PREVOST
COACH MANUFACTURER

MAINTENANCE MANUAL

LE MIRAGE XLII
BUS SHELLS

PA1553

CONTENTS

ILLUSTRATIONS

1. FOREWORD

This manual includes procedures for diagnosis, service, maintenance and repair for components of the XLII series bus shell models as 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 bus shell 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. Coach operating information is provided in a separate Owner's 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.

Prévost Car 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 **XLII Multiplex** vehicles, also execute procedure no: PR060034 "MULTIPLEX MODULES DISCONNECTION PROCEDURE PRIOR TO WELDING" included at the end of this section.*

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, disconnect electronic modules and battery terminals.

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, disconnect electronic modules and battery terminals.

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% CO_2

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 :

- o SMAW (Shield Metal-Arc Welding) process;
- o Welding rod conforms to AWS (American Welding Standards) A5.4 specifications; 308L-17 type welding rod with 3/32" diameter (2,4 mm);
- o 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 PRÉVOST vehicles.

This manual covers only the procedures as of manufacturing date.

Safety features may be impaired if other than genuine PRÉVOST 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 coach 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

The engine serial and model numbers are stamped on the cylinder block (as viewed from the flywheel end) on the left side just below the fire deck and above the cast-in Detroit Diesel logo (Fig. 1).

In addition, option plates made of laminated paper are located on the rocker cover (starter side). The engine serial and model number and a list of the optional engine equipment is written on the option plate. Refer to this information when ordering replacement parts (Fig. 1).

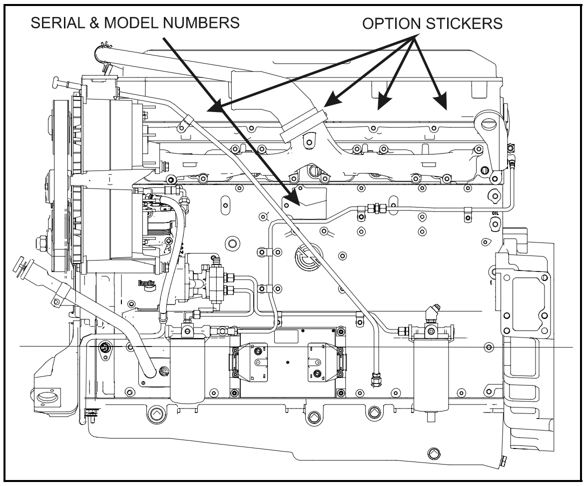


FIGURE 1 : DETROIT DIESEL SERIES 60 00043

4.1.2 Transmission

The transmission identification plate is located on the fluid level dipstick side of the transmission (Fig. 2). The identification plate shows the transmission serial number, part number (assembly number), and model number. Use all three numbers when ordering parts.

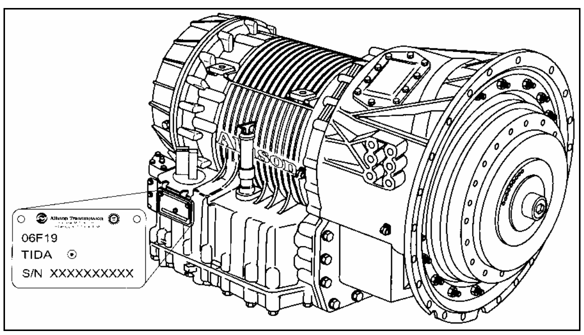


FIGURE 2: ALLISON TRANSMISSION 07139

4.1.3 Drive Axle

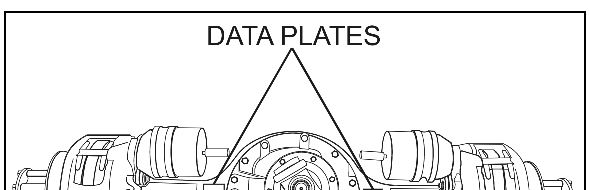


FIGURE 3: TYPICAL SERIAL & MODEL NUMBERS 11019

4.1.4 Front Suspension

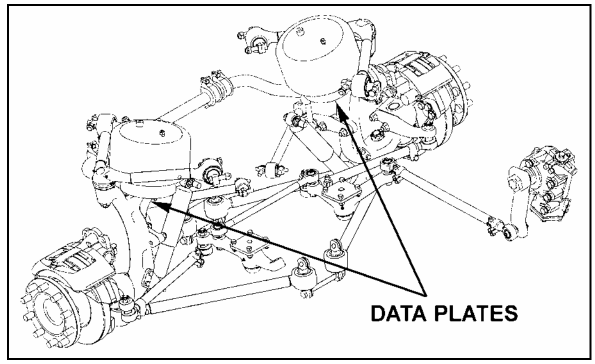


FIGURE 4: ISS TYPICAL SERIAL & MODEL NUMBERS

4.1.5 Power Steering Pump

Power steering pump serial number is located on a tag on the pump (Fig. 5). The pump is mounted on the engine beside the crankshaft pulley.

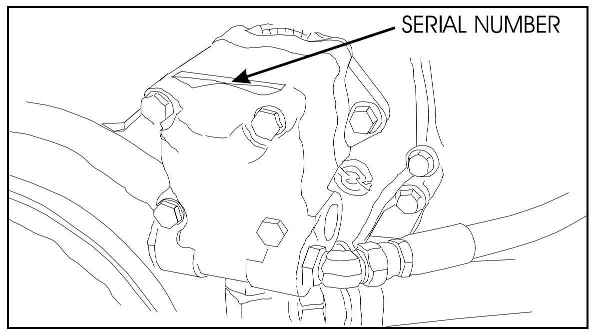


FIGURE 5 : POWER STEERING PUMP NAMEPLATE 00035

4.1.6 Coach Final Record

The Coach Final Record is a record of all data pertaining to the assembly of the coach. This record is included in the technical publication package supplied with the coach. Retain this record in the company records office for reference and safe-keeping.

4.1.7 Safety Certification

Coach 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 coaches 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 to L.H. control panel.

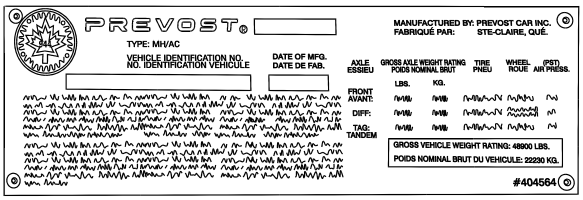
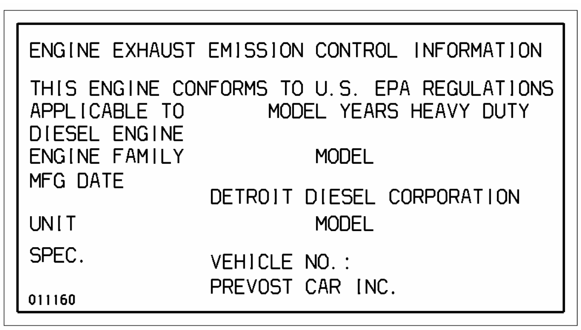


FIGURE 6: DOT CERTIFICATION PLATE 00016

4.1.9 EPA Engine Label

The exhaust emission certification label affixed above the engine certifies that the engine conforms to federal and any state exhaust emission regulations (Fig. 7). It gives the operating conditions under which certification was made.



ENGINE EXHAUST EMISSION CONTROL INFORMATION

THIS ENGINE CONFORMS TO U.S. EPA REGULATIONS
APPLICABLE TO MODEL YEARS HEAVY DUTY
DIESEL ENGINE
ENGINE FAMILY MODEL
MFG DATE
DETROIT DIESEL CORPORATION
UNIT MODEL
SPEC.
VEHICLE NO.:
PREVOST CAR INC.
011160

FIGURE 7 : ENGINE COMPARTMENT 00173

4.1.10 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.

4.1.11 Vehicle Identification Number (VIN)

The seventeen digit vehicle identification number (VIN) is located on a plate (Fig. 8 & 9) located on the windshield frame pillar (driver's side). The VIN is visible from the outside of the coach. Make sure the correct vehicle identification number is given when ordering replacement parts. Using the VIN when ordering parts will facilitate processing.

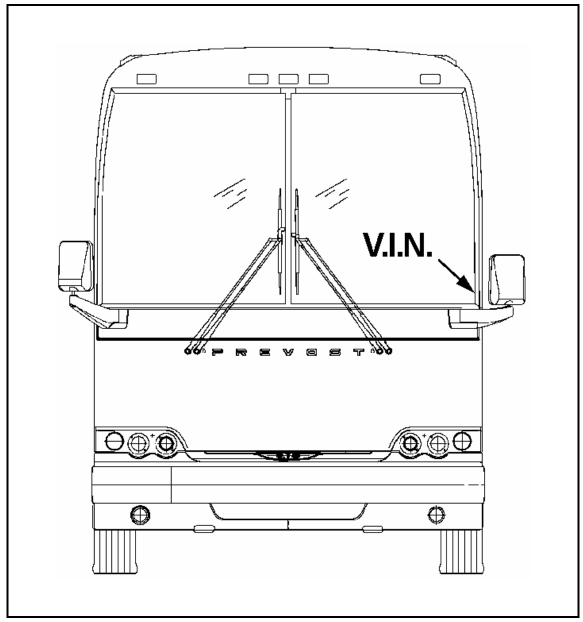
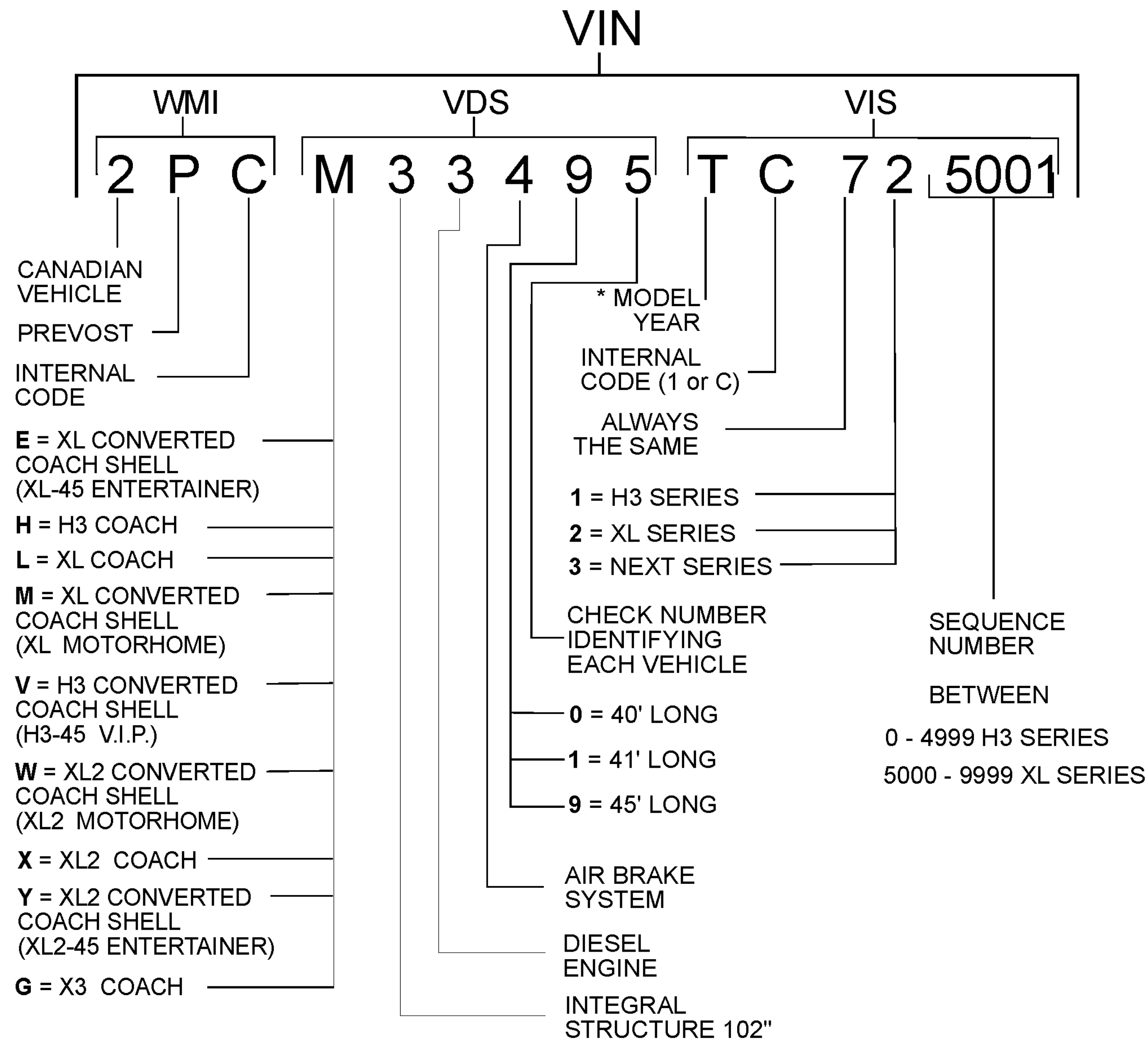


FIGURE 8 : VEHICLE I.D. 00020

NOTE
Record the VIN in the coach 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.

FIGURE 9 : VEHICLE IDENTIFICATION NUMBER 00050

YEAR	CODE	YEAR	CODE
2000	Y	2006	6
2001	1	2007	7
2002	2	2008	8
2003	3	2009	9
2004	4	2010	A
2005	5	2011	B

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. 11 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 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.

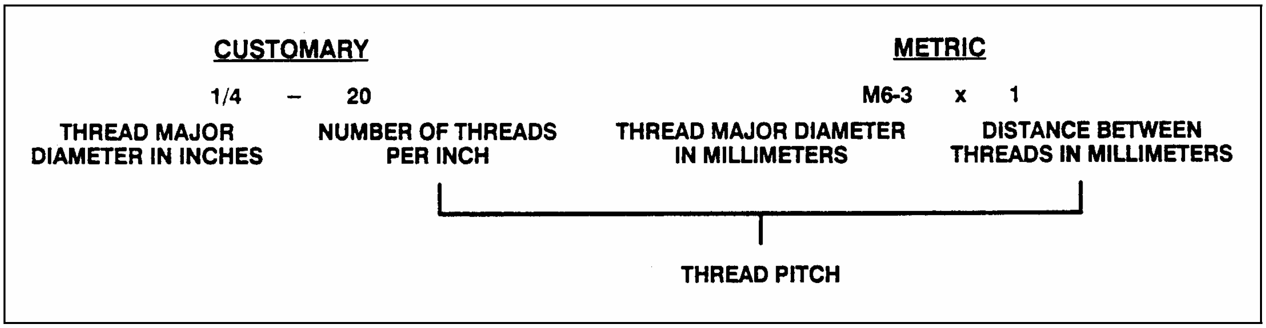


FIGURE 10 : THREAD NOTATION 00002

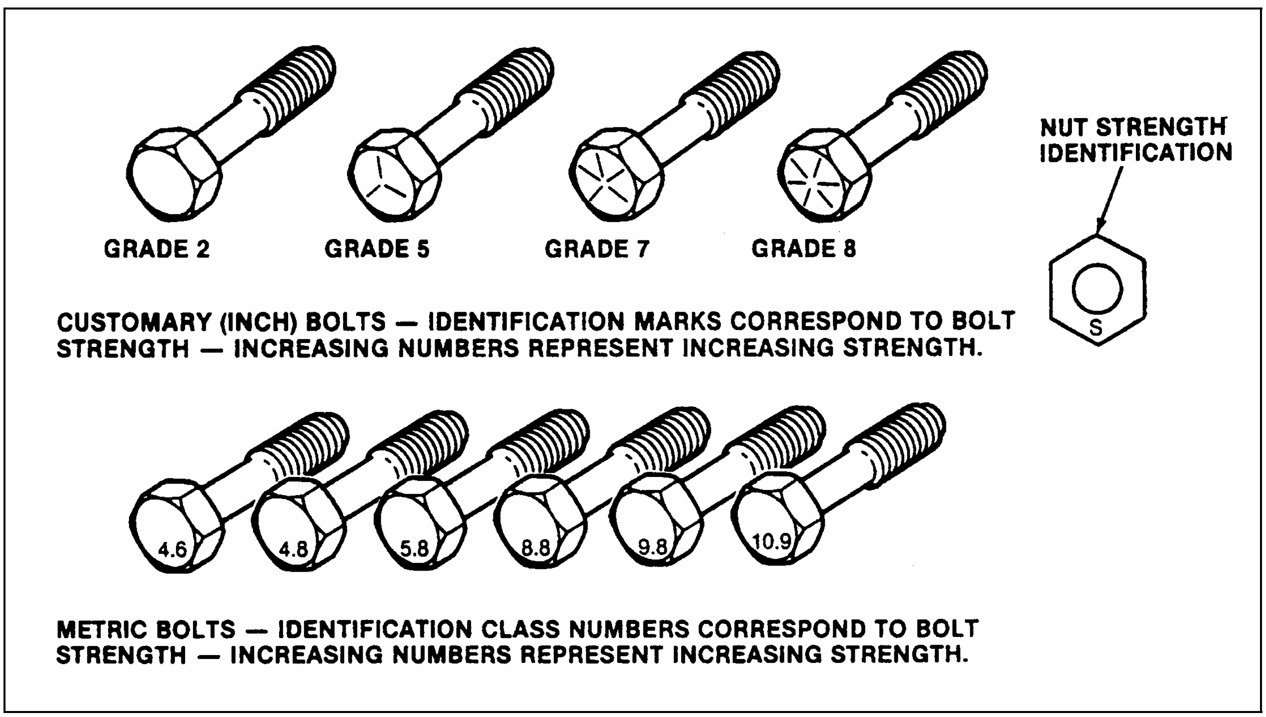


FIGURE 11: BOLT STRENGTH MARKINGS 00003

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 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. 12).

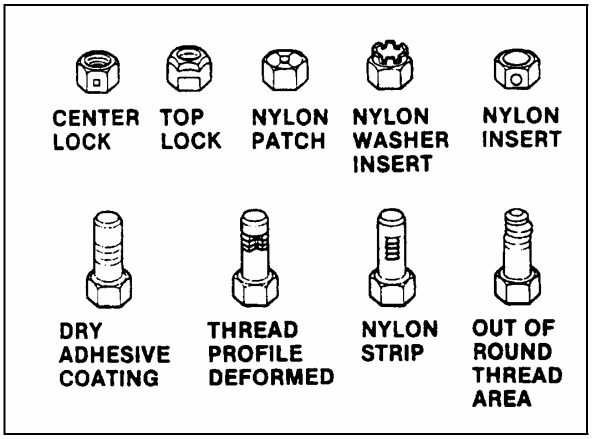


FIGURE 12 : SELF-LOCKING FASTENERS 00004

5.2 RECOMMENDATIONS FOR REUSE

Clean, unrusted 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

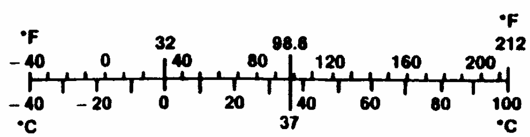
METRIC		6 & 6.3	8	10	12	14	16	20
NUTS AND ALL-METAL BOLTS	Nm	0.4	0.8	1.4	2.2	3.0	4.2	7.0
	Lbf-in	4.0	7.0	12	18	25	35	57
ADHESIVE OR NYLON COATED BOLTS	Nm	0.4	0.6	1.2	1.6	2.4	3.4	5.6
	Lbf-in	4.0	5.0	10	14	20	28	46

US STANDARD		.250	.312	.375	.437	.500	.562	.625	.750
NUTS AND ALL-METAL BOLTS	Nm	0.4	0.6	1.4	1.8	2.4	3.2	4.2	6.2
	Lbf-in	4.0	5.0	12	15	20	27	35	51
ADHESIVE OR NYLON COATED BOLTS	Nm	0.4	0.6	1.0	1.4	1.8	2.6	3.4	5.2
	Lbf-in	4.0	5.0	9.0	12	15	22	28	43

5.3 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	(† 0F − 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 3.6×10^6	joules (J = one W's)
	LIGHT	
Foot candle	1.076	lumens/meter² (lm/m²)
	VELOCITY	
Miles/hour	1.609	kilometers/hr (km/h)

FIGURE 13: 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 14: CONVERSION CHART

00006

PREVOST

MULTIPLEX MODULES DISCONNECTION PROCEDURE PRIOR TO WELDING

PROCEDURE NO: PR060034	REVISION 3 2007-02-27

Material : N/A

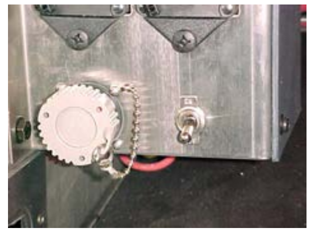
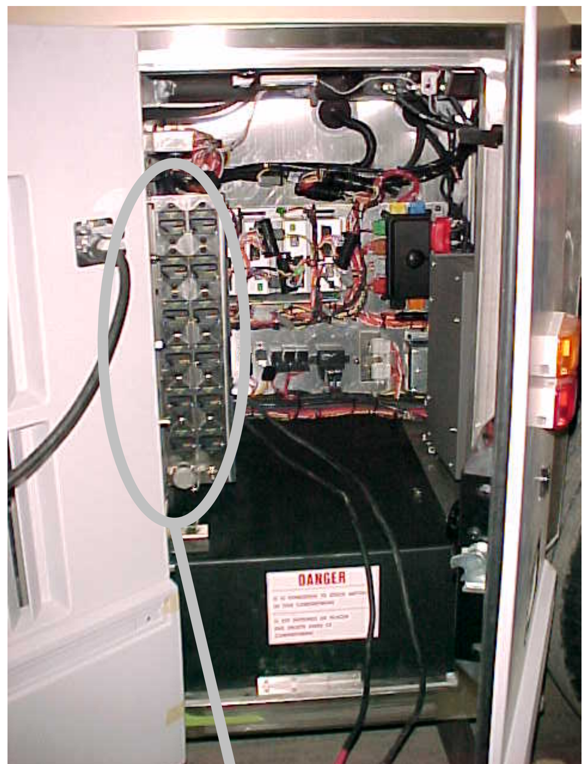
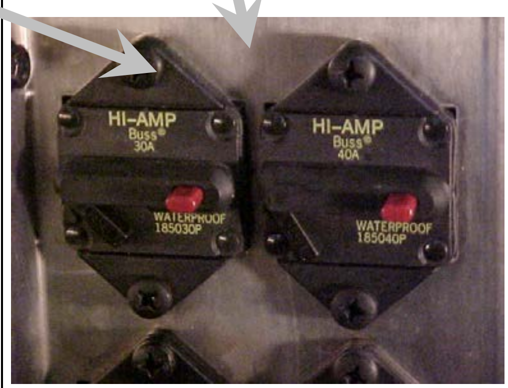
Equipment(s) :
Phillips-head screwdriver
Ratchet handle
3/8" socket
Electric tape
Long nose pliers

Reference schematics: N/A

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

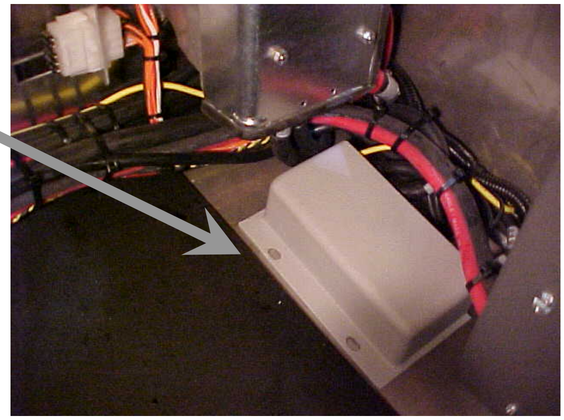
Recommendations: **This procedure should be performed by qualified personnel only.**

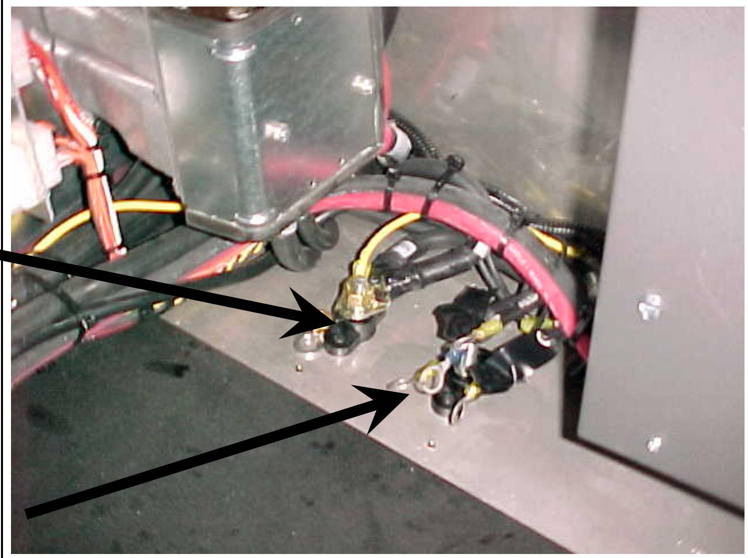
	Effective
Revision 0 : Issued with multiplex	
Revision 1 : Modified for Fire Protection System and also for VIP with multiplex	
Revision 2 : Step 5 modified for introduction of VIP with multiplex	**-0436**
Revision 3 : Step 1.15 added C397 **Addition of SECTION 2 for X3 Coaches** **Addition of SECTION 3 for XLII MTH**	

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 circuit breakers CB2, CB4, CB6 Push the red button to open the circuit	 

1.10 **Location: Main power compartment**

Remove the protective cover



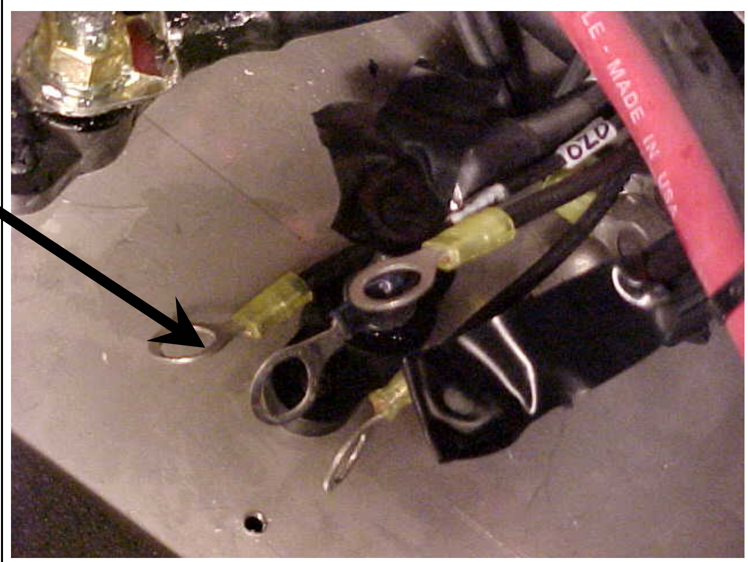


⚠ WARNING ⚠

LIVE WIRE

This 12-volt terminal remains energized

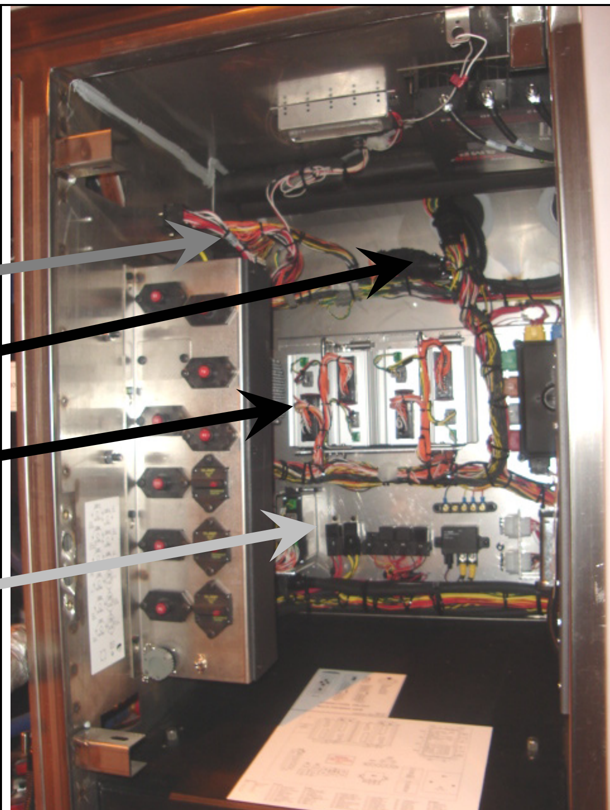
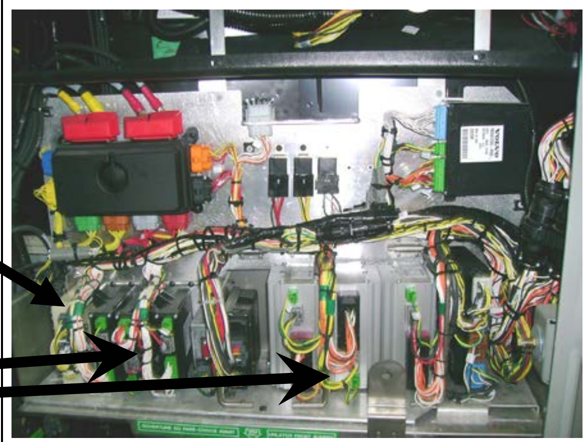
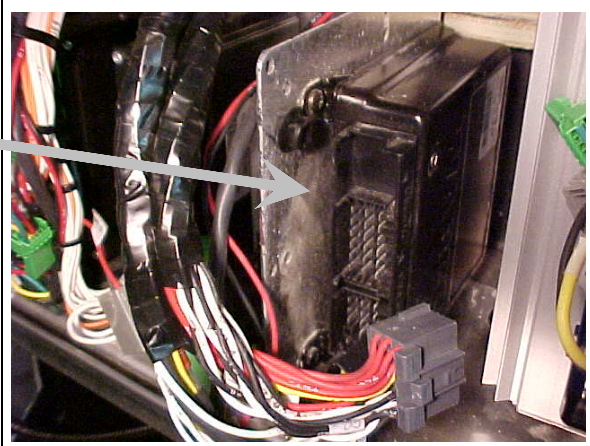
Disconnect the electronic ground terminals from the stud



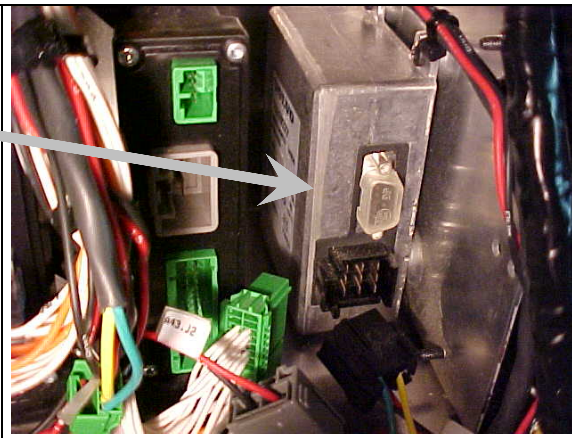
Using electric tape, insulate the 2 largest gage wires. Make sure the ring terminals do not touch each others and the vehicle body.

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 the I/O A and I/O B modules Disconnect C397 Disconnect connector C717 Unplug 3 connectors per I/O B modules Unplug 3 connectors on the I/O A module	
1.20	**Location: Front electrical compartment** **VIP + COACH:** Disconnect the I/O A, I/O B, ABS, master ID, CECM and CPC modules. Unplug connector C92 **VIP:** Disconnect all keyless module connectors. Unplug 3 connectors per I/O B modules and 3 connectors per I/O A modules. Unplug 2 connectors from the ABS module	 

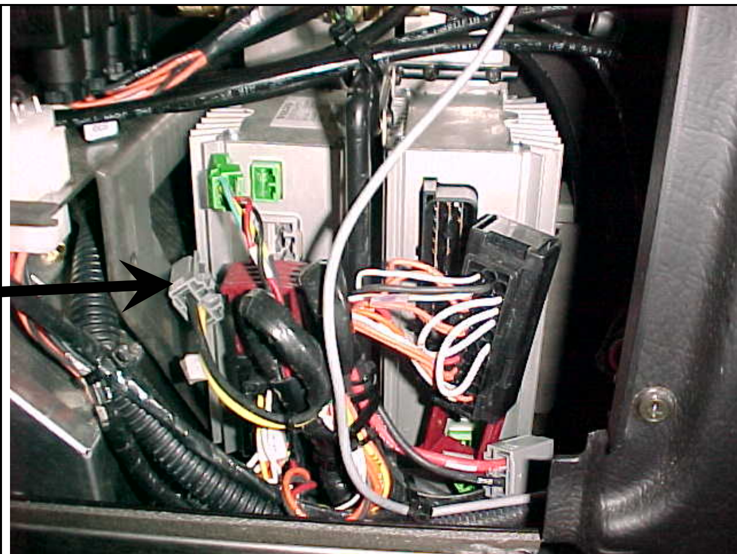
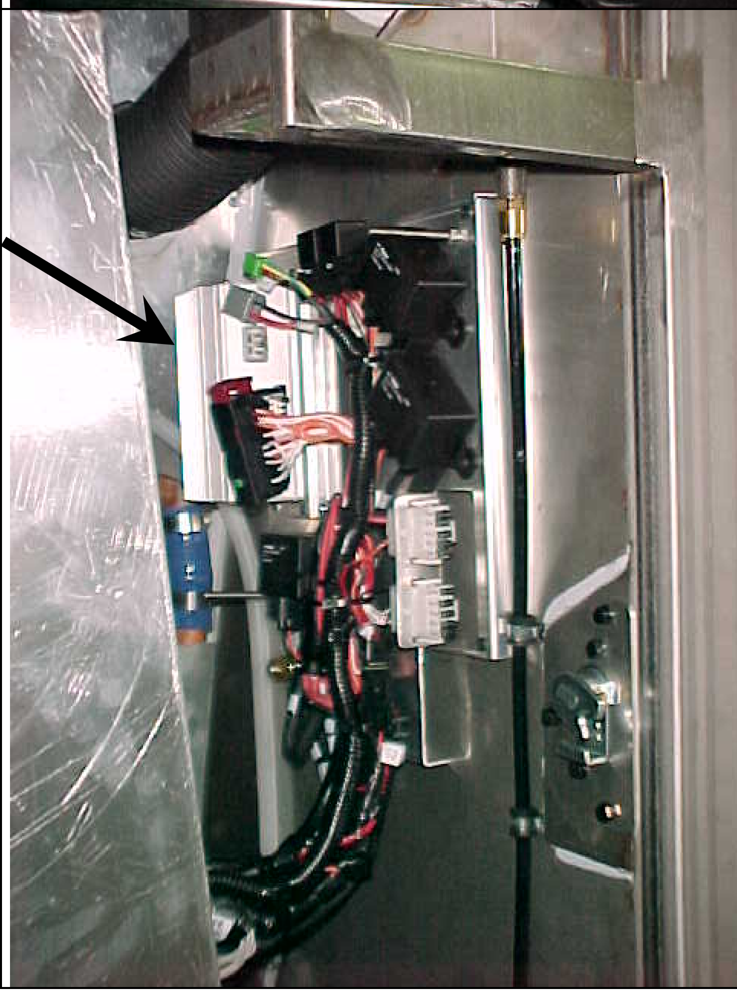
Unplug 1 connector from the master ID



Disconnect CPC connectors

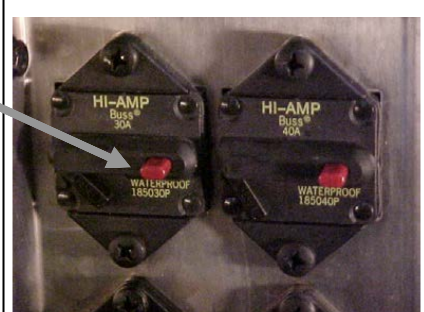
Unplug 3 connectors from the CECM

Unplug connector C92

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: Evaporator compartment** Remove the protective cover and disconnect the 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

2.00	**Location: Rear electrical compartment and dashboard** Set the battery master switch to the OFF position. Place the ignition switch to the OFF position.	 
2.05	**Location: Rear electrical compartment** Trip circuit breakers CB2-CB4-CB6 located on rear junction panel Push the red button in to open the circuit	 

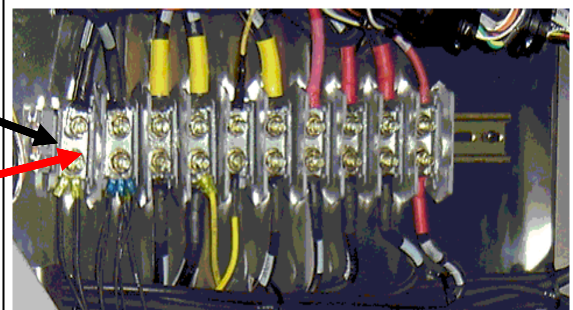
<table>
<tr><td>2.10</td><td>Location: Rear electrical compartment

Disconnect the electronic ground terminals from this stud

Warning: The remaining terminals may still be energized

Use electric tape; make sure that cables do not touch each others and the vehicle body.

NOTE

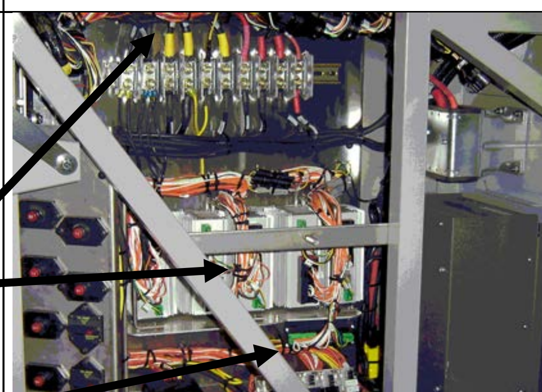
With disconnection of the electronic ground terminals, disconnecting the engine ECM, transmission TCM and the dashboard electronic components (telltale module, HVAC module, radio, control head, …) is not required.</td><td></td></tr>
<tr><td>2.15</td><td>Location: Rear electrical compartment

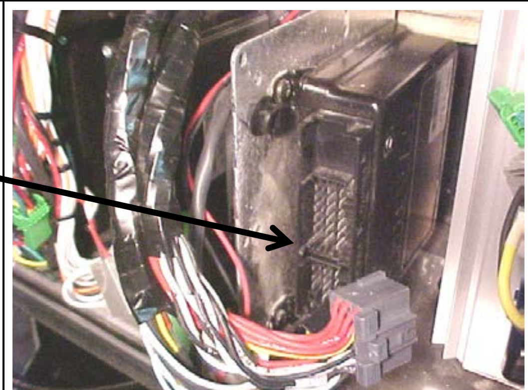
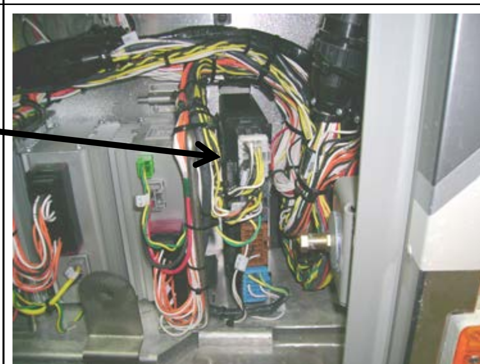
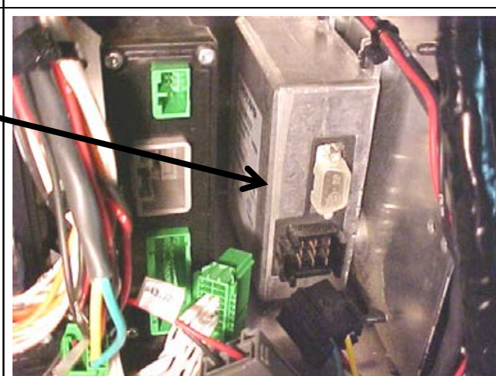
Disconnect the electronic modules:

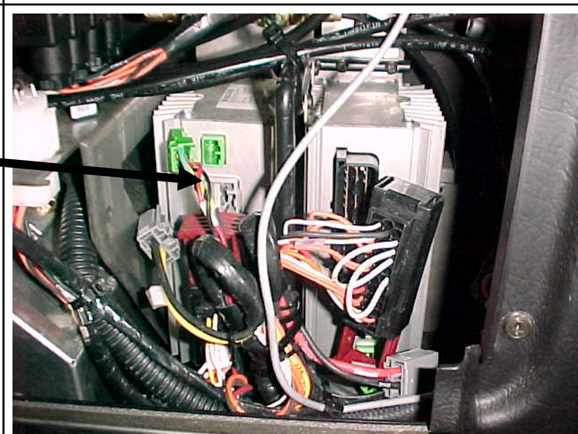
Disconnect all I/O A and I/O B modules

Disconnect C397 and C717

Disconnect 3 connectors from each I/O B module

Disconnect 3 connectors from each I/O A module</td><td></td></tr>
</table>

2.20	**Location: front electrical compartment** Disconnect I/O A, I/O B, ABS, master ID, CECM and CPC modules and also disconnect connector C92 Disconnect the 3 connectors from the I/O B and I/O A modules	
	Disconnect the 2 connectors from the ABS module	
	Disconnect CPC connectors	
	Disconnect connector from master ID	

	Disconnect the 3 connectors from CECM	
	Disconnect connector C92	
2.25	**Location: Entrance door & wiper control panel** Remove windshield wiper motor access panel and disconnect both I/O B modules	
2.30	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**
2.40	**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 3 XLII MTH

2.00	**Location: Dashboard** Place the ignition switch to the OFF position.	
2.05	**Location: Engine compartment R. H. side area** Trip circuit breakers CB1-CB2 located on circuit breaker panel. Push the blue button in to open the circuit	
2.10	**Location: Rear Junction Box** Disconnect the electronic ground terminals from this stud. **Warning: The remaining terminals may still be energized.** 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 Junction Box**

Disconnect the electronic modules:

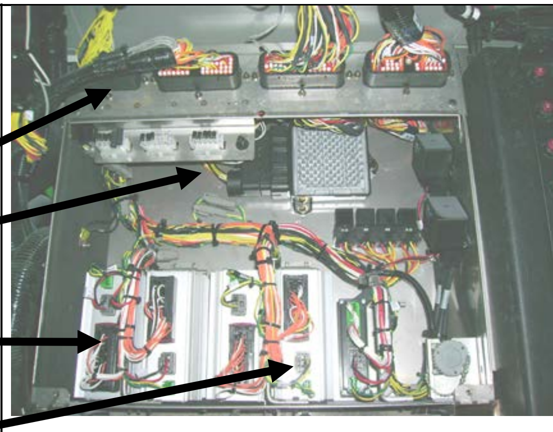
Disconnect all I/O A and I/O B modules

Disconnect C397

Disconnect transmission module (A1)

Disconnect 3 connectors from each I/O B

Disconnect 3 connectors from each I/O A



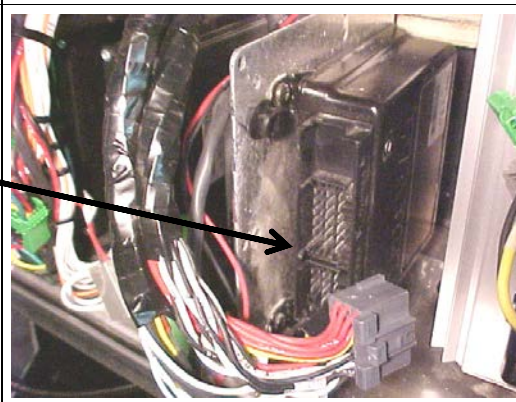
2.20 **Location: Front Electrical Compartment**

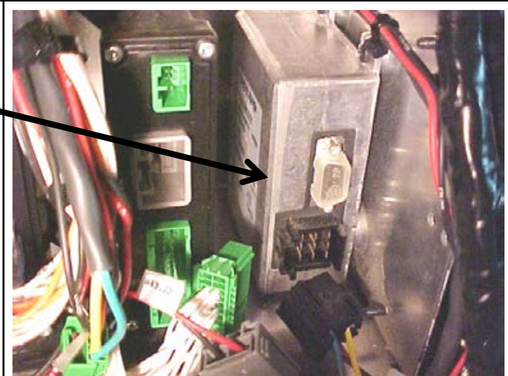
Disconnect I/O A, I/O B, ABS, master ID, CECM, CPC, keyless modules and also disconnect connector C92.

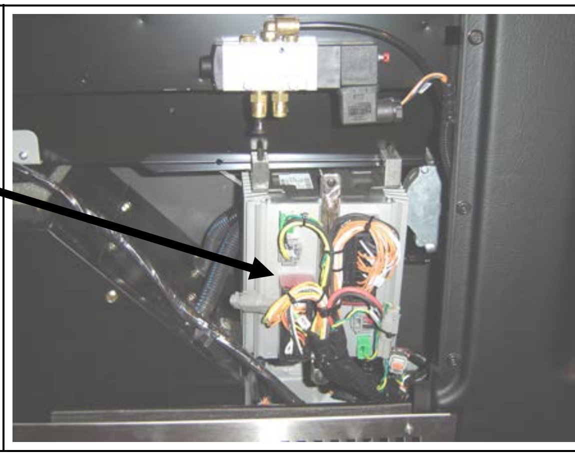
Disconnect 3 connectors from the I/O B and I/O A modules

Disconnect connectors from Keyless module

Disconnect 2 connectors from ABS module



	Disconnect connectors from CPC	
	Disconnect connector from master ID	
	Disconnect 3 connectors from CECM	
	Disconnect connector C92	

	Location: Wiper Control Panel Remove windshield wiper motor access panel And disconnect I/O B modules	

2.30	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**
2.35	**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**

CONTENTS

ILLUSTRATIONS

1. ENGINE

This vehicle is powered by a 6-cylinder, four-cycle, Detroit Diesel series 60 engine equipped with an electronic control system (DDEC V).

Two engine displacements are used in the Series 60 engines: 12.7 and 14.0 liters. Summary information on the Electronic Control System is given in this section.

Complete maintenance and repair information on the engine will be found in the current DDEC V Service Manual. This maintenance manual covers engine accessories, controls and related components.

Procedures for engine removal and installation are given at the end of this section. The DDEC system is self-diagnostic. It can identify faulty components and other engine-related problems by providing the technician with a diagnostic code.

Refer to DDEC Troubleshooting Guide published by Detroit Diesel for more complete information on diagnosis of components and system problems.

DDEC V (**D**etroit **D**iesel **E**lectronic **C**ontrol) controls the timing and quantity of fuel injected by the electronic unit injectors (EUI). The system also monitors several engine functions using electrical sensors, which send electrical signals to the Electronic Control Module (ECM). The ECM computes the electrical signals and determines the correct fuel output and timing for optimum power, fuel economy and emissions. The ECM also has the ability to display warnings or shut down the engine completely (depending on option selection) in the event of damaging engine conditions, such as low oil pressure, low coolant level, or high oil temperature.

Two categories divide system components: engine-mounted components and engine-related components.

2. ENGINE-MOUNTED COMPONENTS

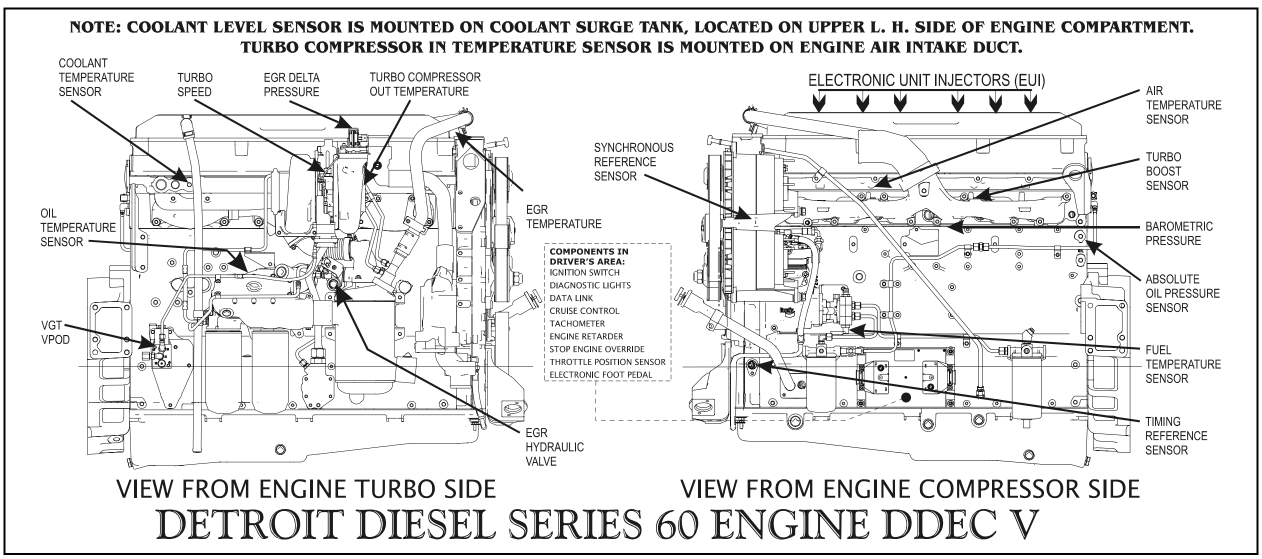


FIGURE 1: DETROIT DIESEL SERIES 60 ENGINE (TYPICAL) 01150

Engine-mounted components are as follows:

- Electronic Control Module
- Electronic Unit Injector
- Synchronous Reference Sensor
- Timing Reference Sensor
- Turbo Boost Pressure Sensor
- Coolant Temperature Sensor
- Fuel Temperature Sensor
- Air Temperature Sensor
- Absolute Oil Pressure Sensor
- Oil Temperature Sensor
- Barometric Pressure
- EGR Delta Pressure
- EGR Temperature
- Turbo Speed
- Turbo Compressor Out Temperature
- Turbo Compressor In Temperature

2.1 ELECTRONIC CONTROL MODULE

The Electronic Control Module is mounted, on the starter side of the engine (Fig. 2). Considered the *"Brain"* of the DDEC V system, it provides overall monitoring and control of the engine. It does so by comparing input data from the various sensors to a set of calibration data stored in the EEPROM (**E**lectrically **E**rasable, **P**rogrammable, **R**ead-**O**nly **M**emory) within the Electronic Control Module. After comparing the input data with the calibration data, the ECM sends high-current command pulses to the Electronic Unit Injectors (EUI) to initiate fuel injection. The ECM also receives feedback regarding the start and end of injection for a given cylinder. The EEPROM within the Electronic Control Module is factory programmed by Detroit Diesel. Reprogramming must be done at a Detroit Diesel authorized service center. However, some changes may be performed to the cruise control and road speed limiter using a diagnostic data reader (see paragraph "DDEC V Diagnostic Codes" in this section).

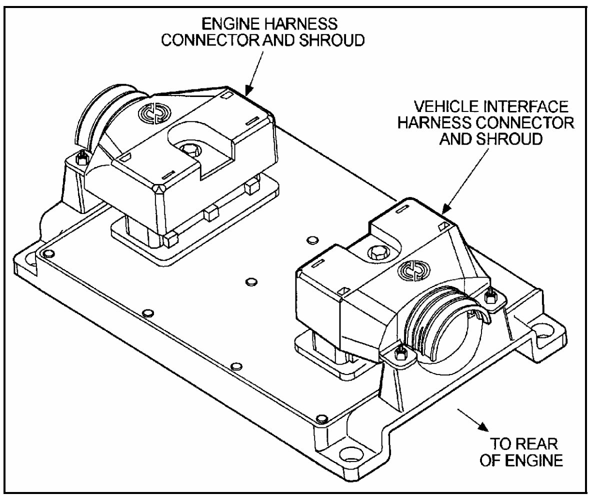


FIGURE 2: ELECTRONIC CONTROL MODULE (ECM) 01145

2.2 N3 ELECTRONIC UNIT INJECTOR

The N3 Electronic Unit Injector (EUI) is a compact device that injects diesel fuel directly into the combustion chamber (Fig. 3). The amount of fuel injected and injection timing is determined by the Electronic Control Module (ECM). The ECM sends a command pulse, which activates the injector solenoid. The EUI performs four functions:

- o Creates the high-fuel pressure required for efficient injection;
- o Meters and injects the exact amount of fuel required to handle the load;
- o Atomizes the fuel for mixing with the air in the combustion chamber;
- o Permits continuous fuel flow for component cooling**.**

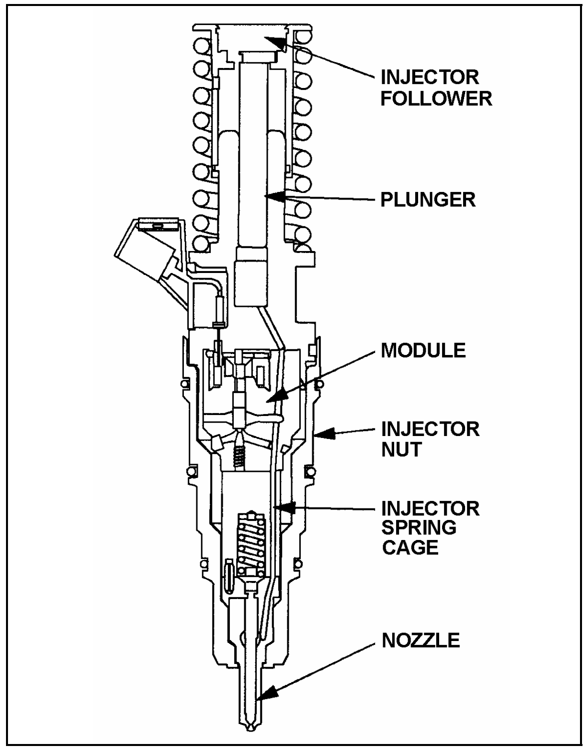


FIGURE 3: UNIT INJECTOR CROSS SECTION 01146

2.3 VPOD

There is one air-operated Variable Pressure Output Device (VPOD) that controls the Variable Geometry Turbo (VGT). The location of the VPOD is to the left of the engine oil filters (Fig. 4). Pneumatic system supplies air pressure.

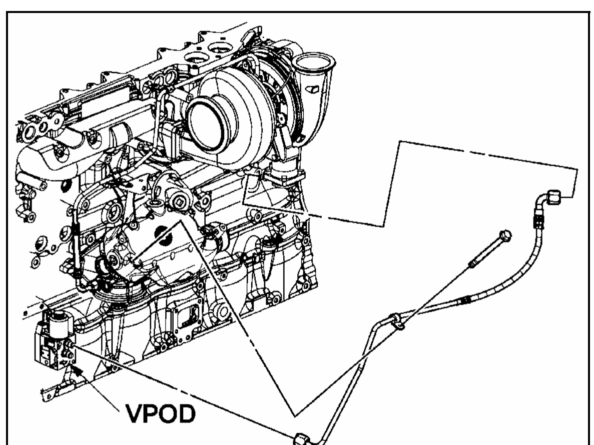


FIGURE 4: VPOD LOCATION 01149

2.3.1 VPOD Removal

1. Remove airline from VPOD.
2. Unplug harness connection.
3. Remove two bolts and one stud holding VPOD assembly and bracket to engine block.

2.3.2 VPOD Installation

1. Align VPOD assembly and bracket to threaded holes in engine block; install two bolts and one stud. Torque the M10 bolts and M10 stud to 43-54 Lbf-ft (58-73 Nm). Torque the M8 bolt to 22-28 Lbf-ft (30-38 Nm).
2. Connect airline to VPOD and tighten.
3. Plug harness connection into VPOD assembly.

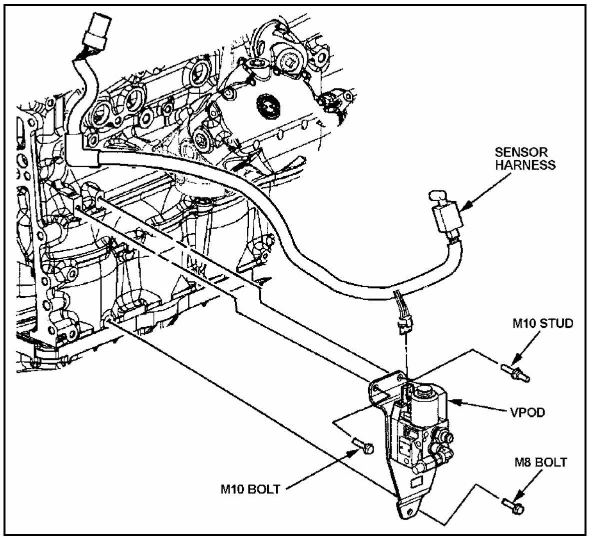


FIGURE 5: VPOD INSTALLATION 01147

NOTE
VPOD assembly is not serviceable, remove and replace only.

2.4 EGR HYDRAULIC VALVE

The hydraulic valve that controls the Exhaust Gas Recirculation (EGR) system is located on the same side as the VPOD but near the EGR cooler (Fig. 1 & 6).

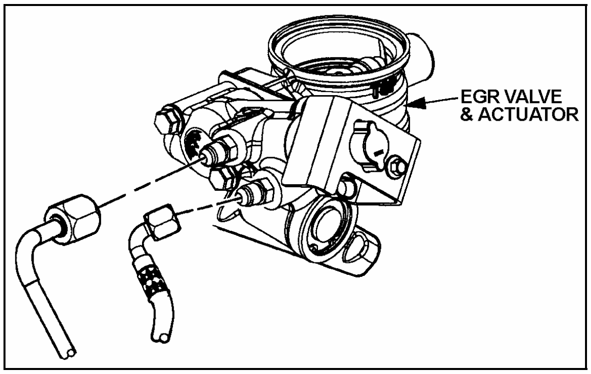


FIGURE 6: EGR VALVE & ACTUATOR ASSEMBLY 01148

2.5 SYNCHRONOUS REFERENCE SENSOR

The Synchronous Reference Sensor (SRS) is an electronic component, mounted to the rear of the gear case (Fig. 1). The SRS senses a raised metal pin on the rear of the camshaft idler gear and sends a signal to the ECM via a black connector wire. The SRS sensor extends through a hole in the gear case. It is positioned near the rear of the idler gear. A bolt, inserted through a hole in the SRS bracket, secures the SRS assembly to the gear case.

The idler gear pin passes by the SRS as piston number one crank pin reaches 45° before Top-Dead-Center. The ECM uses this information to determine engine speed.

The SRS is non-serviceable and must be replaced as a unit. No adjustment is required.

2.6 TIMING REFERENCE SENSOR

The Timing Reference Sensor (TRS) is an electronic component mounted on the left side of the gear case (right side of coach), near the crankshaft centerline. The TRS is positioned near the timing wheel gear teeth and extends through an opening in the gear case. A bolt, inserted through a hole in the TRS bracket, secures the TRS assembly to the gear case. The TRS connector is gray. The TRS sends a signal to the ECM, this signal is generated by a series of evenly spaced special teeth on the timing wheel. A tooth passes by the TRS as each cylinder crank pin reaches 10° before Top-Dead-Center.

The ECM uses these signals to determine injector solenoid operation time. The TRS is non-serviceable and must be replaced as a unit. No adjustment is required.

2.7 TURBO BOOST PRESSURE SENSOR

The Turbo Boost Pressure Sensor is located on the intake manifold. This device is a pressure sensor that sends an electrical signal to the ECM. The ECM uses this information to compute the volume of air entering the engine. Turbo boost sensor information regulates fuel supply to control engine exhaust.

The turbo boost pressure sensor is non-serviceable and must be replaced as an assembly. No adjustment is required.

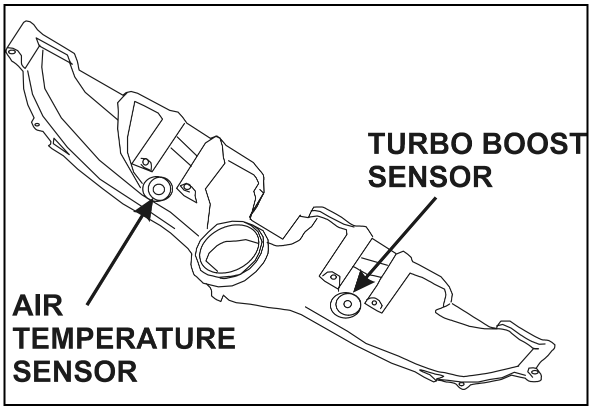


FIGURE 7: TURBO BOOST PRESSURE SENSOR 01138

2.8 COOLANT TEMPERATURE SENSOR

The coolant temperature sensor (Fig. 1) is mounted on the engine's radiator side (turbo side). The sensor helps protect the engine against overheating by sensing coolant temperature.

2.9 FUEL TEMPERATURE SENSOR

The Fuel Temperature Sensor (FTS) is installed underneath the fuel pump (Fig. 8).

The FTS sends an electrical signal to the ECM indicating fuel inlet temperature. The ECM uses this information to calculate fuel consumption.

The FTS is non-serviceable and must be replaced as a unit. No adjustment is required.

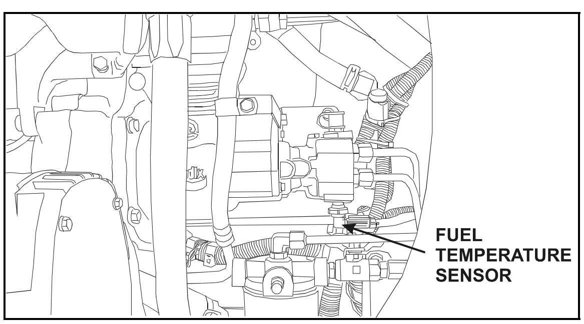


FIGURE 8: FUEL TEMPERATURE SENSOR 03053B

2.10 AIR TEMPERATURE SENSOR

The Air Temperature Sensor (Fig. 1 & 7) located on the intake manifold provides input data to vary hot idle speed and injection timing. This helps to improve cold starts and reduces white exhaust smoke.

2.11 TURBO COMPRESSOR IN TEMPERATURE SENSOR

The Turbo Compressor In Temperature Sensor is located on the engine air intake pipe (Fig. 9).

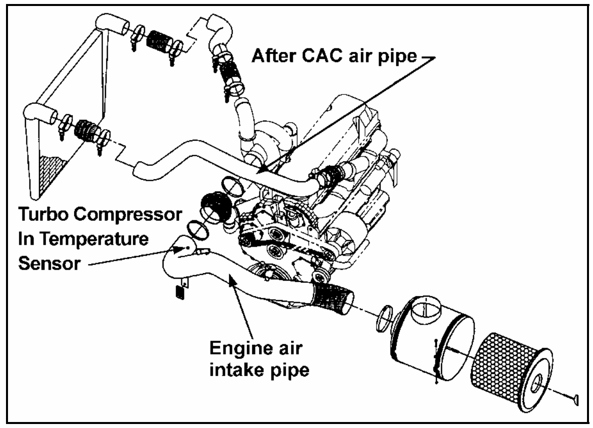


FIGURE 9: TURBO COMPRESSOR IN TEMPERATURE SENSOR LOCATION 01170

2.12 ABSOLUTE OIL PRESSURE SENSOR

The Absolute Oil Pressure Sensor (OPS) is installed in the main engine-oil gallery. A typical location is the left rear corner of the cylinder block (Fig. 10). The OPS sends an electrical signal to the ECM indicating the engine oil pressure at any given speed. A low oil pressure signal exceeding seven seconds is used by the ECM to begin the stop engine or warning function. The OPS is non-serviceable and must be replaced as a unit. No adjustment is required.

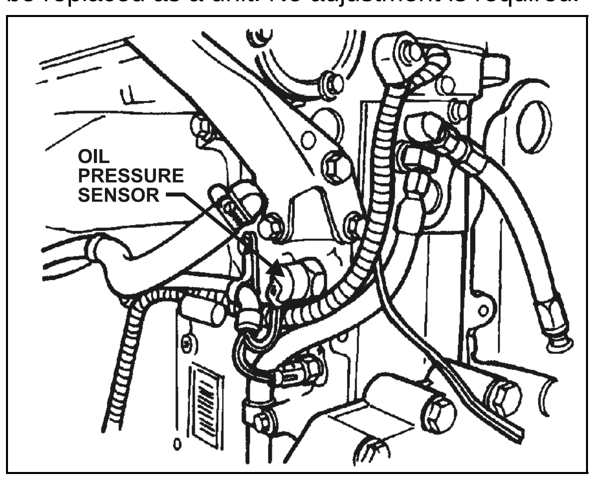


FIGURE 10: ENGINE OPS 01025B

2.13 OIL TEMPERATURE SENSOR

The Oil Temperature Sensor (OTS) is installed behind the engine oil filters manifold (Fig. 1). The OTS sends an electrical signal to the ECM indicating engine oil temperature. The ECM uses this information to modify engine speed for better cold weather starts and faster warm-ups. Oil temperatures exceeding engine specifications for two seconds or more will illuminate the Check Engine Light.

The OTS is non-serviceable and must be replaced as a unit. No adjustment is required.

3. ENGINE-RELATED COMPONENTS

Engine-related components include:

- Coolant Level System (CLS)
- Electronic Foot Pedal Assembly (EFPA) and Throttle Position Sensor
- Cruise Control Switch (CCS)
- Diagnostic System Accessories (DSA)

3.1 COOLANT LEVEL SYSTEM (CLS)

The coolant level system consists of a conductivity probe mounted in the surge tank and an electronic interface module located inside the rear junction box. Coolant level is determined by the change in impedance of the probe and its brass mount when immersed in coolant. The electronic device in the module conditions the signal to levels compatible with DDEC. A low coolant level will trigger the engine warning functions.

The probe and electronic interface module are non-serviceable items and should be replaced as units, if found defective. No adjustment is required.

3.2 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 Electronic Control Module (ECM). The TPS signal 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. 11). The (TPS) converts the operator's foot pedal input into a signal for the ECM. The (EFPA) is shown in Figure 11.

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.

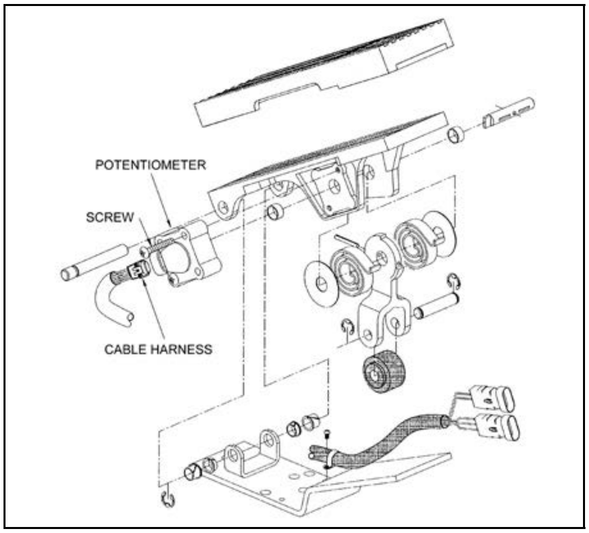


FIGURE 11: ELECTRONIC FOOT PEDAL ASSEMBLY 03035

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 ECM will signal diagnostic codes of 21-12 for idle error and 21-23 for wide-open throttle error.

3.3 CRUISE CONTROL SWITCHES (CCS)

The four cruise control switches are located in the driver's area on the L.H. side control panel.

1. **Cruise:** This is the main switch that actuates the ECM memory in order to use the speed-regulating mode.
2. **Set:** This switch is used to set the cruise control speed or to decrease the set speed by 2 MPH at each application.

NOTE
Cruise control system will not accept speed settings, nor will the "Resume" switch operate below 20 mph (32 km/h) and the engine speed must be above 1100 RPM.

3. **Resume:** Each time this switch is actuated, the speed will be increased by 2 mph (3,5 km/h). This switch allows the driver return to the last regulated speed following a brake or *"DECEL"* switch application.

NOTE
On-off switch must be in the "ON" position in order to return to the last regulated speed.

4. **Decel:** Will cancel the cruise temporarily and let the vehicle coast. Set speed is still in memory for resume.

For additional information, refer to the "Owner's Manual".

3.4 DIAGNOSTIC SYSTEM ACCESSORIES (DSA)

The DDEC V engine Diagnostic System Accessories includes the following:

- o Check Engine telltale light;
- o Stop Engine telltale light;
- o Stop Engine Override switch;
- o Diagnostic Data Link (DDL) connectors.

3.4.1 Check Engine Telltale Light

The Check Engine telltale, mounted on the telltale light panel indicates that a problem has been detected and that a code has been stored in the ECM memory. This light also has a 5-second bulb check when the ignition is first turned on. The Check Engine telltale illuminates when the temperature at coolant sensors exceeds 217°F (103°C) and the temperature at oil sensors exceeds 260°F (127°C). When sensors reach those temperatures, DDEC starts to decrease engine power linearly.

3.4.2 Stop Engine Telltale Light

This light, also mounted on the telltale light panel, illuminates to indicate that a major engine problem is occurring (with the exception of a 5-second bulb check when the ignition is first turned on). The Stop Engine Light illuminates when the temperature at coolant sensors exceeds 222°F (106°C) and the temperature at oil sensors exceeds 239°F (115°C). When sensors detect such temperatures, DDEC shuts the engine down after a 30 seconds grace period. This 30-second delay may be extended another 30 seconds (if absolutely necessary) by using the STOP ENGINE OVERRIDE switch.

NOTE
Once engine is stopped, it can not be restarted until the malfunction is corrected.

3.4.3 Stop Engine Override Switch

This switch, mounted on the dashboard, may be used to extend the 30-second delay period before engine shutdown when the Stop engine telltale light is illuminated. This switch can be repeatedly depressed in order to move the vehicle out of traffic.

NOTE
The stop engine override switch will be operative only if it has been depressed before the end of the 30 second delay period.

CAUTION
The OVERRIDE switch must be used only in emergency cases, such as to move the vehicle out of traffic. Excessive use of this switch can cause serious damage to the engine.

This switch is also used for DDEC diagnostic code requests. Press this switch with the engine at idle or off but with the ignition in the "ON" position and active codes will be flashed on the CHECK ENGINE and STOP ENGINE telltale lights alternately. Refer to “DDEC V DIAGNOSTIC CODES” in this section for more information.

3.4.4 Diagnostic Data Link (DDL) Connectors

A connector is mounted on the L.H. footwell wall. Another connector is located in the rear electric compartment. They allow the connection of the Diagnostic Data Reader (DDR) to read the codes or to access pertinent data on the condition of the engine. This enables a more complete analysis of any defect found in the DDEC system operation. For more information, see Detroit Diesel Troubleshooting Guide.

4. DDEC V DIAGNOSTIC CODES

4.1 READING DIAGNOSTIC CODES - FLASHING LIGHT METHOD:

DDEC V makes use of two types of codes: Active and inactive. The difference between the two types of codes is as follows:

Active Codes: Codes that are currently keeping the Check Engine or Stop Engine telltale light illuminated. Active codes are flashed via the Stop Engine Light when checked with the stop-engine-override switch.

Inactive Codes: These are all the codes logged in the ECM (whether or not they are currently turning on the Stop or Check Engine Light). Inactive codes are flashed via the Check Engine telltale light when checked with the stop-engine-override switch. In most instances, only the DDR can provide the information necessary for a quick diagnosis of the problem.

If you just need to read out codes, however, and do not have a DDR available, the following procedure will let you read out codes. Make sure the rear-starting switch (located in the engine compartment) is in the normal position. With the ignition ON, the engine idling or engine shut-off, momentarily depress the Stop Engine Override switch.

Active codes will be flashed on the stop engine telltale, followed by the inactive codes being flashed on the check-engine telltale panel. The cycle repeats itself until the operator depresses the stop engine override switch again. A code "43" consists of four flashes, followed by a short pause, then three flashes in quick succession.

Refer to DDEC Troubleshooting Manual for more information and SAE codes.

NOTE
Active codes are flashed in ascending numerical flash code order. Inactive codes are flashed in most recent to least recent order.

NOTE
Fault codes can only be cleared using the DDR.

NOTE
The listed codes may not be used in all applications. A default value in the normal operating range is used by the ECM to provide for engine operation if a sensor failure is present.

