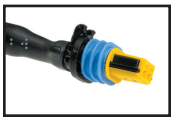
CAUTION: Wire harness lengths must be carefully selected for the vehicle. Excess lengths of wire are **not** to be wound to form coils, instead re-route, repair or replace wire harness to avoid the possibility of electrical interference and wire damage. Do not attempt to stretch harnesses that are too short, since mechanical strain can result in wire breakage.

SAS-60™ Sensors/YAS-60™ Sensor Wiring

If it is necessary to replace the wiring that connects the SAS-60 or the YAS-60 to the ECU, it is important to use the same wiring as that utilized by the vehicle OEM.

ABS Component	Connector	Wire Terminal	Wire Seal/ Plug	Terminal Lock	Terminal Crimp Tool
Controller Harness 17-Way AMP MCP 2.8 (X1)	 1718091-1	 927768-9 1 - 2.5 mm² X1-12 & 18	N/A	 967634	 539723-2
Controller Harness 18-Way AMP MCP 2.8 (X2)	 8-968974-1	 968874 2.5 - 4 mm²	N/A	N/A	
Controller Harness 15-Way AMP MCP 2.8 (X3)	 8-968973-1	 968873 1.0 - 2.5 mm²	N/A	N/A	
Controller Harness 12-Way AMP MCP 2.8 (X4)	 8-968972-1		N/A	N/A	
ABS Modulator Harness AMP Twist-Lock (Bayonet)	 1-967325-2	 929975-1	N/A	N/A	 539635-1
ATC Modulator Harness AMP Twist-Lock (Bayonet)	 1-967325-3	 929975-1	N/A	N/A	
ABS Modulator Harness 3-pin Packard Metri-Pack 280 Series	 12040977	 12077411	 12015323	 12034145	 12155975

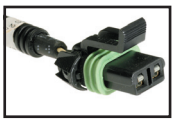
WS-24™ Wheel Speed Sensor Connectors


Packard GT 150 series


Packard Metripack 150.2 series


Deutsch DTM06 series


Packard Metripack 280 series (female)


Packard Metripack 280 series (male)


Deutsch DT04 series


Standard round two pin

Not Shown:

SAS-60™ Sensor Connectors:
- Straight Connector (4 contact, DIN 72575) (Schlemmer) part number 9800 351
- 90 degree Connector (4 contact, DIN 72575) (Schlemmer) part number 9800 331
- Contact Pins (Schlemmer) part number 7814 125

YAS-60™ Wire Harness Connectors:
- (Robert Bosch) part number 1 928 404 025

YAS-60™ Wire Harness Terminals:
- (Robert Bosch) part number 1 928 498 001

Brake Demand Sensor/Load Sensor Wire Harness Connectors:
- Metri-Pack Connector (Packard) part number 1206 5287
- Contact Pins (Packard) part number 1210 3881

CHART 4 - EC-60™ CONTROLLER COMPONENT CONNECTORS

Troubleshooting: Wiring (Continued)

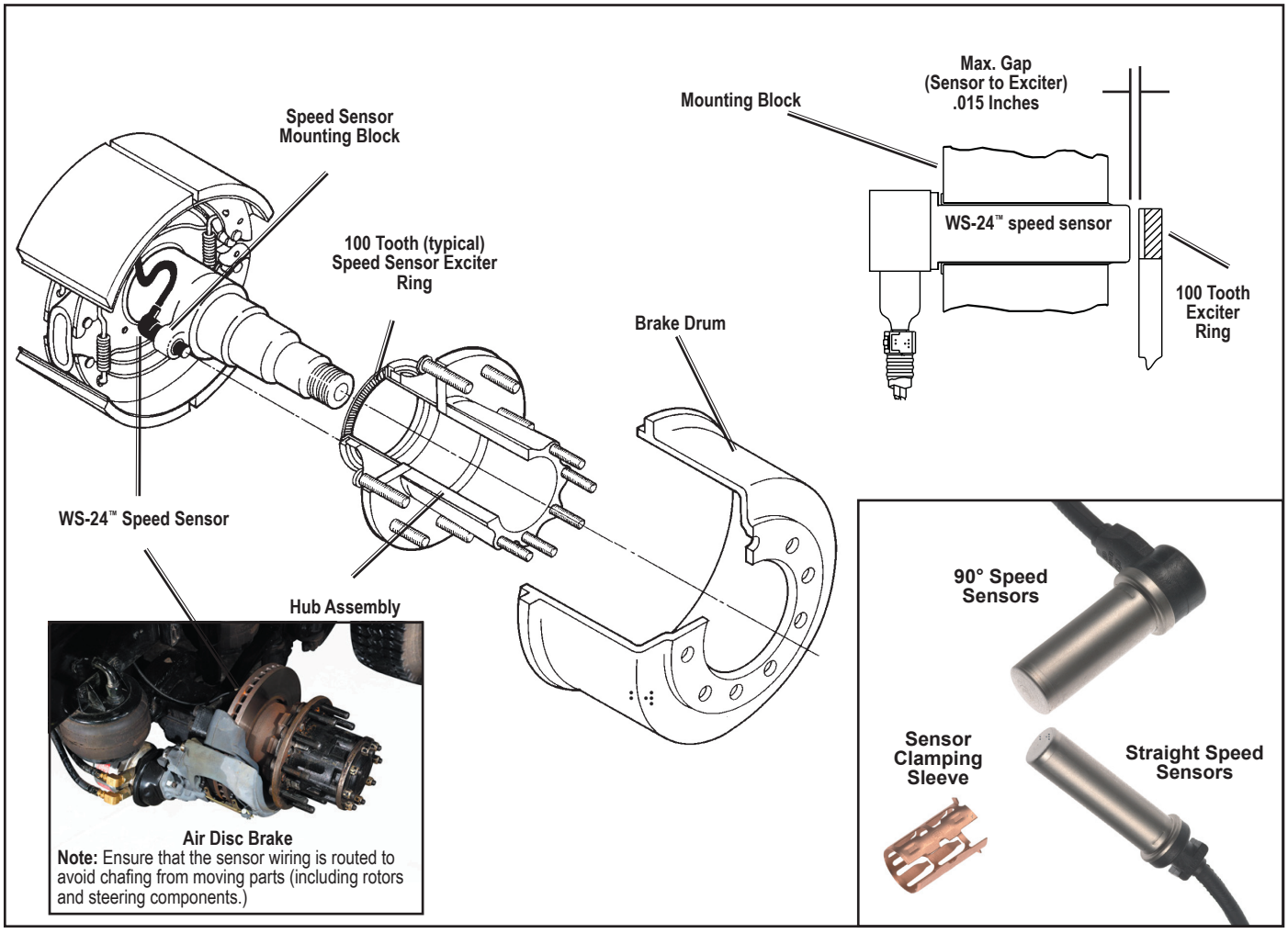


FIGURE 19 - WS-24™ WHEEL SPEED SENSOR INSTALLATION (S-CAM AND AIR DISC BRAKE)

Wheel Speed Sensor Wiring

Route sensor wiring coming out of the wheel ends away from moving brake components. Sensor wiring needs to be secured to the axle to prevent excess cable length and wiring damage. It is required that cable ties be installed to the sensor wire within 3 inches (76.2 mm) of the sensor head to provide strain relief.

Following the axle, the sensor wires must be attached along the length of the service brake hoses using cable ties with ultraviolet protection and secured every 6 to 8 inches (152 to 203 mm). Sufficient – but not excessive – cable length must be provided to permit full suspension travel and steering axle movement. Install wires so that they cannot touch rotating elements such as wheels, brake discs or drive shafts. Radiation protection may be necessary in the area of brake discs.

Bendix does not recommend using standard tie-wraps to secure wiring harnesses directly to rubber air lines. This may cause premature wiring failure from the pressure exerted on the wiring when air pressure is applied through the air line. Non-metallic hose clamps or bow-tie tie-wraps are preferred.

The use of grommets or other suitable protection is required whenever the cable must pass through metallic frame members.

All sensor wiring must utilize twisted pair wire, with approximately one to two twists per inch.

It is recommended that wires be routed straight out of a connector for a minimum of three inches before the wire is allowed to bend.

Troubleshooting: Wiring Schematic

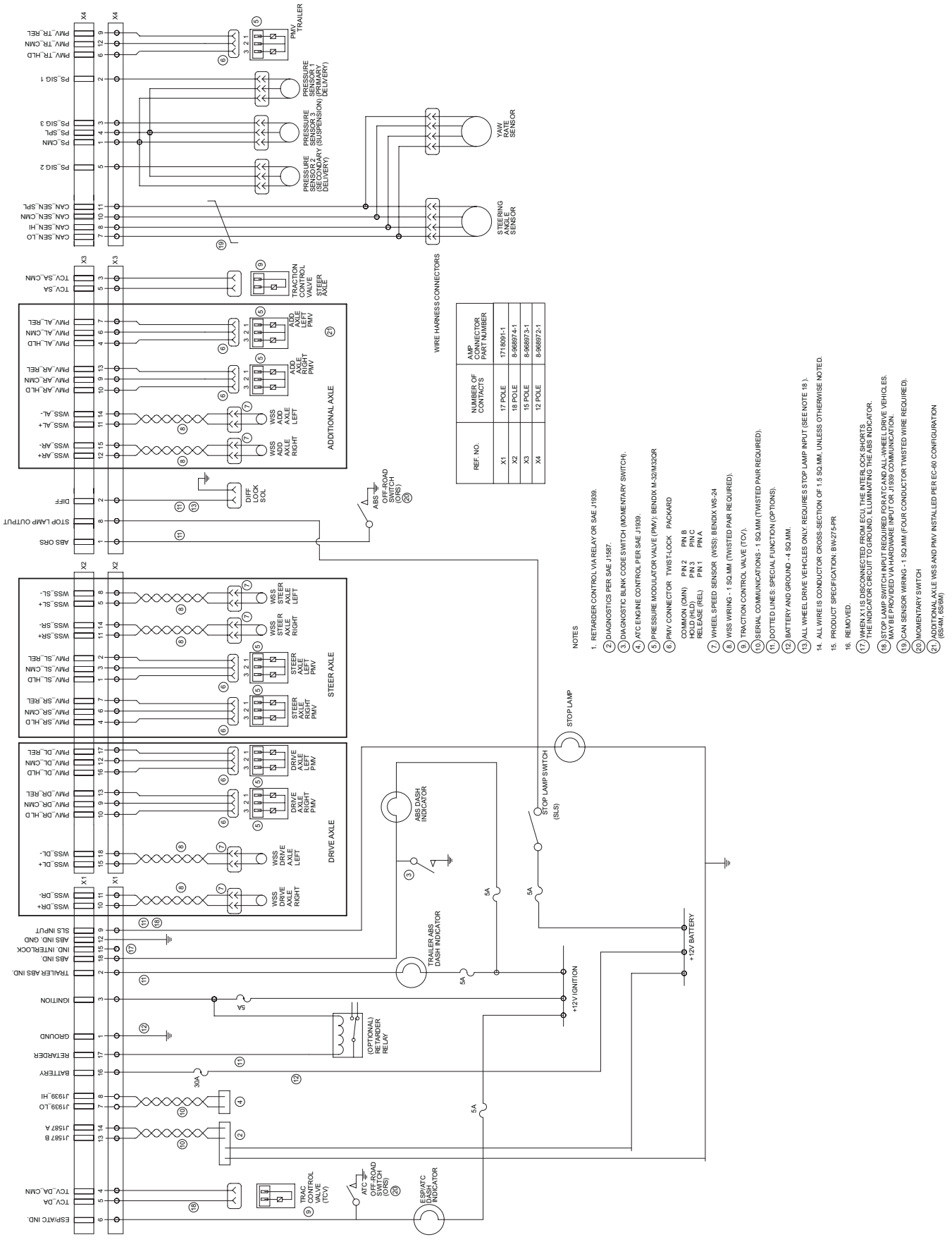


FIGURE 20 - STANDARD CAB WIRING SCHEMATIC

Glossary

ABS — Antilock Brake System.

ABS Event — Impending wheel lock situation that causes the ABS controller to activate the modulator valve(s).

ABS Indicator Lamp — An amber lamp which indicates the operating status of an antilock system. When the indicator lamp is on, ABS is disabled and the vehicle reverts to normal brake operation.

Air Gap — Distance between the Sensor and tone ring.

ASR — Automatic Slip Regulation. Another name for traction control.

ATC — Automatic Traction Control. An additional ABS function in which engine torque is controlled and brakes are applied differentially to enhance vehicle traction.

ATC/ESP Lamp — A lamp that indicates when stability functions, including traction control, roll stability program or yaw control are operating.

Channel — A controlled wheel site.

CAN — Controller Area Network. J1939 is an SAE version of the CAN link.

Clear Codes — System to erase historical diagnostic trouble codes from the ECU, from either the Diagnostic Switch or from a hand-held diagnostic tool (only repaired diagnostic trouble codes may be cleared).

Configuration — The primary objective is to identify a “normal” set of sensors and modulators for the Electronic Control Unit, so that it will identify future missing sensors and modulators.

Diagnostic Connector — Diagnostic receptacle in vehicle cab for connection of J1587 hand-held or PC based test equipment. The tester can initiate test sequences, and can also read system parameters.

Diagnostic Switch — A switch used to activate blinks codes.

Differential Braking — Application of brake force to a spinning wheel so that torque can be applied to wheels which are not slipping.

ECU — Electronic Control Unit.

ESP — Electronic Stability Program. Full stability function that includes RSP & YC subfunctions.

Diagnostic Trouble Code — A condition that interferes with the generation or transmission of response or control signals in the vehicle's ABS system that could lead to the functionality of the ABS system becoming inoperable in whole or in part.

FMVSS-121 — Federal Motor Vehicle Safety Standard which regulates air brake systems.

IR — Independent Regulation. A control method in which a wheel is controlled at optimum slip, a point where retardation and stability are maximized. The brake pressure that is best for the wheel in question is directed individually into each brake chamber.

J1587 — The SAE heavy duty standard diagnostic data link.

J1708 — An SAE standard which defines the hardware and software protocol for implementing 9600 baud heavy vehicle data links. J1587 version of a J1708 data link.

J1939 — A high speed 250,000 baud data link used for communications between the ABS ECU engine, transmission and retarders.

LAS — Lateral Acceleration Sensor.

MIR — Modified Independent Regulation. A method of controlling the opposite sides of a steer axle during ABS operation so that torque steer and stopping distance are minimized.

PLC — Power Line Carrier. The serial communication protocol used to communicate with the trailer over the blue full time power wire.

PMV — Pressure Modulator Valve. An air valve which is used to vent or block air to the brake chambers to limit or reduce brake torque.

QR — Quick Release. Quick release valves allow faster release of air from the brake chamber after a brake application. To balance the system, quick release valves have hold off springs that produce higher crack pressures (when the valves open).

Relay Valve — Increases the application speed of the service brake. Installed near brakes with larger air chambers (type 24 or 30). The treadle valve activates the relay valve with an air signal. The relay valve then connects its supply port to its delivery ports. Equal length air hose must connect the delivery ports of the relay valve to the brake chambers.

Retarder Relay — A relay which is used to disable a retarder when ABS is triggered.

RSP — Roll Stability Program. An all-axle ABS solution that helps reduce vehicle speed by applying all vehicle brakes as needed, reducing the tendency to roll over.

SAS — Steering Angle Sensor.

Sensor Clamping Sleeve — A beryllium copper sleeve which has fingers cut into it. It is pressed between an ABS sensor and mounting hole to hold the sensor in place.

Stored Diagnostic Trouble Codes — A diagnostic trouble code that occurred.

TCS — Traction Control System, another name for ATC or ASR.

Tone Ring — A ring that is usually pressed into a wheel hub that has a series of teeth (usually 100) and provides actuation for the speed sensor. Note maximum run out is .008.

YC — Yaw Control. Helps stabilize rotational dynamics of vehicle.

YRS — Yaw Rate Sensor.

Appendix A: J1587 SID and FMI Codes and Their Bendix Blink Code Equivalents

SID (J1587)	FMI (J1587)	General	Bendix Blink Code Equivalent(s) (1st Digit)	(2nd Digit)	Diagnostic Trouble Code Description
-	-	No DTCs	1	1	No DTCs
1	1	Wheel Speed Sensor DTCs	2	1	SA Left WSS Excessive Air Gap
2	1	Wheel Speed Sensor DTCs	3	1	SA Right WSS Excessive Air Gap
3	1	Wheel Speed Sensor DTCs	4	1	DA Left WSS Excessive Air Gap
4	1	Wheel Speed Sensor DTCs	5	1	DA Right WSS Excessive Air Gap
5	1	Wheel Speed Sensor DTCs	14	1	AA Left WSS Excessive Air Gap
6	1	Wheel Speed Sensor DTCs	15	1	AA Right WSS Excessive Air Gap
1	14	Wheel Speed Sensor DTCs	2	2	SA Left WSS Output Low @ Drive-Off
2	14	Wheel Speed Sensor DTCs	3	2	SA Right WSS Output Low @ Drive-Off
3	14	Wheel Speed Sensor DTCs	4	2	DA Left WSS Output Low @ Drive-Off
4	14	Wheel Speed Sensor DTCs	5	2	DA Right WSS Output Low @ Drive-Off
5	14	Wheel Speed Sensor DTCs	14	2	AA Left WSS Output Low @ Drive-Off
6	14	Wheel Speed Sensor DTCs	15	2	AA Right WSS Output Low @ Drive-Off
1	2	Wheel Speed Sensor DTCs	2	3	SA Left WSS Open or Shorted
2	2	Wheel Speed Sensor DTCs	3	3	SA Right WSS Open or Shorted
3	2	Wheel Speed Sensor DTCs	4	3	DA Left WSS Open or Shorted
4	2	Wheel Speed Sensor DTCs	5	3	DA Right WSS Open or Shorted
5	2	Wheel Speed Sensor DTCs	14	3	AA Left WSS Open or Shorted
6	2	Wheel Speed Sensor DTCs	15	3	AA Right WSS Open or Shorted
1	10	Wheel Speed Sensor DTCs	2	4	SA Left WSS Loss of Sensor Signal
2	10	Wheel Speed Sensor DTCs	3	4	SA Right WSS Loss of Sensor Signal
3	10	Wheel Speed Sensor DTCs	4	4	DA Left WSS Loss of Sensor Signal
4	10	Wheel Speed Sensor DTCs	5	4	DA Right WSS Loss of Sensor Signal
5	10	Wheel Speed Sensor DTCs	14	4	AA Left WSS Loss of Sensor Signal
6	10	Wheel Speed Sensor DTCs	15	4	AA Right WSS Loss of Sensor Signal
1	7	Wheel Speed Sensor DTCs	2	5	SA Left WSS Wheel End
2	7	Wheel Speed Sensor DTCs	3	5	SA Right WSS Wheel End
3	7	Wheel Speed Sensor DTCs	4	5	DA Left WSS Wheel End
4	7	Wheel Speed Sensor DTCs	5	5	DA Right WSS Wheel End
5	7	Wheel Speed Sensor DTCs	14	5	AA Left WSS Wheel End
6	7	Wheel Speed Sensor DTCs	15	5	AA Right WSS Wheel End
1	8	Wheel Speed Sensor DTCs	2	6	SA Left WSS Erratic Sensor Signal
2	8	Wheel Speed Sensor DTCs	3	6	SA Right WSS Erratic Sensor Signal
3	8	Wheel Speed Sensor DTCs	4	6	DA Left WSS Erratic Sensor Signal
4	8	Wheel Speed Sensor DTCs	5	6	DA Right WSS Erratic Sensor Signal
5	8	Wheel Speed Sensor DTCs	14	6	AA Left WSS Erratic Sensor Signal
6	8	Wheel Speed Sensor DTCs	15	6	AA Right WSS Erratic Sensor Signal
1	13	Wheel Speed Sensor DTCs	2	7	SA Left WSS Tire Size Calibration
2	13	Wheel Speed Sensor DTCs	3	7	SA Right WSS Tire Size Calibration
3	13	Wheel Speed Sensor DTCs	4	7	DA Left WSS Tire Size Calibration
4	13	Wheel Speed Sensor DTCs	5	7	DA Right WSS Tire Size Calibration
5	13	Wheel Speed Sensor DTCs	14	7	AA Left WSS Tire Size Calibration
6	13	Wheel Speed Sensor DTCs	15	7	AA Right WSS Tire Size Calibration
1	9	Wheel Speed Sensor DTCs	2	9	SA Left WSS (RESERVED)
2	9	Wheel Speed Sensor DTCs	3	9	SA Right WSS (RESERVED)
3	9	Wheel Speed Sensor DTCs	4	9	DA Left WSS (RESERVED)
4	9	Wheel Speed Sensor DTCs	5	9	DA Right WSS (RESERVED)
5	9	Wheel Speed Sensor DTCs	14	9	AA Left WSS (RESERVED)
6	9	Wheel Speed Sensor DTCs	15	9	AA Right WSS (RESERVED)
5	13	Wheel Speed Sensor DTCs	14	10	AA Left WSS Configuration Error
6	13	Wheel Speed Sensor DTCs	15	10	AA Right WSS Configuration Error
251	4	Power Supply DTCs	6	1	Battery Voltage Too Low
251	3	Power Supply DTCs	6	2	Battery Voltage Too High
251	4	Power Supply DTCs	6	3	Battery Voltage Too Low During ABS
251	5	Power Supply DTCs	6	4	Battery Voltage Input Open Circuit
251	4	Power Supply DTCs	6	5	Ignition Voltage Too Low
251	3	Power Supply DTCs	6	6	Ignition Voltage Too High
251	4	Power Supply DTCs	6	7	Ignition Voltage Too Low During ABS
251	2	Power Supply DTCs	6	8	Input Voltage Excessive Noise (Temp.)
251	14	Power Supply DTCs	6	9	Input Voltage Excessive Noise (Latched)
48	4	Pressure Modulator Valve DTCs	7	1	SA Left PMV REL Solenoid Shorted to Ground
49	4	Pressure Modulator Valve DTCs	8	1	SA Right PMV REL Solenoid Shorted to Ground
50	4	Pressure Modulator Valve DTCs	9	1	DA Left PMV REL Solenoid Shorted to Ground
51	4	Pressure Modulator Valve DTCs	10	1	DA Right PMV REL Solenoid Shorted to Ground
52	4	Pressure Modulator Valve DTCs	16	1	AA Left PMV REL Solenoid Shorted to Ground

SID (J1587)	FMI (J1587)	General	Bendix Blink Code Equivalent(s) (1st Digit)	(2nd Digit)	Diagnostic Trouble Code Description
53	4	Pressure Modulator Valve DTCs	17	1	AA Right PMV REL Solenoid Shorted to Ground
66	4	Pressure Modulator Valve DTCs	20	1	Trailer PMV REL Solenoid Shorted to Ground
48	3	Pressure Modulator Valve DTCs	7	2	SA Left PMV REL Solenoid Shorted to Voltage
49	3	Pressure Modulator Valve DTCs	8	2	SA Right PMV REL Solenoid Shorted to Voltage
50	3	Pressure Modulator Valve DTCs	9	2	DA Left PMV REL Solenoid Shorted to Voltage
51	3	Pressure Modulator Valve DTCs	10	2	DA Right PMV REL Solenoid Shorted to Voltage
52	3	Pressure Modulator Valve DTCs	16	2	AA Left PMV REL Solenoid Shorted to Voltage
53	3	Pressure Modulator Valve DTCs	17	2	AA Right PMV REL Solenoid Shorted to Voltage
66	3	Pressure Modulator Valve DTCs	20	2	Trailer PMV REL Solenoid Shorted to Voltage
48	5	Pressure Modulator Valve DTCs	7	3	SA Left PMV REL Solenoid Open Circuit
49	5	Pressure Modulator Valve DTCs	8	3	SA Right PMV REL Solenoid Open Circuit
50	5	Pressure Modulator Valve DTCs	9	3	DA Left PMV REL Solenoid Open Circuit
51	5	Pressure Modulator Valve DTCs	10	3	DA Right PMV REL Solenoid Open Circuit
52	5	Pressure Modulator Valve DTCs	16	3	AA Left PMV REL Solenoid Open Circuit
53	5	Pressure Modulator Valve DTCs	17	3	AA Right PMV REL Solenoid Open Circuit
66	5	Pressure Modulator Valve DTCs	20	3	Trailer PMV REL Solenoid Open Circuit
42	4	Pressure Modulator Valve DTCs	7	4	SA Left PMV HLD Solenoid Shorted to Ground
43	4	Pressure Modulator Valve DTCs	8	4	SA Right PMV HLD Solenoid Shorted to Ground
44	4	Pressure Modulator Valve DTCs	9	4	DA Left PMV HLD Solenoid Shorted to Ground
45	4	Pressure Modulator Valve DTCs	10	4	DA Right PMV HLD Solenoid Shorted to Ground
46	4	Pressure Modulator Valve DTCs	16	4	AA Left PMV HLD Solenoid Shorted to Ground
47	4	Pressure Modulator Valve DTCs	17	4	AA Right PMV HLD Solenoid Shorted to Ground
66	4	Pressure Modulator Valve DTCs	20	4	Trailer PMV HLD Solenoid Shorted to Ground
42	3	Pressure Modulator Valve DTCs	7	5	SA Left PMV HLD Solenoid Shorted to Voltage
43	3	Pressure Modulator Valve DTCs	8	5	SA Right PMV HLD Solenoid Shorted to Voltage
44	3	Pressure Modulator Valve DTCs	9	5	DA Left PMV HLD Solenoid Shorted to Voltage
45	3	Pressure Modulator Valve DTCs	10	5	DA Right PMV HLD Solenoid Shorted to Voltage
46	3	Pressure Modulator Valve DTCs	16	5	AA Left PMV HLD Solenoid Shorted to Voltage
47	3	Pressure Modulator Valve DTCs	17	5	AA Right PMV HLD Solenoid Shorted to Voltage
66	3	Pressure Modulator Valve DTCs	20	5	Trailer PMV HLD Solenoid Shorted to Voltage
42	5	Pressure Modulator Valve DTCs	7	6	SA Left PMV HLD Solenoid Open Circuit
43	5	Pressure Modulator Valve DTCs	8	6	SA Right PMV HLD Solenoid Open Circuit
44	5	Pressure Modulator Valve DTCs	9	6	DA Left PMV HLD Solenoid Open Circuit
45	5	Pressure Modulator Valve DTCs	10	6	DA Right PMV HLD Solenoid Open Circuit
46	5	Pressure Modulator Valve DTCs	16	6	AA Left PMV HLD Solenoid Open Circuit
47	5	Pressure Modulator Valve DTCs	17	6	AA Right PMV HLD Solenoid Open Circuit
66	5	Pressure Modulator Valve DTCs	20	6	Trailer PMV HLD Solenoid Open Circuit
7	5	Pressure Modulator Valve DTCs	7	7	SA Left PMV CMN Open Circuit
8	5	Pressure Modulator Valve DTCs	8	7	SA Right PMV CMN Open Circuit
9	5	Pressure Modulator Valve DTCs	9	7	DA Left PMV CMN Open Circuit
10	5	Pressure Modulator Valve DTCs	10	7	DA Right PMV CMN Open Circuit
11	5	Pressure Modulator Valve DTCs	16	7	AA Left PMV CMN Open Circuit
12	5	Pressure Modulator Valve DTCs	17	7	AA Right PMV CMN Open Circuit
66	5	Pressure Modulator Valve DTCs	20	7	Trailer PMV CMN Open Circuit
7	13	Pressure Modulator Valve DTCs	7	8	SA Left PMV Configuration Error
8	13	Pressure Modulator Valve DTCs	8	8	SA Right PMV Configuration Error
9	13	Pressure Modulator Valve DTCs	9	8	DA Left PMV Configuration Error
10	13	Pressure Modulator Valve DTCs	10	8	DA Right PMV Configuration Error
11	13	Pressure Modulator Valve DTCs	16	8	AA Left PMV Configuration Error
12	13	Pressure Modulator Valve DTCs	17	8	AA Right PMV Configuration Error
231	12	J1939 DTCs	11	1	J1939 Serial Link
231	14	J1939 DTCs	11	2	J1939 Retarder
231	2	J1939 DTCs	11	3	J1939 Engine Communications
231	2	J1939 DTCs	11	10	Invalid Data From Transmission
231	2	J1939 DTCs	11	4	J1939 Invalid Data (Engine/Retarder)
231	2	J1939 DTCs	11	5	J1939 Supply Pressure
231	2	J1939 DTCs	11	6	J1939 ESP Messages Invalid Data
55	7	Miscellaneous DTCs	12	1	Stop Lamp Switch Not Detected
55	2	Miscellaneous DTCs	12	2	Stop Lamp Switch Defective
17	14	Miscellaneous DTCs	12	3	Dynamometer Test Mode
13	2	Miscellaneous DTCs	12	4	Retarder Relay Open Circuit or Shorted to Ground
13	3	Miscellaneous DTCs	12	5	Retarder Relay Circuit Shorted to Voltage
23	2	Miscellaneous DTCs	12	6	ABS Dash Indicator Circuit DTC
93	4	Miscellaneous DTCs	12	7	PMV Common Shorted to Ground
93	3	Miscellaneous DTCs	12	8	PMV Common Shorted to Voltage
17	14	Miscellaneous DTCs	12	9	ATC Disabled to Prevent Brake Fade
79	13	Miscellaneous DTCs	12	10	Tire Size Out of Range (Front to Rear)

SID (J1587)	FMI (J1587)	General	Bendix Blink Code Equivalent(s) (1st Digit)	(2nd Digit)	Diagnostic Trouble Code Description
22	7	Miscellaneous DTCs	12	11	Wheel Speed Sensors Reversed on an Axle
102	5	Miscellaneous DTCs	12	12	Diff Lock Solenoid Shorted to Ground or Open Circuit
102	3	Miscellaneous DTCs	12	13	Diff Lock Solenoid Shorted to Voltage
103	2	Miscellaneous DTCs	12	14	Sensor CAN Supply Voltage Error
N/A	N/A	Miscellaneous DTCs	12	15	Reserved
"	"	Miscellaneous DTCs	12	16	Reserved
"	"	Miscellaneous DTCs	12	17	Reserved
"	"	Miscellaneous DTCs	12	18	Reserved
"	"	Miscellaneous DTCs	12	19	Reserved
"	"	Miscellaneous DTCs	12	20	Reserved
"	"	Miscellaneous DTCs	12	21	Reserved
103	2	Miscellaneous DTCs	12	22	ESP Sensor Voltage Out of Range
254	12	ECU DTCs	13	1	ECU (02)
254	12	ECU DTCs	13	2	ECU (10)
254	12	ECU DTCs	13	3	ECU (11)
254	2	ECU DTCs	13	4	ECU (12)
254	2	ECU DTCs	13	5	ECU (13)
254	12	ECU DTCs	13	6	ECU (14)
254	2	ECU DTCs	13	7	ECU (15)
254	13	ECU DTCs	13	8	ECU (16)
254	13	ECU DTCs	13	9	ECU (17)
254	12	ECU DTCs	13	10	ECU (18)
254	12	ECU DTCs	13	11	ECU (1A)
254	12	ECU DTCs	13	12	ECU (1B)
254	12	ECU DTCs	13	13	ECU (80)
254	12	ECU DTCs	13	14	ECU (04)
254	12	ECU DTCs	13	15	ECU (06)
254	12	ECU DTCs	13	16	ECU (0E)
254	2	ECU DTCs	13	17	ECU (0D)
254	2	ECU DTCs	13	18	ECU (19)
253	12	ECU DTCs	13	19	ECU (1C)
253	12	ECU DTCs	13	20	ECU (27)
253	13	ECU DTCs	13	21	ECU (1D)
253	13	ECU DTCs	13	22	ECU (1E)
253	13	ECU DTCs	13	23	ECU (28)
254	12	ECU DTCs	13	24	ECU (37)
254	12	ECU DTCs	13	25	ECU Internal VIN Mismatch
18	4	TCV DTCs	18	1	TCV DA Solenoid Shorted to Ground
18	3	TCV DTCs	18	2	TCV DA Solenoid Shorted to Voltage
18	5	TCV DTCs	18	3	TCV DA Solenoid Open Circuit
18	13	TCV DTCs	18	4	TCV DA Configuration Error
19	4	TCV DTCs	19	1	TCV SA Solenoid Shorted to Ground
19	3	TCV DTCs	19	2	TCV SA Solenoid Shorted to Voltage
19	5	TCV DTCs	19	3	TCV SA Solenoid Open Circuit
19	13	TCV DTCs	19	4	TCV SA Configuration Error
89	13	Steering Angle Sensor DTCs	21	1	SAS Not Calibrated
89	13	Steering Angle Sensor DTCs	22	15	YRS Sign Check Not Finished
89	13	Steering Angle Sensor DTCs	21	2	SAS Calibration in Progress
89	2	Steering Angle Sensor DTCs	21	3	SAS Static Signal
89	2	Steering Angle Sensor DTCs	21	4	SAS Signal Out of Range
89	2	Steering Angle Sensor DTCs	21	5	SAS Signal Reversed
89	12	Steering Angle Sensor DTCs	21	6	SAS Invalid Signal
89	2	Steering Angle Sensor DTCs	21	7	SAS Gradient Error
89	9	Steering Angle Sensor DTCs	21	8	SAS CAN Timeout
89	2	Steering Angle Sensor DTCs	21	9	SAS Long Term Calibration Error
89	2	Steering Angle Sensor DTCs	21	10	SAS Plausibility Check (Ref Yaw Rate)
103	2	Yaw Rate Sensor DTCs	22	1	YRS Signal Out of Range
103	2	Yaw Rate Sensor DTCs	22	2	YRS Sensor Reversed Signal
103	2	Yaw Rate Sensor DTCs	22	3	YRS Invalid Signal
103	2	Yaw Rate Sensor DTCs	22	4	YRS Gradient Error
103	9	Yaw Rate Sensor DTCs	22	5	YRS CAN Timeout
103	2	Yaw Rate Sensor DTCs	22	6	YRS Static BITE Error
103	2	Yaw Rate Sensor DTCs	22	7	YRS Dynamic BITE Error
103	2	Yaw Rate Sensor DTCs	22	8	YRS Fast Calibration Error
103	2	Yaw Rate Sensor DTCs	22	9	YRS Static Calibration Error
103	2	Yaw Rate Sensor DTCs	22	10	YRS Normal Calibration Error
103	2	Yaw Rate Sensor DTCs	22	11	YRS Sensitivity Calibration Error

SID (J1587)	FMI (J1587)	General	Bendix Blink Code Equivalent(s) (1st Digit)	(2nd Digit)	Diagnostic Trouble Code Description
103	2	Yaw Rate Sensor DTCs	22	12	YRS Plausibility Check (Ref Yaw Rate)
103	2	Yaw Rate Sensor DTCs	22	13	YRS Plausibility Error (Inside Model Based Limits)
103	2	Yaw Rate Sensor DTCs	22	14	YRS Plausibility Error (Outside Model Based Limits)
99	2	Lateral Acceleration Sensor DTCs	23	1	LAS Signal Out of Range
99	13	Lateral Acceleration Sensor DTCs	23	2	LAS Calibration in Progress
99	2	Lateral Acceleration Sensor DTCs	23	3	LAS Static Calibration Error
99	2	Lateral Acceleration Sensor DTCs	23	4	LAS Long Term Calibration Error
99	12	Lateral Acceleration Sensor DTCs	23	5	LAS Plausibility Error (Inside Model Based Limits)
99	12	Lateral Acceleration Sensor DTCs	23	6	LAS Plausibility Error (Outside Model Based Limits)
99	14	Lateral Acceleration Sensor DTCs	23	7	Erratic ESP Sensor Signal
77	2	Brake Demand/Load Sensor DTCs	24	1	Shorted Brake Demand Sensor (Primary CKT) Open
78	2	Brake Demand/Load Sensor DTCs	24	2	Shorted Brake Demand Sensor (Secondary CKT) Open
69	2	Brake Demand/Load Sensor DTCs	24	3	Open or Shorted Load Sensor
77	11	Brake Demand/Load Sensor DTCs	24	4	Plausibility Error Brake Demand Sensor
77	2	Brake Demand/Load Sensor DTCs	24	5	PS Supply Voltage Error
77	7	Brake Demand/Load Sensor DTCs	24	6	PS Not Calibrated
89	13	Yaw Rate Sensor	22	15	Check Incomplete

REVISED 5/31/05

Bendix®

Service Data

SD-13-4870

Bendix® M-32™ and M-32QR™ AntiLock Modulators

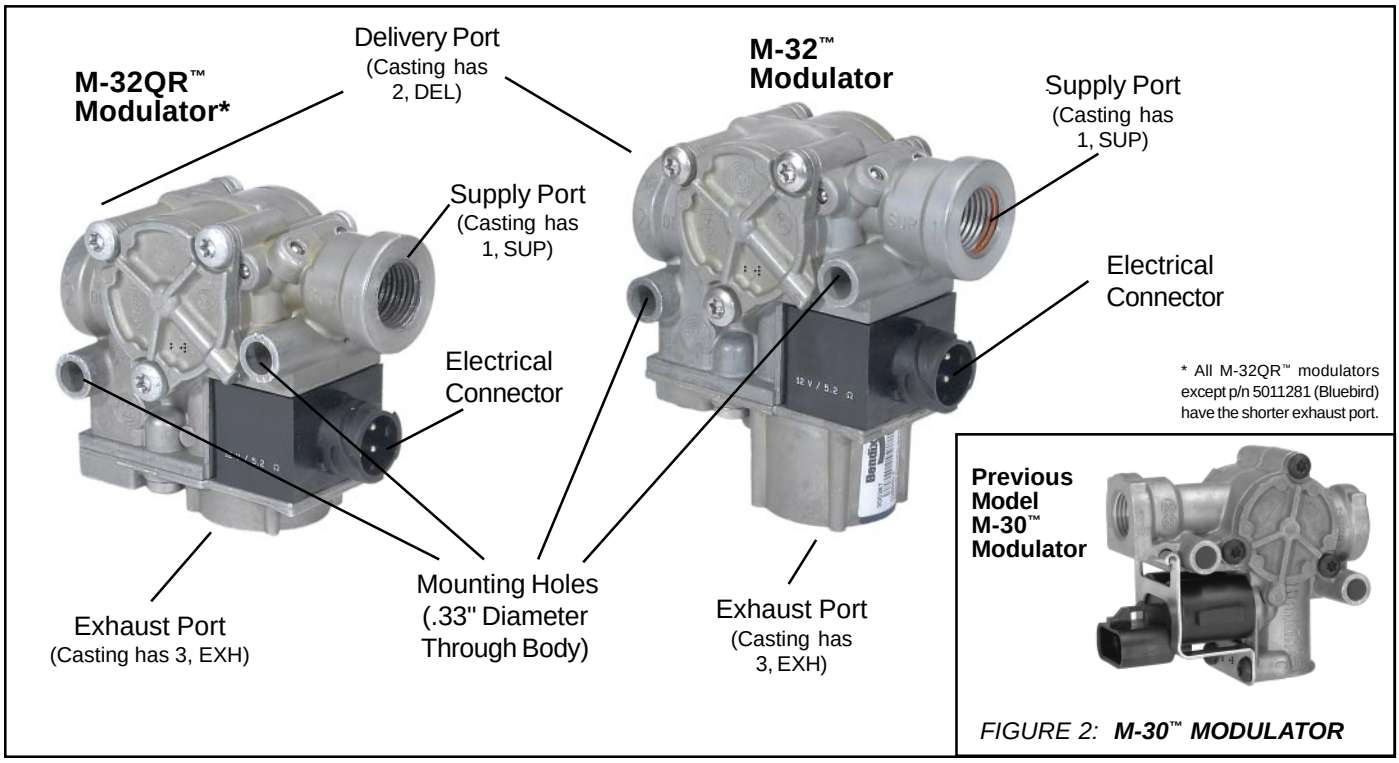


FIGURE 2: ***M-30™ MODULATOR***

FIGURE 1: ***M-32™ AND M-32QR™ MODULATORS***

DESCRIPTION

The M-32™ and M-32QR™ (quick release) antilock system modulators (Figure 1) are high capacity, on/off air valves that incorporate a pair of electrical solenoids for control. The solenoids provide the electro-pneumatic interface between the antilock controller electronics and the air brake system. The modulator is used to control the braking function on individual or dual service actuators during antilock activity.

The M-32QR™ modulator is the direct replacement for the M-30™ (Figure 2) modulator in all applications. The M-32QR™ modulator includes a bias valve to provide an internal quick release function. In applications using an M-32™ modulator, an external quick release valve may be required, depending on the system design (see Figure 3 for typical system schematics). When used to control both service chambers on an axle or two chambers on the same side of a tandem axle, the modulator is sometimes mounted ahead of a quick release valve, which provides quick exhaust of service applications during normal braking. In the case of individual wheel control applications, the modulator is always the last control valve through which air passes on its way to the service brake actuator.

The modulator consists of a die cast aluminum body and a solenoid assembly which contains one normally open solenoid, one normally closed solenoid, and an inlet and exhaust diaphragm valve. A three pin, weather resistant electrical connector is an integral part of the modulator solenoid assembly and serves to carry control commands from the antilock controller to the modulator. Two mounting holes are provided for frame or cross member mounting of the valve.

The supply, delivery and exhaust ports on the M-32™ modulator are identified with a cast, embossed numeral for positive identification.

Identification	Air Line Connection
1, SUP	Supply (incoming air from foot, relay or quick release valve)
2, DEL	Delivery (air delivery to service actuators)
3, EXH	Exhaust

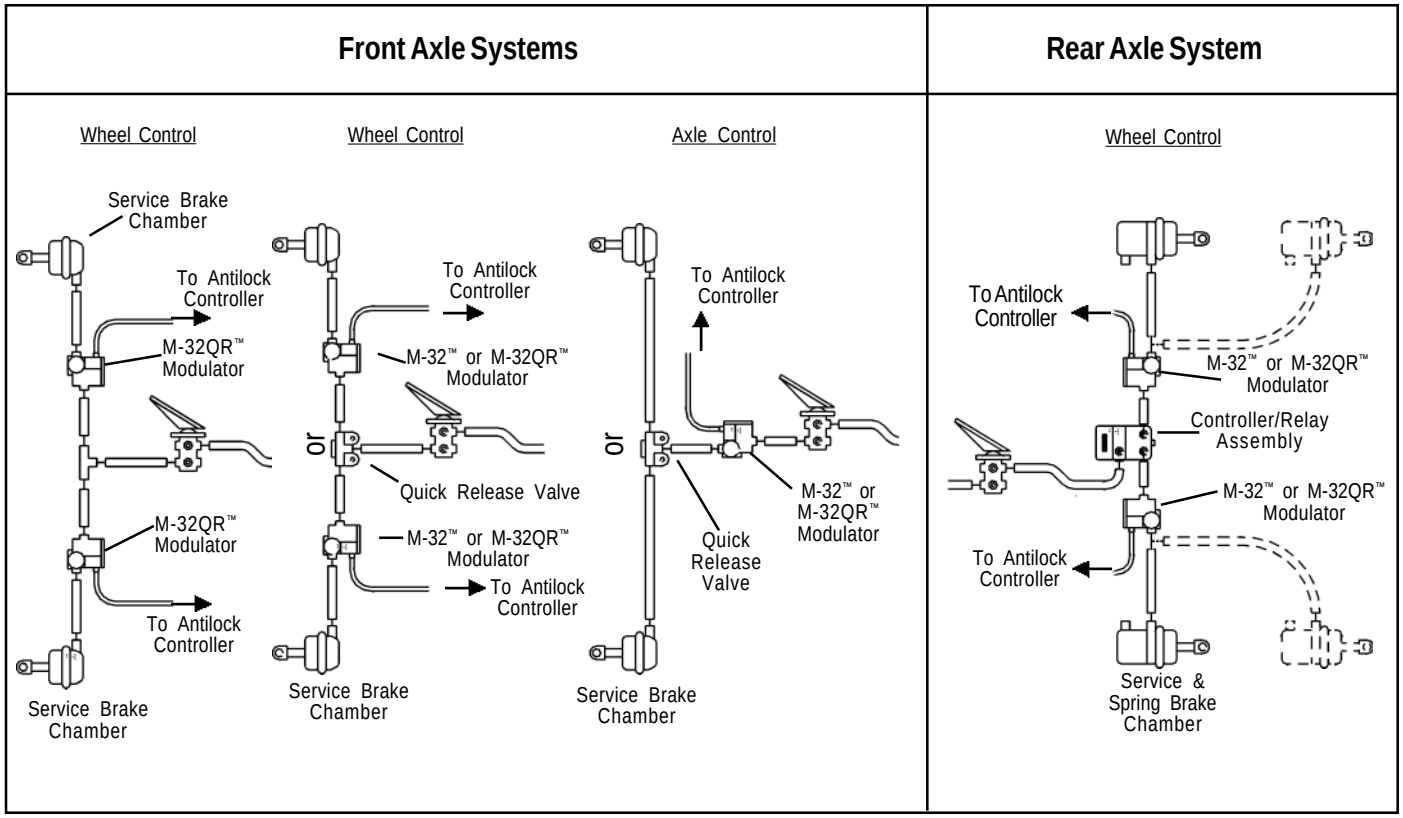


FIGURE 3: ***TYPICAL WHEEL AND AXLE CONTROL SYSTEMS***
NOTE: *use of a quick release valve is not typically required with the M-32QR™ modulator. Refer to vehicle specifications for recommended configuration.*

FUNCTIONAL CHECK

A wiring harness connects the vehicle modulators to the controller. The ABS controller is able to simultaneously and independently control the individual modulators. When vehicle power is supplied to the ABS ECU, a modulator "chuff" test is performed. When the brake pedal is depressed and the ignition turned on, the modulator "chuff" test can be heard. This test will verify if the modulator is functioning pneumatically correct. The modulators will exhaust air in the sequence of right front, left front, right rear, left rear. If they do not follow this sequence, proceed with modulator troubleshooting.

OPERATION

NON-ANTILOCK BRAKE APPLICATION *(Figure 4)*

During normal, non antilock braking, both solenoids are de-energized (no electrical power). Brake application air enters the Supply port of the modulator and flows to the exhaust diaphragm. Air pressure, along with spring force, seats the exhaust diaphragm on the exhaust passage, thus preventing the escape of service air. Simultaneously, application air flows to the supply diaphragm and forces it away from its seat. Air flows past the open supply port and out the modulator delivery port to the service brake chambers.

NON-ANTILOCK HOLD *(Figure 5)*

When the desired air pressure is attained in the service brake chambers, the brake system is in the Holding position. In the Holding position, both solenoids in the modulator remain de-energized and the balance of the internal components remain in the same position as they assumed during application.

NON-ANTILOCK EXHAUST

The manner in which air exhausts through the modulator differs depends upon how rapidly the brake application is released by the driver.

Normal Exhaust *(Figure 6)* - During a normal, relatively “slow” brake release, air moves back through the modulator in the reverse direction as it flowed during application. The internal components of the modulator will remain in the same position as they assumed during application until air pressure decreases to approximately one half psi, at which time the supply diaphragm will seat on the supply passage. A relatively small amount of air will generally be expelled from the modulator exhaust port during “slow” brake release.

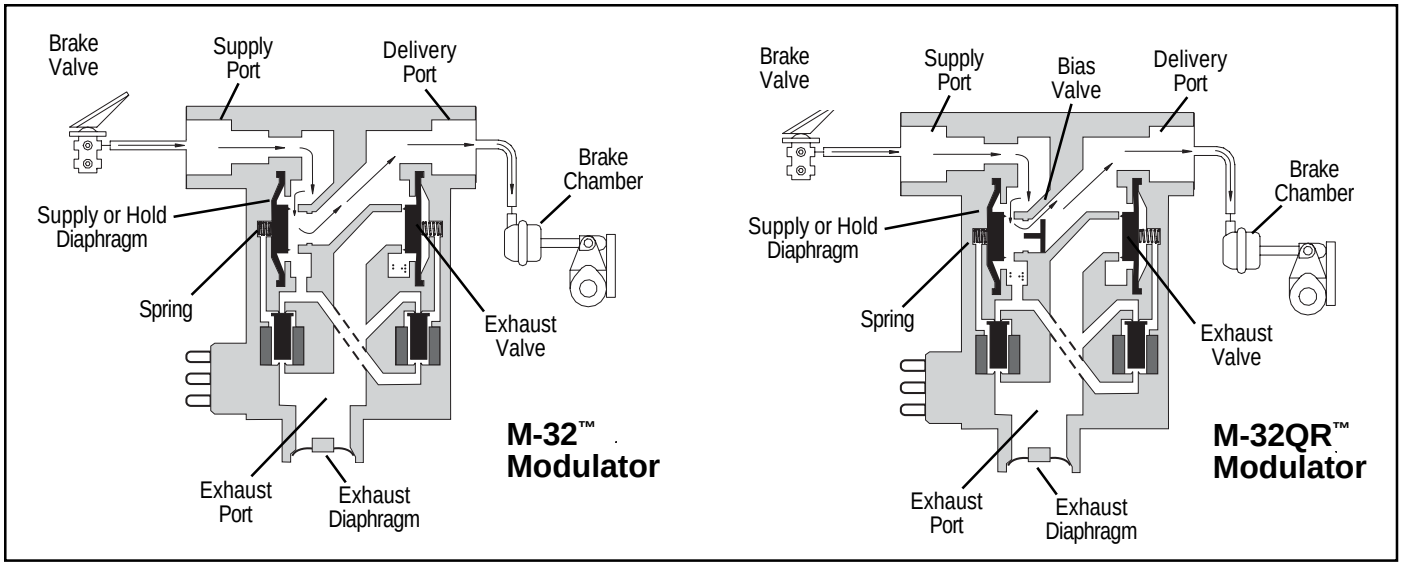


FIGURE 4: ***M-32™ AND M-32QR™ MODULATORS NON-ANTILOCK APPLICATION OF SERVICE BRAKES***

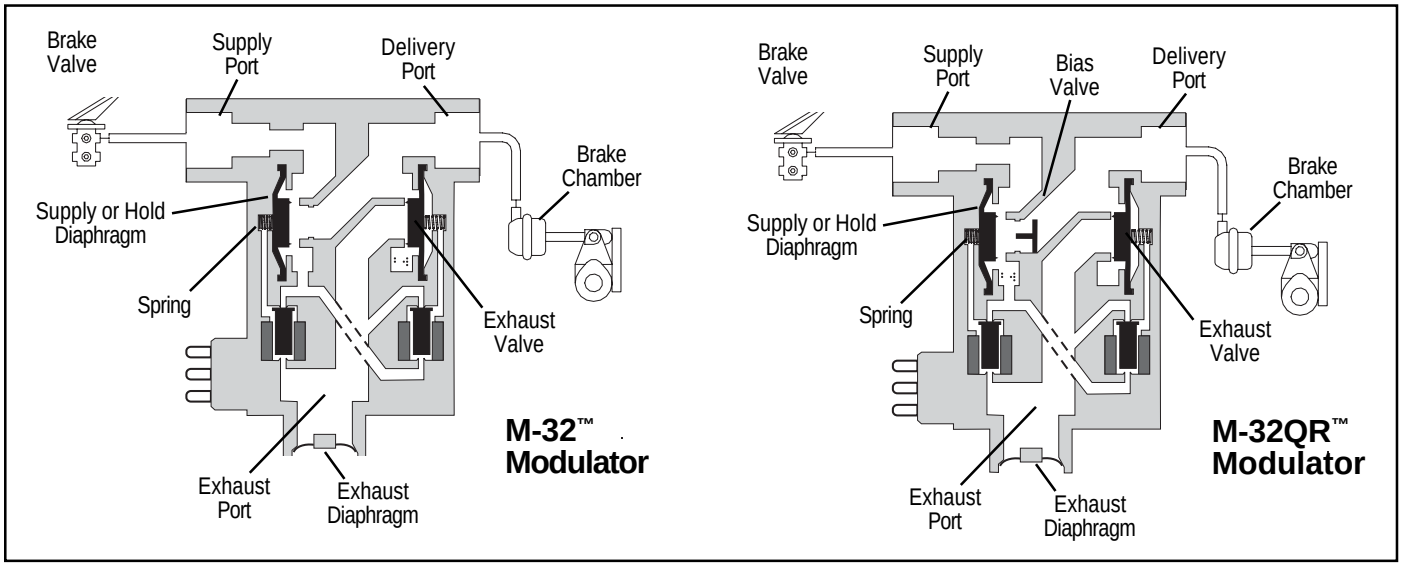


FIGURE 5: ***M-32™ AND M-32QR™ MODULATORS NON-ANTILOCK BRAKE APPLICATION HELD POSITION***

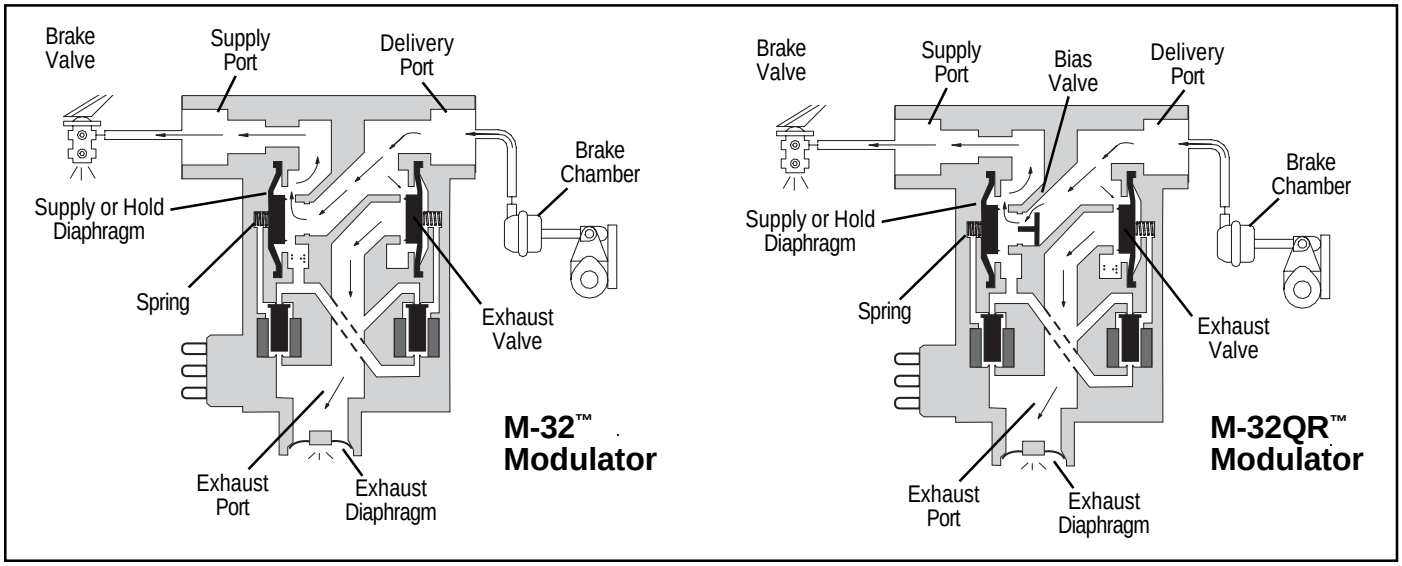


FIGURE 6: ***M-32™ and M-32QR™ MODULATORS "SLOW" NON-ANTILOCK EXHAUST OF SERVICE BRAKES***

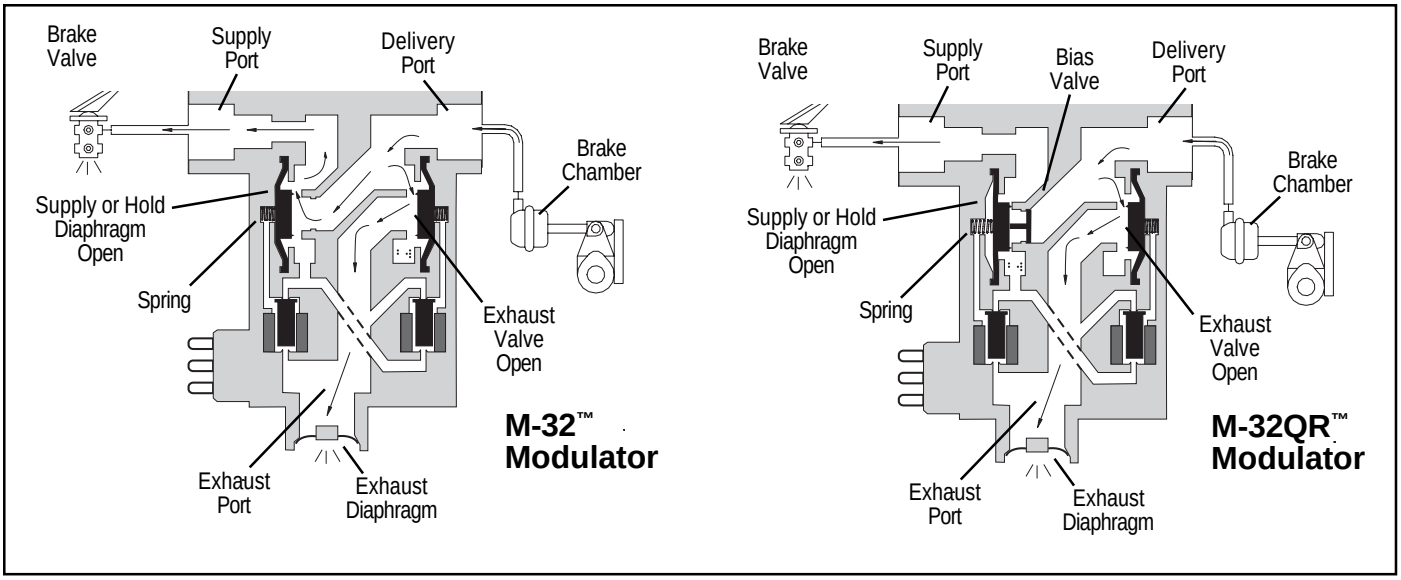


FIGURE 7: ***M-32™ AND M-32QR™ MODULATORS RAPID NON-ANTILOCK EXHAUST OF SERVICE BRAKES***

Rapid Exhaust *(Figure 7)* - The Rapid Exhaust operation described in the following text occurs when the modulator is controlling service chamber(s). During a rapid brake release the quick release modulator will exhaust air differently to a "slow" brake release.

An example of this would be the case if the driver made a severe brake application then lifted his foot from the foot valve. During a rapid brake release, the air previously delivered to the brake chamber is vented through the M-32™ modulators as follows:

For the M-32QR™ Modulator: The bias valve moves to its closed position, closing the air return route to the brake valve's exhaust. Air pressure against the exhaust valve within the M-32™ modulator overcomes the spring force and allows air to exhaust through the M-32QR™ modulator exhaust port. Residual air pressure between the bias valve and the brake pedal flows back to the brake valve exhaust.

For the M-32™ Modulator: As in the "slow" brake release, air pressure travels back to the brake valve's exhaust, but also the air pressure against the exhaust valve within the M-32™ modulator overcomes the spring force and allows air to exhaust through the M-32™ modulator exhaust port.

ANTILOCK OPERATION

GENERAL

If a service brake application is made and the antilock system detects an impending wheel lockup, the antilock controller will make a controlled brake application using the modulator.

In order to control the brake application, the coils of the two solenoid valves contained in the modulator are energized or de-energized in a preprogrammed sequence by the antilock controller. When a solenoid coil is energized, and depending whether the exhaust or hold solenoid is energized, it either opens or closes, thereby causing the exhaust or reapplication of air pressure to the brake actuator. The solenoids in the modulator are controlled independently by the antilock controller (ECU).

An experienced driver (of a vehicle without ABS) who encounters wheel lock-up may sometimes "pump the brakes" in order to attempt to prevent wheel lock-up and maintain vehicle control. In the case of an ABS braking system, the driver does not need to "pump the brakes" since the antilock controller is able to apply and release the brakes using the modulators, with far greater speed and accuracy. Depending on the number of modulators used, some systems are able to apply braking power to wheels independently (see page 2).

ANTILOCK EXHAUST *(Figure 8)*

When wheel lock is detected or imminent, the antilock controller energizes the supply and exhaust solenoids in the modulator.

Energizing the supply solenoid allows application air to flow to the control side of the supply diaphragm. Air pressure acting on the supply diaphragm, along with the spring force, enables the diaphragm to prevent further delivery of air to the brake chamber.

Energizing the exhaust solenoid shuts off the air normally applied to the control side of the exhaust diaphragm to keep it closed. Air pressure acting on the exhaust diaphragm, overcomes the spring force, and allows air to exhaust through the exhaust port.

ANTILOCK HOLD MODE *(Figure 9)*

The antilock controller will place the modulator in the Hold position when it senses that the correct wheel speed (braking force) has been attained. The antilock controller will also

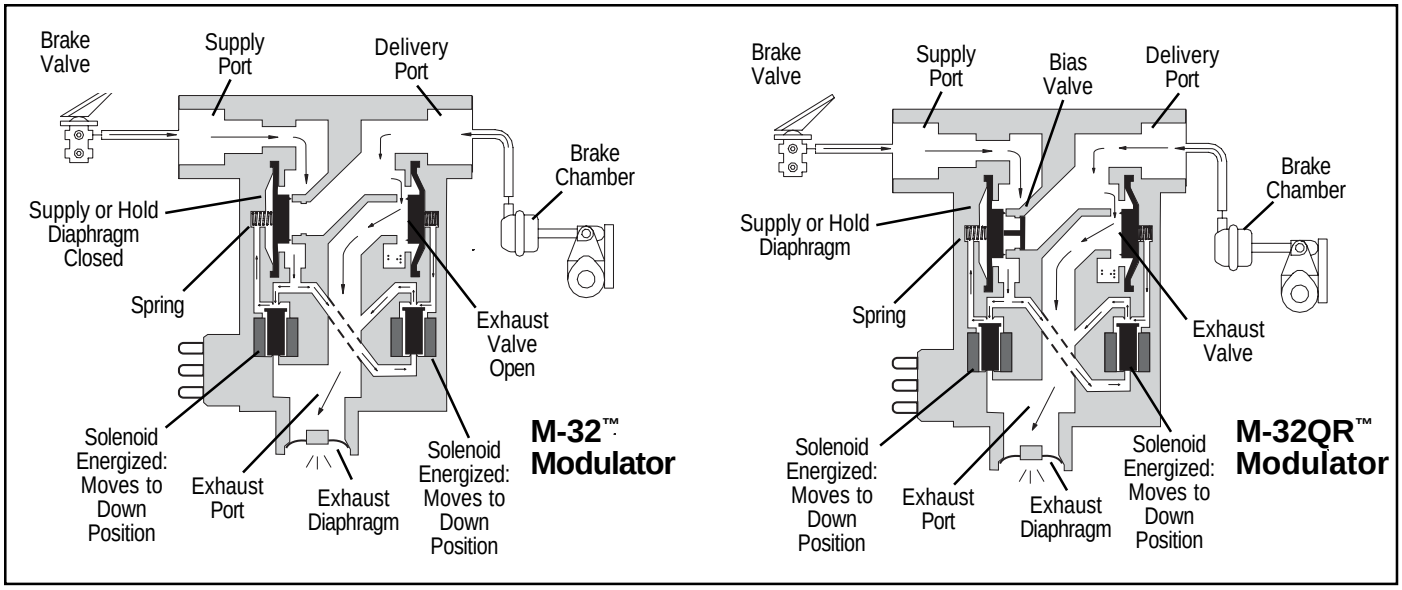


FIGURE 8: ***M-32™ MODULATOR ANTILOCK EXHAUST OF BRAKES***

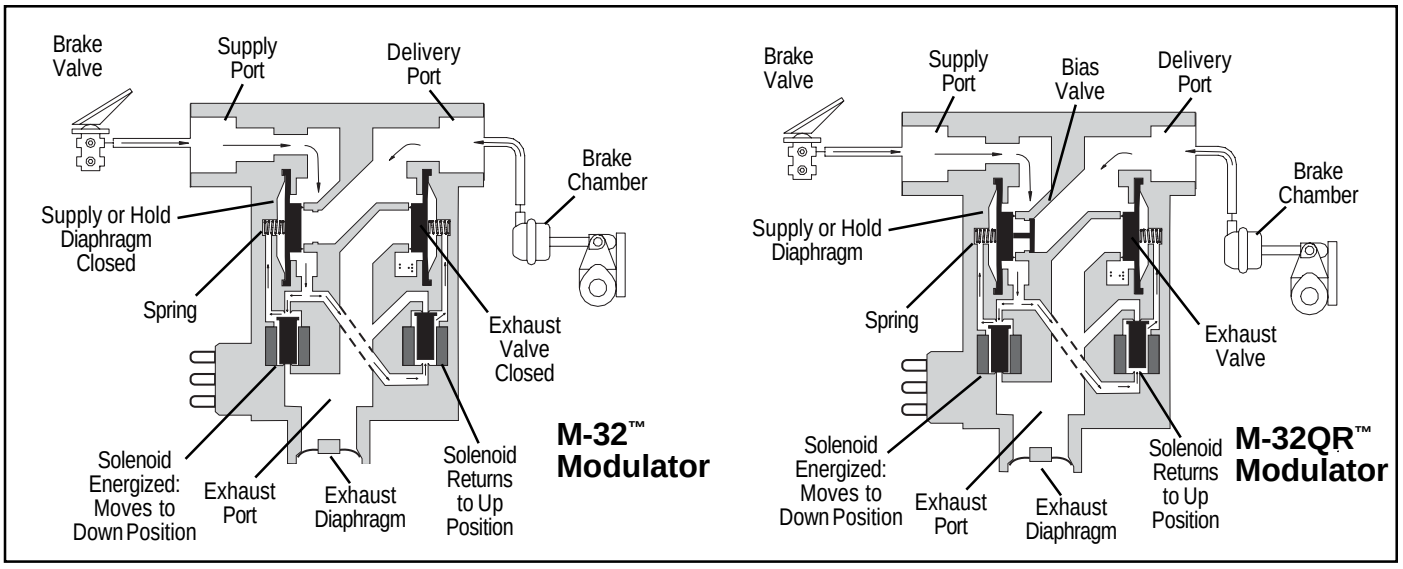


FIGURE 9: ***M-32™ AND M-32QR™ MODULATORS ANTILOCK APPLICATION HELD POSITION***

place the modulator in the hold position, prior to entering the reapply mode, when it detects recovery from a locked wheel condition. In this mode of operation, the modulator supply/hold solenoid remains energized while the exhaust solenoid returns to its normal position. The exhaust solenoid allows application air to flow to the control side of the exhaust diaphragm, which then seals the exhaust passage. With the exhaust diaphragm seated, further exhaust of brake chamber air pressure is prevented. Because the supply solenoid remains energized, the supply diaphragm remains seated, thus preventing application air from flowing to the delivery port and out to the brake chamber. The modulator can enter both the antilock exhaust or reapply mode from the antilock hold mode depending on the needs of the antilock controller.

ANTILOCK "REAPPLY" MODE

If the antilock controller senses that wheel speed has increased sufficiently enough to allow re-application of braking pressure, without further wheel lock-up, it de-energizes the supply solenoid. With both solenoids de-energized, the modulator re-applies air to the brakes in the same manner it did during a non-antilock event.

PREVENTIVE MAINTENANCE

GENERAL

Perform the tests and inspections presented at the prescribed intervals. If the modulator fails to function as described, or leakage is excessive, it should be replaced with a new Bendix unit, available at any authorized parts outlet.

EVERY MONTH, 10,000 MILES OR 350 OPERATING HOURS

1. Remove any accumulated contaminates and visually inspect the exterior for excessive corrosion and physical damage.
2. Inspect all air lines and wire harnesses connected to the modulator for signs of wear or physical damage. Replace as necessary.
3. Test air line fittings for leakage and tighten or replace as necessary.
4. Perform the ROUTINE OPERATION AND LEAKAGE TESTING described in this manual.

OPERATION & LEAKAGE TESTS

LEAKAGE TEST

1. Park the vehicle on a level surface and block or chock the wheels. Release the parking brakes and build the air system to full pressure.
2. Turn the engine OFF and make 4 or 5 brake applications and note that the service brakes apply and release promptly.
3. Build system pressure to governor cut-out and turn the engine OFF.
4. After determining the pressure loss with the brakes released (2 PSI/minute allowed), make and hold a full service brake application. Allow the pressure to stabilize for one minute.
5. Begin timing pressure loss for two minutes while watching the dash gauges for a pressure drop. The leakage rate for the service reservoirs should not exceed 3 PSI/minute.
6. If either circuit exceeds the recommended two PSI/minute, apply soap solution to the exhaust port of the modulator and any other components in the respective circuit.
7. The leakage at the exhaust port of most Bendix components, including M-32™ modulators, should not exceed a one-inch bubble in three seconds. If leakage at the modulator is determined to exceed the maximum limits, replace the modulator.

OPERATION TEST

To properly test the function of the modulator will require two (2) service technicians.

1. Park the vehicle on a level surface and block or chock the wheels. Release the parking brakes and build the air system to governor cut out.
2. Turn the engine ignition key to the OFF position then make and hold a full brake application.
3. With the brake application held and one (1) service technician posted at one (1) of the modulators, turn the vehicle ignition key to the ON position. ONE OR TWO SHORT bursts of air pressure should be noted at the modulator exhaust. Repeat the test for each modulator on the vehicle. If at least a single burst of exhaust is not noted or the exhaust of air is prolonged and not short, sharp and well defined, perform the Electrical Tests.

ELECTRICAL TESTS

1. Before testing the solenoid assembly of a suspect modulator, its location on the vehicle should be confirmed using the Trouble Shooting or Start Up procedure for the specific antilock controller in use. (See the Service Data Sheet for the antilock controller for this procedure.)
2. Proceed to the modulator in question and inspect its wiring connector. Disconnect the connector and test the resistance between the pins ON THE MODULATOR. Refer to Figures 10 and 11.

A. HOLD TO SOURCE **(41-42)**: Read 4.9 to 5.5 Ohms.

B. EXHAUST TO SOURCE **(43-41)**: Read 4.9 to 5.5 Ohms.

C. EXHAUST TO HOLD **(43-42)**: Read 9.8 to 11.0 Ohms.

D. Individually test the resistance of each pin to vehicle ground and note there is NO CONTINUITY.

If the resistance readings are as shown, the wire harness leading to the modulator may require repair or replacement. Before attempting repair or replacement of the wire harness, refer to the test procedures specified for the antilock controller in use for possible further testing that may be required to substantiate the wire harness problem. If the resistance values are NOT AS STATED, replace the modulator.

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following general precautions should be observed at all times.

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.

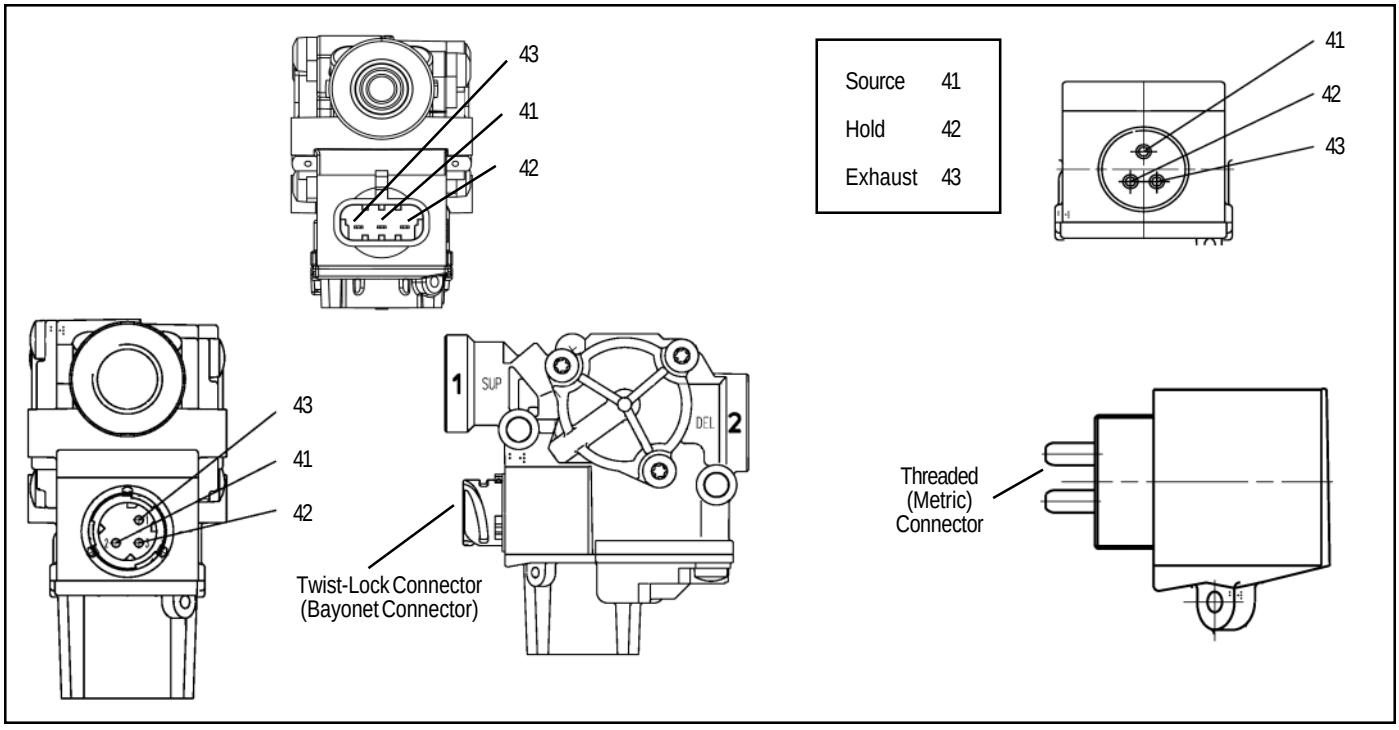
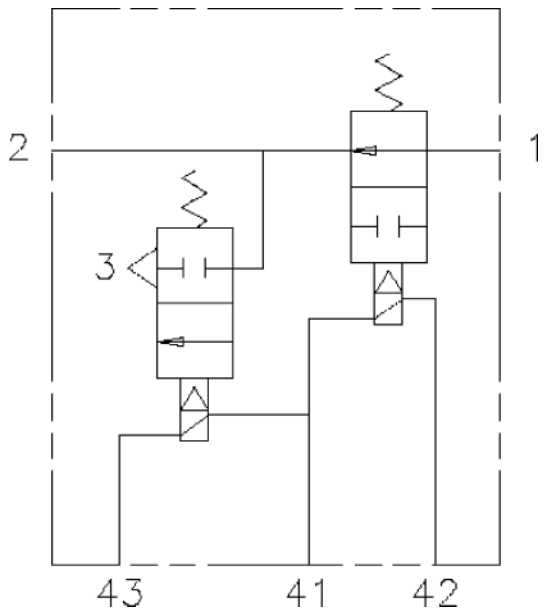


FIGURE 10: ***M-32™ AND M-32QR™ MODULATORS CONNECTOR VIEWS***

2. **Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.**
3. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
4. **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with an AD-IS™ air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.**
5. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
6. **Never exceed manufacturer's recommended pressures.**
7. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
8. **Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.**
9. **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
10. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**
11. **For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.**

MODULATOR REMOVAL

1. Locate the modulator that will be replaced and clean the exterior.
2. Identify and mark or label all air lines and their respective connections on the valve to facilitate ease of installation.
3. Disconnect both air lines and the electrical connector.
4. Remove the modulator from the vehicle.
5. Remove all air line fittings and plugs. **These fittings will be re-used in the replacement modulator.**



Port Designation	
Supply	1
Delivery	2
Exhaust	3

Electrical Control	
Source	41
Hold	42
Exhaust	43

FIGURE 11: ***M-32™ AND M-32QR™ MODULATORS DIN SYMBOL***

MODULATOR INSTALLATION

1. Install all air line fittings and plugs, making certain thread sealing material does not enter the valve.
2. Install the assembled valve on the vehicle.
3. Reconnect both air lines to the valve using the identification made during VALVE REMOVAL step 5.
4. Reconnect the electrical connector to the modulator.
5. After installing the valve, test all air fittings for excessive leakage and tighten as needed.

TECHNICAL INFORMATION

Porting 1 Supply Port (from brake, relay or quick release valve) - 1/2" NPT

1 Delivery Port (brake actuator) - 1/2" NPT

Optional: 1 Push-to-connect for 1/2" tubing

2 NPT supply, PTC delivery

Solenoid Voltage: 12 Volts DC Nominal, optional 24 Volt available.

Weight: 1.7 pounds

Maximum Operating Pressure: 150 psi Gauge

Operating Temperature Range: -40 to 185 degrees Fahrenheit

Pressure Differential: 1 psi maximum (supply to delivery)

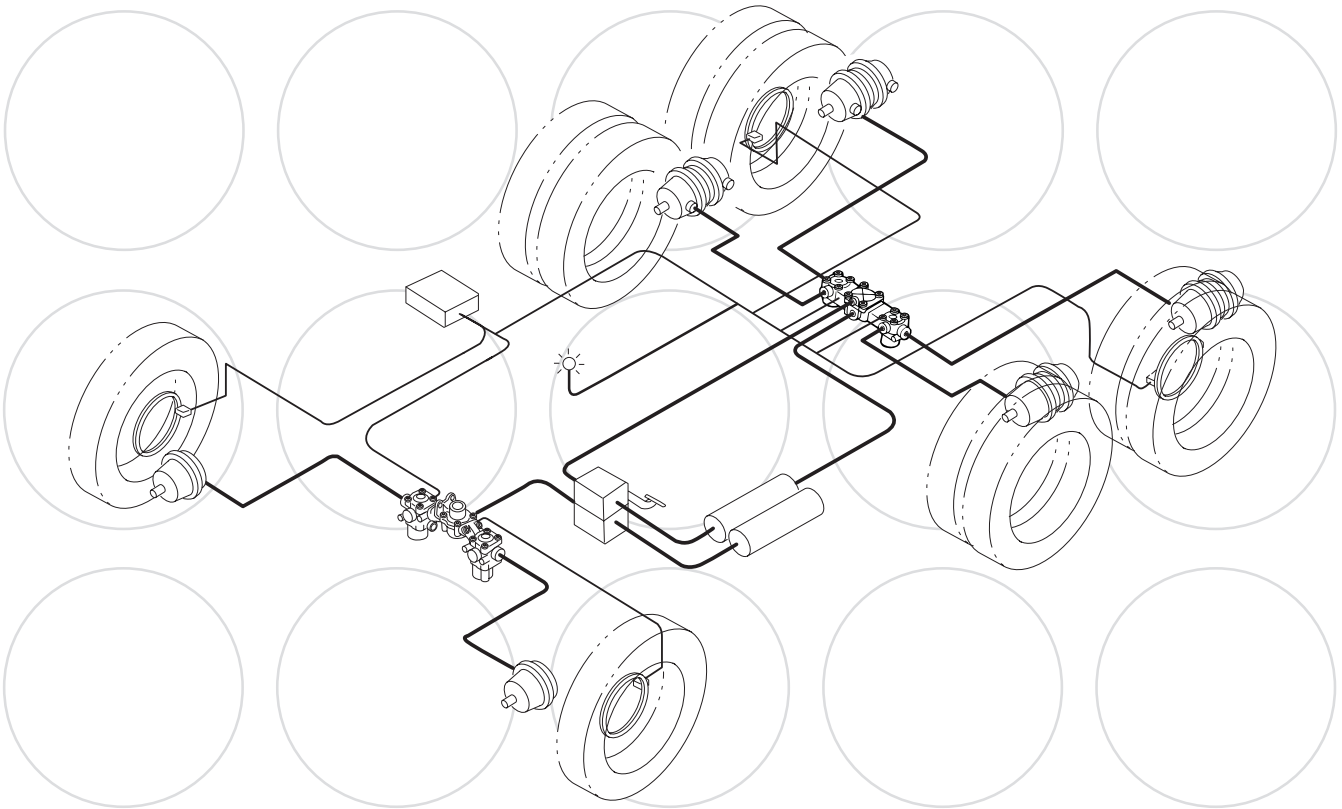
Mounting Hole Sizes: 0.33" diameter through body

MERITOR WABCO

Maintenance Manual MM-0112

Anti-Lock Braking System (ABS) for Trucks, Tractors and Buses

Revised 07-05



For E Version ECUs
12-Volt Systems

About This Manual

This manual contains maintenance procedures for Meritor WABCO's Anti-Lock Braking System (ABS) for trucks, tractors and buses.

Before You Begin

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.
3. Follow your company's maintenance and service, installation and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Hazard Alert Messages and Torque Symbols

⚠ WARNING

A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.

⚠ CAUTION

A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components.

This symbol alerts you to tighten fasteners to a specified torque value.

How to Obtain Additional Maintenance and Service Information

On the Web

Visit the meritorwabco.com website to easily access product and service information. The website also offers an interactive and printable Literature Order Form.

ArvinMeritor's Customer Service Center

Call ArvinMeritor's Customer Service Center at 800-535-5560.

Technical Electronic Library on CD

The DriveTrain Plus™ by ArvinMeritor Technical Electronic Library on CD contains product and service information for most Meritor and Meritor WABCO products. $20. Specify TP-9853.

How to Obtain Tools and Supplies Specified in This Manual

Call ArvinMeritor's Commercial Vehicle Aftermarket at 888-725-9355 to obtain Meritor tools and supplies.

pg. i **Asbestos and Non-Asbestos Fibers**

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6 ABS Valve Packages
7 ABS Sensors
8 Off-Road ABS
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⚠ ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from ArvinMeritor.

Hazard Summary

Because some brake linings contain asbestos, workers who service brakes must understand the potential hazards of asbestos and precautions for reducing risks. Exposure to airborne asbestos dust can cause serious and possibly fatal diseases, including asbestosis (a chronic lung disease) and cancer, principally lung cancer and mesothelioma (a cancer of the lining of the chest or abdominal cavities). Some studies show that the risk of lung cancer among persons who smoke and who are exposed to asbestos is much greater than the risk for non-smokers. Symptoms of these diseases may not become apparent for 15, 20 or more years after the first exposure to asbestos.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons. OSHA has set a maximum allowable level of exposure for asbestos of 0.1 f/cc as an 8-hour time-weighted average and 1.0 f/cc averaged over a 30-minute period. Scientists disagree, however, to what extent adherence to the maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling asbestos dust. OSHA requires that the following sign be posted at the entrance to areas where exposures exceed either of the maximum allowable levels:

DANGER: ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA.

2. Respiratory Protection. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA for use with asbestos at all times when servicing brakes, beginning with the removal of the wheels.

3. Procedures for Servicing Brakes.

a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c. If an enclosed vacuum system or brake washing equipment is not available, employers may adopt their own written procedures for servicing brakes, provided that the exposure levels associated with the employer's procedures do not exceed the levels associated with the enclosed vacuum system or brake washing equipment. Consult OSHA regulations for more details.

d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

5. Worker Clean-Up**.** After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

⚠ NON-ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to non-asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from ArvinMeritor.

Hazard Summary

Most recently manufactured brake linings do not contain asbestos fibers. These brake linings may contain one or more of a variety of ingredients, including glass fibers, mineral wool, aramid fibers, ceramic fibers and silica that can present health risks if inhaled. Scientists disagree on the extent of the risks from exposure to these substances. Nonetheless, exposure to silica dust can cause silicosis, a non-cancerous lung disease. Silicosis gradually reduces lung capacity and efficiency and can result in serious breathing difficulty. Some scientists believe other types of non-asbestos fibers, when inhaled, can cause similar diseases of the lung. In addition, silica dust and ceramic fiber dust are known to the State of California to cause lung cancer. U.S. and international agencies have also determined that dust from mineral wool, ceramic fibers and silica are potential causes of cancer.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to non-asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons.

2. Respiratory Protection. OSHA has set a maximum allowable level of exposure for silica of 0.1 mg/m^3 as an 8-hour time-weighted average. Some manufacturers of non-asbestos brake linings recommend that exposures to other ingredients found in non-asbestos brake linings be kept below 1.0 f/cc as an 8-hour time-weighted average. Scientists disagree, however, to what extent adherence to these maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling non-asbestos dust.

Therefore, wear respiratory protection at all times during brake servicing, beginning with the removal of the wheels. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA, if the exposure levels may exceed OSHA or manufacturers' recommended maximum levels. Even when exposures are expected to be within the maximum allowable levels, wearing such a respirator at all times during brake servicing will help minimize exposure.

3. Procedures for Servicing Brakes.

a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.

b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

c. If an enclosed vacuum system or brake washing equipment is not available, carefully clean the brake parts in the open air. Wet the parts with a solution applied with a pump-spray bottle that creates a fine mist. Use a solution containing water, and, if available, a biodegradable, non-phosphate, water-based detergent. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.

d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.

e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.

4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA, to minimize exposure. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.

5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.

6. Waste Disposal**.** Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

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Contents

This manual contains service information for E version Meritor WABCO Anti-Lock Braking System (ABS) and ABS with Automatic Traction Control (ATC) for trucks, tractors and buses. E version ABS incorporates Power Line Carrier Communication (PLC), an optional feature that allows tractor/trailer communication. For the driver, this means that a trailer ABS indicator lamp located on the vehicle dash will come on if a trailer ABS fault occurs on a trailer equipped with PLC.

NOTE: For diagnostic and testing procedures for systems with C version ECUs, use Maintenance Manual 28, Anti-Lock Braking Systems (ABS) for Trucks, Tractors and Buses. For D version ECUs, use Maintenance Manual 30, Anti-Lock Braking Systems (ABS) for Trucks, Tractors and Buses. The ABS version is marked on the ECU. Figure 1.1. If you cannot identify the ECU version installed on your vehicle, contact ArvinMeritor's Customer Service Center at 800-535-5560.

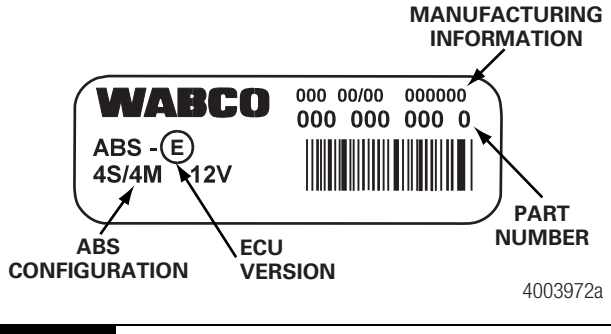


Figure 1.1

Description

How ABS Works

Meritor WABCO ABS is an electronic system that monitors and controls wheel speed during braking. The system works with standard air brake systems.

ABS monitors wheel speeds at all times and controls braking during wheel lock situations. The system improves vehicle stability and control by reducing wheel lock during braking.

The ECU receives and processes signals from the wheel speed sensors. When the ECU detects a wheel lockup, the unit activates the appropriate modulator valve, and air pressure is controlled.

In the event of a malfunction in the system, the ABS in the affected wheel(s) is disabled; that wheel still has normal brakes. The other wheels keep the ABS function.

Two ABS indicator lamps, one for tractor and one for trailer, let drivers know the status of the system. The tractor ABS lamp is also used to display tractor blink code diagnostics. Figure 1.2. The location of the ABS indicator lamps varies depending on the make and model of the vehicle.

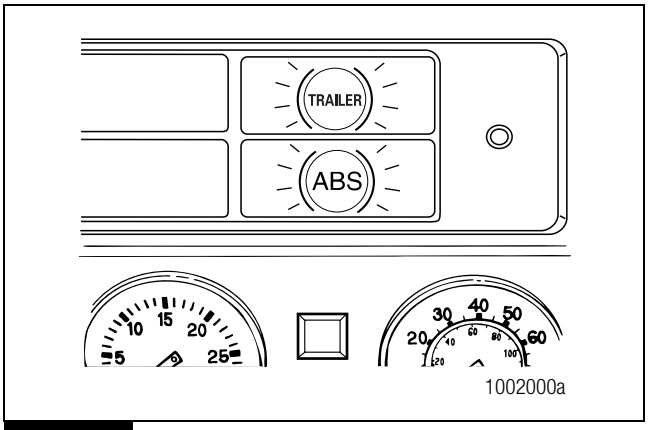


Figure 1.2

Do not open the ECU. Opening the ECU to gain access to the internal components will void the warranty.

If the vehicle is equipped with optional Automatic Traction Control (ATC), or with ATC and Roll Stability Control (RSC), the ATC indicator lamp is used to indicate both ATC and RSC. Refer to Section 2.

Blink code diagnostics information for **trailer** ABS is not included in this manual. Refer to Maintenance Manual 33, Easy-Stop™ Trailer ABS, or Maintenance Manual MM-0180, Enhanced Easy-Stop™ Trailer ABS with PLC, for trailer diagnostics.

ABS Configuration

With the E Basic ECU, 4S/4M is the only configuration used. Figure 1.3.

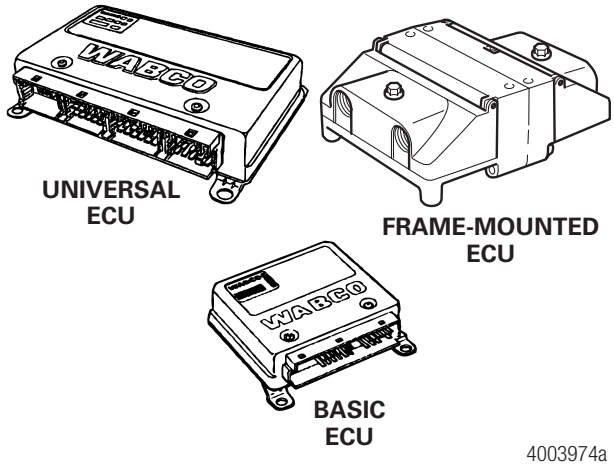


Figure 1.3

The ABS configuration is defined by the number of wheel-end sensors and modulator valves. There are three common ABS configurations used with E version ECUs.

- 4S/4M (4 wheel speed sensors, 4 modulator valves). Figure 1.4.
- 6S/4M (6 wheel speed sensors, 4 modulator valves)
- 6S/6M (6 wheel speed sensors, 6 modulator valves)

Typical illustrations in this manual use the 4S/4M configuration as a sample. Layouts for 4S/4M, 6S/4M and 6S/6M configurations are included in Appendix I.

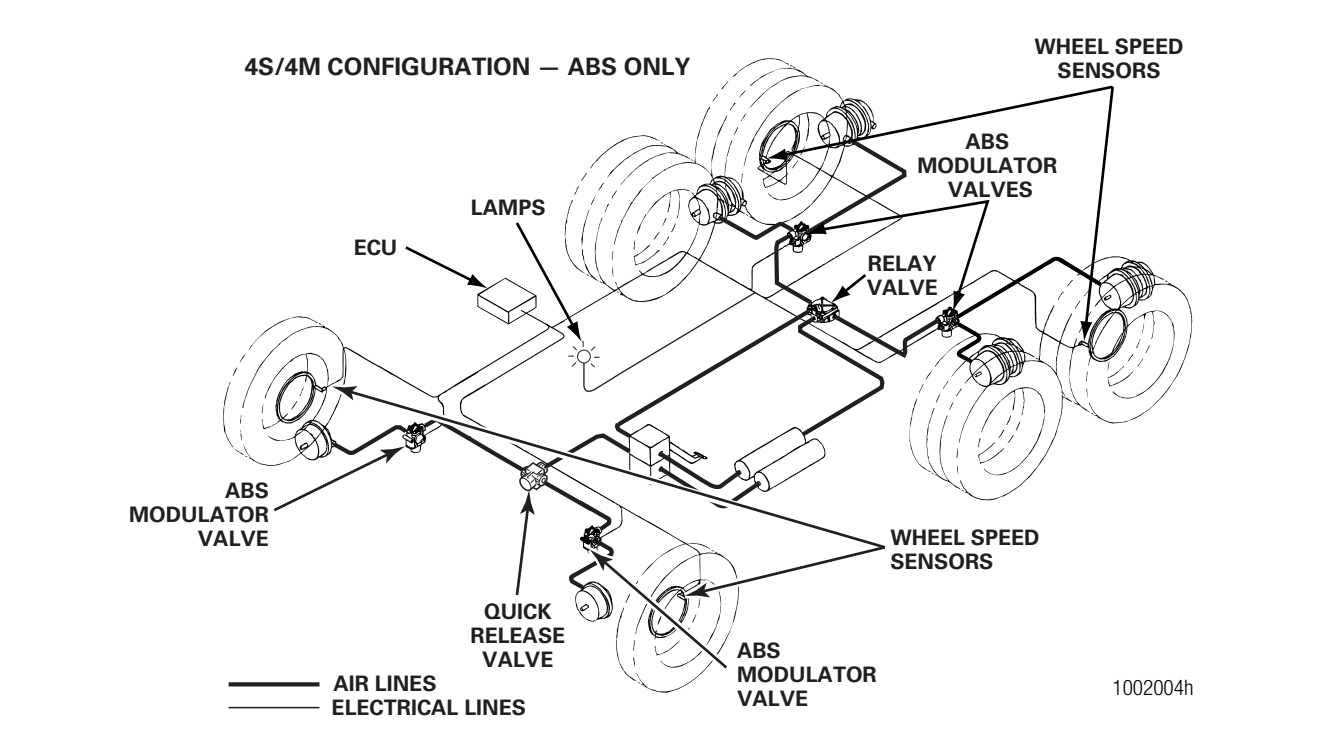
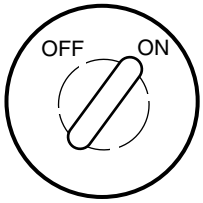


Figure 1.4

ABS Indicator Lamp

The ABS indicator lamp works as follows:

Ignition ON  1002005a	Normal Operation	ABS lamp comes on at ignition momentarily for a bulb check, then goes out.	System is OK.
	After servicing ABS	ABS lamp does not go out at ignition.	When vehicle is driven at speeds above 4 mph (6 km/h), lamp goes out. System is OK.
	Off-road ABS operation. Refer to the off-road ABS information in this section.	ABS lamp flashes during vehicle operation.	The vehicle's normal ABS function is being modified due to road conditions.
	Existing Fault	ABS lamp does not go out at ignition.	Lamp does not go out at speeds above 4 mph (6 km/h) — a fault exists in the ABS system.

NOTE: If the ECU senses a tractor ABS fault during normal vehicle operation, the ABS indicator lamp will come on and stay on.

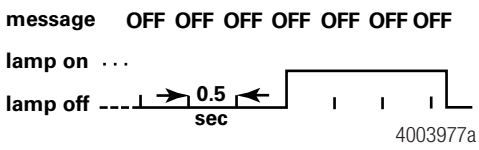
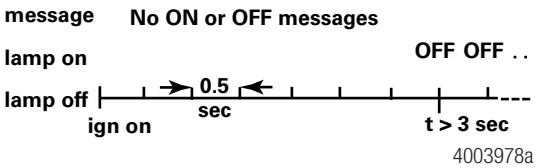
Trailer ABS Indicator Lamp

The trailer ABS indicator lamp on the vehicle dash applies to Trailer ABS only. The lamp is controlled by a signal to the tractor ECU, sent over the power line (PLC function). When a trailer ABS fault is detected, an ON message is sent; when no fault is detected, the ECU receives an OFF message. Table A illustrates trailer ABS lamp operation at power-up, or ignition on. Table B depicts lamp responses that occur during operation.

Lamp turn ON and OFF messages do not turn the lamp ON or OFF instantly. The delay between the receipt of the message and the lamp response time is intentional. It prevents erratic lamp activity.

NOTE: For doubles or triples, the lamp does not distinguish between trailers. A system fault in any of the trailers will activate the trailer ABS indicator lamp.

Table A: Dash-mounted Trailer ABS Indicator Lamp Operation — Bulb Check (Information for Drivers)

Signal from Trailer to Tractor ECU	Status of Trailer ABS Lamp on Vehicle Dash	Explanation
Single or Multiple Trailers  4003977a	Trailer ABS lamp comes on at ignition, OFF message is detected within three seconds of ignition, Trailer ABS lamp goes out.	Bulb Check performed AND Trailer ABS system is OK. In this case, the lamp is ON for a Bulb Check only.
Single or Multiple Trailers  4003978a	Trailer ABS lamp does not come on within three seconds of ignition.	No Bulb Check, trailer added after initial power-up, system OK. There was no trailer PLC message for at least three seconds following ignition ON.

ON = Turn ON message to the "trailer ABS" lamp

OFF = Turn OFF message to the "trailer ABS" lamp

Removing a trailer with a fault will cause the ABS lamp to turn off. Remember to have the trailer with the fault repaired as soon as possible before returning it to service.

Table B: Dash-mounted Trailer ABS Indicator Lamp Operation (Information for Service Technicians)

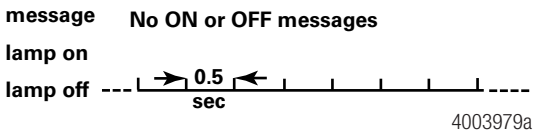
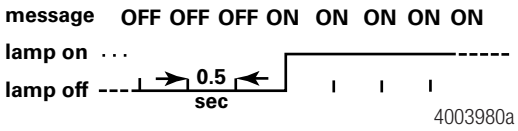
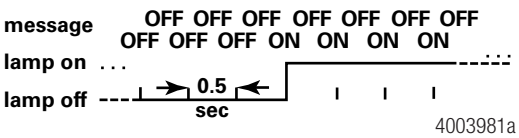
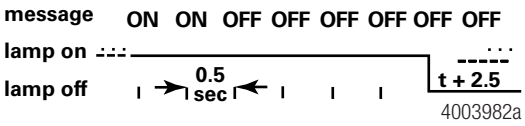
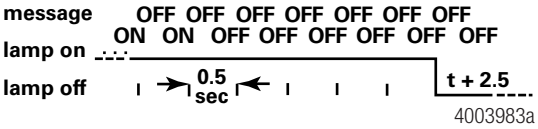
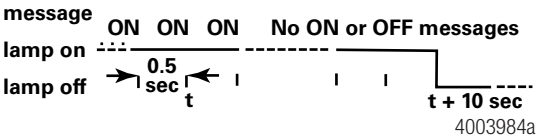
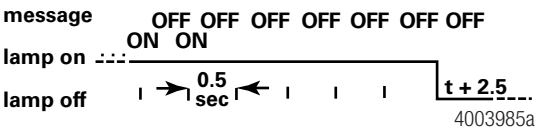
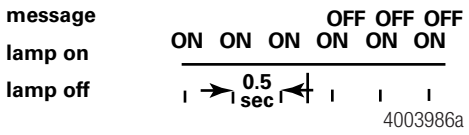
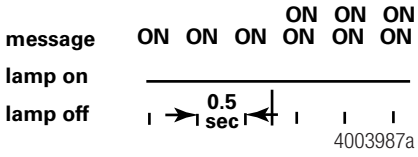
Signal from Trailer to Tractor ECU	Status of Trailer ABS Lamp on Vehicle Dash	Explanation	Action
Single or Multiple Trailers  4003979a	Trailer ABS lamp does not come on within three seconds of ignition.	Not using the PLC system (no trailer connected) or trailer not equipped with PLC or fault in PLC system.	Use lamp on side of trailer to identify fault. Make necessary repairs.
Single Trailer  4003980a	Trailer ABS lamp comes on.	Trailer ABS fault(s) occurred during operation and still exists.	
Multiple Trailers/Dollies  4003981a			
Single Trailer  4003982a	Trailer ABS lamp comes on but goes out after 2.5 seconds after fault is detected.	Trailer ABS fault occurred during operation and the fault was corrected.	None
Multiple Trailers/Dollies  4003983a			
Single Trailer  4003984a	ABS lamp is off, comes on, then goes off, 10 seconds after loss of messages.	ABS fault existed, then signal was lost because trailer disconnected or PLC fault.	Use lamp on side of trailer to identify fault. Make necessary repairs.
Multiple Trailers/Dollies  4003985a		ABS fault existed, then trailer with fault lost signal because trailer was disconnected or PLC fault.	

Table B: Dash-mounted Trailer ABS Indicator Lamp Operation (Information for Service Technicians)

Signal from Trailer to Tractor ECU	Status of Trailer ABS Lamp on Vehicle Dash	Explanation	Action
Single Trailer to Multiples  	ABS lamp is on and stays on when a new trailer with no new fault is added.	There was a fault in existence before the new trailer was added AND the ignition was not turned off before the trailer was added.	Use lamp on side of trailer to identify fault. Make necessary repairs.
Single Trailer to Multiples  	ABS lamp is on and stays on when a new trailer with a new fault is added.	ABS fault was in existence before the new trailer was added AND the ignition was not turned off before the trailer was added AND the new trailer has an ABS fault.	

ON = Turn ON message to the “trailer ABS” lamp

OFF = Turn OFF message to the “trailer ABS” lamp

Removing a trailer with a fault will cause the ABS lamp to turn off. Remember to have the trailer with the fault repaired as soon as possible before returning it to service.

ABS Modulator Valves

Modulator valves control the air pressure to each affected brake during an ABS function.

Valve Arrangement Option

In Figure 1.4, the modulator valves on the rear axle are mounted separately and a relay valve is used to deliver air pressure to the modulator valves. There is also an optional valve package available from Meritor WABCO, the ABS valve package, which may be found on certain vehicle models. The **ABS valve package** may be used on all D and E version units, including D and E Basic, and is available for front or rear axle installation.

Easy Listening Tip!

To ensure the ABS valves are working — just listen! Figure 1.5.

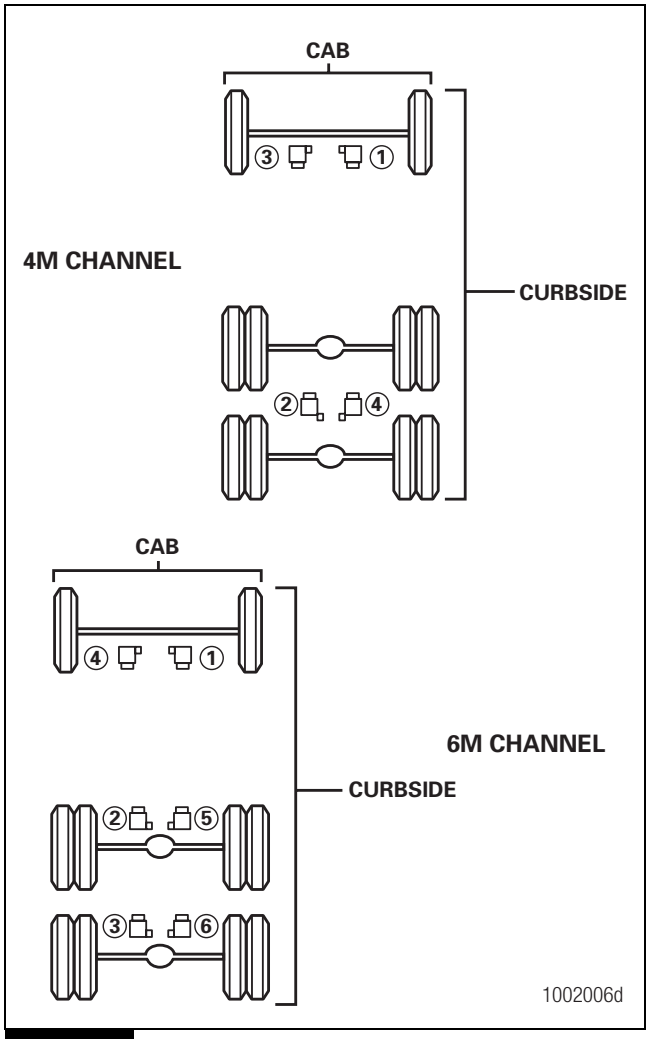


Figure 1.5

1. Apply the brakes.
2. Turn on the ignition.
3. Wait for the ABS indicator lamp to come on.

   NOTE: In previous versions of ABS, the valves are cycled diagonally. Diagonal cycling does not occur with E version ABS.

4. Listen to the valves cycle one by one, then together diagonally, as follows:

   - 4M (channel) valve cycle order:

     1 – 2 – 3 – 4

   - 6M (channel) valve cycle order:

     1 – 2 –3 – 4 – 5 – 6

ABS Valve Packages

The front ABS valve package combines a quick release valve with two ABS modulator valves and is mounted in the front of the vehicle. The rear ABS valve package combines a service brake relay valve with two ABS modulator valves and is mounted in the rear of the vehicle. The valve package, front or rear, must be mounted near the brake chambers it serves. Figure 1.6.

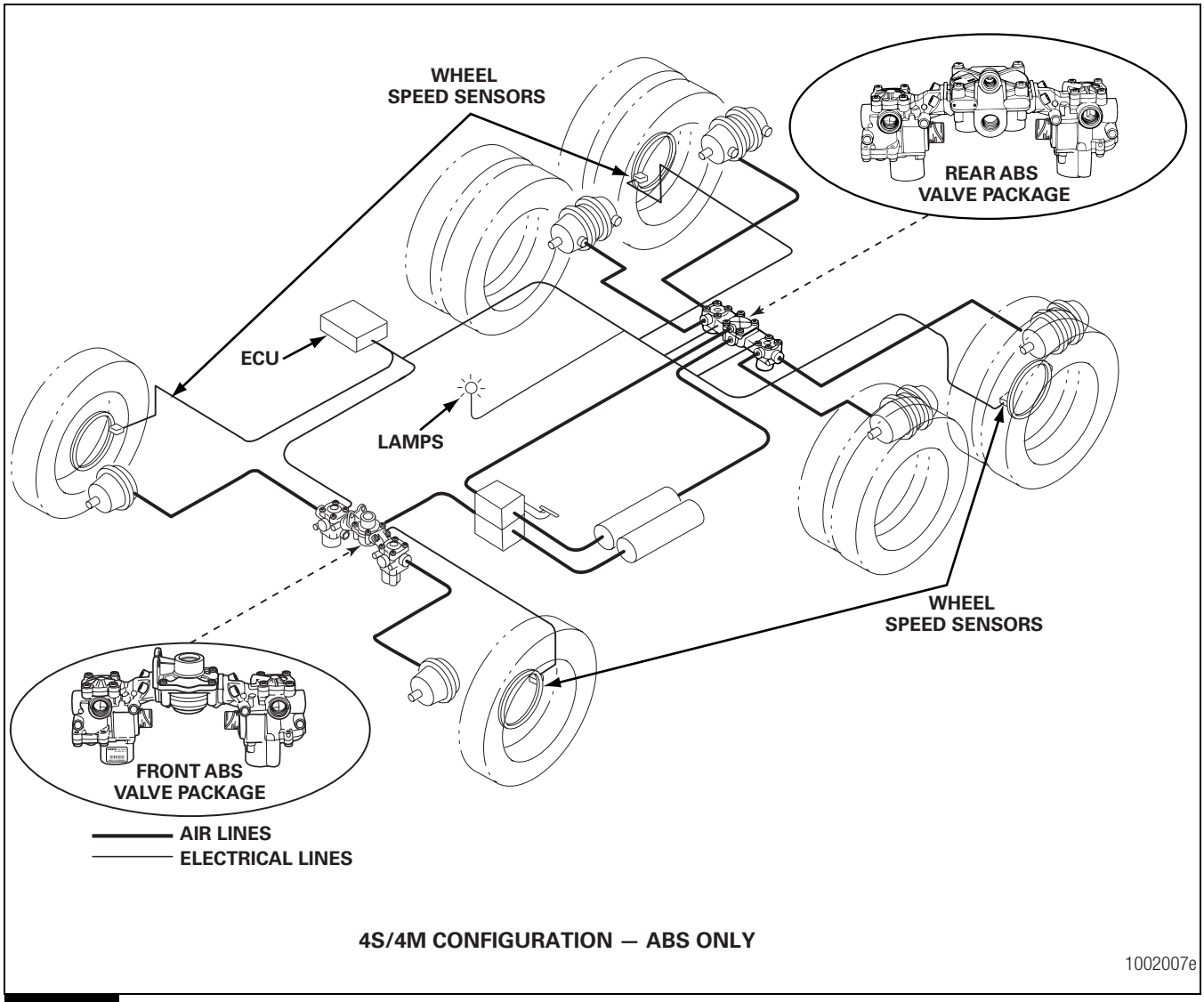


Figure 1.6

ABS Sensors

ABS sensor systems consist of a tooth wheel mounted on the hub of each monitored wheel and a sensor installed so that its end is against the tooth wheel. The sensor continuously sends wheel speed information to the ECU. A sensor clip holds the sensor in place at the tooth wheel.

The type of axle determines sensor mounting location.

- Steering axle sensors are installed in the steering knuckle or in a bolted-on bracket.
- Drive axle sensors are mounted in a block attached to the axle housing or in a bolted-on bracket.

Check the wheel speed sensors for correct alignment and apply lubricant to the sensor and sensor clip whenever wheel-end maintenance is performed. Refer to Section 3 and Section 4.

Off-Road ABS

On some vehicles, an off-road ABS function may be selected. Off-road ABS improves vehicle control and helps reduce stopping distances in off-road conditions or on poor traction surfaces such as loose gravel, sand and dirt. **This option is not available on 4S/4M frame-mounted ECUs.**

NOTE: On vehicles equipped with an off-road switch, the off-road ABS mode is manually selected by the driver. On some vehicles, the off-road mode may be fully automatic. Refer to the vehicle specifications for information about the off-road ABS feature.

The ABS indicator lamp on the dash will flash while the vehicle is in the off-road mode. This alerts the driver that the vehicle's normal ABS function is being modified.

Automatic Traction Control (ATC)

ATC is an option with Basic and frame-mounted E version ECUs and is available with all Universal ECUs. ATC can be used with individual valves, or with an integrated ABS/ATC valve package. Universal and frame-mounted 4S/4M E version ECUs with ATC may have roll stability control. Basic ECUs with ATC do not have RSC. Section 2 describes ATC and RSC in detail.

System Components

The **ECU** is the brain of the ABS system. It receives information from the sensors and sends signals to the ABS valves. ECUs are available for cab- or frame-mounted applications. Basic and universal ECUs are cab-mounted. Universal and frame-mounted 4S/4M E version ECUs with ATC may have roll stability control. Basic ECUs with ATC do not have RSC. Figure 1.7.

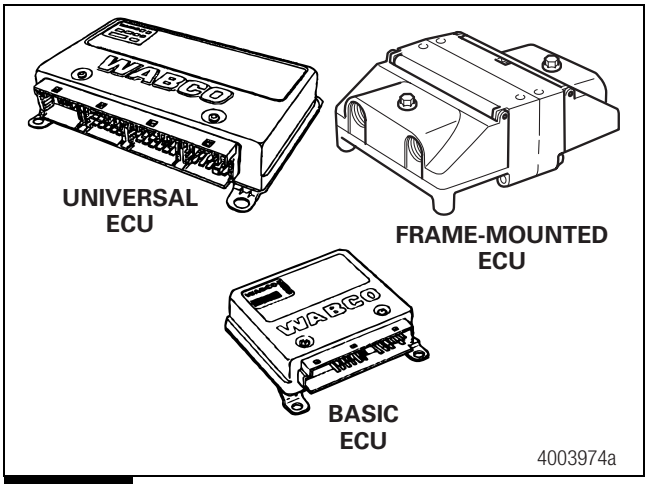


Figure 1.7

A **tooth wheel** is mounted at, or cast in, the hub of each sensed wheel, with a sensor installed so that its end is against the tooth wheel. A sensor clip holds the sensor in place at the tooth wheel. Figure 1.8.

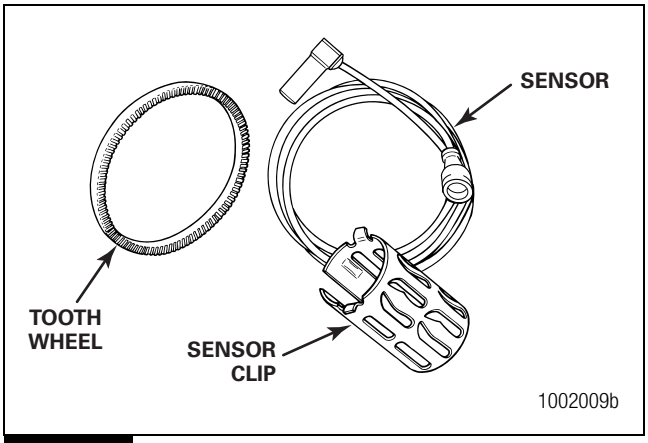


Figure 1.8

NOTE: The sensor and clip must be greased with Meritor WABCO-recommended lubricant whenever wheel-end maintenance is performed. Refer to Section 4 for lubrication specifications.

An **ABS modulator valve** controls air pressure to each affected brake during an ABS event. The modulator valve is usually located on a frame rail or cross member near the brake chamber. The modulator valve is available in bayonet-style, Figure 1.9, or open-style connector.

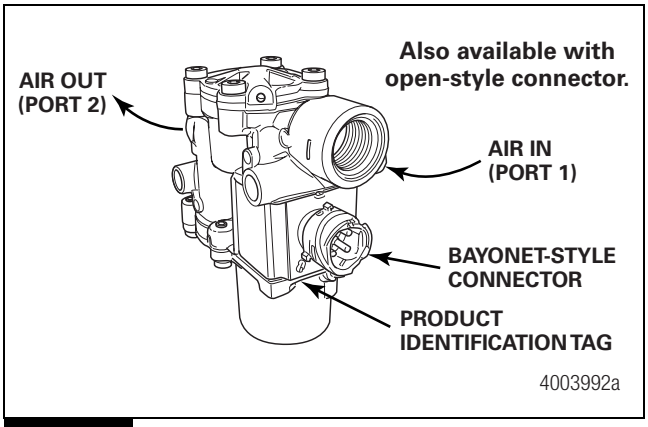


Figure 1.9

The **ABS valve package** is an alternative to individual valves.

The **rear ABS valve package** combines two modulator valves and one service relay valve. Figure 1.10.

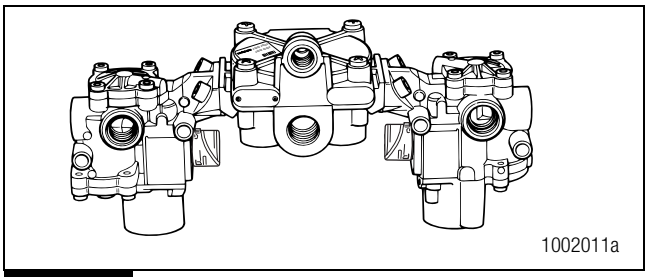


Figure 1.10

The **front ABS valve package** combines two modulator valves and a quick release valve. Figure 1.11.

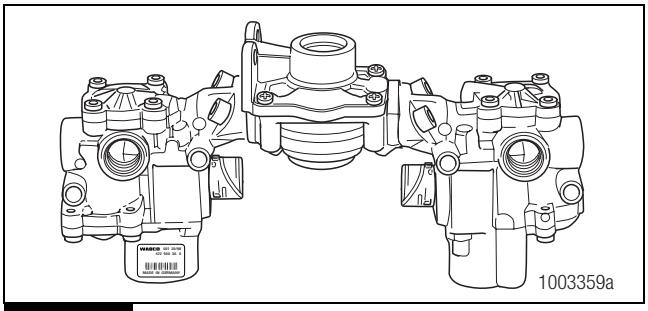


Figure 1.11

Sensor cables connect the sensor to the ECU. Figure 1.12.

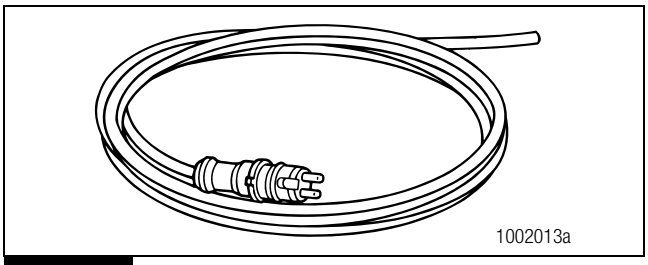


Figure 1.12

ABS modulator valve cables connect the modulator valve to the ECU. Figure 1.13.

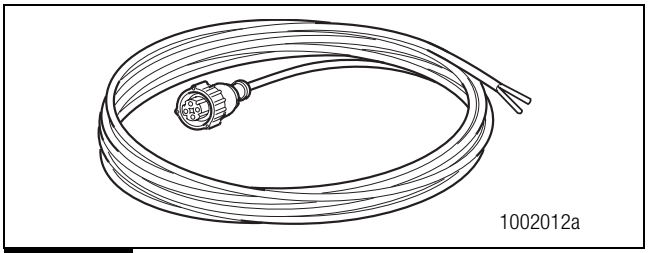


Figure 1.13

TOOLBOX™ Software is a PC-based diagnostics program that can display wheel speed data, test individual components, verify installation wiring and more. Runs in Windows® 98*, Me, 2000 or XP**. Internet Explorer version 3.02 or higher must be installed. RS232 to J1708 convertor box is required. Figure 1.14.

* Not recommended

** Approved for use with TOOLBOX™ as of July 2005

Figure 1.14

The **MPSI Pro-Link® Plus** with a multiple protocol cartridge (MPC) and Meritor WABCO applications card, version 2.0 or higher, provides diagnostic and testing capabilities for the E version ABS. Figure 1.15.

Figure 1.15

NOTE: The RSC functions of E version ABS cannot be tested with the Pro-Link® Plus.

ATC

Automatic traction control is available as an option on all E version ABS ECUs and is standard on most. ATC can be used with individual valves, or with an integrated ABS/ATC valve package. ATC helps improve traction when vehicles are on slippery surfaces by reducing drive wheel overspin. ATC works automatically in two different ways.

A. If a drive wheel starts to spin, ATC applies air pressure to brake the wheel. This transfers engine torque to the wheels with better traction.

B. If all drive wheels spin, ATC reduces engine torque to provide improved traction.

If ATC turns itself on and off, drivers do not have to select this feature. If drive wheels spin during acceleration, the ATC indicator lamp comes on, indicating ATC is active. It goes out when the drive wheels stop spinning. Figure 2.1.

NOTE: Some vehicle manufacturers may refer to ATC as Anti-Spin Regulation (ASR).

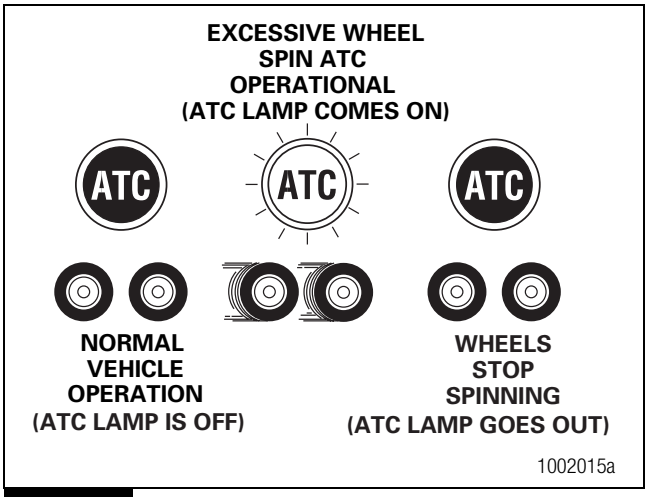


Figure 2.1

If ATC is installed, there will be an indicator lamp on the vehicle dash or instrument panel marked ATC or ASR.

If the ATC lamp goes out before the ABS lamp, there is no ATC.

An ATC installation may use an individually mounted valve, or the valve may be part of the ABS valve package. Figure 2.2.

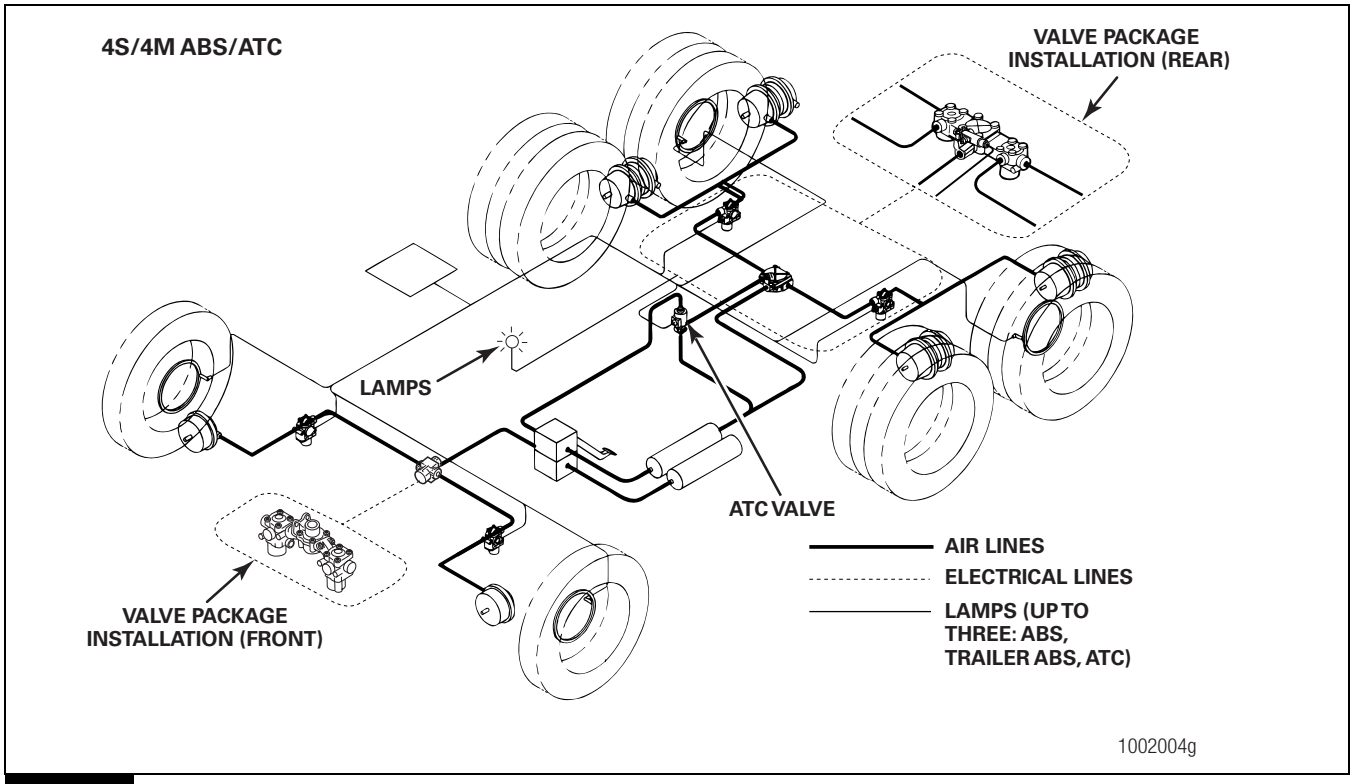


Figure 2.2

ATC Components

ATC may be used with individual ABS modulator valves, or installed with the ABS valve package.

When installed with individual ABS modulator valves, an ATC solenoid valve is mounted on the frame or cross member, near the rear of the vehicle.

When it is part of the ABS valve package, an ATC valve is attached to the relay valve.

A cable connects the ECU to the ATC valve.

ATC components are illustrated in Figure 2.3.

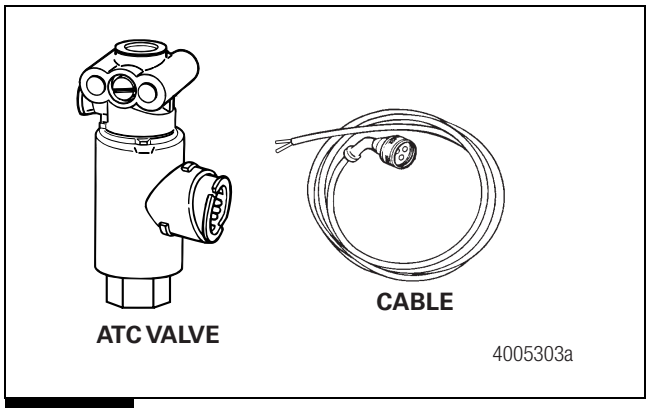


Figure 2.3

Deep Snow and Mud Switch

A deep snow and mud option switch is included with ATC. This function increases available traction on extra soft surfaces like snow, mud or gravel, by slightly increasing the permissible wheel spin.

Drivers use a deep snow and mud switch to select this feature. When this function is in use, the ATC indicator lamp blinks continuously. Figure 2.4.

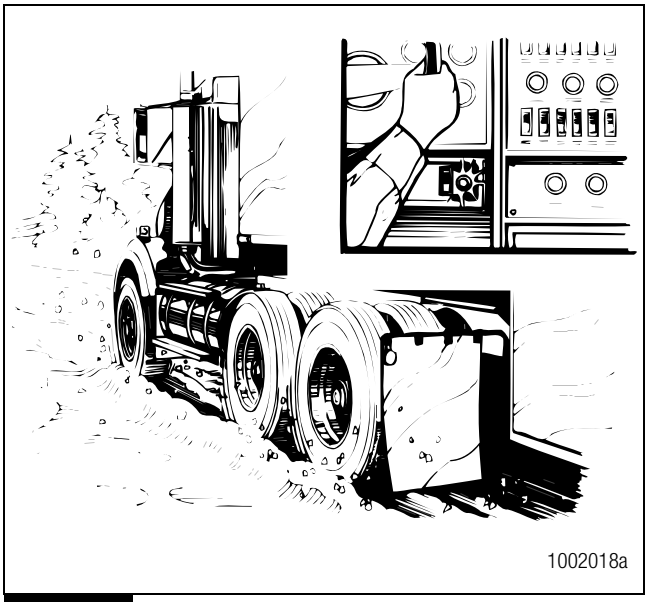


Figure 2.4

Switch and lamp locations will vary, depending on the vehicle make and model.

Here's how the deep snow and mud feature works.

		Function	
Driver Action	**System Response**	**Active**	**Not Active**
Press deep snow and mud switch	ATC lamp blinks continuously	X	
Press switch again	ATC lamp stops blinking		X

NOTE: Turning off the ignition will also deactivate the deep snow and mud feature.

RSC

Roll stability control is an option designed to assist drivers in managing the conditions that result in commercial vehicle rollovers. When RSC senses conditions that may result in a rollover, it reduces engine torque, engages the engine retarder, applies enough pressure to the drive axle brakes and may modulate the trailer brakes to slow the vehicle down. Like ATC, RSC works automatically. The driver does not have to select this feature.

RSC uses many of the same components used by ABS and ATC. A second solenoid valve, the RSC valve, controls the trailer service brakes during an RSC event. This is a stand-alone valve that is not available as part of the ABS/ATC valve package. Figure 2.5.

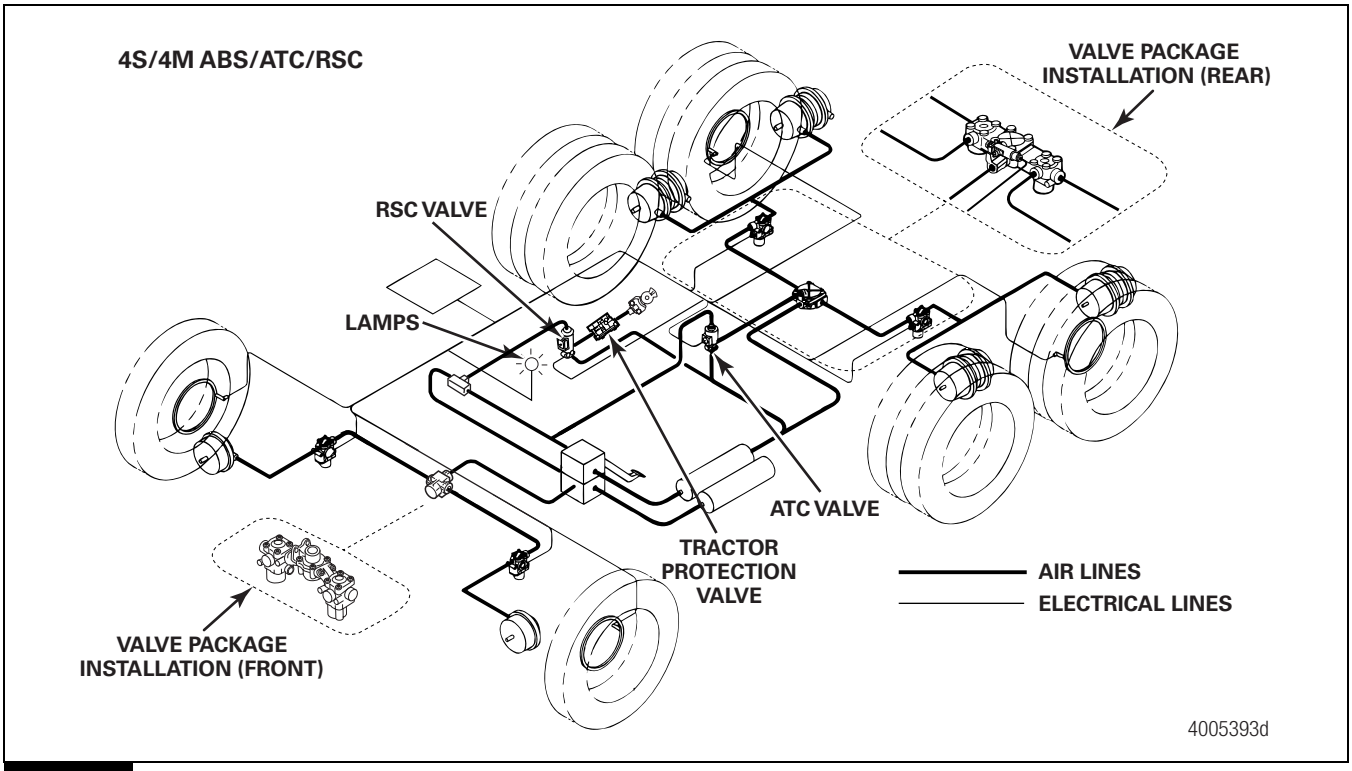


Figure 2.5

Because ATC and RSC functions share the same dash indicator lamp, understanding how the ABS and ATC/RSC lamps work is very important.

- If the vehicle is equipped with ATC, but not RSC, when the ignition is turned to the ON position, the ABS and ATC lamps will light for approximately three seconds, then both lamps will turn off simultaneously. Figure 2.6.
- If the vehicle is equipped with ATC and RSC, when the ignition is turned to the ON position, the ABS and ATC/RSC will both light . . . but the ATC/RSC lamp will stay lit briefly after the ABS lamp goes out.

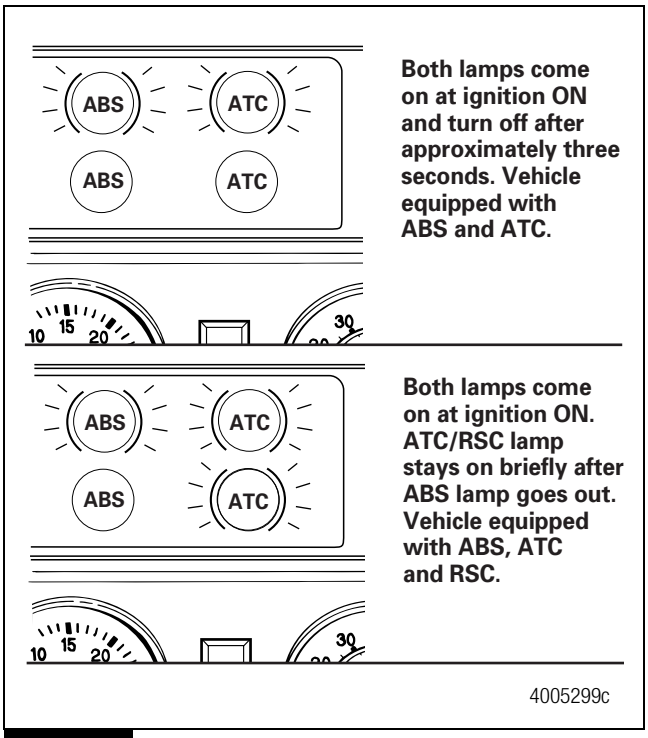


Figure 2.6

NOTE: Active mode means RSC is installed and will become active if it is needed.

TOOLBOX™ Software can also be used to determine if RSC is active. Refer to Section 3.

RSC Components

An additional solenoid valve is needed for RSC. The RSC valve controls the trailer service brakes during an RSC event. The RSC valve is a stand-alone valve. The valve is not part of an ABS valve package. Figure 2.7.

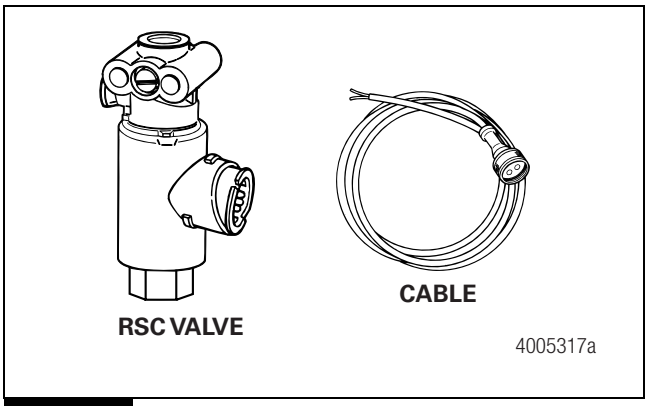


Figure 2.7

General

Maintenance Information

There is no regularly scheduled maintenance required for the Meritor WABCO ABS or ABS/ATC. However, ABS does not change current vehicle maintenance requirements.

- **Lamp Check:** To ensure the ABS tractor lamp is operating, drivers should check the lamp every time the vehicle is started. When the vehicle is started, the ABS lamp should come on momentarily. If it does not come on, it could mean a burned-out bulb.
- **ABS Wheel Speed Sensors:** Check the wheel speed sensor adjustment and lubricate the sensor and sensor clip whenever wheel-end maintenance is performed. Use only Meritor WABCO-recommended lubricant, as specified in Section 4.

Diagnostics

Use any of the following methods to diagnose E version ABS:

- TOOLBOX™ Software, a PC-based ABS diagnostic and testing program that runs in Windows® 98*, Me, 2000 or XP**. Internet Explorer version 3.02 or higher must be installed. Refer to the information in this section.
- Blink Codes. Refer to the information in this section.
- MPSI Pro-Link® Plus with MPC and Meritor WABCO applications card, version 2.0 or higher. Refer to the information in this section.
- OEM Diagnostic Displays. Refer to the vehicle operator's manual.

Information about TOOLBOX™ Software, MPSI Pro-Link® Plus and blink codes follows. If you have any questions about system diagnostics, please contact ArvinMeritor's Customer Service Center at 800-535-5560.

* Not recommended

** Approved for TOOLBOX™ as of July 2005

TOOLBOX™ Software Diagnostics

NOTE: For complete instructions for using TOOLBOX™ Software, refer to the User's Manual. The manual is posted on meritorwabco.com/TOOLBOX.

If you have TOOLBOX™ Software installed on your computer, use it to identify system faults. Then, follow the on-screen repair information to make the necessary repairs or replacements.

To display E version ABS faults:

1. Connect the computer to the vehicle:
   - Attach the cable from your computer to the J1708 to RS232 converter box.
   - Attach the diagnostic cable (Deutsch) to the vehicle. Figure 3.1.

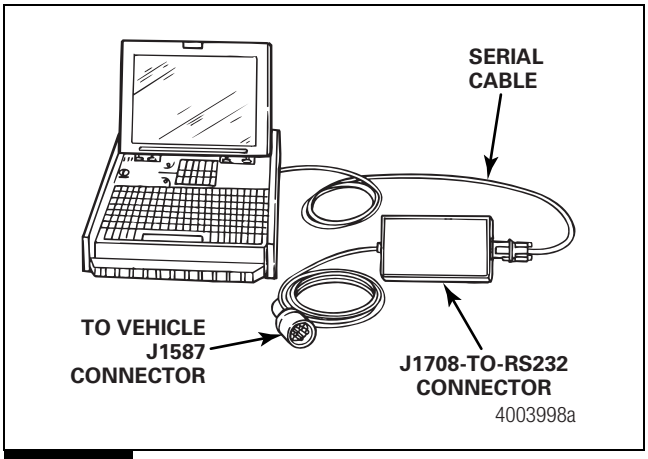


Figure 3.1

2. Select TOOLBOX™ Software from the Desktop or from the Windows Start Menu to display the TOOLBOX™ Main Menu. From the **Main Menu**, select **Tractor ABS**. The **ABS Main Screen** will appear. Figure 3.2.

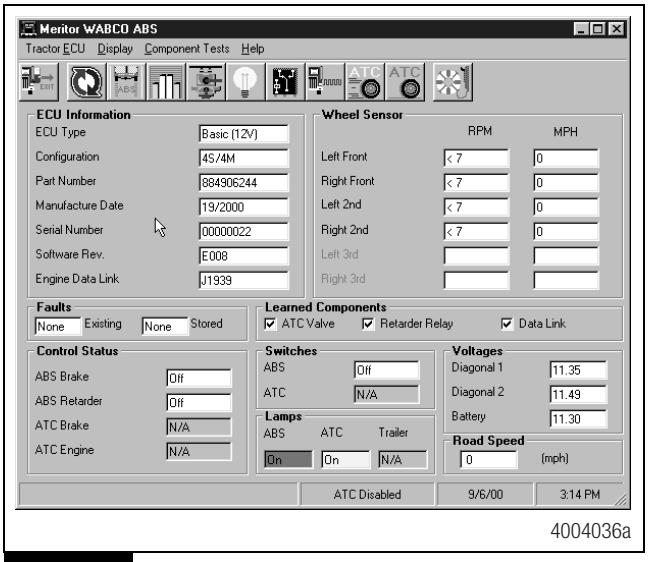


Figure 3.2

3. Select **Display** for a pull-down menu.

4. From the pull-down menu, select **Faults** to bring up the Fault Information screen. Figure 3.3.

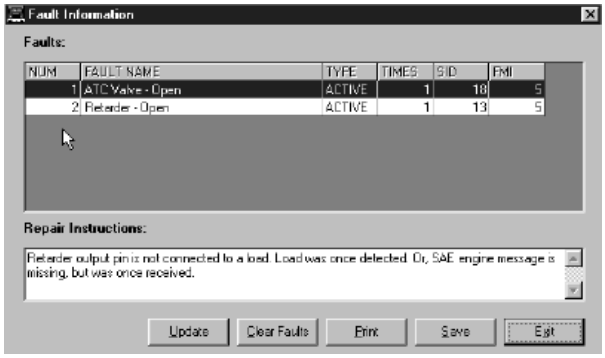


Figure 3.3

5. A description of the fault, the number of times the fault occurred, the system identifier (SID) and the failure mode (FMI) are all displayed in the fault information window. Basic repair instructions for each fault are also provided. Figure 3.3.

   For detailed repair instructions, click on the fault to display a troubleshooting information sheet. **Bookmark** and **Thumbnail** tabs at the side of the troubleshooting information sheet provide additional information. A s ample troubleshooting information sheet appears in the Appendix. This screen also provides a link to the appropriate system schematic.

   Faults that may occur after the screen is displayed will not appear until a screen update is requested. Use the **update** button to refresh the fault information table.

   After making the necessary repairs, use the **clear faults** button to clear the fault. Use the **update** button to refresh the fault information table and display the new list of faults.

   Use the **Save** or **Print** button to save or print the fault information data.

Blink Code Diagnostics (Tractor ABS Only)

Definitions

Before using blink code diagnostics, you should be familiar with a few basic terms. If you used previous versions of Meritor WABCO's blink code diagnostics, review these definitions to identify major changes.

ABS Indicator Lamp: This lamp serves two purposes: it alerts drivers to an ABS tractor fault and it is used during diagnostics to display the blink code.

Blink Code: A series of blinks or flashes that describe a particular ABS system fault or condition.

Blink Code Cycle: Two sets of flashes with each set separated by a one-and-one-half second pause. Blink codes are defined in the blink code identification information in this section.

Blink Code Switch: A momentary switch that activates blink code diagnostic capabilities. Switch types and locations vary, depending on the make and model of the vehicle.

Clear: The process of erasing faults from the ECU.

Diagnostics: The process of using blink codes to determine ABS system faults.

Fault: An ABS malfunction detected and stored in memory by the Meritor WABCO ECU. System faults may be Active or Stored.

Active Fault: A condition that **currently exists** in the ABS system; for example, a sensor circuit malfunction on the left front steering axle. An active fault must be repaired before it can be cleared from memory — and before you can display additional blink code faults.

Stored Fault: There are two types of stored faults:

A. A repaired active fault that **has not been cleared** from the ECU.

B. A fault that occurred but **no longer exists**. For example, a loose wire that makes intermittent contact. Because stored faults are not currently active, they do not have to be repaired before they can be cleared from memory.

Meritor WABCO recommends you keep a record of these faults for future reference.

System Configuration Code: One digit code displayed during the clear mode. Blink codes for common ABS system configurations are shown in Figure 3.4.

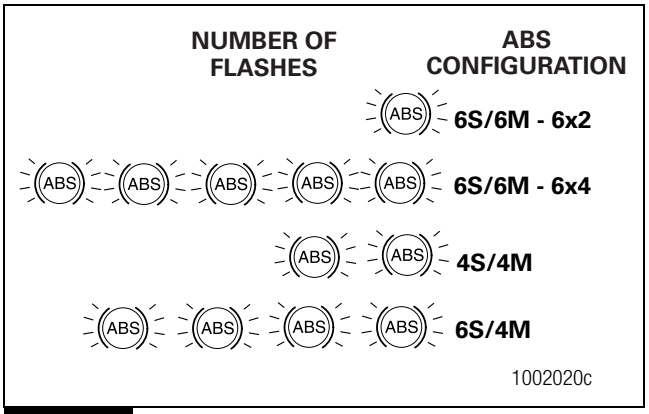


Figure 3.4

Diagnostic Mode

To enter the diagnostic mode, press and hold the blink code switch for one second, then release.

Clear Mode

To erase faults from the ECU, you must be in the clear mode. To enter the clear mode, press and hold the blink code switch for at least three seconds, then release.

If the system displays eight quick flashes followed by a system configuration code, the clear was successful. Stored ABS faults have been cleared from memory.

If you do not receive eight flashes, there are still active faults that must be repaired before they can be cleared.

NOTE: The clear mode is also used to disable the ATC function.

Table C: Troubleshooting with Blink Code Diagnostics

Procedure	System Response	Action
	Diagnostics Mode	
Step I.	Possible responses:	
Turn ignition ON.	ABS indicator lamp comes on momentarily then goes out, indicating System OK.	No recognizable active faults in the ABS. No action required.
	ABS indicator lamp does not light, indicating possible wiring fault or burned-out bulb.	Inspect wiring. Inspect bulb. Make necessary repairs.
	ABS indicator lamp stays on, indicating:	
	• Fault, or faults, in the system.	Continue with blink code diagnostics. **(Go to Step II.)**
	• Sensor fault during last operation.	Continue with blink code diagnostics. **(Go to Step II.)**
	• Faults cleared from ECU, but vehicle not driven.	Drive vehicle — lamp will go out when vehicle reaches 4 mph (6 km/h).
	• ECU disconnected.	Connect ECU.
Step II.	ABS indicator lamp begins flashing two digit blink code(s).	Determine if fault is active or stored:
Press and hold Blink Code Switch for one second, then release.		**Active Fault:** Lamp will repeatedly display one code.
		Stored Fault: Lamp will display code for each stored fault then stop blinking. Faults will be displayed **one time only.**
Step III.	First Digit: 1-8 flashes, Pause (1-1/2 seconds)	Find definition for blink code on blink code chart.
Count the flashes to determine the blink code.	Second Digit: 1-6 flashes, Pause (4 seconds)	
Step IV.	Active Fault	Make the necessary repairs. Repeat Step 1, Step II and Step III until System OK, code (1-1) received.
Turn ignition OFF.		
Repair and record faults.	Stored Fault	Record for future reference.
		NOTE: Last fault stored is first fault displayed.
	Clear Mode	
Step V.	ABS indicator lamp flashes eight times.	All stored faults successfully cleared. Turn ignition OFF.
Turn ignition ON.		
Clear Faults from memory: Press and hold blink code switch for at least three seconds, then release.	Eight flashes not received.	Active faults still exist, repeat Step I through Step V.

Blink Code Illustrations

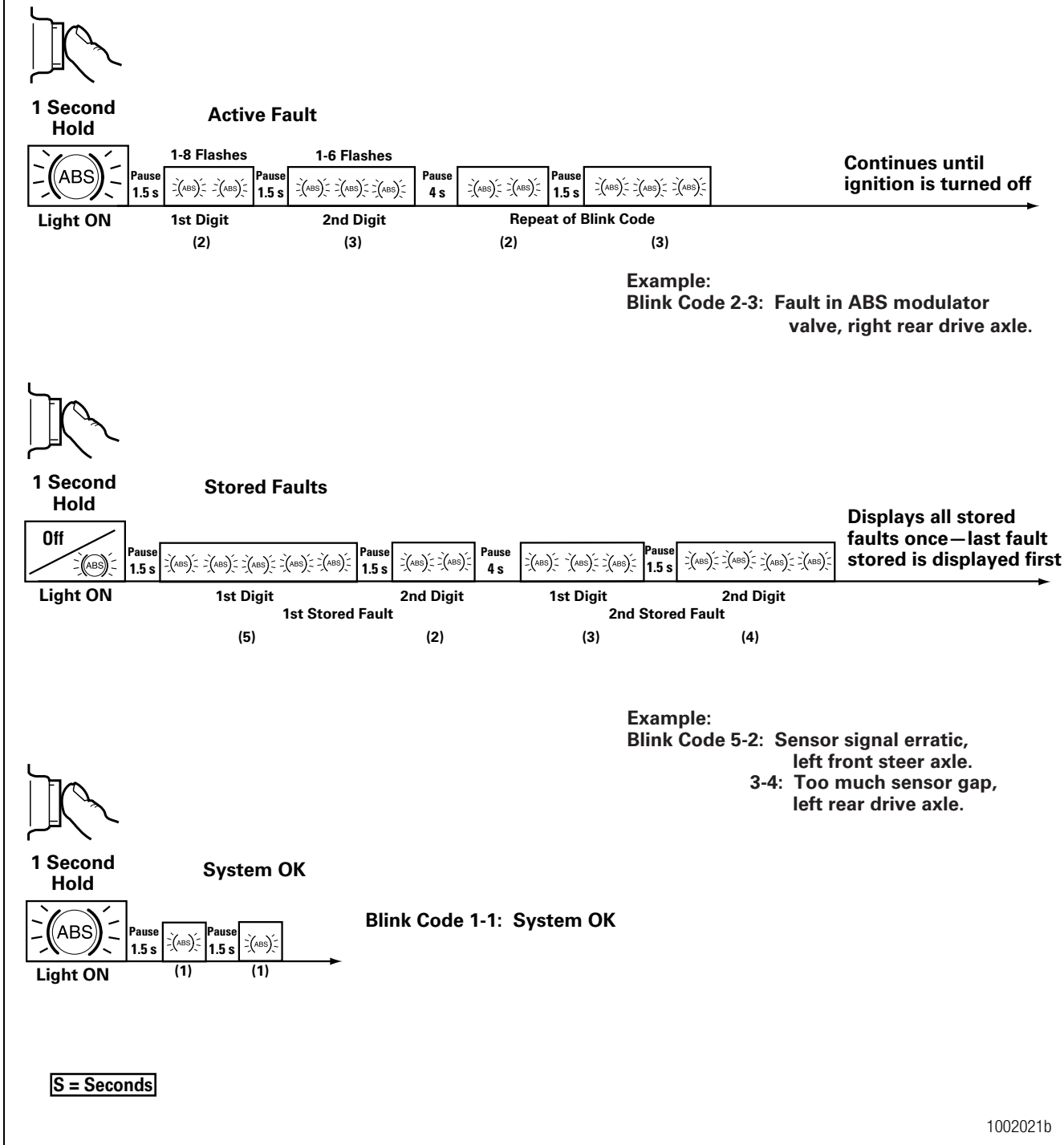


Figure 3.5

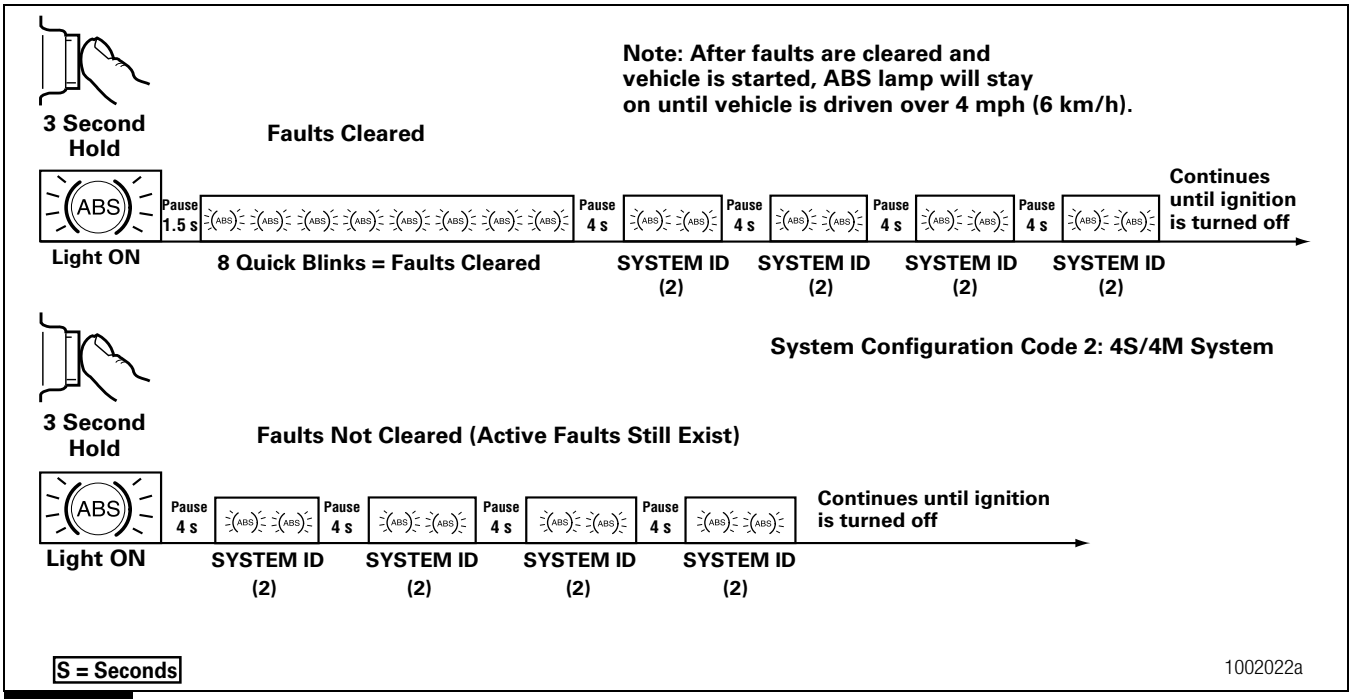


Figure 3.6

Blink Code Conditions

When using blink code diagnostics, the following conditions could occur:

Table D: Blink Code Conditions

Condition	Reason	Action
ABS indicator lamp does not come on at ignition.	Loose or burned-out bulb.	Check bulb. Check connections. Make necessary repairs.
	Voltage not within acceptable range (9.5-14.0 volts).	Check connections. Measure voltage. Make necessary repairs.
Can't use blink code diagnostics. ABS indicator lamp will not go off when blink code is activated.	Switch not held for correct length of time: 1 Second — Diagnostics Mode 3 Seconds — Clear All Mode	Repeat procedure, hold switch for correct length of time.
	Incorrect or faulty wiring.	Inspect and repair wiring.
	Fault not erased from ECU after report.	Repeat procedure until System O.K. code received.
Eight flashes not received after blink code switch pressed for at least three seconds, then released.	Active faults still exist.	Identify active faults, then make necessary repairs. Turn ignition OFF, then repeat Blink Code Diagnostics.

Blink Code Identification

Use the following information to identify the blink code:

First Digit (Type of Fault)	Second Digit — Specific Location of Fault
1 No faults	1 No faults
2 ABS modulator valve	1 Right front steer axle (curb side)
3 Too much sensor gap	2 Left front steer axle (driver's side)
4 Sensor short or open	3 Right rear drive axle (curb side)
5 Sensor signal erratic/tire size	4 Left rear drive axle (driver's side)
6 Tooth wheel	5 Right rear/additional axle (curb side)[1]
	6 Left rear/additional axle (driver's side)[1]
7 System function[2]	1 J1939 datalink
	2 ATC valve
	3 Retarder relay (third brake)
	4 ABS indicator lamp
	5 ATC configuration
	6 RSC valve
8 ECU	1 Low power supply
	2 High power supply
	3 Internal fault
	4 System configuration error
	5 Ground
	6 RSC accelerometer

[1] Tandem, lift, tag or pusher axle depending upon the type of suspension

[2] If this code continues after all repairs have been made — or if you receive a code for a component that is not installed on the vehicle — it may be necessary to reconfigure the ECU. Refer to Appendix III. TOOLBOX™ Software may also be used to reconfigure the ECU (refer to Appendix III). Contact ArvinMeritor's Customer Service Center at 800-535-5560 for reconfiguration information.

Blink Code Troubleshooting and Repair

Blink Code	Action Required	Reference
2-1, 2-4 2-2, 2-5 2-3, 2-6	Check ABS modulator valve, valve cable and connectors. Verify 4.0-9.0 ohms resistance (ABS modulator valve).	Refer to Valve Tests in this section.
3-1, 3-4 3-2, 3-5 3-3, 3-6	Adjust wheel sensor to touch tooth wheel. Check sensor gap. Check for loose wheel bearings or excessive hub runout. Verify minimum 0.2 volts AC output @ 30 rpm.	Refer to Testing Components in this section.
4-1, 4-4 4-2, 4-5 4-3, 4-6	Check sensor, sensor cable and connectors. Verify 900-2000 ohms resistance.	Repair or replace as needed.
5-1, 5-4 5-2, 5-5 5-3, 5-6	Check for tire size mismatch or tooth wheel difference. Check sensor, sensor cable, and connector for intermittent contact.	Refer to Tire Size Range in this section.
6-1, 6-4 6-2, 6-5 6-3, 6-6	Check for damaged tooth wheel.	Repair or replace as needed.
7-1*	Check for correct J1939 data link connection. Verify correct sensor adjustment. Refer to the sensor adjustment information in this section.	Refer to the wiring diagram in Appendix II.
7-2*	Check ATC valve, valve cables and connectors. Verify 7.0-14.0 ohms resistance.	Refer to Valve Tests in this section.
7-3*	Check retarder (third brake) connections.	Refer to the wiring diagram in Appendix II.
7-4*	Check ABS indicator lamp connections. Verify blink code switch was activated longer than 16 seconds.	
7-5*	Verify correct ATC set-up.	
7-6*	Check RSC valve. Verify 7.0-14.0 ohms resistance.	Refer to Valve Tests in this section.
8-1	Check for low voltage. Check vehicle voltage, fuse and supply to ECU (9.5-14.0 volts).	Refer to the wiring diagram in Appendix II and Voltage Check in this section.
8-2	Check for high voltage. Check for vehicle voltage (9.5-14.0 volts). Verify accuracy of blink code and clear from ECU memory.	Refer to Voltage Check and Blink Code Diagnostics (Tractor ABS Only) in this section.
8-3	Verify accuracy of blink code and clear from ECU memory.	Refer to Blink Code Diagnostics (Tractor ABS Only) and Clear Mode information in this section.
8-4	Verify all ECU connectors are in place. Verify accuracy of blink code and clear from ECU memory. *If code does not clear, it may be necessary to replace the ECU.*	Contact ArvinMeritor's Customer Service Center at 800-535-5560.
8-5	Check all ABS, ECU, ATC and RSC valve grounds.	Refer to the wiring diagram in Appendix II.
8-6	Verify accuracy of blink code and clear from ECU memory.	Contact ArvinMeritor's Customer Service Center at 800-535-5560.

* If this code continues after all repairs have been made — or if you receive a code for a component that is not installed on the vehicle — it may be necessary to reconfigure the ECU. Refer to the Appendix III. TOOLBOX™ Software may also be used to reconfigure the ECU (refer to Appendix III). Contact ArvinMeritor's Customer Service Center at 800-535-5560 for additional information or assistance.

Pro-Link® Plus Diagnostics

NOTE: You must use the Multiple Protocol Cartridge (MPC) and Meritor WABCO applications card, version 2.0 or higher, with E version ECUs. **The PLC functions of E version ABS cannot be tested with the Pro-Link® Plus.**

The Pro-Link® Plus may be used in place of blink code diagnostic procedures.

The Pro-Link® Plus screens illustrated appear with E version ECUs. Refer to Maintenance Manual 28, Anti-Lock Braking Systems (ABS) for Trucks, Tractors and Buses, if you are using the Pro-Link® Plus with C version ECUs or Maintenance Manual 30, Anti-Lock Braking Systems (ABS) for Trucks, Tractors and Buses, if you are using the Pro-Link® Plus with D version ABS.

Diagnostic Procedure

1. Slide the MPC into the Pro-Link® Plus keypad until the connection is tight. Then, insert the Meritor WABCO applications card into the cartridge.
2. Block the wheels, apply the parking brake, and verify that the ignition power is off.
3. Locate the 6-pin diagnostic receptacle in the vehicle cab. Insert the 6-pin connector from the Pro-Link® Plus into the receptacle.
4. Turn the ignition to the ON/RUN position. The Pro-Link® Plus screen should power up.

   If the Pro-Link® Plus does not power up, or if the screen indicates NO DATA RECEIVED:

   - Check connections.
   - Verify that the cartridge is correctly connected to the Pro-Link® Plus keypad.
   - Verify 9.5-14.0 volts DC power and ground at the connector and ABS ECU.
   - Check the fuse panel for a blown fuse.
   - Check for correct wiring in the diagnostic connector.
5. Refer to the Pro-Link™ Plus manual for complete diagnostic instructions.

The Pro-Link® Plus is available from SPX, 800-328-6657.

Pro-Link® Plus Screens

This information provides basic screen explanations for the Pro-Link® Plus with an MPC and Meritor WABCO application card. For complete operating instructions and test information, refer to the Pro-Link® Plus manual.

Fault Information Screens

Existing Faults: Use these screens to identify existing faults. The Pro-Link® Plus screen displays a written description of the fault, including the location on the vehicle where each exists. As long as there is an active (existing) fault in the system, the Pro-Link® Plus will not let you clear faults.

Stored Faults: Use these screens to identify faults stored in the ECU memory. Stored faults may be existing faults that have been repaired, or faults that existed for a short time, then corrected themselves. After displaying the stored faults, the Pro-Link™ Plus lets you erase them from memory. All stored faults are cleared at one time.

Pro-Link® Plus Display

Depending upon the ECU being tested, the Pro-Link® Plus screen will display certain options or components only when recognized by the ECU. These include:

- ATC, ATC Indicator Lamps, Trailer ABS Indicator Lamp, ATC Valve
- Engine Datalink
- Retarder Relay
- Retarder Datalink

Component Test Screens (Pro-Link® Plus)

These screens help you test ABS components. Select this function from the Tractor ABS/ATC menu.

ABS VALVES

ATC

ABS INDICATOR LAMP

ABS TRAILER INDICATOR LAMP

ATC INDICATOR LAMP

ABS/ATC SWITCHES

SENSORS

ENGINE DATALINK

RETARDER RELAY

RETARDER DATALINK

VEHICLE VOLTAGES

Select the appropriate function. Each screen has instructions to guide you through the test. Refer to the Pro-Link® Plus Manual for complete instructions.

J1939 Datalink Verification — Pro-Link® Plus

The Pro-Link® Plus diagnostic tool may be used to verify J1939 datalink connection. If you do not have a Pro-Link® Plus, you can use the blink code switch to verify this connection.

1. Turn ignition ON. Press blink code switch — hold for three seconds.

   A. ATC indicator lamp will come on and stay on for the entire test.

   If the vehicle is not equipped with ATC, the ATC indicator lamp will not come on.

   B. ABS indicator lamp will come on and blink eight times.

   If the lamp does not blink eight times, there are faults that must be cleared before you continue with this test.

   C. The eight quick flashes will be followed by the system configuration code. A 4S/4M (two blinks) system is identified here.

   The system configuration code will continue during the entire test.

2. Activate the J1939 engine torque reduction code, as follows:

   A. Step on the accelerator. Bring the engine to 1000 rpm.

   Leave your foot on the accelerator during the entire test.

   B. While the engine is at 1000 rpm, press the blink code switch twice, as follows:

   Press for one second

   Release for one second

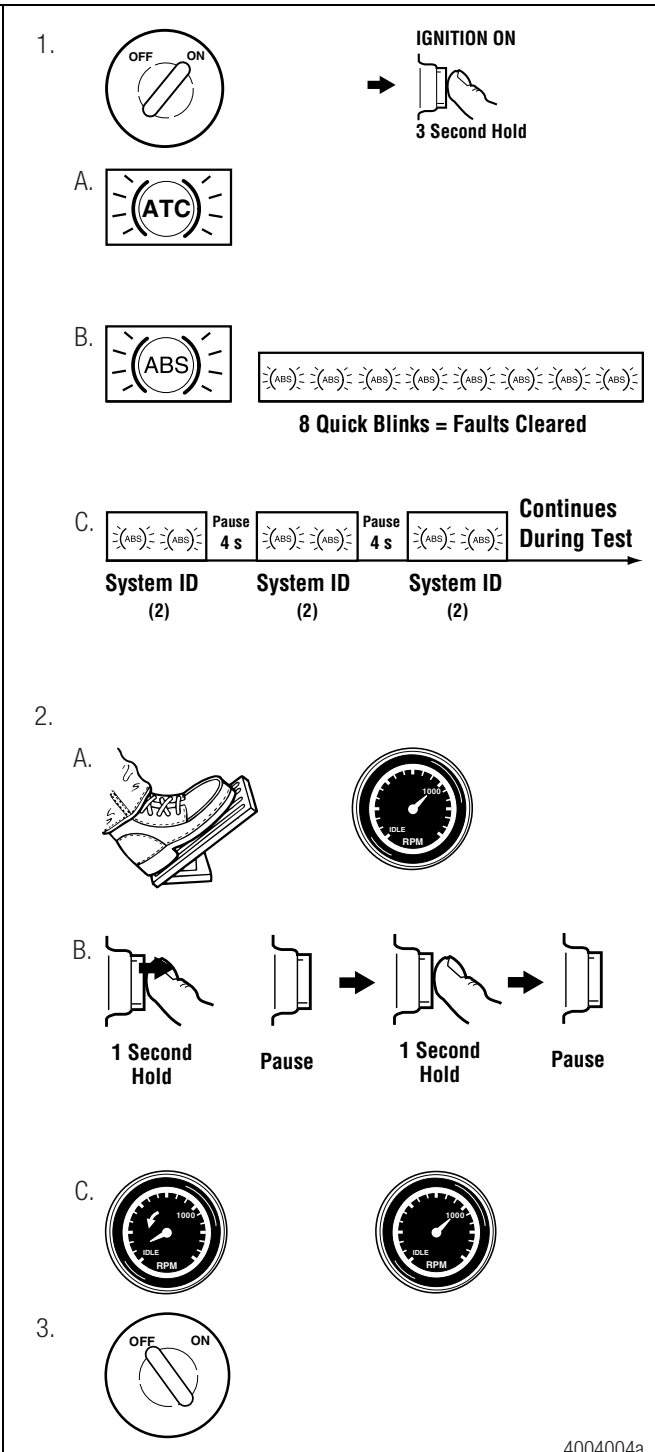
   Press for one second

   Release for one second

   C. The engine will go to idle for approximately 10 seconds and then return to 1000 rpm.

3. Turn ignition OFF.

   Test complete, engine torque reduction command verified.

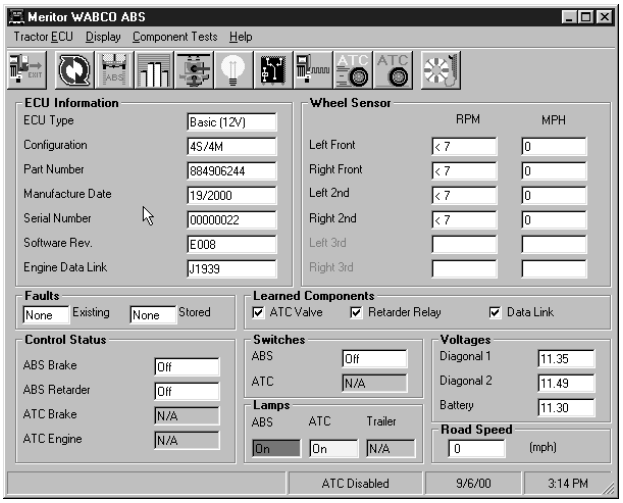


System Information

TOOLBOX™ Software Display

NOTE: Refer to the procedure in this section for TOOLBOX™ Software instructions, or refer to the Software Owner's Manual, TP-99102, for complete operating instructions.

The quickest method of verifying system information is the TOOLBOX™ Software **ABS Main Screen**. Figure 3.7.



4004036a

Figure 3.7

This screen provides information about the current state of Meritor WABCO ABS. ECU information is read once from the ECU and does not change. All other information (e.g., wheel sensors, control status, voltages, faults and road speed) is read and updated continuously.

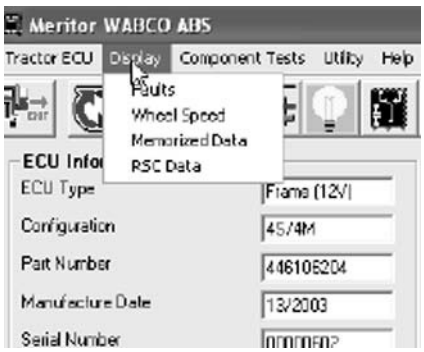
The status of ABS switches and lamps, as well as other data, may also be observed from this screen.

TOOLBOX™ Software

Display

Select ***Display*** from the Tractor ***ABS Main Screen***. A pull down menu will appear.

In addition to fault identification and repair information, the display option on the Tractor Main Screen provides Wheel Speed, Memorized Data and RSC Data. Figure 3.8.

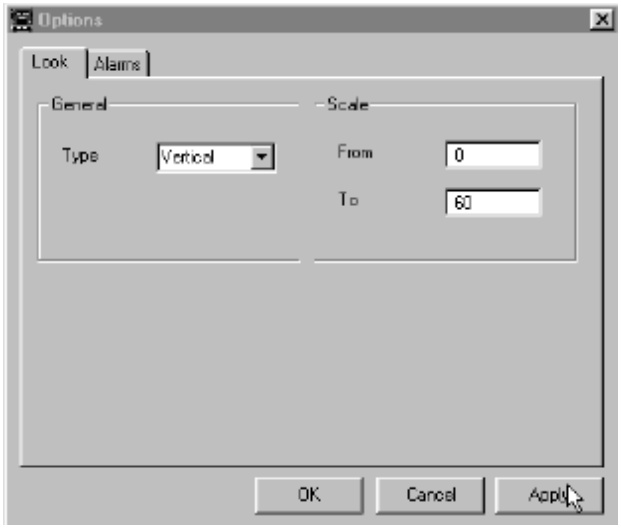


4005305a

Figure 3.8

Wheel Speed

Select the wheel speed icon or use the Display menu from the ABS Main Screen to display wheel speed data in both numeric and graphical form. This data may be shown in RPM or MPH format, Figure 3.9, and in vertical or horizontal graphs, Figure 3.10 and Figure 3.11. Select the appearance and style from the options menu.



4004006a

Figure 3.9

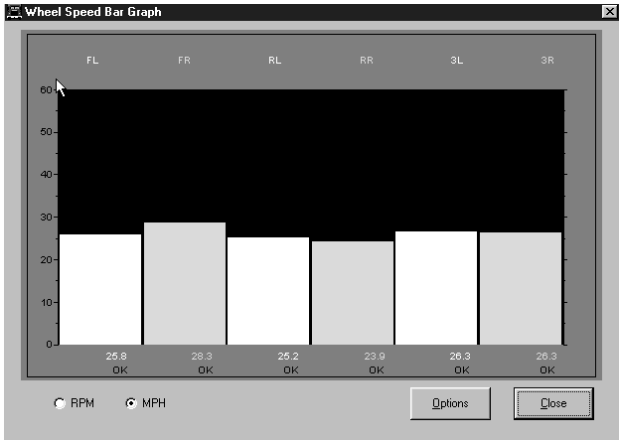


Figure 3.10

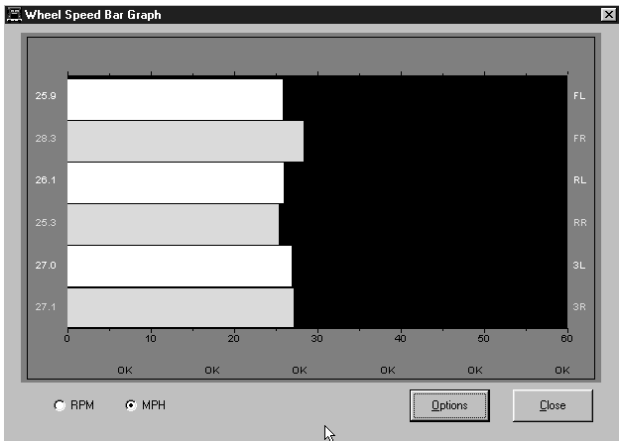


Figure 3.11

Memorized Data

Select ***Memorized Components*** from the Display menu.

NOTE: Use Display/Memorized Components to **view** data. Figure 3.12. To **clear** a memorized component, use the Memorized Components function that appears on the Component Tests Menu.

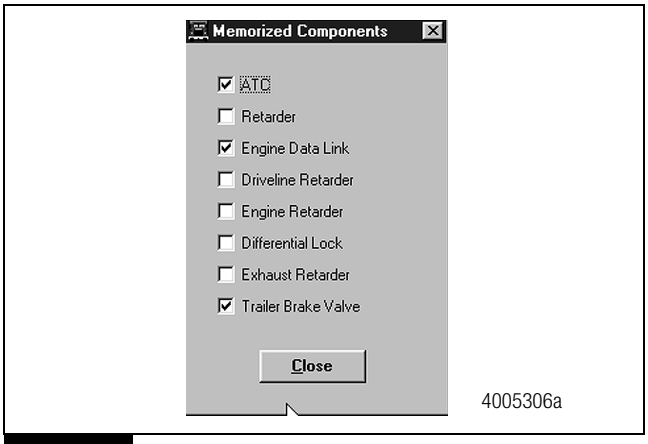


Figure 3.12

NOTE: Trailer Brake Valve = RSC Valve

RSC Data

Select ***RSC Data*** from the pull down menu for RSC status information. Figure 3.13.

For RSC Control Status:

NA — RSC is not an option

OFF — RSC is installed but is not currently active

For Accelerometer sensor:

Acceptable range is 2.21-2.78 volts.

A **red** background in this field indicates voltage is outside of the acceptable range.

A **green** background in this field indicates voltage is within the acceptable range.

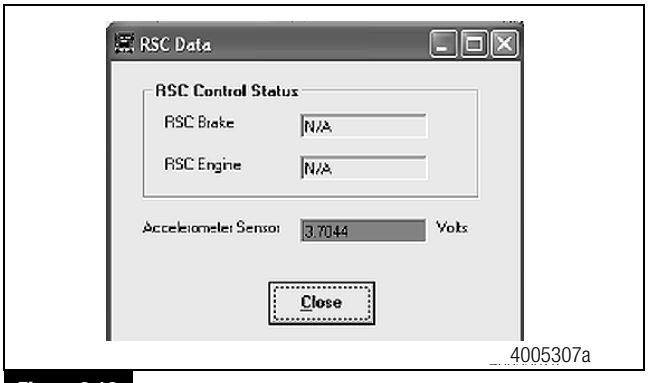


Figure 3.13

NOTE: Trailer Brake Valve = RSC Valve

Component Tests

Select ***Component Tests*** from the Tractor ***ABS Main Screen***. A pull down menu will appear. Figure 3.14.

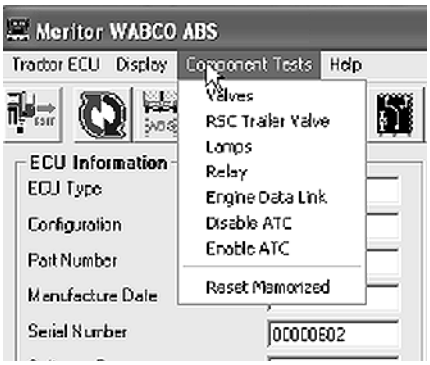


Figure 3.14

NOTE: Components for test may also be selected from the icons on the Tractor ABS Main Screen.

Select ***Valves*** from the pull down menu to select and cycle individual ABS modulator valves. Then, listen to ensure the correct valve is cycling. This is also helpful in verifying correct operation, installation and wiring. Figure 3.15.

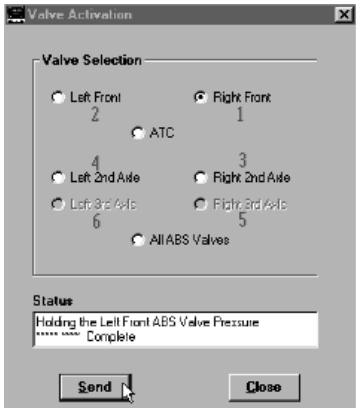


Figure 3.15

Select ***all valves*** from the menu to cycle all available ABS valves in the order shown below.

Verification of the ATC valve is also available from this menu.

RSC Trailer Valve

Select ***RSC Trailer Valve*** from the pull down menu to cycle the RSC trailer valve.

Do not activate the service brake while testing the RSC trailer valve. Figure 3.16.

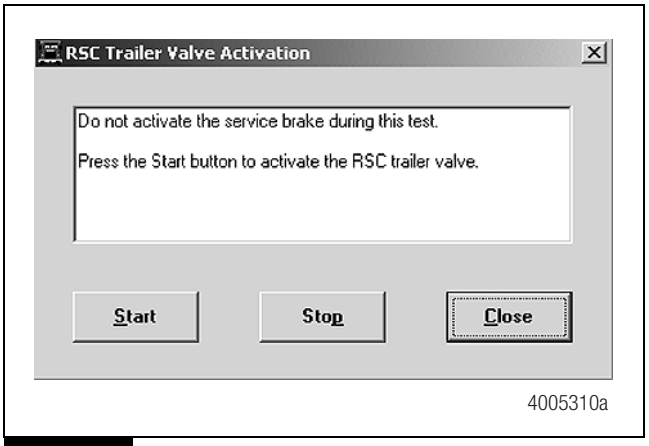


Figure 3.16

Press **Start** to begin the test. Figure 3.17.

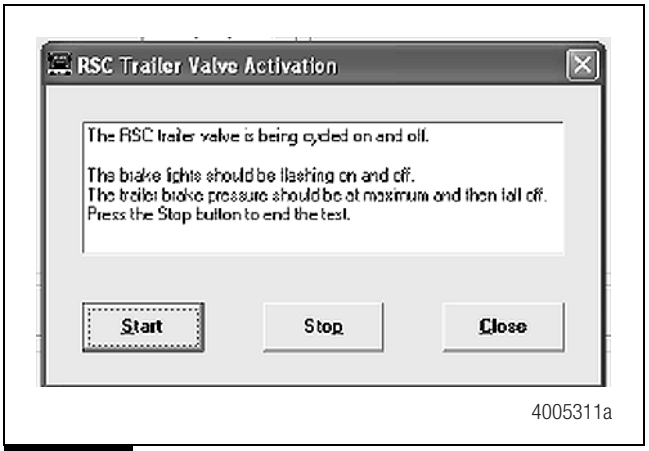


Figure 3.17

Lamps

Select ***Lamps*** from the pull down menu to turn the tractor ABS, trailer ABS or ATC (wheel spin) indicator lamps on or off. Figure 3.18.

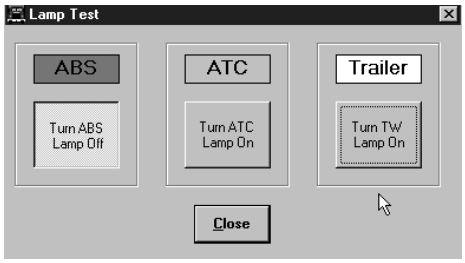


Figure 3.18

This is helpful in verifying correct operation, installation and wiring of the lamps to the ECU.

Relay

Select ***Relay*** from the pull down menu to turn the Retarder Relay on or off. Figure 3.19.

Figure 3.19

This is helpful in verifying correct operation, installation and wiring of the unit under test.

Select ***Engine Data Link*** from the pull down menu to send a "limit engine torque" command to the engine or a "disable retarder" command to the retarder. Figure 3.20.

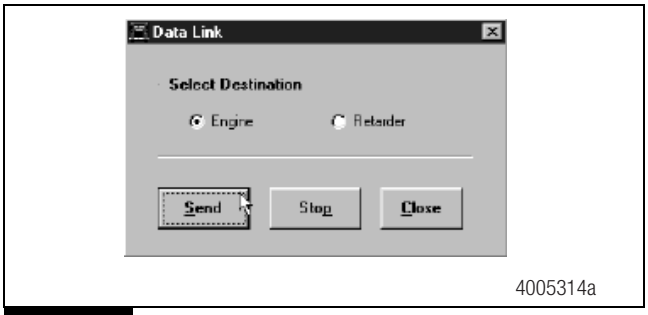


Figure 3.20

Select ***Disable ATC*** from the pull down menu to send a command to the ECU to disable automatic traction control. ATC will remain disabled until the enable command is sent or the vehicle ignition is cycled. The status bar on the Main Screen reflects the current state of the ATC function, either Enabled, Disabled or N/A (not available).

Using the **Disable ATC** command is useful and essential for dynamometer testing. Figure 3.21.

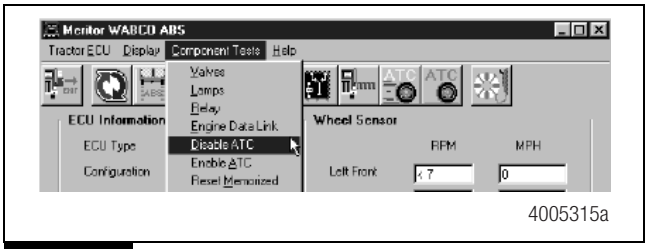


Figure 3.21

Enable ATC

Select ***Enable ATC*** from the pull down menu to send a command to the ECU to enable automatic traction control. This is the normal state of the ECU. The status bar on the Main Screen reflects the current state of the ATC function, either Enabled, Disabled or N/A (not available). Figure 3.22.

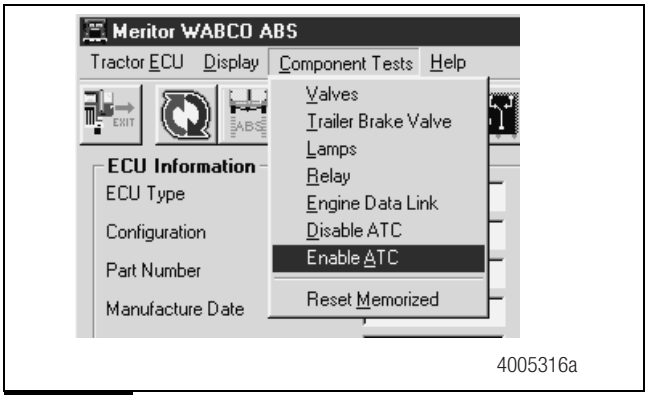


Figure 3.22

Reset Memorized

Select ***Reset Memorized*** from the pull down menu to tell the ECU to reset the memorized or "learned" components.

The ECU has the ability to learn the following components: ATC valve, engine datalink and retarder relay. Once any of these have been detected, the ECU expects to see them each time the ECU is powered on. If they are not seen, the ECU records a fault.

Because there are times when an ECU is moved to another vehicle — or during diagnostic testing — you may want the ECU to disregard these learned components. Use the ***Reset Memorized*** command for this purpose.

Pro-Link® Plus Display

With some ECUs, the Pro-Link® Plus will display system information — components or options supported by the ECU. Access these screens through System Setup (main ABS menu).

The following screens illustrate:

- A 4S/4M ABS/ATC system
- Where the ECU has not recognized a retarder relay
- Where the ECU has recognized a J1939 datalink
- The ECU is capable of supporting ABS and ATC switches.

NOTE: Yes indicates the ECU is capable of supporting these options. These may or may not be installed on the vehicle.

TRACTOR ABS/ATC	
SYSTEM INFORMATION	
SENSORS	**4**
MODULATORS	**4**

ATC VALVE	YES
RETARDER RELAY	NO
J1939	YES
ABS SWITCH	YES
ATC SWITCH	YES

Component Test Screens

These screens help you test ABS components. Select this function from the Tractor ABS/ATC menu.

ABS VALVES

ATC

ABS INDICATOR LAMP

ATC INDICATOR LAMP

ABS/ATC SWITCHES

SENSORS

ENGINE DATALINK

RETARDER RELAY

RETARDER DATALINK

VEHICLE VOLTAGES

Select the appropriate function. Each screen has instructions to guide you through the test. Refer to the Pro-Link® Plus Manual for complete instructions.

Component Tests and Functions (Pro-Link® Plus)

These screens help you test ABS components. Select this function from the Tractor ABS/ATC menu.

TRACTOR COMP TESTS
— SELECTIONS —
↑ VEHICLE VOLTAGES ↓

Select the appropriate function. Each screen has instructions to guide you through the test. Refer to the Pro-Link® Plus Manual for complete instructions.

The following definitions explain the function of each test.

Table E: Definitions

Component Test	Function
Vehicle Voltages	Monitors the voltage signals powering the ECU.
ABS Valves	Cycles the valves, one at a time. With brake pedal applied, you should hear four short air exhausts, then one long air pressure hold. A menu selection lets you choose from four or six valves. This test is used to verify valve locations and correct wiring. **NOTE:** The treadle must be applied to pressurize the brake chambers.
ATC	Checks the ATC valve. You will hear a click as the valve cycles. **NOTE:** TOOLBOX™ Software or the Pro-Link® Plus may be used to shut off ATC for dynamometer testing.
ABS Tractor Lamp	Monitors the commanded (on/off) states of the ABS tractor lamp. Follow the screen prompts (1 On, 2 Off) to change the status of the lamp on the instrument panel.
ABS Trailer Lamp	Monitors the commanded (on/off) states of the ABS trailer lamp. Follow the screen prompts (1 On, 2 Off) to change the status of the lamp on the instrument panel.
ATC Tractor Lamp	Monitors the commanded (on/off) states of the ATC tractor lamp. Follow the screen prompts (1 On, 2 Off) to change the status of the lamp on the instrument panel.
ABS/ATC Switches	Checks the status of ABS and ATC/Deep Snow and Mud switches on the instrument panel.
Sensors	Monitors the input to the ECU from the wheel. Vehicle must be stationary and wheels must be rotated during this test.
Engine Datalink	Checks wiring connections and response between the engine and the ECU.
Retarder Relay	Activates the relay to verify function (a click will be heard). This test also checks wiring connections.
Retarder Datalink	Checks wiring connections and retarder response between the retarder and the ECU.

Tire Size Range

ABS

For correct ABS/ATC operation with the standard ECU, front and rear tire sizes must be within ± 14% of each other. When this tire size range is exceeded without electronically modifying the ECU, the system performance can be affected and the indicator lamp can illuminate.

Calculate the tire size with the following equation:

$$\% \text{ Difference} = \left\{ \frac{\text{RPM Steer}}{\text{RPM Drive}} - 1 \right\} \times 100$$

RPM — tire revolutions per mile

RSC

RSC requires that the steer axle tire size range be no more than 4% of a pre-set value.

Call Meritor WABCO at 800-535-5560 if you plan a tire size range greater than those specified.

Testing Components

⚠ CAUTION

When troubleshooting and testing the ABS system, do not damage the connector terminals.

Voltage Check

Measure voltage at the pins indicated in Table F.

- Voltage must be between 9.5 and 14.0 volts.
- The ignition must be turned ON for this test.

Table F: Voltage Check Pins

ECU	Connector	Pins
Universal	14-Pin	4 and 9
		9 and 4
Basic	14-Pin	7 and 4
		8 and 9
Frame-mounted	X1-Grey	1 and 12
		2 and 11

NOTE: Pin locations are illustrated in Figure 3.23 (Frame) and Figure 3.24 (Basic and Universal).

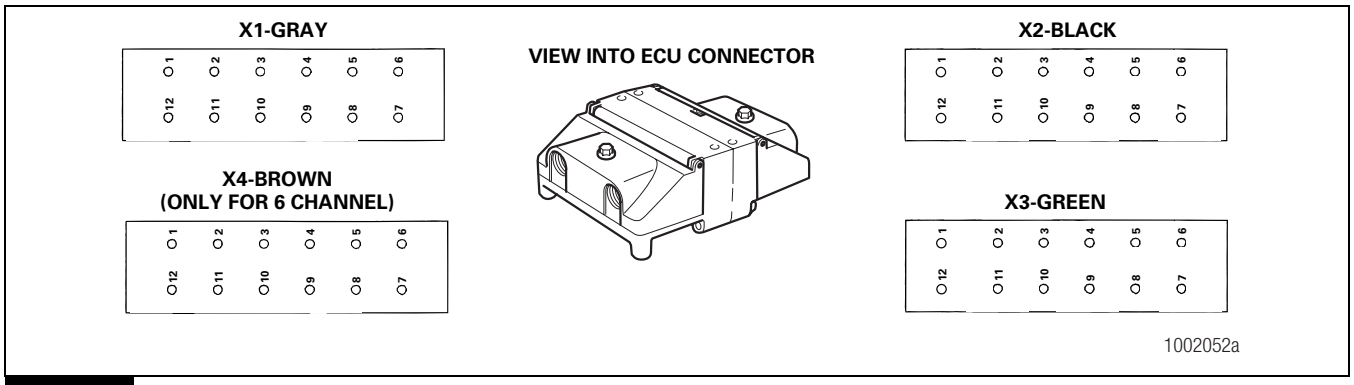


Figure 3.23

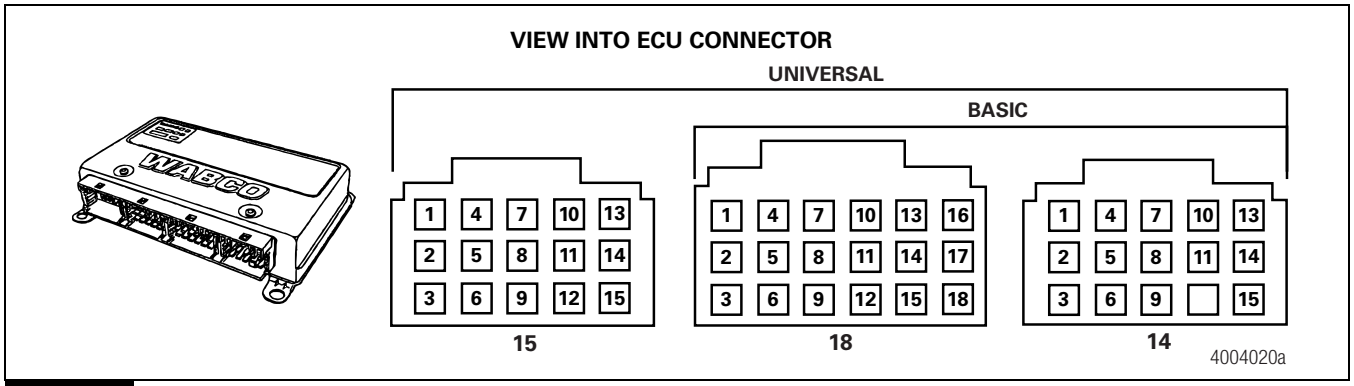


Figure 3.24

Location of Sensors

On steering axles, the sensor is accessible on the in-board side of the steering knuckle.

On drive axles, the drum assembly may have to be pulled to gain access to the sensor.

Sensor Adjustment

- Push the sensor in until it contacts the tooth wheel.
- Do not pry or push sensors with sharp objects.
- Sensors will self-adjust during wheel rotation.

Sensor Output Voltage Test

Voltage must be at least 0.2 volts AC at 30 rpm.

1. Turn ignition OFF.
2. Disconnect the appropriate connector from the ECU (refer to Appendix II).
3. Rotate the wheel by hand at 30 rpm (1/2 revolution per second).
4. Measure the voltage at the pins indicated in Table G.
   - **If the minimum output voltage is less than 0.2:** Push the corresponding sensor toward the tooth wheel, then repeat the measurement.

Table G: Sensor Check Pins

ECU	Sensor	Connector	Pins
Universal	LF	18-Pin	12 and 15
	RF	18-Pin	10 and 13
	LR	18-Pin	11 and 14
	RR	18-Pin	17 and 18
6S/6M	LR (3rd Axle)	15-Pin	2 and 5
6S/6M	RR (3rd Axle)	15-Pin	11 and 14
Basic	LF	18-Pin	12 and 15
	RF	18-Pin	10 and 13
	LR	18-Pin	11 and 14
	RR	18-Pin	17 and 18
Frame-mounted	LF	X2 — Black	7 and 8
	RF	X2 — Black	5 and 6
	LR	X3 — Green	1 and 2
	RR	X3 — Green	3 and 4
	LR (3rd Axle)	X4 — Brown	3 and 4
	RR (3rd Axle)	X4 — Brown	5 and 6

Sensor Resistance

The sensor circuit resistance must be between 900 and 2000 ohms. Resistance can be measured at the sensor connector, or at the pins on the ECU connector. To measure resistance:

1. Turn ignition OFF.
2. To measure resistance at the sensor connector, disconnect the ECU connector from the ECU. To measure resistance at the sensor connector, disconnect the sensor from the sensor extension cable.
3. Measure output at the pins indicated in Table G.

Valve Tests

ABS Modulator Valve

Measure resistance across each valve solenoid coil terminal and ground on the ABS valve to ensure 4.0 to 9.0 ohms. Figure 3.25 and Figure 3.26.

- If the resistance is greater than 9.0 ohms, clean the electrical contacts in the solenoid. Check the resistance again.
- To check the cable and the ABS valve as one unit, measure resistance across the pins on the ECU connector of the harness. Check the diagram of the system you are testing for pin numbers. (Refer to Appendix II.)

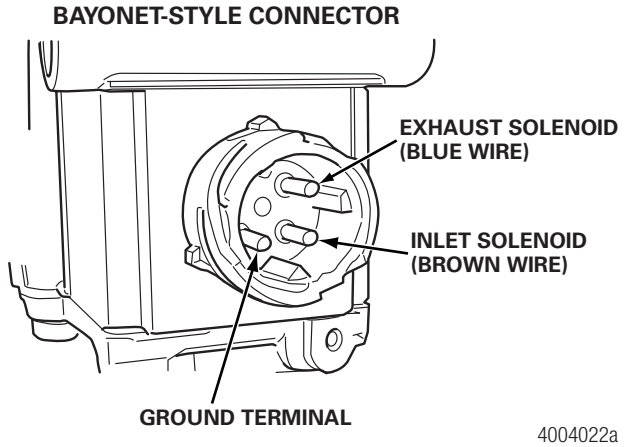


Figure 3.25

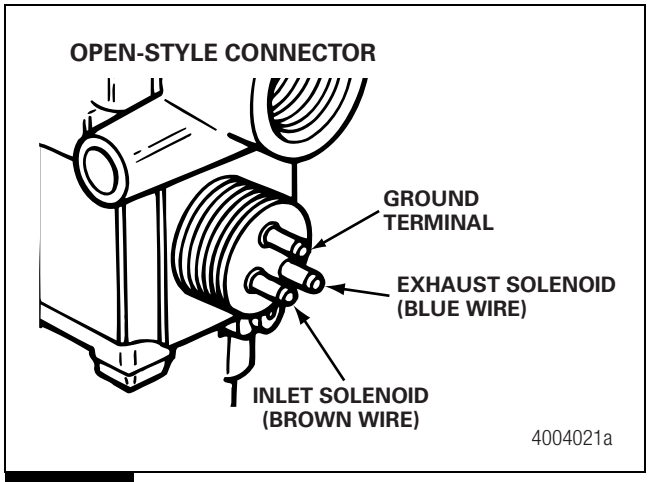


Figure 3.26

ATC Valve

Measure resistance across the two electrical terminals on the ATC valve to ensure 7.0 to 14.0 ohms. Figure 3.27.

- If the resistance is greater than 14.0 ohms, clean the electrical contacts on the solenoid. Check the resistance again.
- To check the cable and ATC valve as one unit, measure resistance across the pins on the ECU connector of the harness. Check the diagram of the system you are testing for pin numbers. (Refer to Appendix II.)

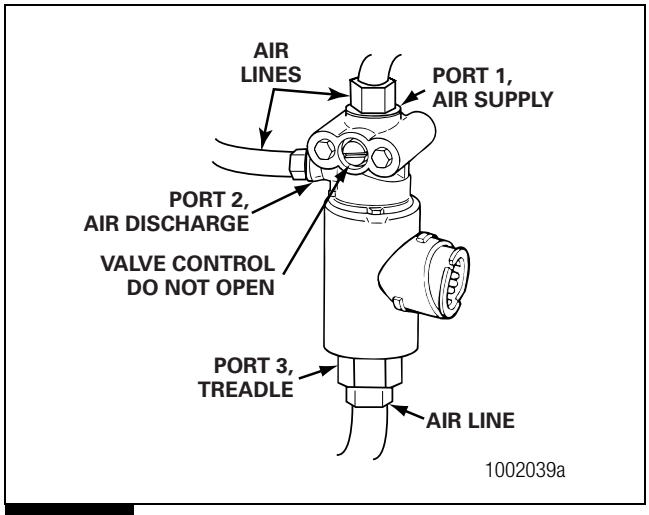


Figure 3.27

Refer to Meritor WABCO ABS Valve Package in Appendix III for ABS Valve Package Troubleshooting information.

RSC Valve

Measure resistance across the two electrical terminals on the RSC valve to ensure 7.0 to 14.0 ohms. Figure 3.28.

- If the resistance is greater than 14.0 ohms, clean the electrical contacts on the solenoid. Check the resistance again.
- To check the cable and RSC valve as one unit, measure resistance across the pins on the ECU connector of the harness. Check the diagram of the system you are testing for pin numbers. (Refer to Appendix II.)

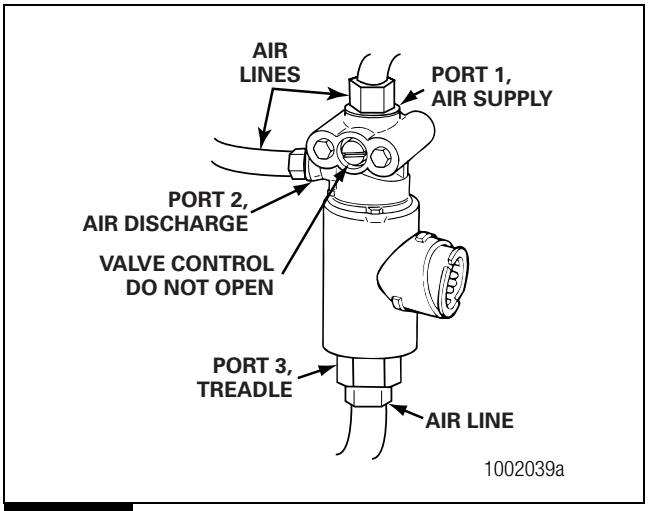


Figure 3.28

Dynamometer Testing Vehicles with ATC

⚠ WARNING

The automatic traction control (ATC) function must be disabled before any type of dynamometer testing is conducted on the vehicle. If the ATC is not disabled, the vehicle ATC may actuate and cause the vehicle to move forward without warning to the operator. If the vehicle moves forward unexpectedly, the vehicle may cause damage or injuries to individuals who are in the path of the vehicle.

⚠ CAUTION

Do not cycle the vehicle ignition while the vehicle is on a dynamometer. Cycling the vehicle ignition will enable the ATC.

Vehicles with ATC must have the ATC disabled to test the vehicle on a dynamometer. To disable the ATC, use one of the following methods:

1. **Blink Code Switch**

   Press and hold the blink code switch for at least three seconds. Refer to the blink code diagnostics information in this section for a description of how the blink code display will appear.

   - Once the system configuration code begins, ATC has been disabled.
   - The ATC lamp comes on and stays on while ATC is disabled.
   - ATC will remain disabled until the vehicle ignition is cycled.
   - After testing, ATC will automatically reactivate the first time the vehicle ignition is cycled.

2. **Remove Power**

   Remove the ABS circuit breaker/fuse or remove the ECU power connector to disable the ABS and ATC.

   - After testing, re-install the circuit breaker/fuse and the ATC will automatically reactivate the first time the vehicle power is applied to the ECU.

3. **TOOLBOX™ Software**

   At the ABS Main Menu, select the ***Disable ATC*** icon or use the pull down menu to send the command to the ECU to disable the ATC. Refer to the TOOLBOX™ Software Owner's Manual for complete instructions for using TOOLBOX™.

   - ATC will remain disabled until the enable command is sent or the vehicle ignition is cycled.
   - After testing, ATC will automatically reactivate the first time the vehicle ignition is cycled.

4. **MPSI Pro-Link® Plus**

   Refer to the MPSI Pro-Link® Plus Owner's Manual for instructions.

   - ATC will remain disabled until the enable command is sent or the vehicle ignition is cycled.
   - After testing, ATC will automatically reactivate the first time the vehicle ignition is cycled.

Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Release all air from the air systems before you remove any components. Pressurized air can cause serious personal injury.

Component Removal and Installation

Valves

- ABS Modulator Valves
- ATC Valve
- RSC Valve
- ABS Valve Package (Front or Rear)
  - — Modulator Valves
  - — Relay Valve or Quick Disconnect Valve
  - — ATC Valve

Sensor Lubricant Specification

Meritor WABCO specifications call for a sensor lubricant with the following characteristics:

Lubricant must be mineral oil-based and contain molydisulfide. It should have excellent anti-corrosion and adhesion characteristics, and be capable of continuous function in a temperature range of –40° to 300°F (–40° to 150°C).

Lubricants approved for use on Meritor WABCO sensors and spring clips are as follows. Figure 4.1.

- Mobilith SHC-220 (Mobil)
- TEK 662 (Roy Dean Products)
- Staburags NBU 30 PTM (Kluber Lubrication)
- Valvoline EP 633

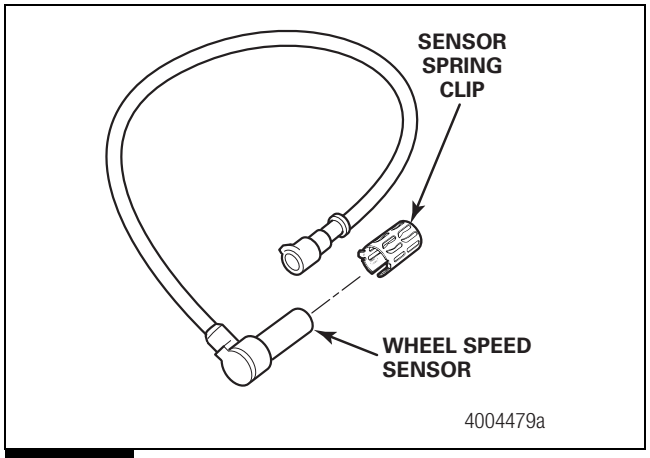


Figure 4.1

⚠ CAUTION

Use the following procedures to avoid damage to the electrical system and ABS/ATC components.

When welding on an ABS- or ABS/ATC-equipped vehicle is necessary, disconnect the power connector from the ECU.

Sensors

NOTE: When replacing the wheel speed sensor, the sensor spring clip must also be replaced.

Wheel Speed Sensor Removal — Front Axle

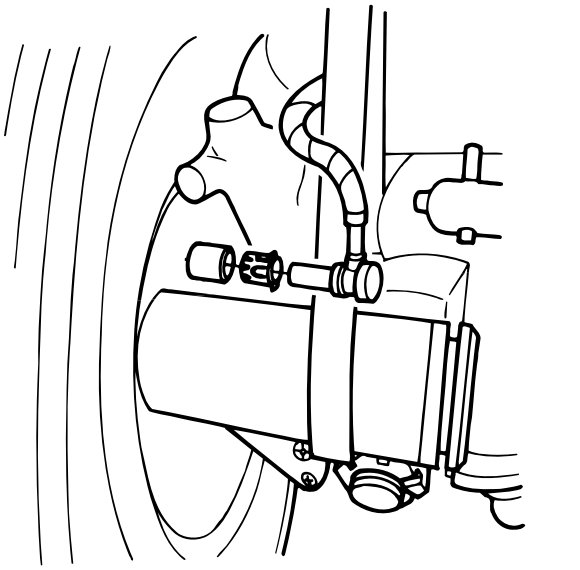
To remove the sensor from the front axle:

⚠ WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

1. Place blocks under the rear tires to stop the vehicle from moving. Apply the parking brake.
2. If necessary, raise the front tires off the ground. Place safety stands under the axle.
3. Disconnect the fasteners that hold the sensor cable to other components.
4. Disconnect the sensor cable from the chassis harness.

5. Remove the sensor from the sensor holder. Use a twisting motion if necessary. **Do not pull on the cable.** Figure 4.2.



KNUCKLE-MOUNTED SENSOR

Figure 4.2

6. Remove the sensor spring clip.

Wheel Speed Sensor Installation — Front Axle

To replace the sensor in the front axle:

1. Connect the sensor cable to the chassis harness.
2. Install the fasteners used to hold the sensor cable in place.
3. Apply a Meritor WABCO recommended lubricant to the sensor spring clip and sensor.
4. Install the sensor spring clip. Make sure the spring clip tabs are on the inboard side of the vehicle.
5. Push the sensor spring clip into the bushing in the steering knuckle until the clip stops.
6. Push the sensor completely into the sensor spring clip until it contacts the tooth wheel.

   NOTE: After installation, there should be no gap between the sensor and the tooth wheel. During normal operation, a gap of up to 0.04-inch (1.016 mm) is allowable.

7. Remove the blocks and safety stands.

Wheel Speed Sensor Removal — Rear Axle

NOTE: When replacing the wheel speed sensor, the sensor spring clip must also be replaced.

To remove the sensor from the rear axle:

⚠ WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

1. Place blocks under the front tires to stop the vehicle from moving.
2. Raise the rear tire off the ground. Place safety stands under the axle.
3. Release the parking brake and back off the slack adjuster to release the brake shoes.
4. Remove the wheel and tire assembly from the axle.
5. Remove the brake drum.
6. Remove the sensor from the mounting block in the axle housing. Use a twisting motion if necessary. **Do not pull on the cable**.
7. Remove the sensor spring clip from the mounting block.
8. Disconnect the fasteners that hold the sensor cable and the hose clamp to other components.
9. Disconnect the sensor cable from the chassis harness.

Wheel Speed Sensor Installation — Rear Axle

1. Apply a Meritor WABCO recommended lubricant to the sensor spring clip and sensor.
2. Install the sensor spring clip. Verify that the spring clip tabs are on the inboard side of the vehicle.
3. Push the sensor spring clip into the mounting block until it stops.

NOTE: After installation, there should be no gap between the sensor and the tooth wheel. During normal operation, a gap of up to 0.04-inch (1.016 mm) is allowable.

4. Push the sensor completely into the sensor spring clip until it contacts the tooth wheel. Figure 4.3.

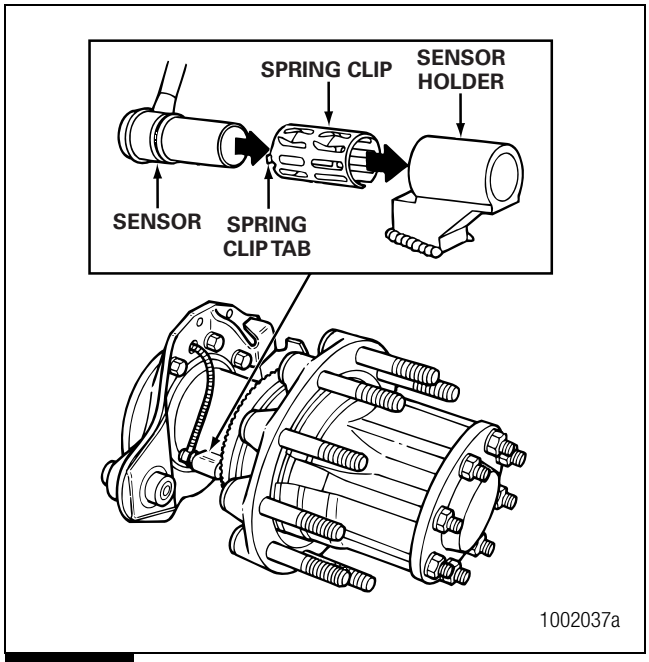


Figure 4.3

5. Insert the sensor cable through the hole in the spider and axle housing flange. Route the cable to the frame rail. Be sure to route the cable in a way that will prevent pinching or chafing and will allow sufficient movement for suspension travel.
6. Connect the sensor cable to the chassis harness.
7. Install the fasteners that hold the sensor cable in place.
8. Install the brake drum on the wheel hub.
9. Complete the installation per the vehicle manufacturer's manual.

ABS Modulator Valve

Removal

1. Turn the ignition switch to the OFF position. Apply the parking brake.

⚠ WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

2. Place blocks under the front and rear tires to stop the vehicle from moving.
3. If necessary, raise the vehicle off the ground and place safety stands under the axle.
4. Disconnect the wiring connector from the ABS valve.
5. Disconnect the air lines from Ports 1 (air supply) and 2 (air discharge) of the ABS valve. Figure 4.4.

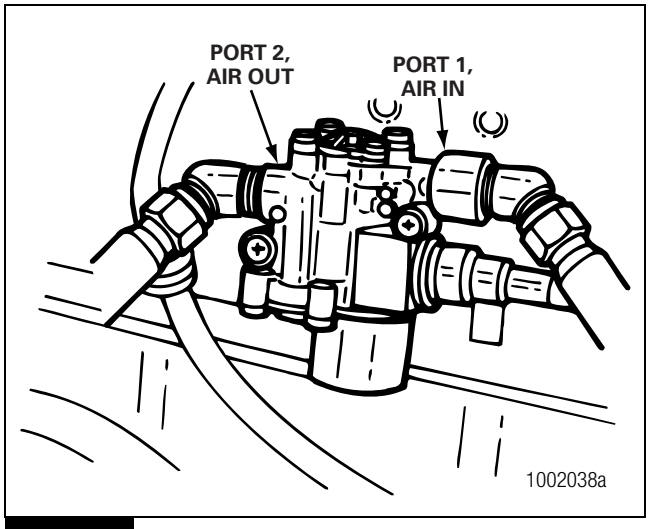


Figure 4.4

6. Remove the two mounting capscrews and nuts.
7. Remove the ABS valve.

Installation

⚠ CAUTION

Moisture can affect the performance of all ABS/ATC systems, as well as the standard braking system. Moisture in air lines can cause air lines to freeze in cold weather.

1. Install the ABS valve with two mounting capscrews and nuts. Tighten the capscrews per the manufacturer's recommendation.
2. Connect the line to the brake chambers to Port 2 of the ABS valve. Connect the air supply line to Port 1 of the ABS valve.
3. Connect the wiring connector to the ABS valve. Hand tighten only.
4. Remove the blocks and stands.
5. Test the installation.

Checking the Installation

1. Apply the brakes. Listen for leaks at the modulator valve.
2. Turn the ignition on and listen to the modulator valve cycle. If the valve fails to cycle, check the electrical cable connection. Make repairs as needed.
3. Drive the vehicle. Verify that the ABS indicator lamp operates correctly.

ATC Valve

Removal

1. Turn the ignition switch to the OFF position. Apply the parking brake.

⚠ WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

2. Place blocks under the front and rear tires to stop the vehicle from moving.
3. If necessary, raise the vehicle off the ground. Place safety stands under the axle.
4. **Relieve line pressure by bleeding the air from the appropriate supply tank.**
5. Disconnect the wiring from the ATC valve.
6. Disconnect the air lines from Port 1 (air supply), Port 2 (air discharge) and Port 3 (treadle) of the ATC valve. Figure 4.5.

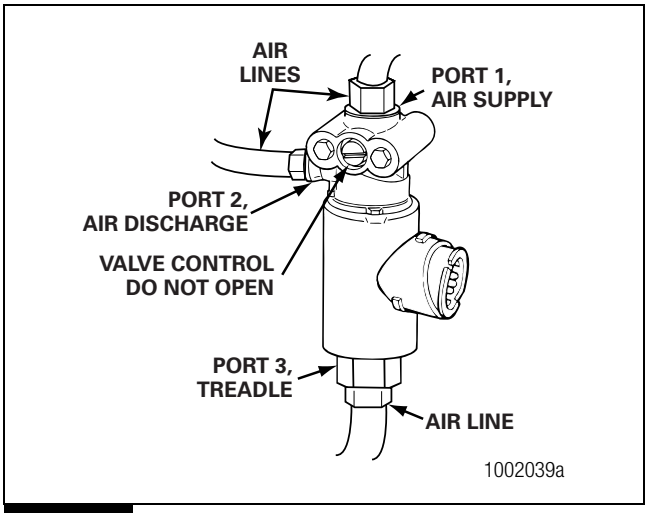


Figure 4.5

7. Remove the two mounting capscrews and nuts. Remove the ATC valve.

Installation

1. Install the ATC valve with two mounting capscrews and nuts.

   Tighten the capscrews per the manufacturer's recommendation.
2. Connect the air supply, discharge and treadle lines to Ports 1, 2 and 3 of the ATC valve.
3. Connect the harness connector to the ATC valve. Hand tighten only.
4. Remove the blocks and stands.
5. Test the installation.

Checking the Installation

To test the ATC valve:

1. Start the vehicle.
2. Fully charge the reservoirs with air. Shut off the vehicle.
3. Apply the brakes.
4. Listen for air leaks at the ATC valve.
5. Release the brakes.
6. Activate the ATC valve using the MPSI tool.
7. Disconnect the MPSI tool.
8. Drive the vehicle. Verify that the ATC indicator lamp operates correctly.

RSC Valve

Removal

1. Turn the ignition switch to the OFF position. Apply the parking brake.
2. Place blocks under the front and rear tires to stop the vehicle from moving.
3. If necessary, raise the vehicle off the ground. Place safety stands under the axle.
4. **Relieve line pressure by bleeding the air from the appropriate supply tank.**
5. Disconnect the wiring from the RSC valve.
6. Disconnect the air lines from Port 1 (air supply), Port 2 (air discharge) and Port 3 (treadle) of the RSC valve. Figure 4.6.

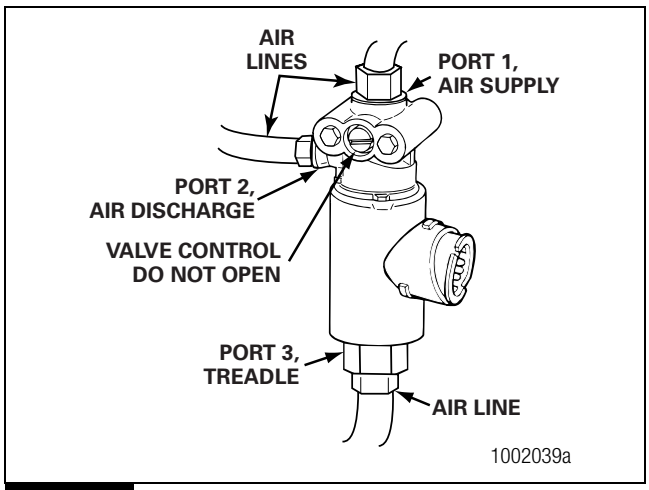


Figure 4.6

7. Remove the two mounting capscrews and nuts. Remove the RSC valve.

Installation

1. Install the RSC valve with two mounting capscrews and nuts.

   Tighten the capscrews per the manufacturer's recommendation.
2. Connect the air supply, discharge and treadle lines to Ports 1, 2 and 3 of the RSC valve.
3. Connect the harness connector to the RSC valve. Hand tighten only.
4. Remove the blocks and stands.
5. Test the installation.

Checking the Installation

To test the RSC valve:

1. Connect the blue glad hand to a 50 cu. in. (819 cu. cm) air tank.
2. Start the vehicle.
3. Fully charge the reservoirs with air. Shut off the vehicle.
4. Activate the RSC valve using TOOLBOX™ Software.
5. Listen for air leaks at the RSC valve.
6. Make necessary repairs.
7. Turn the ignition on. Verify that the ATC/RSC indicator lamp operates correctly.

Front or Rear ABS Valve Package

Removal and Installation — Complete Package

1. Place blocks under tires to stop the vehicle from moving.
2. If necessary, raise the tires off the ground.
3. Drain the air from all system air tanks.
4. Remove all the air lines and connections from the ABS valve package. Figure 4.7 and Figure 4.8.

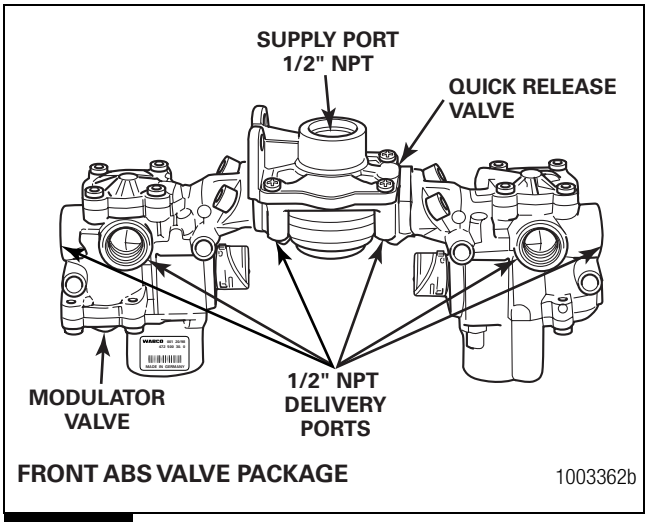


Figure 4.7

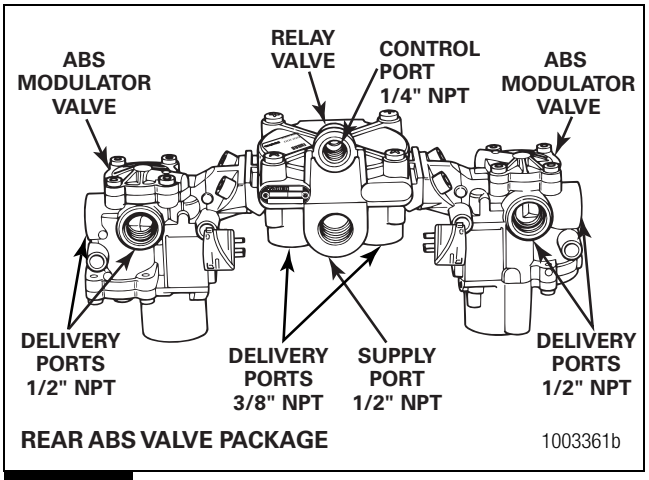


Figure 4.8

5. Remove the mounting bolts from the valve package. Remove the valve package from the vehicle.
6. **Replace the ABS valve package:** Tighten the bolts to the vehicle manufacturer's recommendation. Remove the blocks and safety stands as necessary.
7. Test the installation.

Removal and Installation — Component Valves

1. Remove the ABS valve package from the vehicle. Figure 4.9.

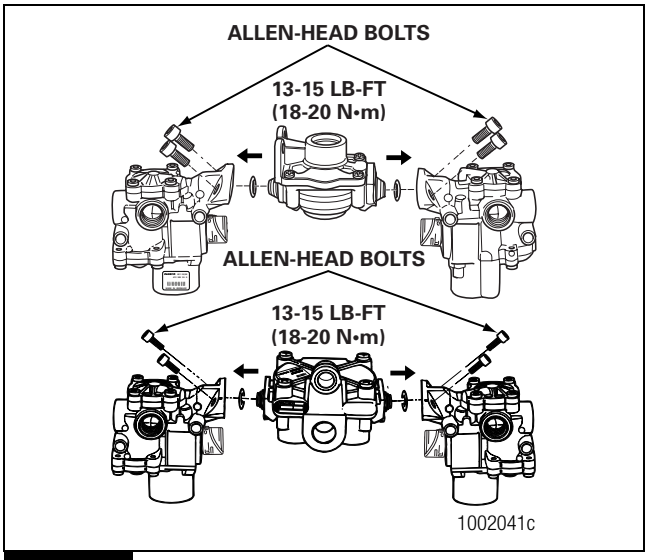


Figure 4.9

2. Use a 6 mm Allen wrench to loosen and remove the Allen-head bolts.
3. Carefully separate the ABS modulator valve(s) from the relay or quick release valve.
4. Remove and discard old O-rings. Lubricate replacement O-rings with the grease provided.
5. Plug any unused ports on the replacement valve(s).
6. Attach the ABS modulator valve(s) to the relay or quick release valve. Use a 6 mm Allen wrench to tighten the Allen-head bolts to 13-15 lb-ft (18-20 N•m).
7. **Replace the ABS valve package:** Tighten the bolts to the vehicle manufacturer's recommendation. Remove the blocks and safety stands as necessary.
8. Check the valves for leaks:
   - Modulator valve(s). Refer to the procedure for checking the modulator valve installation in this section.
   - Relay or quick release valve. Refer to the procedure for checking the quick release or relay valve installation in this section.

ATC Valve on the Rear ABS Valve Package

Removal

NOTE: If there is enough room to work, it is not necessary to remove the valve package from the vehicle before replacing the ATC valve. If the valve package must be removed, follow the instructions for removing and replacing the ABS Valve Package that appear in this section of the manual.

When installing the new ATC valve on the valve package, you must use the new O-rings, seals, mounting bolts and lubricant included with the replacement kit.

1. Turn the ignition switch to the OFF position. Apply the parking brake.
2. Place blocks under the front and rear tires to stop the vehicle from moving.
3. If necessary, raise the vehicle off the ground. Place safety stands under the axle.
4. **Relieve line pressure by bleeding the air from the appropriate supply tank.**
5. Disconnect the wiring from the ATC valve.
6. Disconnect the supply air line from the adapter and the treadle air line from the ATC valve.
7. Use a 5 mm Allen wrench to remove the two screws that hold the adapter piece to the relay valve portion of the valve package.

   Use a 6 mm Allen wrench to remove the two mounting bolts that hold the ATC valve to the adapter piece. Remove the ATC valve from the adapter piece. Remove the ATC valve.

   Remove the adapter piece, seal and O-rings from the valve package. Figure 4.10.

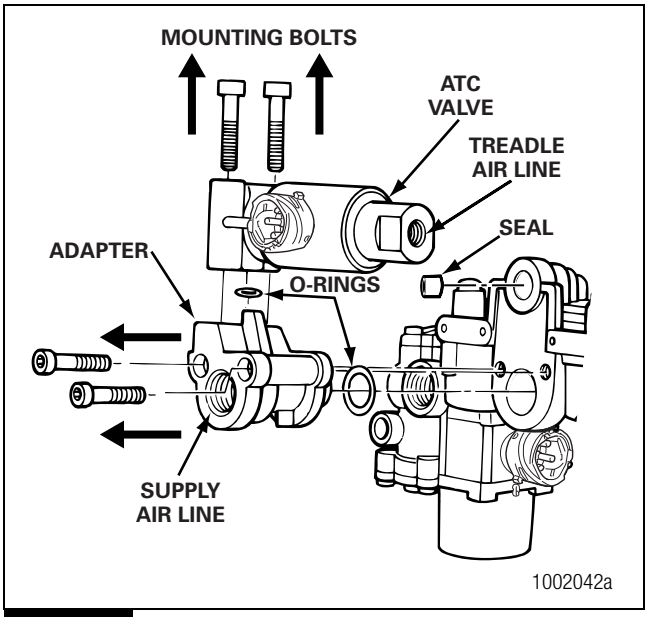


Figure 4.10

Installation

1. Clean and lubricate the small adapter piece O-ring. Install the O-ring on the adapter piece.

   Use the two new M8 Allen-head bolts to attach the ATC valve to the adapter piece. Use a 6 mm Allen-head tool to tighten to 13-15 lb-ft (18-20 N•m). Figure 4.11. ◆T◆

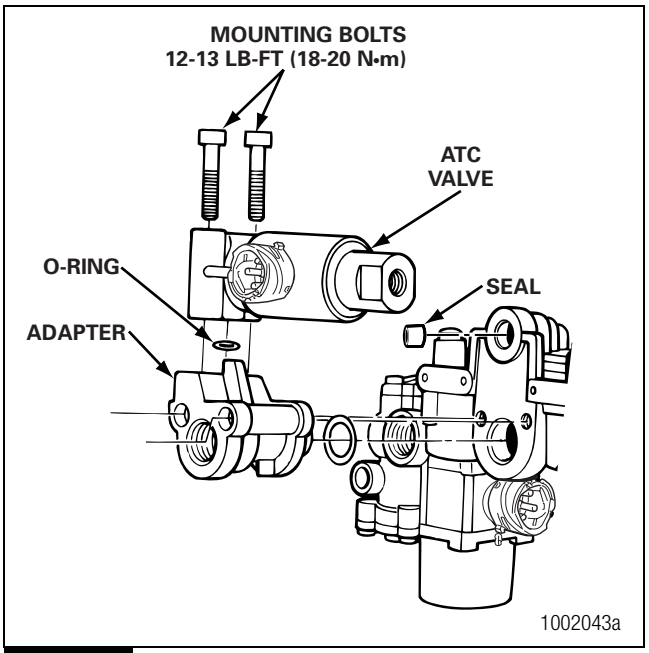


Figure 4.11

2. Lubricate the replacement seal and install it in Port 2 of the ATC valve.

   Lubricate the large replacement O-ring and install it in the groove of the relay valve supply port. Figure 4.12.

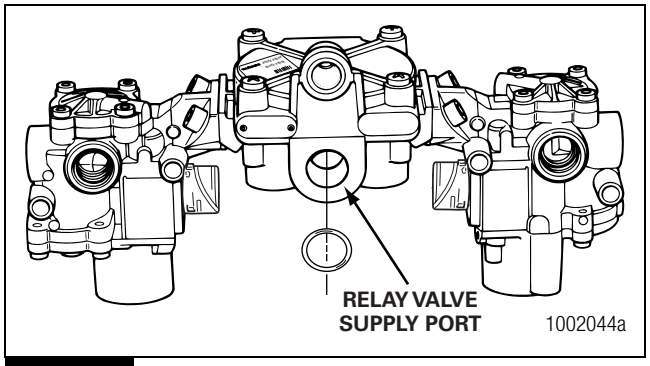


Figure 4.12

NOTE: Use Meritor WABCO-recommended lubricant.

3. Use the two M6 Allen-head bolts to attach the adapter to the relay valve. Use a 5 mm Allen-head tool to tighten to 4-5 lb-ft (6-8 N•m). Figure 4.13. ◆1◆

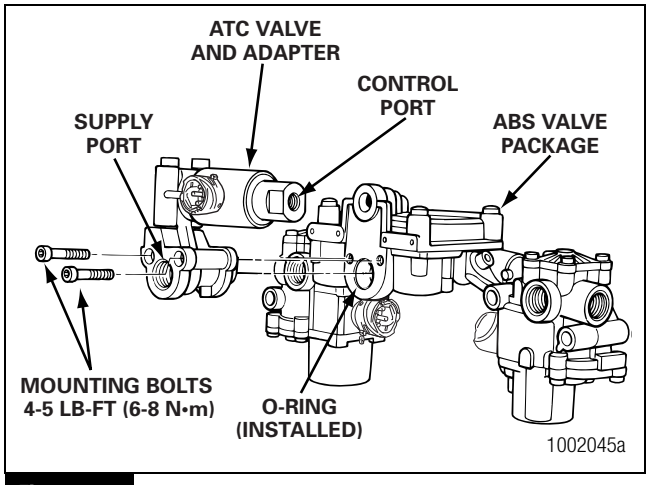


Figure 4.13

4. Connect the supply air line to the supply port on the adapter. Connect the treadle air line to the control port on the ATC valve.
5. Attach the wiring connector to the ATC valve. Hand tighten only.
6. Remove the blocks and stands.
7. Test the installation.

Checking the Installation

1. Start the vehicle.
2. Fully charge the reservoirs with air. Shut off the vehicle.
3. Apply the brakes.
4. Listen for air leaks at all valves.
5. Drive the vehicle. Verify that the ABS indicator lamp operates correctly.

ABS Configurations

Refer to Figure 5.1, Figure 5.2, Figure 5.3, Figure 5.4, Figure 5.5, Figure 5.6 and Figure 5.7 for system configuration layouts.

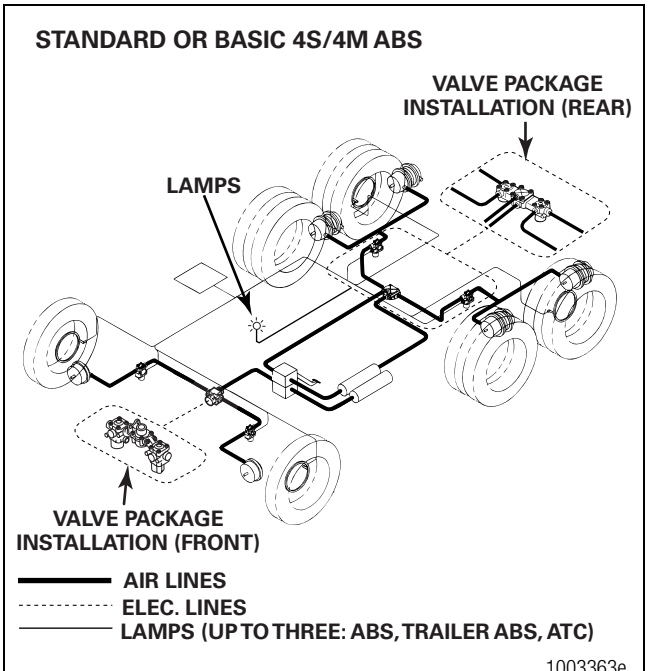


Figure 5.1

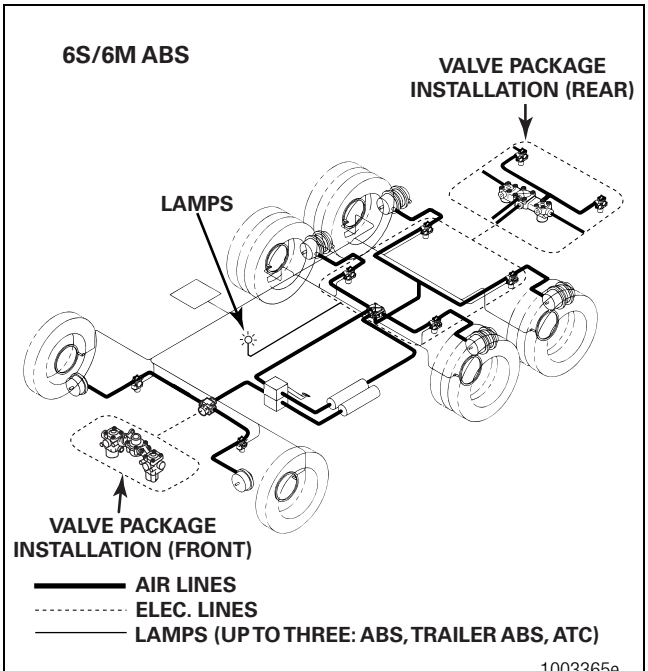


Figure 5.3

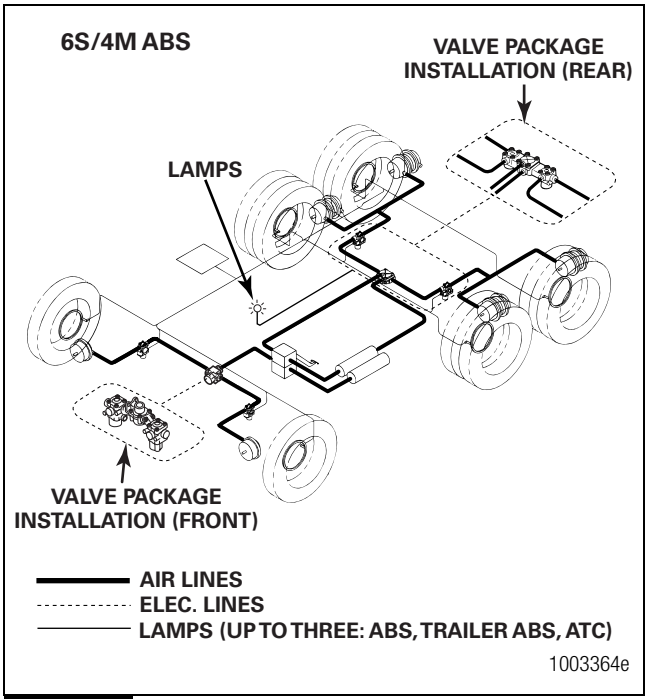


Figure 5.2

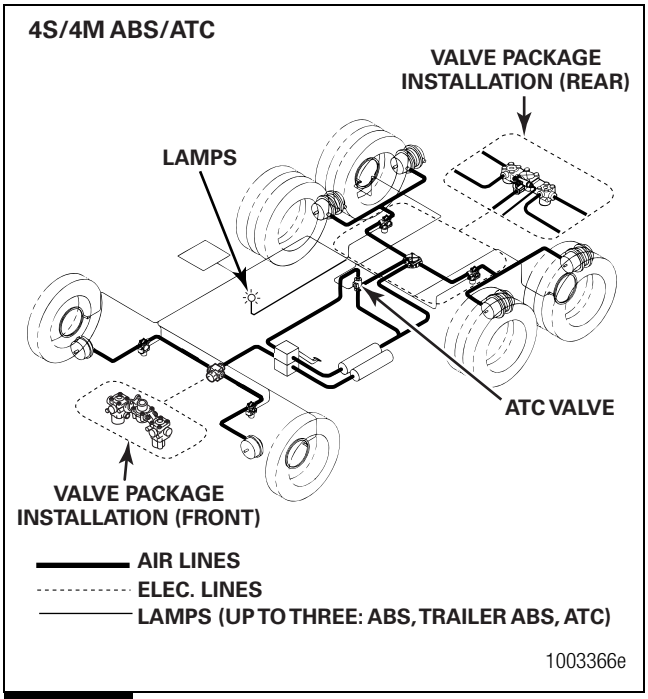


Figure 5.4

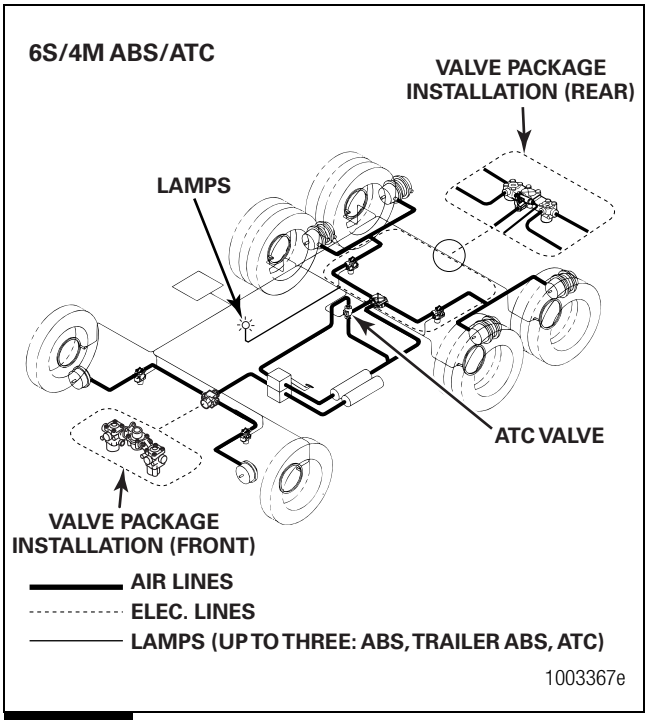


Figure 5.5

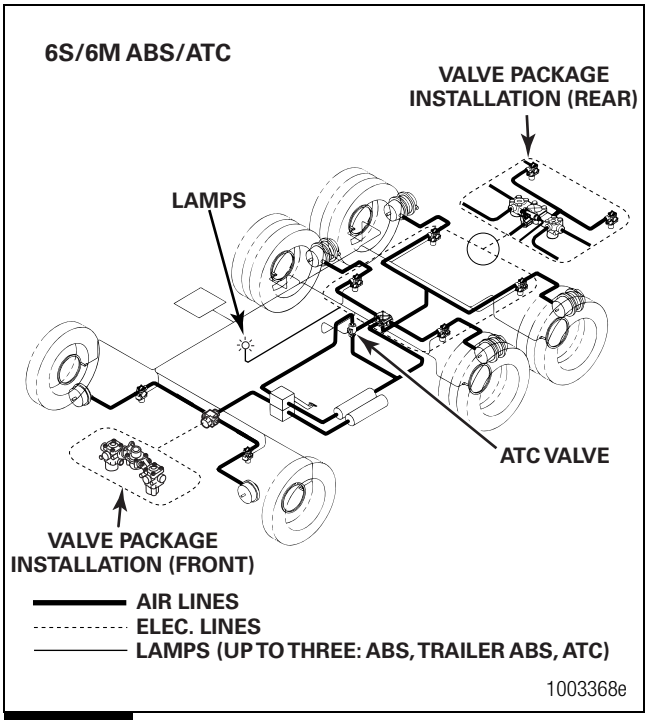


Figure 5.7

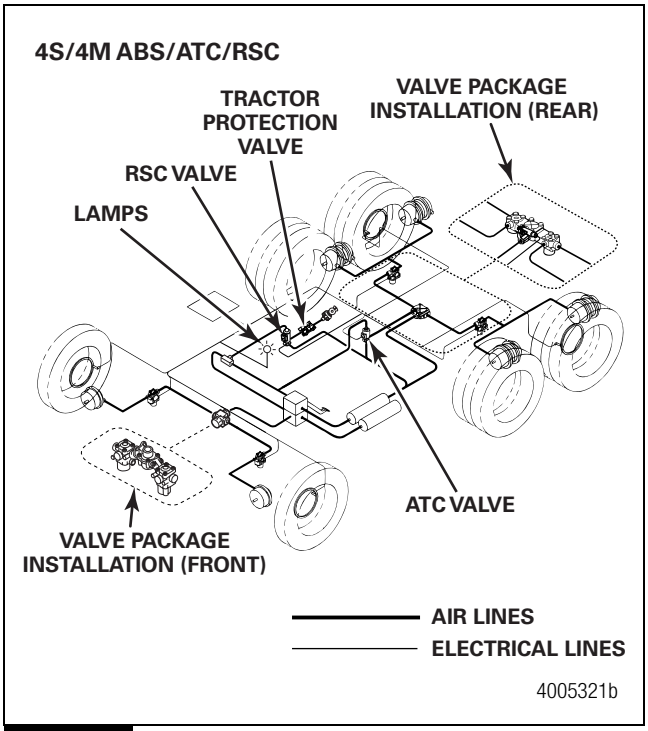
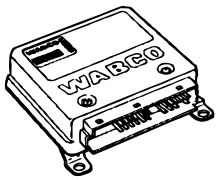
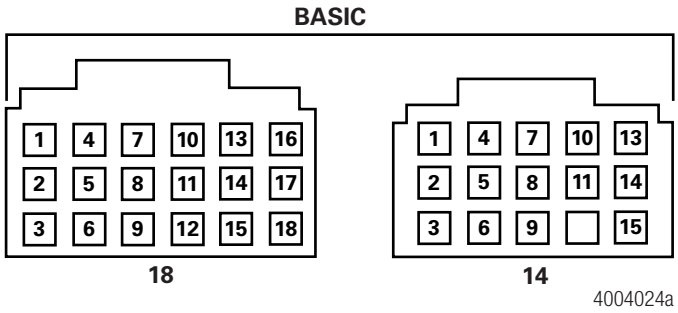


Figure 5.6

ECU Connector Pin Assignments

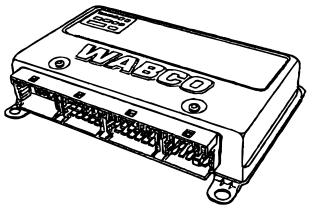
Refer to Figure 6.1, Figure 6.2, Figure 6.3, Figure 6.4, Figure 6.5, Figure 6.6 and Figure 6.7 for ECU wiring diagrams.

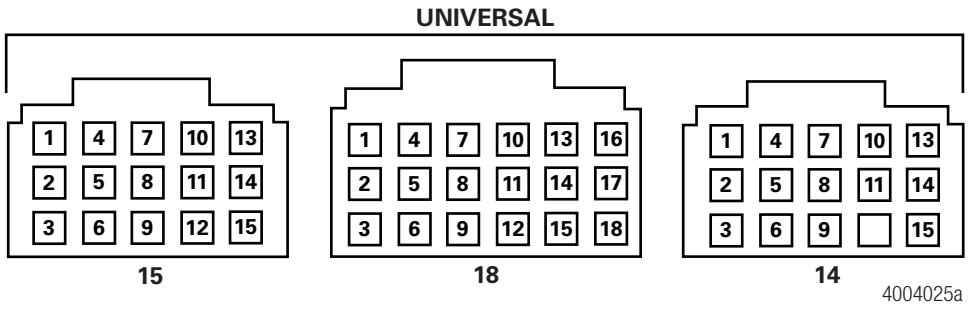




BASIC ECU (CAB-MOUNTED)

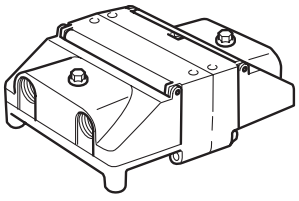
Figure 6.1

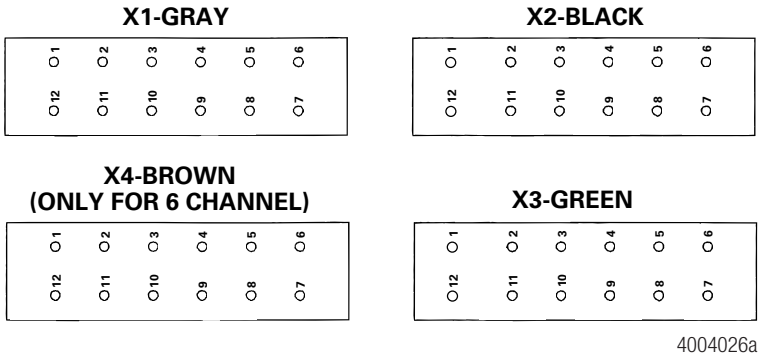




UNIVERSAL ECU (CAB-MOUNTED)

Figure 6.2

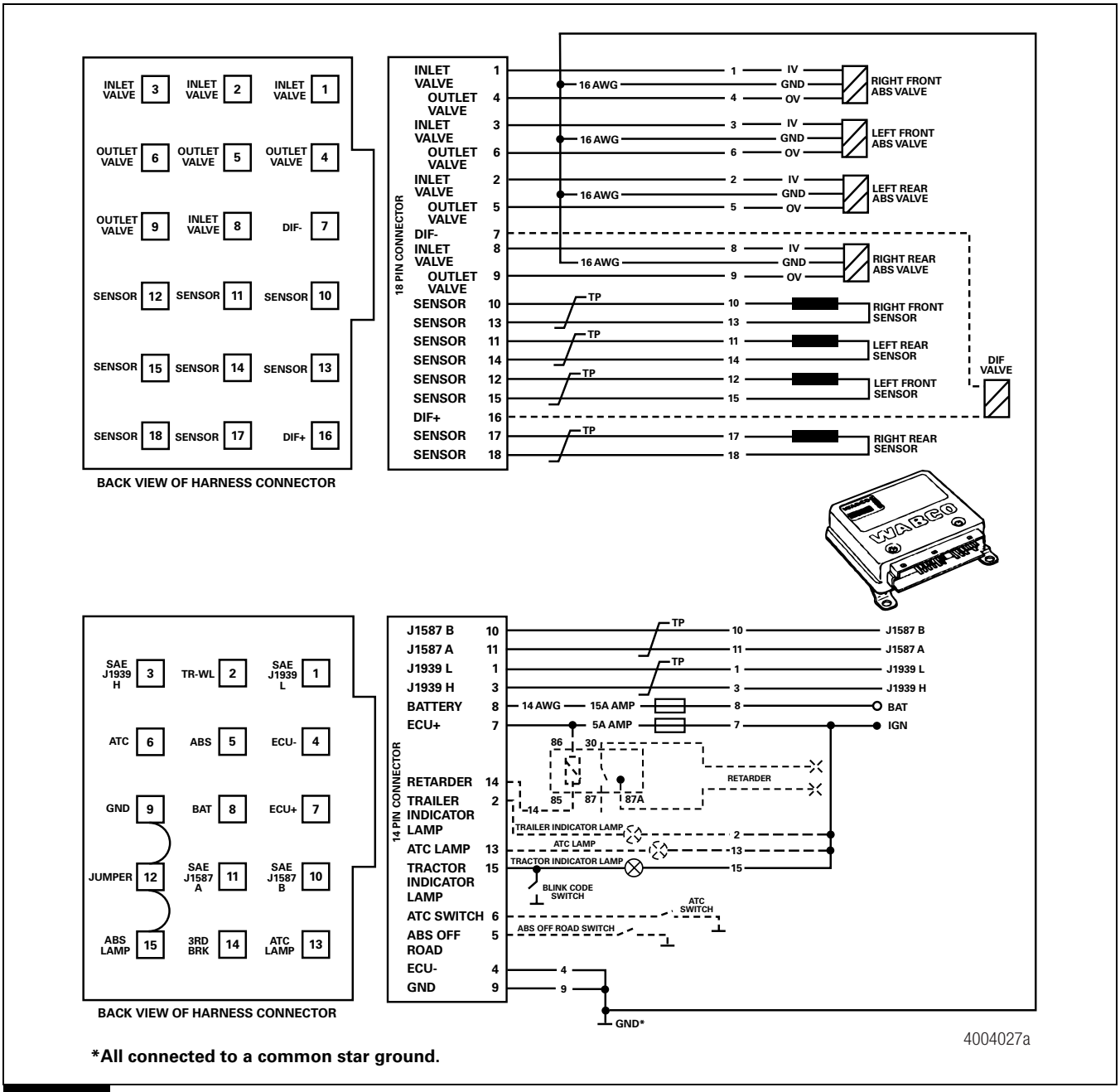




FRAME-MOUNTED ECU

Figure 6.3

Basic ECU (Cab-mounted)



***All connected to a common star ground.**

Figure 6.4

6S/6M Universal ECU (Cab-mounted)

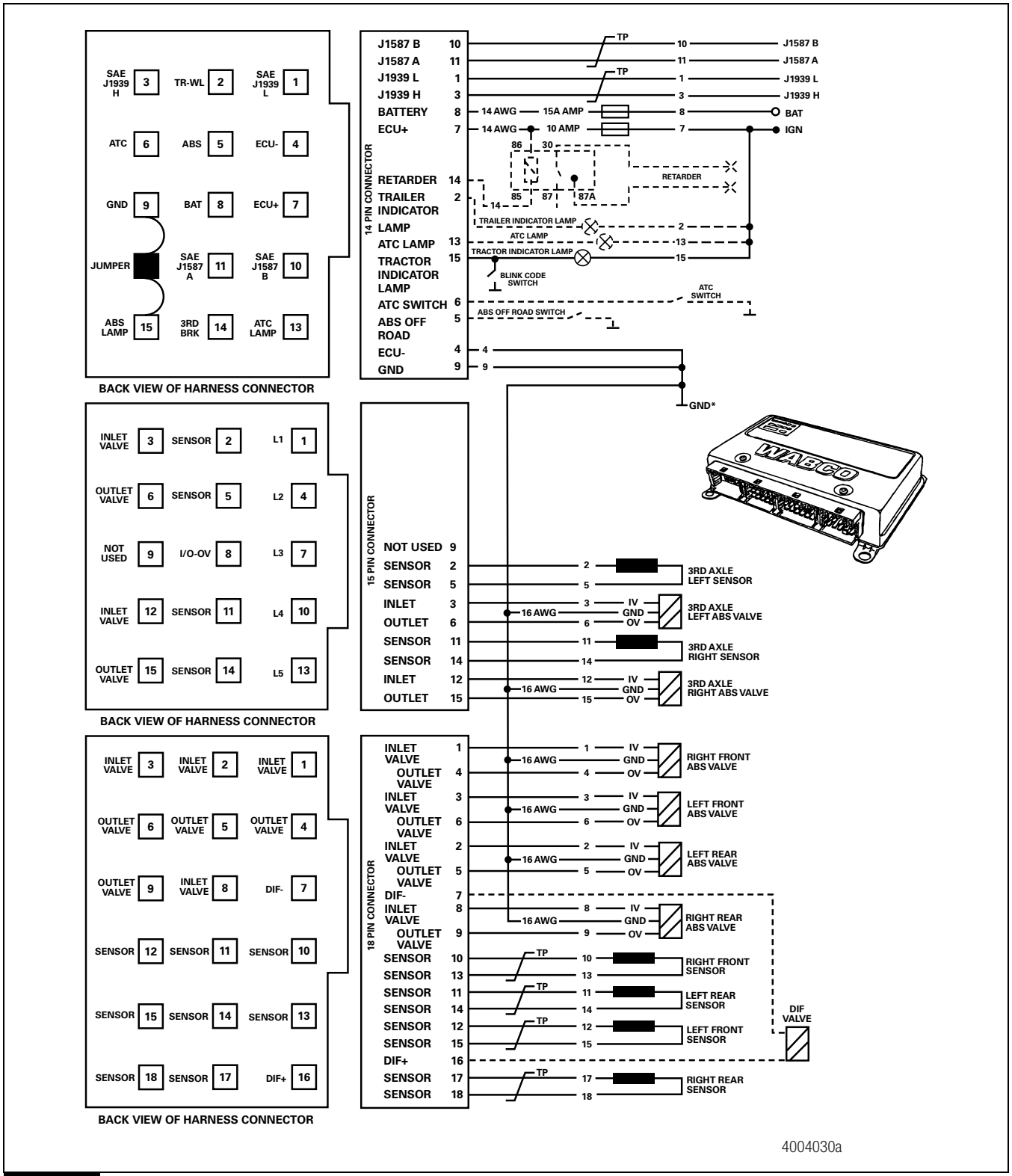


Figure 6.5

4S/4M Universal ECU (Cab-mounted) with RSC

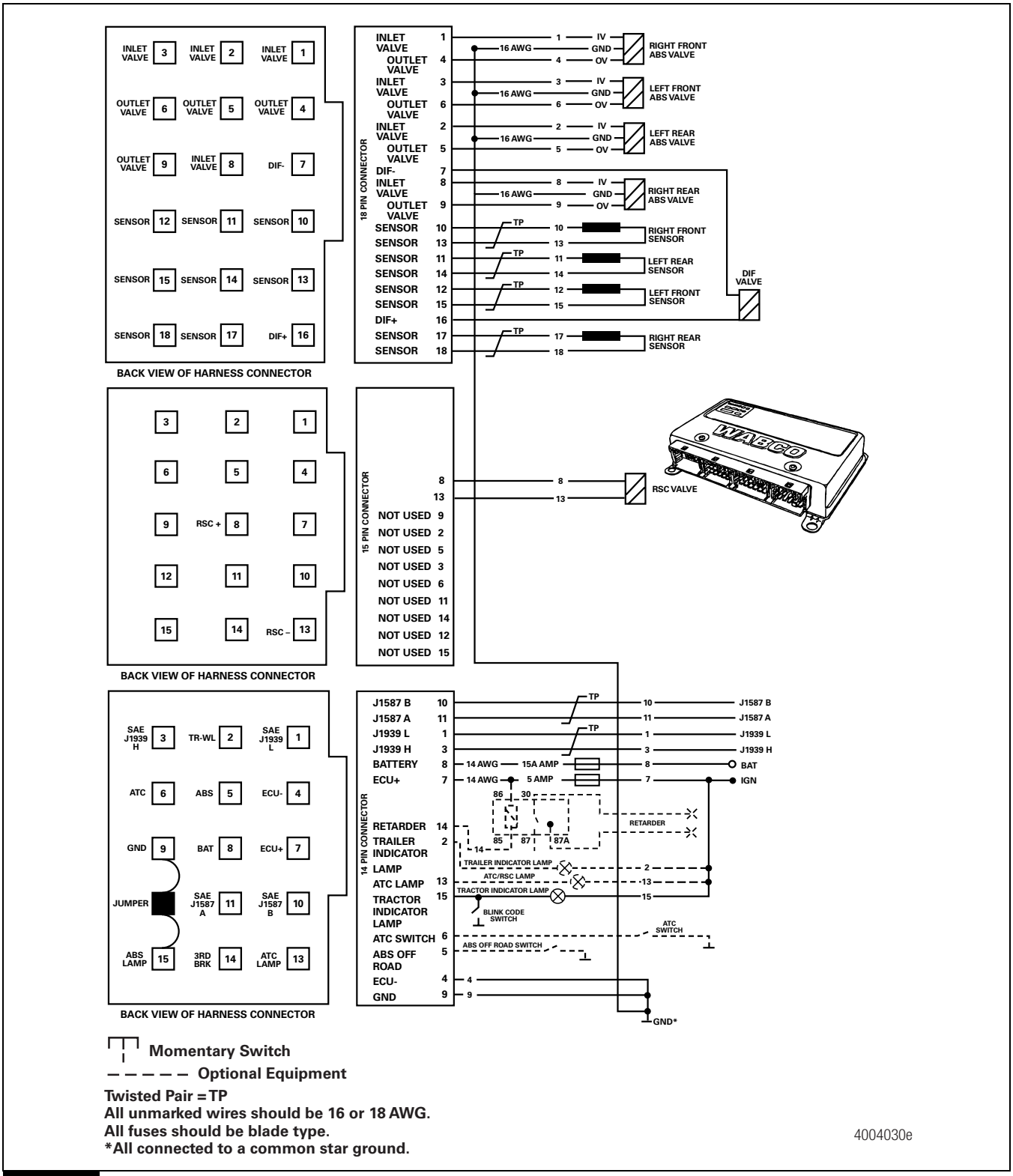


Figure 6.6

Frame-mounted ECU

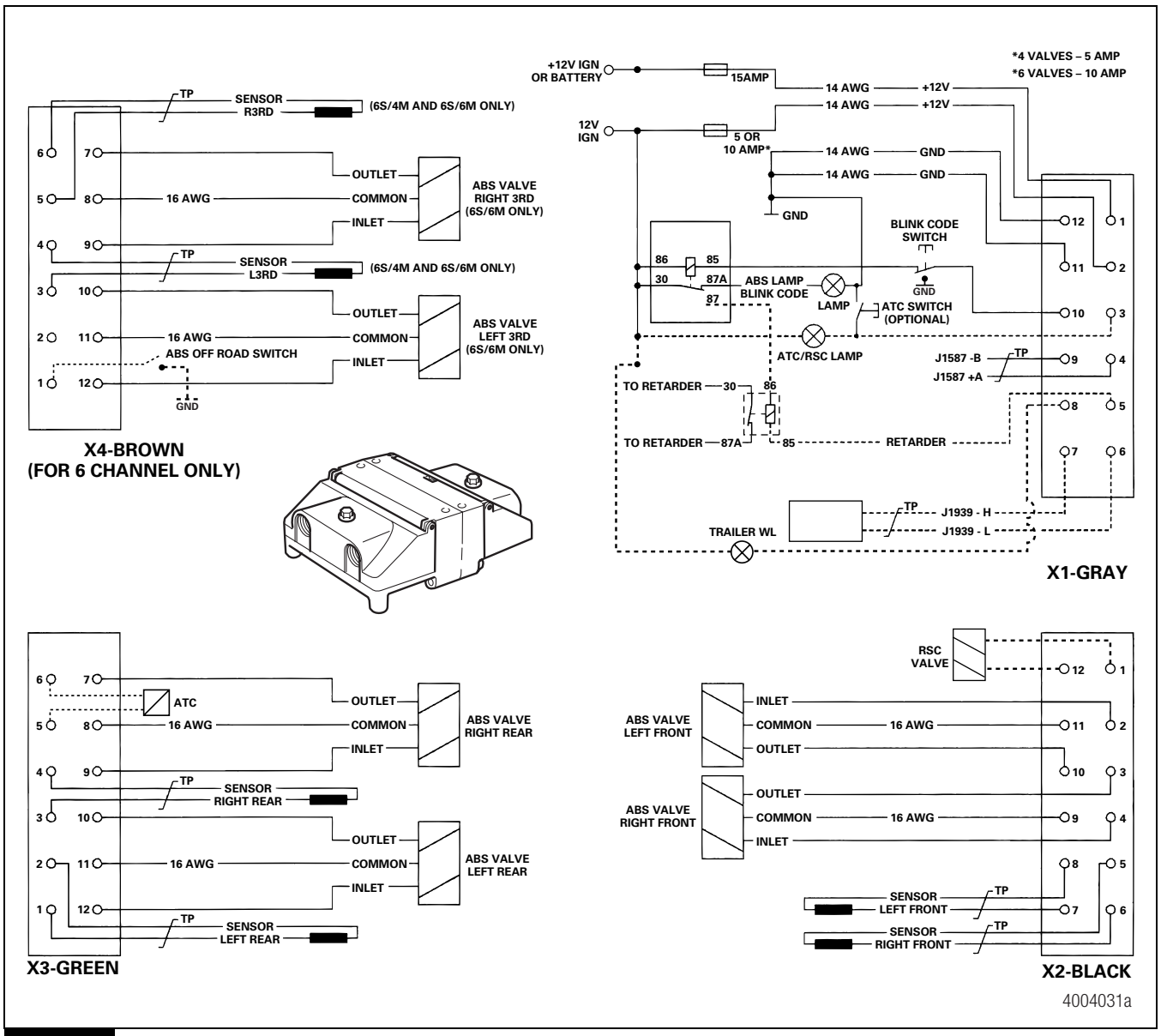
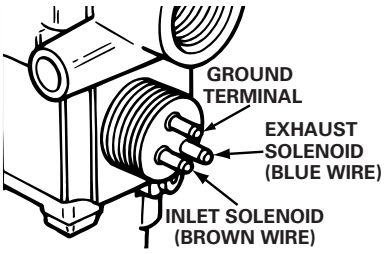
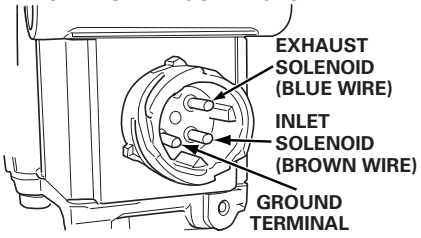


Figure 6.7

Troubleshooting

Meritor WABCO ABS Valve Package

This troubleshooting information is a reference tool to help identify possible malfunctions of the ABS modulator or relay valves. It does not take the place of diagnostic tests or other service instructions.

Condition	Possible Cause	Recommended Action
Air constantly leaks from exhaust port of relay valve.	Internal relay valve problem.	Replace the relay valve.
Air leaks from exhaust port of ABS modulator valve or relay valve when parking brake is released.	Parking brake problem. OR Anti-compound 2-way check valve problem.	Service the appropriate component. • Refer to manufacturer's service manual for instructions.
Rear service brakes releasing slowly (brakes dragging).	Kinked air line. Dirt buildup inside relay valve.	Inspect/repair lines, brakes. If the condition is not corrected: • Replace the relay valve.
Valves don't cycle at power-up. **OR** **Indicator lamp comes on (blink code or diagnostic tool indicates electrical problem with ABS valve).**	Broken wire. OR Loose or broken terminal connection. Corroded connector pins. OR Problem with solenoid. **OPEN-STYLE CONNECTOR**  **BAYONET-STYLE CONNECTOR**  	Check the wires and connections. • Make repairs as needed. **If condition is not corrected:** Measure resistance across each valve solenoid coil terminal and ground on the ABS modulator valve to ensure 4.0 to 8.0 ohms. • If **greater than 8.0 ohms,** clean the valve and repeat the measurement. — If cleaning does not solve the problem, replace the ABS modulator valve. • If **less than 4.0 ohms,** replace the ABS modulator valve.
ABS valve package damaged.	Road hazards. OR Vehicle damage.	Replace the complete ABS valve package or individual component as required.

Reconfiguration Procedure

How to Reconfigure an ECU (E Version)

Before reconfiguring the ECU, contact ArvinMeritor's Customer Service Center at 800-535-5560 for additional information.

E version ECUs memorize the following components if they are connected at power-up:

- ATC valve
- Retarder relay
- Datalink SAE J1939

NOTE: The ATC valve and Datalink SAE J1939 are required for RSC. The RSC ECUs cannot be reconfigured to remove these components. Only the retarder relay is memorized or cleared.

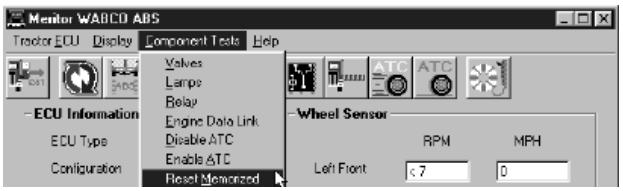
Once these components have been memorized, the ECU will look for them at each power-up. If a memorized component is not present, the ECU will record a fault. For example, if an ATC valve is memorized, but is not present at the next power-up, the ECU records a fault. This can occur if an ECU is moved from one truck to another and one or more of the memorized components are not available on the new truck. If this occurs, use TOOLBOX™ Software to reconfigure the ECU. If you do not have TOOLBOX™ Software, follow the manual reconfiguration instructions in this section.

TOOLBOX™ Software

NOTE: For complete instructions for using TOOLBOX™ Software, refer to the TOOLBOX™ User's Manual, TP-99102.

To reconfigure the ECU with TOOLBOX™ Software, use the ***Reset Memorized*** command.

Select ***Reset Memorized*** from the pull down menu to tell the ECU to reset the memorized or "learned" components. Figure 7.1 and Figure 7.2.



4004034a

Figure 7.1

4004035a

Figure 7.2

Manual Reconfiguration

Refer to Table H and Figure 7.3 for information on manual reconfiguration.

Table H

Action	Result	Reason
1. **Turn the ignition ON.** 2. **Press and hold the blink switch for at least three seconds.** **NOTE:** Do not hold this switch longer than seven seconds.	The ABS lamp displays the ABS system configuration code: • One blink: 6S/6M • Two blinks: 4S/4M • Four blinks: 6S/4M **NOTE:** The ABS lamp may display eight quick flashes before the system configuration code begins.	Stored faults cleared, no active faults present. Continue with reconfiguration. **NOTE:** The reconfiguration procedure cannot be conducted if there are active faults present. These must be repaired before proceeding with the reconfiguration.
Observe the ABS and ATC lamps.	The ATC lamp comes on and stays on.	A complete ATC system — including an ATC lamp — is installed. If not, the ATC lamp will not come on.
	The ABS lamp will continuously blink the system configuration code.	ECU reconfiguring the system. The ECU checks the following components and reprograms itself based on the new system: • ATC valve AND/OR • Retarder relay AND/OR • Datalink J1939
While the configuration code is flashing, press the blink code switch three times (one second each, with a one second pause between each). **Turn the ignition OFF.**	The ABS lamp displays **four quick flashes**, followed by a continuous display of the system configuration code. **NOTE:** The system configuration code continues until ignition is turned OFF.	Successfully reconfigured.

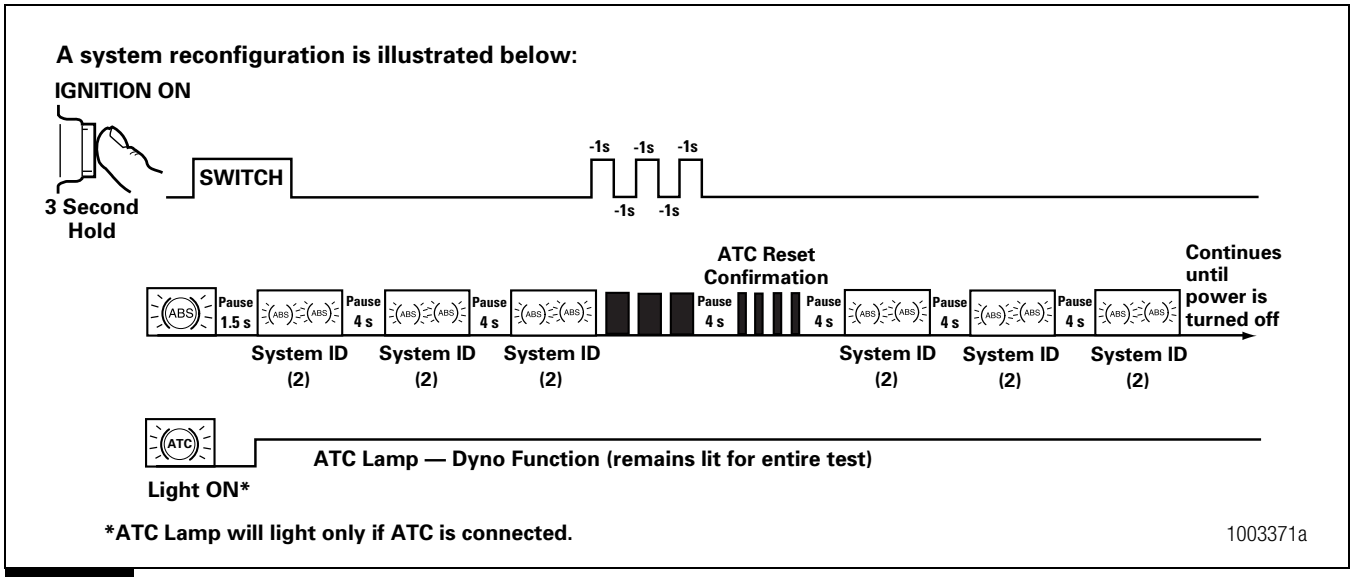

A system reconfiguration is illustrated below:
IGNITION ON
3 Second Hold
SWITCH
-1s
-1s
-1s
-1s
-1s
ATC Reset Confirmation
Continues until power is turned off
ABS
Pause 1.5 s
Pause 4 s
System ID (2)
ATC
ATC Lamp — Dyno Function (remains lit for entire test)
Light ON*
*ATC Lamp will light only if ATC is connected.
1003371a

Figure 7.3

Meritor WABCO Vehicle Control Systems
2135 West Maple Road
Troy, MI 48084-7121 USA
800-535-5560
meritorwabco.com

Printed in USA

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Maintenance Manual MM-0112 (16579/24240)

MERITOR WABCO

MERITOR WABCO

Technical Bulletin

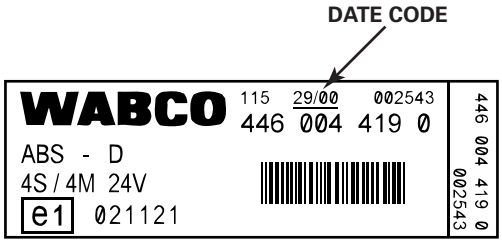
Engine Torque Reduction Diagnostics (J1922 Datalink Verification) for D-Version Meritor WABCO Pneumatic ECUs with Date Codes of 25/00 or Higher

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

The information in this technical bulletin explains the procedure for J1922 datalink verification for all D-version Meritor WABCO pneumatic ABS Electronic Control Units (ECUs) with date codes of 25/00 or higher. These ECUs require the ABS blink code be activated using **both** the vehicle ABS blink code switch **AND** a diagnostic tool — either TOOLBOX™ Software or the MPSI Pro-Link. Do not use the instructions in Maintenance Manual 30 for datalink verification if your ECU has a date code of 25/00 or higher.

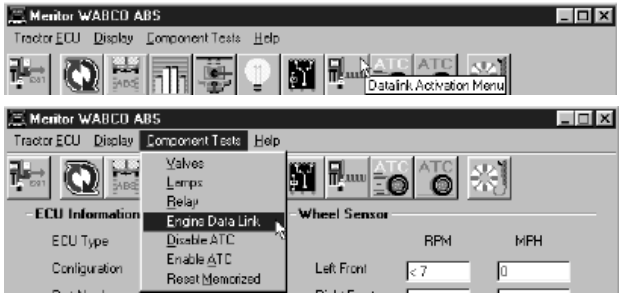
NOTE: The date code appears on the ECU identification label, as illustrated. The date code is also displayed on the Main Screen of TOOLBOX™ Software and on the Program ID screen of the Pro-Link.



There are two ways to perform J1922 datalink verification, one using TOOLBOX™ Software and the other using the MPSI Pro-Link. Both methods require the use of the vehicle ABS blink code switch.

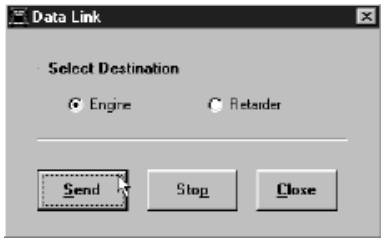
Using TOOLBOX™ Software for J1922 Datalink Verification

1. With TOOLBOX™ Software connected to the vehicle, turn the ignition ON.
   A. Press the ABS blink code switch. Hold for 3 seconds. The ATC lamp will come on and stay on for the entire test. If vehicle is not equipped with ATC, the ATC lamp will not come on.
   B. The ABS lamp will come on and blink eight times. If the lamp does not blink eight times, there are faults that must be cleared **before** you continue with this test. The eight quick flashes will be followed by the system identification code. The system identification code will continue during the entire test.
2. Click on the Datalink Activation menu icon, or from the Component Tests pull down menu click on Engine Data Link.



3. Click on Engine.
4. Click on Send.

NOTE: TOOLBOX™ Software sends the engine torque reduction command continuously until you click on the Stop button.



5. Send the Blink Code J1922 engine torque reduction command, as follows:

   A. Step on the accelerator. Bring the engine to 1000 RPM. Leave your foot on the accelerator during the entire test.

   B. While the engine is at 1000 RPM, press the blink code switch twice, as follows:

   - Press and hold for one second.
   - Release for one second.
   - Press and hold for one second.
   - Release for one second.

   The engine will alternate between 1000 RPM and idle indefinitely. Click the Stop button on the TOOLBOX™ screen. This stops the test and returns the RPM to accelerator control.

NOTE: To retest, begin at Step 4.

6. Click the Close button to exit the screen.
7. Take your foot off the accelerator. Turn the ignition OFF.

Engine torque reduction command verified.

Using the Pro-Link for J1922 Datalink Verification

1. With the Pro-Link connected to the vehicle, turn ignition ON.

   A. Press the ABS blink code switch — hold for 3 seconds. The ATC lamp will come on and stay on for the entire test. If vehicle is not equipped with ATC, the ATC lamp will not come on.

   B. ABS lamp will come on and blink eight times. If the lamp does not blink eight times, there are faults that must be cleared **before** you continue with this test. The eight quick flashes will be followed by the system identification code. This indicates the ECU is in the Datalink Verification mode. The system identification code will continue during the entire test.

2. Select the Pro-Link Engine Datalink choice, as follows:

   A. Press the arrow key(s) to find the Component Test choice.

   B. Press the Enter key to enter Component Test.

   C. Press the arrow key(s) to find the Engine Datalink choice.

3. Prepare the Pro-Link Engine Datalink command, as follows:

   A. Press the Enter key once to enter the first stage of the Datalink setup. The Pro-Link screen will display the following message: "run engine 1000 RPM/engine torque will change during test/[ENTER] to continue."

   B. **DO NOT** press Enter at this time.

4. Prepare the Blink Code J1922 Engine Datalink command, as follows:

   A. Step on the accelerator.

   B. Bring the engine to 1000 RPM. Leave your foot on the accelerator during the entire test.

   C. While engine is at 1000 RPM, press the blink code switch twice, as follows:

   - Press and hold for one second.
   - Release for one second.
   - Press and hold for one second.
   - Release for one second.

   This mode remains active for 10 seconds, which means you must start Step 5 within 10 seconds.

5. Send the Pro-Link J1922 engine torque reduction, as follows:

   Press the Enter key on the Pro-Link. The engine will alternate between 1000 RPM and idle for approximately 10 seconds, then return to 1000 RPM.

NOTE: To repeat the test, start with Step 3.

6. Take your foot off the accelerator. Turn ignition OFF.

Engine torque reduction command verified.

ArvinMeritor™

Meritor WABCO
Vehicle Control Systems
3331 West Big Beaver Road, Suite 300
Troy, MI 48084 USA
800-535-5560
meritorwabco.com

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1. WHEELS

The vehicle is equipped with hub-mounted wheels as standard equipment, all studs and nuts have right-hand threads Either steel wheels or optional aluminum-polished wheels may be installed on the vehicle. Both are mounted with radial tubeless tires.

1.1 X3-45 COACHES

All wheel dimensions are 22.50 X 9.0 inches (571.5 X 228.6 mm) for 315/80 R 22.5 tires except inner drive wheels ,which are always steel wheels and 22.50 X 8.25 inches (571.5 X 209.6 mm) for 315/80 R 22.5 tires. All other wheels can either be steel or aluminum wheels.

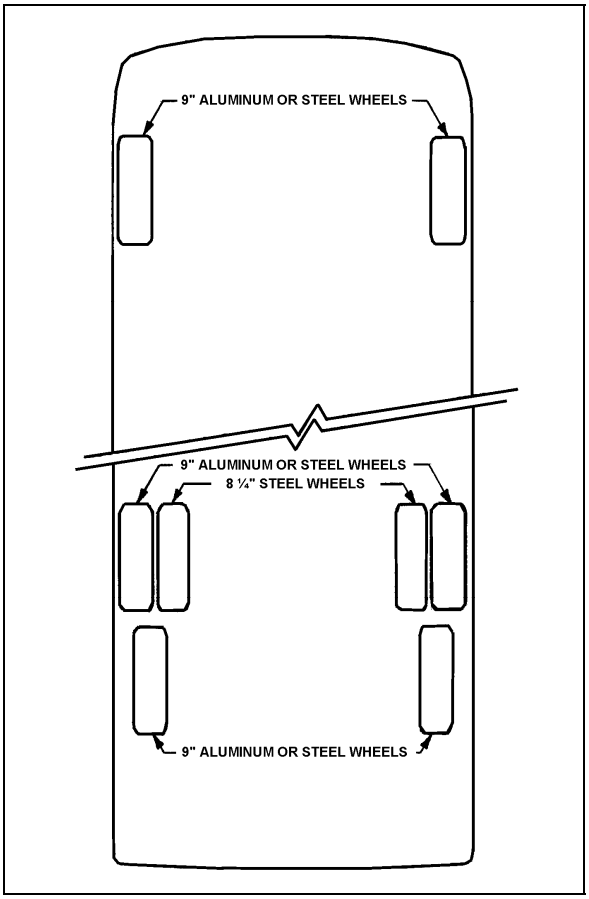


FIGURE 1: ALUM/STEEL WHEEL ARRANGEMENT 13001

1.2 X3-45 VIP & XLII BUS SHELLS

Drive axle wheel dimensions are 22.50 X 9.0 inches (571.5 X 228.6 mm) for 315/80 R 22.5 tires while front and tag axle wheels may either be 22.50 X 9.0 inches (571.5 X 228.6 mm) or 22.50 X 10.5 inches (571.5 X 266.7 mm) for 365/70 R 22.5 tires. Dura-Bright coating on aluminum wheels is optional.

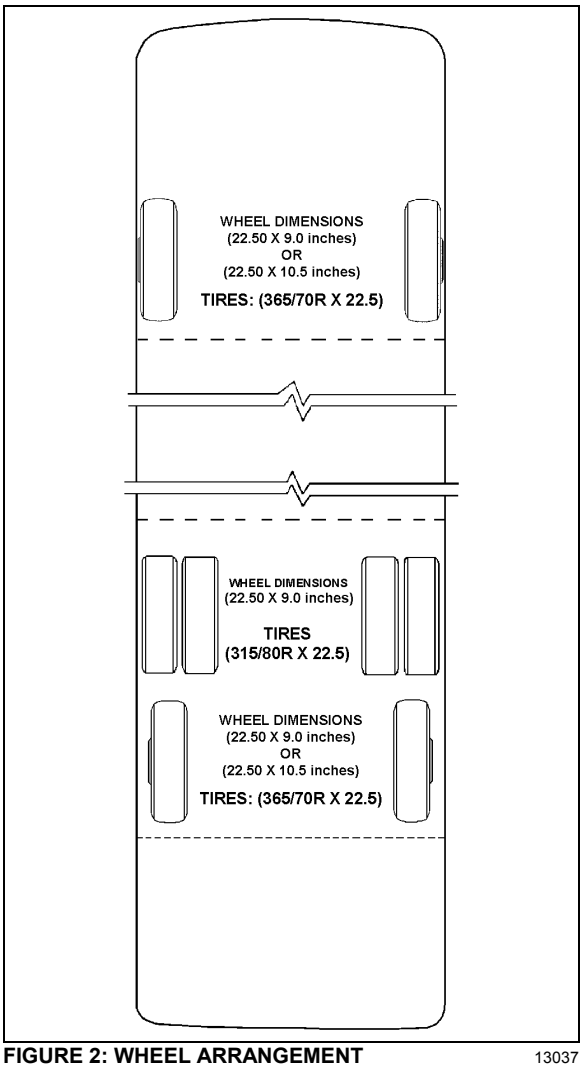


FIGURE 2: WHEEL ARRANGEMENT 13037

2. WHEEL MAINTENANCE

Wheel maintenance consists of periodic inspections. Check all parts for damage and make sure that wheel nuts are tightened to the proper torque. In the case of a new vehicle, or after a wheel installation, stud nuts should be tightened every 100 miles (160-km) for the first 500 miles (800-km) to allow setting in of clamping surfaces.

Wheel studs and nuts must be kept free from grease and oil. No lubricant whatsoever should be used. Cleanliness of the wheel and its rotor mating surfaces is important for proper wheel mounting.

However, for hub mounted wheels, it is recommended to add some rust protection lubricant on the pilot diameter of the hub (to facilitate future removal).

It is also important that wheel stud nuts be tightened alternately on opposite sides of the wheel. Refer to Figure 3 for the suggested tightening sequence.

2.1 INSPECTION

Tighten stud nuts progressively as shown in Figure 3. The final tightening should be done with a torque wrench. Tighten stud nuts to 450 - 500 lbf-ft (610 - 680 Nm) for aluminum as well as steel wheels.

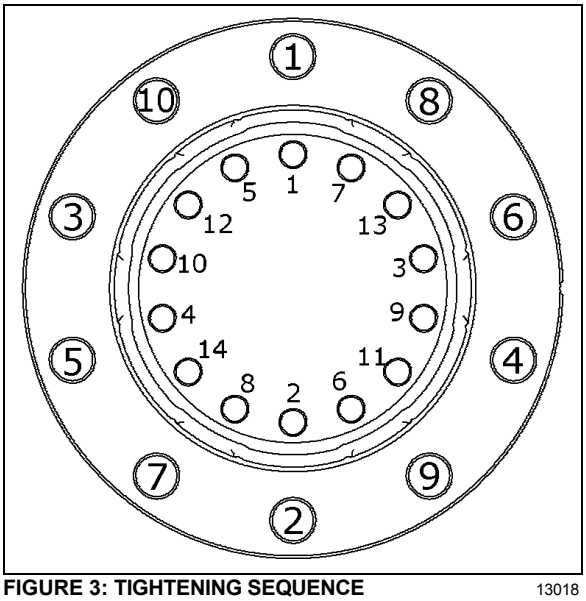


FIGURE 3: TIGHTENING SEQUENCE 13018

2.2 SINGLE WHEEL REMOVAL

1. Stop engine and apply parking brake.
2. Loosen wheel nuts about one turn (do not remove the nuts). This is not necessary if equipped with hydraulic powered gun.
3. Raise the vehicle by its jacking points on the body. See Section 18, *"Body",* under heading *"Vehicle Jacking Points";*
4. Unscrew wheel hex stud nuts and remove the wheel;

⚠ CAUTION

Always mark position of the wheel on the axle prior to removal in order to replace wheel at the same location, thus avoiding a new wheel balancing.

2.3 SINGLE WHEEL INSTALLATION

1. Mount the wheel over studs, being careful not to damage stud threads;
2. Screw in the hex stud nuts (refer to Figure 3 for sequence) so that wheel will position itself concentrically with hub. This is important, otherwise wheel may be eccentric with hub and will not run straight. In this initial step, slightly tighten the nuts to correctly position the wheel;
3. Tighten stud nuts progressively as shown in Figure 3. The final tightening should be done with a torque wrench. Tighten stud nuts to 450 - 500 lbf-ft (610 - 680 Nm) for aluminum as well as steel wheel.

⚠ CAUTION

Insufficient mounting-torque can result in damage to parts. Excessive mounting torque can cause studs to break and the wheel to crack in stud hole area.

3. DUAL WHEELS

3.1 OUTER WHEEL REMOVAL

Same as described in *"Single Wheel Removal"* procedure described previously.

3.2 INNER WHEEL REMOVAL

1. Remove outer wheel;
2. Remove inner wheel.

3.3 INNER WHEEL INSTALLATION

Mount the wheel over studs, being careful not to damage stud threads;

3.4 OUTER WHEEL INSTALLATION

With inner and outer wheels installed, tighten the stud nuts progressively as shown in Figure 3. The final tightening should be done with a torque wrench. Tighten stud nuts to 450 - 500 lbf-ft (610 - 680 Nm) for aluminum as well as steel wheel.

⚠ CAUTION

Insufficient mounting-torque can result in damage to parts. Excessive mounting torque can cause studs to break and the wheel to crack in stud hole area.

NOTE

On dual wheel assemblies, position the wheels with the tire valves 180º apart in order to have access to both the inner and outer valves.

3.5 INSPECTION

1. Loosen a hex stud nut three turns (Fig. 5);
2. Retighten the hex stud nut to 450 - 500 lbf-ft (610 - 680 Nm).

Repeat for each of the 10 *"hex stud nuts"* according to the tightening sequence in figure 3.

CAUTION

The actual length of thread engagement present in an assembled wheel can not always be determined by visual inspection of measurement of a tightened assembly. The relationship of the wheel cap nut seat to the end of the stud may vary. If there is any doubt that enough thread engagement is present, the number of engaged threads may be counted. Tighten all nuts in the regular manner, then loosen one to hand-tightness. The number of turns to disengage a 1-1/8-inch nut should be at least five full turns.

At least seven full turns should be required to disengage a ¾-inch nut or a M22 nut. Ideally, when torqued to the proper load, the stud should be flush with the face of the nut. The face of the nut may be recessed in nuts that are taller for improved wrenching. With most of the nuts in present use, a few unengaged threads at the outer end will cause no problem provided at least 5-7 full turns are required to disengage the nut depending on thread size.

4. ALUMINUM WHEEL ANTI-CORROSION PROTECTION

Clean wheels often by means of a high pressure water jet. Cleaning may be accelerated with mild soap. Do not use concentrated alkaline cleaning products.

When tire is removed, clean and inspect wheel thoroughly. Remove dirt and corrosion on rim by means of a wire brush. Do not use a wire brush on the outer surface of the wheel.

The following measures should be taken to maintain original appearance of the aluminum wheels:

1. Remove any tar from wheel surface with a good quality tar remover.
2. Spray Alcoa Cleaner (Prévost #683529) evenly on cool outer surface of wheel. Let work 15-20 minutes (keep wet by spraying more Cleaner if necessary).
3. Rinse thoroughly with clean water and let air dry. Heavy oxidation may require a repeat application of cleaner.
4. Apply Alcoa Polish (Prévost #683528) sparingly to a small area using a clean, soft cloth. Work polish into surface as you would a rubbing compound.
5. Buff, turning cloth frequently, until surface is clean and shiny. Let air dry. Use power buffer to improve ease of use and gloss uniformity.
6. On completely dry, clean and polished surface, generously apply Alcoa sealant (Prévost #683527). Rinse thoroughly with water while surface is still wet in appearance (have water source ready as the dry time is very short, usually less than 2 minutes).
7. For best results, finish by wiping the surface with a clean rag to remove excess water, then allow surface to dry.

Clean aluminum wheels as required to maintain original look.

WARNING

Wheel surfaces may have sharp or cutting edges that may cause injury to the hands. To prevent contact with sharp edges, it is strongly recommended to wear rubber gloves when washing or polishing wheels.

5. WHEEL STRAIGHTNESS TEST

1. Slightly raise axle to be checked and place a safety support underneath;
2. Check wheel lateral run-out. Install a dial gauge as shown in figure 4, then rotate the wheel by hand one full turn. As the wheel turns, note any variation on the dial gauge;

CAUTION

Damage to the dial gauge could occur if it strikes a wheel balancing weight.

3. If the variation in lateral run-out exceeds 0.0625 inch (1,6 mm), the wheel must be replaced.

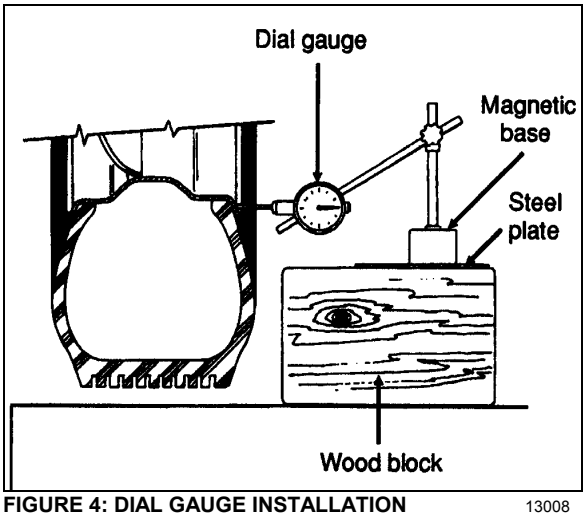


FIGURE 4: DIAL GAUGE INSTALLATION 13008

If doubt exists whether wheel or hub is distorted, hub may be checked as follows:

- Replace the existing wheel with a wheel known to be correct;
- Check wheel lateral run-out as outlined in step 2;
- If, within specifications, the hub is correct but the suspected wheel must be replaced.

WARNING

NEVER STRAIGHTEN ALUMINUM WHEELS. Never heat aluminum wheels to repair damages incurred after hitting a curb or resulting from other causes. The special alloy in wheels has been heat treated, and any uncontrolled heating could alter wheel structure. Furthermore, never weld aluminum-forged wheels for any reason whatsoever.

6. WHEEL STUDS

Stripped threads may be the result of excessive torquing or may have been damaged during wheel installation when placing the wheel over the studs. A stud having damaged threads must be replaced. Broken studs are a direct result of operating with loose stud nuts or improperly seated wheels. When a broken stud is replaced, the adjacent studs, on each side of the broken one must also be replaced since they could have been subjected to excessive strain and may be fatigued.

When installing wheel studs to hubs, check nuts retaining the wheel stud to wheel hub and replace if they are deformed, damaged or severely corroded. Install nut (and washer where applicable) to new stud. Torque to 450 - 500 Ft-lbs (610 - 680 Nm).

6.1 DRIVE AXLE WHEEL STUDS

Hub-mounted wheels are mounted with M22 x 1.5 studs and an M22 flange nut.

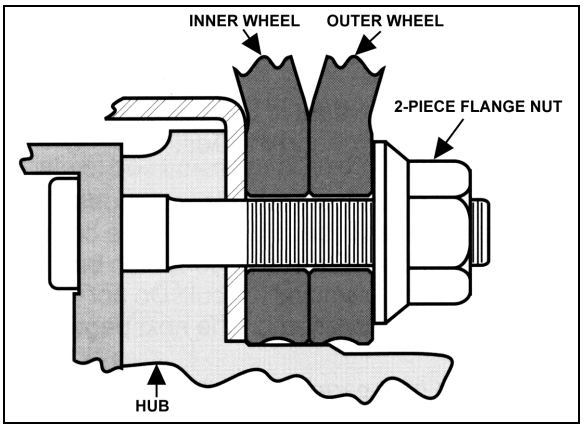


FIGURE 5: DRIVE AXLE WHEELS 13007

6.2 FRONT AND TAG AXLE WHEEL STUDS

Wheel is hub mounted on front and tag axle (M22 x 1.5 thread).

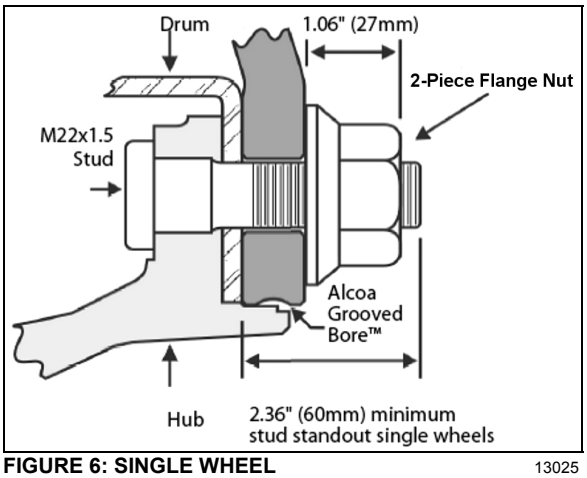


FIGURE 6: SINGLE WHEEL 13025

NOTE
Wheel studs and nuts must be kept free from grease and oil. No lubricant whatsoever should be used.

7. HUB MOUNTED WHEELS

Wheel surfaces in contact with hubs, nuts or other wheels should be kept free of all rust, grease and paint (except for initial “E” coat protection, applied to stop rusting and to facilitate wheel removal). The reason for this is to assure that all faces are clamped together without buildup of any coating. The threads of the wheel studs and the wheel nuts should be clean and undamaged.

NOTE
When painting wheels, make sure to mask all surfaces identified above.

Using a calibrated torque wrench, tighten wheel nuts to 450 - 500 lbf-ft (610 - 680 Nm) of torque. Do not use power tools or long bars for tightening. Tighten wheel nuts alternately as shown in figure 3.

NOTE
Tightening should not be done immediately after prolonged braking or when wheel ends are hot.

Check wheel nut torque at every 100 miles (160 km) for 500 miles (800 km) after fitting wheels. Let cool before checking. If any relaxation of the initial 450 - 500 lbf-ft (610 - 680 Nm) of torque has occurred, retighten. Relaxation of initial torque may occur because of the “bedding down” of the hub and wheel surfaces.

NOTE
Torque relaxation occurs when wheel ends are hot but should revert to original setting when cool. Retightening when hot will produce a higher torque reading than recommended.

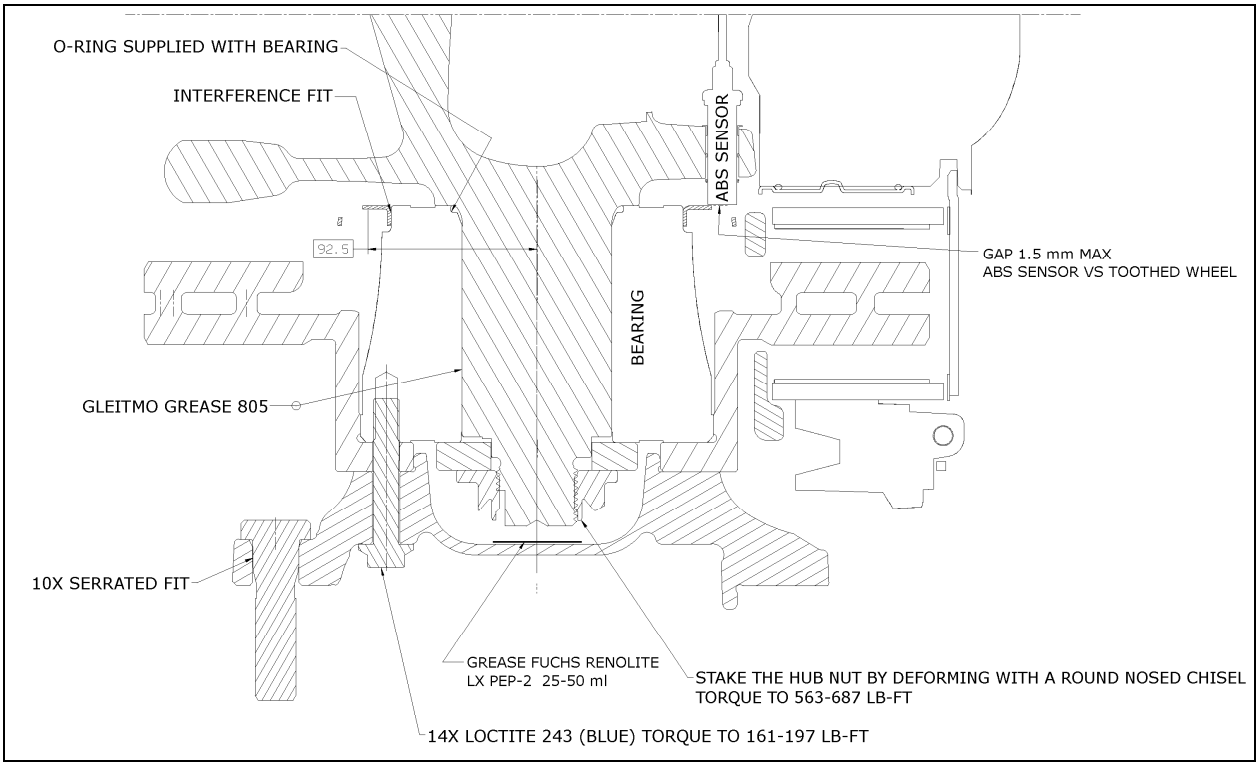


FIGURE 7: FRONT & TAG AXLE WHEEL HUB

7.1 CARE OF WHEELS

Check for cracks in wheels, especially around the fixing holes, studs, nuts and washers. If in doubt, renew.

Do not simply retighten very loose wheel fixings or wheels that are continually becoming loose. Find out why they are loose and whether any damage has been caused.

Use trained personnel and keep records of all attention to wheels and fixings, including which parts were renewed and when.

8. FRONT AND TAG AXLE WHEEL HUBS

The unitized hub bearings used on the NDS range of axles, are non-serviceable items. Bearings are pre-adjusted, lubricated and have seals fitted as part of the manufacturing process. The bearings are greased for life and there is no need or facility for re-lubrication

8.1 HUB BEARING INSPECTION

An inspection should be made at intervals of 30,000 miles (48 000 km).

- Apply parking brake, raise wheels off the ground and support axle on stands.
- When the wheels are raised, they should revolve quite freely without roughness.
- Place magnetic base of a dial indicator on brake caliper and position dial indicator stem against a convenient marked spot on face of hub flange.
- With dial indicator in position pull hard but steadily on hub flange and oscillate at same time until a steady reading is achieved.
- Without releasing the pressure, turn bearing so that dial indicator stem contacts marked spot and note reading on indicator.
- Push bearing flange hard and oscillate as before until a steady reading is achieved.
- Without releasing the pressure, turn bearing so that indicator stem again contacts the marked spot and note new reading on indicator.
- The difference between readings is the amount of mounted end play in bearing unit.
- The mounted end play figure should not exceed 0.050 mm (0.002”) for a new bearing and 0.20 mm (0.008”) for a bearing which has been in service.

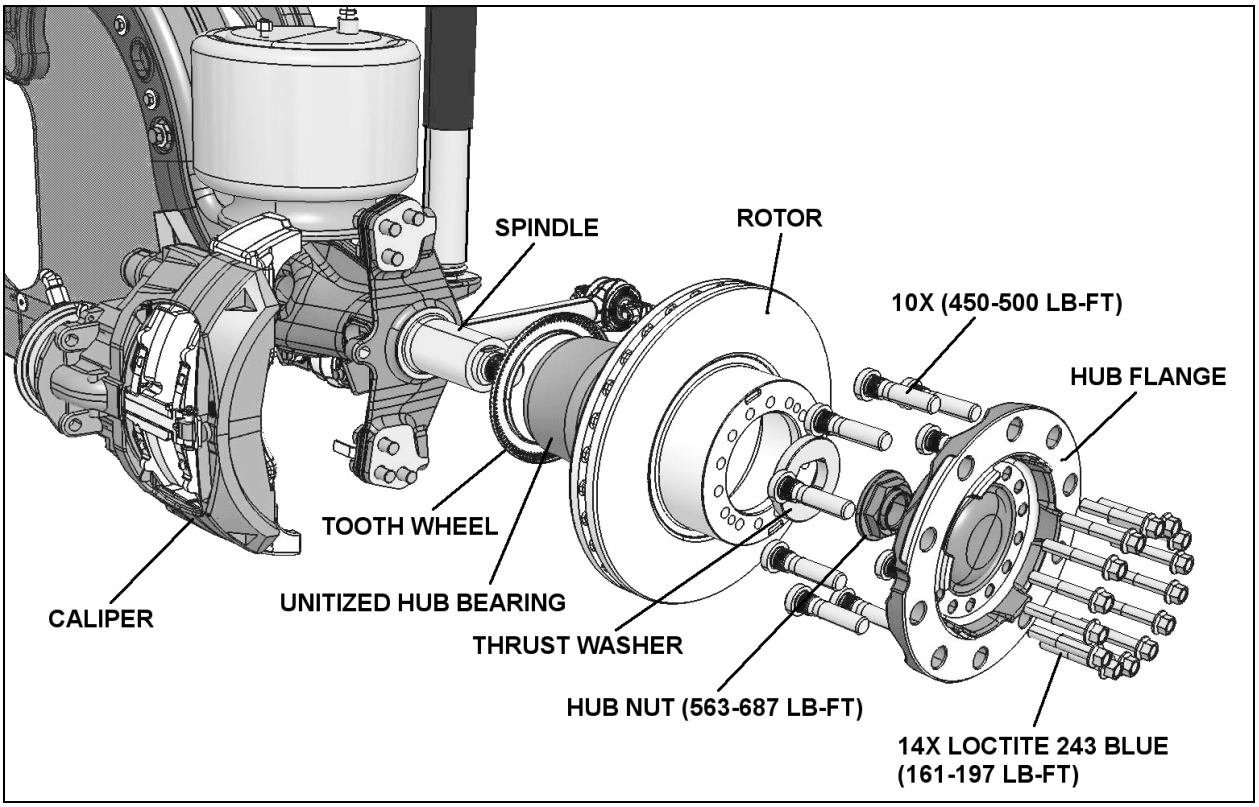


FIGURE 8: FRONT & TAG AXLE HUB AND ROTOR ASSEMBLY

NOTE
If original bearing unit is re-fitted, and end-float is measured at 1 mm, with hub not fully tightened to correct torque [563-687 lb-ft (763-931 Nm)], then the retaining clip within the unit is damaged and a new unit must be fitted.

NOTE
For more information on front and tag axle wheel hub, refer to "DANA SPICER Maintenance Manual Model NDS and Maintenance Manual NDS Axles" annexed at the end of Section 11.

8.2 HUB BEARING REMOVAL

- Stop engine and apply parking brake.
- Loosen wheel nuts about one turn (do not remove the nuts). This is not necessary if equipped with hydraulic powered gun.
- Raise the vehicle by its jacking points on the body. See Section 18, *"Body",* under heading *"Vehicle Jacking Points".*
- Unscrew wheel hex stud nuts (10) and remove the wheel.
- Unscrew hub flange hex cap screws (14).
- Remove hub flange and rotor.
- Unscrew hub nut.
- Remove hub nut and thrust washer.
- Remove unitized hub bearing by hand or use a puller if necessary.

8.3 HUB BEARING INSTALLATION

- Clean spindle using EFX degreaser (Prevost #685313).
- Lubricate part of spindle where bearing will be located, use Gleitmo 805 grease (Prevost #685274).
- Slide unitized hub bearing over spindle and position using insertion tool #32950.
- Clean thrust washer and hub nut using EFX degreaser.
- Install thrust washer and hub nut then torque hub nut to [563-687 lb-ft (763-931 Nm)].
- Stake the hub nut by deforming with a round nosed chisel.
- Clean hub bearing, rotor and hub flange clamping surfaces using EFX degreaser.
- Install rotor onto hub bearing.
- Add some grease (25-50 ml) (Fuchs Renolite LX PEP-2) (Prevost #685325) into the bottom of the hub flange cap. Mount hub flange onto rotor.
- Apply some Loctite 243 blue onto cap screw threads then secure hub flange and rotor to unitized hub bearing using cap screws (14). Torque to [161-197 Lb-Ft (218-267 Nm)] (Refer to figure 3 for tightening sequence).
- Mount the wheel over studs, being careful not to damage stud threads.
- Screw in the hex stud nuts (refer to Figure 3 for sequence) so that wheel will position itself concentrically with hub. This is important, otherwise wheel may be eccentric with hub and will not run straight. In this initial step, slightly tighten the nuts to correctly position the wheel.
- Tighten stud nuts progressively as shown in Figure 3. The final tightening should be done with a torque wrench. Tighten stud nuts to [450 - 500 lbf-ft (610 - 680 Nm)] for aluminum as well as steel wheel.

9. DRIVE AXLE WHEEL HUBS

Drive wheels use a single oil-seal assembly. They are lubricated from the oil supply in the differential housing. Bearings are tapered rollers, adjustable to compensate wear. Maintain differential oil level with general-purpose gear lubricant (refer to Section 24 *"Lubrication"* for proper oil grade selection) to ensure adequate oil supply to wheel bearings at all times.

9.1 BEARING ADJUSTMENT

To adjust drive wheel bearings:

1. Raise vehicle until both dual wheels can be turned freely (approximately 6 inches from the ground). Position jack stands under drive axle, then lower vehicle approximately 2 inches in order to avoid entire weight of the axle being supported by the suspension air bellows and the shock absorber pins.
2. Remove axle shaft as indicated in *"Meritor - Maintenance Manual No. 5"* under heading *"Single Reduction Differential Carriers"* annexed to *"Section 11"* of this manual.

Remove gaskets. Unscrew lock nut and remove adjusting nut lock ring.

3. To adjust, tighten adjusting nut until the wheel binds. Rotate the wheel while tightening so that all surfaces are in proper contact. Back off adjusting nut approximately, ¼ to 1/3 turn to assure 0.001/0.007" (0.0254/0.1778 mm) endplay and to ensure that wheel turns freely. Replace the lock ring, and adjust nut dowel pin in one of the holes. The ring may be turned over if necessary to allow more accurate bearing adjustment.
4. Tighten lock nut and check bearing adjustment. Replace the axle shaft using a new gasket.

9.2 DISASSEMBLY AND REPAIR

1. Jack vehicle as per “Bearing Adjustment" and remove axle shaft as indicated in *"Meritor - Maintenance Manual No. 5"* entitled *"Single Reduction Differential Carriers"* annexed to Section 11 of this manual.
2. Remove wheels and tires.

⚠ CAUTION

To replace wheel at the same location, always mark position of the wheel on the axle before removal, thus avoiding a new wheel balancing.

3. Remove lock nut, lock ring and adjusting nut from axle housing to prevent the outer bearing from falling out. Remove outer bearing cone and roller assembly.
4. Remove screws attaching inner oil seal retainer to hub, and remove inner oil seal assembly. Remove inner bearing cone and roller assembly. Bearing cups can be separated from the hub using a hammer and a long brass drift.
5. Thoroughly clean all parts. Bearing cone and roller assemblies can be cleaned in a suitable cleaning solvent using a stiff brush to remove old lubricant.
6. In case that excessive wear, deterioration, cracking or pitting is present on the bearing cups, rollers or cones, the bearings should be replaced. Seals should be replaced each time they are removed from the hub. To install new oil seal, use a suitable adapter and drive the seal into the retainer bore until it bottoms.
7. When installing wheel on spindle, center the wheel hub with spindle to avoid damaging the seal with the end of the spindle. Push wheel straight over the spindle until inside diameter of seal press fits on wiper ring. Fill hub cavity with general-purpose gear lubricant (refer to Section 24 *"Lubrication"* for proper oil grade selection). Lubricate, then install outer bearing cone. Adjust bearing and lock.
8. Assemble axle flange to axle using a new gasket. Apply sealant in stud area. After both wheels have been assembled according to above procedure, fill the differential with the recommended lubricant to the proper factory recommended level.

NOTE

During regular inspection, do not forget to check lubricant level in differential. Clean thoroughly or replace vent as required.

10. SPARE WHEEL (COACHES ONLY)

Tire failure is a rare event if tires are properly cared for. In case of a flat tire, move vehicle a safe distance away from traffic and apply parking brake. Remember to use the hazard flashers and according to the Highway Code regulations, set up the triangular reflectors (see *"Emergency Warning Reflectors"* in the Operator's Manual) at an adequate distance, to warn incoming motorists. This kit is located at the ceiling of the first baggage compartment, on the R.H. side.

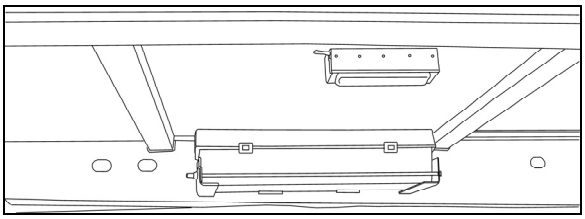


FIGURE 9: WARNING REFLECTORS LOCATION 23376

The spare wheel is stored in a dedicated compartment behind the front bumper. To access, pull the release handle located in the front service compartment. Although the bumper is heavy, sprung hinges permit one person operation.

When closing bumper compartment, make sure bumper is securely installed.

WARNING

This compartment has not been designed for storage. Never leave loose objects in this area since they may interfere with steering linkage mechanism. Make sure bumper is safely locked in place after closing the compartment.

10.1 PULLING OUT SPARE WHEEL

To remove the spare, untighten the pressure screw holding the tire in place, then press down on the spring loaded locking pin located at the top of the retaining bracket and remove the bracket. Using the strap, pull the spare out of the compartment (refer to the following illustrations). Rollers ease manipulation. Remove the protective cover. Install the flat in place of the spare by reversing the procedure. Do not forget to have the flat repaired as soon as possible.

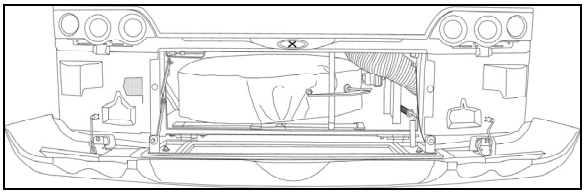


FIGURE 10: SPARE WHEEL COMPARTMENT 18614

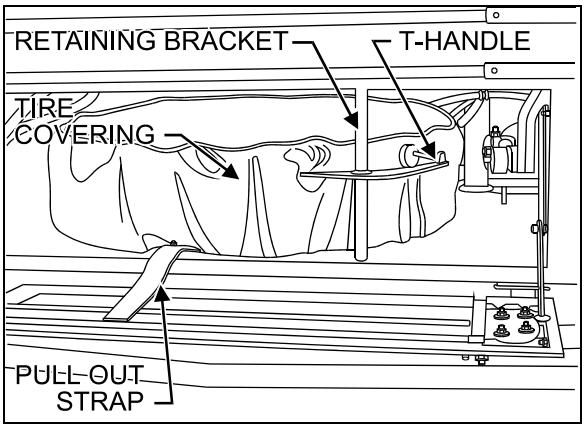


FIGURE 11: SPARE WHEEL AND TIRE 18415

NOTE

The jack and wheelnut wrench are stored in front service compartment.

The jack/tools kit stowed in the front service compartment contains a:

1. 30 ton hydraulic jack;
2. Wheel nut wrench and lever.

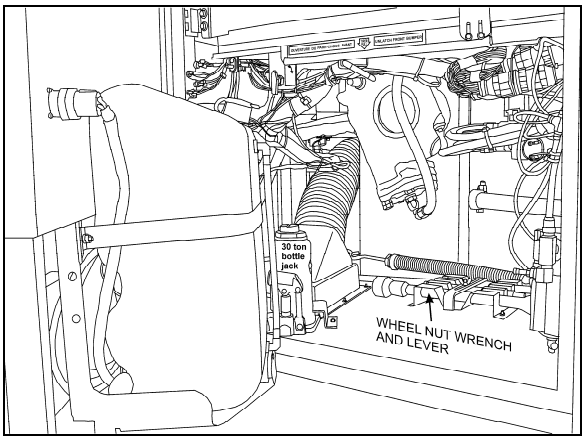


FIGURE 12: FRONT SERVICE COMPARTMENT 23377

NOTE

Check the inflation pressure of the spare tire periodically to keep it ready for use. Inflate spare tire to the pressure of the tire, which has the highest pressure on the vehicle. When installing, deflate to correct pressure if necessary.

10.2 CHANGING A FLAT TIRE (COACHES ONLY)

In case of flat tire, refer to appropriate procedure under “Wheel Maintenance" heading in this section.

NOTE

For hydraulic jack placement, refer to Section 18 "Body", under heading "Vehicle Jacking Points".

DANGER

Place jack on stable and level ground; if necessary, place a board under the jack. Do not raise the vehicle until you are sure the jack is securely engaged.

WARNING

To prevent personal injury and/or equipment damage, use only the recommended jacking points. Passengers must not remain inside vehicle while wheel is being replaced.

CAUTION

Adjust tire pressure according to the appropriate cold tire inflation-pressure.

NOTE

Store damaged wheel in spare tire compartment. Repair and balance the flat tire as soon as possible.

10.3 CHANGING A FLAT TIRE (X3-45 VIP & XLII BUS SHELLS)

In case of a flat tire, turn *ON* the hazard flashers and bring the vehicle to a stop on the side of the road. Apply the parking brake. Make sure the vehicle is parked safely away from traffic. Set up the triangular reflectors in accordance with applicable highway regulations.

We suggest that you **do not** attempt to change a wheel. First, the wheel and tire are very heavy and usually there is no space available to put the removed flat. Second, the wheel nuts, especially those on inner dual, can become very tight after being on for only a short time. Often a heavy air wrench is required to get these nuts loose. We suggest you get help via CB radio or cellular phone. There are tire service trucks all over the country that can bring a wheel and make the change safely.

NOTE

Bus shell vehicles contain no spare wheel. Access to compartment is obtained by pulling the release handle located in the front service compartment.

WARNING

The reclining bumper compartment has not been designed for storage. Never leave loose objects in this area since they may interfere with steering linkage mechanism. Make sure bumper is safely locked in place after closing the compartment.

10.4 SPARE WHEEL MAINTENANCE

Maintenance of the spare wheel and tire consists in ensuring that tire inflation pressure is the same as the tire on the coach that has the highest inflation pressure (refer to "Specifications" in this section for the recommended tire inflation pressure). Inspect rim to ensure that there is no important corrosion. In addition, check if spare wheel covering is in good condition and check that spare tire is securely fastened in compartment.

11. TIRE MAINTENANCE

The most critical factor in tire maintenance is proper inflation (Fig. 13). No tire is impervious to loss of air pressure. To avoid the hazards of under inflation, always maintain tires at their recommended inflation pressure. Improper inflation decreases tire life.

NOTE

X3-45 VIP & XLII Bus Shells vehicles, before being converted, are not at their maximum weight and tire pressures are adjusted at lower level than the maximum allowed appearing on the DOT plate. Tires pressure must be re-adjusted once converted.

An under inflated tire builds up heat that can cause sudden tire destruction, resulting in improper vehicle handling and possible loss of vehicle control. At least once a week, before driving (when tires are cold), check inflation pressure on all the tires, including the spare tire. This is especially important in cases when different drivers operate the vehicle.

WARNING

Failure to maintain correct tire inflation pressure may result in sudden tire destruction, improper vehicle handling, and will cause rapid and irregular tire wear. Inflation pressure should be checked weekly and always before long distance trips.

11.1 INFLATION PRESSURE

- Vehicles equipped with BERU TPMS

On vehicles equipped with the Beru Tire Pressure Monitoring System (TPMS), it is better to use the TPMS display as the primary reference to judge when tire pressure need adjustment.

The TPMS presents pressure readings of each tire as a +/- deviation from the wanted target.

If a tire reads within +/- 3 PSI no adjustment is needed.

If a tire reads -4 PSI and below, re-inflate by the marked amount.

If a tire reads +4 PSI and above , deflate by the marked amount.

Relying on the TPMS system is better than relying on a hand gage since the TPMS is

temperature compensated and remain accurate no matter if the tires are cold or hot.

Tires take up to 3 hours to get down to ambient temperature after a ride. A common mistake consist of checking pressure while the tires have not fully cooled down which leads into under-inflated tires. Relying on the TPMS eliminate this mistake.

Running tires at optimal pressure reduce tire wear, improve safety and fuel economy.

NOTE

It is more accurate to use the TPMS display to set the tire pressures than a pressure gauge.

The TPMS target pressures are factory set to equal the prevailing tire pressure at delivery time.

When tire pressures are increased to account for higher vehicle weight, the TPMS set point need to be increased accordingly.

- Vehicles not equipped with BERU TPMS

The condition and pressure of the tires can greatly affect both useful tire life and road safety.

At regular intervals, verify the tire pressures. Use an accurate tire pressure gauge when checking inflation pressures. Never exceed the maximum inflation pressure specified on each tire.

NOTE

Inflation pressure should be checked when tires are cold. Cold tire inflation pressure can be measured when a vehicle has not been driven for at least 3 hours or less than 1 mile (1.6 km). Driving, even for a short distance, causes tires to heat up and air pressure to increase. Check inflation pressure on all tires (including the spare tire) using an accurate tire gauge.

NOTE

The recommended tire inflation pressures are given in the applicable documents supplied with the vehicle. In addition, cold tire inflation pressures are listed on the Department of Transport's certification plate, affixed on the panel behind the driver's seat. For special tire selection, a "PRÉVOST COACH SPECIAL SPECIFICATION" chart is supplied with the vehicle and is affixed on the left wall near the driver's seat. Remember, tire inflation pressure must be adjusted according to vehicle loading - see table in "Coach Final Record"

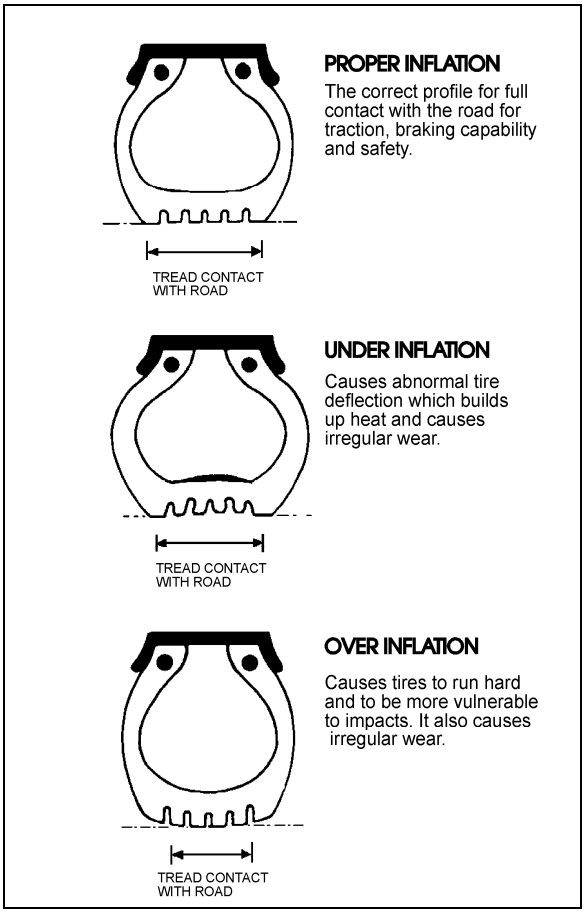


FIGURE 13: TIRE INFLATION 13009

CAUTION

Never bleed air from hot tires as tires will then be under inflated. Use an accurate tire gauge to check pressures (Do not kick tires as an inflation check. This is an unreliable method).

CAUTION

These tire pressures are established in accordance with the maximum allowable load on each axle. A lower pressure is recommended if the axle load is less than the above specifications. Weigh vehicle fully loaded and pressurize according to tire manufacturer's recommendations. For other tire and wheel specifications, see Prévost tire pressure tabulation in "Coach Final Record".

WARNING

Incorrect tire pressures cause increased tire wear and adversely affect road holding of the vehicle, which may lead to loss of vehicle control.

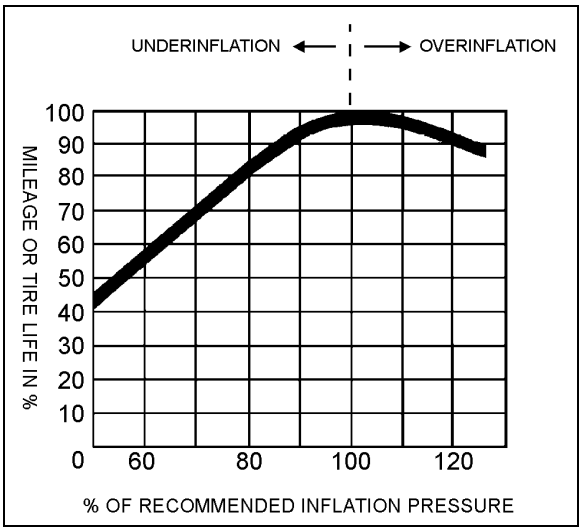


FIGURE 14: TIRE LIFE / INFLATION PRESSURE 13010

WARNING

Recommended tire inflation pressures and maximum allowable loads apply to speeds up to 65 mph (105 km/hr). Do not drive vehicle at a higher speed than 65 mph (105 km/h) or above the posted speed limit.

WARNING

All tires on the same axle should always be inflated to the same pressure. There should not be a difference in pressure between right and left tires on the same axle.

A 5-psi (35-kPa) underinflation in one front tire can not only reduce vehicle maneuverability, but will create steering hazards which can lead to an accident.

11.2 TIRE MATCHING

Unmatched tires on drive axle will cause tire wear and scuffing, as well as possible damage to the drive unit. Consequently, we recommend that tires be matched within 1/8" (3 mm) of the same rolling radius.

NOTE

It is recommended that all tires on coach be of the same type.

11.3 WHEEL BALANCING

Before balancing, wheels must be clean and free from all foreign matter. The tires should be in good condition and properly mounted. An unbalanced wheel can be due to a bent wheel or improper mounting. Before removing the wheel from the vehicle, check for swaying movement and if necessary, check the wheel lateral runout as outlined under heading *"Wheel Straightness Check".*

WARNING

When balancing wheel and tire assemblies, it is strongly recommended to closely follow instructions covering the operation of wheel balancer.

CAUTION

A maximum of 16-oz (450 g) of balancing weight is recommended. If more weight is necessary, check and correct the cause.

11.4 TIRE ROTATION

Radial tires should be rotated only when necessary. If the tires are wearing evenly, there is no need to rotate. If irregular wear becomes apparent or if the wear rate on the tires is perceptively different (from axle to axle), then tires should be rotated in such a manner as to alleviate the condition.

NOTE

There is no restriction on criss-cross rotation.

12. SPECIFICATIONS

12.1 X3-45 COACHES

STEEL WHEELS (except inner drive axle)

Wheel size ..... 9.0" X 22.5"
Wheel nut torque ..... 450 - 500 lbf-ft (610 - 680 Nm)
Tire size ..... 315/80 R 22.5

STEEL WHEELS (inner drive axle)

Wheel size ..... 8.25" X 22.5"
Wheel nut torque ..... 450 - 500 lbf-ft (610 - 680 Nm)
Tire size ..... 315/80 R 22.5

ALUMINUM WHEELS (All wheels are 9" X 22.5" except inner drive axle)

Wheel size ..... 9" X 22.5"
Wheel nut torque ..... 450 - 500 lbf-ft (610 - 680 Nm)
Tire size ..... 315/80 R 22.5

12.2 X3-45 VIP & XLII BUS SHELLS

DRIVE AXLE WHEELS

Wheel size ..... 9" X 22.5"
Wheel nut torque ..... 450 - 500 lbf-ft (610 - 680 Nm)
Tire size ..... 315/80 R 22.5

STANDARD FRONT AND TAG AXLE WHEELS

Wheel size ..... 9" X 22.5"
Wheel nut torque ..... 450 - 500 lbf-ft (610 - 680 Nm)
Tire size ..... 365/70 R 22.5

SPECIAL WHEELS FOR FRONT & TAG AXLES

Wheel size ..... 10.5" X 22.5"
Wheel nut torque ..... 450 - 500 lbf-ft (610 - 680 Nm)
Tire size ..... 365/70 R 22.5

RECOMMENDED TIRE INFLATION PRESSURE AT MAXIMUM LOAD (cold)

NOTE
Vehicle is delivered with the specific inflation pressure certification plate according to the tire selection.

WARNING

Special tire selection may lower maximum allowable speed limit, even below posted speed limit. For maximum safety, check with tire manufacturer.

CAUTION

Bus shell vehicles should be weighed fully loaded and tires pressurized according to tire manufacturer's recommendations.

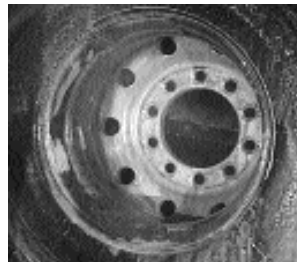
WARNING

Recommended tire inflation pressures and maximum allowable loads apply to speeds up to 65 mph (105 km/hr). Do not drive vehicle at a higher speed than 65 mph (105 km/h) or above the posted speed limit.

ALUMINUM WHEEL CLEANING AND MAINTENANCE PRODUCTS

Aluminum Wheel Cleaner (22 Oz bottle) ..... Prévost #683529
Aluminum Wheel Polish (16 Oz bottle) ..... Prévost #683528
Aluminum Wheel Sealer (13 Oz bottle) ..... Prévost #683527

Alcoa Dura-Bright® Wheel Finish Care and Maintenance



New Dura-Bright® wheels shed dirt, brake dust and grease.
Wash them off - no scrubbing, no special chemical solutions - and watch them shine.

ALCOA

Alcoa Dura-Bright® Wheel Care and Maintenance

Maintenance against corrosion

1. Clean frequently with high-pressure water from a hose. The use of a mild detergent will speed the cleaning process. Do not clean with abrasives, abrasive brushes, steel wool, scouring pads or strong chemicals, such as acids or lye-based products. Never spray cold water on extremely hot wheels. Always allow time to cool before cleaning.

2. When tires are removed, the entire rim must be cleaned and inspected (see section 2, page 3 of the Alcoa Wheel Service Manual, July 2002). With a brush, remove any foreign products **from the tire side of the rim** (portion of the wheel that supports the tire). Do not use an abrasive brush to remove dirt, corrosion or other foreign products from the Dura-Bright® wheel surfaces. Generously coat the entire air chamber surface with an approved surface protectant and lubricate each time the tire is removed (see 3-1, page 11 of the Alcoa Wheel Service Manual, July 2002).

3. To maintain the original appearance of your Alcoa Dura-Bright® wheels, the following procedures are recommended:

a. After installing new wheels and prior to operating your vehicle, use a sponge or cloth to wash exposed wheels surfaces with a mild detergent and warm water. Do not use abrasives, abrasive brushes, steel wool, scouring pads or strong chemicals (such as acids or lye-based products). Standard off-the-shelf car wash and wheel detergents are sufficient.

b. Rinse thoroughly with clean water. Warm water and a mild detergent will speed the cleaning process.

c. Wipe dry to avoid water spots.

d. Clean your Alcoa Dura-Bright® wheels using the above procedures as frequently as required to maintain their appearance. Typical road soils, grime and brake dust trap moisture, which can cause corrosion over a period of time. These must be removed regularly. To assist in the removal of excessive dust, dirt and road grime, the use of warm, high-pressure water with a mild detergent is recommended. The surface of Alcoa Dura-Bright® wheels will be damaged, discolored or removed if abrasives, abrasive brushes, steel wool, scouring pads or strong chemicals (such as acids or lye-based products) are used to clean the wheel. **DO NOT USE** the Alcoa Aluminum Care System on Dura-Bright® wheels at any time during their service life.

Do not exceed maximum wheel load. Customer must compare OEM vehicle load raiting to maximum wheel load rating.

Refer to tire manufacturer's recommedation for proper tire pressure. Before mounting the tire, perform a wheel fitment check to ensure proper clearance from any obstructions.

4. Once in service, Dura-Bright® wheels can become nicked or scratched by road debris and/or mechanical damage. If this occurs, continue to follow the normal washing and cleaning instructions provided above. The surface of Alcoa Dura-Bright® wheels is designed to limit cracking and peeling if nicked or scratched while in service.

5. Even as durable as Dura-Bright® wheels are, the mounting area can become scratched, marred or discolored when mounted against another wheel, hub or drum. Keeping this surface consistently located. The use of a wheel mounting surface guard, such as Alcoa DiscMates™, is highly recommended. The use of the Alcoa Hub Cover System on Alcoa Dura-Bright® wheels will also assist in limiting such damage and help maintain the appearance of your Alcoa Dura-Bright® wheels.

Avoid abuse

Abuse can shorten the life of a wheel. Lack of care in changing a tire, heavy pounding on the wheel rim, overloading or hitting curbs at high speed or a sharp angle can damage wheels.

Rim flange wear

Irregular wear on the sruface of the rim flange is caused by the chafer and side wall area of the tire working on the surface of the rim flange. Remove the wheel from service when rim flange wear is excessive. Excessive wear can be determined using an Alcoa approved wear gauge and procedures. For availability, contact Alcoa Wheel Products at 800-242-9898 or 1600 Harvard Avenue, Cleveland, Ohio 44105. If rim flange wear becomes sharp and/or cuts the tire, contact Alcoa Wheel Products for recommended maintenance procedures.

Valves

Alcoa drop center wheels for tubeless tires come from the factory with air valves installed. If it becomes necessary to replace an air valve, install it using the following torque values.

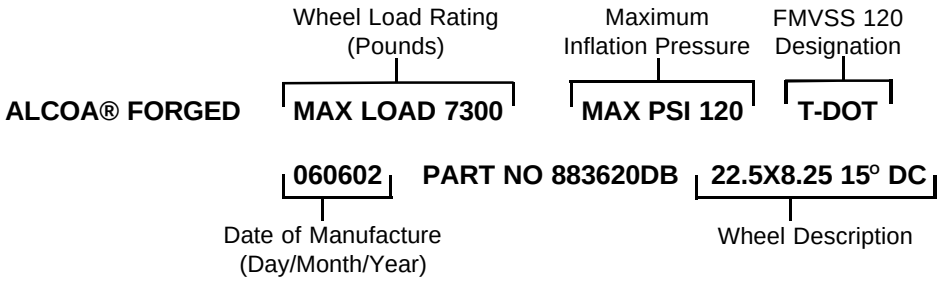
10 to 14 foot-pounds for part numbers	**7 to 11 foot-pounds for part numbers**
TR 509	TR 542 Series
TR 510	TR 543 Series
TR 511	TR 544 Series
	TR 545 Series

Replacement valves may be obtained from your authorized Alcoa wheel distributor. Always use silicone O-rings - not rubber - when reinstalling valve stems. Metal valve stem caps are recommended over plastic.

Identification

Alcoa wheel identification

Since 1977, all Alcoa aluminum disc wheels have been identified with a stamp that shows the wheel load rating, maximum inflation pressure, date of manufacture, part number, wheel description and DOT marking designation (shown below).



Prior to June 1996, all Alcoa heavy duty truck wheels has the Alcoa identification symbol ⧖ on the outside of the disc near the hand hole and in line with the valve location. This marking was phased out on heavy duty truck wheels manufactured after June 1996.

Note: Prior to June 1999, all heavy duty truck wheels manufactured by Alcoa Wheel Products were date stamped with the month and year only.

Keep wheel nuts tight

Wheel cap nuts must be kept tight (see section 4 of the Alcoa Wheel Service Manual, July 2002). When checking the cap nuts on dual disc wheels using the stud located ball seat mounting system, loosen every other outer cap nut and then check the torque of the inner cap nuts. Re-torque the loosened outer cap nuts. Repeat these steps on the remaining studs. Check all cap nuts for proper torque after the first use or any removal. Inspect wheels and check wheel nuts during service stops (see section 2 of the Alcoa Wheel Service Manual, July 2002). Dirt streaks from cap nuts may indicate looseness.

Flange nuts must be kept tight, and studs and nuts should be checked frequently. At tire changes, nuts and studs should be inspected to be sure they are in good condition. If nuts require frequent tightening or studs break frequently, hardware and mounting practices should be reviewed.

The proper torque for ball seat cap nuts is between 350 and 400 foot-pounds for stud threads lubricated with SAE 30W oil and between 450 and 500 foot-pounds for threads that are not lubricated. The proper torque for M22-1.5 two-piece flange nuts (33 mm hex head) is between 450 and 500 foot-pounds.

Lead balance weights (clip-on)

Lead balance weights for Alcoa wheels are available from your Alcoa wheel distributor. With radial tires, it may be necessary to temporarily reduce the tire pressure to allow clearance of the weight clamp over the rim flange.

Do not straighten wheels

Do not heat wheels in an attempt to soften them for straightening to repair damage from striking curbs or other causes. The special alloy used in these wheels is heat-treated, and uncontrolled heating will weaken the wheel.

Do not rework, weld, heat or braze Alcoa aluminum wheels for any reason. This does not include normal wheel maintenance as described and approved by Alcoa.

Owner/in-service identification

Some fleets wish to specially identify wheels with OWNERSHIP and IN-SERVICE DATE information. If this practice is adopted:

1. Use “Lo-Stress” stamps or equivalent.
2. Location of stamped areas on outside disc should be in space outward from a line between hand hole centers and a minimum of one inch from the periphery of any hand hole.
3. Location of stamped identification on inside of wheel should be as close to the factory identification stamping as possible.

Note: Use of an impression stamp on Dura-Bright® wheels can affect the appearance and performance of the Dura-Bright® surface treatment local to the stamp.

Limited Warranty

FOR HEAVY DUTY TRUCKS, TRUCK TRAILERS AND BUSES

Dura-Bright wheels denoted by Alcoa part numbers ending with a "4" and "7" with bead seat diameters measured in 0.5-inch increments

Alcoa Inc. warrants to the original purchaser from Alcoa or its authorized distributor that a new Alcoa Dura-Bright® aluminum disc heavy duty truck, truck trailer or bus wheel is free from defects in material and workmanship. Alcoa agrees, without charge, to repair or replace a Dura-Bright® wheel that fails in normal use and service because of defects in material or workmanship. Wheels are structurally warranted for 60 months from the date of manufacture, and the Dura-Bright® surface treatment is also warranted for 60 months from the date of manufacture. Alcoa bus mount wheels (10-hole, 11.25-inch bolt circle, 8.670-inch hub bore with 1.22-inch diameter bolt holes) and other wheels used in transit bus service are structurally warranted for 120 months from the date of manufacture, and the Dura-Bright® surface treatment is warranted for 60 months from the date of manufacture. In all cases, the date of manufacture is shown on the wheel. Alcoa does not warrant and will not repair, replace or make adjustments with respect to normal wear or for any wheel that has been damaged or subjected to misuse or abuse including, without limitation, the following:

(a) Using a tire that is improperly sized according to standards recommended by Alcoa or the Tire and Rim Association, Inc.;
(b) Loading beyond the applicable maximum wheel load as specified by Alcoa;
(c) Inflating the tire beyond the applicable maximum as specified by Alcoa;
(d) Changing the original condition of the wheel by alteration or by subjecting it to processing, such as heating, welding, straightening or machining;
(e) Accidents, road conditions, abnormal or severe operating conditions;
(f) Failure to follow instructions and recommended maintenance on the wheel as set forth in the Alcoa Wheel Service Manual, Alcoa Technical Bulletins and other Alcoa literature. Recommended maintenance includes, without limitation, periodic cleaning with standard non-abrasive wheel and/or car wash cleaners/ detergents, valve replacement and rim flange wear inspections and procedures.

This limited warranty in regards to the Dura-Bright® wheel finish (denoted by Alcoa part numbers ending in "4" and "7") does not cover corrosion or other damage associated with the conditions addressed above or associated with the following: damage in areas of the mounting surfaces (such as lug holes, hubs, drums and against other wheels in dual position), damage due to cleaning with abrasives, abrasive brushes, steel wool, scouring pads or strong chemicals (such as acids or lye-based products), and removal/damage of the Dura-Bright® wheel finish, including chipping, by contact with road obstacles such as stones, gravel, concrete curbs, metallic barriers, signs, etc. Alcoa recommends cleaning the wheels with mild soap and water. For detailed recommended use and maintenance instructions, see the Alcoa Wheel Service Manual and the Alcoa Dura-Bright® Wheel Finish Care and Maintenance instructions.

Do not exceed maximum wheel load. Customer must compare OEM vehicle load raiting to maximum wheel load rating.

Refer to tire manufacturer's recommedation for proper tire pressure. Before mounting the tire, perform a wheel fitment check to ensure proper clearance from any obstructions.

THERE IS NO WARRANTY THAT THE WHEEL IS MERCHANTABLE OR SATISFACTORY FOR ANY PARTICULAR PURPOSE. NOR IS THERE ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, ON THE WHEEL.

ALCOA WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR ANY BREACH OF WARRANTY, ITS LIABILITY AND THE PURCHASER'S EXCLUSIVE REMEDY BEING EXPRESSLY LIMITED TO REPAIR OR REPLACEMENT OF THE WHEEL.

Repair or replacement will be handled by any authorized Alcoa wheel distributor or by any Alcoa wheel representative under Alcoa's return policy. This warranty gives you specific legal rights. You may also have other rights under other applicable laws.

To obtain a copy of the Alcoa Wheel Service Manual, the Alcoa Dura-Bright® Wheel Finish Care and Maintenance instructions, or other product and specification literature, contact Alcoa Wheel Products at 800-242-9898 or at 1600 Harvard Avenue, Cleveland, Ohio 44105. For additional information on our warranty or to submit a warranty claim, contact the Alcoa Wheel Service Center at 800-242-9898 (option 2) or 888-279-3055.

ALCOA

WHEEL SERVICE MANUAL

HEAVY DUTY TRUCK | TRAILER | BUS | MOTOR HOME

IMPORTANT SAFETY PRECAUTIONS FOR TRUCK RIMS AND WHEELS

JANUARY 2009

(SUPERSEDES JANUARY 2007)

IMPORTANT: Federal OSHA Regulations require all employers to make sure their employees who service rims/wheels understand the safety information contained in this manual. Do not let your employees service rims/wheels unless they are thoroughly trained and completely understand this safety information.

If you are a service technician do not service rims/wheels unless you are thoroughly trained and completely understand this safety information.

LIMITED WARRANTY

FOR HEAVY DUTY TRUCKS, TRUCK TRAILERS,
BUSES, RV and MOTORHOME WHEELS

(Wheels with bead seat diameters measured in .5 inch increments and Alcoa tube type wheels)

Alcoa warrants to the original purchaser, from Alcoa or its authorized distributor, that a new Alcoa aluminum disc heavy duty truck, truck trailer, bus, 19.5-inch and 22.5-inch RV or motorhome wheel is free from defects in material and workmanship. Alcoa agrees, without charge, to repair or replace a wheel that fails in normal use and service because of defects in material and workmanship. Truck, truck trailer, Dura-Flange® and the Dura-Bright® surface treatment wheels not used in transit service are warranted for 60 months from the date of manufacture as shown on the wheel except the Dura-Flange® rim flange treatment is warranted for a period of 24 months. Alcoa bus mount wheels (10-hole, 11.25 inch bolt circle, 8.670 inch hub bore with 1.22 inch diameter bolt holes) and other wheels used in transit service® are warranted for 120 months from date of manufacture, except the Dura-Bright® surface treatment on bus and transit service wheels is warranted for a period of 60 months from the date of manufacture and the Dura-Flange® rim flange treatment is warranted for 24 months against sharp edges. Satin finish, polished and Dura-Bright® surface treatment 19.5-inch and 22.5-inch RV and motorhome wheels are warranted for 120 months from the date of manufacture as shown on the wheel. Alcoa does not warrant and will not repair or replace or make adjustment with respect to any wheel that has been subjected to misuse or abuse including the following:

(a) Using a tire that is oversized according to standards recommended by the Tire and Rim Association, Inc. or other recognized tire and rim agencies such as ETRTO (Europe) or others;

(b) Loading the wheel beyond the applicable maximum wheel load as specified by Alcoa;

(c) Inflating beyond the applicable maximum as specified by Alcoa;

(d) Changing the original condition of the wheel by alteration or by subjecting it to any processing such as welding or straightening.

(e) Accidents, abnormal or severe operating conditions including without limitation tire fires, brake fires, severe brake system drags or seizures or running with a flat tire; or

(f) Failure to follow maintenance and other instructions and warnings set forth in the Alcoa Wheel Service Manual, Alcoa Technical Bulletins and other Alcoa literature. Recommended maintenance includes, without limitation, using proper torque, periodic cleaning, polishing, valve replacement, periodic inspection for damage, loose lug nuts and rim flange wear inspections and procedures.

(g) Nicks, scratches and other surface blemishes resulting from improper maintenance, cleaning, road debris, curbing, accident or operation are not warrantable.

(h) Rim flange wear (other than Dura-Flange®) is not warrantable.

(i) Damage due to cleaning with abrasives, abrasive brushes, steel wool, scouring pads, or strong chemicals (acids or alkaline).

Dura-Bright® Surface Treated Wheels are warranted against:

(a) Filiform corrosion (worm or hair like lines, generally milky in appearance, underneath surface protective treatment and emanating from damage to the surface treatment such as nicks, scratches or damage from mounting hardware or wheel weights)

(b) Blistering due to loss of adhesion of the surface treatment,

(c) Lift off of the surface treatment due to physical damage (nicks, scratches, gouges)

If nicks, dings, scratches or other damage does occur to the Dura-Bright® treatment that exposes the aluminum underneath, the metal exposed may naturally oxidize, but any corrosion will be confined to the metal exposed and will not extend into or underneath the Dura-Bright® treatment.

Normally, any washing materials or chemicals (including mild acid washes) that can safely be used on a vehicle, its painted surfaces and components, can safely be used on the Dura-Bright® surface treatment. The Dura-Bright® treatment prevents corrosion of aluminum wheels and protects their shine. So long as the treatment remains in place (see comments (g) and (h) above) and is maintained in accordance with the Alcoa Dura-Bright® Care and Maintenance manual, it is warranted against corrosion. If corrosion does occur within the treatment warranty period, subject to the limitations stated above, Alcoa will replace any wheel exhibiting such corrosion.

There is no warranty that the wheel shall be merchantable or fit for any particular purpose, nor is there any other warranty, express or implied, except such as is expressly set forth herein.

Alcoa shall not be liable for any incidental or consequential damages for any breach of warranty, its liability and the purchaser's exclusive remedy being limited to repair or replacement of the wheel as stated in this limited warranty.

Alcoa Wheel Service Manual. This limited warranty should be used in conjunction with the Alcoa Wheel Service Manual and the Alcoa Dura-Bright® Wheel Finish Care and Maintenance Manual. The Wheel Service Manual contains important safety information and warnings, and failure to read and understand this information may result in serious injury or death. The limited warranty is included with the Wheel Service Manual, but may appear elsewhere. If you do not have copies of the Wheel Service Manual you may obtain copies free of charge from Alcoa Wheel Products, 1600 Harvard Avenue, Cleveland, Ohio 44105, (800) 242-9898 and on the web at www.alcoawheels.com.

WARNING

WARNING Wheels that are not properly installed or maintained may not be safe.

Failure to follow proper wheel installation or maintenance practices may result in injury or death.

Follow the proper wheel installation and maintenance practices as contained in this Alcoa Wheel Service Manual. For additional copies of the manual and other useful items listed below, available free of charge, or for the most recent updates, contact Alcoa Wheel Products at 1-800-242-9898 or on the web at www.alcoawheels.com.

To obtain information on free training on proper installation and maintenance procedures, contact Alcoa Wheel Products at (800) 242-9898 or on the web at www.alcoawheels.com.

Important information available free from Alcoa

Alcoa Wheel Service Manual

Videos/CD
- Safe Wheel and Tire Changing Practices for Heavy Duty Trucks and Buses
- Maintaining Your Edge Rim Flange Maintenance
- Simple Facts about Hub-Piloted Wheel System Maintenance
- Disc Wheel Inspection CD published by the TIA

Maintenance Charts
- Zipper Rupture Published by RMA
- Tire Information Service Bulletin Published by RMA
- Heavy & Medium Truck & Trailer Torque Specifications Published by WRIS
- Demounting & Mounting Procedures for Truck/Bus Tires Published by RMA
- Multipiece Rim Matching Chart Published by OSHA
- Mounting/Demounting Instructions for Alcoa Aluminum 19.5" RW Published by Alcoa Wheel Products
- Wheels and Steel Disc 19.5" Wheels Published by Alcoa Wheel Products

Alcoa Rim Flange Safety Material
- Maintaining Alcoa Aluminum Wheels Rim Flange Wear Instructions
- Rim Flange Wear Gauge

Technical Bulletins available on Alcoa web at www.alcoawheels.com.
- Welding Rim Flange or otherwise heating Alcoa Aluminum Wheels
- Altering Alcoa Wheels from original design and use of adaptor plates
- Tire Balancers/Sealants
- Wheel balancing weights
- Mounting/demounting tires on Alcoa 22.5 non-symmetrical wide base wheels
- Rim Flange Wear

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This manual is written in a style called structured text.

Throughout the manual you will find numbers which look like this (See Section 3-1). These numbers are cross references to other sections of the manual. The numbers (3-1) refer to section 3, subtopic 1. You will find the section number and subtopic number under the heading in each section.

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1 Safety

Safe service practices are a matter of life and death.

1-1

WARNING

WARNING An inflated wheel and tire assembly contains enough air pressure to cause an explosive separation.

Unsafe handling or failure to follow approved mounting and demounting procedures can lead to serious injury or death.

Study, understand and follow the procedures contained in this manual.

Safety is serious business. All tire shops must know and follow OSHA work regulations... no matter how small the shop. Under U.S. federal law any individual handling tire/wheel assemblies must be trained in OSHA regulations as mentioned in section 7.

Safety is everybody's business. Do not attempt to service any wheel assembly without proper training.