DDEC V Code	PID	SID	FMI	DESCRIPTION
11	187	--	4	Variable Speed Governor Sensor Voltage Low
11	187	--	7	Variable Speed Governor Switch System Not Responding
12	187	--	3	Variable Speed Governor Sensor Voltage High
13	111	--	4	Coolant Level Sensor Input Voltage Low
13	111	--	6	Add Coolant Level Sensor Input Voltage Low
13		146	6	EGR Valve Current too High
14	52	--	3	Intercooler Coolant Temperature Sensor Input Voltage High
14	110	--	3	Coolant Temperature Sensor Input Voltage High
14	175	--	3	Oil Temperature Sensor Input Voltage High
15	52	--	4	Intercooler Coolant Temperature Sensor Input Voltage Low
15	110	--	4	Coolant Temperature Sensor Input Voltage Low
15	175	--	4	Oil Temperature Sensor Input Voltage Low
16	111	--	3	Coolant Level Sensor Input Voltage High
16	111	--	5	Add Coolant Level Sensor Input Voltage High

DDEC V Code	PID	SID	FMI	DESCRIPTION
16		146	5	EGR Valve Current too Low
17	51	--	3	Throttle Plate Position Sensor Input Voltage High
17	72	--	3	Blower Bypass Position Input Voltage High
17	354	--	3	Relative Humidity Sensor Circuit Failed High
18	51	--	4	Throttle Plate Position Sensor Input Voltage Low
18	72	--	4	Blower Bypass Position Input Voltage Low
18	354	--	4	Relative Humidity Sensor Circuit Failed Low
21	91	--	3	Throttle Position Sensor Input Voltage High
22	91	--	4	Throttle Position Sensor Input Voltage Low
23	174	--	3	Fuel Temperature Sensor Input Voltage High
23	--	65	3	Oxygen Content Circuit Input Voltage High
24	174	--	4	Fuel Temperature Sensor Input Voltage Low
24	--	65	4	Oxygen Content Circuit Input Voltage Low
25	--	--	--	Reserved for ‘‘No Codes"
26	--	25	11	Aux. Shutdown #1 Active
26	--	61	11	Aux. Shutdown #2 Active
27	105	--	3	Intake Manifold Temperature Sensor Input Voltage High
27	171	--	3	Ambient Air Temperature Sensor Input Voltage High
27	172	--	3	Air Temperature Sensor Input Voltage High
28	105	--	4	Intake Manifold Temperature Sensor Input Voltage Low
28	171	--	4	Ambient Air Temperature Sensor Input Voltage Low
28	172	--	4	Air Temperature Sensor Input Voltage Low
29	351	—	4	TCI Temperature Circuit Failed Low
29	404	—	4	Turbo Compressor Temperature Out Sensor Input Voltage Low
31	--	51	3	Aux. Output #3 Open Circuit (High Side) – Pin E-49
31	--	51	4	Aux. Output #3 Short To Ground (High Side) – Pin E-49
31	--	51	7	Aux. Output #3 Mechanical System Fail - Pin E-49
31	--	52	3	Aux. Output #4 Open Circuit (High Side) - Pin E-48
31	--	52	4	Aux. Output #4 Short to Ground (High Side) - Pin E-48
31	--	52	7	Aux. Output #4 Mechanical System Failure - Pin E-48
31	--	260	3	Aux. Output #12 Open Circuit (High Side) - Pin E-46
31	--	260	4	Aux. Output #12 Short to Ground (High Side) - Pin E-46
31	--	260	7	Aux. Output #12 Mechanical System Failure - Pin E-46
31	--	261	3	Aux. Output #13 Open Circuit (High Side) - Pin E-47
31	--	261	4	Aux. Output #13 Short to Ground (High Side) - Pin E-47

DDEC V Code	PID	SID	FMI	DESCRIPTION
31	--	261	7	Aux. Output #13 Mechanical System Failure - Pin E-47
31	--	262	3	Aux. Output #14 Open Circuit (High Side) - Pin E-50
31	--	262	4	Aux. Output #14 Short to Ground (High Side) - Pin E-50
31	--	262	7	Aux. Output #14 Mechanical System Failure - Pin E-50
31	--	263	3	Aux. Output #15 Open Circuit (High Side) - Pin E-51
31	--	263	4	Aux. Output #15 Short to Ground (High Side) - Pin E-51
31	--	263	7	Aux. Output #15 Mechanical System Failure - Pin E-51
31	--	264	3	Aux. Output #16 Open Circuit (High Side) - Pin E-52
31	--	264	4	Aux. Output #16 Short to Ground (High Side) - Pin E-52
31	--	264	7	Aux. Output #16 Mechanical System Failure - Pin E-52
31	--	265	3	Aux. Output #17 Open Circuit (High Side) - Pin E-53
31	--	265	4	Aux. Output #17 Short to Ground (High Side) - Pin E-53
31	--	265	7	Aux. Output #17 Mechanical System Failure - Pin E-53
32	--	238	3	RSL Short to Battery (+)
32	--	238	4	RSL Open Circuit
32	--	239	3	AWL Short to Battery (+)
32	--	239	4	AWL Open Circuit
33	102	--	3	Turbo Boost Pressure Sensor Input Voltage High
34	102	--	4	Turbo Boost Pressure Sensor Input Voltage Low
35	19	--	3	High Range Oil Pressure Sensor Input Voltage High
35	100	--	3	Oil Pressure Sensor Input Voltage High
36	19	--	4	High Range Oil Pressure Sensor Input Voltage Low
36	100	--	4	Oil Pressure Sensor Input Voltage Low
37	18	--	3	High Range Fuel Pressure Sensor Input Voltage High
37	94	--	3	Fuel Pressure Sensor Input Voltage High
37	95	--	3	Fuel Restriction Sensor Input Voltage High
38	18	--	4	High Range Fuel Pressure Sensor Input Voltage Low
38	94	--	4	Fuel Pressure Sensor Input Voltage Low
38	95		4	Fuel Restriction Sensor Input Voltage Low
39	—	146	2	EGR Leak- Boost Power
39	—	146	12	EGR Leak- Boost Jake
39	—	146	7	EGR Valve Not Responding
39	—	147	2	VNT Vanes Not Responding – Boost Power
39	—	147	11	VNT Vanes at Max – Jake
39	—	147	12	VNT Vanes Not Responding – Boost Jake
39	—	147	14	EGR Flow too low
39	—	147	7	VNT Vanes Not Responding – EGR

DDEC V Code	PID	SID	FMI	DESCRIPTION
41	--	21	0	Too Many CKP Sensor (missing CMP Sensor)
42	--	21	1	Too few CKP Sensor (missing CKP Sensor)
43	111	--	1	Coolant Level Low
44	52	--	0	Intercooler Coolant Temperature High
44	105	--	0	Intake Manifold Temperature High
44	105	--	14	Engine Power Derate Due to Intake Manifold Temperature
44	110	--	0	Coolant Temperature High
44	110	--	14	Engine Power Derate Due to Coolant Temperature
44	172	--	0	Air Inlet Temperature High
44	175	--	0	Oil Temperature High
45	19	--	1	High Range Oil Pressure Low
45	100	--	1	Oil Pressure Low
46	168	--	1	ECM Battery Voltage Low
46	--	155		Injector V (reg) Voltage Failed Low
46	--	211	1	Sensor Supply Pins V-11/V-12 Low
46	--	212	4	Injector V (slope) Voltage Failed Low
46	--	214	1	RTC Backup Battery Voltage Low, Pin E-59
46	--	221	4	Injector I (pull-in) Voltage Failed Low
46	--	232	1	Sensor Supply Voltage Low, Pin E-12/E-26
47	18	--	0	High Range Fuel Pressure High
47	94	--	0	Fuel Pressure High
47	102	--	0	Turbo Boost Pressure High
47	102	--	14	Engine Power Derate Due to Turbo Boost Pressure
47	106	--	0	Air Inlet Pressure High
47	164	--	0	Injection Control Pressure High
48	18	--	1	High Range Fuel Pressure Low
48	94	--	1	Fuel Pressure Low
48	106	--	1	Air Inlet Pressure Low
48	164	--	1	Injection Control Pressure Low
48	351	--	1	TCI Temperature Low
48	404	—	1	Turbo Compressor Temperature Out Low
48	404	--	14	Engine Power Derate Due to Turbo Compressor Out Temperature
48	411	--	1	EGR Differential Pressure Low
48	412	--	1	EGR Temperature Low
49	351	--	0	TCI Temperature High
49	404	--	0	Turbo Compressor Out Temperature High

DDEC V Code	PID	SID	FMI	DESCRIPTION
51	351	--	3	TCI Temperature Circuit Failed High
51	404	--	3	Turbo Compressor Out Temperature Sensor Input Voltage High
52	--	254	12	A/D Conversion Fail
53	--	253	2	Nonvolatile Checksum Incorrect
53	--	253	12	EEPROM Write Error
53	--	253	13	Out of Calibration
54	84	--	12	Vehicle Speed Sensor Fault
55	--	216	14	Other ECU Fault (This fault is logged in conjunction with another fault to indicate missing information from another ECU.)
55	--	231	12	J1939 Data Link Fault
55	--	248	8	Proprietary Data Link Fault (Master)
55	--	248	9	Proprietary Data Link Fault (Receiver)
56	--	250	12	J1587 Data Link Fault
57	--	249	12	J1922 Data Link Fault
58	92	--	0	Torque Overload
61	--	xxx	0	Injector xxx Response Time Long
62	--	26	3	Aux. Output #1 Short to Battery (+) – Pin V-4
62	--	26	4	Aux. Output #1 Open Circuit - Pin V-4
62	—	26	7	Aux. Output #1 Mechanical System Not Responding Properly - Pin V-4
62	--	40	3	Aux. Output #2 Short to Battery (+) - Pin V-5
62	--	40	4	Aux. Output #2 Open Circuit - Pin V-5
62	—	40	7	Aux. Output #2 Mechanical System Not Responding Properly – Pin V-5
62	--	53	3	Aux. Output #5 Short to Battery (+) - Pin V-6
62	--	53	4	Aux. Output #5 Open Circuit - Pin V-6
62	—	53	7	Aux. Output #5 Mechanical System Not Responding Properly - Pin V-6
62	--	54	3	Aux. Output #6 Short to Battery (+) - Pin V-7
62	--	54	4	Aux. Output #6 Open Circuit - Pin V-7
62	--	54	7	Aux. Output #6 Mechanical System Not Responding Properly - Pin V-7
62	--	55	3	Aux. Output #7 Short to Battery (+) - Pin V-40
62	--	55	4	Aux. Output #7 Open Circuit - Pin V-40
62	—	55	7	Aux. Output #7 Mechanical System Not Responding Properly - Pin V-40
62	--	56	3	Aux. Output #8 Short to Battery (+) – Pin V-53
62	--	56	4	Aux. Output #8 Open Circuit - Pin V-53

DDEC V Code	PID	SID	FMI	DESCRIPTION
62	--	56	7	Aux. Output #8 Mechanical System Not Responding Properly - Pin V-53
62	--	257	3	Aux. Output #9 Open Circuit – Pin V-54
62	--	257	4	Aux. Output #9 Short to Gnd – Pin V-54
62	--	257	7	Aux. Output #9 Mechanical System Failure – Pin V-54
62	--	258	3	Aux. Output #10 Open Circuit – Pin V-55
62	--	258	4	Aux. Output #10 Short to Gnd – Pin V-55
62	--	258	7	Aux. Output #10 Mechanical System Failure – Pin V-55
62	--	259	3	Aux. Output #11 Open Circuit – Pin E-13
62	--	259	4	Aux. Output #11 Short to Gnd – Pin E-13
62	--	259	7	Aux. Output #11 Mechanical System Failure – Pin E-13
63	--	57	0	PWM #1 Above Normal Range, Pin V-53
63	--	57	1	PWM #1 Below Normal Range, Pin V-53
63	--	57	3	PWM #1 Short to Battery (+), Pin V-53
63	--	57	4	PWM #1 Open Circuit, Pin V-53
63	--	58	0	PWM #2 Above Normal Range, Pin V-46
63	--	58	1	PWM #2 Below Normal Range, Pin V-46
63	--	58	3	PWM #2 Short to Battery (+), Pin V-46
63	--	58	4	PWM #2 Open Circuit, Pin V-46
63	--	59	0	PWM #3 Above Normal Range, Pin E-3
63	--	59	1	PWM #3 Below Normal Range, Pin E-3
63	--	59	3	PWM #3 Short to Battery (+), Pin E-3
63	--	59	4	PWM #3 Open Circuit, Pin E-3
63	--	60	0	PWM #4 Above Normal Range, Pin E-4
63	--	60	1	PWM #4 Below Normal Range, Pin E-4
63	--	60	3	PWM #4 Short to Battery (+), Pin E-4
63	--	60	4	PWM #4 Open Circuit, Pin E-4
63	--	267	0	PWM #5 Above Normal Range - Pin E-8
63	--	267	1	PWM #5 Below Normal Range - Pin E-8
63	--	267	3	PWM #5 Short to Battery (+) - Pin E-8
63	--	267	4	PWM #5 Open Circuit - Pin E-8
63	--	267	7	PWM #5 Mechanical System Failed - Pin E-8
63	--	268	0	PWM #6 Above Normal Range - Pin E-11
63	--	268	1	PWM #6 Below Normal Range - Pin E-11
63	--	268	3	PWM #6 Short to Battery (+) - Pin E-11
63	--	268	4	PWM #6 Open Circuit - Pin E-11
63	--	268	7	PWM #6 Mechanical System Failed - Pin E-11

DDEC V Code	PID	SID	FMI	DESCRIPTION
64	103	--	0	Turbo Overspeed
64	103	--	8	Turbo Speed Sensor Input Failure – Abnormal Period
65	51	--	0	Throttle Plate Position Above Normal Range
65	51	--	1	Throttle Plate Position Below Normal Range
65	51	--	2	Throttle Plate Position Erratic
65	51	--	7	Throttle Plate Not Responding
65	107	--	3	Air Filter Restriction Sensor Voltage High
65	107	--	4	Air Filter Restriction Sensor Voltage Low
66	99	--	3	Oil Filter Restriction Sensor Voltage High
66	99	--	4	Oil Filter Restriction Sensor Voltage Low
66	--	76	0	Engine Knock Level Above Normal Range
66	--	76	3	Engine Knock Level Sensor Input Voltage High
66	--	76	4	Engine Knock Level Sensor Input Voltage Low
66	--	76	7	Engine Knock Level Sensor Not Responding
67	20	--	3	High Range Coolant Pressure Sensor Input Voltage High
67	20	--	4	High Range Coolant Pressure Sensor Input Voltage Low
67	106	--	3	Air Inlet Pressure Sensor Input Voltage High
67	106	--	4	Air Inlet Pressure Sensor Input Voltage Low
67	109	--	3	Coolant Pressure Sensor Input Voltage High
67	109	--	4	Coolant Pressure Sensor Input Voltage Low
68	--	230	5	TPS Idle Validation Circuit Fault (open circuit)
68	--	230	6	TPS Idle Validation Circuit Fault (short to ground)
71	--	xxx	1	Injector xxx Response Time Short
72	84	--	0	Vehicle Overspeed
72	84	--	11	Vehicle Overspeed (Absolute)
72	--	65	0	Oxygen Content Too High
72	--	65	1	Oxygen Content Too Low
73	107	--	0	Air Filter Restriction High
73	--	77	0	Gas Valve Position Above Normal Range
73	--	77	1	Gas Valve Position Below Normal Range
73	--	77	3	Gas Valve Position Input Voltage High
73	--	77	4	Gas Valve Position Input Voltage Low
73	--	77	7	Gas Metering Valve Not Responding
74	70	--	4	Optimized Idle Safety Loop Short to Ground
74	99	--	0	Oil Filter Restriction High
75	168	--	0	ECM Battery Voltage High
75	--	155	3	Injector V (reg) Voltage Failed High

DDEC V Code	PID	SID	FMI	DESCRIPTION
75	--	211	0	Sensor Supply Pins V-11/V-12 Voltage High
75	--	212	3	Injector V (slope) Voltage Failed High
75	--	221	3	Injector V (pull-in) Voltage Failed High
75	--	214	0	RTC Backup Battery Voltage High
75	--	232	0	Sensor Supply Voltage High, Pin E-26
76	121	--	0	Engine Overspeed With Engine Brake
77	19	—	0	High Range Oil Pressure High
77	20	—	0	High Range Coolant Pressure High
77	21	—	0	ECM Temperature Above Range
77	21	—	1	ECM Temperature Below Range
77	21	—	3	ECM Temperature Above Failed High
77	21	—	4	ECM Temperature Above Failed Low
77	72	—	0	Blower Bypass Door Position High
77	72	—	1	Blower Bypass Door Position Low
77	73	—	1	Fire Pump Pressure Low
77	81	—	0	Exhaust Back Pressure High
77	81	—	1	Exhaust Back Pressure Low
77	81	—	3	Exhaust Back Pressure Sensor Voltage High
77	81	—	4	Exhaust Back Pressure Sensor Voltage Low
77	81	—	12	Exhaust Back Pressure at Rampdown Threshold
77	95	—	1	Fuel Filter Differential Pressure Low
77	99	—	1	Oil Filter Differential Pressure Low
77	100	—	0	Engine Oil Pressure High
77	102	—	1	Turbo Boost Pressure Low
77	105	—	1	Inlet Manifold Temperature Low
77	107	—	1	Air filter Restriction Pressure Low
77	108	—	0	Barometric Pressure High
77	108	—	1	Barometric Pressure Low
77	109	—	0	Coolant Pressure High
77	110	—	1	Coolant Temperature Low
77	111	—	0	Coolant Level High
77	171	—	0	Ambient Air Temperature High
77	171	—	1	Ambient Air Temperature Low
77	172	—	1	Air Inlet Temperature Low
77	174	—	0	Fuel Temperature High
77	174	—	1	Fuel Temperature Low
77	175	—	1	Engine Oil Temperature Low

DDEC V Code	PID	SID	FMI	DESCRIPTION
77	222	—	14	Anti-Theft Fault Present
77	251	—	10	Clock Module Abnormal Rate of Change
77	251	—	13	Clock Module Failure
77	252	—	10	Clock Module Abnormal Rate of Change
77	252	—	13	Clock Module Failure
77	354	—	0	Relative Humidity Above Range
77	354	—	1	Relative Humidity Below Range
77	446	—	0	Cylinder Head Temperature Above Range
77	—	151	11	Service Now Lamp Fault Expiration
78	86	--	14	Cruise Control/Adaptive Cruise Control Fault
81	98	--	3	Oil Level Sensor Input Voltage High
81	101	--	3	Crankcase Pressure Sensor Input Voltage High
81	153	--	3	Extended Crankcase Pressure Input Voltage High
81	164	--	3	Injection Control Pressure Sensor Input Voltage High
81	173	--	3	Exhaust Temperature Sensor Input Voltage High
81	411	—	3	EGR Delta Pressure Sensor Circuit Failed High
81	412	—	3	EGR Temperature Circuit Failed High
81	412	—	9	EGR Temperature Network Sensor Not Responding
81		20	3	Timing Actuator Failed High
81		20	4	Timing Actuator Failed Low
81	--	129	3	Exhaust Port Temperature #1 Sensor Voltage High
81	--	130	3	Exhaust Port Temperature #2 Sensor Voltage High
81	--	131	3	Exhaust Port Temperature #3 Sensor Voltage High
81	--	132	3	Exhaust Port Temperature #4 Sensor Voltage High
81	--	133	3	Exhaust Port Temperature #5 Sensor Voltage High
81	--	134	3	Exhaust Port Temperature #6 Sensor Voltage High
81	--	135	3	Exhaust Port Temperature #7 Sensor Voltage High
81	--	136	3	Exhaust Port Temperature #8 Sensor Voltage High
81	--	137	3	Exhaust Port Temperature #9 Sensor Voltage High
81	--	138	3	Exhaust Port Temperature #10 Sensor Voltage High
81	--	139	3	Exhaust Port Temperature #11 Sensor Voltage High
81	--	140	3	Exhaust Port Temperature #12 Sensor Voltage High
81	--	141	3	Exhaust Port Temperature #13 Sensor Voltage High
81	--	142	3	Exhaust Port Temperature #14 Sensor Voltage High
81	--	143	3	Exhaust Port Temperature #15 Sensor Voltage High
81	--	144	3	Exhaust Port Temperature #16 Sensor Voltage High
81	—	277	9	EGR Rate Sensor not Responding

DDEC V Code	PID	SID	FMI	DESCRIPTION
81	—	277	12	EGR Rate Sensor Failed
82	98	--	4	Oil Level Sensor Input Voltage Low
82	101	--	4	Crankcase Pressure Sensor Input Voltage Low
82	153	--	4	Extended Crankcase Pressure Input Voltage Low
82	164	--	4	Injection Control Pressure Sensor Input Voltage Low
82	173	--	4	Exhaust Temperature Sensor Input Voltage Low
82	411	—	4	EGR Delta Pressure Sensor Circuit Failed Low
82	412	—	4	EGR Temperature Circuit Failed Low
82	412	—	12	EGR Temperature Network Sensor Failed
82	--	129	4	Exhaust Port Temperature #1 Sensor Voltage Low
82	--	130	4	Exhaust Port Temperature #2 Sensor Voltage Low
82	--	131	4	Exhaust Port Temperature #3 Sensor Voltage Low
82	--	132	4	Exhaust Port Temperature #4 Sensor Voltage Low
82	--	133	4	Exhaust Port Temperature #5 Sensor Voltage Low
82	--	134	4	Exhaust Port Temperature #6 Sensor Voltage Low
82	--	135	4	Exhaust Port Temperature #7 Sensor Voltage Low
82	--	136	4	Exhaust Port Temperature #8 Sensor Voltage Low
82	--	137	4	Exhaust Port Temperature #9 Sensor Voltage Low
82	--	138	4	Exhaust Port Temperature #10 Sensor Voltage Low
82	--	139	4	Exhaust Port Temperature #11 Sensor Voltage Low
82	--	140	4	Exhaust Port Temperature #12 Sensor Voltage Low
82	--	141	4	Exhaust Port Temperature #13 Sensor Voltage Low
82	--	142	4	Exhaust Port Temperature #14 Sensor Voltage Low
82	--	143	4	Exhaust Port Temperature #15 Sensor Voltage Low
82	--	144	4	Exhaust Port Temperature #16 Sensor Voltage Low
82	—	277	12	EGR Rate Sensor Failed
82	412	—	9	EGR Temperature Smart Sensor not Responding
82	412	—	12	EGR Temperature Smart Sensor failed
83	73	—	0	Pump Pressure High
83	98	--	0	Oil Level High
83	101	--	0	Crankcase Pressure High
83	153	--	0	Extended Crankcase Pressure High
83	173	--	0	Exhaust Temperature High
83	411	—	0	EGR Delta Pressure High
83	412	—	0	EGR Temperature High
83	--	129	0	Exhaust Port Temperature #1 High
83	--	130	0	Exhaust Port Temperature #2 High

DDEC V Code	PID	SID	FMI	DESCRIPTION
83	--	131	0	Exhaust Port Temperature #3 High
83	--	132	0	Exhaust Port Temperature #4 High
83	--	133	0	Exhaust Port Temperature #5 High
83	--	134	0	Exhaust Port Temperature #6 High
83	--	135	0	Exhaust Port Temperature #7 High
83	--	136	0	Exhaust Port Temperature #8 High
83	--	137	0	Exhaust Port Temperature #9 High
83	--	138	0	Exhaust Port Temperature #10 High
83	--	139	0	Exhaust Port Temperature #11 High
83	--	140	0	Exhaust Port Temperature #12 High
83	--	141	0	Exhaust Port Temperature #13 High
83	--	142	0	Exhaust Port Temperature #14 High
83	--	143	0	Exhaust Port Temperature #15 High
83	--	144	0	Exhaust Port Temperature #16 High
84	98	--	1	Oil Level Low
84	101	--	1	Crankcase Pressure Low
84	153	--	1	Extended Crankcase Pressure Low
85	190	--	0	Engine Overspeed
85	190	--	14	Engine Overspeed Signal
86	73	--	3	Pump Pressure Sensor Input Voltage High
86	108	--	3	Barometric Pressure Sensor Input Voltage High
87	73	--	4	Pump Pressure Sensor Input Voltage Low
87	108	--	4	Barometric Pressure Sensor Input Voltage Low
88	20	--	1	High Range Coolant Pressure Low
88	109	--	1	Coolant Pressure Low
89	95	--	0	Fuel Restriction High
89	111	--	12	Maintenance Alert Coolant Level Fault

5. ENGINE OIL LEVEL

Check the oil level daily with the engine stopped. If the engine has just been stopped and is warm, wait at least 10 minutes to allow the oil to drain back to the oil pan before checking. Wipe the dipstick clean then check oil level. The level should always be within the safe range on the dipstick (Fig. 12). Add the proper grade of oil to maintain the correct level on the dipstick. All diesel engines are designed to consume some oil, so a periodic addition of oil is normal.

WARNING

Touching a hot engine can cause serious burns.

CAUTION

Do not overfill. Oil may be blown out through the crankcase breather if the crankcase is overfilled.

CAUTION

Clean end of tube before removing the dipstick to prevent oil contamination.

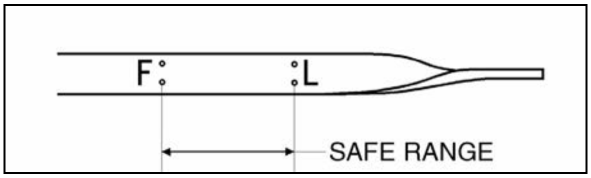


FIGURE 12: ENGINE OIL LEVEL DIPSTICK 01027

CAUTION

If the oil level is constantly above normal and excess lube oil has not been added to the crankcase, consult with an authorized Detroit Diesel service outlet for the cause. Fuel or coolant dilution of lube oil can result in serious engine damage.

The vehicle may be provided with an oil reserve tank in the engine compartment. To adjust oil level, open the oil reserve tank drain valve and allow oil to discharge into the engine until the "Full" mark on the dipstick is reached then close the valve. Check oil reserve tank level and pour oil in the reserve tank if necessary (Fig. 13).

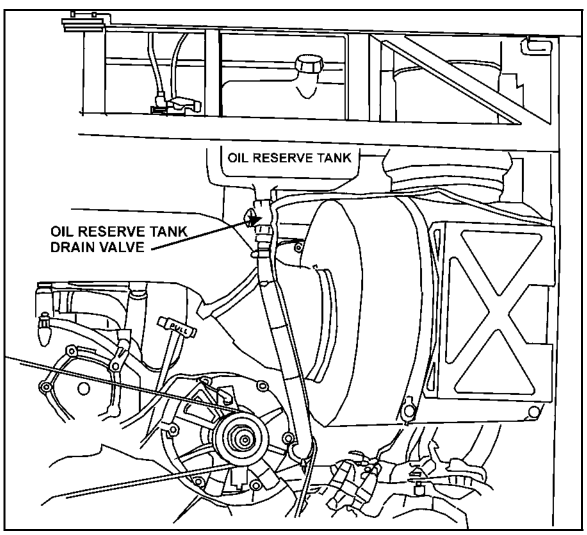


FIGURE 13: OIL RESERVE TANK 01172

6. ENGINE OIL AND FILTER CHANGE

Both the oil and filter should be changed every 12,500 miles (20,000 km) or once a year, whichever comes first. However, changes that are more frequent may be required when the engine is subject to high levels of contamination and/or overheating. Change intervals may be decreased or gradually increased with experience on specific lubricants until the most practical service condition has been established. Always refer to the lubricant manufacturer's recommendations (analysis of drained oil can be helpful).

CAUTION

Do not use solvents to dilute the engine oil when draining. Dilution of fresh oil can occur which may be detrimental to the engine.

Change engine oil with the vehicle on a flat and level surface and with the parking brake applied. It is best to drain the oil when the engine is still warm.

1. From under the vehicle, remove the engine drain plug on the oil pan. Allow oil to drain (Fig. 14).

WARNING

Hot engine oil can cause serious burns. Wear coveralls with sleeves pulled down and gloves to protect hands.

2. Reinstall the drain plug.
3. Remove the spin-on filter cartridge using a ½" drive socket wrench and extension.
4. Dispose of the used oil and filter in an environmentally responsible manner in accordance with state and/or federal (EPA) recommendations.

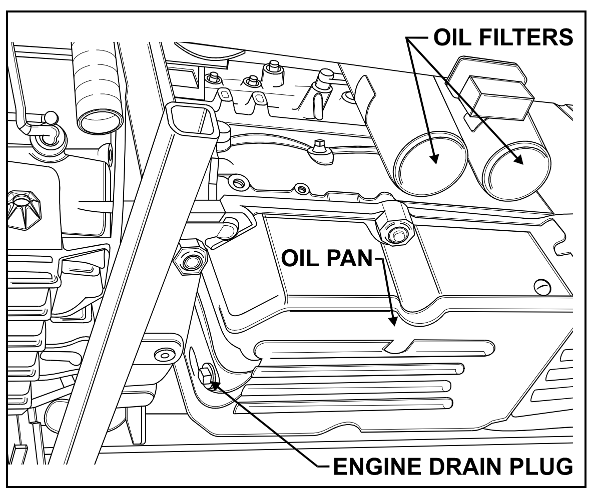


FIGURE 14: ENGINE DRAIN PLUG AND OIL FILTERS 01029

5. Clean the filter adapter with a clean rag.

6. Lightly coat the filter gasket (seal) with clean engine oil.
7. Install the new filter on the adapter and tighten manually until the gasket touches the mounting adapter head. Tighten full-flow filters an additional two-thirds of a turn manually. Then, manually tighten bypass filter one full turn.

CAUTION

Overtightening may distort or crack the filter adapter.

8. Remove the engine-oil filler cap and pour oil in the engine until it reaches the "FULL" mark on the dipstick (Fig. 12).
9. Start and run the engine for a short period and check for leaks. After any leaks have been corrected, stop the engine long enough for oil from various parts of the engine to drain back to the crankcase (approximately 20 minutes).
10. Add oil as required to bring the level within the safe range on the dipstick (Fig. 12).

7. RECOMMENDED ENGINE OIL TYPE

To provide maximum engine life, lubricants shall meet the following specifications: SAE Viscosity Grade: 15W-40 API Classification: CI-4.

NOTE

Monograde oils should not be used in these engines regardless of API Service Classification.

NOTE

The use of supplemental oil additives is discouraged from use in Detroit Diesel Engines.

Synthetic oils: Synthetic oils may be used in Detroit Diesel engines provided they are API-licensed and meet the performance and chemical requirements of non-synthetic oils outlined previously. Synthetic oils do not permit extension of recommended oil drain intervals.

Lubricant Selection World Wide: Oils meeting API CD or CC specifications may be used if they also meet military specification MIL-L-2104 D or E. Oils which meet European CCMC D4 specifications may also be used.

Modification of drain interval may be necessary, depending on fuel quality. Contact Detroit Diesel Corporation for further guidance.

8. 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 ECM are serviceable. If found defective, replace the complete ECM unit.

1. 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. In addition, the Electronic Unit Injectors (EUI) will be disabled, preventing any fuel delivery to the injector tips.

WARNING

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

2. Remove the rear bumper assembly from the vehicle. Refer to Section 18, BODY, under "REAR BUMPER REMOVAL ".
3. Drain the engine cooling system. Refer to Section 05, COOLING under "DRAINING COOLING SYSTEM".

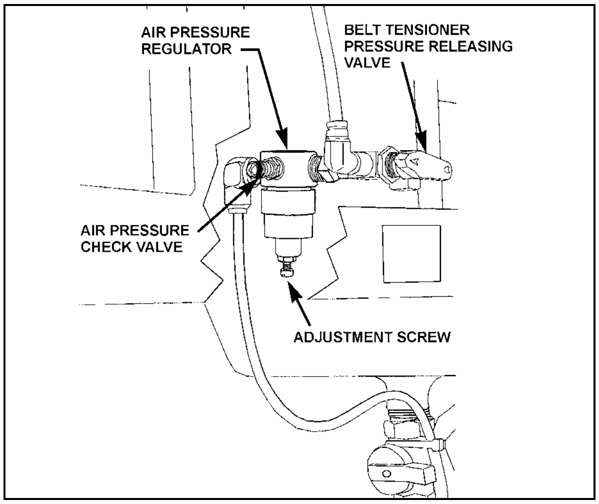


FIGURE 15: BELT TENSIONER VALVE 12200

4. Locate the belt tensioner pressure releasing valve (Fig. 15). Turn pressure releasing valve handle counterclockwise in order to release pressure in belt-tensioner air bellows and loosen belts. Remove the belts.
5. To release all pressure from the air system. Refer to Section 12, BRAKES & AIR SYSTEM for instructions.
6. Disconnect and remove the engine-air intake duct mounted between air cleaner housing and turbocharger inlet (1, Fig.17).

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

7. Disconnect and remove the air intake duct mounted between the air cooler outlet and the engine intake (2, Fig. 17).
8. Disconnect and remove section of coolant pipe assembly mounted between the radiator outlet and the water pump inlet (3, Fig. 17).
9. Disconnect the coolant delivery hose located close to the water pump.
10. Disconnect the electric fan-clutch connector, close to the water pump (Fig. 17).
11. Dismantle the air bellows from the upper bracket of the fan-drive assembly tensioner. Remove the upper bracket (4, Fig. 17).
12. If necessary, remove the fan drive from the engine compartment by removing the four retaining bolts, washers and nuts securing the fan drive to the floor.

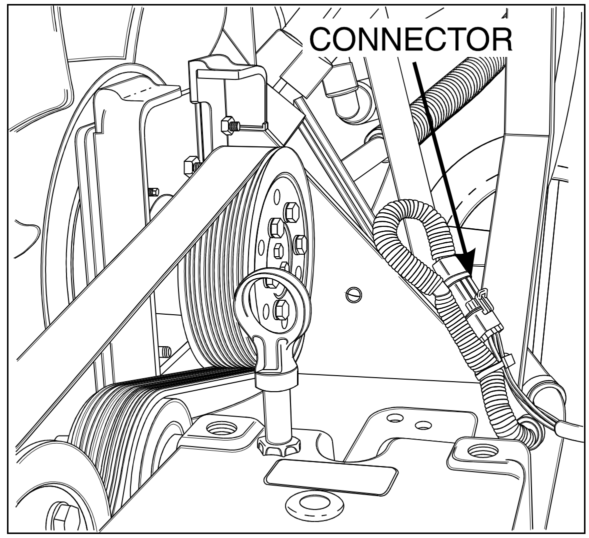


FIGURE 16: ELECTRIC FAN-CLUTCH CONNECTOR 010XX

13. Disconnect and remove the air intake duct mounted between the turbocharger outlet and the air cooler inlet (5, Fig. 17).
14. Disconnect two vent hoses from the thermostat housing and from the coolant pipe assembly.
15. Disconnect and remove a section of coolant pipe assembly mounted between the thermostat housings and the radiator inlet.
16. Disconnect and remove the small hose connected to the heater line valve and to the water pump.
17. Disconnect the small heater hose located on the cylinder head at the back of the engine.
18. Disconnect and remove the exhaust pipe mounted between the turbocharger outlet and the exhaust bellows. If necessary, refer to Section EXHAUST SYSTEM under MUFFLER REMOVAL AND INSTALLATION".

> **⚠ CAUTION**
>
> To avoid damage to turbocharger, cover the turbocharger outlet opening to prevent foreign material from entering.

19. Disconnect the steel-braided airline from the A/C compressor air bellows.
20. Disconnect the power steering pump supply and discharge hoses. Cap hose openings immediately to limit fluid loss. Remove retaining clips from cradle (6, Fig. 17).

21. Disconnect the oil delivery hose from the valve located at the reserve tank drain (7, Fig. 17).

22. Disconnect the block heater connector from the power steering pump if applicable.

23. Close engine fuel supply shutoff valve on primary fuel filter. Disconnect the fuel line connected to inlet port. On vehicles equipped with the optional water-separator-fuel-filter, disconnect the connector and remove cable ties from cradle.

24. Disconnect the air compressor discharge, governor steel-braided airlines and manual filling airlines from compressor. Remove retaining clips.

25. Disconnect the hose connecting the compressor head to the sump tank.

26. Disconnect ground cables from rear subframe ground-stud located close to the starter motor.

27. Disconnect positive cable (red terminal) from starting motor solenoid.

28. Disconnect the power plant wiring-harness main connectors from ECM and remove retaining clips from engine compartment backwall.

29. 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 above the rear junction box and is accessible through the engine compartment R.H. side door.

30. Disconnect fuel return line from bulkhead fixed on engine cylinder head end.

31. On vehicles equipped with an electrically operated cold-starting aid, disconnect the delivery hose from the starting-aid cylinder solenoid valve. Remove cable ties securing hoses.

32. Disconnect turbo boost pressure gauge airline from engine air intake.

33. Disconnect connectors from transmission. On the left side: four on rear side with one close to yoke. On right side: close to the solenoid valve of the output retarder.

34. From under the vehicle, disconnect the propeller shaft as detailed in Section 09, under heading "Propeller Shaft Removal".

35. 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.

36. Remove the six retaining bolts, washers and nuts securing the power plant cradle to the vehicle rear subframe (Fig. 18).

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.

37. Using a forklift, with a minimum capacity of 4,000 lbs (1 800 kg), slightly raise the power plant cradle.

CAUTION
Due to the minimum clearance between the power plant equipment and the top of the engine compartment, extreme care should be used to raise the power plant cradle, just enough to free the cradle. Clearance between power plant cradle and mounting rail should range between ¼" and ½" (6-12 mm).

38. Pull engine out slowly from the engine compartment. Make sure all lines, wiring and accessories are disconnected and are not tangled.

9. 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 (255 Nm).
2. If fan drive has been removed, reinstall and align as per Section 05, COOLING SYSTEM, under "FAN DRIVE ALIGNMENT".
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.

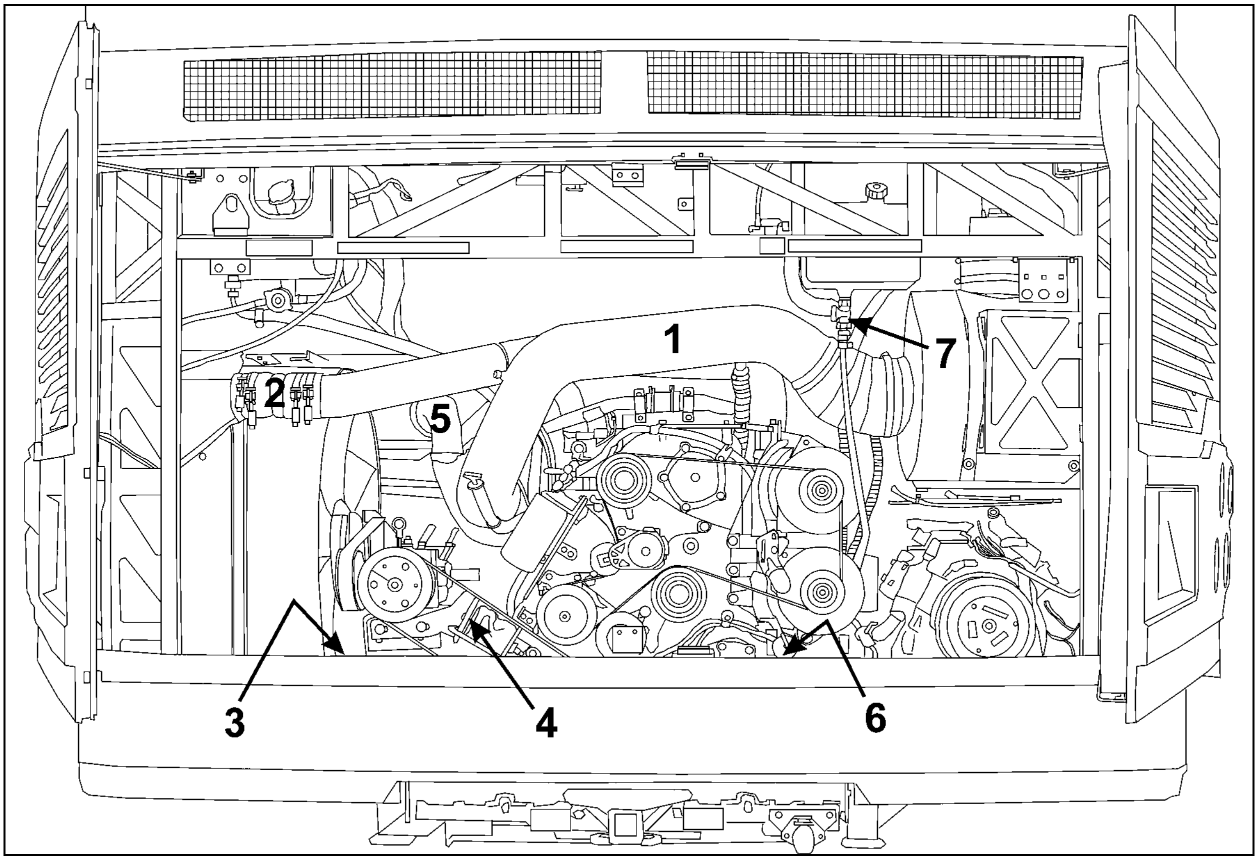


FIGURE 17: ENGINE COMPARTMENT XLII MTH (TYPICAL) 01174

10. VALVE COVER REMOVAL

Refer to the series 60 Detroit diesel service manual for injectors and valves adjustment. Access to engine cover differs depending on vehicle model.

Wait until engine is cold prior to working on vehicle.

10.1 XLII MOTORHOMES

1. Remove air intake pipe.
2. Remove the after CAC (Charger-Air-Cooler) air pipe.
3. Disconnect ventilation pipe from valve cover.
4. Remove trap door located in the middle rear end of vehicle.
5. Remove engine cover.
6. Adjust Jake brakes (if applicable), injectors and valves using Detroit Diesel service manual for series 60 engines.
7. Verify engine cover gasket and replace if necessary.
8. Reinstal engine cover with a tightening torque of 18-22 Lbf-ft (25-30 Nm).

NOTE
New gasket must be ordered directly from Detroit Diesel.

9. Connect ventilation pipe to engine cover.
10. Reinstall air intake and after CAC air pipes.
11. Reinstall trap door and interior finish.

11. JAKE BRAKE

Refer to both "The Jake Brake Troubleshooting and Maintenance Manual" and "Installation Manual for Model 790 Engine Brakes" for troubleshooting and installation procedures. They are annexed at the end of this section.

12. ENGINE MOUNTS

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

Two rubber mounts are used at the front of the engine while two others are mounted on each side of the flywheel housing (Fig. 18).

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

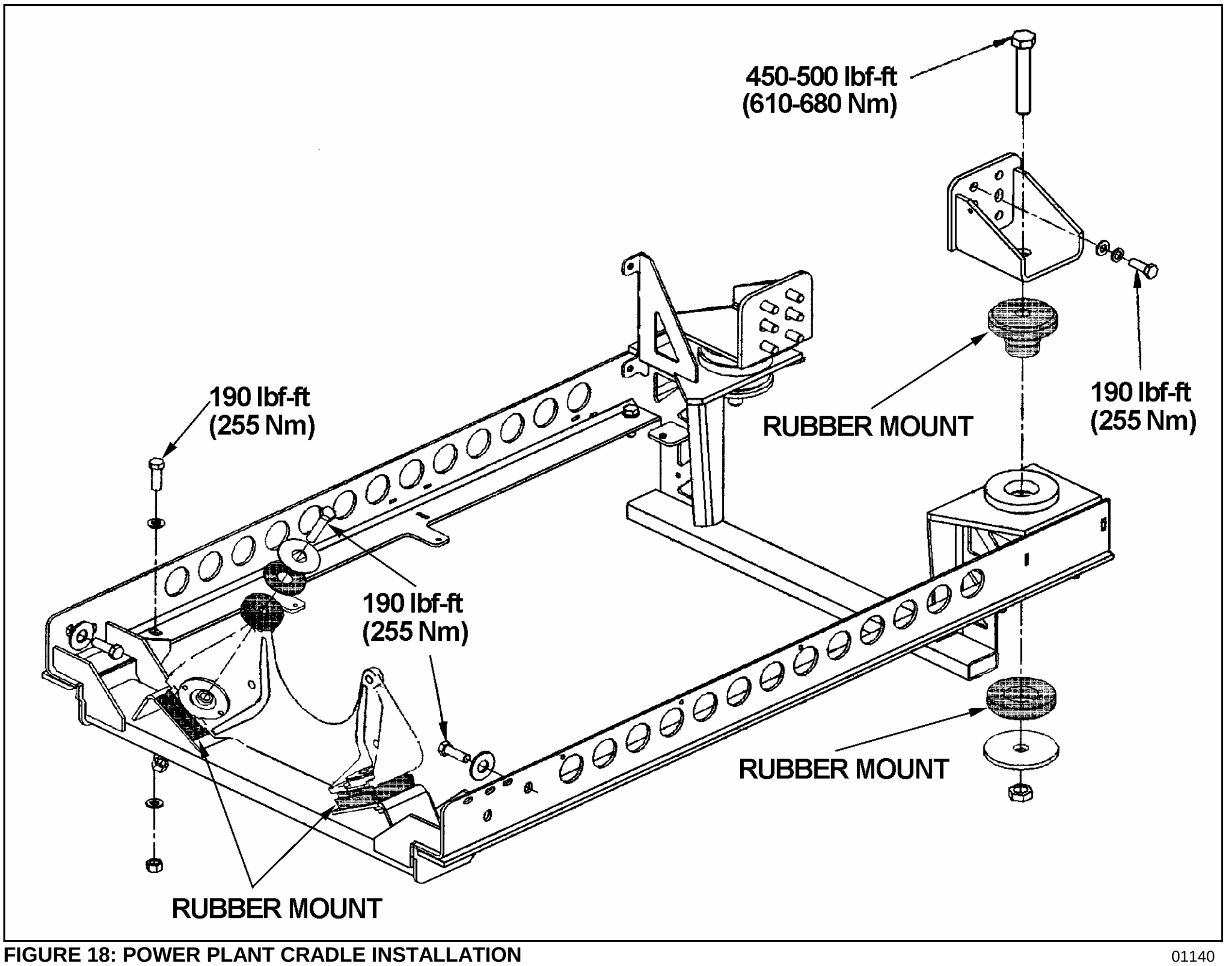
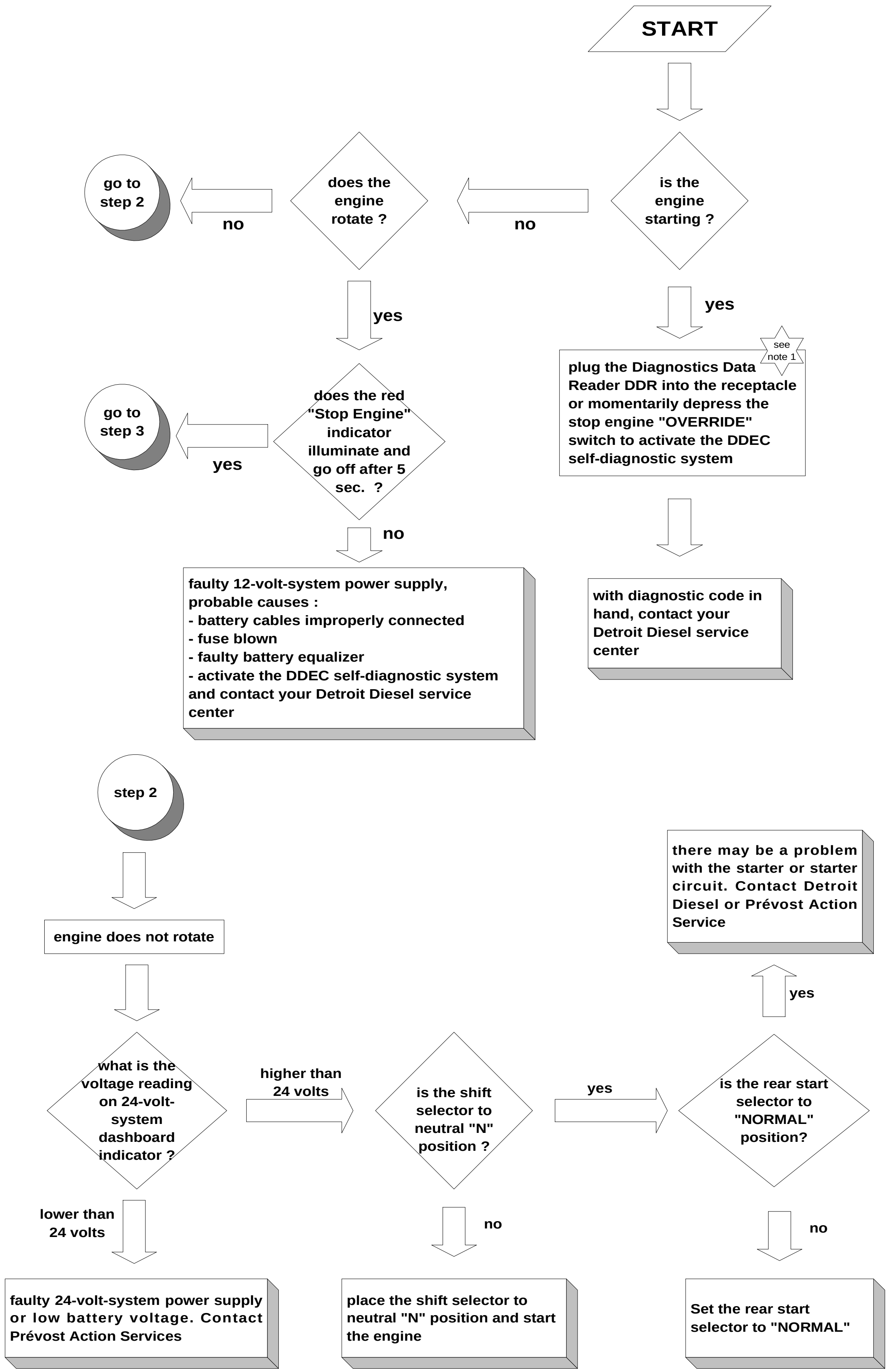
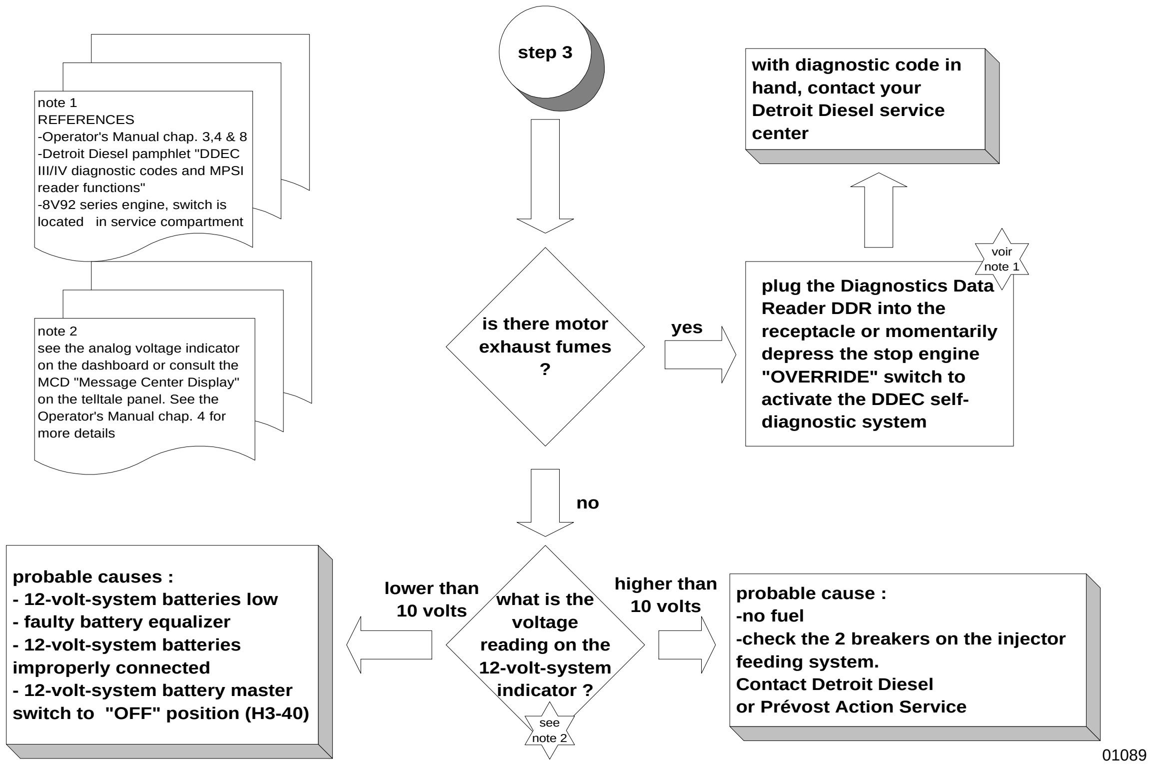


FIGURE 18: POWER PLANT CRADLE INSTALLATION 01140

13. ENGINE TROUBLESHOOTING GUIDE





14. SPECIFICATIONS

Series 60 Engine

Make .... Detroit Diesel

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

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

No. of cylinders 6

Operating range .... 1200-2100 RPM

Maximum RPM 2100

Lubricant

Heavy-duty engine oil SAE Viscosity Grade 15W-40, API Classification CI-4. Synthetic oil may be used if it meets the performance and chemical requirements of non-synthetic oils outlined previously. Some engine operating conditions may require exceptions to this recommendation.

CAUTION

To avoid possible engine damage, do not use single grade (Monograde) lubricants in Detroit Diesel four-cycle Series 60 engines, regardless of API classification.

Detroit Diesel Series 60 engine ratings

Series 60 engine ratings used in Prevost Car Models are listed in the following tables. The standard engine ratings are written in bold, customer may easily switch from one rating to another within the same table by having the DDEC V system reprogrammed.

XL2 Entertainer & 40' MTH Engine (12.7L)	
445 HP	@1800 rpm; 1550 lb-ft @1200 rpm
450 HP	@1800 rpm; 1550 lb-ft @1200 rpm
455 HP	**@1800 rpm; 1550 lb-ft @1200 rpm**
445/455 HP	@1800 rpm; 1550 lb-ft @1200 rpm

XL2 45' MTH Engine (14.0L)	
470 HP	@1800 rpm; 1650 lb-ft @1200 rpm
490 HP	@1800 rpm; 1650 lb-ft @1200 rpm
515 HP	**@1800 rpm; 1650 lb-ft @1200 rpm**
470/515 HP	@1800 rpm; 1650 lb-ft @1200 rpm

Capacity

Oil reserve tank .... 8.4 US qts (8.0 L)

Engine oil level quantity

Oil Pan Capacity, Low Limit .... 26 quarts/25 liters

Oil Pan Capacity, High Limit .... 32 quarts/30 liters

Total Engine Oil Capacity with Filters .... 38 quarts/36 liters

Lubricating oil filter elements

Make .... AC Rochester Div. GMC # 25014505

Make .... A/C Filter # PF-2100

Type .... Full Flow

Prévost number 510458

Torque specification

Engine oil filter .... Tighten 2/3 of a turn after gasket contact

Filters

Engine Air Cleaner Filter

Make .... Nelson # 70337-N

Prévost number 530197

Engine Coolant Filter/Conditioner

Make .... Nalco Chemical Company # DDF3000

Make .... Detroit Diesel # 23507545

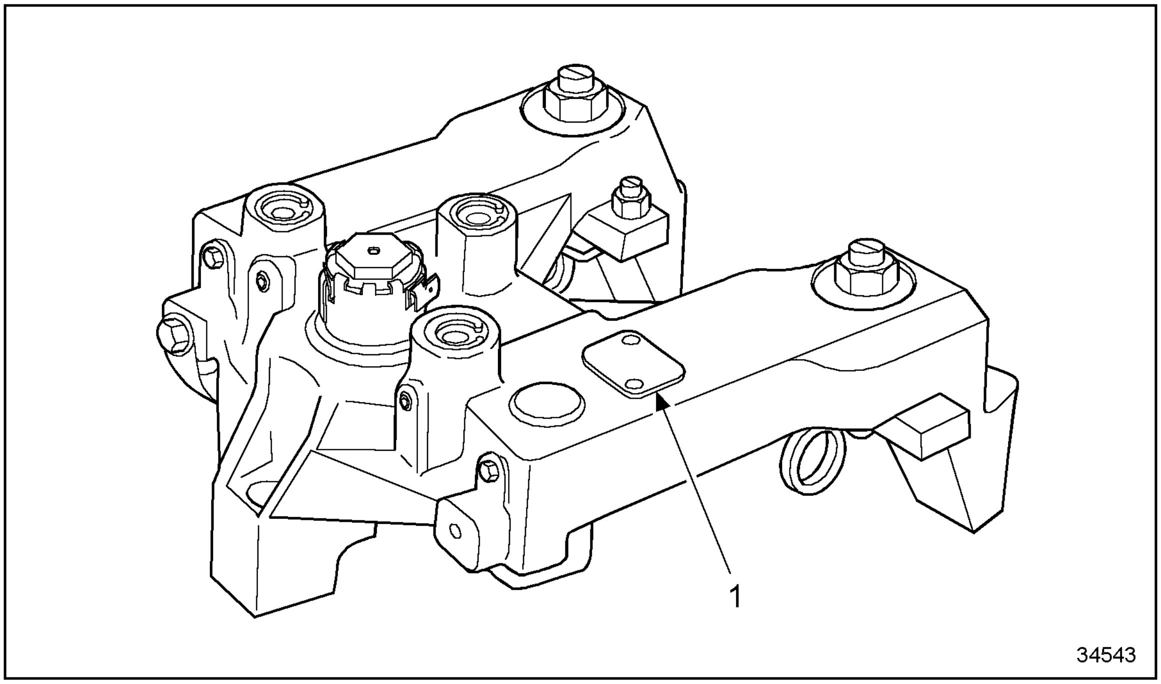
Prévost number 550630

NOTE
For primary and secondary fuel filters, refer to Specifications in section 03

1.29 JAKE BRAKE

The engine brake has been designed to fit on the Series 60 engine with no additional valve cover spacers. There are three styles of valve covers for the Series 60 engine. On engines equipped with a two-piece aluminum valve cover, it is NOT necessary to remove the lower valve cover to install the engine brake. However, one style of upper valve cover may require modification at the breather housing location (inside) for engine brake clearance.

The model, part number and serial number are located on the nameplates at the top of each housing. See Figure 1-414.



1. Identification Plate

Figure 1-414 Nameplate Location on Housing

NOTICE:
Only the specific brake model can be used with the engine model it was designed for. Also, the correct slave piston adjustment specification must be used. Failure to follow these instructions may result in serious engine or engine brake damage.

Listed in Table 1-9 are the different Jake Brake models used and the slave piston adjustment specification.

Model Number	Model Year	Engine Displacement	Engine Brake	Slave Piston Adjustment
6067WU40	Pre-1991	11.1L	760/760A	0.660 mm (0.026 in.)
6067GU40	Pre-1991	12.7L	760/760A	0.508 mm (0.020 in.)
6067WU60	1991	11.1L	760/760A	0.660 mm (0.026 in.)
6067GU40	1991	12.7L	765	0.660 mm (0.026 in.)
6067GU28	1991	12.7L	765	0.660 mm (0.026 in.)
6067GU91	1991	12.7L	765	0.660 mm (0.026 in.)
6067WK60	1994	11.1L	760A	0.660 mm (0.026 in.)
6067GK60	1994	12.7L	765	0.660 mm (0.026 in.)
6067GK28	1994	12.7L	765	0.660 mm (0.026 in.)
6067EK60	1998	11.1L	760B	0.584 mm (0.023 in.)
6067PK60	1998	12.7L	765A	0.584 mm (0.023 in.)
6067TK60	1998	12.7L	765A	0.584 mm (0.023 in.)
6067TK45	1998	12.7L	765A	0.584 mm (0.023 in.)
6067MK60	1998	12.7L	770	0.660 mm (0.023 in.)
6067BK60	1998	12.7L	770	0.660 mm (0.023 in.)
6067HKXX	1998 (Non-Line Haul)	14L	770	0.660 mm (0.023 in.)
6067MK28, 6067MK45, 6067MK57, 6067MK60	2000	12.7L Standard	790	0.660 mm (0.026 in.)
6067BK28, 6067BK45, 6067BK57, 6067BK60	2000	12.7L Premium	790	0.660 mm (0.026 in.)
6067HK45, 6067HK60	2000	14L U.S.	790A	0.660 mm (0.026 in.)
6067WK28, 6067WK60	2000	11.1L	790B	0.660 mm (0.026 in.)
6067LK28, 6067LK45, 6067LK60	2000	11.1L	790B	0.660 mm (0.026 in.)
6063GK60, 6067GK28, 6067GK45, 6067GK91, 6067PK62, 6067TK28, 6067TK60, 6067TK62	2000	12.7L	790B	0.660 mm (0.026 in.)
6067HK62	2000	14L Australian	790C	0.660 mm (0.026 in.)

All slave piston adjustments shown here are current as of the date of this manual and supersede all previous adjustments.

XXXX = Model numbers to be determined.

Table 1-9 Jake Brake Model Information

NOTE:
All engines built after serial number 06R0004455 have the correct engine parts for engine brake installation. The model numbers have changed because of design changes in the engine brakes.

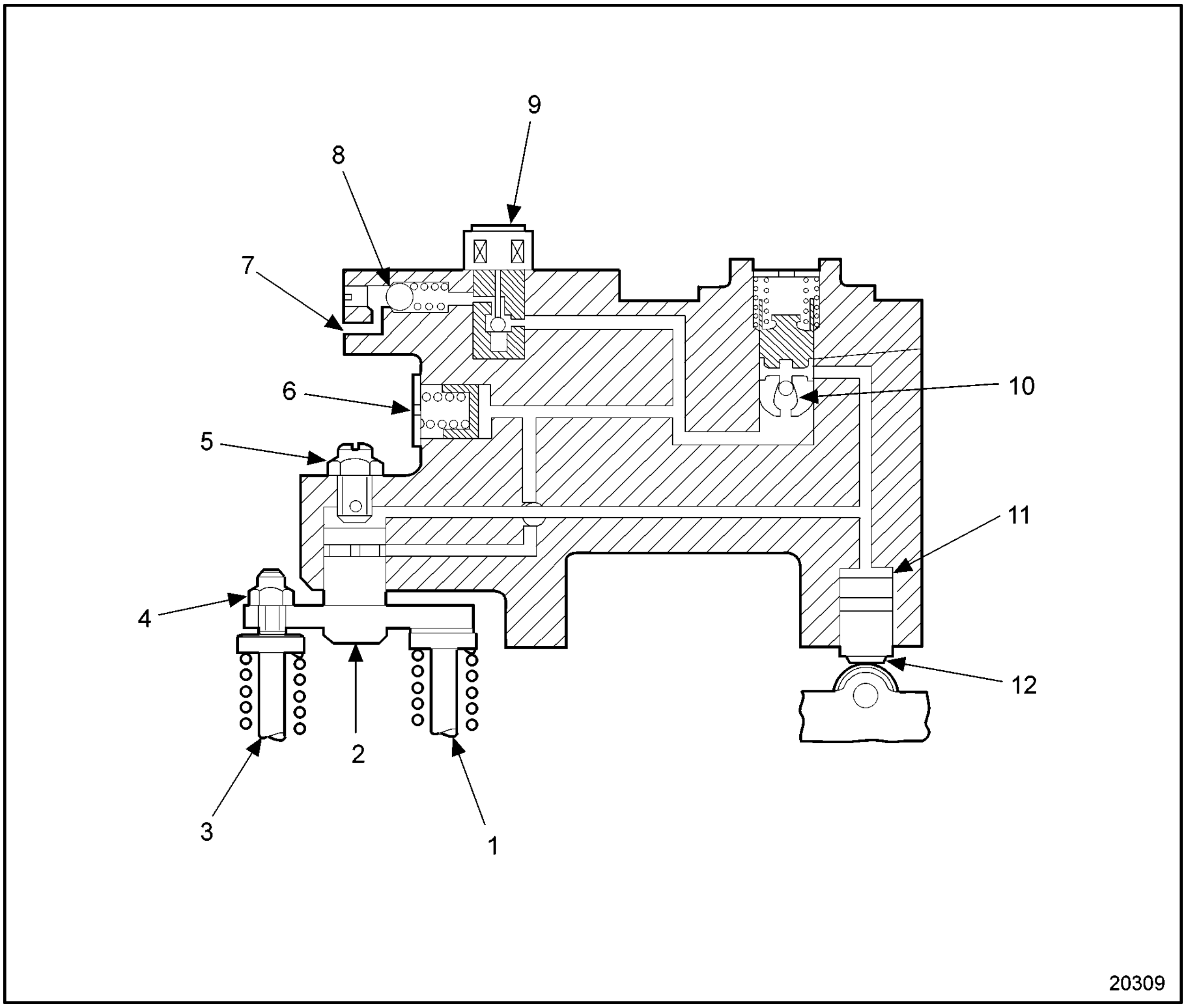
NOTE:
All Series 60 engines with serial numbers 06R0004455 or higher are Jake Brake ready. Do not install a Jake Brake on engines with lower serial numbers.

Effective December 16,1999, Model 790 Jake Brakes are used on all Series 60 engines requiring an engine brake.

Former Jake Brake production models for the Series 60 engine were the 760A (which replaced model 760), 760B, 765, 765A, and 770.

Detroit Diesel engine model Nos. 6067GU28 and 6067GK28 are for bus/coach applications. Due to interference fits on some coach chassis, a two-housing Jake Brake kit may be required. Contact your Detroit Diesel Distributor for information on these kits.

Energizing the engine brake effectively converts a power-producing diesel engine into a power-absorbing air compressor. This is accomplished through motion transfer using a master-slave piston arrangement which opens cylinder exhaust valves near the top of the normal compression stroke, releasing the compressed cylinder charge to exhaust. See Figure 1-415.



1. Exhaust Valve
2. Slave Piston Assembly
3. Exhaust Valve
4. Leveling Screw
5. Slave Piston Adjusting Screw
6. Accumulator
7. Oil In
8. Check Valve (Model 760)
9. Solenoid Valve
10. Control Valve
11. Master Piston
12. Injector Pin and Roller

Figure 1-415 Jake Brake Schematic

The blowdown of compressed air to atmospheric pressure prevents the return of energy to the engine piston on the expansion stroke, the effect being a net energy loss, since the work done in compressing the cylinder charge is not returned during the expansion process.

Exhaust blowdown occurs as the energized solenoid valve permits engine lube oil to flow under pressure through the control valve to both the master piston and the slave piston. See Figure 1-415.

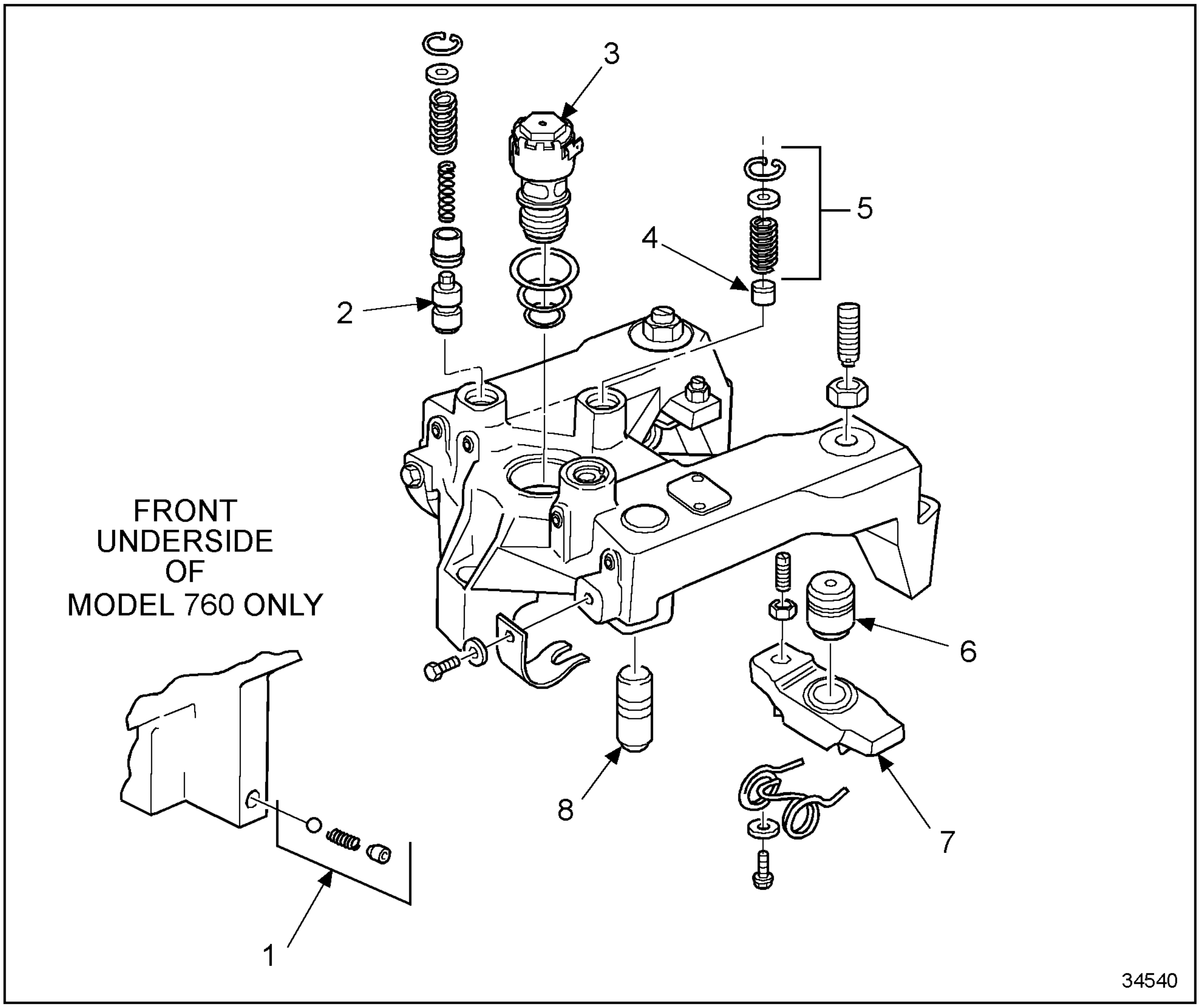
Oil pressure causes the master piston to move down, coming to rest on the injector rocker arm roller.

The injector rocker arm begins its travel as in the normal injection cycle, moving the master piston upward and directing high-pressure oil to the slave piston. The ball check valve in the control valve traps high-pressure oil in the master-slave piston system.

High pressure oil causes the slave piston to move down, momentarily opening the exhaust valves, while the engine piston is near its top-dead-center position, releasing compressed cylinder air to the exhaust manifold.

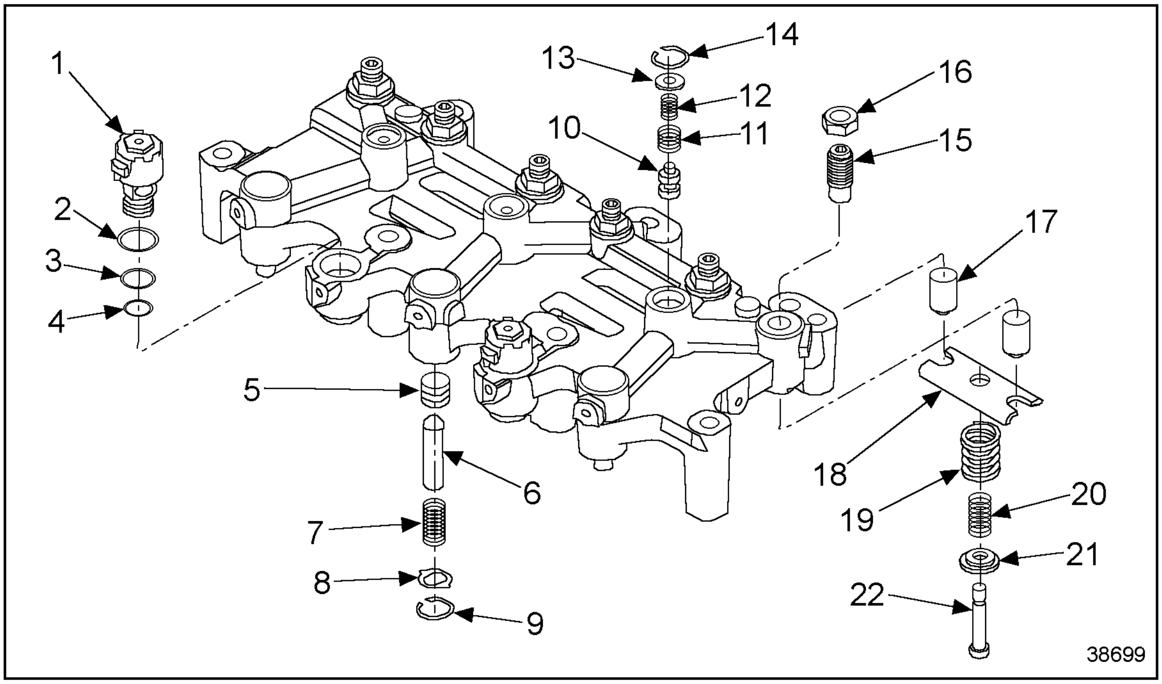
At the bottom of its stroke, the slave piston separates from the valve in the slave piston adjusting screw, allowing high pressure oil to flow into the accumulator. This reduces the pressure in the high pressure circuit, permitting the slave piston to retract and the exhaust valves to close in preparation for the normal exhaust valve cycle. The oil pressure reserved in the accumulator ensures that the hydraulic circuit is fully charged for the next cycle. Compressed air escapes to the atmosphere, completing a compression braking cycle.

The Jake Brake is electronically controlled. Jake Brake control system wiring will vary depending on the vehicle manufacturer. For a general overview of the Jake Brake, see Figure 1-416 and see Figure 1-416a.



1. Ball Check Valve (Model 760 Only)
2. Control Valve
3. Solenoid Valve
4. Accumulator Piston
5. Power Lash Assembly
6. Slave Piston
7. Bridge
8. Master Piston

Figure 1-416 Typical Model 760, 765, or 770 Jake Brake Assembly



1. Solenoid Valve
2. Upper Seal
3. Center Seal
4. Lower Seal
5. Master Piston
6. Master Piston Pushrod
7. Master Piston Spring
8. Washer
9. Retaining Ring
10. Control Valve
11. Outer Control Valve Spring
12. Inner Control Valve Spring
13. Washer
14. Retaining Ring
15. J-Lash® Screw
16. Locknut
17. Slave Piston
18. Slave Piston Bridge
19. Outer Slave Piston Spring
20. Inner Slave Piston Spring
21. Slave Piston Spring Seat
22. Shoulder Bolt

Figure 1-416a Typical Model 790 Jake Brake Assembly

NOTICE:
This application and adjustment information must be strictly followed. Failure to follow these instructions may result in serious engine or engine brake damage.

1.29.1 Repair or Replacement of Jake Brake

To determine if repair is possible or replacement is necessary, perform the following procedure. See Figure 1-417.

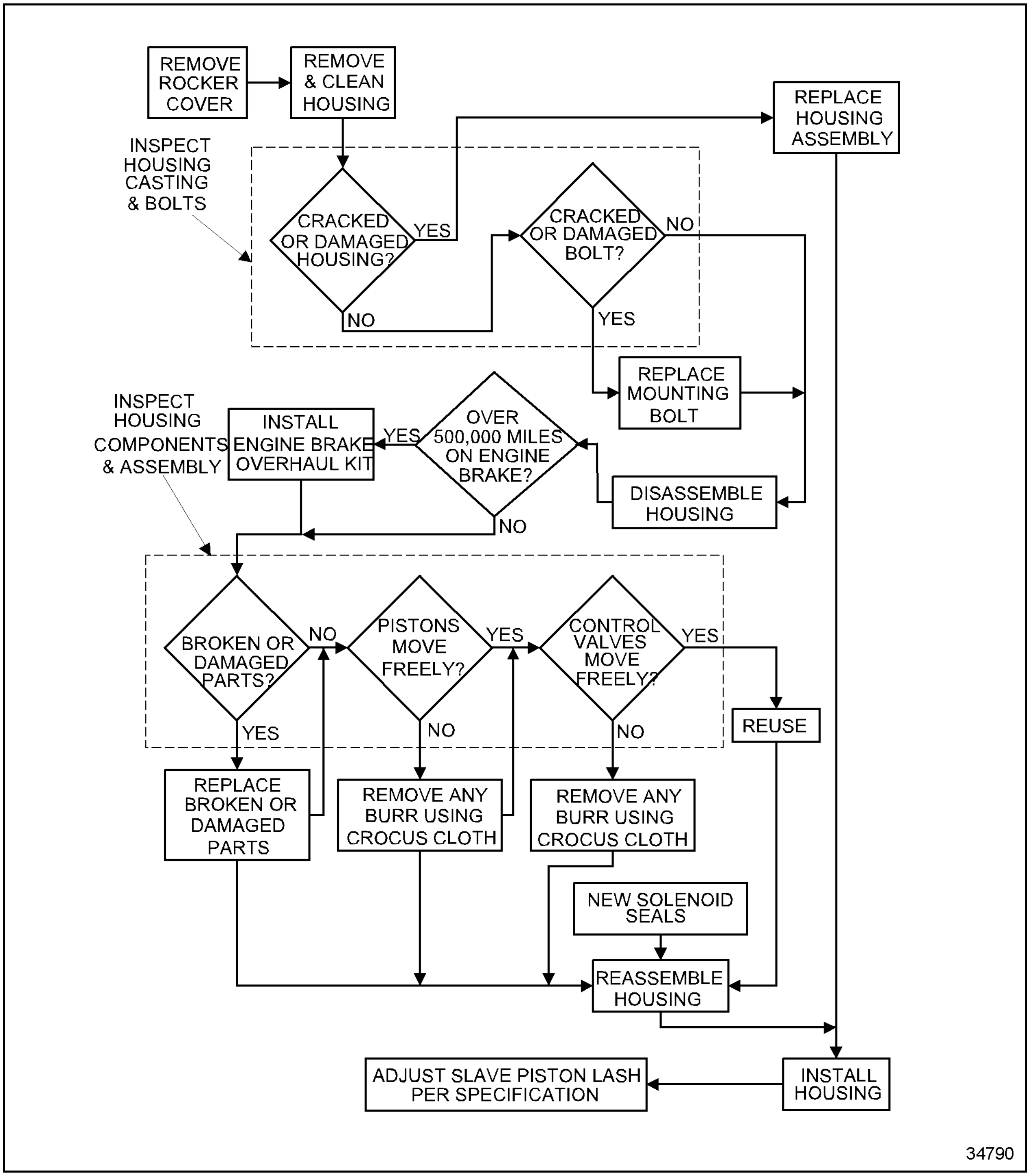


Figure 1-417 Jake Brake Repair or Replacement Flowchart

1.29.2 Removal of Model 760, 765, or 770 Jake Brake

Remove the model 760, 765, or 770 Jake Brake as follows:

NOTE:
The following procedures apply to Model 760, 765, and 777 Jake Brakes. For Model 790 Jake Brake removal procedures, refer to section 1.29.6.

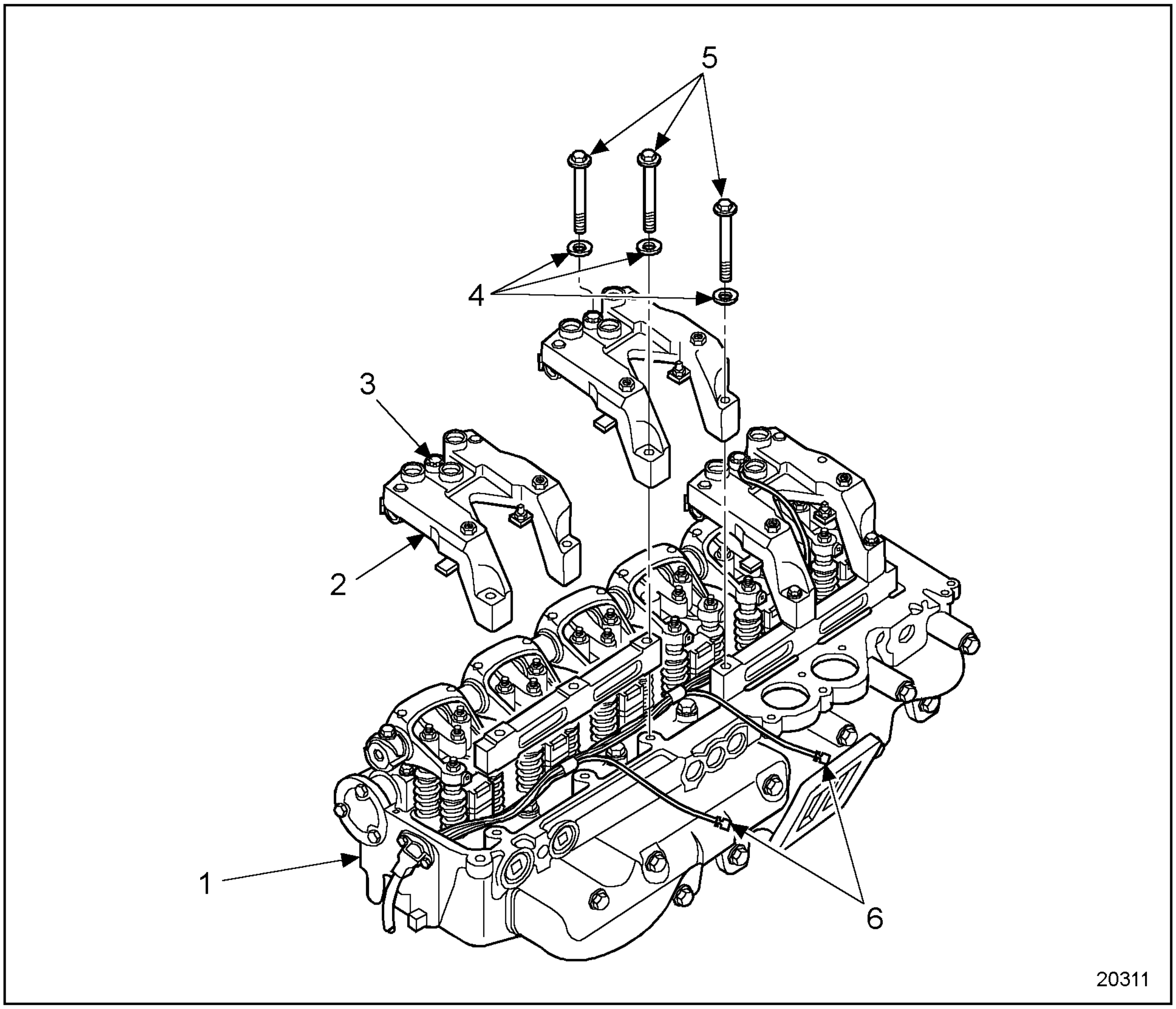
CAUTION:

To avoid possible personal injury, never remove any engine brake component with engine running.

1. Disconnect starting power for engine. Refer to OEM guidelines.
2. Remove the engine rocker cover. Refer to section 1.6.2 for one-piece, refer to section 1.6.3 for two-piece and refer to section 1.6.5 for three-piece.

NOTE:
If the engine is equipped with an aluminum two-piece valve cover, remove only the upper valve cover when installing the engine brake.

3. Note the location of the rocker arm shaft, the exhaust valve rocker arm, the fuel injector rocker arm, and the intake valve rocker arm.
4. Disconnect the solenoid wiring harness connectors from the engine brake solenoids. See Figure 1-418.



1. Cylinder Head
2. Jake Brake Assembly
3. Solenoid
4. Washers (3 each)
5. Mounting Bolts (3 each)
6. Engine Brake Harness

Figure 1-418 Jake Brake Assembly

5. Remove the nine mounting bolts and washers that secure the engine brake assemblies to the cylinder head. See Figure 1-418.

NOTE:
Only the Model 760 Jake Brake uses two different length mounting bolts. Six bolts, 120 mm (4.72 in.) long, are used on the exhaust side of the engine. Three bolts, 110 mm (4.33 in.) long, are used on the intake side of the engine. These bolts must be reinstalled in their correct positions.

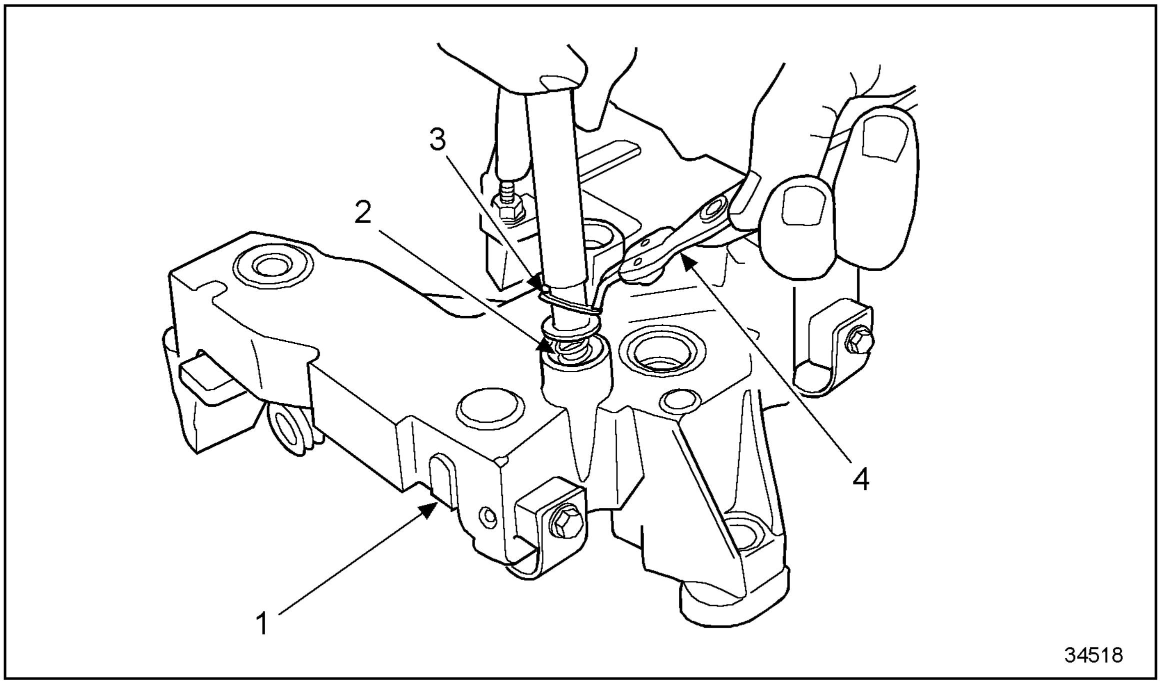
6. Remove the engine brake assemblies and the spacer bar.

1.29.3 Disassembly of Model 760, 765, or 770 Jake Brake

Remove the control valve as follows:

To avoid personal injury, remove control valve covers carefully. Control valve covers are under load from the control valve springs.

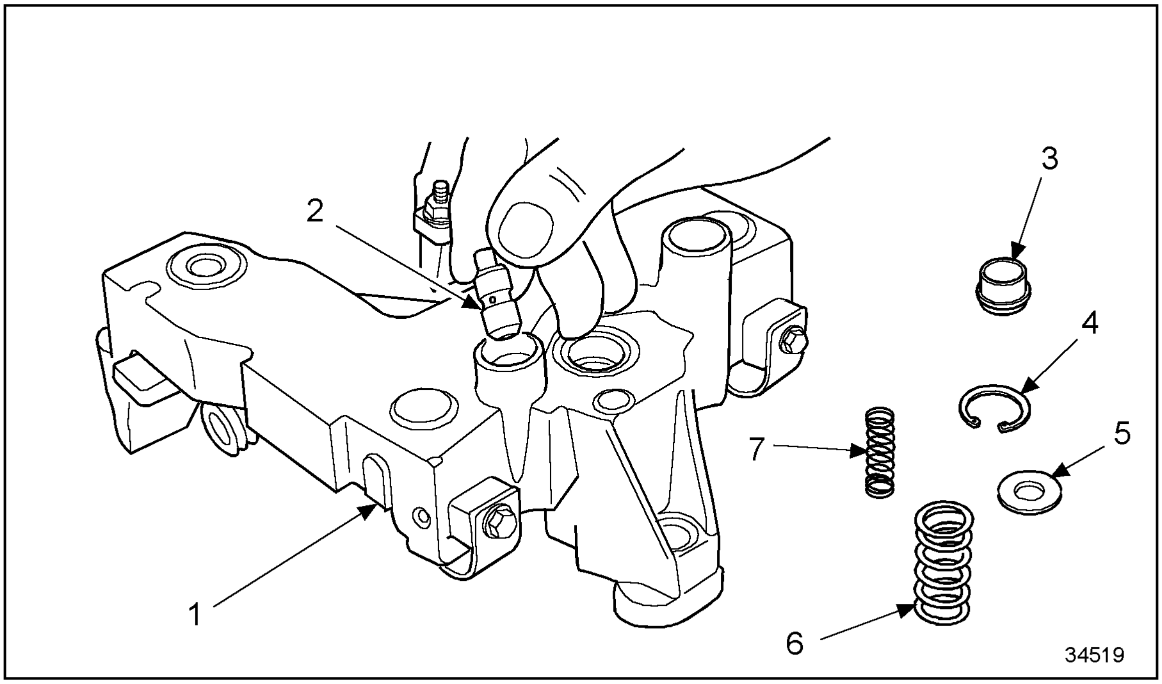
1. Press down on control valve washer using an appropriate diameter rod to relieve spring pressure. See Figure 1-419.



1. Jake Brake Assembly
2. Spring
3. Snap Ring Retainer
4. Snap Ring Pliers

Figure 1-419 Relieving Spring Pressure

2. Using retaining ring pliers, remove retaining ring.
3. Slowly remove cover until spring pressure ceases, then remove the two control valve springs and collar. See Figure 1-420.



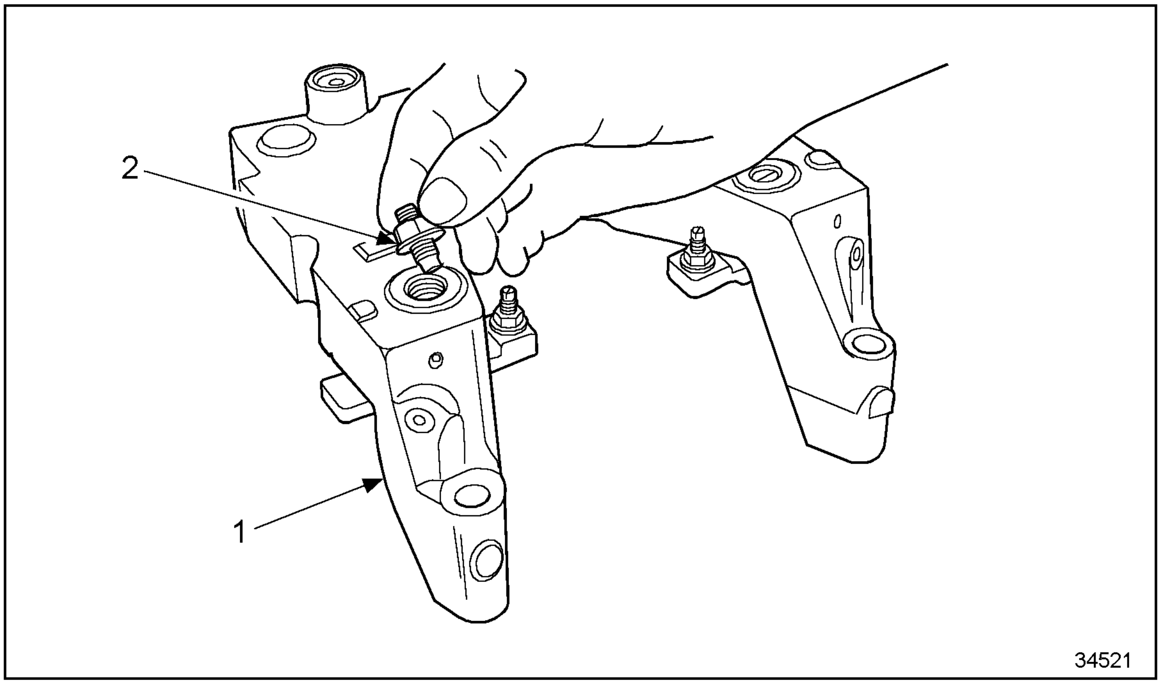
1. Jake Brake Assembly
2. Control Valve
3. Collar
4. Snap Ring Retainer
5. Washer
6. Collar Spring
7. Control Valve Spring

Figure 1-420 Removing Control Valve Springs and Collar

4. Using needle-nose pliers, reach into the bore and grasp the stem of the control valve. Remove control valve.

Remove the slave piston adjusting screw as follows:

1. Loosen slave piston adjusting screw locknut.
2. Remove adjusting screw from housing. See Figure 1-421.



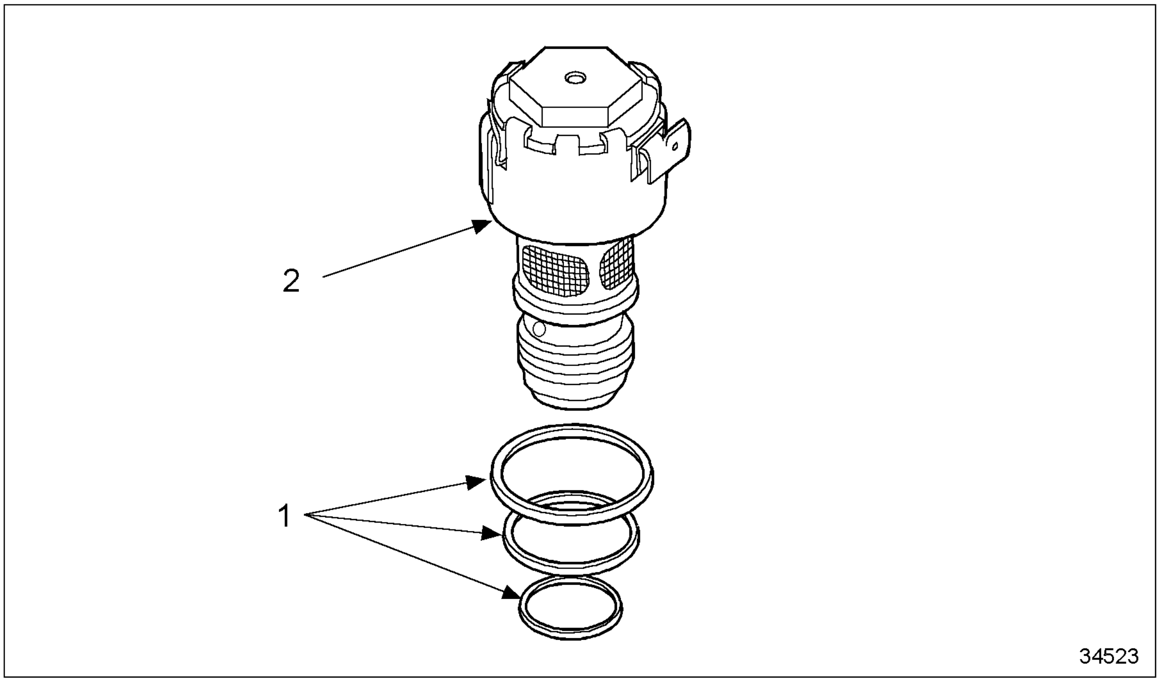
1. Jake Brake Assembly
2. Slave Piston Adjusting Screw

Figure 1-421 Removing Slave Piston Adjusting Screw

Remove the solenoid valve as follows:

NOTICE:
To avoid possible engine damage, do not disassemble or tamper with the solenoid valve.

1. Disconnect solenoid valve harness.
2. Using a 7/8 in. socket and extension for former solenoids or a 3/4 in., 6 point socket and extension for current solenoids, unscrew solenoid valve.
3. Remove and discard the three rubber seal rings. See Figure 1-422.



1. Seal Rings (3)
2. Solenoid

Figure 1-422 Removing Rubber Seal Rings

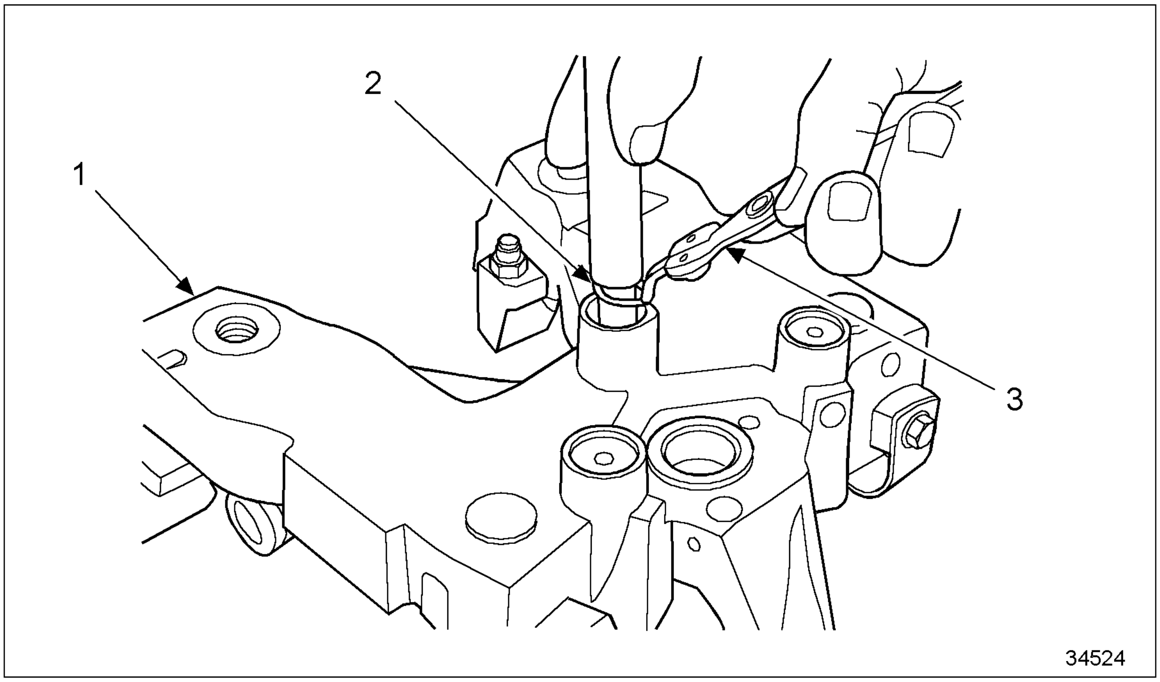
4. If the lower ring stays in the bottom of the housing bore, remove with a piece of wire.

Remove the accumulator as follows:

CAUTION:

The accumulator spring is under strong compression. To avoid possible personal injury if the accumulator spring is discharged, wear safety glasses and use caution when removing the retaining ring and cover.

1. Push down on the accumulator cover using the appropriate diameter rod, and remove the retaining ring. See Figure 1-423.

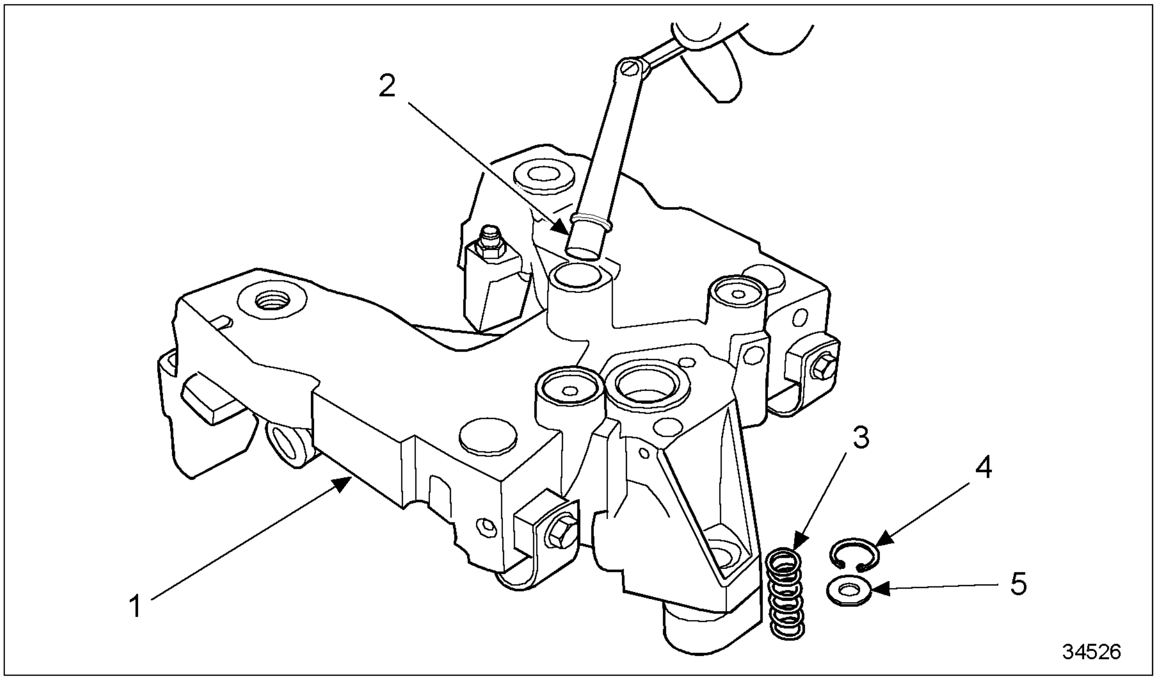


1. Jake Brake Assembly
2. Retaining Ring
3. Retaining Ring Pliers

Figure 1-423 Removing Retaining Ring

2. Relieve pressure on the accumulator cover.
3. Remove the cover and spring.

4. Use a magnet to remove the piston from the accumulator bore. See Figure 1-424.



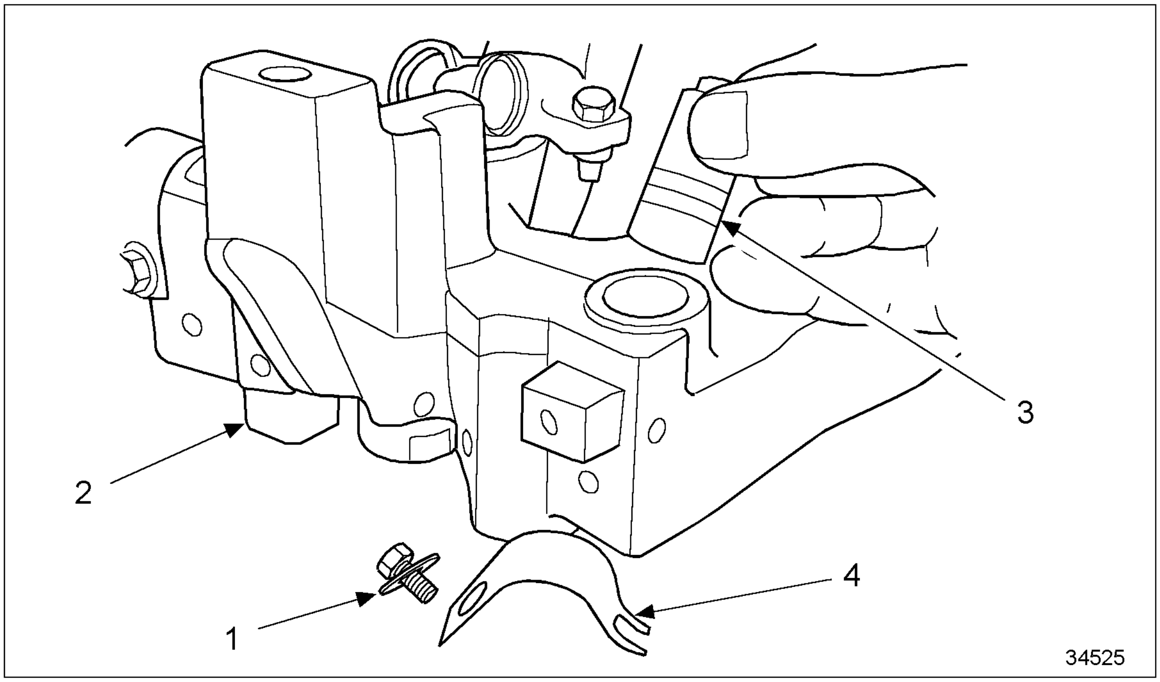
1. Jake Brake Assembly
2. Piston
3. Spring
4. Retaining Ring
5. Washer

Figure 1-424 Removing Piston from Accumulator Bore with Magnet

Remove the master piston as follows:

1. Remove the screw, washer, and master piston spring from the housing.
2. Remove the master piston. See Figure 1-425.

NOTE:
Use needle-nose pliers, if necessary.



1. Washer and Screw Assembly
2. Jake Brake Assembly
3. Master Piston
4. Master Piston Spring

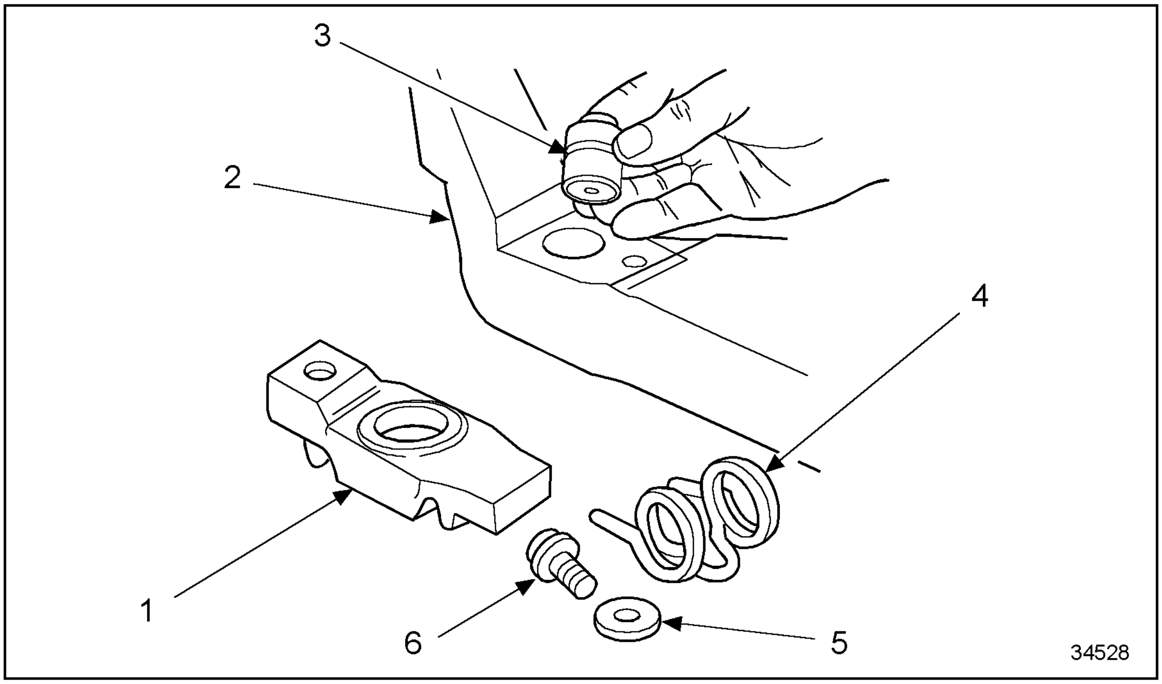
Figure 1-425 Removing The Master Piston

On Model 760 only, remove the ball check valve as follows:

1. Remove the plug.
2. Remove the ball check valve and spring.

Remove the slave piston as follows:

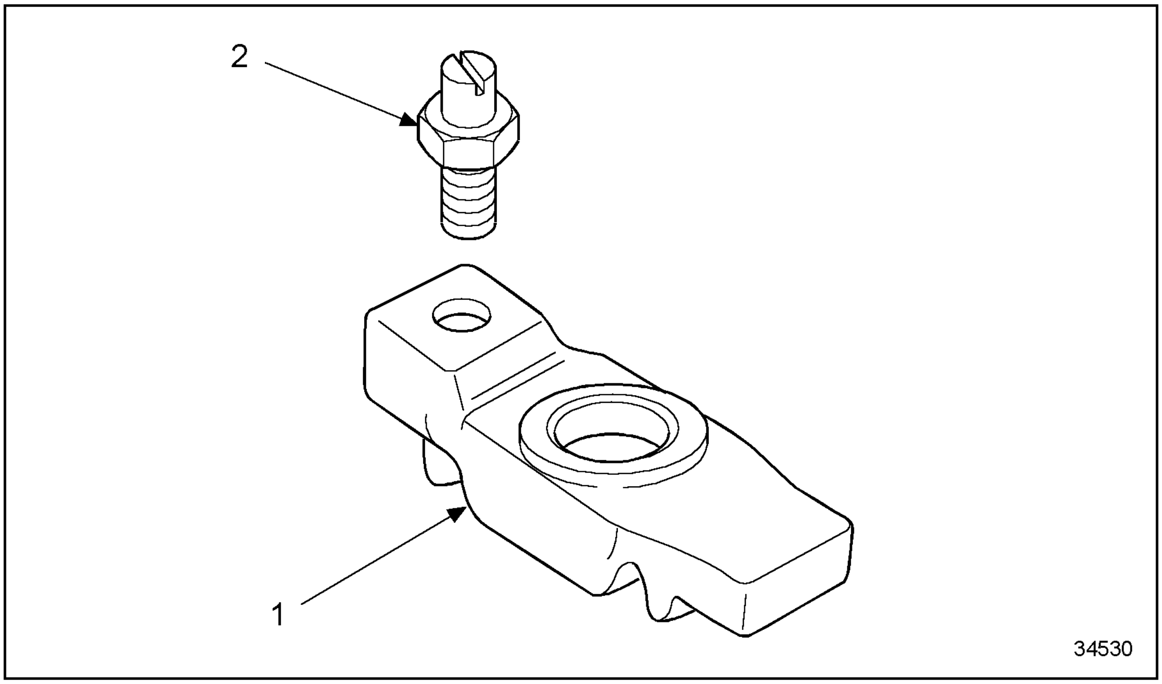
1. Remove the screw and spring that retains the slave piston return spring.
2. Remove the bridge and the slave piston. See Figure 1-426.



1. Slave Piston Bridge
2. Jake Brake Housing
3. Slave Piston
4. Return Spring
5. Washer
6. Screw

Figure 1-426 Removing Bridge and Slave Piston

3. Loosen the leveling screw locknut and remove the leveling screw from the bridge. See Figure 1-427.



1. Slave Piston Bridge
2. Slave Piston Leveling Screw

Figure 1-427 Removing the Leveling Screw from the Bridge

The injector rocker arm contains a pin and roller for actuating the engine brake master piston. If excessive wear or damage to the roller is present, replace the rocker arm assembly. Refer to Section 1.6.2.

1.29.3.1 Cleaning of Model 760, 765, or 770 Jake Brake

Clean the Jake Brake as follows:

NOTE:
Use an OSHA-approved cleaning solvent when washing parts. Be sure to coat parts with clean engine oil when reinstalling them.

1. Wash the control valves with approved cleaning solvent.
2. Push a wire through the hole in the base of the valve to the distance required to ensure that the ball check is free.

NOTE:
The ball should lift with light pressure on the wire.

CAUTION:

To prevent possible personal injury when using compressed air, wear adequate eye protection (face plate or safety glasses) and do not exceed 40 psi (276 kPa) air pressure.

3. Dry the valve with compressed air, and wipe clean with a paper towel.
4. Thoroughly clean the control valve bore in the housing using clean paper towels.
5. Clean slave piston adjusting screw in an approved cleaning solvent.
6. Clean out the solenoid valve bore in the housing.

NOTICE:

Use clean paper towels to clean the solenoid valve bore. Never use rags, as they may leave lint and residue which can plug the oil passageways, causing Jake Brake malfunction.

7. Clean the master piston in approved cleaning solvent.

1.29.3.2 Inspection of Model 760, 765, or 770 Jake Brake

The Jacobs engine brake is typically a trouble-free device. However, inspections are necessary and some maintenance is required. Use the following procedures to keep the engine brake in top condition.

Inspect the Jake Brake as follows:

1. Inspect slave piston adjusting screw for protrusion, spring pressure and freedom of movement.

NOTE:
The plunger should protrude from the bottom of the screw, have light spring pressure apparent when depressed, and move freely. Be sure the retaining ring is fully engaged in its groove (groove is located on the bottom of the reset screw and top of the POWER-LASH assembly).

   [a] If the plunger does not protrude, the spring does not have light pressure or does not move freely, replace the entire screw assembly. Refer to Section 1.29.4

   [b] If the slave piston adjusting screw meets specifications, continue with inspection.

2. Inspect the accumulator for wear or damage.

   [a] If worn or damaged, replace the accumulator. Refer to Section 1.29.4.

   [b] If accumulator is not worn or damaged, continue with inspection.

3. Inspect the master piston bore for wear or damage.

NOTE:
Some wear marks are permissible.

   [a] If worn or damaged, replace the master piston. Refer to Section 1.29.4.

   [b] If not worn or damaged, continue with inspection.

4. Apply clean lube oil to the piston, and insert into bore.

NOTE:
Master piston should move in and out freely with no binding.

   [a] If binding occurs, replace master piston and/or housing. Refer to Section 1.29.4.

   [b] If no binding occurs, continue with inspection.

5. Inspect master piston spring for relaxation.

NOTE:
The spring should hold the master piston completely in the housing.

   [a] If relaxed, replace the spring. Refer to Section 1.29.4.

   [b] If spring holds tightly, continue with inspection.

6. Inspect the ball check valve (Model 760 only) for wear or damage.
   [a] If worn or damaged, replace ball check valve. Refer to Section 1.29.4.
   [b] If not worn or damaged, proceed with inspection.
7. Inspect slave piston components for excessive wear or damage.
   [a] If worn or damaged, replace slave piston component.
   [b] If not worn or damaged, proceed with inspection.

1.29.3.3 Inspection of Control Valve

Inspect the control valve as follows:

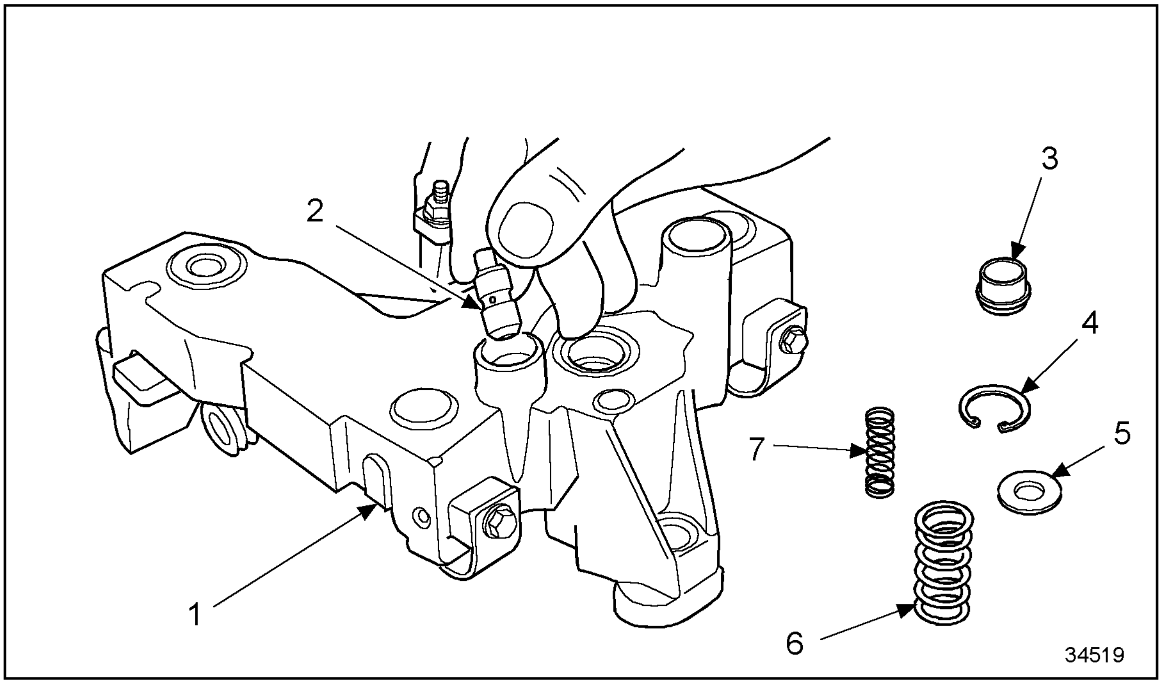
1. Dip the control valves in clean lube oil.
2. Holding the control valve by the stem, let it drop into the bore.
   [a] If binding occurs or if the ball sticks in the valve, replace the control valve. Refer to Section 1.29.4.
   [b] If no binding occurs and the ball does not stick in the control valve, assemble the Jake Brake. Refer to Section 1.29.4.

1.29.4 Assembly of Model 760, 765, or 770 Jake Brake

Install the control valve as follows:

1. Slip the control valve into the bore. See Figure 1-428.

NOTE:
Make sure the control valve collar is installed with the longer sleeve area facing up. If the collar is installed upside down, the engine brake cylinder will not operate.



1. Jake Brake Assembly
2. Control Valve
3. Collar
4. Snap Ring Retainer
5. Washer
6. Collar Spring
7. Control Valve Spring

Figure 1-428 Installing the Control Valve

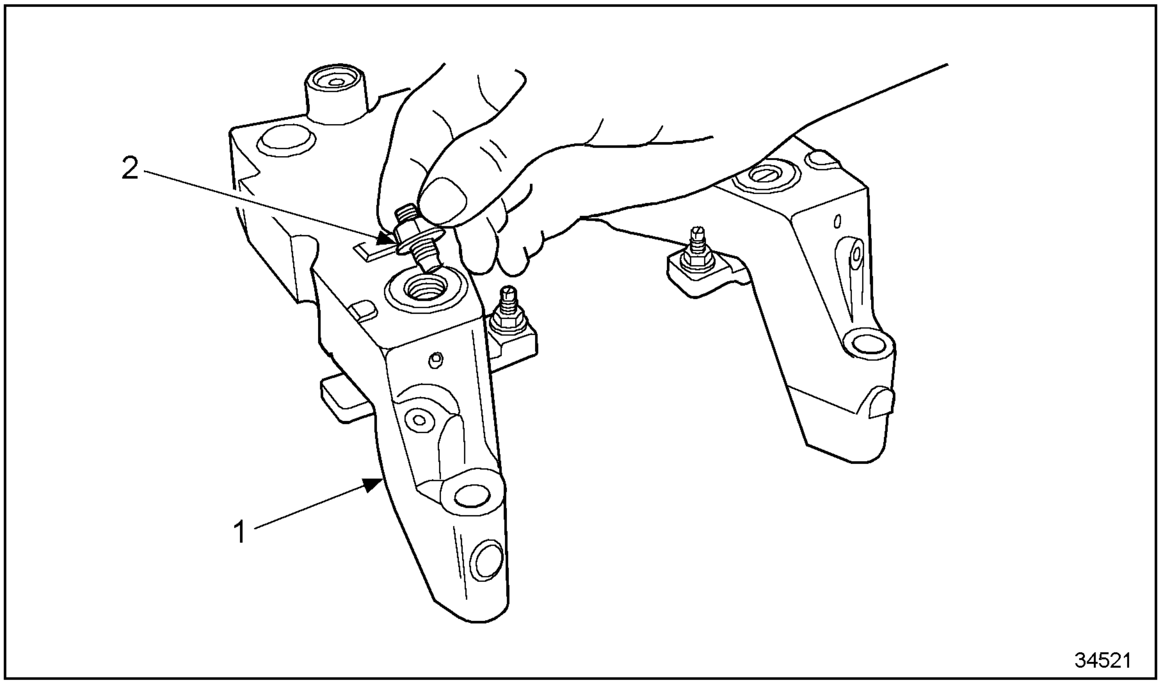
2. Install the control valve collar and two springs.

NOTE:
Ensure the collar is installed with the longer sleeve area facing up. If the collar is installed upside down, the engine brake cylinder will not operate.

3. Press the cover (washer) into place.
4. While holding the cover tightly in place, install the retaining ring.
5. Rotate retaining ring ears 90 degrees to assure ring is seated in groove.

Install the slave piston adjusting screw as follows:

1. Place the screw in the housing. See Figure 1-429.



1. Jake Brake Assembly
2. Slave Piston Adjusting Screw

Figure 1-429 Installing the Slave Piston Adjusting Screw

2. Torque the slave piston adjusting screw locknut to 35 N·m (25 lb·ft).

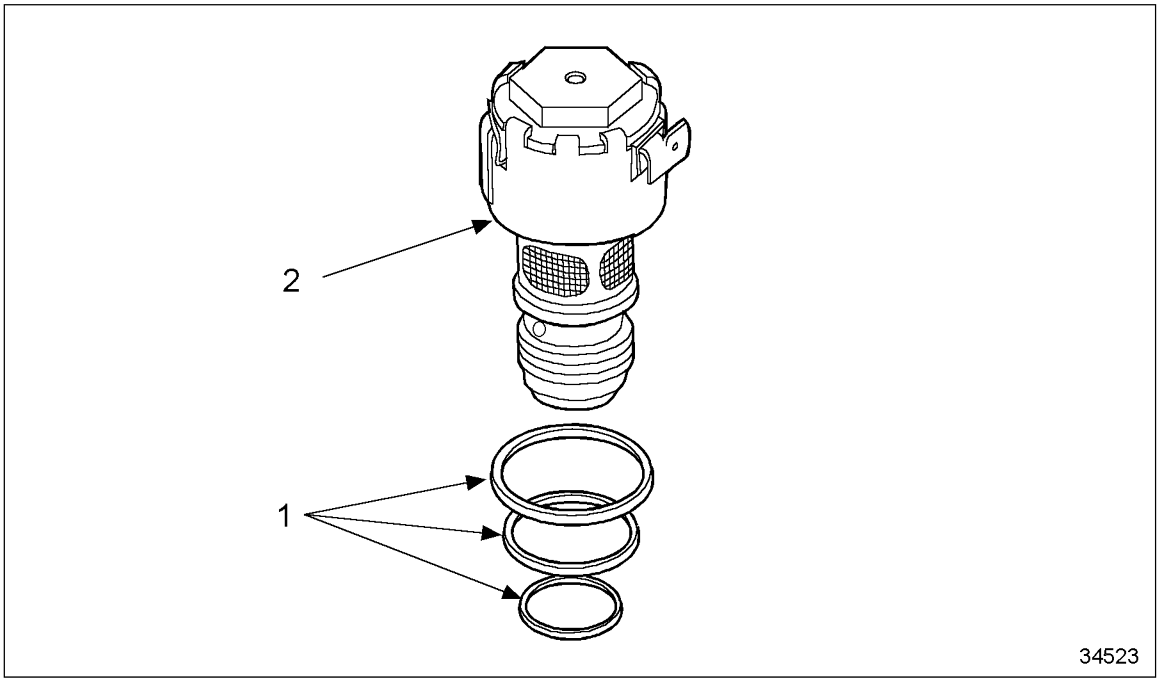
Install the solenoid valve as follows:

NOTE:
As of October 19, 1997, former solenoids have been replaced with the current improved solenoids. The current solenoids have an increased installation torque and improved durability. The current solenoid is interchangeable with the former.

1. Coat new solenoid valve seal rings with clean lube oil.

NOTE:
Use current upper seals when installing current solenoids. New seals are identified with yellow stripes.

2. Install the upper and center seal rings on the solenoid valve body and the lower seal ring into the bottom of the bore in the housing. See Figure 1-430.



1. Seal Rings (3)
2. Solenoid

Figure 1-430 Installation of Solenoid Valve Seal Rings

3. Make sure the seals are seated properly.
4. Using a 7/8 in. socket and extension for former solenoids or a 3/4 in., 6 point socket and extension for current solenoids, carefully screw the solenoid valve into the housing without unseating the seals.
5. Torque the former solenoid to 12.4 N·m (9 lb·ft). Torque the current solenoid to 20 N·m (15 lb·ft.)

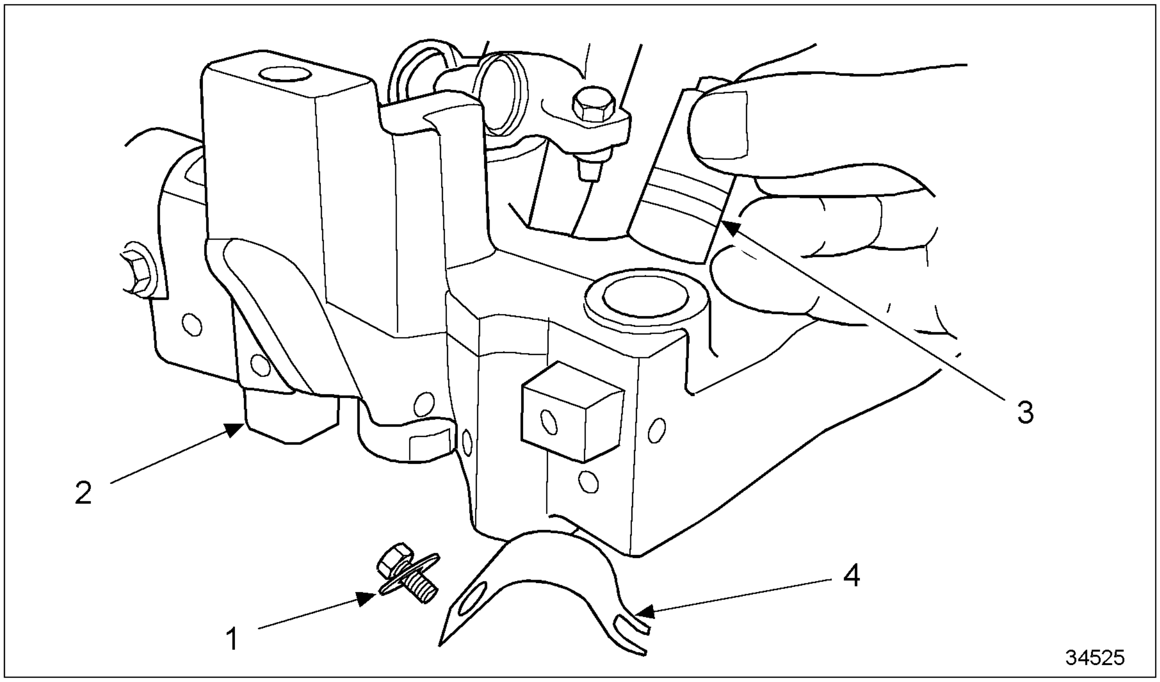
NOTE:
Be careful not to twist the seals while installing.

Install the accumulator as follows:

1. Place the piston into the accumulator bore.
2. Insert the spring, and install the cover.
3. Push down the accumulator cover, and insert retaining ring.

Install the master piston as follows:

1. Apply clean lube oil to the piston.
2. Insert master piston into bore. See Figure 1-431.



1. Washer and Screw Assembly
2. Jake Brake Assembly
3. Master Piston
4. Master Piston Spring

Figure 1-431 Inserting Master Piston into Bore

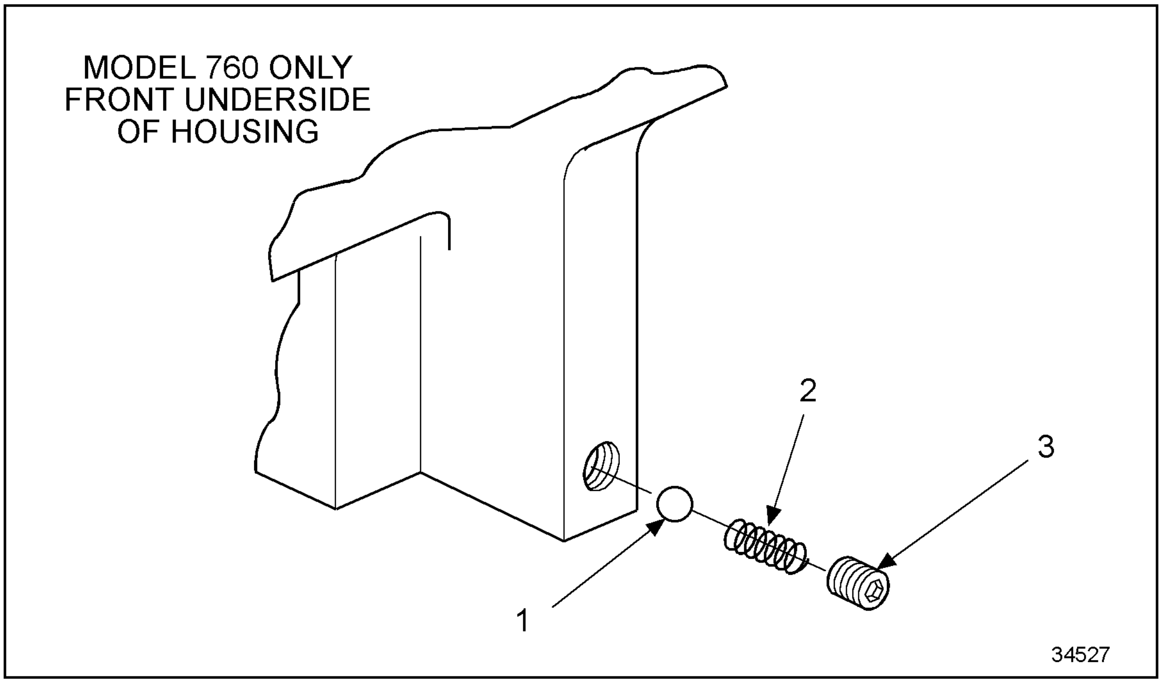
3. Install spring, washer, and screw.

NOTE:
Make sure spring legs are centered around master piston boss.

4. Torque screw to 10 N·m (7.4 lb·ft).

On model 760 only, install the ball check valve as follows:

1. Install the ball check valve and spring. See Figure 1-432.



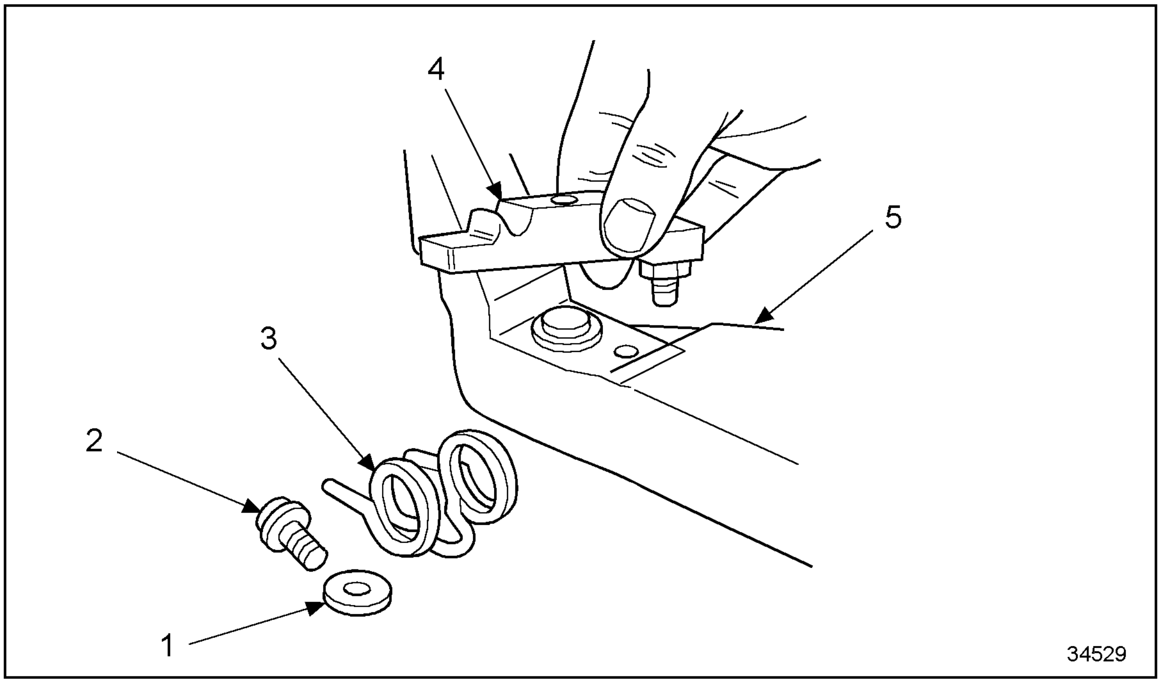
1. Ball Check Valve
2. Spring
3. Pipe Plug

Figure 1-432 Installation of Ball Check Valve

2. Insert the plug. Torque pipe plug to 11.2 N·m (8.3 lb·ft).

Install the slave piston as follows:

1. Install the screw from the slave piston side of the bridge.
2. Install the leveling screw locknut.
3. Install the bridge with the leveling screw toward the center of the housing. See Figure 1-433.



1. Washer
2. Screw
3. Torsion Spring
4. Bridge Assembly
5. Jake Brake Housing

Figure 1-433 Installing Bridge with Leveling Screw Toward Center of Housing

4. Install the slave piston assembly torsion spring with the ends over the bridge. See Figure 1-434.

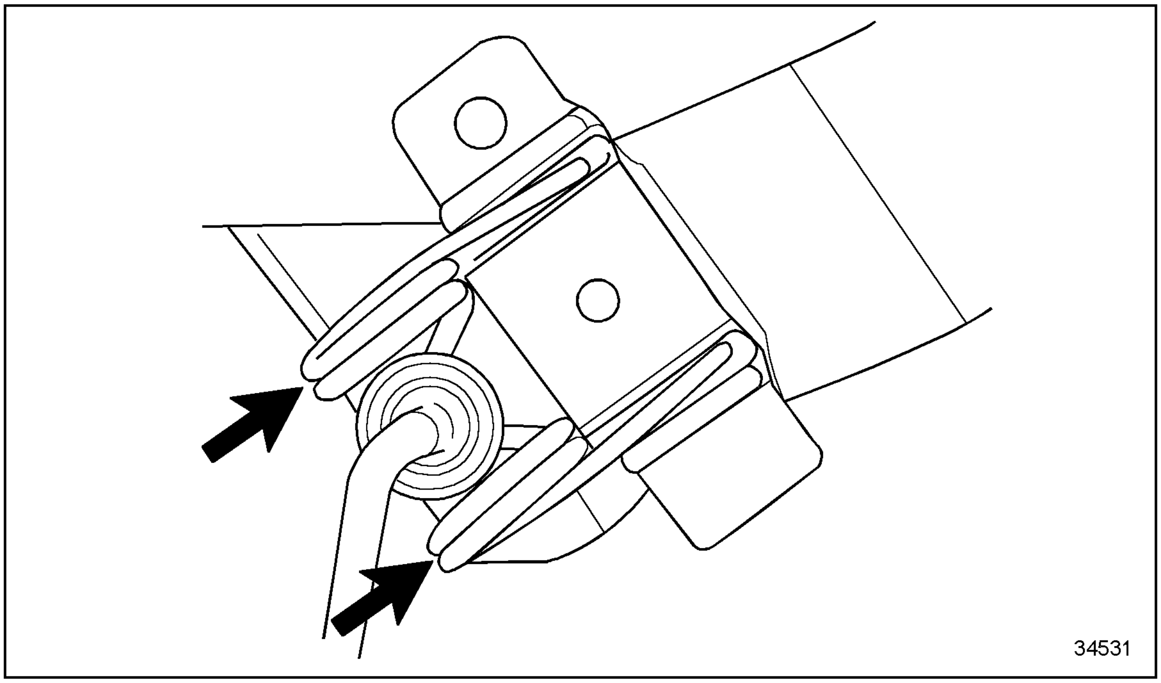


Figure 1-434 Installing the Slave Piston Assembly Torsion Spring

5. Install the screw over the center part of the spring.

NOTICE:
While tightening the screw on the torsion spring, push the spring toward the slave piston assembly. Failure to do so may result in contact between the intake valve adjusting screw and torsion spring. Serious engine damage may result.

6. Torque the screw to 20 N·m (15 lb·ft.).
7. Torque the slave piston leveling screw locknut to 47 N·m (35 lb·ft.).

1.29.5 Installation of Model 760, 765, or 770 Jake Brake

Install the model 760, 765, or 770 Jake Brake as follows:

NOTE:
The following procedures apply to Model 760, 765, and 770 Jake Brakes. For Model 790 Jake Brake installation procedures, refer to section 1.29.10.

1. Adjust the intake and exhaust valve clearances and set the injector heights. Refer to section .

CAUTION:
To prevent possible personal injury when using compressed air, wear adequate eye protection (face plate or safety glasses) and do not exceed 40 psi (276 kPa) air pressure.

2. Attach the length of tubing to a blow gun nozzle, and blow out the oil from the bolt holes.
3. Cover the holes with hand towels to minimize oil spray.

NOTE:
Removing the oil from the bolt holes prevents the cylinder head from cracking when tightening the bolts.

4. Place the spacer bar on the exhaust manifold side of the cylinder head with the "OUT" markings adjoining each other and facing the exhaust manifold. See Figure 1-435, and see Figure 1-436.

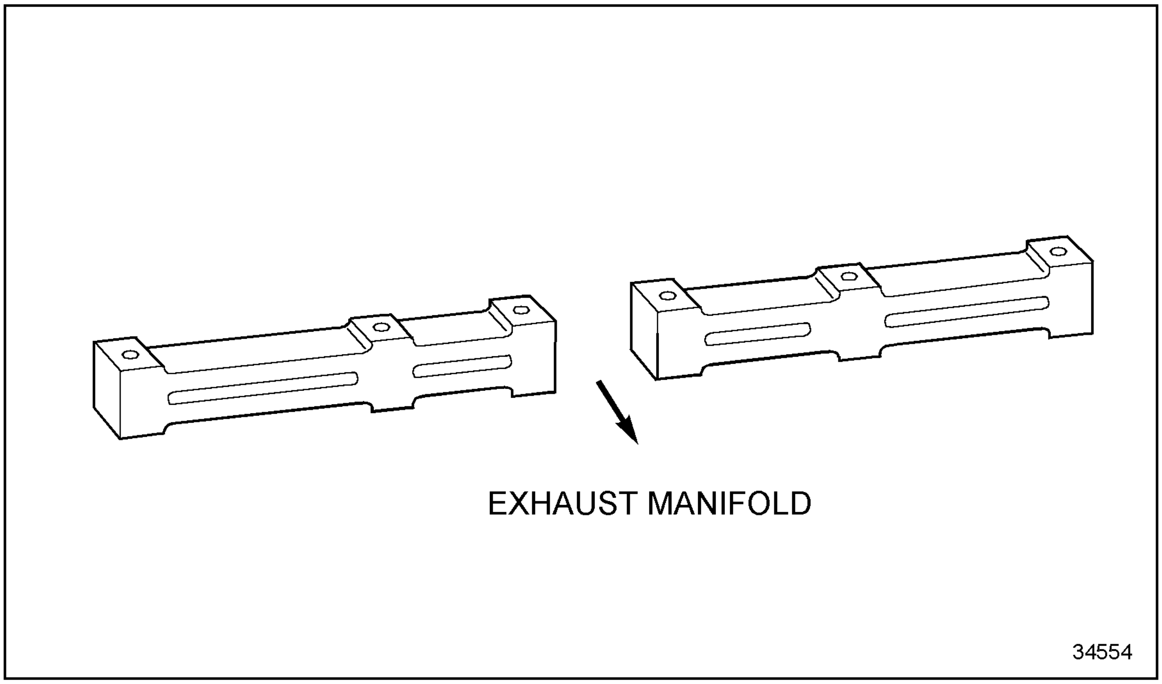


Figure 1-435 Spacer Bars with "Out" Marks Adjoined

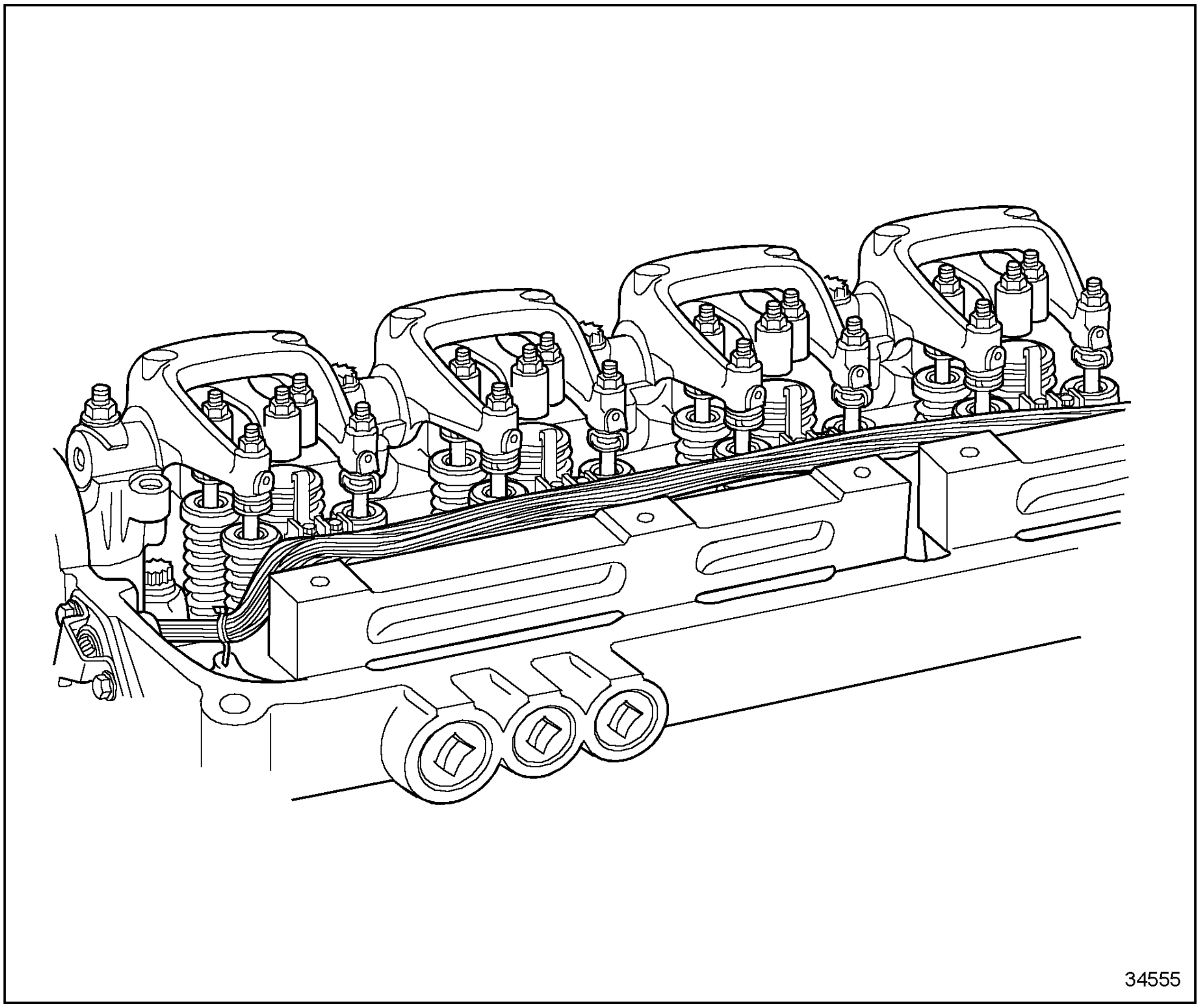


Figure 1-436 Location of Spacer Bars

5. Place the three engine brake housings over the rocker shafts with the solenoid valves toward the camshaft side of the engine.

NOTE:
Be sure housings do not interfere with wiring harness.

NOTICE:
Do not mix the rocker arm shaft bolts and the Jake Brake mounting bolts. If the rocker arm shaft bolt is mistakenly used to mount the Jake Brake housing, the longer shoulder on the bolt will block the oil supply to the Jake Brake on the camshaft side of the housing. The brake will not retard the engine as designed. This condition could cause loss of vehicle braking control on downgrades, which may create a risk of personal injury to the vehicle operator or other persons and damage to the vehicle or property of others.

NOTE:
The rocker arm shaft mounting bolt and Jake Brake mounting bolt, part of the Jake Brake assembly, are similar in appearance. Both are M12 x 110 mm (4.33 in.) long and have 12–point heads.

NOTE:
In the event of a housing hold down bolt failure on a Jacobs engine brake housing, replace all bolts on that particular housing.

NOTICE:
Use bolts that have the Jacobs logo, circled "J". Installation of bolts that do not have the circled "J" may result in damage to the engine, engine brake or both.

[a] The Jake Brake bolt has the Jacobs logo (circled "J") and the letters "EF" marked on the head. The bolt length is no longer marked atop the bolt head.

[b] The DDC rocker arm shaft bolt has the DDC logo (spinning arrows) and the vendor I.D. (F-C) on its head.

[c] Jake Brake model 760 requires two bolts along with one bolt and new washers.

NOTE:
Be sure that only Jake Brake bolts, see Figure 1-437, are installed in the Jake Brake housing.

[d] The DDC bolt shoulder is much longer, 17.0 mm (0.669 in.) versus 4 mm (0.157 in.) than the Jake Brake bolt. See Figure 1-437.

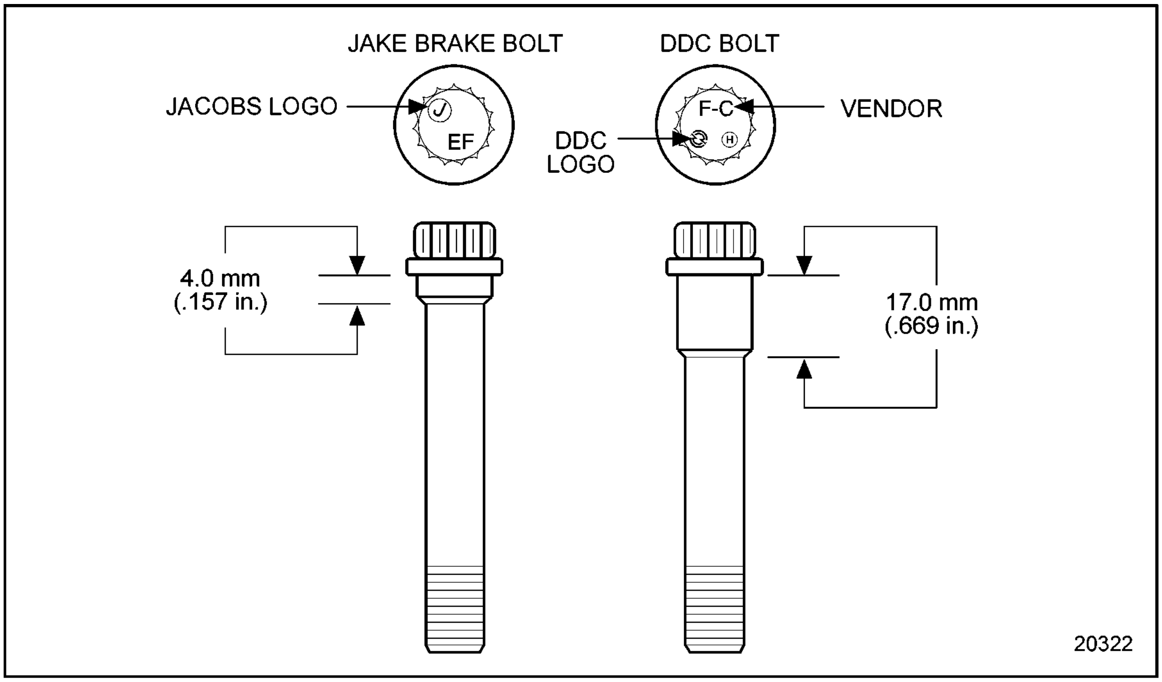
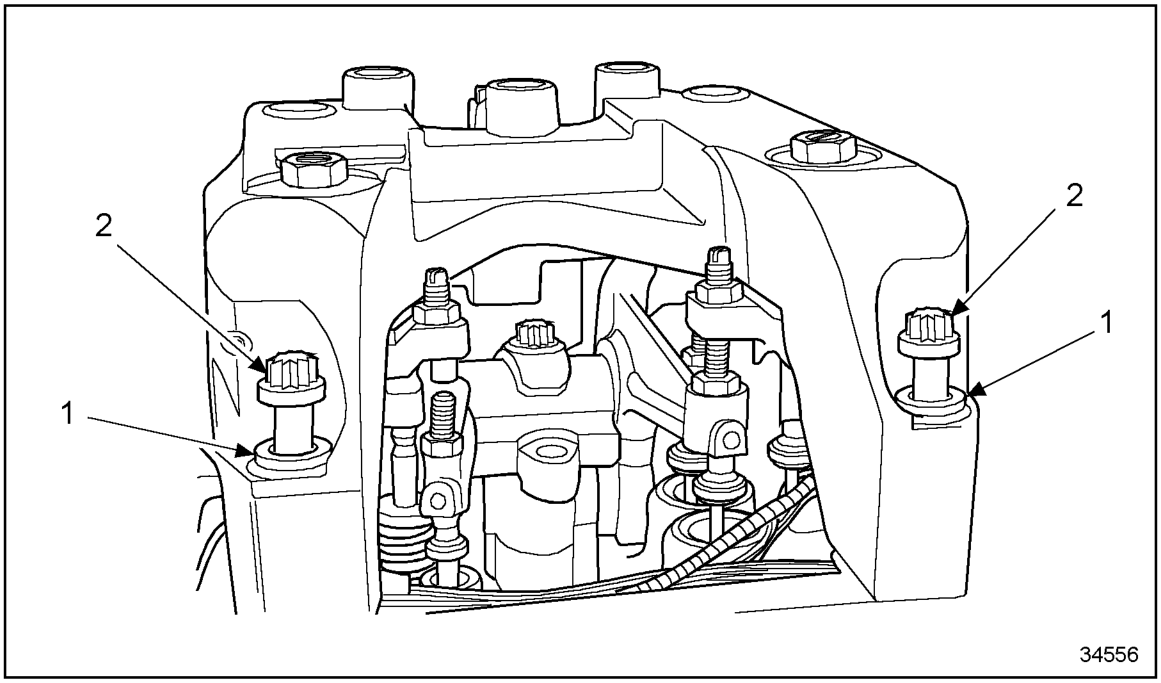


Figure 1-437 Jake Brake and DDC Bolt Identification

NOTICE:
The model 760 uses two lengths of mounting bolts. Six 120 mm bolts should be installed on the exhaust side of the engine. Three 110 mm bolts should be installed on the camshaft side of the engine. Failure to do so will result in engine damage.

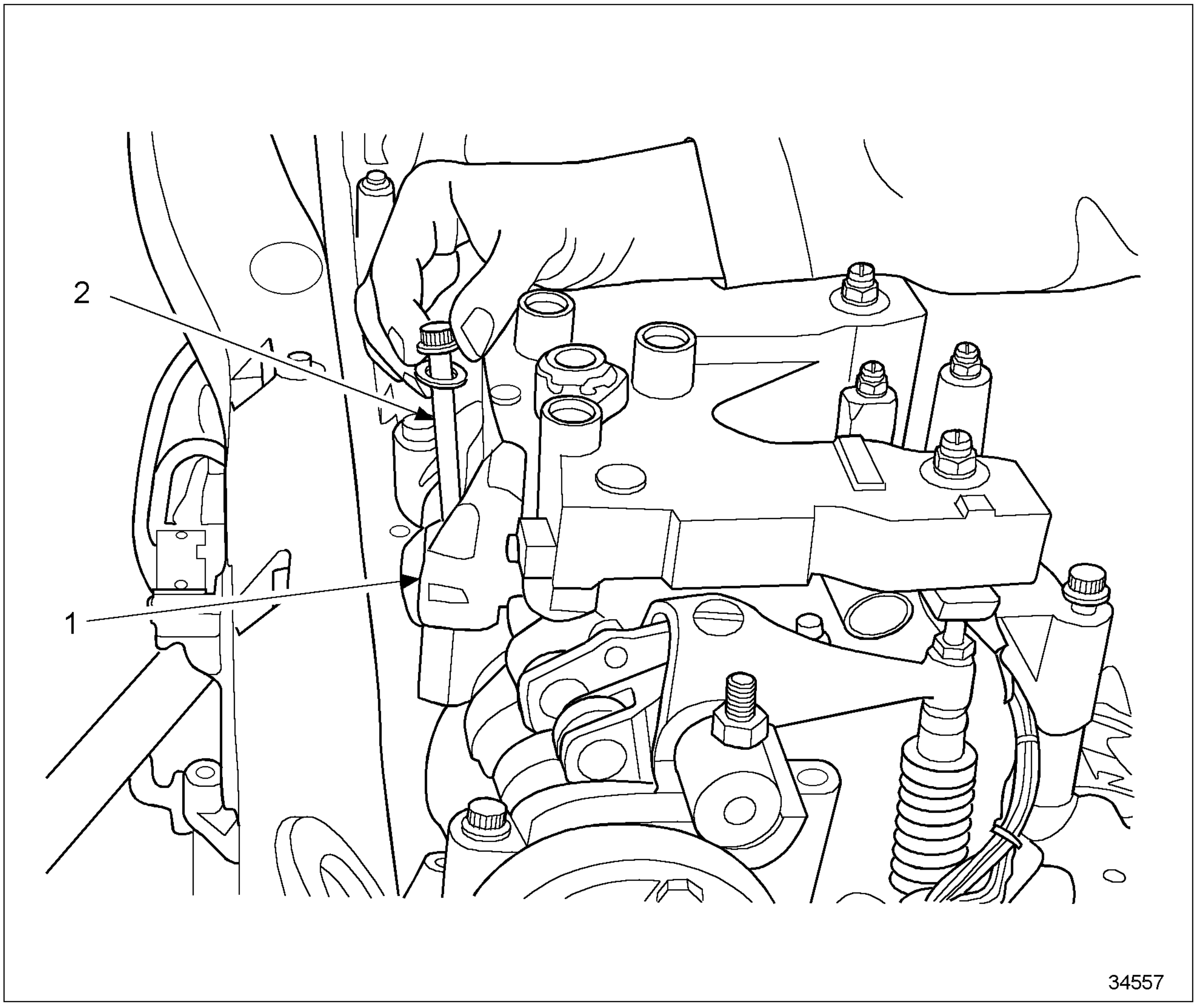
6. On model 760, install one washer onto each 120 mm (4.75 in.) bolt, and insert into brake housing on the exhaust manifold side (two per housing). See Figure 1-438.



1. Washer
2. Long Bolt

Figure 1-438 Installation of Brake Housing Bolts on Exhaust Manifold Side

7. On model 760, install one washer on the 110 mm (4.375 in.) bolt, and insert into brake housing at the camshaft side (one per housing). See Figure 1-439.



1. Jake Brake Housing Assembly
2. Mounting Bolt

Figure 1-439 Installation of Brake Housing Bolts on Camshaft Side

8. On models 760A, 760B, 765, and 765A, lubricate each hold down bolt with clean engine oil.

NOTE:
All the housing mounting bolts for these models are the same length of 110 mm (4.375 in.).

9. On models 760A, 760B, 765, and 765A, install a washer on each bolt, and install into housings (three bolts per housing).

10. On models 760A and 765, move the housing from side to side, and locate the housing in the center position of the movement. See Figure 1-440.

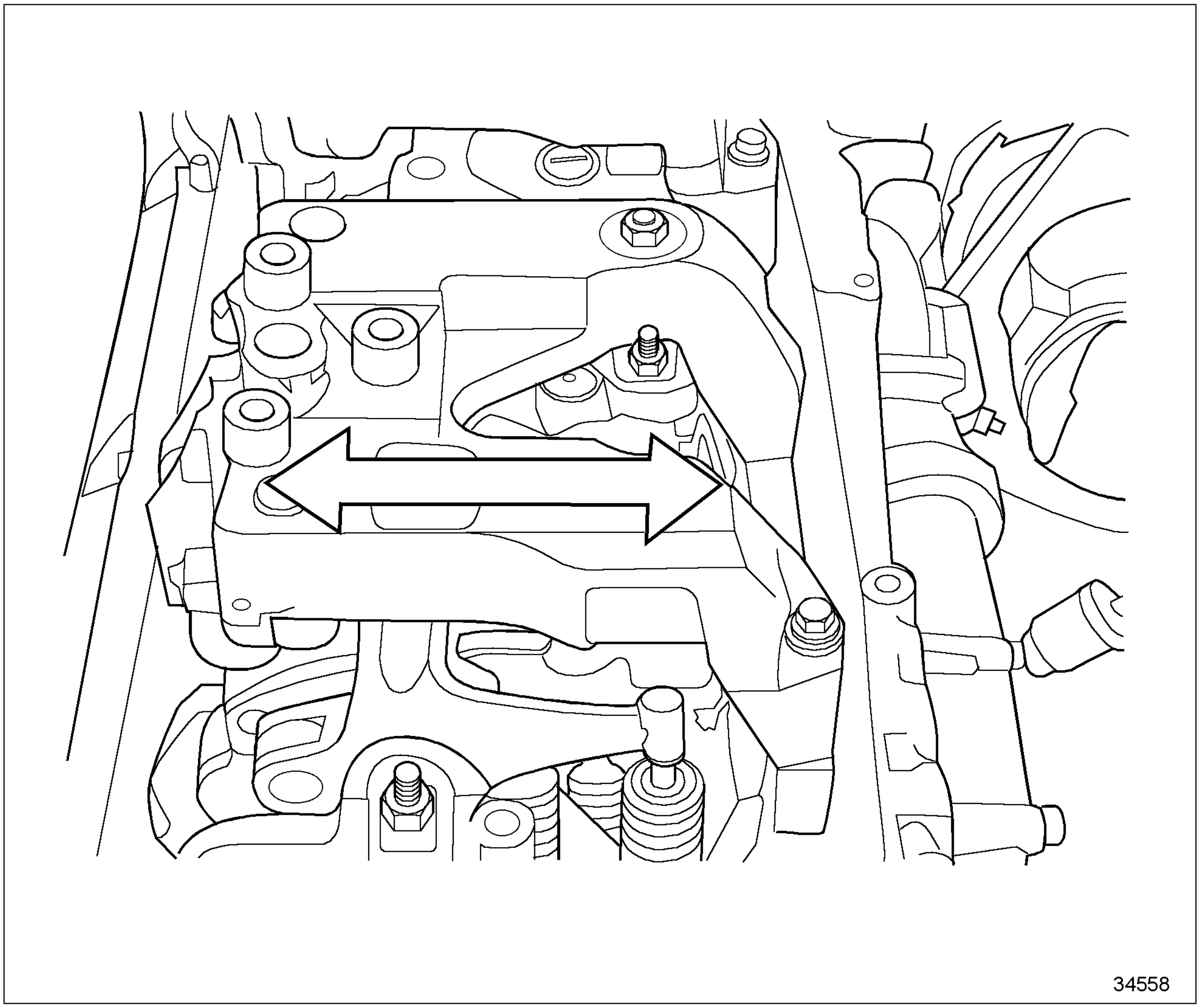


Figure 1-440 Locating Center Position of Housing

11. On models 760B and 765A, move the housing from side to side, and locate as far toward the camshaft side of the engine as possible.
12. On all models, torque the engine brake mounting bolts using the following sequence:
    [a] Torque the three bolts on the camshaft side of the engine to 55 N·m (40 lb·ft).
    [b] Torque the six bolts on the exhaust manifold side of the engine to 55 N·m (40 lb·ft).
    [c] Repeat the tightening sequence and re-torque all bolts to 136 N·m (100 lb·ft).
    [d] Check the torque to 136 N·m (100 lb·ft).
13. Secure wire harness to spacer bars with plastic ties.
14. Connect wiring harness solenoid connectors to solenoids.

1.29.5.1 Adjustment of Slave Piston on Model 760, 765, or 770 Jake Brake

Make the following adjustment with the engine stopped and cold, and the oil temperature at 60°C (140°F) or below. The exhaust valves on the cylinder *must* be in the closed position (rocker arm roller on the base circle of the camshaft). When setting the engine brake lash, the exhaust valves must be in the closed position. Adjust the slave piston on all models as follows:

NOTE:
The following procdures apply to Model 760, 765, and 770 Jake Brakes. For Model 790 Jake Brake slave piston lash setting procedures, refer to section 1.29.10.1.

NOTE:
Model 770 Jacobs engine brake requires a special procedure for adjusting the slave piston. The procedure is clearly indicated in the following adjustment steps.

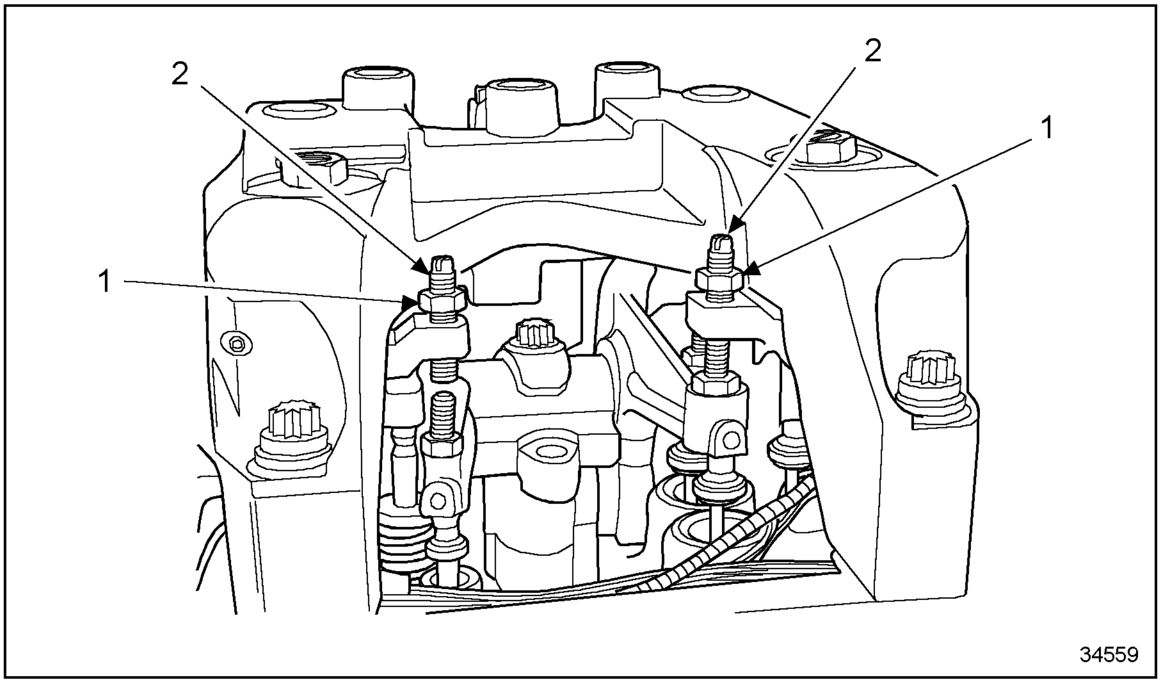
NOTICE:
Improper slave piston adjustment can result in engine or brake housing damage.

NOTICE:
Strictly follow the slave piston adjustment procedure. Failure to use the proper adjustment procedure will result in poor engine brake performance and/or serious engine damage.

1. Refer to section 1.29 for proper slave piston clearance setting.

2. Back out the leveling screw in the slave piston assembly until the end of the screw is beneath the surface of the bridge in the slave piston assembly. See Figure 1-441.

NOTE:
The leveling screw is located in the bridge member of the slave piston assembly.

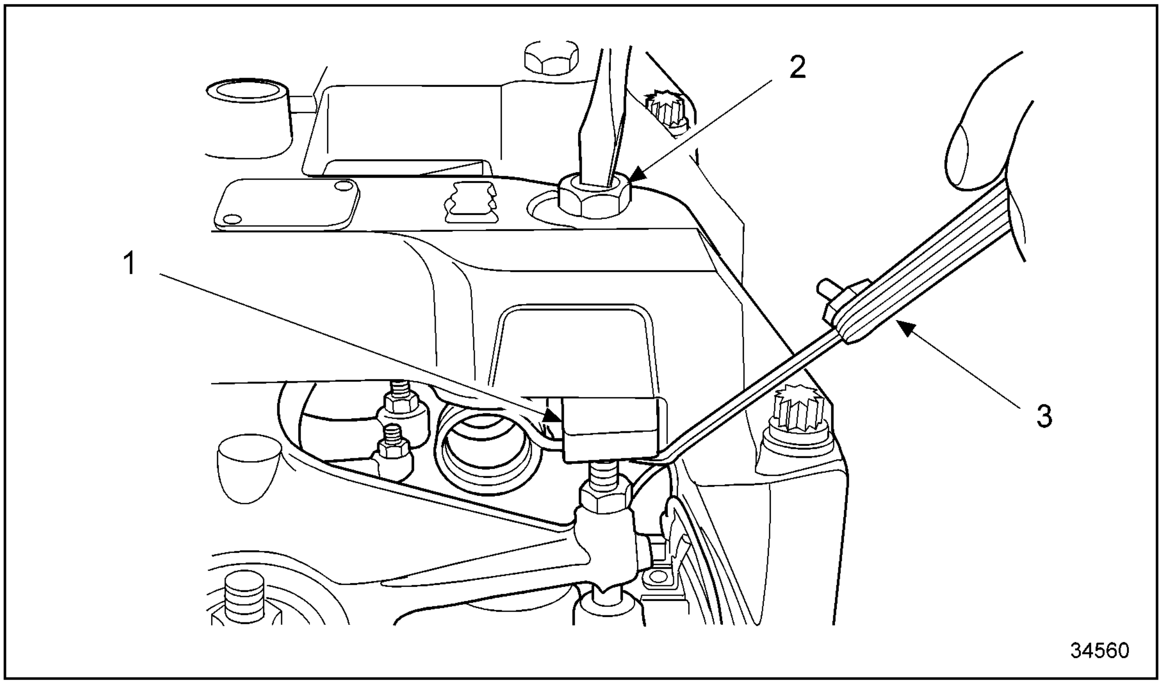


1. Leveling Screw
2. Locknut

Figure 1-441 Location of Leveling Screw

3. On models 760, 760A, 760B, 765, and 765A, place the correct size feeler gage between the solid side of the slave piston (the side without the leveling screw) and the exhaust rocker arm adjusting screw. Feeler gage sizes are listed in Table 1-9.

4. On models 760, 760A, 760B, 765, and 765A, turn the slave piston adjusting screw clockwise until a slight drag is felt on the feeler gage. See Figure 1-442.



1. Slave Piston Bridge
2. Slave Piston Adjusting Screw
3. Feeler Gage

Figure 1-442 Turn Slave Piston Adjusting Screw Clockwise

5. Perform the following additional steps on model 770:

   [a] Turn in the J-Lash® adjusting screw until the solid side of the slave piston bridge assembly contacts the exhaust valve and the valve springs begin to compress. Turn in one additional turn.

NOTICE:
All oil must be purged from the J-Lash adjusting screw. Oil remaining in the J-Lash screw will cause inaccurate clearance adjustment, resulting in possible engine or engine brake damage. If oil is below room temperature (below 60°F), wait at least two minutes for oil to be purged from the J-Lash adjusting screw.

NOTE:
Wait at least 30 seconds for oil to be purged from the J-Lash adjusting screw.

   [b] Back out the adjusting screw **only** until the correct size feeler gage can be inserted between the solid side of the slave piston bridge assembly and the exhaust valve.

   [c] Adjust the J-Lash so that a light drag is felt on the feeler gage.

NOTE:
Do not back out the J-Lash more than required to obtain a light drag on the feeler gage.

   [d] Use a screwdriver to hold the J-Lash in place, and torque the lock nut to 34 N·m (25 lb·ft).

NOTE:
If the J-Lash screw is backed out until it no longer compresses the slave piston spring, oil will enter the screw and the adjustment will be incorrect. If this occurs, repeat the J-Lash adjustment procedure.

   [e] Recheck the lash settings. If clearance setting is incorrect, repeat the J-Lash adjustment procedure.

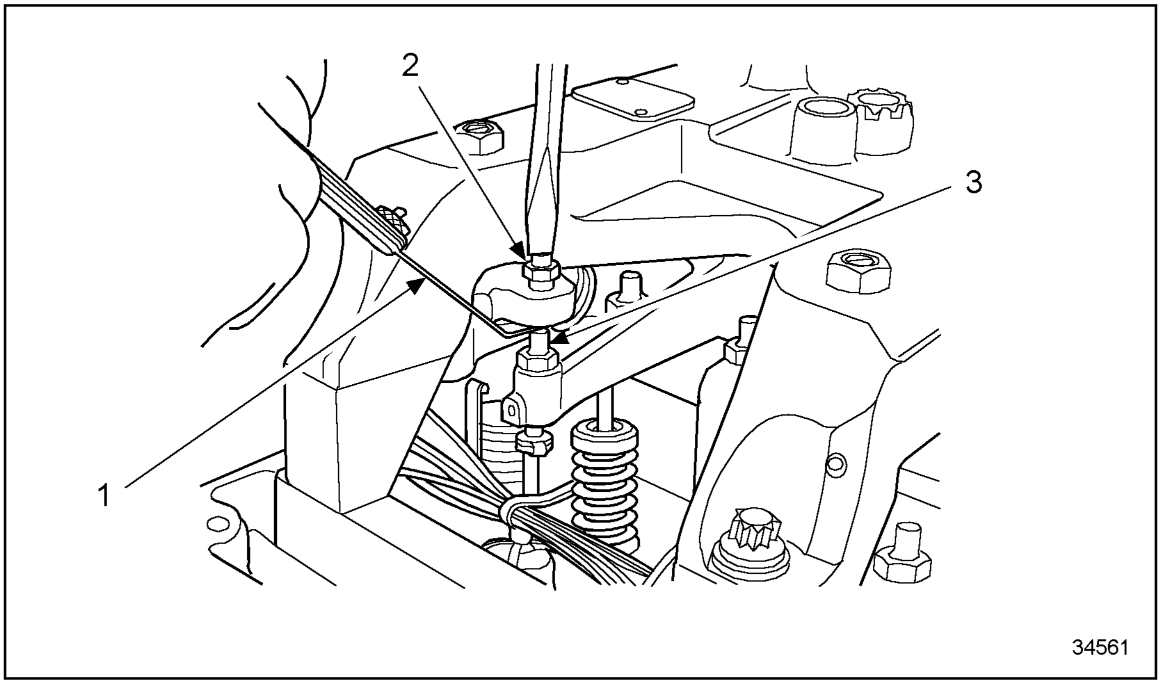
NOTE:
Once the engine brake has been run, oil enters the J-Lash screw making the engine brake adjustment unreadable. If unsure of the adjustment, repeat the J-Lash adjustment procedure.

6. On all models, hold the screw in position, and torque the locknut to 35 N·m (26 lb·ft).
7. Check the adjustment, and repeat if necessary.

NOTE:
Do not disassemble the slave piston adjusting screws.

8. Place the correct feeler gage between the leveling screw and the rocker arm adjusting screw.

9. Turn the leveling screw clockwise until a slight drag is felt on the feeler gage. See Figure 1-443.



1. Feeler Gage
2. Slave Piston Leveling Screw
3. Rocker Arm Adjusting Screw

Figure 1-443 Setting Clearance on Leveling Screw and Rocker Arm Adjusting Screw

10. Hold the leveling screw in position, and torque the locknut to 47 N·m (35 lb·ft).
11. Check adjustment, and repeat if necessary.
12. Repeat the adjustment procedures for the remaining cylinders. Refer to step 2 through step 11.

NOTE:
Bar over the engine when necessary to place the exhaust valves in the closed position for slave piston adjustment.

13. Install the engine rocker cover. Refer to section 1.6.2 for one-piece, refer to section 1.6.3 for two-piece, and refer to section 1.6.5 for three-piece.
14. Install all remaining components that were removed for this procedure.
15. Connect starting power for the engine.
16. Verify proper Jake Brake installation by driving the vehicle, then checking engine brake performance.

1.29.6 Removal of Model 790 Jake Brake Assembly

Remove the Model 790 Jake Brake as follows:

CAUTION:

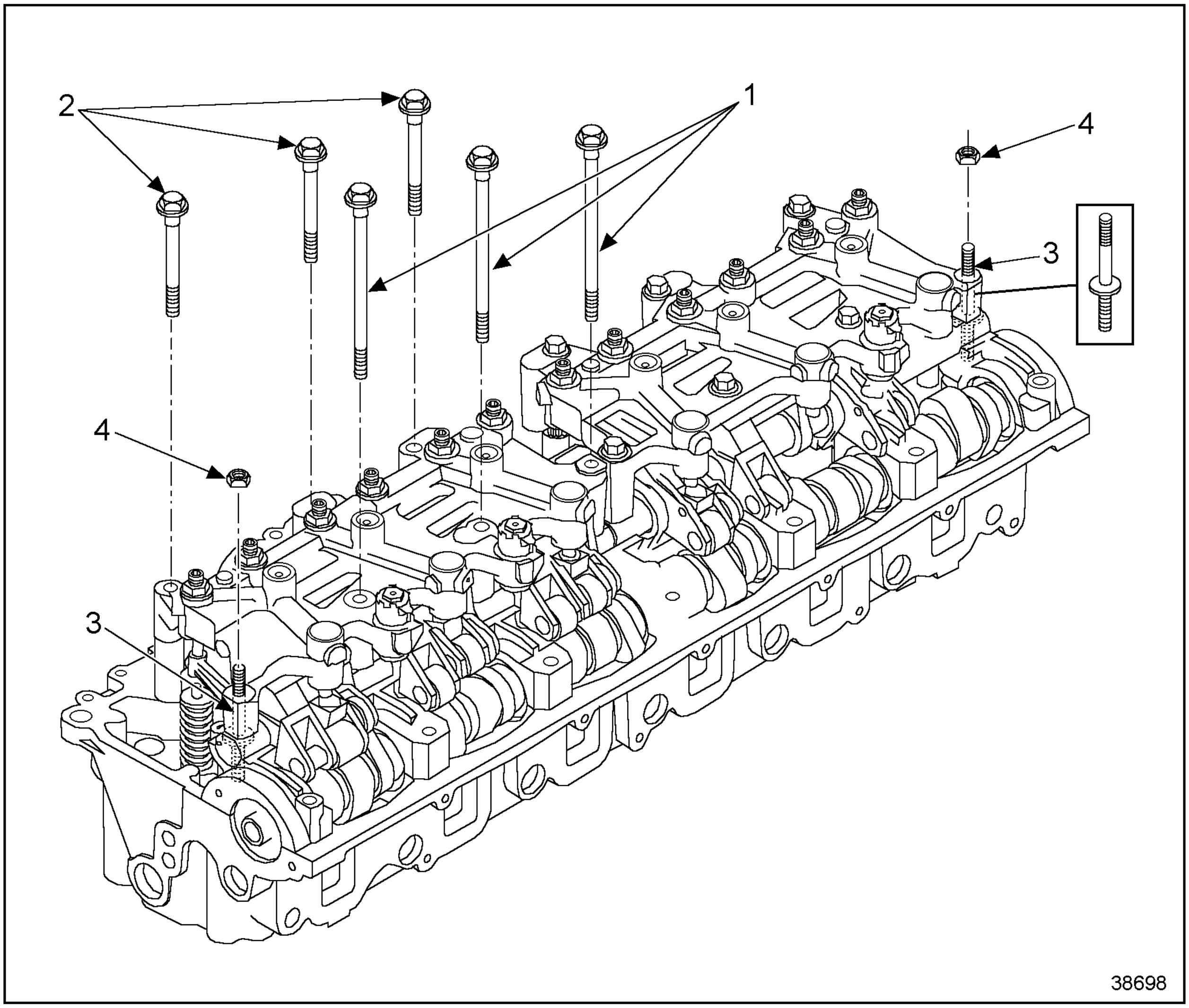
To avoid injury from hot engine surfaces, stop the engine and allow it to cool ambient temperature before working on it.

CAUTION:

To avoid injury from accidental engine start-up, disable/disconnect power to the engine starting system.

1. With the engine at ambient temperature and power to the starting system disconnected, Refer to section of the *Series 60 Service Manual,* 6SE483 and remove the engine rocker cover.
2. Note the location of the rocker arm shaft, the exhaust valve rocker arm, the fuel injector rocker arm, and the intake valve rocker arm.
3. Disconnect the solenoid wiring harness connectors from the Jake Brake solenoids.