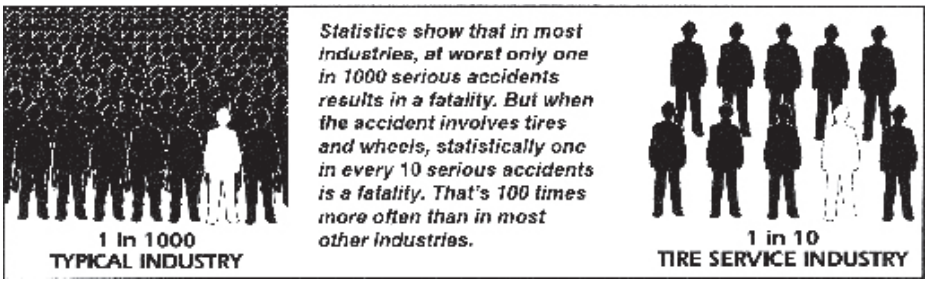
Proper equipment is important. Be sure you have the recommended tools and equipment on hand and use them according to manufacturer's instructions.

Tubeless wheels and tires require the same equal care. Even though tubeless assemblies have fewer parts than multi-piece wheels, they still require respect and proper handling.

Pay particular attention during crucial steps:

- Removal of tire and wheel assemblies from vehicles
- Demounting tire from wheel
- Wheel inspections
- Inflation of tire
- Handling and storing of inflated assembly

Safety and service information is readily available. Wheel, tire and service equipment manufacturers offer service manuals and other training materials. Stay up to date on proper procedures and keep current instructional materials handy in the shop. Study safety and service information and use it on the job.



2 Wheel Specifications

Alcoa aluminum disc wheel mounting dimensions are consistent with SAE Recommended Practice J694 June 2007. Part numbers listed for all sizes are brushed finish (the last digit of the six-digit numerical part number is "0"). Polished finishes are indicated by changing the last digit of the part number listed to one of the following: For polished outside only, part number should end in "1." For polished inside only, part number should end in "2." For polished both sides, part number should end in "3." Only for item numbers marked with a single asterisk (*), part numbers ending in "9" are inset position wheels brushed finished (see footnote).

Dura-Bright® Wheels with XBR™ Technology are identified by using the regular numerical part number and the addition of "DB" at the end. Finishes are indicated by changing the last numerical digit of the part number to one of the following. For brushed both sides, the number is "0." For polished outside only, the number is "1." For polished inside only, the number is "2." For polished both sides, the number is "3." Only the wheel part numbers with available surface finishes having the "DB" suffix are available with the Dura-Bright® with XBR™ Technology option. Dura-Flange® Wear Protection wheels are identified by using the regular numerical part number and the addition of "DF" at the end. Only the wheel part numbers with available surface finishes having the "DF" suffix are available with the Dura-Flange® option. The Dura-Bright® with XBR™ Technology surface treatment and the Dura-Flange® Wear Protection options are currently available together on the same wheel, indicated by the "DD" suffix.

TUBELESS WHEELS (round hand holes) ENGLISH UNITS

Item no.	Wheel description	Maximum wheel load[1] in lbs.	Approx. Wheel wt. lbs.	Outset inches[3]	Inset inches	Maximum inflation PSI—cold	Valve stem*** (Alcoa Part No.)	Part number[2]	Available finishes[4]	Stabilizer	Front outer cap nuts	Rear inner cap nuts Al/Al	Rear inner cap nuts Al/Stl	Rear outer cap nuts
Six-hole, stud located, ball seat mounting—8.750 in. bolt circle, 6.495 in. hub bore, 1.219 in. bolt hole diameter Lug nut covers: 150, Hub covers: N/A														
1	17.5x6.75-15°DC	5070	32	5.55	4.72	125	TR553C (005533)	663170	0, 2	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	5996 L&R
10-hole, stud located, ball seat mounting—8.750 in. bolt circle, 6.495 in. hub bore, 1.219 in. bolt hole diameter Lug nut covers: 150, Hub covers: N/A														
2	17.5x6.75-15°DC	5070	31	5.55	4.72	125	TR553C (005533)	663070	0, 2	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	5996 L&R
10-hole, stud located, ball seat mounting—11.25 in. bolt circle, 8.73 in. hub bore, 1.219 in. bolt hole diameter Lug nut covers: 150, Hub covers: Front - 076015, Rear - 077015														
3	22.5x8.25-15°DC	7200	52	6.66	5.68	120	TR555D (005554)	883110	0, 1, 2, 0DB**, 1DB**, 2DB**	2225	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R
4	22.5x9.00-15°DC	9000	60	6.94	5.94	130	TR553C (005533)	893000	0, 1, 2	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R
5	22.5x12.25-15°DC	11,400	62	.56 Reversible	—	130	TR553E (005535)	823000	0	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	-	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R
*6	22.5x12.25-15°DC	11,400	66	3.88	2.76	130	TR553E outset (005535) TR555E inset (005555)	823050	0, 1, 2**, 9	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	- -	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R
7	22.5x12.25-15°DC	11,000	71	5.84	4.68	130	TR555E (005555)	823060A	0, 1	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	-	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R
††8	22.5x14.00-15°DC	12,800	71	2.0	—	130	TR553E outset (005535)	841100	0, 2**	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	-	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R
9	24.5x8.25-15°DC	7200	59	6.6	5.59	120	TR555D (005554)	983120	0, 1, 2	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R
Eight-hole, hub piloted mounting—275mm bolt circle, 221.1mm hub bore, 26.75mm bolt hole diameter (use two-piece flange nuts) Lug nut covers: 181 Hub covers: N/A Hub Cover Kits: 082122 (Front 33mm), 082133 (Rear 33mm), 082012 (30mm) 140233A (Stainless Front 33mm), 109176A (Stainless Rear 33mm)														
10	22.5x7.50-15°DC	7300	53	6.28	5.44	120	TR555D (005554)	873400	0**, 1, 2	2225	39874	-	-	39874
11	22.5x8.25-15°DC	7400	50	6.66	5.82	130	TR5554D (005544)	883440	0, 1**, 2, 0DF, 1DF,** 2DF	8864	39874	-	-	39874
††12	22.5x14.00-15°DC	12,800	71	2.0	—	130	TR553E outset (005535)	841400	0**, 2**	-	39874	-	-	39874

This Specifications guide is not inclusive of all applicable Alcoa part numbers. If a part number is not on this list call 1-800-242-9898 for further information.

TUBELESS WHEELS (round hand holes) ENGLISH UNITS — continued														
Item no.	Wheel description	Maximum wheel load[1] in lbs.	Approx. Wheel wt. lbs.	Outset inches[3]	Inset inches	Maximum inflation PSI—cold	Valve stem*** (Alcoa Part No.)	Part number[2]	Available finishes[4]	Stabilizer	Front outer cap nuts	Rear inner cap nuts Al/Al	Rear inner cap nuts Al/Stl	Rear outer cap nuts
10-hole, hub piloted mounting—285.75mm bolt circle, 220.1mm hub bore, 26.75mm bolt hole diameter (use two-piece flange nuts) Lug nut covers: 181 Hub covers: Front - 076018 or 076085‡ Rear - 077018 or 077085‡ One-Piece hub cover system: Front - 086100S, Rear - 087100S														
14	22.5x7.50-15°DC	7300	53	6.28	5.44	120	TR555D (005554)	873600	0, 1, 2, 0DB**, 1DB**, 2DB**	2225	39874	-	-	39874
15	22.5x8.25-15°DC	7400	47	6.66	5.81	130	TR554D (005544)	883640	0, 1, 2, 3, 0DB,1DB, 2DB, 3DB, 0DF, 1DF, 2DF, 0DD, 1DD, 2DD	8864	39874	-	-	39874
§16	22.5x8.25-15°DC	8000	55	6.66	5.69	130	TR553C (005533)	885600	0, 1, 2, 0DF, 1DF, 2DF	-	39874	-	-	39874
17	22.5x9.00-15°DC	9000	59	6.94	6.04	130	TR554D (005544)	893640	0, 1, 2, 3, 0DB, 1DB, 2DB, 3DB, 0DF, 1DF, 2DF, 3DF, 0DD, 1DD, 2DD, 3DD	8964	39874	-	-	39874
18	22.5x9.00-15°DC	10,000	53	—	3.12	130	TR555E (005555)	893630	0, 1, 0DB**, 1DB	-	39874	-	-	39874
19	22.5x10.50-15°DC	10,500	68	6.61	5.5	130	TR553 (005530)	803600	1, 1DB**	-	39874	-	-	-
20	22.5x12.25-15°DC	12,300	63	.56 Reversible	–	130	TR553E (005535)	823600	0, 2	-	39874		-	39874
*21	22.5x12.25-15°DC	11,400	66	3.88	2.75	130	TR553E outset (005535) TR555E inset (005555)	823650	0, 1, 2, 9, 0DB, 1DB, 2DB, 9DB 0DF, 1DF, 2DF, 9DF	-	39874	-	-	39874
22	22.5x12.25-15°DC	11,000	68	5.8	4.68	130	TR552 (005520)	823640	0, 1, 0DB, 1DB, 0DF, 1DF	-	39874	-	-	39874
*23	22.5x13.00-15ºDC	12,300	70	3.5	2.38	130	TR553E outset (005535) TR555E inset (005555)	833650	0,1,2,9	-	39874	-	-	39874
24	22.5x13.00-15°DC	11,000	74	6.42	5.3	130	TR552 (005520)	833640	0, 1	-	39874	-	-	39874
††25	22.5x14.00-15°DC	12,800	68	2.0	—	130	TR553E outset (005535)	841600	0, 2, 0DB, 2DB	-	39874	-	-	39874
††26	22.5x14.00-15°DC	12,800	71	1.13	0	130	TR555E outset (005555) TR553E inset (005535)	841610	0, 1 , 2, 9, 0DB, 1DB, 2DB, 9DB	-	39874	-	-	39874
27	24.5x8.25-15°DC	7400	56	6.6	5.73	130	TR555D (005554)	983640	0, 1, 2, 3, 0DB, 1DB, 2DB, 3DB, 0DF, 1DF, 2DF, 3DF	8864	39874	-	-	39874
§28	24.5x8.25-15°DC	8000	65	6.6	5.63	130	TR555D (005554)	985600	0, 1, 2, 0DF, 1DF, 2DF	-	39874	-	-	39874
10-hole, hub piloted bus mounting—11.25 in. bolt circle, 8.670 in. hub bore, 1.219 in. bolt hole diameter (use two-piece flange nuts) Lug nut cover: 182 Hub covers: N/A														
29	22.5x8.25-15°DC	7300	53	6.66	5.82	120	TR555D (005554)	883610	0, 3, 0DB, 3DB, 0DF, 3DF, 0DD, 3DD	-	-	-	-	-
30	24.5x8.25-15°DC	7300	62	6.6	5.77	120	TR555D (005554)	983610	0**, 3**, 0DB**, 3DB**	2245	-	-	-	-

Specifications are subject to change without notice. To request a copy of the current Alcoa Specifications Data brochure for aluminum wheels for trucks, trailers and buses, call toll-free 800-242-9898. To view online, go to www.alcoawheels.com. The Spec Data brochure contains current part number availability and complete specifications such as wheel dimensions, load rating, wheel weight, outset and inset, inflation pressure and accessory part numbers.

Alcoa provides training, live or on video, on proper wheel installation and maintenance practices free of charge. Contact Alcoa Wheel and Forged Products at 800-242-9898.

Note: Dura-Bright® wheels produced after November 2002 have Alcoa wheel part numbers ending with "DB" (earlier wheels have part numbers ending in a 4 or 7). Not all Alcoa wheels are available with the Dura-Bright®surface treatment.

TUBELESS WHEELS (round hand holes) ENGLISH UNITS (METRIC UNITS)

Item no.	Wheel description	Maximum wheel load[1] in lbs. (kilograms)	Approx. Wheel wt. lbs. (kilograms)	Outset inches[3] (mm)	Inset inches (mm)	Maximum inflation PSI—cold (KPa)	Valve stem*** (Alcoa Part No.)	Part number[2]	Available finishes[4]	Stabilizer	Front outer cap nuts	Rear inner cap nuts Al/Al	Rear inner cap nuts Al/Stl	Rear outer cap nuts
Eight-hole, hub piloted mounting—275mm bolt circle, 221.1mm hub bore, 24.75mm bolt hole diameter (use two-piece flange nuts) Lug nut covers: 181 Hub covers: N/A Hub Cover Kits: 082122 (Front 33mm), 082133 (Rear 33mm), 082012 (30mm) 140233A (Stainless Front 33mm), 109176A (Stainless Rear 33mm)														
31	17.5x6.75-15°DC	5515 (2500)	29.5 (13.4)	5.55 (141)	4.72 (120)	142 (978)	TR553C (005533)	663470	0, 2	-	39874	-	-	39874
32	19.5x6.75RW-15°DC	5515 (2500)	36.4 (16.5)	5.55 (141)	4.72 (120)	142 (978)	TR553C (005533)	764490	0, 1, 2	-	39874	-	-	39874
33	19.5x7.50RW-15°DC	6615 (3000)	37.7 (17.1)	6.10 (155)	5.28 (134)	142 (978)	TR553C (005533)	773400	0**, 1, 2	-	39874	-	-	39874
10-hole, hub piloted mounting—285.75mm bolt circle, 220.1mm hub bore, 26.75mm bolt hole diameter (use two-piece flange nuts) Lug nut covers: 181 Hub covers: Front - 076018 or 076085‡ Rear - 077018 or 077085‡ One-Piece hub cover system: Front - 086100S, Rear - 087100														
34	19.5x7.50RW-15°DC	6615 (3000)	37.7 (17.1)	6.10 (155)	5.28 (134)	142 (978)	TR553C (005533)	773600	0, 1, 2, 3	-	39874	-	-	-
10-hole, hub piloted mounting—335mm bolt circle, 281.2mm hub bore, 26.75mm bolt hole diameter (use two-piece flange-nuts), Lug nut covers: 181 Hub covers: 5811 polished with view port for P/N 833580 only, all others: N/A														
†35	22.5x8.25-15°DC	8047 (3650)	50.6 (23.0)	6.57 (167)	5.70 (145)	138 (952)	70MS7 (007007)	886520	0, 3, 0DB, 3DB, 0DF, 3DF, 0DD, 3DD	-	39874	-	-	39874
†36	22.5x9.00-15°DC	9094 (4125)	51.5 (23.4)	6.89 (175)	6.02 (153)	142 (978)	70MS7 (007007)	896520	0, 3, 0DB, 3DB, 0DF, 3DF	-	39874	-	-	39874
‡‡37	22.5x13.00-15°DC	12,800 (5806)	76.0 (34.5)	—	6.12 (155)	130 (896)	TR553 (005530)	833580	0, 1	-	39874	-	-	39874
38	24.5x8.25-15°DC	8500 (3855)	64.0 (29.0)	6.79 (172.5)	5.81 (147.5)	120 (827)	TR554D (005544)	983500	0, 3	-	39874	-	-	39874
Ten-hole, hub piloted mounting—335mm bolt circle, 281.2mm hub bore, 32.87mm bolt hole diameter (use two-piece flange - nuts), Lug nut covers: N/A Hub covers: N/A														
†39	22.5x8.25-15-°DC (32mm bolt hole)	8047 (3650)	50.3 (22.8)	6.57 (167)	5.70 (145)	138 (952)	70MS7 (007007)	886510	0, 3, 0DB, 3DB, 0DF, 3DF, 0DD, 3DD	-	4306.32	-	-	4307.32
†40	22.5x9.00-15-°DC (32mm bolt hole)	9094 (4125)	51.2 (23.2)	6.89 (175)	6.02 (153)	142 (978)	70MS7 (007007)	896510	0, 3, 0DB, 3DB, 0DF, 3DF	-	4306.32	-	-	4307.32
Six-hole, hub piloted mounting—205mm bolt circle, 160.2mm hub bore, 21.5mm bolt hole diameter (use two-piece flange nuts) Lug nut covers: N/A Hub covers: N/A														
41	17.5x6.00-15°DC	4000 (1814)	27.0 (12.2)	5.0 (127)	4.25 (108)	130 (896)	TR554C	664800	0,1	–	–	–	–	–

Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating. Do not overinflate. Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire, perform a wheel fitment check to ensure proper clearance from any obstructions.

1 Capacity ratings as dual or single in highway service — bias-ply or radial. Load ratings in lbs. for items 31 through 41 rounded to nearest multiple of 5.

2 Part numbers listed for all sizes are brushed finish (the last digit of the six-digit numerical part number is "0"). Polished finishes are indicated by changing the "0" with any of the suffixes in the adjacent column (Available Finishes). Some wheels may bear part numbers not shown in this manual. Before servicing these wheels, contact your Alcoa wheel representative for proper load, inflation and part compatibility information.

3 Outset (positive)/inset (negative) — The distance from the rim centerline to the mounting face of the wheel. Inset (negative) places the rim centerline inboard of the wheel mounting face and outset (positive) places the rim centerline outboard of the wheel mounting face (½ dual spacing = offset).

4 The Dura-Bright® surface treatment and the Dura-Flange® options are currently available together on the same wheel, indicated by the "DD" suffix.

* Part numbers should end in "1" or "9" when used in an inset position and "0" or "2" when used in an outset position.

** This finish is only available under the non-stock policy.

*** TR55XX Valve stems are the standard rim valves with a rubber grommet. TR54XX are an acceptable option with "O" rings.

† Indicates European New Generation Wheels.

†† Check with vehicle manufacturer or axle manufacturer before retrofitting to outset wide base wheels to ensure compatibility with axle and wheel end components. P/Ns 841100, 841400, and 841600 are not recommended for use on "N" spindle trailer axles.

‡ Hub cover system kits P/N 076085 (front) and P/N 077085 (rear) contain screw-on Hug-a-lug® nut covers and require a minimum of four threads of the stud to extend above the tightened cap nut for use.

‡‡ The minimum stud standout required for P/N 833580 is 2.375 inches (60.3mm) when using wheel nut P/N 39874. Taller nuts will require more stud standout.

§ P/Ns 885600 and 985600 are Alcoa Severe Service™ Wheels.

Dura-Bright® wheels with XBR™ Technology surface treatment option shine without polishing.
Just wash with soap and water, do not polish or clean with abrasives.

For more information call 800-242-9898 or visit www.alcoawheels.com/durabrightxbr.

3 Inspection and Maintenance

Inspect thoroughly and frequently

3-1

Safe operation requires thorough examination of wheels and attaching hardware, at frequent intervals, both on and off the vehicle.

Wheels that have been in service need to be inspected at regular intervals to assure proper and safe performance.

It is not always possible to predict the useful life of a wheel. Wheels will eventually wear out. Generally, older wheels and wheels operating in extreme conditions should be examined more frequently for obvious signs that they should be removed from service.

Examine all exposed areas frequently. Clean wheels and look for cracks or other damage. Also check the inner dualed wheel when the outer wheel is removed.

During tire changes, thoroughly examine the entire wheel. Pay particular attention to the rim contour and the surfaces of the rim.

Hidden damage

Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

Do not overinflate. Use the tire manufacturer's recommended pressure, but under no circumstances exceed cold tire pressures listed in Section 2 Specifications of this manual. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

Some forms of wheel damage can be hidden beneath the tire, so whenever a tire is removed, thoroughly examine the complete wheel. Remove all grease and road dirt. Use a wire brush or steel wool to remove rubber from the bead seats.

Check mounting holes for the enlargement and elongation which can occur if the cap nuts are not kept tight (see Section 3-8). Dirt streaks radiating from stud holes may indicate loose cap nuts.

Wheel alteration

3-2

Alcoa does not approve any form of alteration to wheels except minor cosmetic buffing for appearance purposes or sanding in the rim flange area (see Section 3-12).

Wheels should not be altered by welding, brazing or other heat application in an attempt to repair or straighten a wheel. Use of adapter plates or bead-locks are not approved on Alcoa wheels.

Wheels should not be painted or otherwise coated in any way that may interfere with the mounting surfaces.

Any wheels that shows signs of alteration should be removed from service and scrapped.

WARNING Welding, brazing or otherwise heating any area of an Alcoa aluminum wheel will weaken the wheel. Weakened or damaged wheels can lead to an explosive separation of tires and wheels or wheel failure on the vehicle.

Explosive separations of tires and wheels or wheel failure on the vehicle could cause serious injuries or death.

Never attempt to weld, braze or heat any surface of an Alcoa aluminum wheel.

Heat damage

3-3

WARNING

WARNING Excessive heat from fire, brake malfunction, wheel bearing failure, tire failure or other sources may weaken the metal and cause the wheel/tire assembly to separate explosively.

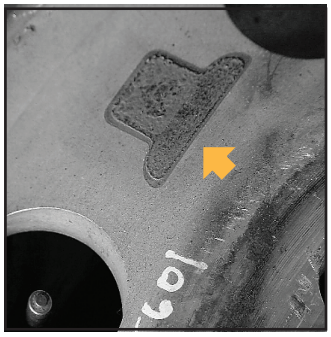
Exploding wheel/tire assembly can cause serious injury or death.

Immediately and permanently remove from service any wheel that has been exposed to excessive heat.

Inspect for exposure to excessive heat. A wheel that has been subjected to excessive heat may appear charred or burned. A wheel that has been exposed to excessive heat may appear to be in good condition if it has been cleaned. Do not use any wheel that has been overheated regardless of appearance. Even if a wheel does not appear to be obviously burned, labels, tire bead, brake drum and Disc Mate for evidence of charring, melting, blistering or burning.

A wheel may discolor from excessive heat. It can appear a dull grayish color and will not polish to a bright finish as a typical wheel would.

Any wheel run with a flat tire longer than the time necessary to immediately pull off the road should be checked for excessive heat damage.

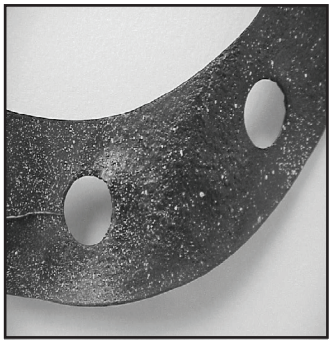


Charred Sticker (prior to 2009)

After January 2009 the new Alcoa Logo may not show heat damage

A blistered, charred, blackened or cracked-looking logo decal on an Alcoa wheel may indicate that the wheel has been exposed to excessive heat as shown in picture to the left, or discoloration of the wheel as shown in picture to the right

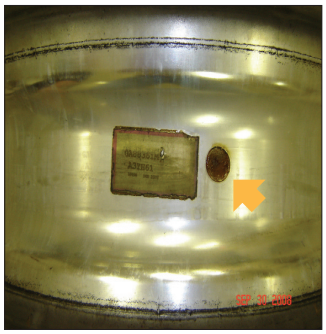
Discoloration of Wheel



Charred Discmate

Inspect all axle end components for signs of exposure to excessive heat. Pay particular attention to brake drums (or discs), Disc Mate wheel liners and tire beads. If these components show signs of over heating, the entire assembly, including the wheel, should be replaced.

Charred Rubber



Charred Heat Indicator Drop Center (2009 and after)

Charred Heat Indicator
(2009 and after)

Wheels manfactured starting in January 2009 will have a 1 inch clear round heat indicator located next to the roll stamp on the inside shown on the left and right, along with the same 1 inch clear round heat indicator located on the tire side drop well as shown in the photo above.

If either of these round labels show signs of blistering, charred, blackened, or cracked look, this may indicate that the wheel has been exposed to excessive heat.

Charred Heat Indicator
(2009 and after)

IF ANY OF THE ABOVE CONDITIONS ARE SEEN, REMOVE THE WHEEL FROM SERVICE IMMEDIATELY. THIS INCLUDES ANY HEAT DAMAGE TO THE TIRE, DISCOLORATION TO THE WHEEL, AND OR BRAKE DRUM, AND ANY BURNT OR CHARRED LABELS.

Dimension checks

3-4

Open side circumference check

WARNING

WARNING Wheels that have been subjected to high pressure tire and rim separation or excessive heat damage may no longer have sufficient dimension and contour to retain the tire bead while under pressure.

Exploding wheel/tire assembly can cause serious injury or death.

Immediately and permanently remove from service any wheel that has been exposed to high pressure tire and rim seperation or excessive heat.

WARNING

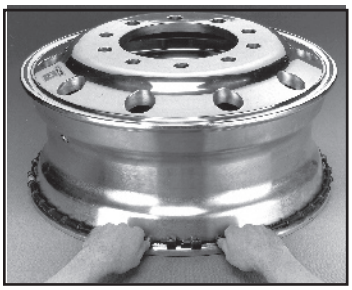
WARNING Wheels that have been run flat or have other physical damage may no longer have sufficient dimension and contour to retain the tire bead while under pressure.

Rims that lack proper dimension and contour can lead to explosive separation of the tire and rim, causing serious injury or death.

Any wheel that has been in service must be inspected prior to mounting. Follow dimension check procedures described in this section during each wheel inspection.

Best Inspection Method

Photo to the right shows the TRA Ball Tape



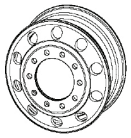
Measure the circumference of the bead seat on the open side (see illustration to left) with a ball tape.

The circumference of the bead seat on the open side of the wheel should be checked at each tire change. The open side is the side opposite the disc face. In the case of center flange wide base wheels, or wheels with insets less than 3 inches, both rim flanges should be checked. Any wheel should be inspected prior to mounting. If the circumference of the bead seat does not match the required dimension as indicated by the TRA certified ball tape, immediately and permanently remove the wheel from service.

Ball tapes used for measuring wheel circumference can be purchased from the Tire and Rim Association, Inc., 175 Montrose West Avenue, Copley, Ohio 44321. (330) 666-8121 or at www.rma.org. For instructions on proper use of ball tape, reference the current Tire and Rim Association yearbook.

2nd Best Inspection Method

If a ball tape is unavailable



Dual wheel

Non-Dual wheel

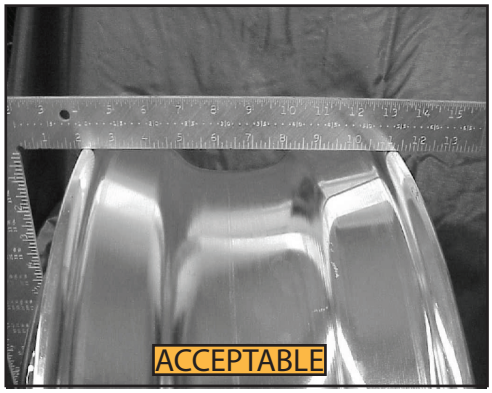


Photo above shows carpenter square even on both bead seats.

Photo above shows and undersized wheel that you can clearly place a credit card (approximately .030 in. or .76mm) between the square and the wheel.

THIS INSPECTION TECHNIQUE ONLY APPLIES TO DUAL OR DISC FACED WHEELS

Check all wheels at each tire change for proper contour of the open side of the rim. Place the long leg of a carpenters square across the center of the disc side of the wheel. Extend the short leg across both rim flanges of the wheel as shown above. Repeat this process at four equidistant points around the wheel.

The short leg should touch both rim flanges at each point. If a distance greater than the thickness of a credit card (or .030 in. or .76mm feeler gauge) appears between the short leg and the rim flange, the wheel should be removed from service and scrapped.

3rd Best Inspection Method

Rolling wheel as described on this page.

If a ball tape or carpenters square is unavailable, roll the unmounted wheel, without a tire, a minimum of 10 feet over a smooth, flat, level, clean surface such as asphalt or concrete pavement. Any deviation from rolling in a straight line is an indication of a potential lack of proper dimension and contour. Remove the wheel from service until it can be properly checked with a ball tape.

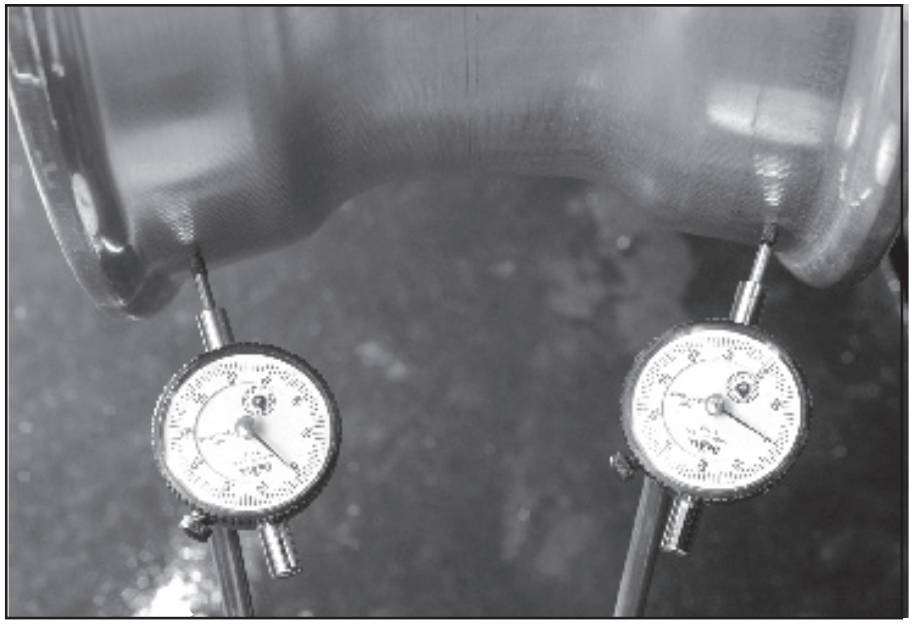
IF YOU DO NOT FULLY UNDERSTAND ANY OF THESE INSPECTION METHODS AS DESCRIBED IN THIS SECTION CONTACT ALCOA AT 800-242-9898 FOR CLARIFICATION.

Dimension checks (continued)

Tire wear or ride problems

If you experience tire wear or ride problems it may be helpful to check radial run out. Remove the wheel from the vehicle, deflate and remove the tire (see Section 4-5, for recommendations and instructions for demounting tubeless tires).

Remount the wheel on the vehicle without the tire. Be sure to follow proper mounting procedures to assure the wheel is well centered on the hub. Place a dial indicator as illustrated below to trace the bead seats of the wheel. Rotate the wheel noting the amount of variation shown on the dial indicator. Note: Alcoa aluminum wheels should be tested for radial run out only at the bead seat surface. A total indicator reading of .040 inches or less is acceptable.



Tire wear can also be caused by improperly seated tires. Inspect the tire for proper seating on the wheel. The tire beads may not be seated properly. If so, remove the wheel from the vehicle, deflate and break the bead seats (see Section4-5 for recommendations and instructions for demounting tubeless tires). Adequately lubricate the bead seats and properly reseat the tire beads. Reinflate the wheel in a safety cage or other suitable restraint (refer to OSHA rule 1910.177, paragraph b, see Section 7).

Cracked or damaged wheel checks

3-5

WARNING

WARNING Cracked or damaged wheels may fail or come off the vehicle.

Wheels that fail or come off the vehicle while it is moving can cause serious injury or death.

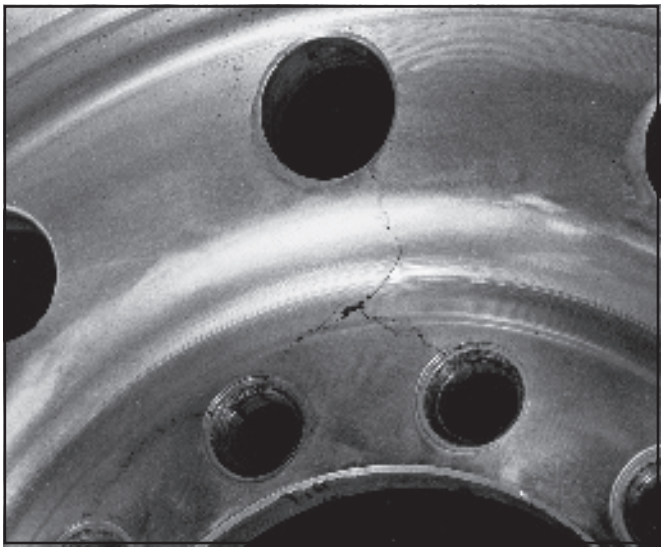
Immediately and permanently remove cracked or damaged wheels from service.

Visually inspect wheels for cracks or damage. Remove wheels from service with known or suspected damage.

Mounting area

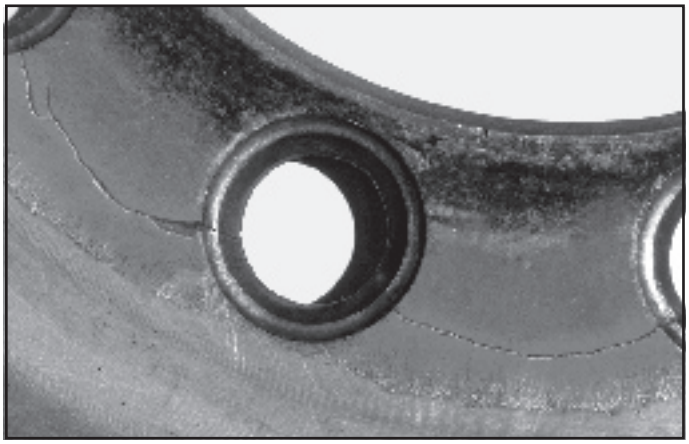
3-6

Stud hole cracks are usually caused by improper torquing (see Sections 5-8, and 6-2), excessive loading or insufficient mounting flange support by the hub
or brake drum. Remove wheel from service.



Shown below are stud hole cracks emanating from bolt hole to bolt hole. Causes are: undersized diameter of wheel support surface (see specifications on next page), support surface not flat, incorrect attachment parts (see Section 5-2) and insufficient torque (see Sections 5-8, 5-11, 6-2). Remove wheel from service.

Support surface should be flat to the diameter recommended on the chart on the following page.



Inspect the hub/drum contact area thoroughly for cracks or other damage.

Mounting area (continued)

Support surface diameters

Support surface should be flat to the diameter recommended per SAE J694:

Number of Bolts	Bolt Circle	Mounting Type	Backup Diameter	Thread Size
10	11.25 inch	U.S. Stud pilot	13.2-13.5 in.	.750/1.125 in.
10	285.75mm	Hub pilot	13.2-13.4 in.	22mm
10	335mm	Hub pilot	15.0-15.2 in.	22mm
8	275mm	U.S. Stud pilot	13.2-13.5 in.	22mm
8	275mm	ISO Hub pilot	12.4-12.6 in.	20mm

Corrosion

Certain environments can lead to corrosion. Some of the more common corrosives are: salt, magnesium chloride and calcium chloride compounds used for snow removal and highly alkaline materials. If the air used to fill tubeless tires, or the tire itself, is not dry, the areas of the wheel under the tire can corrode severely.

3-7

Bead seat and valve stem corrosion often are caused by entrapped moisture. Mild corrosion should be removed thoroughly by wire brush and the rim protected with non-water-based tire lubricant (see Section 4-1). Remove any severely corroded wheel from service.

Hub bore gauge does not fit.

Hub bore gauge with severe corrosion. Remove any severely corroded wheel from service

CAUTION

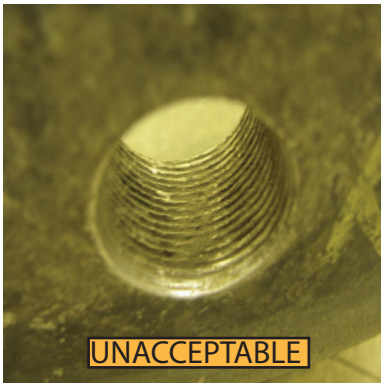
CAUTION The use of liquid tire balancers or sealants in Alcoa wheels may cause extremely rapid corrosion of the wheel rim surface.

Severely corroded wheels are unsuitable for service. Alcoa wheels corroded by the use of liquid tire balancers or sealants will not be replaced under the Alcoa limited warranty.

Bolt holes

If wheels are run loose, both stud located wheels and hub piloted wheels can be damaged. Look for wallowed out or elongated ball seats on stud located wheels. On hub piloted wheels look for elongated stud holes. Over torquing can lead to damaged ball seats on stud located wheels and can damage the disc surface of hub piloted wheels. Remove damaged wheels from service.

3-8



For hub piloted - normally if you see thread marks on the inside diameter of the bolt holes, this would indicate the wheel ran loose.

For hub piloted - normally if you see a wallowed out bolt hole, this would indicate the wheel ran loose.

Damaged ball seat contact area. Pounding of nut on ball seat contact area identified by arrows.

Disc area

3-9

Inspect both sides of disc area for hand hole cracks. If cracks are found, remove the wheel from service.

Rim area

Check the entire rim area for nicks, gouges and cracks. Loss of air may be caused by cracks in areas around the valve stem hole. Remove the wheel from service.

3-10

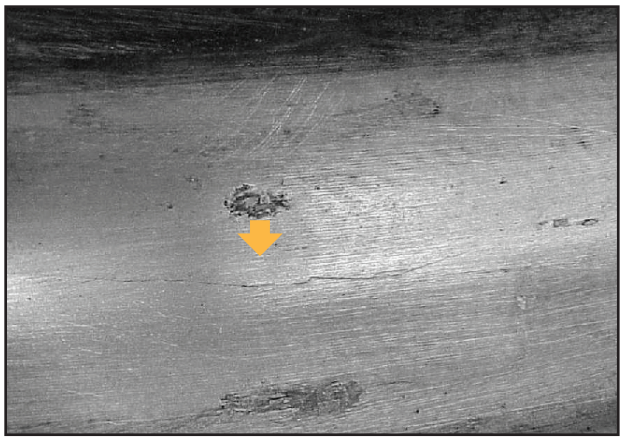
Valve hole crack

Drop center crack

Bead Seat area

Loss of air may be caused by cracks in the bead seat areas around the rim. Remove the wheel from service if damaged.

3-11

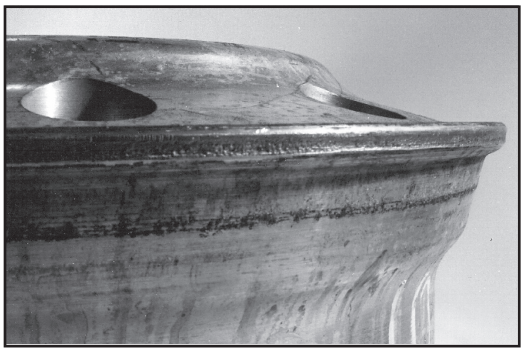


Bead seat cracks are normally caused by overloading of the wheels. If you have this type of wheel breakage it would be recommended to use SEVERE SERVICE WHEELS.

Rim flange wear

3-12

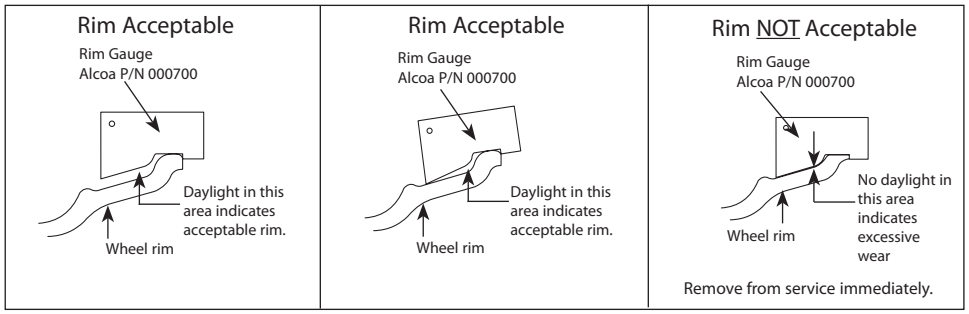
Rim Flange wear is not a warrantable issue. Only Dura-Flange® wheels have a warranty on rim flange wear against sharp edges for the 24 month warranty period.



Irregular wear on the surface of the rim flange is caused by abrasion from the tire chafer and sidewall. Rim flange wear happens most often in applications with heavy or shifting loads. If you are experiencing excessive rim flange wear in your operation, consider using Alcoa Dura-Flange® aluminum wheels. These wheels have been specially treated to significantly reduce rim flange wear. Remove wheels from service when rim flange wear is excessive. Excessive wear can be determined using an Alcoa approved wear gauge and procedures detailed below. If rim flange wear becomes sharp and/or cuts the tire, contact Alcoa for recommended maintenance procedures.

Alcoa Rim Flange Wear Gauge Instructions

THESE GAUGES ARE TO BE USED FOR RIM FLANGE WEAR ONLY. THEY ARE NOT A BEAD SEAT ANGLE OR DIAMETER TOOL



To obtain a gauge(s) at no charge and information on free training on proper installation and maintenance procedures, contact Alcoa Wheel Products at (800) 242-9898 or on the web at www.alcoawheels.com.

Determining Rim Flange Wear

STEP 1. Remove the wheel/tire assembly from the vehicle. Remove the valve core to deflate the tire completely. Remove the tire from the wheel according to OSHA regulations, TMC recommended practices for tire and rim safety procedures and/or the Alcoa Wheel Service Manual.

Rim flange wear (continued)

STEP 2. After the wheel is separated from the tire, verify the circumference of the bead seat on the open side is acceptable (see Section 3-4). Check the wheel flange with the Alcoa Rim Flange Wear Gauge to determine if the wheels must be removed from service for excessive rim flange wear (photo 1 on previous page).

See Rim Flange Wear Gauge Instructions on the illustrations on previous page to make this determination. If you do not have an Alcoa Rim Flange Wear Gauge, contact Alcoa Wheel Products to obtain a gauge(s) at no charge by calling (800) 242-9898 or on the web at www.alcoawheels.com.

STEP 3. If the wheel is deemed to be serviceable by the rim flange gauge, examine the wheel flange edge for sharpness by using a rubber sharpness gauge. These gauges are constructed by having a section of tire side wall or a suitable piece of rubber attached to a block of wood (photo 2). By running the sharpness indicator gauge along the wheel in the area of the wear, determine if the wear is sharp enough to cut or damage the rubber on the sharpness indicator (photo 3). If the rubber is cut, then follow the edge removal instructions below.

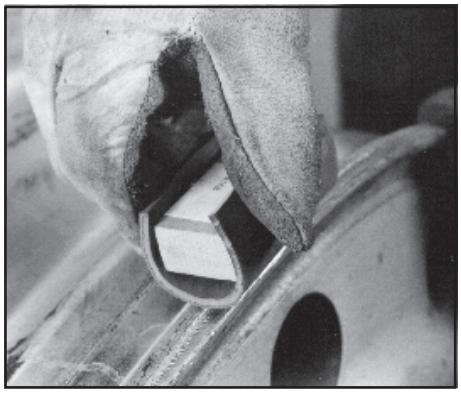


Photo 2. A rubber sharpness gauge or a suitable piece of rubber attached to a block of wood.

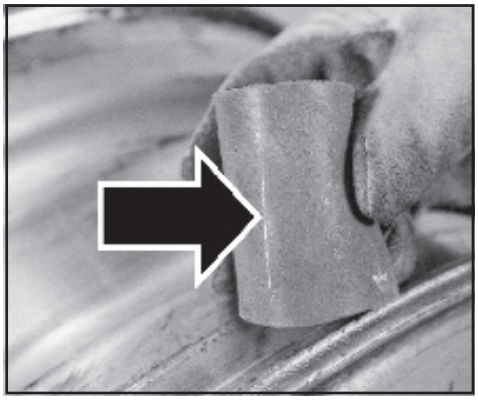


Photo 3. Run the sharpness indicator gauge along the wheel in the area of the wear to determine if the wear is sharp enough to cut or damage the rubber on the sharpness indicator.

NOTICE: Examine the tire for cuts in the bead area and side wall. If no damage occurred to these areas, return the tire to service. Cut tires should be removed from service. The tire should be inspected at this time for any other damage and be treated per normal tire procedures recommended by the tire manufacturer.

NOTICE: Check the wheel at every tire change or ONCE PER YEAR for rim flange wear and any sharp edges. If you follow this practice, you will significantly reduce the possibility of a rim flange cutting into the tire.

If the flange cuts or appears close to being sharp enough to cut the rubber on the sharpness indicator gauge, the edge can be removed per the edge removal procedures below. If the rubber is not cut, then the wheel can be returned to service without further work for rim flange wear.

CAUTION

CAUTION Do not run unprotected hands or fingers across worn rim flange areas of used wheels.

Worn rim flange areas are sharp and can cut hands or fingers. Cuts can lead to infection.

Always wear gloves when handling used wheels or when testing for edge sharpness.

Rim flange wear (continued)

Edge Removal Procedures

There are many tools available to remove the sharp edge on the wheel caused by rim flange wear. Here are some examples of commonly used tools:

File. A file can be used very effectively to remove the edge (photo 4).

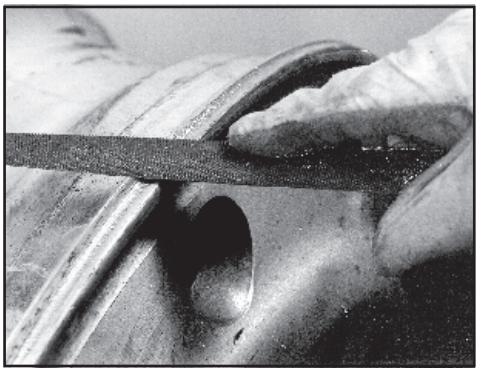


Photo 4. Removing sharp edge by hand with a metal file.

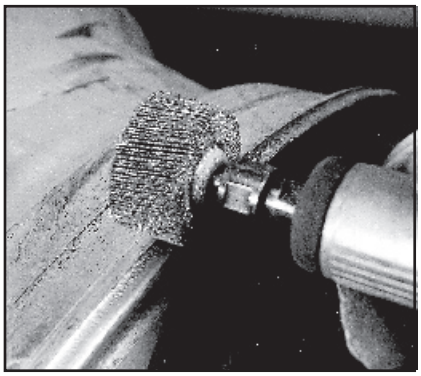


Photo 5. Air or electric power sander.

Air or Electric Powered Sander. This provides a very quick and effective method of removing the edge. Operators should use all care to keep a uniform edge when using these tools (photo 5).

Air or Electric Grinder. Another quick and effective method of removing the sharp edge caused by rim flange wear. Be careful as grinding pads may "gum up" from the aluminum that is removed (photo 6). Care must be used to avoid gouging the wheel.

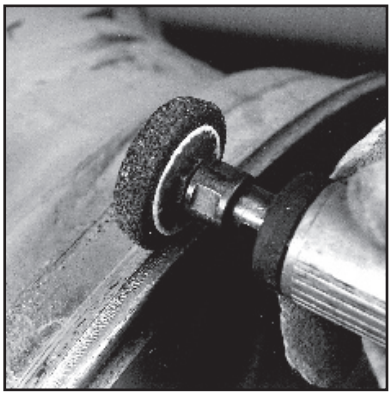


Photo 6. Air or electric grinder

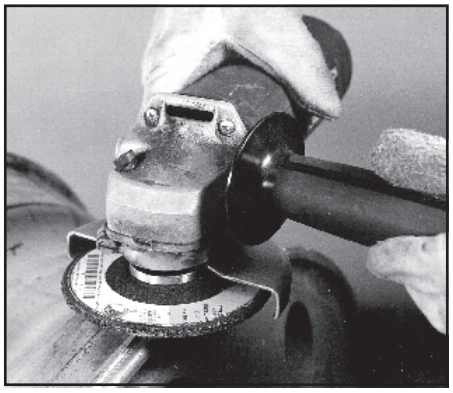


Photo 7. Die grinder.

Rim flange wear (continued)

Die Grinder. Used with a sanding wheel, cutting stone or grinding tool, this is a version of an electric grinder. This tool is very quick and effective as well, and care must be taken to remove metal as uniformly as possible and not to gouge the wheel (photo 7 on previous page).

CAUTION

CAUTION Removing sharp edges with hand or power tools produces metal filings and sparks. Many power tools have edges that are sharp or may become hot during use. Some power tools produce excessive noise when used.

Metal filings can be sharp and, when projected by the action of power tools, can cause serious skin or eye damage. Excessive noise from power tools can harm hearing. Sharp edges can produce cuts and hot surfaces can cause burns. Cuts and burns can lead to infection.

Always wear appropriate safety gear such as protective eye wear, gloves, protective clothing and hearing protection when using hand or power tools.

Photo 8. Severe rim flange wear.

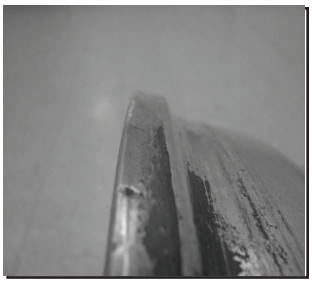


Photo 9. Sharp edge removed.

STEP 4. These photographs show the process of removing the edge. Using whatever tool is selected, work the tool around the wheel's circumference removing only enough material to eliminate the sharp edge. This should only be a small amount of metal. Perform this work on both flanges if there is evidence of sharpness.

Regardless of the method which you choose, the objective is to remove only the sharp edge (photo 9). Remove just enough metal to smooth the edge. Take care to make sure the edge removal is as uniform as possible. Avoid gouging the wheel.

Rim flange wear (continued)

STEP 5. After the edge is removed, run the sharpness indicator gauge along the area of edge removal to check for any remaining sharpness. If the rubber is still cut, perform the steps again to remove the sharp edge. Always remove the minimum amount of material necessary to eliminate the sharp edge.

STEP 6. Check the rim flange height with the Alcoa Rim Flange Wear gauge to make sure there is adequate height remaining to safely support the tire. The photograph again shows how this gauge is used (photo 1). Be sure to move the gauge all around the wheel's circumference and make sure that no area of the flange is below what the gauge indicates is acceptable. If the entire wheel flange is within the limits of the rim flange wear gauge, the wheel may be returned to service.

STEP 7. Always inspect the wheel for any other conditions that would warrant removal from service. Consult the Alcoa Wheel Service Manual or the TMC User's Guide to Wheels and Rims.

WARNING Welding or brazing the rim flange or any area of an Alcoa aluminum wheel will weaken the wheel. Weakened or damaged wheels can lead to an explosive separation of tires and wheels or wheel failure on the vehicle.

Explosive separations of tires and wheels or wheel failure on the vehicle could cause serious injury or death.

Never attempt to weld or braze any surface of an Alcoa aluminum wheel.

WARNING Returning wheels to service with inadequate flange height as determined by the Alcoa Rim Flange Wear Gauge can lead to an explosive separation of tires and wheels.

Explosive separation can cause serious injury or death.

Wheels with flange height that falls below the Alcoa gauge have inadequate rim flange height to support the tire on the rim. Immediately and permanently remove any wheel from service that has inadequate rim flange height.

WARNING Excessive heat from fire, brake malfunction, wheel bearing failure, tire failure or other sources may weaken the metal and cause the wheel/tire assembly to separate explosively.

Exploding wheel/tire assembly can cause serious injury or death.

Immediately and permanently remove from service any wheel that has been exposed to excessive heat.

Always follow safe mounting procedures as recommended using OSHA approved tire inflation cages. See the Alcoa Wheel Service Manual or OSHA safety wall charts and procedures.

Dura-Flange® maintenance

3-13

1. Dura-Flange® has a 24 month warranty against wear which creates a sharp edge that would require maintenance per section 3-12.

2. Minor wear or minor pitting is not a warrantable condition.

3. Edge re-conditioning cannot be performed on Dura-Flange® wheels including those described in Section 3-12.

Maintenance against corrosion (non-Dura-Bright® surface treated wheels)

3-14

The following information is for standard Alcoa forged aluminum wheels without the Dura-Bright® surface treatment. See Section 3-15 for specific instructions on the care and cleaning of Alcoa Dura-Bright® surface treated wheels.

1. Clean frequently with high pressure water from a hose. The use of a mild detergent will speed the cleaning process. Use no strong cleaners.

2. When tires are removed the entire wheel must be cleaned and inspected. (See Section 3). With a wire brush, remove any foreign products from the tire side of the rim. Do not use a wire brush to remove dirt and corrosion products from the appearance surface of the wheel. Generously coat the entire air chamber surface with an approved surface protectant and lubricant each time the tire is removed (see Section 4-1).

3. To maintain the original appearance of your Alcoa wheels, the following procedures are recommended:

a. After installing new wheels and prior to operating your vehicle, use a sponge, cloth or soft fiber brush to wash exposed wheel surfaces with a mild detergent and warm water solution.

b. Rinse thoroughly with clean water.

c. Wipe dry to avoid water spots.

d. Wax the cleaned surface with Alcoa Advanced Aluminum Care System Polish or any automotive polish equivalent.

e. Clean your Alcoa truck wheels as frequently as required to maintain their appearance.

Dura-Bright® surface treated wheels cleaning and maintenance

3-15

1. The Dura-Bright® surface treatment is designed to be easy to clean and generally only requires water. If soils attached to the surface do not come off with cold water, try warm water and wipe with a soft towel or chamois material. If soils remain, use warm water and a mild detergent (with assistance of a commerical high pressure power washer, if available). Always dilute the detergent according to the manufacturer's recommendation; never use the detergent straight without diluting with water. In the mixed, diluted state the cleaner acidity should be at pH equal or greater than 5; avoid cleaners that contain any hydroflouric acid. In the mixed, diluted state the cleaner alkalinity (basicity) should be at pH equal or lower than 9.

2. When tires are removed, the entire rim must be cleaned and inspected (see Section 3). With a soft brush, remove any foreign products from the rim (portion of the wheel that supports the tire). Generously coat the entire air chamber surface with an approved surface protectant and lubricate each time the tire is removed (see Section 4-1).

3. Once in service, Dura-Bright® wheels can become nicked or scratched by road debris and/or mechanical damage. If this occurs, continue to follow the normal washing and cleaning instructions provided above.

4. Even as durable as Dura-Bright® wheels are, the mounting area can become scratched, marred or discolored when mounted against another wheel, hub or drum. The use of a wheel mounting surface guard, such as Disc Mates, are highly recommended.

- Note: pH value can be found in chemical MSDS (Material Safety Data Sheet). If the cleaner is in concentrated form, contact your cleaning chemical supplier to determine pH

Only Alcoa's Warranty Center can authorize warranty claims and determine justified warranty returns. Dura-Bright® and Dura-Flange® claims can only be authorized and determined by Alcoa's Warranty Center.

4 Mounting Alcoa wheels with Tubeless Tires

Recommendations for mounting tubeless tires

4-1

NOTICE: For complete information on tube type wheels, contact Alcoa at (800) 242-9898.

WARNING

WARNING Damaged tires or wheels can lead to an explosive separation of tires and wheels.

Explosive separation can cause serious injury or death.

Inspect tires and wheels for damage before removing from vehicle. If damage is found, the tire must be completely deflated before loosening cap nuts. Immediately and permanently remove damaged tires or wheels from service.

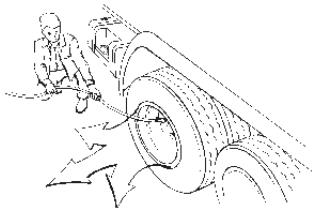
WARNING

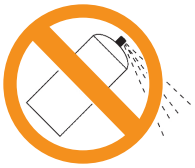
WARNING Use of inner tubes in tubeless wheels will hide slow leaks. Slow leaks may indicate cracked (see Section 3-10, 3-11) or damaged wheels which lead to wheel failures.

Wheel failures can cause accidents which may result in serious injury or death.

Never use an inner tube on an Alcoa tubeless wheel. Immediately and permanently remove cracked or damaged wheels from service.

NOTICE: Alcoa aluminum non-symetrical wheels require special tire mounting techniques, see Section 4-3.





1. Do not gouge or nick the wheel. Place aluminum wheels on clean wooden floor or rubber mat when hand mounting tires. Additional care should be used when mounting Alcoa Dura-Bright® surface treated wheels since minor nicks and scratches cannot be polished out (see Section 3-15, pages 19 for specific cautions, care and maintenance procedures). Disc Mate wheel spacers are recommended for use with Alcoa Dura-Bright® surface treated wheels to protect the wheel contact surfaces from marring.

2. Always use a rubber, leather-faced or plastic mallet.

3. Inspect the wheel for damage. Do not use a damaged or severely corroded wheel (see Section 3).

4. Clean the wheel face with mild detergent and the tire bead seat areas with a wire brush. Be sure the wheel is dry before applying tire lubricant.

5. Inspect the tire for damage. Be sure the inside of the tire is dry before it is mounted.

6. Use of a non-water-based lubricant is recommended as a rim surface protectant and tire mounting lubricant. Coat the entire rim surface (see Section 4-2).

7. Lubricate the rim and tire bead immediately before mounting the tire. Do not use any lubricant which contains water. Water-based lubricants can promote corrosion attack on the rim surface. The use of non-water-based lubricants is especially important when mounting tubeless tires as the air in the tire is contained by the seal between the bead and tire rim.

8. Never lubricate the rim or tire bead with a flammable solution. This can lead to an explosion during airing of the tire or in subsequent operation of the vehicle (see Warning on next page).

9. If using a tire mounting/demounting machine on aluminum wheels, care should be taken to prevent gouging the wheel.

10. Use only dry air for tire inflation. The use of moisture traps in the air compressor feed line is recommended.

11. Do not overinflate. Use the tire manufacturer's recommended pressure, but under no circumstances exceed cold tire pressures listed in Section 2 Specifications of this manual (see page 3).

12. When inflating a tire always use a clip-on air chuck or threaded straight chuck and a remote valve with pressure gauge.

Recommendations for mounting tubeless tires (continued)

WARNING

WARNING Never use a volatile or flammable material, such as ether or gasoline, as an aid to seating the tire beads on the wheel can lead to an uncontrolled pressure build-up in the tire and may result in an explosion.

Explosive separation of the tire and wheel can occur while seating beads in this manner, while adding air to the tire on or off the vehicle, or later on the road. Loss of vehicle control can result, which can cause serious injury or death.

Only use approved mechanical or pneumatic bead seating devices.

WARNING

WARNING A pressurized tire/wheel assembly can explode and separate violently.

This violent separation can cause serious injury or death.

Always contain the tire/wheel assembly in an inflation cage during inflation.

4

Mounting tubeless tires

4-2

NOTICE: Not all tire mounting/demounting machines work alike. Be sure to read the operating or instruction manual for your particular machine before attempting to mount or demount tires.

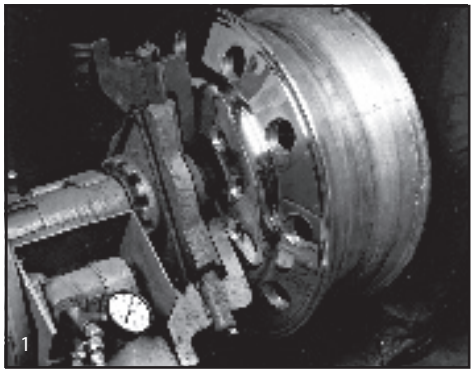
NOTICE: Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

NOTICE: When match mounting tires on Alcoa wheels locate valve stem adjacent to low point mark on the tire.

NOTICE: Alcoa aluminum 19.5" non-symmetrical wheels require tires to be mounted and demounted over the disc side of the wheel only.

NOTICE: Refer to tire manufacturer's recommendation for proper tire pressure.



Position wheel on machine. Lubricate wheel (entire air chamber surface) and tire bead using approved lubricant. Tire beads should be mounted over the rim flange closest to the wheel well. Push bead over flange as far as possible.

Insert curved end of tool between bead and wheel flange with tool stop against flange. In circular motion, use short successive bites to work the bead over the flange. Push down on tool as bead is worked over flange.

Lubricate the second tire bead. Start second bead into the well, holding it in position with the clamp to the rim flange. Lubricate bead half way around. With curved end of tool between tire bead and flange, and the stop towards the wheel, push tool outward to work tire over flange. Continue to pry bead over flange using the tool until remaining bead is over flange. Seat the tire bead using an air ring or other mechanical bead seating aid.

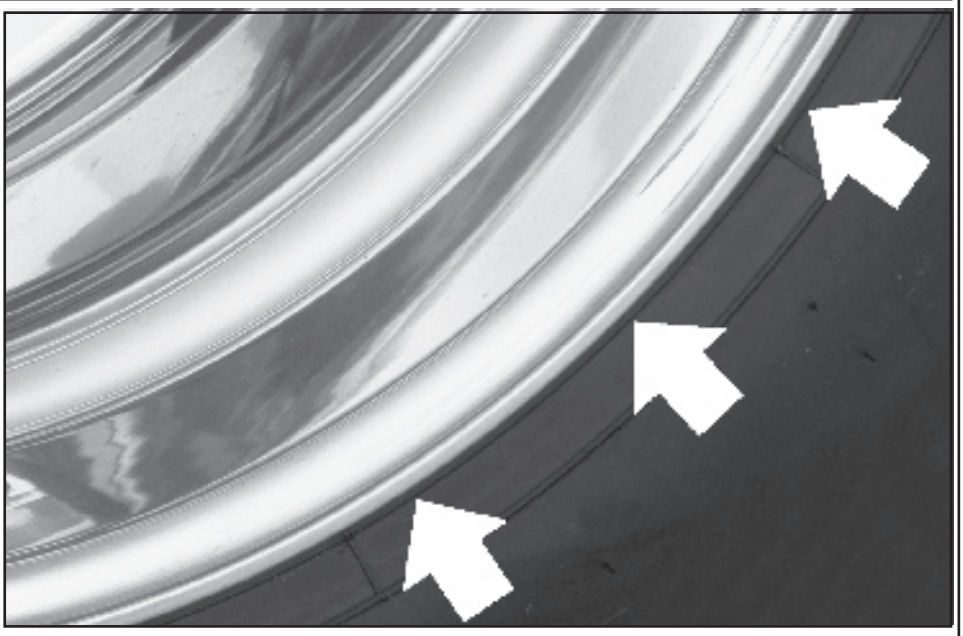
Place tire/wheel assembly inside safety cage or other suitable restraint (refer to OSHA rule 1910.177, paragraph b, see Section 7). Refer to tire manufacturer's recommendation for proper tire pressure. Using a clip-on air chuck or a self-locking straight chuck with remote valve and pressure gauge, inflate the tire/wheel assembly to proper pressure. If air escapes, roll tire or use bead expander to force tire beads against rim. Be sure to stay out of the path of potential exploding parts or air blasts.

Mounting tubeless tires (continued)

CAUTION

CAUTION The use of liquid tire balancers or sealants in Alcoa wheels may cause extremely rapid corrosion of the wheel rim surface.

Severely corroded wheels are unsuitable for service. Alcoa wheels corroded by the use of liquid tire balancers or sealants will not be replaced under the Alcoa limited warranty.



Heavy duty truck tires have a "guide rib" molded into the sidewall next to the tire bead. When the tire is inflated this ring should be evenly spaced from the wheel rim all the way around the wheel. Check the position of the ring before removing the assembly from the inflation cage. If the ring and wheel are not concentric, deflate the assembly in the cage and remount the tire.

4

Mounting tires on non-symmetrical drop well wheels

4-3

Alcoa wheels often contain a symmetrical drop well with a narrow ledge on both sides of the rim. This feature allows mounting of the tire from either side of the wheel. However, some Alcoa wheels are non-symmetrical and contain a narrow ledge on only one side of the wheel. Reduced well wheels as well as some other wheel designs feature an increased underwell diameter and also have a non-symmeterical sloping rim profile which provides additional brake clearance.

In order to minimize the possibility of tire bead damage, all mounting and dismounting of the tire should be performed only from the narrow ledge side of the wheel in accordance with OSHA regulation.

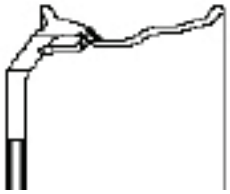
Tires should be mounted/demounted only across the disc side of the wheel.

Mount from this side

Do not mount from this side

Mount from this side

Do not mount from this side



Rim width to tire matching

4-4

Rim to tire matching chart for medium and heavy trucks.

Tire Size (for both radial and bias tires)	Approved Rim Widths	Tire Size (for both radial and bias tires)	Approved Rim Widths
8R17.5	5.25, 6.00	8R22.5	5.25, 6.00, 6.75
9R17.5	6.00, 6.75	9R22.5	6.00, 6.75, 7.50
10R17.5	6.75, 7.50	235/80R22.5	6.75, 7.50
11R17.5	7.50, 8.25	245/75R22.5	6.75, 7.50
		10R22.5	6.75, 7.50, 8.25
		255/70R22.5	7.50, 8.25
		255/80R22.5	7.50, 8.25
		275/80R22.5	7.50, 8.25
		11R22.5	7.50, 8.25
		265/75R22.5	7.50, 8.25
		12R22.5	8.25, 9.00
		295/60R22.5	8.25, 9.00
		295/75R22.5	8.25, 9.00
		305/75R22.5	8.25, 9.00
		305/85R22.5	8.25, 9.00
		315/80R22.5	9.00, 9.75
		335/65R22.5	9.00, 9.75, 10.5
		15R22.5	11.75, 12.25
		385/65R22.5	11.75, 12.25
		425/65R22.5	11.75, 12.25, 13.00
		16.5R22.5	12.25, 13.00
		18R22.5	13.00, 14.00
		445/50R22.5	14.00
		445/55R22.5	14.00
		445/65R22.5	13.00, 14.00
8R19.5	5.25, 6.00, 6.75	1124.5	7.50, 8.25
225/70R19.5	6.00, 6.75	275/80R24.5	7.50, 8.25
245/70R19.5	6.75, 7.50,	285/75R24.5	8.25
265/70R19.5	7.50, 8.25	12R24.5	8.25, 9.00
445/65R19.5	13.00, 14.00		

There may be additional rim to tire matches not shown above. Contact the tire manufacturer or your Alcoa wheel representative for additional information.

Recommendations for demounting tubeless tires

4-5

WARNING

WARNING An aluminum wheel can be structurally weakened by excessive heat.

Tire/wheel assemblies using wheels that have been exposed to excessive heat may experience a sudden and unpredictable tire/wheel separation causing serious injury or death.

Immediately and permanently remove any wheel from service that has been subjected to excessive heat (such as a tire fire, wheel bearing failure or braking system drag/seize) or a high pressure tire/wheel separation.

WARNING

WARNING Damaged tires or wheels can lead to an explosive separation of tires and wheels.

Explosive separation can cause serious injury or death.

Inspect tires and wheels for damage before removing from vehicle. If damage is found, tire must be completely deflated before loosening cap nuts. Immediately and permanently remove damaged tires or wheels from service.

Recommendations for demounting tubeless tires (continued)

1. When hand demounting tires from wheels, placing aluminum wheels on a clean wooden floor or rubber mat is recommended. Remove valve core/air from tire wheel assembly prior to removal from vehicle. Additional care should be used when demounting Alcoa Dura-Bright® surface treated wheels since minor nicks and scratches can not be polished out (see Section 3-15, for specific cautions, care and maintenance procedures).

2. Always use a rubber, leather-faced or plastic mallet.

3. Keep tire tools smooth. Use them with care. Rim gouges or nicks may cause cracks.

4. If using a tire mounting/demounting machine on aluminum wheels, care should be taken to prevent gouging the wheel.

Demounting of tubeless tires

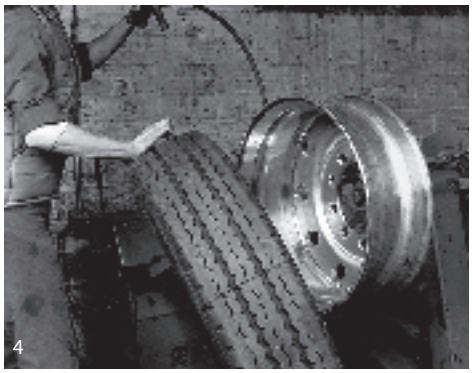
4-6

NOTICE: Not all tire mounting/demounting machines work alike.
Be sure to read the operating or instruction manual for your particular machine before attempting to mount or demount tires.

Remove the valve core from the valve stem to ensure complete deflation. Place wheel on machine and position tool so flat end can be driven between tire bead and rim flange. Straighten tool to a vertical position until bead is separated from wheel.

Repeat procedure at intervals until bead is totally separated from wheel. Repeat procedure on other side of tire. Tire is now ready for demounting. Lubricate the tire bead.

Insert curved end of tire tools between tire and wheel, approximately 10 inches apart. Pull one tool toward center of wheel, then pull second tool in the same manner. To free bead, leave one tool in position, take out and reinsert the other tool, curved end between bead and flange, a short distance from the spanned area. Pry bead free of rim, repeating process until entire bead is free from wheel.



Insert straight end of tire tool between beads and both rim flanges, hooking stop on the tool over second flange. Position inserted tool at 90° angle to tire assembly at top of wheel and lubricate bead areas on both sided of tool. Lean tire assembly toward tool and rock or bounce to pry off the tire.

5 Wheel Installation

Recommendations for proper installation of wheels

5-1

NOTICE: Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

NOTICE: Check for and replace bent, broken, cracked or damaged studs. When replacing broken studs, always replace the studs on each side of the broken stud. If two or more studs are broken, replace all the studs for that wheel position. Check with the stud manufacturer for regular maintenance and stud replacement practices.
All wheel fastener hardware should be grade 8 or metric conversion 10.9. Follow the hardware manufacturer's recommendations when replacing studs.

1. Make sure all wheel cap nuts are properly torqued — check them often (see Section 5-8). If the wheel is loose, the holes will pound out (deform). If some cap nuts are tight and others are loose, the wheel may develop cracks or studs may break. This condition may cause wheel to loosen and disengage from the vehicle. Dirt streaks or rust radiating from stud holes can indicate loose nuts (see Section 3).

2. Be sure the end of the wheel wrench is smooth or cover the wheel mounting surface with a protective shield prior to tightening the cap nuts. The wrench end will mar the wheel around the cap nuts if it is not smooth.

3. Keep all component contact surfaces smooth and clean. Dirt or projections on mounting surfaces may lead to loose wheels. Remove all projections resulting from burrs, nicks, etc. Be sure that loose dirt does not fall onto mounting surface during assembly.

4. Do not introduce any foreign objects such as spacers or top hats into the contact surface areas of the mounting system unless approved by Alcoa. Do not paint Alcoa forged aluminum wheels.

5. Additional care should be used when mounting Alcoa Dura-Bright® surface treated wheels since minor nicks and scratches cannot be polished out (see Section 3-15, for specific cautions, care and maintenance procedures).

6. Disc Mates are a protection gasket designed to be placed between the wheels and also the brake drum/wheel contact surfaces (see Sections 5-2, 5-6, 5-7, 5-9). Disc Mates are recommended to be replaced when the tire/wheel assemblies are removed and reinstalled.

WARNING Wheels that are not properly installed or maintained may not be safe.

Failure to follow proper wheel installation or maintenance practices may result in serious injury or death.

Follow the proper wheel installation and maintenance practices as contained in this Alcoa Wheel Service Manual. For training on proper installation and maintenance, available free of charge from Alcoa, or for the most recent updates, contact Alcoa Wheel Products at 1-800-242-9898 or on the web at www.alcoawheels.com.

Wheel cap nuts

5-2

WARNING

WARNING Use of chrome-plated cap nuts which have chrome plating on the surfaces which contact the wheel can cause reduced and inconsistent wheel clamping.

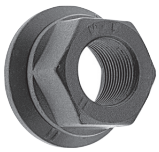
This condition can cause wheels to loosen and disengage from the vehicle, causing serious injury or death.

Never use cap nuts with chrome-plated contact surfaces. Use only recommended hardware on Alcoa aluminum wheels.

There are many types of nuts and studs in use, and their design and specifications are not standardized. The "R" and "L" on cap nut part numbers indicate right and left-hand threads respectively. Alcoa recommends the following cap nuts for use with Alcoa aluminum truck wheels:

Cap Nuts

NOTICE: One-piece flange nuts are not approved for use on any Alcoa wheel application.



2-piece 33mm hex head flange nut. Mounts single and dualed wheels to wheel centering hubs. Right hand threads used on both sides of vehicle. Single wheels require 2" (50.8 mm) stud standout. Dualed wheels require 2-13/16 (71.44 mm) stud standout.
P/N 39874 (supersedes P/Ns 39701 and 39691); M22-1.5 RH threads.

2-piece 30mm hex head flange nut. Mounts single and dualed wheels to wheel centering hubs. Right hand threads used on both sides of vehicle. P/N 39708; M20x1.5 RH threads.

2-piece 33mm hex head flange nut. Mounts dualed wheels with 32mm bolt holes to wheel centering hubs. Right hand threads used on both sides of vehicle. P/N 4307.32; M22x1.5 RH threads.

1-1/8" cap nut. Mounts standard single wheels and wide base wheels to 1-1/8" studs. Also mounts outer dualed wheel to 1-1/8" inner cap nut. P/N 5996R, 5996L (replaces P/N 5552R, 5552L).

3/4"x16 cap nut. Mounts Alcoa wide base wheels to 3/4" studs. Do not use on steel wheels.
P/N 5995R, 5995L (replaces P/N 5554R, 5554L).

2 piece 1-1/16" hex head flange nut. Mounts single and dualed wheels to wheel centering hubs. Right hand threads used in both sides of vehicle. P/N 39946; 5/8"x18 RH threads

2-piece 33mm hex head flange nut. Mounts single wheels to wheel centering hubs with 32mm bolt holes. Right hand threads used on both sides of vehicle. P/N 4306.32; M22x1.5 RH threads.

Inner cap nut, inner thread 3/4"x16, outer thread 1-1/8"x16. For use with steel inner dual wheel an aluminum outer dual wheel with 1.31" (1-5/16) to 1.44" (1-7/16) stud standout. P/N 7896R, 7896L (Grade 8).

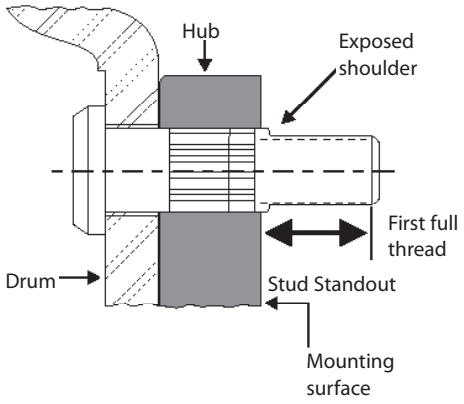
Inner cap nut, inner thread 3/4"x16, outer thread 1-1/8"x16. For use with standard length studs (1.31" [1-5/16] to 1.44" [1-7/16]) stud stand-out) or longer studs not to exceed 1.88" [1-7/8] stud standout. Full internal and external threads. P/N 5978R, 5978L (Grade 8). For studs without exposed shoulders. Do not use with steel inner dualed wheel.

Inner cap nut for use with standard length studs (1.31" [1-5/16] to 1.44" [1-7/16]) stud standout) or longer studs not to exceed 1.88" (1-7/8) stud standout. Full internal and external threads, counter bore 5/16" deep at open end. Prevents stud from bottoming out in cap nut. P/N 5988R, 5988L (Grade 8). For use with studs with exposed shoulders. Do not use with steel inner dualed wheel.

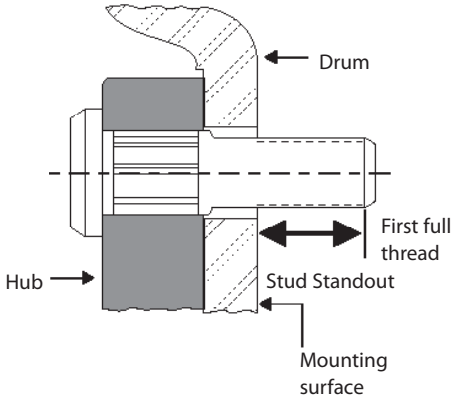
How to measure stud standout

5-3

Stud standout is measured from the axle end mounting surface (the hub, for inboard mounted drums, and the drum, for outboard mounted drums) to the first complete thread at the outside end of the stud.



Inboard mounted drum



Outboard mounted drum

Stud located ball seats are spherical

5-4

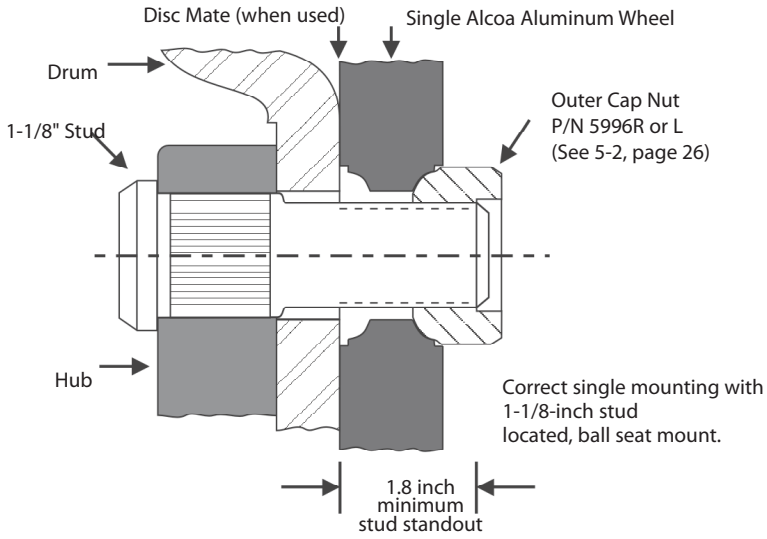
The nut seat for the stud located ball seat mounting system is a precision-machined spherical surface. Cap nuts must be properly manufactured to assure correct seating. Never use one or two-piece flange nuts on a wheel designed with ball seats (see Section 5-11).
Ball seat cap nuts may be obtained from your Alcoa Wheel Distributor.

Single and wide base wheel, stud located, ball seat mounting

5-5

Front wheels are mounted as singles and require 1.8" (45.7mm) minimum stud standout. Most vehicles have 1-1/8-inch studs on the front hubs. Alcoa single cap nuts, Part Nos. 5996R and 5996L, or equivalents, should be used. Some front hubs have 3/4-inch studs. On these hubs, use Alcoa single cap nuts, Part Nos. 5995R and 5995L or equivalents.

Disc Mate wheel spacers are recommended for use with Alcoa Dura-Bright® surface treated wheels to protect the wheel contact surfaces from marring. Disc Mate wheel spacers are placed between the contact surfaces of the Dura-Bright® wheel and the brake drum as shown below and on the next page.



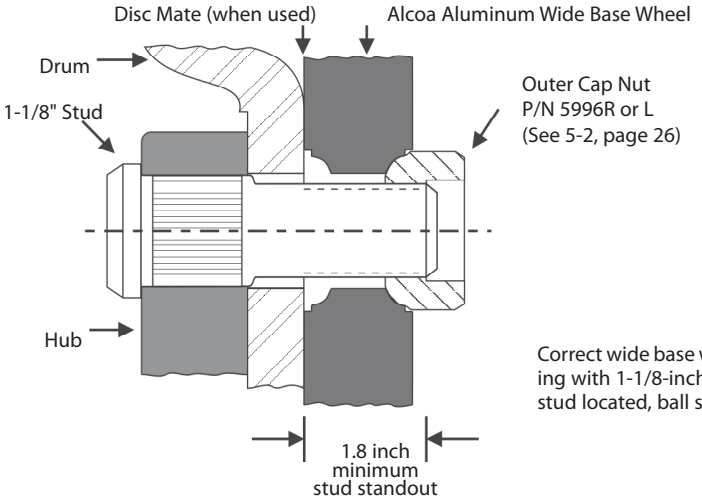
Continued on the next page

Single and wide base wheel, stud located, ball seat mounting (continued)

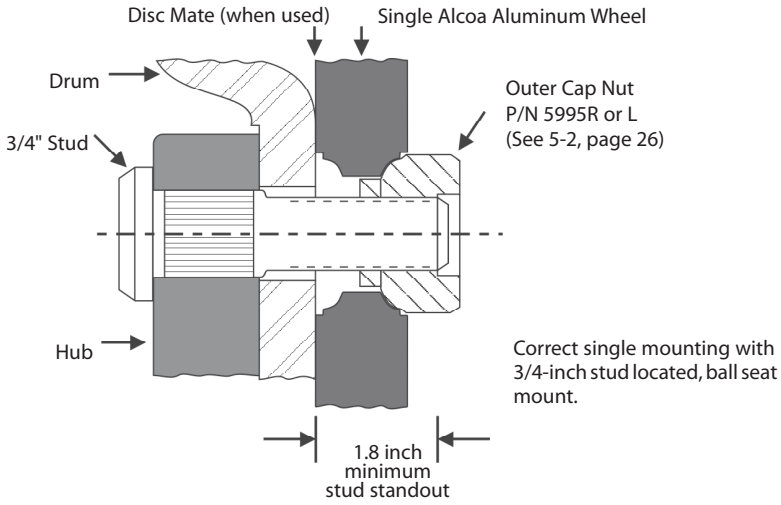
NOTICE: Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

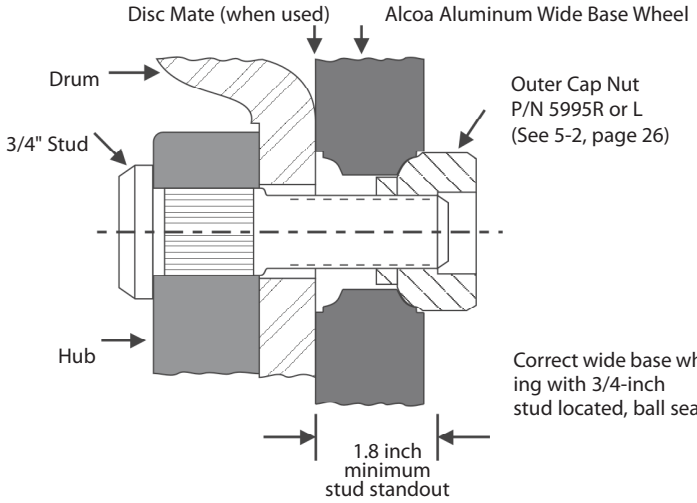
NOTICE: Check for and replace bent, broken, cracked or damaged studs. When replacing broken studs, always replace the studs on each side of the broken stud. If two or more studs are broken, replace all the studs for that wheel position. Check with the stud manufacturer for regular maintenance and stud replacement practices.
All wheel fastener hardware should be grade 8 or metric conversion 10.9. Follow the hardware manufacturer's recommendations when replacing studs.



Correct wide base wheel mounting with 1-1/8-inch stud located, ball seat mount.



Correct single mounting with 3/4-inch stud located, ball seat mount.



Correct wide base wheel mounting with 3/4-inch stud located, ball seat mount.

5

Dualed wheels, stud located, ball seat mounting

Rear wheels are most frequently mounted as duals. Each inner aluminum wheel is attached by 10 inner cap nuts. Alcoa recommends use of inner cap nuts 5978R, 5978L, or 5988R, 5988L (see 5-2, page 26).

Cap nuts recommended by Alcoa are compatible with Alcoa wheels. Hardware of equal dimensions and strength may be used.

Continued on next page.

5-6

Dualed wheels, stud located, ball seat mounting (continued)

NOTICE: Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

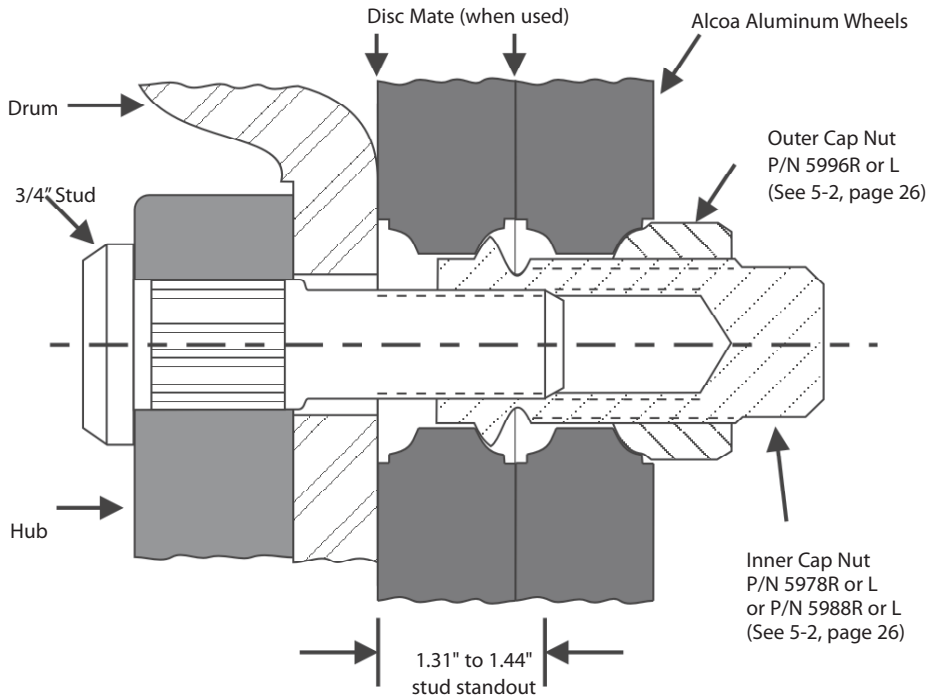
NOTICE: Check for and replace bent, broken, cracked or damaged studs. When replacing broken studs, always replace the studs on each side of the broken stud. If two or more studs are broken, replace all the studs for that wheel position. Check with the stud manufacturer for regular maintenance and stud replacement practices.
All wheel fastener hardware should be grade 8 or metric conversion 10.9. Follow the hardware manufacturer's recommendations when replacing studs.

Most vehicles have standard length studs (1.31" [1-5/16"] to 1.44" [1-7/16"] stud standout). Some vehicles use studs longer than standard (up to 1.88" [1-7/8"] standout).

When changing types of brake drums be sure to check for excessive stud standout (greater than 1.88" [1-7/8"]). All states and provinces have their own standards for fastener engagement. Most of these consist of at least 1 to 2 threads past full thread engagement. Excessive stud standout may cause the inner cap nut to bottom out on the longer stud preventing proper seating of the wheel.

Each outer dual wheel is attached by 10 single cap nuts which thread on the inner cap nuts. Use Alcoa outer cap nuts, Part Nos. 5996R, 5996L or equivalents. Match mounted dual wheels should be put on the vehicles with the valve stems 180° apart.

Disc Mate wheel spacers are recommended for use with Alcoa Dura-Bright® surface treated wheels to protect the wheel contact surfaces from marring. Disc Mate wheel spacers are placed between the contact surfaces of the Dura-Bright® wheel and the brake drum and between the dual aluminum



Correct mounting for dual aluminum, stud located / ball seat mount wheels.

WARNING

WARNING Incorrect inner cap nuts used with dualed aluminum wheels can bottom out on the unthreaded portion of the stud before the wheels are properly seated.

Improperly seated wheels can run loose, cause stud breakage and disengage from the vehicle which can cause serious injury or death. Loose running wheels can lead to stud breakage.

Use only cap nut 5978R or L, 5988R or L, or their equivalent when mounting dual aluminum wheels.

On occasion Alcoa aluminum truck wheels are operated dualed with a steel inner wheel. When this application occurs it is recommended to use a Disc Mate, because of corrosion issues. In the event a steel inner wheel is used, extreme care must be exercised to properly seat it to the hub or drum prior to mounting the outer aluminum wheel. Selection of an inner cap nut capable of fixing the steel inner wheel and providing adequate external thread length to secure the outer aluminum dualed wheel is critical to a safe assembly. Alcoa recommends the use of inner cap nuts 7896R and L (Grade 8), or equivalent, for this purpose.

Dualed wheels, steel inner / aluminum outer stud located ball seat mounting (continued)

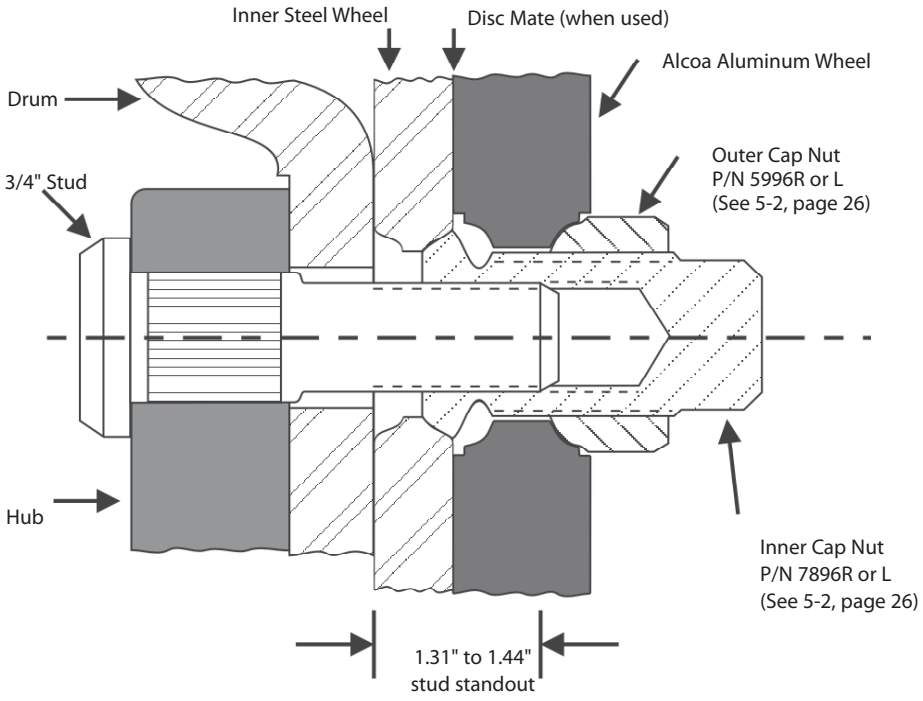
5-7

NOTICE: Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

NOTICE: Check for and replace bent, broken, cracked or damaged studs. When replacing broken studs, always replace the studs on each side of the broken stud. If two or more studs are broken, replace all the studs for that wheel position. Check with the stud manufacturer for regular maintenance and stud replacement practices.
All wheel fastener hardware should be grade 8 or metric conversion 10.9. Follow the hardware manufacturer's recommendations when replacing studs.

Disc Mate wheel spacers are recommended for use with Alcoa Dura-Bright® surface treated wheels to protect the wheel contact surfaces from marring. Disc Mate wheel spacers are placed between the contact surfaces of the Dura-Bright® wheel and the brake drum and between the steel and aluminum wheels as shown below.



Correct dual mounting for steel inner/aluminum outer stud located ball seat mount.

WARNING

WARNING Incorrect inner cap nuts used with steel wheels can bottom out on the unthreaded portion of the stud before the wheels are properly seated.

Improperly seated wheels can run loose, cause stud breakage and disengage from the vehicle which can lead to serious injury or death. Loose running wheels can lead to stud breakage.

Use only cap nut 7896R or L or its equivalent when mounting steel inner duals.

WARNING

WARNING Inadequate wheel support surface can lead to stud hole-to-stud hole fracture resulting in separation of the outer disc and rim from the vehicle.

Separation of the wheel from the vehicle can cause serious injury or death.

Alcoa aluminum wheels with 11-1/4" diameter bolt circle require a support surface at least 13-3/16" in diameter. Check the outer support surface of the inner steel wheel for flatness and adequate diameter before installing the outer wheel. When the wheels are serviced, check the mounting surfaces of both wheels for stud hole to stud hole cracks. If cracks are found, immediately and permanently remove the wheel from service. For the support surface diameter required by other bolt circle sizes, ask your Alcoa representative.

WARNING

WARNING Use of two-piece flange nuts on ball seat wheels or ball seat cap nuts on hub piloted wheels is dangerous.

Using the wrong cap nuts can cause loss of torque, broken studs and cracked wheels, conditions which can lead to serious injury or death.

Use only hardware designed specifically for each wheel type. See Section 5-2 pg. 26 for proper hardware assemblies.

Tightening stud located, ball seat cap nuts

5-8

Cap nuts must be kept tight, and studs and nuts should be checked frequently. Nuts should be retorqued if necessary. At tire changes, nuts and studs should be inspected for cracks and stripped or damaged threads. After each wheel mounting, cap nut torque should be checked with a torque wrench.

Impact wrenches, if used, should be carefully adjusted to apply torques within the limits recommended. Torquing of cap nuts should be done in recommended sequences.

Some states have laws which dictate full thread engagement or thread engagement past the nut body. Make sure you know the laws for the states in which you operate and comply.

WARNING Lubricants should not be applied to the cap nut seat or to the cap nut-to-wheel contact surface.

Oiled seats can lead to over-torquing which can stretch studs causing failure of studs. Failed studs can cause the wheel to disengage from the vehicle, causing serious injury or death.

Lubricants must be completely removed from the cap nut seats and contact surfaces if applied accidentally.

WARNING Undertorqued cap nuts allow wheels to run loose, pounding out (deforming) the ball seats, fatiguing studs or losing nuts. Overtorquing can stretch studs causing them to fail.

Both under and overtorquing can lead to wheels coming off, causing serious injury or death.

Check all parts, including wheels, studs and cap nuts. Check mounting faces of wheels, hubs and drums. Check for dirt, corrosion or damage. Remove dirt and rust; replace damaged parts. Follow correct tightening sequences and torque levels.

Continued on next page

Tightening stud located, ball seat cap nuts (continued)

Stud located, ball seat mounting system.

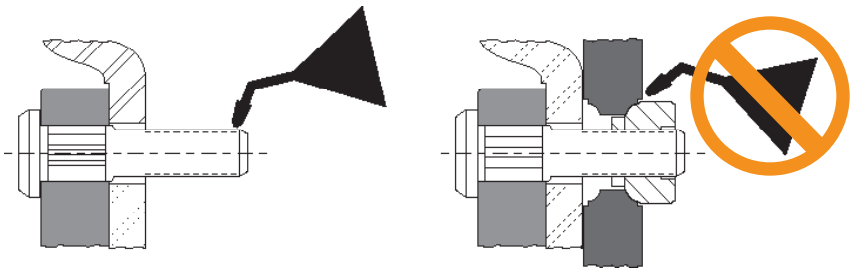
It is recommended to torque to between 450 and 500 foot-pounds. If lubricated with SAE 30W oil torque should be between 350 and 400 foot-pounds. Note: when dualing steel wheels with Alcoa aluminum wheels, follow the steel wheel manufacturer's recommendations regarding the proper torque and use of thread lubricants to mount the wheel.

WARNING

WARNING Application of lubricant to the ball seats can cause excessive torque. Over torque can stretch studs causing them to fail.

Overtorquing can lead to wheel disengagement causing serious injury or death.

Do not allow oil to contact ball seats or mounting surfaces of the wheel, hub or drum. Do not use aerosol cans for lubrication of stud threads.

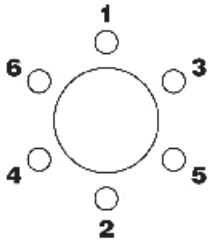


On vehicles equipped to accept wheels manufactured for use with the stud located ball seat mounting system, wheel studs on the right side of the vehicle have right-hand threads and those on the left have left-hand threads. The "R" and "L" on the studs and nuts indicate right and left-hand threads respectively (see Section 5-2).

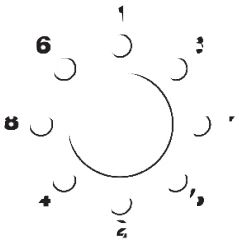
After mounting a wheel over the studs, snug up the cap nuts in the order shown in the illustrations that follow. After all the cap nuts have been snugged, tighten the cap nuts to the recommended torques, following the same tightening sequence.

NOTICE: In service, stud dimensions and condition may change over time due to environmental conditions, multiple re-installations, improper torquing and other factors. Consult with your hub and stud manufacturer for maintenance and replacement recommendations.

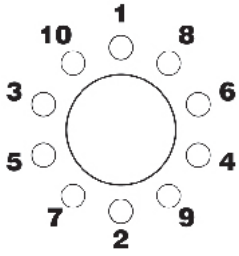
Five Stud



Six Stud



Eight Stud



Ten Stud

Continued on the next page

Tightening stud located, ball seat cap nuts (continued)

After 5-50 miles of operation, torque should be rechecked, unless your documented fleet practices determine otherwise. Loosen outer cap nuts on every other stud to check the torque on inner cap nuts, then retorque outer cap nuts. Repeat steps on remaining studs. Check torque frequently from then on. If nuts require frequent tightening, studs break frequently, or wheel nut seats are pounding out, hardware and mounting practices should be reviewed. Note: whenever the outer cap nut is loosened ALWAYS retorque the inner cap nut before retorquing the outer cap nut.

Single, dualed and wide base wheels, hub piloted mounting, two-piece flange nuts

5-9

NOTICE: Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

NOTICE: Check for and replace bent, broken, cracked or damaged studs. When replacing broken studs, always replace the studs on each side of the broken stud. If two or more studs are broken, replace all the studs for that wheel position. Check with the stud manufacturer for regular maintenance and stud replacement practices.

All wheel fastener hardware should be grade 8 or metric conversion 10.9. Follow the hardware manufacturer's recommendations when replacing studs.

Most U.S. manufacturers of highway trucks, tractors and trailers which incorporate the hub piloted wheel mounting system require wheel studs and cap nuts with metric threads. Most frequently these are M22x1.5.

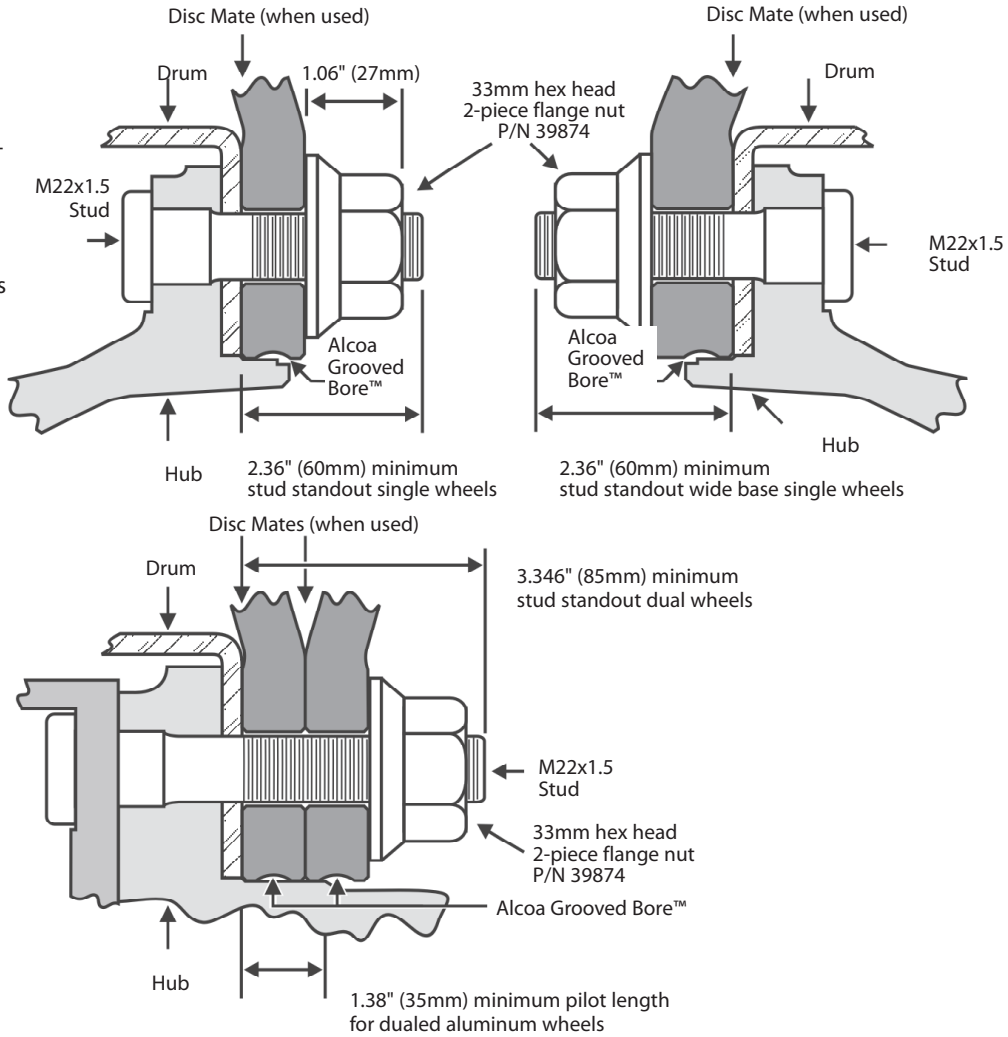
Generally the same diameter stud is used to mount either single or dualed wheels.

Studs on both sides of the vehicle are right-hand threads thereby eliminating the need for flange nuts peculiar to either the right or left side of the vehicle. The same flange nut is used to mount dualed or single wheels. Proper stud standout for single wheels is 2.36-inch (60mm) minimum, dualed wheels require 3.346-inch (85mm) minimum and single wide base wheels require 2.36-inch (60mm).

Some states have laws which dictate full thread engagement or thread engagement past the nut body. Make sure you know the laws for the states in which you operate and comply.

Disc Mate wheel spacers are recommended for use with Alcoa Dura-Bright® surface treated wheels to protect the wheel contact surfaces from marring. Disc Mate wheel spacers are placed between the contact surfaces of the Dura-Bright® wheel and the brake drum and between the dual wheels as shown below.

Note: Some stud located ball seat wheels have the same number of holes and bolt circle diameter as hub piloted wheels. They should not be mixed.



Typical assembly of single and dual wheels of hub piloted type with 33mm hex head two-piece flange nut, Part No. 39874. If hex nuts with greater overall height are used, more stud length is required.

Continued on the next page.

Single, dualed and wide base wheels, hub piloted mounting, two-piece flange nuts (continued)

Hubs designed for steel hub piloted wheels may not have enough pilot length to locate dualed aluminum wheels. Pay close attention to pilot length, particularly when converting from steel to aluminum duals. Measure the hub pilot to make sure the hub has a minimum pilot length of 1.38-inch or (35mm) for dualed wheels.

When mounting painted steel inner dual wheels with outer aluminum wheels, be cautious of excessive paint build-up on the inner steel wheel. Excessive paint can reduce the clamping force and allow the wheels to become loose.

Tightening hub piloted mounting, two-piece flange nuts

Flange nuts must be kept tight, and studs and nuts should be checked frequently. At tire changes, nuts and studs should be inspected to be sure they are in good condition. If nuts require frequent tightening or studs break frequently, hardware and mounting practices should be reviewed.

Impact wrenches, if used, should be carefully adjusted to apply torques within the limits recommended. Torquing of flange nuts should be done in recommended sequences.

5-10

5

WARNING

WARNING Under or Over torqued flange nuts allow wheels to run loose and fatigue studs or lose nuts. Overtorquing can stretch studs causing them to fail with loss to torque and may cause pre-mature fatigue.

Both under and overtorquing can lead to wheel disengagement causing serious injury or death.

Check all parts including wheels, studs and flange nuts. Check mounting faces of wheels, hubs and drums. Check for dirt, corrosion or damage. Remove dirt and rust; replace damaged parts. Follow correct tightening sequences and torque levels.

Two-piece flange nuts with a 33mm hex head design (see Section5-2), used with hub piloted wheels should be tightened to a torque of 450 to 500 foot-pounds. Two-piece flange nuts with 1-1/2-inch hex head design and other designs have different torque requirements. Inquire of the manufacturer for the proper torque values. See section 6-2.

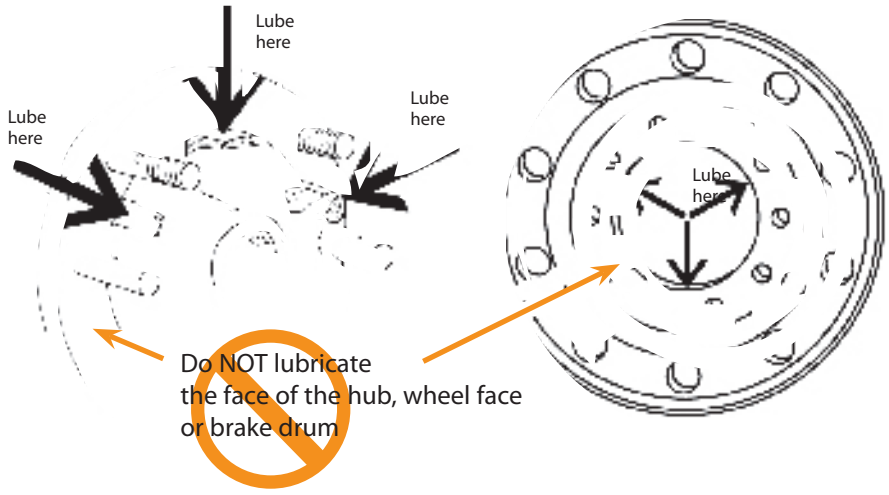
Wheel studs on both the right and left side hubs of vehicles utilizing the hub piloted wheel system have right-hand threads.

Prior to mounting hub piloted wheels, generously coat the wheel pilot or hub pads with a non-water-based lubricant to minimize corrosion product build-up between the wheel and hub pilot. Excessive corrosion build-up between the wheel and hub pilots can make wheel removal difficult. Do not lubricate the face of the wheel, hub or brake drum (see illustration on the next page).

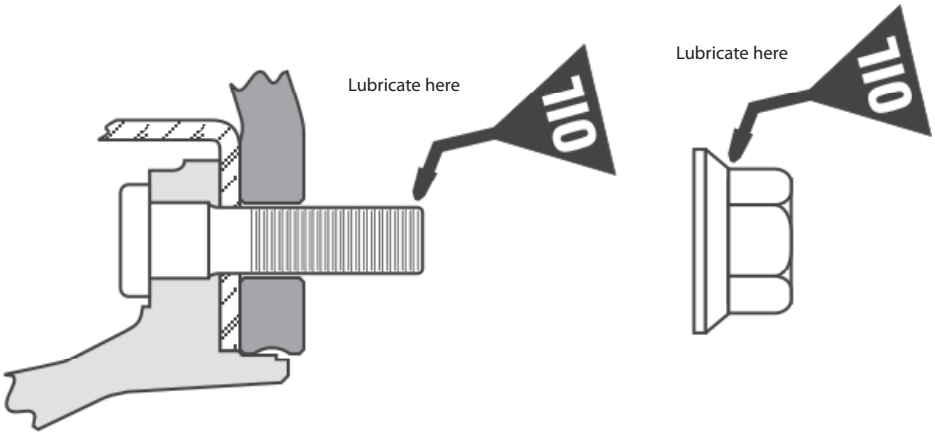
Continued on the next page.

Tightening hub-piloted mounting, two-piece flange nuts (continued)

Lubricate the hub pads or the wheel hub bore generously with a non-water-based lubricant.

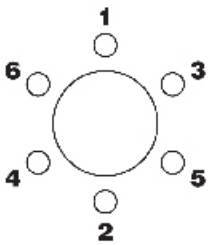


Before installing two-piece flange nuts, lightly lubricate the stud threads and the contact surfaces between the cap nut and the washer as illustrated below with an SAE 30W oil. This will minimize corrosion between the mating surfaces. Lubrication is not necessary with new hardware.

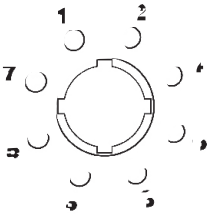


Position one of the hub's pilot pads at the twelve o'clock position. After positioning wheels on the pilot pads, hand tighten all two-piece flange nuts, then tighten to the recommended torque following the proper sequence shown below for your type wheel. After 5-50 miles of operation torque should be rechecked, unless your documented fleet practices determine otherwise. Check torque frequently from then on. If nuts require frequent tightening, studs break frequently, or wheel bolt holes are pounding out, hardware and mounting practices should be reviewed.

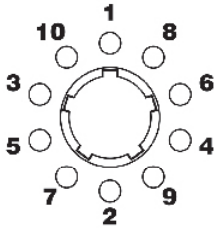
NOTICE: In service, stud dimensions and condition may change over time due to environmental conditions, multiple re-installations, improper torquing and other factors. Consult with your hub and stud manufacturer for maintenance and replacement recommendations.



Six Stud



Eight Stud



Ten Stud

5-11

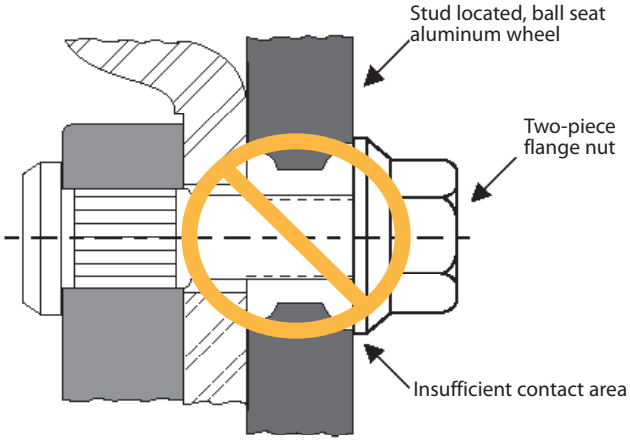
WARNING

WARNING Use of two-piece flange nuts on ball seat wheels, ball seat cap nuts on hub piloted wheels or single-piece flange nuts in place of 2-piece flange nuts is dangerous.

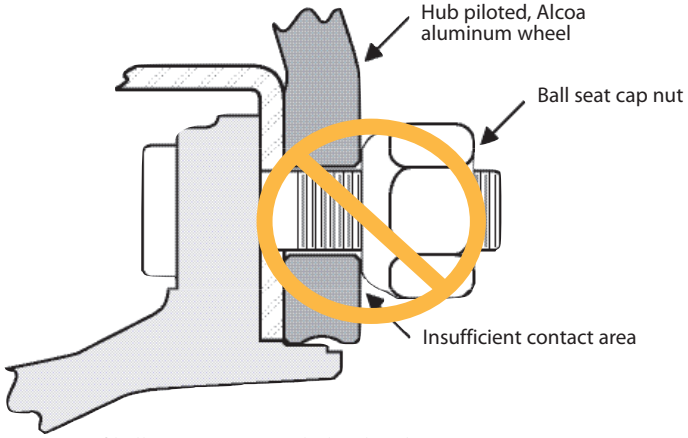
Using the wrong wheel nuts can cause loss of torque, broken studs and cracked wheels, conditions which can lead to serious injury or death.

Use only hardware designed specifically for each wheel type. See Section 5-2 pg. 26 for proper hardware assemblies.

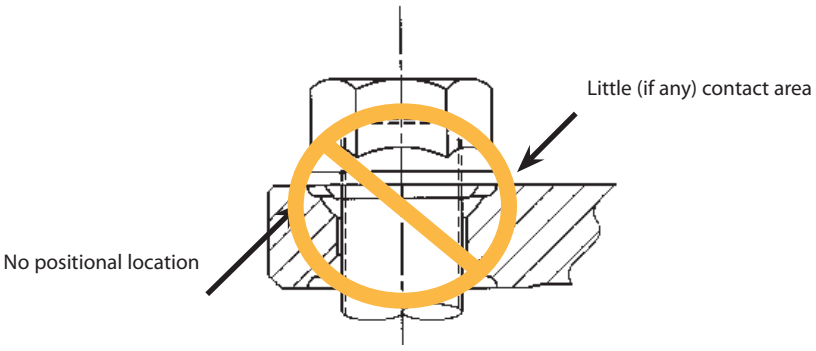
The following are examples of incorrect wheel assemblies.



Do not use two-piece flange nuts with stud located ball seat wheels.



Incorrect use of ball seat cap nut on hub piloted system.
Do not use ball seat cap nuts with hub piloted wheels.



Incorrect use of flange nut positioned on Alcoa ball seat wheel.
Do not use any flange nut on Alcoa aluminum ball seat wheels.

6 Proper Torque, Wheel Identification and Valves

Avoid abuse

6-1

Abuse can shorten the life of a wheel. Lack of care in changing a tire, heavy pounding of the wheel rim, overloading, exposure to excessive heat or hitting curbs at high speed or a sharp angle can damage wheels.

Do not overinflate. Use the tire manufacturer's recommended pressure, but under no circumstances exceed cold inflation pressures listed in Section 2 Specifications of this manual. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

Keep wheel nuts tight

6-2

Wheel cap nuts must be kept tight (see Section 5-8). When checking the cap nuts on dual disc wheels utilizing the stud located ball seat mounting system, loosen every other outer cap nut and then check the torque of the inner cap nuts. Retorque the loosened outer cap nuts. Repeat procedure with the rest of the nuts. Check all cap nuts for proper torque after the first use or any removal. Inspect wheels and check wheel nuts during service stops (see Section 3). Dirt streaks from cap nuts may indicate looseness.

Flange nuts must be kept tight, and studs and nuts should be checked frequently. At tire changes nuts and studs should be inspected to be sure they are in good condition. If nuts require frequent tightening or studs break frequently, hardware and mounting practices should be reviewed.

For proper nut torque, refer to the chart below:

Mount Type	Nut Thread	Torque Level Ft-Lb Lubricated*	Torque Level Ft-Lb Dry*
Hub piloted using two-piece flange nut	11/16" - 16 7/8 - 14 M20 x 1.5 M22 x 1.5	300-400 350-400 280-330 450-500	
Stud piloted, double cap nut standard type (7/8" radius)	3/4" - 16 1-1/8" - 16		450-500 450-500
Stud piloted, double cap nut heavy duty type (1-3/16" radius)	15/16" - 12 1-1/8" - 16 1-5/16" - 12		750-900 750-900 750-900

*For nuts used on hub piloted wheels, apply two drops of oil to the point between the nut and flange and two drops to the first two or three threads at the tip of each stud (see Section 5-10).

For nuts used on stud piloted wheels, apply two drops of oil to the first two or three threads at the tip of each stud only (see Sections 5-8).

NOTE:

1. If using specialty fasteners (cap nuts), consult the manufacturer for recommended torque values.

2. Tightening wheel nuts to their specified torque is extremely important. Undertightening which results in loose wheels can damage wheels, studs and hubs, and can result in wheel loss. Overtightening can damage studs, nuts and wheels and results in loose wheels as well.

3. All torque wrenches, air wrenches and any other tools should be calibrated periodically to ensure the proper torque is applied.

Balance weights (clip-on)

6-3

Balance weights for Alcoa wheels are available from your Alcoa Wheel Distributor. With radial tires it may be necessary to temporarily reduce the tire pressure when installing clip-on weights to allow clearance of the weight clamp over the rim flange. Use of coated balance weights is recommended to avoid staining and corrosion of the aluminum wheel surface.

Excessive rim flange wear (see Section 3-12) could dictate the use of "stick-on" or adhesive wheel weights if there is inadequate rim to properly hold a clip-on style weight.

Improperly installed weights could "fly off" during use and damage the vehicle or cause personal injury. Always follow the recommended procedures in this manual or the wheel weight manufacturer. Adhesive weights should be applied only to a clean surface on the brake side of the wheel rim. These weights should be installed only in a location where they will not contact the brake components during vehicle operation.

Owner/in-service identification

6-4

Some fleets wish to specially identify wheels as to OWNERSHIP and IN-SERVICE dates. Alcoa recommends that fleets and owner-operators adopt the practice of permanently stamping wheels with the date they are first placed into service.

1. Use "Lo-Stress" stamps or equivalent.

2. Location of stamped areas on outside disc should be in space outward from a line between hand hole centers and a minimum of one inch from the periphery of any hand hole.

3. Location of stamped identification on inside of wheel should be as close to the factory identification stamping as possible.

Note: Use of an impression stamp on Dura-Bright® surface treated wheels can affect the appearance and performance of the Dura-Bright® surface treatment local to the stamp.

Valves

6-5

Alcoa drop center wheels for tubeless tires come from the factory with air valves installed. If it becomes necessary to replace an air valve, install it using 9 to 11 foot-pounds of torque.

Replacement valves may be obtained from your authorized Alcoa Wheel Distributor. Always use silicone or EPDM O-rings or grommets – not rubber – when reinstalling valve stems. Metal valve stem caps are recommended instead of plastic. It is recommended that valve stems with O-rings or grommets be replaced at every tire change.

When replacing valve stems, it is recommended to lubricate the threads and O-ring with a non-water based tire lubricant.

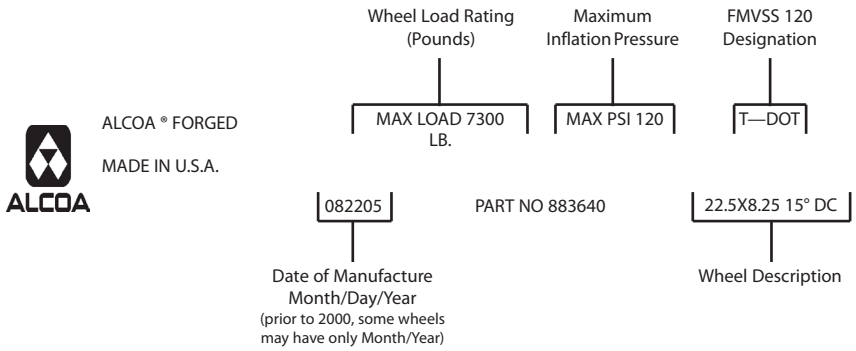
When valve stem extensions are used, it is recommended that valve stem stabilizers be used.

6-6

Alcoa wheel identification

Since 1977, all Alcoa aluminum disc wheels have been identified with a stamp that shows the wheel load rating, maximum inflation pressure, date of manufacture, part number, wheel description and DOT marking designation.

Prior to June 1996, all Alcoa heavy duty truck wheels had the Alcoa identification symbol – on the outside of the disc near the hand hole in line with the valve location. This marking was phased out on heavy duty truck wheels manufactured after June 1996.



All Dura-Bright® surface treated wheels are designated by the letters “DB” following the part number such as 883640DB.

Note: Dura-Bright® wheels produced after November 2002 have Alcoa wheel part numbers ending with “DB” (earlier wheels have part numbers ending in a 4 or 7) with bead seat diameters measured in 0.5-inch increments. Not all Alcoa wheels are available with the Dura-Bright® surface treatment.

All Dura-Flange® wheels are designated by the letters “DF” following the part number such as 883640DF.

All Dura-Bright® / Dura-Flange® wheels are designated by the letters "DD" following the part number such as 883640DD.

If you cannot identify the size or load rating of the wheel it should not be used.

As of January 2009 Alcoa introduced a new logo label.

7 OSHA Regulations

OSHA Regulations

Sec. 1910.177 Servicing multi-piece and single piece rim wheels.

7-1

(a) Scope

(1) This section applies to the servicing of multi-piece and single piece rim wheels used on large vehicles such as trucks, tractors, trailers, buses and off-road machines. It does not apply to the servicing of rim wheels used on automobiles, or on pickup trucks and vans utilizing automobile tires or truck tires designated "LT".

(2) This section does not apply to employers and places of employment regulated under the Construction Safety Standards, 29 CFR part 1926; the Agriculture Standards, 29 CFR part 1928; the Shipyard Standards, 29 CFR part 1915; or the Longshoring Standards, 29 CFR part 1918.

(3) All provisions of this section apply to the servicing of both single piece rim wheels and multi-piece rim wheels unless designated otherwise.

(b) Definitions

Barrier means a fence, wall or other structure or object placed between a single piece rim wheel and an employee during tire inflation, to contain the rim wheel components in the event of the sudden release of the contained air of the single piece rim wheel.

Charts means the U.S. Department of Labor, Occupational Safety and Health Administration publications entitled "Demounting and Mounting Procedures for Truck/Bus Tires" and "Multi-piece Rim Matching Chart," the National Highway Traffic Safety Administration (NHTSA) publications entitled "Demounting and Mounting Procedures Truck/Bus Tires" and "Multi-piece Rim Matching Chart," or any other poster which contains at least the same instructions, safety precautions and other information contained in the charts that is applicable to the types of wheels being serviced.

Installing a rim wheel means the transfer and attachment of an assembled rim wheel onto a vehicle axle hub. Removing means the opposite of installing.

Mounting a tire means the assembly or putting together of the wheel and tire components to form a rim wheel, including inflation. Demounting means the opposite of mounting.

Multi-piece rim wheel means the assemblage of a multi-piece wheel with the tire tube and other components.

Multi-piece wheel means a vehicle wheel consisting of two or more parts, one of which is a side or locking ring designed to hold the tire on the wheel by interlocking components when the tire is inflated.

Restraining device means an apparatus such as a cage, rack, assemblage of bars and other components that will constrain all rim wheel components during an explosive separation of a multi-piece rim wheel, or during the sudden release of the contained air of a single piece rim wheel.

Rim manual means a publication containing instructions from the manufacturer or other qualified organization for correct mounting, demounting, maintenance, and safety precautions peculiar to the type of wheel being serviced.

Rim wheel means an assemblage of tire, tube and liner (where appropriate), and wheel components.

Service or servicing means the mounting and demounting of rim wheels, and related activities such as inflating, deflating, installing, removing, and handling.

Service area means that part of an employer's premises used for the servicing of rim wheels, or any other place where an employee services rim wheels.

Single piece rim wheel means the assemblage of single piece rim wheel with the tire and other components.

Single piece wheel means a vehicle wheel consisting of one part, designed to hold the tire on the wheel when the tire is inflated.

Trajectory means any potential path or route that a rim wheel component may travel during an explosive separation, or the sudden release of the pressurized air, or an area at which an airblast from a single piece rim wheel may be released. The trajectory may deviate from paths which are perpendicular to the assembled position of the rim wheel at the time of separation or explosion. (See appendix A for examples of trajectories.)

Wheel means that portion of a rim wheel which provides the method of attachment of the assembly to the axle of a vehicle and also provides the means to contain the inflated portion of the assembly (i.e., the tire and/or tube).

(c) Employee Training

(1) The employer shall provide a program to train all employees who service rim wheels in the hazards involved in servicing those rim wheels and the safety procedures to be followed.

(i) The employer shall assure that no employee services any rim wheel unless the employee has been trained and instructed in correct procedures of servicing the type of wheel being serviced, and in the safe operating procedures described in paragraphs (f) and (g) of this section.

(ii) Information to be used in the training program shall include, at a minimum, the applicable data contained in the charts (rim manuals) and the contents of this standard.

(iii) Where an employer knows or has reason to believe that any of his employees is unable to read and understand the charts or rim manual, the employer shall assure that the employee is instructed concerning the contents of the charts and rim manual in a manner which the employee is able to understand.

(2) The employer shall assure that each employee demonstrates and maintains the ability to service rim wheels safely, including performance of the following tasks:

(i) Demounting of tires (including deflation);

(ii) Inspection and identification of the rim wheel components;

(iii) Mounting of tires (including inflation with a restraining device or other safeguard required by this section);

(iv) Use of the restraining device or barrier, and other equipment required by this section;

(v) Handling of rim wheels;

(vi) Inflation of the tire when a single piece rim wheel is mounted on a vehicle;

(vii) An understanding of the necessity of standing outside the trajectory both during inflation of the tire and during inspection of the rim wheel following inflation; and

(viii) Installation and removal of rim wheels.

(3) The employer shall evaluate each employee's ability to perform these tasks and to service rim wheels safely, and shall provide additional training as necessary to assure that each employee maintains his or her proficiency.

(d) Tire servicing equipment.

(1) The employer shall furnish a restraining device for inflating tires on multi-piece wheels.

(2) The employer shall provide a restraining device or barrier for inflating tires on single piece wheels unless the rim wheel will be bolted onto a vehicle during inflation.

(3) Restraining devices and barriers shall comply with the following requirements:

(i) Each restraining device or barrier shall have the capacity to withstand the maximum force that would be transferred to it during a rim wheel separation occurring at 150 percent of the maximum tire specification pressure for the type of rim wheel being serviced.

(ii) Restraining devices and barriers shall be capable of preventing the rim wheel components from being thrown outside or beyond the device or barrier for any rim wheel positioned within or behind the device;

(iii) Restraining devices and barriers shall be visually inspected prior to each day's use and after any separation of the rim wheel components or sudden release of contained air. Any restraining device or barrier exhibiting damage such as the following defects shall be immediately removed from service:

(A) Cracks at welds;

(B) Cracked or broken components;

(C) Bent or sprung components caused by mishandling, abuse, tire explosion or rim wheel separation;

(D) Pitting of components due to corrosion; or

(E) Other structural damage which would decrease its effectiveness.

(iv) Restraining devices or barriers removed from service shall not be returned to service until they are repaired and reinspected. Restraining devices or barriers requiring structural repair such as component replacement or rewelding shall not be returned to service until they are certified by either the manufacturer or a Registered Professional Engineer as meeting the strength requirements of paragraph (d)(3)(i) of this section.

(4) The employer shall furnish and assure that an air line assembly consisting of the following components be used for inflating tires:

(i) A clip-on chuck;

(ii) An in-line valve with a pressure gauge or a presettable regulator; and

(iii) A sufficient length of hose between the clip-on chuck and the in-line valve (if one is used) to allow the employee to stand outside the trajectory.

(5) Current charts or rim manuals containing instructions for the type of wheels being serviced shall be available in the service area.

(6) The employer shall furnish and assure that only tools recommended in the rim manual for the type of wheel being serviced are used to service rim wheels.

(e) Wheel component acceptability.

(1) Multi-piece wheel components shall not be interchanged except as provided in the charts or in the applicable rim manual.

(2) Multi-piece wheel components and single piece wheels shall be inspected prior to assembly. Any wheel or wheel component which is bent out of shape, pitted from corrosion, broken, or cracked shall not be used and shall be marked or tagged unserviceable and removed from the service area. Damaged or leaky valves shall be replaced.

(3) Rim flanges, rim gutters, rings, bead seating surfaces and the bead areas of tires shall be free of any dirt, surface rust, scale or loose or flaked rubber build-up prior to mounting and inflation.

(4) The size (bead diameter and tire/wheel widths) and type of both the tire and the wheel shall be checked for compatibility prior to assembly of the rim wheel.

(f) Safe operating procedure - multi-piece rim wheels.

The employer shall establish a safe operating procedure for servicing multi-piece rim wheels and shall assure that employees are instructed in and follow that procedure.
The procedure shall include at least the following elements:

(1) Tires shall be completely deflated before demounting by removal of the valve core.

(2) Tires shall be completely deflated by removing the valve core before a rim wheel is removed from the axle in either of the following situations:

(i) When the tire has been driven underinflated at 80% or less of its recommended pressure,

or

(ii) When there is obvious or suspected damage to the tire or wheel components.

(3) Rubber lubricant shall be applied to bead and rim mating surfaces during assembly of the wheel and inflation of the tire, unless the tire or wheel manufacturer recommends against it.

(4) If a tire on a vehicle is underinflated but has more than 80% of the recommended pressure, the tire may be inflated while the rim wheel is on the vehicle provided remote control inflation equipment is used, and no employees remain in the trajectory during inflation.

(5) Tires shall be inflated outside a restraining device only to a pressure sufficient to force the tire bead onto the rim ledge and create an airtight seal with the tire and bead.

(6) Whenever a rim wheel is in a restraining device the employee shall not rest or lean any part of his body or equipment on or against the restraining device.

(7) After tire inflation, the tire and wheel components shall be inspected while still within the restraining device to make sure that they are properly seated and locked. If further adjustment to the tire or wheel components is necessary, the tire shall be deflated by removal of the valve core before the adjustment is made.

(8) No attempt shall be made to correct the seating of side and lock rings by hammering, striking or forcing the components while the tire is pressurized.

(9) Cracked, broken, bent or otherwise damaged rim components shall not be reworked, welded, brazed, or otherwise heated.

(10) Whenever multi-piece rim wheels are being handled, employees shall stay out of the trajectory unless the employer can demonstrate that performance of the servicing makes the employee's presence in the trajectory necessary.

(11) No heat shall be applied to a multi-piece wheel or wheel component.

(g) Safe operating procedure - single piece rim wheels.

The employer shall establish a safe operating procedure for servicing single piece rim wheels and shall assure that employees are instructed in and follow that procedure.
The procedure shall include at least the following elements:

(1) Tires shall be completely deflated by removal of the valve core before demounting.

(2) Mounting and demounting of the tire shall be done only from the narrow ledge side of the wheel. Care shall be taken to avoid damaging the tire beads while mounting tires on wheels. Tires shall be mounted only on compatible wheels of matching bead diameter and width.

(3) Nonflammable rubber lubricant shall be applied to bead and wheel mating surfaces before assembly of the rim wheel, unless the tire or wheel manufacturer recommends against the use of any rubber lubricant.

(4) If a tire changing machine is used, the tire shall be inflated only to the minimum pressure necessary to force the tire bead onto the rim ledge while on the tire changing machine.

(5) If a bead expander is used, it shall be removed before the valve core is installed and as soon as the rim wheel becomes airtight (the tire bead slips onto the bead seat).

(6) Tires may be inflated only when contained within a restraining device, positioned behind a barrier or bolted on the vehicle with the lug nuts fully tightened.

(7) Tires shall not be inflated when any flat, solid surface is in the trajectory and within one foot of the sidewall.

(8) Employees shall stay out of the trajectory when inflating a tire.

(9) Tires shall not be inflated to more than the inflation pressure stamped in the sidewall unless a higher pressure is recommended by the manufacturer.

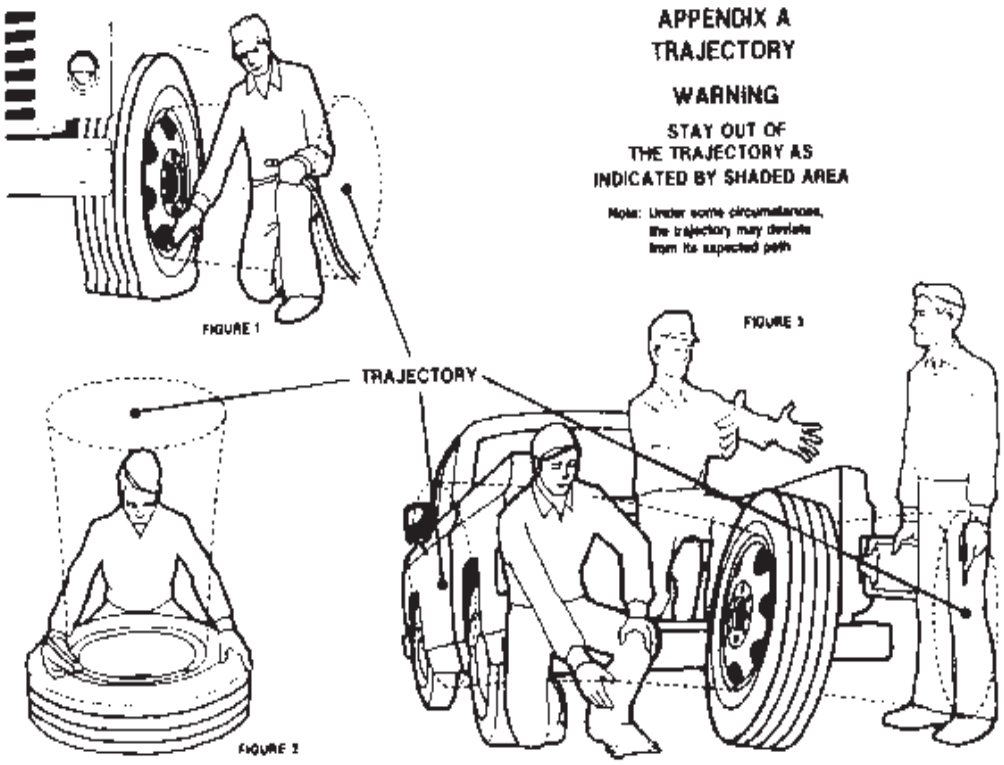
(10) Tires shall not be inflated above the maximum pressure recommended by the manufacturer to seat the tire bead firmly against the rim flange.

(11) No heat shall be applied to a single piece wheel.

(12) Cracked, broken, bent, or otherwise damaged wheels shall not be reworked, welded, brazed, or otherwise heated.

[39 FR 23502, June 27, 1974, as amended at 52 FR 36026, Sept. 25, 1987; 53 FR 34736, Sept. 8, 1988]

Appendix A - Trajectory



Appendix B - Ordering Information for NHTSA Charts

OSHA has printed two charts entitled "Demounting and Mounting Procedures for Truck/Bus Tires" and "Multi-piece Rim Matching Chart," as part of a continuing campaign to reduce accidents among employees who service large vehicle rim wheels.

Reprints of the charts are available through the Occupational Safety and Health Administration (OSHA) Area and Regional Offices. The address and telephone number of the nearest OSHA office can be obtained by looking in the local telephone directory under U.S. Government, U.S. Department of Labor, Occupational Safety and Health Administration.

Single copies are available without charge.

Individuals, establishments and other organizations desiring single or multiple copies of these charts may order them from the OSHA Publications Office, U.S. Department of Labor, Room N-3101, Washington, DC 20210, Telephone (202) 219-4667.

[49 FR 4350, Feb. 3, 1984, as amended at 52 FR 36026, Sept. 25, 1987; 53 FR 34737, Sept. 8, 1988; 61 FR 9227, Mar. 7, 1996]

8 Glossary of Common Terms

Glossary of Common Terms

8-1

1/2 DUAL SPACING - One half the distance between the two center lines of dualed wheels. The dimension is the same as the OUTSET dimension.

1-PIECE FLANGE NUT - A one-piece washer and nut combination not recommended for use on any Alcoa wheel application.

2-PIECE FLANGE NUT - A two-piece washer and nut combination used to secure hub piloted wheels.

AIR CHAMBER - The space enclosed by a tire and wheel rim or inner tube.

BEAD SEAT - The area along the outer edges of the rim where the mounted tire and rim are in contact.

BOLT CIRCLE - The circle defined by the centers of the bolt holes (stud holes) of a wheel, dimensions stated in diameter inches or millimeters.

BOLT HOLE - Hole found in the disc of the wheel through which the bolt (stud) passes.

BORE - See “HUB BORE.”

CENTER BORE - See “HUB BORE.”

CONE LOCK CAP NUT - See “2-PIECE FLANGE NUT.”

DC - Abbreviation for drop center.

DISC AREA - The vertical wheel face which supports the rim.

DISC MATE - (wheel gasket) A nylon 6-6 gasket that goes between the brake drum and wheel and/ or between two wheels to protect against corrosion.

DISC WHEEL - A one-piece (forged) or two-piece (welded) assembly of a disc and a rim.

DROP CENTER - The well or center portion of the wheel rim.

DUAL WHEEL - Any wheel that can be mated disc side to disc side with another wheel resuliting in an inner and outer dual wheel assembly.

FLAT BASE WHEEL - A multi-piece wheel with a removable side ring.

FOOT-POUNDS - The measure of the amount of torque applied to a cap nut or other part. May be measured with a torque wrench.

GUTTER FLANGE - A groove which supports the removable portion of a multi-piece wheel.

HUB BORE - The center hole of a disc wheel, dimensions stated in inches or millimeters.

HUB PILOTED MOUNTING - A wheel mounting system which uses the hub to center the wheel and two-piece flange nuts to secure it.

in. - Abbreviation for inches.

INNER CAP NUT - Cap nut used to mount the inner wheel in a dualed stud located wheel system.

INSET - The distance from the wheel mounting surface to the rim centerline when the centerline is placed inboard of the mounting surface.

kg - Abbreviation for kilogram (weight measurement), equal to 1000 grams.

kPa - Abbreviation for kilo Pascals (pressure measurement).

Glossary of Common Terms (continued)

LOCK RING - The third piece of a three piece rim assembly which positions and supports the side ring to the rim base.

MAXIMUM INFLATION - The highest amount of air pressure allowed, measured at normal ambient temperatures.

mm - Abbreviation for millimeters.

MULTI-PIECE WHEEL - A wheel assembly in which the rim portion of the wheel consists of two or more separate parts.

N-m - Abbreviation for Newton meters

OFFSET - See "OUTSET."

OPEN SIDE - The side of the wheel opposite the disc face.

OSHA - Abbreviation for the U.S. Department of Labor, Occupational Saftey and Health Administration.

OUTER CAP NUT - A cap nut used to secure the outer stud located wheel in a dualed wheel pair and threaded onto the inner cap nut.

OUTSET - The distance from the mounting surface of the wheel to the rim centerline when the rim centerline is mounted outboard of the hub face. This dimension is the same as the 1/2 DUAL SPACING dimension.

PILOT PAD - The raised surfaces on a hub used to center a hub piloted wheel.

PSI - Abbreviation for pounds per square inch.

REVERSIBLE - Term applied to a disc wheel which can be reversed on the hub without changing the position of the tire centerline.

RIM CENTERLINE - A line to the radial axis of the wheel running through the mid point between the rim flanges.

RIM FLANGE - That portion of the rim which extends above the rim surface which retains the tire bead.

RIM - That portion of the wheel which supports the tire.

SIDE RING - A removable piece of a multi-piece wheel assembly which provides lateral support for one tire bead.

SINGLE CAP NUT - A cap nut used to secure single wheels or outer dual wheels.

STUD - A threaded bolt extending from the hub surface to which the wheels are secured by the cap nuts.

STUD LOCATED, BALL SEAT MOUNTING - A wheel mounting system which uses the studs and spherical ball seat cap nuts to center and secure the wheel.

TIRE BEAD - That surface of the tire which contacts the angled surface of the wheel rim.

TORQUE - The amount of force used to tighten cap nuts. Usually stated in foot-pounds or kilograms and measured with a torque wrench.

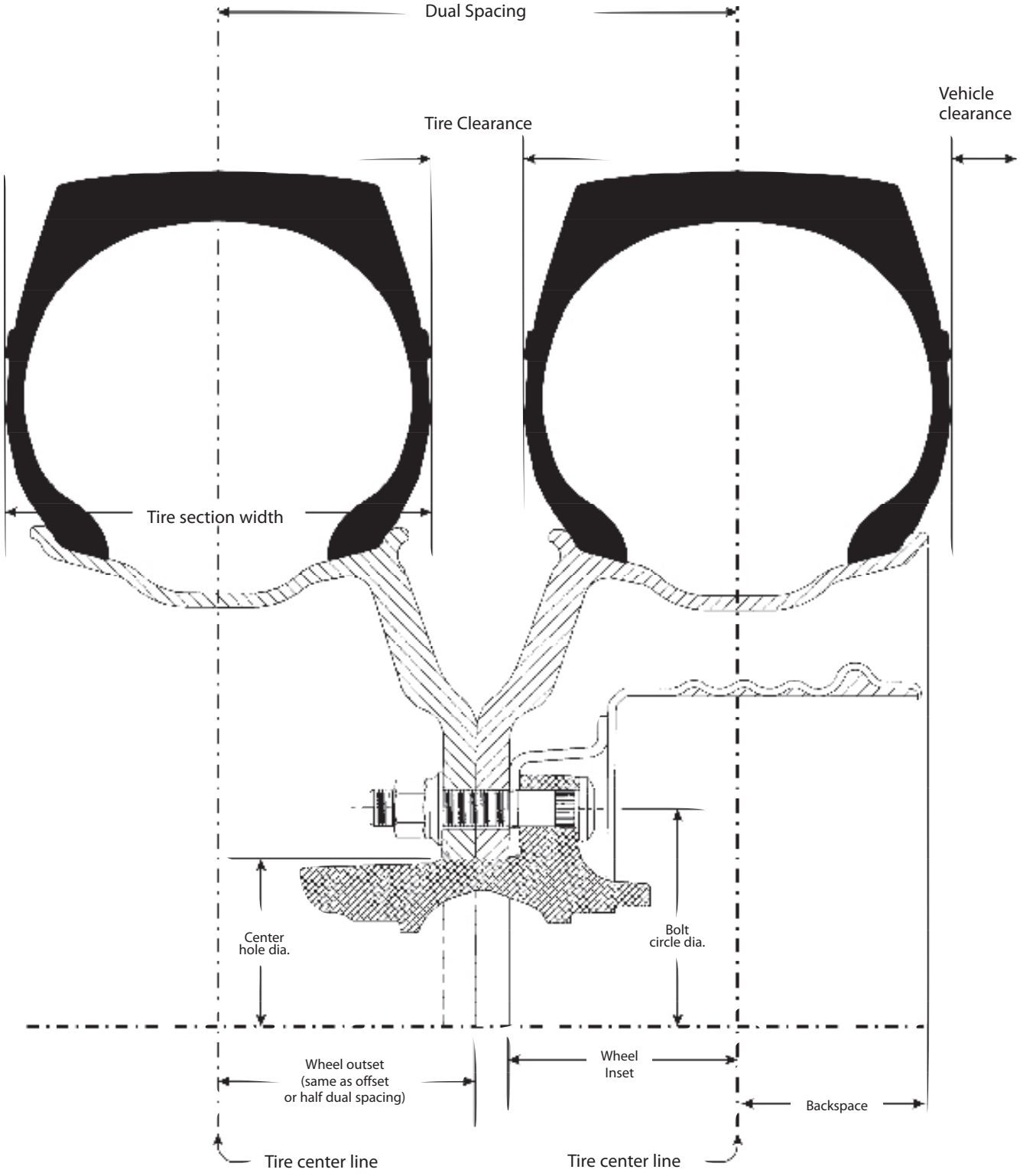
WHEEL MOUNTING FACE - That portion of the wheel face which contacts the hub or brake drum.

wt. - Abbreviation for weight.

8-2

How to measure minimum dual spacing

Minimum dual spacing measurement is determined by the tire manufacturer and may be obtained from the tire manufacturer's handbook. To determine if the Alcoa aluminum dual wheel assembly has adequate minimum dual spacing for the selected tires, double the wheel outset measurement of the Alcoa wheel used. If the doubled outset measurement is equal to or greater than the tire manufacturer's recommendation, there will be sufficient minimum dual spacing. Wheel inset and outset is given for each Alcoa wheel on pages 2 and 3. Both inset and outset wheels are measured from the mounting surface of the wheel to the center line of the rim. Maintaining proper tire inflation and load ratings are essential to maintaining proper minimum dual spacing.



9 Conversion Tables

Inch Fraction, Decimal and Millimeter Equivalents Chart (Up to 1 inch)

9-1

Inches	Decimals	Millimeters
1/64	0.0156	0.3969
1/32	0.0313	0.7938
3/64	0.0469	01.1906
1/16	0.0625	1.5875
5/64	0.0781	1.9844
3/32	0.0938	2.3813
7/64	0.1094	2.7781
1/8	**0.1250**	**3.1750**
9/64	0.1406	3.5719
5/32	0.1563	3.9688
11/64	0.1719	4.3656
3/16	0.1875	4.7625
13/64	0.2031	5.1594
7/32	0.2188	5.5563
15/64	0.2344	5.9531
1/4	**0.2500**	**6.3500**
17/64	0.2656	6.7469
9/32	0.2813	7.1438
19/64	0.2969	7.5406
5/16	0.3125	7.9375
21/64	0.3281	8.3344
11/32	0.3438	8.7313
23/64	0.3594	9.1281
3/8	**0.3750**	**9.5250**
25/64	0.3906	9.9219
13/32	0.4063	10.3188
27/64	0.4219	10.7156
7/16	0.4375	11.1125
29/64	0.4531	11.5094
15/32	0.4688	11.9063
31/64	0.4844	12.3031
1/2	**0.5000**	**12.7000**

Inches	Decimals	Millimeters
33/64	0.5156	13.0969
17/32	0.5313	13.4938
35/64	0.5469	13.8906
9/16	0.5625	14.2875
37/64	0.5781	14.6844
19/32	0.5938	15.0813
39/64	0.6094	15.4781
5/8	**0.6250**	**15.8750**
41/64	0.6406	16.2719
21/32	0.6563	16.6688
43/64	0.6719	17.0656
11/16	0.6875	17.4625
45/64	0.7031	17.8594
23/32	0.7188	18.2563
47/64	0.7344	18.6531
3/4	**0.7500**	**19.0500**
49/64	0.7656	19.4469
25/32	0.7813	19.8438
51/64	0.7969	20.2406
13/16	0.8125	20.6375
53/64	0.8281	21.0344
27/32	0.8438	21.4313
55/64	0.8594	21.8281
7/8	**0.8750**	**22.2250**
57/64	0.8906	22.6219
29/32	0.9063	23.0188
59/64	0.9219	23.4156
15/16	0.9375	23.8125
61/64	0.9531	24.2094
31/32	0.9688	24.6063
63/64	0.9844	25.0031
1	**1.000**	**25.4000**

Conversion Factors

9-2

Inches to Millimeters

Inches	x	25.4	=	Millimeters

Millimeters to Inches

Millimeters	x	0.03937	=	Inches

PSI to kPa

PSI	x	6.8948	=	kPa

kPa to PSI

kPa	x	0.145	=	PSI

Pounds to Kilograms

Pounds	x	0.4536	=	kg

Kilograms to Pounds

kg	x	2.2046	=	Pounds

Foot-pounds to Newton Meters

Ft-lbs	x	1.35582	=	N-m

Newton Meters to Foot-pounds

N-m	x	.737561	=	Ft-lbs

Alcoa Wheel Products
1600 Harvard Avenue
Cleveland, Ohio 44105
(800) 242-9898

www.alcoawheels.com

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SECTION 14: STEERING

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1. STEERING SYSTEM

1.1 I-BEAM AXLE STEERING SYSTEM DESCRIPTION

The steering system consists of the steering wheel and column assembly, a vane-type hydraulic pump, reservoir, filter, interconnecting system lines and hoses, integral power steering gear, linkage and steering damper (Fig. 1). The steering linkage includes the pitman arm, drag link, steering arm, tie rod arms and tie rod.

Hydraulic components are added to transmit, increase and regulate steering control forces.

These elements are:

1. Steering stabilizer (damper);
2. A vane type hydraulic pump; and
3. Hydraulic reservoir and hoses.

The steering stabilizer reduces road shocks and vibrations in the system. The steering gearbox is self powered and provides movement with power assistance to the left wheel.

Steering stability and tire wear are influenced by wheels, hubs, tires, air suspension, brakes, front suspension and front end alignment which are all covered in their respective sections in this manual.

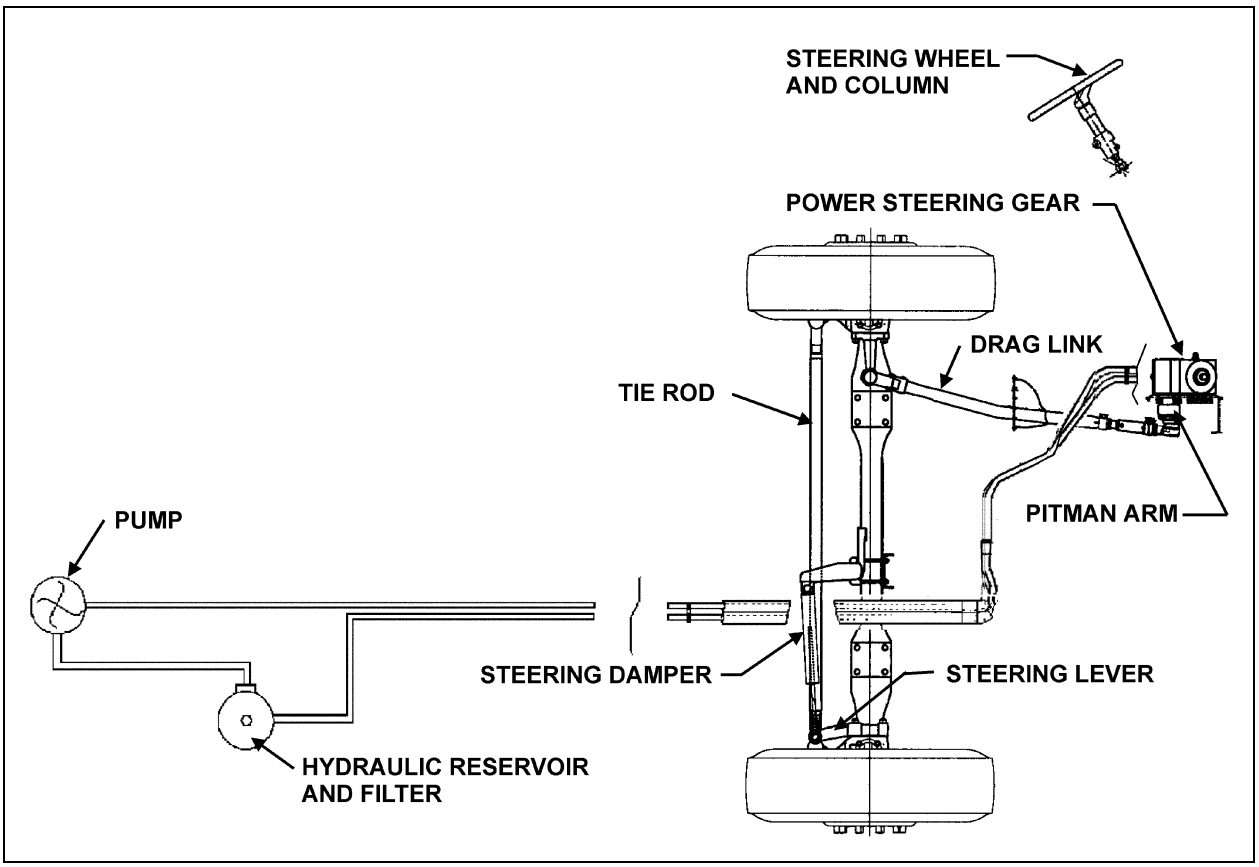


FIGURE 1: I-BEAM AXLE STEERING SYSTEM SETUP 14041

1.2 INDEPENDENT FRONT SUSPENSION STEERING SYTEM DESCRIPTION

The steering system consists of the steering wheel and column assembly, a vane-type hydraulic pump, reservoir, filter, interconnecting system lines and hoses, integral power steering gear and linkage (Fig. 2). The steering linkage consists of tie rods connected to the bell crank and the steering arm at the left side of the coach, and to the idler arm and steering arm at the right side of the coach. The bell crank and idler arm are connected by a relay rod. A drag link connected to the bell crank and the pitman arm, which is mounted to the steering gear, transfers the turning motion of the steering wheel to the steering arms.

Hydraulic components are added to transmit, increase and regulate steering control forces.

These elements are:

1. A vane type hydraulic pump; and
2. Hydraulic reservoir and hoses.
3. Hydraulic power cylinder (X3-45 VIP & XLII Bus Shells only).

NOTE
X3-45 VIP & XLII Bus Shells are also equipped with a hydraulic power cylinder. The hydraulic power cylinder provides an added source of assistance and being connected to the R.H. wheel, makes it such that the total steering forces are produced with minimal stress on mechanical linkages.

The steering gearbox is self powered and provides movement with power assistance to the left wheel.

Steering stability and tire wear are influenced by wheels, hubs, tires, air suspension, brakes, front suspension and front end alignment which are all covered in their respective sections in this manual.

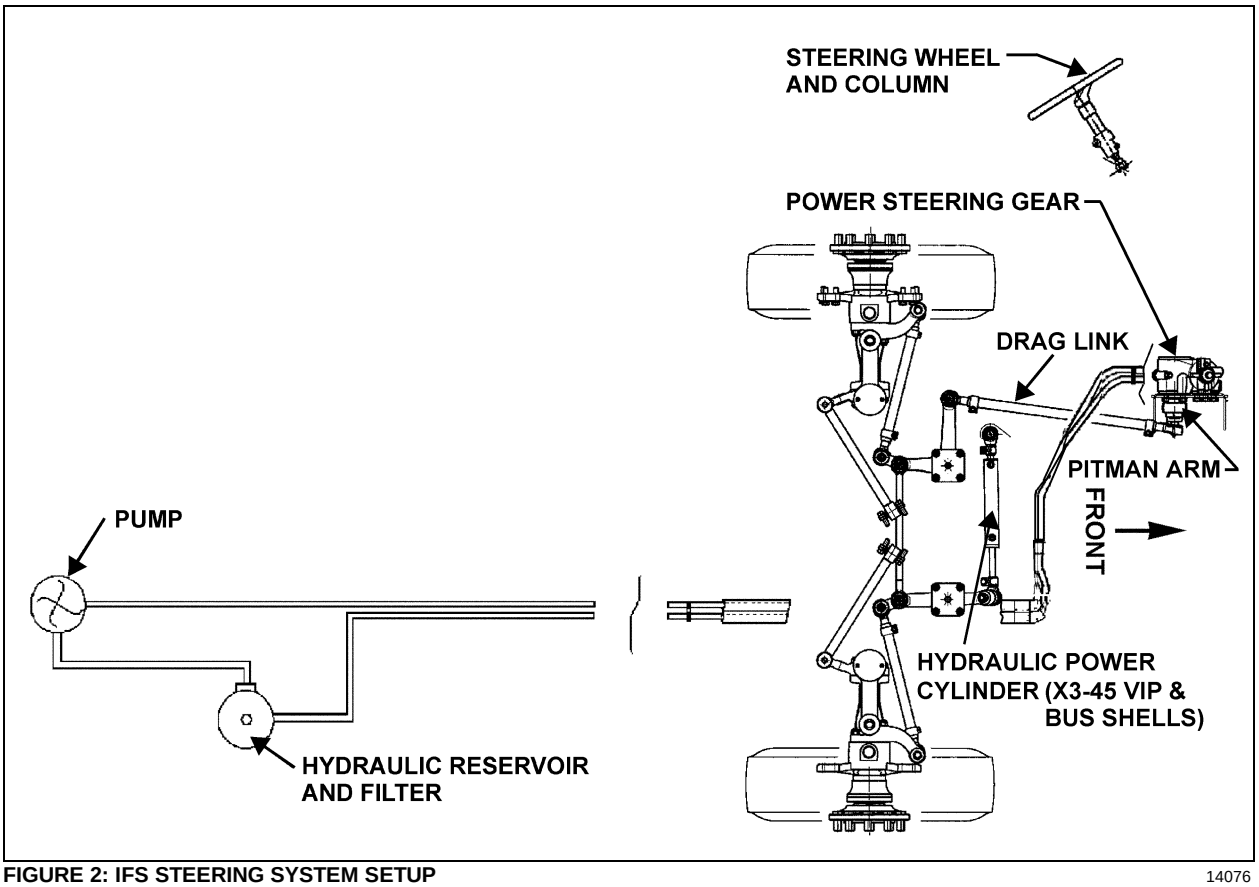


FIGURE 2: IFS STEERING SYSTEM SETUP 14076

2. POWER STEERING GEAR

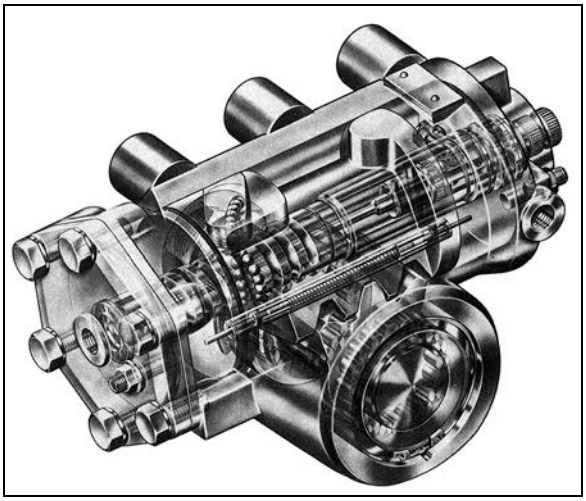


FIGURE 3: POWER STEERING GEAR 14035

2.1 DESCRIPTION

The power steering gear is located in the lower part of front service compartment (Figs. 3 & 4). The housing of the ZF-Servocom contains a control valve, working cylinder and a complete mechanical steering gear. The pressure oil for the steering is delivered by a motor-driven oil pump which is supplied with oil from an oil tank.

The housing is designed as a cylinder for the piston, which converts the rotation of the steering shaft and the worm into an axial movement and transfers this to the steering worm sector shaft. The serration of the sector shaft is straight-cut with a high surface quality in such a way that it is only possible to set a unique setting without play on installation in the straight-ahead driving area by means of the two eccentrically designed lateral housing covers.

The piston and worm are connected via a ball chain. When the worm is turned, the balls are collected by a circulating pipe at one end of the chain and fed in again at the other end, thus producing an endless ball chain.

The control valve consists of the valve slide in a needle bearing in the worm, with six control grooves on the circumference and the control sleeve on the worm, which also has six control grooves. The valve slide, designed with steering shaft connection, turns together with the worm as the steering wheel is turned.

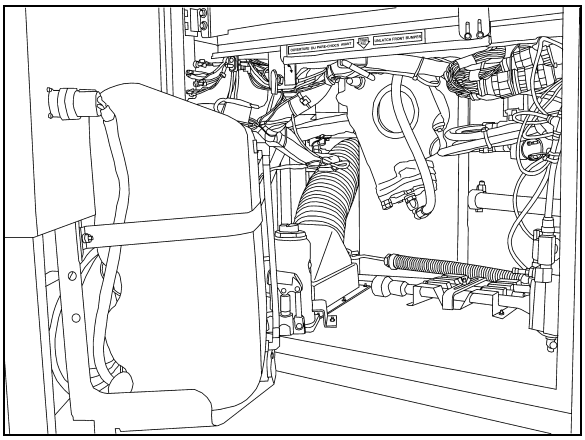


FIGURE 4: FRONT SERVICE COMPARTMENT 18611

A torsion bar, which is pinned with the valve slide and the worm, keeps the control valve in the neutral position as long as no opposing force is applied to the steering wheel. The steering housing contains a pressure relief valve, which limits the discharge pressure of the oil pump to the maximum value required. A replenishing valve can also be used, through which oil is sucked from the return if steering is not hydraulically boosted.

Compared with constant ratio, steering versions with variable ratio are more directly designed in the center area than outside the center area. The resulting smaller steering corrections benefit steering behavior in straight-ahead driving. At the same time, the indirect transmission means that there is a higher hydraulic torque available at the steering arm in parking movement. If the hydraulic assistance fails, the operating forces on the steering wheel are correspondingly lower in this area. This is achieved through a piston/steering worm sector shaft serration with differing modulus and angle of pressure.

Upon transfer of a torque from the steering shaft to the worm, or vice versa, the torsion bar is deformed in the elastic area so that there is torsion between the valve slide and the control sleeve. When the steering wheel is released, the torsion bar ensures that the valve is returned to the neutral position.

Refer to the *"ZF-SERVOCOM Repair Manual"* and "*ZF-SERVOCOM Operating, Servicing /Maintenance and Inspection Instructions"* annexed to this section for the functional aspects and maintenance procedure of the steering gear.

NOTE
Also available is the ZF-Servocomtronic, which provides variable assistance in function of speed.

2.2 POWER STEERING GEAR REMOVAL

WARNING

The steering gearbox weighs approximately 100 lbs (45 kg) dry. Exercise caution when handling.

1. Put a container into place, then disconnect both the inlet and outlet hoses from the power steering gear. Cover fittings to prevent fluid contamination.
2. Mark both the pitman arm and sector shaft with a line, then remove pitman arm. Refer to *"11.1 Pitman Arm Removal"* procedure.
3. Mark both the steering shaft universal joint yoke and steering gear input shaft with a line, then disconnect universal joint.
4. Unscrew and remove the power steering gear.

2.3 POWER STEERING GEAR INSTALLATION

Reverse *"Power Steering Gear Removal"* procedure paying particular attention to the following:

1. Tighten fasteners as recommended under paragraph 14: *"Torque Specifications".*
2. Bleed air from the system as per step 3, next.

2.4 TROUBLESHOOTING

Perform troubleshooting of the steering gear as outlined in the *"ZF-SERVOCOM REPAIR MANUAL"*, the *"ZF-SERVOCOM Operating, Servicing/Maintenance and Inspection Instructions*.

3. BLEEDING POWER STEERING HYDRAULIC SYSTEM

To bleed the power steering hydraulic system, refer to the *"ZF-SERVOCOM Repair Manual"* annexed to this section, under heading *"Setting And Functional Test"*.

4. HYDRAULIC PRESSURE TEST

Perform a pressure test as outlined in the *"ZF-SERVOCOM Repair Manual"* annexed to this section under heading *"Setting And Functional Test"*.

NOTE

For vehicles equipped with ZF-SERVOCOMTRONIC unit, refer to the supplement to the repair manual ZF-SERVOCOM.

5. POWER STEERING HYDRAULIC PUMP

5.1 DESCRIPTION

The power steering pump is a gear driven hydraulic unit which supplies hydraulic pressure for the operation of the steering gear. The pump is mounted on the engine, at the flywheel end and is also used for driving the fuel pump.

5.2 REMOVAL AND INSTALLATION

The pump is accessible through the engine compartment R.H. access door.

To remove the pump, proceed as follows:

- You must first remove the fuel feed pump.
- Clean around the fuel pump and fuel lines. Position a container to catch any fuel that might drain from the pump or lines.
- Remove the fuel pump.

NOTE

Only unfasten the bolts marked with arrows.

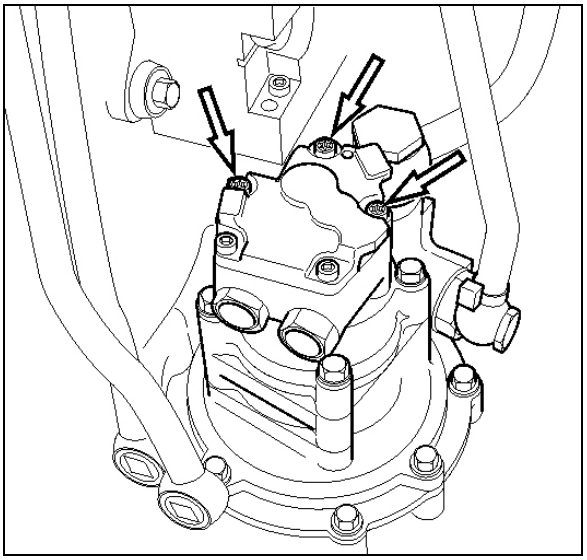


FIGURE 5: FUEL PUMP REMOVAL

CAUTION

Ensure to clean around the head of the bolts. Debris will prevent the tool from fitting properly and cause damage to the fasteners.

- Check that the adapter and fuel pump drive axle are not damaged.

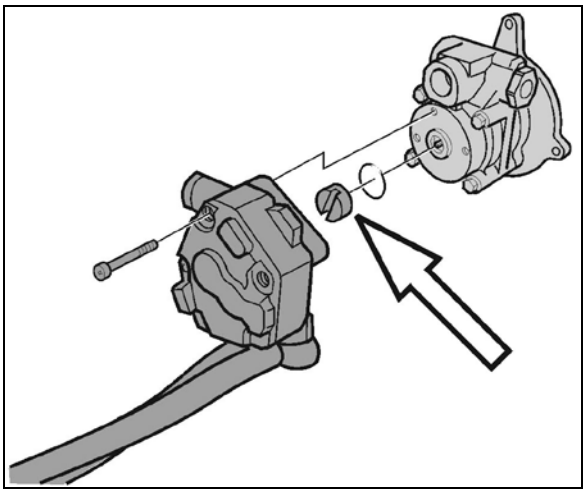


FIGURE 6: FUEL PUMP DRIVE AXLE

- Set the fuel pump aside.
- Clean around the power steering pump and loosen the steering lines. Position a container to catch any hydraulic fluid that might drain from the pump or lines.
- Unfasten the power steering pump bolts.

NOTE
Only unfasten the bolts marked with arrows.

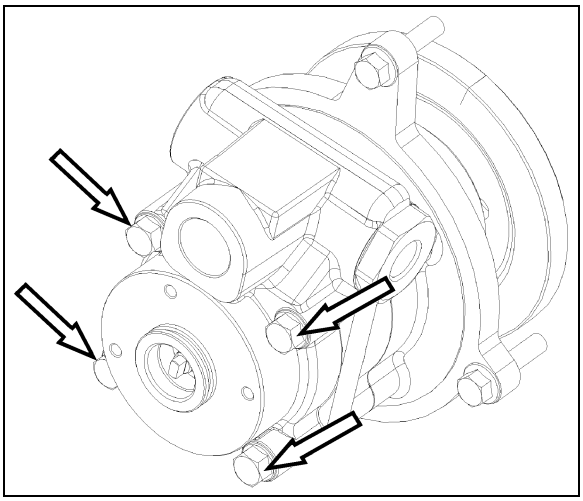


FIGURE 7: POWER STEERING PUMP REMOVAL

- Install the new power steering pump. Torque-tighten bolts to specification.

NOTE
Use a new gasket.

- Connect the hydraulic lines to the power steering pump.
- Install the fuel pump. Torque-tighten bolts to specification.

NOTE
Use a new sealing ring. Check that the fuel pump drive axle sits correctly in the power steering pump.

- Start the engine and let run for 5 minutes. Make sure that there are no leaks.

6. STEERING COLUMN

6.1 REMOVAL

To disassemble the steering column from system, refer to figure 8 & 9. The steering column has no lubrication points. The lower steering column U-joint is easily accessible through the front service compartment. The upper steering column U-joint and the steering slip joint are accessible from the front driver's area. To access these joints, proceed as follows:

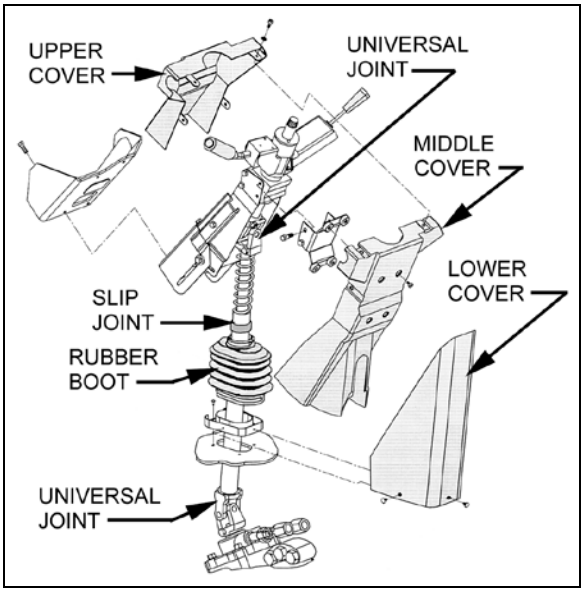


FIGURE 8: STEERING COLUMN COVERS 14040

1. From the front driver's compartment area, remove the three plastic fasteners on steering column lower cover. Remove the lower cover (Fig. 8).
2. Unscrew the four retaining screws on steering column middle cover.
3. Unscrew the four retaining screws fixing steering column upper cover to middle cover. Remove the steering column middle and upper covers.

4. Position the steering wheel in order to gain access to the joints.

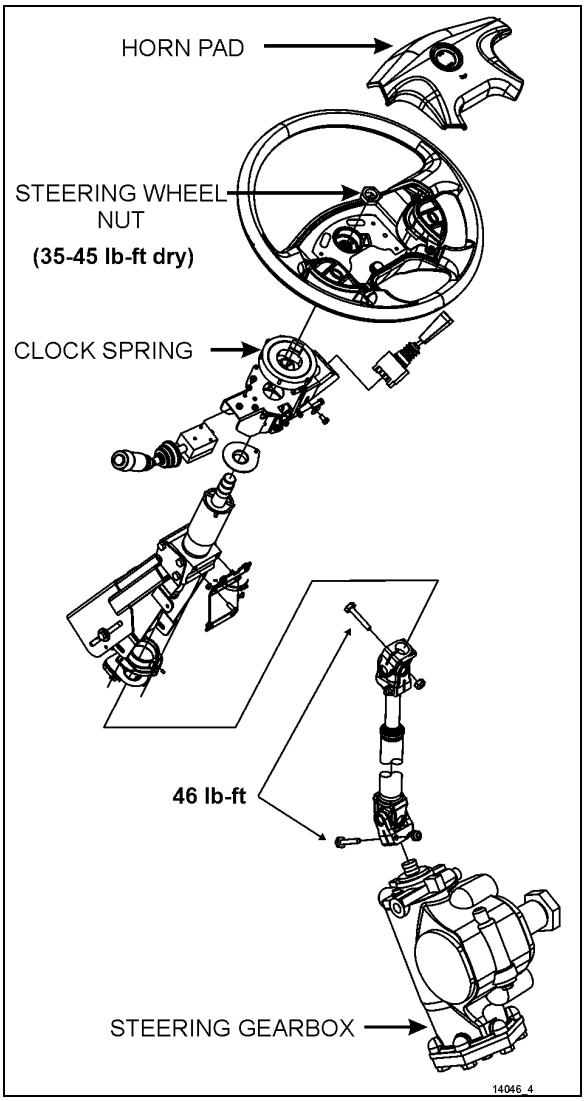


FIGURE 9: STEERING COLUMN

7. STEERING WHEEL

7.1 REMOVAL

NOTE
Before undertaking the steering wheel removal, assure that the front wheels are pointing straight ahead, aligned with the vehicle.

1. Set the battery master switch located in the rear electrical compartment to the *"OFF"* position.
2. Pull the horn pad straight up gently to detach it from the steering wheel (Fig. 10).
3. Disconnect the horn wire (white) connected to the horn pad and the steering wheel harness 4-pin connector.

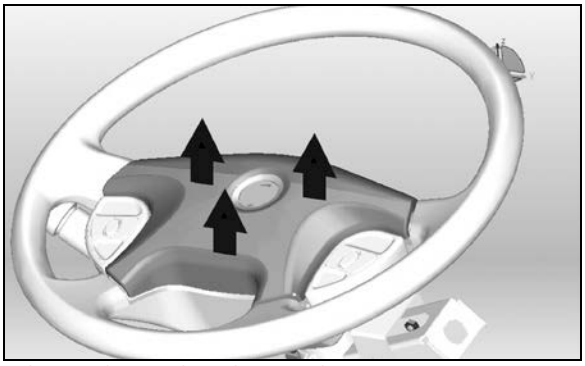


FIGURE 10: REMOVING THE HORN PAD

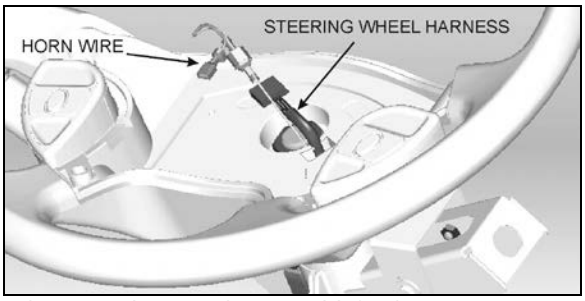


FIGURE 11: STEERING HARNESS & HORN WIRE

4. Unscrew the steering wheel nut. To simplify installation and ensure steering wheel alignment, mark the relationship of the spline shaft to the steering wheel hub (if marks don't already exist or don't line up).
5. Using an appropriate puller, separate the steering wheel from the spline shaft.
6. From behind the steering wheel, pull gently on the electrical wires passing through the rectangular opening in the steering wheel to finish removal of the steering wheel.
7. Once the steering wheel is removed, it is important to block any rotating movement of the clockspring in order to prevent it from losing its neutral position. Use two pieces of masking tape to lock it in place (Fig. 12).

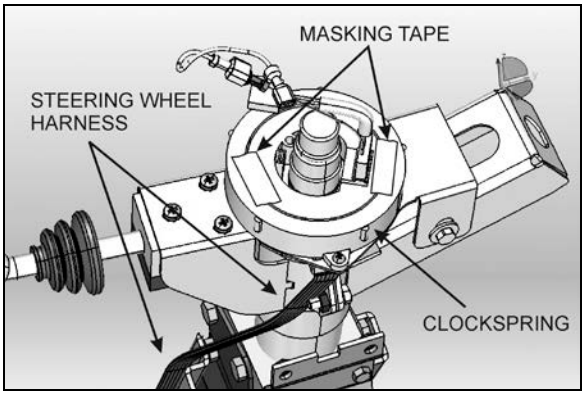


FIGURE 12: LOCKING THE CLOCKSPRING IN PLACE

NOTE
The clockspring mechanism permits a certain number of turns in each direction. At the moment of reinstalling the steering wheel, if the clockspring is not at its neutral position, the number of available turns will be reduced. This may damage the clockspring if the steering wheel is turned to its maximum amplitude.

7.2 INSTALLATION

1. Route the white horn wire and the 4-pin connector through the opening on the steering wheel.
2. Align the mark on the steering wheel hub with the mark on the spline shaft and slide the wheel onto the shaft.
3. Tighten wheel retaining nut to a torque of 35-45 lbf·ft.
4. Plug the 4-pin connector and connect the white horn wire to the center pad.
5. Reinstall the center pad and test for proper horn functioning.

7.3 CLOCKSPRING REPLACEMENT

1. Remove the steering wheel.
2. Remove the 2 clockspring mounting screws and then remove the clockspring. You will have to disconnect the clockspring harness connector located lower along the steering wheel column. If necessary, remove the steering column covers (Fig. 8).
3. Route the new clockspring harness through the opening in the clockspring support (Fig. 13). Plug the connector at the base of the steering wheel column and fix harness along the steering wheel column.

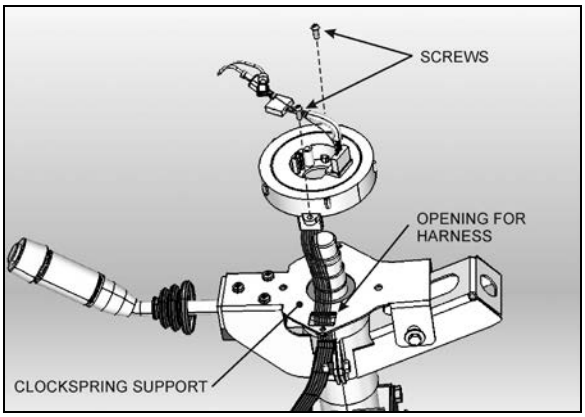


FIGURE 13: CLOCKSPRING INSTALLATION

4. Mount the clockspring in place with 2 screws.
5. Break the paper seal and rotate the center part of the clockspring about 50° clockwise (Fig. 14). This step is necessary for the installation of the steering wheel.

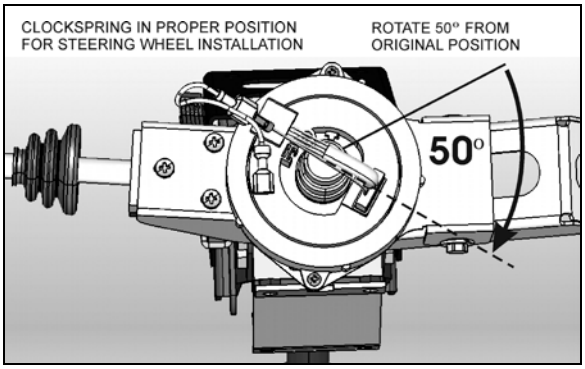


FIGURE 14: PROPER CLOCKSPRING POSITION

6. Reinstall the steering wheel.

8. TURNING ANGLE ADJUSTMENT

The maximum turning angle is set through two (2) steering stop screws installed on the knuckles, above the ABS wheel sensors. Steering stop screws are factory adjusted to accommodate the chassis design, and therefore, do not require adjustment on new vehicles. However, these should be checked and adjusted if necessary, any time a steering system component is repaired, disassembled or adjusted. Refer to section 10 *"Front Axle"* under heading *"6.4 "Turning Angle Adjusment".*

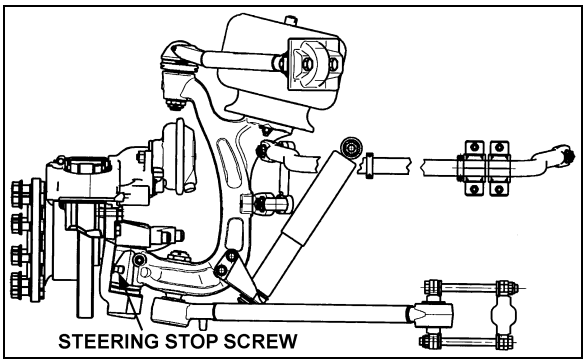


FIGURE 15: STEERING STOP SCREW ON IFS 14063

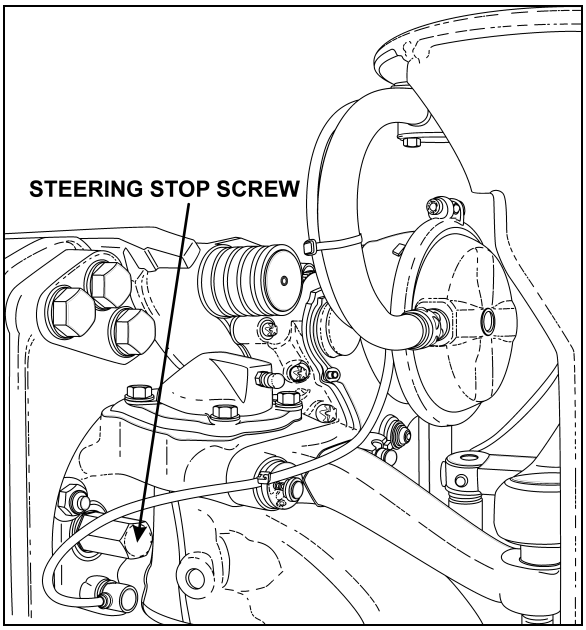


FIGURE 16: STEERING STOP SCREW ON I-BEAM AXLE

CAUTION

To prevent the steering damper from interfering with the adjustment of turning angles on vehicles equipped with I-Beam axle, make sure its fixing bracket is at correct location on the axle (refer to "12.2 Steering Stabilizer Cylinder (Damper)).

Hydraulic Stop

CAUTION

Never maintain the relief pressure for more than 5 seconds, since damage to the power steering pump may occur.

CAUTION

Reduce or shut off the power steering hydraulic pressure before the boss on the knuckle touches the stop screw. If not, the components of the front axle will be damaged (refer to "ZF-SERVOCOM Repair Manual" *and "ZF-SERVOCOM Operating, Servicing /Maintenance and Inspection Instructions" annexed to this section, under heading* "Setting The Steering Limiter").

9. STEERING LINKAGE ADJUSTMENT

Perform lubrication according to *"DANA SPICER NDS Axles Lubrication and Maintenance"* annexed to section 10 *"Front Axle".*

Drag link ends are provided with grease fittings. Under normal conditions, these should be serviced every 6,250 miles (10 000 km). Refer to section 24 *"Lubrication".*

Steering linkage pivot points should be checked each time they are lubricated. Looseness can be visually detected while rotating the steering wheel in both directions. Replace defective parts.

9.1 X3-45 COACHES

The steering linkage includes the pitman arm, drag link, steering arm, tie rod arms and tie rod.

CAUTION

Front wheel alignment should be checked and adjusted if necessary, any time a component of the steering system is repaired, disassembled or adjusted. Refer to section 10 "Front Axle" *under heading* 6. "Front Wheel Alignment".

9.2 X3-45 VIP & XLII BUS SHELLS

The steering linkage consists of tie rods connected to the bell crank and the steering arm at the left side of the bus shell, and to the idler arm and steering arm at the right side of the bus shell.

CAUTION

Front wheel alignment should be checked and adjusted if necessary, any time a component of the steering system is repaired, disassembled or adjusted. Refer to section 16 "Suspension" under heading: "Front End Alignment".

10. PITMAN ARM

10.1 REMOVAL

1. Remove cotter pin, nut and washers from drag link ball stud at pitman arm.
2. Disconnect drag link from pitman arm, using jaw style pullers (pressure screw type).

WARNING

Always wear approved eye protection when operating pullers.

CAUTION

Do not drive (hammer in) pitman arm on or off pitman shaft as this can damage the steering gear.

CAUTION

Heating of components to aid in disassembly is not allowed because it has a detrimental effect on axle components and steering linkages.

3. Using a cold chisel, undo punch mark that locks fixing nut to the pitman arm.
4. Remove pitman arm fixing nut.
5. Check the radial position of the pitman arm in relation to the sector shaft prior to removal of pitman arm.

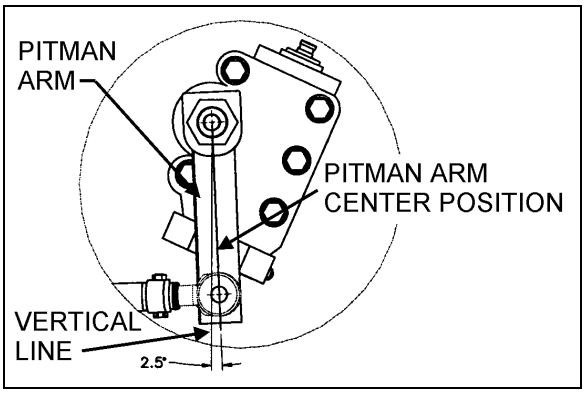


FIGURE 17: I-BEAM FRONT AXLE PITMAN ARM ADJUSTMENT 14037

6. Add reference marks to the arm and shaft if necessary to ensure correct alignment at reassembly.

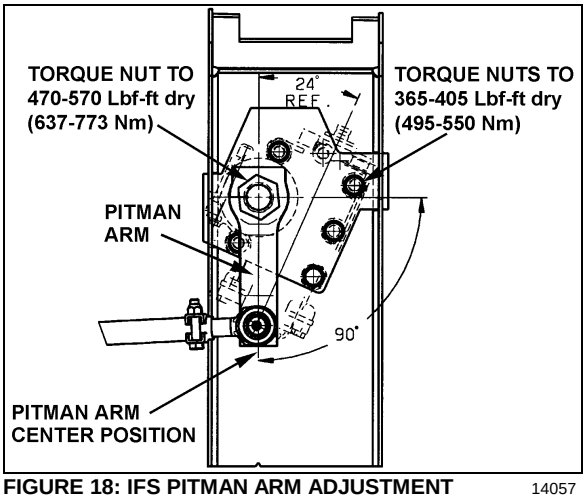


FIGURE 18: IFS PITMAN ARM ADJUSTMENT 14057

7. You must use a puller to remove pitman arm.

10.2 INSTALLATION

1. Position pitman arm on sector gear shaft with reference marks aligned.
2. Install fixing nut (Prevost #661050). Tighten nut to 470-570 lbf-ft (637-773 Nm).

NOTE

Use a new nut if the previously removed nut was punched.

3. Lock nut with sector shaft using a punch mark into the groove (Refer to figures 17 and 18).

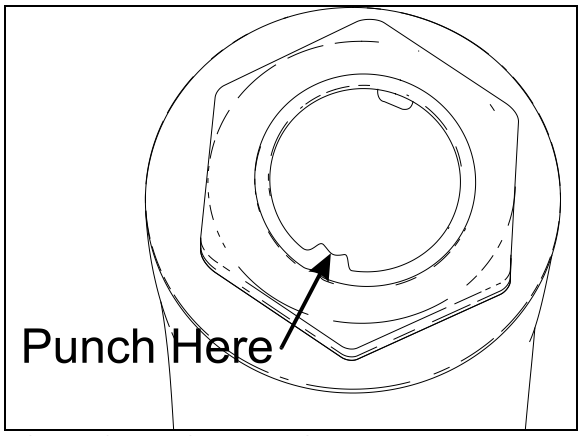


FIGURE 19: FIXING NUT PUNCH MARK 16098

4. Connect drag link to pitman arm while ensuring that rubber stabilizer is in place on the rod end. Install washers. Tighten nut to 150-200 lbf-ft (203-271 Nm). Afterwards, install a new cotter pin.

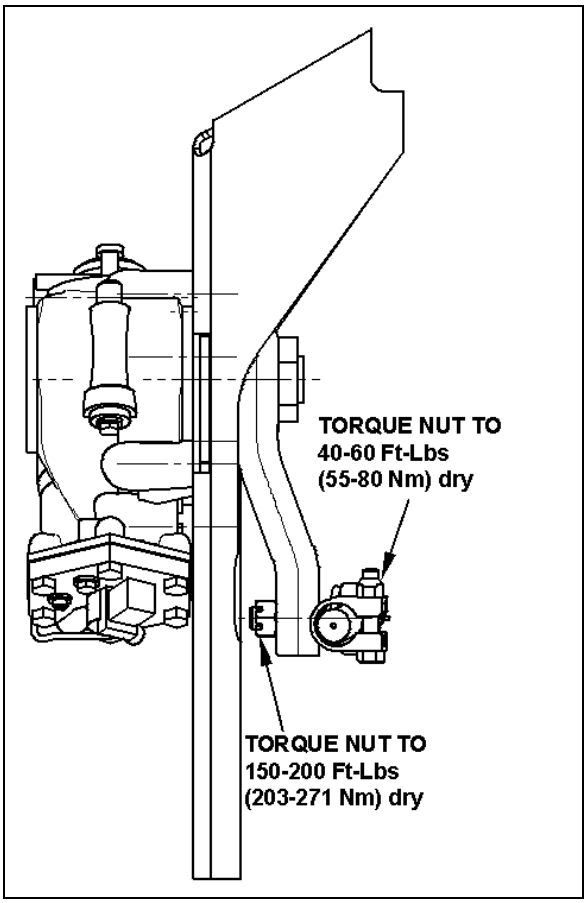


FIGURE 20: DRAG LINK INSTALLATION 14065

CAUTION

Input shaft marks must be aligned before adjusting pitman arm.

10.3 ADJUSTMENT

1. Disconnect the drag link from pitman arm. Center steering wheel by dividing the total number of steering wheel turns in two. Scribe a reference mark on steering gearbox at the center previously determined.
2. Using a protractor, check the angle of the pitman arm (refer to Fig. 17 and 18 for details).
3. The pitman arm should be adjusted with reference marks aligned or to an angle of 2.5º towards front of vehicle (I-Beam axle) or 90° (Independent Front Suspension) in relation with the vertical axis. If not, unscrew and remove fixing nut. Remove the pitman arm according to the procedure outlined under previous heading *"Pitman arm removal"*. Adjust to the proper angle.
4. When adjustment is achieved, replace fixing nut and torque to 470-570 lbf-ft (637-773 Nm).

10.4 TAG AXLE UNLOADING SWITCH ADJUSTMENT (X3-45 COACHES ONLY)

1. Make sure vehicle wheels are straight and facing forward.
2. Line up switch lever with reference to the bracket center (Refer to figure 21).

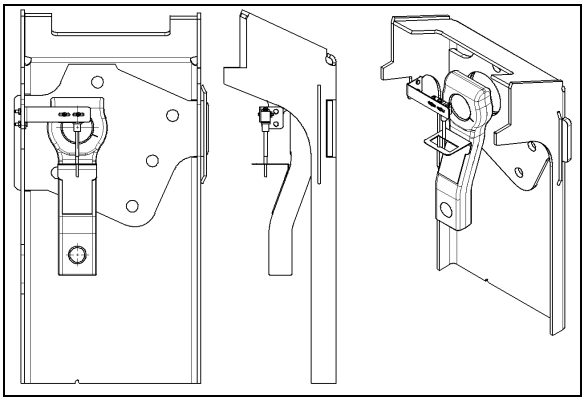


FIGURE 21: TAG AXLE UNLOADING SWITCH ADJUSTMENT 14061

11. MAINTENANCE

The power steering system requires little maintenance. However, the system should be kept clean to ensure maximum operating performance and troublefree service. Periodic inspections should also be made to check for leakage and all parts for damage or distortion. Insure all fasteners are tight (see *"14. Torque Specifications"* for recommended tightening torques.

When the slightest evidence of dirt, sludge or water is discovered in the system, disconnect fluid lines at the power steering gear to drain the system. Drain and refill the system with *"Dexron-IIE or Dexron-III"* automatic transmission oil.

Air in the hydraulic system will cause spongy action and noisy operation. When a hose has been disconnected or when fluid has been lost for any reason, the system must be bled. Bleed system as outlined under heading 3*: "Bleeding Power Steering Hydraulic System".*

CAUTION

Do not operate the pump without fluid in the power steering fluid reservoir.

If the steering linkage between the steering gear and the two front wheels is not properly adjusted,

or if it is bent, twisted or worn, the steering of the vehicle will be seriously impaired. Whenever a steering linkage part is repaired, replaced or adjusted, steering geometry and front wheel alignment must be checked and necessary corrections made. Refer to section 10 *"Front Axle"* under heading 6: *"Front Wheel Alignment"* or to section *16* "Suspension" *under heading:* "Front End Alignment".

At regular lubrication intervals, the steering linkage should be thoroughly inspected for worn or loose components.

After the vehicle has been operated continually and high mileage figures have been reached, overhaul of the various steering units will be required. General overhaul procedure normally requires removal of the entire assembly, cleaning and inspection of all parts and final assembly. Careful inspection of all parts during overhaul is very important and must not be neglected.

Lubrication fittings must all be cleaned before applying lubricant. Moreover, always be sure the equipment used in applying lubricant is clean. Every precaution should be taken to prevent entry of dirt, grit, lint or other foreign matter into lubricant containers. Replace fittings that have become broken or damaged. Lubrication intervals, as well as the recommended lubricants for the steering components, are given in the *"Lubrication And Servicing Schedule"* in Section 24 of this manual. The intervals given in the schedule are recommended for normal service. More frequent intervals may be required under severe operating conditions.

11.1 POWER STEERING RESERVOIR AND FILTER

The power steering reservoir is located on R.H. side of engine compartment and accessible through the engine compartment doors. (Fig. 22).

MAINTENANCE

At regular intervals, fluid level should be checked in the reservoir and filter assembly. Furthermore, the oil filter cartridge element in the power steering reservoir should be replaced every 50,000 miles (80 000 km) or once a year, whichever comes first.

11.1.1 Oil Level Check Procedure

1. Stop engine. Open engine compartment doors.
2. Unscrew and remove the dipstick located on top of reservoir and wipe with a clean rag.
3. Insert dipstick in reservoir. Remove it again to check fluid level (Fig. 23).
4. Adjust level to *"FULL"* mark using proper dipstick side depending on fluid temperature, use *"Dexron-IIE or Dexron-III"* automatic transmission oil.
5. Reinsert and tighten the dipstick.

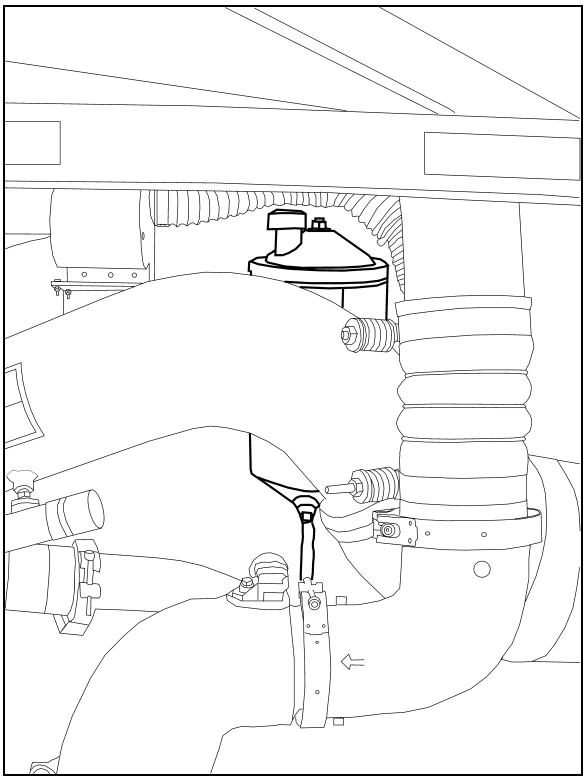


FIGURE 22: HYDRAULIC FLUID RESERVOIR LOCATION

11.1.2 Filter Replacement

1. Unscrew and remove the cover nut located on top of the power steering reservoir.
2. Remove the reservoir cover and the gasket.
3. Remove the retaining spring and finally the filter cartridge element.

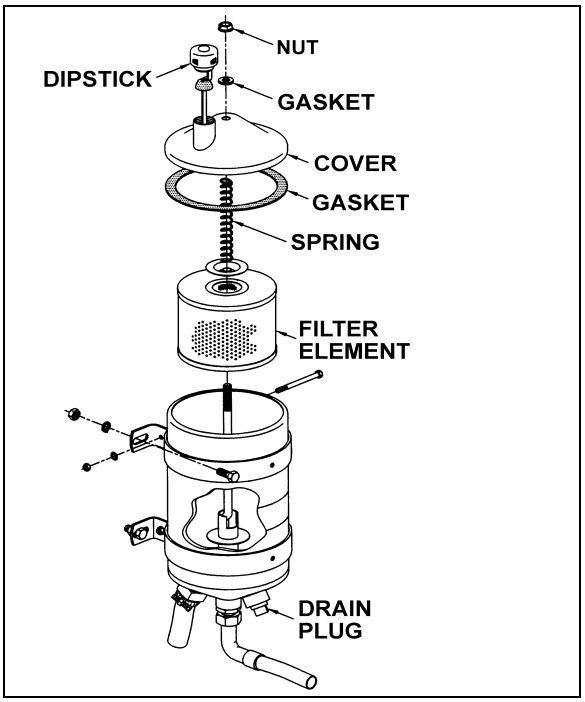


FIGURE 23: POWER STEERING FLUID RESERVOIR 14018A

11.2 STEERING STABILIZER CYLINDER (DAMPER) (I-BEAM AXLE ONLY)

The steering damper is located on R.H. side, at back of front I-Beam axle (Fig. 24).

The cylinder is nonadjustable and non-repairable. Check for oil leaks or lack of resistance. Disconnect the cylinder from axle, then carefully attempt to extend and collapse it manually.

MAINTENANCE

Steering damper ball joint (rod end) is provided with a grease fitting for pressure lubrication. Under normal conditions, it should be serviced every 6,250 miles (10 000 km) or twice a year, whichever comes first.

Check the ball joint for wear, and replace if necessary.

Good quality lithium-base grease NLGI No. 1 and 2 like Shell Retinax LX are recommended.

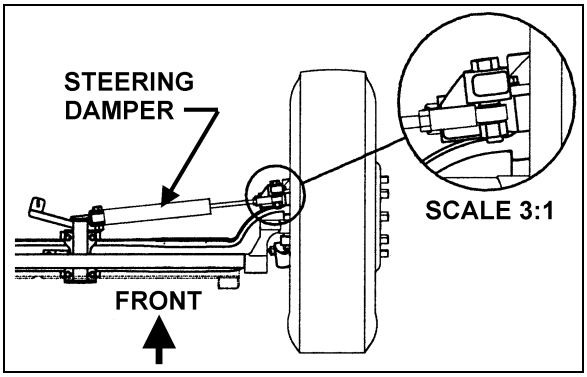


FIGURE 24: STEERING STABILIZER (DAMPER) 14042

11.3 DRAG LINK

Visually inspect drag link components for broken clamps, loose nuts and gauges on tube from rubbing parts.

MAINTENANCE

Drag link ends (ball joint) are provided with grease fittings for pressure lubrication. These grease fittings should be serviced every 6,250 miles (10 000 km) or every 6 months whichever comes first.

To prevent corrosion from forming around the ball pin (in particular, the drop type ball joint as it is exposed to dirt and water), remove the old grease bead and ensure sufficient grease is applied to purge the old grease and fill the joint and dust seal.

Good quality lithium-base mineral grease NLGI No. 1 and 2 like Shell Retinax LX are recommended.

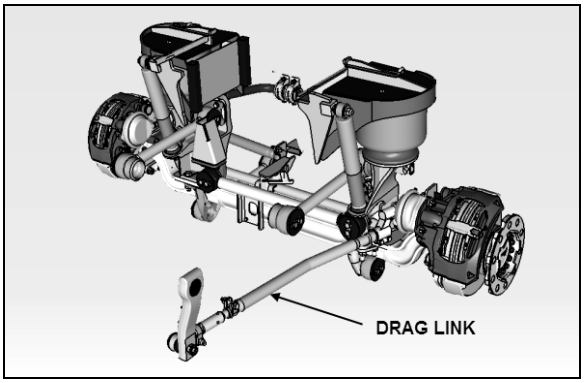


FIGURE 25: DRAG LINK

11.4 TIE ROD

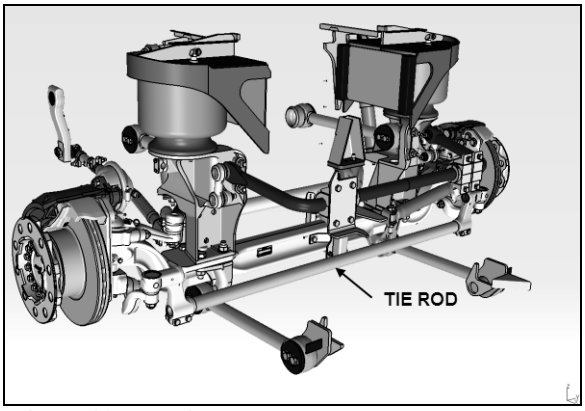


FIGURE 26: TIE ROD

MAINTENANCE

Tie rod ends (ball joint) are provided with grease fittings for pressure lubrication. These grease fittings should be serviced every 6,250 miles (10 000 km) or every 6 months whichever comes first.

To prevent corrosion from forming around the ball pin, remove the old grease bead and assure sufficient grease is applied to purge the old grease and fill the joint and dust seal.

Good quality lithium-base mineral grease NLGI No. 2 like Shell Retinax LX are recommended.

11.5 DRAG LINK AND TIE ROD BALL JOINT INSPECTION FOR CORROSION

Inspection of ball joints is important. Damaged sealing boots, salt and climatic conditions can cause loss of the corrosion protection coating applied at time of manufacturing.

MAINTENANCE

Inspect drag link end and tie rod end ball joints for corrosion once a year.

1. Carefully clean the sealing boot or dirt seal contact area to ensure that no contaminants can get under the sealing boot or dirt seal during the following inspection procedure.
2. Use an appropriate inspection tool (e.g. spatula with cut out) to push up (sealing boot) or down (dirt seal) the seal (without damaging it) until ball pin surface is visible. Degrease the ball pin surface and inspect carefully.
3. If there is corrosion of the ball pin or the sealing boot has deteriorated through ageing or is damaged, replace the ball joint.
4. If there is corrosion of the steering arm or tie rod arm area which is in contact with the sealing boot or dirt seal, clean and eliminate all surface irregularities.
5. If there is no corrosion or damage to the sealing boot or dirt seal, smear the steering arm and tie rod arm with Lithium grease and push seal back into its properly seated position.

When dismantling tie rod or drag link, ensure that no damage is caused to the sealing boots, dirt seals or ball joint housings.

11.6 DROP TYPE BALL JOINT

11.6.1 Drop Type Ball Joint End Play

If end play (direction of the ball pin axis) exceeds 0.047” (1.2 mm), readjustment is necessary.

Remove protective cap, using a suitable tool ie: a 1” x 1/8” x 9” long flat bar, tighten adjuster piece fully home (SOLID) locating thrust cup onto ball pin.

Still with tool located on adjuster piece, back off carefully (LEAST AMOUNT) until adjuster piece cotter pin is allowed to pass through body, then remove tool.

Reinstall protective cap.

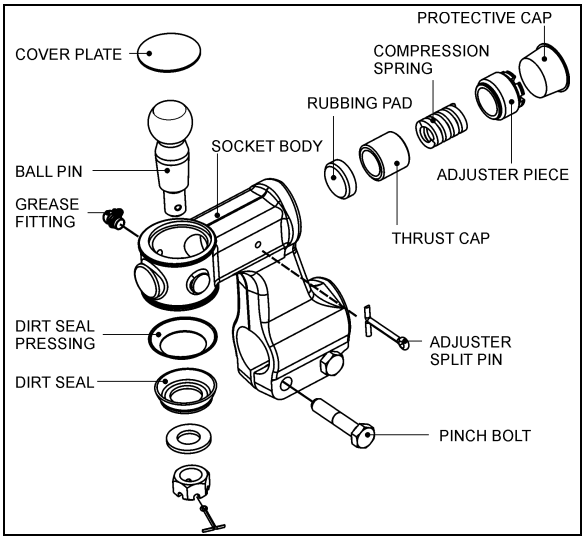


FIGURE 27: DROP TYPE BALL JOINT FOUND ON TIE ROD (2X) AND DRAG LINK (1X) 10029

11.6.2 Dismantling Drop Type Ball Joint

1. Remove dirt seal and dirt seal pressing from ball pin.
2. Slacken pinch bolt nut then unscrew and remove ball joint assembly from tie rod having first marked ball joint body and tie rod to enable tracking on re-assembly.
3. Remove adjuster split pin from ball joint body.
4. Remove cap then using a suitable tool ie: a piece or 1”x1/8”x 9” flat bar, unscrew and remove adjuster piece. Waggle ball pin to free thrust cap.
5. Remove compression spring and thrust cap from ball joint body.
6. Relieve peening on socket body top then using a hide faced mallet, tap ball pin out of body. This operation will also remove cover plate from body.
7. The rubbing pad can now be removed from body.

Thoroughly clean all parts and check for wear, renewing where necessary.

11.6.3 Assembling Drop Type Ball Joint

1. Apply a bead of Loctite 638 sealant to mating corner of rubbing pad in socket body then knock rubbing pad into its recess in ball joint body.
2. Thoroughly grease rubbing pad and ball pin with Shell Retinax LX or equivalent.
3. Insert ball pin into body.
4. Insert thrust cap, compression spring and adjuster piece into body.
5. Tighten adjuster piece fully home (SOLID) locating thrust cup onto ball pin.
6. Still with tool located on adjuster piece, back off carefully (LEAST AMOUNT) until adjuster piece split pin is allowed to pass through body, and that ball pin shank can be moved by moved of hand, then remove tool.

NOTE: If ball pin does not rotate when re-adjusted in line with above instructions, this suggests that ball pin has local worn flats. In this instance ball pin, thrust cup and rubbing pad MUST be replaced, if not FAILURE could occur in service, i.e. ball pin not being able to move in assembly when turning from lock to lock.

7. Fit cover plate into top of ball joint body, re-peen using a cold chisel to secure.
8. Screw assembled ball joint onto tie rod. Lining up marks on both body and tie rod previously made, or retracking using manual instructions.
9. Fit pinch bolts and nuts then tighten nuts alternately and progressively to 65- 75 lbf-ft (88-102 Nm.) thus securing ball joint to tie rod.
10. Fit dirt seal (pressing) and dirt seal (rubber) onto ball pin.
11. Locate ball joint and tie rod assembly with lever, carefully align and fit ball pin into hole in tie rod arm.

NOTE: Ball pin and ball pin tapers in bottom tie rod arms must be clean, dry and free from oil prior to assembly.

12. Fit pin washer onto ball pin.
13. Screw pin nut onto ball pin then tighten to 175 lbf-ft (237 Nm) torque.
14. Using a 2lb hammer, tap tie rod arm to "shock' ball pin into taper hole.
15. Re-torque pin nut to 175 lbf-ft (23 7Nm).
16. Fit split pin, if slot/hole are not in line, adjust up to next slot.

Pin nut torque 175 lbf-ft, max pin nut torque 200 lbf-ft.

17. Re-charge ball joint with Shell “Retinax LX” or equivalent grease through grease fitting.

11.7 STRAIGHT BODY TYPE BALL JOINT

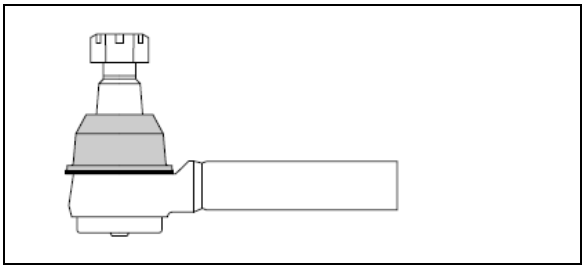


FIGURE 28: STRAIGHT BODY TYPE BALL JOINT

11.7.1 Visual Inspection

- Visually inspect for missing or damages grease fittings and replace if required.
- Damaged sealing boot or improper sealing requires seal replacement.

- Check ball joint connection for missing cotter pins.
- Check for looseness in the ball/socket assembly.

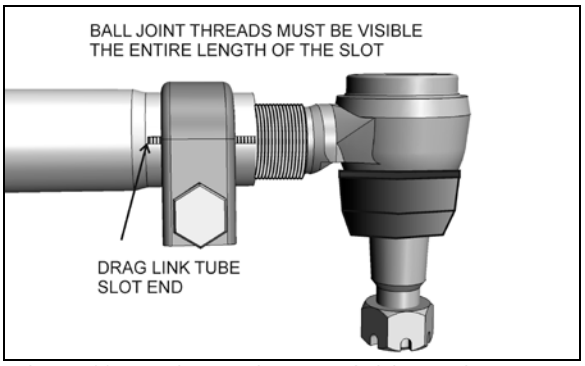


FIGURE 29: ADEQUATE CLAMPING CONDITION

For adequate clamping, the ball joint threads must be visible the entire length of the tube slot. If not, the drag link must be adjusted or replaced. It is either the wrong size, or improper adjustment was used to compensate for another problem (e.g. bent steering arm).

11.7.2 Straight Body Type Ball joint End Play And Looseness

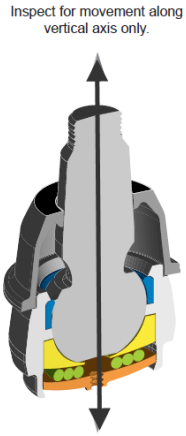
What creates movement in sockets?

In each TRW straight body type ball joints, the compressive force of the spring creates resistive torque by applying a constant load on the bearing and stud.

As wear occurs on the components, the spring creates less resistive torque. With less torque, you no longer have the precise joint needed for optimum steering, but you do still have a safe linkage. **When all compression is lost, it's time to replace the linkage**. This wear can be caused by impact, lack of lubrication and normal wear.

1. With vehicle engine on, lightly rock the steering wheel while checking for looseness in any threaded joint. Observe any looseness in the two mating tapers or any movement of the ball pin nut. Any looseness requires further inspection. If either of the mating tapered parts show distortion or wear, both parts must be replaced.

2. With the engine off and wheels straight ahead and no force is being exerted on the linkage by the steering gear, push and pull the ball joint in and out by hand (approximately 100 lbs force) in the direction of the ball pin. If no movement is detected, the ball joint is safe. **Any movement detected by hand requires replacement of the ball joint.**



CAUTION

Do not use a wrench or other object to apply leverage when inspecting ball joint. Applying leverage can give distorted results and damage components.

12. DRIVING TIPS

In order to maximize power steering pump service life, do not attempt to turn the steering wheel when the vehicle is stationary, and especially when service brakes are applied (wheel locking will oppose the effect of steering geometry which tends to make the front wheels rotate in opposite directions).

Persisting in turning, or maintaining the steering wheel with an extra effort, could make the hydraulic system work at the relief pressure, and consequently, cause the hydraulic fluid to become overheated.

CAUTION

Never maintain the hydraulic system at the relief pressure for longer than 5/10 seconds to avoid damaging the power steering pump.

NOTE

Unequal or low tire pressure, oversize tires, and vehicle overloading are some of the causes that may increase steering effort.

13. TROUBLESHOOTING

CONDITION	CAUSE	CORRECTION
Tires wear out quickly or have uneven tire tread wear.	1. Tires have incorrect air pressure. 2. Tires out-of-balance. 3. Incorrect tag axle alignment. 4. Incorrect toe-in setting. 5. Incorrect steering arm geometry.	1. Put specified air pressure in tires. 2. Balance or replace tires. 3. Align tag axle. 4. Adjust toe-in specified setting. 5. Service steering system as necessary.
Vehicle is hard to steer.	1. Low pressure in the power steering system. 2. Steering gear not assembled correctly. 3. Steering linkage needs lubrication. 4. King pins binding. 5. Incorrect steering arm geometry. 6. Caster improperly adjusted. 7. Tie rod ends hard to move. 8. Worn thrust bearing.	1. Repair power steering system. 2. Assemble steering gear correctly. 3. Lubricate steering linkage. 4. Replace king pins. 5. Service steering system as necessary. 6. Adjust caster as necessary. 7. Replace tie rod ends. 8. Replace thrust bearing.
Bent or broken steering arm, steering top lever or tie rod assembly.	1. Too much pressure in the power steering system. 2. Cut-off pressure of the power steering system improperly adjusted. 3. Vehicle not powered on correctly. 4. Power steering system not installed correctly.	1. Replace damaged part(s), adjust power steering system to specified pressure. 2. Make sure vehicle is powered on correctly. 3. Correctly install the power steering system. 4. Correctly install the power steering system.
Worn or broken steering ball pin.	1. Drag link fasteners tightened past specified torque. 2. Lack of lubrication or incorrect lubricant. 3. Power steering stops improperly adjusted.	1. Replace damaged part(s), tighten drag link fasteners to specified torque. 2. Lubricate linkage with specified lubricant. 3. Adjust stops to specified dimension.
Worn king pins and knuckle bushings.	1. Worn or missing seals and gaskets. 2. Incorrect lubricant. 3. Axle not lubricated at scheduled frequency. 4. Incorrect lubrication procedures. 5. Lubrication schedule does not match operating conditions.	1. Replace damaged part(s), replace seals and gaskets. 2. Lubricate axle with specified lubricant. 3. Lubricate axle at scheduled frequency. 4. Use correct lubrication schedule to match operating conditions. 5. Change lubrication schedule to match operating conditions.
Vibration or shimmy of front axle during operation.	1. Caster not adjusted properly. 2. Wheels and/or tires out-of balance. 3. Worn steering stabilizer cylinder.	1. Adjust caster. 2. Balance or replace wheels and/or tires. 3. Replace steering stabilizer cylinder.

14. TORQUE SPECIFICATIONS

The torque specifications applicable to the front axle steering are grouped with information regarding the front suspension. Please refer to Section 16: SUSPENSION of this manual.

15. SPECIFICATIONS

Power Steering Gear

Make ..... ZF-SERVOCOMTRONIC
Prevost number 661044
F.E.W. ..... 16,600 lbs (7 545 kg)
Pressure rating ..... 2,175 psi (150 Bar)
Gear ratio (center) ..... 22.2 : 1
Gear ratio (extremities) ..... 26.2 : 1
Minimum pump flow for 1.5 hwt/sec ..... 4.22 gpm (16 lpm)

Power Steering Gear

Make ..... ZF-SERVOCOM
Prevost number 661045
F.E.W. ..... 16,600 lbs (7 545 kg)
Pressure rating ..... 2,175 psi (150 Bar)
Gear ratio (center) ..... 22.2 : 1
Gear ratio (extremities) ..... 26.2 : 1
Minimum pump flow for 1.5 hwt/sec ..... 4.22 gpm (16 lpm)

Power Steering Reservoir

Oil capacity ..... 4 US qts (3.7 liters)
Prevost number 660982
Make ..... Nelson Muffler

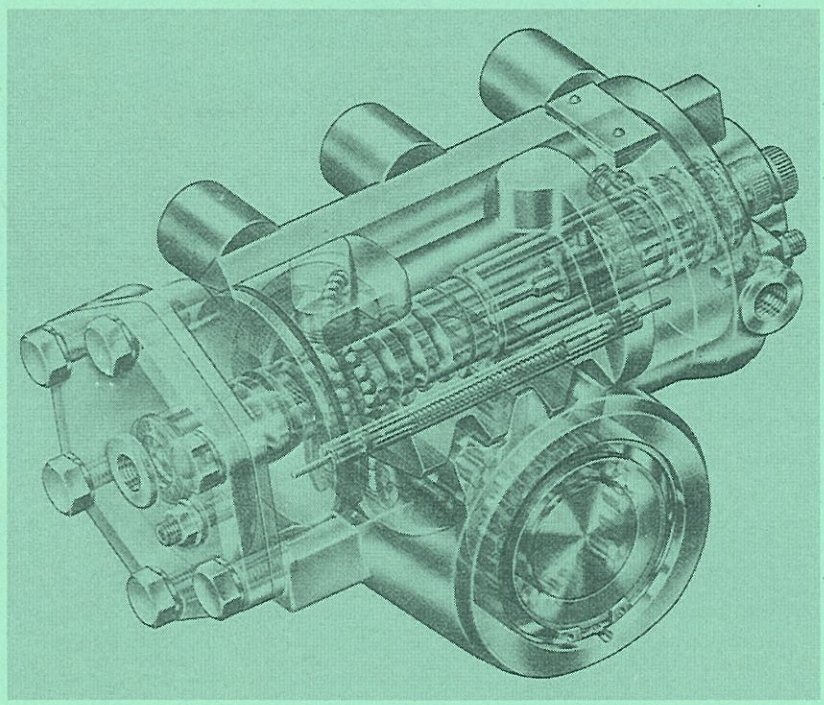
Steering Stabilizer Cylinder (Damper)

Extended length ..... 32.73±0.12"
Collapsed length ..... 20.26±0.12"
Stroke ..... 12.47±0.12"

ZF-Servocom

Types 8090 - 8099
(Single and dual-circuit versions)

Repair Manual



ZF-FRIEDRICHSHAFEN AG
Geschäftsbereich Lenkungstechnik

D- 73522 Schwäbisch Gmünd

Telephone (07171)31-0
Telefax (07171)31-4396
Telex 7248801
Telex 7248825 for customer servic

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→ The present Manual aims to help the user properly to execute the necessary maintenance and repair work on the ZF product.

→ Read the Manual before starting any inspection and repair work.

→ On completion of the maintenance and repair work, the specialist personnel must make certain that the product is once more operating flawlessly.

→ ***Please note that the ZF product must be repaired only in workshops that***

- ☞ ***employ trained personnel***
- ☞ ***have the prescribed equipment, including a test rig, crack detector and special tools***
- ☞ ***use ZF genuine spare parts.***

→ This Manual is only for foremen and fitters who have undergone practical and theoretical training in our Customer Service School. Together with service information bulletins, it is intended to supplement their knowledge.

→ All work carried out on ZF products must be executed with extreme care and diligence. This applies in particular to products and transmission components from vehicles damaged in accidents.

→ The manufacturer does not, of course, accept any liability for damage and its consequences arising from incorrectly or inexpertly executed repairs.

→ This Manual draws attention to notes on safety as follows:

Note: Where incorrect and careless work can cause damage to the product.

Attention: Where incorrect and careless work can lead to personal injury and endanger life.

→ This Manual is not part of the updating service.

→ The contents of the additional service information bulletins must also be observed.

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I. Disassembly

Attention:
Utmost cleanliness must be maintained when disassembling and storing the parts in order to ensure that the steering operates reliably. Force must never be used when disassembling parts, as this may damage the sealing ring seats, sealing faces, etc. The resultant damage may lead to partial or total failure of the steering.

Notes:

→ The figures in round brackets, e.g. (348), refer to the part numbers used in Chapter VIII and the list of spare parts.

→ The figures in square brackets, e.g. [1], refer to the special tools listed in Chapter VII.

1 Preparing the steering for disassembly

Clamp steering in tool [1] or between the soft jaws of a standard vice.

Turn the steering through from end to end and note the total number of turns (reference value for function tests).

Set the steering to straight-ahead position (half the total number of turns) and check or restore the markings for straight-ahead.

2 Removal and disassembly of the bevel box

2.1 Versions with cross disc (348)

2.1.1 Remove bevel box

Mark position of bevel box and intermediate flange (335).

Unscrew cap screws / hexagon screws (352) with washers (350) ***(Fig.1)***.

Remove complete bevel box.

Remove shim plate (330) and O-ring (333).

2.1.2 Disassembly of intermediate flange (335)

Unscrew cap screws (334).

Remove intermediate flange (335) with cross disc (348) and ball bearing (343).

Remove O-ring (341).

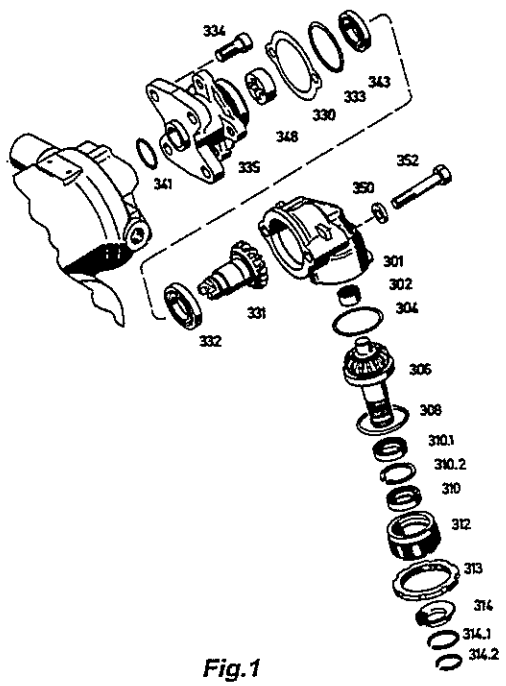


Fig.1

2.1.3 Disassembly of bevel box

Note:
The bevel gear (306) must not be forced off in order to replace the ball bearing, as it cannot be ensured that the notched gearing locks securely when the bevel gear (306) is pressed into position a second time.

Remove snap ring (314.1 and 314.2) and draw dust seal (314) off steering shaft stub.

Unscrew slotted nut (313) and unscrew adjusting screw (312) from housing with tool [25].

Remove O-ring (308). Remove shaft seal (310), retaining ring (310.2) and shaft seal (310.1).

Draw bevel gear (306) out of housing with ball bearing. Remove washer (304).

Note:
Needle sleeve (302) should only be removed if the bearing journal of the bevel gear assembly is found to be damaged. If necessary, needle sleeve (302) can be drawn out with tools [26] and [27].

Dismantle ball bearing (332) and remove bevel gear (331).

2.2 Versions with coupling sleeve (349)

2.2.1 Remove bevel box

Mark position of bevel box in relation to housing (1).

Unscrew hexagon screw (352) and remove complete bevel box ***(see Fig.4)***.

Remove coupling sleeve (349), centering ring (346) and O-ring (333).

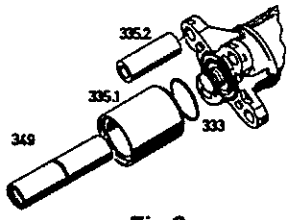


Fig.2

2.2.2 Remove pipes

Remove pipes (335.1 and 335.2). Dismantle O-ring (333) ***(Fig.2)***.

2.2.3 Disassembly of bevel box

Remove protecting cap (314) and draw off shaft seal (310) with tool [33] ***(see Fig.4)***.

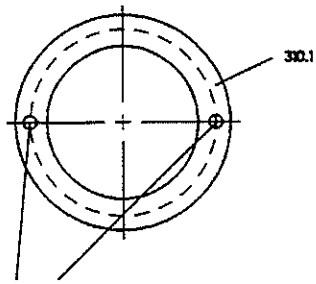


Fig.3

Unspring retaining ring (310.2). Drill holes through shaft seal (310.1) as shown in ***Fig.3*** (diameter of holes approx. 0.3 mm smaller than core diameter of the sheet metal screws required to pull out the shaft seal).

Screw in the sheet metal screws and pull out complete with shaft seal (310.1) with the aid of two pliers.

Unspring retaining ring (310.3) and remove any burr produced ***(Fig.4)***.
Clamp bevel gear (306) in soft jaws and drive it out of the housing by knocking against the housing (301) with a plastic mallet.

Unspring retaining ring (310.4), remove any burr produced and remove the bevel gear (331).
Note:
Needle sleeves (302) should only be removed if the bearing journal of the bevel gears (306 and 331) is damaged.

Use tools [27] and [34] for this purpose.

Tool [35] must also be used additionally to remove the lower-level needle sleeve (302).

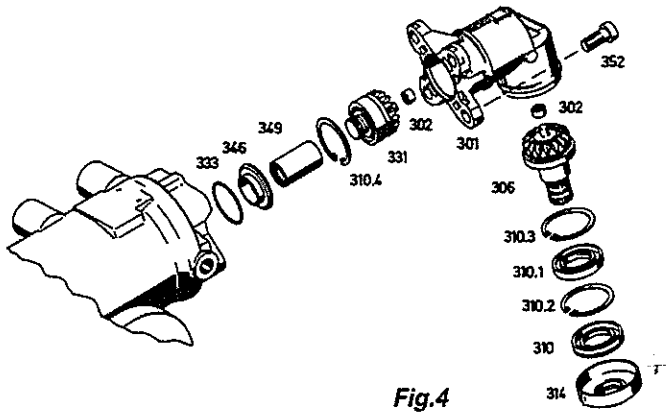


Fig.4

3 Removal and disassembly of valve housing (203)

Remove protecting cap (53) and gasket (53.3) ***(Fig.5)***.

Mark position of valve housing (203).
Remove piping (225 and 226) and pipe unions (205 and 206) in the case of versions with add-on cylinder (250) ***see Fig.8***.

Unscrew cap screws (204) and lift off valve housing (203).

Remove control sleeve (174), bearing ring (201) and ball cage (200).

Dismantle screw (30) with O-ring (31) and valve insert (32) (replenishing valve).

Unscrew valve insert (22.1) with O-ring (23) (pressure limiting valve).c
Note:
Valve inserts (22.1 and 32) cannot be dismantled. The complete valve insert must be replaced if a fault develops.

Remove sealing elements (8 and 202).

Unscrew adjusting screw (20) and remove O-ring (20.1).

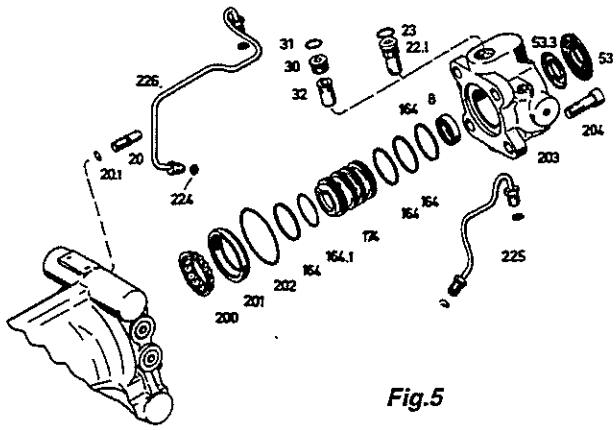


Fig.5

4 Removal and disassembly of housing cover (221)

4.1 Versions with valves (36) - steering limiter valves

Unscrew hex nut (38) and remove washers (37) ***(Fig.6)***.

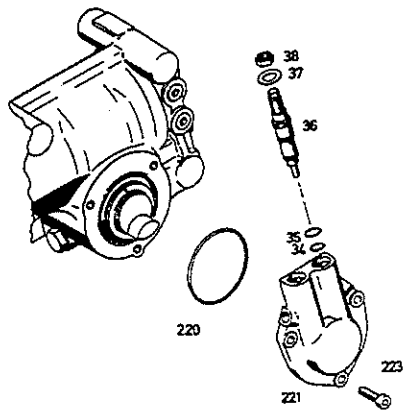


Fig.6

Unscrew valves (36) and remove O-rings (34 and 35). Remove cap screws (223) and lift off housing cover (221).

4.2. For versions with switch (222)

Mark position of cover (221) in relation to housing (1). Unscrew cap screws (223) and remove cover (221) with cam disc (227) and retaining ring (228) ***(Fig.7)***.

Remove O-ring (220). Unspring retaining ring (228) and remove cam disc (227).

Remove switch (222) with washer (222.1).

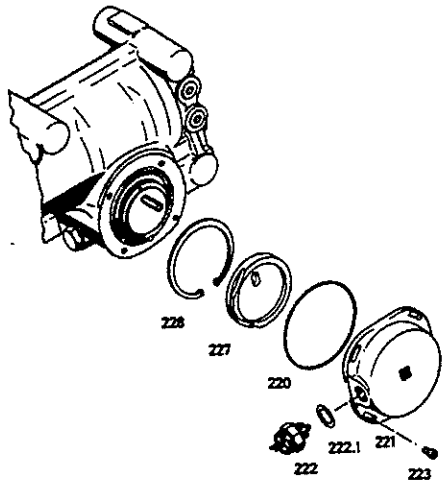


Fig.7

5 Removal and disassembly of add-on cylinder (250)

Unscrew pipe unions (205 and 206).

Unscrew hexagon screws (252) with washers (251) and remove add-on cylinder (250) ***(Fig.8)***.

Unspring retaining rings (261). Prise off cylinder cover (259) and remove O-ring (260).

Draw out piston (258) and remove gaskets (257) and O-rings (256).

Remove gear (254) and bush (253), as well as O-ring (255).

Unscrew Torx screws (250.1).

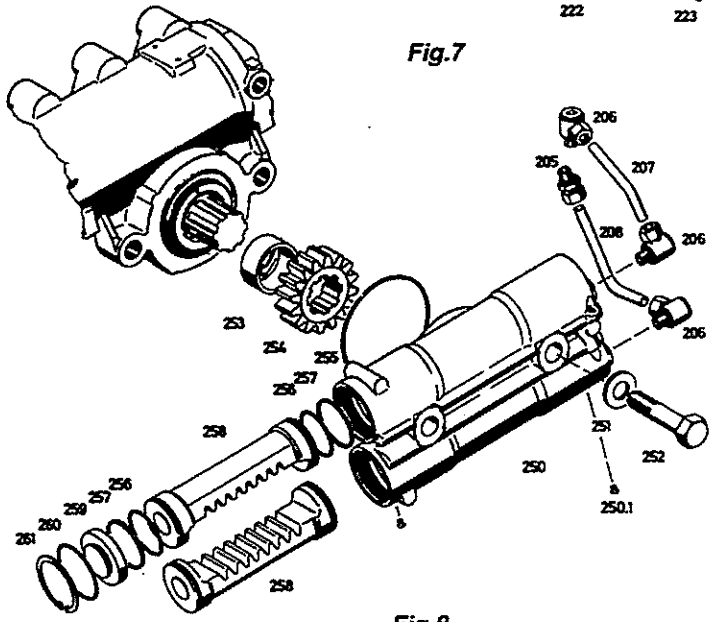


Fig.8

6 Removal and disassembly of cylinder cover (125)

Unscrew hexagon screws (127) with or without washers (126) ***(Fig.9)***.

Note:
Retract piston (101) towards bottom of housing so that the valve tappet of valve insert (109) is not damaged when turning the cylinder cover (125).

Slip steering drop arm onto sector shaft (80).

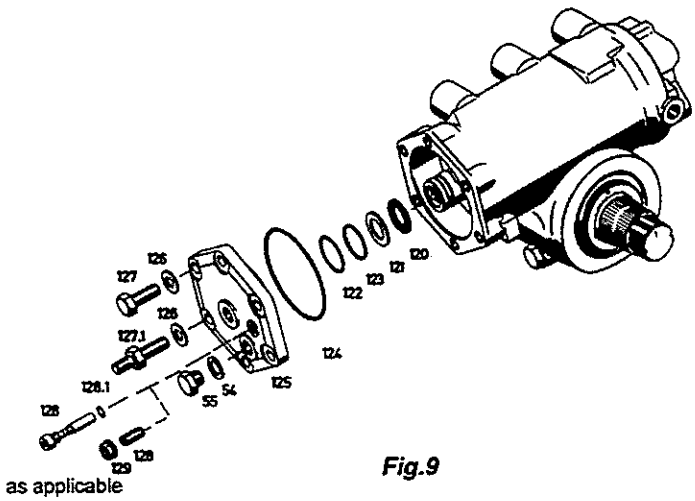


Fig.9

Turn worm (151) to remove cylinder cover (125).

Remove needle cage (120) and washer (121). Remove screw (128) and O-ring (128.1) and set aside for later use (required for function tests, chapter IV).

Remove sealing elements (122, 123 and 124). Unscrew screw plug (55) with sealing ring (54).

Unscrew set screw (128) and collar nut (129).

7 Removal and disassembly of piston (100)

7.1 Draw piston (100) out of housing (1) together with worm (151), turning the steering drop arm which is still mounted on the sector shaft (80) at the same time ***(Fig.10)***.

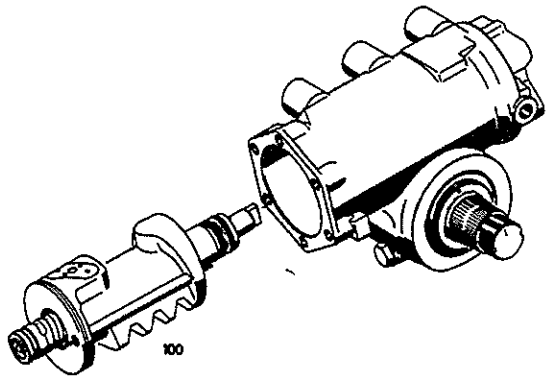


Fig.10

Attention:
The tappet of the valve insert (109) ***(see Fig. 13)*** installed in piston (101) must not be damaged.

7.2 Remove gasket/plug (112) complete with compensating plate (113.1), gasket (113), sealing elements (114 and 115), pin (113.2) and recirculating half tubes (111) ***(Fig.11)***.

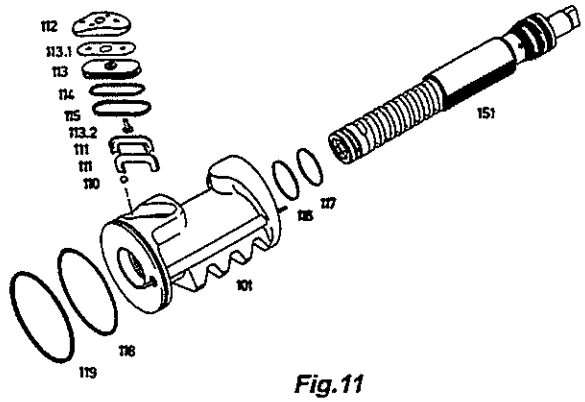


Fig.11

Turn worm (151) to release the balls (110) and carefully set them aside for later use.

Remove sealing elements (116, 117, 118 and 119).

7.3 Check the valve insert (109) installed in piston (101) ***(see Fig.13)*** for radial or axial play, mechanical damage and any internal leaks.

Check caulking of valve insert (109).

The complete valve insert (109) must be replaced if any of the above defects is observed.

7.3.1 Versions with caulked valve insert (109) - steering limiter valve

Position piston (101) upright so that the caulking on valve insert (109) points upwards ***(Fig.12)***.

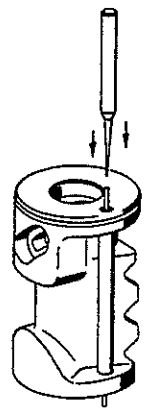


Fig.12

Using a cylindrical punch, dia. 4.5 mm, press tappet inwards and drive valve insert (109) down and out.

7.3.2 Versions with screwed valve insert (109) - steering limiter valve

Release caulking and screw valve insert (109) out of piston (101) with tool [2] ***(Fig.13)***.

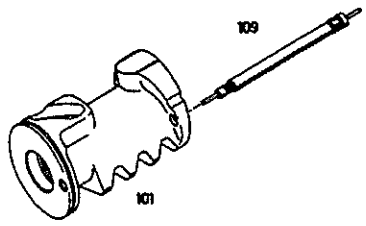


Fig.13

8 Disassembly of worm (151)

8.1 Unspring snap ring (155) and pull off sliding tube (156) ***(Fig.14)***.

Remove plug (163) and pin (162).

Remove sealing elements (158, 159, 164).

Further disassembly of the worm (151) is not permitted, since the hydraulic centre is then no longer set correctly.

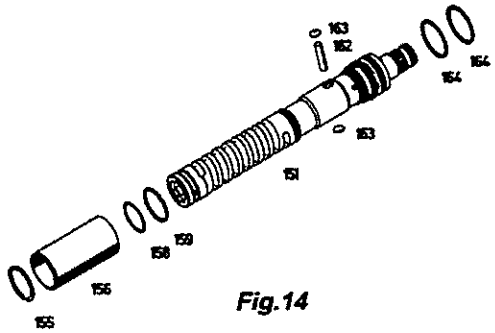


Fig.14

8.2 **Exception:**
Sealing ring (170) may be replaced by specially trained personnel:

Mark position of valve slide (168) and worm (161) ***(Fig.15)***.

Remove caulking from worm (161).

Drive out pin (160).

Pull valve slide (168) out of worm (161) together with torsion bar (165).

Remove O-ring (169) and sealing ring (170).

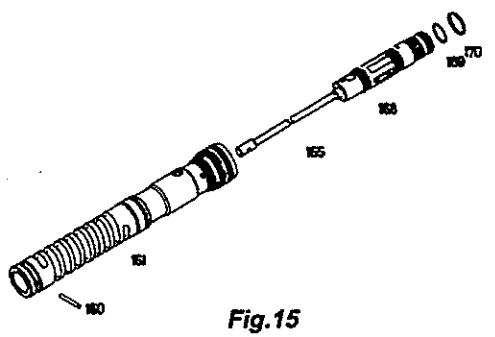


Fig.15

8.3 Additionally required for dual-circuit versions:

Remove sealing elements (172 and 173) ***(Fig.16)***.

Remove sealing rings (164) and O-ring (164.1) from control sleeve (174).

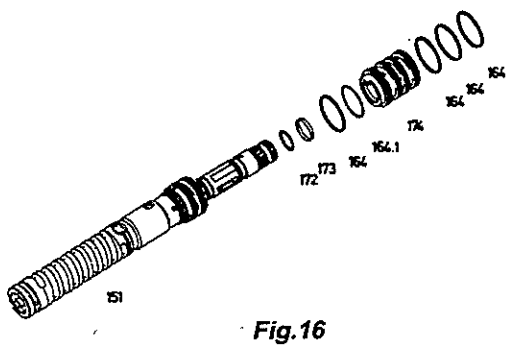


Fig.16

9 Removal of sector shaft (80)

Remove dust seal (51), stop-ring (51.1), gasket (51.2) and plug (52) on both sides ***(Fig.17)***.

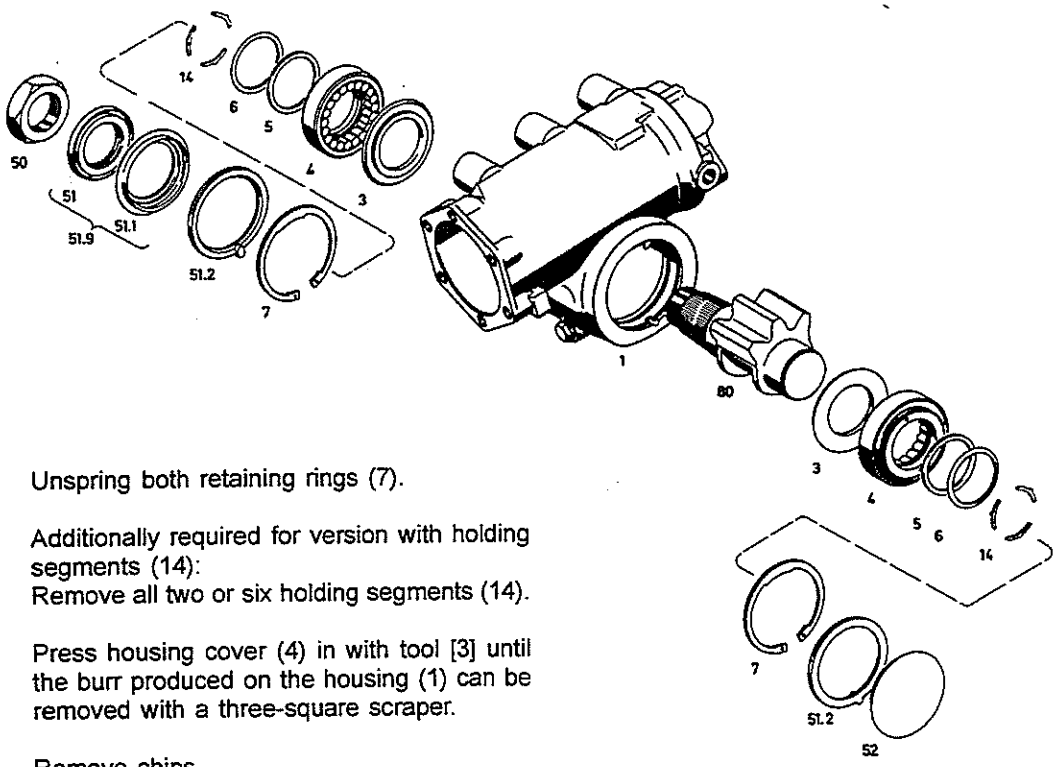


Fig.17

Unspring both retaining rings (7).

Additionally required for version with holding segments (14):
Remove all two or six holding segments (14).

Press housing cover (4) in with tool [3] until the burr produced on the housing (1) can be removed with a three-square scraper.

Remove chips.

Draw housing cover (4) out with tool [4].

Note:
The spindle of tool [4] must not be inserted in the centering bore of the sector shaft (80), otherwise the sector shaft (80) may tilt due to eccentricity.

Draw support rings (6) and gaskets (5) out of the grooves.

Notes:

→ The housing covers (4) must not be refitted in the same position otherwise they cannot be caulked correctly.

→ The individual rolls must not be exchanged between housing covers (4).

→ If one of the rolls is defective, the complete housing cover (4) must be replaced.

Draw washers (3) off the sector shaft (80).

Mark the side on which the notched serration of the sector shaft (80) is installed.

Remove sector shaft (80) from housing (1).

10 Disassembly of housing (1)

10.1 Remove needle cage (10), washer (9) and shaft seal (8) from housing (1) ***(Fig.18)***.

Remove O-rings (2).

Disassemble set screw (20) with collar nut (21) or screw (20) with O-ring (20.1) and set aside for later use (required for function testing).

Unscrew screw plug (55) with sealing ring (54).

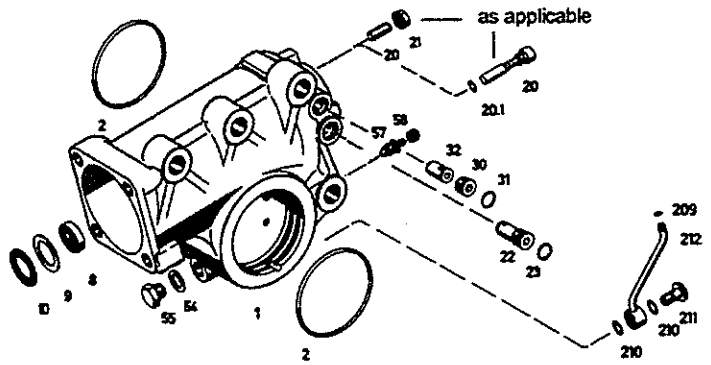


Fig.18

Remove breather (57) with protective cap (58).

Unscrew screw (30) with O-ring (31) and remove valve insert (32) - replenishment valve.

Unscrew valve insert (22) - pressure limiting valve - with O-ring (23).

Note:
Valve inserts (22 and 23) cannot be disassembled. The complete valve inserts must therefore be replaced if a defect develops.

10.2 Additionally required for versions with pipe (212)

Unscrew union screw (211).

Remove pipe (212) with O-rings (209 and 210).

II. Examining the individual parts

→ All parts must be cleaned thoroughly.

Note:
Sealing rings and other rubber parts must not be allowed to come in contact with chlorinated hydrocarbons, as they may swell.

→ All parts must be examined for wear, corrosion, pressure damage or other defects and assessed from the point of view of reusability.

→ Flange faces and sealing faces (e.g. the mating faces of sealing rings) must be repolished or ground if necessary.

Attention:
Experience and a conscientious approach are essential when examining the parts. The fitter must personally decide whether or not the parts need to be replaced.

The following must be examined:

1 Housing (1)

→ Cylinder bore: minor scoring must be eliminated by removing the elevations, e.g. with the aid of a serrated washer.

→ Recesses in retaining rings: any elevations must be removed to avoid scratches when fitting the housing covers (absence of leaks).

→ Running faces of the worm head (151)

→ Screw thread

→ Outer seat of shaft seal must be examined for signs of rubberization

→ Face side of housing must be examined for signs of sag due to sudden, accidental impacts around the axial needle bearing for the worm. Apply a ruler to the machined face side for the protecting cap (53). Housing (1) must be replaced if a distinct sag is evident.

2 Cylinder cover (125)

→ Outer seat of shaft seal must be examined for signs of rubberization

→ Face side of cover must be examined for signs of sag due to sudden, accidental impacts around the axial needle bearing for the worm (151). Apply a ruler to the machined face for the return port. Cylinder cover (125) must be replaced if a distinct sag is evident.

3 Piston (101)

→ Outside diameter

→ Valve insert (109) - steering limiter valve - must be examined for leaks, loose fit, damage (even slight external mechanical damage can cause the valve to jam).

→ Serration must be examined for wear (longitudinal and transverse crack testing using a suitable method, e.g. ferrofluxing).

Attention:
Cracked parts must be scrapped.

→ Recirculating ball screw:
Both piston (101) and worm (151) must be replaced if any signs of damage or wear are observed.

→ Check friction value in assembly with worm (151) - see chapter III.

→ **Caulked valve insert (109) - steering limiter valve:**

Tight fit: radial or axial play and damage are not permissible.

→ **Screwed valve insert (109) - steering limiter valve:**

Check that valve insert (109) is not twisted or damaged.

Caulking

4 Worm (151)

→ Recirculating ball screw: piston (101) and worm (151) must both be replaced if any signs of damage or wear are observed. Check friction value in assembly with piston (101) - see chapter III.

→ Notched serration of valve slide (168)

→ Running surfaces of needle bearings and shaft seal. Indentations on the face-end running surfaces of the needle bearings (10 and 120) may be due to accidental impacts. In this case, the housing (1) and cylinder cover (125) must be examined for signs of sagging around the needle bearing (120).

→ Longitudinal and transverse crack testing (using suitable methods, e.g. ferrofluxing). (The liquid jet must be directed in such a way that the valve body is not wetted so that iron particles cannot enter the control grooves.)

Attention:
Cracked parts must be scrapped.

→ O-ring recesses must be examined for hammer marks

→ The complete worm (151) must be replaced if the O-rings are found to have hardened on account of excessive service temperatures, since the O-ring (169) between valve slide (168) and worm (161) will also have been damaged in this case.

5 Sector shaft (80)

→ Toothed segment

→ Serrations

→ Running surfaces of the sealing rings

→ Running surfaces of the roller bearings

→ Longitudinal and transverse crack testing (using suitable methods, e.g. ferrofluxing).

Attention:
Cracked parts must be scrapped.

→ Caulking points on housing cover (4)

→ Longitudinal scoring on outside diameter

→ Screw thread

→ Radial run–out (warping) of the sector shaft (80) need only be checked if roller bearing imprints due to impacts have been observed, for instance on the face ends of the worm.
Mount the sector shaft (80) between centres and measure the maximum permissible radial run–out on the running surface of the roller bearing on the steering drop arm side, beside the tooth segment. The max. permissible radial run–out must not exceed 0.1 mm.

Additionally required for versions with switch (222):

→ Check grooved pin for tight fit and wear

→ Slot on grooved pin must point towards the middle tooth or be at 180° to it.

6 Housing cover(4)

→ Scoring and rust on outside diameter

→ Sealing faces

7 Needle, cage and roller bearings

→ The corresponding bearings must be replaced if indentations and wear are observed on the running surfaces of the steering elements.

→ Check needles, balls and rollers for signs of wear and damage.

8 Valve insert (22, 22.1 and 32) and breather (57)

→ Outside diameter (scoring, wear, damage and jamming in the valve bore)

→ Ensure that bore holes are clean

9 Additionally required for dual-circuit versions

9.1 Housing cover (221)

→ Screw thread

→ Flange face

→ O-ring seats

→ Pipe / line connections

9.2 Valve housing (203)

→ Screw thread

→ Rubberization on seat of shaft seal

→ Pipe connections

→ Running surface of sealing rings

→ O-ring seats

9.3 Additionally required for versions with add-on cylinder (250)

9.3.1 Add-on cylinder (250)

→ Scoring in cylinder bores

→ O-ring seats

→ Pipe connections

9.3.2 Piston (258)

→ Sealing ring seats

→ Signs of wear on serration (longitudinal and transverse crack testing using suitable methods, e.g. ferrofluxing)

Attention:
Cracked parts must be scrapped.

9.3.3 Gear (254)

→ Signs of wear on serrations (longitudinal and transverse crack testing using suitable methods, e.g. ferrofluxing)

Attention:
Cracked parts must be scrapped.

10 Additionally required for versions with switch (222)

→ Easy movement of actuating cam on switch (222)

→ Check cam ways of cam disc (227) for signs of wear

11 Additionally required for versions with bevel box

→ Bevel gears (306 and 331):
Signs of wear and indentations on serrations
Damage and corrosion on running surfaces of shaft seals

Longitudinal and transverse crack testing (using suitable methods, e.g. ferrofluxing), particularly for cracks at the bottom of the teeth.

Attention:
Cracked parts must be scrapped

→ Intermediate flange (335) and housing (301):
Flange faces, screw thread and sealing ring seats

→ Cross disc (348): signs of wear in driving grooves

→ Screw thread

III. Assembly

Attention:

Utmost cleanliness must be maintained during assembly in order to ensure that the steering operates reliably. Force must never be used when assembling parts, as this may damage the sealing ring seats, sealing faces, etc. The resultant damage may lead to partial or total failure of the steering.

Notes:

→ All parts must be cleaned thoroughly before assembling the steering. Each part must be examined for signs of wear and other defects (see chapter II.) and oiled before being assembled.

→ New gaskets, shaft seals and O-rings must always be fitted and the face ends of the housings and covers ground down to remove any paint residues and damage.

→ In the case of shaft seals, the space between the sealing lip and dust lip must be filled with grease type Spectron FO 20 made by Messrs. DEA or an equivalent calcium complexing grease of consistency class 2.

→ The accuracy of the measuring and adjusting tools used for repairs must be verified at regular intervals.

→ The specified tightening torques apply when tightening screws and bolts with a torque wrench by hand.

→ Before starting the assembly work, the spare parts list must be consulted to determine whether it specifies tightening torques and insertion depths or information on the installed position of special screws and holders. The following values and descriptions apply if nothing is specified in the spare parts list.

1 Preassembly of housing (1)

1.1 Screw in valve insert (22) - pressure limiting valve - with preassembled O-ring (23) (tightening torque: 30+10 Nm) ***(Fig.19)***.

Fit valve insert (32) - replenishing valve - in housing. Fit screw (30) with fitted O-ring (31) (tightening torque: 30+10 Nm).

Screw in breather (57) (tightening torque: 30 Nm) and plug on protective cap (58).

Fit screw plug (55) with sealing ring (54) (tightening torque: M16: 40 Nm; M18: 50 Nm).

Insert O-rings (2) in housing (1).

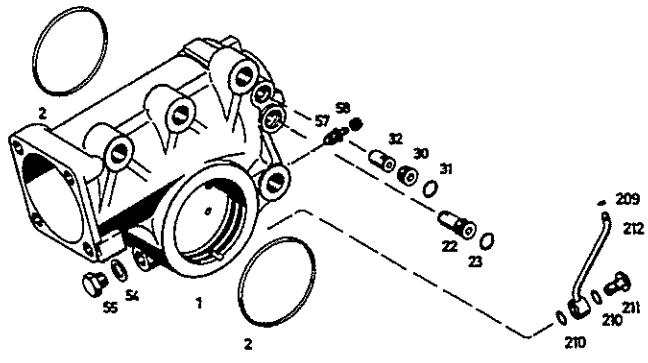


Fig.19

1.2 Additionally required for versions with pipe (212)

Mount pipe (212) with new O-rings (209 and 210). Torque union screw (211) down with 20±2 Nm.

2 Preassembly of housing cover (4)

Notes:

→ The housing covers (4) must not be reinstalled on the same side.

→ The individual rollers must not be interchanged between housing covers (4).

→ The complete housing cover (4) must be replaced if one of the rollers is defective.

Any rollers which have dropped out must be bonded into the housing cover (4) with grease (type of grease, see Note in chapter III.) and a pad fitted in the roller gap.

Fit gasket (5) and support ring (6) in housing cover (4) ***(Fig.20)***.

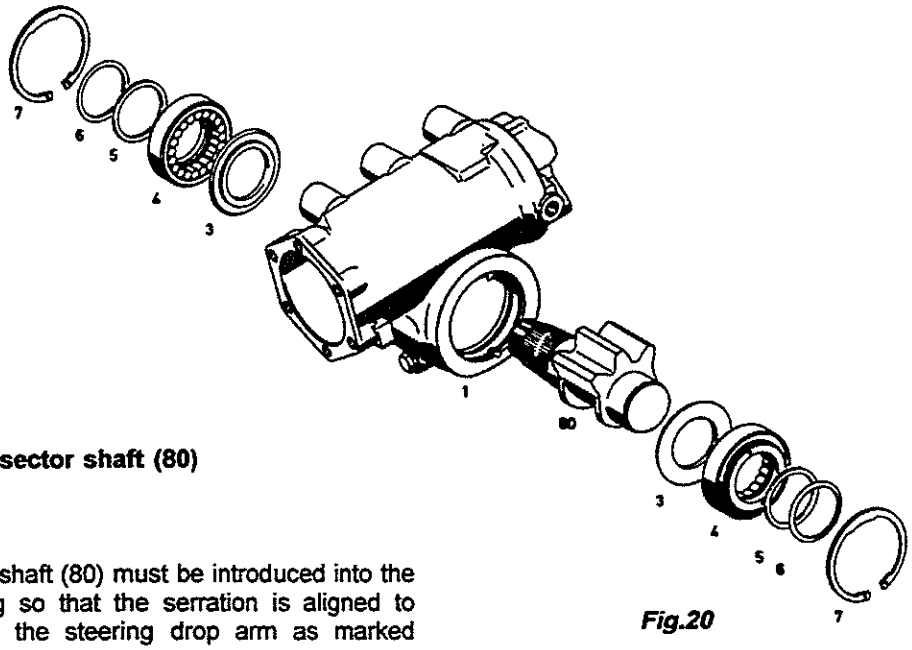


Fig.20

3 Install sector shaft (80)

Sector shaft (80) must be introduced into the housing so that the serration is aligned to receive the steering drop arm as marked during disassembly.

Fit washers (3) on sector shaft (80).

Place housing (1) on a flat surface underneath a hand-operated press with the steering drop arm side facing upwards.

Mount tool [5] on the serration.

Press the preassembled housing cover (4) up to the recess in the retaining ring (7) with tool [3] and with the larger of the two face-end holes or marks facing upwards (towards the piston).

Fit retaining ring (7) so that the gap is on the caulked side opposite the piston (101).

Attention:
Check that retaining rings (7) are seated correctly.

4 Adjustment of recirculating ball element

4.1 Assembly of recirculating ball element

Insert worm (151) into the bore in piston (101) so that the balls (110) from the front piston bore for the recirculating pipe can be filled into the threaded bore of worm (151) *(Fig.21)*.

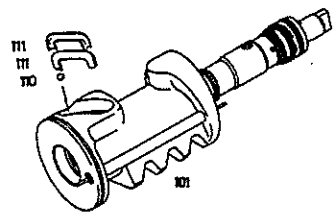


Fig.21

Attention:
37 balls (110) must be used. All the balls (110) used must belong to the same tolerance group.

The balls (110) must be filled in separately and the worm (151) turned slowly at the same time so that all balls (110) are lined up side-by-side (direction of rotation depends on the spiral direction of the worm (151)).

The recirculating ball screw is not full until the first ball (110) inserted reaches the edge of the rear bore in the recirculating pipe (30 balls).

Attention:
None of the balls (110) may drop out of the threaded bore into the longitudinal bore of the piston (101), as this could result in partial or complete failure of the steering.

Place the remaining balls (110) in the recirculating half tube (111).

To facilitate assembly, the outer balls (110) can be bonded into place with grease. Type of grease, see note in chapter III.

Insert both the filled recirculating half tubes (111) into the bore holes.

4.2 Check the friction torque

☐ **New parts**

The friction torque of the recirculating ball element must be measured in a horizontal position using tools [8], [9] and [10] while simultaneously holding the recirculating half tubes (111) tight in the piston (100).

→ In the middle area:

The following friction torques must be obtained when turning the worm through 90°:

Type 8090:	5 - 20 Ncm
Types 8095-8099:	5 - 30 Ncm

→ Outside the middle area:

The friction torque measured in the middle area must increase by no more than 15 Ncm.

❑ **Used parts**

Check friction torque and tilting clearance (hold recirculating half tubes (111) tight)

The friction torque of the recirculating ball element (111) must be measured in a horizontal position with tools [8], [9] and [10]. ***Fig.22.*** The tilting clearance must be measured in a horizontal position as shown in ***Fig.22.***

Measurement of friction torque

Measurement of tilting clearance

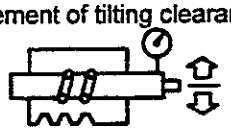


Fig.22

→ In middle area:
The value measured must lie within the following range when worm (151) is turned through 90° .

Upper limit: max friction torque:	8090:	5-20 Ncm
	8095-99:	5-30 Ncm
Lower limit: max. tilting clearance:	0.1 mm	

→ Outside the middle area:

The friction torque may increase to max. 35 Ncm for type 8090 and to max. 60 Ncm for types 8095-8099.

4.3 If a higher friction torque is obtained, the balls (110) must be removed and replaced with balls from a smaller tolerance group.

If the friction torque is below the permissible minimum value or if the tilting clearance is too large, larger balls (110) must be fitted and the measurement repeated.

Once the correct balls (110) have been chosen, piston (100) must be disassembled again and the selected balls (110) carefully set aside.

5 Preassembly of worm (151)

5.1 Fit O-ring (169) and sealing ring (170). Install torsion bar (165) with valve slide (168) as marked during disassembly. Press in pin (160) and caulk to the same depth and form as before ***(Fig.23).***

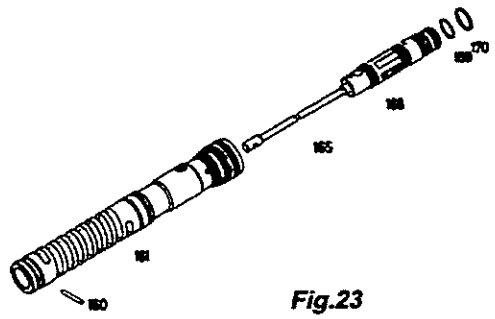


Fig.23

5.2 Place O-ring (158) in radial groove and slip on sealing ring (159) ***(Fig.24).***

Fit pin (162) with plug (163).
Carefully slide on sliding tube (156).

Fit snap ring (155) and check axial play of sliding tube (156).

The axial play must not exceed max. 0.1 mm and can be corrected by using a different snap ring (155).

Use tool [11] to slip on sealing rings (164) and press them home with tool [12].

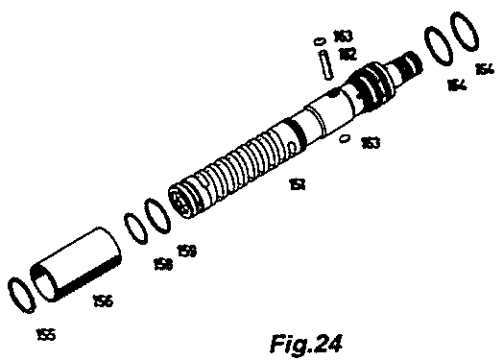


Fig.24

5.3 Additionally required for dual-circuit versions:

Slip O-ring (164.1) and sealing rings (164) onto control sleeve (174) with tool [11] ***(Fig.25)***.

Then draw in sealing ring (164) with tool [11].

Mount tool [13] on worm (151).

Fit O-ring (172) and sealing ring (173) and press home with a suitable tool (e.g. hose clip).

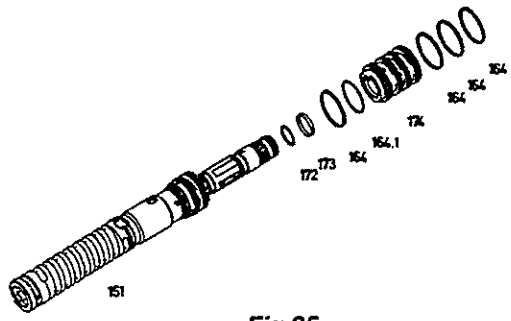


Fig.25

6 Preassembly of piston (100)

Note:
This preassembly is only required if the valve insert (109) - steering limiter valve - was disassembled.

6.1 Versions with caulked valve insert (109) - steering limiter valve

Introduce valve insert (109) as far as possible in piston (100). Mount piston in tool [6] with the caulked area pointing upwards ***(Fig.26)***.

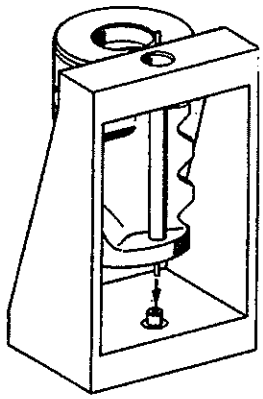


Fig.26

At the same time, ensure that valve tappet protruding beyond the piston is introduced into the bore in tool [6].

Adjust the supporting screw of tool [6] so that a gap of 0.1 - 0.2 mm is obtained between the fixture and piston when the latter has been fitted ***(Fig.27)***.

Screw caulking die of tool [6] onto a pressure pickup and insert it in the upper bore of tool [6].

Caulk the metal edge of the valve insert with a press applying a force of 7000 N + 800 N without backlash.

Attention:
Correct operation of the steering may be impaired if the caulking force is too high or too low.

Check that the valve insert (109) is seated securely.

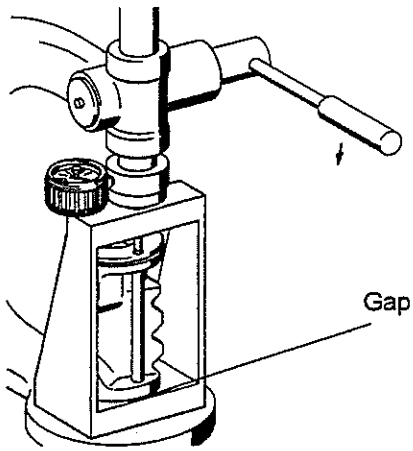


Fig.27

6.2 Versions with screwed valve insert (109) - steering limiter valve

Screw valve insert (109) into piston as far as possible with tool [2] ***(Fig.28)*** (tightening torque: 15±1 Nm).

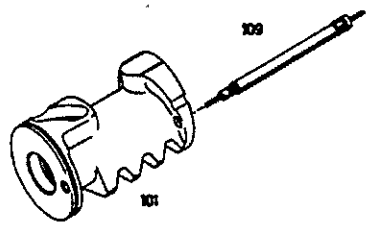


Fig.28

Note:
Hold the tube of the valve insert (109) tight when screwing in the valve insert so that only the larger threaded sleeve is entrained.

Align tool [7] with the two cutting edges so that they are centered in the groove. Then press tool [7] towards the piston until it rests against valve insert (109).

Caulk with tool [7] as shown in ***Fig.29*** (caulk to the same depth on both sides).

Attention:
Check that the valve insert (109) is tightly seated and that the valve tappet moves easily.

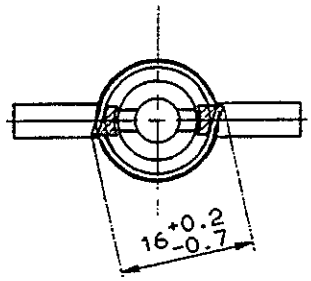


Fig.29

7 Assembly of piston (100) and worm (151)

First fit sealing ring (116) and then insert sealing ring (117) ***(Fig.30)***.

Fit O-ring (118) and then slip on gasket (119).

Reinsert worm (151) into piston (100) so that the balls (110) selected earlier can be fitted and the recirculating tube (111) can be inserted in piston (100) ***(see Fig.21)***.

Note for steering versions 8095 to 8099:

New parts (111, 112, 113 and 113.2) must be used if a pin (113.2) was not present during removal.

Place gasket (113) and plug (112) in piston without O-ring (114) or sealing ring (115).

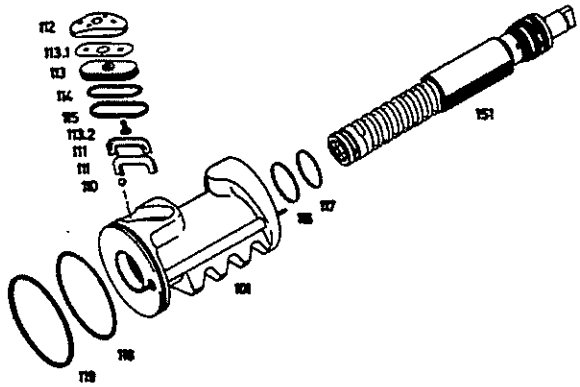


Fig.30

Check that plug (112) is flush with the piston surface ***(Fig.31)*** or does not exceed the following maximum clearance:

Max. permissible clearance:

Type 8090:	max. 0.1 mm
Types 8095-8099:	max. 0.5 mm
Type 8099: (with add-on cylinder)	max. 0.2 mm

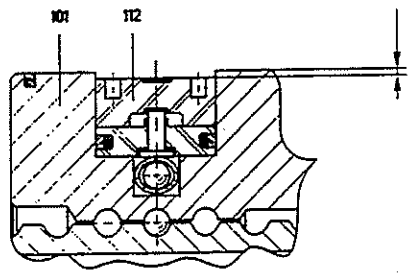


Fig.31

If necessary, insert a compensating plate (113.1) between gasket (113) and plug (112) (even if a compensating plate was not present during removal).

Ensure that the plug does not protrude in a way leading to increased friction.

Remove plug (112), compensating plates (113.1) and gasket (113).

Fit O-ring (114) and sealing ring (115) on gasket (113).

Press pin (113.2) into piston (101) with complete gasket (113).

Place the compensating plates (113.1) and plug (112) selected beforehand on gasket (113) and check again that plug (112) is flush with the piston face or does not exceed the maximum clearance.

8 Installation of piston/worm assembly

8.1 For 1-circuit versions and versions with bevel box

Fill space between sealing lip and dust lip of shaft seal (8) with grease (see note in chapter III.).

Press shaft seal (8) in as far as possible with tool [14] ***(Fig.32)***.

Place washer (9) and needle cage (10) in turned recess of housing (1). Washer must be free of grease.

Slip tool [15] onto serration of worm (151).

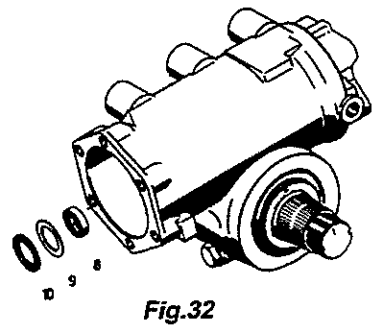


Fig.32

8.2 All versions

Turn sector shaft (80) so that the toothed segment swings towards the cylinder cover (125).

First introduce piston (100) into housing complete with worm (151) until toothed segment engages the first gap in the teeth of piston (100) when swung upwards ***(Fig.33)***.

In this position, insert piston (100) completely by turning the sector shaft (80) with the aid of the provisionally attached steering drop arm.

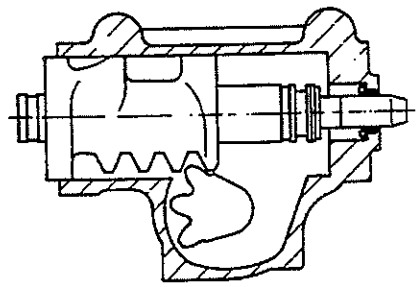


Fig.33

9 Assembly of cylinder cover (125)

Note:
Only for 1-circuit version and versions without bevel box

Screw in screw plug (55) with sealing ring (54).

Tightening torque: M16: 40 Nm
M18: 50 Nm

Place washer (121), which was removed during disassembly, in the recess in cylinder cover (125) with the bevelled side first; needle cage (120) must be fitted without grease ***(Fig.34)***.

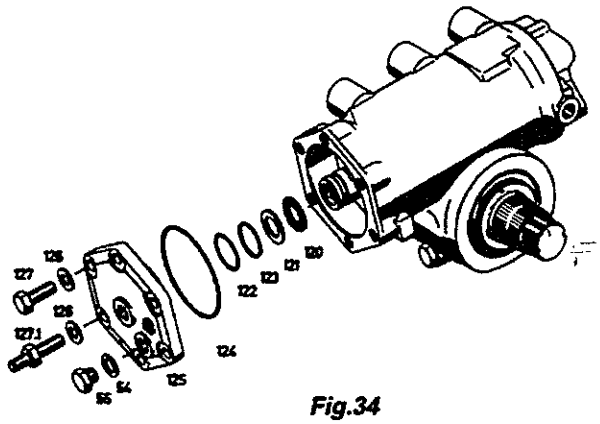


Fig.34

Note:
The following sealing elements should not be fitted until the worm bearing - section 12 - has been adjusted.

Place O-ring (122) in the inner radial groove in cylinder cover (125) and lay sealing ring (123) on top of it.

Place the greased O-ring (124) in the outer radial groove.

Place cylinder cover (125) on housing (1) without damaging the sealing elements.

Attention:
The inserted washer (121) may be too thick if any of the parts housing (1), worm (151) or cylinder cover (125) has been replaced. A complete readjustment as described in section 12 is required in this case.

If present during disassembly, the hex screws (127) with washers (126) must be carefully tightened while constantly turning the steering shaft in order to ensure that the worm bearing is not subjected to axial pressure.

Hex screws (127) and screw (127.1) must be torqued down as specified below.

Type 8090: (M12x1.5)	135 Nm
Type 8095/8096/8097: (M16x1.5)	285 Nm
Type 8098/8099: (M14x1.5)	189 Nm

10 Assembly of valve housing (203)

Note:
Dual-circuit version only

Screw in valve insert (22.1) - pressure limiting valve - with O-ring (23) ***(Fig.35)*** (Tightening torque: 30+10 Nm).

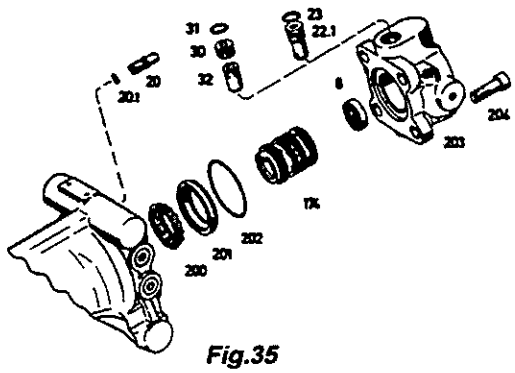


Fig.35

Fit valve insert (32) - replenishing valve - and screw (30) with O-ring (31) (tightening torque: 30+10 Nm).

Press bearing ring (201) into valve housing (203).

Position ball cage (200) on worm (151).

Insert preassembled control sleeve (174) in worm (151) (note position of drivers).

Screw adjusting screw (20) in by at least three turns.

Fill space between sealing lip and dust lip of shaft seal (8) with grease (see note in chapter III.).

Press shaft seal (8) in as far as possible with tool [14].

Mount tool [15] on serration of worm (151).

Insert O-ring (202) and mount valve housing (203) as marked during disassembly.

Torque cap screws (204) down to 140 Nm.

Fit pipes (225 and 226) ***(see Fig.43)*** with new O-rings (224).

Tightening torque: 8096: 12+2 Nm
8099: 18+2 Nm

11 Check sector shaft position and total turns of steering wheel

Turn the steering through from one end to the other and check that the number of turns equals that counted during disassembly.

Turn steering to straight-ahead position and check that the mark on the sector shaft is at the top and perpendicular to the piston axis ***(Fig.36)***.

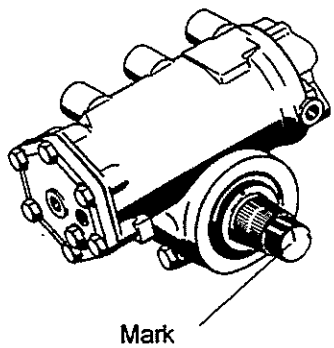


Fig.36

12 Adjustment of worm bearing

Note:
This setting must be checked at room temperature.

Strip paint from face end of housing in order to mount the dial gauge of tool [17].

Secure tools [16] and [17] on the steering shaft stub ***(Fig.37).***

Turn sector shaft (80) until worm (151) axially comes to rest on one side. Set dial gauge to "zero".

Turn sector shaft (80) until worm (151) axially comes to rest on the opposite side without tool [16] being radially entrained and check the permissible axial backlash.

Required values:

Type 8090:	0.005 - 0.025 mm
Types 8095/8096:	0.010 - 0.030 mm
Type 8097:	0.015 - 0.035 mm
Types 8098/8099:	0.020 - 0.040 mm

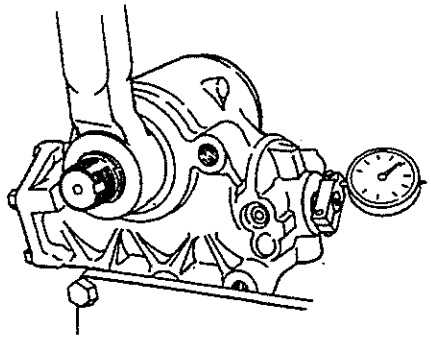


Fig.37

Fit a different washer (121) to correct a divergent axial backlash.
Remove cylinder cover (125).
Install sealing elements as described in section 9 and fit cylinder cover (125).

13 Set pressure point

Note:
The bevel box must be installed first as described in section 17 in versions with bevel box.

Clamp steering horizontally and mount tools [18] and [19].

Turn housing cover (4) so that the larger of the two face-end bores and the mark point towards piston (100).

Move steering to one of the limit positions.

Measure the friction torque required to turn the steering ouside the straight-ahead range (approx. half a turn short of the limit position).

Turn steering approx. one half-turn to the right and left beyond the middle position with tools [8], [9] and [10]. Measure the associated increase in friction torque.

Required increase in friction torque:

Type 8090:	20-60 Ncm
Type 8095/8096:	20-80 Ncm
Type 8097-8099:	20-100 Ncm

Turn both housing covers (4) with tools [18] and [19], keeping the same angle (in the direction of the arrow), until the required increase in friction torque is obtained ***(Fig.38).***

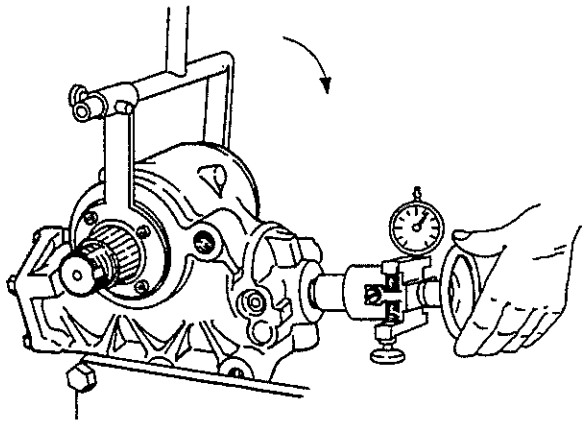


Fig.38

While making the adjustment with tools [18] and [19], use tools [8], [9] and [10] to turn the steering several times approx. one half-turn to the right and left beyond the middle position.

Note:
The max. permissible friction torque should be set if possible when making this adjustment.

14 Caulking housing cover (4)

14.1 Versions with single caulk

14.1.1 Screw tool [20] onto the steering so that it is parallel to the steering. The caulking tool must fit into the caulking groove as accurately as possible ***(Fig.39)***.

Tool [21] must be used additionally for steering versions with a C-value greater than 137 mm.

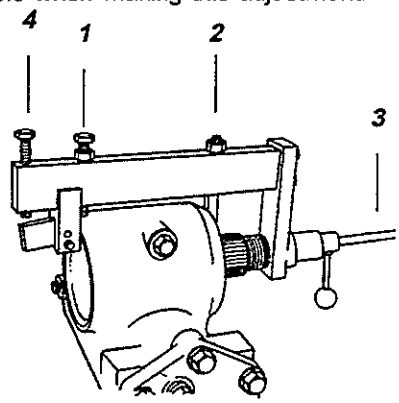


Fig.39

In this position, set adjusting screw ***1*** on the fixture so that the caulking tool is horizontal.

Secure fixing hook ***2*** on the opposite side of the housing at the height indicated by thrust spindle ***3***.

Tighten thrust spindle ***3*** until housing cover (4) comes to rest on retaining ring (7) on the caulking side.

Tighten screw ***4*** on the fixture by hand (without using additional tools) until it rests on the caulking tool.

Turn screw ***4*** through - value specified below - with a torque wrench (maximum value of 18 Nm must not be exceeded, otherwise the tool may break !).

Turns of screw ***4***: Types 8090-8097: approx. 2.75
Types 8098/8099: approx. 3.50

Remove fixture and check caulked area.
The housing has been caulked correctly when the collar of the housing cover is pressed into the housing groove to the depth specified in the following table.

Caulking depth:

Types 8090/8095/8096:	1.3+0.4 mm
Type 8097:	1.4+0.4 mm
Types 8098/8099:	1.7+0.4 mm

Slight cracks are permissible in the caulking edge at the edge of the groove ***(Fig.40)***.

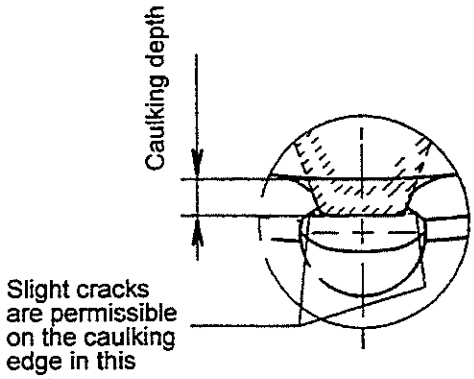


Fig.40

Additionally required for versions with holding segments (14):

Holding segments (14) must be pressed in until flush ***(Fig.41)***.

Fit retaining ring (7) so that the gap is located at the caulking point opposite the piston (100).

Attention:
Check that retaining ring (7) is seated securely.

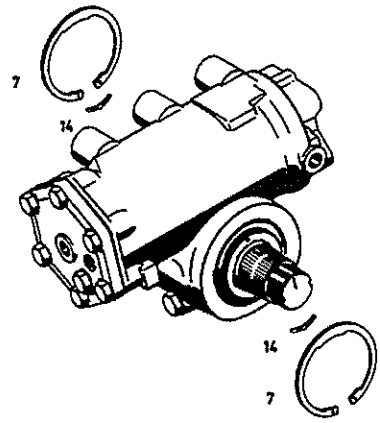


Fig.41

14.1.2 Repeat the complete procedure for the other side as described in section 14.1.1.

14.2 Versions with three-fold caulking

14.2.1 Carry out single caulking on both sides as described in section 14.1.

Remove retaining ring (7) and insert tool [22] (without caulking tool) in the caulking grooves of the housing with the three pilot pins.

Turn tool [22] through 60° in the groove of the retaining ring until one of the two caulking points is reached. Secure tool [22] with a stop pin to prevent it twisting and fit the caulking tool.

Proceed as described in section 14.1. Remove caulking tool. Release stop pin and turn fixture through 120° until the third caulking point is reached.

Proceed as described in section 14.1 for the third caulk.

Dismount tool [22] from the steering and check the caulked area as described in section 14.1.1.

Additionally required for versions with holding segments (14):

Press holding segments (14) in until flush ***(Fig.42)***.

Fit retaining ring (7) so that the gap is located on the caulking point opposite the piston (100).

Attention:
Check that retaining ring (7) is seated securely.

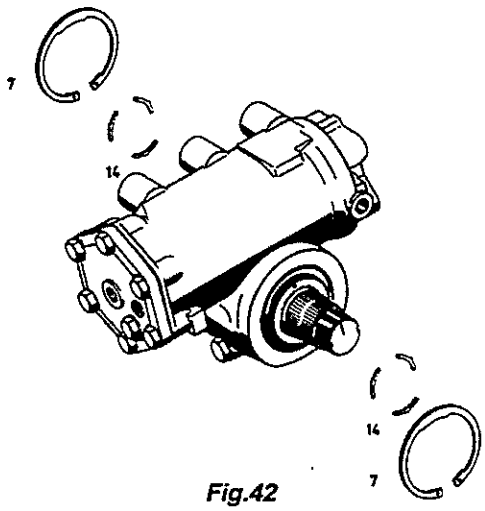


Fig.42

14.2.2 Repeat the complete procedure for the other side as described in section 14.1.1.

15 Assembly of housing cover (221)

15.1 Dual-circuit versions

Insert O-ring (220) ***(Fig.43)***.

Install housing cover (221) with cap screws (223) (tightening torque: 37 Nm).

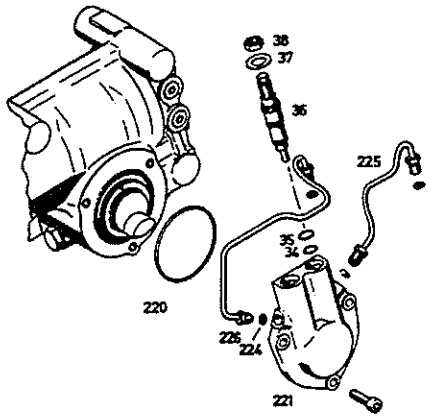


Fig.43

Install pipes (225 and 226) with new O-rings (224).

Tightening torque: Type 8096: 12+2 Nm
Type 8099: 18+2 Nm

Screw in valves (36) - steering limiter valves - with O-rings (34 and 35).

Fit hex nut (38) with washer (37) and torque down to 25-35 Nm after adjustment.

15.2 Versions with switch (222)

Note:
The housing cover should not be installed until the setting and functional test - chapter IV. - is complete, otherwise it cannot be tested for leakages.

Insert cam disc (227) in housing cover (221) so that the cam ways point towards switch (222) ***(Fig.44)***.

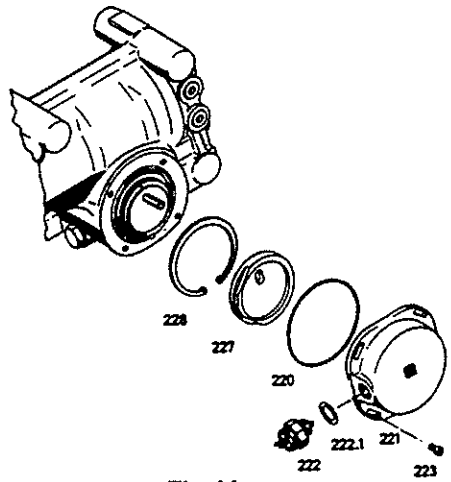


Fig.44

Fit retaining ring (228).

Place O-ring (220) in annular groove of housing cover (221).

Fit complete housing cover (221) as marked during disassembly so that the driver in the sector shaft engages in the longitudinal groove in cam disc (227).

Turn housing cover (221) so that the cam points towards the threaded bore of switch (222) when the steering is in the straight-ahead position.

Torque cap screws (223) down to 5.5 Nm.

Note:
The switching range of switch (222) can be adjusted on a test bench by using washers (222.1) of a different thickness.

Fill cover area with 50 cm^3 oil (oil sort see List of Lubricants TE–ML 09).

Screw in switch (222) with washer (222.1) (tightening torque: 50 Nm).

16 Assembly and installation of add-on cylinder (250)

Set steering to straight-ahead position.

Slide bush (253) and gear (254) as far as possible onto sector shaft (80) ***(Fig.45)***.

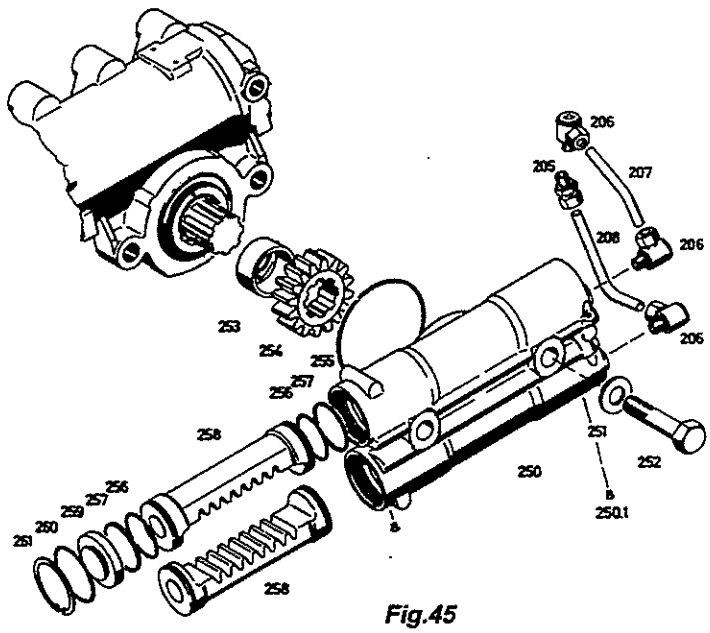


Fig.45

Slip two O-rings (256) and two gaskets (257) onto each piston (258).

Slide both pistons (258) into add-on cylinder (250) up to the middle position (installed value 60.7 ±0.2 mm) ***(Fig.46)***.

Notes:

→ The middle tooth of both pistons (258) is marked on both face ends.

→ The centered bore (with installed breather valve) in pistons (258) must point towards the closed end of add-on cylinder (250).

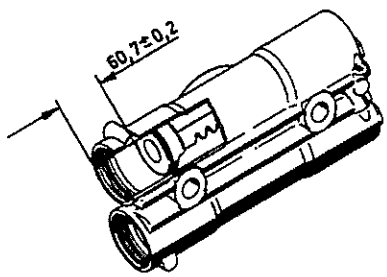


Fig.46

Screw add-on cylinder (250) onto the steering so that the middle tooth of piston (258) engages in the gap in gear (254) in each case ***(Fig.47)***.

Screw in hexagon screw (252) with washers (251) (tightening torque: 500 Nm).

Turn steering through from end to end and then back to the straight-ahead position.

Check that the installed value equals 60.7 ±0.2 mm for both pistons (258).

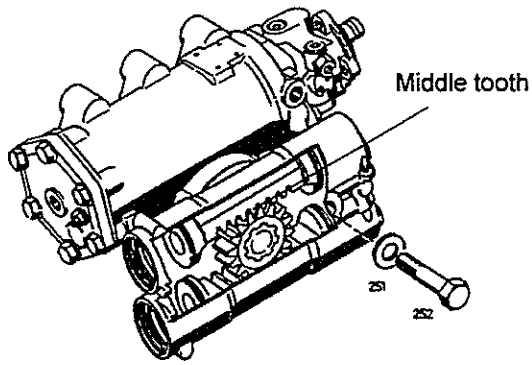


Fig.47

Place O-ring (260) in radial groove of cylinder bore and press cylinder cover (259) in until the retaining rings (261) can be fitted ***(see Fig.45)***.

Fit retaining rings (261).

Install pipes (207) and (208).

Tightening torques:

Pipe union (205):	50 Nm
Pipe union (206):	39 Nm
Screw plugs for both pipe unions (205 and 206):	59 Nm

Tighten Torx screw (250.1) with tool [23] (tightening torque: 5 Nm).

17 Preassembly and installation of bevel box

17.1 Versions with cross disc (348)

17.1.1 Fit intermediate flange (335)

Slip O-ring (341) onto intermediate flange (335). Press cross disc (348) and ball bearing (343) onto intermediate flange (335) ***(Fig.48)***. Use tool [28] for this purpose.

Secure intermediate flange (335) with cap screws (334) as marked during disassembly (tightening torque: 140 Nm).

Slip shim plate (330) onto intermediate flange (335).

17.1.2 Preassemble bevel box

Press needle sleeve (302) into housing (301) as far as possible with tool [29] ***(Fig.48)***.

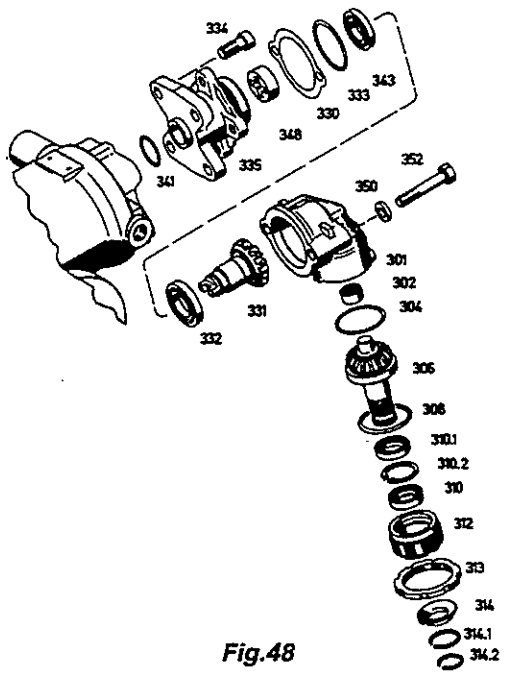


Fig.48

Press ball bearing (332) onto bevel gear (331) with tool [30].

Place 0.35 mm thick washers (304) or the washers (304) removed during disassembly into the housing bore. Slide bevel gear (306) as far as possible into housing (301).

Screw adjusting screw (312) into housing (301) without shaft seals (310 and 310.1), using tool [25] (tightening torque: 50 Nm).

Set bevel box to straight-ahead position. Align notch in steering shaft of bevel box with the mark on the housing.

In this position, mark one tooth on bevel gear (306) in the housing and two opposing teeth on bevel gear (331) in intermediate flange (335) with chalk so that the marked teeth engage when the bevel box is mounted.

17.1.3 Installation of bevel box

Slip on bevel box.

Uniformly screw in screws (352) with fitted washers (350), while simultaneously and constantly turning the steering shaft, until bevel gears (306 and 331) engage without backlash.

Screws (352) must not be turned further if bevel gears (306 and 331) engage before the flange of the bevel box comes to rest.

The remaining gap must be compensated with shim plates (330) in this case.

A thinner shim plate (330) must be used if zero backlash cannot be obtained.

The bevel gear must be precision adjusted when zero backlash has been obtained. Both the shim plates (330) and the washers (304) on bevel gear (306) are used for this purpose.

The bevel gears are correctly set when they engage with virtually no backlash and without jamming (max. backlash 0.04 mm).

Note:
However, the adjustment must be made in straight-ahead position so that the backlash is absolutely zero.

If the backlash is not zero when the steering gear is set to the straight-ahead position, the tooth contact must be relocated by one or more teeth until this requirement is met.

Make a new notch marking the straight-ahead position and take the bevel box off the steering again.

Place a greased O-ring (333) in the radial groove of the intermediate flange (335).

Place the bevel box back on the steering in the position marked after fitting the chosen washers (330).

Screw in screws (352) with fitted washers (350) (tightening torque: 62 Nm).

Unscrew adjusting screw (312) from housing (301).

Place a greased O-ring (308) in the radial groove of housing (301), behind the threaded bore.

Fill space between sealing lip and dust lip of shaft seal (310 and 310.1) with grease, see note in chapter III.

Mount tool [32] on bevel gear (306).

Fit retaining ring (310.2) in adjusting screw (312).

Press inner shaft seal (310.1) in as far as possible with tool [31].

Fit outer shaft seal (310) in adjusting screw (312) flush with face end.

Screw adjusting screw (312) into housing (301) with tool [25] and a torque of 50 Nm.

Tighten slotted nut (313) to a torque of 50 Nm.

Depress cast edge of housing to secure slotted nut (313) and prevent it twisting.

Check set friction value again (required value: max. 80 Ncm).

17.2 Versions with coupling sleeve (349)

17.2.1 Preassembly of bevel box

Press needle sleeves (302) in as far as possible with tool [36]. Install bevel gear (306) ***(Fig.49)***.

Select a retaining ring (310.3) leaving the bevel gear (306) with a max. backlash of 0.06 mm.

Install bevel gear (331).

Choose a retaining ring (310.4) ensuring zero backlash over the largest possible angle of rotation while simultaneously allowing the bevel box to run as smoothly as possible.

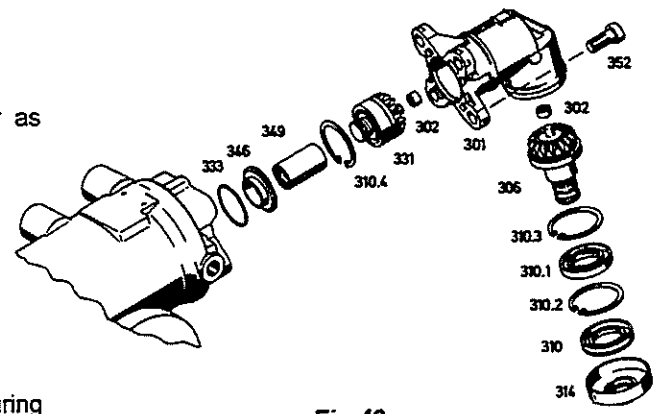


Fig.49

Fit retaining ring (310.4).

Mount tool [38] on bevel gear (306).

Grease space between sealing lip and dust lip of shaft seal (310.1) (see note in chapter III.) and press it in, together with retaining ring (310.2), with tool [37] until they engage completely.

Press a greased shaft seal (310) - see note in chapter III. with regard to the type of grease - in as far as possible with tool [39].

Measure friction torque with tools [8], [9] and [10] (required value: max. 60 Ncm).

Turn to find a zero-backlash area and fit protecting cap (314) with the mark pointing towards the steering gear. Remove former straight-ahead marking.

Fit O-ring (333).

Slip on centering ring (346) and coupling sleeve (349).

Note:
Coupling sleeve (349) must be fitted so that the inner chamfer points towards the steering gear.

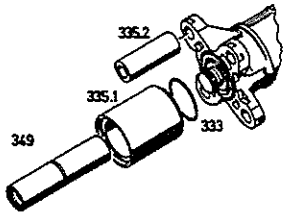


Fig.50

17.2.2 Fit pipes

Fit O-ring (333). Slip on pipes (335.1 and 335.2) ***(Fig.50).***

17.2.3 Install bevel box

Secure bevel box with cap screws (352) as marked during disassembly (tightening torque: 62 Nm).

Turn steering to straight-ahead position and fit protecting cap (314) with the mark pointing towards the steering gear.

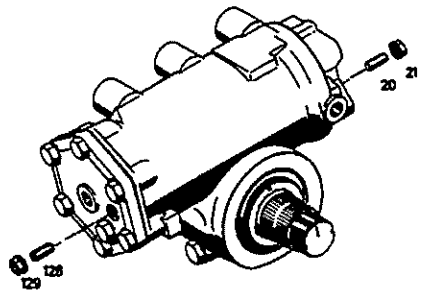


Fig.51

18 Assembly of set screw/screw (20 and 128)

18.1 Versions with collar nut (21 and 129)

Screw set screws (20 and 128) in by at least three turns and secure with collar nuts (21 and 129) (tightening torque: 20+10 Nm) ***(Fig.51).***

18.2 Versions with screws (20 and 128)

Refit the screws (20 and 128) which were removed during disassembly (tightening torque: 12+3 Nm) ***(Fig.52).***

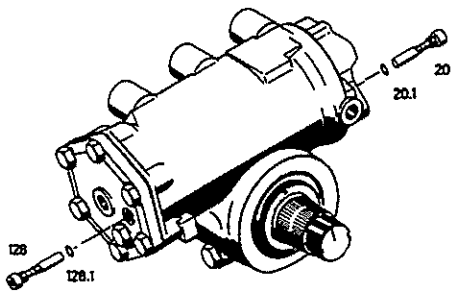


Fig.52

Attention:

→ These screws (20 and 128) may only be used for the functional tests described below.

→ New screws (20 and 128) must be fitted after the functional tests (tightening torque: 12+3 Nm).

→ The steering must subsequently not be turned to either limit position before being installed in the vehicle, otherwise the hydraulic steering limiter cannot be adjusted as specified.

19 Final assembly of steering gear

Note:
The final assembly described here must not be undertaken until the setting and functional tests (chapter IV.) have been completed on the test bench.

19.1 Fit plug (52)

19.1.1 Versions with gasket (51.2)

Oil or grease the inner groove of dust seal (51), the outer circumference of gasket (51.2) and the mating face of gasket (51.2) on housing (1) (see note in chapter III. with regard to type of grease) ***(Fig.53)***.

Insert stop-ring (51.1) in the groove of dust seal (51) and place gaskets (51.2) on the inside of stop-ring (51.1) or plug (52) so that the protruding nose points away from plug (52) and stop-ring (51.1).

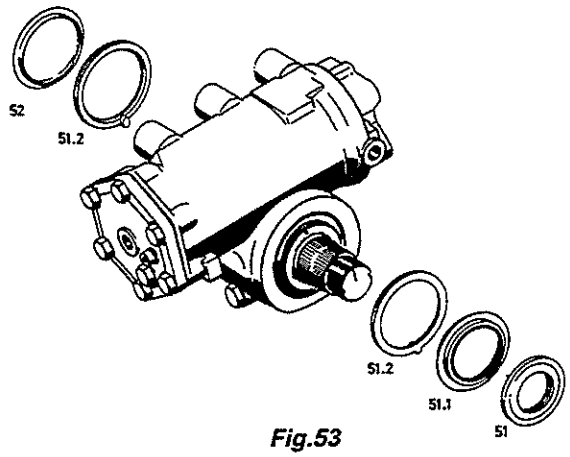


Fig.53

Slide the assembled dust seal (51) over the serration of sector shaft (80) by hand (the sector shaft must be kept as free of grease as possible) and press it into housing (1) until stop-ring (51.1) is flush with housing (1).

When fitting dust seal (51), ensure that the nose on gasket (51.2) fits exactly in the groove in housing (1).

On the opposite side of the serration on the sector shaft, press the preassembled plug (52) into housing (1) by hand until it is flush with housing (1).

When fitting plug (52), ensure that the nose on gasket (51.2) fits exactly in the groove in the housing.

Note:
Plug (52) may arch outwards due to air trapped under it during installation. For this reason, insert a small screwdriver between gasket (51.2) and housing (1) so that the trapped air can escape.

19.1.2 Versions without gasket (51.2)

Slip dust seal (51) and plug (52) onto sector shaft (80) after ensuring that the space between the dust lip and housing (1) is filled with grease (see note in chapter III. with regard to the type of grease) ***(Fig.54)***.

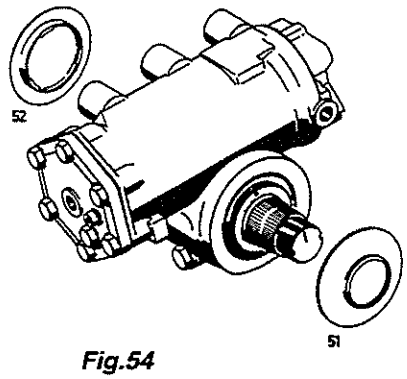


Fig.54

19.2 Fit protecting cap (53)

19.2.1 Versions with gasket (53.3)

Fit gasket (53.3) on the worm stub so that it fits exactly into the recess ***(Fig.55)***.

Press protecting cap (53) on as far as possible with tool [24]. Check assembly value of 5.4-0.2 mm (see illustration).

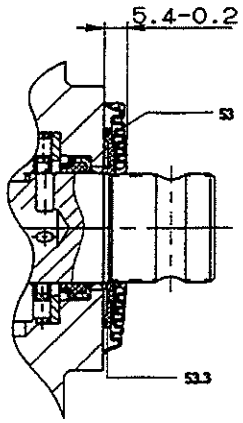


Fig.55

19.2.2 Versions without gasket (53.3)

Fit protecting cap (53) on the worm stub as far as possible with tool [24] after ensuring that the gap between dust lip and housing (1) is filled with grease (see note in chapter III. with regard to the type of grease).

19.2.3 Versions with retaining ring (53.1)

Slip protecting cap (53) onto the worm stub and fit retaining ring (53.1) ***(Fig.56)***.

19.3 Fit dust seal (314)

19.3.1 Bevel box versions with cross disc (348)

Fit dust seal (314) on bevel gear (306) after ensuring that the gap between adjusting screw (312) and dust lip is filled with grease (see note in chapter III. with regard to the type of grease) ***(see Fig.48)***.

Fit snap rings (314.1 and 314.2).

19.3.2 Angular gear versions with coupling sleeve (349)

Fit dust seal (314) on bevel gear (306) ***(see Fig.49)***.

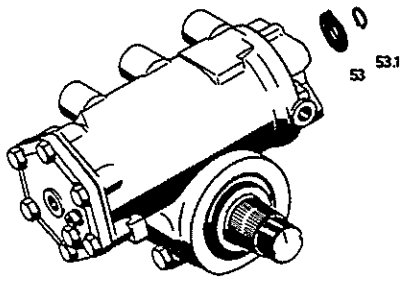


Fig.56

19.3.3 Check that the markings for the straight-ahead position are present as shown in ***Fig.57***.

Exception:
The markings may be in a different position in special versions. This is then indicated on the technical cover sheet of the spare parts list.

19.4 Versions with automatically adjusted steering limiter

Fit new screws (20 and 128) with new O-rings (20.1 and 128.1) (tightening torque: 12+3 Nm) ***(Fig.58)***.

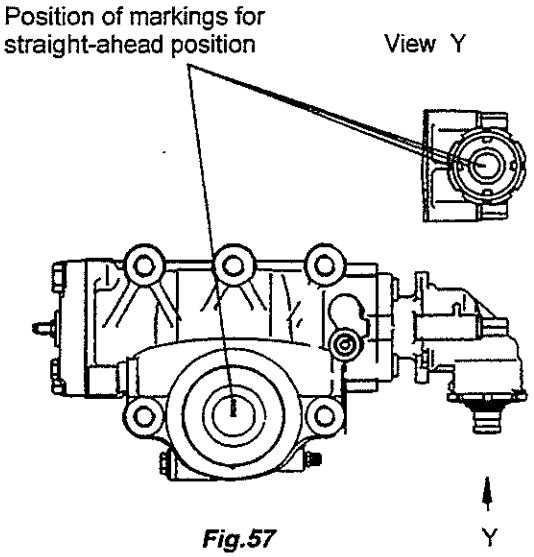


Fig.57

Attention:
The steering must not subsequently be turned to either limit position, otherwise the sliding sleeves of screws (20 and 128) are displaced into their limit position.

This then makes it impossible to adjust the hydraulic steering limiter in the vehicle as specified.

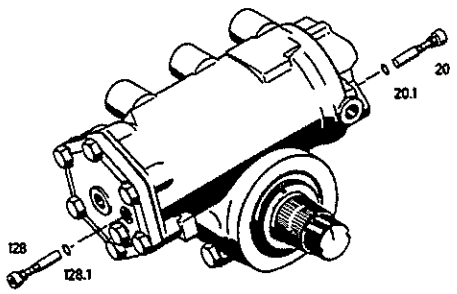


Fig.58

20 Checking the friction torque of the completely assembled steering gear

Mount tools [8], [9] and [10] on the steering shaft. Turn steering through from end to end and measure the friction torque outside the pressure point. Required value, see chapter VI.

The torque may vary by up to 40 Ncm when the steering is turned uniformly.

IV. Setting and functional test

Attention:
Every steering must undergo a setting and functional test on the test bench after being repaired in order to ensure traffic safety. The steering **must not** be installed in the vehicle without functional testing so that its correct function can subsequently be verified in a test drive.

Note:

→ All the required values, tolerances etc. necessary for this functional test are specified in the spare parts list. The values mentioned below apply if nothing is specified in the spare parts list.

→ The notes contained in the Instruction Manual for the test bench apply regardless of the following description.

1 Prepare steering for functional test

Set up completely assembled steering on test bench.

Connect delivery and return lines.

Attention:
Only lines and connections approved for the maximum pressure encountered may be used.

Additionally required for dual-circuit versions:
Seal ports for working cylinder with dummy plugs.

1.1 Bleed the steering:

❑ Versions with automatic bleeding:

These versions are fitted with automatic breather valves. It is therefore not necessary to open any breathers.

To bleed the steering, it must be turned from end to end several times. An unnecessarily high build-up of pressure must be avoided, since the breather valves are only effective in the continuous pressure range.

❑ Versions with breather (57):

Turn the steering so that breather (57) is positioned as near the top as possible.

Adjust the test bench to the flow rate specified below and do not turn the steering wheel.

Remove protecting cap (58) and open breather (57) by roughly one-half or a full turn.

Let air escape and reclose breather (57) when oil emerges.

Rapidly turn steering wheel from end to end several times and repeat bleeding procedure.

Torque breather (57) down to 30 Nm.

Refit protecting cap (58).

1.2 Set test bench: (Test temperature 50° C)

Note:
Test bench must be set to 20 bar above the maximum pressure specified on the rating plate for steering versions with built-in pressure limiter valve.

Pressure	Flow rate		
Type	8090:	150 bar	7 l/min
Type	8090 N:	170 bar	8 l/min
Type	8095:	150 bar	12 l/min
Types	8096-8099:	150 bar	16 l/min

2 Setting and functional test

2.1 Check absence of external leaks

The absence of external leaks must also be checked while carrying out the following tests 2.2 to 3.

2.2 Check maximum pressure

→ Determine the straight-ahead position by halving the total number of turns of the steering wheel or total steering angle.

→ Check or mark the middle on the steering shaft.

→ Lock steering in straight-ahead position.

→ Close steering valve by turning steering wheel in one direction.

→ A maximum pressure corresponding to the value set on the test bench must build up when the steering valve is fully deflected (approx. 100 N manual force applied to the steering wheel).

Note:
A maximum pressure corresponding to the value specified on the rating plate (tolerance: +10%) must build up if the steering is equipped with a pressure limiting valve.

→ Repeat the test for the other direction of rotation.

→ If the maximum pressure is not reached, this may be due to excessive leakage oil in the steering or to a defective pressure limiting valve.

→ If the maximum pressure is exceeded, the pressure limiting valve must be replaced or the setting of the pressure limiting valve on the test bench checked if the steering does not have a built-in pressure limiting valve.

2.3 Check oil leakage

2.3.1 Check oil leakage at a high flow rate

→ Lock steering in straight-ahead position.

→ The leakage oil draining into the return line should be measured at the following pressure when the steering valve is fully deflected (approx. 100 N manual force applied to the steering wheel):

Steering systems with built-in pressure limiting valve:
20 bar below the maximum pressure specified on the rating plate.

Steering systems without pressure limiting valve:
150 bar

Maximum permissible oil leakage:

Type 8090:	1.5 l/min
Types 8095-8099:	2.0 l/min

2.3.2 Check oil leakage at reduced flow rate

→ Set test bench to a flow rate of 2-3 l/min.

→ Check oil leakage as described above. The oil leakage established in section 2.3.1 must not be exceeded.

2.4 Check hydraulic centre

2.4.1 Steering not locked

→ Slowly turn steering through to the end in both directions with tools [8], [9] and [10], letting it go several times in the process.

The steering must not move in either direction of its own accord.

2.4.2 Steering locked in straight-ahead position

→ Turn steering shaft to lock steering valve in one direction until the pressure on the pressure gauge has risen 3 bar above the continuous pressure.

→ Read off the value on tools [9] and [10].

→ Repeat the measurement in the opposite direction.

The difference in torques when steering to the right or left must not exceed 30% referred to the higher value.

2.5 Valve reset

→ Lock steering in straight-ahead position.

→ Set test bench to previous values.

→ Turn steering wheel to close steering valve, thus building up the maximum pressure.

Slowly release the steering wheel and adjust to a pump pressure 10 bar above the continuous pressure.

The valve must then return to the neutral position, i.e. the oil pressure must drop to the continuous pressure within one second.

→ Check steering hitch:

There must not be any perceptible hitch when alternately turning the steering wheel in the other direction three times in succession at approx. 50 bar (hydraulic steering hitch).

2.6 Set hydraulic steering limiter

→ Set counterforce on test bench.

2.6.1 Versions with manually adjusted steering limiter (identified through collar nuts (21 and 129))

→ Turn the steering until the steering drop arm is deflected 47° and the hydraulic steering limiter is tripped.

Note:
Steering systems for which a different special switching range of 35 - 42°, for example, is specified in the spare parts list must be set to the explicitly specified maximum value, e.g. 42°.

→ Turn set screw (20 or 128) until the oil pressure drops to 40 - 50 bar and a considerably greater effort is required to turn the steering outwards.

Attention:
In all cases, ensure that the set screws (20 and 128) are screwed in by at least three turns, otherwise they may be forced out when the maximum pressure is applied.

→ Tighten the collar nut (21 or 129) down to 20+10 Nm.

→ Repeat adjustment for other side.

2.6.2 Versions with automatically adjusted steering limiter (identified through screws (20 and 128))

Note:
The screws (20 and 128) originally fitted are merely used to check whether the steering limiter valve opens, but without adjusting the switching range.

Attention:
The steering limiter may only be adjusted after installation and with new screws (20 and 128) in the case of these versions.

→ Turn steering in one direction and check that the pressure drops to 40 - 50 bar when the steering limiter valve opens.

→ Repeat test for other side.

3 Additionally required for dual-circuit versions

3.1 Check the maximum pressure, the hydraulic centre and valve reset for the second circuit as described in section 2.

3.2 Check oil leakage

3.2.1 Check oil leakage for circuit II

→ Connect delivery and return lines to circuit II.

→ Seal ports for working cylinder of circuit II with dummy plugs.

→ Check oil leakage as described in section 2.3.

Maximum permissible oil leakage for circuit II: 2 l/min

3.2.2 Measure oil leakage for sealing elements (164, 164.1, 172 and 173) separating circuits I and II.

→ Lock steering in straight-ahead position.

→ Then remove the screw plug (55) in the bottom of the housing or screw plug (55) in cylinder cover (125) if the former is not installed or unscrew the corresponding return line and drain off the oil

→ Drain the oil until the oil level in the housing reaches the drainage hole and the flow of oil ceases.

→ Seal the two working cylinder ports in circuit II with dummy plugs. Apply a pressure set to 3 bar above the continuous pressure on the test bench to the delivery line of circuit II. Collect the oil leaking from the housing bore or return line port of circuit I in a beaker for precisely one minute.

Max. permissible oil leakage: 0.001 dm^3/min (1 cm^3/min).

→ This test must be performed statically with the control valve not deflected.

→ Check oil leakage again dynamically at a pressure of 30 bar (set on the test bench), steering valve fully deflected once to the right and left.

3.3 Set hydraulic steering limiter

3.3.1 Steering limiter in piston

Set as described in section 2.6.

3.3.2 Steering limiter in housing cover

Turn steering in one direction until the steering drop arm is deflected as specified in the spare parts list for steering circuit II to trip the hydraulic steering limiter.

Turn valves (36) until the oil pressure drops to 30 - 40 bar and a considerably greater effort is required to turn the steering further outwards.

Torque hex nuts (38) down to 25 - 35 Nm.

4 Remove steering from test bench

Drain off the test oil by turning the steering shaft several times in both directions.

Remove steering from test bench.

Versions with automatically adjusted steering limiter

→ Affix note on settings, order number 7012 782 115, to the steering.

Versions with manually adjusted steering limiter

→ Affix note on settings, order number 7012 782 116, to the steering.

5 Check friction torque of completely assembled steering

Mount tools [8], [9] and [10] on steering shaft.

Turn steering through from end to end and measure friction torque within and beyond the pressure point.

Required values, see chapter VI.

The torque may deviate by up to max. 40 Ncm outside the pressure point when the steering is turned uniformly.

6 Affix repair code number

7 Carry out final assembly as described in chapter III. section 19.

V. Troubleshooting

Notes:

→ The ZF Servocom hydraulic steering has been built for heavy loads. It is designed in such a way that faults cannot develop if it is serviced correctly and operated normally.

→ If faults do develop, however, the following sections will help to locate and eliminate them.→ Before attempting to locate individual faults in the steering, the oil level must be checked with the engine running.

→ At the same time, attention is explicitly drawn to the fact that faults can occur when using oil with a strong tendency to foam, since such oil releases very little or none of the air entrained into the steering system.

Fault	Cause	Remedy
Moves stiffly in both directions	→ Sealing elements (116, 117, 119, 169, 170) defective	→ Replace
	→ Internal fault	→ Repair
		→ Replace
	→ Valve insert (22) defective	→ Replace
For dual-circuit versions also:		—
	→ Working cylinder defective	→ Repair
		→ Replace
	→ Sealing elements (159/164) defective	→ Replace
Moves stiffly in one direction	→ Valve insert (109) defective	→ Replace
	→ Sealing element (123) defective	→ Replace
	→ Internal fault	→ Repair
		→ Replace
For dual-circuit versions also:		
	→ Valves (36) defective/ wrongly set	→ Repair → Replace
		→ Adjust
	→ Sealing element (164) defective	→ Replace
Steering hitch	→ Air in oil	→ Bleed

Fault	Cause	Remedy
Obstructed return travel	→ Excessive friction torque in steering	→ Check friction torque - see chapter IV.
Imprecise straight-ahead travel	→ Wrong friction torque	→ Check friction torque - see chapter IV.
Steering wheel knocks	→ Backlash in recirculating ball element or wrong friction torque	→ Check - see chapter III.
	→ Excessive backlash in worm bearing	→ Check - see chapter III.
	→ Centre engagement piston - sector shaft	→ Check - see chapter III.
Backlash in steering wheel	→ Backlash in recirculating ball element or wrong torque	→ Check - see chapter III.
	→ Excessive backlash in worm bearing	→ Check - see chapter III.
	→ Centre engagement piston - sector shaft	→ Check - see chapter III.
Steering drifts	→ Hydraulic centre not OK	→ Replace piston/ worm assembly
Loss of oil	Sealing elements (2, 5, 8, 124, 310 and 310.1) defective	→ Replace - see chapter III.
	→ Leak in lines or connections	→ Repair [1]
Noises	→ Worm defective	→ Repair → Replace
	→ Valve insert (22) and(32) defective	→ Repair → Replace
	→ Air in oil	→ Bleed
	→ Loose connections	→ Retighten

[1] See vehicle manufacturer's manual

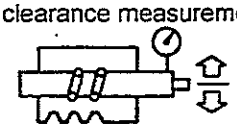
VI. Friction torques, adjustment values and tightening torques

❑ Friction torques:

Recirculating ball element:

Friction torque measurement

Tilting clearance measurement



New parts	Disassembled parts
In middle area: Type 8090: 5-20 Ncm Types 8095-8099: 5-30 Ncm	In middle area: max. 0.1 mm Tilting clearance or for type 8090: max. 20 Ncm for types 8095-8099: max. 30 Ncm
Outside the middle area: Additional increase of max. 15 Ncm	Outside the middle area: Max. increase to for type 8090: 35 Ncm for types 8095-8099: 60 Ncm

Increase in friction torque at the pressure point:

Type	8090:	20-60 Ncm
Types	8095/8096:	20-80 Ncm
Types	8097-8099:	20-100 Ncm

Completely assembled steering outside the pressure point:

Type Transmission constant (e.g. i_1, i_2 ...) and variable (e.g. iv_1, iv_2 ...)	Friction torque [Ncm] without bevel box	 with bevel box
8090		
i_1 = 15.2 : 1	max. 160	max. 240
iv_1 = 16.6 : 1 / 14.0 :1		
i_2 = 18.0 : 1	max. 140	max. 220
iv_2 = 19.6 : 1 / 16.6 : 1		

				8095						
i_1	=	17.0	:	1				max. 180		max. 260
iv_1	=	18.5	:	1	/	15.6	:1	max. 160		max. 240
i_2	=	19.6	:	1						
iv_2	=	21.3	:	1	/	18.1	:1	max. 140		max. 220
i_3	=	23.1	:	1						
iv_3	=	25.2	:	1	/	21.3	:1			
				8097						
i_1	=	16.6	:	1				max. 200		max. 280
iv_1	=	18.2	:	1	/	15.4	:1			
i_2	=	18.9	:	1				max. 180		max. 260
iv_2	=	20.6	:	1	/	17.4	:1			
i_3	=	21.8	:	1				max. 160		max. 240
iv_3	=	23.7	:	1	/	20.1	:1			
i_4	=	25.7	:	1				max. 140		max. 220
iv_4	=	28.1	:	1		23.8	: 1			
				8098						
i_1	=	18.3	:	1				max. 220		max. 300
iv_1	=	20.1	:	1	/	17.0	:1			
i_2	=	20.7	:	1				max. 200		max. 280
iv_2	=	22.6	:	1		19.2	: 1			
i_3	=	23.9	:	1				max. 180		max. 260
iv_3	=	26.1	:	1		22.1	: 1			

Type Transmission constant (e.g. i_1, i_2 ...) and variable (e.g. iv_1, iv_2...)								**Friction torque [Ncm] without bevel box - add-on cylinder**	**without bevel box + add-on cylinder**	**with bevel box - add-on cylinder**	**with bevel box + add-on cylinder**
				8096							
i_1	=	17.0	:	1				max. 210	-	max. 290	-
iv_1	=	18.5	:	1	/	15.6:1					
i2	=	19.6	:	1				max. 190	-	max. 270	-
iv_2	=	21.3	:	1	/	18.1:1					
i_3	=	23.1	:	1				max. 170	-	max. 250	-
iv_3	=	25.2	:	1		21.3:1					
				8099							
i_1	=	18.3	:	1				max. 250	max. 320	max. 330	max. 400
iv_1	=	20.1	:	1	/	17.0:1					
i_2	=	20.7	:	1				max. 230	max. 300	max. 310	max. 380
iv_2	=	22.6	:	1		19.2:1					
i_3	=	23.9	:	1				max. 210	max. 280	max. 290	max. 360
iv_3	=	26.1	:	1	/	22.2:1					

❑ Adjustment values:

Protecting cap (53) - Fitting value			5.4 - 0.2 mm
Plug (112) - Radial clearance	Type	8090:	max. 0.1 mm
	Types	8095-8099:	max. 0.5 mm
	Type	8099 with add-on cylinder:	max. 0.2 mm
Needle cage (120) - Axial clearance (at room temperature)	Type	8090:	0.005 - 0.025 mm
	Types	8095/8096:	0.010 - 0.030 mm
	Type	8097:	0.015 - 0.035 mm
	Types	8098/8099:	0.020 - 0.040 mm
Sliding tube (156) - Axial clearance			max.0.1 mm
Piston (258) - Installed value			60.7±0.2 mm

❑ Tightening torques:

Screw (20)			12+3 Nm
Collar nut (21)			20+10 Nm
Valve insert (22)			30+10 Nm
Valve insert (22.1)			30+10 Nm
Screw (30)			30+10 Nm
Hex nut (38)			25-35 Nm
Screw plug (55)		M16:	40 Nm
		M18:	50 Nm
Breather (57)			30 Nm
Valve insert (109)			15±1 Nm
Hexagon screws (127)	Type	8090 (M12x1.5):	135 Nm
	Types	8095/8096/8097 (M16x1.5):	285 Nm
	Types	8098/8099 (M14x1.5):	189 Nm
Screw (128)			12+3 Nm

Collar nut (129)		20+10 Nm
Cap screws (204)		140 Nm
Pipe union (205)		50 Nm
Pipe union (206)		50 Nm
Screw plug for pipe unions (205) and (206)		59 Nm
Union screws (211)		20±2 Nm
Switch (222)		50 Nm
Cap screw (223)	Type 8096 (M8):	37 Nm
	Type 8098 (M6) (version with switch):	5.5 Nm
Pipes (225)	Type 8096:	12+2 Nm
	Type 8099:	18+2 Nm
Pipes (226)	Type 8096:	12+2 Nm
	Type 8099:	18+2 Nm
Torx screw (250.1)		5 Nm
Hexagon screw (252)		500 Nm
Adjusting screw (312)		50 Nm
Slotted nut (313)		50 Nm
Cap screw (334)		140 Nm
Hexagon screw (352)		62 Nm

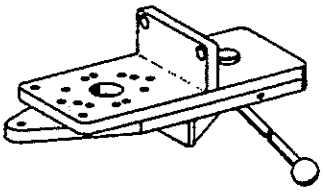
VII. Special tools

Note:
The special tools listed below refer to the standard version and the design version on the basis of which the entire manual has been compiled. Other tools may consequently be required for the particular unit in question.