4. Remove the three (3) 140 mm long mounting bolts that secure the engine brake to the cylinder head. See Figure 1-443a.



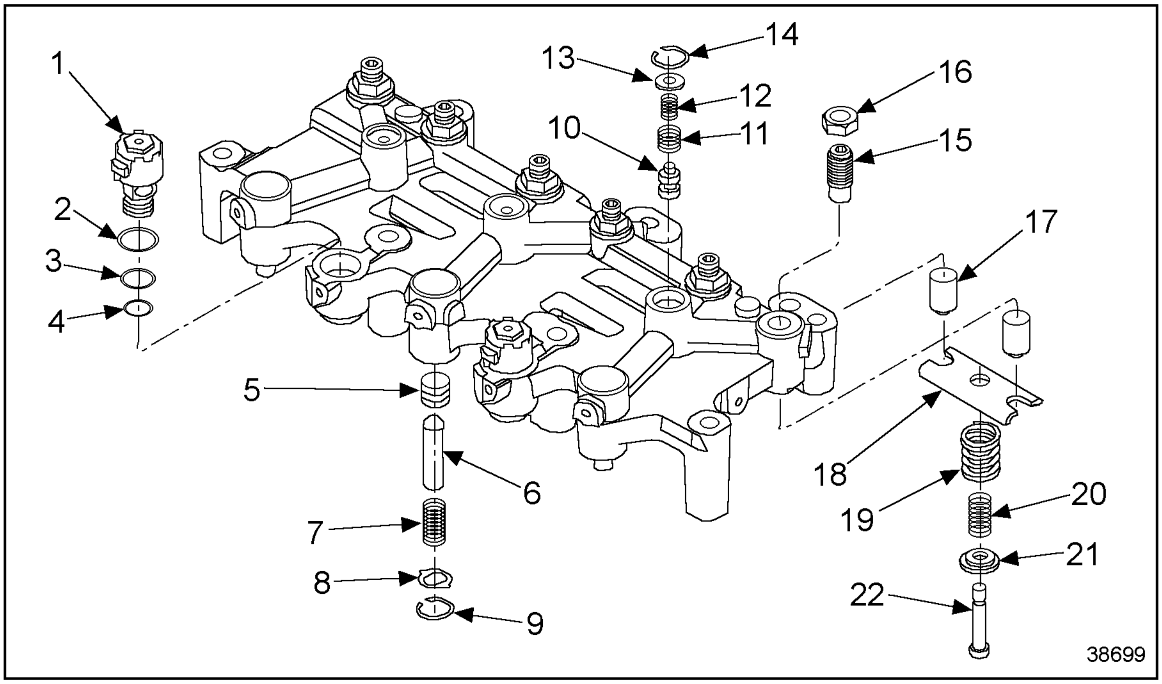
1. Mounting Bolt — 170 mm Long
2. Mounting Bolt — 140 MM Long
3. Stud Bolt
4. Nut

Figure 1-443a Model 790 Jake Brake Fasteners

5. Remove the three (3) 170 mm long mounting bolts and the two (2) nuts that secure the engine brake to the cylinder head.
6. Remove the engine brake assembly.
7. Repeat steps 1 through step 5 and remove the second Jake Brake assembly from the engine.

1.29.6.1 Disassembly of Model 790 Jake Brake

Instructions for disassembly of Model 790 Jake Brakes are incomplete at time of publication, but will be provided at a future date. For components of Model 790 Jake Brakes, see Figure 1-443b.



1. Solenoid Valve

3.Center Seal

4. Lower Seal

5. Master Piston

6. Master Piston Pushrod

7. Master Piston Spring

8. Retaining Ring

9.Control Valve

10. Outer Control Valve Spring

11. Inner Control Valve Spring

12. Washer

13. Retaining Ring

14.J-Lash® Screw

15. Locknut

16. Slave Piston

17. Slave Piston Bridge

18. Outer Slave Piston Spring

19. Inner Slave Piston Spring

20. Slave Piston Spring Seat

21. Shoulder Bolt

22. Shoulder Bolt

Figure 1-443b Typical Model 790 Jake Brake Assembly

1.29.7 Cleaning of Model 790 Jake Brake

Instructions for cleaning of Model 790 Jake Brake are incomplete at the time of publication, but will be provided at a future date.

1.29.8 Inspection of Model 790 Jake Brake

Instructions for inspection of Model 790 Jake Brake are incomplete at the time of publication, but will be provided at a future date.

1.29.9 Assembly of Model 790 Jake Brake

Instructions for assembly of Model 790 Jake Brake are incomplete at the time of publication, but will be provided at a future date.

1.29.10 Installation of Model 790 Jake Brake Assembly

The installation procedures for the model 790 Jake Brake assemblies differ slightly from the former engine brakes. Two brake housings are used, instead of three, and spacer bars are not required. Install the model 790 Jake Brake assemblies as follows:

1. With the engine at ambient temperature, install front Jake Brake housing (with two solenoids) over the front three cylinders. Position with solenoids on camshaft side of engine.
2. Install the rear housing (with one solenoid) over the rear three cylinders. Position with solenoid on camshaft side of engine.

NOTE:
There is one extra mounting hole drilled on the slave piston side of each housing. These holes are for manufacturing purposes only and are not used for installation.

3. Install six (6) 170 mm bolts through the housings into the rocker shafts in locations 1 through 6, and install two (2) nuts in locations 7 and 8. See Figure 1-443c.

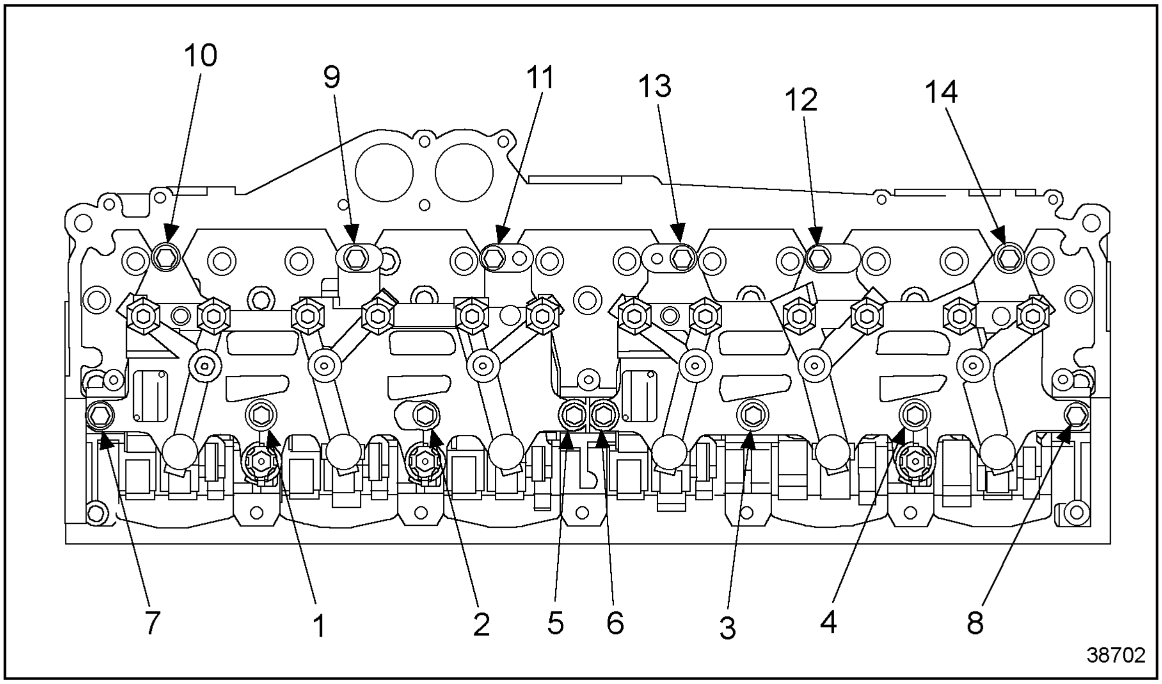


Figure 1-443c Housing Hold-Down Bolt Locations

NOTICE:
To ensure proper engine brake housing installation, Jake Brake mounting bolts (identified by a circle "J" on the heads) and required one-piece spacers *must* be used when mounting the brake assemblies.

4. Install six (6) 140 mm bolts into each housing and through the spacers in locations 9 through 14.
5. Torque all mounting bolts to 136 N·m (100 lb-ft) in bolt location number sequence shown. See Figure 1-443c.
6. Route the wire to the solenoid for cylinder 1 through the front retaining clip on the front housing and connect to the solenoid. Torque screw to 1.13 N·m (10 lb·in.).
7. Route wire to the solenoid for cylinders 3 and 4 through the rear retaining clip on the front housing and connect to the solenoid. Torque screw to 1.13 N·m (10 lb·in.).
8. Route wire to the solenoid for cylinders 4, 5 and 6 through the single retaining clip on the rear housing and secure to the terminal screw on the solenoid. Torque screw to 1.13 N·m (10 lb·in.).
9. Secure any excess wire to the injector harness with wire ties.

1.29.10.1 Set Slave Piston Lash

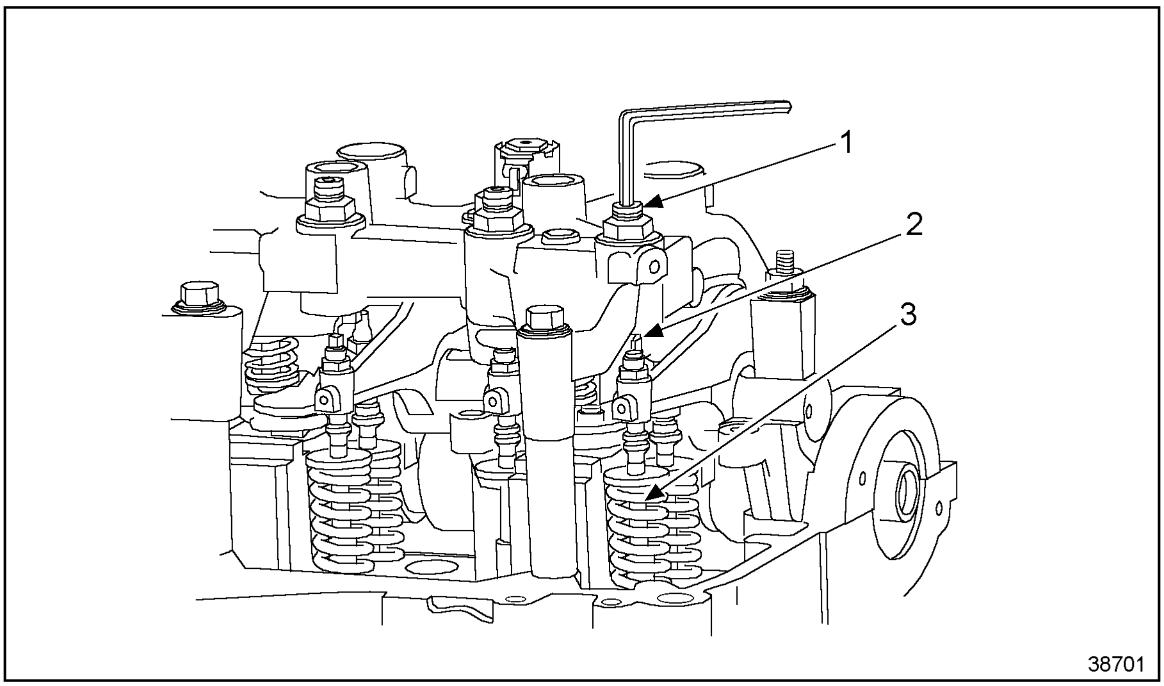
The slave piston lash must be set after Jake Brake housings are installed. Adjustments must be made with the engine stopped and cold and the oil temperature at 60°C (140°F) or below. Exhaust valves on the cylinder must be in the closed position (rocker arm roller should be on the base circle of the camshaft).

NOTICE:

The slave piston adjustment procedure *must* be followed exactly. Failure to properly adjust Jake Brakes will result in inefficient engine brake performance and may lead to severe engine or Jake Brake damage.

Adjust Jake Brake Model 790 slave piston lash as follows:

1. Loosen the locknut. Then, using a 5/16 in. Allen wrench, turn the J-Lash adjusting screw counter-clockwise until a 0.660 mm (0.026 in.) feeler gauge can be inserted between the slave piston and the exhaust rocker adjusting screw. Insert the feeler gauge.
2. Using the 5/16 in. Allen wrench, turn the J-Lash adjusting screw in (clockwise) until the slave piston contacts the feeler gauge and the exhaust rocker adjusting screw. When the valve spring begins to compress, turn the screw clockwise *one* additional turn. *Wait at least 30 seconds for oil to be purged from the J-Lash adjusting screw.* See Figure 1-443d.



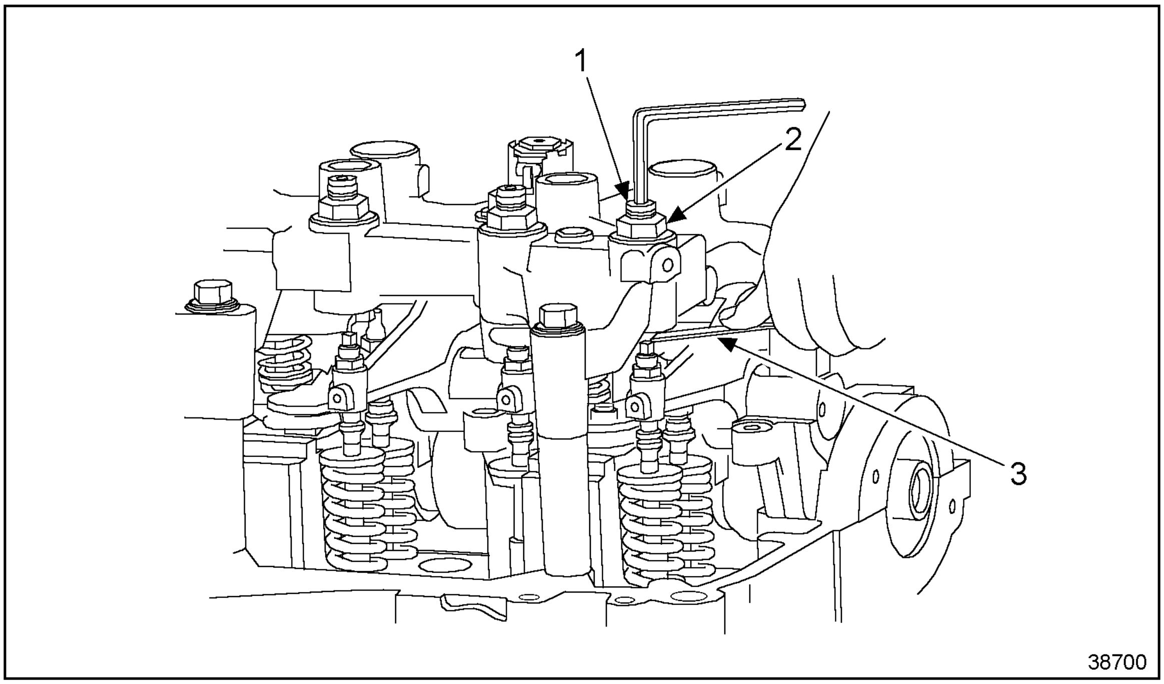
1. J-Lash Adjusting Screw
2. Slave Piston
3. Exhaust Valve Spring

Figure 1-443d Turn the Adjusting Screw Until the Valve Spring Compresses

NOTICE:

Oil *must* be purged from the J-Lash adjusting screw. Oil remaining in the J-Lash screw will cause inaccurate clearance adjustment, which could result in damage to the engine or Jake Brake. ***If oil is below room temperature (below 16° C or 60° F), wait at least two minutes for oil to be purged from the J-Lash adjusting screw.***

3. After waiting the required interval to purge oil from the J-Lash adjusting screw, back out the adjusting screw (turn counter-clockwise) ***only*** until a 0.660 mm (0.026 in.) feeler gage can be moved with a slight resistance. See Figure 1-443e. *Do not back out the J-Lash adjusting screw more than required to obtain a light drag on the feeler gage.* Using the Allen wrench to hold the J-Lash adjusting screw in place, torque the lock nut to 35 N·m (25 lb-ft).



1. J-Lash Adjusting Screw
2. Locknut
3. Feeler Gage

Figure 1-443e Adjusting Slave Piston Lash

NOTE:

If the J-Lash adjusting screw is backed out until it no longer compresses the slave piston spring, oil will enter the screw and the adjustment will be incorrect. If this occurs, repeat step 1 and step 2.

4. After torquing the adjusting screw lock nut, recheck lash setting. If lash is incorrect, repeat step 1 and step 2.

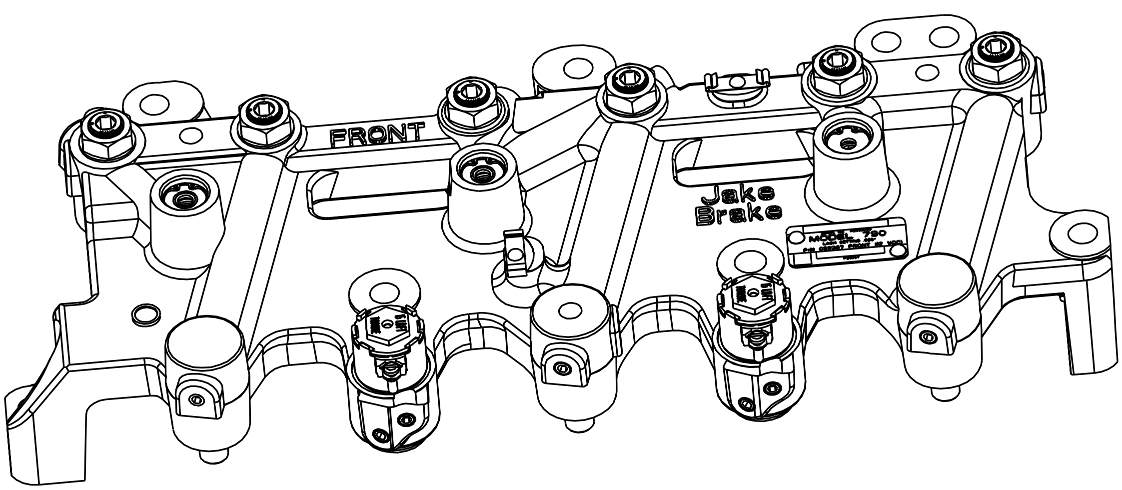
NOTE:
Once the engine brake has been run, you will not be able to check Jake Brake adjustment. This is because of oil retained in the J-Lash adjusting screw. If unsure of the adjustment, you must repeat step 1 through step 3.

5. Repeat step 1 through step 3 for the remaining slave piston on the same cylinder.
6. Repeat step 1 through step 4 for the remaining cylinders.
7. Complete the installation by installing the rocker cover. Refer to section 1.6 of the service manual.
8. Install all remaining components that were removed for this procedure.
9. Connect starting power for the engine.
10. Start and drive the vehicle to verify proper Jake Brake performance.

Jacobs Vehicle Systems™

Jacobs Engine Brake™

Tune-Up Kit 790/795 Series P/N 29013



Information in this manual was current at time of printing and is subject to change without notice or liability.

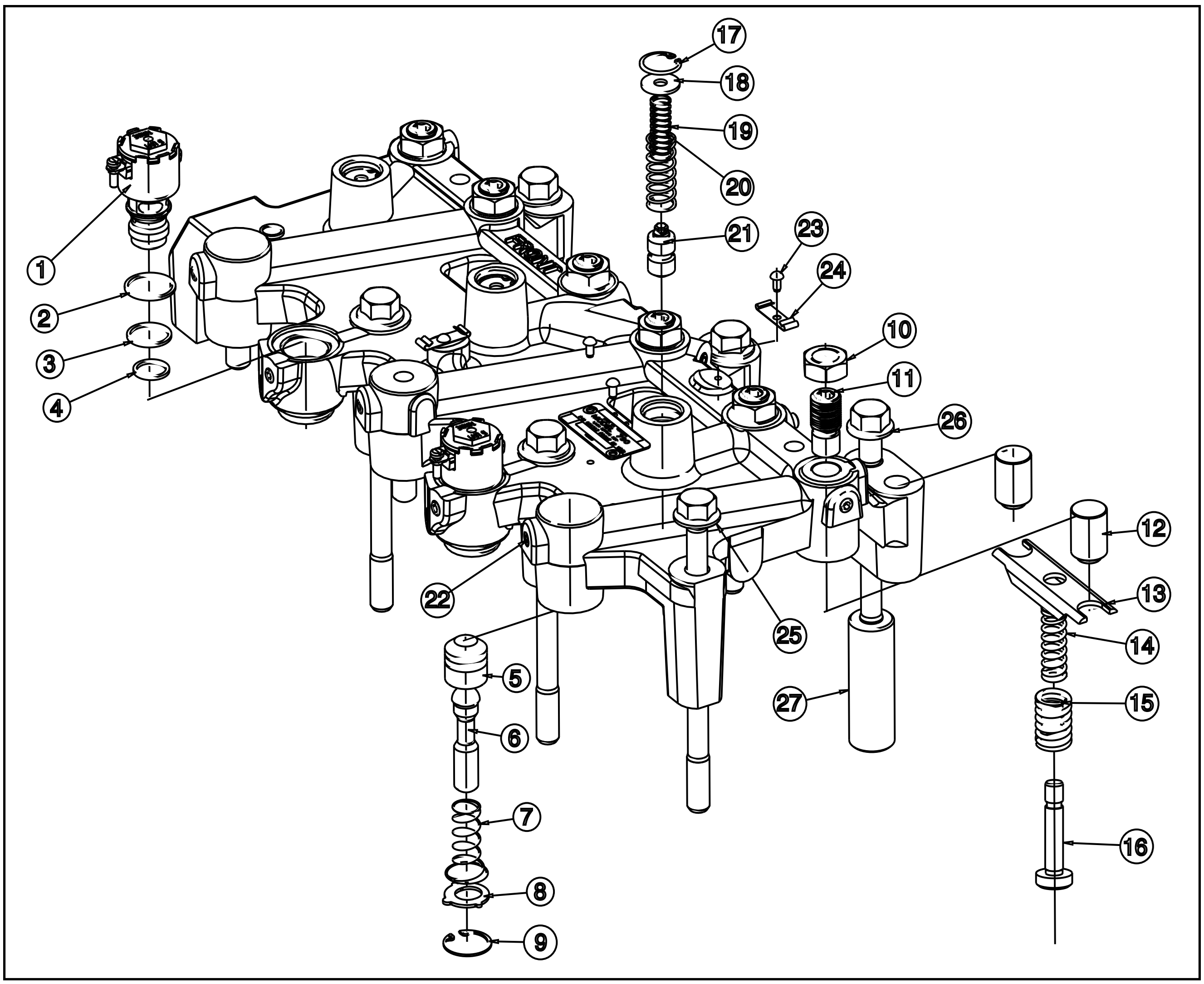
Refer to the Application guide, P/N 24770 for specific application information. Also refer to the Install Manual, P/N 29901 and the engine manual for specific installation instructions.

TUNE-UP KIT INSTRUCTIONS

Tune-up Kit Contents Model 790/795

Illus. No.	P/N	Part Name	Quantity per kit
1	1024612	Solenoid, 12VDC S/L	0
1	1024619	Solenoid, 24VDC S/L	0
2	20229	Seal, Solenoid Upper	3
3	1082	Seal, Solenoid Center	3
4	1083	Seal, Solenoid lower	3
5	26932	Master Piston	0
6	28791	Push Rod, Master Piston	0
7	28768	Spring, Master Piston	6
8	29944	Retainer, Master Piston	6
9	26555	Ring, Retainer	6
10	19987	Nut, Hex (790 series)	0
10	29908	Nut, Hex (795)	0
11	28341	J-lash™ assembly (790)	0
11	29300	J-lash™ assembly (790A)	0
11	29317	J-lash™ assembly (790B)	0
11	29310	J-lash™ assembly (790C)	0
11	29908	Solid Screw 3/8-24 (795)	0

Illus. No.	P/N	Part Name	Quantity per kit
12	26142	Slave Piston	0
13	28379	Bridge, Slave Piston	0
14	28372	Spring, Inner Slave Piston	6
15	28373	Spring, Outer Slave Piston	6
16	29295	Bolt, Shoulder-Slave Piston	6
17	12991	Ring, Retainer	6
18	16505	Washer	6
19	18179	Spring, Inner Control Valve	6
20	10843	Spring, Outer Control Valve	6
21	11930	Control Valve	6
22	18485	Pipe Plug	0
23	17303	Drive Screw	0
24	29127	Clip, Wire Harness	0
25	28346	CapScrew, M12X1.75X170	0
26	29132	CapScrew, M12X1.75X140	0
27	29118	Spacer Tube	0
NI	29015	Instructions	0



General Information

These instructions describe how to properly remove, clean and reinstall Jacobs Engine Brake™ components. For additional information on the 790/795 Series engine brakes, refer to the Series 60 Engine Service Manual, P/N 6SE483.

For slave piston clearance refer to the Jacobs Application Guide for Detroit Diesel Engines, P/N 24770.

Use OSHA-approved cleaning solvent for cleaning parts. Original parts to be reused should be inspected for wear and replaced as required. Be sure to coat parts with clean engine oil when reinstalling them.

The standard Jacobs Vehicle Systems Service Parts Warranty applies to the components of this Tune-up Kit. The warranty is administered by Detroit Diesel Corporation.

Safety Precautions

The following symbols in this manual signal conditions potentially dangerous to the mechanic or equipment. Read this manual carefully. Know when these conditions can exist. Then take necessary steps to protect personnel as well as equipment.

⚠ WARNING — THIS SYMBOL WARNS OF POSSIBLE PERSONAL INJURY.

⚠ CAUTION — THIS SYMBOL REFERS TO POSSIBLE EQUIPMENT DAMAGE.

NOTE: INDICATES AN OPERATION, PROCEDURE OR INSTRUCTION THAT IS IMPORTANT FOR CORRECT SERVICE.

Fuels, electrical equipment, exhaust gases and moving engine parts present potential hazards that could result in personal injury. Take care when installing equipment or parts. Always wear safety glasses. Always use correct tools and follow proper procedures as outlined in this manual.

Instructions

⚠ WARNING — NEVER REMOVE OR ADJUST ANY ENGINE BRAKE OR COMPONENT WITH THE ENGINE RUNNING.

Access Engine Brake

1. Thoroughly clean engine.
2. Remove valve rocker cover and gasket.

NOTE: IF THE ENGINE HAS A TWO-PIECE COVER, THE LOWER VALVE COVER BASE DOES NOT HAVE TO BE REMOVED TO GAIN ACCESS TO THE ENGINE BRAKE HOUSINGS.

3. Disconnect the lead wires from each of the solenoid valves (1) and detach them from the wire clips (24).
4. Remove the six capscrews (25&26) and nut securing each engine brake housing. Remove the housings.
5. Retain six spacer tubes (27).

Disassemble Housings

1. Remove the solenoid valve (1) and discard the three seal rings (2,3,4).

⚠ WARNING — WEAR SAFETY GLASSES. REMOVE CONTROL VALVE COVERS CAREFULLY TO AVOID PERSONAL INJURY. COVERS ARE UNDER LOAD FROM CONTROL VALVE SPRINGS (19,20).

2. Hold down the control valve cover while removing the retaining ring (17). Remove and discard all parts.
3. Loosen the locknut (10) and remove the adjusting screws (11) and locknuts. Retain the adjusting screws and locknuts.
4. Remove the retaining rings (9), retainers (8) and springs (7) that retains the master pistons; discard the springs, retainers and retaining rings. Remove and save the master pistons (5) and the push rods (6).
5. Remove the shoulder bolt (16) and springs (14,15) that retain the slave piston; discard springs only. Remove and save the bridge (13) and slave piston (12).

Assemble Housings

1. Clean all parts in an approved cleaning solvent. Dry with compressed air.

2. Coat all parts to be installed into housings with clean lube oil.

3. Reinstall the original slave piston (12) and bridge (13), reversing the removal procedure.

4. Install the new shoulder bolts (16) and springs (14,15). Tighten the bolt to 23 N•m (200 lb-in).

5. Reinstall the master pistons (5) and push rods (6). Install the new springs (7), retainers (8) and retaining rings (9). Rotate the retaining rings 90° to ensure that the ring is seated in the groove.

6. Install the adjusting screw (11) and locknut (10). Do not tighten the locknut at this time.

7. Install the new control valves (21), springs (19,20), washers (18) and retaining rings (17). Rotate the retaining ring 90° to ensure that the ring is seated in the groove.

8. Install the lower (smallest) solenoid seal ring (4) into the bottom of the solenoid valve bore. Install the upper (2) and center (3) seal rings on the solenoid valve. Coat the seals with engine oil prior to assembly.

NOTE: NEW UPPER SEAL RINGS CAN BE IDENTIFIED BY A YELLOW STRIPE.

9. Insert the solenoid valve and torque to 20 N•m (15 lb-ft).

NOTE: INSTALL THE SOLENOID CAREFULLY TO AVOID CUTTING OR TWISTING THE SEAL RINGS. IMPROPER INSTALLATION COULD RESULT IN POOR ENGINE BRAKE PERFORMANCE.

Install Engine Brake Housings

CAUTION REMOVING THE OIL FROM THE BOLT HOLES PREVENTS THE CYLINDER HEAD FROM CRACKING WHEN BOLTS ARE TIGHTENED. ATTACH A LENGTH OF TUBING TO AN AIR GUN NOZZLE AND BLOW OUT THE OIL FROM THE HOUSING HOLD-DOWN BOLT HOLES. COVER THE HOLES WITH HAND TOWELS TO MINIMIZE OIL SPRAY.

WARNING WEAR SAFETY GLASSES WHILE BLOWING THE OIL FROM THE BOLT HOLES.

1. Place the engine brake housings on the rocker shafts and spacer tubes with the solenoids on the camshaft side of the engine and the slave pistons over the exhaust valves.

2. Lubricate each hold-down capscrew with clean engine oil prior to installation.

3. Install three M12x170 capscrews (25) on solenoid side of brake. Install three M12x140 capscrews (26) on the exhaust side of the engine.

CAUTION INSTALLING 170 MM CAPSCREWS (25) ON THE EXHAUST SIDE OF THE ENGINE CAN RESULT IN SERIOUS ENGINE DAMAGE.

4. Before tightening the capscrews, move the housing from side to side. Position housing in the center of the range of motion.

5. Tighten the capscrews in the following sequence:

   a. Starting with the middle capscrew, tighten the three capscrews on the camshaft side of the engine to 55 N•m (40 lb-ft).

   b. Starting with the middle bolt, tighten the three bolts on the exhaust manifold side of the engine to 55 N•m (40 lb-ft).

   c. Tighten the nut at the end of the rocker shaft to 55 N•m (40 lb-ft)

   d. Repeat the tightening sequence and torque all capscrews to 136 N•m (100 lb-ft).

   e. Follow the same sequence for the other brake.

6. Connect the lead wires to the solenoid valves passing the wires through the wire clips. Torque solenoid screw to 1 N•m (9 lb-ft) and pull the lead wires away from the housing.

Adjust Slave Piston Clearance

CAUTION FAILURE TO FOLLOW ADJUSTMENT PROCEDURES CAN RESULT IN ENGINE OR ENGINE BRAKE DAMAGE.

NOTE: MAKE SLAVE PISTON ADJUSTMENT WITH THE ENGINE STOPPED AND COLD. ADJUST EACH CYLINDER WITH THE EXHAUST VALVES IN THE CLOSED POSITION.

1. Back out the adjusting screws on the slave pistons until the slave piston does not touch the rocker arm.

2. Insert the proper feeler gage between the slave piston and the exhaust rocker adjusting screw. Using a 3/16 inch hex wrench turn in the adjusting screw until the slave piston contacts the exhaust rocker adjusting screw through the feeler gage. For Model 795 applications, skip to step 4, For J-Lash installation only, continue turning in the adjusting screw until the valve springs begin to compress, then turn in one (1) additional turn. Wait at least 30 seconds for oil to be purged from the J-Lash adjusting screw.

NOTE: ALL OIL MUST BE PURGED FROM THE J-LASH ADJUSTING SCREW. IF OIL IS BELOW 60 °F, 16 °C, WAIT AT LEAST TWO MINUTES FOR OIL TO BE PURGED FROM THE J-LASH ADJUSTING SCREW.

⚠ CAUTION SERIOUS ENGINE DAMAGE MAY OCCUR FROM IMPROPER LASH SETTING.

3. After the time interval specified in step (2), back out the adjusting screw ONLY until a light drag is felt on the feeler gage. Do not retract more than required to obtain a light drag on the feeler gage.

NOTE: IF THE J-LASH ADJUSTING SCREW IS BACKED OUT UNTIL IT NO LONGER COMPRESSES THE SLAVE PISTON SPRING, OIL WILL ENTER THE SCREW AND THE ADJUSTMENT WILL BE INCORRECT. IF THIS OCCURS, REPEAT STEPS (1) AND (2).

4. Hold the J-Lash adjusting screw in place and torque the lock nut to 38 N•m (336 lb-in). Recheck lash settings. If lash setting is incorrect, repeat steps (1) through (3) above.

NOTE: ONCE THE ENGINE BRAKE HAS BEEN RUN YOU WILL NOT BE ABLE TO CHECK THE ENGINE BRAKE ADJUSTMENT FOR ENGINES USING J-LASH ADJUSTING SCREWS. THIS IS BECAUSE OF OIL RETAINED IN THE J-LASH ADJUSTING SCREW. IF UNSURE OF THE ADJUSTMENT, YOU MUST REPEAT STEPS (1) THROUGH (4) ABOVE.

Engine Brake Operational Check

⚠ WARNING WEAR EYE PROTECTION AND DO NOT EXPOSE YOUR FACE OVER THE ENGINE AREA. TAKE PRECAUTIONS TO PREVENT OIL LEAKAGE ONTO THE ENGINE. COVER CONTROL VALVE AREAS SUFFICIENTLY TO PREVENT OIL SPLASH.

Bleed the engine brake housings.

1. Be sure wires are away from moving parts.

2. Start the engine and allow to run for a few minutes.

3. Manually activate the solenoid valve several times to allow the housing to be filled with oil.

NOTE: THE SOLENOID VALVE IS MANUALLY ACTIVATED BY DEPRESSING THE ARMATURE. THE ARMATURE IS LOCATED IN THE CENTER OF THE TOP OF THE SOLENOID.

Check for proper operation.

1. Manually activate the solenoid valve and watch the master piston to be sure it is moving down onto the roller in the injector rocker arm.

2. Watch the slave piston assembly. It should move down to contact the exhaust valve rocker arm adjusting screws.

3. Check each housing to be sure it is functioning.

4. Shut down engine.

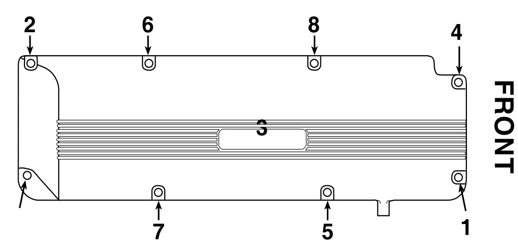
Rocker Cover Installation

1. Make sure the seal is in place in the rocker cover base and set the cover in place on the cover base.

2. Install the bolt with a flat washer, isolator and limiting sleeve into the cover holes.

3. Tighten the bolts to 14 N•m (10 lb-ft) in the sequence shown in Fig. 1.

4. Torque the bolts to 27 N•m (20 lb-ft).



SERIES 60 ROCKER COVER

FIG. 1

Jacobs Vehicle Systems
22 East Dudley Town Road
Bloomfield, CT 06002

Jacobs Vehicle Systems™

Visit us on the Internet:
www.jakebrake.com

P/N 29015 Rev. A

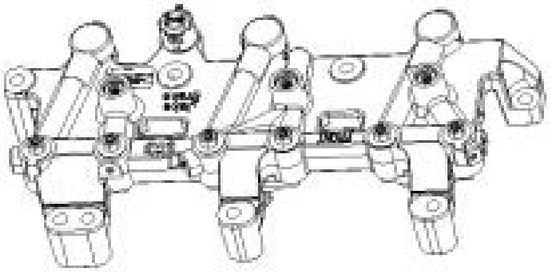
Printed in U.S.A.
Rev. 10/00

SPECIFICATIONS - 790/795/797

Jake Brake® Models 790, 795 & 797

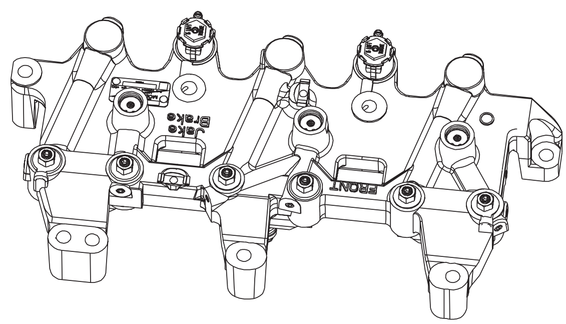
for Detroit Diesel Series 60® Engines

Year 2000 Production Engines and Beyond



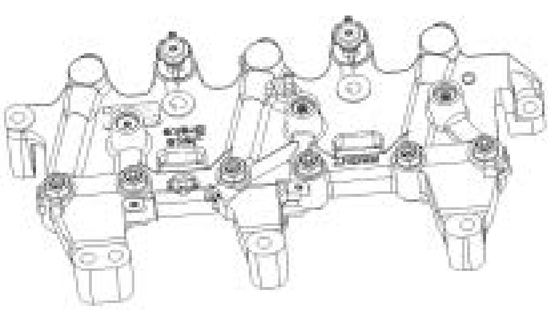
797 Series

For engines manufactured 10/01/02-



Model 795

For engines manufactured 8/10/00-9/30/02



790 Series

For engines manufactured 12/15/99-8/10/00

Features & Benefits

Designed in partnership with Detroit Diesel to yield a more simplified design, reducing weight while increasing performance & reliability:

- *Significant low & mid-range RPM performance improvements*
- *Respected Jake Brake® reliability & durability*

Jake Brake is the only engine brake brand installed at Detroit Diesel

Backed by Detroit Diesel's worldwide distributor & dealer network

2-year/unlimited mileage standard warranty

Engineered for the Road Ahead™

Jake Brake® Models 790, 795 & 797

for Detroit Diesel Series 60® Engines

Technical Specifications

Height	*4.2”*	*107 mm*
Length	*19.6”*	*498 mm*
Width	*4”*	*102 mm*
Kit Added Weight	*75 lbs.*	*34 kg.*
Housings Per Engine	*2*	

Application Information

For the most accurate application information, refer to the Detroit Diesel Application Guide (Jacobs P/N 24770), available from your Detroit Diesel Distributor or online at www.jakebrake.com.

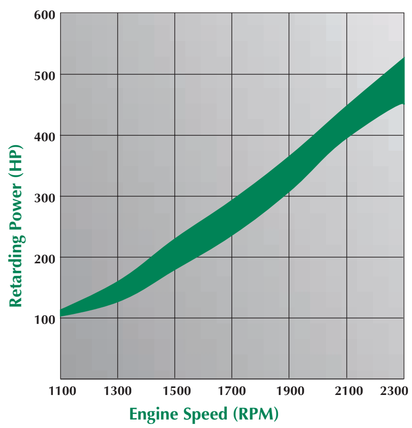
How The Jake Brake® Works:

Energizing the engine brake effectively converts a power-producing diesel engine into a power-absorbing air compressor. This is accomplished through motion transfer using a master/slave piston arrangement which opens cylinder exhaust valves near the top of the normal compression stroke, releasing the compressed cylinder charge to exhaust.

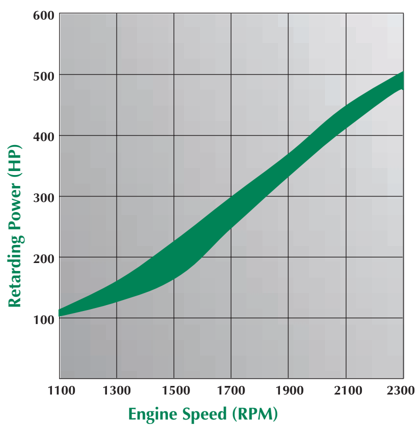
The blowdown of compressed air to atmospheric pressure prevents the return of energy to the engine piston on the expansion stroke, the effect being a net energy loss since the work done in compressing the cylinder charge is not returned during the expansion process.

Retarding Performance

790



795



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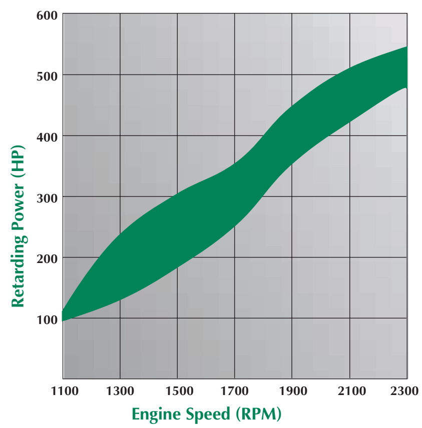


RPM	790				
	12.7L 330-350	*12.7L Std*	*12.7L Prem*	*14L US Hwy*	*14L Australia*
1100	101	101	105	105	110
1300	138	136	142	143	163
1500	193	194	190	185	235
1700	267	273	251	241	294
1900	342	351	323	308	368
2100	406	413	397	401	455
2300	465	470	480	483	525

RPM	795			
	12.7L 330-350	*12.7L Std*	*12.7L Prem*	*14L US Hwy*
1100	110	108	102	109
1300	157	150	135	140
1500	220	215	165	193
1700	299	280	250	253
1900	359	363	340	333
2100	419	445	420	412

RPM	797					
	12.7L 426	*12.7L 433*	*12.7L Australia*	*14L 430*	*14L 489*	*14L 500*
1100	111	104	99	116	113	109
1300	156	150	135	233	238	151
1500	226	229	191	285	302	221
1700	307	320	262	324	348	305
1900	366	382	359	404	448	404
2100	426	433	439	443	510	489
2300	475	479	496	492	564	552

Important Note: The performance data shown above is measured in accordance with SAE J1621 power measurement standard, up to engine manufacturer's rated engine speed of 2100 RPM.

Others may claim higher retarding performance. Only the Jacobs Engine Brake® is designed and tested in cooperation with Detroit Diesel to provide the highest performance available while maintaining or improving engine brake system reliability and durability.

Jacobs Vehicle Systems™

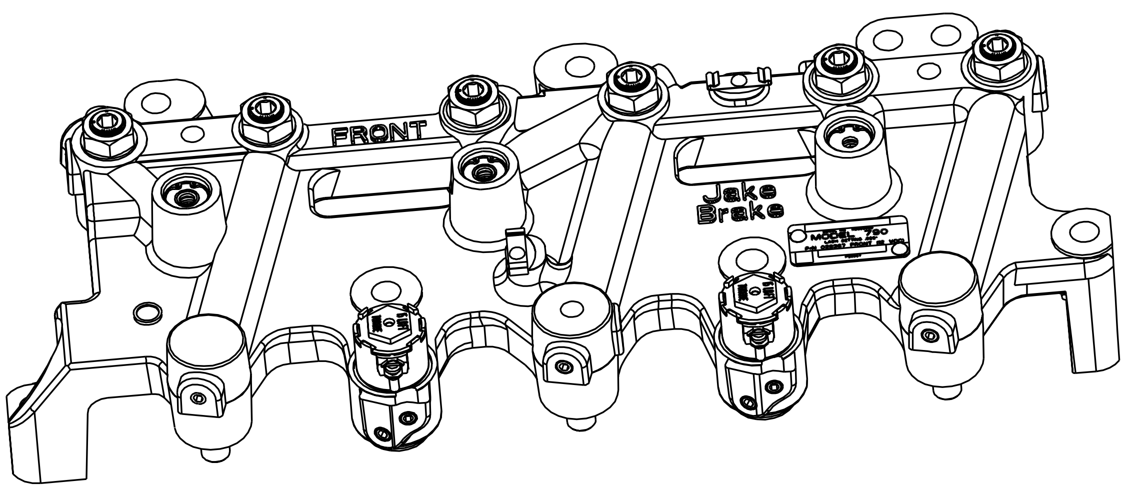
P/N 030562 *Rev. B 3/03*

Printed in U.S.A.

Jacobs Vehicle Systems™

Jacobs Engine Brake®

Models 790/795/797



PARTS MANUAL

Information in this manual was current at time of printing and is subject to change without notice or liability.

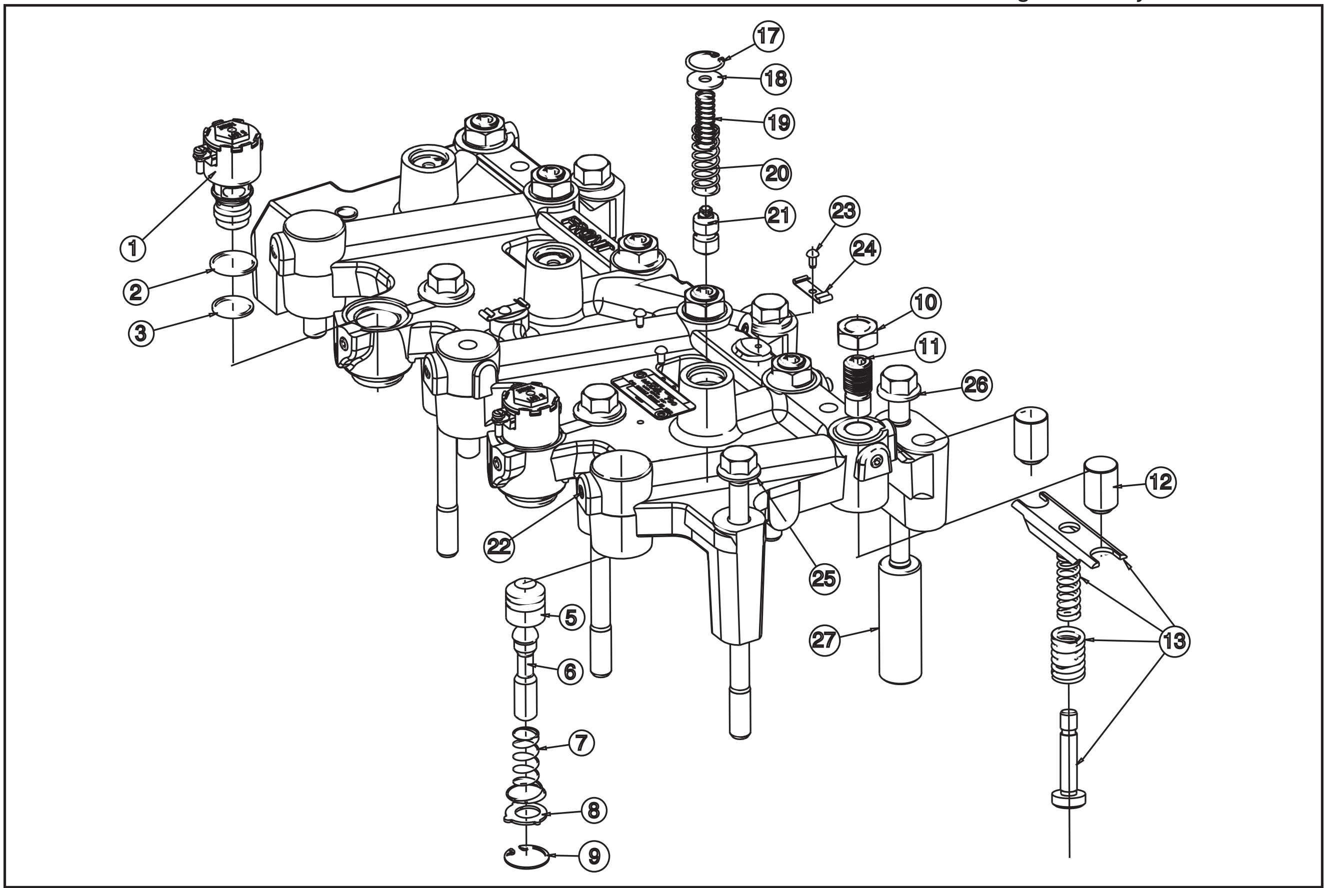
Refer to the Application guide, P/N 24770 for specific application information. Also refer to the Installation Manual, P/N 29901 and the Engine Manual for specific installation instructions.

790/795/797 KITS

Model No.	P/N	Description
790	29240	Engine Brake Kit, 12 VDC
790	29020	Engine Brake Kit, 24 VDC
790A	29123	Engine Brake Kit, 12 VDC
790A	29232	Engine Brake Kit, 24 VDC
790B	29302	Engine Brake Kit, 12 VDC
790B	29304	Engine Brake Kit, 24 VDC
790C	29321	Engine Brake Kit, 12 VDC
790C	29323	Engine Brake Kit, 24 VDC
795	30505	Engine Brake Kit, 12 VDC
795	30506	Engine Brake Kit, 24 VDC
797	31361	Engine Brake Kit, 12 VDC
797	31860	Engine Brake Kit, 24 VDC

790/795/797 HOUSING ASSEMBLIES

Model No.	P/N	Description
790	28367	Front housing Assembly, 12 VDC, S/L
790	28368	Rear housing Assembly, 12 VDC, S/L
790	29017	Front housing Assembly, 24 VDC, S/L
790	29018	Rear housing Assembly, 24 VDC, S/L
790A	29029	Front housing Assembly, 12 VDC, S/L
790A	29030	Rear housing Assembly, 12 VDC, S/L
790A	29124	Front housing Assembly, 24 VDC, S/L
790A	29125	Rear housing Assembly, 24 VDC, S/L
790B	29128	Front housing Assembly, 12 VDC, S/L
790B	29129	Rear housing Assembly, 12 VDC, S/L
790B	29130	Front housing Assembly, 24 VDC, S/L
790B	29131	Rear housing Assembly, 24 VDC, S/L
790C	29148	Front housing Assembly, 12 VDC, S/L
790C	29149	Rear housing Assembly, 12 VDC, S/L
790C	29150	Front housing Assembly, 24 VDC, S/L
790C	29151	Rear housing Assembly, 24 VDC, S/L
790D	1031226	Front housing Assembly, 12 VDC, S/L
790D	1031227	Rear housing Assembly, 12 VDC, S/L
790D	1031228	Front housing Assembly, 24 VDC, S/L
790D	1031229	Rear housing Assembly, 24 VDC, S/L
795	29902	Front housing Assembly, 12 VDC, S/L
795	29903	Rear housing Assembly, 12 VDC, S/L
795	29904	Front housing Assembly, 24 VDC, S/L
795	29905	Rear housing Assembly, 24 VDC, S/L
797	1031322	Front housing Assembly, 12 VDC, S/L
797	1031323	Rear housing Assembly, 12 VDC, S/L
797	1031765	Front housing Assembly, 24 VDC, S/L
797	1031766	Rear housing Assembly, 24 VDC, S/L



HOUSING ASSEMBLY 790/795/797

Illus. No.	Part Name	790	795	797	Qty per housing
1	**Solenoid**	1024612(12VDC) -or- 1024619(24VDC)			2*
2	**Seal, Solenoid Upper**	20229			2*
3	**Seal, Solenoid Middle**	1082			2*
4	Seal, Solenoid Lower	not required		not required	2*/***
5	Master Piston	26932		31282	3
6	**Pushrod - Master Piston**	28791			3
7	**Spring, Master Piston**	28768			3
8	Washer- MP Retainer	29944		31854	3
9	Ring, Retainer	26555		31331**	3
10	Nut, Hex	19987	29908		6
11	Adjusting Screw	(See 790 J-Lashes)	29864	31270	6
12	Slave Piston	26142		31324	6
13	Slave Piston Spring Group	32160		32127	3
	Bridge, Slave Piston	n/a		n/a	-
	Spring, Inner Slave Piston	n/a		n/a	-
	Spring, Outer Slave Piston	n/a		n/a	-
	Shoulder Bolt, Slave Piston	n/a		n/a	-
17	**Ring, Retainer**	12991			3
18	**Washer**	16505			3
19	**Spring, Inner Control Valve**	18179			3
20	**Spring, Outer Control Valve**	10843			3
21	**Control Valve Assembly**	11930			3
22	**Pipe Plug**	18485			-
23	**Drive Screw**	17303			-
24	**Clip, Wire Harness**	29127			-

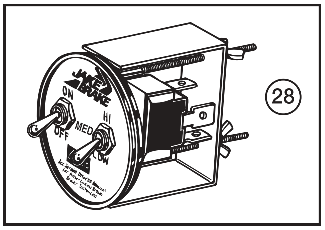
Notes: **Bold** text deplicts parts that are common to all brake models listed.
*For 790/795, front housing has two solenoid and the rear housing has one;
For 797, both front and rear housings have only one solenoid.
**Requires assembly tool part #J-45976
***Reference Technical Service Letter 02TS-17

790 J-lash™ Assemblies & Groups

Illus. No.	Part Name	790	790A	790B&D	790C	Qty per housing
11	J-lash™ Assembly	28341	29300	29317	29310	6
	J-lash™ Assy Group (12 pack)	29019	29414	29415	29416	-

ATTACHING PARTS

Illus. No.	P/N	Part Name	Quantity per kit
NI	**29133**	**Attaching Parts Group**	1
25	28346	CapScrew, M12X1.75X170	6
26	29132	CapScrew, M12X1.75X140	6
27	29118	Spacer Tube	6



CAB CONTROL GROUP

Illus. No.	P/N	Part Name	Quantity per kit
NI	**20220**	**Cab Control Group**	
NI	20244	Harness, 6ft	1
28	20035	Switch	1

SERVICE PARTS 790/795/797

P/N	Part Name
17671	Feeler gauge 0.026 IN. (0.660 mm)
16590	Screw, Rocker Adjusting
29013	Tune up kit - 790/795 Series
29589	Wire Clip Kit - Model 790
30503	Solid Screw Group (12 pack), 795
32128	Solid Screw Group (12 pack), 797
32146	Tune up kit - 797 Series
J-45976	Master Piston Assembly Tool, 797
29901	Installation Manual

Jacobs Vehicle Systems
22 East Dudley Town Road
Bloomfield, CT 06002

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2.15 ELECTRONIC ENGINE CONTROL

The Detroit Diesel Electronic Control System (DDEC) controls fuel injection timing and output by the electronic unit injectors (EUI) on the Series 60 Diesel engine. DDEC controls throttle, gas valve and the ignition system on the Series 60G engine. The system also monitors several engine functions using electrical sensors which send electrical signals to the Electronic Control Module (ECM). The ECM then computes the incoming data and determines the correct fuel output and timing for optimum power, fuel economy and emissions. The ECM also has the ability to display warnings or shut down the engine completely (depending on option selection) in the case of damaging engine conditions, such as low oil pressure, low coolant, or high oil temperature.

Early Series 60 engines have the DDEC system called DDEC I. Later Series 60 engines have the 2nd generation DDEC system called DDEC II. See Figure 2-78. The current engines have the third generation DDEC system, DDEC III/IV.

Series 60 2004 Exhaust Gas Recirculation (EGR) engines will use the fifth generation of the DDEC system, DDEC V® Electronic Control Unit. See Figure 2-78a.

The replacement of DDEC components is based on indicated diagnostic codes leading to faulty components. Check the *Detroit Diesel Single ECM Troubleshooting Manual* (6SE497) for more complete information on diagnosis of components and system problems.

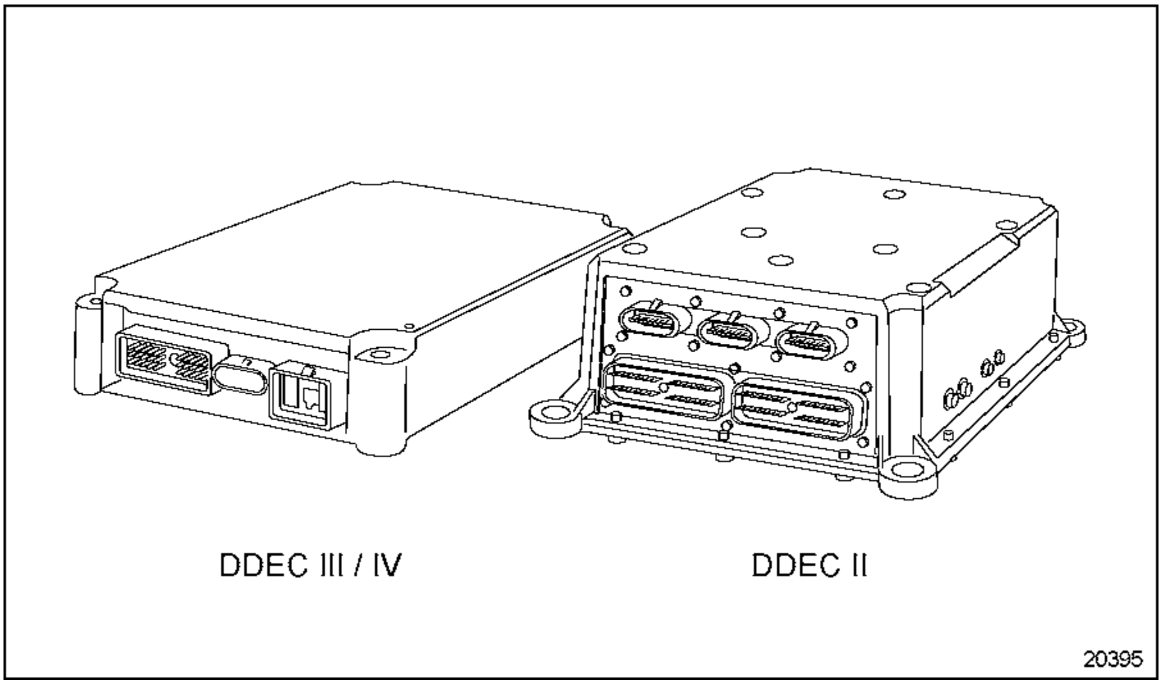


Figure 2-78 DDEC III/IV and DDEC II Electronic Control Module (ECM)

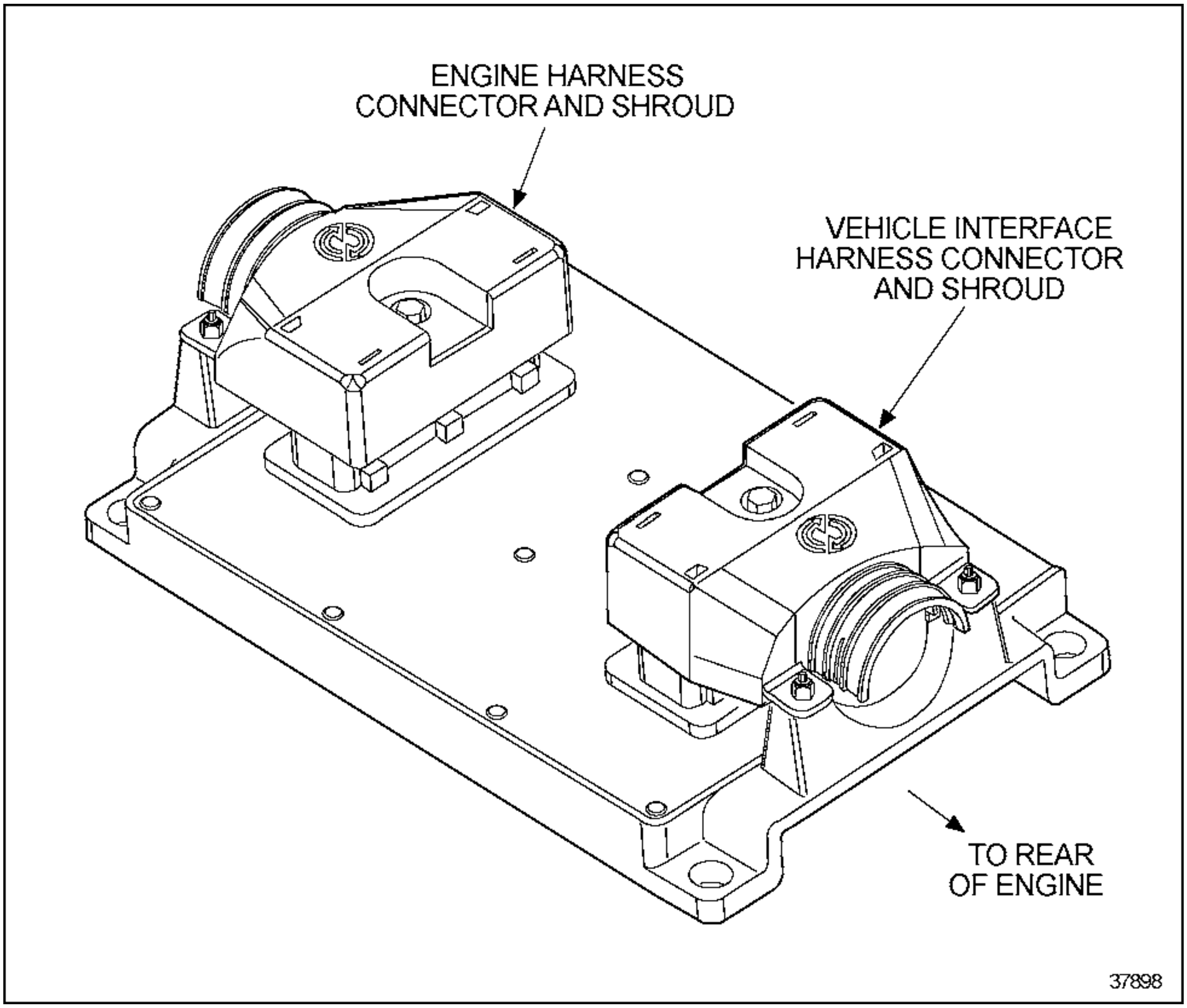


Figure 2-78a DDEC V Electronic Control Unit

2.16A DDEC V ELECTRONIC CONTROL UNIT

DDEC V provides an indication of engine and vehicle malfunctions. The ECU continually monitors the DDEC V system. See Figure 2-79a.

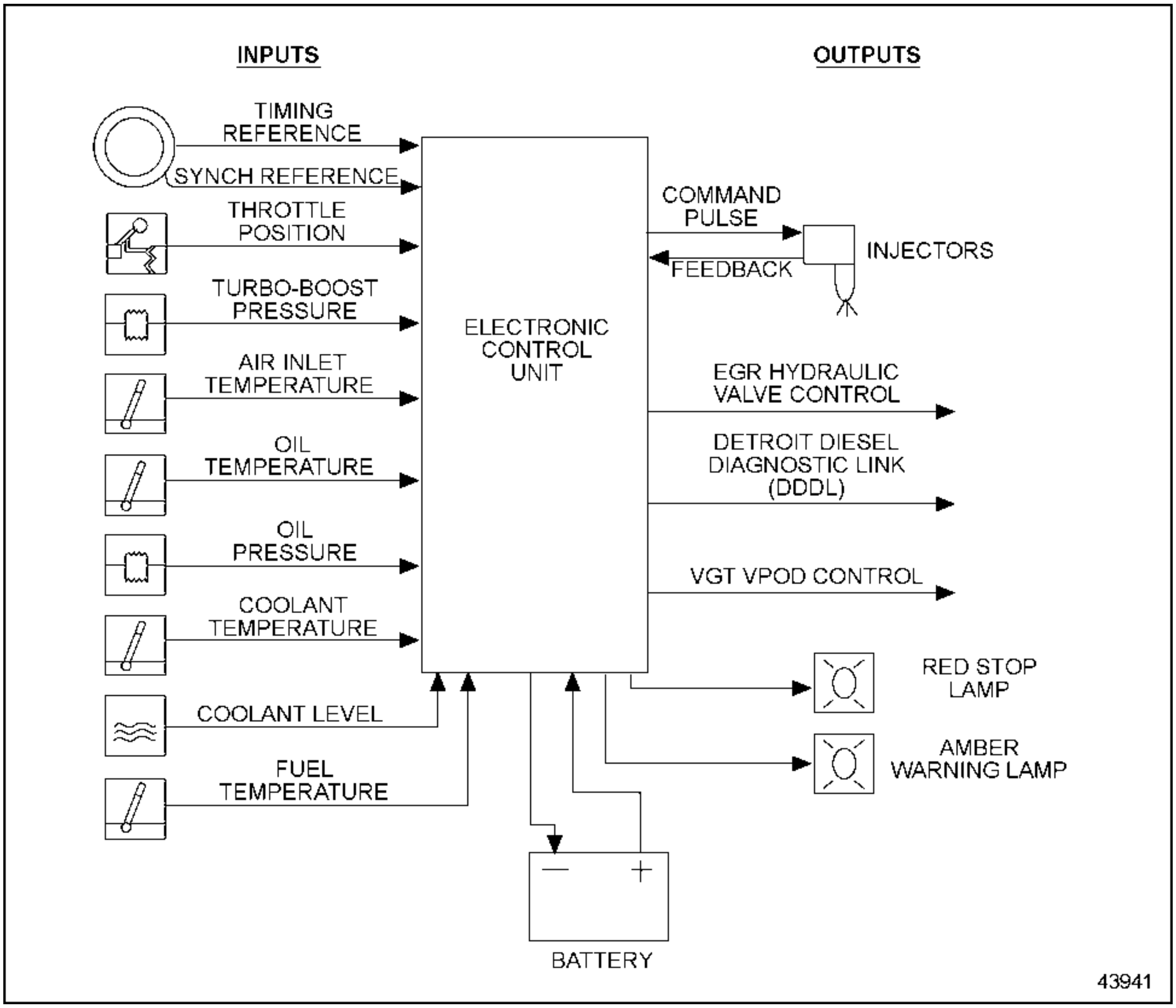


Figure 2-79a DDEC V System Series 60 Diesel Engine

Any faults that occur are stored as codes in the ECU's memory. These codes can be accessed in any of three ways:

1. A DDDL® can be used to read the codes.
2. A personal computer (PC) connected to the ECM through a translator device which converts J1708 to RS232 protocol can be used.
3. The Amber Warning Lamp (AWL) or the Red Stop Lamp (RSL) is illuminated.
   - The AWL (panel mounted yellow indicator light) illuminated diagnose condition as soon as convenient.
   - The RSL (panel mounted red indicator light) and AWL illuminated, a major fault occurred and immediate attention required to avoid engine damage.
   - Automatic engine shutdown or rampdown is available as an option. A shutdown override switch is required to allow the vehicle to be moved to a safe location during automatic shutdown or rampdown.

The Detroit Diesel Diagnostic Link® (DDDL) is a sophisticated PC software package that requests and receives engine data and diagnostic codes. The Detroit Diesel Diagnostic Link® DDDL supports DDEC V and the Series 60 2004 engine. See Figure 2-79b.

The DDDL functions are:

- Read and display current calibration for an ECU.
- Create a calibration for the ECU on an individual engine.
- Save a single calibration with an ECU password, this same password can be used for fleet of vehicles with the same password or technican who does not have access to the password.
- Change the engine rating of a vehicle.
- Set the injector calibration when you replace the injectors.
- View an audit trail of ECU and injector calibration changes.

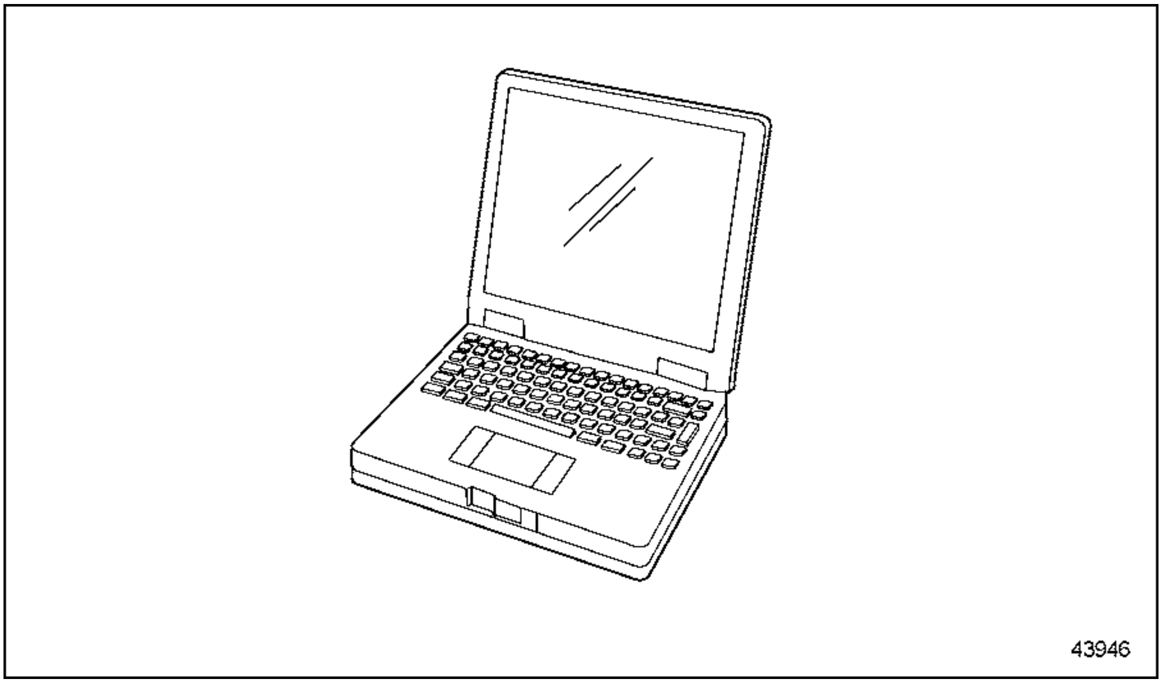


Figure 2-79b Detroit Diesel Diagnostic Link® (DDDL)

The SAE Standard Communications of the DDEC V system are listed in Table 2-6a. The fan control inputs and outputs for DDEC V are listed in Table 2-6b. The engine brake control features of DDEC V are listed in Table 2-6c. DDEC V can identify faulty components and other engine-related problems by providing the technician with a diagnostic code. Standard sensors are listed in Table 2-6d. OEM installed sensors are listed in Table 2-6e.

SAE Standard Communication
SAE J1587 protocol on J1708 hardware
Diagnostics
Electronic dashes
Data Hub
SAE J1922 protocol on J1708 hardware
Traction control systems
Transmission controls
SAE J1939 high speed data link
Vehicle controls

Table 2-6a SAE Standard Communications for DDEC V

Inputs	Outputs
Coolant temperature	Single on/off fan clutch
Oil temperature	Dual on/off fan clutch
Air temperatures	Two-speed single fan
Air conditioning	Modulated fan clutch

Table 2-6b Fan Controls for DDEC V

Engine Brake Control
Cruise Control with Engine Brake
Engine Brake Disable
Engine Brake Active
Engine Fan Braking
Clutch Release Input
Service Brake Control of Engine Brakes
Min. MPH for Engine Brakes

Table 2-6c Engine Brake Controls with DDEC V

DDEC V
Barometric Pressure Sensor (Baro Sensor)
Camshaft Position Sensor (CPM Sensor)
Crankshaft Position Sensor (CKP Sensor)
EGR Delta Pressure Sensor (EGR Delta Pressure)
EGR Temperature Sensor
Engine Coolant Temperature Sensor (ECT Sensor)
Engine Oil Level (EOL Sensor)
Engine Oil Pressure Sensor (EOP)
Engine Oil Temperature Sensor (EOT)
Fuel Restriction Sensor
Intake Air Temperature Sensor (IAT)
Intake Manifold Pressure Sensor (IMP)
Mass Air Flow Sensor
Supply Fuel Temperature Sensor (SFT Sensor)
Turbo Compressor Temperature Out Sensor
Turbo Speed Sensor (TSS)

Table 2-6d Standard Sensors for DDEC V

DDEC V
Accelerator Pedal Sensor (AP Sensor)
Add Engine Coolant Level Sensor (AECL Sensor)
Air Filter Restriction Sensor (AFR Sensor)
Engine Coolant Level Sensor (ECL)
Fire Truck Pump Pressure Sensor *
Turbo Compressor In Temperature Sensor
Vehicle Speed Sensor (VSS)

Table 2-6e OEM Installed Sensors

* Available in some applications

2.16a.1 Repair or Replacement of the DDEC V Electronic Control Unit

The DDEC V ECU is a sealed, nonserviceable unit. Tag defective ECU for recore.

2.16a.2 Removal of the DDEC V Electronic Control Unit

Perform the following steps for ECU removal:

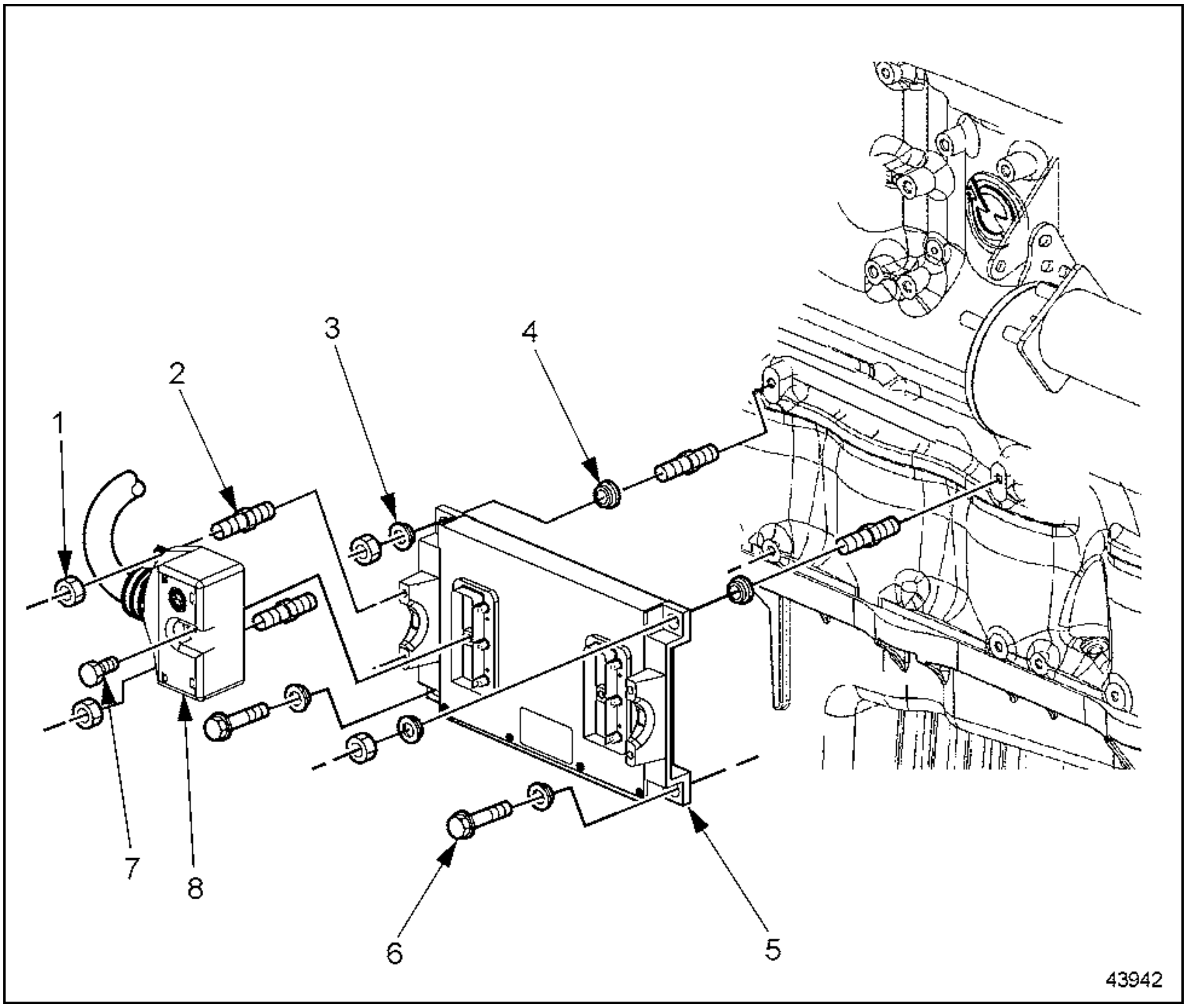
1. Remove screw from center of shroud and connector. Remove two nuts from threaded studs at the base of the shroud and ECU see Figure 2-79c.
2. Remove shroud and connector from ECU.
3. Remove the two through-bolts, two nuts and two studs holding the ECU to the engine, remove the ECU from engine. See Figure 2-79c.

2.16a.3 Installation of the DDEC V Electronic Control Unit

Perform the following steps for ECU installation:

1. Inspect the ECU isolators for damage and replace if required.
2. Mount the ECU to the engine.
3. Secure the ECU to the engine with two through-bolts, two studs and nuts. Torque the ECU-to-engine bolts to 23-27 N·m (17-20 lb·ft).
4. Install the engine harness connector and shroud to the ECU. Torque center screw and two nuts to 5.6 N·m (50 in.· lb).

5. Turn the ignition to the "ON" position. Observe the DDDL for any diagnostic code(s). If any code(s) other than code 25 is logged, refer to the *Detroit Diesel DDEC V Single ECM Troubleshooting Manual* (6SE565).



1. Nut	5. Electronic Control Unit
2. Stud	6. Bolt
3. Isolater	7. Bolt
4. Isolater	8. Shroud

Figure 2-79c DDEC V Electronic Control Unit and Related Parts

CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

6. Start the engine, and check for leaks.

tyco / Electronics

AMP

68–Position Heavy Duty Hybrid Connector

Application Specification

114–13053

14 MAR 02 Rev O

NOTE *All numerical values are in metric units [with U.S. customary units in brackets]. Dimensions are in millimeters. Unless otherwise specified, dimensions have a tolerance of ±0.13 and angles have a tolerance of ±2°. Figures and illustrations are for identification only and are not drawn to scale.*

1. INTRODUCTION

This specification covers the requirement for application of the 68–Position Heavy Duty Hybrid Connector. This connector is used on engine control modules and consist of sixty 1 mm contacts and eight 1.6 mm contacts. It is a vertical–mount wire–to–board connector system which mounts to the exterior of modules.

NOTE *Refer to Application Specifications 114–6071 and 114–13045 for all termination and application information for the contacts which are used in the 68–Position Heavy Duty Hybrid Connector.*

When corresponding with Tyco Electronics personnel, use the terminology provided in this specification to facilitate your inquiry for information. Basic terms and features of components are provided in Figure 1.

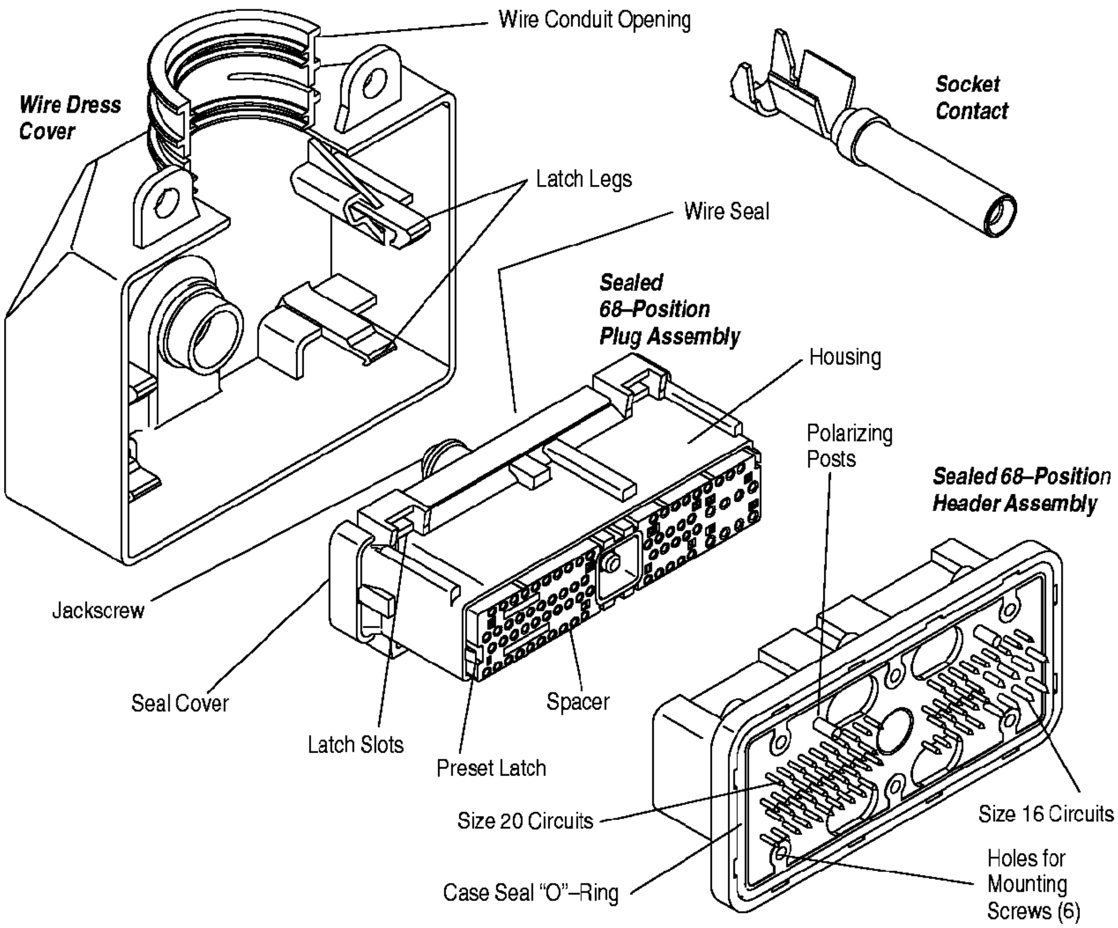


Figure 1

2. REFERENCE MATERIALS

2.1. Revision Summary

Per EC 0990–1179–01

- Initial release of application specification

2.2. Customer Assistance

Reference Base Part Number 776315 and Product Code A243 are representative numbers that identify the 68–Position Heavy Duty Hybrid Connector product line. These numbers are used in the customer service network to access tooling and product application information. This service is provided by your local Tyco Electronics Representative (Field Sales Engineer, Field Application Engineer, etc.) or, after purchase, by calling the Tooling Assistance Center number at the bottom of page 1.

2.3. Drawings

Customer Drawings for each product part number are available from the service network. The information contained in the Customer Drawings takes priority if there is a conflict with this specification or with any other technical documentation supplied by Tyco Electronics.

2.4. Specifications

Product Specification 108–1945 provides product performance requirements and test information. Application Specifications 114–6071 and 114–13045 provide information for termination and requirements of the contacts used in this connector assembly.

2.5. Manuals

Manual 402–40 is available upon request and can be used as a guide in soldering. This manual provides information on various flux types and characteristics along with the commercial designation and flux removal procedures. A checklist is included in the manual as a guide for information on soldering problems.

2.6. Instructional Material

The following list includes available instruction sheets (408–series) that provide information for the handling of this product line.

Document Number	Document Title
408–3295	Preparing Reel of Contacts for Application Tooling
408–6927	Design Recommendations for Printed Circuit (PC) Board Support Fixture
408–7424	Checking Terminal Crimp Height Gaging Die Closure
408–9816	Handling Of Reeled Products

3. REQUIREMENTS

3.1. Storage

A. Ultraviolet Light

Prolonged exposure to ultraviolet light may deteriorate the chemical composition used in the connectors.

B. Reel Storage

When using reeled contacts, store coil wound reels horizontally and traverse wound reels vertically.

C. Shelf Life

The contacts and connectors should remain in the shipping containers until ready for use to prevent deformation to the product. The contacts and connectors should be used on a first in, first out basis to avoid storage contamination that could adversely affect signal transmissions.

D. Storage Temperature

Maximum storage temperature should not exceed 150° C [302° F].

E. Chemical Exposure

Do not store contacts near any chemicals listed below, as stress corrosion cracking in the contacts may occur.

Alkalies	Ammonia	Citrates	Phosphates Citrates	Sulfur Compounds
Amines	Carbonates	Nitrites	Sulfur Nitrites	Tartrates

NOTE *Where the above environmental conditions exist, phosphor–bronze contacts are recommended if available.*

3.2. Exposure Limitations

The operating temperature range of this connector assembly is –40° to 125° C [–40° to 257° F].

3.3. Special Considerations

Size 16 circuits (8 larger circuits) will seal properly with 14 AWG GXL, 16 AWG GXL, and 14 AWG Teflon•wire, with wire insulation (OD) between 2.5 and 3.18 mm. Size 20 circuits (60 smaller circuits) will seal properly with 18 AWG GXL and 16 AWG Teflon wire, with wire insulation (OD) between 2 and 2.5 mm.

3.4. Strain Relief Arrangement

CAUTION *Care should be taken when attaching the wire dress cover as not to bend or crush any wires. make sure that the wires are not bent or angled coming through the wire seal. Doing so may cause the wires to open the wire seal holes too much and form leak paths. The wires should be bent after exiting the wire cover, in order to fit all the wires comfortably underneath the wire dress cover.*

3.5. Contact Termination

Terminate the contacts in according to the specific tooling instructional material and crimp requirements provided in Application Specifications 114–6071 and 114–13045.

3.6. Plug Assembly Procedures

CAUTION *Seal cover and wire seal must not be removed or altered in any way.*

CAUTION *The back of the connector must be completely sealed. Those cavities that are not used must have individual seal plugs. Use seal plug 776363–1 for size 16 holes, and seal plug 776364–1 for size 20 holes. See Figure 2.*

NOTE *Contact retention fingers will not engage if contact assemblies are inserted into plug housing cavity while the plug spacer (TPA) is in the closed position.*

Check to be sure the plug spacer is in the *open*, or as–shipped position. See Figure 2. Proceed as follows:

1. To insert a terminated contact, push it straight into the appropriate circuit cavity as far as it will go. See Figure 2.

2. Pull back on the contact wire with a force or 8.9 to 13.3 N [2 to 3 lbs] to be sure the retention finger is holding the contact.

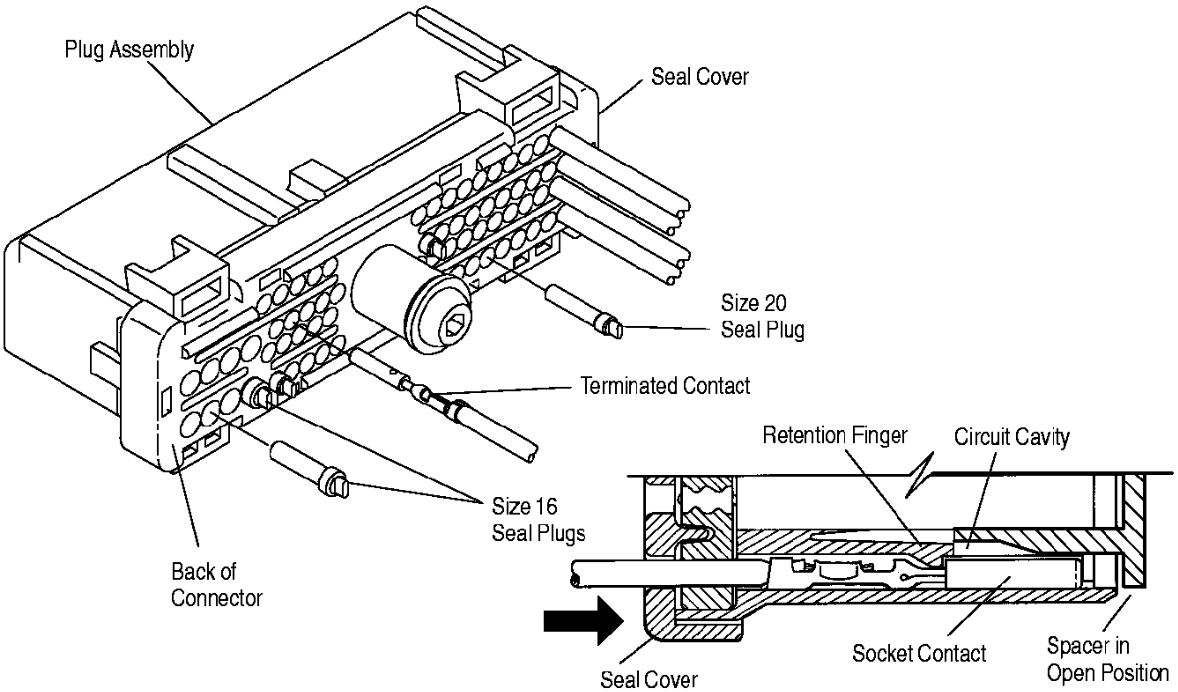


Figure 2

• Trademark of E. I. DuPont de Nemours and Company Corporation

3. After all required contacts have been inserted, the spacer must be closed to its *locked* position. Release the locking latches by squeezing them inward and slide the spacer forward until it is flush with the housing plug assembly. See Figure 3.

NOTE *The spacer should seat with a force of 56 N [12.5 lbs]. If the spacer does not seat, verify that all contacts are fully inserted.*

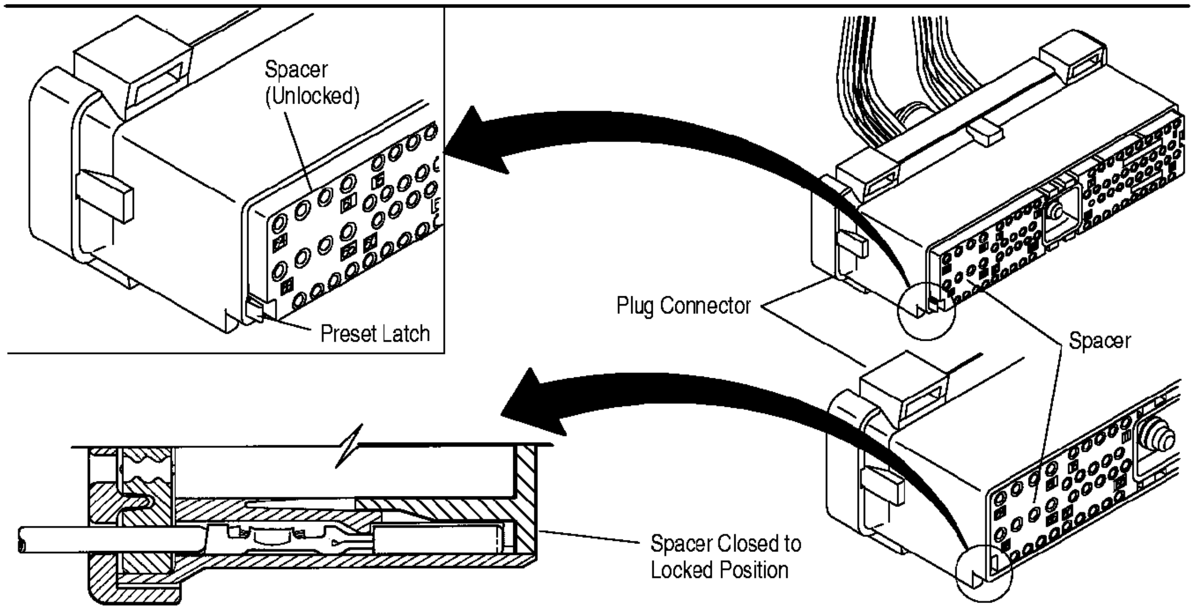


Figure 3

4. Assemble the wire dress cover and dress wires as shown in Figure 4.

5. Bolt the wire dress cover to the electronics module using customer supplied hardware. See Paragraph 3.15.

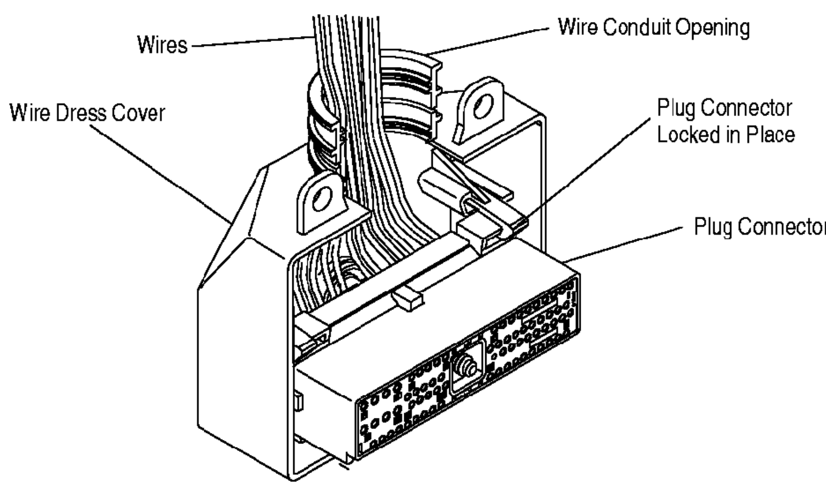


Figure 4

3.7. Plug Disassembly Procedures

Refer to Figure 5 and proceed as follows:

1. To remove the wire dress cover, loosen the two bolts holding the wire dress cover to the electronics module.

2. Cut the wire tie around the conduit, and release the four latch legs going into the plug assembly. See Figure 5.

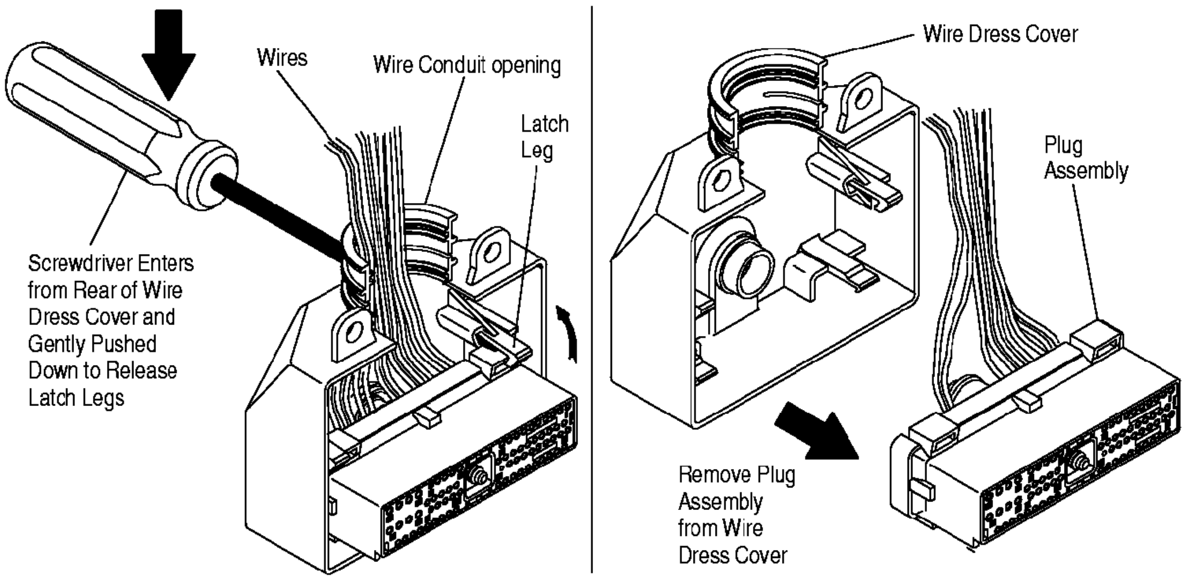


Figure 5

3. To remove the plug spacer, insert any hooked tool into the opening around the jackscrew. Rotate the tool to catch the underneath the spacer. Pull spacer straight out from the plug housing. See Figure 6.

CAUTION *Do not pry against the wall of the plug housing, as damage to the connector sealing system could occur.*

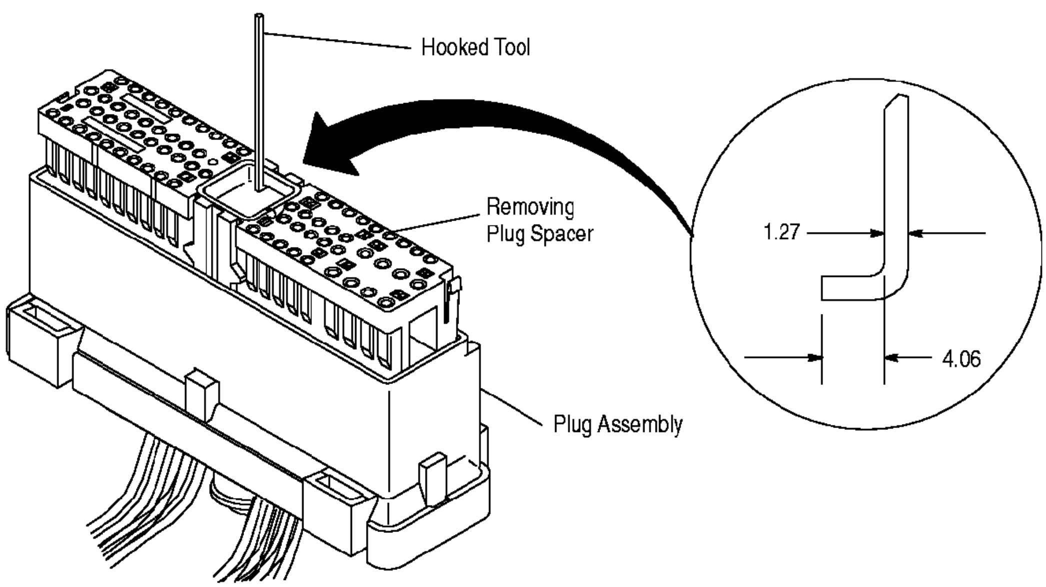


Figure 6

4. Insert a 1.4 mm screwdriver into the contact cavity and deflect the retention finger holding the contact. Gently pull the wire until the contact is free from the housing. Repeat this procedure for the remaining number of contacts to be removed as shown in Figure 7.

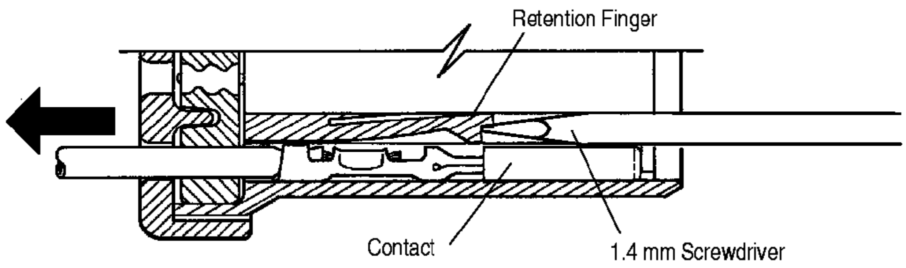


Figure 7

3.8. Printed Circuit Boards

A. Thickness

The header assembly has been designed to accommodate a pc board thickness of 2 mm thick. Contact the Product Information Center or the Tooling Assistance Center at the number listed at the bottom of page 1 for suitability of other board thicknesses.

B. Tolerance

The maximum bow of the pc board shall be 0.03 over the length of the header assembly.

C. Layout

The mounting and contact holes in the pc board must be precisely located to ensure proper placement and optimum performance of the header assembly. The "X" and "Y" symbols on the pc board layout represent customer established datums. They are the origin for the basic dimension (XXX and YYY datum), the point from which ALL hole positions must be located. Design the pc board using the dimensions provided in Figure 8.

NOTE: PC board layout is for reference only.

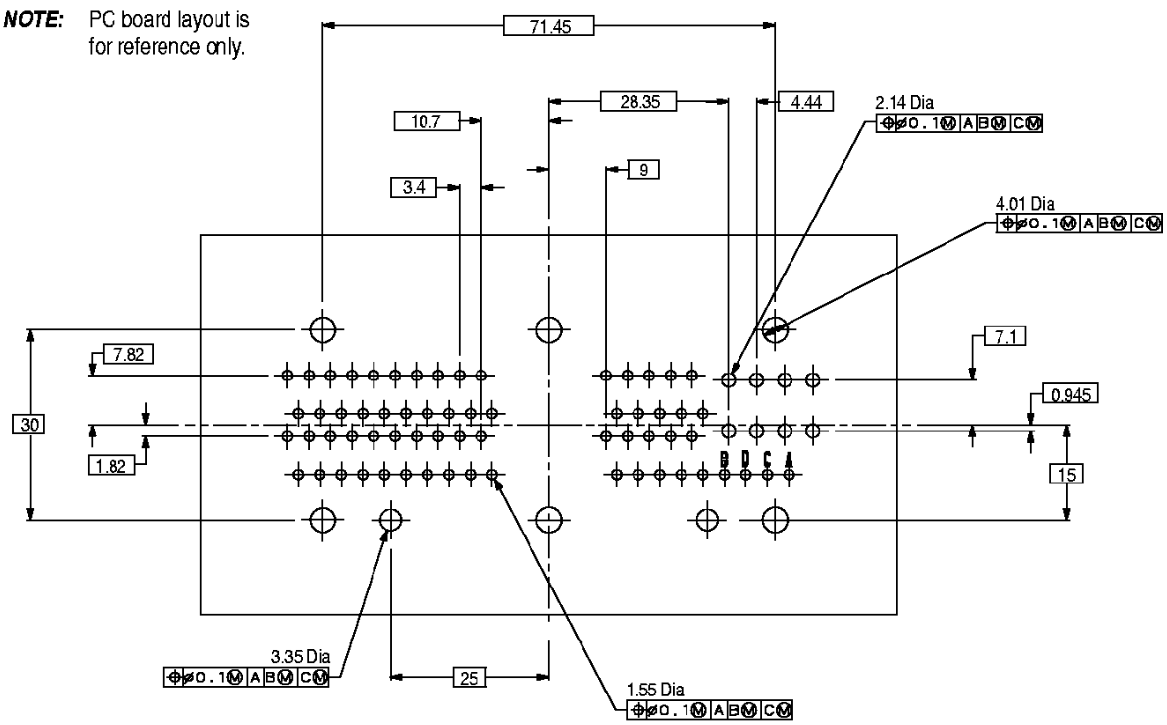


Figure 8

3.9. Contact Holes

The holes in the pc board for all contacts must be prepared as specified in Figure 9.

NOTE: The drilled hole diameter must be sized so that the diameter of the finished hole after plating meets the dimensions as shown.

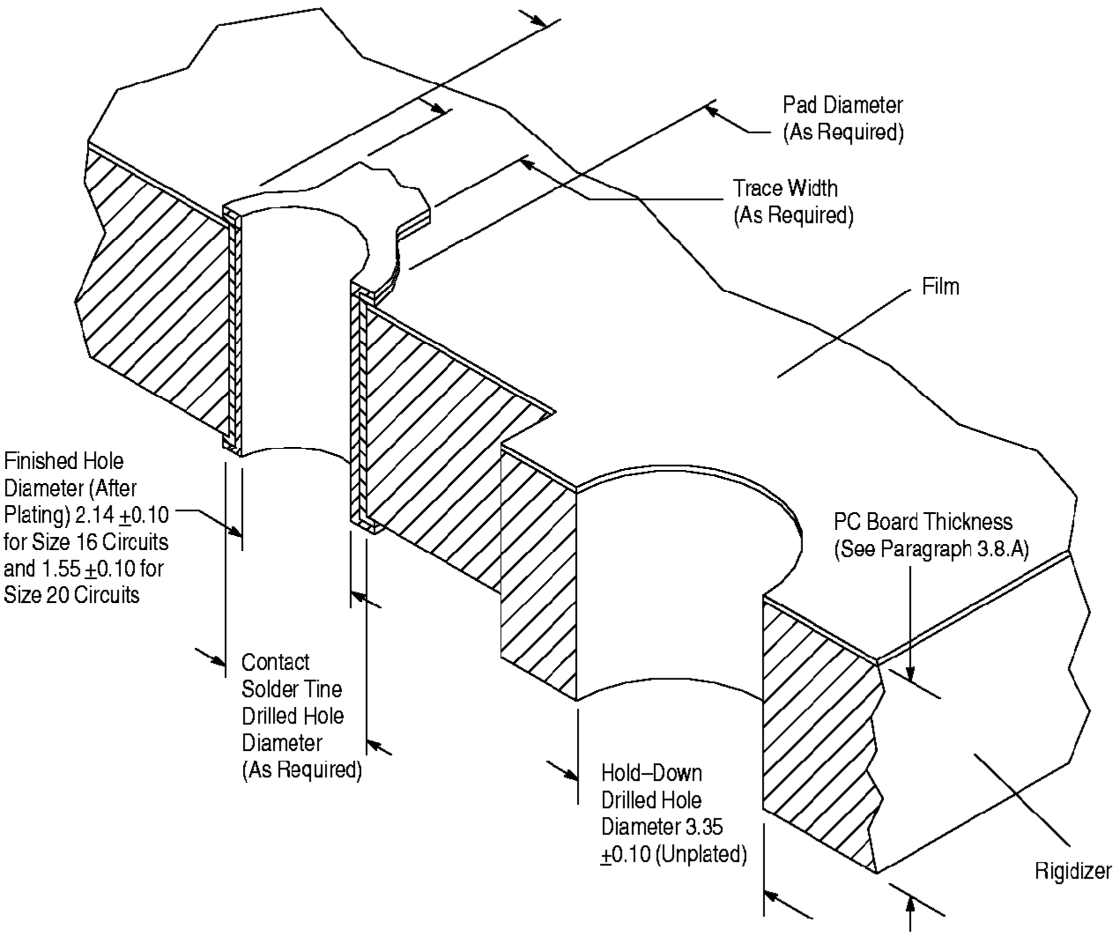


Figure 9

3.10. Header Assembly Application

This connector is for a vertical, surface mount application with pc boards. The header housing has a case seal for sealing against electronic module housings.

3.11. Header Assembly Placement

NOTE *Make sure that the case seal o–ring is properly placed inside the groove on the bottom side of the header assembly before mating to the rigidizer. The seal should not be bunched up or popping out of its retention features.*

1. The header assembly contains two plastic posts on the underside which are meant to polarize the header through the rigidizer and pc board.

2. All six mounting screws must be torqued through the rigidizer plate into the header assembly. The torque shall be 2.25 ±.22 N•m [20 ±2 in–lbs].

3. Check for proper placement of the header interface seal, which sits inside the header pocket. This seal should be flush against the bottom of the pocket. See Figure 10.

CAUTION *The interface seal and case seal must be in place to use the connector. Removing either seal will result in module failures.*

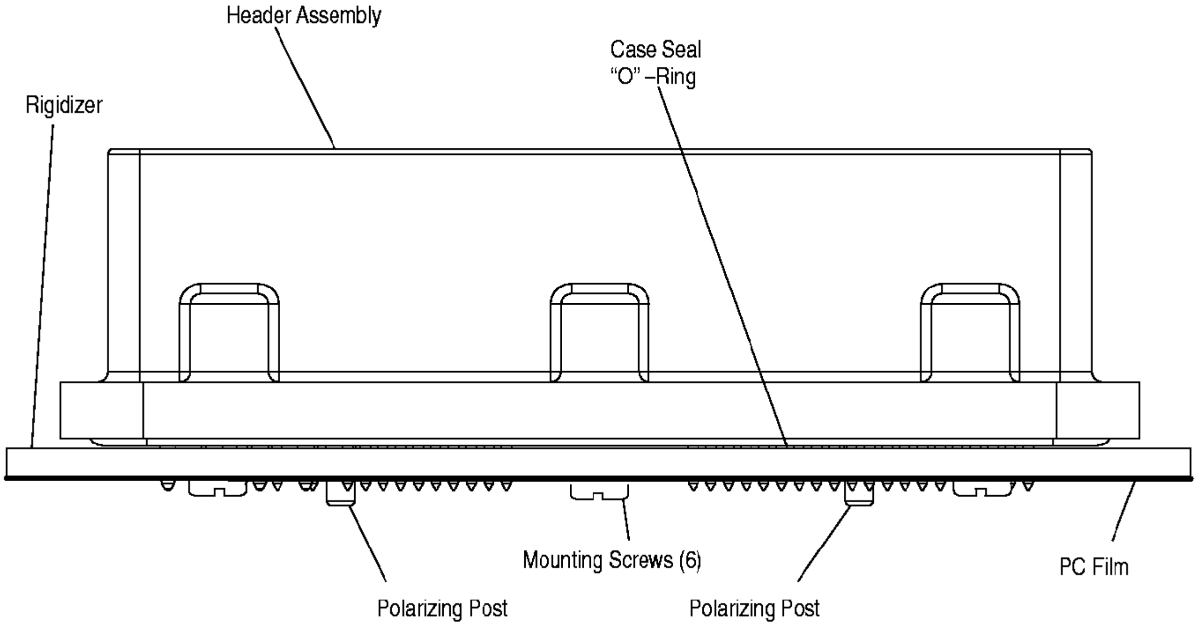


Figure 10

3.12. Soldering Header Assembly

The 68–Position Heavy Duty Hybrid Connector Header Assembly may be soldered to the pc board with an infrared reflow process, provided the temperature and exposure time is within the ranges specified in Figure 11. Tyco Electronics recommends the use of SN60 or SN62 solder for the connectors. Refer to Paragraph 2.5 for documentation material that is available for establishing soldering guidelines.

SOLDERING PROCESS	TEMPERATURE		TIME (At Max Temperature)
	CELSIUS	FAHRENHEIT	
Infrared Reflow Soldering	225	437	30 Seconds

Figure 11

A. Flux Selection

The connector solder tines must be fluxed prior to soldering with a mildly activated rosin base flux. Selection of the proper flux will depend on the type of pc board and other components mounted to the board.

B. Reflow Parameters

Due to the many variables involved with the reflow process (e.g., component density, orientation, etc.), Tyco Electronics recommends that the user conduct trial runs under actual manufacturing conditions to ensure product and process compatibility.

C. Cleaning

After soldering, removal of fluxes, residues, and activators is necessary. Consult with the supplier of the solder and flux for recommended cleaning solvents. For a list of common cleaning solvents that will not affect the connectors or assemblies for the times and temperatures provided without any adverse effects on the connector assembly, refer to Figure 12.

DANGER *Consideration must be given to toxicity and other safety requirements recommended by the solvent manufacturer. Trichloroethylene and Methylene Chloride can be used with no harmful affect to the connectors; however Tyco Electronics does not recommend them because of the harmful occupational and environmental effects. Both are carcinogenic (cancer–causing) and Trichloroethylene is harmful to earth ozone layer.*

NOTE *If you have a particular solvent that is not listed, contact the Tooling Assistance Center or Product Information number at the bottom of page 1.*

CLEANER		TIME (Minutes)	TEMPERATURES (Maximum)	
NAME	TYPE		CELSIUS	FAHRENHEIT
Alpha 2110■	Aqueous	1	132	270
Bioact EC–7◆	Solvent	5	100	212
Butyl Carbitol●	Solvent	1	Room Ambience	
Isopropyl Alcohol	Solvent	5	100	212
Kester 5778⌘	Aqueous	5	100	212
Kester 5779⌘	Aqueous	5	100	212
Loncoterge 520●	Aqueous	5	100	212
Loncoterge 530●	Aqueous	5	100	212
Terpene Solvent	Solvent	5	100	212

■ Product of Fry's Metals, Inc. ◆ Product of Petroferm, Inc. ● Product of Union Carbide Corp. ⌘ Product of Litton Systems, Inc.

Figure 12

D. Drying

CAUTION *Excessive temperatures may cause housing degradation. Do NOT solder the header assembly with the plug connector or wire dress cover attached to it.*

The header assembly can withstand a temperature of –40 to 225°C [–40 to 437°F]. Values may vary with different automatic cleaning equipment (see equipment manufacturer's recommendations).

E. Checking Installed Connector

All solder joints should conform to those specified in Workmanship Specification 101–21. The mounting screws must be torqued to 2.25 ±0.22 N●m [20 ± 2 in–lbs]. The housing wall should be almost flush against the rigidizer. See Figure 13.

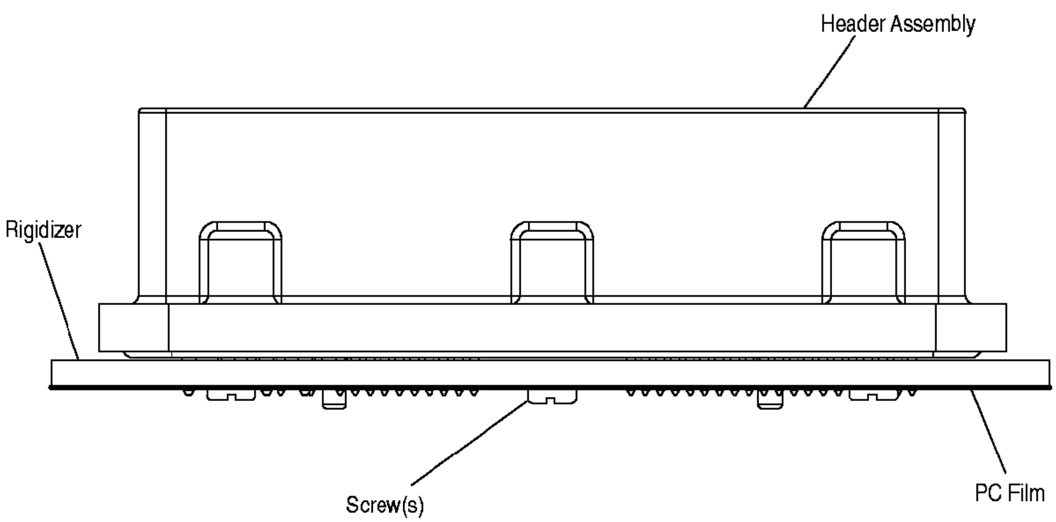


Figure 13

3.13. Polarization and Keying Features

The header assembly has key slots on the sides of the pocket which will accept corresponding keying protrusions from the plug assembly. There are four different possible keying arrangements. See Figure 14.

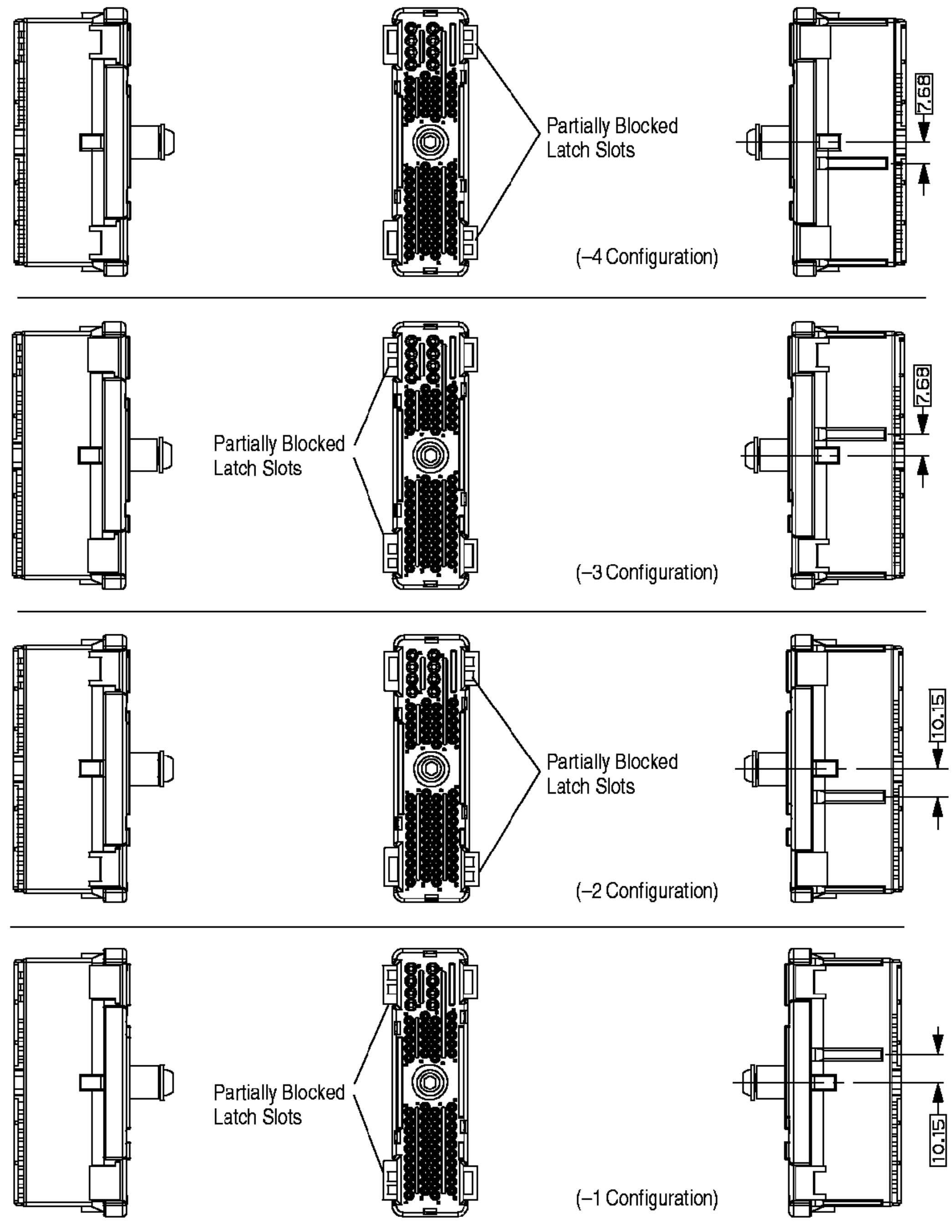


Figure 14

The plug assembly has polarized latch holes for mating with the wire dress cover. Two of the latch slots will be partially blocked, allowing the wire dress cover to only be mated in one direction. See Figure 15.

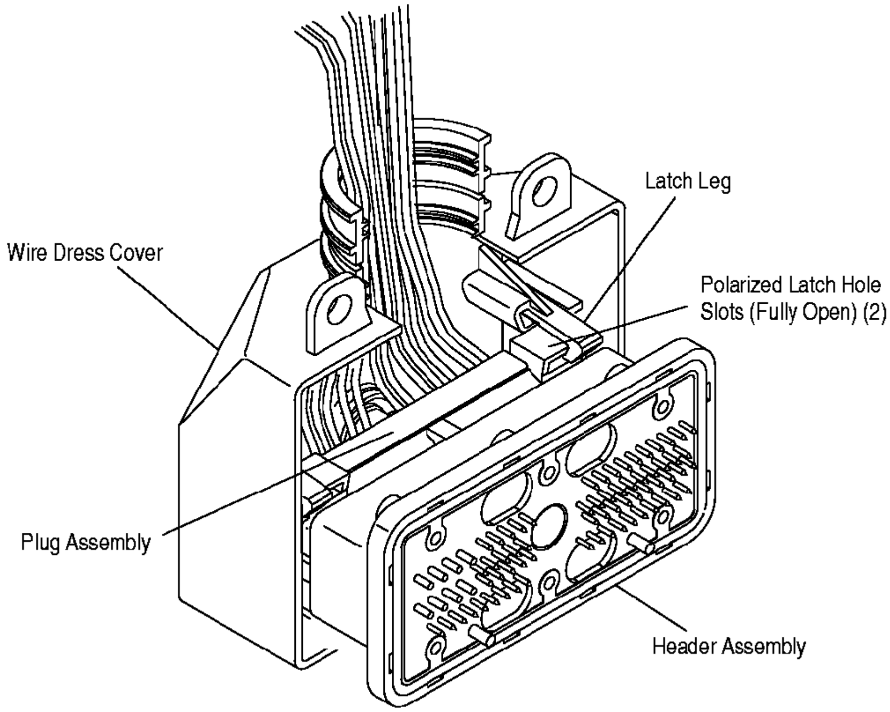


Figure 15

3.14. Mounting Hardware

Six customer supplied No. 6–19 screws are required to mount the header assembly to the rigidizer. Also, to mount the wire dress cover to the electronic module, two customer supplied screws are required. These screws must have a shaft of <7.0 mm diameter, and a head flange diameter > 9.0 mm.

3.15. Reading Voltage During Service

CAUTION *Do NOT pierce wire insulation to take voltage readings.*

It has been common practice in electrical troubleshooting to probe wires by piercing the insulation with a sharp point. This practice must be strongly discouraged when dealing with the 68–Position Heavy Duty Hybrid Connector System, or any other sealed connector system. The resulting pinholes in the insulation will allow moisture to invade the system by traveling along the wire strands. This nullifies the effectiveness of the connector seals and may result in system failure.

3.16. Repair/Replacement

Damaged crimped contacts or housings must be removed, discarded, and replaced with new components. Damaged pc board connectors must be removed from the pc board by standard desoldering methods and replaced.

CAUTION *If a damaged contact is apparent before the the contacts are inserted into the housing, cut the wire in back of the contact and reterminate the wire end. If contacts or housing are damaged after insertion, the wire must be cut directly in back of the housing and reterminated with new contacts and housing.*

4. QUALIFICATIONS

The 68–Position Heavy Duty Hybrid Connector is not required to be Listed or Recognized by Underwriters Laboratories Inc. (UL), or Certified by the Canadian Standards Association (CSA).

5. TOOLING

No specific application tooling is required for the application of the 68–Position Heavy Duty Hybrid Connector. Information for crimp termination tooling for the contacts is available in Application Specifications 114–6071 and 114–13045.

6. VISUAL AID

Figure 16 shows a typical application of 68–Position Heavy Duty Hybrid Connector. This illustration should be used by production personnel to ensure a correctly applied product. Applications which DO NOT appear correct should be inspected using the information in the preceding pages of this specification and in the instructional material shipped with the product or tooling.

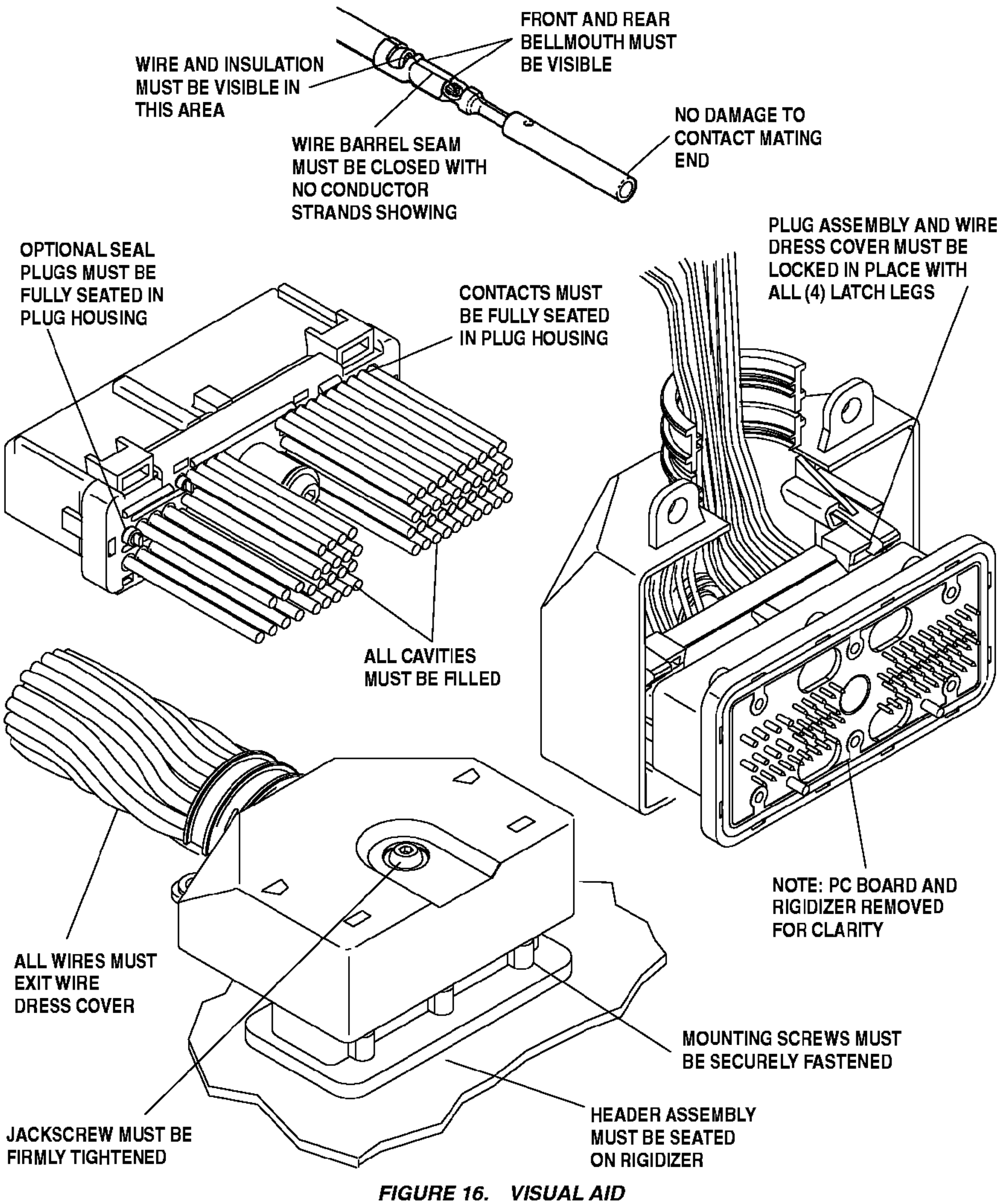


FIGURE 16. VISUAL AID

DETROIT DIESEL

SERIES 60®

The *ONLY* Motor Coach Power Choice

Since 1992, More Have Selected The SERIES 60® Than Any Other Heavy-D

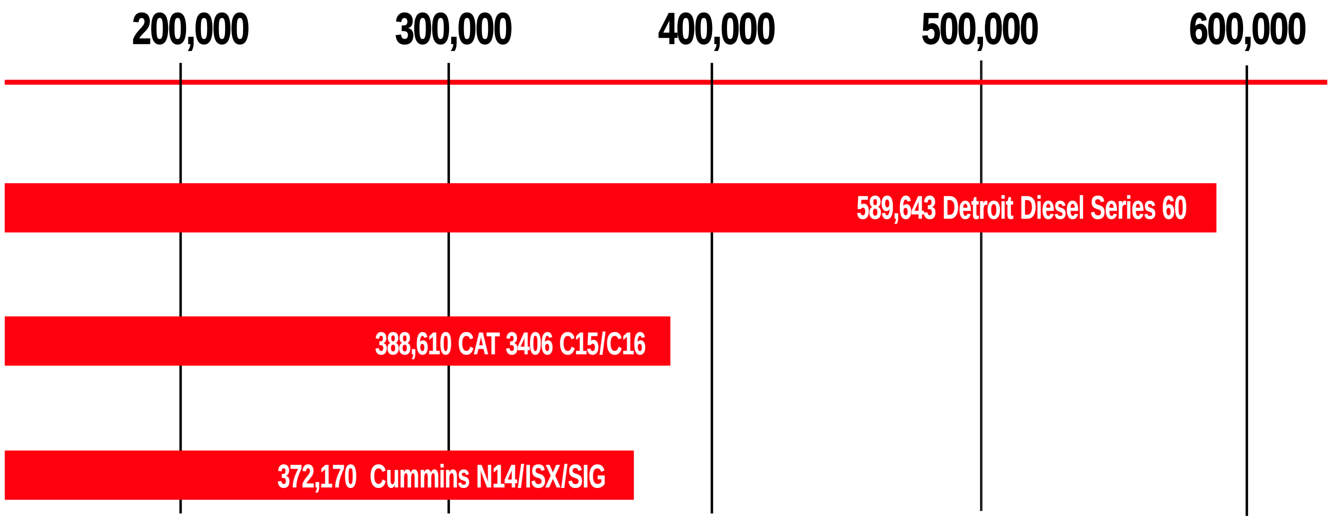
Why Is The Series 60 So Popular?

Because It Offers Motor Coach Operators The Best Combination Of:

- Performance
- Fuel Economy
- Low Cost Of Operation
- Reliability
- Long Life To Overhaul
- Driver Satisfaction
- Ease of Service
- Warranty Satisfaction
- Ratings Flexibility
- Electronic Controls
- Lightweight
- Residual Value

Coach Operators

Engines Registered Since 1/1/92



Based on R.L. Polk Registrations (through Nov. 2003)

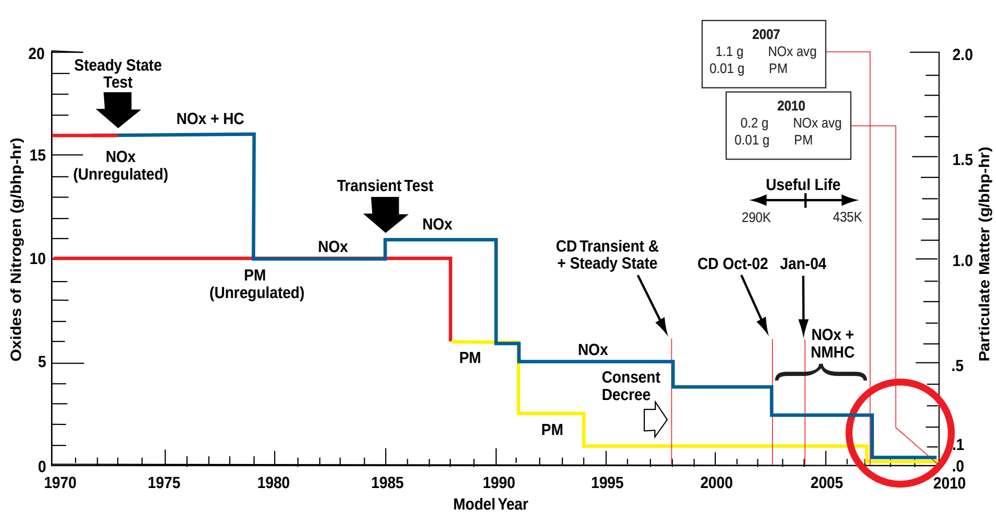
uty Engine

And The Tradition Carries On Into 2004

The EPA has regulated heavy-duty diesel engines since the 1970s. The following chart shows the trend to ever-lower emissions. Understanding the details of the chart is not of interest to most truckers.

Even though the emissions standards become increasingly more difficult to meet, the diesel engine industry has always been able to continue to improve engine durability, reliability, performance, and fuel economy. A quick look at the bottom right hand side of the chart also shows that emissions from diesel engines built in 2007 and beyond will approach zero.

EPA Heavy-Duty Engine Emission Standards



The Series 60 EGR®

The NOx Challenge

2002 emission regulations required a reduction in oxides of nitrogen (NOx) to 2.5 g/hp-hr. NOx is a by-product of high temperatures in the combustion chamber, the higher the temperature, the higher the production of NOx.

How Does EGR Work?

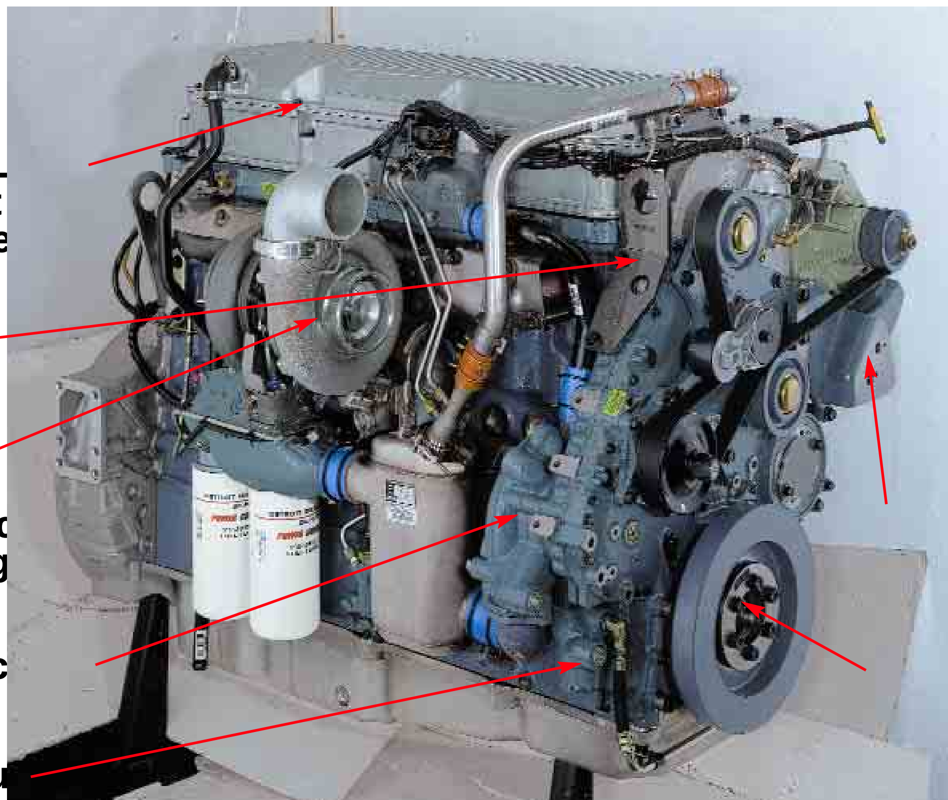
EGR (Exhaust Gas Recirculation) is a simple concept. During certain conditions of engine operation, the EGR valve is opened and measured amounts of exhaust gas are routed to the intake manifold. The exhaust gas mixes with the incoming fresh air and displaces some of the oxygen. Since there is now slightly less oxygen in the air, the peak temperatures created in the combustion chamber are reduced, and the levels of NOx are also reduced.

EGR Is The Best Solution

EGR is the technology chosen by all but one major engine maker in North America. EGR has been in use on automobile engines since the mid-1970s.

The challenge faced by Detroit Diesel and the other engine makers was to reduce NOx without adversely affecting fuel economy, performance, durability, or other factors of engine operation. EGR has proven to be the best way to reduce NOx while maintaining excellent driveability, performance, fuel economy, and engine life.

When EGR Was Added To The Series 60, Additional Refinements Were Also Made To The Series 60's Proven Design.



These Refinements Paid Off In A Number Of Ways

Base Engine Improvements

Power Assembly

- **Piston**
  — Enhance Combustion Piston Bowl
- **Fire Ring**
  — Increase Thickness from 2.5 mm to 3.0 mm
  — Base Material and Face Coating Material Enhancements
- **Connecting Rod**
  — 12.7L Common Rod with 14L
  — 12% More Rod Bearing Area
- **Crankshaft**
  — 12.7L "Big Pin" 95 mm Rod Journals
- **Higher Output Water Pump**
  — Improved Cooling

Cylinder Head Assembly

- **Cylinder Head Modifications**
  For Long Life and Fuel Efficiency
  — Head Bolt Bosses
  — Top Deck Thickness
  — Intake Manifold Bolt Pattern
  — Intake Port Machining
  — Recessed Exhaust Valves
- **Valves, Guides & Seals**
  For Long Life
  — Nickel Chrome Intake Valves
  — Pyromet Exhaust Valves
  — Nickel Based Valve Seat Material
  — Powdered Metal Valve Guides

Next Generation Gear Train

- **Less Vibration and Noise**
- **Decreased Frontal Area for Improved Under Hood Air Flow**
- **Improvements in Component Bracketry**
- **Higher Water Pump Flow**
- **Less Weight (53 lbs)**

Single Cylinder Air Compressor

- **Bendix Model DF-359**
- **Same Output as TF-750 (16CFM)**
- **Naturally Aspirated**
- **Less Friction**
- **Reduced Oil Consumption (up to 60% less)**
- **Less Weight (20 lbs)**

What Is Being Said In The Field About Series 60 With EGR?

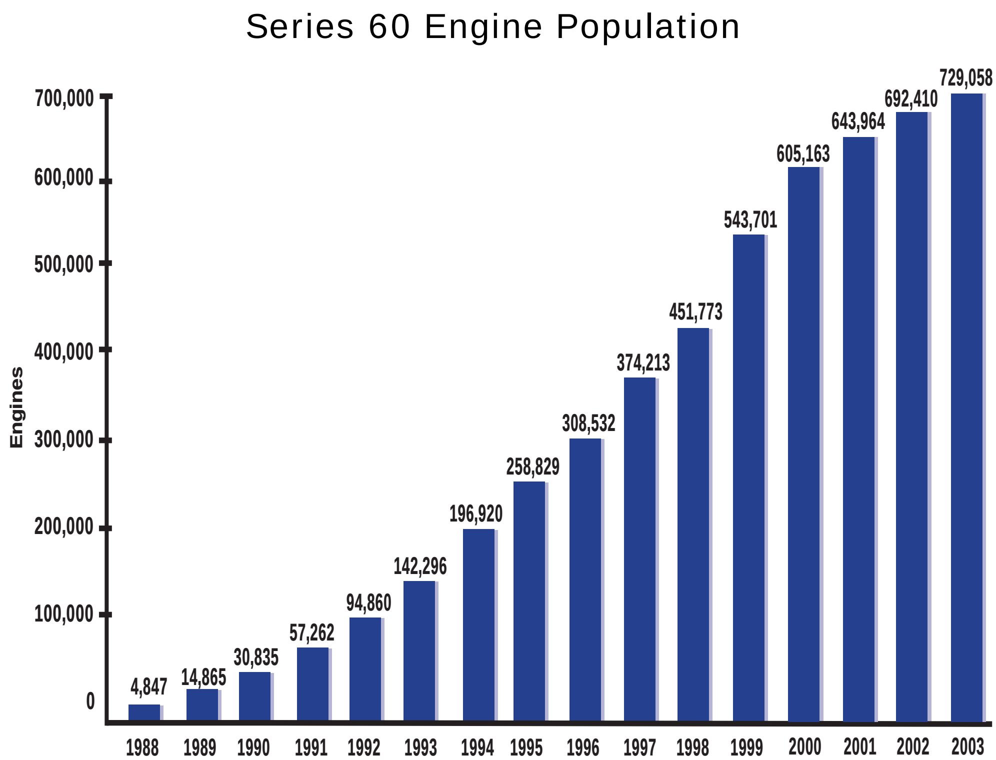
“Our Driver Acceptance Is At The Highest Level I Can Remember.”

“Fleet representatives, reporting their first impressions of new lower-emission diesel engines, gave them generally high marks for the way they perform in actual operations.”

(Roger Gilroy, *Transport Topics*, March 24, 2003)

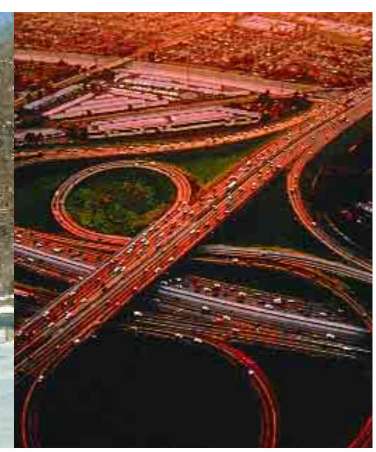
“Drivers should appreciate the new powerplants as they clearly perform better, especially at the bottom end, thanks to the changeover to variable geometry turbochargers and improved ECU programs. I’ve driven all brands with EGR and have been quite impressed.”

Eight Million Miles Of Durability Testing Revealed That The Series 60® EGR Engines Are Showing A 49% Reduction In Liner Wear, And A 78% Reduction In Ring Wear Compared To Previous Engines, Which Translates To Even Better Life To Overhaul.



The Series 60 Engine Is The Favorite





The Rapid Acceptance Of EGR

In 2003, DDC Shipped Over 36,000 Series 60 Engines With EGR, Bringing The Field Population Of Series 60 And Series 50 Engines With EGR To

Over 40,000 Units

How Well Are They Doing?

After 250,000 Miles Of Operation DDC Wanted To See How The New Components Were Holding Up. See For Yourself.

Main bearings did their job and show no wear. Upper no load main bearings show no wear and lower load bearings look as good. Bearings show only minor overlay polish.

Cam bearings show minor polishing.

Camshaft looks excellent. Journals and lobes show only contact path polishing.

Rod bearings show only minor overlay wear.

More...

Connecting rod bushing machining marks are still visible indicating minimal wear.

Piston bushings only show typical polishing.

Piston liner shows cross hatch pattern intact.

And...
The Series 60 Is Still The Fuel Economy Leader!

Look At These Fuel Economy Results
From Fleets That Ran Their Own
SAE Fuel Economy Tests

Series 60 w/EGR vs. ISX w/EGR

July 24, 2003	**Fleet "A"**	**Series 60 5.4% (12L) & 5.9% (14L) Better**
August 20, 2003	**Fleet "B"**	**Series 60 2.83% Better**

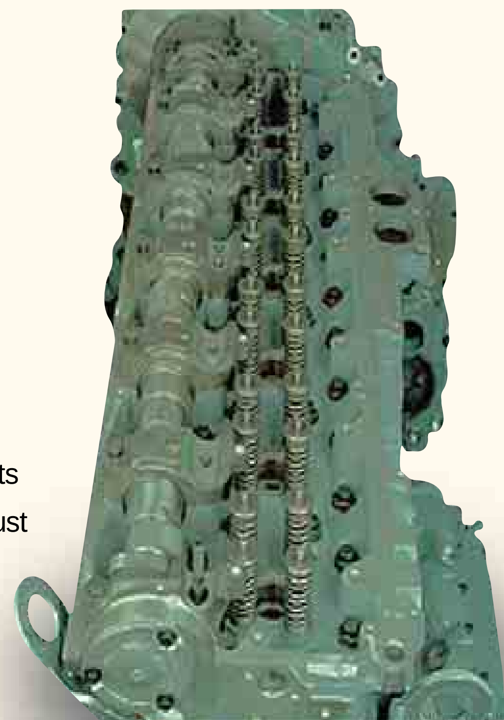
Series 60 w/EGR vs. C15 ACERT

August 8, 2003	**Fleet "C"**	**Series 60 3.9% Better @ 45,000 GCW** **Series 60 4.1% Better @ 75,000 GCW**

What's New For 2004?
The Series 60 Continues To Evolve.

2004 Series 60 Engine Hardware Enhancements

- **Unit Injector, Monotherm Piston**
- **New Cold Pipe**
- **DDEC V**
- **Tube & Shell EGR Cooler**



- **Cylinder Head**
  - Better Air Flow For Improved Performance
- **Camshaft / Overhead**
  - Optimized Injector And Valve Events
  - Ceramic Injector, Intake And Exhaust Rollers For Better Roller Durability Under Adverse Conditions

- **One Piece (Monotherm) Piston**
  - Reduced Friction For Improved Performance
  - Closed Oil Gallery For Improved Ring Cooling And Longer Life
  - Higher Compression Ratio For Better Cold Weather Starting

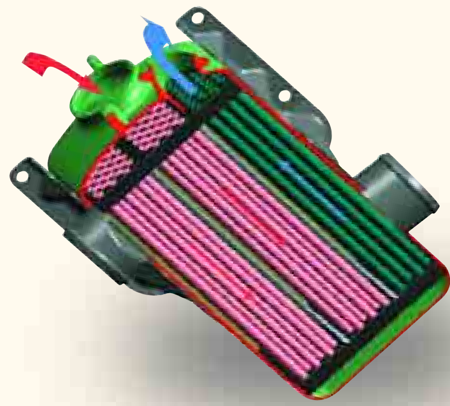
■ EGR Cooler

– Tube In Shell Design For Improved Durability

– Improved Efficiency

– Simpler Stainless Steel Housing With Less Welding

– 10 Lb. Weight Reduction



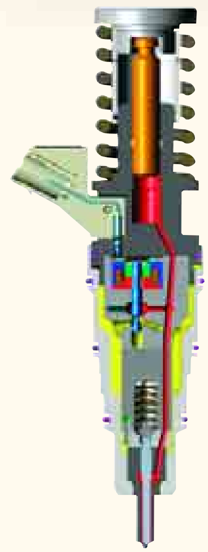
■ New Fuel Injector

– Improved End Of Injection Quality And Faster Response Time For Better Efficiency

– Reduced Weight – 2.5 Lbs.

– Stainless Steel Injector Sleeve Replaces Copper Tube

- Increased Durability
- Increased Corrosion Resistance
- Serviced From The Top Of The Engine



■ Electronic Controls – DDEC V

– Increased Capability For Future Needs

- Increased Microprocessor Power
- 4 Times More Memory
- 150 Output Pins vs. 81 Current
- Ability To Add Options (MAS)

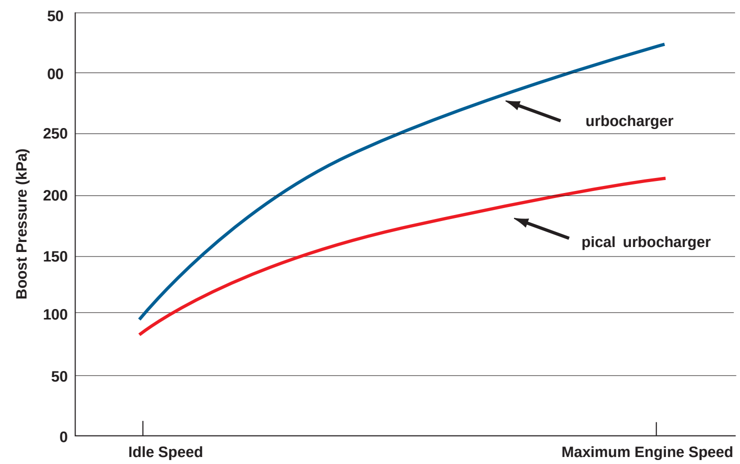
– Improved Reliability

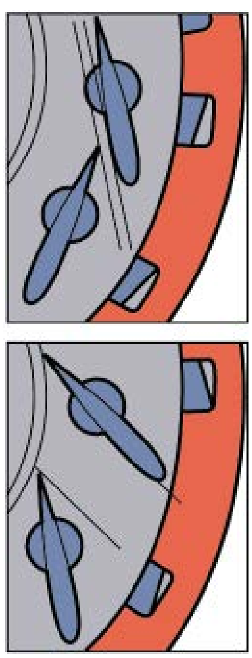
- Improved Housing
- Latest Connectors And Harness Technology

More Benefits Of Variable Geometry Turbocharging (VGT)

- **Maximum engine power up to 12,000 feet**
- **Improved engine braking**
- **Improved engine driveabilit and acceleration**
- **Improved performance at high altitudes**
- **Better fuel economy**
- **Faster turbo response and quicker acceleration**

Boost Pressure Benefit With VGT Turbocharger





425-515 HP

The Most Complete Power Range In A Single Engine Package

12.7L	
Maximum HP @ RPM	Peak Torque @ RPM
445 HP @ 1800 RPM	1450 LB-FT @ 1200 RPM
435 HP @ 1800 RPM	1450 LB-FT @ 1200 RPM
425 HP @ 1800 RPM	1450 LB-FT @ 1200 RPM
425/445 HP @ 1800 RPM	1450 LB-FT @ 1200 RPM
455 HP @ 1800 RPM	1550 LB-FT @ 1200 RPM
450 HP @ 1800 RPM	1550 LB-FT @ 1200 RPM
445 HP @ 1800 RPM	1550 LB-FT @ 1200 RPM
445/455 HP @ 1800 RPM	1550 LB-FT @ 1200 RPM
14.0L	
Maximum HP @ RPM	Peak Torque @ RPM
515 HP @ 1800 RPM	1450 LB-FT @ 1200 RPM
490 HP @ 1800 RPM	1550 LB-FT @ 1200 RPM
455 HP @ 1800 RPM	1550 LB-FT @ 1200 RPM
455/490 HP @ 1800 RPM	1550 LB-FT @ 1200 RPM
515 HP @ 1800 RPM	1550 LB-FT @ 1200 RPM
490 HP @ 1800 RPM	1550 LB-FT @ 1200 RPM
455 HP @ 1800 RPM	1550 LB-FT @ 1200 RPM
455/515 HP @ 1800 RPM	1550 LB-FT @ 1200 RPM
515 HP @ 1800 RPM	1650 LB-FT @ 1200 RPM
490 HP @ 1800 RPM	1650 LB-FT @ 1200 RPM
470 HP @ 1800 RPM	1650 LB-FT @ 1200 RPM
470/515 HP @ 1800 RPM	1650 LB-FT @ 1200 RPM
470 HP @ 1800 RPM	1650 LB-FT @ 1200 RPM
470/515 HP @ 1800 RPM	1650 LB-FT @ 1200 RPM
490 HP @ 1800 RPM	1650 LB-FT @ 1200 RPM
470 HP @ 1800 RPM	1650 LB-FT @ 1200 RPM
470/490 HP @ 1800 RPM	1650 LB-FT @ 1200 RPM

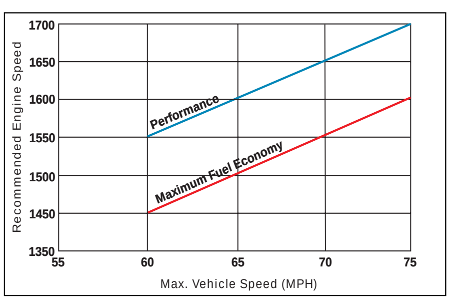
Big Power With All The Other Benefits Of A Series 60 Engine

With more than 5 different power ratings to choose from, it's easy to match a Series 60 engine to the exact needs of any coach operator. But sometimes their needs change. That's not a problem with the Series 60 engine! The power chart on the left shows the groups of engine ratings within each family.

The families contained in each of the shaded sections have identical hardware. The groups displayed in each family show the preprogrammed horsepower range in a single engine. A simple electronic tool is all that is required to change power within a group. Power changes from one group to another within the same family simply require reprogramming of the engine's electronic control module.

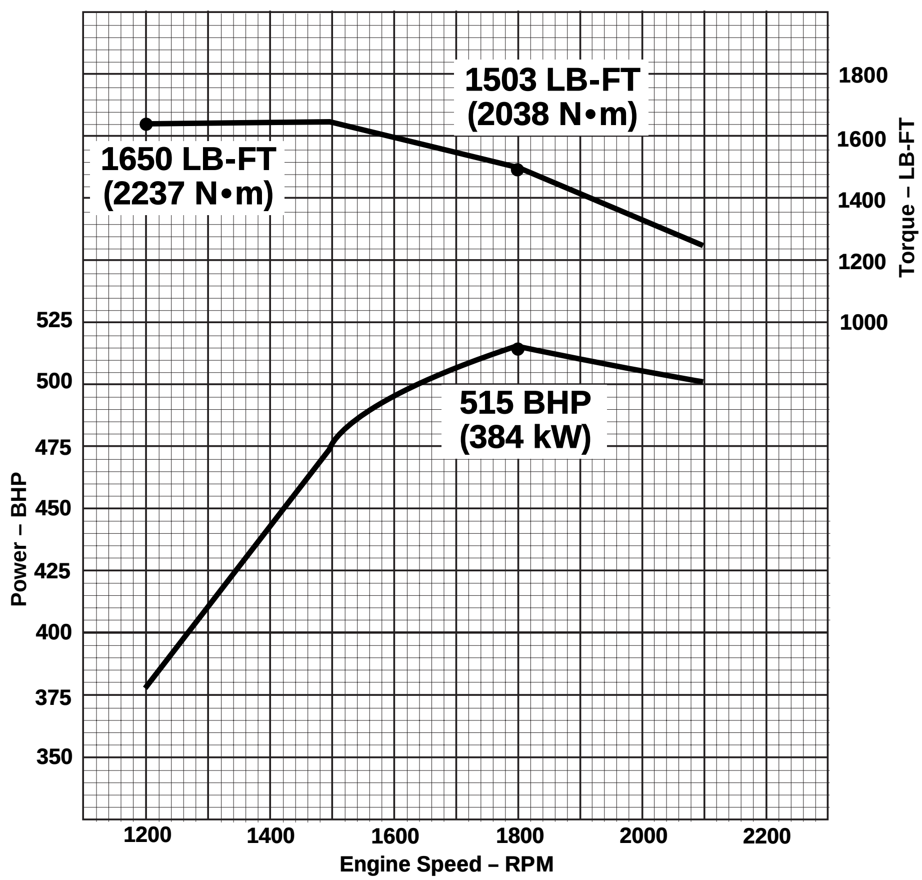
It is possible to change power from one group to another (just make sure the coach cooling, air intake and exhaust systems and the driveline can handle the change). Upping the horsepower to the maximum limit at time of trade-in is an easy way to increase both the resale value and desirability of any coach.

Gearing Recommendations Remain the Same



"Another engine maker was going to give me a fuel economy guarantee, but they backed off when they discovered how well the Series 60 was doing."

515 BHP



Want To Know More?

Take A Look At The Simple Design Of The Engine. The One-Piece Cylinder Head Contains The Overhead Camshaft, Providing A Variety Of Benefits:

- Intake and exhaust passages are straight for easy entry and exit of air from the cylinder. The engine doesn't waste fuel "pumping" air in and out.
- Intake and exhaust passages are also short. Intake air is not overly heated as it passes through the head. The resulting cooler air in the cylinder improves economy. And the hot exhaust gases don't transfer too much heat into the head as they exit, saving more energy to operate the turbo and increase fuel economy.
- The overhead cam allows for direct actuation of the fuel injectors without push rods or push tubes. The result is high fuel injection pressure and better fuel economy.
- The overhead cam also allows for the use of 38 head bolts, providing over 1,000,000 pounds of clamp load on the head gasket.

These Features Combine To Produce The Economy, Durability And Performance The Series 60 Engine Is Known For

The cylinder liner is cooled all the way to the top, using a patented DDC feature called top liner cooling. This reduces ring temperatures by 100ºF, another reason Series 60 engines live so long.

Main and rod bearings are big. That's why the Series 60 engine has no requirement to roll out bearings—it's just not necessary.

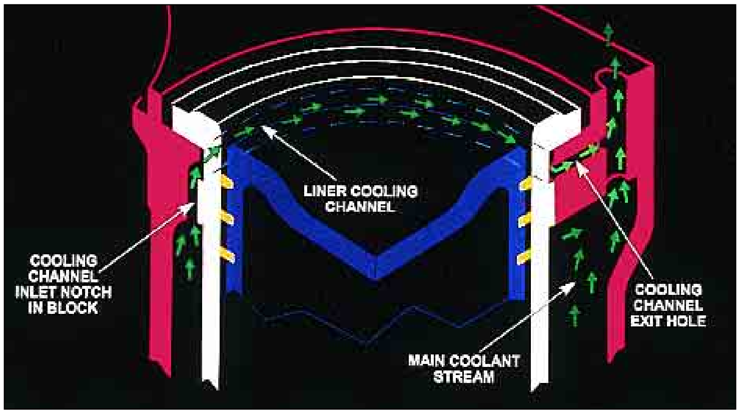
The Series 60 engine block, with no camshaft, is a simple, trouble-free design.

The Series 60 engine features a high performance variable output turbocharger for improved low speed performance, economy and excellent driveability.

Another benefit is the Pad Mounted Alternator System with a Poly V belt and self tensioner. It's strong, rugged and simple.

Add the gear train to drive the accessories and the camshaft, and you have a complete Series 60 engine.

- Simple
- Rugged
- Easy to work on
- Key components are right under the rocker cover
- Fewer parts



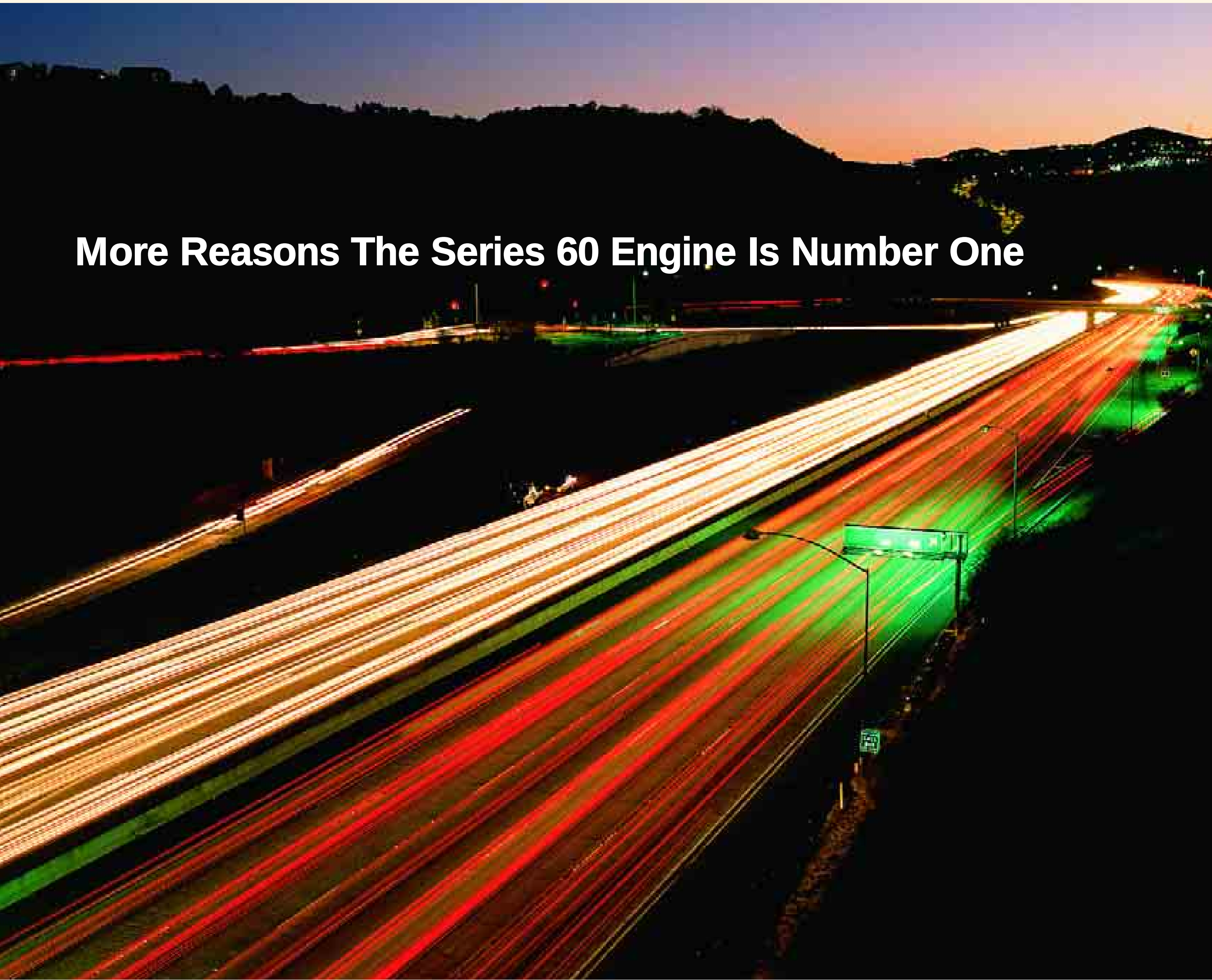
DDEC Engine Management Technology

Every Series 60 engine is equipped with Detroit Diesel Electronic Controls (DDEC). DDEC® is the most popular electronic control system available. DDEC V, the fourth generation of DDEC, is now standard equipment on all Series 60 engines. In addition to precisely controlling fuel injection, DDEC offers all of the following:

- Three levels of engine protection
  - — Warning only
  - — Power ramp down
  - — Automatic shutdown
- Cruise control
- Auto resume cruise control
- Multiple hp ratings
- Three levels of engine braking
- Engine fan braking
- Progressive shifting
- Vehicle speed limiting
- Vehicle overspeed diagnostics
- Low gear torque limiting
- Starter lockout
- Remote PTO control
- Communication capability with electronically controlled transmissions
- Idle speed adjustment
- Droop adjustment
- Idle timer shutdown
- Air temperature shutdown
  - — High or low
- Warnings for:
  - — Low voltage
  - — Low coolant
  - — High oil temperature
  - — Low oil pressure
- Self diagnosis
- Four levels of security

New for DDEC V is the addition of more memory, a built-in clock and calendar and built-in battery backup.

More Reasons The Series 60 Engine Is Number One



DDEC Electronic Technology

Ordinary Diesel Engines Have Electronic Controls

DDEC takes electronic engine management to a whole new level with a sophisticated control system that provides the ability to customize the engine to your application for peak efficiency.

DDEC electronic control optimizes fuel injection in real time to maximize fuel economy, performance and emissions. It diagnoses your Series 60 on the fly, using onboard diagnostics. It even protects the engine from damage by directing system shutdowns to prevent catastrophic failures.

- Sensors signal operations outside of preset engine parameters
- Auto shutdown will prevent engine damage
- Data can be downloaded to fleet managers
- Multiple performance and fuel economy reports are available
- Built-in electronic redundancies for superior reliability

Fully electronic, fully automatic and fully reliable, with fewer moving parts than less sophisticated engine management systems

- **Self-diagnosing and self-protecting** to eliminate guesswork and accidental damage
- **Modular components** can be replaced easily and inexpensively
- **Data collection/sharing enabled** for fleet management
- **Supported by Detroit Diesel Distributors, the world's most experienced engine electronics service network**

ProDriver™ DC

ProDriver DC is a dashboard-mounted display with data card extraction capabilities. It provides real time and summary information on vehicle and engine operation, as well as graphic displays of driver performance relative to fleet goals. ProDriver DC is a second generation display product. It delivers all the functionality provided by the original ProDriver display, along with many new features and capabilities.

Effective coach management starts with quick performance data retrieval. The key benefit of ProDriver DC is instant feedback on fuel economy so that the operator can adjust driving habits to maximize mpg and thereby reduce costs.

ProDriver DC Works To:

- Increase fuel economy
- Improve driver performance
- Increase driver satisfaction
- Lower operating costs
- Improve safety records
- Reduce maintenance expenses

Diagnostic Link™ Software

Detroit Diesel Diagnostic Link is a PC Windows® based software engine troubleshooting tool that includes a built-in service manual and can aid in extracting data, analyzing and managing information from ECMs.

This tool can view or change:

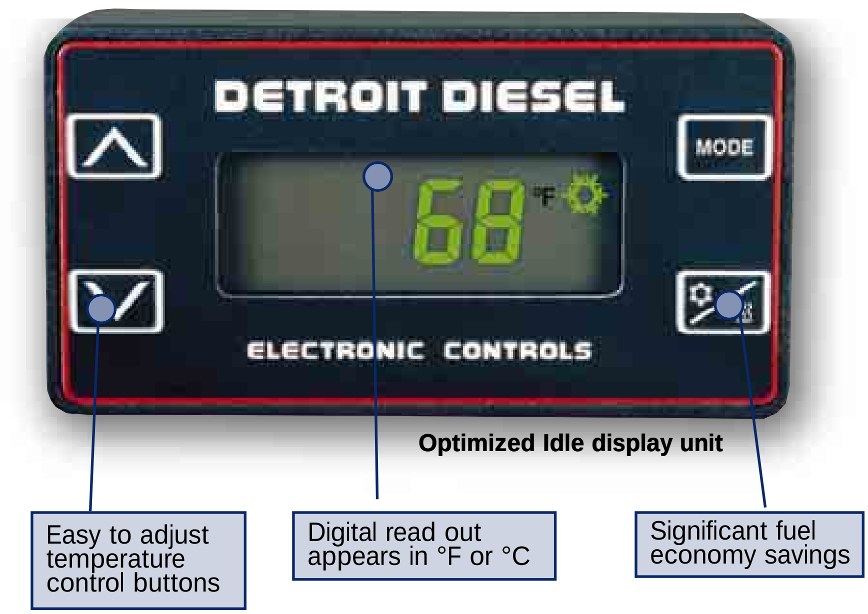
- Engine Configurations
- Fault Codes
- Vehicle Speed Settings
- Total Engine and Trip Data
- Engine Protection Options
- Information From DDEC Data
- Idle Shutdown
- Cruise Control

Diagnostic Link™

The immediate feedback from ProDriver™ DC allows the driver to take a more active role in meeting coach goals.

ProDriver™ DC

IRIS - Infrared Information System



Optimized Idle display unit

Maintenance Alert System

"We had to switch to the Series 60 because the residual value is higher."

IRIS – Infrared Information System

The IRIS system consists of simple infrared transmitters and receivers (transceivers). One transceiver is mounted on the vehicle. Another transceiver is mounted at the location (or locations) where the vehicle owner wants to extract information, such as the entrance to the shop or the fuel island. IRIS provides a wireless connection between vehicle systems and off-board PC software applications.

Optimized Idle®

Optimized Idle is an engine controlled management tool that automatically starts and stops the engine based on:

- Battery Voltage
- Engine Temperature
- Cab/Sleeper Temperature

When these variables fall below predetermined values, DDEC will start the engine and allow it to idle until the parameters are brought to in-range values. Optimized Idle provides benefits of:

- Less Fuel Used
- Extended Battery Life
- Reduced Idle Time
- Safety

Maintenance Alert System

The Maintenance Alert System (MAS) is designed to take the guesswork out of filter and fluid checks and changes. Sensors monitor oil level, coolant level, and pressure drop across the oil, fuel and air filters. The MAS monitor is mounted in the coach for easy access by service technicians when the vehicle enters the fuel and service island. When filters begin to clog or fluid levels drop, DDEC illuminates a light indicating what maintenance item needs to be serviced. No hassle, no guesswork, no wasted downtime.

What About Warranty?

The Series 60 engine is covered by a standard warranty of two years, unlimited miles with 100% parts and labor coverage, and 5 years or 500,000- mile.

Want more coverage? Custom-tailor a support package to fit your needs. Extended service coverage is available from 3 years or 300,000 miles or as much as 5 years or 500,000 miles.

And Everything Is Backed Up With A Parts And Service Organization Of Over 1300 Outlets In North America.

What Can You Expect From The Series 60?

Heavy-duty diesel engines produced in North America after October 1, 2002, must meet new emission standards. The proven Detroit Diesel Series 60 engine, newly-equipped with a simple EGR system, meets these new standards. The same design that has made the Series 60 the most popular engine with coach operators for the past decade will continue for years to come.

"Maintenance is a substantial savings."