8090	8095	8096	8097	8098	8099
7418 798 654					
8098 798 151					
8090 798 006	8095 798 002		8097 798 002	8098 798 002	
8090 798 201					

Tool [1]

Assembly vice

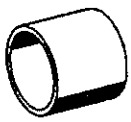


Tool [2]

Insert for screw–out and screw–in the valve insert (109)

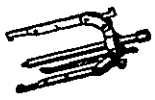
Tool [3]

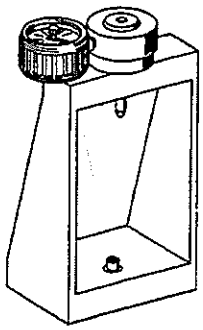
Sleeve for pressing the housing covers (4)



Tool [4]

Puller for housing cover (4)

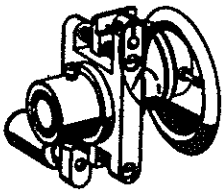


	8090	8095	8096	8097	8098	8099
Tool [5] Guide bush for housing cover (4) 		8043 798 001				
Tool [6] Peening fixture for valve insert (109) 		8090 798 655				
Tool [7] Punch for screwed valve insert (109) 		8098 798 654				
Tool [8] Insert for tool [9]  	serration 1x54	7/8"x48	1x79	1x75	7/8x48	1x79
	8052 798 552	8043 798 551	7419 798 551	7418 798 553	8043 798 551	7419 798 551
		serration 1x79	A6x23x26	1x79	1x79	A6x23x26
		7419 798 551	8065 798 552	7419 798 551	7419 798 551	8065 798 552

8090	8095	8096	8097	8098	8099
Valve slide			ø25	ø25,99	
			7421 798 551	8097 798 554	
Valve slide serration			ø25,99	24/48x22	
			8097 798 554	8038 798 551	
7470 798 703					
7470 798 706					
8090 798 004	8090 798 001				
		8090 798 005		8090 798 005	

Tool [9]

Torque measuring device



Tool [10]

Dial gauge: Graduation 0.01 mm

Tool [11]

Guide bush for sealing rings (164)

for dual–circuit version

Tool [12]

Pliers for pressing on the sealing rings (164)

Tool [13]

Sleeve for mounting the O–ring (172) and the sealing ring (173)

Tool [14]

Mandrel for shaft seal (8)

Tool [15]

Guide bush for shaft seal (8)

8090	8095	8096	8097	8098	8099
8090 798 652	8090 798 651				
		8096 798 001			8096 798 001
8090 798 052	8090 798 051				
8090 798 002	8090 798 003				

Tool [16]

Dial gauge holder for adjustment of axial play–worm

8090	8095	8096	8097	8098	8099
		serration			
1x54	7/8"x48	1x79	1x75	7/8x48	1x79
8090 798 101	8095 798 102	8095 798 101	8097 798 101	8095 798 102	8095 798 101
		serration			
	1x79	A6x23x26	1x79	1x79	A6x23x26
	8095 798 101	8097 798 102	8095 798 101	8095 798 101	8097 798 102
		Valve slide	serration		
			ø25	24/48x22	
			8095 798 101	8097 798 101	
		Valve slide			
			ø25.99		
			8097 798 102		

Tool [17]

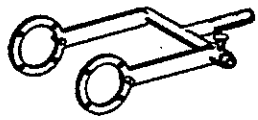
Dial gauge graduation 0.001 mm for tool [16]

7016 798 704

8090	8095	8096	8097	8098	8099
8090 798 151					
8090 798 551	8095 798 551		8097 798 551	8098 798 551	
8090 798 654					
				8090 798 656	

Tool [18]

Adjusting device for pressure point setting

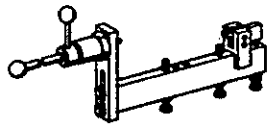


Tool [19]

Insert for tool [18]
(2 pieces are required)

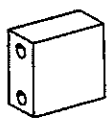
Tool [20]

Assembly tool for prying over of housing covers (4)



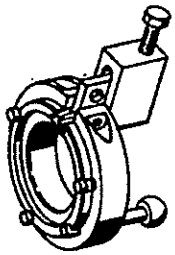
Tool [21]

Extension for tool [20]
for steerings with C–mass >137 mm



Tool [22]

Assembly tool for threefold prying

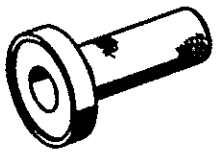


Tool [23]

Insert for torx screw (250.1)

Tool [24]

Mandrel for pressing the protecting cap (53)

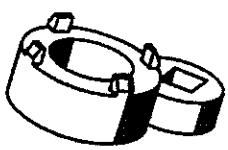


8090	8095	8096	8097	8098	8099
		8096 798 651		8098 798 651	
					7016 798 152
8090 798 053	8095 798 051				

Bevel box with cross disc (348)

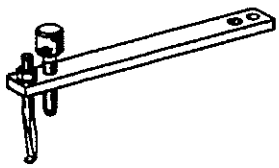
Tool [25]

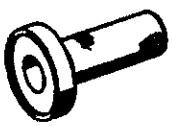
Grooved nut wrench for adjusting screw (312)



8096	8097	8098	8099
1249 898 151			

	8096	8097	8098	8099
Tool [26] Puller for needle sleeve (302) 	7421 798 201			
Tool [27] Counter for tool [26] and [34] 	7421 798 351			
Tool [28] Mandrel for ball bearing (343) 	7421 798 051			
Tool [29] Mandrel for needle sleeve (302) 	7677 798 051			
Tool [30] Press–in sleeve for ball bearing (332) 	7330 798 053			

	8096	8097	8098	8099
Tool [31] Mandrel for shaft seal (310 and 310.1) 	7418 798 051			
Tool [32] Guide bush for shaft seal (310 und 310.1) 	8090 798 003			
Bevel box with coupling sleeve (349)				
Tool [33] Puller for shaft seal (310) 	8052 798 201			
Tool [34] Puller for needle sleeve (302) 	8098 798 201			
Tool [35] Extension for tool [34] 	8098 798 202			

	8096	8097	8098	8099
Tool [36] Mandrel for needle sleeve (302) 	8098 798 052			
Tool [37] Sleeve for shaft seal (310.1) 	8090 798 006			
Tool [38] Guide bush for shaft seal (310) 	8098 798 003			
Tool [39] Mandrel for shaft seal (310) 	8098 798 051			

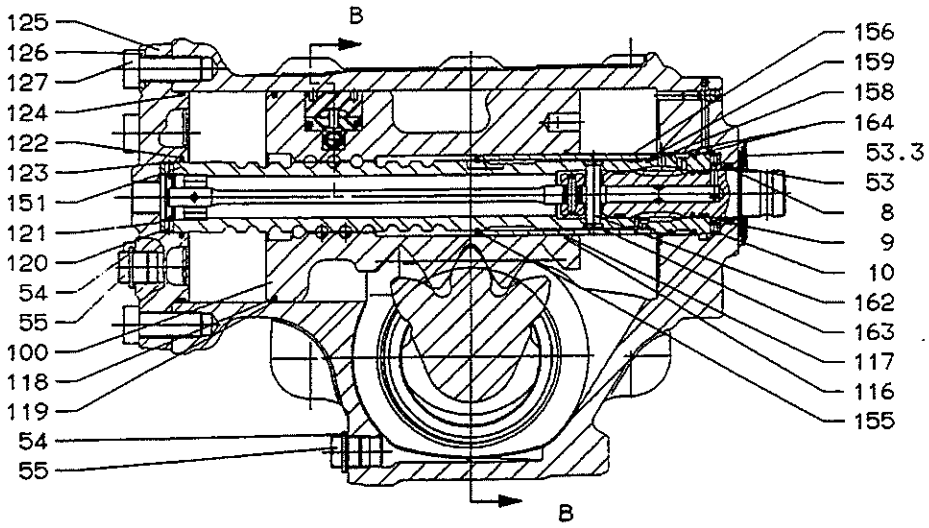
VIII. Key to numbers in figures, sectional drawings and exploded drawings

1.0	Housing
2.0	O-ring
3.0	Washer
4.0	Housing cover
5.0	Gasket
6.0	Support ring
7.0	Retaining ring
8.0	Shaft seal
9.0	Axial-, washer
10.0	Needle cage
11.0	Type plate
12.0	Grooved stud
14.0	Holding segment
20.0	Set screw / Adjusting screw / Screw
20.1	O-ring
21.0	Collar nut
22.0	Valve insert
22.1	Valve insert
23.0	O-ring
30.0	Screw
31.0	O-ring
32.0	Valve insert
34.0	O-ring
35.0	O-ring
36.0	Valve
37.0	Washer
38.0	Hex nut
50.0	Locking nut
51.0	Dust seal
51.1	Stop-ring
51.2	Gasket
51.9	Dust seal
52.0	Plug
53.0	Protecting cap
53.1	Retaining ring
53.3	Gasket
54.0	Sealing ring
55.0	Screw plug
56.0	Protecting sleeve
57.0	Breather
58.0	Protecting cap
63.0	Stick-on label
80.0	Sector shaft
100.0	Piston
101.0	Piston
109.0	Valve insert
110.0	Ball set
111.0	Recirculating half tube
112.0	Gasket/Plug
113.0	Gasket
113.1	Compensating plate
113.2	Pin
114.0	O-ring
115.0	Sealing ring
116.0	Sealing ring
117.0	Sealing ring
118.0	O-ring
119.0	Gasket
120.0	Needle cage
121.0	Washer
122.0	O-ring
123.0	Sealing ring
124.0	O-ring
125.0	Cylinder cover
126.0	Washer
127.0	Hexagon screw
127.1	Screw
128.0	Set screw / Screw
128.1	O-ring
129.0	Collar nut
150.0	Worm
151.0	Worm
155.0	Snap ring
156.0	Sliding tube
157.0	Bush
158.0	O-ring
159.0	Sealing ring
160.0	Pin
161.0	Worm
162.0	Pin

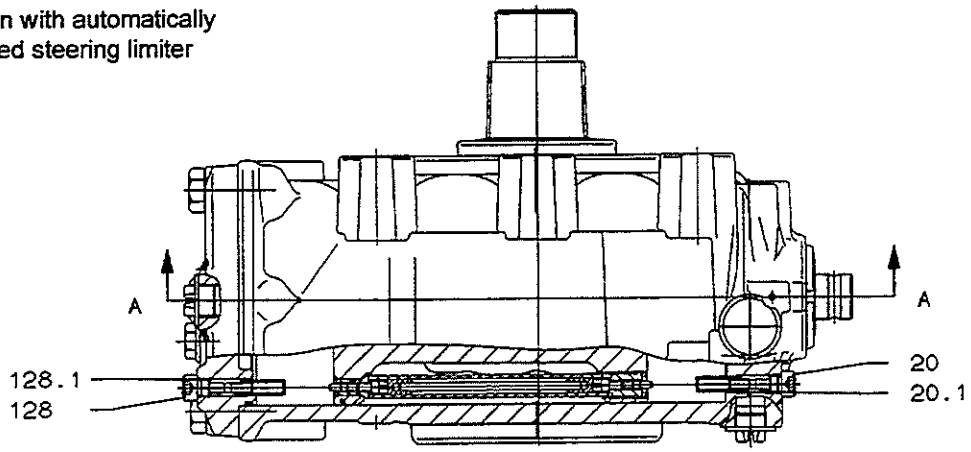
163.0	Plug
164.0	Sealing ring
164.1	O-ring
165.0	Torsion bar
166.0	Needle cage
166.1	Snap ring
167.0	Pin
168.0	Valve slide
169.0	O-ring
170.0	Sealing ring
171.0	Needle cage
172.0	O-ring
173.0	Sealing ring
174.0	Control sleeve
200.0	Ball cage
201.0	Bearing ring
202.0	O-ring
203.0	Valve housing
204.0	Cap screw
205.0	Pipe union
206.0	Pipe union
207.0	Pipe
208.0	Pipe
209.0	O-ring
210.0	O-ring
211.0	Union screw
212.0	Pipe
220.0	O-ring
221.0	Housing cover / Cover
222.0	Steering limiter kit / Switch
222.1	Washer
223.0	Cap screw
224.0	O-ring
225.0	Pipe
226.0	Pipe
227.0	Cam disc
228.0	Retaining ring
250.0	Add-on cylinder
250.1	Torx screw
251.0	Washer
252.0	Hexagon screw
253.0	Bush
254.0	Gear
255.0	O-ring
256.0	O-ring
257.0	Gasket
258.0	Piston
259.0	Cylinder cover
260.0	O-ring
261.0	Retaining ring
301.0	Housing
302.0	Needle sleeve
304.0	Washer
306.0	Bevel gear
308.0	O-ring
310.0	Shaft seal
310.1	Shaft seal
310.2	Retaining ring
310.3	Retaining ring
310.4	Retaining ring
312.0	Adjusting screw
313.0	Slotted nut
314.0	Dust seal / Protecting cap
314.1	Snap ring
314.2	Snap ring
330.0	Shim plate
331.0	Bevel gear
332.0	Ball bearing
333.0	O-ring
334.0	Cap screw
335.0	Intermediate flange
335.1	Pipe
335.2	Pipe
341.0	O-ring
343.0	Ball bearing
346.0	Centering ring
348.0	Cross disc
349.0	Coupling sleeve
350.0	Washer
352.0	Hexagon screw/Screw/ Cap screw

Types 8090 - 8099

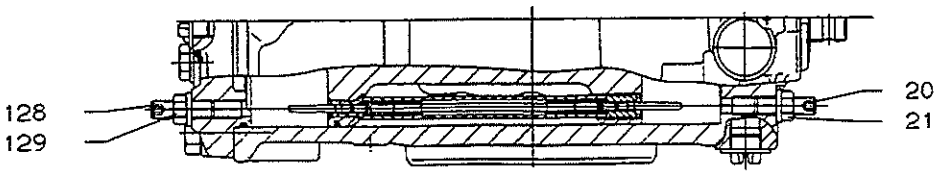
Section A-A



Version with automatically adjusted steering limiter

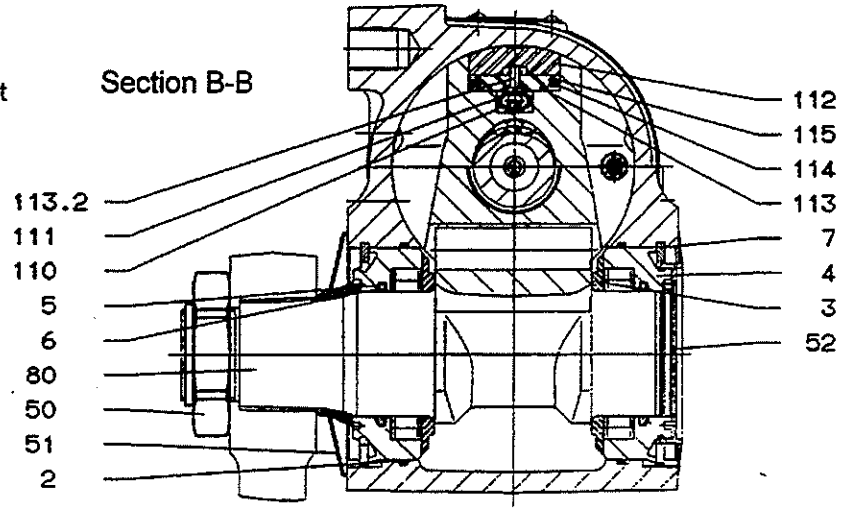


Version with manually adjusted steering limiter



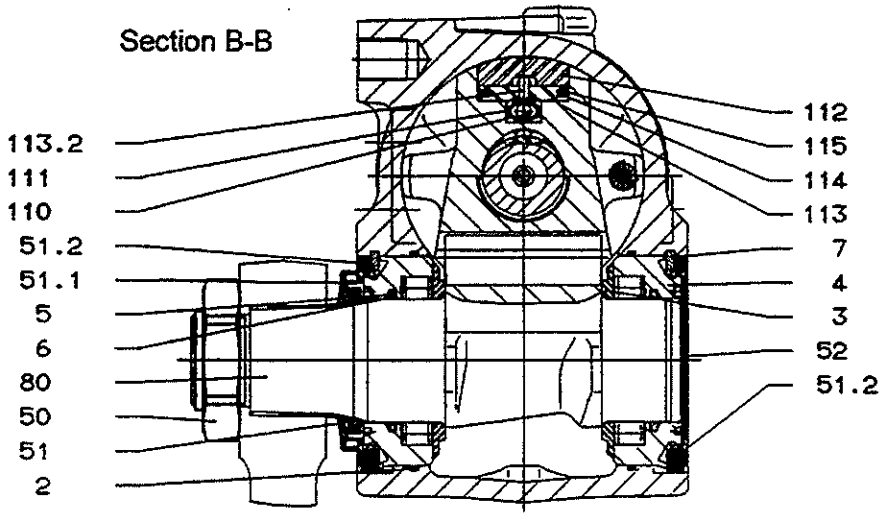
Version without gasket (51.2)

Section B-B



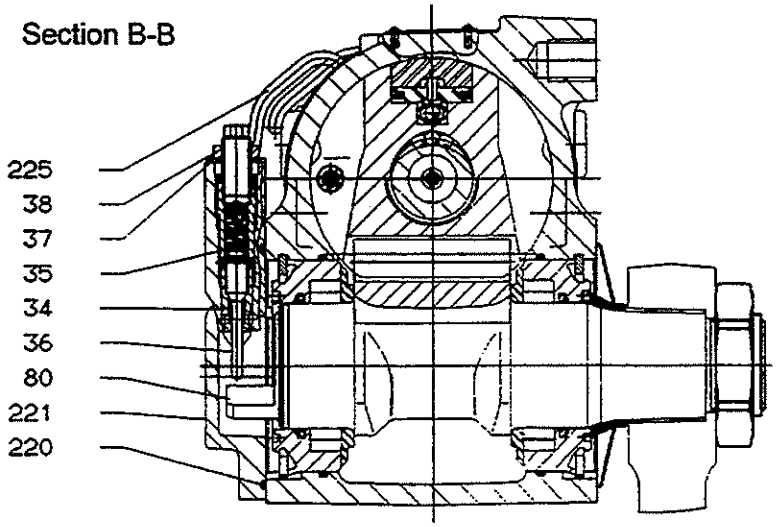
Version with gasket (51.2)

Section B-B

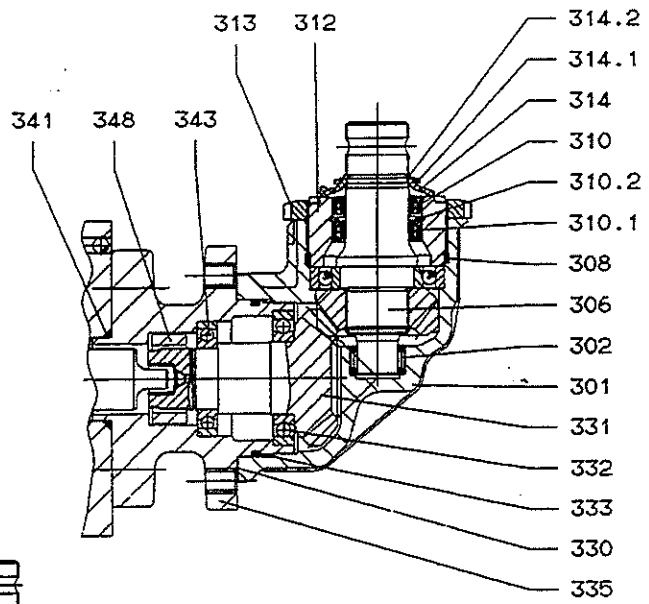


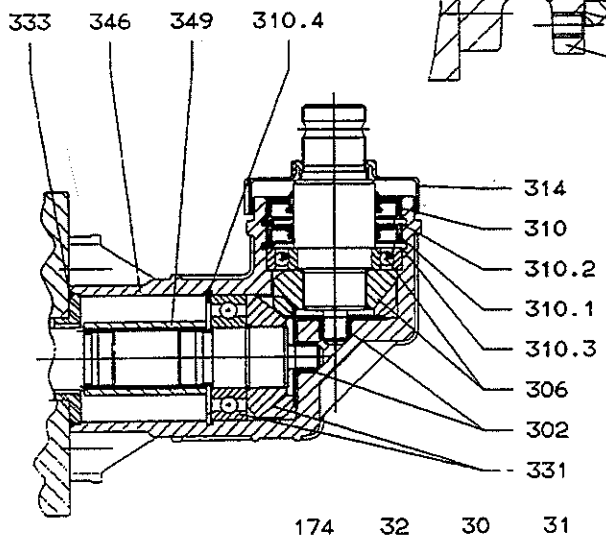
Dual–circuit version with steering limiter in housing cover (221)

Section B-B



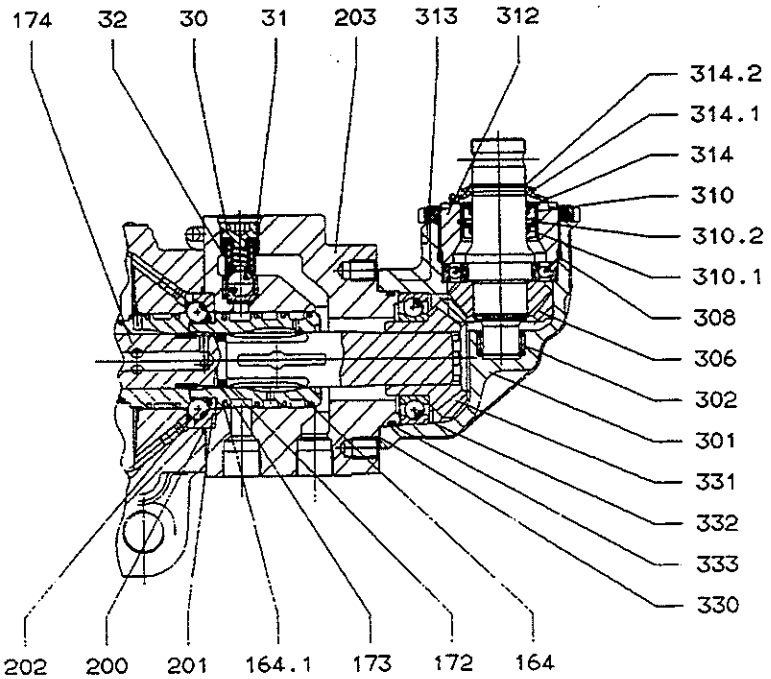
Bevel box with cross disc (348)

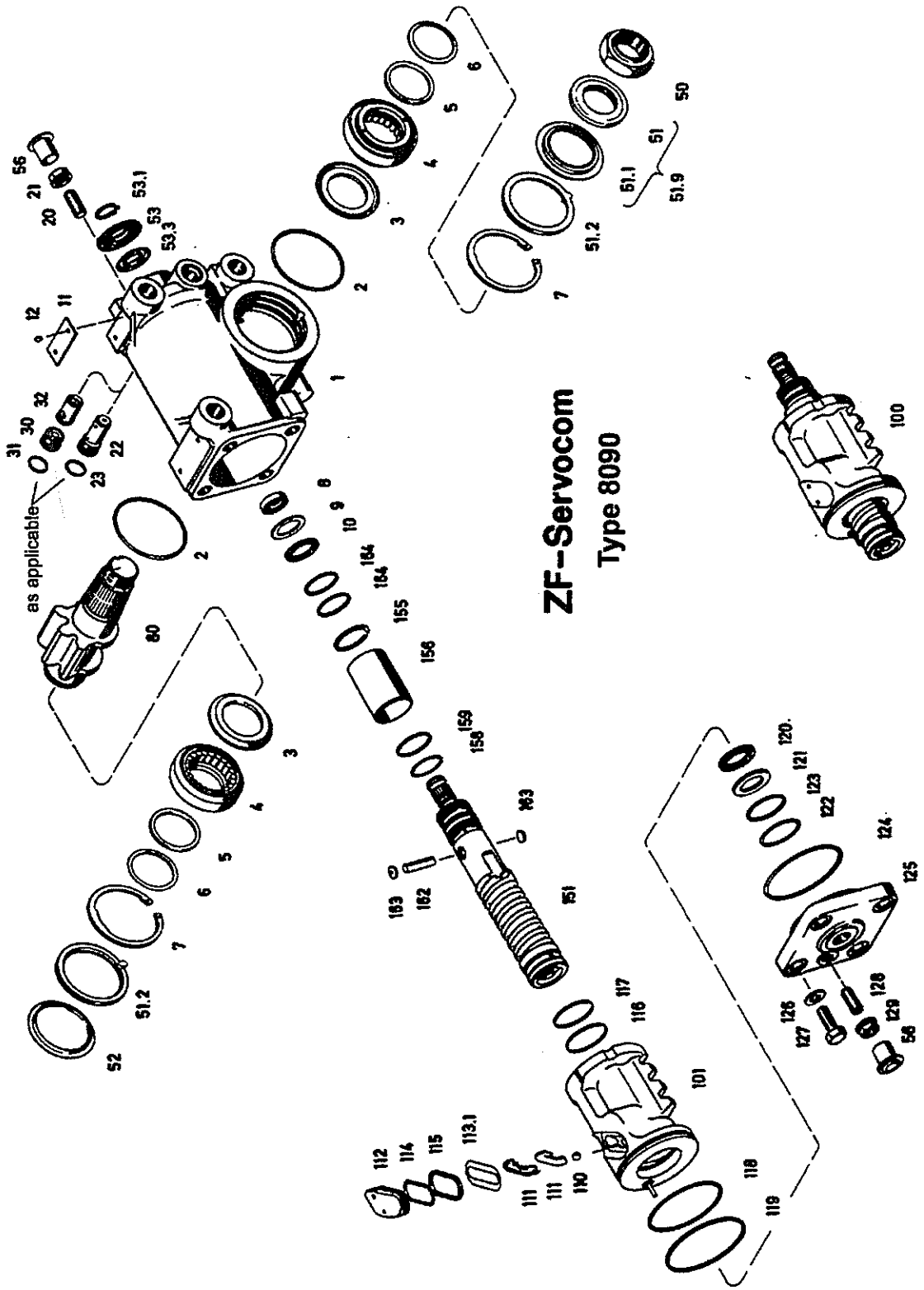




Bevel box with coupling sleeve (349)

Dual–circuit version with bevel box

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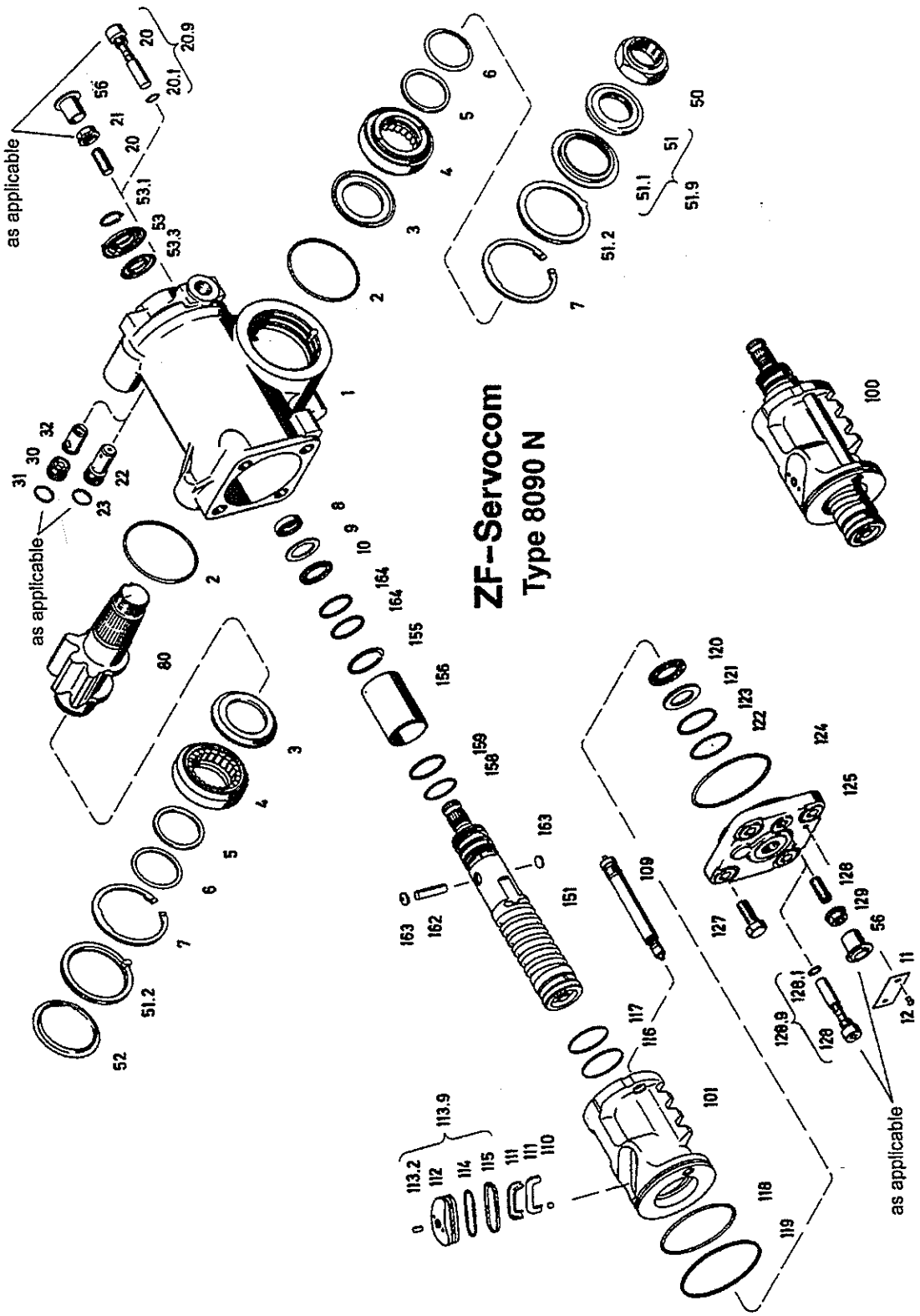
Type 8090
as applicable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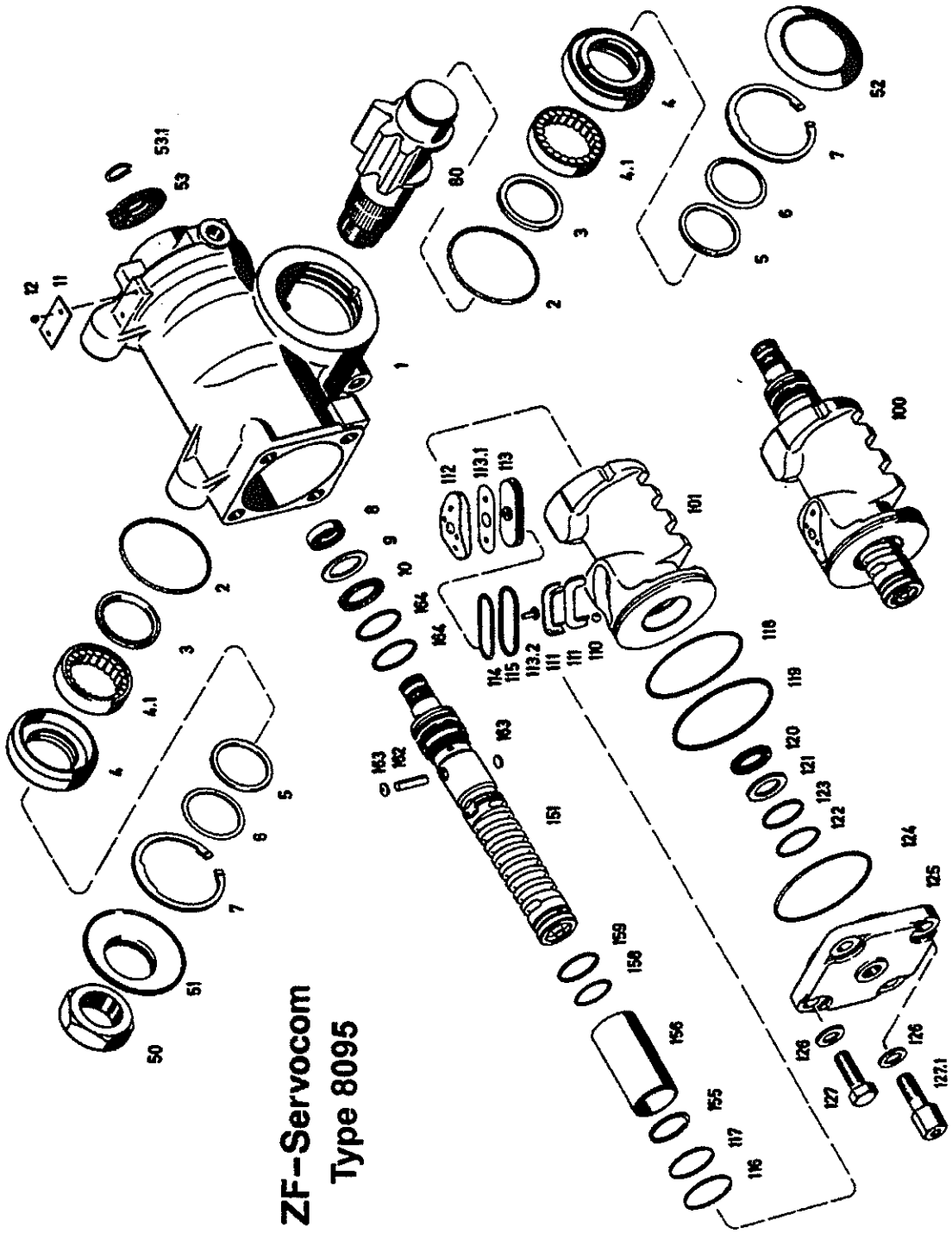
Type 8090 N
as applicable
as applicable
as applicable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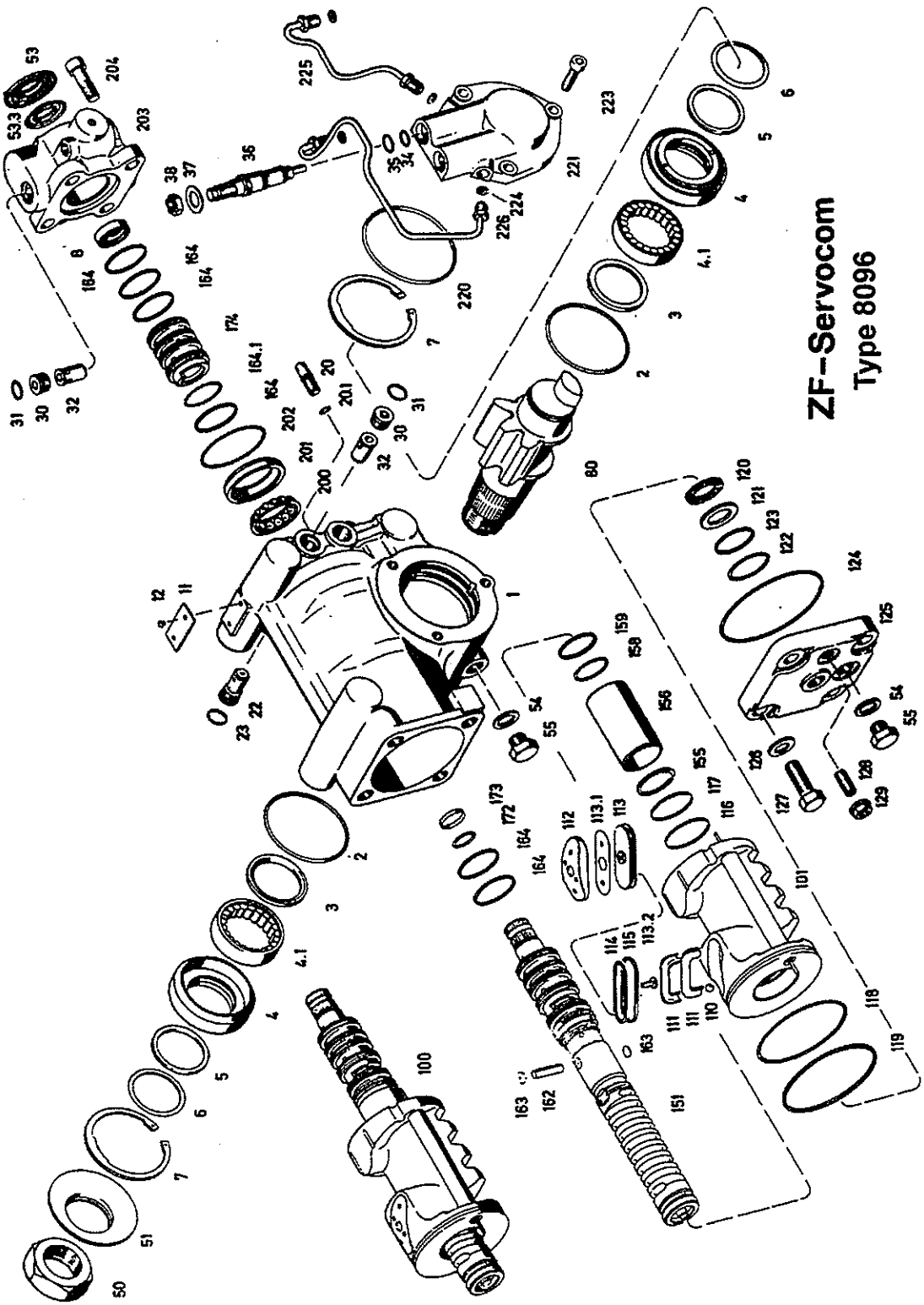
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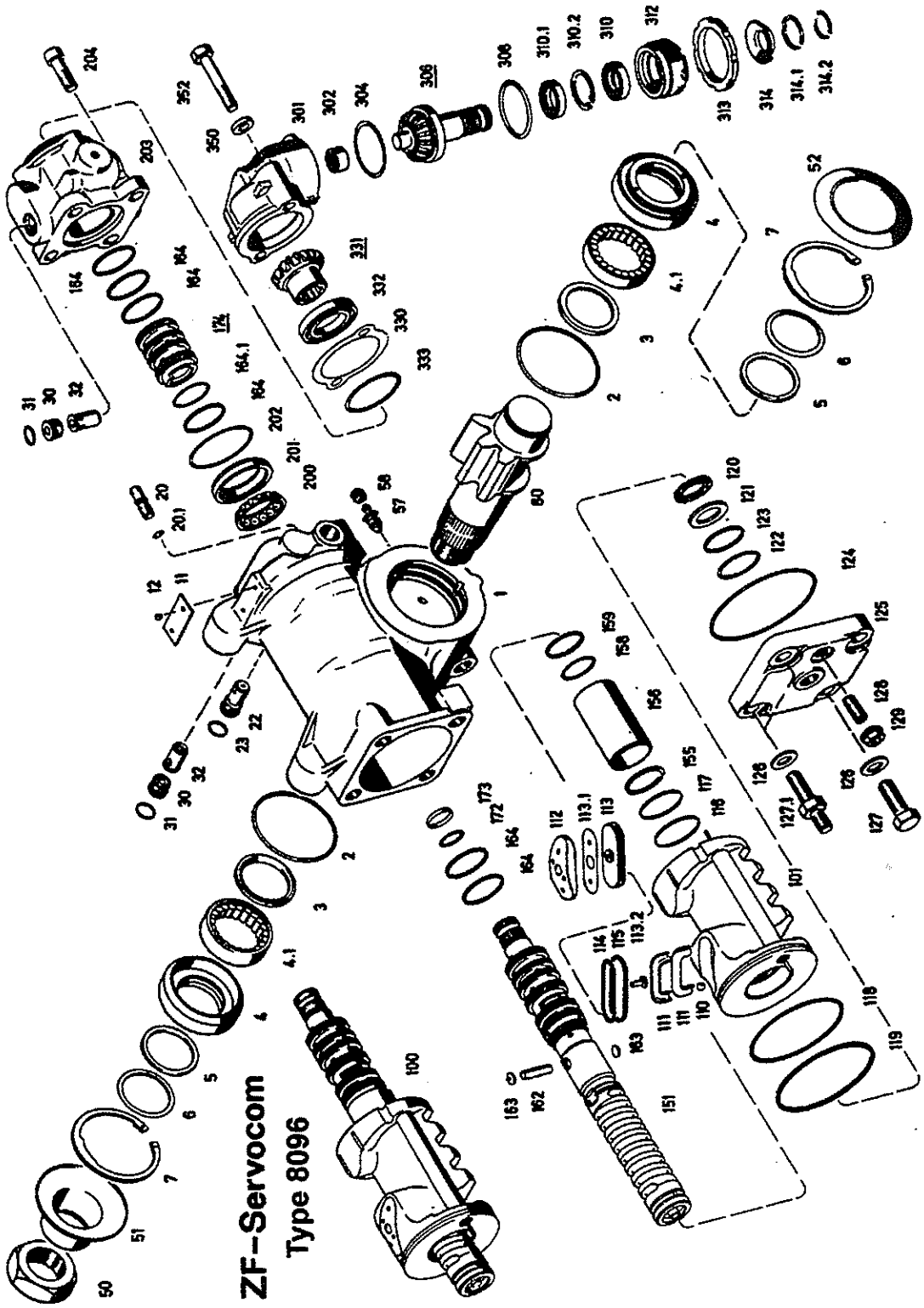
Type 8096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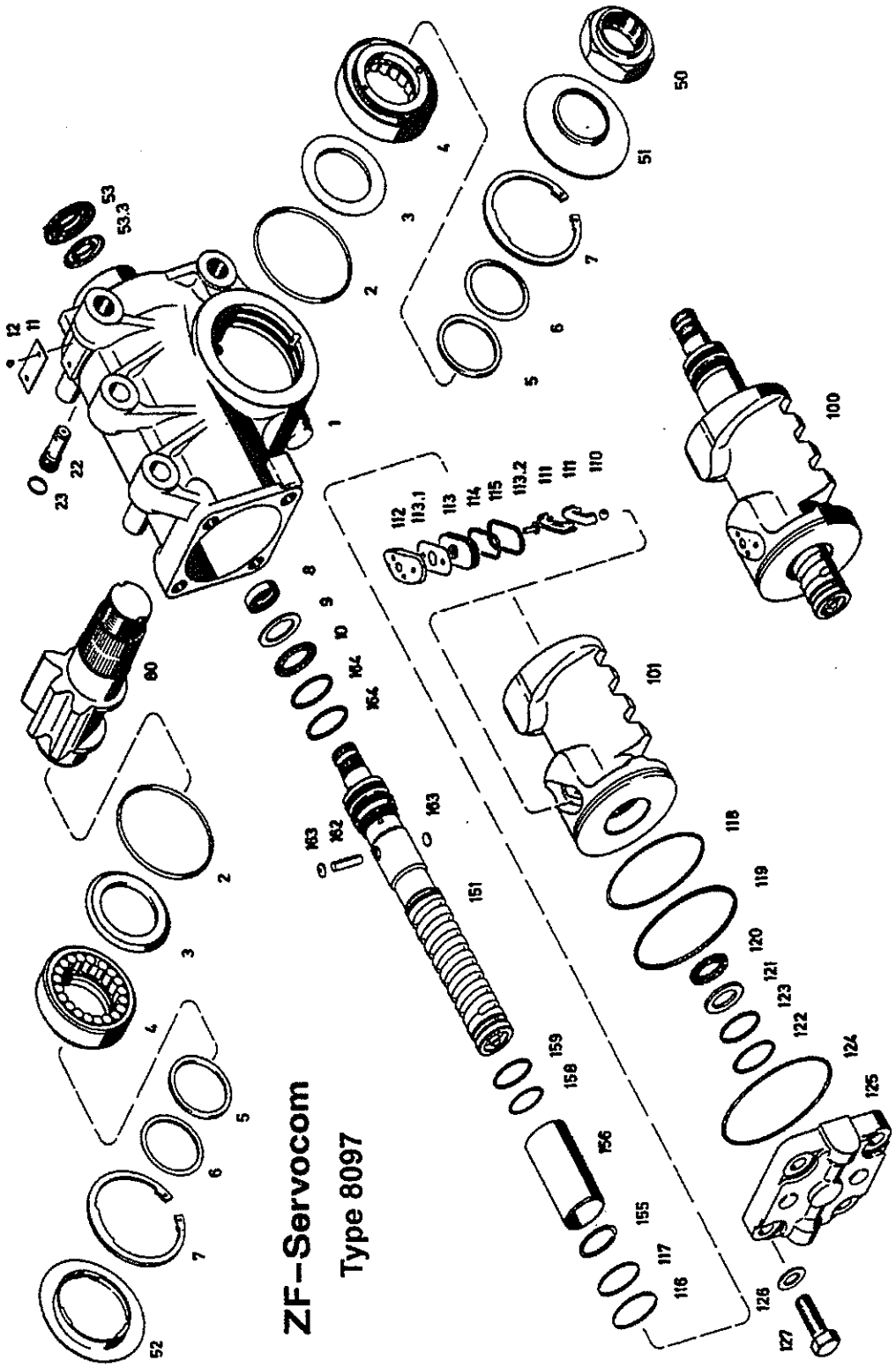
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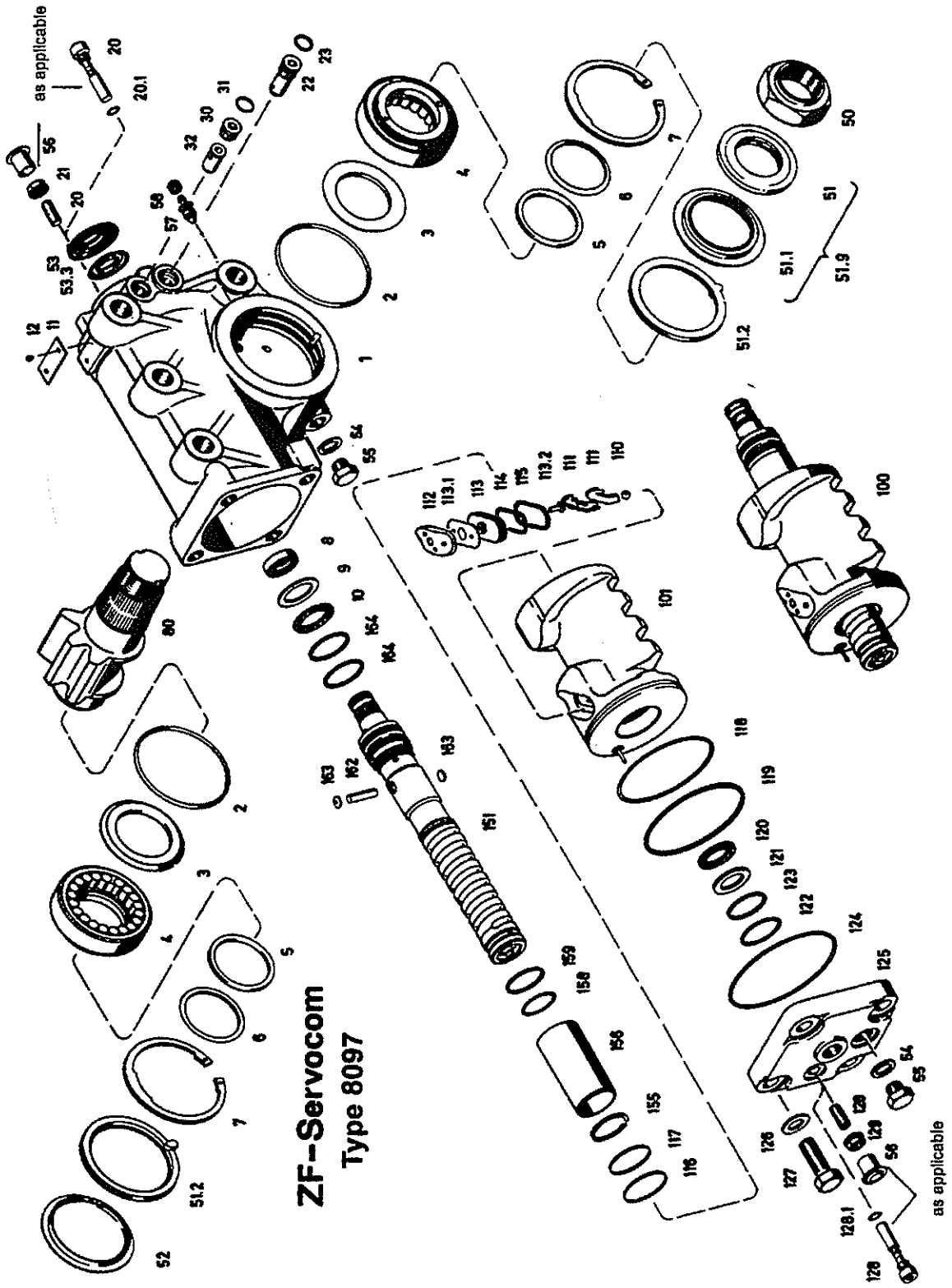
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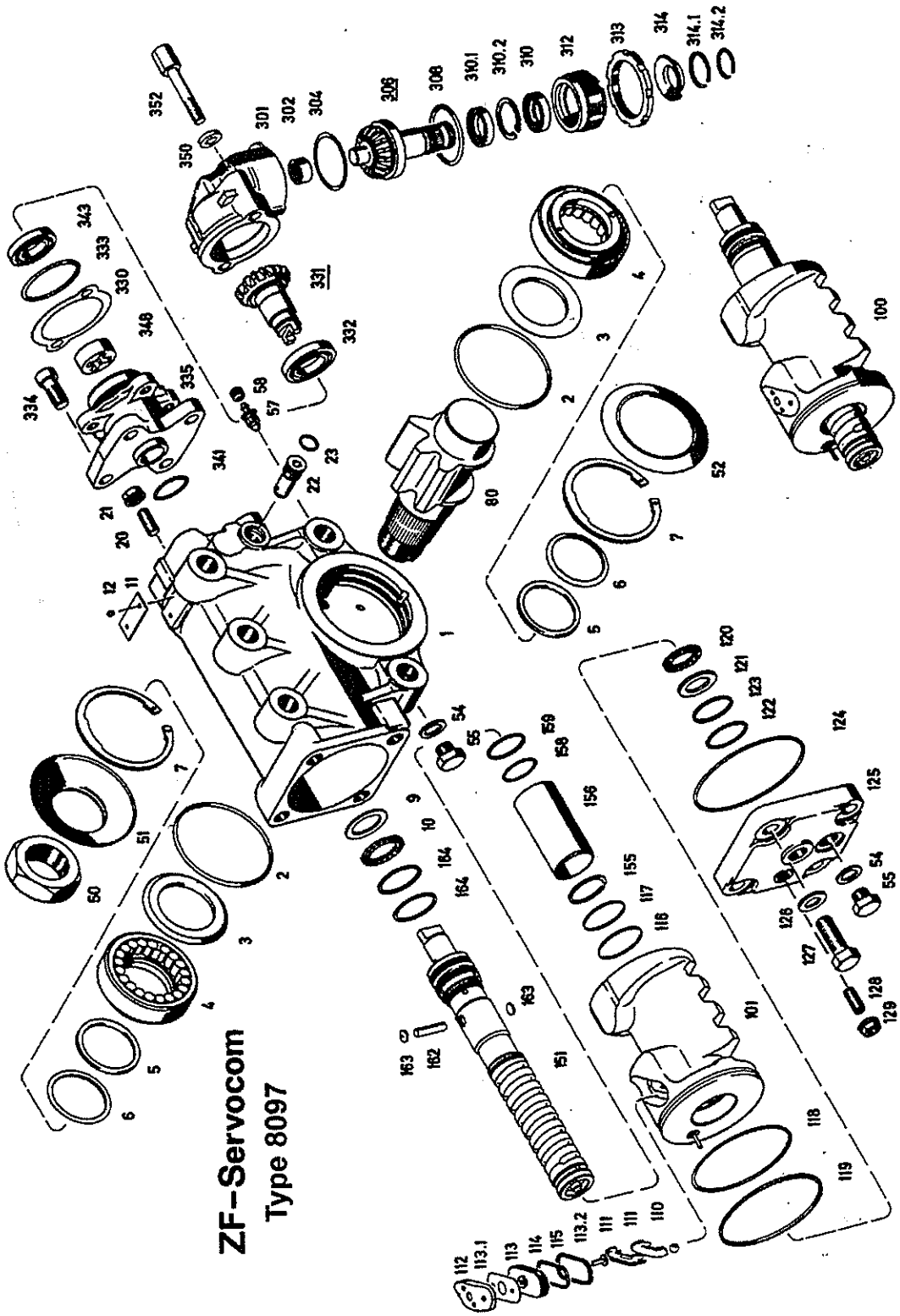
as applicable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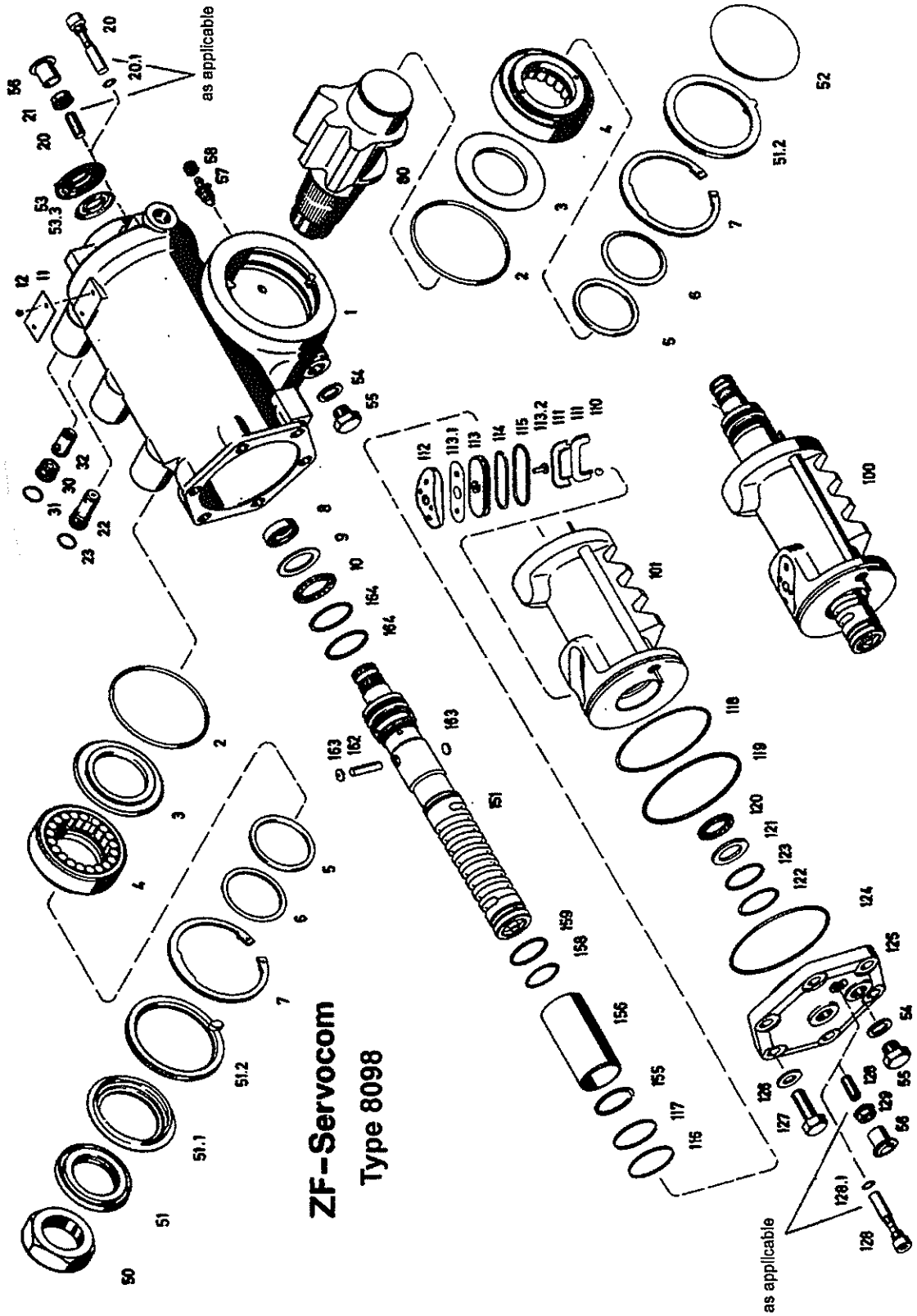
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as applicable
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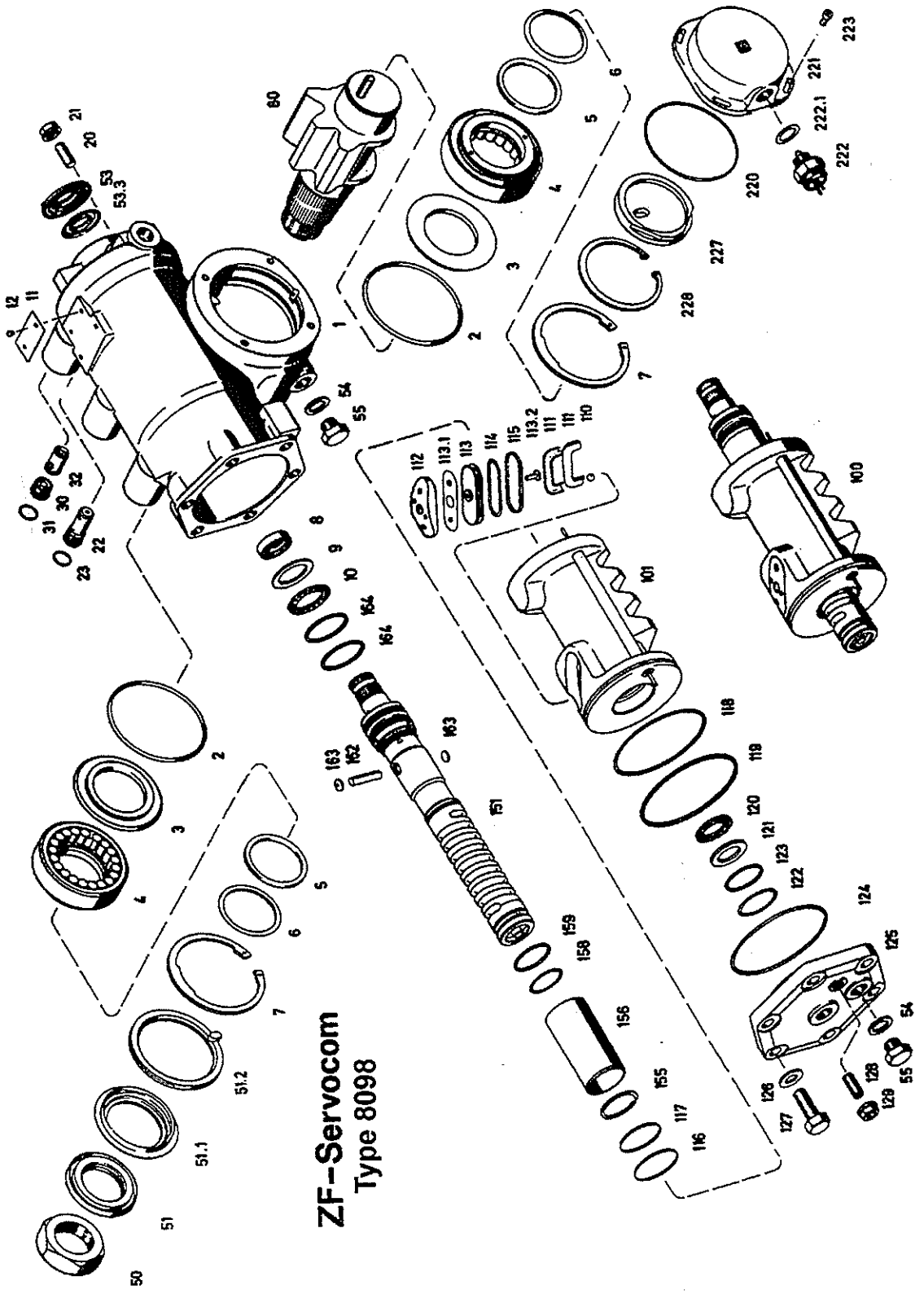
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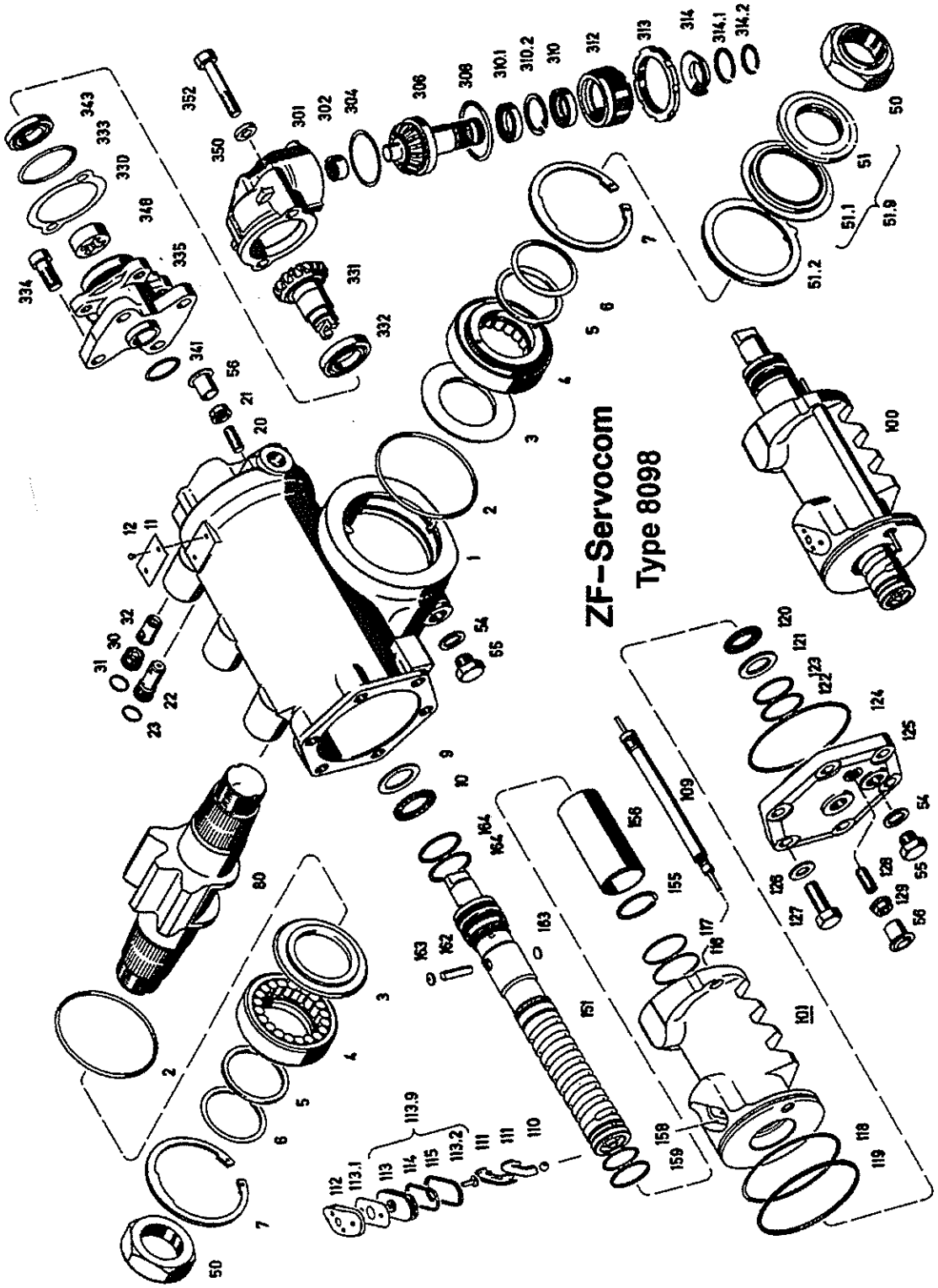
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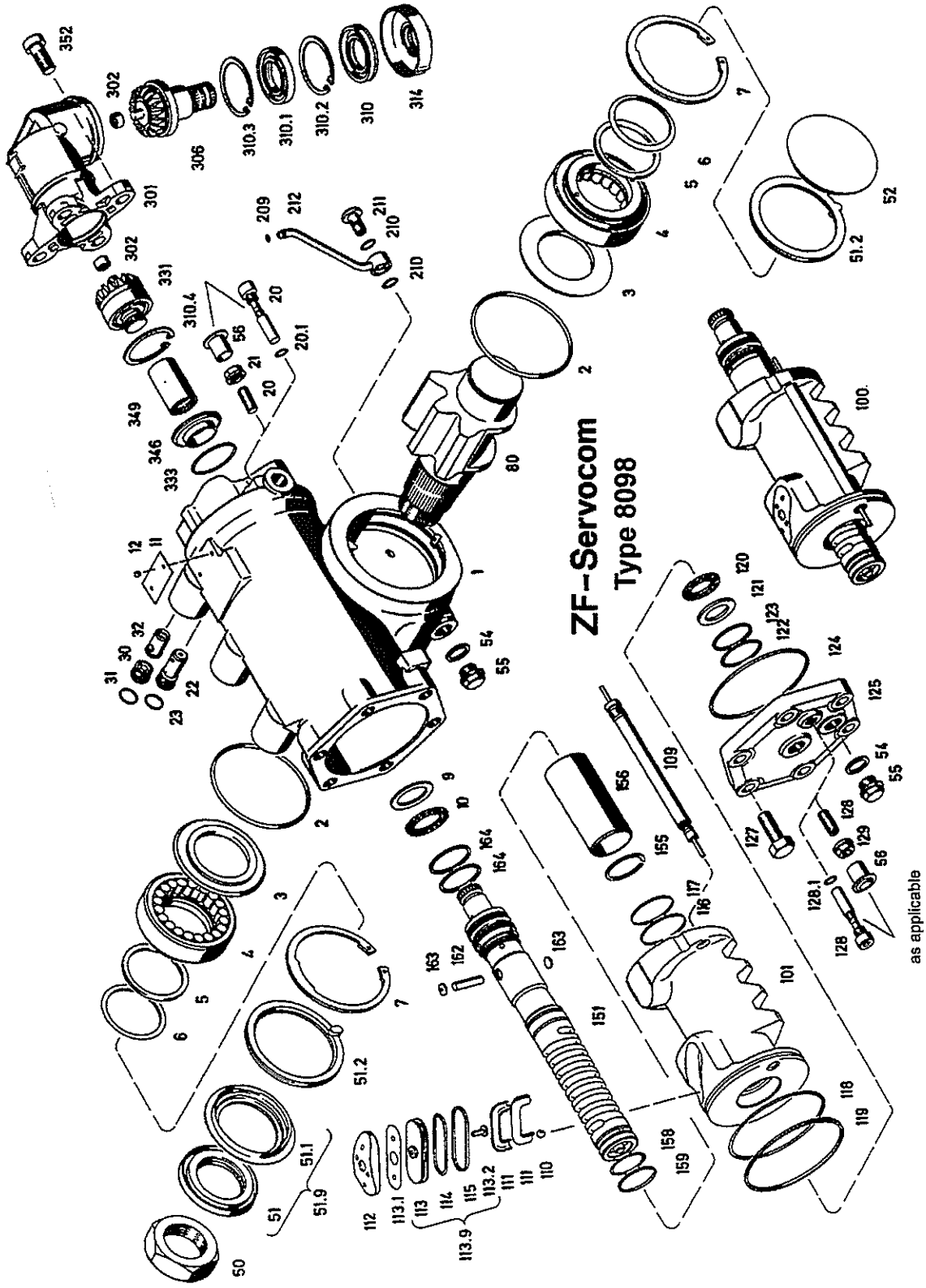
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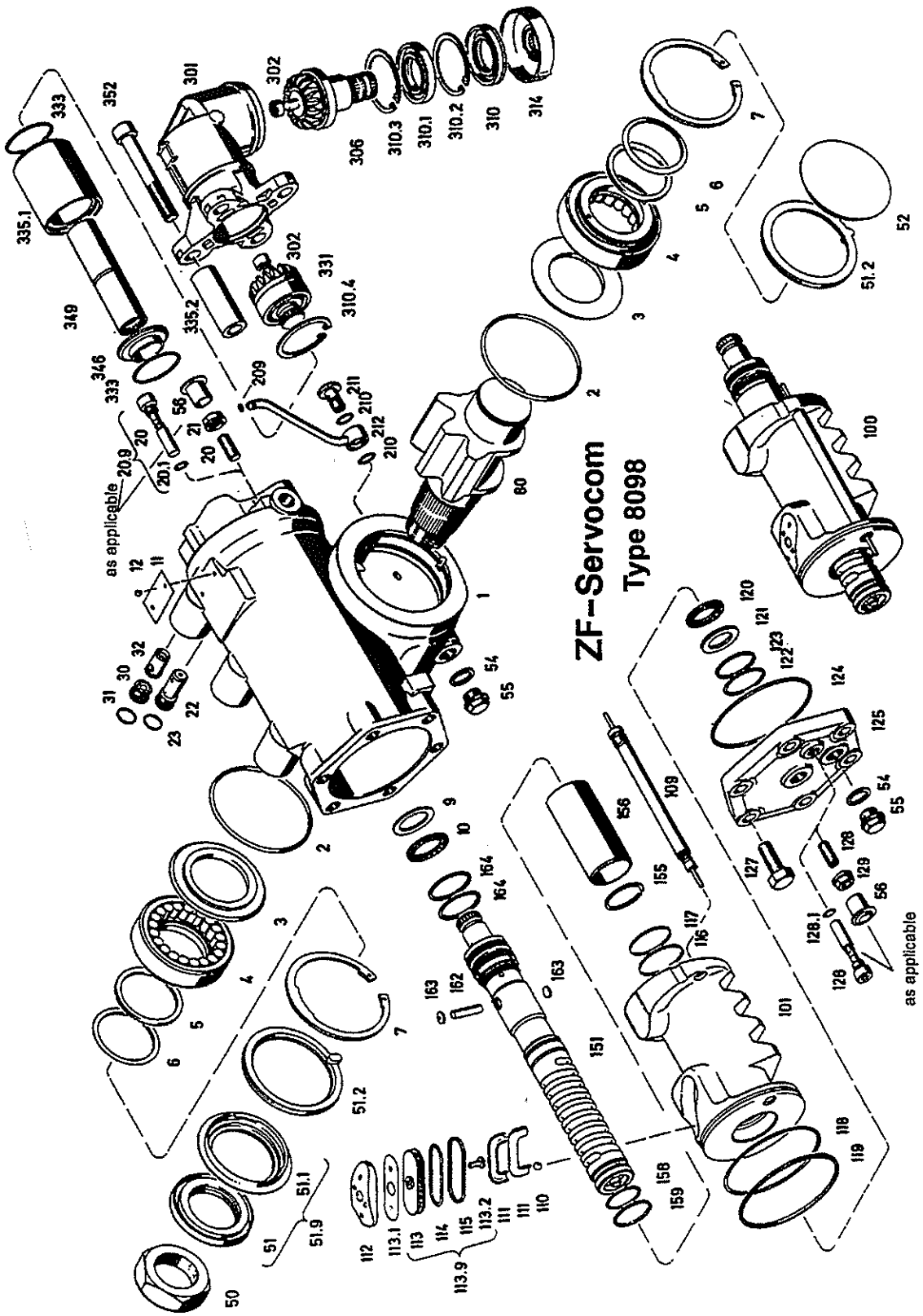
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Type 8098
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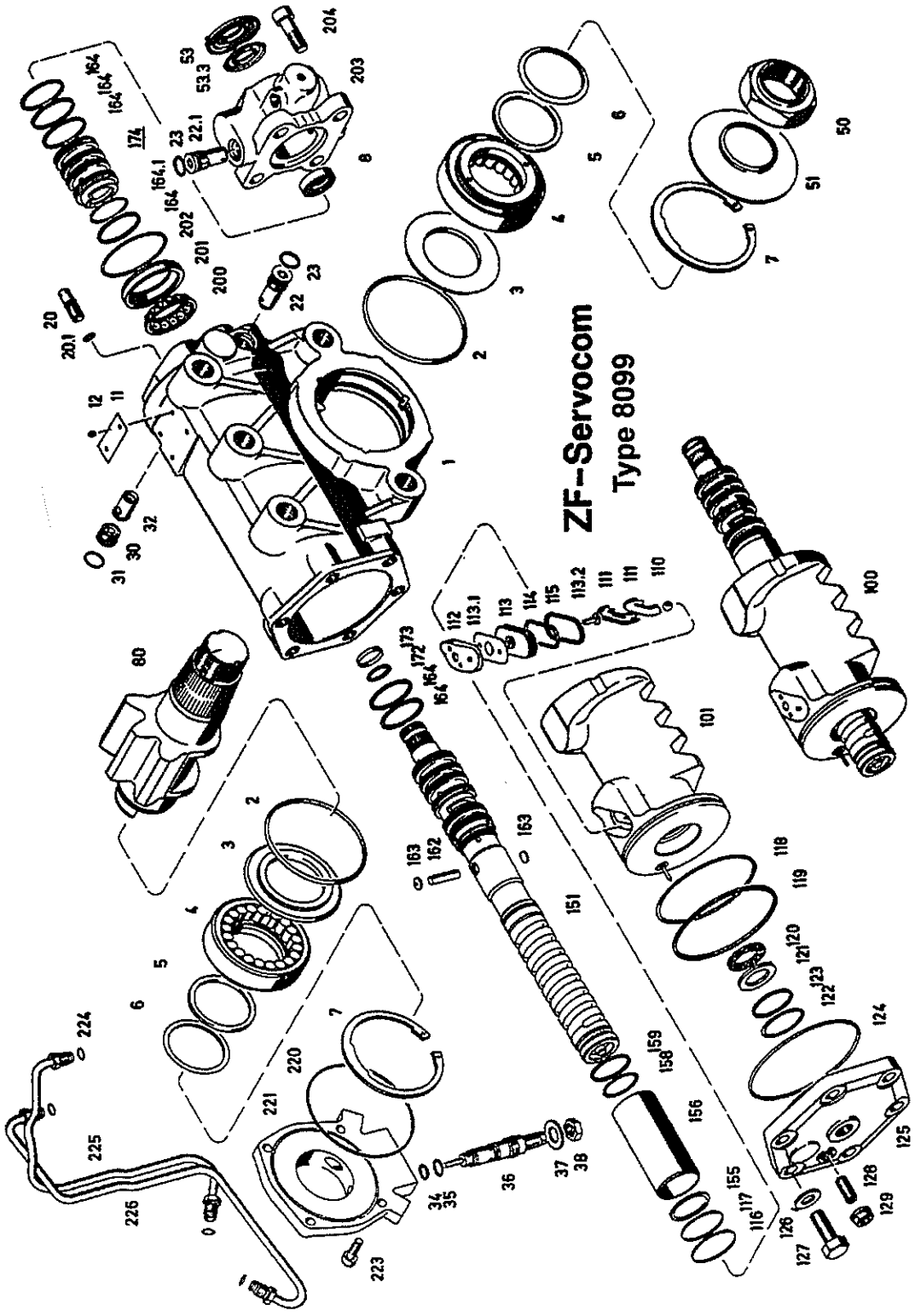
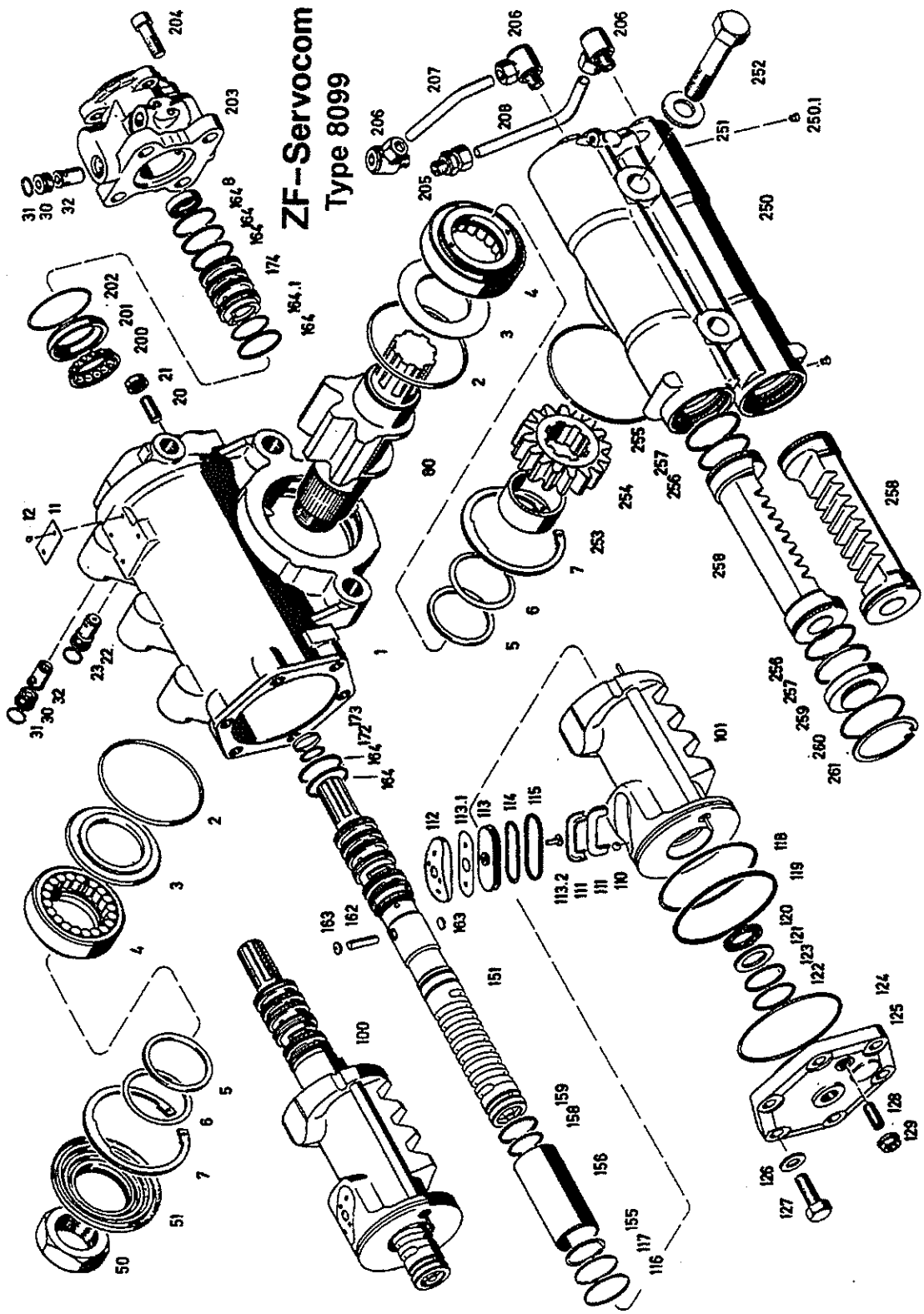

ZF-Servocom
Type 8099


ZF-Servocom
Type 8099

ZF-Servocomtronic®

Supplement to the Repair Manual ZF–Servocom

ZF FRIEDRICHSHAFEN AG
GESCHÄFTSBEREICH LENKUNGSTECHNIK

D - 73522 Schwäbisch Gmünd

Telephone: (07171) 31-0

Telefax: (07171) 31-4396

G 8098 RE1–KTD 6/98 e

→ The present Manual aims to help the user properly to execute the necessary maintenance and repair work on the ZF product.

→ Read the Manual before starting any inspection and repair work.

→ On completion of the maintenance and repair work, the specialist personnel must make certain that the product is once more operating flawlessly.

→ ***Please note that the ZF product must be repaired only in workshops that***

- ☞ ***employ trained personnel***
- ☞ ***have the prescribed equipment, including a test rig, crack detector and special tools***
- ☞ ***use ZF genuine spare parts.***

→ This Manual is only for foremen and fitters who have undergone practical and theoretical training in our Customer Service School. Together with service information bulletins, it is intended to supplement their knowledge.

→ All work carried out on ZF products must be executed with extreme care and diligence. This applies in particular to products and transmission components from vehicles damaged in accidents.

→ The manufacturer does not, of course, accept any liability for damage and its consequences arising from incorrectly or inexpertly executed repairs.

→ This Manual draws attention to notes on safety as follows:

Note: Where incorrect and careless work can cause damage to the product.

Attention: Where incorrect and careless work can lead to personal injury and endanger life.

→ This Manual is not part of the updating service.

→ The contents of the additional service information bulletins must also be observed.

Page

I. **Disassembly** 2

II. **Examining the individual parts** 4

III. **Assembly** 4

IV. **Setting and functional test** 6

V. **Troubleshooting** 8

VI. **Special tools** 12

VII. **Key to numbers in figures and exploded drawing** 12

Notes:

→ The processes necessary for the repair of a ZF–Servocomtronic have mostly been described in the Repair Manual ZF–Servocom.

→ Any deviating or additional process will be described in the following.

I. Disassembly

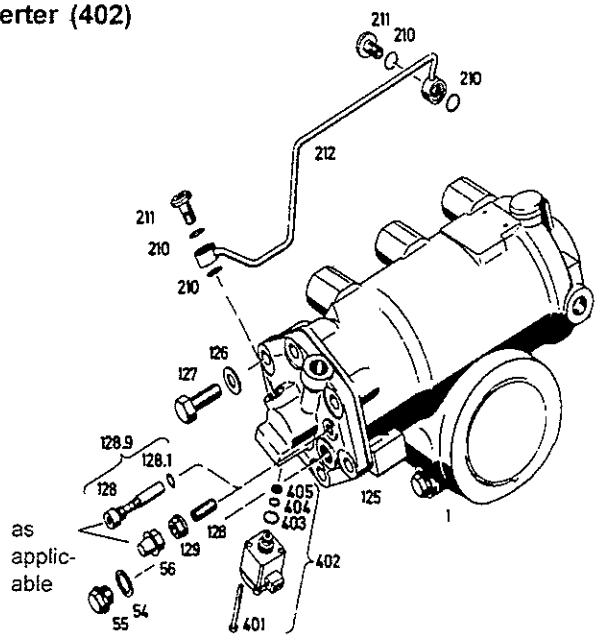
1 Removal of pipe (212) and converter (402)

Screw out union screws (211) and remove pipe (212) with O–rings (210).

Mark position of converter (402).

Turn out two cap screws (401) provided with an internal hexagon.

Remove converter (402) and dismantle O–rings (403 and 404) as well as oil screen (405).



Unscrew hexagon screws (127) with washers (126).

Drive piston (101) back towards bottom of housing so that the valve tappet of valve insert (109) is not damaged when turning the cylinder cover (125).

Remove screw (128) with O–ring (128.1) and set them aside for later use (required for functional tests, chapter IV.).

or:

Remove set screw (128) and collar nut (129).

Unscrew screw plug (55) with sealing ring (54).

Put steering drop arm onto sector shaft (80).

Turn worm (151) or steering drop arm to lift off cylinder cover (125).

Remove needle cage (120) and washer (121).

Remove sealing elements (122, 123 and 124).

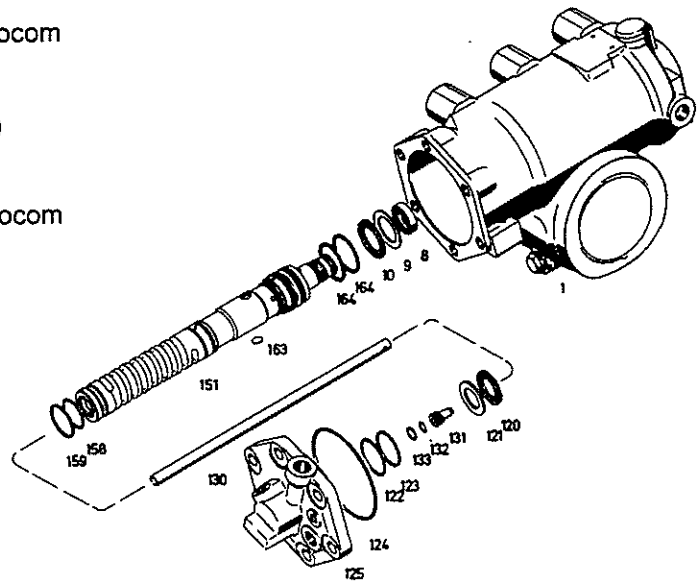
Pull pipe (130) together with reaction piston (131) out of worm (151).

2 Removal of piston (100) and worm (151)

See Repair Manual ZF–Servocom

3 Disassembly of worm (151)

See Repair Manual ZF–Servocom



Pull reaction piston (131) out of pipe (130).

Remove sealing ring (133) and O–ring (132) from reaction piston (131).

4 Removal of sector shaft (80) and disassembly of housing (1)

See Repair Manual ZF–Servocom

II. Examining the individual parts

See Repair Manual ZF–Servocom

1 Cylinder cover (125), reaction piston (131) and converter (402)

→ Tidiness of the bores

2 Reaction piston (131)

→ Free play in cylinder cover (125)

III. Assembly

1 Preassembly of housing (1) and housing cover (4) and installation of sector shaft (80)

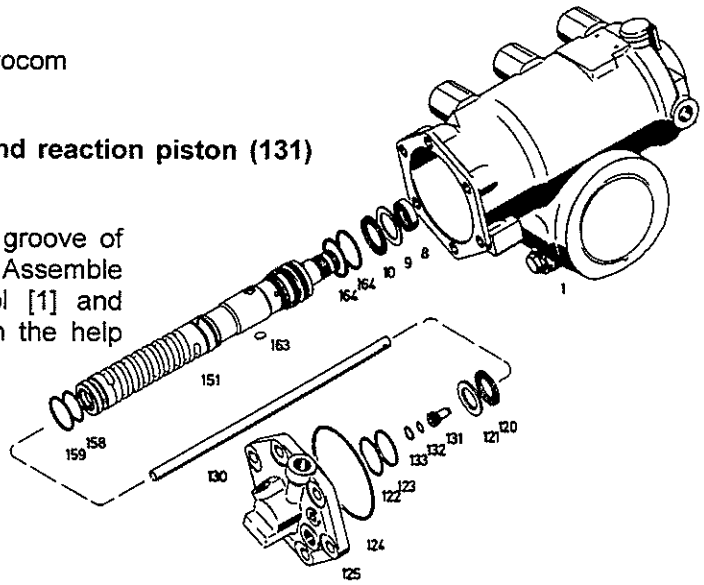
See Repair Manual ZF–Servocom

2 Preassembly of worm (151) and piston (100), installation of piston (100) and worm (151)

See Repair Manual ZF–Servocom

3 Installation of pipe (130) and reaction piston (131)

Insert O–ring (132) into the groove of the reaction piston (131). Assemble sealing ring (133) with tool [1] and press it into the groove with the help of a mounting ring.



Insert pipe (130) and reaction piston (131) in cylinder cover (125).

4 Installation of cylinder cover (125)

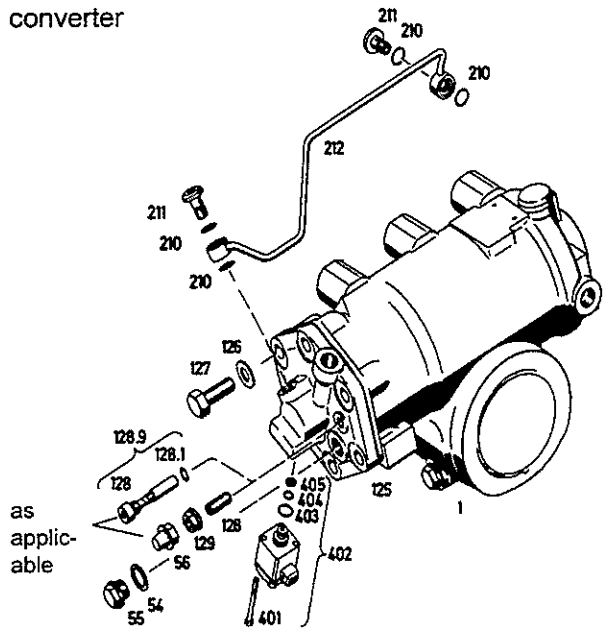
See Repair Manual ZF–Servocom

5 Completing assembly of cylinder cover (125)

Place oil screen (405) in cylinder cover (125).

Place O–rings (404 and 403) in converter (402).

Mount converter (402) as marked upon disassembly with cap screws (401) (tightening torque: 2.9 Nm).



6 Mounting of pipe (212)

Mount pipe (212) with union screws (211) and O–rings (210) (tightening torque: 20±2 Nm).

IV. Setting and functional test

1 See Repair Manual ZF–Servocom

Note:

The checking for oil leakage described in the Repair Manual ZF–Servocom must be performed while the converter is closed. To do so, tool [2] (Servotronictest) must expose the converter to a current that produces a scale reading of 0.65...0.85. Please observe the following description.

2 Functional test of the converter and of the control unit

Note:

Before using the Servotronictest unit, you should read the corresponding operating instructions.

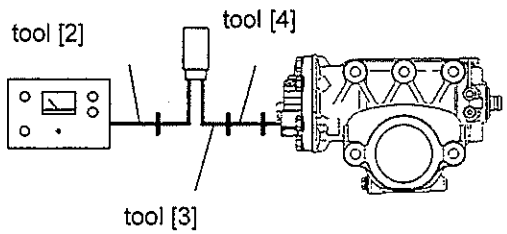
The following functional test refers to the separate checking of the converter and of the control unit. The joint checking of both units is described in the above–mentioned operating instructions.

2.1 Functional test of the converter

→ Set up the steering gear on the test bench. Adjust oil flow, pressure, and oil temperature as required for the hydraulic checking on the test bench (see Repair Manual ZF-Servocom). Lock the steering gear in central position.

→ Connect the Servotronictest (tool [2]) to a 220V mains supply with the help of a power supply unit. Now the ready–to–operate tell–tale lamp must light up.

→ Connect the tools [2, 3, and 4] to the steering gear as described below.



→ Set switch 8 of the Servotronictest to position "0" .

→ Note on the Servotronictest unit:

By slowly turning the control knob 4 (converter) any driving speed can be simulated.

Turning the control knob to the right end position produces a large deflection of the pointer.
A scale reading of 0.65...0.85 means parking, i.e. low actuation force.

Turning the control knob to the left end position produces a smaller deflection of the pointer.
A scale reading 0...0.1 means maximum speed, i.e. high actuation force.

→ Testing in the parking mode

Put switch 8 of the Servotronictest in position "Wandler/converter" and turn control knob 4 (converter) to the right until the scale reading 0.65...0.85 is attained.

With the test bench switched on, turn the steering wheel to either direction until a pressure of 50 bar is built up at the test bench.

If the Servocomtronic and the converter function correctly the actuation momentum at the torque meter should be between 3.5...5.5 Nm, for example.

For the exact value, please refer to the technical data sheet of the spare parts list or the Service Information circulars.

→ Testing in the high speed mode

Turn control knob 4 (converter) of the Servotronictest to the left until the scale reading 0...0.1 is attained.

With the test bench switched on, turn the steering wheel to either direction until a pressure of 50 bar is built up at the test bench.

If the Servocomtronic and the converter function correctly the actuation momentum at the torque meter should be between 9...11 Nm, for example.

For the exact value, please refer to the technical data sheet of the spare parts list or the Service Information circulars.

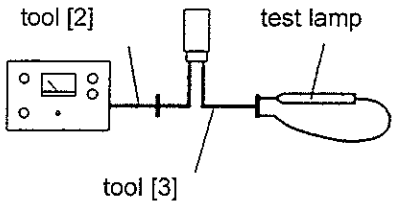
2.2 Functional test of the control unit:

→ Connect the Servotronictest to a 220V mains supply with the help of a power supply unit. Now the ready–to–operate tell–tale lamp must light up.

→ Set switch 8 of the Servotronictest to position "0".

→ Connect tool [3] to Servotronictest (tool [2]).

→ Connect the test lamp directly to the control unit or to the cable leading to the converter as accessibility allows.



→ Set switch 8 of the Servotronictest to position "Tacho/speedometer".

→ Turn control knob 5 (Tacho/speedometer).

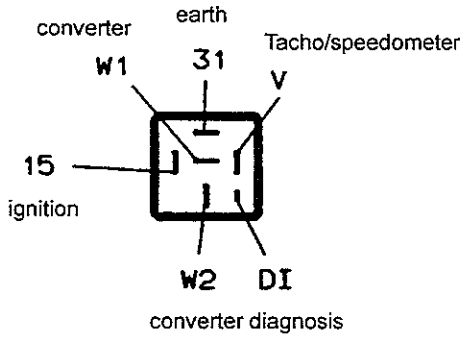
When the control knob is turned to the right end position, the test lamp must light up.

When the control knob is turned to the left end position, the test lamp must go out.

During this test, the scale reading indicated on the Servotronictest rises to max. 0.25.

V. Troubleshooting

Pin layout at the socket of the control unit (plug location):



Trouble		Cause		Remedy
Heavy when steering with the vehicle stationary	→	no on–board voltage	→	check and replace, if necessary – remove the control unit – measure at the socket [2] with the help of a multimeter connecting pin 15 to 31 nom. value: 10...16 V

[2] **Attention!** Any measurement between V and 31 must be performed only with a voltmeter. Otherwise the speed signal sensor will be destroyed.

Trouble	Cause	Remedy
	→ wrong control unit	→ check → replace
	→ control unit placed at the wrong plug location	→ check
	→ defective cable connection from control unit to the steering gear	→ check and repair, if necessary – remove control unit – measure at the socket [2] with the help of a multimeter connecting pin W1 to W2 nom. value: 5...9 Ω (at 20 ° 7,5 Ω)
	→ converter plug not engaged	→ check and repair, if necessary
	→ earth contact of converter cable	→ check → replace
	→ earth contact of converter	→ check → replace
	→ defective control unit	→ check → replace
	→ wrong speedometer signal before switching off ignition at a speed > 20 km/h	→ check speed signal sensor [1] [2]
	→ converter does not close	→ disassemble blow through clean
	→ defective pump	→ check → replace
	→ excessive internal oil leakage	→ check → replace

[1] see vehicle manufacturer's manual

[2] **Attention!** Any measurement between V and 31 must be performed only with a voltmeter. Otherwise the speed signal sensor will be destroyed.

Trouble	Cause	Abhilfe
Heavy steering when driving, o.k. when vehicle stationary	→ converter opens at too low speed	→ check control unit → replace control unit
	→ wrong control unit	→ check → replace
	→ wrong speedometer signal	→ check speedometer signal [1] → replace speedometer signal [1]
Steering too easy when driving, o.k. when vehicle stationary	→ defective control unit	→ check → replace
	→ dirt in converter	→ disassemble clean blow through
	→ wrong speedometer signal at speed < 20 km/h	→ check speed signal sensor [1]
	→ cable connection to converter in contact with on–board voltage	→ check and replace, if necessary –remove control unit –measure at the socket [2] voltage from pin W1 to 31 nom. value: 0V resistance from pin W2 to 31 nom. value: ∞Ω i.e. no connection

[1] see vehicle manufacturer's manual

[2] **Attention!** Any measurement between V and 31 must be performed only with a voltmeter. Otherwise the speed signal sensor will be destroyed.

Trouble		Cause		Remedy
	→	wrong control unit	→	check
			→	replace
	→	defect in cable tree	→	check [1]
			→	replace
Alternate heavy and easy steering during travelling	→	wrong speedometer signal	→	check speedometer signal [1]
			→	replace speed signal sensor [1]
	→	defective cable connections	→	check
	→	wrong control unit	→	replace
	→	defective control unit	→	check
			→	replace
Pulsating steering-momentum (tingle at steering wheel) at any driving speed	→	defective control unit	→	check
			→	replace

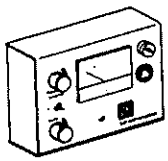
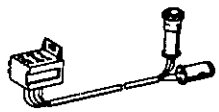
[1] see vehicle manufacturer's manual

[2] **Attention!** Any measurement between V and 31 must be performed only with a voltmeter. Otherwise the speed signal sensor will be destroyed.

VI. Special tools

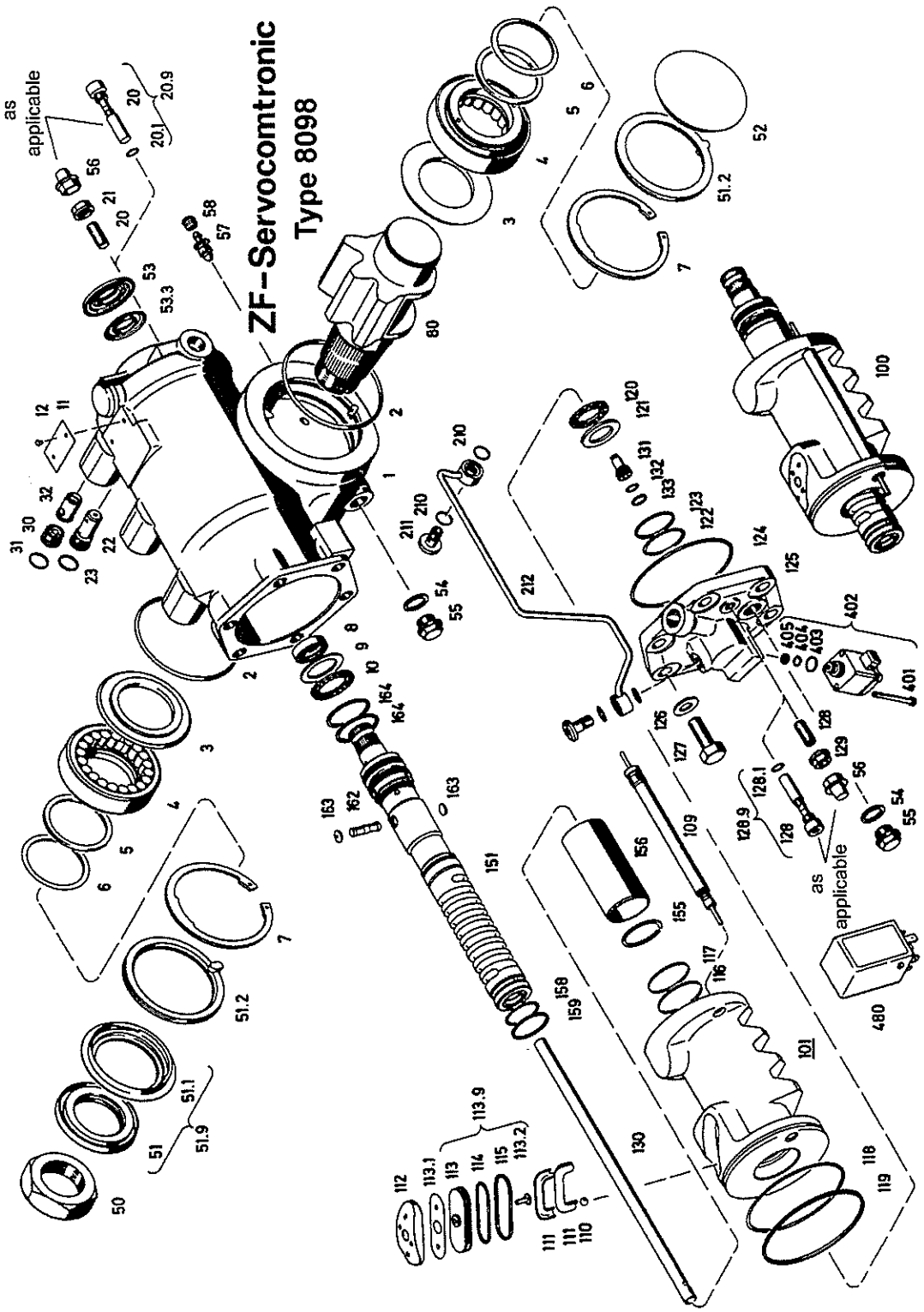
Note:
The special tools listed below refer to the standard version and the design state of the ZF–Servocomtronic on the basis of which the entire manual has been compiled.

Other tools may consequently be required for the particular ZF–Servocomtronic unit to be repaired.

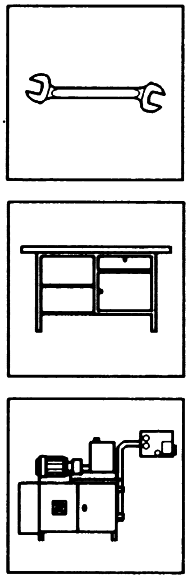
Tool [1]		**Part-No.**
Guide bush		8098 798 004
Mounting ring		8098 798 655
Tool [2]		
Servotronictest		7418 798 545
Power supply unit		7418 798 546
Tool [3]		
Adapter		7038 340 201
Tool [4]		
Adapter cable		7418 798 543

VII.Key to numbers in figures and exploded drawing

130.0	pipe
131.0	reaction piston
132.0	O–ring
133.0	sealing ring
401.0	cap screw
402.0	converter
403.0	O–ring
404.0	O–ring
405.0	oil screen


ZF-Servocomtronic
Type 8098
as applicable
as applicable

Service



ZF Lenksysteme

Design

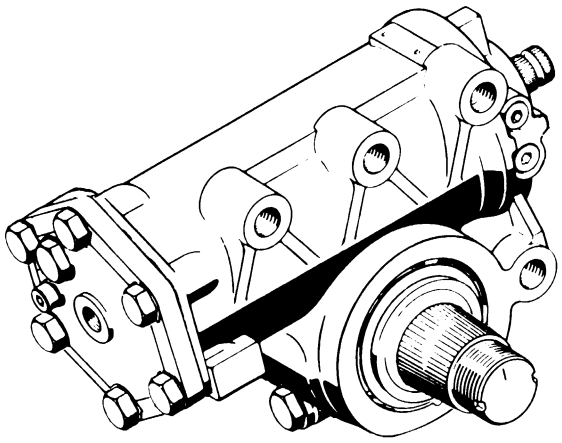
Operation

Maintenance

Inspection

ZF Servocom®

Types 8090, 8095, 8097 and 8098



ZF Lenksysteme GmbH

D-73522 Schwäbisch Gmünd

Telephone (07171) 31-0 Fax (07171) 31-4396

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Inspection report 48

I. Safety note

Attention: Important safety note for the driver and the workshop personnel, respectively

If the steering system is in a perfect working order, the steering efforts the driver has to exert on the steering wheel are low (e.g., 30 N corresponding to approx. 3 kg).

In the event of a failure of the hydraulic assistance (for example owing to lack of oil) the effort needed to carry out a steering motion will increase considerably (for example to 450 N corresponding to approx. 45 kg).

As this happens very seldom and unexpectedly, the driver may be led to believe, erroneously, that the steering system cannot be moved at all any longer.

However, even in the event of a failure of the hydraulic assistance, there is always a mechanical connection between the steering wheel and the road wheel ensuring that manual steering at increased steering efforts can take place.

To avoid damages inside the steering gear and damages to the steering column, the steering effort at the steering wheel rim must not exceed 700 N (approx. 70 kg) when steering motions are carried out without hydraulic assistance and at vehicle standstill.

II. Design and operation

1 Design

The housing of the ZF Servocom steering gear houses the steering valve, the steering cylinder and a complete manual steering gear.

The oil flow and the pressure required by the steering gear is supplied by an engine-driven pump. To achieve this, the oil is taken in from the oil tank and fed back to the tank via the pump and the steering gear.

The housing (A) - see ***Fig. 1*** - and the piston (B) have the function of a cylinder. The piston transforms the rotation of the steering input shaft (C) and of the worm (D) into an axial motion which it transmits to the sector shaft (F).

The piston (B) and the worm (C) are positively connected with each other by means of a ball chain. As the worm rotates, the balls at one end of the chain are taken up by a recirculation tube and fed back to the other end so that an endless ball chain is formed.

The teeth of the piston (B) and of the sector shaft (F) cause the sector shaft to rotate when the piston is displaced.

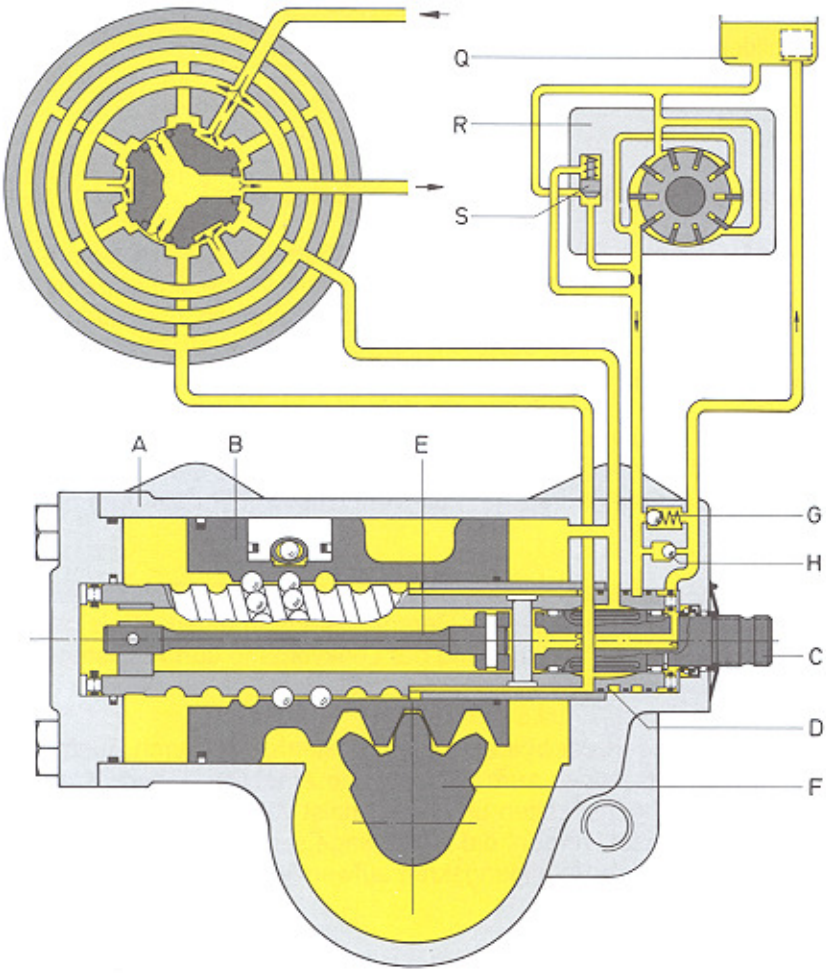


Fig. 1
Valve rotor in mid-position

A	Housing
B	Piston
C	Valve rotor/steering input shaft
D	Valve sleeve/worm
E	Torsion bar
F	Sector shaft
G	Pressure relief valve
H	Replenishment valve
Q	Oil tank
R	Vane pump
S	Flow limiting valve

Return line pressure

The steering valve consists of the valve rotor (C) which is carried in a needle bearing in the worm and is provided with six control grooves on the circumference, and of the valve sleeve (D) on the worm.

A torsion bar (E) pinned to the valve rotor (C) and the worm (D) keeps the steering valve in mid-position as long as no effort is exerted on the steering wheel.

A pressure relief valve (G) limiting the maximum pressure within the steering system may be integrated in the steering gear housing.

In addition, a replenishment valve (H) sucking oil from the return oil line when a steering motion without hydraulic assistance takes place can be fitted to the housing or to the steering valve.

In comparison with constant ratio steering gears, variable ratio steering gears are more direct around centre than outside the mid-position area, which has a favourable effect on the steering performance during straight ahead driving as minor steering corrections only, if any, are required.

At the same time, in the static parking range requiring a wider steering wheel turning angle a higher hydraulic torque is available at the sector shaft owing to the more indirect steering ratio.

In the event of a failure of the hydraulic assistance the steering efforts at the steering wheel rim are lower in this range than they would be for a constant ratio steering gear.

The 3 functional drawings to ***Figs. 1*** to ***3*** give a simplified representation of the steering valve and the oil flow. In addition, these figures give a cross-sectional view of the steering valve in order to schematically represent the connections from the steering valve to the cylinder chambers and the mode of operation of the valve.

2 Operation

When a torque is transmitted from the steering input shaft to the worm or vice-versa, the torsion bar is subjected to a deformation in the elastic area of its length, causing a torsion to occur between the valve rotor and the valve sleeve and, thus, to move the control grooves of the valve rotor away from the mid-position as compared with the position of the valve sleeve control grooves.

When the steering wheel is released, the action of the torsion bar will make the steering valve return to the neutral (mid) position.

Through the bore in the housing, the oil flows into the annular groove of the valve sleeve and is fed to the arcuate control grooves of the inner valve rotor through three symmetrically-arranged radial bores.

The position of the control grooves in the valve rotor and the valve sleeve is such that, in the mid-position of the steering valve, the oil can flow through the inlet slots (J and K) to the axial grooves (N and O) of the valve sleeve, which are also arcuate. From there, the oil can freely flow through radial bores to the cylinder chambers.

As long as the steering valve is in the mid-position, the oil can flow to both cylinder chambers, and via the three return grooves (P) in the valve rotor it can also flow off to the oil tank.

2.1 Forward steering motion to the right (piston with right-handed thread)

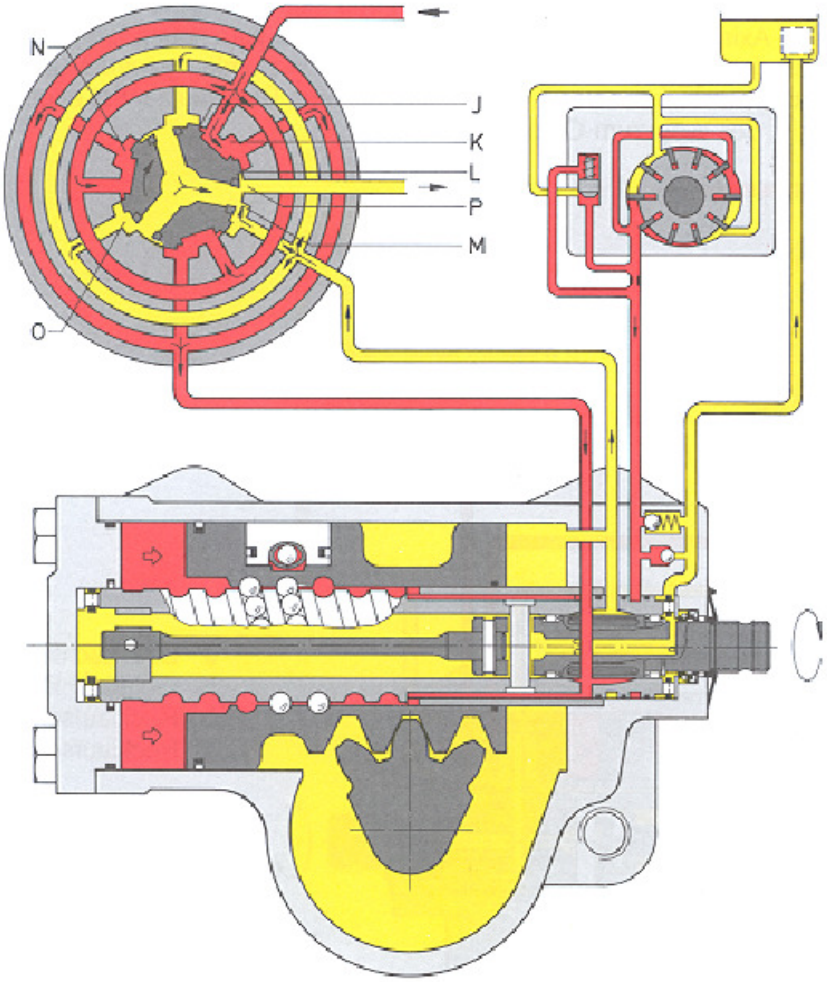


Fig. 2
Valve rotor in operating position
Steering wheel turned clockwise

J Inlet slot
K Inlet slot
L Return slot
M Return slot
N Axial groove
O Axial groove
P Return groove

Operating pressure

Return line pressure

When the steering wheel is turned to the right, the piston will shift to the right ***(Fig. 2)***. A pressure will now build up in the left-hand cylinder chamber which is a function of the steering effort required.

To achieve this, the control grooves of the valve rotor are displaced clockwise and the inlet slots (K) are opened wider to admit the oil, while the inlet slots (J) are closed to the same extent and thus obstruct the feeding of oil to the axial grooves (O) of the valve sleeve.

The oil will now flow through the inlet slots (K) to the axial grooves (N) of the valve sleeve and, from there, will pass through the ball screw thread and flow to the left-hand cylinder chamber. The closed inlet slots (J) prevent the oil from flowing off to the tank and, thus, cause a pressure to build up.

The oil from the right-hand cylinder chamber is displaced. Via the opened return slots (M), it flows to the return grooves (P) of the valve rotor. From there, it can at any time flow through the central oil bore in the valve rotor and the worm and off to the oil tank.

2.2 Forward steering motion to the left (piston with right-handed thread)

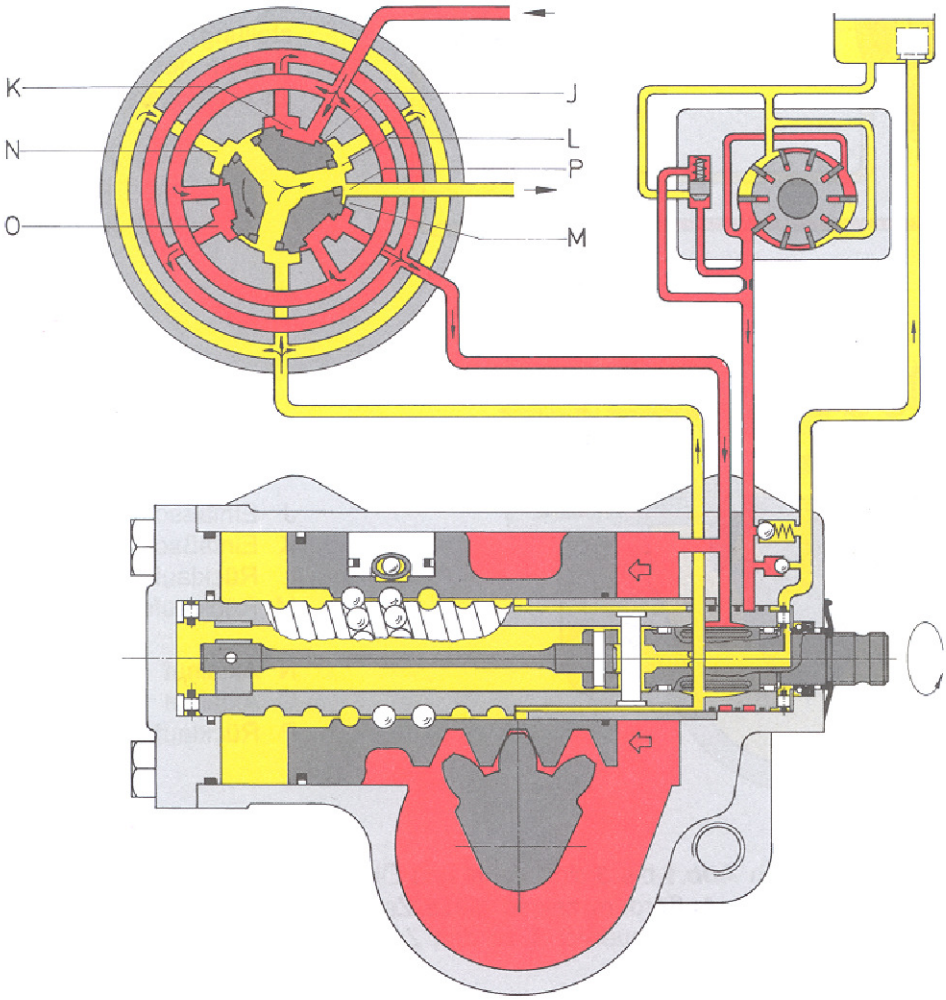


Fig. 3

Valve rotor in operating position

Steering wheel turned counter-clockwise

J Inlet slot
K Inlet slot
L Return slot
M Return slot
N Axial groove
O Axial groove
P Return groove

Operating pressure

Return line pressure

When the steering wheel is turned to the left, the piston will shift to the left ***(Fig. 3)***. Therefore, pressure build-up now takes place in the right-hand cylinder chamber.

The control grooves of the valve rotor are displaced counter-clockwise and allow the oil to flow through the opened inlet slots (J) to the axial grooves (O) from where there is a connection to the right-hand cylinder chamber.

The oil from the left-hand cylinder chamber flows to the return grooves (P) of the valve rotor, via the ball screw thread and the opened return slots (L), and can then freely flow off to the oil tank through the central bore in the valve rotor and the worm.

3 Operation of the hydraulic steering limitation

The hydraulic steering limitation prevents a steering to the lock stops at full hydraulic pressure. It, thus, protects the pump and the steering linkage and prevents high oil temperatures.

A double-acting steering limiting valve with spring-loaded valve pins (T and U) is arranged in the longitudinal direction in the piston (B). The valve pins project over the right-hand and the left-hand front faces of the piston ***(Fig. 4)***.

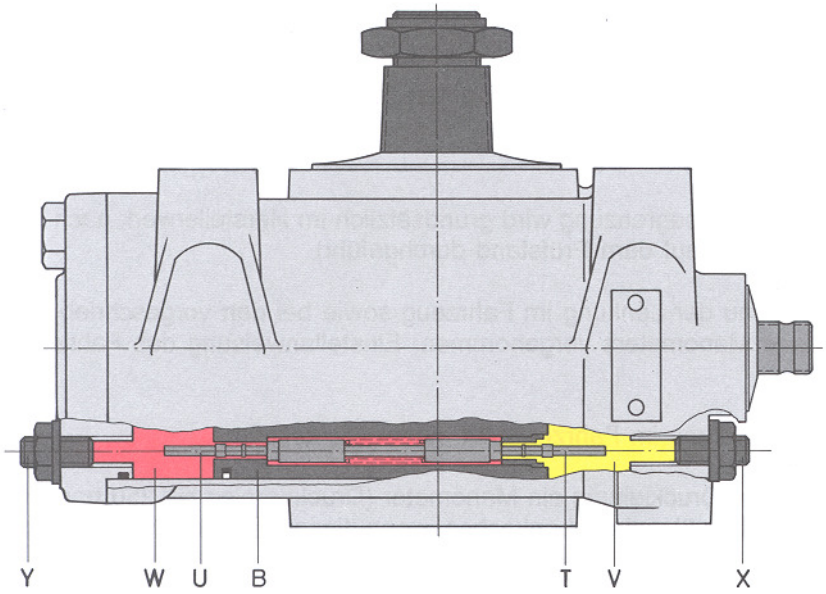


Fig. 4 Steering limiting valve closed

T Right-hand valve pin of steering limiting valve
U Left-hand valve pin of steering limiting valve

V Right-hand cylinder chamber
W Left-hand cylinder chamber

X Right-hand adjusting screw
Y Left-hand adjusting screw

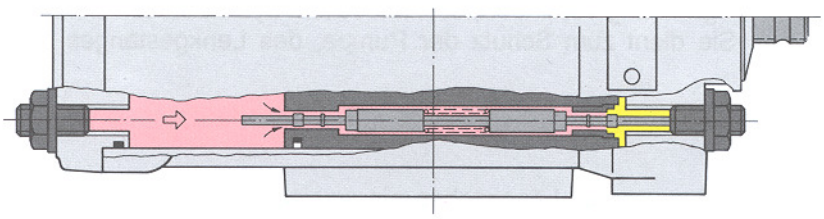
Operating pressure

Return line pressure

If the piston is shifted to the right or to the left towards the lock stop, the valve pins (T and U) are actuated by the adjusting screws (X and Y) fastened in the housing and the cylinder cover, respectively. The steering limiting valve remains closed until one of the valve pins hits against an adjusting screw.

If for instance the piston is displaced to the right ***(Fig. 5)***, the right-hand valve pin will hit against the adjusting screw (X) before the piston end position is reached. Valve pin (U) is displaced by the oil pressure so that the oil can flow away from cylinder chamber (W) to cylinder chamber (V) and from there to the return line. When the piston is displaced to the left, the same sequence of operations as described above will take place by analogy.

Fig. 5 Piston displacement to the right. Right-hand valve pin open. Oil pressure greatly reduced.



Reduced operating pressure

Return line pressure

As soon as the steering limiting valve is open, the steering gear can be turned forward further at an increased steering effort and with greatly reduced hydraulic assistance until the lock stop is reached.

III. Servicing work

1 Hints

In a number of countries a safety inspection (Sicherheitsprüfung = SP) is prescribed by law for vehicles with more than 8 passenger seats or a gross vehicle weight rating in excess of 7.5 t.

Attention:

On vehicles not subject to the safety inspection (SP), the work detailed in Chapter III. Servicing work,.para.s 3.5...3.10, has to be carried out in addition.

Following a **test drive** and a subsequent visual inspection of the complete steering system (steering column, bevel box, steering gear, drag links, pump, and hydraulic lines) we recommend to carry out the following work.

Within the scope of **maintenance** the proper functioning of the steering system is checked by a test drive and a visual inspection.

During an **inspection**, safety-critical characteristics are tested.

2 Maintenance

Maintenance intervals:
We recommend to carry out the following work within the scope of the general maintenance work. [1]

2.1 Test driving

During the test drive, in particular look out for the following chacteristics:

- return to neutral
- sticking
- increased friction
- play

2.2 Checking and inspecting for external leakproofness/damages

Check the steering gear (with bellows), the protecting caps, the pumps (engine-driven and ground-driven), the valves and the steering cylinders, the lines and the screwed connections for leakproofness and damages. The piston rod of the steering cylinder may be covered by a thin oil film but there must not be any oil drops.

Note:
When cleaning with a high pressure cleaning machine, make sure not to direct the water jet directly towards the sealing elements of the steering system. Ingressing water and impurities can cause malfunctions.

2.3 Checking the oil level

Oil grade required: please refer to List of Lubricants TE-ML 09

Prior to pulling out the oil dipstick, thoroughly clean the oil tank and its immediate vicinity to protect the hydraulic oil from being soiled by impurities.

Attention:
Too low an oil level may cause malfunctions which can entail a failure of the hydraulic assistance of the steering system.

[1] see vehicle manufacturer's instructions

For vehicles with ZF Servocom RAS (Rear Axle Steering System)

Check the oil level in the straight ahead driving position.

If the oil level is above the top mark, there may be a leakage in the master cylinder of the ZF Servocom RAS steering.

Check the ZF Servocom RAS as specified in the Instructions for the Functional Check, Maintenance and Inspection of ZF Servocom RAS steering gears.

- **Oil level check with the engine stopped:**

The oil must be topped up to the upper mark of the oil dipstick.

- **Oil level check with the engine running:**

When the engine is running, the oil level must be between the lower and the upper marks.

When the engine is stopped, the oil level may rise by 1...2 cm (depending on the capacity of the steering system)

If the oil level rises by more than 2 cm, the steering system has to be bled

Start the engine.

For vehicles equipped with an additional ground-driven emergency steering pump: jack up the drive axle of the emergency steering pump [1] and engage a gear.

[1] see vehicle manufacturer's instructions

3 Inspection

Attention:

The inspection intervals depend on how the vehicle is used.

Therefore, the table below distinguishes between different kinds of use which may, though, be overlapping.

For the sake of increased traffic safety, we recommend to inspect the steering system in accordance with the inspection intervals listed below.

Minor variations in inspection intervals are permissible if it is desirable to adjust these intervals to the vehicle-specific inspection intervals.

Note:

The work listed below also includes work that has to be carried out within the scope of the safety inspection (SP).

Such work is marked “(part of SP)”. Therefore, inspection steps bearing this mark can be omitted when vehicles subject to safety inspection (SP) are checked within the scope of the normal inspection.

In addition, the safety inspection (SP) rules applying in the country of registration of the vehicle being inspected have to be complied with.

3.1 Inspection intervals

❑ up to date of manufacture 12/93

Kind of use	Ist inspection Inspection on the vehicle	IInd inspection Inspection on the vehicle	IIIrd inspection
Long-distance vehicles	100 000 km 60 000 miles	200 000 km 120 000 miles	300 000 km 180 000 miles
Vehicles in long and short distance use	100 000 km 60 000 miles	175 000 km 105 000 miles	250 000 km 150 000 miles
Construction site vehicles and vehicles in off-road use	80 000 km 50 000 miles 2 500 op.hrs	150 000 km 90 000 miles 4 500 op.hrs	200 000 km 120 000 miles 6 000 op.hrs

Additionally, at the time of the IIIrd inspection, the mechanical transmission elements of the ZF Servocom steering gear have to be inspected.

To this effect, dismantle the steering gear and visually inspect and crack test all transmission elements (see Repair Instructions).

❑ **starting from date of manufacture/repair 1/94**

Kind of use	**Ist inspection** Inspection on the vehicle	**Further inspections** Inspection on the vehicle
Long-distance vehicles Coaches with high mileages	600 000 km	after a further 300 000 km, ea.
Buses Construction site vehicles Vehicles in short-distance use Vehicles subject to extreme loads	300 000 km 7 500 op.hrs	every 300 000 km 7 500 op.hrs

3.2 Test driving

During test driving, in particular look out for the following characteristics:

- return to neutral
- sticking
- increased friction
- play

3.3 Visual inspection

- Check the screws of the complete steering system (steering column, bevel box, steering gear, drag links and steering cylinder) for correct fastening.
- Check whether the locking plate and the split pin are still perfectly secured.
- By turning the steering wheel to both sides or by applying a load to it, check whether the fit of the drop arm on the sector shaft is still tight.
- Check the steering column, bevel box, steering gear, axle stops, drag links and tie rods for damages, cracks and corrosion.
- With the engine running, check the complete steering system for external leakproofness.

3.4 Replacing the oil filter

⚠ **Attention:**
Before taking off the oil tank cover, thoroughly clean the oil tank and its immediate vicinity to prevent the ingress of impurities into the hydraulic fluid.

Pull the filter insert out of the oil tank.

Avoid any dripping of oil from the insert into the tank.

If heavily soiled, clean the oil tank.

Fit a new filter insert.

Attention:

Below is a list of all work that has to be carried out on the steering gear within the scope of the safety inspection (SP).

This list represents the currently valid status and is not subject to the Updating Service.

3.5 Steering gear play (part of SP)

- Start the engine
- Rotate the steering gear to the straight ahead driving position.
- Slowly turn the steering wheel and, simultaneously, watch the front wheel to see how far the steering wheel has to be turned to make the front wheel move.

  perm. total displacement (stg. wheel ∅ 500 mm): max. 50 mm

  max. 55 mm for version with bevel box

3.6 Hydraulic steering limitation (part of SP)

The hydraulic steering limitation causes the pressure to drop in the area of the steering stop, thus protecting the steering pump and the steering linkage and preventing increased temperatures.

- For a check of the setting please refer to Chapter III., para. 5.

3.7 Light operation of the steering gear (part of SP)

If the steering system has a hydraulic defect, this is indicated by increased steering efforts.

- Start the engine.
- At vehicle standstill, quickly rotate the steering gear twice from lock to lock and look out for stiff operation of the steering.

3.8 Points of stiff operation (part of SP)

Defective transmission elements (steering column, universal joints, ...) may cause a temporarily stiff operation of the steering gear.

- Relieve the front axle (conform to vehicle manufacturer's instructions)
- With the engine cut off, rotate the steering gear from lock to lock and look out for points of stiff operation.

3.9 Automatic return to neutral (part of SP)

The axle geometry ensures automatic return to neutral during driving.

- Test drive the vehicle on a cordoned-off ground.
- During the test drive, rotate the steering gear to full lock.
- Release the steering wheel and find out whether the steering gear automatically returns to mid-position.

3.10 Steering wheel (part of SP)

- Check whether the steering wheel is properly fastened.
- Check the steering wheel for damages.

4 Oil change and bleeding

4.1 Oil change

4.1.1 Draining the oil

Note:
An oil change is only required if steering gear units were repaired or replaced.

Do not use any drained oil to refill the system. Avoid any blending of oils.

4.1.2 Draining the steering system

Jack the steered axle up. [1]

Unscrew the pressure and return lines from the steering gear.

Then have the engine run for a short time (maximum 10 seconds) to allow the oil to be sucked from the pump and the oil tank. Collect any escaping oil in a pan.

Screw in again all components unscrewed earlier.

4.1.3 Draining the steering gear

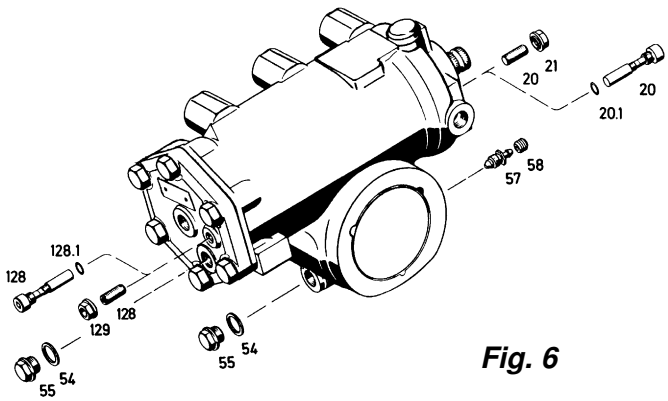


Fig. 6

If existing on the version inspected, unscrew

- the screw plugs (55) from the cylinder cover or the housing
- the set screw or the collar nut (20 or 128)
- the screw (20 or 128)
- the bleeder (57)

(Fig. 6).

[1] see vehicle manufacturer's instructions

To achieve a quick draining, open the one among the components referred to above which is lowest in the installed position.

Rotate the steering gear manually from lock to lock until no more oil is draining.

Unscrewed components must be screwed in again at the following tightening torques:

Screw plug (55):	40 Nm (M16x1.5)
	50 Nm (M18x1.5)
Collar nut (21 and 129):	20+10 Nm
Screw (20 and 128):	12+3 Nm
Bleeder (57):	30 Nm

Note:
Even after unscrewing all components mentioned above, a residual oil quantity may be left over in the steering gear.
A complete draining of the steering gear may be necessary depending on the amount of impurities in the oil. To this effect the steering gear has to be removed from the vehicle and opened at a ZF Service Centre.

4.2 Oil filling

Attention:
When the steering system is filled with oil, there is a risk of impurities getting into the steering oil circuit. To avoid malfunctions caused by foreign bodies in the system, maximum cleanliness is of paramount importance both at initial fill and when topping up with oil.

For admitted oil grades, refer to the List of Lubricants TE-ML 09.

Fill the tank with oil to the rim.

Start the engine and have it run at idling speed to fill the steering system with oil.

During this operation, the oil level in the tank will quickly drop.

Therefore, to avoid any suction of air, the oil tank has to be topped up constantly.

In addition, for vehicles equipped with a ground-driven emergency steering pump:

Jack up the drive axle. [1]

Select a gear and have the engine run at idling speed.

To avoid any suction of air, constantly top up with oil.

[1] see vehicle manufacturer's instructions

4.3 Bleeding

- For steering gear versions with automatic bleeding:

Steering gear versions with automatic bleeding do not have any bleed scews. These steering gears automatically bleed any air remaining within the steering system.

Note:
Automatic bleed valves operate in the idle pressure range only; therefore, any unnecessary pressure build-up should be avoided.

When the steering system is filled to an extent preventing the oil level from dropping below the upper mark of the oil dipstick:

Have the engine run at low speed for 2...3 minutes.

Rotate the steering wheel several times from lock to lock and, while doing so, watch the oil level.

Top up with oil if required.

- In addition, for vehicles equipped with a ground-driven emergency steering pump:

Jack up the drive axle. [1]

With a gear selected and the engine running, bleed the emergency steering pump.

2...3 minutes later rotate the steering wheel several times from lock to lock.

Note:
In the end positions, do not pull heavier at the steering wheel than is necessary to rotate the steering gear.

Top up with oil if required.

- Versions with additional steering cylinder:

The line connections of the steering cylinder must point upward to allow for an escaping of the air in the cylinder.

If required turn the steering cylinder to a suitable position and mount it again in its original position after air bleeding.

[1] see vehicle manufacturer's instructions

- Versions with bleeder (57):

With the engine running, open the bleeder (57) until nothing but oil is coming out ***(Fig. 7)***.
Afterwards, close the bleeder again until it is oil-tight.
On versions without automatic bleeding (installed position horizontal, steering output shaft in the bottom position) the topmost screw/set screw (20 and 128, respectively) can be used for bleeding.

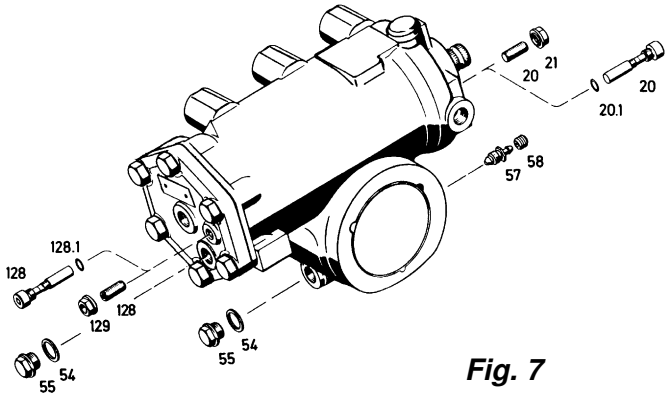


Fig. 7

- Versions with screw (20 and 128):

Open the topmost screw (20 and 128, respectively) until nothing but oil is coming out.
Re-tighten the screw (20 or 128) using a torque of 12+3 Nm.

- Versions with set screw (20 and 128):

Slacken the collar nut (21 or 129) of the topmost set screw (20 or 128) until nothing but oil is coming out.
Re-tighten the collar nut (21 and 129) using a torque of 20+10 Nm.
The hydraulic steering limitation must be checked after bleeding.

- For versions with flange (335), in addition:

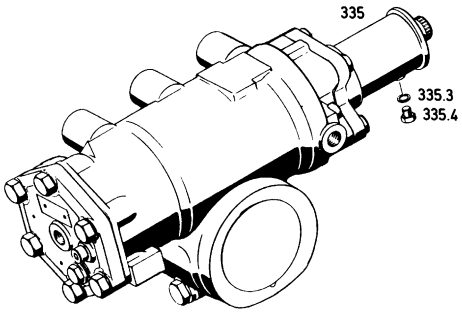


Fig. 8

Open the screw plug (335.4) until nothing but oil is coming out ***(Fig. 8)***.
Then close the screw plug again.
Tightening torque: 8+1 Nm (M8x1)

- If bleeding was done correctly, the oil level in the tank must not rise by more than 1 to 2 cm when the engine is stopped.
  Turn the engine off and lower the jacked-up steered axle or drive axle to the ground.

5 Setting the hydraulic steering limitation

A setting of the steering limitation is necessary if or when

- a new or repaired steering gear is fitted or
- new screws (20 and 128) were fitted to the automatically adjusting steering limitation or
- alterations to or adjustments of the front axle were carried out.

5.1 Hydraulic steering limitation with manual setting *(Fig. 9)*

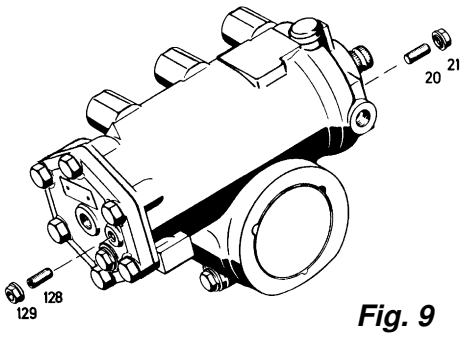
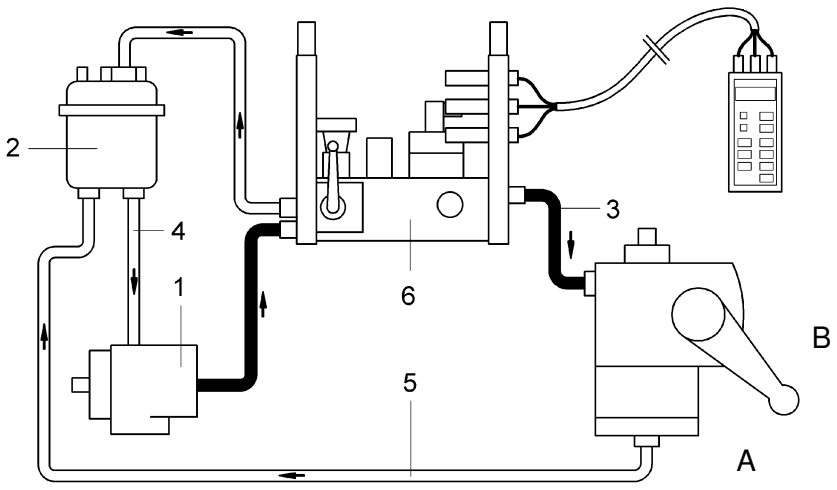


Fig. 9

Fit a pressure gauge (pressure range up to 250 bar) or tool [1] (ZF Servotest power steering tester) to the pressure line between the pump and the steering gear ***(see Fig. 10).***



1 Pump
2 Oil tank
3 Pressure line
4 Suction line
5 Return line
6 ZF-Servotest

Fig. 10

If the setting takes place at set screw (128) the drop arm will be caused to move in direction “B” ***(Fig. 10)***.

If the setting takes place at set screw (20) the drop arm will be caused to move in direction “A”.

Test temperature: 50° C ±10°

- Rigid axle:

Relieve the axle by jacking it up or place it on swivel plates. [1]

- Single-wheel suspension:

Place the steered wheels on swivel plates.

- With the engine running at **idling speed**, rotate the steering gear to the lock stop.

Upon reaching the lock stop, overcome the return force of the steering valve by rotating the steering wheel further for a short time (5 sec. maximum) until a positive steering stop is reached.

Read the pressure at the pressure gauge or at tool [1] (ZF Servotest power steering tester).

Specified values:	Steering systems	up to 16 dm^3/min:	40...50 bar
		up to 20 dm^3/min:	50...60 bar
		above 20 dm^3/min:	70...80 bar

To correct, slacken the corresponding collar nut (21 or 129) and screw the set screw (20 or 128) ***Fig. 14*** in or out.

If a higher pressure is measured, the corresponding set screw must be **screwed in** further.

If a lower pressure is measured, the corresponding set screw must be **screwed out** further.

While doing so, release the steering wheel so that idle pressure only can build up during this work.

Then tighten the collar nut (21 or 129) using a torque of 20+10 Nm.

Attention:

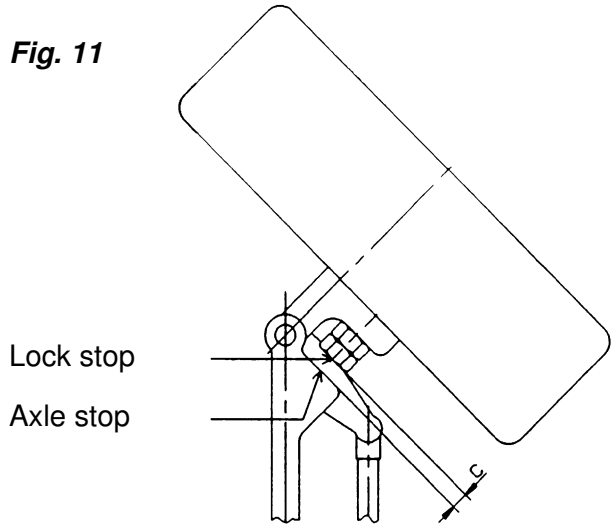
During the setting operation as well as in the built in condition, the set screws (20 and 128) must be screwed in at least 3 threads deep for otherwise, because of insufficient thread overlap, they would run the risk of being ejected when maximum pressure is built up in the steering gear.

[1] see vehicle manufacturer's instructions

Proceed as described above for the setting of the second lock stop.

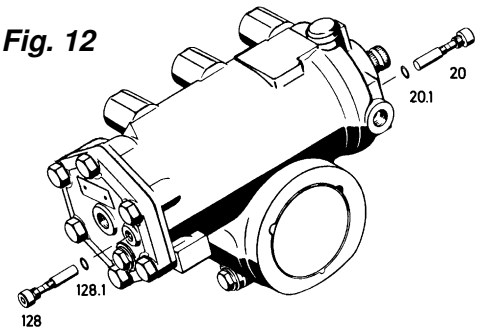
Note:
At variance with the setting described above, the vehicle manufacturer may specify a different way of adjustment, e.g. by inserting a spacer to ensure that, when the steering limitation responds, a distance dimension “C” can be kept ***(Fig. 11)***.

Fig. 11



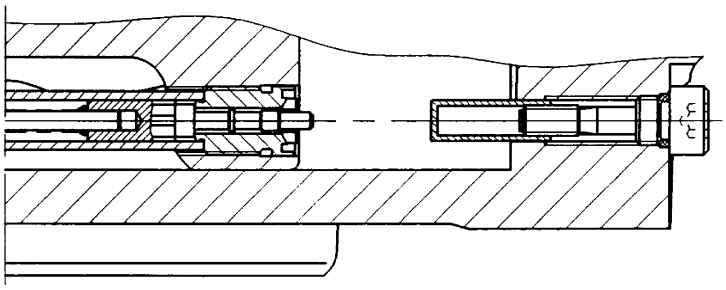
5.2 Automatically adjusting hydraulic steering limitation *(Fig. 12)*

Fig. 12



Attention:
Steering gears with automatically adjusting steering limitations must not be rotated manually to the end positions when the steering linkage is removed or when the steering gear is removed from the vehicle, for the sliding bushes of the screws (20 and 128, respectively) would, thereby, be shifted to the cut-off position that is at maximum possible, and an automatic adjustment on the vehicle would only be possible with **new** screws (20 and 128) ***(Fig. 12)***. The screws (20 and 128) and the set screws (20 and 128) are **not** interchangeable.

Fig. 13 Initial position
Sliding bushes not yet adjusted



5.2.1 Operating mode of the automatically adjusting steering limitation

In the end positions, the valve piston tappets run up against the sliding bushes (20 and 128, respectively) and open the steering limiter valves (U and T, respectively).

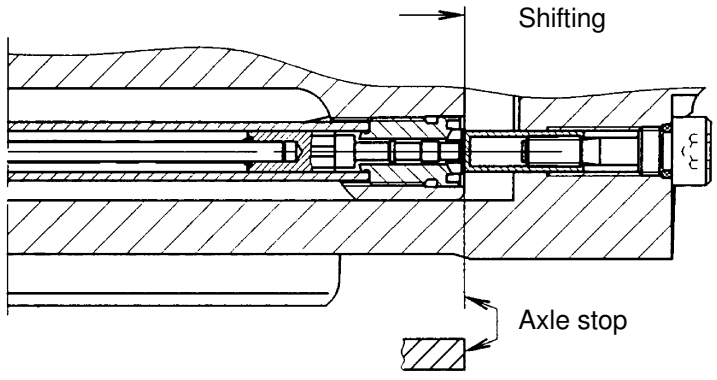
The opening of the steering limiter valve is determined by the position of the sliding bushes on the screws (20 and 128).

5.2.2 Setting

Note:
This setting ***(Fig. 14)*** can only be carried out after the steering gear was fitted to the vehicle. To enable the setting, the steering linkage and the axle stops must be installed and set.

Fig. 14 Setting operation

Positioning of the sliding bushes



- For vehicles with a rigid axle:

Relieve the steered axle by jacking it up (there must, however, still be a load on the steered axle) or place it on swivel plates. [1]

[1] see vehicle manufacturer's instructions

- For vehicles with single-wheel suspension:

  Place the wheels on swivel plates.

- Rotate the steering wheel, with and without hydraulic assistance, to the maximum lock stop.

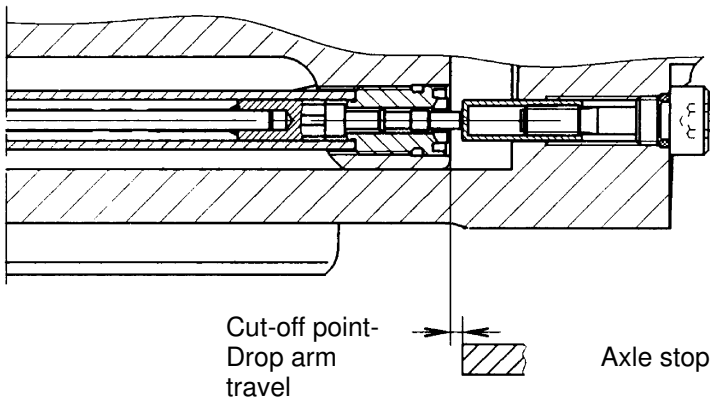
  This will cause the piston to push the sliding bush on the screw (20 and 128) up to the required cut-off position ***(Fig. 15)***.

Note:
During this setting operation the steering limiter valve is constantly open which means that, with as well as without hydraulic assistance, the steering wheel can only be rotated further at an increased effort.

Repeat the setting operation for the other direction of rotation.

Fig. 15

Left-hand steering limiter valve
open, oil pressure highly reduced



5.2.3 Correcting the drop arm travel

Increasing the drop arm travel:

Carry out the setting as described above.

Reducing the drop arm travel:

Fit new screws (20 and 128, respectively).

Attention:
The sliding bushes on the screws (20 and 128) may not be pulled back.

Tightening torque for the screws (20 and 128, respectively): 12+3 Nm

IV. Repair of external leakages

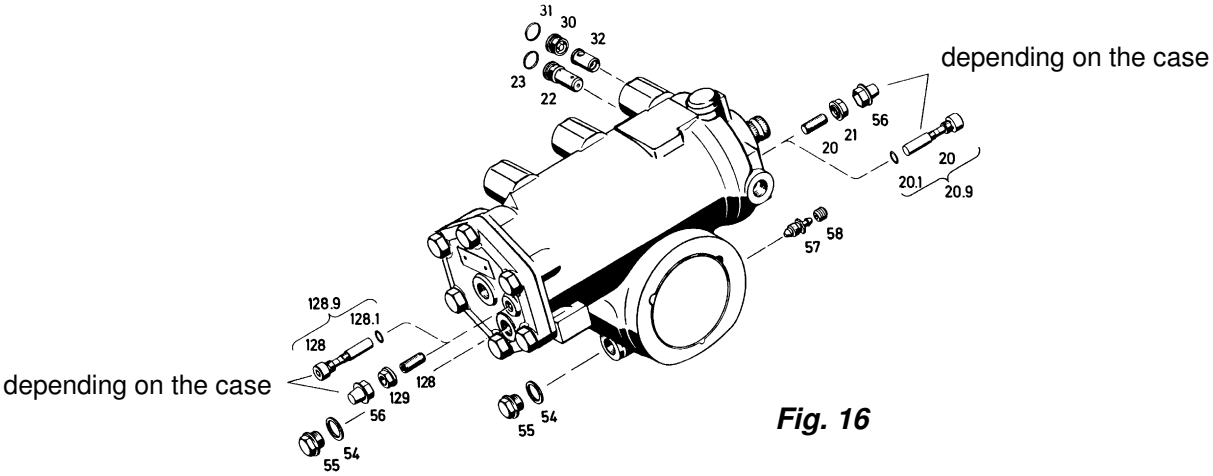


Fig. 16

1 Valve insert (22) - Pressure relief valve

Unscrew the valve insert (22) from the housing ***(Fig. 16)*** and remove O ring rests. If the pressure does not conform to the specified value or if there is any leakage, replace the complete valve insert (22).
Fit a new greased O ring (23) to the valve insert (22) and screw it in again.
Tightening torque: 30+10 Nm

2 Valve insert (32) - Replenishment valve

Unscrew the screw (30) and the valve insert (32).
Put the valve insert (32) into the housing bore. Remove o ring rests.
Fit a new greased O ring (31) to the screw (30) and screw it in again.
Tightening torque: 30+10 Nm

3 Screws (20 and 128)

Screw in new screws (20 and 128)
Tightening torque: 12+3 Nm
Setting the steering limitation - please refer to Chapter III., para. 5.

4 Collar nuts (21 and 129)

Screw in new collar nuts (21 and 129).
Tightening torque: 20+10 Nm
Setting the steering limitation - please refer to Chapter III., para. 5.

5 Screw plug (55)

Unscrew the screw plug (55), fit a new sealing ring (54) and screw it in again.
Tightening torque: 40 Nm (M16x1.5)
50 Nm (M18x1.5)

6 Bleeder (57)

Screw in a new bleeder (57).
Tightening torque: 30 Nm

Attention:

Apart from the work detailed above, no further repair work may be carried out. Any repair work exceeding the extent described above has to be done by a ZF Service Centre.

V. Replacing and setting the switch (222) and the potentiometer (232)

1 Replacing the switch (222)

Unscrew the switch (222) and replace it by a new one (tightening torque: 50 Nm).

Starting from mid-position, rotate the steering gear to the left and to the right. The contact of the switch (222) must open after drop arm travels of 5° (±10%), each (110° ± 10% drop arm travel corresponding to 0.3 steering wheel turns) ***(Fig. 17)***. Make sure that the steer angles to the left and to the right are uniform. If required, correct the symmetry of the switching range by rotating the cover (221).

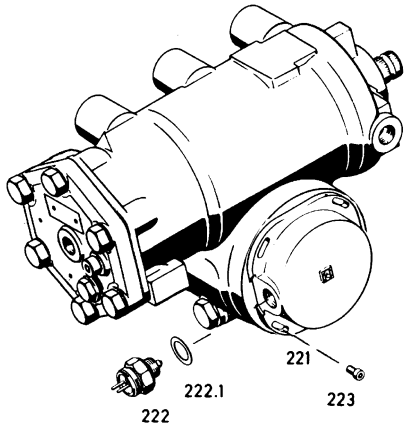


Fig. 17

Tightening torque:

Cap screws (223): 5.5 Nm

Testing tool: Multimeter

Note:
The switching range is set by varying the screw-in depth of the switch (222). Washers (222.1) of different thicknesses are available to enable this setting.

Do not use more than 3 washers (222.1) for the setting operation. (A washer thickness of approx. 0.25 mm corresponds to a drop arm travel of 1° - 22° at the steering wheel).
The cover (221) must be filled with 50 cm^3 of oil (see list of lubricants TE-ML 09).

2 Replacing the potentiometer

2.1 Removing the potentiometer (232)

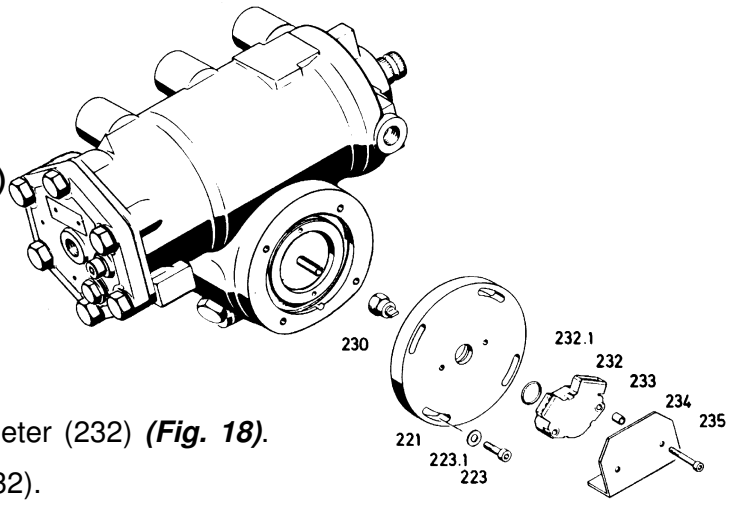


Fig. 18

Rotate the steering gear to mid-position.

Clean the area surrounding the potentiometer (232) ***(Fig. 18)***.

Mark the position of the potentiometer (232).

Unscrew the cap screws (235).

Remove the potentiometer (232) along with the screening plate (234), the spacing sleeves (233) and the O ring (232).

2.2 Fitting the potentiometer (232) again

Check whether the steering gear is in mid-position.

Fit an O ring (232.1) to the potentiometer (232).

Place the deep groove of the potentiometer (232) drive on the carrier (230).

Note:
The slider of the potentiometer (232) being spring-loaded, it will return to its initial position when disassembled.

Therefore, check whether the potentiometer (232) can be turned through 50° minimum to either side when the steering gear is in mid-position.

Fasten the potentiometer (232) along with the spacing sleeves (233), the screening plate (234) and the cap screws (235).

Tightening torque: 2.8 Nm

Check:

The installed position of the potentiometer (232) must be identical with the position as marked during disassembly.

2.3 Setting the potentiometer (232)

Attention:
A maximum value of 6 V must not be exceeded for otherwise the potentiometer (232) would be destroyed.
The tumbler switch of the Servotronictest tester (tool [7]) must not be switched to speedo position as otherwise the potentiometer would be destroyed.

Rotate the steering gear to mid-position (dividing the total number of steering wheel turns in two).

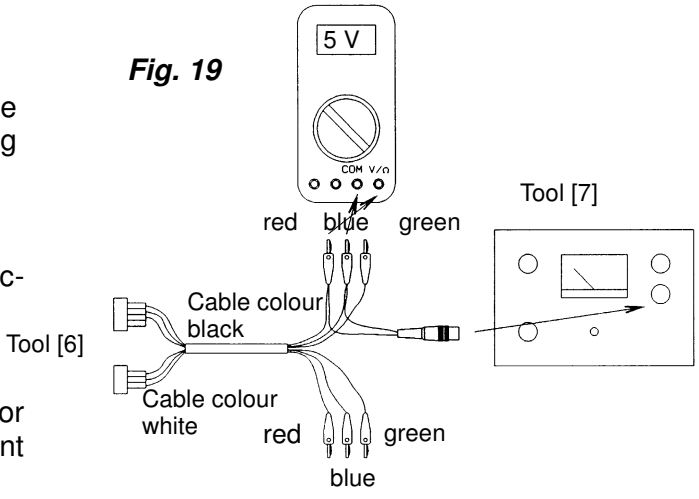
- **Setting a voltage of 5V**

Connect tools [6] and [7] (or use a suitable transformer) and the Multimeter measuring instrument as shown in ***Fig. 19*** .

Switch the tumbler switch of the Servotronic-test tester (tool [7]) to transducer position.

Continue adjusting the transducer regulator until the Multimeter measuring instrument reads 5V.

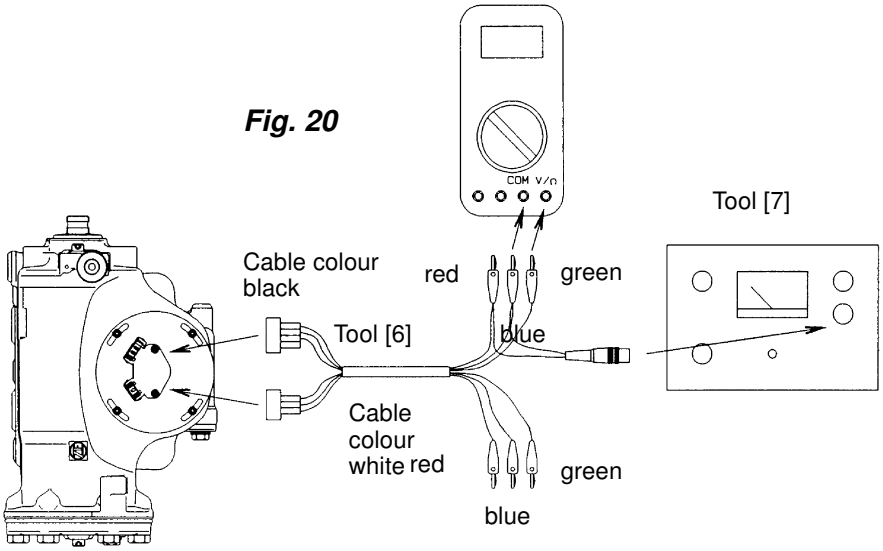
Fig. 19



- **Setting the potentiometer (232) to steering gear mid-position**

Connect tools [6] and [7] and the Multimeter measuring instrument as shown in ***Fig. 20***.

Fig. 20



Rotate the potentiometer (232) together with the cover (221) until the Multimeter measuring instrument reads half the voltage applied, namely 2.5 V + 0.03 V.

In this position, tighten the cap screws (223) (tightening torque: 4+1.5 Nm).

Instructions on measurements, paths 1 and 2

Measurement, path 2:
See ***Fig. 20***

Measurement, path 1:
See ***Fig. 20***

Additionally: Plug in a jumper from blue to blue
Plug in a jumper from red to red
Unplug the green cable of path 2

At variance: Plug the green cable of path 1 in the Multimeter

Rotate the potentiometer (232) along with the cover (221) until the same voltage (specified value: 2.3...2.7 V) is indicated for both paths.

In this position, tighten the cap screws (223) (tightening torque 4 +1.5Nm).

Rotate the steering gear to the right-hand lock and measure the voltages of paths 1 and 2 (specified value: 0.122 V...4.88 V).

Rotate the steering gear to the left-hand lock and, again, measure the voltages of paths 1 and 2 (specified value: 0.122 V...4.88 V).

Note:
If the specified values are not attained, a new potentiometer has to be used.

VI. Removal and re-installation of the steering gear

1 Removing the steering gear

1.1 Thoroughly clean the steering gear and its immediate surroundings, in particular the pipe connections.

Drain the oil as described in Chapter III..

Take a note of the pressure and return lines‘ position.

Unscrew the pressure and return lines.

Obturate all oil pipes (danger of soiling).

1.2 Check whether the marks on the sector shaft and the drop arm coincide.

Note:
If the marks are offset from each other, prior to fitting the drop arm inquire with the vehicle manufacturer whether differing assembly instructions exist.

Screw out the locking screw (50).

Pull the drop arm off, using tool [5].

Attention:
Heating up the drop arm or driving in a wedge between the housing and the drop arm or removing the drop arm by means of hammer blows is not permitted as such action may cause changes to the material and/or inner damages to the steering gear.

1.3 Additionally, for vehicles with adjustable steering column:

- Adjust the driver’s workplace to the topmost position to relieve the ball-track relay shaft as much as possible.
- By means of a suitable tool, for instance a ratchet belt, relieve the ball-track relay shaft in such a way that no thrust force can act towards the steering gear.

  When a ratchet belt is used, pass the belt through the yoke spaces if possible (see arrows in ***Fig. 21***). Tension the belt to an extent avoiding any damage to the sealing elements or the steering gear protection cap caused by a dislocation of the universal joints at the moment the clamping screws are unscrewed.

1.4 Unscrew the universal joint or the elastic coupling between the steering gear and the steering column or the separately mounted bevel box.

Unscrew the mounting screws and remove the steering gear.

Note:
If a fitting bolt was used, write its position down.

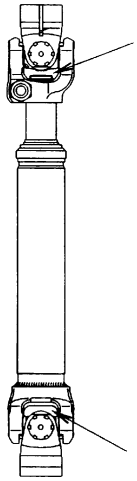


Fig. 21

2 Re-installing the steering gear

Attention:
To guarantee a safe operation of the steering system, maximum cleanliness is an absolute must when re-installating all units that are part of the system.

Note:

To avoid malfunctions caused by foreign bodies or impurities in the oil circuit of the steering gear, the plugs in the ports of the steering gear, the oil pump, the steering cylinder, the valves etc. ... should only be removed at the moment the lines are connected. Remove protecting sleeves in the installed position, only, if this is possible. Connecting lines and screwed connections must be thoroughly cleaned and deburred.

2.1 Rotate the steering wheel to the straight ahead driving position.

Clean the locating surfaces of the mounting bracket and the steering gear.

2.2 Additionally, for vehicles with adjustable driver's workplace:

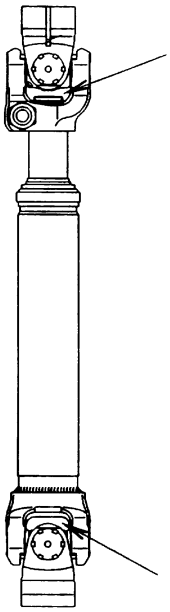
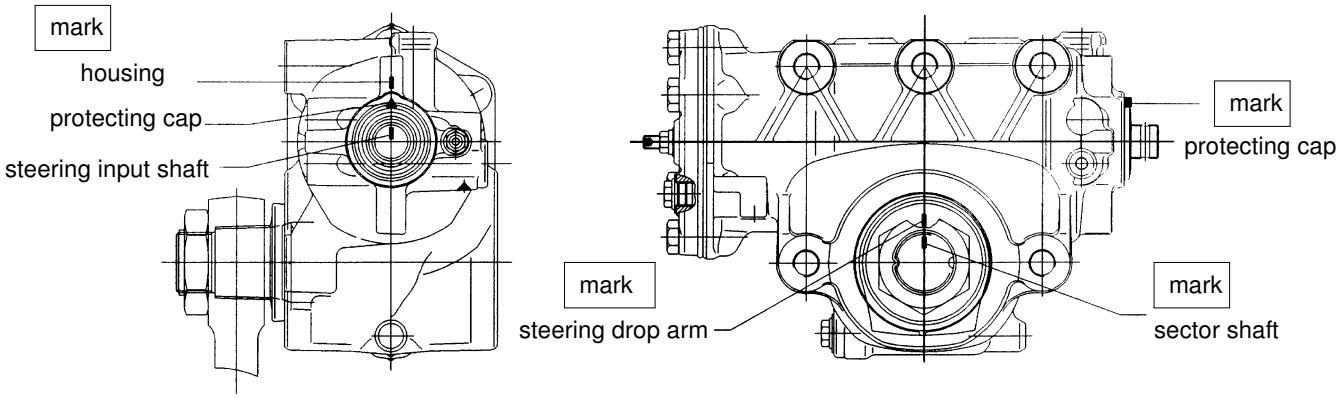


Fig. 22

Using a suitable tool, for example a ratchet belt, constrict the ball-track relay shaft until there is sufficient space for the steering gear to be built in without constricting the ball-track relay shaft any further. ***(Fig. 22)***.

2.3 Rotate the steering gear to mid-position by dividing the total number of steering wheel turns in two. Then continue to rotate until the marks (see ***Fig. 23***) on the input shaft, the protection cap and the housing coincide.

Fig. 23



2.4 Place the steering gear into the mounting bracket and fasten it with screws.

Note:
Make sure that the position of the fitting bolt is correct.
For the tightening torque, please refer to the technical cover sheet of the spare parts list. If no data is given in the list, the values below shall apply.

Depending on the vehicle type, space restrictions may require a previous fitment of the drop arm.

Tightening torque:

Thread	Screw grade	Tightening torque
M18x1.5	10.9	410+10% Nm
M20x1.5	10.9	520+10% Nm

Attention:
Conform to vehicle manufacturer's instructions.

2.5 Fit the universal joint or the elastic coupling between the steering column and the steering gear.

Note:
The clamping slot in the universal joint must point towards the mark on the cover cap or on the input shaft.

2.6 Additionally, for vehicles with adjustable driver's workplace:

Put the universal joint on without damaging the steering gear seal.

Tighten the clamping screw (M10x1,25) applying a torque of 48+5 Nm.

Relieve the tool, e.g. the ratchet belt (see ***Fig. 22***), **cautiously** and remove it.

2.7 Move the steered wheels of the vehicle to the straight ahead driving position.

This position is reached when the steered wheels are in line with or parallel to, respectively, the second pair of road wheels (place a graduated ruler against the front and rear wheels).

2.8 Put the drop arm on the serration, making sure that the marks on the drop arm and on the sector shaft coincide ***(see Fig. 23)***.

Screw the locking nut (50) on and tighten it, applying the torques specified below.

- For versions with tapered serration:

Note:
For the tightening torque, please refer to the technical data sheet of the spare parts list. If no data is given in the list, the following values shall apply:

Thread	Serration	Tightening torque	Exception
M30x1.5	1 3/8"x36	250 Nm +10%	
M30x1.5	1 1/2"x36	300 Nm +10%	
M30x1.5	1 5/8"x36	330 Nm +10%	
M35x1.5		400 Nm +10%	
M42x1.5		500 Nm +10%	
M45x1.5		550 Nm +10%	MAN: 850 Nm+10%

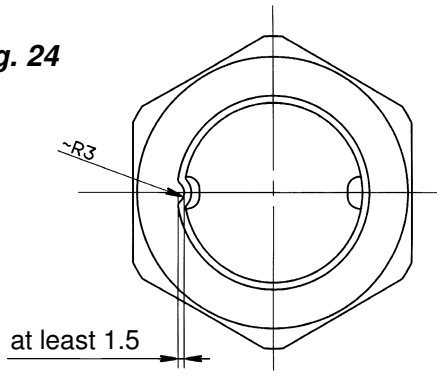
If the vehicle manufacturer specifies different values, manufacturer's values shall apply.

- For versions with cylindrical serration and/or clamping screws:

Apply the tightening torque specified by the vehicle manufacturer.

2.9 Peen the locking nut (50) as shown in ***Fig. 24***. [1]

Fig. 24



Put the drag link or the tie rod into place and tighten it. [1]

Rotate the steering gear to the left until reaching the stop.

Take off the drag link or the tie rod.

2.10 Additionally, for versions with automatically adjusting steering limitation:

Unscrew the screws (20 and 128).

2.11 Check at the steering wheel whether any further movement to the left is possible.

If the steering gear cannot be rotated any further to the left, the lock stop and the axle stop. respectively, must be re-set.

Attention:

It must be guaranteed that the steering angle limitation takes place at the lock stops and the axle stops, respectively, and is not done by the steering gear.

Mount the drag link or the tie rod. [1]

Repeat the check for the right-hand side and, if required, re-set the lock stop and the axle stop, respectively.

2.12 Additionally, for versions with automatically adjusting steering limitation:

Screw in the screws (20 and 128). Tightening torque: 12+3 Nm

2.13 Mount the drag link or the tie rod. [1]

[1] see vehicle manufacturer's instructions

2.14 Connect the pressure and return lines between the pump, the steering gear and the steering cylinder according to the notes taken on the removal.

Fill the steering system with oil and bleed it.

See Chapter III.

2.15 Set the hydraulic steering limitation

See Chapter III.

2.16 Check the oil level

Before pulling out the oil dipstick, thoroughly clean the oil tank and its immediate vicinity to prevent dirt from getting into the hydraulic fluid.

Attention:
If the oil level is too low, it can entail malfunctions which, in turn, may cause a failure of the hydraulic steering assistance.

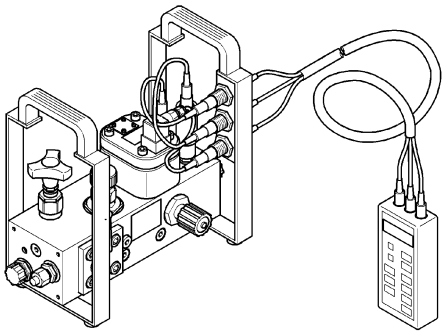
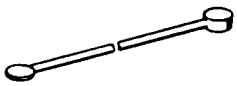
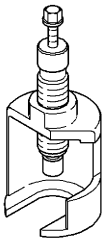
Additionally, for vehicles equipped with a ZF Servocom RAS (rear axle steering system):

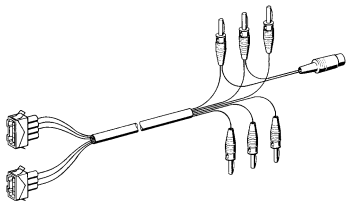
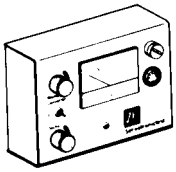
Check the oil level in the straight ahead driving position.

If the oil level is above the upper mark, there may be a leakage in the master cylinder of the ZF Servocom RAS.

VII. Special tools

Note:
The tools described below are universal tools. For special applications, special tools recommended by the vehicle manufacturer may therefore be necessary.

		Ordering ref. No.
Tool [1] ZF Servotest 600 tester		7418 798 600
Tool [2] Dial with pointer		7418 798 452
Tool [3] Thrust pad		7418 798 556
Tool [4] 1 pair of expanders		7418 798 653
Tool [5] Extracting device		7418 798 219

		Ordering ref. No.
Tool [6] Adapter cable		7418 798 567
Tool [7] Servotronictest tester		7418 798 545

VIII. Troubleshooting

1 Troubleshooting on the steering system, incl. checking the hydraulic functions

1.1 Checking the play of the input shaft bearing in the steering column

By moving (shaking) the steering wheel sideward to and fro, check whether there is any play.

If so, replace or repair the steering column/the bearing.

1.2 Checking the universal joint, the telescopic shaft and the bevel box for angular play or stiff operation

If play (can be identified by the noticeable rattling noise occurring when the steering wheel is turned to and fro) or stiff operation are ascertained, replace the defective components.

1.3 Checking for leakage

- Start the engine.
- Check whether all screwed connections, lines and sealing elements of the complete steering system (bevel box, steering gear, pump and steering cylinder) are leakproof.
- Check all hoses and lines, protecting caps and bellows for possible traces of chafing and embrittlement cracks.
- Switch the engine off.

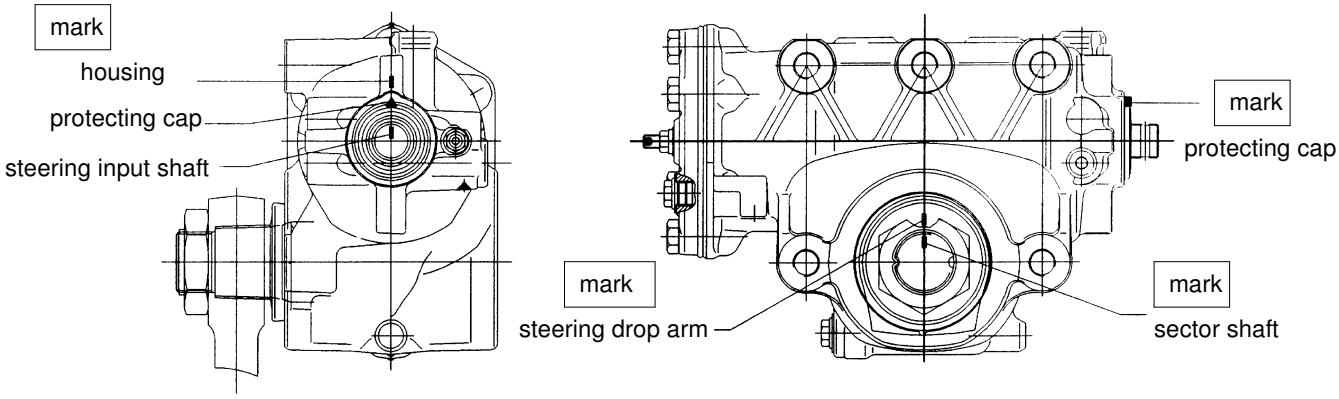
Attention:
When you replace hose lines or parts with externally visible damages such as for instance cracks, only use spare parts that are pressure-tested and released by the vehicle manufacturer.

1.4 Checking the straight ahead driving position of the steering gear and the vehicle

Attention:
Steering gears equipped with an automatically adjusting hydraulic steering limitation must not be rotated to the end positions if the steering linkage had been removed previously.

- Vehicles with single-wheel suspension:
  Place the wheels of the steered axle on swivel plates.
- Vehicles with a rigid axle:
  Jack the steered axle up. [1]
- Move the steering gear to mid-position by rotating it half the total number of steering wheel turns. Then rotate it further until the marks ***(see Fig. 25)*** coincide.

Fig. 25



Now turn the steered wheels to the straight ahead driving position.

Corrections can be made by screwing the ball joint on the drag link further in or out.

Attention:
If the steering wheel position is not correct or if a length correction of the steering linkage turns out to be necessary, it may well be that this necessity originates in a preceding accident-like event. We, therefore, recommend to check whether the serration of the sector shaft (30) is twisted (to do so, pull the drop arm off), whether the input shaft is installed in a twisted position and whether some or all further transmission elements are bent or have cracks. In addition, check the play as detailed in Chapter III., para. 3. Deformed components may not be re-bent to shape but must be replaced.

Additionally, for versions with automatically adjusting hydraulic steering limitation:

If required, fit new screws (20 and 128, respectively) and reset the steering limitation - see Chapter III., para. 5.

[1] see vehicle manufacturer's instructions

1.5 Checking the belt tension of the pump drive

Check the tension of the drive belt. [1]

Even at maximum pump pressure, the drive belt must transmit the power without any slip.

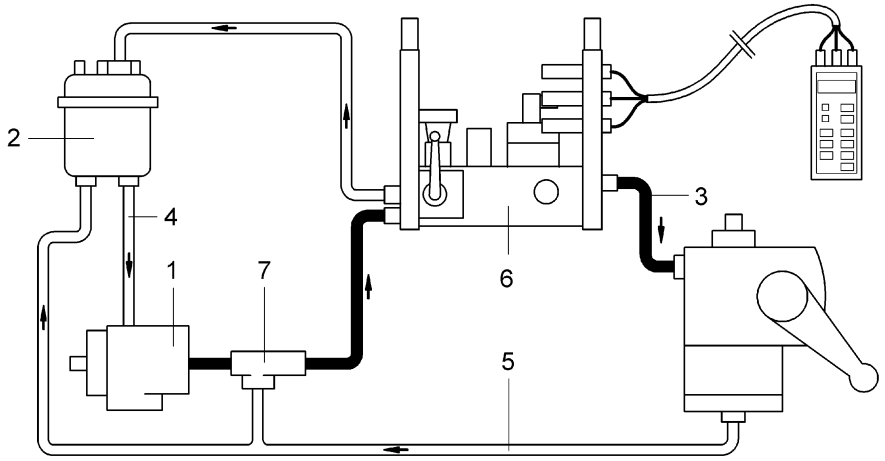
1.6 Checking the hydraulic functioning of pump and steering gear

1.6.1 Installing tool [1] (ZF Servotest tester)

For the implementation of the pressure and leakage oil tests described below, it is necessary to distinguish 2 kinds (variants ① and ②) of steering systems.

Variant ①

Steering systems with the **pressure relief valve arranged in the pump or in the pressure line between the pump and tool [1] (ZF Servotest power steering tester)** ***(Fig. 26)***. This means that pressure relief takes place ahead of built-in tool [1]. On steering systems of this type the nameplate of the pump or of the pressure relief valve will indicate the maximum pressure, e.g. 130 bar.



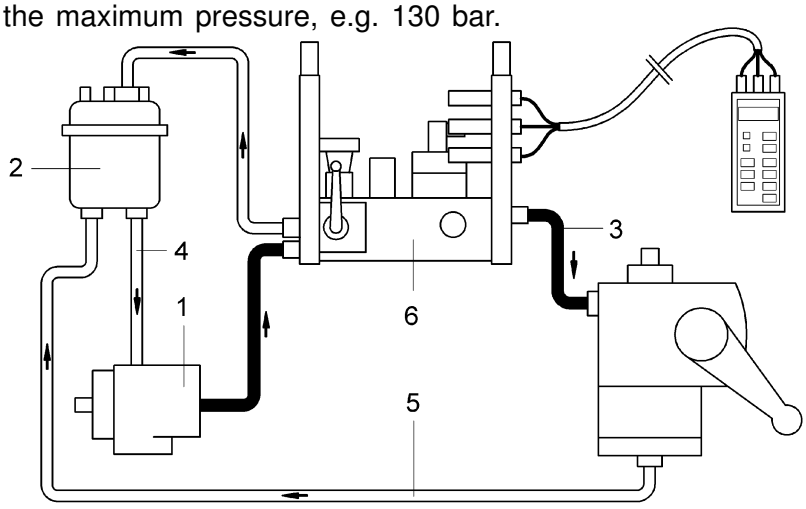
1 Pump
2 Oil tank
3 Pressure line
4 Suction line
5 Return line
6 ZF-Servotest Tool [1]
7 Pressure-relief valve

Fig. 26

Variant ②

Steering systems with the **pressure relief valve arranged in the steering gear or in the pressure line between tool [1] (ZF Servotest power steering tester) and the steering gear** ***(Fig. 27)***.

On steering systems of this type the nameplate of the steering gear or of the pressure relief valve will indicate the maximum pressure, e.g. 130 bar.



1 Pump
2 Oil tank
3 Pressure line
4 Suction line
5 Return line
6 ZF-Servotest Tool [1]

Fig. 27

[1] see vehicle manufacturer's instructions

Fit tool [1] (ZF Servotest) to variants ① or ② in such a way that the readings can be seen from the driver's seat.

Check the oil level and bleed the steering system - see Chapter III.

Test conditions: oil temperature 50°C

1.6.2 Checking the maximum pressure of the ZF pump

Read the maximum permissible pressure from the nameplate of the steering gear/the pump or of the separately arranged pressure relief valve. Start the engine.

Set the pressure relief of tool [1] (ZF Servotest) to a value excluding any damages to the steering system during the tests decribed below.

1.6.2.1 For steering systems with pressure relief **ahead of** tool [1]: **Variant** ①
Have the engine run at idling speed.

Close the shut-off valve of tool [1] (ZF Servotest) and read the maximum pressure.

Attention:
Admit maximum pressure for a short time only (10 seconds maximum) to avoid an excessive heating-up of the inner parts of the pump and, in consequence, a premature wear of these parts.

Specified value: maximum pressure (see nameplate) +10 %

Open the shut-off valve again.

Wird der Sollwert nicht erreicht Pumpe ersetzen bzw. reparieren.

1.6.2.2 For steering systems with pressure relief **aft of** tool [1]: **Variant** ②

Attention:
If tool [1] is installed to variant ② make absolutely sure that during the entire period of pressure testing the engine is running at idling speed, only. An increase in engine speed would entail an immediate and sharp rise in system pressure which could cause a damage to the pressure line/the pump.

Have the engine run at idling speed.

While watching the pressure gauge of tool [1], slowly close the shut-off valve until the maximum pressure indicated is reached.

Do not close the shut-off valve any further. Admit maximum pressure for a short time only (maximum 10 seconds) to avoid an excessive heating of the inner parts of the pump.
Have the shut-off valve return to its initial position.

If maximum pressure is not reached during this measurement, the pump has to be replaced or repaired.

1.6.3 Checking the flow rate of the ZF pump

Note:
Specified values for flow rate, test pressure and test speed: see table below. Designations and operation of tool [1] (ZF Servotest power steering tester 6..): see separate operating instructions for ZF Servotest 6.. .

- **Checking the controlled flow rate**

Raise the engine speed until the pump flow rate remains constant despite a further increase in speed (approx. 1300 r.p.m.)

The pump is now in the flow setting range.

Specified value: see spare parts list

- **Checking the minimum flow rate**

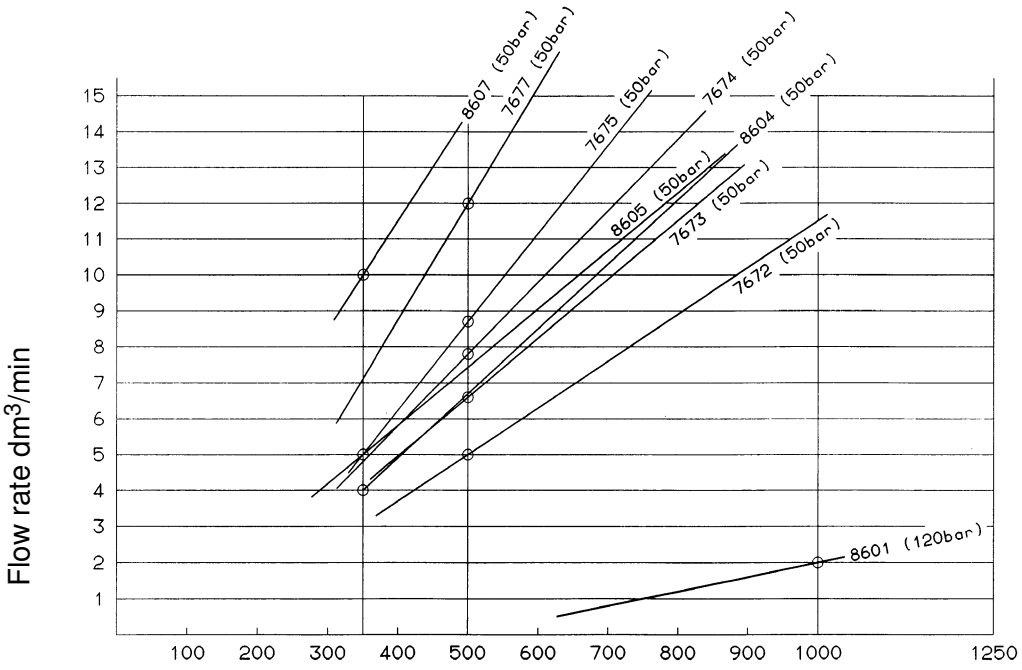
With the engine running at idling speed, progressively close the shut-off valve until the test pressure specified for the pump type in question is built up.

Read the flow rate.

Make sure the engine speed/pump speed ratio is correct.

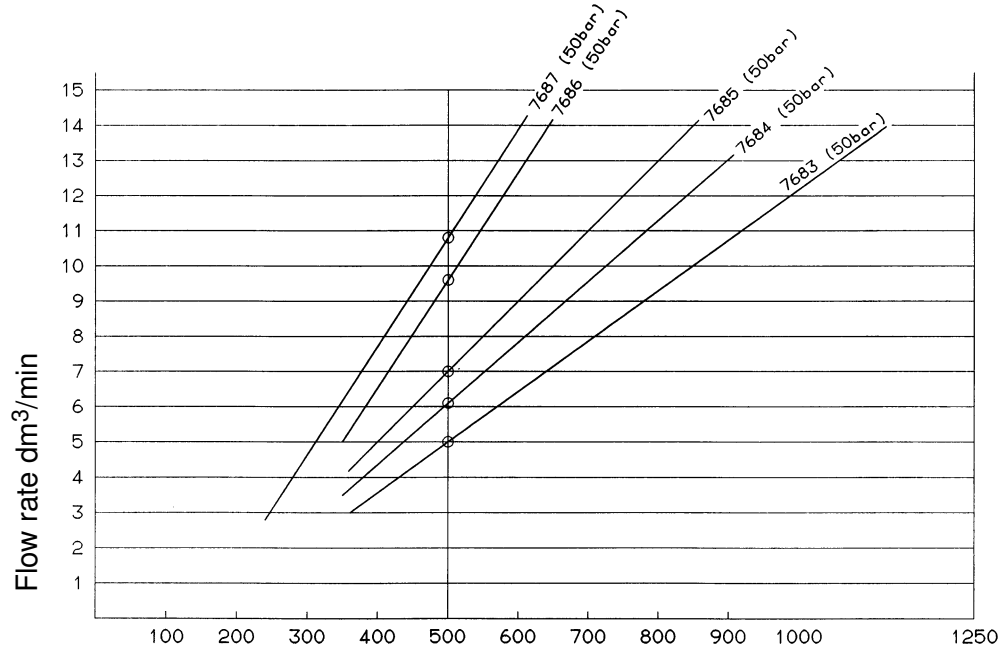
Pump Type	Test Speed [r.p.m.]	Test Pressure [bar]	Minimum Flow Rate [dm^3/min]
7672	500	50	5.0
7673	500	50	6.6
7674	500	50	7.8
7675	500	50	8.7
7677	500	50	12
7683	500	50	5.0
7684	500	50	6.1
7685	500	50	7.0
7686	500	50	9.6
7687	500	50	10.8
8601	1000	120	2.0
8604	350	50	4.0
8605	350	50	5.0
8607	350	50	5.0

Graphs see next page.



○ Minimum values

Pump speed r.p.m.



○ Minimum values

Pump speed r.p.m.

1.6.4 Checking the hydraulic steering limitation

1.6.4.1 Manually adjustable hydraulic steering limitation

- Vehicles with a rigid axle:
  Jack the steered axle up. [1]
- Vehicles with single-wheel suspension:
  Place the wheels of the steered axle on swivel plates.
- Rotate the steering wheel clockwise. When the axle stop and the lock stop, respectively, are reached, continue to rotate the steering wheel until a positive stop is reached.
  In this position read the pressure at the pressure gauge:

Specified values:Steering systems	up to 16 dm^3/min:	40...50 bar
	up to 20 dm^3/min:	50...60 bar
	above 20 dm^3/min:	70...80 bar

Repeat this test for the other direction of rotation.

Setting the steering limitation: see Chapter III., para. 5.

1.6.4.2 Automatically adjusting hydraulic steering limitation

Carry out the test as described in para. 1.6.4.1.

If there is no more space left at the lock stop components or if the oil pressure does not drop to the specified value, fit new screws (20) and (128), respectively, and reset the steering limitation as specified in Chapter III., para. 5.

Specified values: Steering systems	up to 16 dm^3/min:	40...50 bar
	up to 20 dm^3/min:	50...60 bar
	above 20 dm^3/min:	70...80 bar

If there is too much space available at the lock stop components and if the oil pressure does not drop to the specified value, reset the steering limitation as specified in Chapter III., para. 5.

Repeat this test for the other direction of rotation.

[1] see vehicle manufacturer's instructions

1.6.5 Checking the maximum pressure and the leakage oil of the steering gear

For steering systems with pressure relief ahead of tool [1]: Variant ①
Between the lock stops, insert tool [3] or approx. 15 mm thick thrust pads ***(Fig. 28)*** ensuring that the steering motion is stopped 1/2 to 3/4 steering wheel turn before reaching the axle stop/lock stop. The restriction of the steering motion must take place at tool [3] or at the said thrust pads and must not be done by the piston in the steering gear.

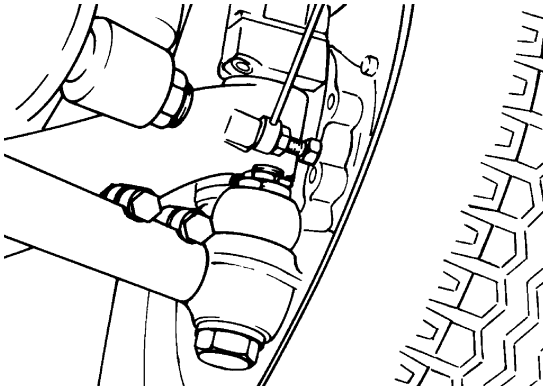


Fig. 28

Attention:

A tool under pressure may be ejected - avoid any direct visual contact with the tool. Danger of accidents by squeezing.

Use the special tool specified by the vehicle manufacturer for the axle version in question.

At engine idling speed, rotate the steering wheel to the stop and continue to turn for abt. 5 seconds with an effort of 100...200 N at the steering wheel. Read the maximum pressure and the leakage oil.

Repeat this test in the opposite direction of rotation.

Maximum permissible leakage oil values: Type 8090: 2.0 dm^3/min
Types 8095...8098: 2.5 dm^3/min

Checking the leakage oil at a reduced flow rate:

Set tool [1] (ZF Servotest) 6.. to a flow rate which is 0.5 dm^3/min higher than the maximum permissible leakage oil value.

Repeat the leakage oil test as described above. The leakage oil value measured in this repetition test must not exceed the value measured previously - see above.

Cause of insufficient maximum pressure/too much leakage oil:

- Pressure relief valve and/or replenishment valve defective.
- Pressure cut-off of steering limitation valve comes too early - refer to Chapter III., para. 5 for setting.
- Seals in the steering gear defective.

For steering systems with pressure relief aft of tool [1]: Variant ②
The shut-off valve (4) must be closed completely and the throttle valve (5) must be closed progressively until a pressure is achieved that is 30 bar lower than maximum pressure. Re-open the shut-off valve (4).
Repeat this test as described above.

1.6.6 Checking the return to neutral of the valve

Note:
Make sure the steering column has sufficient clearance (floor carpets, coverings).

By rotating the steering wheel, close the steering valve, thus causing maximum pressure to build up. Then rotate the steering wheel back until idle pressure is available. Next, raise the pressure to idle pressure +10 bar.

Release the steering wheel and watch the pressure which must drop to idle pressure (at maximum 0.5 bar higher) within 1 second.

Example:Idle pressure: 4.0 bar Maximum permissible value: 4.5 bar

1.6.7 Checking the steering gear play

Prerequisite for the test described below:

The transmission parts between the steering wheel and the road wheel must be free from play.

- Versions with leaf spring:

Lock the LH front wheel (the RH front wheel if the vehicle is RH steered) in the straight ahead driving position by fitting tool [4] between the wheel rim (rear and front) and the front spring ***(Fig. 29)***.

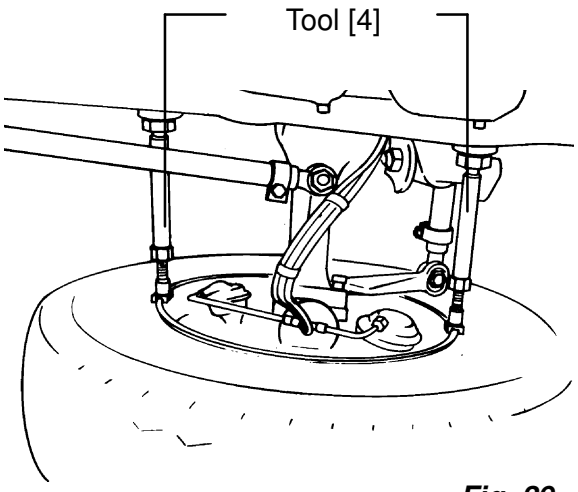


Fig. 29

Attention:

Do not exert any pressures in excess of those mentioned below on the tools and the wheel rim in order to avoid damages to the wheel rim.

- Versions with single-wheel suspension:

Lock the LH front wheel (the RH front wheel if the vehicle is RH steered) as per vehicle manufacturer's instructions.

- Put tool [2] on the steering wheel and attach the pointer to the dashboard or to the windscreen ***(Fig. 30)***.

Raise the engine speed to approx. 1000 r.p.m..

Read the idle pressure at tool [1] (ZF Servotest/pressure gauge).

Rotate the steering wheel to the left until a pressure of 1 bar above idle pressure is indicated.

On tool [2] read the dial value.

Rotate the steering wheel to the right until a pressure of 1 bar above idle pressure is indicated.

On tool [2] read the dial value.

Calculate the total travel covered.

Specified value: max. 50 mm (steering wheel Ø 500 mm)

For versions with bevel box:

Specified value: max. 55 mm (steering wheel Ø 500 mm)

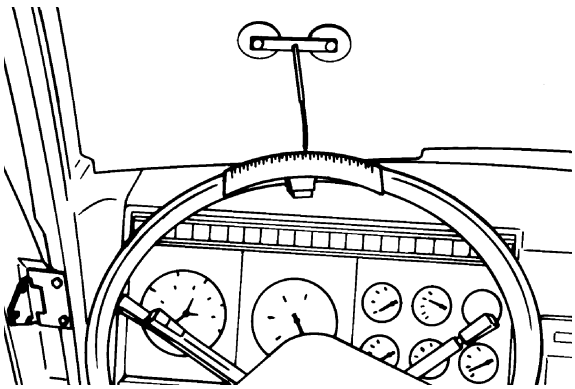


Fig. 30

If the maximum value is exceeded, check the play of the steering column and, if required, repair or replace the steering gear.

Remove tool [1] (ZF Servotest)/the pressure gauge.

Check the oil level and bleed the steering system - see Chapter III.

2 Troubleshooting aid

Fault	Cause	Remedial action
Noise	Air in the oil Oil level too low	Bleed steering system [3] Top up with oil
	Pump defective	Repair [2] Replace [2]
Stiff operation to either side	Oil level too low	Repair leakage Top up with oil [3]
	Steering system is sucking in air (Suction area)	Repair leakage Top up with oil [3] Bleed steering system [4]
	Universal joints/steering column Stiff operation	Check Replace [1]
	Oil filter soiled	Replace [3]
	Steering gear defective	Repair [2] Replace [2]
	Pump defective	Repair [2] Replace [2]
Stiff operation in one direction	Incorrect setting of steering limitation	Set [3]
	Steering gear defective	Repair [2] Replace
Stiff operation during fast steering motion	Steering system is sucking in air (Suction area)	Repair leakage Top up with oil Bleed steering system [3]
	Pump defective or wrong version	Replace pump [2]

[1] see vehicle manufacturer's instructions

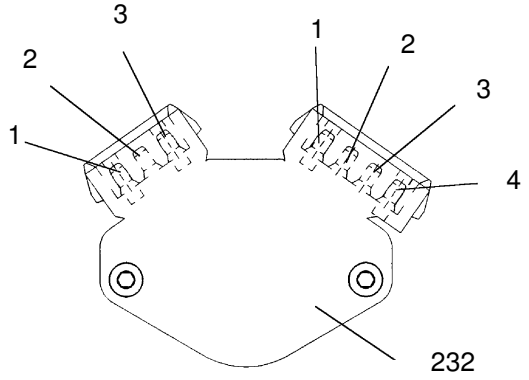
[2] approach ZF Service Centre

[3] see Chapter III.

Fault	Cause	Remedial action
Self-centring hampered	Stiff operation of axle/ axle guide components	Repair [1]
	Steering gear/steering column fitted in twisted position	Eliminate twisting [1]
	Stiff operation of steering column	Eliminate stiff operation [1]
	Steering gear defective	Repair [2] Replace [2]
Exact straight ahead driving impossible	Oil level too low	Repair leakage Top up with oil [3] Bleed steering system [3]
	Axle/axle guide components/ steering column not play-free	Check [1] Replace [1]
	Steering gear not play-free	Check [3] Replace [2]

Additionally, for versions with potentiometer (232):

Pin assignment at potentiometer and plug, respectively (vehicle electrical system)



Potentiometer (232) does not work	No operating voltage	At plug (vehicle electrical system) measure between pins 1-3 Specified value: operating voltage [1]
	Contact problems	Remove dirt and/or corrosion

Fault	Cause	Remedial action
	Internal malfunction	Check potentiometer (see below)
	No tripping of potentiometer (232)	Replace steering gear [2]
Wrong operation of potentiometer (232)	Wrong setting	Set potentiometer [4]
	Wrong cabling	Check cabling [4]
	Cap screws (223 and 235) loose	Check and tighten [4]
	Potentiometer (232) mounted incorrectly	Check [4]

[1] see vehicle manufacturer's instructions

[2] approach ZF Service Centre

[3] see Chapter III.

[4] see Chapter V.

IX. Key to numbers in figures and exploded drawing

20 Set screw/screw

20.1 O ring

20.9 Screw

21 Collar nut

22 Valve insert

23 O ring

30 Screw

31 O ring

32 Valve insert

54 Sealing ring

55 Screw plug

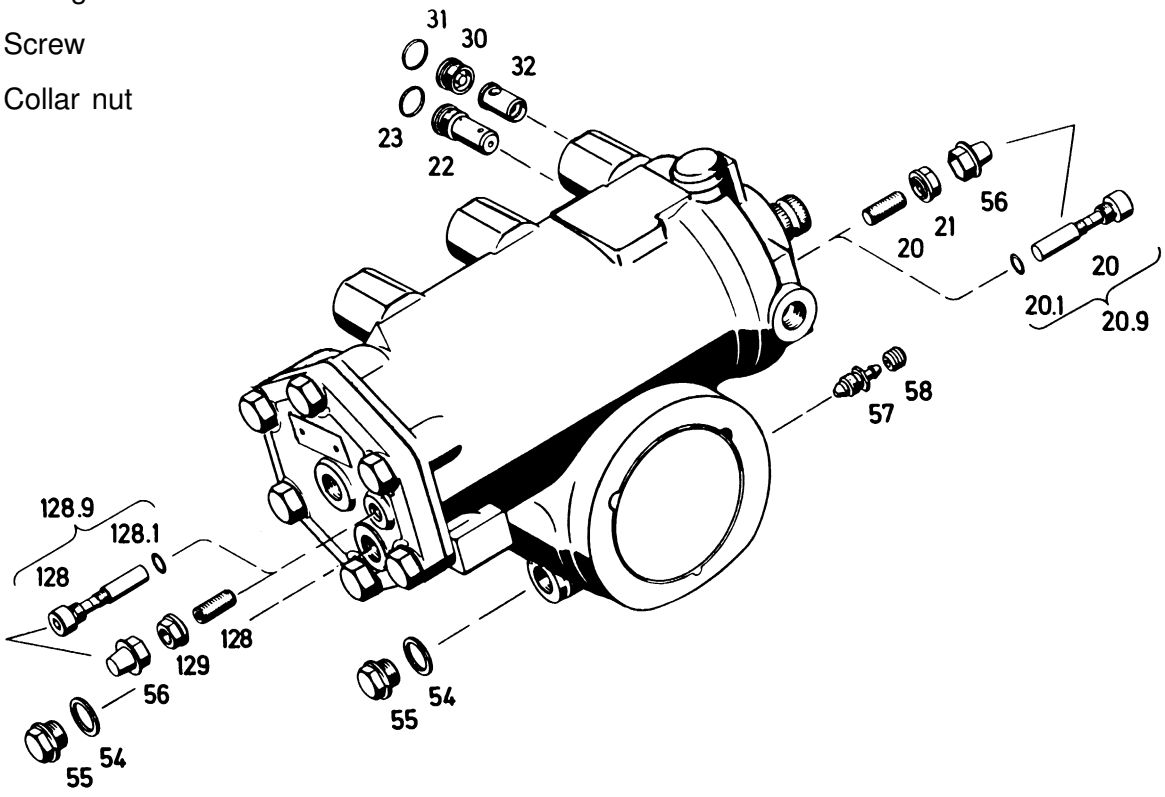
57 Bleeder

128 Set screw/screw

128.1 O ring

128.9 Screw

129 Collar nut



Maintenance Report for ZF Servocom Steering Gears

Original for duplicating

ZF Lenksysteme

Customer: . . . . . Steering gear version: . . . . . .

Vehicle manufacturer: . . . . . Pump manufacturer: . . . . . .

Vehicle type (or model): . . . . . Pump version: . . . . . .

Mileage: . . . . . Emergency steering pump: . . . . . .

1 Test drive carried out ☐ yes ☐ no

Complaints: . . . . . .

2 Tested or checked for external leakproofness / damages ☐ yes ☐ no

Complaints: . . . . . .

3 Oil level checked ☐ yes ☐ no

Remarks: . . . . . .

. . . . . .

Checked by (name): . . . . . Date: . . . . . .

Inspection Report for ZF Servocom Steering Gears

Original for duplicating

ZF Lenksysteme

Customer: . . . . . Steering gear version: . . . . . .

Vehicle manufacturer: . . . . . Pump manufacturer: . . . . . .

Vehicle type (or model): . . . . . Pump version: . . . . . .

Mileage: . . . . . Emergency steering pump: . . . . . .

1 Inspection intervals (see Chapter III.)

2 Test drive carried out ☐ yes ☐ no

Complaints: . . . . . .

3 Visual inspection carried out ☐ yes ☐ no

Complaints: . . . . . .

4 Oil filter replaced ☐ yes ☐ no

5 Steering gear play checked ☐ yes ☐ no

Specified value: Measured value: . . . . . mm

max. 50 mm

max. 55 mm (for versions with bevel box)

6 Safety inspection (SP) checks carried out ☐ yes ☐ no

Remarks: . . . . . .

Checked by (name): . . . . . Date: . . . . . .

Guideline to Evaluate Warranty Claims

Heavy-duty Shock Absorbers

Index:

1) Inspection
2) Misting
3) Leakage
4) Noise – Rubber Bushings
5) Noise – Scratching Metal Dust Cover
6) Damping Performance

1) Inspection

It is recommended to inspect Sachs shocks visually during regular maintenance schedules, however at least:

- linehaul applications: every 100,000 miles
- vocational applications: every 50,000 miles

The visual inspection should include

- the shock itself (leakage, any irregularities)
- shock bushings
- tires (tire cupping)

The most common failures and their possible causes are compiled in this document. By understanding the cause you may be able to correct the problem, avoid future failures and ensure ride safety.

For further assistance please contact:

Sachs Automotive of America

(859) 647 – 84 47 Ivan Botello
or (248) 458 – 36 88 Jim C. King

Guideline to Evaluate Warranty Claims
Heavy-duty Shock Absorbers

2) “Misting“

Appearance might be deceptive. A certain degree of vapor is normal and actually necessary for lubrication of the rod seal.

The inspection must not be conducted after drive in wet weather or a vehicle wash. Shock needs to be free from water.

“Misting“

OBSERVATION:

A precipitation of oil mist on the outside of the shock is visible.

Carefully touch shocks with dry finger. (Use caution: shocks may be hot!) If the finger remains dry, the shock is not leaking.

If in doubt, wipe shock clean and check again after a few days of operation.

CAUSE:

Oil vapor is necessary to lubricate the rod seal. At high operating temperatures this results in oil mist and precipitation.

EFFECT:

none

ACTION:

none

SACHS Automotive of America | Heavy-Duty Suspension | Tel. (248) 458-3600
2107 Crooks Rd | Troy, MI 48084 | Fax. (248) 458-3603

Guideline to Evaluate Warranty Claims
Heavy-duty Shock Absorbers

3) „Leaker“

OBSERVATION

A shock is considered a „leaker“, if

- the reservoir tube (smaller diameter) is largely covered with oil
- finger gets wet, when touching shock (see „Misting“)

- after above finger test, shock exhibits a glossy film of oil and/or dirt, or an oil droplet forms on reservoir tube
- a film of oil is also visible in the upper area of the reservoir tube, after extension of the shock. If oil is only visible around the bottom, it likely stems from an outside source

CAUSE:

- worn, damaged or overheated seal

EFFECT:

- loss of oil
- loss of damping function
- loss of ride control and safety

ACTION:

replace leaking shock

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Guideline to Evaluate Warranty Claims

Heavy-duty Shock Absorbers

4) Noise - Rubber Bushings

Noise emitted during operation is not necessarily caused by defective shocks.

Therefore in case of noise issues:

Check all relevant suspension and axle components, e.g. rubber mounts, springs, jounce stops, bushings, steering.

Rubber bushing „worn“ or „deformed“

OBSERVATION:

- rubber bushing is visibly deformed or damaged
- eye (or „loop“) is eccentrically deformed
- sleeve is not centered within bushing

CAUSE:

- extensive use of rebound stop, incorrect ride height, shock may be too short for application

- extremely high conical angles, not suitable for this design

EFFECT:

noise, increased wear of shock and suspension

ACTION:

- verify ride height

- verify that shock is suitable for this application

- replace defective shock absorber

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Guideline to Evaluate Warranty Claims

Heavy-duty Shock Absorbers

5) Noise - Scratching Metal Dust Cover

Noise emitted during operation is not necessarily caused by defective shocks.

Therefore in case of noise issues:

Check all relevant suspension and axle components, e.g. rubber mounts, springs, jounce stops, bushings, steering.

„Metal dust cover scratches reservoir tube“

OBSERVATION:

- Paint scratched off reservoir tube

CAUSE:

- suspension is misaligned, shock is under unintended lateral or longitudinal preload

EFFECT:

- noise

- corrosion of reservoir tube

- subsequently wear of rod seal, leakage and loss of function

ACTION:

- check suspension, while vehicle is at design height

- replace shock only, if significant amount of paint is already scratched off or loss of oil is visible

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6) Degradation of Damping Performance

It is impossible to verify the correct damping characteristic of a shock absorber without a dynamometer. In the field, the following, more practical test can help to identify a shock, which is suspected to have failed:

1) Conduct test few minutes after operating the vehicle

2) Touch a metal element of the chassis to determine a reference temperature

3) Carefully touch the shock reservoir tube (lower tube, smaller diameter) on either side of the same axle to measure temperature of shock absorbers

4) Both shocks should be
   - warmer than the original reference point
   - similar in temperature

5) A cool or significantly colder shock absorber likely is a failure and needs to be replaced

6) After removal from the vehicle, the following may hint to the cause of failure:
   - Manually stroke shock several times in vertical position:
     no or delayed resistance would indicate a loss of damping force.
   - Shake shock upside down: rattling would indicate a broken internal component

7) A final determination can only be made by the manufacturer, using a dynamometer

Other indicators of damping force degradation include:

a) ride deterioration
b) deteriorated rubber attachments
c) uneven tire wear („tire cupping“)
d) excessive vibrations and premature wear on other vehicle components

EFFECT: Reduced ride control, comfort and safety

ACTION: Replace shock absorber

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1. DESCRIPTION

The vehicle is provided with an air suspension system. The system consists of air springs, height control valves, radius rods, sway bars, tripod and shock absorbers (Fig. 1, 2, 11, 36, 37 and 38). The system operation is fully automatic and maintains a constant vehicle height regardless of load, or load distribution.

The vehicle may also be equipped with systems such as:

- Front Kneeling (w/ Front High-Buoy);
- Front Kneeling (w/ Full High-Buoy);
- Front Kneeling (w/ Front High-Buoy) and Low-Buoy Combination;
- Front Kneeling (w/ Full High-Buoy) and Low-Buoy Combination;

2. VEHICLES EQUIPPED WITH AN I-BEAM AXLE FRONT SUSPENSION

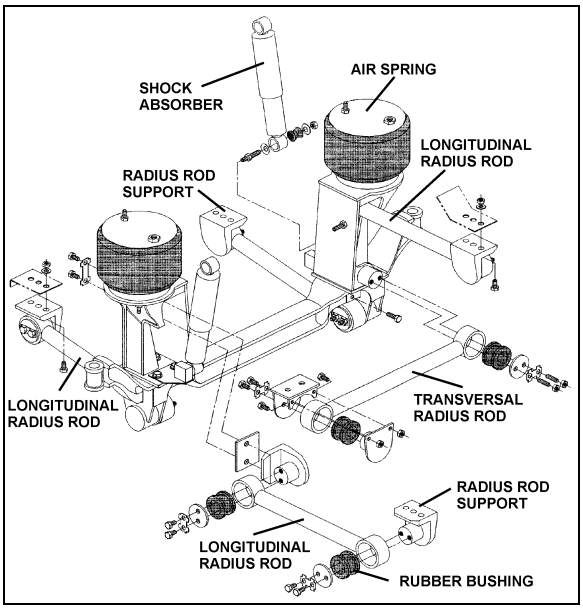


FIGURE 1: FRONT I-BEAM AXLE SUSPENSION 16105

2.1 AIR SPRINGS

The air springs are made from a special compound rubber molded to the proper contour and dimensions. The entire vertical load of the vehicle is supported by these springs. The I-beam front axle is provided with air springs that are attached to the subframe and to the axle (Fig. 3).

2.1.1 Inspection

1. Check operation of bellows.
2. Visually inspect bellows for evidence of cracks, punctures, deterioration, or chafing. Replace the bellows if any damage is evident.
3. With the primary air system at normal operating pressure (95 - 125 psi (655 - 860 kPa)), coat all suspension air line connections and bellows mounting areas with a water and soap solution. Bubbles will indicate an air leak, and none is permissible. Repair or replace defective parts.

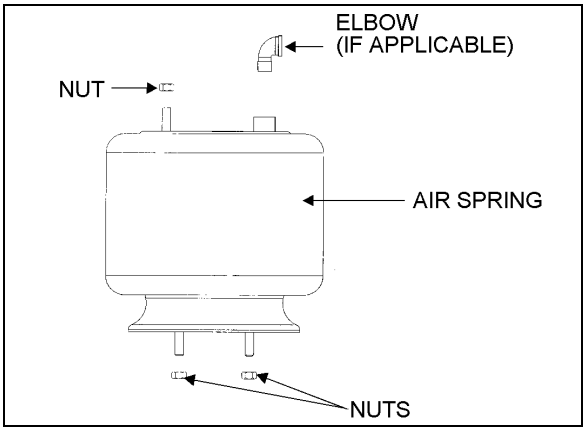


FIGURE 2: AIR SPRING 16052

NOTE

If air spring is removed from vehicle, bellows can be lightly inflated and submerged in water to detect any leakage. If any leakage is detected, replace bellows.

WARNING

To prevent personal injury, do not apply more than 10 psi (69 kPa) of air pressure to the uninstalled air spring.

2.1.2 Removal

NOTE
Front suspension air springs can be removed without removing the entire axle assembly.

1. Safely support vehicle at the recommended body jacking points. To gain access to a given air spring, the corresponding wheel can be removed as follows.

   a) Jack vehicle until the tire clears the ground, and place safety supports underneath body.

⚠ **CAUTION**
Only the recommended jacking points must be used as outlined in Section 18, “Body”.

   b) Support the axle with a suitable hydraulic floor jack at the recommended jacking point.

   c) Remove wheel.

2. Exhaust compressed air from accessory air tank by opening drain cock under reservoir.

3. Disconnect the height control valve link and pull down the overtravel lever to ensure all air is exhausted from air springs.

NOTE
While performing this step, do not change the height control valve overtravel lever adjustment.

4. Disconnect air line from air spring, remove elbow (if applicable), and cover both the line end and fitting to prevent the entry of foreign matter.

5. Remove the air spring upper nut, and then the two lower nuts. Remove air spring.

2.1.3 Installation

1. Compress air spring as necessary, then aligning studs with their holes, position air spring between both the lower and upper supports. Thread the lower nuts and the small upper nut a few turns.

NOTE
To facilitate air spring installation, compress it manually then put a piece of tape over the air line threaded fitting. This prevents air from getting back into the bag and keeps it compressed, thus enabling to place the bag in between the mounting plates and greatly easing installation.

2. Tighten and torque the lower stud nuts, and then the upper one to 20 – 25 lbf-ft (27 – 34 Nm).

3. Thread the remaining upper nut (large nut) and tighten to 20 – 25 lbf-ft (27 – 34 Nm).

4. Install elbow (if applicable), then connect air line.

5. Connect the height control valve link.

6. Build up air pressure in system.

NOTE
To accelerate this operation, air reservoirs can be filled from an exterior air supply connected to the accessory tank fill valve or to the emergency fill valve.

7. Check operation of bellows, and with the primary air system at normal operating pressure (95 – 125 psi (655 – 860 kPa)), coat the air line connections and air spring mounting areas with a water and soap solution. Bubbles will indicate an air leak, and none is permissible. Repair or replace defective parts.

8. Reinstall wheel.

9. Remove the hydraulic floor jack from under the axle, then lower vehicle to ground.

2.2 SHOCK ABSORBERS

Double-action, telescoping-type shock absorbers ensure a smooth ride and enhance vehicle stability on the road. All shock absorbers are eye-type mountings. The front axle is provided with two shock absorbers (Fig. 1, 2, and 4).

Shock absorbers are non-adjustable and non-repairable. Maintenance requirements involve replacement of the rubber mounting bushings, and tightening of all shock absorber pins at the proper torque of 500 - 550 lbf-ft (680 - 750 Nm) when shock absorber replacement occurs. If a shock absorber becomes inoperative, complete unit must be replaced.

> **CAUTION**
>
> When a shock absorber is found defective, always replace with a new set on affected axle, except if there has been a recent replacement of one unit. The following method will help in determining if both shock absorbers on the same axle have to be replaced.

2.2.1 Inspection

Loosen lower mounting of both shocks, and then carefully attempt to raise and lower the bottom portion of each shock. Note the rate of effort for distance of travel. Replace both shocks if a definite differential rate is found.

The shock must be bench checked in an upright, vertical position. If checked in any other position, air will enter the cylinder tube and make the shock absorber appear defective.

Proceed as follows to check shock absorbers:

1. With the shock absorber in a vertical position (top end up), clamp the bottom mount in a vise.

> **CAUTION**
>
> Do not clamp the reservoir tube or the dust tube.

2. Rotate the dust tube. Notice any binding condition (may be compared with new unit). Binding condition indicates a scored rod. Units with scored rods should be replaced.
3. Fully extend shocks and check for leaks in the seal cover area. Shock fluid is a very thin hydraulic fluid that has a characteristic odor and dark brown tint. A slight trace of shock fluid around the seal cover area is not a cause for replacement. The shock seal is designed to permit a very slight seepage to lubricate the rod. Units that leak should be replaced.
4. Visually check shock for dents that could cause the shock to bind. Also, check for a bent rod.
5. Extend and collapse shock several times to determine that it has control (resistance) in both rebound and compression.
6. Visually inspect the shock mountings and vehicle mounting for:
   a. Broken mounts;
   b. Extreme bushing wear;
   c. Shifted bushing or sleeve;
   d. Deep cracks in bushing material (shallow surface cracks are normal);
   e. Loose shock absorber pins;
   f. Presence of convex washers, and their position relative to the rubber bushing.

2.2.2 Removal

1. Remove nuts and washers from shock absorbers on upper and lower mounting pins, taking care to identify the inner and outer washers to ease reinstallation. Refer to figure 4 for details.
2. Remove the shock absorber assembly from pins.
3. Remove the two inner bushings from the shock absorber and discard them.

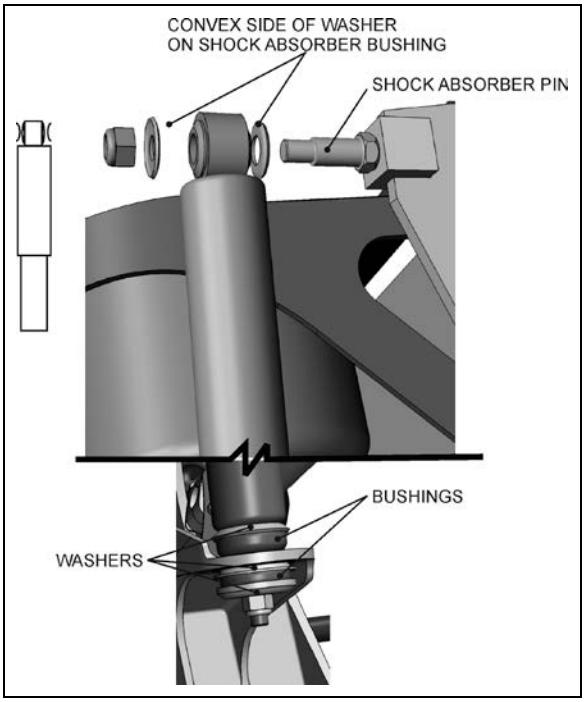


FIGURE 3: SHOCK ABSORBER 16008

2.2.3 Installation

1. Ensure that the shock absorber mounting pins are tight and that the threads are not stripped.
2. Install new rubber mounting bushings on shock absorbers (upper and lower).

3. Place the inner washers (with washer convex side facing the shock absorber rubber bushing) on each shock absorber pin (Fig. 5).

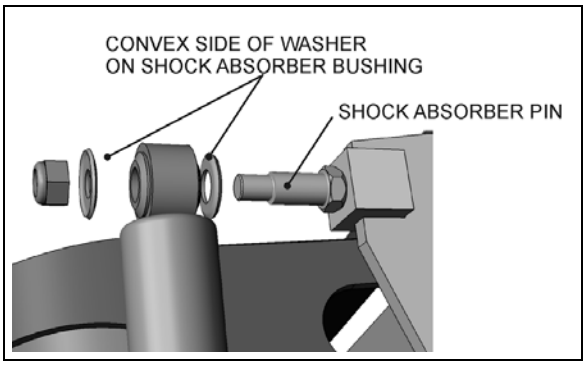


FIGURE 4: TYPICAL SHOCK ABSORBER SETUP 16009

4. Install the shock absorber eyes over the mounting pins, then the outer washers (with washer convex side facing the shock absorber rubber bushing) on each shock extremity.

NOTE
If shock absorber pins are removed, they must be reinstalled using "loctite" (see "Parts Specifications" in this section).

5. Place the lower and upper mounting pin stud nuts and torque according to paragraph 13 Torque Specifications.

2.3 RADIUS RODS

Radius rods are used to secure the axles in the proper transversal and longitudinal positions. Four radius rods are provided on the front axle suspension (three longitudinal and one transversal). Refer to figures 1, 2 and 6 for details. These rods transmit both braking and driving forces from the axles to the vehicle body.

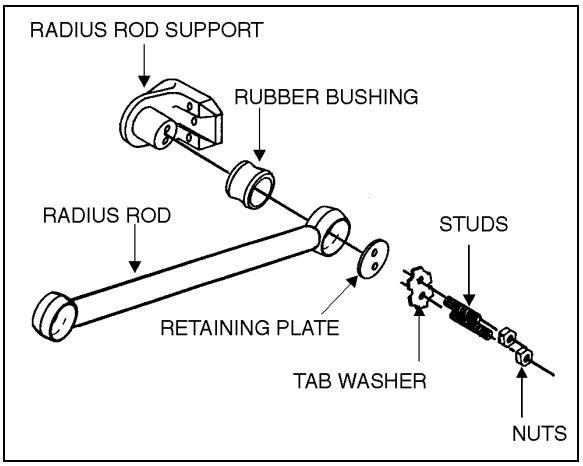


FIGURE 5: TYPICAL RADIUS ROD SETUP 16010

2.3.1 Inspection

The following instructions apply to all radius rods used on this vehicle:

1. Clean all parts thoroughly.
2. Inspect radius rods for distortion and cracks. We recommend the "Magnaflux" process to detect cracks in the radius rod. Any damaged part should be replaced with a new one.

NOTE
New bushings should be used when rods are replaced.

3. The radius rod bushings should be checked periodically for signs of shearing, deterioration, or damage. Any defective part should be replaced with a new one.

2.3.2 Radius Rod Removal

1. Flatten the tab washer which secures the two retaining nuts (or bolts), then unscrew the nuts (or bolts) at each extremity of the radius rod (Fig. 6).
2. Remove the tab washer and the retaining plates and radius rod ends from anchor pins, and then remove the radius rod.

2.3.3 Bushing removal

1. Safely support the radius rod as shown in figure 7.

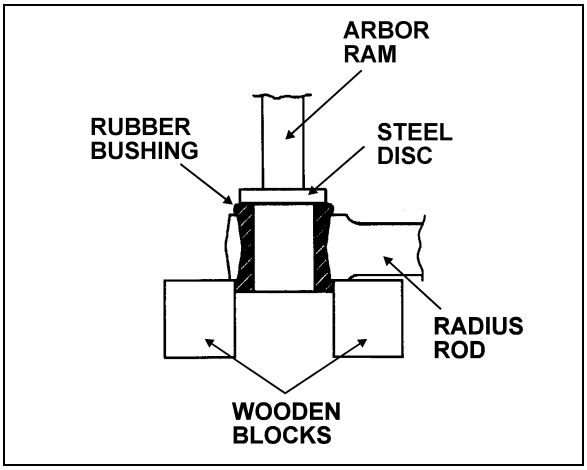


FIGURE 6: RADIUS ROD BUSHING REMOVAL 16011

2. Place a flat steel disc, slightly smaller than the outside diameter of the bushing (Fig. 7).
3. Using an arbor press or a suitable driving tool, press or drive the old bushing out of the rod and discard the bushing.

CAUTION

Make sure to prevent the steel disc from contacting the radius rod end.

2.3.4 Bushing installation

1. Lightly spray the inner and outer surfaces of radius rod bushing with water.

CAUTION

No lubricant whatsoever is to be used on the rubber bushing.

2. Safely support the radius rod, and place new bushing on top of the radius rod end (Fig. 8).
3. Place a block of wood on top of bushing and press on it manually.
4. If necessary, use an arbor press or a suitable driving tool. Press or drive the bushing into the radius rod end until it extends equally on both sides of the rod.
5. It is also possible to proceed differently. Place radius rod bushing on a plane surface. Spray a light coat of water on the inner and outer surfaces of radius rod bushing.
6. Take radius rod, align the bushing. Tap radius rod on bushing until latter is positioned correctly.

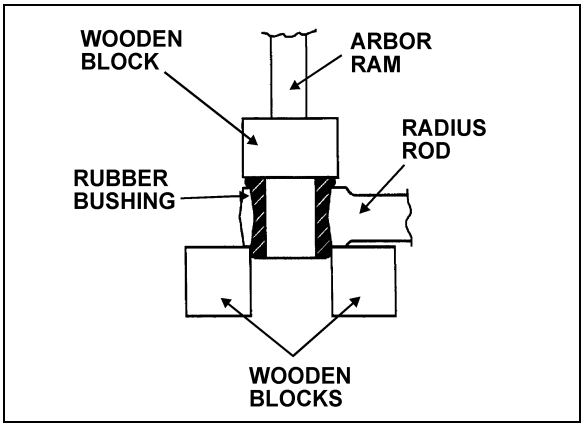


FIGURE 7: RADIUS ROD BUSHING INSTALLATION 16012

2.3.5 Radius Rod Installation

1. Lightly spray the radius rod support with water. Place the radius rod end over the radius rod support (Fig. 9).
2. Position the retaining plate. Install the tab washer and nuts (or bolts).

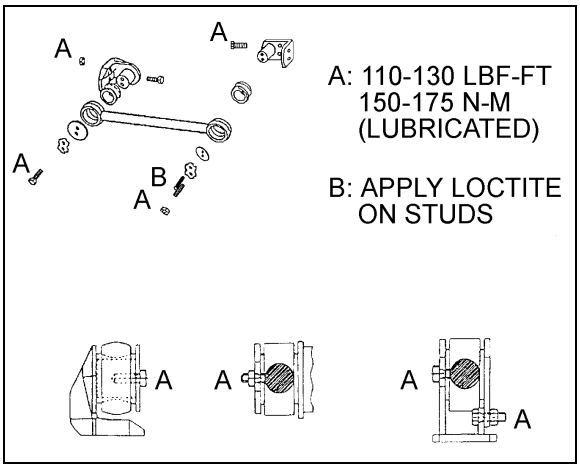


FIGURE 8: RADIUS ROD INSTALLATION 16028

CAUTION

Always use new tab washers at installation.

3. Tighten the nuts (or bolts) lightly, and repeat at the other end.
4. Refer to heading *"Suspension Height Adjustment"* later in this section, and set the vehicle to normal ride height.
5. With the vehicle at normal ride height, apply oil on threads and tighten all radius rod anchor pin nuts or bolts to 110 – 130 lbf-ft (150 – 175 Nm).

CAUTION

It is extremely important upon reconnection of the rods that the proper clearance height between the axle and body be maintained. Otherwise, the rubber bushings in radius rod ends will become preloaded, thus reducing their life span.

2.4 SWAY BAR

A sway bar is provided on the front axle to increase vehicle stability. It controls lateral motion (swaying movement) of the vehicle (Fig. 10).

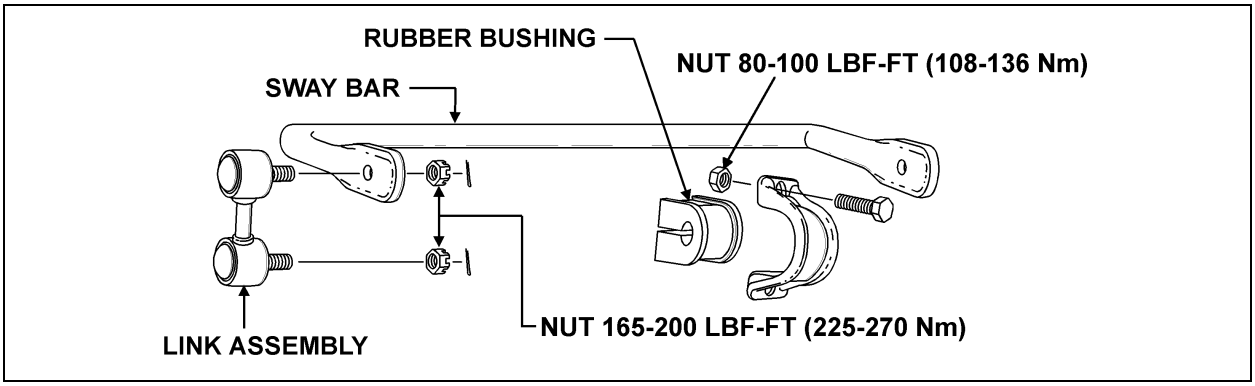


FIGURE 9: I-BEAM FRONT AXLE SWAY BAR 16099

2.4.1 Removal

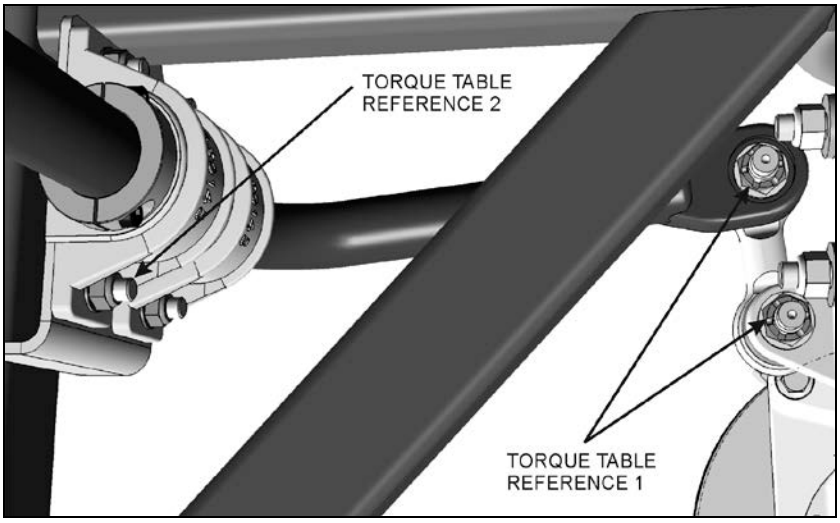
1. Disconnect the two links from sway bar.
2. Safely support the sway bar. Unbolt the four bushing collars from subframe.
3. Remove sway bar.

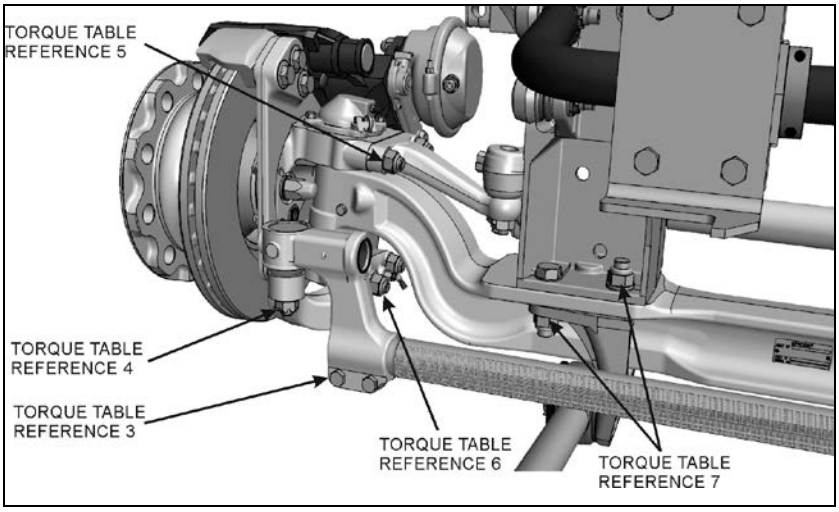
NOTE
Sway bar bushings are slitted to ease their removal.

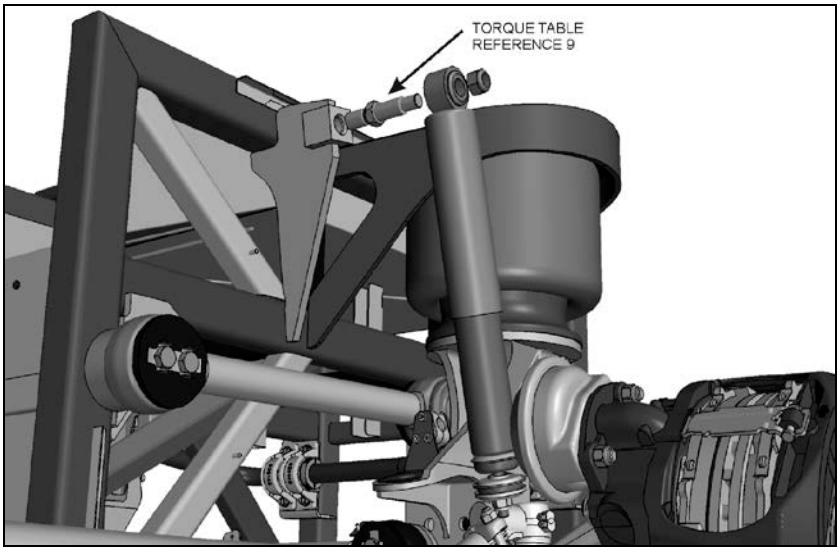
2.4.2 Installation

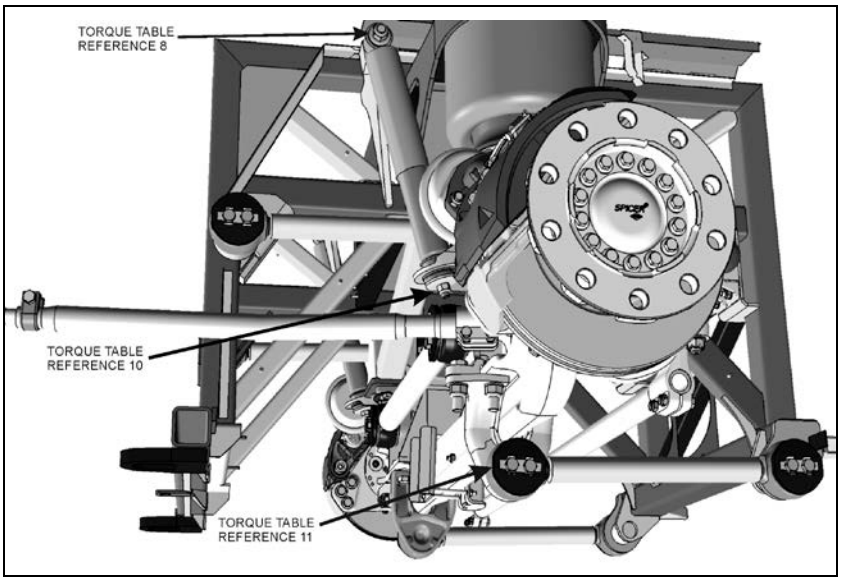
1. Loosely install the sway bar.
2. Tighten the eight bushing collar nuts to 80-100 lbf-ft dry (108-136 Nm) (Fig. 10).
3. Install two sway bar link upper and lower nuts and tighten to 165-200 lbf-ft dry (225-270 Nm) (Fig. 10).
4. Install a cotter pin on each nut and bend.

2.5 TORQUE SPECIFICATIONS








TORQUE TABLE
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TORQUE TABLE
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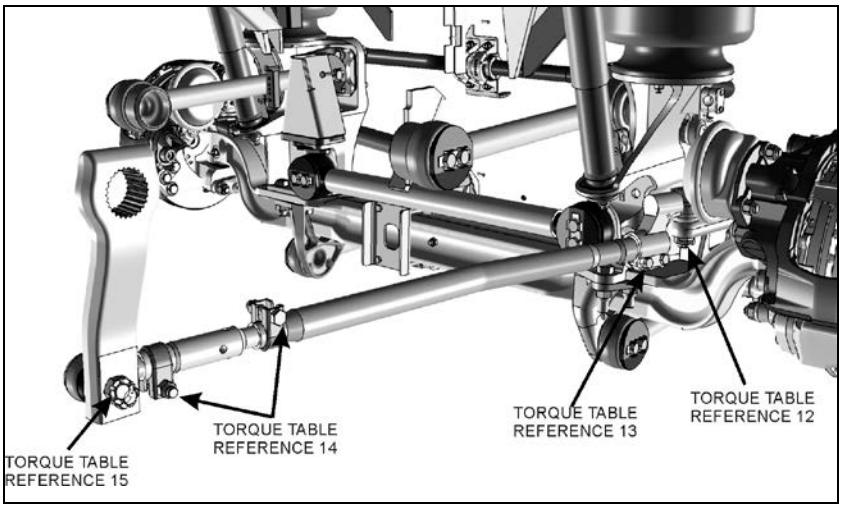
REFERENCE 11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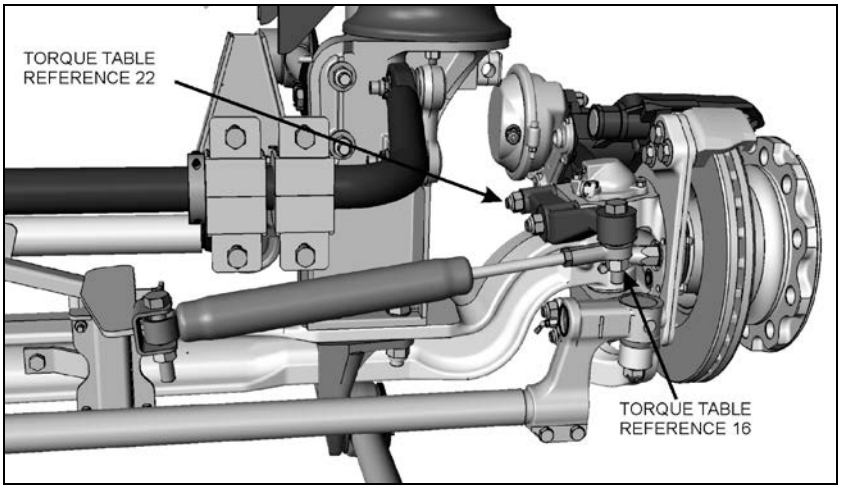
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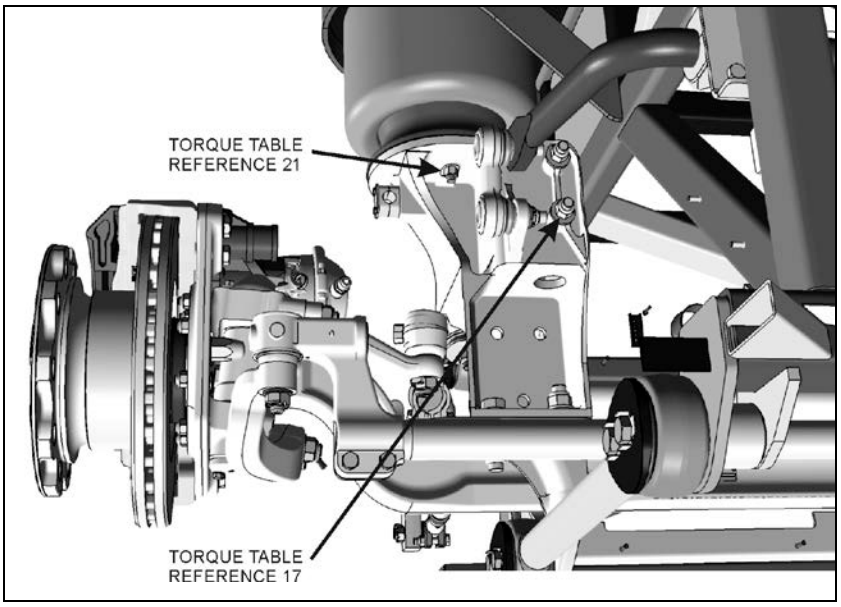
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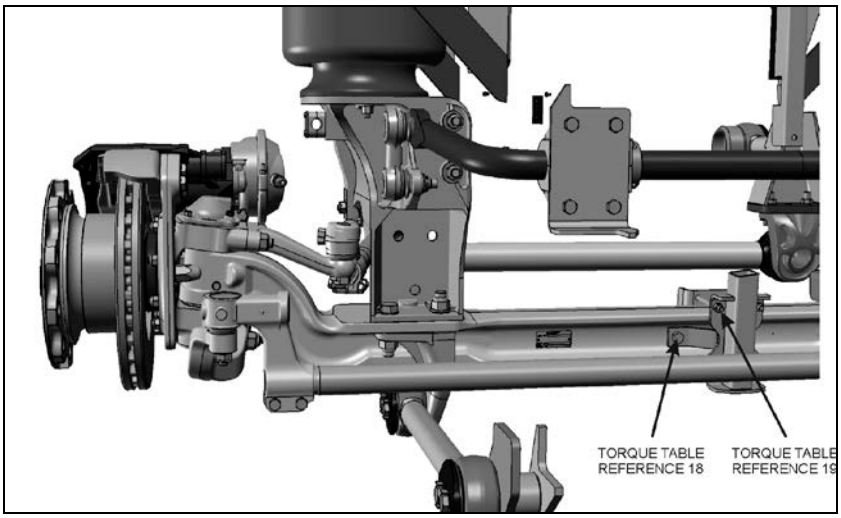
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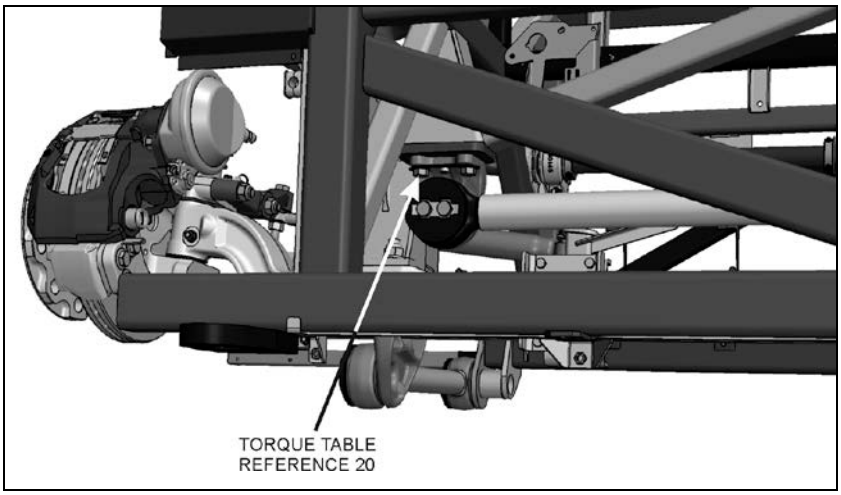

TORQUE TABLE
REFERENCE 20

The following table lists the tightening torques for fasteners requiring a specific torque value. When no torque specification is indicated, use the Standard Torque Specifications table found in Section 00: General Information of the Maintenance Manual.

SPECIFIC TORQUE TABLE 1 – FRONT AXLE SUSPENSION & STEERING				
DESCRIPTION	***QTY***	***REFERENCE***	***TORQUE DRY*** *(lbf-ft / Nm)*	
SWAY BAR LINK UPPER AND LOWER NUTS	*4*	*1*	*165-200*	*224-271*
SWAY BAR BUSHING COLLAR (FRONT SUSPENSION)	*8*	*2*	*80-100*	*108-136*
TIE ROD END CLAMP PINCH BOLT	*4*	*3*	*65-75*	*88-102*
TIE ROD END BALL PIN NUT	*2*	*4*	*150-200*	*203-271*
STEERING ARM STUD NUT	*2*	*5*	*520-575*	*705-780*
TIE ROD ARM STUD NUT	*4*	*6*	*520-575*	*705-780*
I-BEAM AXLE MOUNT	*8*	*7*	*230-280*	*311-378*
SHOCK ABSORBER UPPER MOUNTING PIN STUD NUT	*2*	*8*	*99-121*	*134-164*
SHOCK ABSORBER PIN	*2*	*9*	*350-400*	*475-545*
SHOCK ABSORBER LOWER MOUNTING PIN NUT	*2*	*10*	*60-75*	*81-102*
RADIUS ROD RETAINING BOLT	*20*	*11*	*140-155*	*190-210*
DRAG LINK BALL PIN NUT	*1*	*12*	*150-200*	*203-271*
DRAG LINK CLAMP BOLT NUT	*2*	*13*	*65-75*	*88-102*
DRAG LINK SOCKET END CLAMP PINCH BOLT	*2*	*14*	*50-60*	*68-81*
DRAG LINK TO PITMAN ARM STUD NUT	*1*	*15*	*150-200*	*203-271*
STEERING DAMPER	*2*	*16*	*100-120*	*135-160*
RADIUS ROD SUPPORT	*4*	*17*	*228-252*	*309-342*
STEERING DAMPER BRACKET	*1*	*18*	*39-45*	*53-61*
STEERING DAMPER BRACKET	*4*	*19*	*30-36*	*41-49*
RADIUS ROD SUPPORT	*2*	*20*	*200-220*	*271-298*
AIR SPRING NUT	*6*	*21*	*31-38*	*42-52*
STEERING DAMPER ARM NUTS	*2*	*22*	*285-315*	*386-427*

3. VEHICLES EQUIPPED WITH AN INDEPENDENT FRONT SUSPENSION (IFS)

3.1 STEERING LINKAGE

Turning motion of the steering wheel is transferred by the steering gear and steering linkage to the steering arms at the right and left front wheels. The steering linkage consists of tie rods connected to the bell crank and the steering arm at the left side of the vehicle, and to the idler arm and steering arm at the right side of the vehicle. The bell crank and idler arm are connected by a relay rod. A drag link connected to the bell crank and the pitman arm, which is mounted to the steering gear, transfers the turning motion of the steering wheel to the steering arms. X3-45 VIP & XLII Bus Shells are also equipped with a hydraulic power cylinder, which provides an added source of assistance and being connected to the R.H. wheel, makes it such that the total steering forces are produced with minimal stress on mechanical linkages (Fig. 11).

Lower and upper A-arms are widely spaced. They are mounted on ball joints. Torque rods prevent rotation of the uprights around the lower and upper ball joints.

If the steering linkage is bent, twisted or worn, steering action of the vehicle will be seriously affected. Any time steering linkage components are replaced or adjusted, steering geometry and front wheel alignment must be checked as explained in this section.

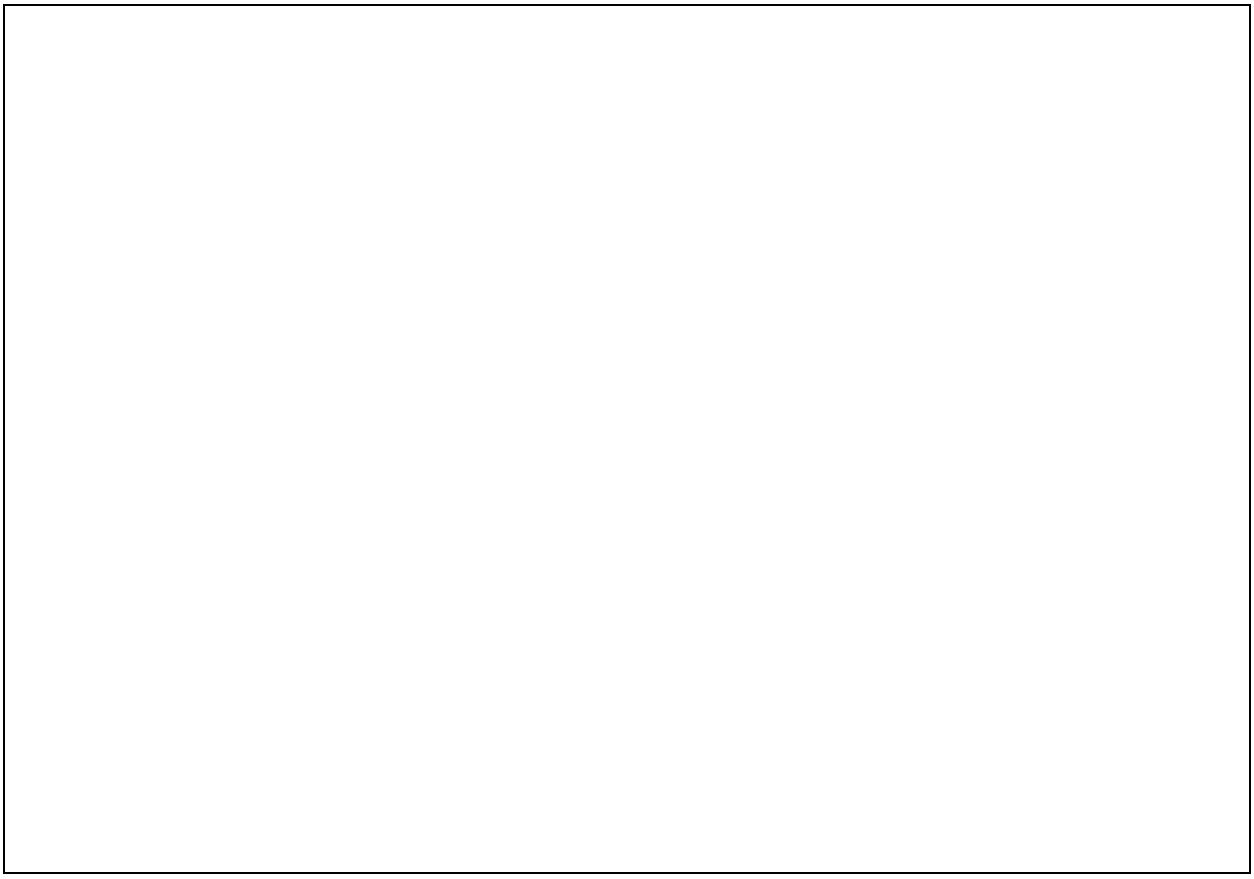


FIGURE 10: SUSPENSION AND STEERING LINKAGE 16125

Turning Angle

The maximum turning angle is set mechanically through the two steering stop screws installed on the steering knuckle assembly. The turning angle (58° + 0° - 1°) mechanical stop is factory adjusted to accommodate the chassis design, and therefore, does not require adjustment on new vehicles.

However, turning angle should be checked and adjusted hydraulically, if necessary, any time a component of the steering system is repaired, disassembled or adjusted.

Before checking the turning angle, be sure the front end is properly aligned as described under paragraph "3.16 Front End Alignment" in this section.

To check steering maximum turning angle, proceed with the following method:

1. Check if front tires rub against the frame or if the steering gear has been serviced.

⚠ CAUTION

If clamps are not correctly installed, they can interfere with other parts.

2. For a full left and right turn, check clamps' position and for interfering parts. Refer to figures 12 to 18 for location and positioning of clamps. If readjustment is required, make the proper adjustment.

NOTE

Prior to steering limiter adjustment, verify vehicle wheel alignment, and ensure that oil level is adequate and that air bleeding is done.

3. If necessary readjust steering limiter. Refer to "ZF-SERVOCOM Repair Manual" annexed to Section 14 of Maintenance Manual, "Steering", under heading: "Setting and Functional Test".

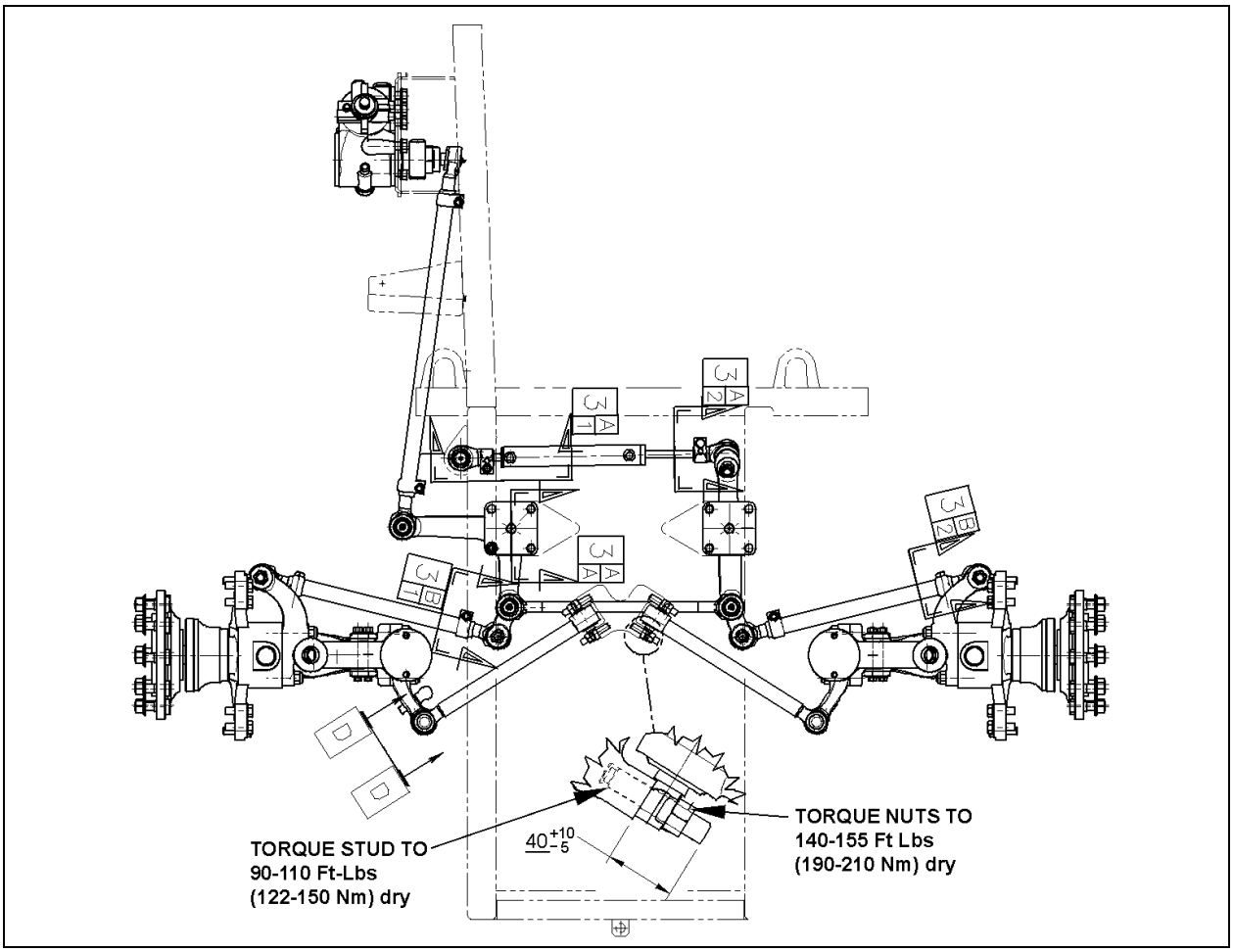


FIGURE 11: LOCATION OF CLAMPS 16168

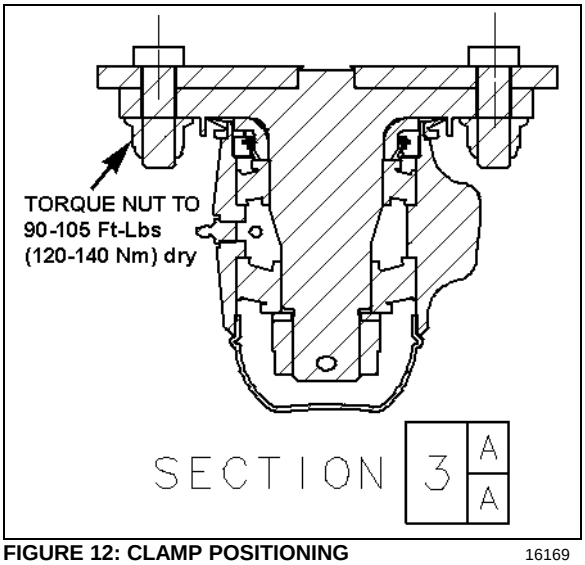


FIGURE 12: CLAMP POSITIONING 16169

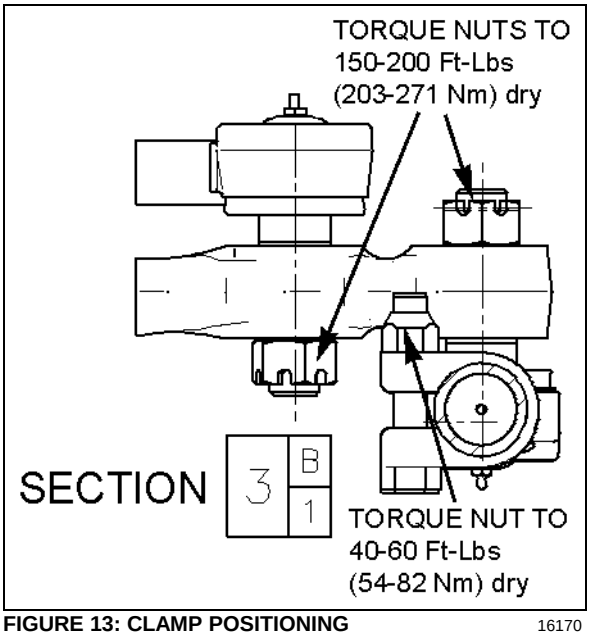


FIGURE 13: CLAMP POSITIONING 16170

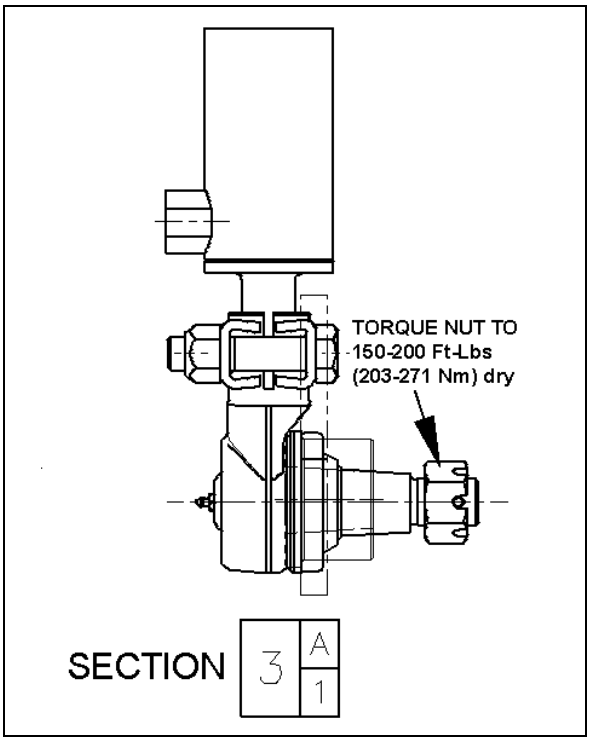


FIGURE 14: CLAMP POSITIONING 16178

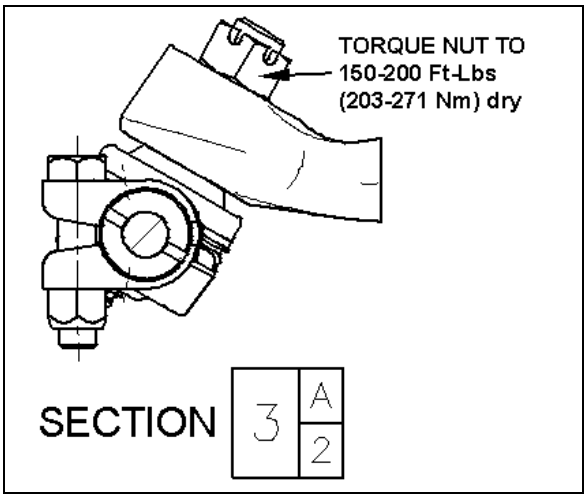


FIGURE 15: CLAMP POSITIONING 16179

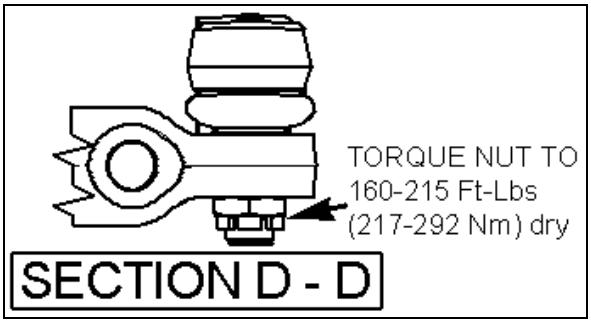


FIGURE 16: CLAMP POSITIONING 16172

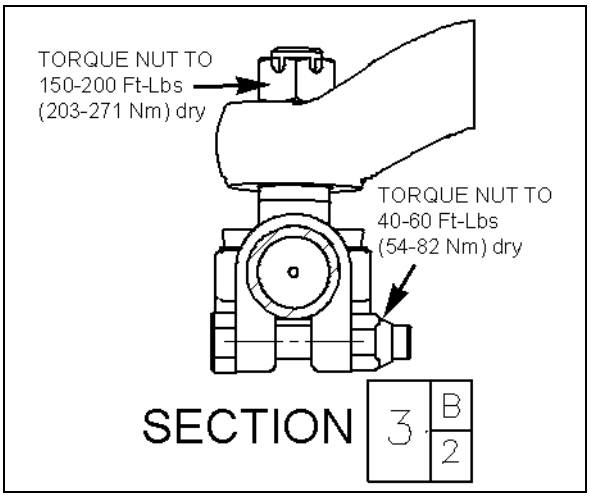


FIGURE 17: CLAMP POSITIONING 16171

3.2 STEERING LINKAGE ADJUSTMENT

> ***NOTE***
>
> *Whenever a steering linkage component has been removed and replaced, check steering geometry and front end alignment as directed in this Section. Check to insure that all stud nuts and mounting bolts and nuts have been tightened to proper torques listed under "14. Torque Specifications" at the end of this section.*

1. First, align input shaft marks.
2. Afterwards, the pitman arm should be adjusted with reference mark aligned or to an angle of 90° in relation with the horizontal axis (Fig. 19).

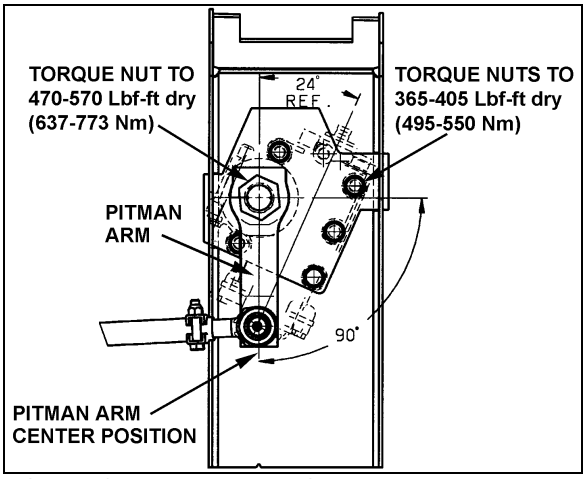


FIGURE 18: PITMAN ARM ALIGNMENT 14057

3. Locate centerline of vehicle then install relay rod in boss at steering bell crank and idler arm. Align center of relay rod with centerline of vehicle.

4. Install drag link to pitman arm and adjust opposite end of drag link to fit mounting stud hole in bell crank.
5. Install tie rods, and then adjust toe-in as per "Front End Alignment" in this Section.

3.3 PITMAN ARM REMOVAL

1. Remove cotter pin, nut and washer from drag link ball stud at pitman arm.
2. Disconnect drag link from pitman arm, using jaw style pullers (pressure screw type).

WARNING

Always wear approved eye protection when operating pullers.

CAUTION

Do not drive pitman arm on or off pitman shaft as this can damage the steering gear.

CAUTION

Heating of components to aid in disassembly is not allowed because it has a detrimental effect on axle components and steering linkages.

3. Remove pitman arm fixing nut.
4. Check the radial position of the pitman arm in relation to the sector shaft prior to removal of pitman arm.
5. Add reference marks to the arm and shaft if necessary to ensure correct alignment at reassembly.
6. Use a puller to remove pitman arm.

3.4 PITMAN ARM INSTALLATION

1. Position pitman arm on sector gear shaft with reference marks aligned.
2. Install fixing nut. Tighten nut to 470-570 lbf-ft (637-773 Nm)

NOTE

Use a new nut if the previously removed nut was punched.

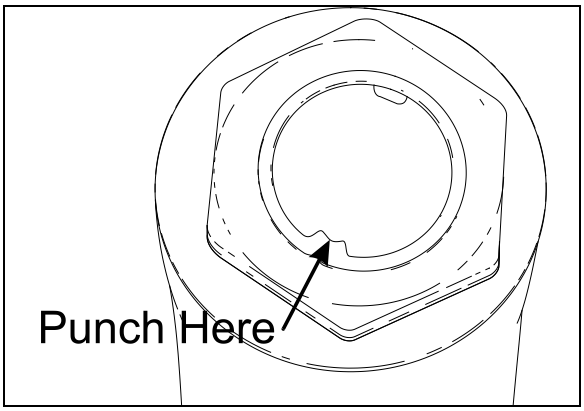


FIGURE 19: FIXING NUT PUNCH MARK 16098

CAUTION

Lock nut with sector shaft using a punch mark into the groove (Refer to figure 20).

3. Connect drag link to pitman arm. Install washers. Tighten nut to 150-200 lbf-ft (203-271 Nm). Advance nut to next alignment cotter pin slot and install a new cotter pin.

3.5 DRAG LINK

Drag link assembly consists of three parts; a drag link and two end assemblies. Both end assemblies are identical and they are retained on the drag link with a clamp bolt and nut.

Stud nuts at the pitman arm and bell crank ends of the drag link must be kept tight or hole at ball stud end of drag link and hole in pitman arm may become enlarged as a result of excessive looseness. Subsequent tightening of stud nuts may draw studs too far into holes and dust cover parts may become damaged which can result in component failure.

Drag link end sockets are equipped with lubrication fittings and should be lubricated as directed in "Lubrication Fittings" in this section.

3.5.1 Adjustment

It should not be necessary to alter the length of the drag link except when a new link is installed or when removable end assembly has been replaced. If drag link adjustment is necessary, proceed as follows:

1. Position front wheels in straight ahead position.

2. Center steering gear as previously explained in paragraph "3.2 Steering Linkage Adjustment".
3. Remove cotter pin and stud from drag link at bell crank. Locate centerline of vehicle and center of relay rod. With center of relay rod aligned with centerline of vehicle, loosen clamp bolt at socket end (bell crank end) of drag link and adjust length of socket end assembly to fit in boss of bell crank.

NOTE
Do not change position of pitman arm.

4. Install stud nut and torque to 150-200 lbf-ft (203-271 Nm). Align nut with cotter pin slot (tighten) and install a new cotter pin.
5. Torque mounting clamp bolt nut to 40-60 lbf-ft (55-80 Nm), then test the adjustment. Front wheels should turn from right to left extremities without noticeable binding at drag link ends.

3.6 BELL CRANK AND IDLER ARM

Bell crank and idler arm are equipped with one lubrication fitting and should be lubricated as directed in paragraph "3.10 Lubrication Fittings" of this Section.

3.6.1 Bell Crank and Idler Arm Removal

NOTE
Use a piece of wire to anchor loosen end of relay rod and tie rod in order to prevent placing an excessive load on opposite socket end.

Bell crank: Disconnect drag link, tie rod and relay rod from bell crank by removing cotter pins, stud nuts and washers from ball studs. Separate socket assemblies from the bell crank.

Idler arm: Remove cotter pins, nuts and washers from ball studs connecting relay rod and tie rod to idler arm. Separate socket assemblies from idler arm.

Remove nuts and washers from bolt attaching bell crank or idler arm mounting bracket to vehicle understructure. Remove bell crank or idler arm mounting bracket.

3.6.2 Bell crank or Idler Arm Ball Joint Disassembly

1. Remove adjacent link assemblies from bell crank or idler arm as previously described.
2. Remove the cap (Fig.21).
3. Remove the cotter pin, nut and tongue washer. Remove bearings, grease seal, bearing bushing and the bell crank or idler arm from its mounting bracket stud (Fig. 21).

3.6.3 Bell Crank or Idler Arm Ball Joint Reassembly

NOTE
For bearing installation use tool Prevost # 110684.

1. Install bearing bushing on bell crank or idler arm mounting bracket stud.
2. Install bearing and grease seal in bell crank or idler arm eye (Fig. 23).

NOTE
Install grease seal according to figure 23. Grease must be able to exit the bell crank or idler arm mechanism. For grease seal installation use tool Prevost # 110683.

3. Install bell crank or idler arm on its mounting bracket stud (Fig. 23).
4. Install bearing and nut.

NOTE
Apply grease on bearing before installation.

5. Firmly tighten nut (Fig. 21).
6. Unscrew nut until bell crank or idler arm starts to turn by the application of 1 to 3 pounds load (Fig. 22).

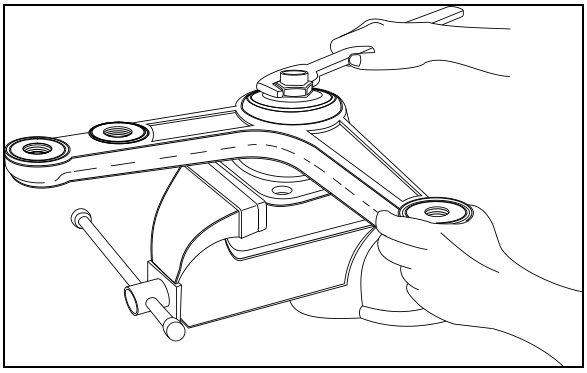


FIGURE 20: BELL CRANK 16044

7. Check for loose bearings by applying an up and down load on bell crank or idler lever (Fig. 22). The lever is not supposed to move in the vertical axis direction.

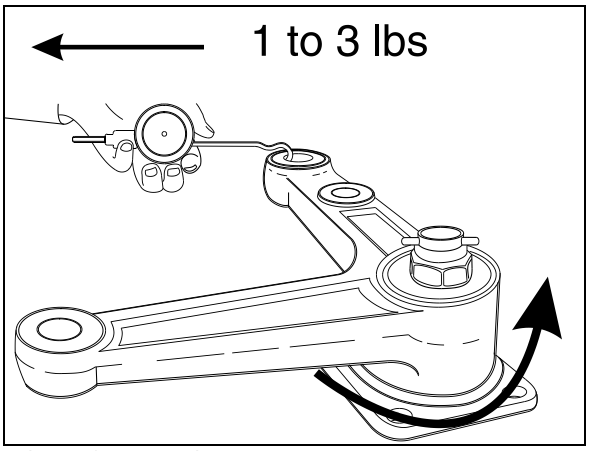


FIGURE 21: BELL CRANK 16045

8. Align nut with cotter pin slot (tighten) and install a new cotter pin.

NOTE
Bend cotter pin around the nut (Fig. 23). Do not bend the cotter pin in the direction of the cap, because it may interfere with the cap.

9. Install the cap.
10. **Bell crank:** Install drag link, tie rod and relay rod as directed herein under each specific subject.
11. **Idler arm:** Install tie rod and relay rod as directed herein under each specific subject.
12. Adjust turning angle as previously directed under paragraph "**Turning Angle**" and check front end alignment as specified in paragraph "3.16. Front End Alignment" of this section.

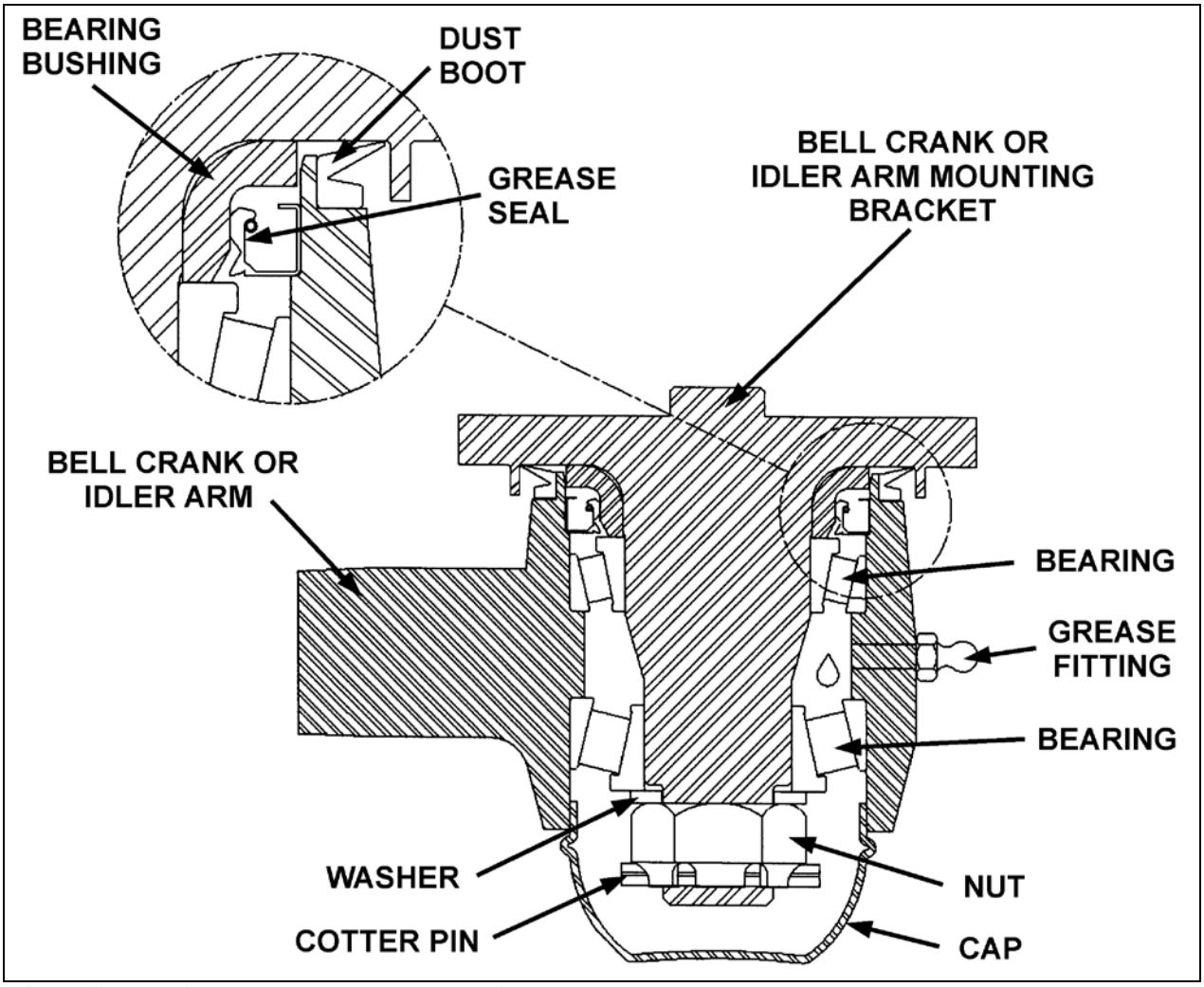


FIGURE 22: BELL CRANK AND IDLER ARM BALL JOINT 16109

3.7 RELAY ROD

Relay rod ends are equipped with lubrication fittings and should be lubricated as directed in paragraph "3.10 Lubrication Fittings" in this section.

NOTE
The relay rod is crimped in place and it is not possible to remove the ball joints.

3.7.1 Replacement

1. Remove cotter pins from bell crank and idler arm end of relay rod. Loosen nuts flush with end of studs.
2. Use a puller or place a sledge hammer behind the adjacent part to absorb shocks. Strike the studs with a brass hammer to loosen end assemblies.
3. Remove stud nuts and washers then remove studs.
4. Position relay rod studs into bell crank and idler arm then tap stud ends with a brass hammer to seat tapered surfaces.
5. Install washers and stud nuts. Tighten nuts to 150-200 lbf-ft (203-271 Nm) torque. Align cotter pin slot (tighten) and install a new cotter pin.

3.8 TIE RODS

Tie rod ends are connected to the bell crank and left steering arm, and to the idler arm and right steering arm. Each tie rod assembly consists of three parts; a tube and two socket end assemblies. The tie rod ends are threaded into the tube and secured with clamp bolts. Right and left hand threads are provided to ease toe-in adjustment. Tie rod assemblies are inter-changeable from the right to the left side of the vehicle.

Tie rod end sockets require no maintenance other than periodic lubrication and inspection to see that ball studs are tight. Replace socket ends when there is excessive up and down motion, lost motion or end play at ball end of stud.

1. Periodically check bolt nut for tightness.
2. Inspect tie rod for bent condition and inspect tube for damaged threads. If tie rod is bent or threads are damaged, replace the assembly.
3. Lubricate tie rod end fittings as directed in paragraph "3.10 Lubrication Fittings" of this section.

3.8.1 Removal

1. Remove cotter pins and stud nuts which attach tie rod socket ends to bell crank and left steering arm (or idler arm) and right steering arm.
2. Remove tie rod ball stud by tapping on steering arm and bell crank or idler arm with hammer, while using a sledge hammer to absorb shocks.

NOTE
If tie rod end assemblies are damaged in any way, they must be replaced

3.8.2 Installation

1. Install socket end assemblies on tie rod. Be sure both ends are threaded an equal distance into the tube.
2. Make sure threads on stud and in stud nut are clean and not damaged.
3. Position ball studs (socket ends of tie rod) in holes in steering arm and bell crank or idler arm. Install a ball stud nut on each stud and tighten firmly.
4. Torque stud nuts to 150-200 lbf-ft (203-271 Nm). Align cotter pin slot (tighten) and install a new cotter pin.

NOTE
Adjust toe-in as directed in paragraph "3.15.4 Toe-In Adjustment" of this section.

5. Make sure tie rod ends are properly aligned with ball studs, then torque tie rod end clamp bolts to 40-60 lbf-ft (55-80 Nm).

NOTE
If tie rod is not properly aligned with stud, binding will result.

3.9 STEERING ARMS

The left and right wheel steering arms are secured to a steering knuckle at one end and to a tie rod at the other end.

3.9.1 Removal

1. Remove wheel as directed in Section 13, "Wheel, Hubs and Tires" of the maintenance manual.
2. Remove cotter pin, washer and nut from stud securing tie rod to steering arm. Remove ball stud from steering arm by tapping on arm with a hammer, placing a sledge hammer underneath steering arm to absorb shocks.
3. Remove cotter pin and nut securing steering arm to steering knuckle assembly. Remove steering arm from steering knuckle.

3.9.2 Installation

1. Install steering arm onto steering knuckle.
2. Torque steering arm to steering knuckle fixing bolts. Torque short bolt (M20 X 65) to 520-575 lbf-ft (705-780 Nm). Torque long bolt (M20 X 100) to 520-575 lbf-ft (705-780 Nm).
3. Position tie rod ball stud in steering arm and tap with a brass hammer to seat ball stud in steering arm. Install washer and nut on stud. Torque nut to 150-200 lbf-ft (203-271 Nm). Tighten nut to nearest cotter pin slot and install a new cotter pin.
4. Install wheel as directed in Section 13, "Wheel, Hubs and Tires" under paragraph "2.3 Installation" of the maintenance manual.

3.10 LUBRICATION FITTINGS

All lubrication fittings must be clean before applying lubricant. Also, always be sure equipment used in applying lubricant is clean. Every precaution should be taken to prevent entry of dirt, grit, lint or other foreign matter into lubricant containers. Replace fitting when they become broken or damaged.

Intervals of application given in the following paragraphs are recommended for normal service. More frequent intervals may be applied under severe operating conditions. In selecting proper lubricants, supplier reputation must be considered. The supplier must be responsible for product quality. The diagram (Fig. 24) shows approximate location of steering lubrication fittings.

1. **Drag Link Ends:** Lubricate at two fittings, one at each end of link, every 6,250 miles (10 000 km) with good quality lithium-base grease NLGI No. 2 (Shell Retinax LX or equivalent).
2. **Relay Rod Ends:** Lubricate at two fittings, one at each end of rod, every 6,250 miles (10 000 km) with good quality lithium-base grease NLGI No. 2 (Shell Retinax LX or equivalent).
3. **Tie Rod Ends:** Lubricate at four fittings, one at each end of both tie rods, every 6,250 miles (10 000 km) with good quality lithium-base grease NLGI No. 2 (Shell Retinax LX or equivalent).
4. **Steering Knuckle Assembly:** Refer to DANA SPICER MAINTENANCE MANUAL NDS AXLES Lubrication and Maintenance" annexed at the end of Section 10.
5. **Idler Arm and Crank bell:** Lubricate at two fittings, one on the idler arm and the other on the crank bell, every 6,250 miles (10 000 km) with good quality lithium-base grease NLGI No. 2 (Shell Retinax LX or equivalent). Apply grease gun pressure to the fitting until lubricant appears at the top seal.
6. **Upper A-Arm Central Ball Joint:** Lubricate at fitting until you see some grease on the relief valve nearby, every 6,250 miles (10 000 km) with good quality lithium-base grease NLGI No. 2 (Shell Retinax LX or equivalent).

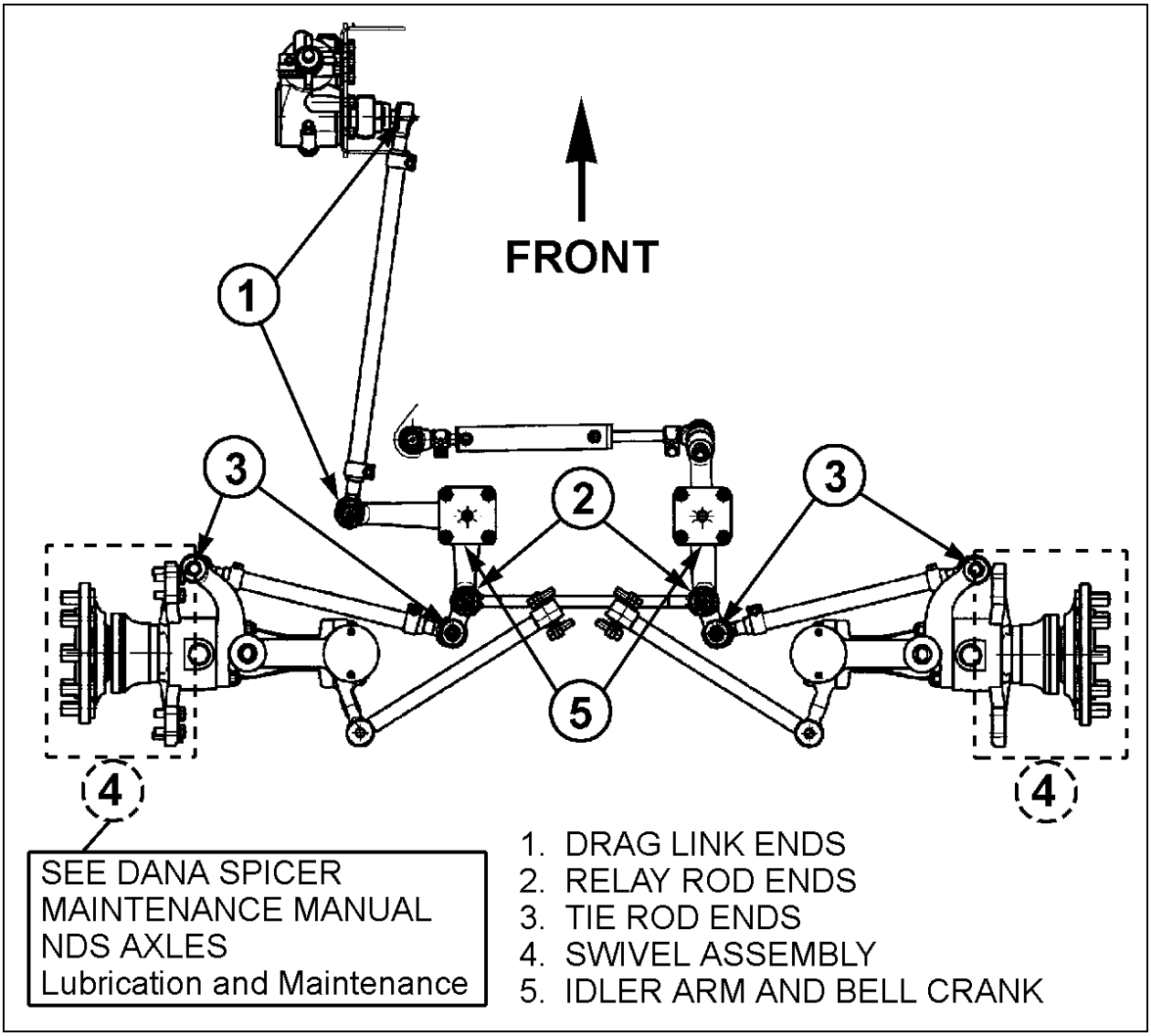


FIGURE 23: LUBRICATION FITTINGS' LOCATION DIAGRAM 16119

3.11 BALL JOINTS

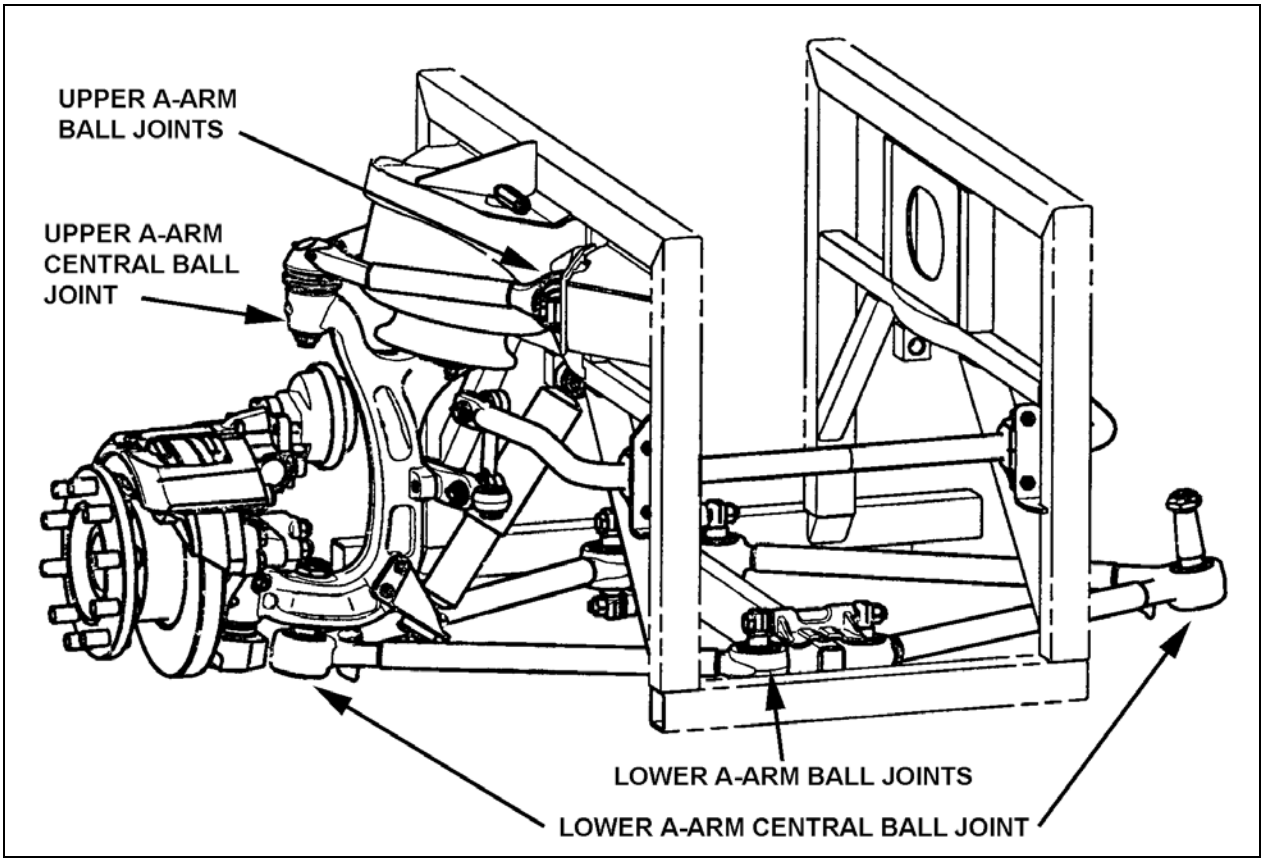


FIGURE 24: BALL JOINTS LOCATION 16137

3.11.1 Lower and Upper A-Arm Ball Joint

The assembly work may be done only by a recognized specialized workshop. Ensure that old and new parts do not get mixed up with each other. It is for this reason that all the old parts are to be scrapped immediately after a joint has been stripped down. A complete repair set must be used for each joint repaired, i.e. use of only part of a repair set is not permissible.

- **Inspection**

Take off the load from the ball joint by lifting the front of the vehicle. Apply a load on the joint in all of the degrees of freedom in an axial, radial, etc. sense with a suitable lever tool. After the load is taken off, the joint has to spring back into its starting position. Free play is not acceptable.

Separation of rubber from ball pin or external joint shell is in accordance with "normal wear characteristics".

When the following characteristics are noted, the joint is to be changed:

- Free play;
- Radial cracking of the external sheet-metal race.

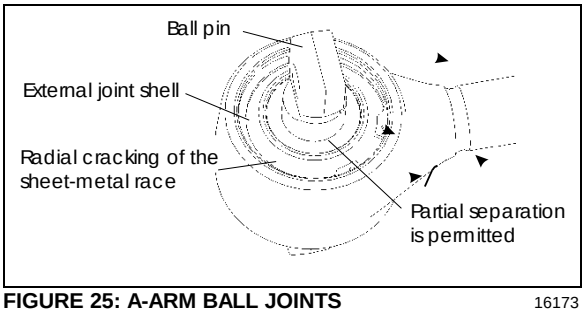


FIGURE 25: A-ARM BALL JOINTS 16173

- **Stripping Down**

Strip down the defective joint through removal of retaining ring, annular spacer and ball pin/bushing, assembly and thereafter clean out housing bore and locking circlips groove.

- **Assembly**

Execute assembly of the new joint parts in the following sequence:

1. Complete moistening of the contact surface between housing bore and ball pin through application of the grease.

NOTE
Apply grease, only in the case of repair kit (Prevost # 611114)).

2. Insert ball pin/bushing, assembly. In case of the two-bolt type, ensure that the bolt bores are in the correct position in relation to the axis of the tube.
3. Place joint in receiving fixture and mount annular assembly tool on the housing. Then locate annular spacer and retaining ring in the housing using axial load with the aid of assembly matrix. If the ends of the annular spacer are not in contact with each other, the thus formed opening must be located at 180° to the opening of the retaining ring. Pay attention during assembly to ensure that the retaining ring eyelets are located at each side of the housing shaft axis (retaining ring eyelet lug points to tube), and that retaining ring is properly engaged in the groove of the housing.
4. When repairing defective ball pin assemblies, the necked down-bolt must regularly be replaced with a new one.

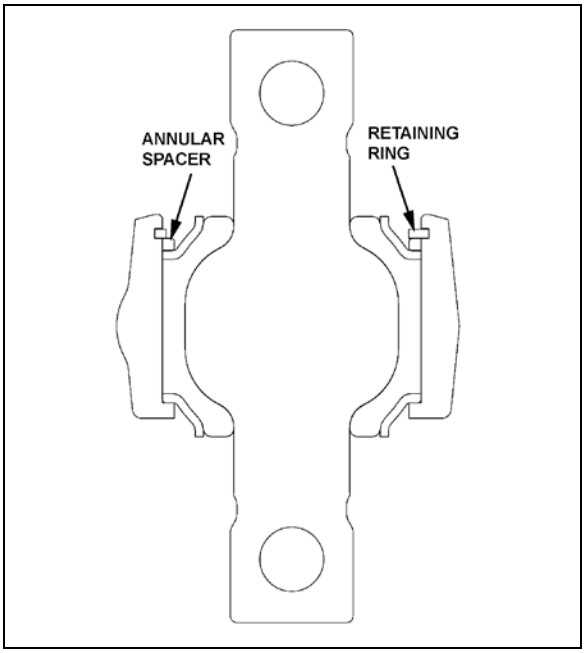


FIGURE 26: LOWER A-ARM BALL JOINTS 16114

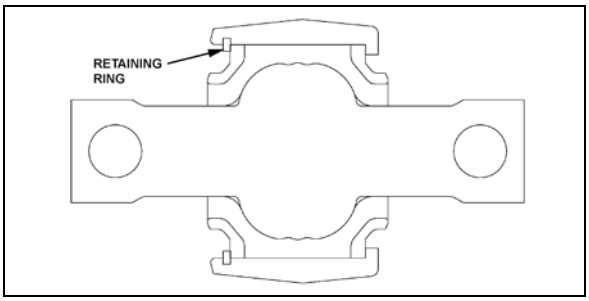


FIGURE 27: UPPER A-ARM BALL JOINTS 16115

3.11.2 Lower A- Arm Central Ball Joint

- **Inspection**

Take off the load from the ball joint by lifting the front of the vehicle. Apply a load on the joint in all of the degrees of freedom in an axial, radial, etc. sense with a suitable lever tool. After the load is taken off, the joint has to spring back into its starting position. Free play is not acceptable. Separation of rubber from ball pin or external joint bushing shell is in accordance with "normal wear characteristics".

When the following characteristics are noted, the joint is to be changed:

- Free play;
- Radial cracking of the external bushing shell.

- **Stripping Down**

Strip down the defective joint through removal of retaining ring, annular spacer and ball pin/bushing, assembly and thereafter clean out housing bore and locking circlips groove.

- **Assembly**

Assemble the new component parts of the joint in the following sequence:

1. Complete moistening of the contact surface between housing bore and ball pin through application of the grease.
2. Place joint in receiving fixture and mount annular assembly tool on the housing. Then locate annular spacer and retaining ring in the housing using axial load with the aid of assembly matrix. If the ends of the annular spacer are not in contact with each other, the thus formed opening must be located at 180° to the opening of the retaining ring. Pay attention during assembly to ensure that the retaining ring eyelets are located at each side of the housing shaft axis (retaining ring eyelet lug points to tube), and that retaining ring is properly engaged in the groove of the housing.

3. Faultlessly apply grease by mechanical means to bracket-outer core and ball-inner cone. Insert bracket outer cone in fixture with distance ring and then use press tool to apply pressure to press mount with ball-inner cone.

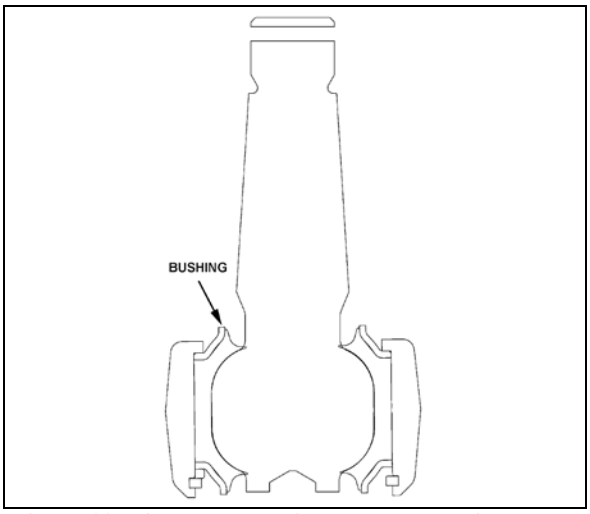


FIGURE 28: LOWER A-ARM CENTRAL BALL JOINT 16113

3.11.3 Upper A-Arm Central Ball Joint

- **Visual Inspection**

Check the condition of the sealing boot, in particular:

Check if the retainer ring, which secures the sealing boot at the conical section of the ball stud, is still present.

Check if grease is present on the external surface of the sealing boots. Escaped fluid and accumulations of grease on the sealing boot may be the result of the sealing boot's rupturing. In this case, the ball joint must be systematically replaced.

- **Play Measurement**

1. Raise the vehicle and support through axle jacking points.
2. Using a caliper, measure dimension A on figure 30.
3. With a lever tool, exert sufficient force under the upper A-arm as to separate the upper A-arm from the upright in order to have the ball joint to its maximum extent. Remeasure dimension A. If the difference between the two dimensions is greater than 0.060" (1.5 mm), then the ball joint should be replaced.

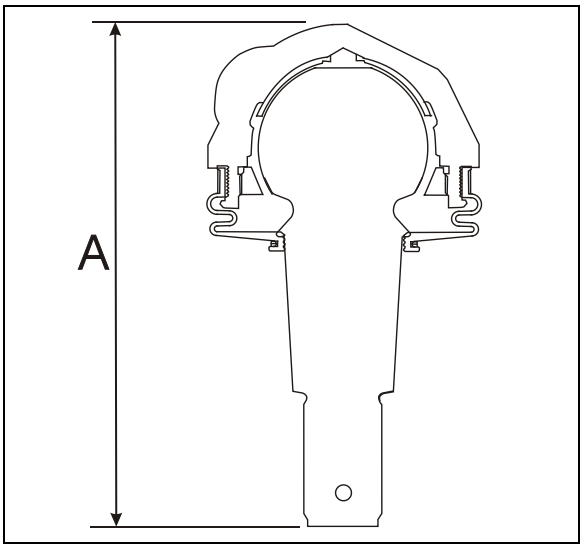


FIGURE 29: UPPER A-ARM CENTRAL BALL JOINT 16116

3.12 FRONT END ALIGNMENT

Proper front end alignment must be maintained to insure ease of steering and provide satisfactory tire life. When making front end alignment inspections, the vehicle must be level and empty with the full weight of the vehicle on the wheels.

Front end alignment inspections fall into two groups: regular service inspections performed at periodic intervals, and inspections to determine the extent of damage after a collision or severe service.

Regular service inspections concern toe-in, camber and caster.

Any variation from the specified alignment will indicate either a need for adjustment or a more thorough inspection to determine if parts replacement is required.

WARNING

During alignment, both camber and caster among other angles are adjusted. When adjusting these we install or remove shims from the lower “A” arms of the IFS. After performing alignment, make sure that the following is done:

- Installing a new lock nut after all shims are finalized.
- Torque replaced nuts as per figure 34.
- Installing a longer bolt if less the 2 threads are remaining after the nut.
- Using a Torque mark on the nut for future visual inspection.

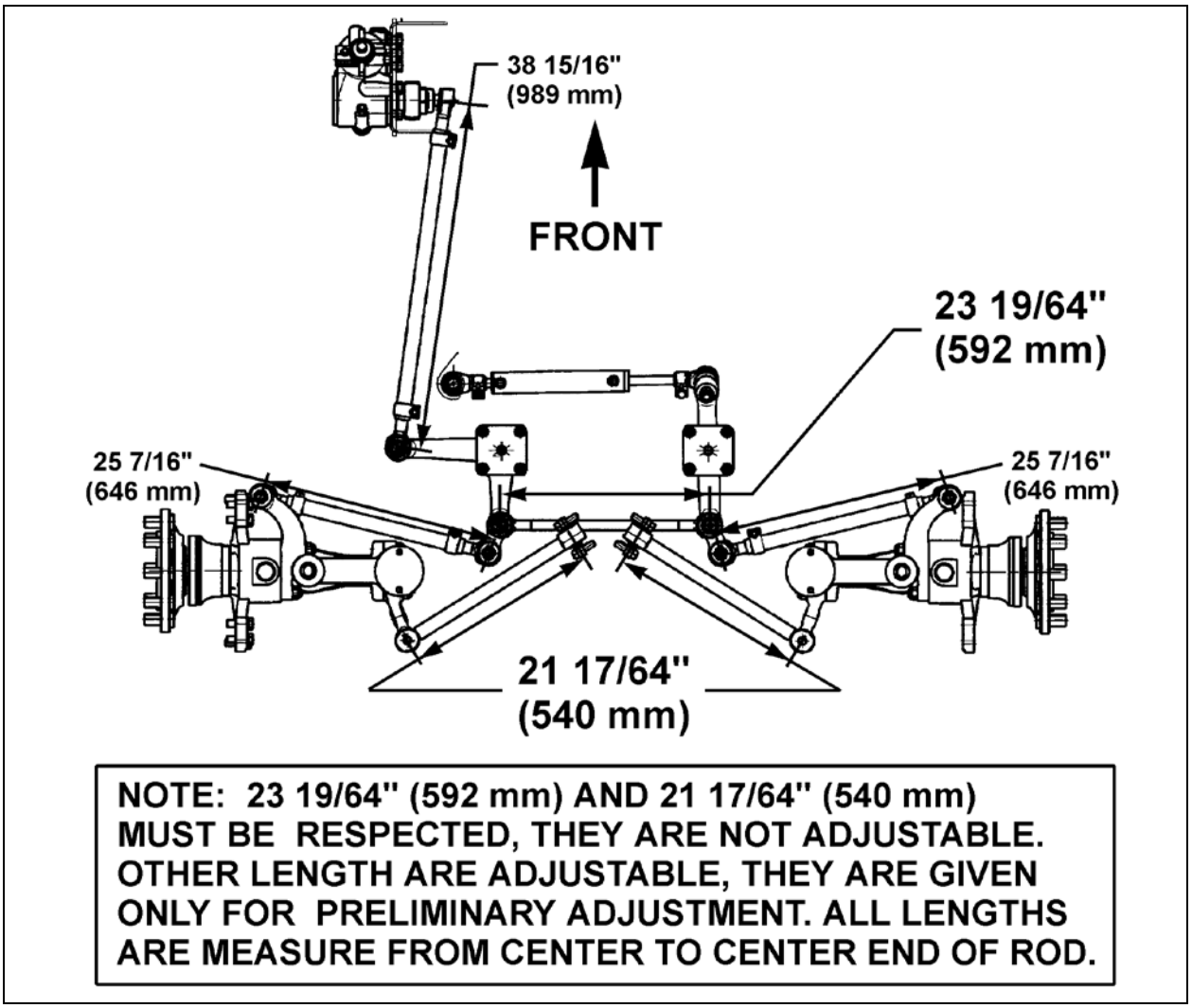


FIGURE 30: STEERING LINKAGE MEASURE 16130

3.12.1 Alignment Terminology

Wheel Camber

The amount the wheels are inclined from the vertical plane (A, Fig. 32).

Wheel Toe-In

The distance the front wheels are closer together at the front than at the rear of the tires (D minus E, Fig. 32).

Steering Knuckle Pin Inclination

The inclination of the steering knuckle pin from vertical toward the center of the vehicle at the top and outward at the bottom (B, Fig. 32).

Front Axle Caster

The inclination of the steering knuckle pin from vertical in the fore and aft direction (C, Fig. 32).

3.12.2 Front End Inspection

Before checking front end alignment, make the following inspection:

1. Check that the vehicle is at normal ride height (see paragraph "5. Suspension Height Adjustment").
2. Check the tires for proper inflation.
3. Check wheel installation and run-out.
4. Check wheel bearing adjustment.
5. Check tie rods and drag link ends for looseness.
6. Check steering knuckle pins for looseness.
7. Check if the length of the torque rod is 21 17/64" (540 mm) (Fig. 31). Check if the length of the relay rod is 23 19/64" (592 mm).

3.12.3 Front Wheel Camber

Positive camber is the outward inclination of the wheels at the top, negative or reverse camber is the inward inclination of the wheels at the top. Camber variations may be caused by wear at the wheel bearings, wheel spindle bushings, or bent suspension parts.

Check camber, with an accurate gauge. If camber is incorrect, check suspension parts for wear and replace worn parts. If wear is not perceptible, suspension parts may be bent or lower suspension arm may be improperly shimmed.

Check steering knuckle pin inclination. If steering knuckle pin inclination is incorrect, readjust the camber and check steering knuckle pin inclination again.

NOTE
Camber is more important than steering knuckle pin inclination, so adjust camber and verify steering knuckle pin inclination.

Shim the lower suspension arm to adjust camber. If the steering knuckle pin inclination is incorrect, the wheel steering knuckle pin assembly may be bent and therefore should be replaced.

Excessive positive camber results in irregular wear of the tires at the outer shoulders. Negative or reverse camber causes wear at the inner shoulders.

NOTE
Shim only the lower suspension arm to adjust the front wheel camber.

CAUTION
Once the perfect shim combination is achieved, always install new “Stover” nuts because the self looking effect is lost after tightening and loosening of the nut. It is recommended to punch marks to detect loosening of the nuts during future visual inspections.

3.12.4 Front Wheel Toe-In

Toe-in is measured from the center of the tire treads. Measurements at the front and rear of the tires must be made at the same height from the floor. Incorrect toe-in results in excessive tire wear and steering instability with a tendency to wander.

- **Toe-In Check**

1. Check the camber adjustment and adjust if necessary.
2. Hoist the front of the vehicle and spin the wheels marking the centerline of the tire treads.
3. Place the wheels in the straight ahead position and lower the vehicle to rest on the floor.

4. Roll the vehicle ahead several feet. This removes any slack caused by looseness in the wheel bearings or steering connections.
5. Check the distance between the tire centerlines at the front and rear of the front tires. These two measurements must be made at the same height above the floor. The front measurement must be 3/32 ±1/32 of an inch less than the rear measurement.

- **Toe-In Adjustment**

1. Loosen the tie rod clamp bolts.
2. Using a pipe wrench, turn the tie rod tubes to obtain the toe-in measurement specified in step 5 under paragraph "**Toe-in Check**" of this section.
3. Tighten the tie rod clamp bolts and recheck toe-in.
4. Check that the angular relationship of the pitman arm to the steering gear is as shown in figure 19.

NOTE
Use only tie rods to adjust toe-in.

3.12.5 Front Axle Caster

Positive caster is the inclination of the top of the steering knuckle pins toward the rear of the vehicle. Negative or reverse caster is the inclination of the steering knuckle pins toward the front of the vehicle. This vehicle is designed with positive caster. The purpose of caster is to provide steering stability by keeping the wheels in a straight ahead position.

Caster variations may be caused by bent upper suspension arm, lower suspension arm, or steering knuckle pin housing. Caster should be adjusted with shims. Precision instruments should be used to measure caster. Shim bell crank and idler arm to adjust caster.

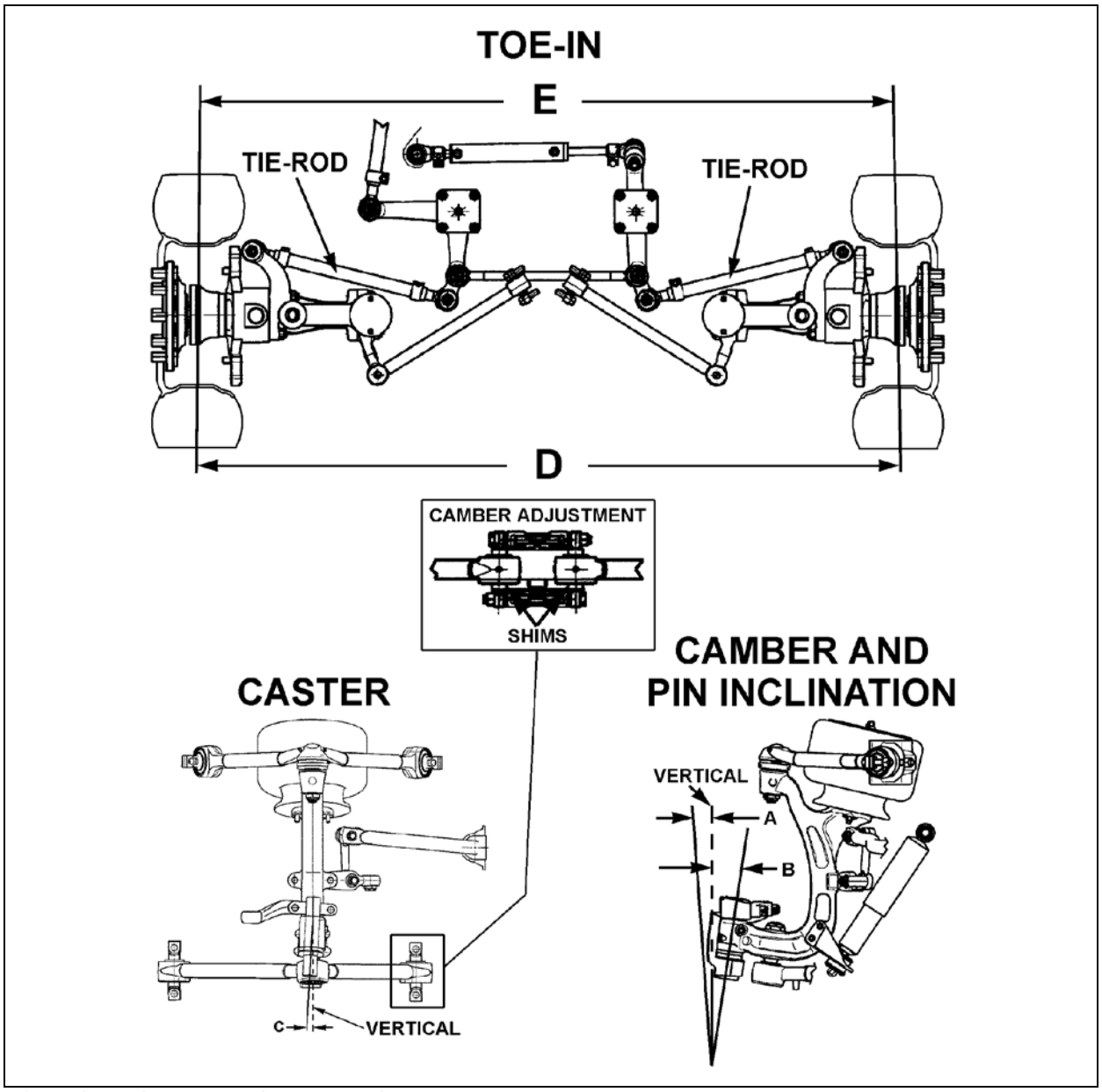


FIGURE 31: FRONT END ALIGNMENT DIAGRAM 16134

X3-45 COACHES ALIGNMENT SPECS (See Figure 32)				
		Minimal	Nominal	Maximal
A	WHEEL CAMBER	0.0	0.150	0.35
B	STEERING KNUCKLE PIN INCLINATION	8° (not adjustable)		
C	CASTER	2.35	2.6	2.85
D-E	TOTAL TOE	0.06	0.08	0.10

X3-45 VIP & XLII BUS SHELLS ALIGNMENT SPECS (See Figure 32)							
		Minimal		Nominal		Maximal	
Load		Non-converted	Converted	Non-converted	Converted	Non-converted	Converted
A	WHEEL CAMBER	0.2	-0.150	0.35	0.0	0.55	0.200
B	STEERING KNUCKLE PIN INCLINATION	8° (not adjustable)					
C	CASTER	2.55		2.8		3.05	
D-E	TOE-IN	0.08		0.10		0.12	

Variations from the specified caster will affect steering stability, cause wandering, wheel shimmy, and produce poor steer re-centering after turns.

3.12.6 Major Damage

If the suspension has sustained major damage, it may be necessary to shim the bell crank and the idler arm to avoid the bump steer or roll steer. Moreover refer to paragraph "3.12: Front End Alignment".

3.13 FRONT AIR SPRINGS

Two *"rolling lobe"* type air springs are used with the independent front suspension, one at each wheel. These air springs are special and use the complete piston as an extra reservoir to lower the spring stiffness. Front air springs are attached to the subframe and to uprights.

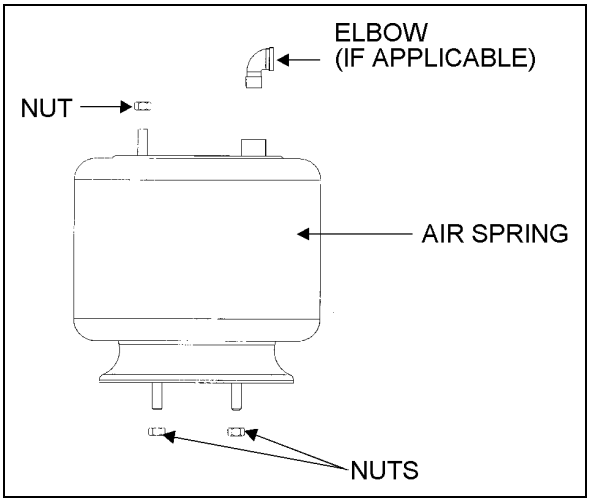


FIGURE 32: AIR SPRINGS 16052

3.13.1 Inspection

1. Check operation of bellows.
2. Visually inspect bellows for evidence of cracks, punctures, deterioration, or chafing. Replace the bellows if damage is evident.
3. With the primary air system at normal operating pressure (95 - 125 psi (655 - 860 kPa)), coat all suspension air line connections and bellow mounting areas with a water and soap solution. Bubbles will indicate an air leak, and none is permissible. Repair or replace defective parts.

NOTE
If air spring is removed from vehicle, bellows can be lightly inflated and submerged in water to detect any leakage. If leakage is detected, replace bellows.

WARNING

To prevent personal injury, do not apply more than 10 psi (69 kPa) air pressure to the unmounted air spring.

3.13.2 Removal

NOTE
Front air springs can be removed without removing the entire suspension assembly.

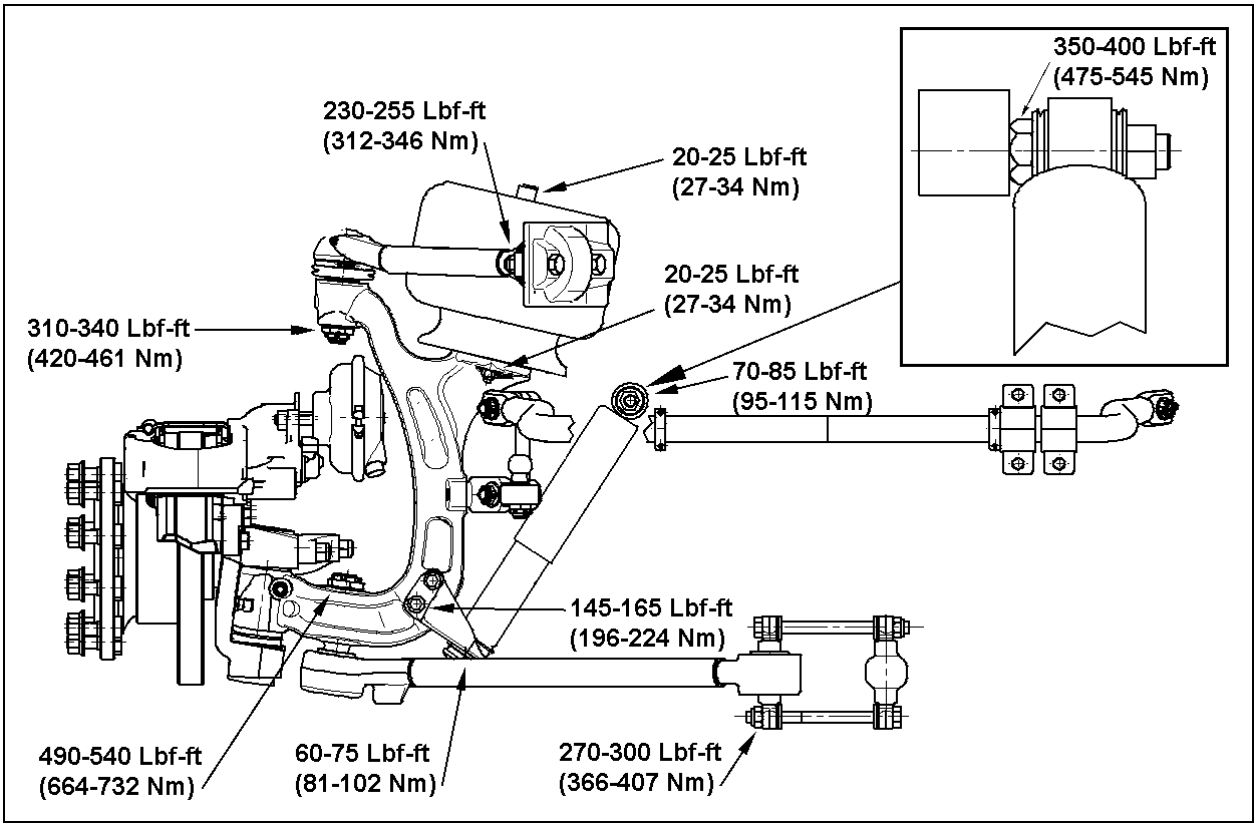


FIGURE 33: AIR SPRING AND SHOCK ABSORBER 16145

1. Safely support vehicle at the recommended body jacking points and jack up body understructure.
2. To gain access to a given air spring, the corresponding wheel can be removed.

⚠ CAUTION

Only the recommended jacking points must be used as outlined in Section 18, "Body" in the maintenance manual.

3. Support the assembly with a suitable jack.
4. Exhaust compressed air from accessory air tank by opening drain cock under reservoir.
5. Disconnect the height control valve link and pull down the overtravel lever to ensure all air is exhausted from air springs.

NOTE

While performing this step, do not change the height control valve overtravel lever adjustment.

6. Disconnect air line from air spring, remove elbow (if applicable), and cover both the line end and fitting to prevent the entry of foreign matter.
7. Remove the air spring upper nut, and then the two lower nuts. Remove air spring and remove the back up plate from the top of the air spring.

3.13.3 Installation

NOTE

To facilitate air spring installation, compress it manually then put a piece of tape over the air line threaded fitting. This prevents air from getting back into the bag and keeps it compressed, thus enabling to place the bag in between the mounting plates and greatly easing installation.

1. Compress air spring as necessary, then aligning studs with their holes, position air spring between both the lower and upper supports. Thread the lower nuts and the small upper nut a few turns.

2. Tighten and torque the lower stud nuts, and then the upper nut to 20-25 lbf-ft (27–34 Nm).
3. Install elbow (if applicable), then connect air line.
4. Connect the height control valve link.
5. Build up air pressure in system.

NOTE
To accelerate this operation, air reservoirs can be filled from an exterior air supply connected to the accessory tank fill valve or to the emergency fill valve.

6. Check operation of bellows and with the primary air system at normal operating pressure (95 - 125 psi (655 - 860 kPa), coat the air line connections and air spring mounting areas with a water and soap solution. Bubbles will indicate an air leak, and none is permissible. Repair or replace defective parts.
7. Remove the hydraulic floor jack from underneath shock absorber bracket.

3.14 SHOCK ABSORBERS

The two front shock absorbers are double-acting and telescopic type. Shock absorbers ensure a smooth ride and enhance vehicle stability on the road. Front shock absorbers have eye-type mountings on the upper side and bayonet type on lower side. Shock absorbers are non-adjustable and non-repairable.

CAUTION
When a shock absorber is found defective, always replace with a new set on affected axle, except if there has been a recent replacement of one unit. The following method will help in determining if both shock absorbers on the same axle have to be replaced.

3.14.1 Shock Absorber Removal

1. Remove the nut, washer and rubber joint from shock absorber mounting stud. Discard the rubber joints.
2. Remove the nut and washer from shock absorber mounting pin (upper side), taking care to identify the inner and outer washers to ease reinstallation. Refer to figure 35 for details.
3. Remove the shock absorber from the vehicle.
4. Remove inner: washers, rubber joint and bushings from the shock absorber. Discard bushings and rubber joint.

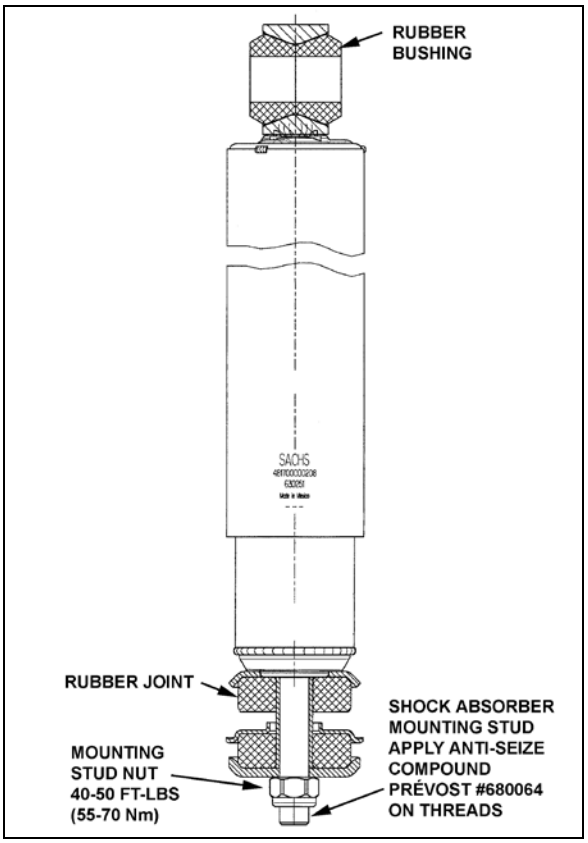


FIGURE 34: SHOCK ABSORBER 16112

3.14.2 Shock Absorber Installation

1. Check that the shock absorber mounting pin torque is proper (350-400 lbf-ft (475-545 Nm)). Ensure that the stud is clean and not stripped (upper side).
2. Install new rubber (mounting) bushing on shock absorber (upper side).
3. Place the inner washer on shock absorber pin (Fig. 35).
4. Install washer and rubber joint on shock absorber mounting stud (lower side).
5. Install the shock absorber as shown in figure 34 with the mounting stud protruding through the hole in the mounting bracket and the shock absorber eyes over the mounting pins. Install the outer washer.
6. Place a rubber joint and washer on the shock absorber mounting stud. Place the

lower shock absorber mounting stud nut and torque to 40-50 lbf-ft (55–70 Nm).

7. Place the upper mounting pin stud nut and torque to 70-85 lbf-ft (95–115 Nm).

3.15 SWAY BAR

A sway bar is provided on the front and rear suspensions to increase vehicle stability. It controls lateral motion (swaying movement) of vehicle.

3.15.1 Removal

1. Disconnect the two links from sway bar.
2. Safely support the sway bar. Unbolt bushing collars from subframe.
3. Remove sway bar.

NOTE
Sway bar bushings are slit to ease their removal.

3.15.2 Installation

1. Loosely install the sway bar.
2. Torque bushing collar nuts to 80-100 lbf-ft dry (108-136 Nm) on front and rear suspensions.
3. Torque sway bar link upper nuts to 165-200 lbf-ft dry (225-270 Nm) on front suspension and to 99-121 lbf-ft dry (134-164 Nm) on rear suspension.
4. Torque sway bar link lower nuts to 165-200 lbf-ft dry (225-270 Nm) on front suspension and to 80-100 lbf-ft dry (108-136 Nm) on rear suspension.

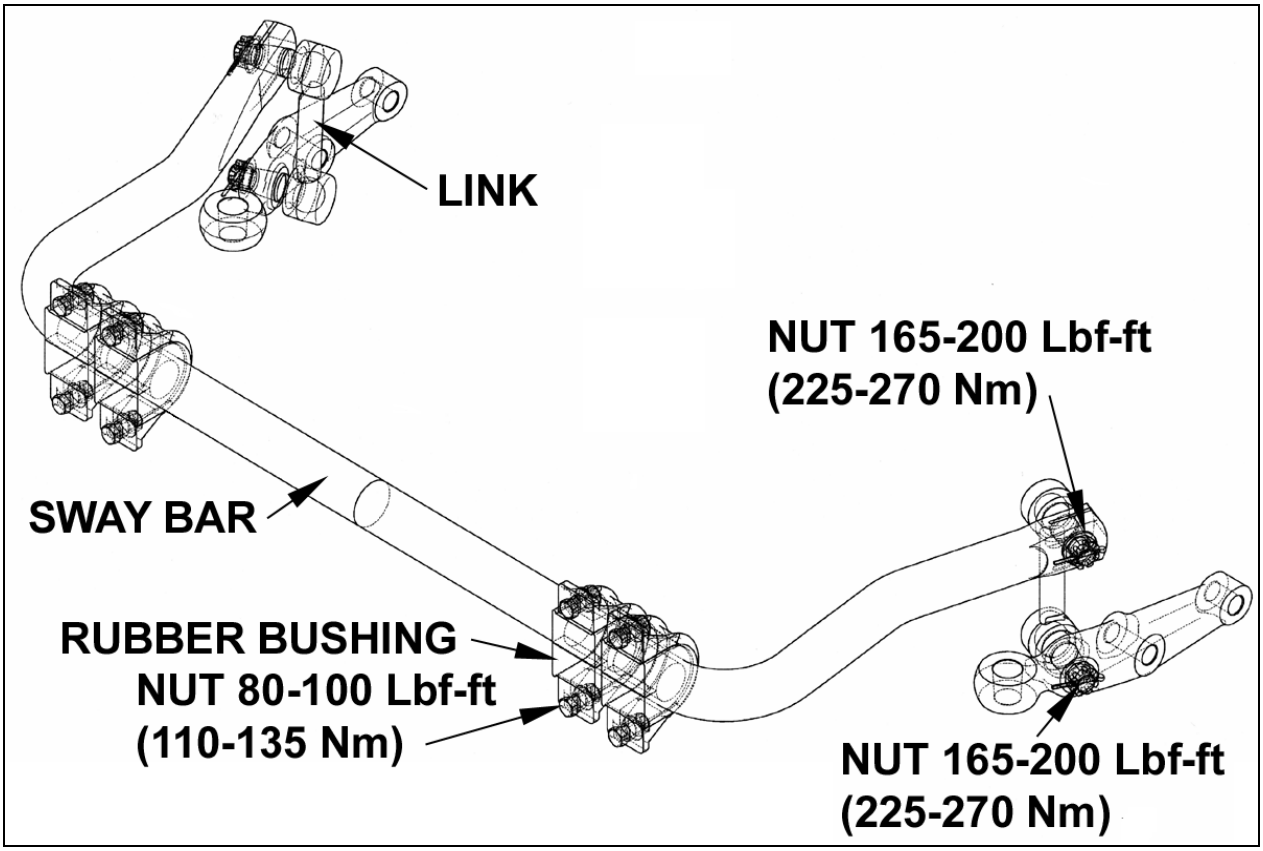


FIGURE 35: SWAY BAR (FRONT SUSPENSION) 16138B

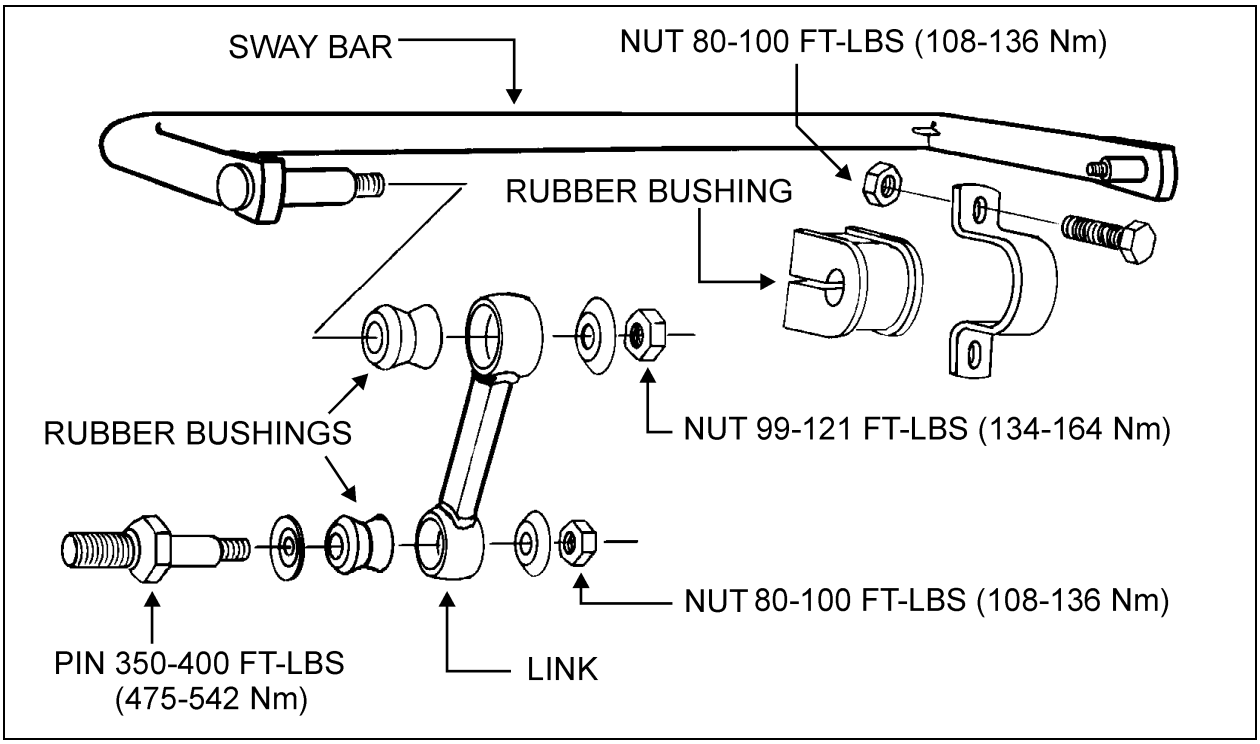
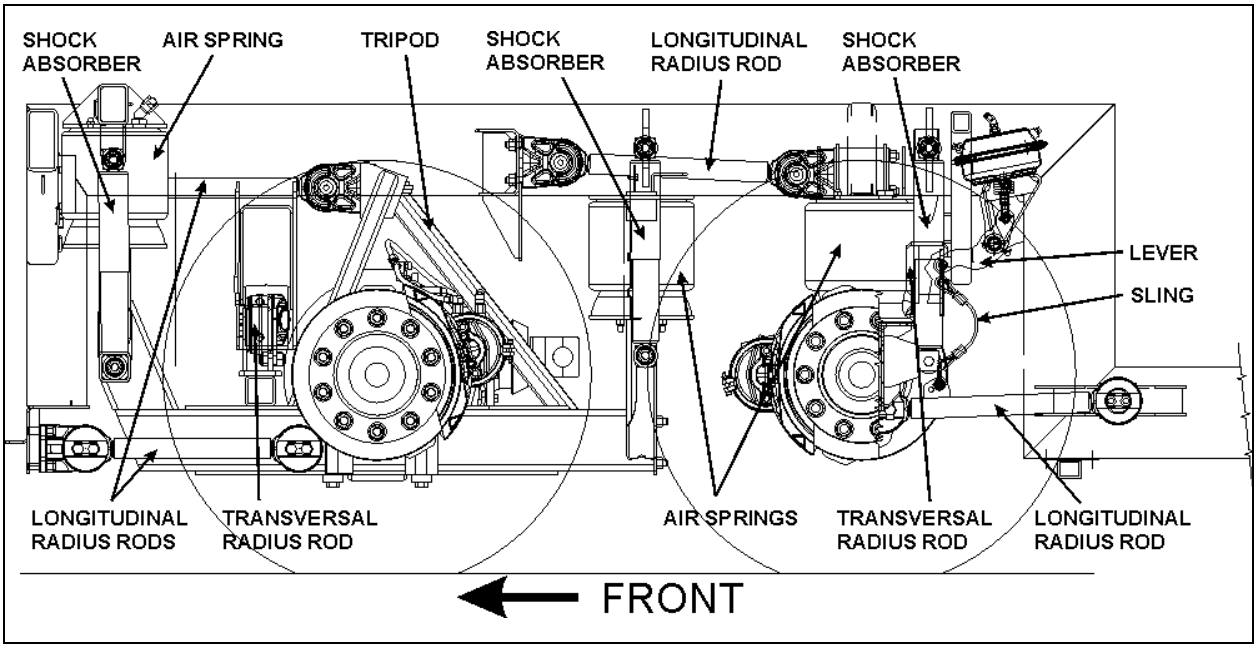

SWAY BAR
NUT 80-100 FT-LBS (108-136 Nm)
RUBBER BUSHING
RUBBER BUSHINGS
NUT 99-121 FT-LBS (134-164 Nm)
NUT 80-100 FT-LBS (108-136 Nm)
PIN 350-400 FT-LBS
(475-542 Nm)
LINK

FIGURE 36: SWAY BAR (REAR SUSPENSION) 16144

4. REAR SUSPENSION

For a description of all these systems, refer to the appropriate heading in this section.



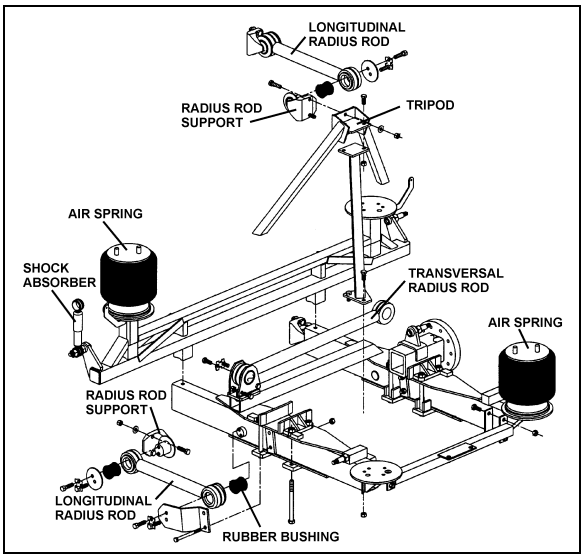


FIGURE 37: REAR UNDERFRAME SUSPENSION 16106

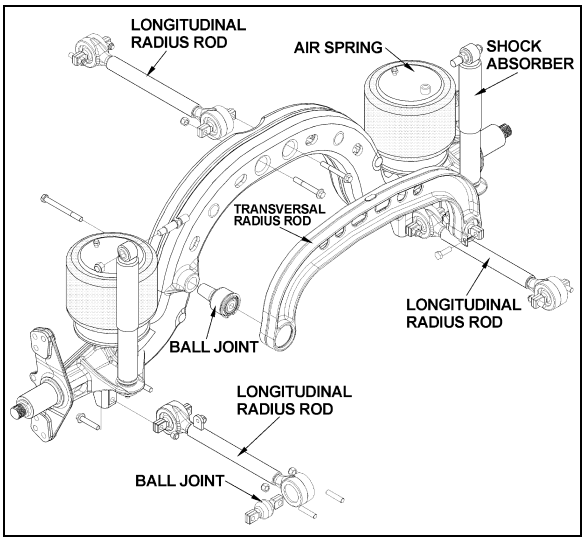


FIGURE 38: TAG AXLE SUSPENSION 16107

4.1 AIR SPRINGS

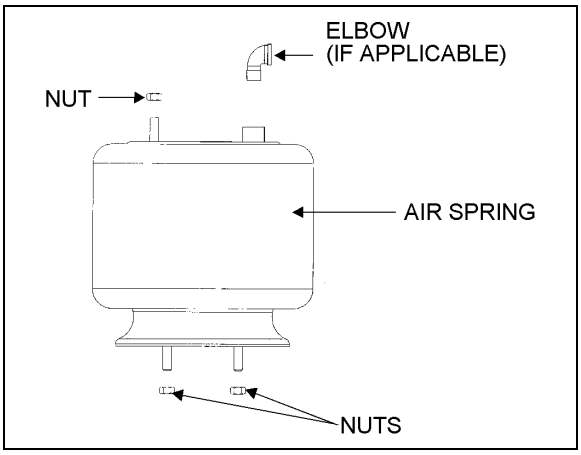


FIGURE 39: AIR SPRING 16052

The air springs are made from a special compound rubber molded to the proper contour and dimensions. The entire vertical load of the vehicle is supported by these springs. Each of the two axles is provided with air springs that are attached to the subframe and to the axles (Fig. 41).

4.1.1 Inspection

1. Check operation of bellows.
2. Visually inspect bellows for evidence of cracks, punctures, deterioration, or chafing. Replace the bellows if any damage is evident.
3. With the primary air system at normal operating pressure (95 - 125 psi (655 - 860 kPa)), coat all suspension air line connections and bellows mounting areas with a water and soap solution. Bubbles will indicate an air leak, and none is permissible. Repair or replace defective parts.

NOTE
If air spring is removed from vehicle, bellows can be lightly inflated and submerged in water to detect any leakage. If any leakage is detected, replace bellows.

WARNING
To prevent personal injury, do not apply more than 10 psi (69 kPa) of air pressure to the uninstalled air spring.

4.1.2 Removal

NOTE
Suspension air springs (drive and tag axles) can be removed without removing the entire axle assembly.

1. Safely support vehicle at the recommended body jacking points. To gain access to a given air spring, the corresponding wheel can be removed as follows.

   a) Jack vehicle until the tire clears the ground, and place safety supports underneath body.

CAUTION
Only the recommended jacking points must be used as outlined in Section 18, “Body”.

   b) Support the axle with a suitable hydraulic floor jack at the recommended jacking point.

   c) Remove wheel.

2. Exhaust compressed air from accessory air tank by opening drain cock under reservoir.
3. Disconnect the height control valve link and pull down the overtravel lever to ensure all air is exhausted from air springs.

NOTE
While performing this step, do not change the height control valve overtravel lever adjustment.

4. Disconnect air line from air spring, remove elbow (if applicable), and cover both the line end and fitting to prevent the entry of foreign matter.
5. Remove the air spring upper nut, and then the two lower nuts. Remove air spring.

4.1.3 Installation

1. Compress air spring as necessary, then aligning studs with their holes, position air spring between both the lower and upper supports. Thread the lower nuts and the small upper nut a few turns.

NOTE

To facilitate air spring installation, compress it manually then put a piece of tape over the air line threaded fitting. This prevents air from getting back into the bag and keeps it compressed, thus enabling to place the bag in between the mounting plates and greatly easing installation.

2. Tighten and torque the lower stud nuts, and then the upper one to 20 – 25 lbf-ft (27 – 34 Nm).
3. Thread the remaining upper nut (large nut) and tighten to 20 – 25 lbf-ft (27 – 34 Nm).
4. Install elbow (if applicable), then connect air line.
5. Connect the height control valve link.
6. Build up air pressure in system.

NOTE

To accelerate this operation, air reservoirs can be filled from an exterior air supply connected to the accessory tank fill valve or to the emergency fill valve.

7. Check operation of bellows, and with the primary air system at normal operating pressure (95 – 125 psi (655 – 860 kPa)), coat the air line connections and air spring mounting areas with a water and soap solution. Bubbles will indicate an air leak, and none is permissible. Repair or replace defective parts.
8. Reinstall wheel.
9. Remove the hydraulic floor jack from under the axle, then lower vehicle to ground.

4.2 SHOCK ABSORBERS

Double-action, telescoping-type shock absorbers ensure a smooth ride and enhance vehicle stability on the road. All shock absorbers are eye-type mountings. The tag axle is provided with two shock absorbers while the drive axle is provided with four of them (Fig. 38, 39 and 40).

Shock absorbers are non-adjustable and non-repairable. Maintenance requirements involve replacement of the rubber mounting bushings, and tightening of all shock absorber pins at the proper torque of 500 - 550 lbf-ft (680 - 750 Nm) when shock absorber replacement occurs. If a shock absorber becomes inoperative, complete unit must be replaced.

CAUTION

When a shock absorber is found defective, always replace with a new set on affected axle, except if there has been a recent replacement of one unit. The following method will help in determining if both shock absorbers on the same axle have to be replaced.

4.2.1 Inspection

Loosen lower mounting of both shocks, and then carefully attempt to raise and lower the bottom portion of each shock. Note the rate of effort for distance of travel. Replace both shocks if a definite differential rate is found.

The shock must be bench checked in an upright, vertical position. If checked in any other position, air will enter the cylinder tube and make the shock absorber appear defective.

Proceed as follows to check shock absorbers:

1. With the shock absorber in a vertical position (top end up), clamp the bottom mount in a vise.

CAUTION

Do not clamp the reservoir tube or the dust tube.

2. Rotate the dust tube. Notice any binding condition (may be compared with new unit). Binding condition indicates a scored rod. Units with scored rods should be replaced.
3. Fully extend shocks and check for leaks in the seal cover area. Shock fluid is a very thin hydraulic fluid that has a characteristic odor and dark brown tint. A slight trace of shock fluid around the seal cover area is not a cause for replacement. The shock seal is designed to permit a very slight seepage to lubricate the rod. Units that leak should be replaced.
4. Visually check shock for dents that could cause the shock to bind. Also, check for a bent rod.
5. Extend and collapse shock several times to determine that it has control (resistance) in both rebound and compression.
6. Visually inspect the shock mountings and vehicle mounting for:

a) Broken mounts;

b) Extreme bushing wear;

c) Shifted bushing or sleeve;

d) Deep cracks in bushing material (shallow surface cracks are normal);

e) Loose shock absorber pins;

f) Presence of convex washers, and their position relative to the rubber bushing.

4.2.2 Removal

1. Remove nuts and washers from shock absorbers on upper and lower mounting pins, taking care to identify the inner and outer washers to ease reinstallation. Refer to figure 42 for details.
2. Remove the shock absorber assembly from pins.
3. Remove the two inner bushings from the shock absorber and discard them.

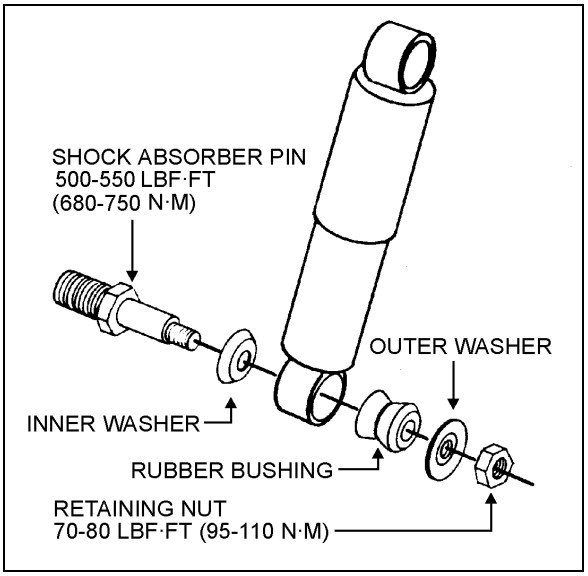


FIGURE 40: SHOCK ABSORBER 16008

4.2.3 Installation

1. Ensure that the shock absorber mounting pins are tight and that the threads are not stripped.
2. Install new rubber mounting bushings on shock absorbers (upper and lower).
3. Place the inner washers (with washer convex side facing the shock absorber rubber bushing) on each shock absorber pin (Fig. 43).
4. Install the shock absorber eyes over the mounting pins, then the outer washers (with washer convex side facing the shock absorber rubber bushing) on each shock extremity.

NOTE
If shock absorber pins are removed, they must be reinstalled using "loctite" (see "Parts Specifications" in this section).

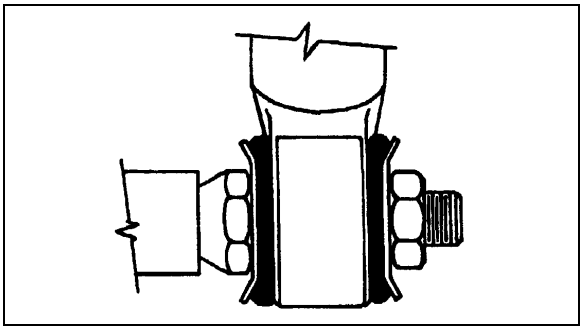


FIGURE 41: TYPICAL SHOCK ABSORBER SETUP 16009

5. Place the lower and upper mounting pin stud nuts and torque to 70 - 80 lbf-ft (95 – 110 Nm).

4.3 RADIUS RODS

Radius rods are used to secure the axles in the proper transversal and longitudinal positions. Four radius rods are provided on the drive axle suspension (three longitudinal and one transversal) and also four on the tag axle with a layout similar to the drive axle. Refer to figures 38, 39 and 40 for details. These rods transmit both braking and driving forces from the axles to the vehicle body.

4.3.1 Rear Underframe Suspension

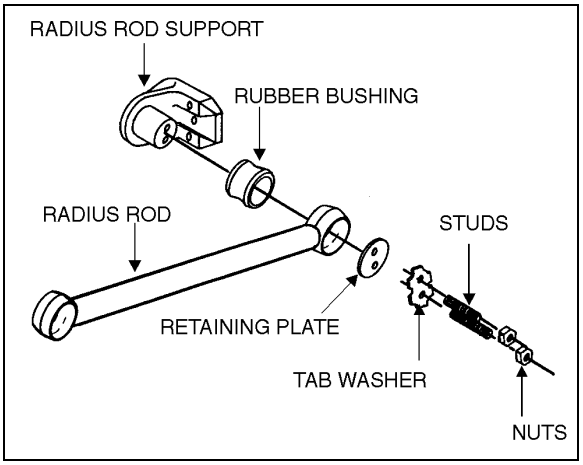


FIGURE 42: TYPICAL RADIUS ROD SETUP 16010

Radius Rod Inspection

The following instructions apply to the radius rods used on the rear underframe suspension:

1. Clean all parts thoroughly.
2. Inspect radius rods for distortion and cracks. We recommend the “Magnaflux” process to detect cracks in the radius rod. Any damaged part should be replaced with a new one.

NOTE
New bushings should be used when rods are replaced.

3. The radius rod bushings should be checked periodically for signs of shearing, deterioration, or damage. Any defective part should be replaced with a new one.

Radius Rod Removal

1. Flatten the tab washer which secures the two retaining nuts (or bolts), then unscrew the nuts (or bolts) at each extremity of the radius rod (Fig. 44).
2. Remove the tab washer and the retaining plates and radius rod ends from anchor pins, and then remove the radius rod.

Bushing removal

1. Safely support the radius rod as shown in figure 45.

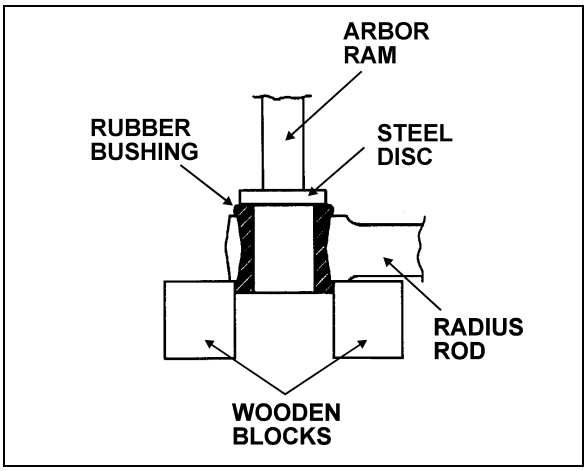


FIGURE 43: RADIUS ROD BUSHING REMOVAL 16011

2. Place a flat steel disc, slightly smaller than the outside diameter of the bushing (Fig. 45).
3. Using an arbor press or a suitable driving tool, press or drive the old bushing out of the rod and discard the bushing.

CAUTION
Make sure to prevent the steel disc from contacting the radius rod end.

Bushing installation

1. Lightly spray the inner and outer surfaces of radius rod bushing with water.

CAUTION
No lubricant whatsoever is to be used on the rubber bushing.

2. Safely support the radius rod, and place new bushing on top of the radius rod end (Fig. 46).
3. Place a block of wood on top of bushing and press on it manually.
4. If necessary, use an arbor press or a suitable driving tool. Press or drive the bushing into the radius rod end until it extends equally on both sides of the rod.
5. It is also possible to proceed differently. Place radius rod bushing on a plane surface. Spray a light coat of water on the inner and outer surfaces of radius rod bushing.

6. Take radius rod, align the bushing. Tap radius rod on bushing until latter is positioned correctly.

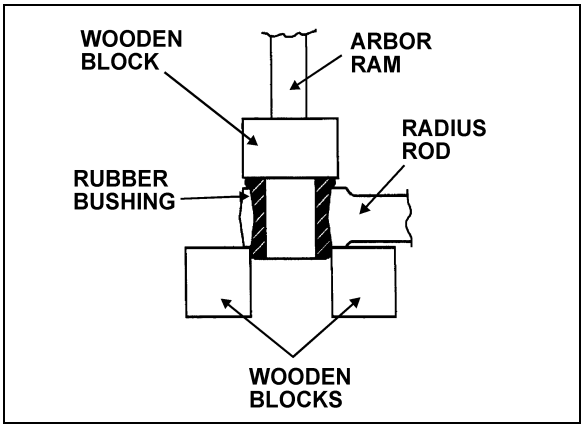


FIGURE 44: RADIUS ROD BUSHING INSTALLATION 16012

Radius Rod Installation

1. Lightly spray the radius rod support with water. Place the radius rod end over the radius rod support (Fig. 47).
2. Position the retaining plate. Install the tab washer and nuts (or bolts).

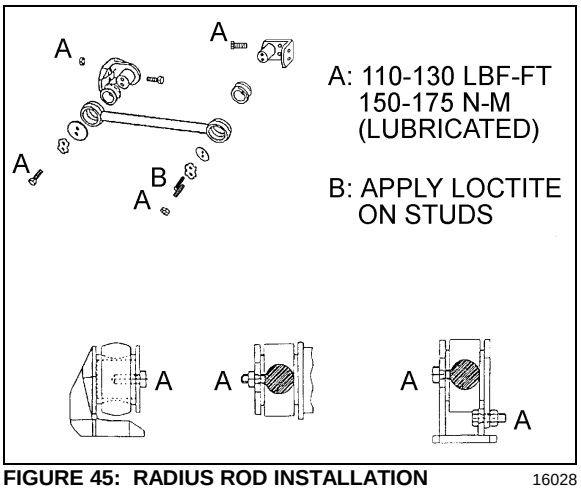


FIGURE 45: RADIUS ROD INSTALLATION 16028

CAUTION

Always use new tab washers at installation.

3. Tighten the nuts (or bolts) lightly, and repeat at the other end.
4. Refer to heading *"Suspension Height Adjustment"* later in this section, and set the vehicle to normal ride height.
5. With the vehicle at normal ride height, apply oil on threads and tighten all radius rod anchor pin nuts or bolts to 110 – 130 lbf-ft (150 – 175 Nm).

CAUTION

It is extremely important upon reconnection of the rods that the proper clearance height between the axle and body be maintained. Otherwise, the rubber bushings in radius rod ends will become preloaded, thus reducing their life span.

4.3.2 Tag Axle Suspension

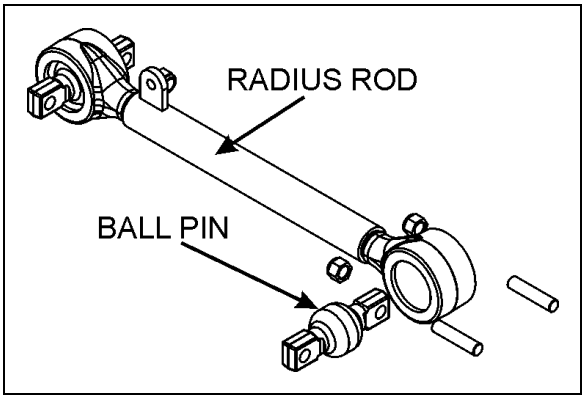


FIGURE 46: TYPICAL RADIUS ROD SETUP 16010

The assembly work may be done only by a recognized specialized workshop. Ensure that old and new parts do not get mixed up with each other. It is for this reason that all the old parts are to be scrapped immediately after a joint has been stripped down. A complete repair set must be used for each joint repaired, i.e. use of only part of a repair set is not permissible.

Radius Rod Inspection

Take off the load from the ball joint by lifting the rear of the vehicle. Apply a load on the joint in all of the degrees of freedom in an axial, radial, etc. sense with a suitable lever tool. After the load is taken off, the joint has to spring back into its starting position. Free play is not acceptable.

Separation of rubber from ball pin or external joint shell is in accordance with "normal wear characteristics".

When the following characteristics are noted, the joint is to be changed:

- Free play;
- Radial cracking of the external sheet-metal race.

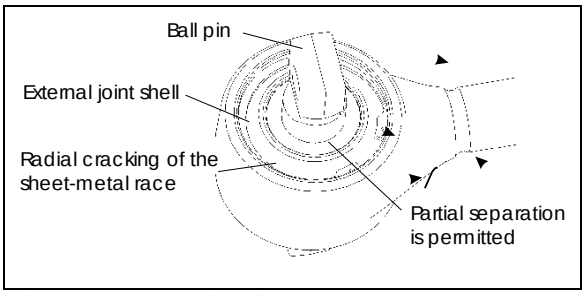


FIGURE 47: BALL JOINTS 16173

Stripping Down

Strip down the defective joint through removal of retaining ring, annular spacer and ball pin/bushing, assembly and thereafter clean out housing bore and locking circlips groove.

Radius Rod Assembly

Execute assembly of the new joint parts in the following sequence:

1. Complete moistening of the contact surface between housing bore and ball pin through application of the grease.

NOTE
Apply grease, only in the case of repair kit (Prevost # 611114)).

2. Insert ball pin/bushing, assembly. In case of the two-bolt type, ensure that the bolt bores are in the correct position in relation to the axis of the tube.
3. Place joint in receiving fixture and mount annular assembly tool on the housing. Then locate annular spacer and retaining ring in the housing using axial load with the aid of assembly matrix. If the ends of the annular spacer are not in contact with each other, the thus formed opening must be located at 180° to the opening of the retaining ring. Pay attention during assembly to ensure that the retaining ring eyelets are located at each side of the housing shaft axis (retaining ring eyelet lug points to tube), and that retaining ring is properly engaged in the groove of the housing.

When repairing defective ball pin assemblies, the necked down-bolt must regularly be replaced with a new one.

5. SUSPENSION HEIGHT ADJUSTMENT

The flow of pressurized air from the accessory air tank to the air springs is controlled by three height control valves. The two rear valves are mounted to the subframe and connected to the rear axles through an arm and link connection. The front valve is mounted to the subframe and connected to the front air tank support. These connections allow the valves to apportion air pressure in the springs to the vehicle load, maintaining normal ride height.

Immediate response height control valves increase or decrease the air pressure in the suspension system as required. One height control valve is located **at center of front sway bar**, and regulates air to front suspension air springs in order to maintain the vehicle at the required height. Two are located at the drive axle, one on each inner side of rear wheelhousing.

The appropriate vehicle body height is obtained by measuring the clearance of all the air springs installed on the vehicle. The two front air springs clearance should be 11 ± ¼“ (279 ± 6 mm). Refer to figure 50 to identify the correct area to take measurement. The rear air springs clearance should be 11 ½ ± ¼" (292 ± 6 mm).

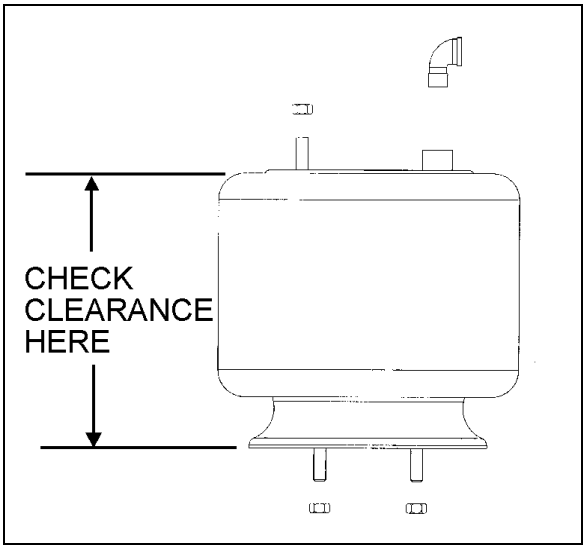


FIGURE 48: TYPICAL AIR SPRING CLEARANCE 16058

At this point, it should not be necessary to make an adjustment under normal service conditions. However, if an adjustment is required, change the position of the overtravel lever in relation to the overtravel control body. The lever should be moved up to raise vehicle height, and down to lower it. Check that main air pressure is at normal operating pressure and raise the vehicle to the specified height.

CAUTION

Always adjust on "fill cycle". If it is necessary to lower vehicle height, release sufficient air to be well below height, and adjust to height or fill cycle.

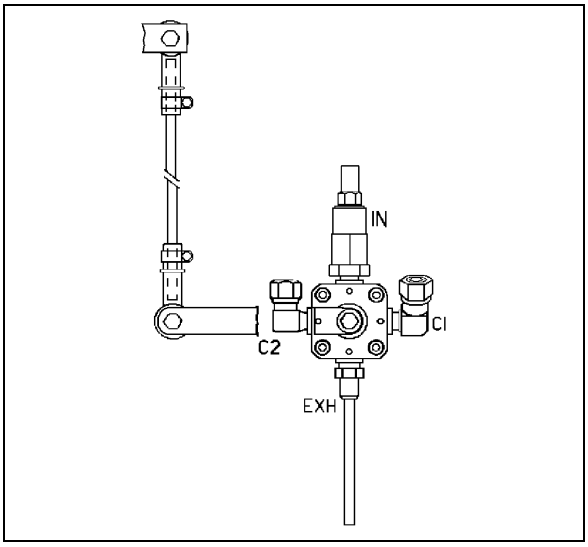


FIGURE 49: FRONT HEIGHT CONTROL VALVE 16100

The normal ride height is obtained by adjusting air spring clearance of both front and rear suspension as follows:

Front air spring clearance

1. With the vehicle at normal operating air pressure [100 - 125 psi (689 - 860 kPa)], measure air spring clearance. This clearance should be 11 ± ¼" (279 ± 6 mm).

NOTE

The measurement should be taken from underneath the upper air spring support on subframe to top of the lower air spring support on axle (refer to figure 46 for more details). If adjustment is required, begin with the drive axle.

2. Loosen the clamp on the height control valve rubber coupling and bring it up or down (Fig. 51).

NOTE

Allow suspension to stabilize before taking reading.

When the desired height is obtained, tighten clamp.

Rear air spring clearance

1. With the vehicle at normal operating air pressure [100 - 125 psi (689 - 860 kPa)], measure air spring clearance. This clearance should be 11 ½ ± ¼" (292 ± 6 mm).

NOTE

The measurement should be taken from underneath the upper air spring support on subframe to top of the lower air spring support on axle (refer to figure 46 for more details).

2. Loosen the clamp on the height control valve rubber coupling and bring it up or down (Fig. 52).

NOTE

Allow suspension to stabilize before taking reading.

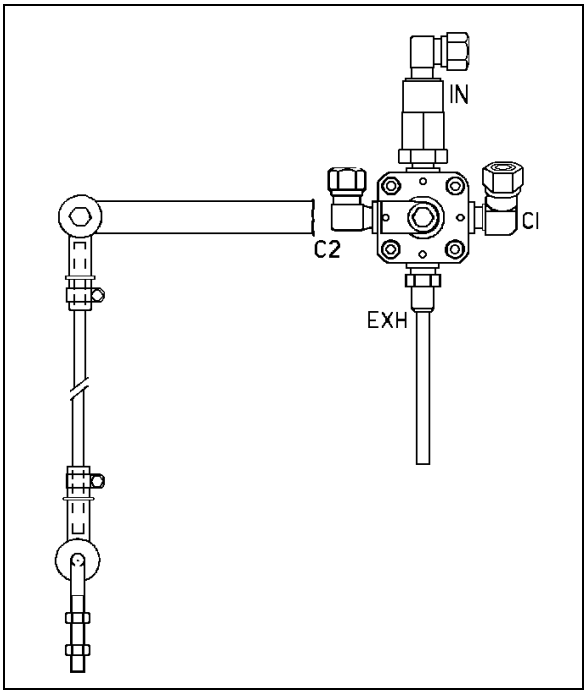


FIGURE 50: REAR HEIGHT CONTROL VALVE 16093

When the desired height is obtained, tighten clamp.

6. HEIGHT CONTROL VALVE

The height control valves automatically add air to, or release air from air springs to maintain constant suspension height regardless of load, or load distribution. Each valve adjusts independently according to the following conditions:

Loading Position

As the load increases and lowers the vehicle body, the overtravel lever commands the height control valve to add air to air springs.

Neutral Position

When vehicle body reaches the normal ride height, the height control valve overtravel lever reaches the "neutral" position and keeps both the supply and exhaust ports closed to ensure normal ride height is maintained. This condition remains static until the vehicle load is altered.

Unloading Position

As the load decreases and raises the vehicle body, the overtravel lever commands the height control valve to release air from air springs.

6.1 MAINTENANCE

The height control valve requires no periodic maintenance. Height control valve linkage operates on rubber bushings and no lubrication should be attempted at this location. Inspect the valve for loose joints, air leaks and worn bushings.

6.2 REMOVAL AND INSTALLATION

Before disconnecting a height control valve air line, securely support the vehicle by its jacking points on the body, and place safety supports underneath body. Refer to paragraph *"16. Vehicle Jacking Points"* in Section 18, *"Body"*.

1. Exhaust air from air system by opening all air tank drain cocks. Remove height control valves.
2. Disconnect overtravel lever from link and pull down lever to exhaust remaining air from air springs.
3. Disconnect air supply and delivery lines from the height control valve. Cover line ends with tape to prevent entry of foreign matter.
4. Remove the nuts retaining the height control valve to the mounting bracket, then remove valve assembly.

Reverse removal procedure to replace height control valve. After installation, check for leakage using a soap and water solution.

7. AIR SYSTEM

The basic air system consists of an air compressor, tanks, valves, filters and interconnecting lines and hoses (refer to Section 12, "Brake and Air System" for complete information). It provides a means for braking, operating controls and accessories, and suspension. An air system schematic diagram is annexed at the end of this section for better understanding of the system.

The air coming from the air dryer is first directed to the wet air tank, then to the primary (for the primary brake system), secondary (for the secondary brake system), and accessory (for the pneumatic accessories) air tanks (Fig. 53 and 54).

In addition, an expansion air tank may be installed in series with each air spring.

7.1 AIR TANK MAINTENANCE

Ensure that the accessories air tank is purged during pre-starting inspection. A good practice is to purge this tank at the end of every driving day by the remote air tank drain valve located in the front service compartment (Fig. 56).

Moreover, purge all tanks by their bottom drain valves at specified intervals.

7.1.1 Wet Air Tank

This tank is installed above the drive axle on the L.H. side, and is provided with a bottom drain valve. It is recommended to **purge** the wet air tank by its bottom drain valve every 12,500 miles (20 000 km), or once a year, whichever comes first.

A remote valve located in engine compartment and accessible through engine R.H. side door is used to **drain** the air dryer (Fig. 55).

7.1.2 Primary Air Tank

The primary air tank is located above the drive axle on the R.H. side.

This tank is provided with a bottom drain valve (Fig. 53 and 54). It is recommended to purge the primary air tank by its bottom drain valve every 12,500 miles (20 000 km) or once a year, whichever comes first.

7.1.3 Secondary Air Tank

This tank is located in front wheelhousing, between air springs. The tank may be installed vertically depending on type of front suspension and is provided with a bottom drain valve (Fig. 53 and 54).

It is recommended to purge the tank by its bottom drain valve, every 12,500 miles (20 000 km) or once a year, whichever comes first.

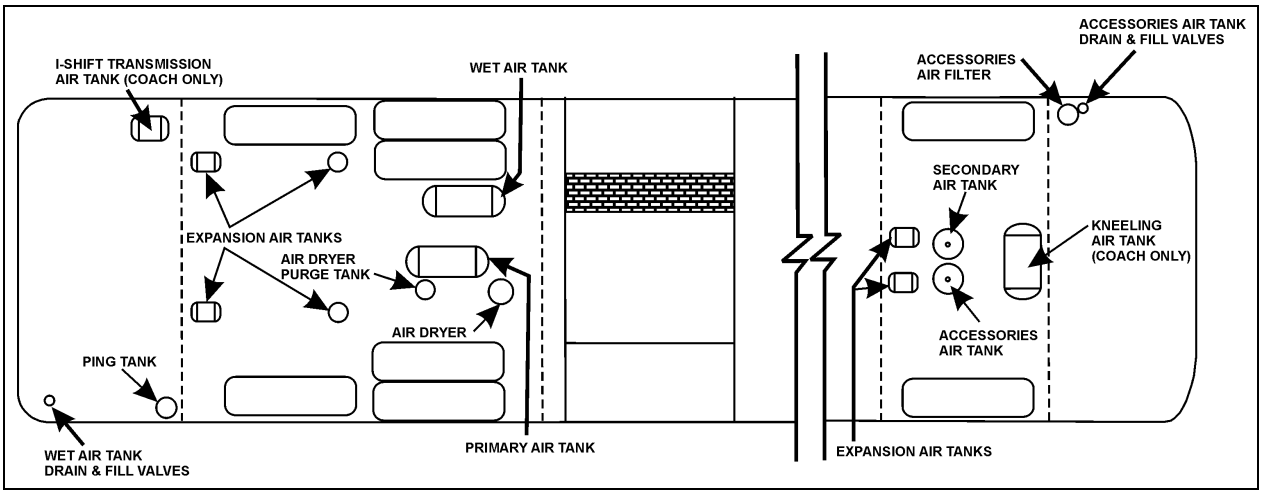


FIGURE 51: IFS AIR TANKS LOCATION 24034

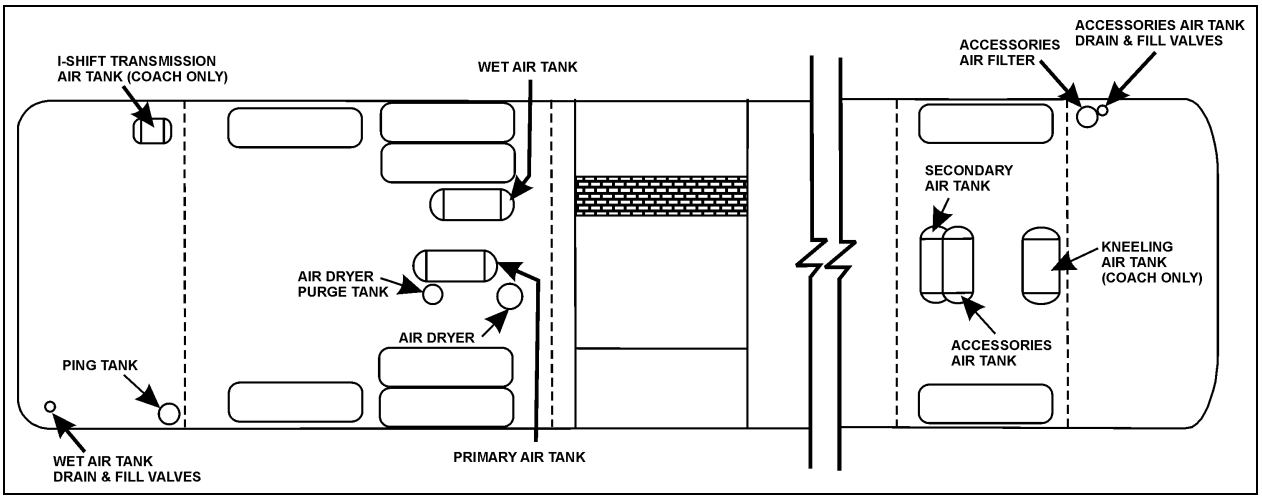


FIGURE 52: I-BEAM FRONT SUSPENSION AIR TANKS LOCATION24035

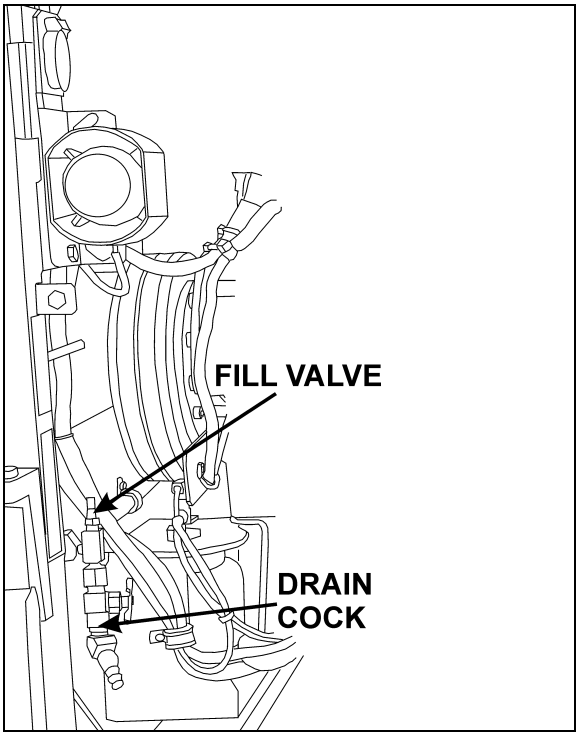


FIGURE 53: REAR VALVE LOCATION 12211

7.1.4 Accessory Air Tank

The accessory air tank is installed next to the secondary air tank. The tank may be installed vertically depending on type of front suspension and is provided with a bottom drain valve (Fig. 53 and 54).