The Series 60 Engine Will Continue To Provide Coach Operators With The Best Combination Of:

- **Performance**
- **Fuel Economy**
- **Reliability**
- **Low Cost Of Operation**
- **Proven Durability**
- **Driver Satisfaction**
- **High Residual Value**
- **Proven Electronics – DDEC**
- **Flexible Power Ratings**
- **Excellent Parts And Service Support**
- **Exhaust Gas Recirculation**

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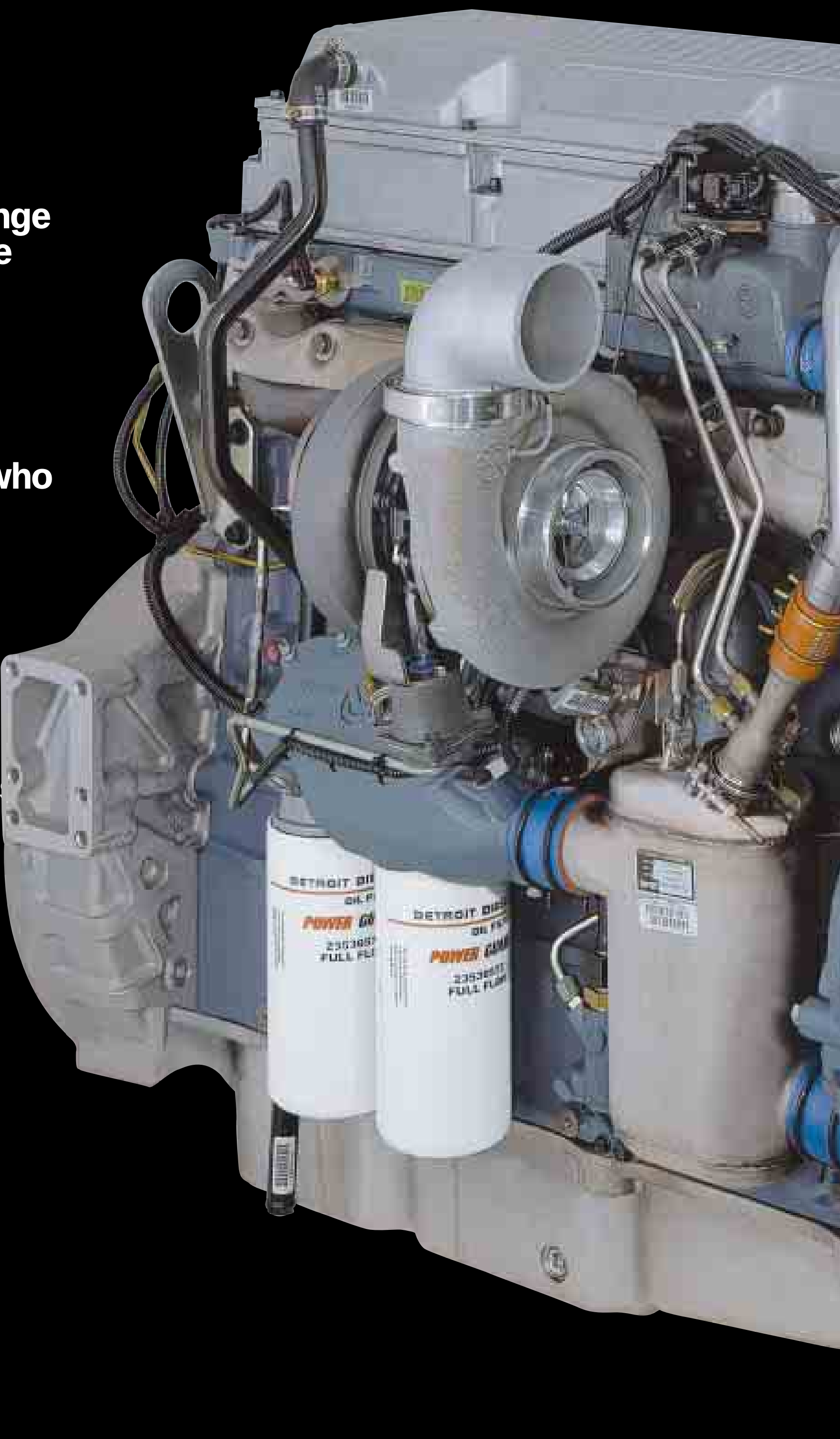
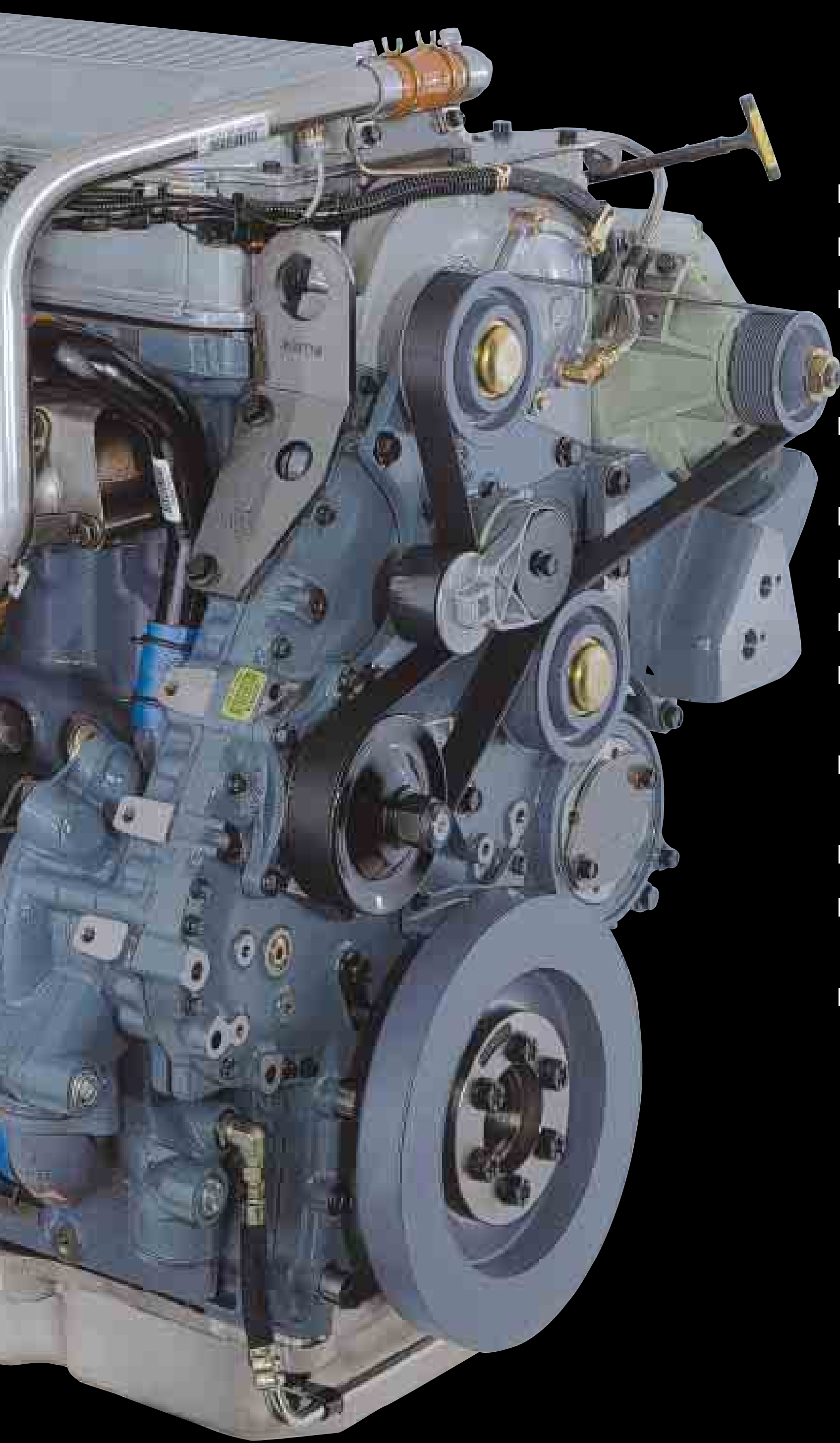
Series 60 24-Hour Hotline

Why Should Series 60

- A complete power range in a common package
- Easy to change horsepower settings
- The choice of the top fleets
- The choice of those who want big power
- Lightweight
- Low cost per mile
- Unaided cold starts to 20º F
- DDEC-controlled automatic Ether Start to –30º F
- Maximum revenue



You Buy A Engine?



- Simple design
- Easy to service
- Dozens of DDEC features as standard equipment
- The complete DDEC System
- ProDriver® DC
- Data Summaries
- Optimized Idle®
- Fuel Economy Incentive
- 1-800-445-1980 direct line to support
- Customized warranties
- Service throughout North America
- Diagnostic Link

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6SA0581 0401 As technical advancements continue, specifications may change. Printed in U.S.A.

CONTENTS

ILLUTRATIONS

1. FUEL SYSTEM DESCRIPTION

Figure 1 shows a schematic of the fuel system. Fuel is drawn from the fuel tank through a manual shut-off valve, a primary fuel filter or a fuel filter/water separator (optional) before it enters the fuel pump. If the vehicle is equipped with the optional “Davco Fuel Pro 382”, it is designed to be the only fuel filter in the system, no secondary fuel filter is necessary. Leaving the pump under pressure, the fuel flows through a secondary fuel filter and a shut-off valve, then to the cylinder head. The fuel reaches the injectors in the cylinder head through passages within the head. Excess fuel exits at the rear of the head just above the inlet, through a restrictive return fitting which maintains fuel pressure in the system. Finally, the fuel flows through the check valve and the fuel cooler before it returns to the fuel tank.

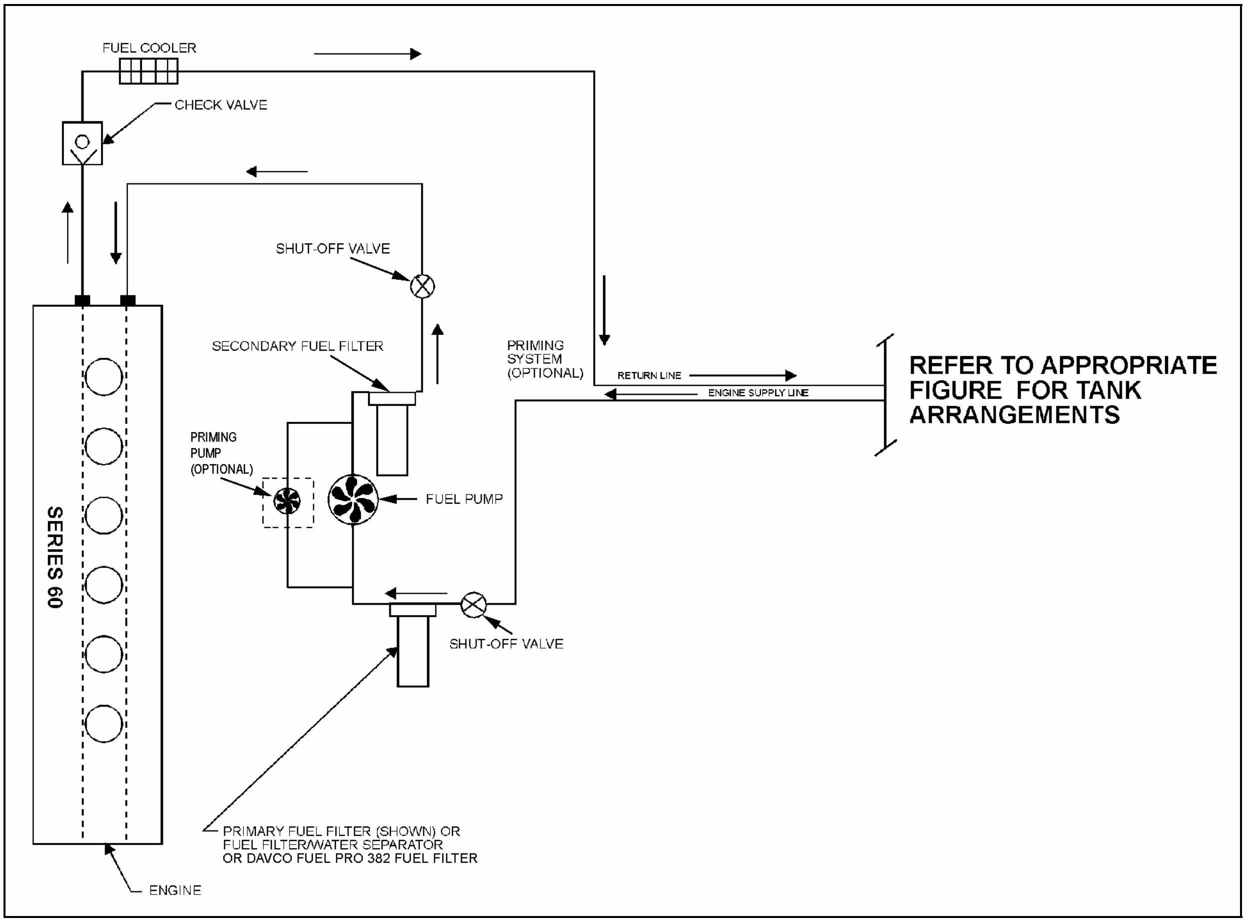


FIGURE 1: FUEL SYSTEM SCHEMATIC 03067

2. 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.

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.

3. FUEL VALVES

Manual shut-off valves on engine fuel-supply line are located on the R.H. side of engine compartment (Fig. 2). A manual shut-off valve is located at the inlet side of the primary fuel filter (fuel filter/water separator, if vehicle is so equipped) under the starter. Another manual shut-off valve is located at the outlet side of the secondary fuel filter, under the air compressor.

4. FILTERS AND WATER SEPARATOR

The fuel system is equipped with primary and secondary fuel filters for additional protection of the injectors. A fuel-filter/water-separator may be installed in primary fuel-filter location, to prevent water infiltration in engine fuel system (Fig. 2). It should be drained periodically, or when the water separator telltale light on the dashboard illuminates.

To drain, loosen positive seal drain valve below separator, and tighten after water has been flushed out.

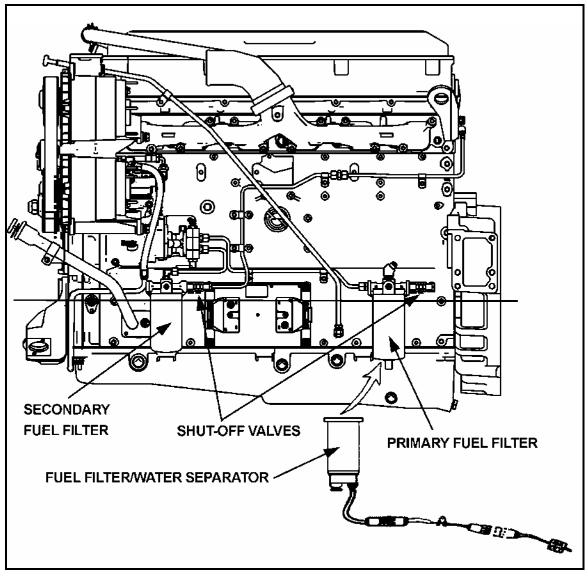


FIGURE 2: MANUAL SHUT-OFF VALVES 03060

NOTE

The operating conditions and cleanliness of type of fuel used determine the service intervals of the filter/water separator element and the secondary fuel filter cartridge.

4.1 FUEL FILTER/WATER SEPARATOR SERVICING

The fuel filter/water separator is located on the starter side of the engine, below the starter. The water separator must be drained periodically or when the telltale light on the dashboard illuminates.

Replace the water separator element as follows:

1. Drain the fuel filter/water separator as stated previously.
2. With engine "OFF" and engine fuel supply line valves closed; remove the filter element/bowl assembly from cover (for valve location, see *"3. FUEL VALVES"* in this section).
3. Separate bowl from filter element. Clean bowl and O-ring groove.

NOTE

Bowl is reusable, do not discard.

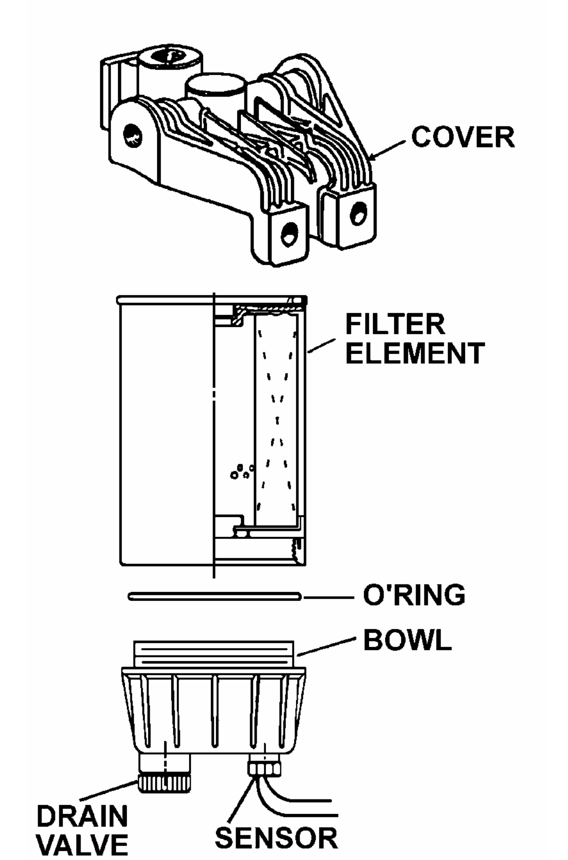


FIGURE 3: FUEL FILTER/WATER SEPARATOR 03025

4. Lubricate O-ring with clean diesel fuel or motor oil and place it in bowl groove.
5. Screw new filter element onto bowl snugly by hand.

> **CAUTION**
>
> Do not use tool to tighten. Tighten by hand only.

6. Lubricate filter seal with clean diesel fuel or motor oil.

> **CAUTION**
>
> If the water separator continuously requires draining, it is possible that water or sediment has accumulated in the fuel tank. To correct this situation, open the drain plug under the tank when the fuel gauge indicates tank is 1/4 full in order to drain any contaminant.

7. Fill filter element/bowl assembly with clean diesel fuel and attach onto cover. Hand tighten an additional 1/3 to 1/2 turn after making full seal contact.
8. Open valves of the engine fuel supply line.
9. Run the engine and check for leaks.

4.2 FUEL FILTER SERVICING (PRIMARY AND SECONDARY)

The primary and secondary fuel filters are located on the R.H. side of the engine. The primary filter is located below the starter, and the secondary fuel filter is below the air compressor. They are of a spin-on type and must be replaced every 12,500 miles (20 000 km) or once a year, whichever comes first. The primary fuel filter is equipped with a positive seal drain-valve to prevent water infiltration in engine fuel system. To drain, loosen positive seal drain-valve below filter and tighten after water has been flushed out.

A method of determining when filters are clogged to the extent that they should be changed is based on the fuel pressure at the cylinder head fuel inlet fitting and the inlet restriction at the fuel pump. In a clean system, the maximum pump-inlet restriction should not exceed 6 inches of mercury (20.3 kPa) and must not exceed 12 inches of mercury (41 kPa) with a dirty system.

At normal operating speeds and with the standard 0.080" restriction fittings, the fuel pressure at the cylinder head inlet is 50-75 psi (345-577 kPa). Change the fuel filters whenever the inlet restriction at the fuel pump reaches 12 inches of mercury (42 kPa) at normal operating speeds. Also, change whenever the fuel pressure at the cylinder head inlet fitting falls to the minimum fuel pressure given above.

Change the filter cartridge(s) as follows:

> *NOTE*
>
> *Use a suitable band wrench or filter wrench, such as J22775, to remove the filters.*

1. Stop engine, shut off the engine fuel supply line valves (for valve location, See *"3. FUEL VALVES").* Unscrew and discard filters.
2. Fill new filter replacement cartridge(s) with clean fuel oil, about two thirds (2/3). Apply a thin coat of clean fuel oil on gasket.

3. Install new filters. Tighten until filter is snug against the gasket, with no side movement. Rotate an additional 1/2 turn by hand.
4. Open engine fuel supply line valves.

⚠ CAUTION
Mechanical tightening of the fuel filters is not recommended and may result in seal and/or cartridge damage. Tighten the fuel filters by hand only.

5. Start the engine and check for leaks.

NOTE
There is a fuel system shut-off valve on the discharge side of the secondary fuel filter. This check valve is designed to prevent fuel loss at time of filter replacement.

4.3 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 4).

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. Change filter when fuel level reaches the top of filter element (refer to figure 5).

Filter renewal:

1. Stop engine;
2. Drain fuel by opening the drain valve;
3. Untighten upper collar, remove cover;
4. Replace filter element;
5. Check O-Rings and components for wear;
6. Replace cover, hand tighten collar;
7. Pour fuel up to bottom of filter element through spin off cap located on top of cover.
8. Start engine, raise rpm for 2-3 minutes, hand tighten collar again.

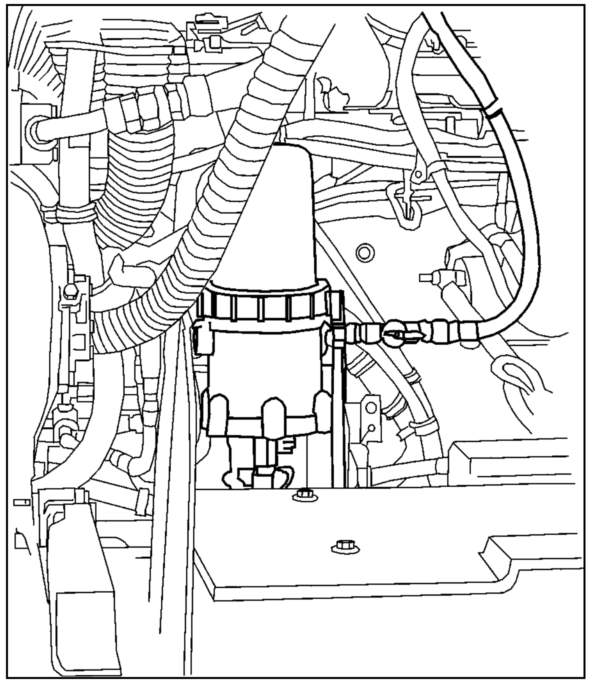


FIGURE 4: DAVCO FUEL PRO 382 FUEL FILTER 03032

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.

4.4 PREHEATER FUEL FILTER

The preheater fuel filter is located above the preheater, in the L.H. side rear service compartment. Replace the filter every 50,000 miles (80 000 km) or once a year, whichever comes first.

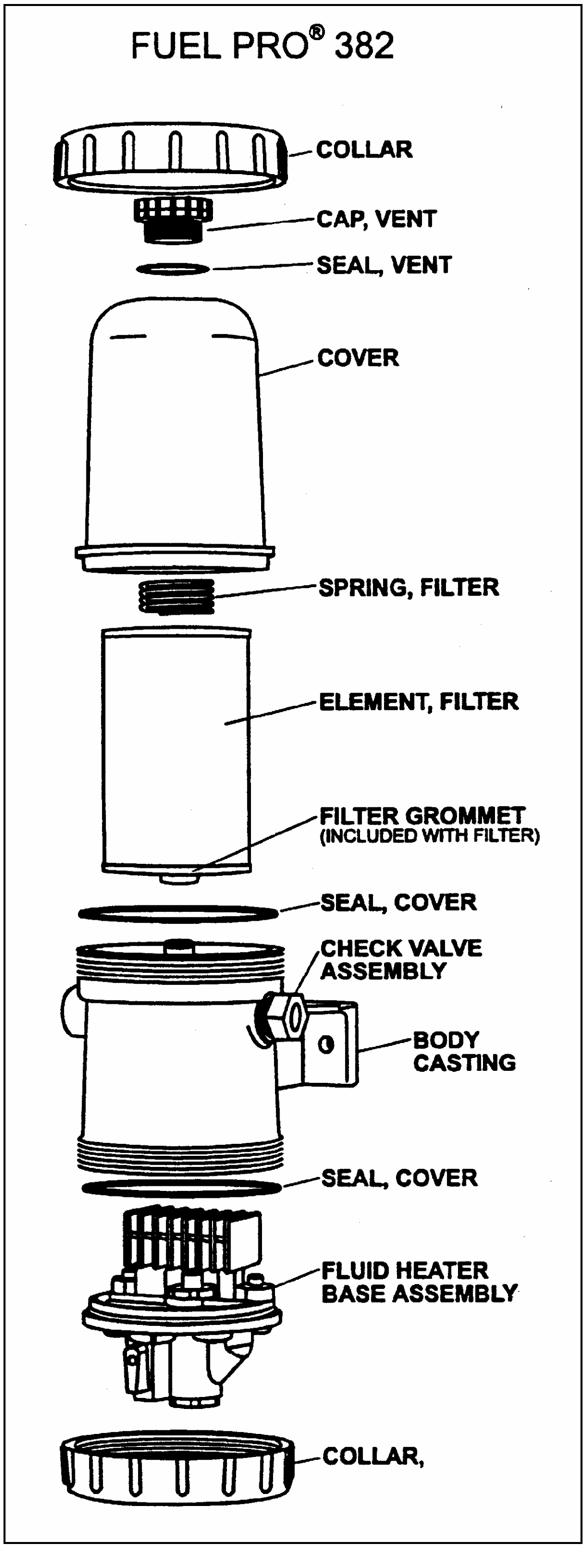


FIGURE 5: DAVCO FUEL PRO 382 EXPLODED VIEW 03034

5. FUEL TANK

All XLII series motorhomes are equipped with a high-density cross-link polyethylene fuel tank. W0 and WE vehicles fuel tanks have a total capacity of 250 US gallons (945 liters) while W5 can be equipped with an optional 90 US gallons (341 Liters) auxiliary stainless steel tank forward of the standard 208 US gallons (787 liters) fuel tank. The main tank is located just forward of the rear baggage compartment, between the A/C condenser and evaporator. The auxiliary tank is located in the baggage compartment just forward of the main tank.

On all vehicles, fuel filling access doors on both sides of vehicle (with the exception of W0) provide direct access to filler necks; offering the added advantage of refueling from either side of vehicle.

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(s).

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(s).

For vehicles equipped with a transverse tank or an auxiliary tank, drain it as well since it is directly connected to the main tank.

NOTE
It is possible to drain both tanks through only one plug, but the other tank will not drain completely since the connecting hose is not on the bottom.

5.1.1 Main Fuel 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. If applicable, unscrew clamps retaining L.H. side filler tube to the fuel tank, then disconnect tube and remove it.
3. Unscrew clamps retaining R.H. side filler tube to fuel tank and filler neck. Disconnect tube and remove it.
4. If applicable, unscrew preheater supply line, preheater return line, auxiliary return line and/or auxiliary return line from fuel tank connection-panel.
5. Unscrew engine supply and return lines from fuel tank connection-panel, identify them for reinstallation.

NOTE
For vehicles equipped with a transverse tank or an auxiliary tank, the two hoses joining the tanks should be disconnected.

6. 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.

7. 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.
8. 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.
9. Carefully remove tank from under the vehicle.

5.1.2 Auxiliary Fuel Tank (if so equipped)

1. Open the baggage compartment just forward of condenser compartment, disconnect the (2) hoses previously joining the tanks.
2. From underneath vehicle, unscrew the two (2) bolts retaining the tank strap (one on each side).
3. From inside the baggage compartment just forward of condenser compartment, slightly raise the strap and pull out auxiliary fuel tank using the same care as for the main fuel tank.

CAUTION
Protective cushions or rags should be placed on the baggage compartment floor to prevent it from being scratched by the fuel tank during removal.

5.1.3 Transverse Fuel Tank

1. The transverse fuel tank must be removed from R.H. side. The stainless steel panel must be removed by first removing the adhesive.
2. From underneath the vehicle, unscrew the bolt on left and right hand side securing the tank foot. Unscrew the two screws at the center of the tank then disconnect the two hoses previously joining the tanks.
3. Unscrew clamps retaining L.H. side filler tube to the fuel tank, then disconnect tube and remove it.
4. Unscrew clamps retaining R.H. side filler tube to fuel tank and filler neck. Disconnect tube and remove it.
5. Remove plastic molded panel from inside baggage compartment located forward of A/C & Heating compartment.
6. Slide the tank out carefully.

5.2 TANK INSTALLATION

To install Main, Auxiliary and Transverse Fuel Tanks, simply reverse the *"Tank Removal"* procedure.

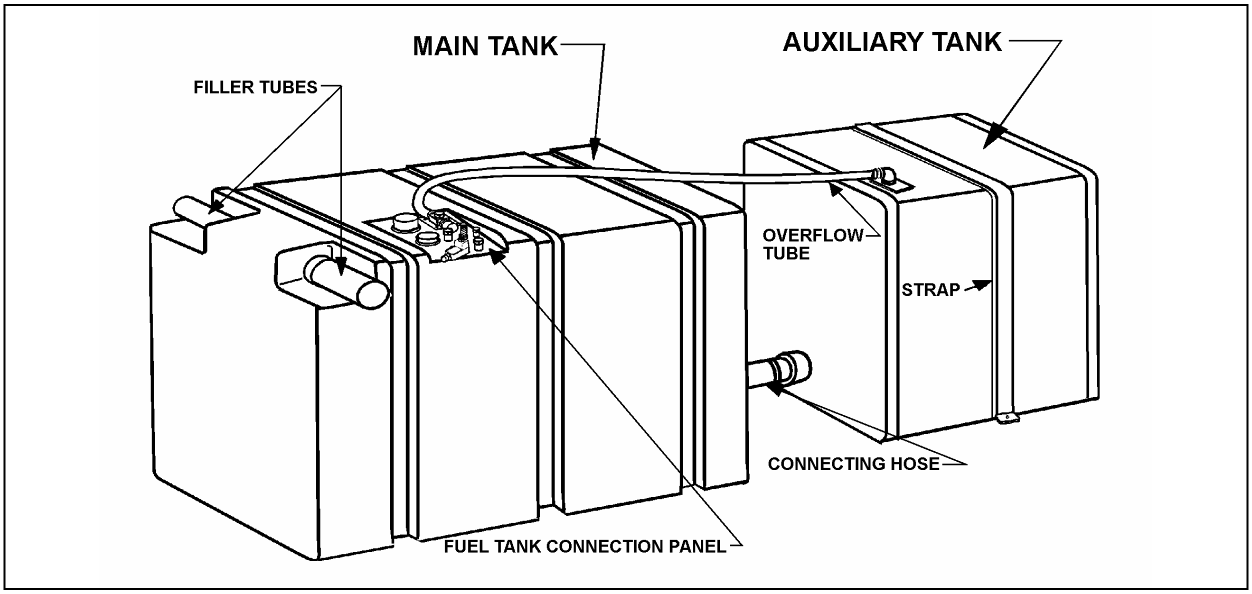


FIGURE 6: 208 US GAL. MAIN FUEL TANK & 90 US GAL. AUXILIARY FUEL TANK (OPTIONAL) (W5) 03028

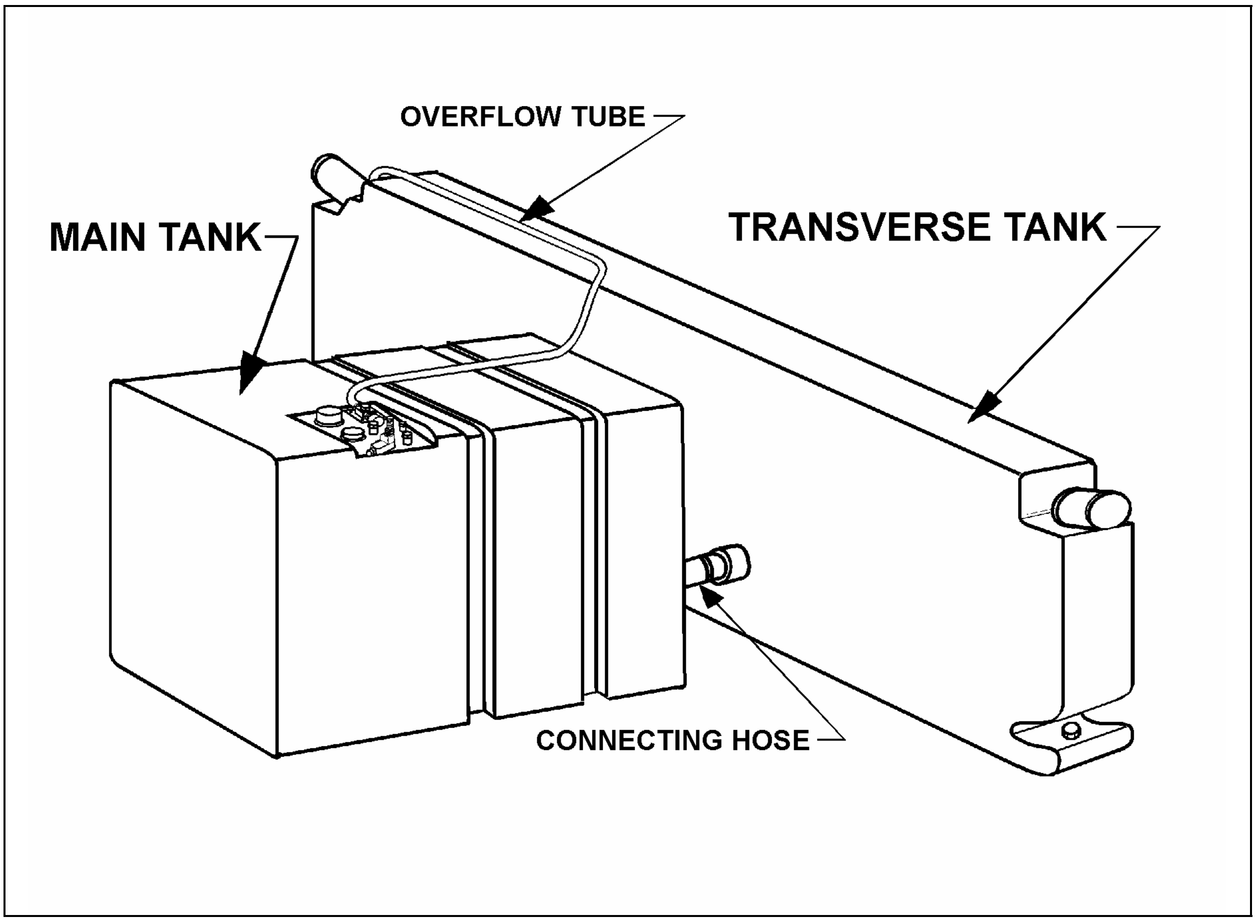


FIGURE 7: 250 US GALLONS FUEL TANKS (MAIN TANK & TRANSVERSE FUEL TANK) (W0 & WE) 03029

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.

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

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 (Prévost #5001244) into anchor nut (Prévost #500331).
5. Place assembly in drill hole. Tighten screw by 10 complete turns. Refer to Fig. 8.

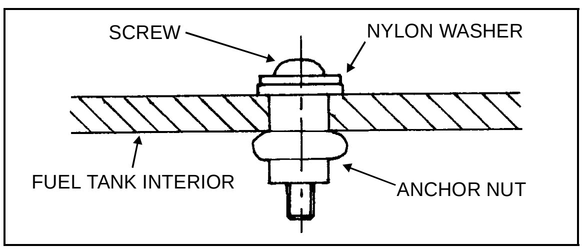


FIGURE 8: FUEL TANK REPAIR 03014

6. Apply sealant on head plug (Prévost #507300) and seal hole with the head plug.

6. PRIMING FUEL SYSTEM

The problem with restarting a diesel engine that has run out of fuel, is that after the fuel is exhausted from the tank, it is pumped from the primary fuel filter or the fuel filter/water separator (if vehicle is so equipped), and sometimes partially removed from the secondary filter. This results in an insufficient fuel supply to sustain engine firing. The primary fuel filter or fuel filter/water separator and secondary filter must be free of air in order for the systems to provide adequate fuel for the injectors. When the engine runs out of fuel, the following operations must be performed before restarting:

Fill fuel tank with the recommended fuel oil. If only partial filling is possible, add a minimum of 10 gallons (38 liters) of fuel.

* If the vehicle is equipped with a Fuel Pro 382 fuel filter/water separation, pour fuel through spin on cap as per "4.3 DAVCO FUEL PRO 382".
* If the vehicle is equipped with an optional priming pump **(**see Figure 9).

Press the priming switch, located in the engine compartment on the rear start panel. Start the engine and check for leaks.

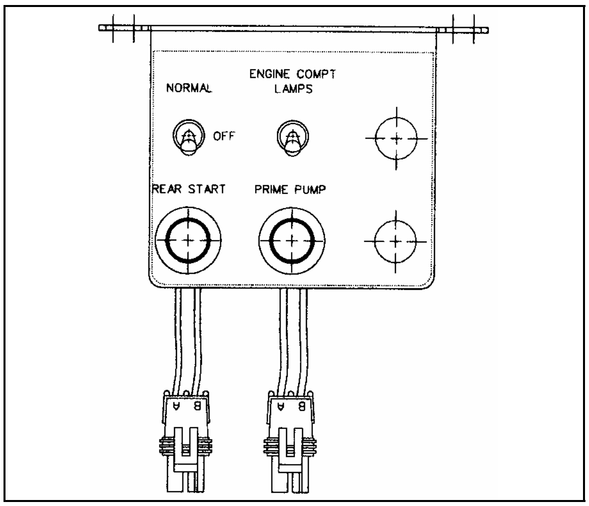


FIGURE 9: PRIME PUMP SWITCH LOCATION 06622

If the vehicle is not equipped with a priming pump:

1. Unscrew the cap on the priming valve located on the secondary filter;
2. Direct fuel under pressure 25 psi (172 kPa) to the priming valve using a quick coupling;
3. Start the engine and check for leaks.

7. FUEL PUMP INSTALLATION

The fuel pump is driven off the rear of the air compressor.

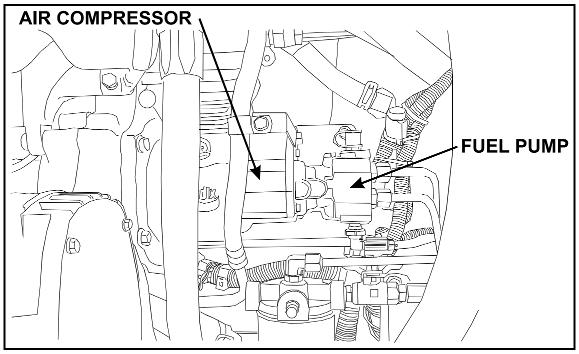


FIGURE 10: FUEL PUMP LOCATION 03053

1. If removed, install inlet and outlet fittings in the cover of the fuel pump.

NOTE
New fittings have sealant already applied. When reusing fittings, coat the threads lightly with Locktite Pipe Sealant, Detroit Diesel number J 26558-92, or equivalent, before installing. To prevent sealant from entering fuel system, do not apply to the first two threads of the fitting. Do not use Teflon tape or paste on the fittings.

2. Install drive coupling in drive hub of the fuel pump. Install a new gasket to the mounting flange of the pump.
3. Index the drive coupling with the drive hub on the end of the air compressor crankshaft and align the pump mounting bolt holes with those in the air-compressor rear cover.

NOTE
When correctly positioned, the outlet fitting on the pump should be in approximately an 8 o'clock position when viewed from the rear, and the drain opening in the pump body facing down.

4. Seat the fuel pump squarely against the air compressor. Pilot the flange on the pump body, in the opening in the rear cover of the compressor. Install three mounting bolts and tighten them to 22-28 Lbf-ft (30-38 Nm).
5. Connect the fuel inlet and outlet lines to the fuel pump and tighten.
6. Prime engine fuel system before starting engine to ensure pump seal lubrication and prompt engine starting.

8. FUEL OIL 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 fuel oil should meet ASTM designation D 975. Grade 1-D is recommended, however grade 2-D is acceptable.

NOTE
These fuel grades are very similar to grade DF-1 or DF-2 of Federal Specifications VV-F-800. For detailed fuel recommendations, refer to publication "Engine Requirements-Lubricating Oil, Fuel, and Filters" #7SE270 available from Detroit Diesel Distributors.

9. 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 (2) two intake ducts located just above engine side doors. 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).

9.1 PRE-CLEANER SERVICING

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.

9.2 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.

9.3 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.

9.4 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.

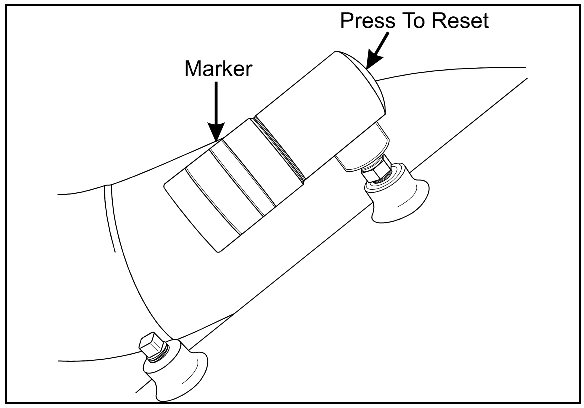


FIGURE 11: RESTRICTION INDICATOR 01052

10. FUEL COOLER

The fuel cooler serves to cool the surplus diesel fuel after it has exited the cylinder head, on its way back to the fuel tank. It is accessible through the engine radiator door, and it is located just in front of the coolant radiator (Fig. 12).

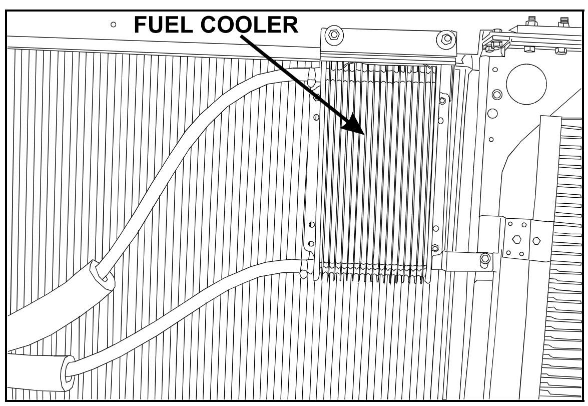


FIGURE 12: FUEL COOLER LOCATION 03054

11. 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.

11.1 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.

11.2 POTENTIOMETER REPLACEMENT

1. Disconnect cable harness connector.

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. Loosen the two screws and remove potentiometer. Retain for re-assembly.
3. Discard potentiometer (Fig. 13).
4. 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. 13) and tighten just enough to secure potentiometer lightly. Tighten screws to 10 - 20 Lbf-in (1.5 - .2 Nm).
5. 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.

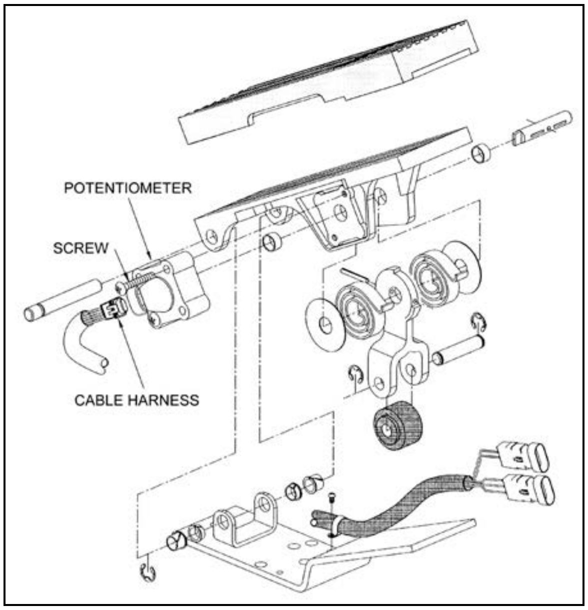


FIGURE 13: ELECTRONIC FOOT PEDAL ASSEMBLY 03035

12. SPECIFICATIONS

Davco FuelPro 382 Fuel Filter / Water Separator Element

Supplier number 23521528
Prévost number 531437

Primary Fuel Filter / Water Separator (optional)

(May be used instead of primary filter (never use with a primary filter).
Make .... Racor
Type .... Spin-on

<u>ELEMENT</u>
Supplier number .... S 3202
Prévost number 531390

<u>BOWL</u>
Supplier number RK30051
Prévost number 531389

<u>DRAIN VALVE AND SEAL</u>
Supplier number RK30058
Prévost number 531397

<u>O-RING</u>
Supplier number RK30076
Prévost number 531398

<u>PROBE/WATER SENSOR</u>
Supplier number RK21069
Prévost number 531391

Primary Fuel Filter

Make .... AC
Type .... Spin-on
Filter No. T-915D
Service Part No. 25014274
Prévost number 510137
<u>OR</u>
Service Part No (Type with Water Separator) 23512317
Prévost number 531407
Element torque .... 1/2 turn after gasket contact

Secondary Fuel Filter

Make .... AC
Type .... Spin-on
Filter No. T-916D
Service Part No. 25014342
Prévost number 510128
Element torque .... 1/2 turn after gasket contact

Fuel tank(s) Capacity (ies)

Standard (W5) .... 208 US gallons (787 liters)
Standard (W0 & WE) .... 250 US gallons (945 liters)
Optional (W5) .... 90 US gallons (341 liters)

Air Cleaner

Make .... Nelson
Prevost Number 530206
Service Part No 7182 8N
Supplier number (element cartridge) 70337N
Prévost number (element cartridge) 530197

Air Cleaner Restriction Indicator

Make .... Donaldson
Model RBX00-2220
Indicates .... at 20" (508 mm) of water
Prévost number 530161

Fuel Cooler

Make .... Berendsen
Supplier number DB-1240
Prévost number 950109

CONTENTS

ILLUSTRATIONS

1. DESCRIPTION

The muffler is rubber mounted on the vehicle frame. This feature reduces the transmission of vibrations to the muffler thus resulting in extended life of muffler, brackets and other components.

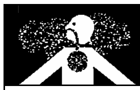
2. MAINTENANCE

The exhaust system should be inspected periodically for restrictions and leaks. The exhaust systems are shown on figures 1 & 2 (fig. 1 = W0 & WE and fig. 2 = W5). Restrictions such as kinked or crimped pipes result in excessive back pressure that can lead to increased fuel consumption, power loss, and possible damage to engine combustion chamber components. Exhaust leaks are commonly the result of loose clamp bolts, corroded pipes, or a punctured muffler. In addition to objectionable noise, a leaking exhaust system could allow toxic gases to enter the vehicle. Inspect the exhaust system as follows:

* At vehicle inspection intervals ;
* Whenever a change is noticed in the sound of the exhaust system ; and
* 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.

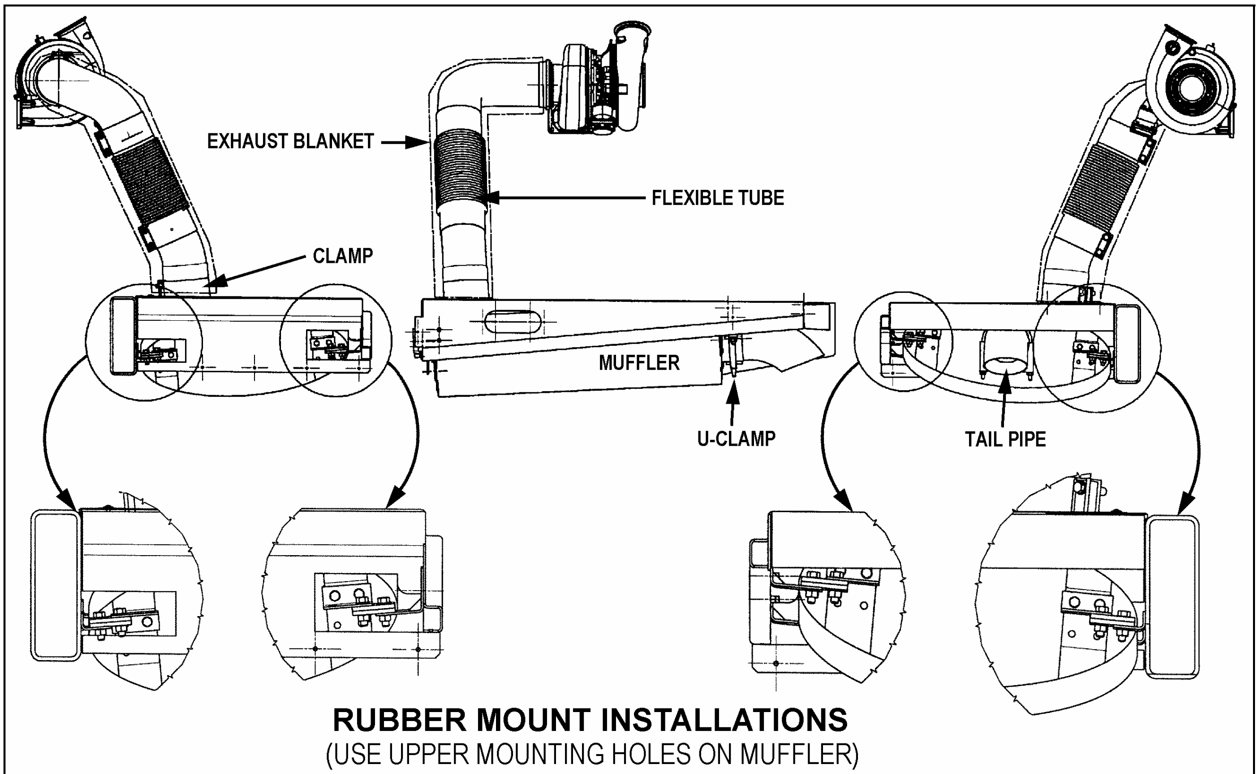


FIGURE 1: EXHAUST SYSTEM INSTALLATION- (W0 & WE) 04012

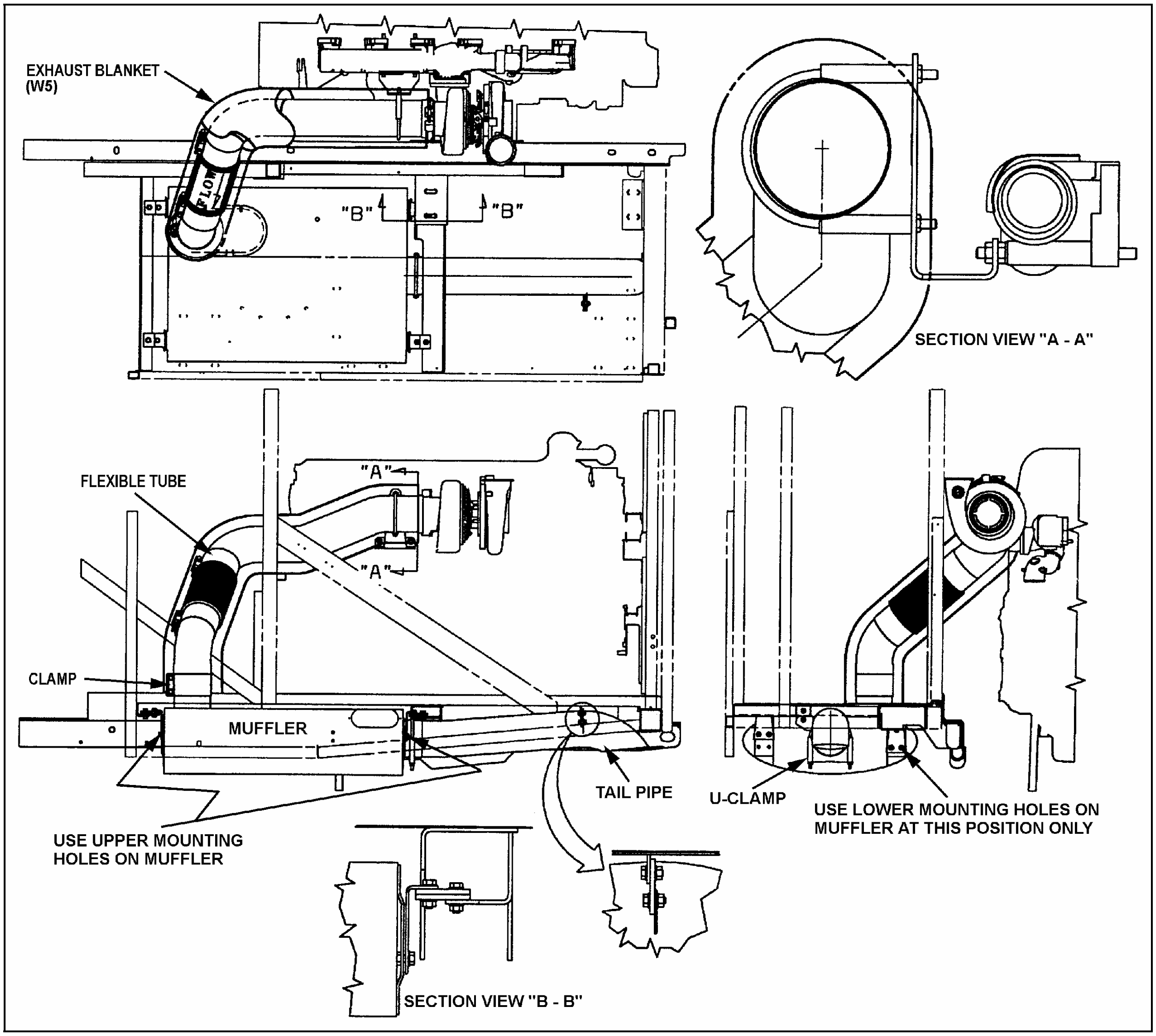


FIGURE 2: EXHAUST SYSTEM INSTALLATION (W5) 04013

3. MUFFLER REMOVAL & INSTALLATION

WARNING

Make sure that muffler and components are cold before handling.

1. Remove bolts and clamps securing exhaust pipe bellows to the muffler.
2. Support the muffler from underneath vehicle.
3. Remove U-clamp retaining the tail pipe to the muffler.
4. Remove bolt holding the tail pipe to the frame bracket.
5. Remove the tail pipe.
6. Remove the fasteners holding the four rubber mounts to the frame brackets.
7. Remove the fasteners securing the rubber mounts to the muffler brackets.
8. Remove rubber mounts then muffler from underneath vehicle.
9. Remove parts which are attached to the muffler such as brackets and collar.
10. Inspect and replace parts if necessary. Reinstall parts on the new muffler.

For installation, reverse the removal procedure.

WARNING

Check connections for tightness and fasteners for proper assembly.

4. FLEXIBLE TUBE INSTALLATION

The flexible exhaust tube contains an inside rigid pipe. To allow appropriate flexibility for assembly, make sure that the rigid pipe is concentric to the flexible part.

To maintain the pipe centered at the time of installation, cardboard spacers must be inserted at four places at equal distance around tubing (Fig. 3). These spacers may be left in place and will deteriorate over time.

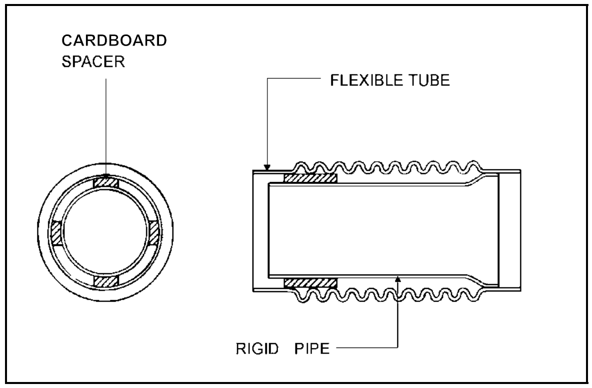


FIGURE 3: FLEXIBLE TUBE INSTALLATION 04003

5. BUS SHELLS HEAT BLANKETS

5.1 EXHAUST

5.1.1 Installation on W5 Bus Shells

1. Remove L.H. side tag axle wheel.
2. Locate splash guard panel located at rear of vehicle (behind L.H. side tag axle wheel), then remove, cover bellows and exhaust pipe with 2-piece blanket #040553 (Fig. 4). Use velcro to secure blanket in place.

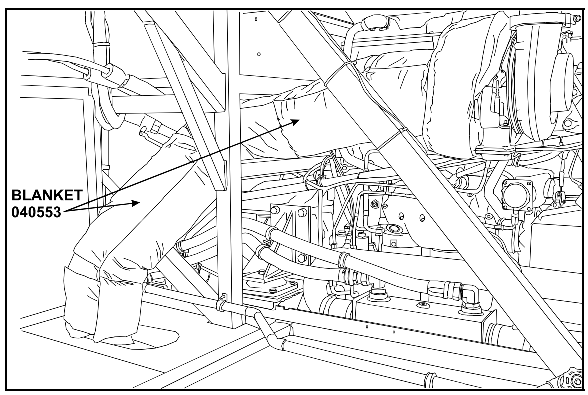


FIGURE 4: EXHAUST BLANKET INSTALLATION 04009

5.1.2 Installation on W0 & WE Bus Shells

1. Remove L.H. side tag axle wheel.
2. Locate splash guard panel located at rear of vehicle (behind L.H. side tag axle wheel), then remove, cover bellows and exhaust pipe with 2-piece blanket #040565. Refer to figure 4 showing installation on W5 shells. Use velcro to secure blanket in place.

CONTENTS

ILLUSTRATIONS

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 (Fig. 1).

Two full blocking-type thermostats are 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.

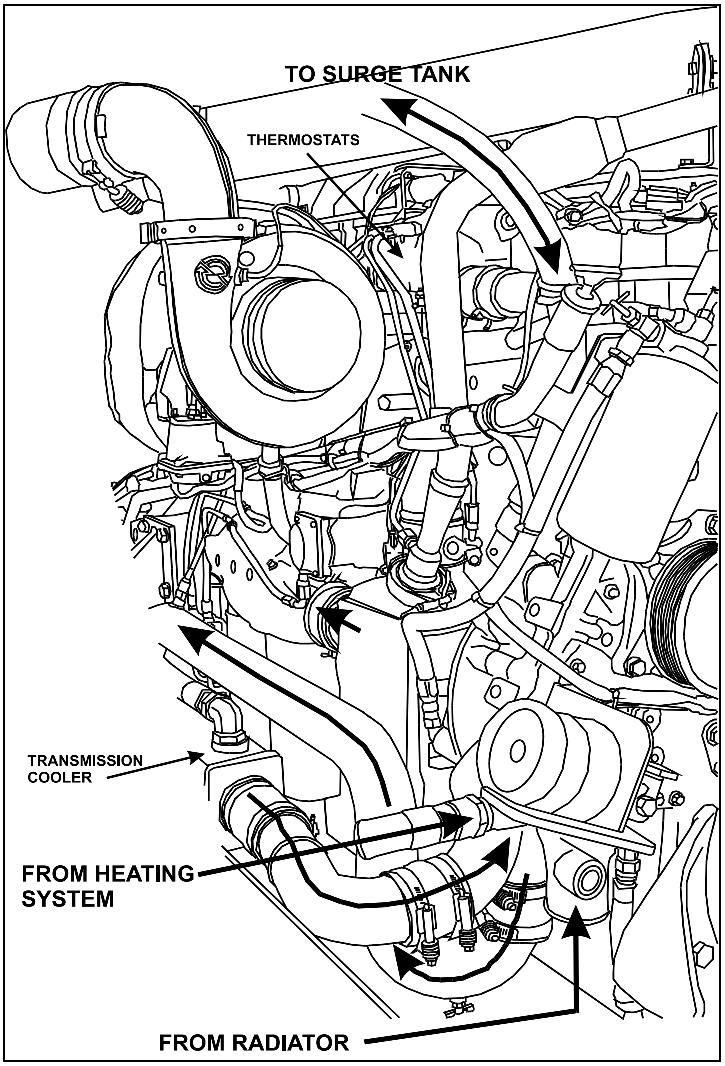


FIGURE 1: COOLING SYSTEM 05087

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 thermostats direct 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 thermostats are completely open, all of the coolant flow is to the radiator inlet.

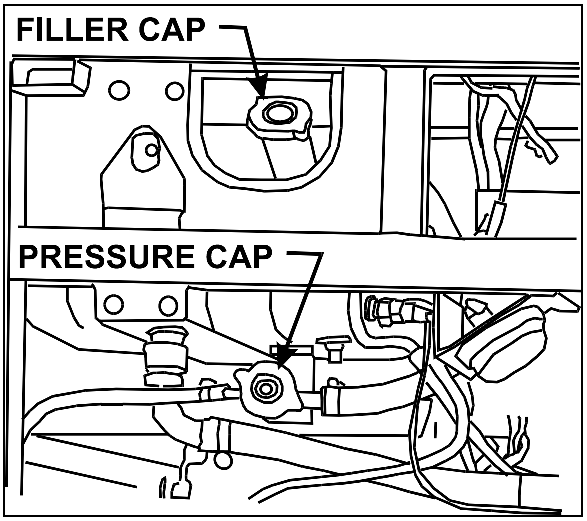


FIGURE 2: SURGE TANK - ENGINE COMP'T 05079

The cooling system is filled through a filler cap on the surge tank (Fig. 2). A pressure cap underneath the surge tank is 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. 2). Two thermostats are located in the housing attached to the right side of the cylinder head (Fig. 1). Furthermore, a water temperature sensor mounted on the cylinder head (radiator side) is also supplied for engine protection purposes.

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.

2. MAINTENANCE

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

- o Check coolant level in the surge tank daily, and correct if required. Test antifreeze strength.
- o Maintain the prescribed inhibitor strength levels as required. Coolant and inhibitor concentration must be checked at each oil change, every 12,500 miles (20 000 km) or once a year, whichever comes first to ensure inhibitor strength. For vehicles equipped with coolant filters replace precharge element filter with a maintenance element filter as per *"COOLANT FILTER"* in this section. If the vehicle is not equipped with a filter, add the recommended inhibitor concentration to the antifreeze/water solution.
- o Drain, flush, thoroughly clean and refill the system every two years or every 200,000 miles (320 000 km), whichever comes first. For vehicle equipped with coolant filters, change the precharge element filter or the existing maintenance element filter for a new maintenance element filter. If the vehicle is not equipped with filters add the recommended inhibitor concentration to the antifreeze/water solution.

NOTE
Do not add inhibitors to the antifreeze / water solution if vehicle is equipped with a coolant filter.

Coolant must be discarded in an environmentally safe manner.

2.1 VEHICLES WITHOUT COOLANT FILTERS

Refer to Nalcool 3000 with Stabil-Aid bulletin annexed to the end of this section for preventive maintenance (at each oil change) and initial treatment instructions (each time the cooling system is drained and flushed).

2.2 VEHICLES WITH COOLANT FILTERS

Change the coolant precharge element filter for a maintenance element filter at initial oil change (see *"Specifications"* at the end of this section) and replace existing maintenance element filter with a new one as per *"COOLANT FILTER"* in this section. A precharge element filter must be installed each time the cooling system is drained and flushed prior to installing a maintenance element filter.

- o Check belts for proper tension; adjust as necessary and replace any frayed or badly worn belts.
- o 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.
- o Inspect the water pump operation. A leaky pump sucks in air, increasing corrosion.
- o Repair all leaks promptly. Unrepaired leaks can lead to trouble. Inspect and tighten radiator mounts periodically. Test and replace thermostats 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.

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

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.

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).

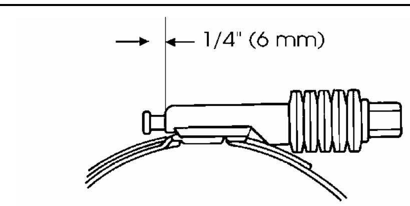


FIGURE 3: CONSTANT-TORQUE CLAMP 05037

CAUTION

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

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.**

4. COOLANT

4.1 COOLANT LEVEL VERIFICATION

Coolant level is correct when cold coolant is visible through the surge tank sight glass (Fig. 4). If coolant level is low, fill cooling system.

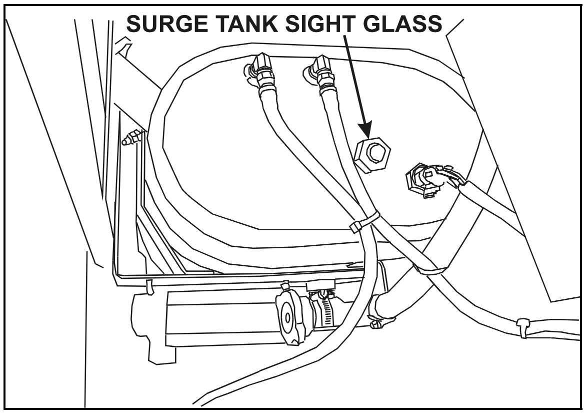


FIGURE 4: SURGE TANK SIGHT GLASS 05094

4.2 COOLANT LEVEL SENSOR

This warning device consists of a fluid level probe mounted on the surge tank. The probe sends a signal to the ECM 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 R.H. side of the surge tank while the electronic module is mounted inside the rear electric junction box.

4.3 THAWING COOLING SYSTEM

If the cooling system becomes frozen solid, place the coach in a warm area until the ice is completely thawed. 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.

4.4 COOLANT REQUIREMENTS

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.

Combining suitable water with reliable inhibitors satisfies the first five requirements. When freeze protection is required, a solution of suitable water and antifreeze containing adequate inhibitors will provide a satisfactory coolant fluid. Ethylene glycol-based antifreeze is recommended for use in Series 60 engines. The cooling system capacity is 24 US gal (91 liters).

NOTE

In general, antifreeze does not contain adequate inhibitors. For this reason, supplemental coolant additives are required.

For a complete overview of engine coolants used with Detroit Diesel Engines, refer to *"Coolant Selections"* For Engine Cooling Systems Guide at the end of this section (#7se298).

4.5 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.

Recommended phosphate free coolants: Detroit Diesel “DDC Power Cool” (P/N 23512138) or Prestone AF977 (bulk) Prevost #685125, 72702 (3.78 L), 70119 (205L), 70102 (4L).

A decal (052635) located on the surge tank provides information on recommended coolants.

4.6 INHIBITORS

A coolant solution, which has insufficient inhibitors or no inhibitors at all, invites the formation of rust, scale, sludge and mineral deposits within the cooling system. These deposits can cause water pump seal wear and coat the interior of coolant system passages. Heat transfer is reduced as deposits build up, leading to an overheating condition. Continued operation with this condition can lead to serious engine damage: liner scuffing, scoring, piston seizure and cylinder head cracking. These damages can occur quickly or over a longer period of time, depending of location and amount of deposits. Improperly inhibited coolants can become corrosive enough to "eat away" coolant passages and seal ring grooves and cause leaks to develop. Hydrostatic lock can occur if leak is internal and accumulates on top of a piston. The result may be a bent connecting rod. Cavitation erosion may occur in improperly inhibited coolants. Cavitation erosion is caused by the implosion of tiny bubbles against localized surfaces of the system. Such implosion causes pinpoint pressures high enough to erode pump impellers, cylinder liners and cylinder blocks. In extreme cases, their surfaces are so deeply pitted that they appear to be spongy, and holes can develop completely through them.

4.6.1 Inhibitor Test Procedures

Test Kits are commercially available to check engine coolant for nitrite concentration. Nitrite concentration is an indication of Supplemental Coolant Additive (SCA) level. Nitrite must be maintained within recommended levels. Coolant must be tested at each oil change to insure that inhibitor levels are maintained within the ranges shown hereafter:

NOTE

Above SCA values with Detroit Diesel #7se298 or TMC RP-329 “Type A”. Use Nalco Chemical Company nitrite test kits (CO-318). A factory coolant analysis program is available through Detroit Diesel distributors under part number 23508774.

DDC Fully Formulated Glycol Coolant Limits	
-30 -– 50(°F)	Freeze Point (°F)
125 -– 500 ppm	Boron (ppm)
800 -– 3200 ppm	Nitrite (ppm)
200 -– 750 ppm	Nitrate (ppm)
50 –- 250 ppm	Silicon (ppm)
0 ppm MAX	Phosphorus (ppm)
8.0 -– 11.0	pH
40 ppm MAX	Chlorides (ppm)
100 ppm MAX	Sulfates (ppm)

4.7 COOLANT RECOMMENDATIONS

1. Always use recommended antifreeze, inhibitor and water at proper concentration levels. A 50% coolant/water solution is normally used as factory fill. Antifreeze concentration over 70% is not recommended because of poor heat transfer capability, adverse freeze protection and silicate dropout. Antifreeze concentration below 30% offers little freeze, boilover or corrosion protection.
2. Use only ethylene glycol antifreeze meeting the Detroit Diesel #7se298 or TMC RP-329 “Type A” formulation.
3. Use an antifreeze solution year-round for freeze and boil-over protection. Seasonal changing of coolant from an antifreeze solution to an inhibitor/water solution is recommended.
4. Pre-mix coolant makeup solutions at proper concentrations before adding to the cooling system.
5. Maintain the prescribed inhibitor strength levels as required.
6. Do not mix different base inhibitor packages.
7. Always maintain proper coolant level.

CAUTION

Always test the solution before adding water or antifreeze.

8. If cooling system is not at the proper protection level. Mix coolant/water solution to the proper concentration before adding to the cooling system
9. Use only non-chromate inhibitors.
10. Distilled water is recommended.

4.7.1 Coolant Not Recommended

- o All antifreeze and coolant containing phosphorous;
- o Automotive type coolants;
- o Methoxy propanol-base antifreeze;
- o Methyl alcohol-base antifreeze;
- o Sealer additives or antifreezes containing sealer additives.

4.7.2 Additives Not Recommended

- o Soluble Oils;
- o Chromates.

WARNING

Never remove filler cap while coolant is hot. When coolant is at ambient temperature, release pressure from system by turning the pressure cap counterclockwise 1/4 turn; then remove filler cap slowly. A sudden release of pressure from the heated cooling system can result in severe burns from the expulsion of hot coolant fluid.

4.7.3 Vehicles Without Coolant Filters

Refer to Nalcool 3000 with Stabil-Aid bulletin annexed to the end of this section for preventive maintenance (at each oil change) and initial treatment instructions (each time the cooling system is drained and flushed).

4.7.4 Vehicles With Coolant Filters

Change the coolant precharge element filter for a maintenance element filter at initial oil changes (see Specifications at the end of this section) and replace existing maintenance element filter with a new one as per *"COOLANT FILTER"* in this section. A precharge element filter must be installed each time the cooling system is drained and flushed before installing a maintenance element filter.

NOTE

The coolant filter contains inhibitors.

5. DRAINING COOLING SYSTEM

Use the following procedures to drain the cooling system partially or completely.

5.1 VEHICLES EQUIPPED WITH CENTRAL HVAC SYSTEM

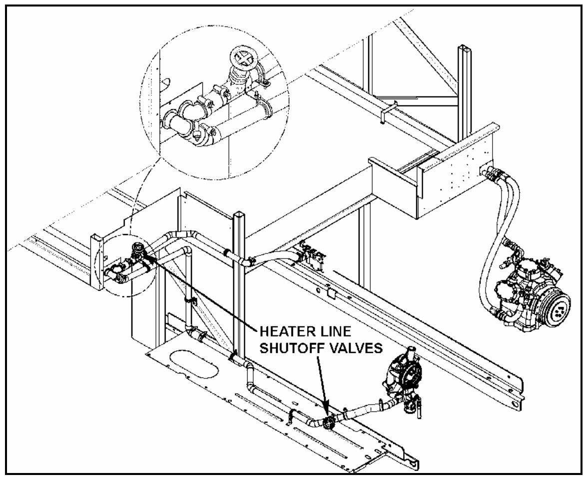


FIGURE 5: HEATER LINE SHUTOFF VALVES (W5)

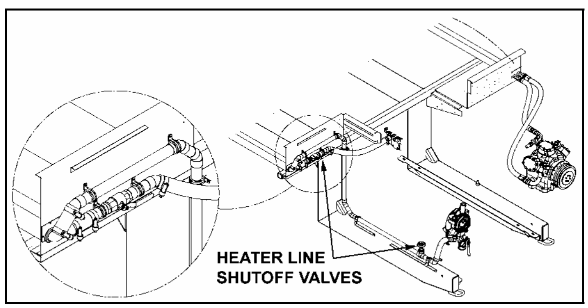


FIGURE 6: HEATER LINE SHUTOFF VALVES (W0 & WE)

5.2 VEHICLES EQUIPPED WITH SMALL HVAC SYSTEM

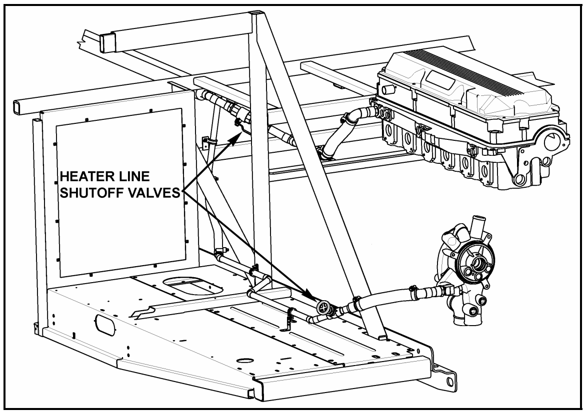


FIGURE 7: HEATER LINE SHUTOFF VALVES (W5)

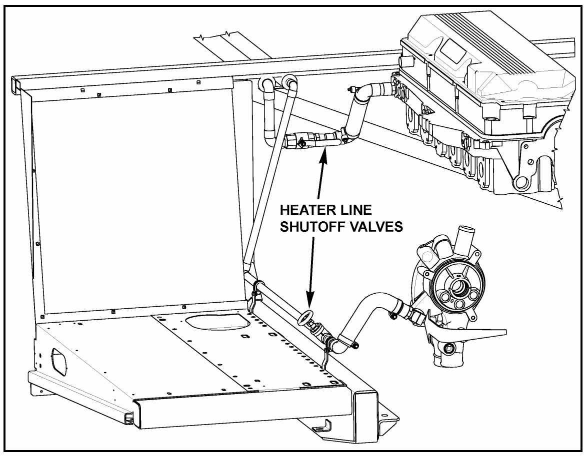


FIGURE 8: HEATER LINE SHUTOFF VALVES (W0 & WE)

To drain engine and related components:

1. Stop engine and allow engine to cool. Close both heater line shutoff valves (Refer to figures 5, 6, 7& 8)

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. Unscrew the surge tank pressure cap counterclockwise, ¼ turn to let air enter the system and permit the coolant to drain completely from system.
3. Unscrew the water pump housing inlet line drain plug (Fig. 10).
4. Open drain cock at bottom of thermostat housing to drain the coolant trapped above the thermostats (1, Fig. 9).

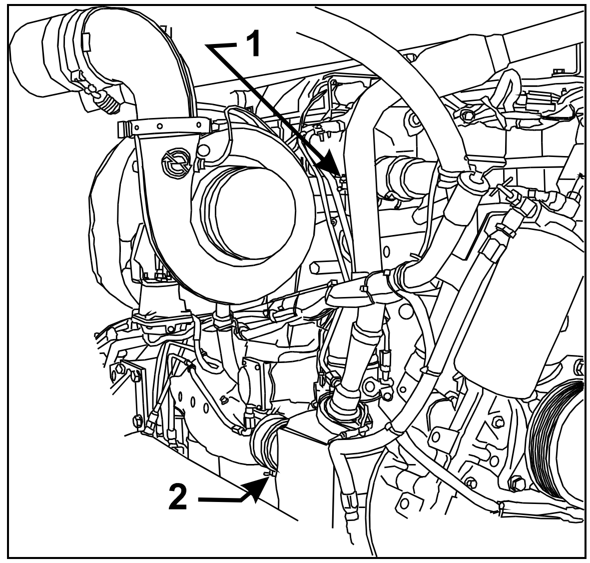


FIGURE 9: ENGINE COOLANT DRAIN COCKS 05088

5. Open the radiator drain cock.

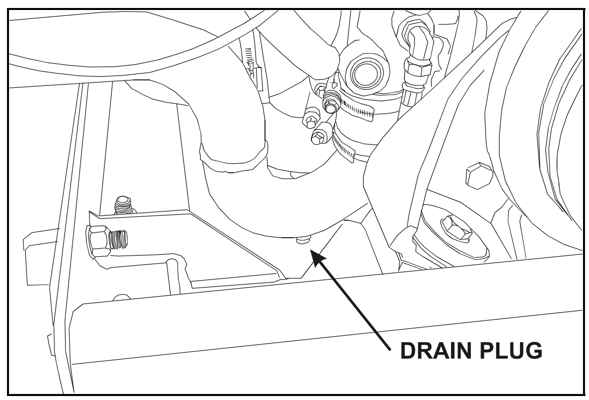


FIGURE 10: WATER PUMP DRAIN PLUG 05072

6. Open engine drain cock (2, Fig. 9).
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 *"11.1.1 or 11.2.1 Draining Heating System"* in Section 22.

6. 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 all drain cocks. Refer to draining procedure for the location of draining points.
2. Refill cooling system from the surge tank filler cap inlet with a recommended ethylene glycol-based antifreeze and water solution of the required concentration. Add Detroit Diesel selected product cooling system inhibitors (if required).

NOTE

The coolant level should remain within two inches of the surge tank filler neck.

NOTE

Make sure the vent line at top of thermostat housing is properly connected and not obstructed. The vent line (thermostat housing dome to radiator top tank) is required to ensure complete engine fill and proper venting of air in the system.

3. Install the filler and pressure caps, 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 light will flash

4. Stop engine and allow cooling.
5. 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 crack 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 *"11.1.3 Bleeding Heating System".*

7. 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:

Replace the coolant filter with a precharge element filter; in this case do not mix inhibitors with antifreeze/water solution.

Dispose of spent fluids in an environmentally responsible manner according to regulations in effect in your area.

7.1 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.

7.2 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.

8. 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 located beside the belt tensioning arm (Fig. 11).

The precharge element filter lasts for 12,500 miles (20 000 km) or one year, whichever comes first. Replace the precharge element filter with a maintenance element filter, which lasts for 200,000 miles (320 000 km) or two years, whichever comes first. Each time the coolant is renewed, a precharge element filter must be installed before installing a maintenance element filter.

NOTE
If a coolant filter is to be installed on an engine already in service, drain and flush the cooling system before installing the filter.

To replace a filter:

1. Close the two filter shutoff cocks 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.

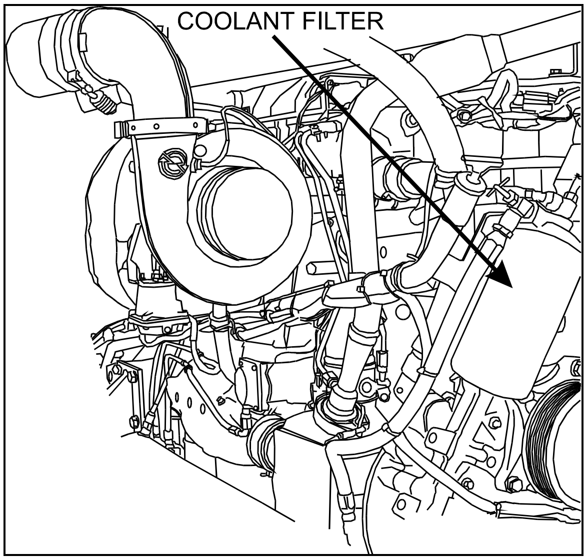


FIGURE 11: COOLANT FILTER 05089

3. Clean the filter adapter with a clean, lint-free cloth.
4. Coat surface of gasket with oil, tighten 2/3 to 1 turn after gasket makes contact with head.
5. Open the two filter shutoff cocks.
6. Start engine and check for leaks.

CAUTION

Do not exceed recommended service intervals.

9. 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.

9.1 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.

10. VARIABLE SPEED RADIATOR FAN

The radiator fan has two thermostatically controlled speeds. The ECM controls the speed by comparing data from engine coolant temperature, charge air cooling temperature, engine oil temperature, A/C condenser temperature, transmission retarder state, manual switch to a set of calibration data. Once fan switches to a state, it stays at that state for 30 seconds long before changing, to reduce clutch cycling. The fan drive clutch is electromagnetic; the ECM 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:

- 190°F (87.5°C) Thermostat starts to open
- 192°F (89°C) Fan medium speed, descending, off
- 196°F (91°C) Fan medium speed, rising, on
- 199.5°F (93°C) Fan high speed, descending, off
- 203°F (95°C) Fan high speed, rising, on
- 205°F (96°C) Thermostats fully open

NOTE

In case of an electrical power failure: remove the bolt from the end of the shaft and screw it into the locking plate. This procedure will prevent engine from overheating by forcing fan rotation (Fig. 12).

On certain models, the mechanical locking device consists of two threaded bushings fixed on the pulley and two drilled metal plates fixed on the rotor. Use the two screws located on the face of the clutch to fasten the metal plates and the bushings (Fig.13).

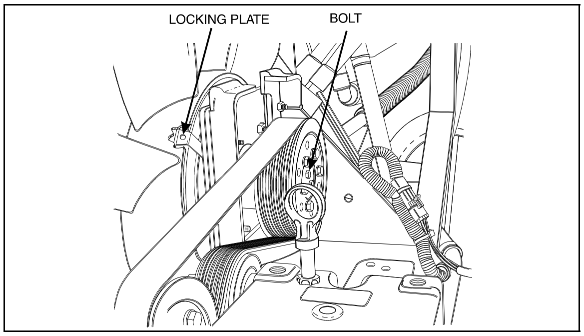


FIGURE 12: MECHANICAL LOCKING DEVICE 05061

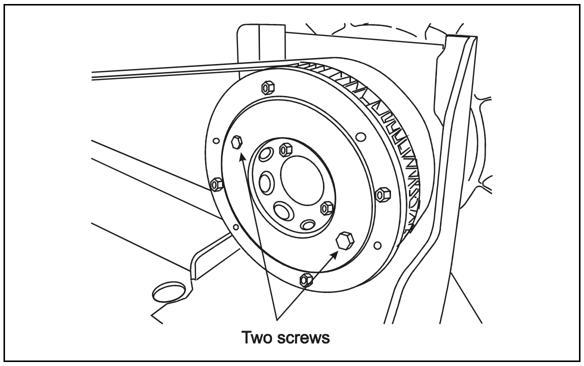


FIGURE 13: SCREWS LOCATION

10.1 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 add any fluids or lubricants to the fan driving mechanism.
5. Do not restrict fan rotation during engine operation for any reason.
6. Do not operate fan-driving mechanism with a damaged fan assembly. Replace a damaged fan as soon as the fault is noted.
7. Immediately investigate and correct any operator complaint involving driving mechanism or cooling system performance.
8. When questions arise, obtain answers before proceeding. Assistance is available through the authorized Field Sales distributor serving your area.

10.2 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 driving mechanism.
- Check coupling installation between fan blade assembly and gearbox.
- Visually inspect fan driving mechanism, fan blade assembly, shroud, radiator, and surrounding area for evidence of contact between rotating and non-rotating parts.
- Check fan transfer belt for fraying, cracking, and proper tension.
- Turn fan through at least 360° of rotation. It should turn smoothly with no resistance.

10.3 THERMOSTAT OPERATION

Coolant temperature is controlled by two blocking-type thermostats located in a housing attached to the cylinder head, on the turbo side of the engine (Fig. 14).

At coolant temperature below approximately 190°F (88°C), the thermostat valves remain closed and block the flow of coolant from the engine to the radiator. During this period, all of the coolant in the system is recirculated through the engine and directed back to the suction side of the water pump via a bypass tube. As the coolant temperature rises above 190°F (88°C) the thermostat valves start to open, restricting the bypass system, and allowing a portion of the coolant to be recirculated through the radiator.

When the coolant temperature reaches approximately 205-207°F (96-97°C) thermostat valves are fully open, the bypass system is blocked off and the coolant is directed through the radiator.