It is recommended to purge the tank by its bottom drain valve, every 12,500 miles (20 000 km) or once a year, whichever comes first.

A remote drain valve is located in front service compartment (Fig. 56) underneath the accessory air filter. Refer to Section 12, paragraph "4. Accessory Air Filter" of the maintenance manual for daily purge procedure.

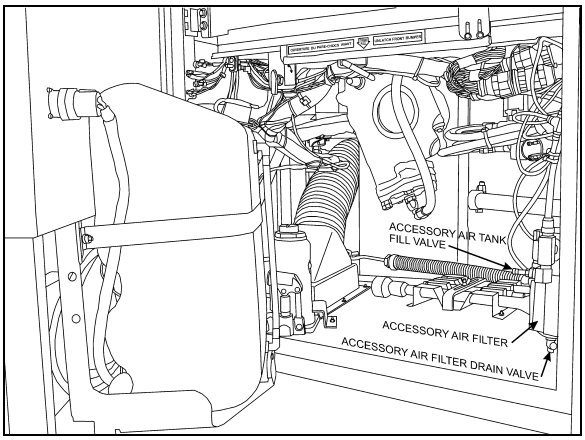


FIGURE 54: FRONT VALVE LOCATION
12210

7.1.5 Expansion Air Tank

Two expansion tanks will be installed in front wheelhousing if the IFS was chosen as an option. These air tanks are located behind secondary and accessory air tank. Also, six expansion tanks are located near rear air springs (Fig. 53 and 54). Expansion tanks are connected in series with air springs. Expansion tanks are used to lower the stiffness of the air spring. They are provided with a bottom drain valve.

It is recommended to purge them, with all other tanks, every 12,500 miles (20 000 km) or once a year, whichever comes first.

7.2 EMERGENCY FILL VALVES

The vehicle is equipped with two air system emergency fill valves to supplement the air system when air pressure is low and engine cannot be operated.

The rear valve is located in engine compartment and accessible from engine R.H. side door (Fig. 55).

⚠ CAUTION

No other point should be used to supply air system. The maximum allowable air pressure is 125 psi (860 kPa).

The front valve is located in the front service compartment close to accessory air filter (Fig. 56).

These two air valves are fitted with the same valve stems as standard tires, and can be filled by any standard external air supply line.

The rear valve will supply air for all systems (brakes, suspension and accessories) while the front valve will supply air for accessories only.

CAUTION

Air filled through these two points will pass through the standard air filtering system provided by Prevost. Do not fill air through any other points.

8. HUB UNIT AND STEERING KNUCKLE ASSEMBLY

Refer to "DANA SPICER Service Manual General Information, Maintenance Manual Model NDS and Maintenance Manual NDS Axles" annexed to Section 10 of the maintenance manual.

9. "LEVEL LOW" LEVELING SYSTEM

X3-45 VIP & XLII Bus shells are equipped with a "LEVEL-LOW" leveling system. The purpose of the "LEVEL-LOW" is to adjust the suspension in three separate points (front, rear right and rear left air springs) in order to level the vehicle body. Three height control valves, automatically control air pressure in the three separate points (air springs) and maintain a constant vehicle height regardless of load, or load distribution. The control solenoid valve supplies air to the five way three-position air control valve, which bypasses the height control valve, and opens a passage to allow the air control and exhaust valve to release/supply air from airs springs. To improve road comfort, an expansion air tank is installed in series with each air spring.

In addition to the above suspension components the system also includes: sway bar, upper and lower A-arms, rods and shock absorbers.

NOTE

Only for preliminary adjustment, refer to figure 41. Torque rod length must be fixed to 21 17/64" (540 mm) and relay rod to 23 19/64" (592 mm).

CAUTION

Parts must be replaced by ones with the same part numbers or with equivalent parts, if replacement becomes necessary. Do not use parts of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.

The purpose of the *"level-low"* leveling system is to adjust the suspension in three separate points (front, rear right and rear left) in order to level the vehicle body. This system can be put into service when the ignition key is turned to the *"ON"* position, and must be used only when the parking brake is applied. The *"level-low"* warning light on the dashboard indicates that the selector switch is not in the *"OFF"* position. Level low system controls are located on L.H. side control panel.

9.1 PRINCIPLES OF OPERATION

DOWN:

The (front/rear right/rear left) control solenoid valve supplies air to the (front/rear right/rear left) five-way three-position air control valve, which bypasses the (front/rear right/rear left) height control valve, and opens a passage to allow the air control and exhaust valve to release air from (front/rear right/rear left) air springs.

UP:

The (front/rear right/rear left) control solenoid valve supplies air to the (front/rear right/rear left) five-way three-position air control valve, which bypasses the (front/rear right/rear left) height control valve, and opens a passage to allow the air control and exhaust valve to supply air to (front/rear right/rear left) air springs.

DRIVE:

When the ignition key is turned to the *"ON"* position with selector knob in the *"DRIVE"* position, the drive control solenoid valve supplies air to all five-way three-position air control valves, each one opening a passage to allow height control valves to accomplish their function.

When the ignition key is turned to the *"OFF"* position and selector knob to the *"DRIVE"* position, the air is entrapped between air springs and five-way three-position air control valves to ensure the adjusted level will be kept.

WARNING

Never move vehicle with selector knob in any other position than the "DRIVE" position.

9.2 MAINTENANCE

Since the kneeling action is issued from both the air system and electrical system, refer to Section: 12, *"Brake and Air System"* and Section 06, *"Electrical System*".

For diagnosis and understanding of the system, refer to wiring diagrams, and to the appropriate air system schematic diagram annexed to Section 12, *"Brake and Air System"*.

10. FRONT KNEELING SYSTEM (X3-45 COACHES 0NLY)

The kneeling system is used to lower the front of vehicle. This allows passengers to board the vehicle with greater ease. The kneeling action is achieved by exhausting air from the front air springs (bellows). This system bypasses the height control valve to provide a fast up and down movement of the front suspension. Only seven seconds are required to lower vehicle from normal level to the lowered position, and approximately the same time to raise the vehicle back to normal level. The quick response is achieved by an auxiliary air tank installed beside the secondary air reservoir (for exact position, refer to Section 12, *"Brake and Air System").* This tank provides sufficient air supply to the kneeling system for some successive operations.

The system is provided with two safety features; first, a speed switch will enable the kneeling system to work only at less than 5 mph (8 km/h). Secondly, the parking brake is automatically applied, and a limit switch will keep it applied as long as the vehicle has not returned to a certain height where the driver will be able to manually remove the parking brake.

The purpose of the hi-buoy function in this system is to raise the front end of the vehicle to allow an extra ground clearance for particular situations. In driving condition, the height control valve is in operation and only the hi-buoy can be operated.

10.1 PRINCIPLE OF OPERATION

Refer to the air system schematic diagram annexed at the end of Section 12, *"Brake and Air System".*

DOWN (FRONT KNEELING):

Both the bellows control and bellows exhaust solenoid valves are energized, so the air control valves release air from front air springs. The height control valve is bypassed to ensure no air is forwarded to air springs while lowering the front suspension.

UP (FRONT HIGH-BUOY):

Only the bellows control solenoid valve is energized, so the air coming from the kneeling air tank is routed through air control valves, and up to front air springs.

The height control valve is bypassed until the kneeling proximity switch signals the kneeling module to cut off the bellows control solenoid valve, about 1" (25 mm) below normal ride height. The final height adjustment is achieved by the height control valve.

10.2 MAINTENANCE

Since the kneeling action is issued from both the air system and electrical system, refer to Section: 12, *"Brake and Air System"* and Section 06, *"Electrical System".*

For diagnosis and understanding of the system, refer to wiring diagrams, and to the appropriate air system schematic diagram annexed to Section 12, *"Brake and Air System".*

10.3 BELLOWS CONTROL SOLENOID VALVES

10.3.1 Removal and installation

1. On the rear side of steering compartment, locate both the bellows control and bellows exhaust solenoid valves.
2. Identify hoses and wires to ease reinstallation. Disconnect solenoid wires and the three flexible black hoses from solenoid valves.
3. Unscrew and remove the control solenoid valve and exhaust solenoid valve assembly. Place on a clean working place.

Reverse removal procedure to reinstall.

> **CAUTION**
>
> Any cable tie that has been cut during removal procedure should be replaced with a new one.

11. HIGH-BUOY SYSTEM (X3-45 COACHES ONLY)

The purpose of the rear high-buoy system is to raise the entire vehicle body about 4" (100 mm) in order to increase ground clearance to board a ferryboat, to jump a curb, etc. This system can be put into service during normal vehicle operation.

11.1 PRINCIPLES OF OPERATION

The rear high-buoy system is added over the front kneeling (with front high-buoy). The front end uses the same valves as the front kneeling (with front high-buoy). A solenoid valve is added to send air to the double shuttle valves for the rear end. It uses the same dash switch as the kneeling (with front high-buoy).

UP:

The air coming from the control valve flows through double shuttle valves, to supply air springs. The double shuttle valves prevent height control valves from releasing air from air springs.

DOWN:

The control valve, on the dashboard, cuts off air supply, so the double shuttle valves allow height control valves to accomplish their function. Height control valves release air from air springs until suspension returns to its normal position.

11.2 MAINTENANCE

Refer to the air system schematic diagram "Opt. Front Kneeling With Rear High-Buoy Combination" annexed at the end of this Section.

11.3 HIGH-BUOY – PRESSURE REGULATING VALVE

The regulating valve is located in the front service compartment. This valve should be adjusted to 90 psi (621 kPa).

11.3.1 Adjustment

1. Before turning on system air pressure, release jam nut (2, Fig. 57) then turn regulator adjustment counterclockwise until all load is removed from the regulating spring.
2. Turn on system pressure.
3. Turn regulator adjustment clockwise until the desired outlet pressure is reached.
4. To avoid minor readjustment after making a change in pressure setting, always approach the desired pressure from a lower pressure. When reducing from a higher to a lower setting, first reduce the pressure at a lower pressure, and then increase it to the desired level of pressure.
5. Tighten jam nut (2, Fig. 57) to lock pressure setting.

11.3.2 Disassembly

1. Shut off inlet pressure and reduce pressure in inlet and outlet lines to zero. Turn regulator adjustment (1, Fig. 57) counterclockwise until all load is removed from regulating spring. Regulator can be disassembled without removal from air line.
2. Disassemble regulator in accordance with the item numbers on the exploded view.

11.3.3 Cleaning

1. Clean parts with warm water and soap. Dry parts and blow out internal passages in body using clean, dry compressed air.
2. Inspect parts. Replace those found to be damaged.

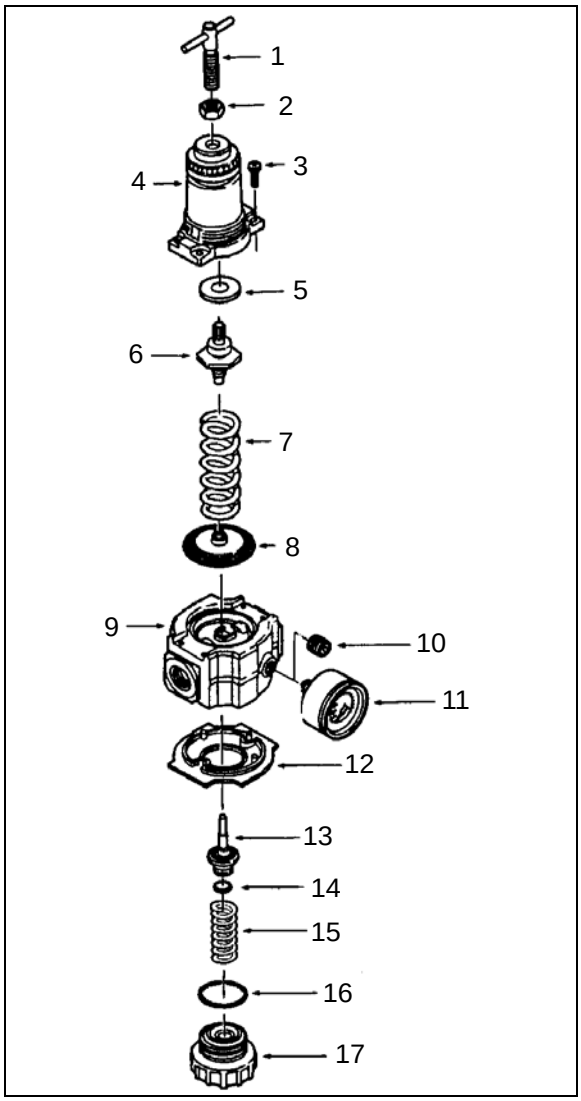


FIGURE 55: REGULATING VALVE 16035

11.3.4 Reassembly

1. Lubricate O-ring (14 and 16, Fig. 57), valve stem (13, Fig. 57), tip of adjusting screw (1, Fig. 57), and the outer circumference and both sides of the thrust washer (9, Fig. 57) with a light coat of good quality O-ring grease.
2. Assemble the regulator as shown on the exploded view.

Torque Table	
Item	Torque in lbf-inch (Nm)
3 (Screw)	25-35 (2.8-3.9)
17 (Bottom plug)	20-25 (2.3-2.8)

12. LOW-BUOY SYSTEM (X3-45 COACHES ONLY)

The purpose of the low-buoy system is to lower the whole suspension by about 4” (100 mm) in order to reduce the overall height for low clearances. This system can be put into service during normal vehicle operation.

12.1 PRINCIPLES OF OPERATION

On X3 coaches, the rear low-buoy is added over the front kneeling system. The control valve on the left console panel sends an electric signal from its pressure switch to control the front suspension as if kneeling. It also removes air from a relay valve that exhausts air supply to all leveling valves and the quick release in the rear section. Air from the rear suspension can then be depleted through the check valve-quick release assembly.

Down:

The control valve, on the L.H. control panel, cuts off air supply, so air is released from air springs. A relay valve prevents height control valves from supplying air springs.

Up:

The control valve, on the L.H. control panel, supplies air to close the passage between both the delivery and supply ports. A relay valve opens and provides air springs until the suspension reaches the normal ride height.

12.2 MAINTENANCE

Refer to the air system schematic diagram “Opt. Front Kneeling With Rear Low-Buoy Combination” annexed at the end of this Section.

13. TROUBLESHOOTING

Condition	Cause	Correction
Bellows deflate over time	1. Defective check valve assembly. 2. Defective exhaust valve assembly. 3. Leak in air line and/or bellows. 4. Defective valve cover, rubber O-rings or gasket.	1. Replace check valve assembly. 2. Replace exhaust valve assembly. 3. Replace air line or bellows. 4. Replace valve cover, O-rings or gasket.
Bellows raise to full height and fail to exhaust air pressure	1. A clogged exhaust screen in height control valve assembly. 2. A combination clogged exhaust screen and defective air inlet valve assembly.	1. Remove and clean screen. 2. Clean exhaust screen and replace air inlet valve assembly.
Erratic valve action	1. Dirt or foreign matter in the air valve lever chamber. 2. Defectives valves.	1. Remove valve cover and blow out dirt. Install cover using new gasket. 2. Overhaul height control valve assembly
Vehicle body fails to level to satisfactory ride height	1. Improper height control valve overtravel lever adjustment	1. Adjust lever as directed.

14. TORQUE TABLE

DESCRIPTION	QTY	TORQUE (DRY)	
		Lbf-ft	Nm
Drag Link to Pitman Arm Stud Nut *	1	150-200	203-271
Drag Link to Bell crank Stud Nut *	1	150-200	203-271
Drag Link Socket End Clamp Bolt Nut	2	40-60	55-80
Radius Rod Stud	2	20-40	27-54
Radius Rod Retaining Nut or Bolt	2	110-130	150-175
Radius Rod Support Nut	4	110-130	150-175
Relay Rod to Bell crank Stud Nut *	1	150-200	203-271
Relay Rod to Idler Arm Stud Nut *	1	150-200	203-271
Tie Rod to Bell crank Stud Nut *	1	150-200	203-271
Tie Rod to Idler Arm Stud Nut*	1	150-200	203-271
Tie Rod to Steering Arm Stud Nut *	2	150-200	203-271
Tie Rod End Clamp Bolt Nut	4	40-60	55-80
Steering Arm to Steering Knuckle Bolt (M20 X 65)	2	520-575	705-780
Steering Arm to Steering Knuckle bolt (M20 X 100)	2	520-575	705-780
Torque Rod Stud Nut	2	160-215	217-292
Torque Rod Mounting Bracket Stud	4	90-110	122-150
Torque Rod Mounting Bracket Nut	4	140-155	190-210
Idler Arm and Bell Crank Mounting Spindle Nut	8	90-105	122-142
Jacking Point Bracket Nut	8	70-80	95-110
Sway Bar Bushing Collar Nuts	8	80-100	108-136
Sway Bar Link Upper and Lower Nuts (Front Suspension)	2	165-200	225-270
Sway Bar Link Upper Nuts (Rear Suspension)	2	99-121	134-164
Sway Bar Link Lower Nuts (Rear Suspension)	2	80-100	108-136
Shock Absorber Pin	2	500-550	680-750
Shock Absorber Support	4	145-165	196-224
Shock Absorber Upper Mounting Pin Stud Nut	2	70-85	95-115
Shock Absorber Lower Mounting Pin Nut	2	60-75	81-102
Air Spring Lower Nut	4	20-25	27-34
Air Spring Upper Nut	2	20-25	27-34
Upper A-Arm Central Ball Joint (Hex Castle Nut)*	2	310-340	420-461
Upper A-Arm Ball Joint	8	230-255	312-346
Lower A-Arm Central Ball Joint (Hex Castle Nut)*	2	490-540	664-732
Lower A-Arm Ball Joint	8	270-300	366-407

*** Tighten nut to specified torque, then advance to next aligning cotter pin slot and install a new cotter pin.**

15. PARTS SPECIFICATIONS

Independent Front Suspension Air Springs

Make..... Goodyear Tire and Rubber
Model..... 1400
Type ..... Mae West
Diameter..... 14.5 inches
Air Inlet .....1/2''- 14 NPTF
Prevost number630239

I-Beam Front Axle and tag axle air springs

Make..... Goodyear Tire and Rubber
Model..... 1200
Type ..... Mae West
Nominal diameter ..... 12" (304 mm)
Prevost number..... 630125

Drive axle air springs

Make..... Goodyear Tire and Rubber
Model..... 1100
Type ..... Double Flare
Nominal diameter ..... 11.5" (292 mm)
Prevost number..... 630104

Independent Front suspension shock absorbers

Make..... Arvin
Color..... Black
Piston Diam. ..... 1 5/8 inch
Collapsed length..... 14.16 inches
Extended length ..... 22.44 inches
Prevost number..... 630136

I-Beam Front suspension shock absorbers

Make..... Sachs
Color..... Black
Type NUV45X230HA
Ext. Diam. ..... 75 mm
Collapsed length..... 14.88" (378 mm)
Extended length ..... 23.86" (606 mm)
Prevost number..... 630254

Drive and tag axle shock absorbers

Make..... Sachs
Color..... Black
Type N45X225HA
Ext. Diam. ..... 75 mm
Collapsed length..... 15.51" (394 mm)
Extended length ..... 24.37" (619 mm)
Prevost number..... 630253

Height control valve (Front only)

Make ..... Barksdale
Quantity used 1
Prevost number..... 630157

Height control valve (Rear only)

Make ..... Barksdale
Quantity..... 2
Prevost number..... 630156

Bellows control and exhaust solenoid valve assembly

Make ..... Norgren

Solenoid valve manifold

Prevost number..... 641130

Coil

Voltage ..... 24 V DC
Current draw ..... 29 amperes
Prevost number..... 641144

Valve (3 way, 2 positions)

Type ..... N/C
Prevost number..... 641357
Type ..... N/O
Prevost number..... 641356

Radius rod bushing

Make ..... Prevost
Prevost number..... 630021

Loctite

Make ..... Loctite
Prevost number..... 680039

Sway bar bushing (Front Suspension)

Make ..... Prevost
Prevost number..... 630020

Sway bar link

Make ..... Tennaco Automotive
Prevost number..... 630230

Shock absorber bushings

Make ..... Monroe
Prevost number..... 630062

Air regulator

Make.....Norgren
Recommended pressure sett... 90 psi (621 kPa)
Prevost number.....641352

SECTION 18: BODY

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1. VEHICLE EXTERIOR

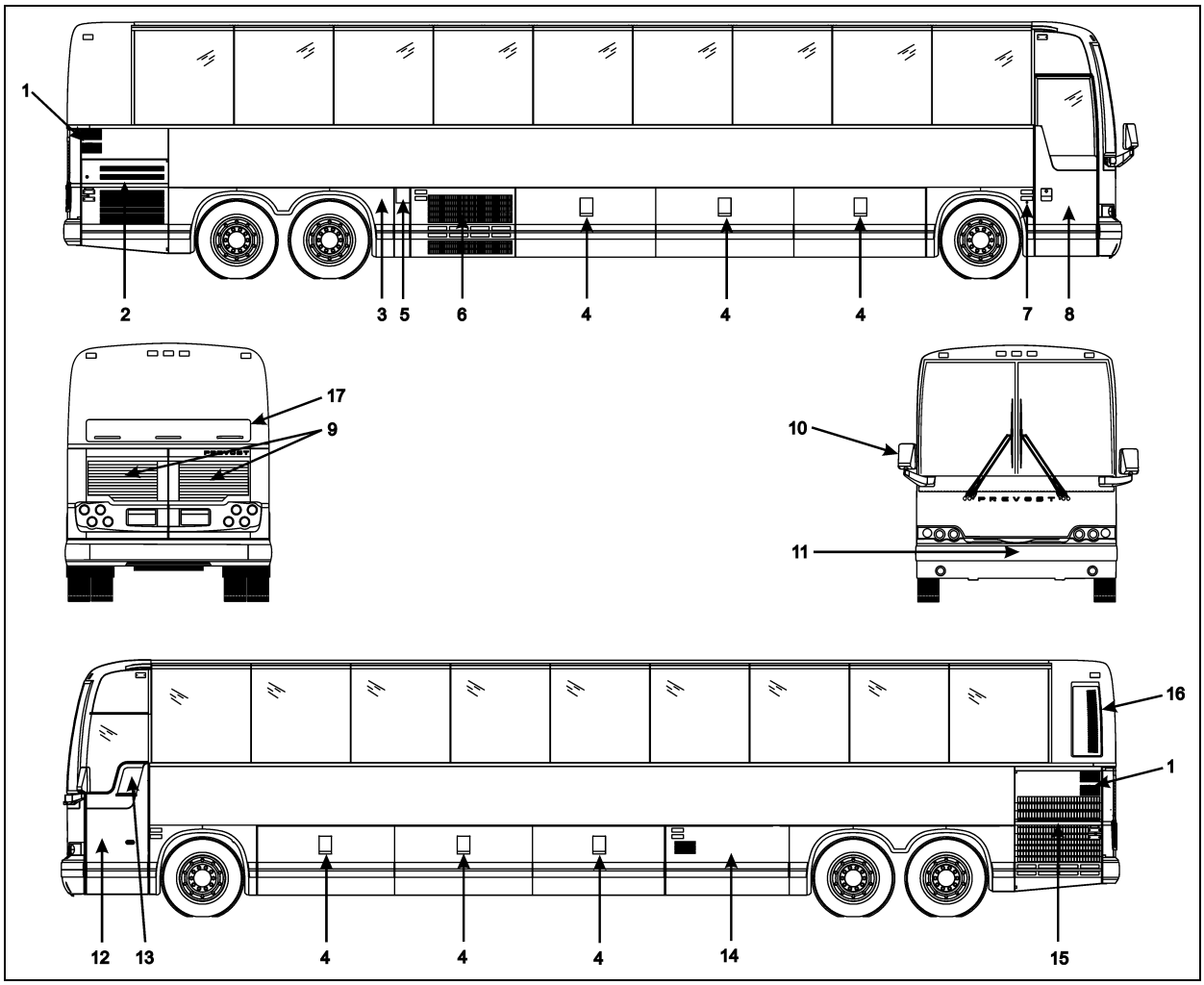


FIGURE 1: X3 COACHES EXTERIOR VIEW 18606

1. Engine air intake
2. Engine compartment curb-side door
3. Hinged rear fender
4. Baggage compartment
5. Fuel filler door
6. Condenser compartment
7. Entrance door control switch
8. Entrance door
9. Engine compartment rear doors
10. Rear-view mirrors
11. Spare wheel compartment
12. Front electrical and service compartment
13. Driver's power window
14. Evaporator compartment and engine coolant heater compartment
15. Radiator door
16. Catalytic converter access door
17. Exhaust aftertreatment system access door

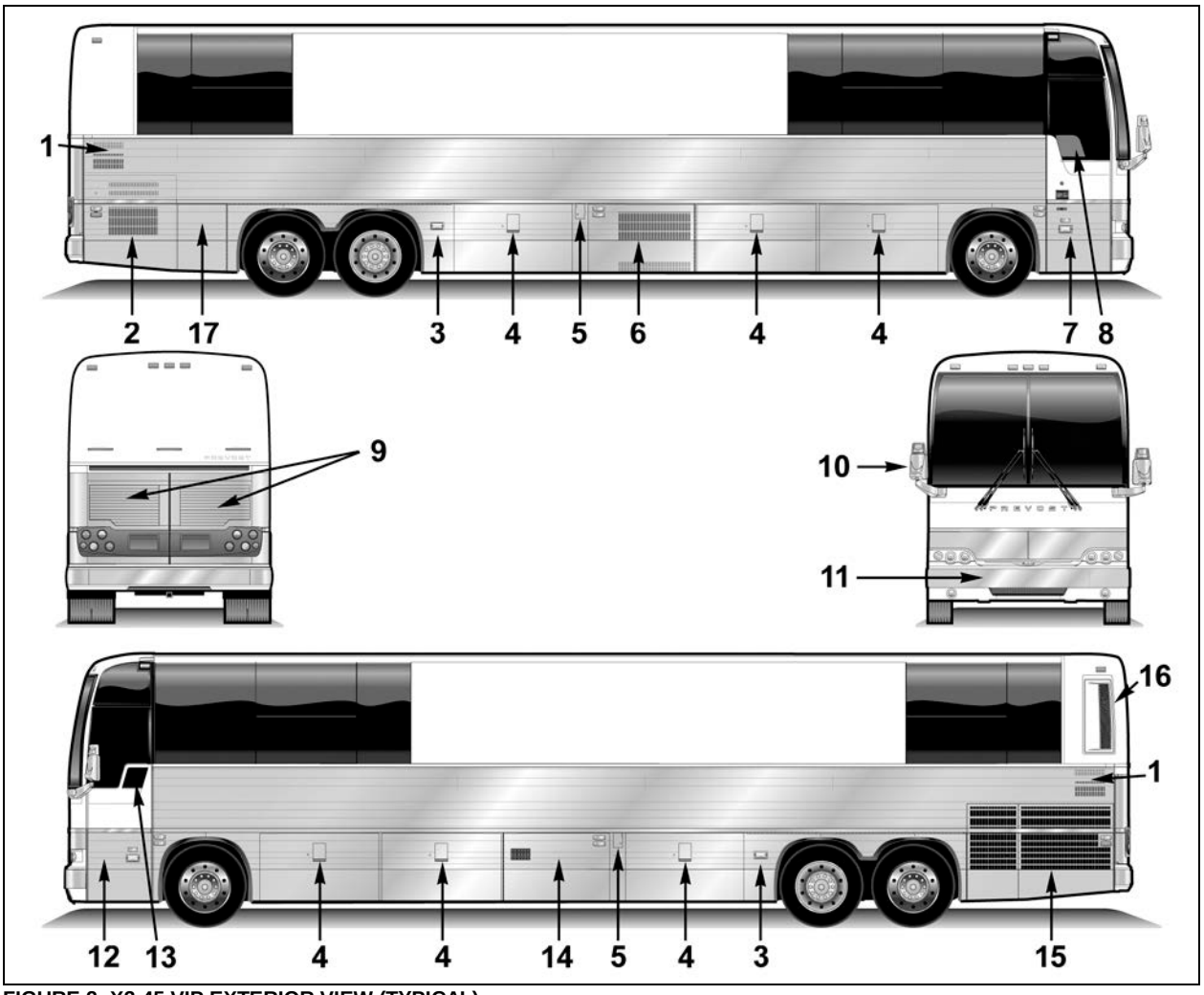


FIGURE 2: X3-45 VIP EXTERIOR VIEW (TYPICAL)

1. Engine air intake
2. Engine compartment R.H. side door
3. Hinged rear fender
4. Baggage compartment
5. Fuel filler door
6. Condenser compartment or Baggage compartment
7. Entrance door
8. Entrance door power window
9. Engine compartment rear doors
10. Rear-view mirror
11. Reclining bumper
12. Front electrical & service compartment
13. Driver's power window
14. Evaporator compartment or Baggage compartment
15. Radiator door
16. Diesel Particulate Filter (DPF) compartment access door
17. R.H. side rear service compartment

Front Slide-Out (Optional)

Rear Slide-Out (Optional)

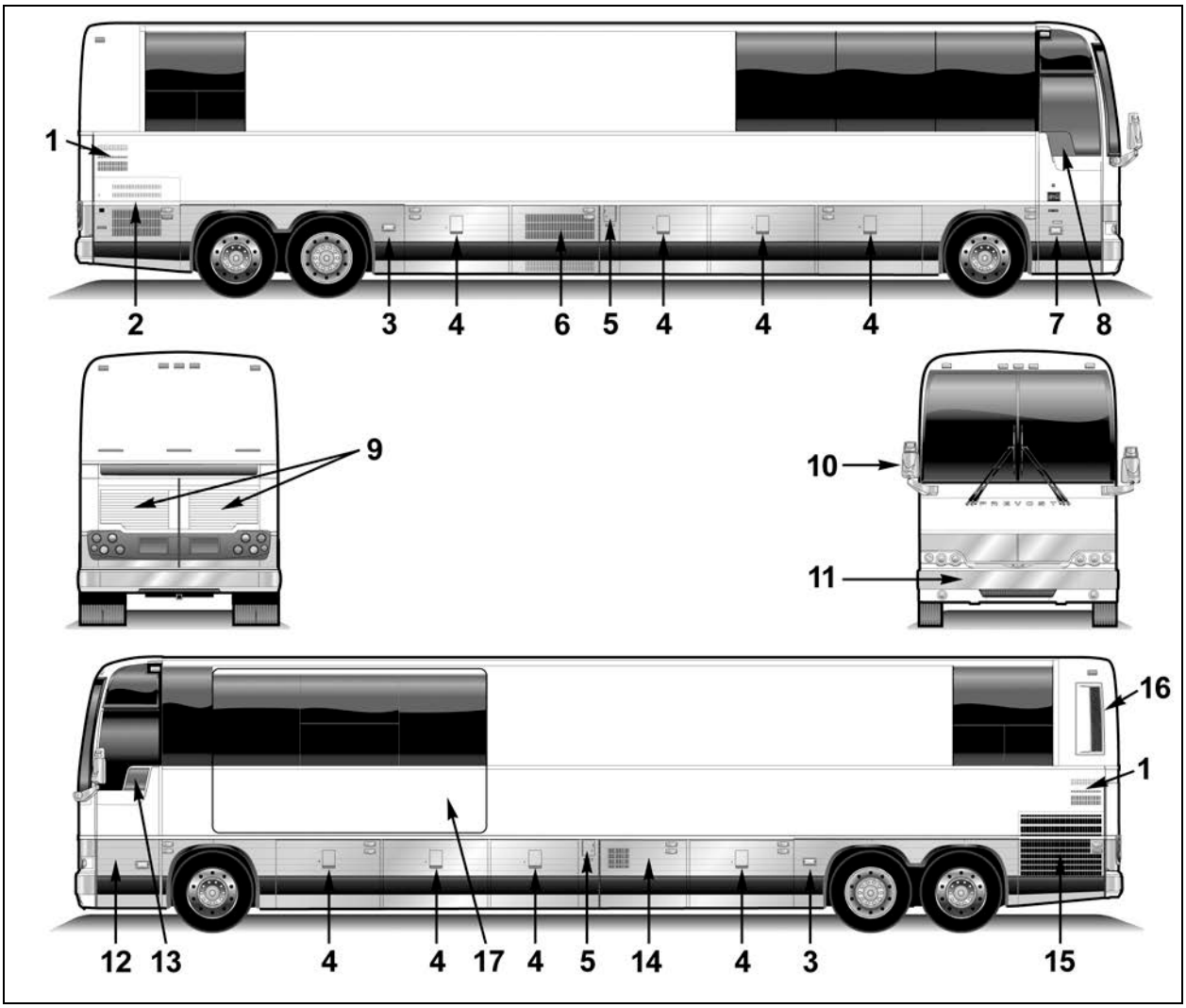


FIGURE 3: XLII-45E CONVERTED VEHICLE EXTERIOR VIEW (TYPICAL)
18369

1. Engine air intake
2. Engine compartment R.H. side door
3. Hinged rear fender
4. Baggage compartment
5. Fuel filler door
6. Condenser compartment or Baggage compartment
7. Entrance door
8. Entrance door power window
9. Engine compartment rear doors
10. Rear-view mirror
11. Reclining bumper
12. Front electrical & service compartment
13. Driver's power window
14. Evaporator compartment or Baggage compartment
15. Radiator door
16. Diesel Particulate Filter (DPF) compartment access door
17. Front Slide-Out (Optional)

2. VEHICLE STRUCTURE

The body of the X Series vehicles is an integral structure made of 14, 16 and 18 gauge welded and braced high tensile steel and stainless steel members. All stainless exterior panels are glued to anti-corrosion coated members. The complete structure is protected against corrosion prior to assembly. The front and rear caps are made of molded fiberglass. The main roof is made of high tensile aluminum panels riveted to the roof structure. The floor is made of 2 layers of ½" (13 mm) thick plywood separated by a 1/8" (3 mm) insulation to reduce power train and road noises.

Welding

Since welding is a procedure that may be carried out either as specific instructions from Prevost or by an independent decision of the owner, the following information pertaining to welding should be read before beginning any welding procedure. The prohibitions and requirements outlined below must be followed during welding procedure:

1. Welding must be done only by a qualified and experienced person.
2. Adequate ground contacts and shields must be positioned as required to protect components from damage due to heat, contact by weld splatter, arcing, or other potentially damaging events associated with welding.
3. The following precautions are to be taken to protect the electronic control components. Refer to section 00, paragraph 3: “PRECAUTIONS TO BE OBSERVED BEFORE WELDING” in this manual.
4. Always wear the appropriate safety equipment.
5. Weld in clean and well ventilated area, and always have an appropriate fire extinguisher within your reach.

3. VEHICLE EXTERIOR MAINTENANCE

Regular washing to remove dust and dirt is recommended. See *"Owner's Manual"* for more details on washing and cleaning your vehicle.

3.1 CORROSION PREVENTION

Preventive maintenance is a key factor in avoiding corrosion and must be considered as part of the regular service intervals. The entire underside of the vehicle is sprayed with a heavy application of asphalt base undercoating.

The operating environment the vehicle is subjected to will largely influence the amount of dirt and corrosion that will accumulate over a given period. Corrosion is one of the most costly factors of part failure and shortened part life. It is, however, an item that can be controlled when it is conscientiously looked after and the proper steps are taken in a timely manner.

Certain areas of the coach are more vulnerable to corrosion than others, and it is these areas that should be addressed. For example, the rear baggage compartment bulkhead in the rear wheelhousing area contains many key components and should be examined regularly for corrosion. Other areas include the front wheelhousing area and the engine compartment.

Road splash will affect undercarriage, condenser coil and engine compartment. These areas must be thoroughly cleaned to remove dirt accumulations from flanges, channels and ledges. These places accumulate dirt and salt and hold it in direct contact with steel and aluminum surfaces. Use an understructure high pressure spray as part of a regular wash. Damaged undercoating or paint should be promptly repaired before corrosion can start.

Frequency of wash periods depends on operating conditions. During periods of exposure to salt, daily washing as described above is recommended. If underbody parts show evidence of rust or corrosion, treat as follows:

1. Remove dirt, grease and oil by solvent washing.
2. Remove corrosion as well as all loose coating by cleaning with a wire brush or sandblasting.

⚠ CAUTION

Sandblasting can be used for cleaning bulkheads, brackets and other structural members. It should not be used for exterior side paneling. Extreme care should be taken not to sandblast excessively.

3. Apply correct primer, paint and undercoating after removing all corrosion to prevent further damage.

3.2 PREVENTIVE MAINTENANCE SCHEDULE

NOTE

TECTYL 185 GW rust inhibitor may have been applied on your vehicle underbody as an option, if this is the case, follow this procedure thoroughly. For future application of product, refer to paragraph 3.3 in this section.

DESCRIPTION	INTERVALS		MAINTENANCE	CORRECTIVE ACTION	REFERENCE
	MONTHS	KM MILES			
BODY, EXTERNAL WINDOW FRAME	6	40 000 25 000	VISUALLY INSPECT SEALING BEADS CONDITION	REPAIR OR REPLACE SEALING BEADS IF NECESSARY	
VEHICLE UNDERBODY	12	100 000 60 000	USE A LOW PRESSURE SPRAY TO CLEAN UNDER-STRUCTURE AND VISUALLY INSPECT FOR CALCIUM DEPOSIT, CORROSION OR ANY DIRT ACCUMULATED ONTO EXPOSED SURFACES. VISUALLY INSPECT SEALING BEADS CONDITION. VISUALLY INSPECT IF UNDERFLOOR IS PEALING. VISUALLY INSPECT WHEELHOUSING COATING. MAKE SURE DISCHARGE TUBES ARE FREE FROM OBSTRUCTIONS	APPLY UNDERCOATING LOCALLY AS NECESSARY. APPLY UNDERCOATING LOCALLY AS NECESSARY REMOVE ANY OBSTRUCTION OR REPLACE DEFECTIVE TUBE	
SUSPENSION AND UNDER-STRUCTURE	12	100 000 60 000	VERIFY THE CONDITION OF ALL SUSPENSION AND UNDERSTRUCTURE FASTENERS AND CLAMPS	TIGHTEN OR REPLACE DEFECTIVE OR MISSING FASTENERS	
FLOOR COVERING	3	20 000 12 500	VISUALLY INSPECT IF FLOOR COVERING IS SHOWING SIGNS OF DETERIORATION SUCH AS CUTS, BURNS, ETC. ALSO, VISUALLY INSPECT SEALANT ALONGSIDE TRACKS. INSPECT WALL PANELS FROM BOTTOM TO WINDOWS	REPAIR OR REPLACE DEFECTIVE COVERING. MAKE SURE PROPER SEALANT IS USED.	
FLOOR CLEANING			CLEAN FLOOR COVERING AS NECESSARY		

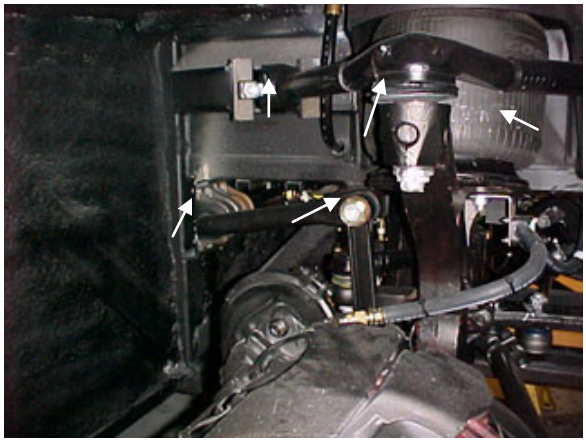
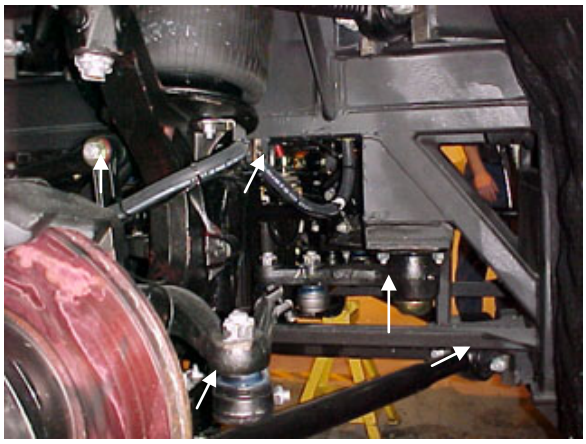
WARNING

Failure to follow this preventive maintenance schedule will result in warranty void.

3.3 RUST INHIBITOR APPLICATION

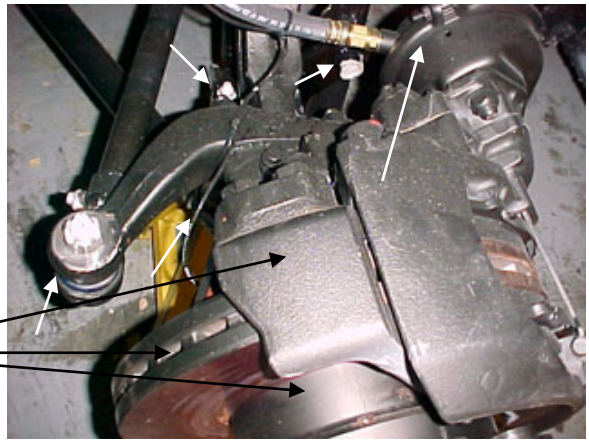
Material: Tectyl 185 GW R1KG21

Safety Rules: Use safety glasses
Supplied air hood
Solvent-resistant rubber gloves

1.0 Wash both wheelhousing mechanical parts before masking.	A water-hose nozzle is recommended. Water may be hot to reduce washing time especially during winter. If parts are soiled with oil, clean using R1KG21. Avoid rubber parts.
2.0 Dry all water sprayed parts. Surface temperature and dew point must be respected before applying rust inhibitor.	Air pressure system may be used, refer to annex 1 for surface temperature and dew point.
3.0 **Front wheelhousing** a) Mask all rubber joints. Braking system must also be protected (refer to arrows). Commercial aluminum foil may be used for masking.	
3.1 **Front wheelhousing** Front view	
3.2 **Front wheelhousing**	

3.3 **Front wheelhousing**

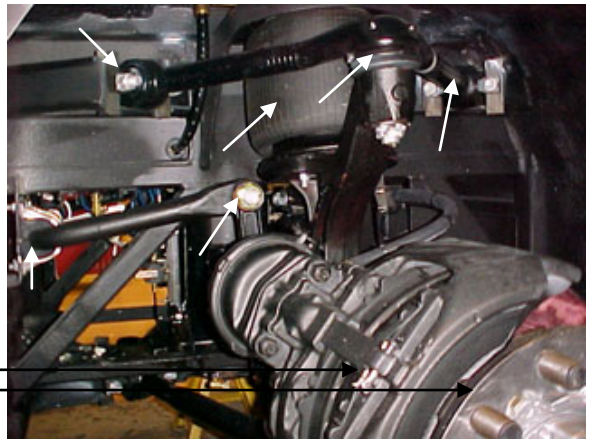
(Entire braking system)



4.0 **Rear wheelhousing**

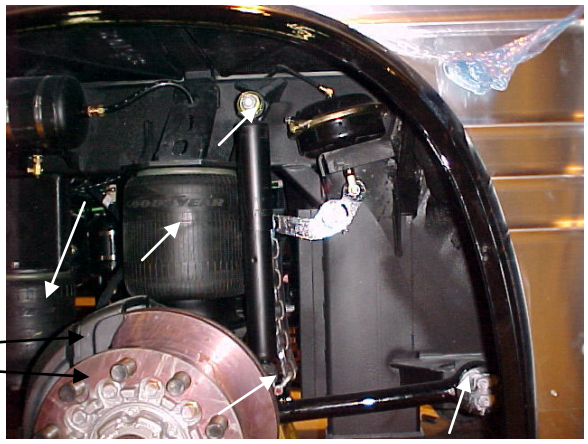
a) Mask all rubber joints. Braking system must also be protected (refer to arrows). Commercial aluminum foil may be used for masking

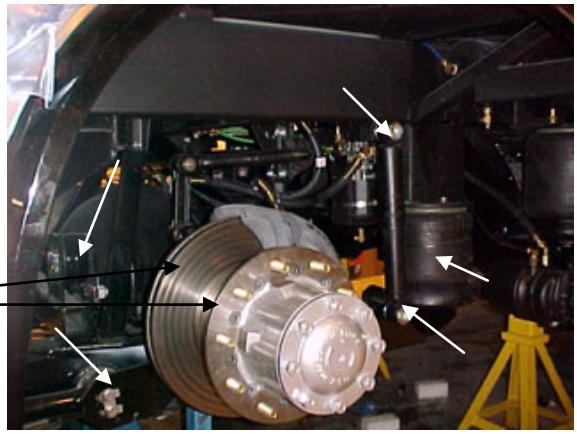
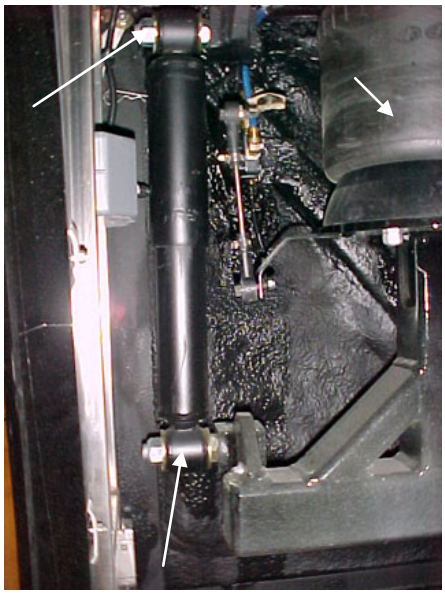
(Entire braking system)



4.1 **Rear wheelhousing**

(Entire braking system)



4.2 **Rear wheelhousing** (Entire braking system)	
4.3 **Rear wheelhousing**	
5.0 Close off wheelhousing using masking paper.	Prevent rust inhibitor from coming in contact with paint. To close off wheelhousing, a polythene sheet may be used.
6.0 Apply TECTYL 185 GW black rust inhibitor onto wheelhousing mechanical parts.	A spray gun and pumping system are required to apply the rust inhibitor. If the application is done inside a paint room, select high speed ventilation. **Minimum required thickness is 10 mils wet or 5 mils dry**.
7.0 Remove all masking material 30 minutes after application.	

ANNEX 1

1. Check and confirm that dew point and surface temperature are in accordance with to the following criteria:

   Surface temperature > 10°C

   Surface temperature > or = to dew point + 3°C

NOTE
Use the following table to determine dew point.

2. Check and confirm that TECTYL temperature is between 10°C and 35°C.

DEW POINT

	Relative Humidity (%)									
	10	20	30	40	50	60	70	80	90	100
Temp (c)										
0	---	-16	-11	-8	-5	-3	-1	0	1	3
1	---	-15	-10	-7	-5	-3	-1	1	2	4
2	---	-14	-10	-6	-4	-1	0	2	3	5
3	---	-13	-9	-5	-3	-1	1	2	4	6
4	---	-13	-8	-5	-2	0	2	4	5	7
5	---	-11	-7	-4	-1	1	3	5	6	8
6	---	-11	-8	-3	0	2	4	6	7	9
7	-18	-10	-6	-2	0	2	5	6	8	10
8	-17	-9	-5	-1	1	4	6	7	9	11
9	-16	-9	-4	-1	2	4	6	9	10	12
10	-16	-8	-3	0	3	5	7	10	11	13
11	-15	-7	-3	1	4	6	9	10	12	14
12	-14	-6	-1	2	5	7	10	11	13	15
13	-14	-6	-1	2	6	8	10	12	14	16
14	-13	-5	0	4	6	9	11	14	15	17
15	-12	-4	1	4	7	10	12	14	16	18
16	-11	-4	1	5	9	11	13	15	17	19
17	-10	-3	2	6	9	12	14	16	18	20
18	-10	-2	3	7	10	13	15	17	19	21
19	-9	-1	4	8	11	14	16	18	20	22
20	-9	0		5	9	12	15	17	19	21	23
21	-8	0		5	10	13	16	18	20	22	24
22	-7	1		6	11	14	16	19	21	23	25
23	-6	2		7	11	15	17	20	22	24	26
24	-6	2		8	12	16	19	21	23	25	27
25	-5	3		9	13	16	20	22	24	26	28
26	-4	4		10	14	17	20	23	25	27	29
27	-4	5		11	15	19	21	24	26	28	30
28	-3	6		11	16	19	22	25	27	29	31
29	-2	6		12	17	20	23	26	28	30	32
30	-1	7		13	17	21	24	27	29	31	33
31	-1	8		14	19	22	25	27	30	32	34
32	0	9		15	20	23	26	29	31	33	35

4. COMMON FIBERGLASS REPAIR PROCEDURE

All repairs to fiberglass parts consist of filling the damaged area with fiberglass cloth and resin or strand fiberglass and resin. The repair is allowed to harden, and then finishing operations may be performed. Use of the various materials is determined by the type of repair to be made. Large holes, torn sections and separate joints require the adhesive qualities of the resin and the reinforcing qualities of the fiberglass. Small dents, scratches or pits can be repaired using resin and strand fiberglass and filler mixed into paste. Instructions for either mix are explained under their respective headings in this section. For best results when making repairs, temperature should be between 70 and 75 ^{o}F (21-24 ^{o}C). Some people experience a skin reaction to resins. In such cases, wipe resin off with denatured alcohol or a good thinner. Use of protective hand cream is recommended.

WARNING

Always wear a respirator and goggles when grinding or sanding.

Extreme care must be taken if the sander is electrically operated, as dust from some resins is combustible when subjected to sparks or open flames. The proper tool for sanding resin is a low speed, air driven disc sander with a water attachment or a dry sander having a vacuum bag. Either will eliminate flying glass and resin dust.

The following additional tools and materials will assist in making repairs: hacksaw blade, assorted files, emery paper or cloth (150 or finer), scissors or tin snips, wax paper or cellophane sheets, a 3" (75 mm) paint roller, paint brush, putty knife, acetone and one or more heat lamps.

4.1 REPAIR USING FIBERGLASS CLOTH

Where necessary, sand paint away around damaged area and scrape away undercoating, if any, and wipe clean with solvent. Grind or file the damaged area to form a "V" at the broken or cracked portion. Sides of "V" should have a shallow pitch for maximum bonding area.

NOTE

Roughening the surface improves adhesion of resin.

If part is warped from original shape, use clamping equipment to straighten the surface. Preheat area to be repaired with one or two heat lamps placed 18 to 24 inches (450-610 mm) from repair.

CAUTION

Temperature should not exceed 140 ^{o}F (60 ^{o}C) during 30 minutes in order to avoid distortion.

Cut fiberglass cloth with scissors or tin snips, 1 to 3 inches (25-75 mm) larger than area to be repaired. Build area to desired height.

Mix resin and hardener following instructions on their containers. Saturate layers of fiberglass with mixture and place laminates over damaged area. Smooth out wrinkles and make sure general contour of area is maintained. Bubbles and wrinkles can be eliminated with a roller.

CAUTION

The pot life of the mix is approximately 15 minutes. Any accidental contamination to the skin, clothing, tools, etc. must be removed within this period. Use acetone to remove uncured resin.

Heat resin material again by placing heat lamps 18 to 24 inches (450-610 mm) from repaired area. Allow 12 to 15 minutes for repair to cure. After repair is cured, grind, file or sand to contour. Files other than body files may be more suitable. Featheredge and finish sanding.

If small pits or irregularities appear after making repair, correct by using a liberal amount of chopped strand or filler mixed with resin to form a paste. Refer to heading *"Repair using Fiberglass Paste"* in this section.

4.2 REPAIR USING FIBERGLASS PASTE

Fiberglass paste is used for repairing small dents, scratches, and pits. Paste is made by mixing resin, hardener and fiberglass strand or filler to the consistency of putty. Where it may be necessary, sand paint away around damaged area. On underside of coach, scrape away undercoating from damaged area, and wipe clean with solvent.

Preheat the area to be repaired using heat lamps. Mix desired quantities of resin and hardener according to manufacturer's instructions. Add powdered fiberglass strand into mixture to thicken it into a putty state.

NOTE
If repair is made on a vertical surface, adding powdered filler material to mixture will reduce tendency of hot resin to flow or run.

Apply the material with a putty knife or similar object, building material up to the desired contour. For deep filling and on vertical surfaces, several layers of material may be used.

A hacksaw blade, held flat to adjacent contour and then moved in a sawing action across the repair when the resin is in a gel state, will remove excess resin from repair. Finish repair with the same procedure as when using fiberglass cloth.

4.3 TYPICAL FIBERGLASS REPAIR PROCEDURE

Remove all loose particles or damaged material using a power sander or rasp. Clean area, overlapping hole approximately 1" to 1-½" (25-40 mm) all around. Remove all dirt, grease and paint from area to ensure good bonding surface. Feather the cleaned area all around (Fig. 4).

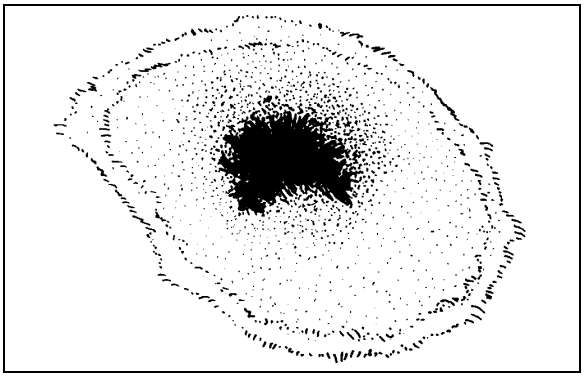


FIGURE 4: FIBERGLASS REPAIR 18089

Cut a piece of fiberglass mat slightly larger than area being repaired. Impregnate mat with general purpose polyester resin catalyzed normally. Use a clean paint brush to apply the polyester resin. Apply impregnated mat over hole and press onto surface with brush to obtain good adherence. Another coat of general purpose polyester resin can be applied at this time (Fig. 5).

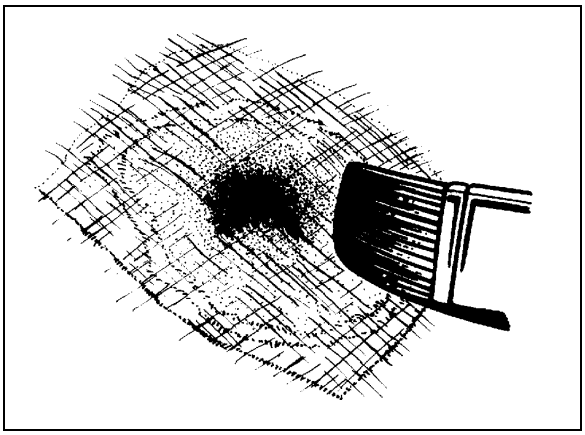


FIGURE 5: FIBERGLASS REPAIR 18090

NOTE
Remove all air between surfaces being joined. Allow area to harden and sand surface to remove any wax.

Apply another mat, followed by a cloth patch, and another mat. All layers must be thoroughly impregnated with polyester resin, brushed well and free of air. Apply more layers of mat and cloth as required until the desired strength and thickness is obtained, minimum two 1-½ oz (43 g) mats and one 9 oz (255 g) cloth (Fig. 6).

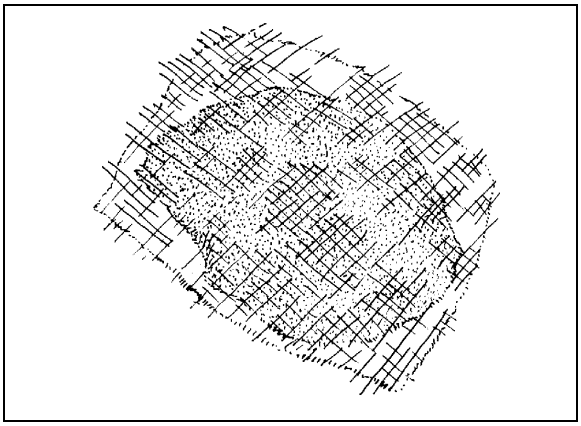


FIGURE 6: FIBERGLASS REPAIR 18091

Allow area to harden and contour the area with coarse sandpaper #100 (Fig. 7).

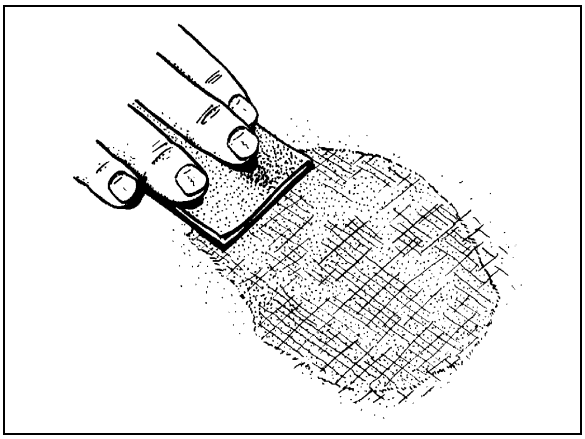


FIGURE 7: FIBERGLASS REPAIR 18092

Cover the area with a layer of resin putty and allow drying for approximately 15 to 20 minutes (Fig. 8).

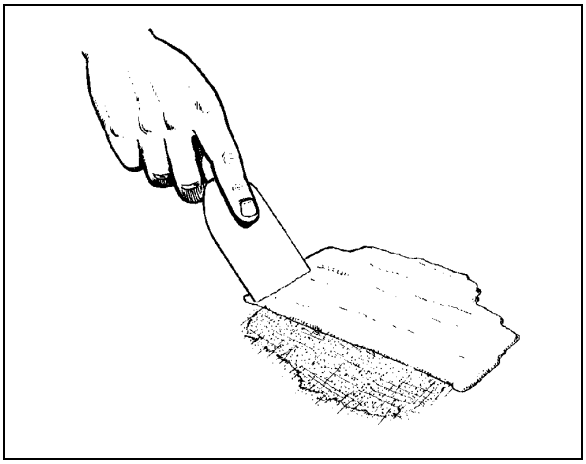


FIGURE 8: FIBERGLASS REPAIR 18093

Smooth off surface with coarse sandpaper #100 to desired shape. Further smooth surface with fine sandpaper #120 until repaired surface matches surrounding area paneling. Prime and paint the area to match surrounding paintwork.

5. COMMON PAINTING PROCEDURE

5.1 NEW PAINT CARE

Our paint supplier recommends that you follow these simple precautions the first months of your new vehicle's life.

⚠ CAUTION

Apply these recommendations after repainting vehicle.

During the first 30 days:

- Do not use a commercial bus wash. Stiff brushes or sponges could mar the finish and damage the surface. Wash the vehicle by hand only and with cool water and a very mild bus wash solution. Be careful to use only a soft cloth or sponge;
- Wash vehicle in the shade, never in direct sunlight;
- Do not "dry wipe" vehicle –always use clean water. Dry wiping could scratch the finish;
- Avoid extreme heat and cold. Park vehicle in the shade whenever possible;
- Do not park under trees which drop sap or near factories with heavy smoke fallout. Tree sap and industrial fallout may mar or spot a freshly painted surface;
- Trees are also likely to attract birds. Bird droppings are highly acidic and will damage a freshly painted surface. Bird droppings, tree sap and industrial fallout should be washed off as soon as possible;
- Do not spill oil, gasoline, antifreeze, transmission fluid or windshield solvent on new finish. IMMEDIATELY rinse off any such spill with clean water, DO NOT WIPE;
- Do not drive on gravel roads. Paint finish easily chips during the first 30 days;
- Do not scrape ice or snow from the surface. A snow scraper can act like a paint scraper if the finish is new. Brush off loose material with a soft snow brush.

During the first 90 days:

- Do not wax or polish the vehicle. This will allow the finish to dry and harden completely.

5.2 PAINT TOUCHUP

When paint touchup or partial repainting is necessary, refer to the vehicle's paint scheme for color codes and paint brand.

Prevost recommends using the original paint brand to ease color matching.

In the event you sand through to the gelcoat surface you should prime the area with Standox "Non Stop Fill Primer (ST-11000)".

If you sand through to metal surface, first prime with Standox “Etch Primer (ST-11858)” then with Standox “Non Stop Fill Primer (ST-11000)”.

> **CAUTION**
>
> Be sure to heed all paint manufacturer’s recommendations, especially concerning paint dilution and application.

5.3 PAINTING

The standard paint used on the exterior of the vehicle is Standox Basislack. It is a high gloss polyurethane enamel finish designed for exposure to extreme conditions. Other types of paint may be called for as options by owner but are not dealt with in this section.

5.3.1 Safety

Care should be exercised in storing, handling, mixing, and applying paint and chemicals listed in this manual. The topcoat, primer, solvent, catalysts, accelerators, and cleaners are highly volatile and/or toxic if not properly used. Observe all safety instructions marked on the different packaging, as well as the following:

1. Do not smoke in the paint room or in adjacent area exposed to residue fumes.
2. Wear respirators approved by the governing safety and health regulations.
3. Maintain adequate ventilation at all times.
4. Dispose of any leftover paint mix properly.
5. Wear rubber gloves, rubber apron, and face shield during all phases of paint and chemical handling

5.3.2 Surface Preparation And Paint Application

	Aluminum and / or Stainless Steel	Fiberglass	Comments
Surface Preparation	Sand using P-150 grit sandpaper. It is recommended to sandblast rivets and panel edges with OLIMAG 35-70 blast media.	Sand using P-180 or P-240 sandpaper.	Do not use paint remover over aluminum or fiberglass.
Cleaning	STANDOX silicone remover ST-11654 (68-2989)		
Priming	STANDOX Reactive Etch Primer ST-13908 * Wait 30 minutes then apply STANDOX Non-Stop Füllprimer ST-11000 (68-2973)	STANDOX Non-Stop Füllprimer ST-11000 (68-2973)	Refer to product Technical Data sheet for proper mixing
Basecoat	Refer to paint scheme or coach record for proper color code and paint brand. We recommend using the same paint brand to ease color matching.		Refer to product Technical Data sheet for proper mixing
Clearcoat	STANDOX 2K MS Rapid Clear ST-11760 (68-2979) Allow 16 hours for drying		Refer to product Technical Data sheet for proper mixing

If assistance or technical information on STANDOX products is needed, please dial: 1 (800) 551-9296

6. X3-45 COACHES EXTERIOR FINISHING AND BODY REPAIR

The following procedures explain the steps to be followed for proper repair, installation and replacement for various doors, panels and windows. The paragraph divides the vehicle into zones to facilitate the search; each zone is then sub-divided into components.

Refer to the appropriate zone then component for complete procedure.

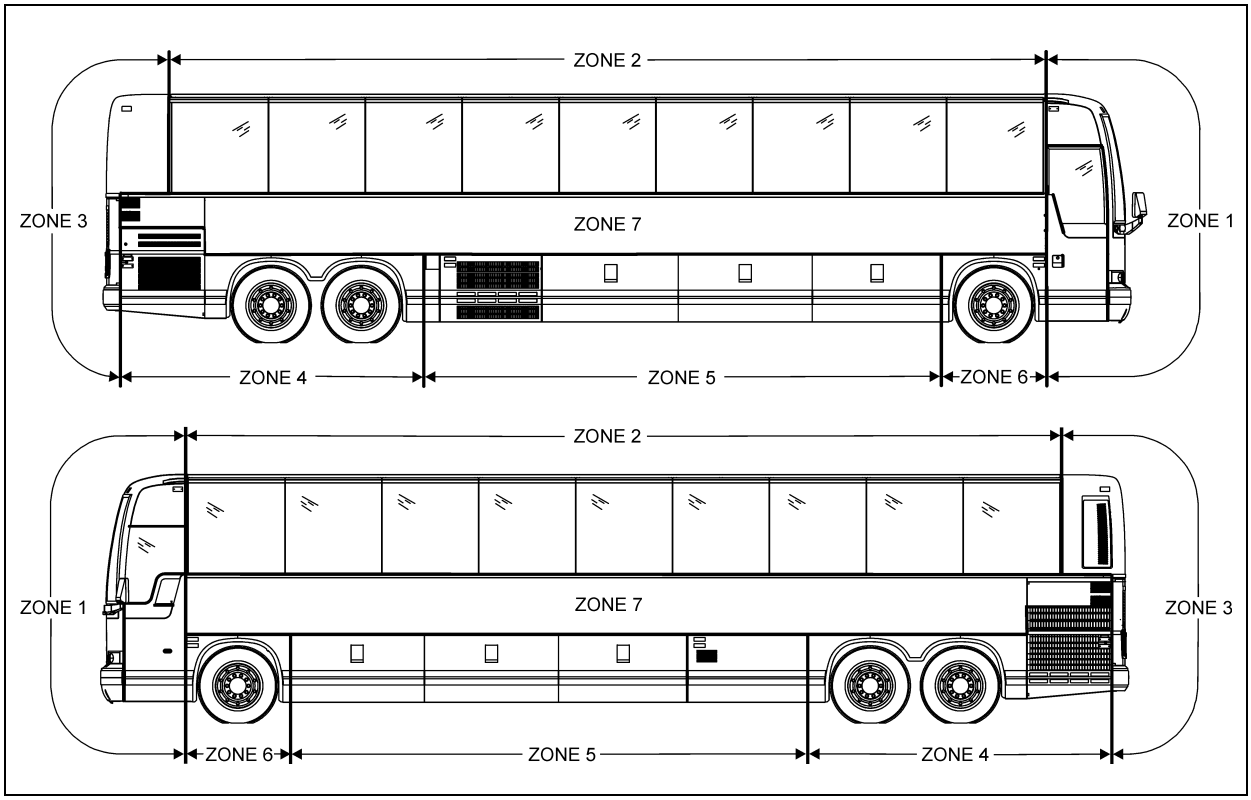


FIGURE 9: X3 COACHES ZONING 18623

6.1 ZONE 1

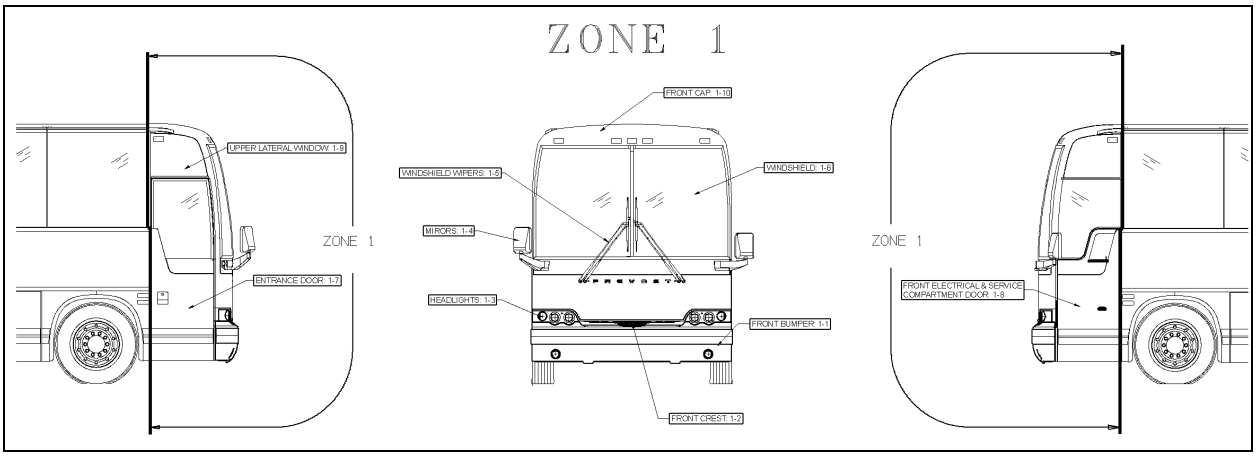


FIGURE 10: ZONE 1 18624

6.1.1 Front Bumper

The front bumper is hinged to give access to the spare wheel and tire compartment. Pull the handle located in the front service compartment to open the spare wheel and tire compartment. Bumper must first be tilted down before its removal. Two people are required to remove and

install the front bumper. Safely support the bumper and remove the two bolts on each bumper side to separate the bumper from the spare wheel compartment door. To install bumper, reverse the removal procedure.

WARNING

Front bumper is heavy. Use proper lifting equipment to support the bumper during the removal and installation operations to avoid personal injury.

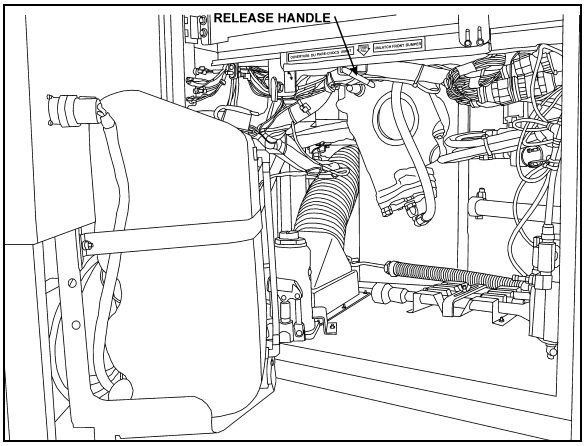


FIGURE 11: FRONT BUMPER RELEASE HANDLE 18613

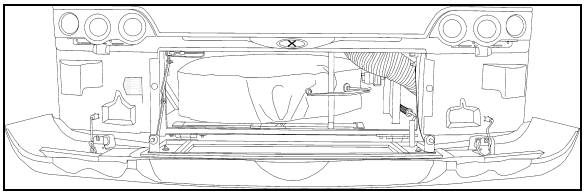


FIGURE 12: FRONT BUMPER 18614

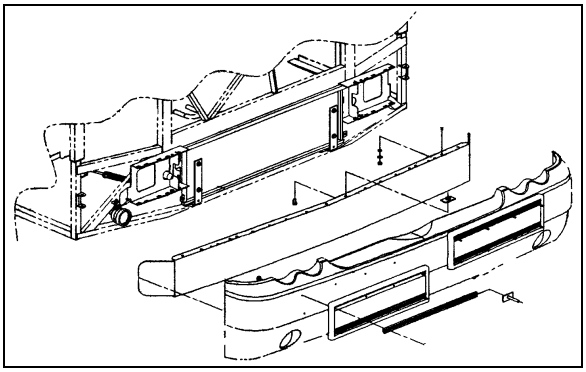


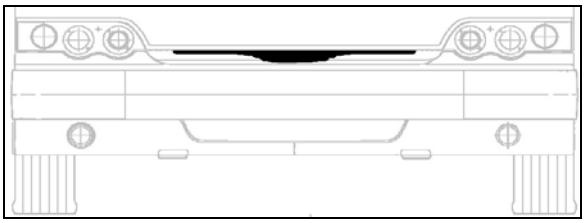
FIGURE 13: FRONT BUMPER REMOVAL 18565

6.1.2 Front Crest

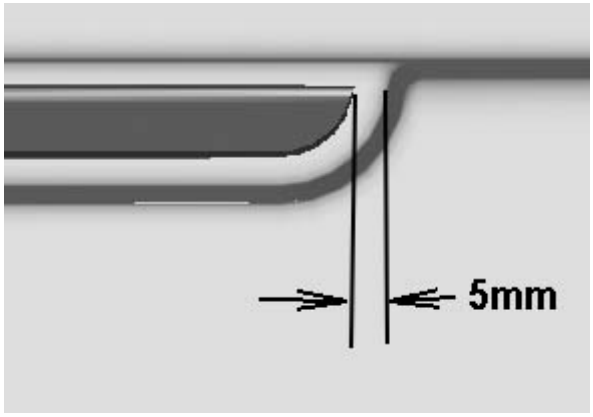
- Use a Chix cloth and anti-silicone to clean the surface where the crest will be applied.

CAUTION

Do not exceed the crest dedicated surface.



- Peel the back from the self adhesive crest side pieces.



- Peel the back from the self adhesive crest center piece. Center crest and apply.
- Compress the crest three pieces using your hands.

6.1.3 Headlights

Refer to Paragraph Headlights, included in Section 06: Electrical of the Maintenance Manual for complete information on headlights.

6.1.4 Rear View Mirrors (Ramco)

Your vehicle is equipped with two exterior mirrors.

The mirrors may be equipped with an optional electric heating system which serves to minimize ice and condensation on the mirror glass in extreme weather conditions. Integral thermostats are installed in both mirrors to avoid continuous heating. Use the appropriate switch on the dashboard to activate the defroster system on both mirrors simultaneously. The mirrors can easily be adjusted by using the remote controls located on the L.H. side control panel. The mirrors have easy to replace glass in case of breakage. Remote control motors can also be replaced.

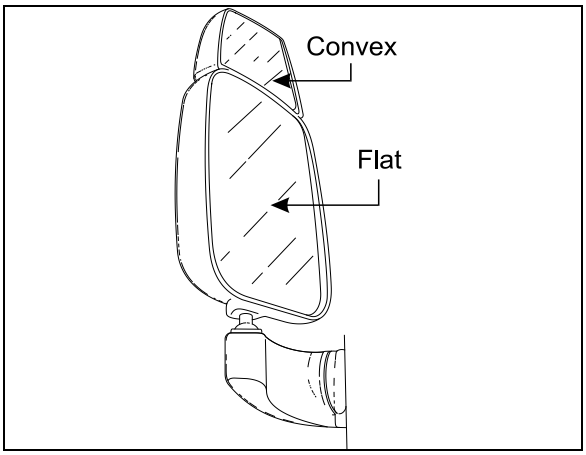


FIGURE 14: REAR VIEW MIRROR (RAMCO) 18398A

- **Adjustment**

At the base of the mirror arm, loosen the mounting bolt to swing arm in or out.
To pivot the mirror head, loosen the setscrews on each side of the ball stub at the base of the mirror head to facilitate the adjustment.

- **Disassembly**

At end of mirror arm, loosen the setscrews to relieve tension on the ball stem. Remove the ball stem from the arm.
Remove the four screws fastening the mirror arm base to the coach.

- **Assembly**

Mount the mirror arm base to the coach. Insert the ball stem into the mirror arm and tighten the socket setscrews.

NOTE

Position the ball cup halves so the joint between them lies on the centerline of the arm. Ensure that the setscrews are not on the joint between the cup halves.

- **Replacement of Mirror Glass**

Remove the broken glass.

Position new glass in mirror head and press to lock the Velcro in place.

- **Heated / Remote Controlled Rear View Mirrors**

Heated/remote controlled external rear view mirrors may be provided to prevent the mirrors from frosting up in cold weather.

The remote controlled external rear view mirrors attach to support arms using a pivot collar secured by setscrews. Loosening the setscrews allows the whole head assembly to turn on the support arm for initial adjustment. A mounting bolt and washer hold the arm support to the mounting bracket. The arm support can be moved to position the mirror head into or away from the coach body.

The mirror heat switch is located to the left of the driver on the dashboard. This switch must be activated before the mirror heating element will energize. Once energized, the mirror heating element is kept at a sustained temperature (between 60-80°F) by a thermostat. Refer to wiring diagram annexed in the technical publication box.

⚠ CAUTION

Do not attach stick-on type convex mirror accessories to the heated mirror glass. This could impede uniform heat distribution on the mirror surface which could break the mirror.

Mirror Control

The remote control pointer knob(s) for the mirrors is (are) mounted on the L.H. side control panel. The harness to the mirror head runs through the arm support. The remote motor is mounted to the mirror head behind the mirror glass.

Turn pointer knob to the left for mirror head adjustments and to the right for convex mirror adjustment, then push down on either of the

button's (4) sides to adjust the selected mirror viewing angle.

Disassembly

At end of mirror arm, loosen the setscrews to relieve tension on the ball stud. Remove the ball stud. Remove the ball stud from the arm and gently pull the harness out until the connector is exposed.

Remove the four screws fastening the mirror arm base to the coach. Slide the harness free of the mirror arm base.

Assembly

Attach a stiff wire (snake) to the end of the harness and insert the wire through the mirror arm base and arm, gently pull the harness through the arm and disconnect the "snake".
Connect the mirror head harness. Insert the harness connector back into the mirror arm.
Insert the ball stud into the mirror arm and tighten the socket setscrews.

NOTE
Position the ball cup halves so the joint between them lies on the centerline of the arm. Ensure that the setscrews are not on the joint between the cup halves.

Convex & Flat Mirror Removal

The mirror glass assembly is mounted to the control mechanism or to mirror base with Velcro strips. Remove the mirror glass by gently pulling the lens to release the Velcro. Disconnect the heater grid at the two connectors.
Connect the connectors of the new mirror's grid to the harness. Install the lens by positioning the lens in the mirror frame and pressing to lock the Velcro in place.

6.1.5 Windshield Wipers

Refer to Paragraph 23.8 Windshield Wipers and Washers, included in Section 23: Accessories of the Maintenance Manual for complete information on windshield wipers.

6.1.6 Windshield

For the removal or installation of windshield, you will need:

A rope,

A plastic spatula to lift the rubber seal lip,

A metal rod or screwdriver to clean the seal groove,

A filler insertion tool,

Goggles and protective gloves.

- From inside of vehicle, remove center post and interior finishing panels surrounding the windshield. In this case, we are replacing the R.H. side windshield.
- From outside of vehicle, remove filler located inside rubber seal to ease damaged windshield removal.
- From inside of vehicle, push against the top L.H. side corner of windshield for the removal of a R.H. side windshield. If the L.H. side windshield had to be removed, you would have to push against the top R. H. side corner.

NOTE
We are referring to the L.H and R.H. side as viewed from the inside of the vehicle.

- At the same time, another person gradually lifts the rubber lip from the vehicle exterior using a plastic spatula from top to bottom.
- Remove the entire damaged windshield and broken glass if applicable.
- If applicable, using a screwdriver or metal rod, remove black butyl sealant residue from rubber seal then clean with Sika 205.

- **Windshield Installation**

NOTE
Rubber seal may have to be replaced if it was used on several windshield replacements.

- Spray rubber seal with soapy water to ease windshield insertion.
- Insert rope into rubber extrusion leaving enough length at each corner to make a loop. Spray soapy water onto rope and rubber extrusion (Fig. 15).
- Slide windshield into rubber seal groove starting with the bottom curved side edge. Using a plastic spatula, move the rubber seal lip aside to gradually insert the windshield into the groove.
- Spray soapy water on a regular basis to ease this operation.

- Using the same type of plastic spatula, repeat the same operation from inside of vehicle, gradually inserting the windshield into the groove.

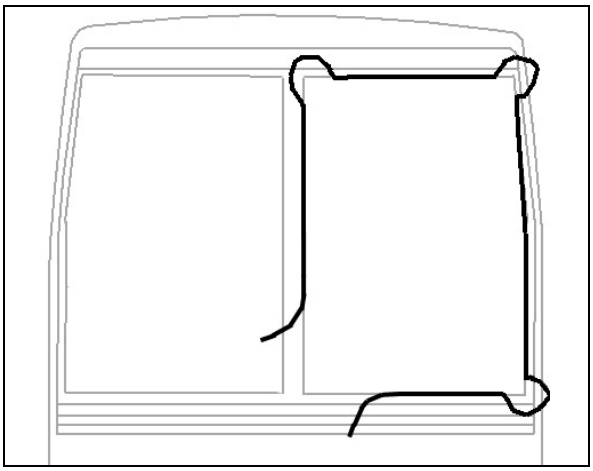


FIGURE 15: WINDSHIELD INSTALLATION USING ROPE

NOTE
Make sure windshield bottom edge is well inserted into the rubber seal groove before proceeding with the sides.

- Then, working from both sides of windshield bottom to top, gradually move the rubber seal lip aside to insert the windshield into the groove. Use also soapy water on the inside of vehicle to insert the windshield into the rubber seal groove.
- Insert the top curved corner then finish with the top of windshield.
- At the top of windshield, clean surface between fiberglass and rubber extrusion using Sika 205 (Fig. 16).
- Apply Sika 221 black between fiberglass and rubber extrusion
- Spray filler and rubber seal groove generously with soapy water.
- Using the special filler insertion tool, insert the filler into the rubber seal groove.
- Gradually insert filler into the rubber seal groove ensuring to leave a 2 inch excess length at the filler extremity.
- Every 6 inches or so, it is important to compress the filler due to its tendency to contract during drying process.
- When filler insertion is almost complete, cut filler leaving ¼" of excess length to thwart filler contraction over time then insert filler into groove.

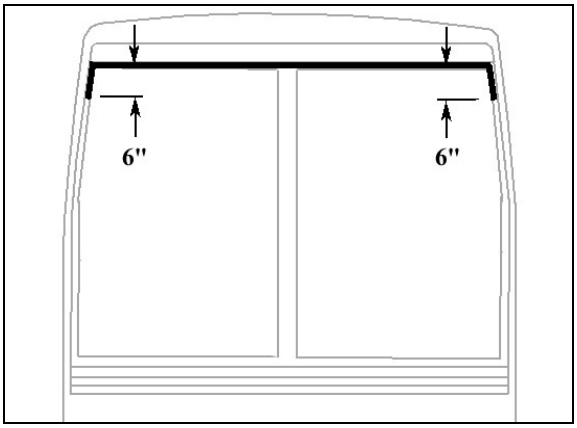


FIGURE 16: APPLICATION 0F SIKA 221 BLACK

- Reinstall center post and interior finishing panels.
- Clean windshield surface of butyl residue.

6.1.7 Entrance Door

An air operated "sedan type" entrance door, with an air door cylinder and damper assembly are installed under the right hand dash. The opening and closing door speed cycle is adjustable by a damper mounted in parallel with the door cylinder on the door hinge. Door activation is controlled by a panel (Fig. 17), located near the defroster and wiper motors. The accessory air reservoir supplies air to this system.

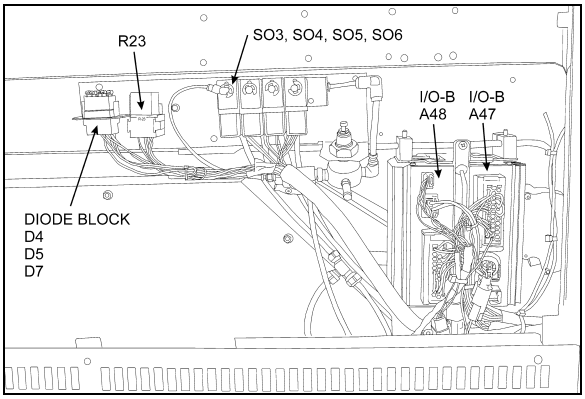


FIGURE 17: ENTRANCE DOOR & WIPER CONTROL PANEL 06619

The door is held in the closed position during coach operation by a two air cylinder locking mechanisms (Fig. 19). Air cylinders with return spring in the cylinder body are used. Air cylinders are controlled by an electrically operated solenoid valve energized by a rocker switch located under the right hand dashboard.

To open the door, initial movement of the rocker switch de-energizes the air lock solenoid valve, venting the door locking cylinders. The return locking spring pulls the door lock away from the latch, unlocking the door. Door movement starts only when pressure in the central air door lock is below 10 psi. The “air cylinder open solenoid valve” opens and allows air to flow to the door cylinder, “the air cylinder close solenoid valve” exhausts air from the rod side of the cylinder.

To close the door, initial movement of the switch energizes the “air cylinder close solenoid valve” and air flows to the cylinder by its rod side port. The “air cylinder open solenoid valve” exhausts air from cylinder. When entrance door latch is grounded with the door frame, the air lock solenoid valve is de-energized and loads the door lock cylinders. The cylinder moves the door lock in a position which engages a latch on the entrance door, holding the door positively closed.

Emergency exit valve, which opens the air valve circuit should be used only in emergencies, or when the door control system does not function properly.

Refer to the air system schematic diagram annexed at the end of section 12, “Brakes” and to page 22 of the wiring diagram.

- **Operation**

The air-operated door is controlled from inside the coach by two push-button switches located on the R.H. dashboard.

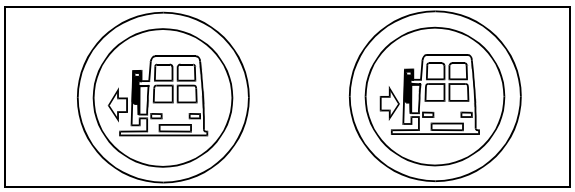


FIGURE 18: ENTRANCE DOOR OPERATING BUTTONS 06464

Opening and closing of the door from outside the coach is accomplished by a momentary toggle switch located under the front R.H. side marker light (Fig. 20).

To close the door, the switch must be pushed towards the rear of the coach and held in position until the door has completed its movement.

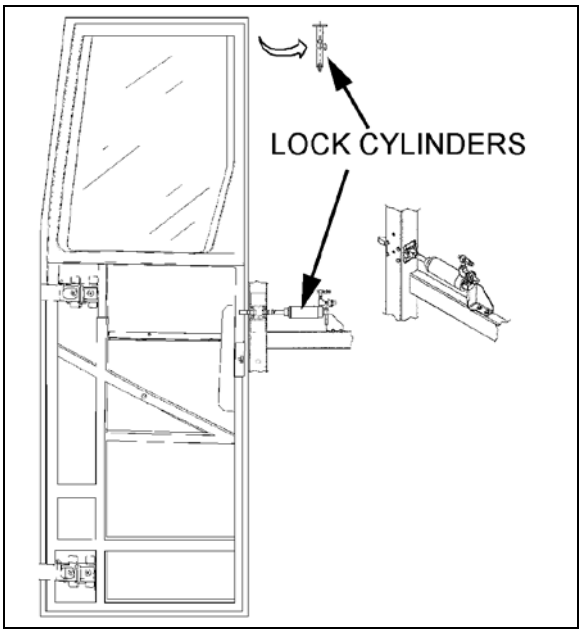


FIGURE 19: COACH ENTRANCE DOOR 18642

To open the door, the switch must be pushed towards the front of the coach and held in position. When the door reaches the fully opened position, the system will keep pressure in the cylinder locking the door in that position. The door can be stopped in any position by releasing the switch. The door is not locked in position when not fully opened or closed.

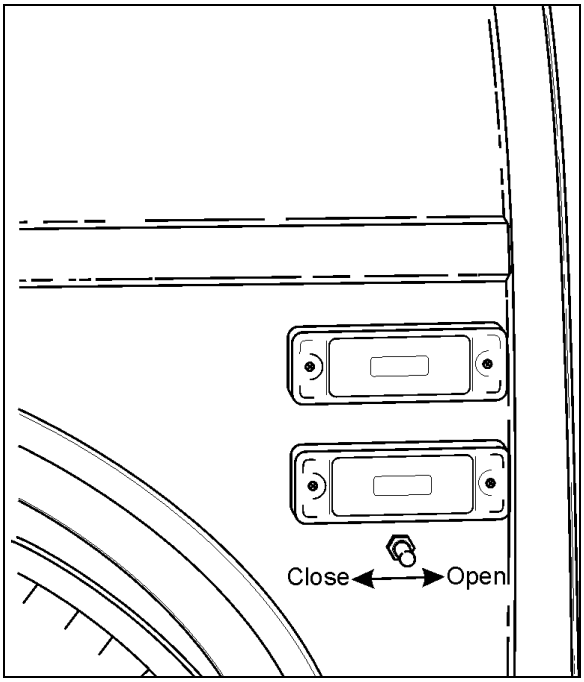


FIGURE 20: ENTRANCE DOOR CONTROL SWITCH 18599

If the door has been locked with the key, a lever on the door can be moved to unlock.

- **Emergency Exit Valves**

From inside the vehicle, an emergency exit valve located near the door on the dash panel, releases the pressure from the lock cylinder. From the exterior, an emergency exit valve located in the front service compartment, also releases the air from the lock cylinder.

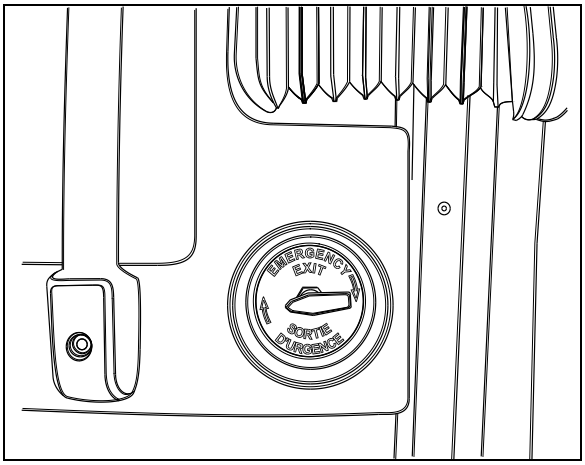


FIGURE 21: INTERIOR UNLATCH AIR VALVE 18330

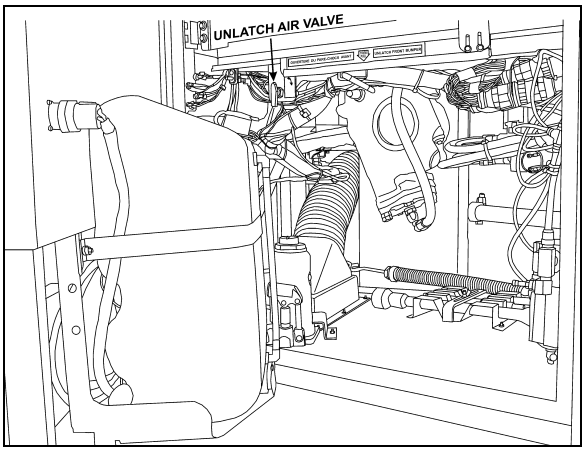


FIGURE 22: EXTERIOR UNLATCH AIR VALVE 12209

Without Air and/or Without Electricity

If the air pressure drops while the coach has or hasn't any electricity, the spring loaded cylinders will unlatch the door. In such a case, unlock the door by moving the lever on the door or by using the key, then open the door manually.

With Air but Without Electricity

From inside the vehicle, turn the emergency exit valve to the "UNLOCK" position. Move the lever. From the exterior, turn the emergency exit valve to the "UNLOCK" position. Open the door. Close it, lock with the key and reset the outside emergency exit valve to the "NORMAL" position.

- **Door Cycle Speed Adjustment**

To do any adjustment, remove the two panels located next to the door hinge, as well as the door's upper hinge control.

CAUTION

It is important to make sure that damper does not reach end of stroke when door is completely closed or opened. The door cylinder must stop the door on opening. Screw or unscrew rod end to adjust if necessary.

To adjust opening and closing cycle speed on damper (Fig. 23):

1. Remove the damper from the vehicle and hold it vertically with the lower eye or pin attachment in a vice. Use clamp plates to prevent damage.
2. Fully close the damper while turning the dust cap or piston rod slowly CCW until it is felt that the cams of the adjusting nut engage in the recesses of the foot valve assembly (Fig. 23).

NOTE

In figure 23, if there is an indentation (B) in the dust cap (C) and the cover shows two holes (A), the damper is fitted with a bump rubber (D). If so, fully extend the damper and insert a round bar or screwdriver through the holes. Push the bump rubber down and remove. Remove the split plastic collar (E) (if fitted) from the piston rod.

3. The damper may have already been adjusted. Therefore check whether the damper is adjusted or not by keeping it closed and gently turning further CCW, counting at the same time the half-turns until a stop is felt. Stop turning and do not force.
4. While keeping the damper closed, make two CW half-turns. In case of prior adjustment, add the number of half-turns previously counted. The total range is about five half-turns. Pull the damper out vertically without turning for at least 3/8" (1cm) to disengage the adjusting mechanism. The dust cap or piston rod may now be turned freely.
5. The damper can now be refitted in the vehicle.

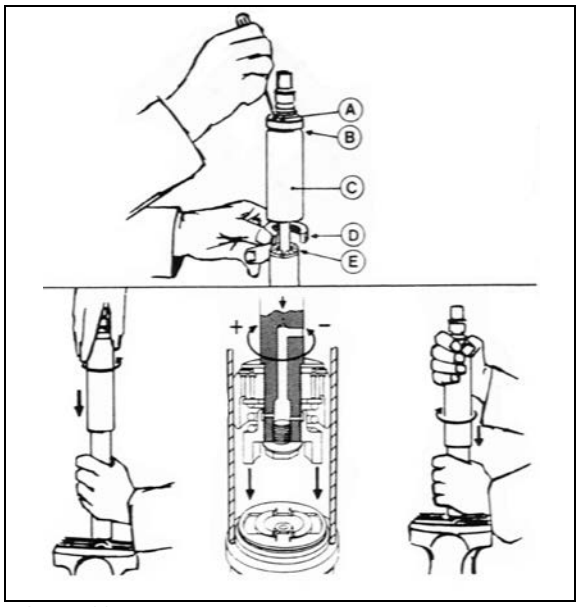


FIGURE 23: DAMPER 18643

NOTE
Where a bump rubber was installed, refit same inside the dust cap and by fully closing the damper, the rubber will seat again at top of the dust cap. Refit the split plastic collar E (Fig. 23).

6. Reinstall panels and entrance door hinge cover.

- **Horizontal And Vertical Adjustment**

Before attempting to correct any door operating problem by adjusting any part of the air cylinder assembly, first perform the following mechanical checks and procedure.

Check around the perimeter of the door for binding. If any binding is found, adjust as follows:

1. Remove the screws and the plastic molding covering each of the hinges.

NOTE
Ask an assistant to help you to perform the following adjustments.

2. Remove the Allen button head screw and the washer retaining the rod end with bearing to the upper hinge. See figure 24.
3. Support the door with a wooden block and a hydraulic jack.
4. Loosen the horizontal bolts retaining the door to the hinges. Adjust the door horizontally and vertically with the jack. Tighten the bolts to 30-36 Lbf-ft (40-50 Nm). Remove the jack and the wooden block.

CAUTION
Make sure the front side door does not interfere with the exterior panel.

5. Pull and fasten the rod end to the hinge with the washer and the button screw.
6. Screw the plastic moldings covering the hinges.

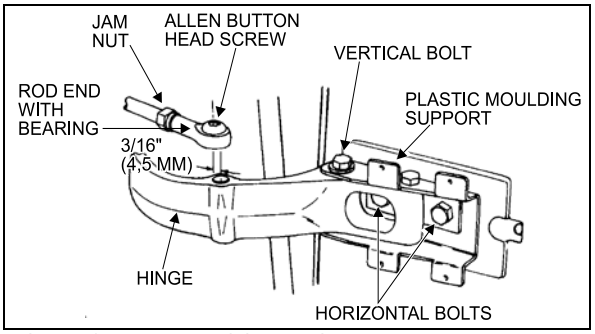


FIGURE 24: UPPER DOOR HINGE 18058

Seal Compression Adjustment

1. Turn the emergency exit valve to the "UNLOCK" position and close the door.
2. From the outside of vehicle, insert a straight edge in the gap along the door outside perimeter. Measure the distance between the door frame and the door outside surface at the door four corners (refer to figure 25).

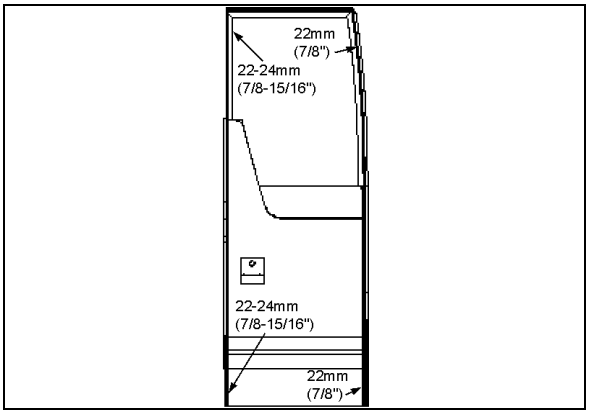


FIGURE 25: SEAL COMPRESSION ADJUSTMENT 18632

NOTE
The front measurements are the most important. If required, ask an assistant to help you to perform the following adjustments.

3. If required loosen the bolts retaining the door to the hinges. Adjust the bolts to obtain the proper seal compression.

Door Seal Replacement

1. Inspect the seal; if cracked or torn, it must be replaced:
2. Remove the old seal and with a sharp edge knife, scrape tape left on the fiberglass door surface.
3. Sand the surface of the door where a new seal will be applied with 240 grit sandpaper.
4. Clean the surface with alcohol.

WARNING

Wear rubber gloves and do not smoke when cleaning.

5. Peel of protective paper from the seal. Position the seal flush with the top, sides and lower edges of the door.
6. Progress slowly all around the door.
7. Cut the seal and glue both ends with LOCTITE 414 glue.
8. To assure bonding, press a small roller on top of the new seal.

- **Troubleshooting**

SYMPTOM	PROBABLE CAUSE	REMEDY
DOOR WILL NOT OPEN FROM EXTERIOR SWITCH.	Manual door locks engaged.	Release manual door locks.
	Upper and lower solenoid locks do not disengage.	Check voltage at solenoid locks when door is open. If the voltage is 24 volts then replace solenoid #641217. Else, check circuit power.
	Relay module do not receive current.	Reset breaker "ON" or check batteries power supply.
	Opening solenoid door does not receive current.	Check voltage at opening solenoid door. If the voltage is 24 volts then replace it. Else replace control relay.
	Switch malfunction.	Replace switch.
DOOR WILL NOT CLOSE FROM EXTERIOR SWITCH.	Switch malfunction.	Replace switch.
	Solenoid failure.	Check voltage at solenoid. If the voltage is 24 volts then replace solenoid. Else replace control relay.
DOOR WILL NOT OPEN FROM INTERIOR SWITCH.	Manual door locks engaged.	Release manual door locks (open position) from vehicle exterior.
	Upper and lower solenoid locks do not disengage.	Check voltage at solenoid locks when door is open. If the voltage is 24 volts then replace solenoid #641217. Else, check circuit power and replace control relay.
	Module relay does not receive electric current.	Reset breaker "ON" or check batteries power supply.
	Door opening solenoid does not receive current.	Check voltage at door opening solenoid. If the voltage is 24 volts then replace it. Else replace control relay.
	Switch malfunction.	Replace switch.
	Upper lock stays engaged	Lubricate upper lock assembly. Check wear and replace parts if necessary.
DOOR WILL NOT CLOSE FROM INTERIOR SWITCH.	Switch malfunction.	Replace switch.
	Door closing solenoid does not receive electric current.	Check voltage at door closing solenoid. If the voltage is 24 volts then replace it. Else replace control relay.
DOOR WILL NOT OPEN AFTER DRAINING AIR FROM SYSTEM BY EMERGENCY VALVE(S).	Manual door locks engaged.	Release manual door locks (open position) from vehicle exterior.
	Damper cylinder blocks the door.	Adjust or replace damper cylinder.

SYMPTOM	PROBABLE CAUSE	REMEDY
	The upper lock blocks the door.	Adjust upper lock. Lubricate upper latch bolt. Adjust upper latch height.
DOOR LOCKS STAY ENGAGED WHEN DOOR IS OPEN.	Power supply is cut at solenoid.	Place switch in open position.
	Lock solenoid does not disengage.	Check voltage at solenoid lock when door is OPEN. If the voltage is 24 volts then replace solenoid #641217. Else, check circuit power and replace control relay.
DOOR LOCKS DO NOT LOCK WHEN DOOR IS CLOSED.	Emergency valve is open.	Close emergency valve.
	Lock solenoid stays electrified.	Check latch bolt ground on door frame. If needed clean locks for better contact. Check ground circuit.
	Lock solenoid works in reverse.	Reverse air hoses at solenoid locks.
	Relay does not function.	Replace relay.

- **Lubrication**

Part	Lubricant	Frequency
Latches Upper door catch Door cylinder rod end with bearing grease fitting	Low temperature grease	Every six months
Door locking mechanism	White grease	Every six months
Key hole Damper pins Hinges	Low viscosity oil	Every six months

- **Entrance Door Body Panel and Window**

  Window

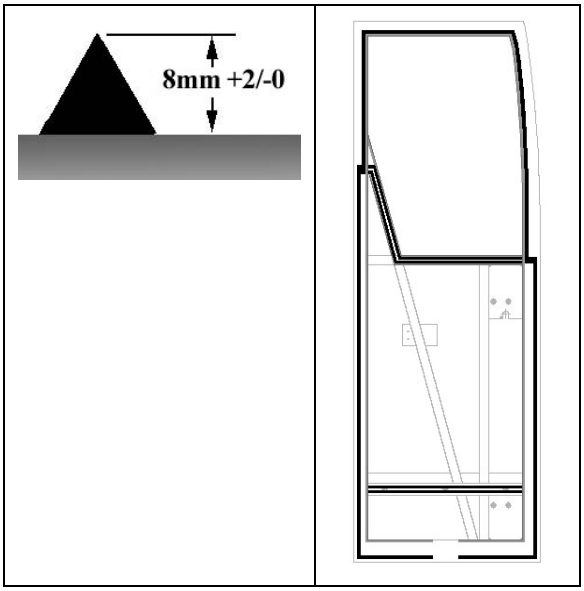
For the removal of entrance door window, you will need:

Pneumatic “Zip gun” type tool;
Razor sharp window scraper;
“Olfa” knife;
Face shield.

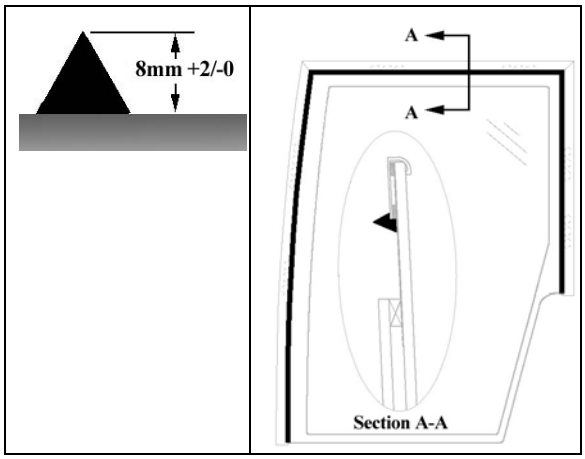
- Open entrance door.
- Mark the position of the entrance door window for future reference.
- Remove interior finishing panel.
- From inside of vehicle, cut Sika bead around window perimeter using a “Zip gun” while another person hold the window from the outside.

NOTE
Wear ear plugs during this operation.

- Then, move outside of vehicle and cut Sika bead to free window while somebody else hold the window from the inside.
- Carefully remove window from frame, ask for help if needed.
- Using a razor sharp window scraper, remove from window frame Sika bead and double-face self adhesive tape residue.
- Clean window using window cleaner.
- Apply Sika Aktivator around window perimeter.
- Clean door frame using anti-silicone.
- Using a scratch pad “Scotch Brite”, scratch the perimeter of the window frame where the adhesive will be applied.
- Clean door frame again using anti-silicone.
- Apply some Sika 206 G+P onto door frame.
- Apply Sika 255 onto door frame structure.



- Apply Sika 255 at junction of frame and window.



- Install and center window onto door frame. Using your hands, compress window.
- Discard waste according to applicable environmental regulations, use dangerous waste containers.
- Apply masking tape before applying Sika glue to protect paint and adjacent surfaces during surface treatment

Body Panel

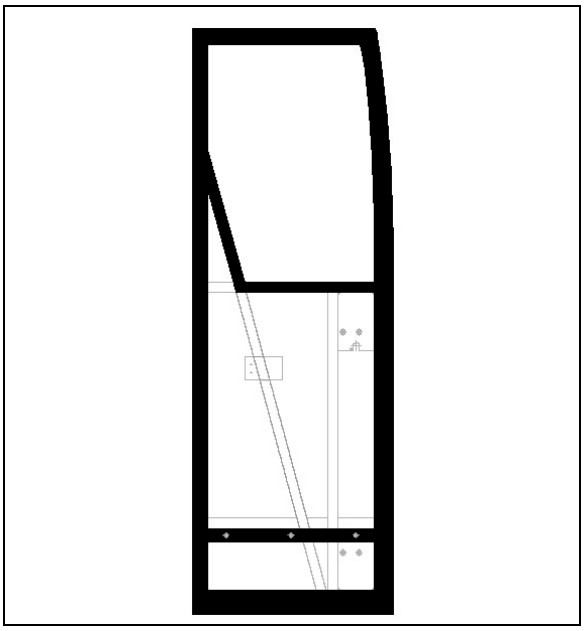
For the removal of entrance door body panel, you will need:

Pneumatic “Zip gun” type tool;
Razor sharp window scraper;

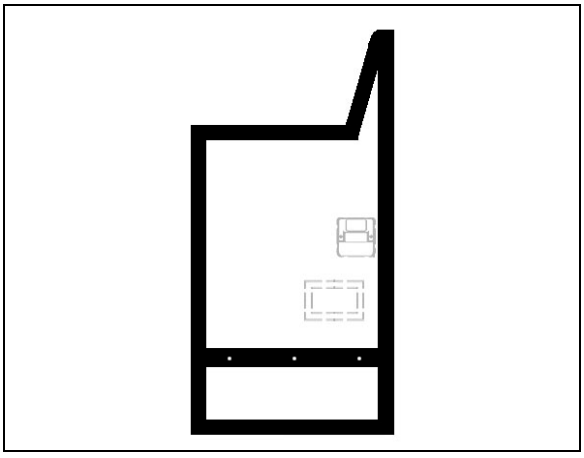
- Open entrance door.
- Remove interior finishing panels to access rub rail fixing bolts, then remove rub rail.
- Remove door lock and interior lighting.
- Using the “**Zip Gun**”, cut Sika bead located ¼ inch (7-8 mm) from each body panel edge.

NOTE
Wear ear plugs during this operation.

- Separate body panel from door.
- Using a razor sharp window scraper, remove from door frame Sika bead and double-face self adhesive tape residue.
- Using a scratch pad “Scotch Brite”, scratch the perimeter of the door frame where the adhesive will be applied.
- Clean door frame again using anti-silicone.
- Apply some Sika 206 G+P onto door frame.

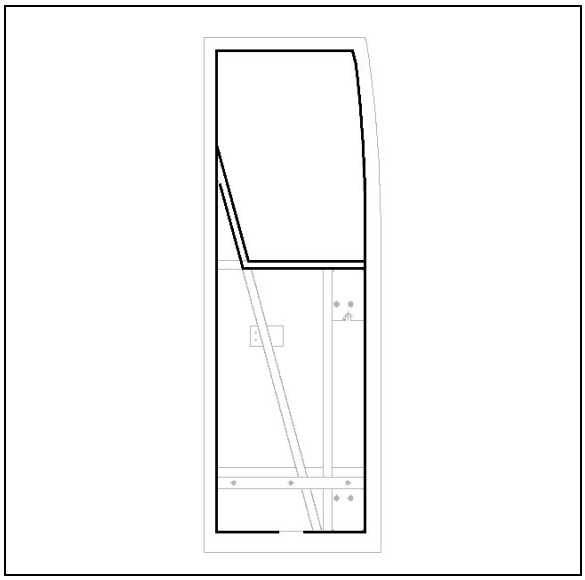


- Using a scratch pad “Scotch Brite”, scratch the perimeter of the body panel where the adhesive will be applied.
- Clean body panel using anti-silicone.
- Apply some Sika 206 G+P onto body panel.

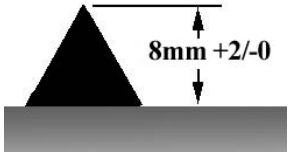


- Apply 1/8 x1/4 double face self-adhesive tape onto door frame.

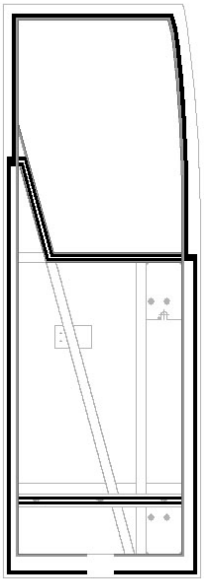
NOTE
Leave some space at the bottom (50mm) for water dripping



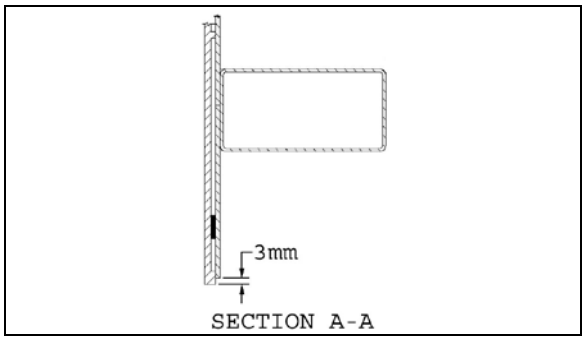
- Apply Sika 255 onto door frame structure.



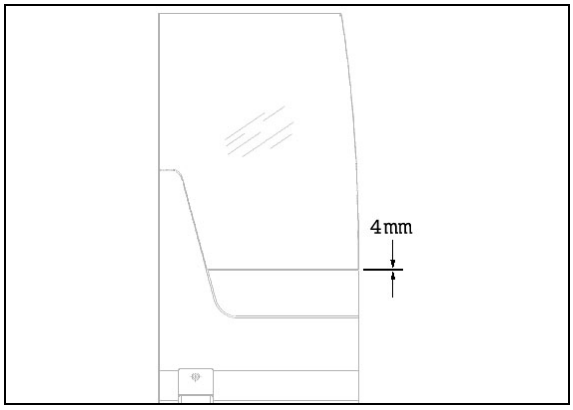
Note: Leave some space at the bottom (50mm) for water dripping.



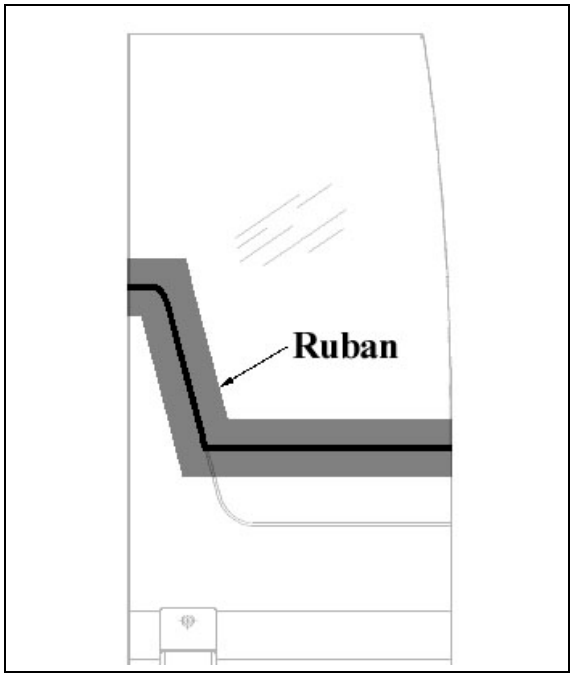
- Install and center fiber glass body panel onto door frame leaving an excess of 3mm all around the frame.



- Line-up body panel with window. There must be a gap of 4±2mm between window and body panel.



- Apply some masking tape **1mm** from window edge and body panel.
- Fill the gap between window and body panel with Sika 255.
- Smooth down the joint with a plastic scraper then remove masking tape.
- Wet Sika joint using water to accelerate the curing process and put the finishing touch with your finger.



- Discard waste according to applicable environmental regulations, use dangerous waste containers.

- **Front Electrical & Service Compartment Door Body Panel and Window**

  Door Body Panel

For the removal of front electrical & service compartment door body panel, you will need:

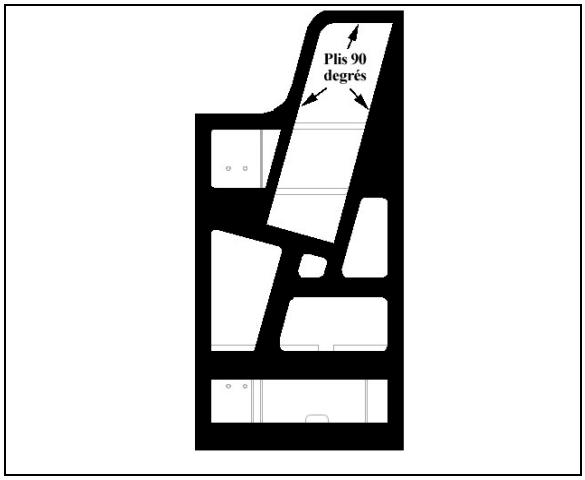
Pneumatic “Zip gun” type tool;

Razor sharp window scraper;

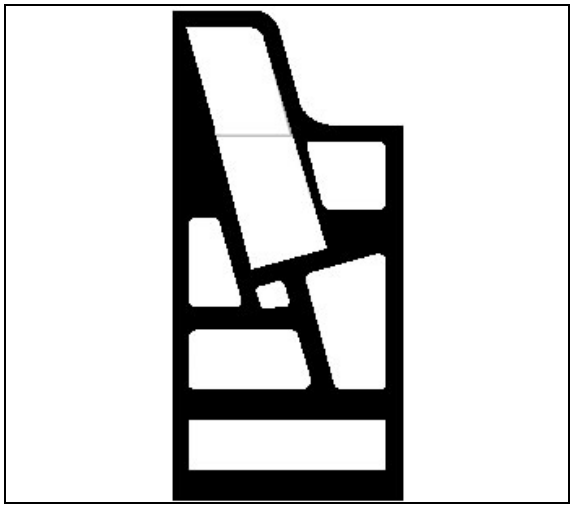
- Open service door.
- Remove interior finishing panels to access rub rail fixing bolts, then remove rub rail.
- Remove windshield washer reservoir, door lock and power window connector.
- Using the “**Zip Gun**”, cut Sika bead located ¼ inch (7-8 mm) from each body panel edge.

NOTE
Wear ear plugs during this operation.

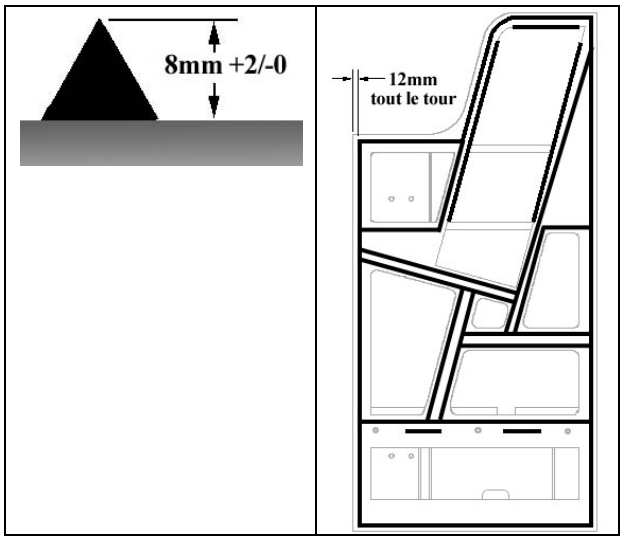
- Separate body panel from door.
- Using a razor sharp window scraper, remove from door frame Sika bead and double-face self adhesive tape residue.
- Clean door frame using anti-silicone.
- Using a scratch pad “Scotch Brite”, scratch the perimeter of the door frame where the adhesive will be applied.
- Clean door frame again using anti-silicone.
- Apply some Sika 206 G+P onto door frame.



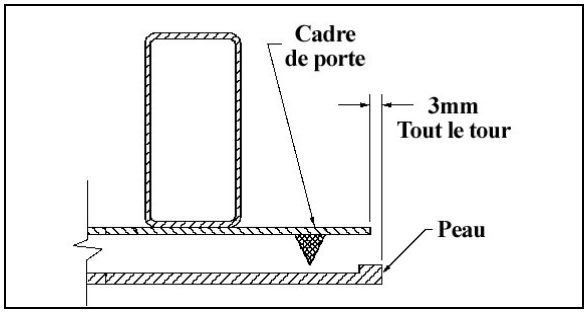
- Prepare new body panel using a scratch pad “Scotch Brite”.
- Use a tack cloth to remove any dust or residue from the body panel surface.
- Clean body panel using anti-silicone.
- Apply some Sika 206 G+P onto body panel.



- Apply an even coat of Sika 255 onto the door frame.

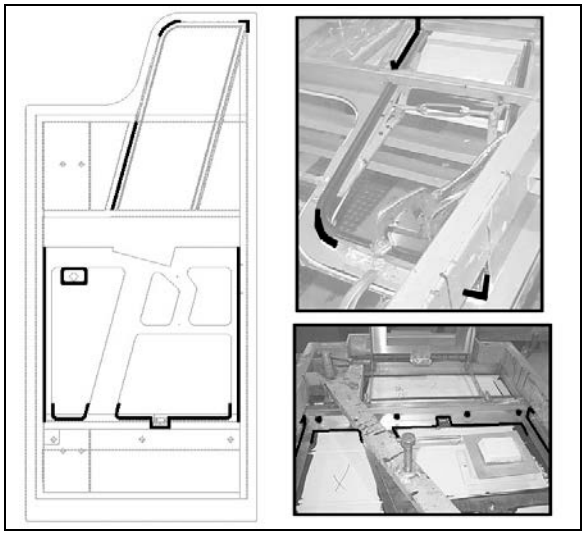


- Position body panel onto door frame and compress with your hands. Use a ruler.



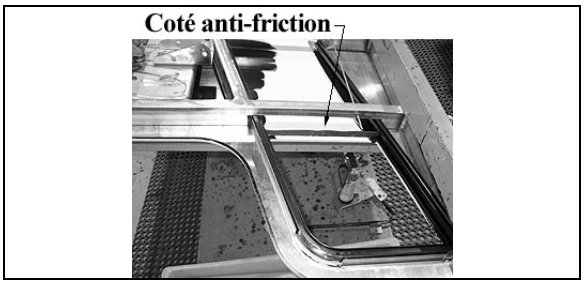
- Check body panel flatness using a 2-foot ruler (must be within 2mm).

- Check proper power window sliding inside window frame.
- If applicable, remove excess of Sika adhesive all around door frame using Sika 208.
- From the inside of the door, apply some Sika 221 between door body panel and frame and on welding spots as per figure.

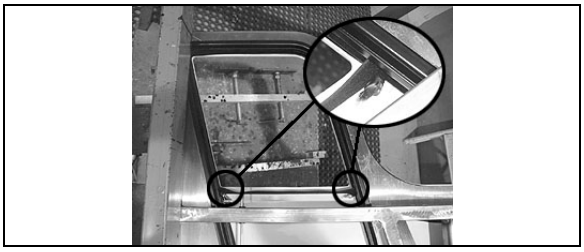


- Apply some #680066 glue inside fiber glass groove and fix power window wiper.

NOTE
Anti-friction side must be on glass side.

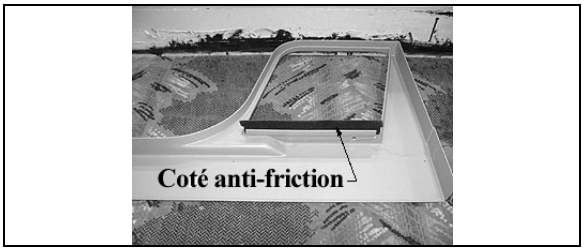


- From inside the door, apply some Sika 252 at the corners of window wiper.



- Apply some #680066 glue inside finishing panel groove and fix power window wiper.

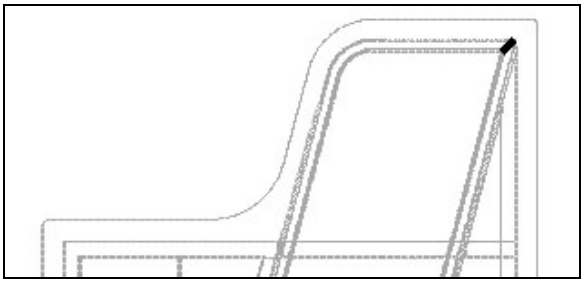
NOTE
Anti-friction side must be on glass side.



- Discard waste according to applicable environmental regulations, use dangerous waste containers.

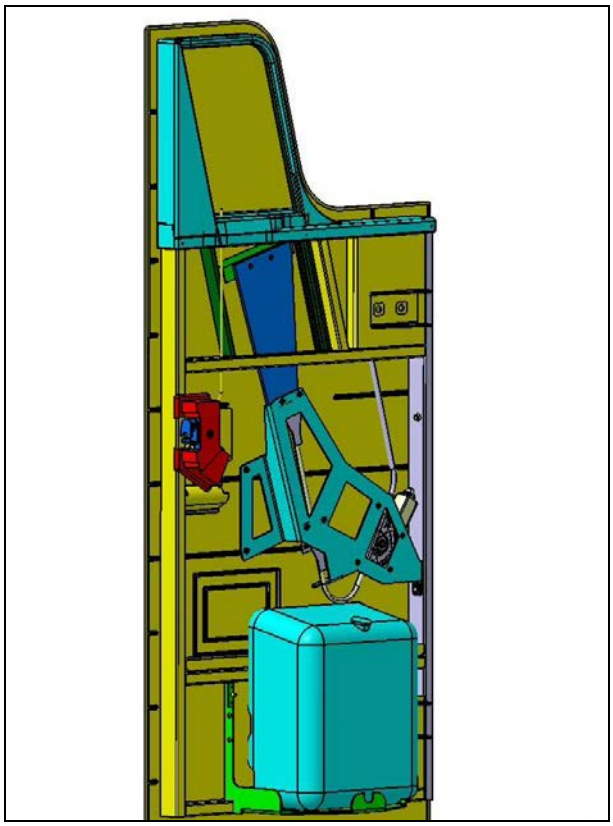
Electrical Power Window

- Insert 2 seals in the window frame.
- Apply some #680066 glue at the intersection of the 2 seals and also sparingly in order to fix the seal to the window frame.

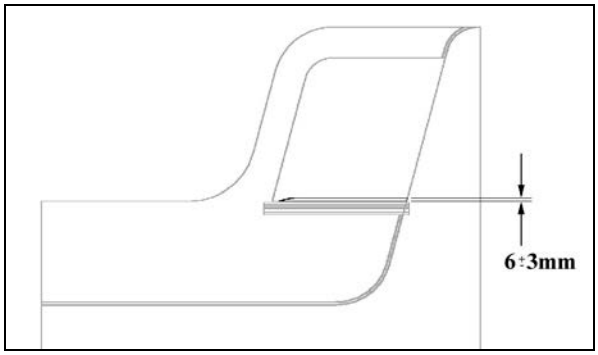


- Clean window using window cleaner.

- Insert window into frame.
- Secure window pane to raising mechanism.

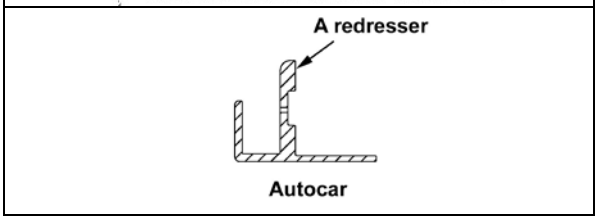


- Adjust window travel (6±3mm above window wiper).

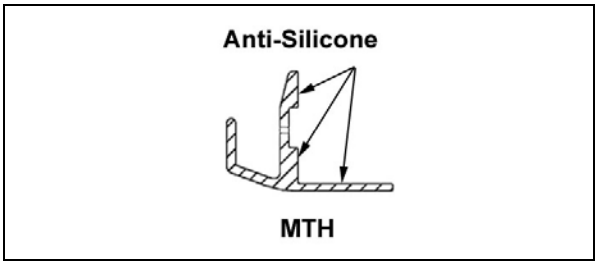


Driver's Window Gutter

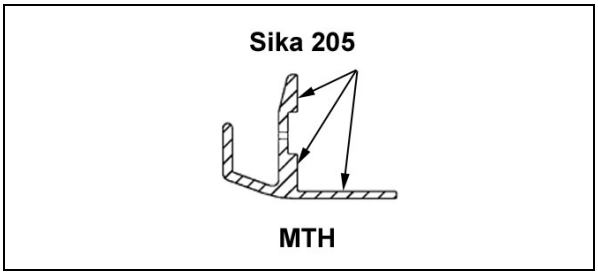
- Dry fit the gutter on the vehicle. If required, straighten up gutter using a hammer and a wooden block.



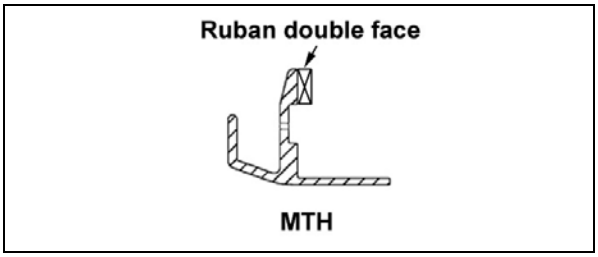
- Apply anti-silicone inside right angle.



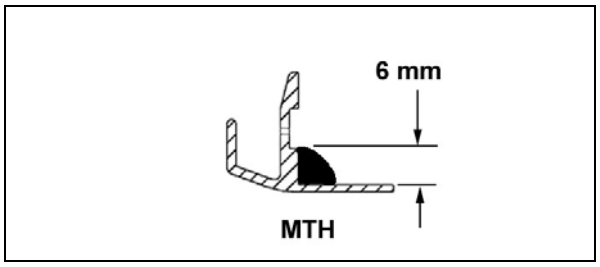
- Apply Sika 205 inside right angle.



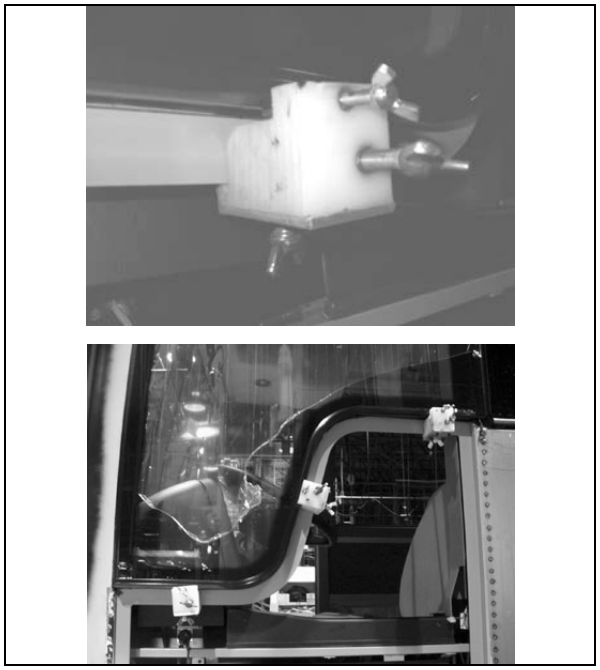
- Apply 1/16 x1/4 double face self-adhesive tape onto gutter.



- Peel the back from double face self-adhesive tape.
- Apply Sika 252 inside right angle.



- If applicable, remove plastic film at the bottom of driver's window.
- Remove excess of Sika underneath driver's window.
- Clean bottom of driver's window using window cleaner.
- Apply Sika Aktivator at the bottom of driver's window.
- Install gutter under driver's window then compress in order to fix double face self-adhesive tape.
- Install 3 clamps and allow curing for 4 hours.



- **Upper Lateral Window**

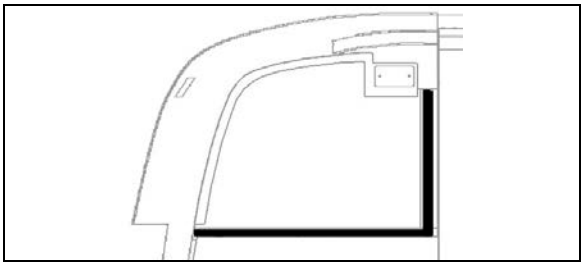
For the removal of upper lateral window, you will need:

Pneumatic «Zip gun» type tool;
Razor sharp window scraper;
"Olfa" knife;
Face shield.

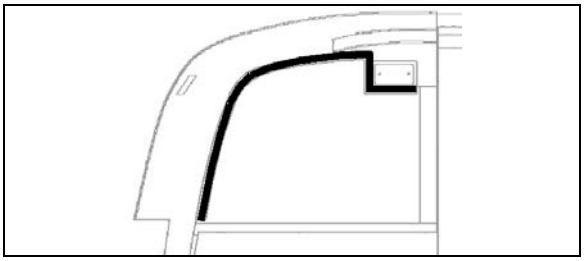
- From inside of vehicle, cut Sika bead around window perimeter using a "Zip gun" while another person hold the window from the outside.

NOTE
Wear ear plugs during this operation.

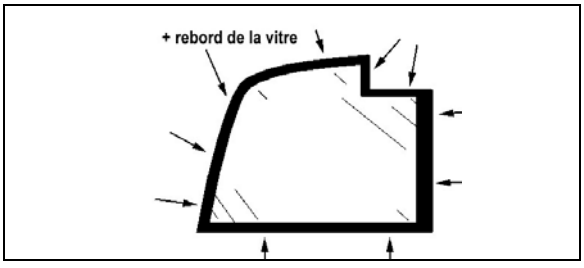
- Then, move outside of vehicle and cut Sika bead to free window while somebody else hold the window from the inside.
- Carefully remove window from frame, ask for help if needed.
- Using a razor sharp window scraper, remove from window frame Sika bead and double-face self adhesive tape residue.
- Remove clearance light
- Apply some water to vehicle structure to clean surface.



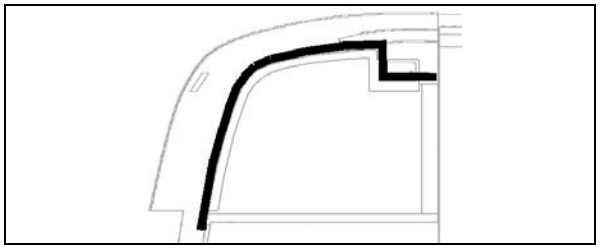
- Clean inside and outside of fiberglass using anti-silicone.
- Apply some Sika 206 G+P.



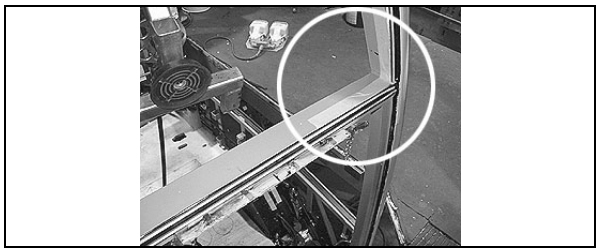
- Clean window perimeter and edges using window cleaner.
- Apply Sika Aktivator.



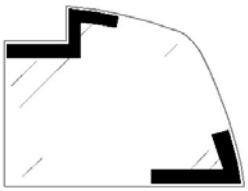
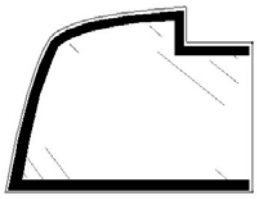
- Apply masking tape onto front face before applying Sika glue to protect paint and adjacent surfaces.



- Apply masking tape onto structure.

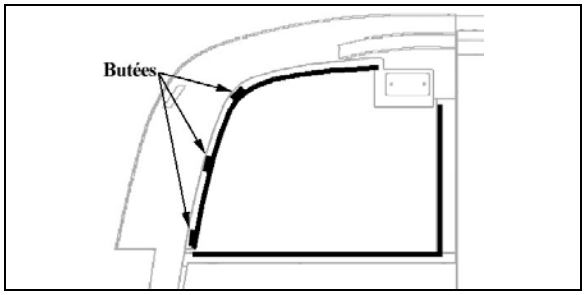


- Apply masking tape onto window.

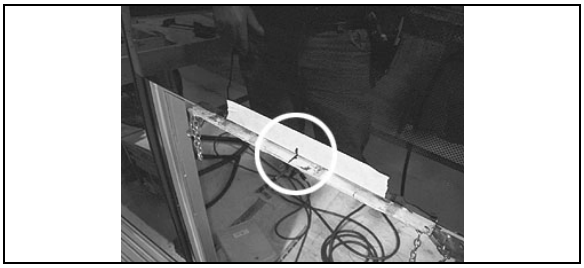
Interior	Exterior
	

- Affix 3 spacers #790392 onto fiberglass.
- Apply a double-face self adhesive tape 1/8 by ¼ inch onto fiberglass perimeter (front face exterior).

NOTE
Do not peel the back from double face self-adhesive tape at this moment.

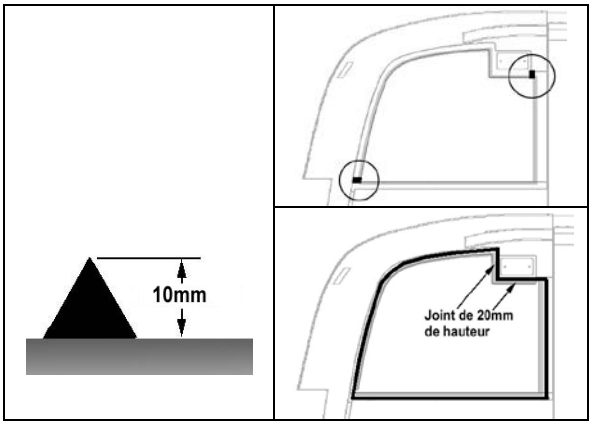


- Install window inside the opening to check if window curve and front face are the same.
- L.H. side: Front of window must line up with front of driver's window. Use shims to adjust window height if necessary.
- R.H. side: Once the window is centered, apply some masking tape on bottom of window to mark off the position.

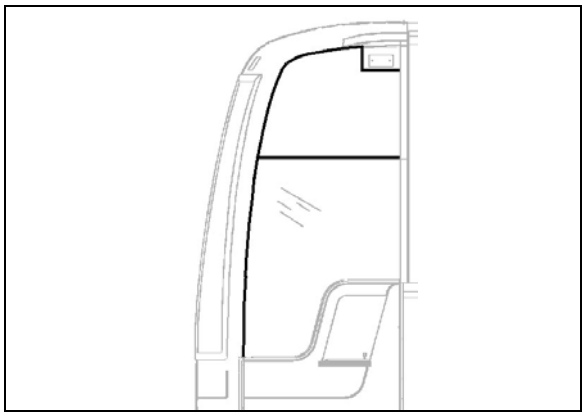


- Peel the back from double face self-adhesive tape.
- Apply some Sika 255 onto fiberglass perimeter (front face exterior).

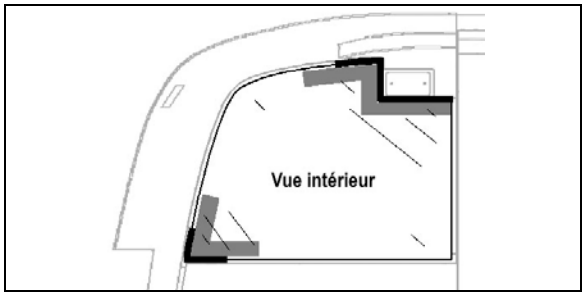
NOTE
Make sure the 2 small cavities between fiberglass and structure are filled with Sika.



- Install and compress all around window perimeter to fix window to self adhesive tape.
- To support the window, position two "Quick Grip" type pliers at the base of the frame.
- Center and align the window base using the two pliers while pressing firmly the window perimeter against the frame.
- Complete a finishing joint and scrape the excess with a plastic scraper.
- Carefully remove masking tape then smooth down finishing joint with your finger. Use soapy water or Sika 208.



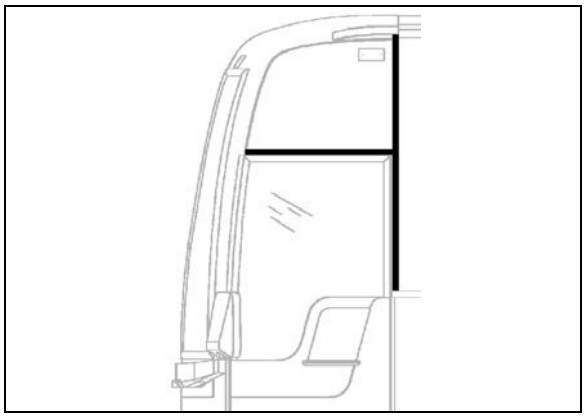
- From vehicle's interior, apply some Sika 255 and make 2 finishing joints. Smooth down the joints and remove masking tape.



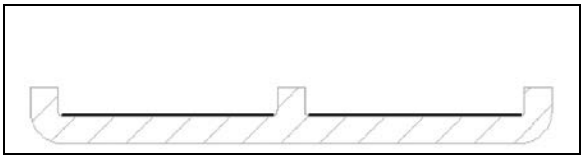
- Reinstall clearance lights.
- Discard waste according to applicable environmental regulations, use dangerous waste containers.

Glued Molding Installation

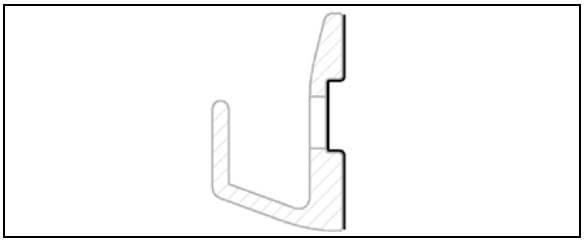
- Clean window gluing area using window cleaner.
- Apply Sika Aktivator onto gluing area making sure to avoid Sika adhesive if it is not cured yet.



- Apply anti-silicone onto molding.
- Apply Sika 205.

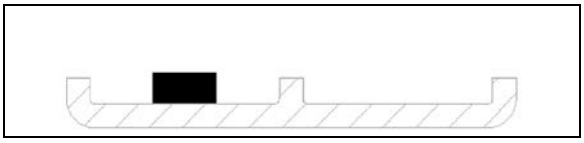


- Clean gutter using anti-silicone.

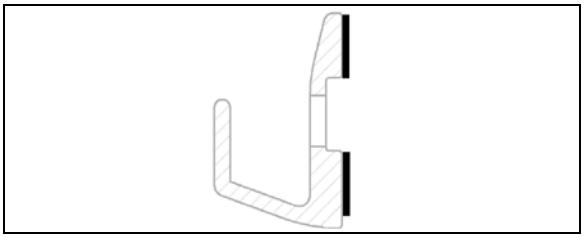


- To seal screw holes, remove screw, apply Sika 205 inside the hole then apply Sika 252.

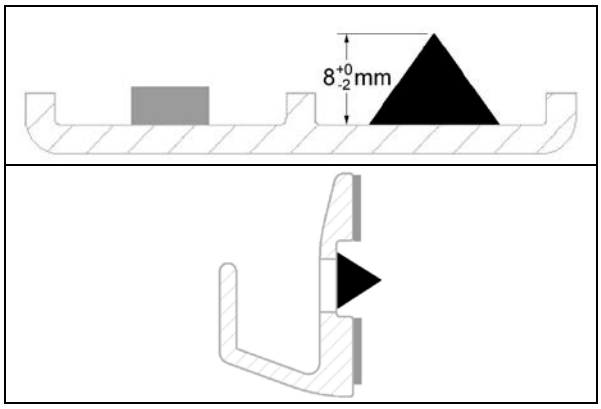
- Apply a double-face self adhesive tape 1/8 by ¼ inch inside the molding onto the whole length.



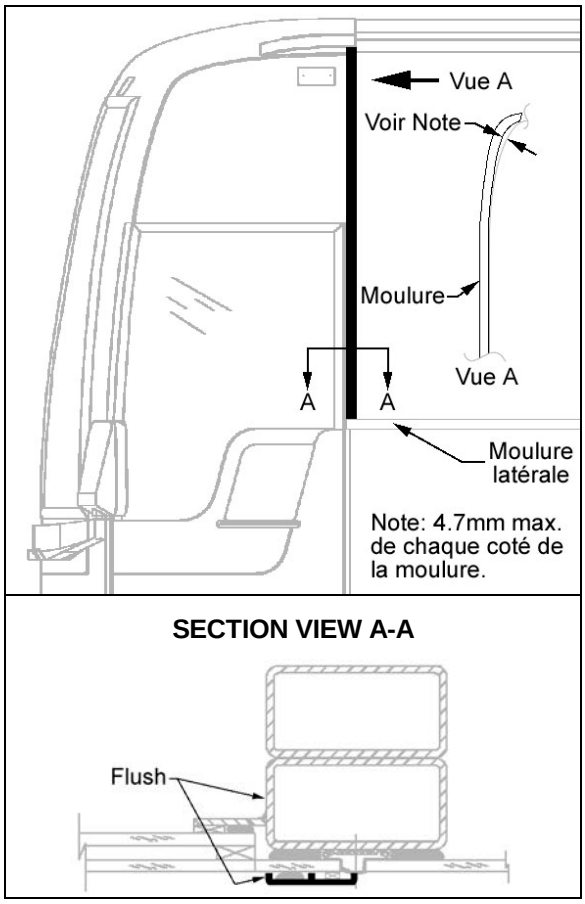
- Apply a double-face self adhesive tape 1/32 by ¼ inch onto the whole length of the gutter.



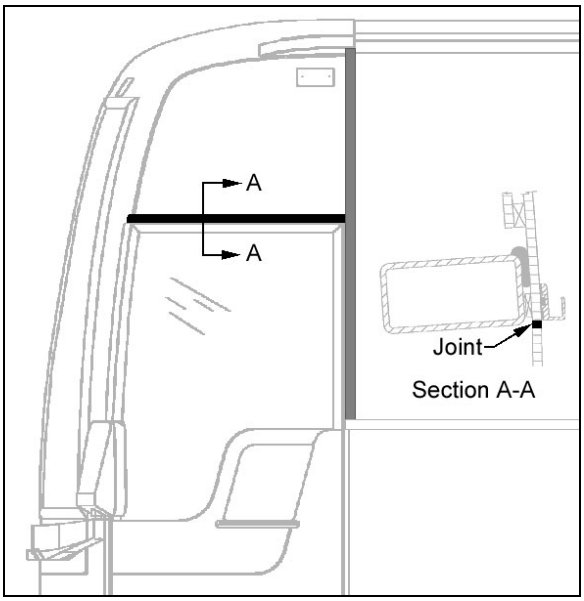
- Apply Sika 252 inside the moldings onto the whole length.



- Position and fix vertical molding. Lean vertical molding against lateral molding. Make sure vertical molding lines up with structural tubing.



- Position and fix horizontal molding (gutter). Lean gutter against vertical molding. Position gutter just above Sika finishing joint.



- Apply masking tape on each side of vertical molding. Apply Sika 252 to fill the gap between molding and windows.
- Smooth down the joint with finger.
- If required, clean surfaces using Sika 208.

6.1.8 Front Cap

The fiberglass front cap does not need any maintenance except painting as needed. It is held in place with adhesive. If ever it has to be replaced, make an appointment at a Prevost service center near you. For minor damages, refer to section 4 "Fiberglass Repair" and section 5 "Painting".

6.2 ZONE 2

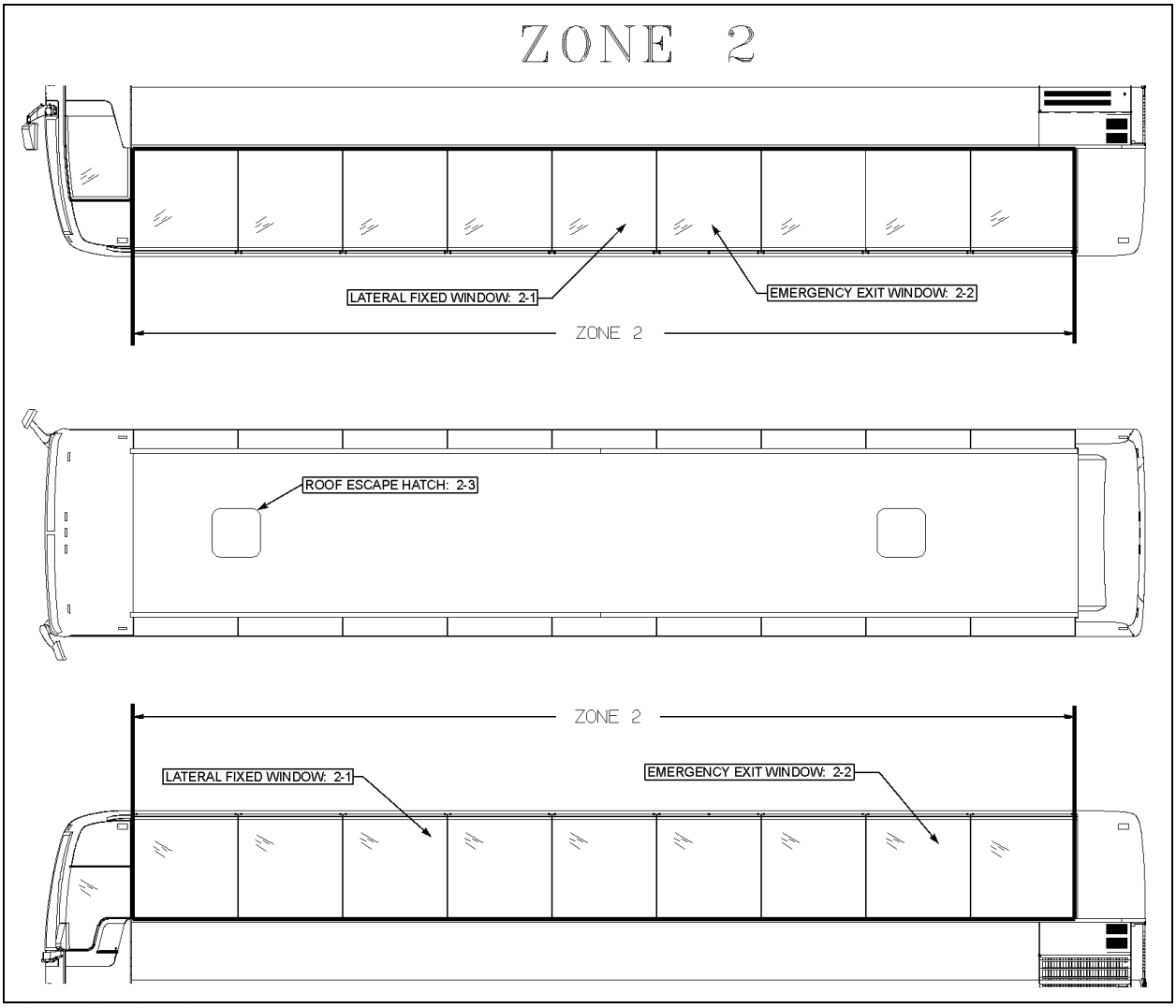


FIGURE 26: ZONE 2 18625

6.2.1 Lateral Fixed Window

Nine passenger side windows are provided on each side on X3-45. They are made of fixed, single or double-glazed, heat absorbing AS-3 glass. Windows are mounted in painted aluminum extrusions, which hold the glass in place from the top rail of the coach. The extrusion also serves as a hinge to allow the window to swing open when needed. The single-glazed windows are made of tinted tempered safety glass, while the double-glazed windows are made of tinted tempered safety glass outside and clear tempered glass inside.

For fixed side window removal or installation, you will need:

Hammer or;

Drill equipped with a sharp pointed rod into which a small hole was drilled;

Braided windshield wire and a pair of handles;

Gloves, goggles or face shield.

- **Fixed Window Removal**

  Method A

  - Apply a sticky plastic film onto window outside surface (thermos) and break window. For single pane, apply a sticky plastic film on both sides of window.

Method B

- Using a drill equipped with the special sharp pointed rod, drill through the window seal into one of the bottom corners, from a 30º angle with reference to the vehicle.
- This procedure requires accuracy and it is possible not to succeed on the first attempt. From the inside of vehicle, a second person ensures the rod passes through.
- Remove the rod, thread the wire into the small hole. Reinsert the rod and the wire into the hole far enough so that the person inside the vehicle can pull the rod using a pair of pliers.
- Attach the wire ends to the specially designed handles.
- Pull in turn from the inside and the outside of vehicle to gradually cut the Sika bead on the window perimeter.
- When you reach top corner, detach wire from the outside handle, secure it to a fish wire or rod and thread it underneath the aluminum molding behind the rivets.
- Detach wire from fish wire and continue cutting using the handle.
- Cut Sika bead until you come back to starting point, then you can remove the window by carefully pushing it out from the inside of vehicle.

- **Preparation of Structure and Installation of Window**

Preparation of Structure

- Remove old Sika adhesive.
- If primer was removed at the same time than Sika, perform the following steps:
  * Clean using anti-silicone.
  * Remove from structure old primer using a sander (120-150 grit).
  * Clean again using anti-silicone.
  * Apply 206 G+P primer.
- Reactivate 206 G+P primer.

Installation of Window

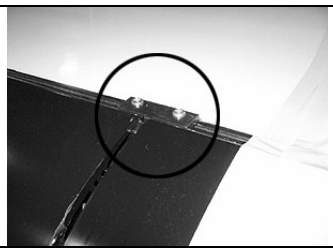
- Use window cleaner around window interior perimeter and edges to remove any oily film while inspecting for damages.
- Apply Sika Aktivator.
- Using a triangular nozzle (20mm X 10mm), apply Sika Ultrafast II onto structure.

NOTE
You only have 8 minutes to install window once the SIKA ULTRAFAST II product is applied.

- Install window.

CAUTION
To prevent damaging the Sika joint, do not raise the window once it as touched the bead.

- Before compressing window against Sika joint, install two stops into the aluminum extrusion one inch from each window edge.



- Verify window alignment with reference to adjacent surfaces.
- Vehicle must remain stationary for 30 minutes at more than 23°C.

6.2.2 Emergency Exit Windows

Three of the windows on curb side of the X3-45 serve as emergency exits, while there are four on driver's side. See figure 27. Except for the top window side, the three other glass sides are unprotected, which causes the workers to be exceptionally careful when manipulating or installing such windows.

In addition, when it becomes necessary to lay down the unprotected edges of the glass window, never use a steel or concrete floor support. It is recommended to use a wooden support, even better, a padded surface.

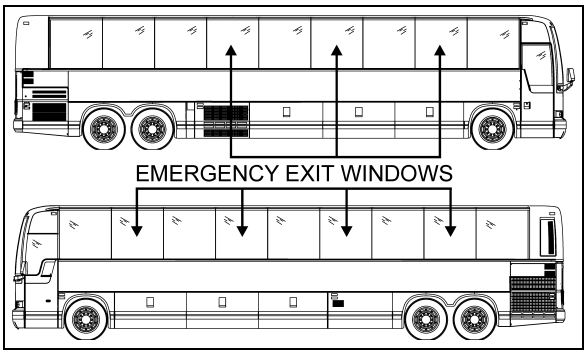


FIGURE 27: X3-45 COACH 18617

An emergency exit window can be opened by pulling the lower part of the release bar to disengage the safety latches, and then by pushing out the window frame (Fig. 28).

Emergency operating instruction decals are affixed under each emergency exit window. To close the window, pull back the window and push down the release bar.

- **Emergency Exit Release Bar**

The emergency exit release bar system is generally maintenance free. It has been designed to answer the twenty pound resistance criteria for opening the emergency window. If this handle should be replaced:

1. Remove the screws and bolts securing it to the emergency exit window;
2. Install a new release bar, reverse the procedure.

NOTE
Check the legal twenty pound maximum resistance to be sure to comply with regulations.

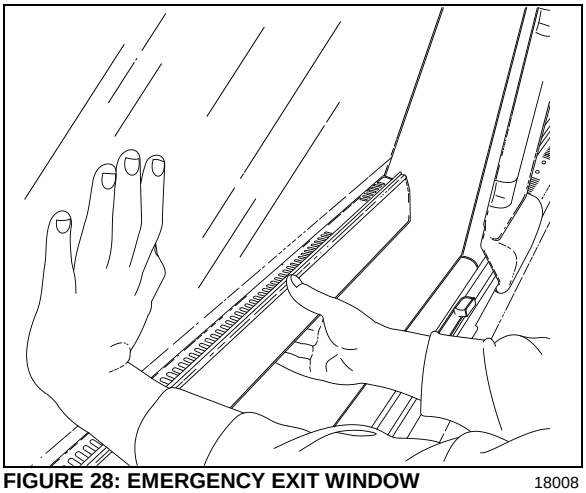


FIGURE 28: EMERGENCY EXIT WINDOW 18008

- **Emergency Exit Window Adjustment**

Emergency exit windows should be checked periodically for easy opening and closing. Pulling the lower part of the release bar with both hands placed near the safety latches should disengage both locks on the window simultaneously. The tension required to release the window should not exceed twenty pounds (9 kg) of force.

The release bar mechanism itself has been designed such as no adjustments are necessary.

If too much effort is required to disengage the locks when pulling the release bar or if the window doesn't close tightly or rattles, check for interference by foreign objects or nearby parts into mechanism, such as the microswitch, rubber seal, wires, etc. Correct situation immediately.

NOTE
Tangs on the lock must be in a horizontal position.

- **Emergency Exit Window Replacement**

1. Lift the bar release system;
2. Remove the stop blocks from the top exterior of the window.
3. Push the glass window out ninety degrees (90°).

WARNING
The window may fall out.

4. The window is free and can be unhooked.

Reverse the procedure to install a new emergency exit window.

6.2.3 Roof Escape Hatch

The vehicle can be equipped with one or two escape hatches. The escape hatch is designed to provide years of reliable service with a minimum of maintenance. All components are rust proof, and moving parts are Teflon coated to eliminate need for lubrication. Should water infiltrate the vehicle from the escape hatch, refer to the heading "Sealing" in this paragraph for procedures on how to seal this area.

CAUTION

Use of lubricants, paints, or other coatings such as graffiti deterring sprays is not recommended.

Suggested maintenance includes periodic inspection of fasteners for evidence of loosening due to tampering, and regular cleaning with mild soap and water.

Although there are other cleaning solutions available, some contain solvents and other chemicals that can attack the high strength materials used in the production of the escape hatch.

CAUTION

Ensure that cleaning solutions are compatible with the materials used on the escape hatch.

Graffiti removing cleaners often contain acetone, ether, lacquer thinner or other solvents known to destroy the high strength properties of many plastics. Use of these cleaners must be avoided. Graffiti-resisting coatings often leave a sticky residue that interferes with smooth up/down movement of the hatch mechanism. Some of these coatings also contain solvents that will reduce the strength of certain components.

CAUTION

Use of these coatings is at considerable risk and should be avoided.

- **Repair**

All components used in the production of the escape hatch are available as service parts, except for one hinge that represents a possible hazard when improperly reattached to a hidden tapping plate, itself often damaged whenever the hinge is damaged. The tapping plate is permanently laminated between the inner and outer cover assemblies, and it cannot be inspected or replaced. It is therefore necessary to replace the entire assembly following damage to the hinge. See figure 29.

CAUTION

Hinge assembly is critical and hinge should never be removed from cover assembly. Fasteners used in this assembly are special and have critical torque requirements and tamper-resistant heads to discourage tampering.

- **Sealing**

1. Open and tilt up the escape hatch cover.
2. Join the 2 ends of the rubber seal.

CAUTION

Seal joint should be toward rear of vehicle.

3. Apply rubber adhesive CA-40 (Prevost # 681285) in the gap between the seal ends.
4. Apply Sikaflex 221 sealant (Prevost # 680532) along the outline of the escape hatch on the roof of vehicle.

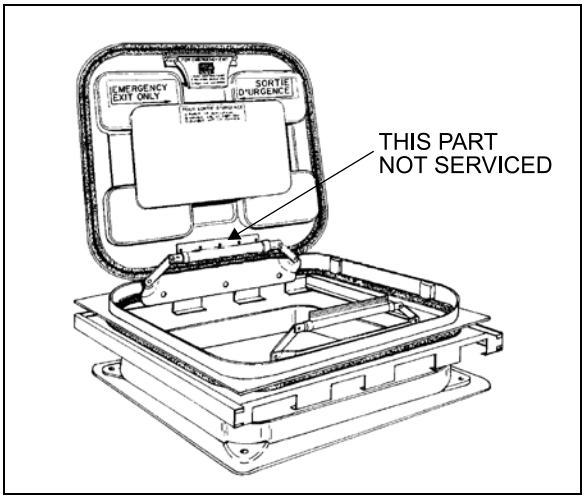


FIGURE 29: ESCAPE HATCH 18104

- **Escape Hatch Panel Assembly**

The frame of the escape hatch is riveted to the roof of the vehicle. The escape hatch panel assembly can be replaced as a unit and a new panel assembly installed in the existing frame. To remove the panel assembly, remove the 4 bolts fastening the 2 hinges to the escape hatch frame and retain the 4 flat washers. Reinstall the panel assembly by fastening the 2 hinges with the 4 bolts and flat washers removed earlier.

CAUTION

CAUTION

When installing, roof escape hatch's hinge must be toward the front of vehicle, to prevent the hatch from being ripped out if accidentally opened while vehicle is running.

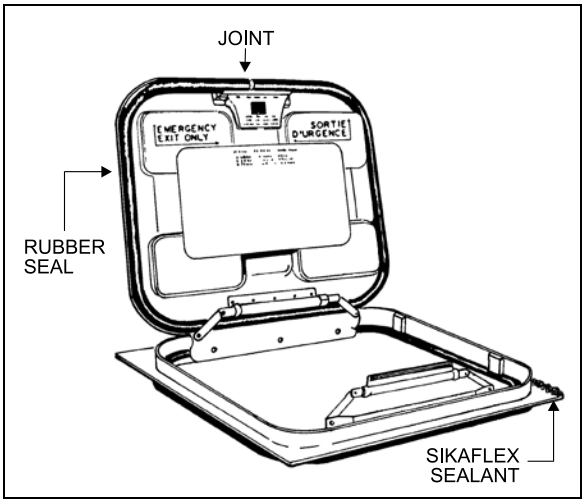


FIGURE 30: ESCAPE HATCH 18105

- **Escape Hatch Frame**

When necessary, the escape hatch frame can be removed and replaced in the following way:

1. Support the frame from inside the vehicle.
2. Remove rivets.
3. Cut the rubber seal with a sharp edge knife and remove the hatch frame.
4. On vehicle top, using the knife, remove as much as possible the remaining rubber seal.
5. Drill holes (if needed) in the new metal frame.
6. Clean both vehicle top and new hatch frame with SIKA 205.
7. Apply rubber adhesive SIKA 221 under the hatch frame surface.
8. Install the frame in place and fix it with rivets.
9. Remove excess adhesive and clean all around.

6.3 ZONE 3

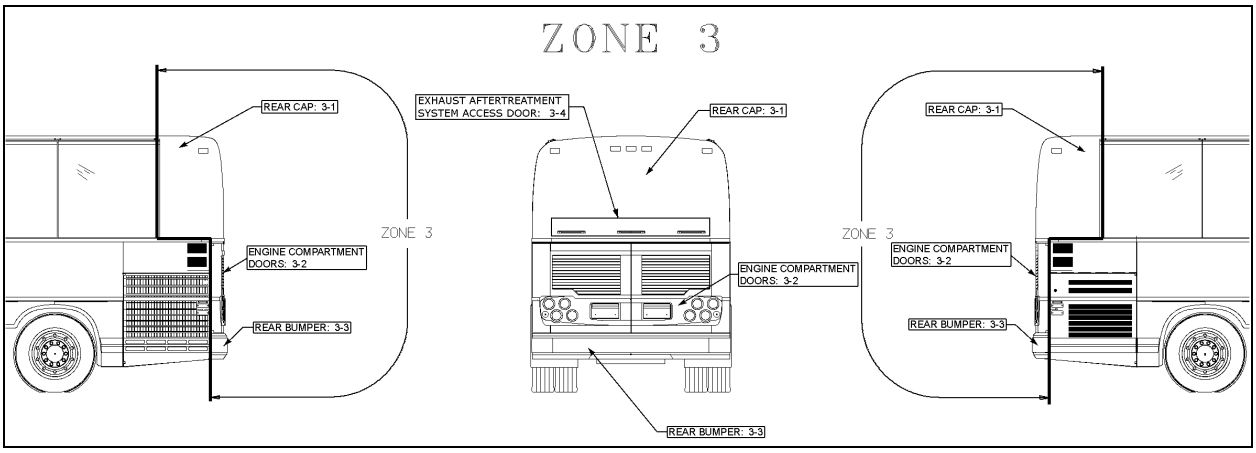


FIGURE 31: ZONE 3 18626

6.3.1 Rear Cap

The fiberglass rear cap does not need any maintenance except painting as needed. It is held in place with adhesive. If ever it has to be replaced, make an appointment at a Prevost service center near you. For minor damages, refer to Paragraph 4 "Common Fiberglass Repair Procedure" and Paragraph 5 "Common Painting Procedure".

6.3.2 Engine Compartment Doors

Engine compartment doors may be adjusted for proper fit by untightening hinge bolts:

1. Loosen the bolts, (1, 2 Fig. 32) holding the hinge to the vehicle structure to shift the door "UP or DOWN".
2. Loosening the bolts (3, Fig. 32) allows the door to be shifted "LEFT or RIGHT" and "IN or OUT".
3. Adjust the doors position depending on the gap needed between exterior finishing panels.

4. Tighten the bolts.
5. Check that the doors swing freely and close properly. It may be necessary to adjust the door latch to get proper fit and operation.

To adjust the latch mechanism (4, Fig. 32) and the striker pin:

1. Open the doors to access the striker pin.
2. Slightly loosen the striker pin.
3. Using a hammer, adjust the striker pin to center it in the door latch mechanism.
4. Tighten the striker pin.
5. Check doors fit and operation.

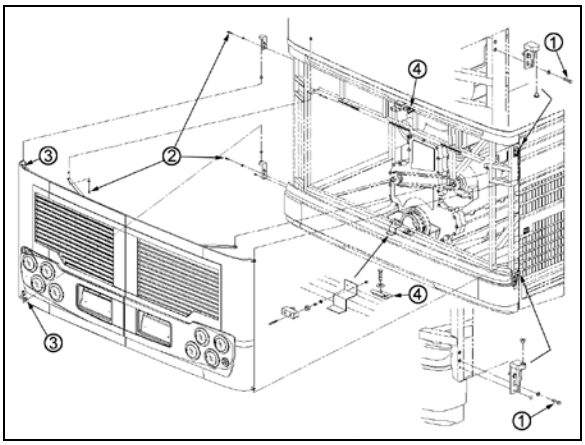


FIGURE 32: ENGINE COMPARTMENT DOORS 18633

6.3.3 Rear Bumper

Remove three bolts on each side holding bumper to vehicle and remove bumper.

To install bumper, reverse the procedure.

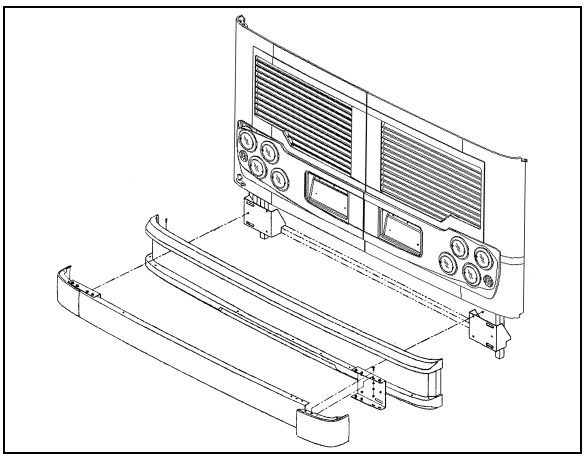


FIGURE 33: REAR BUMPER 18634

6.3.4 Exhaust Aftertreatment System Access Door

1. Open exhaust aftertreatment system access door.
2. Loosen the screws holding the panel to hinge assembly.
3. Adjust the door position according to distance required between exterior finishing parts.
4. Tighten the nuts.
5. Check that the door swings freely and closes properly.

6.4 ZONE 4

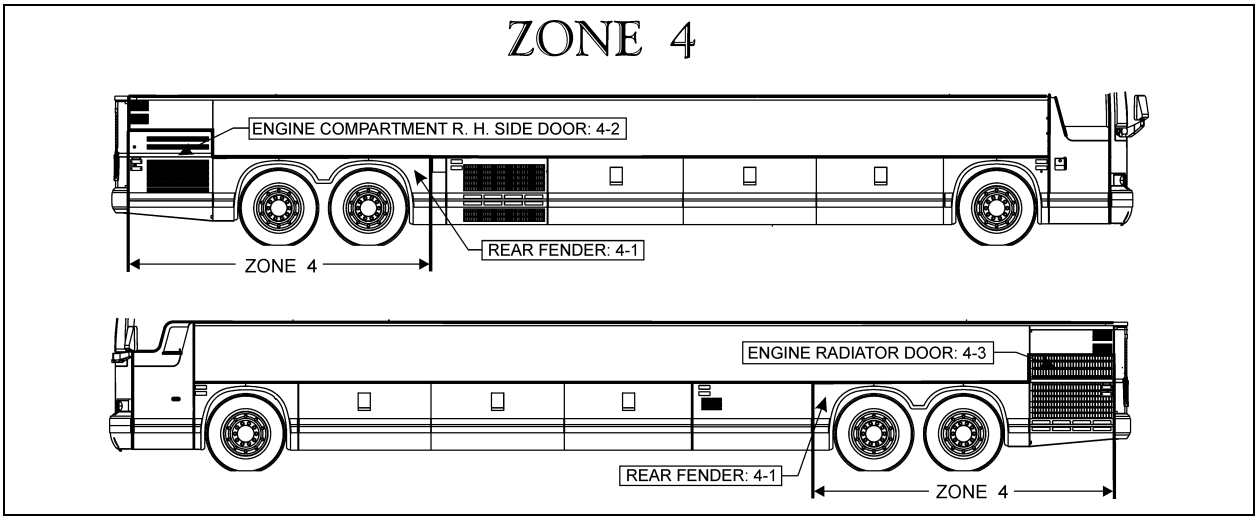


FIGURE 34: ZONE 4 18627

6.4.1 Rear Fender

On the "X3" series vehicle, rear fenders are hinged for maintenance on brakes and suspension. Each rear fender panel has two mechanical spring loaded holding devices fixing it to the vehicle's structure. Push the spring type rod sideways to disengage the lock.

6.4.2 Engine Compartment R. H. Side Door

Engine compartment R. H. side door may be adjusted for proper fit by untightening hinge bolts:

1. Loosen the bolts, (1, Fig. 35) holding the hinge to the vehicle structure to shift the door "IN or OUT" and "UP or DOWN".
2. Loosening the bolts (2, Fig. 35) allows the door to be shifted "LEFT or RIGHT" and "UP or DOWN".

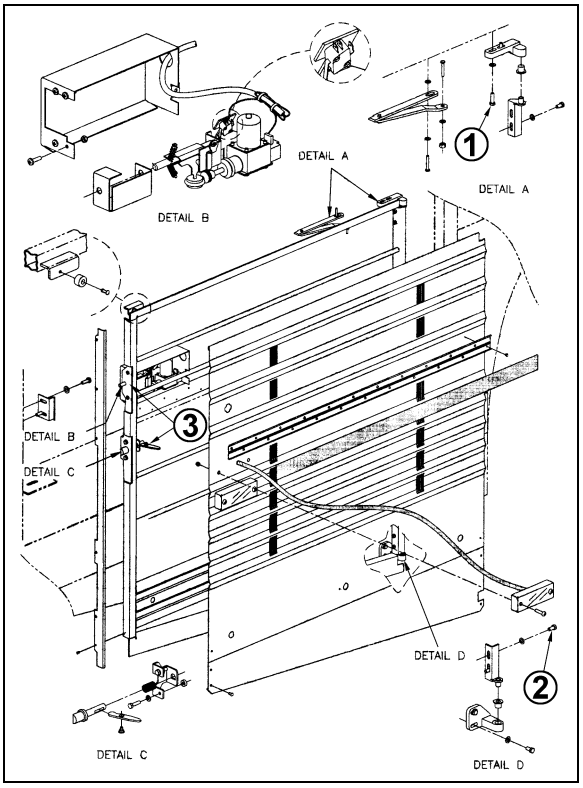


FIGURE 35: ENGINE COMPARTMENT R.H. SIDE DOOR 18635

3. Adjust the door position depending on the gap needed between exterior finishing panels.
4. Tighten the bolts.
5. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

To adjust the latch mechanism (3, Fig. 35) and the striker pin:

1. Open the door to access the striker pin.
2. Slightly loosen the striker pin.
3. Using a hammer, adjust the striker pin to center it in the door latch mechanism.
4. Tighten the striker pin.
5. Check door fit and operation.

6.4.3 Engine Radiator Door

Radiator door may be adjusted for proper fit by untightening hinge bolts:

1. Loosen the bolts, (1, Fig. 36) holding the hinge to the vehicle structure to shift the door "IN or OUT" and "UP or DOWN".
2. Loosening the bolts (2, Fig. 36) allows the door to be shifted "LEFT or RIGHT" and "UP or DOWN".

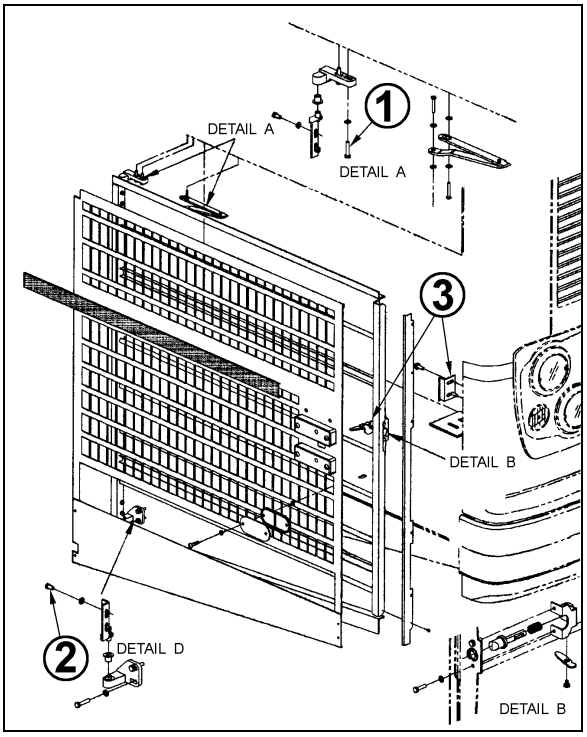


FIGURE 36: RADIATOR DOOR 18636

3. Adjust the door position depending on the gap needed between exterior finishing panels.
4. Tighten the bolts.
5. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

To adjust the latch mechanism (3, Fig. 36) and the striker pin:

1. Open the door to access the striker pin.
2. Slightly loosen the striker pin.
3. Using a hammer, adjust the striker pin to center it in the door latch mechanism.
4. Tighten the striker pin.
5. Check door fit and operation.

6.5 ZONE 5

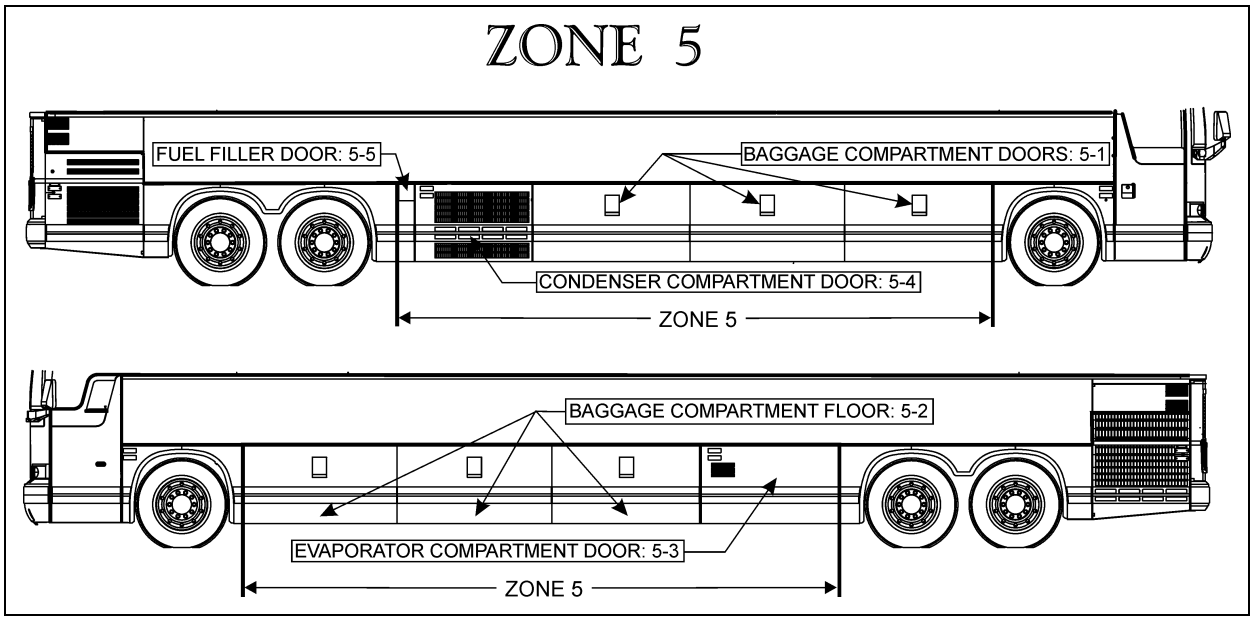


FIGURE 37: ZONE 5 18628

6.5.1 Baggage Compartment Doors

For the removal and installation of baggage compartment door stainless steel body panel, you will need:

A drill with drill bits;

Pneumatic “Zip gun” type tool;

Razor sharp window scraper or putty knife;

- Open damaged compartment door and unfasten rub rail fixing bolts. Remove rub rail.
- Unfasten bolts and disconnect cable if necessary in order to remove door from vehicle.
- Preferably install the door onto a work surface where it can be solidly fixed.

- **Door Lower Panel**

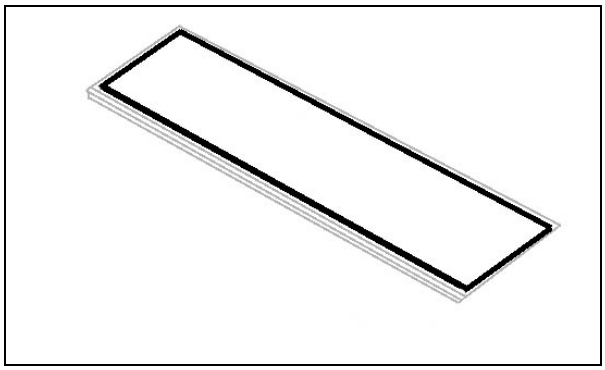
  Panel Removal

  - Using the “Zip Gun”, cut Sika bead located ½ inch from the door panel perimeter edge.
  - Wearing gloves, goggles and ear plugs, pry loose body panel using a “Zip gun” or lever starting from the door lower part.
  - Using the window scraper, remove any Sika bead or self adhesive tape residue left on the door frame.

  Lower Panel Preparation and Installation

  - Use a Chix cloth and anti-silicone to remove any dust or residue from door frame.
  - Prepare door frame using a scratch pad “Scotch Brite”.
  - Clean door frame again using anti-silicone.

- Apply some Sika 206 G+P onto door frame.
- Clean door lower panel using anti-silicone.
- Prepare door lower panel using a scratch pad “Scotch Brite”.
- Clean door lower panel again using anti-silicone.
- Apply some Sika 206 G+P onto door lower panel.
- Using a triangular nozzle (8mm X 9mm), apply some Sika 255 onto door lower panel.



- Position and install door lower panel onto frame.
- Compress and hold for 8 hours.

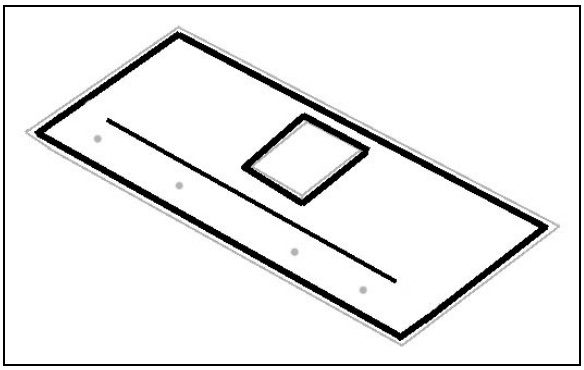
- **Door Upper Panel**

Upper Panel Removal

- From the back of the baggage compartment door, remove handle housing fixing screws (6).
- Remove lock access panel
- Wearing gloves, goggles and ear plugs, pry loose body panel using a “Zip gun” or lever starting from the door lower part.
- Cut Sika bead around handle housing.
- Using the window scraper, remove any Sika bead or self adhesive tape residue left on the door frame.

Upper Panel Preparation and Installation

- Use a Chix cloth and anti-silicone to remove any dust or residue from door frame.
- Prepare door frame using a scratch pad “Scotch Brite”.
- Clean door frame again using anti-silicone.
- Apply some Sika 206 G+P onto door frame.
- Clean door upper panel using anti-silicone.
- Prepare door upper panel using a scratch pad “Scotch Brite”.
- Clean door upper panel again using anti-silicone.
- Apply some Sika 206 G+P onto door upper panel.
- Using a triangular nozzle (8mm X 9mm), apply some Sika 255 onto door lower panel.



- Position and install door upper panel onto frame.

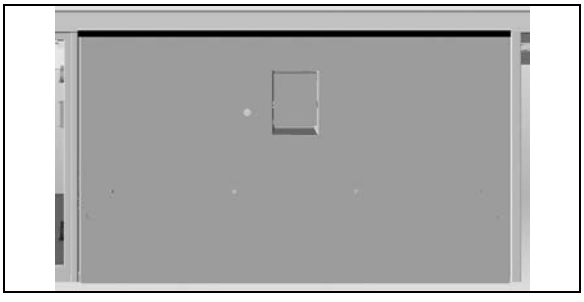
NOTE
Use rub rail fixing holes for upper panel proper positioning.

- Compress and hold for 8 hours.

Baggage Compartment Door Adjustment

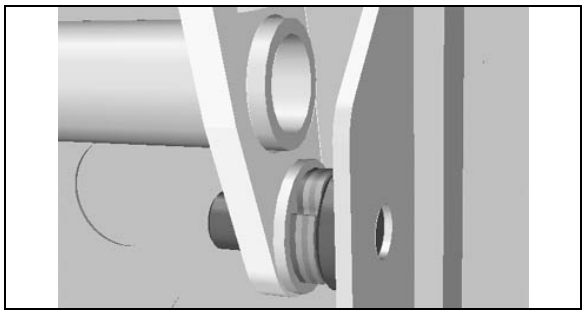
- Adjust door to get a 7mm gap at the top.

NOTE
Adjustment is made using the side plates.



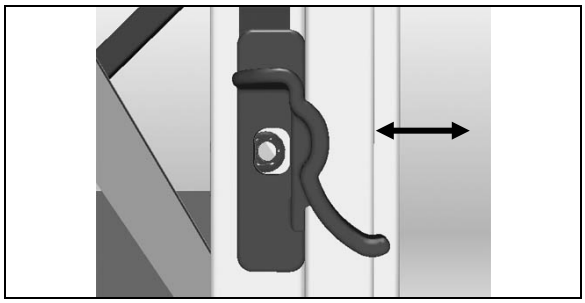
- Center door in the opening using the side plate shims.

NOTE
Adjustment is made using shims on the side plates. A total of 8 shims per door must be used e.g. 4 on L.H. side and 4 on R.H. side or 2 on L.H. side and 6 on R.H. side, etc.



- Adjust door position and evenness with reference to adjacent panels and doors.

NOTE
Adjustment is made by moving IN or OUT the lock plates. Adjust one corner at a time.



- Check handle adjustment. Handle must remain tight against its plastic housing.

NOTE
Adjustment is made by moving UP or DOWN the lock plates.

- Open baggage compartment door and adjust height using the catch plates.
- Tighten cylinder blocks fixing screws.

6.5.2 Baggage Compartment Floor

- **Repair of Mantex Urethane Covering**

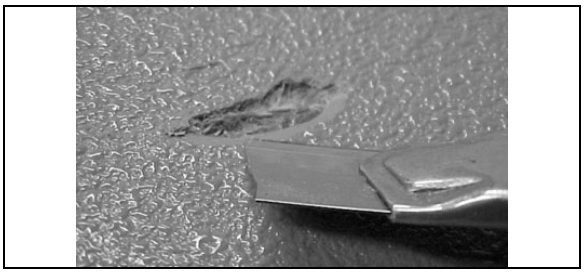
Minor Repair

Use “Dupont IMRON” paint. Apply using a paint brush or roller depending on gravity.

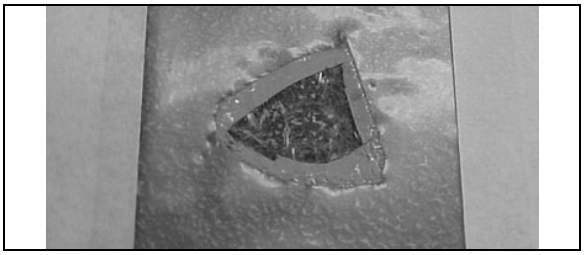
Paint Code: #J4099U

Major Repair (Hole)

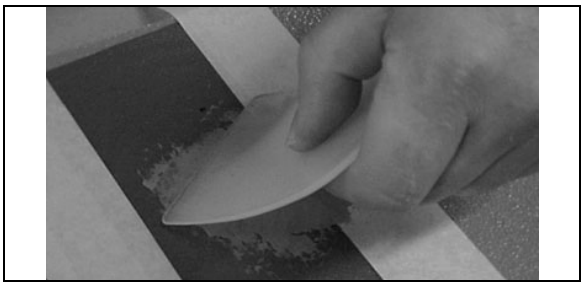
Chamfer the whole perimeter of the damaged area. If applicable, remove loose covering. Remove dust and particles.



Cover and protect damaged area surroundings.



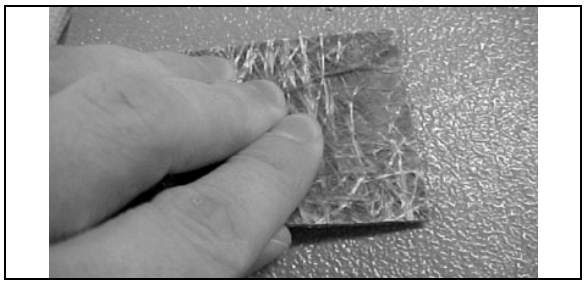
Using a plastic spatula, apply some Sika 221 grey onto the damaged area.



Remove masking tape and protection around damaged area.

Spray pure water onto Sika. Use a floor sample to create some texture onto the adhesive.

If possible spray some more water onto the adhesive to accelerate curing.

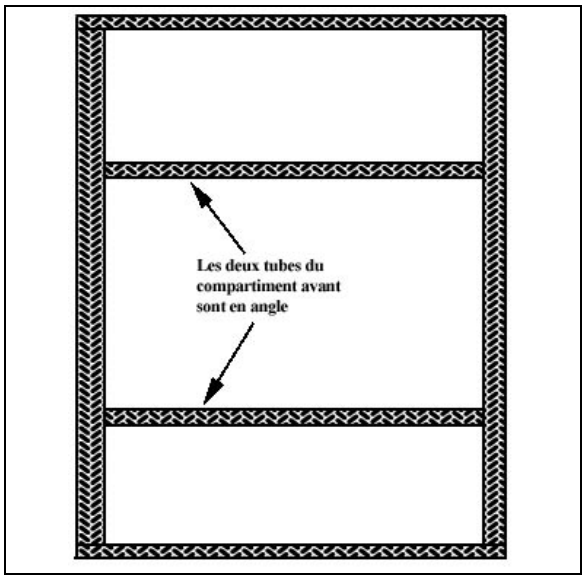


Allow drying for at least **2 hours** then repaint as per paragraph: Minor Repair.

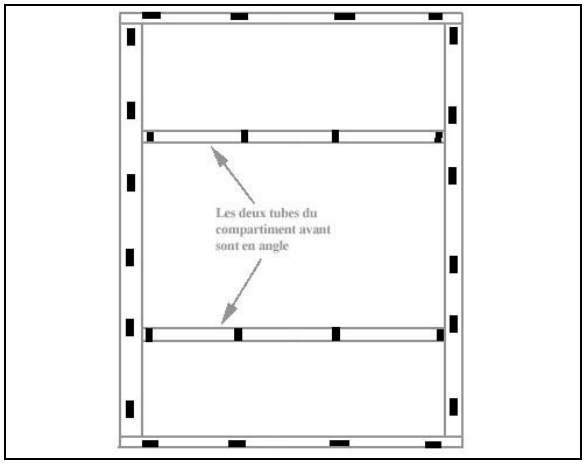
- **Baggage Compartment Floor Installation**

  Preparation and Installation

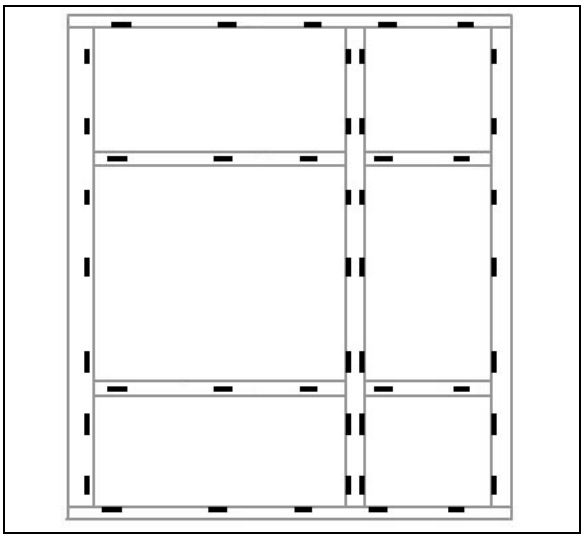
Clean baggage compartment support structure using anti-silicone.



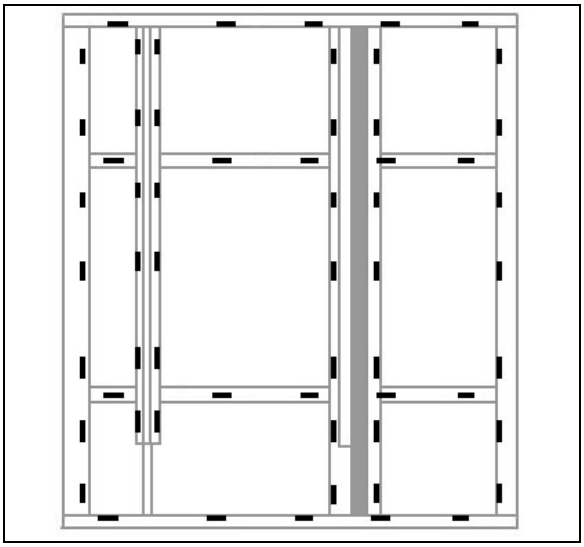
Glue spacers (790392) about 16-inch apart.



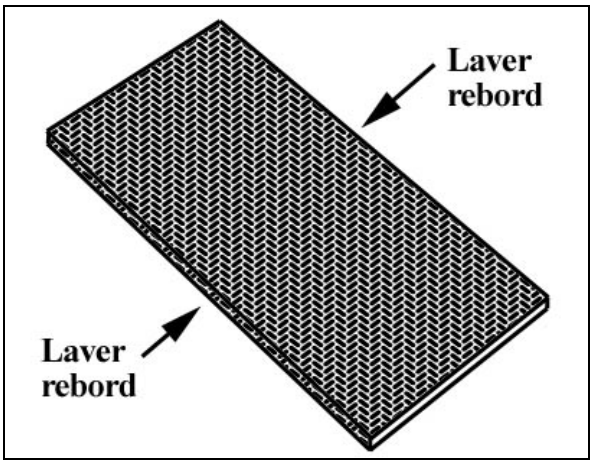
Rear baggage compartment without WCL.



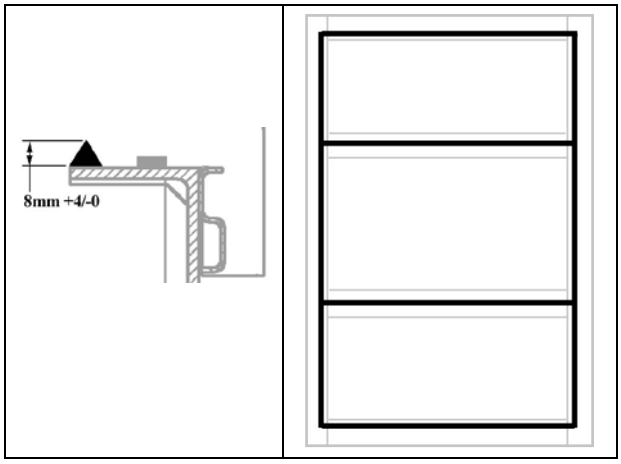
Rear baggage compartment equipped with WCL



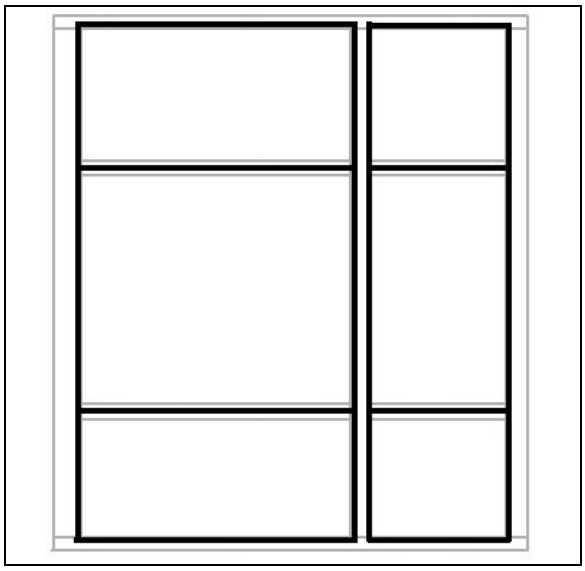
Prepare baggage compartment Mantex floor. Clean panel underside and edges.



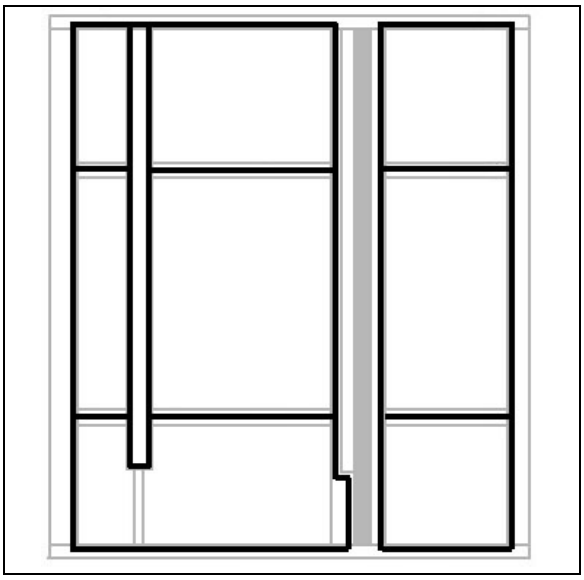
Using a triangular nozzle, apply “Simson” glue (685126) onto support structure.



Rear baggage compartment without WCL.



Rear baggage compartment equipped with WCL

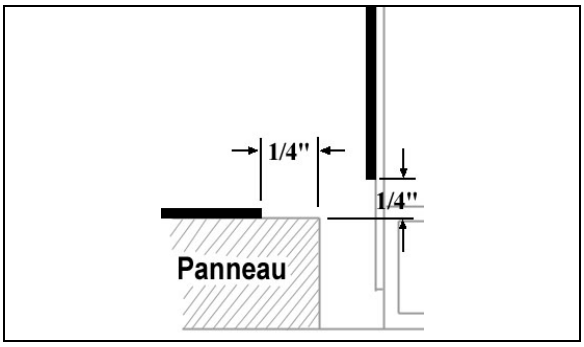


Carefully install panel onto support structure.

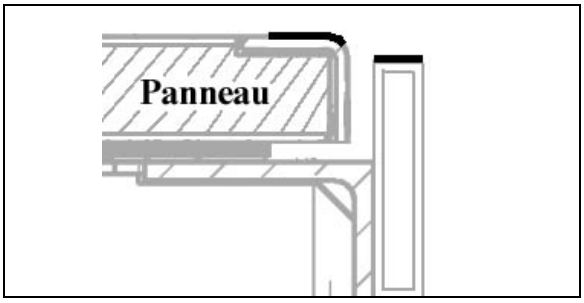
Evenly distribute and install conforming weights (6 to 8) (80 to 100 lbs **total**) onto panel for at least **4 hours**. Make sure panel does not move.

Finishing Joints

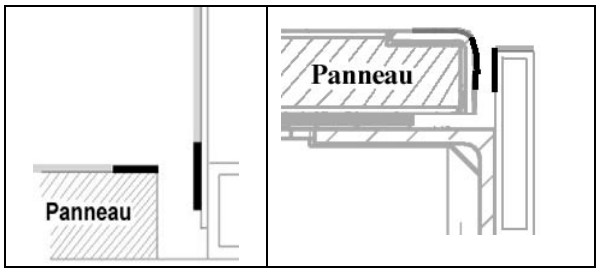
In the case of lateral finishing joint, apply some masking tape ¼“ from panel edge and ¼” above panel.



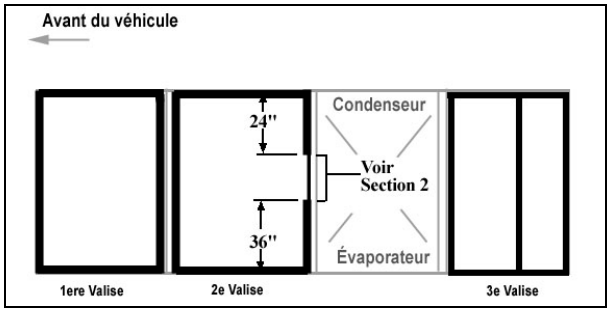
In the case of front finishing joint, apply some masking tape on each side of joint.

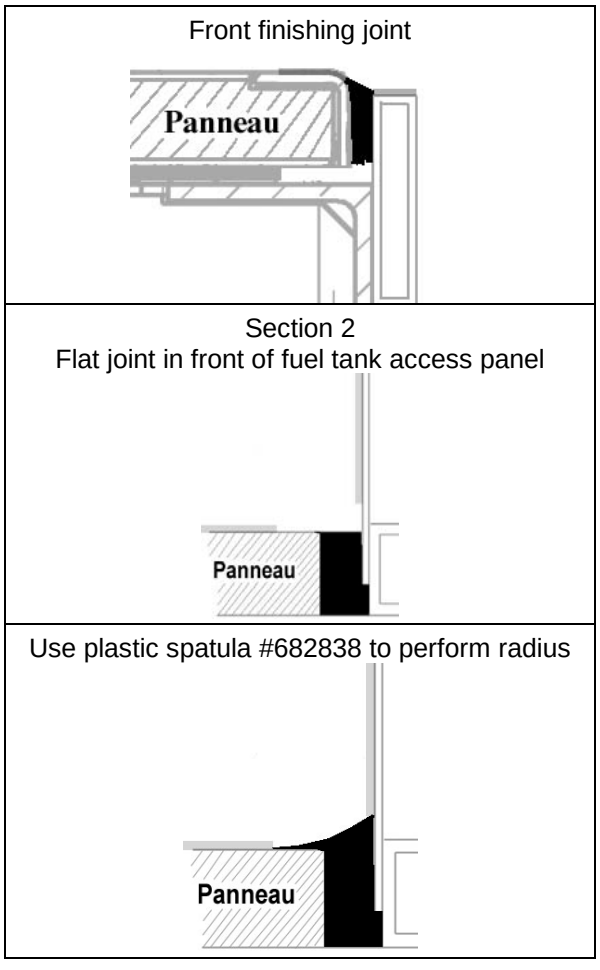


Clean with anti-silicone the area where the Simson glue will be applied.

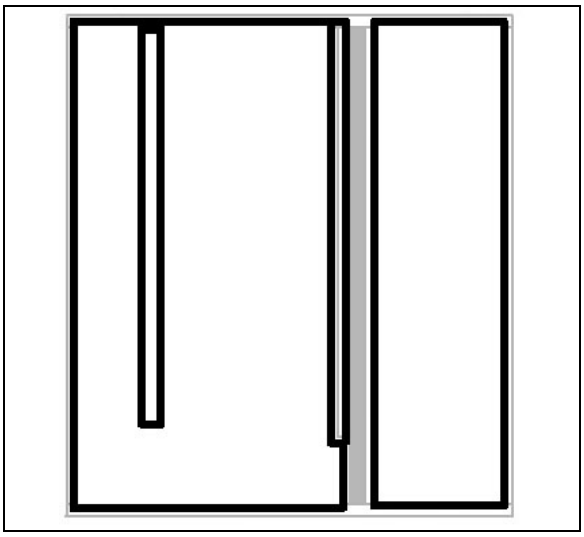


Apply some Simson glue to fill the gap.

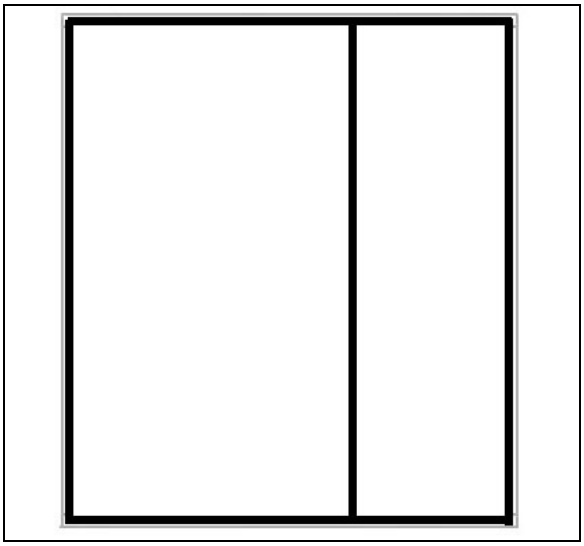




Rear baggage compartment equipped with WCL



Rear baggage compartment without WCL.



Remove masking tape.

Smooth down joints using soapy water.

6.5.3 Evaporator Compartment Door

1. Open the evaporator door.
2. Loosen the screws fixing the hinge to hinge attachment or hinge to door assembly. Loosening the screws allows the evaporator door assembly to be shifted "LEFT or RIGHT" and "UP or DOWN" or “IN and OUT”.
3. Adjust evaporator door assembly position at the hinge.
4. Tighten the screws.

5. Respect the required gap between exterior finishing panels.
6. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

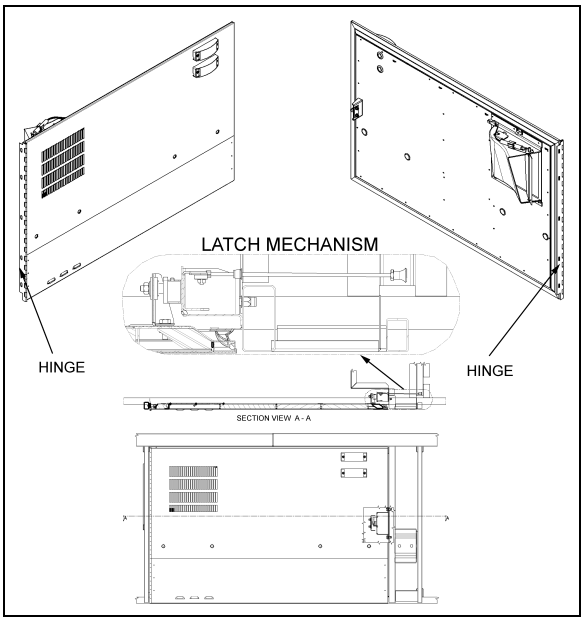


FIGURE 38: EVAPORATOR DOOR 18637

6.5.4 Condenser Compartment Door

1. Open the condenser door.
2. Loosen the screws fixing the hinge to hinge attachment or hinge to door assembly. Loosening the screws allows the condenser door assembly to be shifted "LEFT or RIGHT" and "UP or DOWN" or “IN and OUT”.
3. Adjust condenser door assembly position at the hinge.
4. Tighten the screws.
5. Respect the required gap between exterior finishing panels.
6. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

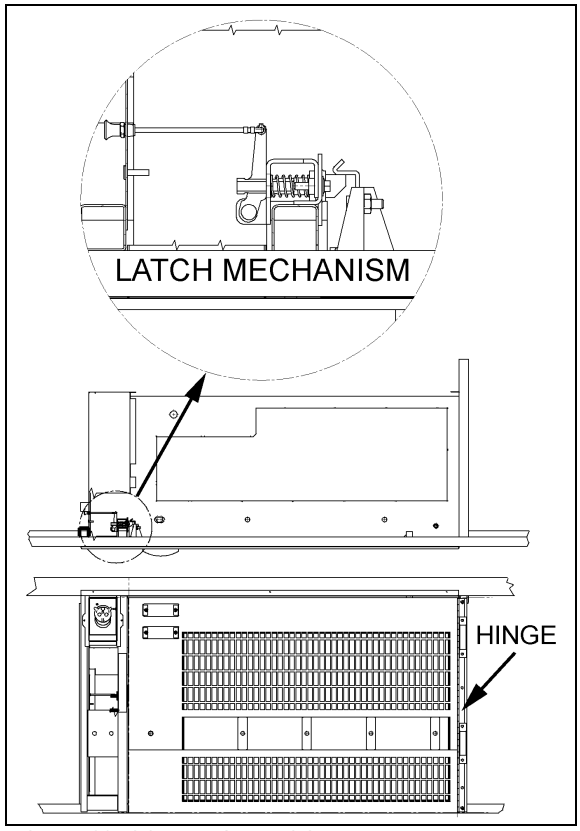


FIGURE 39: CONDENSER DOOR 18638

6.5.5 Fuel Filler Door

1. Open the fuel filler door.
2. Loosen the screws holding the panel to hinge assembly.
3. Adjust the fuel filler door position according to distance required between exterior finishing panels.
4. Tighten the nuts.
5. Check that the door swings freely and closes properly.

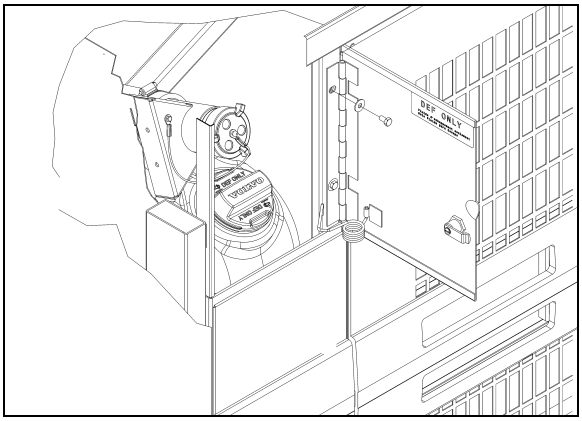


FIGURE 40: FUEL FILLER DOOR 03046

6.6 ZONE 6

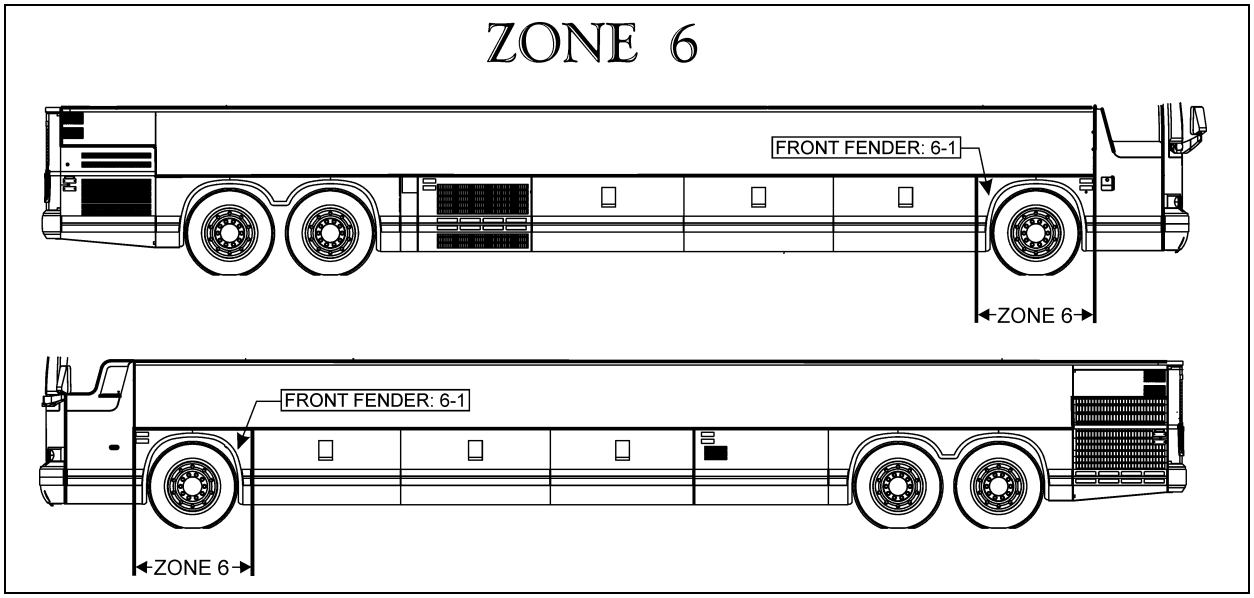


FIGURE 41: ZONE 6 18629

6.6.1 Front Fender

Front fender may be removed using the following procedure:

Remove the nuts on the inside of the fender. Remove the fender from the vehicle. To reinstall, reverse the procedure.

6.7 ZONE 7

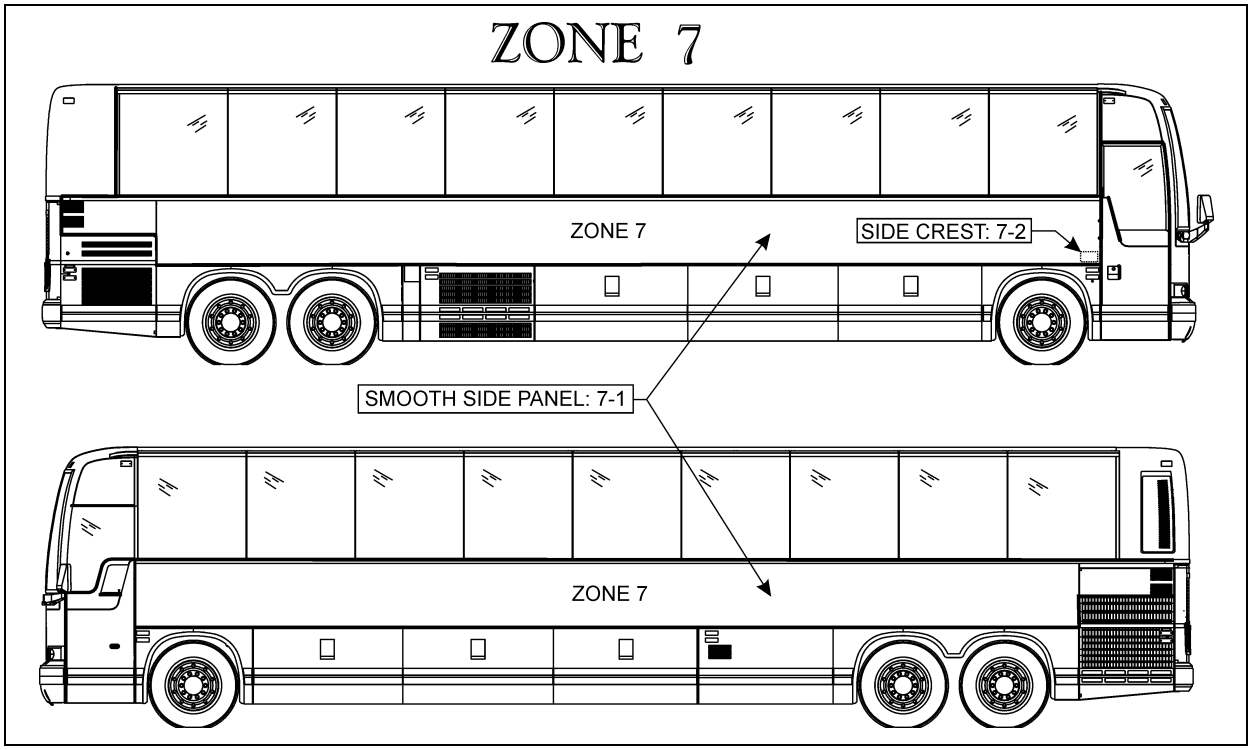


FIGURE 42: ZONE 7 18630

6.7.1 X3 Smooth Side Panel Replacement Procedure

Material:

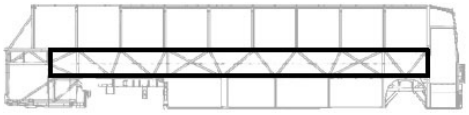
Anti-silicone (682989)	√	Scotchbrite gray (680226)	√	Sika 221 gray	√
CHIX cloth (682384)	√	Sika 205 1liter (683097)	√	Sika 252 black	√
Blue cloth (682383)	√				

Equipment:

Glue gun	√	
Pencil	√	

SECTION 1 SMOOTH SIDE PANEL REMOVAL			
1.00	**REMOVAL**		
	A)	Remove finishing molding. Insert a screwdriver into snap-on finishing molding joint. Bend finishing molding enough to be able to fix a pair of locking pliers. Using the pair of locking pliers, pull the stainless steel molding and at the same time gradually cut Sika bead with a sharp knife.	Be careful not to damage the adjacent surfaces.
	B)	Using a hammer and punch, drive out rivet shanks from top and bottom and from front and rear finishing molding supports. Use a #11 titanium drill bit to remove rivet heads.	
	C)	Grind tig weld spots at each end of side panel.	
	D)	Safely support or temporary fix side panel.	**Warning: Panel weights over 200 pounds**
	E)	Insert a flat screwdriver between the side panel and the vehicle chassis, in the top left and right corners. Make sure to separate side panel from structure.	Be careful not to damage the adjacent surfaces.
	F)	Use the c-clamp to separate the side panel from the back structural panel and at the same time gradually cut Sika bead with a sharp knife.	Ideally, the hoist or chain block must be fastened to the floor while pulling from a 45^{o} angle so as not to damage the vehicle structure
	G)	Remove as much glue as possible from the structure using a putty knife or pneumatic knife without damaging 206 G+P primer.	Never heat SikaFlex adhesive to remove.
	H)	Check panel horizontal supports for straightness using a straight edge. Take measurements with a ruler.	Tolerance : 1mm towards the outside and 1.5mm towards the inside.

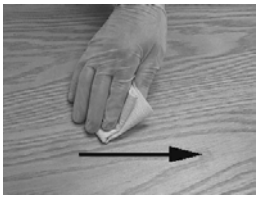
SECTION 2 PREPARATION OF SURFACES

2.00	**VEHICLE SURFACE PREPARATION**		
	A)	Clean using "anti-silicone" until all clothes come clean. See PR000001 section A.	
	B)	Use the belt sander (grit coarse) Use a new paper on each vehicle side.	
	C)	Clean using "anti-silicone" until all clothes come clean. See PR000001 section A.	
	D)	Apply – Sika 205 See PR000001 section B.	
2.05	**SIDE PANEL PREPARATION**		
	A)	Clean using “anti-silicone” until all clothes come clean. See PR000001 section A.	
	B)	Use the belt sander (grit coarse) Use a new paper on each vehicle side panel.	
	C)	Clean using “anti-silicone” until all clothes come clean. See PR000001 section A.	
	D)	Apply – Sika 205 See PR000001 section B.	

PR000001 Section A Alcohol or Anti-silicone

1. **Apply**

CHIX cloth



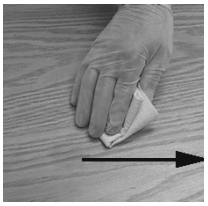
2. **Dry immediately**

Blue cloth

3. **Allow to dry**

Mandatory	**Minimum time : Wait for product to evaporate**
	After 2 hours: Start cleaning operation again
Before applying any other product	If surface seems dusty, greasy or with finger marks, start cleaning operation again.

Section B Sika 205



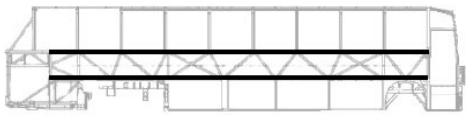
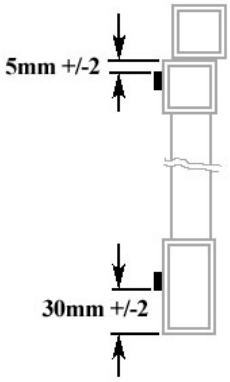
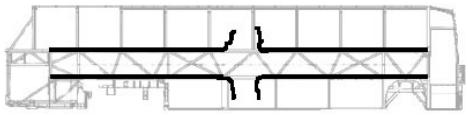
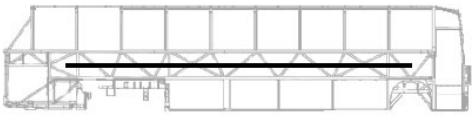
1. **Apply**

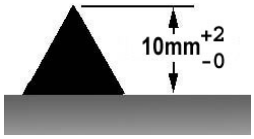
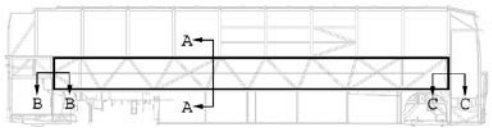
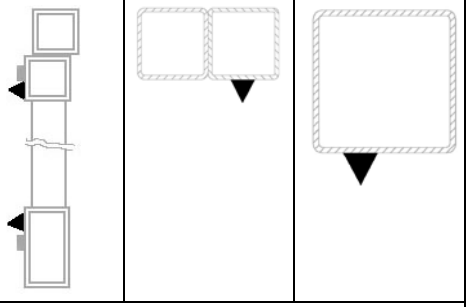
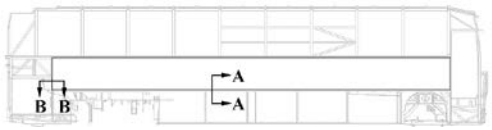
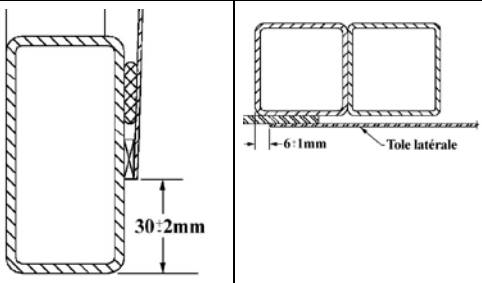
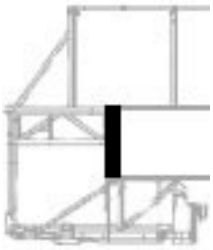
CHIX cloth

2. **Allow drying**

Mandatory	**Minimum time**	**- For a smooth surface (aluminum, stainless, steel, fiber glass (gelcoat side), etc.):**	**2 minutes**
		- Pour a porous surface (fiber glass (non gelcoat side), etc.)	**10 minutes**
	After 2 hours : Reactivate surface with Sika 205		
Before applying any other product	If surface seems dusty, greasy or with finger marks, start operation again.		

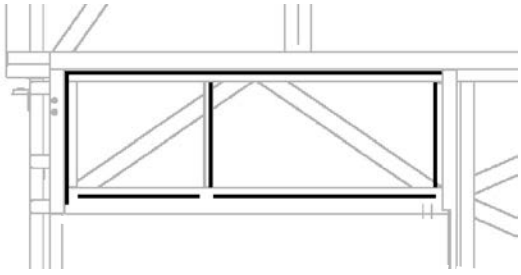
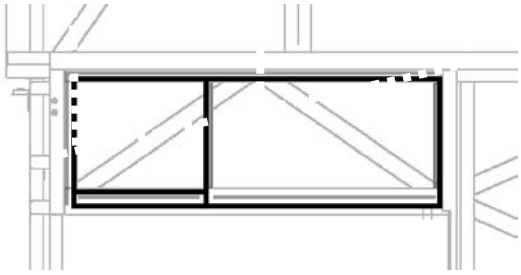
SECTION 3 SIDE PANEL INSTALLATION

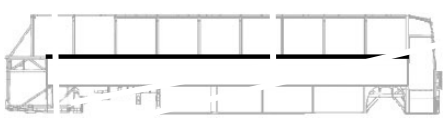
3.00	A)	Using a pencil, mark the double-face self adhesive tape position onto vehicle side.	
	B)	Apply 1/8 X ½"double-face tape as per marking.	
	C)	Compress tape	
	D)	Remove protective film from double-face self adhesive tape center section.	
3.05	Install 1/8 X ½" foam tape onto middle reinforcement then compress.		

<table>
<tr><td>3.10</td><td colspan="2">Apply Sika 252
 
– Onto vehicle surface
– Cut nozzle as per template
– Use the guide for the application
Bead must be continuous for the whole perimeter.</td><td> 
Section A-A | Section B-B | Section C-C
  </td></tr>
<tr><td rowspan="5">3.15</td><td>A)</td><td>Install side panel onto support jig.</td><td>  </td></tr>
<tr><td>B)</td><td>Position side panel in front of vehicle structure</td><td>Section A-A | Section B-B
  </td></tr>
<tr><td>C)</td><td>Perform final adjustment to make sure that side panel is true and square</td><td>– 30 mm. ± 2 with reference to bottom tubing
– 6 mm ± 1 with reference to vertical tubing</td></tr>
<tr><td>D)</td><td>Sand rear of side panel 2" wide</td><td>  </td></tr>
<tr><td>E)</td><td>Perform tig spot welding (1” apart)</td><td>Quantity of "tig spot": 30 minimum.</td></tr>
<tr><td rowspan="2">3.20</td><td>A)</td><td>Install pulling equipment at the other end of side panel</td><td></td></tr>
<tr><td>B)</td><td>Make a final adjustment in height</td><td></td></tr>
</table>

	C)	Sand front of side panel 2" wide	
	D)	Pull side panel so that panel moves 1/8"	Make sure the equipment pulls along the whole width of side panel
	E)	Perform tig spot welding	Quantity of "tig spot": 30 minimum.
3.30	Remove pulling equipment		
3.40	A)	Remove protective film from double-face self adhesive tape.	
	B)	Compress top and bottom section of side panel	
3.50	A)	Cut excess of side panel. Make sure that cut is parallel with tubing.	
	B)	Grind side panel end to line up with door tubing.	
3.60	To seal each panel end, apply masking tape on each side of side panel joint. Use a caulking nozzle and grey Sikaflex 221 adhesive to fill the cavity between the panel and vehicle structure. Clean using Sika 205. Allow 5 minutes minimum for drying. Wear surgical gloves and smooth down the joint with your finger.		

SECTION 4 ENGINE AIR INTAKE PANEL INSTALLATION		
4.00	Make sure that sealing of structure has been performed properly	
4.05	Prepare vehicle surface as for side panel.	Refer to step # 2.00
4.10	Prepare air intake panel as for side panel	Refer to step # 2.05

4.15	Install foam tape 1/8" X ¼" onto structure, as shown in picture	
4.20	Install foam tape 1/16" X ¼ onto air intake panel pleat	
4.25	Apply a bead of 252 onto structure as per picture Important: Make sure bead is continuous Triangular bead: 10mm x 8mm	
4.30	Install panel onto structure	Use a jig to make sure that panel is lined up with engine door or tubing.
4.40	Use a brush to compress Sika bead	

5.00 *		

	A)	Install a protective tape onto the tubing above welding	
	B)	Apply Sika 205 Use a plastic spatula inside a Chix cloth to ensure that Sika 205 reaches as far as the corner. See PR000001 section B.	
	C)	Apply Sika 252 black at the junction of both tubing. Smooth down the joint	
	D)	Remove protective tape	

6.7.2 Side Crest

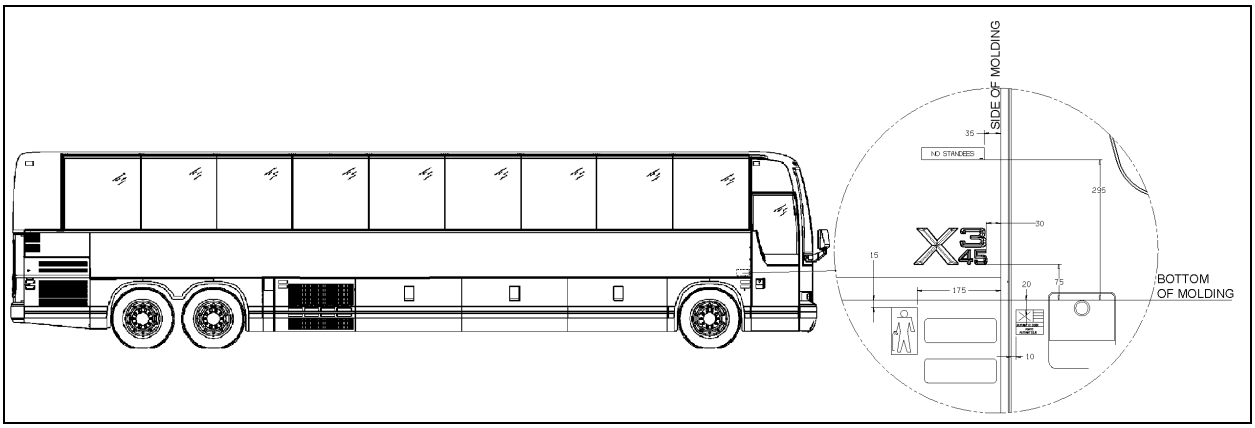


FIGURE 43: SIDE CREST POSITIONING 18639

- Clean vehicle surface using anti-silicone where the side crest and stickers will be applied.
- Using hands apply and compress side crest.
- Apply required stickers.

6.8 BODY PANEL AND WINDOW SPACING

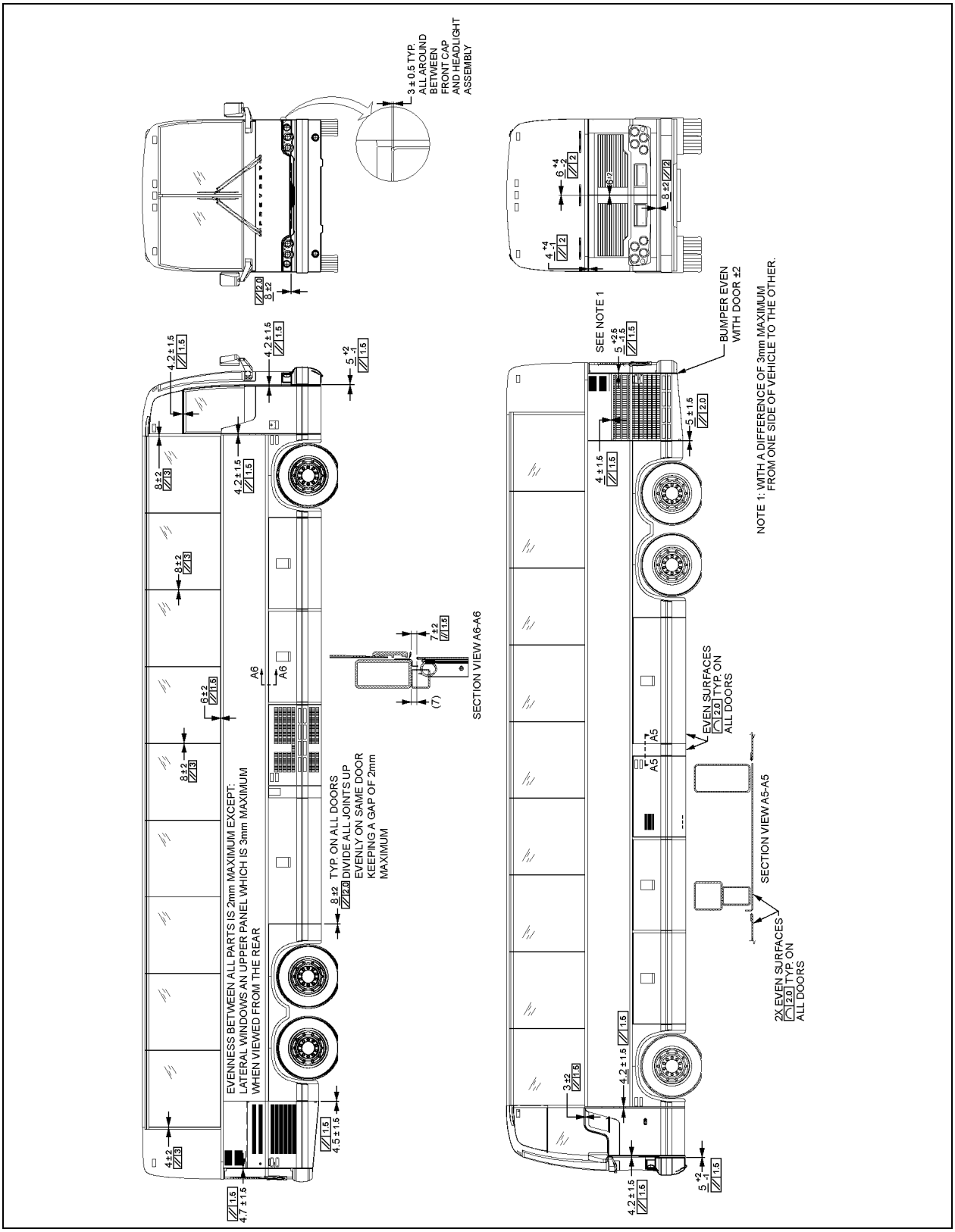


FIGURE 44: BODY PANEL AND WINDOW SPACING 18631

6.9 PASSENGER SEATS

X3 coaches can be equipped with any of 3 basic seat models and installed in a variety of seating arrangements:

1. The *"Tourismo 2"* seat is the base model and is available in heights of 40" (102 cm) and 42" (107 cm). Seating arrangement includes 2 card tables which can be folded and removed, and pivoting seats ahead of each card table. Each pair of seats is built on a welded steel frame fastened to the side wall and on a track-mounted pedestal.
2. The *"Silhouette"* seat is an optional model with each pair also built on a welded steel frame and mounted the same way as the *"Tourismo 2"* seat. Standard seating arrangement with "Silhouette" seat includes 2 card tables and 2 pivoting seats. Seating capacity is the same as with the *"Tourismo 2"* seat.
3. The *"V.I.P."* seat model is an optional seat. *"V.I.P."* seats are mounted on one row of paired seats built on a common frame on one side of the vehicle, and a row of single seats on the other side of the vehicle with an off-center aisle. Each *"V.I.P."* seat has its own set of armrests.

Each seat has a easily removable bottom cushion. Upholstery is clipped on the cusion frame for cleaning or replacement. To remove the fabric, simply unclip from the frame. The *"Tourismo 2"* and *"Silhouette"* seats have 3 armrests. The aisle and center armrests can be folded up and down manually, while the window armrest is fixed.

6.9.1 Rotating Seats

1. Remove 1 wing nut holding each seat bottom cushion from under the seat frame.
2. Lift front part of cushions and remove cushions.
3. Remove 4 wing screws fastening seat assembly to seat frame.
4. Pull seat toward aisle and rotate.
5. Align mounting holes and reinstall 4 wing screws.
6. Reinstall seat bottom cushions with wing nuts.

6.9.2 Removing Fixed Seats

> ***NOTE***
>
> *Seats on one row are not interchangeable with seats of the other row.*

To remove fixed seats, proceed as follows:

1. Remove 1 nut holding each seat bottom cushion from under the front part of the seat frame.
2. Lift front part of cushions and remove cushions.
3. Remove 4 finishing screws holding plastic cover between side wall and seat frame.
4. Remove 2 cap screws, nuts, and washers holding seat frame to side wall and retain the 2 holding brackets. See figure 45.
5. Remove 2 nuts and washers holding seat frame to pedestal rods. See figure 46.

> ***NOTE***
>
> *Bottom end of rod is coated with Locktite and threaded in a steel block which slides in the floor track. Removal of rod is possible if loosened from block. Otherwise, slide rod and block assembly to the front end of track after removing all seats located in front.*

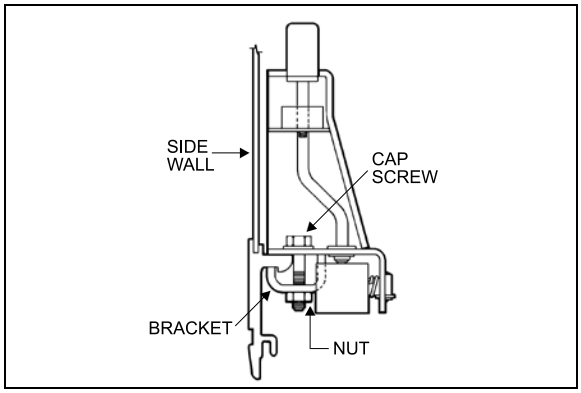


FIGURE 45: ARMREST 18106

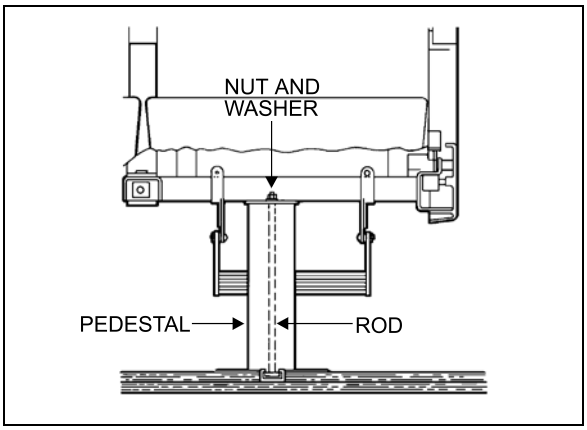


FIGURE 46: SEAT PEDESTAL ASSEMBLY 18107

6. Remove seat assembly.
7. Reverse the above procedure to install seat assembly.

NOTE
On newer vehicles, the rod consists of a carriage bolt inserted in a square plate sliding in the floor track. Removal is possible only by the front or rear end of track.

6.9.3 Upholstery Maintenance

Coach seats are lightweight, with foam-padded backs and cushions. For both appearance and wearability, best results are obtained if upholstery is cleaned at regular intervals before dirt, dust and grit have been ground into the fabric. Seat fabric is made of 50% wool, 33% cotton, 9% nylon, and 8% acrylic.

- **Routine Cleaning**

All that is required to remove the dirt is a gentle beating with the hand or the back of a brush. This will bring the dirt to the surface where it is easily removed with a vacuum or brush in the direction of the pile which can easily be recognized by running a hand lightly over the pile. If the fabric becomes excessively dirty, particles of grit will cause gradual wear, reducing the life span of the fabric.

- **Dry Cleaning**

If covers are to be removed for cleaning, dry cleaning is recommended since washing might cause some shrinkage, preventing the covers from being reapplied to the seats without damage. Other than spot cleaning the covers while they are in place, dry cleaning is not recommended, since the resulting fumes could be hazardous in the confines of the coach and the solvent could be detrimental to the foam padding of the seats.

- **Cleaning With Covers in Place**

The most effective and economical method to clean the fabric seat covers is by washing with either an approved foam upholstery cleaner or with a mild household detergent.

Thoroughly vacuum the upholstery. Remove any spots or stains before the seats are washed to avoid a cleaning ring.

Dilute household detergent or liquid foam cleaner according to directions on the container. Pour a small quantity into a flat pan and work into a thick foam with a sponge or brush.

Apply only the foam to the fabric with a sponge or brush. Clean a small area of the fabric at a time with the foam. DO NOT SOAK. Rub vigorously. Sponge the suds from the fabric with a clean sponge or cloth moistened with water. Rinse the sponge or cloth often and change the water when it becomes dirty.

Allow the upholstery to dry completely before the coach goes back into service. To speed up drying, excess moisture can be blown off the fabric with compressed air.

CAUTION
Oil in the air line will soil the fabric. Blow the line clear and test air discharge against a plain white piece of paper. It is also effective to press the edge of a flat hardwood stick down on the cushion and slowly draw it across the fabric.

Even very soiled areas can be returned to their original appearance by a thorough cleaning, but a regular schedule of cleaning that keeps the upholstery reasonably clean at all times will greatly enhance the life span of upholstery.

6.10 TARABUS FLOOR COVERING REPAIR OR REPLACEMENT

On X3-45 coaches equipped with “Tarabus” covering, it is possible to replace or repair this covering. The purpose of this paragraph is to explain the steps to be followed to ensure the best results and adherence.

MATERIAL

Part No	Description	Qty
680028	Adhesive, Tarabus Floor Covering (White)	A/R
684655	Adhesive, Contact (3M)	3.8L
684654	Adhesive, Contact (3M)	18.9L
680532	Sikaflex 221 Gray	A/R

NOTE

Material can be obtained through regular channels.

1. Remove number of passenger seats required to perform repair.
2. Cut and remove damaged section of floor covering.

NOTE

It would be preferable to cut under two rows of seats so that repair is not as noticeable.

3. Clean plywood using a scraper.

NOTE

Make sure that no staples are sticking out beyond surface. Adjacent plywood sheets must be leveled.

4. Fill up holes and imperfections using MAPI PRP 110 then sand.
5. Remove dirt and adhesive residue.

CAUTION

Do not leave floor covering folded down except temporarily during installation.

6. Apply floor covering adhesive (680028) onto plywood using a serrated spreader with 1/8-inch serration. If required, apply contact adhesive (3M) (684655 or 684654) onto aluminum molding and also onto section of floor covering, which will be in contact with molding (refer to figure 47).

NOTE

Allow adhesive to dry (3 to 5 minutes).

7. Compress floor covering using a roller so as to remove any trapped air bubble.
8. Apply Sikaflex 221 gray sealant (680532) alongside passenger seat fixing tracks (refer to figure 48).

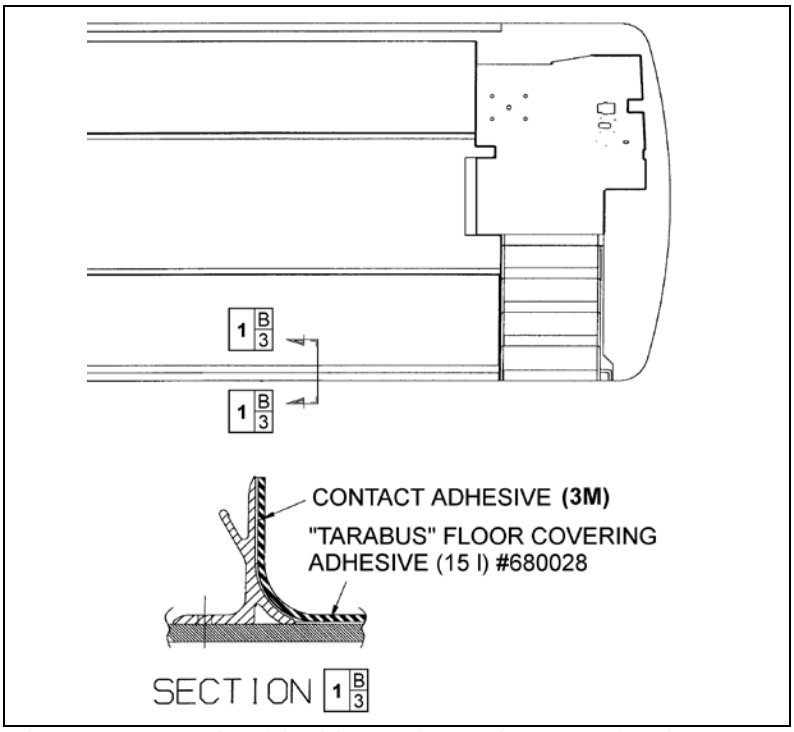


FIGURE 47: TARABUS FLOOR COVERING ADHESIVE APPLICATION 18640

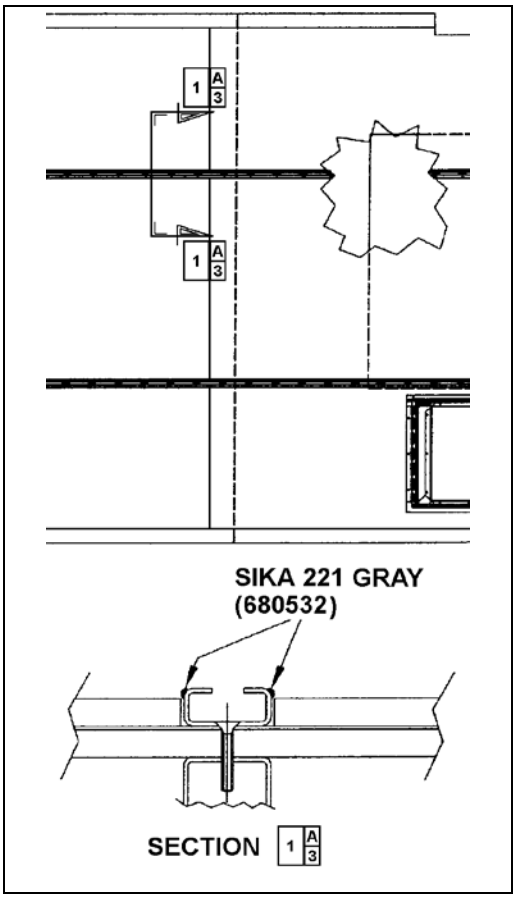


FIGURE 48: APPLICATION OF SIKA 221 GRAY 18641

6.10.1 Front Steps Replacement Procedure

MATERIAL

Part No	Description	Qty
682989	Anti-silicone	A/R
683097	Sika 205 (1 liter)	A/R
685101	Sika Remover 208	A/R
683916	Sika 215 (1 liter)	A/R

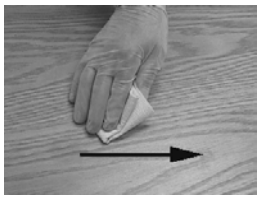
1. Cut and remove damaged step(s).
2. Remove dirt and adhesive residue.

NOTE
In wintertime, condensation and cold temperature may greatly influence bonding parameters. Working area must be at a temperature sufficient to prevent reaching condensation point. Mechanically preheat working area (heat lamp or heat gun) or wait until vehicle reaches room temperature.

PREPARATION OF "TARABUS" FLOOR COVERING

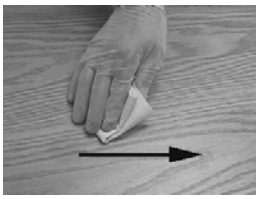
1. Sand under step using "Scotchbrite".
2. Clean using anti-silicone (refer to Section A).

Section A Alcohol or Anti-silicone



1. **Apply**

CHIX cloth



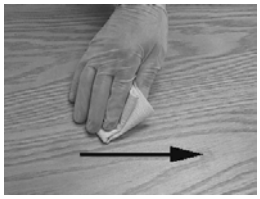
2. **Dry immediately**

Blue cloth

3. **Allow drying**	
Mandatory	**Minimum time : Wait for product to evaporate**
	After 2 hours: Start cleaning operation again
Before applying any other product	If surface seems dusty, greasy or with finger marks, start cleaning operation again.

3. Apply Sika Primer 215 (refer to Section D).

Section D Sika Primer 215



1. **Shake bottle to mix product**

2. **Apply a thin layer**

CHIX cloth

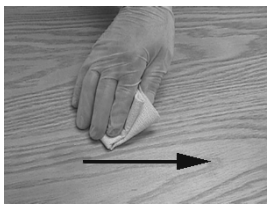
3. **Allow drying**

Mandatory	**215**	**Minimum time : 20 minutes**
		After 2 hours : Remove dust using damp cloth (pure water)
Before applying any other product		If surface seems dusty, dust using damp cloth.
		If surface seems greasy or with finger marks, reactivate with Aktivator.

PREPARATION OF FIBERGLASS

1. Clean using anti-silicone (refer to Section A).
2. Apply Sika 205 (refer to Section B).

Section B Sika 205



1. **Apply**

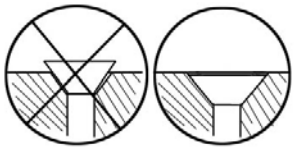
CHIX cloth

2. **Allow drying**

Mandatory	**Minimum time**	**- For a smooth surface (aluminum, stainless, steel, fiberglass (gelcoat side), etc.):**	**2 minutes**
		- For a porous surface (fiberglass (non gelcoat side), etc.)	**10 minutes**
	After 2 hours : Reactivate surface with Sika 205		
Before applying any other product		If surface seems dusty, greasy or with finger marks, start operation again.	

X3 VEHICLES FRONT STEPS GLUING

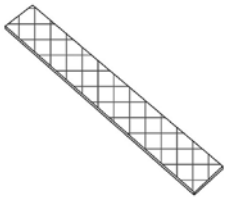
1. Use step nosing to measure and cut necessary length of white safety strip.
2. Use a screw to check depth of countersinking in step nosing. Screw top must not stick out beyond the aluminum surface. Countersink if needed.



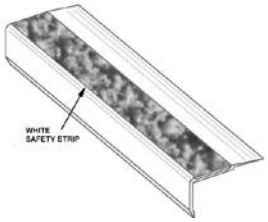
3. Apply some Sika 252 onto the step; make sure to cover the whole surface of the step. Use a serrated spreader with 1/8-inch serration to spread Sika.
4. Apply a bead of Sika 221 onto the perimeter of the step.
5. Install step and press with hands. If Sika overflows, clean with Sika 208. Repeat previous stages for each step if applicable.
6. Remove protective film from double-coated self adhesive tape located underneath step nosing, position step nosing then press. Drill and fix using screws.

7. Clean top of step nosing using Sika 205 (refer to Section B).

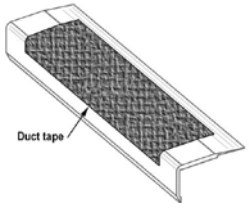
8. Apply some Sika 221 onto white safety strip, spread with a spatula to cover the whole surface.



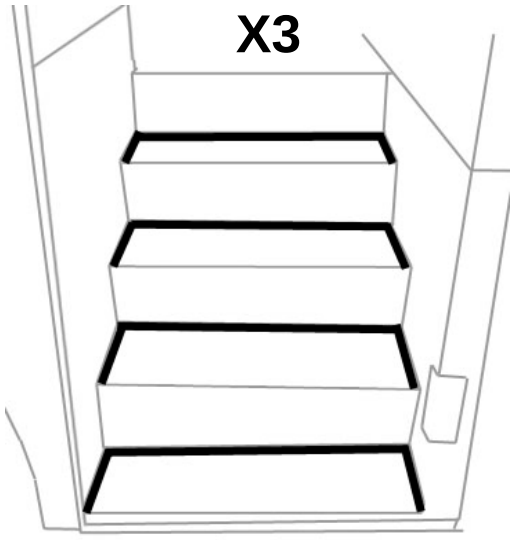
9. Position white safety strip then press using hands. If Sika overflows, clean with Sika 208.



10. Temporarily fix white safety strip with a piece of duct tape, leaving 1 to 2 inches free at each end.

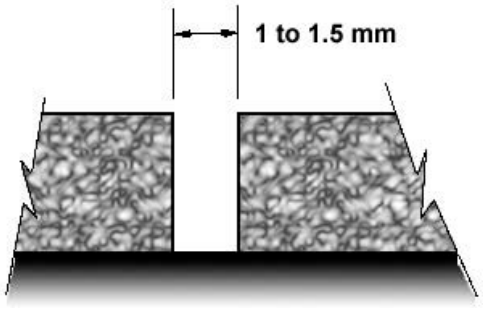


11. Apply some masking tape onto the step perimeter, clean using Sika 205 (refer to Section B) then apply a bead of Sika 252 black. Smooth out the joints then remove masking tape.
12. Install weights onto the steps. Minimum waiting time: 2 hours.



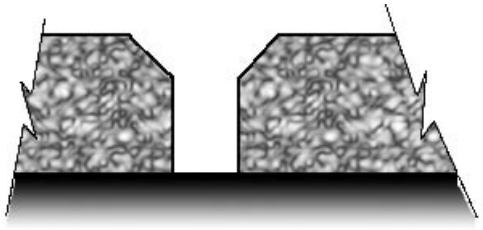
6.10.2 Welding Of Joint Between White Safety Strip And "Tarabus" Floor Covering

1. Pre-heat welding torch;
   Set welding torch to position #4.5 (temperature of 500 °C),
   Heating time: 5 minutes.
2. Before welding, visually ensure that a 1 to 1.5 mm gap exists between white safety strip and "Tarabus" floor covering. Use a knife if this is not the case.



NOTE
There should be no excess of adhesive on top of surfaces, clean if required using "All-Sol".

3. Chamfer the joint.



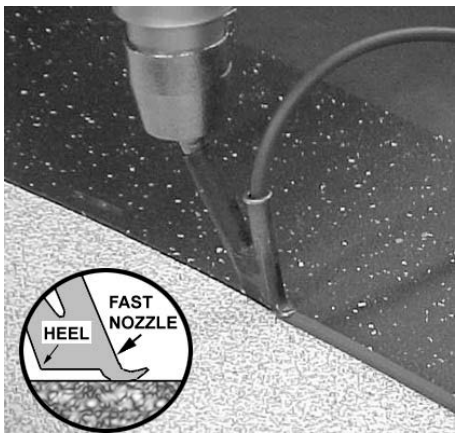
NOTE
The chamfer width must always be less than the filler bead diameter (between 2.5 and 3 mm).

4. Use chamfer knife. **Be careful not to overcut or to cut to the side to prevent damaging "Tarabus" covering.**

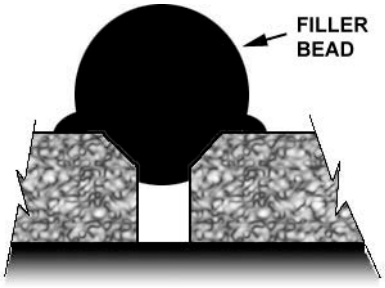
5. Add (about 6 inches) some length to the required length of filler bead to make the joint then cut.
6. Take position with welding torch. The proper position is with a slight slope to the rear.

7. Once the welding torch is ready, insert the filler bead into the nozzle and immediately start welding. Move in a regular manner while pressing slightly with torch.

8. The heel of the fast nozzle must not lean against "Tarabus" covering (always parallel to the surface).

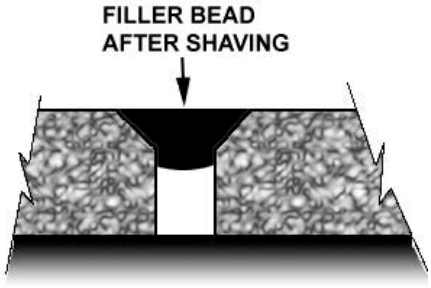


9. Allow cooling down of filler bead (about 5 minutes).



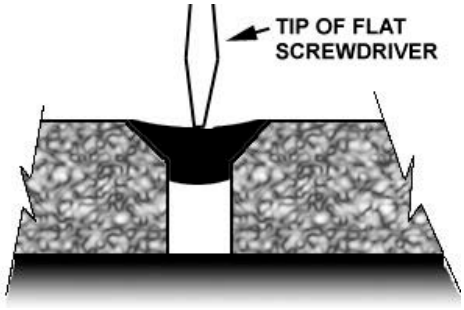
10. Shave filler bead to make it level to the floor. Use supplied knife designed for that purpose.

NOTE
To facilitate the cut, you can spray some soapy water onto the joint.

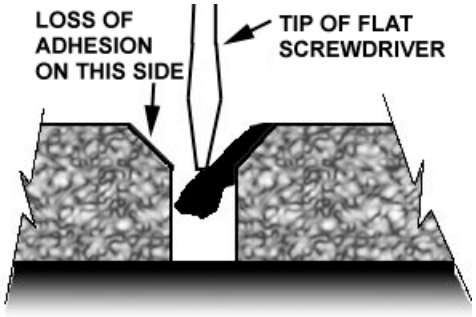


CAUTION
The procedure for turning the torch off must absolutely be followed. If this step is not taken, the element may burn.

11. Set temperature potentiometer to “0” position. Fan will evacuate residual heat. Leave the torch in operation as it is for 3 minutes.
12. Perform adhesion test using the tip of a flat screwdriver; apply a slight pressure on the joint.



13. If welding was not performed properly, there will a loss of adhesion on one side. If this is the case, repair the joint.



6.10.3 Repair Of A Welded Joint

NOTE
In wintertime, condensation and cold temperature may greatly influence bonding parameters. Working area must be at a temperature sufficient to prevent reaching condensation point. Mechanically preheat working area (heat lamp or heat gun) or wait until vehicle reaches room temperature.

1. Using a knife, remove portion of joint to be repaired.

NOTE
Loss of adhesion may be local. If this is the case, repair may also be local.

2. Chamfer the joint again as indicated in paragraph 6.10.2, Section: Welding Of Joint Between White Safety Strip And “Tarabus” Floor Covering.
3. Re-weld the joint as indicated in paragraphs 6, 7 and 8. Use your thumb to hold the filler bead end.

WARNING
Nozzle is hot.

4. Always add an extra inch of filler bead at the beginning and at the end of repair.
5. Perform steps indicated in paragraphs 9, 10 and 11.

7. X3-45 VIP EXTERIOR FINISHING AND BODY REPAIR

The following procedures explain the steps to be followed for proper repair, installation and replacement for various doors, panels and windows pertaining to X3-45 VIP. The paragraph divides the vehicle into zones to facilitate the search; each zone is then sub-divided into components.

Refer to the appropriate zone then component for complete procedure.

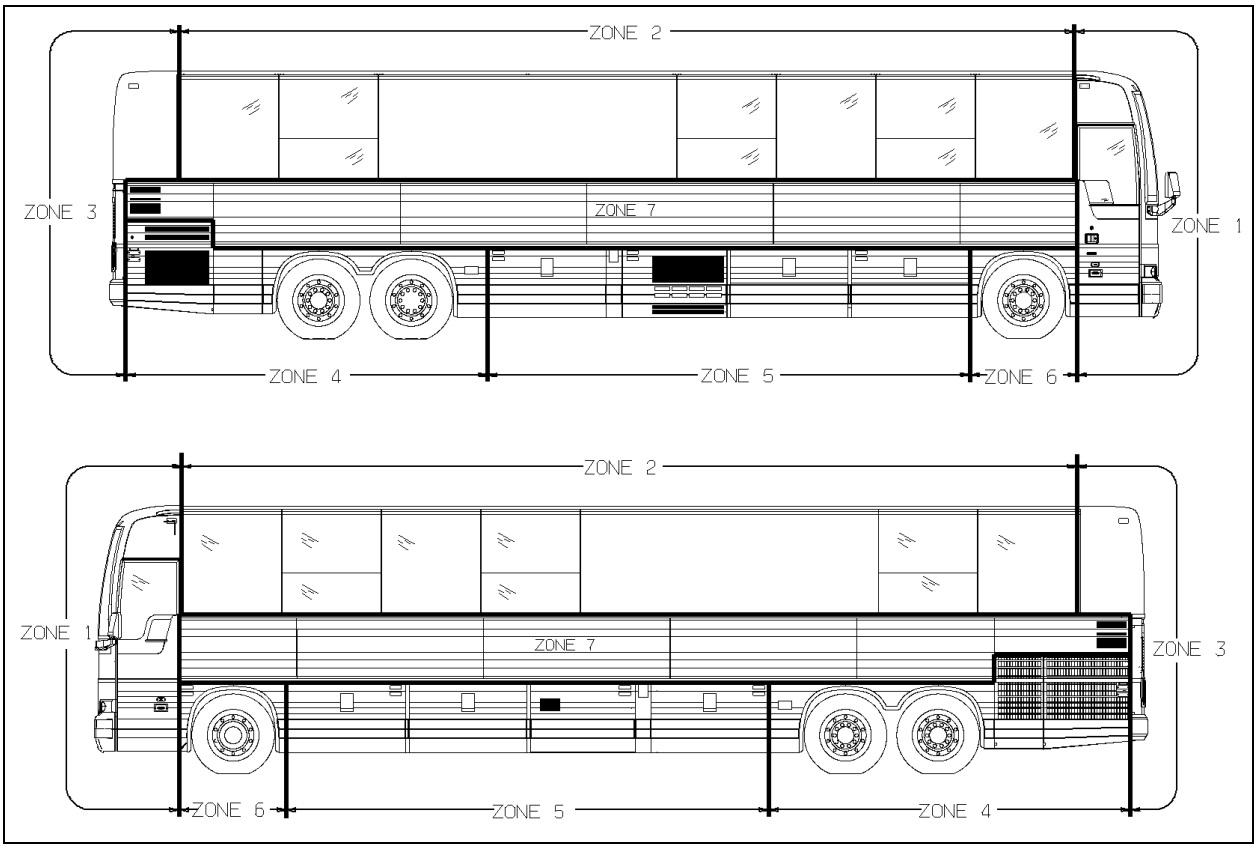


FIGURE 49: W5 MTH ZONING

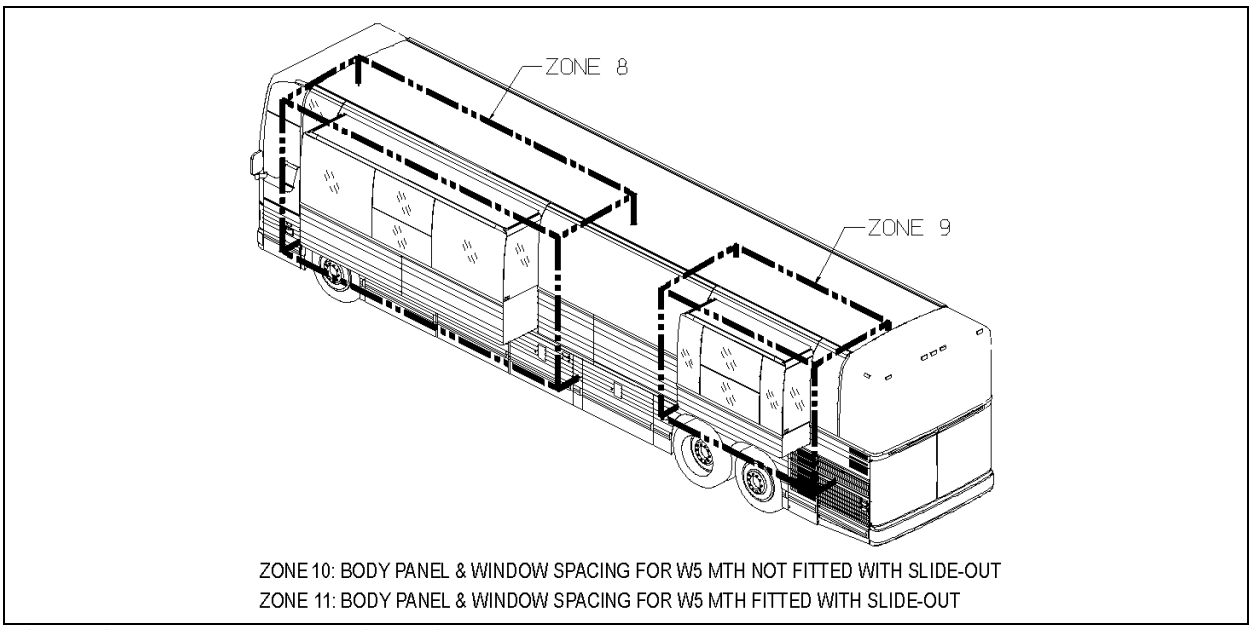


FIGURE 50: W5 MTH FITTED WITH SLIDE-OUT

7.1 ZONE 1

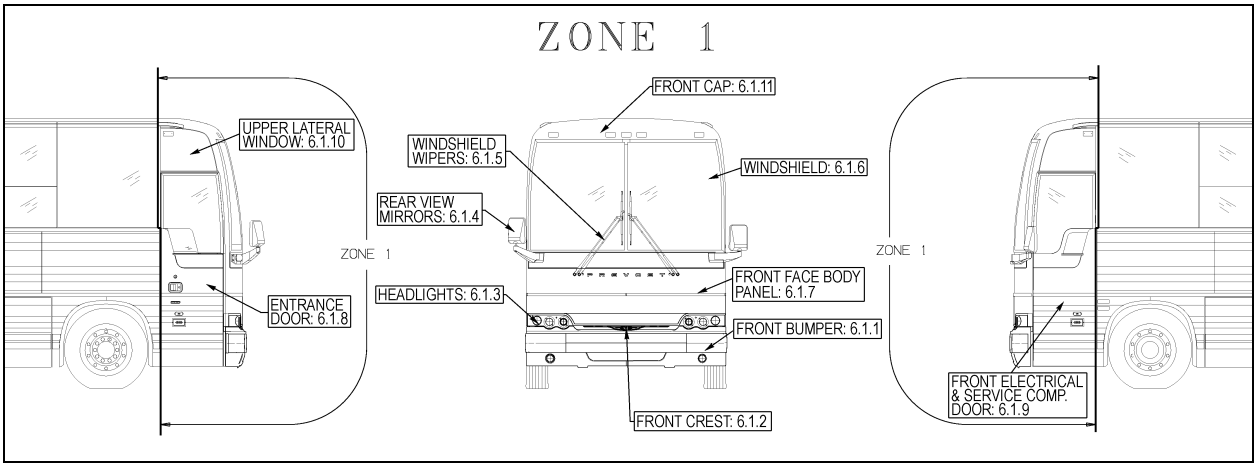


FIGURE 51: ZONE 1

7.1.1 Front Bumper

The front bumper can be tilted downward to give access to the bumper compartment. Pull the release handle located inside front service compartment to unlock. Tilt down the entire bumper assembly to access the compartment. Push the bumper back up firmly in place to lock in position.

Two people are required to remove and install the front bumper. Safely support the bumper and remove the two bolts on each bumper side to separate the bumper from the spare wheel compartment door. To install bumper, reverse the removal procedure.

WARNING

Front bumper is heavy. Use proper lifting equipment to support the bumper during the removal and installation operations to avoid personal injury.

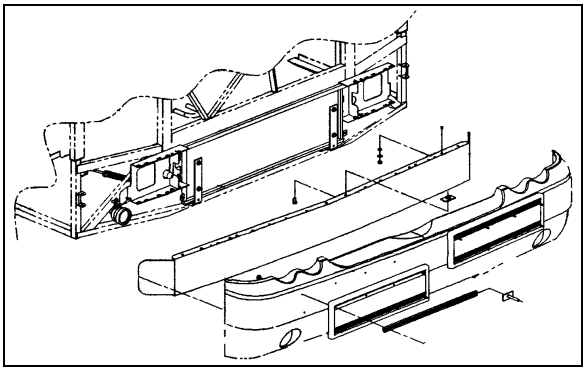


FIGURE 52: FRONT BUMPER REMOVAL

WARNING

The compartment behind the bumper is not designed for storage. Never store loose objects in this compartment since they can interfere with the steering linkage mechanism.

Use care when opening or closing the reclining bumper compartment to prevent personal injury.

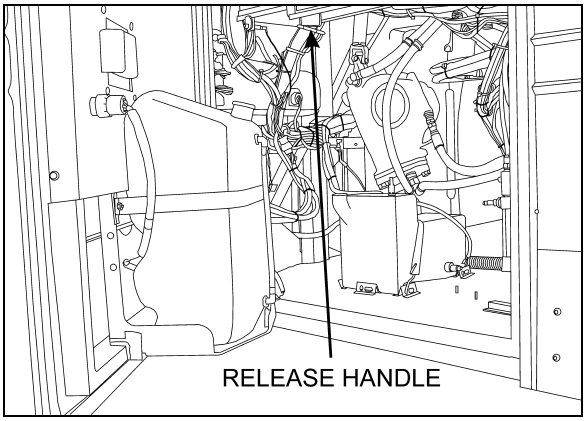


FIGURE 53: FRONT BUMPER RELEASE HANDLE 18613

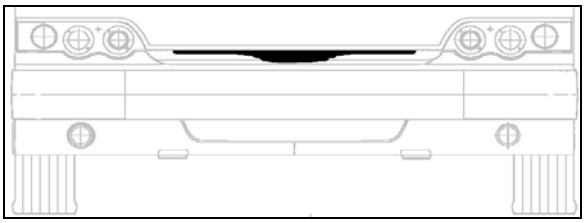
For gluing of front bumper panel refer to procedure **SAV00198** included at the end of this section.

7.1.2 Front Crest

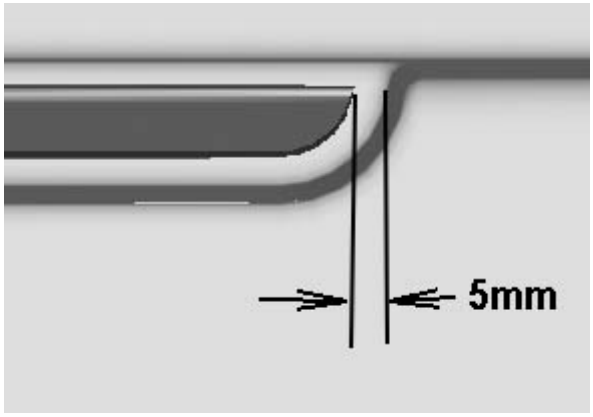
* Use a Chix cloth and anti-silicone to clean the surface where the crest will be applied.

CAUTION

Do not exceed the crest dedicated surface.



* Peel the back from the self adhesive crest side pieces.



* Peel the back from the self adhesive crest center piece. Center crest and apply.
* Compress the crest three pieces using your hands.

7.1.3 Headlights

Refer to Paragraph Headlights, included in Section 06: Electrical of the Maintenance Manual for complete information on headlights.

7.1.4 Rear View Mirrors

Your vehicle is equipped with two exterior mirrors.

The mirrors may be equipped with an optional electric heating system which serves to minimize ice and condensation on the mirror glass in extreme weather conditions. Integral thermostats are installed in both mirrors to avoid continuous heating. Use the appropriate switch on the dashboard to activate the defroster system on both mirrors simultaneously. The mirrors can easily be adjusted by using the remote controls located on the L.H. side control panel. The mirrors have easy to replace glass in case of breakage. Remote control motors can also be replaced.

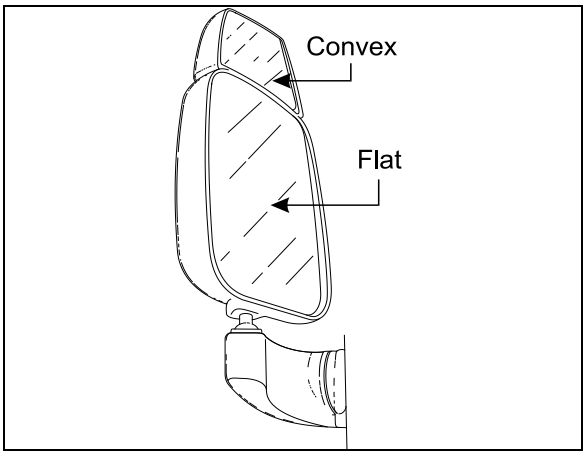


FIGURE 54: REAR VIEW MIRROR (RAMCO) 18398A

❖ **Adjustment**

At the base of the mirror arm, loosen the mounting bolt to swing arm in or out.

To pivot the mirror head, loosen the setscrews on each side of the ball stub at the base of the mirror head to facilitate the adjustment.

❖ **Disassembly**

At end of mirror arm, loosen the setscrews to relieve tension on the ball stem. Remove the ball stem from the arm.

Remove the four screws fastening the mirror arm base to the coach.

❖ **Assembly**

Mount the mirror arm base to the coach. Insert the ball stem into the mirror arm and tighten the socket setscrews.

NOTE
Position the ball cup halves so the joint between them lies on the centerline of the arm. Ensure that the setscrews are not on the joint between the cup halves.

❖ **Replacement of Mirror Glass**

Remove the broken glass.

Position new glass in mirror head and press to lock the Velcro in place.

❖ **Heated / Remote Controlled Rear View Mirrors**

Heated/remote controlled external rear view mirrors may be provided to prevent the mirrors from frosting up in cold weather.

The remote controlled external rear view mirrors attach to support arms using a pivot collar secured by setscrews. Loosening the setscrews allows the whole head assembly to turn on the support arm for initial adjustment. A mounting bolt and washer hold the arm support to the mounting bracket. The arm support can be moved to position the mirror head into or away from the coach body.

The mirror heat switch is located to the left of the driver on the dashboard. This switch must be activated before the mirror heating element will energize. Once energized, the mirror heating element is kept at a sustained temperature (between 60-80°F) by a thermostat. Refer to wiring diagram annexed in the technical publication box.

⚠ **CAUTION**
Do not attach stick-on type convex mirror accessories to the heated mirror glass. This could impede uniform heat distribution on the mirror surface which could break the mirror.

- Mirror Control

The remote control pointer knob(s) for the mirrors is (are) mounted on the L.H. side control panel. The harness to the mirror head runs through the arm support. The remote motor is mounted to the mirror head behind the mirror glass.

Turn pointer knob to the left for mirror head adjustments and to the right for convex mirror adjustment, then push down on either of the button's (4) sides to adjust the selected mirror viewing angle.

- Disassembly

At end of mirror arm, loosen the setscrews to relieve tension on the ball stud. Remove the ball stud. Remove the ball stud from the arm and gently pull the harness out until the connector is exposed.

Remove the four screws fastening the mirror arm base to the coach. Slide the harness free of the mirror arm base.

- Assembly

Attach a stiff wire (snake) to the end of the harness and insert the wire through the mirror arm base and arm, gently pull the harness through the arm and disconnect the "snake".
Connect the mirror head harness. Insert the harness connector back into the mirror arm.
Insert the ball stud into the mirror arm and tighten the socket setscrews.

NOTE
Position the ball cup halves so the joint between them lies on the centerline of the arm. Ensure that the setscrews are not on the joint between the cup halves.

- Convex & Flat Mirror Removal

The mirror glass assembly is mounted to the control mechanism or to mirror base with Velcro strips. Remove the mirror glass by gently pulling the lens to release the Velcro. Disconnect the heater grid at the two connectors.

Connect the connectors of the new mirror's grid to the harness. Install the lens by positioning the lens in the mirror frame and pressing to lock the Velcro in place.

7.1.5 Windshield Wipers

Refer to Paragraph 23.7 Windshield Wipers and Washers, included in Section 23: Accessories of the Maintenance Manual for complete information on windshield wipers.

7.1.6 Windshield

For the removal or installation of windshield, you will need:

- A rope,
- A plastic spatula to lift the rubber seal lip,

- A metal rod or screwdriver to clean the seal groove,
- A filler insertion tool,
- Goggles and protective gloves.

o From inside of vehicle, remove center post and interior finishing panels surrounding the windshield. In this case, we are replacing the R.H. side windshield.

o From outside of vehicle, remove filler located inside rubber seal to ease damaged windshield removal.

o From inside of vehicle, push against the top L.H. side corner of windshield for the removal of a R.H. side windshield. If the L.H. side windshield had to be removed, you would have to push against the top R. H. side corner.

NOTE
We are referring to the L.H and R.H. side as viewed from the inside of the vehicle.

o At the same time, another person gradually lifts the rubber lip from the vehicle exterior using a plastic spatula from top to bottom.

o Remove the entire damaged windshield and broken glass if applicable.

o If applicable, using a screwdriver or metal rod, remove black butyl sealant residue from rubber seal then clean with Sika 205.

❖ **Windshield Installation**

NOTE
Rubber seal may have to be replaced if it was used on several windshield replacements.

o Spray rubber seal with soapy water to ease windshield insertion.

o Insert rope into rubber extrusion leaving enough length at each corner to make a loop. Spray soapy water onto rope and rubber extrusion (Fig. 55).

o Slide windshield into rubber seal groove starting with the bottom curved side edge. Using a plastic spatula, move the rubber seal lip aside to gradually insert the windshield into the groove.

o Spray soapy water on a regular basis to ease this operation.

o Using the same type of plastic spatula, repeat the same operation from inside of vehicle, gradually inserting the windshield into the groove.

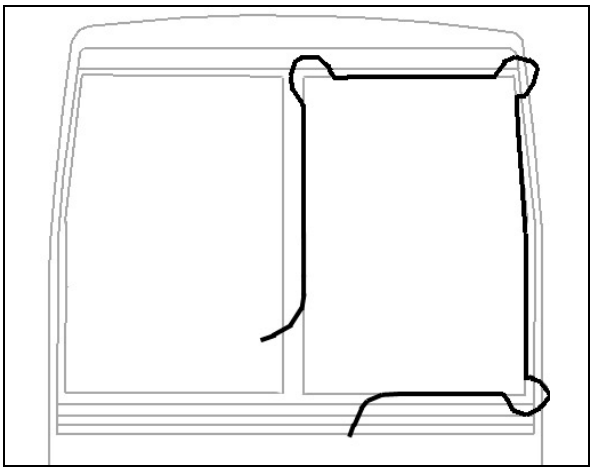


FIGURE 55: WINDSHIELD INSTALLATION USING ROPE

NOTE
Make sure windshield bottom edge is well inserted into the rubber seal groove before proceeding with the sides.

o Then, working from both sides of windshield bottom to top, gradually move the rubber seal lip aside to insert the windshield into the groove. Use also soapy water on the inside of vehicle to insert the windshield into the rubber seal groove.

o Insert the top curved corner then finish with the top of windshield.

o At the top of windshield, clean surface between fiberglass and rubber extrusion using Sika 205 (Fig. 56).

o Apply Sika 221 black between fiberglass and rubber extrusion

o Spray filler and rubber seal groove generously with soapy water.

o Using the special filler insertion tool, insert the filler into the rubber seal groove.

o Gradually insert filler into the rubber seal groove ensuring to leave a 2 inch excess length at the filler extremity.

o Every 6 inches or so, it is important to compress the filler due to its tendency to contract during drying process.

o When filler insertion is almost complete, cut filler leaving ¼" of excess length to

thwart filler contraction over time then insert filler into groove.

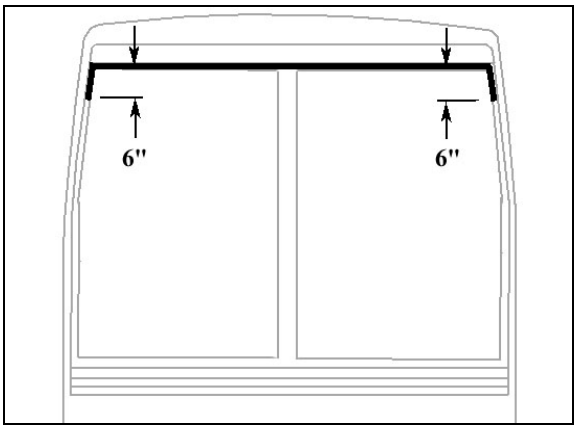


FIGURE 56: APPLICATION 0F SIKA 221 BLACK

- Reinstall center post and interior finishing panels.
- Clean windshield surface of butyl residue.

7.1.7 Front face Body Panel

For removal of front face body panel and molding, you will need:

Drill with drill bits,
Lever or similar tool,
Olfa knife,
"C"-clamp,
Razor sharp window scraper.

❖ **Front Face Molding Removal**

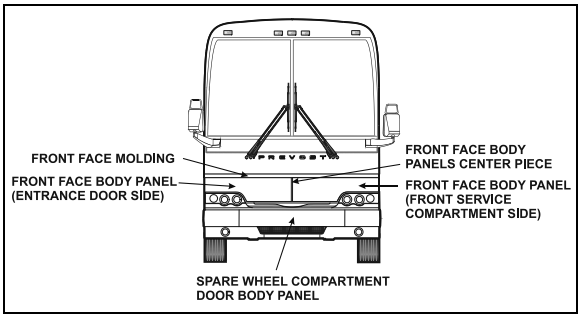


FIGURE 57: VIEW OF FRONT FACE

- First of all, pry loose the front face molding using the lever. Save molding if only the body panel needs to be changed.
- Using the Olfa knife, cut the Sika bead and the double-face self adhesive tape. Remove the Sika bead and self adhesive tape residue with the scraper.

❖ **Front Face Body Panel Removal**

- Using a drill and a 1/8" drill bit remove the rivets fixing the vertical molding. The stainless steel molding is located on the entrance door or service door frame side depending on body panel to be removed.
- Using the Olfa knife, cut the Sika bead and the double-face self adhesive tape. Remove the Sika bead and self adhesive tape residue with the scraper.
- Pry loose the front face body panel using the lever.
- While somebody cuts the Sika bead and double-face self adhesive tape, another person pulls the body panel using the "C"-clamp to exert tension.
- Using the window scraper, remove any Sika bead or self adhesive tape residue left on fiber glass surface.

❖ **Front Face Molding Installation**

For gluing of front face molding, refer to procedure **SAV00212** included at the end of this section.

❖ **Front face Body Panel Installation**

For gluing of front face body panels, refer to procedure **SAV470047** included at the end of this section.

7.1.8 Entrance Door

For the removal of entrance door body panel, you will need:

Pneumatic "Zip gun" type tool;
Razor sharp window scraper;

- Before removing body panel, you can to ease repair uninstall entrance door from vehicle. If applicable, remove reflector, keyless system keyboard and cornering light.
- You must also remove horizontal finishing molding located underneath the window. This molding is glued and will have to be replaced because it will be damaged at removal.
- Remove interior finishing panel to access rub rail fixing bolts, then remove rub rail.
- Using the "**Zip Gun**", cut Sika bead located ¼ inch (7-8 mm) from each body panel edge and around cornering light.
- Separate body panel from door.

- Remove from door surface Sika bead and double-face self adhesive tape residue using a razor sharp window scraper.
- Use a Chix cloth and anti-silicone to remove any dust or residue.

For assembly, gluing or finishing joints of entrance door, refer to procedure **SAV280020** included at the end of this section.

For gluing of entrance door horizontal finishing molding, refer to procedure **SAV00213** included at the end of this section.

For the installation of entrance door, refer to procedure **SAV280022** included at the end of this section.

7.1.9 Front Electrical & Service Compartment Door

For the removal of front electrical & service door body panel, you will need:

Pneumatic “Zip gun” type tool;
Razor sharp window scraper;

- Before removing body panel, you can to ease repair uninstall front electrical & service door from vehicle. If applicable, remove reflector and cornering light.
- You must also remove horizontal finishing molding located underneath the window. This molding is glued and will have to be replaced because it will be damaged at removal.
- Remove interior finishing panel to access rub rail fixing bolts, then remove rub rail.
- Using the “**Zip Gun**”, cut Sika bead located ¼ inch (7-8 mm) from each body panel edge and around cornering light.
- Separate body panel from door.
- Remove from door surface Sika bead and double-face self adhesive tape residue using a razor sharp window scraper.
- Use a Chix cloth and anti-silicone to remove any dust or residue.

For assembly, gluing or finishing joints of front electrical & service compartment door, refer to procedure **SAV280021** included at the end of this section.

For gluing of driver’s window, refer to procedure **SAV290013** included at the end of this section.

For gluing of front electrical & service compartment door horizontal finishing molding, refer to procedure **SAV00213** included at the end of this section.

For the installation of front electrical & service compartment door, refer to procedure **SAV280022** included at the end of this section.

7.1.10 Upper Lateral Window

For the removal of driver’s window or upper lateral window, you will need:

Pneumatic «Zip gun» type tool;
Razor sharp window scraper;
“Olfa” knife;
Face shield.

- In the case of driver’s window only, open front service compartment door.
- Mark the position of the driver’s window for future reference.
- From inside of vehicle, cut Sika bead around window perimeter using a “Zip gun” while another person hold the window from the outside.

NOTE
Wear ear plugs during this operation.

- Then, move outside of vehicle and cut Sika bead to free window while somebody else hold the window from the inside.
- Carefully remove window from frame, ask for help if needed.
- Using a razor sharp window scraper, remove from window frame Sika bead and double-face self adhesive tape residue.
- First of all, check Sika 205 cleaner expiration date.
- Before applying Sika cleaner, fold “Chix” cloth twice for proper width.
- Apply an even coat onto the inside of window frame and allow drying for 2 minutes (maximum 2 hours).
- Discard waste according to applicable environmental regulations, use dangerous waste containers.
- Apply masking tape before applying Sika glue to protect paint and adjacent window during surface treatment.

For gluing of upper lateral window, refer to procedure **SAV290016** included at the end of this section.

7.1.11 Front Cap

The fiberglass front cap does not need any maintenance except painting as needed. It is held in place with adhesive. If ever it has to be replaced, make an appointment at a Prevost service center near you. For minor damages, refer to paragraph 4 "Common Fiberglass Repair procedure" and paragraph 5 "Common Painting Procedure".

7.2 ZONE 2

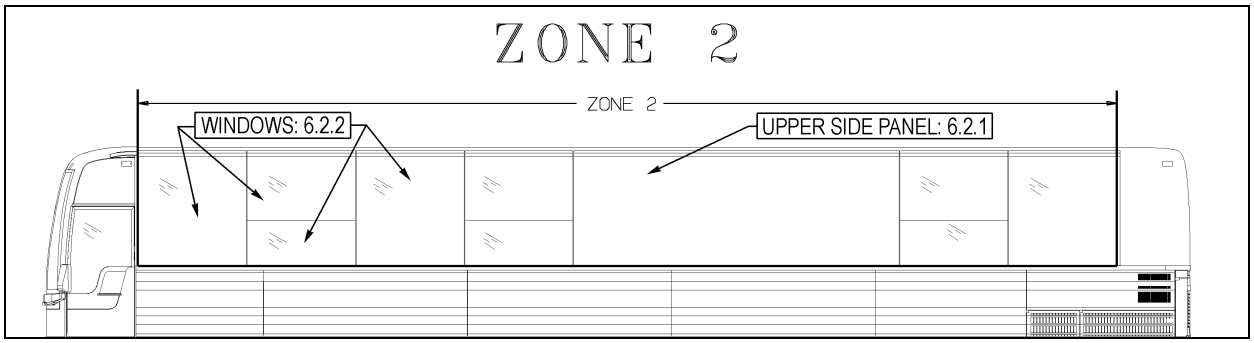


FIGURE 58: ZONE 2

7.2.1 Upper Side Panel

For structure preparation, refer to procedure **SAV00035** included at the end of this section.

For installation of upper side panel neoprene foam tapes, refer to procedure **SAV00036** included at the end of this section.

For installation of upper side panel, refer to procedure **SAV00041** included at the end of this section.

7.2.2 Fixed Windows

Depending on the method chosen for fixed side window removal or installation, you may need:

* Drill equipped with a sharp pointed rod into which a small hole was drilled;
* Razor sharp window scraper;
* Braided windshield wire and a pair of handles;
* Gloves, goggles or face shield.

Fixed Window Removal

1st Method

NOTE
This method is used only in the case of a regular fixed side window. For the fixed upper portion of awning or sliding windows, you must use method number 2.

- Apply a sticky plastic film onto all of window outside surface for safety reason.
- Using a drill equipped with the special sharp pointed rod, drill through the window seal into one of the bottom corners, from a 30º angle with reference to the vehicle.
- This procedure requires accuracy and it is possible not to succeed on the first attempt. From the inside of vehicle, a second person ensures the rod passes through.
- Remove the rod; thread the wire into the small hole. Reinsert the rod and the wire into the hole far enough so that the person inside the vehicle can pull the rod using a pair of pliers.
- Attach the wire ends to the specially designed handles.
- Pull in turn from the inside and the outside of vehicle to gradually cut the Sika bead on the window perimeter.
- When you reach top corner, detach wire from the outside handle, secure it to a fish wire or rod and thread it underneath the aluminum molding behind the rivets.
- Detach wire from fish wire and continue cutting using the handle.

- Cut Sika bead until you come back to starting point, then you can remove the window by carefully pushing it out from the inside of vehicle.

2nd Method

- Apply a sticky plastic film onto all of window outside surface.
- To limit as much damage as possible, remove any interior molding in the way. Install a plastic film on the window interior surface and secure using masking tape onto all of window perimeter.

NOTE
Do not stretch plastic film and leave enough play to be able to push window out without tearing the plastic film.

- Using a ball peen hammer, hit one of the window bottom corners from the **outside**.
- Carefully push window out and lift it up sufficiently to separate it from the aluminum molding.
- Attach the windshield wire to a fish wire and thread it underneath the aluminum molding behind the rivets.
- Detach wire from fish wire and continue cutting using the handle.
- Make a notch at each window top corner to make sure you pass underneath the remaining pieces of glass.
- Remove the aluminum molding and clean up the frame using the window scraper.

For gluing of lateral fixed window behind driver, refer to procedure **SAV00046** included at the end of this section.

For gluing of lateral fixed half-window, refer to procedure **SAV00045** included at the end of this section.

For the installation of awning or sliding window, refer to procedure **SAV00038** included at the end of this section.

For gluing of lateral fixed window, refer to various procedures: **SAV00037** for gluing vertical and bottom rubber seals; **SAV00043** for the installation of lateral fixed window and **SAV00044** for making the Simson joint around fixed windows.

All these procedures are included at the end of this section.

7.2.3 Electric Awning Windows

The electric awning windows are connected directly on the batteries 24 V DC terminal block. As a result, they can be operated regardless of the state open or close of the master switch.

Window Removal

Replacement awning window does not include a new motor. If in working order, transfer the motor of the replaced window to the replacement window. If not, the motor can be bought separately. When replacing the window, keep the components in working order as spare parts.

1. Push the vertical latch handle downwards to release the track and then open the window using the horizontal latch handle.
2. Take out the screw at the lower end of the track to let free the swiveling arm roller.
3. Unplug connectors. Dismount the gas spring from the window.
4. Loosen the set screws #5 (figure 19) (rotate the arm to get to the second set screw) and disengage the swiveling arm from the motor shaft extension.
5. Push the glass window out ninety degrees (90°).

⚠ **CAUTION**
The window may fall out.

6. The window is free and can be unhooked.
7. Reverse procedure to install a new one.

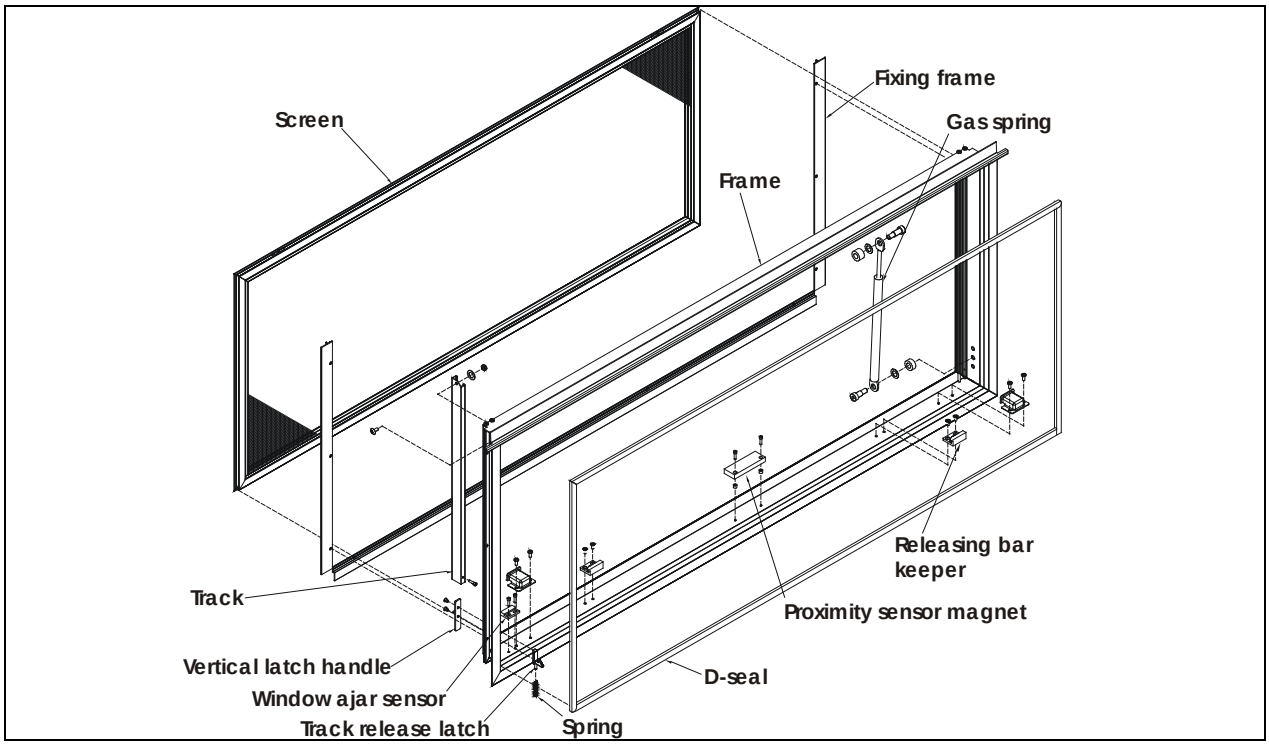


FIGURE 59: ELECTRIC AWNING WINDOW EXPLODED VIEW (FRAME) 18586

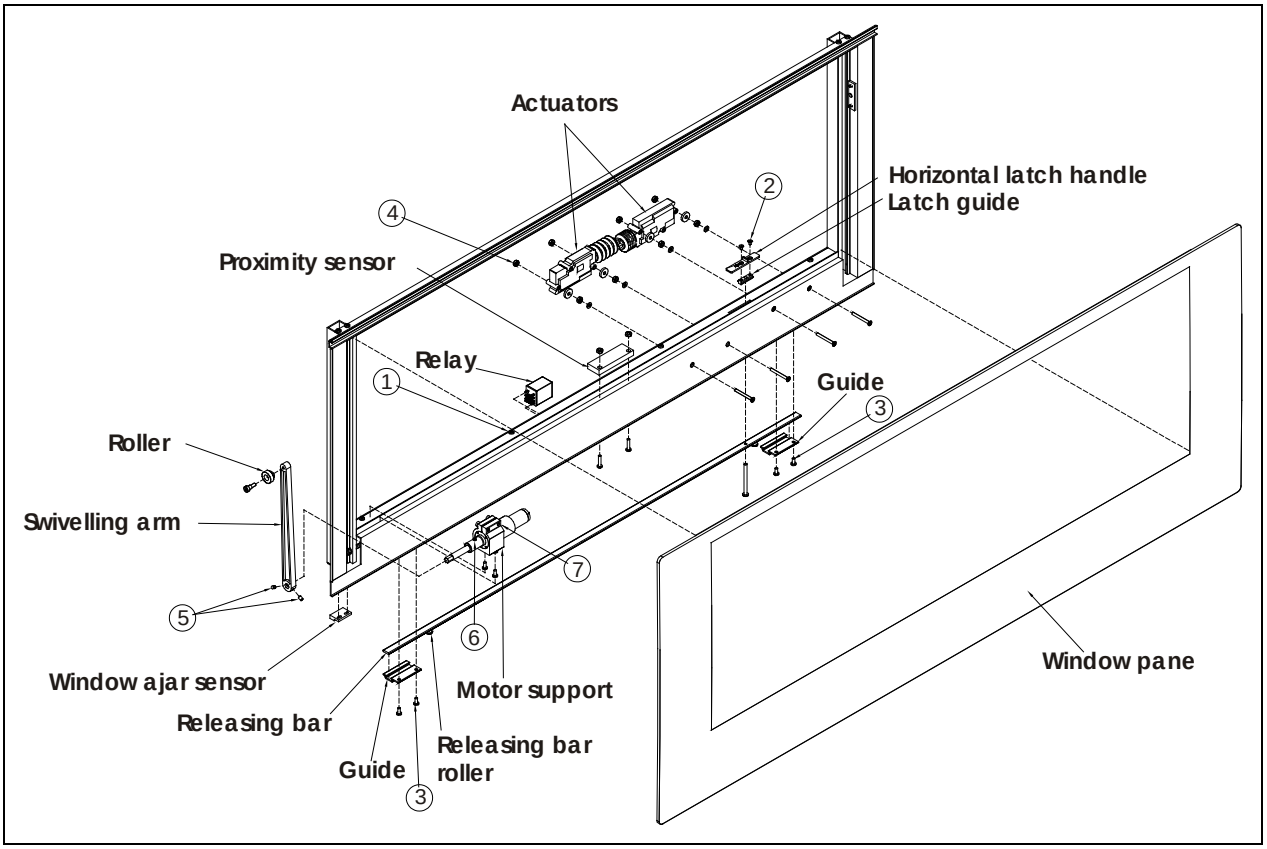


FIGURE 60: ELECTRIC AWNING WINDOW EXPLODED VIEW (SASH) 18583

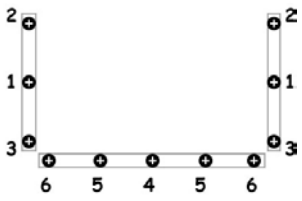
Actuator Replacement

1. Push the vertical latch handle downwards to release the track and then unlatch the window using the horizontal latch handle.
2. Remove actuator access cover by taking out screws #1 (8x).
3. Take out screws #2 (2x) and remove horizontal latch handle and guide.
4. Take out the guide screws #3 (4x) and remove releasing bar.
5. Unplug connectors from defective actuator, unscrew nuts #4 (2x) and remove the actuator.
6. Reverse operations for reinstallation.

Motor Replacement

1. Push the vertical latch handle downwards to release the track and then unlatch the window using the horizontal latch handle
2. Take out the screw at the lower end of the track to let free the swiveling arm roller.
3. Remove actuator access cover by taking out screws #1 (8x).
4. Loosen the set screws #5 (rotate the arm to get to the second set screw) and disengage the swiveling arm from the motor shaft extension.
5. Unplug motor connector and dismount motor and support assembly.
6. The shaft extension is glued to the motor shaft. It has to be heated to break the binding to permit removal. Loosen set screw #6 and remove the shaft extension. Also loosen screw #7 and remove motor from the support.

Reverse operations for reinstallation.

ELECTRIC AWNING WINDOW – CONVERTER CHECKLIST	
Check the electrical circuit & proximity sensor	A: The latching system will not operate without power. Is there electrical power to the latching circuit? The horizontal latch handle, on the sill sash will be seen to move if there is power on this circuit, or it can be checked with an electrical tester. If there is no power to this circuit when the window is closed and either rocker switch are switched "ON", there is a problem with the electrical system. B: The Proximity Sensor on the sash may not be switching power to the latching circuit if the magnet is not getting close enough to the switch OR the Proximity Sensor may be broken (or stuck in one position). Is the proximity sensor switching when the window is closed?
Check the release force required to operate the horizontal latch handle	A: If the pull force required to move the latch is more than 20lbs the window will not latch properly. Average pull force during testing by manufacturer is 12lbs -15lbs. What is the force required to release the handle? Check using a force gauge (same test done by manufacturer).
Check Installation	A: If the window is too tightly installed OR if the sequence for tightening the clamping frame screws Is incorrect the window may not close properly. Was the window installed correctly? Was the correct sequence (see below) used when tightening the clamping frame screws?  B: Removing the shipping blocks before the window is installed can create major problems.

	Were the shipping blocks in place during installation? C: Failure to remove the shipping blocks after installation can create interference between sash and frame. Have the shipping blocks been removed after installation? D: The window is misaligned or not installed squarely. Is there interference with any coach parts? Is there proper clearance between the bottom of the outer glass and the belt-line trim / seal?
Check for missing parts or misaligned parts	A: The frame and sash are misaligned. Is there any interference between the sash and frame? Is there clearance between the sash and the rocker switch covers? B: Releasing bar guides are missing. Check that the releasing bar guides are installed. There should be 4 installed on H windows, and 3 installed on XL2 windows.

7.2.4 Electric Sliding Windows

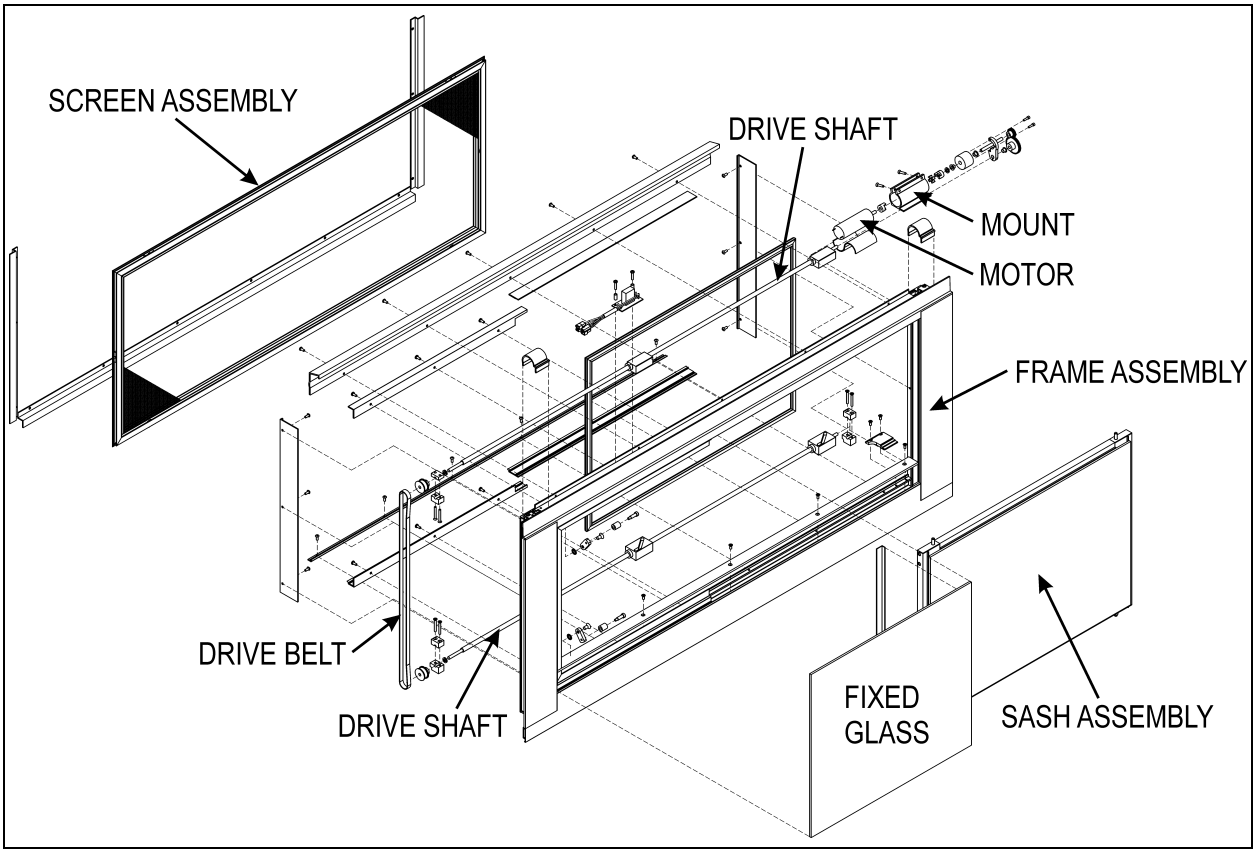


FIGURE 61: ELECTRIC SLIDING WINDOW EXPLODED VIEW

Sash Removal

1. Remove the Screen Assembly
2. Pull down on both release latches simultaneously and rotate the sash inwards approximately 10 degrees.(Figure 62)

FIGURE 62: REMOVING THE SASH

3. Lift the sash up and out to disengage the bottom of the sash from the window frame. (Figure 63)

FIGURE 63: DISENGAGING THE BOTTOM OF THE SASH

Installation

1. Align the leading edge of the slot on the lower cam follower block with the sash stop. Use the power toggle switch to obtain the correct alignment. (Figure 64)

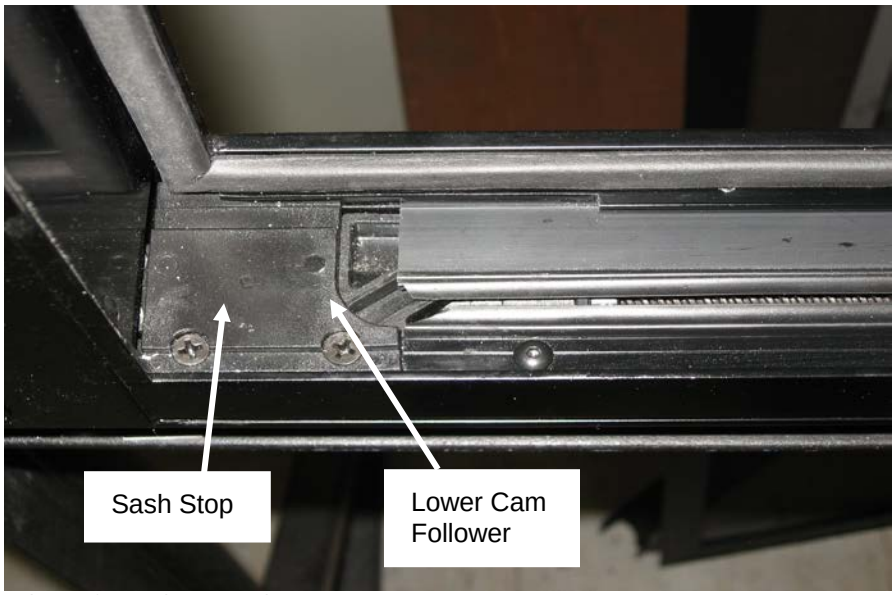


FIGURE 64: PROPER ALIGNMENT

2. Position the left hand lower corner of the sash over the front cam follower block (Figure 65)

FIGURE 65: POSITIONING THE LOWER LEFT CORNER OF THE SASH

3. Engage the sash pin with the leading edge of the slot of the cam follower block. Do the same at the rear of the sash.
4. Pull down on the release latches and rotate the sash inwards until it is parallel with the window frame.
5. Release the latches to engage the latch pins with the upper cam follower blocks.
6. Confirm that both latches are in the closed (latched) position. The upper edge of the latch opening must be aligned with upper edge of the sash opening (Figure 66)

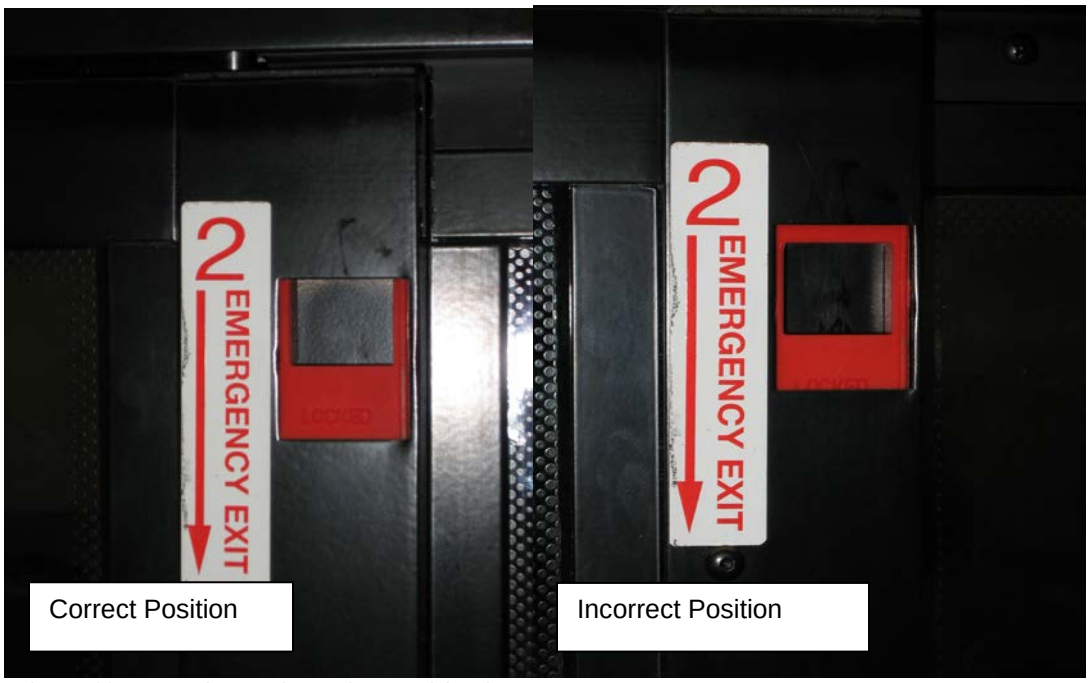


FIGURE 66: RELEASE LATCH PROPER POSITION

7. * Failure to confirm this step may lead to the sash becoming disengaged with the frame and could result in personal injury.
8. Operate the window to confirm that it opens and closes properly.
9. Install the screen assembly.

7.3 ZONE 3

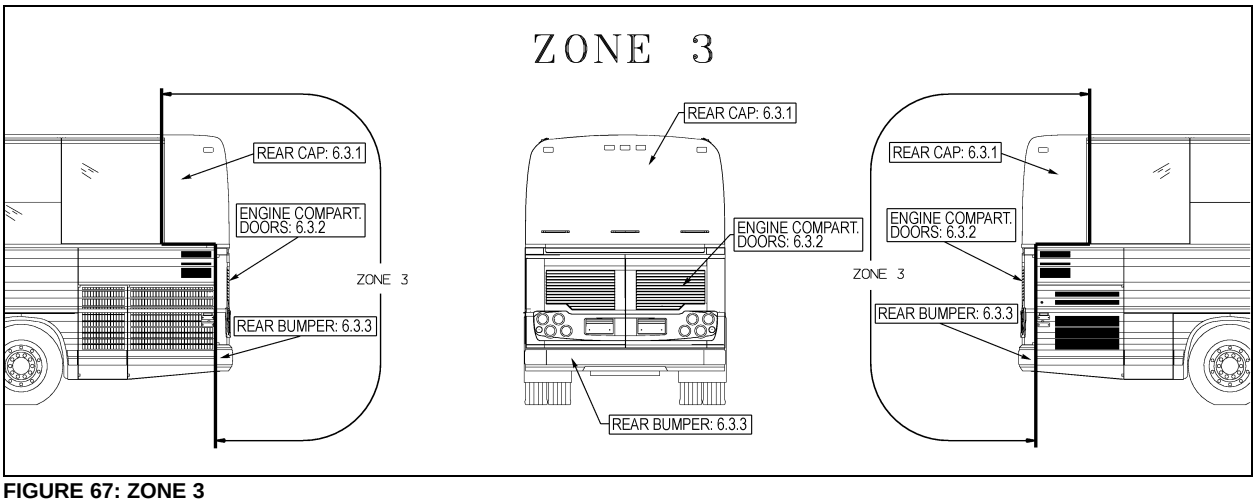


FIGURE 67: ZONE 3

7.3.1 Rear Cap

The fiberglass rear cap does not need any maintenance except painting as needed. It is held in place with adhesive. If ever it has to be replaced, make an appointment at a Prevost service center near you.

For minor damages, refer to Paragraph 4 "Common Fiberglass Repair Procedure" and Paragraph 5 "Common Painting Procedure".

7.3.2 Engine Compartment Doors

❖ **Engine Compartment Doors Adjustment**

Engine compartment doors may be adjusted for proper fit by untightening hinge bolts:

6. Loosen the bolts, (1, 2 Fig. 68) holding the hinge to the vehicle structure to shift the door "UP or DOWN".
7. Loosening the bolts (3, Fig. 68) allows the door to be shifted "LEFT or RIGHT" and "IN or OUT".
8. Adjust the doors position depending on the gap needed between exterior finishing panels.
9. Tighten the bolts.
10. Check that the doors swing freely and close properly. It may be necessary to adjust the door latch to get proper fit and operation.

To adjust the latch mechanism (4, Fig. 68) and the striker pin:

6. Open the doors to access the striker pin.
7. Slightly loosen the striker pin.
8. Using a hammer, adjust the striker pin to center it in the door latch mechanism.
9. Tighten the striker pin.
10. Check doors fit and operation.

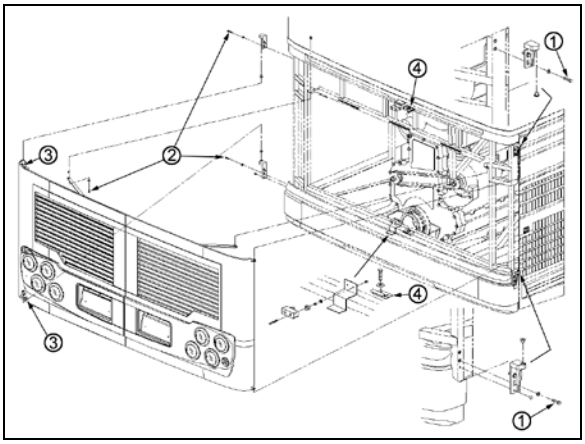


FIGURE 68: ENGINE COMPARTMENT DOORS 18633

❖ **Engine Compartment Door Body Panel Removal**

For the removal of engine compartment door body panel, you will need:

Pneumatic “Zip gun” type tool;
Razor sharp window scraper;
A pair of locking pliers;
Isopropyl alcohol.

- o Remove damaged engine compartment door from vehicle.
- o Install the damaged door onto an appropriate support.
- o Wearing gloves, goggles and ear plugs, pry loose body panel using a “Zip gun” or lever starting from the edge opposite the curved side.
- o Use the “Zip gun” to detach completely the stainless steel body panel from door frame.

CAUTION

Do not damage painted surface.

- o Use a second person equipped with a pair of locking pliers to pull the body panel as you cut the Sika bead.

WARNING

Be very careful when pulling the body panel, somebody could get hurt if the body panel suddenly detach from the door surface without notice.

- o Using the window scraper, remove any Sika bead or self adhesive tape residue left on the fiber glass surface.

For gluing of engine compartment doors molding, refer to procedure **SAV00211** included at the end of this section.

For engine compartment door body panel installation, refer to procedure **SAV280032** included at the end of this section.

7.3.3 Rear Bumper

Remove three bolts on each side holding bumper to vehicle and remove bumper.

To install bumper, reverse the procedure.

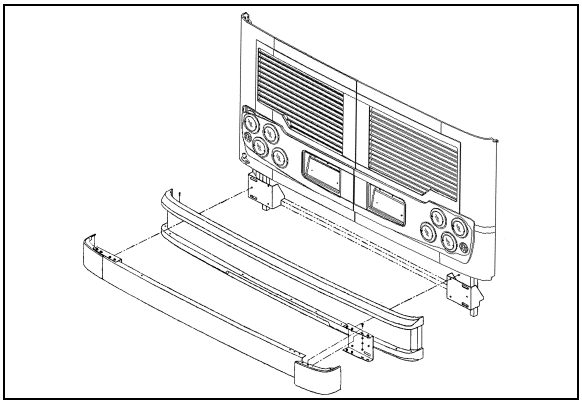


FIGURE 69: REAR BUMPER

7.4 ZONE 4

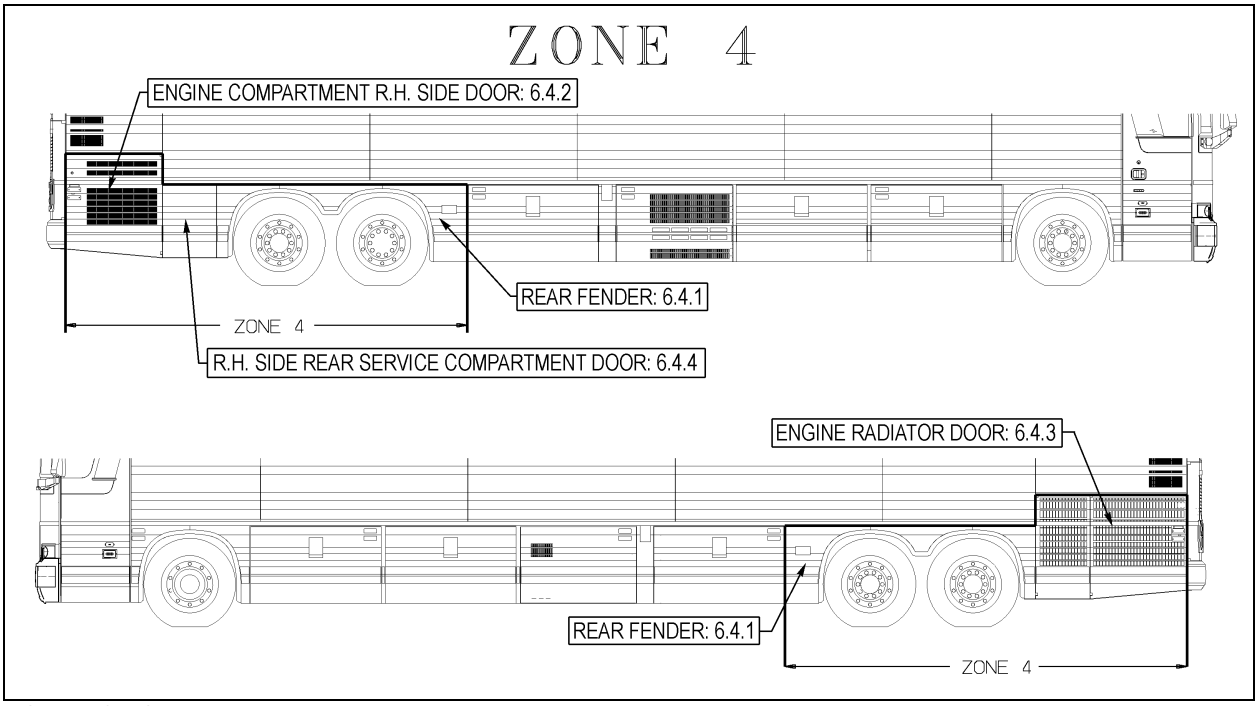


FIGURE 70: ZONE 4

7.4.1 Rear Fender

On X3-45 VIP vehicles, rear fenders are hinged for maintenance on brakes and suspension. Each rear fender panel has two mechanical spring loaded holding devices fixing it to the vehicle's structure. Push the spring type rod sideways to disengage the lock.

For the installation of rear fender body panel, refer to procedure **SAV470046** included at the end of this section.

7.4.2 Engine Compartment R.H. Side Door

Engine compartment R. H. side door may be adjusted for proper fit by untightening hinge bolts:

1. Loosen the bolts, (1, Fig. 71) holding the hinge to the vehicle structure to shift the door "IN or OUT" and "UP or DOWN".
2. Loosening the bolts (2, Fig. 71) allows the door to be shifted "LEFT or RIGHT" and "UP or DOWN".
3. Adjust the door position depending on the gap needed between exterior finishing panels.
4. Tighten the bolts.
5. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

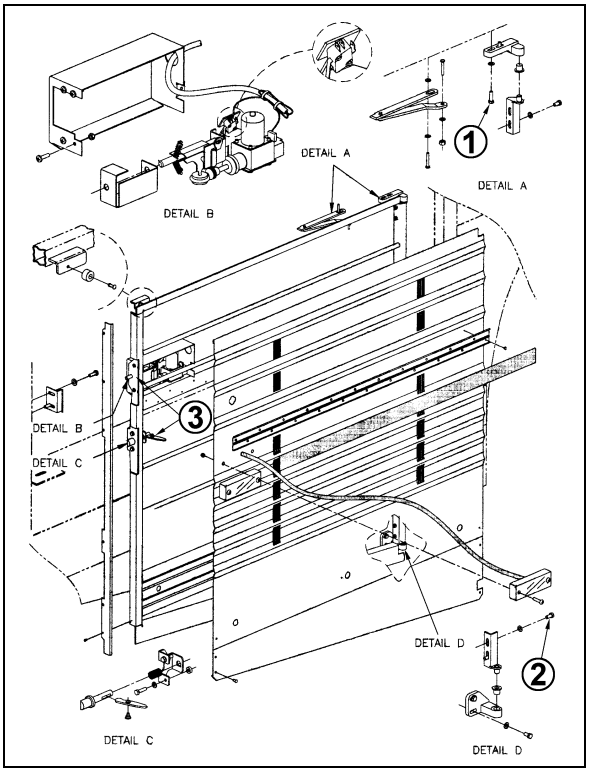


FIGURE 71: ENGINE COMPARTMENT R.H. SIDE DOOR18635

To adjust the latch mechanism (3, Fig. 71) and the striker pin:

6. Open the door to access the striker pin.
7. Slightly loosen the striker pin.
8. Using a hammer, adjust the striker pin to center it in the door latch mechanism.
9. Tighten the striker pin.
10. Check door fit and operation.

For gluing of engine compartment R.H. side door finishing molding, refer to procedure **SAV00210** included at the end of this section.

7.4.3 Engine Radiator Door

Radiator door may be adjusted for proper fit by untightening hinge bolts:

6. Loosen the bolts, (1, Fig. 72) holding the hinge to the vehicle structure to shift the door "IN or OUT" and "UP or DOWN".
7. Loosening the bolts (2, Fig. 72) allows the door to be shifted "LEFT or RIGHT" and "UP or DOWN".

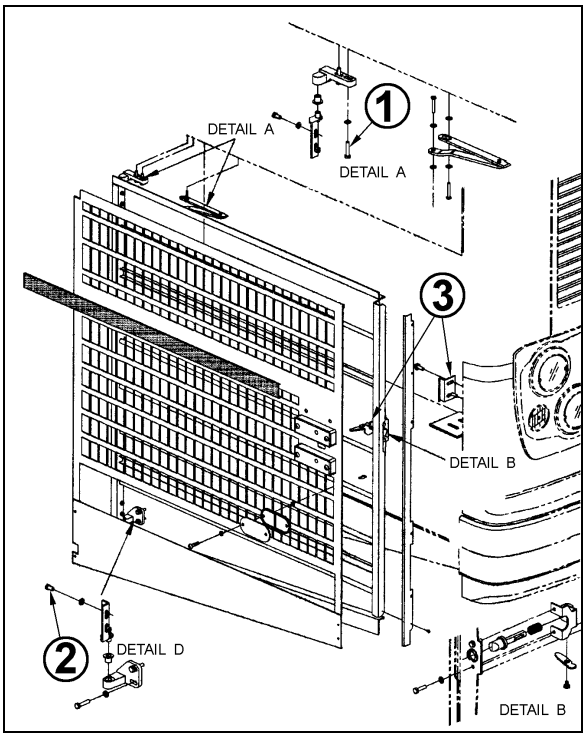


FIGURE 72: RADIATOR DOOR 18636

8. Adjust the door position depending on the gap needed between exterior finishing panels.
9. Tighten the bolts.
10. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

To adjust the latch mechanism (3, Fig. 72) and the striker pin:

6. Open the door to access the striker pin.
7. Slightly loosen the striker pin.
8. Using a hammer, adjust the striker pin to center it in the door latch mechanism.
9. Tighten the striker pin.
10. Check door fit and operation.

❖ **Engine Small Radiator Door**

Small radiator door may be adjusted for proper fit by untightening hinge bolts:

1. Loosen the bolts, (1, Fig. 73) holding the hinge to the vehicle structure to shift the door "IN or OUT" and "UP or DOWN".
2. Loosening the bolts (2, Fig. 73) allows the door to be shifted "LEFT or RIGHT" and "UP or DOWN".

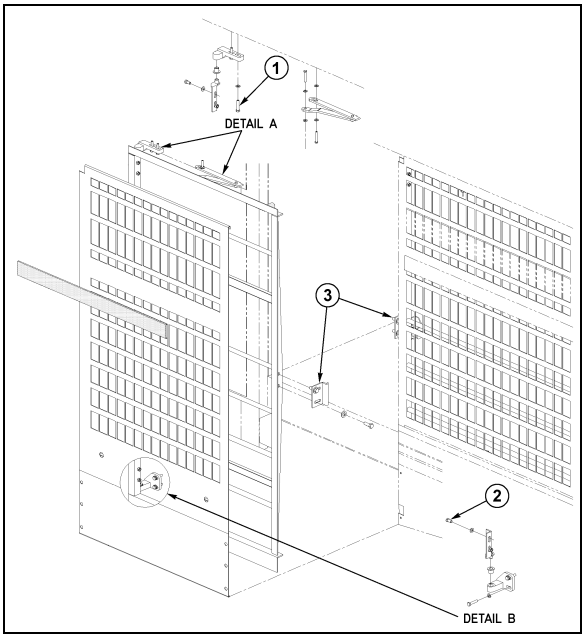


FIGURE 73: SMALL RADIATOR DOOR 18636

3. Adjust the door position depending on the gap needed between exterior finishing panels.
4. Tighten the bolts.
5. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

To adjust the latch mechanism (3, Fig. 73) and the striker pin:

1. Open the radiator door to access the striker pin.
2. Slightly loosen the striker pin.
3. Using a hammer, adjust the striker pin to center it in the door latch mechanism.
4. Tighten the striker pin.
5. Check door fit and operation.

For gluing of engine radiator door finishing molding, refer to procedure **SAV00210** included at the end of this section.

7.4.4 R.H. Side Rear Service Compartment Door

To adjust the R. H. side rear service compartment door:

1. Open the compartment door.
2. Loosen the screws fixing the hinge to hinge attachment or hinge to door assembly. Loosening the screws allows the compartment door assembly to be shifted "LEFT or RIGHT" and "UP or DOWN" or “IN and OUT”.
3. Adjust compartment door assembly position at the hinge.
4. Tighten the screws.
5. Respect the required gap between exterior finishing panels.
6. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

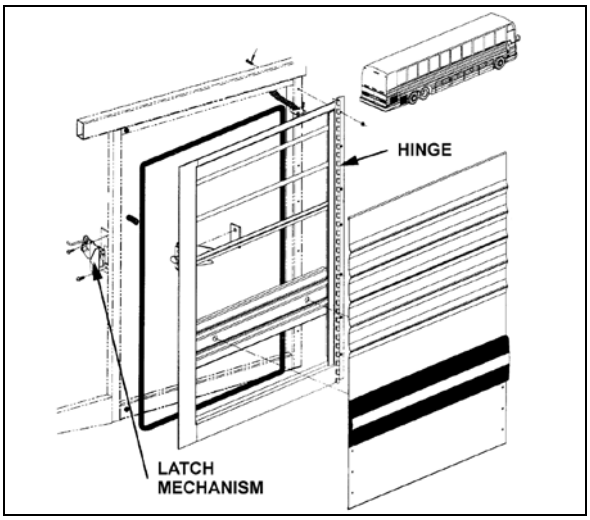


FIGURE 74: R.H. SIDE REAR SERVICE COMPARTMENT DOOR

To adjust the latch mechanism and the striker pin:

1. Open the door to access the striker pin.
2. Loosen slightly the striker pin.
3. Using a hammer, adjust the striker pin to center it in the door latch mechanism.
4. Tighten the striker pin.
5. Check door fit and operation.

7.5 ZONE 5

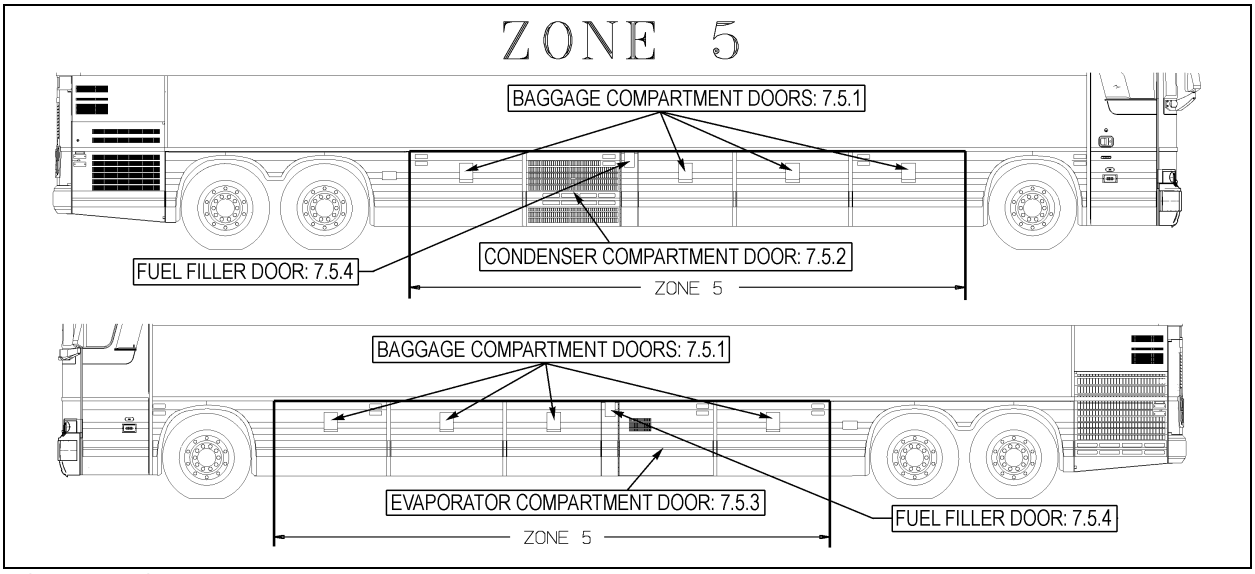


FIGURE 75: ZONE 5

7.5.1 Baggage Compartment Doors

The baggage compartment doors on the vehicle are of identical design. The doors are pantograph, vertical-lift type and are fully sealed. Each door has a flush-mounted latch handle. To open, lift latch handle, then pull door outward and up. The door is held open by 2 gas-charged cylinders. To close, leave latch handle in the open position, pull downward on door and push down on latch to secure door. The door lower arm is spring loaded to secure effort required to close the door (Fig. 76).

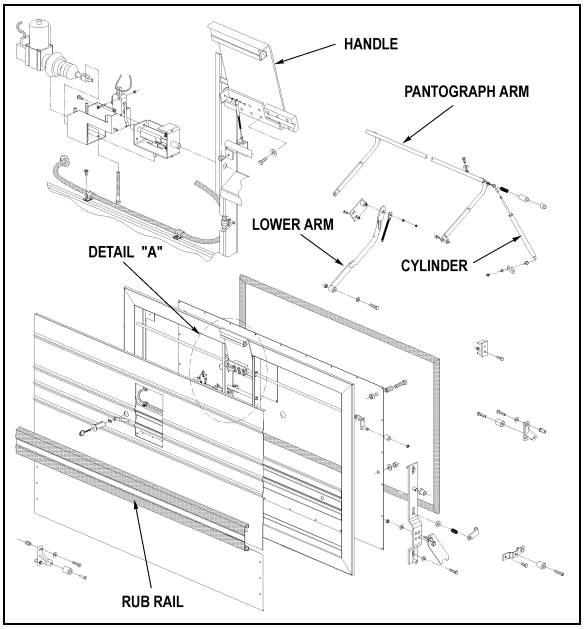


FIGURE 76: BAGGAGE COMPARTMENT DOOR 18145

If a door does not remain in the fully open position, one or both cylinders on that door is (are) defective. To test the cylinders, first support the door in the open position with proper equipment. Disconnect the rod end of one cylinder and retract the rod. If strong resistance is felt, the cylinder is in good condition and can be reinstalled. If the rod retracts with little effort, the cylinder is defective and should be replaced at once. Use the same procedure to test the other cylinder on that door.

❖ **Door Removal**

CAUTION

Two people are required to remove the baggage compartment doors.

1. Maintain the door halfway open by placing a wooden block between one of the pantograph arms and the upper frame.
2. Remove cap screw, lock washer and flat washer retaining lower arm to door
3. Remove spring pins and lock washers fastening the pantograph arms to the door.

WARNING

Support the door properly to prevent it from falling.

4. Spread the pantograph arms away from the door and remove door.
5. Inspect all pivot points and bushings for wear and damage. Check tension of gas-charged cylinders and replace if necessary.

❖ **Pantograph Arms Removal and Installation**

1. Disconnect rod end of gas-charged cylinders from the pantograph arms.
2. Loosen jam nut and cap screw locking the horizontal member of the pantograph to the pivot pin.
3. Slide pantograph assembly to the right and remove assembly from the vehicle.
4. To install, perform the removal instructions in reverse.

❖ **Door Installation**

1. Use a wooden block to support the pantograph arms horizontally.
2. Support the door and insert each pantograph arm into the pivot pins on the side of the door.
3. Install washer and spring pin to fasten each arm to its pivot pin.
4. Fasten lower arm to the door with flat washer, lock washer and cap screw.
5. Remove wooden block and close baggage compartment door.

Door should be adjusted to leave a gap of 3/16" (5 cm) above the top edge of the door. To adjust, loosen the bolts retaining lock plate support and position the door correctly. Tighten the bolts after the adjustment.

If the baggage door locks too tightly or too loosely, the position of the catch striker is misadjusted. To adjust, loosen the catch striker retaining bolts, position the striker correctly and tighten the retaining bolts.

If the lower part of the baggage door does not close evenly with the side of the vehicle, adjust the lock plates by loosening their retaining bolts and positioning the locking plates correctly (Fig. 77).

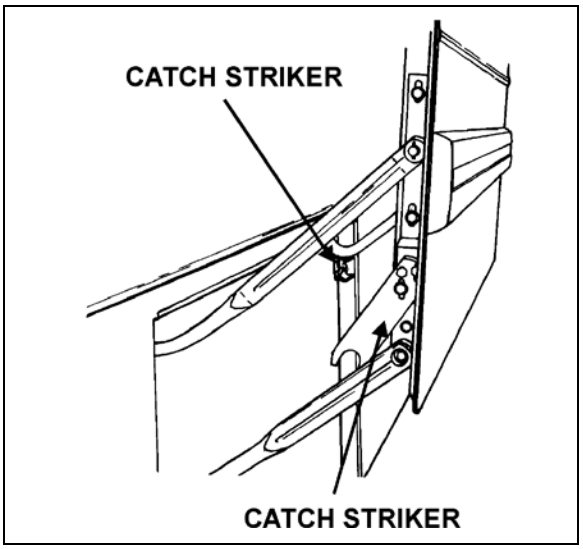


FIGURE 77: BAGGAGE DOOR CATCH STRIKER 18146

For the removal and installation of baggage compartment door body panels, refer to procedure **SAV00177** included at the end of this section.

7.5.2 Condenser Compartment Door

1. Open the condenser door.
2. Loosen the screws fixing the hinge to hinge attachment or hinge to door assembly. Loosening the screws allows the condenser door assembly to be shifted "LEFT or RIGHT" and "UP or DOWN" or “IN and OUT”.
3. Adjust condenser door assembly position at the hinge.
4. Tighten the screws.
5. Respect the required gap between exterior finishing panels.
6. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

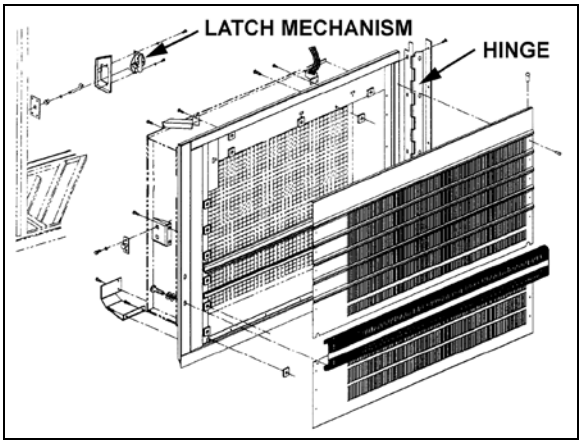


FIGURE 78: CONDENSER DOOR

For the installation of condenser compartment door body panel, refer to procedure **SAV00131** included at the end of this section.

7.5.3 Evaporator Compartment Door

1. Open the evaporator door.
2. Loosen the screws fixing the hinge to hinge attachment or hinge to door assembly. Loosening the screws allows the evaporator door assembly to be shifted "LEFT or RIGHT" and "UP or DOWN" or “IN and OUT”.
3. Adjust evaporator door assembly position at the hinge.
4. Tighten the screws.
5. Respect the required gap between exterior finishing panels.
6. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

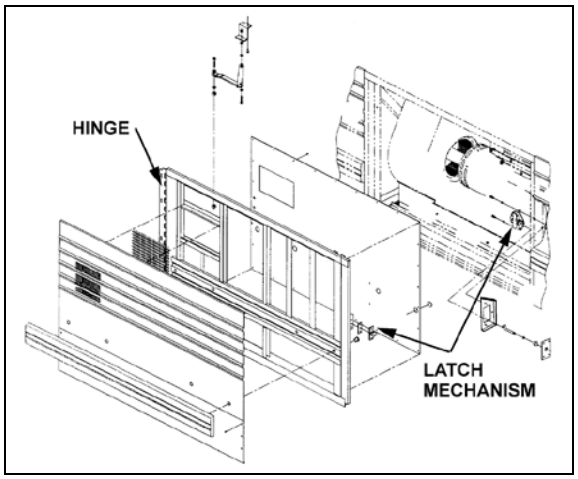


FIGURE 79: EVAPORATOR DOOR

For the installation of evaporator compartment door body panel, refer to procedure **SAV00133** included at the end of this section.

7.5.4 Fuel Filler Door

- o Open the fuel filler door.
- o Loosen the screws holding the panel to hinge assembly.
- o Adjust the fuel filler door position according to distance required between exterior finishing panels.
- o Tighten the nuts.
- o Check that the door swings freely and closes properly.

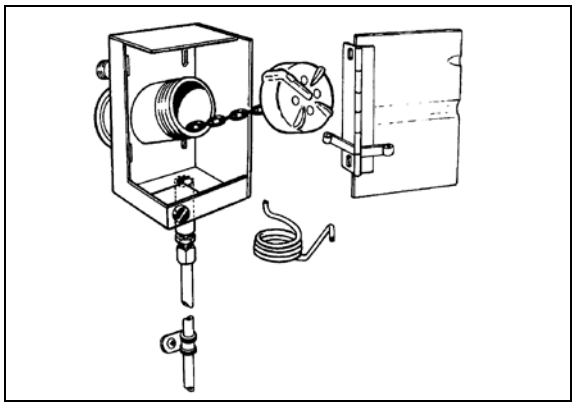


FIGURE 80: FUEL FILLER DOOR 03046

7.6 ZONE 6

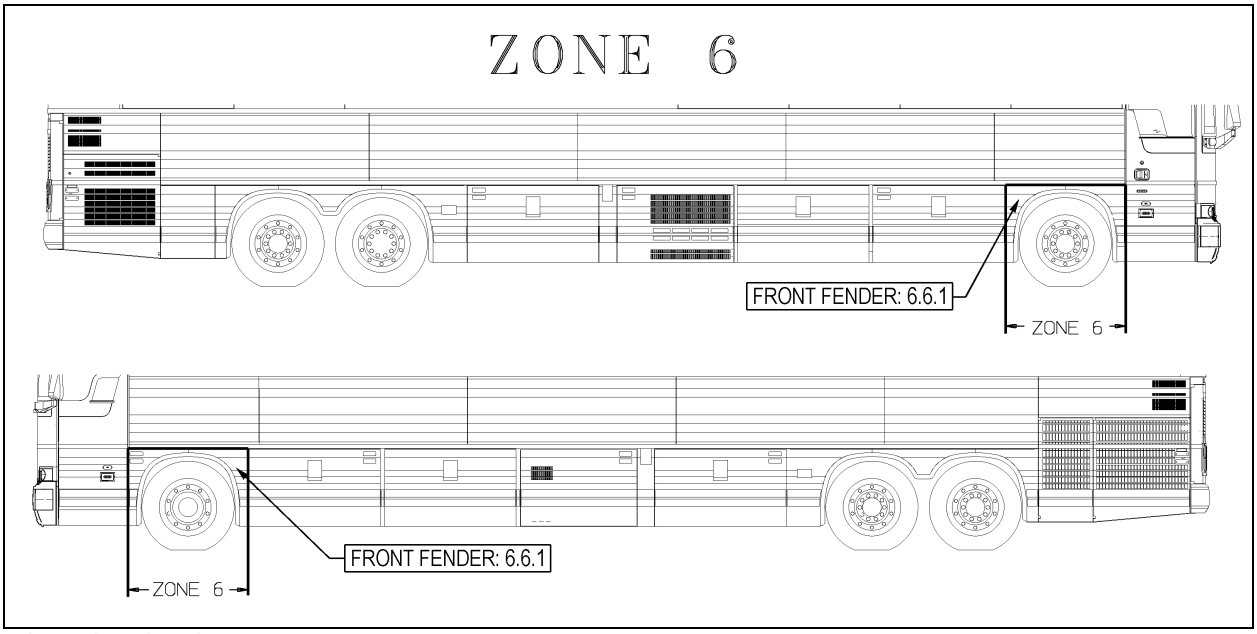


FIGURE 81: ZONE 6

7.6.1 Front Fender

Front fender may be removed using the following procedure:

Remove the nuts on the inside of the fender. Remove the fender from the vehicle. To reinstall, reverse the procedure.

For the installation of front fender body panel, refer to procedure **SAV470024** included at the end of this section.

7.7 ZONE 7

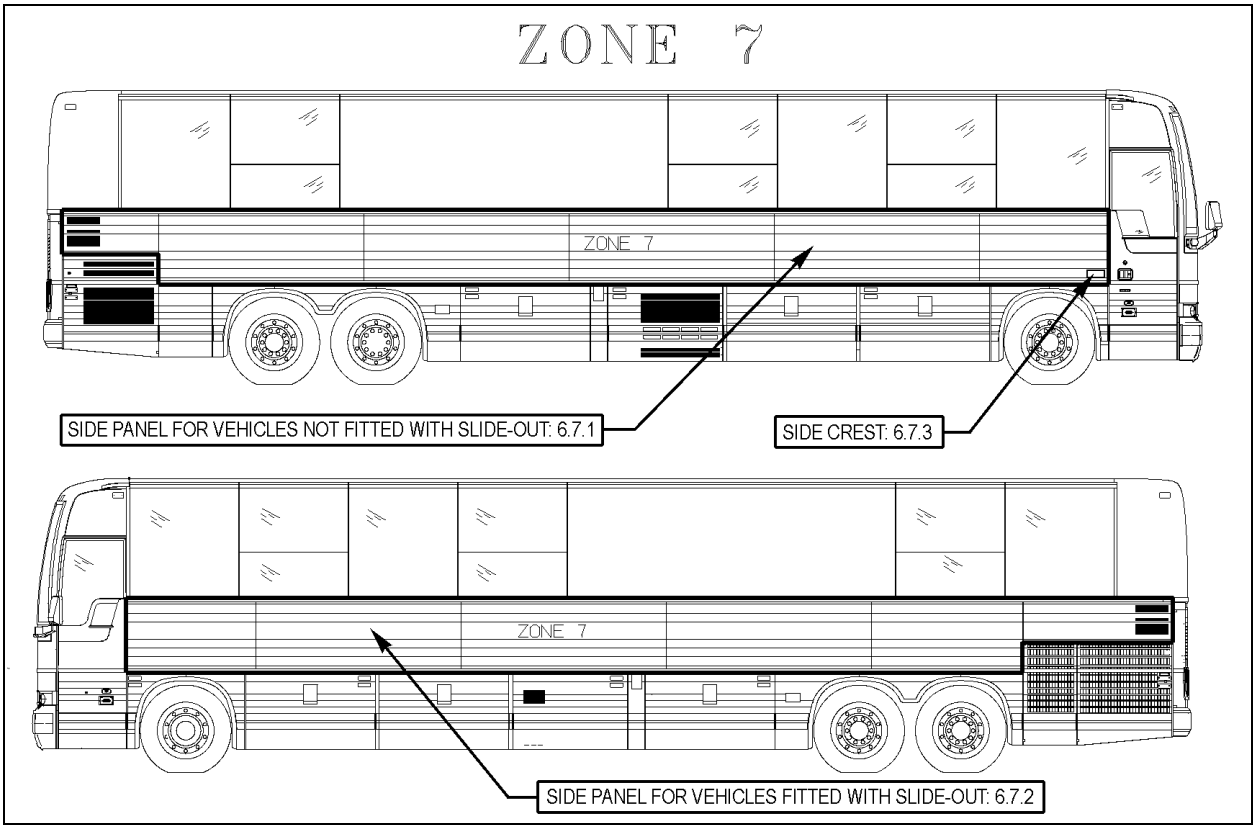


FIGURE 82: ZONE 7

7.7.1 Side Panel for Vehicles Not Fitted With Slide-Out

❖ **Removal**

Remove top and bottom finishing moldings. Insert a screwdriver into snap-on finishing molding joint. Bend finishing molding enough to be able to fix a pair of locking pliers. Using the pair of locking pliers, pull the stainless steel molding and at the same time gradually cut Sika bead with a sharp knife.	Be careful not to damage the adjacent surfaces You need to remove the finishing molding support and rivets in the case of engine air intake panel.
Insert a flat screwdriver between the side panel and the vehicle chassis, in the top left and right corners.	
Use the c-clamp to peel the side panel from the back structural panel as far as the middle and at the same time gradually cut Sika bead with a sharp knife. Do the same for the other corner.	Ideally, the hoist or chain block must be fastened to the floor while pulling from a 45^{o} angle so as not to damage the vehicle structure
Remove as much glue as possible from the structure using a putty knife or pneumatic knife without damaging 206 G+P primer.	Never heat SikaFlex adhesive to remove.
Check panel horizontal supports for straightness using a straight edge. Take measurements with a ruler.	Tolerance: 1mm towards the outside and 1.5mm towards the inside.

For the structure preparation before the installation of a ridged side panel, refer to procedure **SAV00027** included at the end of this section.

For gluing of ridged side panels, refer to procedure **SAV00028** included at the end of this section.

For sealing the side panels' upper portion, refer to procedure **SAV00030** included at the end of this section.

For gluing of horizontal finishing molding, refer to procedure **SAV00208** included at the end of this section.

7.7.2 Side Panel for Vehicles Fitted With Slide-Out

❖ **Removal**

Refer to paragraph 7.7.1 for procedure.

CAUTION

Because most junction panels are only riveted and not spot welded, be careful when removing a side panel not to damage adjacent panels.

For the slide-out junction panel preparation before the installation of a ridged side panel, refer to procedure **SAV00031** included at the end of this section.

For gluing of ridged side panels on vehicles fitted with slide-out, refer to procedure **SAV00029** included at the end of this section.

7.7.3 Side Crest

- Clean vehicle surface using anti-silicone where the side crest and stickers will be applied.
- Using hands apply and compress side crest.
- Apply required stickers.

7.8 ZONE 8

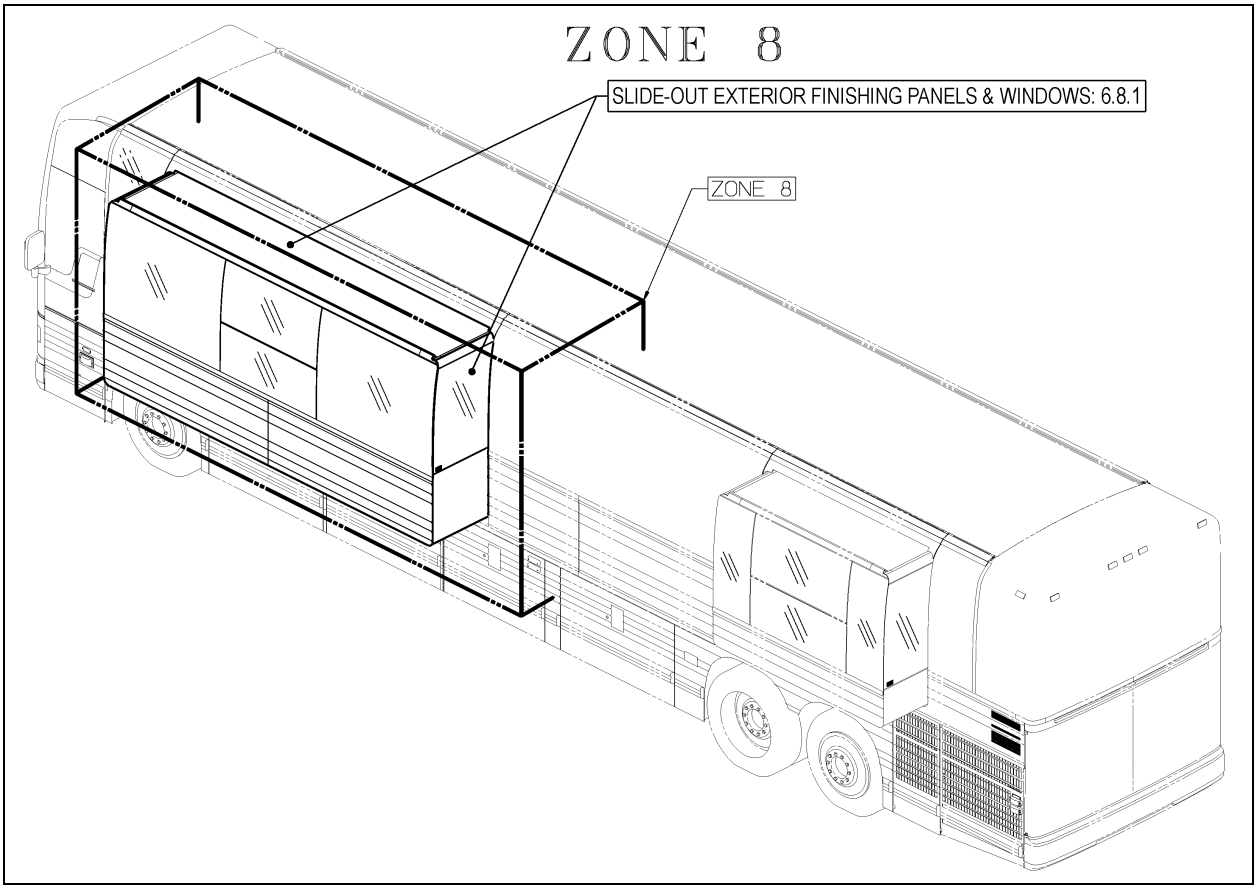


FIGURE 83: ZONE 8

7.8.1 Slide-Out Exterior Finishing Panels & Windows

Refer to Maintenance Manual, Section 26: Paragraph 16 for the procedure on slide-out exterior finishing panels & windows.

7.9 ZONE 9

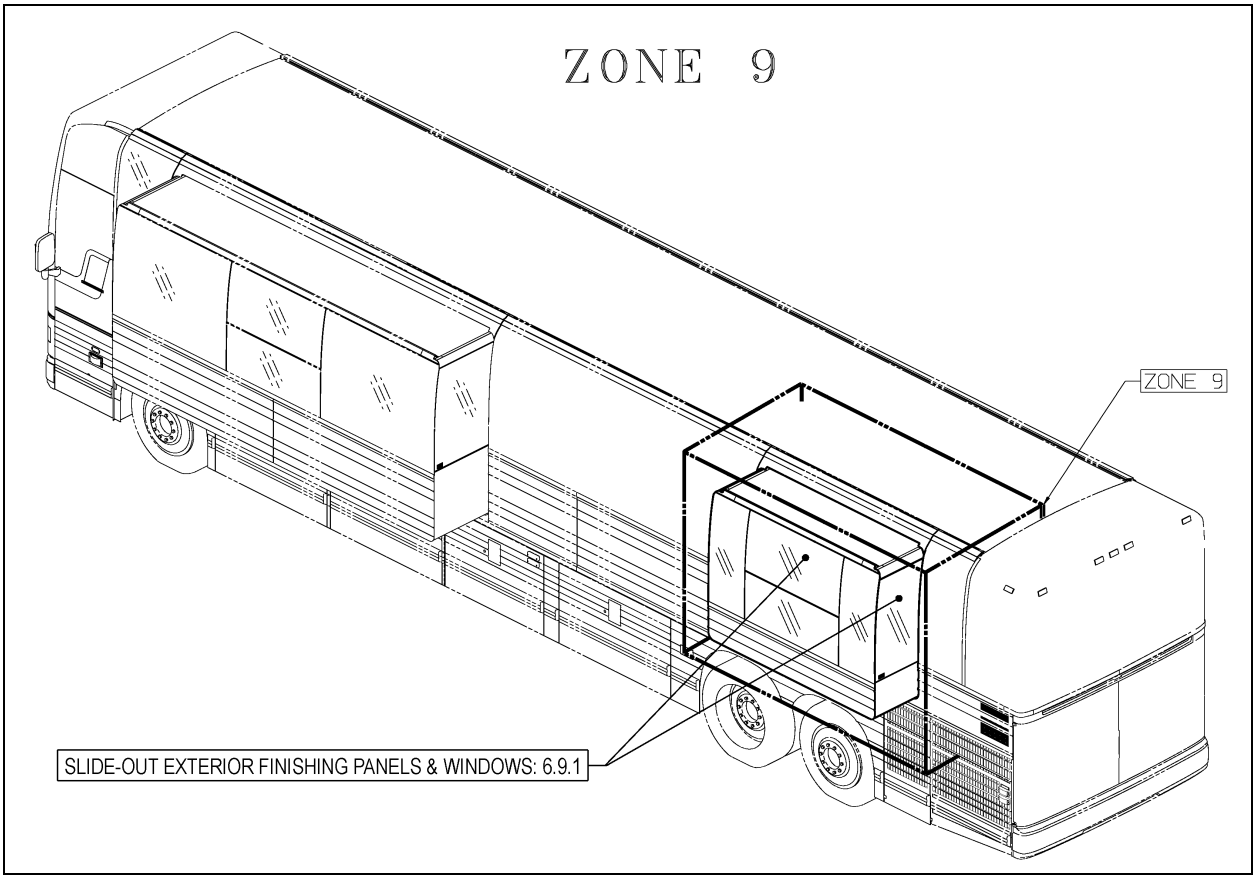


FIGURE 84: ZONE 9

7.9.1 Slide-Out Exterior Finishing Panels & Windows

Refer to Maintenance Manual, Section 26: Paragraph 16 for the procedure on slide-out exterior finishing panels & windows.

7.10 BODY PANEL AND WINDOW SPACING FOR X3-45 VIP NOT FITTED WITH SLIDE-OUT

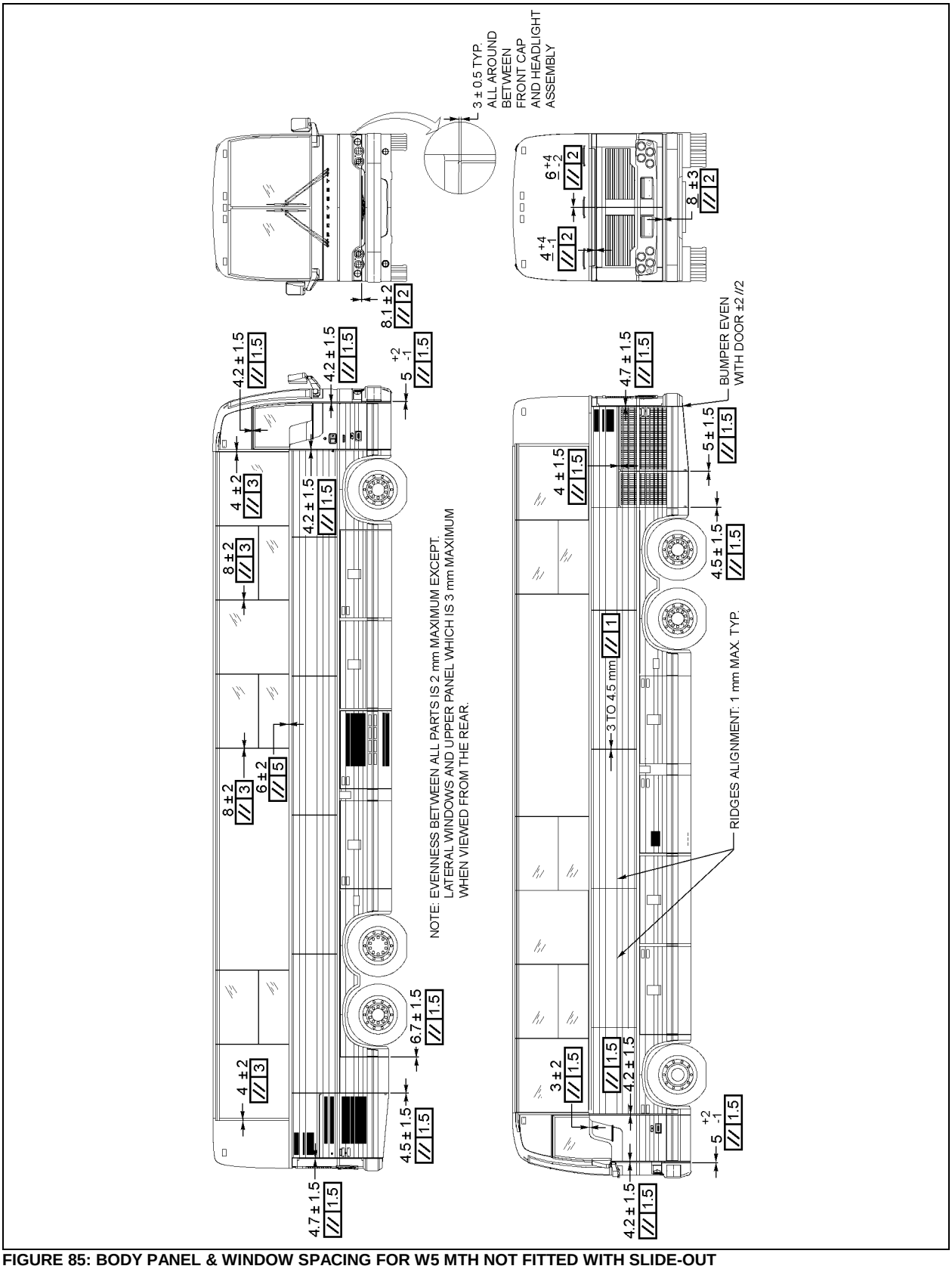


FIGURE 85: BODY PANEL & WINDOW SPACING FOR W5 MTH NOT FITTED WITH SLIDE-OUT

7.11 BODY PANEL AND WINDOW SPACING FOR X3-45 VIP FITTED WITH SLIDE-OUT

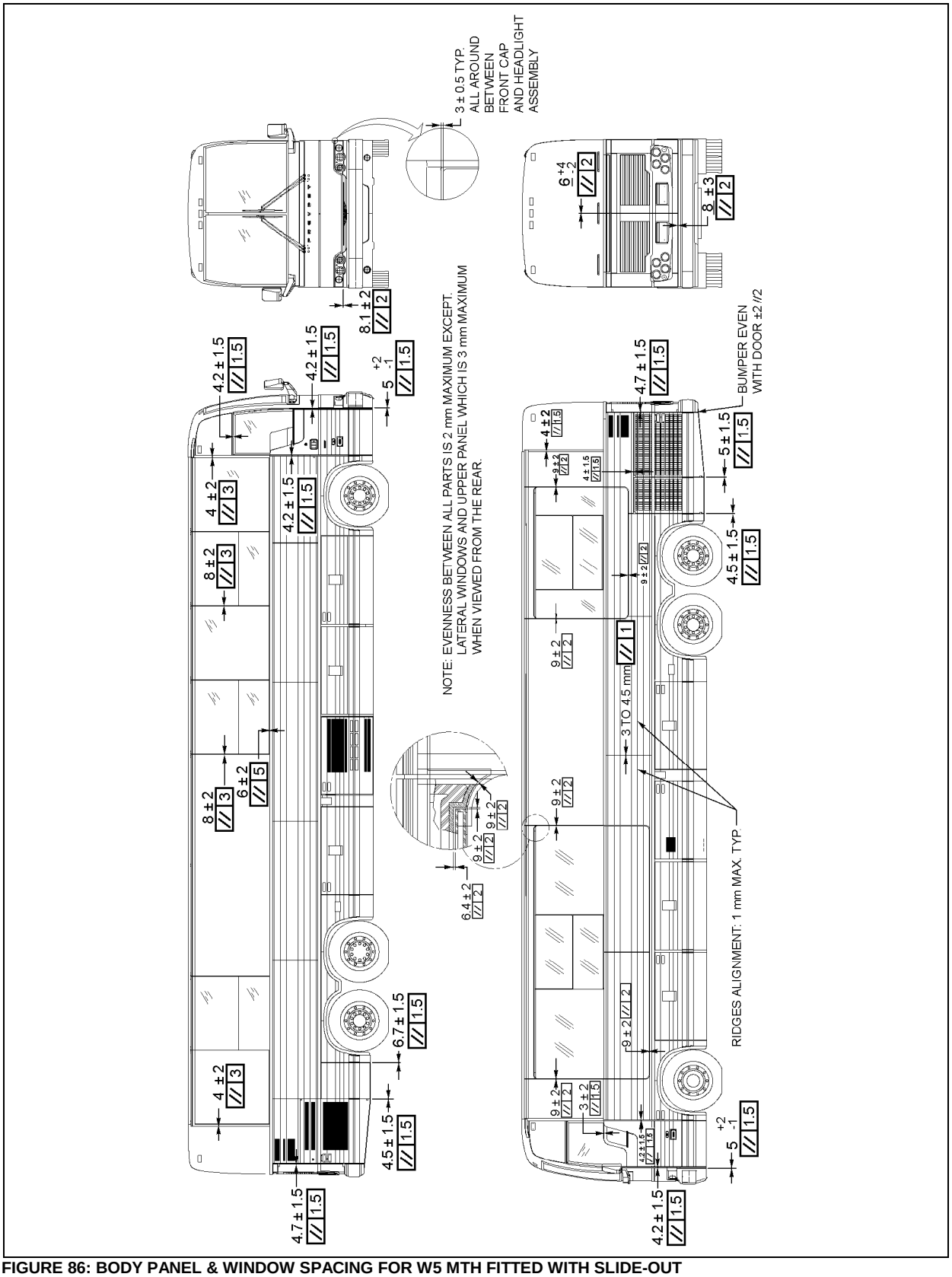


FIGURE 86: BODY PANEL & WINDOW SPACING FOR W5 MTH FITTED WITH SLIDE-OUT

8. LE MIRAGE XLII ENTERTAINER BUS SHELLS EXTERIOR FINISHING AND BODY REPAIR

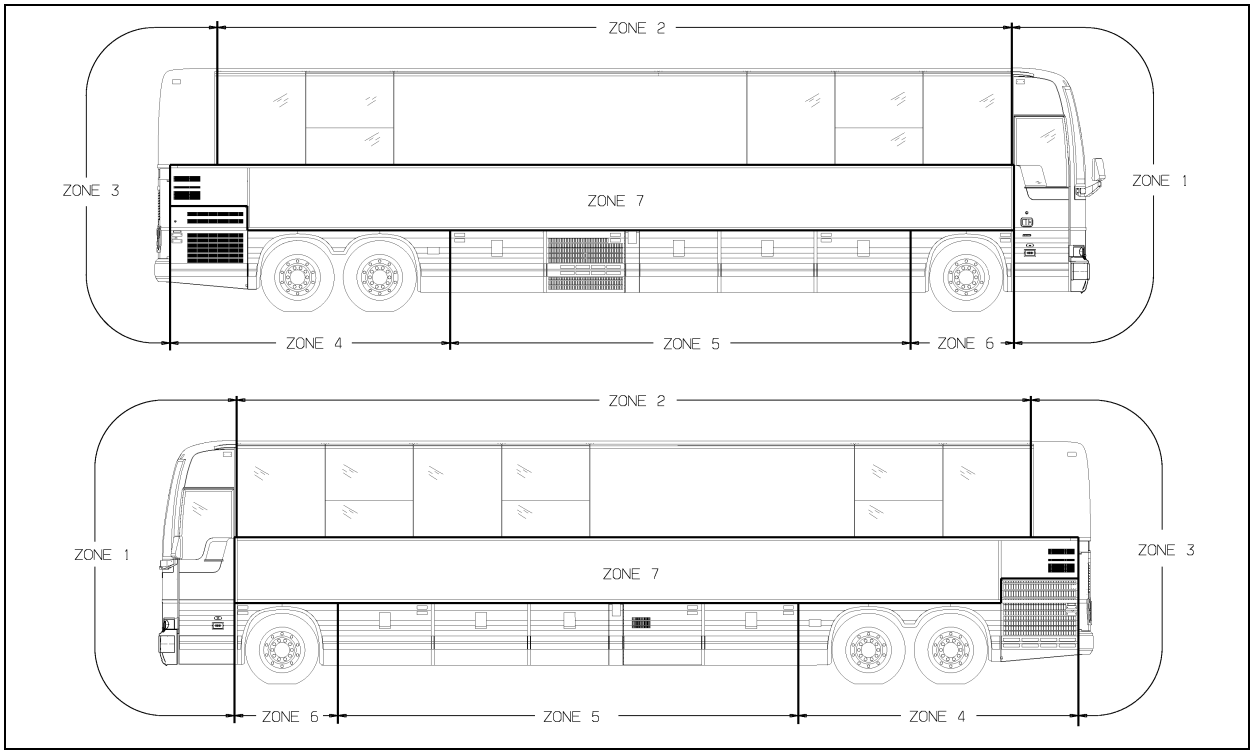


FIGURE 87: WE MTH ZONING

8.1 ZONE 1

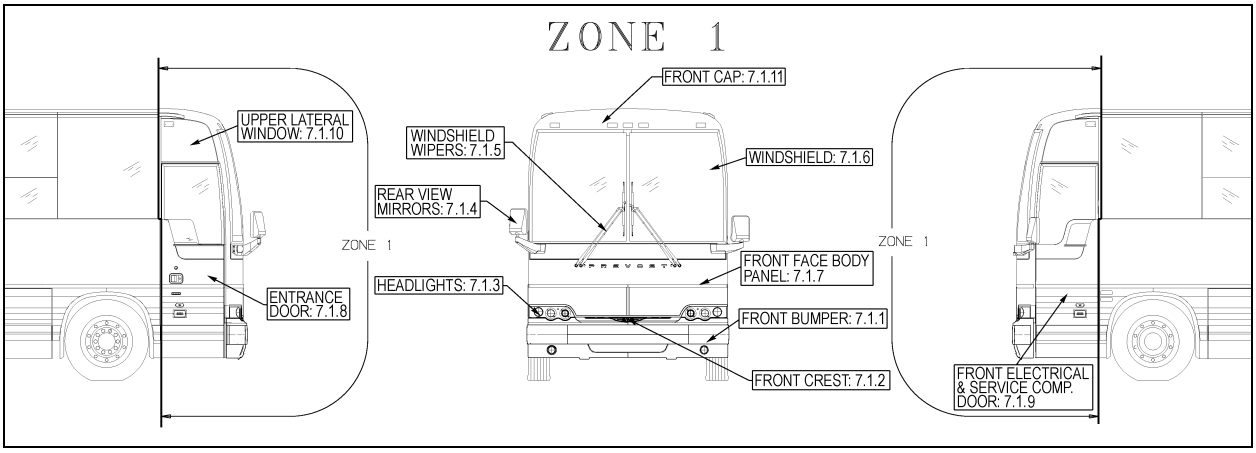


FIGURE 88: ZONE 1

8.1.1 Front Bumper

The front bumper can be tilted downward to give access to the bumper compartment. Pull the release handle located inside front service compartment to unlock. Tilt down the entire bumper assembly to access the compartment.

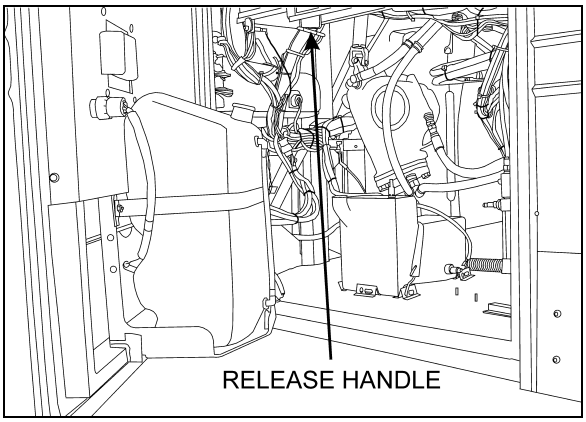


FIGURE 89: FRONT BUMPER RELEASE HANDLE 18613

Push the bumper back up firmly in place to lock in position.

Two people are required to remove and install the front bumper. Safely support the bumper and remove the two bolts on each bumper side to separate the bumper from the spare wheel compartment door. To install bumper, reverse the removal procedure.

WARNING

Front bumper is heavy. Use proper lifting equipment to support the bumper during the removal and installation operations to avoid personal injury.

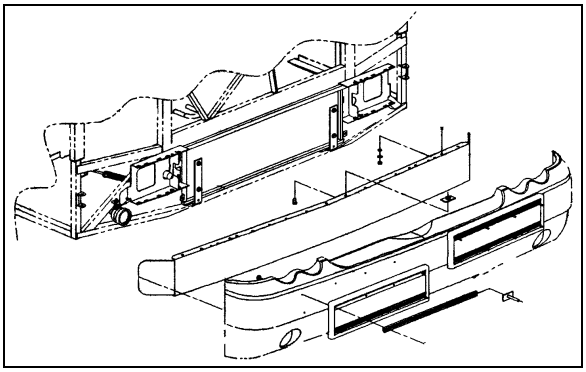


FIGURE 90: FRONT BUMPER REMOVAL

WARNING

The compartment behind the bumper is not designed for storage. Never store loose objects in this compartment since they can interfere with the steering linkage mechanism.

Use care when opening or closing the reclining bumper compartment to prevent personal injury.

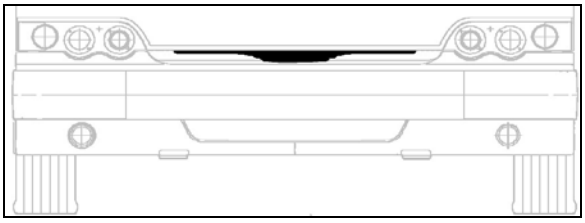
For gluing of front bumper panel refer to procedure **SAV00198** included at the end of this section.

8.1.2 Front Crest

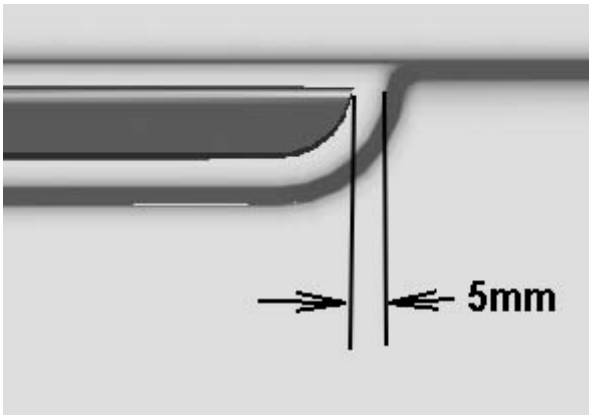
* Use a Chix cloth and anti-silicone to clean the surface where the crest will be applied.

CAUTION

Do not exceed the crest dedicated surface.



* Peel the back from the self adhesive crest side pieces.



* Peel the back from the self adhesive crest center piece. Center crest and apply.
* Compress the crest three pieces using your hands.

8.1.3 Headlights

Refer to Paragraph Headlights, included in Section 06: Electrical of the Maintenance Manual for complete information on headlights.

8.1.4 Rear View Mirrors

Your vehicle is equipped with two exterior mirrors.

The mirrors may be equipped with an optional electric heating system which serves to minimize ice and condensation on the mirror glass in extreme weather conditions. Integral thermostats are installed in both mirrors to avoid continuous heating. Use the appropriate switch on the dashboard to activate the defroster system on both mirrors simultaneously. The mirrors can easily be adjusted by using the remote controls located on the L.H. side control panel. The mirrors have easy to replace glass in case of breakage. Remote control motors can also be replaced.

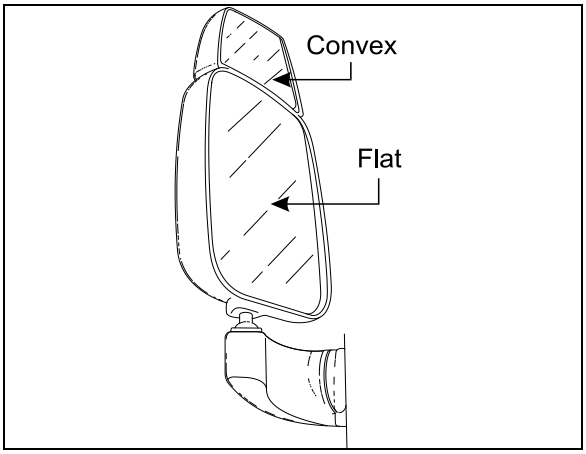


FIGURE 91: REAR VIEW MIRROR (RAMCO) 18398A

❖ **Adjustment**

At the base of the mirror arm, loosen the mounting bolt to swing arm in or out.
To pivot the mirror head, loosen the setscrews on each side of the ball stub at the base of the mirror head to facilitate the adjustment.

❖ **Disassembly**

At end of mirror arm, loosen the setscrews to relieve tension on the ball stem. Remove the ball stem from the arm.

Remove the four screws fastening the mirror arm base to the coach.

❖ **Assembly**

Mount the mirror arm base to the coach. Insert the ball stem into the mirror arm and tighten the socket setscrews.

NOTE
Position the ball cup halves so the joint between them lies on the centerline of the arm. Ensure that the setscrews are not on the joint between the cup halves.

❖ **Replacement of Mirror Glass**

Remove the broken glass.

Position new glass in mirror head and press to lock the Velcro in place.

❖ **Heated / Remote Controlled Rear View Mirrors**

Heated/remote controlled external rear view mirrors may be provided to prevent the mirrors from frosting up in cold weather.

The remote controlled external rear view mirrors attach to support arms using a pivot collar secured by setscrews. Loosening the setscrews allows the whole head assembly to turn on the support arm for initial adjustment. A mounting bolt and washer hold the arm support to the mounting bracket. The arm support can be moved to position the mirror head into or away from the coach body.

The mirror heat switch is located to the left of the driver on the dashboard. This switch must be activated before the mirror heating element will energize. Once energized, the mirror heating element is kept at a sustained temperature (between 60-80°F) by a thermostat. Refer to wiring diagram annexed in the technical publication box.

⚠ **CAUTION**
Do not attach stick-on type convex mirror accessories to the heated mirror glass. This could impede uniform heat distribution on the mirror surface which could break the mirror.

- Mirror Control

The remote control pointer knob(s) for the mirrors is (are) mounted on the L.H. side control panel. The harness to the mirror head runs through the arm support. The remote motor is mounted to the mirror head behind the mirror glass.

Turn pointer knob to the left for mirror head adjustments and to the right for convex mirror adjustment, then push down on either of the button's (4) sides to adjust the selected mirror viewing angle.

- Disassembly

At end of mirror arm, loosen the setscrews to relieve tension on the ball stud. Remove the ball stud. Remove the ball stud from the arm and gently pull the harness out until the connector is exposed.

Remove the four screws fastening the mirror arm base to the coach. Slide the harness free of the mirror arm base.

- Assembly

Attach a stiff wire (snake) to the end of the harness and insert the wire through the mirror arm base and arm, gently pull the harness through the arm and disconnect the "snake".
Connect the mirror head harness. Insert the harness connector back into the mirror arm.
Insert the ball stud into the mirror arm and tighten the socket setscrews.

NOTE
Position the ball cup halves so the joint between them lies on the centerline of the arm. Ensure that the setscrews are not on the joint between the cup halves.

- Convex & Flat Mirror Removal

The mirror glass assembly is mounted to the control mechanism or to mirror base with Velcro strips. Remove the mirror glass by gently pulling the lens to release the Velcro. Disconnect the heater grid at the two connectors.

Connect the connectors of the new mirror's grid to the harness. Install the lens by positioning the lens in the mirror frame and pressing to lock the Velcro in place.

8.1.5 Windshield Wipers

Refer to Paragraph 23.7 Windshield Wipers and Washers, included in Section 23: Accessories of the Maintenance Manual for complete information on windshield wipers.

8.1.6 Windshield

For the removal or installation of windshield, you will need:

- A rope,
- A plastic spatula to lift the rubber seal lip,
- A metal rod or screwdriver to clean the seal groove,
- A filler insertion tool,
- Goggles and protective gloves.

  - From inside of vehicle, remove center post and interior finishing panels surrounding the windshield. In this case, we are replacing the R.H. side windshield.
  - From outside of vehicle, remove filler located inside rubber seal to ease damaged windshield removal.
  - From inside of vehicle, push against the top L.H. side corner of windshield for the removal of a R.H. side windshield. If the L.H. side windshield had to be removed, you would have to push against the top R. H. side corner.

NOTE
We are referring to the L.H and R.H. side as viewed from the inside of the vehicle.

  - At the same time, another person gradually lifts the rubber lip from the vehicle exterior using a plastic spatula from top to bottom.
  - Remove the entire damaged windshield and broken glass if applicable.
  - If applicable, using a screwdriver or metal rod, remove black butyl sealant residue from rubber seal then clean with Sika 205.

❖ **Windshield Installation**

NOTE
Rubber seal may have to be replaced if it was used on several windshield replacements.

- Spray rubber seal with soapy water to ease windshield insertion.
- Insert rope into rubber extrusion leaving enough length at each corner to make a loop. Spray soapy water onto rope and rubber extrusion (Fig. 92).
- Slide windshield into rubber seal groove starting with the bottom curved side edge. Using a plastic spatula, move the rubber seal lip aside to gradually insert the windshield into the groove.
- Spray soapy water on a regular basis to ease this operation.
- Using the same type of plastic spatula, repeat the same operation from inside of vehicle, gradually inserting the windshield into the groove.

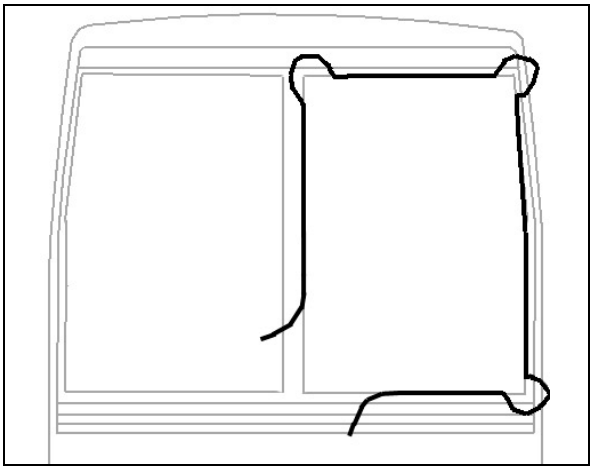


FIGURE 92: WINDSHIELD INSTALLATION USING ROPE

NOTE
Make sure windshield bottom edge is well inserted into the rubber seal groove before proceeding with the sides.

- Then, working from both sides of windshield bottom to top, gradually move the rubber seal lip aside to insert the windshield into the groove. Use also soapy water on the inside of vehicle to insert the windshield into the rubber seal groove.
- Insert the top curved corner then finish with the top of windshield.
- At the top of windshield, clean surface between fiberglass and rubber extrusion using Sika 205 (Fig. 93).
- Apply Sika 221 black between fiberglass and rubber extrusion
- Spray filler and rubber seal groove generously with soapy water.
- Using the special filler insertion tool, insert the filler into the rubber seal groove.
- Gradually insert filler into the rubber seal groove ensuring to leave a 2 inch excess length at the filler extremity.
- Every 6 inches or so, it is important to compress the filler due to its tendency to contract during drying process.
- When filler insertion is almost complete, cut filler leaving ¼" of excess length to thwart filler contraction over time then insert filler into groove.

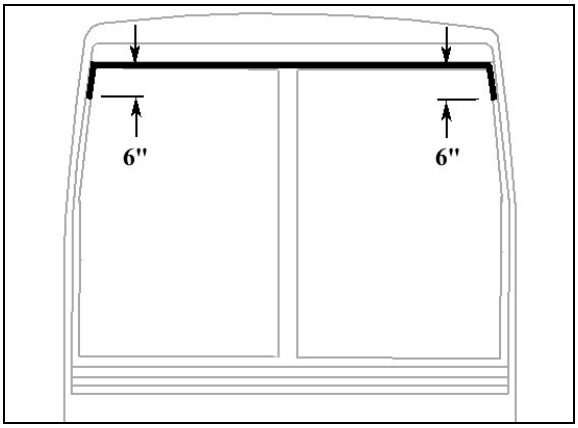


FIGURE 93: APPLICATION 0F SIKA 221 BLACK

- Reinstall center post and interior finishing panels.
- Clean windshield surface of butyl residue.

8.1.7 Front face Body Panel

For removal of front face body panel and molding, you will need:

Drill with drill bits,
Lever or similar tool,
Olfa knife,
"C"-clamp,
Razor sharp window scraper.

❖ **Front Face Molding Removal**

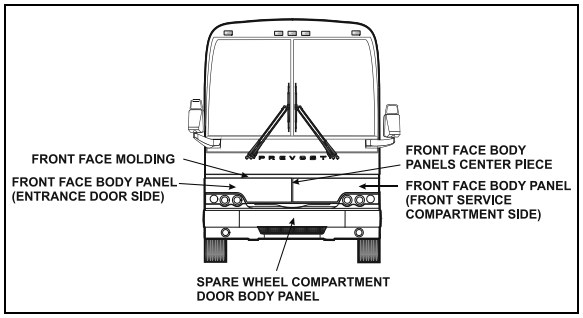


FIGURE 94: VIEW OF FRONT FACE

- First of all, pry loose the front face molding using the lever. Save molding if only the body panel needs to be changed.
- Using the Olfa knife, cut the Sika bead and the double-face self adhesive tape. Remove the Sika bead and self adhesive tape residue with the scraper.

❖ **Front Face Body Panel Removal**

- Using a drill and a 1/8" drill bit remove the rivets fixing the vertical molding. The stainless steel molding is located on the entrance door or service door frame side depending on body panel to be removed.
- Using the Olfa knife, cut the Sika bead and the double-face self adhesive tape. Remove the Sika bead and self adhesive tape residue with the scraper.
- Pry loose the front face body panel using the lever.
- While somebody cuts the Sika bead and double-face self adhesive tape, another person pulls the body panel using the "C"-clamp to exert tension.
- Using the window scraper, remove any Sika bead or self adhesive tape residue left on fiber glass surface.

❖ **Front Face Molding Installation**

For gluing of front face molding, refer to procedure **SAV00212** included at the end of this section.

❖ **Front face Body Panel Installation**

For gluing of front face body panels, refer to procedure **SAV470047** included at the end of this section.

8.1.8 Entrance Door

For the removal of entrance door body panel, you will need:

Pneumatic "Zip gun" type tool;
Razor sharp window scraper;

- Before removing body panel, you can to ease repair uninstall entrance door from vehicle. If applicable, remove reflector, keyless system keyboard and cornering light.
- You must also remove horizontal finishing molding located underneath the window. This molding is glued and will have to be replaced because it will be damaged at removal.
- Remove interior finishing panel to access rub rail fixing bolts, then remove rub rail.
- Using the "**Zip Gun**", cut Sika bead located ¼ inch (7-8 mm) from each body panel edge and around cornering light.
- Separate body panel from door.
- Remove from door surface Sika bead and double-face self adhesive tape residue using a razor sharp window scraper.
- Use a Chix cloth and anti-silicone to remove any dust or residue.

For assembly, gluing or finishing joints of entrance door, refer to procedure **SAV280020** included at the end of this section.

For gluing of entrance door horizontal finishing molding, refer to procedure **SAV00213** included at the end of this section.

For the installation of entrance door, refer to procedure **SAV280022** included at the end of this section.

8.1.9 Front Electrical & Service Compartment Door

For the removal of front electrical & service door body panel, you will need:

Pneumatic "Zip gun" type tool;
Razor sharp window scraper;

- Before removing body panel, you can to ease repair uninstall front electrical & service door from vehicle. If applicable, remove reflector and cornering light.

- You must also remove horizontal finishing molding located underneath the window. This molding is glued and will have to be replaced because it will be damaged at removal.
- Remove interior finishing panel to access rub rail fixing bolts, then remove rub rail.
- Using the "**Zip Gun**", cut Sika bead located ¼ inch (7-8 mm) from each body panel edge and around cornering light.
- Separate body panel from door.
- Remove from door surface Sika bead and double-face self adhesive tape residue using a razor sharp window scraper.
- Use a Chix cloth and anti-silicone to remove any dust or residue.

For assembly, gluing or finishing joints of front electrical & service compartment door, refer to procedure **SAV280021** included at the end of this section.

For gluing of driver's window, refer to procedure **SAV290013** included at the end of this section.

For gluing of front electrical & service compartment door horizontal finishing molding, refer to procedure **SAV00213** included at the end of this section.

For the installation of front electrical & service compartment door, refer to procedure **SAV280022** included at the end of this section.

8.1.10 Upper Lateral Window

For the removal of driver's window or upper lateral window, you will need:

Pneumatic «Zip gun» type tool;
Razor sharp window scraper;
"Olfa" knife;
Face shield.

- In the case of driver's window only, open front service compartment door.
- Mark the position of the driver's window for future reference.
- From inside of vehicle, cut Sika bead around window perimeter using a "Zip gun" while another person hold the window from the outside.

NOTE
Wear ear plugs during this operation.

- Then, move outside of vehicle and cut Sika bead to free window while somebody else hold the window from the inside.
- Carefully remove window from frame, ask for help if needed.
- Using a razor sharp window scraper, remove from window frame Sika bead and double-face self adhesive tape residue.
- First of all, check Sika 205 cleaner expiration date.
- Before applying Sika cleaner, fold "Chix" cloth twice for proper width.
- Apply an even coat onto the inside of window frame and allow drying for 2 minutes (maximum 2 hours).
- Discard waste according to applicable environmental regulations, use dangerous waste containers.
- Apply masking tape before applying Sika glue to protect paint and adjacent window during surface treatment.

For gluing of upper lateral window, refer to procedure **SAV290016** included at the end of this section.

8.1.11 Front Cap

The fiberglass front cap does not need any maintenance except painting as needed. It is held in place with adhesive. If ever it has to be replaced, make an appointment at a Prevost service center near you. For minor damages, refer to paragraph 4 "Common Fiberglass Repair procedure" and paragraph 5 "Common Painting Procedure".

8.2 ZONE 2

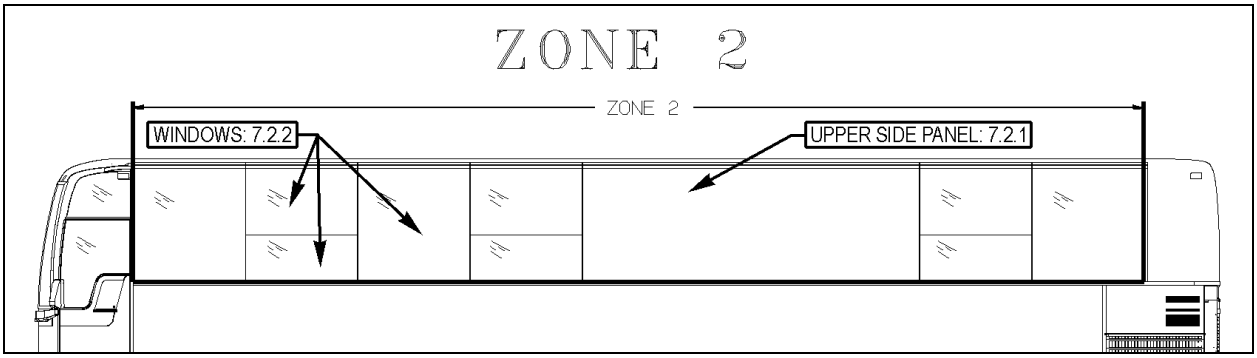


FIGURE 95: ZONE 2

8.2.1 Upper Side Panel

For structure preparation, refer to procedure **SAV00035** included at the end of this section.

For installation of upper side panel neoprene foam tapes, refer to procedure **SAV00036** included at the end of this section.

For installation of upper side panel, refer to procedure **SAV00041** included at the end of this section.

8.2.2 Fixed Windows

Depending on the method chosen for fixed side window removal or installation, you may need:

* Drill equipped with a sharp pointed rod into which a small hole was drilled;
* Razor sharp window scraper;
* Braided windshield wire and a pair of handles;
* Gloves, goggles or face shield.

Fixed Window Removal

1st Method

NOTE
This method is used only in the case of a regular fixed side window. For the fixed upper portion of awning or sliding windows, you must use method number 2.

- Apply a sticky plastic film onto all of window outside surface for safety reason.
- Using a drill equipped with the special sharp pointed rod, drill through the window seal into one of the bottom corners, from a 30º angle with reference to the vehicle.
- This procedure requires accuracy and it is possible not to succeed on the first attempt. From the inside of vehicle, a second person ensures the rod passes through.
- Remove the rod; thread the wire into the small hole. Reinsert the rod and the wire into the hole far enough so that the person inside the vehicle can pull the rod using a pair of pliers.
- Attach the wire ends to the specially designed handles.
- Pull in turn from the inside and the outside of vehicle to gradually cut the Sika bead on the window perimeter.
- When you reach top corner, detach wire from the outside handle, secure it to a fish wire or rod and thread it underneath the aluminum molding behind the rivets.
- Detach wire from fish wire and continue cutting using the handle.
- Cut Sika bead until you come back to starting point, then you can remove the window by carefully pushing it out from the inside of vehicle.

2nd Method

- Apply a sticky plastic film onto all of window outside surface.
- To limit as much damage as possible, remove any interior molding in the way. Install a plastic film on the window interior surface and secure using masking tape onto all of window perimeter.

NOTE
Do not stretch plastic film and leave enough play to be able to push window out without tearing the plastic film.

- Using a ball peen hammer, hit one of the window bottom corners from the **outside**.
- Carefully push window out and lift it up sufficiently to separate it from the aluminum molding.
- Attach the windshield wire to a fish wire and thread it underneath the aluminum molding behind the rivets.
- Detach wire from fish wire and continue cutting using the handle.
- Make a notch at each window top corner to make sure you pass underneath the remaining pieces of glass.
- Remove the aluminum molding and clean up the frame using the window scraper.

For gluing of lateral fixed half-window, refer to procedure **SAV00045** included at the end of this section.

For the installation of awning or sliding window, refer to procedure **SAV00038** included at the end of this section.

For gluing of lateral fixed window, refer to various procedures: **SAV00037** for gluing vertical and bottom rubber seals; **SAV00043** for the installation of lateral fixed window and **SAV00044** for making the Simson joint around fixed windows.

All these procedures are included at the end of this section.

8.2.3 Electric Awning Windows

For window or components replacement, refer to paragraph 7.2.3.

8.2.4 Electric Sliding Windows

For sash removal or replacement, refer to paragraph 7.2.4.

8.3 ZONE 3

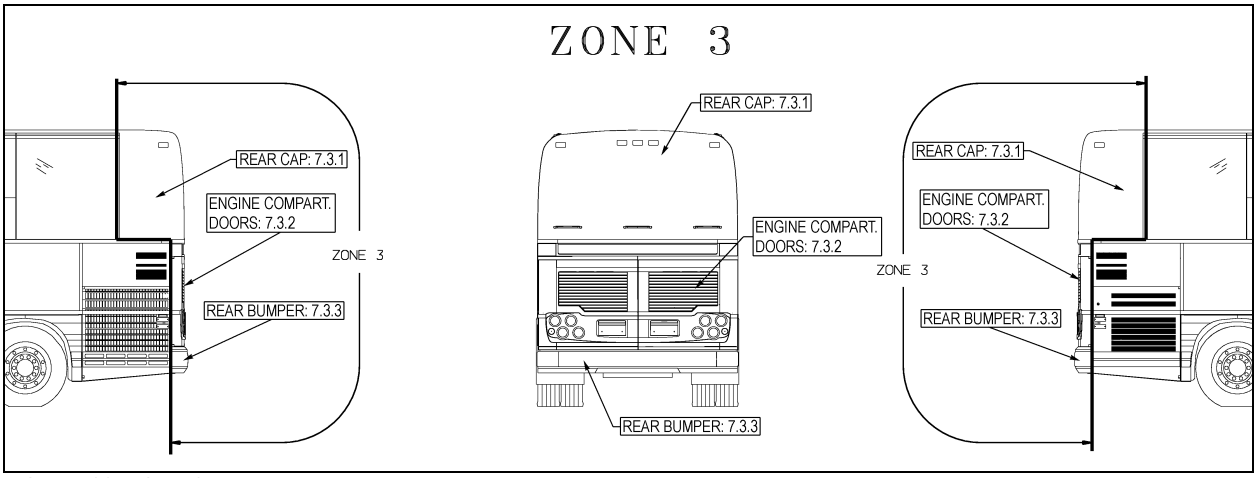


FIGURE 96: ZONE 3

8.3.1 Rear Cap

The fiberglass rear cap does not need any maintenance except painting as needed. It is held in place with adhesive. If ever it has to be replaced, make an appointment at a Prevost service center near you.

For minor damages, refer to Paragraph 4 "Common Fiberglass Repair Procedure" and Paragraph 5 "Common Painting Procedure".

8.3.2 Engine Compartment Doors

❖ **Engine Compartment Doors Adjustment**

Engine compartment doors may be adjusted for proper fit by untightening hinge bolts:

1. Loosen the bolts, (1, 2 Fig. 97) holding the hinge to the vehicle structure to shift the door "UP or DOWN".
2. Loosening the bolts (3, Fig. 97) allows the door to be shifted "LEFT or RIGHT" and "IN or OUT".

3. Adjust the doors position depending on the gap needed between exterior finishing panels.
4. Tighten the bolts.
5. Check that the doors swing freely and close properly. It may be necessary to adjust the door latch to get proper fit and operation.

To adjust the latch mechanism (4, Fig. 97) and the striker pin:

1. Open the doors to access the striker pin.
2. Slightly loosen the striker pin.
3. Using a hammer, adjust the striker pin to center it in the door latch mechanism.
4. Tighten the striker pin.
5. Check doors fit and operation.

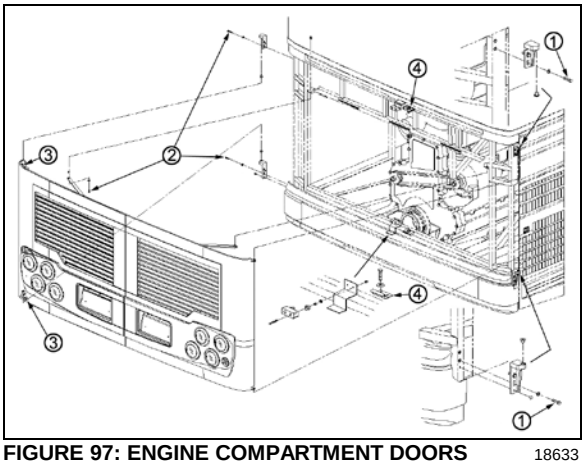


FIGURE 97: ENGINE COMPARTMENT DOORS 18633

❖ **Engine Compartment Door Body Panel Removal**

For the removal of engine compartment door body panel, you will need:

Pneumatic “Zip gun” type tool;
Razor sharp window scraper;
A pair of locking pliers;
Isopropyl alcohol.

- o Remove damaged engine compartment door from vehicle.
- o Install the damaged door onto an appropriate support.
- o Wearing gloves, goggles and ear plugs, pry loose body panel using a “Zip gun” or lever starting from the edge opposite the curved side.
- o Use the “Zip gun” to detach completely the stainless steel body panel from door frame.

CAUTION

Do not damage painted surface.

- o Use a second person equipped with a pair of locking pliers to pull the body panel as you cut the Sika bead.

WARNING

Be very careful when pulling the body panel, somebody could get hurt if the body panel suddenly detach from the door surface without notice.

- o Using the window scraper, remove any Sika bead or self adhesive tape residue left on the fiber glass surface.

For gluing of engine compartment doors molding, refer to procedure **SAV00211** included at the end of this section.

For engine compartment door body panel installation, refer to procedure **SAV280032** included at the end of this section.

8.3.3 Rear Bumper

Remove three bolts on each side holding bumper to vehicle and remove bumper.

To install bumper, reverse the procedure.

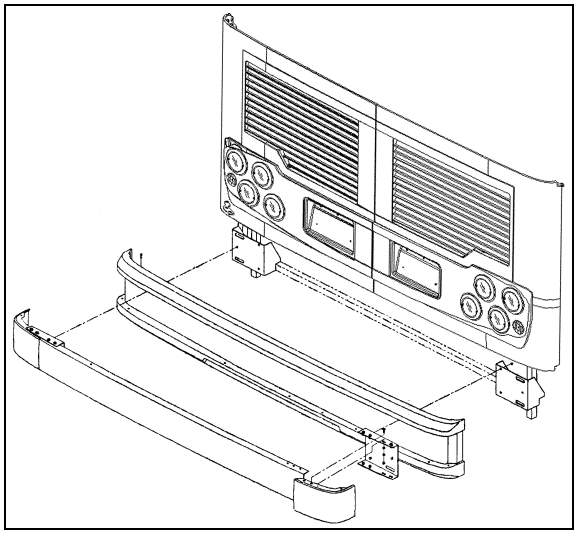


FIGURE 98: REAR BUMPER

8.4 ZONE 4

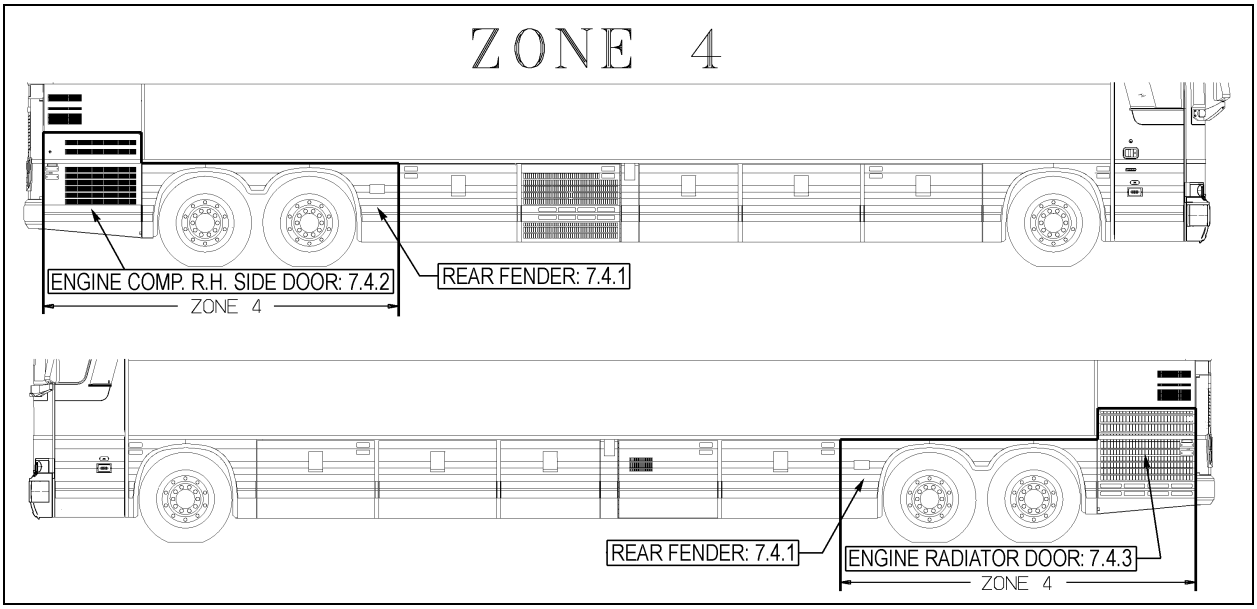


FIGURE 99: ZONE 4

8.4.1 Rear Fender

On the "XLII Bus Shells vehicles, rear fenders are hinged for maintenance on brakes and suspension. Each rear fender panel has two mechanical spring loaded holding devices fixing it to the vehicle's structure. Push the spring type rod sideways to disengage the lock.

For the installation of rear fender body panel, refer to procedure **SAV470046** included at the end of this section.

8.4.2 Engine Compartment R.H. Side Door

Engine compartment R. H. side door may be adjusted for proper fit by untightening hinge bolts:

1. Loosen the bolts, (1, Fig. 100) holding the hinge to the vehicle structure to shift the door "IN or OUT" and "UP or DOWN".
2. Loosening the bolts (2, Fig. 100) allows the door to be shifted "LEFT or RIGHT" and "UP or DOWN".
3. Adjust the door position depending on the gap needed between exterior finishing panels.
4. Tighten the bolts.
5. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

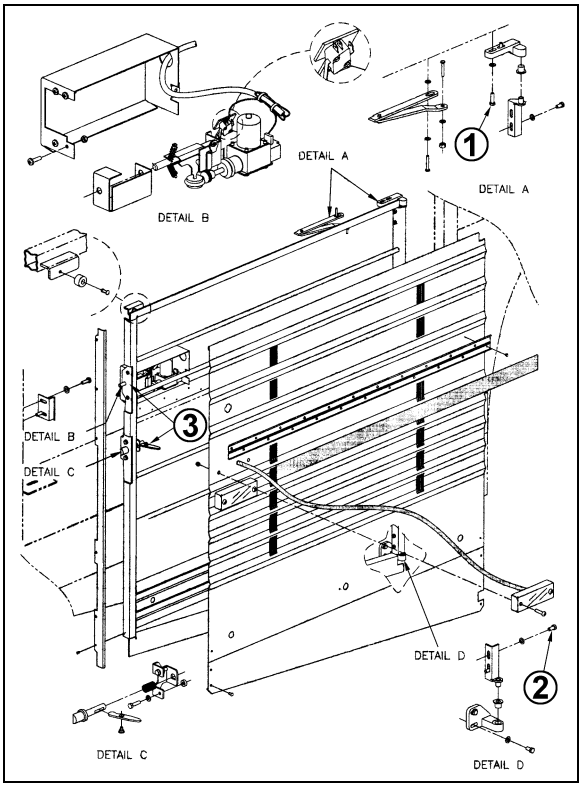


FIGURE 100: ENGINE COMPARTMENT R.H. SIDE DOOR18635

To adjust the latch mechanism (3, Fig. 100) and the striker pin:

1. Open the door to access the striker pin.
2. Slightly loosen the striker pin.

3. Using a hammer, adjust the striker pin to center it in the door latch mechanism.
4. Tighten the striker pin.
5. Check door fit and operation.

For gluing of engine compartment R.H. side door finishing molding, refer to procedure **SAV00210** included at the end of this section.

8.4.3 Engine Radiator Door

Radiator door may be adjusted for proper fit by untightening hinge bolts:

1. Loosen the bolts, (1, Fig. 101) holding the hinge to the vehicle structure to shift the door "IN or OUT" and "UP or DOWN".
2. Loosening the bolts (2, Fig. 101) allows the door to be shifted "LEFT or RIGHT" and "UP or DOWN".
3. Adjust the door position depending on the gap needed between exterior finishing panels.
4. Tighten the bolts.
5. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

To adjust the latch mechanism (3, Fig. 101) and the striker pin:

1. Open the door to access the striker pin.

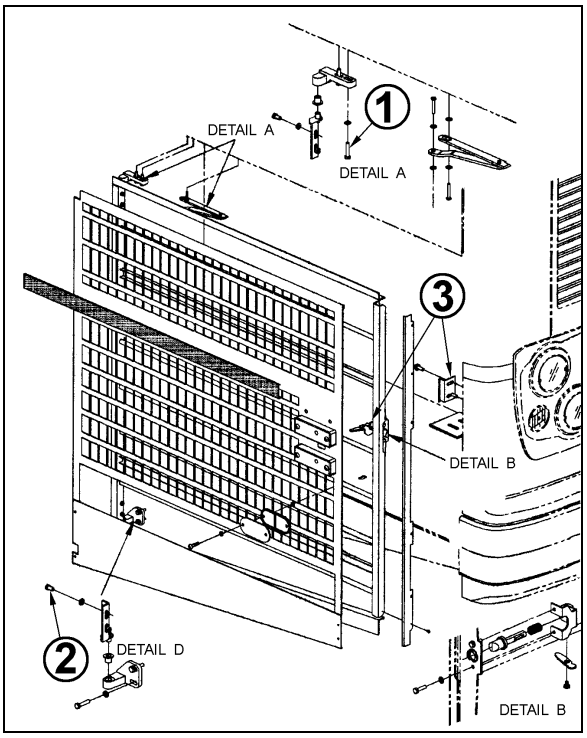


FIGURE 101: RADIATOR DOOR 18636

2. Slightly loosen the striker pin.
3. Using a hammer, adjust the striker pin to center it in the door latch mechanism.
4. Tighten the striker pin.
5. Check door fit and operation.

For gluing of engine radiator door finishing molding, refer to procedure **SAV00210** included at the end of this section.

8.5 ZONE 5

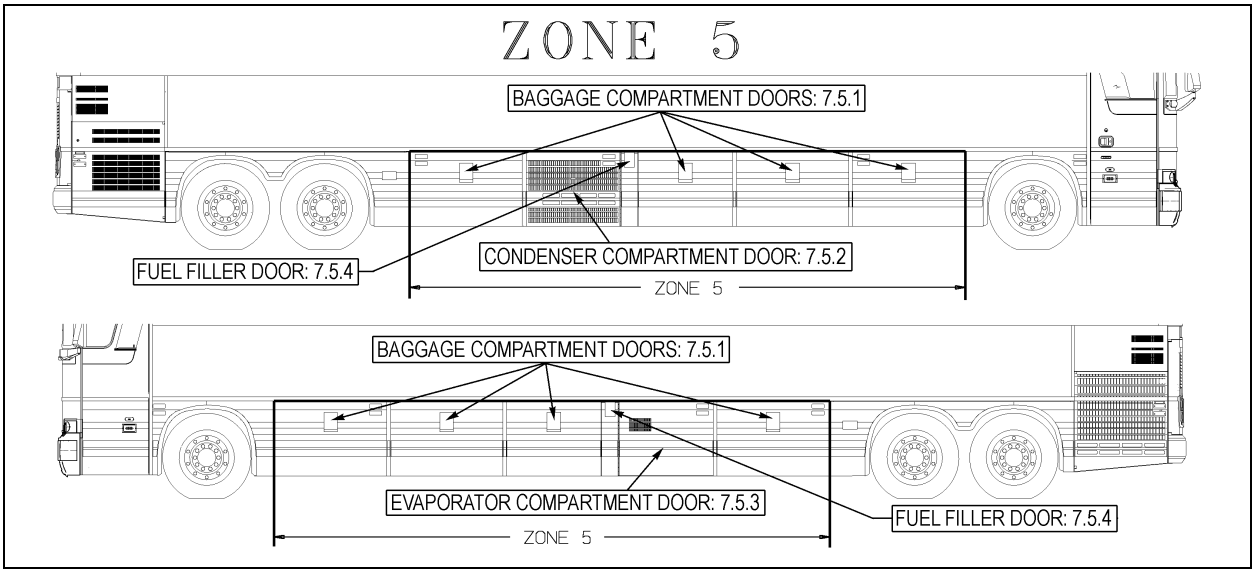


FIGURE 102: ZONE 5

8.5.1 Baggage Compartment Doors

The baggage compartment doors on the vehicle are of identical design. The doors are pantograph, vertical-lift type and are fully sealed. Each door has a flush-mounted latch handle. To open, lift latch handle, then pull door outward and up. The door is held open by 2 gas-charged cylinders. To close, leave latch handle in the open position, pull downward on door and push down on latch to secure door. The door lower arm is spring loaded to secure effort required to close the door (Fig. 103).

If a door does not remain in the fully open position, one or both cylinders on that door is (are) defective. To test the cylinders, first support the door in the open position with proper equipment. Disconnect the rod end of one cylinder and retract the rod. If strong resistance is felt, the cylinder is in good condition and can be reinstalled. If the rod retracts with little effort, the cylinder is defective and should be replaced at once. Use the same procedure to test the other cylinder on that door.

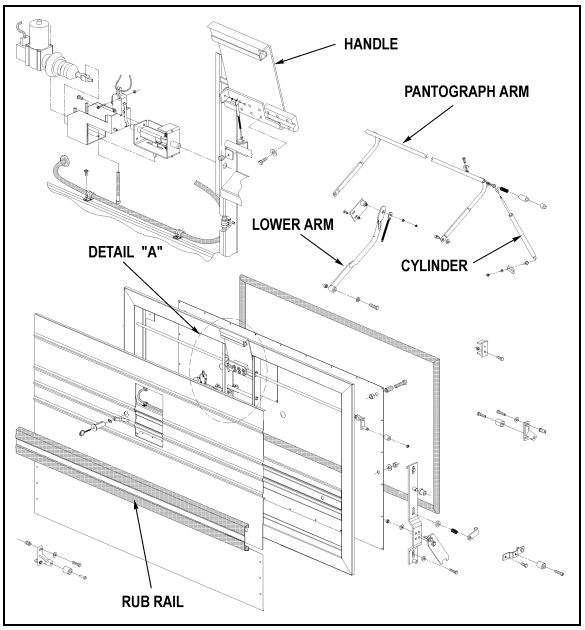


FIGURE 103: BAGGAGE COMPARTMENT DOOR 18145

❖ **Door Removal**

CAUTION

Two people are required to remove the baggage compartment doors.

1. Maintain the door halfway open by placing a wooden block between one of the pantograph arms and the upper frame.
2. Remove cap screw, lock washer and flat washer retaining lower arm to door
3. Remove spring pins and lock washers fastening the pantograph arms to the door.

WARNING

Support the door properly to prevent it from falling.

4. Spread the pantograph arms away from the door and remove door.
5. Inspect all pivot points and bushings for wear and damage. Check tension of gas-charged cylinders and replace if necessary.

❖ **Pantograph Arms Removal and Installation**

1. Disconnect rod end of gas-charged cylinders from the pantograph arms.
2. Loosen jam nut and cap screw locking the horizontal member of the pantograph to the pivot pin.
3. Slide pantograph assembly to the right and remove assembly from the vehicle.
4. To install, perform the removal instructions in reverse.

❖ **Door Installation**

1. Use a wooden block to support the pantograph arms horizontally.
2. Support the door and insert each pantograph arm into the pivot pins on the side of the door.
3. Install washer and spring pin to fasten each arm to its pivot pin.
4. Fasten lower arm to the door with flat washer, lock washer and cap screw.
5. Remove wooden block and close baggage compartment door.

Door should be adjusted to leave a gap of 3/16" (5 cm) above the top edge of the door. To adjust, loosen the bolts retaining lock plate support and position the door correctly. Tighten the bolts after the adjustment.

If the baggage door locks too tightly or too loosely, the position of the catch striker is misadjusted. To adjust, loosen the catch striker retaining bolts, position the striker correctly and tighten the retaining bolts.

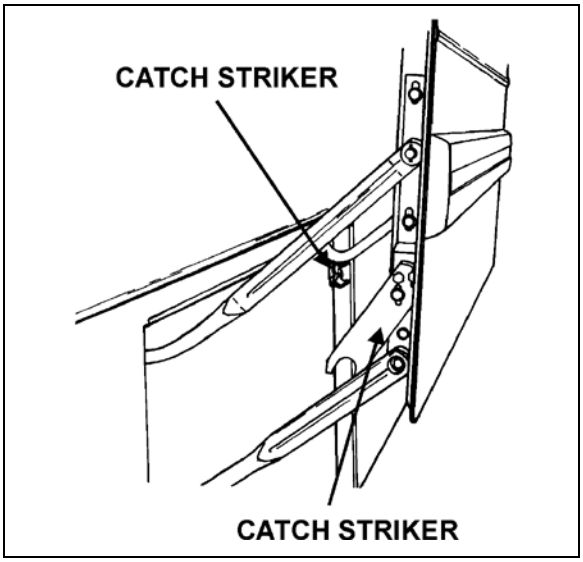


FIGURE 104: BAGGAGE DOOR CATCH STRIKER 18146

If the lower part of the baggage door does not close evenly with the side of the vehicle, adjust the lock plates by loosening their retaining bolts and positioning the locking plates correctly (Fig. 104).

For the removal and installation of baggage compartment door body panels, refer to procedure **SAV00177** included at the end of this section.

8.5.2 Condenser Compartment Door

1. Open the condenser door.
2. Loosen the screws fixing the hinge to hinge attachment or hinge to door assembly. Loosening the screws allows the condenser door assembly to be shifted "LEFT or RIGHT" and "UP or DOWN" or “IN and OUT”.
3. Adjust condenser door assembly position at the hinge.
4. Tighten the screws.
5. Respect the required gap between exterior finishing panels.
6. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

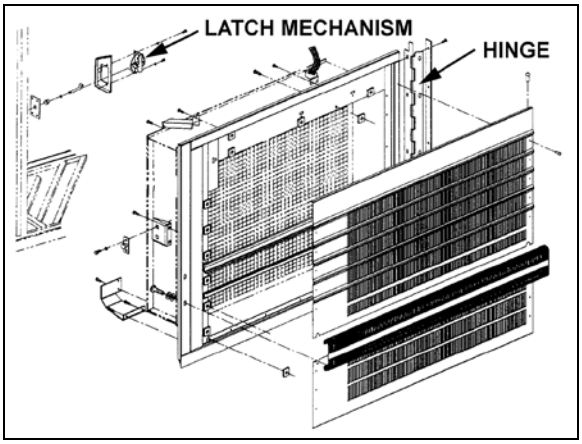


FIGURE 105: CONDENSER DOOR

For the installation of condenser compartment door body panel, refer to procedure **SAV00131** included at the end of this section.

8.5.3 Evaporator Compartment Door

1. Open the evaporator door.
2. Loosen the screws fixing the hinge to hinge attachment or hinge to door assembly. Loosening the screws allows the evaporator door assembly to be shifted "LEFT or RIGHT" and "UP or DOWN" or “IN and OUT”.
3. Adjust evaporator door assembly position at the hinge.
4. Tighten the screws.
5. Respect the required gap between exterior finishing panels.
6. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

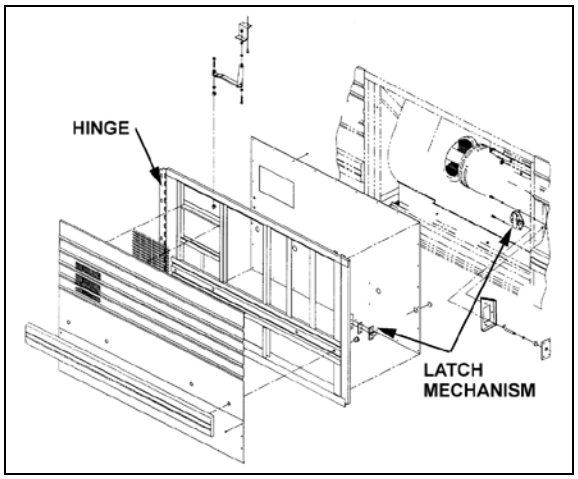


FIGURE 106: EVAPORATOR DOOR

For the installation of evaporator compartment door body panel, refer to procedure **SAV00133** included at the end of this section.

8.5.4 Fuel Filler Door

- o Open the fuel filler door.
- o Loosen the screws holding the panel to hinge assembly.
- o Adjust the fuel filler door position according to distance required between exterior finishing panels.
- o Tighten the nuts.
- o Check that the door swings freely and closes properly.

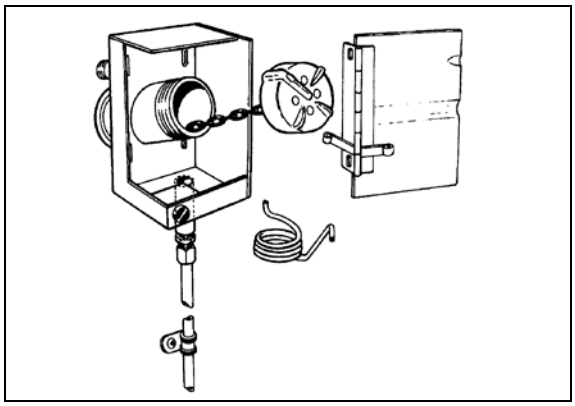


FIGURE 107: FUEL FILLER DOOR 03046

8.6 ZONE 6

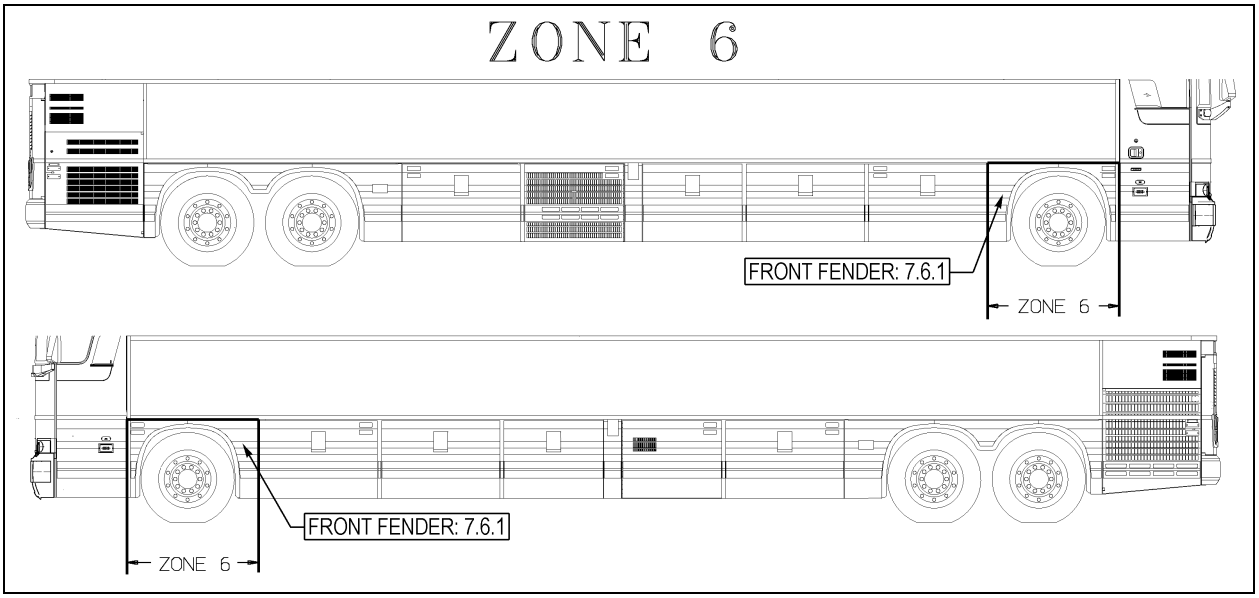


FIGURE 108: ZONE 6

8.6.1 Front Fender

Front fender may be removed using the following procedure:

Remove the nuts on the inside of the fender. Remove the fender from the vehicle. To reinstall, reverse the procedure.

For the installation of front fender body panel, refer to procedure **SAV470024** included at the end of this section.

8.7 ZONE 7

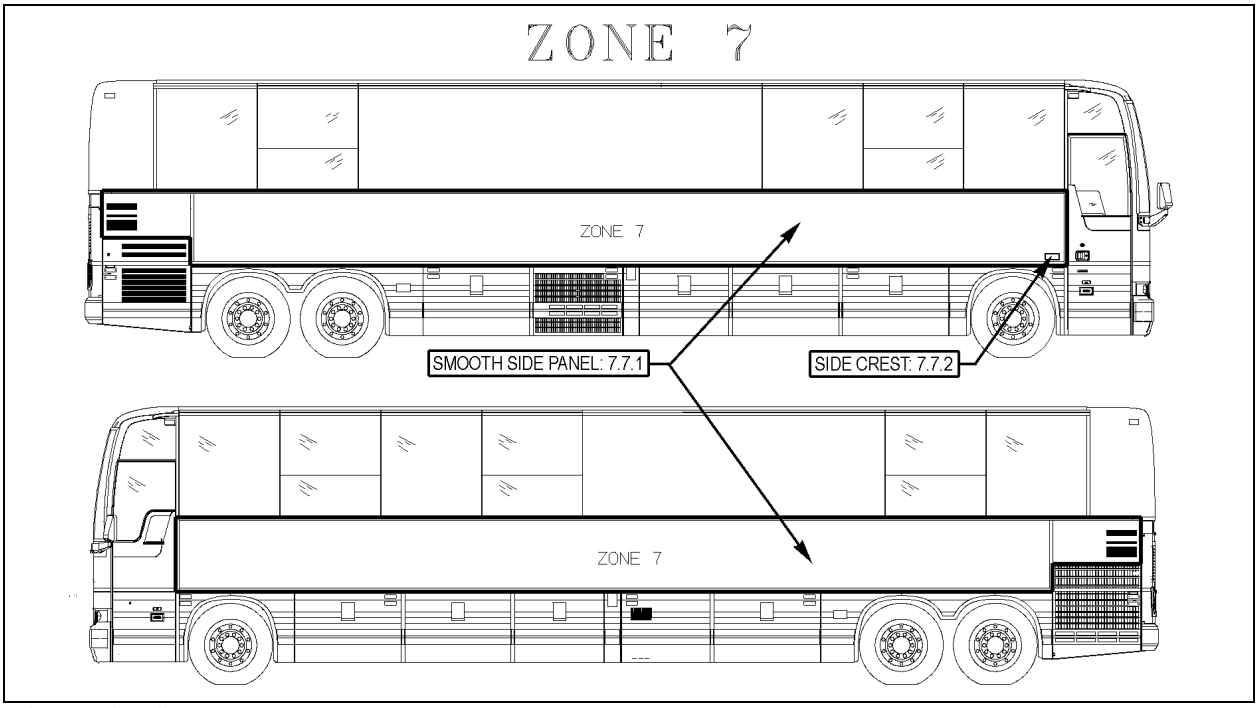


FIGURE 109: ZONE 7

8.7.1 Smooth Side Panel

❖ **Removal**

A)	Remove finishing molding. Insert a screwdriver into snap-on finishing molding joint. Bend finishing molding enough to be able to fix a pair of locking pliers. Using the pair of locking pliers, pull the stainless steel molding and at the same time gradually cut Sika bead with a sharp knife.	Be careful not to damage the adjacent surfaces.
B)	Using a hammer and punch, drive out rivet shanks from top and bottom and from front and rear finishing molding supports. Use a #11 titanium drill bit to remove rivet heads.	
C)	Grind tig weld spots at each end of side panel.	
D)	Safely support or temporary fix side panel.	**Warning: Panel weights over 200 pounds**
E)	Insert a flat screwdriver between the side panel and the vehicle chassis, in the top left and right corners. Make sure to separate side panel from structure.	Be careful not to damage the adjacent surfaces.
F)	Use the c-clamp to separate the side panel from the back structural panel and at the same time gradually cut Sika bead with a sharp knife.	Ideally, the hoist or chain block must be fastened to the floor while pulling from a 45^{o} angle so as not to damage the vehicle structure
G)	Remove as much glue as possible from the structure using a putty knife or pneumatic knife without damaging 206 G+P primer.	Never heat SikaFlex adhesive to remove.
H)	Check panel horizontal supports for straightness using a straight edge. Take measurements with a ruler.	Tolerance: 1 mm towards the outside and 1.5 mm towards the inside.

❖ **Installation Procedures**

SMOOTH SIDE PANEL – STRUCTURE PREPARATION	**SAV00072**
SMOOTH SIDE PANEL – INSTALLATION	**SAV00073**
ENGINE AIR INTAKE PANEL - GLUING	**SAV00074**
SMOOTH SIDE PANEL – FINISHING JOINT	**SAV00075**
SMOOTH SIDE PANEL – GLUING MOLDINGS	**SAV00214**
SMOOTH SIDE PANEL – REAR MOLDING GLUING	**SAV00215**
SMOOTH SIDE PANEL – PROTECTION OF UNPRIMED TIG WELDING SPOTS	**SAV00216**
SMOOTH SIDE PANEL – GLUING SLIDE-OUT VERTICAL MOLDING	**SAV00217**
SMOOTH SIDE PANEL – CUTTING HORIZONTAL FINISHING MOLDING AT SLIDE-OUT LEVEL	**SAV00220**

8.7.2 Side Crest

- Clean vehicle surface using anti-silicone where the side crest and stickers will be applied.
- Using hands apply and compress side crest.
- Apply required stickers.

8.8 ZONE 8

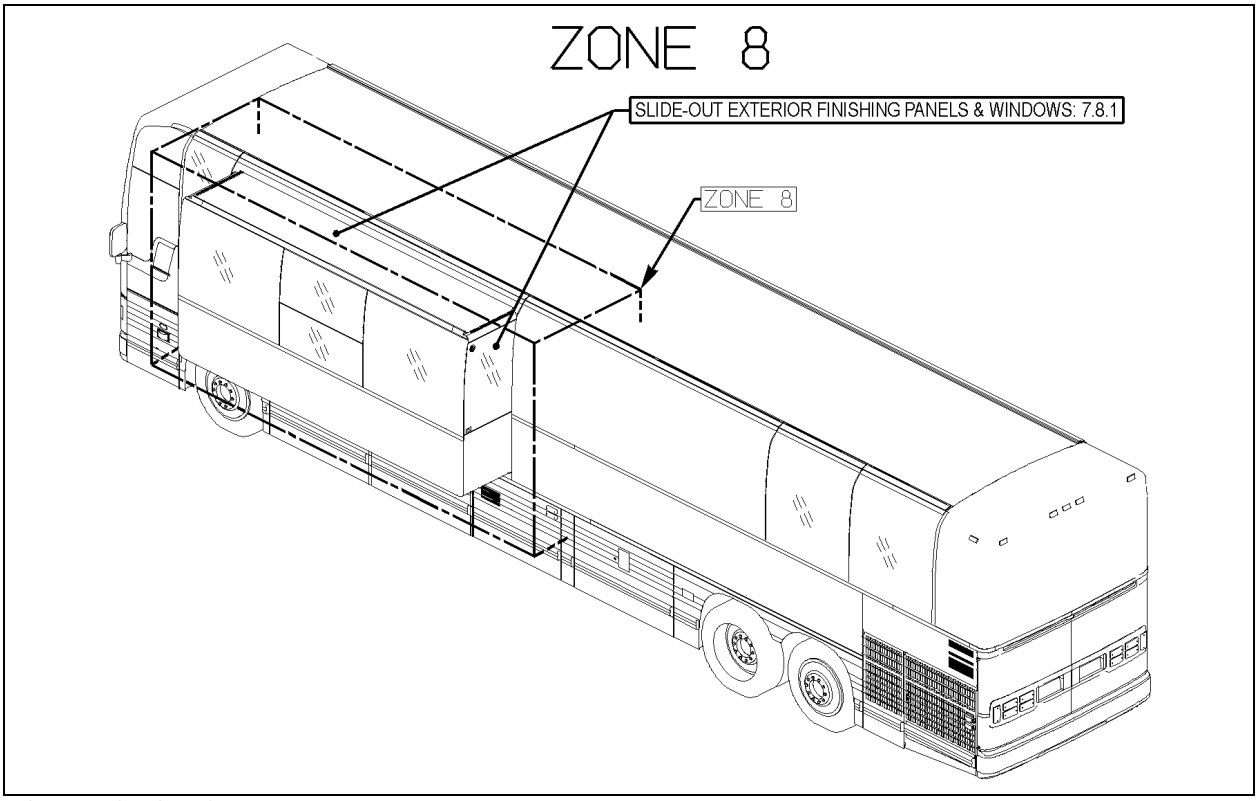


FIGURE 110: ZONE 8

8.8.1 Slide-Out Exterior Finishing Panels & Windows

Refer to Maintenance Manual, Section 26: Paragraph 16 for the procedure on slide-out exterior finishing panels & windows.

8.9 BODY PANEL AND WINDOW SPACING FOR XLII BUS SHELLS FITTED WITH SLIDE-OUT

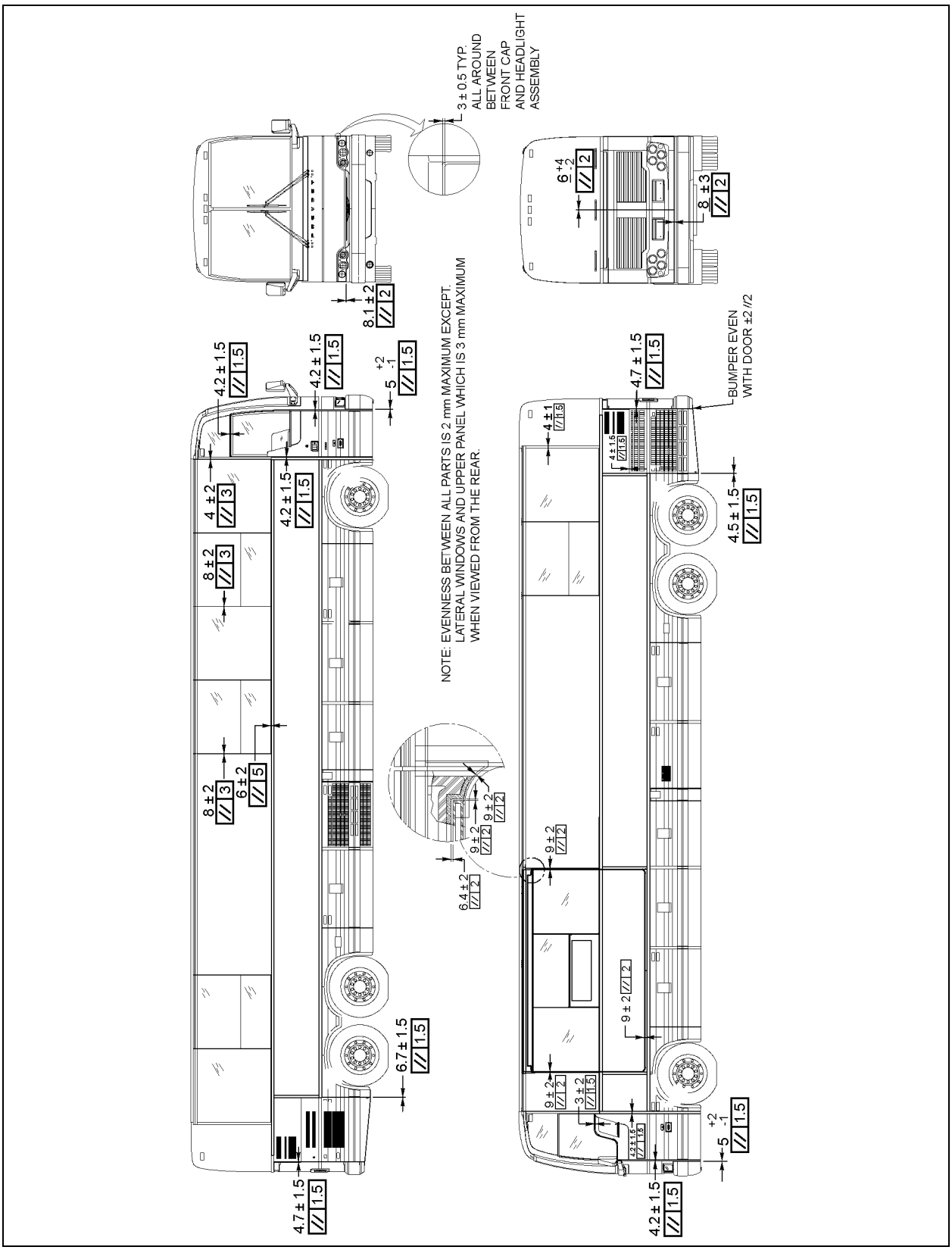


FIGURE 111: BODY PANEL & WINDOW SPACING FOR WE MTH FITTED WITH SLIDE-OUT

9. VEHICLE JACKING POINTS

The vehicle can be lifted by applying pressure under body jacking points or front and drive axle jacking points. When it is necessary to lift the vehicle, care should be taken to ensure that the pressure is applied only on the specified areas. Equipment for lifting the front of the vehicle must have a combined lifting capacity of at least 20,000 lb. (9 100 kg). Equipment for lifting the rear of the vehicle must have a combined lifting capacity of at least 40,000 lb. (18 200 kg).

WARNING

DO NOT tow or jack vehicle with people on board.

WARNING

When it is necessary to raise the vehicle, care should be taken to ensure that pressure is applied only at the points indicated in figures 112 to 118.

WARNING

Extra lift capacity may be required if luggage or any other type of load (e.g. conversion equipment) are onboard the vehicle.

CAUTION

The suspension of the vehicle must be in the normal ride position before jacking. The "Level Low" system on X3-45 VIP & XLII Bus Shells must be in the "DRIVE" position prior to turning the ignition key "OFF".

Twelve jacking points are located on the vehicle: three are located on each side of the frame and two are located under each axle. Refer to the following illustrations for the location of jacking points.

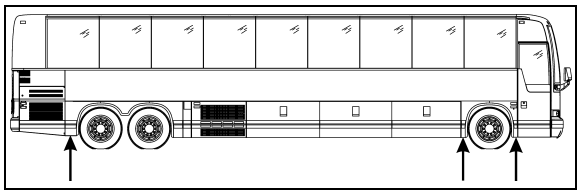


FIGURE 112: JACKING POINTS ON FRAME

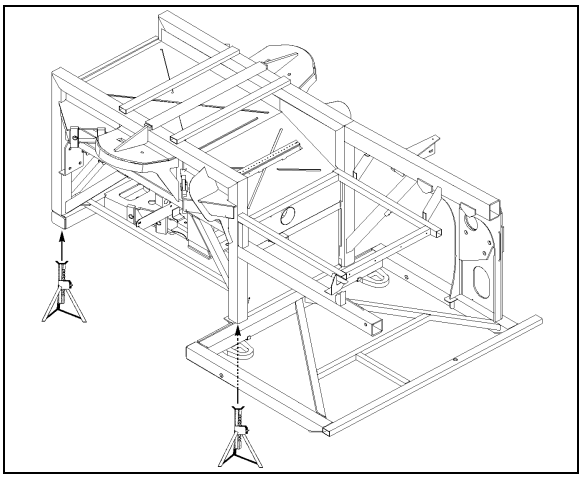


FIGURE 113: FRONT END JACKING POINTS 18592

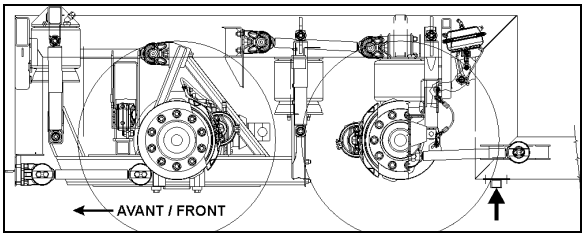


FIGURE 114: REAR END JACKING POINTS

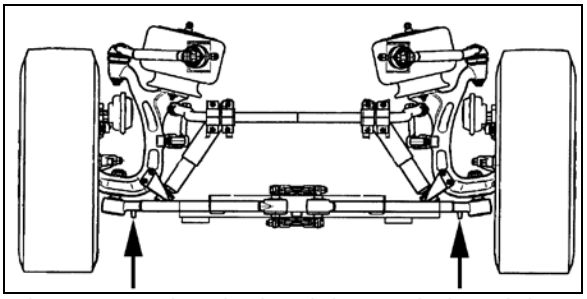


FIGURE 115: JACKING POINTS ON IND. SUSPENSION
16095

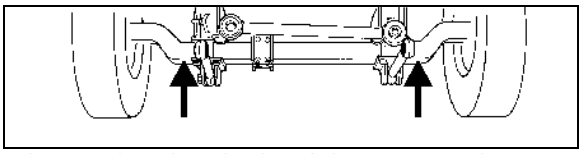


FIGURE 116: JACKING POINTS ON I-BEAM FRONT AXLE

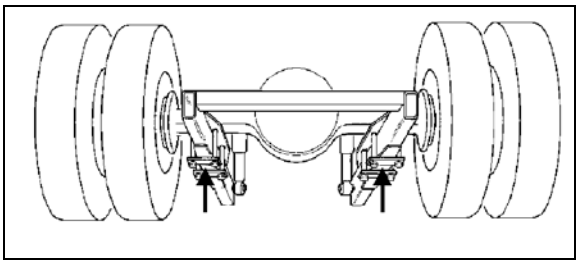


FIGURE 117: JACKING POINTS ON DRIVE AXLE
OEH3B762

CAUTION

Always unload or retract the tag axle before jacking the vehicle from the front and drive axle jacking points to prevent damage to suspension components.

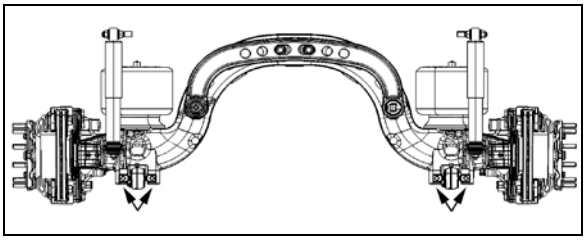


FIGURE 118: JACKING POINTS ON TAG AXLE OEH3B764

WARNING

The jacking points on the tag axle must be used for raising the tag axle only.

Several kinds of hydraulic jacks can be used. Only jack at the specified jacking points. Jack must support the following capacities:

Front axle: 20,000 lb. (9 100 kg);

Drive axle: 40,000 lb. (18 200 kg).

9.1 HYDRAULIC JACK

To raise: turn release valve clockwise. Insert handle in socket and raise vehicle by pumping.

To lower: remove handle and turn the release valve slowly counterclockwise.

Always keep ram and extension screw retracted when jack is not in use.

Service: Check oil level when jack fails to raise to full height. Lower ram completely with release valve open and jack in upright position, remove filler plug and refill to level of filler hole with hydraulic jack oil. Never use brake fluid.

DANGER

Jack is intended for lifting only. Do not get under the vehicle or load for any reason unless it is properly supported with safety stands and securely blocked.

DANGER

Do not overload jack above rated capacity. Prevent "side loading", make sure load is centered on ram. Do not push or tilt load off jack.

10. TOWING THE VEHICLE

The vehicle can be transported on a low bed semi-trailer of adequate gross axle weight capacity. When transporting a vehicle, apply parking brake and shut down the engine. Block all wheels and secure vehicle with tie-downs. Check that overall height will clear obstacles on the route to follow, and obtain required permits.

The vehicle can also be towed by lifting the front axle or by towing from the front with all wheels on the ground. These two methods are described below under their respective headings. Whatever the method used, the vehicle should be towed by truck operators authorized and experienced in towing highway coaches.

Observe normal precautions including, but not limited to, the ones listed below when towing the vehicle:

- Make sure the parking brake is released before towing.
- Do not allow passengers to ride onboard the towed vehicle.
- Tow the vehicle at a safe speed as dictated by road and weather conditions.
- Accelerate and decelerate slowly and cautiously.

To prevent damage to the vehicle, use the two tow eyes located under the back bumper and/or fixed to the vehicle's frame between the front axle and the front bumper. Use only a solid link tow bar and a safety chain to tow the vehicle. If required, connect an auxiliary air supply to the vehicle so brakes can be operated while towing.

WARNING

During a towing operation, the driver should be alone inside the vehicle.

CAUTION

To prevent damage to the drive train components, disconnect axle shafts or driveshaft before towing. Do not attempt to push or pull-start a vehicle equipped with an automatic transmission or automated mechanical transmission.

Failure to disconnect the driveshaft, remove the drive axle shafts or lift the drive wheels off the ground before towing can cause serious transmission damage and void the warranty..

CAUTION

Make sure axle shafts or driveshaft are installed correctly after towing. Tighten axle shaft and driveshaft nuts to the correct torque settings. Do not invert shafts

10.1 LIFTING AND TOWING

The towed vehicle must be lifted from under the front axle only. The tow truck must be equipped with the proper lifting equipment to reach under the front axle since no other lifting points are recommended. Lifting and towing from any other point are unauthorized as it may cause serious damage to the structure. Do not unload or raise the tag axle when lifting and towing to prevent overloading the drive axle.

1. Remove both drive axle shafts to prevent damage to the transmission. Plug axle tube to prevent oil loss. Refer to Refer to Arvin Meritor *"Maintenance manual no.5"* annexed at the end of Section 11, Rear axle, in this manual for correct procedure.

CAUTION

Transmission lubrication is inadequate when towing. The drive axle shafts must be removed to avoid serious damage to the transmission.

Failure to disconnect the driveshaft, remove the drive axle shafts or lift the drive wheels off the ground before towing can cause serious transmission damage and void the warranty..

2. Operate the engine when towing to maintain brake system air pressure. If the engine cannot be operated, connect an external air pressure line from the tow truck to the emergency fill valve in the engine compartment.
3. The emergency fill valve in the front service compartment does not supply air pressure to the brake system. The air pressure must be a minimum of 75 psi (520 kPa), and the line should be attached to the air line with a clip-on chuck.

WARNING

Do not tow the vehicle without external air pressure applied to the emergency fill valve if the engine does not operate. Without brake system air pressure, the brakes may apply automatically if system air drops below 40 psi (275 kPa). If failure prevents releasing the parking brakes with air pressure, disengage the parking brakes mechanically.

4. Lift the vehicle from under the front axle, and adequately secure the underside to the tow vehicle lifting attachment with chains.
5. Observe safety precautions when towing.

10.2 TOWING WITHOUT LIFTING

WARNING

When towing vehicle without lifting, use only a tow truck with a solid link tow bar and related equipment. All other means of towing are unauthorized. Tow only from the front of the vehicle.

1. Remove both drive axle shafts to prevent damage to the transmission. Plug axle tube to prevent oil loss. Refer to Arvin Meritor *"Maintenance manual no.5"* annexed at the end of Section 11, Rear axle, in this manual for correct procedure.

CAUTION

Transmission lubrication is inadequate when towing. The drive axle shafts must be removed to avoid serious damage to the transmission.

CAUTION

Failure to disconnect the driveshaft, remove the drive axle shafts or lift the drive wheels off the ground before towing can cause serious transmission damage and

void the warranty..

2. Operate the engine when towing to maintain brake system air pressure. If the engine cannot be operated, connect an external air pressure line from the tow truck to the emergency fill valve in the engine compartment. The emergency fill valve in the front service compartment does not supply air pressure to the brake system. The air pressure must be a minimum of 75 psi (520 kPa), and the line should be attached to the air line with a clip-on chuck.

WARNING

Do not tow the vehicle without external air pressure applied to the emergency fill valve if the engine does not operate. Without brake system air pressure, the brakes may apply automatically if system air drops below 40 psi (275 kPa). If failure prevents releasing the parking brakes with air pressure, disengage the parking brakes mechanically.

3. Position the tow truck so that the tow bar contacts the front bumper of the vehicle.
4. Attach the tow truck chains only in the tow eyes of the vehicle under the bumper and take up all the slack.
5. Attach safety chains as applicable.
6. Observe safety precautions when towing.

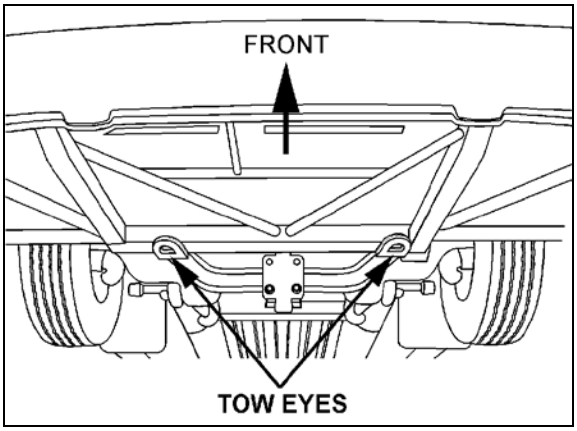


FIGURE 119: TOW EYES

11. SPECIFICATIONS

Door cylinder

Manufacturer	Bimba
Type	Pneumatic
I.D.	1½" (mm)
Stroke	8" (mm)
Prevost number	780595

Damper

Manufacturer	Koni
Prevost number	780565

Lock cylinder (upper)

Manufacturer	Bimba
Type	Air, single action, 1/8 NPT, hexagonal rod
I.D.	7/8" (22 mm)
Stroke	1" (25 mm)
Prevost number	641392

Lock cylinder (central)

Manufacturer	Bimba
Type	Air, single action, ¼ NPT
I.D.	1¾" (45 mm)
Stroke	1" (25 mm)
Prevost number	641209

Manifold solenoid

Manufacturer	Norgren
Type	4 ports, 1/8 NPT

Voltage .....24 VDC
Power consumption.....6 watts
Maximum pressure.....150 psi (1035 kPa)
Prevost number..... 641448

Solenoid valve (Latching valve)
Manufacturer .....Humphrey
Model..... 310
Operating range .....0 to 125 psi (0 to 860 kPa)
Voltage .....24 VDC
Voltage tolerance .....+10%, -15% of rated voltage
Power consumption.....4 watts
Leak rate (max allowed)..... 0.245 in3/min @ 100 psi (4cc/min @ 690 kPa)
Type of operation ..... Direct solenoid
Lubrication.....Not required (factory pre-lubed)
Filtration.....40 micron recommended
Prevost number..... 641412

Pressure switch assembly
Prevost number..... 452831

Isringhausen

Seat Model 6800/338 Bus
Seat Model 6800/338 Premium LX

Service Manual

Read and understand this manual before servicing this seat.

ISRINGHAUSEN
ISRI

Manual No. 7018081-02, Rel. Jun. 1999

INTRODUCTION

SERVICE AND REPAIR

Proper service and repair are important to the safe, reliable operation of this seat. Service and repair should be preformed only by responsible persons who have been properly instructed and authorized to do so. The procedures recommend in this manual are safe effective methods for performing service and repair operations.

We could not possibly know, evaluate, and advise the service trade of all conceivable ways in which service can be done or of the possible hazardous consequences of each way. If you use a service procedure which is not recommended, be sure that personal safety and equipment safety will not be jeopardized.

It is the responsibility of the mechanic performing the service and repair to:

- inspect for abnormal wear and damage
- choose a repair procedure that will ensure your safety, the safety of others, and the safe operation of the equipment
- fully inspect and test the equipment to ensure that the repair or service has been properly performed and the equipment will function properly.

This manual describes the correct service procedures for Model 6800/348 Premium seats. The information in this manual was current at the time of printing and is subject to change without notice or liability.

READ AND UNDERSTAND THIS MANUAL AND THE OPERATOR'S MANUAL

Learn how to service Model 6800/348 Premium seats. Failure to do so could result in personal injury or equipment damage. Consult your dealer if you do not understand the instructions in this manual and/or need additional information.

KEEP THIS MANUAL

This manual should be considered a permanent part of the seat and be available for reference when servicing the seat.

WARRANTY

Warranty is provided as part of Isringhausen's support program for customers who operate and maintain their seat as shown in this manual. See the warranty for details.

MODEL 6800/338 BUS
MODEL 6800/338 PREMIUM LX

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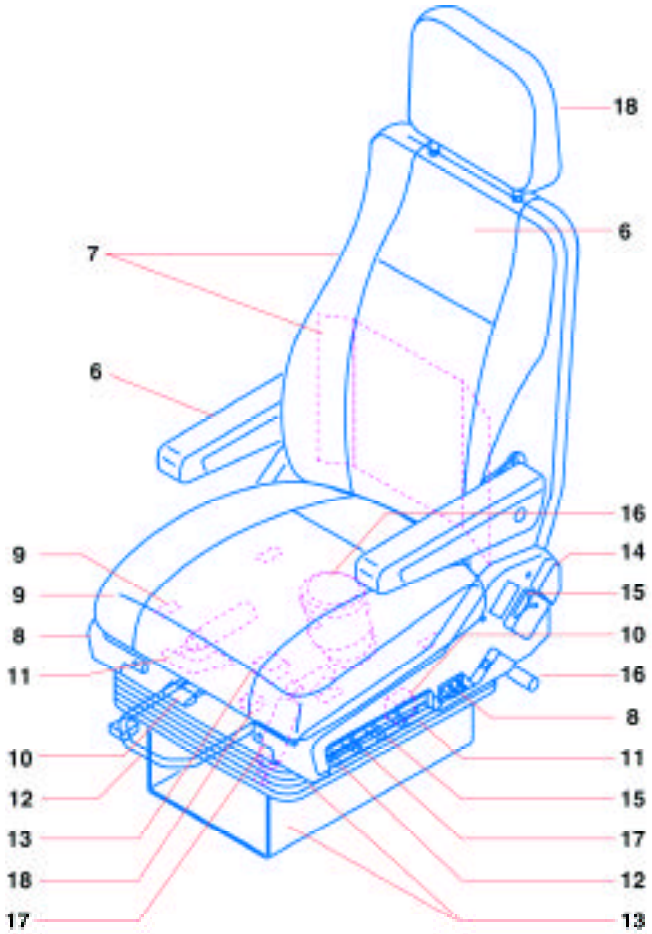
REMOVAL AND INSTALLATION PAGE NUMBERS



GENERAL SAFETY

In this manual safety messages will alert persons to a specific hazard, the degree or level of hazard seriousness, the probable consequences of involvement with the hazard, and how the hazard can be avoided. Safety messages will include the safety alert symbol, a signal word, and a word message.

SAFETY ALERT SYMBOL

 Indicates a potential personal safety hazard.

SIGNAL WORDS

DANGER: Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING: Indicates an potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION: Indicates an potentially hazardous situation which, if not avoided, may result in minor or serious injury.

WORD MESSAGE

The word message will identify the hazard, indicate how to avoid the hazard, and advise of probable consequence of not avoiding the hazard.

TROUBLESHOOTING

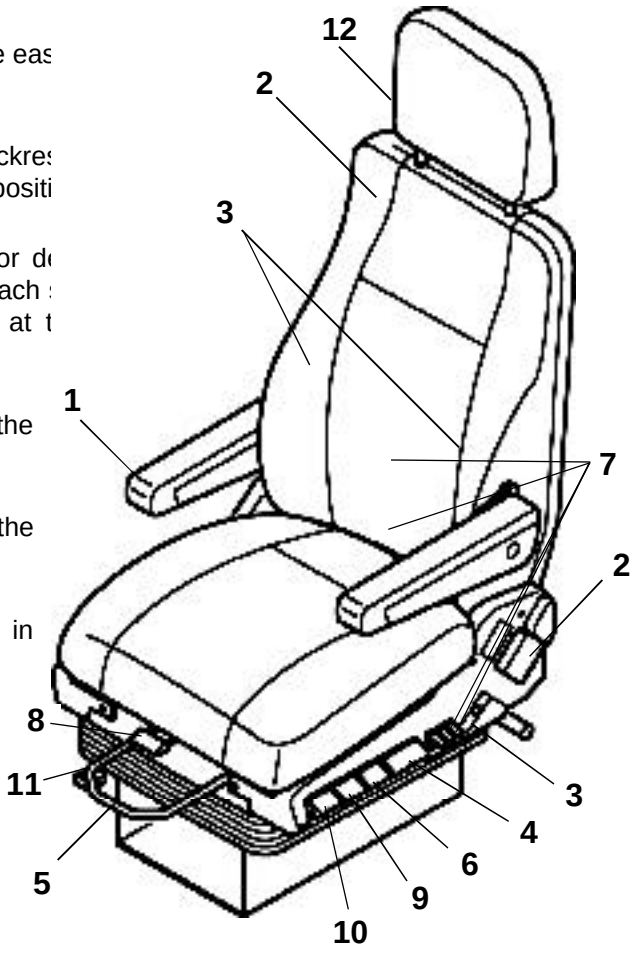
Problem	Cause	Solution	Page
Armrest will not stay in position.	Armrest control is defective.	Replace armrest.	6
Backrest will not adjust and/or stay adjusted.	Teeth on backrest are defective.	Replace backrest.	6
	Backrest seat latch is defective.	Replace backrest seat latch.	14
Lumbar/Bolster will not inflate.	No air supply to seat.	90 to 145 psi req'd.	5
	Air lines leak.	Replace air lines.	7
	Valve is defective.	Replace valve.	8
	Air bags leak.	Replace air bags.	7
Height will not adjust and/or stay adjusted.	Height adj. cam is defective.	Replace height adj. cam.	11
	Height adj. cylinder is defective.	Replace height adj. cylinder.	11
	Height adj. valve is defective.	Replace height adj. valve.	10
Horizontal slide will not adjust and/or stay adjusted.	Horizontal slide is defective.	Replace horizontal slide.	12
Seat pan assem. will not adjust and/or stay adjusted.	Seat pan lever is defective.	Replace seat pan lever.	10
	Seat pan glides are defective.	Replace seat pan glides.	9
Quick air release will not function.	No air supply to seat.	90 to 145 psi req'd.	5
	Valve is defective.	Replace valve.	12
Adjustable shock absorber will not adjust.	Shock absorber is defective.	Replace shock absorber.	17
	Shock absorber cable is defective.	Replace shock absorber cable.	17
Suspension will not function properly.	Suspension is defective.	Replace suspension.	13

INSPECTION

CAUTION

Avoid the risk of injury.
Vehicle must be in a safe parked position before inspecting seat.

Visually inspect the seat. Look for damaged or worn upholstery and parts. The seat should be clean and free of dirt and debris. Check all the seat functions they should work properly and be in good condition.



1. Adjustable armrest
Should move up freely, the adjustment knob should be eas the armrest must stay in the adjusted position.

2. Backrest adjustment
The control should be easy to release then the backres move freely. The backrest must stay in the adjusted positi

3. Backrest side bolster
The control should be easy to move to the inflate or d position and must return to neutral when released. Each support should inflate and deflate evenly and stay at t adjusted firmness..

4. Height adjustment
Control should be easy to move and hold the seat in the adjusted position when released.

5. Horizontal adjustment
Control should be easy to move and hold the seat in the adjusted position when released.

6. Seat tilt adjustment
Control should be easy to move and hold the seat in position when released.

7. Lower and upper lumbar support
The controls should be easy to move to the inflate or deflate position and must return to neutral when released. Each lumbar support must stay at the adjusted firmness.

8. Cushion length adjustment
Control should be easy to move and hold the seat cushion in the adjusted position when released.

9. Adjustable shock absorber
Control should be easy to move and stay in position when released.

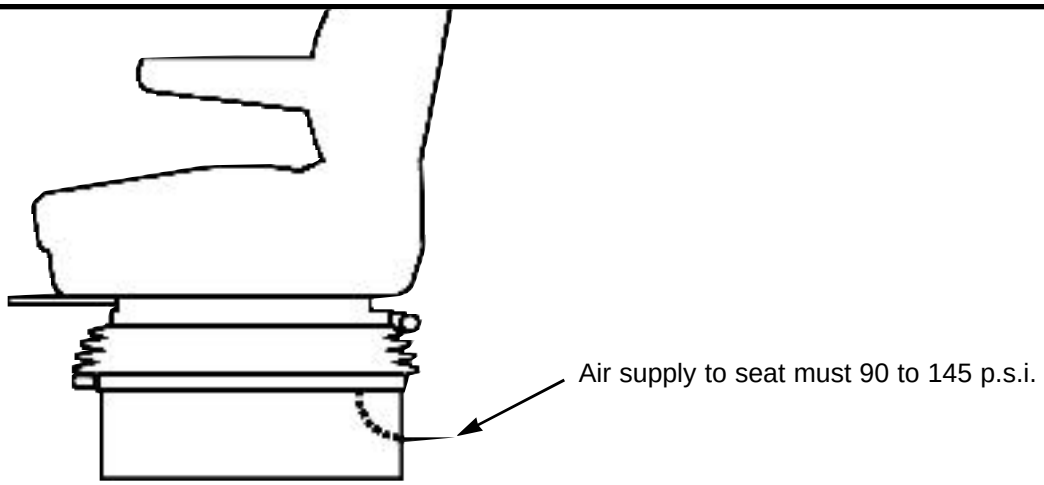
10. Quick air release
Control should be easy to move and hold seat in the adjusted position when released.

11. Horizontal isolator
Control should be easy to move and stay in position when released.

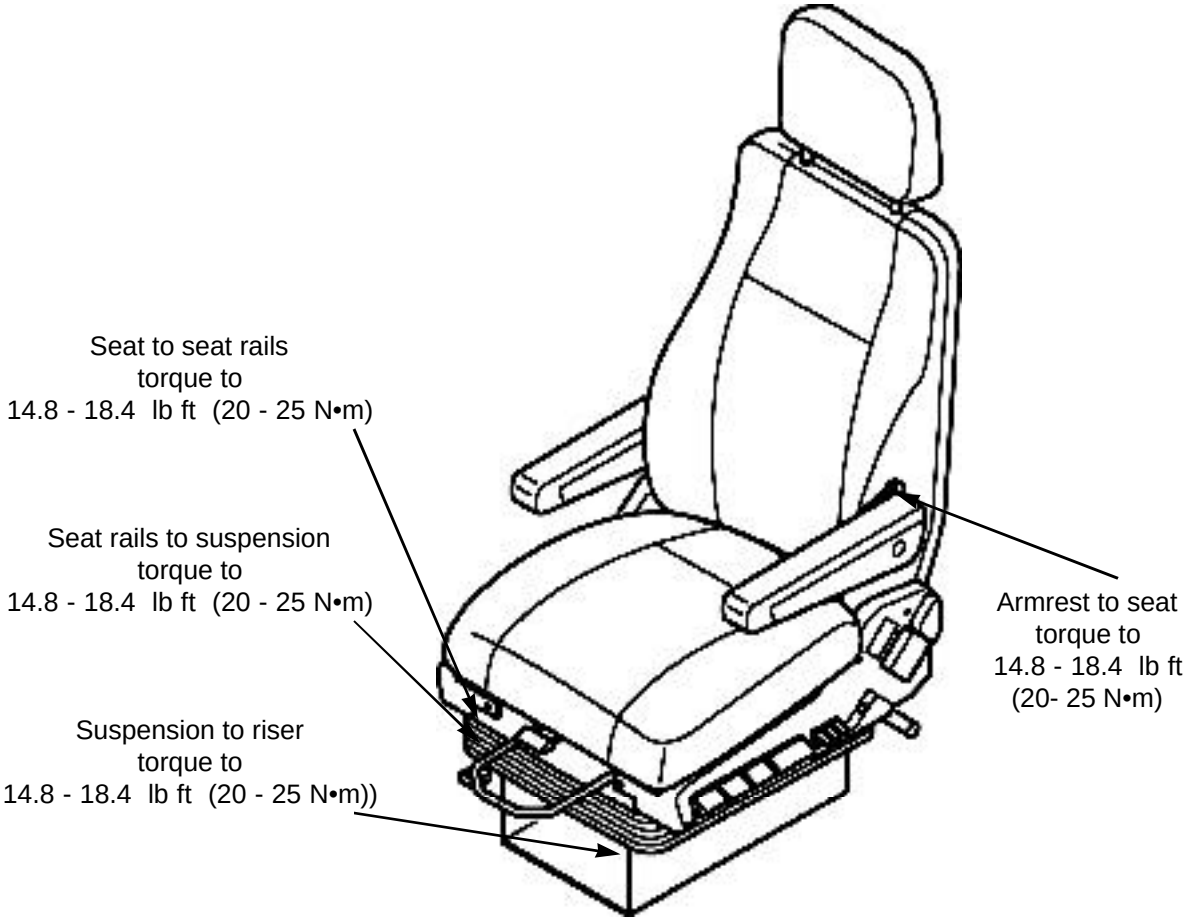
12. Headrest
Should be easy to move up and down and stay in position. Headrest should tilt forward and backward freely.

If the seat is not functioning properly take it out of service until it can be repaired.

Air supply



Critical fastener torque



⚠ CAUTION

Avoid the risk of injury. Vehicle must be in a safe parked position before working on the seat.

NOTICE

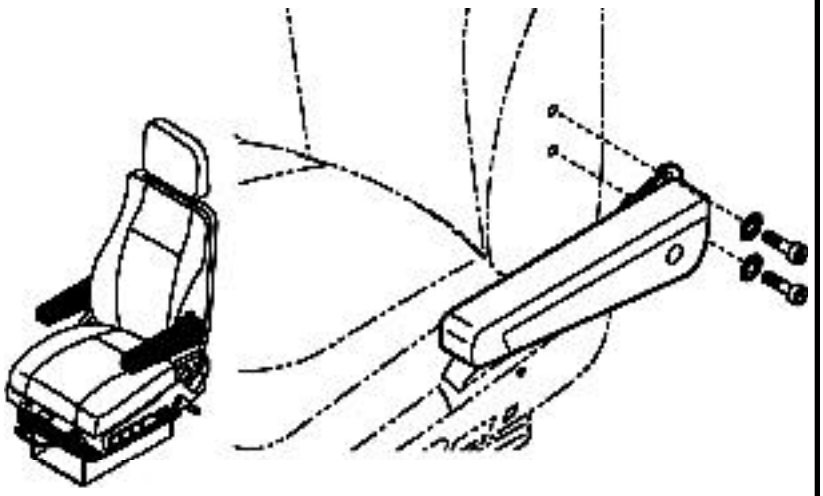
To remove seat from vehicle follow vehicle manufacturer's instructions.

Armrest

Set up
- Vehicle must be in a safe parked position or seat removed from vehicle.

Removal
- Remove fasteners
- Remove armrest

Installation
- Fasten armrest to seat with screws and lockwashers.
- Torque screws to 14.8 - 18.4 lb ft (20 - 25 N•m)

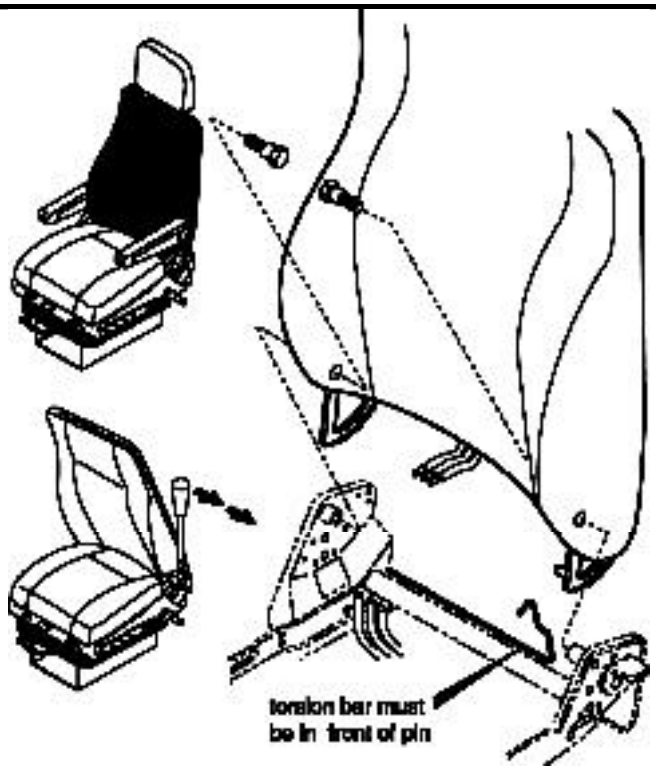


Backrest

Set up
- Vehicle must be in a safe parked position or seat removed from vehicle.

Removal
- Mark and disconnect air lines
- Remove fasteners
- Pry one side of seat frame away from backrest
- Remove backrest

Installation
- Put one side of backrest in place
- Pry other side of seat frame away and put backrest in place
- Fasten backrest to seat frame with shoulder bolts
- Torque shoulder bolts to 22 - 25.5 lb ft (30 - 35 N•m)
- Connect air lines

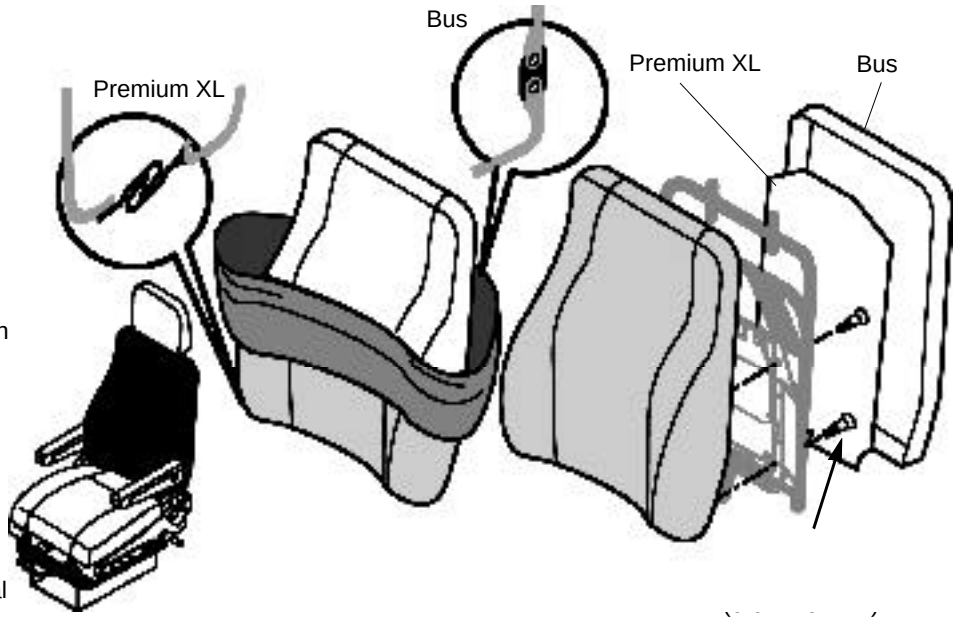


Backrest assembly

Set up
- Backrest must be removed from seat (**see Backrest**)

Removal
- Premium XL - remove upholstery and backrest liner
- Bus - remove cover, hog rings and wires.-- remove upholstery
- Remove backrest cushion fasteners -- remove cushion

Installation
- Fasten backrest cushion to backrest frame with screws
- Premium XL - install backrest liner and upholstery
- Bus - install upholstery, hog rings and wires.-- instal cover

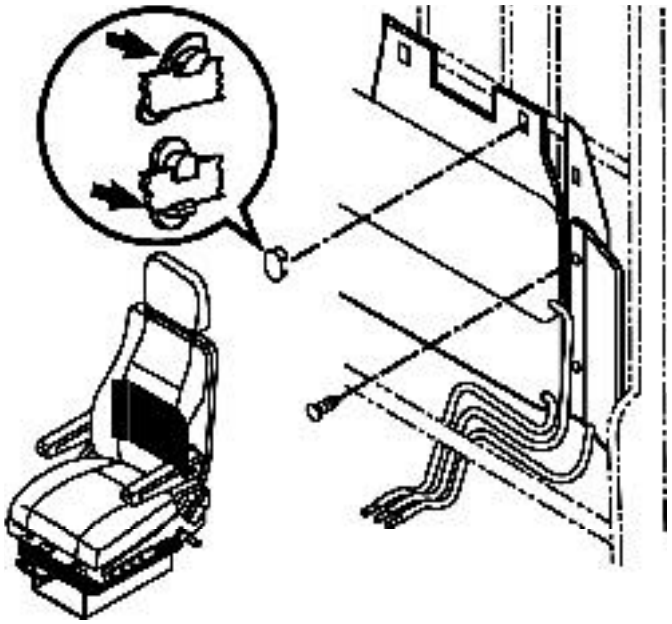


Lumbar and bolster air bags

Set up
- Remove backrest components (**see Backrest assembly**)

Removal
- Remove air bag clips, push fasteners and cable ties
- Remove air bags

Installation
- Fasten air bags to backrest frame with clips - put long clip arm over bar and snap bottom of clip in place
- Install push fasteners and cable ties

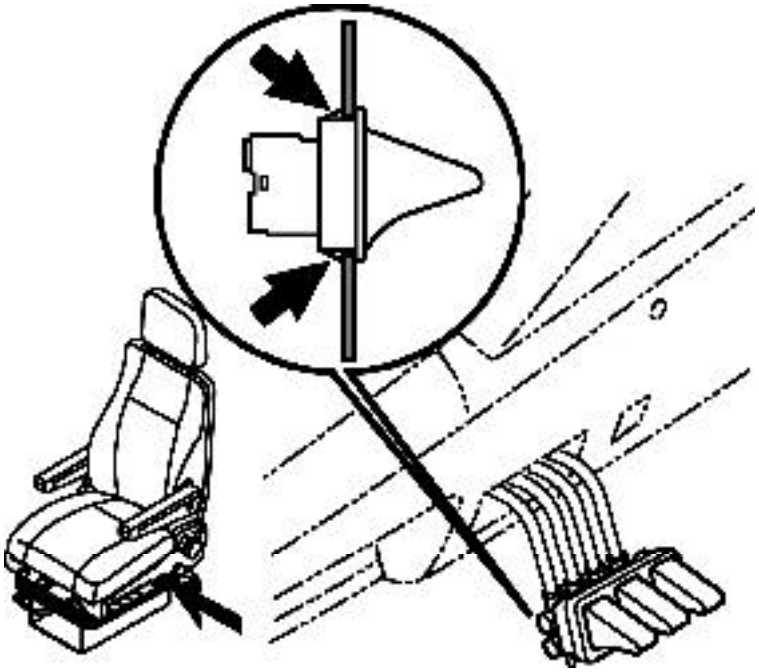


Lumbar and bolster valve

Set up
- Cover must be removed from seat (**see Covers front, LH and RH**)

Removal
- Mark air line and remove them from valve
- Press valve clips in and remove valve from cover

Installation
- Snap valve into cover
- Connect air lines



Covers, LH and RH

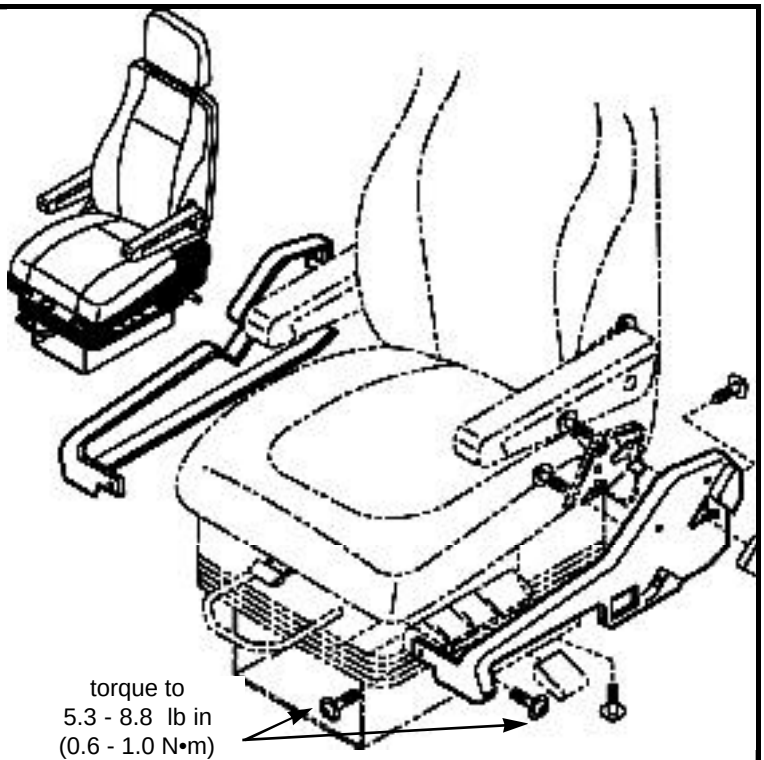
Set up
- Vehicle must be in a safe parked position or seat removed from vehicle.

Removal
Control cover
- Remove backrest adjustment handle
- Remove tilt adjustment handle - for fastener access
- Remove fasteners and cover

Non control cover
- Remove fasteners and cover

Installation
Control cover
- Fasten cover to seat frame with screws
- Install backrest adjustment handle
- Install tilt adjustment handle - removed for fastener access

Non control cover
- Fasten cover to seat frame with screws

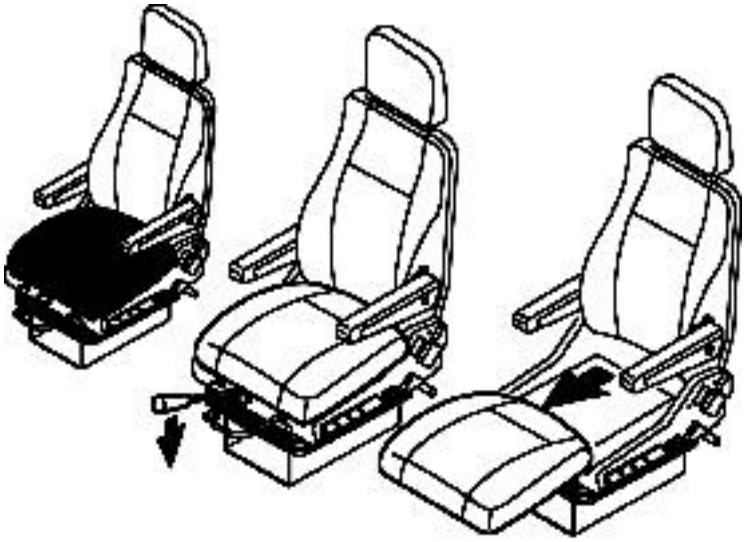


Seat pan assembly

Set up
- Vehicle must be in a safe parked position or seat removed from vehicle.

Removal
- Slide cushion assembly forward
- Pry lever handle up to release cushion stop -- lift cushion off of glides

Installation
- Put seat cushion assembly on glides and slide back

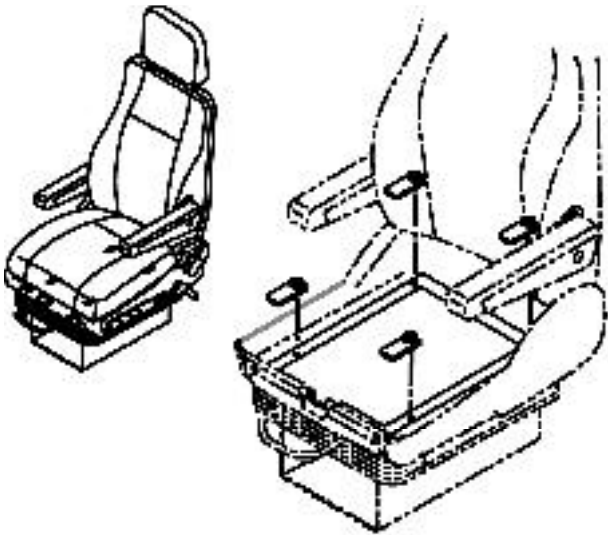


Glides - seat pan

Set up
- Seat cushion must be removed from seat (**see Cushion seat pan**)

Removal
- Remove cushion glides

Installation
- Install cushion glides to seat frame

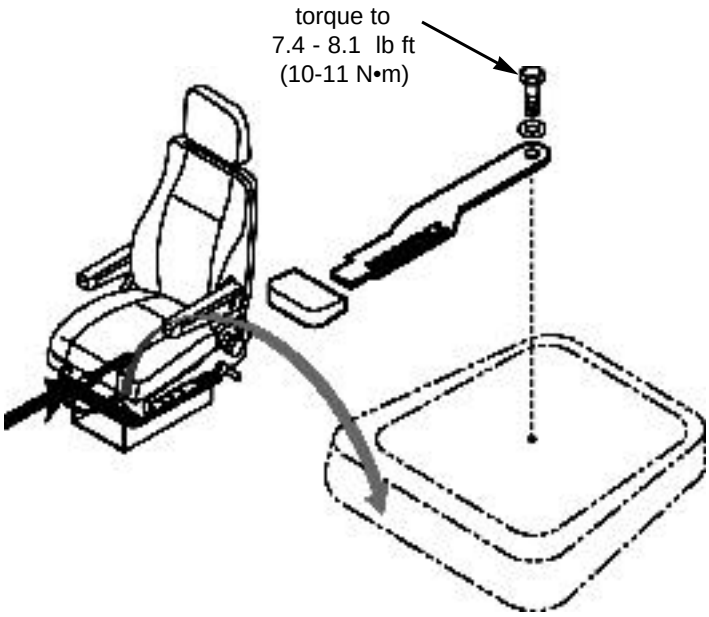


Seat pan assembly, lever and handle

Set up
- Seat cushion must be removed from seat (**see Cushion seat pan**)

Removal
- Pull handle off
- Remove lever fasteners and remove lever

Installation
- Align locator button of lever with hole in seat pan
- Fasten lever to seat pan with screw and washer
- Push handle on



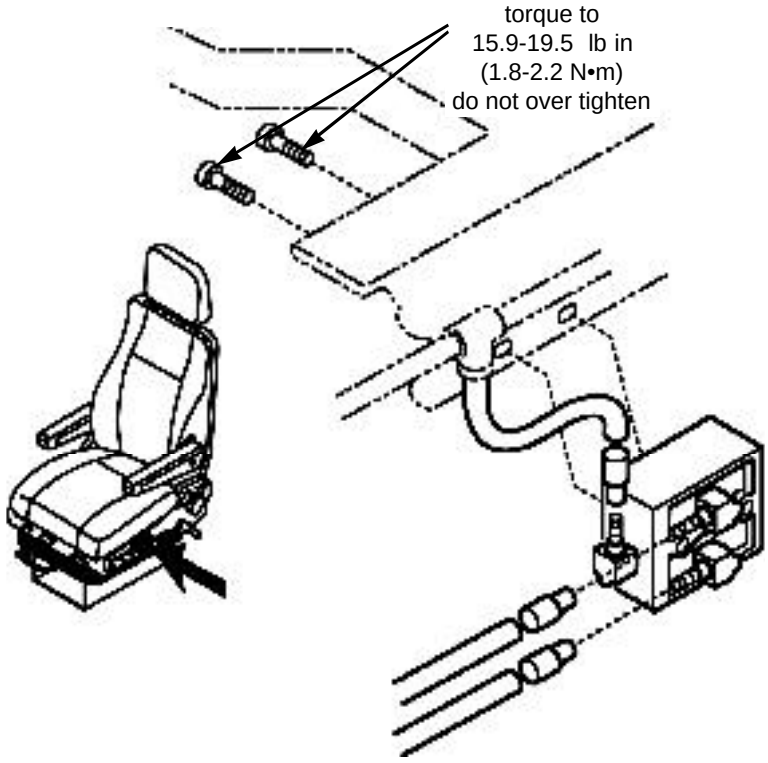
Height adjustment valve

Set up
- Seat cushion must be removed from seat (**see Cushion seat pan**)

Removal
- Mark and remove air lines from valve
- Remove valve fasteners

* Remove valve

Installation
- Fasten valve to seat frame with screw
- Connect air lines

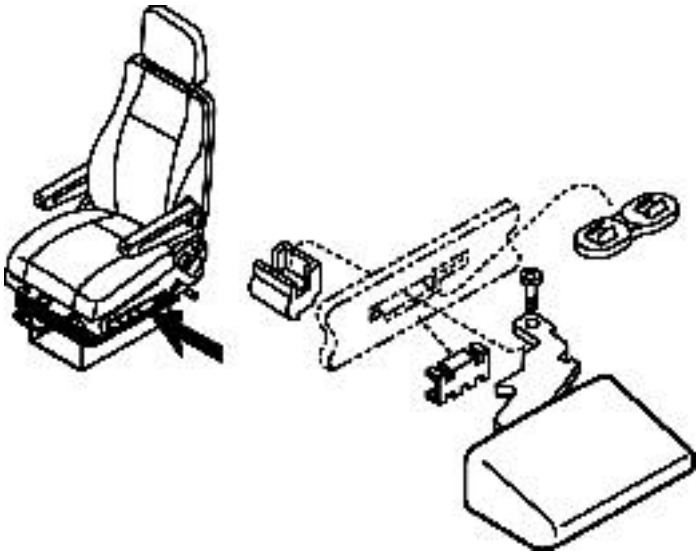


Height adjustment handle

Set up
- Vehicle must be in a safe parked position or seat removed from vehicle
- Control cover must be removed (**see Covers front, LH and RH**)

Removal
- Remove screw and cam
- Pull handle and lever out
- Remove retainers

Installation
- Put upper retainers in place
- Put lever in place
- Put lower retainers in place - be sure it snaps in place
- Install cam and screw
- Install handle



Height adjustment cylinder and cam

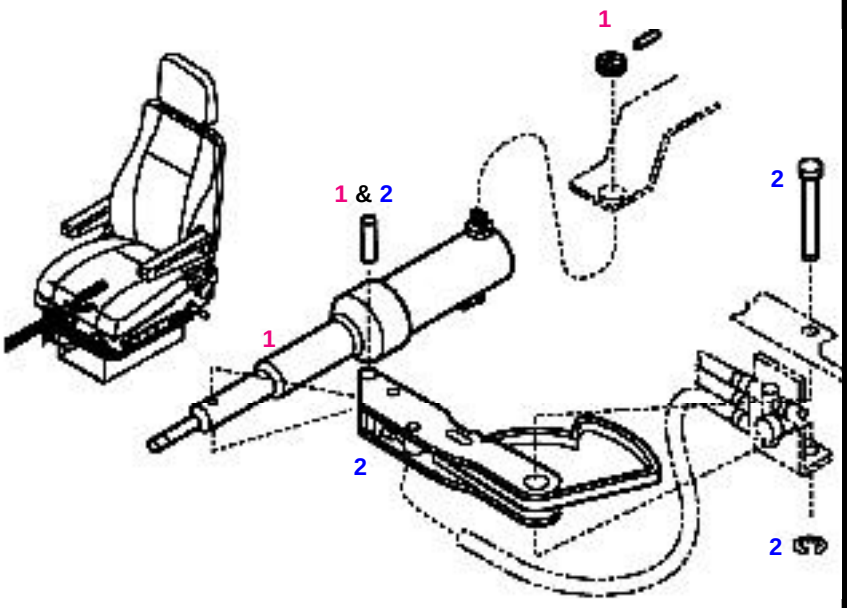
Set up
- Vehicle must be in a safe parked position or seat removed from vehicle
- Seat cushion must be removed from seat (**see Cushion seat pan**)

Removal
Air cylinder
- Remove base end pin and retainer washer - remove rod end fastener, air line, and remove cylinder

Cam
- Remove rod end fastener
- Remove E ring and mounting pin
- Remove cam

Installation
Air cylinder
- Put cylinder in place and install base end pin and retainer washer - install rod end fastener, connect air line

Cam
- Put cam in place and install pin and E ring



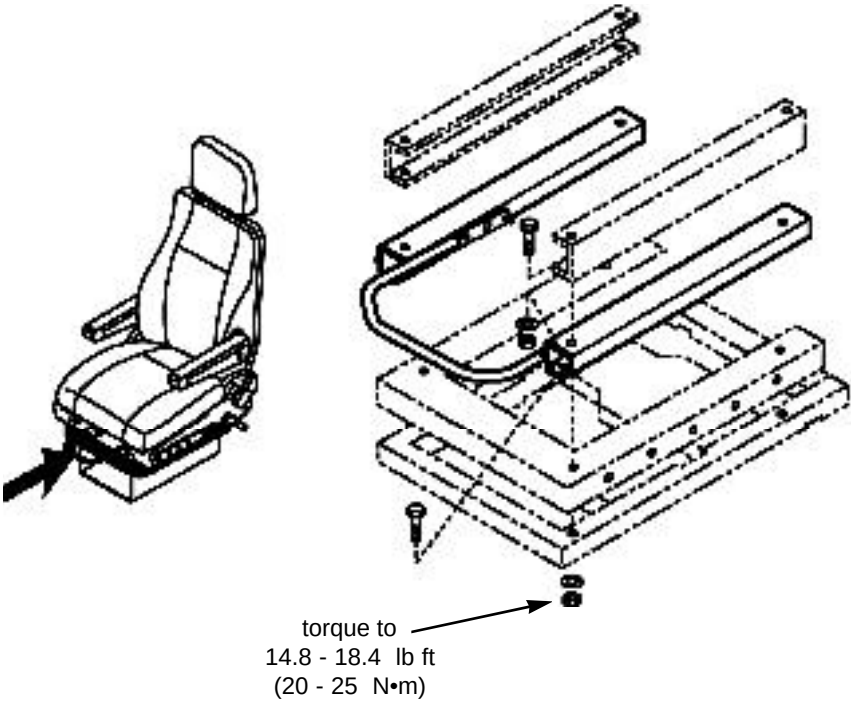
1 = Cylinder kit
2 = Cam kit

Horizontal adjustment slide set

Set up
- Seat frame must be removed (**see Seat frame**)

Removal
- Move horizontal adjustment forward or back to allow access to fasteners
- Remove mounting fasteners

Installation
- Move horizontal adjustment forward or back to allow access to fasteners
- Install mounting fasteners

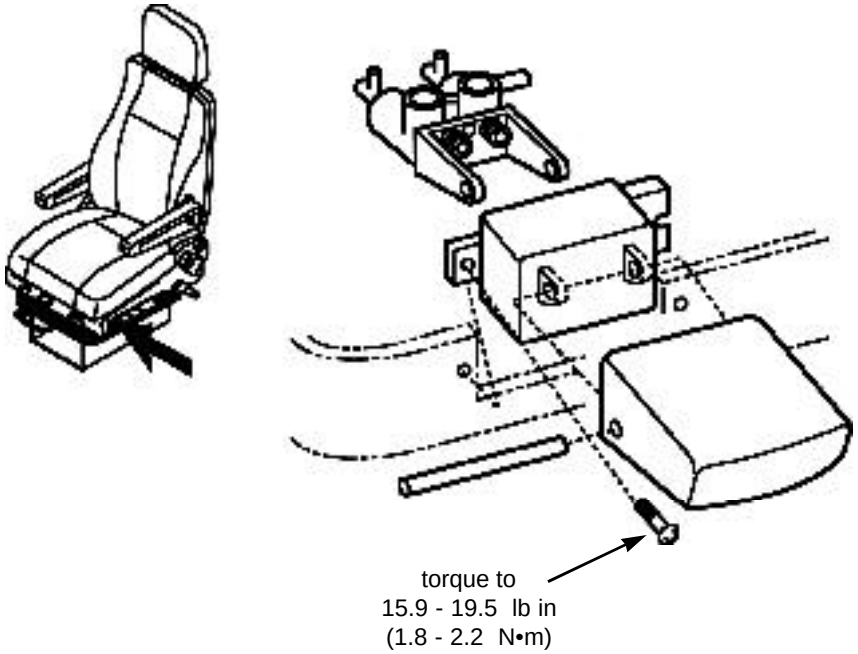


Quick air release - valve and handle LH and RH

Set up
- Seat cushion must be removed from seat (**see Cushion seat pan**)

Removal
- Mark and remove air lines from valve
- Remove valve fasteners
- Remove valve
- Remove valve handle pin and valve handle

Installation
- Fasten valve handle to valve with pin
- Fasten valve to seat frame with screw
- Connect air lines

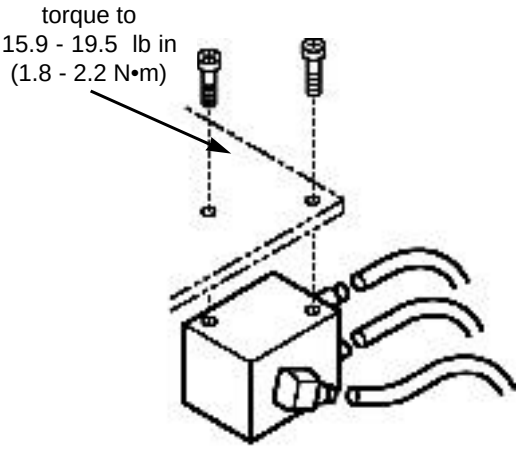


Quick air release valve - suspension

Set up
- Seat cushion must be removed from seat (**see Cushion seat pan**)

Removal
- Mark and remove air lines from valve
- Remove valve fasteners and remove valve

Installation
- Fasten valve to suspension with screws
- Connect air lines



Riser and Suspension

Set up - riser and suspension
- Vehicle must be in a safe parked position or seat removed from vehicle.

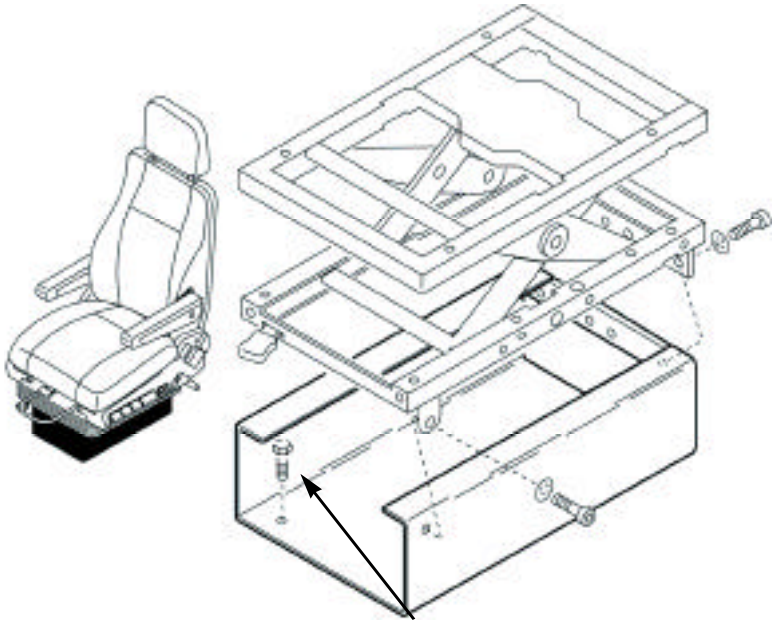
Set up - suspension
- Boot, Boot adapter plate, ICP bar, and tethers must be removed (see **Boot, Boot adapter plate, ICP bar, and tethers**)

Removal - suspension
- Remove air line
- Remove suspension to riser fasteners and remove suspension

Installation - suspension
- Put suspension in place
- Install fasteners and torque to 14.8 - 18.4 lb ft (20 - 25 N•m)
- Connect air line

Removal - riser
- Remove riser to floor fasteners and remove riser

Installation - riser
- Put riser in place and install fasteners, torque to manufactures specification

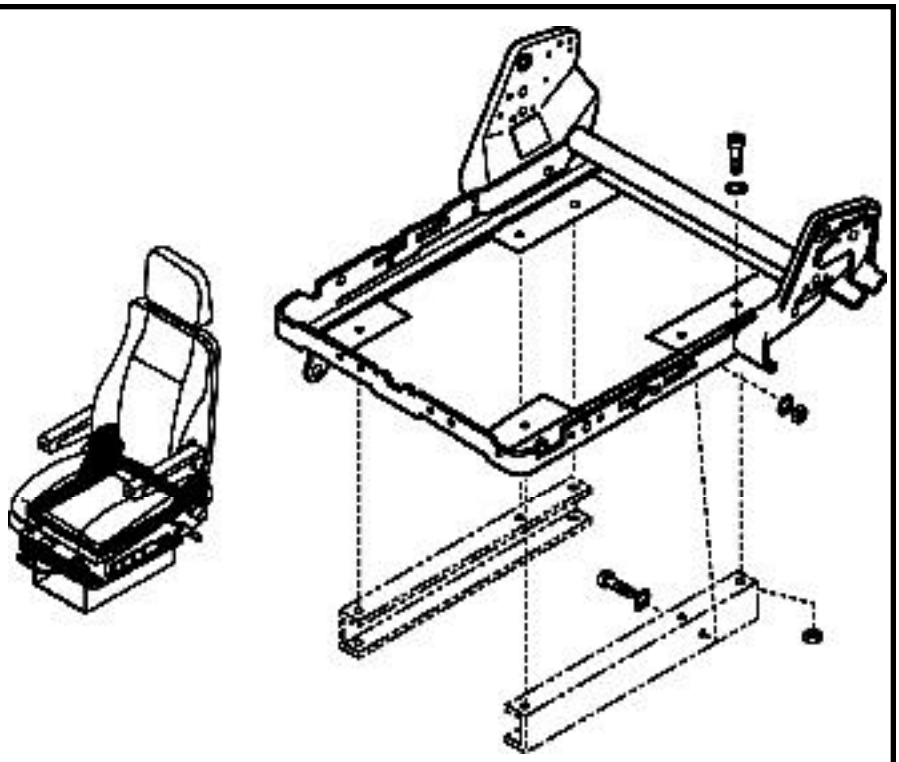


Seat frame

Set up
- Seat cushion and backrest must be removed from seat (**see Cushion seat pan and Backrest**)
- Shock absorber handle and cable must be removed. (**see Adjustable shock absorber handle and cable - handle end**)

Removal
- Mark and remove air lines
- Remove fasteners
- Remove seat frame

Installation
- Fasten seat frame to static spacer rails with bolts and nuts
- Torque fasteners to 14.8 - 18.4 lb ft (20 - 25 N•m)
- Connect air lines

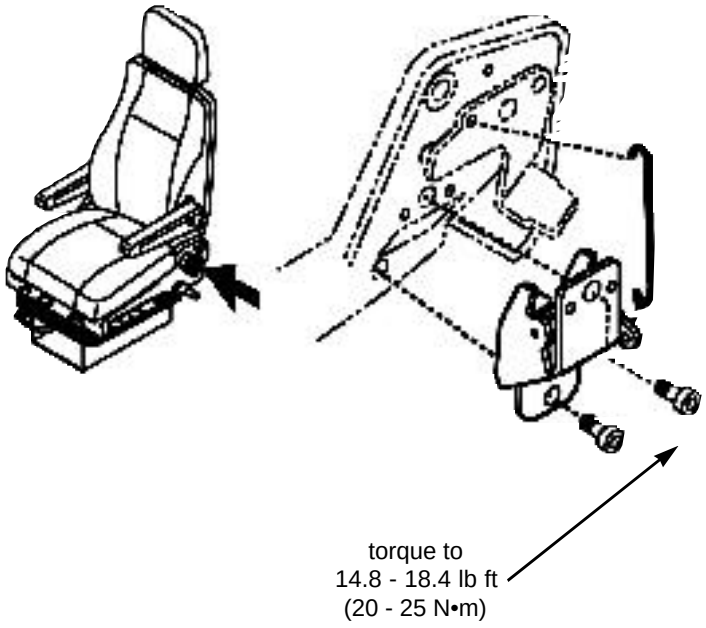


Seat frame tooth plate

Set up
- Backrest and covers must be removed from seat (**see Backrest and Covers front, LH and RH**)

Removal
- Remove seat latch fasteners
- Remove seat latch
- Remove connecting link

Installation
- Install connecting link
- Fasten seat latch to seat frame with screws

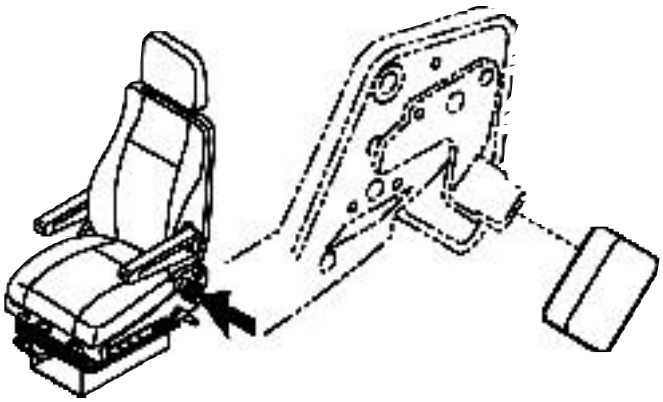


Backrest adjustment handle

Set up
- Vehicle must be in a safe parked position or seat removed from vehicle.

Removal
- Pull handle off

Installation
- Push handle on

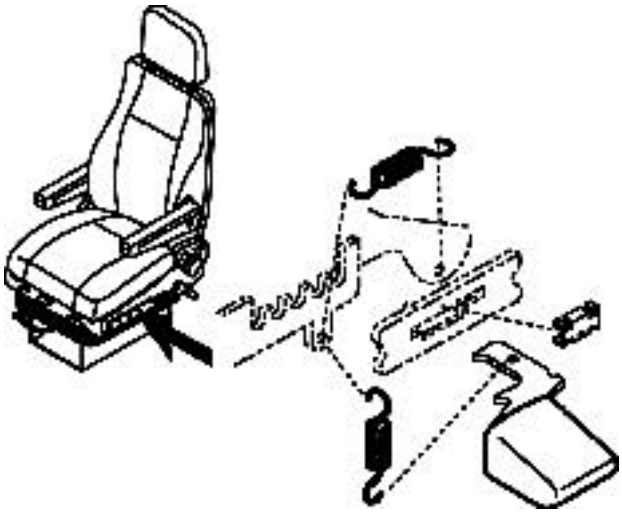


Tilt handle

Set up
- Vehicle must be in a safe parked position or seat removed from vehicle.

Removal
- Remove springs
- Pull handle and lever out
- Remove retainer

Installation
- Put lever in place
- Install retainer, be sure it snaps in place
- Install springs
- Install handle

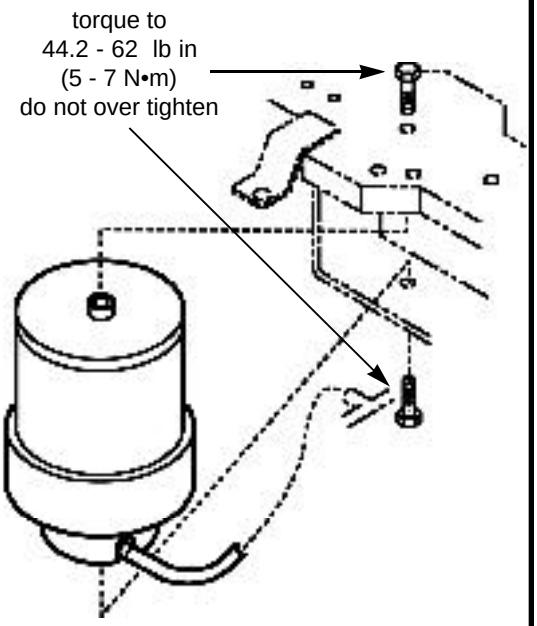


Air spring

Set up
- Seat must be removed from vehicle
- Seat cushion must be removed from seat (**see Cushion seat pan**)

Removal
- Mark and disconnect air line
- Remove top and bottom mounting fasteners
- Remove air spring

Installation
- Put air spring in place
- Install top and bottom mounting fasteners
- Connect air line

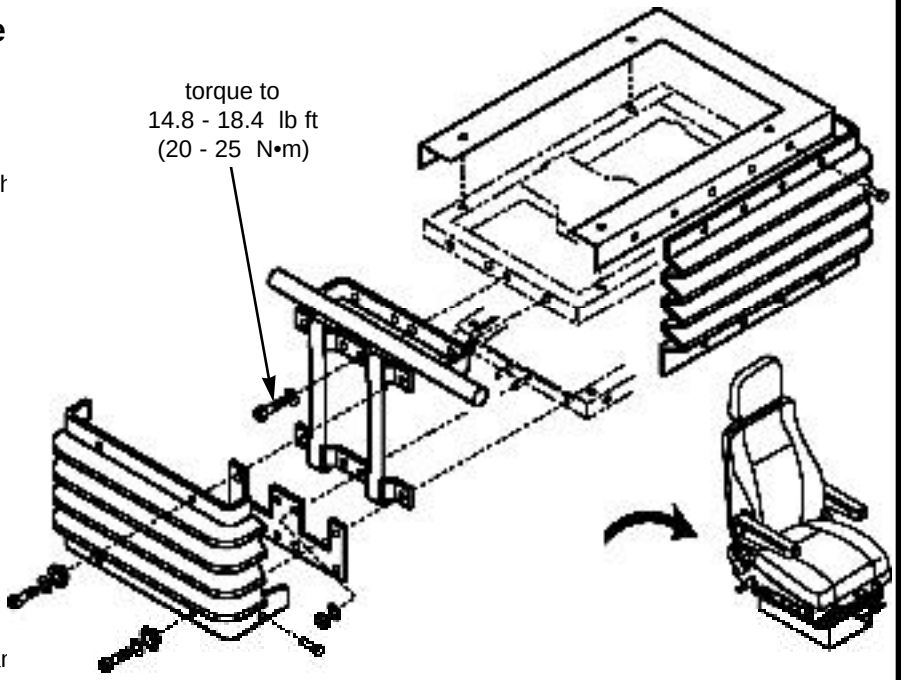


Boot, Boot adapter plate ICP bar, and tethers

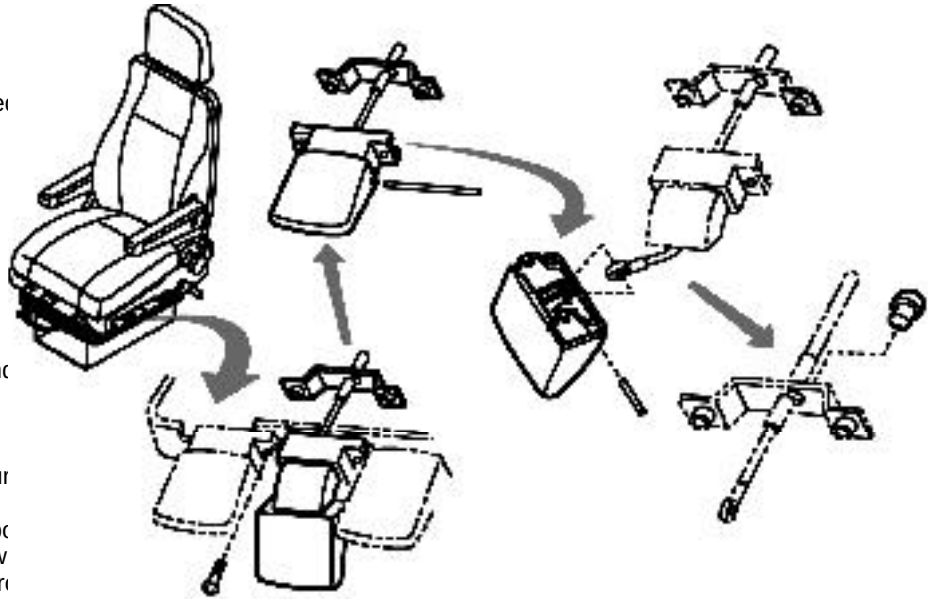
Set up
- Vehicle must be in a safe parked position or seat removed from veh
- Horizontal adjustment must be removed (see **Horizontal adjustment**)

Removal
- Remove belts from ICP bar
- Remove boot fasteners, remove boot, and boot adapter plate
- Remove fasteners, tether plate, tether brackets, tethers, and ICP bar

Installation
- Install fasteners, tether plate, tether brackets, tethers, and ICP bar
- Install boot adapter plate, boot, ar fasteners
- Install belts to ICP bar



Adjustable shock absorber handle and cable (handle end)

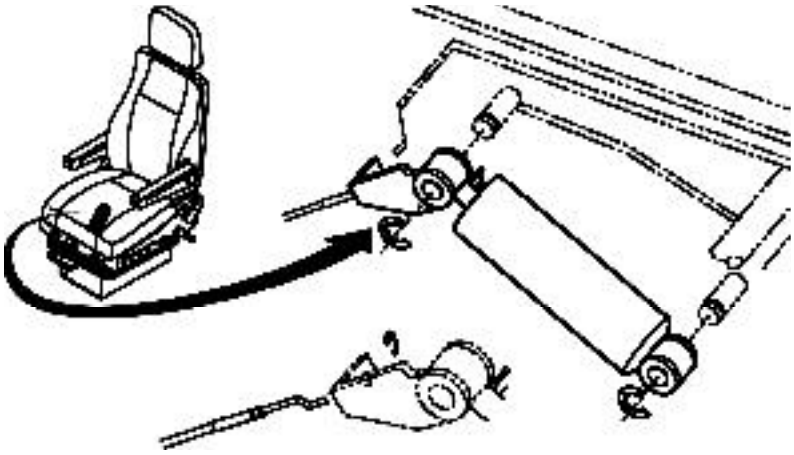


Set up
- Seat cushion must be removed from seat (**see Cushion seat pan**)

Removal
- Remove fasteners and move control, bracket, and cable up away from seat frame
- Remove control handle pin and control handle
- Remove cable pin and cable
- Remove plug from bracket and remove cable

Installation
- Put cable in bracket and secure plug
- Route cable through control box and fasten to control handle with
- Fasten control handle to control with pin
- Fasten control and bracket to frame with screws

Adjustable shock absorber and cable (shock absorber end)



Set up
- Vehicle must be in a safe parked position or seat removed from vehicle
- Seat cushion must be removed from seat (**see Cushion seat pan**)

Removal
Adjustable shock absorber
- Remove retaining rings
- Remove shock absorber

Adjustable shock absorber cable
- Remove retaining ring
- Remove cable

Installation
Adjustable shock absorber cable
- Put cable in place
- Install retaining ring

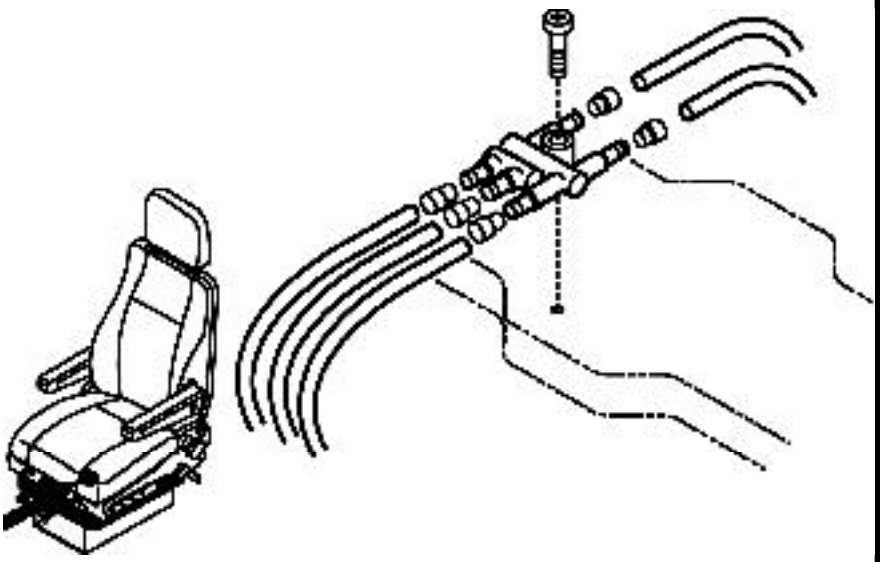
Adjustable shock absorber
- Put shock absorber in place
- Install retaining rings

Distribution valve

Set up
- Seat cushion must be removed from seat (**see Cushion seat pan**)

Removal
- Mark and remove air lines from valve
- Remove valve fastener and remove valve

Installation
- Fasten valve to frame with screw
- Connect air lines

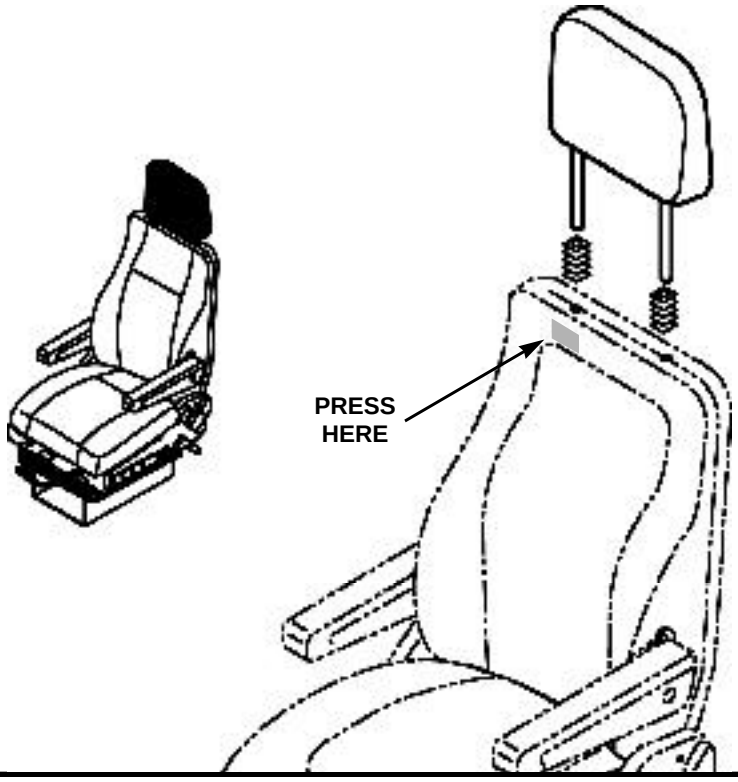


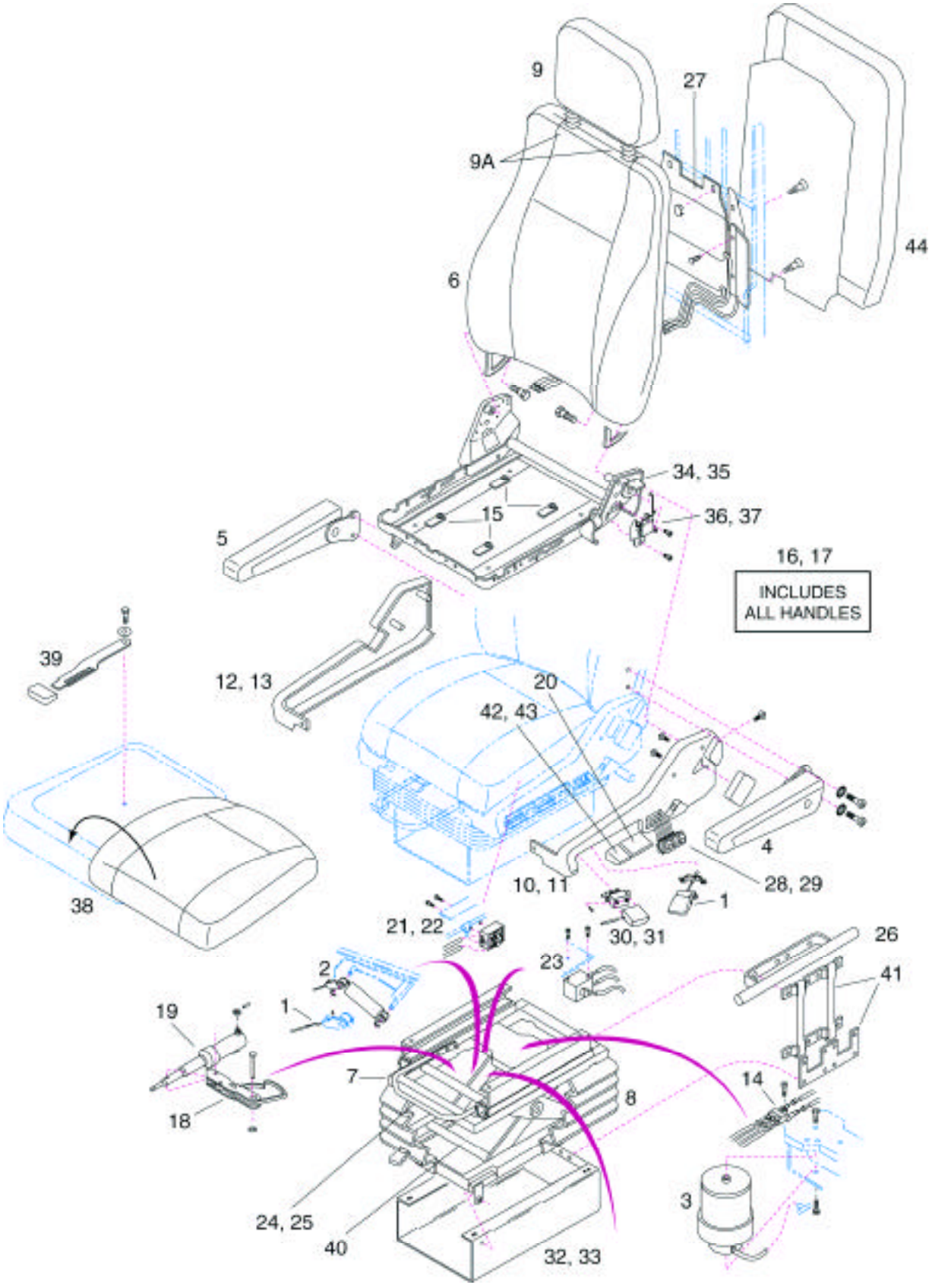
Headrest

Set up
- Vehicle must be in a safe parked position or seat removed from vehicle

Removal
- Pull headrest to upper locking position
- Press foam, as shown, to release locking clip from detent on headrest and pull up

Installation
- Guide headrest bars into position
- Press down to engage locking clip





item	part number	description
1	910353-09	ADJUSTABLE SHOCK ABSORBER CABLE KIT
2	98889-06	ADJUSTABLE SHOCK ABSORBER KIT
3	98872-15	AIR SPRING KIT
4	924473-32	ARMREST KIT - LH
5	924474-32	ARMREST KIT - RH
6	03003-00	BACKRESTASSEMBLY - NUDE
7	111776P02	BOOTADAPTER PLATE
8	926513-01	BOOT KIT
9	110922-00	HEADRESTASSEMBLY - NUDE
9A	47541	HEADREST BOOT (2 PCS)
10	920260-04	COVER KIT CONTROL - LH
10	927399-01	COVER KIT CONTROL - LH (W/O LOGO)
11	920263-04	COVER KIT CONTROL - RH
11	927398-01	COVER KIT CONTROL - RH (W/O LOGO)
12	920262-01	COVER KIT NON-CONTROL - LH
12	927397-01	COVER KIT NON-CONTROL - LH (BELT TO FRAME W/ LOGO)
12	927397-02	COVER KIT NON-CONTROL - LH (BELT TO FRAME W/O LOGO)
13	920261-01	COVER KIT NON-CONTROL - RH
13	927396-01	COVER KIT NON-CONTROL - RH (BELT TO FRAME W/ LOGO)
13	927396-02	COVER KIT NON-CONTROL - RH (BELT TO FRAME W/O LOGO)
14	915105-03	DISTRIBUTION VALVE KIT
15	914516-04	GLIDE KIT - SEAT PAN
16	920264-03	HANDLE KIT - SEAT FRAME - LH
17	920264-04	HANDLE KIT - SEAT FRAME - RH
18	33487	HEIGHTADJUSTMENT CAM KIT
19	95486-03	HEIGHTADJUSTMENT CYLINDER KIT
20	920266-05	HEIGHTADJUSTMENT HANDLE KIT - LH
20	920266-06	HEIGHTADJUSTMENT HANDLE KIT - RH
21	98976-07	HEIGHTADJUSTMENT VALVE KIT - LH
22	98875-07	HEIGHTADJUSTMENT VALVE KIT - RH
23	98873	HEIGHTADJUSTMENT VALVE KIT - SUSPENSION
24	24569F	HORIZONTALADJUSTMENT SLIDE HANDLE
25	18755-02	HORIZONTALADJUSTMENT SLIDE SET
26	111973P02	ICP BAR - TRUCK (NOT USED W/ BELT TO FRAME)
26	111895P01	ICP BAR - BUS (FOR BELT TO ICP BAR ONLY)
27	920272-01	LUMBAR/BOLSTER KIT
28	36571-01	LUMBAR/BOLSTER VALVE - LH
29	36572-01	LUMBAR/BOLSTER VALVE - RH
30	914514-24	QUICK AIR RELEASE VALVE AND HANDLE KIT - LH
31	914514-25	QUICK AIR RELEASE VALVE AND HANDLE KIT - RH
32	03007P	RISER - 127 MM (MCI 'D-SERIES' COACH)
33	03463P	RISER - 127 MM (STD, NEOPLAN, ORION VI, NEW FLYER)
33	03013P	RISER - 156 MM (MCI 'E-SERIES' COACH)
33	03468	RISER KIT - 76 MM (PREVOST COACH)
33	111779P03	RISER - 127 MM (KW O W900 & T2000, MACK, NAVISTAR)
33	112256P02	RISER - 110 MM (PB - 379)
34	03307-01	SEAT FRAME - LH
35	03308-01	SEAT FRAME - RH
36	914500-23	SEAT FRAME TOOTH PLATE KIT - LH
37	914500-24	SEAT FRAME TOOTH PLATE KIT - RH
38	03002-00	SEAT PAN ASSEMBLY - NUDE
39	921845-02	SEAT PAN ASSEMBLY LEVER AND HANDLE KIT
40	111833-01	SUSPENSION
41	924464-01	TETHER AND TETHER PLATE KIT
42	920267-05	TILT HANDLE KIT - LH
43	920267-06	TILT HANDLE KIT - RH
44	01955-03	BACKREST PANEL (BUS ONLY)

ISRINGHAUSEN
ISRI®

SERVICE PARTS LIST

Customer Name:	Prevost Car	ISRI Model:	6801/525
ISRI P/N:	86506-00	Customer P/N:	860912

Seat Specification: LH controls, 16 degree restriction, Air lumbar/Manual valve (IPS5), Adjustable shock, Armrest-padded, Long air supply hose

Property / User / Application: Prevost Car motor coach

ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
A	Headrest Kit	----------	
B	Armrest Kit	----------	
C-024	Backrest Asm	17518-00	860739
D-008	Seat Pan Asm	14663-04	860742
E-059	Seat Frame Asm	02371-02	861099
F-016	Static Spacer	18191P	861083
G	Swivel Asm	----------	
H	Isolator Asm	----------	
J-006	Slide Set	17491	860758
K-019	Suspension Asm	17259-01	
L-004	ICP Bar	23914P	
M-001	Boot Kit	92625-01	860523
N	Riser	----------	
P	Seat Belt Kit	----------	
	Assembly Hardware		
	Bolt-Hex Hd (Backrest)	60199	
	Screw (Seat Pan)	60560	
	Nut-Hex-Nylon Lock-M8	60016	
	Bolt-Soc Hd-M8 x 16	60185	
	Bolt-Soc Hd-M8 x 20	60172	
	Spacer	40432B	
	Washer-Lock-A8.2	60400	
	Bolt-Hex Hd-M8 x 25	60055	
	Nut-Hex-Crimp Lock-M8	60008	
L-004	Cover Plate – ICP Bar	34824D	

ISRINGHAUSEN
ISRI®

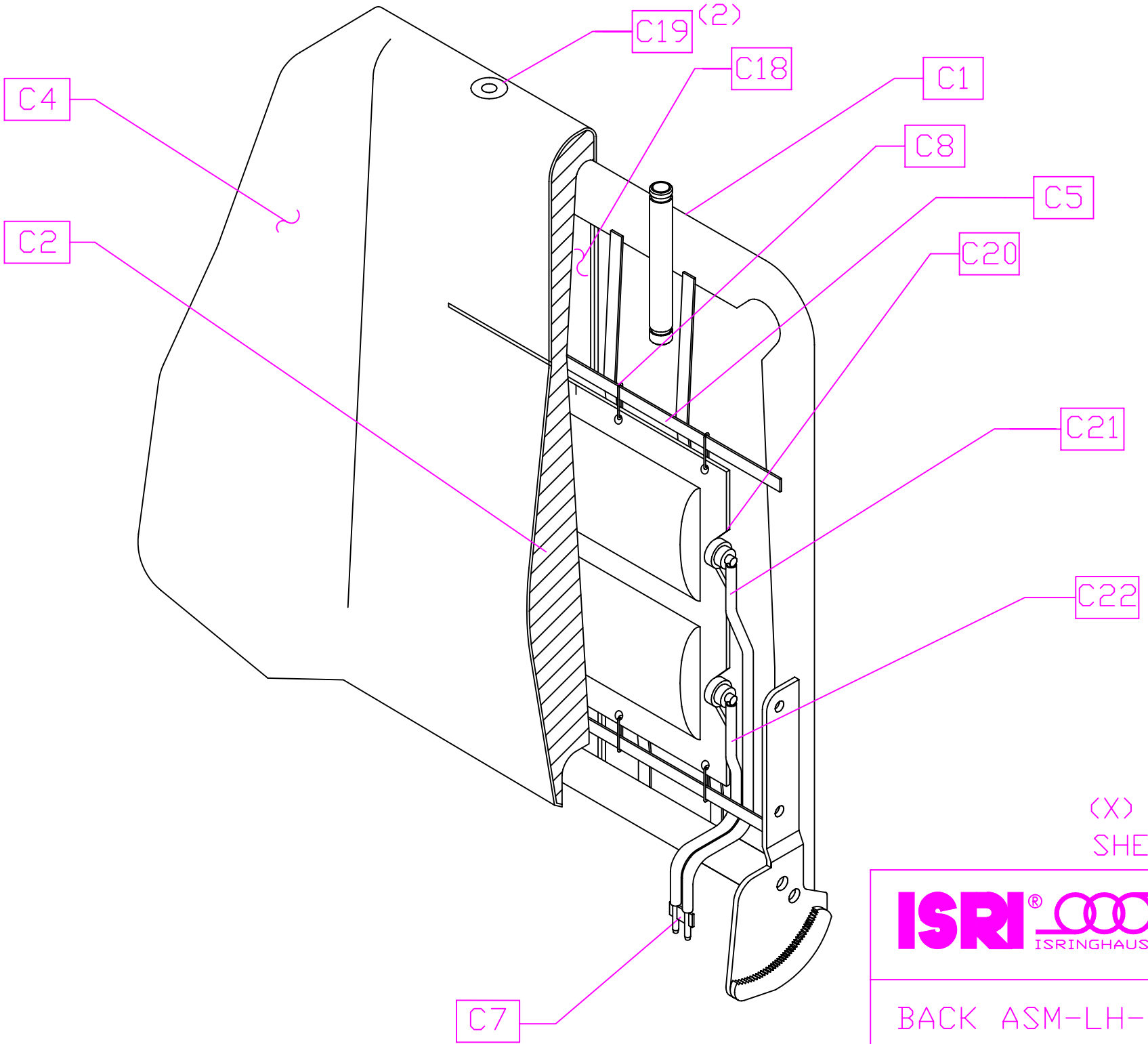
SERVICE PARTS LIST

ISRI P/N: 17518-00 Description: Backrest–517-LH-AL
ISRI Illus. No.: C-024
Customer: Prevost Car Customer P/N: 860739

Specification: LH controls, Air lumbar, Poly foam

ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
C1	Backrest Frame	17734D01	860740
C2	Backrest Foam	00849	864741
C3	Kit – Air Lumbar Bag	95622-01	860494
C4	Uph – Backrest	----------	
C5	Uph Rod – Long	See C27	
C7	Fitting	* 47278	
C8	Clip – Lumbar Bag Attach	See C3	
C18	Filler Foam – Back	13797	
C20	Air Lumbar Bag	See C24	
C21	Hose – Upper	See C24	
C22	Hose – Lower	See C24	
C23	Sew Strip	See C25	
C24	Air Lumbar Bag Asm	See C3	
C25	Uph Hdw Kit – Back – Nude	914413	
C27	Uph Hdw Kit – Back – Retro	----------	
C42	Hog Ring	See C25	
C47	Rub Strip	See C49	
C48	Screw (Rub Strip)	See C49	
C49	Rub Strip Kit	914439	

*** PART OF KIT**



(X) = QUANTITY

SHEET 1 OF 2

ISRI® ISRINGHAUSEN

05/92

(REV 5/22/01)

BACK ASM-LH-AL

C-024

KIT #	P/N	ITEM NO. IN KIT	ITEM
1	C3	C8, C24	AIR LUMBAR BAG – KIT
2	C24	C7, C20, C21, C22	AIR LUMBAR BAG – ASM
3	C25	C5, C18, C23	UPH HDW KIT–BACK–NUDE
4	C27	C5, C18	UPH HDW KIT–BACK–RETRO

ISRI® ISRINGHAUSEN

05/92
(REV 5/22/01)

KIT DESCRIPTION

C-024

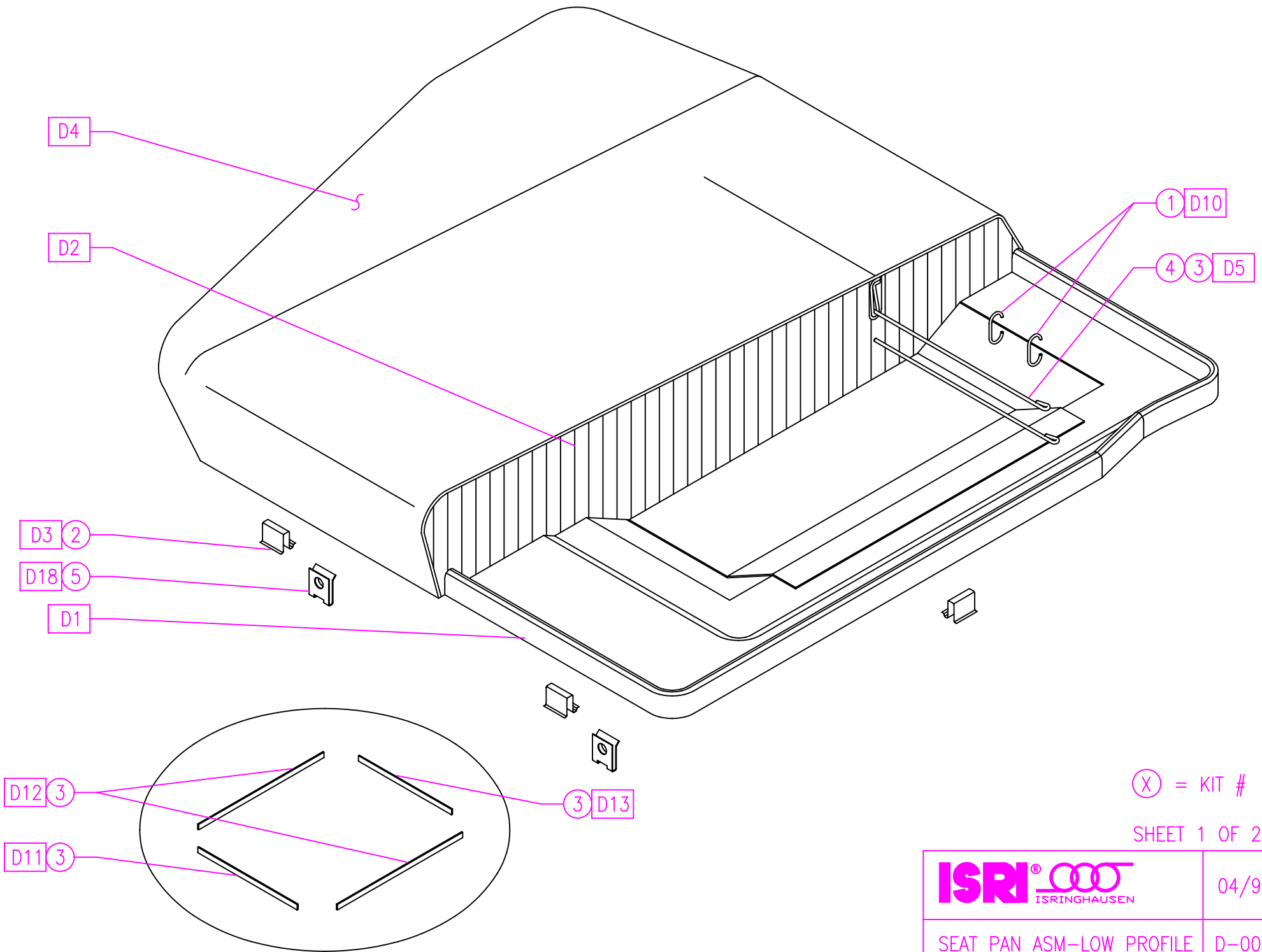
SERVICE PARTS LIST

ISRI P/N:	14663-04	Description:	Seat Pan-515
ISRI Illus. No.:	D-008		
Customer:	Prevost Car	Customer P/N:	860742

Specification: Poly foam, w/o upholstery

ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
D1	Seat Pan	17832P	860743
D2	Seat Foam	00425	860744
D3	Uph Clip	See D15	
D5	Uph Rod – Long	See D16	
D10	Hog Ring	See D16	
D11	Sew Strip – Front	See D16	
D12	Sew Strip – Side	See D16	
D13	Sew Strip – Rear	See D16	
D14	Hog Ring Kit	* 912040	
D15	Uph Clip Kit	* 912039	
D16	Uph Hdw Kit – Seat – Nude	96728	861104
D18	Nut – Clip	See D19	
D19	Hdw Kit – Nut Clip	914257	

*** PART OF KIT**



SHEET 1 OF 2

ISRI® ISRINGHAUSEN	04/91
SEAT PAN ASM–LOW PROFILE	D–008

KIT #	P/N	ITEM NO. IN KIT	ITEM
1	D14	D10	HOG RING KIT
2	D15	D3	UPH CLIP KIT
3	D16	D5,D11,D12,D13,D14,D15	UPH HDW KIT – NUDE
4	D17	D5, D14, D15	UPH HDW KIT – RETRO
5	D19	D18	SEAT PAN CLIP KIT

ISRI® ISRINGHAUSEN

04/91

KIT DESCRIPTION

D-008

ISRINGHAUSEN
ISRI®

SERVICE PARTS LIST

ISRI P/N: 02371-02 Description: Seat Frame-515-LH-AL/MV(RH)
ISRI Illus. No.: E-059
Customer: Prevost Car Customer P/N: 861099

Specification: LH controls, double swivel bolt, controls – black w/symbol, Air lumbar/Manual valve-RH (IPS 5)

ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
E1	Side Plate Kit	95733-03	860487
E3	Valve Kit – Air Lumbar/MV	917471-04	861096
E4	Valve Asm – Air Lumbar/MV	* 35270-01	
E5	Torsion Bar Kit	95739-01	861091
E7	Spring Kit – Height/Slope	95619-04	860755
E8	Bushing Kit – Height/Slope	95773-01	860753
E9	Bushing / Hdw Kit – H/S	95847-01	860754
E13	Tooth Plate Kit	914209-05	
E14	Swivel Bolt / Clip Kit	914204-02	860757
E50	Cover – Seat Frame – Rear	See E1	
E51	Hose–Lumbar Upper-Rubber	See E4	
E52	Cover – Side Plate – RH	See E1	
E54	Handle – H/S – Front	* 47270-02	
E55	Cap – Side Plate	See E1	
E56	Handle – Backrest	* 43537-02	
E57	Cover – Side Plate – LH	See E1	
E58	Hose-Lumbar Supply-PU3	See E4	
E59	Cap – Torsion Bar	See E5	
E60	Bar – Torsion	See E5	
E61	Lock – Torsion Bar	See E5	
E62	Pad – Felt	* 42258	
E63	Seat Frame w/o Covers	917673D	
E65	Screw – Hose Guide	See E3	
E66	Hose Guide	See E3	
E67	Hose-Lumbar Lower-Rubber	See E4	
E70	Nut – Tee	See E3	
E73	Bushing	See E8 or E9	
E74	Link-Pivot-H/S-Opp Control	See E63	
E75	Ring – Retaining	See E14	
E76	Bolt – Swivel	See E14	

*** PART OF KIT**

ISRINGHAUSEN
ISRI®

SERVICE PARTS LIST

ISRI P/N: 02371-02 Description: Seat Frame-515-LH-AL/MV(RH)
ISRI Illus. No.: E-059
Customer: Prevost Car Customer P/N: 861099

Specification: LH controls, double swivel bolt, controls – black w/symbol, Air lumbar/Manual valve-RH (IPS 5)

ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
E77	Bolt – Shoulder – M8	See E9	
E78	Bushing	See E8 or E9	
E79	Link-Pivot-H/S-Control	See E63	
E80	Lever – Backrest Adjust	41509D	
E81	Ring – Retaining	See E1	
E82	Spring – Tension – Backrest	41552D	860751
E83	Plate – Latch – H/S – Rear	35865J	
E84	Pin – Pivot – Latch	40647N	
E85	Ring – Retaining	60020	
E86	Guide – H/S	42962	
E88	Spring – Tension	See E7	
E89	Lever – H/S – Front	43012D	860588
E90	Spring – Tension	See E7	
E91	Spring – Tension	See E7	
E92	Plate – Latch – H/S – Front	47275D	860756
E93	Ring – Retaining	60020	
E94	Nut – Hex – Crimp Lock – M8	See E9	
E95	Linkage – H/S – Rear – DS	See E63	
E96	Ring – Retaining	60047	
E97	Link	See E63	
E98	Plate – Tooth – Seat Frame	See E13	
E99	Ring – Retaining	See E13	
E100	Ring – Retaining	60020	
E102	Bushing	See E8	
E103	Ring – Retaining	60020	
E104	Clip – U	60186	
E105	Linkage – H/S – Front – DS	See E63	
E138	Hose-PU3 (MV/Air Spring)	See E3	
E139	Housing – AL/MV	* 24111-02	
E140	Screw-Mtg-AL/MV Housing	See E3	
E141	Cover – Rocker – AL – Lower	* 45480-24	861094

*** PART OF KIT**

ISRINGHAUSEN
ISRI®

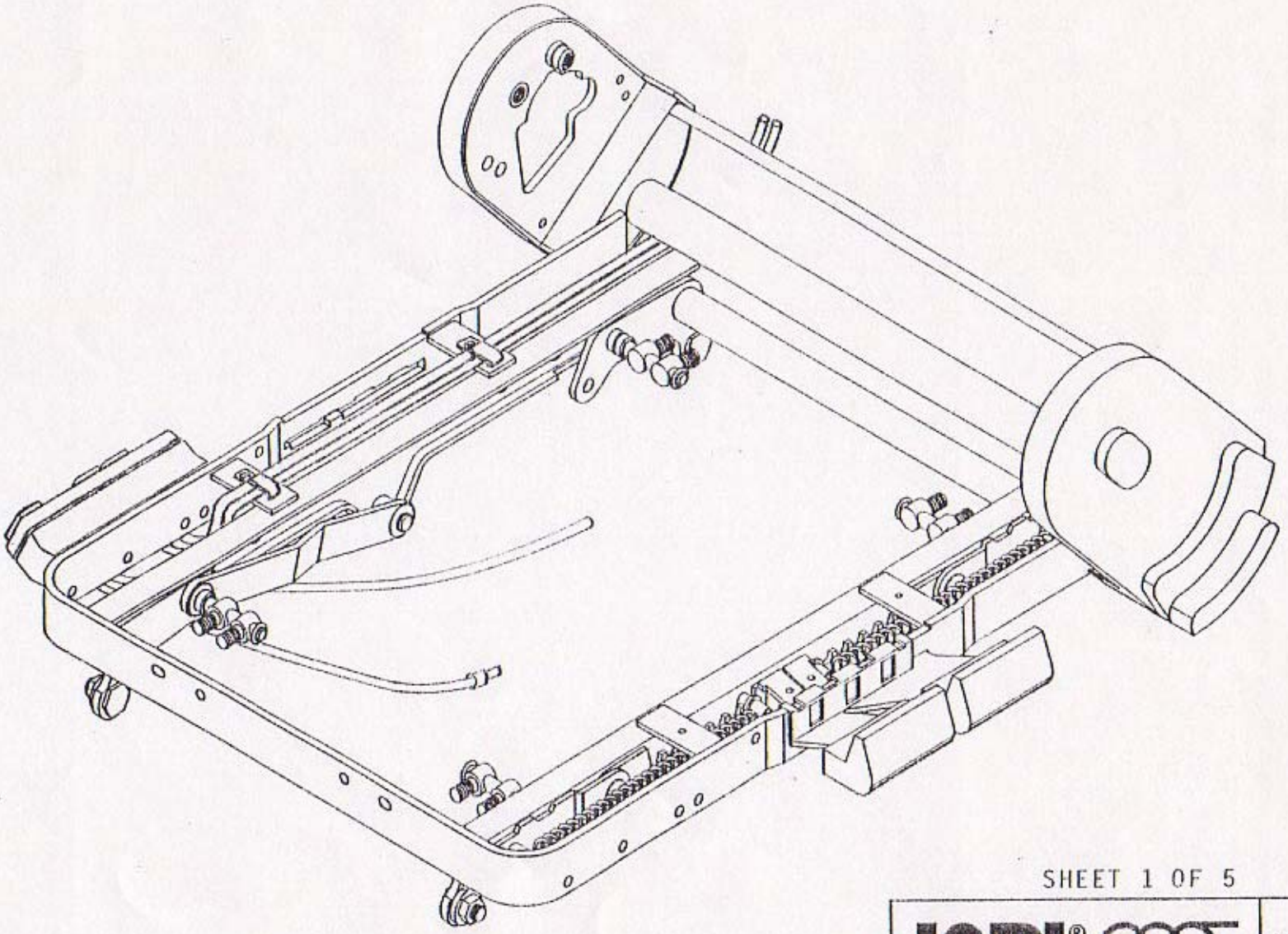
SERVICE PARTS LIST

ISRI P/N: 02371-02 Description: Seat Frame-515-LH-AL/MV(RH)
ISRI Illus. No.: E-059
Customer: Prevost Car Customer P/N: 861099

Specification: LH controls, double swivel bolt, controls – black w/symbol, Air lumbar/Manual valve-RH (IPS 5)

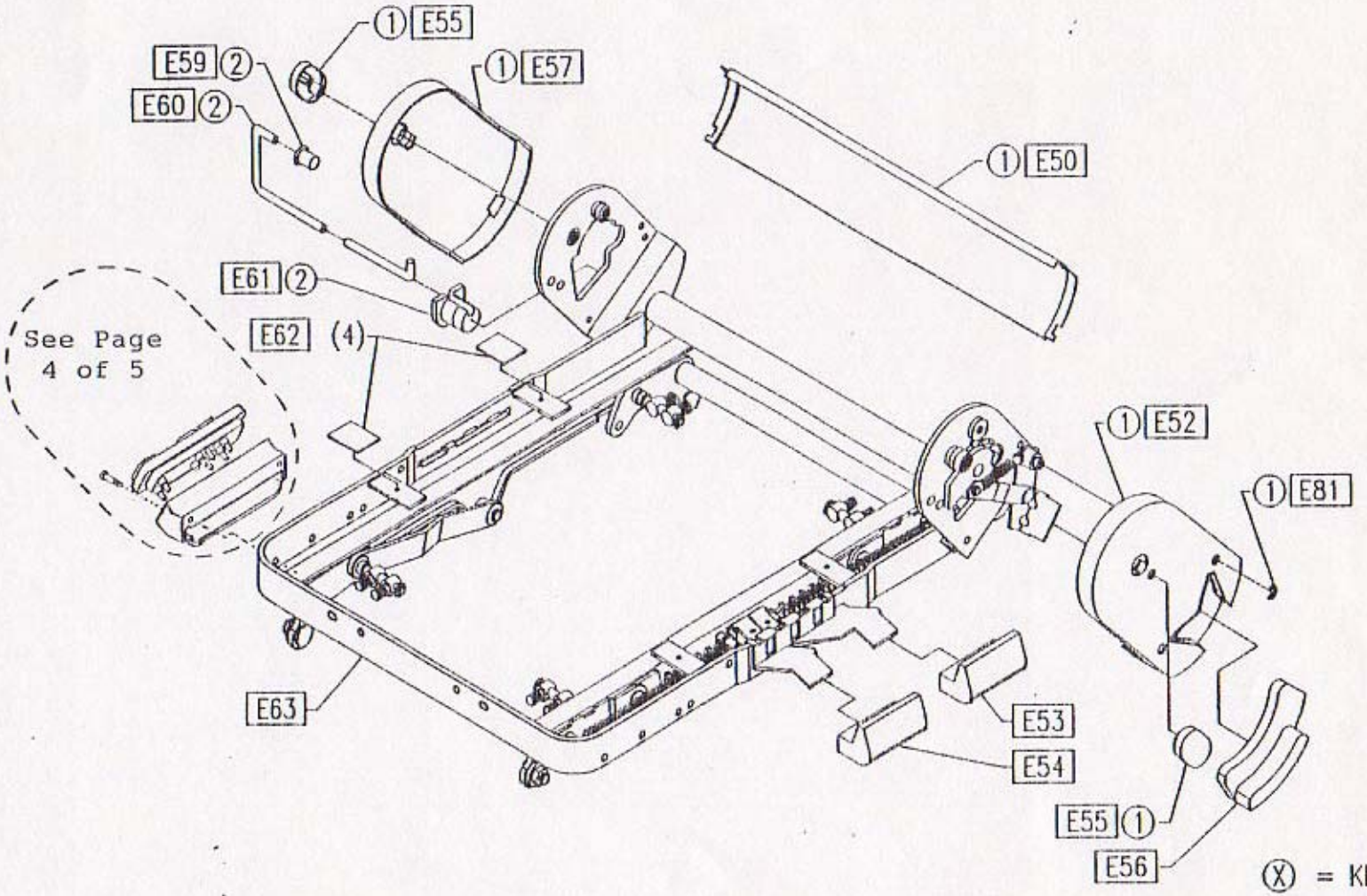
ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
E142	Washer – Flat – A8.4	See E3	
E143	Sleeve – Push On – PU4	* 46097-02	
E144	Sleeve – Push On – PU3	* 44713-02	
E145	Ring – Retaining	60045	
E147	Hose-PU3 (AL Supply)	See E3	
E149	Valve – AL/MV (IPS5)	See E4	
E150	Cover – Rocker – AL – Upper	* 45480-23	861093
E152	Cover – Rocker – MV (+/-)	* 46680-02	861097
E156	Plastic Tie	See E3	
E179	Connector - “Y” - PU4	* 44712	
E181	Connector–Inline–PU4/PU3	* 44436	
E182	Connector-Inline-PU3/PU3	* 46708	
E183	Hose-PU4 (Y/Valve Supply)	See E3	
E184	Hose-PU4 (Supply/Y)	See E3	
E185	Tag – “P” (Supply Hose)	See E3	

*** PART OF KIT**



SHEET 1 OF 5

ISRI® ISRINGHAUSEN	12/95
SEAT FRAME-515-LH	E-059



SHEET 2 OF 5

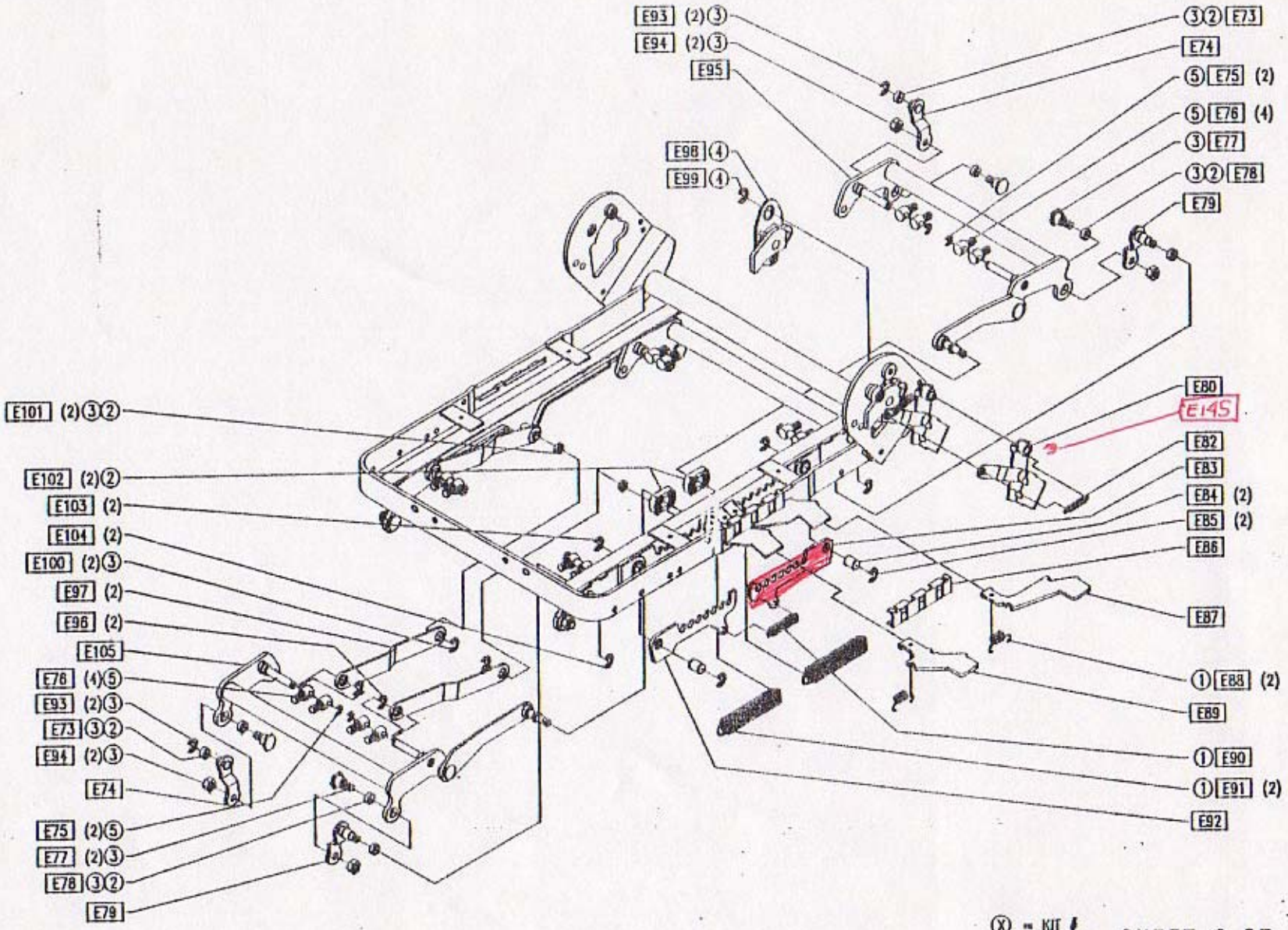
KIT #	P/N	ITEM NO. IN KIT	ITEM
1	E1	E50, E52, E55, E57, E81	SIDE PLATE KIT
2	E5	E59, E60, E61	TORSION BAR KIT

ISRI® ISRINGHAUSEN

12/95

SEAT FRAME-515-LH

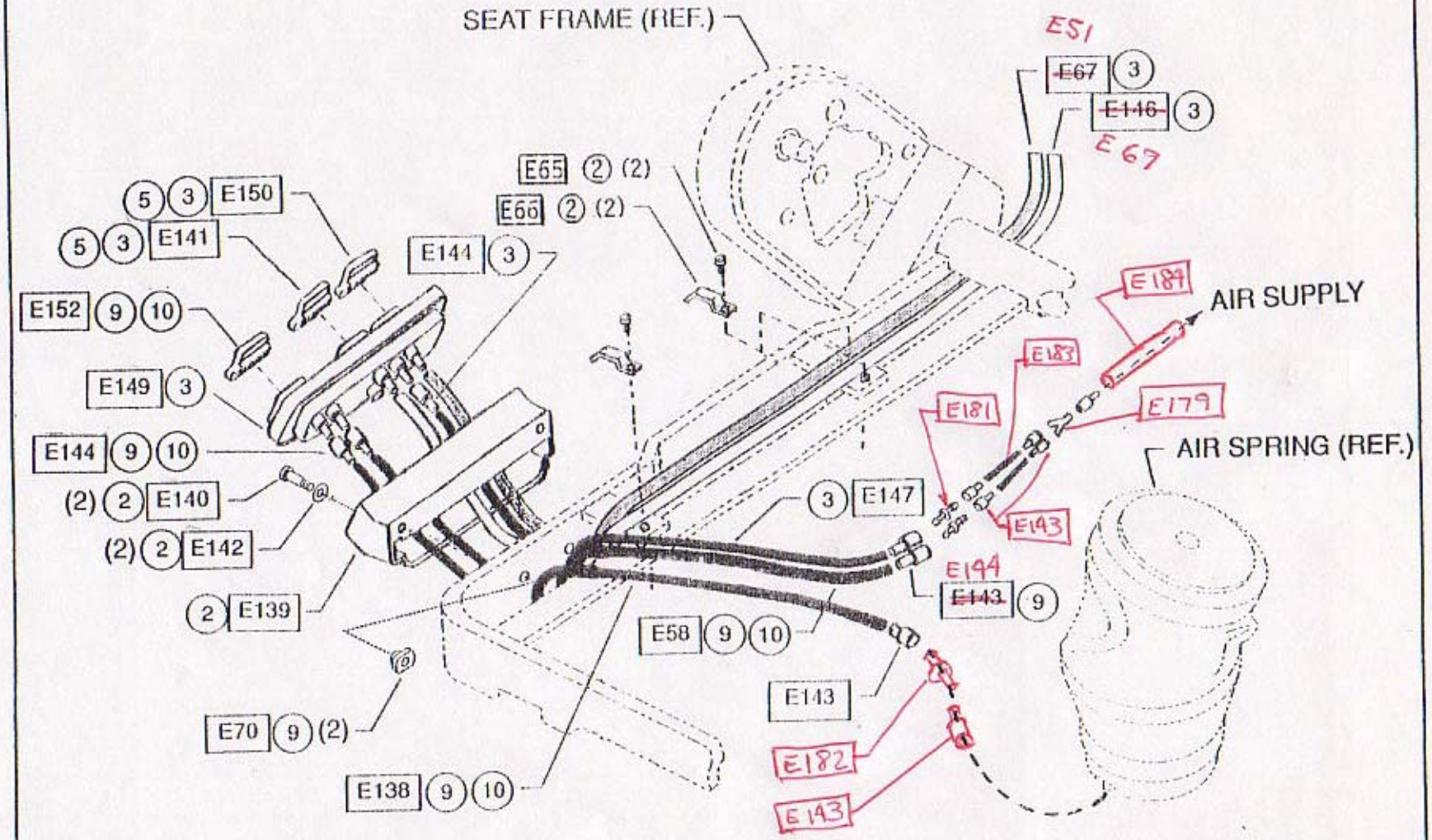
E-059



Ⓧ = KIT #
(X) = QUANTITY

SHEET 3 OF 5

ISRI	12/95
SEAT FRAME-515-LH	E-059



SHEET 4 OF 5

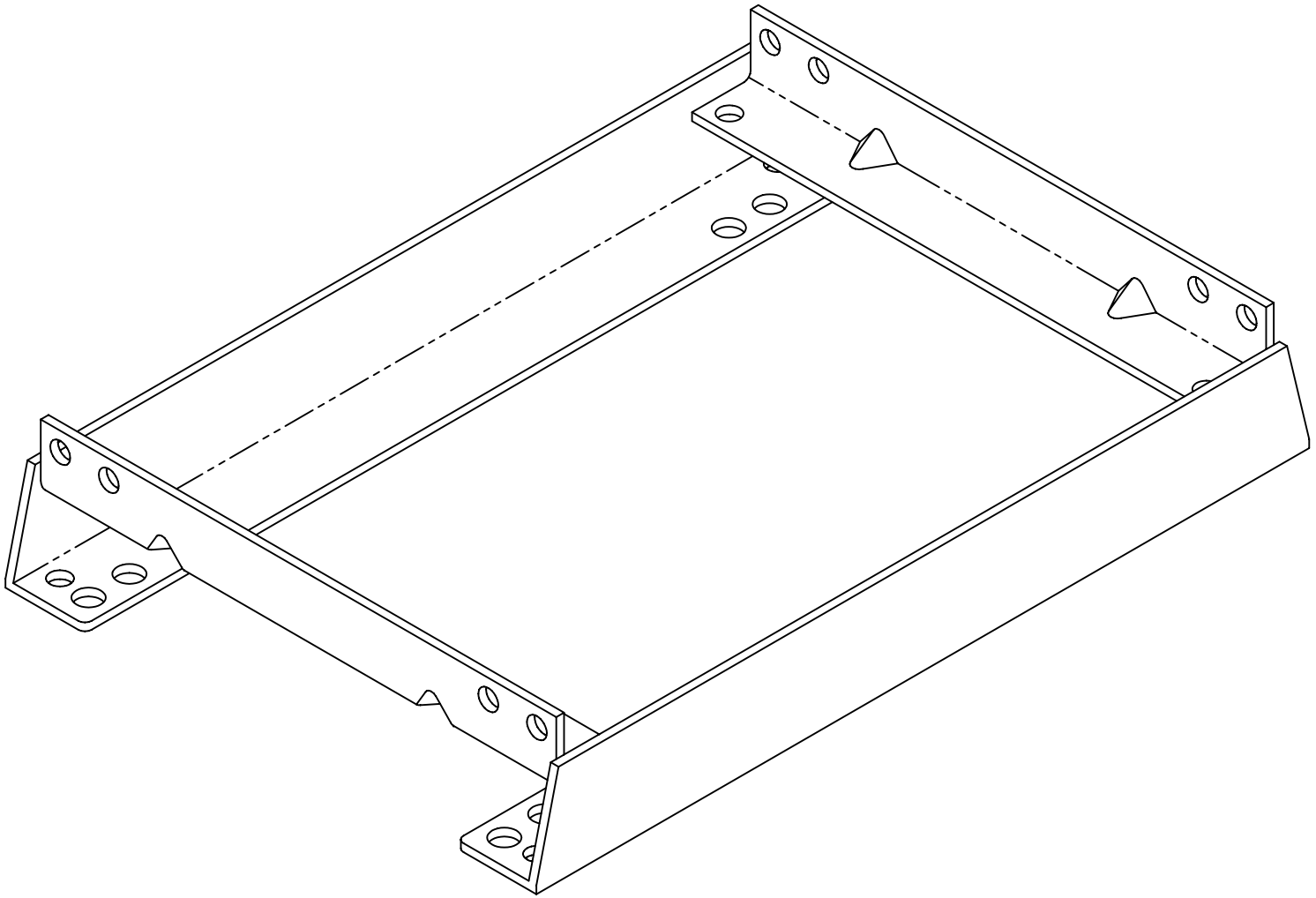
ISRI® ISRINGHAUSEN	12/95
SEAT FRAME-515-LH	E-059

◯ = KIT #

( ) = QUANTITY

KIT #	P/N	ITEM NO. IN KIT	ITEM
1	E1	E50, E52, E55, E57, E81	SIDE PLATE KIT
2	E3	E4, E70, E139, E140, E142, E143	VALVE KIT-AL/MV
3	E4	E51, E67, E141, E144, E146, E147, E149, E150	VALVE ASM-AL/MV
4	E5	E59, E60, E61	TORSION BAR KIT
5	E6	E54, E56, E141, E150, E152	HANDLE KIT-SF-AL/MV
6	E7	E88, E90, E91	SPRING KIT-H/S
7	E8	E72, E73, E102	BUSHING KIT-H/S
8	E9	E72, E77, E78, E93, E94, E100	BUSHING/HDW KIT-H/S
9	E13	E98, E99	TOOTHPLATE KIT
10	E14	E75, E76	SWIVEL BOLT/CLIP KIT

ISRI® ISRINGHAUSEN	12/95
KIT LIST	E-059



ISRI® ISRINGHAUSEN

06/99

STATIC SPACER

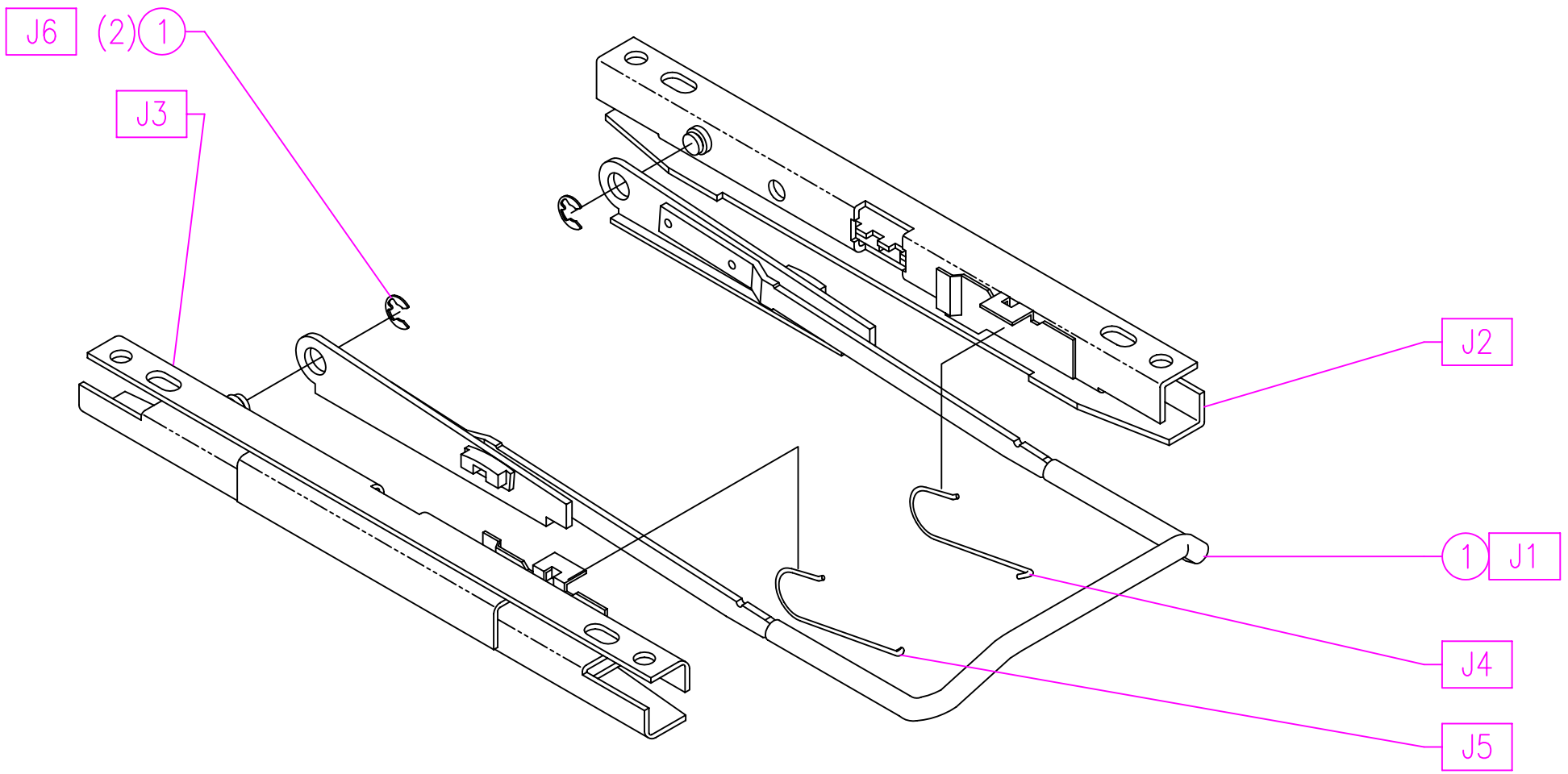
F-016

SERVICE PARTS LIST

ISRI P/N: 17491 Description: Slide Set – “B” Style
ISRI Illus. No.: J-006
Customer: Prevost Car Customer P/N: 860758

Specification: 90/60 slide stroke, double locking, bar handle up

ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
J1	Handle – Slide	See J8	
J2	Slide – Slave – LH	23908	
J3	Slide – Master – RH	23907	
J4	Spring – Handle Return – LH	43284C	
J5	Spring – Handle Return – RH	43283C	
J6	Ring – Retaining	See J8	
J8	Handle/Clip Kit	914212-04	



KIT #	P/N	ITEM NO. IN KIT	ITEM
1	J8	J1, J6	HANDLE KIT

ISRI® ISRINGHAUSEN

04/91

SLIDE SET

J-006

ISRINGHAUSEN
ISRI®

SERVICE PARTS LIST

ISRI P/N: 17259-01 Description: Susp–Air
ISRI Illus. No.: K-019
Customer: Prevost Car Customer P/N:

Specification: Manual air, 100 mm stroke, Adjustable shock

ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
K2	Suspension Hdw Kit	95477-03	860770
K3	Bumper / Bracket Asm	See K12	
K5	Shock Kit	914410	860766
K6	Air Spring Kit	95474-02	
K12	Bumper Kit	913934-05	860769
K19	Shock Cable Kit	914411	860767
K20	Shock Handle Kit	914412-01	861105
K50	Nut – Hex – M8	See K12	
K51	Washer – Split Lock – B8	See K12	
K53	Bumper – Cone Shape	See K12	
K56	Bushing – Flange	See K2	
K59	Nut–Hex–Crimp Lock-M10	See K2	
K61	Spring – Air	See K6	
K66	Washer – Flat – A6.4	See K6	
K67	Screw – Air Spring Mtg - Lwr	See K6	
K69	Bracket – Bumper Stop	See K3	
K70	Bumper – Up Stop	See K3	
K72	Bolt – Shock Mtg - Lower	See K5	
K73	Hose–MV / Air Spring	See K16	
K75	Bolt – Shoulder – M10	See K2	
K78	Roller	See K2	
K83	Bushing – Shock - Lower	See K5	
K84	Shock Absorber	See K5	
K106	Frame – Upper	N/A Separate	
K108	Frame – Lower	N/A Separate	
K109	Scissor – Outer	N/A Separate	
K110	Scissor – Inner	N/A Separate	
K125	Cable Tie	See K5 or K9	
K152	Spacer Block	See K2	
K153	Bearing Block	See K2	
K154	Bolt – Air Spring Mtg – Upr	See K6	

***PART OF KIT**

ISRINGHAUSEN
ISRI®

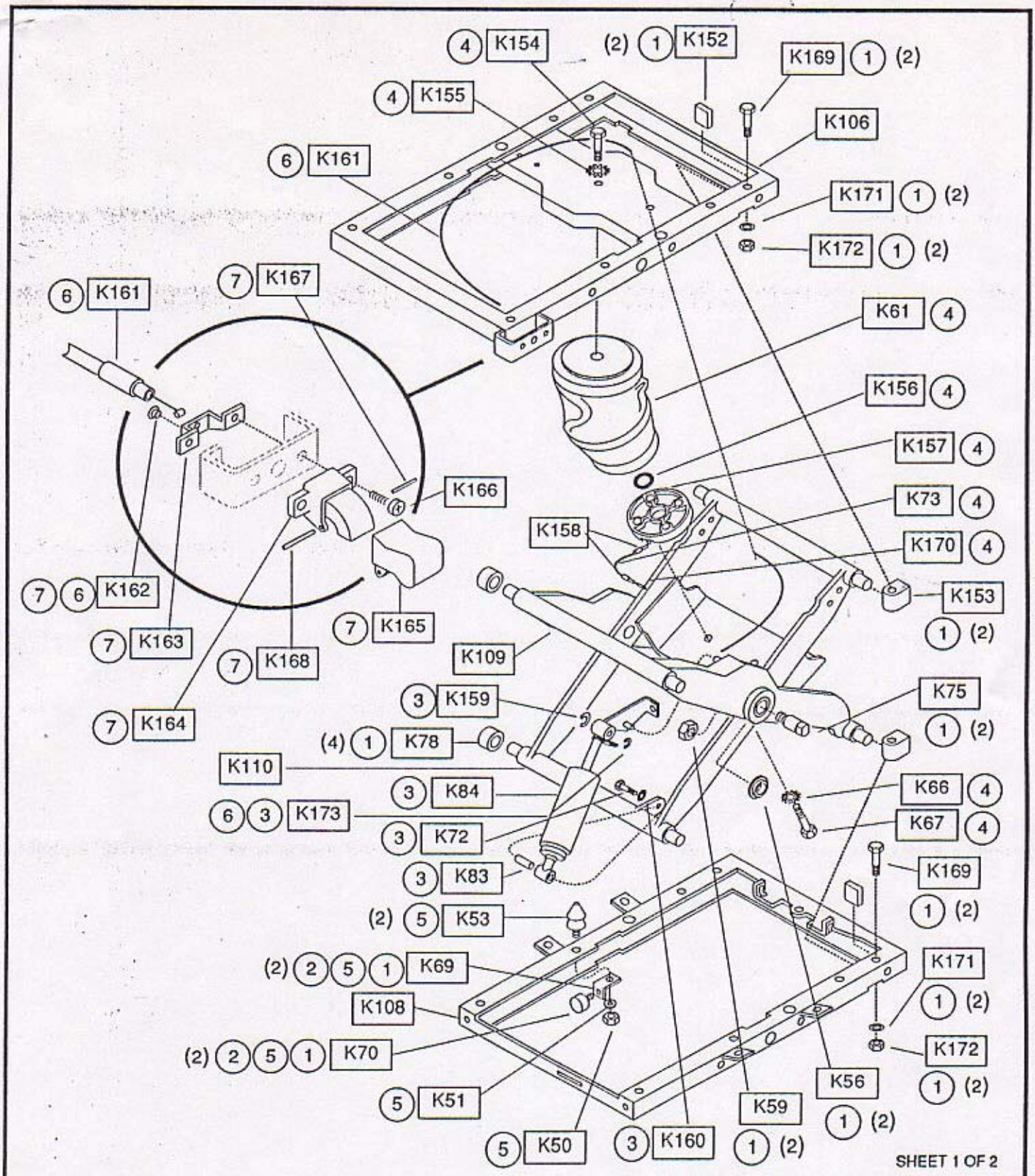
SERVICE PARTS LIST

ISRI P/N: 17259-01 Description: Susp–Air
ISRI Illus. No.: K-019
Customer: Prevost Car Customer P/N:

Specification: Manual air, 100 mm stroke, Adjustable shock

ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
K155	Washer–Air Spring Mtg-Upr	See K6	
K156	O-Ring (Air Spring)	See K6	
K158	Sleeve – Push on – PU3	* 44713-01	
K159	Ring–Retaining–Shock-Upr	See K5	
K160	Washer-Shock-Lwr	See K5	
K161	Cable – Adjustable Shock	See K19	
K162	Plug	See K19 or K20	
K163	Bracket – Cable/Handle Mtg	See K20	
K164	Housing – Adjustable Shock	See K20	
K165	Handle – Adjustable Shock	See K20	
K166	Screw (Adj Shock Housing)	See K20	
K167	Pin-Long (Shock Hdl Pivot)	See K20	
K168	Pin-short (Shock Cable)	See K20	
K169	Bolt – Bearing Block	See K2	
K170	Conn-Reducer-PU4/PU3	* 44436	
K171	Washer-Bearing Block	See K2	
K172	Nut-Bearing Block	See K2	
K173	Ring–Retaining (Shk Cable)	See K19	

*** PART OF KIT**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K169 1 (2)
4 K155
K106
6 K161
K171 1 (2)
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K156 4
K157 4
K73 4
K166
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K110
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3 K160
SHEET 1 OF 2
ISRI ISRINGHAUSEN
5/92
= KIT #
( ) = QUANTITY
Susp Asm - Air
K-019

Kit No.	P/N	Item No. In Kit	Description
1	K2	K12, K56, K59, K75, K78, K152, K153, K169, K171, K172	Susp. HDW Kit
2	K3	K69, K70	Bumper/Bracket Assembly
3	K5	K72, K83, K84, K159, K160, K173	Shock Kit
4	K6	K61, K66, K67, K73, K154, K155, K156, K157, K170	Air Spring Kit
5	K12	K50, K51, K53	Bumper Kit

ISRI® ISRINGHAUSEN | 7/92

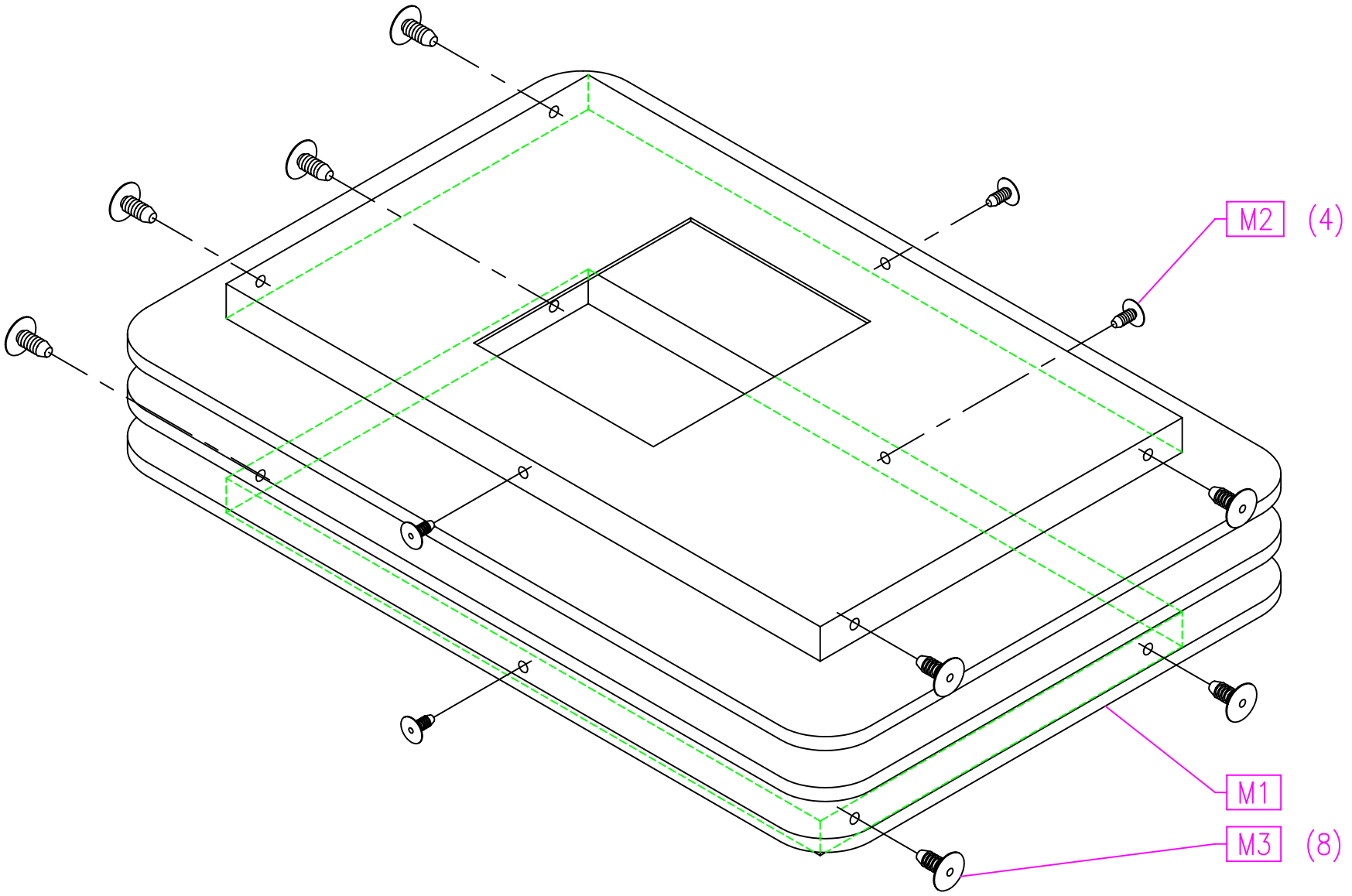
Susp Asm - Air | K-019

SERVICE PARTS LIST

ISRI P/N: 92625-01 Description: Boot Kit-Susp–Air-AL
ISRI Illus. No.: M-001
Customer: Prevost Car Customer P/N:

Specification:

ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
M1	Boot	00169	
M2	Boot Button – Small	See M4	
M3	Boot Button – Large	See M4	
M4	Hdw Kit – Boot Button	910507	



(X) = QUANTITY

ISRI® ISRINGHAUSEN	10/90
AIR SUSP BOOT KIT	M-001

Sheffield Plastics Inc.
A Bayer MaterialScience Company

119 Salisbury Road
Sheffield, Massachusetts 01257
TEL: 413.229.8711
FAX: 413.229.8717
www.sheffieldplastics.com

Makrolon Cleaning Instructions

The Following techniques for cleaning Makrolon polycarbonate sheet are based on standard industry practice. To ensure acceptability of the results, always test a sample of the material with the cleaner and technique to be used.

Guidelines:

Do rinse the sheet with warm water prior to cleaning process.
Don't use abrasives or high alkaline cleaners.
Don't leave cleaners on sheet for long periods, wash immediately.
Don't apply cleaners in direct sunlight or at elevated temperatures.
Don't use scrapers, squeegees or razors.
Don't clean with gasoline.
Do follow the application with a lukewarm water rinse.

Compatible Cleaners and Detergents:

Formula 409[1], Joy[2], Windex with Ammonia D[3], Palmolive[4], Naphtha VM&P Grade, Isopropyl Alcohol

To Minimize Fine or Hairline Scratches:

Plastic Polishes applied and removed per manufacturer instructions.

Suggested Polishes:

Mirror Glaze Clear Plastic Polish, Cleaner & Detailer (by Meguiars 800-347-5700 or Meguiars.com)
Novus Plastics Polish #1, #2 (by Novus Inc. 800-NOVUS60 or noscratch.com)
Plexus Plastic Cleaner and Polish (by BTI Chemical Co. PlexusPlasticCleaner.com)

To Remove Masking Adhesive and Glazing Compound:

Apply Naphtha VM&P grade, Kerosene or Isopropyl Alcohol with clean soft cloth. Wash immediately with soap and lukewarm water and rinse with thoroughly with clean water.

To Remove Graffiti:

Naphtha VM&P grade, Isopropyl Alcohol or Butyl Cellosolve removes paint, marker ink. (Do not use in direct sunlight).
Isopropyl Alcohol, Naphtha VM&P grade or Kerosene will help lift stickers and other adhesive backed labels. Wash immediately with soap and lukewarm water and rinse with thoroughly with clean water.

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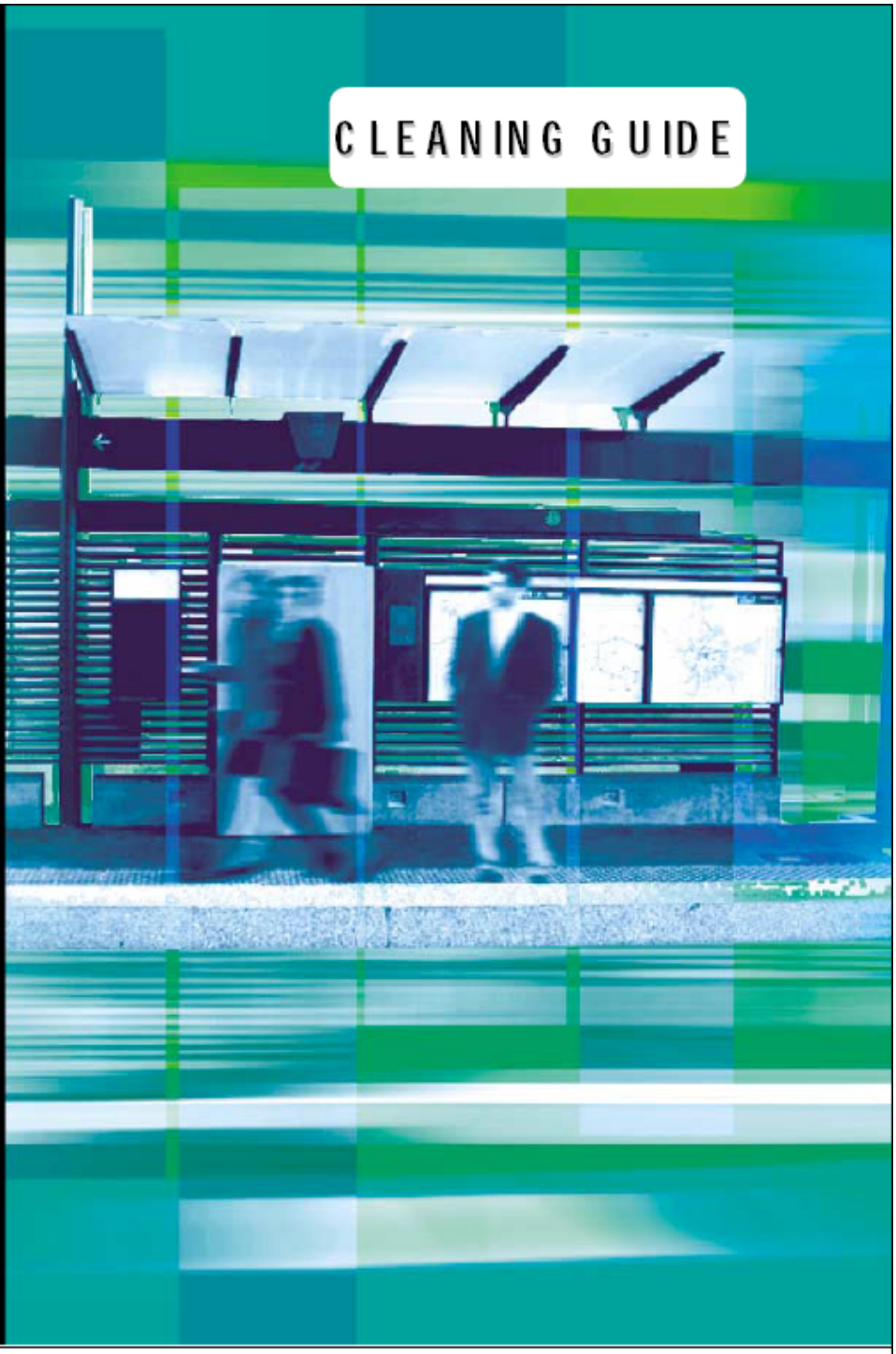
TARABUS

CLEANING GUIDE



Gerflor
Transport Floorings

TARABUS floor coverings are specifically designed to meet the requirements of the coach and transit bus industry such as durability, slip resistance, ease of cleaning and resistance to aggressive agents.

In common with all heavy duty floorings, they require correct and regular maintenance.
A cleaning procedure to meet your special needs is essential to ensure the optimum life span of the floor covering.

TARABUS floor coverings are ideally suited to the specific constraints of the Transport sector and have been tested in thousands of vehicles all over the world !

REGULAR MAINTENANCE

1 **Equipment :**
- Broom or industrial vacuum cleaner
- Damp mop

2 **Procedure :**
- Remove dust and loose debris with an industrial cleaner.
- Mop the floor using clean water with 2 to 5% neutral detergent.
- With a thoroughly rinsed mop, remop the floor using only clean water to remove all detergent residues

3 **Frequency :**
daily or several times a week depending on the traffic.

INTENSIVE MAINTENANCE

1 **Equipment :**
- Broom or industrial vacuum cleaner
- Damp mop
- Medium stiff bristled brush or broom

2 **Procedure :**
- Remove dust and loose debris with an industrial vacuum cleaner.
- In case of grease/oil spots on the flooring, scrub the floor using a medium stiff bristled hand brush, a broom or an electric scrubber with alkaline detergent if required.
- Detergent's dilution should be done according to manufacturer's instructions
- Rinse with copious amounts of clean water to remove all detergent residues
- Dry with a mop or a liquid vacuum cleaner.

3 **Frequency :**
A minimum of once a month or more frequently

DO NOT !

1. Use an electric scrubber with abrasive discs.
2. Use solvents.
3. Use industrial stain removers without first testing them on a small hidden area to prevent any damage.
4. Leave a detergent residue on the floor.
5. Apply a surface treatment.
   Wax or surface treatments **are not suitable** for bus floors as this will be detrimental to anti-slip properties.
6. Use a high pressure water jet.

TARABUS is the easiest vinyl flooring on the market to clean !

DO !

1. TARABUS products are resistant to diluted acids and bases, with the obvious exception of PVC solvents
2. To remove stains, only use alcohol, “C oil” or recommended industrial spot removers such as : “Write Off” from Certi fied Laboratories* or “Grafforange Bio” from MC2 CHIMIE-DERCAM*.
3. Thoroughly rinse the floor with clean water. Remaining cleaning agents might affect the slip resistance properties of the floor.

* List of local distributor available upon request.
  Please contact the local TARABUS sales representative.

SPECIAL POINTS

1. **Chewing gum** can only be mechanically scraped off after chilling with a compressed nitrogen spray unit or specific orange oil gum remover

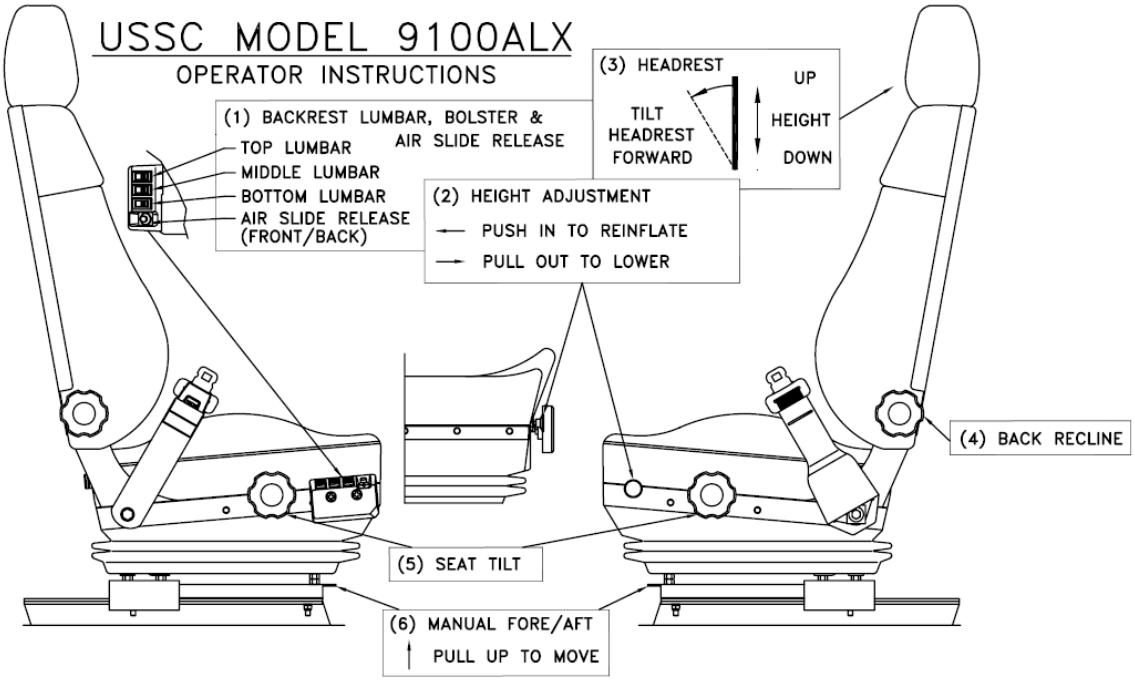
2. **Glue** can generally be removed with Mineral Spirit. Rinse immediately after with diluted detergent.

3. **Oil/grease** spots can be taken away by using an alkaline detergent, as can food stains such as **ketchup or sodas.**

MANUFACTURERS

Colgate Palmolive Institutional Product Division	Diversey Lever Taski	Henkel Ecolab Ecolab
Toll free number : 800-432-8226 www.colpalipd.com	Toll free number : 800-831-9890 www.taski.com	Toll free number : 800-451-7191 www.ecolab.com

MAINTENANCE		pH
Stripping	Stripper	≥ 12
	Stripper(dry)	> 10
Cleaning	Spray Cleaner	8
Detergent	Neutral Cleaning Agent	8.5 - 9
	Alkaline Cleaning Agent	≥ 9
	Cleaning Agent (removing rubber marks)	≥ 12
	Desinfectant/Detergent	10
	Cleaning Agent (heavy traffic)	4.5



SEAT HEIGHT: The 91X ALX Air Suspension Seat has five (5) inches of vertical height adjustment. Seat height adjustment knob is located on the front left edge of the seat cushion. Pulling the knob out releases air pressure, this decreases height. Pushing the knob in increases the seat height.

SEAT TILT: The 91X ALX seat cushion angle can be adjusted eight (8) degrees by turning the seat tilt knobs located in the center of the seat cushion. Seat tilt is independent of seat height adjustment. This allows full tilt range at all seat heights.

SLIDE (MANUAL): The entire seat can be adjusted 6.25-11.8 inches front to back. Raising the slide handle located at the seat front below the rubber bellow releases the lock and lets the seat move front/back.

SLIDE (AIR SLIDE): Air slide release button is located on the switchbox that controls the seat lumbar. Press the red button to release the slides, move the seat to the desired location and release the button. Slides will automatically lock in place.

REPLACE SLIDES OR SLIDE HANDLE:

1. Slides are connected to the bottom of seat by screws on each end of the slide. Undo screws to replace slide tracks. Apply semi permanent thread locker such as (Loctite 242) before installing screws.
2. Insert slide handle by fitting each side onto the two (2) tabs on the slide tracks.

LUMBAR SUPPORT: Air lumbar switches are located on the switch box on the side of the seat. Pushing the switches increases or decreases the amount of lumbar support. The lumbar system is operated via regulated vehicle air supply (regulator is internal to supplied suspension).

SEAT CUSHION REPLACEMENT:

1. Lower the rubber bellow. Remove the black plastic rivets that hold it up. The rivets are simple push pins that are removed by prying them out with a flat screwdriver. Be careful not to tear the plastic so the rivets may be reused. If the bellow is glued, use a sharp chisel to separate the bellow from the suspension.
2. Remove the seat tilt knobs.
3. To remove old cover release three secured flaps by using a flat screwdriver. Pry the flaps downward to release plastic strips from metal runners. Note how they fit into the runners.
4. Put on new covers. Beginning at the front, slip the plastic strip that is sewn on the replacement cover under the metal runner. Next, do both sides by fitting the plastic strips under each runner. Last, secure the back of the replacement cover to the seat by the plastic rivets. Locate the holes with a center punch and pierce the fabric before inserting the plastic rivets.
5. Replace the rubber bellow and reinsert the plastic rivets.
6. Reattach knobs.

REPLACE AIR LUMBAR BAGS:

1. Remove cover and back foam to expose lumbar bags.
2. Drill the rivets securing air lumbar bag(s) to the back frame.
3. Remove defective lumbar bag(s) from metal back frame plate.
4. Replace with new bag(s) and replace mounting rivets.
5. Replace foam and cover.

SEAT BACK COVER REPLACEMENT:

1. Remove headrest.
2. Remove backshell.
3. Remove the back from the seat: Two (2) screws are located on each side of the back base.
4. Disconnect air lines to the back.
5. Remove cover: Release J hook by pressing cushion toward the frame then remove center panel by slow, even pulling. The center panel is held in place by Velcro on the top, sides and bottom.
6. Replace cover: Beginning with the cape, reattach J hook to the back frame and pull the upholstery over the edges.
7. Firmly attach the loop strips on the upholstery to the hook in the foam. Adjust foam and upholstery as needed and attach loop and hook at the bottom edge.
8. Reattach back to seat. Reattach air lines, backshell and headrest.

MOUNTING AND REMOVING SEAT FROM RISER:

1. Disconnect the air hose.
2. Slide the seat back and remove the two (2) screws that are connecting slide with the riser.
3. Slide the seat forward and perform the same operation as step 2 to the rear screws.

PREVENTATIVE MAINTENANCE FOR BASE:

1. Check to see if there is any loose hardware.
2. Check slide track for any obstructing objects.

USSC 91X ALX
TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	CORRECTIVE ACTION
Suspension bounces excessively	Shock absorber seals worn	Replace both shocks
Air leaks from seat	Air line is leaking at connector	Tighten or reconnect at fitting
	Air line is cut	Replace air line
	Height adjustment valve is leaking	Replace valve
	Regulator is leaking	Tighten body or replace
	Air valve for bolsters or lumbar leaking	Replace valve
Lumbar or bolster bag deflates	Hole in bag	Replace bags
	Air line is leaking at connector	Tighten/reconnect at fitting
	Air line is cut	Replace air line
	Air valve is leaking	Replace valve
Lumbar or bolster bag will not inflate	Faulty regulator	Replace regulator
	Air valve is leaking	Replace valve
	Air line disconnected at the rear of back	Reconnect
Air slide release not functioning	Air line is leaking at connector	Tighten/reconnect at fitting
	Air line is cut	Replace air line
	Air valve is leaking	Replace valve
	Pinched air line	Reroute air line
	Air cylinder not functioning	Replace air cylinder
Height adjustment not functioning	Height adjustment knob missing	Replace knob
	Inadequate air supply	Check air supply pressure
	Pinched air line	Reroute air line
	Faulty valve	Replace valve
	Air spring leaks	Replace air springs
Knob comes off	Backing nut not tight	Tighten securely
Alarm pad not functioning	Faulty warning	Check electrical connections

RECOMMENDED SEAT MAINTENANCE

In general the seat will require little maintenance. Following are scheduled inspections and maintenance.

Frequency	Inspection
Daily	Check that the seat functions are not obstructed by foreign objects. Check belt function & condition. Look for webbing cuts.
Weekly	Check seat functions. Repair as required. Fore/aft Height Seat rake Back recline Lumbar Bolsters Air valve Seat belt
	Check upholstery. If torn or soiled, replace.
Monthly	Check fore/aft slides. If more than 1mm “play”, replace assembly. Otherwise grease the slide tracks.
	Check shock absorbers. If seat “bounces” too much, replace both shock absorbers.
	Check seat anchorage to vehicle. Seat should be securely fastened to vehicle floor.
	Check backrest and bearing bolts.
	Clean the backshell and upholstery by wiping with mild soap and warm water. Surface cleaners not harmful to vinyl and ABS plastic are acceptable alternatives.

SECTION 22: HEATING AND AIR CONDITIONING

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1. HEATING AND AIR CONDITIONING

The interior of the vehicle is pressurized by its Heating, Ventilation, Air Conditioning (HVAC) system. Two HVAC systems are available: Small HVAC System and Central HVAC System. If the vehicle is equipped with a Central HVAC System; air flow and controls divide the vehicle in two areas: driver's area and passengers' or cabin area. The interior of the vehicle should always be slightly pressurized to prevent dust and moisture from entering vehicle. Each section has its own fresh air, returning air and discharge air ducting. The exhaust is mainly done through the lavatory ventilator (if equipped) and through normal air-tightness losses.

2. AIR CIRCULATION WITH CENTRAL HVAC SYSTEM

2.1 DRIVER'S AREA

Fresh air is taken from a plenum underneath the front service compartment and enters the mixing box through an ON/OFF damper. Return air is taken through the base of the dashboard panel utility compartments into the mixing box. Mixed air goes through cooling and heating coils, fans and discharge ducts.

Both right and left discharge ducts defrost one half of the windshield. The driver can also divert some air flow to the console, from which he can direct air to his knees and/or upper body with adjustable HVAC air registers and to his feet with the appropriate button (see Fig. 1 and Owner's or Operator's manual).

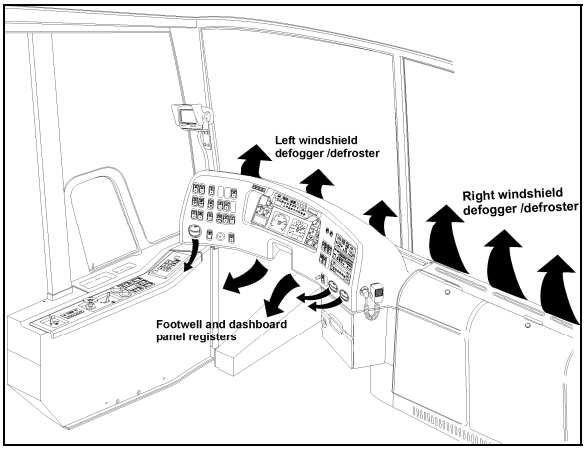


FIGURE 1: DRIVER'S AIR CIRCULATION 22307

X3-45 coaches are also equipped with a windshield upper section de-icing system. Also, one additional air register is located in the driver's area but supplied by the passengers' air ducting system. It is installed in the stepwell for step de-icing.

2.2 CABIN OR PASSENGERS' AREA

Fresh air enters the vehicle on the L.H. side, through the recirculation damper located inside the evaporator compartment door (Fig. 2). The damper can be fully opened for normal operation or closed for extreme weather or highly polluted areas (Refer to the Owner's or Operator's Manual for more details). The recirculation REC button is located on the HVAC control unit. Press down the button to partially close the fresh air damper. Return air is drawn from inside the vehicle through the register duct located on L.H. side of vehicle (Fig. 3).

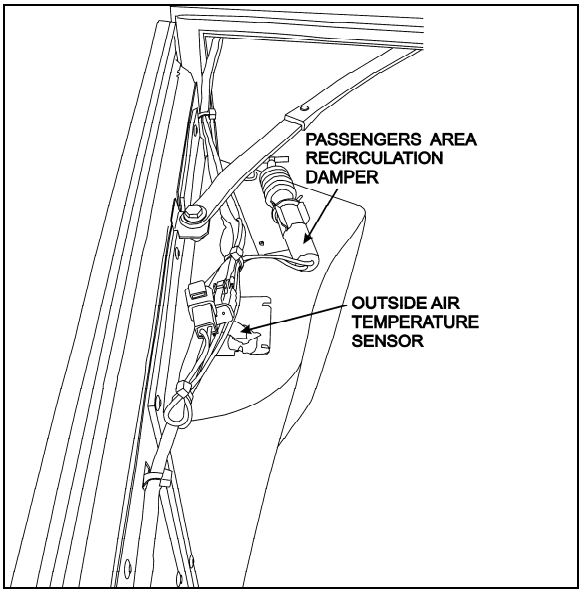


FIGURE 2: PASSENGERS' AREA RECIRCULATION DAMPER 22302

A double blower fan unit, which is activated by the evaporator motor, draws mixed air through an air filter, cooling and heating coils, then forces this air in the ventilation ducts along the walls, and finally exhausts it just below side windows.

X3-45 coaches are also equipped with an overhead compartment ventilation system, a three-position rocker switch  (0FF - 1st speed - 2nd speed) located on R.H. dashboard panel controls the speed of both fans. Return air is drawn just below the middle side windows through an air filter into the overhead compartment fan; discharge air is fed to the rotating registers through the ventilation duct (Fig. 4).

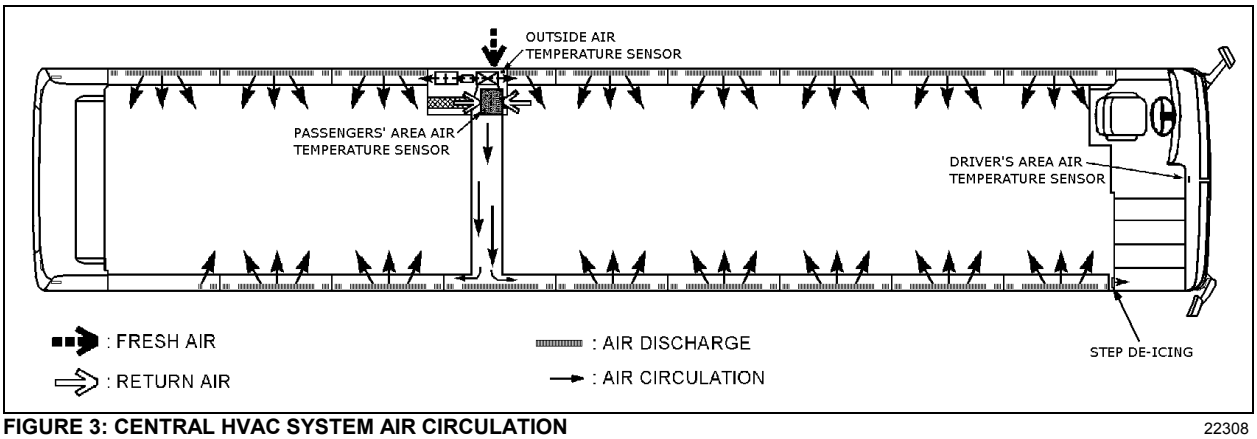


FIGURE 3: CENTRAL HVAC SYSTEM AIR CIRCULATION 22308

The overhead compartment air registers are used to control air flow for the passenger seats. One register per seat direct air flow by pointing or rotating register. Open or close register to adjust air flow.

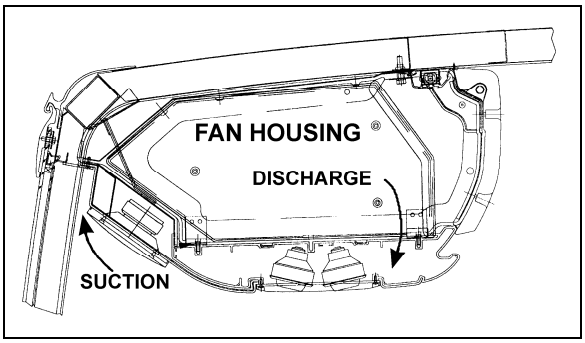


FIGURE 4: PASSENGERS OVERHEAD COMPARTMENT VENTILATION SYSTEM 22211

3. AIR CIRCULATION WITH SMALL HVAC SYSTEM

Fresh air is taken from a plenum behind the front bumper and enters the mixing box through an adjustable damper. Returning air is taken through the right console into the mixing box. The recirculation REC button is located on the HVAC control unit (Fig. 5). Mixed air goes through cooling and heating coils, fans and discharge ducts.

Both right and left discharge ducts defrost/defog one half of the windshield. The driver can divert his air flow to the dashboard, from which he can direct vent to his upper body with adjustable HVAC register and to his feet with the appropriate button (see fig. 1 and Owner's manual).

4. SMALL HVAC SYSTEM OPERATION

Only the temperature in the driver's area is controlled by the HVAC control unit mounted on the R.H. dashboard panel (Fig. 5).

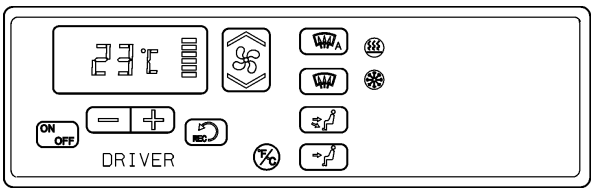


FIGURE 5: SMALL HVAC SYSTEM CONTROL UNIT 22184

Using the Up/Down type switch sets the fan speed and the speed chosen is displayed on the HVAC control unit.

NOTE
The driver's area air temperature sensor is located behind the grill of the R.H. side console.

NOTE
The outside air temperature sensor is located behind the front bumper on the L.H. side.

5. CENTRAL HVAC SYSTEM OPERATION

To operate the air conditioning system when vehicle is stationary, engine should run at fast idle. During operation of the air conditioning system, windows should be kept closed and door not left open longer than necessary. In order to prevent battery discharge, HVAC system will not operate if vehicle charging system is not working properly.

5.1 DRIVER'S SECTION OPERATION

The temperature control in the driver's area is provided directly by the L.H. portion of the HVAC

control unit mounted on the R.H. dashboard panel (Fig. 5).

The driver's HVAC section piping is paralleled with the cabin or passengers HVAC section piping. Both sections use the same refrigerant and coolant, and are linked to the same condenser and compressor, even if they are individually controlled. It requires the passengers HVAC section to engage the A/C compressor magnetic clutch. Consequently, the driver's section cannot be operated in the A/C mode alone.

NOTE
The driver's HVAC section turns on automatically at starting of the engine and uses the settings that were kept in memory before turning off of the system.

The A/C compressor starts automatically when the two following conditions are satisfied:

1. The outside temperature is above 32°F (0°C).
2. The cabin or passenger's area temperature has reached 7°F (4°C) under the set point.

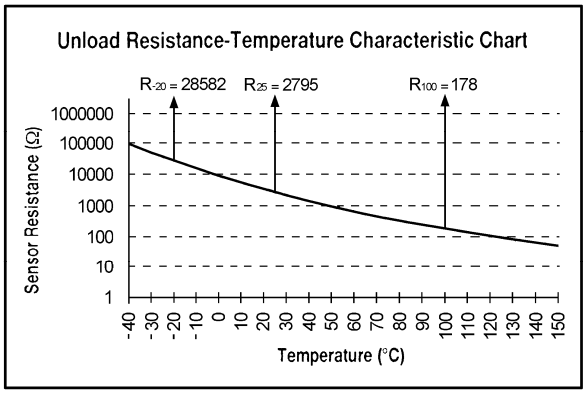
Using the Up/Down type switch  sets the fan speed and the speed chosen is illustrated on the window display.

NOTE
Upon starting, if the outside temperature is above 32*°F (0°C) and then drops below* 32*°F (0°C), the compressor will keep running up to a temperature of 15°F (-9°C) to prevent condensation from forming on the windows.*

NOTE
To perform a test of the driver's section windshield defroster, it is possible to run the system without running the engine.

The following 2% error chart and table can be used to troubleshoot the driver's area air temperature sensor and the outside air temperature sensor.

NOTE
The driver's area air temperature sensor is located behind the grill of the R.H. side console (Refer to fig.13).



Temp °C	Temp °F	Resistance Ohms
-40	-40	100865
-35	-31	72437
-30	-22	52594
-25	-13	38583
-20	-4	28582
-15	5	21371
-10	14	16120
-5	23	12261
0	32	9399
5	41	7263
10	50	5658
15	59	4441
20	68	3511
25	77	2795
30	86	2240
35	95	1806
40	104	1465
45	113	1195
50	122	980
55	131	808
60	140	670
65	149	559
70	158	468
75	167	394
80	176	333
85	185	283
90	194	241
95	203	207
100	212	178
105	221	153
110	230	133
115	239	115
120	248	100
125	257	88
130	266	77
135	275	68
140	284	60
145	293	53
150	302	47

5.2 PASSENGERS' SECTION OPERATION

The R.H. portion of the HVAC control unit enables the selection of the temperature in the cabin or passenger's area (refer to the Owner's or Operator's Manual for details).

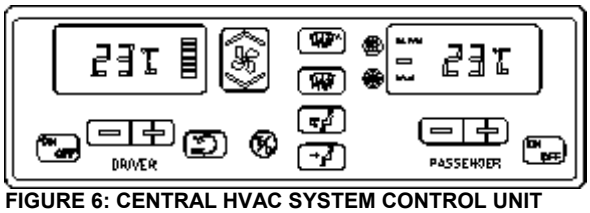


FIGURE 6: CENTRAL HVAC SYSTEM CONTROL UNIT

Temperature control is provided in conjunction with a thermistor sensor inside register duct, located on L.H. side of vehicle (Figs. 3 & 7).

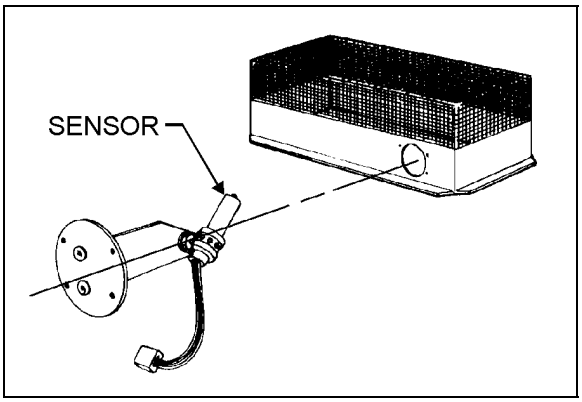


FIGURE 7: THERMISTOR SENSOR

The flow of water to the vehicle's main heater core is controlled by a pneumatic water valve which varies the cycling rate depending on selected temperature. A red LED, located on HVAC control unit, illuminates when heating mode is selected. A green LED illuminates when compressor clutch is in operation.

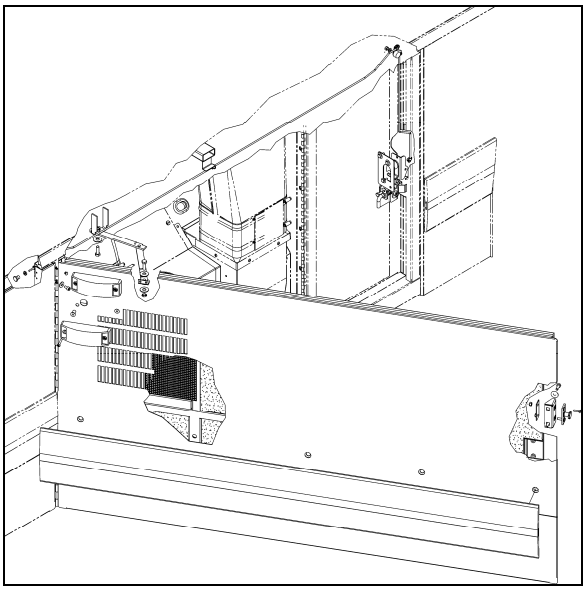


FIGURE 8: EVAPORATOR COMPARTMENT 22301

The evaporator fan motor, located in the evaporator compartment, is protected by a 90 amps, manually-resettable (CB3 or CB4) circuit breaker located on the rear junction panel and is accessible from the engine compartment curb-side door, on R.H. side of the vehicle (refer to Section 06, *"Electrical System"* in this manual for details).

The condenser coil mounted on the opposite side of the evaporator is ventilated by four axial fans. The fan motors are protected by a manually-resettable 70 amp circuit breaker (CB 5 or CB7) mounted on the rear junction panel and accessible from the engine compartment curb-side door.

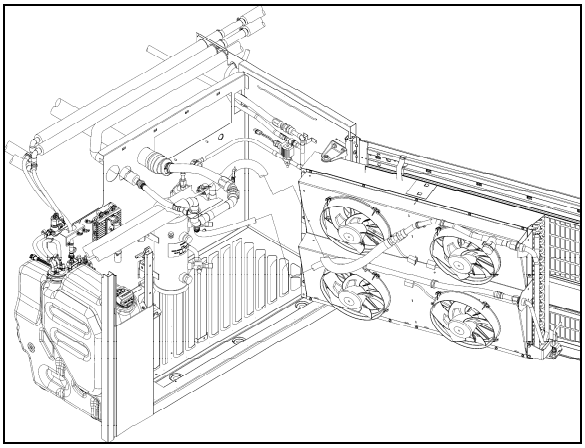


FIGURE 9: CONDENSER COMPARTMENT 22299

Furthermore, the following relays, diodes and multiplex module are located in the evaporator compartment (Fig. 10). They are mounted in the HVAC junction box located inside the evaporator compartment door.

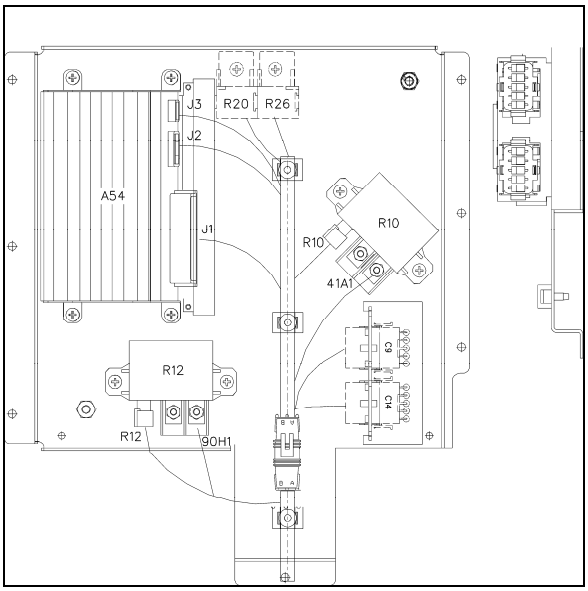


FIGURE 10: A/C JUNCTION BOX

A/C Junction Box			
Multiplex Module			
A54	I/O-B		
Relays			
R10	Condenser Fan Sp. 2		
R12	Evaporator Fan		
R20	Water Pump Relay		
R26	Water Pre-heater Relay		
Diodes			
D9	HVAC	D10	Pre-Heater
D11	Pass. Liq. Sol.	D17	Lugg. 5th Compt
D19	Lugg. 2nd Compt	D20	Lugg. 1st Compt
D25	Evap. Fan	D30	Water Pump
D73	Opt.	D80	Opt.

5.3 OVERHEAD COMPARTMENT A/C

On X3-45 coaches, optional small A/C evaporator coils may be added to both overhead compartments existing air system. These auxiliary A/C system components are separate and completely independent of central system and permit a wider temperature range in the passenger's area. The three-position rocker switch used to control the fans also controls the A/C system.

6. HVAC UNIT MAINTENANCE

No special maintenance is required on the passengers, driver's and auxiliary HVAC units, with the exception of cleaning their respective coils and air filters, plus periodic inspection for broken drains, hoses and charging of system.

NOTE

Squeeze rubber discharge tubes located underneath the appropriate compartment to eliminate the accumulated water and dirt when you make routine maintenance.

6.1 COIL CLEANING

Check the external surface of the coil at regular intervals for dirt or any foreign matter.

For the driver's HVAC unit, remove the grill and the access panels and back flush the coil from inside (Fig. 11).

For the passengers' section evaporator coil, remove the access panel and back flush the coil (Fig. 12 & 13) every 12,500 miles (20 000 km) or once a year, whichever comes first.

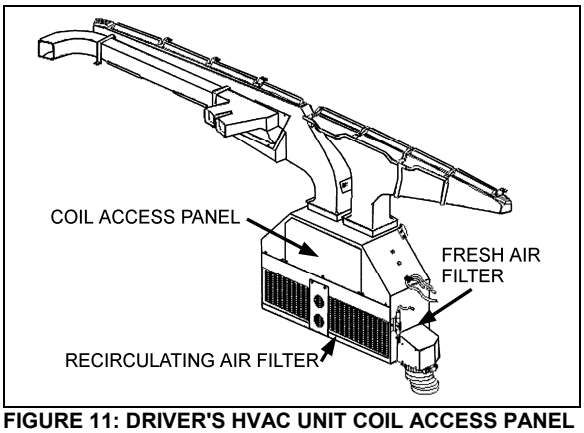


FIGURE 11: DRIVER'S HVAC UNIT COIL ACCESS PANEL

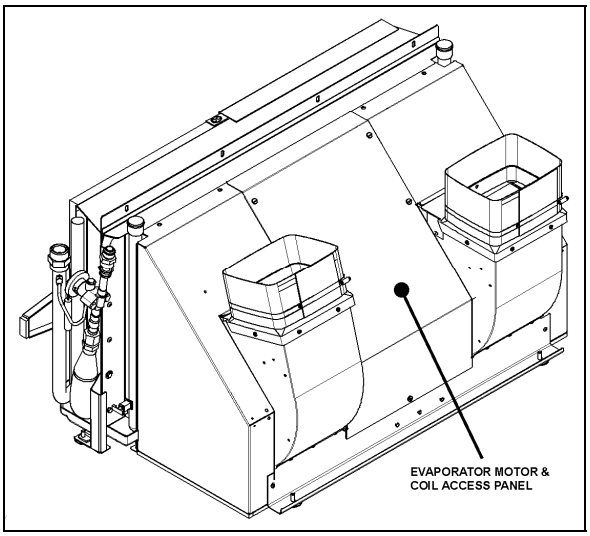


FIGURE 12: EVAPORATOR COIL ACCESS PANEL (TYPICAL) 22309

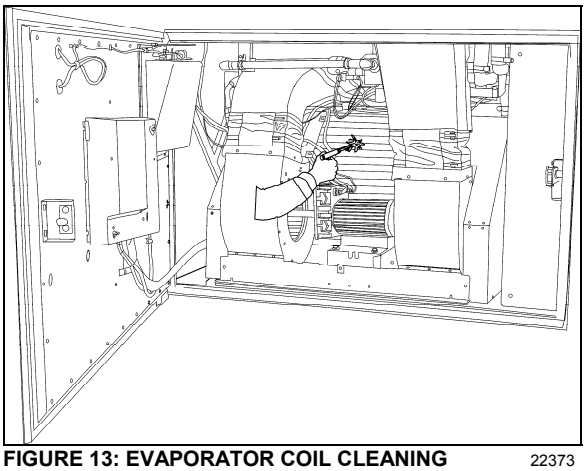


FIGURE 13: EVAPORATOR COIL CLEANING 22373

For the condenser coil, back flush the coil (Fig. 14) every 6,250 miles (10 000 km) or twice a year, whichever comes first.

⚠ CAUTION

Use a water jet or water mixed with low air pressure to clean the coil.

⚠ CAUTION

Direct the pressure straight through the coil to prevent bending of fins and do not use extremely high pressure. Do not use hot water, steam or caustic soap.

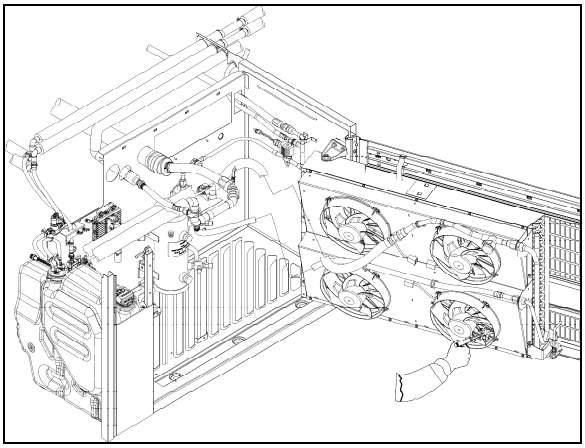


FIGURE 14: CONDENSER COMPARTMENT 22311

6.2 DRIVER'S SECTION AIR FILTERS

The driver HVAC system is located behind the dashboard's R.H. side lateral plastic panel. To gain access to the A/C filters, unscrew the R.H. lateral console's grill located at the top step of the entrance door steps. Slide out the recirculating air and fresh air filters. To clean filters back flush with water, then dry with air, every 12,500 miles (20 000 km) or once a year, which-ever comes first (Fig. 15 & 16).

NOTE

If the windshield is continuously fogged, check that the driver's air filter is not clogged.

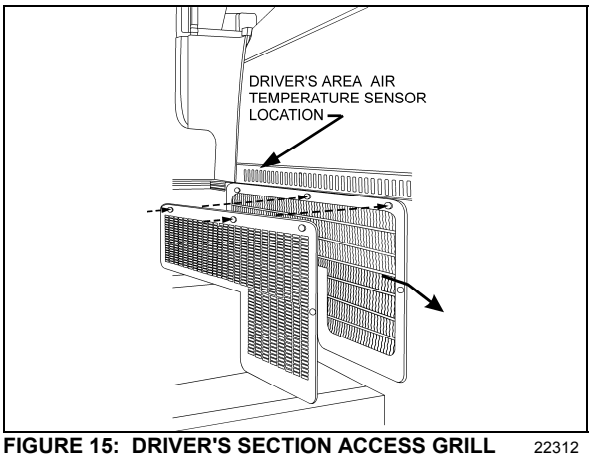


FIGURE 15: DRIVER'S SECTION ACCESS GRILL 22312

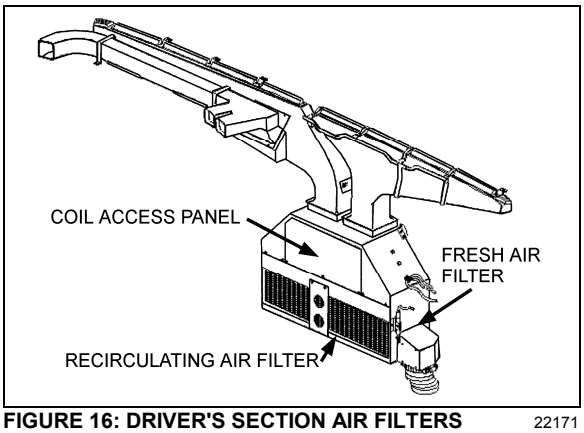


FIGURE 16: DRIVER'S SECTION AIR FILTERS 22171

6.3 PASSENGERS' SECTION AIR FILTER

The cabin or passengers' section air filter is located in the evaporator compartment. To access the filter, open baggage compartment door located forward of the evaporator compartment (L.H. side). Open access panel by turning the three screws of panel ¼ of a turn, unsnap both fasteners on top of filter, and slide out filter (Fig. 17). To clean filter, back flush with water or soapy water, then dry with air every 12,500 miles (20 000 km) or once a year, whichever comes first.

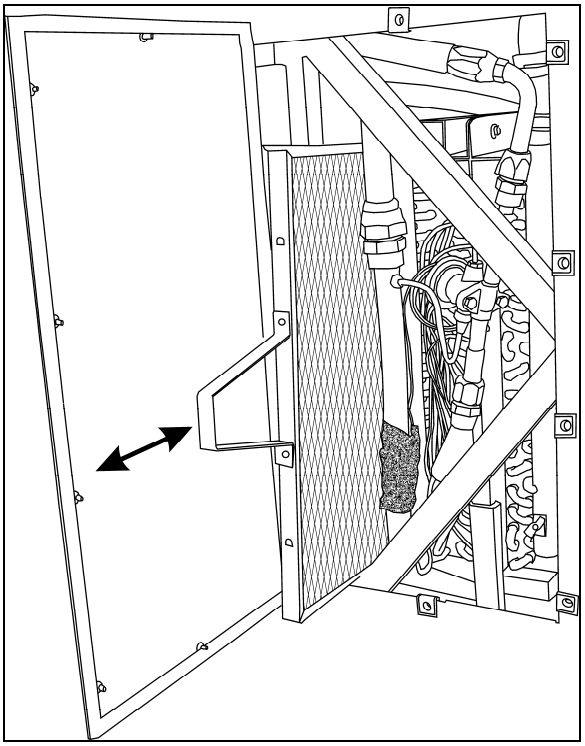


FIGURE 17: PASSENGERS' SECTION AIR FILTER 22306

CAUTION

Do not use high pressure water jet to avoid damaging filter.

CAUTION

Be sure not to reverse filter upon installation.

6.4 OVERHEAD COMPARTMENT FAN AIR FILTER

On X3-45 coaches, A/C evaporator coils may be installed in both overhead compartment air systems, only the air filters are serviceable. The air filters are accessible from inside the overhead compartments. Slide out the filters, then back flush with water, dry with air and replace. This procedure should be done every 12,500 miles (20,000 km) or once a year, whichever come first.

If A/C units were installed, ball valves are added on supply and return lines in the engine compartment. They have service port to evacuate the A/C overhead compartment circuit. When work has to be done on an evaporator coil unit, it will be easier to remove it and repair it on a bench.

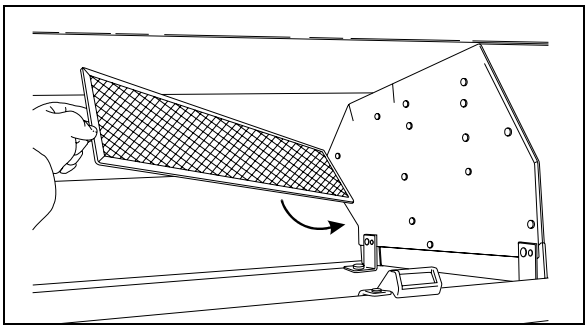


FIGURE 18: OVERHEAD COMPARTMENT FAN AIR FILTER 22201

7. HVAC SYSTEM PARTICULARITIES, TESTING AND TROUBLESHOOTING

Before undertaking any troubleshooting on the HVAC system, study the appropriate wiring diagrams to get a complete understanding of the HVAC components circuitry, read and understand section 06:ELECTRICAL of this manual under "Troubleshooting And Testing The Multiplex Vehicles" and "Test Mode For Switches And Sensors". The information included in these paragraphs is necessary for troubleshooting the HVAC system on Multiplex vehicles.

7.1 HVAC SYSTEM AND TEST MODE FOR SWITCHES AND SENSORS

When in switch/sensor test mode (see Section 06: ELECTRICAL for complete information), the A/C compressor HI and LO pressure values are displayed one after the other instead of the outside temperature in the telltale panel LCD display. This feature can be used when the vehicle is traveling to check the A/C compressor pressure values.

NOTE

When starting the A/C compressor wait 5 seconds before checking pressures in order to give the system a chance to build its pressure. During the first 5 seconds after startup, the compressor is active on 6 cylinders and the A/C valve is open regardless of the pressure readings.

In test mode, with the parking brake applied and the passenger set point set to a value higher than 64°F (18°C), the hot water circulating pump is not set to OFF as it would normally do when the outside temperature gets above 50°F (10°C). This feature allows verification of the pump when inside a garage. This is also useful

when working on the heating system to remove air pockets trapped in the system.

When performing an A/C cooling test and having the water pump shut off in switch/sensor test mode is required, just set the passenger set point temperature to the minimum 64°F (18°C) to shut off the pump.

7.2 HVAC SYSTEM AND TEST MODE FOR ELECTRIC MOTORS

The test mode allows testing the motors and electric contactors without the need to have the engine running (see Section 06: ELECTRICAL under "TEST MODE FOR ELECTRICAL MOTORS" for complete information).

Use this test mode for testing of the condenser motors, the A/C compressor clutch activation, left and right unloaders, evaporator motor, water pump, hot water solenoid valve and overhead compartment air register fan.

7.3 PARTICULARITIES

Conditions for engaging the 2nd speed on the evaporator motor (cooling demand).	The 2nd speed engages if the cabin or passenger's area temperature is 1 degree above the set point and it revert to speed 1 if the temperature gets equal or below the set point.
Conditions for hot water recirculating pump activation (heating demand).	The pump turns to OFF if the outside temperature is above 50°F (10°C), when there is less demand for heating. Note: To test a working pump, it is possible to keep it active even if the outside temperature is above 50°F (10°C). See paragraph 7.2 HVAC SYSTEM AND TEST MODE FOR ELECTRIC MOTORS.
The compressor unloaders are working based on pressure and also on the difference between the passenger's area temperature and the set point.	**2 left compressor cylinders:** Stop if: Cabin or passenger's area temperature is at less than 0.4°C degree above the set point or if the compressor output is above 280 psi, or if the compressor input is below 26 psi. Restart if: Cabin or passenger's area temperature is 0.9°C or more above the set point and the compressor pressure output is less than 220 psi and the compressor pressure input is above 34 psi. **2 right compressor cylinders:** Stop if: Cabin or passenger's area temperature is at less than 0.2°C above the set point or if the compressor input falls below 23 psi. Restart if: Cabin or passenger's area temperature is 0.7°C or more above the set point and the compressor input pressure is above 32 psi.
The A/C deactivation pressure is 320 psi.	In case of high pressure, the analog pressure sensor connected to the Multiplex module deactivates the compressor. There is also a « Pressure switch » adjusted to 350 PSI that acts to stop the compressor in the instance that the Multiplex module fails.

7.4 HVAC SYSTEM TROUBLESHOOTING

Problem/Symptom	Probable Causes	Actions
No temperature control in the cabin or passenger area Passenger temperature display indicates two dashes "--"	Problem with the temperature sensor located in the evaporator compartment air intake or the sensor wiring	Instruct the driver to manually control the temperature by playing with the passenger set point. Set above 22°C (72°F) to heat and below 22° C (72°F) to cool
Defroster fan not functioning	Module A47 is not powered or is faulty	1. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message “Voltage Module A47, Value too Low, Active” confirms a power problem on the module 2. Check / reset circuit breaker CB2 or CB6 3. Check / replace fuse F5 4. Use the air release valves near the entrance door and in the front service compartment to lock / unlock the door
HVAC condenser fans not functioning in speed 1	Circuit breaker CB5 or CB7 was manually tripped and not reset Seized bearing Faulty brushes Bad wiring	Check / reset circuit breaker CB5 or CB7
HVAC condenser fans not functioning in speed 1	Module A54 is not powered or is faulty	1. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message “Voltage Module A54, Value too Low, Active” confirms a power problem on the module 2. Check / reset circuit breaker CB5 or CB7 3. Check / replace fuse F67 , F68
HVAC condenser fans not functioning in speed 2	Circuit breaker CB5 or CB7 was manually tripped and not reset Seized bearing Faulty brushes Bad wiring	Check / reset circuit breaker CB5 or CB7
Defroster fan is functioning but no heat or cooling available in the driver’s area	Module A46 is not powered or is faulty Faulty speed control Bad wiring	1. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message “Voltage Module A46, Value too Low, Active” confirms a power problem on the module. 2. Check / reset circuit breaker CB1 or CB7 3. Check / replace fuse F12

Problem/Symptom	Probable Causes	Actions
The A/C compressor clutch does not engage	Module A52 is not powered or is faulty	1. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message "Voltage Module A52, Value too Low, Active" confirms a power problem on the module 2. Check / reset circuit breaker CB5 or CB7. 3. Check / replace fuse F65
Evaporator fan not functioning	Circuit breaker CB3 or CB4 tripped Module A54 is not powered or is faulty Faulty brushes	1. Check / reset circuit breaker CB3 or CB4 2. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message "Voltage Module A54, Value too Low, Active" confirms a power problem on the module 3. Check / reset circuit breaker CB4 or CB5 4. Check / replace fuse F67 , F68

8. CENTRAL AIR CONDITIONING SYSTEM

The schematic of Figure 19 shows the central and auxiliary A/C systems and their components. The central system is equipped with a 6 cylinder, 05G Twin Port Carrier compressor with an air conditioning capacity of 7½ tons. The receiver tank and filter dryer are mounted inside the condenser compartment.

As an option, X3-45 Coaches may be supplied with an auxiliary A/C system (Fig. 19). Auxiliary A/C system comes with a 6 cylinder, ICE TM-16HD compressor with an air conditioning capacity of 2 tons.

X3-45 VIP and XLII Bus Shells may be supplied with a central or small A/C system (Fig. 19 and 43). For vehicles equipped with a small A/C system, refer to paragraph 10: SMALL OR AUXILIARY AIR CONDITIONING SYSTEM AND COMPONENTS further in this section.

8.1 A/C CYCLE

Refrigeration may be defined as "the transfer of heat from a place where it is not wanted to a place where it is unobjectionable". Components required for a closed circuit refrigeration system are shown in Figure 19.

The air conditioning system used on X series vehicles is of the *"Closed"* type using *"R-134a".*

1. The refrigerant flowing to the compressor is compressed to high pressure and reaches a temperature higher than the surrounding air. It is passed through the air-cooled fins and tubes of the condenser causing the hot, high pressure gas to be condensed into a liquid form.
2. The liquid refrigerant flows to the receiver tank, then passes through a filter dryer where moisture, acids and dirt are removed and then through a moisture indicator which indicates if any moisture is present in the system.
3. By its own pressure, the liquid refrigerant flows through a thermal expansion valve where the pressure drop causes the refrigerant to vaporize in a vapor-liquid state at a low temperature pressure.
4. The cold low pressure refrigerant passes through the passengers and the driver's evaporator coils which absorbs heat from the air passing over the fins and tubes, and changes into gas. In this form, the refrigerant is drawn into the compressor to repeat the air conditioning cycle.
5. The success of the air conditioning system depends on retaining the conditioned air within the vehicle. All windows and intake vents should be closed. An opening of

approximately 8 in^2 (5162 mm^2) could easily neutralize the total capacity of the system.

6. Other causes of inadequate cooling are dirty coils or filter. Dirt acts as insulation and is also serves as a restriction to the air flow.
7. The refrigeration load is not constant and varies. It is also affected by outside temperature, relative humidity, passenger load, compressor speed, the number of stops, etc.
8. The compressor will load or unload depending on operating conditions.

8.2 REFRIGERANT

The A/C system of this vehicle has been designed to use Refrigerant 134a as a medium. Regardless of the brand, only R-134a must be used in this system. The chemical name for this refrigerant is Ethane, 1, 1, 1, 2-Tetrafluoro.

DANGER

Refrigerant in itself is nonflammable, but if it comes in contact with an open flame, it will decompose.

8.2.1 Procurement

Refrigerant is shipped and stored in 30 and 100 pound (13,6 and 45 kg) metal cylinders. Approximately 24 pounds (10,9 kg) are used in the central system. If vehicle is equipped with an auxiliary A/C system, then approximately 5.5 lbs (2,5 kg) will be needed.

It will be impossible to draw the entire refrigerant out of the cylinder. However, the use of warm water when charging the system will assure the extraction of a maximum amount of refrigerant from the cylinder.

8.2.2 Precautions in Handling Refrigerant

1. Do not leave refrigerant cylinder uncapped.
2. Do not subject cylinder to high temperatures, do not weld or steam clean near system or cylinder.
3. Do not fill cylinder completely.
4. Do not discharge vapor into an area where a flame is exposed.
5. Do not expose the eyes to liquid refrigerant.

All refrigerant cylinders are shipped with a heavy metal screw cap. The purpose of the cap is to protect the valve and safety plug from damage. It is a good practice to replace the cap after each use of the cylinder for the same reason. If the cylinder is exposed to the sun's radiant heat pressure increase resulting may cause release of the safety plug or the cylinder may burst.

For the same reason, the refrigerant cylinder should never be subjected to excessive temperature when charging a system. The refrigerant cylinder should be heated for charging purposes by placing it in 125°F (52°C) water. Never heat above 125°F (52°C) or use a blowtorch, radiator, or stove to heat the cylinder. Welding or steam cleaning on or near any refrigerant line or components of the A/C system could build up dangerous and damaging pressures in the system.

If a small cylinder is ever filled from a large one, never fill the cylinder completely. Space should always be allowed above the liquid for expansion. Weighing cylinders before and during the transfer will determine the fullness of the cylinders.

WARNING

One of the most important precautions when handling refrigerant consists in protecting the eyes. Any liquid refrigerant which may accidentally escape is approximately -40°F (-40°C). If refrigerant comes in contact with the eyes, serious injury could result. Always wear goggles to protect the eyes when opening refrigerant connections.

8.2.3 Treatment in Case of Injury

If liquid refrigerant comes in contact with the skin, treat the injury as if the skin was frost-bitten or frozen. If liquid refrigerant comes in contact with the eyes, consult an eye specialist or doctor immediately. Give the following first aid treatment:

1. Do not rub the eyes. Splash eyes with cold water to gradually bring the temperature above the freezing point.
2. Apply drops of sterile mineral oil (obtainable at any drugstore) in the eyes to reduce the possibility of infection. The mineral oil will also help in absorbing the refrigerant.

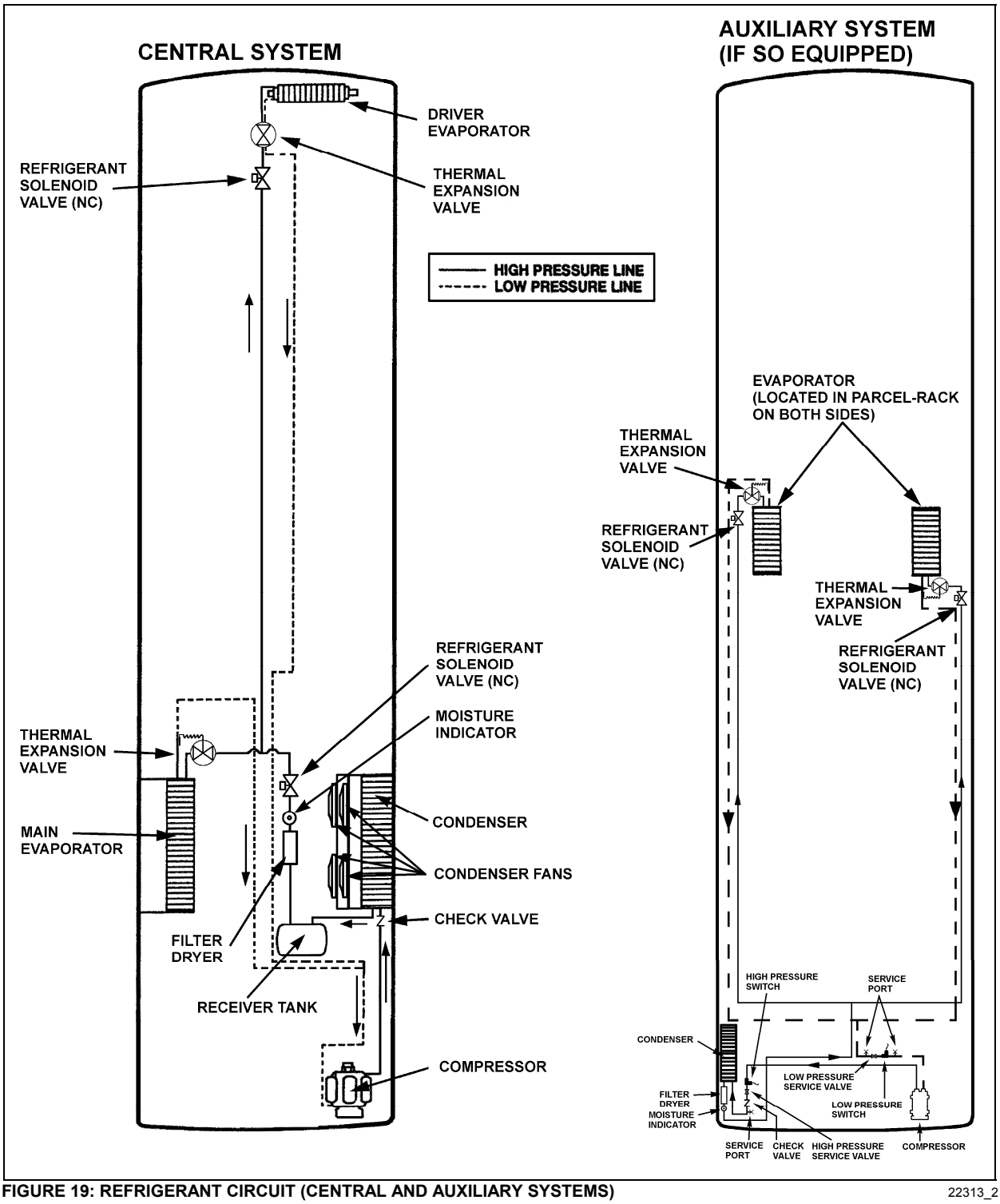


FIGURE 19: REFRIGERANT CIRCUIT (CENTRAL AND AUXILIARY SYSTEMS) 22313_2

8.2.4 Precautions in Handling Refrigerant Lines

1. All metal tubing lines should be free of kinks, because of the resulting restrictions on the flow of refrigerant. A single kink can greatly reduced the refrigeration capacity of the entire system.
2. The flexible hose lines should never be allowed to come within a distance of 2-½" (6,3 cm) from the exhaust manifold.
3. Use only sealed lines from parts stock.
4. When disconnecting any fitting in the refrigeration system, the system must first be discharged of all refrigerant. However, proceed very cautiously, regardless of gauge readings. If liquid refrigerant happens to be in the line, disconnect fittings very slowly, keeping face and hands away so that no injury can occur. If pressure is noticed when fitting is loosened, allow it to bleed off very slowly.

WARNING

Always wear safety goggles when opening refrigerant lines.

5. In the event that any line is opened to the atmosphere, it should be immediately capped to prevent entrance of moisture and dirt.
6. The use of the proper wrenches when making connections on O-ring fittings is important. The use of improper wrenches may damage the connection. The opposing fitting should always be backed up with a wrench to prevent distortion of connection lines or components. When connecting the flexible hose connections, it is important that the swaged fitting and the flare nut, as well as the coupling to which it is attached, be held at the same time using three different wrenches to prevent turning the fitting and damaging the ground seat.
7. The O-rings and seats must be in perfect condition. The slightest burr or piece of dirt may cause a leak.
8. O-rings should be coated with refrigeration oil and installed on the line before the line is inserted into the fitting to prevent damaging the O-ring. If leaks are encountered at the couplings or connectors, no attempt should be made to correct the leaks by tightening the connections beyond the recommended torque. The O-rings are designed to seal at the specified torque and overtightening the connection does not result in a satisfactory and permanently sealed connection. The connection must be disassembled and the cause of the leak (damaged O-ring, defective lines, etc.) corrected. Use new O-ring.

8.2.5 Auxiliary System Refrigerant Lines

1. From the inside of the coach, remove the mirror located inside the lavatory to access the Y connector separating the system two sides. Also a small access panel located in front of the lavatory entrance door, near the ceiling enables to reach the R.H. side supply and return line fittings.
2. The L.H. side supply and return line fittings are accessible by removing the rearmost overhead storage compartment separator.

8.3 PUMPING DOWN

This procedure is intended to reduce refrigerant loss, on the central system only, by isolating it in the compressor and the receiver tank, as well as in their connecting line, in order to carry out repairs on other sections of the air conditioning system (lines and components).

NOTE

Before attempting any repair between compressor and receiver tank, use a recovery unit to remove refrigerant from the system.

NOTE

On vehicles equipped with an auxiliary A/C system, refer to "ICE TM-16HD Service Manual".

WARNING

To prevent any injury, when air conditioning system must be opened, refer to previous paragraph "PRECAUTIONS IN HANDLING REFRIGERANT".

⚠ CAUTION

The filter dryer must be changed each time a line in the system is opened.

Procedure

1. Energize cabin or passengers 'section liquid solenoid valve.
2. Run the system for 10 minutes, shut it OFF, then close the receiver tank outlet valve by turning it clockwise, backseat the suction service valve on the compressor, install an appropriate pressure gauge set, and turn the valve forward ¼ turn to enable a visual check of the suction pressure.
3. Disconnect the *"Low Pressure Switch"* connector (mounted near the A/C compressor, and install a jumper wire.

NOTE

This jumper wire will allow the clutch to remain engaged after pressure drops below 15 psi (103,5 kPa).

4. Start the engine, press the *"Passenger ON/OFF"* switch then adjust (lower) temperature control ⊖⊕ to maximum A/C.
5. Run the compressor until pressure reaches 1-2 psi (7-14 kPa).

NOTE

During this operation, care must be taken not to fill the receiver tank over the upper sight glass. If so, stop process immediately. Always allow refrigerant piping and units to warm up to the ambient air temperature before opening system or sweating will take place inside the lines.

6. Stop engine, and close compressor outlet valve by turning it clockwise until valve is properly seated.
7. Close compressor suction valve by turning it clockwise until it is properly seated.
8. Wait until pressure gauge reaches 1 to 2 psi (7 to 14 kPa). To accelerate procedure, lightly open compressor suction valve until pressure reaches this value.

8.4 ADDING REFRIGERANT (VAPOR STATE)

Use the suction service valve on the compressor to add a small quantity of refrigerant to the system. Backseat the valve and connect a charging line from the refrigerant cylinder to the valve. Tighten connection at level of refrigerant cylinder and open tank end slightly to purge air from the charging line. Tighten the charging line at the compressor. Screw in the stem of suction valve approximately two turns. Start the engine and run at fast idle. Add sufficient refrigerant to bring the level in lower sight glass of receiver tank to mid-point. Always charge the system with the cylinder upright and the valve on top to avoid drawing liquid out of the cylinder.

8.5 EVACUATING SYSTEM

1. Open both receiver valves by turning "out" (normal position).
2. Remove the caps from the two 90° adapters on the suction, discharge valves and connect two hoses to the vacuum.
3. Place the two compressor valves, suction and discharge, in neutral position by turning each one 3 to 4 turns "in" from the "out" position.
4. Open the solenoid valve by energizing or manually bypass.
5. Start the vacuum pump. Open the large (suction) shutoff valve and close the small vacuum gauge valve.
6. The pressure will drop to approximately 29 inches vacuum (14.2 psi or 97,9 kPa) (the dial gauge only gives a general idea of the absolute system pressure.
7. Backseat the compressor valves by turning "out" all the way.
8. Shut down the vacuum pump.
9. Remove the hoses.
10. Reinstall the caps at the suction valve take-off points.

8.5.1 Double Sweep Evacuation Procedure

1. Remove any remaining refrigerant from the system using a refrigerant recovery machine.
2. Connect the evacuation manifold, vacuum pump, hoses and micron gauge to the unit.
3. With the unit service valves closed (back seated) and the vacuum pump and the thermistor valves open, start the pump and draw the manifold and hoses into a very deep vacuum. Shut the vacuum pump off and see if the vacuum holds. This is to check the setup for leaks.
4. Midseat the system service valves.
5. Open the vacuum pump and the thermistor valves. Start the pump and evacuate to a system pressure of 2000 microns.
6. Close the vacuum pump and the thermistor valves, turn off the vacuum pump (closing the thermistor valve protect the valve from damage).
7. Break the vacuum with clean refrigerant (or dry nitrogen) and raise the pressure to approximately 2 PSIG. Monitor the pressure with the compound gauge.
8. Remove the refrigerant with the recovery machine.
9. Repeat steps #5 – 8 one time.

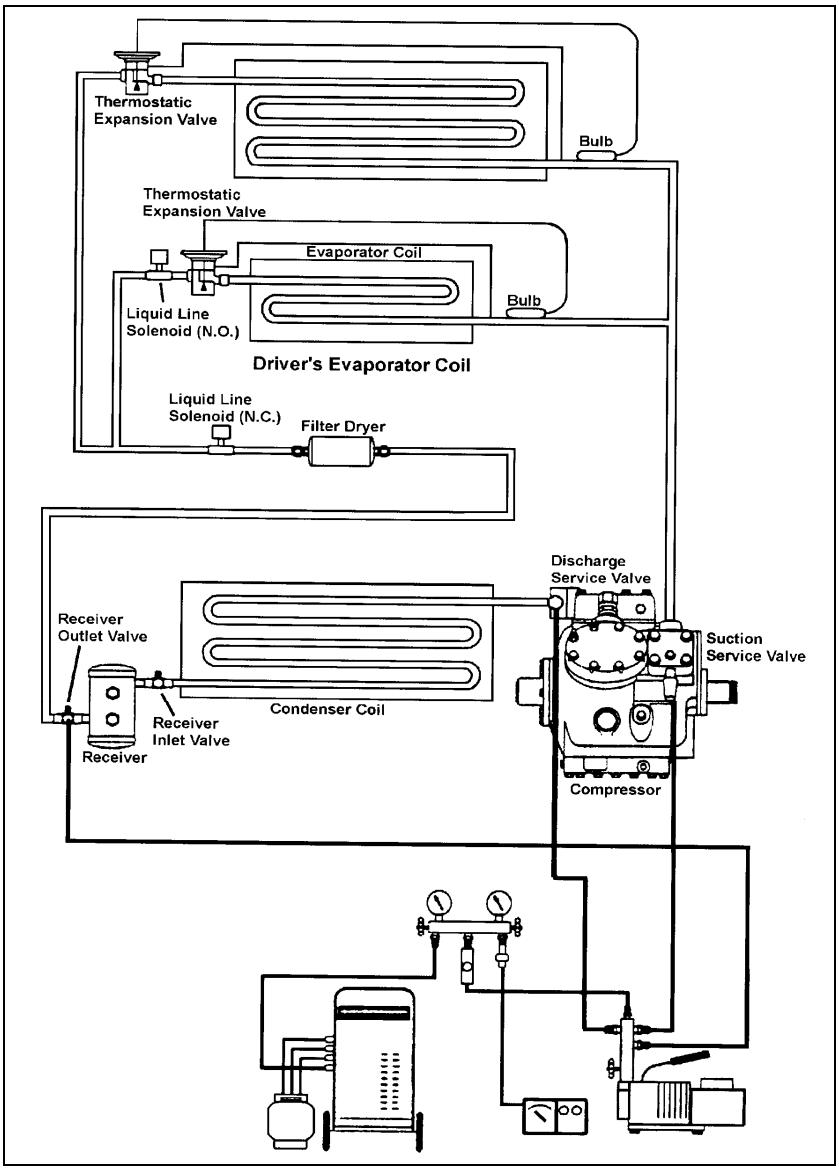


FIGURE 20: DOUBLE SWEEP EVACUATION SET-UP 22298

10. After the second “sweep”, change the filter drier (if you have not yet done so) and evacuate to 500 microns.
11. Evacuating the system below 500 microns on systems using the Carrier 05G compressor may risk drawing air into the system past the carbon shaft seal.
12. Check to insure that vacuum holds. (If the pressure continues to rise, it indicates a leak or moisture in the system).
13. Charge the system with the proper amount of refrigerant using recommended charging procedures.

NOTE
This method will aid in preventing unnecessary system failures by ensuring that the refrigeration system is free of contaminants.

8.6 CHARGING SYSTEM

When a system has been opened or if there are any questions about the air or moisture in the system, evacuate the system. Charging of an evacuated system may be accomplished by forcing liquid R-134a directly into the receiver tank. This may be accomplished by placing the refrigerant cylinder upside down on a scale with the valves at the bottom. This ensures that only liquid will enter the receiver tank.

When charging an empty system, weigh the amount of refrigerant put into the system. This will eliminate any possibility of overfilling. A nominal charge requires 24 pounds (10,9 kg). If the vehicle is equipped with an auxiliary system, a full charge requires 5.6 lbs (2,6 kg).

1. Backseat the two compressor shutoff valves ("out").
2. Install the test gauges at the shutoff valves noting that the 400 psi (2758 kPa) gauge is connected to the discharge.
3. Turn in the two shutoff valves 3 to 4 turns.
4. Open the lower receiver valve by turning “out” all the way.
5. Backseat the upper receiver valve by turning out all the way.
6. Remove the cover cap from the service fitting in the top receiver valve.
7. Attach a charging hose to the R-134a tank. Open the tank valve slightly permitting R-134a to escape thus purging the hose of air.
8. Connect the charging hose to the service fitting.
9. Open the R-134a tank valve.
10. To build up pressure in the receiver tank, heat the receiver tank with a heating blanket.
11. Turn in the upper receiver valve several turns. The R-134a will now enter the system.
12. The proper charge of R-134a is 24 lbs (10.89 kg). When the scale indicates this amount of charge, backseat the receiver valve and close the R-134a tank valve.
13. Disconnect the charging hose. Replace the cover caps.
14. The system is now ready for operation.

⚠ **CAUTION**
The evacuation of the system must be made by authorized and qualified personnel only. Refer to local laws for R-134a recuperation.

8.7 REFRIGERANT SYSTEM CLEAN-OUT AFTER COMPRESSOR FAILURE

Although the vast majority of reciprocating refrigerant compressors manufactured today are extremely reliable, a small percentage do fail. These failures usually result in minor or extensive system contamination depending on the severity of the failure. When an open type compressor becomes damaged internally, this provokes small particles of bearings, steel, brass, copper, and aluminum and, in severe cases, carbonized oil, which could contaminate the system. To prevent repeated failures, the problem which caused the failure should be corrected, and depending upon the severity of the failure, the system should be thoroughly cleaned out using one of the clean-out procedures mentioned.

8.7.1 Determining Severity of Failure

The severity of compressor failure can be categorized as minor or major. A failure is considered minor when the contamination is limited to the compressor with little or no system contamination. A major failure, or burnout, results in extensive system contamination as well as compressor damage. Extensive system contamination can be determined by withdrawing a small sample of compressor oil and checking its color, odor and acidity. A Virginia Chemical "TKO" one step acid test kit is one of several compressor oil test kits that may be used. A high acid content would indicate a major failure or burnout. A small amount of refrigerant gas may be discharged. A characteristic burned odor would also indicate severe system contamination.

8.7.2 Clean-out after Minor Compressor Failure

1. Be sure to correct the problem which caused the failure.
2. Change liquid line filter dryer.
3. Run the unit for 2 hours on high speed cool only.
4. Check compressor oil level to ensure compressor is not overcharged with oil. Sometimes a significant amount of oil is pumped out of the compressor to other parts of the system when a compressor fails. This oil will return to the replacement compressor when it is started, causing an overcharge of oil in the sump of the replacement compressor. In this case, it is important that the oil level be adjusted to the proper level.
5. Withdraw a sample of the compressor oil and check its color, odor, and acidity, using instructions supplied above. If the oil is contaminated, change the oil and filter dryer, and repeat the procedure until the system is clean.

8.7.3 Clean-out After Major Compressor Failure

1. Reclaim the refrigerant into a refrigerant bottle through a filter dryer to filter out contaminants.
2. Remove the failed compressor and repair it if possible.
3. Install new or repaired compressor.
4. Change the filter dryer.
5. Circulate clean R-134a or nitrogen using a pressurized metal cylinder or a reclaiming machine to clean out many of the contaminants collected in the coil valves, TXV (Thermal Expansion Valve), solenoid valves, check valves, and any other mechanical component that may have collected contaminants.
6. Evacuate and charge the system normally.
7. Run the unit for 8 hours and monitor the pressure drop across the filter dryer. Also check the liquid line dryer for signs of restriction. If the pressure drop across the filter dryer exceeds 12 to 14 psig (82,75 to 96,5 kPa) with a 40°F (5°C) evaporator coil temperature, stop the unit and change the liquid line and suction line filter dryer. After 4 or 5 hours of operation, stop the unit and replace the filter dryer.
8. After 8 hours of operation, stop the unit and remove a sample of the compressor oil and check its color, odor, and acidity, using instructions supplied above. If the oil is contaminated, replace the oil and repeat step 7. If the oil is not contaminated, change the filter dryer again and replace the moisture-liquid indicator.
9. After approximately 7 days of operation, recheck the compressor oil for cleanliness and acidity.

9. CENTRAL A/C SYSTEM COMPONENTS

9.1 COMPRESSOR (CENTRAL SYSTEM)

9.1.1 Belt Replacement

DANGER

Set the battery master switch to the “Off” position. For greater safety, set the engine starter selector switch in engine compartment to the “Off” position.

1. Open engine compartment rear doors and locate the belt tensioner pressure releasing valve (Fig. 21), mounted above the engine R.H. side door next to the air pressure regulator, then turn handle clockwise in

order to release pressure and tension on belts.

2. Remove the radiator fan driving mechanism belt (Refer to Section 05: Cooling).
3. Slip the old A/C compressor belts off and the new ones on.
4. Reset belt tensioner pressure releasing valve (Fig. 21) to 45 psi (310 kPa) to apply tension on the new belts as explained in Section 12.

NOTE
Both belts must always be replaced simultaneously to ensure an equal distribution of load on each of them.

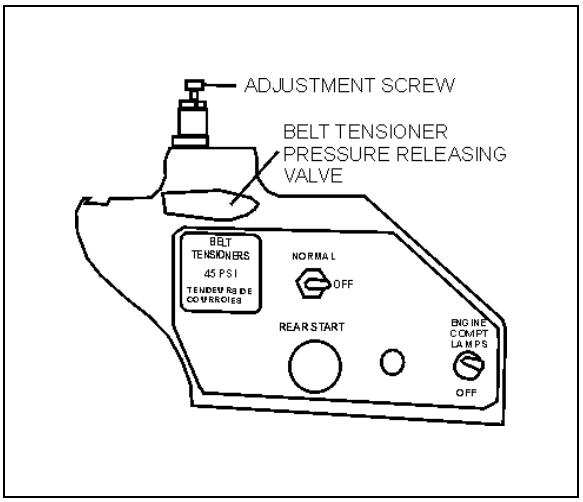


FIGURE 21: AIR PRESSURE REGULATOR

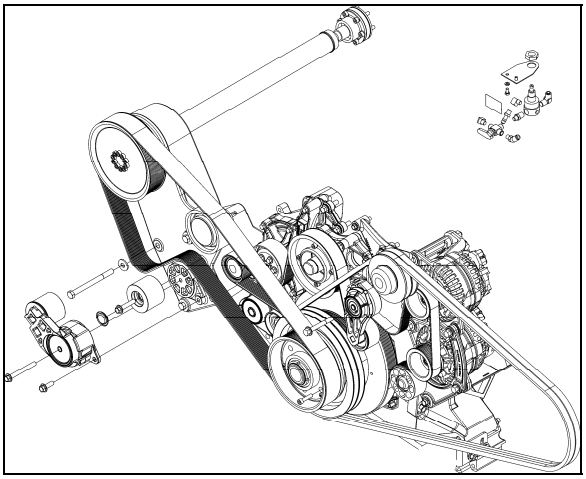


FIGURE 22: BELTS ARRANGEMENT

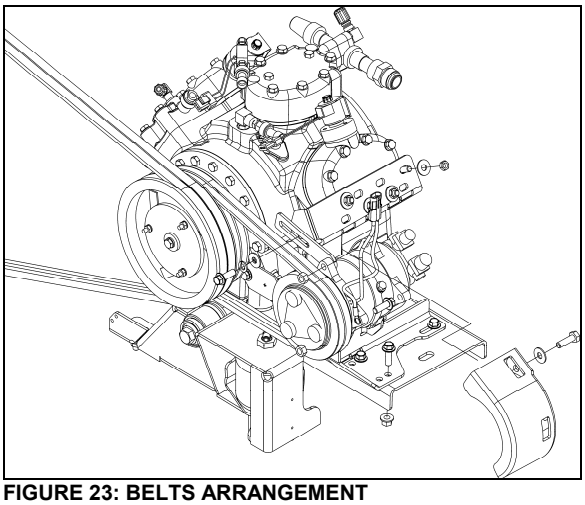


FIGURE 23: BELTS ARRANGEMENT

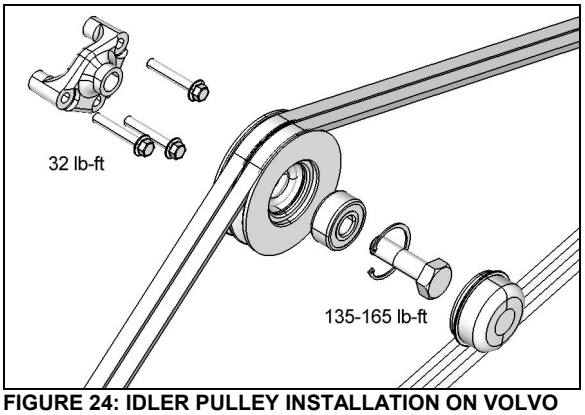


FIGURE 24: IDLER PULLEY INSTALLATION ON VOLVO D13 ENGINE

9.1.2 Belt Tension Adjustment

Belt tensioning is applied through air bellows which are adjusted by an air pressure regulating valve. The correct pressure of 45 psi (310 kPa) is set at the factory. Periodically verify the pressure at the regulating valve using a pressure gauge and correct if necessary.

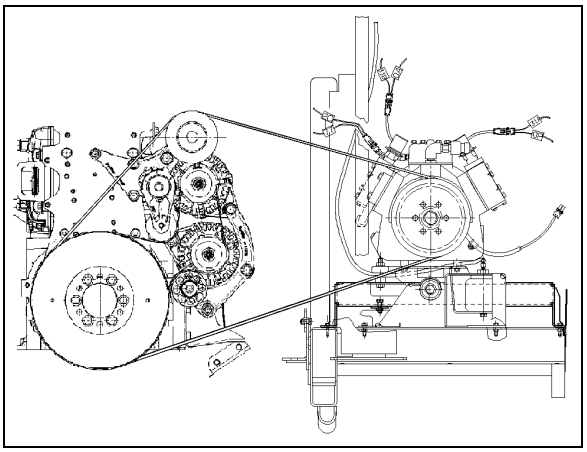


FIGURE 25: A/C COMPRESSOR BELT ADJUSTMENT 22288

9.1.3 Pulley Alignment

In order to avoid skipping, disengagement and a premature wear of compressor belt, it is necessary to align compressor pulley with the crankshaft pulley. Before performing the following procedure, release air from belt tensioner bellows by means of the air pressure releasing valve. After completing these procedures reset belt tensioner air pressure regulator to 45 psi (310 kPa).

9.1.4 Longitudinal Compressor Alignment

1. Rest an extremity of a straight edge of approximately 46 inches (117 cm) against the upper part of the outer face of crankshaft pulley, positioning the other end close to the compressor clutch pulley (Figs. 26 & 27).
2. Check the distance between each extremity of straight edge (1. Fig. 26) and the first drive belt. If they are different, loosen the compressor support bolts and with a hammer, knock support to slide it in order to obtain the same distance; then tighten bolts.

9.1.5 Horizontal Compressor Alignment

1. Rest an extremity of the straight edge against the upper part of the outer face of compressor pulley, positioning the other end close to the crankshaft pulley.
2. Check the distance between each extremity of straight edge (1, Fig. 27) and drive belt. If they are different, loosen the pillow block compressor bolts and with a hammer, knock compressor pillow block to slide it, in order to obtain the same distance; then tighten bolts.

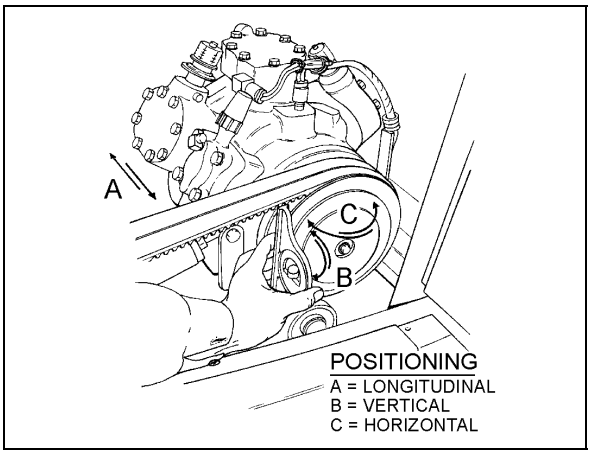


FIGURE 26: COMPRESSOR ALIGNMENT 22072

9.1.6 Vertical Compressor Alignment

Rest a short "angle and level indicator" on the outer side face of the crankshaft pulley, adjust the level indicator inclination at 0^{o} and check if the compressor pulley is at same angle (Fig. 26). If it is not the same, shim under the appropriate pillow block in order to obtain the correct angle.

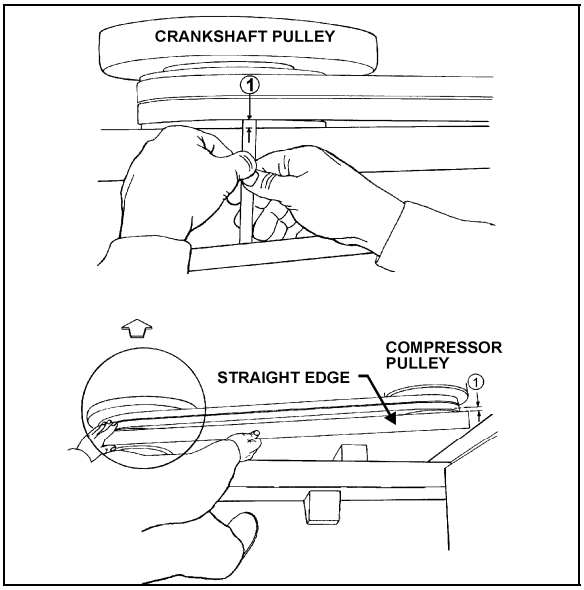


FIGURE 27: COMPRESSOR ALIGNMENT 22040

9.1.7 Compressor Maintenance

For the maintenance of the A/C compressor, see the *Carrier Compressor "WORKSHOP MANUAL* for MODEL 05G TWIN PORT COMPRESSOR" included at the end of this section.

⚠ CAUTION

Use only Castrol SW 68 (POE) oils with refrigerant 134a.

9.1.8 Troubleshooting Guide

A preliminary check may be made by simply feeling the cylinder heads with the unit in operation at ambient temperatures of $35^{o}F$ ($2^{o}C$) and over. The cylinder heads are internally divided into suction and discharge valves. The lower half of the cylinder head is the suction side, and it should be relatively cool to the touch, as opposed to the hot upper discharge side. If a valve plate or head gasket is blown, or a compressor unloader is stuck open, partially

compressed refrigerant vapor will be circulated between the suction and discharge sides of the head. The affected cylinder head will then have a relatively even temperature across its surface and be neither as hot as the normal discharge temperature nor as cool as the normal suction temperature.

Blown Head Gaskets

Symptom:

* Loss of unit capacity at low temperature.
* Even cylinder head temperature.

Cause:

* Improperly torqued cylinder head bolts.
* Improperly positioned gasket at assembly.
* Warped cylinder head.
* Severe liquid refrigerant floodback.

Blown Valve Plate Gaskets

Symptom:

* Loss of unit capacity at medium and low temperatures.
* Very hot cylinder head surface.
* Higher than normal suction pressure.

Cause:

* Improperly torqued cylinder head bolts.
* Severe liquid refrigerant floodback.
* Oil slugging caused by an overcharge of oil or flood starts.
* Discharge valves not seated properly (liquid drainback during shutdown).

Broken Suction Valves

Symptom:

* Loss of unit capacity at all temperatures.
* Compressor unable to pull extremely low vacuum with suction service valve frontseated.

Cause:

* Repeated liquid refrigerant floodback.
* Flooded starts.
* Overcharge of oil.
* Discharge valves not seated properly (liquid drainback during shutdown).
* Expansion valve not controlling properly.

Unloader Valve Stuck Open

Symptom:

* Loss of unit capacity at all temperatures.
* Higher than normal suction pressure.
* Even cylinder head temperature.

Cause:

* Unloader body stem bent.
* Foreign material binding unloader piston or plunger.

9.2 MAGNETIC CLUTCH

Refer to Carrier service information entitled "Housing-Mounted Electric Clutch" at the end of this section for the description and maintenance of the magnetic clutch.

9.3 EVAPORATOR MOTOR

The evaporator motor is installed in the evaporator compartment (L.H. side of vehicle) (Fig. 28). It is a 27.5 volt, 2 HP (1.5 kW) motor which activates a double blower fan unit.

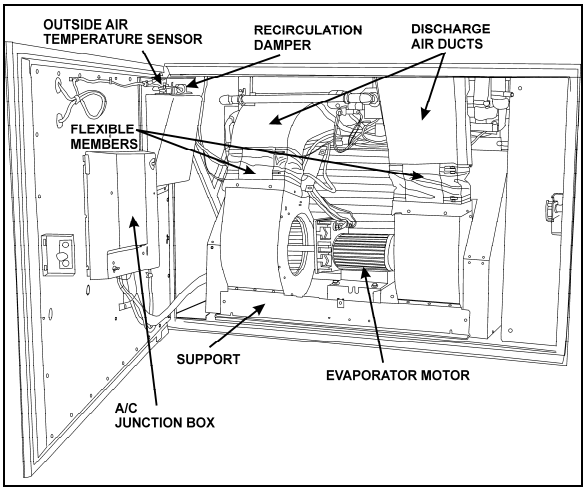


FIGURE 28: EVAPORATOR COMPARTMENT 22372

9.3.1 Removal

- Set the battery master switch (master cut-out) to the *"OFF"* position and trip circuit breakers CB3 or CB4.

- Open the last L.H. side baggage compartment door. Pull the black release button located on the L.H. side in order to unlock and open the evaporator compartment door.
- Remove the evaporator motor and coil access panel.
- Identify the L.H. side discharge duct inside compartment and remove the Phillips head screws retaining the flexible member to duct.
- Repeat step 4 for the R.H. side air duct.
- Disconnect the electrical motor speed control connections on the motor plate.
- From under the vehicle, remove the eight bolts retaining the evaporator fan motor support. Remove the complete unit from the evaporator compartment (Fig. 29 & 30).

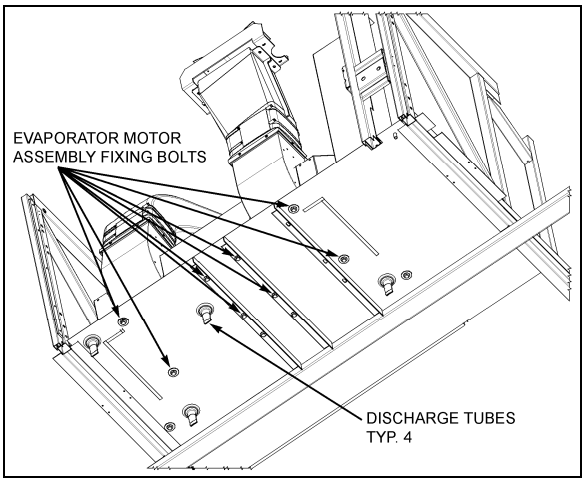


FIGURE 29: EVAPORATOR MOTOR ASSY FIXING BOLTS
22315

CAUTION

Never support evaporator motor by its output shafts while moving it.

- On a work bench, unscrew the fan square head set screws, the Phillips head screws retaining cages to support and slide out the assemblies from the evaporator motor output shaft.

9.3.2 Installation

To reinstall the evaporator motor, reverse "Evaporator Motor Removal" procedure.

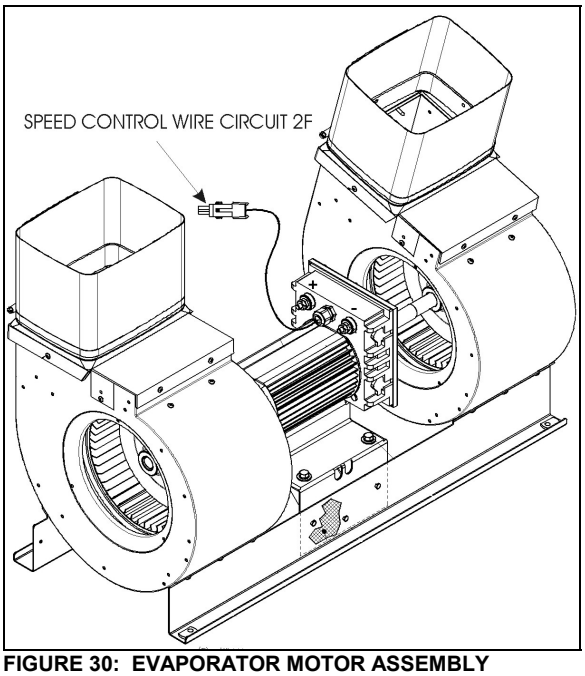


FIGURE 30: EVAPORATOR MOTOR ASSEMBLY

9.4 CONDENSER

The central A/C system condenser coil is hinge mounted on the R.H. side of the vehicle on the A/C condenser door (Fig. 32). The condenser coil for vehicles equipped with an auxiliary A/C system is mounted on the outer face of engine radiator. Since condenser's purpose is to dissipate heat from the hot refrigerant, it is important to keep the cooling coils and fins clean. A clogged coil will cause high discharge pressure and insufficient cooling.

9.4.1 Condenser Fan Motors

Four brushless fan motors (Fig. 31), 28.5 V - (0.6 HP - 0.42 kW) are installed in the condenser compartment on R.H. side of vehicle in order to ventilate the condenser coil. They are mounted on a support, fastened to the door. The fans pull outside air through the condenser coil and discharge it through an opening at bottom of compartment. When temperature drops inside condenser, the pressure in the refrigerant line also drops and it is, therefore, no longer required to cool condenser. Consequently, when pressure drops to 130 psi, the motors will run at low speed and if the pressure continues to drop to 90 psi, a pressure switch stops the motors so that fans do not operate needlessly. When pressure rises to 120 psi, the pressure switch reactivates the motors. If the pressure rises to 170 psi, the motors will switch to high speed.

For details about electrical wiring, refer to *"A/C and Heat system"* in the master wiring diagram.

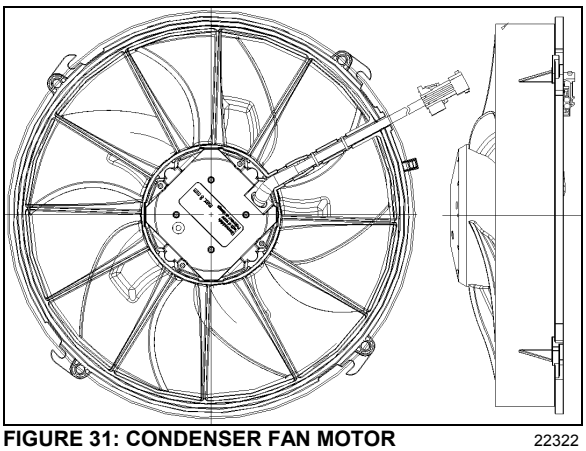


FIGURE 31: CONDENSER FAN MOTOR 22322

9.4.2 Condenser Fan Motor Removal

1. Set the battery master switch to the *"Off"* position.
2. Disconnect wiring from terminals on motor. Tag each wire to aid in identification at time of reconnection.
3. Remove the four hexagonal head cap screws retaining the fan motor assembly to the mounting support.
4. Remove the motor.

9.5 RECEIVER TANK

The receiver tank is located in the condenser compartment (Fig. 32). The function of the receiver tank is to store the liquid refrigerant. During normal operation, the level of the refrigerant should be approximately at the mid-point of the lower sight glass.

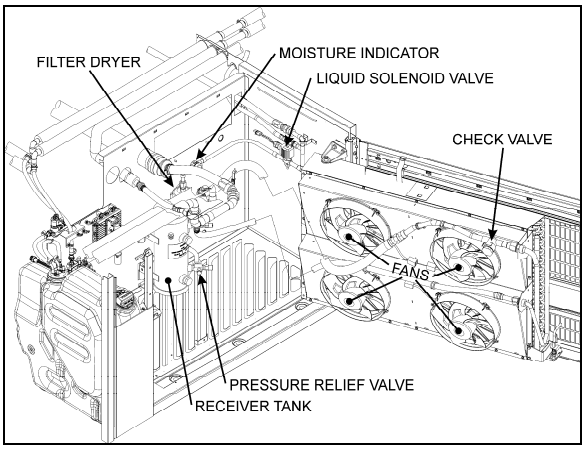


FIGURE 32: A/C CONDENSER COMPARTMENT 22323

In case of extreme pressure there will be a rise in the liquid receiver tank. A pressure relief valve will break at 450 psi (3103 kPa) and relieve the receiver tank pressure.

The receiver tank incorporates an inlet valve on the inlet side (upper section) which allows the tank to be isolated or serviced. An outlet valve on the outlet side (lower section) permits complete isolation from the rest of the system.

9.6 FILTER DRYER

A filter dryer, also located in the condenser compartment, is installed on the liquid refrigerant line after the receiver tank. It is used to absorb moisture and foreign matter from refrigerant before it reaches the expansion valves.

The filter should be replaced if the system has been opened or after a prolonged exposure, when the moisture indicator sight glass turns to pink.

A filter dryer, located close to the engine compartment L.H. side rear door, is installed on vehicles equipped with an auxiliary A/C system. Its function is similar to that of filter used on main systems. Replace only when system is opened or a problem occurs.

9.6.1 Replacement

The filter is of the disposable type. When replacement is required, remove and discard the complete unit and replace with a new unit of the same type according to this procedure:

1. Isolate the refrigerant in the receiver tank by following the "Pumping Down" procedure explained in this section
2. Change the filter dryer as a unit.
3. Add a small quantity of refrigerant R-134a to the low side of the system. Check for leaks. Return the system to normal operation.

⚠ CAUTION

Do not use carbon tetrachloride or similar solvents to clean parts. Do not use steam guns. Use mineral spirits or naphtha. All parts should be thoroughly cleaned. Use a stiff brush to wash dirt from grooves, holes, etc.

DANGER

Cleaning products are flammable and may explode under certain conditions. Always handle in a well ventilated area.

9.6.2 Moisture Indicator

The moisture sensitive element consists of a color changing ring which is reversible from pink to blue and vice versa as the moisture content in the refrigerant changes. Pink indicates a wet refrigerant, light violet (caution) and blue indicates a dry refrigerant.

Since temperature changes affect the solubility, color change will also vary with the refrigerant temperature. The above table shows the color change for R-134a at various moisture levels and liquid line refrigerant temperatures.

COLOR INDICATOR			
TEMPERATURE	BLUE (ppm)	LIGHT VIOLET (ppm)	PINK (ppm)
75°F (24°C)	Below 5	5-15	Above 15
100°F (38°C)	Below 10	10-30	Above 30
125°F (52°C)	Below 15	15-45	Above 45
p.p.m.= parts per million (moisture content)			

A moisture level of less than 15 p.p.m. for R-134a indicated in the blue color range of the above table is generally considered dry and safe. A color indication of light blue to light violet indicates the caution range of moisture level. For positive protection, the drying of the system should be continued until the color of the element turns to deep blue.

The liquid refrigerant is readily visible through the center opening of the moisture element where the presence of bubbles indicates a shortage of refrigerant or restriction in line.

Moisture is one of the main causes of chemical instability or contamination in air conditioning systems. If moisture is present, it can corrode the valves, condenser and evaporator coils, compressor and other components causing a malfunction and eventual failure of the system. Uncontrolled moisture in the system can result in very expensive multiple component replacements if not corrected at an early stage. The moisture indicator permits an early detection of moisture in the system and when corrected by a desiccant charge, system contamination is greatly minimized.

9.7 LIQUID REFRIGERANT SOLENOID VALVE

The flow of liquid refrigerant to the driver's and main evaporators is controlled by a normally-closed solenoid valve. The driver's liquid solenoid valve is located on the ceiling of the spare wheel and tire compartment and is accessible through the reclining bumper.

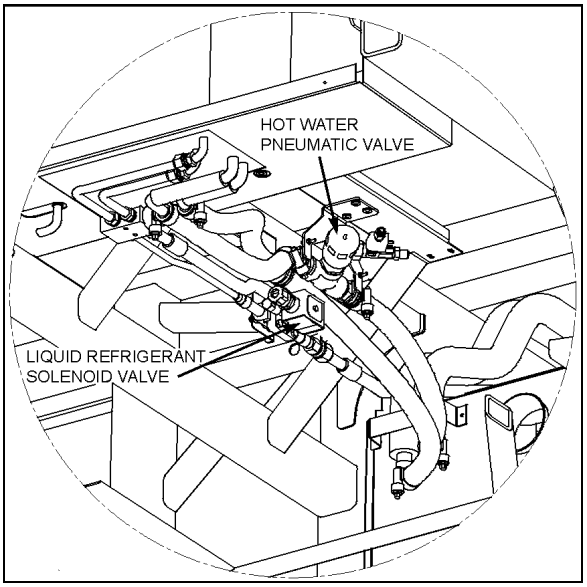


FIGURE 33: DRIVER'S EVAPORATOR LIQUID SOLENOID VALVE 22324

NOTE

An identical refrigerant solenoid valve is used on the auxiliary A/C system and is located near the auxiliary A/C unit.

9.7.1 Manual Bypass

This type of solenoid valve is equipped with a manual operating stem. The 3/16" square stem located on the bonnet is exposed when the seal cap is removed. To manually open valve, turn stem ½ turn counterclockwise. To manually close valve, turn stem clockwise until tight against seat. Manual stem must be in closed position for automatic electric operation.

9.7.2 Coil Replacement

1. Disconnect connector from the coil connector.

2. Take out the retaining screw at the top of the coil housing. The entire coil assembly can then be lifted off the enclosing tube.
3. Place the new coil and yoke assembly on the enclosing tube. Lay data identification plate in place.
4. Insert the coil retaining screw, rotate housing to proper position and tighten screw securely.
5. Connect connector from coil connector.

9.7.3 Valve Disassembly

1. Remove the coil as stated previously.
2. Pump down the system as stated earlier in this section.
3. Remove the four socket head screws which hold the body and bonnet together (Fig. 34).
4. Carefully lift off the bonnet assembly (upper part of the valve) so that plunger will not fall out. The diaphragm can now be lifted out.

NOTE
The above procedure must be followed before brazing solder-type bodies into the line.

⚠ **CAUTION**
Be careful not to damage the machined faces while the valve is apart.

9.7.4 Valve Reassembly

1. Place the diaphragm in the body with the pilot port extension up.
2. Hold the plunger with the synthetic seat against the pilot port.
3. Make sure the bonnet O-rings are in place. Lower the bonnet assembly over the plunger, making sure that the locating sleeve in the bonnet enters the mating hole in the body.
4. Insert the four socket head screws and tighten evenly.
5. Replace the coil as stated previously.
6. Add a small quantity of refrigerant R-134a to the low side of the system. Check for leaks. Return the system to normal operation.

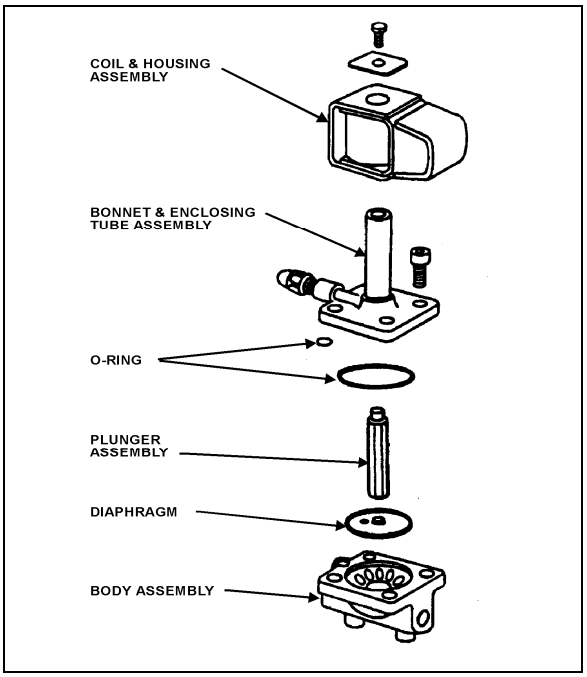


FIGURE 34: REFRIGERANT SOLENOID VALVE 22044

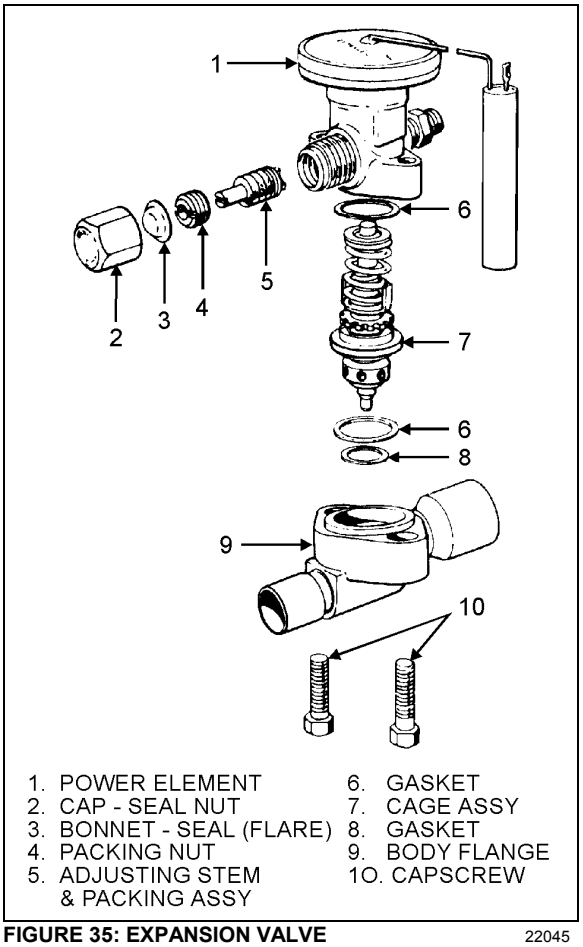
9.8 EXPANSION VALVE

9.8.1 Cabin or Passenger's Section HVAC Unit

The expansion valve for the cabin or passenger's section HVAC unit is a thermo-sensitive valve with a remote control bulb head attached to the evaporator outlet line and is accessible by the evaporator coil access door (Fig. 17 & 33). The valve regulates the flow of refrigerant liquid into the evaporator coils and is controlled by the suction gas temperature leaving the evaporator. The bulb head senses the refrigerant gas temperature as it leaves the evaporator. High temperature will cause expansion and pressure on the power head and spring. Such action causes the assembly valve to open, allowing a flow of refrigerant liquid into the evaporator.

The remote bulb and power assembly is a closed system. The pressure within the remote bulb and power assembly corresponds to the saturation pressure of the refrigerant temperature leaving the evaporator and moves the valve pin in the opening direction. Opposed to this force, on the under side of the diaphragm and acting in the closing direction, is the force exerted by the superheat spring. As the temperature of the refrigerant gas at the evaporator outlet increases above the saturation temperature corresponding to the evaporator

pressure, it becomes superheated. The pressure thus generated in the remote bulb and power assembly surpasses the combined pressures of the evaporator pressure and the superheat spring, causing the valve pin to move in the opening direction. Conversely, as the temperature of the **refrigerant** gas leaving the evaporator decreases, the pressure in the remote bulb and power assembly also decreases and the combined evaporator and spring pressures cause the valve pin to move in the closing position.



1. POWER ELEMENT
2. CAP - SEAL NUT
3. BONNET - SEAL (FLARE)
4. PACKING NUT
5. ADJUSTING STEM & PACKING ASSY
6. GASKET
7. CAGE ASSY
8. GASKET
9. BODY FLANGE
1O. CAPSCREW

FIGURE 35: EXPANSION VALVE 22045

As the operating superheat is raised, the evaporator capacity decreases, since more of the evaporator surface is required to produce the superheat necessary to open the valve. It is obvious, then, that it is most important to adjust the operating superheat correctly and that a minimum change in superheat to move the valve pin to full open position, is of vital importance because it provides savings in both initial evaporator cost of operation. Accurate and sensitive control of the refrigerant liquid flowing to the evaporator is necessary to provide maximum evaporator capacity under load conditions. The spring is adjusted to give 12 to 16° F (-11.1 to -8.8 ° C) of superheat at the evaporator outlet.

This ensures that the refrigerant leaving the evaporator is in a completely gaseous state when drawn into the suction side of the compressor. Liquid would damage the compressor valve, piston and heads if allowed to return in the suction line.

A vapor is said to be superheated when its temperature is higher than the saturation temperature corresponding to its pressure. The amount of the superheat is, of course, the temperature increase above the saturation temperature at the existing pressure.

As the refrigerant moves along in the evaporator, the liquid boils off into a vapor and the amount of liquid decreases until all the liquid has evaporated due to the absorption of a quantity of heat from the surrounding atmosphere equal to the latent heat of vaporization of the refrigerant. The gas continues along in the evaporator and remains at the same pressure. However, its temperature increases due to the continued absorption of heat from the surrounding atmosphere. The degree to which the gas refrigerant is superheated is related to the amount of refrigerant being fed to the evaporator and the load to which the evaporator is exposed.

Superheat Adjustment

The starting method of adjusting the superheat is to unscrew completely the main evaporator expansion valve adjusting screw, then screw in 13 turns clockwise for 134A (Fig. 36). Afterwards, the following procedure should be followed:

1. Operate coach for at least one-half hour at fast idle with temperature control set at 82°F (27,7°C), Then set temperature to minimum to keep the compressor on 6 cylinders.
2. Install pressure gauge at the evaporator suction header. You may install the pressure gauge at compressor suction, but then add 3 psi to reading.

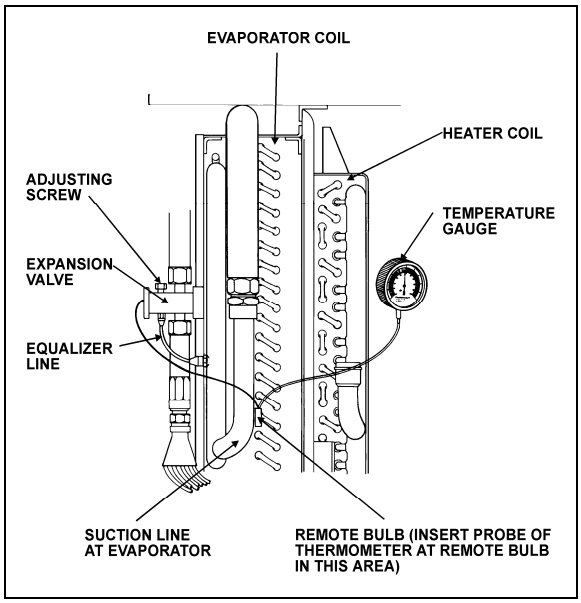


FIGURE 36: SUPERHEAT ADJUSTMENT INSTALLATION 22046

3. Install a remote reading thermometer to the evaporator outlet line near the existing remote bulb (Fig. 36).
4. Apply thermostatic tape around the bulb and evaporator outlet line to get a true reading of the line temperature.
5. Block condenser if necessary to keep pressure over 150 psi.

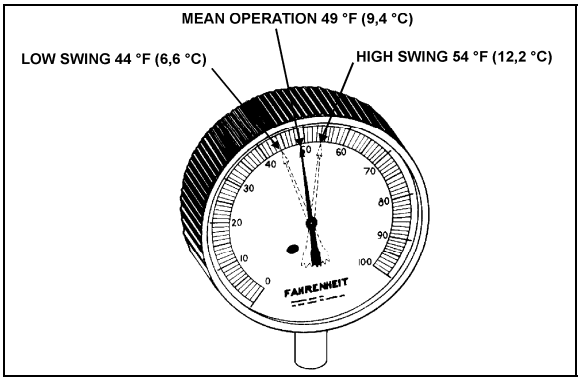


FIGURE 37: HIGH & LOW SWING TEMPERATURE AT REMOTE BULB 22047

6. Check approximately 5 readings of pressure at 2-minute intervals and convert to temperature using the temperatures & pressures table (page 35). Likewise check the temperature reading at the remote bulb at the same 2-minute intervals and record the low and high swing readings of the needle (refer to Fig. 37).

Example of readings taken at fig. 37:

A/C pressure gauge converted to temperature at expansion valve fitting	Temperature on remote bulb	
40°F (4,4°C)	Low-swing 44°F (6,6°C)	High swing 54°F (12,2°C)
Formula for superheat 49°F-40°F=9°F (9,4°C-4,4°C = 5°C)	Average of low and high swing is 49°F (9,4°C)	

NOTE

The low swing of the superheat should be a minimum of 4°F (2,2°C) higher at the remote bulb and have an average of 8 to 12°F (4 to 6°C) higher range at the bulb than the fitting at the expansion valve.

NOTE

To reduce the superheat, flow of refrigerant is increased by turning adjusting screw of expansion valve lower evaporator temperature counterclockwise. To increase temperature or increase superheat, flow of refrigerant is reduced by turning adjustment screw of expansion valve clockwise.

6. Regulate suction pressure to temperature reading according to temperature chart or to the R-134a temperature scale on the pressure gauge.

Example: Suction pressure 30 psi (207 kPa) converted to 32°F (0°C) on chart. If temperature reading is 40°F (4,4°C), subtract 32°F (0°C) and the result will be 8°F (4,4°C) of superheat.

⚠ CAUTION

Before proceeding to the expansion valve adjustment, check for restriction on suction side for plugged filter dryer and partially open valves. These conditions will give a high superheat.

Maintenance

1. Pump down the system as previously indicated in this section.

2. Disconnect the external equalizer line from the under side of the power head, and unclamp the remote control bulb from the evaporator coil outlet line.
3. Remove the two cap screws holding the power assembly to the valve body flange. Lift off the power assembly and remove the cage assembly.
4. When reassembling, replace with the new gaskets in proper location. Make sure the two lugs on the cage assembly fit into grooves provided in the power assembly. Do not force the valves together. The cage must fit properly before tightening the body flange. Tighten bolts evenly.
5. Check for leaks.

Safety Instructions

1. Make sure the valve is installed with the flow arrow on the valve body corresponding to the flow direction through the piping system.
2. Before opening any system, make sure the pressure in the system is brought to and remains at the atmospheric pressure. Failure to comply may result in system damage and/or personal injury.

9.8.2 Driver's HVAC Unit

The function and operation of the expansion valve for the driver's HVAC unit are similar to the cabin or passenger's HVAC unit but no superheat adjustment is required (see figures 19 and 33).

9.9 TORCH BRAZING

Use electrode containing 35% silver.

CAUTION

When using heat near a valve, wrap with water saturated rag to prevent overheating of vital parts.

DANGER

Before welding any part of refrigeration system, make sure the area is well ventilated.