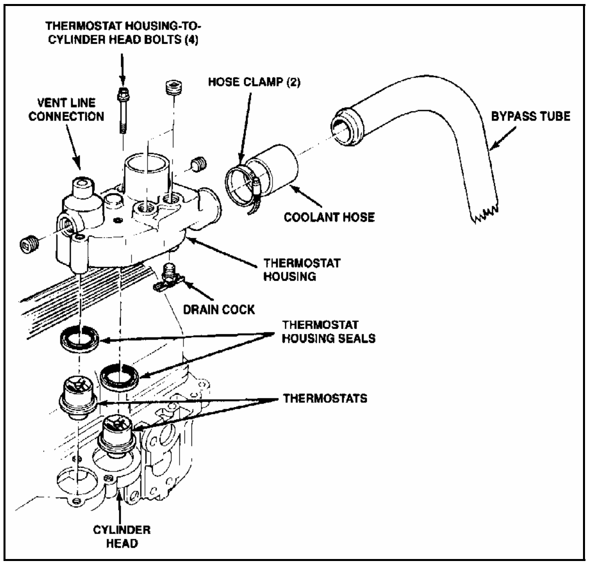


FIGURE 14: THERMOSTAT AND RELATED PARTS 05034

11. FAN GEARBOX

The radiator fan is belt driven from the engine crankshaft pulley through a standard gearbox, which is designed with two output shafts.

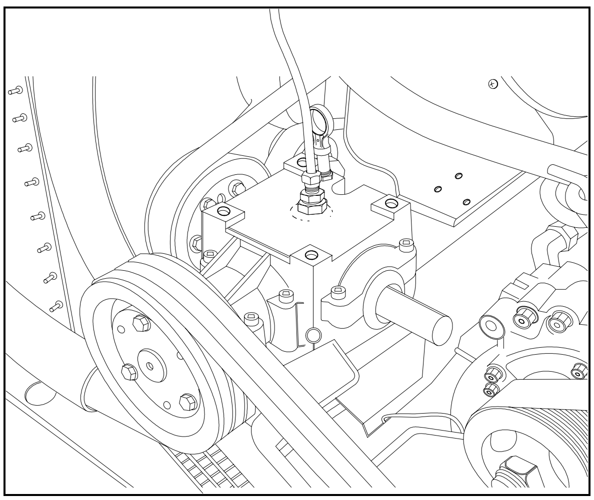


FIGURE 15: FAN GEARBOX 05062

11.1 MAINTENANCE

Change the gearbox oil at 3,000 miles (4,800 km) and subsequently every 50,000 miles (80,000-km) or once a year, whichever comes first.

11.2 OIL CHANGE

1. Stop engine and make sure that all engine safety precautions have been observed.
2. Remove the drain plug located underneath the gearbox case.
3. Drain gearbox.
4. Replace drain plug.
5. Remove the dipstick located on top of gearbox and wipe with a clean rag (Fig. 15).
6. Adjust level to ″Full″ mark using Mobil SHC 630 (Prévost #180217) synthetic oil.
7. Insert dipstick in gearbox case, then remove again to check mark.
8. Reinsert the dipstick.

12. RADIATOR FAN BELT REPLACEMENT

Locate the belt tensioner pressure-releasing valve (Fig. 16), then turn handle counter-clockwise in order to release pressure in belt tensioner air bellows, thus releasing tension on belts.

Remove existing belts (3″V″belts & 1 Poly) from fan assembly and replace with new ones.

Turn the pressure-releasing valve clockwise to its initial position to apply tension on the new belts.

NOTE
For proper operation of the belts, adjust the air bellows tensioner pressure regulating valve (located next to control valve) to 45 psi (310 kPa).

12.1 BELT TENSION ADJUSTMENT

The regulator is located in the engine compartment behind the belt tension pressure releasing valve panel. Turn the screw located under the regulator assembly to change the tension pressure. Check proper pressure using the pressure check valve (Fig. 16).

Use Belt Tension Gauge #68-2404 to measure tension of engine belts. For proper operation of air tensioners, adjust upper tensioning bracket to provide a ¼" (7 mm) gap between stopper and bracket under normal pressure of 45 psi - 310 kPa. Refer to figure 16 for more information.

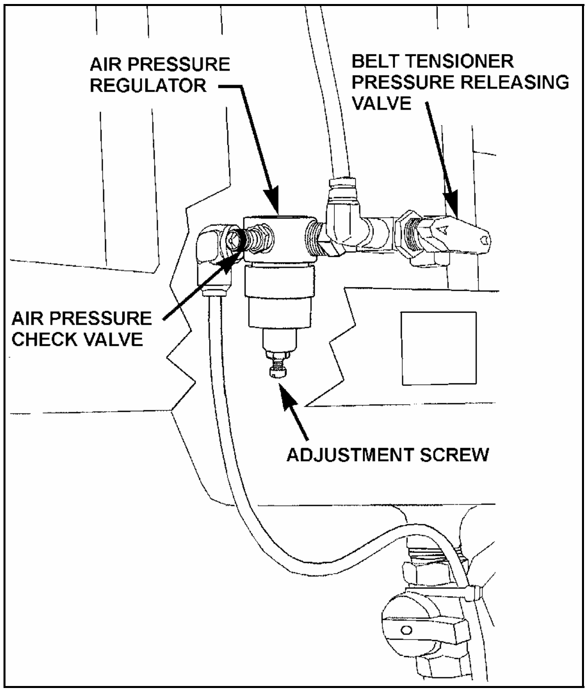


FIGURE 16: REGULATOR VALVE 12200

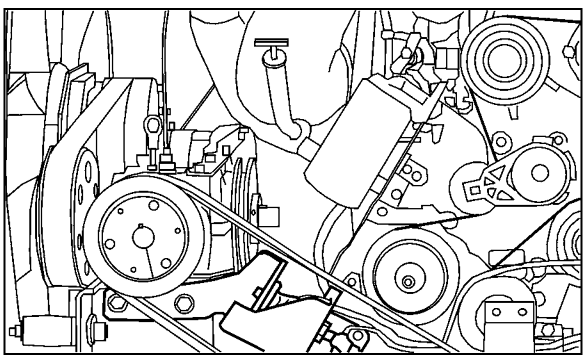


FIGURE 17: BELT TENSIONER 01059

13. FAN DRIVE ALIGNMENT

1. Install both attachment assembly plates (P/N 051779) (48, Fig. 18) through lower plating and secure with four spring nuts (P/N 500666), (70, Fig. 18). Then install one spacer (P/N 050705), (49, Fig. 18) on each spring nut at both anchoring locations (Fig. 18).
2. Center seat assembly in the fan shroud using the horizontal displacement of the fan driving mechanism support. Center with the slots in the floor at anchoring angle support (on some vehicles only). Vertical displacement of the fan clutch is made possible by slots at the base of the fan clutch (on some vehicles only) or by shimming with additional spacers at anchoring locations. Temporarily secure assembly with two nuts (P/N 500709), (74, Fig. 18) at both anchoring locations.

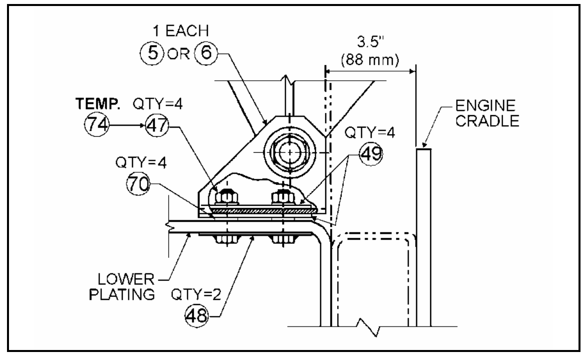


FIGURE 18: ANGLE SUPPORT 05014

> **CAUTION**
>
> Tilt fan and check for clearance.

3. Using a straight edge, align the 3"V"pulley on gearbox central shaft pulley with engine pulley, while taking pulleys outer edge thickness under consideration i.e. 3"V"pulley's outer edge is thicker than that of engine pulley's (Fig. 19).

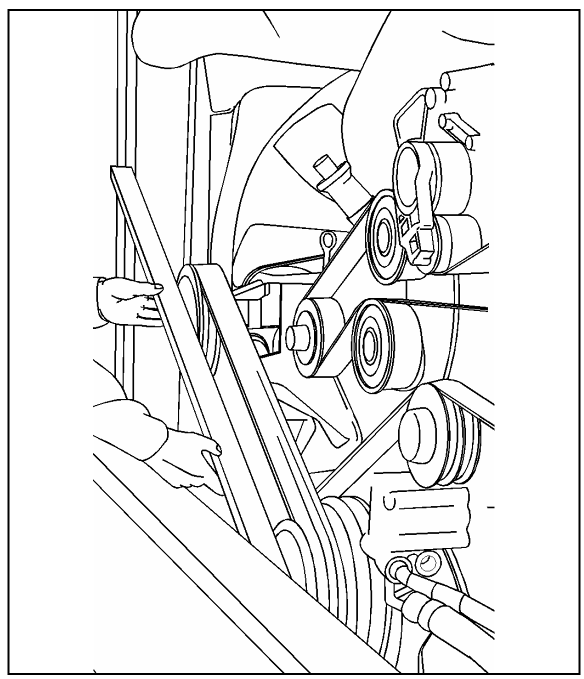


FIGURE 19: PULLEY ALIGNMENT 05064

4. Using a universal protractor, check 3"V" pulley's vertical angle with that of engine pulleys. If angles do not correspond, raise seat assembly by shimming with additional spacers (#49 - P/N 050705).

NOTE
Use a straight edge to measure engine pulley's vertical angle (Fig. 20).

5. Check alignments again (steps 2, 3 & 4) then replace temporary anchoring nuts (P/N 500709) (74, Fig. 18) with four nuts (P/N 500714) (47, Fig. 18) and tighten using a wrench.

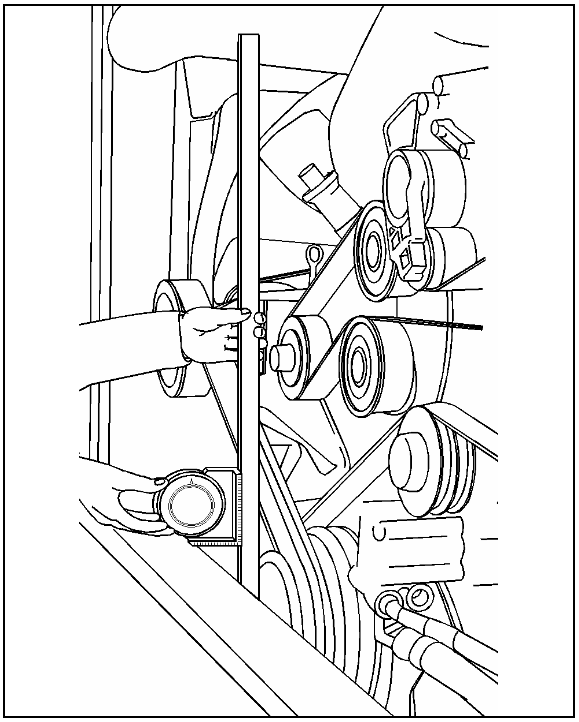


FIGURE 20: PULLEY VERTICAL ANGLE 05063

6. Align multi "V" pulley with fan pulley. Adjust the depth of the pulley on the gearbox shaft.
7. Set belt tensioner pressure regulating valve to 50 PSI - 345 kPa.

CAUTION
In order for tensioning system to work properly, adjust upper tensioning bracket to provide a ¼" (7 mm) gap between stopper and bracket. Otherwise, release tension on system and readjust distance using bolts securing upper tensioning bracket (Fig. 16).

.

14. SPECIFICATIONS

Cooling System Capacity (Approximation)

Includes heating system............ 24 US gal (91 liters)

Thermostat

Number used............ 2
Start to open............ 186-193°F (86-89°C)
Fully open............ 207°F (97°C)

Radiator

Make............ Valeo
Location............ Rear L.H. side
<u>W0 & WE MTH</u>
Prevost number............ 550820
<u>W5 MTH</u>
Prevost number............ 550819

Surge Tank Filler Cap

Make............ Stant
Model............ R3
Prevost number............ 052355

Pressure Cap

Make............ Stant
Pressure setting............ 14 psi (96.53 kPa)
Prevost number............ 550606

Fan Clutch

Make............ Linnig
Type............ 3 speed
<u>XLII MTH</u>
Prevost number............ 550839

NOTE
The fan clutch is controlled by DDEC (not by thermoswitch).

Fan Gearbox

Make............ Superior Gearbox
Ratio............ 1:1
Prevost number............ 550789
Lubricating Oil............ MOBIL SHC 630
Prevost number (Oil)............ 683666

Fan Belt (gearbox-fan)

Make............ Dayco
Type............ Poly-V
Qty............ 1
<u>W0 & WE MTH:</u>
Prevost number............ 506684
<u>W5 MTH:</u>
Prevost number............ 507627

Fan Belt (gearbox-motor)

Make .... Dayco
Type .... V belt
Qty 3

W0 & WE MTH:

Prevost number 506691

W5 MTH:

Prevost number 509822

Coolant

Prevost Number 685125

MAINTENANCE ELEMENT FILTER

Prevost number 550630

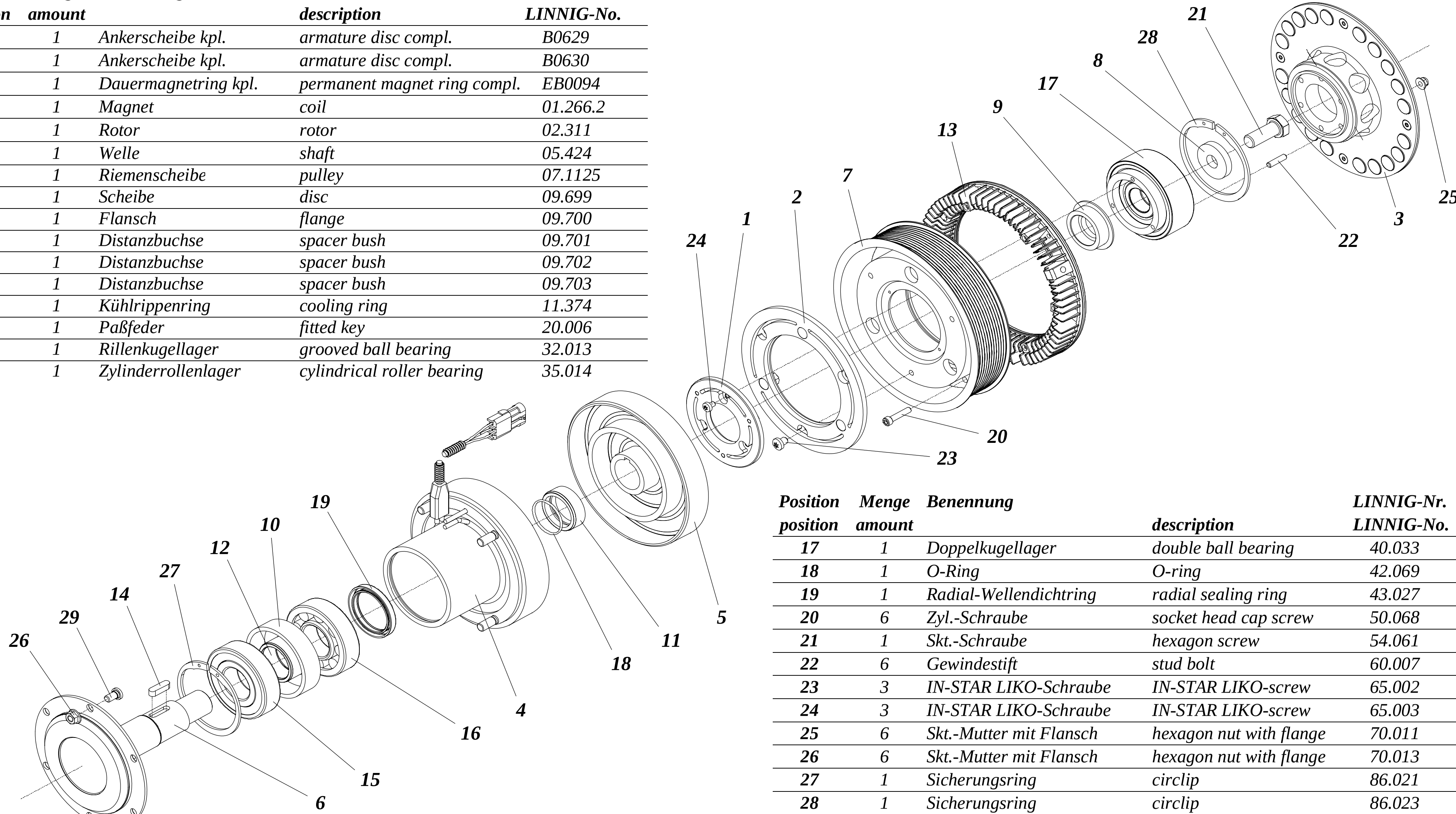
PRECHARGE ELEMENT FILTER

Prevost number 550629

LINNIG
Antriebstechnik GmbH
Riedheimer Str.5
D - 88677 Markdorf

Ersatzteilliste / spare part list LA1.2.0131Y

Position position	Menge amount	Benennung	description	LINNIG-Nr. LINNIG-No.
1	1	*Ankerscheibe kpl.*	*armature disc compl.*	*B0629*
2	1	*Ankerscheibe kpl.*	*armature disc compl.*	*B0630*
3	1	*Dauermagnetring kpl.*	*permanent magnet ring compl.*	*EB0094*
4	1	*Magnet*	*coil*	*01.266.2*
5	1	*Rotor*	*rotor*	*02.311*
6	1	*Welle*	*shaft*	*05.424*
7	1	*Riemenscheibe*	*pulley*	*07.1125*
8	1	*Scheibe*	*disc*	*09.699*
9	1	*Flansch*	*flange*	*09.700*
10	1	*Distanzbuchse*	*spacer bush*	*09.701*
11	1	*Distanzbuchse*	*spacer bush*	*09.702*
12	1	*Distanzbuchse*	*spacer bush*	*09.703*
13	1	*Kühlrippenring*	*cooling ring*	*11.374*
14	1	*Paßfeder*	*fitted key*	*20.006*
15	1	*Rillenkugellager*	*grooved ball bearing*	*32.013*
16	1	*Zylinderrollenlager*	*cylindrical roller bearing*	*35.014*

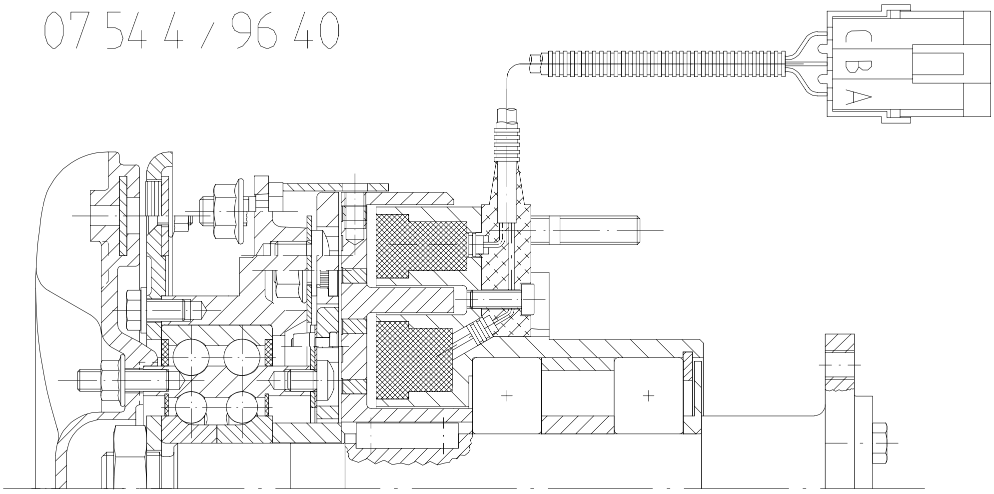


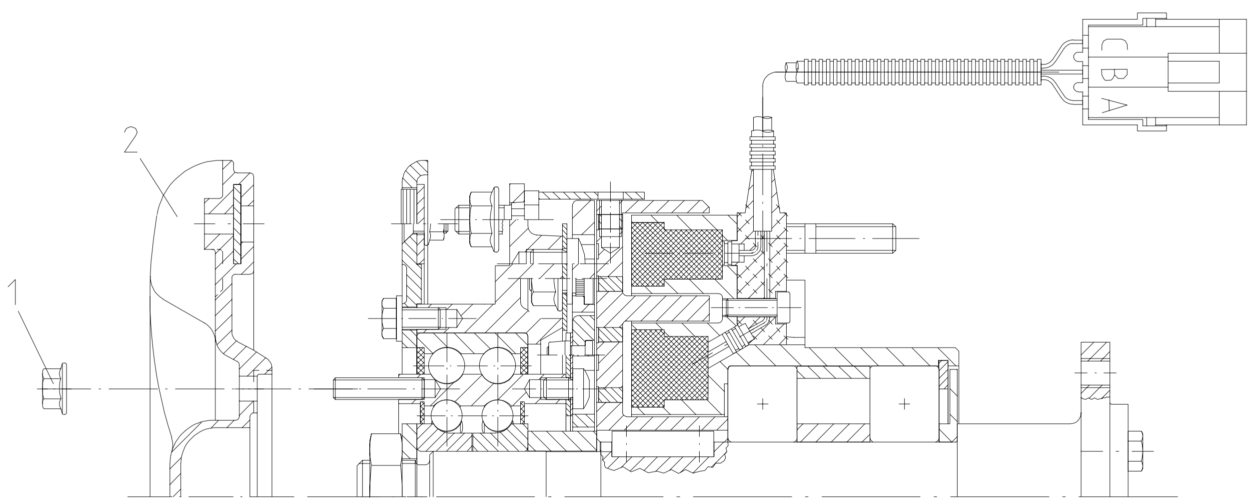
Position position	Menge amount	Benennung	description	LINNIG-Nr. LINNIG-No.
17	1	*Doppelkugellager*	*double ball bearing*	*40.033*
18	1	*O-Ring*	*O-ring*	*42.069*
19	1	*Radial-Wellendichtring*	*radial sealing ring*	*43.027*
20	6	*Zyl.-Schraube*	*socket head cap screw*	*50.068*
21	1	*Skt.-Schraube*	*hexagon screw*	*54.061*
22	6	*Gewindestift*	*stud bolt*	*60.007*
23	3	*IN-STAR LIKO-Schraube*	*IN-STAR LIKO-screw*	*65.002*
24	3	*IN-STAR LIKO-Schraube*	*IN-STAR LIKO-screw*	*65.003*
25	6	*Skt.-Mutter mit Flansch*	*hexagon nut with flange*	*70.011*
26	6	*Skt.-Mutter mit Flansch*	*hexagon nut with flange*	*70.013*
27	1	*Sicherungsring*	*circlip*	*86.021*
28	1	*Sicherungsring*	*circlip*	*86.023*
29	6	*Einpress-Gewindebolzen*	*press-in bolt*	*120.017*

Blatt 1/1 | Ersteller: Metzner | Stand: 15. Nov. 2002 | Revision: A | 142.182

Repair instructions
for LA1.2.0118Y and LA1.2.119Y

LINNIG
Antriebstechnik GmbH
Box 1430
88672 Markdorf
07 54 4 / 96 40





1) Loose hexagon head nut M6 (1).

2) Remove aluminium fan (2) by hand.
Mind the acceleration of the permanent magnets.

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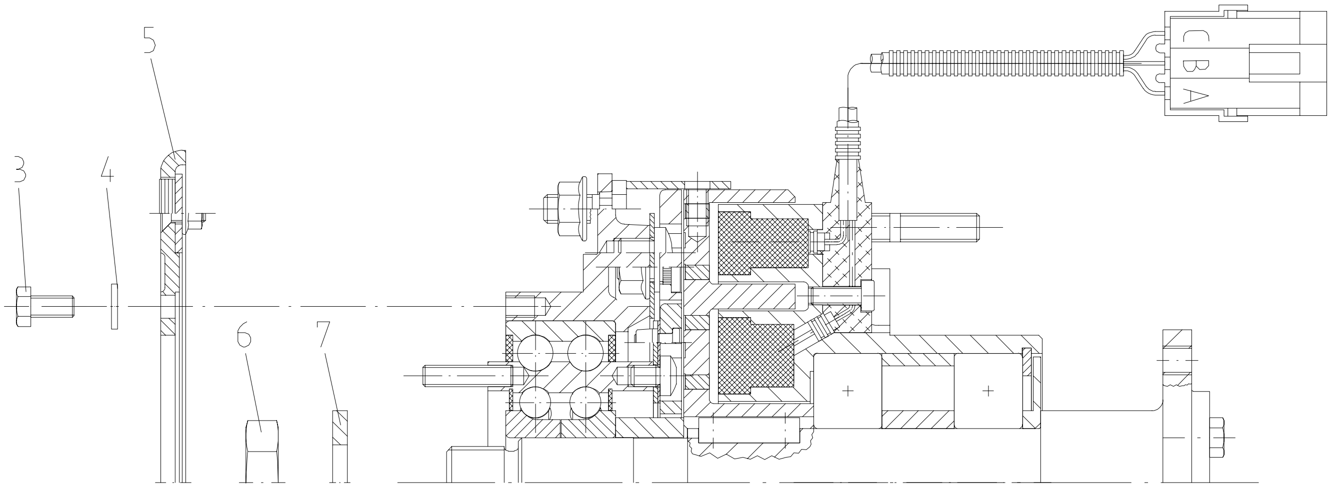
11.11.02
Meckes

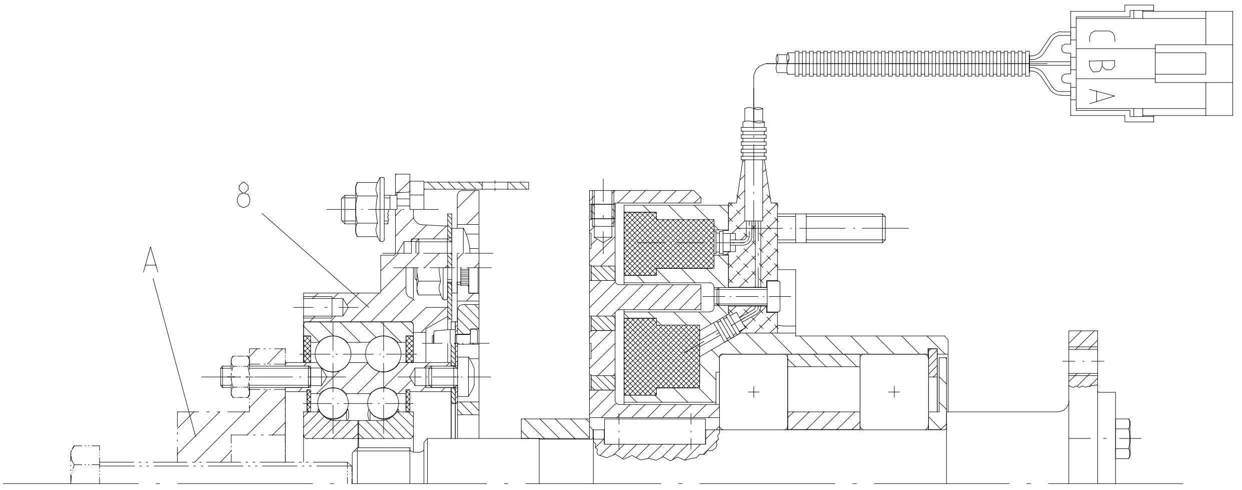


3) Loose hexagon head screw (3)
and remove washers (4).

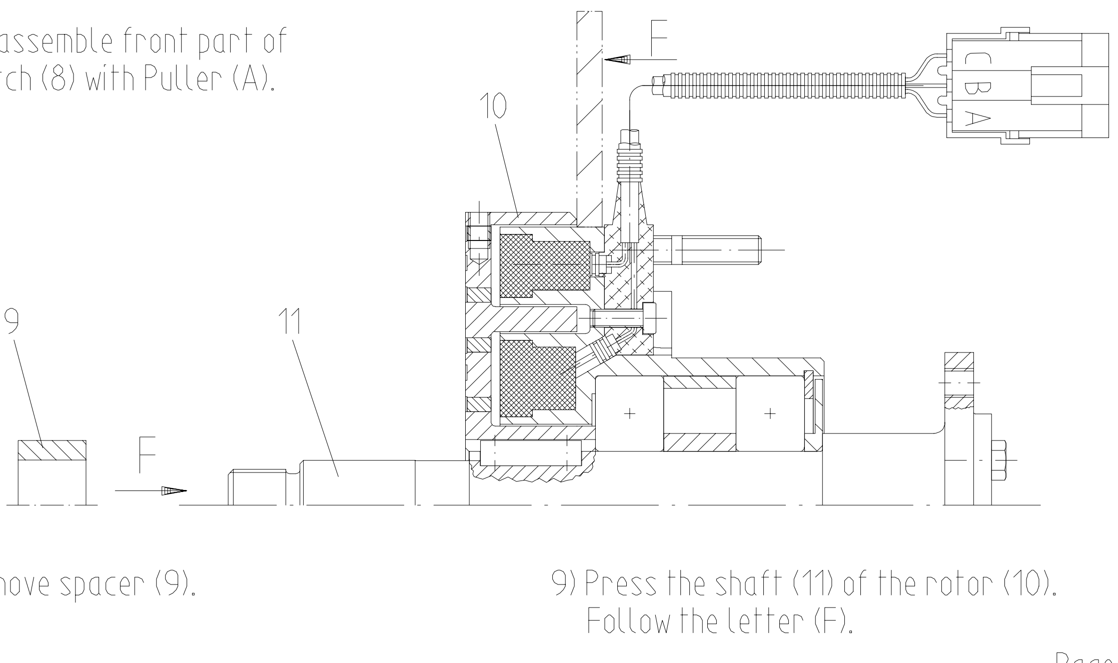
4) Dismantle the permanent magnet ring (5).

5) Remove fan.

6) Remove hexagon head nut M20×1.5 (6).
Remove washer (7).



7) Disassemble front part of
clutch (8) with Puller (A).

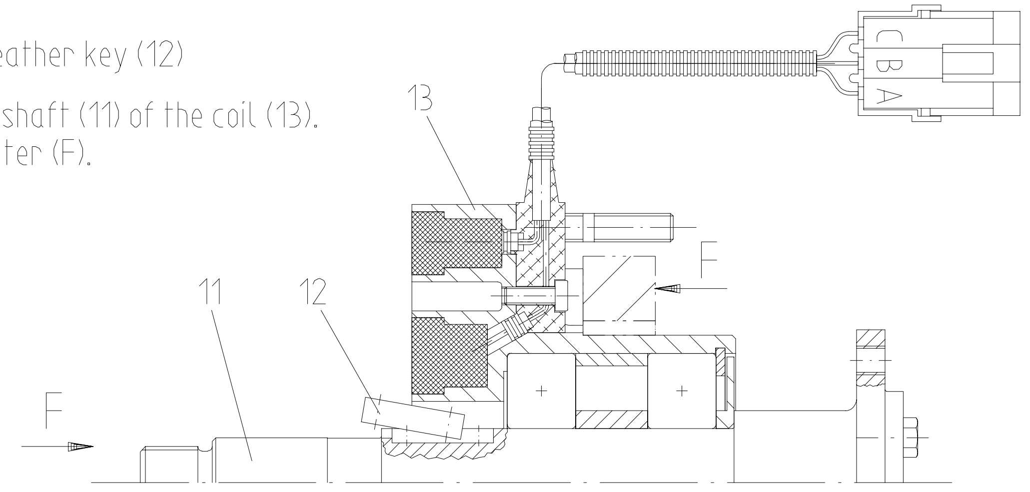


8) Remove spacer (9).

9) Press the shaft (11) of the rotor (10).
Follow the letter (F).

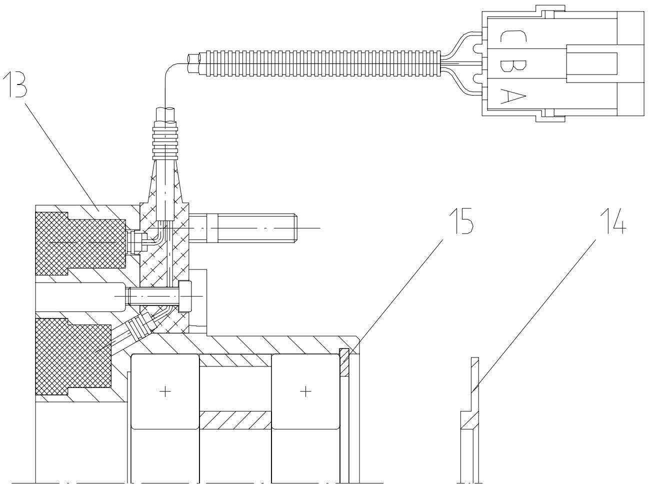
10) Remove feather key (12)

11) Press the shaft (11) of the coil (13).
Follow letter (F).



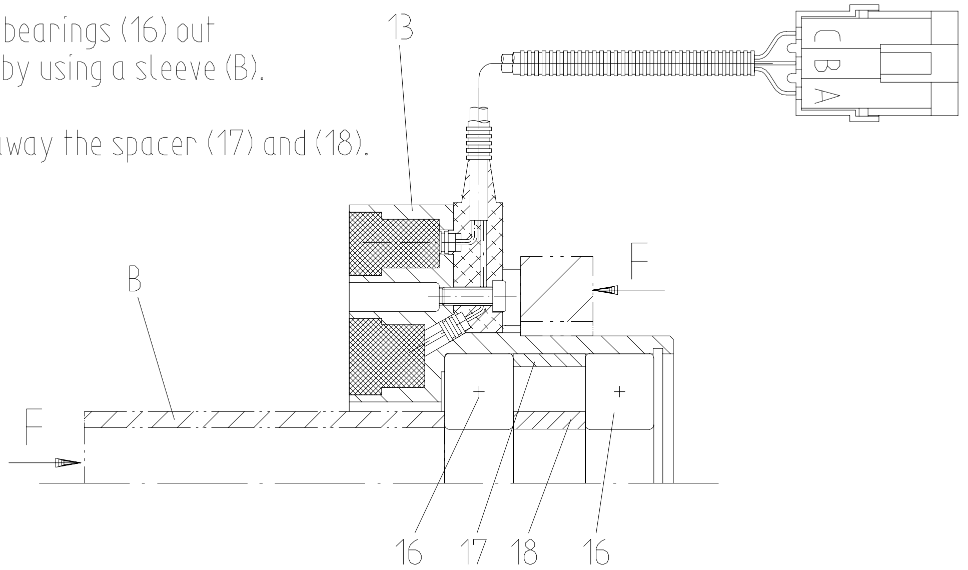
12) Remove gasket (14) from shaft.

13) Take out circlip (15) from coil (13).



14) Press the ball bearings (16) out
of the coil (13) by using a sleeve (B).

15) Don't through away the spacer (17) and (18).

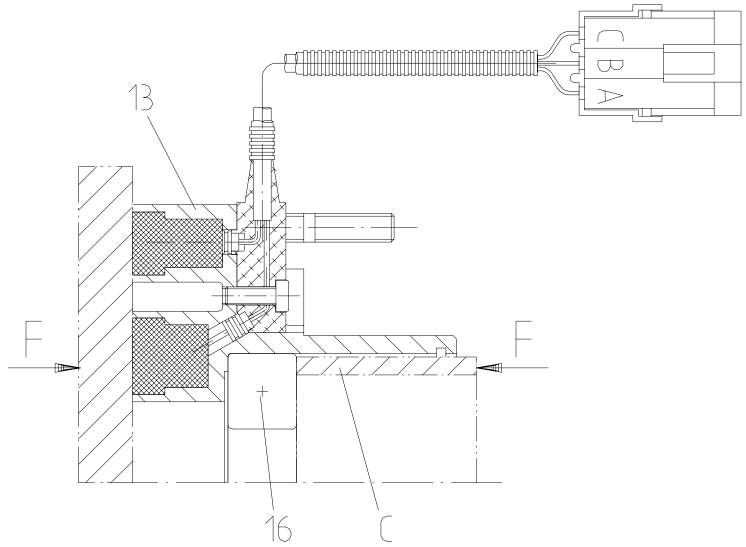


Renew the following parts
when reassemble the clutch:

clutch-front-part (8)	LINNIG No. EB0095
rotor (10)	LINNIG No. 02.264
2 × ball bearings (16)	LINNIG No. 32.005

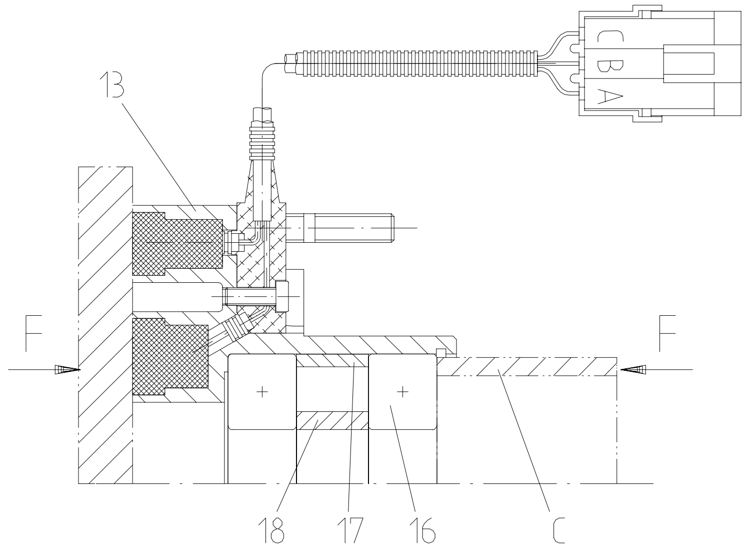
Assembly instruction

16) Press the ball bearing (16)
    into the coil (13).
    (Note: Press only the outer ring
    of the bearing. See (F).

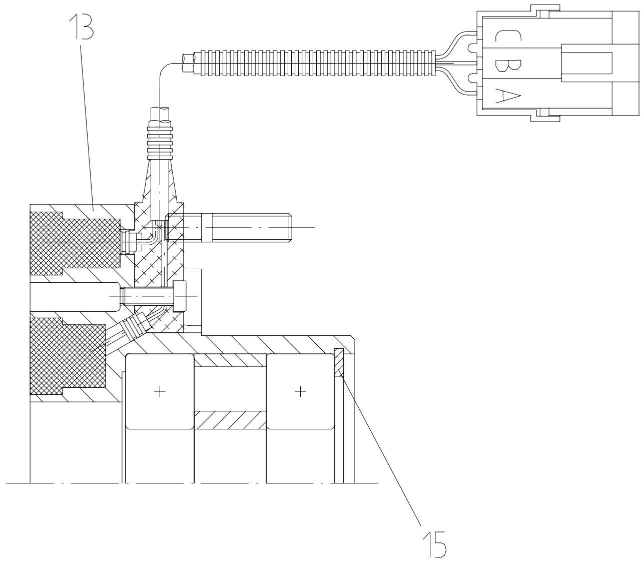


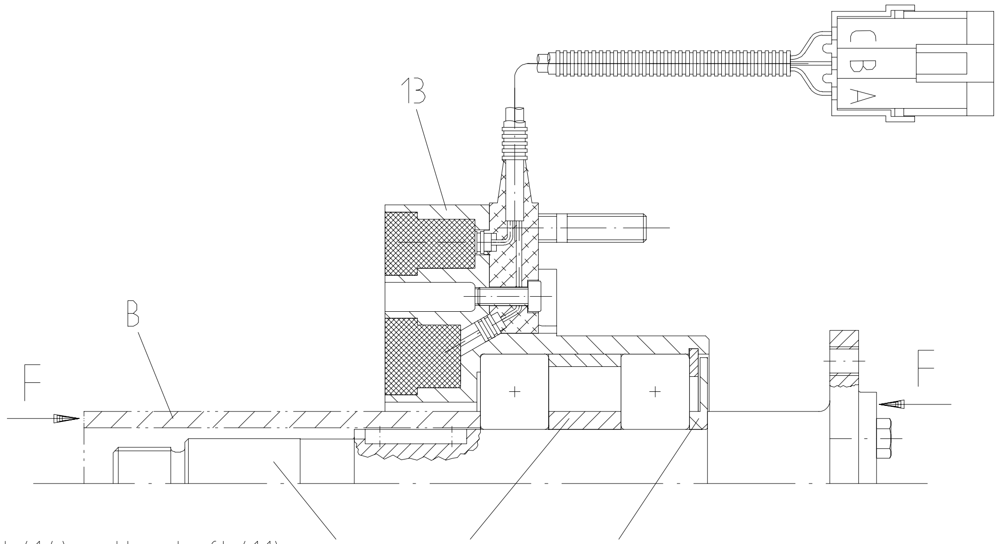
17) Insert spacer (17) and (18)
    into the coil (13).

18) Press the ball bearing (16)
    into the coil (13).
    (Note: Press only on the
    outer ring of the bearing.
    See (F).



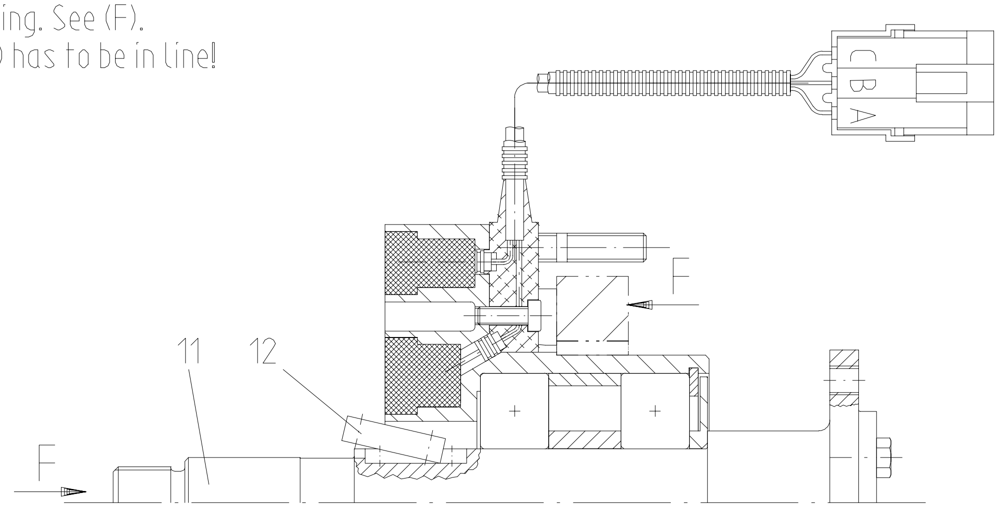
19) Replace circlip (15)
    into the coil (13).



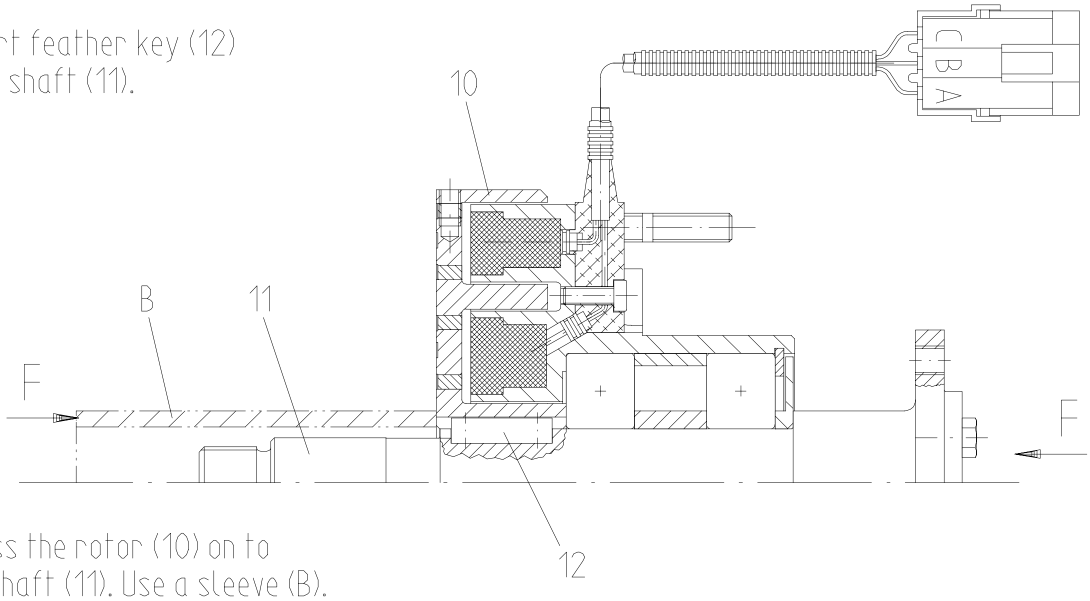


20) Push gasket (14) on the shaft (11).
(Take care for the right position)

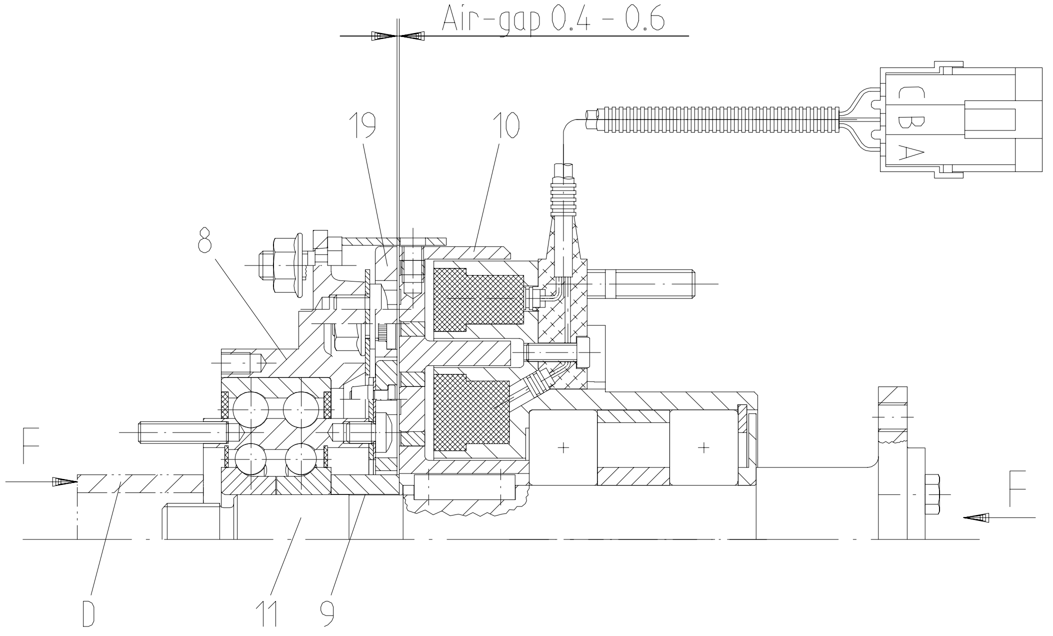
21) Press the coil (13) onto the shaft (11).
(Note: Press only the inner ring
of the bearing. See (F).
Spacer (18) has to be in line!



22) Insert feather key (12)
into shaft (11).



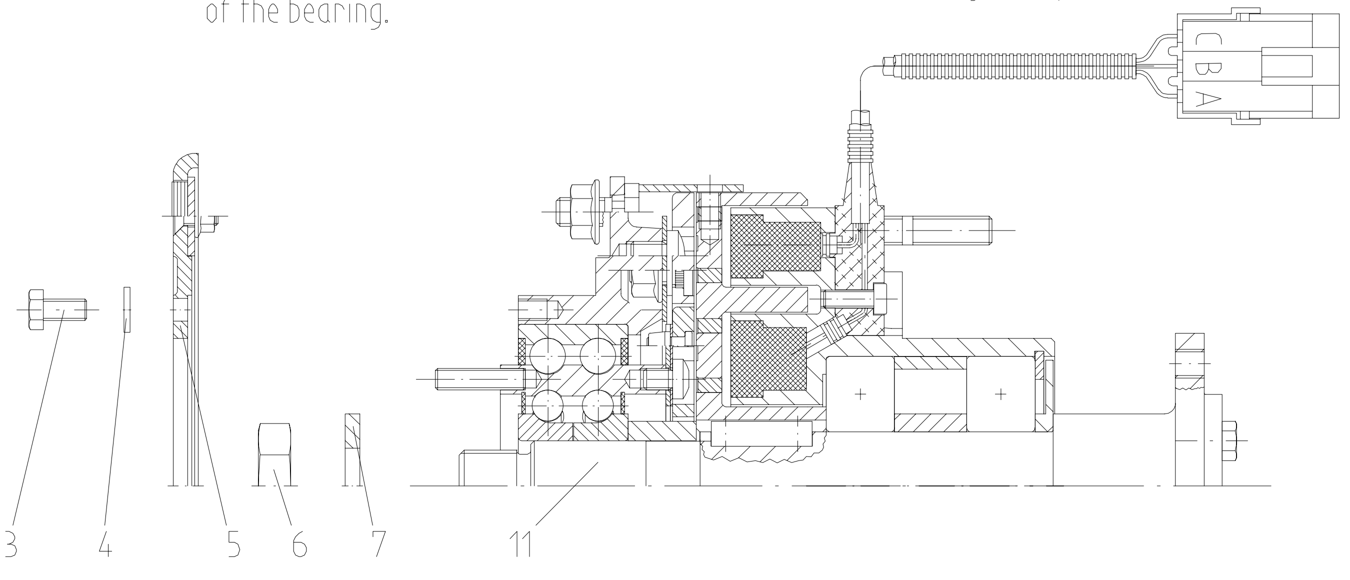
23) Press the rotor (10) on to
the shaft (11). Use a sleeve (B).
Look after the position of the feather key (12).



24) Push spacer (9) on to the shaft (11).

25) Press the clutch front part (8)
with sleeve on to the shaft.
Press only on the inner ring
of the bearing.

26) Check the air-gap 0.4 - 0.6 mm
between rotor (10) and
core disc (19).
If necessary put toleranced
washers between bearing
inner ring and spacer (9).



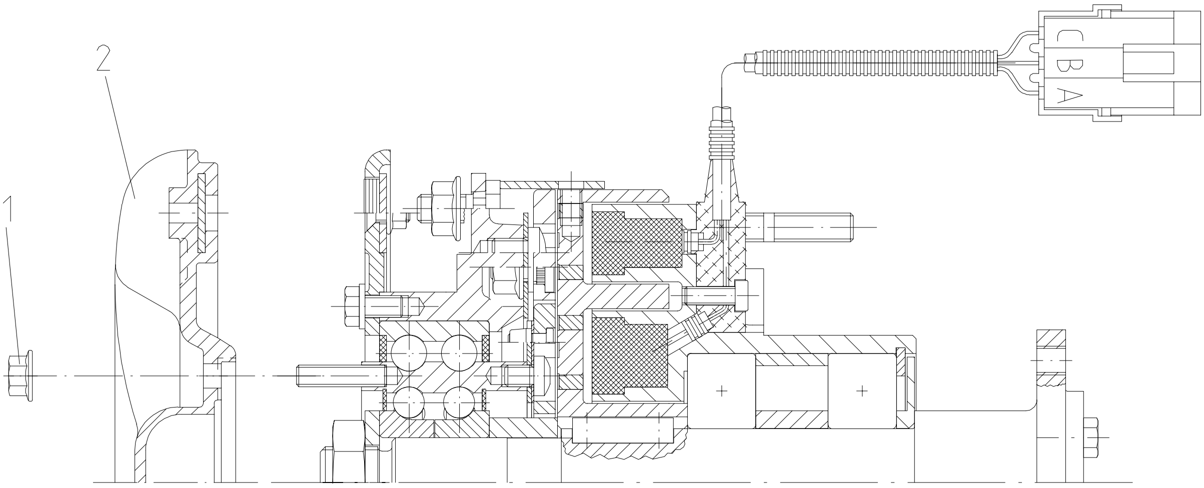
27) Push washer (7) on to the shaft (11).

28) Assemble hexagon head nut M20×1.5 (6).
Torque Ma = 90 Nm
Secure hexagon head nut
with locking paint

29) Assemble fan.

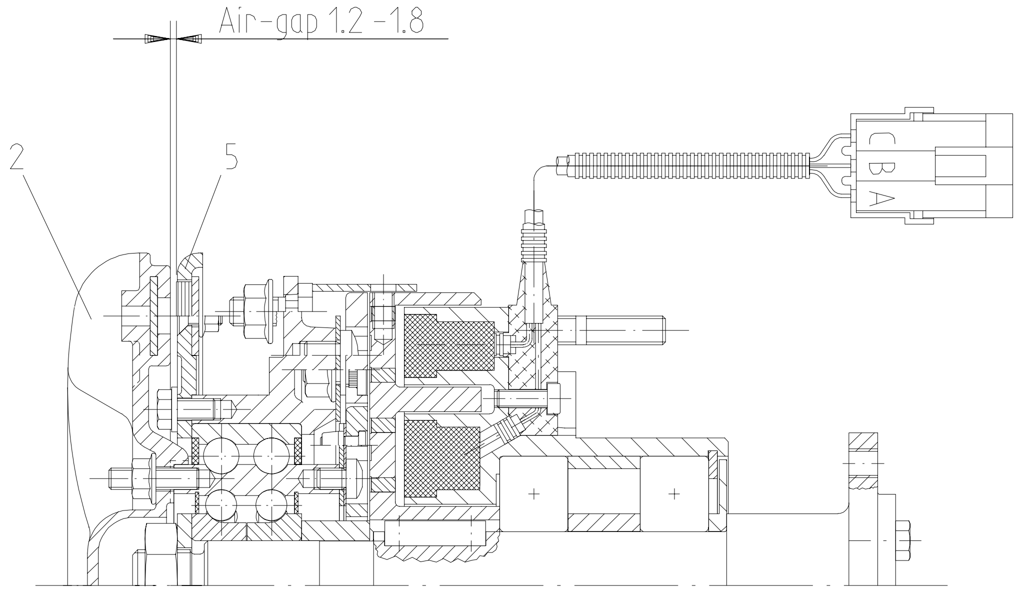
30) Assemble permanent magnet ring (5)

31) Bolt the permanent magnet ring (5)
with three hexagon head screws
M6×12-8.8 and washers (4) on to
the clutch front part.
Torque Ma = 10 Nm



32) Assemble aluminium fan (2).

33) Screw the aluminium fan (2)
on to the clutch front part
with hexagon head nut M6-8 (1).
Torque Ma = 10 Nm



34) Check air-gap 1.2 - 1.8 mm between
fan (2) and permanent magnet ring (5).

CONTENTS

ILLUSTRATIONS

1. GENERAL DESCRIPTION

This vehicle uses 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. One or two 24 volt self-rectified alternators are belt driven from the engine, and can be reached through the engine compartment door.

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.

- o The Multiplexed Device Index,
- o The Arrangement-Harness drawing showing the harnesses arrangement and harness number on the vehicle,
- o Glossary,
- o Circuit number listing,
- o Circuit breaker code,
- o Connector code,
- o Diode number code,
- o Resistor number code,
- o Fuse code.

1.1.1 Using Wiring Diagram

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 CB6 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 CB6, 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 CB6, 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 level low system of the vehicle is inoperative and you must trace the electric circuit.

a) Refer to wiring diagram index and look for *“Level Low”.*

b) You will find on page 28.1 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 to see all the fault messages.

Problem: MCD displays the fault "Low docking lights SW102; shorted to ground" as being active.

a) Refer to wiring diagram index, and look for *"Multiplexed Device Index"*, pages B1-B3.

b) In first column DEVICE ID, look for device SW102.

c) At device SW102, find the fault message, the minimum condition to activate, other inputs involved in logic, the multiplex module related to switch 102, 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)
Green	110 V ac system (ground)
White	110 V ac system (neutral)
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.

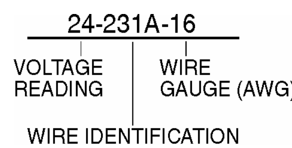


FIGURE 1: WIRE IDENTIFICATION 06048

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 in the engine compartment, on R.H. side of the vehicle.

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
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.

This type of circuit breaker deenergizes the circuit without disconnecting any wire. 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.

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.

Many systems on this vehicle are provided with control relays, which are all, located in or on the junction boxes, figures 6, 9, 10 and 12.

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 ECM, transmission TCM, instrument cluster module, the battery equalizer and some Multiplex modules which are energized during 15 minutes after the ignition has been set 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 (1 and 2) located in the rear circuit breakers 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.

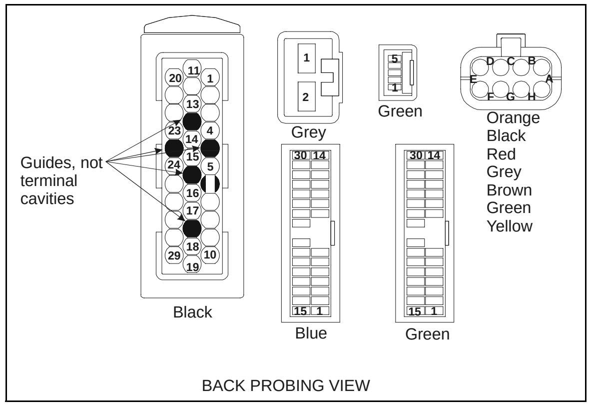
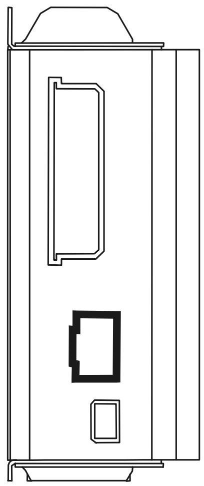
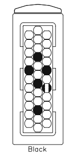
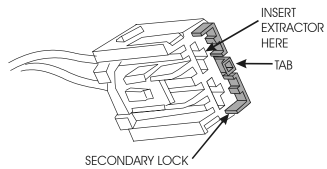
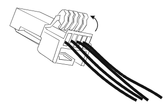
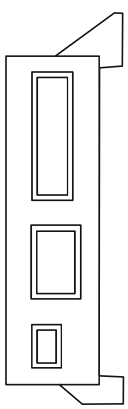
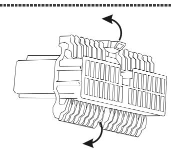
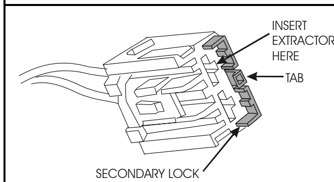
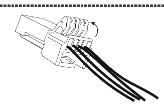
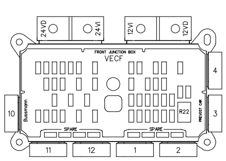
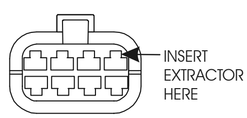


FIGURE 2: MULTIPLEX MODULE CONNECTORS PIN-OUT 06624

Multiplex modules	Connector type	Terminal removal
 IO-B 06625	 **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.
	 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.
	 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	 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. XLII MOTORHOMES ELECTRICAL COMPARTMENTS AND JUNCTION BOXES

FIGURE 3: ELECTRICAL COMPARTMENTS (XLII-40 BUS SHELLS) 06647

FIGURE 4: ELECTRICAL COMPARTMENTS (XLII-45E BUS SHELLS) 06648

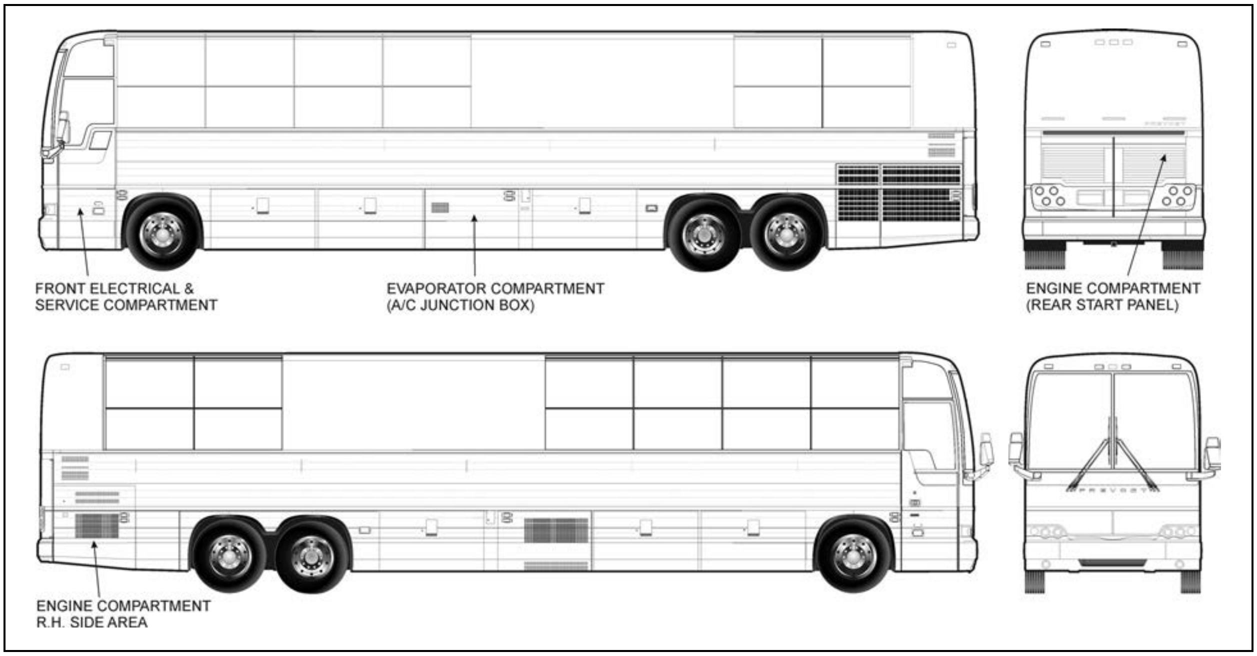


FIGURE 5: ELECTRICAL COMPARTMENTS (XLII-45 BUS SHELLS) 06646

2.1 MAINTENANCE

A Cortec VCI-238 corrosion inhibitor has been sprayed in all electrical compartments to protect components from corrosion. The life expectancy of this product is five years, so it is recommended to reapply it every five years. It is also recommended to spray it on new components when added or replaced.

DANGER

Use VIC-238 in a well ventilated area. Do not smoke. Avoid prolonged contact with skin and breathing of spray mist. Harmful or fatal if swallowed. Do not induce vomiting. Call physician immediately.

2.2 REAR JUNCTION BOX

The rear junction box is located in the engine compartment, on R.H. side of the vehicle. The rear junction box provides access to the following:

- o Multiplex Modules: I/O-A, I/O-B;
- o Voltage Regulator;
- o Vehicle Electrical Center Rear (VECR);
- o Relays and Fuses;
- o Transmission ECU;
- o Diagnostic Data Reader (DDR Receptacle);
- o Electronic Ground Stud;
- o Rear Junction Box Temperature Sensor.

Rear Junction Box			
Multiplex Modules			
A49	I/O-A	A52	I/O-B
A50	I/O-B	A53	I/O-B
A51	I/O-B		
Relays			
R1	24V IGN	R30	24V Door llock/Unlock
R3	12V IGN		
R8	Service Brake	R31	24V Door lock/Unlock
R11	Not Used	R32	24V Door lock/Unlock
R17	12V wake-up mode		
R21	Emergency	R33	24V Door lock/Unlock
R25	Engine ECM		
Fuses			
F50	Delco Regulator	F71	Spare
F51	24VD Customer	F72	12VI A50
F52	Lugg. Lock/Unlock	F73	Spare
F53	Cabin area Liq. Valve	F74	12VI ECM Motor
F54	Window ajar & Awning	F75	12VI Trans.
F55	Spare	F76	12VI Customer
F56	Spare	F77	12V Wake-up Transmission
F57	Spare	F78	12V Wake-up ECM
F58	Spare	F79	12V Wake-up ECM
F59	Spare	F80	12V Wake-up A51
F60	Lugg. Lock/Unlock	F81	24V Excitation
F61	Lugg. Lock/Unlock	F85	Not Used
F62	Spare	F86	Spare
F63	Priming Pump	F87	12VI Trailer
F64	Spare	F88	Spare
F65	24VI A49, A52, A53	F89	Spare

F66	Power Fan Clutch	F90	Spare
F67	24VI A54	F91	Spare
F68	24VI A54	F96	Spare
F69	24VI R8	F98	Spare
F70	24 VI Customer	F99	Spare
Resistors			
RES13	Excitation	RES16	Current Reducer
RES14	Excitation	RES17	Current Reducer
Diodes			
D15	Ignition	D46	Service Brakes
D28	Suppression	D67	Upper Rear Light
D29	Suppression	D68	Upper Rear Light
D31	Suppression	D69	Upper Rear Light
D36	Suppression	D70	Upper Rear Light
D37	Suppression		

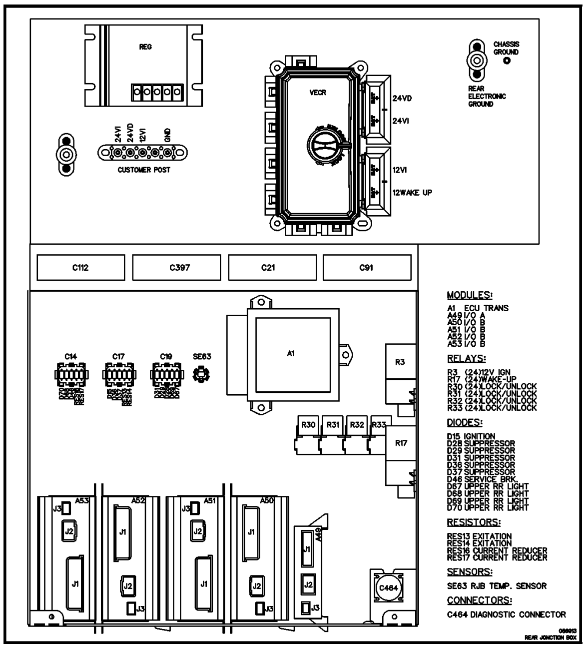


FIGURE 6: REAR JUNCTION BOX 06508

DANGER

During repair or maintenance periods, set ignition key switch to the "OFF" position in order to avoid personal injury. This ensures that power from the batteries is automatically cut off.

NOTE

When 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 Equalizers and the Digital Clock.

2.3 CIRCUIT BREAKERS

All manually-resettable circuit breakers are located in the engine compartment R.H. side area. An identification decal is affixed on the inside face of the door.

MTH W0, WE and W5 may be equipped with nine (9) main breakers; six (5) of which are standard (CB1, CB2, CB3, CB7 & CB9). Three (3) are supplied only on vehicles equipped with central A/C system (CB4, CB5 & CB8); and one (1) is supplied only on vehicles equipped with slide-out (CB6).

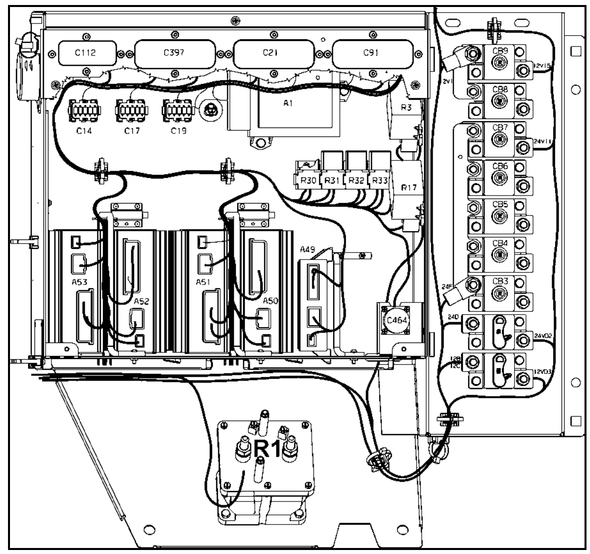


FIGURE 7: REAR JUNCTION BOX & CIRCUIT BREAKER PANEL

On all vehicles, breakers CB1 to CB9 are installed on circuit breaker panel in engine compartment R.H. side area (Fig. 7). They are accessible through engine R.H. side door and can be identified as follows:

1. Distribution (CB1) 150 A - 12 volts;
2. Distribution (CB2) 50 A - 24 volts;
3. Front Distribution (CB3) 70 A - 24 volts;
4. Distribution (CB7) 60 A - 24 volts;
5. Distribution (CB9) 70 A - 12 volts;

On all vehicles equipped with central A/C, breakers CB4, CB5 and CB8 are installed on breaker panel in engine compartment R.H. side area (Fig. 7). They are accessible through engine R.H. side door and are identified as follows:

1. HVAC - Evaporator (CB4) 90 A - 24 volts;
2. HVAC – Condenser (CB5) 70 A - 24 volts;
3. HVAC - Condenser (CB8) 40 A - 12 volts.

On all vehicles equipped with one or two slide-outs, breaker CB6 is installed on breaker panel in engine compartment R.H. side area (Fig. 7). It is accessible through engine R.H. side door and is identified as follows:

1. Slide-Out (CB6) 35 A - 24 volts.

2.4 A/C JUNCTION BOX

The following components are located in the Evaporator Compartment (HVAC). They are mounted inside the A/C junction box.

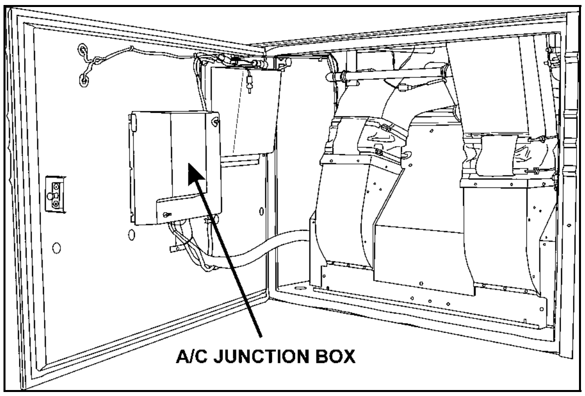


FIGURE 8: LOCATION OF A/C JUNCTION BOX IN EVAPORATOR COMPARTMENT 22178F

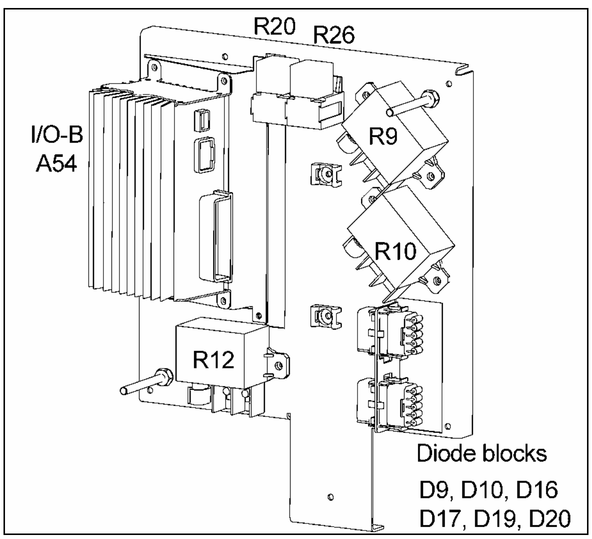


FIGURE 9: A/C JUNCTION BOX 06317

Evaporator Compartment			
Multiplex Module			
A54	I/O-B		
Relays			
R9	24V Condenser fan R.H	R20	Water pump
R10	24V Condenser fan L.H	R26	Pre-heating
R12	24V Evaporator fan		

Diodes			
D9	Pre-heating	D19	Baggage compartment -2
D10	Pre-heating	D20	Baggage compartment -1
D16	Baggage compartment -3	DXX	Not used
D17	Baggage compartment -5		

2.5 FRONT ELECTRICAL & SERVICE COMPARTMENT

The front electrical & service compartment is located on L.H. side of vehicle, under the driver's window. It contains the following components (Fig. 10):

- o Multiplex Modules;
- o CECM;
- o Vehicle Electrical Center Front (VECF);
- o Relays and fuses;
- o Diodes;
- o ABS Electronic control unit (ECU).

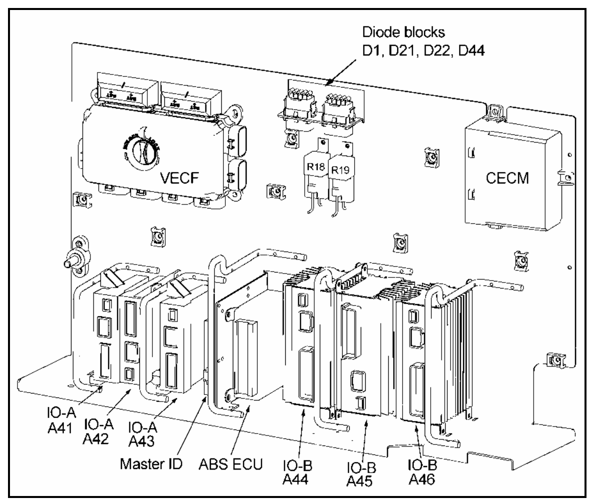


FIGURE 10: FRONT ELECTRICAL COMPARTMENT 06319

The light in the front electrical & service compartment turns *ON* automatically when the door is opened.

Front Electrical & Service Compartment			
Multiplex Modules			
VECF	Vehicle Electrical Center Front	A41	I/O-A
A9	ABS-ECU	A42	I/O-A
		A43	I/O-A
A13	Master ID	A44	I/O-B
A27	ZF Steering Ctrl	A45	I/O-B
A31	Keyless	A46	I/O-B
A36	CECM		

Relays			
R18	24V Wake-up mode	R22	Engine ECU Power
R19	12V Wake-up mode		
Fuses			
F1	CECM Power	F24	Mirror
F2	Front start main switch	F25	Spare fuse
F3	Driver liquid solenoid valve	F26	Spare fuse
F4	Spare fuse	F27	12VI Customer
F5	24 volts Wake-up mode	F28	Driver's seat
F6	24VD Customer	F29	Instrument cluster & data reader
F7	Spare fuse	F30	Driver's window
F8	Multi function switch	F31	Keyless module
F9	Spare fuse	F32	Spare fuse
F10	Pneumatic cut-out solenoid	F33	12VD Wake-up mode
F11	Sun visor	F34	12VD Wake-up mode
F12	PWR MUX modules	F35	12-volt accessory outlet
F13	PWR MUX modules	F36	HVAC module & telltale panel
F14	24VI Customer	F37	Spare fuse
F15		F38	PWR A41 multiplex module
F16	Defroster unit	F39	Spare fuse
F17	Level low	F40	Entrance door window
F18		F41	12-volt accessory outlet & lighter
F19		F82	Lower windshield wipers
F20	Witness red LED	F83	Spare fuse
F21	PWR A44 multiplex module	F84	12VD Customer
		F104	Spare fuse
F22	ZF steering control	F105	Spare fuse
F23	ABS brake system		
Diodes			
D1	Accessories	D13	ABS
D2	Driver unit liquid solenoid valve	D22	Service brake
D12	Engine brake	D44	ignition

2.6 ENGINE COMPARTMENT (REAR START PANEL)

The rear start panel is located over the engine in the engine compartment. Switches to start and stop the engine from inside the engine compartment are mounted on that panel. (Fig.11):

- o engine compartment light switch;
- o starter selector switch;
- o Rear start (push button switch);
- o Prime pump switch.

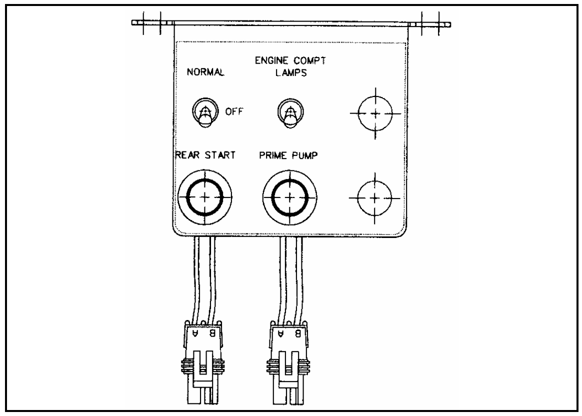


FIGURE 11: REAR START PANEL 06622

2.7 WIPER CONTROL PANEL

To access the wiper control panel of the right console, remove the panel under the larger utility compartment at the right of the dashboard.

Wiper Control Panel Inside Right Console			
Multiplex Modules			
A47	I/O-B	A48	I/O-B
Relays			
R23	Lower windshield wipers		
Diodes			
D4	Lower windshield wipers speed 2	DXX	Not Used
D5	Lower windshield wipers speed 1	DXX	Not Used
DX	Not Used		

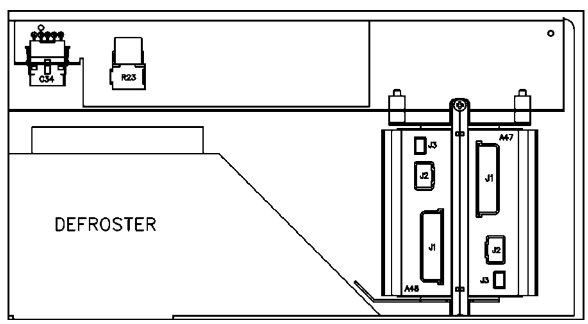


FIGURE 12: WIPER CONTROL PANEL

3. BATTERIES

The vehicle is provided with four (4) maintenance-free 12 volt heavy-duty batteries connected in series-parallel (Fig. 13). 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 the 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.

The batteries are located in the engine compartment R.H. side (Fig. 13).

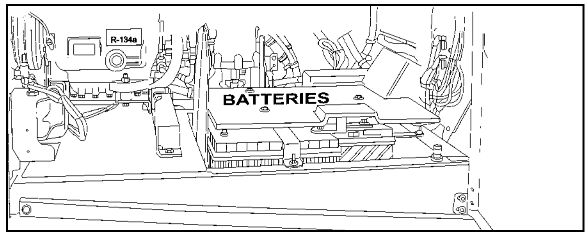


FIGURE 13: ENGINE COMPARTMENT R.H. SIDE 18513

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 relays (24V & 12V) are provided for this vehicle. The relays are located in the rear junction box (R1 & R3). The 24-volt battery relay engages when ignition key is in the ON or ACC position.

When the main battery relays 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;
- ECM;
- Transmission Control Module (TCM);
- Preheater electronic timer;
- Preheater and water recirculating pump;
- Radio memory;
- CECM;
- Cluster memory.

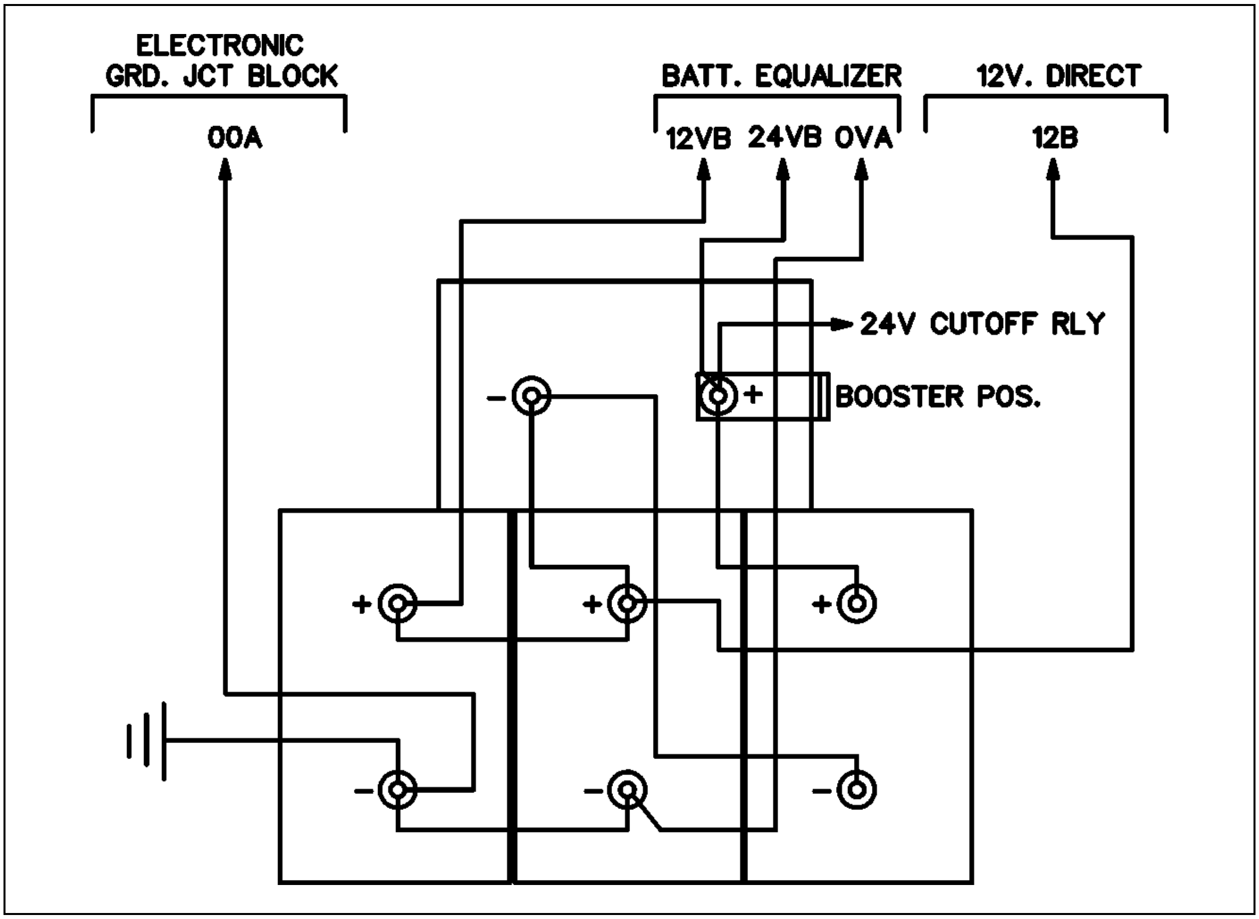


FIGURE 14: BATTERIES CONNECTIONS 06649

3.3 BATTERY REMOVAL AND INSTALLATION

The batteries are located in the engine compartment R.H. side area (Fig. 13).

1. Remove the tree (3) plastic protective cover retaining bolts. Remove the plastic protective cover.
2. Remove the support retaining bolt.

DANGER

To prevent possible electric shocks or sparking, trip circuit breakers CB1 & CB2 and turn the ignition key switch in the "Off" position before disconnecting cables from the batteries.

3. Remove the support (if necessary, remove battery cables). To remove battery cables, unscrew terminal nuts and remove cables.
4. Remove battery cables from defective batteries.

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.

5. Remove defective batteries.
6. Installation is the reverse of removal.

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, trip circuit breakers CB1 & CB2 and turn the ignition key switch in the "Off" position before tightening an electrical connection.

NOTE

A protective silicone free, coating should be applied on all terminals that have been disconnected. We recommend the use of Cortec VCI-238 (Prévost #682460) on all electrical connections.

3.4 BATTERY RATING

Each of the 12 volt batteries used on the vehicle has the following rating:

- o Reserve capacity: 195 minutes
- o Cold cranking (amps): 950 @ 0°F (-18°C)
- o 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. 15).

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.