9.10 TROUBLESHOOTING

9.10.1 Expansion Valve

PROBABLE CAUSE	PROBABLE REMEDY
LOW SUCTION PRESSURE-HIGH SUPERHEAT	
EXPANSION VALVE LIMITING FLOW:	
Gas in liquid line due to pressure drop in the line or insufficient refrigerant charge.	Locate cause of line flash and correct by use of any of the following methods. Add R-134a. Replace or clean filter dryer.
Inlet pressure too low from excessive low condensing temperature. Resulting pressure difference across valve too small.	Increase head pressure. Verify pressure switch for fan speed control.
Superheat adjustment too high.	Adjust superheat as outlined under "Superheat Adjustment".
Power assembly failure or partial loss of charge.	Replace power assembly or replace valve.
Air filter screen clogged.	Clean or replace air filter screen.
Plugged lines.	Clean, repair or replace lines.
LOW SUCTION PRESSURE-LOW SUPERHEAT	
Uneven or inadequate evaporator loading due to poor air distribution or liquid flow.	Balance evaporator load distribution by providing correct air or liquid distribution.
HIGH SUCTION PRESSURE-HIGH SUPERHEAT	
Compressor discharge valve leaking.	Replace or repair valve.
HIGH SUCTION PRESSURE-LOW SUPERHEAT (DEFECTIVE UNLOADER)	
Valve superheat setting too low.	Adjust superheat as outlined under "Superheat Adjustment".
Compressor discharge valves leaking.	Replace or repair discharge valve.
Incorrect superheat adjustment.	Superheat adjustment 12 to 16°F.
FLUCTUATING DISCHARGE PRESSURE	
Insufficient charge.	Add R-134a to system.
HIGH DISCHARGE PRESSURE	
Air or non-condensable gases in condenser.	Purge and recharge system.
Overcharge or refrigerant.	Bleed to proper charge.
Condenser dirty.	Clean condenser.

9.10.2 A/C

TROUBLE	CAUSE
Low suction pressure and frosting at dryer outlet.	Clogged filter.
Low Oil Level.	Check for oil leaks and for leaking oil seal. Do not attempt to check oil level unless system has been stabilized at least 20 minutes. See oil level verification.
Excessively cold suction line.	Loss of contact between the expansion valve bulb and the suction line or sticking of the expansion valve. Check for foreign matter and clean, repair or replace the valve.
Excessively cold suction line and noisy compressor.	Check superheat adjustment. Check remote bulb contact. Check expansion valve for sticking.
Compressor squeaks or squeals when running.	Check oil level. Replace oil seal.
Noisy or knocking compressor.	Check for broken internal parts. Overhaul if required.
Compressor vibrates.	Check and tighten compressor mounting bolts and belt tension.
Low refrigerant level	Check for refrigerant leaks and add refrigerant if required.
Suction pressure rises faster than 5 pounds per minute after shutdown.	Check compressor valve for breakage or damage.
Insufficient cooling.	Check for refrigerant leaks. Check condition of air filter and motors.
Insufficient air flow.	Dirty or iced evaporator. Dirty air filter. Blowers inactive. Clogged ducts.
No flow of refrigerant through expansion valve.	Filter dryer is clogged. Remote bulb has lost charge or expansion valve is defective.
Expansion valve hisses. Bubbles in moisture and liquid indicator.	Gas in liquid line. Add refrigerant.
Loss of capacity	Clogged filter. Obstructed or defective expansion valve.
Superheat too high.	Reset superheat adjustment. Check for clogged external equalizer line, or filter dryer.
Reduced air flow: a. Dirty or clogged air filter; b. Evaporator motor inoperative; or c. Plugged return air ducts.	Dirty or iced evaporator coil. Clean air filter screen. Check return ducts for obstructions. Check blower motor.
Frequent starting and stopping on low pressure control switch.	Lack of refrigerant. Check for leaks. Recharge.
Compressor intermittently starts and stops.	Intermittent contact in electrical control circuit. Compressor valves not in operating position.
Non-condensable in the refrigeration system.	Leak on system, system in vacuum in low temp. Specific symptom, pressure in system will not correspond to ambient temperature on shutdown. Only non-condensable will cause this. (Example: Pressure of idle R-134a system in 80°F (26.6°C) room should be 86.4 psi (595.7 kPa). See temperature chart in this section.)

TROUBLE	CAUSE
	An evaporator just does a proper cooling job without sufficient air. Shortage of air can be caused by the following: * Dirty filters; or * Dirty coils.

Testing condenser pressure.

NOTE: R-134A pressure is function of the temperature variation.

Example, for an exterior temperature of 100°F.
Exterior temperature (100°F) + 30°F = 130°F. Refer to paragraph "10.11 Temperature & Pressure".
Note the corresponding pressure for a temperature of 130°F, 199.8 psi.
Read the condenser pressure, example 171.9 psi.
171.9 psi & 199.8 psi, the pressure in the condenser is inferior to the pressure corresponding to the exterior temperature, in this case the condenser pressure may be too low. Check for refrigerant leaks and add refrigerant if necessary. If the pressure corresponding to the condenser temperature is superior to the pressure corresponding to the exterior temperature, then the air cooled condenser pressure may be too high. Most frequent causes are:

Reduced air quantity. This may be due to:
* Non-condensable in system;
* Dirt on the coil;
* Restricted air inlet or outlet;
* Dirty fan blades;
* Incorrect rotation of fan;
* Fan speed too low;
* Fan motor going out on overload; or
* Prevailing winds.
* Too much refrigerant in system. Remove refrigerant if necessary.

9.11 TEMPERATURES & PRESSURES

VAPOR-PRESSURE			
TEMPERATURE		PRESSURE	
°F	°C	psi	kPa
-100	-73.3	27.8	191.7
-90	-67.8	26.9	185.5
-80	-62.2	25.6	176.5
-70	-56.7	23.8	164.1
-60	-51.1	21.5	148.2
-50	-45.6	18.5	127.6
-40	-40.0	14.7	101.4
-30	-34.4	9.8	67.6
-20	-29	3.8	26.2
-10	-23	1.8	12.4
0	-18	6.3	43.4
10	-12	11.6	80
20	-7	18.0	124.1
30	-1	25.6	176.5
40	4	34.5	237.9
50	10	44.9	309.6
60	16	56.9	392.3
70	21.1	70.7	487.5
80	27	86.4	595.7
90	32.2	104.2	718.5
100	38	124.3	857.0
110	43.3	146.8	1012.2
120	49	171.9	1185.3
130	54.4	199.8	1377.6
140	60	230.5	1589.3
150	65.6	264.4	1823.0
160	71	301.5	2078.8
170	76.7	342.0	2358.1
180	82.2	385.9	2660.8

VAPOR-PRESSURE			
TEMPERATURE		PRESSURE	
°F	°C	psi	kPa
190	87.8	433.6	2989.7
200	93.3	485.0	3344.1
210	98.9	540.3	3725.4

9.12 LEAK TESTING

Some methods such as nitrogen pressure, soap and electronic sniffer can be used for leak testing. However, the most common method used is a "Halide" torch consisting of an acetylene tank, a burner and a suction test hose. Proceed as follows:

DANGER

Do not inhale fumes from leak detector.

The flow of acetylene to the burner causes suction in the test line. Any gas refrigerant present will be drawn through the hose and into the burner where it decomposes into free acids.

These acids come in contact with the hot copper reaction plate in the burner, causing color reaction in the flame. A small concentration is indicated by a green tint and a large concentration by an intense blue. Do not confuse this change in color with the change caused by shutting off the air supply through the hose by holding the end too close to an object.

The procedure for testing is:

1. Adjust flame so that the top of the cone is approximately level or within one-half inch above the plate.
2. Probe end of suction test tube around all joints, valves, etc. When a leak has been found at a soldered joint, this section of the system must be pumped down. Do not solder as pressure will force hot solder out. If the system is empty, it is more economical to put in just enough R-134a to produce about 15 psi (103 kPa). The pressure can be raised to about 150 psi (1034 kPa) with dry nitrogen.

NOTE

This gas is put into the suction and discharge shutoff valves at the compressor. The receiver valves must be opened. If no leaks are found, dump this mixture, evacuate the system and fill with refrigerant.

10. SMALL OR AUXILIARY AIR CONDITIONING SYSTEM COMPONENTS

10.1 COMPRESSOR

Consult the small Compressor Service Manual included at the end of this section.

WARNING

Read the cautionary information in the small Compressor Service Manual included at the end of this section.

10.2 COMPRESSOR REMOVAL

10.2.1 When the compressor is operational

* Perform the “OIL RETURN OPERATION” (Refer to paragraph 10.5).

10.2.2 When the compressor is inoperable

* Perform the “Refrigerant Recovery” operation.
* Slacken bolts A (Refer to figure 38).
* Remove bolts B & C (Refer to figure 38).
* Remove the compressor.

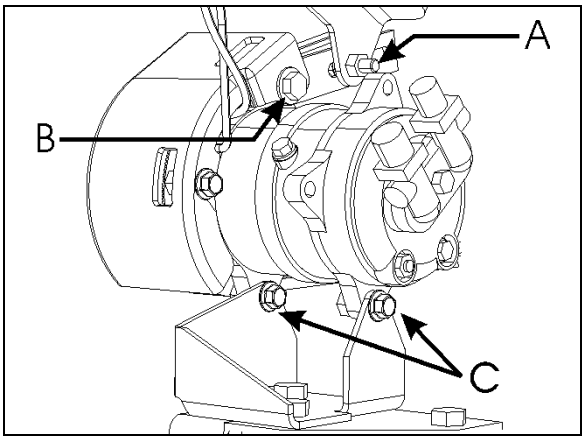


FIGURE 38: COMPRESSOR REMOVAL OR INSTALLATION 22349

10.2.3 Evacuating System Before Adding Refrigerant

When a system has been opened for repairs, change the filter dryer and evacuate the system. Vehicles equipped with a small or auxiliary A/C system must use high-pressure service port located on the other side of check valve and low-pressure port located alongside rear truss (Figures 19 and 39). It would be good practice to open solenoid valve.

1. Connect two hoses equipped with a micron gauge between the high-pressure service port, the low-pressure service port and the vacuum pump.
2. With the unit service valves open and the vacuum pump valves open, start the pump and draw the manifold and hoses into a very deep vacuum (700 microns).
3. Close manifold valve
4. Shut down the vacuum pump.
5. Check to insure that vacuum holds. (If the pressure continues to rise, it indicates a leak or moisture in the system).
6. Charge the system with the proper amount of refrigerant through the service port near the check valve using recommended charging procedures.
7. Remove the hoses.

10.3 OIL ADDITION

The chart below shows the approximate amount of oil to be added to the system when replacing a component.

Component replaced	Typical amount of oil
Evaporator	50 cm³ (1.7 ozs)
Condenser	30 cm³ (1.0 ozs)
Filter-Dryer	10 cm³ (0.3 ozs)

The amount of oil recovered with the refrigerant recovery should be added at the same time (25 ml of oil/lb of refrigerant)

10.4 COMPRESSOR OIL CONTAMINATION

Unlike engine oil, no cleaning agent is added to the compressor oil. Even if the compressor is run for a long time, the oil never becomes turbid as long as there is nothing wrong with the compressor or its method of use. Inspect the extracted oil for any of the following conditions:

- Dirt in the oil.
- Change to a varnish color.
- Presence of foreign substance, metal shavings, etc. in the oil. When the oil extracted from the compressor is as described above, replace the oil as follows:
  1. Clean the interior of the system with approved method (Paragraph 8.7)
  2. Replace the filter-dryer.
  3. Supply with new oil as specified in ICE (International Components Engineering) Compressor Service Manual included at the end of this section.

10.5 OIL RETURN OPERATION

There is a close affinity between oil and refrigerant. During normal operation, part of the oil recirculates with the refrigerant in the system. Therefore, when checking the amount of oil in the system or replacing any system component, the compressor must be run in advance to ensure return. This procedure is as follows:

- If the amount of refrigerant in the system has decreased, charge to the proper amount.
- Start the engine and select fast idle.
- Set the fan speed to full air/full A/C and let run for 20 minutes.

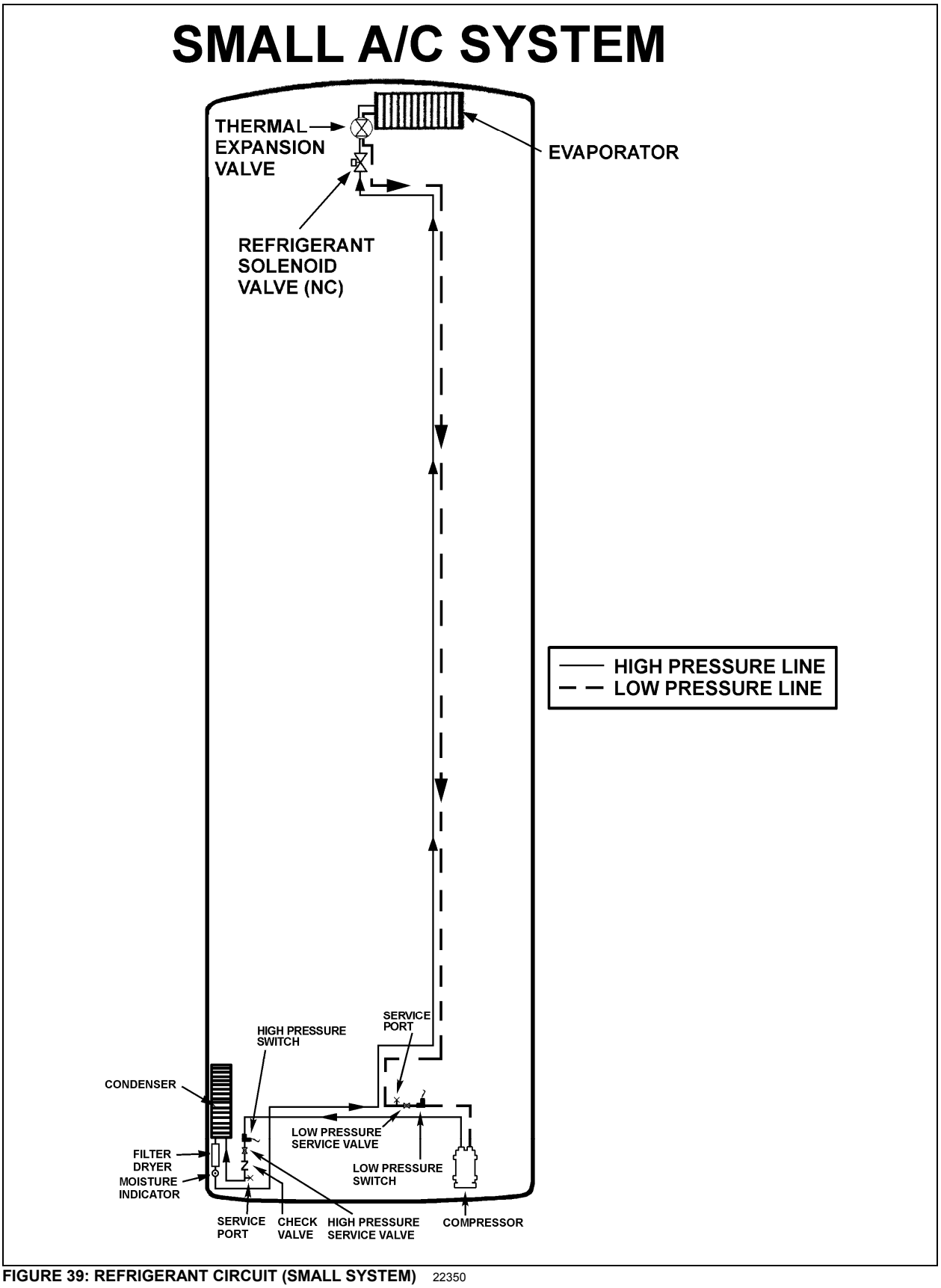


FIGURE 39: REFRIGERANT CIRCUIT (SMALL SYSTEM) 22350

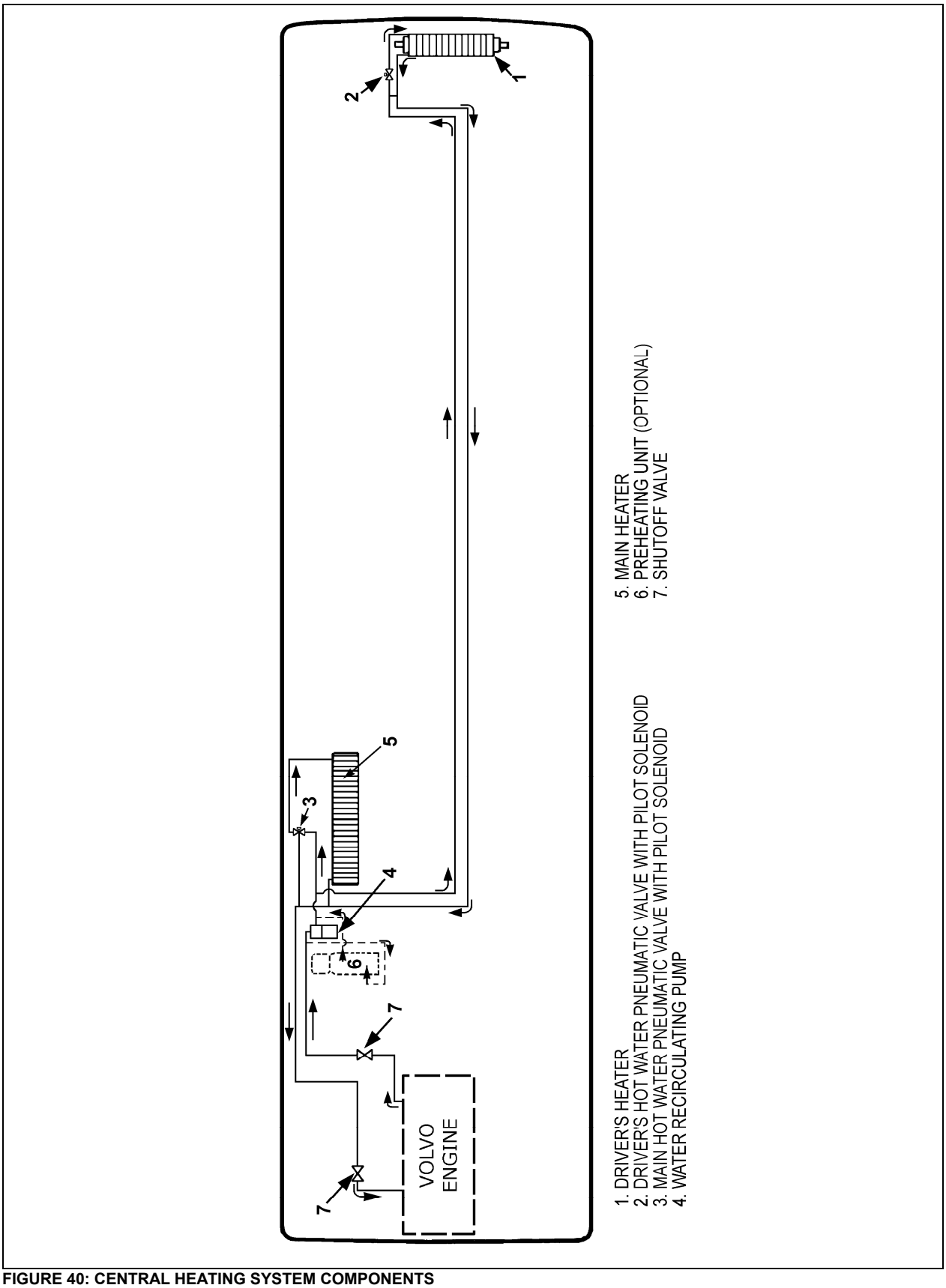


FIGURE 40: CENTRAL HEATING SYSTEM COMPONENTS

11. HEATING SYSTEM

As seen earlier in this section, the vehicle interior is pressurized by its Heating, Ventilation and Air Conditioning (HVAC) system. Two heating systems are available: Central Heating System and Small Heating System. The vehicle interior should always be slightly pressurized to prevent cold and moisture from entering. If the vehicle is equipped with a Central Heating System; air flow and controls divide the vehicle into two areas: driver's area and cabin or passenger's area.

The schematic of figure 40 shows the central heating system with its components.

In addition to the normal heating provided by the engine, a preheating system (104,000 Btu/hr) (optional) may have been installed in the vehicle.

11.1 CENTRAL HEATING SYSTEM

11.1.1 Draining Heating System

To drain the entire system, refer to Section 05, *"Cooling*". If only the driver's or main heater core must be drained, refer to the following instructions.

- **Draining Driver's Heater Core**

1. Stop engine and allow engine coolant to cool.
2. Locate the normally open water pneumatic valve on the ceiling of the spare wheel compartment (Fig. 41), move the pilot-solenoid valve red tab to close the valve.

WARNING

Before proceeding with the following steps, check that coolant has cooled down.

3. Loosen hose clamp, install an appropriate container to recover coolant, and disconnect silicone hose from water solenoid valve.
4. From inside of vehicle, remove the two finishing panels in front of unit. Remove the three screws fixing the unit front panel. Open the manual vent located inside the HVAC unit, on the driver's side (Fig. 42) to ensure an efficient draining.

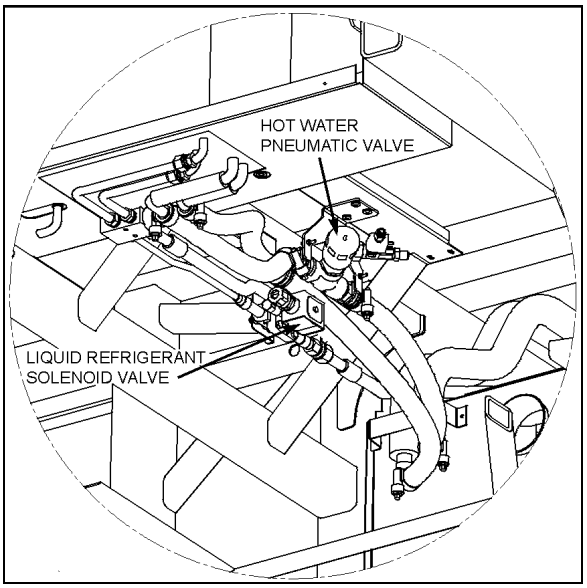


FIGURE 41: CEILING OF THE SPARE WHEEL COMPARTMENT

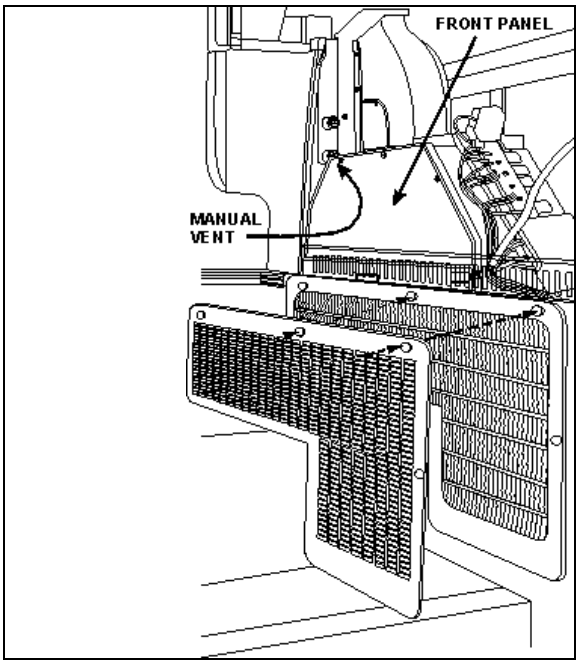


FIGURE 42: DRIVER'S HVAC UNIT

- **Draining Main Heater Core**

1. Stop engine and allow engine coolant to cool.
2. Close both heater line shutoff valves.

On X Series vehicles, the valves are located in the engine compartment. One is on the L.H. side of compartment in front of the radiator and the other valve is located under the radiator fan gearbox (Fig. 43).

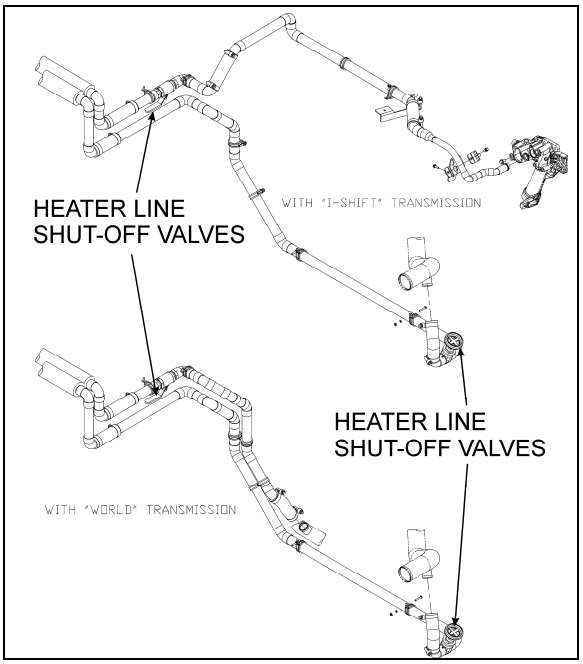


FIGURE 43: HEATER LINE SHUT-OFF VALVES

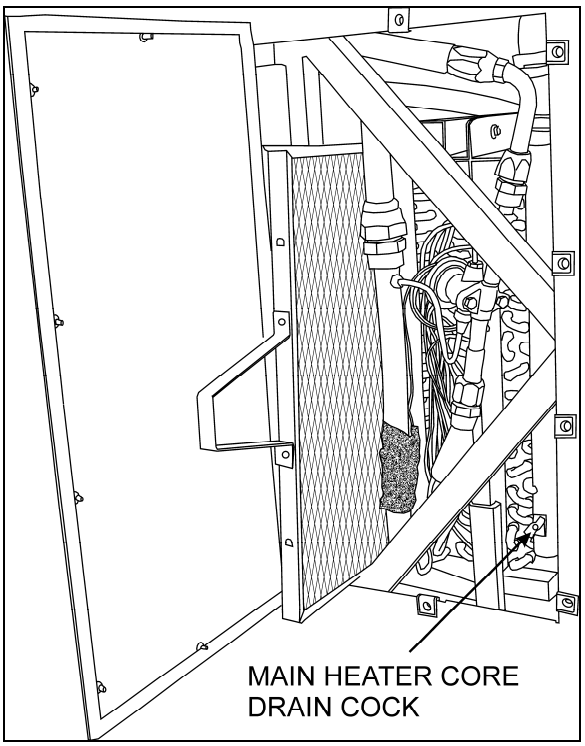


FIGURE 44: EVAPORATOR COMPARTMENT

3. The main heater core drain cock is located in the evaporator compartment. To access the valve on X Series vehicles, open baggage compartment door located in front of the evaporator compartment (L.H. side). Open access panel by turning the three screws of panel ¼ of a turn.

WARNING

Before proceeding with the following steps, check that coolant has cooled down.

4. Open drain cock in bottom of heater core, you can unfasten a hose connection on top of heater core (Fig.44) in order to allow air to enter while draining.

11.1.2 Filling Heating System

1. Ensure that the drain hose is reconnected and the manual vent and drain cock are closed.
2. Open the surge tank filler cap and slowly fill the system to level of filler neck.
3. After initial filling, the water shut-off valves should be open and the water recirculating pump should be energized to assist in circulating coolant through the heating system. To perform this operation, start the engine, switch on the HVAC control unit, both driver and cabin (passengers') sections, and set temperature to their maximum positions in order to request the heating mode in each of these sections.
4. When coolant level drops below the surge tank filler neck, slowly fill the system to level of filler neck.
5. Once the level has been stabilized, replace cap.

11.1.3 Bleeding Heating System

Whenever the heating system has been drained and refilled, or the system has run low on coolant and coolant has been added, it is necessary to bleed air from heating system. Locate the manual vent illustrated in Figure 42, and open momentarily until no air escapes from the line.

11.1.4 Soldering

Before soldering any part of the system, make sure the area is well ventilated. Use (stay clean) flux sparingly and apply solder (95-5 round wire 1/8 inch). After completing repairs, test for leaks.

When using heat at or near a valve, wrap with water saturated rag to prevent overheating of vital parts.

11.1.5 Driver's Hot Water Pneumatic Valve Assembly

- **Description**

The flow of hot water to the driver's heater core is controlled by a pneumatic NO water valve assembly. The valve, located at the ceiling of the spare wheel compartment, is designed so that the pilot solenoid valve, which is part of the assembly, opens and closes a port which directs air pressure to the actuator casing, thereby opening or closing the valve.

When the vehicle is operating with no current to the pilot solenoid valve, no air pressure is admitted to the actuator casing, the cylinder spring pushes up against the cylinder, thereby keeping the water valve open.

The driver's heater water valve requires a minimum amount of maintenance. The valve should be free of dirt sediment that might interfere with its operation. No other maintenance is needed unless a malfunction occurs.

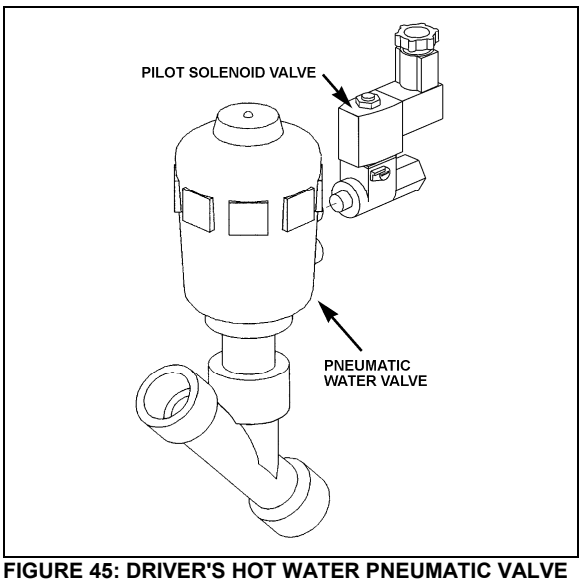


FIGURE 45: DRIVER'S HOT WATER PNEUMATIC VALVE ASSEMBLY

- **Pneumatic Water Valve Disassembly**

1. Shut off air supply pressure and electrical current to the pilot solenoid valve. Disconnect wires.
2. The water valve need not be removed from the line. Unscrew nipple, the actuator casing, tube, spindle and closure member can be removed (Fig. 46).
3. Remove the snap ring using a pair of pliers.
4. You can now access all seals for replacement

   Pneumatic water valve replacement seal kits:

   * Water Side: 871311
   * Actuator Side: 871312

- **Pneumatic Water Valve Reassembly**

1. Assemble the actuator casing, tube, nipple, spindle and closure member.
2. Tighten the nipple in place in the body cavity as per figure 46. Fasten pilot solenoid vale to the pneumatic water valve. Reconnect air supply pressure and electrical current to the pilot solenoid valve.
3. Check for proper operation.

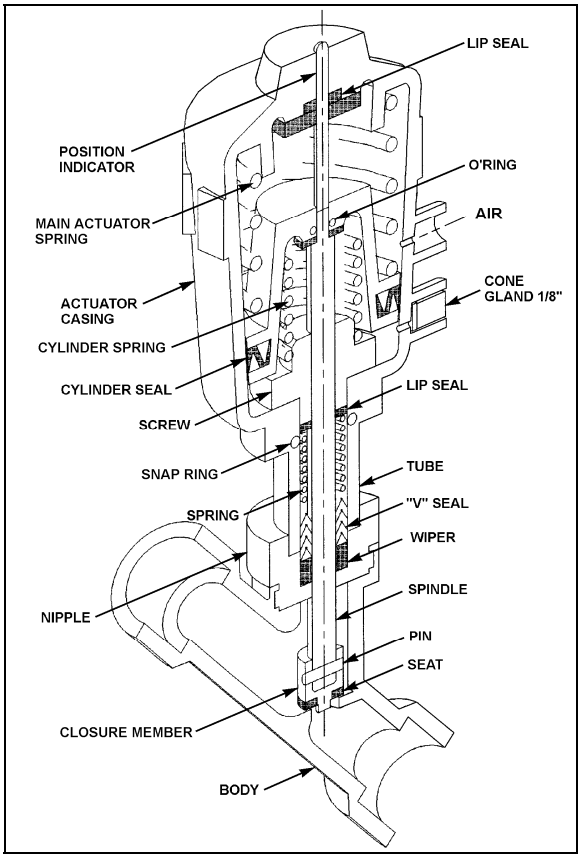


FIGURE 46: PNEUMATIC WATER VALVE

- **Pilot Solenoid Valve**

1. No maintenance is needed unless a malfunction occurs.
2. A pilot solenoid valve replacement seal kit is available: 871313.

- **Valve Troubleshooting**

PROBLEM	PROCEDURE
Valve fails to close	1. Check electrical supply with a voltmeter. It should agree with nameplate rating. 2. Check pressure at pilot solenoid valve inlet. It must be at least equal to the minimum pressure stamped on the nameplate. It should not go below minimum while valve is operating.
	1. Check that the closure member assembly, and that main actuator and cylinder springs are free to travel. 2. Check that there is no restriction to the air escaping from the actuator casing. 3. Make sure that pilot solenoid valve operates properly.

11.1.6 Central Hot Water Pneumatic Valve Assembly

- Description

The flow of hot water to the vehicle's central heater core is controlled by a 3-way pneumatic water valve assembly. The valve, located in the evaporator compartment, is designed so that the pilot solenoid valve, which is part of the assembly, opens and closes a port which directs air pressure to the actuator casing, thereby allowing the hot water to enter the main heater core or bypassing it.

When the vehicle is operating with no current to the pilot solenoid valve, no air pressure is admitted to the actuator casing, the cylinder spring pushes up against the cylinder, thereby allowing the hot water to enter the main heater core.

The central heater water valve requires a minimum amount of maintenance. The valve should be free of dirt sediment that might interfere with its operation. No other maintenance is needed unless a malfunction occurs.

- **Pneumatic Water Valve Disassembly**

1. Shut off air supply pressure and electrical current to the pilot solenoid valve. Disconnect wires.
2. The water valve need not be removed from the line. Unscrew nipple, the actuator casing, tube, spindle and closure member can be removed (Fig. 47).
3. Remove the snap ring using a pair of pliers.

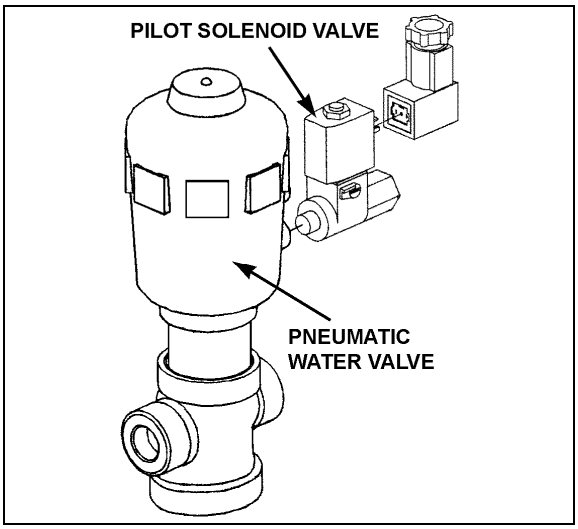


FIGURE 47: CENTRAL HOT WATER PNEUMATIC VALVE ASSEMBLY 22329

4. You can now access all seals for replacement

   Pneumatic water valve replacement seal kits:

   * Water Side: 871389
   * Actuator Side: 871388

- **Pneumatic Water Valve Reassembly**

1. Assemble the actuator casing, tube, nipple, spindle and closure member.
2. Tighten the nipple in place in the body cavity as per figure 48. Fasten pilot solenoid vale to the pneumatic water valve. Reconnect air supply pressure and electrical current to the pilot solenoid valve.
3. Check for proper operation.

- **Pilot Solenoid Valve**

1. No maintenance is needed unless a malfunction occurs.
2. A pilot solenoid valve replacement seal kit is available: 871390.

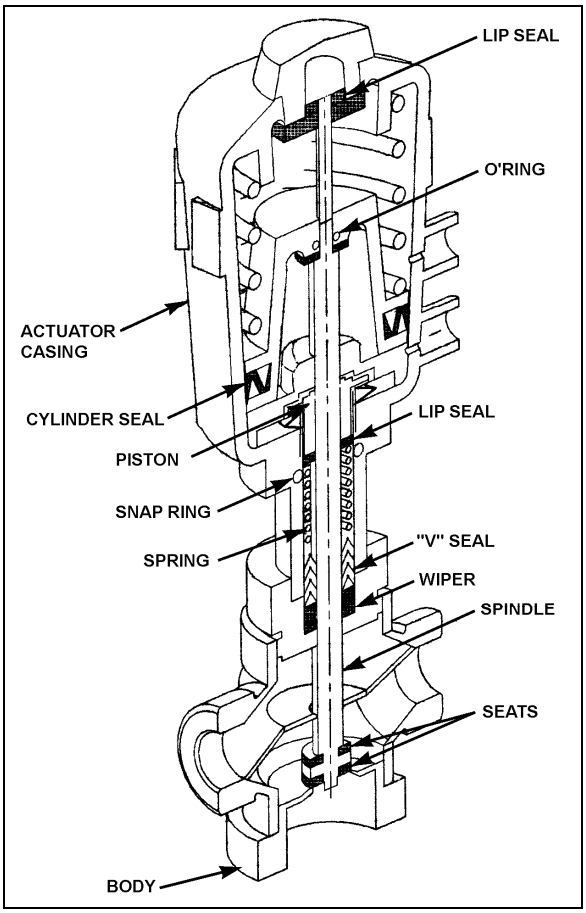


FIGURE 48: PNEUMATIC WATER VALVE 22330

- **Valve Troubleshooting**

PROBLEM	PROCEDURE
Valve fails to close	1. Check electrical supply with a voltmeter. It should agree with nameplate rating. 2. Check pressure at pilot solenoid valve inlet. It must be at least equal to the minimum pressure stamped on the nameplate. It should not go below minimum while valve is operating.
Valve fails to open.	1. Check that the closure member assembly, and that main actuator and cylinder springs are free to travel. 2. Check that there is no restriction to the air escaping from the actuator casing. 3. Make sure that pilot solenoid valve operates properly.

11.1.7 Water Recirculating Pump

This vehicle is provided with a water recirculating pump which is located in the engine coolant heater compartment (Fig. 49). The water recirculating pump consists of a centrifugal pump and an electric motor which are mounted in a compact assembly.

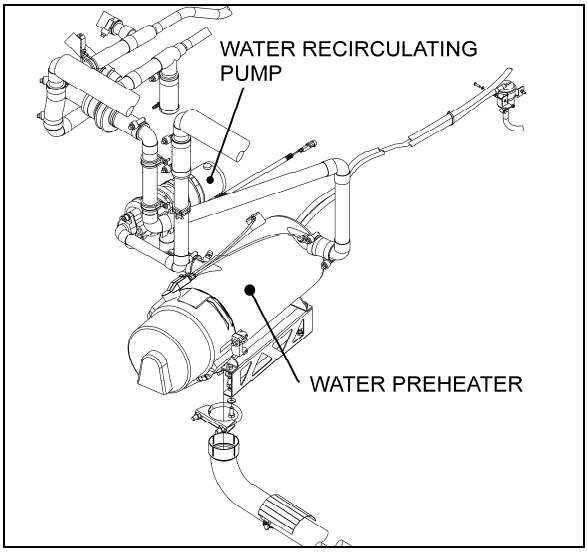


FIGURE 49: PUMP LOCATION (CENTRAL A/C) 22331

The (seal less) pump requires no periodic maintenance other than replacement of motor brushes. Replacement of motor brushes can be performed without removing the pump assembly. Inspection of the pump, to determine if the pump is working properly, should be made while the pump is in operation. If there is evidence that the pump is not operating as per specifications, the unit must be disassembled for corrective measures.

Disassembly of the pump will be necessary only in the case of a rotor failure or motor failure.

- **Removal**

1. Stop engine and allow engine coolant time to cool.
2. Close shutoff valves. Refer to *"05 COOLING"* under heading *"Draining Cooling System"* for location of valves.
3. Disconnect the electrical wiring from the motor.

WARNING

Before proceeding with the following steps, check that coolant has cooled down.

4. Disconnect water lines from pump at flange connections. Place a container to recover the residual coolant in the line.
5. Remove the two clamps holding the pump motor to its mounting bracket. Remove the pump with the motor as an assembly.

- **Disassembly**

1. Separate the housing (1) from the adapter (7) by first removing the 4 capscrews. Remove housing carefully to prevent damaging the O-ring (2).
2. Remove rotor assembly (4), washers (3) and shaft (5) from the adapter.

Inspection

Components removed from the recirculating pump and motor assembly should be compared with new parts to determine the degree of wear.

- **Brushes**

1. When removing brushes, note the position of the brush in the tube. Brush life is shortened if the brushes are not replaced properly.
2. Examine brushes for the following:

   a. Wear
      Replace the brushes if less than 25% of the usable brush is left (less than 0.300 inch [8 mm]).

   b. Chipped edges
      Chips can be caused by improper handling or installation. Badly chipped brushes should be replaced regardless of their length.

   c. Annealed brush spring
      This can be detected by noting the resiliency of the spring. Annealing is caused by failing to tighten the brush caps properly, thus not providing a good low resistance contact between the terminal and the brush tube. Replace brushes showing evidence of annealed springs.

   d. Frayed or broken pigtail
      An improperly installed brush may have the pigtail (shunt) pinched under the terminal or between the coils of the spring. If the pigtail is badly frayed or broken, replace the brush.

3. Observe the following factors when replacing brushes:
   a. The face of a new brush is carefully cut to cause proper seating during the *"wear-in"* period.
   b. Improper installation can harm both the brush and the commutator.
   c. Replacement brushes should be of the proper grade.
   d. Brush performance will be affected if the spring and terminal are not properly placed in the brush tube. The spring should be free over its entire length and the terminal should make good contact with the metal brush tube insert.

- **Assembly**

1. Install washer (3), shaft (5) and rotor assembly (4) into adapter (7).
2. Install O-ring (2) into housing (1) and assemble housing to the adapter.
3. Secure housing to adapter using 4 capscrews (6).

- **Installation**

1. Apply gasket cement to the line flanges, put the two gaskets in place, and connect water lines to the pump at the flange connections. Position the pump and motor assembly on the mounting bracket. Position the mounting clamps over the motor and secure with mounting bolts.
2. Connect electrical wiring to the pump motor.
3. Open shutoff valve. Refer to *"05 COOLING"* under heading *"Draining Cooling System"* for location of valves.
4. Fill the cooling system as previously instructed in this section under *"11.2 Filling Heating System"*, then bleed the system as previously instructed in this section under *"11.3 Bleeding Heating System"*.

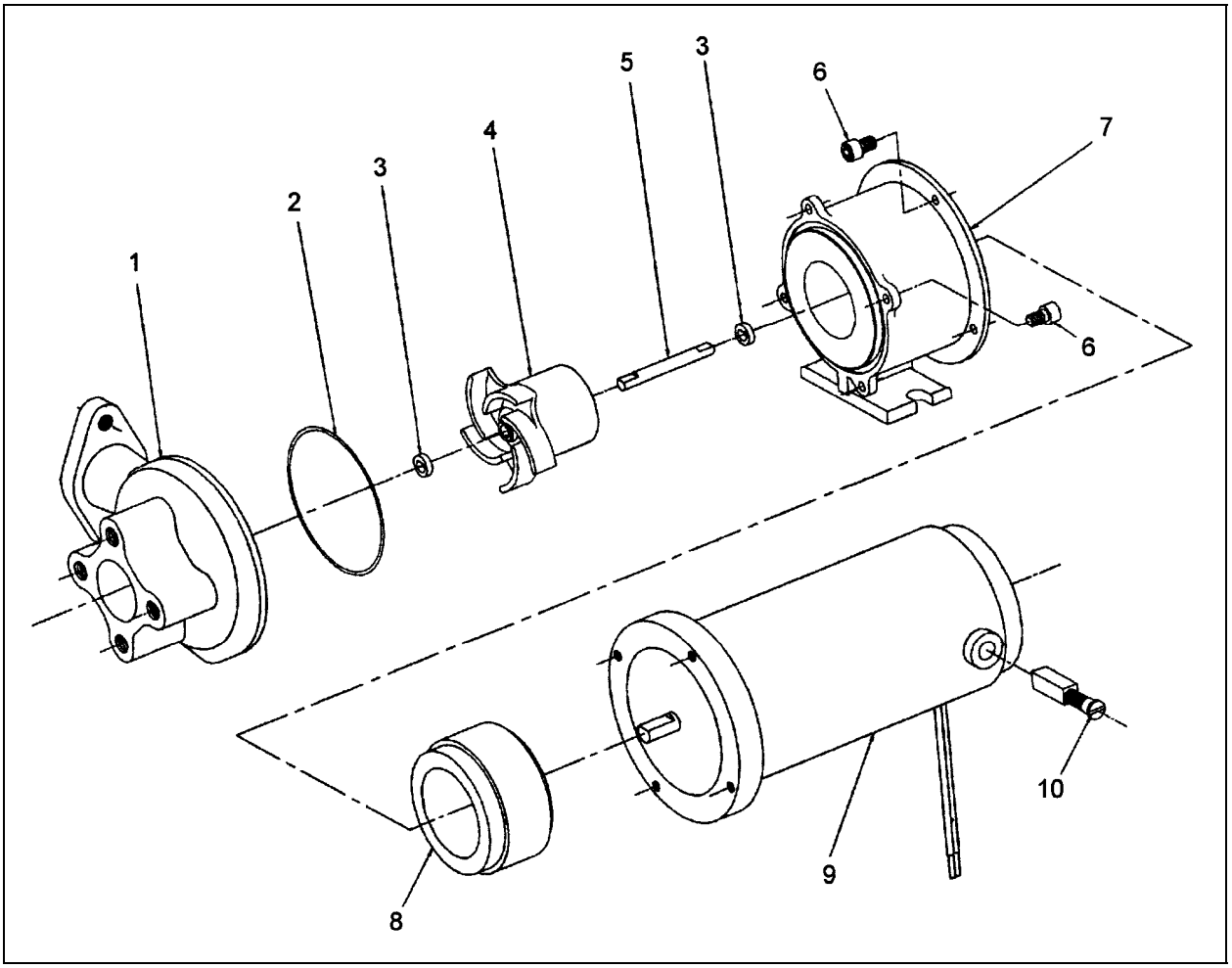


FIGURE 50: WATER RECIRCULATING PUMP (CENTRAL A/C) 22282

ITEM	DESCRIPTION	QTY.
1	Housing	1
2	O-Ring	1
3	Washer SS	2
4	Rotor Assembly	1
5	Shaft SS	1
6	Screw, Cap Hex Soc. Head 8-32 X 3/8	8
7	Adaptor	1
8	Drive Magnet	1
9	Motor Assembly 24V	1
10	Brush	2

11.1.8 Preheating System (Optional)

The vehicle may be equipped with the optional preheater located aft of the evaporator compartment, inside the engine coolant heater compartment and accessible through the evaporator compartment door (refer to Fig. 51).

This Auxiliary Preheating System is used for preheating and retaining the heat of water-cooled engines. It can be used before starting the engine to ease its starting and to provide immediate heat inside the vehicle upon operation of the system. It can also be used with engine running to maintain coolant heat and maintain the set temperature inside the vehicle.

The heater operates independently from the vehicle engine. It is connected to the cooling and heating circuits, the fuel system and the electrical system of the vehicle.

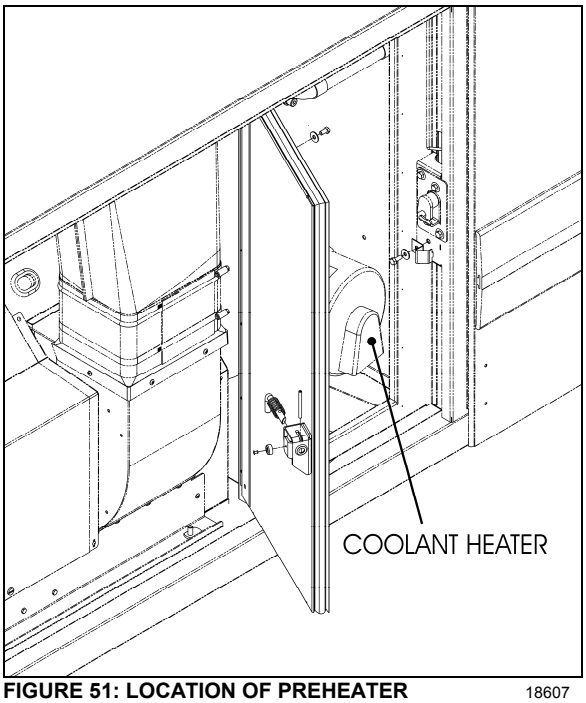


FIGURE 51: LOCATION OF PREHEATER 18607

The pilot lamp turns on when the heater is switched on. Combustion air flows in to flush out the combustion chamber and the water circulation pump is put into operation. The fuel metering pump conveys fuel in precise doses to the combustion chamber where fuel and combustion air form a combustible mixture which is ignited by the glow plug.

Once the flame sensor has signaled to the control unit that combustion has taken place correctly, the glow spark plug and ignition coil are switched off.

The hot combustion gases are diverted at the end of the flame pipe, then pass through the indirect heating surfaces of the heat exchanger and transmit their heat to the engine coolant passing through the heat exchanger.

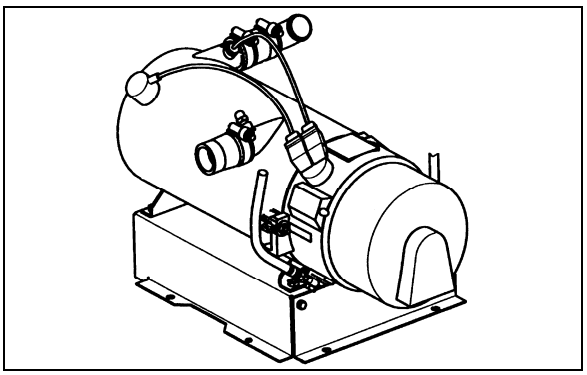


FIGURE 52: SPHEROS PREHEATER (104,000 BTU)

The heat is thermostatically controlled and operates intermittently, i.e. the switched-on times of the burner vary depending on the heat requirement. The water temperature depends on the setting of the built-in water thermostat.

The water circulation pump remains in operation as long as the heater is operating, even in the regulation intervals and during the delayed cutout of the switched-off heater. The pump can also be operated independently from the heater by means of an appropriate circuit. The heater can be switched on at any time, even during the delayed cutout period. Ignition takes place once this delay time is over.

When the heater is switched off, the fuel supply is interrupted. The flame goes out, and at the same time a delayed cutout of some 2.5 minutes begins. The combustion air still flowing flushes the remaining combustion gases out of the chamber and cools off the hot parts on the exhaust side of the heat exchanger, while the water circulation pump, still running, transmits the heat present in the heat exchanger, thus preventing local overheats. Once the delayed cutout time is over, both the combustion air blower and the water circulation pump switch off automatically. A cutout will take place in case of any failure of the preheater.

- **Preheater Fuel Filter**

The preheater fuel filter is located beside the preheater in the engine coolant heater compartment, and is accessible by opening the evaporator compartment door.

MAINTENANCE

Replace preheater fuel filter every 50,000 miles (80 000 km) or once a year, whichever comes first.

- **Operation**

Switch on the heater. The operation indicator lamp comes on and the heater motor and circulating pump begin to run. After about 10-25 seconds the solenoid valve opens and fuel is sprayed into the combustion chamber. At the same time, the electronic ignition unit produces high voltage (8000 V) and the mixture of fuel and air in the combustion chamber is ignited by the spark on the ignition electrodes. The flame is indicated by the flame detector, then the electronic ignition unit stops producing high voltage and combustion continues by itself (spark on electrodes is required only to ignite the flame). At this moment, the heater is working and producing heat.

If the heater is switched off by the on/off switch, the solenoid valve interrupts fuel supply, combustion stops and indicator lamp turns off. Combustion air fan still blows air, cleaning the combustion chamber of any fumes and cooling down the combustion chamber. Coolant circulation pumps coolant, making a purge cycle for approximately 2-3 minutes, thus protecting the heater against overheating.

If the heater is not switched off by the on/off switch, the control thermostat will switch off the heater when coolant temperature reaches 165° ± 6°F (75° ± 3°C) and turns it on at 154° ± 9°F (68° ± 5°C). During this time, the heater (combustion) is off and the indication lamp and coolant pump are on. Combustion air fan blows air for 2-3 minutes and then turns off.

- **Preheating System Timer**

The timer, located on L.H. lateral console is used to program the starting and stopping time of the preheating system. The system indicator light, located on the timer, illuminates when the system is functional.

CAUTION

The preheating system should not operate for more than one hour before starting engine as this could discharge batteries.

DANGER

Preheating system must not operate when vehicle is parked inside or during fuel fill stops.

NOTE

Preheating system uses the same fuel as the engine.

In case of failure:

1. Shut off and turn on again.
2. Check main circuit breaker and overheat fuse.
3. Have system repaired in a specialized shop.

- **Timer Operating Instructions**

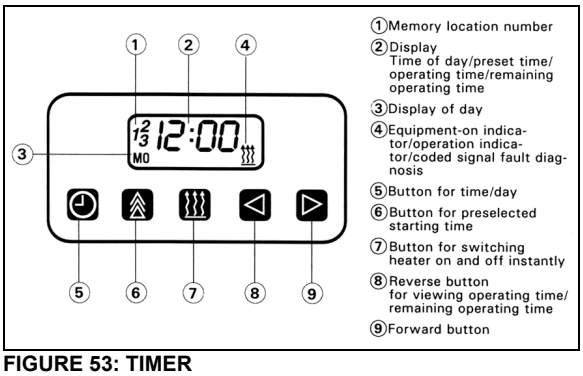


FIGURE 53: TIMER

These instructions refer to the timer illustrated in figure 53. They are the same instructions provided in the Spheros instruction booklet, provided with your vehicle.

Remaining Operating Time

The remaining operating time refers to the period of time the heater still continues to remain in operation. It may be changed while the heater is in operation.

Setting the Digital Timer

After the power has been connected, all symbols on the digital display are flashing. The time of the day and the day of the week must be set.

All flashing symbols of the timer can be set by means of the Forward (9) or Reverse (8) buttons.

When buttons (8) and (9) are pressed for more than 2 seconds, the quick digit advance mode is activated.

Setting the Time and Day of the Week

1. Press button (5) for more than 2 seconds (time display flashes).
2. Press (8) or (9) button to set the time of day.
3. Wait 5 seconds. The time of day is stored (time of week flashes).
4. Press (8) or (9) button to set the correct day of week.
5. Wait 5 seconds. The day of week is stored.

Viewing the Time (Ignition ON)

Continuous display of current time and day of the week.

Viewing the Time (Ignition OFF)

Briefly press button (5) to display current time and day for 5 seconds.

- **Switching Heater On (Instant Heating)**

With Ignition ON:

Press button (7). Heater is switched on (continuous operation) and continues to operate until button (7) is pressed again or ignition is switched off.

NOTE
If the ignition is switched off while heater is in operation, the remaining operating time of 5 minutes flashes on the display and the heater will continue to operate for this period of time.

With Ignition OFF:

Press button (7). Heater is switched on for preset operating time (the factory-set heater operating duration is 60 minutes)

- **Switching Heater Off**

Press button (7). The heater starts its after-run cycle and switches off thereafter.

Presetting Operating Duration

1. Press button (6). Memory location number flashes.

NOTE
By repeatedly pressing button (6), starting time 2 or 3 can be preset.

2. Press button (8) or (9) until correct startup time is set.
3. Wait 5 seconds. Preset starting time is stored and day of week flashes.
4. Press button (8) or (9) to select the correct startup day of week.
5. Wait 5 seconds. The startup day of week is stored.

The number of memory location remains on the display. The timer is now in the programmed mode and will switch the heater in at the preset time.

NOTE
We recommend that memory locations 1 and 2 be used for presetting times within 24 hours of setting the timer. Memory location 3 can be used for a starting time within the next 7 days of setting the timer.

Recalling Preset Times

Press (6) repeatedly until the desired memory location number and preset time are displayed.

Canceling Preset Time

Press button (6) repeatedly until no more memory location number is visible on the display.

Setting Operating Time

1. With heater off, press button (8). Operating time flashes.
2. Press button (8) or (9) to set the operating time (between 1 and 120 minutes).

The heater remains in operation for the preset time (except for continuous operation).

Setting the Remaining Operating Time

1. With heater in operation, press button (8). Remaining operating time flashes.
2. Set remaining time with button (8) or (9).
3. Wait 5 seconds. Remaining operating time is stored.

Operational Failure Symptoms via Fault/Flash code

On heaters equipped with a fault diagnosis system using coded light signals, the equipment-on indicator/operation indicator flashes. Refer to the following table.

Failure Symptom	Probable Cause	Check and Correct
1X Flash (F 01) No combustion after completion of start up sequence.	- Fuel system - Combustion air - Electronic ignition	- Fuel level - Type of fuel being used - Fuel filter - Fuel line connections (air bubbles in fuel lines) - Fuel nozzle plugged - Air intake or exhaust, restricted or plugged - Incorrect electrode gap
2X Flashes (F 02) Flame out during burner operation no restart possible	- Fuel supply (shortage of fuel)	- Restriction in the fuel system - Fuel filter - Fuel line connections (air bubbles in fuel lines) - Type of fuel being used
3X Flashes (F 03) Low voltage for more than 20 seconds	- Electrical system	- Load test batteries - Corrosion at connections - Loose connections
4X Flashes (F 04) Flame detector recognizes false flame signal during pre-start or shut-down cycle	- Defective flame detector	- Replace flame detector
5X Flashes (F 05) Flame detector	- Wiring - Defective flame detector	- Damaged wiring, open or short circuit - Replace flame detector
6X Flashes (F 06) Temperature sensor	- Wiring - Defective temperature sensor	- Damaged wiring, open or short circuit - Replace temperature sensor
7X Flashes (F 07) Fuel solenoid valve	- Wiring - Defective solenoid valve	- Damaged or corroded wiring, open or short circuit - Replace solenoid valve
8X Flashes (F 08) Combustion air fan motor	- Wiring - Wrong RPM - Defective combustion air fan motor	- Damaged wiring, open or short circuit - Replace combustion air fan - Replace combustion air fan
9X Flashes (F 09) Circulation pump motor	- Wiring - Defective circulation pump motor	- Damaged wiring, open or short circuit - Replace circulation pump motor
10X Flashes (F 10) Temperature limiter	- Overheat condition - Coolant flow - Wiring - Defective temperature limiter	- Reset temperature limiter - Coolant level or flow restriction - Air trapped in coolant circuit - Damaged or corroded wiring, open or short circuit - Replace temperature limiter
11X Flashes (F 11) Electronic ignition coil	- Wiring - Defective electronic ignition coil	- Damaged wiring, open or short circuit - Replace electronic ignition coil
12X Flashes (F 12) Heater lock out	- 3 repeated faults/flame-outs or 5 repeated start attempts	- Reinitialize control unit by switching heater on and disconnecting power.

- **Troubleshooting and Maintenance**

Refer to the Spheros manual for more information.

NOTE

If there are no heater faults, the heater will go through a normal start cycle and regulate based on thermostat setting.

NOTE

Switch on the preheating system briefly about once a month, even during the warm season.

CAUTION

When welding on the vehicle, disconnect the preheater module connector in order to protect this system from voltage surges.

CAUTION

To avoid running down the batteries, do not turn on the preheating system for more than one hour before starting the engine.

DANGER

The preheating system uses the same fuel as the engine. Do not operate in a building or while refueling. Operate only in a well-ventilated area.

11.2 SMALL HEATING SYSTEM

11.2.1 Draining Heating System

To drain the entire system, refer to Section 05, *"Cooling*". If only the driver's HVAC unit heater core must be drained, refer to the following instructions.

- **Draining Driver's HVAC Unit Heater Core**

a) Stop engine and allow engine coolant to cool.

b) Locate the normally open hot water pneumatic valve on the ceiling of the spare wheel compartment (Fig. 54), move the pilot-solenoid valve red tab to close the valve.

WARNING

Before proceeding with the following steps, check that coolant has cooled down.

c) Loosen hose clamp, install an appropriate container to recover coolant, and disconnect silicone hose from hot water pneumatic valve.

d) From inside of vehicle, remove the two finishing panels in front of unit. Remove the three screws fixing the unit front panel. Open the manual vent located inside the HVAC unit, on the driver's side (Fig. 42) to ensure an efficient draining.

11.2.2 Filling Heating System

a) Ensure that the drain hose is reconnected and the manual vent is closed.

b) Open the surge tank filler cap and slowly fill the system to level of filler neck.

c) After initial filling, the water valve should be open and the water recirculating pump should be energized to assist in circulating coolant through the heating system. To perform this operation, start the engine, switch on the HVAC control module and set temperature to the maximum position in order to request the heating mode.

d) When coolant level drops below the surge tank filler neck, slowly fill the system to level of filler neck.

e) Once the level has been stabilized, replace cap.

11.2.3 Driver's Hot Water Pneumatic Valve Assembly

The small system driver's hot water pneumatic valve assembly is similar to the one installed in a central heating system.

Refer to figure 54 for hot water pneumatic valve location and to paragraph 11.1.5 for more information.

11.2.4 Water Recirculating Pump

The small system water recirculating pump is similar to the one installed in a central heating system.

Refer to figure 54 for pump location and to paragraph 11.1.7 for more information.

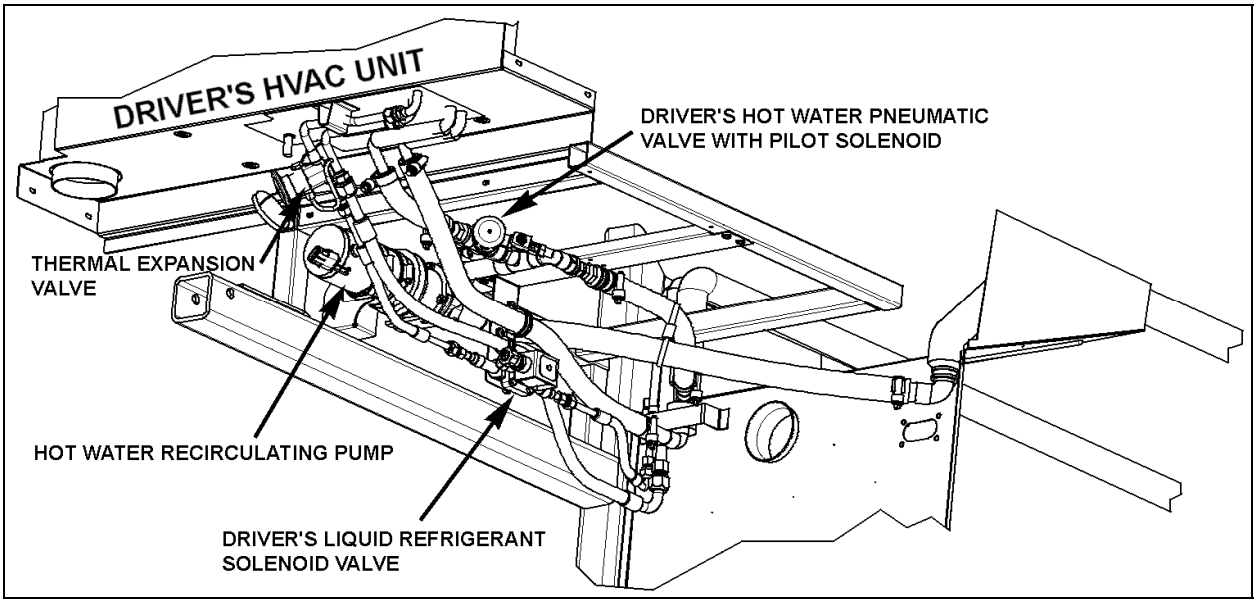


FIGURE 54: CEILING OF THE SPARE WHEEL COMPARTMENT

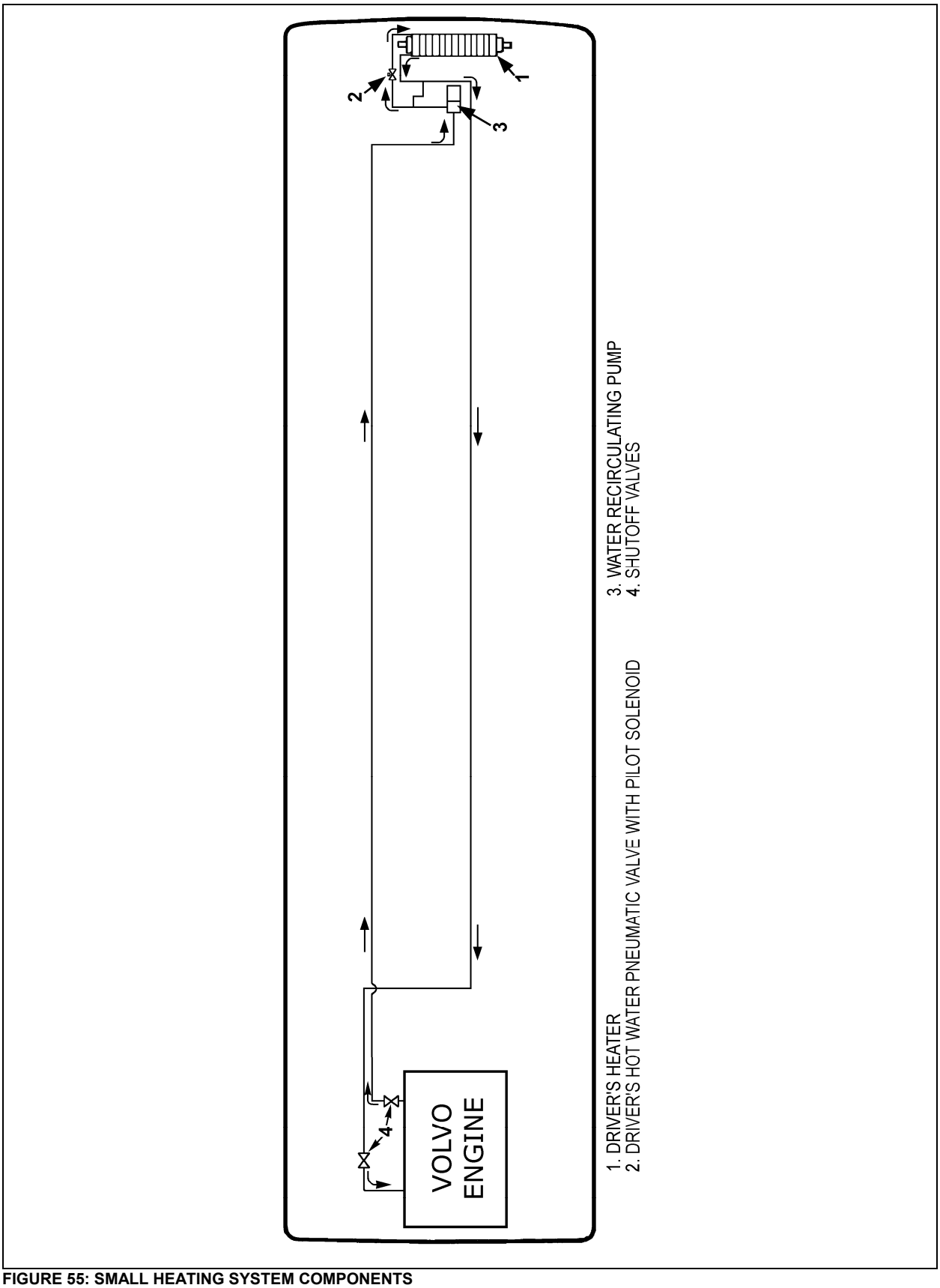


FIGURE 55: SMALL HEATING SYSTEM COMPONENTS

12. SPECIFICATIONS

Main evaporator motor

Make..... AMETEK ROTRON
Type .....BRUSHLESS DC MICROPROCESSOR CONTROLED
Voltage ..... 27.6 V DC
Current draw ..... 68 amps
Horsepower.....2
Revolution ..... 1400 & 1700 rpm
Insulation.....Class F
Motor Prevost number.....563586

Condenser fan motors

Make..... EBMPAPST
Type .....AXIAL BRUSHLESS
Voltage ..... 24 V DC
Qty.....4
Prevost number.....563461

Evaporator air filter (Central system)

Make..... Permatron Corp.
Type ..... Polypropylene
Prevost number.....874272

Driver's unit evaporator motors

Make.....MCC
Voltage ..... 24 V DC
Quantity.....1
Prevost number.....871135

Driver's unit evaporator air filters

Make.....MCC
TYPE ..... Recirculating air 6-¼" x 28" Washable
Prevost number.....871147

Make.....MCC
TYPE ..... Fresh air 3-5/8" X 5-1/4" Washable
Prevost number.....871144

Refrigerant

Type R-134a
Quantity (standard) ..... 24 lbs (10.89 Kg)
Quantity (A/C Aux. system located in overhead compartments).....4 lbs (1.8 Kg)

Compressor (Central system)

Make..... Carrier Transicold
Capacity, option R-134a ..... 41 CFM
Capacity, option R-22..... 37 CFM
Model, option R-134.....05G-134A
Model, option R-22..... 05G-22
No. of cylinders 6
Bore..... 2” (50,8 mm)
Operating speed.....400 to 2200 rpm (1750 rpm. Nominal)
Minimum speed (for lubrification).....400 rpm
Nominal horsepower 15
Oil pressure at 1750 rpm ..... 15 to 30 psi (103-207 kPa)
Oil capacity..... 1.13 U.S. gal (4,3 liters)
Weight ..... 142 lbs (64,5 kg)
Approved oils
-Castrol..... SW 68 (POE)
Prevost number, option R-134a 950314
Prevost number, option R-22 950207

A/C Compressor (Small or Auxiliary system)

Make.....ICE (International Components Engineering)
Model..... TM-16HD
Prevost number..... 950436
Approved oil .....OIL-ICE (PAG)
Prevost number..... 950382

Compressor unloader valve

Make..... Carrier Transicold
Type .....Electric (AMC)
Voltage ..... 24 V DC)
Watts 15
Prevost number (without coil) 950095
Coil Prevost numbert..... 950096

Magnetic clutch

Make..... Carrier Transicold
Type .....Housing mounted 9” dia., 2-B grooves
Voltage ..... 24 V DC
Coil resistance at 68 ^{o}F (20 ^{o}C)..... 5.15 – 5.69 ohms
Prevost number..... 950204

Compressor V belt (Carrier)

Make.....Dayco

Model.....BX100

Prevost number (with two BOSH Alternators).....506864

Condenser coil (Auxiliary system)

Make.....Valeo

Prevost number.....

Condenser coil (Central system)

Make..... Carrier Transicold

Aluminum

Prevost number.....870654

Copper

Prevost number.....870729

Evaporator coil (Central system)

Make..... Carrier Transicold

Prevost number.....871070

Receiver tank (with sight glasses)

Make..... HENRY

Maximum pressure..... 450 psig

Prevost number.....950261

Moisture indicator

Make..... Henry

Prevost number.....950029

Driver's refrigerant liquid solenoid valve

Make..... Parker

Type ..... Normally closed with manual bypass

Voltage ..... 24 V DC

Amperage draw..... 0.67 amps

Watts 16

Prevost number (without coil) 95-0054

Coil Prevost number.....950055

Repair kit Prevost number 950056

Hot water pneumatic valve (Central system)

Make..... Burkert

Type 3-WAY

Voltage ..... 24 V DC
Prevost number 871381
Seal kit, Water Side 871389
Seal kit, Actuator Side 871388
Seal kit, Pilot Solenoid Valve 871390

Driver's hot water pneumatic valve

Make ..... Burkert
Type ..... Normally open
Voltage ..... 24 V DC
Prevost number 871252
Seal kit, Water Side 871311
Seal kit, Actuator Side 871312
Seal kit, Pilot Solenoid Valve 871313

Water recirculating pump

Make ..... M.P. pumps
Voltage ..... 24 V DC
Prevost number 871342

Water filter (small A/C system)

Make ..... BRAUKMANN
Prevost number 870807

Driver's expansion valve

Prevost number, option R-134a 950221
Prevost number, option R-22 950282

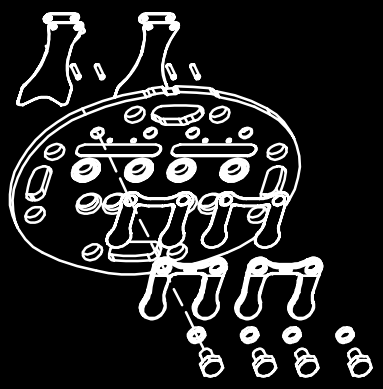
Expansion valve (Central system)

Make ..... Alco
Model ..... TCLE 5-1/2
Prevost number 950320

Preheating system

Make ..... SPHEROS
Model ..... THERMO 300
Capacity ..... 104 000 Btu/h (30 kW)
Heating medium ..... Coolant
Rated voltage ..... 24 V DC
Operating voltage ..... 20-28 V DC
Electric power consumption (without coolant recirc. Pump) ..... 110 watts
Fuel consumption ..... 1,2 US gallons/hr (4,5 liters/hr)
Prevost number 871202

Carrier® Compressor



WORKSHOP MANUAL

for

MODEL 05G TWIN PORT COMPRESSOR

62-11052 Rev A

Carrier
TRANSICOLD

WORKSHOP MANUAL

MODEL 05G TWIN PORT

COMPRESSOR

SAFETY SUMMARY

GENERAL SAFETY NOTICES

The following general safety notices supplement the specific warnings and cautions appearing elsewhere in this manual. They are recommended precautions that must be understood and applied during maintenance of the equipment covered herein. The general safety notices are presented in the following three sections labeled: First Aid, Operating Precautions and Maintenance Precautions. A listing of the specific warnings and cautions appearing elsewhere in the manual follows the general safety notices.

FIRST AID

An injury, no matter how slight, should never go unattended. Always obtain first aid or medical attention immediately.

OPERATING PRECAUTIONS

Always wear safety glasses.

No work should be performed on the unit until all circuit breakers and start-stop switches are turned off, and power supply is disconnected.

Always work in pairs. Never work on the equipment alone.

MAINTENANCE PRECAUTIONS

Be sure power is turned off before working on motors, controllers, solenoid valves and electrical control switches. Tag circuit breaker and power supply to prevent accidental energizing of circuit.

Do not bypass any electrical safety devices, e.g. bridging an overload, or using any sort of jumper wires. Problems with the system should be diagnosed, and any necessary repairs performed, by qualified service personnel.

WARNING AND CAUTION STATEMENTS

To help identify the label hazards on the unit and explain the level of awareness each one carries, an explanation is given with the appropriate consequences:

⚠ DANGER

DANGER – warns against an immediate hazard which WILL result in severe personal injury or death.

⚠ WARNING

WARNING – warns against hazards or unsafe conditions which COULD result in severe personal injury or death.

⚠ CAUTION

CAUTION – warns against potential hazard or unsafe practice which could result in minor personal injury, or product or property damage.

NOTE

NOTE – gives helpful information that may help and avoid equipment and property damage.

SPECIFIC WARNING AND CAUTION STATEMENTS

The statements listed below are specifically applicable to this unit and appear elsewhere in this manual. These recommended precautions must be understood and applied during operation and maintenance of the equipment covered herein.

⚠ WARNING

Do not operate compressor unless suction and discharge service valves are open.

⚠ WARNING

Midseat service valves or by other means relieve pressure in replacement compressor before removing plugs.

⚠ WARNING

Do not unscrew capscrews all the way before breaking seal. Entrapped pressure could result in injury.

⚠ CAUTION

The high capacity oil pump must be set to rotate in the same direction as the crankshaft. (Refer to Section 3.5)

⚠ CAUTION

Ensure that thrust washer does not fall off dowel pins while installing oil pump.

⚠ CAUTION

Do not allow crankshaft to drop on connecting rods inside the crankcase when removing the crankshaft.

⚠ CAUTION

Do not allow crankshaft to drop on connecting rods inside the crankcase when installing the crankshaft.

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SECTION 1

DESCRIPTION

1.1 INTRODUCTION

This workshop manual covers the Carrier Transicold Model 05G Twin Port compressors. These compressors are designed for refrigeration (trailer) or air conditioning (bus & rail) applications. (See Figure 1-1) A detailed list of tools needed to service the 05G Twin Port compressor may be found in the Service Tool catalog 62-03213-. Replacement parts may be found in the Service Parts List for Model 05G Twin Port Compressor 62-11053-.

1.2 GENERAL DESCRIPTION

The 05G Twin Port compressors are of the open-drive reciprocating type. A crankshaft, connecting rods, pistons, and reed type valves accomplish vapor compression. Compressor wear is minimized by splash lubrication and by force feed lubrication. The oil pump is driven directly from the end of the compressor crankshaft. (See Figure 1-3)

The end of the crankshaft, which extends outside the crankcase, is adaptable to a variety of direct drive or belt-driven clutch mechanisms. A mechanical seal prevents refrigerant leakage where the rotating shaft passes through the crankcase. A shaft seal reservoir is provided to collect any oil seepage that might escape the seal.

The compressor is equipped with flanges for connecting suction and discharge service valves. Connections are also provided for pressure gauges and safety cutout switches. Sight glasses installed on both sides of the crankcase, provides a means for checking oil level in the compressor crankcase. A drain plug facilitates draining of oil from the crankcase and an oil fill plug enables addition of oil when necessary. A bottom plate provides access through the bottom of the crankcase for maintenance.

⚠ WARNING

Do not operate compressor unless suction and discharge service valves are open.

Capacity of the Model 05G Twin Port compressor is determined by piston displacement and clearance, suction and discharge valve size, compressor speed, suction and discharge pressure, type of refrigerant, and unloader valves.

1.3 COMPRESSOR REFERENCE DATA

Table 1-1. Compressor Reference Data

Model	05G-37CFM	05G-41CFM
Displacement	37CFM	41CFM
No. Cylinders	6	
Bore	50.8 mm (2.00 in)	
Stroke	49.2 mm (1.937 in)	54.36 mm (2.14 in)
Weight	62 kg (137 lbs)	
SPEED (RPM) FOR OIL PUMP		
Low Profile	500 to 2200	

NOTE

The oils below are suitable for use with evaporator temperatures above -40°F (-40°C).

Table 1-2. Oils

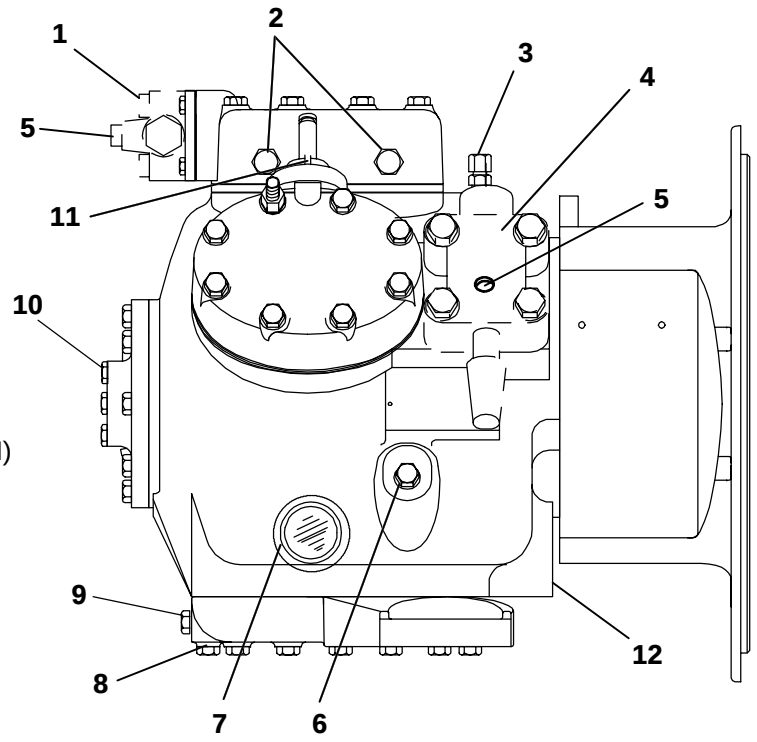
Approved Oil for REFRIGERATION USE (TRAILER)	
Refrigerant	**Oil**
R-12, R-22, R-500 or R-502	Alkyl Benzene (Synthetic) P/N 07-00274-00
R-404A	Polyolester (POE) P/N 07-00317-00PK6

Approved Oil for AIR CONDITIONING USE (BUS AND RAIL)	
Refrigerant	**Oil**
R-12, R-22, R-500 or R-502	Mineral (150 Viscosity) P/N 07-00275-00
R-12, R-22, R-502	Mineral (300 Viscosity) P/N 07-00377-00
R-22	Alkyl Benzene (Synthetic) P/N 07-00430-00
R-134a	Polyolester (POE) P/N 07-00317-00PK6

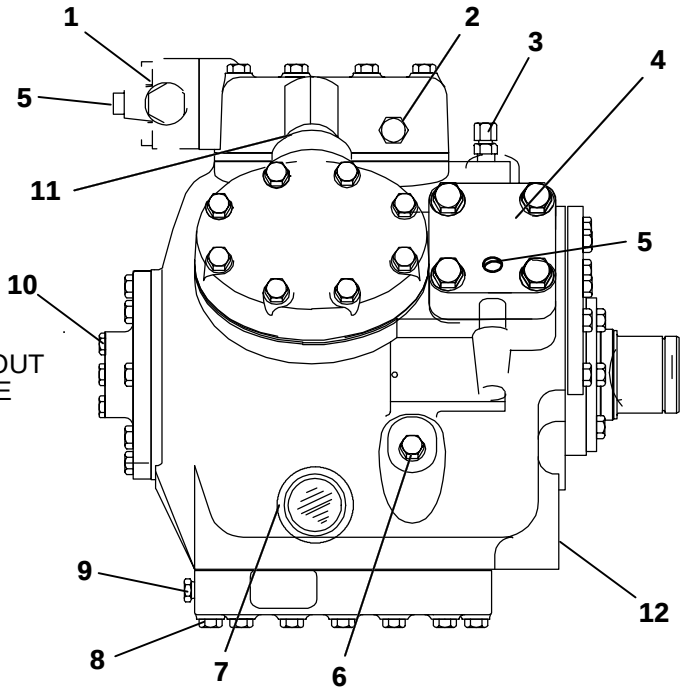
NOTE

Proper use and storage of Polyester (POE) type oil used with HFC refrigerants is critical. This type of oil is extremely hygroscopic, meaning that if allowed to become exposed to the atmosphere, it can collect moisture that leads to the formation of acids that will damage refrigeration components. Some refrigeration assemblies such as o-ring assemblies, compressor shaft seals and most solenoid valves require that refrigerant oil be applied to some of the parts during the assembly process. When this is needed, always use alkylated benzene oil CTD P/N 07-00274 (Zerol 150) even for R134a or R404A systems. All refrigerant oils must be stored in a sealed, airtight container.

COMPRESSOR WITH MOUNTING FLANGE (ULTRA TYPE SHOWN)



COMPRESSOR WITHOUT MOUNTING FLANGE



1. Discharge Service Valve
2. High Pressure Connection
3. Low Pressure Connection
4. Suction Service Valve
5. Guage Connection
6. Oil Fill Plug
7. Oil Level Sight Glass
8. Bottom Plate
9. Oil Drain Plug
10. Oil Pump (See Figure 1-3)
11. Unloader
12. Shaft Seal Reservoir

Figure 1-1. Model 05G Compressor

1.4 DETAILED DESCRIPTION

1.4.1 Service Valves

The suction and discharge service valves used on the compressor are equipped with mating flanges for connection to flanges on the compressor. These valves are provided with a double seat and a gauge connection, which allows servicing of the compressor and refrigerant lines (See Figure 1-1).

Turning the valve stem counterclockwise (all the way out) will *backseat* the valve to open the suction or discharge line to the compressor and close off the gauge connection. In normal operation, the valve is backseated to allow full flow through the valve. The valve should always be backseated when connecting the service manifold gauge lines to the gauge ports.

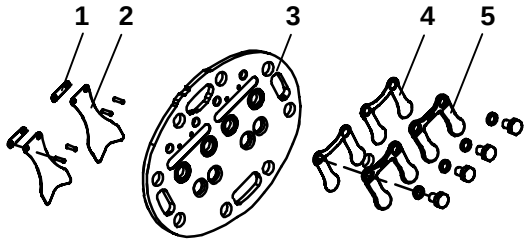
Turning the valve stem clockwise (all the way forward) will *frontseat* the valve to close off the suction or discharge line to isolate the compressor and open the gauge connection.

To measure suction or discharge pressure, midseat the valve by opening the valve clockwise about 2 turns. With the valve stem midway between frontseated and backseated positions, the suction or discharge line is open to both the compressor and the gauge connection.

1.4.2 Suction And Discharge Valves

The compressor uses reed type suction and discharge valves made of highest quality steel for long life. The valves operate against hardened integral seats in the valve plate.

The downstroke of the piston admits refrigerant gas through the suction valve, and then compresses this gas on the upstroke, thereby raising it's temperature and pressure. The compressed gas is prevented from re-entering the cylinder on it's next downstroke by the compressor discharge valve. (See Figure 1-2)



1. Valve Spring
2. Suction Valve
3. Valve Plate
4. Discharge Valve
5. Discharge Valve Backer

Figure 1-2. Suction & Discharge Valve

1.4.3 Lubrication System

Force-feed lubrication of the compressor is accomplished by an oil pump (See Figure 1-3) driven directly from the compressor crankshaft. Refrigeration oil is drawn from the compressor crankcase through the oil filter screen and pick up tube to the oil pump located in the bearing head assembly. The crankshaft is drilled to enable the pump to supply oil to the main bearings, connecting rod bearings, and the shaft seal.

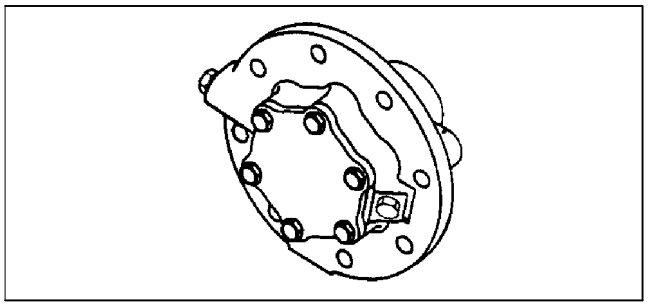


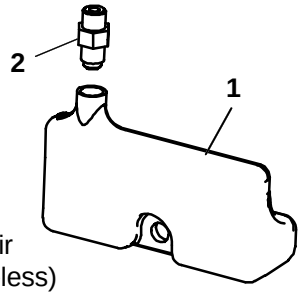
Figure 1-3. Oil Pump

The oil flows to the pump end main bearings, connecting rod bearings and seal end main bearings, where the oil path is divided into two directions. The largest quantity flows to the oil relief valve, which regulates oil pressure at 15 to 18 psi (1.02 to 1.22 bar) above suction pressure. When the oil pressure reaches 15 to 18 psi (1.02 to 1.22 bar) above suction pressure, the relief valve spring is moved forward allowing oil to return to the crankcase. The remaining oil flows through an orifice and into the shaft seal cavity to provide shaft seal lubrication and cooling. This oil is then returned to the crankcase through an overflow passage.

An additional oil pressure relief valve, built into the oil pump. It opens at speeds above 400 rpm to relieve a portion of the oil pressure to the crankcase in order to maintain oil pressure below an acceptable maximum. At low speeds, the valve is closed to ensure adequate oil pressure at 400 rpm. At speeds above 1900 rpm, the oil pressure will be 25 to 30 psi (1.70 to 2.04 bar) above suction pressure.

The crankcase pressure equalization system consists of two oil return check valves and a 1/8-inch pressure equalization port between the suction manifold and crankcase. Under normal conditions, check valves are open and allow for oil return to the crankcase. Under flooded start conditions, pressure rises in the crankcase and closes the check valves, preventing excess oil loss. The equalization port allows for release of excessive pressure, that has built up in the crankcase, to the suction manifold; this ensures that the oil loss is kept to a minimum.

1.4.4 Shaft Seal Reservoir



1. Shaft Seal Reservoir
2. Access Valve (Coreless)

Figure 1-4. Shaft Seal Reservoir

The shaft seal oil reservoir has been fitted to the crankcase. The coreless access valve taps into the crankshaft seal cavity where any oil that escapes the crankshaft seal will form. The coreless access valve then drains that compressor oil that escapes the crankshaft seal into the shaft seal reservoir.

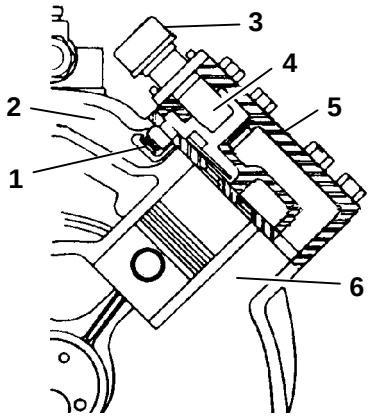
1.5 COMPRESSOR UNLOADERS

The compressor is equipped with unloaders for capacity control. This consists of a self-contained, cylinder head hot gas bypass arrangement. (See Figure 1-5)

The compressor unloader system can be controlled with either a pressure actuated valve or an electrically actuated (solenoid) valve.

1.5.1 Electric-Controlled Unloaders

The capacity controlled cylinder is easily identified by an electric solenoid which extends from the side of the cylinder head. When the solenoid energizes, the cylinder unloads allowing discharge gas to circulate as shown in Figure 1-6. The unloaded cylinder operates with little or no pressure differential, consuming very little power. A de-energized solenoid reloads the cylinder as shown in Figure 1-7.



1. Discharge Check Valve
2. Discharge Manifold
3. Solenoid Valve
4. Piston Bypass Control Valve
5. Cylinder Head
6. Suction Manifold

Figure 1-5. Compressor Unloader

a. Major Working Parts

1. Solenoid and valve system
2. Spring loaded piston type bypass control valve
3. Spring loaded discharge check valve

b. Unloaded Operation

Pressure from the discharge manifold (Figure 1-6, item 15) passes through the strainer (9) and bleed orifice (8) to the back of the piston bypass valve (7). Unless bled away, this pressure would tend to close the piston (6) against the piston spring (5) pressure.

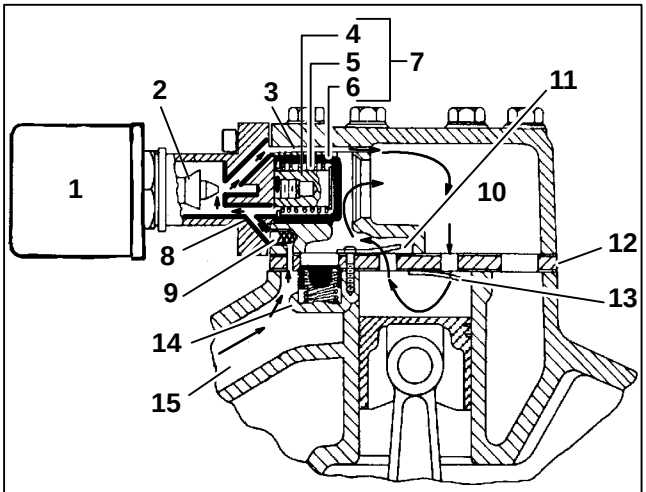
With the solenoid valve (1) *energized* the solenoid valve stem (2) will *open* the gas bypass port (3).

Refrigerant pressure will be bled to the suction manifold (10) through the opened gas bypass port . A reduction in pressure on the piston bypass valve will take place because the rate of bleed through the gas bypass port is greater than the rate of bleed through the *bleed orifice* (8)**.**

When the pressure behind the piston has been reduced sufficiently, the valve spring will force the piston bypass valve *back*, *opening* the gas bypass from the discharge manifold to the suction manifold.

Discharge pressure in the discharge manifold will close the discharge piston check valve assembly (14) isolating the compressor discharge manifold from the individual cylinder bank manifold.

The *unloaded* cylinder bank will continue to operate *fully unloaded* until the solenoid valve control device is *de-energized* and the gas bypass port is closed.



1. Solenoid Valve
2. Valve Stem
3. Gas Bypass Port
4. Spring Guide
5. Spring
6. Piston
7. Piston Bypass Valve
8. Bleed Orifice
9. Strainer
10. Suction Cavity
11. Cylinder Discharge Valve
12. Valve Plate
13. Cylinder Suction Valve
14. Discharge Piston Check Valve Assembly
15. Discharge Manifold

Figure 1-6. Electric-Operated Unloader-Unloaded Operation

c. Loaded Operation

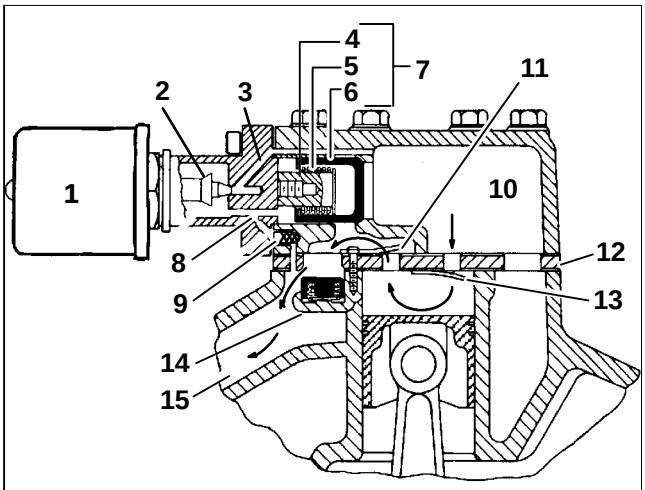
Discharge pressure bleeds from the discharge manifold (Figure 1-7, item 15) through the strainer (9) and bleed orifice (8) to the solenoid valve stem (2) chamber and the back of the piston bypass valve (7).

With the solenoid valve (1) *de-energized* the solenoid valve stem (2) will *close* the gas bypass port (3).

Refrigerant pressure will overcome the bypass valve spring (5) tension and force the piston (6) *forward closing* the gas bypass from the discharge manifold to the suction manifold (10).

Cylinder discharge pressure will force open the discharge piston check valve assembly (14). Refrigerant gas will pass into the compressor discharge manifold.

The loaded cylinder bank will continue to operate fully loaded until the solenoid valve control device is energized and the gas bypass port is opened.



1. Solenoid Valve
2 Valve Stem
3. Gas Bypass Port
4. Spring Guide
5. Spring
6. Piston
7. Piston Bypass Valve
8. Bleed Orifice
9. Strainer
10. Suction Cavity
11. Cylinder Discharge Valve
12. Valve Plate
13. Cylinder Suction Valve
14. Discharge Piston Check Valve Assembly
15. Discharge Manifold

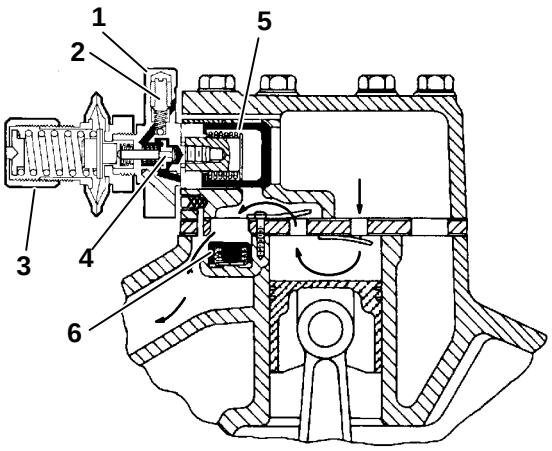
Figure 1-7. Electric-Operated Unloader-Loaded Operation

1.5.2 Pressure-Operated Unloaders

The pressure-operated unloaders are controlled by suction pressure and actuated by discharge pressure. The unloader valve controls two cylinders. On startup, controlled cylinders do not load up until differential between suction and discharge pressure is 10 psi (0.68 bar).

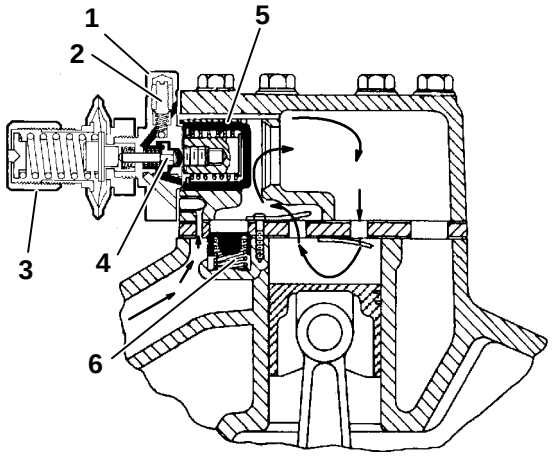
During *loaded operation*, (Figure 1-8) when suction pressure is above the valve control point, the poppet valve (4) will close. Discharge gas bleeds into the valve chamber; the pressure closes the piston bypass valve (5) and the cylinder bank loads up. Discharge gas pressure forces the discharge piston check valve (6) open, permitting gas to enter the discharge manifold.

During *unloaded operation*, (Figure 1-9) when suction pressure drops below the valve control point, the poppet valve (4) will open. Discharge gas bleeds from behind the bypass piston to the suction manifold. The bypass piston valve (5) opens, discharge gas is recirculated back to the suction manifold and the cylinder bank is unloaded. Reduction in discharge pressure causes the discharge piston check valve (6) to close, isolating the cylinder bank from the discharge manifold.



1. Sealing Cap
2. Pressure Differential Adjustment Screw
3. Control Set Point Adjustment Nut
4. Poppet Valve
5. Piston Bypass Valve
6. Discharge Piston Check Valve

Figure 1-8. Pressure-Operated Unloader Loaded Operation



1. Sealing Cap
2. Pressure Differential Adjustment Screw
3. Control Set Point Adjustment Nut
4. Poppet Valve
5. Piston Bypass Valve
6. Discharge Piston Check Valve

Figure 1-9. Pressure-Operated Unloader - Unloaded Operation

SECTION 2

COMPRESSOR REPLACEMENT

2.1 COMPRESSOR REMOVAL

Refer to the operation and service manual covering the equipment in which the compressor is installed for specific removal instructions. A general removal procedure is given below.

a. If compressor is completely inoperative, frontseat the suction and discharge service valves to trap the refrigerant in the unit. If the compressor will operate, pump down the unit; then, frontseat the suction and discharge service valves.

b. Ensure power source is removed from any controls installed on the compressor.

c. Remove refrigerant from the compressor using a refrigerant recovery system.

d. Disconnect refrigerant lines at service valve flange connections on the compressor; retain hardware.

e. Remove any components necessary to gain access to the compressor or to enable removal.

f. Disconnect the drive mechanism at the compressor.

g. Remove mounting hardware and remove compressor from unit.

h. If compressor is to be repaired, refer to section 3 for repair procedures. if a replacement compressor is to be installed, refer to section 2.2 for replacement procedures.

2.2 COMPRESSOR REPLACEMENT

Consult the unit service parts list for the correct replacement.

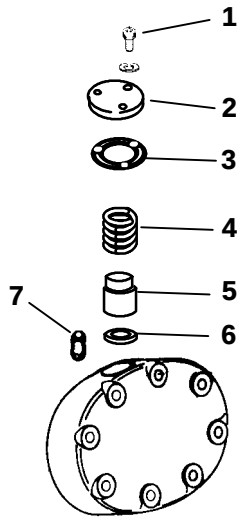
Service replacement compressors are furnished without suction and discharge service valves and unloader valves. The service valves are normally retained on the unit to isolate the refrigerant lines during compressor replacement. Blank-off pads are installed on the service replacement compressor valve flanges. These pads must be removed prior to installing the compressor. If the defective compressor is to be returned for overhaul or repair, install the pads on the compressor for sealing purposes during shipment.

Service replacement compressors are furnished with cylinder head bypass piston plugs installed on the unloader flanges in lieu of the unloader valves. The unloaders (if used) must be removed from the defective compressor and transferred to the replacement compressor prior to installation. Refer to section 2.2.1.

If the defective compressor is to be returned for overhaul or repair, install the plugs on the compressor for sealing purposes during shipment.

2.2.1 Installing Compressor Unloaders

a. Remove the three socket head capscrews holding piston plug to cylinder head of the replacement compressor. See Figure 2-1.



1. Capscrews
2. Flange Cover
3. Gasket
4. Spring
5. Bypass Piston Plug
6. Seat Ring
7. Strainer

Figure 2-1. Removal of Piston Plug

b. Remove flange cover, gasket, spring, bypass piston plug, and seat ring. A tapped hole is provided in piston plug for use with a jackscrew to enable removal of the plug. One of the socket head capscrews may be used as a jackscrew.

c. Remove the three socket head capscrews holding unloader in the cylinder head of the defective compressor; remove the unloader and retain the capscrews.

NOTE

Capscrews removed from the bypass piston plug flange cover are not interchangeable with capacity control unloader valve capscrews. When installing the unloaders, be sure to use the unloader capscrews.

d. Using a new gasket and unloader ring pliers (P/N 07-00223), install the unloaders in the cylinder heads of the replacement compressor. Refer to Table 3-1, for required torque values.

e. If the defective compressor is to be returned for overhaul or repair, install the bypass piston plug, spring, seat ring and flange cover onto the cylinder heads.

2.2.2 INSTALLING COMPRESSOR

⚠ WARNING

Midseat service valves or by other means relieve pressure in replacement compressor before removing plugs.

⚠ CAUTION

The high capacity oil pump must be set to rotate in the same direction as the crankshaft. (Refer to Section 3.5)

a. Install the compressor by reversing the procedure of section 2.1. Install new locknuts on compressor mounting bolts and new gaskets on suction and discharge service valves.

b. Check oil level in sight glass (See Figure 2-2). If necessary, add or remove oil.

c. Leak test, evacuate, and dehydrate the compressor.

d. Fully backseat suction and discharge service valves.

e. Run the compressor and check for leaks and noncondensibles in the refrigerant system.

f. Check refrigerant level.

g. Recheck compressor oil level.

h. Check operation of compressor unloaders (if installed).

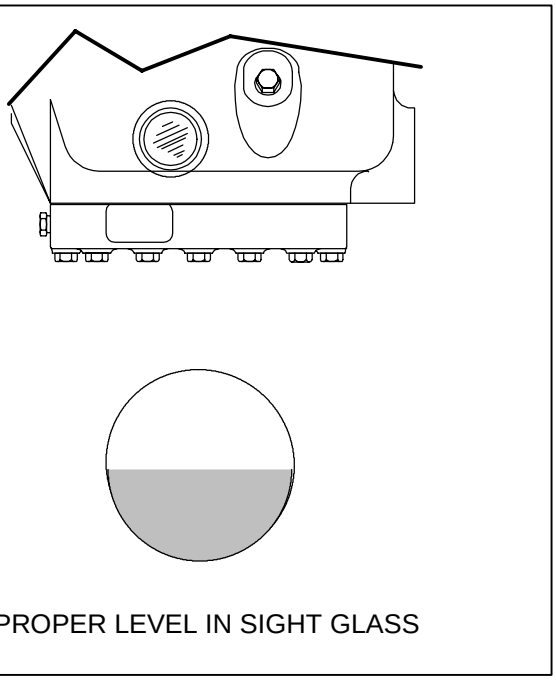


Figure 2-2. Oil Level in Sight Glass

SECTION 3

COMPRESSOR MAINTENANCE

3.1 SHAFT SEAL RESERVOIR

The shaft seal reservoir will accumulate up to 3.5 ounces of oil. It should be serviced (checked and drained) at least once a year. To service the reservoir:

a. Remove the capscrew and washer that secures the reservoir to the crankcase.

b. Remove the reservoir and properly dispense of the contents.

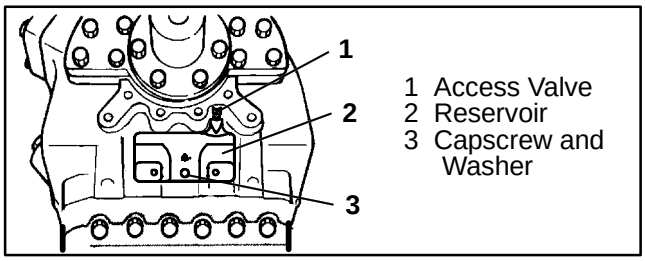


Figure 3-1. Shaft Seal Reservoir

NOTE

Do not return this oil to the compresser. This oil is contaminated. Dispose this oil in an environmentally correct manner.

c. Return the reservoir to its mounting location insuring that the neck of the reservoir is seated over the access valve.

d. Reinstall the capscrew and washer.

Refer to Table 3-1 for torque values for tightening the capscrew.

3.2 INTRODUCTION

Prior to disassembly of the compressor, oil must first be drained from the crankcase. Place the compressor in a position where it will be convenient to drain the oil. Remove the oil fill plug to vent the crankcase. Loosen the drain plug and allow the oil to drain out slowly.

If dismantled parts are to be left overnight or longer, dip them in clean compressor oil (to prevent rusting) and store in protected area.

Refer to Table 3-1 for torque values for tightening bolts.

3.3 INSPECTION AND PREPARATION FOR REASSEMBLY

a. Clean all parts with an approved solvent. Use a stiff bristle brush to remove dirt from grooves and crevices.

b. Inspect all parts for wear and overall condition. Replace any defective or excessively worn parts.

c. Inspect suction and discharge valve seats (on valve plate).

d. If unloaders are installed, inspect operation of unloader.

e. After cleaning, ensure all moving parts are coated with compressor oil before reassembly.

f. Use only new gaskets during reassembly. Ensure all gaskets (includes cylinder head, valve plate, and unloader or bypass plug gaskets) are installed dry.

3.4 CYLINDER HEAD AND VALVE PLATE

3.4.1 Disassembly

⚠ WARNING

Do not unscrew capscrews all the way before breaking seal. Entrapped pressure could result in injury.

a. Loosen cylinder head capscrews. If the head is stuck, tap it lightly with a wooden or lead mallet to free it. Be careful not to drop the head or damage the gasket sealing surface. Remove cylinder head capscrews and gasket. (See Figure 3-2)

b. Remove the discharge valve capscrews, lock washers, stops, and valves.

c. Free the valve plates from the cylinder deck by using the discharge valve capscrews, without washers, as jackscrews through the outermost tapped holes in the valve plate after the valve stops and valves have been removed. Remove the valve plate gasket.

d. Discard valves and gaskets. Use only new valves and gaskets when assembling cylinder head and valve plate assemblies.

3.4.2 Reassembly

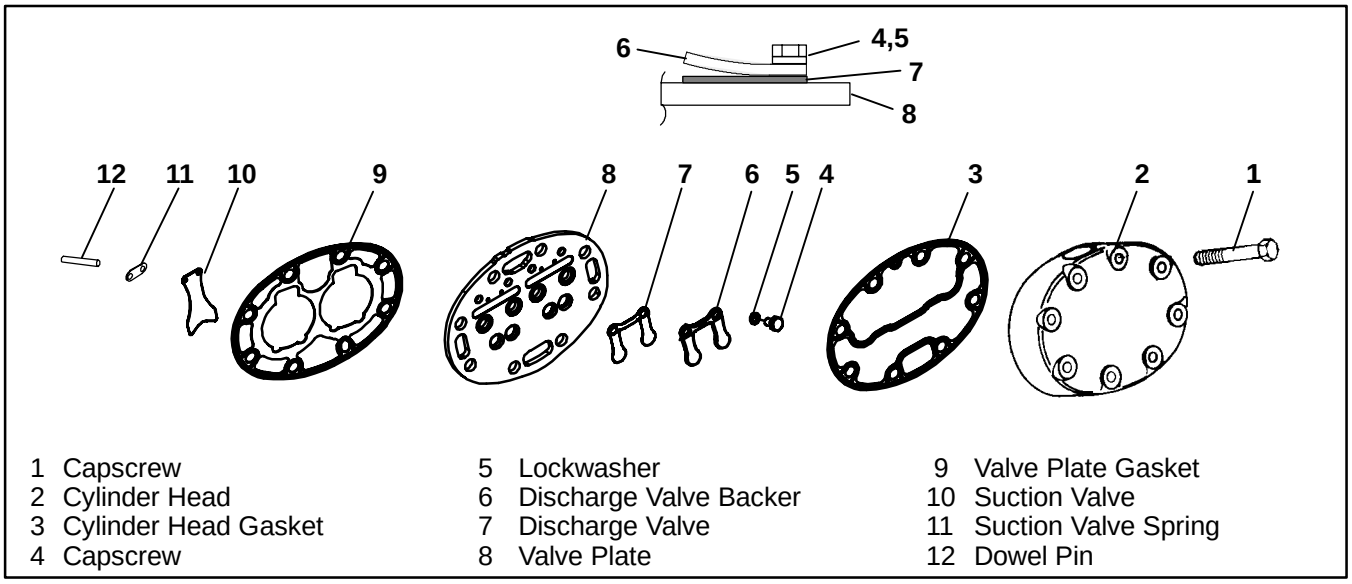
Install only new valves and gaskets, do not interchange valves.

a. Install the discharge valves and discharge valve stops with capscrews and lock washers onto the valve plates. Torque the capscrews to a value shown in Table 3-1.

b. Turn the valve plate over.

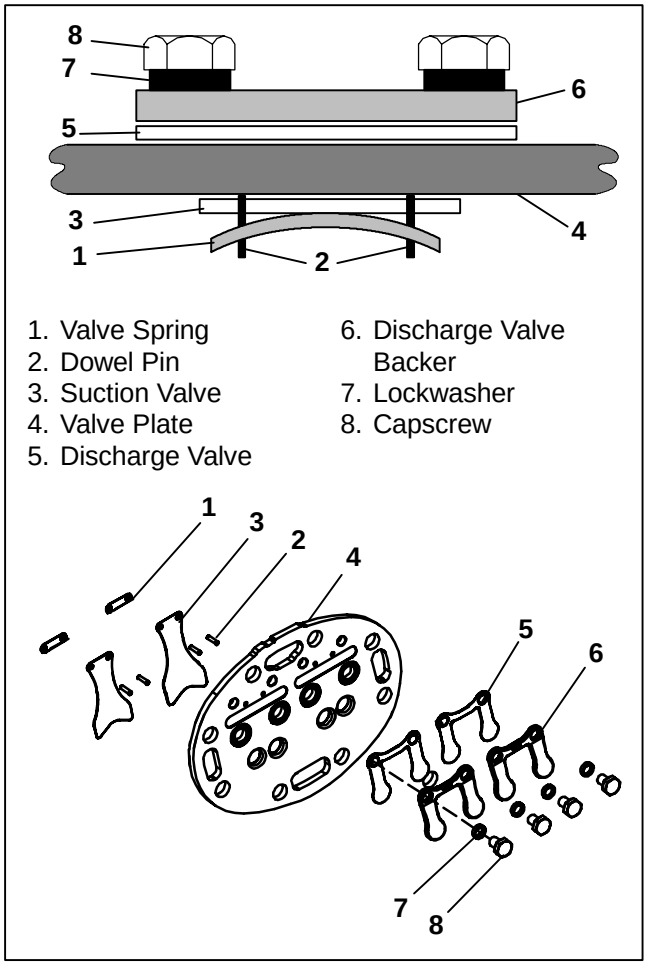
c. Place suction valve on dowel pins.

d. Install the suction valve spring on the dowel pins with the spring ends bearing away from the cylinder head. (See Figure 3-3)



1 Capscrew	5 Lockwasher	9 Valve Plate Gasket
2 Cylinder Head	6 Discharge Valve Backer	10 Suction Valve
3 Cylinder Head Gasket	7 Discharge Valve	11 Suction Valve Spring
4 Capscrew	8 Valve Plate	12 Dowel Pin

Figure 3-2. Cylinder Head & Valve Plate



1. Valve Spring
2. Dowel Pin
3. Suction Valve
4. Valve Plate
5. Discharge Valve
6. Discharge Valve Backer
7. Lockwasher
8. Capscrew

Figure 3-3. Installing Suction Valves

e. Place the valve plate and new valve plate gasket on cylinder deck, ensuring that the valve plate is properly positioned on the four dowel pins.

f. Using a small screwdriver, operate the suction valves to ensure that the valve tips are not being held by the valve plate gasket. (See Figure 3-4)

g. Install capscrews, cylinder head and new cylinder head gasket with flat side to valve plate, ensuring that the gasket and cylinder head are properly positioned on the valve plate. Torque the capscrews, in a diagonal pattern, to a value shown in Table 3-1.

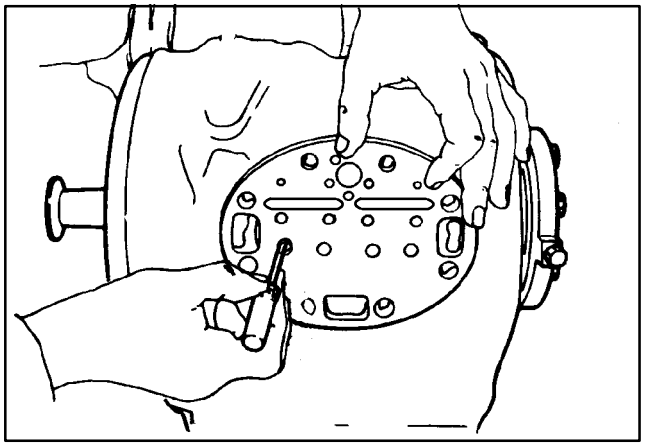


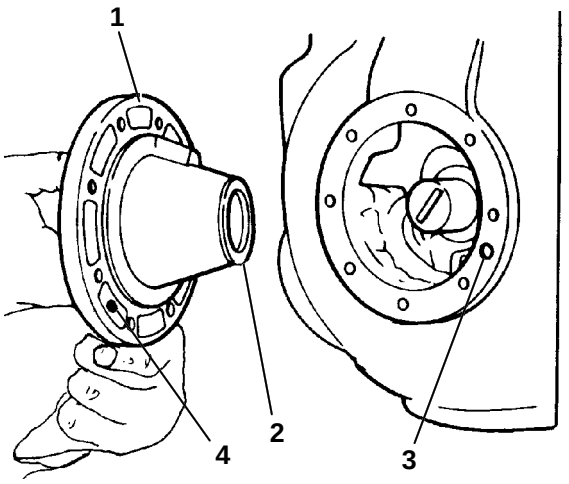
Figure 3-4. Checking Suction Valve

3.5 OIL PUMP AND BEARING HEAD

The oil pump is driven directly from the end of the compressor crankshaft.

3.5.1 Removal

Remove eight capscrews and remove the oil pump bearing head assembly, gasket and thrust washer. (See Figure 3-5.)

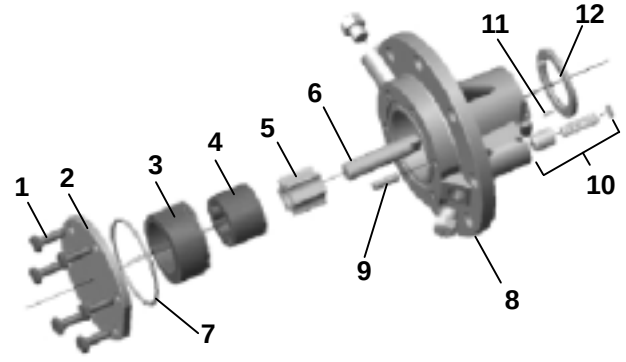


1. Oil Pump & Bearing Head
2. Thrust Washer
3. Oil Pickup Tube
4. Oil Inlet Port

Figure 3-5. Oil Pump and Bearing Head Assembly

3.5.2 Disassembly, & Inspection

If it is determined that the oil pump is not operating properly, the entire oil pump and bearing head assembly must be replaced. Replacement parts for the pump are not available except for the cover plate O−ring. However, in the event the pump requires inspection or cleaning, refer to Figure 3-6 for disassembly and reassembly. Clean all parts; coat all moving parts with compressor oil before proceeding with reassembly.



1	Capscrews	7	O-Ring
2	Cover	8	Oil Pump & Bearing
3	Eccentric Ring	9	Dowel Pin
4	Rotor	10	Relief Valve Assembly
5	Idler	11	Pins (2)
6	Shaft (Drive)	12	Thrust Washer

Figure 3-6. Oil Pump

3.5.3 Reassembly

a. Install the pump end thrust washer on the two dowel pins located on the bearing head. (See Figure 3-5.)

⚠ CAUTION

Ensure that thrust washer does not fall off dowel pins while installing oil pump.

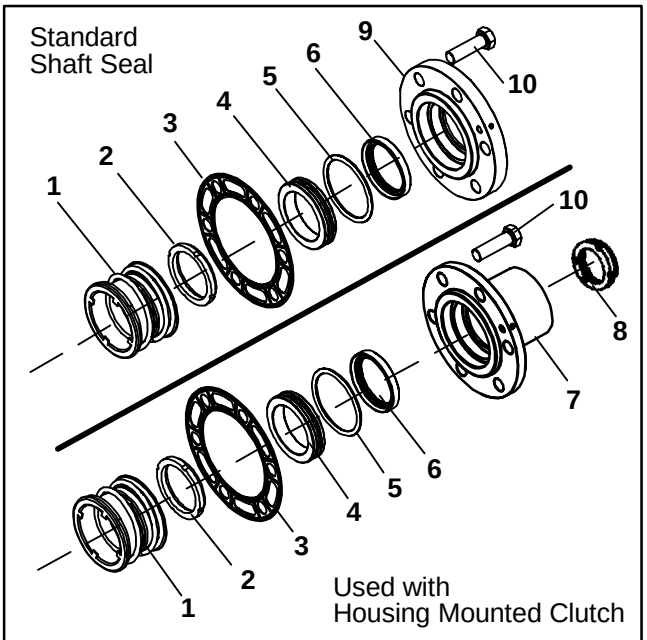
b. Install the bearing head assembly with a new gasket on the compressor crankshaft. Carefully push oil pump on by hand ensuring that the thrust washer remains on the dowel pins, the tang on the end of the drive engages the slot in the crankshaft, and the oil inlet port on the pump is aligned with the oil pickup tube in the crankcase. The oil pump should mount flush with the crankcase with the **"TOP"** stamp on the pump oriented straight up. (See Figure 3-12)

c. Align the gasket and install the eight capscrews in the mounting flange. Refer to Table 3-1, for applicable torque values.

3.6 SHAFT SEAL

3.6.1 Disassembly

a. Remove 6 capscrews, remove the shaft gland plate or clutch mounting hub. Remove rotor from top of bellows assembly. (See Figure 3-7)



1	Bellows Assembly	6	Lip Seal
2	Rotor	7	Clutch Mounting Hub
3	Gasket	8	Hub Nut
4	Stator	9	Gland Plate
5	O-Ring	10	Hex Head Screw

Figure 3-7. Shaft Seal

b. Lubricate the end of the crankshaft with clean oil.

c. Using two long screwdrivers, pry out the shaft seal but do not damage the gasket surface or the crankshaft. (See Figure 3-8)

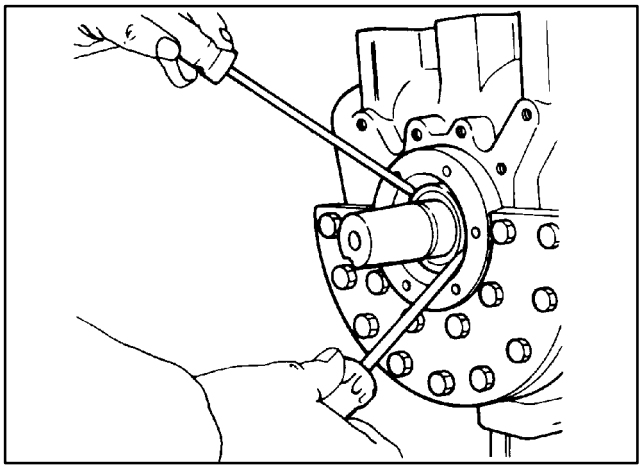


Figure 3-8. Shaft Seal Removal

3.6.2 Reassembly

NOTE

Install a new shaft seal assembly and cover gasket, with the shaft seal cover/clutch mounting hub. Never install a used seal assembly or gasket. A new rotor should never be installed with a used stator. When installing the seal assembly, use care not to damage the rotor or stator.

a. Remove the **NEW** rotor from new seal assembly. Lubricate shaft and the neoprene seal bellows where it contacts the shaft with clean/fresh compressor oil. Slide the seal assembly onto shaft until the neoprene bellows starts to grip the shaft.

b. Install the **OLD** rotor in the new seal seat. Install two capscrews in opposite sides of the old cover/mounting hub. Draw up capscrews evenly to properly position new seal assembly against the shoulder on the crankshaft. Remove the capscrews and old rotor and cover plate/mounting hub.

c. Install the **NEW** rotor. Ensure that notches in rotor are aligned with two small knurls inside the seal seat. Install the new cover plate and gasket.

d. Remove the old stator and O−ring from the shaft seal cover/clutch mounting hub.

e. Inspect the lip seal that is still in the cover/clutch mounting hub. If it shows any signs of damage or wear remove it.

f. Install the lip seal into the cover/clutch mounting hub. Insure that the back side of the lipseal seats on the shoulder machined in the cover/clutch mounting hub.

g. Using clean refrigerant oil, lubricate the new O−ring and install it into the outside groove of the new stator being careful not to touch the sealing surfaces of the stator with your fingers.

NOTE

Do not touch the sealing surfaces with your fingers. If the sealing surfaces become contaminated, clean with isopropyl alcohol and a clean dry lint−free cloth.

h. Install the stator into the cover/clutch mounting hub. Insure that the back side of the stator seats to the lip seal.

NOTE

The shaft seal cover or clutch mounting hub on this compressor must be oriented so that the oil communication hole in the cover/hub lines up correctly with the port in the crankcase. The cover/hub should mount flush with the crankcase with the **"TOP"** stamp on the pump oriented straight up.

i. Assemble the seal cover/clutch mounting hub, the gasket and the six hex head screws on to the compressor, paying attention to the orientation of the cover/hub (see Figure 3-9).

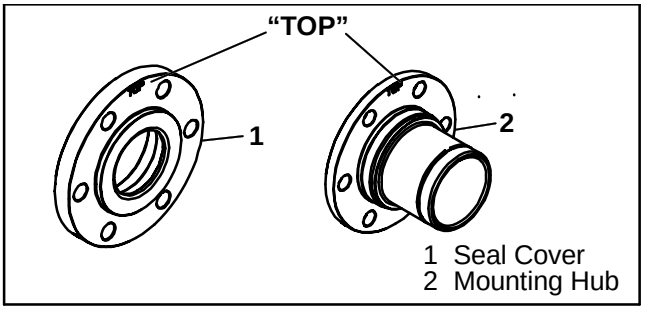


Figure 3-9. TOP Orientation

j. Align the gasket and install the six capscrews in the mounting flange. Refer to Table 3-1, for applicable torque values.

3.7 COMPRESSOR RUNNING GEAR REMOVAL

In order to disassemble Piston, Rod and Rings, first the cylinder heads and valve plate aseemblies, oil pump and bearing head assemblies and shaft seal must be removed. (Refer to sections 3.4, 3.5 and 3.6).

3.7.1 Bottom Plate, Strainer, and Connecting Rod Caps

a. Turn the compressor over, bottom side up, and remove the bottom plate. (See Figure 3-10) Scrape off gasket.

b. Remove the oil strainer.

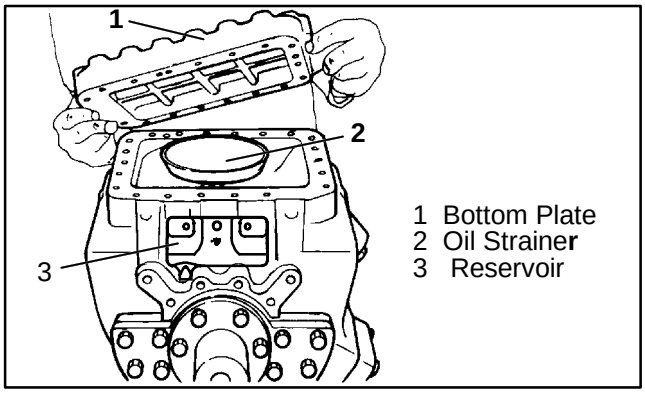


Figure 3-10. Bottom Plate Removal

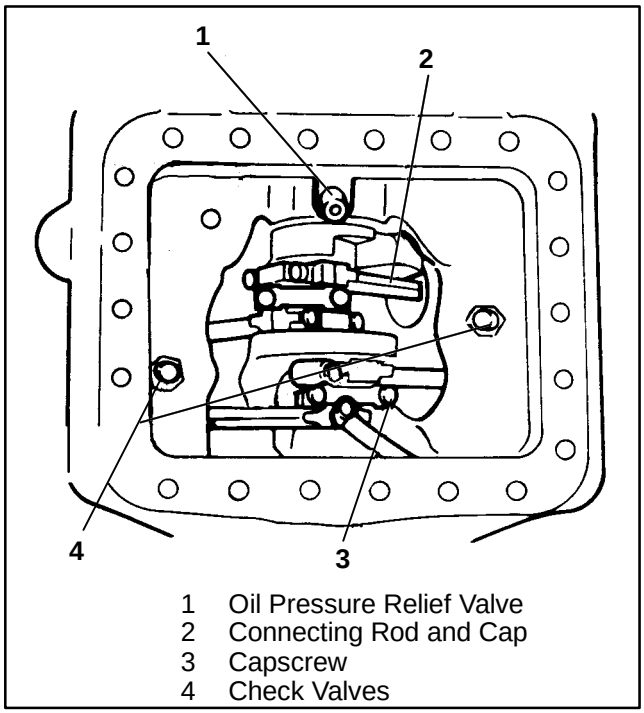


Figure 3-11. Bottom Plate and Oil Strainer Removed

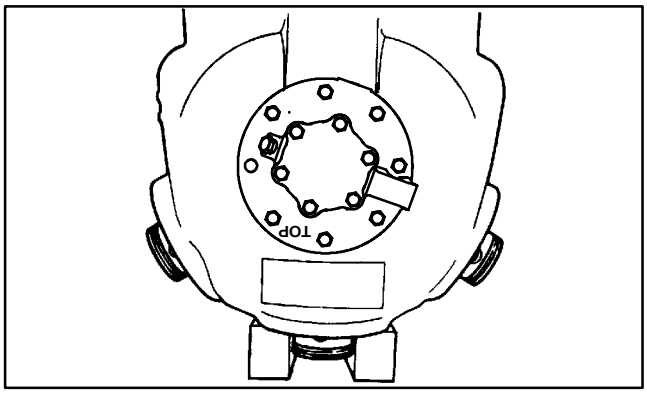


Figure 3-12. Piston Rings Removed

c. Match mark each connecting rod cap and connecting rod for correct reassembly. Remove the capscrews, flat washers and connecting rod caps. It is recommended that the capscrews and flat washers be discarded and new capscrews (special) and flat washers be installed during compressor reassembly. (See Figure 3-11)

d. Push the piston rods down so that the piston rings extend below the cylinders. Remove and discard piston rings. Use only new rings when reassembling the compressor. (See Figure 3-12.)

3.7.2 Crankshaft and Seal End Thrust Washer

⚠ CAUTION

Do not allow crankshaft to drop on connecting rods inside the crankcase when removing the crankshaft.

a. Push piston rod assemblies out of the way and remove crankshaft and seal end thrust washer.

b. Remove and check operation of oil return check valves (See Figure 3-11). The check valves are free floating devices and can easily be checked visually.

c. Remove and check oil pressure relief valve (See Figure 3-11). The oil pressure relief valve is a spring loaded device which can be checked by using a small piece of stiff wire to ensure that the spring can be depressed.

d. Remove piston rod assemblies.

3.7.3 Pistons, Rods, and Rings

a. Piston and pin, and connecting rod and rod cap are matched sets and must not be interchanged. That is, if either the piston or piston pin is to be replaced, you must replace both of them. Likewise, if a connecting rod or rod cap must be replaced, both must be replaced.

b. Match mark and disassemble pistons, pins, connecting rods, and caps. (See Figure 3-13)

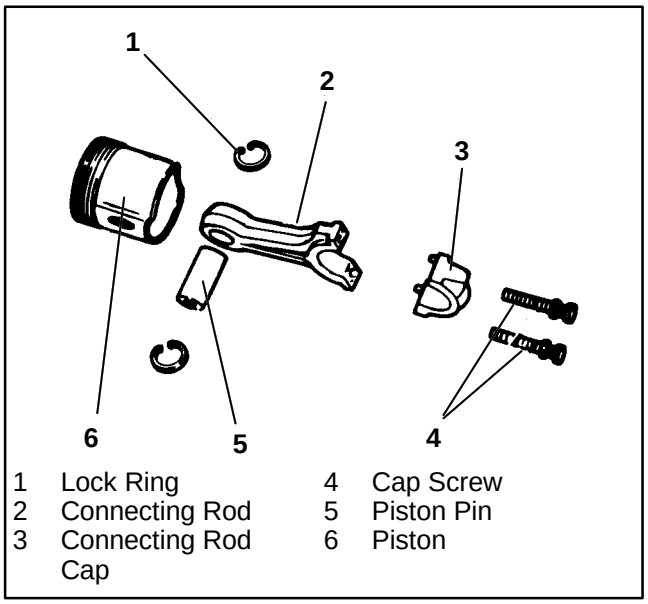


Figure 3-13. Connecting Rod, Piston, and Pin

c. Check wear dimensions of disassembled parts to determine if they are worn beyond limits given in Table 3-2.

d. Measure side clearance between ring and ring groove in piston. Maximum dimensions are provided in Table 3-2.

e. If parts are worn beyond limits, replace them in matched sets as specified above.

f. Coat piston pins with compressor oil and reassemble pistons, pins, and connecting rods in matched sets.

NOTE

Pay particular attention to the orientation of the piston in relation to the connecting rod, and the cylinder they are intended for. See Figure 3-15 and .

3.7.4 Seal End Main Bearings

a. Inspect seal end main bearings. Check wear dimensions to determine if they are worn beyond limits given in Table 3-2.

b. If worn beyond limits remove seal end main bearings.

3.8 COMPRESSOR RUNNING GEAR REASSEMBLY

3.8.1 Seal End Main Bearings

a. When installing new seal end main bearings the oil V grooves are oriented towards the top of the compressor with oil V grooves pointing to each other. When installed, there must be a 5/16 inch (7.93 mm) gap between the two bearings (See Figure 3-14).

b. Line boring seal end main bearings.

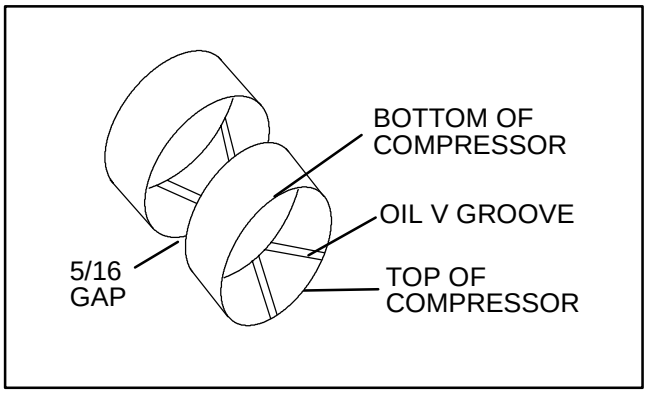


Figure 3-14. Seal End Main Bearings

3.8.2 Pistons, Rods, and Rings

Prior to installing new piston rings, it is necessary to break the hard glazed surface of the cylinder in order to reduce the wearing-in period of the new rings. Break the glaze by honing lightly in an up and down rotating motion. Clean thoroughly after breaking glaze.

Some 05G compressors for refrigeration use only may have contoured pistons (See Figure 3-15). When installing contoured pistons into compressor, check suction valve and contoured piston are in the same orientation.

Figure 3-15. Piston

a. The gap between the ends of the piston rings can be checked with a feeler gauge by inserting the ring into the piston bore about one inch below the top of the bore. Align the ring in the bore by pushing it slightly with a piston. The maximum and minimum allowable ring gaps are shown in Table 3-2.

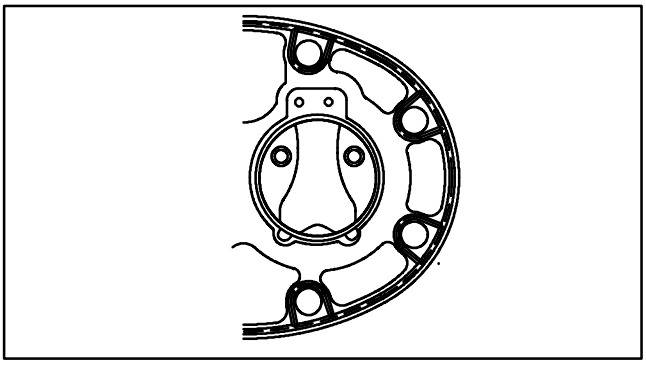


Figure 3-16. Correct Piston in Cylinder Orientation

b. Install the piston and rod assemblies up through the bottom of the crankcase and into the cylinders. Allow pistons to extend beyond the top of the cylinder to enable installation of piston rings. Pistons must be installed so that the chamfer, on the connecting rod, faces toward the crankshaft journals. Center rods on each crankshaft throw may be installed in either direction. (See Figure 3-17)

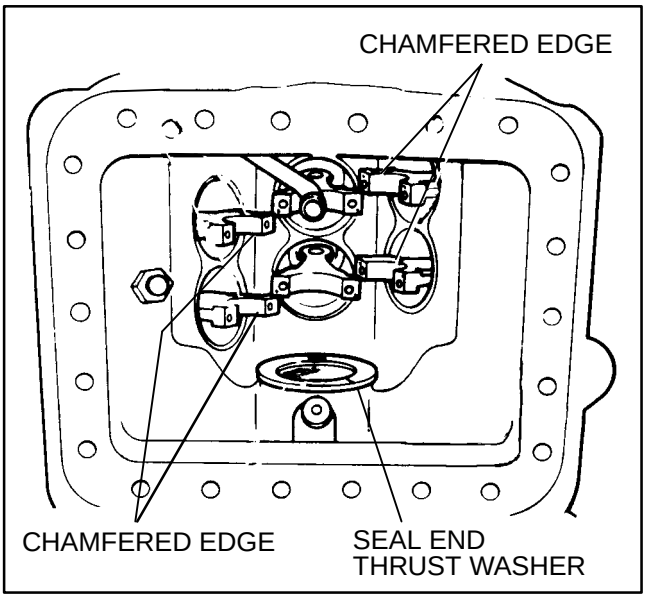


Figure 3-17. Installing Piston Rod Assemblies and Seal End Thrust Washer

c. The compressor will be fitted with double ring pistons.

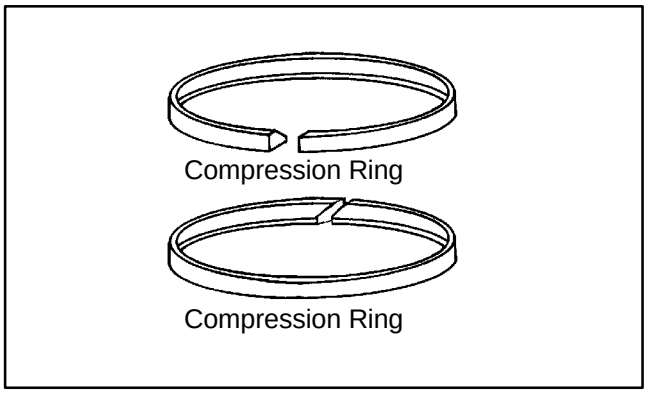


Figure 3-18. Piston Rings

d. The compression ring is chamfered on the inside circumference. This ring is installed with the chamfer towards the top. Stagger the ring end gaps so they are on opposite sides of the piston.

3.8.3 Crankshaft and Seal End Thrust Washer

a. Two brass thrust washers are used. The pump end thrust washer is positioned on two dowel pins located on the bearing head and is installed with the oil pump and bearing head assembly. The seal end thrust washer is positioned just ahead of the seal end main bearing on one dowel pin installed in the crankcase. Both thrust washers should be inspected for wear and scoring before reassembly (Refer to Table 3-2).

b. Install the seal end thrust washer on the dowel pin. (See Figure 3-17) Ensure piston rods are pushed out of the way and install the crankshaft.

⚠ CAUTION

Do not allow crankshaft to drop on connecting rods inside the crankcase when installing the crankshaft.

3.8.4 Bottom Plate, Strainer, and Connecting Rod Caps

a. Do not tap piston with hammer if rings are caught at entrance to the cylinder. Using a ring compressor, squeeze rings sufficiently to allow piston to be pushed down into the cylinder. Ensure that ring ends are staggered so that the gaps are not aligned, and lightly tap piston down into the cylinder. (See Figure 3-19) The ring compressor can be easily fabricated from a piece of sheet metal.

b. Install connecting rod caps on connecting rods using new capscrews (special) and flat washers. Reuse of the old capscrews is not recommended. Ensure that the caps are installed on the locating pins. Torque capscrews to torque value shown in Table 3-1. Ensure freedom of movement of crankshaft after capscrews are torqued on each rod cap.

c. Check operation and reinstall check valves and relief valve. (See Figure 3-11). The check valves are free-floating devices and can easily be checked visually. The relief valve is a spring-loaded device which can be checked by using a small piece of stiff wire to ensure that the spring mechanism can be depressed.

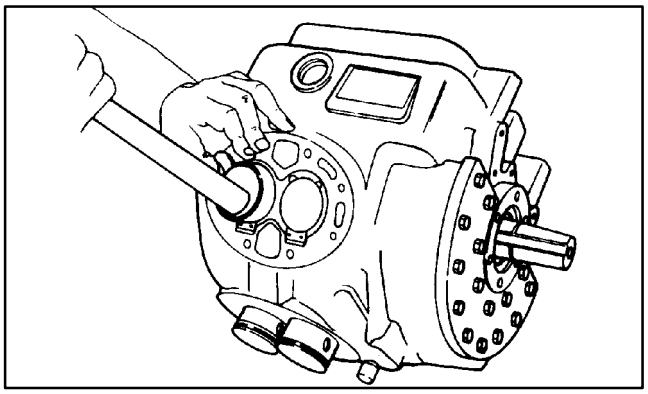


Figure 3-19. Installing Pistons

d. Clean and reinstall the oil strainer.

e. Using a new gasket, install the bottom cover plate. See figure 1-1 for relative location of compressor mounting flanges. Torque cover capscrews, in a diagonal pattern, to the torque value shown in Table 3-1.

f. Reassemble the cylinder head, oil pump and shaft seal (Refer to sections 3.4, 3.5 and 3.6).

3.9 SUCTION STRAINER

NOTE

The suction strainer has been preformed to fit into the suction cavity.

Remove and clean the suction strainer. (See Figure 3-20) Check it for damage. If it is damaged, replace suction strainer. Install suction strainer and suction service valve using a new gasket.

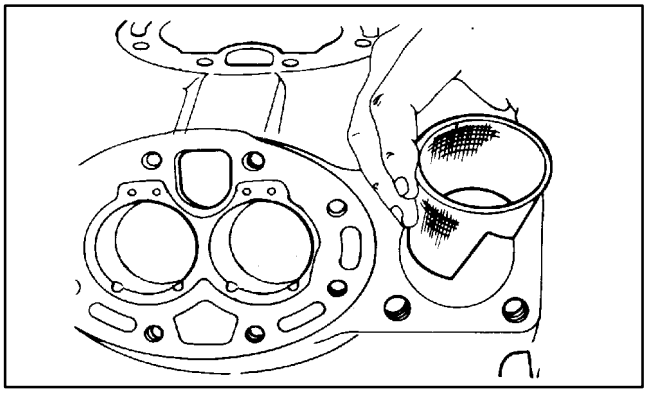


Figure 3-20. Installing Suction Strainer

3.10 ADDING OIL

Add the proper oil charge to the compressor through the oil fill plug. Refer to section 2.2.2 for the required oil charge. Refer to unit operation manual for other methods of adding oil to compressor.

3.11 INSTALLING COMPRESSOR

Refer to section 2.2.2 and the unit service manual to install the compressor.

Table 3-1. Torque Values

SIZE DIAMETER (INCHES)	THREADS PER INCH	TORQUE RANGE		USAGE
		FT-LB	MKG	
1/16	27 (pipe)	5.5 to 7	0.8 to 1.0	Crankshaft Center Web Plug
1/8	27 (pipe)	8 to 16	1.1 to 2.2	Oil Return Check Valve – Crankcase
7/16	20	8 to 14	1.1 to 1.9	Oil Fill/Drain Plug
1/4	20 (pipe)	20 to 25	2.8 to 3.5	Pipe Plug – Gauge Connection
1/4	20	8 to 12	1.1 to 1.7	Connecting Rod Capscrew
		10 to 13	1.4 to 1.8	Connecting Rod Counter Weight
1/4	28	5.5 to 7	0.8 to 1.0	Crankshaft Setscrew
		8 to 18	1.1 to 2.5	Unloader Valve
		12 to 16	1.7 to 2.2	Discharge Valve Backer
5/16	18	16 to 20	2.2 to 2.8	Cover – Oil Pump
		20 to 30	2.8 to 4.1	Discharge Service Valve
3/8	16	8 to 15	1.1 to 2.1	Oil Reservoir
		30 to 50	4.1 to 6.9	Bottom Plate – Crankcase
				End Flange – Crankcase
				Shaft Seal Cover
				Pump End Bearing Head
		42 to 55	5.8 to 7.6	Cylinder Head
1/2	13	55 to 80	7.6 to 11.1	Suction Service Valve
1–1/2	18 NEF	35 to 50	4.8 to 6.9	Oil Level Sight Glass

NEF - National Extra Fine

Table 3-2. Wear Limits

PART NAME	FACTORY MAXIMUM		FACTORY MINIMUM		MAXIMUM WEAR BEFORE REPAIR	
	INCHES	MM	INCHES	MM	INCHES	MM
SEAL END						
End Play (Seal Removed)	0.034	0.8636	.013	0.3302	-	-
Main Bearing Diameter	1.8760	47.6504	1.8754	47.6352	.002	0.051
Main Bearing Journal Diameter	1.8732	47.5793	1.8725	47.5615	.002	0.051
PUMP END						
Main Bearing Diameter	1.3761	34.9529	1.3754	34.9352	.002	0.051
Main Bearing Journal Diameter	1.3740	34.8996	1.3735	34.8869	.002	0.051
CONNECTING ROD						
Connecting Rod Diameter	1.3768	34.9707	1.3760	34.9504	.0020	0.051
Piston Pin Bearing	0.6883	17.4752	0.6878	17.4701	.001	0.0254
CRANKSHAFT						
Crankpin Diameter	1.3740	34.8996	1.3735	34.8869	.0025	0.0635
Throw - Height **(37 CFM)**	0.9698	24.6329	0.9678	24.5821	-	-
Throw - Height **(41 CFM)**	1.072	27.2288	1.070	27.1780	-	-
THRUST WASHER (Thickness)						
Pump End	0.145	3.6830	0.144	3.658	.0250	0.6350
Seal End	0.157	3.987	0.155	3.937	.0250	0.6350
CYLINDERS and PISTONS						
Bore	2.001	50.8254	2.000	50.800	.002	0.051
Piston (Diameter)	-	-	See Figure 3-21		.002	0.051
Piston Pin (Diameter)	0.6882	17.4803	0.6877	17.4676	.001	0.025
Piston Ring Gap	0.013	0.3302	0.005	0.127	.025	0.635
Piston Ring Side Clearance	0.002	0.051	0.001	0.0254	.002	0.051

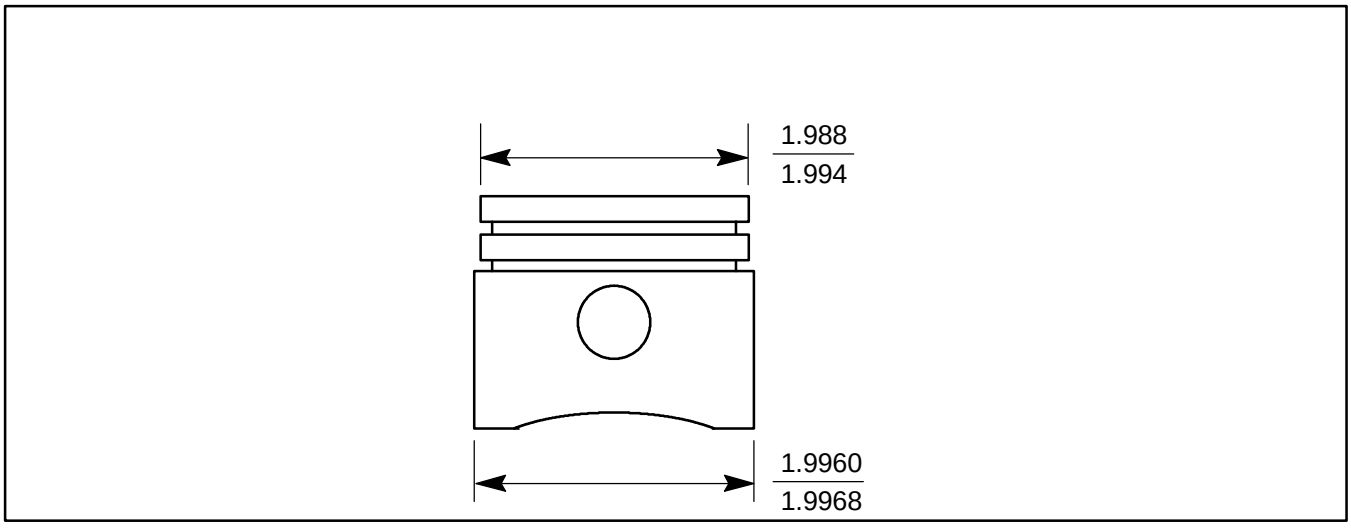


Figure 3-21. Piston Dimension (Wear Limits)

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Carrier Transport Air Conditioning
50 Grumbacher Road
York PA 17402 USA
Tel: 1-800-673-2431
Fax: 1-717-764-0401

North America
Carrier Transicold
700 Olympic Drive
Athens, GA 30601 USA
Tel: 1-706-357-7223
Fax: 1-706-355-5435

Central America and Mexico
Ejercito Nacional No. 418
Piso 9, Torre Yumal
Col. Chapultepec Morales
11570 Mexico, D.F.
Tel: (5255) 9126.0300
Fax: (5255) 9126.0373

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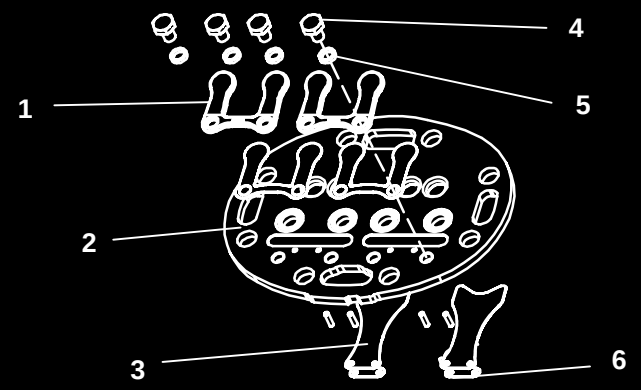

SERVICE PARTS LIST
for
MODEL 05G TWIN PORT COMPRESSOR

62-11053 Rev B

Carrier

TRANSICOLD

Service Parts List

Model
05G Twin Port Compressor

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INTRODUCTION

This parts list identifies service replacement parts for the 05G Twin Port Compressors listed in the Model Chart below. To find replacement parts, determine the major group in which the replacement parts are located (refer to the Table of Contents) and turn to the appropriate page for the illustrated parts breakdown of the replacement parts. A detailed list of the tools needed to service the O5G Twin Port Compressor may be found in the Service Tool List catalog 62-03213.

MODEL CHART

New Twin Port 05G Compressor Part Number	Carlyle/CSM Manufacturer's Number	Replaces This Part Number Of The Previous Design Three Port 05G Compressor	Compressor Configuration	Application
18-00091-103	6GDG009UA0313A	18-00059-126RM	Ultra Bottom Cover, **37 CFM**, Contoured Pistons, Ultra Flange, 2 Electric Unloaders, No Oil	Trailer
18-00091-105	6GDJ009UA0313A	18-00059-72RM	Ultra Bottom Cover, **41 CFM**, Contoured Pistons, Ultra Flange, 2 Electric Unloaders, No Oil	Trailer
18-00091-106	6GCG008WB03131	18-00059-130RM	Standard Bottom Cover, **37 CFM**, Contoured Pistons, Star Flange, 1 Electric Unloader, No Oil	Truck (Supra 9XX)
18-00091-108	6GDG00DUA0313A	18-00059-128RM	Ultra Bottom Cover, **37 CFM**, Contoured Pistons, Ultra Flange With Threaded Clutch Hub, 2 Electric Unloaders, No Oil	Trailer With Standby
18-00091-150	6GCF00ATA03031	18-00059-169	Standard Bottom Cover, **37 CFM**, Flat Pistons, Half Moon Flange With Hub, 2 Electric Unloaders, No Oil	Bus (R-22 or R-134a)
18-00091-160	6GCH00ATA03431	17-44062-00	Standard Bottom Cover, **41 CFM**, Flat Pistons, Half Moon Flange With Hub, 2 Electric Unloaders, **5.8 Pints POE Oil**	Bus (R-134a)
18-00091-180	6GCF00A3A03031	18-00059-169	Standard Bottom Cover, **37 CFM**, Flat Pistons, Half Moon Flange With Hub, 2 Pressure Unloaders, No Oil	Bus (R-22 or R-134a)

ORDERING INSTRUCTIONS

All orders and inquiries for parts must include: Unit Serial Number, Part Number, description of part as shown on list and quantity required. Address all correspondence for parts to the following address:

CARRIER TRANSICOLD DIVISION
Replacement Components Group, TR-20
P.O. Box 4805, Syracuse, NY 13221.
or
Fax to: (315) 432-3778

GENERAL NOTES

To find replacement parts consult table of contents, and turn to the appropriate page for the illustrated breakdown of replacement parts. The following letter designations are used to classify parts throughout this list.

A/R *As Required*

NSA *Non-Stock Assembly* - order components listed under the assembly.

NSS *Not Sold Separately* - order next higher assembly or kit.

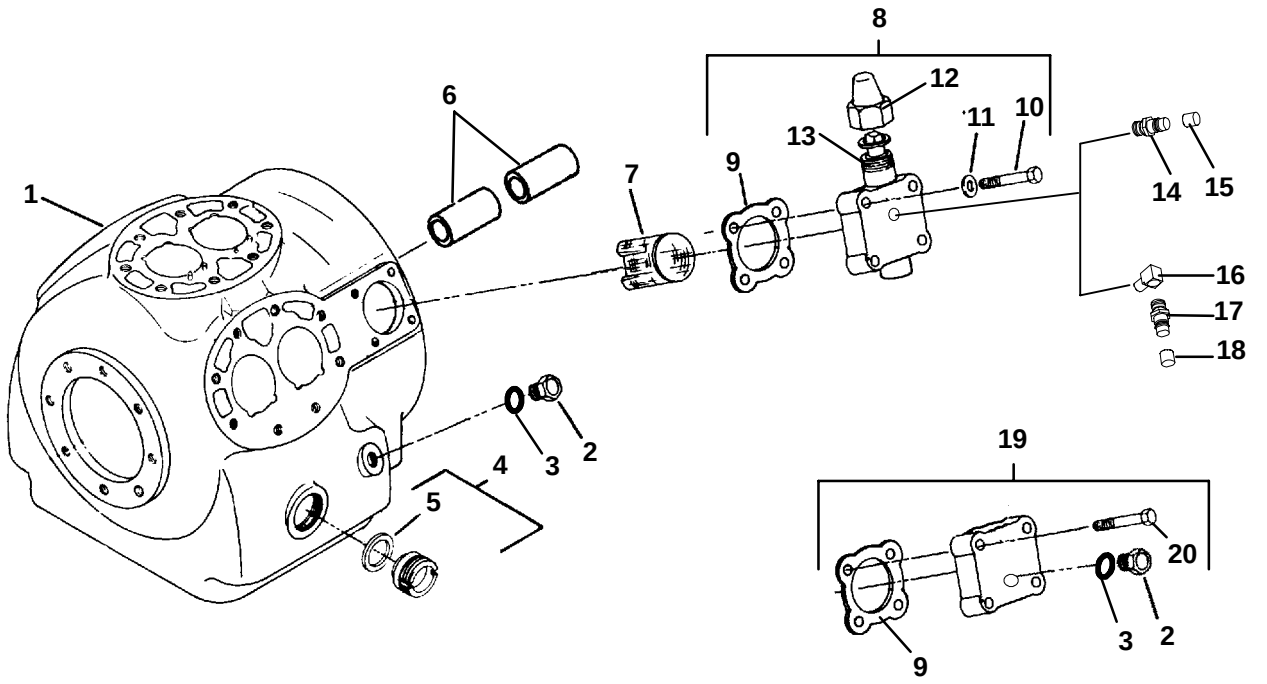
COMPRESSOR OIL CHART

Part Number	Oil Type	Viscosity	Refrigerants	Application	Packaging
07-00275-00	Mineral	150	R-12, R-22, R-500, R-502	Large Bus	1 Gallon x 6
07-00377-00	Mineral	300	R-12, R-22, R-500	Large Bus	1 Gallon x 6
07-00430-00	Alkyl Benzene (A/B)	68	R-22	Large Bus	1 Gallon x 6
07-00274-00	Alkyl Benzene (A/B)	150	R-12, R-22, R-500, R-502	Trailer	1 Gallon x 6
07-00317-00PK6	Polyolester (POE)	68	R-134a, R-404a	Truck, Trailer, and Large Bus	1 Gallon x 6

NOTE

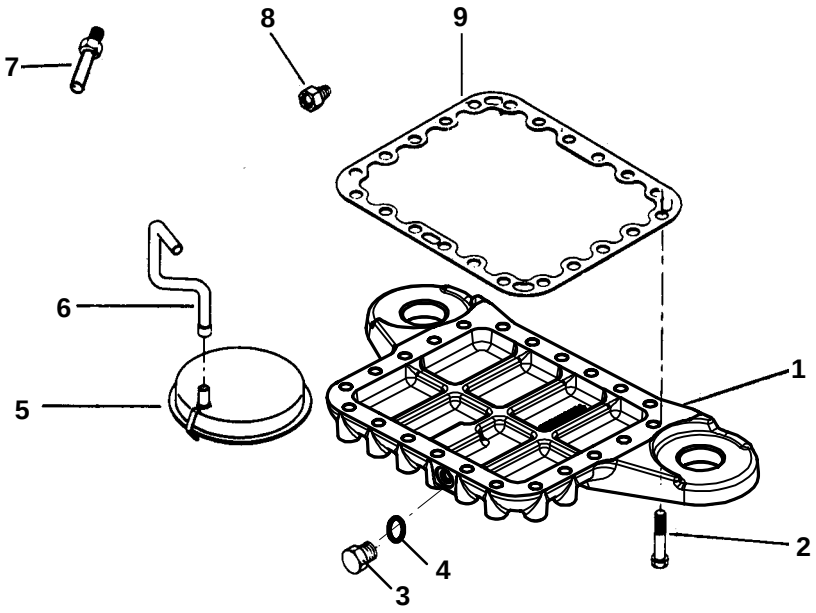
Refer to the unit operation and service manual for the correct procedure for checking compressor oil level.

1 CRANKCASE AND SUCTION SERVICE VALVE



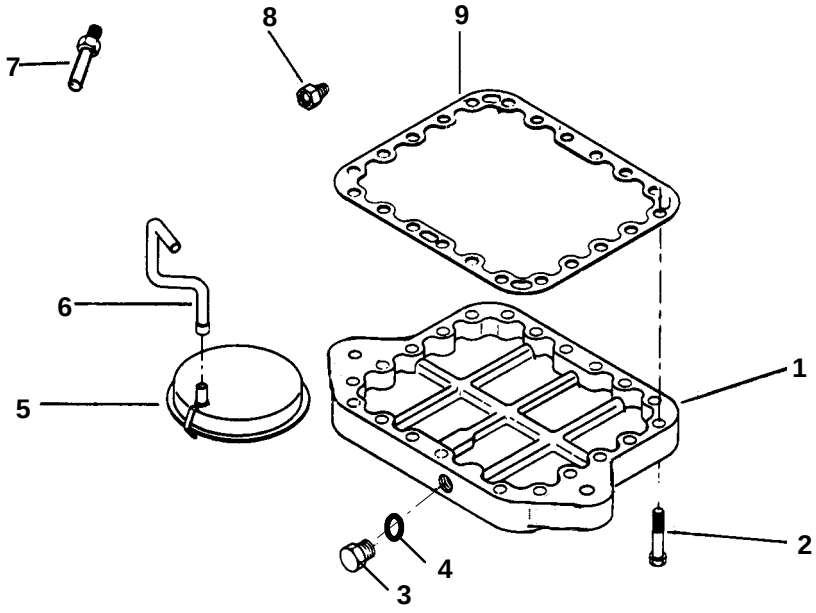
Item	Part Number	Description	Qty
1	NSA	Crankcase	1
2	17-44037-00	Plug, O-Ring, 7/16-20 - Includes:	1
3	42-00243-07	O-Ring	1
4	17-10218-00	Sight Glass, Oil Level - Includes:	2
5	17-10218-02	Gasket (Fiber)	1
	17-44021-00	Gasket (Metal)	
6	17-44015-00	Bearing, Main Seal End (Requires Line Boring)	2
7	17-44005-00	Strainer, Suction	1
8	17-31062-00	Valve, Service, 1-1/8 ODF (Bus/Supra 9xx) - Includes:	1
	17-40002-01	Valve, Service, 1-3/8 ODF (Truck/Trailer) - Includes:	
9	17-40005-05	Gasket, Service Valve (Fiber)	1
10	17-13020-00	Capscrew, 1/2-13 x 2-1/2 Inches Long - SAE Grade 8	4
11	17-40007-00	Gasket, Capscrew, 1/2 Inch	4
12	17-10812-00	Cap, Service Valve (Plastic)	1
	17-10806-10	Cap, Service Valve (Brass)	
9	17-44141-00	Gasket, 4 Bolt Service Valve (Metal)	1
13	17-13022-00	Packing, Service Valve Stem (package of 10)	1
14	06DA403-844	Valve, Access (1/4 Flare, Schrader) (for R-12, R-22, R-404A)	1
15	DD19CA061	Cap, 1/4 Flare, Schrader	1
16	40-00524-00	Elbow, 1/4 NPT x M13, Brass (for R-134a)	1
17	40-00520-00	Coupling, M13, R-134a, Brass - Includes:	1
18	40-00520-02	Cap, Service Port	1
19	17-13006-00	Kit, Valve Pad Blank Off, 4 Bolt Suction Service Valve - Includes:	1
2	17-44037-00	Plug, O-Ring, 7/16-20 - Includes:	1
3	42-00243-07	O-Ring	1
9	17-40005-05	Gasket, Service Valve (Fiber)	1
20	AABR293	Capscrew, 1/2-13 x 1-1/2 Inches Long	4

2 COMPRESSOR BASE GROUP - ULTRA STYLE



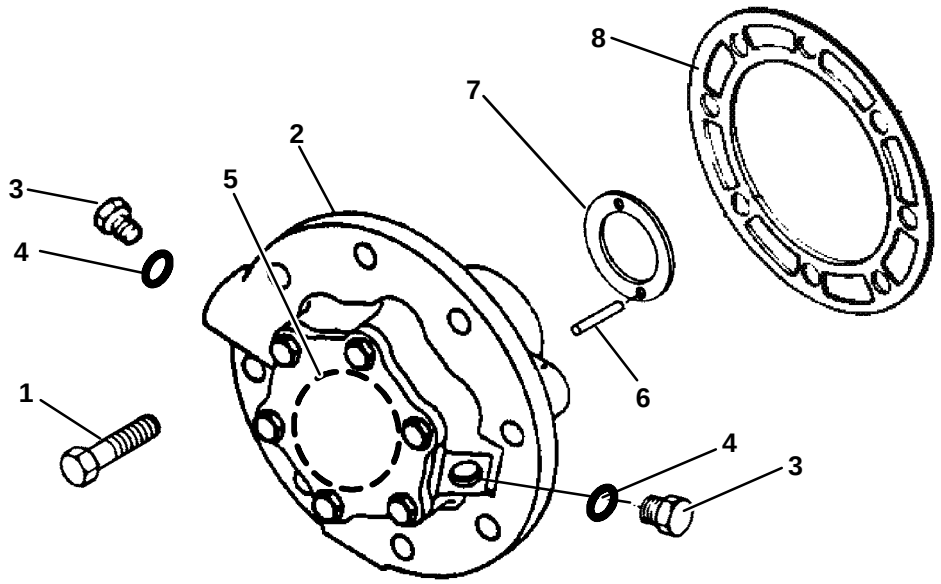
Item	Part Number	Description	Qty
1	17-44026-00	Plate, Bottom, Aluminum, (Ultra Style Compressors)	1
2	17-44117-00	Capscrew, Hex Head, 3/8-16 x 2-1/4 Inches Long - SAE Grade 8	22
3	17-44037-00	Plug, O-Ring, 7/16-20 - Includes:	1
4	42-00243-07	O-Ring	1
5	17-40020-00	Oil Filter Screen Assembly	1
6	17-40021-00	Tube, Oil Suction	1
7	17-44011-00	Oil Relief Valve	1
8	17-40042-00	Oil Return Check Valve Assembly	2
9	17-44129-00	Gasket, Bottom Plate (Metal)	1

3 COMPRESSOR BASE GROUP - STANDARD (NON-ULTRA) STYLE



Item	Part Number	Description	Qty
1	17-44035-00	Plate, Bottom, Aluminum, (Non-Ultra Style Compressors)	1
2	17-44117-00	Capscrew, Hex Head, 3/8-16 x 2-1/4 Inches Long - SAE Grade 8	22
3	17-44037-00	Plug, O-Ring, 7/16-20 - Includes:	1
4	42-00243-07	O-Ring	1
5	17-40020-00	Oil Filter Screen Assembly	1
6	17-40021-00	Tube, Oil Suction	1
7	17-44011-00	Oil Relief Valve	1
8	17-40042-00	Oil Return Check Valve Assembly	2
9	17-44129-00	Gasket, Bottom Plate (Metal)	1

4 BEARING HEAD AND OIL PUMP

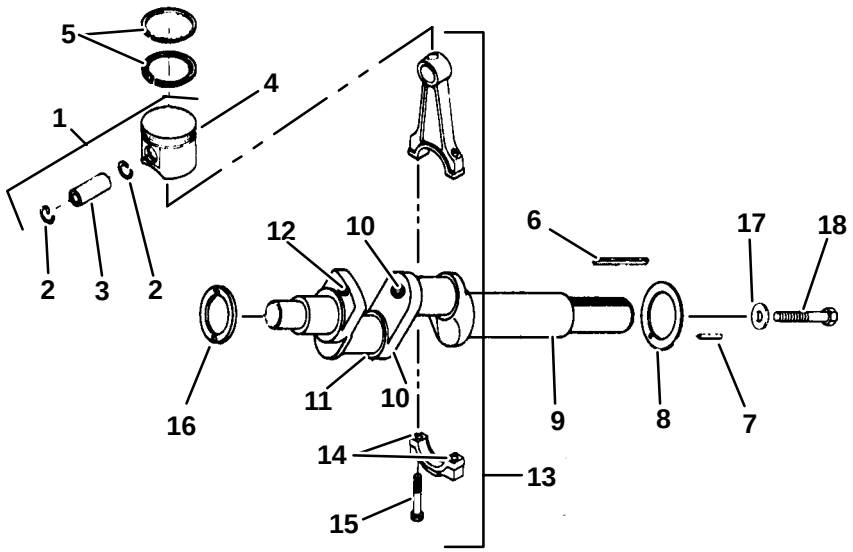


Item	Part Number	Description	Qty
1	17-10308-00	Capscrew, Hex Head, 3/8-16 x 1-1/4 Inches Long - SAE Grade 5	8
2	17-44137-00	Oil Pump and Bearing Head - Includes:	1
3	17-44037-00	Plug, O-Ring, 7/16-20 - Includes:	2
4	42-00243-07	O-Ring	2
5	17-44139-00	O-Ring, Pump Cover Plate	1
6	17-40204-00	Pin, Roll, 1/8 x 1/2 Inch	2
7	17-55009-01	Thrustwasher, Pump End	1
8	17-40078-05	Gasket, Bearing Head (Fiber)	1
	17-44022-00	Gasket, Bearing Head (Metal)	

5 CRANKSHAFT, ROD AND PISTON GROUP

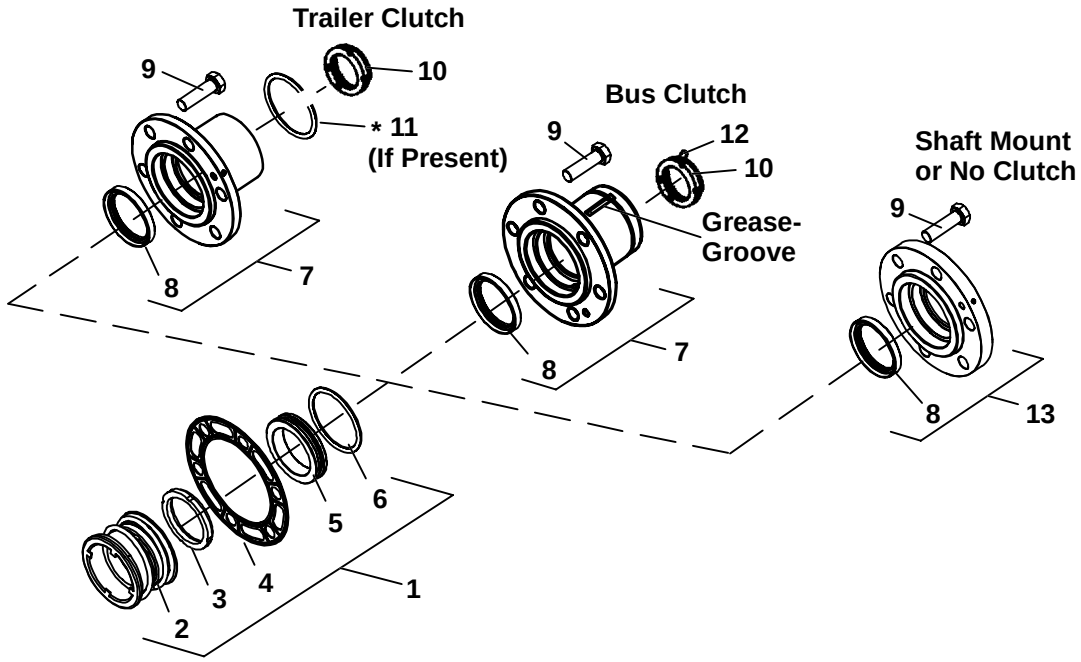
Flat (Bus)

Contoured (Truck/Trailer)



Item	Part Number	Description	Qty
1	17-44045-01	Piston, 05G37 CFM, **Flat**, Standard - Includes:	6
	17-44045-03	Piston, 05G37 CFM, **Flat**, .020 Inch Oversize - Includes:	
	17-44121-01	Piston, 05G41 CFM, **Flat**, Standard - Includes:	
	17-44122-01	Piston, 05G41 CFM, **Flat**, .020 Inch Oversize - Includes:	
1	17-44070-00	Piston, 05G37 CFM, **Contoured**, Standard - Includes:	6
	17-44071-00	Piston, 05G37 CFM, **Contoured**, .020 Inch Oversize - Includes:	
	17-44072-00	Piston, 05G41 CFM, **Contoured**, Standard - Includes:	
	17-44073-00	Piston, 05G41 CFM, **Contoured**, .020 Inch Oversize - Includes:	
2	17-40053-00	Retainer, Piston Pin	2
3	NSS	Pin, Piston	1
4	NSS	Piston	1
5	17-40055-00	Ring, Compression (Standard)	12
	17-55025-00	Ring, Compression (.020 Inch Oversize)	12
6	17-40324-00	Key, Crankshaft, 1/4 x 1/4 x 1-1/2 Inches Long (For Shaft Mounted or No Clutch)	1
	68G2-9072	Key, Crankshaft (For Housing Mounted Clutch)	
7	17-44036-00	Pin, Spiral, 1/8 x 1/2 Inch Long	2
8	17-44008-00	Thrustwasher, Seal End	1
9	17-44074-00	Crankshaft Assembly, 05G37 CFM (05G Twin Port) - Includes:	1
	17-44075-00	Crankshaft Assembly, 05G41 CFM (05G Twin Port) - Includes:	
10	17-40317-00	Expansion Plug	2
11	AF55CQ164	Setscrew, 1/4-28 x 1/2 Inch Long	1
12	34-00300-07	Capscrew, Hex Head, 1/4-20 x 7/8 Inch Long - Grade 5	1
13	17-40056-02	Connecting Rod and Cap Assembly (Standard) - Includes:	6
	17-55023-00	Connecting Rod and Cap Assembly (.010 Inch Undersize) - Includes:	A/R
14	17-40057-00	Pin, Dowel	2
15	17-55008-00	Capscrew (Special)	2
16	17-55009-01	Thrustwasher, Pump End	1
17	34-00616-00	Washer, 13/32 ID x 1-1/2 OD x 3/16 Thick	1
18	34-00613-07	Capscrew, Hex Head, 3/8-24 UNF x 7/8 Inch Long - SAE Grade 8	1

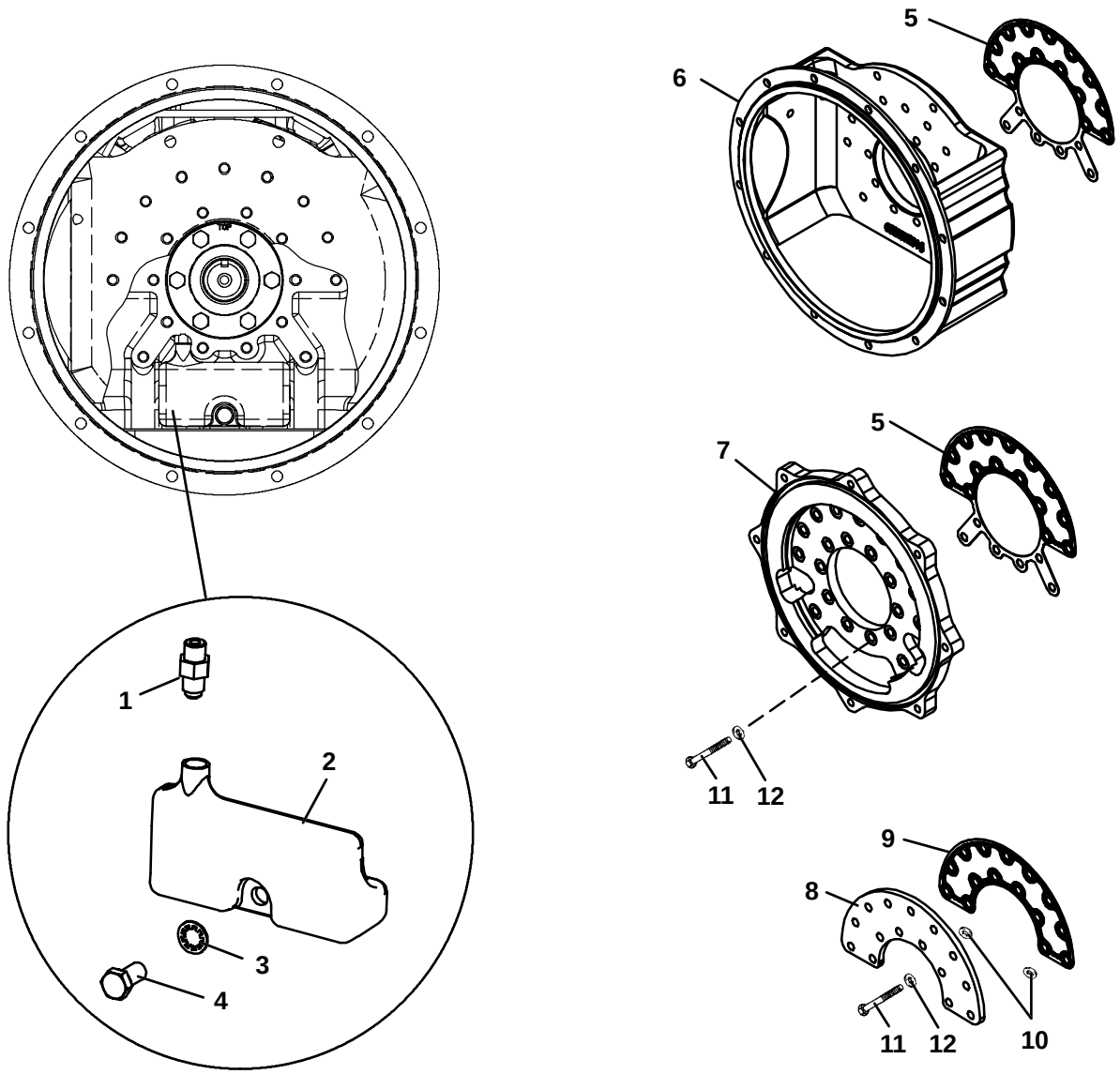
6 SHAFT END GROUP



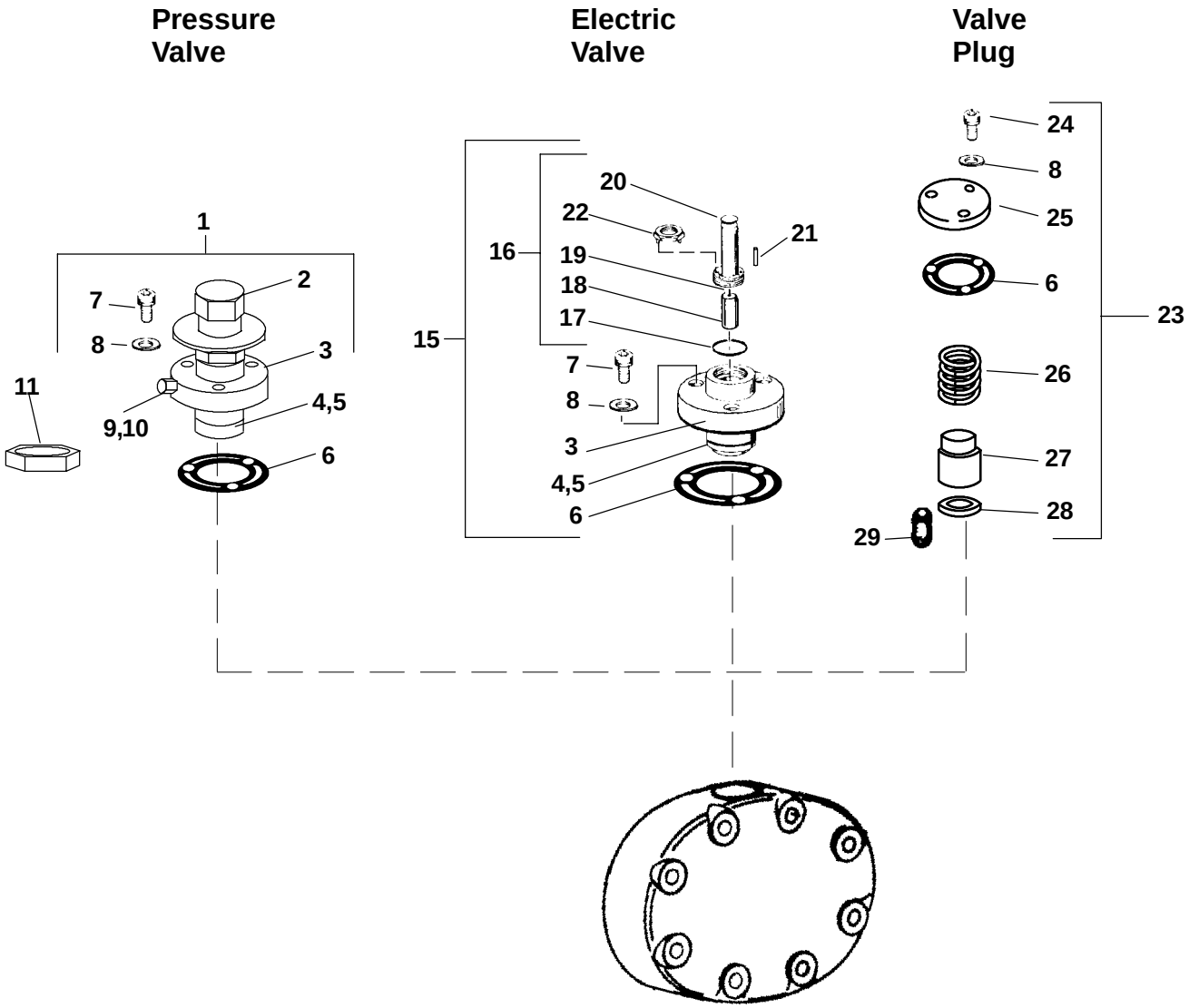
*NOTE: Early production trailer compressors may have had the snap ring style clutch hub. Should the hub require replacement, it must be converted to the threaded clutch hub (Item 7).

Item	Part Number	Description	Qty
1	17-44770-00	Seal Assembly (Shaft) - Includes:	1
2	NSS	Spring And Bellows Assembly, Shaft Seal	1
3	17-44768-00	Rotor, Seal	1
4	17-44004-06	Gasket, Seal Cover - (Metal)	1
5	NSS	Stator, Seal, (Wear Ring)	1
6	17-44773-00	O-Ring, Stator	1
7	17-44766-00	Hub Assembly, Housing Mounted Clutch, Threaded, No Groove - **Trailer** - Includes:	1
	17-44767-00	Hub Assembly, Housing Mounted Clutch, Threaded, W/Grease Groove - **Bus** - Includes:	
8	17-44765-00	Seal, Lip, Shaft Seal	1
4	17-44004-06	Gasket, Seal Cover - (Metal)	1
9	17-40308-00	Capscrew, 3/8-16 X 1-1/4 Inch Long Grade 5	6
10	34-01304-00	Nut, Hub, Without Grease Fitting Port **(Trailer Only)**	1
	34-06083-00	Nut, Hub, Without Grease Fitting Port - **Bus**	
	34-01161-00	Nut, Hub, With Grease Fitting Port - **(Fitting Not Included) Bus**	
11	50-00221-30	Ring, Snap (If Applicable)	1
12	40-01132-00	Fitting, Grease, 1/4-28 NPT- **Bus**	1
13	17-44772-00	Seal Cover Assembly, Shaft (Gland Plate) - Includes:	1
4	17-44004-06	Gasket, Seal Cover - (Metal)	1
8	17-44765-00	Seal, Lip, Shaft Seal	1

7 SHAFT SEAL RESERVOIR AND SHAFT END FLANGES



Item	Part Number	Description	Qty
1	05GA503-724	Access Valve, **Coreless**, 7/16-20, With O-Ring	1
2	17-44771-00	Reservoir, Shaft Seal	1
3	05GA503-734	Washer, Internal Tooth, 3/8 Inch, Plated	1
4	AA06GS228	Cap Screw, Hex Head, 3/8-16 X 0.75 Inch Long, Grade 8	1
5	17-44119-00	Gasket, End Flange, Ultra Style or Full Ring Flange (Used With Items 6 and 7)	1
6	17-44025-00	End Flange, Ultra Style (Trailer)	1
7	17-44002-00	End Flange, Full Ring (Star Flange)	1
8	17-44127-00	End Flange, Half Moon (Bus)	1
9	17-44118-00	Gasket, Half Moon End Flange (Used Only With Item 8)	1
10	17-44014-00	Gasket, Flange Spacer (Used Only With Items 8 and 9)	2
11	17-10308-00	Cap Screw, Hex Head, 3/8-16 X 1.25 Inch Long, Grade 5	A/R
12	17-40019-00	Gasket, Cap Screw	A/R


Pressure Valve
Electric Valve
Valve Plug
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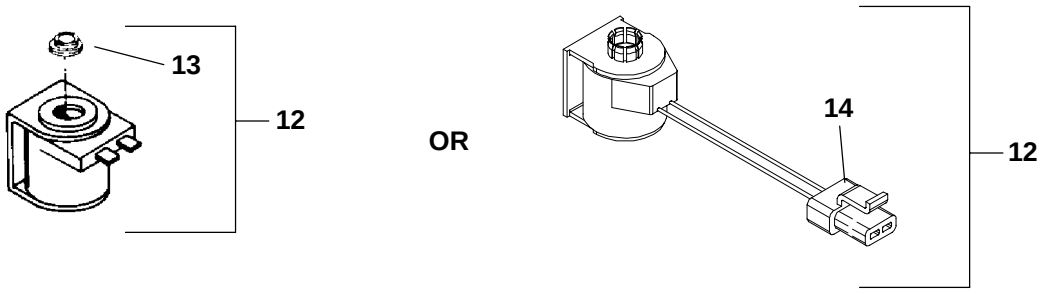
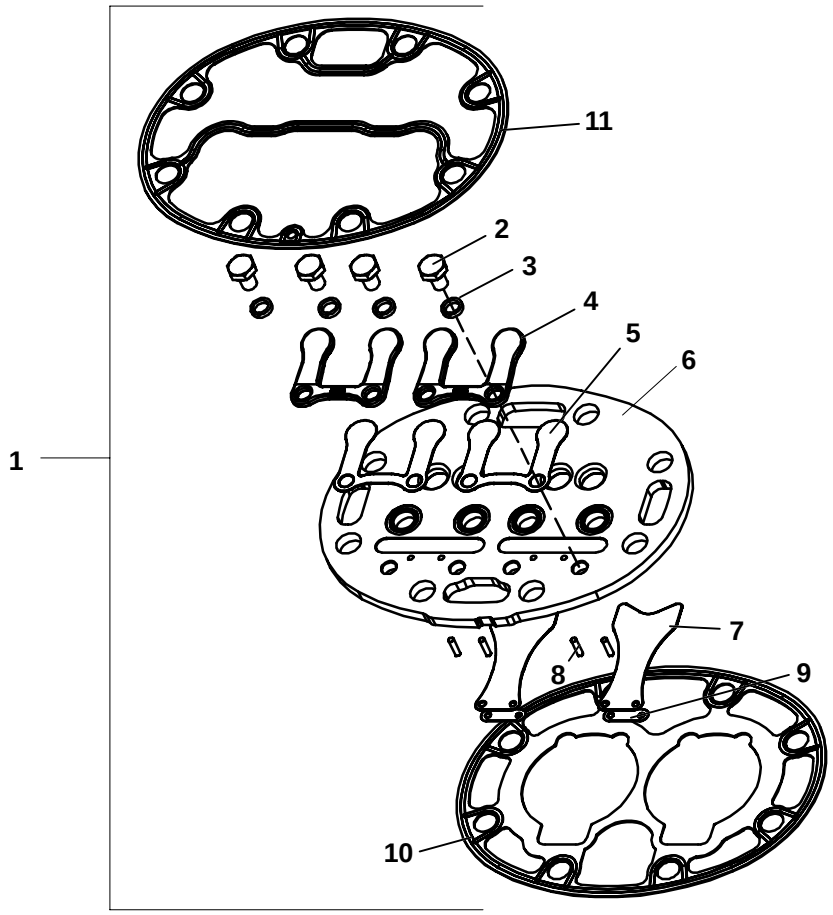
COILS


13
12
OR
14
12

8 UNLOADERS (Continued)			
Item	**Part Number**	**Description**	**Qty**
1	17-55018-01	Valve Assembly (Pressure) - Includes:	A/R
2	NSS	Power Assembly, Unloader (Suction Pressure Activated)	1
3	NSS	Body Assembly, Valve	1
4	17-40409-00	Piston, Unloader - Includes:	1
5	17-55010-00	Ring, Piston	1
6	17-40104-07	Gasket, Unloader Valve	1
7	17-40111-00	Screw, Socket Head, 1/4-28 x 3/4 Inch Long	1
8	17-40104-20	Gasket, Socket Head Screw, 1/4 Inch	1
9	17-55028-00	Cap, Adjustment Screw	1
10	42-50019-00	O-Ring, Adjustment Screw Cap	1
11	34-01139-00	Nut, Unloader Adjuster Lock	1
12	22-02804-00	Coil, Valve, 12 VDC With Connector **(Truck/Trailer)** - Includes:	A/R
	22-02567-00	Coil, Valve, 12 VDC With Spade Terminal - Includes:	
	14-00143-07	Coil, Valve, 12 VDC With 6 inch wire leads - Includes:	
	22-50030-00	Coil, Valve, 24 VDC With 42 inch wire leads - Includes:	
	22-02567-01	Coil, Valve, 24 VAC With Spade Terminal - Includes:	
	16-00149-00	Coil, Valve, 115 VAC With 42 inch Wire Leads - Includes:	
	17-10829-00	Coil, Valve, 230 VAC With 42 inch Wire Leads - Includes:	
13	17-40408-02	Cap, Snap	1
14	22-50078-02SV	Connector, 2 Wire, 22-02804-00 Coil Only (Mates W/ 22-50078-01SV)	1
15	17-40417-00	Valve Assembly (Electric) - Includes:	A/R
3	NSS	Body Assembly, Valve	1
4	17-40409-00	Piston, Unloader - Includes:	1
5	17-55010-00	Ring, Piston	1
6	17-40104-07	Gasket, Unloader Valve	1
7	17-40111-00	Screw, Socket Head, 1/4-28 x 3/4 Inch Long	1
8	17-40104-20	Gasket, Socket Head Screw, 1/4 Inch	1
16	17-40418-00	Kit, Valve Stem Repair (For 17-40417-00) - Includes:	A/R
17	42–00243–03	Gasket, O-ring	1
18	NSS	Plunger Assembly	1
19	NSS	Spring, Plunger	1
20	NSS	Enclosing Tube	1
21	34-06026-00	Pin, Unloader Coil Retainer	1
22	NSS	Tool, Valve Stem Installation/Removal	1
23	17-55013-00	Kit, Plug, To Fully Load Cylinder Bank - Includes:	A/R
24	17-10721-00	Screw, Socket Head, 1/4-28 x 1.0 Inch Long	3
25	NSS	Plate Cover	1
26	NSS	Spring	1
27	NSS	Plug	1
28	17-55014-00	Ring, Seat	1
29	17-40108-00	Strainer	1
6	17-40104-07	Gasket, Unloader Valve	1
8	17-40104-20	Gasket, Socket Head Screw, 1/4 Inch	1

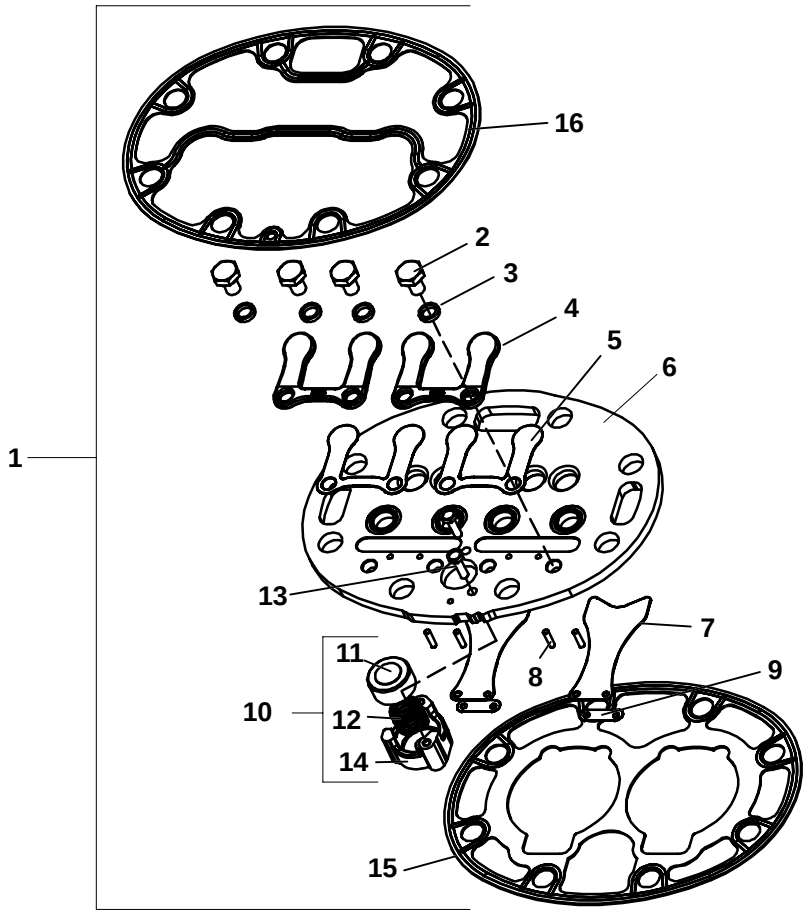
9 VALVE PLATE ASSEMBLY



CAUTION: The above valve plate can only be used on the Twin Port 05G compressor. **It will not function in** the previous design (3 port) 05G compressor.

Item	Part Number	Description	Qty
1	17-44742-00	Valve Plate Assembly, **Center or Side Bank With No Unloader** - Includes:	1
2	17-44113-00	Capscrew, HexHead, 1/4-28 x 3/8 Inch Long	4
3	17-10715-00	Lockwasher, 1/4 Inch	4
4	17-44750-00	Backer, Discharge Valve	2
5	17-44749-00	Valve, Discharge	2
6	NSS	Valve Plate	1
7	17-44748-00	Valve, Suction	2
8	17-40057-00	Dowel, Pin Suction Valve	4
9	17-44751-00	Spring, Suction Valve	2
10	17-44746-00	Gasket, Valve Plate, Center or Side Banks	1
11	17-44747-00	Gasket, Cylinder Head, Center or Side Banks	1

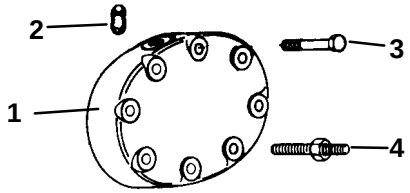
10 UNLOADER VALVE PLATE ASSEMBLY



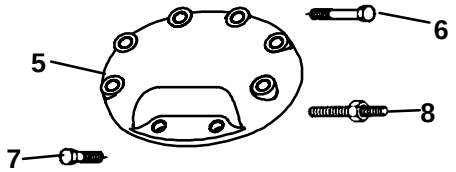
CAUTION: The above valve plate can only be used on the Twin Port 05G compressor. **It will not function in** the previous design (3 port) 05G compressor.

Item	Part Number	Description	Qty
1	17-44744-00	Valve Plate Assembly, **Side Bank With Unloader** - Includes:	1
2	17-44113-00	Capscrew, HexHead, 1/4-28 x 3/8 Inch Long	4
3	17-10715-00	Lockwasher, 1/4 Inch	4
4	17-44750-00	Backer, Discharge Valve	2
5	17-44749-00	Valve, Discharge	2
6	NSS	Valve Plate	1
7	17-44748-00	Valve, Suction	2
8	17-40057-00	Dowel, Pin Suction Valve	4
9	17-44751-00	Spring, Suction Valve	2
10	17-55012-00	Check Valve, Unloader, - Includes:	1
11	17-40104-08	Piston, Check Valve	1
12	17-40104-09	Spring, Check Valve	1
13	NSS	Screw, Round Phillips Head, #6-32 x 1/2 Inch Long	2
14	NSS	Body Check Valve	1
15	17-44746-00	Gasket, Valve Plate, Center or Side Banks	1
16	17-44747-00	Gasket, Cylinder Head, Center or Side Banks	1

11 CYLINDER HEAD (SIDE)



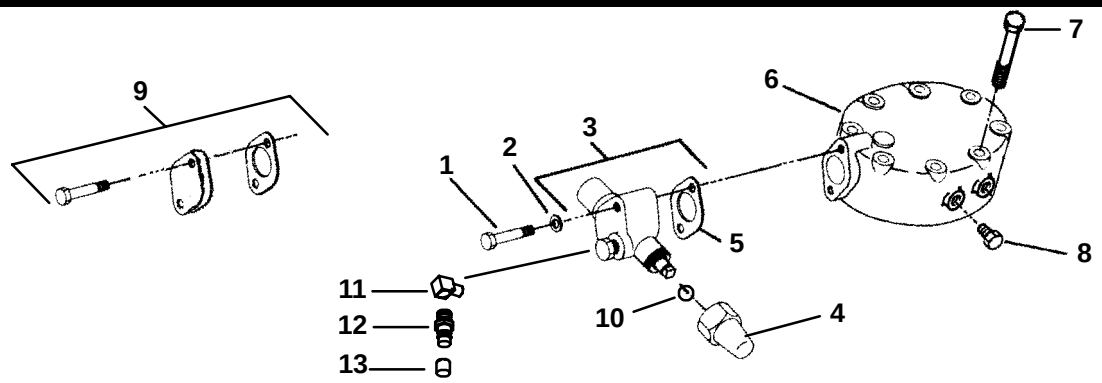
UNLOADER CYLINDER HEAD



STANDARD SHAVED CYLINDER HEAD

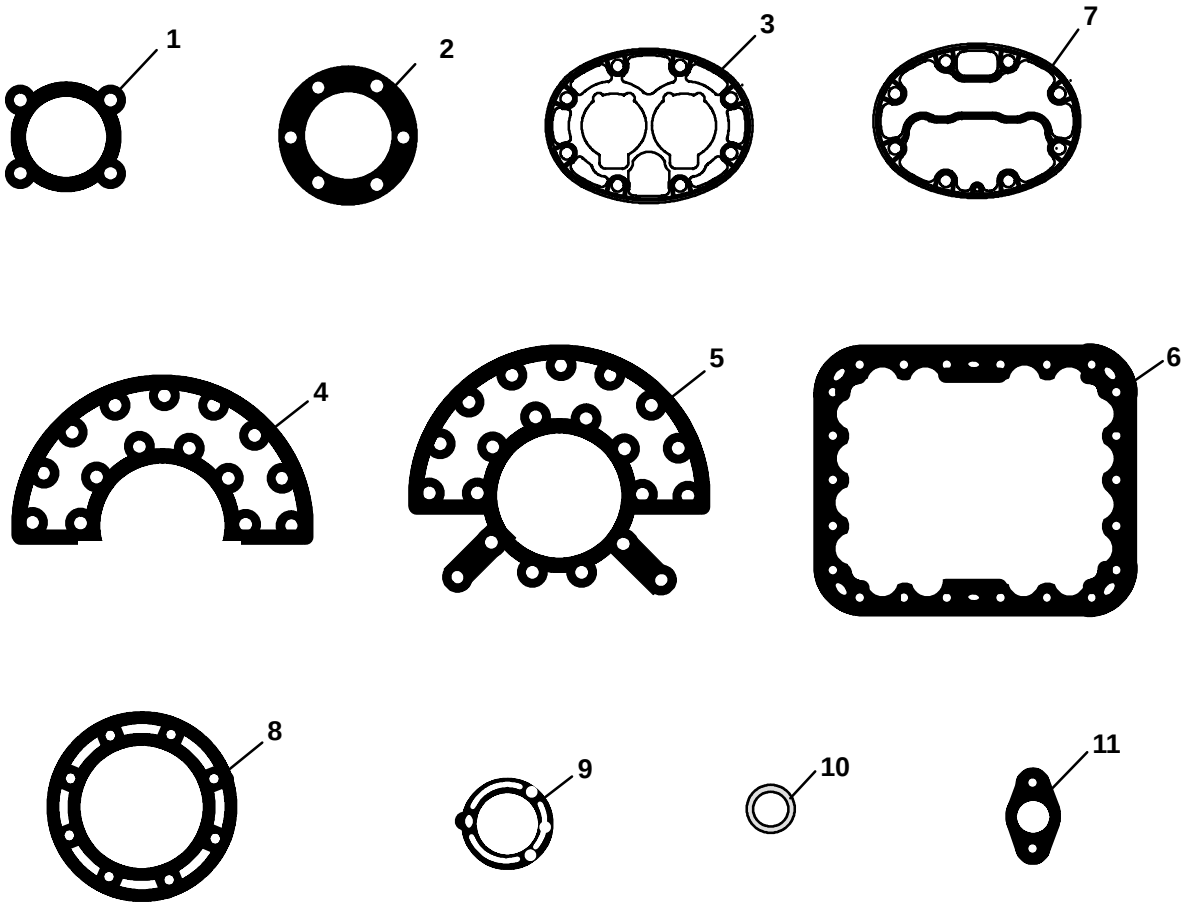
Item	Part Number	Description	Qty
1	17-44743-00	Cylinder Head, Unloader - Side Banks	2
2	17-40108-00	Strainer	1
3	17-10224-05	Capscrew, Hex Head, 3/8 -16 x 3-1/4 Inches Long - SAE Grade 8	8
4	17-44017-00	Stud, Cylinder Head (Unloader or Center), 3/8 -16 x 4-1/4 Inches Long	A/R
5	17-44753-00	Cylinder Head - Side Banks, Shaved (Standard, No Unloader)	2
6	17-44117-00	Capscrew, Hex Head , 3/8 -16 x 2-1/4 Inches Long - SAE Grade 8	6
7	AA06GR232	Capscrew, Hex Head, 3/8 -16 x 1-1/4 Inches Long - SAE Grade 8	2
8	17-44780-00	Stud, Cylinder Head (Shaved), 3/8 -16 x 3-1/4 Inches Long	A/R

12 CYLINDER HEAD (CENTER)



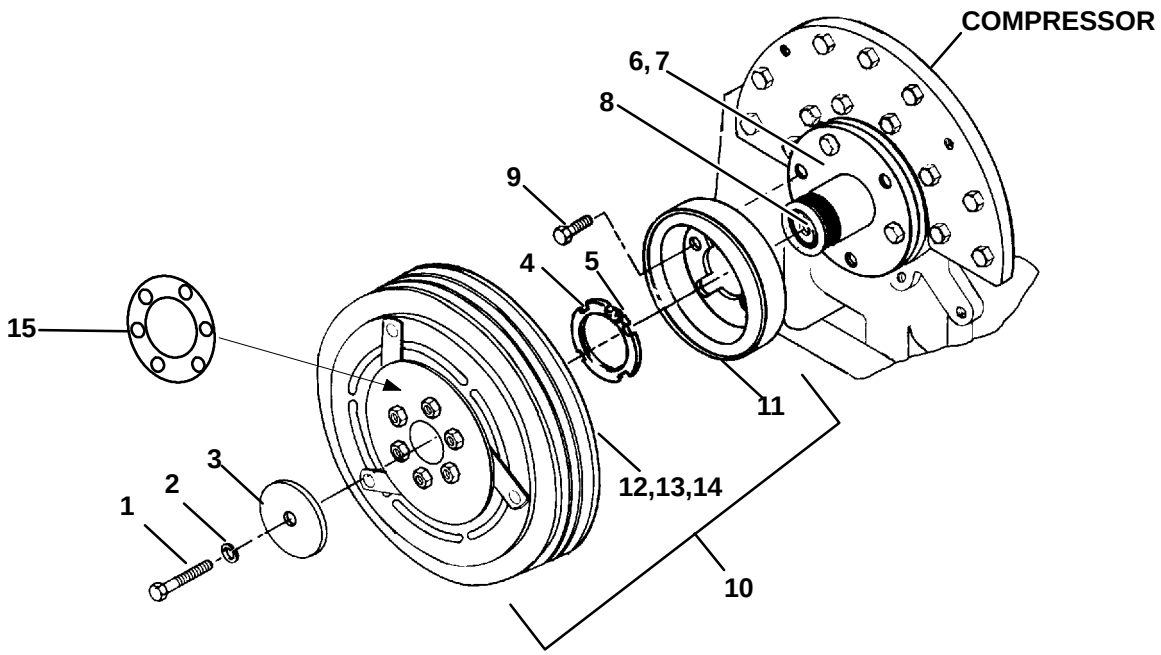
Item	Part Number	Description	Qty
1	17-40012-00	Capscrew, Hex Head, 5/16 -18 x 2 Inches Long - SAE Grade 8	2
2	17-40013-00	Gasket, Capscrew, 5/16 Inch	2
3	17-01042-04	Valve, Service 7/8 Inch ODF (1/8 Inch FPT Gauge Port)- Includes:	1
	14-00206-01	Valve, Service 7/8 Inch ODF (M15 Gauge Port For R-134a) - Includes:	1
4	17-10812-00	Cap, Service Valve (Plastic)	1
5	17-10811-05	Gasket, Service Valve (Fiber)	1
	17-44138-00	Gasket, Service Valve (Metal)	1
4	17-10806-10	Cap, Service Valve (Brass)	1
6	17-44752-00	Cylinder Head, Center Bank, One Pressure Port (Bus)	1
	17-44754-00	Cylinder Head, Center Bank, Two Pressure Ports (T/T)	1
7	17-10224-05	Capscrew, Hex Head, 3/8 -16 x 3 -1/4 Inches Long - SAE Grade 8	8
8	CA63AA051	Pipe Plug, 1/4 -18NPT (package of 20)	A/R
9	17-13004-00	Kit, Valve Pad Blank Off, 2 Bolt Suction Service Valve	1
10	17-13022-00	Packing, Service Valve Stem	1
11	40-00524-01	Elbow, 1/8 MPT x M15 - Brass (for R -134a)	1
12	40-00520-01	Coupling, M15, High Side - Brass - Includes:	1
13	40-00520-03	Cap, Service Port	1
11	40-00060-08	Elbow, 1/8 MPT x 1/4 FPT - Brass (for R -12, R -22)	1
12	06DA403-844	Valve, Access (1/4 Flare, Schrader)	1
13	DD19CA061	Cap, 1/4 Flare, Schrader	1

13 GASKET SET



Item	Part Number	Description	Qty
-	17-44775-00	Gasket Set, Metal - Includes:	1
1	17-44141-00	Gasket, Suction Service Valve - 4 Bolt	1
2	17-44004-06	Gasket, Shaft Seal	1
3	17-44746-00	Gasket, Valve Plate	3
4	17-44118-00	Gasket, End Flange	1
5	17-44119-00	Gasket, End Flange	1
6	17-44129-00	Gasket, Bottom Plate	1
7	17-44747-00	Gasket, Cylinder Head, Center or Side Banks	3
8	17-44022-00	Gasket, Pump End Bearing Head	1
9	17-40104-07	Gasket, Unloader Body	2
10	17-44021-00	Gasket, Sight Glass	2
11	17-44138-00	Gasket, Service Valve - 2 Bolt	2

14 CLUTCH ASSEMBLY - HOUSING MOUNTED (WARNER - GRAY IN COLOR)

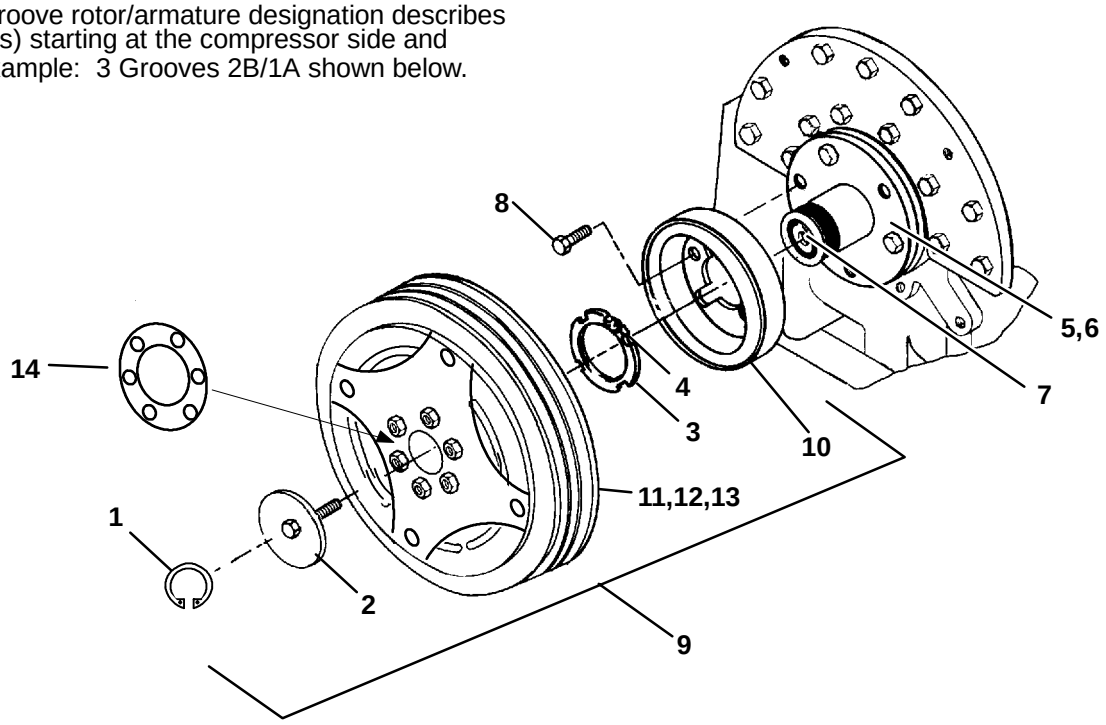


Item	Part Number	Description	Qty
NS	76-50013-00	Kit, Conversion Shaft to Housing Mounted Clutch	A/R
1	34-00613-07	Capscrew, Hex Head, 3/8-24 x 7/8 Inch Long - SAE Grade 8	1
2	--AU--11AR-241	Washer, Lock, Spring, 3/8 Inch	1
3	34-00616-00	Washer, 13/32 ID x 1-1/2 OD x 3/16 Inch Thick	1
4	34-01161-00	Nut, Hub, With Grease Fitting Port (Fitting Not Included)	1
	34-06083-00	Nut, Hub Without Grease Fitting Port	
5	40-01132-00	Fitting, Grease, 1/4–18	1
6	17-44041-01	Hub, Clutch Mounting - Includes:	1
7	17-44042-00	Ring, Felt and Retainer	1
8	68-G---2--9072	Key, Crankshaft, Special	1
9	17-10308-00	Capscrew, Hex Head, 3/8-16 x 1-1/4 Inches Long - SAE Grade 8	1
10	50-01122-01	Clutch, Assembly, 24 VDC, 2-C Grooves, 9 Inch Diameter - Includes:	1
11	50-01122-50	Coil, 24 VDC	1
12	50-01122-85	Rotor/Armature, 2-C Grooves, 9 Inch Diameter - Includes:	1
13	34-01186-00	Ring, Snap	1
14	04-00130-00	Bearing, Rotor	1
10	50-01122-04	Clutch, Assembly, 12 VDC, 2-C Grooves, 9 Inch Diameter - Includes:	1
11	50-01122-41	Coil, 12 VDC	1
12	50-01122-85	Rotor/Armature, 2-C Grooves, 9 Inch Diameter - Includes:	1
13	34-01186-00	Ring, Snap	1
14	04-00130-00	Bearing, Rotor	1
10	50-01122-02	Clutch, Assembly, 24 VDC, 3-3V Grooves, 8.48 Inch Diameter - Includes:	1
11	50-01122-50	Coil, 24 VDC	1
12	50-01122-86	Rotor/Armature, 3-3V Grooves, 8.48 Inch Diameter - Includes:	1
13	34-01186-00	Ring, Snap	1
14	04-00130-00	Bearing, Rotor	1

14 CLUTCH ASSEMBLY - HOUSING MOUNTED (WARNER - GRAY IN COLOR) - Continued			
Item	**Part Number**	**Description**	**Qty**
10	50-01122-07	Clutch, Assembly, 24 VDC, 2-B Grooves, 9 Inch Diameter - Includes:	1
11	50-01122-50	Coil, 24 VDC	1
12	50-01122-90	Rotor/Armature, 2-B Grooves, 9 Inch Diameter - Includes:	1
13	34-01186-00	Ring, Snap	1
14	04-00130-00	Bearing, Rotor	1
10	50-01122-09	Clutch, Assembly, 24 VDC, 4 Grooves (2-A/2-B), 10.35 Inch Diameter - Includes:	1
11	50-01122-50	Coil, 24 VDC	1
12	50-01122-501	Rotor/Armature, 4 Grooves (2-A/2-B), 10.35 Inch Diameter - Includes:	1
13	34-01186-00	Ring, Snap	1
14	04-00130-00	Bearing, Rotor	1
10	50-01122-12	Clutch, Assembly, 24 VDC, 2-5V Grooves, 8.7 Inch Diameter - Includes:	1
11	50-01122-50	Coil, 24 VDC	1
12	50-01122-91	Rotor/Armature, 2-5V Grooves, 8.7 Inch Diameter - Includes:	1
13	34-01186-00	Ring, Snap	1
14	04-00130-00	Bearing, Rotor	1
10	50-01122-14	Clutch, Assembly, 24 VDC, 2-5V Grooves, 10.5 Inch Diameter - Includes:	1
11	50-01122-50	Coil, 24 VDC	1
12	50-01122-93	Rotor/Armature, 2-5V Grooves, 10.5 Inch Diameter - Includes:	1
13	34-01186-00	Ring, Snap	1
14	04-00130-00	Bearing, Rotor	1
15	50-01122-65	Shim, .010 Inch Thick	5
	50-01122-66	Shim, .020 Inch Thick	1

15 CLUTCH ASSEMBLY - HOUSING MOUNTED (LINNIG - GOLD IN COLOR)

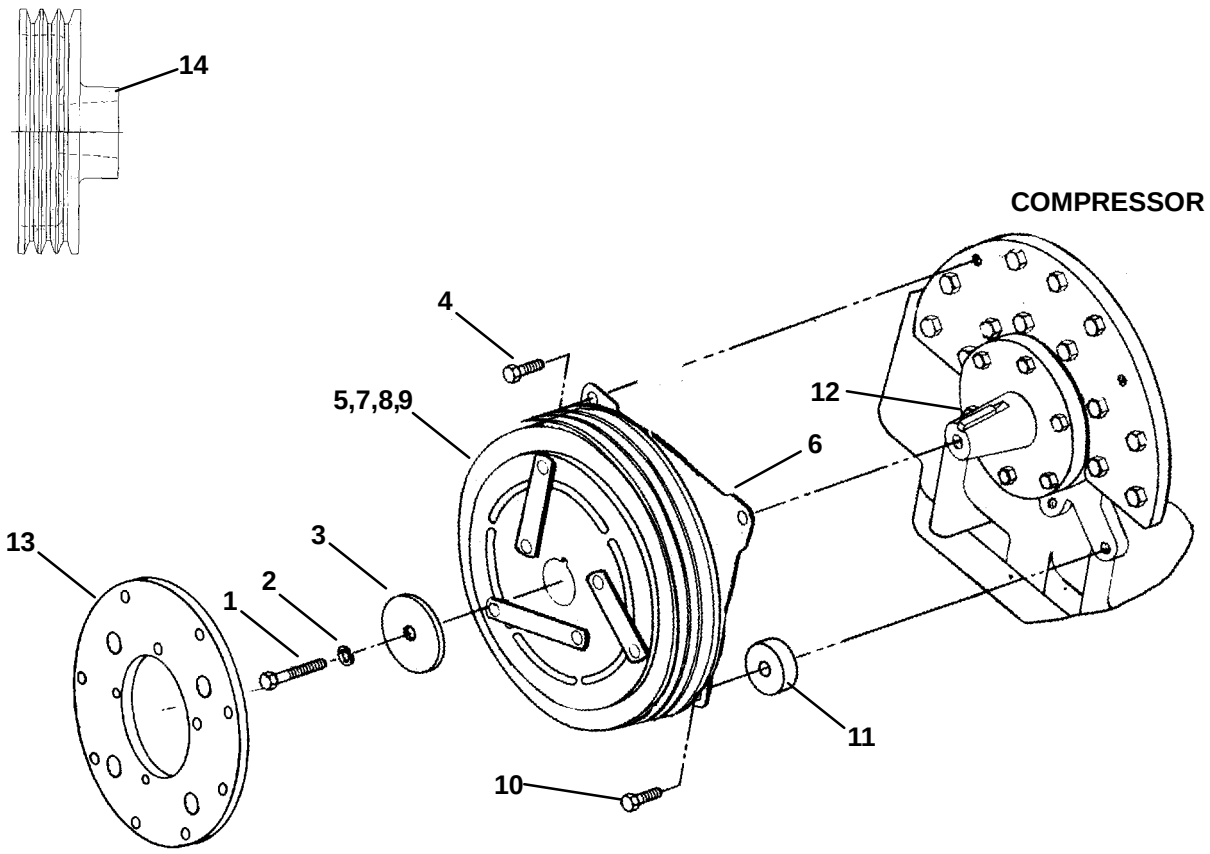
Note: Multiple groove rotor/armature designation describes groove location(s) starting at the compressor side and working out. Example: 3 Grooves 2B/1A shown below.



Item	Part Number	Description	Qty
NS	76-50013-00	Kit, Conversion Shaft to Housing Mounted Clutch	A/R
1	34-50035-00	Ring, Snap	1
2	34-50034-00	Bolt, Retaining, Special	1
3	34-01161-00	Nut, Hub, With Grease Fitting Port (Fitting Not Included)	1
	34-06083-00	Nut, Hub Without Grease Fitting Port	
4	40-01132-00	Fitting, Grease, 1/4–18	1
5	17-44041-01	Hub, Clutch Mounting - Includes:	1
6	17-44042-00	Ring, Felt and Retainer	1
7	68-G---2--9072	Key, Crankshaft, Special	1
8	17-10308-00	Capscrew, Hex Head, 3/8-16 x 1-1/4 Inches Long - SAE Grade 8	1
9	50-00226-09	Clutch Assembly, 24 VDC, 4 Grooves (2A/2B), 10.35 Inch Dia. - Includes:	1
10	50-00226-50	Coil, 24 VDC	1
11	50-00226-501	Rotor/Armature, 4 Grooves (2A/2B), 10.35 Inch Diameter - Includes:	1
12	50-50040-05	Ring, Snap	1
13	50-50040-04	Bearing	1
9	50-00226-09	Clutch Assembly, 24 VDC, 4 Grooves (A/B/2C), 10 Inch Dia. - Includes:	1
10	50-00226-50	Coil, 24 VDC	1
11	50-01130-13	Rotor/Armature, 4 Grooves (A/B/2C), 10 Inch Diameter - Includes:	1
12	50-50040-05	Ring, Snap	1
13	50-50040-04	Bearing	1
9	50-00226-18	Clutch Assembly, 12 VDC, 4 Grooves (2B/2A), 10.35 Inch Dia. - Includes:	1
10	50-00226-41	Coil, 12 VDC	1
11	50-50040-11	Rotor/Armature, 4 Grooves (2B/2A), 10.35 Inch Diameter - Includes:	1
12	50-50040-05	Ring, Snap	1
13	50-50040-04	Bearing	1

15 CLUTCH ASSEMBLY - HOUSING MOUNTED (LINNIG - GOLD IN COLOR) - continued			
Item	**Part Number**	**Description**	**Qty**
9	50-00226-19	Clutch Assembly, 24 VDC, 4 Grooves (2B/2A), 10.35 Inch Dia. - Includes:	1
10	50-00226-50	Coil, 24 VDC	1
11	50-50040-11	Rotor/Armature, 4 Grooves (2B/2A), 10.35 Inch Diameter - Includes:	1
12	50-50040-05	Ring, Snap	1
13	50-50040-04	Bearing	1
9	50-01130-03	Clutch Assembly, 24 VDC, 3-3V Grooves, 8.48 Inch Diameter - Includes:	1
10	50-00226-50	Coil, 24 VDC	1
11	50-50040-02	Rotor/Armature, 3-3V Grooves, 8.48 Inch Diameter - Includes:	1
12	50-50040-05	Ring, Snap	1
13	50-50040-04	Bearing	1
9	50-01130-20	Clutch Assembly, 12 VDC, 2-B Grooves, 10.35 Inch Diameter - Includes:	1
10	50-00226-41	Coil, 12 VDC	1
11	50-50040-03	Rotor/Armature, 2-B Grooves, 10.35 Inch Diameter - Includes:	1
12	50-50040-05	Ring, Snap	1
13	50-50040-04	Bearing	1
9	50-01130-21	Clutch Assembly, 24 VDC, 2-B Grooves, 10.35 Inch Diameter - Includes:	1
10	50-00226-50	Coil, 24 VDC	1
11	50-50040-03	Rotor/Armature, 2-B Grooves, 10.35 Inch Diameter - Includes:	1
12	50-50040-05	Ring, Snap	1
13	50-50040-04	Bearing	1
9	50-01130-22	Clutch Assembly, 12 VDC, 2-C Grooves, 10 Inch Diameter - Includes:	1
10	50-00226-41	Coil, 12 VDC	1
11	50-50040-12	Rotor/Armature, 2-C Grooves, 10 Inch Diameter - Includes:	1
12	50-50040-05	Ring, Snap	1
13	50-50040-04	Bearing	1
14	50-00226-65	Shim, .012 Inch Thick	5
	50-00226-66	Shim, .039 Inch Thick	1

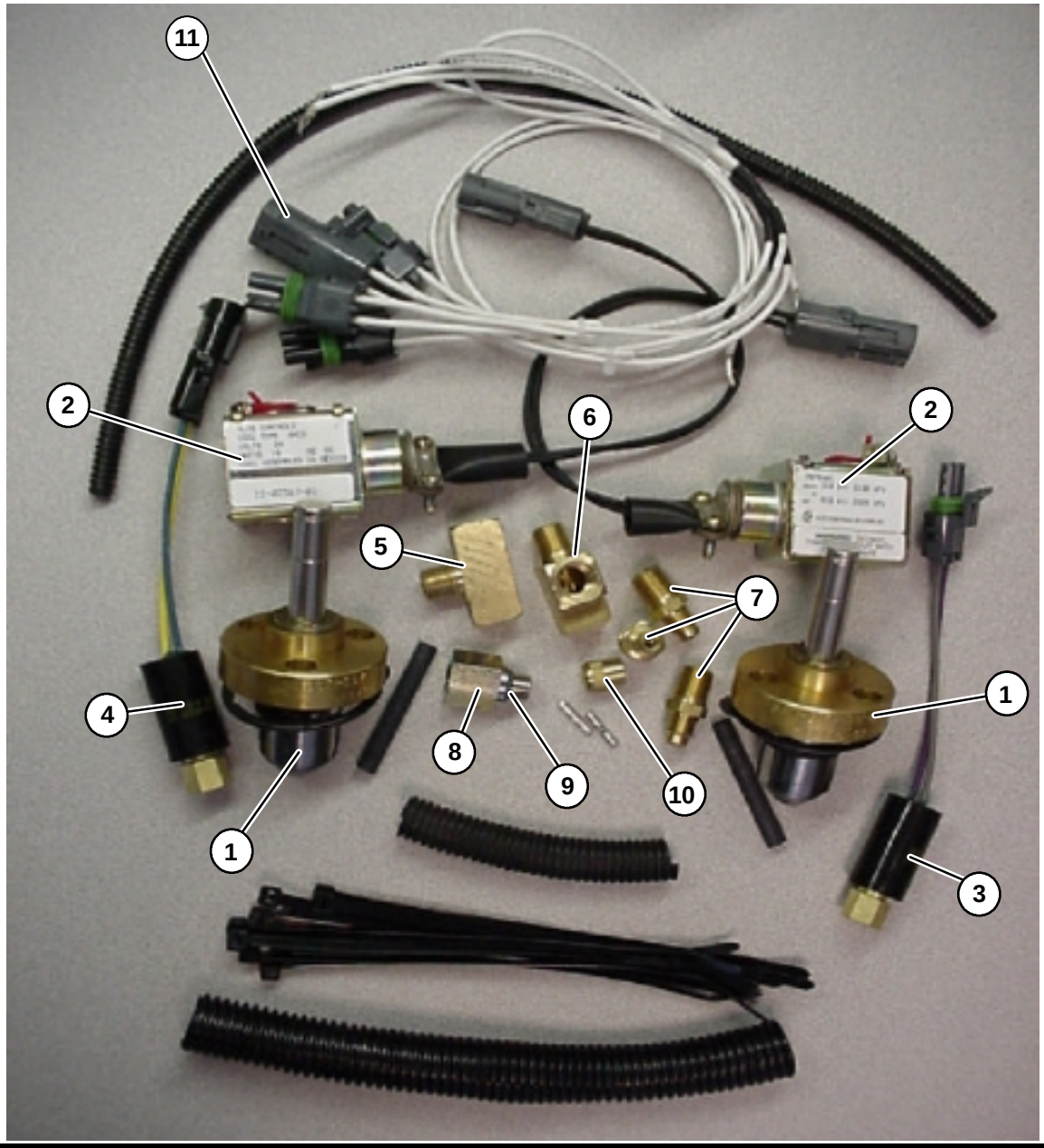
16 CLUTCH ASSEMBLY - SHAFT MOUNTED



Item	Part Number	Description	Qty
1	34-00613-07	Capscrew, Hex Head, 3/8 UNF x 7/8 Inch Long - SAE Grade 8	1
2	--AU--11AR-241	Washer, Lock, Spring, 3/8 Inch	1
3	34-00616-00	Washer, 13/32 ID x 1-1/2 OD x 3/16 Inch Thick	1
4	17-40037-05	Capscrew, Hex Head, 3/8-16 x 1 Inch Long	2

16 CLUTCH ASSEMBLY - SHAFT MOUNTED			
Item	**Part Number**	**Description**	**Qty**
5	50-01108-00	Clutch, 24 VDC, 2-C Grooves, 9 Inch Diameter	1
	50-01110-00	Clutch, 24 VDC, 3-3V Grooves, 8.48 Inch Diameter	
	50-01110-01	Clutch, 12 VDC, 3-3V Grooves, 8.48 Inch Diameter	
	50-01114-00	Clutch, 12 VDC, 2-B Grooves, 8.64 Inch Diameter	
6	50-50011-00	Coil, 24 VDC	1
	50-50014-00	Coil, 12 VDC	
7	50-50015-00	Ring, Retaining - External	1
8	50-50016-00	Ring, Retaining - Internal	1
9	50-50017-00	Bearing	1
10	17-10308-00	Capscrew, Hex Head, 3/8-16 x 1-1/4 Inches Long - SAE Grade 8	2
11	68-G---2--8522-1	Spacer, 1-3/8 OD x 1/2 Inch Thick - CRES	2
12	17-40324-00	Key, Crankshaft, 1/4 x 1/4 x 1-1/2 Inches Long	1
13	50-01115-00	Plate, Adapter (Used with 50-01114 Clutch)	1
14	68-G---2--1823	Sheave, Power Takeoff, 3-3V Grooves, 6 Inch Diameter, (On Allison Transmission)	1

17 UNLOADER KITS, BUS - PRESSURE TO ELECTRIC



17 UNLOADER KIT - PRESSURE TO ELECTRIC - R-134a ONLY - 24 VDC

Item	Part Number	Description	Qty
	74-50111-00	Kit, Convert Pressure Hot Gas Bypass to Electric Unloader (24 VDC), Includes:	2
1	17-40417-00	Unloader Valve	2
2	68PD-2-102-3	Solenoid Coil - 24 VDC	2
3	12-00334-02	Switch, Pressure (UPS2) - R-134a	1
4	12-00334-03	Switch, Pressure (UPS1) - R-134a	1
5	40-00249-01	Fitting, Tee, Male Branch, 1/4 FPT x 1/4 FPT x 1/4 MPT	1
6	40-00243-01	Fitting, Tee, Street, 1/4 MPT x 1/4 x 1/4 FPT	1
7	06DA403-844	Valve, Access (1/4 Flare, Schrader)	3
8	40-00528-02	Connector, 1/4 FPT x 7/16-20 Straight Thread With O-Ring - Includes:	1
9	42-00243-07	O-Ring	1
10	DD19CA061	Cap, 1/4 Flare, Schrader	1
11	22-50222-00	Wire Harness	1

17 UNLOADER KIT - PRESSURE TO ELECTRIC - R-22 ONLY - 24 VDC			
Item	**Part Number**	**Description**	**Qty**
	74-50111-01	Kit, Convert Pressure Hot Gas Bypass to Electric Unloader (24 VDC), Includes:	2
1	17-40417-00	Unloader Valve	2
2	68PD-2-102-3	Solenoid Coil - 24 VDC	2
3	12-00334-00	Switch, Pressure (UPS2) - R-22	1
4	12-00334-01	Switch, Pressure (UPS1) - R-22	1
5	40-00249-01	Fitting, Tee, Male Branch, 1/4 FPT x 1/4 FPT x 1/4 MPT	1
6	40-00243-01	Fitting, Tee, Street, 1/4 MPT x 1/4 x 1/4 FPT	1
7	06DA403-844	Valve, Access (1/4 Flare, Schrader)	3
8	40-00528-02	Connector, 1/4 FPT x 7/16-20 Straight Thread With O-Ring - Includes:	1
9	42-00243-07	O-Ring	1
10	DD19CA061	Cap, 1/4 Flare, Schrader	1
11	22-50222-00	Wire Harness	1
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	74-50111-02	Kit, Convert Pressure Hot Gas Bypass to Electric Unloader (36 VDC), Includes:	2
1	17-40417-00	Unloader Valve	2
2	14-50086-00	Solenoid Coil - 36 VDC	2
3	12-00334-02	Switch, Pressure (UPS2) - R-134a	1
4	12-00334-03	Switch, Pressure (UPS1) - R-134a	1
5	40-00249-01	Fitting, Tee, Male Branch, 1/4 FPT x 1/4 FPT x 1/4 MPT	1
6	40-00243-01	Fitting, Tee, Street, 1/4 MPT x 1/4 x 1/4 FPT	1
7	06DA403-844	Valve, Access (1/4 Flare, Schrader)	3
8	40-00528-02	Connector, 1/4 FPT x 7/16-20 Straight Thread With O-Ring - Includes:	1
9	42-00243-07	O-Ring	1
10	DD19CA061	Cap, 1/4 Flare, Schrader	1
11	22-50222-00	Wire Harness	1
17 UNLOADER KIT - PRESSURE TO ELECTRIC - R-22 ONLY - 36 VDC			
	74-50111-03	Kit, Convert Pressure Hot Gas Bypass to Electric Unloader (36 VDC), Includes:	2
1	17-40417-02	Unloader Valve	2
2	14-50086-00	Solenoid Coil - 36 VDC	2
3	12-00334-00	Switch, Pressure (UPS2) - R-22	1
4	12-00334-01	Switch, Pressure (UPS1) - R-22	1
5	40-00249-01	Fitting, Tee, Male Branch, 1/4 FPT x 1/4 FPT x 1/4 MPT	1
6	40-00243-01	Fitting, Tee, Street, 1/4 MPT x 1/4 x 1/4 FPT	1
7	06DA403-844	Valve, Access (1/4 Flare, Schrader)	3
8	40-00528-02	Connector, 1/4 FPT x 7/16-20 Straight Thread With O-Ring - Includes:	1
9	42-00243-07	O-Ring	1
10	DD19CA061	Cap, 1/4 Flare, Schrader	1
11	22-50222-00	Wire Harness	1

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Carrier Transport Air Conditioning
50 Grumbacher Road
York PA 17402 USA
Tel: 1-800-673-2431
Fax: 1-717-764-0401

North America
Carrier Transicold
700 Olympic Drive
Athens, GA 30601 USA
Tel: 1-706-357-7223
Fax: 1-706-355-5435

Central America and Mexico
Ejercito Nacional No. 418
Piso 9, Torre Yumal
Col. Chapultepec Morales
11570 Mexico, D.F.
Tel: (5255) 9126.0300
Fax: (5255) 9126.0373

Carrier
A United Technologies Company

Carrier Transicold Division,
Carrier Corporation
Truck/Trailer Products Group
P.O. Box 4805
Syracuse, N.Y. 13221 U.S A

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Housing-Mounted Clutch Installation

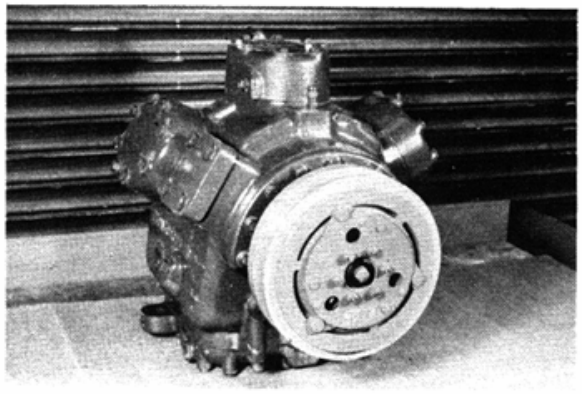
The procedure on the attached pages should be followed carefully when servicing the Carrier Transicold housing-mounted clutch. The following tools are recommended when removing and replacing this clutch:

TOOL LIST

DESCRIPTION	CTC PART NO. (WHERE APPLICABLE)
Spanner Wrench	07-00240-01
Rotor Installation Tool	07-00241
Socket Bearing Retaining Nut-Large	07-00242-01
Socket Bearing Retaining Nut-Small	07-00242-02
3/8″ Socket Set	
Torque Wrench	
3 Leg Puller w/ 3 1/4-20 UNC Cap Screws	
1 - Bolt 7/8-14 UNC x 2″ Long	
Feeler Gauge .020 .030 .060	
Grease Gun, Manual, 0.1 Oz Per Stroke	
Depth Gauge 0-1/2″	
Ohmmeter	

05G COMPRESSOR HOUSING MOUNTED CLUTCH

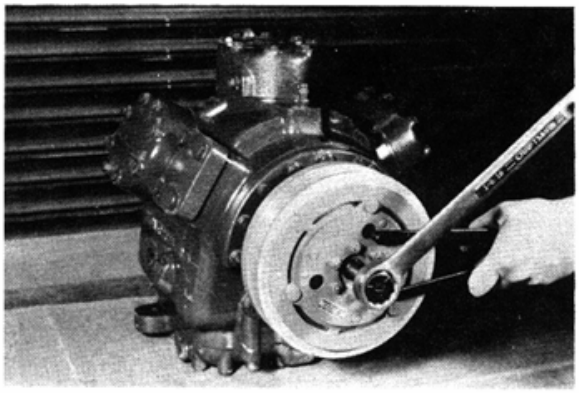
The new housing-mounted electric clutch, HMC, eliminates drive belt loading on the 05G crankshaft, and applies this load directly to the crankcase of the compressor. The following procedure should be followed carefully whenever it becomes necessary to remove and replace the HMC.



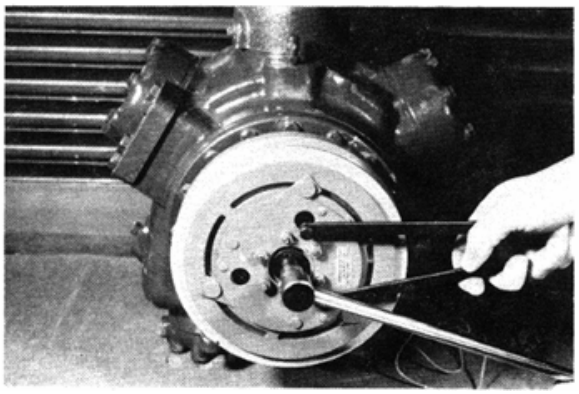
Housing-Mounted Clutch Removal

CAUTION: Remove drive belt before attempting to remove clutch.

1. Remove armature as a complete assembly by removing retaining capscrew (3/8-24 x 1-1/4″ Lg.), lock washer, and special 3/8 washer from compressor crankshaft. Use special CTD tool P/N 07-00240-01 to prevent crankshaft rotation, as shown.

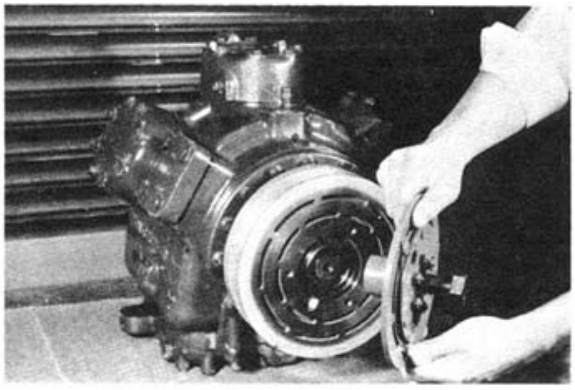


2. Install a 7/8-14 x 2″ capscrew into the center hole of the armature assembly. Use this capscrew as a jacking bolt to remove the armature assembly. Use tool 07-00240-01 as in Step 1 to prevent crankshaft rotation.

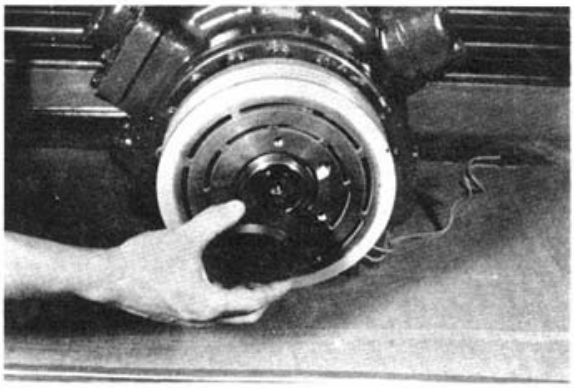


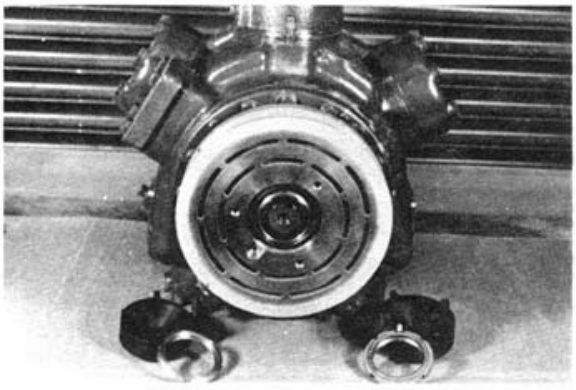
Note: Do not use a puller or pry against the armature hub or bumper plate, as this could cause damage to these parts.

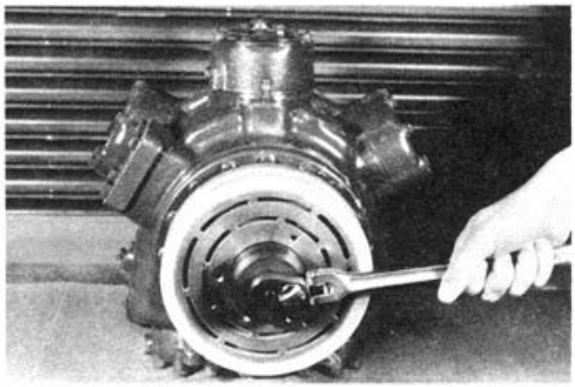
3. Remove the clutch armature assembly from the compressor crankshaft as a complete assembly, as shown.



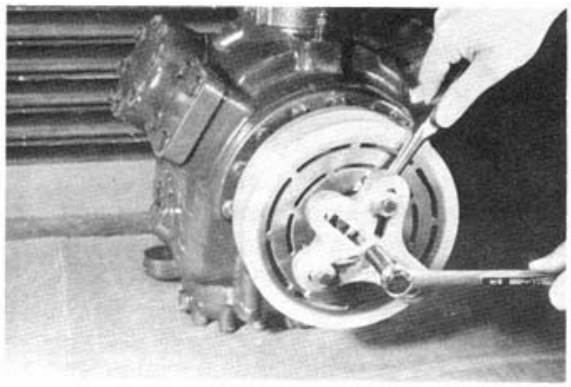
4. Remove the rotor retaining nut with special CTD tool P/N 07-00242-01.





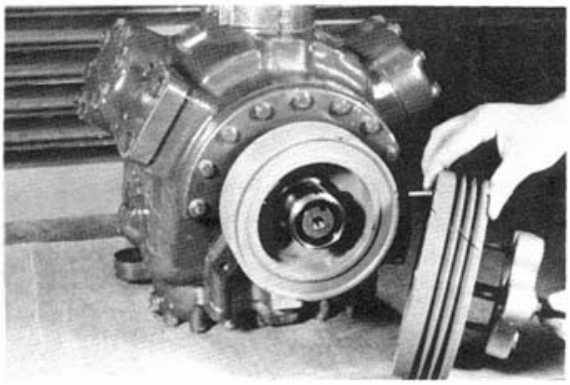


5. Install a flange-type gear puller into the three 5/16-18 tapped holes in the clutch rotor assembly, as shown.

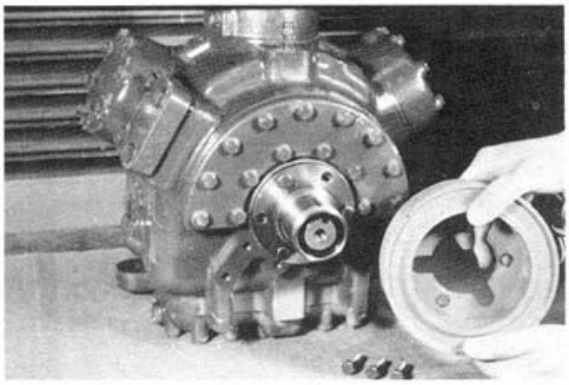


CAUTION: Use a washer or other protective device to prevent damage to crankshaft and threaded hole in the crankshaft by the puller. Never use a puller in the belt grooves, as damage to the rotor may result. Use a pry bar as shown to prevent rotation of the clutch rotor.

6. Once the rotor has been pulled from the clutch bearing mounting hub, carefully lift the rotor assembly away from the compressor, as shown.

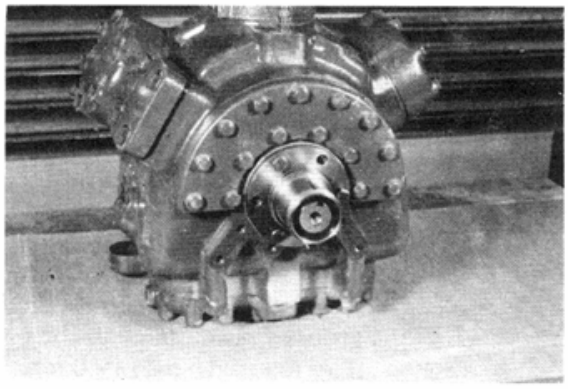


7. To remove the clutch coil, disconnect the coil's electrical cable from the wiring harness. Then remove only the three 3/8-16 capscrews holding the coil to the flange of the clutch bearing mounting hub, and carefully remove the coil, pulling straight out from the flange. Do not pry coil off, as it may bend the mounting plate.



Housing-Mounted Clutch Installation

1. Prior to installing the HMC, inspect for dents, nicks, or burrs on the clutch bearing mounting hub and clutch assembly. Correct if any are found, and clean clutch mounting hub and ID of clutch bearing with a chlorinated base or naphtha type solvent.



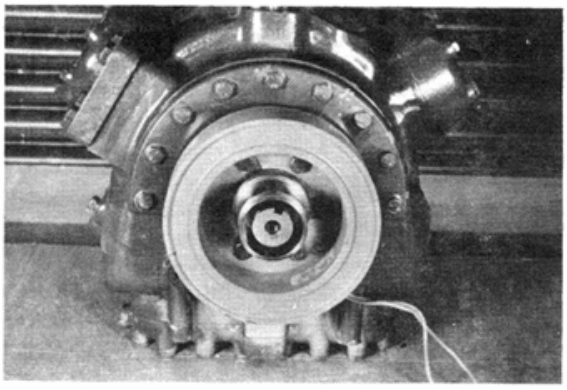
2. Inspect coil for damaged power leads, bent or cracked mounting plate, or burned or cracked potting material.

3. Check coil for electrical continuity, resistance, and shorts to ground.

Resistance at 68°F:	Lead to Lead	24 VDC coil	5.15-5.69 ohms
		12 VDC coil	1.92-2.12 ohms
	Lead to Ground	12/24 VDC coil	INF or open

Replace coil if above conditions are not met.

4. Slide the coil onto the clutch bearing mounting hub so that the lead wires exit between the 3 and 5 o'clock position, as shown.



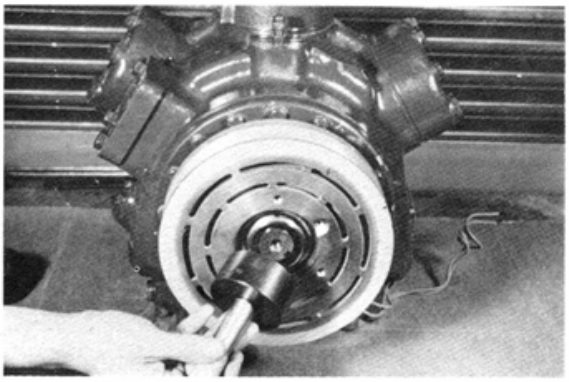
5. Secure the coil to the bearing mounting hub flange with the three 3/8-16 capscrews removed in Step 7 of Clutch Removal. Torque capscrews to 25-30 ft-lb (3.46-4.15 MKG).

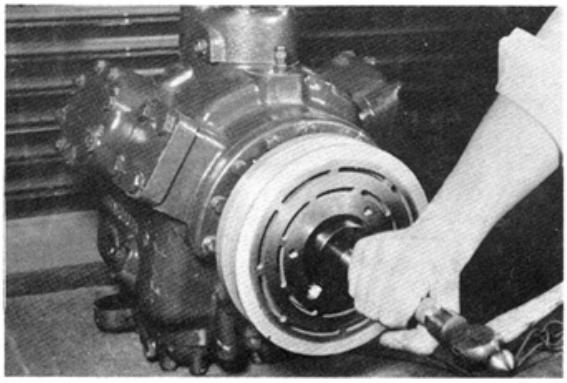
   CAUTION: Do not draw coil onto the clutch bearing mounting hub flange with the capscrews, as this may distort the coil.

6. To ease the installation of the rotor onto the clutch bearing mounting hub, preheat the inner race of the rotor bearing by placing an electric heater inside the bearing bore (a 75-100 watt outdoor post lamp style bulb applied for 15-30 minutes may be used).

   CAUTION: Do not heat bearing with an open flame or heat bearing above 175°F.

7. After preheating bearing, slide rotor assembly onto clutch bearing mounting hub. To facilitate seating of the bearing on the hub, place CTD tool P/N 07-00241 against the inner race of the bearing and tap gently with a hammer, as shown.

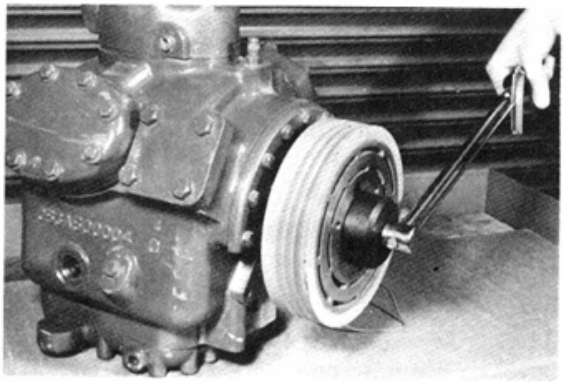




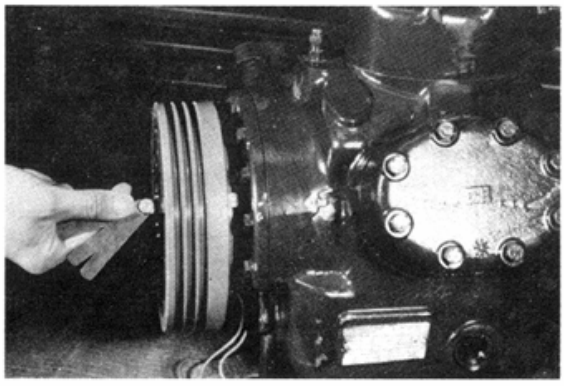
8. Install bearing retaining nut on clutch mounting hub and use torque wrench to tighten.

   If the smaller nut without the grease fitting is used, torque nut to 50 ft-lb. with CTD tool P/N 07-00242-02. The taper on the nut faces the bearing.

   If the larger nut with the grease fitting is used, torque the nut with CTD tool P/N 07-00242-01. Due to the self-locking feature of the nut, the installation torque may vary. When installing the nut, observe the torque required to turn the nut onto the hub. After the nut seats the bearing against the hub, apply a torque 50 ft-lb. greater than the installation torque.

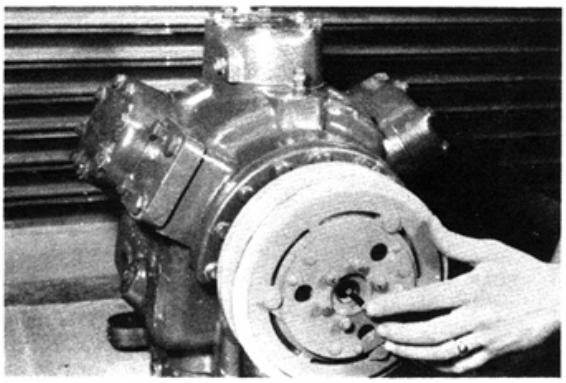


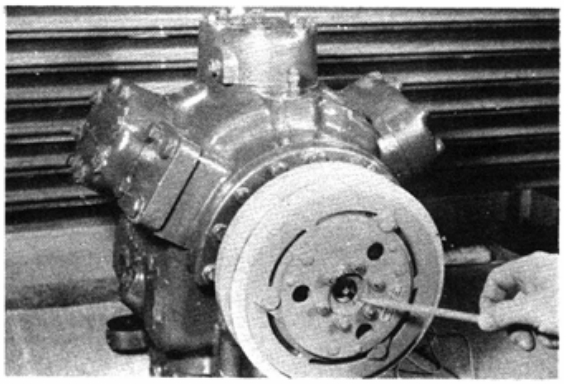
9. Check coil to rotor clearance by inserting .020 thick by .156 wide (max.) feeler gauge through an outer slot in rotor, as shown. Insert the feeler gauge so it extends beyond the rear face of the rotor and rotate the rotor one full turn. There should be no rubbing or binding.



10. Place armature and hub assembly onto the compressor crankshaft and insure the hub seats on the crankshaft properly.

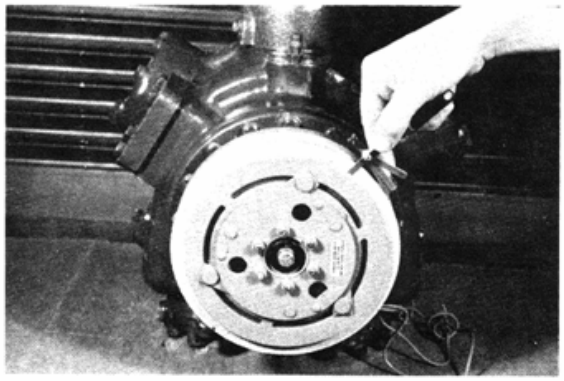
11. Insert the special key CTD P/N 68G2-9072 (1.75 x .250 x .199) in the keyway until outer end of key is flush with the hub's counter bore, as shown.





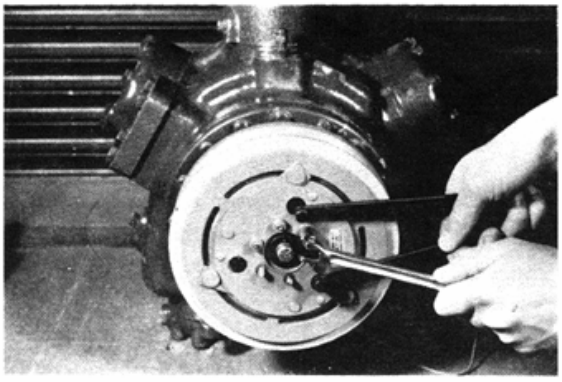
12. Secure armature assembly to crankshaft with the 3/8 special flat washer, lock washer, and 3/8-24 x 1-1/4" lg. capscrew removed in Step 1 of Clutch Removal. Torque capscrew to 16-20 ft-lb using CTD tool P/N 07-00240-01 to prevent crank shaft rotation.

Steps 13-19 are for <u>new</u> clutch installation <u>only.</u> After the initial adjustment, shim stack should not be changed.



13. Measure the air gap between the armature and rotor surfaces, as shown.

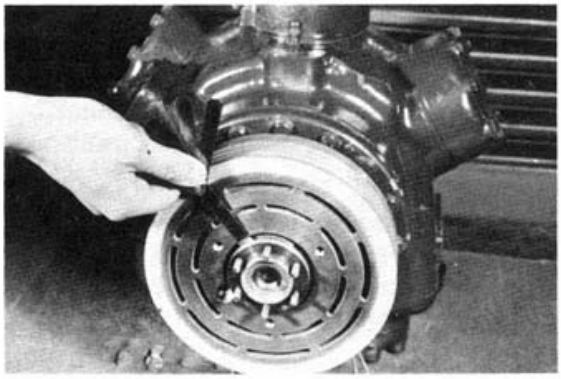
14. Record this measurement and determine the amount of shims that must be removed to obtain a 030/.060 air gap. The shims consist of (one) .010 and (six) .020 shims.



15. Remove the six armature plate to armature hub retaining nuts and washers. Use CTD tool P/N 07-00240-01 to prevent armature rotation, as shown.

16 Remove the required number of shims to obtain an air gap of .030/.060.

17. Insert a .020 feeler gauge between the outside edge of the clutch bearing mounting hub and the inside edge of the armature mounting hub, as shown. The clearance should be .020 or greater.



18. Reinstall armature plate, washers, and retaining nuts and torque to 7 ft-lb using CTD tool P/N 07-00240-01 to prevent crankshaft rotation.

19. Recheck air gap to confirm that you have obtained the .030/.060 clearance.

FIELD SERVICE PROCEDURES

1. Greasing of Clutch Bearing

The clutch bearings are pre-greased by the bearing manufacturer with the proper operating charge. Do not add grease to the bearing for at least 5000 hours of bus operation.

CAUTION: Over-greasing of the bearing will cause the bearing to operate at higher temperatures that may result in:

1. Blowing grease through the bearing seals onto the clutch friction faces, causing clutch slippage. A slipping clutch tends to run extremely hot, resulting in forcing more grease from the bearing, thereby increasing slippage and burning the magnetic coil.
2. Reduction in torque transmission capacity.

Recommended frequency for adding grease:

Up to 5000 hours bus operation	None
After initial 5000 hours	Add 0.1 oz SR1-2 grease during pre-season A/C system checkout (i.e., once per year during a Spring month)

Grease required must be "Chevron SR1-2" or CTD Engineering approved equal.

Procedure for Adding Grease to the Clutch Bearing

The grease fitting is located in the clutch bearing retaining nut. Access to the grease fitting is accomplished by removing the armature assembly as in Steps 1, 2, and 3 of HMC Removal.

NOTE: The removal of the armature in order to add grease to the bearing is deliberate to insure that all grease spillage can be cleaned from the clutch, reducing the potential for clutch slippage and the resulting loss of clutch torque transmission capacity.

Any unauthorized modification of the clutch armature to facilitate greasing of the bearing will void the clutch and compressor warranties.

It is recommended that a hand operated grease gun with approximately 0.1 oz delivery per stroke be used to add grease to the bearing. Grease gun must contain "Chevron SR1-2" grease.

Wipe the grease fitting clean of all dirt and foreign materials.

Attach grease gun to grease fitting. Insert 0.1 oz grease into bearing (1 to 2 strokes of the gun).

CAUTION: Do not give extra strokes "for good measure" as premature clutch performance degradation may result.

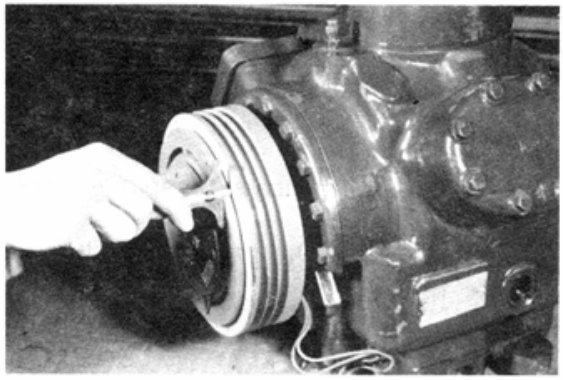
After adding grease to the bearing, wipe all grease spillage from clutch faces, retaining nut, and hubs. If you can see it, wipe it up.

Reinstall armature assembly and torque retaining nut to 16-20 ft-lb. torque, as in Steps 10, 11, and 12 of HMC Assembly.

2. Inspection for Wear

CAUTION: Insure bus or compressor drive engine is not operating. Take extra precautions to prevent inadvertent engine starting while clutch is being serviced.

A) With clutch coil de-energized, measure distance from face of armature to face of rotor, as shown. Feeler gauges inserted between the rotor and armature friction faces is not recommended due to the uneven wear on friction surfaces.



Energize the clutch coil and repeat the measurement. If the difference between the first and second measurements exceeds .110 inches, the clutch rotor and armature are to be replaced.

NOTE: Do not attempt to readjust the armature travel by removing shims. A catastrophic clutch failure may result. After initial (new) air gap adjustment the shim stack should never be changed.

B) Never mix rotor and armature assemblies between used assemblies or new and used assemblies.

CAUTION: If either the armature or rotor assemblies are defective, both assemblies must replaced.

C) If raised ribs on friction face are worn flat or nearly flat, replace armature and rotor assemblies.

http://www.intl-comp.com

Compressor Service Manual

for
TM-08
TM-13
TM-15
TM-16
TM-21
TM-31
Compressors

INTERNATIONAL COMPONENTS ENGINEERING

Ingersoll-Rand

ICE No. 51068 (Rev. 2a, 12/03)

This manual is published for informational purposes only and the information so provided should not be considered as all-inclusive or covering all contingencies. If further information is required, International Components Engineering should be consulted.

Sale of product shown in this manual is subject to International Components Engineering terms and conditions including, but not limited to, the International Components Engineering Limited Express Warranty. Such terms and conditions are available upon request.

International Components Engineering warranty will not apply to any equipment which has been "so repaired or altered outside the manufacturer's plants as, in the manufacturer's judgment, to effect its stability."

No warranties, express or implied, including warranties of fitness for a particular purpose or merchantability, or warranties arising from course of dealing or usage of trade, are made regarding the information, recommendations, and descriptions contained herein. Manufacturer is not responsible and will not be held liable in contract or in tort (including negligence) for any special, indirect or consequential damages, including injury or damage caused to vehicles, contents or persons, by reason of the installation of any product or its mechanical failure.

The compressor is designed for use with R-12 and R-134a for vehicle air conditioning only. Use with other refrigerants will void any warranty.

The ICE compressor is not intended nor designed for use on aircraft.

TM Advantages

Wide Range of Applications

- Single Operator Cabs to Large Trucks, Buses, RVs, and other Specialty Applications.

Smooth Operation

- Balanced Swash Plate design offers low pulsation noise, quiet and smooth operation, less vibration, and lower horsepower requirements.

High Efficiency

- Cooling capacity is stable throughout the entire RPM operating range.

High Durability

- MoS_2 coated steel swash plate provides additional protection during liquid slugging and high load conditions.
- Ball and shoe design promotes lubrication for better compressor durability.
- Needle bearings insure high durability for long life and high speed operation.
- Lip Shaft Seal insures excellent sealing integrity and extends compressor life.

TM-31 ALSO INCLUDES

TM-31 Compressor with Oil Sight Glass

- Ease of maintenance.

Optimized Lubrication System

- Pressure lubrication system provides superior lubrication to cylinder walls, pistons, bearings, and shaft seals.

Recover Refrigerant

At International Components Engineering, we recognize the need to preserve the environment and limit potential harm to the ozone layer that can result from allowing refrigerant to escape into the atmosphere.

We strictly adhere to a policy that promotes the responsible use and handling of CFC/HCFC/HFC refrigerants by using approved recovery and recycling methods and equipment that limits the loss of refrigerant into the atmosphere.

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Safety Precautions

Safety Definitions

Hazard precautions come in the following levels, which you should be familiar with:

DANGER: Denotes the possibility of serious injury or death.

WARNING: Denotes the possibility of serious equipment damage or serious personal injury.

CAUTION: Denotes the possibility of minor to severe equipment damage or personal injury.

General Safety

DANGER: Refrigerants in the presence of an open flame, spark or electrical short produce toxic gases that are severe respiratory irritants capable of causing death.

DANGER: EXPLOSIVE HAZZARD! Do not close the compressor discharge valve with the unit in operation. Do not start the compressor with the discharge valve closed. This increases internal pressure on the compressor which will cause the compressor to explode.

WARNING: Keep your hands, clothing and tools clear of the fans when the unit is running. This should also be considered when opening and closing the compressor service valves (when equipped).

WARNING: Make sure the gauge manifold hoses are in good condition. Keep them away from belts, fan motors, engine pulleys, and hot surfaces.

WARNING: Do not apply heat to a sealed refrigeration system or container. This increases internal pressure and can cause an explosion.

WARNING: Make sure all mounting bolts are tight and are the correct length for their particular application. Using an incorrect length bolt may cut a wire and cause an electrical short or penetrate air conditioning components.

DANGER: Use caution with a refrigeration system in a closed or confined area with a limited air supply (for example, a bus or garage). Refrigerant displaces air and can cause oxygen depletion, resulting in suffocation and possible death.

WARNING: Do not wear jewelry, watches or rings. These items can short out, causing severe burns to the wearer.

WARNING: Wear eye protection when handling compressors. Refrigerant liquid and battery acid can permanently damage the eyes

Refrigerant

CAUTION: When removing refrigerant from a compressor, use a recovery process that minimizes refrigerant loss to the atmosphere. Although fluorocarbon refrigerants are classified as safe, precautions must be observed when handling them.

First Aid

Objectives of first aid for frostbite are to protect the frozen area from further injury, to warm the affected area rapidly, and to maintain respiration.

EYES: For contact with liquid, immediately flush eyes with large amounts of water and get prompt medical attention.

SKIN: Flush area with large amounts of lukewarm water. Do not apply heat. Remove contaminated clothing and shoes. Wrap burns with dry, sterile, bulky dressing to protect from infection/injury. Get medical attention. Wash contaminated clothing before reuse.

INHALATION: Move victim to fresh air and use CPR or mouth-to-mouth ventilation, if necessary. Stay with victim until arrival of emergency medical personnel.

Refrigerant Handling

CAUTION: Never directly heat service cans or put them in hot water heat ed above 104 F (40 C) since the can may explode and cause personal injury. When it is necessary to heat service cans for charging in cold weather, use warm water at a temperature below104 F (40 C).

CAUTION: Do not put the charge valve in the warm water.

DANGER: Never put service cans on the engine or the radiator when charging.

DANGER: Never store service cans in direct sunlight, near flame or where the temperature exceeds 104 F (40 C). Always store service cans in a cool dry place.

DANGER: Never throw or strike service cans and never handle the packing carton roughly. Do not use service cans which are damaged or dented. Store service cans out of reach of children.

Refrigerant Oil

DANGER: Avoid refrigeration oil contact with the eyes. Avoid prolonged or repeated contact of refrigeration oil with skin or clothing. Wash thoroughly after handling refrigeration oil to prevent irritation.

First Aid

In case of eye contact, immediately flush with plenty of water for at least 15 minutes. CALL A PHYSICIAN. Wash skin with soap and water.

Leak Detection

DANGER: Do not use a Halide torch for lead detection. When a flame contacts refrigerant, toxic gases are produced which may cause suffocation or even death.

Check manufactures information when using leak detectors. All leak detectors must detect fluorine.

Leaks can be detected by using soap bubbles and with Halogen leak detectors such as G.E. H10G or a portable leak detector. These are commercially available.

R-134a Applications

R-134a is a Hydrofluoro-carbon (HFC) because it contains hydrogen, fluorine, and carbon. It does not contain chlorine.

Always use recommended procedures when servicing equipment:

- Do not vent refrigerant to the atmosphere.
- Recover and reclaim all refrigerants.

DANGER: Store refrigerants in proper containers, out of direct sunlight and away from intense heat.

DANGER: Do not breathe vapors. Use in well-ventilated areas. Refrigerants cause oxygen depletion and death.

WARNING: Wear eye protection and avoid contact with skin. Refrigerant can cause severe frostbite.

CAUTION: Use butyl-lined gloves when handling refrigerants to prevent frostbite.

DANGER: Do not use open flame near refrigerant. Do not burn it as toxic fumes may be released.

DANGER: Do not use Oxygen (O_2) or compressed air for leak testing. An explosion may occur.

Polyalkylene Glycol (PAG) Oil Handling Procedures

CAUTION: Use dedicated equipment for systems containing R-134a to prevent contaminating the system with oil from other systems.

CAUTION: Store oil in sealed containers.

Polyalkylene Glycol (PAG) oil is a hygroscopic oil, which means it absorbs or attracts moisture from the air. Therefore, this oil requires special care and handling procedures. Discard partially used cans of PAG oil.

Equipment for R-134a Use Only

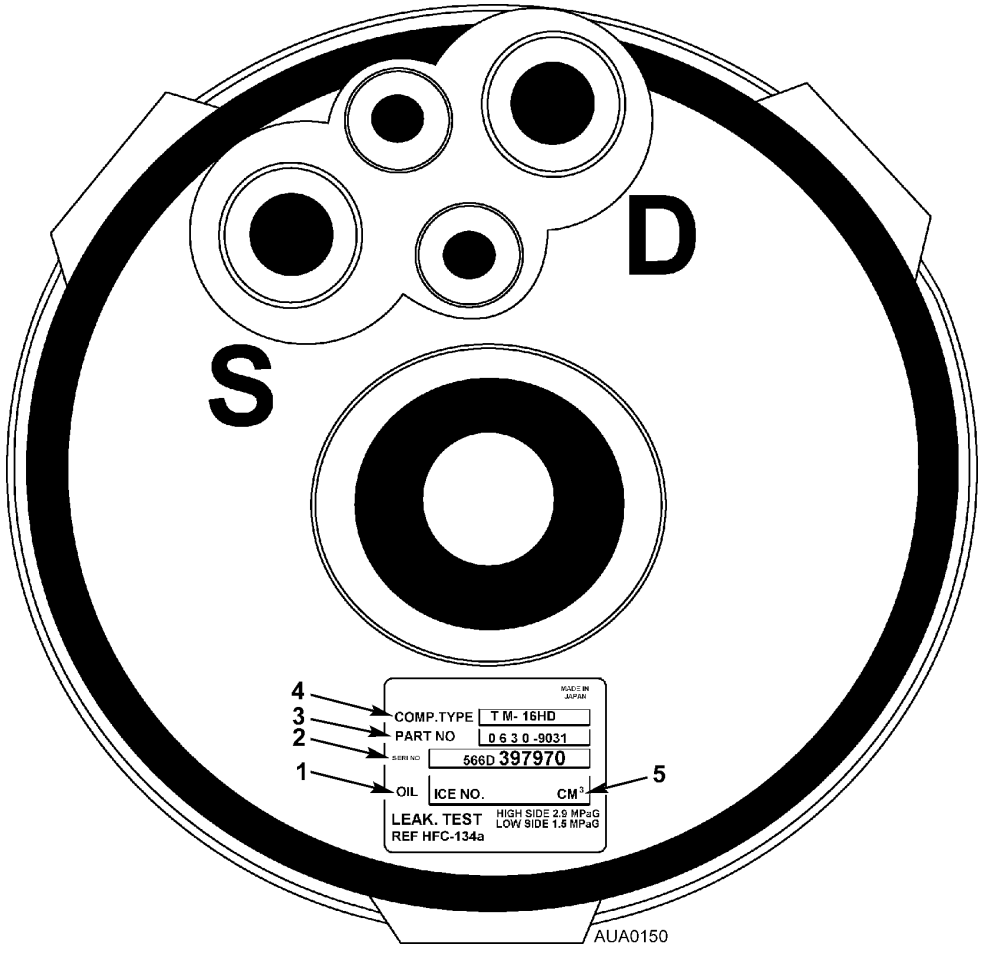
CAUTION: Use dedicated equipment for R-134a to prevent contamination from other refrigerants and compressor oils. If you cannot use dedicated equipment, clean, flush, or purge equipment before using to avoid contamination.

CAUTION: Mixing of refrigerants or oils in the compressor may damage your pump.

- Gauge Manifold.
- All service hoses.
- All adaptors and fittings.
- Micron Gauge optional, but must be used with refrigerant dedicated hoses.
- Vacuum pump. (5 cfm size [0.14 meter^3/min.] or larger recommended).
- Recovery and recycling equipment.
- Proper storage equipment for refrigerants and oils.
- Suction service filter(s) for system clean-up (if needed).

NOTE: The larger the size of the vacuum pump, the faster the evacuation process.

Compressor Identification Label



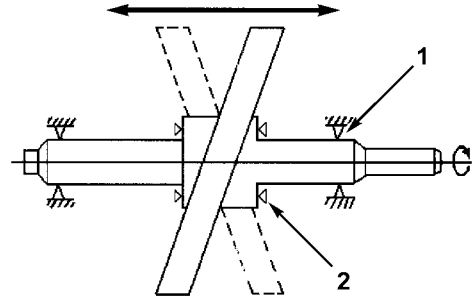
1.	ICE Oil Number	4.	Compressor Type (Model)
2.	Manufactures Serial Number	5.	Compressor Oil Charge
3.	ICE Part Number 4		

Compressor Identification Label

Introduction

Swash Plate System

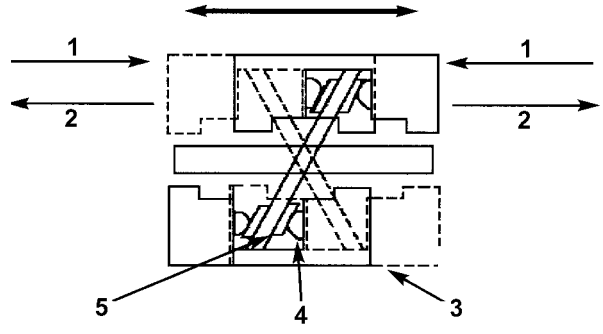
The driveshaft is supported by two radial bearings and two thrust bearings. As the swash plate reciprocates through the rotation of the drive shaft, the pistons are driven back and forth.



1.	Radial Bearing
2.	Thrust Bearing

Piston Drive System

The pistons in the cylinders are mounted on the swash plate through a dive ball and shoe disk. Each piston has a compression head at each end. Swash plate rotation results in reciprocating piston movement parallel to the driveshaft. The cylinders are arranged at intervals around the driveshaft, providing 5 front and 5 rear bores.



1.	Suction
2.	Compression
3.	Pistons
4.	Ball
5.	Shoe Disk

Compressor System Guidelines

- The specified rotation of the TM-08, TM-13, TM-15, TM-16, and TM-21 is clockwise or counterclockwise.
- The specified rotation of the TM-31 is clockwise as viewed from the clutch side.
- The compressor must be operated within the conditions shown below.

Item	Condition
Ambient Temperature	Under 212 F (100 C)
Speed	6000 rpm maximum
Pressure	Max: 284 psig (1960 KPa)

CAUTION: The A/C system pressure must not exceed 284 psig (1960 KPa).

Suggested Operating Region

The figure below shows the suggested operating region for compressors using R-134a refrigerant:

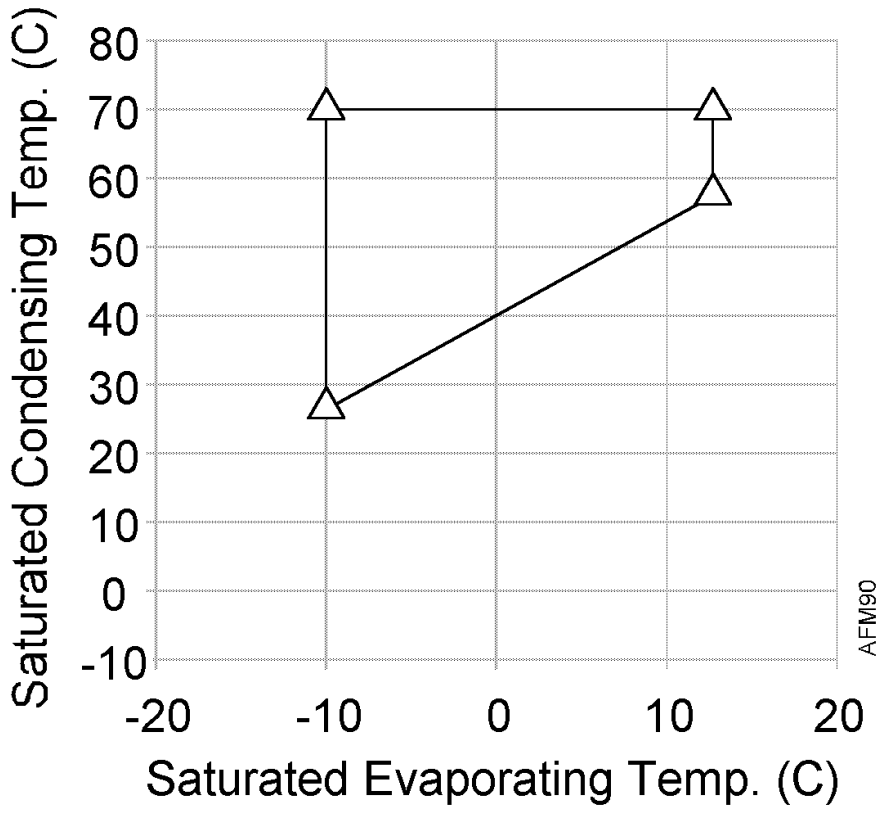
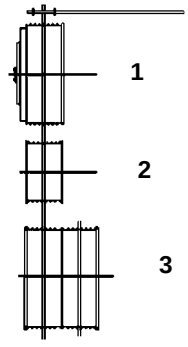


Figure 1: R-134a Compressor Operation Map

Clutch Application Guidelines



1.	Magnetic Clutch
2.	Idle Pulley
3.	Drive Pulley

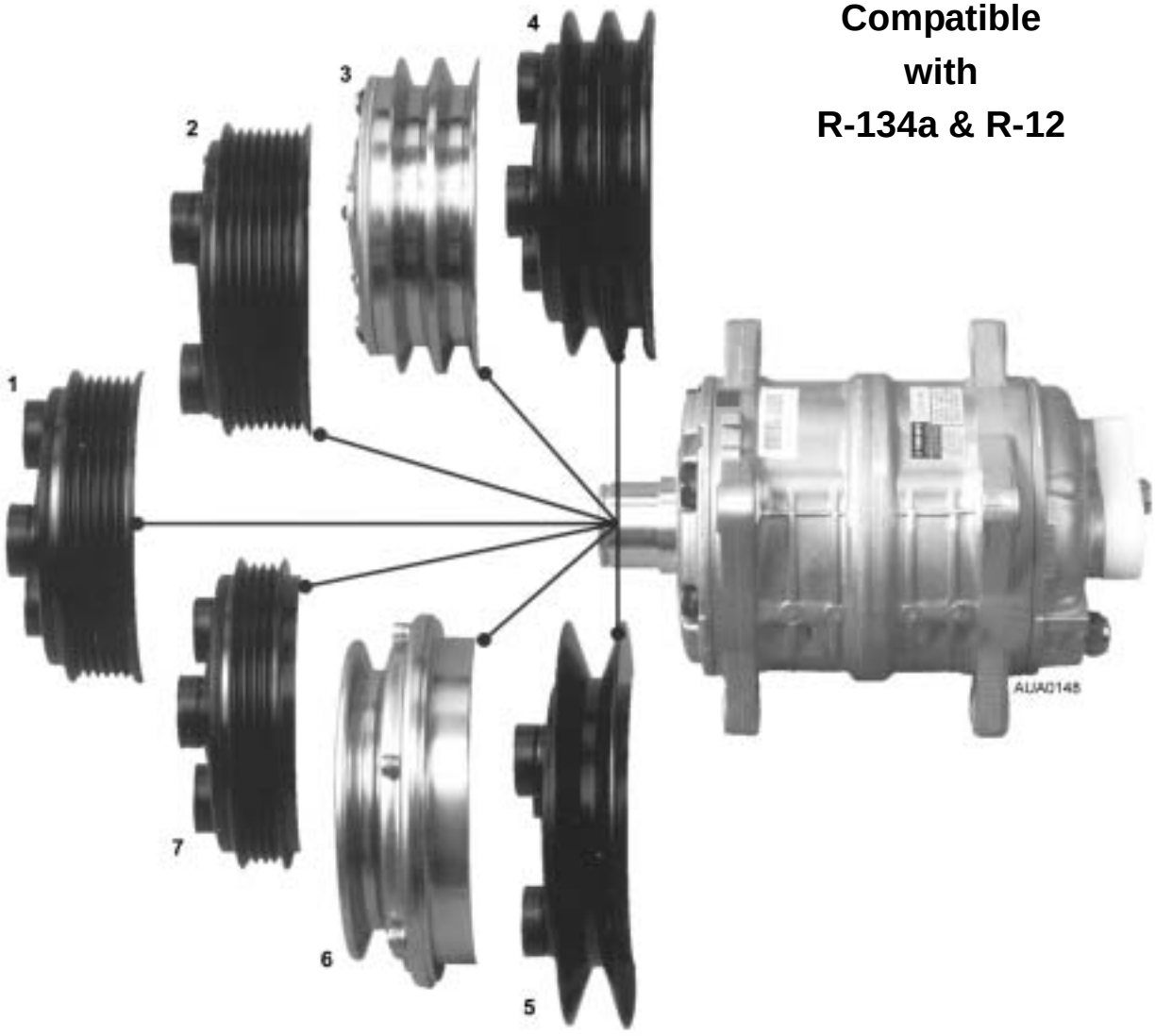
- Ratio of magnetic clutch to drive pulley:

NOTE: Pulley ratio is defined as the ratio of the magnetic clutch diameter to the drive pulley diameter.

  - To avoid vibration and resonance, avoid pulley ratio ranges between 1:0.92 and 1:1.08.
  - Compressor speed must not exceed the specified speed.
- Pulley alignment tolerance is less than 0.049 in. (1 mm).
- Belt tension must be adjusted to the specified tension. See belt manufacturer or system specifications for tension guidelines.

Compressor Clutch and Fitting Options

Compatible with R-134a & R-12

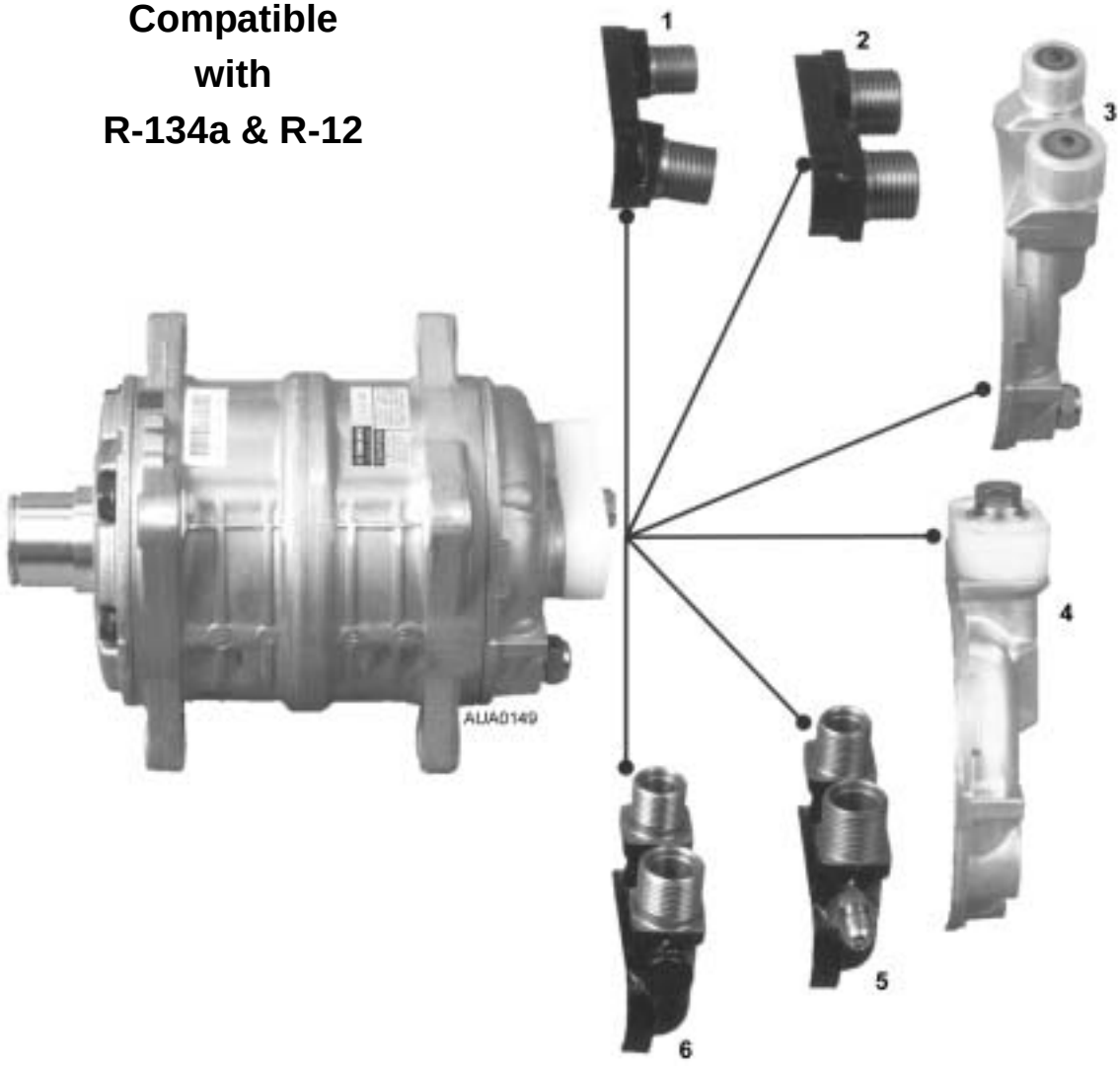


Clutch Options

1.	6 Groove
2.	8 Groove
3.	125 mm Double A Groove
4.	135 mm Double A Groove
5.	Variable Grove
6.	Overhang
7.	4 Groove

Capacities Available
TM-08 (82 cc)
TM-13 (131 cc)
TM-15 (147 cc)
TM-16 (163 cc)
TM-21 (215 cc)

Compatible with R-134a & R-12



Fitting Options

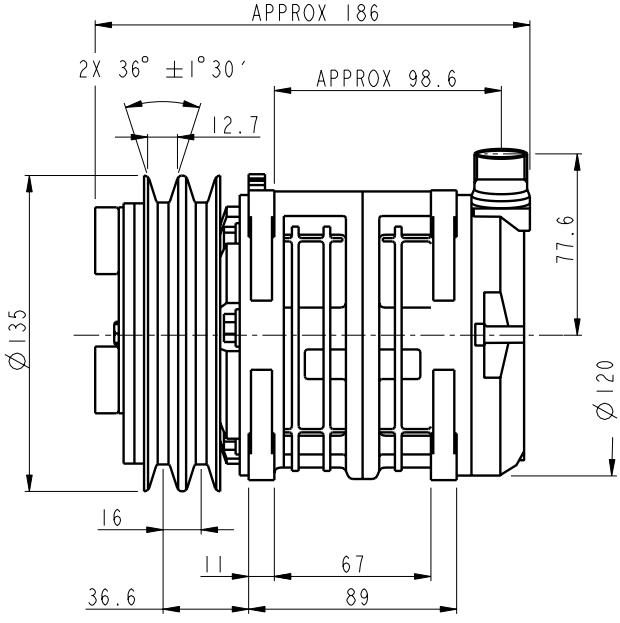
1.	3/4 X 7/8 Horizontal O-ring
2.	1 X 14 Horizontal O-ring
3.	Most ICE Compressors are available with 3/4 X 7/8 Monolothic O-ring Configuration
4.	Vertical Pad
5.	3/4 X 7/8 Vertical O-ring (R-12)
6.	3/4 X 7/8 or 1X14 Vertical O-ring

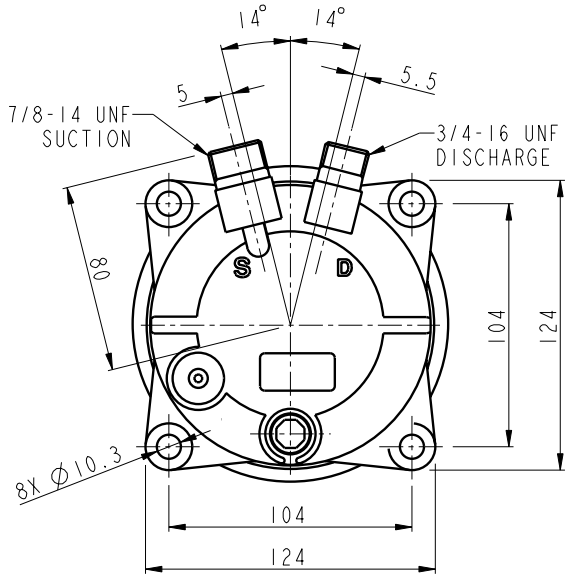
Capacities Available
TM-08 (82 cc)
TM-13 (131 cc)
TM-15 (147 cc)
TM-16 (163 cc)
TM-21 (215 cc)

Dimensions and Specifications

TM-08 Ear Mount Dimensions and Specifications

NOTE: Sample configuration shown. Some specifications may vary.





Compressor Specifications

Model	TM-08HD
Type	Swash Plate type
Number of Cylinders	6
Bore	36 mm (1.42 in)
Stroke	13.4 mm (0.53 in.)
Displacement	82 cm^3 (5 cu. in)
Permissible Speed	700-6000 rpm
Refrigerant	R-134a
Lubricant	Oil - ICE No. 2560101 (1 L PAG)
Oil Charge	150^{+20} cm^3
Mass	4.1kg (9.1 lbs)

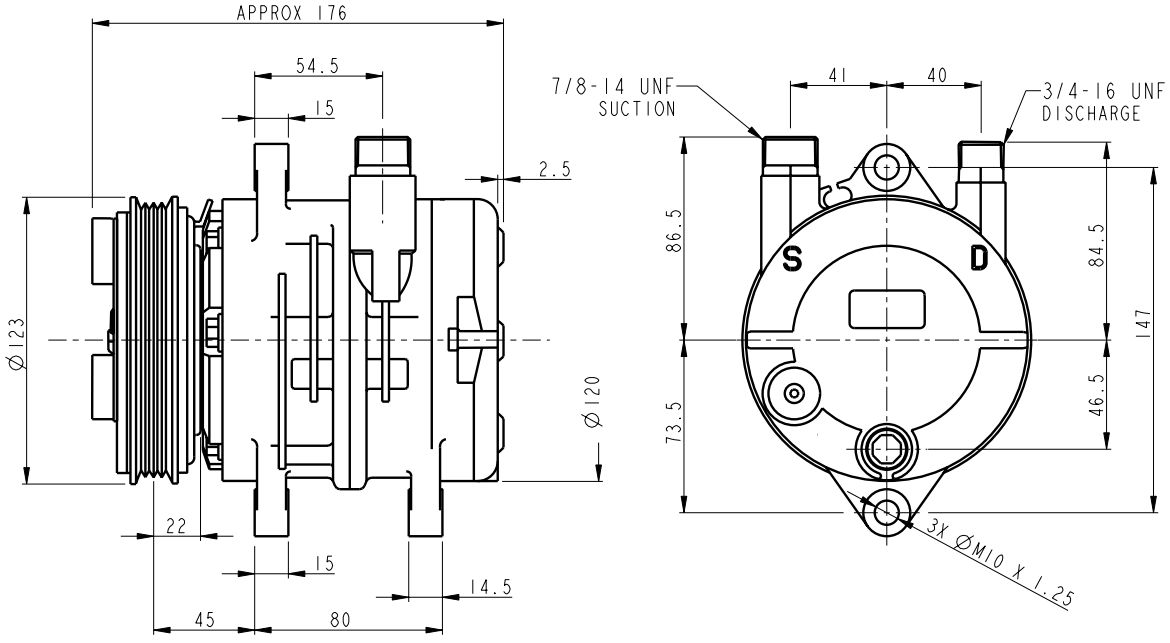
Magnetic Clutch Specifications

Type	Electromagnetic Single-Plate Dry Clutch
Rated Voltage	12/24 volts DC
Belt	2A Type
Current Consumption	3.75 amperes (max)
Static Torque	Initial: 35 N•m (3.5 kgfm) After burnishing: 49 N•m (5 kgfm)
Rotation	CW/CCW
Weight	2.2 kg (4.9 lbs)

CAUTION: Check system decals and operation manual for oil type. Mixing incompatible oils causes system damage. Compressor Oil ICE No. 2560101 (1L PAG) recommended for R-134a Systems.

TM-08 Alternator Mount Dimensions and Specifications

NOTE: Sample configuration shown. Some specifications may vary.



Compressor Specifications

Model	TM-08HD
Type	Swash Plate type
Number of Cylinders	6
Bore	36 mm (1.42 in)
Stroke	13.4 mm (0.53 in)
Displacement	82 cm^3 (5 cu. in)
Permissible Speed	700-6000 rpm
Refrigerant	R-134a
Lubricant	Oil-ICE No. 2560101 (1 L PAG)
Oil Charge	150^{+20} cm^3
Mass	4.1kg (9.1 lbs)

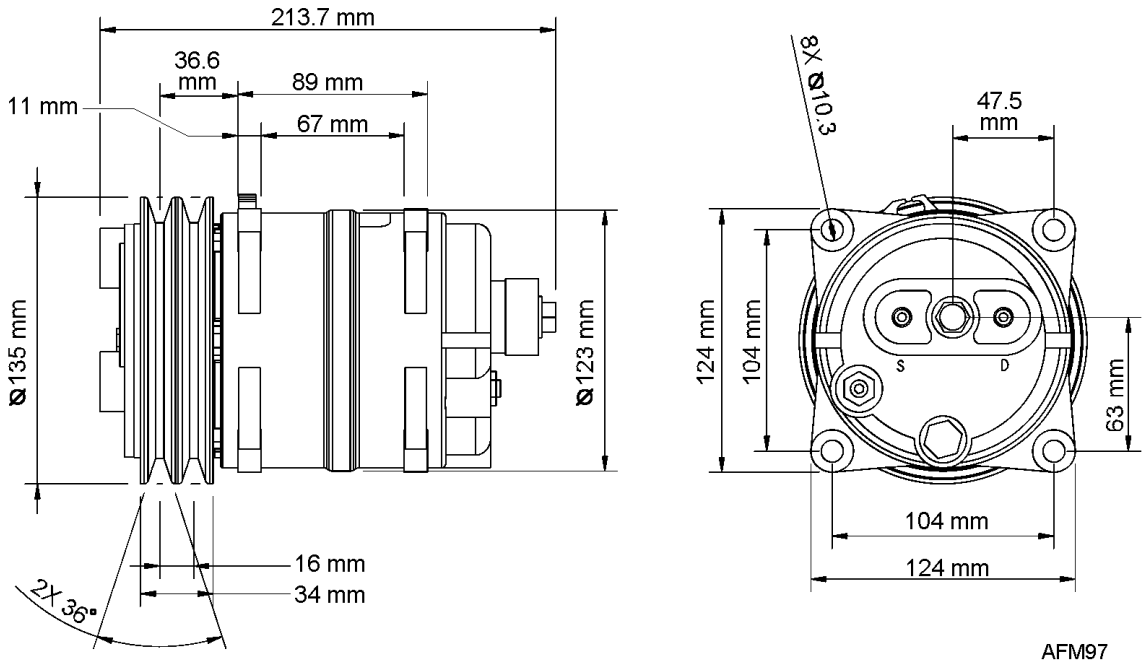
Magnetic Clutch Specifications

Type	Electromagnetic Single Plate Dry Clutch
Rated Voltage	12/24 volts DC
Belt	Ply “V” 4K type
Current Consumption	3.75 amperes (max)
Static Torque	Initial: 35 N•m (3.5 kgfm) After burnishing: 49 N•m (5 kgfm)
Rotation	CW/CCW
Weight	2.2 kg (4.9 lbs)

CAUTION: Check system decals and operation manual for oil type. Mixing incompatible oils causes system damage. Compressor Oil ICE No. 2560101 (1L PAG) recommended for R-134a Systems.

TM-08 Ear Mount Pad-Type Fittings

NOTE: Sample configuration shown. Some specifications may vary.



Compressor Specifications

Model	TM-08HD
Type	Swash Plate type
Number of Cylinders	6
Bore	36 mm (1.42 in)
Stroke	13.4 mm (0.53 in)
Displacement	82 cm^3 (5 cu. in)
Permissible Speed	700-6000 rpm
Refrigerant	R-134a
Lubricant	Oil-ICE No. 2560101 (1 L PAG)
Oil Charge	150^{+20} cm^3
Mass	4.1kg (9.1 lbs)

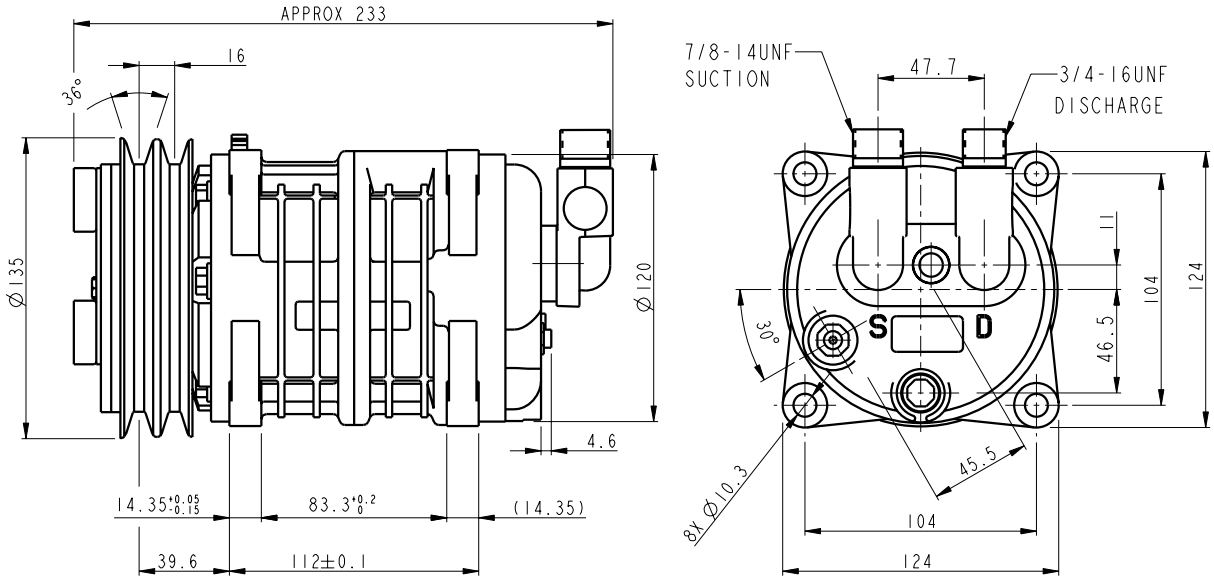
Magnetic Clutch Specifications

Type	Electromagnetic Single Plate Dry Clutch
Rated Voltage	12/24 volts DC
Belt	Ply “V” 8K type
Current Consumption	3.75 amperes (max)
Static Torque	Initial: 35 N•m (3.5 kgfm) After burnishing: 49 N•m (5 kgfm)
Rotation	CW/CCW
Weight	2.2 kg (4.9 lbs)

CAUTION: Check system decals and operation manual for oil type. Mixing incompatible oils causes system damage. Compressor Oil ICE No. 2560101 (1L PAG) recommended for R-134a Systems.

TM-13 Dimensions and Specifications

NOTE: Sample configuration shown. Some specifications may vary.



Compressor Specifications

Model	TM-13HD
Type	Swash Plate type
Number of Cylinders	6
Bore	36 mm (1.42 in)
Stroke	21.4 mm (0.84 in)
Displacement	131 cm^3 (8 cu. in)
Permissible Speed	700-6000 rpm
Refrigerant	R-134a
Lubricant	Oil -ICE No. 2560101 (1 L PAG)
Oil Charge	150^{+20} cm^3
Mass	4.4 kg (9.7 lbs)

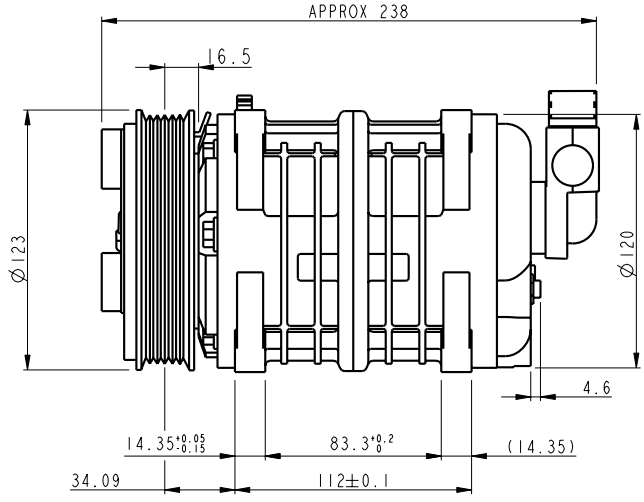
Magnetic Clutch Specifications

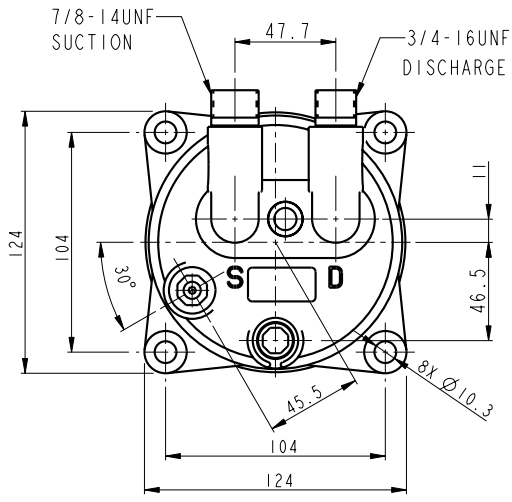
Type	Electromagnetic Single Plate Dry Clutch
Rated Voltage	12/24 volts DC
Belt	2A type
Current Consumption	3.75 amperes (max)
Static Torque	Initial: 35 N•m (3.5 kgfm) After burnishing: 49 N•m (5 kgfm)
Rotation	CW/CCW
Weight	2.25 kg (5.0 lbs)

CAUTION: Check system decals and operation manual for oil type. Mixing incompatible oils causes system damage. Compressor Oil ICE No. 2560101 (1L PAG) recommended for R-134a Systems.

TM-15 Dimensions and Specifications

NOTE: Sample configuration shown. Some specifications may vary.





Compressor Specifications

Model	TM-15HD
Type	Swash-Plate type
Number of Cylinders	6
Bore	36 mm (1.42 in)
Stroke	24 mm (0.94 in)
Displacement	146 cm^3 (8.9 cu. in)
Permissible Speed	700-6000 rpm
Refrigerant	R-134a
Lubricant	Oil - ICE No. 2560101 (1 L PAG) 150^{+20} cm^3
Mass	4.4 kg (9.7 lbs)

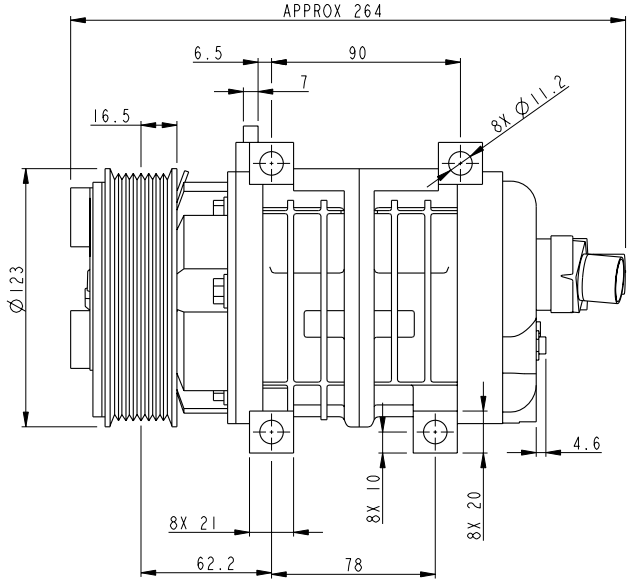
Magnetic Clutch Specifications

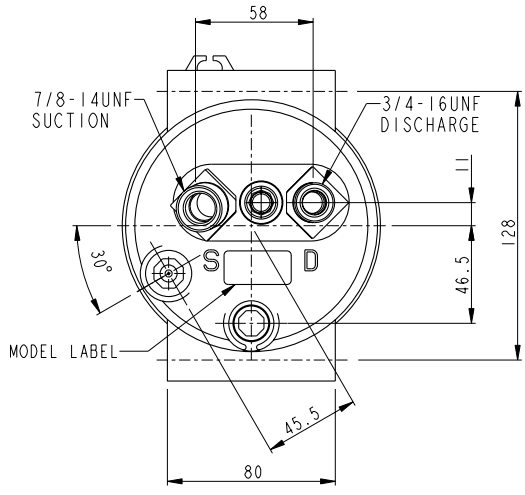
Type	Electromagnetic Single-Plate Dry Clutch
Rated Voltage	12/24 volts DC
Belt	Ply “V” 6K type
Current Consumption	3.75 amperes (max)
Static Torque	Initial: 35 N•m (3.5 kgfm) After burnishing: 49 N•m (5 kgfm)
Rotation	CW/CCW
Weight	2.28 kg (5 lbs)

CAUTION: Check system decals and operation manual for oil type. Mixing incompatible oils causes system damage. Compressor Oil ICE No. 2560101 (1L PAG) recommended for R-134a Systems.

TM-15 Direct Mount Dimensions and Specifications

NOTE: Sample configuration shown. Some specifications may vary.





Compressor Specifications

Model	TM-15HD–Direct Mount
Type	Swash Plate type
Number of Cylinders	6
Bore	36 mm (1.42 in)
Stroke	24.0 mm (0.94 in)
Displacement	147cm³ (8.97 cu. in)
Permissible Speed	700-6000 rpm
Refrigerant	R-134a
Lubricant	Oil-ICE No. 2560101 (1 L PAG)
Oil Charge	180^{+20} cm³
Mass	4.5 kg (9.9 lbs)

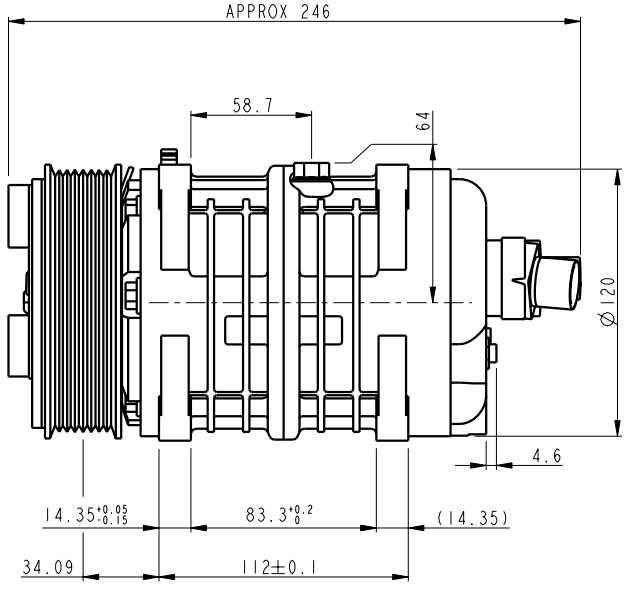
Magnetic Clutch Specifications

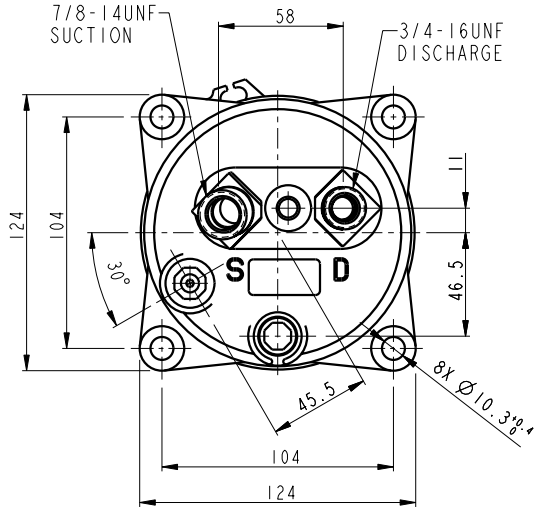
Type	Electromagnetic Single Plate Dry Clutch
Rated Voltage	12/24 volts DC
Belt	Ply “V” 8K type
Power Consumption	45 max 45 W @ 25 C (77 F)
Static Torque	Initial: 35 N•m (3.5 kgfm) After Burnishing: 49 N•m (5 kgfm)
Rotation	CW/CCW
Weight	2.3 kg (5.07 lbs)

CAUTION: Check system decals and operation manual for oil type. Mixing incompatible oils causes system damage. Compressor Oil ICE No. 2560101 (1L PAG) recommended for R-134a Systems.

TM-16 Dimensions and Specifications

NOTE: Sample configuration shown. Some specifications may vary.





Compressor Specifications

Model	TM-16HD
Type	Swash Plate type
Number of Cylinders	6
Bore	36 mm (1.42 in)
Stroke	26.7 mm (1.05 in)
Displacement	163 cm³ (9.95 cu. in)
Permissible Speed	700-6000 rpm
Refrigerant	R-134a
Lubricant	Oil-ICE No. 2560101 (1 L PAG)
Oil Charge	150 cm³
Mass	4.9 kg (10.8 lbs)

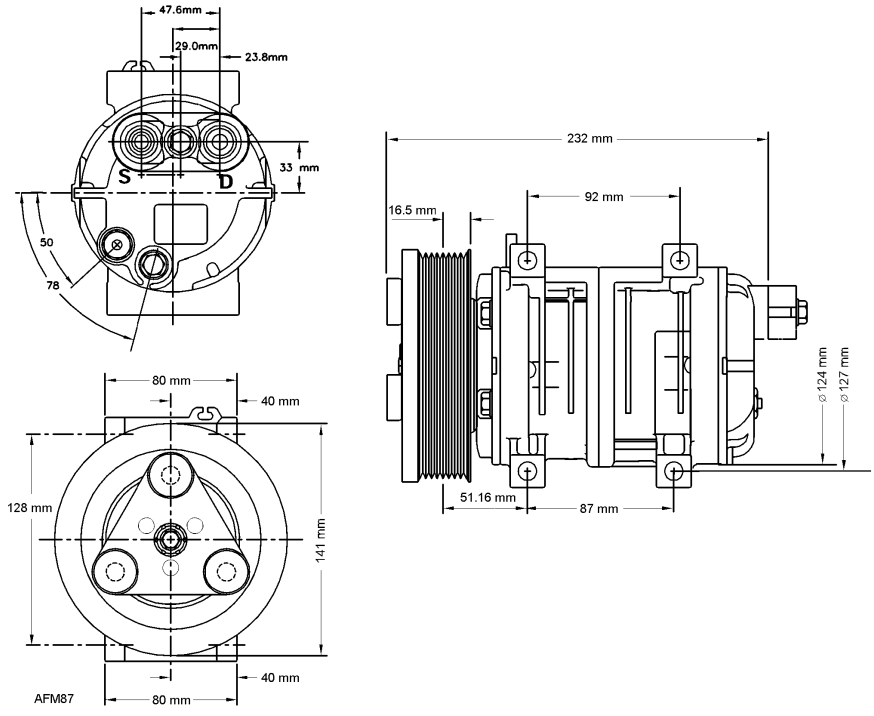
Magnetic Clutch Specification

Type	Electromagnetic Single Plate Dry Clutch
Rated Voltage	12/24 volts DC
Belt	Ply “V” 8K
Current Consumption	3.75 amperes (max)
Static Torque	Initial: 35 N•m (3.5 kgfm) After burnishing: 49 N•m (5 kgfm)
Rotation	CW/CCW
Weight	2.3 kg (5.1 lbs)

CAUTION: Check system decals and operation manual for oil type. Mixing incompatible oils causes system damage. Compressor Oil ICE No. 2560101 (1L PAG) recommended for R-134a Systems.

TM-21 Dimensions and Specifications

NOTE: Sample configuration shown. Some specifications may vary.



TM-21 Compressor Dimensions

Model	TM 21HD
Type	Swash-plate type
Number of Cylinders	10
Bore	1.26 in. (32 mm)
Stroke	1.05 in. (26.7 mm)
Displacement	13 cu. in. (215 cm^3)
Permissible Speed	700 to 6000 rpm
Refrigerant	R-134a
Compressor Oil[1]	See note below
Mass	11.3 lbs (3.1 kg)

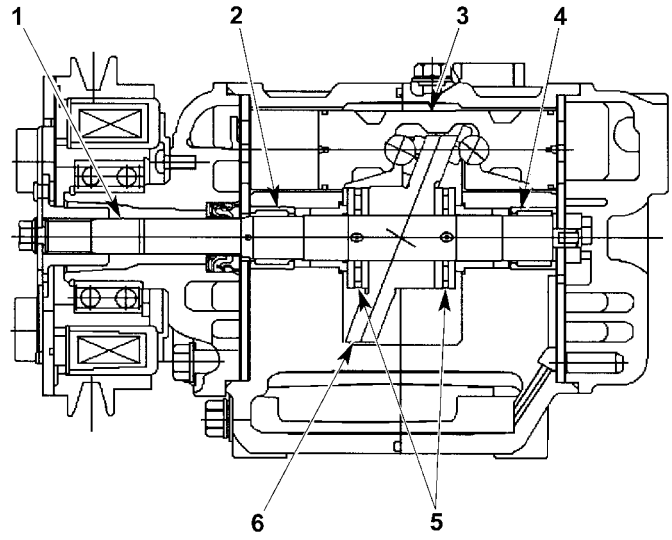
[1] Depending on application, this compressor can be used with different and non-compatible compressor oils. See unit labels for proper oil. The initial installer is responsible for proper labeling.

Magnetic Clutch

Type	Electromagnetic, single-plate dry clutch
Rated Voltage	12 or 24 Volts dc
Current Consumption	3.75 amperes (MAX)
Stalling Torque	59 N•m (43.5 ft. lb)
Rotation	CW/CCW
Mass	6.8 lbs (3.1 kg)

CAUTION: Check system decals and operation manual for oil type. Mixing incompatible oils causes system damage. Compressor Oil ICE No. 2560101 (1L PAG) recommended for R-134a Systems.

TM-31HD Dimensions and Specifications



1.	Drive Shaft
2.	Radial Bearing
3.	Piston
4.	Radial Bearing
5.	Thrust Bearing
6.	Swash Plate

TM-31 Internal Components

NOTE: Sample configuration shown. Some specifications may vary.

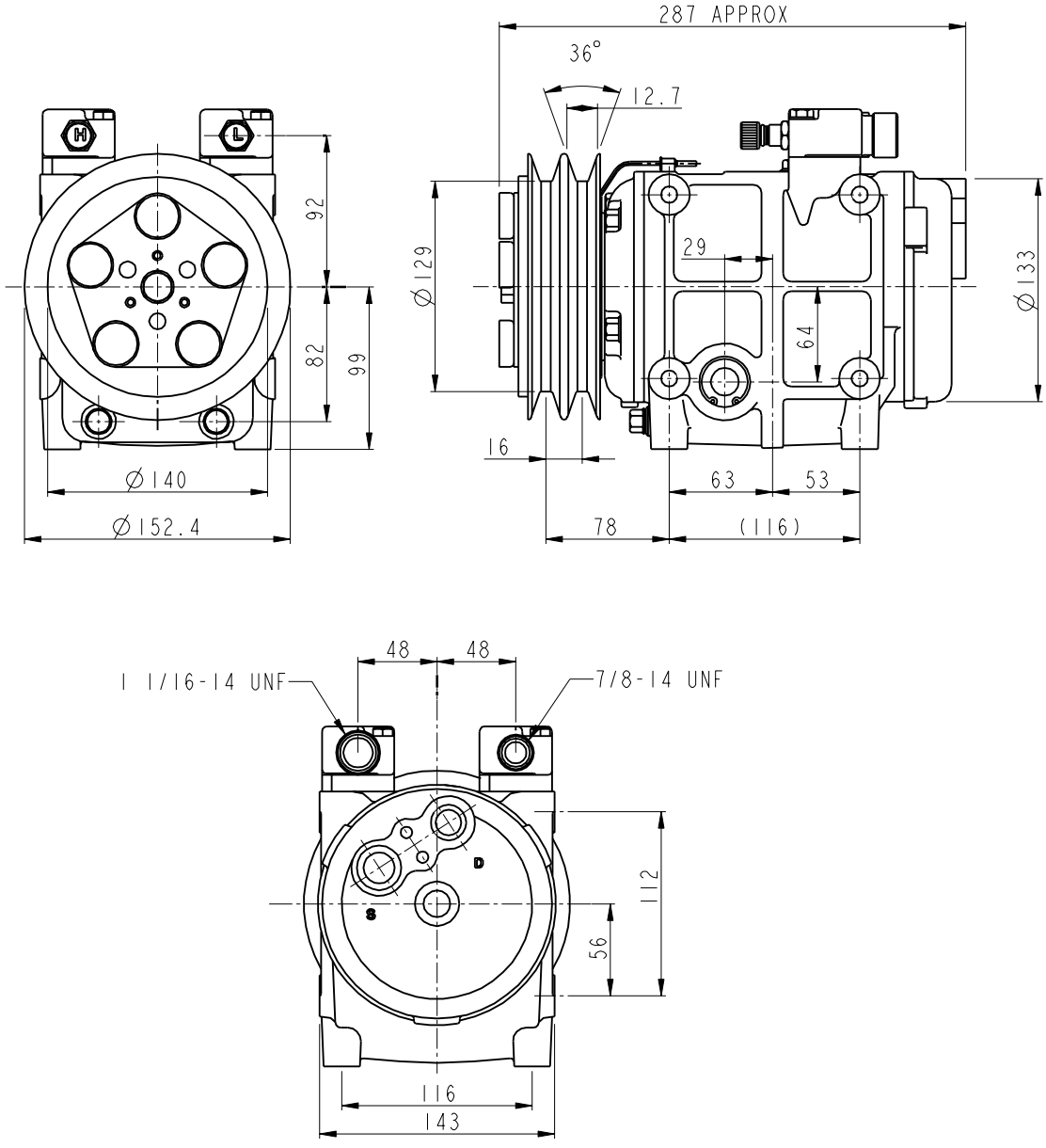


Figure 2: TM-31

Model	TM-31
Type	Swash Plate
Number of Cylinders	10
Bore	36 mm (1.42 in.)
Stroke	30.7 mm (1.21 in.)
Displacement	313 cm^3 (19.1 cu. in.)
Maximum Speed	6000 rpm
Direction of Rotation	Clockwise, viewed from clutch
Lubrication System	Gear Driven Positive Pressure
Lubricant	Oil - ICE No. 2560101 (1 L PAG)
Oil Charge	500 cc (16.9 fl. oz.)
Refrigerant	R-134a
Shaft Seal	Shaft Seal Lip Seal Type
Weight	9.5 kg (21 lbs)

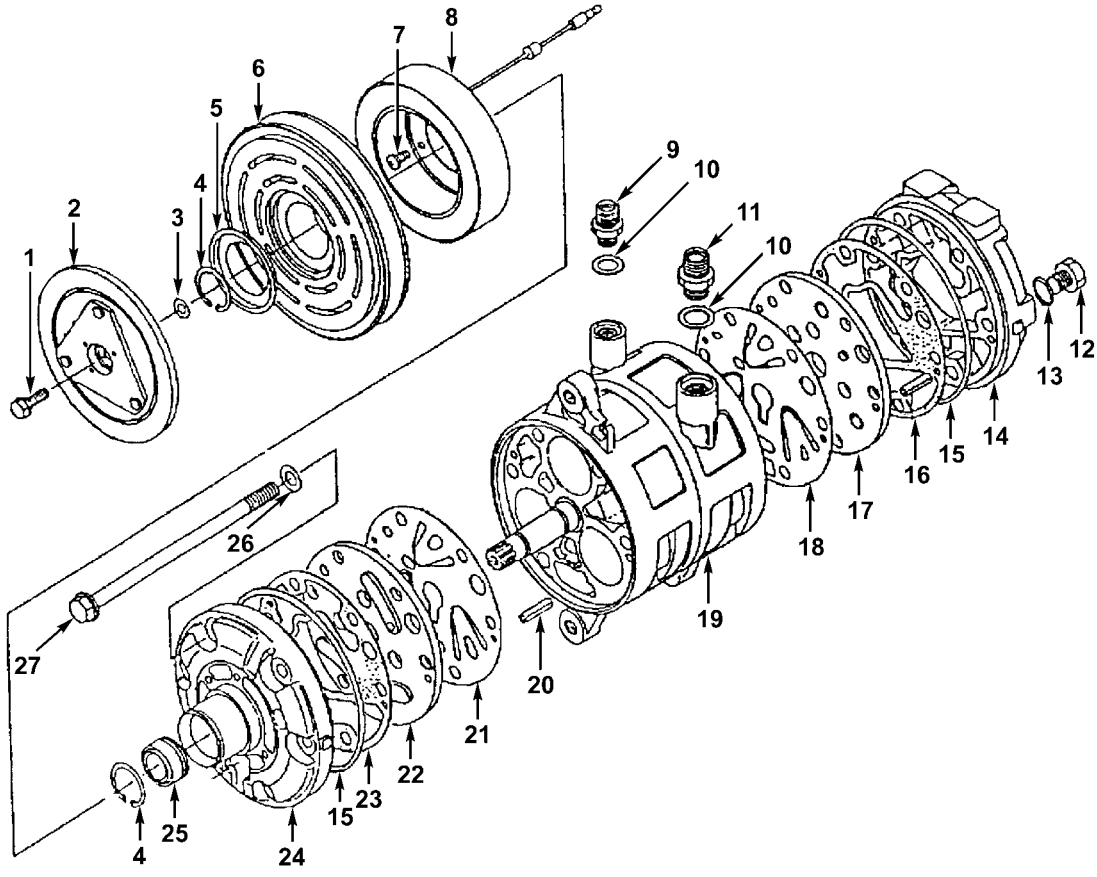
TM-31 Compressor Specifications

Type	Electro Magnetic Single Plate Dry Clutch
Rated Voltage	12 V DC/ 24 V DC
Current Consumption	46 Watts @ 25 C
Static Torque	78.1 N• m (8.0 kgf-m, 58 ft-lb)
Direction of Rotation	Clockwise, viewed from clutch
Weight	Approximate 4.7 kg (10 lbs)

TM-31 Magnetic Clutch Specifications

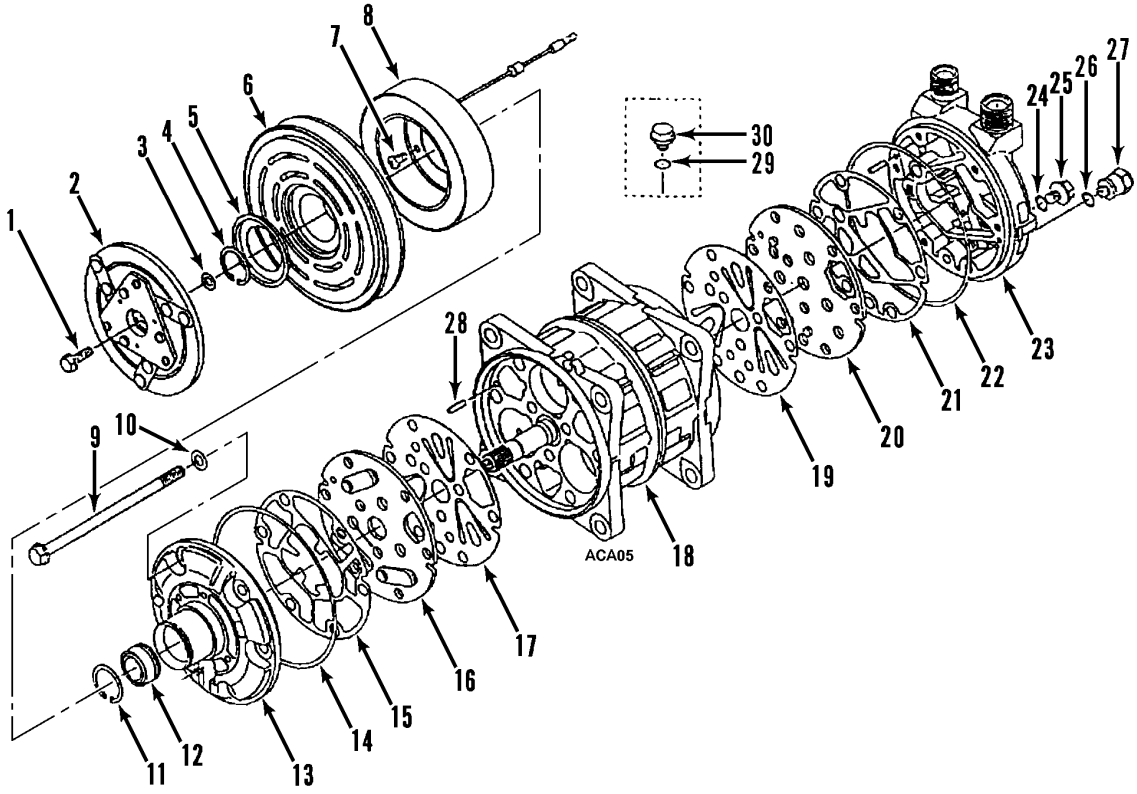
CAUTION: Check system decals and operation manual for oil type. Mixing incompatible oils causes system damage. Compressor Oil ICE No. 2560101 (1L PAG) recommended for R-134a Systems.

TM-08 Exploded View



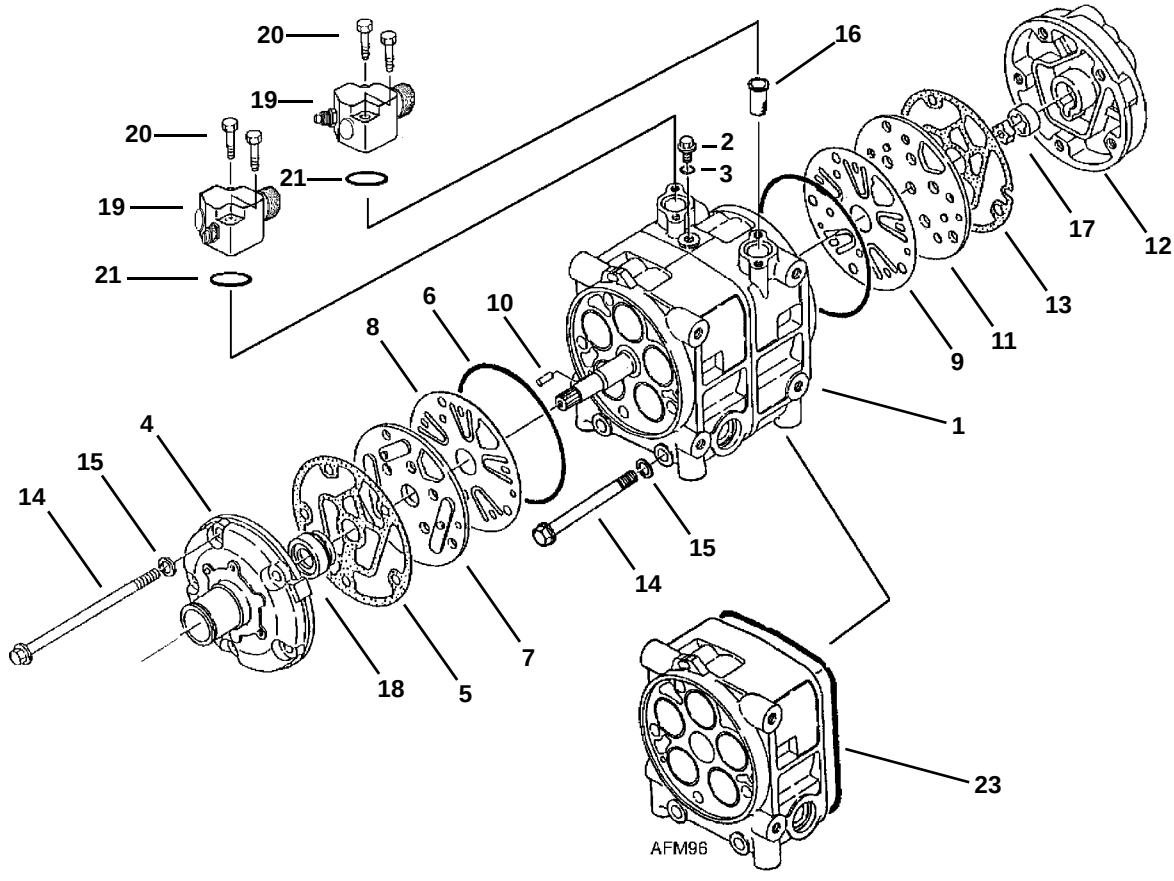
1.	Armature Bolt	15.	O-ring Body
2.	Armature Plate	16.	Rear Gasket
3.	Shim	17.	Rear Valve Plate
4.	Snap Ring	18.	Rear Suction Valve
5.	Cover	19.	Cylinder Shaft Assembly
6.	Pulley Assembly	20.	Pressure Relief Valve
7.	Coil Screw	21.	Front Suction Valve
8.	Coil	22.	Front Valve Plate
9.	Discharge Fitting	23.	Front Gasket
10.	Gasket Fitting	24.	Front Cylinder Head
11.	Suction Fitting	25.	Shaft Seal
12.	Oil Fill Plug	26.	Washer
13.	O-ring	27.	Body Bolt
14.	Rear Cylinder Head		

TM-13, TM-15, TM-16, TM-21 Exploded View



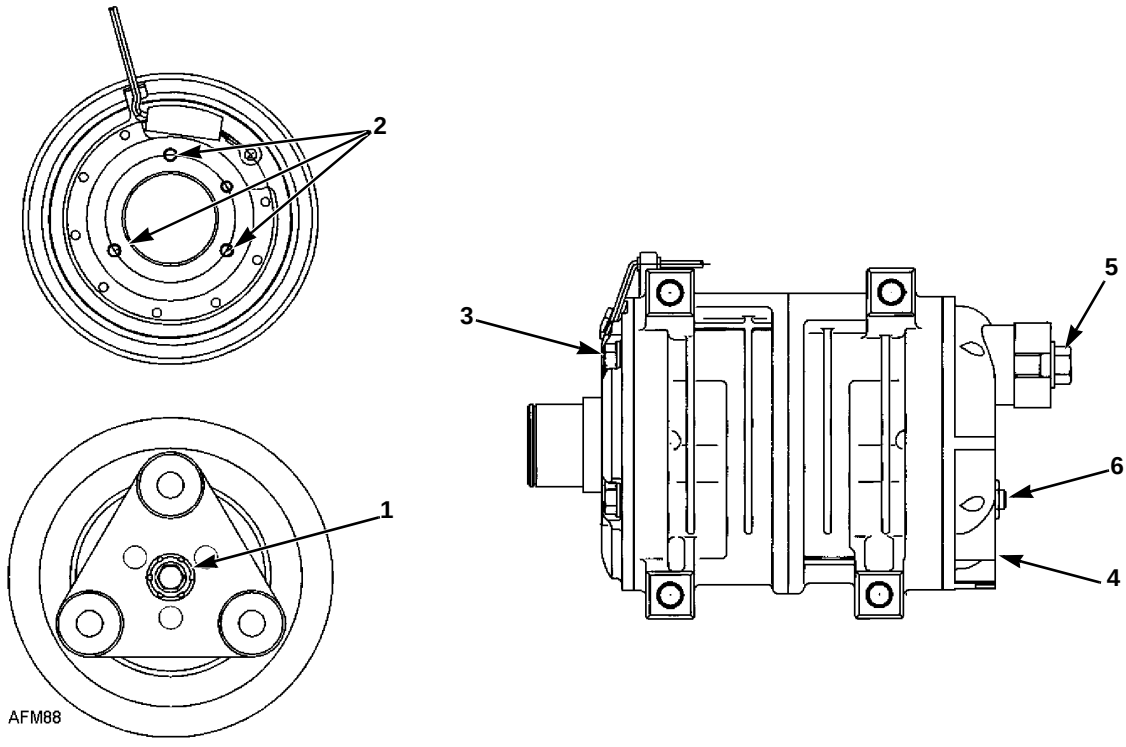
1.	Bolt, Armature	16.	Front Valve Plates
2.	Armature Plate	17.	Front Suction Valve
3.	Shim	18.	Cylinder Shaft Assembly
4.	Snap Ring	19.	Rear Suction Valve
5.	Cover	20.	Rear Valve Plate
6.	Pulley Assembly	21.	Rear Gasket
7.	Screw, Coil	22.	O-ring, Body
8.	Coil	23.	Rear Cylinder Head
9.	Body Bolt	24.	O-ring, Drain Plug
10.	Washer	25.	Drain Plug
11.	Snap Ring	26.	Pressure Relief Valve
12.	Shaft Seal	27.	Pressure Relief Valve
13.	Front Cylinder Head	28.	Pin, Alignment
14.	O-ring, Body	29.	O-ring, Oil Fill Plug (TM16)
15.	Front Gasket	30.	Oil Fill Plug (TM16)

TM-31 Exploded View



1.	Compressor Body	13.	Rear Gasket
2.	Oil Fill Plug	14.	Body Bolt
3.	Oil Plug O-ring	15.	Body Bolt Washer
4.	Front Cylinder Head	16.	Suction Screen
5.	Front Gasket	17.	Oil Pump
6.	Body O-ring	18	Shaft Seal
7.	Front Valve Plate	19.	Manifold
8.	Front Valves	20.	Manifold Bolt
9.	Rear Valves	21.	Manifold O-ring
10.	Alignment Pin	22.	Sight Glass
11.	Rear Valve Plate	23.	Body Center O-ring
12.	Rear Cylinder Head		

Tightening Torques



TM-08–TM-21 Thread Size and Torque Specifications

	Part	Thread Size	Tightening Torque
1.	Armature Bolt	M6 x 1.0	8.7 to 10.1 ft-lb (12 to 14 N•m)
2.	Field Coil Screw	M5 x 0.8	2.9 to 4.3 ft-lb (4 to 6 N•m)
3.	Body Bolt	M8 x 1.25	12.5 to 15.5 ft-lb (17 to 21 N•m)
4.	Oil Drain Plug	M8 x 1.25	9.4 to 10.8 ft-lb (13 to 15 N•m)
5.	Manifold Bolt	M8 x 1.25	14.5 to 17.3 ft-lb (20 to 24 N•m)
6.	Pressure Relief Valve	3/8-24 UNF	5.9 to 7.4 ft-lb (8 to 10 N•m)

TM-31 Thread Size and Torque Specifications

	Part	Thread Size	Tightening Torque
1.	Armature Bolt	M10 x 1.5	14.8 to 16.2 ft-lb (20 to 22 N•m)
2.	Field Coil Screws	M6 x 1	5.9 to 7.4 ft-lb (8 to 10 N•m)
3.	Body Bolts	M10 x 1.5	18.4 to 22.1 ft-lb (25 to 30 N•m)
4.	Oil Fill Plug	M8 x 1.25	10.3 to 11.8 ft-lb (14 to 16 N•m)
5.	Manifold Bolts	M8 x 1.25	14.8 to 16.2 ft-lb (20 to 22 N•m)

Compressor Maintenance: TM-08, TM-13, TM-15, TM-16, TM-21

Safety

DANGER: Explosion Hazard! Do not throw or strike service cans. Do not handle the packing carton roughly. Do not use damaged or dented service cans. Store service cans out of reach of children.

DANGER: Explosion Hazard! Do not directly heat service cans or put them in water above 104 F (40 C). Do not put service cans on the engine or radiator when charging.
If is necessary to heat service cans for charging in cold weather, use water below 104 F (40 C).

DANGER: Explosion Hazard! Do not store service cans in direct sunlight, near flame, or where temperature exceeds 104 F (40 C).

CAUTION: Do not put the charge valve in the warm water.

Refrigerant Recovery

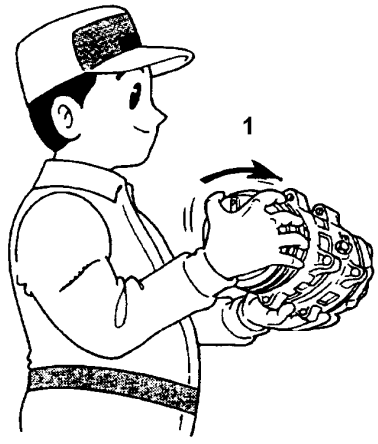
Avoid releasing refrigerant into the atmosphere. If you are removing refrigerant from an air conditioning system, use a refrigerant recovery unit.

Consult your recovery unit operators manual for hookup and operating procedures.

Figure 3: Recovery Unit – ICE No. 2590119

Compressor Handling

CAUTION: Do not strike or turn the compressor upside down. If the compressor is turned upside down, rotate it 5 to 6 times to circulate oil.



1.	Rotate Compressor Drive Shaft Several Times

Compressor Storage

Store new and rebuilt compressors:

- With the correct oil charge.
- Within the orientation range shown in Figure 4 on page 35. If the compressor sits outside that orientation for more than one minute, turn compressor manually (slowly) to clear oil from the cylinders.
- With a holding charge of refrigerant or nitrogen to a pressure of 7 to 21 psig (48 to 145 kPa). This protects internal parts from moisture and corrosion.

Compressor Removal

Operating Compressor

1. Perform the Oil Return Operation. See “Returning Oil to the Compressor” on page 37).
2. Recover the refrigerant. (See “Refrigerant Recovery” on page 33 and your system manual).
3. Remove the compressor from the system Consult system manual if necessary.

Non-Operating Compressor

1. Perform the Refrigerant Recovery” (For more information, see “Refrigerant Recovery” on page 33.)
2. Remove the compressor from the system.

Compressor Installation

Installation Precautions

The new compressor has a specified quantity of compressor oil and nitrogen gas (N_2). When mounting the compressor, take the following steps:

- Loosen the discharge side connector cap. Gently release N_2 from compressor.

NOTE: This may be applicable to new compressors only.

CAUTION: Do not let oil escape.

- Manually rotate the drive shaft several times to distribute oil that has settled in the cylinders.

- Check and adjust the oil quantity before replacing the compressor. (see “Returning Oil to the Compressor” on page 37.) Follow system specifications.

Installation Position

Install the compressor within the range shown in Figure 4 below.

NOTE: The compressor has a pressure-feed lubrication system that cannot function if the compressor is installed outside this range.

When the compressor is mounted in its final position, turn it over manually approximately 10 revolutions before hooking the drive belt up to the pulley. If you do not do this, damage to the compressor valves can result from oil slugging. This is not covered under warranty!

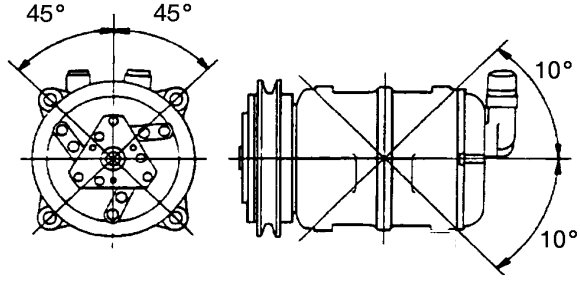
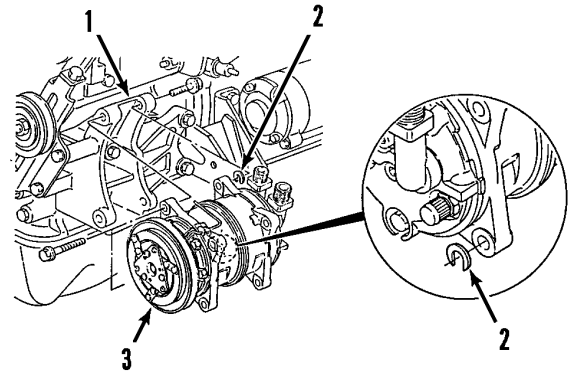


Figure 4: Compressor Installation Range

Mounting Compressors

1. **Range of Motion.** Verify the range of motion positioning at both extremes of the belt adjustment. Figure 4 shows the range of motion for the compressor.
2. **Clearance**. Clearance between the compressor mounting supports and bracket must be less than 0.004 inches (0.10 mm). Use shims as necessary to adjust this clearance (Shim Kit ICE No. 2570101). This reduces stress on the compressor.
3. **Pulley alignment.** Maintain correct pulley alignment for the drive belt.



1.	Bracket
2.	Shim ICE No. 257101
3.	Compressor

Figure 5: Shim Installation

Leak Testing the Compressor

After repairs and before installation, check a compressor for refrigerant leaks:

1. Install the discharge and suction caps on the connector.

2. Fill the compressor with refrigerant gas (same type used in the system) through the connector suction port. Raise the pressure to at least 70 psig (483 Kpa).
3. Check the compressor for leaks using a reliable leak detector.

NOTE: Use a leak tester being capable of detecting fluorine-based refrigerants.

Compressor Oil Procedures

Compressor Oil Caution Statements

CAUTION: Do not leave a system or oil containers open to the air longer than necessary. Compressor oils (POE and PAG) absorb moisture. Moisture-contaminated oil will damage system components.

CAUTION: Do not open refrigeration system unnecessarily. Doing so increases chances of contamination.

CAUTION: Discard used oil containers. These containers are hazardous.

CAUTION: Do not store PAG oil in plastic containers. PAG oil absorbs moisture through the plastic container.

Oil Charge Considerations

Most compressors come with a factory oil charge, which is listed on the rear label. This oil charge is for an average system that is already "wet." The actual oil charge needed is application-specific, and may be different than the factory oil charge. Consult your application manual for the specific oil charge needed.

If you are replacing the compressor in an already "wet" system which has had no leaks, follow the procedure "Returning Oil to the Compressor" on page 37 to determine the oil charge needed for the new compressor.

If you are placing the compressor in a new, "un-wet" installation, use the amount of oil specified in the application manual. If no amount is specified, you will have to determine the amount experimentally. New systems require an additional oil charge to "wet" system components.

CAUTION: Not using the correct oil charge will damage your system.

Oil Type Considerations

Your compressor comes with an oil charge that may not be compatible with your system. Check system decals and operation manual for correct oil type.

If the oil charge in a new compressor is not compatible with your air conditioning system, remove and replace the oil.

Compressor Oil ICE No. 2560101 (1L PAG) is recommended for R-134a Systems.

CAUTION: Mixing incompatible oils will damage your system.

Oil Check Interval

Check and replenish or replace the compressor oil:

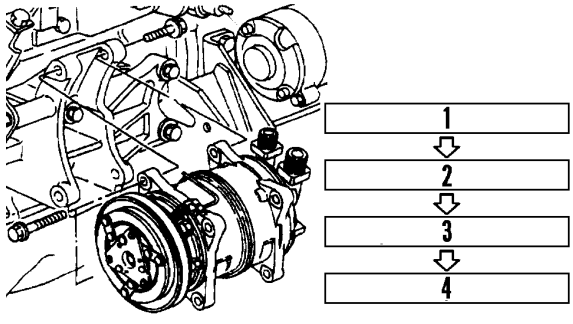
- At the start of the season
- Every 3,200 miles (5000 km) or every 5 months for commercial vehicles and vehicles that are in constant use
- When the compressor, evaporator, condenser, or receiver-drier is replaced
- When refrigerant has leaked from the system (for example, high pressure relief valve discharges)
- When gas or refrigerant leaks from the compressor
- When oil-related problems occur in the cooling cycle.

Oil Check Procedure

To check the compressor oil on an operating compressor, follow these steps:

- Return oil to the compressor
- Recover the refrigerant
- Remove the compressor
- Drain and inspect the oil.

Oil return, draining, and inspection procedures are described in this section. For compressor removal, see “Compressor Removal” on page 34. For refrigerant recovery, consult your system and recovery unit manuals.



1.	Return Oil to Compressor
2.	Recover Refrigerant

Figure 6: Oil Check Procedure

3.	Compressor Removal
4.	Inspect the Oil

Figure 6: Oil Check Procedure

Returning Oil to the Compressor

During operation, oil circulates with refrigerant in a system. Before checking the oil, you must return as much as possible to the compressor. Not doing so will result in an incorrect measurement.

To return oil to the compressor:

1. Open the vehicles doors and windows to raise the interior air temperature to 75 to 80 degrees [25 to 27 C]. (The ambient air temperature should be above 85 degrees F (29 C). If not, partially block the condenser air flow to raise the compressor discharge pressure above 170 psig (1172 kPa).)
2. Run the A/C system at idle or high idle (800 and 1500 rpm) for approximately 20 minutes.
3. Turn the A/C system off.
4. Recover the refrigerant. See your system and recovery unit manuals for this procedure.
5. Remove the compressor from the system. See “Compressor Removal” on page 34.
6. Drain the oil as described below.

Draining the Oil

1. Perform the “Returning Oil to the Compressor” procedure above.
2. Remove the drain plug from the compressor.
3. Drain oil from the compressor drain plug and all other ports.
4. Remove remaining oil through the discharge side connector by manually rotating the drive plate until all oil is removed.
5. Measure oil in a measuring cylinder.

   NOTE: See your application specifications for the correct oil amount.

6. Inspect oil for contamination (see “Checking Compressor Oil for Contamination” on page 38).

7. Replace the oil drain plug and tighten it per specifications (see “Tightening Torques” on page 31).
8. If necessary add oil. See “Adding Compressor Oil” on page 38.
9. Install the compressor (see “Compressor Installation” on page 34). Tighten bolts to the specified torque (see “Tightening Torques” on page 31).

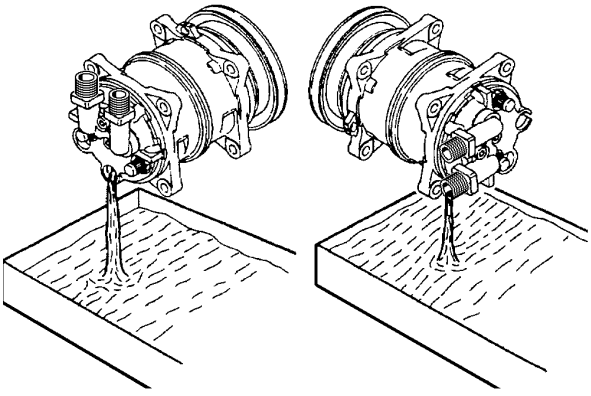


Figure 7: Draining Oil

Checking Compressor Oil for Contamination

Inspect extracted oil for the following:

- Dirt
- Color changed to red or black
- Presence of foreign substances, metal shavings, etc. in the oil.

Black oil indicates a severely contaminated system. To determine the extent of contamination, remove the filter-drier, then check if the black colored oil is present there. If so, flush the system. If flushing is required, use industry approved materials.

If the oil is clean at the filter-drier, install a new filter-drier and replace the oil with new oil. See “Adding Compressor Oil” below.

Adding Compressor Oil

To add oil:

1. Verify the correct oil type on the compressor label.
2. Verify the correct oil amount in your system specifications.
3. If oil is contaminated, replace old oil with new oil.
4. Add oil to the compressor through the suction port as shown in Figure 8.
5. Turn the shaft manually several times while adding oil to distribute oil evenly.

NOTE: Replace oil with fresh oil taken only from a sealed metal container.

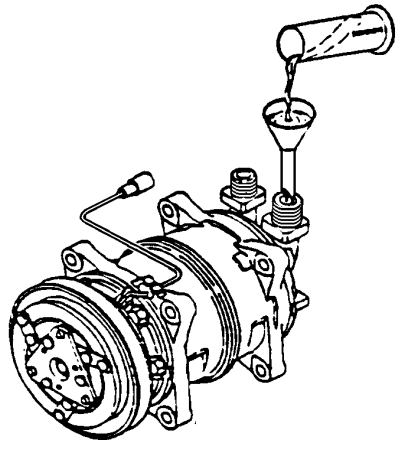


Figure 8: Typical Compressor Oil Fill Procedure

Clutch Procedures

For application guidelines, see “Clutch Application Guidelines” on page 13.

Clutch Run-In

Use this procedure to break in a new magnetic clutch.

1. Install the clutch on the compressor. For more information, see “Clutch Installation” on page 41.
2. Install the compressor on the engine. Charge the system. Operate the compressor by running the system.
3. Maintain the compressor speed at idle. Operate the A/C Switch through the on/off cycle at least 10 times (on for 10 seconds, off for 10 seconds).

Clutch Test

If the field coil lead wire is broken, replace the field coil. Check the amperage and voltage. The amperage range should be:

System	Amperage
12 Volt System	3.6 to 4.2
24 Volt System	1.8 to 2.1

Amperage indications:

- A very high amperage reading indicates a short within the field coil.
- No amperage reading indicates an open circuit in the winding.
- An intermittent or poor system ground results in lower voltage at the clutch. Check for a tight fit on the coil retaining snap ring, or for good ground at the coil retaining screws.

Clutch Removal

NOTE: See the Appendix for correct tools. Contact your local International Components Engineering Dealer for more information.

1. Remove the center armature bolt.

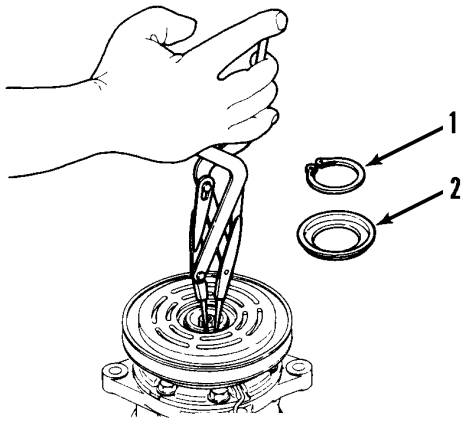
1.	Holder

Figure 9: Remove Center Bolt

2. Remove the armature plate using the armature plate puller. Remove the shims from the armature shaft or the armature plate.

Figure 10: Remove Drive Plate

3. Remove the snap ring using external snap ring pliers. Remove the cover (if equipped).



1.	Snap Ring
2.	Cover (If Equipped)

Figure 11: Remove Snap Ring and Cover

4. Remove the pulley assembly using the pulley remover and the spacer positioned on the cylinder head hub.

CAUTION: To avoid damaging the pulley groove, hook the puller claws into, not under, the pulley groove.

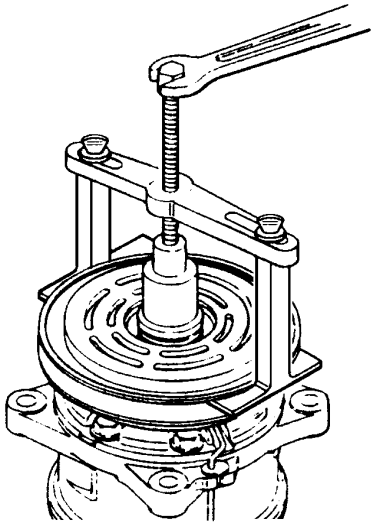


Figure 12: Remove Pulley

5. Remove the coil lead wire from the holder on the top of the compressor.
6. Remove the three screws that attach the coil to the compressor. Remove the coil.

NOTE: Do not hold the coil by the lead wire.

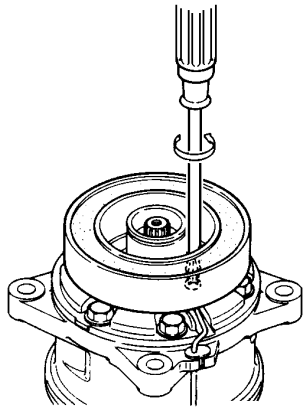


Figure 13: Remove Coil

Clutch Inspection

- **Armature Plate**

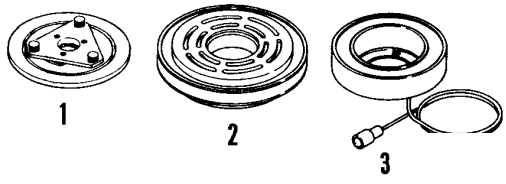
  If the contact surface is scorched, replace the armature plate and pulley.

- **Pulley Assembly**

  Inspect the appearance of the pulley assembly. If the pulley contact surface is excessively grooved due to slippage, replace the coil, pulley assembly, and armature plate. There should also be no foreign matter, such as oil or grit, lodged between the clutch plate and pulley. Clean these contact surfaces and the drive plate with a suitable solvent before installation.

- **Coil**

  Inspect the coil for a loose connector or cracked insulation. If the insulation is cracked, replace the coil. Repair or replace the wire or the connector if either is loose or damaged.



1.	Drive Plate
2.	Pulley Assemble
3.	Coil

Figure 14: Inspect Components

Clutch Installation

See “Clutch Inspection” before installing the clutch.

1. Install the coil on the compressor with the lead wire on top. Tighten the mounting screws to the specified torque. See “Tightening Torques” on page 31.
2. Install the lead wire in the wire holder on the compressor.

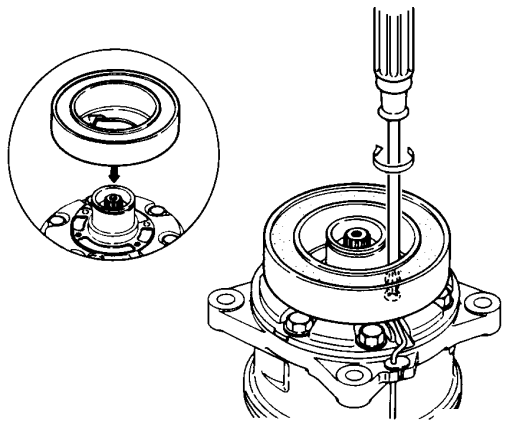


Figure 15: Install Coil

3. Install the pulley assembly using the Installer (ICE No. 2590118) and a hand press.

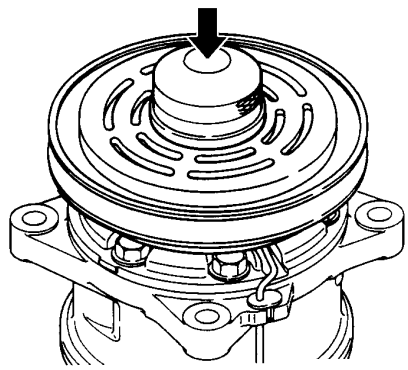
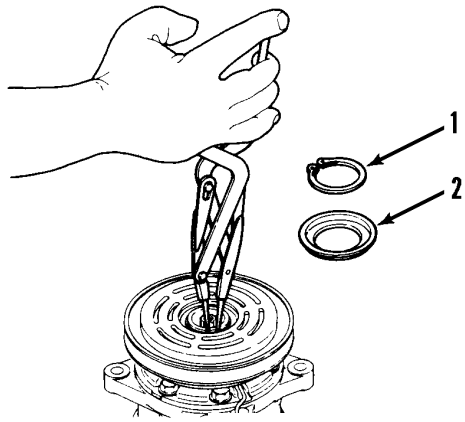


Figure 16: Install Pulley

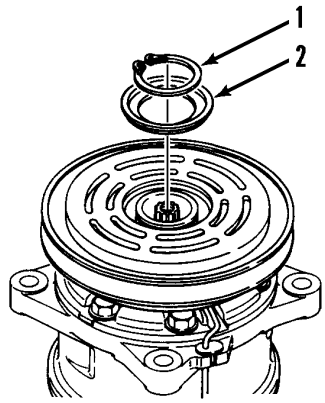
4. Install the cover and the snap ring using external ring pliers.



1.	Snap Ring
2.	Cover (If Equipped)

Figure 17: Install Cover and Snap Ring (1)

NOTE: Install the snap ring with the chamfered inner edge outward (facing away from seal).



1.	Snap Ring
2.	Cover (If Equipped)

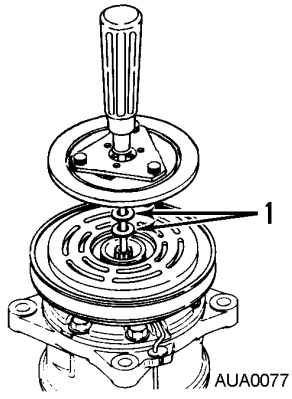
Figure 18: Install Cover and Snap Ring (2)

5. Install the driver plate on the drive shaft, together with the original shim(s). Press the drive plate down by hand.

   NOTE: If replacement or additional shims are required, a clutch hardware kit is available (ICE No. 2530109).

6. Tighten the bolt to the specified torque using the Arbor puller (ICE No. 2590113) to prevent drive-plate rotation. See “Tightening Torques” on page 31.

After tightening the bolt, ensure that the pulley rotates smoothly.



1.	Shims

Figure 19: Install Shims and Drive Plate

7. Ensure that the clutch clearance is as specified. If necessary, adjust the clearance using shims.

   NOTE: Adjusting shims are available in the clutch Hardware kit ICE No. 2530109.

   NOTE: Specified clearance: 0.012 to 0.024 in. (0.3 to 0.6 mm).

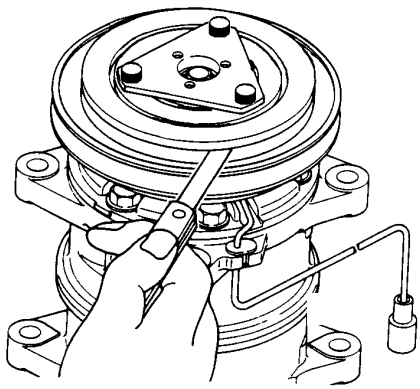


Figure 20: Check Clearance

Electrical Connection

1. Connect the lead wire to the electrical circuit.

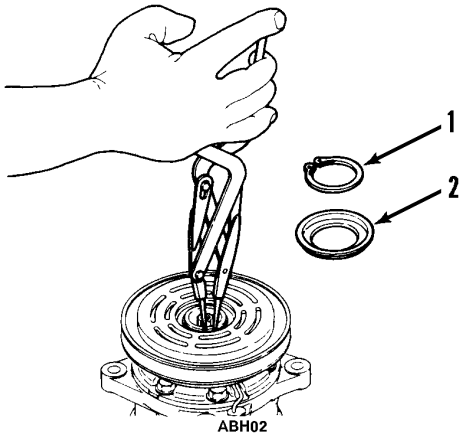
   NOTE: The stationary field is grounded at the factory. Connect the hot (lead) wire only.

2. Engage and disengage the clutch several times to check the engagement. The disc should snap firmly against the pulley.

Shaft Seal Procedures

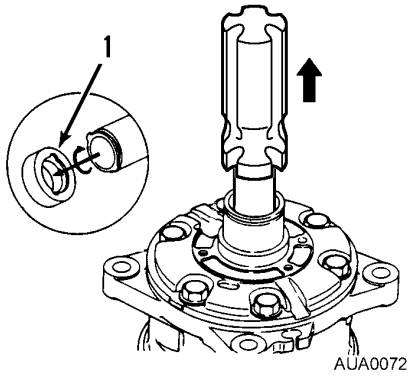
Shaft Seal Removal

1. Remove the magnetic clutch assembly See “Clutch Removal” on page 39.
2. Use the seal remover (from the shaft seal kit ICE No. 2590114) to remove the shaft seal cover. Turn the seal remover to engage the hook on the seal remover with the hook on the shaft seal cover, then slowly pull the shaft seal cover out of the cylinder head (some models).
3. Remove the snap ring using internal snap ring pliers.



1.	Snap Ring
2.	Cover (When equipped)

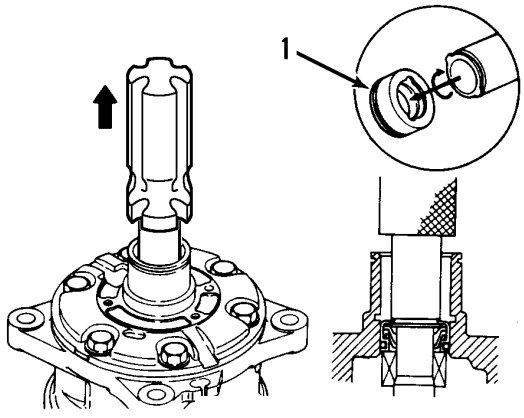
NOTE: Do not reuse the shaft seal cover. Use a new shaft seal cover when reassembling a compressor.



1.	Shaft Seal Cover (Some Models)

Figure 21: Remove Shaft Seal Cover

4. Use the seal remover (from the shaft seal kit (ICE No. 259114) to remove the shaft seal. Turn the seal remover to engage the hook on the seal remover with the hook on the shaft seal, then slowly pull the shaft seal housing out of the cylinder head.



1.	Shaft Seal

Figure 22: Remove Shaft Seal

Shaft Seal Inspection

Use a new shaft seal when reassembling the compressor. Inspect the lip of the new shaft seal for scratches and other damage. Make sure the shaft seal is free from lint and dirt.

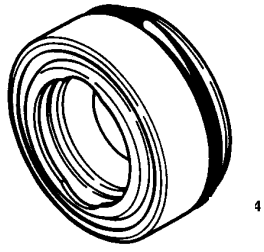
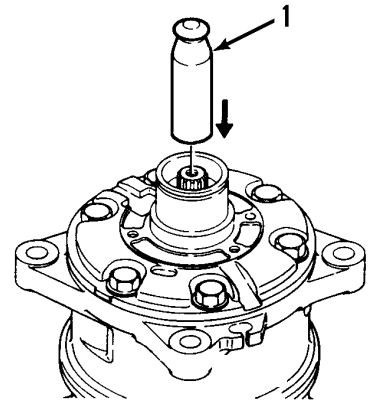


Figure 23: Inspect Shaft Seal

Shaft Seal Installation

Before installing a shaft seal inspect it carefully (see “Shaft Seal Inspection” above).

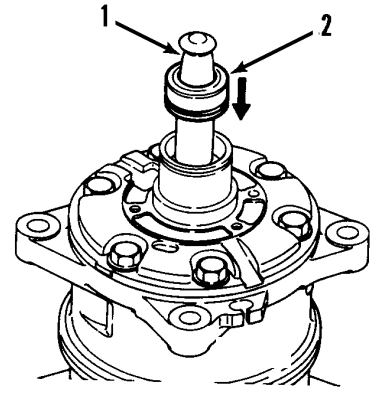
1. Clean the seal section of the front cylinder head that holds shaft seal.
2. Apply clean compressor oil to the new shaft seal and front cylinder head. If the slip surfaces are dirty, clean them with thinners, dry the clean surfaces, and apply clean compressor oil. Use the same oil in the system.
3. Place the seal guide (from the shaft seal kit ICE No. 2590114) on the end of the spline shaft.



1.	Seal Guide

Figure 24: Place Guide on Shaft

4. Place the shaft seal over the seal guide. Slide the seal into the front cylinder head.



1.	Seal Guide
2.	Shaft Seal

Figure 25: Place Shaft Seal on Guide

5. Use the seal installer (from the shaft seal kit ICE No. 2590116) to press the shaft seal into the cylinder head as far as possible.
6. Remove the seal guide from the spline shaft.

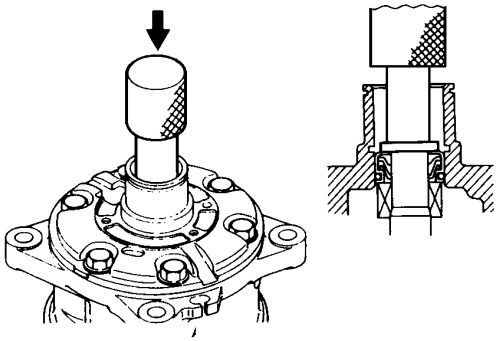
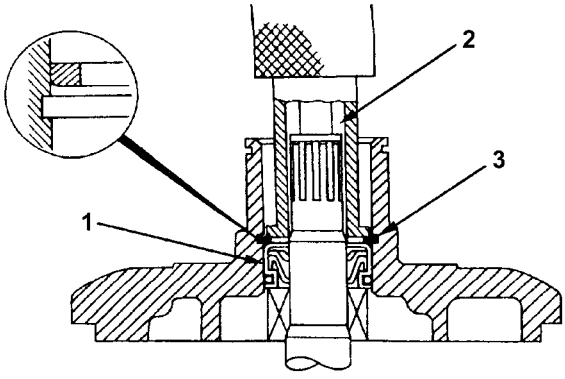


Figure 26: Press Seal Into Cylinder Head

7. Install the snap ring using internal snap ring pliers. Press the snap ring using the installing end of the remover until you hear a “click.”



1.	Shaft Seal
2.	Guide
3.	Snap Ring

NOTE: Install the snap ring with the chamfered edge facing upward.

Shaft Seal Cover Installation (When Equipped)

1. Place the seal guide (from the shaft seal kit ICE No. 2590116) on the end of the shaft.
2. Place the shaft seal cover on the seal guide and slide the shaft seal cover into the cylinder head.

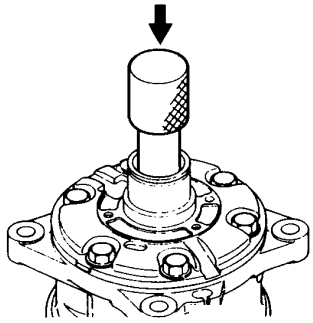
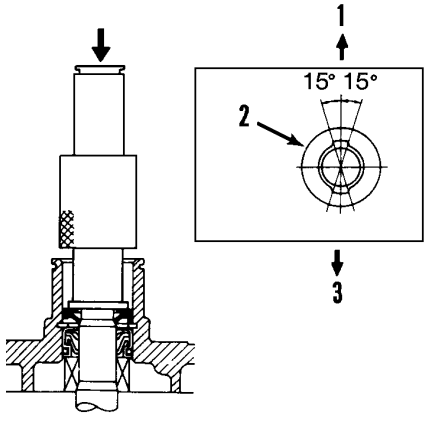


Figure 27: Shaft Seal Cover (When equipped)

3. Use the seal installer (from the shaft seal kit ICE No. 2590114) to press the shaft seal cover into the cylinder.
4. Remove the seal guide from the spline shaft.

NOTE: Position the shaft seal cover as shown in the illustration.



1.	Top
2.	Shaft Seal Cover
3.	Bottom

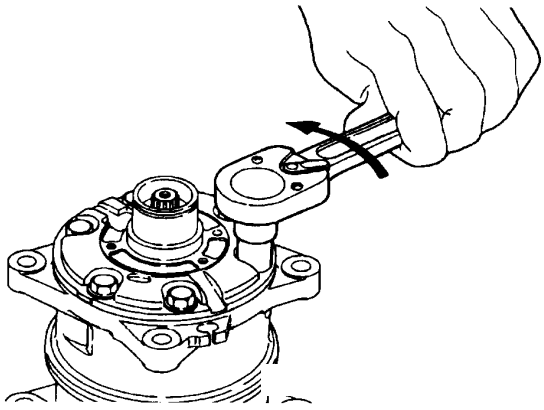
Figure 28: Shaft Seal Cover Position

Cylinder Head Procedures

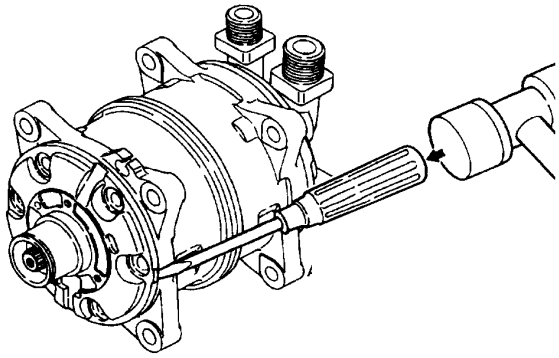
Cylinder Head Disassembly–Front and Rear

1. Remove the magnetic clutch assembly, as outlined in “Clutch Removal” on page 39.
2. Remove the connector caps and the drain Drain the oil. See “Draining the Oil” on page 37.

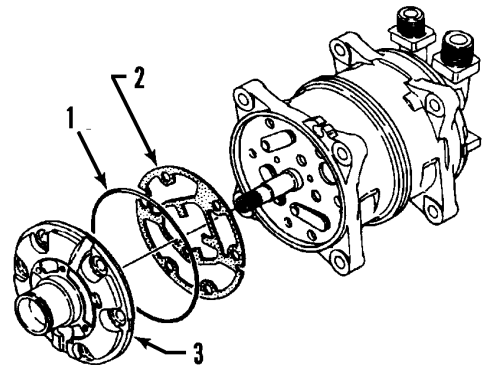
3. Remove the shaft seal cover and shaft seal. See “Shaft Seal Removal” on page 42.
4. Remove the six body bolts securing the head using a socket wrench.



5. To remove the front cylinder head, alternately tap the two projections on the circumference of the front cylinder head with a screwdriver and a plastic mallet.

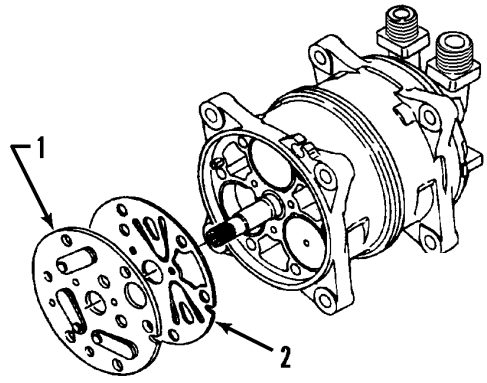


6. Remove the O-ring from the front cylinder head. Remove the gasket material from the front cylinder head.



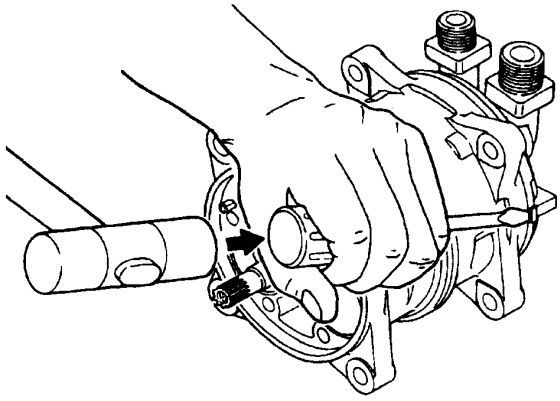
1.	O-ring
2.	Gasket
3.	Front Cylinder Head

7. Remove the valve plate and suction valve from the cylinder shaft assembly. Remove the gasket material from the valve plate.

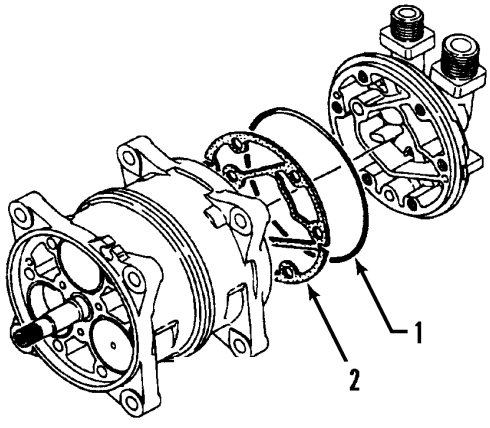


1.	Valve Plate
2.	Suction Valve

8. To remove the rear cylinder head, alternately tap the projections on the circumference of the rear head with a screwdriver and a plastic mallet.

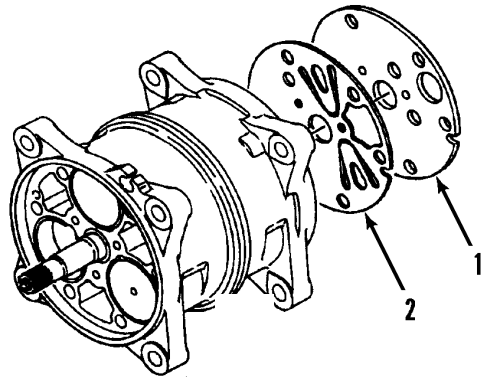


9. Remove the O-ring from the rear cylinder head. Remove the gasket material from the rear cylinder head.



1.	O-ring
2.	Gasket

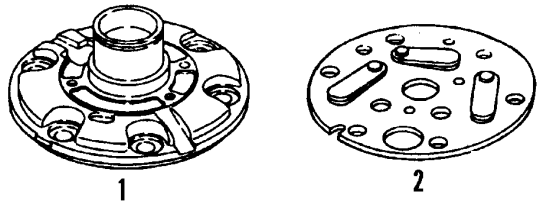
10. Remove the valve plate and suction valve from the cylinder shaft assembly. Remove the gasket material from the valve plate.



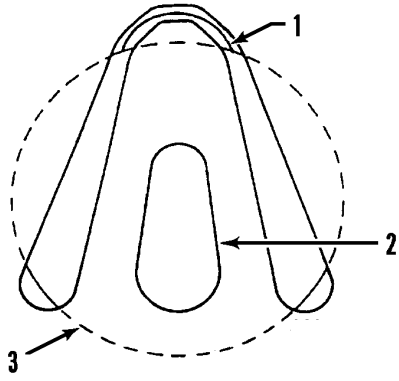
1.	Valve Plate
2.	Suction Valve

Cylinder Head Inspection

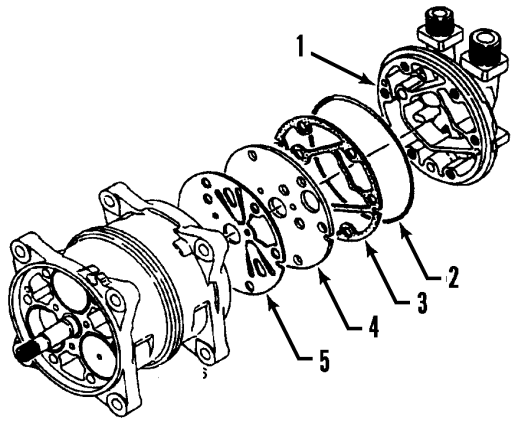
- Check the front and rear valve plates for scratched, bent, or damaged parts.
- Inspect both cylinder heads and both valve plate assemblies for nicks and burrs on the sealing surfaces. Clean or replace them if damaged.
- Ensure that all passages in the valve plate are unobstructed. If the cylinder head or valve plate is cracked, replace it.



1.	Front Cylinder
2.	Valve Plate



1.	Escape Groove
2.	Suction Valve
3.	Piston



1.	Rear Cylinder Head
2.	O-ring
3.	Gasket
4.	Valve Plate
5.	Suction Valve

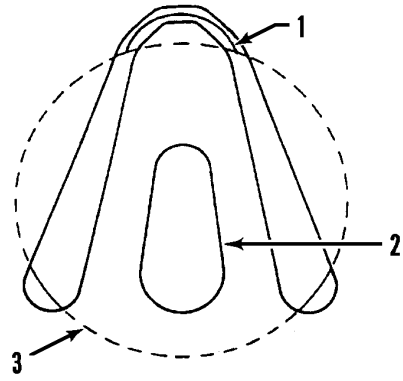
Cylinder Head Reassembly

Rear Cylinder Head

1. Place the cylinder shaft assembly on the bench with the rear side up.

2. Install the rear suction valve so that it aligns with the alignment pin.

CAUTION: Ensure that the valve is aligned with the valve escape groove of each cylinder.



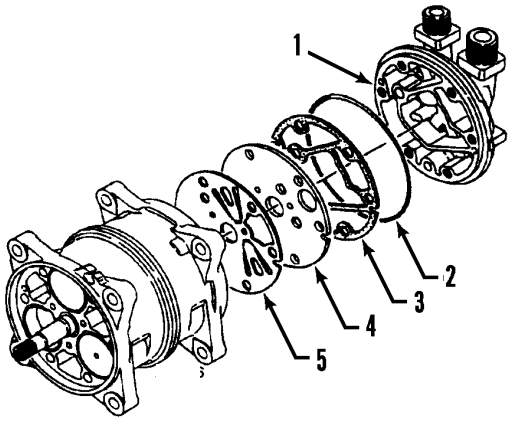
1.	Escape Groove
2.	Suction Valve
3.	Piston

3. Install the rear valve plate on the rear suction valve.

CAUTION: Do not mistake the front valve plate for the rear valve plate.

4. Coat the new gasket with clean compressor oil. Install it on the rear valve plate. Use the same oil used in the system.

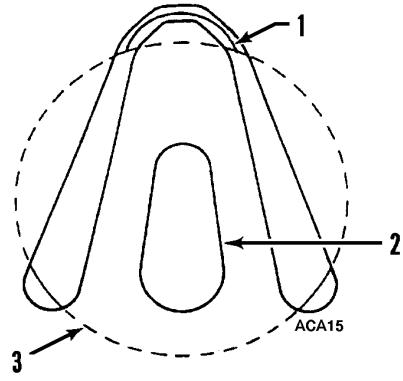
5. Thinly coat the new O-ring with clean compressor oil (same type of oil that is used in the system). Install it on the rear cylinder head.
6. Install the rear cylinder head. If the rear cylinder head is difficult to install, tap the cylinder head lightly with a mallet.



1.	Rear Cylinder Head
2.	O-ring
3.	Gasket
4.	Valve Plate
5.	Suction Valve

Front Cylinder Head

1. Place the cylinder shaft assembly on the bench with the front side up.
2. Install the front suction valve so that it aligns with alignment pin.



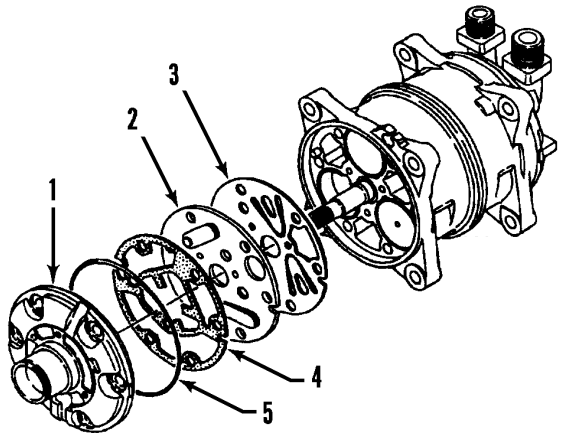
1.	Escape Groove
2.	Suction Valve
3.	Piston

CAUTION: Ensure that the valve is aligned with the valve escape groove of each cylinder.

3. Install the front valve plate on the front suction valve.

CAUTION: Do not to mistake the rear valve plate for the front valve plate.

4. Coat the new gasket with clean compressor oil (same oil used in the system). Install it on the front valve plate.
5. Thinly coat the new O-ring with clean compressor oil (same oil used in the system). Install it on the front cylinder head.
6. Install the front cylinder head. If the front cylinder head is difficult to install, tap the cylinder head lightly with a plastic mallet.



1.	Front Cylinder Head
2.	Valve Plate
3.	Suction Valve
4.	Gasket
5.	O-ring

7. Install new gaskets on the body bolts. Insert the six body bolts from the front cylinder head side and tighten them to the specified torque. TIghten each bolt gradually in three or more stages to ensure the specified torque (see “Tightening Torques” on page 31). Tighten bolts in the order shown in Figure 29 on page 49.

   Turn the drive shaft 2 to 3 times manually to ensure that the shaft rotates smoothly.

8. Install the oil drain plug with a new O-ring, thinly coated with clean compressor oil, and tighten it to the specified torque. See “Tightening Torques” on page 31.

9. Fill the compressor with the specified amount of clean compressor oil. See “Adding Compressor Oil” on page 38.

CAUTION: Check label to verify you are using the correct oil for the system.

10. Install the magnetic clutch (see “Clutch Installation” on page 41).

11. :Leak test the system. See “Leak Testing the Compressor” on page 36.

NOTE: Air Gap—An incorrect air gap could cause erratic engagement or disengagement and/or clutch rattle. Check the air gap with a feeler gauge (0.012 to 0.024 in. [0.3 to 0.6 mm]). Adjust based on “Clutch Installation” on page 41.

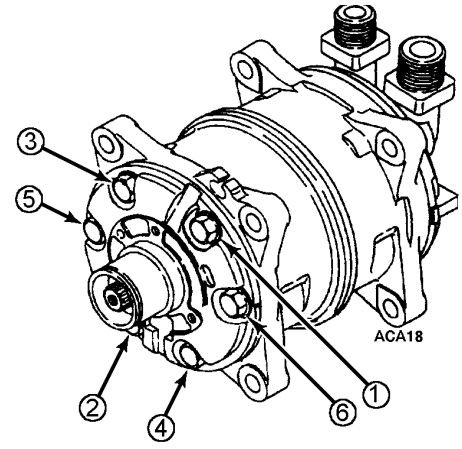
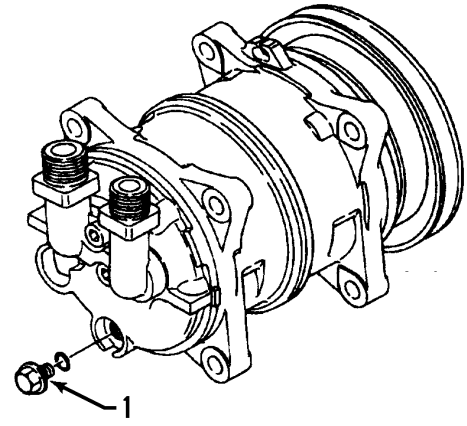


Figure 29: Tightening Sequence



1.	Drain Plug

Compressor Maintenance: TM-31

Safety

DANGER: Explosion Hazard! Do not throw or strike service cans. Do not handle the packing carton roughly. Do not use damaged or dented service cans. Store service cans out of reach of children.

DANGER: Explosion Hazard! Do not directly heat service cans or put them in water above 104 F (40 C). Do not put service cans on the engine or radiator when charging.
If is necessary to heat service cans for charging in cold weather, use water below 104 F (40 C).

DANGER: Explosion Hazard! Do not store service cans in direct sunlight, near flame, or where temperature exceeds 104 F (40 C).

CAUTION: Do not put the charge valve in the warm water.

Refrigerant Recovery

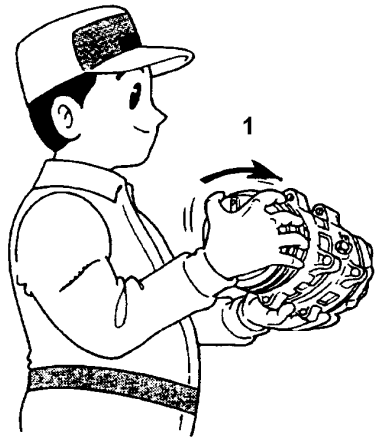
Avoid the release of refrigerant into the atmosphere. If releasing refrigerant from an air conditioning system, use a refrigerant recovery unit to recover the refrigerant.

Consult your recovery unit operators manual for hookup and operating procedures.

Figure 30: Recovery Unit – ICE No. 2590119

Compressor Handling

CAUTION: Do not strike or turn the compressor upside down. If the compressor is turned upside down, rotate it 5 to 6 times to circulate oil.



1.	Rotate Compressor's Magnetic Clutch 5 to 6 Times

Compressor Storage

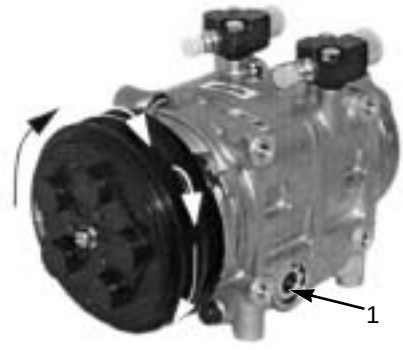
Store new and rebuilt compressors:

- With the correct oil charge.
- Within the orientation range shown in Figure 31 on page 52. If the compressor sits outside that orientation for more than one minute, turn compressor manually (slowly) to clear oil from the cylinders.
- With a holding charge of refrigerant or nitrogen to a pressure of 7 to 21 psig (48 to 145 kPa). This protects internal parts from moisture and corrosion.

Compressor Removal

See "Compressor Removal" on page 34.

Compressor Installation



1.	Compressor Oil Sight Glass

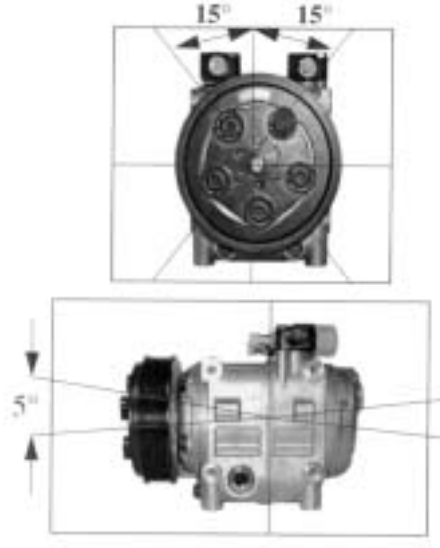


Figure 31: Inclination Limit

NOTE: Inclination limit at installation must be within the range shown above.

NOTE: If mounting shims are required for installation, use Shim Kit (ICE No. 2570101).

Oil Procedures

NOTE: For Compressor Oil Caution Statements, Compressor Oil Charge Considerations, Compressor Oil Type Considerations, Oil Check Interval, Draining the Oil, and all Oil Check procedures, see "Compressor Oil Procedures" on page 36 in this manual.

To check oil level:

1. Return the oil to the compressor. See "Returning Oil to the Compressor" on page 37)
2. Use a flashlight to observe the compressor oil sight glass. Oil level should be approximately in the middle of the sight glass.

CAUTION: If compressor installation does not permit easy viewing, use a mirror to view the sight glass. Be careful of moving belts and pulleys.

1.	Compressor Oil Sight Glass

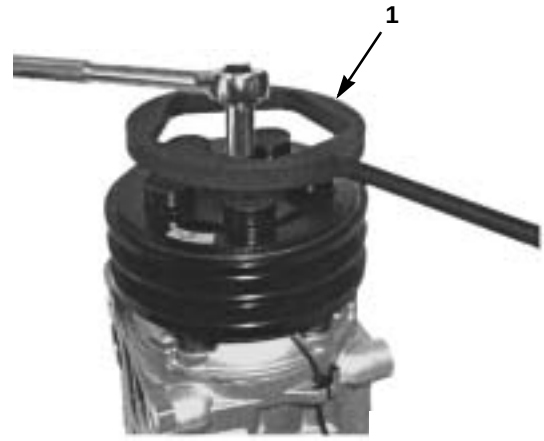
Clutch Procedures

NOTE: See "Clutch Application Guidelines" on page 13 for application information.

Clutch Run-In

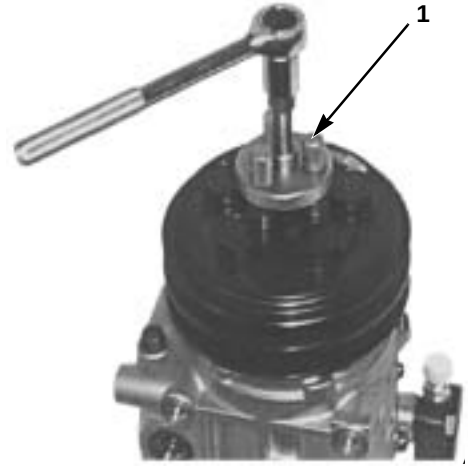
See"Clutch Run-In" on page 39.

Clutch Removal



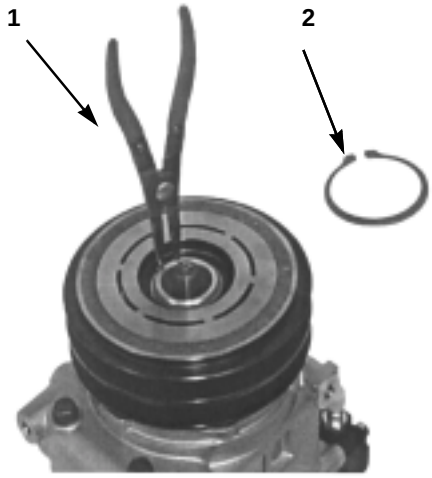
1.	Drive Plate Holder -Typical

1. Remove the center bolt using a drive plate holder to prevent armature assembly rotation.



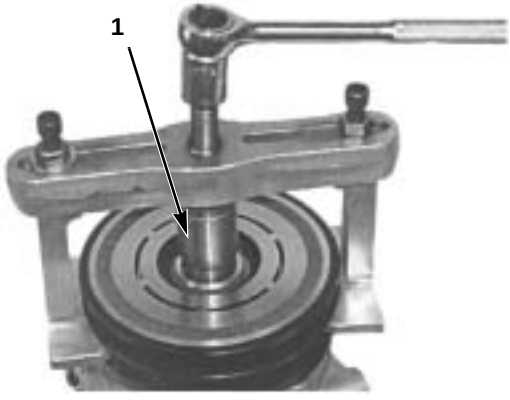
1.	Drive Plate Puller

2. Remove the armature assembly using the drive plate puller. Remove the shims from the compressor driveshaft or armature assembly.



1.	Snap Ring Pliers ICE No. 2590117
2.	Snap Ring

3. Remove the snap ring using external snap ring pliers.



1.	Pulley Puller Center ICE No. 2590115

4. Position the pulley puller center on the end of the driveshaft. Remove the pulley assembly using a suitable pulley puller.

CAUTION: Clip the puller claws into the pulley groove to prevent pulley groove damage.

5. Remove the field coil by releasing the lead wire grommet from the compressor, then removing the three screws that secure the coil.

CAUTION: Do not hold the field coil by the harness.

Clutch Inspection

1.	Armature Assembly
2.	Pulley Assembly
3.	Field Coil

1. If the contact surface has been damaged by excessive heat, replace the armature and pulley.
2. Check the appearance of the pulley assembly. If the contact surface of the pulley is excessively grooved due to slippage, replace both the pulley and armature. Clean the contact surfaces of the pulley assembly with a suitable solvent before reinstallation.
3. Check the field coil for a loose connector or cracked insulation.

Clutch Installation

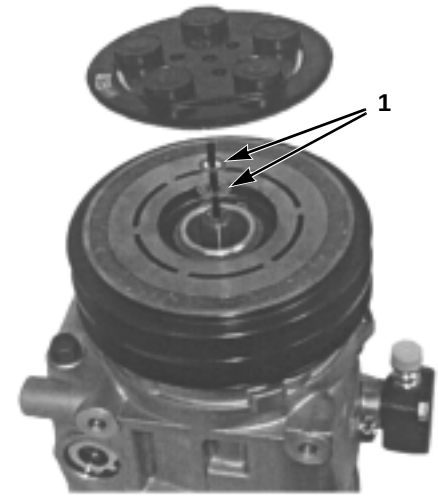
1. Install the field coil on the compressor (with the harness on top). Tighten the mounting screws to the specified torque.

Specified Torque: 6 to 7 ft-lbs (8 to 10 N•m)

2. Install the wire harness/strain relief.

1.	Pulley Installer

3. Install the pulley assembly using the pulley installer and a hand press.
4. Install the snap ring using external snap ring pliers. Install the snap ring with the chamfered inner edge outward (facing away from the seal).



1.	Shim(s)

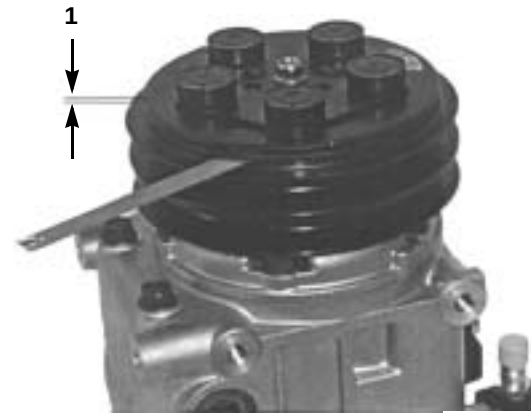
5. Install the armature assembly on the driveshaft together with the original shim(s). Press the armature assembly down by hand.

   NOTE: If required, additional shims are available. Use clutch hardware kit ICE No. 2530109.

6. Install the armature bolt and tighten the bolt to the specified torque using the drive plate holder to prevent armature assembly rotation.

Specified Torque: 14 to 16 ft-lbs (20 to 22 N•m)

CAUTION: After tightening the center bolt, check that the pulley rotates smoothly



Clutch Clearance: 0.012 t 0.024 in. (0.3 to 0.6 mm)

7. Check that the clutch clearance is as specified. If necessary, adjust the clearance using shim(s).

   NOTE: Clutch hardware kit is available (ICE No. 2530109).

Shaft Seal Procedures

Shaft Seal Removal

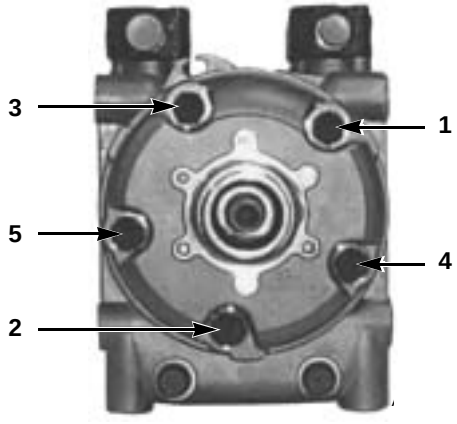
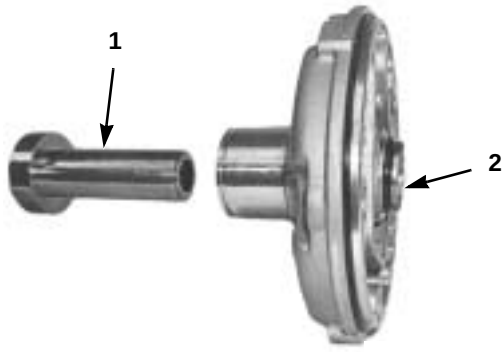


Figure 32: Torque Sequence

1. Remove the magnetic clutch assembly See “Clutch Removal” on page 53.
2. Remove the connector caps and oil drain plug. Drain the oil. See “Draining the Oil” on page 37.
3. Remove the five through-bolts securing the head using a hexagon wrench.

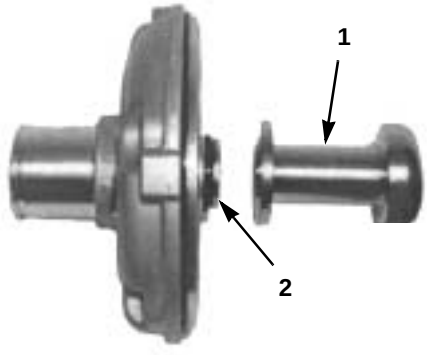
4. Remove the front cylinder head by tapping the three projections on the circumference of the front cylinder head with a screwdriver (flat head) and a plastic or rubber mallet.



1.	Remover - Shaft Seal Kit ICE No. 2590114
2.	Shaft Seal

5. Remove the shaft seal, pushing the remover until the shaft seal is pushed out the back of the head.

Shaft Seal Installation

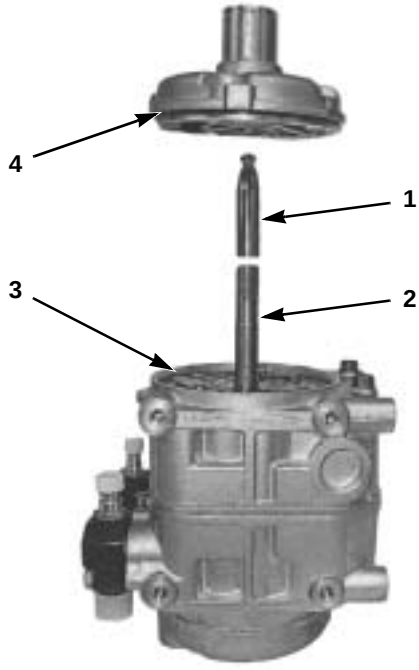


1.	Installer- ICE No. 2590117
2.	Shaft Seal

1. Clean the sealed section of the front cylinder head.
2. Apply clean compressor oil to the new shaft seal.

CAUTION: Use same oil type in the system.

3. Insert the shaft seal as far as possible into the front cylinder head using the installer.



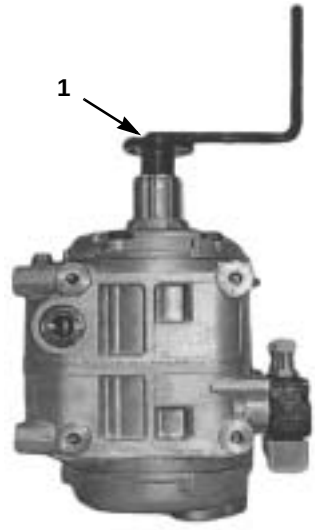
1.	Guide
2.	Shaft
3.	Gasket
4.	O-ring

4. Thinly coat the new O-ring and gasket with clean compressor oil. Use the same oil used in the system.
5. Fit the guide onto the end of the drive shaft. Install the front cylinder head. If the front cylinder head is difficult to install, tap the cylinder head lightly with a plastic or rubber mallet.

6. Mount the new gaskets on the through-bolts.
7. Insert the five through-bolts from the front cylinder head side and tighten them to the specified torque.

   NOTE: Tighten the bolts in the order shown in the torque sequence photo. See "Torque Sequence" on page 56..

Specified Torque: 18.4-22.1 ft-lbs (25 to 30 N•m)



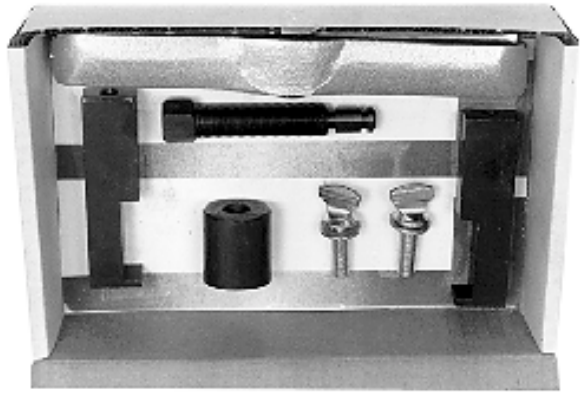
1.	Handle

8. Turn the drive shaft two or three times manually to ensure that the shaft rotates smoothly.
9. Fill the compressor with the specified amount of clean compressor oil through the oil filler. Tighten the oil filler plug to the specified torque.

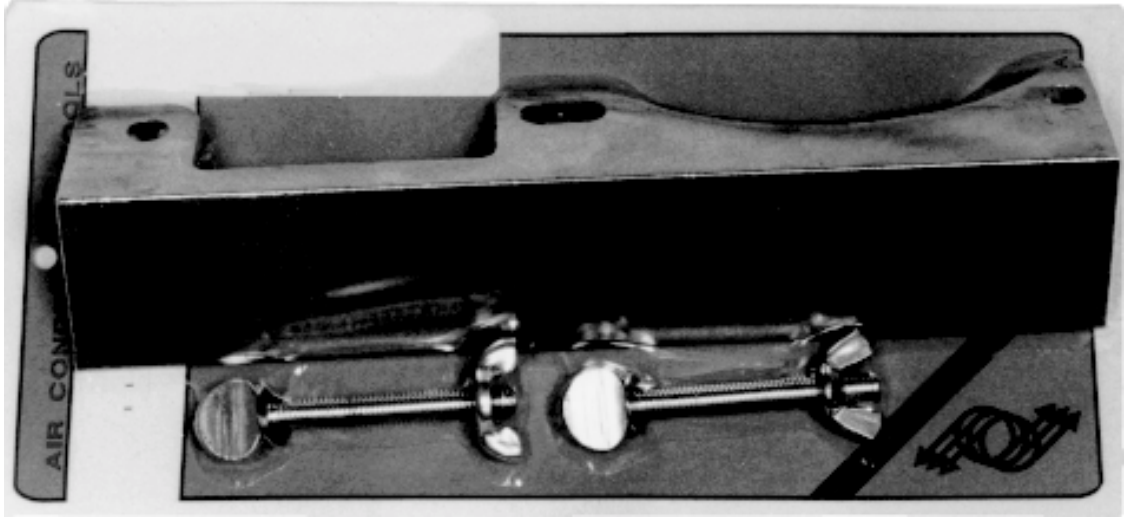
Specified Torque: 10-12 ft-lbs (14 to 16 N•m)

10. Install the magnetic clutch. See "Clutch Installation" on page 55.
11. Do a clutch run-in (see "Clutch Run-In" on page 39) and leak test (see "Leak Testing the Compressor" on page 36).

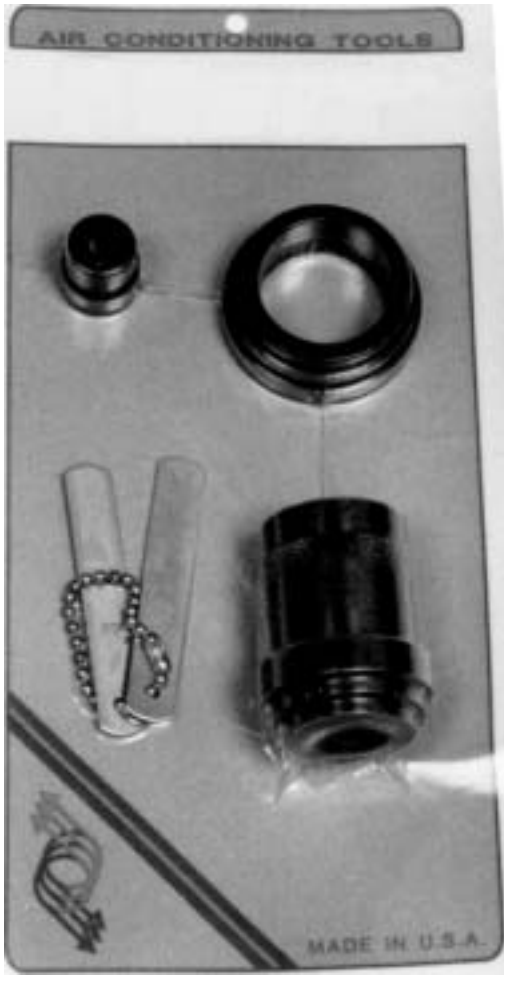
Appendix – Tools and Kits



Clutch Remover – ICE No. 2590115



Compressor Holder – ICE No. 2590116



Clutch Installation Kit – ICE No. 2590118

Shaft Seal Kit – ICE No. 2590114

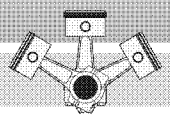
Snap Ring Pliers – ICE No. 2590117

Clutch Hardware Kit – ICE No. 2530109

Shim Kit – ICE No. 2570101

Customer Service: Phone 952-886-6088
Visit our Web site at www.intl-comp.com
or contact our Customer Service at
952-886-6088
Fax: 952-886-6099

Wartungsanleitung
Maintenance Instruction
Instruction de maintenance



KW-540-1

Offene Hubkolbenverdichter für Fahrzeug-Anwendungen

- 4UFC(Y) .. 4NFC(Y)
- 4UFR(Y) .. 4NFR(Y)
- 6UFC(Y) .. 6NFC(Y)

Open drive reciprocating compressors for Transport Applications

- 4UFC(Y) .. 4NFC(Y)
- 4UFR(Y) .. 4NFR(Y)
- 6UFC(Y) .. 6NFC(Y)

Compresseurs ouverts à pistons pour applications en transport

- 4UFC(Y) .. 4NFC(Y)
- 4UFR(Y) .. 4NFR(Y)
- 6UFC(Y) .. 6NFC(Y)

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3 Werkzeuge und Hilfsmittel

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3 Outillage et équipements auxiliaires

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5.2 Travaux d'entretien

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7.2 Evaluer les dégâts et l'usure
7.3 Réassembler le compresseur

8 Diagnostic des défauts

1 Allgemeines

BITZER-Verdichter werden mit Sorgfalt und höchster Fertigungsqualität produziert. Einhaltung der in den Projektierungs-Handbüchern und Bedienungsanleitungen gegebenen Hinweise gewährt zuverlässigen Betrieb und eine lange Lebensdauer.

Sollte es im Betrieb dennoch zu Problemen kommen, so lässt sich dies meist auf Fehler in der Anlage zurückführen. Um schwere Folgeschäden oder den Totalausfall des Verdichters zu vermeiden, muss die eigentliche Ursache für die Störung gefunden und beseitigt werden.

Wenn nach langer Laufzeit Verschleißerscheinungen bemerkbar werden, empfiehlt sich im Regelfall der Austausch des Verdichters.

Wird der Austausch einzelner Bauteile oder eine komplette Überholung bevorzugt, kann nach Abschnitt 6 und 7 vorgegangen werden.

Technische Änderungen vorbehalten!
Eventuelle Änderungen von technischen Details sowie Änderungen in Konstruktion, Ausstattung und Zubehör gegenüber den Angaben und Abbildungen der Wartungsanleitung bleiben dem Hersteller vorbehalten.

Für Schäden am Verdichter, die durch unsachgemäße Handhabung verursacht werden, übernimmt BITZER keine Gewährleistung.

1 General information

BITZER compressors are produced with the greatest care and production quality. Observing the indications given in the applications manuals and operating instructions ensures the dependable operation and a long service life.

Should problems arrive during operation despite this, it is mostly due to errors made in the plant. To avoid further damages or complete failure of the compressor, the actual cause for the malfunction must be found and eliminated.

When signs of wear become noticeable after a longer running time, it is generally recommended to replace the compressor.

If you prefer to replace single components or to carry out a complete overhaul, you may proceed according to sections 6 and 7.

Subject to technical modifications!
The manufacturer reserves the right to make modifications of technical details as well as modifications in construction, equipment and accessories with respect to the data and illustrations of the maintenance instructions should they become necessary.

BITZER assumes no warranty for damages to the compressor that have been caused by incorrect handling.

1 Généralités

Les compresseurs BITZER sont produits avec soin et une qualité de fabrication des plus élevées. Le respect des recommandations contenues dans les manuels de mise en œuvre et les instructions de service garantit un fonctionnement fiable et une longue durée de vie.

Cependant, si des problèmes de fonctionnement viennent à apparaître, ceux-ci sont dûs généralement à des défauts dans la conception de la installation. Afin d'éviter de gros dégâts qui en seraient la conséquence, ou une complète défaillance du compresseur, il faut rechercher la véritable cause du défaut et y remédier.

Si des signes d'usure apparaissent après une longue durée de fonctionnement, il est généralement recommandé de remplacer le compresseur.

Dans le cas du remplacement de pièces individuelles ou d'une remise en état complète du compresseur, se référer alors aux paragraphes 6 et 7.

Sous réserve de modifications techniques !
Le fabricant se réserve le droit de modifications éventuelles de détails techniques, ainsi que de modifications de la construction, de l'équipement et des accessoires par rapport aux données et figures contenues dans les instructions de maintenance.

BITZER n'accorde pas de garantie pour des dégâts résultant d'un usage inapproprié du compresseur.

2 Sicherheit

Autorisiertes Fachpersonal
Sämtliche Arbeiten an Verdichtern und Kälteanlagen dürfen nur von qualifiziertem und autorisiertem Fachpersonal ausgeführt werden.

Die hier beschriebenen Tätigkeiten sind sehr anspruchsvoll und erfordern höchste Präzision.

2 Safety

Authorized personnel
All work done on the compressors and the refrigeration plants may only be performed by qualified and authorized personnel.

The activities described here are very complex and require the highest precision.

2 Sécurité

Personnel compétent autorisé
Toutes les interventions sur les compresseurs et les installations frigorifiques doivent être exécutées exclusivement par un personnel compétent, autorisé et qualifié.

Les activités décrites ci-après sont très exigeantes et nécessitent une précision des plus élevées.

Vorsicht!
Im Betrieb können Oberflächen-Temperaturen von über 100°C bzw. unter 0°C auftreten.
Schwere Verbrennungen sind möglich.
Zugängliche Stellen absperren und kennzeichnen.
Vor Arbeiten am Verdichter: Anlage ausschalten und abkühlen lassen.

Warnung!
Verdichter kann unter Druck stehen!
Bei unsachgemäßen Eingriffen sind schwere Verletzungen möglich.
Verdichter vor Wartungs- oder Reparaturarbeiten auf drucklosen Zustand bringen.

Achtung!
Kältemaschinenöle können größere Mengen Luftfeuchtigkeit aufnehmen, die zu chemischen Reaktionen im Kältekreislauf führen.
Verdichter-Folgeschäden möglich!
Bei Installation oder Wartungsarbeiten Öl befüllten Verdichter nicht länger als 15 Minuten geöffnet lassen.
Nach Wartung oder evtl. Reparatur Verdichter evakuieren. Anschließend mit gasförmigem Kältemittel befüllen, Absperrventile öffnen. Falls der Verdichter am Lager gehalten werden soll, nach dem Evakuieren Schutzgas (N_2 – 0,5 bar) einfüllen. Schutzgas muss bei nachfolgendem Einsatz des Verdichters durch Evakuieren abgesaugt werden!

Caution!
During operation, surface temperatures exceeding 100°C or below 0°C can be reached.
Serious burns and frostbite are possible.
Lock and mark accessible sectors.
Before working on the compressor: Switch off the plant and let it cool off.

Warning!
The compressor may be under pressure!
Incorrect handling can lead to serious injuries.
Before any maintenance or repair work, relieve the compressor of pressure.

Attention!
Refrigeration compressor oils can absorb larger quantities of air humidity that lead to chemical reactions in the refrigerant circuit.
Consequential damages to the compressor are possible!
When performing installation or maintenance tasks, do not keep the oil filled compressor open longer than 15 minutes.
Evacuate the compressor completely after maintenance or repair. Fill up afterward with gaseous refrigerant, open shut-off valves. In case the compressor is to be stored, fill up with holding charge (N_2 – 0.5 bar) after the evacuation. The holding charge must be extracted by evacuation when the compressor is to be used again!

Prudence !
Des températures en surface supérieures à 100° C resp. inférieures à 0° C peuvent apparaître durant le fonctionnement. De graves brûlures sont possibles. Délimiter et signaliser les endroits accessibles.
Avant les travaux sur le compresseur: arrêter l'installation et la laisser refroidir.

Avertissement !
Le compresseur peut être sous pression! Risque de blessures graves en cas d'interventions inappropriées.
Avant les travaux de maintenance ou de réparation, amener le compresseur à pression atmosphérique.

Attention !
Les huiles pour machines frigorifiques peuvent absorber une grande quantité d'humidité de l'air, ce qui peut engendrer des réactions chimiques dans le circuit frigorifique.
Il peut en résulter des dégâts sur le compresseur!
Lors de la mise en place ou durant les travaux de maintenance, limiter le temps d'ouverture du compresseur rempli d'huile à maximum 15 minutes.
Procéder à la mise à vide du compresseur après maintenance ou réparation. Introduire ensuite le fluide frigorigène gazeux, ouvrir les vannes d'arrêt. Si le compresseur reste en stock, le remplir d'un gaz de protection (N_2 – 0,5 bar) après la mise à vide. Ce gaz de protection sera retiré lors de l'opération de mise sous vide du compresseur réutilisé.

3 Werkzeuge und Hilfsmittel

- Plastikhammer (2 kg)
- Innensechskantschlüssel (SW 10)
- Drehmomentschlüssel
- Öl-Auffangwanne
- Waschbenzin und Putzlappen
- Schaber, Schmirgelleinen (zum Entfernen von Dichtungsresten)
- Ringschlüssel (SW 13, 17, 27)
- Seegerringzange
- Montagehülse für Welle
- Montageglocke für Seegerring
- Montagering für Kolben/Pleuel

3 Tools and other devices

- Plastic hammer (2 kg)
- Allen key (SW 10)
- Torque wrench
- Oil drip pan
- Petroleum ether and cleaning cloths
- Scraper, smoothing cloth (for removing remains of gasket)
- Ring spanners (SW 13, 17, 27)
- Circlip pliers
- Mounting sleeves for shaft
- Mounting bell for Seeger ring
- Mounting ring for piston/connecting rod

3 Outillage et équipements auxiliaires

- Maillet à embouts plastiques (2 kg)
- Clé pour vis à six pans creux (SW 10)
- Clé dynamométrique
- Bac de récupération d'huile
- Ligroïne et chiffons
- Racloir, toile d'émeri (pour retirer les restes de joint)
- Clé polygonale (SW 13, 17, 27)
- Pince à circlip
- Douille de montage pour arbre
- Douille de montage pour circlip
- Bague de montage pour piston/bielle

4 Verdichter-Schnittbild

4 Compressor sectional view

4 Vue en coupe du compresseur

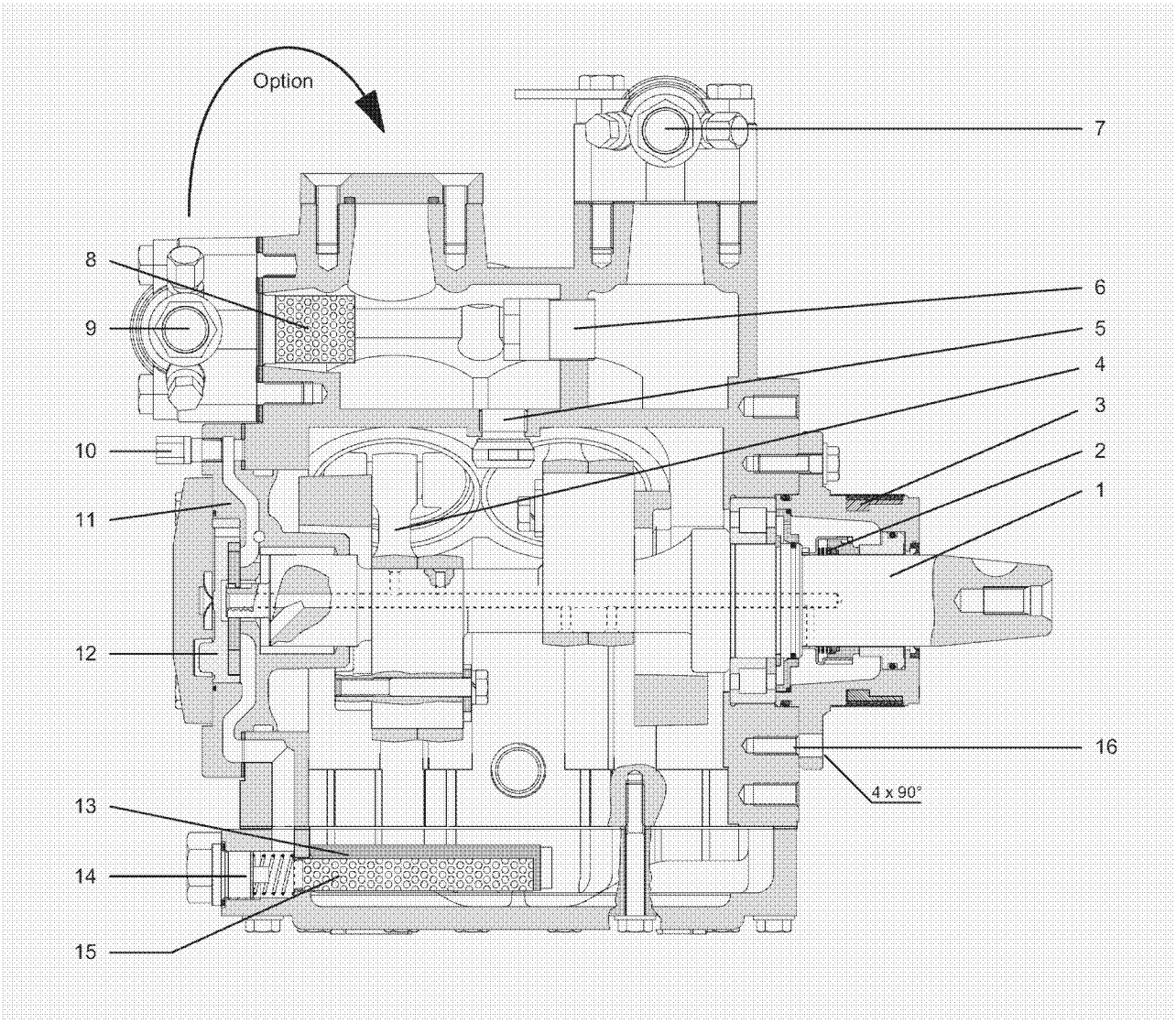


Abb. 1 Offener Hubkolbenverdichter für Fahrzeuganwendung

1 Exzenterwelle
2 Wellenabdichtung
3 Filzring
4 Kolben / Pleuel
5 Druckausgleichsventil
6 Druckentlastungsventil
7 Druckabsperrventil (DL)
8 Saugfilter
9 Saugabsperrventil (SL)
10 Schraderventil für Öldruckmessung
11 Lagerdeckel
12 Ölpumpe
13 Öltrockner (Option)
14 Magnetstopfen
15 Ölfilter
16 Gewinde für Magnetkupplung

Fig. 1 Open drive reciprocating compressor for transport application

1 Eccentric shaft
2 Shaft seal
3 Felt ring
4 Piston / connecting rod
5 Pressure equalizing valve
6 Pressure relief valve
7 Shut-off valve (DL)
8 Suction filter
9 Suction shut-off valve (SL)
10 Schrader valve for oil pressure measurement
11 Bearing cover
12 Oil pump
13 Oil dryer (option)
14 Magnetic plug
15 Oil filter
16 Thread for magnetic clutch

Fig. 1 Compresseur ouvert à pistons pour applications en transport

1 Arbre d'excentrique
2 Garniture d'étanchéité
3 Bague feutre
4 Piston / bielle
5 Soupape d'égalisation de pression
6 Soupape de décharge
7 Vanne d'arrêt au refoulement (DL)
8 Filtre d'aspiration
9 Vanne d'arrêt à l'aspiration (SL)
10 Vanne Schrader pour prise de pression d'huile
11 Couvercle de palier
12 Pompe à huile
13 Deshydrateur d'huile (option)
14 Bouchon magnétique
15 Filtre à huile
16 Filetage pour embrayage électromagnétique

5 Regelmäßige Wartungsarbeiten

Eine komplette Wartung des Verdichters nach einer bestimmten Betriebsdauer ist grundsätzlich nicht erforderlich. Dennoch werden gewisse Routineüberprüfungen empfohlen.

5.1 Empfohlene Routineüberprüfungen

In der Regel genügen einfache optische Wartungskontrollen am eingebauten Verdichter:

- Verdichter auf Verschmutzungen und Leckagen überprüfen.
- Riemenvorspannung überprüfen.
- Riemen auf Verschleiß prüfen.
- Anlage mit erhöhter Leerlauf-Drehzahl auf Betriebstemperatur bringen. Nach ca. 15 min. die Schmierung des Verdichters kontrollieren.
- Ölstand ¼ bis ¾ Schauglashöhe.
- Messen des Öldifferenzdrucks (Abb. 1, Anschluss 10) bei Drehzahl ca. 1500 min^{-1} und Öltemperatur ab 40°C:
  - Differenz gegen Saugdruck (Sollwert) ca. 1.4 bar oder höher.

5.2 Wartungsarbeiten

- Antrieb: Spannband (Abb. 3, Pos. 11) entfernen und Filzring (Abb. 3, Pos. 12) auswechseln.
- Schmierung:
  Bei ordnungsgemäß betriebenen Anlagen ist ein Wechsel des Kältemaschinenöls nicht zwingend erforderlich. Lediglich Verunreinigungen aus den Anlagenkomponenten oder Betrieb außerhalb der Anwendungsbereiche können zu Ablagerungen im Schmieröl führen und es dunkel verfärben. In diesem Fall Öl wechseln. Dabei auch Ölfilter und Magnetstopfen reinigen. Die Ursache für Betrieb außerhalb der Anwendungsbereiche ermitteln und beheben.
  Empfehlung: Etwa alle 3 Jahre bzw. 10 000 .. 12 000 Betriebsstunden Öl und ggf. Öltrockner wechseln, Ölfilter und Magnetstopfen reinigen.
- Saug-/Druckbereich:
  - Sauggasfilter reinigen oder austauschen.
  - Zylinderköpfe abnehmen und Ventilplatte auf Verschmutzungen und Beschädigungen prüfen, gegebenenfalls austauschen.

Verdichter nur dann ausbauen, wenn durch Einbauposition unzugänglich! Dann Vorgehensweise wie in Kapitel 6.

5 Regular maintenance work

It is not basically necessary to perform a complete maintenance of the compressor according to a determined operating time. Despite this, certain routine checks are recommended.

5.1 Recommended routine checks

Generally, simple optical maintenance checks on the installed compressor are sufficient:

- Check the compressor for soiling and leaks.
- Check initial belt tension.
- Check belts for wear.
- Increase idling speed to cause the unit to reach operating temperature. Check the lubrication of the compressor after approx. 15 min.
- Oil level at ¼ to ¾ of sight glass height.
- Measuring of the differential oil pressure (Fig. 1, connection 10) at 1500 rpm and oil temperature beyond 40°C:
  - Difference to suction pressure (nominal value) approx. 1.4 or higher.

5.2 Maintenance tasks

- Drive: Remove tightening strap (Fig. 3, pos. 11) and replace felt ring (Fig. 3, pos. 12).
- Lubrication:
  It is not absolutely necessary to change the refrigeration compressor oil when the plant is operated properly. Impurities stemming from the plant components or operating outside the application ranges are the only things that can cause deposits to form in the lubricating oil, causing it to darken. In this case, change the oil. At the same time, clean the oil filter and magnetic plug. Determine the cause of operating outside of the application area and eliminate it.
  Recommendation: Change oil approximately every 3 years or 10.000 .. 12.000 operating hours along with the oil dryer, if necessary, clean the oil filter and the magnetic plug.
- Suction/pressure range:
  - Clean or replace suction gas filter
  - Remove cylinder heads and check valve plate for soiling and damages, replace if necessary.

Remove compressor only if it cannot be reached due to its mounting position! Then proceed as explained in chapter 6.

5 Entretiens réguliers

En principe, une révision complète du compresseur après une durée de fonctionnement déterminée n'est pas nécessaire. Cependant, certains contrôles de routine sont préconisés.

5.1 Contrôles de routine préconisés

En règle générale, des simples contrôles visuels sur le compresseur installé suffisent:

- Contrôler l'encrassement et les fuites sur le compresseur.
- Contrôler la tension initiale des courroies.
- Vérifier l'usure des courroies.
- Amener le système à la température de fonctionnement avec une vitesse de rotation en marche à vide accélérée. Après environ 15 minutes, contrôler la lubrification du compresseur.
- Niveau d'huile entre ¼ et ¾ de la hauteur du voyant.
- Mesurer la pression différentielle d'huile (fig. 1, raccord 10) pour une vitesse de rotation de 1500 min^{-1} environ et une température d'huile à partir de 40°C:
  - Différence avec pression d'aspiration (point de consigne) environ 1,4 bar ou plus.

5.2 Travaux d'entretien

- Entraînement: retirer le ruban de serrage (fig. 3, pos. 11) et remplacer la bague feutre (fig. 3, pos. 12).
- Lubrification:
  Pour les systèmes exploités dans les règles, la vidange d'huile n'est pas systématiquement nécessaire. Uniquement des impuretés issues des composants du système ou le fonctionnement en dehors des champs d'application peuvent engendrer des dépôts dans l'huile de lubrification et l'assombrir. Dans ce cas, procéder à la vidange d'huile. Par la même occasion, nettoyer le filtre à huile et le bouchon magnétique. Déterminer la cause du fonctionnement en dehors des champs d'application et y remédier.
  Recommandations: environ tous les 3 ans resp. après 10.000 .. 12.000 heures de fonctionnement, procéder à une vidange d'huile; le cas échéant, remplacer le deshydrateur d'huile et nettoyer le filtre à huile et le bouchon magnétique.
- A l'aspiration / au refoulement:
  - Nettoyer ou remplacer le filtre d'aspiration.
  - Retirer les têtes de culasse, contrôler l'encrassement et s'il y a des dégâts; remplacer le cas échéant.

Ne démonter le compresseur que si sa position de montage le rend inaccessible! Procéder alors comme décrit au paragraphe 6.

6 Austausch einzelner Bauteile

Der Austausch einzelner Verdichterbauteile ist nur zu empfehlen, wenn der Schadensumfang genau lokalisiert werden kann. Ansonsten wird ein Verdichteraustausch oder eine komplette Überholung erforderlich. Um schwere Folgeschäden oder den erneuten Ausfall des Verdichters zu vermeiden, muss die eigentliche Ursache für die Störung gefunden und beseitigt werden.
Fehlerdiagnose siehe Kapitel 8.

6.1 Verdichter aus- und einbauen

Wenn die Einbauposition es verlangt, Verdichter aus der Fahrzeuganlage ausbauen, um Wartungsarbeiten durchzuführen (Schraubenanzugsmomente siehe KW-550).

Ausbau

Warnung!
Verdichter kann unter Druck stehen!
Bei unsachgemäßen Eingriffen sind schwere Verletzungen möglich. Verdichter auf **drucklosen** Zustand bringen.

- Kältemittel-Absaugstation an die Service-Anschlüsse der Absperrventile anschließen
- Saug- und Druckabsperrventile zur Anlagenseite schließen.
- Kältemittel mit der Absaugstation bis auf Umgebungsdruck absaugen.
- Riemen entspannen und demontieren.
- Schrauben der Absperrventile am Verdichter lösen.
- Befestigungsschrauben an Bodenplatte lösen.
- Verdichter mit Magnetkupplung aus Fahrzeuganlage herausnehmen.
- Magnetkupplung entfernen (s. 6.2).
- Öl in dafür vorgesehene Auffangwanne ablassen.

Einbau nach erfolgter Instandsetzung

- Verdichter über die Öleinfüll-Anschlüsse mit Öl befüllen.

Achtung!
Es befindet sich bereits Öl im Kreislauf. Deshalb kann es erforderlich sein, einen Teil der Ölfüllung abzulassen.
Ölstand innerhalb markiertem Schauglasbereich halten (¼ Schauglashöhe, bei Neuanlagen ¾ Schauglashöhe).

6 Replacement of single components

Replacing single compressor components is only recommended when the extent of damage can be localized exactly. Otherwise, it will become necessary to replace the compressor or to overhaul it completely. To avoid further damages or repeated compressor failure, the actual cause for the malfunction must be found and eliminated.
For error diagnosis, see chapter 8.

6.1 Removing and installing the compressor

If the mounting position makes it necessary, remove the compressor from the vehicle unit to perform the maintenance tasks (for screw tightening torques, see KW-550).

Removal

Warning!
The compressor may be under pressure!
Incorrect handling can lead to serious injuries. **Relieve the compressor of pressure.**

- Connect the refrigerant recovery station to the service connections of the shut-off valves.
- Close suction and pressure shut-off valves on the unit side.
- Extract the refrigerant using the recovery station until ambient pressure is reached.
- Release belts and dismount.
- Unscrew the shut-off valve screws on the compressor.
- Unscrew the fixing screws on the bottom plate.
- Remove the compressor together with the magnetic clutch from the vehicle unit.
- Remove magnetic clutch (s. 6.2).
- Drain oil out into the appropriate drip pan.

Mounting after having made repairs

- Fill the compressor with oil by means of the oil fill connections.

Attention!
Oil is already inside the circuit. For this reason, it may be necessary to drain some of the oil.
Maintain the oil level between the area marked in the sight glass (¼ of the sight glass height; for new units, ¾ of the sight glass height).

6 Remplacement de pièces individuelles

Le remplacement de pièces individuelles du compresseur n'est conseillé que si l'ampleur des dégâts peut être localisée précisément. Sinon, il est nécessaire de procéder au remplacement du compresseur ou à une remise en état complète. Afin d'éviter de gros dégâts qui pourraient en résulter, ou une nouvelle défaillance du compresseur, il faut rechercher la véritable cause du défaut et y remédier.
Diagnostic des défauts, voir chap. 8.

6.1 Démonter et remonter le compresseur

Si la position de montage le nécessite, extraire le compresseur du circuit afin d'effectuer les travaux d'entretien (couples de serrage des vis, voir KW-550).

Retrait

Avertissement !
Le compresseur peut être sous pression! De graves blessures sont possibles en cas d'interventions inappropriées. **Amener le compresseur à pression atmosphérique.**

- Connecter la station de récupération de fluide frigorigène aux raccords de service des vannes d'arrêt.
- Fermer les vannes d'arrêt à l'aspiration et au refoulement, coté système.
- Retirer le fluide frigorigène avec la station de récupération jusqu'à pression atmosphérique.
- Détendre les courroies et les démonter.
- Desserrer les vis des vannes d'arrêt sur le compresseur.
- Desserrer les vis de fixation sur la plaque de fond.
- Extraire du circuit le compresseur avec l'embrayage électromagnétique.
- Retirer l'embrayage électromagnétique (voir 6.2).
- Laisser écouler l'huile dans un bac de récupération.

Mise en place après remise en état

- Refaire l'appoint en huile du compresseur par les raccords de remplissage d'huile.

Attention !
Il y a déjà de l'huile dans le circuit. Par conséquent, il peut s'avérer nécessaire de retirer une partie de la charge d'huile. Maintenir le niveau d'huile dans les limites du marquage sur le voyant (¼ de la hauteur du voyant; sur nouvelles installations, ¾ de la hauteur du voyant).

- Magnetkupplung auf Welle schieben und festschrauben
- Verdichter mit Magnetkupplung in Fahrzeuganlage einbauen.
- Verdichter (Riemenscheiben) ausrichten.
- Befestigungsschrauben an Bodenplatte anziehen.
- Verdichter gleichzeitig auf Saug- und Hochdruckseite evakuieren, bis bei abgesperrter Pumpe ein Vakuum kleiner als 1,5 mbar bestehen bleibt.
- Absperrventile öffnen – zunächst saugseitig – und anschließend Dichtheitsprüfung vornehmen.
- Während Probelauf bei betriebswarmer Anlage den Ölstand im Schauglas erneut überprüfen.
- Bei Bedarf Kältemittelfüllung ergänzen.

Genaue Vorgehensweise siehe Betriebsanleitung KB-540.

6.2 Magnetkupplung austauschen (Zubehör)

Achtung!
Nur von BITZER zugelassene Kupplungen verwenden.

- 4UFC(Y) .. 6TFC(Y): LA16, KK 73.1
  6PFC(Y) .. 6NFC(Y): LA26, KK 73.4

Austausch am Beispiel der Kupplung LA16 (Abb. 2):

Ausbau

Achtung!
Beim Abziehen der Kupplung darf die Welle keinesfalls durch Einsatz von Hebeln zur Antriebsseite hin verschoben werden!

- Die von BITZER empfohlenen Kupplungen LINNIG LA16, LA26 und LANG KK 73.1 und KK 73.4 haben eine integrierte Abziehvorrichtung:
- Spannschraube (10) soweit nach links drehen, bis der Bund am Seeger-K-Ring (9) aufliegt.
- Spannschraube (10) mit Kraft weiterdrehen, bis sich die Kupplung von der Welle gelöst hat.
- Kupplung abnehmen.

Vorsicht!
Kupplung nicht fallen lassen!
Verletzungsgefahr!

- Magnet (4) abschrauben (4 Befestigungsschrauben).
- Magnet und Kupplung prüfen, ggf. ersetzen.

- Slide the magnetic clutch onto the shaft and screw on tight
- Install the compressor together with the magnetic clutch into the vehicle unit.
- Align the compressor (pulleys).
- Tighten the fixing screws on the bottom plate.
- Evacuate compressor contemporarily from both the suction and high pressure sides until a steady vacuum is reached with the pump blocked off that remains below 1.5 mbar.
- Open shut-off valve – first on the suction side – and afterwards carry out the tightness test.
- Check the oil level in the sight glass while the unit is at operating temperature during the test run.
- Top up refrigerant level, if needed.

For the detailed procedure, see operating instruction KB-540.

6.2 Replacement of magnetic clutch (accessory)

Attention!
Only use clutches approved by BITZER.

- 4UFC(Y) .. 6TFC(Y): LA16, KK 73.1
  6PFC(Y) .. 6NFC(Y): LA26, KK 73.4

Example of replacing the clutch LA16 (Fig. 2):

Removal

Attention!
When removing the clutch, the shaft must not be pushed towards the drive side with the use of levers!

- The clutches recommended by BITZER LINNIG LA16, LA26 and LANG KK 73.1 and KK 73.4 have an integrated pulling device:
- Turn the straining screw (10) to the left until the collar of the Seeger-K-ring (9) lies flat.
- Further turn the straining screw (10) hard enough until the clutch has released itself from the shaft.
- Remove the clutch.

Caution!
Do not drop the clutch!
Risk of injury!

- Screw off the magnet (4) (4 fixing screws).
- Check magnet and coupling, replace if necessary.

- Glisser l'embrayage électromagnétique sur l'arbre et serrer les vis de maintien.
- Réinstaller le compresseur avec l'embrayage électromagnétique dans le circuit.
- Aligner le compresseur (poulies à gorges).
- Serrer les vis de fixation sur la plaque de fond.
- Procéder à la mise à vide du compresseur, simultanément à l'aspiration et au refoulement, jusqu'au maintien d'un vide inférieur à 1,5 mbar quand la pompe est hors service.
- Ouvrir les vannes d'arrêt – d'abord à l'aspiration – puis procéder à l'essai d'étanchéité.
- Recontrôler le niveau d'huile dans le voyant durant la période d'essai, le système étant à température de service .
- Si nécessaire, faire l'appoint de la charge en fluide frigorigène.

Voir instructions de service KB-540 pour plus de détails sur la façon de procéder.

6.2 Remplacer l'embrayage électromagnétique (accessoire)

Attention !
N'utilisez que des accouplements homologués par BITZER.

- 4UFC(Y) .. 6TFC(Y): LA16, KK 73.1
  6PFC(Y) .. 6NFC(Y): LA26, KK 73.4

Remplacement suivant l'exemple de l'embrayage LA16 (fig. 2):

Retrait

Attention !
Lors du retrait de l'embrayage, veiller à ce que, en aucun cas, l'arbre ne soit repoussé vers le coté de l'entraînement sous l'effort exercé par un bras de levier!

- Les embrayages préconisés par BITZER, LINNIG LA16, LA26 et LANG KK73.1 et KK73.4 ont un dispositif de démontage intégré:
- Tourner la vis de tension (10) vers la gauche jusqu'à ce que l'épaulement vienne buter sur le circlip (9).
- Continuer à tourner fermement la vis de tension jusqu'à ce que l'embrayage décolle de l'arbre.
- Retirer l'embrayage.

Prudence !
Ne pas laisser tomber l'embrayage!
Risque de blessures.

- Dévisser l'aimant (4) (4 vis de fixation).
- Contrôler l'aimant et l'embrayage, et remplacer le cas échéant.

Einbau

Achtung!
Schrauben und Muttern mit vorgeschriebenen Drehmomenten anziehen.

- Magnet (4) am Gehäuse befestigen. Schrauben (5) einstecken und kreuzweise anziehen (Anzugsmoment 25 Nm).
- Scheibenfeder (2) montieren.
- Spannschraube (10) einfetten. Rotor (6) auf Welle und Magnet (4) schieben. Spannschraube (10) in Wellenende einschrauben (Anzugsmoment 85 Nm).
- Riemenscheibe über die Stiftschrauben der Kupplung schieben und mit Muttern (7) festschrauben (Anzugsmoment 25 Nm).

Mounting

Attention!
Tighten bolts and nuts to the specified torques.

- Fasten magnet (4) to housing. Insert bolts (5) and tighten crosswise (tightening torque 25 Nm).
- Mount woodruff key (2).
- Lubricate straining screw (10). Slide rotor (6) onto shaft and magnet (4). Screw straining screw (10) into shaft end (tightening torque 85 Nm).
- Slide pulley over the pin screws of the clutch and screw down with nuts (7) (tightening torque 25 Nm).

Montage

Attention !
Serrer les vis et les écrous avec le couple de serrage requis.

- Fixer l'aimant (4) au carter. Introduire les vis (5) et serrer en croix (couple de serrage 25 Nm).
- Monter clavette disque (2).
- Huiler la vis de tension (10). Glisser le rotor (6) sur l'arbre et l'aimant (4). Introduire la vis de tension (10) en bout d'arbre et serrer (couple de serrage 85 Nm).
- Glisser la poulie au-dessus des goujons de l'embrayage et fixer avec les écrous (7) (couple de serrage 25 Nm).

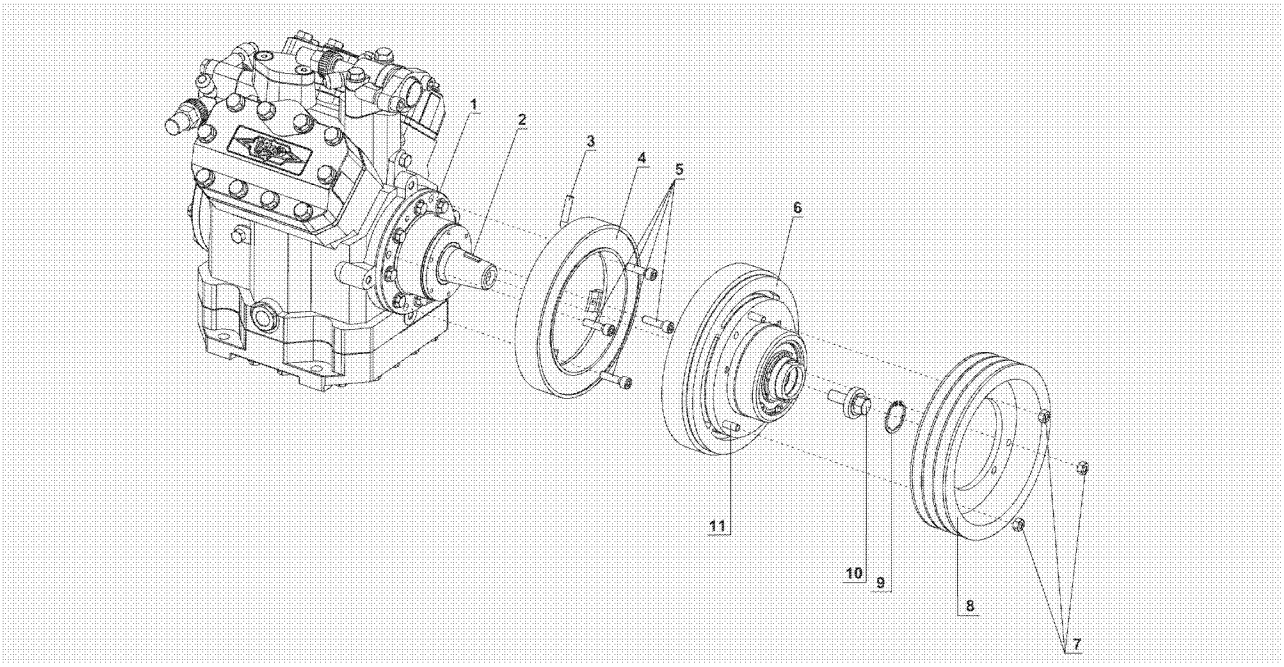


Abb. 2 Elektromagnet-Kupplung montieren

1 Lagerflansch
2 Scheibenfeder
3 Kabel
4 Magnet
5 Schrauben M8x30 DIN 912
6 Rotor
7 Muttern M8
8 Riemenscheibe
9 Seeger-K-Ring JK36 DIN 984
10 Spannschraube
11 Stiftschrauben M8x20

Fig. 2 Mounting the electro-magnetic clutch

1 Bearing flange
2 Woodruff key
3 Cable
4 Magnet
5 Screws M8x30 DIN 912
6 Rotor
7 Nuts M8
8 Pulley
9 Seeger-K-ring
10 Straining screw
11 Pin screws M8x20

Fig. 2 Montage de l'embrayage électromagnétique

1 Couvercle de palier
2 Clavette disque
3 Câble
4 Aimant
5 Vis M8 x 30 DIN 912
6 Rotor
7 Ecrous M8
8 Poulie
9 Circlip JK36 DIN984
10 Vis de tension
11 Goujons M8x20

Achtung!
Riemenscheibe muss sich von Hand drehen lassen, ohne am Magnet zu schleifen!

- Kabel (3) anschließen (polungsunabhängig), dabei von heißen Teilen fernhalten (t_{max} = 105°C).

Anleitungen für den Austausch anderer Kupplungen auf Anfrage.

6.3 Wellenabdichtung austauschen

Warnung!
Verdichter kann unter Druck stehen!
Bei unsachgemäßen Eingriffen sind schwere Verletzungen möglich.
Verdichter auf **drucklosen** Zustand bringen.

Vorbereitende Arbeiten

- Verdichter auf drucklosen Zustand bringen (siehe 6.1)
- Magnetkupplung entfernen (siehe 6.2).

Wellenabdichtung ausbauen

- Befestigungsschrauben des Abschlussdeckels herausdrehen.
- Zwei dieser Schrauben in die Abdrückgewinde eindrehen und durch gleichmäßiges Anziehen den Abschlussdeckel vom Gehäuse abdrücken.
- Abschlussdeckel mit der Hand von der Welle abziehen. Durch die innen am Abschlussdeckel sitzende Dichtscheibe wird meistens auch das rotierende Teil der Wellenabdichtung mit herausgezogen.
- Bleibt nach Abziehen des Abschlussdeckels die Dichtscheibe auf der Welle, rotierendes Teil der Wellenabdichtung und Dichtscheibe von Hand von der Welle abziehen.
- Gegenring der Wellenabdichtung aus dem Abschlussdeckel herausdrücken, ggf. mit leichten Hammerschlägen.

Achtung!
Dichtring am Abschlussdeckel nicht beschädigen!

- Bandage und Filzring entfernen.

Attention!
You must be able to turn the pulley by hand without it rubbing against the magnet!

- Connect cable (3) (polarity is irrelevant here), and keep away from hot parts (t_{max} = 105°C).

Instructions for replacing other clutches upon request.

6.3 Replacement of shaft seal

Warning!
The compressor may be under pressure!
Incorrect handling can lead to serious injuries.
Relieve the compressor of pressure.

Preparatory tasks

- Relieve the compressor of pressure (see 6.1)
- Remove magnetic clutch (see 6.2).

Remove shaft seal

- Screw out the fastening screws of the sealing cover.
- Screw in two of these screws into the forcing thread and, by pulling evenly, push the sealing cover away from the housing.
- Pull off the sealing cover from the shaft by hand. The rotating part of the shaft seal is usually pulled off along with the sealing cover because of sticking to the interior blanking plate.
- If after pulling off the sealing cover the blanking plate remains on the shaft, remove the rotating part of the shaft seal and the blanking plate from the shaft by hand.
- Push the stationary ring of the shaft seal out of the sealing cover, hitting it slightly with a hammer if necessary.

Attention!
Be careful not to damage the gasket ring on the sealing cover!

- Remove bandage and felt ring.

Attention !
La poulie doit pouvoir être tournée à la main sans frotter contre l'aimant!

- Raccorder le câble (3) (polarité ne joue aucun rôle), et le tenir à l'écart des parties chaudes (t_{max} = 105°C).

Instructions pour le remplacement d'autres embrayages sur demande.

6.3 Remplacer la garniture d'étanchéité

Avertissement !
Le compresseur peut être sous pression! Risque de blessures graves en cas d'interventions inappropriées.
Amener le compresseur à pression atmosphérique.

Travaux préliminaires

- Amener le compresseur à pression atmosphérique (voir 6.1).
- Retirer l'embrayage électromagnétique (voir 6.2).

Démonter la garniture d'étanchéité

- Dévisser les vis de fixation du couvercle de recouvrement.
- Introduire deux de ces vis dans les filetages de dégagement et serrer uniformément pour décoller le couvercle de recouvrement du carter.
- Glisser à la main le couvercle de recouvrement au-dessus de l'arbre. A cause du disque d'étanchéité plaqué à l'intérieur du couvercle de recouvrement, la partie tournante de la garniture d'étanchéité est généralement retirée avec.
- Si après le retrait du couvercle de recouvrement, le disque d'étanchéité est resté sur l'arbre, retirer celui-ci à la main ainsi que la partie tournante de la garniture d'étanchéité.
- Presser la bague fixe de la garniture d'étanchéité hors du couvercle de recouvrement; le cas échéant, avec des petits coups de maillet.

Attention !
Ne pas endommager la bague d'étanchéité du couvercle de recouvrement!

- Retirer le ruban de serrage et la bague feutre.

Teile überprüfen

- Abschlussdeckel, Dichtscheibe und Nut des Radialdichtrings reinigen.
- Befinden sich Ablagerungen auf der Welle, müssen diese entfernt werden. Hierzu Putztücher oder ölgetränkte Polierleinen (bzw. Schleifleinen mit Körnung 280 oder feiner) verwenden.
- Falls die Gleitringe beschädigt sind oder starke Verschleißspuren aufweisen, empfiehlt sich ein kompletter Wechsel; ebenso bei Cu-Plattierung und Ablagerungen von Ölkohle.
- Werden lediglich die O-Ringe erneuert, vor Einlegen neuer Ringe die entsprechenden Nuten sorgfältig reinigen und anschließend mit Kältemaschinenöl einölen.

Achtung!
Nur neue O-Ringe verwenden.

Examine the parts

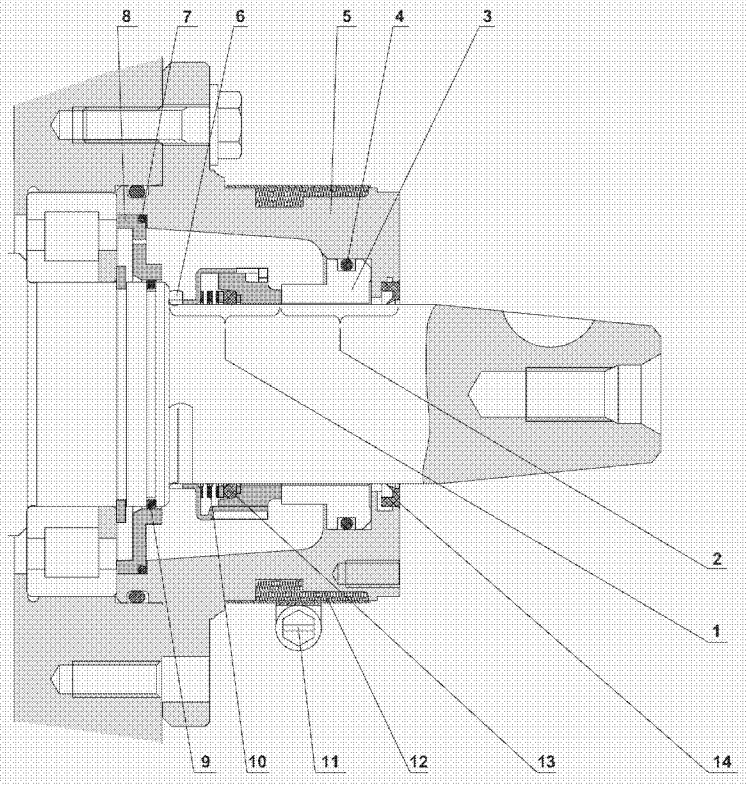
- Clean the sealing cover, blanking plate and groove of the radial gasket ring.
- If there are any deposits on the shaft, they must be removed. For this job, use cleaning cloths or oil-soaked polishing cloths (or sanding cloth with grain 280 or finer).
- If the sliding ring is damaged or heavily worn, it is recommended to make a complete replacement, likewise in the case of copper plating and oil carbon deposits.
- If only the O-rings are replaced, carefully clean their respective grooves before inserting new rings and lubricate thereafter with refrigeration compressor oil.

Attention!
Use only new O-rings.

Contrôler les pièces

- Nettoyer le couvercle de recouvrement, le disque d'étanchéité et la rainure de la bague d'étanchéité radiale.
- S'il y a des dépôts sur l'arbre, ceux ci doivent être enlevés. Utiliser pour cela des chiffons ou des toiles de polissage imbibées d'huile (respectivement des toiles abrasives avec un grain de 280 ou plus fin).
- Si les bagues de glissement sont endommagées ou portent des traces apparentes d'usure, il est conseillé de procéder au remplacement complet; agir de même en cas de cuivrage ou de dépôts de calamine.
- S'il est prévu de ne remplacer que les joints toriques, nettoyer soigneusement les gorges concernées et huiler celles-ci avec de l'huile pour machines frigorifiques avant la pose des nouveaux joints.

Attention !
Ne réutiliser que des nouveaux joints toriques.



1 Rotierende Einheit
Rotating unit
Unité tournante
2 Statische Einheit
Stationary unit
Unité statique
3 Statischer Gleitring (Gegenring)
Static sliding ring (stationary ring)
Bague de glissement statique (bague fixe)
4, 7, 13 O-Ring
O-ring
Joint torique
5 Abschlussdeckel
Sealing cover
Couvercle de recouvrement
6 Stift
Pin
Téton
8 Dichtscheibe
Blanking plate
Disque d'étanchéité
9 Radialdichtring
Rotary shaft seal
Bague d'étanchéité radiale
10 Kohlering (rotierender Gleitring)
Carbon ring (rotating slide ring)
Bague en carbone (bague de glissement tournante)
11 Spannband
Tightening strap
Ruban de serrage
12 Filzring
Felt ring
Bague feutre
14 Radial-Wellendichtring
Rotary shaft gasket ring
Bague d'étanchéité radiale de l'arbre

Abb. 3 Schnitt durch die Wellenabdichtung

Fig. 3 Cross-section of the shaft seal

Fig. 3 Garniture d'étanchéité en coupe

Achtung!
Gleitringe sind bruchempfindlich. Ersatz-Wellenabdichtung bis unmittelbar vor dem Einbau in der Schutzfolie belassen. Gleitflächen nicht berühren.

Attention!
Sliding rings are susceptible to breakage. Keep the replacement shaft seal inside its protective foil until immediately before installing. Do not touch the sliding faces.

Attention !
Les bagues de glissement sont fragiles. Garder la garniture d'étanchéité de rechange de son emballage jusqu'au dernier moment. Ne pas toucher les surfaces de glissement.

Wellenabdichtung einbauen

Achtung!
Schrauben und Muttern mit vorgeschriebenen Drehmomenten anziehen.

- Neuen Radialdichtring (9) in die Nut der Welle einlegen.
- Neuen O-Ring (7) in die Aussparung der Dichtscheibe (8) einlegen. Dichtscheibe auf die Welle schieben, Ölbohrung oben. Der O-Ring muss in Richtung Wellenende zeigen.
- Neues rotierendes Teil der Wellenabdichtung innen mit sauberem Kältemaschinenöl einölen und mit leichter Drehung auf die Welle aufschieben. Bis zum Anschlag auf den Wellenbund drücken. Dabei beachten, dass der auf der Welle sitzende Stift in die Aussparung einrastet.
- Neuen Gegenring in den Abschlussdeckel eindrücken. Dichtfläche nicht beschädigen!
- Neuen O-Ring (4) in die Nut des Abschlussdeckels einlegen. Abschlussdeckel auf die Welle schieben und durch gleichmäßiges Anziehen der Schrauben montieren (Anzugsmoment 25 Nm). Die Austrittsbohrung des Lecköls muss sich in der 1-Uhr-Stellung befinden.
- Neuen Filzstreifen und Spannband montieren.
- Verdichterwelle einige Umdrehungen von Hand durchdrehen
- Verdichter evakuieren.
- Absperrventile öffnen – zunächst saugseitig – und anschließend Dichtheitsprüfung vornehmen.
- Dichtheitsprüfung durchführen.
- Magnetkupplung montieren (siehe 6.2).

Mounting the shaft seal

Attention!
Tighten bolts and nuts with the specified torques.

- Place the new radial gasket ring (9) into the groove of the shaft.
- Place the new O-ring (7) into the recess of the blanking plate (8). Slide the blanking plate onto the shaft, oil bore pointing up. The O-ring must point in the direction of the shaft end.
- Lubricate the inside of the new rotating part of the shaft seal with clean refrigeration compressor oil, and slide it onto the shaft with a slight turn. Press onto the shaft collar up to the stop. Be sure that the pin on the shaft engages in the recess.
- Press the new stationary ring into the sealing cover. Do not damage the sealing surface!
- Place the new O-ring (4) into the groove of the sealing cover. Slide the sealing cover onto the shaft and mount by tightening the screws evenly (tightening torque 25 Nm). The outlet bore for the oil leakage must be in 1 o'clock position.
- Mount new felt tape and tightening strap.
- Rotate the compressor shaft a few revolutions by hand.
- Evacuate compressor.
- Open shut-off valve – first on the suction side – and afterwards carry out the tightness test.
- Perform a tightness test.
- Mount magnetic clutch (see 6.2).

Remonter la garniture d'étanchéité

Attention !
Resserrer les vis et les écrous avec les couples de serrage indiqués.

- Introduire la nouvelle bague d'étanchéité radiale (9) dans la gorge de l'arbre.
- Poser le nouveau joint torique (7) dans l'évidement du disque d'étanchéité (8). Glisser le disque d'étanchéité sur l'arbre, trou de passage de l'huile en haut. Le joint torique doit montrer sur le bout de l'arbre.
- Huiler la nouvelle partie tournante de la garniture d'étanchéité avec de l'huile pour machines frigorifiques propre, puis la glisser sur l'arbre avec une légère rotation. La pousser jusqu'à ce qu'elle bute sur l'épaulement de l'arbre. Veillez à ce que le téton fixé sur l'arbre vienne s'introduire dans l'évidement.
- Presser la nouvelle bague fixe dans le couvercle de recouvrement. Veiller à ne pas détériorer la surface d'étanchéité!
- Poser le nouveau joint torique (4) dans la gorge du couvercle de recouvrement. Glisser le couvercle de recouvrement sur l'arbre et le fixer en serrant uniformément les vis (couple de serrage 25 Nm). La position du percement pour l'évacuation de l'huile de fuite doit se trouver à 1 heure.
- Monter une nouvelle bande feutre et un nouveau ruban de serrage.
- Tourner plusieurs fois l'arbre du compresseur à la main.
- Mettre le compresseur à vide.
- Ouvrir les vannes d'arrêt – d'abord à l'aspiration – puis procéder à l'essai d'étanchéité.
- Effectuer l'essai d'étanchéité.
- Monter l'embrayage électromagnétique (voir 6.2).

6.4 Lagerdeckel / Ölpumpe austauschen (Abb. 1, Seite 4)

Teile nur austauschen, falls tatsächlich ein Schaden an der Ölpumpe oder starker Verschleiß des Wellenlagers festgestellt wird.

Achtung!
Ungenügender Öldruck kann auch durch hohe Kältemittelanreicherung im Öl oder Ölverlagerung ins System verursacht werden.
Überprüfung siehe 5.1.

- Verdichter auf drucklosen Zustand bringen (siehe 6.1).
- Ölpumpendeckel lösen, Ölpumpe (12) entnehmen.
- Lagerdeckel (11) und Dichtung entfernen.
- Alle Teile reinigen. Ölpumpe, Öldruckregulierventil und Lagerfläche prüfen, ggf. austauschen.
- Lagerdeckel mit neuer, nicht eingeölter Dichtung montieren. Schrauben gleichmäßig über Kreuz anziehen.
- Innenläufer, Außenläufer und Umsteuergehäuse der Ölpumpe einölen und so auf die Welle schieben, dass der Innenläufer in die Nut der Welle greift.
- Ölpumpendeckel mit neuem O-Ring montieren. Dabei muss die TOP-Markierung nach oben zeigen und das Umsteuergehäuse in die Aussparung des Deckels greifen.

6.4 Bearing cover / oil pump replacement (Fig. 1, page 4)

Only replace the parts if damage to the oil pump or extreme wear of the shaft bearing has actually been detected.

Attention!
Insufficient oil pressure can also be caused by a too high refrigerant concentration in the oil or oil migration in the system.
For checking, see 5.1.

- Relieve the compressor of pressure (see 6.1).
- Remove the oil pump cover; remove oil pump (12).
- Remove bearing cover (11) and gasket.
- Clean all parts. Check oil pump, oil pressure regulating valve and bearing surface, replace if necessary.
- Mount bearing cover with a new, not lubricated gasket. Screw the bolts in crosswise and tighten them uniformly
- Lubricate the inner and outer rotors along with the reversing part of the oil pump and slide onto shaft so that the inner rotor finds its way into the shaft groove.
- Mount oil pump cover with new O-ring. The TOP marking must point upwards and the reversing part reach into the recess of the cover.

6.4 Remplacer le couvercle de palier / la pompe à huile (fig. 1, page 4)

Ne remplacer ces pièces que si vraiment un dégât à la pompe à huile ou une forte usure du palier de l'arbre a été constaté.

Attention !
Une pression d'huile insuffisante peut être due à une concentration élevée de fluide frigorigène dans l'huile ou à une migration dans le système. Contrôle voir 5.1.

- Amener le compresseur à pression atmosphérique (voir 6.1).
- Démonter le couvercle de la pompe à huile puis retirer celle-ci (12).
- Retirer le couvercle de palier (11) et le joint.
- Nettoyer toutes les pièces. Contrôler la pompe à huile, la vanne de régulation de la pression d'huile et la surface du palier; les remplacer le cas échéant.
- Remonter le couvercle de palier doté d'un nouveau joint qui n'aura pas été huilé. Serrer les vis en croix, de façon uniforme.
- Huiler le pignon interne, le pignon externe et le boîtier d'inversion de la pompe et glisser sur l'arbre de façon à ce que le pignon interne prenne prise dans la gorge de l'arbre.
- Remonter le couvercle de la pompe à huile doté d'un nouveau joint torique. S'assurer que le marquage TOP montre vers le haut et que le boîtier d'inversion prend prise dans l'évidement du couvercle.

6.5 Druckentlastungsventil austauschen

Das Druckentlastungsventil (S. 4, Abb. 1, Pos. 6) ist eine Sicherheitseinrichtung und muss nach Ansprechen sowie bei Defekt ausgetauscht werden.

Der Öffnungsbeginn des Ventils liegt bei 26 bar Differenzdruck. Wenn das Ventil bei niedrigerem Druck auslöst, hat es vermutlich bereits mehrfach geöffnet. In diesem Fall muss zunächst die Ursache für den häufig auftretenden Überdruck beseitigt werden, bevor das Ventil ausgetauscht wird (z.B. geschlossenes Druckabsperrventil beim Start, blockierte Rückschlagventile oder Flüssigkeitsverlagerung in den Zylinderkopf durch Rückkondensation).

- Verdichter auf drucklosen Zustand bringen (siehe 6.1).
- Blindflansch (oder das alternativ dort montierte Saugabsperrventil und der Saugfilter) über Ölpumpe entfernen.
- Druckentlastungsventil austauschen (Schlüsselweite SW 22).

6.5 Replacement of pressure relief valve

The pressure relief valve (p. 4, Fig. 1, pos. 6) is a safety device and must be replaced after having been triggered or when defective.

The valve starts to open at a differential pressure of 26 bar. If the valve opens at a lower pressure, it probably means that it has opened before. In this case, it is necessary to first eliminate the cause of the frequently occurring overpressure before substituting the valve (e.g., closed pressure shut-off valve at startup, blocked check valve or liquid migration into the cylinder head by back condensation).

- Relieve the compressor of pressure (see 6.1).
- Remove the blind flange (or the optionally mounted suction shut-off valve and the suction filter) above the oil pump.
- Replace pressure relief valve (jaw span SW 22).

6.5 Remplacer la soupape de décharge

La soupape de décharge (page 4, fig. 1, pos. 6) est un organe de sécurité et doit être remplacée après avoir été sollicitée ou en cas de défaut.

Le début de l'ouverture de la soupape se situe aux alentours de 26 bar de pression différentielle. Si la soupape déclenche à une pression inférieure, elle a probablement été sollicitée plusieurs fois auparavant. Dans ce cas, il faut d'abord remédier à la cause de cette surpression répétitive avant de remplacer la soupape (par ex. vanne d'arrêt au refoulement fermée au démarrage, clapets de retenue bloqués ou migration de liquide dans les têtes de culasse par retour de condensation).

- Amener le compresseur à pression atmosphérique (voir 6.1).
- Retirer la bride pleine au-dessus de la pompe (ou la vanne d'arrêt et le filtre d'aspiration qui peuvent être à cet endroit).
- Remplacer la soupape de décharge (taille de la clé: SW 22).

6.6 Ventilplatte / Zylinderkopf-dichtung austauschen

- Verdichter in drucklosen Zustand bringen.
- Zylinderkopf und Ventilplatte demontieren (ggf. mit Gummihammer lösen). Alle Dichtflächen sorgfältig reinigen.
- Ventilplatte prüfen, bei Schäden komplett austauschen. Ursache ermitteln und beseitigen.
- Zylinderkopf, Ventilplatte und neue Dichtungen korrekt aufsetzen. In ungünstiger Einbaulage Montagestifte zur Hilfe nehmen.
- Schrauben in der dargestellten Reihenfolge in zwei Stufen anziehen (Anzugsmoment: 70 Nm, siehe Abbildung 4).

6.6 Replacement of valve plate / cylinder head gasket

- Relieve the compressor of pressure.
- Dismount cylinder head and valve plate (using a rubber hammer, if necessary). Carefully clean all sealing surfaces.
- Check valve plate; exchange entire valve plate if damaged. Determine the cause and eliminate it.
- Correctly mount the cylinder head, valve plate and new gaskets. If located in an inconvenient mounting position, use the mounting pins.
- Tighten the bolts in the illustrated sequence in two steps (tightening torque: 70 Nm, see Figure 4).

6.6 Remplacer la plaque à clapets / le joint de tête de culasse

- Amener le compresseur à pression atmosphérique.
- Démonter la tête de culasse et la plaque à clapets (décoller, si nécessaire, avec un maillet en caoutchouc). Nettoyer soigneusement toutes les surfaces d'étanchéité.
- Contrôler la plaque à clapets; à remplacer entièrement en cas de dégâts. Déterminer la cause et y remédier.
- Repositionner correctement les nouveaux joints, la plaque à clapets et la tête de culasse. En cas de position de montage difficile, utiliser des guides de montage.
- Serrer les vis en deux étapes, dans l'ordre indiqué (couple de serrage: 70 Nm, voir figure 4).

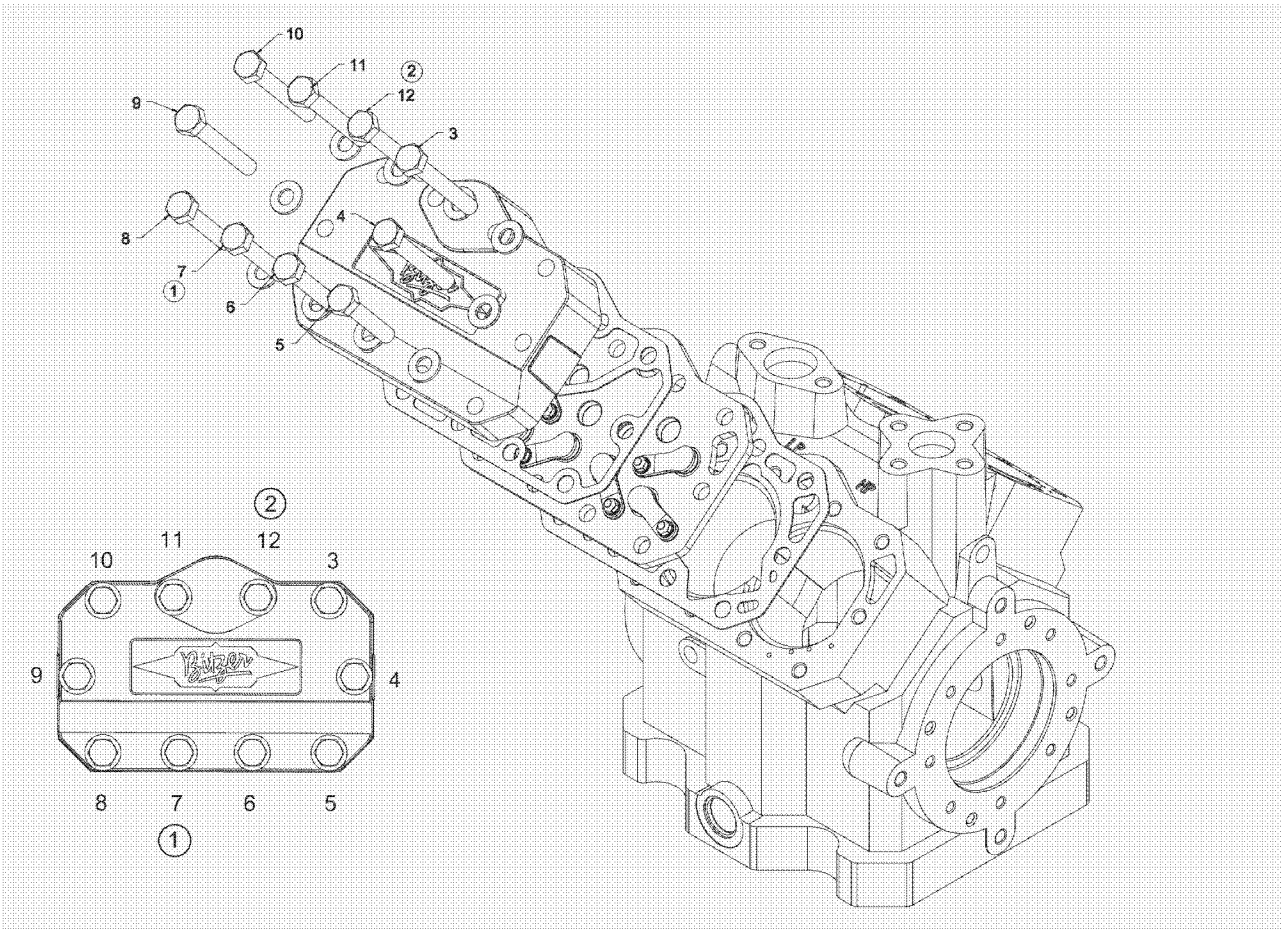


Abb. 4 Ventilplatte / Zylinderkopf dichtung austauschen

Fig. 4 Replacement of valve plate / cylinder head gasket

Fig. 4 Remplacer la plaque à clapets / le joint de tête de culasse

6.7 Leistungsregelung prüfen / austauschen (Zubehör)

- Elektrische Prüfung der Spule, ggf. austauschen.

Zur eventuell erforderlichen Überprüfung der Mechanik Flansch bei drucklosem Verdichter vom Zylinderkopf abmontieren und in folgenden Punkten prüfen:

- Prüfung der Gaskanäle auf Verstopfung, ggf. reinigen.
- Steuerkolben im Zylinderkopf muss sich manuell bewegen lassen und durch Federkraft in Ausgangsstellung zurückgehen. Im Regelfall empfiehlt sich bei Defekt ein kompletter Austausch des Zylinderkopfes.

7 Komplette Überholung des Verdichters

7.1 Demontage des Verdichters

Verdichter zerlegen (Abb. 5)

Wenn nach langer Laufzeit Verschleißerscheinungen bemerkbar werden, empfiehlt sich im Regelfall der Austausch des Verdichters. Sollte im Einzelfall eine komplette Überholung des Verdichters vor Ort vorgezogen werden, den Verdichter nach folgender Anleitung demontieren.

- Verdichter durch Absaugen des Kältemittels drucklos machen und aus der Fahrzeuganlage ausbauen (siehe 6.1).

⚠ **Sicherheitshinweis!**
Montagearbeiten an Verdichtern, die unter Überdruck stehen, können schwerwiegende Verletzungen zur Folge haben.

- Magnetstopfen (29) öffnen und Öl ablassen. Ölfilter (27) entfernen.
- Ausbau der Wellenabdichtung: siehe Abschnitt 6.3.
- Seegerring (47), Dichtscheibe (67), O-Ring (66) und Gleitring (6) entfernen.
- Absperrventile SL (4), DL (5) einschließlich der Zwischenflansche abschrauben, Saugfilter (33) herausnehmen.
- Zylinderköpfe / Ventilplatten entfernen: siehe Abschnitt 6.6, ggf. Leistungsregler entfernen: siehe Abschnitt 6.7.

6.7 Check / replace capacity control (accessory)

- Electrical check of the coil, replace if necessary.

In the event of having to check the mechanics, remove the flange from the cylinder head while the compressor is relieved of pressure, and check the following points:

- Check the gas channels for clogging, clean if necessary.
- The control piston in the cylinder head must be able to be moved by hand and to go back to its initial position by spring force. Generally, it is recommended to change the complete cylinder head in case of defect.

7 Complete overhaul of the compressor

7.1 Dismounting the compressor

Disassemble compressor (Fig. 5)

When signs of wear become noticeable after a longer running time, it is generally recommended to replace the compressor. Should it be preferred in individual cases to make a complete overhaul of the compressor, dismount the compressor according to the following directions.

- Relieve the compressor of pressure by extracting the refrigerant and remove it from the vehicle unit (see 6.1).

⚠ **Safety instruction!**
Performing mounting tasks on compressors that are under overpressure can lead to serious injuries.

- Open magnetic plug (29) and drain off oil. Remove oil filter (27).
- Dismount the shaft seal: see section 6.3.
- Remove Seeger ring (47), blanking plate (67), O-ring (66) and sliding ring (6).
- Screw off shut-off valve SL (4), DL (5) together with the intermediate flanges; remove suction filter (33).
- Remove cylinder heads / valve plates: see section 6.6, remove capacity regulator, if necessary: see section 6.7.

6.7 Contrôler/ remplacer la régulation de puissance (accessoire)

- Contrôle électrique de la bobine; remplacer le cas échéant.

En vue d'un éventuel contrôle, retirer la bride mécanique de la tête de culasse après avoir amené le compresseur à pression atmosphérique, et vérifier les points suivants:

- Contrôler que les canaux de gaz ne sont pas obturés; nettoyer le cas échéant.
- Le piston de commande dans la tête de culasse doit pouvoir être bougé manuellement et doit revenir dans sa position initiale sous l'effet du ressort. En cas de défaut, le remplacement complet de la tête de culasse est généralement préconisé.

7 Remise en état complète du compresseur

7.1 Démontage du compresseur

Mettre le compresseur en pièces (fig. 5)

Si des signes d'usure apparaissent après une longue durée de fonctionnement, il est généralement recommandé de remplacer le compresseur. Dans le cas spécifique d'une remise en état complète sur site, démonter le compresseur en se référant aux instructions suivantes:

- Amener le compresseur à pression atmosphérique par retrait du fluide frigorigène et l'extraire du circuit (voir 6.1).

⚠ **Recommandation de sécurité !**
Des travaux de montage sur des compresseurs sous pression peuvent engendrer de graves blessures.

- Ouvrir le bouchon magnétique (29) et faire la vidange d'huile. Retirer le filtre à huile (27).
- Démontage de la garniture d'étanchéité: voir paragraphe 6.3.
- Retirer le circlip (47), le disque d'étanchéité (67), le joint torique (66) et la bague de glissement (6).
- Dévisser les vannes d'arrêt, asp. (4) et ref. (5), avec les brides intermédiaires et extraire le filtre d'aspiration (33).
- Retirer les têtes de culasse / plaques à clapets: voir paragraphe 6.6; le cas échéant, retirer le régulateur de puissance: voir paragraphe 6.7.

- Ölpumpe / Lagerdeckel entfernen: siehe Abschnitt 6.4.
- Bodenplatte (31) abschrauben.
- Welle (11) und Pleuel/Kolben (7) entfernen: Ausgleichsgewicht (51) abschrauben, Welle unter Drehen herausziehen (nicht verkanten), Pleuel/Kolben nach unten herausziehen.
- Zylinderlaufbuchse aus Zylinderbohrung nach oben herausziehen (für Wiederverwendung Position kennzeichnen).
- Blindflansch (34) und Druckentlastungsventil (40) entfernen.
- Gasausgleichsventil (48) und Schauglas (30) entfernen.
- Zylinderrollenlager (12) mit geeigneter Vorrichtung aus dem Gehäuse drücken.
- Innenring des Zylinderrollenlagers unter Erwärmung von der Welle (11) abziehen.

- Remove oil pump / bearing cover: see section 6.4.
- Screw off the bottom plate (31).
- Remove shaft (11) and connecting rod/piston (7). Screw off balance weight (51), pull out the shaft while turning (avoid jamming), pull out connecting rod/piston downwards.
- Pull out the cylinder sleeve from the cylinder bore towards the top (mark the position for re-use)
- Remove the blind flange (34) and pressure relief valve (40).
- Remove the gas equalizing valve (48) and sight glass (30).
- Push the cylinder roller bearing (12) out of the housing using the appropriate device.
- Remove the inner ring of the cylinder roller bearing by heating up the shaft (11).

- Retirer la pompe à huile / couvercle de palier : voir paragraphe 6.4.
- Dévisser la plaque de fond (31).
- Retirer l'arbre (11) et les bielles / pistons (7) : dévisser le contrepoids d'équilibre (51), sortir l'arbre en le tournant (sans le coincer), extraire les bielles / pistons par le bas.
- Extraire par le haut les chemises de cylindre des alésages (en cas de réemploi, identifier leur position).
- Retirer la bride pleine (34) et la soupape de décharge (40).
- Retirer la soupape d'égalisation de pression des gaz (48) et le voyant (30).
- Avec un dispositif approprié, presser le roulement à rouleaux cylindriques (12) hors du carter.
- Retirer la bague interne du roulement à rouleaux cylindriques en réchauffant l'arbre (11).

7.2 Auf Schäden und Verschleiß prüfen

Nach vollständiger Demontage des Verdichters alle Teile sorgfältig auf Schäden und Verschleiß prüfen. Folgende Teile nach langer Laufzeit generell austauschen:

- Zylinderrollenlager, Lagerdeckel
- Kolben, Pleuel
- Ventilplatten
- Wellenabdichtung
- Öldruckregulierventil
- Druckentlastungsventil

Durch höchste Präzision bei der Fertigung sind Original-Ersatzteile von BITZER universell verwendbar; individuelle Zuordnung ist nicht erforderlich.

Dichtungen, O-Ringe und Schrauben grundsätzlich nicht wiederverwenden.

Bei der Wiederverwendung gebrauchter Teile die Toleranzbereiche sowie folgende Kriterien beachten:

7.2 Checking for damage and wear

After complete disassembling of the compressor, check all parts carefully for damage and wear. Generally replace the following parts after a longer running time:

- Cylinder roller bearing, bearing cover
- Piston, connecting rod
- Valve plates
- Shaft seal
- Oil pressure regulating valve
- Pressure relief valve

BITZER original spare parts can be used universally due to the highest precision during production; no individual allocation is necessary.

Basically, O-rings and screws are not to be reused.

When reusing used parts, observe the tolerance ranges and the following criteria:

7.2 Evaluer les dégâts et l'usure

Après démontage complet du compresseur, contrôler soigneusement toutes les pièces pour évaluer l'ampleur des dégâts et de l'usure. Après une longue durée de fonctionnement, remplacer systématiquement les pièces suivantes :

- Roulement à rouleaux cylindriques, couvercle de palier.
- Pistons, bielles.
- Plaques à clapets.
- Garniture d'étanchéité.
- Vanne de régulation de la pression d'huile.
- Soupape de décharge.

En raison de la grande précision de fabrication, les pièces de rechange originales de BITZER sont utilisables de façon universelle, une attribution spécifique n'est pas nécessaire.

Par principe, ne pas réutiliser les joints, les joints toriques et les vis.

Lors du réemploi des pièces déjà utilisées, prendre en considération les plages de tolérance et les critères suivants :

Zylinderlaufbuchsen

Das Honbild (Rautenmuster) muss noch deutlich sichtbar sein. Leichter Verschleiß in Form von gerade sichtbaren Spuren im Bereich des Kolbenweges ist noch zulässig.

Welle

Die Oberfläche der Lagerstellen muss vollkommen blank sein. Auf der Welle festsitzende Aluminiumpartikel mit Polierleinwand Körnung P280 entfernen. Dabei darf keinesfalls ein Materialabtrag von der Welle erfolgen. Der Ölkanal muss sauber sein.

Ölpumpe

Die Oberfläche darf nicht durch Fremdkörper o.ä. beschädigt sein. Räder und Umschaltvorrichtung müssen leichtgängig sein.

Ventilplatten

Schadhafte Ventilplatten generell komplett austauschen. Die Arbeitsventile/Ventilsitze dürfen nicht eingeschlagen sein. Die Ventillamellen dürfen nicht verbogen sein und müssen an der Platte anliegen. Unter den Lamellen dürfen keine Fremdkörper oder Ölkohle sein.

Druckentlastungsventil

Druckentlastungsventile, die einmal angesprochen haben, müssen getauscht werden. Die Ventile müssen bis zu 26 bar Differenzdruck dicht sein.

Gasausgleichsventil

Prüfen, ob Metallplättchen leicht beweglich ist, andernfalls komplett austauschen.

Bohrungen für Lagerbuchsen

Die Bohrungen sind meist noch in Ordnung, wenn die Buchse noch fest im Gehäuse sitzt. Hat sich die Buchse mit der Welle verschweißt und dabei in der Bohrung mitgedreht, ist das Gehäuse oder der Lagerdeckel nicht mehr verwendbar.

Cylinder sleeves

The honing pattern (diamond barring) must still be clearly visible. Slight wear in the form of slightly visible tracks in area of the piston path is still tolerable.

Shaft

The surfaces of the bearing locations must be perfectly smooth. Remove any aluminum particles stuck to the shaft with a polishing linen, grain P280. While doing so, no material is allowed to rub off from the shaft. The oil channel must be clean.

Oil pump

The surface must not be damaged by foreign objects, or the like. Wheels and switching device must run easily.

Valve plates

In general, replace defective valve plates completely. The working valves/valve faces must not be sunk in. The valve reeds must not be bent and must lie on the plate. No foreign bodies or oil carbon may be under the reeds.

Pressure relief valve

Pressure relief valves must be replaced when they have been triggered once. The valves must resist up to 26 bar differential pressure.

Gas equalizing valve

Check if the metal platelets are easily movable, otherwise replace entirely.

Bores for bearing bushes

The bores are, for the most part, still OK when the bush still fits tight in the housing. If the bush has bonded with the shaft and rotates along inside the bore, the housing or the bearing cover is no longer usable.

Chemises de cylindre

L'empreinte du honing (figures en losange) doit être nettement visible. Une usure légère sous forme de traces à peine visibles sur le trajet du piston est encore admissible.

Arbre

La surface à l'emplacement des paliers doit être vraiment nette. Retirer les particules d'aluminium qui adhérent à l'arbre avec une toile de polissage ayant un grain P280. Cette opération ne doit, en aucun cas, engendrer une abrasion de matière sur l'arbre. Le canal d'huile doivent être propres.

Pompe à huile

La surface ne doit pas être endommagée par des corps étrangers ou quelque chose de similaire. Le mouvement des pignons et du dispositif d'inversion doit être facile.

Plaques à clapets

Remplacer systématiquement les plaques à clapets endommagées complètes. Les soupapes de travail / les sièges de soupapes ne doivent pas être marqués par des chocs. Les lames de soupapes ne doivent pas être déformées et bien porter sur la plaque. Il ne doit pas y avoir de corps étrangers ou de la calamine sous les lames.

Soupape de décharge

Les soupapes de décharge qui ont été une fois sollicitées doivent être remplacées. Les soupapes doivent rester étanches jusqu'à 26 bar de pression différentielle.

Soupape d'égalisation de pression des gaz

Vérifier si le mouvement des plaquettes métalliques est facile, sinon remplacer complètement.

Alésages pour coussinets

Les alésages sont généralement en bon état si le coussinet est encore fermement calé dans son logement. Si le coussinet s'est collé sur l'arbre et a tourné dans l'alésage, alors le carter ou le couvercle de palier n'est plus réutilisable.

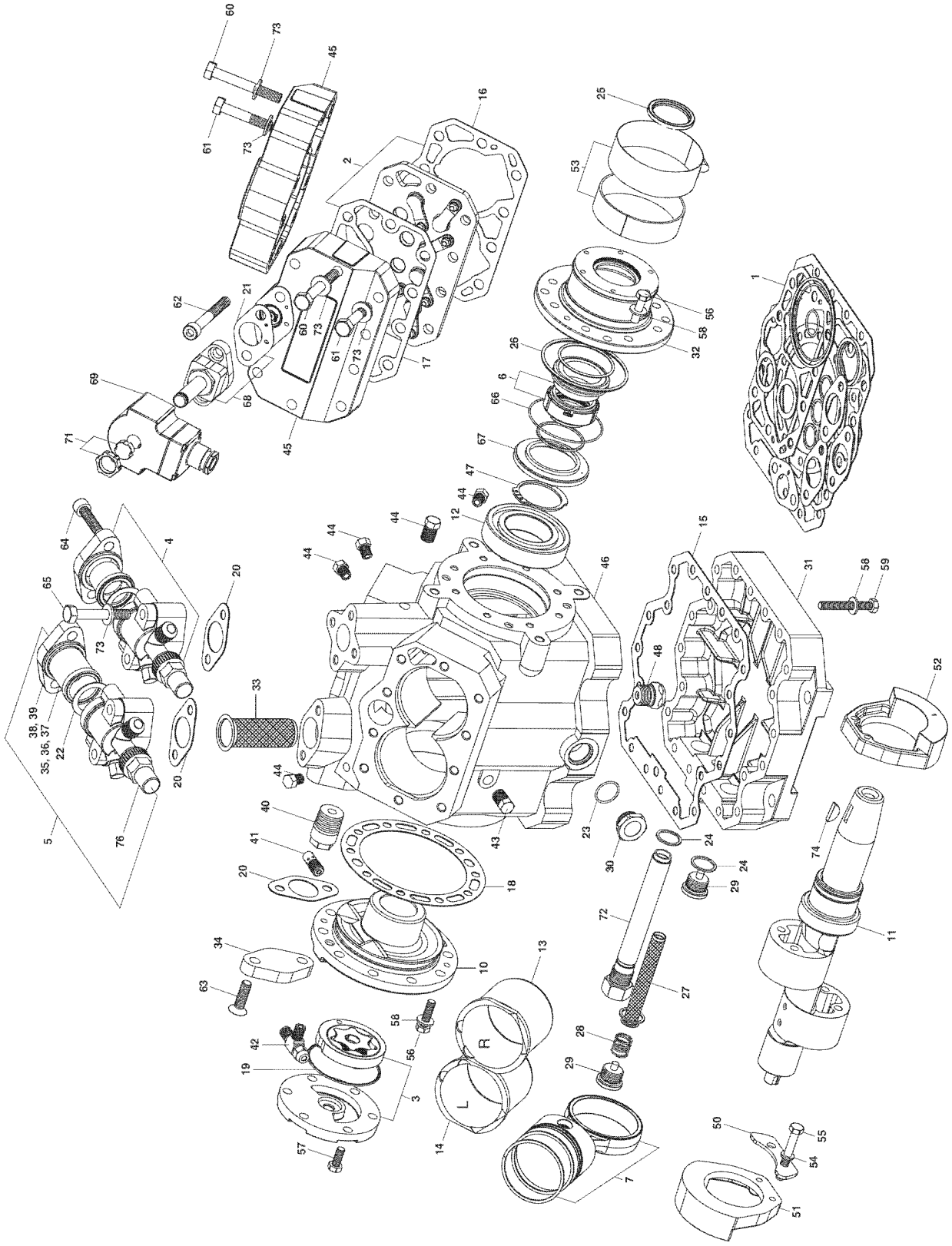


Abb. 5 Explosionsdarstellung 4UFC(Y) .. 4NFC(Y)

Fig. 5 Exploded view 4UFC(Y) .. 4NFC(Y)

Fig. 5 Vue éclatée 4UFC(Y) .. 4NFC(Y)

Lagerbuchsen

Verschleiß oder deutliche Einlaufspuren dürfen nicht vorhanden sein.

Bearing bushes

There must be no wear or visible scratch marks.

Coussinets

Il ne doit pas y avoir d'usure ou de traces distinctes de grippage.

Pleuel und Kolben

Die Pleuellager und die Oberfläche der Kolben sollen keinen Verschleiß aufweisen. Wir empfehlen diese Teile grundsätzlich durch Neuteile zu ersetzen.

Connecting rod and pistons

The connecting rod bearings and the surface of the pistons should show no sign of wear. We recommend replacing these parts principally by new parts.

Bielles et pistons

Aucune usure ne doit être perceptible sur les coussinets de bielle et à la surface des pistons. Nous recommandons de remplacer systématiquement ces pièces par des nouvelles.

7.3 Verdichter zusammenbauen

Achtung!
Grundsätzlich vor dem Wiedereinbau alle Teile sorgfältig prüfen und reinigen (Dichtungsreste entfernen). Bewegte Teile und Gleitflächen mit sauberem Kältemaschinenöl einölen. Asbestfreie Dichtungen und die entsprechenden Dichtflächen nicht einölen!
Schraubenverbindungen mit dem vorgeschriebenen Drehmoment anziehen.

- Innenring des Zylinderrollenlagers (12) auf Heizplatte oder in Ofen vorsichtig erwärmen und bis Anschlag auf Welle schieben.
- Zylinderrollenlager (12) mit geeigneter Vorrichtung in das Gehäuse (46) drücken.
- Gasausgleichsventil (48) und Schauglas (30) einschrauben.
- Druckentlastungsventil (40) und Blindflansch (34) einschrauben.
- Zylinderlaufbuchse von oben in Zylinderbohrung einsetzen (bei Wiederverwendung an ehemaliger Position).
- Pleuel/Kolben (7) und Welle (11) einsetzen: Pleuel/Kolben von unten mit Hilfe eines Montagerings in die Zylinder schieben, Welle mit Montagehülse unter Drehen einschieben (nicht verkanten), Ausgleichsgewicht (51) anschrauben.
- Bodenplatte (31) anschrauben.
- Lagerdeckel montieren: siehe 6.4.
- Gleitring (6), O-Ring (66) und Dichtring (67) einsetzen.

7.3 Assembling compressor

Attention!
Basically check and clean all parts carefully before reassembling (remove gasket remains). Lubricate moved parts and sliding faces with clean refrigeration compressor oil. Do not lubricate the asbestos-free gaskets and their respective sealing surfaces!
Tighten the screwed connections with the specified torque.

- Carefully heat up the inner ring of the cylinder roller bearing (12) on a hotplate or in an oven and slide it onto the shaft up to the stop.
- Push the cylinder roller bearing (12) into the housing (46) using the appropriate device.
- Screw in the gas equalizing valve (48) and sight glass (30).
- Screw in the pressure relief valve (40) and the blind flange (34).
- Insert the cylinder sleeve from above into the cylinder bore (when using again in the former position).
- Insert connecting rod/piston (7) and shaft (11): Push the connecting rod/piston from underneath into the cylinder with the help of a mounting ring; push in the shaft with mounting sleeve while turning (avoid jamming), screw on balance weight (51).
- Screw on the bottom plate (31).
- Mount bearing cover: see 6.4.
- Insert sliding ring (6), O-ring (66) and gasket ring (67).

7.3 Réassembler le compresseur

Attention !
Contrôler et nettoyer soigneusement toutes les pièces avant leur réemploi (ôter les restes de joint). Huiler les pièces mobiles et les surfaces de glissement avec une huile pour machines frigorifiques propre. Ne pas huiler les joints sans amiante et les surfaces d'étanchéité correspondantes! Serrer les raccords vissés avec le couple de serrage indiqué.

- Réchauffer prudemment la bague interne du roulement à rouleaux cylindriques (12) sur une plaque chauffante ou dans un four et glisser jusqu'à l'épaulement.
- Pousser le roulement à rouleaux cylindriques (12) avec un dispositif adapté dans le carter (46).
- Monter la soupape d'égalisation de la pression des gaz (48) et le voyant (30).
- Monter la soupape de décharge (40) et la bride pleine (34).
- Introduire par le haut la chemise de cylindre dans l'alésage du cylindre (en cas de réemploi, à sa position initiale).
- Introduire l'ensemble bielle / piston (7) et l'arbre (11): à l'aide d'une bague de montage, glisser par le bas l'ensemble bielle / piston dans le cylindre; avec une douille de montage, introduire l'arbre avec un mouvement de rotation (ne pas coincer); visser le contrepoids d'équilibrage (51).
- Visser la plaque de fond (31).
- Monter le couvercle de palier: voir 6.4.
- Mettre en place la bague de glissement (6), le joint torique (66) et la bague d'étanchéité (67).

- Seegerring (47) mit Montageglocke auf Welle schieben und mit Seegerringzange zusammendrücken.
- Einbau der Wellenabdichtung: siehe 6.3
- Ölpumpe montieren: siehe 6.4
- Ventilplatten / Zylinderköpfe montieren: siehe 6.6, ggf. Leistungsregler montieren: siehe 6.7.
- Saugfilter (33) einsetzen, Absperrventile SL (4), DL (5) einschließlich der Zwischenflansche anschrauben.
- Alle Magnetstopfen (29), Ölfilter (27) und ggf. Ölheizung einsetzen, Öl einfüllen.
- Kupplung montieren: siehe 6.2.
- Alle Schrauben mit dem vorgeschriebenen Drehmoment nachziehen.
- Leichtlauf der Welle durch Drehen mit Wellenschlüssel prüfen.
- Verdichter evakuieren.
- Verdichter in die Fahrzeuganlage einbauen, Probelauf.

- Slide the Seeger ring (47) onto the shaft by using the mounting bell and pinch with the circlip pliers.
- Install the shaft seal: see 6.3
- Mount oil pump: see 6.4
- Mount valve plates / cylinder heads: see 6.6, mount capacity regulator, if necessary: see 6.7.
- Insert suction filter (33), screw on shut-off valve SL (4), DL (5) along with the intermediate flanges.
- Insert all magnetic plugs (29), oil filters (27) and, if necessary, oil heater; fill with oil.
- Mount clutch: see 6.2.
- Tighten all screws with the specified torque.
- Check the easy running of the shaft by turning it with the shaft wrench.
- Evacuate compressor.
- Install the compressor into the vehicle unit, test run.

- Glisser le circlip (47) avec la bague de montage sur l'arbre et l'écraser avec la pince à circlip.
- Mise en place de la garniture d'étanchéité: voir 6.3.
- Monter la pompe à huile: voir 6.4.
- Monter les plaques à clapets / têtes de culasse: voir 6.6; le cas échéant, monter le régulateur de puissance: voir 6.7.
- Mettre en place le filtre d'aspiration (3), refixer les vannes d'arrêt asp. (4), ref. (5) avec les brides intermédiaires.
- Mettre en place tous les bouchons magnétiques (29), le filtre à huile (27) et le cas échéant, le chauffage carter; faire le remplissage d'huile.
- Monter l'embrayage: voir 6.2.
- Resserrer toutes les vis avec le couple de serrage indiqué.
- Faire tourner l'arbre avec une clé appropriée pour vérifier que la rotation est facile.
- Mettre le compresseur sous vide.
- Réinstaller le compresseur dans le système et effectuer les essais de fonctionnement.

8 Fehlerdiagnose

Die Einhaltung der in den Handbüchern angegebenen Empfehlungen gewährt einen zuverlässigen Betrieb und eine lange Lebensdauer des Verdichters.

Sollte es dennoch zu Betriebsstörungen und Schäden am Verdichter kommen, so lässt sich als Ursache meist eine wiederholte oder dauerhafte Überschreitung der zulässigen Einsatzbedingungen und/oder Schmierungsmangel feststellen. Es genügt daher nicht, das beschädigte Teil oder den Verdichter auszutauschen. Um schwere Folgeschäden oder den Totalausfall des Verdichters zu vermeiden, muss die eigentliche Ursache für die Störung gefunden und beseitigt werden.

Die häufigsten Funktionsstörungen bei Verdichtern sind:

- Sicherheitsabschaltung
- Leistungmangel
- Schmierungsmangel
- Bauteilschäden

Die nachfolgende Liste enthält die wichtigsten Ursachen für diese Störungen (Anordnung der Verdichterbauteile siehe Abb. 1).

8 Error diagnosis

Observing the recommendations given in the manuals ensures the dependable operation and a long service life of the compressor.

Should malfunctions and damages occur to the compressor despite this, it is usually due to the repeated or continually exceeding of the allowable operating conditions and/or a lack of lubrication. It is therefore not sufficient to change the damaged component or the compressor. To avoid further damages or repeated failure of the compressor, the actual cause for the malfunction must be found and eliminated.

The most frequently occurring compressor malfunctions are:

- Safety shutdown
- Lack of power
- Lack of lubrication
- Damaged to the components

The following list contains the most important causes for these faults (for the arrangement of the compressor components, see Fig. 1).

8 Diagnostic des défauts

Le respect des recommandations indiquées dans les manuels garantit un fonctionnement fiable et une longue durée de vie du compresseur.

La cause des incidents de fonctionnement et des dégâts sur le compresseur qui peuvent malgré tout se produire, est généralement un dépassement répétitif ou permanent des conditions d'application autorisées et / ou un manque de lubrification. Il ne s'agit donc pas de se contenter de remplacer la pièce défectueuse ou le compresseur. Afin d'éviter de gros défauts qui en seraient la conséquence, ou une nouvelle défaillance du compresseur, il faut rechercher la véritable cause du défaut et y remédier.

Les incidents de fonctionnement du compresseur les plus fréquents sont:

- Coupure par sécurité
- Manque de puissance
- Manque de lubrification
- Dégâts sur les composants

La liste suivante résume les principales causes de ces incidents (position des composants du compresseur, voir fig. 1).

Mögliche Ursachen	Maßnahmen, Hinweise
Sicherheitsabschaltung (Abschaltung des Verdichters durch Hoch-/Niederdruck-Wächter oder Druckgas-Temperaturfühler)	
zu niedriger Saugdruck	
• Fehlfunktion des TX-Ventils	• Funktion und Überhitzungseinstellung prüfen
• zu wenig Kältemittel	• Systemdichtheit prüfen, auf Mindeststand auffüllen
• Verdampferleistung ungenügend	• reinigen, bei Vereisung Ursache beheben, Lüfter prüfen
• Verdampfer mit Öl überfüllt / verölt	• Ölfüllmenge reduzieren
• Saugfilter verstopft oder Drosselstelle in Saugabsperrventil, Flüssigkeits- oder Saugleitung	• Ursache beseitigen, ggf. Filterwechsel
zu hoher Saug- / Verflüssigungsdruck	
• Verflüssigerleistung ungenügend	• reinigen, Lüfter prüfen
• zu viel Kältemittel	• auf Mindeststand reduzieren
• Fremdgas	• entlüften (siehe Betriebsanleitung)
• Druckabsperrventil gedrosselt	• vollständig öffnen
• Rückschlagventil in Druckgasleitung defekt oder zu geringe Leistung	• austauschen
zu hohe Druckgas- / Öltemperatur	(Druckgas: Druckrohr außen max. 120°C, Öl: Kurbelgehäuse außen max. 80°C (blanke Stelle))
• zu wenig Kältemittel	• Systemdichtheit prüfen, auf Mindeststand auffüllen
• Bypass zwischen Hoch- und Niederdruck	• Druckentlastungsventil prüfen/austauschen, Anlage prüfen
• Fremdgas	• entlüften (siehe Betriebsanleitung)
defekte / undichte Arbeitsventile	
• Ventil / Dichtungssteg gebrochen	• reparieren, Ursache beseitigen. Ventilbruch meist durch Flüssigkeitsschläge wegen zu viel Kältemittel, zu viel Öl oder fehlerhafter Regelung des TX-Ventils; bei Druckventilbruch Gefahr von Pleuellagerschäden
• Verschmutzung (Ölkohle, Fremdpartikel)	• reinigen / austauschen, Ursache beseitigen. Ölkohle meist durch zu hohe Betriebstemperatur oder Fremdgas
undichte Zylinderkopfdichtung	• austauschen (asbestfreie Dichtungen **nicht** einölen!)
Leistungsmangel (Verdichter liefert zu wenig Kälteleistung)	
zu niedriger Saugdruck	• siehe "Sicherheitsabschaltung"
zu geringer Druckaufbau	
• defekte / undichte Arbeitsventile	• siehe "Sicherheitsabschaltung"
• Kolbenringe / Laufbuchse verschlissen	• Kolben/Pleuel und Laufbuchse austauschen
• undichte Zylinderkopfdichtung	• austauschen (asbestfreie Dichtungen **nicht** einölen!)
• Bypass zwischen Hoch- und Niederdruck	• Druckentlastungsventil prüfen/austauschen, Anlage prüfen
• Leistungsregler blockiert	• reparieren / austauschen
abnormale Betriebsbedingungen	
• zu geringe / zu hohe Überhitzung	• siehe "Sicherheitsabschaltung"
• Einsatzgrenzen überschritten	• siehe "Sicherheitsabschaltung"
• Fremdgas	• entlüften (siehe Betriebsanleitung)
• zu wenig / zu viel Kältemittel	• auf Mindestmenge auffüllen / reduzieren
• zu viel Öl	• Ölmenge reduzieren

Mögliche Ursachen	Maßnahmen, Hinweise
Schmierungsmangel (Abschaltung durch Öldruck-Wächter (falls vorhanden) oder Schäden an Gleitflächen und Lagern)	
zu wenig Öl, Ölabwanderung	
• großes Anlagenvolumen	• nachfüllen, über längere Betriebszeit kontrollieren
• ungenügende Gasgeschwindigkeit (Steigleitungen)	• über längere Betriebszeit bei Minimaldrehzahl kontrollieren ggf. Änderung der Rohrführung
zu niedrige Ölviskosität durch Kältemittelanreicherung	
• Verdichter im Stillstand kälter als Verdampfer	• ggf. Magnetventil in Flüssigkeitsleitung und Rückschlagventil in Druckleitung erforderlich
• zu viel Kältemittel	• auf Mindeststand reduzieren
• undichtes Magnetventil in Flüssigkeitsleitung	• reparieren / austauschen
• ungenügende Flüssigkeitsabscheidung beim Start	• Saugleitung mit „Schwanenhals", ggf. Flüssigkeitsabscheider
• zu geringe Sauggasüberhitzung oder starkes Pendeln im Betrieb	• Überhitzungseinstellung mind. 6 .. 7 K, ggf. Position oder Befestigung des Fühlers korrigieren
zu hohe Öltemperatur	
• undichte / defekte Arbeitsventile	• siehe "Sicherheitsabschaltung"
• verschlissene Kolbenringe	• austauschen, Kolben und Zylinder prüfen
Öl nicht mehr schmierfähig	
• verschmutzt durch Abrieb oder Fremdstoffe	• Magnetstopfen, Ölsieb und Bodenplatte kontrollieren, Ölwechsel (evtl. mehrfach), Ursache beseitigen
• chemisch zersetzt, erhöhter Feuchtigkeitsgehalt	• Säure-/Feuchtigkeitsgehalt kontrollieren, auf Verkokungsrückstände (Ventilplatte) und Cu-Plattierung (Gleitflächen, Ventilplatte) prüfen, Öl- und Trockner wechseln (evtl. mehrfach), Ursachen beseitigen (Schlauchverbindungen mit erhöhter Durchlässigkeit erneuern)
Ölpumpe / Öldruckregulierventil defekt	• reparieren / austauschen
zu niedriger Ansaugdruck der Ölpumpe	
• Ölsieb verstopft	• reinigen, Öl wechseln, bei Verschleiß evtl. Verdichter austauschen
• Saugfilter verstopft	• reinigen, Ursache beseitigen
Bauteilschäden (Verdichter läuft trotz Anforderung und Antrieb nicht, nur schwergängig o. mit ungewöhnlichen Geräuschen)	
Bauteile im Verdichter defekt	
• Überlastung, Flüssigkeitsschläge	• reparieren / austauschen, Ursache beseitigen
• Schmierungsmangel	• reparieren / austauschen, Ursache beseitigen
• üblicher Verschleiß	• reparieren / austauschen
Magnetkupplung defekt	
• Magnet überlastet	• austauschen, Ursache (z.B. Spannungsabfall an korrodierten Anschlussklemmen) beseitigen
• Lager überlastet, zu hohe Riemenvorspannung, zu kurze Taktzyklen	• austauschen, Ursache beseitigen
Wellenabdichtung undicht	(Leckölmenge bis ca. 0,05 cm^3/h innerhalb Toleranz)
• Schmierungsmangel	• austauschen, Abhilfe siehe „Schmierungsmangel"
• Überhitzung (Verhärtungen, Risse, Ölkohle)	• austauschen, Ursache beseitigen
• starke Schwingungen (lockere Kupplung, nicht fluchtender Riemenantrieb, ungleichförmiger Antrieb)	• austauschen, Ursache beseitigen
• zu starke Riemenvorspannung	• Riemenspannung einstellen

Possible reasons	Measures, recommendations
Safety cut-out (Compressor cuts out due to LP/HP pressure switch or discharge gas sensor)	
suction pressure too low	
• faulty TX valve function	• check function and superheat setting
• insufficient refrigerant charge	• check system for leaks, charge to minimum level
• insufficient evaporator capacity	• clean, if iced-up cure the cause, check fan
• excessive oil in evaporator	• reduce oil charge
• Suction filter blocked or throttling in suction shut-off valve, liquid or suction line	• cure cause, possibly change filter
suction / condensing pressure too high	
• insufficient condenser capacity	• clean, check fan
• too much refrigerant	• reduce to minimum level
• foreign gas	• purge (see operating instruction)
• discharge shut-off valve throttled	• open fully
• check valve in discharge line defective or too small size	• exchange
discharge gas / oil temperature too high	(discharge gas: max. 120°C on outside of discharge line, oil: max. 80°C outside on crankcase (cleaned surface))
• insufficient refrigerant	• check system for leaks, charge to minimum level
• by-pass between high and low pressure	• check / exchange relief valve, check plant
• inert gas	• purge (see operating instruction)
defective / leaking working valves	
• valve / gasket bridge broken	• repair, cure cause. Valve damage mainly caused by liquid slugging due to excessive refrigerant, too much oil or faulty TX valve regulation; with discharge valve breakage danger of damage to connecting rod bearing)
• contamination (oil coke / foreign particles)	• clean / exchange, cure cause. Oil coke mainly due to excessive operating temperature or inert gas
leaking cylinder head gasket	• exchange (do **not** oil asbestos free gaskets!)
Insufficient capacity (Compressor provides too little refrigeration capacity)	
suction pressure too low	• see "safety cut-out"
insufficient pressure generation	
• defective / leaking working valves	• see "safety cut-out"
• worn piston rings / cylinder liners	• exchange of connecting rods/pistons and liners
• leaking cylinder head gasket	• exchange (do **not** oil asbestos free gaskets!)
• by-pass between high and low pressure	• check / exchange internal relief valve, check plant
• capacity control sticking	• repair / exchange
abnormal operating conditions	
• too low / too high superheat	• see "safety cut-out"
• application limits exceeded	• see "safety cut-out"
• inert gas	• purge (see operating instruction)
• too much / too little refrigerant	• charge / reduce to minimum level
• too much oil	• reduce quantity of oil

Possible reasons	Measures, recommendations
Insufficient lubrication (Cut-out due to oil pressure limiter (if fitted) or damage to sliding surfaces and bearings)	
insufficient oil, oil migration	
• large plant volume	• supplement oil charge, check over longer operating time
• insufficient gas velocity, rising pipelines	• check over longer operating time with minimum compressor speed, change pipe runs if necessary
oil viscosity too low due to high dilution with refrigerant	
• compressor during off cycle colder than evaporator	• solenoid valve in liquid line and check valve in discharge gas line may be necessary
• too much refrigerant	• reduce to minimum level
• leaking solenoid valve in liquid line	• repair / exchange
• insufficient liquid accumulation at start	• fit "swan neck" in suction line, if required fit liquid accumulator
• too little suction gas superheat or hunting during operation	• superheat minimum 6..7 K, correct bulb position or fixing if required
oil temperature too high	
• leaking / defective working valves	• see "safety cut-out"
• worn piston rings	• exchange, check pistons and cylinder liners
oil no longer capable of lubricating	
• contaminated by wear particles or foreign matter	• check magnetic plug, oil filter and base plate, change oil (repeatedly if required), cure cause
• chemically decomposed, increased moisture content	• check for acid / moisture content, check for coke deposits (valve plate) and Cu plating (sliding surfaces, valve plate). Change oil and drier (repeatedly if required), cure cause (renew hose connections which have increased porosity)
oil pump / oil regulation valve defective	• repair / exchange
suction pressure at oil pump inlet too low	
• oil filter blocked	• clean, oil change, with possible wear, exchange compressor
• suction filter blocked	• clean, cure cause
Component damage (Compressor does not run despite demand and drive, only heavily or with unusual noises)	
Components in compressor defective	
• overloading, liquid slugging	• repair / exchange, cure cause
• lack of lubrication	• repair / exchange, cure cause
• usual wear	• repair / exchange
Magnetic clutch defective	
• magnet overloaded	• exchange, cure cause (e.g. loss of voltage due to corroded connecting terminals)
• bearing overloaded, excessive belt tension, too short clcok cycles	• exchange, cure cause
	(oil leakage up to approx. 0,05 cm^3/h within tolerance)
Shaft seal leaking	• exchange, see "insufficient lubrication" for guide
• lack of lubrication	• exchange, cure cause
• overheating (hardening, cracks, oil coke)	• exchange, cure cause
• strong vibration (loose clutch, belt drive not aligned, irregular drive)	• adjust belt tension
• excessive belt tension	

Causes possibles	Mesures à prendre, recommandations
Coupure par sécurité (arrêt du compresseur par pressostat haute / basse pression ou par sonde de température des gaz au refoulement)	
Pression d'aspiration trop basse	
• Mauvais fonctionnement du détendeur thermostatique	• Contrôler le fonctionnement et le réglage de la surchauffe
• Trop peu de fluide frigorigène	• Contrôler l'étanchéité du système, refaire l'appoint jusqu'au niveau minimal
• Puissance de l'évaporateur insuffisante	• Nettoyer; si prise en glace, remédier à ce qui peut en être la cause; contrôler le ventilateur
• Evaporateur surchargé en huile / enduit d'huile	• Réduire la charge en huile
• Filtre d'aspiration obturé ou point d'étranglement, dans la vanne d'arrêt à l'aspiration, dans la conduite de liquide ou d'aspiration	• Remédier à ce qui peut en être la cause; le cas échéant, changer le filtre
Pression d'aspiration / de condensation trop élevée	
• Puissance du condenseur insuffisante	• Nettoyer, contrôler le ventilateur
• Trop de fluide frigorigène	• Réduire jusqu'au niveau minimal
• Gaz étranger	• Purger (voir instructions de service)
• Vanne d'arrêt au refoulement étranglée	• Ouvrir complètement
• Clapet de retenue dans la conduite de refoulement défectueux ou puissance trop faible	• Remplacer
Température d'huile / des gaz au refoulement trop élevée	(gaz au refoulement: conduite de refoulement max. 120° C à l'extérieur; huile: carter max. 80° C à l'extérieur (sur métal nu))
• Trop peu de fluide frigorigène	• Contrôler l'étanchéité du système, refaire l'appoint jusqu'au niveau minimal
• Bipasse entre haute et basse pression	• Contrôler / remplacer la soupape de décharge, contrôler le système
• Gaz étranger	• Purger (voir instructions de service)
Soupapes de travail défectueuses / pas étanches	
• Soupape / joint cassé	• Réparer, en éliminer la cause. Une soupape cassée est souvent le résultat de coups de liquide quand il y a trop de fluide frigorigène, trop d'huile ou que le détendeur thermostatique est mal réglé; avec une soupape de refoulement cassée, il y a risque de dégâts sur les coussinets de bielle.
• Encrassement (calamine; particules étrangères)	• Nettoyer / remplacer, en éliminer la cause (la calamine résulte souvent d'une température de fonctionnement trop élevée ou de gaz étrangers)
Joint de tête de culasse pas étanche	• Remplacer (**ne pas** huiler les joints sans amiante)
Manque de puissance (compresseur ne fournit pas assez de puissance frigorifique)	
Pression d'aspiration trop basse	• Voir "coupure par sécurité"
Elévation de pression insuffisante	
• Soupapes de travail défectueuses / pas étanches	• Voir "coupure par sécurité"
• Segments de piston / chemise usés	• Remplacer l'ensemble bielle / piston et la chemise
• Joint de tête de culasse pas étanche	• Remplacer (**ne pas** huiler les joints sans amiante)
• Bipasse entre haute et basse pression	• Contrôler / remplacer la soupape de décharge, contrôler le système
• Régulateur de puissance bloqué	• Réparer / remplacer
Conditions de fonctionnement anormales	
• Surchauffe trop faible / trop élevée	• Voir "coupure par sécurité"
• Dépassement des limites d'application	• Voir "coupure par sécurité"
• Gaz étranger	• Purger (voir instructions de service)
• Trop peu / trop de fluide frigorigène	• Refaire l'appoint / réduire jusqu'au niveau minimal
• Trop d'huile	• Réduire la quantité d'huile

Causes possibles	Mesures à prendre, recommandations
Manque de lubrification (coupure par pressostat d'huile (si existant) ou dégâts sur les surfaces de glissement et les paliers)	
Trop peu d'huile, migration d'huile	
• Système très volumineux	• Faire l'appoint, contrôle sur une longue période de fonctionnement
• Vitesse de gaz insuffisante (tuyauterie ascendante)	• Contrôler sur une longue période de fonctionnement en vitesse de rotation minimale; le cas échéant, modifier le tracé de la tuyauterie
Viscosité d'huile trop faible à cause d'un enrichissement en fluide frigorigène	
• Compresseur à l'arrêt plus froid que l'évaporateur	• Le cas échéant, une vanne magnétique et un clapet de retenue dans la conduite de refoulement sont nécessaires
• Trop de fluide frigorigène	• auf Mindeststand reduzieren
• Vanne magnétique dans la conduite liquide pas étanche	• reparieren / austauschen
• Séparation de liquide au démarrage insuffisante	• Conduite d'aspiration avec "col de cygne"; le cas échéant, séparateur de liquide
• Surchauffe des gaz à l'aspiration insuffisante ou pompage important en fonctionnement	• Réglage de la surchauffe au moins 6...7K; le cas échéant, corriger la position ou la fixation du bulbe
Température d'huile trop élevée	
• Soupapes de travail pas étanches / défectueuses	• Voir "coupure par sécurité"
• Segments de pistons usés	• Remplacer, contrôler piston et cylindre
L'huile ne lubrifie plus	
• Souillée par des résidus d'abrasion ou des polluants externes	• Contrôler les bouchons magnétiques, le filtre à huile et la plaque de fond, faire une vidange d'huile (éventuellement répéter plusieurs fois), en éliminer la cause
• Décomposée chimiquement, teneur en eau élevée	• Contrôler l'acidité et la teneur en eau, vérifier la présence de résidus de carbonisation (plaque à clapets) ou de cuivrage (surfaces de glissement, plaque à clapets), remplacer le deshydrateur et idanger l'huile (éventuellement répéter plusieurs fois), en éliminer les causes (renouveler les raccords flexibles ayant une perméabilité accrue)
Pompe à huile / vanne de régulation de la pression d'huile défectueuse	• Réparer/ remplacer
Pression d'aspiration de la pompe à huile insuffisante	
• Filtre à huile obturé	• Nettoyer, vidange d'huile; en cas d'usure, remplacer éventuellement le compresseur
• Filtre d'aspiration obturé	• Nettoyer, en éliminer les causes
Dégâts sur les composants (il y a une demande et l'entraînement se fait mais le compresseur ne tourne pas, avec difficulté seulement ou avec des bruits inhabituels)	
Composants défectueux dans le compresseur	
• Surcharge coups de liquide	• Réparer / remplacer, en éliminer la cause
• Manque de lubrification	• Réparer / remplacer, en éliminer la cause
• Usure habituelle	• Réparer / remplacer
Embrayage électromagnétique défectueux	
• Aimant surchargé	• Remplacer, en éliminer la cause (par ex. chute de tension aux bornes de raccordement corrodées)
• Palier surchargé, tension initiale des courroies trop forte, cycles d'impulsions trop courts	• Remplacer, en éliminer la cause
Garniture d'étanchéité pas étanche	(Un débit de fuite d'huile jusqu'à environ 0,05cm3/h est dans les limites tolérées)
• Manque de lubrification	• Remplacer, remède voir "manque de lubrification"
• Surchauffe (durcissement, fissures, calamine)	• Remplacer, en éliminer la cause
• Fortes vibrations (embrayage relâché, défaut d'alignement de l'entraînement par courroies, entraînement irrégulier)	• Remplacer, en éliminer la cause
• Tension initiale des courroies trop forte	• Réajuster la tension des courroies

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Bitzer Kühlmaschinenbau GmbH
Eschenbrünnlestr. 15
71065 Sindelfingen (Germany)
Tel. +49(0)7031-932-0
Fax +49(0)7031-932-146 & -147
http://www.bitzer.de • bitzer@bitzer.de

THE HEART OF FRESHNESS

MAINTENANCE INSTRUCTIONS

WARTUNGSANLEITUNG

INSTRUCTION DE MAINTENANCE

KW-541-2

Austausch der Wellenabdichtung

- 4GFC(Y)
- 4UFC(Y) .. 4NFC(Y)
- 4UFR(Y) .. 4NFR(Y)
- 6UFC(Y) .. 6NFC(Y)

Exchanging the shaft seal

- 4GFC(Y)
- 4UFC(Y) .. 4NFC(Y)
- 4UFR(Y) .. 4NFR(Y)
- 6UFC(Y) .. 6NFC(Y)

Remplacement des garnitures d'étanchéités

- 4GFC(Y)
- 4UFC(Y) .. 4NFC(Y)
- 4UFR(Y) .. 4NFR(Y)
- 6UFC(Y) .. 6NFC(Y)

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4 Einbau 6

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4 Mounting 6

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4 Mise en place 6

1 Allgemeines

Die offenen Hubkolbenverdichter für Fahrzeug-Anwendungen sind an der Wellendurchführung mit einer hochwertigen Gleitring-Dichtung ausgestattet. Sie besteht aus einer rotierenden und einer statischen Einheit.

Diese Wartungsanleitung beschreibt den Austausch der Wellenabdichtung im Schadensfall.

1 General

The open drive reciprocating compressors for Transport Applications are fitted with a high quality shaft seal. This consists of a rotating and a stationary unit.

This maintenance instructions describes the exchange of the shaft seal in case of damage.

1 Généralités

Les compresseurs ouverts à pistons pour applications en transport sont équipés au passage de l'arbre d'une garniture étanchéité à anneau glissant de haute qualité. Elle se compose d'une unité tournante et d'une unité statique.

Cette instruction de maintenance décrit le remplacement de la garniture d'étanchéité en cas de détérioration.

Autorisiertes Fachpersonal
Sämtliche Arbeiten an Verdichtern und Kälteanlagen dürfen nur von qualifiziertem und autorisiertem Fachpersonal ausgeführt werden.

Die hier beschriebenen Tätigkeiten sind sehr anspruchsvoll und erfordern höchste Präzision.

Authorized personnel
All work done on the compressors and the refrigeration plants may only be performed by qualified and authorized personnel.

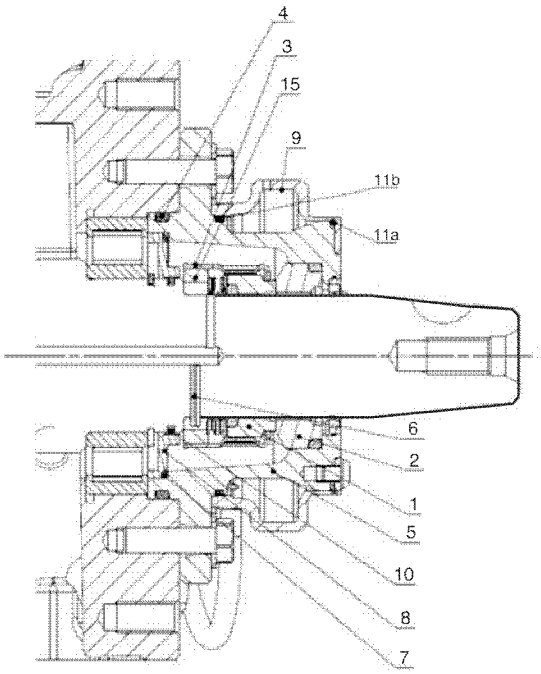
The activities described here are very complex and require the highest precision.

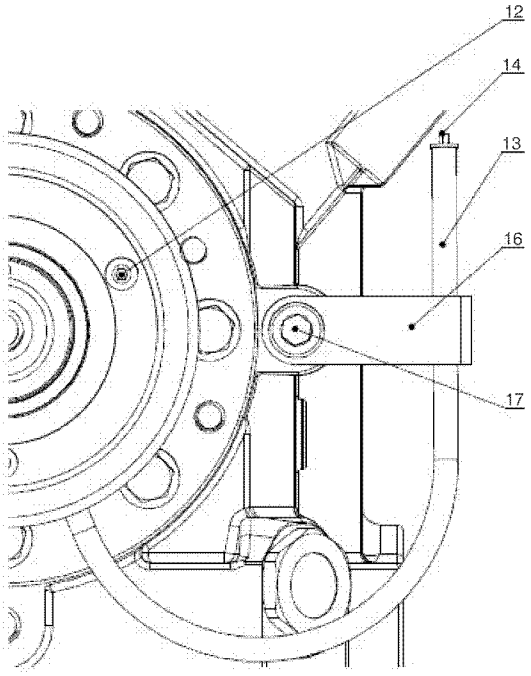
Personnel compétent autorisé
Toutes les interventions sur les compresseurs et les installations frigorifiques doivent être exécutées exclusivement par un personnel compétent, autorisé et qualifié.

Les activités décrites ci-après sont très exigeantes et nécessitent une précision des plus élevées.

2 Konstruktive Ausführung

Typ 1 mit Ölauffangbehälter





1 Gleitring (rotierende Einheit)
2 Gegenring (statische Einheit)
3 Gewindestifte
4 O-Ring ø 85x3,53
5 Abschlussdeckel
6 Spiralspannstift
7 O-Ring ø 74x2,0
8 Dichtscheibe
9 Ölauffangbehälter
10 Radialdichtring
11 O-Ring ø 85x2,0 (2x, 11a, 11b)
12 Schraube M5
13 Ölablaufschlauch
14 Stopfen am Ölablaufschlauch
15 Mitnahmenut
16 Befestigungsblech
17 Schraube M10

2 Design version

Type 1 with oil collection chamber

1 Sliding ring (rotating unit)
2 Stationary ring (stationary unit)
3 Set screws
4 O-ring ø 85x3.53
5 Sealing cover
6 Spiral pin
7 O-ring ø 74x2.0
8 Sealing plate
9 Oil collection chamber
10 Radial gasket ring
11 O-ring ø 85x2.0 (2x, 11a, 11b)
12 Screw M5
13 Oil drain tube
14 Plug at the oil drain tube
15 Driving slot
16 Fixing plate
17 Screw M10

2 Version de construction

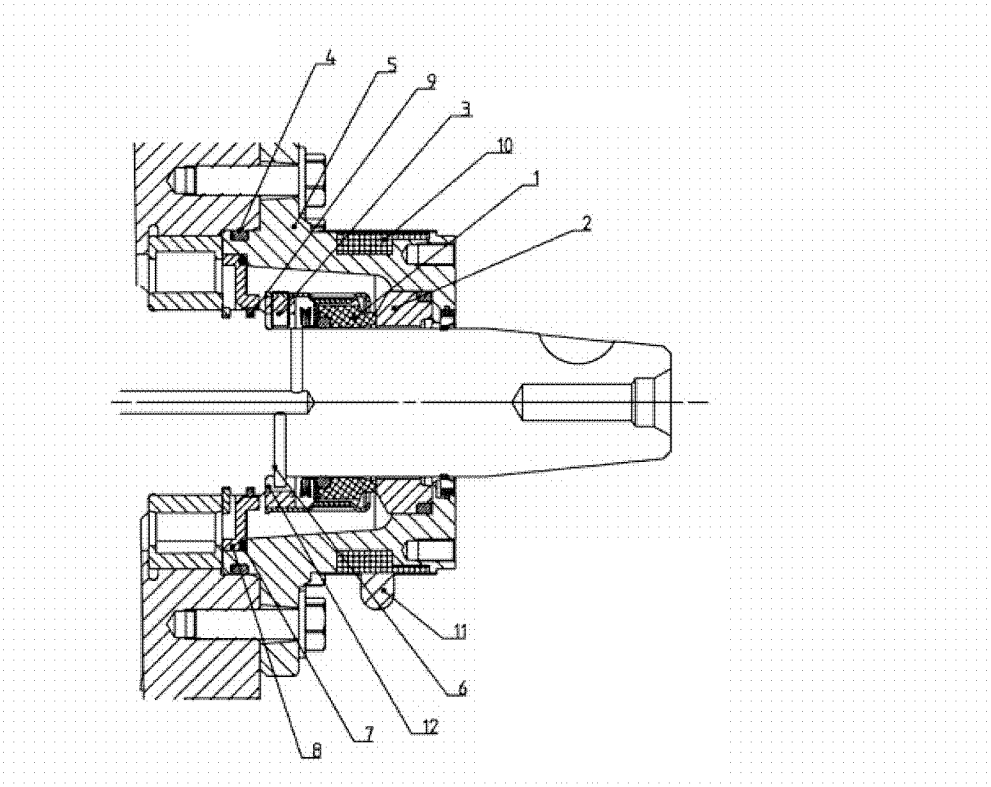
Type 1 avec chambre collectrice d'huile

1 Bague de glissement (unité tournante)
2 Bague fixe (unité statique)
3 Vis sans tête
4 Joint annulaire ø 85x3,53
5 Couvercle de fermeture
6 Goupille spiralée
7 Joint annulaire ø 74x2,0
8 Rondelle d'étanchéité
9 Chambre collectrice d'huile
10 Joint annulaire radial
11 Joint annulaire ø 85x2,0 (2x, 11a, 11b)
12 Vis M5
13 Tuyau flexible de drainage de l'huile
14 Bouchon de vidage
15 Rainure de verrouillage
16 Tôle de fixation
17 Vis M10

Typ 2 ohne Ölauffangbehälter

Type 2 without oil collection chamber

Type 2 sans chambre collectrice d'huile



1 Gleitring (rotierende Einheit)
2 Gegenring (statische Einheit)
3 Gewindestifte
4 O-Ring ø 85x3,53
5 Abschlussdeckel
6 Spiralspannstift
7 O-Ring ø 74x2,0
8 Dichtscheibe
9 Radialdichtring
10 Filzring
11 Bandage
12 Mitnahmenut

1 Sliding ring (rotating unit)
2 Stationary ring (stationary unit)
3 Set screws
4 O-ring ø 85x3.53
5 Sealing cover
6 Spiral pin
7 O-ring ø 74x2.0
8 Sealing plate
9 Radial gasket ring
10 Felt ring
11 Bandage
12 Driving slot

1 Bague de glissement (unité tournante)
2 Bague fixe (unité statique)
3 Vis sans tête
4 Joint annulaire ø 85x3,53
5 Couvercle de fermeture
6 Goupille spiralée
7 Joint annulaire ø 74x2,0
8 Rondelle d'étanchéité
9 Joint annulaire radial
10 Bague feutre
11 Bandage
12 Rainure de verrouillage

Werkzeuge und Hilfsmittel

- Drehmomentschlüssel
- Innensechskantschlüssel (SW 2,5)
- Steckschlüssel (SW 13, 17)
- Schraubendreher

Tools and other devices

- Torque wrench
- Allen key (size 2.5)
- Socket wrench (sizes 13, 17)
- Screw driver

Outillage et équipements auxiliaires

- Clé dynamométrique
- Clé pour vis à six pans creux (ouverture 2,5)
- Clé à douille (ouvertures 13, 17)
- Tournevis

3 Wellenabdichtung ausbauen

Warnung!
Verdichter kann unter Druck stehen!
Bei unsachgemäßen Eingriffen sind schwere Verletzungen möglich.
Verdichter auf drucklosen Zustand bringen.

Vorbereitende Arbeiten

- Schläuche der Kältemittel-Absaugstation an die Service-Anschlüsse der Absperrventile anschließen
- Saug- und Druckabsperrventile zur Anlagenseite schließen
- Kältemittel mit der Absaugstation bis auf Umgebungsdruck absaugen
- Riemen entspannen und demontieren

Magnetkupplung ausbauen

Für detaillierte Beschreibungen zum Ein- und Ausbau des Verdichters sowie zum Austausch der Magnetkupplung siehe KW-540 Kapitel 6.1 und 6.2.

Wellenabdichtung ausbauen

Typ 1 mit Ölauffangbehälter

- Ölablaufschlauch (13) aus Befestigungsblech (16) lösen
- Stopfen am Ölablaufschlauch (14) entfernen und Ölauffangbehälter (9) vollständig entleeren. Anschließend Ölablaufschlauch mit Stopfen verschließen und am Befestigungsblech anbringen
- Schrauben M5 (12) am Ölauffangbehälter lösen
- Ölauffangbehälter (9) mit der Hand vom Abschlussdeckel (5) abziehen (im Ölbehälter zurückbleibendes Öl beachten!) und die O-Ringe (11a, 11b) entnehmen

Typ 2 ohne Ölauffangbehälter

- Spannband und Filzring (10) entfernen

3 Remove shaft seal

Warning!
The compressor may be under pressure!
Incorrect handling can lead to serious injuries.
Relieve the compressor of pressure.

Preparatory tasks

- Connect the hoses of the refrigerant extraction station to the service connections of the shut-off valves
- Shut the suction and discharge shut-off valve on plant side
- Extract the refrigerant with extraction station until ambient pressure is attained
- Relieve belt tension and dismount belt

Remove magnetic clutch

Refer to KW-540 chapters 6.1 and 6.2 for detailed descriptions on how to fit and dismantle the compressor as well as how to exchange the magnetic clutch.

Remove shaft seal

Type 1 with oil collection chamber

- Remove the oil drain tube (13) from the fixing plate (16)
- Remove then plug at the oil drain tube (14) and fully discharge the oil collection chamber (9). Afterwards close the oil drain tube with the plug and place it on the fixing plate
- Release screws M5 (12) at the oil collection chamber
- Pull off the oil collection chamber (9) manually from the sealing cover (5) (pay attention to rests of oil in the oil collection chamber!) and remove the O-rings (11a, 11b)

Type 2 without oil collection chamber

- Remove bandage and felt ring (10)

3 Démonter la garniture d'étanchéité

Avertissement !
Le compresseur peut être sous pression ! Risque de blessures graves en cas d'interventions inappropriées.
Amener le compresseur à pression atmosphérique.

Travaux préparatoires

- Raccorder les tuyaux flexibles de la station d'aspiration du fluide frigorigène aux raccords de service des vannes d'arrêt
- Fermer les vannes d'aspiration et les vannes d'arrêt au refoulement du côté de l'installation
- Aspirer le fluide frigorigène à l'aide de la station d'aspiration jusqu'à la pression ambiante
- Détendre la courroie et la démonter

Démonter l'embrayage électromagnétique

Pour obtenir des descriptions détaillées sur le montage et le démontage du compresseur ainsi que sur le remplacement de l'embrayage électromagnétique, voir KW-540, chapitre 6.1 et 6.2.

Démonter la garniture d'étanchéité

Type 1 avec chambre collectrice d'huile

- Retirer le tuyau flexible de drainage de l'huile (13) du tôle de fixation (16)
- Retirer le bouchon de vidage (14) et vider la chambre collectrice d'huile (9) complètement. Ensuite fermer le tuyau flexible de drainage de l'huile avec le bouchon et fixer le au tôle de fixation
- Dévisser les vis M5 (12) dans la chambre collectrice d'huile
- Enlever avec la main le couvercle de fermeture (5) de la chambre collectrice d'hulie (9) (faire attention aux restes d'huile dans la chambre collectrice d'huile !) et retirer les joints toriques (11a, 11b)

Type 2 sans chambre collectrice d'huile

- Retirer le ruban de serrage et la bague feutre (10)

Die weiteren Schritte sind für Typ 1 und Typ 2 identisch

- Befestigungsschrauben des Abschlussdeckels (5) herausdrehen
- Zwei dieser Schrauben in die Abdrückgewinde eindrehen und durch gleichmäßiges Anziehen den Abschlussdeckel (5) vom Gehäuse abdrücken
- Abschlussdeckel (5) mit der Hand von der Welle abziehen

Achtung!
Die Wellenoberfläche ist empfindlich gegen Verkratzen und Riefenbildung. Ablagerungen auf der Welle mit Putztüchern oder ölgetränkten Polierleinen bzw. Schleifleinen mit Körnung 280 (oder feiner) entfernen!

- Die Gewindestifte im Gleitring (1) lösen und entnehmen (nicht wieder verwenden!)
- Anschließend den Gleitring von Hand von der Welle abziehen

Achtung!
Falls Gewindestifte im Gleitring verbleiben, besteht beim Abziehen Gefahr von Riefenbildung auf der Welle!

- Dichtscheibe (8) von der Welle nehmen
- Radialdichtring (9 bzw. 10) aus der Nut der Welle, die O-Ringe (4 und 7) aus der Aussparung der Dichtscheibe und aus der Nut des Abschlussdeckels entnehmen
- Gegenring (2) der Wellenabdichtung von Hand aus dem Abschlussdeckel (5) herausdrücken (Abb. 1)

The following steps are identical for type 1 and type 2

- Screw out the fastening screws of the sealing cover (5)
- Screw in two of these screws into the forcing thread and, by pulling evenly, push the sealing cover (5) away from the housing
- Pull off the sealing cover (5) from the shaft manually

Attention!
The shaft seal is susceptible to scratches and striation. Remove coatings on the shaft seal by using cleaning rags and oil-soaked polishing cloths or emery cloths with 280 (or finer) grit!

- Loose and remove the set screws inside the sliding ring (1) (do not reuse!)
- Afterwards pull the sliding ring from the shaft manually

Attention!
In case the set screws remain inside the sliding ring, there is imminent danger of striation on the shaft during removal!

- Remove the sealing plate (8) from the shaft
- Remove the radial gasket ring (9 res. 10) from the groove on the shaft, the O-rings (4 and 7) from the recess of the sealing plate and from the sealing cover (5)
- Push the stationary ring (2) of the shaft seal from the sealing cover (5) manually (Fig. 1)

Les instructions suivantes sont identique pour type 1 et type 2

- Dévisser les vis de fixation du couvercle de fermeture (5)
- Introduire deux de ces vis dans les filetages de dégagement et serrer uniformément pour décoller le couvercle de fermeture (5)
- Enlever avec la main le couvercle de fermeture (5) de l'arbre

Attention !
La garniture d'étanchéité est sensible pour égratigner et striation. Retirer des dépôts en utiliser des chiffrons et de la toile à polir ou de la toile émeri imbibée d'huile, grain 280 (ou plus fin) !

- Desserrer et enlever les vis sans tête de la bague de glissement (1) (ne pas les réutiliser !)
- Ensuite enlever avec la main la bague de glissement de l'arbre

Attention !
Si les vis sans tête restent dans la bague de glissement, il y a risque de striation sur l'arbre lors du retrait !

- Enlever la rondelle d'étanchéité (8) de l'arbre
- Enlever le joint annulaire radial (9 res.10) de la rainure de l'arbre, les joints annulaires (4 et 7) de l'évidement de la rondelle d'étanchéité et de la rainure du couvercle de fermeture (5)
- Faire sortir la bague fixe (2) de la garniture d'étanchéité avec la main du couvercle de fermeture (5) (Fig. 1)

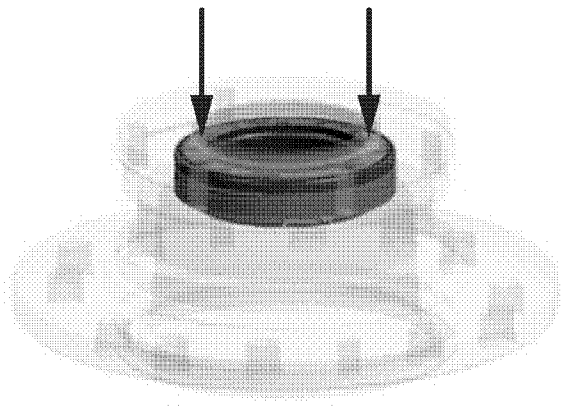


Abb. 1 Abschlussdeckel mit Gegenring

Fig. 1 Sealing cover with stationary ring

Fig. 1 Couvercle de fermeture avec bague fixe

Achtung!
Radialdichtring am Abschlussdeckel nicht beschädigen!

Attention!
Do not damage the radial gasket ring on the sealing cover!

Attention !
Ne pas endommager le joint annulaire radial du couvercle de fermeture !

4 Wellenabdichtung einbauen

Vorbereitung zum Wiedereinbau

- Ölauffangbehälter (bei Typ 1), Abschlussdeckel, Dichtscheibe und Nut des Radialdichtrings reinigen
- Befinden sich Ablagerungen auf der Welle, müssen diese entfernt werden. Hierzu Putztücher und ölgetränkte Polierleinen bzw. Schleifleinen mit Körnung 280 oder feiner verwenden

4 Mounting the shaft seal

Preparation for refitting

- Clean the oil collection chamber (type 1), sealing cover, sealing plate and groove of the radial gasket ring
- If coatings are on the shaft, they must be removed. For this purpose, use cleaning rags and oil-soaked polishing cloths or emery cloths with 280 grit or finer

4 Remonter la garniture d'étanchéité

Préparation pour le remontage

- Nettoyer la chambre collectrice d'huile (type 1), le couvercle de fermeture, la rondelle d'étanchéité et la rainure du joint annulaire radial
- Si l'arbre présente des dépôts, les éliminer. Pour cela, utiliser des chiffrons et de la toile à polir ou de la toile émeri imbibée d'huile, grain 280 ou plus fin

Achtung!
Gleitringe sind bruchempfindlich. Gleitflächen sind empfindlich gegen Verkratzen. Ersatz-Wellenabdichtung bis unmittelbar vor dem Einbau in der Schutzfolie belassen. Gleitflächen nicht berühren.

Attention!
Sliding rings are susceptible to breakage. Sliding faces are susceptible to scratches. Keep the replacement shaft seal inside its protective foil until immediately before installing. Do not touch the sliding faces.

Attention !
Les bagues de glissement sont fragiles. Les surfaces de glissement sont sensible pour égratigner. Garder la garniture d'étanchéité de rechange de son emballage jusqu'au dernier moment. Ne pas toucher les surfaces de glissement.

Achtung!
Nur neue O-Ringe verwenden.

Attention!
Use only new O-rings.

Attention !
Ne réutiliser que des nouveaux joints annulaires.

Achtung!
Schrauben und Muttern mit den vorgeschriebenen Drehmomenten anziehen.

Attention!
Tighten bolts and nuts with the specified torques.

Attention !
Resserrer les vis et les écrous avec les couples de serrage indiqués.

Wellenabdichtung einbauen (Typ 1 mit Ölauffangbehälter)

- Radialdichtring (10) in die Nut der Welle einlegen
- Neuen O-Ring (7) in die Aussparung der Dichtscheibe (8) einlegen und diese auf die Welle aufschieben. Der O-Ring muss in Richtung Welle zeigen und sollte zur besseren Montage nicht geölt werden!
- Dichtscheibe (8) so positionieren, dass die Ölbohrung nach oben zeigt (siehe Abb. 2, Pos. A)
- Neuen Gleitring (1) innen mit sauberem Kältemaschinenöl einölen und auf die Welle schieben. Den Gleitring bis an die Wellenschulter (Wellenbund) führen. Der Spiralspannstift (6) muss dabei in eine der Nuten des Gleitrings (15) einrasten
- Gewindestifte (3) (siehe Abb. 2) einsetzen und anziehen (Anzugsmoment 2,5 Nm)

Achtung!
Den Gleitring (1) beim Anziehen der Gewindestifte (3) an die Wellenschulter drücken, ohne dabei die Gleitfläche zu berühren!

- Neuen Gegenring (2) mit eingebautem O-Ring (4) mit sauberem Kältemaschinenöl benetzen
- Anschließend Gegenring von Hand in den Abschlussdeckel (5) eindrücken

Mounting the shaft seal (Type 1 with oil collection chamber)

- Lay the radial gasket ring (10) in the groove on shaft
- Lay the new O-ring (7) in the recess of the sealing plate (8) and then push it on the shaft. The O-ring must point towards the shaft and to assure a better assembling must not be oiled!
- Position the sealing plate (8) in such a way that the oil hole is on top (see Fig. 2, Pos. A)
- Lubricate the new sliding ring (1) internally with clean refrigeration compressor oil and then push it on the shaft. Guide the sliding ring up to the shaft shoulder (shoulder on the shaft). Make sure that the spiral pin (6) of the shaft locks in one of the grooves (15) on the sliding ring
- Insert set screws (3) (see Fig. 2) and tighten (tightening torque 2.5 Nm)

Achtung!
Press the sliding ring (1) when tightening the set screws (3) on the shaft shoulder, without touching the sliding surface!

- Moisten the new stationary ring (2) with the mounted O-ring (4) with clean refrigeration compressor oil
- Afterwards push the stationary ring manually into the sealing cover (5)

Remonter la garniture d'étanchéité (Type 1 avec chambre collectrice d'huile)

- Insérer le joint annulaire radial (9) dans la rainure de l'arbre
- Insérer le joint annulaire neuf (7) dans la rainure de la rondelle d'étanchéité (8) et glisser cette dernière sur l'arbre. Le joint annulaire doit montrer en direction de l'extrémité de l'arbre et pour assurer un bon assemblage il ne doit pas être lubrifié !
- Positionner la rondelle d'étanchéité (8) de sorte que l'orifice de passage d'huile se trouve en haut (voir Fig. 2, Pos. A)
- Huiler l'intérieur de la bague de glissement neuve (1) avec de l'huile propre pour machine frigorifique et glisser la bague sur l'arbre. Introduire la bague de glissement jusqu'au collet de l'arbre. La goupille spiralée (6) de l'arbre doit s'enclencher dans l'une des rainures (15) de la bague de glissement
- Insérer et serrer les vis sans tête (3) (voir Fig. 2) (couple de serrage 2,5 Nm)

Attention !
Lors du serrage des vis (3), appuyer la bague de glissement (1) contre le collet de l'arbre sans toucher la surface de glissement !

- Humidifier la bague fixe neuve (2) avec le joint annulaire monté (4) avec de l'huile propre pour machine frigorifique
- Ensuite enfoncer avec la main la bague fixe dans le couvercle de fermeture (5)

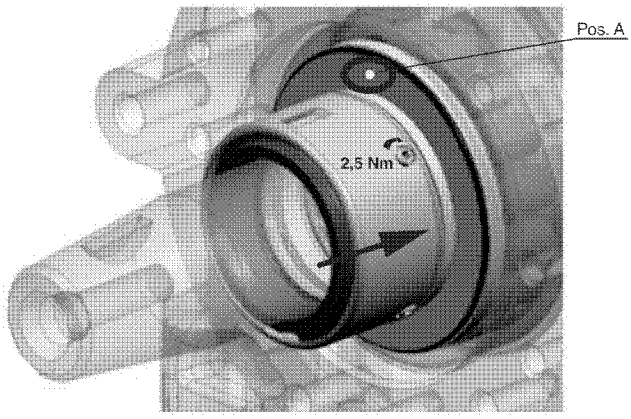


Abb. 2 Dichtscheibe mit Ölbohrung
Fig. 2 Sealing plate with oil hole
Fig. 2 Rondelle d'étanchéité avec passage d'huile

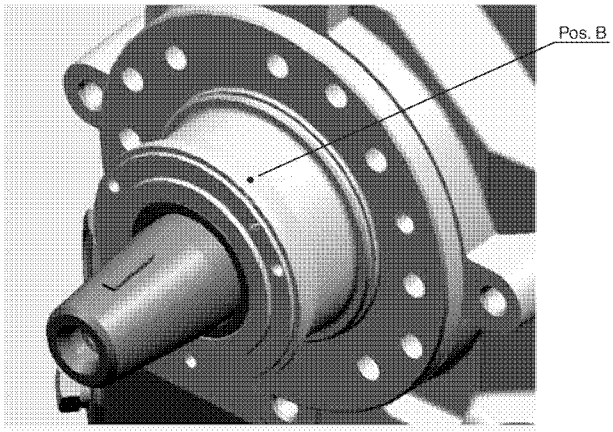


Abb. 3 Austrittsbohrung Leckageöl am Abschlussdeckel
Fig. 3 Exit hole for leakage oil at the sealing cover
Fig. 3 L'orifice de sortie pour l'huile de fuite dans le couvercle de fermeture

Achtung!
Dichtfläche beim Eindrücken nicht beschädigen! Zum Schutz einen sauberen Lappen verwenden.

- Neuen O-Ring (4) in die Nut des Abschlussdeckels (5) einlegen
- Die Dichtflächen des Gleitrings (1) und des O-Rings (4) ausreichend mit sauberem Kältemaschinenöl benetzen
- Abschlussdeckel (5) auf die Welle schieben und durch gleichmäßiges Anziehen der Schrauben montieren (Anzugsmoment 25 Nm)

Achtung!
Die Austrittsbohrung für das Leckageöl am Abschlussdeckel muss sich dabei in 1-Uhr-Stellung befinden! (siehe Abb. 3, Pos. B)

- O-Ring (11b) in die Nut am Abschlussdeckel einsetzen (siehe Abb. 4)
- Nun den zweiten O-Ring (11a) in den Ölauffangbehälter (9) einlegen (siehe Abb. 5) und diesen anschließend auf den Abschlussdeckel stecken

Achtung!
Position des Ölablaufschlauchs wie in Abb. 6 dargestellt beachten!

Attention!
Do not damage the sealing surface when driving in! For protection, use a clean rag.

- Lay the new O-ring (4) in the groove of the sealing cover (5)
- Moisten the sealing surfaces of the sliding ring (1) and the O-ring (4) sufficiently with clean refrigeration compressor oil
- Push sealing cover (5) on the shaft and mount by uniformly tightening the screws (tightening torque 25 Nm)

Attention!
The exit hole for the leakage oil at the sealing cover must be located in the 1 o'clock position! (see Fig. 3, Pos. B)

- Lay O-ring (11b) in the groove of the sealing cover (see Fig. 4)
- Now place the second O-ring (11a) in the oil collection chamber (see Fig. 5) and afterwards plug it on the sealing cover (5)

Attention!
Position the oil drain tube as shown in Fig. 6!

Attention !
Ne pas endommager la surface d'étanchéité lorsque l'enfoncer ! Utilisez un chiffron propre pour la protéger.

- Insérer le nouveau joint annulaire (4) dans la rainure du couvercle de fermeture (5)
- Humidifier les surfaces d'étanchéité de la bague de glissement (1) et de joint annulaire (4) avec suffisamment d'huile propre pour machine frigorifique
- Glisser le couvercle de fermeture (5) sur l'arbre et monter en serrant uniformément les vis (couple de serrage 25 Nm)

Attention !
L'orifice de sortie pour l'huile de fuite dans le couvercle de fermeture doit se trouver en position 1 heures ! (voir Fig. 3, Pos. B)

- Insérer le joint annulaire (11b) dans la rainure du couvercle de fermeture (voir Fig. 4)
- Mettre le joint annulaire (11a) dans la chambre collectrice d'huile (voir Fig. 5) et ensuite placer la dans le couvercle de fermeture (5)

Attention !
Positionner le tuyau flexible de drainage de l'huile comme en Fig. 6 !

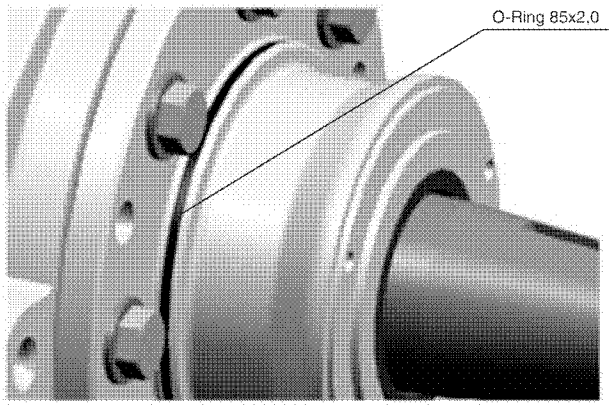


Abb. 4 Position des O-Rings in der Nut des Abschlussdeckels
Fig. 4 Position of the O-ring in the groove of the sealing cover
Fig. 4 Position du joint annulaire dans la rainure du couvercle de fermeture

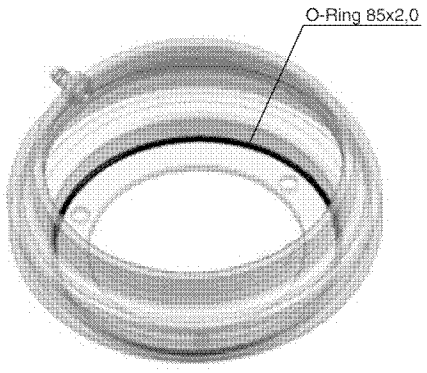


Abb. 5 O-Ring im Ölauffangbehälter
Fig. 5 O-ring in the oil collection chamber
Fig. 5 O-ring dans la chambre collectrice d'huile

- Den Ölauffangbehälter aufsetzen und die 3 Schrauben M5 (12) festziehen (Anzugsmoment 4 Nm)
- Ölablaufschlauch mit Stopfen (14) verschließen und am Befestigungsblech (16) anbringen
- Verdichterwelle einige Umdrehungen von Hand durchdrehen
- Verdichter evakuieren
- Absperrventile öffnen
- Dichtheitsprüfung durchführen

- Attach the oil collection chamber and tighten the 3 screws M5 (12) (tightening torque 4 Nm)
- Close the oil drain tube with the plug (14) and place the tube on the fixing plate (16)
- Rotate the compressor shaft several times by hand
- Evacuate the compressor
- Open the shut-off valves
- Perform tightness test

- Monter la chambre collectrice d'huile et serrer les 3 vis M5 (12) (couple de serrage 4 Nm)
- Fermer le tuyau flexible de drainage de l'huile avec le bouchon (14) et fixer le tuyau au tôle de fixation (16)
- Tourner l'arbre du compresseur de quelques tours avec la main
- Mettre le compresseur sous vide
- Ouvrir les vannes d'arrêt
- Effectuer un essai d'étanchéité

Wellenabdichtung einbauen (Typ 2 ohne Ölauffangbehälter)

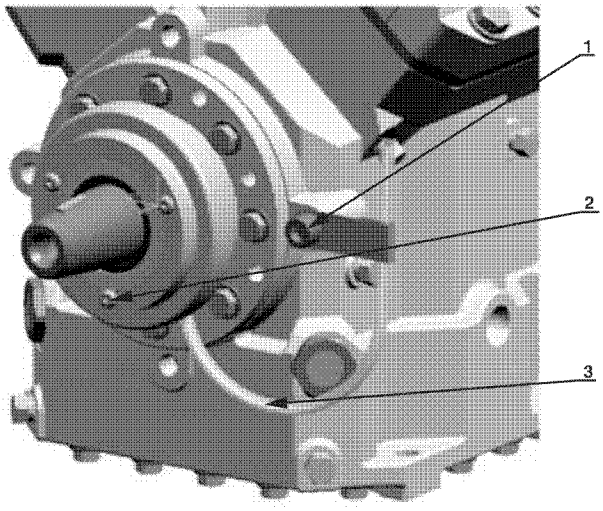
- Radialdichtring (9) in die Nut der Welle einlegen
- Neuen O-Ring (7) in die Aussparung der Dichtscheibe (8) einlegen und diese auf die Welle aufschieben. Der O-Ring muss in Richtung Welle zeigen und sollte zur besseren Montage nicht geölt werden!
- Dichtscheibe (8) so positionieren, dass die Ölbohrung nach oben zeigt (siehe Abb. 2, Pos. A)
- Neuen Gleitring (1) innen mit sauberem Kältemaschinenöl einölen und auf die Welle schieben. Den Gleitring bis an die Wellenschulter (Wellenbund) führen. Der Spiralspannstift (6) muss dabei in eine der Nuten des Gleitrings (12) einrasten
- Gewindestifte (3) (siehe Abb. 2) einsetzen und anziehen (Anzugsmoment 2,5 Nm)

Mounting the shaft seal (Type 2 without oil collection chamber)

- Lay the radial gasket ring (9) in the groove on shaft
- Lay the new O-ring (7) in the recess of the sealing plate (8) and then push it on the shaft. The O-ring must point towards the shaft end and to assure a better assembling must not be oiled!
- Position the sealing plate (8) in such a way that the oil hole is on top (see to Fig. 2, Pos. A)
- Lubricate the new sliding ring (1) internally with clean refrigeration compressor oil and then push it on the shaft. Guide the sliding ring up to the shaft shoulder (shoulder on the shaft). Make sure that the spiral pin (6) of the shaft locks in one of the grooves (12) on the sliding ring
- Insert set screws (3) (see Fig. 2) and tighten (tightening torque 2.5 Nm)

Remonter la garniture d'étanchéité (Type 2 sans chambre collectrice d'huile)

- Insérer le joint annulaire radial (9) dans la rainure de l'arbre
- Insérer le joint annulaire neuf (7) dans la rainure de la rondelle d'étanchéité (8) et glisser cette dernière sur l'arbre. Le joint annulaire doit pointer en direction de l'extrémité de l'arbre et pour assurer un bon assemblage il ne doit pas être lubrifié !
- Positionner la rondelle d'étanchéité (8) de sorte que l'orifice de passage d'huile se trouve en haut (voir Fig. 2, Pos. A)
- Huiler l'intérieur de la bague de glissement neuve (1) avec de l'huile propre pour machine frigorifique et glisser la bague sur l'arbre. Introduire la bague de glissement jusqu'au collet de l'arbre. La goupille spiralée (6) de l'arbre doit s'enclencher dans l'une des rainures (12) de la bague de glissement
- Insérer et serrer les vis sans tête (3) (voir Fig. 2) (couple de serrage 2,5 Nm)



1 Schraube M10 (Anzugsmoment 40 Nm) am Befestigungsblech für den Ölablaufschlauch
Screw M10 (tightening torque 40 Nm) at the fixing plate of the oil drain tube
Vis M10 (couple de serrage 40 Nm) dans le tôle de fixation du tuyau flexible de drainage de l'huile

2 Schrauben M5 (3x) (Anzugsmoment 4 Nm)
Screws M5 (3x) (tightening torque 4 Nm)
Vis M5 (3x) (couple de serrage 4 Nm)

3 Position des Ölablaufschlauchs nach Montage des Ölauffangbehälters
Position of the oil drain tube after assembling the oil collection chamber
Position du tuyau flexible de drainage de l'huile après assemblage de la chambre collectrice d'huile

Abb. 6 Position des Ölablaufschlauchs

Fig. 6 Position of the oil drain tube

Fig. 6 Position du tuyau flexible de drainage d'huile

Achtung!
Den Gleitring (1) beim Anziehen der Gewindestifte (3) an die Wellenschulter drücken, ohne dabei die Gleitfläche zu berühren!

- Neuen Gegenring (2) mit eingebautem O-Ring mit sauberem Kältemaschinenöl benetzen. Anschließend Gegenring von Hand in den Abschlussdeckel (5) eindrücken

Achtung!
Dichtfläche beim Eindrücken nicht beschädigen! Zum Schutz einen sauberen Lappen verwenden.

- Neuen O-Ring (4) in die Nut des Abschlussdeckels (5) einlegen
- Die Dichtflächen des Gleitrings (1) und des O-Rings (4) ausreichend mit sauberem Kältemaschinenöl benetzen
- Abschlussdeckel (5) auf die Welle schieben und durch gleichmäßiges Anziehen der Schrauben montieren (Anzugsmoment 25 Nm)

Achtung!
Die Austrittsbohrung für das Leckageöl am Abschlussdeckel muss sich dabei in 1-Uhr-Stellung befinden! (siehe Abb. 3, Pos. B)

- Neuen Filzring (10) und Bandage (11) montieren
- Verdichterwelle einige Umdrehungen von Hand durchdrehen
- Verdichter evakuieren
- Absperrventile öffnen
- Dichtheitsprüfung durchführen

Attention!
Press the sliding ring (1) when tightening the set screws (3) on the shaft shoulder, without touching the sliding surface!

- Moisten the new the stationary ring (2) with the mounted O-ring with clean refrigeration compressor oil. Afterwards push the stationary ring manually into the sealing cover (5)

Attention!
Do not damage the sealing surface when driving in! For protection, use a clean rag.

- Lay the new O-ring (4) in the groove of the sealing cover (5)
- Moisten the sealing surfaces of the sliding ring (1) and the O-ring (4) sufficiently with clean refrigeration compressor oil
- Push sealing cover (5) on the shaft and mount by uniformly tightening the screws (tightening torque 25 Nm)

Attention!
The exit hole for the leakage oil at the sealing cover must be located in the 1 o'clock position! (see Fig. 3, Pos. B)

- Mount the new felt ring (10) and bandage (11)
- Rotate the compressor shaft several times by hand
- Evacuate the compressor
- Open the shut-off valves
- Perform tightness test

Attention !
Lors du serrage des vis sans tête (3), appuyer la bague de glissement (1) contre le collet de l'arbre sans toucher la surface de glissement !

- Humidifier la bague fixe neuve (2) avec le joint annulaire monté (4) avec de l'huile propre pour machine frigorifique. Ensuite enfoncer avec la main la bague fixe (2) dans le couvercle de fermeture (5)

Attention !
Ne pas endommager la surface d'étanchéité lorsque l'enfoncer ! Utilisez un chiffron propre pour la protéger.

- Insérer le nouveau joint annulaire (4) dans la rainure du couvercle de fermeture (5)
- Humidifier les surfaces d'étanchéité de la bague de glissement (1) et de joint annulaire (4) avec suffisamment d'huile propre pour machine frigorifique
- Glisser le couvercle de fermeture (5) sur l'arbre et monter en serrant uniformément les vis (couple de serrage 25 Nm)

Attention !
L'orifice de sortie pour l'huile de fuite dans le couvercle de fermeture doit se trouver en position 1 heures ! (voir Fig. 3, Pos. B)

- Monter la baque feutre neuve (10) et le bandage (11)
- Tourner l'arbre du compresseur de quelques tours avec la main
- Mettre le compresseur sous vide
- Ouvrir les vannes d'arrêt
- Effectuer un essai d'étanchéité

Magnetkupplung montieren

- Magnet so montieren, dass sich das Anschlusskabel in ursprünglicher Position befindet (Anzugsmoment 25 Nm)
- Kupplung auf die Welle schieben. Dabei darauf achten, dass die Nut der Kupplung auf die in der Welle sitzende Feder geschoben wird
- Zentrale Befestigungsschraube der Kupplung anziehen (Anzugsmoment 85 Nm)

Achtung!
Ölablaufschlauch nicht quetschen!

Mounting the magnetic clutch

- Mount the magnet in such a way that the connection cable is located in the original position (tightening torque 25 Nm)
- Push the clutch on the shaft. Thereby, ensure that the groove on the clutch is pushed over the key seated in the shaft
- Tighten the central fastening screw of the clutch (tightening torque 85 Nm)

Attention!
Do not squeeze the oil drain tube!

Monter l'embrayage électromagnétique

- Monter l'aimant de sorte que le câble de raccordement se trouve en position initiale (couple de serrage 25 Nm)
- Glisser l'embrayage sur l'arbre. Veillez à ce que la rainure de l'embrayage soit glissée sur le ressort se trouvant dans l'arbre
- Serrer la vis de fixation centrale de l'embrayage (couple de serrage 85 Nm)

Attention !
Ne presser pas le tuyau flexible de drainage de l'huile !

Abschließende Arbeiten

- Riemen montieren, spannen und auf Fluchtung prüfen
- Anlage wieder in Betrieb nehmen
- Falls nötig, Kältemittel nachfüllen

Für detaillierte Beschreibungen zum Ein- und Ausbau des Verdichters sowie zum Austausch der Magnetkupplung siehe KW-540 Kapitel 6.1 und 6.2

Final work

- Mount the belt, apply tension and check for axial alignment
- Put the plant in operation again
- Add refrigerant, if necessary

Refer to KW-540 chapter 6.1 and 6.2 for detailed descriptions on how to fit and dismantle the compressor as well as how to exchange the magnetic clutch

Travaux de finition

- Remonter la courroie, la tendre et contrôler l'alignement
- Remettre la machine en service
- Si nécessaire, renouveler la fluide frigorigène

Pour obtenir des descriptions détaillées sur le montage et le démontage du compresseur ainsi que sur le remplacement de l'embrayage électromagnétique, voir KW-540, chapitre 6.1 et 6.2

Kontrolle

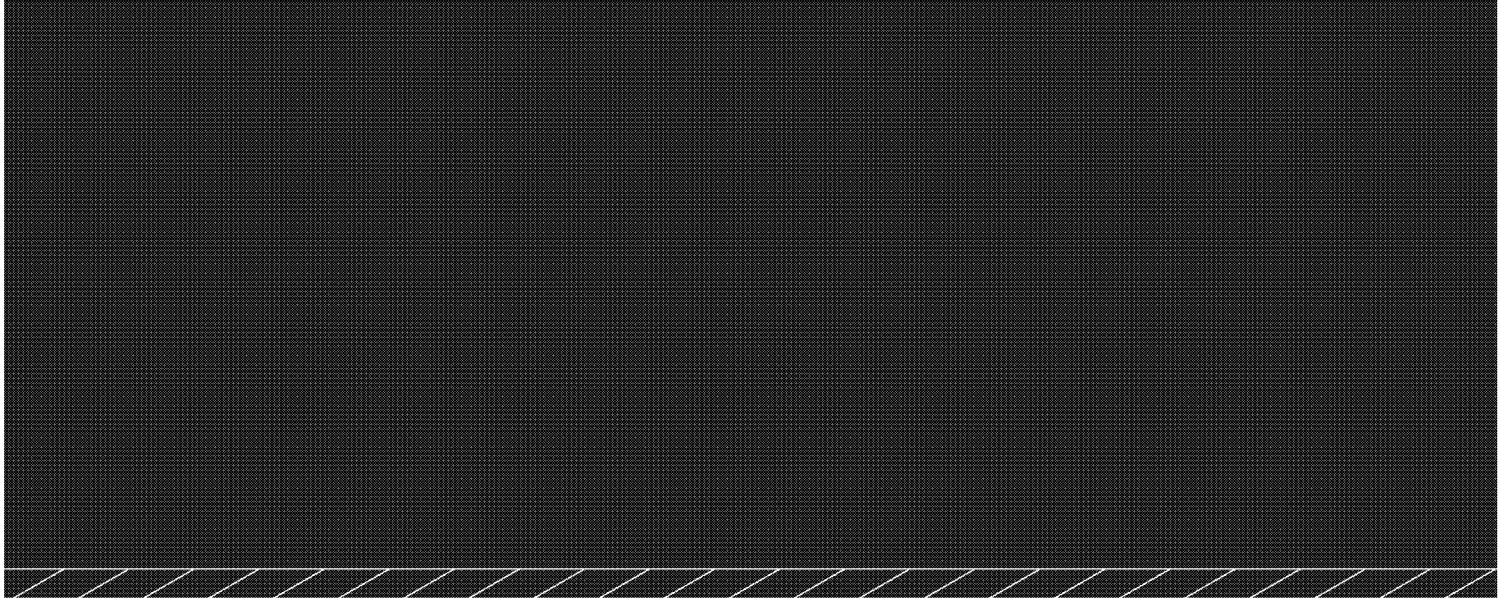
- Dichtheitsprüfung
- Betriebsdaten der Anlage bei verschiedenen Verdichter-Drehzahlen überprüfen und protokollieren:
  - Verdichterdrehzahl
  - Verdampfungsdruck und -temperatur
  - Sauggasüberhitzung
  - Verflüssigungsdruck und -temperatur
  - Öltemperatur, gemessen am Ölablass-Stopfen
  - Ölstand im Schauglas

Check

- Tightness test
- Check and record the plant's operating data under different compressor speeds:
  - Compressor speed
  - Evaporation pressure and temperature
  - Suction gas superheat
  - Condensing pressure and temperature
  - Oil temperature, measured near oil drain plug
  - Oil level in sight glass

Contrôle

- Essai d'étanchéité
- Vérifier et consigner les caractéristiques de fonctionnement de l'installation à différentes vitesses de rotation du compresseur:
  - Vitesse de rotation du compresseur
  - Pression et température d'évaporation
  - Surchauffe du gaz d'aspiration
  - Pression de liquéfaction et température de condensation
  - Température d'huile, mesurée au niveau du bouchon de vidage d'huile
  - Niveau d'huile dans le voyant



BITZER Kühlmaschinenbau GmbH
Eschenbrünnlestraße 15 // 71065 Sindelfingen // Germany
Tel +49 (0)70 31 932-0 // Fax +49 (0)70 31 932-147
bitzer@bitzer.de // www.bitzer.de

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THE HEART OF FRESHNESS

MAINTENANCE INSTRUCTIONS

WARTUNGSANLEITUNG

INSTRUCTION DE MAINTENANCE

KW-550-3

Anzugsdrehmomente für Schraubenverbindungen bei Aluminium-Verdichtern

Tightening Torques for Screw Fixing Aluminium Compressors

Couples de serrage pour assemblages vissés compresseurs de aluminium

Absperrventile	**Shut-off valves**	**Vannes d'arrêt**
M8 ① M10 ①		30 Nm 54 Nm
Blindflansch	**Blind flange**	**Bride d'obturation**
M8 ①, ② M10 ①, ④		30 Nm 54 Nm
Gegenflansch	**Companion flange**	**Contre-bride**
M8 ①, ② M10 ①		30 Nm 45 Nm
Schraderventil	**Schrader valve**	**Vanne Schrader**
1/8"-27 NPTF 1/4"-18 NPTF		10 .. 13 Nm 20 .. 23 Nm
Zylinderkopf	**Cylinder head**	**Tête de culasse**
M10 ①, ②, ③		70 Nm
Bodenplatte	**Bottom plate**	**Plaque de fond**
M8 ①, ③ M8 ②, ③ M10 ①, ③		30 Nm 25 Nm 54 Nm
Abschlussdeckel	**Sealing cover**	**Couvercle de fermeture**
M8 ③		25 Nm
Lagerdeckel / Gehäusedeckel	**Bearing cover / housing cover**	**Couvercle de palier / de corps**
M8 ①, ③ M8 ②, ③ M10 ①, ③		30 Nm 25 Nm 54 Nm
Pumpendeckel	**Pump cover**	**Couvercle de la pompe**
M8 ④		10 Nm
Stromdurchführung	**Terminal plate**	**Plaque à bornes**
M6 ①, ②		11 Nm

① mit Faser-Dichtung	① with fibre gasket	① avec joint plat des fibres
② mit Metall-Dichtung	② with coated metal gasket	② avec joint métallique revêtu
③ mit Unterlegscheibe	③ with washer	③ avec rondelle
④ mit O-Ring	④ with O-ring	④ avec joint annulaire

Druckentlastungs-Ventil	Pressure relief valve	Soupape de décharge
3/4"-14 NPTF		15 .. 20 Nm
Öldruckentlastungs-Ventil	**Oil pressure relief valve**	**Soupape de décharge d'huile**
M12x1		1 .. 1,5 Nm
Schauglas	**Sight glass**	**Voyant**
1 1/8"-18 UNEF		60 Nm
M24x1		50 .. 60 Nm
Ölablass	**Oil drain**	**Vidage d'huile**
M22x1,5		50 .. 70 Nm
Ölsumpftrockner	**Oil drier**	**Déshydrateur d'huile**
M22x1,5		50 .. 60 Nm
Einschraub-Stutzen für Ölsumpfheizung	**Screwed socket for crankcase heater**	**Manchon à vis pour résistance de carter**
M22x1,5		50 .. 60 Nm
Service-Anschluss am Absperrventil	**Service connection at shut-off valve**	**Raccord de service à vanne d'arrêt**
7/16"-20 UNF		max. 10 Nm
Wellenabdichtung Gewindestifte	**Shaft seal set screws**	**Garniture d'étanchéité les vis sans tête**
M5		2,5 Nm
Magnetkupplung	**Magnetic clutch**	**Accouplement magnétique**
Schrauben und Muttern / Screws and nuts / Vis et écrous	M8	25 Nm
Spannschraube / Straining screw / Vis de serrage	M10	80 Nm
Spannschraube / Straining screw / Vis de serrage	M12	85 Nm
Ölauffang-Behälter	**Oil collection chamber**	**Chambre collectrice d'huile**
M5		4 Nm
M6		2,5 Nm
M10		40 Nm
Verschluss-Stopfen & -Schrauben	**Sealing plugs & screws**	**Bouchons & vis de fermeture**
1/8"-27 NPTF		10 .. 13 Nm
1/4"-18 NPTF		20 .. 23 Nm
M20x1,5		50 .. 60 Nm
M36x1,5		50 .. 60 Nm
Druckausgleichs-Ventil ⑤	**Pressure equalising valve ⑤**	**Soupape d'égalisation de pression ⑤**
G 1/2		40 Nm
Ausgleichsgewicht	**Balance weight**	**Poids d'équilibrage**
M6		16 Nm
M8		35 Nm
M10		40 Nm
Rotorschraube	**Rotor screw**	**Vis de rotor**
M12		20 Nm
Sauggas-Leitblech	**Suction gas turning vane**	**Tôle de chicane pour gaz aspiré**
M6		9 Nm

⑤ zw. Kurbelgehäuse und Saugkammer ⑤ between crankcase and suction chamber ⑤ entre carter et chambre d'aspiration

BITZER Kühlmaschinenbau GmbH // Eschenbrünnlestraße 15 // 71065 Sindelfingen // Germany
Tel +49 (0)70 31 932-0 // Fax +49 (0)70 31 932-147 // bitzer@bitzer.de // www.bitzer.de

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SECTION 23: ACCESSORIES

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1. DESCRIPTION OF AUDIO AND VIDEO SYSTEM INSTALLED ON X3-45 COACHES

The rack mounted components are gathered on the audio-video panel which is located in the first driver's side overhead compartment (Fig. 1). In addition to the power amplifier, options for AM/FM radio, satellite radio, karaoke, wireless microphone, DVD, scenic view and back-up camera system and GPS Navigation System module may be featured.

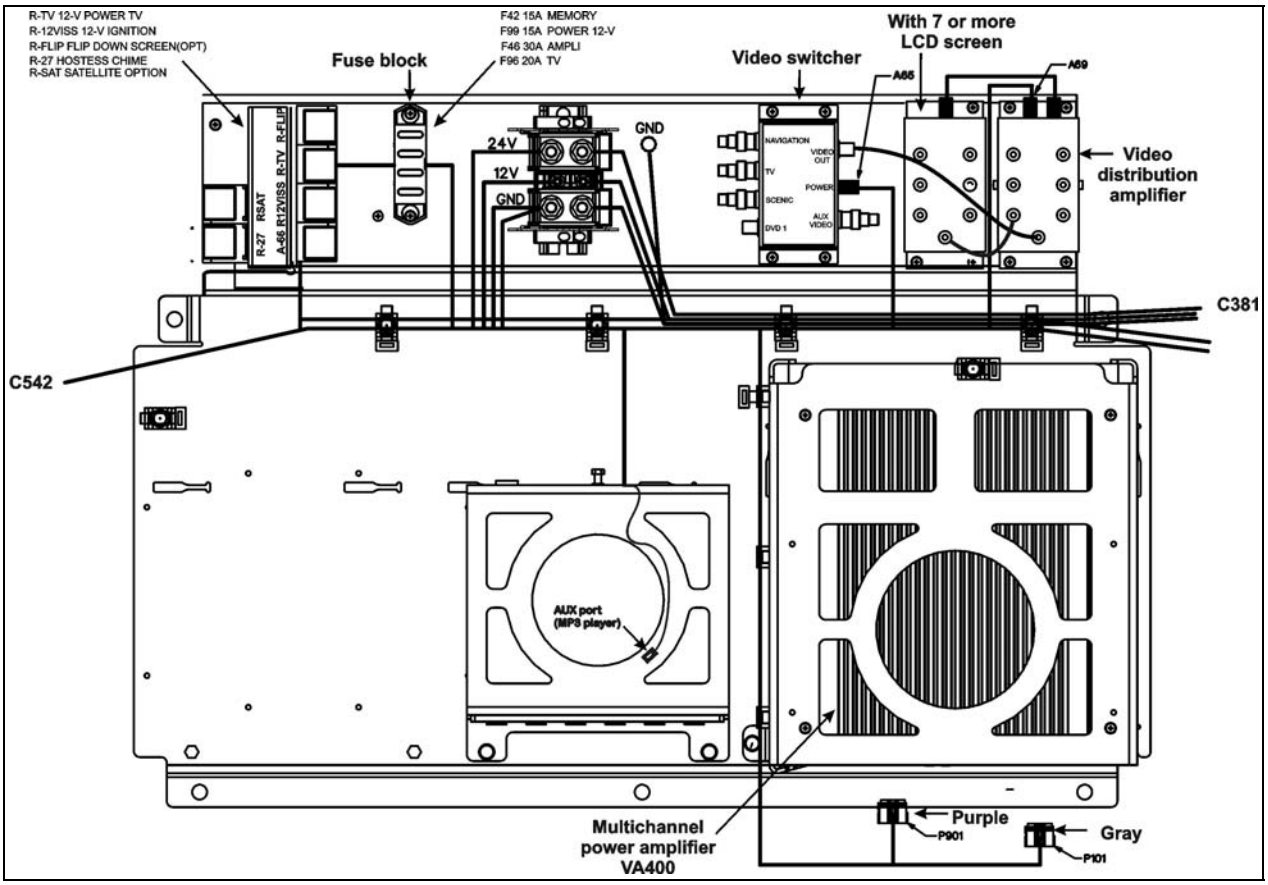


FIGURE 1 : AUDIO-VIDEO PANEL

Each service module mounted to the underside of the parcel racks contains a 40-watt speaker. The speakers in the passenger section are wired in stereo and are powered by the amplifier. A microphone outlet mounted in the driver's area is provided as standard equipment.

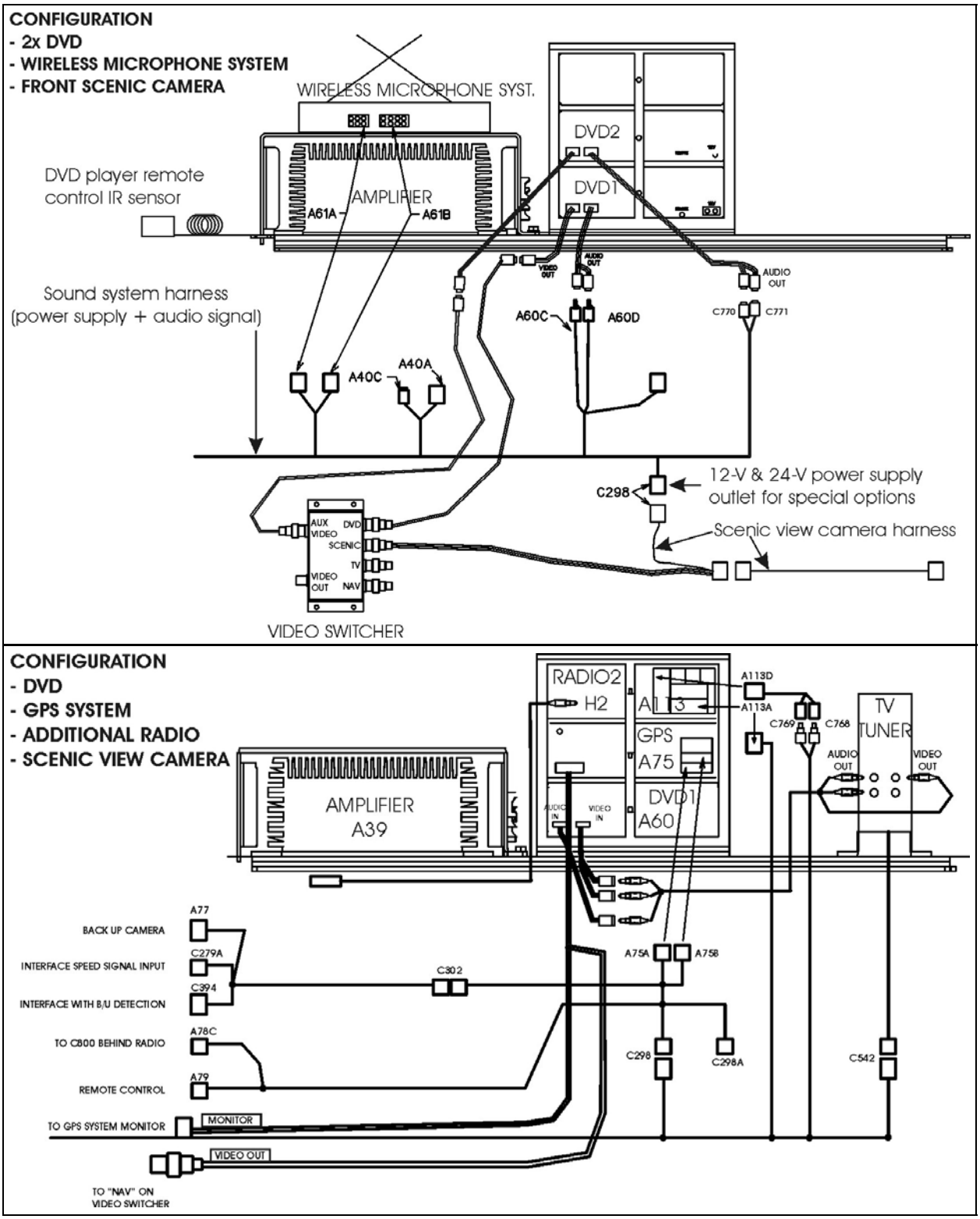


FIGURE 2: AUDIO & VIDEO CONNECTIONS

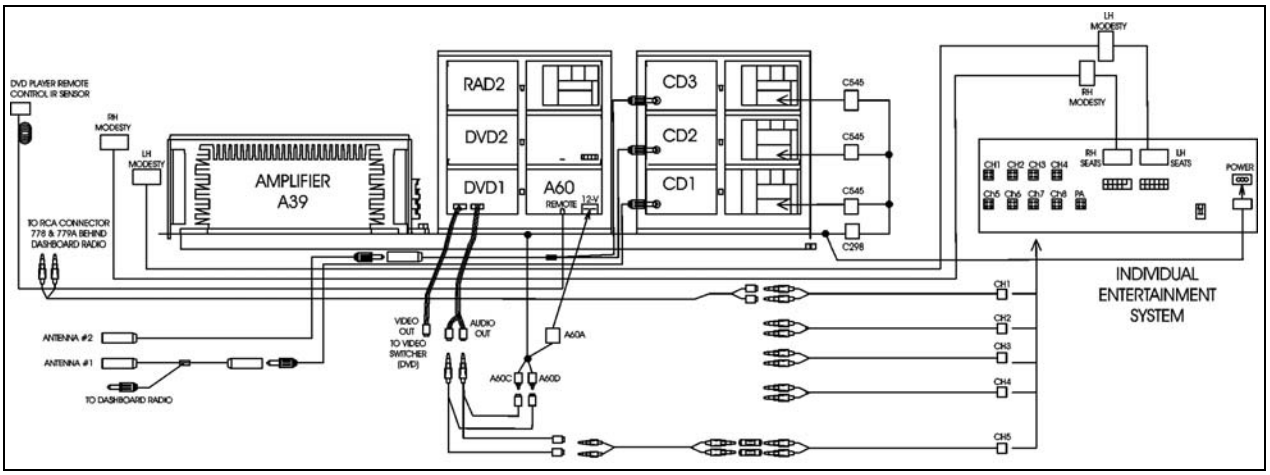


FIGURE 3: AUDIO-VIDEO CONNECTIONS

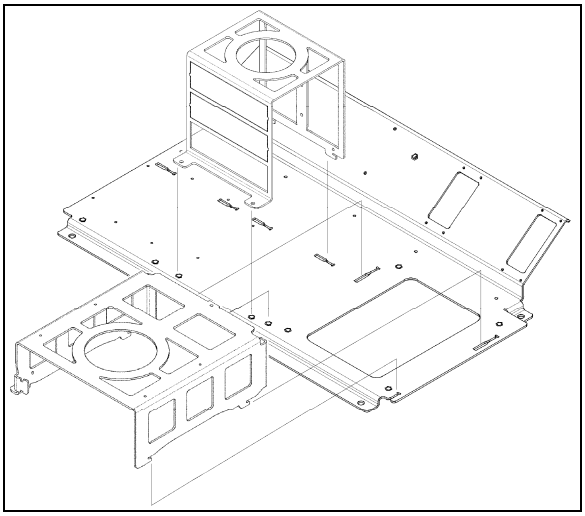


FIGURE 4: RACKS ON AUDIO-VIDEO PANEL 23059

1.1 DASHBOARD AM/FM RADIO

FIGURE 5: DASHBOARD AM/FM RADIO

NOTE
Before attempting to solve an electrical problem on the sound system, refer to the wiring diagrams.

The radio operating instructions manual is included at the end of this section.

- Removal/Installation

To remove the radio from its location, proceed as follows:

- Place the ignition switch in the ''OFF'' position.
- Remove the dashboard cover.
- Disconnect the electrical cable connectors from radio and unfasten back plate securing nuts/screws.
- To separate the radio from its support, insert the removal tool #20584494 in the holes found each side of the radio front panel.
- Push the unit through the front dashboard panel.
- Install a new unit by reversing the procedure.

NOTE
Remember that because power has been interrupted during removal, the radio must be unlocked by entering the four-digit security code after reinstallation.

1.2 VSS-05 SOUND SELECTOR

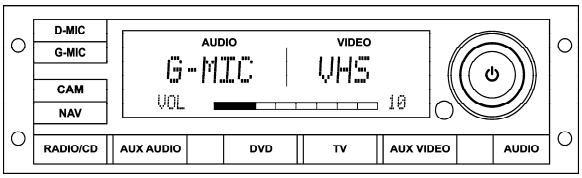


FIGURE 6: VSS-05 SOUND SELECTOR

- Removal/Installation

To remove the Sound Selector from its location, proceed as follows:

* Place the ignition switch in the ''OFF'' position.
* Remove the dashboard cover.
* Disconnect the electrical connectors from unit and unfasten back plate securing nut/screw.
* To separate the Sound Selector from its support, insert the removal tool #20584494 in the holes found each side of the unit front panel.
* Push the unit through the front dashboard panel.
* Install a new unit by reversing the procedure.

The operating instructions are included in your Operator's Manual.

1.3 VD-404 MOBILE DVD PLAYER

FIGURE 7: VD-404 MOBILE DVD PLAYER

The MOBILE DVD PLAYER is located in the first parcel compartment on the driver's side. Instructions for proper use of this unit are included at the end of this section.

Features:

- POWER

  Operating voltage: 12-volt DC

- COMPATIBILITY

  This DVD player can play the following disc formats:
  DVD, CD, VCD, DVCD, MP3, CD-R, CD-RW

- SYSTEM FUNCTIONS

  Video output system: system MULTI, NTSC or PAL switchable.

  1 L/R audio output
  1 L/R audio input
  1 AUX video output
  1 rear camera video input
  3 video outputs with one dedicated self switching rear view monitor

- ADDITIONAL VIDEO FEATURES

Multi-angle, multi-view, multi-audio function, multi-level forward and backward motion, play position memory, resume stop and repeat function.

1.4 MULTICHANNEL POWER AMPLIFIER VA400.8

This 400-watt, 6-channels brings an added dimension to your stereo equipment and increases the total output of the system.

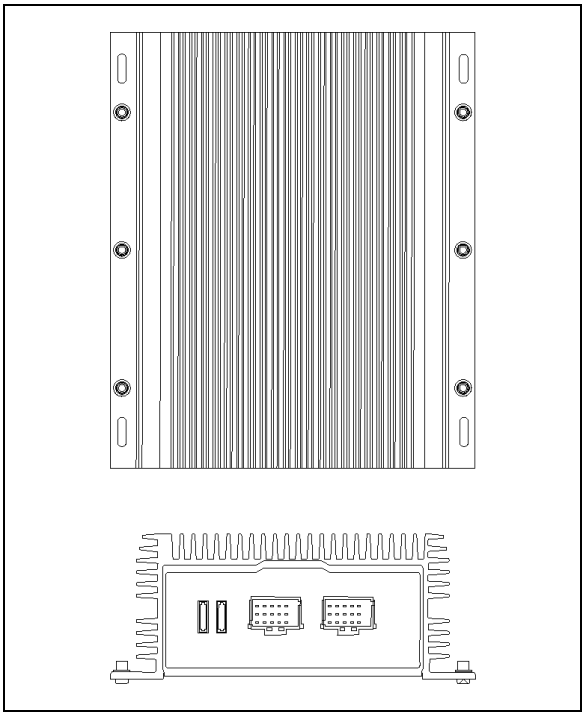


FIGURE 8: MULTICHANNEL POWER AMPLIFIER

For optimum sound quality, adjust the subwoofer crossover filter as shown on figure 10. This adjustment is necessary to balance the subwoofers volume in respect to the other speakers and also to cut high frequencies for a better sound quality.

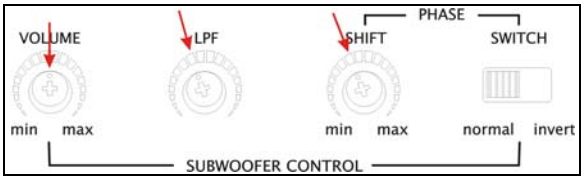


FIGURE 9: CROSSOVER ADJUSTMENT

1.5 SPEAKERS

Each passenger's overhead console mounted to the underside of the parcel racks contains a 20-watt Dual cone or coaxial 10cm speaker. The speakers in the passenger's section, wired in stereo and arranged in a delta configuration are powered by the amplifier.

FIGURE 10: 10CM COAXIAL SPEAKER

The vehicle may be equipped with two additional Hi-Fi speakers in the driver's area, mounted one on each side. This arrangement provides the driver with clear stereo sound. Controls for the driver's audio are performed through the dashboard AM/FM radio.

Two specially designed subwoofers may be fixed as an option under a passenger seat with anti-vibration supports.

1.6 BOOM-TYPE MICROPHONE

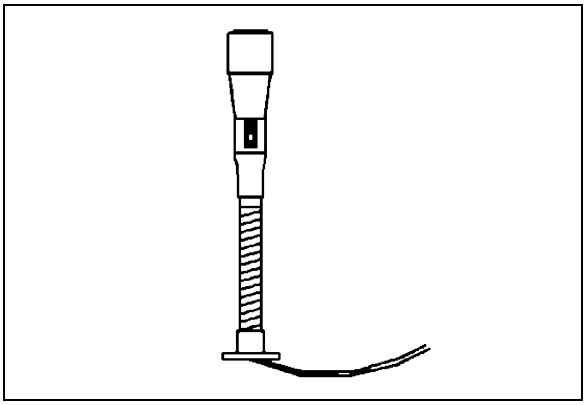


FIGURE 11: BOOM-TYPE MICROPHONE **23083**

1.6.1 Removal

1. Place the ignition switch in the ''OFF'' position.
2. Remove the mounting screws at mounting flange.
3. Disconnect wiring.

1.6.2 Installation

1. Reconnect wiring.
2. Align mounting flange with holes and install screws.
3. Remove spacer block mounting screws.
4. Insert spacer block and install mounting screws.
5. Place the ignition switch in the ''ON'' position.

1.7 HANDHELD PRIORITY MICROPHONE

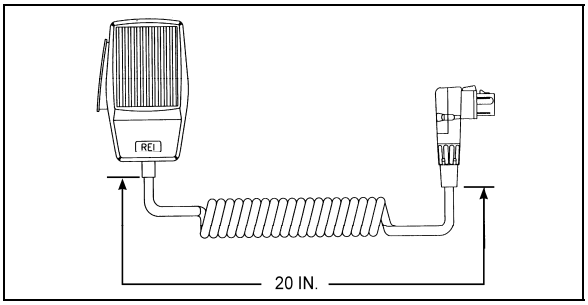


FIGURE 12: HANDHELD PRIORITY MICROPHONE 23216

1.8 WIRELESS MICROPHONE

The system 2000 16 channel wireless micro-phone, Receiver and Charging Cradle are custom designed units that allow for wireless PA communication from anywhere on the coach. The unit consists of a receiver mounted in the parcel area directly behind the driver, and a rechargeable hand-held microphone and charging unit. Instructions for proper use of the microphone are included in the *''REI Operating Manual''* which is provided in the technical publications box delivered with the vehicle.

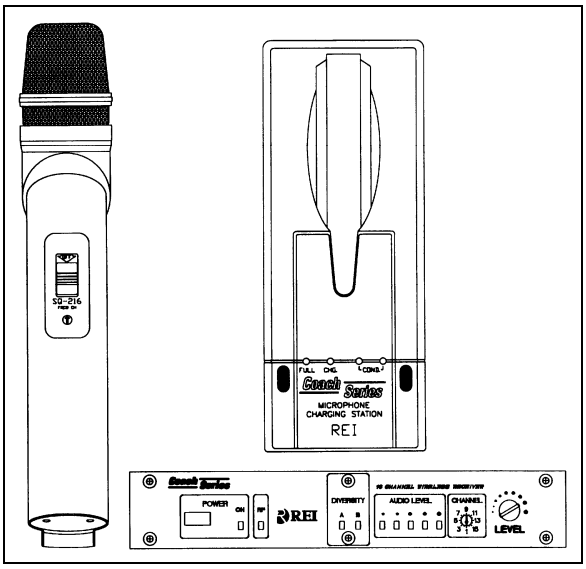


FIGURE 13: WIRELESS MICROPHONE

1.9 TV TUNER

For TV tuner control descriptions, refer to fig. 14.

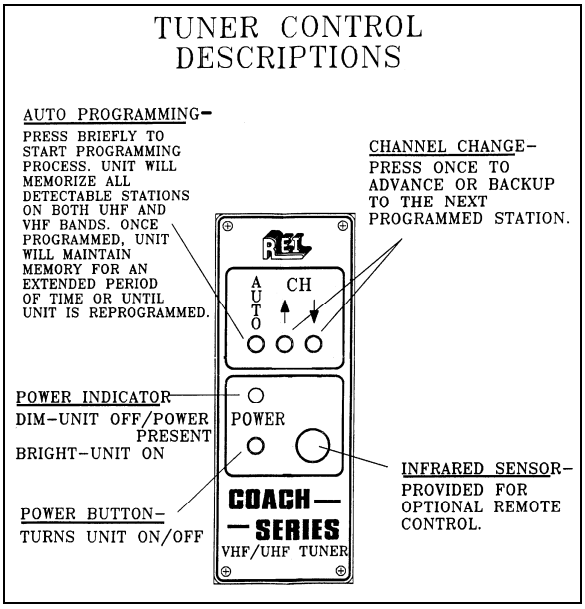


FIGURE 14: TUNER CONTROLS DESCRIPTION

1.10 KARAOKE

The modified Panasonic DVD Player powers up automatically when the video system is activated. The unit can be controlled with the plug-in remote control, or the control head, which has access to the PLAY and STOP commands.

If so equipped, instructions for proper use of the Karaoke system are included in the *''Operating Manual''* that is provided in the technical publications box delivered with the vehicle.

1.10.1 Karaoke Panasonic Sound System – MOBILE DVD PLAYER DV1500

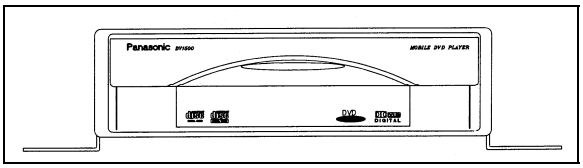


FIGURE 15: PANASONIC DV1500

1.11 DRIVER'S SPEAKERS

The driver's speakers are mounted one on each side. This arrangement provides the driver with clear stereo sound. Controls for the driver's audio allow selection between the radio and the auxiliary audio (independent of the passenger's speakers) or muting the speakers.

1.12 MONITOR

1. Place the ignition switch in the ''OFF'' position.
2. Unfasten the retaining screw located on the monitor R.H. side.
3. Slide the monitor to the right to release it from the mounting bracket.

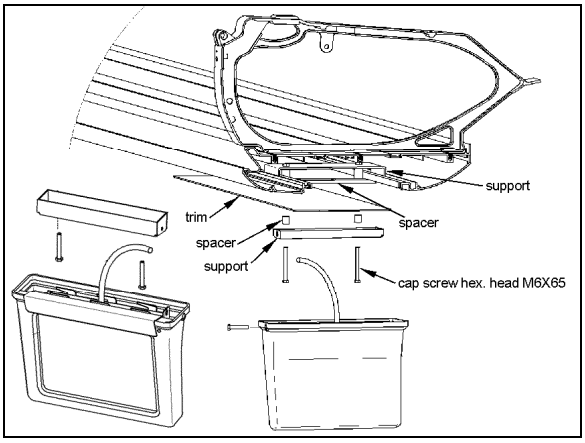


FIGURE 16: MONITOR MOUNTING **23221**

1.13 SCENIC VIEWING SYSTEM

The scenic viewing system enables the passengers to view the road ahead of the vehicle. This system is composed of a camera, a dashboard mounted ON/OFF switch and the video switcher located on the audio-video panel (Figs. 1 & 17).

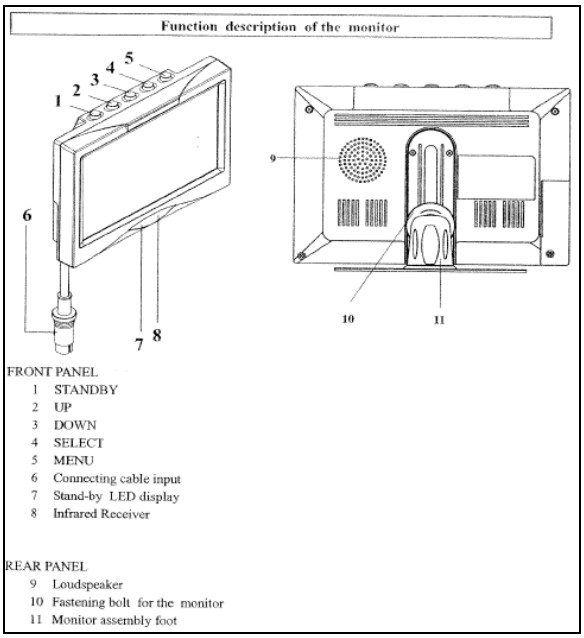
FIGURE 17: SCENIC VIEW CAMERA

1.14 ROOF ANTENNA INSTALLATION

1. Find the desire location and drill a hole according to specification.
2. To remove dirt and grease, wash edge of hole with alcohol.
3. If so equipped, remove foam padding ring from antenna to free the metal surface (foam can produce air bulbs in new rubber seal).
4. With SIKA 205, wash the opening edge and the antenna base surface, wait at least two (2) minutes for chemical evaporation.
5. Apply new seal SIKA 221 on both, vehicle hole edge and antenna base.
6. Fix the antenna in place.
7. Remove excess seal and complete a finishing joint all around the antenna base.

2. BACK-UP CAMERA AND MONITOR

An optional back-up camera is available which provides the driver with visual assistance when backing-up. The camera is automatically activated when the transmission is put in reverse gear and the ignition switch is "ON".



BUTTON DESCRIPTION

1) STANDBY: On/Off switch

2) UP: This key has 3 functions

- Increase of the volume during normal operation;
- Modification of the setting within a function e.g. contrast (after calling up the menu);
- By pressing this key when putting in the reverse gear, the distance markings move upwards;

3) DOWN: This key has 3 functions

- Decrease of the volume during normal operation;
- Modification of the setting within a function e.g. contrast (after calling up the menu);
- By pressing this key when putting in the reverse gear, the distance markings move downwards;

4) SELECT: This key has 3 functions

- Selection of the video sources (CA1→ CA2 → AV → CA1). Press less than 1.5 seconds;
- Selection of the functions e.g. picture setting (after calling up the menu);
- Deleting and calling OSD letters of title & time (press longer than 1.5 seconds) during normal operation;

5) MENU: This key has 2 functions

- Activation of the dimmer function (press less than 1.5 seconds) during normal operation;
- Calling up the menu (press longer than 1.5 seconds, four menus can be called up). Press the key once again to call up the individual menus;
  a) PICTURE= Functions for the image setting;
  b) USER= Selection of the system function;
  c) TIME= Setting time and date;
  d) INSTALL= Setting the camera function (e.g. mirror function);

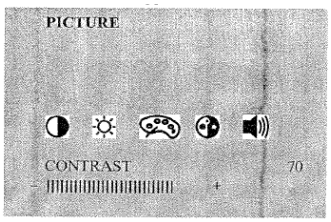
6) BUSH FOR THE MONITOR CABLE OF THE CONNECTION BOX

7) STANDBY DISPLAY

8) INFRARED RECEIVER

MONITOR MENU DISPLAY

The monitor (RV59 HD) is equipped with an On-Screen Display (OSD) function which displays date, camera, channel, mirror mode and distance markings. These functions can be selected on MENU. To calling up the menu, press longer than 1.5 seconds. Four menus can be called up. Press the key once again to call up the individual menus.
For calling up the menu PICTURE press the key **MENU** longer than 1.5 seconds. The menu PICTURE appears.



Graphic means the followings.

→ CONTRAST
→ BRIGHTNESS
→ COLOR
→ TINT
→ VOLUME

Select the function (e.g. contrast) by pressing the key **SELECT** repeatedly. The setting within the function can be modified with the keys **UP** and **DOWN**.

For calling up the menu USER press the key **MENU** once again. The menu USER appears. Select the function (e.g. SELECTION) by pressing the key **SELECT** repeatedly as necessary. The setting within the function can be modified with the keys **UP** and **DOWN**.

USER	POSSIBLE SETTINGS:
LANGUE ENG	LANGUAGE: ENGLISH/GERMAN (ENG/DEUT)
SCREEN WIDE	SCREEN FORMAT: NOR 4:3, picture format 4:3 WIDE, picture format 16:9 FULL, picture format 16:9 middle enlarge
TITLE ON	TITLE: CAMERA TITLE DISPLAY ON/OFF
TIME ON	TIME: TIME DISPLAY ON/OFF

For calling up the menu TIME press the key **MENU** once again. The menu TIME appears. Select the function (e.g. DATE) by pressing the key **SELECT** repeatedly as necessary. The setting within the function can be modified with the keys **UP** and **DOWN**.

TIME	
TIME 08:25	- Hour-Month adjustable by UP BUTTON
DATE MAY01	- Minute/Date adjustable by DOWN BUTTON
YEAR 2005	- Year adjustable by UP/DOWN BUTTON

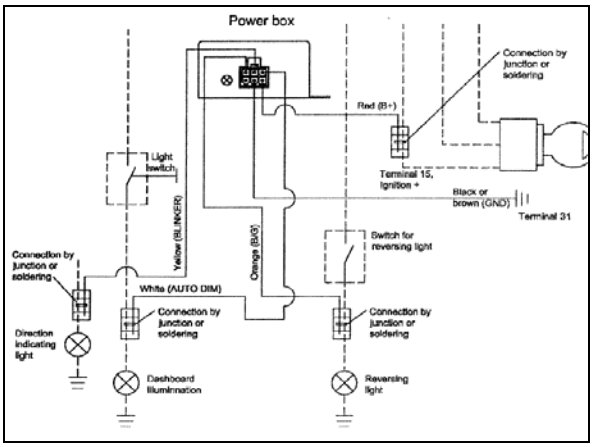
For calling up the menu INSTALL press the key **MENU** once again. The menu TIME appears. Select the function (e.g. SELECTION) by pressing the key **SELECT** repeatedly as necessary. The setting within the function can be modified with the keys **UP** and **DOWN**.

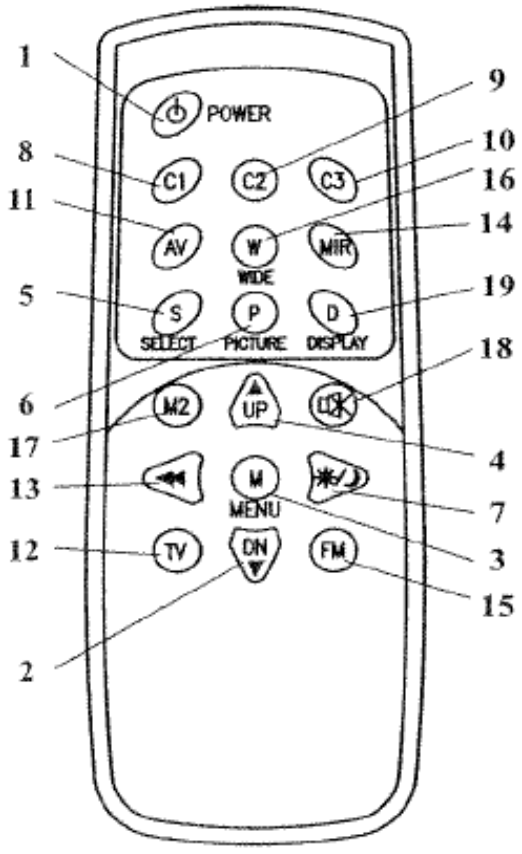
INSTALL	POSSIBLE SETTINGS:
REAR CAM1	REAR: Selection of priority camera (CAM1 or CAM2) which is triggered by rear gear.
CAM1 MIR	CAM1: Selection of real picture or mirrored picture for camera 1
CAM2 NOR	CAM2: Selection of real picture or mirrored picture for camera 2
	NOTE1 The distance mark will appear on the picture of camera which set as MIR (mirrored).
	NOTE2 Engaging the reverse gear, only distance mark will appear on the mirrored camera picture without any OSD. At the moment, no keys are available except UP/DOWN key for moving distance bar.

BACK-UP CAMERA MODULE (Power box)

The connection line consists of 6 branch lines as below:

RED	Voltage supply 12-volt to 24-volt (max. 32-volt)
BLACK/BROWN	Earth cable
WHITE	Control wire for switching on the dimmer function (night operation)
YELLOW	Control wire for switching on the side camera. The connection is to be made at the INDICATOR
ORANGE	Control wire for switching on the reversing camera. The connection is to be made at the reversing light





No	Key	Description
1	STANDBY	On/Off switch
2	DOWN▼	This key has 3 functions. – Decrease of the volume during normal operation. – Modification of the setting within a function e. g. brightness (after calling up the menu). – By pressing this key when putting in the reverse gear the distance markings move downwards.
3	MENU	Calling up the menu on the screen. Three menus can be called up : a: PICTURE = Functions for the image setting b: USER = Selection of the system function c: TIME = Setting time and date d: INSTALL = Setting the camera function (e.g. mirror function)
4	UP ▲	This key has 3 functions. – Increase the volume during normal operation – Modification of the settings within a function e. g. contrast (after calling up the menu) – By pressing this key when putting in the reverse gear the distance markings move upwards.
5	SELECT	This key has 2 functions Selection of the video sources (CA1→CA2→AV) Selection of the functions e.g. picture setting (after calling up the menu)
6	PICTURER	Calls up the functions CONTRAST, BRIGHTNESS etc. directly for the picture setting. Carry out the setting with the key UP or DOWN.
7	DIMMER	Regulates the brightness to night operation temporarily
8	C1	Selection of the camera 1
9	C2	Selection of the camera 2
10	C3	Selection of the camera 3 (camera input 3 is not available))
11	AV	Selection of the video input (RCA)
12	TV	Not available
13	SEARCH	Not available
14	MIRROR	Reversing left and right of picture temporarily
15	FM	Not available
16	WIDE	Setting of the screen format NOR/NOR: 4:3, picture format 4:3 WIDE/WEIT, picture format 16:9 FULL/BREIT, picture format 16:9 middle enlarged
17	MONITOR2	Not available
18	MUTE	Switches off the tone temporarily
19	DISPLAY	This key has 2 functions – Deleting or calling OSD letters of Tile & Time temporarily – Leaving the menu

3. HUBODOMETER

3.1 DESCRIPTION

An optional wheel hubodometer (Fig. 18) may have been installed on the R.H. side of the drive axle. It indicates the total distance in miles or kilometers covered by the coach since it has left the factory, including road testing.

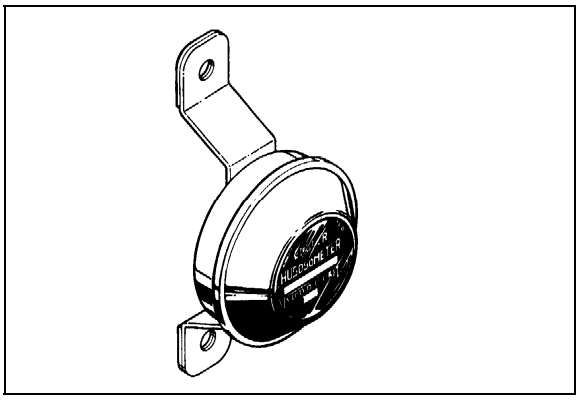


FIGURE 18: HUBODOMETER 23024

3.2 OPERATION

The hubodometer is calibrated for a specific wheel size (diameter). Wheel rotation causes a mechanism inside the hubodometer to record distance after a predetermined number of rotations. The unit should be serviced at a competent speedometer repair facility.

NOTE
Do not use paint, solvent or thinner on hubodometer face or on plastic hubcaps. Do not weld on hubodometer.

3.3 REMOVAL

To remove the unit, remove the two lock nuts and washers securing it to the wheel hub, and pull the unit off the studs.

3.4 INSTALLATION

Place the hubodometer unit over the wheel hub studs. Replace the lock washers and nuts. Torque stud nuts to 110-165 Lbf-ft·(150-225 Nm).

4. ELECTRONIC DESTINATION SIGN INSTALLED ON X3-45 COACHES (OPTIONAL)

The optional destination sign is located at upper front of the vehicle. To change the destination, depress the selecting switches until the desired destination appears in the LCD display.

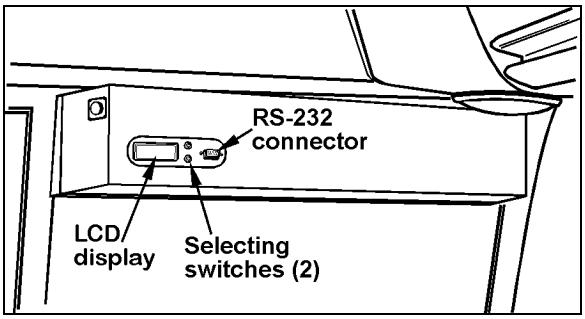


FIGURE 19; DESTINATION SIGN – ELECTRONIC23123

NOTE
The destination sign must be programmed with a computer connected to the RS-232 connector prior to first use. Follow the instructions on the computer disk to install and run the software.

NOTE
The destination sign is equipped with lights (bulb light or fluorescent) which illuminates automatically when the headlight or fog light switch is activated.

5. WINDSHIELD SUNSHADES

Two electrically-operated sunshades are installed in the driver's area at the top of the windshields. Two control buttons located on the steering wheel operate each sunshade individually. Refer to Operator's Manual: "Controls and Instruments" chapter for more information.

Caution: *The electric sunshades should only be operated electrically. Pulling down manually may damage the mechanism.*

5.1 END OF STROKE ADJUSTMENT

The sunshades end positions are pre-adjusted at factory. If an adjustment is required, proceed as follows:

1. Place the ignition key to the ON position.
2. Insert a small nail or similar thin object into sunshade adjustment button access hole and press the appropriate steering wheel sunshade DOWN button **simultaneously** and hold them until a beeping tone sounds. Release both buttons.

FIGURE 20: DRIVER'S SUNSHADE

FIGURE 21: L.H. SUNSHADE CONTROL BUTTON

3. Move the sunshade to the desired lower end of stroke position using the steering wheel button (never move sunshade by hand) and then release button.
4. Proceed to fine adjustment of lower end position by pressing the DOWN button repeatedly.
5. Press the sunshade UP (opposite direction) button to save #1 end position. The confirmation tone will sound.
6. Move the sunshade to the desired upper end of stroke position using the steering wheel button (never move sunshade by hand) and then release button.
7. Proceed to fine adjustment of upper end position by pressing the UP button repeatedly.
8. Press the sunshade DOWN (opposite direction) button to save #2 end position. The confirmation tone will sound. The adjustment mode is then deactivated.

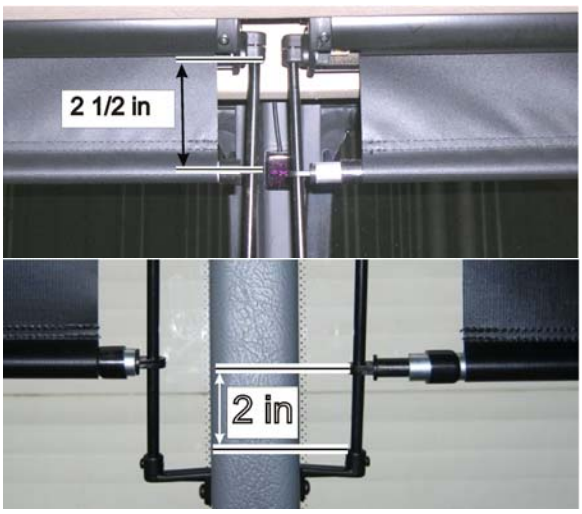


FIGURE 22: FACTORY ADJUSTMENT OF UPPER AND LOWER END POSITION

6. LAVATORY INSTALLED ON X3-45 COACHES

6.1 DESCRIPTION

The lavatory is located in the rear R.H. corner of the coach. It is equipped with a chemical flush toilet, bathroom tissue dispenser, washbasin, towel dispenser, waste container, mirror, ashtray, and a cleaning cabinet. A liquid soap dispenser and moist towel dispenser are optional.

Locking the lavatory door from the inside will illuminate a fluorescent light in the lavatory and two outside signs to indicate occupation. One sign is located on the outer wall of the lavatory and another sign is located over the windshield. An indicator light on the dashboard will illuminate to inform the driver when the lavatory is occupied. A night-light is permanently lit in the lavatory when the ignition switch is in the ON position.

If emergency assistance is required, the lavatory occupant can actuate a buzzer that will sound in driver's area. The buzzer's push-button (c/w instruction label) is located on the inner curbside wall of lavatory.

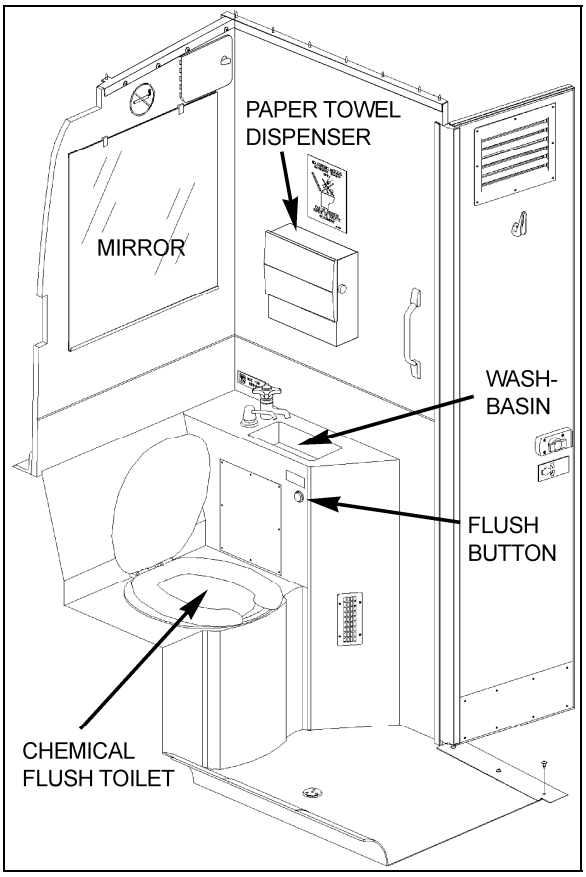


FIGURE 23: LAVATORY 23235

The lavatory has its own ventilation system that operates only when ignition switch is in the "ON" position.

The fresh water tank, located behind compartment mirror (Fig. 23), is equipped with a thermal drain valve that will drain the tank when water temperature approaches the freezing point preventing damage to the tank (Fig. 23). The fresh water supplies water to the washbasin by gravity. Two tubes are connected on top of the tank. One serves as overflow as well as a vent tube and runs along the curbside wall to the engine compartment R.H. side (Fig. 23) while the other tube is connected to the fresh water fill connection which is also located in engine compartment R.H. side (Fig. 23). A third tube connected in the bottom of the fresh water tank allows fresh water to flow to the washbasin faucet. Water from washbasin drain tube flows to the sump tank.

Also, a drain hole located on lavatory floor drain water splashed on the floor to the engine compartment R.H. side.

6.2 MAINTENANCE

The servicing procedure for the lavatory is described in the *"Operator's Manual"* included in the technical publications box delivered with the vehicle.

6.3 VENTILATION FAN

6.3.1 Description

The lavatory ventilation fan, mounted in engine compartment behind the oil reserve tank (Fig. 21), serves two purposes. It exhausts objectionable odors and provides a constant air circulation in the lavatory compartment by heating or cooling the lavatory with the vehicle ambient air. Air flows in the lavatory compartment through a vent grill located on the lavatory door and exhausts through a grill located next to the toilet.

NOTE
This fan runs constantly when the ignition switch located on the dashboard is in the "ON" position.

6.3.2 Maintenance

The frequency of preventive maintenance should be determined according to vehicle mileage and operating conditions. However, it is recommended to check this item every 50,000 miles (80 000 km) or once a year, whichever comes first.

Remove fan and motor assembly. Check for fan housing wheel and motor free operation. When defective motor occurs, new motor must be installed.

6.3.3 Removal and Installation

1. With the engine compartment rear doors opened, remove hose clamp securing duct to ventilation fan inlet, and disconnect duct.
2. Disconnect the ventilation motor wiring connector.
3. Remove the support bracket screw. Remove the three bolts fixing the ventilation fan housing support. Remove the ventilation fan assembly from its location.
4. The unit can now be disassembled and motor replaced.
5. Reverse previous steps to reinstall ventilation fan assembly on vehicle.

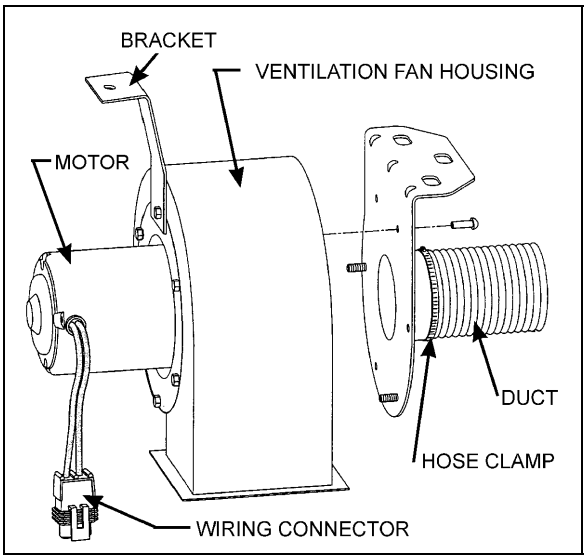


FIGURE 24: VENTILATION FAN INSTALLATION 23222

6.4 DOOR LOCK

Lavatory door lock has inside and outside handles, as well as an inside latch to lock door from inside the compartment. If the lock fails to release, the door can be opened from the outside using a special key which is supplied to the driver. Lock assembly can be removed from the door, then readily disassembled and parts replaced, if necessary (Fig. 22). A thin coat of lubricant on all moving parts will ensure trouble-free operation.

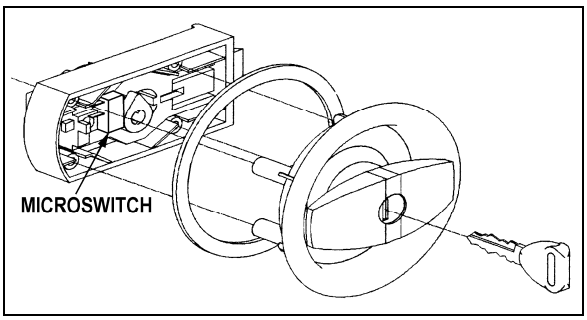


FIGURE 25: DOOR LOCK 23320

6.5 LAVATORY LIGHT

The lavatory light is installed on ceiling. A microswitch, which is mounted inside the latch housing, is activated by the door lock mechanism upon locking to energize the circuit. This switch is readily serviced by removing the four Phillips-head screws securing the housing to the door interior frame.

Proceed as Section 06, Electrical System, *Dome, Rear Roof and Lavatory Lights*" for lights replacement.

6.6 LAVATORY NIGHT-LIGHT

The lavatory night-light is illuminated as soon as the ignition switch is set to the *"ON"* position. See Section 06, Electrical System, "*Parcel Rack / Lavatory Night Light - "Bulb Removal and Replacement*" for lights replacement.

6.7 EMERGENCY BUZZER

The lavatory emergency buzzer is mounted on the inner curb side wall of lavatory and sounds when the emergency call push-button switch in the lavatory compartment is activated. For specific wiring information, refer to wiring diagrams. To remove the emergency call push-button switch, proceed as follows:

1. Remove both phillips-head screws retaining pushbutton switch plate to wall.
2. Remove steel plate located on L.H. side of pushbutton switch.
3. Remove switch through this opening, taking care to disconnect electric wires.

6.8 FRESH WATER TANK

One panel allows access to the fresh water tank. It is located behind the toilet mirror. Remove the tank as follows:

1. Remove the mirror.
2. Remove the fresh water tank tubing, bolts, and different connectors.
3. Remove the tank from the wall.
4. Reverse previous steps to reinstall fresh water tank assembly on vehicle.

6.8.1 Fresh Water Tank Draining

The fresh water tank can be drained by simply opening the fresh water drain cock). Don't forget to close cock when draining is done.

NOTE
The fresh water reservoir is equipped with a thermal valve which is set to open at about 35°F, thereby automatically draining the reservoir in near-freezing temperatures.

Routine draining and filling of lavatory tanks should be performed by maintenance personnel only. If engine or heating failure occurs in extreme weather conditions, emergency draining of water tanks should be performed under the most suitable conditions and should at all times be supervised by driver.

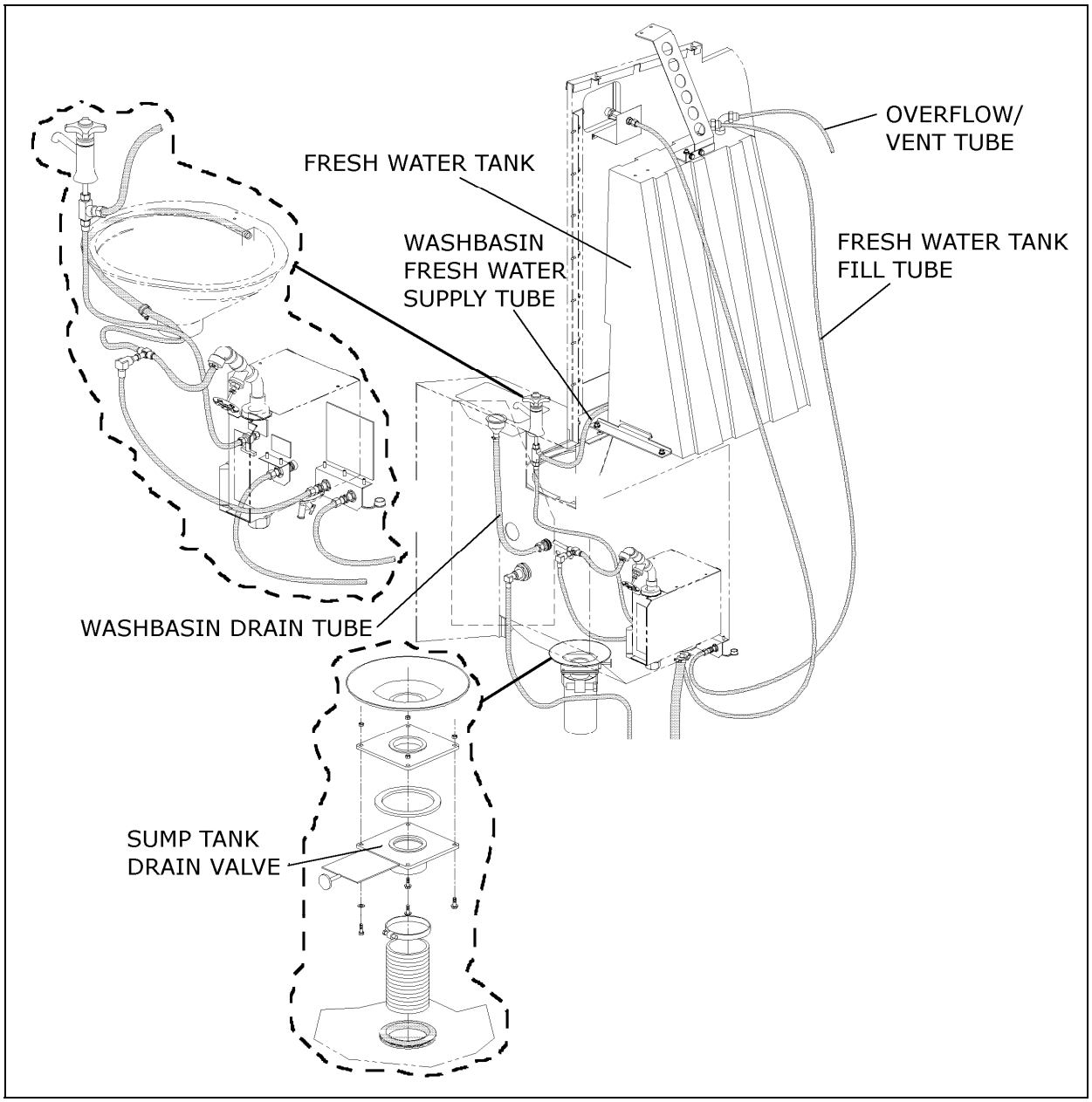


FIGURE 26: FUNCTIONING OF LAVATORY 23051

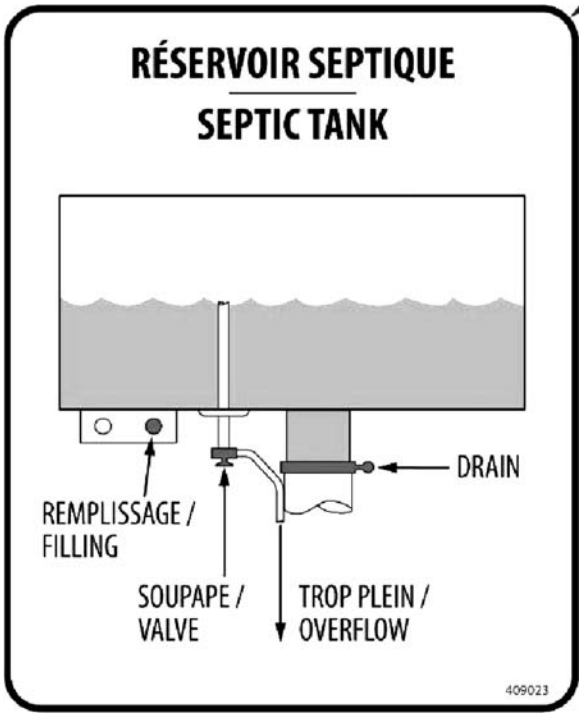


FIGURE 27: SUMP TANK & F/W TANK SERVICE VALVES

6.8.2 Fresh Water Tank Filling

Connect the fresh water supply hose to the fresh water reservoir fill connection (Fig. 24) located in the curb-side section of engine compartment. Fill the reservoir until the overflow tube leaks, signaling that the reservoir is full.

DANGER

Never put antifreeze in fresh water tank; antifreeze is toxic.

WARNING

If tank has not been drained for an extended period of time, draining and filling operations must be repeated three (3) times in order to clean tank and eliminate contaminated water.

6.9 LIQUID SOAP DISPENSER

A liquid soap dispenser may have been installed as optional equipment. To refill dispenser, proceed as follows:

1. Turn cover slightly clockwise until it stops.
2. Lift out piston and spout, cover and supply tube.

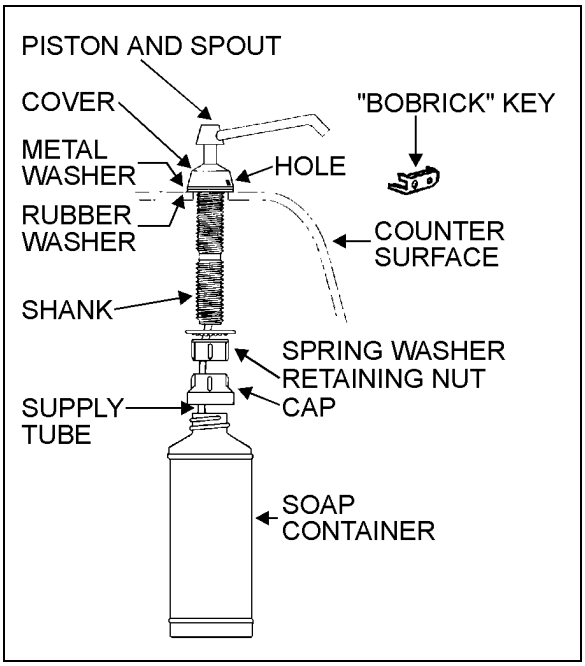


FIGURE 28: LIQUID SOAP DISPENSER 23039

3. Fill dispenser with soap. This model can dispense vegetable oil soaps, synthetic detergents, and lotion soaps.

CAUTION

Never use abrasive cleaners.

4. Replace supply tube, piston, and spout mechanism reversing the steps above.
5. Secure the cover by turning clockwise until lock snaps into position.

NOTE

The dispenser requires priming when extremely viscous lotion soaps are used. Remove piston and spout, cover and supply tube assembly. Pump water into assembly, then replace into dispenser.

6.10 FLUSH PUSH-BUTTON

The green flush push-button is located near the toilet. Press on push-button to actuate a pneumatic timer located on the other side of wall. This timer allows an electric current flow during a preset time to a pump into the sump tank.

6.10.1 Pneumatic Timer Removal and Installation

1. Unscrew and remove the flush push-button locking ring.
2. Remove steel plate located on L.H. side of pushbutton switch.
3. Remove pneumatic timer through this opening, taking care to disconnect electric wires.

NOTE
Care must be taken to avoid losing the spacers installed on the mounting sleeve.

4. Reverse the above procedure to reinstall timer. The recommended torque for the lock nut is 15 Lbf-ft· (21 Nm).

6.10.2 Timer Adjustment

Timer can be adjusted from 0.2 second to 3 minutes by turning the time adjustment screw clockwise to increase time, and counterclockwise to decrease time. To gain access to the time adjustment screw, repeat steps 1, 2 and 3 in the previous paragraph "*6.10.1 Pneumatic Timer Removal and Installation*".

6.11 FLUSH PUMP

The submersible-type flush pump is mounted inside an enclosure in the sump tank (Fig. 26). The enclosure is provided with a screened side which, serves as a strainer to prevent solid matters from entering the pump.

The pump requires no periodic maintenance other than cleaning of the strainer side using a water jet introduced through the circular cap opening, once the sump tank is completely drained. The pump can run dry periodically without damage. However, for maximum seal life, the run dry periods should be kept to a minimum.

CAUTION
If vehicle is stored for an extended period of time, make sure to clean the strainer as solid matter will tend to pack, and will necessitate replacement of strainer.

6.11.1 Flush Pump Removal

1. Remove the toilet to gain access to the pump enclosure.
2. Remove the flush pump enclosure cover
3. Unsnap the flush pump.

6.12 SUMP TANK

6.12.1 Sump Tank Draining

When recirculating water in the toilet is soiled, drain sump tank then perform the filling procedure of the tank.

6.12.2 Sump Tank Filling

Open the sump tank overflow cock and connect a water supply hose to the toilet sump tank fill connection. The tank is full when water starts flowing through the clear overflow tube. Close sump tank overflow cock when the tank is full.

CAUTION
In cold weather, add 2 gallons (9 liters) of antifreeze (e.g.: ethylene glycol) in the toilet before filling sump tank.

CAUTION
Lavatory tank should be serviced only at suitably equipped stations.

NOTE
It is unlawful to dump sump tank contents in any location other than those designated as such.

When a full draining is required, clean sump tank by repeating the draining and filling operations while leaving the drain cock opened. Close cocks and pour a pack of commercial toilet deodorant (Prevost part #900329) in toilet before adding the antifreeze and starting final filling of sump tank.

WARNING
The toilet deodorant contains products that can be very irritating to skin. Use rubber gloves when handling and then clean toilet seat.

WARNING
Antifreeze must comply with the effective environmental act.

CAUTION

When cold weather is expected and there is no antifreeze in the tank, sump tank must be drained.

NOTE

If there is no antifreeze solution in the tank, there is less risk of freezing if engine is operating due to the heat it produces.

NOTE

New coaches are delivered with the sump and fresh water tanks empty. Fill with water before putting the coach in service.

7. HORN INSTALLATION

The electric and air horns are located in a plastic box under the front stepwell and are accessible from the front body understructure. Refer to Operator's or Owner's Manual for operation.

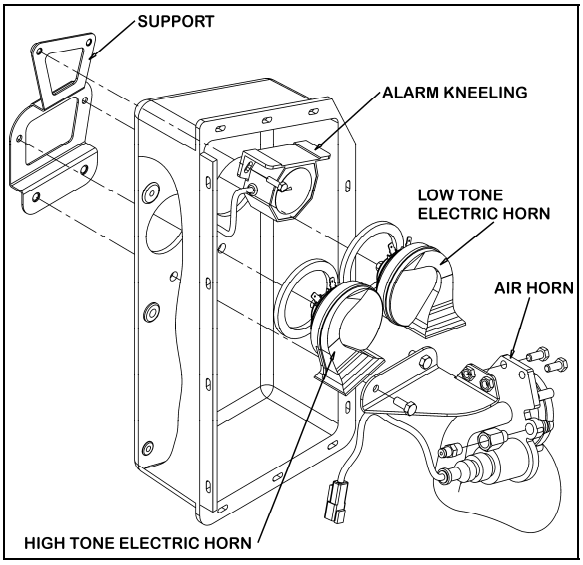


FIGURE 29: ELECTRIC & AIR HORN INSTALLATION 23420

7.1 ELECTRIC OR AIR HORN MAINTENANCE

When needed, the electric or air horn can be serviced or replaced using the following procedure:

1. Raise vehicle by the jacking points;
2. Unplug the cable connector;
3. Disconnect the air tube if applicable;
4. Loosen the retaining bolts;
5. Service or replace the defective horn;
6. Reinstall by reversing procedure.

8. HEADLIGHTS CLEANING SYSTEM

8.1 GENERAL DESCRIPTION

NOTE

When inspecting the headlights cleaning system, check the washer fluid hoses, fittings and connectors to be sure they are properly connected and seal with no restriction to the flow of washer fluid. Check that the washer nozzles are properly aimed.

The headlights cleaning system is independent from the windshield washer system and has its own washer fluid reservoir located in the front electrical and service compartment. However, this system shares the same telltale light than the windshield washer low level sensor (refer to Operator's manual for operation). Each pressing of this switch produces 2 successive 0.7 seconds jets.

CAUTION

Do not operate the headlights washer while the washer fluid reservoir is empty. This may damage the washer fluid pump.

8.2 WASHER FLUID REFILLING

Open the filler neck cap and had regular windshield washer fluid as required. The tank has a capacity of 10 liters (2.6 US gallons). You may use water or windshield washer fluid as well but, during cold weather days, use windshield washer fluid suitable for freezing temperature only.

8.3 WASHER NOZZLES ADJUSTMENT

To avoid waste of washer fluid, assure the fluid jets are properly aimed. Adjust nozzles so they aim as described in figure 29. Align the jet adjustment tool #800377 with the reference line shown on the front view detail. As seen on the side view, position the end of the adjustment tool to a distance of ½" (high beam) and 1" (low beam) from the top of the headlight for proper aiming.

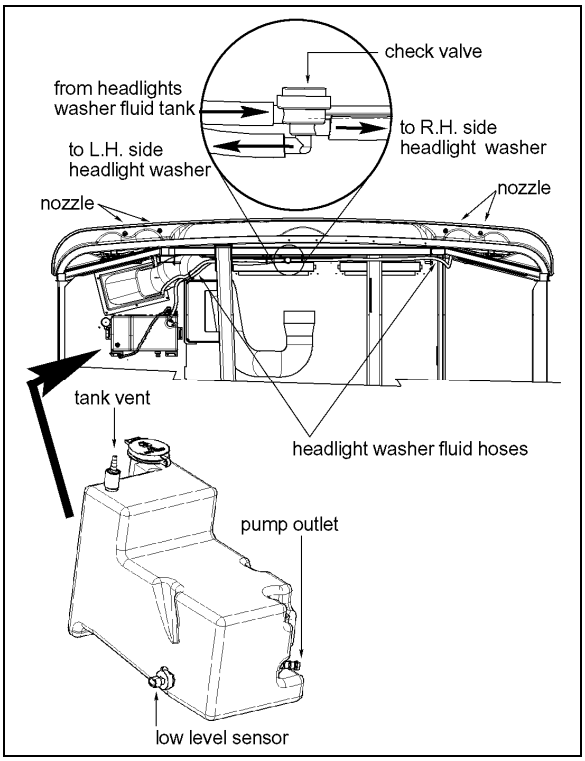


FIGURE 30: HEADLIGHTS CLEANING SYSTEM 23380

CAUTION

Because they are made of plastic, firmly tighten nozzle and bulkhead fittings by hand only.

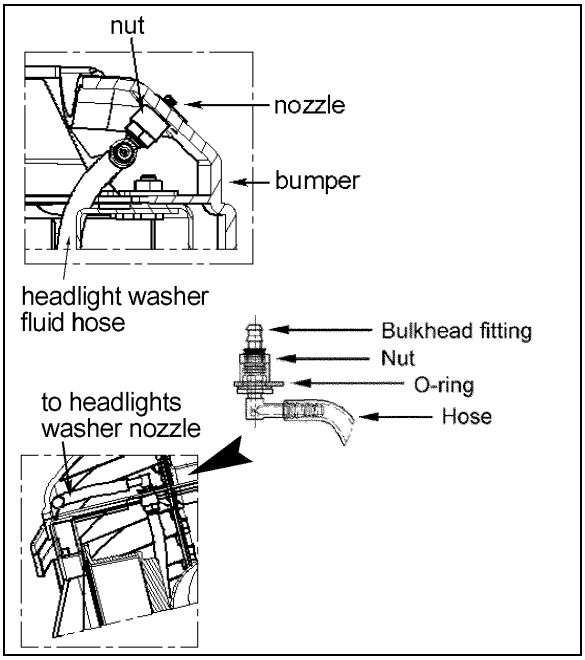


FIGURE 31: TUBING AND FITTINGS 23381

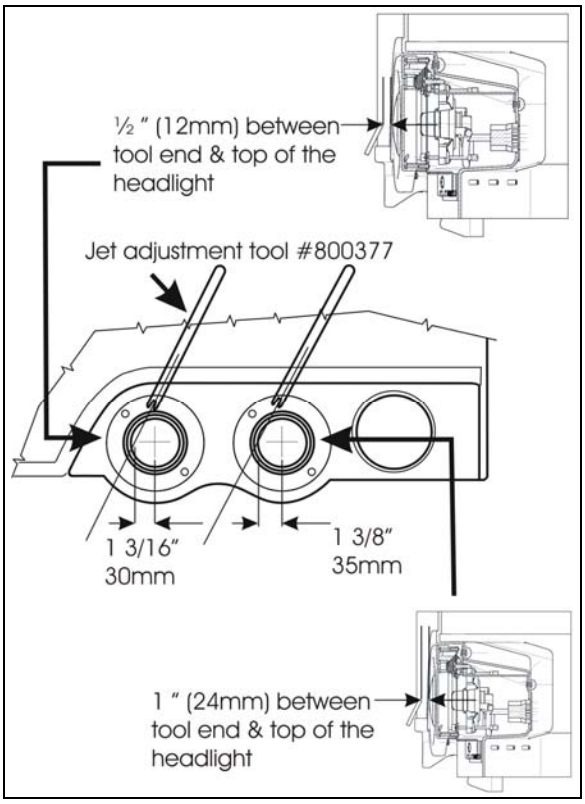


FIGURE 32: WASHER NOZZLES ADJUSTMENT 23382

9. WINDSHIELD WIPERS AND WASHERS

9.1 GENERAL DESCRIPTION

NOTE

When installing a wiper motor, arm or blade, follow recommended procedures to prevent misalignment, binding or malfunction. Check the windshield washer liquid hoses, fittings and connectors to be sure they are properly connected and seal with no restriction to the flow of washer liquid. Check that wiper arms have the proper sweep position and the washer nozzles are aimed so that spray is within the proper wiper pattern.

The windshield wipers are controlled by one electric wiper motor that is accessible for maintenance after removing the appropriate access panel beside the footwell (refer to figure 32).

Turn the multifunction lever forward to activate windshield wipers (item 2, fig. 30). The first position operates the wipers at low speed and the second position operates the wipers at high speed. Turning the lever backwards will operate the wipers in the intermittent mode.

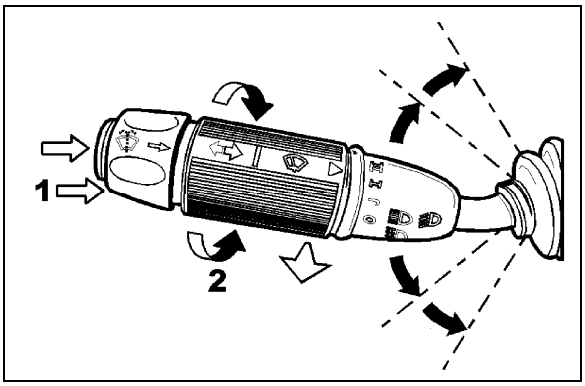


FIGURE 33: MULTIFUNCTION LEVER 23133

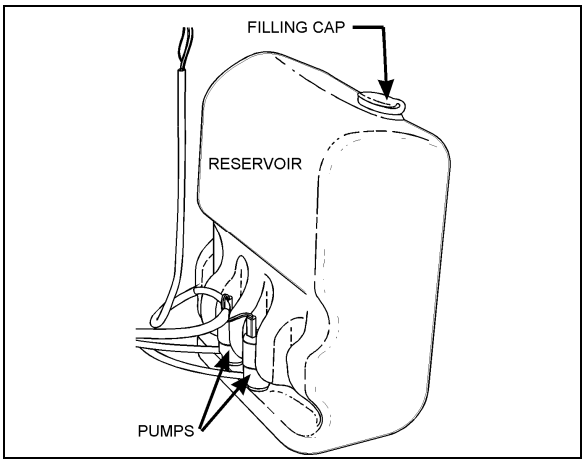


FIGURE 34: WINSHIELD WASHER RESERVOIR 23220

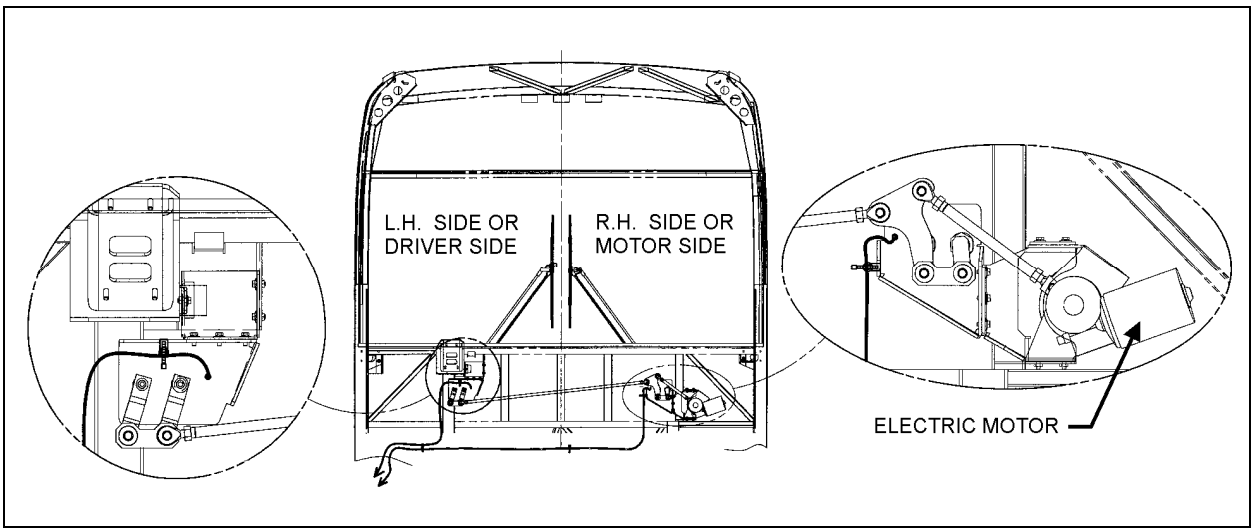


FIGURE 35: WINDSHIELD WIPER INSTALLATION 23287

The windshield washer pumps are electrically operated and are controlled by a washer control ring on the multifunction lever (item 1, fig. 30).

The windshield washer reservoir is located in the front service compartment (Fig. 31). This unit pumps the washer liquid to the spray nozzles where it is dispersed across the windshield.

9.2 WIPER ARM

Check operation of the wipers for proper blade sweep and angle.

9.2.1 Wiper Arms Positioning

1. Reinstall the wiper arms and position as shown in figure 37. Before positioning the wipers at their final position, tighten the nuts to 9 Ft-lbs (12 Nm) at first.
2. To find the final position of the wiper arms, lift then release the wiper arm so if falls back on the windshield.

⚠ CAUTION

Do not attempt to manually move the wiper arms to make wiper blade sweep adjustments as damage to the wiper linkage or motor may occur. If it is necessary to adjust the sweep of blades, remove the arms and make adjustment by positioning the arms using serration on the wiper arm pivot shafts.

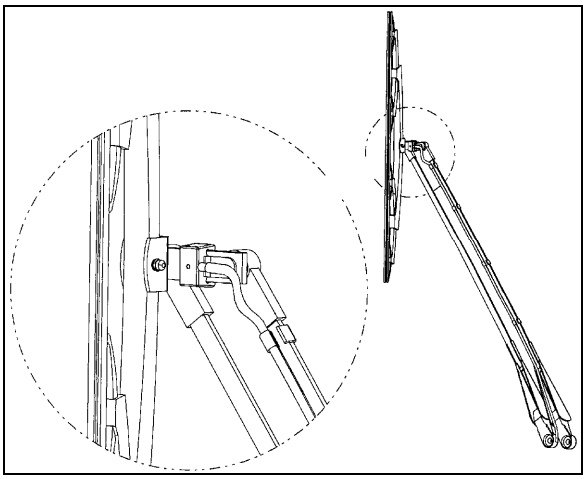


FIGURE 36: WINDSHIELD WIPER (MOTOR SIDE)

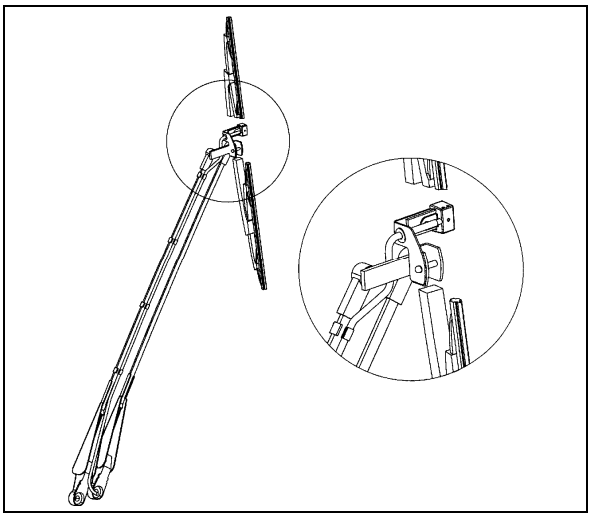


FIGURE 37: WINDSHIELD WIPER (DRIVER SIDE) 23328

3. When the final position is found, tighten the wiper arm nuts to 22 Ft-lbs (30 Nm). Wait 30 minutes and tighten again to 22 Ft-lbs.

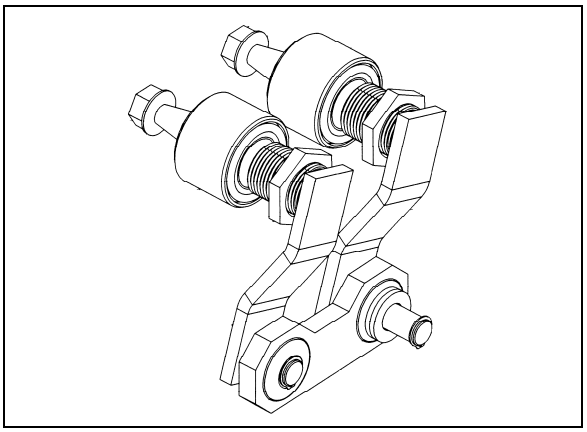


FIGURE 38: DRIVING MECHANISM (DRIVER SIDE) 23284

4. Lower the protective cover.
5. Connect the windshield washer tubing at the base of the wiper arm.
6. Check the adjustment on a wet windshield.

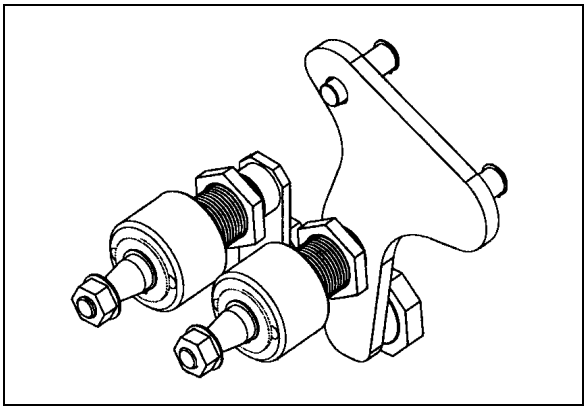


FIGURE 39: DRIVING MECHANISM (MOTOR SIDE) 23285

9.3 WINDSHIELD WIPER MOTOR

9.3.1 Windshield Wiper Motor Replacement

The windshield wiper motor is located at lower front of the vehicle, behind the defroster panel. Refer to figure 32 for motor location.

WARNING

Park vehicle safely, apply parking brake, stop engine and set battery master switch to the ''OFF'' position prior to working on the vehicle.

1. Remove the Phillips-head screws retaining the defroster panels, and remove panels.
2. Disconnect wiring connector from the windshield wiper motor.
3. Loosen clamping screw retaining the lever at the end of the motor driving shaft.
4. Remove the three bolts holding the motor to the steel plate.
5. Remove the windshield wiper motor (Prevost #800328), reverse removal procedure to reinstall.

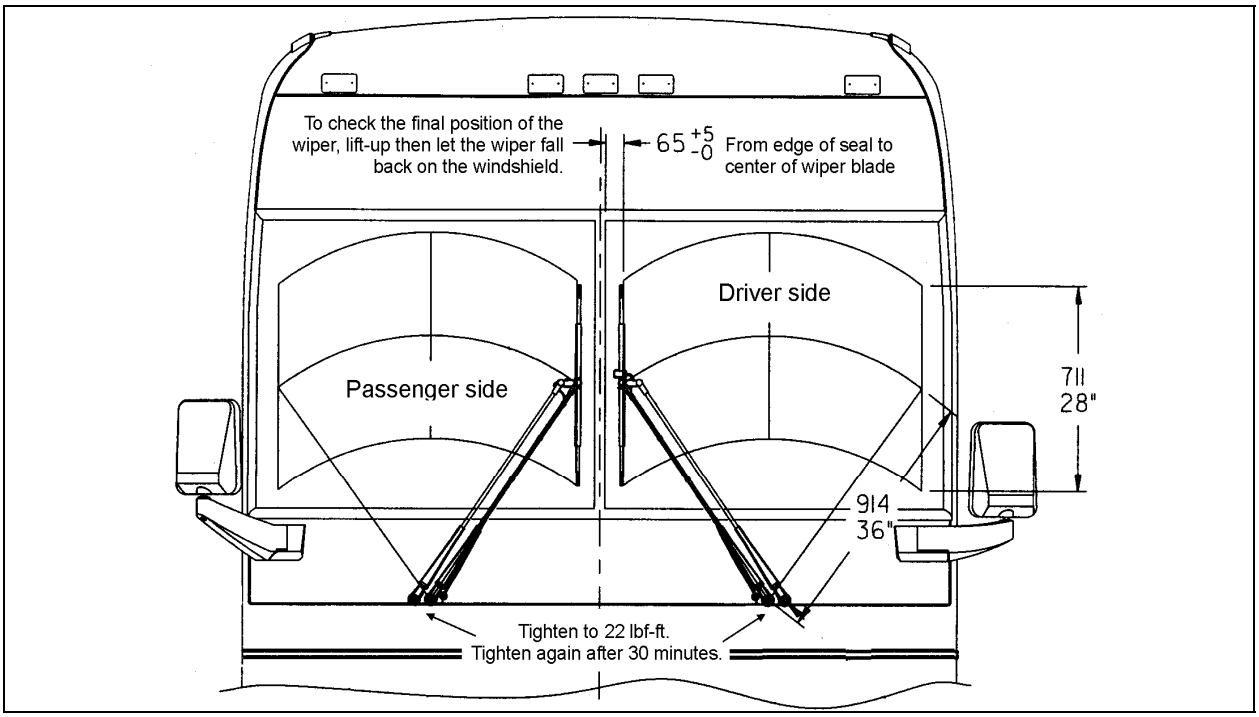


FIGURE 40: WIPER ARMS POSITIONING 23253

9.4 TROUBLESHOOTING

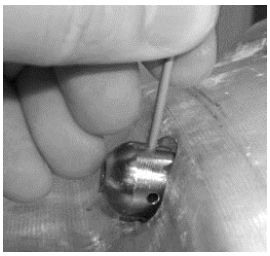
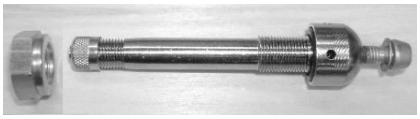
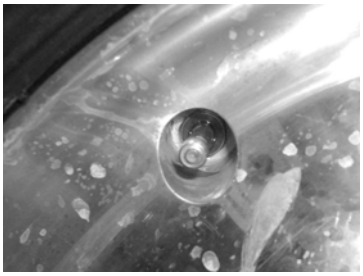
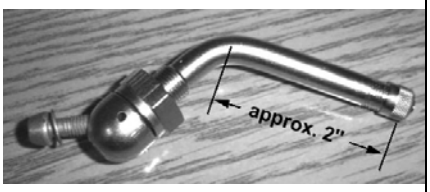
SYMPTOM	PROBABLE CAUSE	REMEDY
FAIL TO SPRAY WASHER FLUID	A. Reservoir empty. B. If below 32°F (0°C), improper washer fluid frozen. C. Contamination in tubing or nozzles. D. Tubing damage. E. Tubing bent (kinked) or off one or more connections.	A. Add proper fluid. B. Store coach or parts in heated area, then purge system with low-temperature solution. C. Remove with compressed air, if severely clogged, replace items. D. Replace section. E. Realign tubing and/or refit. Trim end to ensure proper fit or replace.
INADEQUATE SPRAYING	A. Tubing failure.	A. Replace tubing.
SLOW OPERATION	A. Improper solution. B. Jet stream improperly directed. C. Check if valve is stuck in the open position.	A. Replace with proper type solution. B. Reposition nozzles. C. Remove, clean or replace.

10. TIRE PRESSURE MONITORING SYSTEM (TPMS)

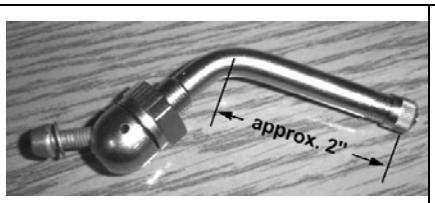
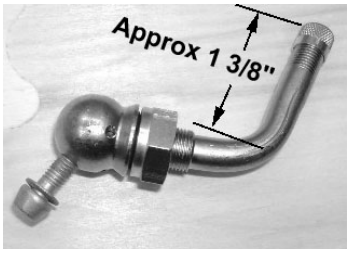
The optional active tire pressure and temperature monitoring system is a sensing device designed to identify and display tire operating data and activate an alert or warning when pressure or temperature irregularities are detected.

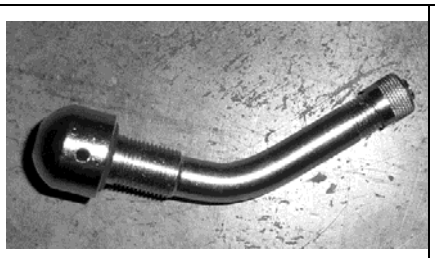
For more information on the operation and troubleshooting of the system, refer to Prevost X3-45 Coaches Operator's Manual, chapters "Controls and Instruments", "Safety Features and Equipment" and also "Appendix G".

10.1 TIRE VALVE INSTALLATION

<table>
<tr><td colspan="3">Use as required a small rod to hold the valve in place when tightening.</td><td>  </td></tr>
<tr><td rowspan="2">Steel Wheels</td><td><u>All wheels</u>
a) Install Beru valve
Torque valve to 44.5lb-in +/- 9.5
b) no extension piece</td><td> 
#Prevost 681083</td><td>  </td></tr>
<tr><td><u>Front axle and tag axle wheels with 365 tires–</u>
a) Remove Alcoa valve
b) Install Beru valve
Torque valve to 102lb-in +/- 22
c) No extension piece</td><td> 
#Prevost 651080</td><td>  </td></tr>
<tr><td>Aluminum Wheels (new Hub-Mounted wheels)</td><td><u>Front axle and tag axle wheels with 315 tires–</u>
a) Remove Alcoa valve
b) Install Beru valve
Torque valve to 102lb-po +/- 22
c) Small extension piece (approx 50mm)</td><td> 

#Prevost 651081</td><td>  </td></tr>
</table>

Aluminum wheels (new Hub-Mounted wheels)	***Drive axle inner and outer wheels with 315 tires–*** **a) Remove Alco valve** **b) Install Beru valve** **Torque valve to 102lb-in +/- 22** **c) no extension piece**	 #Prevost 651081	
	"Super Single" Tires **a) Remove Alcoa valve** **b) Install Beru valve** **Torque valve to 102lb-in +/- 22** **c) no extension piece**	 #Prevost 651079	

Aluminum wheels (former Stud-Mounted wheels)	***All wheels*** **a) Remove Alcoa valve** **b) Install Beru valve** **Torque valve to 102lb-in +/- 22** **c) no extension piece**	 #Prevost 651082	

CAUTION

When replacing Alcoa valve stems, it is recommended to lubricate the threads and O-ring with Permatex Dielectric Tune-Up grease.

When valve stem extensions are used, it is recommended that valve stem stabilizers be used.

10.2 BERU SENSORS INSTALLATION

IMPORTANT NOTE
Beru sensors have a limited lifespan (5 years on average)

Check proper valve positioning before installing sensor onto valve (risk of damaging the sensor or air leaks).

Beru pressure sensor **564078**

Remove bar code with supplied removable tie-rap.

Make sure not to mix bar codes up between wheels (bar code is linked to sensor)

Position sensor onto wheel

Install oval wave spring washer

Torx screw T-20. Torque to 35lb-in (4Nm) (supplier specification for the screw).

IMPORTANT

Use the screw only once. This screw uses a thread lock**. Never use Loctite (incompatibility between Loctite and thread lock) Replacement screw #651084.**

Install bar code and tie it up using wheel holes. Use supplied removable tie-rap.

Decal

Glue decal facing the valve.

#651091 ENGLISH #651090 BILINGUAL

DRIVE AXLE OUTER WHEEL

11. AUTOMATIC FIRE SUPPRESSION SYSTEM (AFSS) (OPTIONAL)

This optional system is used to shut down the engine and to extinguish a fire in the engine compartment or in the vicinity of the preheating system if so equipped.

The system operation is fully automatic and does not require assistance from the operator, however if required, the system can be manually activated by the operator at any time.

Refer to Prevost Operator's Manual for system operation and operational sequence (fire).

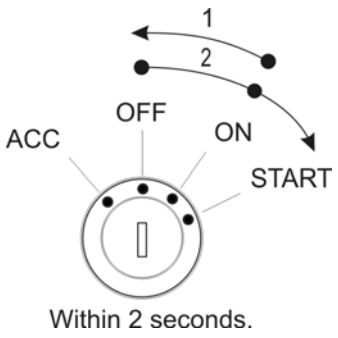
If more information is needed on the system, please refer to Kidde Dual Spectrum "Operation & Maintenance Manual annexed at the end of this section.

11.1 STARTING THE VEHICLE AFTER A FIRE ALARM

The vehicle may be started after a fire alarm without resetting the system. Refer to ignition switch sequence below. This will not reset the system, rather it will instruct the vehicle's multiplex system to ignore vehicle interface outputs from the Protection Panel. This feature is intended to be used only in emergency situations that require the vehicle to be restarted and moved a short distance prior to system reset. It should not be performed if the cause of the fire has not been clearly identified and corrected.

To start the vehicle, perform this ignition switch (key) sequence.

- From the **ON** position,
- Turn to **OFF**, return to **ON** *and* **START** vehicle within 2 seconds.



11.2 PERIODIC MAINTENANCE

PRE-TRIP

o Verify that the Protection Panel "SYSTEM OK" lamp is on solid green.

EVERY 3000 MILES OR MONTHLY (whichever comes first)

General

o Verify that neither the protected equipment nor the hazard has changed.

o Verify that no obvious physical damage or condition exists that might prevent system operation.

Protection Panel

o Verify that all warning lamps and the audible alarm are operational by pressing the "TEST/RESET" button.

Manual Activation Switch

o Verify that the tamper seal is intact and access to the switch is unobstructed.

Fire Detectors

o Optical

- Verify that the status lamp on the detector face is on solid green.
- Verify that nothing is blocking the detector's field of view.

- Verify that the windows on the face of the detector are free of excess contamination (dirt, oil, grease, etc.) – if necessary, clean using a water soaked non-abrasive towel.

o Linear Thermal

- Verify that there is no obvious physical damage and that the unit is free of excess contamination (dirt, oil, grease, etc) – if necessary, clean using a water soaked non-abrasive towel.
- Verify that mounting is secure and taught.

Electrical Harness

o Verify that electrical connectors and electrical wiring have no visible damage and all connectors are securely seated.

Extinguisher & Distribution System

o Verify that that the extinguisher pressure gauge pointer is in the green arc at room temperature.

o Verify that distribution piping and nozzles are intact and unobstructed and that nozzle blow-off caps are in place.

EVERY 18000 MILES OR SEMI-ANNUALLY (whichever comes first)

o Perform a comprehensive fire system test using a Kidde Dual Spectrum System Test Set (Optical Test Kit P/N 420871-2).

o Service the extinguisher in accordance with KDS Document 160296, “KDS Pre-Engineered Fire Suppression System: Installation, Operation and Maintenance Manual”.

EVERY SIX YEARS

o Have the fire extinguisher rebuilt by a qualified fire protection equipment company familiar with Kidde Dual Spectrum equipment and in accordance with KDS Document 160296, “KDS Pre-Engineered Fire Suppression System: Installation, Operation and Maintenance Manual”. Rebuilt shall include actuator, o-ring seals and dry chemical replacement.

EVERY TWELVE YEARS

o Have the Extinguisher cylinder hydrostatically tested by a qualified fire protection equipment company familiar with Kidde Dual Spectrum equipment and in accordance with KDS Document 160296, “KDS Pre-Engineered Fire Suppression System: Installation, Operation and Maintenance Manual”.

12. SPECIFICATIONS

AMPLIFIER
Model..... VA400-8
Output..... 400 watts, 6 channel RMS at 4 ohm @ 0.5 T.H.D.
Prevost number..... 901191

SOUND SELECTOR
Model..... VSS-05
Power source ..... 12 volts
Prevost number..... 21116371

DASHBOARD RADIO (standard)
Power source ..... 12 volts
Prevost number..... 901315

DASHBOARD RADIO (SIRIUS)
Power source ..... 12 volts
Prevost number..... 901317

DASHBOARD RADIO (XM)
Power source ..... 12 volts
Prevost number..... 901316

MOBILE DVD PLAYER
Power source ..... 12 volts
Prevost number..... 901198

SPEAKER (standard)
Model..... Dual Cone
Impedance ..... 4 ohms
Prevost number..... 901194

SPEAKER (optional)
Model..... Coaxial
Impedance ..... 4 ohms
Prevost number..... 901195

SUBWOOFERS (optional)
Model..... J Drive VB170
Impedance ..... 4 ohms
Prevost number..... 901193

VIDEO SWITCHER
Model..... V-3000
Prevost number..... 901030

BOOM-TYPE MICROPHONE
Prevost number..... 900763

HANDHELD PRIORITY MICROPHONE
Prevost number..... 900808

RUBBER COATED MICROPHONE
Prevost number..... 900745

16 CHANNEL WIRELESS MICROPHONE
Make..... R.E.I.
Prevost number..... 900954

16 CHANNEL WIRELESS MICROPHONE CHARGING STATION
Make..... R.E.I.
Prevost number..... 900953

16 CHANNEL WIRELESS MICROPHONE RECEIVER
Make..... R.E.I.
Prevost number..... 900952

KARAOKE
Make..... Panasonic
Model..... MOBILE DVD PLAYER DV1500
Prevost number..... 901033

TV RECEIVER
Power source 24V
Prevost number..... 901054

VIDEO DISTRIBUTION AMPLIFIER
Power source 24V
Prevost number..... 901117

TV MONITOR
Type ..... 10.4” LCD
Power source 24V
Prevost number..... 901130

HUBODOMETER (US model: miles)
Make..... Stemco
Prevost number..... 650002

HUBODOMETER (Canada model: km)
Make..... Stemco
Prevost number..... 650117

ELECTRONIC DESTINATION SIGN
Make..... Pocatec
Prevost number..... 940050

LAVATORY VENTILATION FAN MOTOR
Make..... Aurora
Type RG500EF
Voltage ..... 24 volts DC
Rotation..... R.H.
Prevost number..... 870844

LAVATORY FLUORESCENT TUBES
Make..... General Electric
Model..... F15T8CW
Length ..... 18" (45 cm)
Wattage..... 15
Quantity..... 2
Prevost number..... 830102

EMERGENCY BUZZER SWITCH (PUSH BUTTON)
Make..... Cole Hersee Co.
Voltage .....24 V
Prevost number.....562117

FRESH WATER TANK
Make.....Prevost
Capacity .....18 US gal (68 liters)
Prevost number.....401591

FLUSH PUSH BUTTON PNEUMATIC TIMER
Make.....Furnas
Type .....Resettable
Time ..... 0,2 to 180 seconds
Prevost number.....900348

FLUSH PUMP
Make..... RULE 2000
Model number ..... 12 - 24 V
Power source ..... 24 volts DC
Capacity .....1450 GPH
Prevost number.....900960

AIR HORN
Make.....VOLVO
Prevost number.....20383071

ELECTRIC HORN (HIGH)
Make..... FIAMM TECHNOLOGIES INC.
Prevost number.....563023

ELECTRIC HORN (LOW)
Make..... FIAMM TECHNOLOGIES INC.
Prevost number.....563015

WINDSHIELD WIPER MOTOR
Make..... BOSCH
Prevost number.....800328

WIPER (BLADE)
Make..... BOSCH
Prevost number.....800329

WIPER ARM
Make..... BOSCH
Prevost number.....800331

Kidde Dual Spectrum

OPERATION & MAINTENANCE MANUAL FOR FIRE PROTECTION SYSTEM AS INSTALLED ON PREVOST H345 & EPA10 VEHICLES

Manual Number 160339
Revision 04OCT10

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INTRODUCTION

This manual describes the operation and maintenance of the Kidde Dual Spectrum® Automatic Fire Detection and Suppression System (AFSS) as installed on Prevost H345 & EPA10 series buses manufactured at Prevost Car Inc, Sainte-Claire, QC, Canada.

SYSTEM OPERATION

When a fire is detected inside the engine or auxiliary heater compartment, the system sends a fire alarm signal to the Protection Panel located in the operator's area.

immediately

- The Protection Panel fire "ALARM" lamp illuminates and audio alarm sounds
- The dash-mounted 'FIRE' and 'ENGINE STOP' telltale lamps illuminate
- The dash-mounted audio alarm sounds
- The HVAC, engine fan and auxiliary heater turn off
- The vehicle horn sounds (with ignition off only)

after 15 seconds

- The engine turns off
- The Extinguisher discharges

At any time before or after automatic fire detection, the Manual Activation Switch may be used to immediately initiate or complete the above sequence with no 15-second delay.

The Protection Panel continuously monitors system integrity and displays the information via the "SYSTEM OK", fire "ALARM" and fire "TROUBLE" indicators.

A system block diagram is shown in Figure 1.

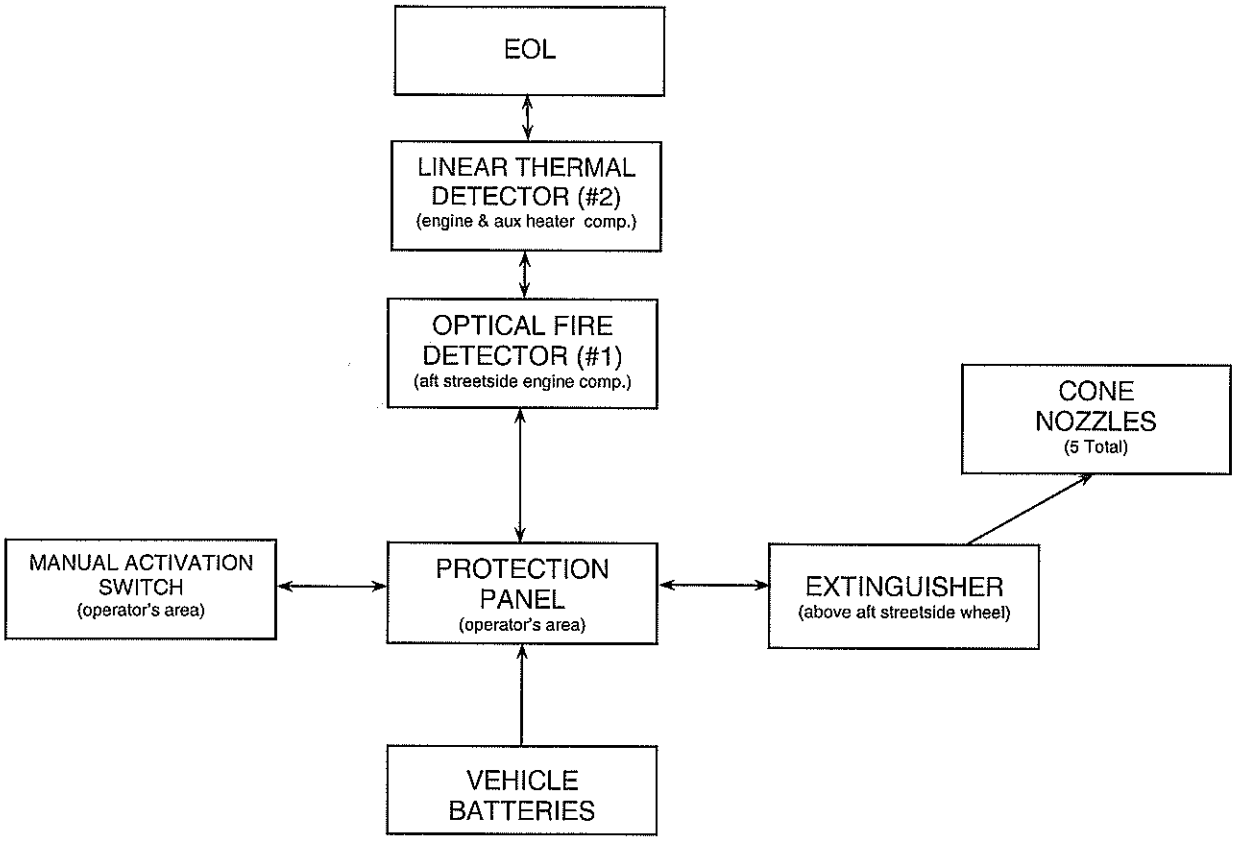

FIGURE 1 - SYSTEM BLOCK DIAGRAM

OPERATIONAL SEQUENCE (FIRE)

FIRE:

1. The Optical Fire Detector or Liner Thermal Detector detects a fire in the engine or auxiliary heater compartment and sends a signal to the Protection Panel in the operator's area.
2. The fire "ALARM" lamp on the Protection Panel illuminates solid red and the audio alarm sounds.
3. The dash-mounted "FIRE" and "ENGINE STOP" telltale lamps illuminate.
4. The dash-mounted audio alarm sounds.
5. The HVAC, engine fan and auxiliary heater turn off.
6. The horn sounds (ignition off only).
7. The operator shall bring the vehicle to a safe stop.
8. The system automatically shuts down the vehicle engine and discharges the Extinguisher into the engine compartment 15 seconds after the fire alarm starts unless advanced or delayed by the operator.
    - If the operator presses the Manual Activation Switch, all delays will terminate and the engine shutdown and extinguisher discharge will occur immediately.
    - If the operator presses and releases the "DELAY ENGINE STOP" switch on the Protection Panel or "ENGINE STOP OVERRIDE" switch on the dash once, the engine shutdown and Extinguisher discharge will be delayed by an *additional* 15 seconds (30 seconds total delay).

WARNING

THE ENGINE WILL STOP 15 SECONDS AFTER THE FIRE ALARM STARTS. THE OPERATOR MUST BE PREPARED TO BRING THE VEHICLE TO A SAFE STOP AS SOON AS THE ALARM SOUNDS. STEERING MAY BECOME DIFFICULT AFTER ENGINE SHUTDOWN. IF MORE TIME IS REQUIRED, THE "DELAY ENGINE STOP" SWITCH MAY BE PRESSED AND RELEASED FOR AN ADDITIONAL 15 SECOND DELAY (30 SECONDS TOTAL DELAY).

WARNING

THE EXTINGUISHER DISCHARGE MAY CAUSE AN OBSCURING CLOUD BEHIND AND NEAR THE VEHICLE

9. The Protection Panel's red fire "ALARM" lamp and audible alarm will stay on. The yellow fire "TROUBLE" lamp will also be on solid indicating a discharged Extinguisher.

10. The system must be reset and the Extinguisher removed and replaced in accordance with the 'SYSTEM RESET' portion of this manual.

NOTE: If the vehicle ignition has been off for greater than 2 hours, the fire protection system will power off. The system will power on again coincident with the vehicle ignition or when an overheat condition is detected by any one the vehicle's overheat detectors, whichever occurs first.

COMPONENT DESCRIPTIONS

PROTECTION PANEL

The Protection Panel is located in the operator's area and displays the current system status. The Protection Panel contains "SYSTEM OK", fire "ALARM" and "TROUBLE" lamps, the audio alarm, the "TEST/RESET" switch, and the "ALARM SILENCE" switch.

The "SYSTEM OK" lamp illuminates solid green to indicate power is on to the system and there are no trouble conditions present. The "SYSTEM OK" lamp will blink green when the system has low on power applied (<22Vdc). The "TROUBLE" lamp blinks yellow if there is a fault in the detection circuitry and illuminates solid yellow if there is a fault in the extinguishing circuitry. When the "TROUBLE" lamp is on, the "SYSTEM OK" lamp will be off and the audio alarm will sound intermittently. Pressing the "TEST/RESET" switch tests the Protection Panel's lamps and audio alarm. Pressing the "ALARM SILENCE" switch disables the audio alarm.

When a fire detector automatically detects a fire, the fire "ALARM" lamp illuminates solid red and the audio alarm sounds. When the Manual Activation Switch is pressed, the fire "ALARM" lamp blinks red and the audio alarm sounds; the lamp will remain blinking until power is cycled to the system.

The vehicle interface outputs are normally open contacts (1 Amp maximum) which short to ground immediately upon fire detection (pin 3) and 15 seconds after fire detection (pin 11) unless advanced or delayed by the operator.

The Protection Panel also has other features which can be enabled via internal configuration switches.

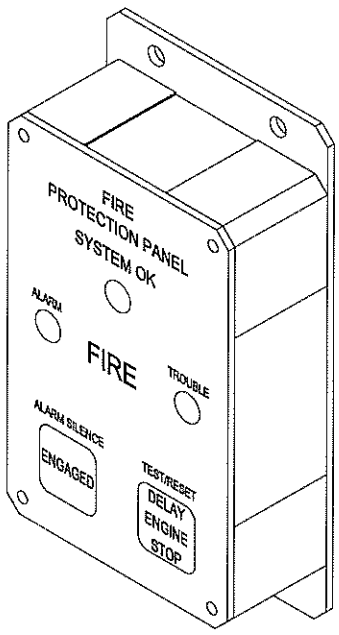

FIGURE 2 - PROTECTION PANEL

OPTICAL FIRE DETECTOR

The Kidde Dual Spectrum® model PM-3M fire sensor operates by sensing two separate bands of infrared energy. A fire signal is generated when the sensors see a fire fueled by gasoline, diesel, CNG, LNG, LPG, methanol, oils, lubricants, and other types of hydrocarbons.

The fire sensor has a 100° solid cone field-of-view. It has a response time to explosive fires of one half of a second maximum. The PM-3M has a detection threshold of 42 inches for a one square foot pan fire fueled by diesel.

The fire sensor is immune to false alarms from sunlight, flashlights, lightning, vehicle headlights, incandescent lights (100W at 2 inches), and welding arcs (30 inches).

Each fire sensor has a green status light in the center of its front surface. The status light is illuminated when the fire sensor has electrical power. The status light will blink after the sensor has responded to a fire. The blinking will not stop with system reset, but is cleared when power has been cycled to the sensor. This feature can be used to help pinpoint the source of the fire.

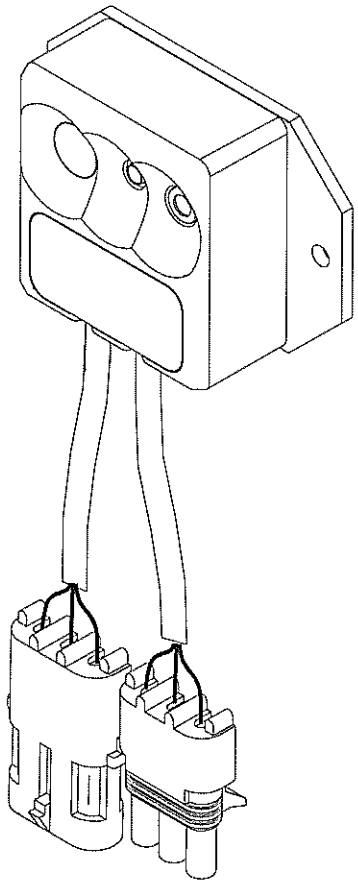

FIGURE 3 – OPTICAL FIRE DETECTOR

LINEAR THERMAL DETECTOR (LTD)

The Linear Thermal Detector (LTD) is a twin conductor cable with temperature-sensitive insulation protected by an outer sheath. It operates by short-circuiting in a fire or overheat condition. The LTD provides economical detection in vehicle engine bays, fuel storage tanks and any other location where the threat of fire exists. The LTD is capable of detecting a fire at any point along its length and will react to a fire situation within approximately 20 seconds. The cable cannot be reset; if the wire alarms to a fire, the wire must be replaced or the damaged section cut out and a new section added prior to returning the system to service.

FIGURE 4 – LINEAR THERMAL DETECTOR

END-OF-LINE DEVICE

The End-of-Line device is required for supervision of the fire detection circuits. It consists of a resistor installed into a connector and is environmentally sealed with potting compound. The End-of-Line device is installed on the last detector in each series of detectors.

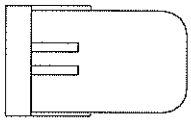

FIGURE 5 – END-OF-LINE DEVICE

MANUAL ACTIVATION SWITCH

The Manual Activation Switch allows immediate system activation (extinguisher discharge and engine shutdown) by the vehicle operator at any time. Activation of the switch is accomplished by twisting and pulling the tamper seal (not shown) to remove, lifting the cover and pressing the red "FIRE" button for more than half a second. After the Manual Activation Switch has been activated, the Protection Panel will blink the fire "ALARM" indicator until power has been cycled to the system.

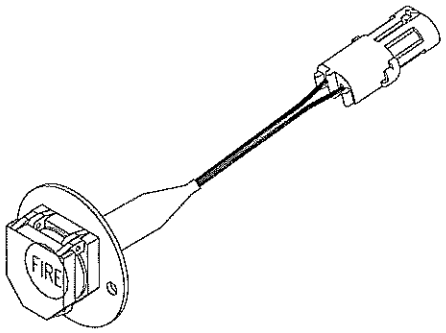

FIGURE 6 – MANUAL ACTIVATION SWITCH (DEPICTED WITHOUT TAMPER SEAL)

CONE NOZZLE

The Cone Nozzle is constructed of plated steel and contains a 45° steel cone, causing the nozzle to disperse a cone shaped spray of dry chemical. The nozzle has a silicone rubber protective cap that is blown off by the dry chemical discharge.

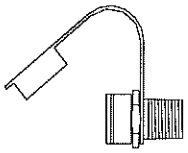

FIGURE 7 – CONE NOZZLE

FIRE EXTINGUISHER

The Fire Extinguisher is an electrically operated, stored pressure type extinguisher that contains 25 pounds of BC rated 'Purple k' dry chemical extinguishing agent pressurized with nitrogen. The cylinder is constructed of steel and meets DOT and TC specifications. The Valve is constructed of nickel-plated brass and is equipped with a fusible pressure relief plug. The valve also contains an easy to read go/no-go type pressure gauge that is protected by a gauge guard.

The Extinguisher is mounted horizontally and the gauge must be oriented perpendicular to the ground and facing to the right as looking from the valve end of the cylinder.

CAUTION

THE EXTINGUISHER WILL NOT FUNCTION AS INTENDED IF ORIENTED INCORRECTLY

WARNING

THE ANTI-RECOIL CAP SHALL BE INSTALLED ON THE VALVE OUTLET PORT AT ALL TIMES EXCEPT WHEN THE EXTINGUISHER IS CONNECTED TO THE DISTRIBUTION PIPING OR WHILE THE EXTINGUISHER IS BEING FILLED.

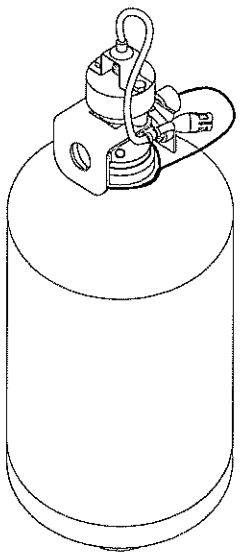

FIGURE 8 – FIRE EXTINGUISHER (DEPICTED IN VERTICAL ORIENTATION)

COMPONENT LOCATIONS

The major system components consist of a Protection Panel, a Manual Activation Switch, an Optical Fire Detector, a 35ft Linear Thermal Detector, an End-of-Line Device, a 25lb Fire Extinguisher and 5 Cone Nozzles. See figure 9.

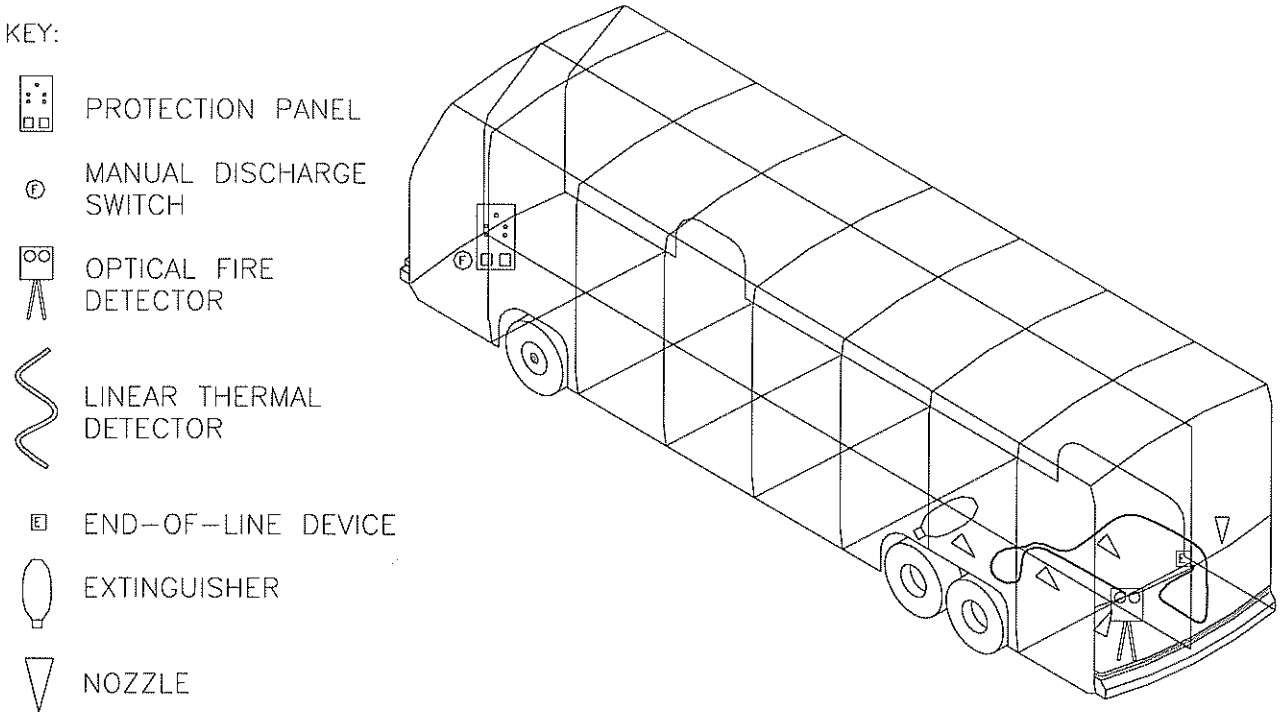

FIGURE 9 – MAJOR SYSTEM COMPONENTS

ELECTRICAL INTERCONNECTIONS

An electrical harness provides system power from the vehicle batteries and interconnects system components including the Protection Panel, Manual Activation Switch, Optical Fire Detector and Extinguisher. The Linear Thermal Detector and End-of-Line Device are connected in series, subsequent to the Optical Fire Detector. The harness also connects the Protection Panel's vehicle interface outputs to the vehicle's multiplex system to control HVAC, engine fan, auxiliary heater and engine shut-off as well as provides remote control of the engine shut-off delay input. See figure 10.

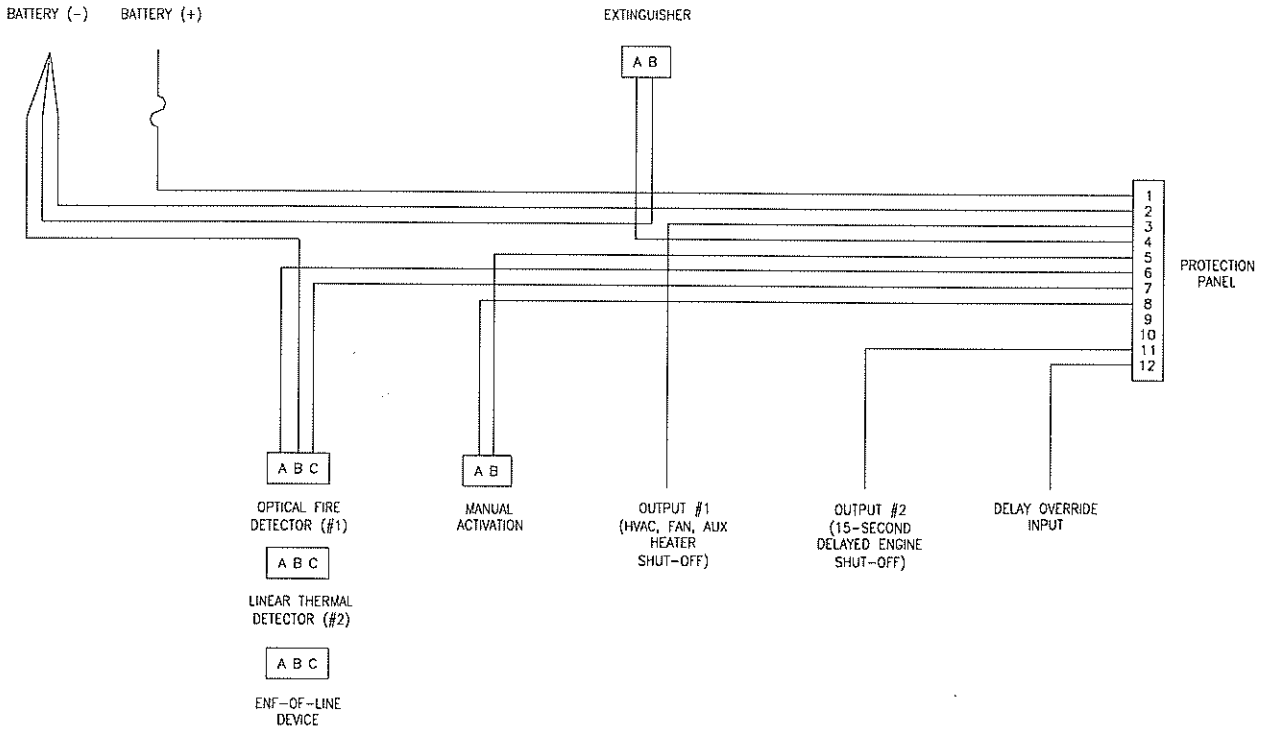

FIGURE 10 - VEHICLE HARNESS

SYSTEM RESET

FIRE:

After a fire, the system is restored to operational status as follows:

1. Disconnect system power by removing system fuse located in battery compartment.
2. Repair and/or replace any damaged detection devices and/or electrical harnessing.
3. Remove the Fire Extinguisher:
   a) Disconnect the electrical connector on the extinguisher valve from the vehicle harness.
   b) Install a shorting plug to the electrical connector on the extinguisher valve.
   c) Remove the distribution piping from the valve outlet port and install the anti-recoil cap.

WARNING

THE ANTI-RECOIL CAP SHALL BE INSTALLED ON THE VALVE OUTLET PORT AT ALL TIMES EXCEPT WHEN THE EXTINGUISHER IS CONNECTED TO THE DISTRIBUTION PIPING OR WHILE THE EXTINGUISHER IS BEING FILLED.

   d) Loosen the mounting clamps and remove the extinguisher.

CAUTION

DO NOT ATTEMPT TO REBUILD THE EXTINGUISHER. HAVE THE FIRE EXTINGUISHER REBUILT BY A QUALIFIED FIRE PROTECTION EQUIPMENT COMPANY FAMILIAR WITH KIDDE DUAL SPECTRUM EQUIPMENT. REBUILD SHALL INCLUDE ACTUATOR, O-RING SEALS AND DRY CHEMICAL REPLACEMENT.

4. Remove the dry chemical nozzles from the distribution tubing for inspection and cleaning.
5. Blow out the distribution tubing with dry compressed air to insure the tubing is dry and free of debris and/or residual agent.
6. Reinstall the dry chemical nozzles wrench tight. NOTE: Do not use pipe dope or Teflon tape on the threads.
7. Replace the Fire Extinguisher:

a) Inspect the new Extinguisher; verify it is the correct part number to ensure it is the correct configuration for the application and verify the anti-recoil cap and the shorting plug are installed.

b) Install the Extinguisher in the mounting bracket and oriented per the instructions on the extinguisher nameplate. Tighten the mounting clamps. Do NOT connect the electrical connector at this time.

CAUTION

THE EXTINGUISHER WILL NOT FUNCTION AS INTENDED IF ORIENTED INCORRECTLY

c) Remove the anti-recoil cap and immediately connect the distribution piping.

d) Connect system power by replacing the system fuse located in the battery compartment and verify the red fire 'ALARM' lamp on the Protection Panel is NOT on. NOTE: The fire 'TROUBLE' lamp will be on solid yellow because the electrical connector on the extinguisher valve is not connected.

CAUTION

IF THE PROTECTION PANEL IS IN ALARM CONDITION, THE EXTINGUISHER MAY DISCHARGE IF IT IS CONNECTED TO THE SYSTEM. BE SURE THE RED FIRE 'ALARM' LAMP ON THE PROTECTION PANEL IS NOT ILLUMINATED BEFORE PROCEDING FURTHER.

e) Remove the shorting plug from the electrical connector on the extinguisher valve.

f) Attach the vehicle harness to the electrical connector on the extinguisher valve.

8. Verify the green 'SYSTEM OK' lamp on the Protection Panel and green status lamp on the Optical Fire Detector is on solid.

NOTE: The vehicle may be *started* after a fire without resetting the system by cycling the ignition switch (key) on-off twice within two seconds. This will not reset the system, rather it will instruct the vehicle's multiplex system to ignore vehicle interface outputs from the Protection Panel. This feature is intended to be used only in emergency situations that require the vehicle to be moved a short distance prior to proper system reset. It should not be performed if the cause of the fire has not been clearly identified and corrected.

PERIODIC MAINTENANCE

The maintenance intervals specified are for typical transit bus applications and may be modified in accordance with the rigors of the application (equipment type and/or environmental circumstances). Maintenance should be performed more frequently when circumstances require. Refer to NFPA-17 for further information.

PRE-TRIP

- Verify the Protection Panel 'SYSTEM OK' lamp is on solid green

EVERY 3000 MILES OR MONTHLY (whichever occurs first)

General

- Verify neither the protected equipment nor the hazard has changed
- Verify no obvious physical damage or condition exists that might prevent system operation

Protection Panel

- Verify all warning lamps and the audible alarm are operational by pressing the 'TEST/RESET' button

Manual Activation Switch

- Verify tamper seal is intact and access to switch is unobstructed

Fire Detectors

- Optical
    - Verify status lamp on the detector face is on solid green
    - Verify nothing is blocking the detector's field of view
    - Verify the windows on the face of the detector are free of excess contamination (dirt, oil, grease, etc) - if necessary, clean using water soaked non-abrasive towel
- Linear Thermal
    - Verify there is no obvious physical damage and that unit is free of excess contamination (dirt, oil, grease, etc) - if necessary, clean using water soaked non-abrasive towel
    - Verify mounting is secure and taught

Electrical Harness

- Verify electrical connectors and electrical wiring have no visible damage and all connectors are securely seated

Extinguisher & Distribution System

- Verify the extinguisher pressure gauge pointer is in the green arc at room temperature
- Verify distribution piping and nozzles are intact and unobstructed and that nozzle blow-off caps are in place

EVERY 18000 MILES OR SEMI-ANNUALLY (whichever occurs first)

- Perform a comprehensive fire system test using a Kidde Dual Spectrum System Test Set (Optical Test Kit P/N 420871-2)
- Service the Extinguisher in accordance with KDS Document 160296, "KDS-25 Pre-Engineered Fire Suppression System: Installation, Operation and Maintenance Manual"

EVERY SIX YEARS

- Have the Extinguisher rebuilt by a qualified fire protection equipment company familiar with Kidde Dual Spectrum equipment and in accordance with KDS Document 160296, "KDS-25 Pre-Engineered Fire Suppression System: Installation, Operation and Maintenance Manual. Rebuild shall include actuator, o-ring seals and dry chemical replacement.

EVERY TWELVE YEARS

- Have the Extinguisher cylinder hydrostatically tested by a qualified fire protection equipment company familiar with Kidde Dual Spectrum equipment and in accordance with KDS Document 160296, "KDS-25 Pre-Engineered Fire Suppression System: Installation, Operation and Maintenance Manual..

TROUBLE SHOOTING GUIDE

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
All Protection Panel lamps off.	No power to system	Check connections to & voltage of vehicle batteries. Check system fuse (15A). Below 9 volts the system will not function
Protection Panel green "SYSTEM OK" lamp blinking.	Low battery voltage	Check connections to & voltage of vehicle batteries. Between 9 and 22 volts the system will provide low voltage indication but remains fully functional.
Protection Panel green "SYSTEM OK" lamp off, yellow fire "TROUBLE" lamp on solid, red fire "ALARM" lamp on solid and audible alarm on.	System automatically discharged	Correct the cause of the fire and reset the system as described in the system reset portion of this manual
Protection Panel green "SYSTEM OK" lamp off, yellow fire "TROUBLE" lamp on solid, red fire "ALARM" lamp on blinking and audible alarm on.	System manually discharged	Correct the cause of the fire and reset the system as described in the system reset portion of this manual
Protection Panel green "SYSTEM OK" lamp off, yellow fire "TROUBLE" lamp on solid and audible alarm beeping.	Component not connected or damaged harness in the extinguisher circuit	Check harness connections at extinguisher Check electrical interconnections (Figure 10)
Protection Panel green "SYSTEM OK" lamp off, yellow fire "TROUBLE" lamp on blinking and audible alarm beeping.	Component not connected or damaged harness in the fire detection circuit	Check harness connections at fire detectors Check connection at EOL Check electrical interconnections (Figure 10)

Bus will not start, Protection Panel red fire "ALARM" lamp on solid and audible alarm on	System not reset after fire	Correct the cause of the fire and reset the system as described in the system reset portion of this manual
Extinguisher pressure gauge reading is low	Extinguisher cold	Let extinguishers warm up to room temperature (about 70°F) and recheck the gauge. If the pointer is then within the green arc no corrective action is required
	Extinguisher leaking or discharged	Have the fire extinguisher serviced by a fire protection equipment company familiar with KDS equipment

REPLACEMENT PARTS LIST

Protection Panel, P/N 413410-146 (H345)

Protection Panel, P/N 413410-14 (EPA10)

Manual Activation Switch Kit, P/N 421317

Manual Activation Switch Tamper Seal, P/N 421317-2

Optical Fire Detector, P/N 420010

Linear Thermal Detector (LTD), 35ft, P/N 421430-35 (H345)

Linear Thermal Detector (LTD), 10ft, P/N 421430-10 (EPA10)

Linear Thermal Detector (LTD), 20ft, P/N 421430-20 (EPA10)

End-of-Line Device (EOL), P/N 420241

KDS-25 Fire Extinguisher, 25lb, BC, Gauge Right, P/N 421220-22 (H345)

KDS-25 Fire Extinguisher, 25lb, ABC, Gauge Right, P/N 421220-12 (EPA10)

KDS-25 Extinguisher Rebuild Kit, P/N 424766

Extinguisher Bracket Assembly, P/N 421222

Nozzle, Dry Chemical, P/N 474946

TEST EQUIPMENT

Optical Fire System Test Kit, P/N 420871-2

Kidde de México

Av. División del Golfo 3308
87019 Cd. Victoria, Tamaulipas, México
e-mail: kidde.mexico@kidde.com.mx

MATERIAL SAFETY DATA SHEET
PURPLE "K" DRY CHEMICAL – POLVO QUÍMICO SECO PURPLE "K"

SECTION 1 – CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Trade Name / Label Name:	PURPLE "K" DRY CHEMICAL
CAS Number:	N/A
Chemical Name / Family	N/A It is a mixture
Synonyms:	Purple K dry chemical powder Siliconized potassium bicarbonate
Manufacturer's Name:	KIDDE DE MEXICO, S. A. DE C. V.
Address:	Av. División del Golfo 3308 Nte. 87019 Cd. Victoria, Tamaulipas, MÉXICO
Business phone / Fax:	+52 (834) 313-03-03 / +52 (834) 313-03-01
Date of preparation:	February 25, 2004

SECTION 2 – COMPOSITION AND INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS N°	% w/w	OSHA PEL mg/m^3	ACGIH TLV mg/m^3	TOXICITY DATA
Potassium bicarbonate	298-14-8	78 – 82	NONE	15	NONE
Sodium bicarbonate	144-55-8	12 – 15	NONE	NONE	NONE
Mica	12001-26-2	1 – 3	3	3	NONE
Attapulguite clay	8031-18-3	1 – 3	NONE	NONE	NONE
Amorphous silica	7631-86-9	0.2 – 1.0	6	10	NONE
Methyl Hydrogen Polysiloxane	63148-57-2	0.2 – 1.0	NONE	NONE	NONE

SECTION 3 – PHYSICAL AND CHEMICAL CHARACTERISTICS

Boiling point, °C:	N/A	**Specific gravity (H_20=1)**	ABOUT 2.2	**Viscosity @ 20°C:**	N/A
Vapor pressure, mm Hg:	N/A	**Percent volatile by volume:**	N/A	**Melting point, °C:**	NDA
Vapor density (Air=1):	N/A	**Evaporation rate (Butyl acetate=1)**	N/A	**Solubility in water:**	NDA
Reactivity in water:	Unreactive	**Appearance and odor:**	Odorless, purple colored fine powder		

SECTION 4 – FIRE AND EXPLOSION HAZARD DATA

Flash point:	N/A	**Flammable limits in air, % by volume**	N/A	**Auto-ignition temperature:**	N/A
Extinguishing media:	N/A – The product is a fire extinguishing agent				
Unusual fire and explosion hazards:	NONE				
Special fire fighting procedures:	The material is a fire extinguishing agent and will not burn. However, if other materials are involved, use standard chemical fire fighting procedures and consider the hazards of those materials. In enclosed areas, fire fighters must wear self-contained breathing apparatus and full protective equipment.				

SECTION 5 – REACTIVITY DATA

Stability:	Stable	**Conditions to avoid:**	Extreme heat	**Hazardous polymerization:**	Will not occur
Incompatibility (materials to avoid):	Strong acids. Do not mix with ABC type dry chemical extinguishing agents.				
Hazardous decomposition products:	Carbon dioxide.				

SECTION 6 – HEALTH HAZARD DATA

Threshold limit value:	ACGIH TLV for particulates not otherwise classified: 10 mg/m^3 OSHA PEL for nuisance dust limit total: 15 mg/m^3
Routes of entry:	**Inhalation:** YES; may be irritant to the respiratory tract. **Eye contact:** YES; mildly irritant for a short period. **Skin contact:** YES; may be mildly irritating. **Ingestion:** NOT an expected route of entry.
Signs and symptoms of overexposure:	**Acute:** Transient cough, shortness of breath, irritation of airways. **Chronic:** This product is not known to cause chronic illness.
Medical conditions generally aggravated by exposure:	Asthma, emphysema, bronchitis or other respiratory illness.
Chemical listed as carcinogen or potential:	NTP program: No IARC monographs: No OSHA: No
Emergency and first aid procedures:	**Eye contact:** Flush with large amounts of water for at least 15 minutes. If irritation persists, seek medical attention. **Skin contact:** Wash with soap and water. If irritation persists, seek medical attention. **Inhalation:** Move victim to fresh air. Seek medical attention if discomfort continues. **Ingestion:** Rinse mouth, drink large amounts of water and induce vomiting. Seek medical help.

SECTION 7 – SPECIAL PRECAUTIONS AND SPILL / LEAK PROCEDURES

Precautions to be taken in handling and storage:	Should be stored in original containers. Store in dry, cool, well-ventilated place away from acidic compounds. Wash after handling. Do not cut, grind, weld or drill on or near product containers. Treat empty containers as if they were full.
Other precautions:	Do not mix with acidic materials.
Steps to be taken in case materials is released or spilled:	Sweep up or vacuum. Store in covered containers. Do not reuse. In case of large spills, use rubber gloves, chemically resistant suit and boots, hard hat and air purifying respirator.
Waste disposal method:	Dispose of in compliance with local, state and federal regulations. Components are non hazardous, sanitary landfill disposal may be acceptable

SECTION 8 – SPECIAL PROTECTION INFORMATION	
Respiratory protection:	Dust mask where dustiness is prevalent or TLV exceeded. Mechanical filter respirator if exposure is prolonged.
Ventilation:	Use adequate ventilation. Use fan or vent to outside.
Protective gloves:	Wear rubber gloves for routine industrial use.
Eye protection:	Recommended as mechanical barrier for prolonged exposure. Safety glasses or chemical type goggles.
Other protective equipment:	If irritation occurs, long sleeves and impervious gloves should be worn.
Work / Hygienic practices:	Use good personal hygiene and good housekeeping practices. Avoid breathing of dust. Wash with soap and water.

SECTION 9 – REGULATORY INFORMATION	
U.S. OSHA HAZARD COMMUNICATION STANDARD	Product assessed in accordance with OSHA 20 CFR 1910.1200 and determined not to be hazardous.
RCRA INFORMATION	The unused product, in our opinion, is not specifically listed by the EPA as hazardous waste (40 CFR, Part 261D), nor is it formulated to contain materials which are listed hazardous wastes. It does not exhibit the hazardous characteristics of ignitability, corrosivity or reactivity, and is not formulated with contaminants as determined by the toxicity characteristics leaching procedure (TCLP). However, used product may be regulated.
SARA Reporting Requirements	No component of this product is subject to the reporting requirements of Sections 302, 304 and 313 of Title III of the Superfund Amendments and Reauthorization Act.
TSCA Inventory status	Kidde de México certifies that the product described herein complies with all applicable rules or orders under TSCA and no chemical substance for entry in violation under TSCA or any applicable rule or order thereunder TSCA is being offered.

HAZARDOUS MATERIAL IDENTIFICATION SYSTEM RATINGS

HEALTH: 1	**FLAMMABILITY: 0**	**REACTIVITY: 0**

HAZARD INDEX:
0 Minimal hazard
1 Slight hazard
2 Moderate hazard
3 Serious hazard
4 Sever hazard

GENERAL KEYS:

N/A: Not applicable.
NDA: No data available.

PREVOST

DASHBOARD RADIO OPERATING INSTRUCTIONS

Beginning with vehicle A-1493, February 2009

●

MANUEL D'UTILISATION DE LA RADIO DU TABLEAU DE BORD

Débutant avec le véhicule A-1493, Février 2009

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Safety Information

IMPORTANT: Before driving this vehicle, be certain that you have read and that you fully understand each and every step of the driving and handling information in this manual. Be certain that you fully understand and follow all safety warnings.

IT IS IMPORTANT THAT THE FOLLOWING INFORMATION BE READ, UNDERSTOOD AND ALWAYS FOLLOWED.

The following types of advisories are used throughout this manual:

DANGER

Danger indicates an unsafe practice that could result in serious personal injury or death. A danger advisory banner is in **white** type on a **black** background with a **black** border.

WARNING

Warning indicates an unsafe practice that could result in personal injury. A warning advisory banner is in **black** type on a **gray** background with a **black** border.

CAUTION

Caution indicates an unsafe practice that could result in damage to the product. A caution advisory is in **black** type on a **white** background with a **black** border.

Note: Note indicates a procedure, practice, or condition that must be followed in order for the vehicle or component to function in the manner intended.

Safe Operation of the Radio

The driving conditions today require that the driver pays full attention to the road at all times. It is advised that when using this radio while driving the driver maintain full concentration on the road. Therefore it is strongly advised to do the following:

- Never Change a CD or read CD labels while driving.
- Always Ensure the Volume of the Audio System is set so that outside acoustics can also be heard.
- When possible use the Steering wheel controls. It is a feature to make it both easy and safe to handle the radio while driving

Introduction

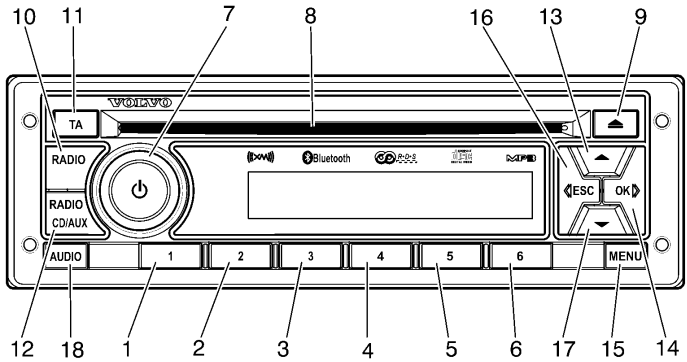
The following instructions explain the general functions and operations of Volvo Radio Models.
Radio information is displayed through the LCD display on the radio.
The radio is commanded by the Faceplate, shown in Fig 1.
Some functions can be commanded by the Steering Wheel Control, shown in Fig 2; or by the Remote Control, shown in Fig 3.

The main functions of the audio unit are:

- CD (supporting mp3 and WMA)
- USB (supporting mp3 and WMA)
- iPod
- Auxiliary audio input
- Hands free (Bluetooth Phone Operation)

General Overview

Radio / CD Controls Quick Reference Guide



W3007746

Fig. 1

1. **"Preset #1" Button:**
   - **Radio:** Push and release: Recall Preset Station
   - **Radio:** Push and hold: Store Preset Station
2. **"Preset #2" Button:**
   - **Radio:** Push and release: Recall Preset Station
   - **Radio:** Push and hold: Store Preset Station
3. **"Preset #3" Button:**
   - **Radio:** Push and release: Recall Preset Station
   - **Radio:** Push and hold: Store Preset Station
4. **"Preset #4" Button:**
   - **Radio:** Push and release: Recall Preset Station
   - **Radio:** Push and hold: Store Preset Station
5. **"Preset #5" Button:**
   - **Radio:**Push and release: Recall Preset Station
   - **Radio:**Push and hold: Store Preset Station

6. **"Preset #6" Button:**

- **Radio:** Push and release: Recall Preset Station
- **Radio:** Push and hold: Store Preset Station

7. **"Rotary Knob/PWR" Button:**

- **Push:** Power On and Off
- **Turn:** Volume Adjust & Audio Value Update

8. **CD Slot:**

- **CD:** Insert / Remove CD

9. **"Eject CD" Button:**

- **CD:** Eject CD

10. **Radio Select Mode:**

- **Radio:** Choose from FM1, FM2, FM3 (Mid radio only), AM, Weather band, and Satellite radio (Mid radio only)

11. **Information (Traffic / News):**

- **Radio:** Switch Traffic on or off
- **Radio:** Cancel ongoing Traffic or News message

12. **CD/Aux Mode Select:**

- **CD/USB:** Switch between sources other than radio

13. **Up Button:**

- **Radio:** Manual tuning up

14. **(Fast) Forward >> Button:**

- **Radio:** Seek
- **CD/USB:** Push and release: Select Next Track
- **CD/USB:** Push and hold: Fast Forward
- **Bluetooth Phone:** Accept incoming call

15. **Menu Button:**

- **Radio:** Push and release: Menu Access

16. **(Fast) Reverse << Button:**

- **Radio:** Seek
- **CD/USB:** Push and release: Select previous Track
- **CD/USB:** Push and hold: Fast Reverse
- **Bluetooth Phone:** Reject incoming call or hang up
- **iPod :** Push and hold: Enter iPod menu (Mid radio only)

17. **Down Button:**

- **Radio:** Manual tuning down

18. **Audio Button:**

- **General:** Audio Settings

Steering Wheel Controls Quick Reference Guide

20. **"Next" Button:**

- **Radio:** Push and release: Seek
- **Radio:** Push and hold: Manual tune up
- **CD/USB:** Push and release: Select next track
- **CD/USB:** Push and hold: Fast forward

21. **"Previous" Button:**

- **Radio:** Push and release: Seek
- **Radio:** Push and hold: Manual tune down
- **CD/USB:** Push and release: Select previous track
- **CD/USB:** Push and hold: Fast reverse

22. **"YES"Button:**

- **Bluetooth Phone:** Accept incoming call (optional)

23. **"NO"Button:**

- **Bluetooth Phone:** Reject incoming call or hang up (optional)

24. **"Vol +" Button:**

- **General :** Increase Sound Volume

25. **"Vol — " Button:**

- **General :** Decrease Sound Volume

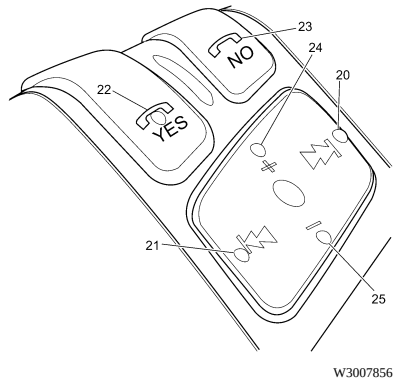


Fig. 2

Remote Control Quick Reference Guide

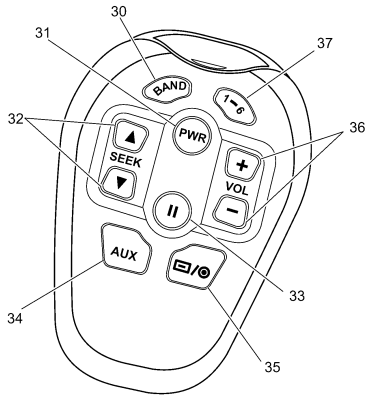


Fig. 3

30. **"Band" Button:**

- **Radio:** Select between FM1, FM2, FM3 (Mid radio only), AM, Weather band, and Satellite radio (Mid radio only)

31. **"PWR" Button:**

- **General:** Turns the Radio On and Off

32. **"Seek" Buttons:**

- **Radio:** Seek
- **CD/USB :** Next or previous track

33. **"Mute / Pause" Button:**

- **General:** Mute or Pause the source of audio

34. **"Aux" Button:**

- Not used for Base radio functions
- **Source:** Select between USB, iPod, Aux.

35. **"CD Select" Button:**

- **CD:** Select CD

36. **"Vol + / Vol ?" Button:**

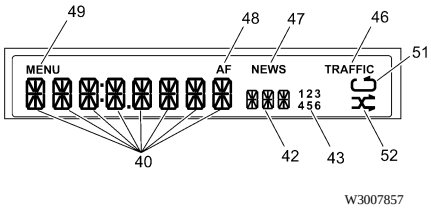
- Adjust the volume up and down

37. **Preset 1 to 6:**

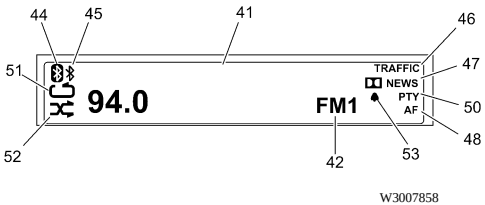
- **Radio:** Select a Preset Station

Display Quick Reference Guide

Radio LCD Display



Base Radio Display (Fig. 4)



Mid Radio Display — Optional (Fig. 5)

40. **Base Radio Text Display:**

- **Radio:** Displays radio frequency and station name
- **CD:** Displays track, time and music info when available

41. **Mid Radio Text Display**

- **Radio:** Displays radio band (FM/AM) and frequency
- **CD/USB:** Displays track, time and music info when available

42. **Source Display**

- **Radio:** Displays radio band (FM1, FM2, FM3 (Mid radio only) AM, WX, or SAT (Mid radio only))
- **CD/USB:** Displays other source than radio

43. **Preset Number**

- **Radio:** Displays preset number

44. **Phone Connected**

- **General:** Indicates that the phone is connected

45. **Bluetooth On**

- **General:** Indicates that the Bluetooth function is on

46. **Traffic Info**

- **General:** Indicates that the traffic function is on

47. **News Info**

- **General:** Indicates that the news function is on

48. **AF**

- **General** Indicates that the AF (Alternative frequency) function is on

49. **Menu**

- **General:** Displayed when in Menu

50. **PTY**

- **General:** Indicates that the PTY (Program type) function is on

51. **Repeat**

- **CD/USB:** Display when Repeat is on

52. **Random**

- **CD/USB:** Displayed when Random is on Menu

53. **Alarm**

- **General:** Indicates that the Alarm clock function is on

Main Functions

Many functions are controlled or adjusted through the radio Menu. If the Menu screen is open and the radio experiences no activity for a 10 second period, the radio will cancel any incomplete actions, close the Menu screen and return to normal operation. The radio will save all completed changes.

Power

Switching On & Off, Mute and Pause of the Audio System

The audio system is switched on or off by pressing the **Volume Knob** (7).

If the driver wants to quickly mute the audio system sound, press the **Volume Knob** (7).

Radio Mode

Band Selection (FM and AM)

To select the radio as the play mode, turn the radio on and press the **RADIO** (10) button .

The radio will then be active on the last used radio band (AM, FM etc).

To switch between the bands (AM/FM1/FM2) use the **RADIO** (10) button .

Seek in Radio Mode

There are two ways to seek for a radio station:

1 Use the Seek buttons **ESC** (16) or **OK** (14) to seek up or down respectively on the radio. Once a station is found the seek function will stop.

OR

2 Use the Seek buttons of the Steering Wheel Control << (21) or >> (20) to seek up or down respectively on the radio. Once a station is found the seek function will stop.

Manual Tuning

Manual Tuning can be performed in two ways:

1 Push **UP** (13) or **DOWN** (17) buttons to tune up or down respectively.

OR

2 Push and hold button << (21) or >> (20) on the steering wheel, to tune up or down respectively.

Presets (Storing Radio Stations)

Up to 12 FM and 6 AM radio stations can be stored for fast access. There are two sets of FM radio preset bands, which are FM1 and FM2, and one AM radio preset band. Each preset band can store 6 stations on buttons 1 thru 6.
To store a specific station into a preset button, do the following:

1 Push **RADIO** (10) button until the required frequency band is active (AM, FM1, FM2, FM3 (Mid radio only), Weather, or Satellite radio (Mid radio only)).
2 Tune the radio to the desired station.
3 Push and hold the desired preset button **1 thru 6**.
4 There will be a short as the station is stored. When audio returns the process is completed.

Presets (Selecting a Stored Radio Station)

To select one of the preset stations, perform the following:

1 Push the **RADIO** (10) button to select the required band (AM, FM1, FM2, FM3 (Mid radio only), Weather, or Satellite radio (Mid radio only)).
2 Push and release the required preset button **1 thru 6** to activate the desired station.

Scan Mode

The scan feature allows the user to perform a radio station search without having to toggle manually through the stations. When in scan mode, each station found will play for 10 seconds to give the user a chance to sample the station program or music. The scan will then continue on to the next available station unless the user chooses to stop the scan and stay at the present station.
To enter scan mode, perform the following:

1 Push **MENU** (15) button.
2 Select “SCAN” by pushing **OK** (14) button.

To exit scan mode and stay at the present station perform:

1 Push the **RADIO** (10) button.

OR
2 Push steering wheel button << (21) or >> (20).

Using the Weather Band

NOAA Weather Radio is a service of the National Weather Service. It provides continuous broadcasts of the latest weather information directly from the National Weather Service offices. Taped weather messages are repeated every four to six minutes and are revised every one to three hours or more frequently if needed. Most of the stations operate 24 hours a day. The weather for the area you are in can be found on one of 7 stations.

When in the Weatherband mode, the display will show the "WX" icon and "CH" plus the channel number. The channel can be changed using the **UP** (13) or **DOWN** (17) buttons and can also be preset to the pushbuttons.

The frequency associated with each channel is as follows:

1 162.550 MHz
2 162.400 MHz
3 162.475 MHz
4 162.425 MHz
5 162.450 MHz
6 162.500 MHz
7 162.525 MHz

The National Weather Service operates approximately 372 stations. Close to 90 percent of the nation's population is within listening range of a NOAA Weather Radio broadcast.

Satellite Radio Service — (Optional Feature)

When the XM[1] or SIRIUS[2] logo appears on your radio, it is satellite radio compatible. XM and Sirius are satellite radio services that offer more than 100 channels of digital quality audio programming and can be heard uninterrupted across the contiguous United States. A service fee is required to receive satellite broadcasts. For more information, contact XM at www.xmradio.com or by phone at 1-800-852-XMXM (9696) or Sirius at http://activate.siriusradio.com or by phone at 1-888-539-7474.

To activate the integrated satellite receiver, you must furnish your satellite radio provider with the satellite receiver's Electronic Serial Number. To find the electronic serial number complete the following instructions:

If your satellite radio provider is XM Satellite Radio:

1 With the ignition and the radio ON, press the **RADIO** (10) button and select XM1 or XM2.
2 Tune your radio to channel 0 and the 8-digit serial number will appear.

If your satellite radio provider is Sirius Satellite Radio:

1 With the ignition and radio ON, press the **RADIO** (10) button and select SR1 or SR2.
2 Tune your radio to channel 0 and the 12-digit serial number will appear.

Note: Satellite radio reception may be degraded by satellite signal obstruction.

[1]XM is a registered trademark of XM Satellite Radio Holdings Inc.

[2]SIRIUS is a registered trademark of SIRIUS Satellite Radio Inc.

CD Mode

The radio is designed to work with standard CD format and MP3 and WMA files. The CD player will accept CD-R as well as CD-RW discs.

Switching to CD Mode

There are two ways to switch to the CD mode:

1 Push the **CD/AUX** (12) button until "CD " shows on display.

OR

2 Insert a CD into the CD slot (8).

Eject a CD

To eject a CD press the **EJECT** (9) button. When CD is ejected the radio will play the previous audio source. If the CD is not removed from the CD slot, it will automatically reload after 15 seconds.

Changing a Track on a CD

There are two ways to change a track on a CD:

1 Push and release the **ESC** (16) or **OK** (14) button to move to the next or previous track respectively.

OR

2 Using the steering wheel controls: Push and release the << (21) or >> (20) button to move to the previous or next track respectively.

Fast Reverse or Fast Forward of a CD

Fast forwarding or reversing a CD can be performed in one of two ways:

1 Push and hold the **ESC** (16) or **OK** (14) button on the radio to fast forward or fast reverse respectively.

OR

2 Using the steering wheel controls: Push and release the << (21) or >> (20) button to move to fast reverse or fast forward respectively.

Play Tracks on a CD in Random Order

There are two possible Random settings for a CD: Random All and Random Folder (If the content of the CD is stored in folders). To play tracks in random order, do the following:

1 Push **MENU** (15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until "RANDOM" is displayed.
3 Push **OK** (14) button to enter the random sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons to choose between All and Folder.
5 Push **OK** (14) button to enter the desired random mode.

Repeating Tracks on a CD — (Optional Feature)

There are three possible Repeat settings for a CD: Repeat All, Repeat track and Repeat Folder (If the content of the CD is stored in folders). By default, Repeat All is active.
To change the repeat setting, do the following:

1 Push **MENU**(15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until “REPEAT” is displayed.
3 Push **OK** (14) button to enter the repeat sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons to choose between All and Folder.
5 Push **OK** (14) button to enter the desired repeat mode.

Changing to Another Folder on a CD — (Optional Feature)

If the content of the CD is stored in folders, it is possible to change folders directly. To do this, push either the **UP** (13) or **DOWN** (17) button to move to the next or previous album/folder respectively.

Scan a CD

When CD is scanned, the first 10 seconds of each track is played.
To activate Scan, do the following:

1 Push **MENU** (15) button.
2 Select “SCAN” by pushing **OK** (14) button.

Scanning will stop if:

1 The face plate buttons **ESC** (16) or **OK** (14).

OR
2 All tracks are browsed through.

External Audio Input — (Optional Feature)

There are three possible external audio input modes, USB, iPod and Aux. A USB and an AUX device can be connected and accessible at the same time. However, if an iPod is connected the USB and the AUX devices will be disabled as an available source.

USB Mode — (Optional Feature)

The radio is designed to work with USB devices formatted with the USB Mass Storage Device Class standard. Other USB devices may still work with the radio though. If a USB device doesn't work properly, try reconnecting the device which may solve the problem in some cases.

Note: A USB device must be connected prior to operating in this mode.

Switching to USB Mode

There are two ways to switch to USB mode.

1 Push the **CD/AUX** (12) button until "USB" shows on the display.

OR

2 Connect a USB device.

Disconnecting a USB Device

No special preparations are needed to disconnect the USB device. When USB device is removed the radio will play the previous audio source.

Changing a Track on USB Device

There are two ways to change a track on a USB:

1 Push and hold the **ESC** (16)or **OK** (14) button on the radio to fast forward or fast reverse respectively.

OR

2 Using the steering wheel controls: Push and release the << (21) or >> (20) button to move to fast reverse or fast forward respectively.

Fast Reverse or Fast Forward on a USB Device

Fast reversing or forwarding can be performed in one of two ways:

1 Push and hold the **ESC** (16) or **OK** (14) button to fast forward or fast reverse respectively.

OR

2 Using the steering wheel controls: Push and release the << (21) or >> (20) button to move to fast reverse or fast forward respectively.

Please note that Push and hold the button will enter the iPod menu

Playing Tracks on a USB Device in Random Order

There are two possible Random settings for a USB device: Random All and Random Folder (If the content of the USB device is stored in folders).
To play tracks in random order, do the following:

1 Push **MENU**(15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until “RANDOM” is displayed.
3 Push **OK** (14) button to enter the random sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons to choose between All and Folder.
5 Push **OK** (14) button to enter the desired random mode.

Repeating Tracks on a USB Device

There are three possible Repeat settings for a USB device: Repeat All, Repeat track and Repeat Folder (If the content of the USB device is stored in folders). By default, Repeat All is active.
To change the repeat setting, do the following:

1 Push **MENU**(15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until “REPEAT” is displayed.
3 Push **OK** (14) button to enter the repeat sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons to choose between All, Track and Folder.
5 Push **OK** (14) button to enter the desired repeat mode.

Changing to Another Folder on a USB

If the content of the CD is stored in folders, it is possible to change folders directly. To do this, push either the **UP** (13) or **DOWN** (17) button to move to the next or previous album/folder respectively.

Scan a USB

When USB is scanned, the first 10 seconds of each track is played.
To activate Scan, do the following:

1 Push **MENU** (15) button.
2 Select “SCAN” by pushing **OK** (14) button.

Scanning will stop if:

1 The face plate buttons **ESC** (16) or **OK** (14).

OR

2 All tracks are browsed through.

iPod Mode — (Optional Feature)

The radio supports iPod Classic, iPod Video, and iPod nano. The iPod settings, e.g. Shuffle or Repeat, used prior to connecting the iPod to the radio will be used by the radio.

Note: An iPod device must be connected prior to operating in this mode.

Connecting an iPod

Connecting the iPod can be done with two different cable sets.

1 A split cable from the iPod 30-pin connector to a USB connector and a 3.5 mm audio connector
2 A separate iPod/USB cable plus a 3.5 mm male/male stereo audio cable connected to the iPod earphone output

The iPod volume should in this case be set to maximum prior to connecting to the radio. When the iPod is connected to the radio, the iPod's controls will lock. All control of the iPod is done by the radio buttons. When in this state, the iPod will display a Volvo logotype.

Switching to iPod Mode

There are two ways to switch to iPod mode:

1 Push the **CD/AUX** (12) button until "iPod " shows on the display.

OR

2 Connect an iPod device.

Disconnecting an iPod Device

No special preparations are needed to disconnect the iPod device. When the iPod device is removed the radio will play the previous audio source.

iPod Menu

When iPod is connected and source, the user can Push and hold the **ESC** (16) button to enter the iPod Menu. This Menu contains some of the most common functions used in the iPod. E.g. the user can search for Artists and Albums, as well as starting a Playlist.

Push and hold the **ESC** (16) button for 1 second to enter the iPod Menu at last used level.
Push and hold the **ESC** (16) button for 2 seconds to enter the iPod Menu at top level.

Changing a Track on an iPod

There are two ways to change a track:

1 Push and release the **ESC** (16) or **OK** (14) button on the radio to move to the next or previous track respectively.

OR

2 Using the steering wheel controls: Push and release the << (21) or >> (20) button to move to the previous or next track respectively.

Fast Reverse or Fast Forward on an iPod

Fast forwarding or reversing a CD can be performed in one of two ways:

1 Push and hold the **ESC** (16) or **OK** (14) button to fast forward or fast reverse respectively.

OR

2 Using the steering wheel controls: Push and release the << (21) or >> (20) button to move to fast reverse or fast forward respectively.

Play Tracks on an iPod in Random Order

There are two possible Random settings for iPod: Random Album and Random All.
To play songs in random order, do the following:

1 Push **MENU**(15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until “RANDOM” is displayed.
3 Push **OK** (14) button to enter the random sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons to choose between All and Folder.
5 Push **OK** (14) button to enter the desired random mode.

Repeat a Track on an iPod

There are two possible Repeat settings for iPod: Repeat One, and Repeat All.
To change the repeat setting, do the following:

1 Push **MENU**(15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until “REPEAT” is displayed.
3 Push **OK** (14) button to enter the repeat sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons to choose between All, Track and Folder.
5 Push **OK** (14) button to enter the desired repeat mode.

Scan iPod

When iPod is scanned, the first 10 seconds of each track is played.
To activate Scan, do the following:

1 Push **MENU** (15) button.
2 Select “SCAN” by pushing **OK** (14) button.

Scanning will stop if:

1 The face plate buttons **ESC** (16) or **OK** (14).

OR

2 All tracks are browsed through.

AUX Mode — (Optional Feature)

To select an auxiliary audio input:
Push the **CD/AUX** (12) button until Aux shows on the display.
An auxiliary audio input may be selected except when in iPod mode.

The output volume of the Aux device should be set to maximum.

Note: Please note that for an Aux device, changing tracks, fast forwarding etc., must be done directly on the Aux device.

Audio Settings

Adjusting Volume Up and Down

The audio systems volume can be adjusted up by turning the **Volume Knob** (7) in a clockwise direction and adjusted down by turning the **Volume Knob** (7) in a counter-clockwise direction.

It can also be adjusted up and down by using the + (24) and - (25) buttons on the steering wheel controls respectively.

Adjusting Bass Up and Down

The audio systems bass can be adjusted by pressing the **AUDIO** (18) button until "BASS" shows on the display.

The bass is then adjusted up by turning the **Volume Knob** (7) in a clockwise direction and adjusted down by turning the **Volume Knob** (7) in a counter-clockwise direction.

It can also be adjusted up and down by using **ESC** (16) or **OK** (14) buttons respectively.

Adjusting Treble Up and Down

The audio systems treble can be adjusted by pressing the **AUDIO** (18) button until "TREBLE" shows on the display.

The treble is then adjusted up by turning the **Volume Knob** (7) in a clockwise direction and adjusted down by turning the **Volume Knob** (7) in a counter-clockwise direction.

It can also be adjusted up and down by using **ESC** (16) or **OK** (14) buttons respectively.

Adjusting Balance Left and Right

The audio systems balance can be adjusted by pressing the **AUDIO** (18) button until "BALANCE" shows on the display.

The balance is then adjusted up by turning the **Volume Knob** (7) in a clockwise direction and adjusted down by turning the **Volume Knob** (7) in a counter-clockwise direction.

It can also be adjusted up and down by using **ESC** (16) or **OK** (14) buttons respectively.

Adjusting Fader Front and Back

The audio systems fader can be adjusted by pressing the **AUDIO** (18) button until "FADER" shows on the display.

The fader is then adjusted up by turning the **Volume Knob** (7) in a clockwise direction and adjusted down by turning the **Volume Knob** (7) in a counter-clockwise direction.

It can also be adjusted up and down by using **ESC** (16) or **OK** (14) buttons respectively.

Adjusting Mid (Medium Frequency Range) Up and Down — (Optional Feature)

The audio systems mid can be adjusted by pressing the **AUDIO** (18) button until "MID" shows on the display.

The mid is then adjusted up by turning the **Volume Knob** (7) in a clockwise direction and adjusted down by turning the **Volume Knob** (7) in a counter-clockwise direction.

It can also be adjusted up and down by using **ESC** (16) or **OK** (14) buttons respectively.

Speakers Selection

The audio system can be adjusted to 4 or 2 speaker mode by performing the following:

1 Push **MENU** (15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until "ADVANCED" is displayed.
3 Push **OK** (14) button to enter the advanced sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons until "SPEAKERS" is displayed.
5 Push **OK** (14) button to change between 2CH and 4CH.

Activate Speed Dependant Volume (ASC) — (Optional Feature)

The audio systems volume can be set to increase with the speed of the vehicle. This is sometimes preferred to compensate for road and engine sounds. The feature can be set to three levels of sensitivity, LOW, MID and HIGH.
To activate ASC, perform the following:

1 Push **MENU** (15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until "ADVANCED" is displayed.
3 Push **OK** (14) button to enter the advanced sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons until "ASC" is displayed.
5 Push **OK** (14) button to enter the ASC sub menu.
6 Push **UP** (13) or **DOWN** (17) buttons to choose between LOW, MID and HIGH.
7 Push **OK** (14) button to enter the desired ASC setting.

Bluetooth Hands Free Phone Mode — (Optional Feature)

The radio is designed to work with mobile phones that support the Bluetooth Hands Free Profile 1.5. Other Bluetooth capable mobile phones may still work with the radio though.
To connect a mobile phone to the radio through Bluetooth, the following steps must be completed on the radio:

Bluetooth Activation

The purpose of this process is to make a Bluetooth connection possible.

1 Push **MENU** (15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until “HANDS FREE” is displayed.
3 Push **OK** (14) button to enter the hands free sub menu.
4 Push **OK** (14) button to activate Bluetooth.

When Bluetooth is active, the display shows the icon (45).

Adding a Phone

The purpose of this process is to make a connection between the radio and a phone as well as to add a phone to the radio phone list.

1 Push **MENU** (15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until “HANDS FREE” is displayed.
3 Push **OK** (14) button to enter the hands free sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons until “ADD PHONE” is displayed.
5 Push **OK** (14) button to initiate the phone connection.

The radio will now do a search for a blue tooth phone. This is indicated by the icon (45) blinking.

Note: Note that the phone must be in a corresponding connecting state during this process.

When a connection is established, the user will be prompted to enter a code on the phone. Enter code 0000 to verify connection.

Activating Another Phone

The purpose of this process is to disconnect a present bluetooth phone and establish a connection to another phone in the phone list.

1 Push **MENU** (15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until “HANDS FREE” is displayed.
3 Push **OK** (14) button to enter the hands free sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons until “ChangePhName” is displayed.
5 Push **OK** (14) button to enter the change phone sub menu.
6 Push **UP** (13) or **DOWN** (17) buttons until phone name that is to be connected is displayed.
7 Push **OK** (14) button to connect to the other phone.

1 Activate the Bluetooth function.
2 Add the Phone.

Note: Please note that corresponding steps have to be taken on the mobile phone.

An added phone will be stored in a list for quick access when connecting at another time.

Deleting a Phone

The purpose of this process is to delete a specific phone from the phone list in the radio.

1 Push **MENU** (15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until “HANDS FREE” is displayed.
3 Push **OK** (14) button to enter the hands free sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons until “EDIT PHONE” is displayed.
5 Push **OK** (14) button to enter the edit phone sub menu.
6 Push **UP** (13) or **DOWN** (17) buttons until phone name that is to be deleted is displayed.
7 Push **OK** (14) button to delete the other phone.
8 The display will show “Delete?”. Push **OK** (14) to verify.

Deleting all Phones

The purpose of this process is to delete all phones from the phone list in the radio.

1 Push **MENU** (15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until “HANDS FREE” is displayed.
3 Push **OK** (14) button to enter the hands free sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons until “EDIT PHONE” is displayed.
5 Push **OK** (14) button to enter the edit phone sub menu.
6 Push **UP** (13) or **DOWN** (17) buttons until “DELETE ALL” is displayed.
7 Push **OK** (14) button to delete all the phones.
8 The display will show “Are U sure?”. Push **OK** (14) to verify.

Switching Phone Calls Between the Vehicle and an Active Phone

The purpose of this process is to allow switching of phone calls from being received and heard through the radio to being received and heard through a active phone.

1 To switch a call from the vehicle to an active phone, press the **AUDIO** button.
2 To switch a call from an active phone to the vehicle, press the **AUDIO** button.

Clock

Displaying the Time

By default, the time of day is displayed only when the ignition is ON and the radio is OFF. The Clock can be set to show the time also when radio is ON, by doing the following:

1 Push **MENU** button (15).
2 Push **UP** (13) or **DOWN** (17) buttons until “CLOCK” is displayed.
3 Push **OK** (14) button to enter the clock sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons until “VISIBLE” is displayed.
5 Push **OK** (14) button to change between ON/OFF status.

12– or 24-Hour Format

The clock can be set to 12-hour or 24-hour mode. The 12-hour mode distinguishes between AM and PM.
To change the time format, do the following:

1 Push **MENU** (15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until “CLOCK” is displayed.
3 Push **OK** (14) button to enter the clock sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons until “12/24 HR” is displayed.
5 Push **OK** (14) button to change between 12H or 24H options.

Setting the Clock

Normally the time is set automatically by the trucks system. The option to manually set the time will then not be available.
To set the clock manually, do the following:

1 Push **MENU** (15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until “CLOCK” is displayed.
3 Push **OK** (14) button to enter the clock sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons until “SET TIME” is displayed.
5 Push **OK** (14) button to enter the set time sub menu.
6 Push **UP** (13) or **DOWN** (17) buttons to adjust the hours up or down respectively.
7 Push **OK** (14) button to set the hour and toggle to the minute adjustment.
8 Push **UP** (13) or **DOWN** (17) buttons to adjust the minutes up or down respectively.
9 Push **OK** (14) button to save the time and finish the process.

Turning the Alarm ON or OFF — (Optional Feature)

To set turn On or Off the Alarm time, do the following:

1 Push **MENU** (15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until “WAKE UP ALARM” is displayed.
3 Push **OK** (14) button to enter the wake up alarm sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons “On/Off” is displayed.
5 Push **OK** (14) button to change the alarm status.

Setting the Alarm — (Optional Feature)

To set the Alarm time, do the following:

1 Push **MENU** (15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until “WAKE UP ALARM” is displayed.
3 Push **OK** (14) button to enter the wake up alarm sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons until “SET TIME” is displayed.
5 Push **OK** (14) button to enter the set time sub menu.
6 Push **UP** (13) or **DOWN** (17) buttons to adjust the hours up or down respectively.
7 Push **OK** (14) button to set the hour and toggle to the minute adjustment.
8 Push **UP** (13) or **DOWN** (17) buttons to adjust the minutes up or down respectively.
9 Push **OK** (14) button to save the time and finish the process.

Anti Theft Code (Guard)

The radio unit is set to function with only one vehicle. The Guard feature prohibits operation of the radio anywhere else. The Guard is automatic and no manual handling is normally needed.

In Case of Malfunction

If, by some reason, the radio fails in detecting the required vehicle, the user will be prompted to enter the Anti Theft Code (sticker found in Drivers Handbook). The display will then show “CODE 0000”.

Note: Please note that this is a malfunction and should be checked at an authorized workshop.

To enter the code, do the following:

1 For the current (blinking) digit, turn the **Volume Knob** (7) until the right number is shown.
2 Press the power button to enter the digit. The next digit will start to blink.
3 Repeat step 1 and 2 until all four digits has been entered.

The user has three tries to enter the code. If these are unsuccessful the radio will be locked for 60 minutes until three new tries are allowed.

Deactivating Guard

It is possible to deactivate Guard, but not recommended.
To deactivate the Guard function, do the following:

1 Push **MENU** (15) button.
2 Push **UP** (13) or **DOWN** (17) buttons until “ADVANCED” is displayed.
3 Push **OK** (14) button to enter the advanced sub menu.
4 Push **UP** (13) or **DOWN** (17) buttons until “GUARD” is displayed.
5 Push **OK** (14) button to enter.
6 Push **OK** (14) button to set Guard On or Off.

The user will be requested for the Anti Theft Code to deactivate or activate Guard. The display will then show “CODE 0000” with the first digit blinking.
To enter the code, do the following:

1 For the current (blinking) digit, turn the **Volume Knob** (7) until the right number is shown.
2 Press the power button to enter the digit. The next digit will start to blink.
3 Repeat step 1 and 2 until all four digits has been entered.

The user has three tries to enter the code. If these are unsuccessful the radio will be locked for 60 minutes until three new tries are allowed.

Tips and Tricks

USB and MP3

The radio is designed to work with USB devices that support the USB Mass Storage Device Class Standard.

Note: Other USB devices may still work with the radio.

If a USB device does not work together with the radio, please try to re-connect the USB device which in some cases solves the problem. Some USB devices come with extra software installed which makes them not compatible with the USB Mass Storage Device Class Standard. If this is the case, formatting the USB device can sometimes solve the problem.

Note: Formatting the unit will erase all data on the USB device, so be sure to back-up of the data before trying this.

- WMA and MP3 are the only formats readable by the device.
- Playlist must be in .PLS or .M3U format.

Bluetooth

The radio is designed to work with Blutooth capable cellular phones that support the Bluetooth Hands-Free Profile 1.5.

Note: Some Bluetooth capable cellular phones that do not support this standard may still work

To see if your phone supports BlueTooth Hands-Free Profile 1.5, visit the BlueTooth organization homepage at https://www.bluetooth.org/tpg/listings.cfm and search for the detailed specifications of your phone.

Note: The link above could change if the structure of the BlueTooth homepage is updated. You can also try contacting your cellular supplier, to get the details directly from them.

- Compatible with standard 1.5.
- More information at www.bluetooth.org.

iPod

The radio is designed to support the following iPod models;

- iPod nano — 1st, 2nd and 3rd generation
- iPod classic — 5th and 6th generation

Note: Both older and newer generations of these iPods may also work.

- An iPod adapter can be purchased through Volvo as part number 21259125.
- Other adapters may also be found at www.sendstation.com.
- For best performance, the iPod firmware should be recently updated www.apple.com.

CD, MP3, and WMA

- A CD with MP3 or WMA will take several seconds to read before it starts playing.
- For best performance, an MP3/WMA CD should not contain other file types than MP3, WMA, M3U and PLS.

Sécurité et utilisation de la radio

De nos jours, les conditions de conduite sont telles que le conducteur doit garder à tout moment sa concentration sur la route. Il est conseillé, lors de l'utilisation de cette radio tout en conduisant, que le conducteur reste concentré sur la conduite. Il est par conséquent vivement conseillé de :

- Ne jamais changer un CD ni lire une étiquette de CD lorsqu'on est au volant.
- Toujours s'assurer que le volume du système audio permette d'entendre les bruits extérieurs.
- Utiliser si possible les commandes situées sur le volant. Cette caractéristique rend la conduite plus sécuritaire et facilite la commande de la radio.

Introduction

Les instructions suivantes expliquent le fonctionnement des modèles de radio Volvo. Les renseignements sur la radio paraissent sur l'afficheur LCD.
Les commandes de la radio sont accessibles sur sa façade, figure 1.
Certaines fonctions, illustrées à la figure 2, sont commandées au volant; ou à la télécommande, illustrée à la figure 3 (en option).
Les fonctions principales de la radio sont le mode radio et lecteur de CD.

Les fonctions principales en option de la radio sont :

- CD en format mp3 et WM
- USB (format mp3 et WMA)
- iPod (baladeur à disque dur)
- Entrée audio auxiliaire
- Mains libres (utilisation du téléphone à l'aide de Bluetooth)

Vue d’ensemble

Guide de référence rapide des commandes de la radio/du lecteur de CD

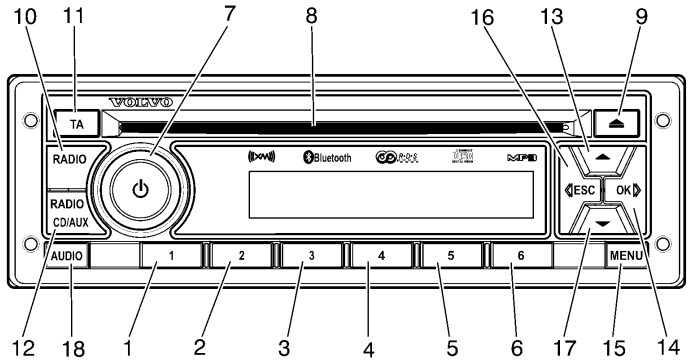


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Fig. 1

1. **Bouton « Préréglage nº 1 » :**

- **Radio :** Appuyer et relâcher : Rappel de la station préréglée
- **Radio :**Appuyer et maintenir enfoncé : Mémorisation de la station préréglée

2. **Bouton « Préréglage nº 2 » :**

- **Radio:** Appuyer et relâcher : Rappel de la station préréglée
- **Radio:** Appuyer et maintenir enfoncé : Mémorisation de la station préréglée

3. **Bouton « Préréglage nº 3 » :**

- **Radio:** Appuyer et relâcher : Rappel de la station préréglée
- **Radio:** Appuyer et maintenir enfoncé : Mémorisation de la station préréglée

4. **Bouton « Préréglage nº 4 » :**

- **Radio:** Appuyer et relâcher : Rappel de la station préréglée
- **Radio:** Appuyer et maintenir enfoncé : Mémorisation de la station préréglée

5. **Bouton « Préréglage nº 5 » :**

- **Radio:** Appuyer et relâcher : Rappel de la station préréglée
- **Radio:** Appuyer et maintenir enfoncé : Mémorisation de la station préréglée

6. **Bouton « Préréglage nº 6 » :**

- **Radio:** Appuyer et relâcher : Rappel de la station préréglée
- **Radio:** Appuyer et maintenir enfoncé : Mémorisation de la station préréglée

7. **Bouton de mise en marche à pousser/rotatif :**

- **Pousser :** Mise en marche et arrêt
- **Tourner :** Réglage du volume et mise à jour des valeurs audio

8. **Fente pour CD :**

- **CD:** Insertion/Extraction du CD

9. **Bouton d'éjection du CD :**

- **CD:** Éjection du CD

10. **Mode de sélection radio :**

- **Radio:** Choisir : FM1, FM2, FM3 (en option), AM, météo ou radio par satellite (en option)

11. **Information (Trafic / Nouvelles) :**

- **Radio:** Trafic en marche ou à l'arrêt

- **Radio:** Annule message continu de Trafic ou Nouvelles

12. **Mode CD/Aux :**

- **CD/USB:** Choisir entre les sources non radio

13. **Bouton vers le haut :**

- **Radio:** Syntonisation manuelle vers le haut

14. **Bouton d'avance (rapide) >> :**

- **Radio:** Recherche
- **CD/USB:** Appuyer et relâcher : Choisir prochaine plage
- **CD/USB:** Appuyer et maintenir enfoncé : Avance rapide
- **Bluetooth Phone:** Acceptation des appels (en option)

15. **Bouton du menu :**

- **Radio:**Appuyer et relâcher : Accès au menu

16. **Bouton de recul (rapide) << :**

- **Radio:** Recherche
- **CD/USB:** Appuyer et relâcher : Choisir plage précédente
- **CD/USB:** Appuyer et maintenir enfoncé : Recul rapide
- **Bluetooth Phone:** Refus d'appel ou raccrochage (en option)
- **iPod :** Appuyer et maintenir enfoncé : Entrer le menu iPod (en option)

17. **Bouton vers le bas :**

- **Radio:** Syntonisation manuelle vers le bas

18. **Bouton audio :**

- **Généralités :** Réglages audio

Guide de référence rapide des commandes au volant

20. **Bouton « suivant » :**

- **Radio:** Appuyer et relâcher : Recherche
- **Radio:** Appuyer et maintenir enfoncé : Syntonisation manuelle vers le haut
- **CD/USB:** Appuyer et relâcher : Choisir prochaine plage
- **CD/USB:** Appuyer et maintenir enfoncé : Avance rapide

21. **Bouton « précédent » :**

- **Radio:** Appuyer et relâcher : Recherche
- **Radio:** Appuyer et maintenir enfoncé : Syntonisation manuelle vers le bas
- **CD/USB:** Appuyer et relâcher : Choisir plage précédente
- **CD/USB:** Appuyer et maintenir enfoncé : Recul rapide

22. **Bouton « OUI » :**

- **Téléphone Bluetooth :** Acceptation d'appel (en option)

23. **Bouton « NON » :**

- **Téléphone Bluetooth :** Refus d'appel ou raccrochage (en option)

24. **Bouton « volume + » :**

- **Généralités :** Augmente le volume

25. **Bouton « volume ? » :**

- **Généralités :** Baisse le volume

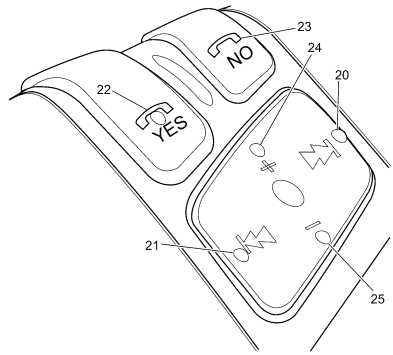


Fig. 2

Guide de référence rapide de la télécommande

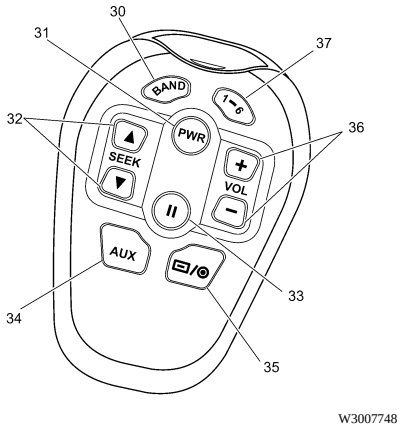


Fig. 3

30. **Bouton « BAND » (bande) :**

- **Radio:** Choisir : FM1, FM2, FM3 (en option), AM, météo ou radio par satellite (en option)

31. **Bouton « PWR » (mise en marche) :**

- **Généralités :** Mise en marche et arrêt de la radio

32. **Boutons « SEEK » (recherche) :**

- **Radio:** Recherche
- **CD/USB :** Plage suivante ou précédente

33. **Bouton « sourdine / pause » :**

- **Généralités :** Sourdine ou pause de la source audio

34. **Bouton « AUX » :**

- Fonction en option
- **Source:** Choisir entre : USB, iPod et Aux

35. **Bouton « sélection CD » :**

- **CD:** Choisir CD

36. **Bouton « volume + / volume ? » :**

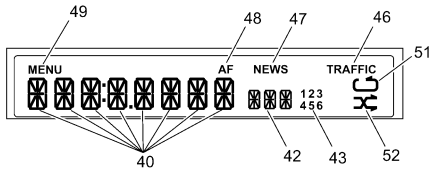
- Ajuster le volume vers le haut ou vers le bas

37. **Préréglage 1 à 6 :**

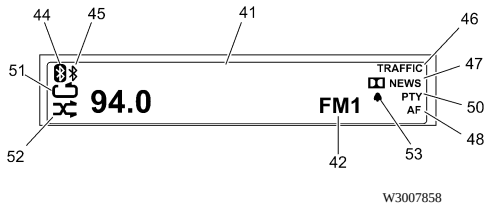
- **Radio:** Choisir une station préréglée

Guide de référence rapide de l'afficheur

Affichage à cristaux liquides de la radio



Affichage LCD de la radio (Fig. 4)



Affichage LCD de la radio (en option) — Optional (Fig. 5)

40. **Affichage texte de la radio :**

- **Radio:** Radiofréquence et nom de station
- **CD:** Plage, heure et information musicale fournie.

41. **Affichage texte de la radio :**

- **Radio:** Bande radio (FM/AM) et fréquence
- **CD/USB:** Plage, heure et information musicale fournie.

42. **Affichage de la source**

- **Radio:** Bande radio (FM1, FM2, FM3 (en option) AM, WX ou SAT (en option)
- **CD/USB:** Autres sources que la radio

43. **Nombre préréglé**

- **Radio:** Nombre préréglé

44. **Téléphone connecté**

- **Généralités:** Indique qu'un téléphone Bluetooth est connecté

45. **Bluetooth en marche**

- **Généralités:** Indique que la fonction Bluetooth est activée

46. **Information sur la circulation**

- **Généralités:** Indique que la fonction circulation est activée

47. **Bulletin d'information**

- **Généralités:** Indique que la fonction Bulletin d'information est activée

48. **AF**

- **Généralités:** Indique que la fonction AF (Alternative Frequency) est activée

49. **Menu**

- **Généralités :** Affiché si intégré au menu

50. **PTY**

- **Généralités :** Indique que la fonction PTY (Program type) est activée

51. **Répétition**

- **CD/USB :** Affiché lorsque la fonction Répétition est activée

52. **Aléatoire**

- **CD/USB :** Affiché si la fonction Aléatoire est activée dans le menu

53. **Alarme**

- **Généralités :** Indique que la fonction Alarme est activée

Fonctions principales

Un grand nombre de fonctions se commandent ou s'ajustent en passant par le menu de la radio. Si le menu est affiché à l'écran et qu'aucune activité ne se présente pendant 10 secondes au niveau de la radio, toute action incomplète sera alors annulée, l'écran avec menu sera fermé et la radio reviendra à son fonctionnement normal. Tous les changements réalisés seront mémorisés par la radio.

Alimentation

Mise en marche, mise à l'arrêt, sourdine et pause du système audio

Appuyer sur le bouton (7) pour allumer ou éteindre le système audio.

Si le conducteur souhaite une activation rapide du mode de discrétion, appuyer sur le bouton (7).

Mode radio

Sélection de bandes (FM et AM)

Pour choisir le mode radio, allumer la radio et appuyer sur le bouton **RADIO** (10).

La bande de fréquence de la radio sera alors la dernière utilisée (AM, FM, etc.).

Pour passer d'une bande à une autre (AM/FM1/FM2), utiliser le bouton **RADIO** (10).

Recherche en mode radio

There are two ways to seek for a radio station:

1 Utiliser le bouton de recherche **ESC** (16) ou le **OK** (14) pour rechercher une station radio vers le haut ou le bas. Une fois que la station voulue est obtenue, la fonction de recherche s'arrête.

OU

2 Utiliser les boutons de recherche au volant, le << (21) ou le >> (20) pour rechercher une station radio vers le haut ou le bas. Une fois que la station voulue est obtenue, la fonction de recherche s'arrête.

Syntonisation manuelle

La syntonisation manuelle s'exécute de deux façons :

1 Appuyer sur le bouton (13) ou le (17) pour un réglage vers le haut ou le bas.

OR

2 Maintenir enfoncé le bouton << (21) ou le >> (20) au volant, pour un réglage vers le haut ou le bas.

Préréglages (mémorisation) des stations radio

Jusqu'à 12 stations FM et 6 AM peuvent être préréglées pour un accès rapide. Il existe deux bandes de fréquence préréglées pour la radio FM, la FM1 et la FM2, et une pour la radio AM. Chaque bande préréglée peut comporter 6 stations sur les boutons allant de 1 à 6. Et en plus, une bande FM ainsi qu'une bande satellite sont en option.
Pour enregistrer une station particulière sur un bouton de préréglage, il faut :

1 Appuyer sur le bouton **RADIO** (10) jusqu'à l'activation de la bande de fréquence nécessaire (AM, FM1, FM2, FM3 [en option], météo, ou radio satellite [en option]).
2 Rechercher la station souhaitée.
3 Maintenir enfoncé le bouton de préréglage voulu **(1) (2) (3) (4) (5) (6)**.
4 Lors de la mémorisation de la station, la radio n'émet aucun son. Le processus est terminé au retour de l'audio.

Préréglages (sélection d'une station radio mémorisée)

Pour choisir l'une des stations préréglées, il faut :

1 Appuyer sur le bouton **RADIO** (10) pour choisir la bande nécessaire (AM, FM1, FM2, FM3 [en option], météo ou radio par satellite [en option]).
2 Appuyer momentanément sur le bouton de préréglage nécessaire **(1) (2) (3) (4) (5) (6)** pour activer la station souhaitée.

Mode balayage

Le balayage permet à l'utilisateur de rechercher une station sans avoir à manuellement passer d'une station à une autre. En mode balayage, chaque station détectée diffuse pendant 10 secondes pour donner à l'utilisateur une idée du programme ou de la musique. Le balayage continue alors jusqu'à la station suivante à moins que l'utilisateur décide d'arrêter le balayage sur la station qu'il vient d'entendre.
Pour obtenir le mode balayage, il faut :

1 Appuyer sur le bouton **MENU** (15) de la radio.
2 Choisir <<SCAN>> (balayage) en appuyant sur **OK** (14).

Pour sortir du mode balayage et rester sur la station actuelle, il faut :

1 Appuyer sur le bouton **RADIO** (10).

OU

2 Appuyer sur le bouton << (21) ou le >> (20).

Utilisation de la bande radiométéo

La radiométéo NOAA est un service de National Weather Service. Cette radiodiffusion transmet en continu les dernières informations météorologiques directement des bureaux du National Weather Service. Des messages enregistrés sur les conditions météorologiques sont répétés toutes les quatre à six minutes et revus toutes les une à trois heures et même plus souvent dans certaines circonstances. La majorité des stations émettent 24 heures sur 24. La météo de votre région est retransmise par une des 7 stations disponibles.

En mode de bande radiométéo, l'afficheur donne l'icône « WX » et « CH » plus le numéro du canal. Il est possible de changer de canal avec le bouton (13) or (17) et le canal peut également être préréglé avec les touches.

La fréquence associée avec chacun des canaux est la suivante :

1 162.550 MHz
2 162.400 MHz
3 162.475 MHz
4 162.425 MHz
5 162.450 MHz
6 162.500 MHz
7 162.525 MHz

Le National Weather Service exploite environ 372 stations. Près de 90% de la population se trouve dans la zone de radiodiffusion de la météo de la NOAA.

Service de radio par satellite — (Caractéristiques en option)

Si votre radio comporte un logo XM [3] ou SIRIUS,[4] elle est donc compatible pour la radio par satellite. XM et Sirius sont des services de radio par satellite offrant plus de 100 canaux de programmation audio de qualité numérique. La transmission est sans interruption aux États-Unis continentaux. Le service de radiodiffusion par satellite est disponible moyennant une cotisation. Pour obtenir de plus amples renseignements, prendre contact avec XM à www.xmradio.com ou par téléphone au 1-800-852-XMXM (9696) ou avec Sirius à http://activate.siriusradio.com ou par téléphone au 1-888-539-7474.

Pour activer le récepteur de signaux de satellite intégré, il faut donner au fournisseur de la radiodiffusion par satellite le numéro de série électronique du récepteur. Voici les instructions qui permettent de trouver le numéro de série électronique :

Si votre fournisseur de radiodiffusion par satellite est XM Satellite Radio :

1 La clé de contact étant tournée et la radio ALLUMÉE, appuyer sur le bouton **RADIO** (10) et choisir XM1 ou XM2.
2 Syntoniser la radio sur le canal 0 et le numéro de série à 8 chiffres paraîtra.

Si votre fournisseur de radiodiffusion par satellite est Sirius Satellite Radio :

1 La clé de contact étant tournée et la radio ALLUMÉE, appuyer sur le bouton **RADIO** (10) et choisir SR1 ou SR2.
2 Syntoniser la radio sur le canal 0 et le numéro de série à 12 chiffres paraîtra.

La réception de la radiodiffusion par satellite peut être perturbée s'il y a des obstructions au niveau des signaux.

[3]XM est une marque déposée de XM Satellite Radio Holdings Inc.

[4]SIRIUS est une marque déposée de SIRIUS Satellite Radio Inc.

Mode CD

La radio est conçue pour fonctionner avec des CD de format standard (fichiers MP3 et WMA en option). Le lecteur de CD accepte les disques CD-R ainsi que les CD-RW.

Sélection du mode CD

Il existe deux façons de passer au mode CD :

1 Appuyer sur le bouton CD/AUX **CD/AUX** (12) jusqu'à ce que CD s'affiche.

OU

2 Introduire un CD dans la fente pour CD (8).

Éjection d'un CD

Pour éjecter un CD, appuyer sur le bouton **EJECT** (9). Une fois le CD extrait, la radio se remet en marche sur la dernière station utilisée. Si le CD n'est pas extrait de son logement, il se remettra en marche dans les 15 secondes.

Changement de la plage du CD

Il existe deux façons pour changer la plage d'un CD :

1 Enfoncer et relâcher le bouton **ESC** (16) ou le **OK** (14) de la radio pour passer à la plage précédente ou à la suivante.

OU

2 Utilisation des commandes situées sur le volant (en option) : Enfoncer et relâcher le bouton << (21) or >> (20) pour passer à la plage précédente ou à la suivante.

Recul rapide ou avance rapide d'un CD

Le recul ou l'avance rapide se réalise de deux manières avec un CD :

1 Maintenir enfoncé le bouton **ESC** (16) ou le **OK** (14) de la radio pour une avance rapide ou un recul rapide.

OU

2 Utilisation des commandes situées sur le volant (en option) : Enfoncer et relâcher le bouton << (21) ou le >> (20) pour passer au recul rapide ou à l'avance rapide.

Activation des plages d'un CD dans un ordre aléatoire

Il existe deux modes de réglage aléatoire pour un CD : Ordre aléatoire total ou ordre aléatoire de fichiers (si le contenu du CD est enregistré sous forme de fichiers).
Pour lire les plages en ordre aléatoire, il faut :

1 Appuyer sur le bouton **MENU** (15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « REPEAT » (répétition) s'affiche.
3 Entrer le sous-menu du réglage aléatoire en appuyant sur le bouton **OK** (14).
4 Appuyer sur le bouton (13) ou le (17) pour choisir entre « All » (tous), « Track » (plage) et « Folder » (fichier).
5 Appuyer sur le bouton **OK** (14) pour activer le mode de répétition souhaité.

Répétition de plage sur un CD — (Caractéristiques en option)

Il existe trois modes de réglage de répétition pour un CD : Répétition pour tous, répétition de plage ou répétition de fichier (si le contenu du CD est enregistré sous forme de fichiers). Par défaut, « Repeat All » (répétition pour tous) est activé.
Pour changer le réglage de répétition, il faut :

1 Appuyer sur le bouton **MENU** (15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « REPEAT » (répétition) s'affiche.
3 Entrer le sous-menu du réglage aléatoire en appuyant sur le bouton **OK** (14).
4 Appuyer sur le bouton (13) ou le (17) pour choisir entre « All » (tous), « Track » (plage) et « Folder » (fichier).
5 Appuyer sur le bouton **OK** (14) pour activer le mode de répétition souhaité.

Changement de fichier sur un CD — (Caractéristiques en option)

Si le contenu du CD est mémorisé dans des fichiers, il est alors possible de changer directement de fichiers. Pour cela, appuyer sur le bouton (13) ou le (17) pour passer au suivant ou au précédent album/fichier.

Balayage d'un CD

Lors du balayage d'un CD, on entend les 10 premières secondes de l'enregistrement de chaque plage.
Pour activer le balayage, il faut :

1 Appuyer sur le bouton **MENU** (15).
2 Choisir « SCAN » (balayage) en appuyant sur le bouton **OK** (14).

Le balayage s'arrête si :

1 Le bouton **ESC** (16) ou le **OK** (14) de la façade est activé..

OU

2 Si toutes les plages sont explorées.

Entrée audio externe — (Caractéristiques en option)

Il existe trois modes d'entrée externe, USB, iPod et Aux. Un appareil USB et un appareil auxiliaire peuvent être branchés et être accessibles simultanément. Cependant, si un iPod est connecté, la source des appareils USB et AUX est désactivée.

Mode USB — (Caractéristiques en option)

La radio est conçue pour fonctionner avec des dispositifs USB formatés selon la norme pour support mémoire de masse USB. Les autres appareils USB pourraient encore fonctionner avec la radio.
Si un appareil USB ne fonctionne pas correctement, essayer de le rebrancher. Ceci peut résoudre le problème dans certains cas.

Note: L'appareil USB doit être connecté avant d'utiliser ce mode.

Sélection du mode USB

Il existe deux façons de passer au mode USB

1 Appuyer sur le bouton **CD/AUX** (12) jusqu'à ce que USB s'affiche.

OU

2 connecter un appareil USB.

Déconnexion d'un appareil USB

Aucune préparation spéciale n'est nécessaire pour débrancher un appareil USB. Une fois l'appareil USB déconnecté, la radio se remet en marche sur la dernière station utilisée.

Changement de la plage d'un appareil USB

Il existe deux façons pour changer la plage d'un USB :

1 Maintenir enfoncé le bouton **ESC** (16)ou le **OK** (14) de la radio pour une avance rapide ou un recul rapide.

OU

2 Utilisation des commandes situées sur le volant (en option) : Enfoncer et relâcher le bouton << (21) ou le >> (20) pour passer au recul rapide ou à l'avance rapide.

Recul rapide ou avance rapide sur un appareil USB

Le recul ou l'avance rapide se réalise de deux manières:

1 Maintenir enfoncé le bouton **ESC** (16) ou le **OK** (14) de la radio pour une avance rapide ou un recul rapide.

OU

2 Utilisation des commandes situées sur le volant (en option) : Enfoncer et relâcher le bouton << (21) or >> (20) pour passer au recul rapide ou à l'avance rapide.

Activation des plages d'un appareil USB dans un ordre aléatoire

Il existe deux modes de réglage aléatoire pour un appareil USB : Ordre aléatoire total ou ordre aléatoire de fichiers (si le contenu de l'USB est enregistré dans des fichiers).
Pour activer les plages dans un ordre aléatoire, il faut :

1 Appuyer sur le bouton **MENU**(15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « RANDOM » s'affiche.
3 Entrer le sous-menu du réglage aléatoire en appuyant sur le bouton **OK** (14).
4 Appuyer sur le bouton (13) ou le (17) pour choisir entre « All » (tous) et « Folder » (fichier).
5 Appuyer sur le bouton **OK** (14) pour activer le mode aléatoire souhaité.

Répétition de plages sur un appareil USB

Il existe trois modes de réglage de répétition pour un appareil USB : Répétition pour tous, répétition de plage ou répétition de fichier (si le contenu du dispositif USB est enregistré dans des fichiers). Par défaut, « Repeat All » (répétition pour tous) est activé.
Pour changer le réglage de répétition, il faut :

1 Appuyer sur le bouton **MENU**(15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « REPEAT » s'affiche.
3 Entrer le sous-menu du réglage aléatoire en appuyant sur le bouton **OK** (14).
4 Appuyer sur le bouton (13) ou le (17) pour choisir entre « All » (tous), « Track » (plage) et « Folder » (fichier).
5 Appuyer sur le bouton **OK** (14) pour activer le mode de répétition souhaité.

Changement de fichier sur un USB

Si le contenu de l'USB est mémorisé dans des fichiers, il est alors possible de changer directement de fichiers. Pour cela, appuyer sur le bouton (13) or (17) pour passer au suivant ou au précédent album/fichier.

Balayage d'un USB

Lors du balayage d'un USB, on entend les 10 premières secondes de l'enregistrement de chaque plage.
Pour activer le balayage, il faut :

1 Appuyer sur le bouton **MENU** (15).
2 Choisir « SCAN » (balayage) en appuyant sur **OK** (14) button.

Le balayage s'arrête si

1 Le bouton **ESC** (16) ou le **OK** (14) de la façade est activé.

OU

2 Si toutes les plages sont explorées.

Mode iPod — (Caractéristiques en option)

La radio est compatible avec iPod Classic, iPod Vidéo et iPod nano. Les réglages du iPod, par ex. « Shuffle » (réarrangement) ou « Repeat » (répétition), utilisés avant de connecter le iPod à la radio seront utilisés par la radio.

Note: Un appareil iPod doit être connecté avant d'utiliser ce mode.

Connexion d'un iPod

Le branchement du IPod est possible avec deux ensembles de câble différents.

1 Un câble divisé du connecteur iPod à 30 broches au connecteur USB et un connecteur audio de 3,5 mm.
2 Un câble séparé iPod/USB plus un câble stéréo audio mâle/mâle de 3,5 mm connecté à la sortie pour écouteur du iPod. Dans ce cas, le volume du iPod doit être réglé au maximum avant de le brancher sur la radio.

Une fois le iPod connecté à la radio, ses commandes se retrouvent verrouillées.
Une fois le iPod connecté à la radio, ses commandes se retrouvent verrouillées.

Sélection du mode iPod

Il existe deux façons de passer au mode iPod :

1 Appuyer sur le bouton **CD/AUX** (12) jusqu'à ce que iPod s'affiche.

OU
2 Connecter un appareil iPod.

Déconnexion de l'appareil iPod

Aucune préparation spéciale n'est nécessaire pour débrancher l'appareil iPod. Une fois l'appareil iPod déconnecté, la radio se remet en marche sur la dernière station utilisée.

Menu iPod

Une fois le iPod connecté et identifié, l'utilisateur peut maintenir enfoncé le bouton **ESC** (16) pour entrer le menu iPod. Ce menu contient certaines des fonctionnalités les plus courantes utilisées sur le iPod. Par exemple, l'utilisateur peut rechercher des artistes ou des albums, et commencer une liste de diffusion.

Maintenir enfoncé le bouton **ESC** (16) pendant 1 seconde pour entrer le menu iPod au dernier niveau utilisé.
Maintenir enfoncé le bouton **ESC** (16) pendant 2 secondes pour entrer le menu iPod au niveau supérieur.

Changement de plage sur le iPod

Le recul ou l'avance rapide se réalise de deux manières :

1 Maintenir enfoncé le bouton **ESC** (16) ou le **OK** (14) pour une avance rapide.

OU

2 Utilisation des commandes situées sur le volant (en option) : Enfoncer et relâcher le bouton << (21) ou le >> (20) pour passer au recul rapide ou à l'avance rapide.

Recul rapide ou avance rapide sur un iPod

Le recul ou l'avance rapide se réalise de deux manières :

1 Maintenir enfoncé le bouton **OK** (14) pour une avance rapide.

OU

2 Utilisation des commandes situées sur le volant (en option) : Enfoncer et relâcher le bouton << (21) or >> (20) pour passer au recul rapide ou à l'avance rapide.

Remarquer qu'en maintenant enfoncé le bouton **ESC** (16) on entre le menu iPod.

Activation des plages d'un iPod dans un ordre aléatoire

Il existe deux modes de réglage aléatoire pour un iPod : Ordre aléatoire pour album et ordre aléatoire pour tous.
Pour activer des chansons dans un ordre aléatoire, il faut :

1 Appuyer sur le bouton **MENU**(15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « RANDOM » s'affiche.
3 Entrer le sous-menu du réglage aléatoire en appuyant sur le bouton **OK** (14).
4 Appuyer sur le bouton (13) ou le (17) pour choisir entre « All » (tous) et « Folder » (fichier).
5 Appuyer sur le bouton **OK** (14) pour activer le mode aléatoire souhaité.

Répétition de plage sur le iPod

Il existe deux modes de réglage aléatoire pour un iPod : Répéter Un, répéter Tous.
Pour changer le réglage de répétition, il faut :

1 Appuyer sur le bouton **MENU**(15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « REPEAT » s'affiche.
3 Entrer le sous-menu du réglage aléatoire en appuyant sur le bouton **OK** (14).
4 Appuyer sur le bouton (13) ou le (17) pour choisir entre « All » (tous), « Track » (plage) et « Folder » (fichier).
5 Appuyer sur le bouton **OK** (14) pour activer le mode de répétition souhaité.

Balayage sur le iPod

Lors du balayage d'un iPod, on entend les 10 premières secondes de l'enregistrement de chaque plage.
Pour activer le balayage, il faut :

1 Appuyer sur le bouton **MENU** (15).
2 Choisir « SCAN » (balayage) en appuyant sur **OK** (14).

Le balayage s'arrête si

1 Le bouton **ESC** (16) ou le **OK** (14) de la façade est activé.

OU

2 si toutes les plages sont explorées.

Mode AUX — (Caractéristiques en option)

Pour choisir une entrée audio auxiliaire :
Appuyer sur le bouton **CD/AUX** (12) bjusqu'à ce que Aux s'affiche.
Une entrée audio auxiliaire peut être sélectionnée sauf en mode iPod.
Le volume de l'appareil auxiliaire doit être réglé au maximum.

Noter que pour un appareil auxiliaire, le changement de plage, l'avance rapide etc. doit être exécuté directement sur l'appareil aux.

Réglages audio

Réglage du volume vers le haut et vers le bas

Le volume du système audio peut être monté en tournant le bouton (7) dans le sens horaire et baissé en tournant le (7) dans le sens antihoraire.

Il peut également être monté et baissé avec les commandes + (24) et - (25) situées sur le volant (en option).

Réglage des graves vers le haut et vers le bas

Pour ajuster les graves sur le système audio, appuyer sur le bouton **AUDIO** (18) jusqu'à ce que «BASS» s'affiche.

Le niveau des graves du système audio peut être monté en tournant le bouton (7) dans le sens horaire et baissé en tournant le bouton (7) dans le sens antihoraire.

Il est aussi possible d'ajuster les graves avec **ESC** (16) ou **OK** (14) sur la radio.

Réglage des aigus vers le haut et vers le bas

Pour ajuster les aigus sur le système audio, appuyer sur le bouton **AUDIO** (18) jusqu'à ce que «TREBLE» s'affiche.

Le niveau des aigus du système audio peut être monté en tournant le bouton (7) dans le sens horaire et baissé en tournant le bouton (7) dans le sens antihoraire.

Il est aussi possible d'ajuster les aigus avec **ESC** (16) ou **OK** (14) sur la radio.

Réglage à gauche et à droite de l'équilibre

Pour ajuster l'équilibre sur le système audio, appuyer sur le bouton **AUDIO** (18) jusqu'à ce que «BALANCE» (équilibre) s'affiche.

Le réglage de l'équilibre vers la droite s'obtient en tournant le bouton (7) dans le sens horaire et le réglage vers la gauche en tournant le bouton (7) dans le sens antihoraire.

Il est aussi possible de l'ajuster vers la gauche et vers la droite avec **ESC** (16) ou **OK** (14) sur la radio.

Équilibreur avant-arrière

Pour ajuster l'équilibreur sur le système audio, appuyer sur le bouton **AUDIO** (18) jusqu'à ce que « FADE » (équilibreur) s'affiche.

L'équilibreur se règle alors vers l'avant en tournant le bouton (7) dans le sens horaire et vers l'arrière en tournant le bouton (7) dans le sens antihoraire.

Il est possible de l'ajuster aussi vers la gauche et vers la droite avec **ESC** (16) ou **OK** (14) sur la radio.

Réglage Mid (Plage des moyennes fréquences) vers le haut et vers le bas — (Caractéristiques en option)

Pour ajuster les moyennes fréquences sur le système audio, appuyer sur le bouton **AUDIO** (18) jusqu'à ce que MID s'affiche.

Le niveau des moyennes fréquences du système audio peut être monté en tournant le bouton (7) dans le sens horaire et baissé en tournant le bouton (7) dans le sens antihoraire.

Il est aussi possible d'ajuster les moyennes fréquences avec **ESC** (16) ou **OK** (14) sur la radio.

Sélection de haut-parleurs

Pour le réglage du système audio en mode de 2 ou de 4 haut-parleurs, il faut

1 Appuyer sur le bouton **MENU** (15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « ADVANCE » s'affiche.
3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu « ADVANCE ».
4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « SPEAKERS » s'affiche.
5 Passer de 2CH à 4CH en appuyant sur le bouton **OK** (14).

Activation de la commande automatique de sensibilité (CAS) — (Caractéristiques en option)

Le volume du système audio se règle afin que celui-ci augmente avec la vitesse du véhicule. Ce réglage permet de compenser pour les bruits de la route et du moteur. Cette fonctionnalité comporte trios niveaux de sensibilité « LOW, MID et HIGH » (BAS, MOYEN et HAUT).
Pour activer la CAS, il faut :

1 Appuyer sur le bouton **MENU** (15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « ADVANCE » s'affiche.
3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu « ADVANCE ».
4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « ASC » s'affiche.
5 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu ASC.
6 Appuyer sur le bouton (13) ou le (17) pour choisir entre « LOW, MID et HIGH » (BAS, MOYEN et HAUT).
7 Appuyer sur le bouton **OK** (14) pour entrer le réglage CAS souhaité.

Mode Téléphone mains libres Bluetooth — (Caractéristiques en option)

La radio est conçue afin de fonctionner avec un téléphone cellulaire compatible avec Bluetooth mains libres Profile 1.5. D'autres téléphones cellulaires avec Bluetooth pourraient aussi fonctionner avec la radio. Pour brancher un téléphone cellulaire sur la radio par l'intermédiaire de Bluetooth, il est nécessaire de passer par les étapes suivantes au niveau de la radio.

Activation Bluetooth

Le but de ce processus est de réaliser une connexion Bluetooth.

1 Appuyer sur le bouton **MENU** (15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Hands Free » (mains libres) s'affiche.
3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Mains libres.
4 Appuyer sur le bouton **OK** (14) pour activer Bluetooth.

Lorsque Bluetooth est actif, l'icône (45) s'affiche.

Addition d'un téléphone

Le but de ce processus est d'obtenir une connexion entre la radio et un téléphone et d'ajouter un téléphone à la liste de téléphones de la radio.

1 Appuyer sur le bouton **MENU** (15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Hands Free » (mains libres) s'affiche.
3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Mains libres.
4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Add phone » (ajouter téléphone) s'affiche.
5 Appuyer sur le bouton **OK** (14) pour lancer la connexion téléphonique.

La radio recherche alors un téléphone Bluetouth. L'icône (45) se met à clignoter pour indiquer que la recherche est en cours.

Remarquer que les paramètres de connexion du téléphone doivent correspondre entre eux pendant ce processus.

Une fois la connexion établie, l'utilisateur devra entrer un code sur le téléphone. Entrer le code 0000 pour vérifier la connexion.

1 Activer la fonction Bluetooth.
2 Ajouter le téléphone.

Noter que les étapes correspondantes doivent être prises sur le téléphone cellulaire.

Un téléphone ajouté sera mémorisé dans une liste pour donner un accès facile lors de la prochaine connexion.

Activation d'un autre téléphone

Le but de ce processus est de déconnecter un téléphone Bluetooth et établir une connexion à un autre téléphone se trouvant sur la liste de téléphones.

1 Appuyer sur le bouton **MENU** (15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Hands Free » (mains libres) s'affiche.
3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Mains libres.
4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « ChangePhName » (« PhName » étant le nom du téléphone actuellement connecté) s'affiche.
5 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Changement de téléphone.
6 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que le nom du téléphone à connecter s'affiche.
7 Appuyer sur le bouton **OK** (14) pour connecter l'autre téléphone.

Suppression d'un téléphone

Le but de ce processus est d'éliminer un téléphone spécifique de la liste de téléphones de la radio.

1 Appuyer sur le bouton **MENU** (15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Hands Free » (mains libres) s'affiche.
3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Mains libres.
4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Edit Phone » (modification de téléphone) s'affiche.
5 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Modification de téléphone.
6 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que le nom du téléphone à éliminer s'affiche.
7 Appuyer sur le bouton **OK** (14) pour éliminer le téléphone.
8 « Delete? » (Éliminer?) s'affiche. Appuyer sur le bouton **OK** (14) pour effectuer une vérification.

Suppression de tous les téléphones

Le but de ce processus est d'éliminer tous les téléphones de la liste de téléphones de la radio.

1 Appuyer sur le bouton **MENU** (15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Hands Free » (mains libres) s'affiche.
3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Mains libres.
4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Edit Phone » (modification de téléphone) s'affiche.
5 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Modification de téléphone.
6 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Delete All » (éliminer tous) s'affiche.
7 Appuyer sur le bouton **OK** (14) pour éliminer tous les téléphones.
8 The display will show "Delete?". Push **OK** (14) to verify.
9 « Are U sure? » (Valider?) s'affiche. Appuyer sur le bouton **OK** (14) pour effectuer une vérification.

Transférer les appels téléphoniques du véhicule à un téléphone actif

Le but de cette opération est de permettre de transférer les appels téléphoniques afin de les recevoir et de les entendre par le truchement d'un téléphone actif au lieu de par la radio.

1 Pour transférer un appel du véhicule à un téléphone actif, appuyer sur la touche **AUDIO**.

2 Pour transférer un appel d'un téléphone actif au véhicule, appuyer sur la touche **AUDIO**.

Horloge

Affichage de l'heure

Par défaut, l'heure n'est affichée que si la clé de contact est ACTIVÉE ou que si la radio est ÉTEINTE. Pour programmer l'horloge afin de pouvoir voir l'heure lorsque la radio est allumée, il faut :

1 Appuyer sur le bouton **MENU** (15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « CLOCK » (horloge) s'affiche.
3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Horloge.
4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « VISIBLE » s'affiche.
5 Appuyer sur le bouton **OK** (14) pour passer de « ON » (marche) à « OFF » (arrêt).

Format 12- ou 24- heures

Le mode de 12 heures et celui de 24 heures sont programmables sur cette horloge.
Le mode de 12 heures permet de faire la distinction entre AM et PM.
Pour changer la base horaire, il faut :

1 Appuyer sur le bouton **MENU** (15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « CLOCK » (horloge) s'affiche.
3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Horloge.
4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « 12/24 HR » s'affiche.
5 Appuyer sur le bouton **OK** (14) pour passer à l'une de ces options 12H ou 24H.

Réglage de l'horloge

Normalement l'heure est automatiquement programmée par le système du camion. L'option de programmation manuelle n'est alors pas disponible.
Pour manuellement programmer l'horloge, il faut :

1 Appuyer sur le bouton **MENU** (15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « CLOCK » (horloge) s'affiche.
3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Horloge.
4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « SET TIME » (programmation de l'heure) s'affiche.
5 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Programmation de l'heure.
6 Appuyer sur le bouton (13) ou le (17) pour changer l'heure dans un sens ou dans l'autre.
7 Appuyer sur le bouton **OK** (14) pour obtenir l'heure et appuyer en alternance pour obtenir le réglage des minutes.
8 Appuyer sur le bouton (13) ou le (17) pour changer les minutes dans un sens ou dans l'autre.
9 Appuyer sur le bouton **OK** (14) pour gagner du temps et terminer le processus.

Mise en marche et arrêt de l’alarme — (Caractéristiques en option)

Pour mettre l’alarme ou l’éteindre, il faut :

1 Appuyer sur le bouton **MENU** (15).
2 Appuyer sur le bouton (13) ou le (17) jusqu’à ce que « WAKE UP ALARM » (réveil par alarme) s’affiche.
3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Réveil par alarme.
4 Appuyer sur le bouton (13) ou le (17) jusqu’à ce que « ON/OFF » (marche/arrêt) s’affiche.
5 Appuyer sur le bouton **OK** (14) pour changer le réglage de l’alarme.

Programmation de l’alarme — (Caractéristiques en option)

Pour programmer l’heure de réveil, il faut :

1 Appuyer sur le bouton **MENU** (15).
2 Appuyer sur le bouton (13) ou le (17) jusqu’à ce que « WAKE UP ALARM » (réveil par alarme) s’affiche.
3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Réveil par alarme.
4 Appuyer sur le bouton (13) ou le (17) jusqu’à ce que « SET TIME » (programmation de l’heure) s’affiche.
5 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Programmation de l’heure.
6 Appuyer sur le bouton (13) ou le (17) pour changer l’heure dans un sens ou dans l’autre.
7 Appuyer sur le bouton **OK** (14) pour obtenir l’heure et appuyer en alternance pour obtenir le réglage des minutes.
8 Appuyer sur le bouton (13) ou le (17) pour changer les minutes dans un sens ou dans l’autre.
9 Appuyer sur le bouton **OK** (14) pour gagner du temps et terminer le processus.

Code antivol

La radio est programmée pour qu'elle ne fonctionne que sur un seul véhicule. La caractéristique antivol empêche la radio de fonctionner partout ailleurs. L'antivol fonctionne automatiquement et normalement il ne nécessite aucune manipulation manuelle.

En cas de dysfonctionnement

Si, pour une raison quelconque, la radio ne détecte pas le bon véhicule, l'utilisateur devra entrer le code antivol (étiquette située dans le guide du conducteur). Le code « CODE 0000 » s'affiche alors.

Remarquer que cela est une défaillance et que celle-ci doit être vérifiée dans un atelier agréé.

Pour entrer le code, il faut :

1 Changer le chiffre (clignotant), en tournant le bouton du volume (7) jusqu'à obtention du bon chiffre.
2 Appuyer sur le bouton de mise en marche pour entrer le chiffre. Le prochain chiffre se mettra à clignoter.
3 Répéter les étapes 1 et 2 jusqu'au dernier chiffre.

Trois essais sont possibles pour entrer le code. Si ces trois essais sont manqués, la radio sera alors verrouillée pendant 60 minutes avant de pouvoir faire trois nouveaux essais.

Désactivation de l'antivol

Il est possible de désactiver l'antivol, mais cela est vivement déconseillé.
Pour désactiver la fonction antivol, il faut :

1 Appuyer sur le bouton **MENU** (15).
2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « ADVANCE » (avancement) s'affiche.
3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Avancement.
4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « GUARD » (antivol) s'affiche.
5 Appuyer sur le bouton **OK** (14) pour valider.
6 Appuyer sur le bouton **OK** (14) pour programmer l'antivol sur « ON » (marche) ou sur « OFF » (arrêt).

L'utilisateur devra alors fournir le code antivol pour activer ou désactiver l'antivol. « CODE 0000 » s'affichera alors et le premier chiffre clignotera.
Pour entrer le code, il faut :

1 Changer le chiffre (clignotant), en tournant le bouton du volume (7) jusqu'à obtention du bon chiffre.
2 Appuyer sur le bouton de mise en marche pour entrer le chiffre. Le prochain chiffre se mettra à clignoter.
3 Répéter les étapes 1 et 2 jusqu'au quatrième chiffre.

Trois essais sont possibles pour entrer le code. Si ces trois essais sont manqués, la radio sera alors verrouillée pendant 60 minutes avant de pouvoir faire trois nouveaux essais.

Conseils et astuces

USB et MP3

La radio est conçue pour fonctionner avec des dispositifs USB compatibles avec le support mémoire de masse USB régulier.
Remarque: D'autres appareils USB peuvent fonctionner avec la radio. Si un appareil USB ne fonctionne pas avec la radio, essayer de le rebrancher, ceci résout, dans certains cas, le problème. Certains appareils USB sont livrés avec des logiciels installés ce qui les rend incompatibles avec le support mémoire de masse USB régulier. Dans ce cas, le formatage d'un appareil USB peut parfois résoudre le problème.
Remarque: Le formatage de l'appareil efface toutes les données sur le dispositif USB, il est préférable de sauvegarder toutes les données avant de procéder.

- WMA et MP3 sont les seuls formats qui sont lisibles par cet appareil.
- La liste de diffusion doit être en version .PLS ou .M3U.

Bluetooth

La radio est conçue afin de fonctionner avec un téléphone cellulaire compatible avec Bluetooth mains libres Profile 1.5.
Remarque: Certains téléphones cellulaires compatibles Bluetooth n'étant pas compatibles avec cette norme peuvent fonctionner malgré tout Pour savoir si votre téléphone est compatible avec le profil Mains-libres BlueTooth 1,5, veuillez consulter la page d'accueil BlueTooth, https://www.bluetooth.org/tpg/listings.cfm et trouver les spécifications correspondantes à votre téléphone.
Remarque: Si la structure de la page d'accueil BlueTooth est mise à jour, le lien ci-dessus pourrait changer. Vous pouvez également prendre contact avec votre fournisseur de téléphone cellulaire afin d'obtenir directement les détails.

- Compatible avec la norme 1.5.
- De plus amples renseignements sur www.bluetooth.org.

iPod

La radio est conçue afin d'être compatible avec les modèles iPod suivants:

- iPod nano – 1e, 2e et 3e génération
- iPod classic – 5e et 6e génération

Remarque: Les anciennes et les nouvelles générations de ces iPod peuvent également fonctionner.

- Un adaptateur iPod peut être acheté par Volvo sous le numéro de référence 21259125.
- D'autres adaptateurs se trouvent aussi sur le site,www.sendstation.com.
- Pour obtenir les meilleures performances possibles, le micrologiciel iPod doit être à jour en allant www.apple.com.

CD, MP3, et WMA

- Au début d'un CD avec MP3 ou WMA, les quelques premières secondes de lecture ne produisent pas de son.
- Pour obtenir les meilleures performances possibles, un CD MP3/WMA ne doit pas contenir des fichiers de types autres que MP3, WMA, M3U et PLS.

OPERATING INSTRUCTIONS

MOBILE DVD PLAYER

Please read this instruction before installation and operation.

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FEATURES

◆POWER

Operating voltage : 12V +20% -30% DC
Low power consumption design.

◆COMPATIBILITY

This DVD player can play the following discs:
DVD, CD, VCD, DVCD, MP3, CD-R,CD-RW.

◆SYSTEM FUNCTIONS

◇VIDEO OUTPUT SYSTEM
System MULTI , NTSC or PAL switchable.

◇1 L/R Audio Output
1 L/R Audio Input
1 AUX Video Input
1 Rear Camera Video Input
3 Video Outputs with one dedicated self switching rear view monitor output

◆ADDITIONAL VIDEO FEATURES

Multi-angle, multi-view, multi-audio function
Multi-level forward and backward motion
Play position memory, Resume stop and repeat function

SAFETY PRECAUTIONS

This digital versatile disc (DVD) video player uses 12V $^{+20\%}_{-10\%}$ DC.
For future reference, record the model and serial number
(located on the case of the DVD player) in the space provided.

CAUTION:

THIS DVD VIDEO PLAYER IS A CLASS I LASER PRODUCT.
USE OF CONTROLS OR ADJUSTMENTS OR PERFORMANCE OF PROCEDURES OTHER
THAN THOSE SPECIFIED HEREIN MAY RESULT IN HAZARDOUS RADIATION EXPOSURE.
AS THE LASER BEAM USED IN THIS DVD VIDEO PLAYER IS HARMFUL TO THE EYES,
DO NOT ATTEMPT TO DISASSEMBLE THE CABINET.
REFER SERVICING TO QUALIFIED PERSONNEL ONLY.

WARNING : class I laser product - Avoid Long Term viewing of Direct Laser Radiation.

WARNING OF DEW FORMATION

Dew may form on the pickup lens in the following conditions.
- Immediately after a heater has been turned on.
- In a steamy or very humid room.

When the unit is suddenly moved from a cold environment to a warm one.
If dew forms inside this unit, it may not operate properly.
In this case, turn on the power and wait about 2 or 3 hours for the dew to evaporate.
When the unit is used under low temperatures,
the pick up lens might warm up very fast and dew will form.
In this case, turn on the power and wait a while for the dew to evaporate.

Precautions

Warning: *This symbol means important instructions.*
Failure to heed them can result in serious injury or death.

1、Do not disassemble or alter this unit. Doing so may result in an accident,fire or electric shock.

2、Keep small objects such as battery out of the reach of children. If swallowed, consult a physician immediately.

3、Use the correct ampere rating when replacing fuses. Failure to do so may result in fire or electric shock.

4、Use only in cars with a 12 VOLT negative ground.(Check with your dealer if you are not sure.) Failure to do so may result in fire, etc.

5、Do not operate any function that takes your attention away from safely driving your vehicle. Any function that requires your prolonged attention should only be performed after coming to a complete stop.
Always stop the vehicle in a safe location before performing these function.
Failure to do so may result in an accident.

6、Do not watch video while driving. Watching the video may distract the driver from looking ahead of the vehicle and cause an accident.

7、Keep the volume at a level where you can still hear outside noise while driving. Failure to do so may result in an accident.

8、Use this product for mobile 12V applications. Use for other than its designed application may result in fire, electric shock or other injury.

9、Do not place hands, fingers or foreign objects in insertion slots or gaps. Doing so may result in personal injury or damage to the product.

10、Do not block vents or radiator panels. Doing so may cause heat to build up inside and may result in fire.

⚠ ***Caution***:*This symbol means important instructions.*
Failure to heed them can result in injury or property damage.

1、*Insert with the correct battery polarity.*
When inserting the battery,be sure to observe proper polarity(+ and-)as instructed. Rupture of the battery may cause fire or personal injury.

2、Halt use immediately if a problem appears. Failure to do so may causepersonal injury or damage to the product. Consult a professional mobilevideo installer.

3、*Temperature.*
Be sure the temperature inside the vehicle is between +55°C(+131°F)and -5 °C(+23 °F) before turning your unit on.

4、*Moisture condensation*
You may notice the CD playback sound wavering due to condensation.If this happens remove the disc from the player and wait an hour forthe moisture to evaporate.

5、*Damaged disc*
Do not attempt to play cracked, warped, or damaged discs. Playing a bad disc could severely damage the playback mechanism.

6、*Maintenance*
If you have problems, do not attempt to repair the unit yourself. Consult a professional mobile video installer.

7、*Never attempt the following*

Do not grip or pull out the disc while it is being pulled back into the player by the automatic reloading mechanism.

Do not attempt to insert a disc into the unit when the unit power is off.

8、*Inserting discs*

Your player accepts only one disc at a time for playback. Do not attempt to load more than one disc.

Make sure the label side is facing up when you insert the disc.

Playing a disc while driving on a very bumpy road may result in skips.

9、*Irregular shaped discs*

Make sure the discs you use in this unit do not have any irregularities.The outer and inner edges should be round and smooth. Use of irregularly shaped discs may cause damage to the mechanism.

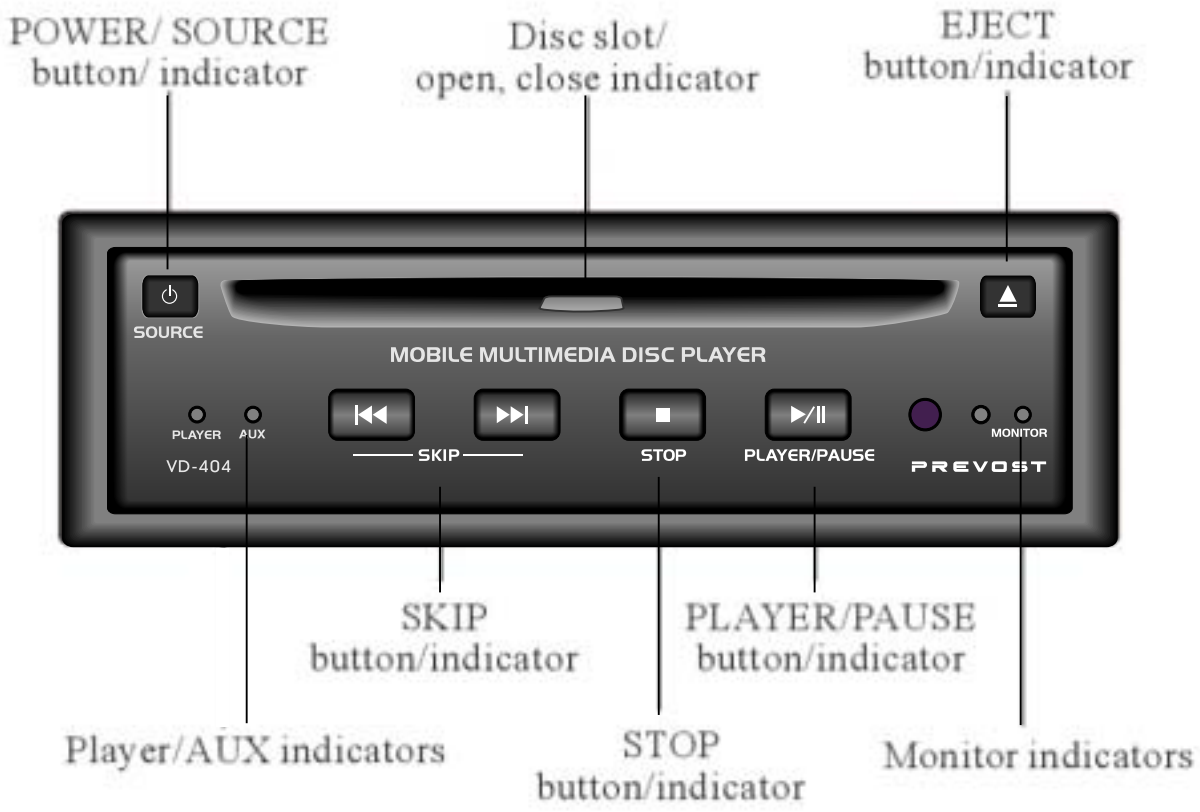
10、*Installation location*

Make sure the unit will not be installed in a location subjected to:

- Direct sun and heat
- High humidity and water
- Excessive dust
- Excessive vibrations

See the page in for the details.

Front panel



The button	
POWER	Power on/off by pressing this button 9
EJECT	To eject a disc 10
▶/II	Play/Pause 11
■	To stop playback 12
⏮ ⏭	To locate previous/next chapter or track 12

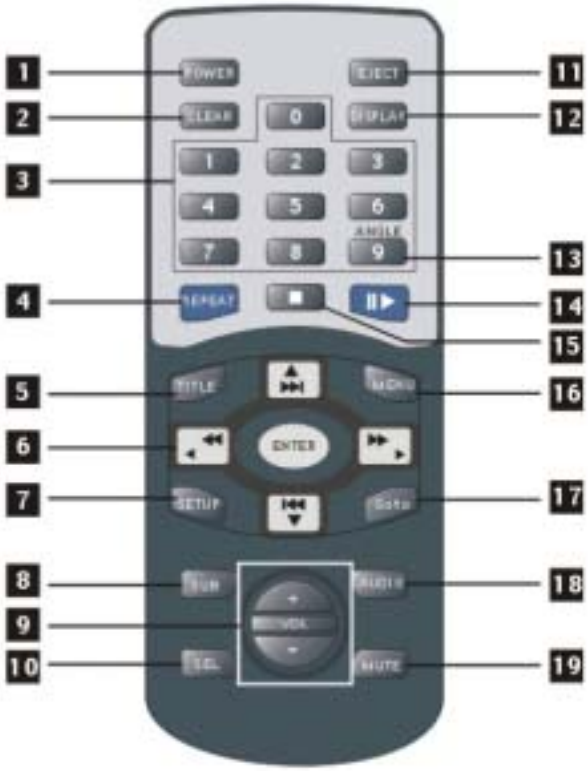
Resetting the unit

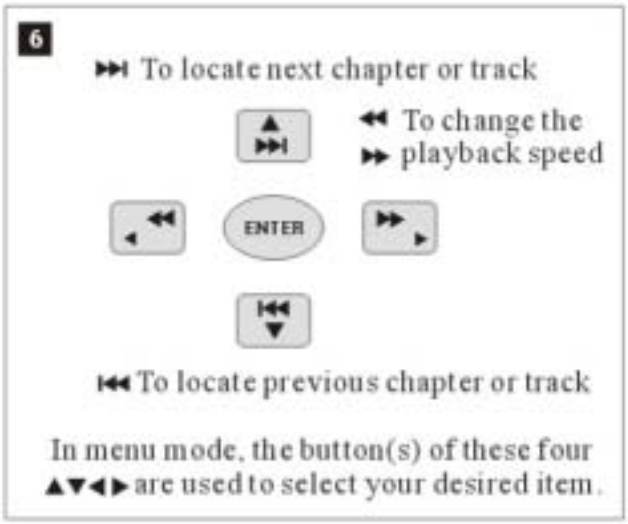
Press the RESET button with a pointed object,
such as a ballpoint pen, as shown.
Unit will turn off momentary after
the RESET button is pressed.
Note: Pressing the RESET button
will erase some stored contents.

SOURCE for AV SEL

Select DVD or AUX input by pressing and holding the SOURCE button
for 6 seconds then release the SOURCE button.

Identification of controls





1 POWER on/off button

2 CLEAR button
to clear the wrong number you entered

3 Number button
Used to input numbers

4 REPEAT button
to play repeatedly

5 TITLE button
to locate a specific title chapter or track

6 Joy stick

7 SETUP button
to change the default settings

8 VOL +/- button
to control the volume

9 SUB button to select subtitle

10 SEL button
to select the audio functions

11 EJECT button to eject the disc

12 DISPLAY button to display the disc status

13 ANGLE button to select the camera angle

14 ⏯ Button Playing/Pausing

15 ■ Button to stop playback

16 MENU Button
to locate a specific title chapter or track

17 Goto Button to Locate a location by entering its corresponding track number, chapter number or time

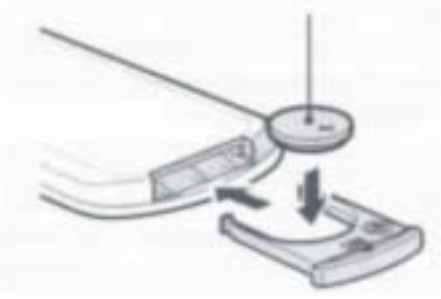
18 AUDIO Button
to switch the audio language

19 MUTE Button
playing with no sound

Preparing the remote control

Insert battery (3V, CR2025) into the remote control.
Make sure the + side of the battery faces up before closing the cover.

1) Open the cover,
pull the cover as illustrated



2)Insert cell (3V),Close the cover

Operating with the remote control

This section shows you how to use the remote control. Point the remote control at the remote sensor and press the buttons.

The remote range: about 4m from the front of the remote sensor.
(Is) off axis: more than 30L in each direction of the front of the remote sensor.

Do not expose the remote sensor of the DVD player and the remote control to a strong light source. such as direct sunlight or other illumination. If you do so, you may not be able to operate the DVD player via the remote control.

With about 4m

Notes on battery

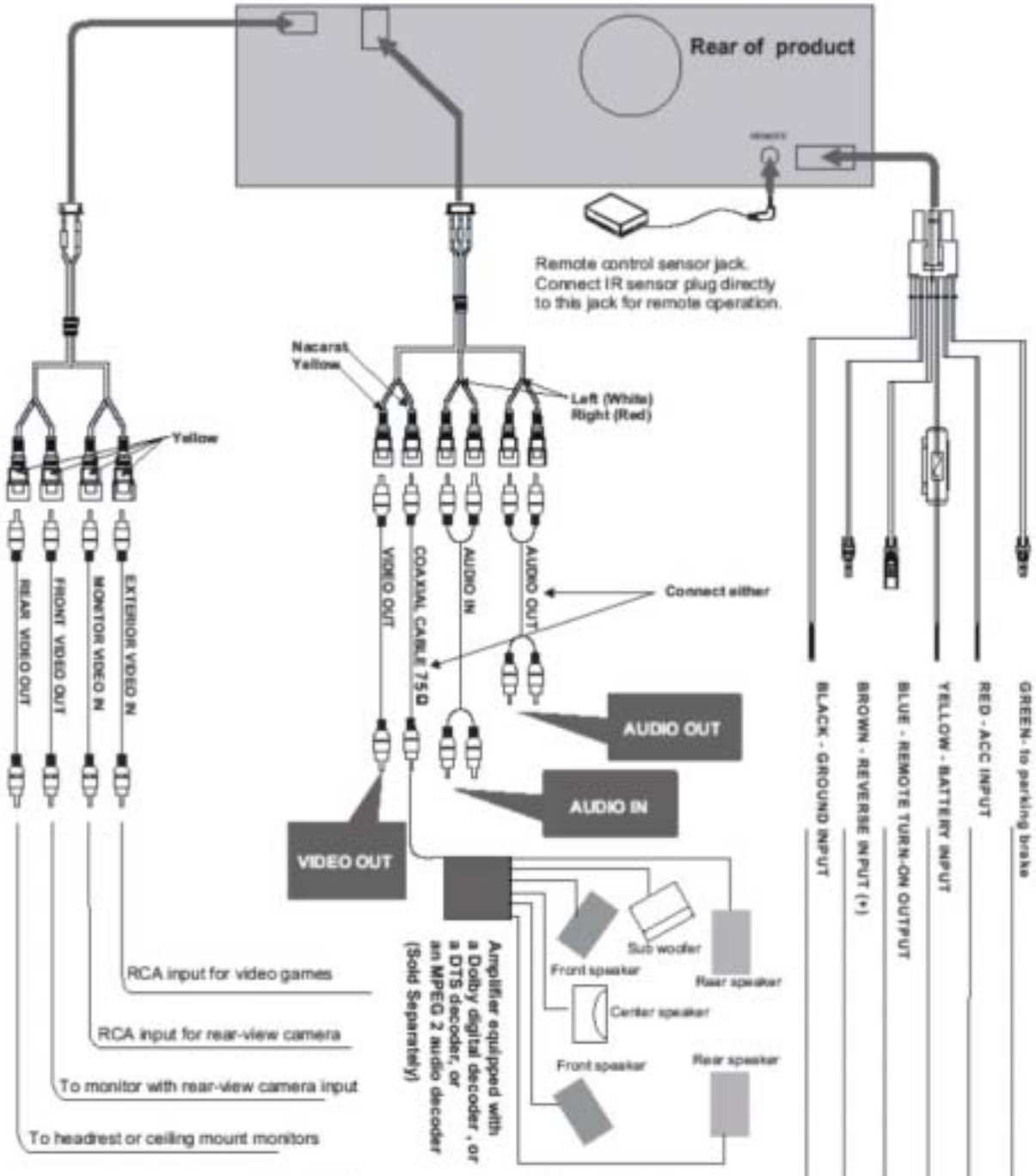
To operate the remote control correctly, follow the instructions below.

Do not insert cell into the remote control in the wrong direction.
Do not charge, heat, open, or short-circuit the cell. Do not throw cell into a fire.
If the remote control does not function correctly or if the operating range becomes reduced,replace the cell with new one.

Notes on the remote control

Direct the remote control at the remote sensor of the DVD player.
Do not drop or give the remote control a shock.
Do not leave the remote control near an extremely hot or humid place.
Do not spill water or put anything wet on the remote control.
Do not disassemble the remote control.

Connections



Black: (-) neg. ground input. To vehicle chassis

Brown: (+) pos. reverse wire input (for rear view camera option)

Blue: (+) 300mA max. remote turn-on wire output

Yellow: (+) pos. 12 volt constant input

Red: (+) pos. 12 volt accessory input

Green: Used to detect the On/Off status of the parking brake. This lead must be connected to the power supply side of the parking brake switch.

1 NOTE

Connect	Audio out(audio related, see page 19)
Coaxial cable	SPDIF/RAW RAW DATA VIA SPDIF
	SPDIF/PCM PCM DATA VIA SPDIF
Audio cable	ANALOG ANALOG OUTPUT

2 NOTE

1 Refer to the owner's manual "for the connected monitor " as well.

2 Refer to the owner's manual of the connected equipment for additional information.

3 When you connect the DVD player to other equipment, be sure to turn off the power .

4 If you place the DVD near a tuner or radio, the radio broadcast sound might be distorted.
In this case, place the DVD player away from any other tuner or radio.

5 The output sound of the DVD player has a wide dynamic range. Be sure to adjust the receiver's volume to a moderate listening level. Otherwise, the speakers may be damaged by a sudden high output.

6 Turn off the amplifier before you connect or disconnect the DVD player's power leads.
If you leave the amplifier power on, the speakers may be damaged.

3 NOTE

1. We advise to connect the EX-VIDEO-CON lead.
   And so the front display only will be on while detecting the parking brake ON.
   Or if the EX-MONITOR-CON and MONITOR VIDEO IN are used, the front display will be on while backing the car.

2. This product's REAR VIDEO OUT and VIDEO OUT are for connections of displays to enable passengers in the rear seats to watch the DVD or Video CD.

⚠ *Warning: NEVER install the display in a location that enables the Driver to watch the DVDor Video CD while driving.*

This product detects whether your car's parking brake is engaged or not, and prevents you from watching a DVD or Video CD on the display connected to Front Video Out while driving.

Example: When you attempt to watch a DVD, the screen is black. When you park yourcar in a safe place and apply the parking brake, the picture appears on the screen.

Loading and unloading a disc

Turn on the power before loading and unloading discs.

1 Insert the disc with the side containing words diagrams facing upwards.
Once the disc is partially inserted, it is drawn in automatically. Playback starts.

2 Unloading disc
Press EJECT ▲ button, the disc is automaticallyejected.

Notes:
If wrong disc, upside-down discs or dirty discshave been inserted, "NO DISC " is displayed.
Remove the disc.
Do not put any objects other than discs into thedisc slot, doing so may cause the player tomalfunction.

DVD VCD CD MP3 *These indicate the discs for which the function can be used.*

DVD You can use this function with DVD discs. MP3 You can use this function with MP3 discs

VCD You can use this function with VIDEO Cds. CD You can use this function with CDs .

About this owner's manual
This owner's manual explains the basic instructions of this DVD player. Some DVD discs are produced in a manner that allows specific or limited operation during playback.
As such, the DVD player may not respond to all operating commands. This is not a defect in the DVD player. Refer to the instruction notes of discs.
" 🖱 "may appear on the screen during operation.
A " 🖱 " means that the operation is not permitted by the DVD player or the disc.

1 Turning the power on and off

Press ⏻ POWER button

The power turns on.
To turn the power off, Press ⏻ POWER button again.

Play Position Memory Function

Even if you turn power off or switch the ignition Key to OFF during playback or change the video source, playback will continue from the point where playback stopped when the power is turned ON again.
The play position memory is released if the disc is removed or the Reset switch is pressed.

2 Switching between DVD and AUX Video Input

To switch between DVD and AUX Video input, press and hold source button for 6 seconds then release button.

Connect		AV SEL
Using AUDIO and VIDEO OUT, connect the monitor or audio system		INTERNAL VIDEO
	Using AUDIO and VIDEO IN, connect the DVD video player to a VTR, TV/VTR combination or video selector	AUX Video Input

3 Adjusting the volume

Press the + button to increase the volume.
Press the - button to decrease the volume.

1 *Playing a disc* DVD VCD CD MP3

Caution

With some DVDs, certain operations are disabled. Such operations are not possible on such DVDs. The DVD functions described in this manual are not supported by all instructions for details on the features supported.
Fingerprints on a disc may adversely affect playback. If a problem occurs, remove the disc and check for fingerprints on the playback side. Clean the disc if necessary.
When using the remote control, be careful to pressing multiple buttons at the same time may cause erroneous operation.

① ***Press ► button.***
Playback starts.

If a menu screen appears DVD VCD MP3

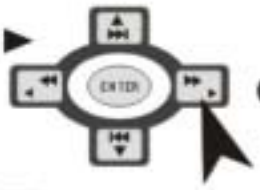
On DVDs and video CDs with playback control (PBC), menu screen may appear automatically.

If this happens, perform the operation described below to start

Note:For many discs, the menu screen can also be displayed by pressing MENU or TITLE.

DVD menu

Use the Joystick or the number keys(0~9) to select the desired item, then press ENTER or ►



Or

Note: For some discs it is not possible to select items for the menu to menu screen using the number buttons (0~9).

ENTER Or

VCD menu

Use the number keys(0~9) to select the desired item, then press ENTER or ►

Or

Note: The menu screen does not appear when the PBC function is turned off. If this is the case press MENU to turn on the PBC function. In PBC off mode, you can use the number keys to input the desired track also.

② *Playing/pausing*

During playback press II► to pause playback.
Press II► again to resume playback.

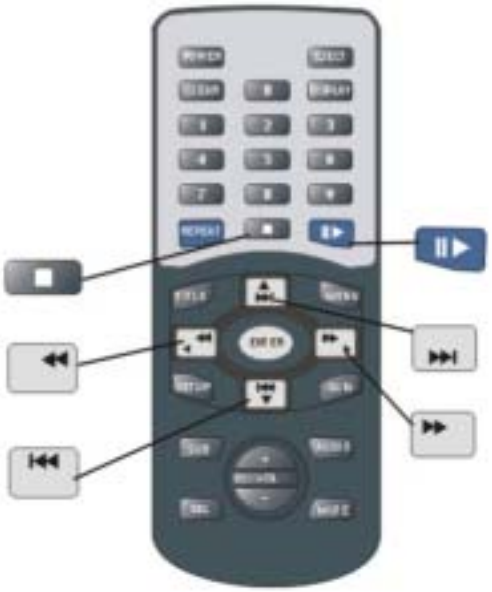
③ *Tuning the sound on and off*

During playback press MUTE , no sound is played. Press Mute to resume normal playback with sound.

Tips

Using the Number keys

This describes use of the Number keys.
To input 16: Press the 1 button and then press the 6 key.
To input 28: Press the 2 key and then press the 8 key.
To input 108: Press the 1 key and then press the 0 and 8 button.
After the number input, press ENTER or PLAY button to start the playback.



1 *Stopping playback*

DVD VCD CD MP3

Press the stop button during playback to stop playback.
Press ■ during playback.

Tips

Using the PRE-STOP function(DVD only.)
When the PRE-STOP function is used, the position at which playback is stopped is stored in the memory, and playback resumes from that position.
Press ■ once during playback.

PRESS PLAY TO CONTINUE is displayed.

Press ▶ in the PRE-STOP mode.

Playback starts from the position at which it was stopped.

To cancel the PRE-STOP function
Either press ■ again in the PRE-STOP mode, eject the disc or turn the power to clear the memory. Playback will start at the beginning of the disc.

Notes:
For some discs, the position at which playback was stopped may not be accurate.
For Video CD:
Press during playback,
1 in PBC off mode, playback stops. Press PLAY, playback will start at the beginning of the disc.
2 in PBC on mode, playback stops and press PLAY then it will be Back to main page.

2 *Fast-forwarding/fast-reversing*

DVD VCD CD MP3

①During playback press ◀◀ (fast-reverse) or ▶▶ (fast-forward)

Each time you press the ◀◀ or ▶▶ button,the playback speed changes to X1, X2,X3 , X4 the normal speed or normal speed.

②Press ▶ to return to normal playback.

Notes:
No sound or subtitles are played during fast-forwarding/fast-reversing of DVDs or Video CDs.
However, sound is played during fastforwarding/fast-reversing of audio Cds.

3 *Finding the beginning of chapters or tracks*

DVD VCD CD MP3

During playback press ⏭ *or* ⏮:
The chapter/track switches each time the button is pressed, and playback of the selected chapter/track starts.

Or

⏭ :Press this to start playback from the beginning of the next chapter or track.

⏮ :Press this to start playback from thebeginning of the previous chapter or track.

Note: Some DVDs do not have chapters.

Supplementary explanation
Chapters are divisions of movies or musical selections on DVDs.
Tracks are divisions of movies or musical selections on video and audio Cds.

1 *Playing from the desired location*

Locating a specific location by entering the track number, the chapter number or the time.

① During playback, press GOTO.

Goto

DVD TITLE 01/02 CHAPTER 012/057

⇩ Press GOTO again

TITLE 01/02 TIME _ _:_ _:_ _

VCD CD VCD(PBC OFF)

GOTO _ _:_ _

②Input the chapter,the title or the time from which you want to start playback using the joystick and the numberkeys(0~9).

TITLE 02/02 CHAPTER 012/057

CURRENT TITLE
TOTAL TITLE NUMBER
CURRENT CHAPTER
TOTAL CHAPTER NUMBER

(When title 2 is input)

TITLE 02/02 CHAPTER 012/057

(When chapter 12 is input)

TITLE 01/02 TIME 01:30:00

(When 1 hour, 30 minutes is input as the elapsed time)

GOTO 30:00

(When 30 minutes is input as the elapsed time)

Notes:
- Input the hours first, followed by the minutes, then the seconds.
- Press CLEAR to delete all digits you input.
- Press GOTO to cancel the search mode and resume normal playback.
- Some discs may not respond to this process.
- Some scenes may not be located precisely as you specified.
- This method for accessing specific locations is available only within the current title of the DVD video disc or within the current track of the VIDEO CD/audio CD.

③*Press ENTER*

Playback starts from the selected chapter, track or the time.

ENTER

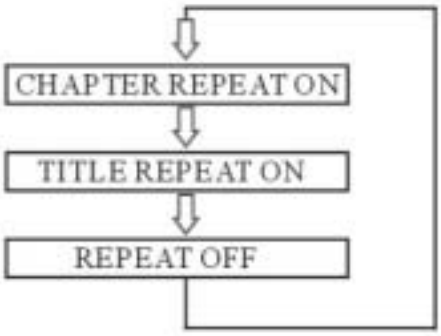
1 *Chapter/track/title repeat playback*

REPEAT

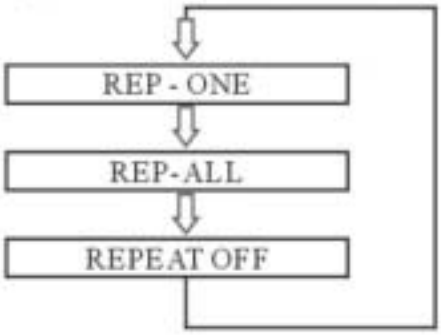
① *During playback ,Press REPEAT*

The repeat mode switches each time the button is pressed.

DVD



VCD CD VCD(PBC OFF)



2 *Switching the audio language*

DVD VCD

On DVDs including multiple audio modes ormultiple audio languages, the audio languagecan be switched during playback.

① *During playback, press AUDIO.*

AUDIO

The sound switches between the different audio modes recorded on the disc each timethe button is pressed.

Notes:

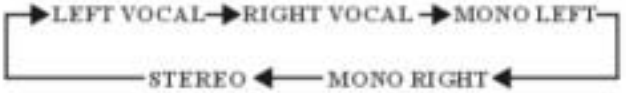
- The language selected with the default setting is set when the power is turned on or the disc is replaced. If the disc does not include that language, the disc s default language is set.
- For some discs it is not possible to switch the audio language during playback.
- Some time may be required for the audio language to change.

Video CDs with multiplex audio

① *During playback, press AUDIO.*

The combination of the left and right channels changes each time the button is pressed.

AUDIO



1 Switching the angle

With DVDs on which images photographed from multiple angles are recorded, the anglecan be switched during playback.

① *During playback, press ANGLE.*

The angle switches between the angles recorded on the disc each time the button is pressed.

ANGLE
9

Note:
- Some time may be required for the angle to change.

2 Switching the subtitles

With DVDs on which multiple subtitle languages are recorded, the subtitle language can be switched during playback.

① *During playback, press SUB.*

SUB

The subtitle language switches between the languages recorded and you also can select whether to display the subtitles on the disc each time the button is pressed.

Note:
- Some time may be required for the subtitle to change.
- The language selected with the default setting is replaced. If the disc does not include that language, the disc 's default language is set.
- For some discs, the subtitles will be displayed even when this is set to off.

Tips

Switching from the menu

For some discs, the audio language, angle and subtitle can be switched from the disc menu.

Press MENU or TITLE, select the item, then press ENTER.

TITLE Or MENU

⇩

ENTER

1 Displaying the disc status

Use the procedure described below to displaythe status(title number, chapter number, etc.) of the currently playing DVD on the screen.

① *During playback, press DISPLAY.* DISPLAY

The playback status switches each time the button is pressed.

TITLE 01/01 CHAPTER 001/057
XX:XX:XX
⇩
TITLE REMAIN
XX:XX:XX
⇩
CHAPTER ELAPSED
XX:XX:XX
⇩
CHAPTER REMAIN
XX:XX:XX
⇩
the display turns off.

2 Displaying the disc status

Use the procedure described below to display the status(track number, etc.) of the currently playing Video CD or Audio CD on the screen.

① *During playback, press DISPLAY.* DISPLAY

The playback status switches each time the button is pressed.

TOTAL ELAPSED
XX:XX:XX PLAY:11 TOTAL:22
⇩
TOTAL REMAIN
XX:XX:XX PLAY:11 TOTAL:22
⇩
SINGLE ELAPSED
⇩
SINGLE REMAIN
⇩
OFF

1 *Adjusting the sound setting*

DVD VCD CD MP3

The sound settings can be changed to suit your personal preferences and usage.

SEL

To select the audio functions as you like:

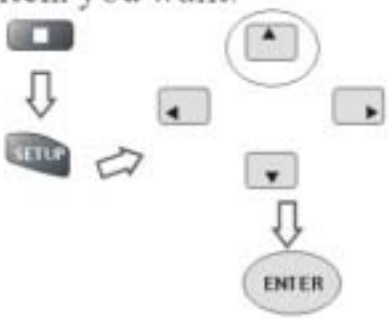
To	Press SEL button on the remote repeatedly until the item you want to adjust appears on the screen	Press the VOL +,- button adjust the setting as you like
Balance	BALANCE : L00	The level changes from L08~L00 and L00~R08
Bass	BASS : -00	The level changes from -07~+07
Treble	TREBLE : -00	The level changes from -07~+07
Loudness	LOUDNESS ON	ON or OFF
Volume	VOLUME 18	The level changes from 00~36

1 *Changing the default settings(setup)*

DVD VCD CD MP3

Press SETUP during stop.
The setting menu appears.
Press joystick button to move the cursor to the item, then press ENTER to select the item you want.

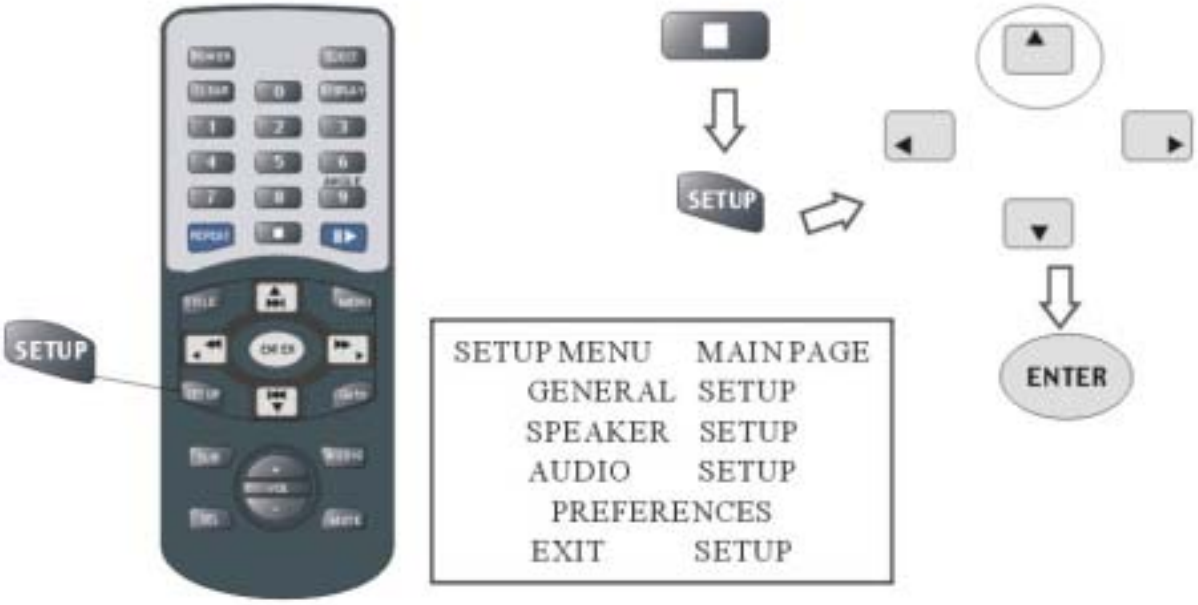
SETUP MENU	MAIN PAGE
GENERAL	SETUP
SPEAKER	SETUP
AUDIO	SETUP
PREFERENCES	
EXIT	SETUP



① GENERAL SETUP

TV DISPLAY	NORMAL/PS NORMAL/LB WIDE
PIC MODE	AUTO HI-RES N-FLICKER
ANGLE MARK	ON OFF
EXT AMP	ON OFF
OSD LANG	ENGLISH
SCR SAVER	ON OFF

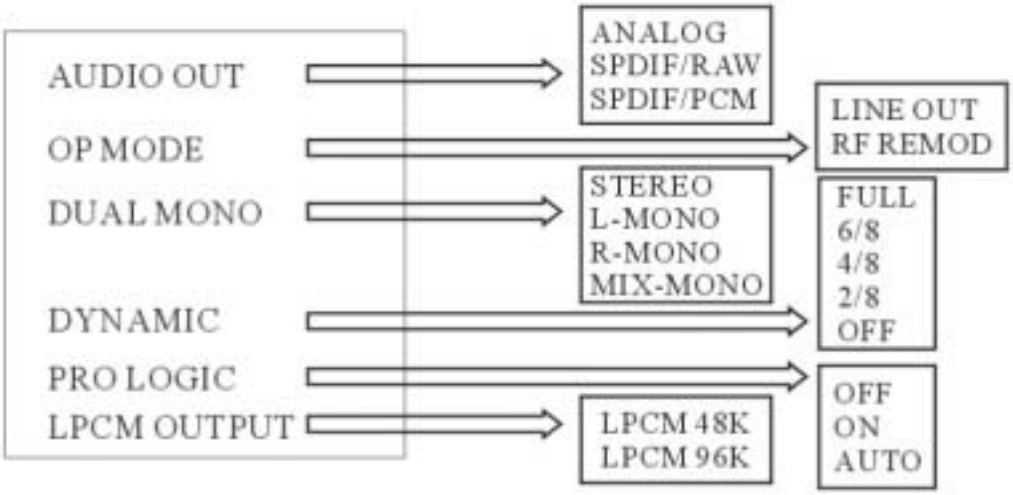
TV DISPLAY	SET TV DISPLAY MODE	NORMAL/PS	NORMAL TV PAN SCAN
		NORMAL/LB	NORMAL TV LETTER BOX
		WIDE	WIDE SCREEN TV
PIC MODE	SET PICTURE MODE	AUTO	AUTO MODE
		HI-RES	HIGH-RESOLUTION MODE
		N-FLICKER	NONFLICKER MODE
ANGLE MARK	ANGLE ON/OFF		
EXT AMP	TURN EXT AMP ON/OFF		
OSD LANG	SET OSD LANGUAGE		
SCR SAVER	SCREEN SAVER		



② SPEAKER SETUP

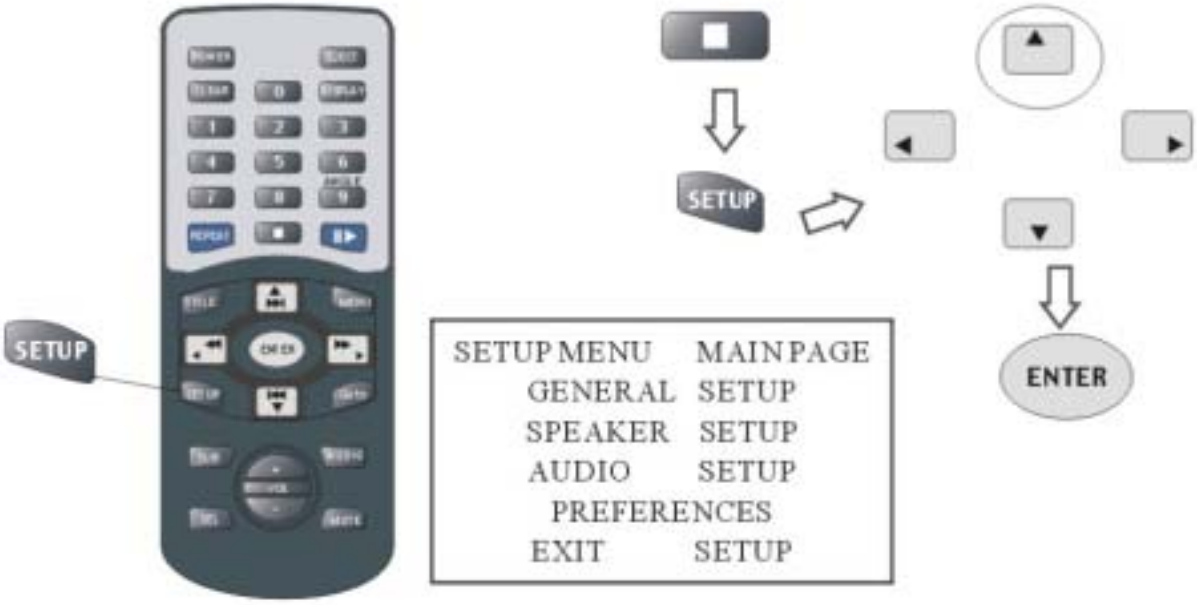
DOWNMIX	LOUD SPEAKERS SETUP	LT/RT	SET LT/RT DOWNMIX
		STEREO	SET STEREO DOWNMIX

③ AUDIO SETUP



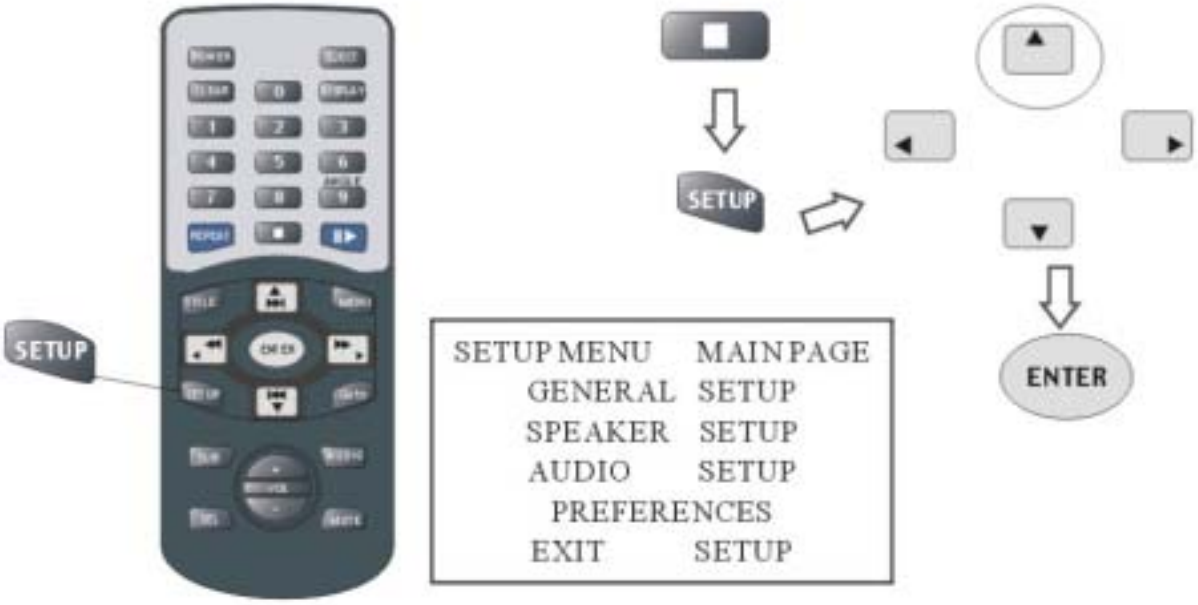
AUDIO OUT	AUDIO RELATED	ANALOG	ANALOG OUTPUT
		SPDIF/RAW	RAW DATA VIA SPDIF
		SPDIF/PCM	PCM DATA VIA SPDIF

Changing the default settings(setup)

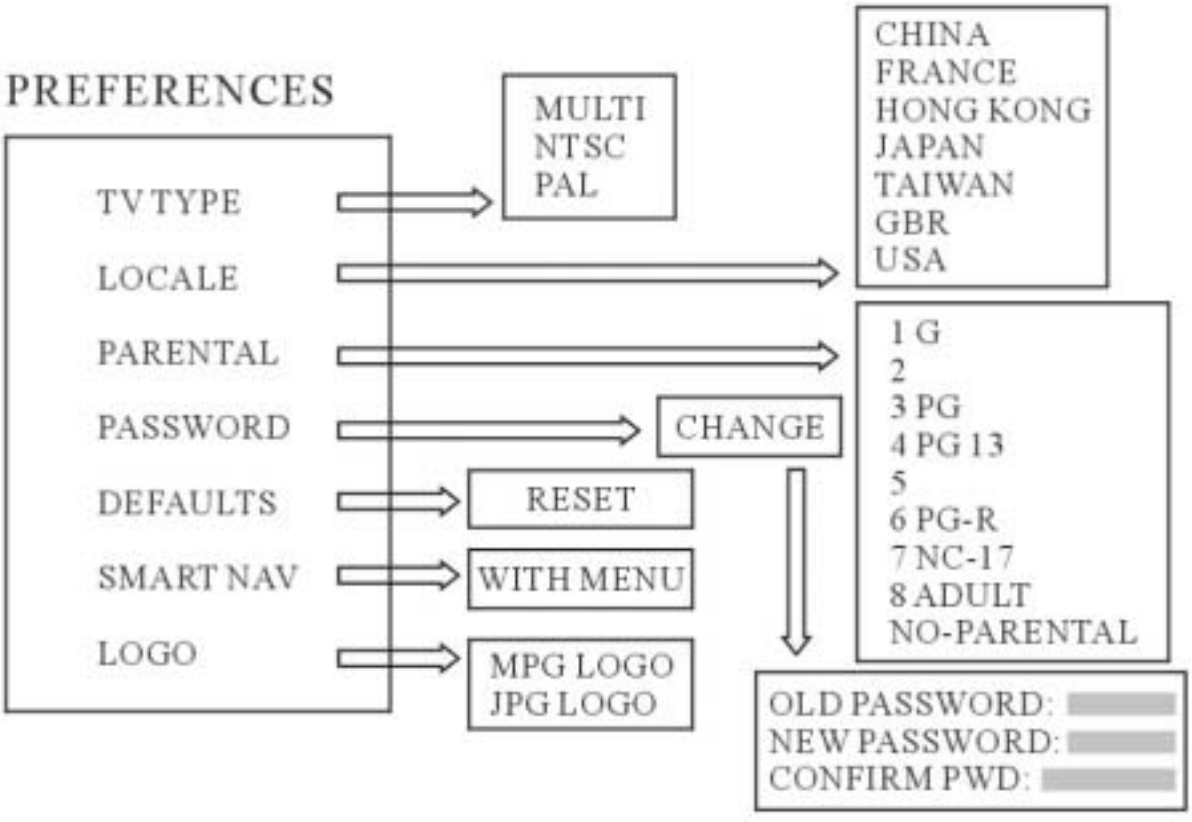


OP MODE	OPERATIONAL MODE SETUP	LINE OUT	LINE OUT MODE
		RF REMOD	TV WITH NO AV INPUT
DUAL MONO	DUAL MONO(1+1) SETUP	STEREO	SET STEREO MODE
		L-MONO	SET LEFT MONO MODE
		R-MONO	SET RIGHT MONO MODE
		MIX-MONO	SET MIXED MONO MODE
DYNAMIC	DYNAMIC RANGE COMPRESSION	FULL	FULL DYNAMIC RNG COMPRESSION
		- -	DYNAMIC RNG COMPRESSION 7/8
		6/8	DYNAMIC RNG COMPRESSION 3/4
		- -	DYNAMIC RNG COMPRESSION 5/8
		4/8	DYNAMIC RNG COMPRESSION 1/2
		- -	DYNAMIC RNG COMPRESSION 3/8
		2/8	DYNAMIC RNG COMPRESSION □
		- -	DYNAMIC RNG COMPRESSION 1/8
		OFF	DYNAMIC RNG COMPRESSION OFF
PRO LOGIC	SET PRO LOGIC ON/OFF	OFF	PRO LOGIC OFF
		PRO	LOGIC ON ON
		AUTO	PRO LOGIC AUTO
LPCM OUTPUT	SET LPCM TO 48K OR 96K	LPCM 48K	LPCM OUTPUT 48K
		LPCM 96K	LPCM OUTPUT 96K

Changing the default settings(setup)

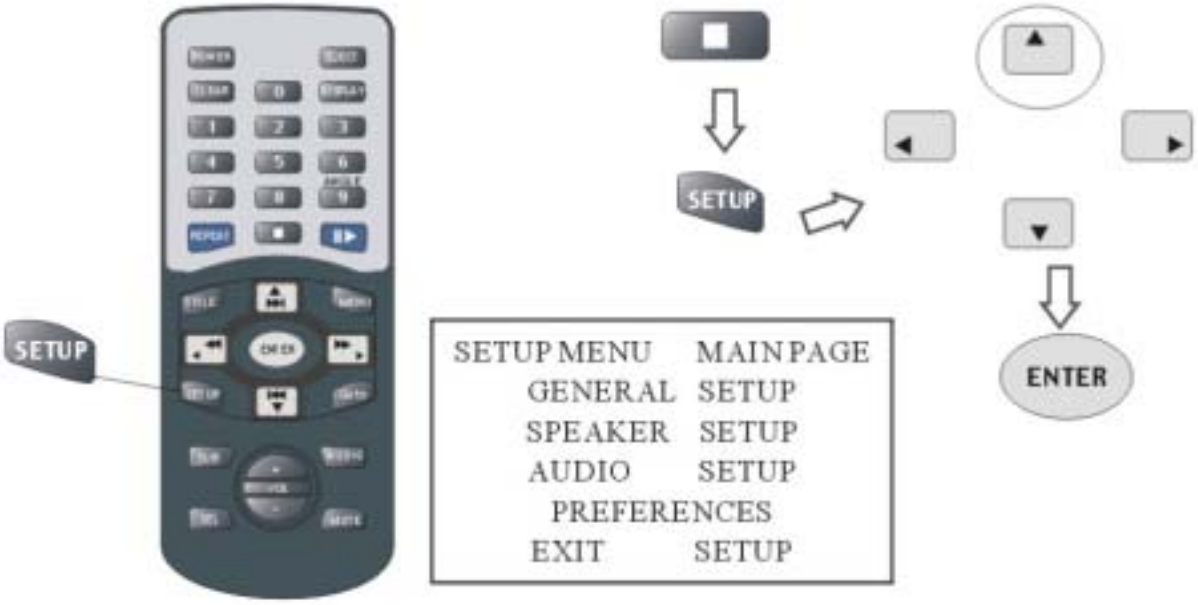


④ PREFERENCES



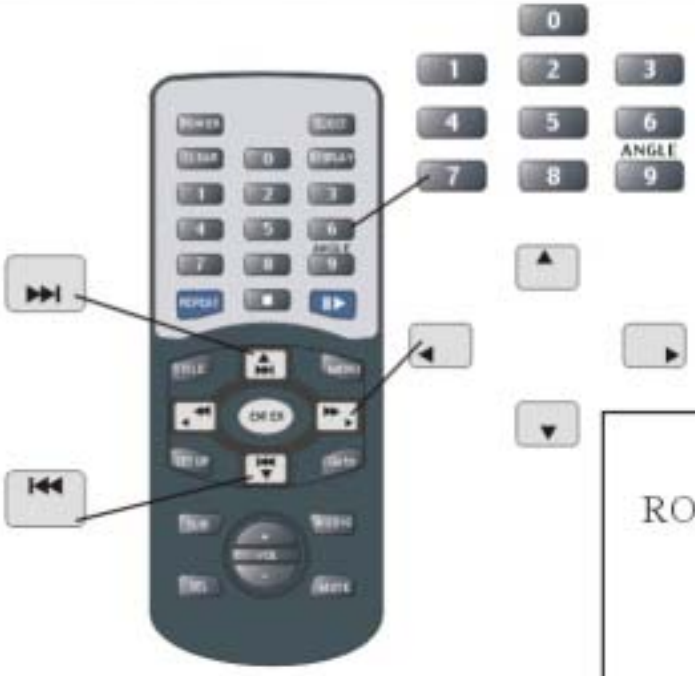
TV TYPE	SET TV STANDARD	MULTI	MULTISYNC TV
		NTSC	NTSC TV
		PAL	PAL TV
LOCALE	PREFERRED LOCALITY CODE	GRB	UNITED KINGDOM

Changing the default settings(setup)



SETUP MENU	MAIN PAGE
GENERAL	SETUP
SPEAKER	SETUP
AUDIO	SETUP
PREFERENCES	
EXIT	SETUP

PARENTAL	SET PARENTAL CONTROL	1 G 2 3 PG 4 PG 13 5 6 PG-R 7 NC-17 8 ADULT NO-PARENTAL	SET TO G, LEVEL 2, PG, PG13, LEVEL 5, PG-R, NC-17, ADULT, OR NO-PARENTAL
PASSWORD		CHANGE	OLD PASSWORD: NEW PASSWORD: CONFIRM PWD:
DEFAULTS		RESET	LOAD FACTORY SETTINGS
SMART NAV	SMART NAV TYPE	WITH MENU	PLAYING MP3 WITH MENU
LOGO	OPEN SCREEN LOGO	MPG LOGO JPG LOGO	



1 *Mp3 instruction*

Insert the MP3 disc then playback starts, the MENU of elapsed track appears.

	SMART	NAV 1	
ROOT	MP3	J&Z	1
	Mp3	xxx	2
	MP3	xxx	3
	Mp3	xxx	4
	Mp3	xxx	5
PLAY MODE	REP-ONE		

PRESS	
⏮ ⏭	To play the preceding or the next track
◀ ▶	In play mode, it starts to fast-forward or fast-revers
Number button	To select the track with the number button Note: For some discs it is not possible to select items for the menu to menu screen using the number buttons (0~9).
PLAY MODE	In stop mode, move cursor to PLAY MODE with joy stick ◀ ▶, pressing joy stick ▼ ▲ to change PLAY MODE: SINGLE, REP-ONE, FOLDER, FOLDER REP, DISC SCAN, DISC, DISC REP, RANDOM, SHUFFLE ON , PROGRAM P0. Select the play mode, thenmove the cursor back to the track menu and you desired track with ◀ ▶ ▼ ▲ , finally press PLAY to start playback again. Desired
DISPLAY	STATUS DISPLAYED: CHAPTER ELAPSED XX:XX:XX CHAPTER REMAIN XX:XX:XX
Playing MP3 disc, the play position memory is not available.	

Others

In case of difficulty

If operation freezes, the screen goes black or the unit should otherwise not function properly, try turning the power off then back on. Alternatively, try the following methods in the order listed until the unit returns to normal playback mode.

1) Turn the car' s ignition OFF and back ON again.
2) Press the RESET button on the face of the unit

This guide will help you isolate the problem if the unit is at fault. Otherwise, make sure the rest of your system is properly connected or consult a professional mobile video installer.

Symptom	*Cause*	*Remedy*
Unit does not operate.	Fuse is blown.	Replace with a fuse of the specified capacity.
	Monitor' s power is not turn on.	Turn on the m onitor' s power
	Condensation	Wait a while(about 1 hour) for the condensation to dry.
Operation is unstable.	Remote control unit' s battery is worn.	Replace the remote control unit' s battery with new one.
	Remote control sensor or transmitter is dirty.	Clean the sensor or transmitter.
No picture is produced.	Monitor' s mode is not switched to the mode you want to see.	Switch to the mode you want to see.
Playback does not start.	Disc is loaded upside-down.	Check the disc and load it with the labeled side facing upward.
	Disc is dirty.	Clean the disc.
	A disc not able to playback with this unit is loaded.	Check if the disc is able to be played back.
	Parental lock is set.	Cancel the parental lock or change the rating level.
Picture is unclear or noisy	Disc is being fast-forwarded or fast-reversed.	The picture may be slightly disturbed, but this is normal.
	Vehicle' s battery power is weak.	Check the battery power and wiring. The unit may malfunction if the battery power is under 10.8 volts with a load applied.
	Monitor' s fluorescent tube is worn.	Replace the monitor' s fluorescent tube.
Image stops sometimes.	Disc is scratched.	Replaced with a non-scratched disc.
No disc	No disc is loaded.	Load a disc.
	Disc is dirty.	Clean the disc.
Not valid	Remote control operation is not possible.	For some discs or playing modes, certain operations are not possible. This not a malfunction.
VIDEO SIGNAL SYSTEM IS NOT CORRECT	PAL(or NTSC) disc is loaded.	Change the TV TYPE of the unit(see SET UP).
No sound	Select the wrong Audio Out	According to the connection, set ANALOG for using audio cable, set SPDIF/RAM/PCM for using coaxial cable. See page 7,8 and 19.

Note

Two black sticking papers

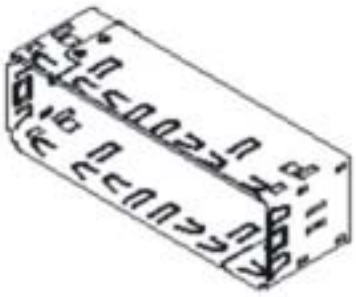
There are 2 mounting screws on the case of the DVD player(as above figure shows) to protect the unit during shipping.
You need to remove the sticking papers and screws after unpacking this product.
Apply the black sticking papers(supplied)on the screw holes to keep out dust.

Specifications

Audio	Audio output(analog) :	2± 0.2V 100kΩ
	Audio output(coaxial):	0.5V 75Ω
	Signal-to-noise ratio:	more than 90dB
	Dynamic range:	more than 85dB
	Distortion:	less than 0.08%
Video	Video output:	1±0.2V
	Resolution:	more than 500 line
Power	Power requirement:	12 $^{+20\%}_{-10\%}$ V DC , 1.5A
	Power consumption:	less than 20W
General	Dimensions(approx.):	178x50x183mm
	Weight:	(w/h/d)incl. Projecting parts 1.4Kg
	Normal operating temperature range: 23°F to131°F	

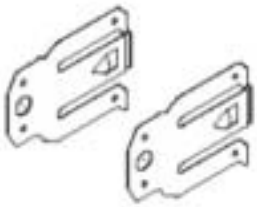
- Design and specifications are subject to change without notice.
- The illustrations in this manual may appear different from the actual product due to printing conditions.

Accessories and Hardware

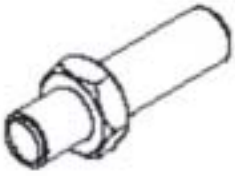


Mounting Bracket (Half Sleeve) × 1

Rear Strap (Brace) ×1



Side bracket × 2

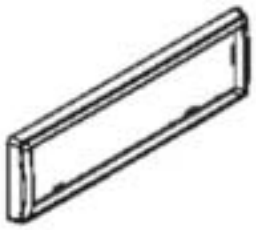


Mounting Screw M5 ×1

Hex bolt M5 x 14 ×2

Flat head screw M5 ×4 ×2

Mounting Grommet ×1



Removable Trim Ring equipped on the unit ×1

Remote control × 1

Lithium Button Cell (3V) ×1

IR sensor ×1

SECTION 24: LUBRICATION

CONTENTS

1. LUBRICATION **2**

2. LUBRICATION AND SERVICE SCHEDULE **2**

2.1 FLEXIBLE HOSE MAINTENANCE 2
2.1.1 Hose Inspection *2*
2.1.2 Leaks *2*
2.1.3 Service life *2*
2.2 LUBRICANT AND COOLANT SPECIFICATIONS 8
2.3 LUBRICATION AND SERVICING SCHEDULE 8

ILLUSTRATIONS

FIGURE 1: LUBRICATION AND SERVICING POINTS ON I-BEAM AXLE FRONT SUSPENSION VEHICLES 4
FIGURE 2: LUBRICATION AND SERVICING POINTS – HVAC UNIT 6
FIGURE 3: LUBRICATION AND SERVICING POINTS ON INDEPENDENT FRONT SUSPENSION VEHICLES (TYPICAL) 7

1. LUBRICATION

The efficiency and life expectancy of mechanical equipment is largely dependent on proper lubrication and servicing. All mechanical components rely on a lubricating film between moving parts to reduce friction, prevent wear and oxidation. Proper lubrication also helps cool the parts and keep dirt particles away from mating surfaces. Efficient lubrication depends upon using the right type of lubricant, at specified intervals and by filling to correct capacities. Past experience shows that many service problems can be traced to an improper lubricant or to incorrect lubrication procedures.

A comprehensive maintenance and lubrication program is important to ensure the long service life this vehicle was designed for and to avoid costly repairs and associated downtime caused by premature part failure.

A lubrication schedule is included in this section to give the location of key service points on the vehicle as well as the lubricant specifications for each component to be serviced. Specific instructions on how to check and service different components are covered in their respective sections in this maintenance manual.

The recommended lubrication intervals are based on normal operating conditions and mileage accumulation.

Shorten the intervals if your vehicle operates in more severe conditions. Severe conditions include heavy towing, high vehicle weight or operation in mountainous areas. Some parts and equipment referred to in this section may not be installed on your vehicle. Check your vehicle's "Coach Final Record" for equipment list.

Dispose of used lubricants and filters in an environmentally safe manner, according to federal and/or local recommendations.

2. LUBRICATION AND SERVICE SCHEDULE

Following this service schedule is the most economical and easiest way to ensure your vehicle performs at its best, safest and longest. Also, unscheduled maintenance will be minimized since inspection should expose potential problems before they become major ones.

2.1 FLEXIBLE HOSE MAINTENANCE

The performance of engine and equipment are greatly related to the ability of flexible hoses to supply lubricating oil, air, coolant, and fuel oil. Maintenance of hoses is an important step to ensure efficient, economical, and safe operation of the engine and related equipment.

2.1.1 Hose Inspection

Check hoses daily as part of the pre-starting inspection. Examine hose for leaks, and check all fittings, clamps, and ties carefully. Ensure that hoses are not resting on or touching shafts, couplings, heated surfaces including exhaust manifolds, any sharp edges, or other obviously damaging areas. Since all machinery vibrates and moves to a certain extent, clamps and ties can fatigue with time. To ensure proper support, inspect fasteners frequently and tighten or replace them as necessary.

2.1.2 Leaks

Investigate leaks immediately to determine if fittings have loosened or cracked, and also if hoses have ruptured or worn through. Take corrective action immediately. Leaks are not only potentially detrimental to machine operation, but can also result in added expenses caused by the need to replace lost fluids.

WARNING

Personal injury and/or property damage may result from fire due to the leakage of flammable fluids, such as fuel or lube oil.

2.1.3 Service life

The limited service life of a hose is determined by the temperature and pressure of the gas or fluid within it, the time in service, its installation, the ambient temperatures, amount of flexing, and the vibration it is subjected to. With this in mind, it is recommended that all hoses be thoroughly inspected at least every 500 operating hours or after 15,000 miles (24 000 km). Look for surface damage or indications of damaged, twisted, worn, crimped, brittle, cracked, or leaking lines. Hoses having a worn outer surface or hoses with a damaged metal reinforcement should be considered unfit for further service.

It is also recommended that all hoses in this vehicle be replaced during major overhaul and/or after a maximum of five service years. Quality of replacement hose assemblies should always be equal to or superior to those supplied by the Original Equipment Manufacturer.

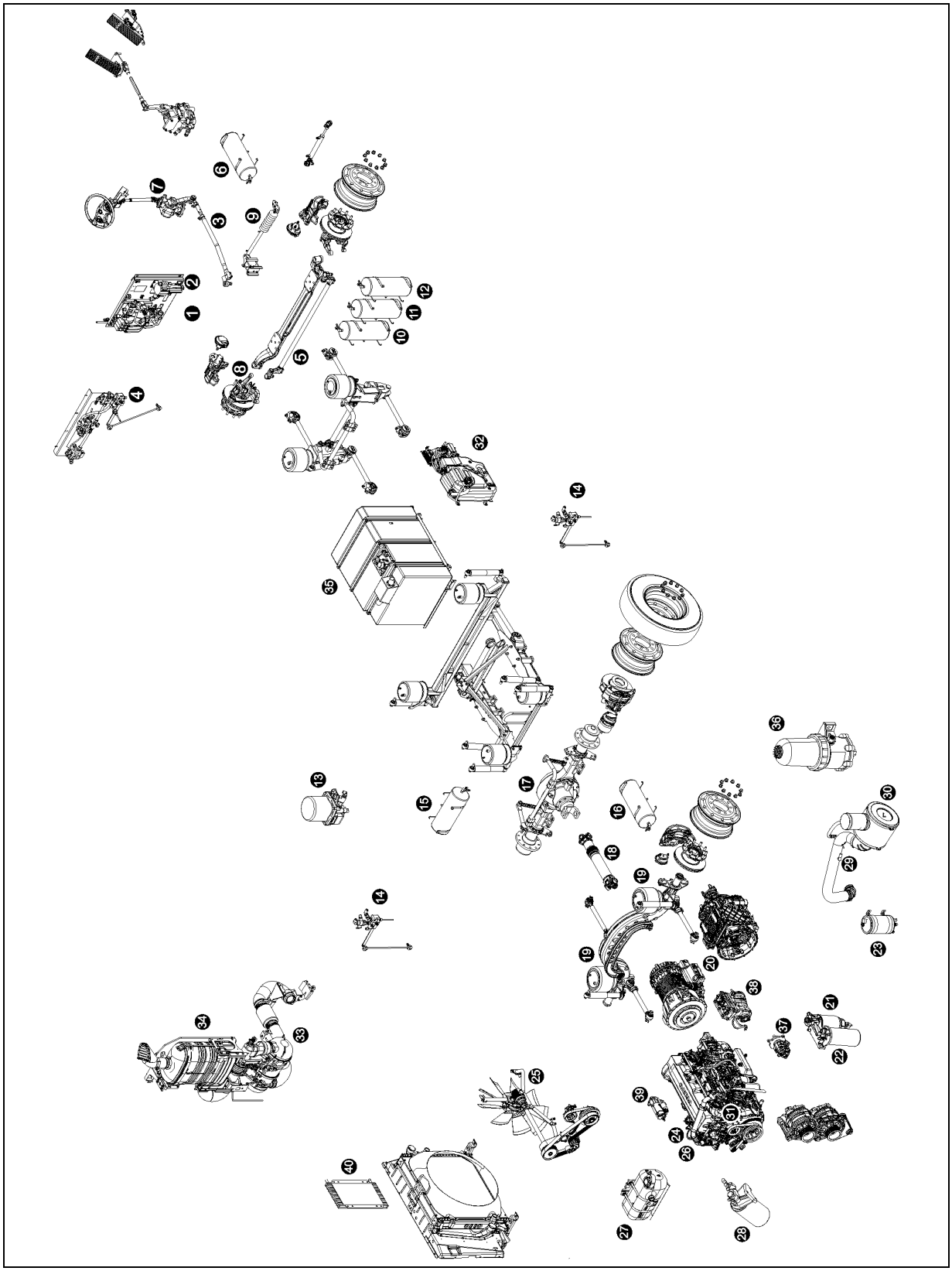


FIGURE 1: LUBRICATION AND SERVICING POINTS ON I-BEAM AXLE FRONT SUSPENSION VEHICLES 24030_1

1 Accessories air tank drain cock
2 Accessories air filter
3 Steering drag link
4 Height control valve (front)
5 Steering tie rod
6 Accessories air tank
7 Steering column U-joints
8 Steering knuckle pins
9 Steering damper cylinder
10 Emergency / parking brake overrule tank
11 Secondary air tank
12 Kneeling air tank
13 Air dryer
14 Height control valve (rear)
15 Wet air tank
16 Primary air tank
17 Differential
18 Propeller shaft
19 Tag axle lever pivot
20 Transmission
21 Primary fuel filter
22 Secondary fuel filter
23 Power steering fluid tank
24 Engine oil filter
25 Cooling fan gearbox
26 Allison transmission oil dipstick
27 Engine coolant surge tank
28 Coolant filter & conditioner
29 Engine air filter restriction indicator
30 Engine air filter
31 Engine oil dipstick and filler tube
32 DEF tank
33 Diesel particulate filter
34 SCR catalytic converter
35 Diesel fuel tank
36 Davco Fuel Pro 382 fuel filter
37 Power steering pump
38 Air compressor
39 Starter
40 Fuel cooler

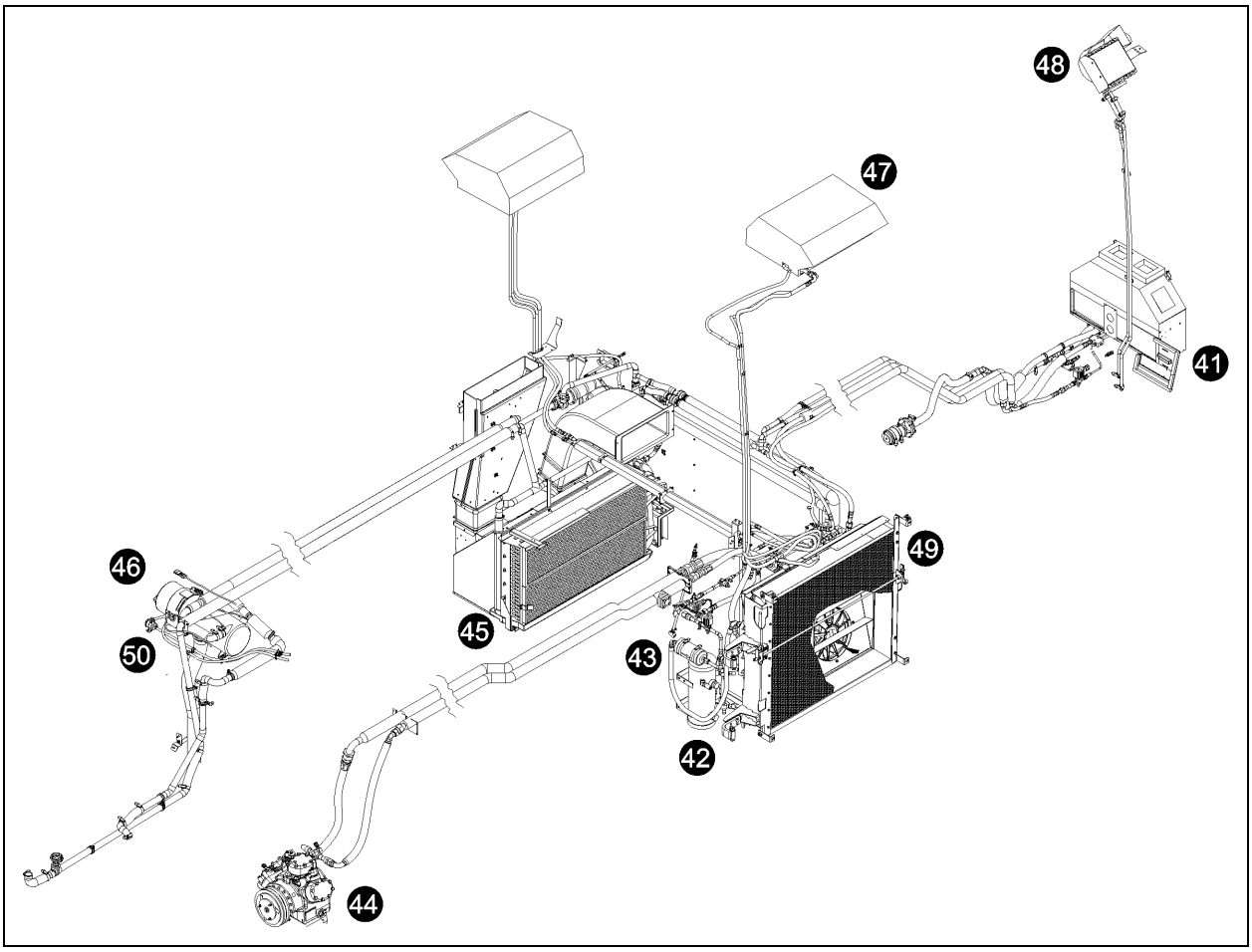


FIGURE 2: LUBRICATION AND SERVICING POINTS – HVAC UNIT

41 HVAC air filter – driver's unit
42 A/C receiver tank
43 Refrigerant moisture indicator
44 A/C compressor
45 HVAC air filter – passenger's unit
46 Coolant preheater
47 A/C system – passenger's overhead console
48 Upper windshield defrost unit
49 Condenser coil
50 Preheater fuel filter

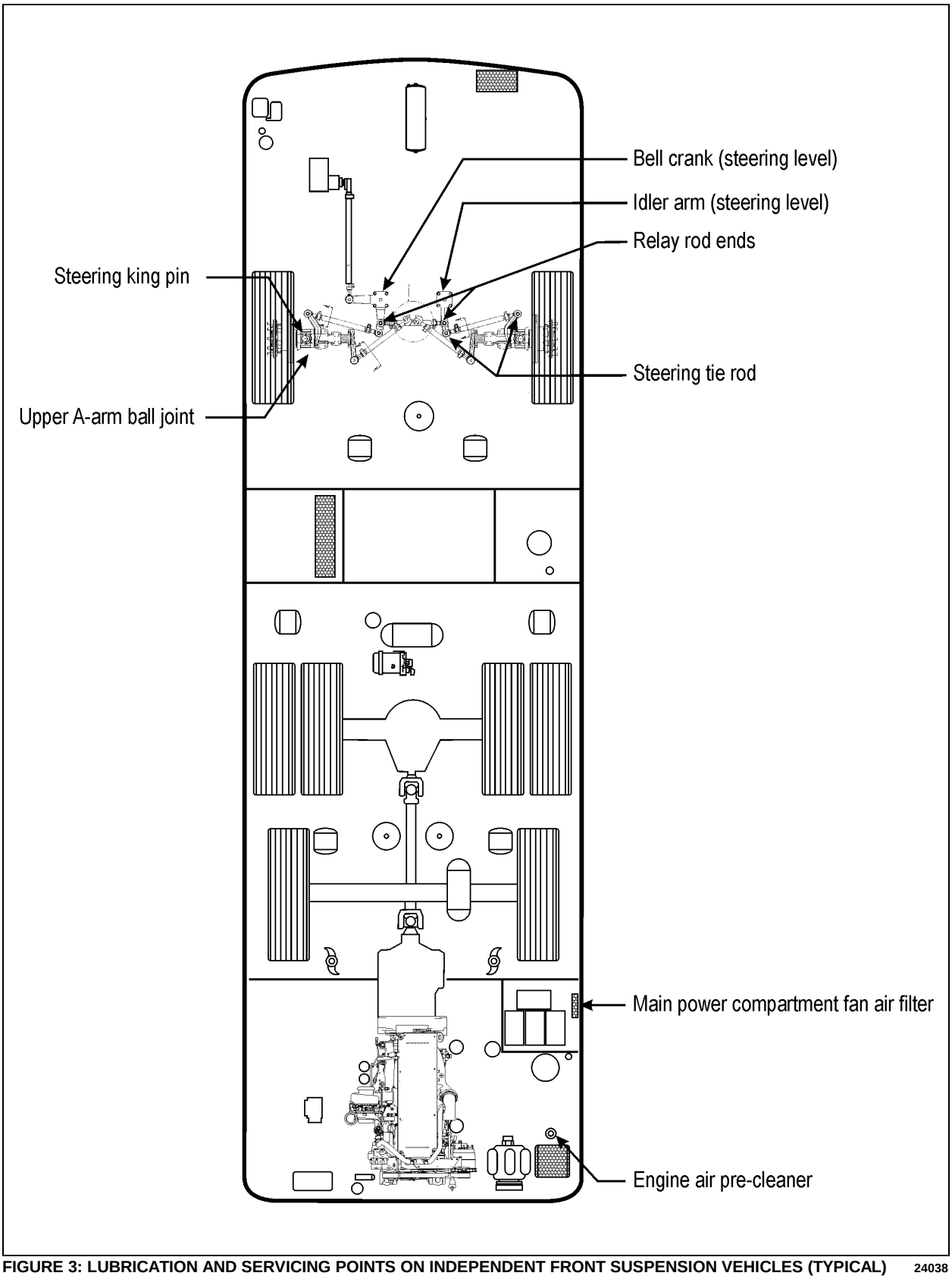


FIGURE 3: LUBRICATION AND SERVICING POINTS ON INDEPENDENT FRONT SUSPENSION VEHICLES (TYPICAL) 24038

2.2 LUBRICANT AND COOLANT SPECIFICATIONS

REF	DESCRIPTION	SPECIFICATIONS
A	Engine Oil	VOLVO D13 SAE Viscosity Grade: 15W-40 API Classification: CJ-4 meeting Volvo specification VDS-4
B	Power Steering Oil	Automatic Transmission Oil, Dexron-III
C	Engine Coolant	VOLVO D13 Texaco or Chevron Extended Life Coolant (ELC) 50% antifreeze/water solution is normally used
D	A/C Compressor Oil	Central HVAC system: Polyolester oil, HFC 134a compatible; Castrol SW-68 (POE) or equivalent Small HVAC system: PAG oil
E	Differential Oil	Multigrade gear oil meeting MIL-L-2105-D: 85W140. If temperature drops below 10°F (-12°C), 80W90 should be used. Below -15°F (-26°C), 75W90 should be used. (In extreme conditions or for better performance, full synthetic gear oil can be used.)
F	Differential Oil (Full Synthetic)	Multigrade gear oil meeting MIL-L-2105-D: 85W140. If temperature drops below 10°F (-12°C), 80W90 should be used. Below -15°F (-26°C), 75W90 should be used.
G	Radiator Fan Gearbox Oil	Shell transmission oil MA 75W-90
H	Allison Automatic Transmission Oil	Castrol TranSynd™ Synthetic Transmission Fluid for Allison or TES 295 approved equivalent
I	Allison Automatic Transmission Oil	Dexron-VI® or approved equivalent 1 Schedule 1 TES-389 fluids;
J	Volvo I-Shift Transmission Oil	Castrol Syntrans Grade SAE 75W-85 (Synthetic)
K	Multi Purpose Grease	Good quality lithium-base grease: NLGI No.2 Grade is suitable for most temperatures NLGI No.1 Grade is suitable for extremely low temperatures
L	Multi Purpose Grease	Molykote longterm 2/78 grease

2.3 LUBRICATION AND SERVICING SCHEDULE

For lubrication and servicing schedule, refer to table A.

IMPORTANT NOTE
Refer to the manufacturers documentation included in this maintenance manual for specific manufacturer's maintenance requirements.

LUBRICATION AND SERVICING SCHEDULE	Item	Months	Odometer reading [1] (miles / km) For higher odometer readings, repeat at the frequency interval established																																LUBRICANT /FLUID [2]
			6 250 / 10 000	12 500 / 20 000	18 750 / 30 000	25 000 / 40 000	31 250 / 50 000	37 500 / 60 000	43 750 / 70 000	50 000 / 80 000	56 250 / 90 000	62 500 / 100 000	68 750 / 110 000	75 000 / 120 000	81 250 / 130 000	87 500 / 140 000	93 750 / 150 000	100 000 / 160 000	106 250 / 170 000	112 500 / 180 000	118 750 / 190 000	125 000 / 200 000	131 250 / 210 000	137 500 / 220 000	143 750 / 230 000	150 000 / 240 000	185 000 / 300 000	200 000 / 320 000	225 000 / 360 000	250 000 / 400 000	275 000 / 440 000	300 000 / 500 000	500 000 / 800 000	600 000 / 960 000	
			proceed to maintenance operation at																							each									
GENERAL																																			
Flexible hoses, thoroughly inspect all hoses	-	12								●								●							●										
01 ENGINE																																			
Air cleaner, change as per mileage or according to restriction indicator	30	24																							●										
Engine oil and filter, change (normal[3] operation condition) **Volvo recommends 35,000miles/55,000km**	24						●					●					●					●													A
Engine oil and filter, change (heavy[3] operation condition)	24					●				●				●				●				●			●											A
Valves and injectors, initial adjust	-	12																				●													
Valves and injectors, check and adjust	-	24																											●						
Drive belts, check	-	36																													●				
03 FUEL																																			
Primary & secondary fuel filters, change at every engine oil change **Volvo recommends 35,000miles/55,000km**	21 22						●					●					●					●													
Preheater fuel filter , replace	50									●								●							●										
04 EXHAUST AND AFTERTREATMENT SYSTEM																																			
DPF filter, change	-																												●						
DEF tank, drain and clean with water, clean filler neck strainer	32	12																								●									
DEF pump, replace filter element	32	36																							●										
05 COOLING																																			
Cooling fan gearbox, check oil level and add if required	25	6		●		●		●		●		●		●		●		●		●		●		●	●										G
Cooling fan gearbox, change oil	25	12								●								●							●										G
Coolant surge tank, test coolant solution	27	12		●		●		●		●		●		●		●		●		●		●		●	●										
Coolant filter, change (with Extended Life Coolant)	28	12																							●										
Cooling system, drain, flush & refill (with Extended Life Coolant) (may require “extender”)	27	48																															●		C
06 ELECTRICAL																																			
Battery terminals, clean and coat terminals	-	12																																	
Bosch HD10 alternator brushes, check and replace if required (commuter application)	-	-								●								●							●										

[1] Proceed to maintenance operation at distance indicated on odometer or specified number of month, whichever comes first.
[2] See paragraph 2.2 of this section for lubricant specifications.
[3] Normal=fuel consumption more than 6 MPG (less than 39 L/100km) ; Heavy= fuel consumption between 4.7 MPG and 6 MPG (between 39 L/100km and 50 L/100km)

TABLE A

LUBRICATION AND SERVICING SCHEDULE

Odometer reading [1] (miles / km)

For higher odometer readings, repeat at the frequency interval established

LUBRICATION AND SERVICING SCHEDULE	Item	Months	6 250 / 10 000	12 500 / 20 000	18 750 / 30 000	25 000 / 40 000	31 250 / 50 000	37 500 / 60 000	43 750 / 70 000	50 000 / 80 000	56 250 / 90 000	62 500 / 100 000	68 750 / 110 000	75 000 / 120 000	81 250 / 130 000	87 500 / 140 000	93 750 / 150 000	100 000 / 160 000	106 250 / 170 000	112 500 / 180 000	118 750 / 190 000	125 000 / 200 000	131 250 / 210 000	137 500 / 220 000	143 750 / 230 000	150 000 / 240 000	185 000 / 300 000	200 000 / 320 000	225 000 / 360 000	250 000 / 400 000	275 000 / 440 000	300 000 / 500 000	500 000 / 800 000	600 000 / 960 000	LUBRICANT /FLUID [2]
			proceed to maintenance operation at																						each								
Bosch HD10 alternator brushes, check and replace if required (for applications other than commuter)	-	-																●																
07 TRANSMISSION [4]																																		
Allison transmission filled with non-TranSynd or non-TES 295 fluid – Refer to TABLE 1 in Section 07: Transmission for fluid and filter change	20																																	I
Allison transmission filled with TranSynd or TES295 synthetic fluid only, no mixture[5], with **Prognostics mode disabled** – Refer to TABLE 2 in Section 07: Transmission for fluid and filter change	20																																	H
Allison transmission filled with TranSynd or TES295 synthetic fluid only, no mixture with **Prognostics mode enabled** [5, 6] - Change fluid & filters when indicated by TRANSMISSION SERVICE indicator or 60 month (five years) whichever occurs first. In addition, change filters with every fluid change.	20	60																																H
Transmission oil cooler, replace unit if vehicle is equipped with transmission retarder	-	24																																
Volvo I-Shift Transmission **(extended oil drain)**, change fluid & filter if filled with Castrol Syntrans SAE 75W85	20	60																														•		J
Volvo I-Shift Transmission, change fluid & filter when not using Castrol Syntrans SAE 75W85	20	36																											•					J
09 PROPELLER SHAFT																																		
Universal joint and slip joint, grease fittings	18	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●								K
10 FRONT AXLE																																		
Steering knuckle (king) pins, inspect 30,000 miles	8	6					●					●					●			●					●									

---

[4] Allison Transmission recommends that customers use fluid analysis as the primary method for determining fluid change intervals. In the absence of a fluid analysis program, the fluid change interval listed in the charts above and below should be used. Change filters according to the charts above and below even is a fluid analysis shows that the fluid doesn't need to be changed.

[5] When the transmission contains a mixture of fluids (defined as the quantity of non-TranSynd/ non-TES 295 fluid remaining in the transmission after a fluid change combined with the quantity of TranSynd™ required to fill the transmission to the proper level), perform the fluid and filter change according to the non-TranSynd™/non-TES 295 intervals.

[6] Extended TranSynd™/TES 295 fluid and filter change intervals are only allowed with Allison High-Capacity filters. If using Gold Series filter, refer to TABLE 3 in Section 7 of this manual for proper fluid and filter change intervals.

TABLE A

LUBRICATION AND SERVICING SCHEDULE	Item	Months	Odometer reading [1] (miles / km) For higher odometer readings, repeat at the frequency interval established																																LUBRICANT /FLUID [2]
			6 250 / 10 000	12 500 / 20 000	18 750 / 30 000	25 000 / 40 000	31 250 / 50 000	37 500 / 60 000	43 750 / 70 000	50 000 / 80 000	56 250 / 90 000	62 500 / 100 000	68 750 / 110 000	75 000 / 120 000	81 250 / 130 000	87 500 / 140 000	93 750 / 150 000	100 000 / 160 000	106 250 / 170 000	112 500 / 180 000	118 750 / 190 000	125 000 / 200 000	131 250 / 210 000	137 500 / 220 000	143 750 / 230 000	150 000 / 240 000	185 000 / 300 000	200 000 / 320 000	225 000 / 360 000	250 000 / 400 000	275 000 / 440 000	300 000 / 500 000	500 000 / 800 000	600 000 / 960 000	
			proceed to maintenance operation at																								each								
Steering knuckle (king) pins, grease two fittings per knuckle	8	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●									K
11 REAR AXLE																																			
Differential, check oil level, add if required	17	6				●				●				●				●				●				●									E
Differential, change oil, clean breathers	17	12																●																	E
Differential, change oil, clean breathers (with full synthetic oil)	17	48																											●						E
Tag axle lever pivot, grease one fitting on each pivot	19	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●									K
12 BRAKE & AIR																																			
Air tanks, drain water from all tanks	-	12		●		●		●		●		●		●		●		●		●		●		●		●									
Accessories air filter, change filter element	2	24																●																	
Air dryer, change cartridge	13	24																●																	
Brake pads, check pad wear indicator and perform caliper slide check	-	12		●		●		●		●		●		●		●		●		●		●		●		●									
13 WHEELS, HUBS & TIRES																																			
Hub bearing inspect 30, 000 miles. See Dana Spicer Service Manual NDS Axle Range	8	12					●					●					●				●					●									
14 STEERING																																			
Steering tie rod ends, clean and grease one fitting at each end	5	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●									K
Drag link ends, clean and grease one fitting at each end	3	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●									K
Tie rod end & drag link end ball joints, inspect for corrosion		12																																	
Steering damper cylinder, grease one fitting at rod end	9	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●									K
Power steering reservoir, replace oil and filter cartridges	23	12								●								●								●									B
VIP only- Idler arm, grease fitting	-	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●									K
VIP only- Bell crank, grease fitting	-	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●									K
VIP only- Relay rod ends, grease one fitting at each end	-	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●									K
16 SUSPENSION																																			
Upper A-Arm ball joint, grease fitting	6	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●									L
22 HEATING & AIR CONDITIONING																																			
A/C compressor, check oil level, add if required	44	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●									D

TABLE A

LUBRICATION AND SERVICING SCHEDULE	Item	Months	Odometer reading [1] (miles / km) For higher odometer readings, repeat at the frequency interval established																															LUBRICANT /FLUID [2]
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			proceed to maintenance operation at																								each								
A/C receiver tank, check refrigerant level, add if required	42	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●									
Refrigerant moisture indicator, replace filter dryer unit according to moisture indicator (as needed)	43	6	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●									
HVAC air filters, clean or replace all elements	41 45	6		●		●		●		●		●		●		●		●		●		●		●		●									
Parcel rack fan air filters, clean or replace	47	6		●		●		●		●		●		●		●		●		●		●		●		●									
Condenser discharge tube, qty:2, check to see if clogged [7]	-	3																																
Front discharge tube, qty:2, check to see if clogged	-	3																																
Evaporator discharge tube, qty:6, check to see if clogged	-	3																																
Evaporator motor, condenser motor, recirculating pump drive motor, inspect brush, replace if required	-	12								●								●								●								

[7] Discharge tubes are rubber tubes located under vehicle

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1 SLIDE-OUT

1.1 INNER STOPPER

The front slide-out is equipped with six inner stoppers laid out in the following way: two stoppers on the top horizontal member of the slide-out, and two stoppers on each vertical upright, while the rear slide-out is equipped with only three stoppers (Fig. 1 & 2). The upper inner stoppers are used to provide a support to position perpendicularly the slide-out with the vehicle structure.

The side inner stoppers are used to block the extension of the slide-out. They act as ultimate physical limits but take note that when the “out limit” sensors are properly adjusted, the slide-out extension stops before the side inner stoppers reach the side structure keys (FIGURES 1 & 2).

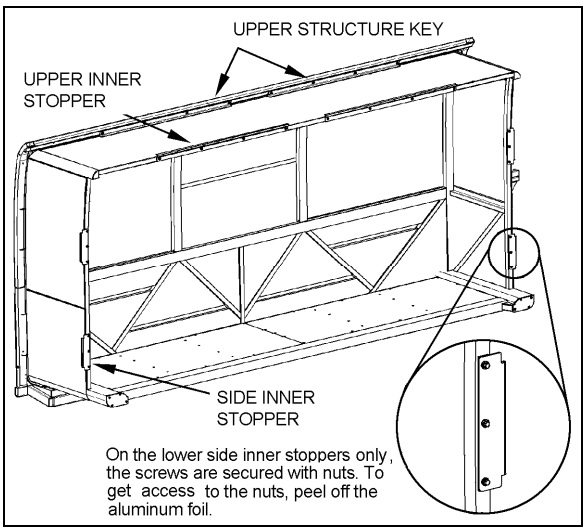


FIGURE 1 : FRONT SLIDE-OUT

1.1.1 Maintenance

Check that the inner stopper screws are tight and that no damage or deformation has taken place for both the side and the upper stoppers.

1.1.2 Adjustment

1. Adjust the side inner stoppers at 1/8" from the vehicle side structure keys, and tighten the screws. Make sure there is a minimum gap of 2mm (0.079”) between the side inner stopper and the side window pane (FIGURE 3). Use shim as required.
2. Adjust the upper structure key and the upper inner stoppers according to FIGURE 4 with the seal deflated. When inflating, the seal presses the roof structure upward and at that moment, the upper inner stopper comes into contact with the upper structure key

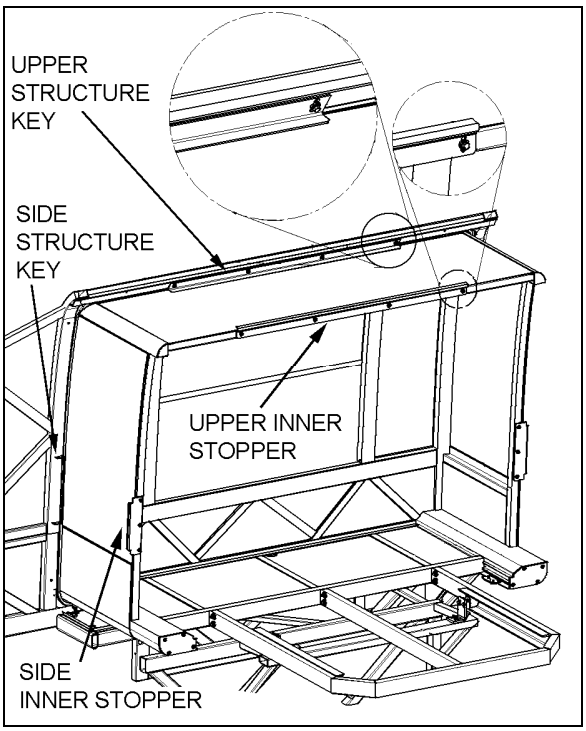


FIGURE 2 : REAR SLIDE-OUT

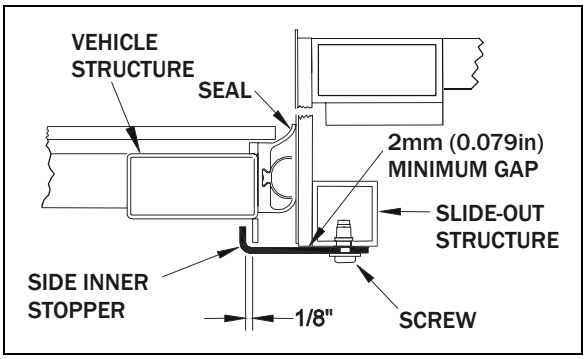


FIGURE 3 : SIDE INNER STOPPER ADJUSTMENT

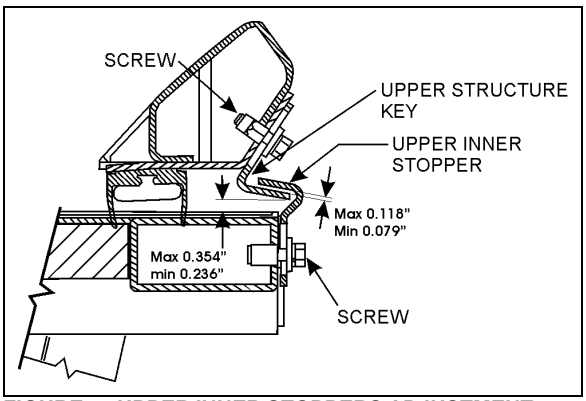


FIGURE 4 : UPPER INNER STOPPERS ADJUSTMENT

1.2 "IN LIMIT" STOPPER

Each slide-out has four "in limit" stoppers. Two "in limit" stoppers are mounted on the exterior extrusion at the top of the slide-out (FIGURE 6) and two other "in limit" stoppers are mounted under the slide-out, next to the rail (FIGURE 5). These stoppers are use to position the outer face of the slide-out flush with the vehicle body when retracted.

1.2.1 Maintenance

Check that the "in limit" stoppers are clean and that there is no foreign matter accumulated between the stopper and their bearing surface. Check that the screws and set screws (where applicable) locking the stoppers in proper position are tight.

1.2.2 Adjustment

NOTE
To properly adjust the "in limit" stoppers, the slide-out system must be turned off to prevent the "in limit" sensors from stopping the slide-out movement before having the "in limit" stoppers contacting their bearing surface.

1. Extend the slide-out partially.
2. Set the ignition switch to the OFF position.
3. To adjust the lower "in limit" stoppers, loosen the set screw and then rotate the stopper CW or CCW to move it back or forward depending on the required adjustment. To adjust the upper plastic "in limit" stoppers, add or remove shims as required between the stopper and the extrusion.
4. Using the manual override procedure (section 18), move the slide-out up to its full "in" position.
5. Using a straight edge, check if the outer face of the slide-out is flush with the vehicle body with the stoppers contacting their bearing surface. Readjust the stoppers if necessary.
6. Readjust the "in limit" sensor.

NOTE
To make sure that the lower "in limit" stoppers are contacting their bearing surface (the acetal plastic blocks) when the slide-out is closed, put white paint on the "in limit" stopper before and check if the acetal plastic blocks are marked with paint.

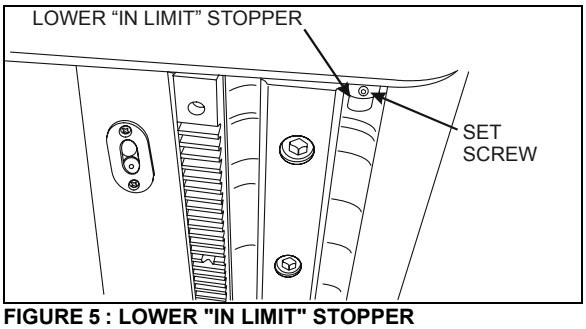


FIGURE 5 : LOWER "IN LIMIT" STOPPER

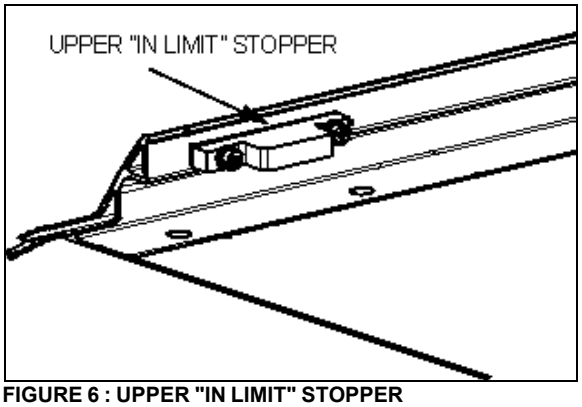


FIGURE 6 : UPPER "IN LIMIT" STOPPER

1.3 EXTERIOR EXTRUSION

The exterior extrusion function is to provide a leaning surface for the inflatable seal. When inflating, the seal leans against the extrusion and presses the roof structure upward until it rests on the inner side of the extrusion.

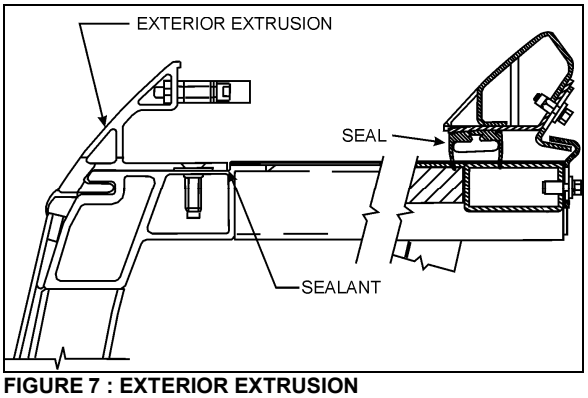


FIGURE 7 : EXTERIOR EXTRUSION

Maintenance

Inspect the exterior extrusion for any deformation or deterioration. Check that the screws are tight. Inspect the sealant condition on screw head and between the extrusion and the vehicle structure, and also at both ends of the extrusion. If needed, clean old sealant and replace with Sika 221 sealant or equivalent product.

2 SECURITY PIN

During normal ride, the slide-out cannot extend by itself because the 740:1 ratio speed reduction worm gear type gearbox system is not reversible, the output shafts are self-locking. The security pin purpose is to lock the slide-out in retracted position if an accident occurs. It is built to stand a great lateral acceleration of the slide-out.

The system consists of a stainless steel pin connected to a single action/spring return pneumatic cylinder (FIGURE 8). The pin engages in the slide-out receptacle with releasing of the parking brake. A knocking sound may be heard at this moment. An O-ring is located at the base of the pin housing to reduce knocking when the pin retracts. The lower hole on the pin housing permits water to drain. The upper hole permits to insert a small screwdriver to prevent the pin from rotating when the air cylinder has to be removed.

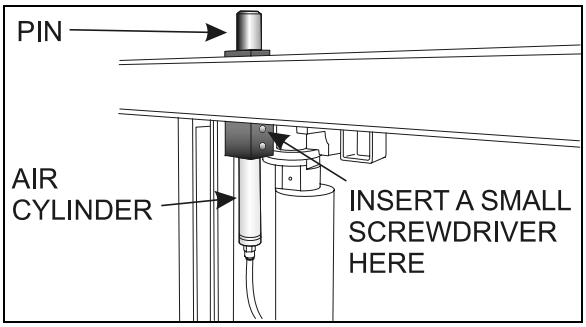


FIGURE 8 : SECURITY PIN AIR CYLINDER REMOVAL

2.1 MAINTENANCE

Inspect air cylinder and fitting for air leaks. Periodically, check that the pin retracts and engages in the receptacle as it should when the parking brake is applied or released. To do slide-out, the slide-out must be in its full “IN” position with the engine running. If the pin produces excessive knocking when it engages with releasing of the parking brake, reduce air cylinder speed by adjusting the air flow regulator on the pneumatic control panel (FIGURE 29, item 11).

2.2 AIR CYLINDER REPLACEMENT

1. Assure the parking brake is applied.

2. Disconnect the cylinder air tubing from the 2nd baggage compartment (front slide-out) or under the bed structure (rear slide-out).

3. Using a wrench at its lower end, unscrew the air cylinder from the pin housing.

4. Insert a small screwdriver through the pin and housing to prevent rotation of the pin an then, unscrew the cylinder rod from the pin.

5. Transfer the fitting on the new cylinder. Place Teflon on threads.

6. Cylinder installation is like removal but in reverse order.

3 ROOF REINFORCING ROD

CAUTION

The front slide-out roof reinforcing rod may have to be adjusted after a load variation inside the vehicle or on the top of the vehicle.

CAUTION

Always lock the turnbuckle using the jam nut to prevent loosening.

The roof reinforcing rod is located on the upper horizontal member of the front slide-out opening and is welded on the roof arches (FIGURE 9).

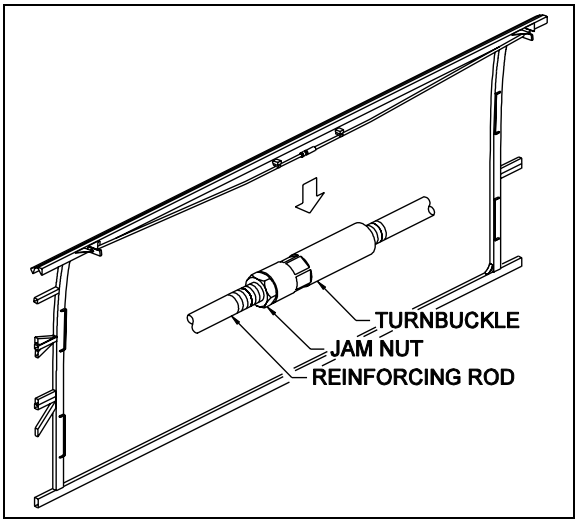


FIGURE 9 : FRONT SLIDE-OUT ROOF REINFORCING ROD

This rod allows an adjustment between the slide-out horizontal member and the roof. When screwing the turnbuckle, the roof is moved upward, and vice versa. Use this rod to adjust the horizontal member parallel to the slide-out. A member not parallel with the slide-out may

cause the inflatable seal to leave the wiper seal or may reduce the inflatable seal and wiper seal efficiency.

4 RACK

Slide-out movement is made by a system of racks and pinions. There are two racks on each slide-out.

4.1 MAINTENANCE

Once a year, check the racks for broken or worn tooth, especially the front slide-out racks. Also, check the rack fastening hole teeth that are weaker and might break (FIGURE 10). Replace the racks if excessive wear is present. Clean racks from sand or other debris. Check that the racks are properly secured. Check the backlash between the gear and the rack. Excessive backlash indicates rack wear.

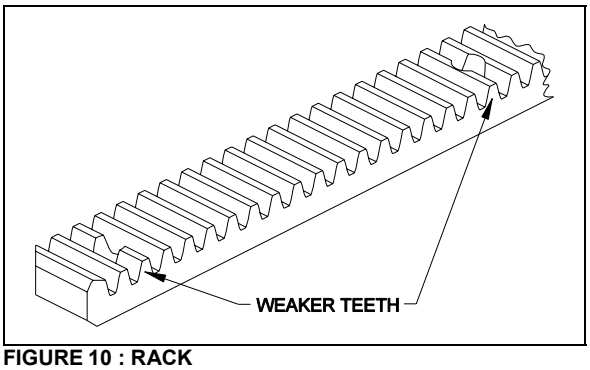


FIGURE 10 : RACK

4.2 FRONT SLIDE-OUT RACK REPLACEMENT

1. Remove the slide-out from the vehicle (removal must be performed according to the Slide-Out Removal Procedure. Ask to your Prevost service representative).
2. From under the slide-out, unscrew all the rack screws and remove the rack.
3. Install a new rack. Tighten the screws to a maximum torque of 2 ft-lbs. Use Loctite™ 242 or equivalent product on threads.
4. Reinstall the front slide-out inside the vehicle.

⚠ CAUTION

The counterboring required for recessed screw heads reduce plastic thickness. Do not torque higher than specified.

4.3 REAR SLIDE-OUT RACK REPLACEMENT

1. Using the slide-out handheld control or the manual override procedure (section 18, if using the manual override procedure, do not forget to deflate the inflatable seal completely), extend the slide-out about one foot.
2. From outside, unscrew and remove only the first two screws of the rack to be changed.
3. Using the manual override procedure (section 18) only, retract the slide-out to its fully closed position.
4. Loosen the pinion keyless bushing of the rack to be changed.
5. From under the slide-out, unscrew all the rack screws and remove the rack.
6. Install a new rack between the slide out structural rack seat and the pinion. Tighten the screws to a maximum torque of 2 ft-lbs. Use Loctite™ 242 or equivalent product.

⚠ CAUTION

The counterboring required for recessed screw heads reduce plastic thickness. Do not torque higher than specified.

7. Tighten the pinion keyless bushing as described in section 5.4.
8. Using the slide-out manual override procedure only, extend the slide-out about one foot.
9. Tighten the two remaining crews to a maximum torque of 2 ft-lbs. Use Loctite™ 242 or equivalent product.
10. Using the slide-out handheld control switch or the manual override procedure, retract the slide-out to its fully closed position.
11. Re-inflate the air seal at 10 psi.

5 PINION

⚠ CAUTION

Make sure all keyless bushings are tightened to 125 lb-ft before moving the slide-out. Refer to section 5.4 for torque wrench settings. A lower torque value may cause the bushing to slip on the shaft, and a higher torque value may break the bushing.

5.1 PINION AND KEYLESS BUSHING POSITIONING

For proper functioning, respect the positioning shown on the following figure.

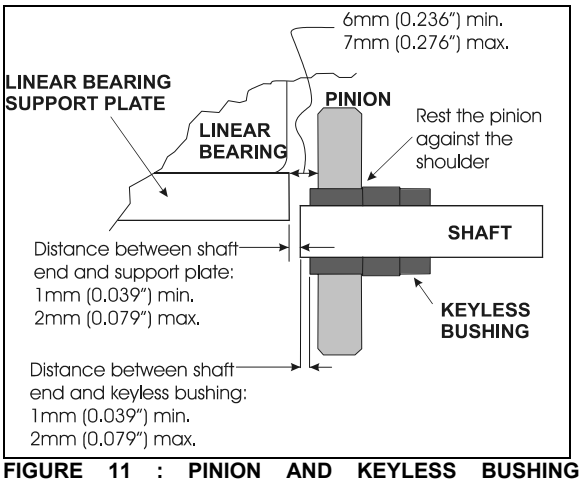


FIGURE 11 : PINION AND KEYLESS BUSHING POSITIONING

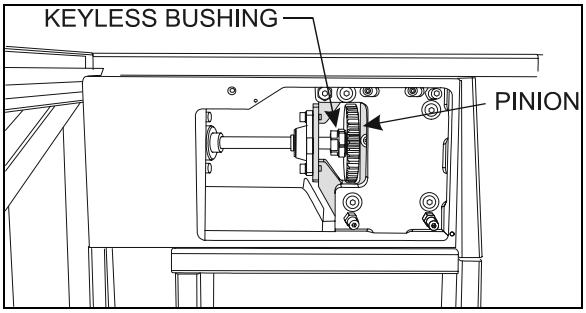


FIGURE 12 : PINION AND KEYLESS BUSHING AS SEEN FROM EVAPORATOR COMPARTMENT

5.2 FRONT SLIDE-OUT SHAFT PINION REPLACEMENT

⚠ CAUTION

Before reinstalling the pinion, clean the following surfaces with alcohol to prevent slippage.

- Pinion bore;
- Keyless bushing I.D. and O.D.;
- Shaft.

Before proceeding with the front slide-out shaft pinion replacement, check the following conditions:

- The locking collars located on the side of the pinion being replaced are disengaged;
- The drive motor/gearbox assembly is removed (see section 7.2);

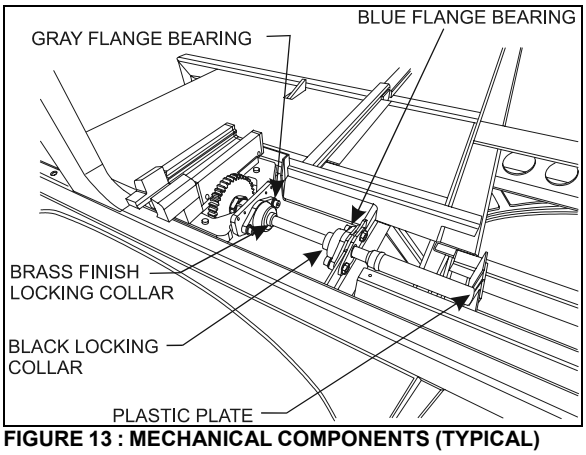


FIGURE 13 : MECHANICAL COMPONENTS (TYPICAL)

1. Loosen the keyless bushing (see section 5.4) of the pinion to be replaced. Slide the pinion and its bushing out of the shaft. Check the keyless bushing condition and replace if needed.

NOTE

If necessary, loosen the blue and gray flange bearing to move the pinion away from the rack.

2. Assemble new pinion on the keyless bushing and then slide on the shaft. Do not tighten the bushing at this moment.
3. Properly position the shaft end in relation to the linear bearing support plate (See FIGURE 11) and then tighten the locking collars to maintain the shaft in that position.
4. Position pinion and keyless bushing as shown on FIGURE 11 and tighten the keyless bushing as described in section 5.4.
5. Reinstall the drive motor/gearbox assembly.

⚠ CAUTION

Make sure the keyless bushing is tightened to 125 lb-ft before moving the slide-out. Refer to section 5.4.1 for torque wrench settings.

5.3 REAR SLIDE-OUT SHAFT PINION REPLACEMENT

The procedure is similar to the front slide-out shaft pinion replacement. Gain access to the mechanism from under the bed structure. Refer to section 5.2.

5.4 KEYLESS BUSHING

The keyless bushings need a specific tightening torque value to ensure proper pinion transmitting torque. They also need specific tools to be tightened.

To tighten or loosen the keyless bushing, use those specific tools:

- crowfoot wrench 1 ½";
- torque wrench;
- combination wrench 1 ¾";
- pipe wrench;
- drive extension 5";
- socket 1 ½".

5.4.1 Installation

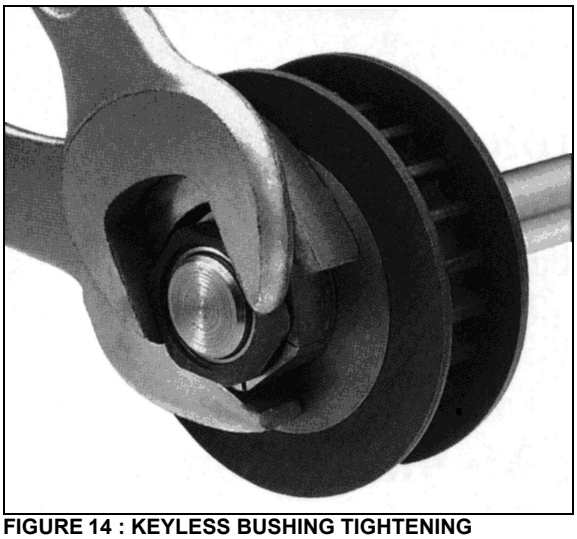


FIGURE 14 : KEYLESS BUSHING TIGHTENING

To tighten the keyless bushing, use a special open-end wrench to retain the yellow part and another wrench to tighten the black part. Figure 20 shows how to tighten the keyless bushing. When tightening, make sure the pinion does not move or rotate.

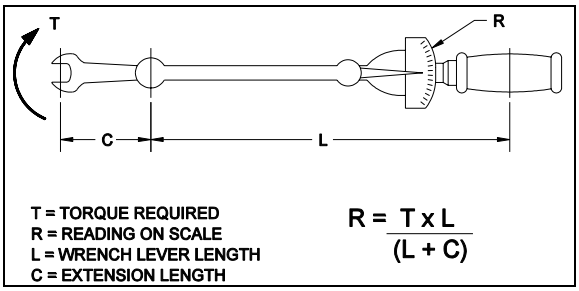


FIGURE 15 : TORQUE WRENCH FORMULA

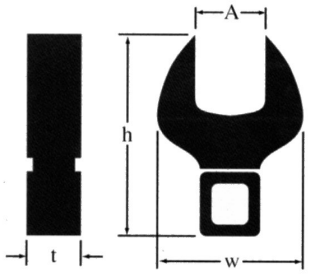
⚠ CAUTION

Make sure all keyless bushings are tightened to 125 lb-ft before moving the slide-out. A lower torque value may cause the bushing to slip on the shaft, and a higher torque value may break the bushing. The torque may need to be recalculated depending of the wrench size. Refer to FIGURE 15 for wrench size compensation.

Take note that when the keyless bushing nut is tightened, the pinion moves about 1/16" to 3/32" toward the slide-out center.

NOTE

On the front slide-out, the driver side keyless bushing is not accessible for tightening or removal unless you remove the front left wheel. If the slide-out has been removed, this keyless bushing should be tightened before reinstalling the slide-out.



Style C
Installation Nut

WRENCHES FOR INSTALLATION

Fenner Drives offers a complete line of high-quality crowfoot wrenches for installation and to provide counter-torque. These wrenches are much narrower than earlier designs and are specifically for use with Trantorque GT units. It is recommended that both wrenches be used when installing a Trantorque GT unit.

1/2" SQUARE DRIVE

Shaft Size	Part Number	Wrench Style	Dimensions (inches)			
			A	h	w	t
13/16 to 1	6202990024	C	1-1/2	3.44	2.75	0.75

INSTALLATION INSTRUCTIONS

A Trantorque GT Keyless Bushing offers flexible and easy installation while providing exceptional holding power. To ensure a Trantorque GT unit performs as specified, it must be installed properly.

Warning: Use no lubricants in this installation.

1. Shaft and component bore must be within ±0.003"(±0.08mm) [±0.0015"(±0.04mm)Mini Series] of stated bore diameter and must have a surface finish of 32-125 Ra (roughness average). If the surface finish is outside these specified values, consult Fenner Drives.

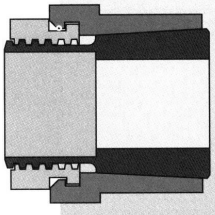
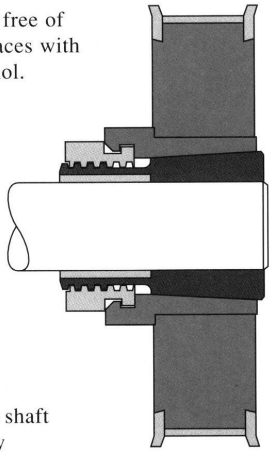


Figure 1

2. Both shaft and component bore must be completely free of paint, grease, oil, and dirt. If necessary, clean the surfaces with a non-petroleum based solvent, such as isopropyl alcohol.

Warning: Do not lubricate the Trantorque GT bushing or shaft. The use of any lubricant on the contact surfaces could result in bushing failure and will void all warranties.



3. Insert the Trantorque GT unit into the component to be mounted, making sure the mating hub is flush against the shoulder at the hex flats.

4. Position the assembly at the desired location on the shaft and hand-tighten the nut (clockwise) until the assembly becomes snug on the shaft.

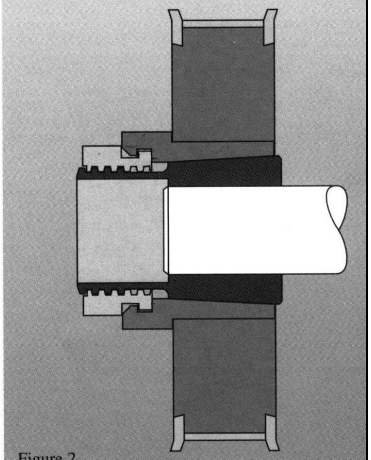


Figure 2

Warning: Do not hammer or use any type of impact to force the Trantorque GT assembly along the shaft.

Warning: The shaft must fully engage the shaft gripping area (Figure 1) of the Trantorque GT unit. Figure 2 illustrates minimum shaft engagement.

5. Using a torque wrench, tighten the nut to the proper installation torque. See table for torque value. (Note: Fenner Drives has available crowfoot wrenches for square drives in sizes from 1/2" to 3-1/2".) The hex flats on the outer ring are provided for counter-torque, eliminating the need to hold the component or shaft while applying installation torque.

Note: At full installation torque, the assembly will have moved approximately ±0.075"(±1.9mm)[±0.045"(±1.1mm)Mini Series] axially along the shaft away from the nut. If axial position is critical it may be necessary to loosen the nut and reposition the assembly.

Warning: Over-tightening the nut could damage the Trantorque GT unit and/or the mounted component.

Do not use an impact wrench in the installation.

Installation Torque on Nut

	Inch Pound System		Metric System	
	Shaft Size	In. Lbs.	Shaft size	N-m
MINI SERIES	3/16–1/4	125	5–6mm	14.1
	5/16–3/8	150	7–9mm	17.0
	7/16–1/2	175	10–12mm	19.8
	9/16–5/8	200	14–16mm	22.6
	3/4	700	17mm	80.0
STANDARD SERIES	5/8–3/4	1200	15–19mm	136
	13/16–1	1500	20–25mm	170
	1-1/16–1-1/4	2000	28–32mm	225
	1-5/16–1-1/2	2300	34–38mm	260
	1-9/16–1-3/4	2800	40–42mm	316
	1-13/16–2	4900	45–50mm	554
LARGE SERIES	2-1/16–2-1/4	5300	55mm	600
	2-5/16–2-1/2	5600	60mm	635
	2-9/16–2-3/4	6000	65–70mm	680
	2-13/16–3	6600	75mm	750

FIGURE 16 : KEYLESS BUSHING INSTALLATION INSTRUCTIONS

6 ELECTRIC MOTOR

The power is supplied by a 24V 1/3 HP electric motor coupled with a speed reduction gearbox. Opposite to the gearbox, the motor is equipped with a 3/8 hexagonal socket shaft extension permitting to move the slide-out without using the handheld control. This is very useful when moving the slide-out very slowly is required like during the inner stoppers adjustment, the tilt adjustment or the 2" inside retraction. See section 18 for the manual override procedures.

⚠ CAUTION

When moving the slide-out with a cordless power drill as described in the manual override procedure, be careful as the slide-out approaches its opened or closed position, in order not to overload the mechanism.

6.1 MAINTENANCE

Inspect the electrical connections and their watertightness. Check that the mounting bolts are tight (Fig. 18).

6.2 REPLACEMENT

1. The slide-out must be retracted.

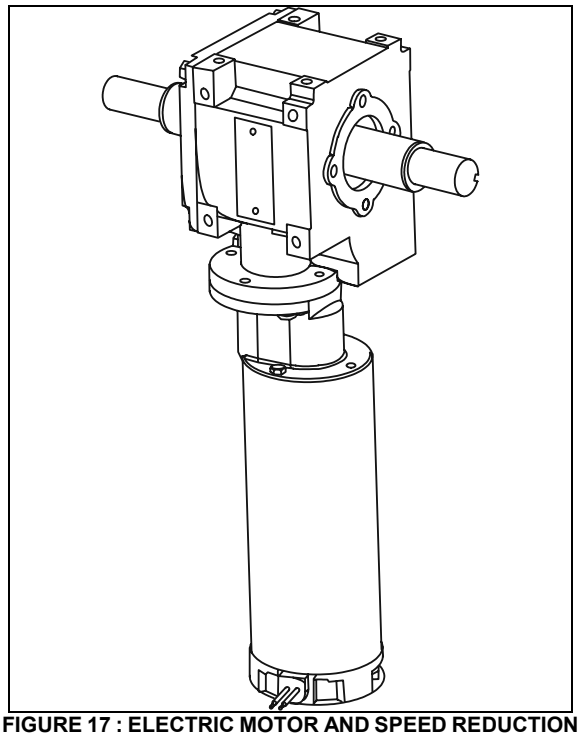


FIGURE 17 : ELECTRIC MOTOR AND SPEED REDUCTION GEARBOX

2. Unplug the electric cable connector.
3. Remove the motor from the gearbox.
4. Fasten the new motor to the gearbox using screws.
5. Re-connect the electric cable connector.

7 SPEED REDUCTION GEARBOX

The speed reduction gearbox used is a helical worm gear type. This gearbox has a 2-stage 740:1 ratio and the output shafts are self-locking. Keys on output shafts are glued into keyseats.

7.1 MAINTENANCE

Inspect the gearbox to check if there is any leakage or backlash in the box. Replace the gearbox if excessive wear is present. Check that all bolts are tight.

The gearbox is lubricated for life and the oil should not have to be changed.

7.2 GEARBOX REPLACEMENT

1. The slide-out must be retracted.
2. Disengage the shafts jaw couplings (refer to section 8: JAW COUPLING).
3. Remove the 4 cap screws securing the drive motor/gearbox assembly and dismount the assembly (See figure 18).
4. Remove the gearbox from the motor and install the new one.
5. Reinstall the drive motor/gearbox assembly on the vehicle mounting bracket. Tighten mounting bolts to a torque of 18 lbf-ft in a criss-cross patern.

⚠ CAUTION

To prevent damaging threads, use your fingers to drive the bolts into the aluminum gearbox housing mounting holes.

6. Reinstall the jaw couplings.

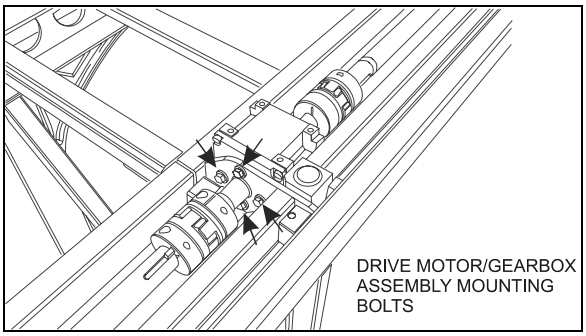


FIGURE 18 : DRIVE MOTOR/GEARBOX ASSEMBLY MOUNTING BOLTS

8 JAW COUPLING

8.1 MAINTENANCE

Inspect the jaw couplings to check if there is backlash between the key and the keyway. Also, check the spider condition. Check that the clamping screws are tight.

8.2 REPLACEMENT & ADJUSTMENT

1. The slide-out must be retracted.
2. Disengage the jaw coupling: loosen the clamping screw on each clamping hub. If required, rotate the motor shaft extension as described in the manual override procedure (section 18) to get to the clamping screws.
3. Separate both clamping hubs.

NOTE
It may be necessary to loosen the blue flange bearings to move the shaft out of the way.

4. Clean and degrease the hub bore and the shaft.
5. Push the new clamping hubs onto the shaft (pinion side).
6. Install a clamping hub on one of the gearbox shaft (opposite side of gearbox mounting bolts) flush with the shaft extremity (FIGURE 19). Tighten the clamping screw to a torque of 18 lbf-ft.
7. Install the second clamping hub on the gearbox shaft. Position the clamping hubs so that they are flush with the shafts extremity (FIGURE 19).

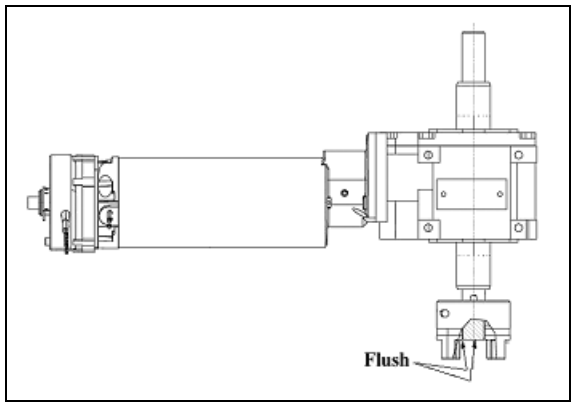


FIGURE 19 : CLAMPING HUB POSITION ON GEARBOX SHAFT

8. Reconnect the clamping hubs with the spider. Leave a gap of 20mm (0.787inch) between each clamping hubs as shown on FIGURE 20. Use the motor hexagonal socket output shaft to align the keyways.
9. Tighten clamping screws to a torque of 18 lbf-ft.

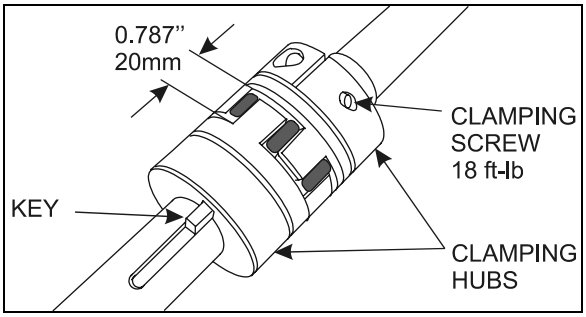


FIGURE 20 : JAW COUPLING

9 FLANGE BEARING

There are two different types of flange bearing on the slide-out mechanism (FIGURE 13). Their purpose is to maintain the shaft in position while permitting rotation. The gray flange bearings are fixed to the linear bearing support plate and are not adjustable. The blue flange bearings are fixed to a support with oblong holes permitting to raise or lower the flange bearing as the linear bearing support plate level is being adjusted.

The flange bearings are pre-lubricated and no subsequent lubrication is required due to the very low extending and retracting speed of the slide-out system.

10 LOCKING COLLAR

The locking collar locks the shaft and the flange bearing together using friction. Once locked, it permits no axial translation of the shaft and prevents rotation of the shaft into the flange bearing bore.

10.1 INSTALLATION

Slide the locking collar along the shaft up to the flange bearing (FIGURE 13). Turn the locking collar clockwise while maintaining it pressed against the flange bearing. Knock the collar with a punch to lock it in place, there is a cavity on the collar made for that purpose. Tighten the set screw.

To remove, loosen the set screw and release the locking collar using channellock pliers or a small pipe wrench.

11 LINEAR BEARING

11.1 MAINTENANCE

Make every effort not to allow dust and foreign objects to enter inside the linear bearing.

The linear bearings are pre-lubricated and no subsequent lubrication is required due to the very low demanding use of the slide-out system.

11.2 REPLACEMENT & ADJUSTMENT

1. Remove the slide-out from the vehicle (removal must be performed according to the Slide-Out Removal Procedure. Ask your Prevost service representative).
2. Disconnect the jaw coupling on the side of the linear bearing being replaced (refer to section 8).
3. Dismount the blue flange bearing.
4. From the mechanism access panel, remove the retaining screws A, B, C & D (see FIGURE 22).
5. Now, you have access to the linear bearing mounting bolts if you turn its support up side down. Dismount the linear bearing and install the new one.
6. Tighten the mounting bolts in a criss-cross pattern to a torque of 60 ft-lb.
7. Reinstall the support plate, retaining screws, blue flange bearing and reengage the jaw coupling. Refer to the specific procedures.

11.3 LEVEL & TILT ADJUSTMENT

Leveling of the slide-out is done by changing the linear bearing support plate height using the leveling screws 1, 2, 3, 4 (FIGURE 22). When proper level is attained, the retaining screws A, B, C & D maintain the support plate seated on the leveling screws. Also, the retaining screws prevent the slide-out from tipping inside the vehicle when it is retracted.

The slide-out is slightly tilted. When retracting, the upper "in limit" stoppers touch first the vehicle structure, followed by the lower "in limit" stoppers. Tilt adjustment is done by changing the linear bearing support plate inclination using the leveling screws 1 & 2 as pivot and 3 to adjust the angle (FIGURE 22).

11.3.1 Procedure

NOTE

*For the **front slide-out**, the front linear bearing leveling screws are accessible from the access panel located over the front wheel while the rear linear bearing leveling screws are accessible from the access panel in the evaporator compartment. For the **rear slide-out**, access the linear bearing from under the bed structure or the radiator compartment.*

WARNING

The slide-out must be retracted when the level and tilt adjustment is performed.

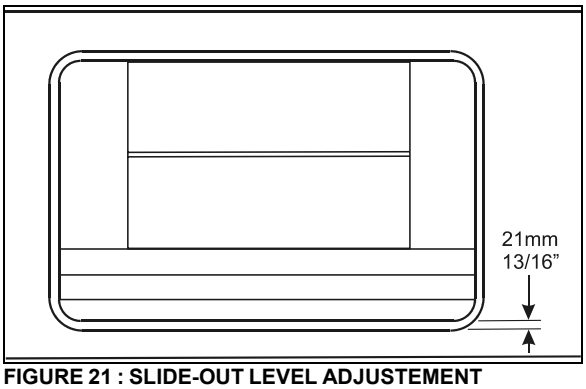


FIGURE 21 : SLIDE-OUT LEVEL ADJUSTEMENT

Before proceeding with the level and tilt adjustment, check the following conditions:

- The slide-out is retracted;
- The 2 lower “in limit” stoppers are perfectly adjusted, that means that the lower edge of the slide-out outer panel is flush with the vehicle body when retracted;
- The 2 upper “in limit” stoppers are removed from the slide-out (see Section 1.2).

1. Loosen the blue flange bearings mounting screws (FIGURE 13).
2. For front slide-out only, loosen the two plastic plates mounting screws along the shafts (FIGURE 13).
3. With the lower edge of the slide-out outer panel flush with the vehicle body, adjust the slide-out level. The distance between the top of the horizontal member under the slide-out and the slide-out under panel must be 21mm (13/16” approximately).

WARNING

Never unscrew completely retaining screw A, B, C, D or the slide-out may tip inside.

To raise the linear bearing support plate, turn levelling screw 1 & 2 clockwise. Slightly and gradually, loosen the retaining screws A & B as the support plate elevates, but keep the retaining screws tighten.

To lower the linear bearing support plate, turn screw 1 & 2 counterclockwise. As the support plate goes down, maintain the retaining screw A & B tighten.

4. Loosen retaining screws C & D. Unscrew leveling screw 4. Now, the support plate should be resting on levelling screw 1, 2 & 3.
5. Using levelling screw 3, adjust the tilt in order to have the top of the slide-out recessed between 5mm and 10mm (7/32" and 3/8") (see FIGURE 23).
6. When proper tilt is attained, tighten leveling screw 4 so that it comes into contact with the support plate.
7. Loosen slightly levelling screw 3 and then tighten it so it is perfectly in contact with the support plate. Make sure screws 1, 2, 3 & 4 are in contact with the support plate.
8. Loosen retaining screw A & B.
9. Using a crisscross pattern, tighten progressively (3 rounds) the retaining screw A, B, C & D to a torque of 50 ft-lb.
10. Assure that the levelling screw 1, 2, 3 & 4 are firmly leaning on the support plate and then firmly tighten the jam nuts.
11. Verify that the tilt is still properly adjusted (between 7/32" and 3/8").

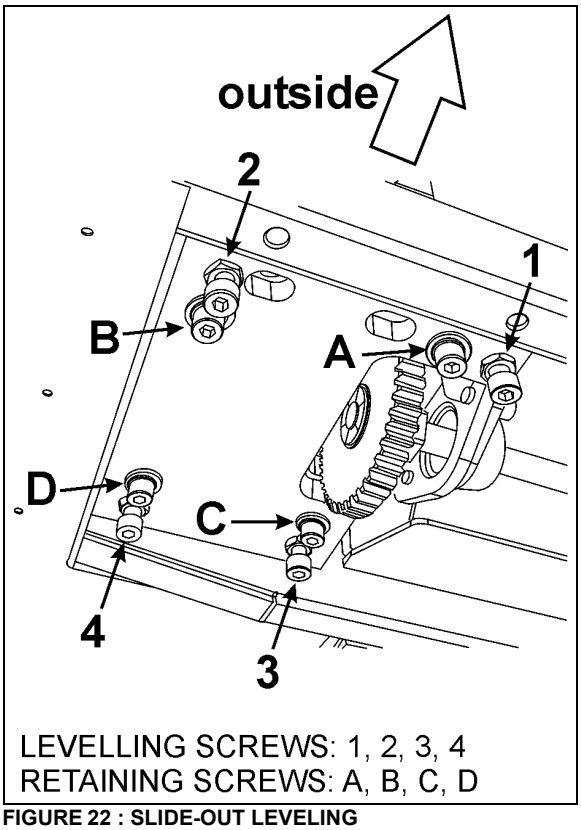


FIGURE 22 : SLIDE-OUT LEVELING

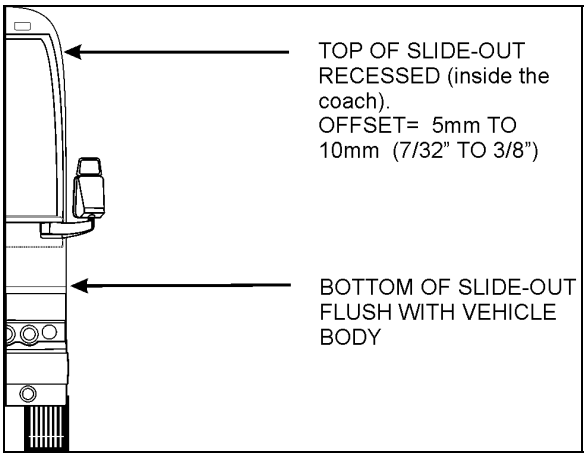


FIGURE 23 : TILT ADJUSTMENT

12 RAIL

Rail and linear bearing system provide precise frictionless linear movement together with high load carrying capacity and high stiffness. These standardized equipments are fully interchangeable.

To prevent corrosion, an electrolytic black film treatment is performed to the rail. Do not strike the rail with metal tools, this could damage the treatment.

After the rail is mounted to the slide-out base, a cap is used to cover the bolt hole to prevent foreign matters from clogging up the hole or from entering into the ball slide. The cap for the bolt hole is made of synthetic resin which is superb in its resistance to oil and wear.

12.1 MAINTENANCE

Check that all the caps for the bolt hole are present. Missing caps must be replaced. To insert a cap into the rail bolt hole, use a flat tool. Pound the cap gradually until its height becomes flush with the rail top face.

Clean accumulated dirt from the rails with a soft cloth.

12.2 REPLACEMENT

1. Remove the slide-out from the vehicle (removal must be performed according to the Slide-Out Removal Procedure. Ask to your Prevost service representative).
2. Remove the bolt hole cap covers. To do so, pierce a hole in the center and hook them out. They will not be reusable.
3. Remove the rail mounting bolts.
4. Wipe off the rust preventive oil applied to the new rail. Remove burrs and small bumps on the slide-out mounting face with an oilstone.
5. Carefully place the rail on the bed on its mounting face.

NOTE
The rail is bolted to a flat bar on which weldnuts are mounted. The flat bar is inserted in the slide-out lower body extrusion and can be removed through the end cap (FIGURE 24).

6. Adjust the flat bar position to align the weldnuts with the rail mounting holes.
7. Temporarily tighten the bolts.
8. Adjust the rail position with as per FIGURE 24. For each rail, make sure the gap is the same both side of the rail.
9. For final tightening of the bolts, tighten on either end of the rail and then start to the other end. Tighten to a torque of 95 ft-lbf. Use blue Loctite ™ on threads.
10. Cap the bolt holes.

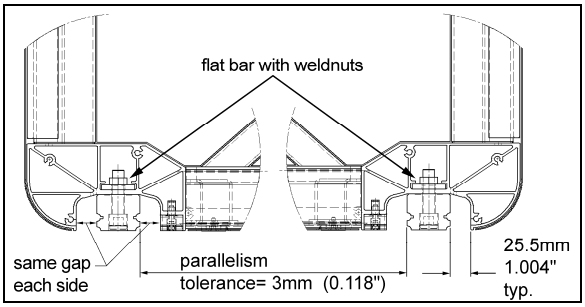


FIGURE 24 : RAIL POSITIONING

13 ACETAL PLASTIC BLOCKS

Three different acetal plastic blocks are installed next to each linear bearing to prevent dirt and foreign matter from entering inside the vehicle. They also serve as bearing surface for:

1. The inflatable seal each side of the rail.
2. The “in limit” stoppers.

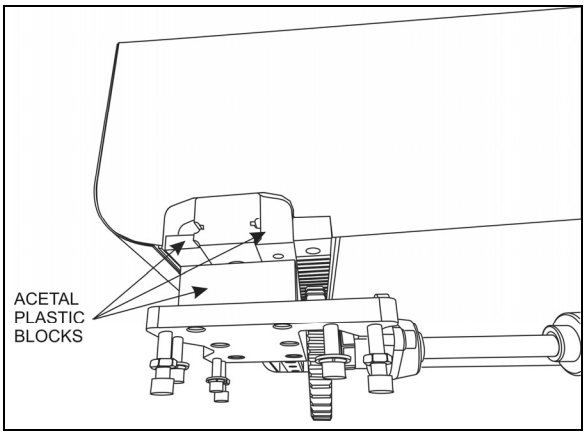


FIGURE 25 : ACETAL PLASTIC BLOCKS

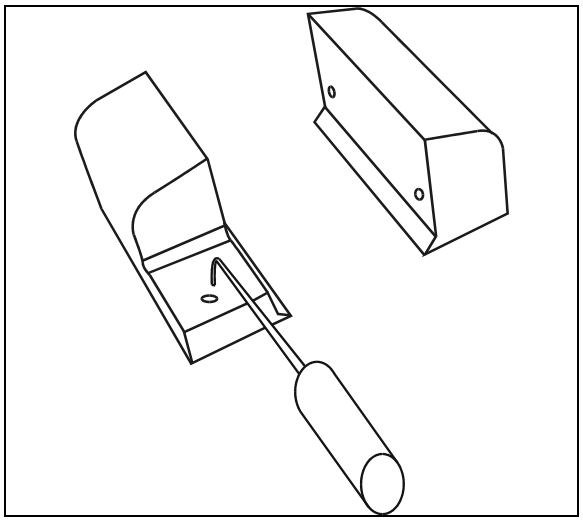


FIGURE 26 : REMOVE THE UPPER ACETAL PLASTIC BLOCKS WITH A PICKING TOOL

13.1 REMOVAL / INSTALLATION

1. Gain access to the linear bearing support plate.
2. From under the support plate, remove the acetal plastic block mounting screws (see the oblong holes on FIGURE 22).
3. Remove the 2 upper acetal plastic blocks. They have holes so they can be removed with a picking tool (FIGURE 26) from outside the vehicle. If the acetal plastic blocks are too hard to reach, slightly extend the slide-out, the movement of the slide-out should bring them out.
4. To remove the lower acetal plastic block, gain access to the compartment under it. Slide the acetal plastic block toward the center of the slide-out. Proceed the same way to reinstall it.
5. Reinstalling the upper acetal plastic blocks. Fold the wiper seal toward the outside with a flat tool to ease installation (FIGURE 27). Tighten the mounting screws to a torque of 7 ft-lb. Leave no gap between the blocks and the rail.

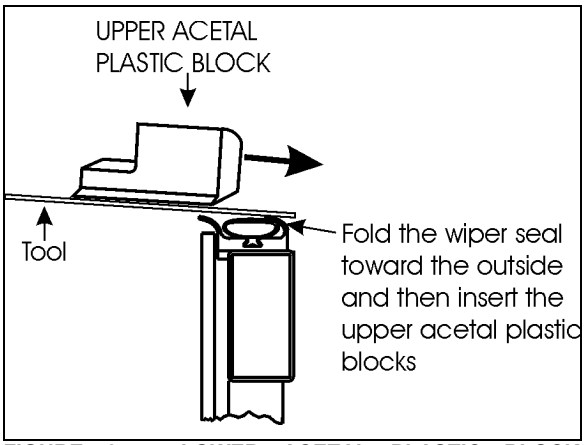


FIGURE 27 : LOWER ACETAL PLASTIC BLOCK INSERTION

14 SLIDE-OUT PNEUMATIC SYSTEM

The slide-out is controlled by a pneumatic and electrical system. Mainly, the pneumatic system consists of electrically operated valves that control slide-out components and safety operations.

14.1 DESCRIPTION

AIR PRESSURE INLET VALVE

The slide-out air pressure comes from the air pressure inlet valve on the pneumatic panel in the front service compartment (FIGURE 28).

INFLATABLE SEAL VALVE

The inflation and the deflation of a seal are done using a 5-port 2-position manifold valve with two solenoids. One solenoid is used for inflating of the seal and the other for deflating of the seal. When one of the solenoids is activated (seal deflating valve for example), the valve will keep its state even if the solenoid is deactivated. The inflating valve solenoid is activated to re-inflate the seal when the slide-out reaches its inner or outer limit. The inflatable seal pressure is set to 10 psi and in full “IN” or full “OUT” position, this pressure is continuously applied to the seal as long as the accessory air tank (which supply the slide-out) is not empty.

VACUUM GENERATOR

A vacuum generator using Venturi principle is controlled by a 5-port 2-position manifold valve and is used to evacuate the air faster from the seal and to ensure that the seal surface does not stay in contact with the slide-out.

The vacuum generator valve is activated simultaneously with seal deflating valve solenoid for 10 seconds. A pressure transducer will detect a seal, vacuum valve or generator failure if -5 psig is not reached after the 10 seconds delay. In that situation, an error code will be stored in the MCD (message center display). In normal operating condition, -5 psig is a necessary condition to consider the seal as deflated.

NOTE
When air pressure is relieved using the shut-off valve, the normal extending and retracting operation cycle is disabled, because the pressure transducer reads 0 psig and that is higher than -5 psig (vacuum). For that reason the slide-out cannot be moved with the handheld control.

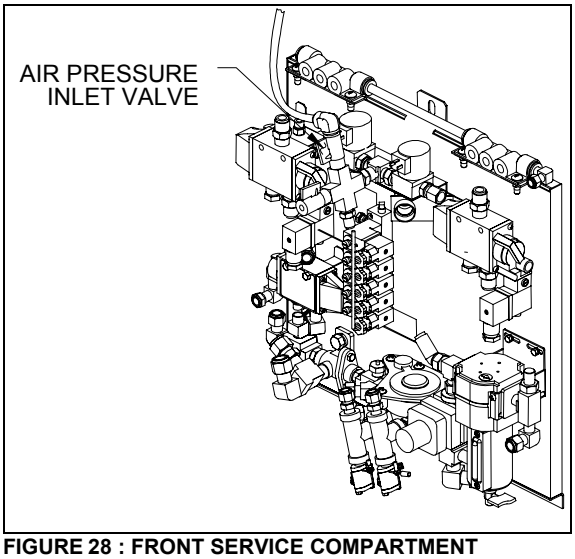


FIGURE 28 : FRONT SERVICE COMPARTMENT

14.2 MAINTENANCE

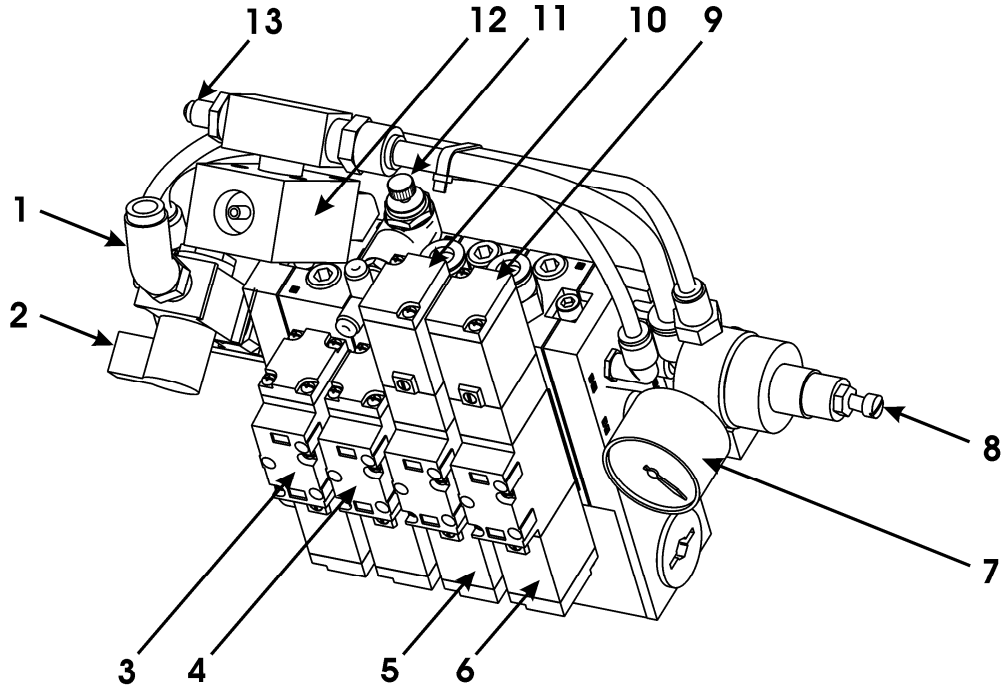
COMPRESSED AIR LINE

Inspect all compressed air line tubing for cut, swelling, kink or other damage or deterioration. Inspect the pneumatic fittings and components for any leak. The slide-out air supply is connected to the accessory air tank and the maintenance is specified in the “brake and air system” section from the Prevost maintenance manual.

INFLATABLE SEAL CIRCUIT

The efficiency of the seal could be affected by impurities, such as white powder in the pneumatic control valve. It is recommended to inspect the inflatable seal control components once a year to prevent malfunction. In this case, remove the seal valves and clean the interior valve components using a compressed air nozzle. Do the same thing with the vacuum generators.

The inflatable seal pressure must be set from 7 to 10 psi maximum. It is recommended to check the inflatable seal pressure once a month to ensure sealing efficiency and prevent any infiltration from outside.



1- AIR SUPPLY
2- RELIEVING SHUT-OFF VALVE & HANDLE
3- SEAL VACUUM VALVE
4- SECURITY PIN VALVE
5- FRONT SLIDE-OUT SEAL VALVE, DEFLATION SOLENOID
6- REAR SLIDE-OUT SEAL VALVE, DEFLATION SOLENOID
7- PRESSURE INDICATOR
8- PRESSURE REGULATOR
9- REAR SLIDE-OUT SEAL VALVE, INFLATION SOLENOID
10- FRONT SLIDE-OUT SEAL VALVE, INFLATION SOLENOID
11- SECURITY PIN AIR FLOW REGULATOR
12- VACUUM GENERATOR
13- PRESSURE TRANSDUCER

FIGURE 29 : PNEUMATIC COMPONENT PANEL

14.3 SEAL

NOTE
Refer to the Prevost parts manual for descriptions of the sealant and adhesives used.

The slide-out sealing device is used to prevent any type of infiltration that may occur between the structure body and the slide-out itself. It is composed of an inflatable seal which is used as a primary sealing device for both retracted and extended slide-out position and a wiper seal as a secondary sealing device which is used to wipe water out and to ensure sealing during slide-out movement.

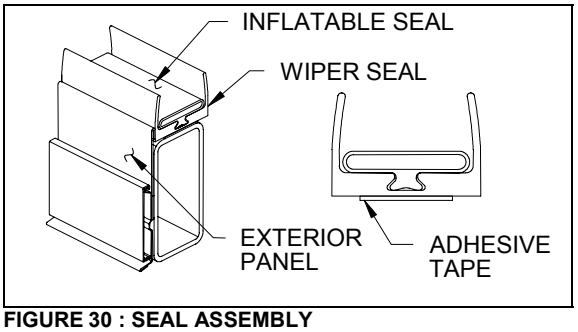


FIGURE 30 : SEAL ASSEMBLY

The seal deflation is done each time the slide-out moves. The deflating valve solenoid is activated before and during the slide-out movement. When the slide-out reaches its retracted or extended position, the deflating solenoid is deactivated before activation of the inflating solenoid to re-inflate the seal.

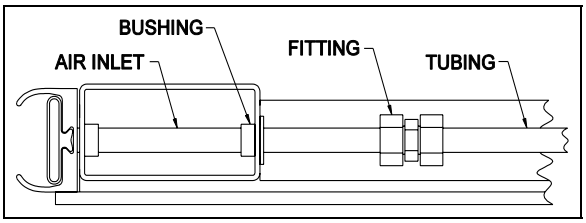


FIGURE 31 : REAR SLIDE-OUT INFLATABLE SEAL AIR INLET

CAUTION

Make sure the inflatable seal is deflated when manually moving the slide-out during service maintenance. Deflate both inflatable seals completely by turning the relief shut-off valve handle clockwise (see FIGURE 29).

CAUTION

Check before using any cleaning or adhesive product on seal, panel or glass to prevent alteration or damage.

14.3.1 Maintenance

The inflatable seal pressure must be set to 10 psi maximum with the pressure regulator. It is recommended to check the inflatable seal pressure once a month to ensure sealing efficiency and prevent any infiltration from outside. Check both seals for air leaks or cracks. Check the sealant between the inflatable seal and the exterior panels and glasses. Add sealant if necessary.

14.3.2 Seal assembly removal

DANGER

Always wear the appropriate safety equipment. Maintain adequate ventilation at all time.

1. Retract the slide-out 2" inside the vehicle (section 14.3.4).
2. Unplug the tubing from the inflatable seal air inlet (FIGURE 31). Keep the bushing.
3. Unstick and remove the wiper seal from the structure.
4. Scrape remaining tape from the structure. Remove old sealant that was between the wiper seal and the exterior panels and glasses.

14.3.3 Seal assembly installation

NOTE

This procedure is to install the inflatable seal assembly on the structure.

CAUTION

Always apply product in the same direction to prevent dirt from being brought back.

CAUTION

Check before using any cleaning or adhesive product on seal, panel or glass to prevent alteration or damage.

NOTE

Refer to the slide-out parts manual for descriptions of primer, cleaner, sealant and adhesives used.

NOTE

Refer to the product specification for drying time.

1. Retract the slide-out 2" inside the vehicle (section 14.3.4).
2. Clean the part of the structure that will receive the inflatable seal and also the back of the exterior panel and glasses with a chix cloth and thinner. Use another cloth to dry the surfaces. Wait at least 2 minutes for drying.
3. Rub the structure and also the back of the exterior panel and glasses with a Scotch Brite (or equivalent product).
4. Clean another times the structure and the back of the exterior panel and glasses with a chix cloth and thinner. Use another cloth to dry the surfaces. Wait at least 2 minutes for drying.
5. Clean the structure and the back of the exterior panel and glasses with appropriate cleaner. Wait until the product is dry before proceeding.
6. Seal the gap between the structure and the exterior panels and the gap between the glasses and the fiberglass panels with appropriate sealant. Make sure not to put

sealant on the structure surface where the inflatable seal will be placed. Wait until the product is dry before proceeding.

7. Install the inflatable seal on the structure, placing it as close as possible from the exterior side of the structure. Position the air inlet first. Then remove locally the inflatable seal adhesive tape protection, and press the upper corners on the structure and hold them in place for 90 to 120 seconds. Install the lower corners next, then the straight section. Press the straight inflatable seal sections on the structure for at least 15 seconds. Use a small roller to ensure a good adhesive contact on the structure.
8. Seal the gap between the inflatable seal and the exterior panels and the gap between the glasses and the fiberglass panels with appropriate sealant. Wait until the product is dry before proceeding. Remove excess sealant with appropriate cleaner.
9. Replace the bushing and plug the pneumatic tubing on the inflatable seal air inlet (FIGURE 31).

14.3.4 Slide-out 2" inside retraction

1. For both sides of the slide-out, remove the 2 upper acetal plastic blocks shown on FIGURE 26 (refer to section 13).
2. Manually deflate the seal completely by turning the relieving shut-off valve clockwise (FIGURE 29). Make sure the pressure indicator reading is "0 psi".
3. Turn the ignition to the off position. Using the manual override procedure (section 18), extend the slide-out a few inches so the exterior extrusion screws located on the top of the slide-out are accessible from outside (FIGURE 7).
4. Using a knife cut the sealant between the extrusion and the roof (FIGURE 7). Unscrew and remove the central exterior extrusion screws and the two end extrusion screws.

CAUTION

Do not use the slide-out handheld control to move the slide-out 2" inside the vehicle, because the limits are not recognized over the closed position. The slide-out will not stop and damage may occur.

5. Using the manual override procedure, move the slide-out 2" inside the vehicle, so the seal is accessible from outside (FIGURE 32).

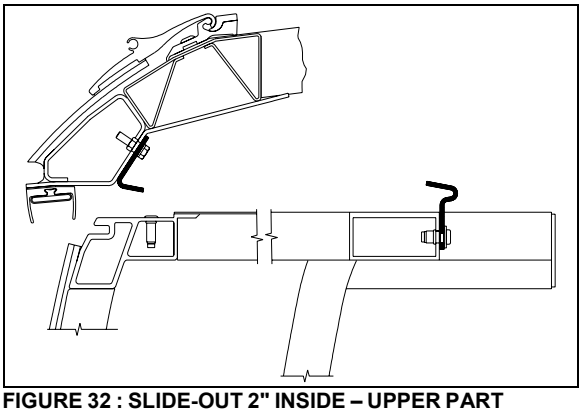


FIGURE 32 : SLIDE-OUT 2" INSIDE – UPPER PART

6. Once completed, use the manual override procedure to extend the slide-out to reinstall the exterior extrusion. Apply appropriate sealant on the exterior extrusion screws and between the extrusion, the roof and the edges to prevent water infiltration (FIGURE 32).
7. Reinstall the acetal plastics blocks.
8. Using the manual override procedure, retract the slide-out to its closed position.
9. Finally, the seal can be re-inflated by turning the shut-off valve handle counterclockwise. Check the pressure gage on the inflatable seal regulator to see if the pressure is increasing to 10 psi.

15 SLIDE-OUT ELECTRICAL SYSTEM

DANGER

Never modify the slide-out electrical wiring without the Prevost Car approval. Any modifications may cause an unexpected slide-out action and could result in personal injuries.

The multiplexed slide-out electrical system is mainly composed of the Master ID module, the CECM module, the VEC module and two I/O-B modules.

Each slide-out has its own I/O-B module and two power relays. The I/O-B modules analyze the input signal conditions and activate outputs like the pneumatic valves, the retracting or extending

programmed sequence, etc. The power relays are used to supply power coming from the I/O-B module to the electric motor and to change polarity to reverse motor rotation.

The I/O-B modules input signals are:

- Handheld control switch IN;
- Handheld control switch OUT;

Also, the following input signals are required for a safe operation of the slide-out:

- Pressure transducer;
- Parking brake;
- “in limit” sensor;
- “out limit” sensor;

The I/O-B modules output signals are:

- Handheld control green indicator light;
- Power relay current reversing;
- Seal valve inflating solenoid;
- Seal valve deflating solenoid;
- Vacuum generator valve solenoid;
- Security pin valve solenoid;
- Electric motor, first power output 15 amps;
- Electric motor, second power output 15 amps;

The CECM module output signals are:

- Dashboard telltale light;
- Transmission inhibit;

DANGER

Before working on the slide-out electrical system, turn the ignition key to the “OFF” position.

15.1 ELECTRICAL INTERCONNECTION WITH PREVOST VEHICLE

The slide-out power supply comes from the 24-volts circuit breaker (FIGURE 34) in the engine R.H. side access compartment. The other interconnections are located on the pneumatic panel and the electrical panel in the front service compartment. All the interconnections are shown on the electrical diagrams of your vehicle.

A blinking signal is added on the dashboard telltale panel (FIGURE 33) to indicate that an error condition or a missing operation condition is present on a slide-out. The slide-out telltale light also illuminates to indicate that at least one of the slide-outs is extended.

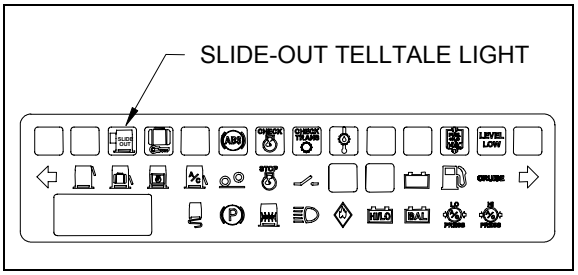


FIGURE 33 : DASHBOARD SLIDE-OUT TELLTALE LIGHT

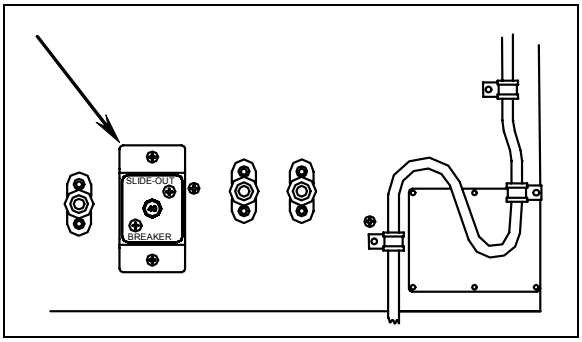


FIGURE 34 : MAIN BREAKER IN ENGINE R.H. SIDE ACCESS COMPARTMENT

15.2 SLIDE-OUT BREAKERS / FUSES

The main breaker (for both slide-outs) is located in the engine R.H. side access compartment. All other slide-out breakers and hardware fuses are located inside the VEC, on the slide-out electrical component panel located in the third baggage compartment on the driver side (FIGURE 35 and FIGURE 36).

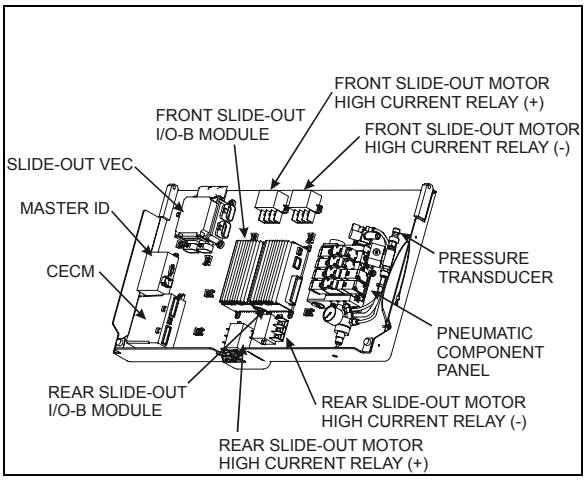


FIGURE 35 : SLIDE-OUT CONTROL PANEL

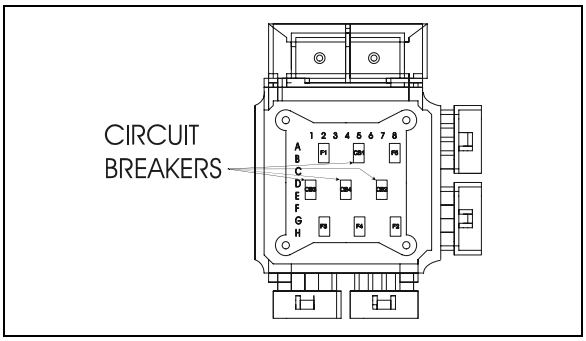


FIGURE 36 : VEC CIRCUIT BREAKERS & FUSES

15.2.1 Multiplex fuses

The multiplex module outputs are protected in current by an internal “soft-fuse”. Each output is programmed to specific maximum amperage. When an output is shorted, the current gets above the limit and the soft-fuse intervenes to turn the output OFF. The output stays OFF until the "soft-fuse" is reset.

Turn the ignition key to the OFF position and turn to the ON position again. This resets all "soft-fuses".

⚠ CAUTION

Never put grease, Cortec VCI-238 or other product on the multiplex modules connector terminals.

15.3 PROBING VOLTAGE ON THE MULTIPLEX CIRCUITS

Multiplex modules are supplied by 24 volts.

Inactive Multiplex output = Residual voltage of 18% to 33% of supply voltage.
Inactive Multiplex input = Residual voltage of 50% of supply voltage.

NOTE

For a 24V module: an active voltage would be 24V or 0V but not in between. If you measure the intermediate tensions (ex. 12V, 4V, or 8V) this must be interpreted as if the input or the output is inactive.

15.4 MODULE REPLACEMENT

I/O-B and CECM multiplex modules can be replaced and reprogrammed without having to connect a computer to the vehicle.

15.4.1 I/O-B replacement

- Turn the ignition key to OFF.
- Replace the module (disconnect the green connector first, then the grey one and finish with the black connector. To disconnect the black connector, slide downwards the red latch).
- Turn the ignition key to the ON position. This engages the automatic reprogramming,
- The slide-out telltale light will turn on and stay on until the reprogramming is complete. Once completed, the slide-out telltale light will turn off or stay on (not blinking) if at least, one slide-out is extended.
- Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. Verify the fault message to be certain the module is reprogrammed. If the module is not reprogrammed, the message « Axx Not Responding » appears where Axx is the module number (A56 or A57).

15.4.2 CECM module replacement

- Turn the ignition key to OFF.
- Replace the module.
- Turn the ignition key to the ON position. This engages the program transfer from the Master ID to the CECM module (the back-up program is inside the Master ID. The Master ID will identify the CECM as being new and will send the correct program to it). The slide-out telltale light will turn on and stay on for a while, and then will turn off. Wait until the slide-out telltale starts blinking each second. At this point, the Master ID module has finished loading the program in the CECM.
- Turn the ignition key to the OFF position and then turn it back to the ON position. This engages I/O's modules automatic reprogramming.
- The slide-out telltale light will turn on. Once completed, the slide-out telltale light will turn off or stay on (not blinking) if at least, one slide-out is extended.

- Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. You should read “no errors”. If an active error appears for a module, this one was not reprogrammed. In this case, repeat the procedure.

15.5 SLIDE-OUT LIMIT SENSORS

Two Hall-Effect sensors are used on each slide-out to define end limit positions. The "in limit" and "out limit" sensor detect two pairs of permanent magnets fixed on the slide-out underbody.

15.5.1 Maintenance and adjustment

The rear slide-out sensors are accessible from inside of the vehicle, under the bed structure while the front slide-out sensors can be reached from the 3rd baggage compartment access panel. To remove the sensors, unsnap them from the mounting bracket.

To adjust the "in limit" sensors:
Prior to adjusting the “in limit” sensors, assure that the “in limit” stoppers are perfectly adjusted (see section 1.2.2).

1. Retract the slide-out to its full “IN” position with the “in limit” stoppers in contact with their bearing surface.
2. Loosen the “in limit” sensor mounting bracket screws and move back the sensor completely (toward the inside of the vehicle).
3. Bring slowly the sensor toward the outside of the vehicle until the light emitting diode (LED) turns on. When it does, move it 0.079” (2mm) further in the same direction and tighten the mounting bracket screws.
4. Check if the “in limit” sensor is properly adjusted. At the moment when the slide-out stops during normal retraction, the “in limit” stoppers must contact their bearing surface (lower acetal plastic block). Put white paint on the “in limit” stopper before and check if the acetal plastic blocks are marked with paint.

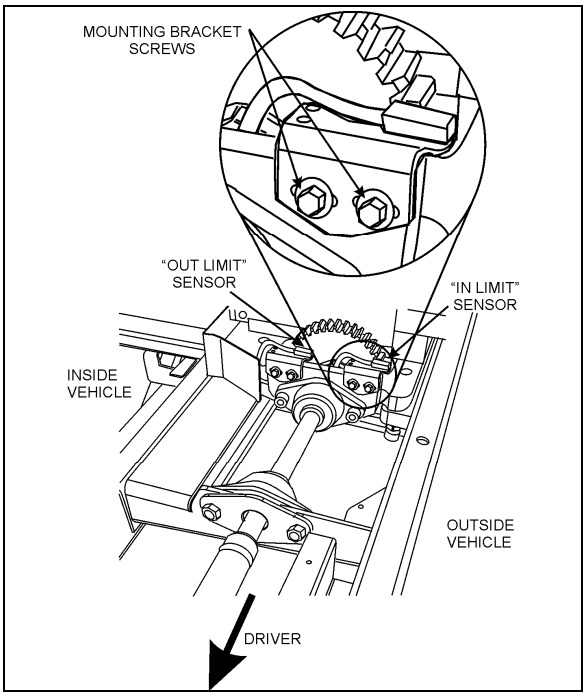


FIGURE 37 : FRONT SLIDE-OUT SENSORS

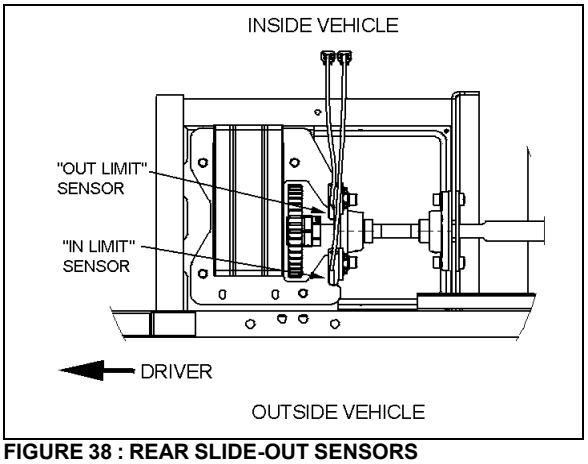


FIGURE 38 : REAR SLIDE-OUT SENSORS

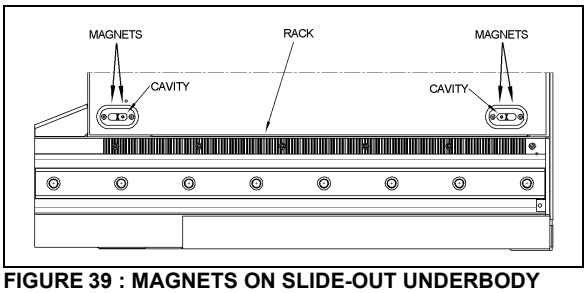


FIGURE 39 : MAGNETS ON SLIDE-OUT UNDERBODY

To adjust the "out limit" sensors:

Prior to adjusting the “out limit” sensors, assure that the inner stoppers are perfectly adjusted (see section 1.1).

1. The slide-out is slightly tilted except when it is in its full “IN” or “OUT” position. Extend the slide-out near its full “OUT” position. When the slide-out straitens up and that it is perpendicular with the vehicle body, stop the slide-out.
2. Loosen the “out limit” sensor mounting bracket screws and move back the sensor completely (toward the inside of the vehicle).
3. Bring slowly the sensor toward the outside of the vehicle until the light emitting diode (LED) turns on. When it does, tighten the mounting bracket screws.

NOTE

When the “out limit” sensors are properly adjusted, the slide-out extension stops before the side inner stoppers reach the vehicle structure.

16 SLIDE-OUT EXTERIOR FINISHING PANELS & WINDOWS

NOTE

The removal and installation procedures are all based on standard service methods described in section 18: BODY. Refer to this manual for procedures, tools, cleaner, adhesives and other product needed.

16.1 FACE PANEL REMOVAL

Use the same procedure as described in section 18: BODY for MTH side panel removal, and:

- Keep the slide-out retracted;
- Make sure not to damage the finishing molding supports to be able to re-use them;
- Remove the old adhesive on the finishing molding supports and clean them before re-using;
- Check where adhesive, sealant and double face adhesive tape are on the structure and the panel back side, in order to be able to stick the new panel in the same way;
- Check the tape width and use same width tape when installing new panels.

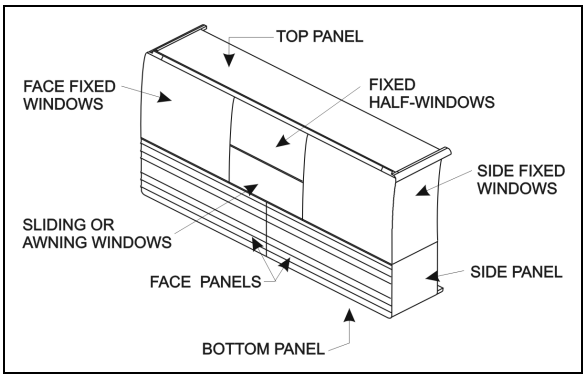


FIGURE 40 : SLIDE-OUT PANELS AND WINDOWS

16.2 FACE PANEL INSTALLATION

For surface cleaning, and preparation, panel installation and products needed, use the same procedure as the MTH side panel installation described in section 18: BODY.

- Keep the slide-out retracted for panel alignment;
- Make sure to apply sealant between the face panels and the side panels, and also between face panels and bottom and top panels. Apply sealant both inside and outside the slide-out panels.

16.3 SIDE PANELS REMOVAL

NOTE

The side panels are made of aluminum, or of stainless steel in option.

CAUTION

Be careful not to damage the adjacent surfaces.

1. Remove the slide-out (according to the Slide-Out Removal Procedure. Ask to your Prevost service representative).
2. Remove the side fixed windows from the slide-out first, as described in section 16.7.
3. Insert a flat screwdriver between the panel and the slide-out structure, in the top left and right corners of the panel, and unstick the panel from the structure.
4. Use C-clamp to peel the panel from the slide-out structure.
5. Check where adhesive, sealant and double face adhesive tape are on the structure and

the panel back side, in order to be able to stick the new panel in the same way.

6. Check the tape width and use same width tape when installing new panels.

CAUTION

Make sure the heat gun nozzle tip is at least 4" from surface.

7. Use a heat gun and putty knife to remove the dried off adhesive and tape residue from the structure.

DANGER

Because of the adhesive toxicity, never use a buffer or other sanding method to remove it.

16.4 SIDE PANELS INSTALLATION

NOTE

The side panels are made of aluminum, or of stainless steel in option. Use rivet of same material as the panels.

For surface cleaning and preparation, panel installation and products needed, refer to the MTH side panel installation procedure described in section 18: BODY.

1. Protect adjacent surfaces with appropriate material;
2. Refer to FIGURE 41 for 1/16x1/4 double face adhesive tape location on structure;
3. Apply Sika 206 G+P on the side panel as shown in FIGURE 42;
4. Apply Sika Tack+Booster (triangular bead: 9mm width X 6mm high) as shown in FIGURE 43 and glue panel in place as shown in FIGURE 44
5. Exert pressure and let dry for at least 90 minutes;
6. Smooth down the joint and remove glue in excess;
7. After drying, apply Sika 252 as a finishing joint;
8. Smooth down the joint.
9. Refer to section 16.11 for the finishing joint application procedure.

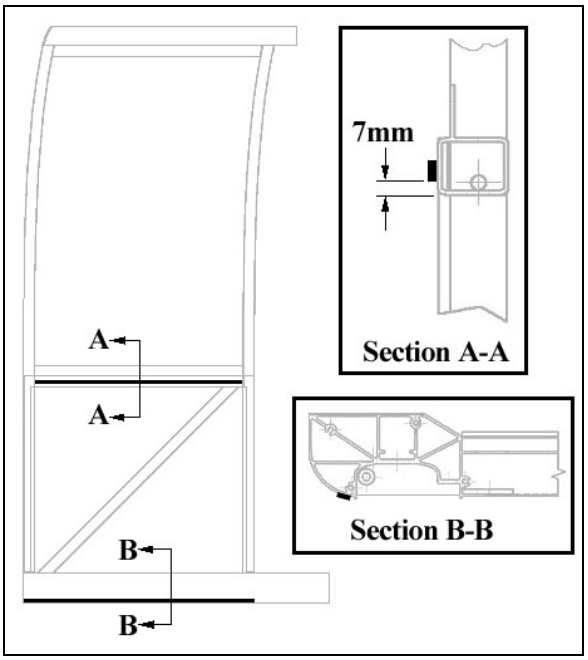


FIGURE 41 : SIDE PANEL INSTALLATION – DOUBLE FACE ADHESIVE TAPE APPLICATION ON THE SLIDE-OUT STRUCTURE

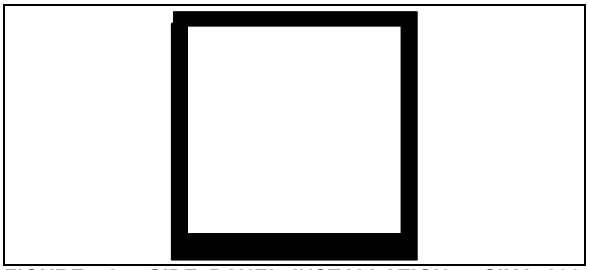


FIGURE 42 : SIDE PANEL INSTALLATION – SIKA 206 G+P APPLICATION

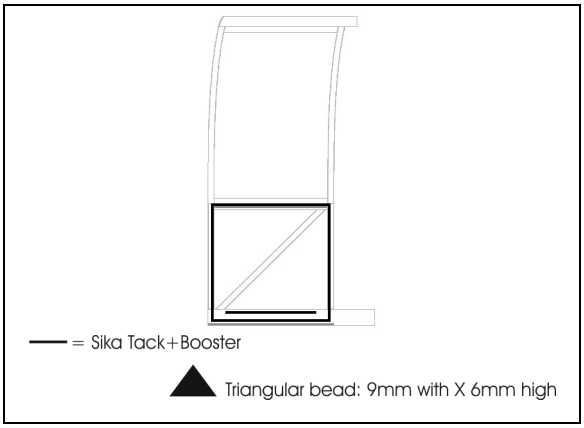


FIGURE 43 : SIDE PANEL INSTALLATION – SIKA TACK+BOOSTER APPLICATION

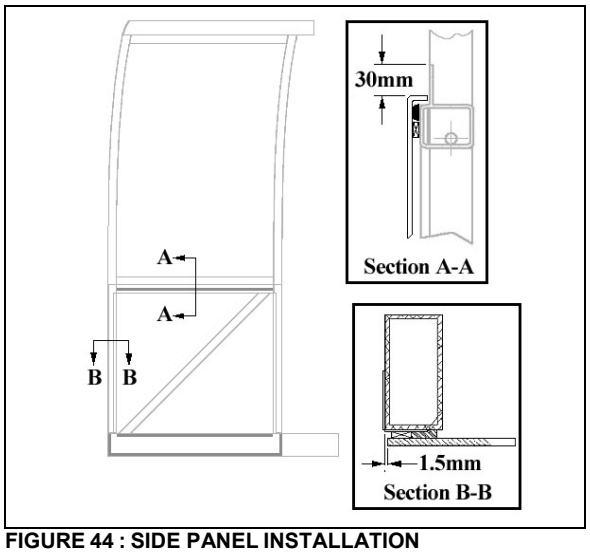


FIGURE 44 : SIDE PANEL INSTALLATION

16.5 TOP AND BOTTOM PANEL REMOVAL

NOTE

The top and bottom panels are made of aluminum sheets.

1. Remove the slide-out (according to the Slide-Out Removal Procedure. Ask to your Prevost service representative).
2. Insert a flat screwdriver between the panel and the slide-out structure, and unstick the panel from the structure.
3. Use C-clamp to peel the panel from the slide-out structure.
4. Check where adhesive, sealant and double face adhesive tape are on the structure and the panel back side, in order to be able to stick the new panel in the same way.
5. Check the tape width and use same width tape when installing new panels.
6. Use a heat gun and putty knife to remove the dried off adhesive and tape residue from the structure.

DANGER

Because of the adhesive toxicity, never use a buffer or other sanding method to remove it.

16.6 TOP AND BOTTOM PANEL INSTALLATION

NOTE

The top and bottom panels are made of aluminum sheets and need aluminum rivet.

For surface cleaning, preparation, panel installation and products needed, refer to the MTH side panel installation procedure described in section 18: BODY.

1. Protect adjacent surfaces with appropriate material.
2. Refer to FIGURE 45 for 1/16x1/4 double face adhesive tape location on structure;
3. Apply Sika 206 G+P on panel as shown in figure 46
4. Apply Sika Tack+Booster (triangular bead: 9mm width X 6mm high) has shown in figure 47 and glue panel in place as shown in FIGURE 48 & FIGURE 49.
5. Exert pressure and let dry for at least 90 minutes;
6. Smooth down the joint and remove glue in excess;
7. After drying, apply Sika 252 as a finishing joint;
8. Smooth down the joint.
9. Refer to section 16.11 for the finishing joint application procedure.

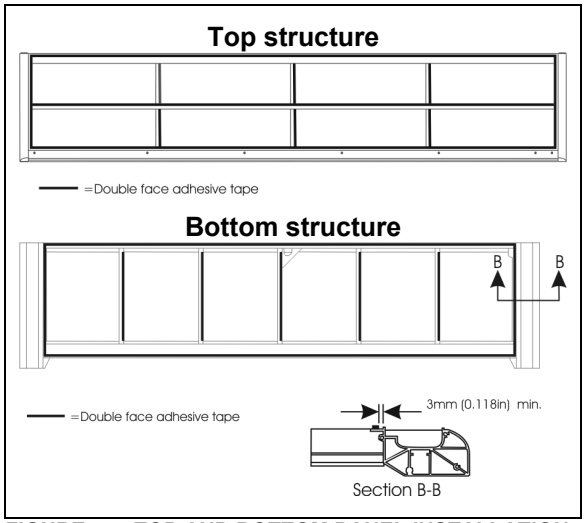


FIGURE 45 : TOP AND BOTTOM PANEL INSTALLATION - DOUBLE FACE ADHESIVE TAPE APPLICATION

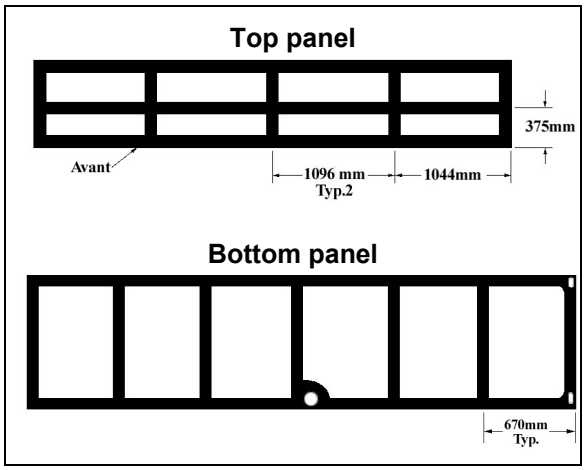


FIGURE 46 : TOP AND BOTTOM PANEL INSTALLATION - SIKA 206 G+P APPLICATION

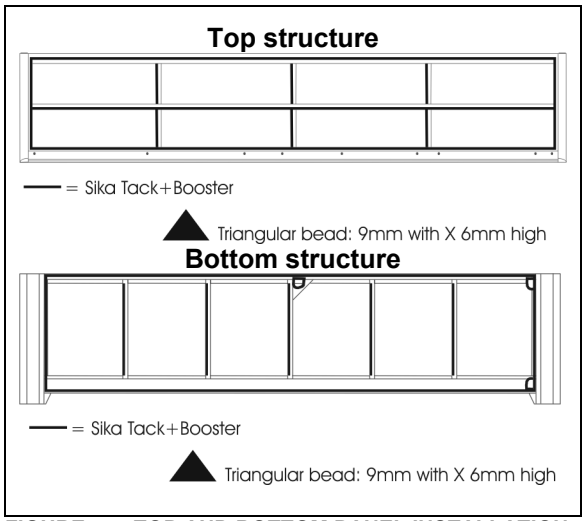


FIGURE 47 : TOP AND BOTTOM PANEL INSTALLATION - SIKA TACK+BOOSTER APPLICATION

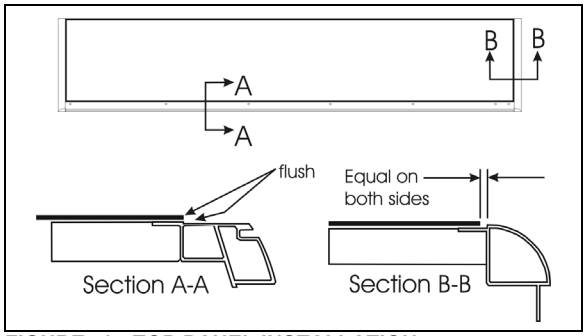


FIGURE 48 : TOP PANEL INSTALLATION

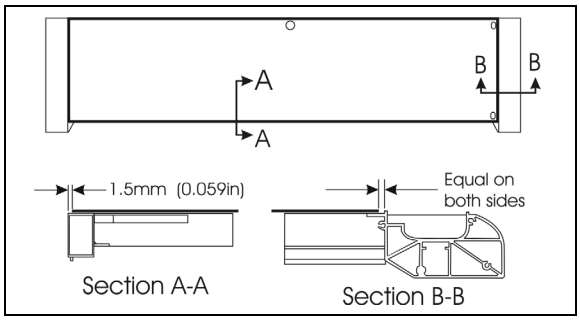


FIGURE 49 : BOTTOM PANEL INSTALLATION

NOTE

The removal and installation procedures are based on standard service methods described in section 18: BODY. Refer to these procedures for tools and adhesives specifications.

DANGER

Always wear safety equipment when working with glass and chemical adhesives.

16.7 WINDOWS REMOVAL

1. Remove the slide-out.
2. If needed, remove the exterior extrusion as described in section 1.3.

CAUTION

Be careful not to damage the adjacent surfaces.

3. With a knife or a wire, cut the sealant and the adhesive between the windows and the structure. Make sure not to damage the rubber seal between the windows.
4. With a helper, remove the window from the slide-out.

16.8 FIXED WINDOWS INSTALLATION

Refer to procedures described in section 18: BODY of the maintenance manual for details.

1. Clean and prepare the windows and the slide-out structure surfaces with appropriate cleaner, abrasives and primers.
2. If necessary, install the rubber seals as per FIGURE 50 & FIGURE 51. Press the seal against the structure with a roller.

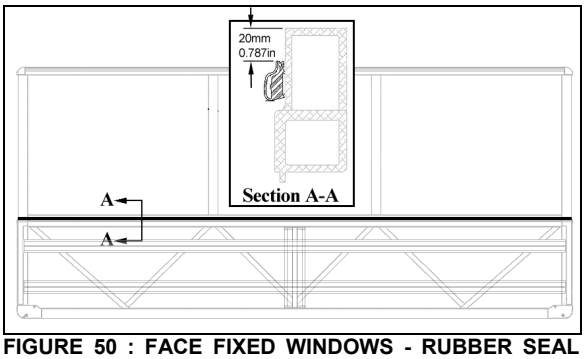


FIGURE 50 : FACE FIXED WINDOWS - RUBBER SEAL INSTALLATION

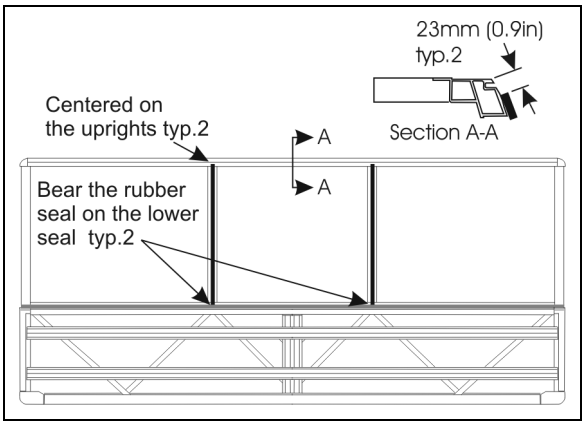


FIGURE 51 : FACE FIXED WINDOWS - RUBBER SEAL INSTALLATION

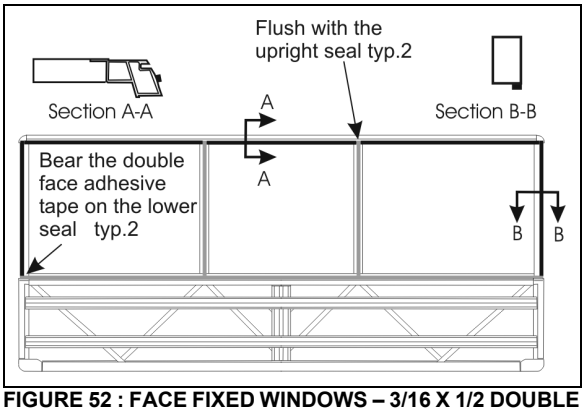


FIGURE 52 : FACE FIXED WINDOWS – 3/16 X 1/2 DOUBLE FACE ADHESIVE TAPE INSTALLATION

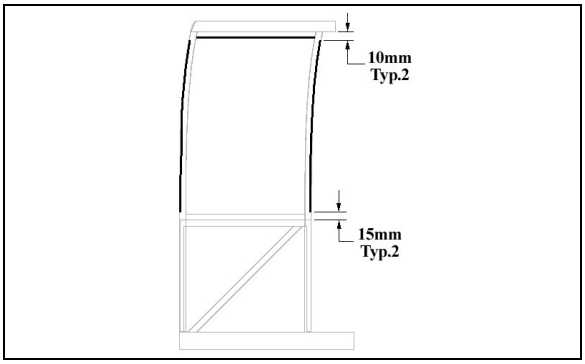


FIGURE 53 : SIDE FIXED WINDOW – ¼ X ½ DOUBLE FACE ADHESIVE TAPE INSTALLATION

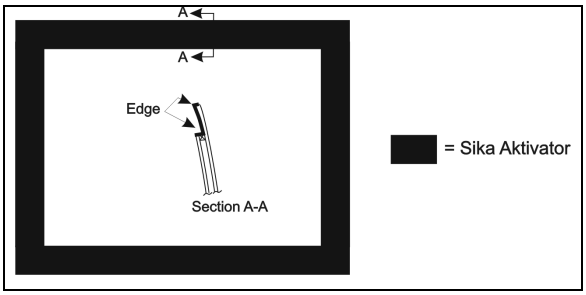


FIGURE 54 : FACE FIXED WINDOW AND HALF-WINDOW – SIKA AKTIVATOR

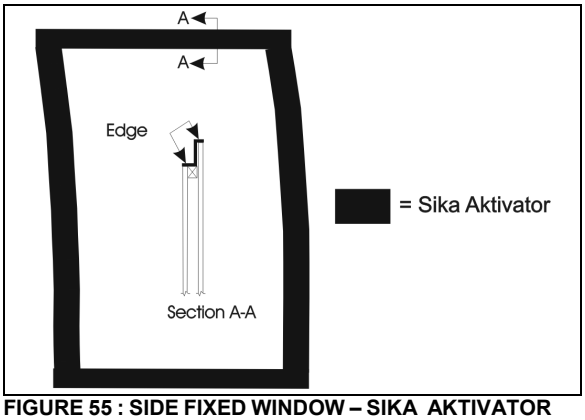


FIGURE 55 : SIDE FIXED WINDOW – SIKA AKTIVATOR

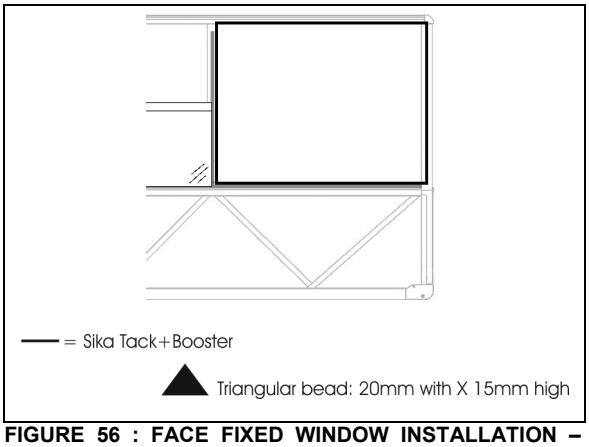


FIGURE 56 : FACE FIXED WINDOW INSTALLATION – SIKA TACK+BOOSTER

FIGURE 57 : FACE FIXED HALF-WINDOW INSTALLATION – SIKA TACK+BOOSTER

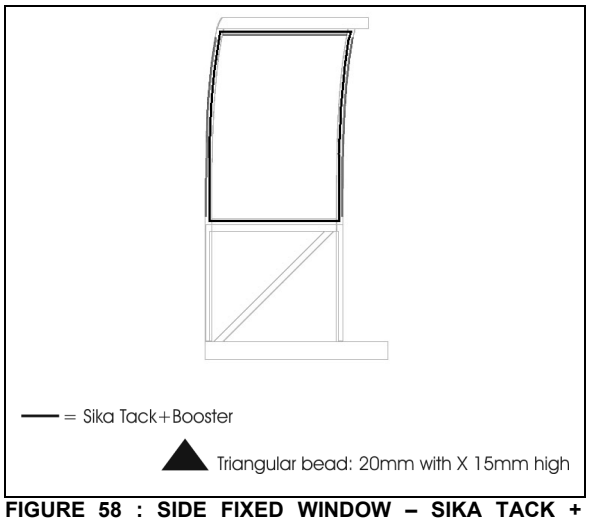


FIGURE 58 : SIDE FIXED WINDOW – SIKA TACK + BOOSTER

3. Apply appropriate double face self adhesive tape on the slide-out structure (see FIGURE 52 for face fixed windows or FIGURE 53 for side fixed window).
4. Clean window with appropriate window cleaner.
5. Apply Sika Aktivator on the window pane as per FIGURE 54 or FIGURE 55.
6. Apply Sika Tack+Booster as per FIGURE 56, FIGURE 57 or FIGURE 58 (triangular bead: 20mm width X 15mm high).
7. Install the windows on the slide-out structure (see FIGURE 59 or FIGURE 60).
8. Press the jigs on the windows and wait for the adhesive to dry (90 minutes minimum).
9. After drying, apply Sika 221 as a finishing joint. Clean excess with Sika 208.
10. Refer to section 16.11 for the finishing joint application procedure.

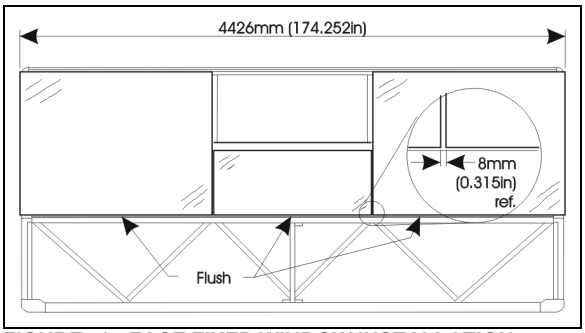


FIGURE 59 : FACE FIXED WINDOW INSTALLATION

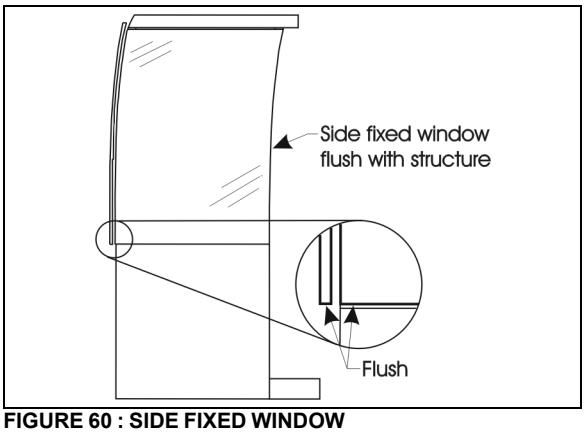


FIGURE 60 : SIDE FIXED WINDOW

16.9 AWNING WINDOW INSTALLATION

1. Clean and prepare the windows and the slide-out structure surfaces with appropriate cleaner, abrasives and primers.
2. Glue on the structure horizontal member, 4 rubber bumpers (#5061020), placing them 2 by 2 to have a total thickness of 1/16" (FIGURE 61).

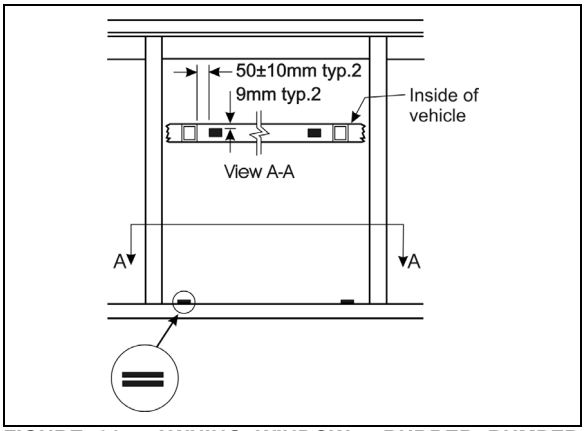


FIGURE 61 : AWNING WINDOW - RUBBER BUMPER INSTALLATION

3. Glue 4 rubber bumpers (#790610) on the awning window frame as per FIGURE 62.

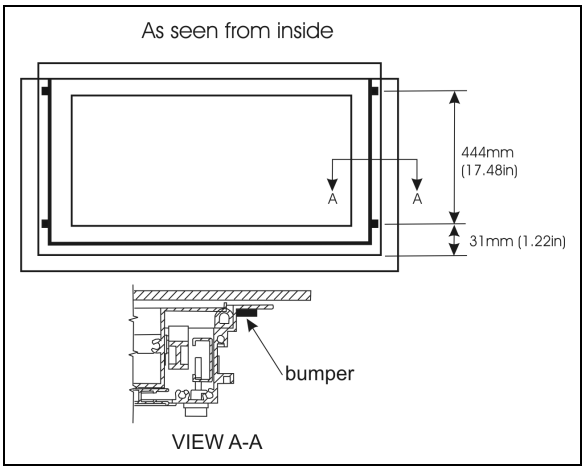


FIGURE 62 : SIDE BUMPERS

4. Place masking tape on the inside of the frame as per FIGURE 63

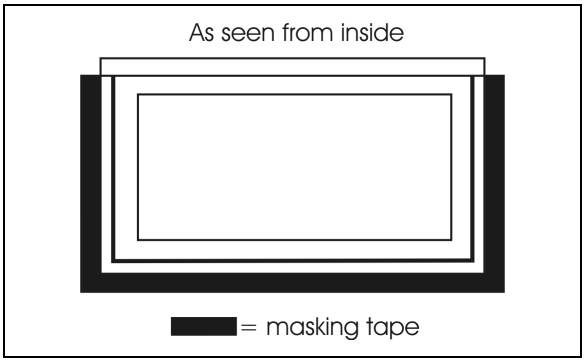


FIGURE 63 : MASKING TAPE APPLICATION

5. Apply Sika 255 in the upper and lower frame corner as per FIGURE 64.

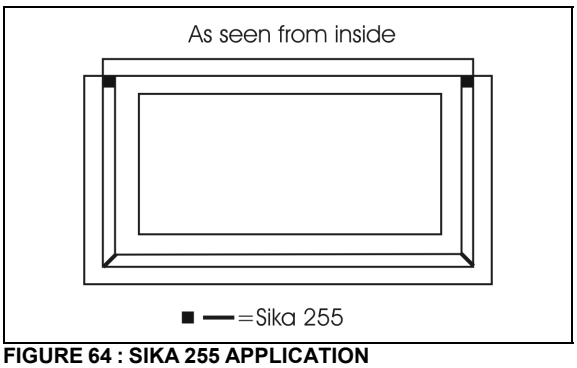


FIGURE 64 : SIKA 255 APPLICATION

6. Apply Sika Aktivator as per FIGURE 65.
7. Apply Sika 255 as per FIGURE 66 (triangular bead: 10mm width X 10mm high).

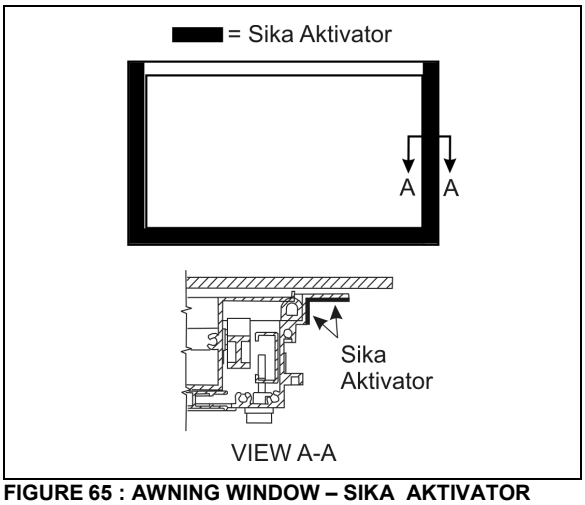


FIGURE 65 : AWNING WINDOW – SIKA AKTIVATOR

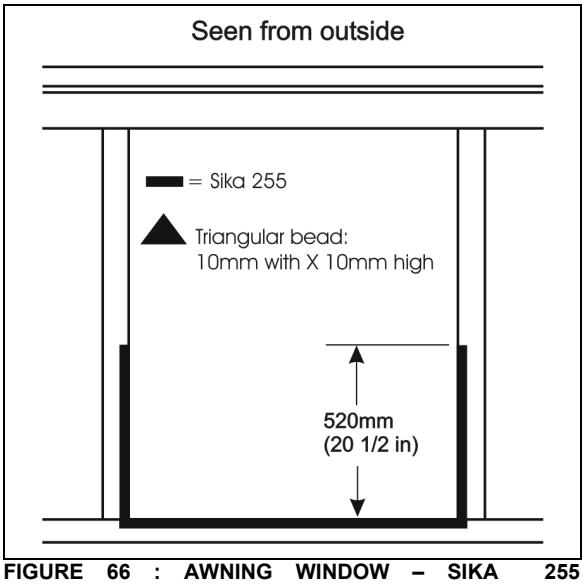


FIGURE 66 : AWNING WINDOW – SIKA 255 APPLICATION

8. Install the awning window centered in the opening. Press the window slightly. The awning window must be kept closed.
9. While a helper is pressing on the window from outside, install the awning window clamping frame and tighten screws according to the sequence shown in FIGURE 67.

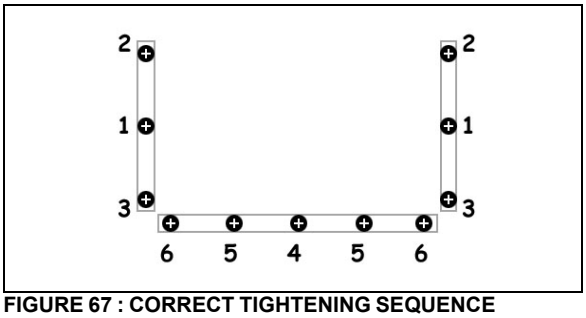


FIGURE 67 : CORRECT TIGHTENING SEQUENCE

10. Open the awning window manually and smooth down the joint (FIGURE 68) and remove glue in excess with Sika 208.

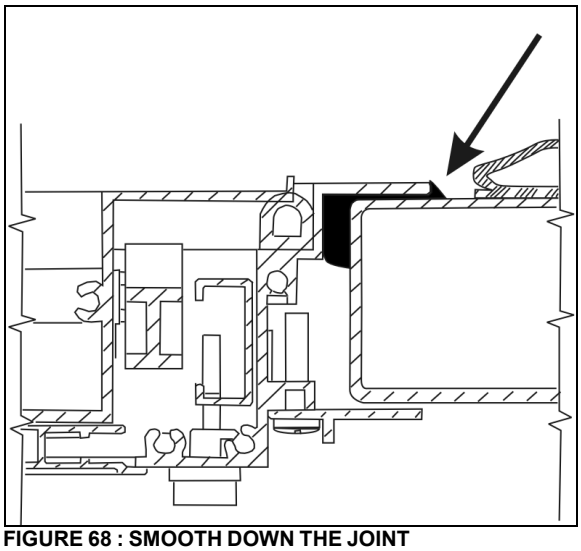


FIGURE 68 : SMOOTH DOWN THE JOINT

11. Using Sika 252 or 255, seal the upper corner of the awning window, both sides (FIGURE 69).
12. Using Sika 252 or 255, seal the chink between the structure vertical member and the awning window, both sides (FIGURE 70).

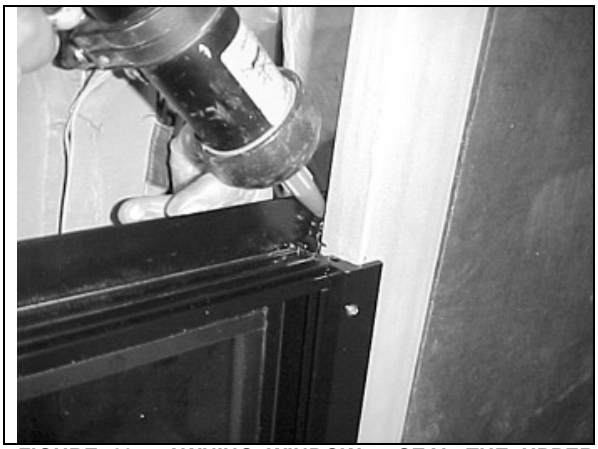


FIGURE 69 : AWNING WINDOW – SEAL THE UPPER CORNERS

FIGURE 70 : AWNING WINDOW – SEAL THE CHINK

16.10 SLIDING WINDOW INSTALLATION

1. Clean and prepare the windows and the slide-out structure surfaces with appropriate cleaner, abrasives and primers. Clean surfaces with anti-silicone.
2. Apply Sika Aktivator on sliding window as per FIGURE 71.
3. Apply Sika Aktivator on the structure as per FIGURE 72.
4. Apply Sika 252 as per FIGURE 73 (triangular bead: 20mm width X 10mm high).
5. Install the sliding window centered in the opening. Press the window slightly. The window must be kept closed.
6. While a helper is pressing on the window from outside, install the awning window clamping frame and tighten screws according to the sequence shown in FIGURE 74.
7. Remove glue in excess with Sika 208.
8. Using Sika 252 or 255, seal the inside upper corner of the sliding window, both sides (FIGURE 75).
9. Using Sika 252 or 255, seal the chink between the structure vertical rubber seal and the sliding window, both sides (FIGURE 76).

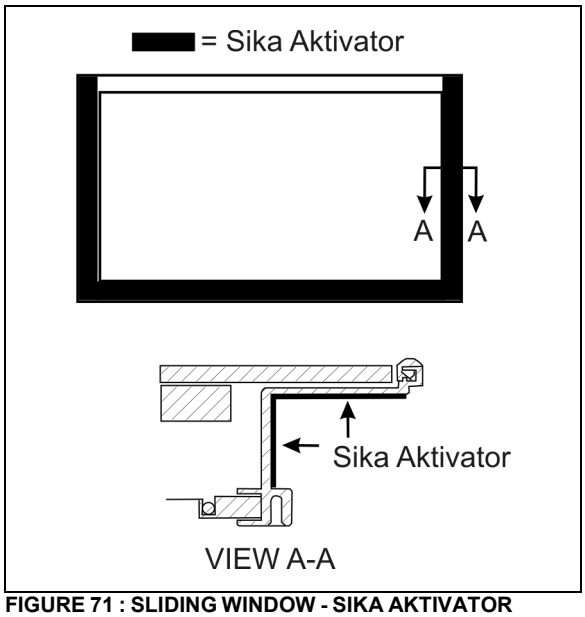


FIGURE 71 : SLIDING WINDOW - SIKA AKTIVATOR

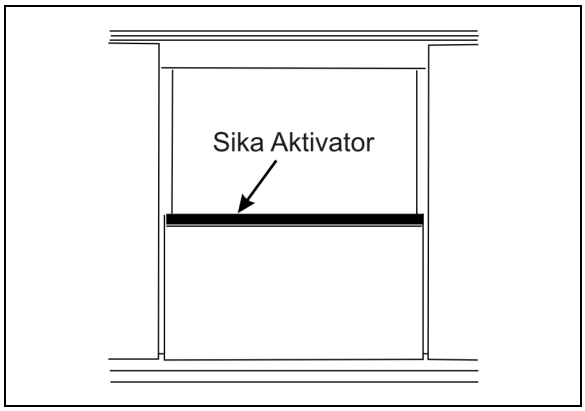


FIGURE 72 : SLIDING WINDOW - SIKA AKTIVATOR

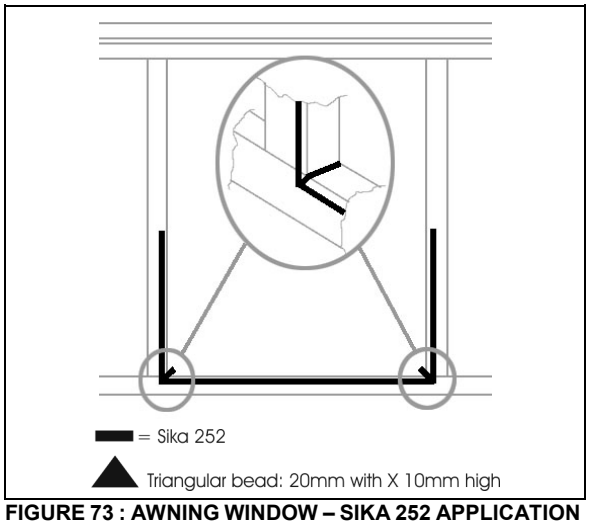


FIGURE 73 : AWNING WINDOW – SIKA 252 APPLICATION

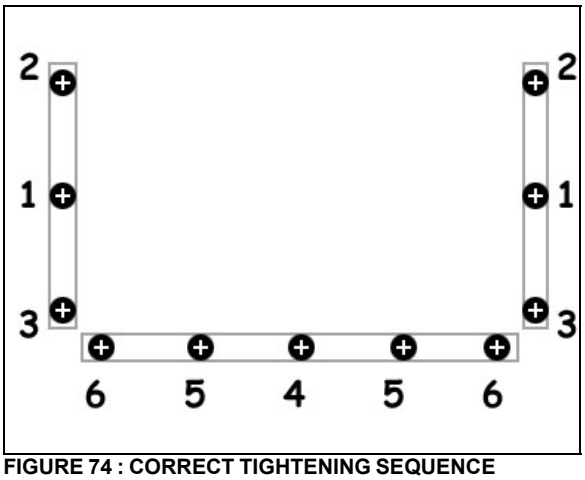


FIGURE 74 : CORRECT TIGHTENING SEQUENCE

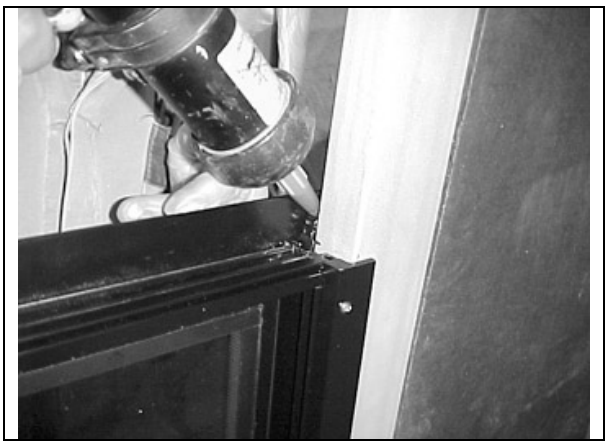


FIGURE 75 : SLIDING WINDOW – SEAL THE UPPER CORNERS

FIGURE 76 : SEAL

16.11 FINISHING JOINT

The following procedure applies to section 16.11.1 up to 16.11.4.

For surface cleaning and preparation, tools, cleaner, adhesives and other product needed, refer to the MTH side panel installation procedure described in section 18: BODY.

1. Place masking tape to protect surfaces from smudge.
2. Apply Sika 221.
3. Using soapy water, smooth down the joint with your finger (wear vinyl gloves).

16.11.1 Slide-out face

Apply Sika 221 between the face panel and the structural member

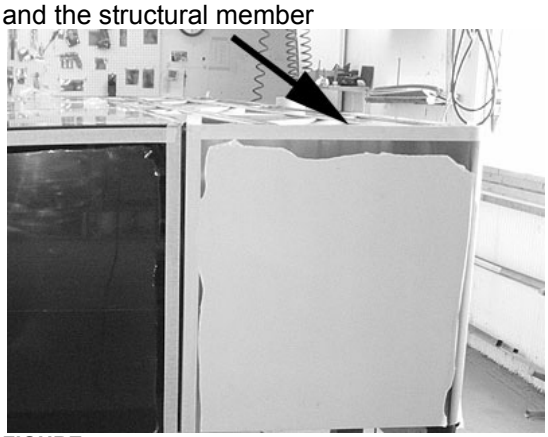


FIGURE 77

Apply Sika 221 between the top of face window and the structural member

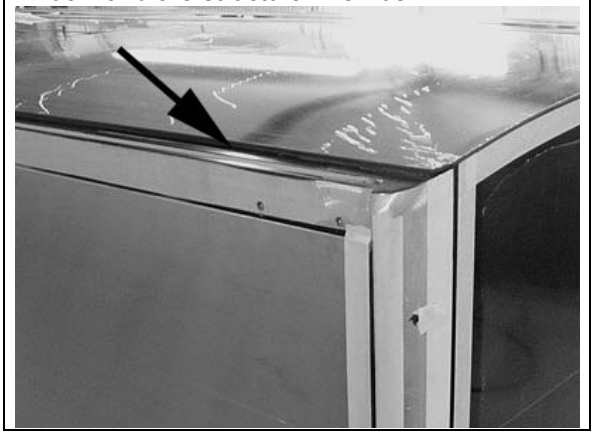


FIGURE 78

16.11.2 Slide-out side

Apply Sika 221 between the top of side window and the structural member

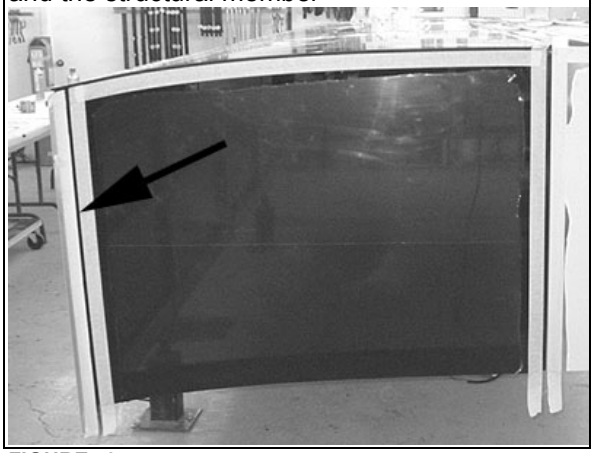


FIGURE 79

Apply Sika 221 between the bottom of side window and top of side panel

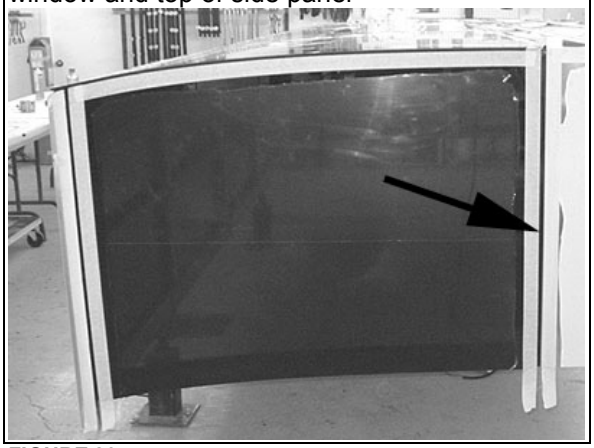


FIGURE 80

Apply Sika 221 between side window and top of face fixed window

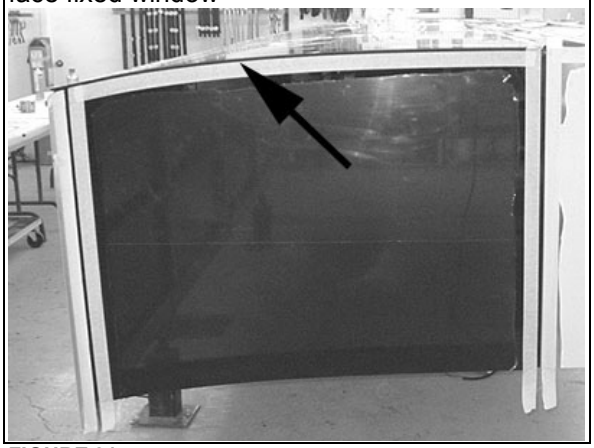


FIGURE 81

16.11.3 Slide-out bottom

Apply Sika 221 between bottom edge of side panel and structural member

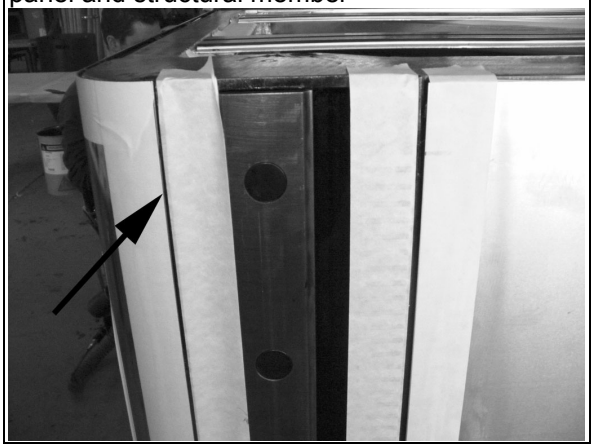


FIGURE 82

Apply Sika 221 between edge of bottom panel and structural member

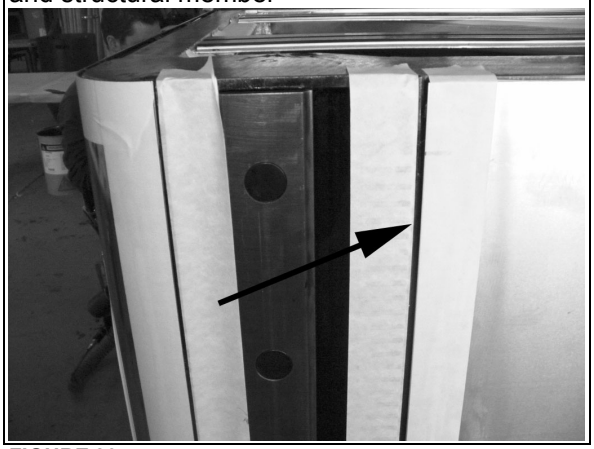


FIGURE 83

Apply Sika 221 between the bottom panel and the magnets

FIGURE 84

Apply Sika 221 around the security pin cavity

FIGURE 85

16.11.4 Top of Slide-out

Apply Sika 221 between edge of top panel and structural member

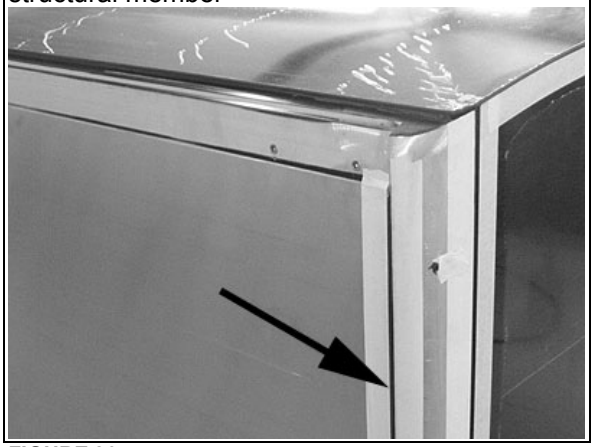


FIGURE 86

17 WELDING PRECAUTION

CAUTION

Prior to arc welding on the vehicle, refer to the Welding Precautions Procedure Prior To Welding" in section 00 GENERAL of this manual to avoid serious damage to the vehicle components.

18 SLIDE-OUT MANUAL OVERRIDE PROCEDURES

In case of power retracting system failure, it is possible to use the manual override procedure to retract or extend the slide-out.

The manual override procedures consist in rotating the slide-out motor shaft extension using a cordless power drill with a 3/8" hexagonal bit. However, it is very important to follow all the instructions very carefully to assure that the inflatable seal or the retraction mechanisms are not damaged.

18.1 PRELIMINARY CONDITIONS FOR MANUAL OVERRIDE PROCEDURE

Before using the slide-out manual override procedures, make sure that the problem cannot be solved by one of the following simple checks:

- Make sure that none of the breakers are tripped (the breakers are located inside the VEC on the slide-out control panel (FIGURE 88) and the main slide-out breaker is located in the engine R.H. side access compartment (FIGURE 89).
- Make sure the barking brake is applied and that transmission is in the "NEUTRAL" position.
- Make sure the voltage is high enough by running the engine at fast idle or having the battery charger connected.

⚠ CAUTION

Before extending or retracting the slide-out, always open a window to avoid movement restriction and to prevent the motor from stopping in overcurrent because of a vacuum or pressure build up inside the vehicle.

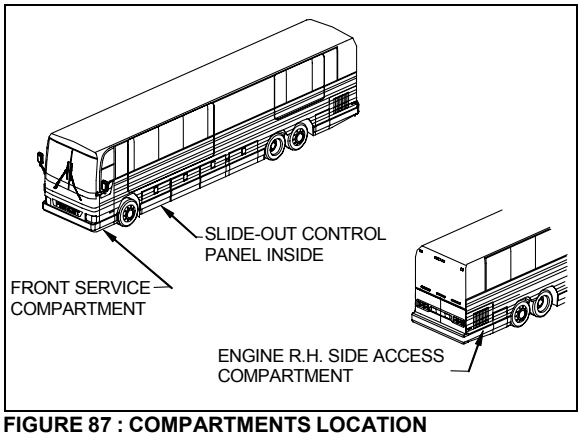


FIGURE 87 : COMPARTMENTS LOCATION

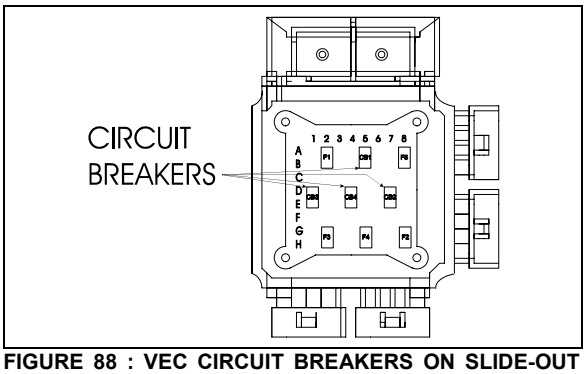


FIGURE 88 : VEC CIRCUIT BREAKERS ON SLIDE-OUT CONTROL PANEL

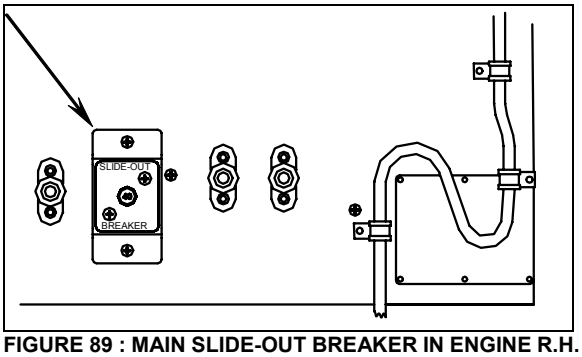


FIGURE 89 : MAIN SLIDE-OUT BREAKER IN ENGINE R.H. SIDE ACCESS COMPARTMENT

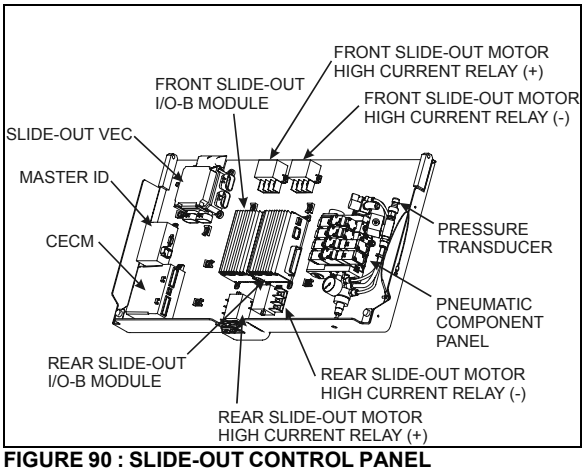


FIGURE 90 : SLIDE-OUT CONTROL PANEL

18.1.1 Manual retracting procedure – Front and rear slide-out

1. Turn the ignition switch to the "OFF" position, and remove the ignition key for more safety.
2. Deflate the inflatable seal by using the relieving shut-off valve located on the pneumatic component panel (FIGURE 91).
3. Turn the handle clockwise to deflate the seal. Make sure the pressure indicator reading is "0 psi".

CAUTION

The pressure in the inflatable seal must be completely relieved to prevent any damage to the seal.

NOTE

When air pressure is relieved using the shut-off valve, the normal extending and retracting operation cycle is disabled, for that reason the slide-out cannot be moved using the handheld control.

4. To move the slide-out, use a cordless power drill with a 3/8" hexagonal bit on the shaft extension of the slide-out motor.

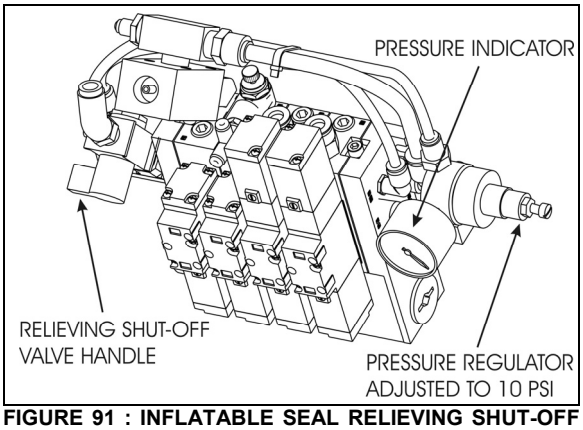


FIGURE 91 : INFLATABLE SEAL RELIEVING SHUT-OFF VALVE

5. Rotate the slide-out motor shaft extension with the power drill until the slide-out comes to its closed position (FIGURE 92).

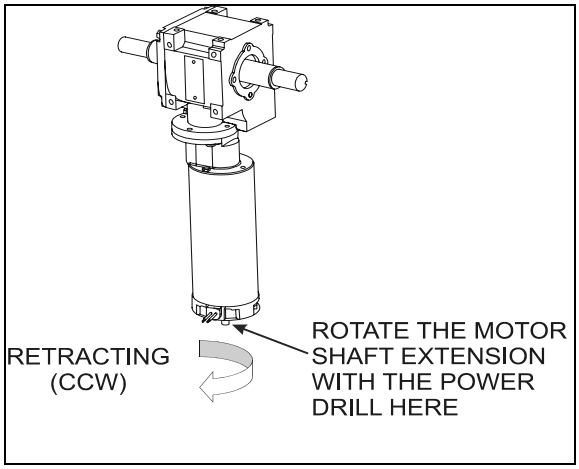


FIGURE 92 : SLIDE-OUT MOTOR ROTATION

6. Once the slide-out room is lined up to its closed position, remove the tool from the motor.

NOTE

*The **front slide-out motor** is located inside the 2nd baggage compartment while the **rear slide-out motor** is accessible from inside the vehicle, under the bed structure.*

CAUTION

Slow down on the closing speed as the slide-out approaches its closed position. As soon as the “in limit” stoppers come in contact with their bearing surface, stop immediately the power drill rotating movement. Not doing so could overload the drive mechanism and cause damage to the reduction gearbox.

4. Finally, the inflatable seal can be re-inflated by turning the shut-off valve handle counterclockwise. Check the pressure gage on the inflatable seal regulator to see if the pressure is increasing to 10 psi (FIGURE 93).

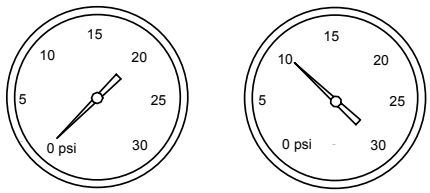


FIGURE 93 : INFLATABLE SEAL PRESSURE GAGE

NOTE

The slide-out control system inhibits transmission range selection to prevent the vehicle from moving if the slide-out is not in its full "IN" position.

18.1.2 Manual extending procedure – Front and rear slide-out

1. Apply parking brake to disengage the security pin from the receptacle.
2. Turn the ignition switch to the "OFF" position, and remove the ignition key for more safety.

3. Deflate the inflatable seal by using the relieving shut-off valve located on the pneumatic component panel (FIGURE 91). Turn the handle clockwise to deflate the seal. Make sure the pressure indicator reading is "0 psi".

⚠ CAUTION

The pressure in the inflatable seal must be completely relieved to prevent any damage to the seal.

NOTE

When air pressure is relieved using the shut-off valve, the normal extending and retracting operation cycle is disabled, for that reason the slide-out cannot be moved with the handheld control.

4. To move the slide-out, use a cordless power drill with a 3/8" hexagonal bit on the shaft extension of the slide-out motor.
5. Rotate the slide-out motor shaft extension with the power drill until the slide-out comes to its opened position (FIGURE 94).
6. Once the slide-out is lined up to its opened position, remove the tool from the motor.

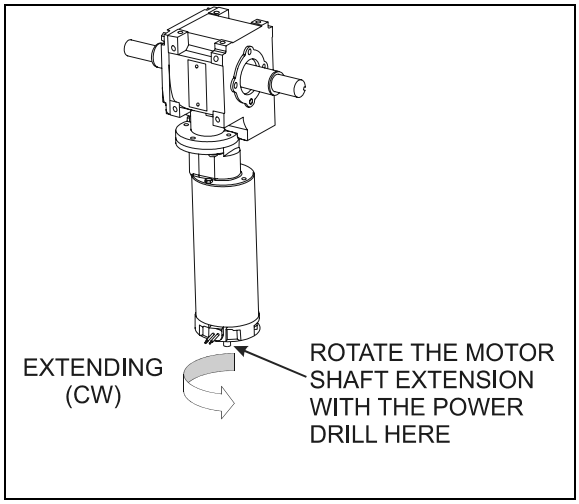


FIGURE 94 : SLIDE-OUT MOTOR ROTATION

NOTE

*The **front slide-out motor** is located inside the 2nd baggage compartment while the **rear slide-out motor** is accessible from inside the vehicle, under the bed structure.*

⚠ CAUTION

Slow down on the closing speed as the slide-out approaches its extended position. As soon as the “out limit” stoppers come in contact with their bearing surface, stop immediately the power drill rotating movement. Not doing so could overload the drive mechanism and cause damage to the reduction gearbox.

7. Finally, the inflatable seal can be re-inflated by turning the shut-off valve handle counterclockwise. Check the pressure gage on the inflatable seal regulator to see if the pressure is increasing to 10 psi (FIGURE 93).

NOTE

The slide-out control system inhibits transmission range selection to prevent the vehicle from moving if the slide-out is not in its full "IN" position.

19 SLIDE-OUT MAXIMUM LOAD

Front slide-out:
Maximum load with vehicle at stand still (retracted or extended) …...1500 lb
Maximum load with vehicle moving or slide-out moving ……...1200 lb[1]

Rear slide-out:
Maximum load with vehicle at stand still (retracted or extended) …..1500 lb
Maximum load with vehicle moving or slide-out moving ……..1000 lb [1]

NOTE

Maximum load includes people weight and equipment added by the converters in the slide-out

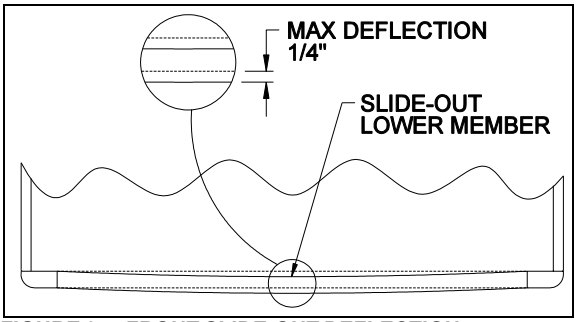
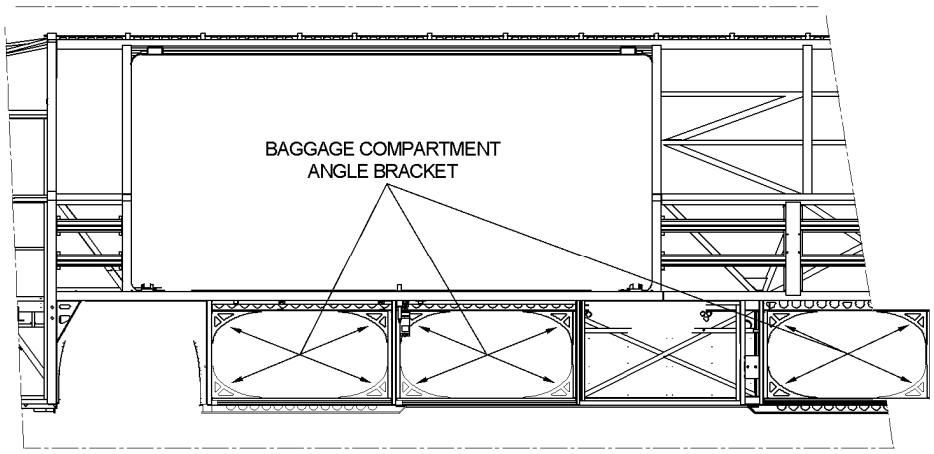


FIGURE 95 : FRONT SLIDE-OUT DEFLECTION

[1] When the load is distributed in the slide-out to prevent a deflection of the inside lower member over ¼” that could damage the seal.

⚠ CAUTION

Never remove the structural reinforcement angle brackets inside the baggage compartments. Doing so could lead to termination of the warranty coverage concerning the structural integrity.



20 CONVERSION CHECKLIST

The converter should check these points before closing the walls covering the roof reinforcing rod and the pinions:

1. Check that the front slide-out exterior panels are parallel with the vehicle panels when retracted. If not, readjust the tilt.
2. Check that the slide-out is straight when completely extended, and that it leans against all inner stoppers.
3. Make sure the vehicle upper member is parallel with the front slide-out structure. If not, readjust the roof reinforcing rod. This may be affected by the loading on the roof.
4. Make sure the front slide-out lower member deflection is within 1/4". If not, redistribute the slide-out load.
5. Check the whole slide-out mechanism good functioning. The slide-out should retract and extend smoothly without vibration.

Final check:

- Make sure the slide-out air pressure inlet valve is completely opened.
- Check the inflatable seal air pressure on the pressure regulator. The pressure should be 10 psi.

TROUBLESHOOTING

20.1 ERROR CONDITION OR MISSING OPERATION CONDITION

When an error condition or a missing operation condition is present on a slide-out, the green indicator light on its respective handheld control starts blinking upon releasing of the IN/OUT rocker switch.
Turning the ignition OFF and ON again, will stop the blinking and reset the fault. If the error condition or a missing operation condition is still present, the blinking will start again the next time that the slide-out is operated. So, to get a fault diagnostic, use the MCD right after operating the slide-out without cycling the ignition switch.

NOTE
It is of the utmost importance to have a MCD (message center display) in working condition because it is the most important tool to achieve troubleshooting on a multiplex vehicle.

Fault diagnostic

To get more specific information about the error condition or the missing operation condition, request a diagnostic from the slide-out CECM using the dashboard message center display (MCD). Check if there are active errors in the slide-out electrical system. With the SYSTEM DIAGNOSTIC menu, highlight FAULT DIAGNOSTIC and then highlight ELECTRICAL SYSTEM to request a diagnostic of the electrical system from the CECM. Press the enter key. If applicable, the MCD shows the device ID, the fault messages or fault codes recorded. When more than one fault is recorded, an arrow pointing down appears on the right of the display. Use the down arrow to see all the fault messages.
Once the problem corrected, the MCD still shows the fault as being active. You have to leave the FAULT DIAGNOSTIC menu, wait approximately 20 to 30 seconds and then return to FAULT DIAGNOSTIC to request a new diagnostic of the ELECTRICAL SYSTEM from the CECM. The MCD should display the fault as being inactive.

20.2 TROUBLESHOOTING – OPERATING CONDITIONS & CONTROL

PROBLEM	CAUSE	CORRECTIVE ACTION
The slide-out functions normally but the handheld control green indicator light blinks	Something is defective and may eventually create an issue if not repaired. The problem may be: A. Faulty limit sensor causing the slide-out to stop in overcurrent; B. CAN network problem causing the transmission inhibit safety to be non-operational; C. Vacuum pressure transducer disconnected or damaged (vacuum is applied for a fixed time of 7 seconds); D. Seal inflating valve solenoid open circuit (the seal is not re-inflated and water can penetrate in the vehicle); E. Security pin valve solenoid open circuit (the security pin is not extended while vehicle is riding).	Request a diagnostic from the electrical system using the MCD SYSTEM DIAGNOSTIC menu and refer to the Fault Message list in section 20.4.

PROBLEM	CAUSE	CORRECTIVE ACTION
The slide-out does not extend	A. The parking brake is not seen by the controller as being applied; B. Not enough air pressure in the accessory air tank to permit proper operation of the vacuum generator; C. Faulty vacuum generator, connection to the vacuum generator open, seal deflating valve solenoid open circuit; D. I/O-B module output defective, regulated 5-volt supply to sensors shorted to ground, “out limit” sensor shorted to ground, connection to the motor negative relay solenoid open circuit;	A. Make sure the parking brake is applied. Confirm parking brake application with the parking brake light on the telltale panel. B. Run the engine at fast idle a few minutes to increase air pressure in the accessory air tank and try again. C. Turn the relieving shut-off valve handle clockwise to deflate the inflatable seal, disconnect the pressure transducer. Do not forget to reconnect the pressure transducer and to close the relieving shut-off valve. Failure to do so could damage the seal and lead to water infiltration; D. Operate the slide-out with the manual override procedures.
The slide-out does not retract	A. Not enough air pressure in the accessory air tank to permit proper operation of the vacuum generator; B. Faulty vacuum generator, connection to the vacuum generator open, seal deflating valve solenoid open circuit; C. I/O-B module output defective, “in limit” sensor shorted to ground, connection to the motor positive relay solenoid open circuit;	A. Run the engine at fast idle a few minutes to increase air pressure in the accessory air tank and try again. B. Turn the relieving shut-off valve handle clockwise to deflate the inflatable seal, disconnect the pressure transducer. CAUTION, do not forget to reconnect the pressure transducer and to close the relieving shut-off valve. Failure to do so could damage the seal and lead to water infiltration; C. Operate the slide-out with the manual override procedures.
When extending, the slide-out stops after having extended by 1 inch	A. The security pin valve solenoid circuit is shorted to (+) 24-volt and the pin remains engaged;	A. Disconnect air supply from the safety pin cylinder;
Transmission DRIVE range or REVERSE cannot be selected (the slide-out telltale light is illuminating).	A. Slide-out not in full "in" position; B. Faulty “in limit” sensor. The slide-out is retracted but the controller doesn’t not see it as retracted.	A. Retract slide-out. B. Confirm that all slide-out are retracted. On the slide-out control panel, disconnect the 5 pins green connector on the I/O-B module to disable the transmission inhibit. CAUTION, this is a temporary measure, the vehicle must be serviced as soon as possible.

20.3 TROUBLESHOOTING - MECHANICAL COMPONENTS

PROBLEM	CAUSE	CORRECTIVE ACTION
Slide-out does not retract or extend when depressing the control switch.	A. Electrical motor failure; B. Speed reduction gearbox failure; C. Security pin still engaged in receptacle;	A. Replace motor. B. Inspect gearbox components, particularly: bronze wheel or first reduction stage output shaft. Replace damaged components. C. Disengage pin and check if air cylinder is damaged.
Slide-out is not straight once retracted or during retracting or extending operation.	A. Broken rack tooth; B. Faulty rack attachment; C. Faulty shaft key at speed reduction gearbox or jaw coupling; D. Pinion keyless bushing slipping; E. Shaft breaking; F. Flange bearing attachment loosen;	A. Replace rack. B. Tighten mounting bolts, apply proper torque and use Loctite threadlocker (replace rack if necessary). C. Replace key or component having a damaged keyway. D. Realign slide-out and apply proper torque to keyless bushing. E. Replace shaft. F. Reposition shaft and tighten flange bearing mounting bolts.
Slide-out moves out slightly when vehicle is traveling.	A. Lower "in limit" stoppers are not leaning against the structure at the moment when the "in limit" sensor detects the magnet;	A. Adjust the sensor position in order to have contact of the stoppers against the structure at the time when the system stops the slide-out retraction.
Slide-out moves when vehicle is moving.	A. Inflatable seal not inflated	A. Check seal condition and seal air supply system.
Slide-out retracts or extends difficultly.	A. Foreign matters accumulated in the linear bearing;	A. Inspect the linear bearing end seals to see if they are in good condition. If not, replace the end seals and clean the inside of linear bearing.
Slide-out oscillates vertically when retracting or extending	A. Linear bearing balls hardened due to a too heavy load; B. Linear bearing mounting bolts loosen;	A. If balls clearance is excessive, replace linear bearing. B. Tighten mounting bolts.
Slide-out vibrating or noisy when extending or retracting	A. Acetal plastic block rubbing against the slide-out structure; B. Worn-out anti-friction coating on wiper seal around slide-out; C. Lower acetal plastic block rubbing against rail;	A. Realign acetal plastic block. B. Replace wiper seal. C. Remove lower acetal plastic block and machine down 1mm (0.039").

PROBLEM	CAUSE	CORRECTIVE ACTION
Top of slide-out moves sideways when vehicle is moving	A. Roof reinforcing rod misadjusted;	A. Readjust as per procedure.
Slide-out does not retract up to its full "in" position	A. Interference between the exterior extrusion and the vehicle upper horizontal member above the slide-out;	A. Check for straightness of horizontal member and adjust the roof reinforcing rod. B. Check for outer wiper seal lip straightness on the slide-out roof.
Bottom of slide-out not flush with vehicle body	A. Broken or misadjusted lower "in limit" stopper; B. Lower "in limit" stoppers are not leaning against the structure at the moment when the "in limit" sensor detects the magnet; C. Acetal plastic block serving as leaning surface for lower "in limit" stopper broken or moved;	A. Replace or adjust lower "in limit" stopper. B. Adjust the sensor position in order to have contact of the stoppers against the structure when slide-out is stopped. C. Replace or adjust acetal plastic block proper position.
Top of slide-out not flush with vehicle body	A. Broken or misadjusted leveling or retaining screw; B. Faulty upper “in limit" stopper;	A. Check and replace screw. B. Replace upper “in limit" stopper.
Lower edge of slide-out not parallel with vehicle body opening	A. Faulty leveling and retaining screw (8 screws each side).	A. Inspect screw, replace and adjust slide-out level.
Watertightness problem	A. Inflatable seal and/or wiper seal damaged or unstuck; B. Insufficient air pressure in the seal; C. No air pressure in the slide-out pneumatic system; D. Sealant missing; E. Wiper seal draining hole clogged; F. Faulty water recovery pan; G. Faulty internal gutter;	A. Check both seals condition. B. Check the pressure regulator, the relieving shut-off valve and the seal valve condition. C. Check the slide-out air pressure inlet valve condition and the accessory air tank pressure. D. Check the exterior extrusion screws, the windows and the exterior panels sealant condition. E. Unclog draining hole. F. Check the recovery pan. G. Check internal gutter.
Knocking sound at end of travel when extending slide-out	A. Inner stoppers misadjusted;	A. Readjust the inner stoppers.

PROBLEM	CAUSE	CORRECTIVE ACTION
Knocking sound when parking brake is released	A. Security pin retracts too rapidly;	A. Adjust security pin air flow regulator.
Inflatable seal damaged or removed, or wiper seal unstuck from the structure.	A. Slide-out has been retracted or extended with the manual procedure with the inflatable seal not deflated; B. Pressure transducer malfunction; C. Faulty roof reinforcing rod adjustment; D. Seal valve malfunction; E. Excessive load in the slide-out; F. Slide-out not centered in the structure opening;	A. Always deflate the seal when manually retracting or extending the slide-out. B. Check the pressure transducer condition, replace if necessary. C. Readjust the roof reinforcing rod. D. Check the seal valve condition. E. Reduce load or distribute load evenly in order to respect the deflection criterion and slide-out load capacity. F. Readjust the slide-out height and center horizontally in opening.
Friction at end of travel when in full OUT position or at beginning of retraction	A. Interference between upper structure key and upper inner stopper;	A. Readjust the upper inner stopper.

20.4 SLIDE-OUT FAULT MESSAGE ON MESSAGE CENTER DISPLAY (MCD)

SID #	FAULT MESSAGE	TEXT	PROBABLE CAUSE	CORRECTIVE ACTION
1	Voltage Module A56	Value Too Low	Module A56 sees a Voltage less than 18 V on its power supply connector. Breaker, fuse or wiring harness open.	Check/ reset circuit breaker CBSo and CBSo1. Check/ replace fuse FSo5 Fix wiring harness
2	No Response Mod A56	Data Error	CECM module does not receive CAN communication from module A56. CAN connector A56 J3 Disconnected or CAN wiring harness open, or module A56 is defective.	Check connection A56 J3 Fix CAN wiring harness Replace module A56
3	Voltage Module A57	Value Too Low	Module A57 sees a voltage less than 18 V on its power supply connector. Breaker, fuse or wiring harness open.	Check/ reset circuit breaker CBSo and CBSo2. Check/ replace fuse FSo2 Fix wiring harness
4	No Response Mod A57	Data Error	CECM module does not receive CAN communication from module A57. CAN connector A57 J3 disconnected or CAN wiring harness open or module A57 is defective.	Check connection A57 J3 Fix CAN wiring harness Replace module
5	SldO Vacuum Sensor	Open Circuit	Pressure transducer disconnected. Faulty pressure transducer. Connection or wiring harness open.	Check/ replace vacuum transducer Check/ reconnect the connector SESo1 Fix wiring harness
		Shorted High	Pressure transducer is faulty Wiring harness shorted to 12v or 24v	Check/ replace vacuum transducer Fix wiring harness
6	SldO Seal Deaf Vac	Mechanical Fault	Does not reach vacuum level (-5 PSIG). Slide-out seal damaged or air leak in the seal deflating pneumatic circuit.	Check the seals and the pneumatic circuit.
7	SldO Motor/Limit se	Mechanical Or Electrical Fault	Slide-Out motor is activated for more than 5 seconds and the limit sensor from the departing end is still seen as active. Either the motor is defective and the slide-out is not moving or the limit sensor from the departing end is broken active.	If the slide-Out is not moving, then check the motor and its wiring. If the slide-out is moving, then check the limit sensor from the departing end. (If problem occurs when extending, check the in-limit sensor. If the problem occurred when retracting, then check the out-limit sensor).
8	SldO Park Br Signal	Mechanical Or Electrical Fault	Parking brake is not applied. Wire between parking brake switch and CECM is open.	Make sure the parking brake is applied and the parking brake telltale illuminates. Check / replace parking brake switch. Fix wiring harness.

SID #	FAULT MESSAGE	TEXT	PROBABLE CAUSE	CORRECTIVE ACTION
		Shorted High	Wire between parking brake switch and CECM is shorted to 12v or 24v.	Fix wiring harness.
9	SldO Mot SpeedA Ctr	Shorted High	Wiring harness shorted to 12v or 24v	Fix wiring harness
		Current Above normal	Security pin or object stop the movement of a slide-out	Check / fix security pin functionality. Check / remove any object around the slide-out.
10	SldO Mot SpeedB Ctr	Shorted High	Wiring harness shorted to 12v or 24v	Fix wiring harness
		Current Above normal	Security pin or object stop the movement of a slide-out	Check / fix security pin functionality. Check / remove any object around the slide-out.
11	SldO Remote Led	Shorted High	LED or wiring harness shorted to 12v or 24v	Fix LED or wiring harness
		Shorted Low	Led or wiring harness shorted to ground	Fix LED or wiring harness
		Open Circuit	LED is broken. Bad connection on handheld control. Wiring harness is cut.	Check / fix remote LED or connection Check /fix wiring harness
		Current Above normal	Led or wiring harness shorted to 12v or 24v	Fix Led or wiring harness
12	SldO Seal Inf Sol	Shorted High	Solenoid or wiring harness shorted to 12v or 24v	Fix solenoid or wiring harness
		Shorted Low	Solenoid or wiring harness shorted to ground	Fix solenoid or wiring harness
		Open Circuit	Solenoid is broken or open. Bad connection on solenoid or bloc valve. Wiring harness is cut.	Check / fix solenoid or connection Check /fix wiring harness
		Current Above normal	Solenoid or wiring harness shorted to 12v or 24v	Fix solenoid or wiring harness
13	SldO Seal Def Sol	Shorted High	Solenoid or wiring harness shorted to 12v or 24v	Fix solenoid or wiring harness
		Shorted Low	Solenoid or wiring harness shorted to ground	Fix solenoid or wiring harness
		Open Circuit	Solenoid is broken or open. Bad connection on solenoid or bloc valve. Wiring harness is cut.	Check / fix solenoid or connection. Check /fix wiring harness
		Current Above normal	Solenoid or wiring harness shorted to 12v or 24v	Fix solenoid or wiring harness
14	SldO Vacc Gen Sol	Shorted High	Solenoid or wiring harness shorted to 12v or 24v	Fix solenoid or wiring harness
		Shorted Low	Solenoid or wiring harness Shorted to ground	Fix solenoid or wiring harness
		Open Circuit	Solenoid is broken or open. Bad connection on solenoid or bloc valve. Wiring harness is cut.	Check / fix solenoid or connection Check / fix wiring harness
		Current Above normal	Solenoid or wiring harness shorted to 12v or 24v	Fix Solenoid or wiring harness
15	SldO Mot Neg Rly	Shorted High	Relay coil or wiring harness shorted to 12v or 24v	Fix relay coil or wiring harness

SID #	FAULT MESSAGE	TEXT	PROBABLE CAUSE	CORRECTIVE ACTION
		Shorted Low	Relay coil or wiring harness shorted to ground	Fix relay coil or wiring harness
		Open Circuit	Relay coil is broken or open. Bad connection on relay. Wiring harness is cut.	Check / fix relay coil or connection Check / fix wiring harness
		Current Above normal	Relay coil or wiring harness shorted to 12v or 24v	Fix relay coil or wiring harness
16	SldO Mot Pos Rly	Shorted High	Relay coil or wiring harness shorted to 12v or 24v	Fix relay coil or wiring harness
		Shorted Low	Relay coil or wiring harness shorted to ground	Fix relay coil or wiring harness
		Open Circuit	Relay coil is broken or open. Bad connection on relay. Wiring harness is cut.	Check / fix relay coil or connection Check / fix wiring harness
		Current Above normal	Relay coil or wiring harness shorted to 12v or 24v	Fix relay coil or wiring harness
17	SldO Open Sw	Shorted High	Switch or wiring harness shorted to 12v or 24v	Fix switch or wiring harness
18	SldO Close Sw	Shorted High	Switch or wiring harness shorted to 12v or 24v	Fix switch or wiring harness
19	SldO Limit In Se	Shorted High	Sensor or wiring harness shorted to 12v or 24v	Fix sensor or wiring harness
20	SldO Limit Out Se	Shorted High	Sensor or wiring harness shorted to 12v or 24v	Fix sensor or wiring harness
21	SldO Secu Pin Sol	Shorted High	Solenoid or wiring harness shorted to 12v or 24v	Fix solenoid or wiring harness
		Shorted Low	Solenoid or wiring Harness shorted to ground	Fix solenoid or wiring harness
		Open Circuit	Solenoid is broken or open. Bad connection on solenoid or bloc valve. Wiring harness is cut.	Check / fix solenoid or connection. Check / fix wiring harness
		Current Above normal	Solenoid or wiring harness shorted to 12v or 24v	Fix solenoid or wiring harness
22	SldO Limit In Out	Mechanical Or Electrical Fault	In Limit and Out Limit are seen at the same time. In Limit or Out Limit problem.	Check / replace in limit or out limit sensors Fix wiring harness.
23	Limit Sensor 5 V supply	Shorted Low	5v IO-B output is less than 2v. Wiring harness is open or shorted to ground.	Check 5v output on IO-B / replace IO-B module. Fix wiring harness.