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.**

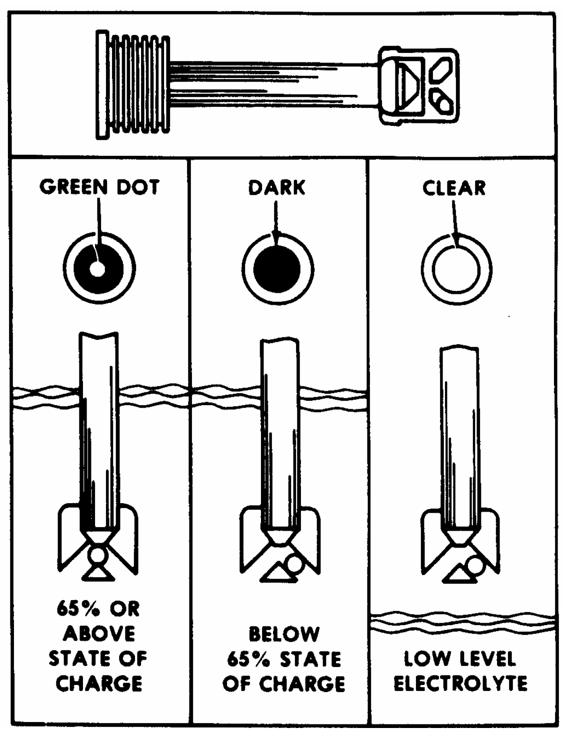


FIGURE 15: TEST INDICATOR 06096

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 17. 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 16.

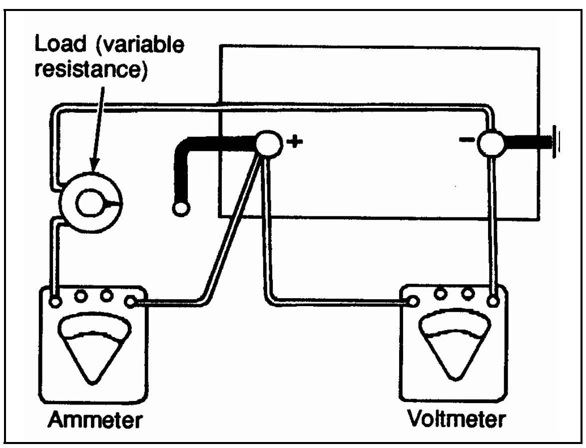


FIGURE 16: LOAD TEST 06064

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, the DDEC engine circuits, which are protected by breakers (CB-1 & CB-2) located in the circuit breaker panel, must be deenergized during these tests; afterward toggle yellow lever upwards to reset the circuit breakers.

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 terminals to charge the batteries when they are left on vehicle and **make sure that the ignition key switch is set to the *"On"* position.**

The alligator clamps of the tester or charger must be placed between the terminal nuts and the lead pads of the terminal studs (Fig. 17) after the vehicle cables are detached. The alligator clamps should make firm contact with the lead pads.

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.

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.

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 terminals, 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.

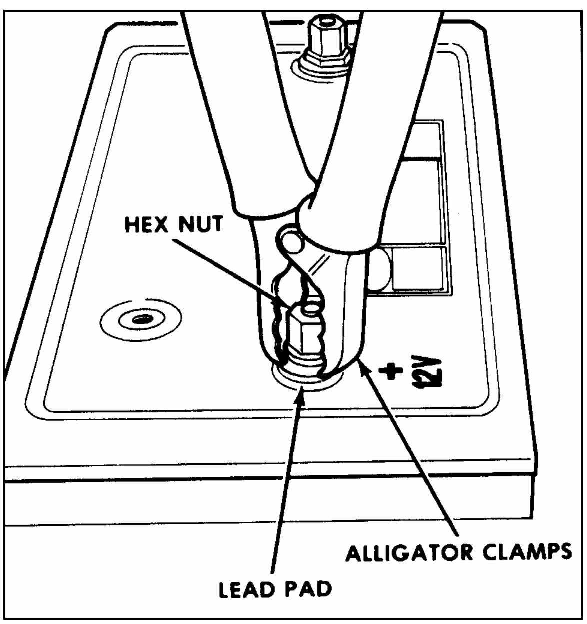


FIGURE 17: ALLIGATOR CLAMPS AND BATTERY 06065

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 up.

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

Do not jump start vehicles equipped with maintenance-free batteries if the test indicator is light yellow.

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.

1. Wear eye protection and remove rings, watches with metal bands and other metal jewelry.
2. 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:
3. Connect one end of one red jumper cable to the positive (+) terminal of the booster power source and the other end to the positive (+) terminal bar on the battery, located in the engine compartment R.H. side area (refer to fig. 18).
4. 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 (-) terminal on the structure.
5. 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.
6. 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.
7. When removing the jumper cables, perform the above procedure exactly in reverse order.

On all XLII MTH, booster terminals are located in the engine compartment on the R.H. side and are accessible through engine compartment R.H. side door (Fig. 18).

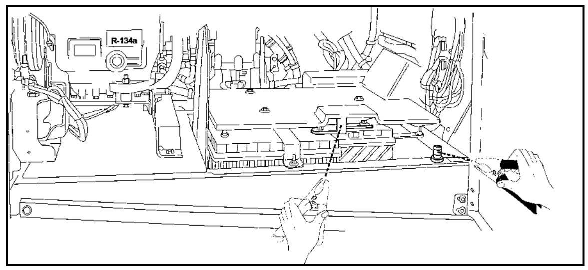


FIGURE 18: JUMP STARTING 06645

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.
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 "BAT" BATTERY VOLTAGE INCORRECT TELLTALE LIGHT

If the “BAT” (battery voltage incorrect) telltale light is illuminated, check the 24-volt voltmeter to determine if the battery voltage is too high or too low.

NOTE
According to the battery charging condition, it is normal that "BAT" telltale light illuminates upon starting the engine and stays illuminated for a few seconds. This is caused by the normal voltage drop of the battery during starting.

3.10.1 "Bat" Telltale Light 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

When performing an electrical system diagnostic with the MCD (message center display), the message “No Response ModA41” indicates either module A41 is not responding due to a CAN link problem or module A41 is not powered. Similar messages exist for all modules (A42, A43, A44, etc.).

Because it is easier to do, check first if the module is powered by probing on its gray connector. If it is, then you can conclude that there is a CAN link problem. Refer to paragraph 4.6: CAN NETWORK LAYOUT AND TROUBLE-SHOOTING in this section.

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 link 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 link, this affects all the modules and they all show « 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 wiper control panel. Connector C100 disconnects the module from the evaporator compartment. Connector C3 (rear junction box) disconnects the modules from the battery compartment.

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 paragraph 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) and also other inputs activate at the same time. 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 control unit cabin area 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 electric window down switch
Entrance door electric window up switch
Electric horn button
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
Windshield lower wiper
Multi-function lever windshield wipers intermit.
Multi-function lever windshield wipers speed 1,2
Lower windshield wipers backup switch
Lower windshield washer switch

The following inputs, either certain options or sensors which are difficult to activate, are not supported by the switch/sensor test:

- o Starter Sensor;
- o ABS Warning input;
- o Driver's Power Window Switch (up & down);
- o Fog Lights Switch;
- o Alternator Sensors 1 & 2;
- o Retarder Active Signal;
- o 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 cabin area (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 cabin (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:

- o Activate the dashboard Telltale Light Test switch 3 times within 4 seconds;
- o Push the ON/OFF button on the driver's side HVAC control module 5 times (that makes 3 transitions from OFF to ON),
- o 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 – MTH Equipped With Central HVAC System

- o Driver’s & cabin units fresh air damper opening. *[20 seconds delay]*
- o Go to the condenser compartment and check the fans. The condenser motors start at speed 1 for 3 seconds, then after a short pause, speed 2 activates. *[3 seconds delay]*
- o The cabin unit refrigerant solenoid valve activates 3 times. *[10 seconds delay]*

Then 5 beeps can be heard from the back-up alarm to indicate to go to the engine compartment.

In the engine compartment, the sequence is as follows:

- o A/C compressor clutch activates 3 times.
- o Left compressor unloader activates 3 times.
- o Right compressor unloader activates 3 times. *[5 seconds delay]*
- o Radiator fan clutch is disengaged (fan can be turned freely by hand). *[3 seconds delay]*
- o Fan clutch engages in speed 1 (fan can be turned by hand but with a certain resistance). *[3 seconds delay]*
- o Fan clutch engages in speed 2 (cannot be turned but hand). *[10 seconds delay]*

5 beeps from the back-up alarm indicate to go to the evaporator compartment.

In the evaporator compartment:

- o Evaporator fan motor runs at speed 1 for 3 seconds then runs at speed 2 for 2 seconds.
- o Hot water pump starts running for 5 seconds and hot water pneumatic valve cycles 3 times. *[20 seconds delay]*

5 beeps from the back-up alarm indicate to go to the reclining bumper compartment behind the reclining bumper.

Inside the reclining bumper compartment:

- o Driver's unit refrigerant solenoid valve activates 3 times.
- o Driver's unit hot water pneumatic valve cycles 3 times.
- o Closing of the fresh air dampers.

This ends the test. Activate the dashboard Telltale Light Test switch one time to leave the motor test mode.

4.5.2 Test Sequence – MTH Equipped With Small HVAC System

- o Driver’s unit fresh air damper opening. *[20 seconds delay]*

Then 5 beeps can be heard from the back-up alarm to indicate to go to the engine compartment.

In the engine compartment, the sequence is as follows:

- o A/C compressor clutch activated 3 times. *[5 seconds delay]*
- o Radiator fan clutch is disengaged (fan can be turned freely by hand). *[3 seconds delay]*
- o Fan clutch engages in speed 1 (fan can be turned by hand but with a certain resistance). *[3 seconds delay]*
- o Fan clutch engages in speed 2 (cannot be turned but hand). *[10 seconds delay]*

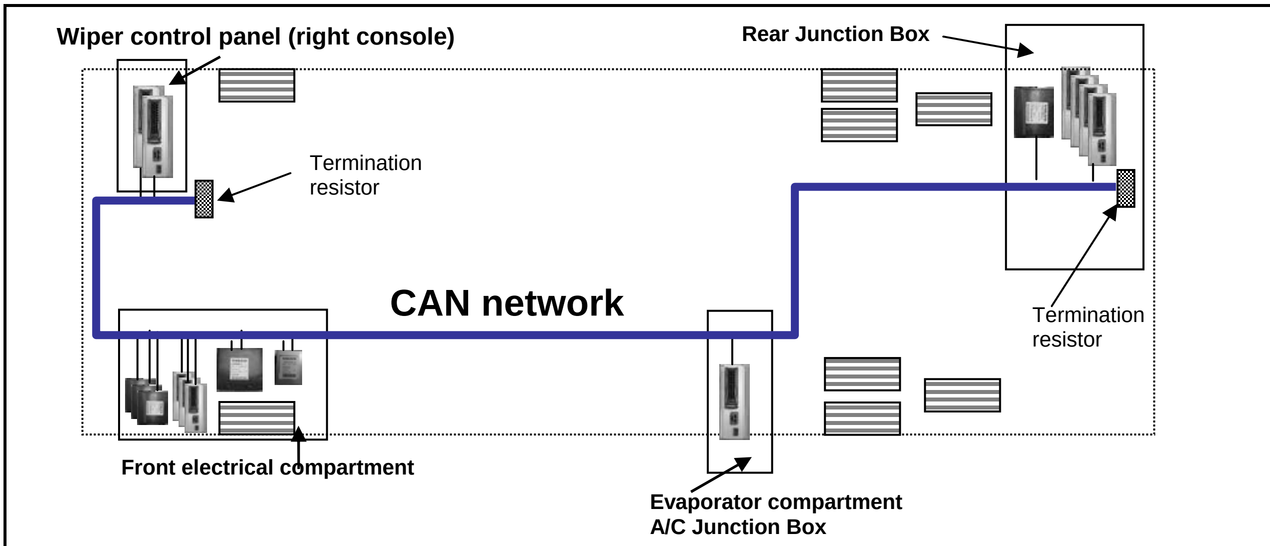
5 beeps from the back-up alarm indicate to go to the reclining bumper compartment behind the reclining bumper.

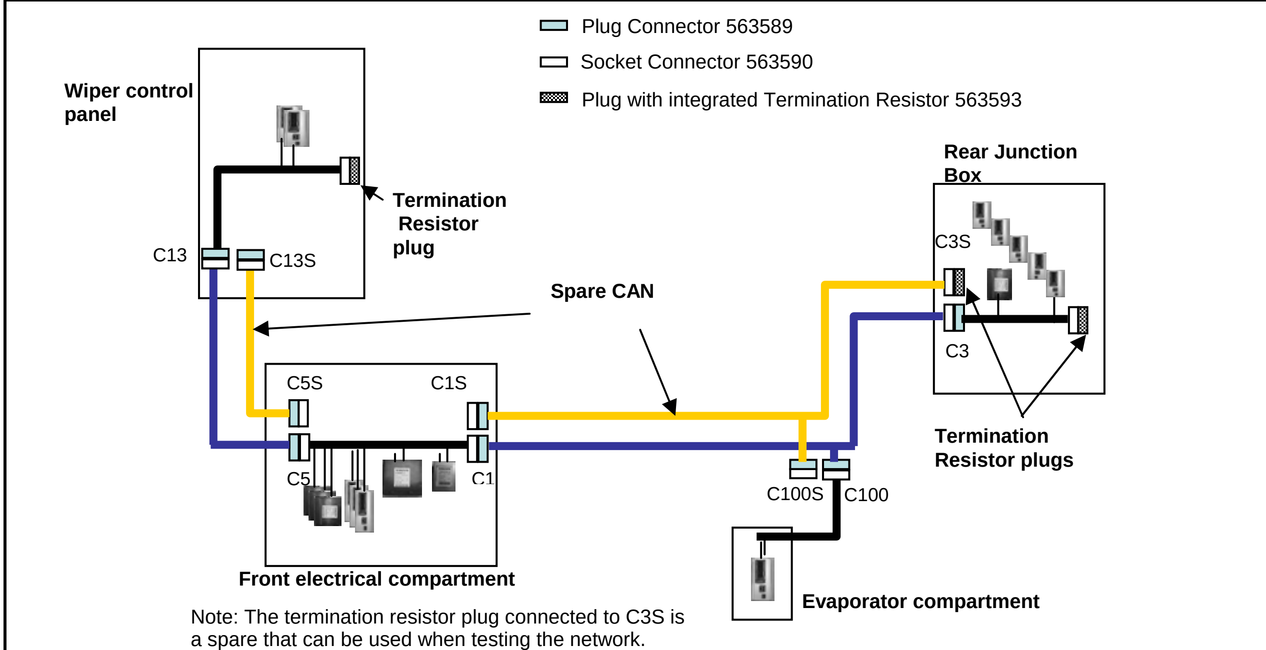
Inside the reclining bumper compartment:

- o Hot water pump starts running for 5 seconds.
- o Driver’s unit refrigerant solenoid valve activates 3 times.
- o Driver’s unit hot water pneumatic valve cycles 3 times.
- o Closing of the fresh air dampers.

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





If all 14 modules (A41 to A54) are showed as Not Responding and Active Fault, the problem could be:

- A short circuit somewhere on the CAN network.
- The network is completely open circuit. That means none of the two termination resistors are connected.

Several simple tests can be done to locate the problem.

4.7 ROADSIDE TROUBLESHOOTING

<table>
<tr><th>Problem/Symptom</th><th>Probable Causes</th><th>Actions</th></tr>
<tr><td rowspan="2">Vehicle does not Start</td><td>Rear Start selector switch is not in the NORMAL position.</td><td>1. Check that the rear start selector switch is flipped up to NORMAL start position and retry cranking.
2. Flip the rear start selector switch to “Rear Start” and start the vehicle from the rear.</td></tr>
<tr><td>CAN network problem (Multiplex)

Module A53 not powered or is defective

Engine ECM does not receive the ignition signal

Engine ECM is not powered</td><td>If the vehicle does not start from the rear:
1. Verify that module A53 is powered:
a) Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). 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 breakers CB1 and CB9.
c) Check / replace fuse F74 and F80.
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.
Check / replace fuse F78 and F79.</td></tr>
<tr><td>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</td><td>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</td><td>1. Engage the auto-programming of the I/O modules: Turn the ignition key to the OFF position 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 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.</td></tr>
</table>

Problem/Symptom	Probable Causes	Actions
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 CB2 (2nd from the bottom. 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.
No temperature control in the cabin area. Cabin temperature display indicates two dashes "--"	Problem with the temperature sensor located in the evaporator compartment air intake or the sensor wiring.	Manually control the temperature by playing with the cabin (passenger) set point. Set above 22°C (72°F) to heat and below 22° C (72°F) to cool.
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 the message center display (MCD). 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 CB3. 3. Check / replace fuse F5 and F16. 4. Probe gray connector on module to see if it is powered.
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 tripped and not reset	Check / reset circuit breaker CB8
HVAC condenser fans not functioning in speed 2	Circuit breaker CB7 tripped and not reset	Check / reset circuit breaker CB5
Windshield washer not functioning	Module A46 is not powered or is faulty	1. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM.

Problem/Symptom	Probable Causes	Actions
Defroster fan is functioning but no heat or cooling available in the driver area.		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 CB3. 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 the message center display (MCD). 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 CB1. 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 the message center display (MCD). 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 CB1. 3. Check / replace fuse F33 and F34. 4. Probe gray connector on module to see if it is powered.
Rear flashers not functioning Stoplights and center stoplights not functioning	Module A51 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 "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).

Problem/Symptom	Probable Causes	Actions
		2. Check / reset circuit breaker CB1. 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 the message center display (MCD). 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 CB7. 3. Check / replace fuse F65. 4. Probe gray connector on module to see if it is powered.
Evaporator fan not functioning	Circuit breaker CB4 tripped Module A54 is not powered or is faulty	1. Check / reset circuit breaker CB4. 2. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). 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 CB7. 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 the message center display (MCD). 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). 2. Check / reset circuit breaker CB7. 3. Check / replace fuse F67, F68. 4. Probe gray connector on module to see if it is powered.

Problem/Symptom	Probable Causes	Actions
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 CB9 is tripped or fuse F21 blown.	Check / reset circuit breaker CB9 Check / replace fuse F21.
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, 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.

- o Never connect a battery charger when the ignition is in the ON position on a vehicle with a CAN defective or certain functions will start up by themselves,
- o Disconnect the charger before starting the vehicle, if not the default functions will not activate,
- o 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

- o Startup: Turn on the ignition in the driver's area and rear start the vehicle from the engine compartment,
- o Windshield wipers: Wipers functions at 1st speed only,
- o Windshield washer fluid,
- o Headlights: Low beams only,
- o Directional signals: Rear and front only,
- o Stoplights: 2 upper stoplights + high-mounted stoplight are functional,
- o 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:

- o High beams,
- o Ability to turn on the parking lights only,
- o Driver's area lighting,
- o Tag axle activation,
- o Courtesy blinkers.

Functions lost if A44 is removed and used as spare part:

- o Fresh air damper mix trap control,
- o Driver's area and entrance overhead light,
- o Front clearance lights.

4.10 MULTIPLEX MODULES

4.10.1 CECM

The CECM plays the role of interface between the engine ECM, the Transmission Control Module TCM, 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.

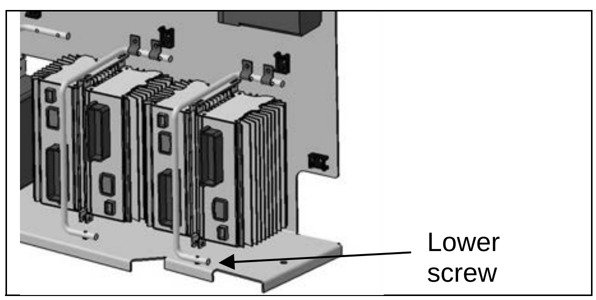


FIGURE 19: IO-B MODULE REMOVAL

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.
- Open engine compartment R.H. side door, trip circuit breaker CB2.
- 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 figure 19).
- Reset circuit breaker CB2. 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 CECM Module

- Set the ignition key to the ON position and leave it in that position at all time while performing this procedure.
- Open engine compartment R.H. side door, trip circuit breaker CB2.
- Replace the module.
- Reset circuit breaker CB2. 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 engine compartment R.H. side area and trip circuit breaker CB2 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 CB2 once again. Wait 1 second and reset CB2. Re-verify the error messages when "CAN" disappears from the telltale panel LCD display.
- 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 ALTERNATOR

Two 24 volt 140 amp., self regulated, belt driven, air-cooled BOSCH alternators may be used in the 24 volt electrical system (instead of the DELCO 24 volt 270 amp. alternator).

Change the brushes and voltage regulator as per “Repair and Testing Instructions for T1 Alternator 0120 69 552” every 100,000 miles (160 000 fm) or once every two years, whichever comes first.

Replace bearings as per “Repair and Testing Instructions for T1 Alternator 0120 69 552” every 200,000 miles (320 000 fm) or once every four years, whichever comes first.

NOTE
Use Polyrex EM grease (684922) when repacking the bearings. Grease comes in 14.1 oz (400gr) cartridges.

Refer to Bosh T1 Alternator Maintenance Manual Annexed at the end of this section.

5.1 TWIN BOSCH ALTERNATORS INSTALLATION

If the alternators needed to be removed, reinstall as follows. Refer to figure 20 for installation and to figure 21 for tightening specifications:

1. Install alternator mounting bracket (1, figure 20) to the gear case. Use the four flanged phosphor alloy bolts on the pulley end of the bracket and the flanged nuts at the transmission end of the bracket;
2. Bolt the alternators to the bracket using the three inch bolt at the top of the upper alternator (2, fig 20) and flanged bolts at the other mounting bosses (3 and 4, figure 20). Tighten the bolts in the sliding sleeves (4, figure 20) last as they will adjust to prevent breaking the alternator mounting bosses upon final tightening. Repeat for the second alternator;
3. On the drive shafts of both alternators, install key, pulley, spring washer and nut. Tighten to 220 Lbf-ft (300 Nm);

NOTE
Final tightening of the pulleys can be performed once the belt is installed. This will help keep the pulley from turning when tightening.

4. Install the snubber bracket (5, fig. 20) using three flanged bolts. Do not tighten the adjustment bolts on the snubber until after final tightening;
5. Install the compressor belt idler pulley (6, fig. 20) as shown. A stud inserts into one of the mounting holes of the pulley assembly. Fasten this one using a nut and bolts for the other two.

6. DELCO ALTERNATOR

The 24 volt charging system consists of a belt driven, oil-cooled, brushless alternator, a 24 volt voltage regulator, an alternator relay and a 12 volt system that includes a 12 volt, 100 amp equalizer. The components used in this system are described under the applicable headings hereafter.

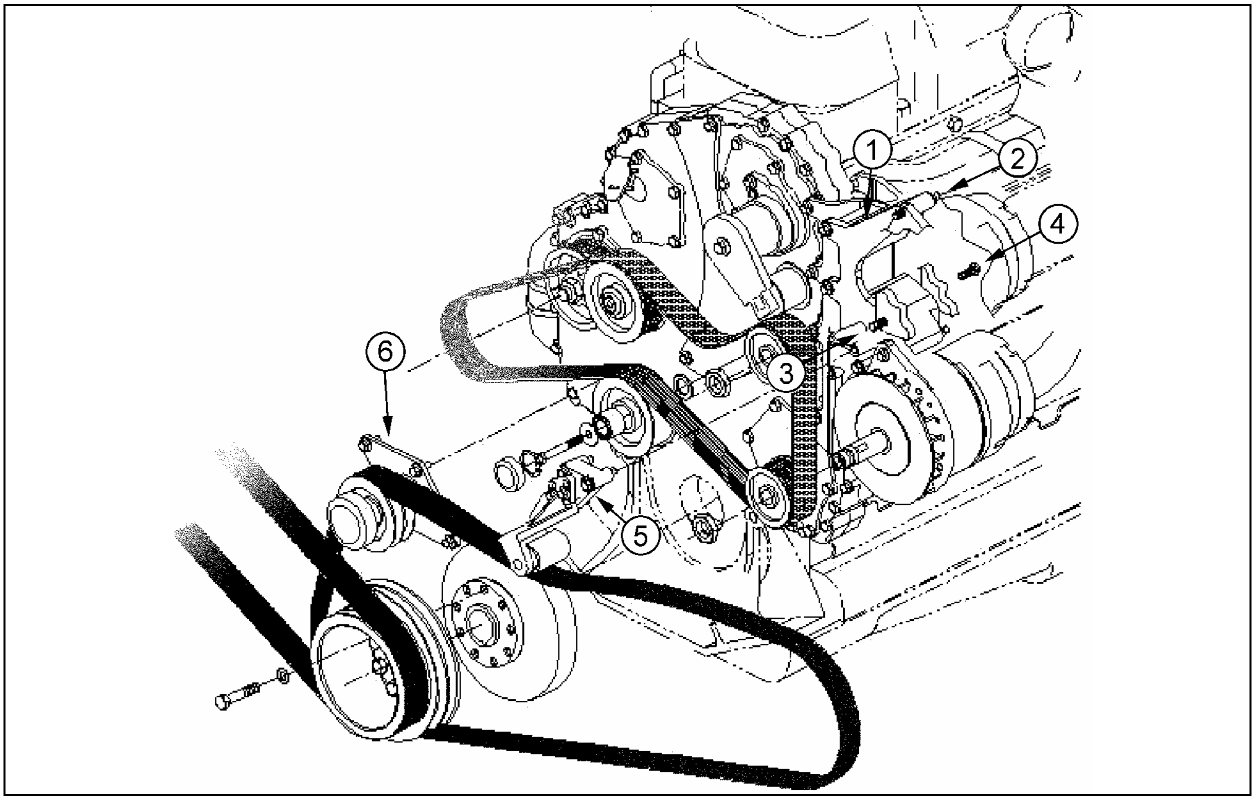


FIGURE 20: TWIN BOSCH ALTERNATORS INSTALLATION

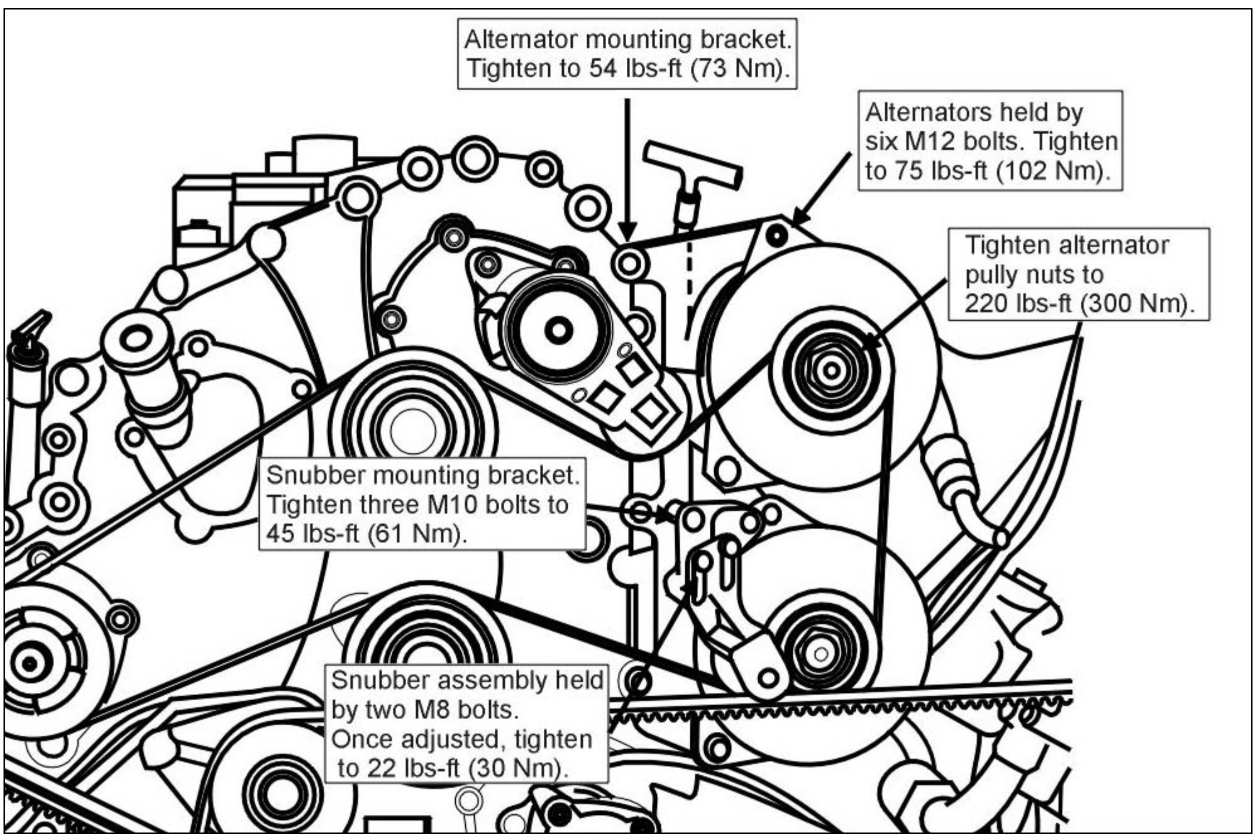


FIGURE 21: ALTERNATORS AND ACCESSORIES MOUNTING TORQUES

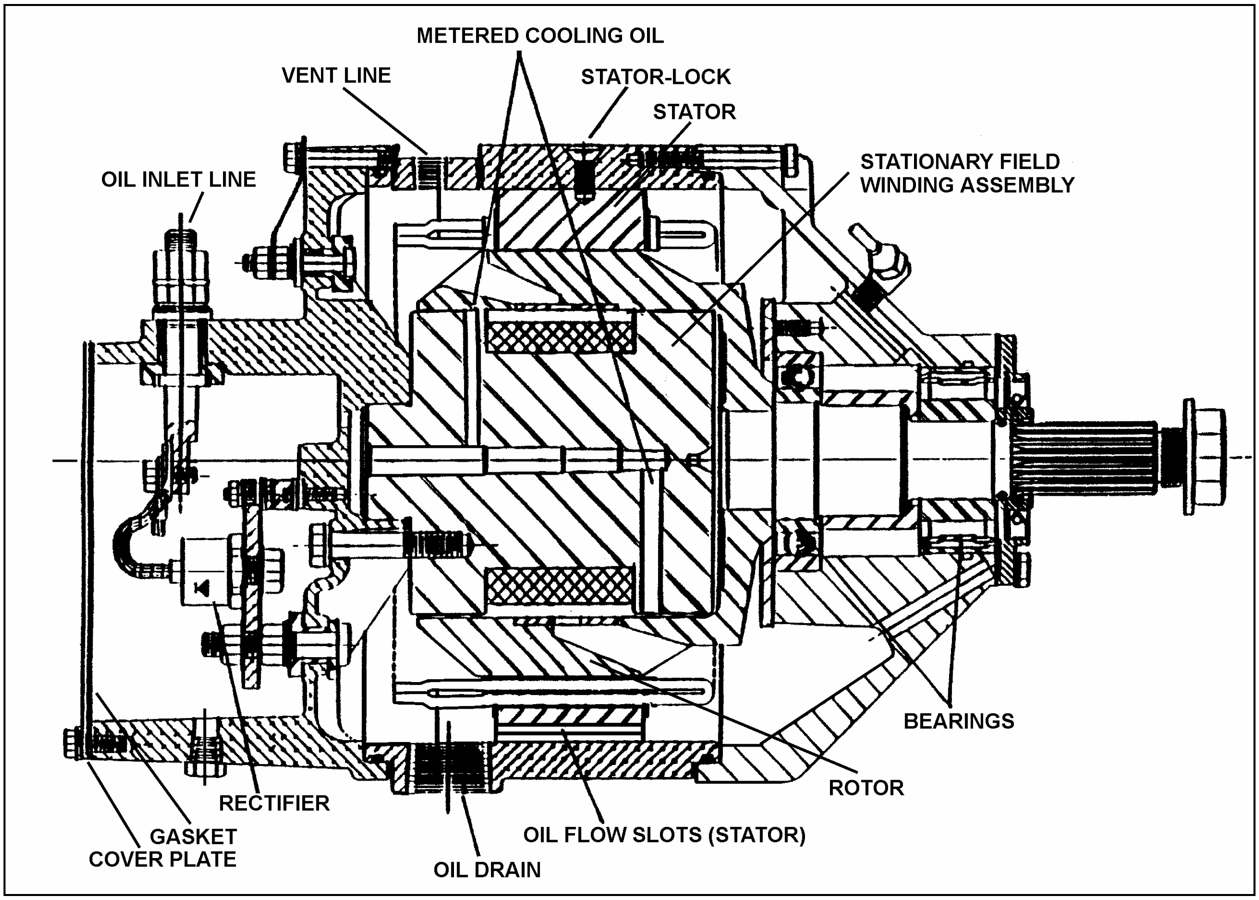


FIGURE 22: 50DN DELCO ALTERNATOR SECTIONAL VIEW 06493

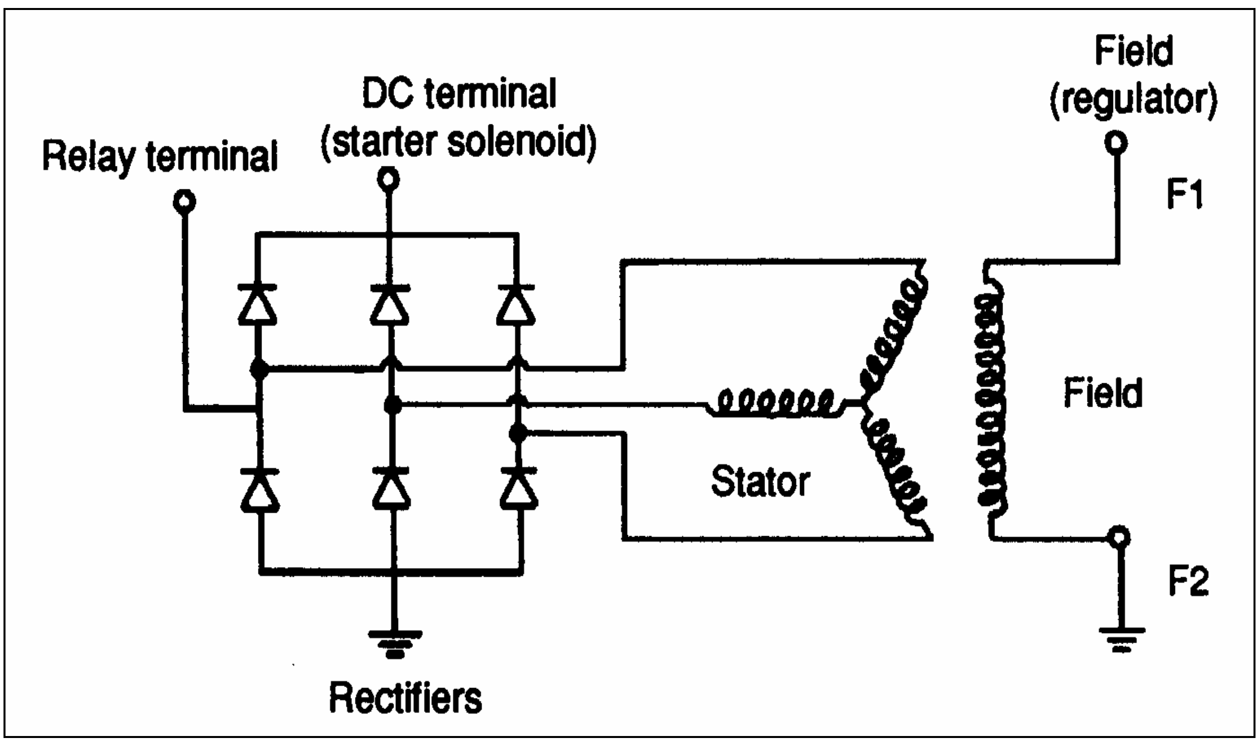


FIGURE 23: ALTERNATOR WIRING DIAGRAM (DELCO) 06067

This oil-cooled alternator is self rectifying. All current carrying members, windings, built-in diodes, and field coils are stationary. The only moving component is the rotor. The alternator is a totally-enclosed unit, cooled and lubricated by engine oil. The oil inlet is on the diode end cover. The oil drains back into the engine crankcase through the drive end frame and drive adapter housing.

This alternator should never be operated with the oil supply line disconnected. A continuous flow of engine oil through the alternator lubricates the bearings and cools the assembly. Four terminals are used on this alternator: the DC output terminal, two field terminals, and a 12 volt relay terminal. The alternator output voltage is regulated by a separate 24 volt regulator that controls the alternator field current (Fig. 22 and 23).

CAUTION

The electrical system is NEGATIVE GROUNDED. Connecting the batteries or a battery charger with the positive terminal grounded will endanger the alternator diodes and vehicle wiring by a high current flow. Burned wiring harnesses and burned "open" diodes will result. Always ensure that the alternator and battery polarities are matched prior to installation. THE ALTENATOR WILL NOT REVERSE TO ACCEPT INVERSE POLARITY. Also, do not ground or short across any of the alternator or regulator terminals.

CAUTION

Since there are no brushes, slip rings, or rubbing seals, the alternator requires no periodic maintenance other than the following:

1. Check alternator-to-engine mounting bolts for looseness and tighten to the proper torque.
2. Check all electrical connections for tightness and corrosion. Clean and tighten connections as necessary. Be sure wiring insulation is in good condition and that all wiring is securely clipped to prevent chafing of the insulation.
3. With the engine running, listen for noise and check the alternator for vibration. If the alternator is noisy or vibrates excessively, it should be removed for inspection and repair.
4. Ensure that battery terminals are clean and tight

NOTE

The relay coils connected to the alternator "relay terminal" SHOULD NEVER BE PROVIDED WITH A SUPPRESSOR DIODE as the output current at this terminal is not rectified, thus rendering relay inoperative.

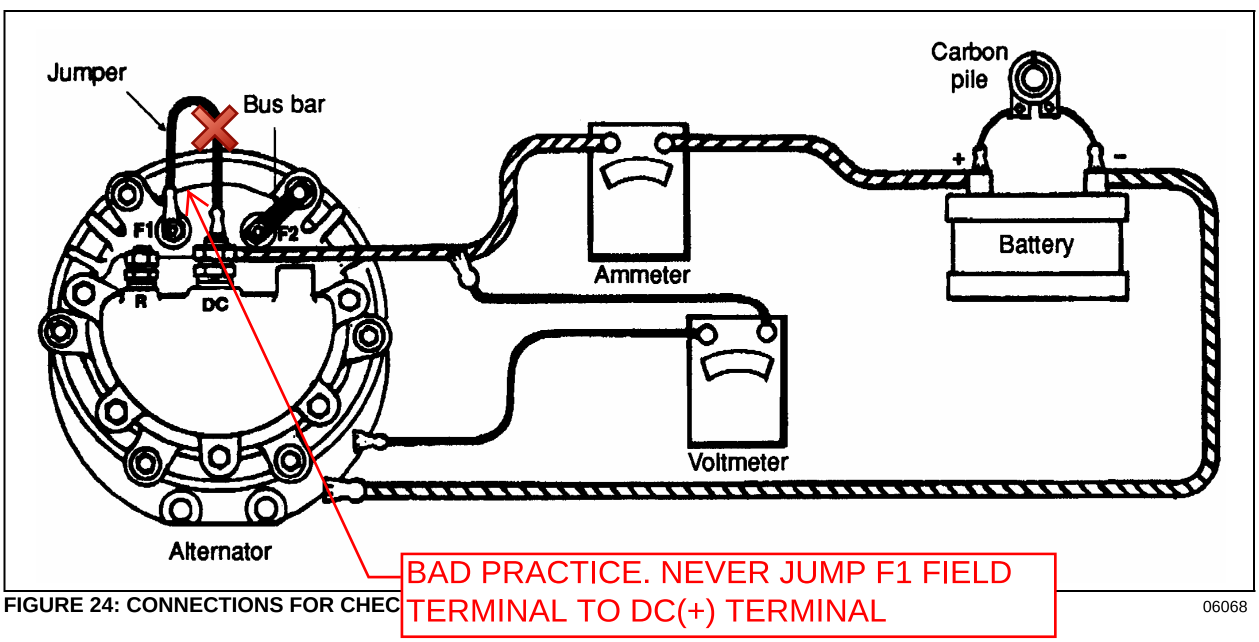


FIGURE 24: CONNECTIONS FOR CHEC

06068

7. CHARGING SYSTEM TROUBLESHOOTING

The troubleshooting of the charging system is made easier by the use of a 12 and a 24 volt voltmeter, "*BAT*" and "*ALT*" telltale lights mounted in the dashboard (for location refer to the *"Owner's Manual"*).

7.1 ALTERNATOR OR VOLTAGE REGULATOR

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

7.2 ALTERNATOR DIAGNOSIS

CAUTION

Before checking the alternator, set the ignition key switch to the OFF position.

It is not necessary to disassemble completely the alternator to make electrical checks. All electrical checks are made at the diode end of the assembly without having to remove the rotor, drive end frame or bearing. If the electrical components are not defective but bearing replacement is necessary, this can be done at the drive end without having to disassemble the diode end of the unit.

The components in the alternator that require electrical checks are the field winding, the six diodes, and the stator winding.

7.2.1 Diode Checks

Each diode may be checked for shorts and opens as follows:

1. Ensure the ignition key switch is set to the "OFF" position.
2. Remove the pipe plug from underneath the end housing to drain the oil in the rectifier engine oil supply.
3. Remove the cap screws (7) and lock washers that attach the diode end cover to the end housing. Remove the end cover from the end housing.

NOTE

Do not operate the alternator unless this unit is completely reassembled.

4. Remove seal from the end housing, detach and remove "DC" and relay terminals, stud, insulating sleeves and O-rings.
5. Disconnect all diode flexible leads; i.e. three from the output terminal stud and three from the diode supports. See figure 25 for more details.

Each diode may be checked for short or open circuits with an ohmmeter.

NOTE

The ohmmeter polarity may be determined by connecting its leads to the voltmeter leads. The voltmeter will read up-scale when the negative leads are connected together and the positive leads are connected together. The polarity of the voltmeter leads may be determined by connecting the leads to the identified terminals on a battery.

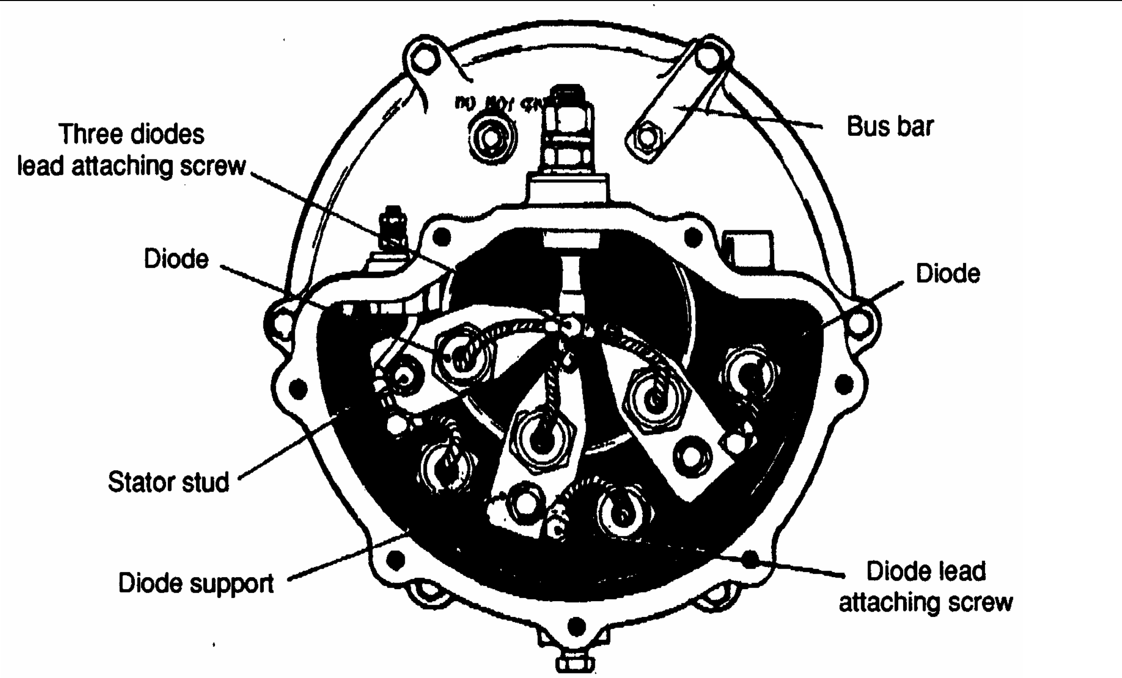


FIGURE 25: VIEW OF RECTIFIER END FRAME WITH COVER REMOVED 06069

NOTE
Use an ohmmeter with a single 1.5 volts cell. Most accurate reading will be determined when the 300 ohms value is calibrated to the center one-third of the scale. DO NOT USE high voltage, such as a 110 volts test lamp to check diodes.

To check diodes mounted in the supports for short fields, connect the positive ohmmeter lead to each diode lead and the ohmmeter negative lead to each support as shown in "A", "B", and "C" of figure 26. To check diodes mounted in the end frame for shorts, connect the ohmmeter positive lead to each diode lead and the ohmmeter negative lead to the end frame as shown in parts "D", "E", "F". The ohmmeter readings may vary considerably when checking diodes for shorts, but if the reading is 300 ohms or less, the diode is probably defective and should be replaced. A diode that reads 300 ohms or less will allow excessive reverse current from the battery. Replace defective diodes as explained later in this section.

To check the diodes mounted in the diode supports for open fields, connect the ohmmeter negative lead to each diode lead and the ohmmeter positive lead to each support as shown in parts “A”, “B”, and “C” of figure 27. To check the diodes mounted in end frame for shorts, connect the ohmmeter negative lead to each diode lead and the ohmmeter positive lead to the end frame as shown in parts “D”, “E” and “F”. An infinite resistance reading indicates an open diode. Diodes can be replaced by following the procedure outlined under DIODE REPLACEMENT”.

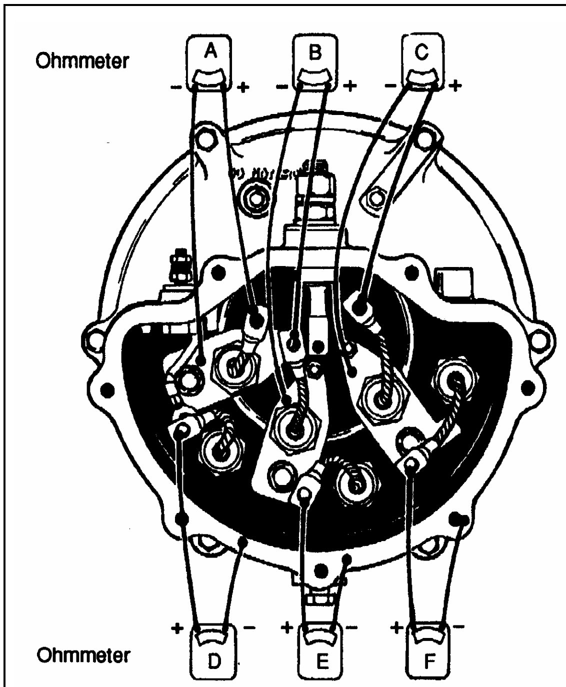


FIGURE 26: DIODE TESTING 06070

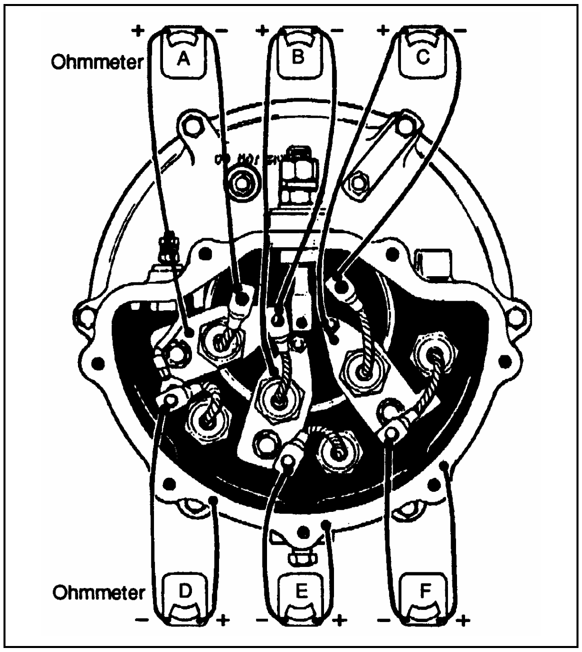


FIGURE 27: DIODE TESTING 06071

When reinstalling diodes, torque to 9-11 lbf-ft (12-15 Nm). Re-stake next to the threads in an arbor press with a 1/8 inch (3,2 mm) round punch. Press the punch with gradual pressure. Do not strike as the shock may damage the diodes.

7.2.2 Field Winding Check

The field winding may be checked for shorts and opens with an ohmmeter. To check the field winding, connect the ohmmeter to field terminal and to ground. A resistance reading above normal indicates an open, and a reading less than normal indicates a short field. The normal resistance value is 3.0 to 3.3 ohms at 80°F (27°C). An alternate method of checking is to place a battery of specified voltage, and an ammeter in series with the field winding. The current should register 7.2 to 8.3 amperes at 24 volts. Coil resistance is approximately 3.1 ohms. Amperage readings, other than the above, indicate an open, grounded, or shorted field. A defective field coil can be replaced by removing the end frame on which the field terminal is located and then removing the four field coil mounting screws. See FIELD REPLACEMENT" for a detailed procedure.

7.2.3 Stator Winding Check

The stator winding may be checked for open and short fields with an ohmmeter as follows:

Open Fields

Connect the ohmmeter leads to two pairs of diode supports as shown in parts "A", "B", and "C" of figure 28. Correct polarity of the leads must be observed. The ohmmeter should indicate a low resistance. If an infinite or a high resistance is measured in either one or both checks, the stator windings are open.

Ground

To check the stator windings for ground, connect an ohmmeter to the diode support and diode end frame as shown in part "C" of figure 28. The ohmmeter should indicate a very high or infinite resistance. If zero or a very low resistance is measured, the windings are grounded.

Shorts

The stator windings are difficult to check for shorts without finely calibrated laboratory test equipment due to the very low resistance values of the windings. However, if all other alternator checks are satisfactory, yet the unit fails to perform to specifications, shorted stator windings are probable.

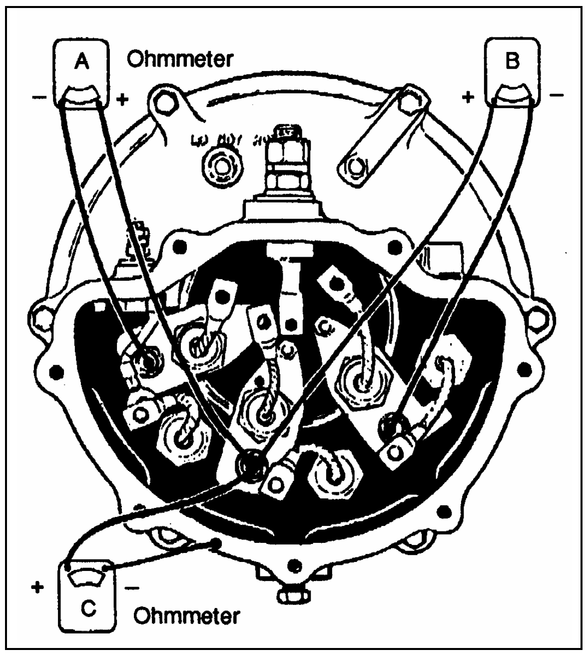


FIGURE 28: STATOR WINDING TEST 06072

7.3 DIODE REPLACEMENT

The following replacement procedures are based on the assumption that the diode end cover is still off and diode leads were disconnected as explained earlier in this section.

NOTE
When replacing a diode, make sure it is designed for a negative ground system. The diode can be identified by the symbol stamped on the diode case. The arrow must point toward the diode flexible lead.

To replace the three diodes that are mounted in the supports attached to the stator lead studs, it is necessary to remove the diode and support assembly. The two outer diode and support assemblies are identical and can be installed on either side. The center unit has a different support, with 2 inches (50,8 mm) between the mounting hole centers.

NOTE
The outer supports are provided with 2 ¼" (57,15 mm) center holes.

7.3.1 Diode Replacement (in Support)

1. Remove nut with lock washer attaching the diode support to the stator lead stud.
2. Remove nut, lock washer, and flat washer attaching support to the small stud in the end frame.
3. Remove the diode and support assembly. Then remove insert from small hole in support or from small stud in the end frame.
4. Remove nut and flat washer from diode mounting stud, and then remove diode from the support.
5. Place a new diode in the support and install a flat washer and nut on the diode mounting stud. Hold the diode with a wrench placed over flats on the diode, while tightening nut on the mounting stud to a torque of 160-180 lbf-in (18-20 Nm).
6. Place diode and support assembly over the stator lead stud and the small mounting stud. Place insert over small stud inside the hole in the support. Install flat washer, lock washer, and nut on the small stud, and tighten to a torque of 22-25 lbf-in (2-3 Nm). Install nut with lock washer on stator lead stud and tighten firmly.

7.3.2 Diode Replacement (in End Frame)

To remove diode, use a thin 1 inch open end wrench on flats of the diode case to unscrew diode from the end frame. Thread the new diode into the end frame and tighten to a torque of 160-180 lbf-in (18-20 Nm). If no other parts are to be replaced, refer to “DIODE END COVER INSTALLATION” in this section.

7.4 FIELD REMOVAL

1. Remove three diode and support assemblies from the end frame to provide access to the lower field to end frame bolts (2).
2. Remove nut with lock washer and flat washer from three stator lead studs.
3. Remove the six bolts and lock washers attaching the diode end frame to the stator frame.
4. Separate the end frame from the stator frame, and remove the end frame and field assembly from the rotor while pushing the stator lead studs out of the end frame.
5. Remove nut, lock washer, flat washer, and insulating washer which secure the field lead terminal stud in the end frame. Push the stud out of the end frame.
6. Remove field terminal stud insulating bushing and seal from the end frame. Remove insulating sleeve from the field terminal stud.
7. Remove the four bolts and lock washers attaching the field to the end frame.
8. To separate the field from the end frame, install four 3/8-24 x 3 inch bolts in place of the 3/8-24 x 2 inch bolts removed in step 7. Thread bolts in to even heights. Support the end frame in an arbor press. Then, using a suitable press plate to exert pressure on all four bolt heads, press the field out of the end frame.

7.5 FIELD INSTALLATION

1. Position the field assembly on the end frame. Insert four 3/8-24 x 3 inch bolts through the end frame and thread into the field to keep holes aligned.
2. Support the end frame on an arbor press bed so that the diodes will not be damaged, and press the field into the end frame. Press in until shoulder on field coil bottoms against the end frame.
3. Remove the four guide bolts. Install four 3/8-24 x 2 inch bolts, using new lock washers to attach the field to the end frame. Tighten bolts securely.

4. Place insulating sleeve in inner side of the field terminal stud hole in the end frame, and insert the terminal stud through the sleeve. Place two O-rings and insulating bushing over the terminal stud and push into hole in the end frame. Install insulating washer, flat washer, toothed lock washer, and nut on terminal stud. Tighten firmly.
5. Install each stator lead stud in the end frame as follows: Place insulating washer over the stud and insert the stud through the end frame. Place the insulating bushing over the stud and position in end frame hole. Install flat washer, lock washer, and nut on the stud. Tighten firmly.
6. Install three diode and support assemblies on the end frame as previously directed under “DIODE REPLACEMENT”.
7. Install a new seal in notch around end of the stator frame. Insert field into the rotor and position the end frame against the stator frame. Attach end frame to the stator frame with six bolts and lock washers. Tighten bolts firmly.
8. If no other parts require replacement, refer to "DIODE END COVER INSTALLATION" in this section to complete the assembly.

7.6 STATOR REPLACEMENT

If tests performed under “Stator Winding Checks” earlier in this section indicated an open circuit or short in the stator, the stator and frame assembly must be replaced.

7.6.1 Removal

1. Remove diode end frame and field assembly as previously directed in steps 1 through 4 under “Field Removal”.
2. Remove the six bolts and lock washers attaching the stator frame to the drive end frame.
3. Separate the stator frame from the drive end frame and remove the stator frame from the end frame and rotor.

7.6.2 Soldering Stator Terminal Leads

1. Using a wire brush, thoroughly clean the wire and terminal.
2. Silver solder the stator lead to the terminal using a torch.
3. Thoroughly clean the silver solder connection with a wire brush.
4. Using a high grade energized rosin flux, coat the silver soldered connection with a 80-20 tin-lead solder or pure tin solder to prevent deterioration of the silver solder by engine oil.

NOTE
The silver solder will provide the required mechanical strength, which will not be affected by temperature. The tin-lead solder will protect the silver solder connection from deterioration by engine oil.

7.6.3 Installation

1. Position new seal in notch around the drive end of the stator frame.
2. Position the stator and frame assembly over the rotor against the drive end frame. Attach the stator frame to the drive end frame with six bolts and lock washers. Tighten bolts firmly.
3. Install diode end frame and field assembly as directed in steps 5, 6 and 7 under “FIELD INSTALLATION”.
4. Install rectifier end cover as directed later.

7.7 DIODE END COVER INSTALLATION

1. Make sure all diodes are properly installed and securely tightened. Leads from diodes threaded into the end frame must be securely attached to the diode supports. The relay terminal lead must also be attached to the left diode support.
2. Connect leads from the three diodes mounted in supports to the output terminal stud. Tighten the attachment screw firmly. Place insulating bushing over relay terminal stud.
3. Place a new seal in the diode end frame.
4. With the end cover in place against the end frame, install the cap screws and lock washers. Tighten the cap screws evenly and firmly.
5. Make sure the drain plug is installed in bottom of the end cover and securely tightened.

7.8 ALTERNATOR REMOVAL (DELCO)

1. Place Rear Start Panel *"Starter Selector Switch"* in engine compartment to the *"OFF"* position.
2. Place the ignition key switch to the "OFF" position.
3. Remove alternator drive belt (see "ALTERNATOR DRIVE BELT").

NOTE
When reinstalling drive belt, it is important to set the belt tension correctly. (Refer to the appropriate heading later in this section).

4. Scratch off protective sealer from electrical connections (relay, field and positive terminals). Refer to figure 29.

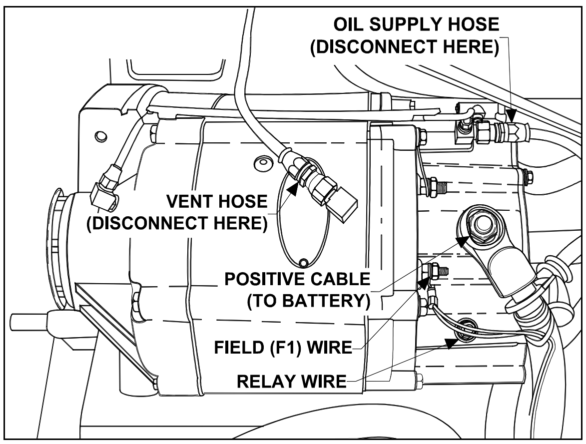


FIGURE 29: ALTERNATOR (HOSES AND WIRES) 06341

NOTE
After reconnecting electrical wires, it is important to cover terminals with protective sealer (Prévost #680745).

5. Disconnect wire #25 from the relay terminal, wire #107 from the field "F1" terminal and disconnect battery cable from the positive "+" terminal on the diode end cover. Tag wires removed to ease identification at time of installation. Refer to figure 29.
6. Disconnect oil supply line and vent hose from top of alternator (Fig. 29) and tape lines to prevent entry of foreign matter. Disconnect oil drain hose from bottom of alternator (Fig. 30) and tape line to prevent entry of foreign matter.
7. Remove the four bolts and lock washers fixing the alternator (refer to fig. 30).

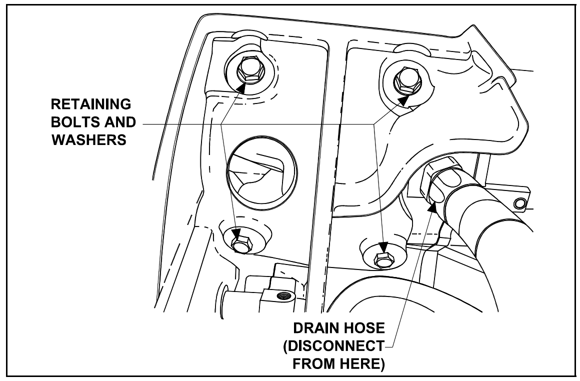


FIGURE 30: ALTERNATOR RETAINING BOLTS AND WASHERS 06350

WARNING
Alternator weights approximately 154 lbs (70 kg). Another person is required to take the alternator out of the engine compartment.

7.8.1 Disassembly of Alternator

After diode, field and stator winding checks, the alternator can be disassembled to repair a faulty component, such as field or stator, or to proceed with bearing or rotor replacement. Perform the following steps to disassemble the alternator:

1. Remove nuts and washers from "DC" terminal on diode end frame.
2. Separate the diode cover plate from the diode end frame by removing the mounting screws.
3. Remove the washer, nut and lock washer attaching the diode supports to the end frame, the three screws connecting the diode leads to the diode supports, and the three nuts which attach the stator studs to the diode supports.
4. Separate the diode support assemblies from the diode end frame, and the three nuts that connect the studs to the diode end frame.
5. Mark the position of the drive end frame and diode frame with respect to the stator assembly so that the parts can be reassembled in the same position.
6. Detach the diode end frame and field assembly from the stator assembly by removing the attachment screws.
7. Separate the field assembly from the diode end frame by removing the four attachment screws.

8. Separate the rotor assembly and drive end frame from the stator assembly by removing the attaching screws.
9. Remove the shaft nut and washer, and the pulley. Press the rotor shaft out of the drive end frame.
10. Remove the retainer plate and pull the bearings from the drive end frame.

7.8.2 Alternator Cleaning and Inspection

Whenever the alternator is disassembled, it should be cleaned and inspected.

Cleaning

If sludge has accumulated on the stator, a light mineral oil should be used to clean it.

Inspection

When the alternator has been disassembled to the extent that the stator is exposed, the stator should be checked for the following:

a) Adequate varnish.

b) Proper spacing of conductors so that “near shorts” do not exist.

c) Proper phase lead placement.

d) Strong conductor and cross-over welds

7.8.3 Bearing or Rotor Replacement

Whenever the rotor and drive end frame are disassembled for any reason, the single-row ball bearing must be replaced with a new one due to the probability of damage during disassembly.

Removal and Disassembly

1. If the pulley was not removed from the rotor shaft at time of alternator removal, remove the nut and flat washer from the shaft and pull the pulley off the shaft.
2. Remove the six bolts and lock washers attaching the drive end frame to the stator frame. Separate the drive end frame from the stator frame. Remove the drive end frame and support assembly.
3. Support the drive end frame in an arbor press so that the rotor can be pressed down out of the end frame. Using a suitable adapter against the end of the rotor shaft that will pass through the inner race of the double-row ball bearing, press the rotor down out of the end frame and bearings. Since the single-row bearing outer race is held in the end frame by the retainer plate, and the inner race is a press fit on to the rotor shaft, the bearing will probably be damaged when the shaft is pressed out and need to be replaced with a new part.
4. Remove the six screws attaching the bearing retainer plate to the drive end frame. Remove the retainer plate, the single-row bearing and the bearing spacer from the end frame.
5. Support the drive end frame in an arbor press with the double-row bearing down, so that the bearing can be pressed down out of the end frame. Using a suitable driver that will exert a force on the bearing outer race, press the bearing out of the end frame.
6. Remove the rubber bearing clamp from groove in the end frame.

Assembly and Installation

1. Install a new single-row ball bearing into inner side of the drive end frame. Install the bearing retainer plate and attach with six screws. Stake screws in place after tightening.
2. Position the rubber bearing clamp in the groove in bearing bore of the drive end frame. Lubricate the clamp to permit the bearing to be pressed in without dislodging or damaging the clamp.
3. Position the rotor in an arbor press with the shaft end up. Install the drive end frame and single-row bearing assembly over the rotor shaft. Using a driver over the rotor shaft, which will exert a force on the bearing inner race, press the bearing onto the shaft until it bottoms against the rotor.
4. Install bearing spacer over the rotor shaft. Position the double-row bearing over the rotor shaft at end frame bore. Using an adapter that will exert a force on both the inner and outer races of the bearing, press the bearing onto the shaft and into the end frame until the inner race bottoms against the bearing spacer.
5. Place a new seal around the drive end of the stator frame.
6. Insert the rotor between the stator and field, and position the drive end frame against the stator frame. Attach the end frame to the stator frame with six bolts and lock washers. Tighten the bolts to a torque of 5 to 5.4 lbf-ft (6-7 Nm).

CAUTION

When replacing the alternator on the vehicle, ensure that an alternator with the proper drive ratio is used. Installation of an alternator with any other drive ratio will result in severe and costly damage to the alternator and engine.

7.8.4 Alternator Reassembly

Reassembly is the reverse of disassembly.

NOTE

When tightening the outside nut on the "DC" output terminal, torque the nut to 30- 35 lbf-ft (41-47 Nm). The lower nut should be supported while doing so.

When reinstalling diodes, tighten to a torque of 9-11 lbf-ft (12-15 Nm).

7.8.5 Output check

When removed from the engine, the alternator may be checked without circulating oil on a test bench, providing the output is limited to 100 amperes or less. The alternator may be bench tested without circulating oil at outputs exceeding 100 amperes, as long as the period of operation is limited to less than 15 seconds.

CAUTION

Operating the alternator at outputs greater than 100 amperes without adequate oil circulation for periods exceeding 15 seconds, will cause the alternator to overheat, resulting in damage to the winding and diodes.

If the alternator is to be operated at an output greater than 100 amperes for longer than 15 seconds, circulating oil must be provided. SAE 30 engine oil must be applied to the connection on the diode end cover at a pressure of 35 psi and at a temperature of 60°F to 220°F (16°C to 104°C). This will provide an oil flow of about one gallon per minute.

To check the alternator on a test bench, make electrical connections as shown in figure 24. Make sure the negative battery terminal is connected to the alternator frame.

7.9 ALTERNATOR DRIVE BELT

Removal

1. Insert a ¾'' socket drive into the tensioning arm opening (Fig. 31).
2. Twist the tensioning arm to slacken belt.
3. Remove belt.

Installation

Installation of the alternator drive belt is the reverse of removal.

7.9.1 Adjustment

Correct belt tension is required to maximize belt life. The tensioning arm maintains proper belt tension, no adjustment is required.

Check for wear and proper tension every 6,250 miles (10 000 km) or twice a year, whichever comes first.

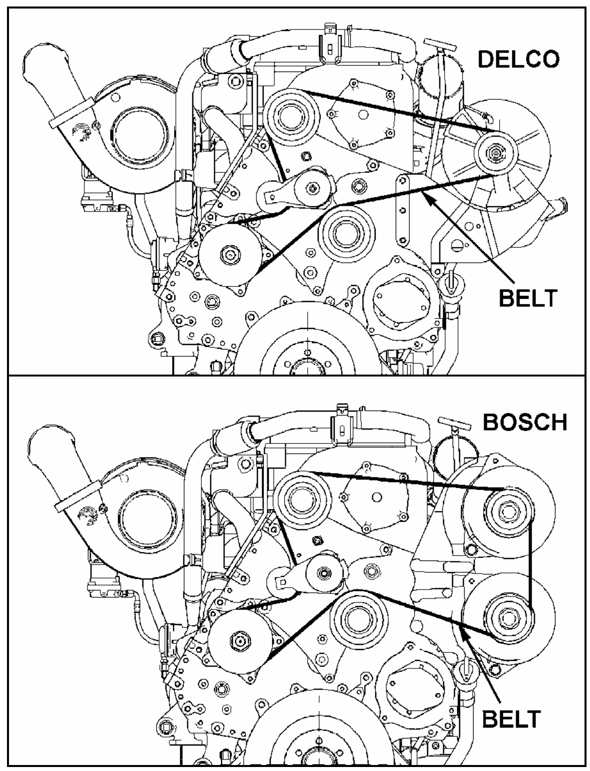


FIGURE 31: ALTERNATOR DRIVE BELT 06509

8. VOLTAGE REGULATOR (DELCO)

The 24 volt regulator used with Delco alternator is located in the engine compartment R.H. side area.

The transistor regulator illustrated in figure 32 is an assembly mainly consisting of diodes, capacitors, resistors and transistors. These components are mounted on a printed circuit panel board to form a completely static unit containing no moving parts. Regulators of this type have only four terminals which are identified "GND." (ground), "FLD" (field) "BAT" (battery) and “IGN” (ignition).

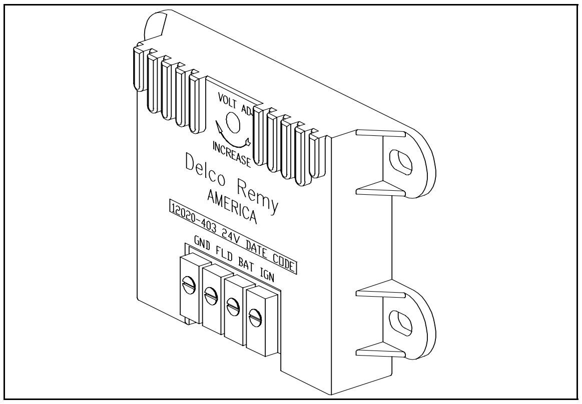


FIGURE 32: VOLTAGE REGULATOR 06408

The regulator components work together to limit the alternator voltage to the preset value by controlling the alternator field current. This is the only function that the regulator performs in the charging system.

The voltage at which the alternator operates is determined by the regulator adjustment. Once adjusted, the alternator voltage remains constant. The regulator is unaffected by length of service, changes in temperature, or changes in alternator output and speed.

A typical wiring diagram of a negative ground system is illustrated in figure 33. This diagram shows only the basic charging system components. It does not show any components such as the control relays. Refer to *“Charging system”* wiring diagram, in *“Wiring diagrams”* for the electric circuits and connections.

Voltage regulator maintenance

The voltage regulator is a service-free electronic unit. When it fails, it should be replaced. The following procedure must be used:

⚠ **CAUTION**
Set the ignition key switch to the “OFF” position.

- o Open the engine compartment R.H. side door in order to get access to the voltage regulator;
- o Unscrew the electrical cable connectors;
- o Unscrew the voltage regulator unit;
- o Install a new voltage regulator by reversing the procedure.

NOTE
For information about BOSCH alternator and voltage regulator, refer to technical publication "Repair and Testing Instructions for T1 Alternator 0120 689 552".

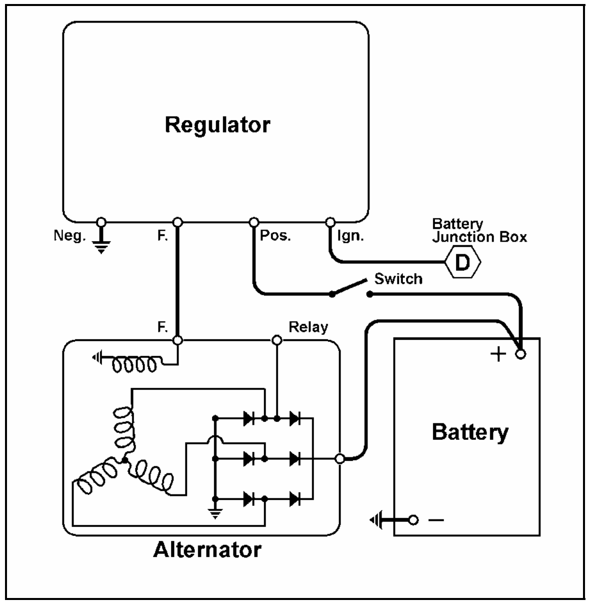


FIGURE 33: TYPICAL WIRING DIAGRAM OF A NEGATIVE GROUND SYSTEM 06415

8.1 TROUBLESHOOTING PROCEDURES

Trouble in the electrical system will usually be indicated by one of two conditions: an undercharged or an overcharged battery. Either condition can result from an improper voltage regulator setting:

Checking Battery Voltage

The absence of gas production during the continuous appearance of the green dot in the battery’s built-in hydrometer indicates that the voltage setting is satisfactory. Check the following conditions:

Checking Voltage Regulator Setting

1. To check the voltage setting, connect a voltmeter across the “POS” and “NEG” terminals on the regulator, and an ammeter to the “C” terminal on the alternator. Refer to figure 34.
2. Operate the engine at approximately 1000 rpm (about 2300 alternator rpm), with accessories on, to obtain an alternator output of 20-200 amperes.

3. Note the voltage setting. It should be steady at 27.5 volts.
4. If not, the desired setting can be obtained by removing the plug from the voltage regulator cover and slightly turning the adjusting screw inside the regulator. Turn the adjusting screw clockwise to increase the voltage setting or counterclockwise to decrease it. See figure 35 for details.

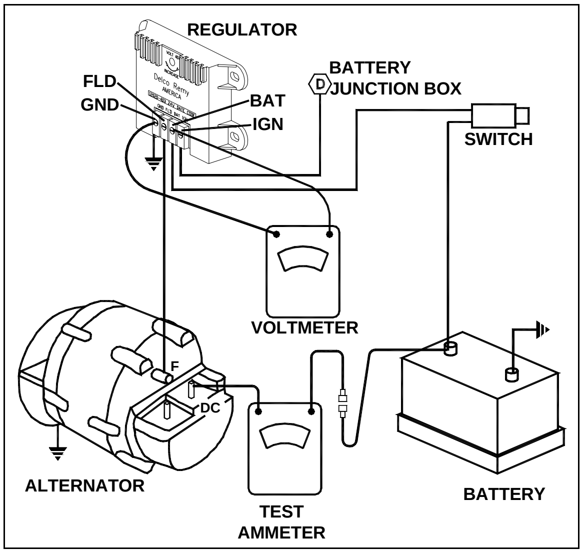


FIGURE 34: REGULATOR VOLTAGE SETTING 06416

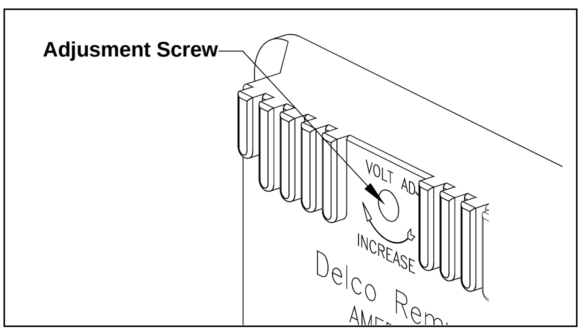


FIGURE 35: ADJUSTING REGULATOR VOLTAGE SETTING 06418

NOTE
If regulator voltage cannot be adjusted to the specified setting, remove the regulator and repair or replace it as necessary.

8.1.1 Undercharged Battery

If the voltage setting is steady and reasonably close to the specified value and the battery is undercharged, raise the setting by 0.3 volt, then check for an improved battery condition over a minimum service period of 48 hours. If the voltage cannot be adjusted to the desired value, the alternator should be checked as follows:

1. Stop alternator, turn off all accessories and disconnect battery ground cable.
2. Disconnect all leads from the regulator and from the alternator field. **Do not allow leads to touch ground.**
3. Connect a voltmeter and an ammeter in the circuit at the alternator "DC" terminal.
4. Connect a jumper lead from the alternator "DC" terminal to the alternator field terminal.

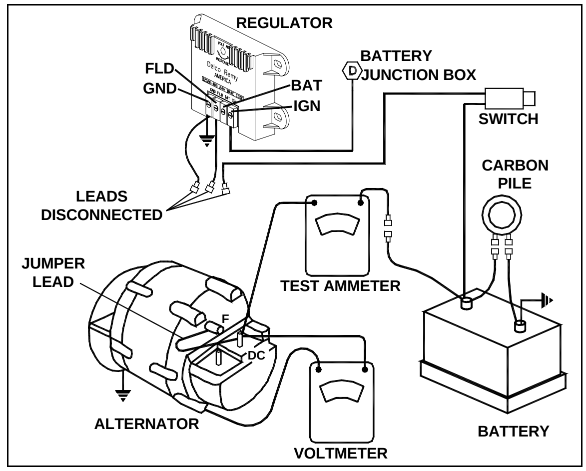


FIGURE 36: REGULATOR VOLTAGE TEST (UNDERCHARGED BATTERY) 06417

5. Connect a carbon pile resistor load across the battery. Turn to the *"Off"* position.
6. See figure 36 for wiring connections.
7. Reconnect battery ground cable
8. Turn on all vehicle accessories.
9. Operate alternator and adjust carbon pile resistor load as required to check for rated output as given in Delco-Remy Service Bulletin 1G-187 or 1G-188.
10. Check the alternator field winding as follows: Disconnect the lead from the field terminal and connect an ohmmeter from the field terminal to ground. A resistance reading above normal indicates an open field, and a resistance reading less than normal indicates a shorted or grounded field. The normal resistance can be calculated by dividing the voltage by the field current published in Delco-Remy Service Bulletin 1G-186, 1G-187, or 1G-188. The normal resistance value should be at or near midscale on the ohmmeter for accuracy. An alternate method of checking is to connect a battery of specified voltage and an ammeter in series with the field winding, and compare

readings with published specifications in Delco-Remy Service Bulletin 1G-186, 1G-187, or 1G-188. An alternator is defective if it does not produce rated output or if field windings are faulty. If the alternator provides rated output, and field windings check satisfactorily, the regulator should be checked as covered under "Regulator Checks".

8.1.2 Overcharged Battery

If the voltage setting as checked above is steady and reasonably close to the specified value, lower the setting by 0.3 volt and check for an improved battery condition over a minimum service period of 48 hours. If the voltage cannot be adjusted to the desired value, proceed as follows: where the alternator field is grounded internally in the alternator as shown in figure 30 a shorted or grounded field or a defective regulator can cause an overcharged battery. The field winding can be checked as covered in paragraph “Undercharged Battery”. If the field winding is found to be correct, the alternator is not defective, and the regulator should be checked as covered under “Regulator Checks”.

8.2 REGULATOR CHECKS

Separate the cover from the base, and remove the panel assembly from the cover. Carefully note the location of all washers and lock washers.

The component parts are keyed to figure 33. Before making electrical checks, visually inspect the components and make sure all soldered connections are secure. Various electrical checks with an ohmmeter can be made to determine which components are defective.

The ohmmeter **must** be accurate, and should be a scale-type meter with a 1.5 or 3 volt cell. Most digital ohmmeters cannot be used to check semiconductors. However, some digital ohmmeters are specially designed to test semiconductors and can be used to test components in the regulator. Consult the ohmmeter’s manufacturer for specifications concerning the capabilities of the ohmmeter.

It is important that all of the following checks be made. If a defective part is found, replace it before proceeding with the remaining checks. Be sure to make all the checks since more than one component may be defective.

A defective regulator can be repaired according to the following methods:

A) By changing the printed circuit board in the regulator. Unscrew the retaining screws on the printed circuit and remove it. Install a new printed circuit board. This method is the most commonly used.

B) By removing any retaining screws involved and unsoldering the connections. When resoldering, limit solder time to a minimum as excessive heat may damage the printed circuit board and component parts. However good soldered connections are essential for satisfactory operation. A resin core 63% tin 37% lead solder with a 360^{o}F (182^{o}C) melting point is recommended along with a soldering iron rated at 50 watts or less. Use extreme care to avoid overheating. Before checking the printed circuit board, remove transistor TR1, which must be checked separately. Connect the ohmmeter as shown in figure 37, and then reverse the ohmmeter leads to obtain two readings on the same component. Use the middle scale on scale-type meters on which the 300 ohm value should be within or nearly within, the middle third of scale.

Capacitors C1 and C2 = The ohmmeter should read high and low on each capacitor. If not, replace capacitor.

Diodes D1, D2 and D3 = Each diode should give one high and one low reading. If not, replace diode.

Resistor R2 = Turn voltage adjustment screw (identified in figure 35) with ohmmeter connecting each way. Reading should change as slotted screw is turned. If not, replace R2.

Transistor TR1 = See figure 37. Use the low scale. Each of the three checks should read low and high. If not, replace TR1.

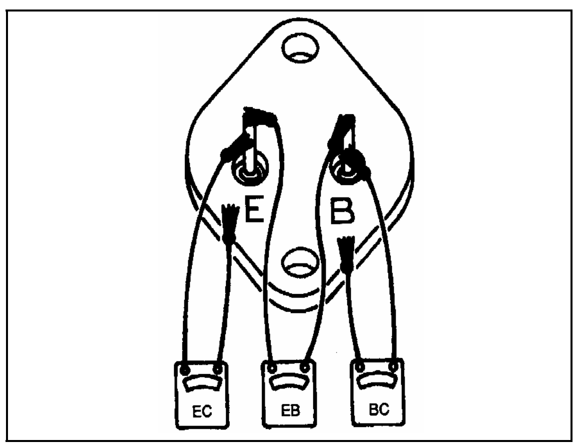


FIGURE 37: CHECKING TRANSISTOR TR1 06081

Transistor TR2 = Change the ohmmeter to use the low scale. EB should read low and high. BC should read low and high. EC should both read high. If not, replace TR2. See figure 38.

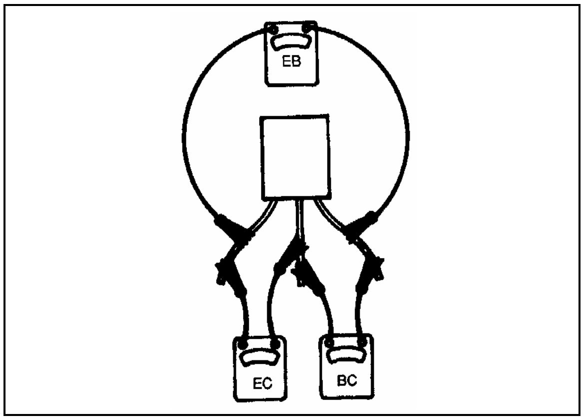


FIGURE 38: CHECKING TRANSISTOR TR2 06081

8.3 ADJUSTING VOLTAGE

After repair, the regulator must be adjusted to the desired voltage setting. Follow the procedure under "Checking Voltage Regulator Setting". Slowly turn the adjusting screw full range and observe the voltmeter to ensure that the voltage is being controlled, then, while still turning, slowly adjust to the desired setting.

9. BATTERY EQUALIZER

VoltMaster Battery Equalizer Owner's Manual (100 amps) is annexed at the end of this section.
Refer to "Electrical Compartments and Junction Box" in this section, for location.

10. 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

Prior to the installation of the Mitsubishi starter, the Flywheel Ring Gear must be examined for excess wear or damage. Service Bulletin A1-M1N-1729EN included at the end of Section 06 shows acceptable levels of wear, and illustrates the proper measuring procedure. Maximum wear is 0.5mm. Ring Gears with more than 0.5mm of wear or damage must be replaced before installing the new starter to prevent engagement and/or disengagement problems. Failure to do so will render the Warranty null and void.

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.

11. 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. 39). 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.

11.1 MAINTENANCE

This heater is non-serviceable except for the cord, and if faulty, must be replaced as a unit.

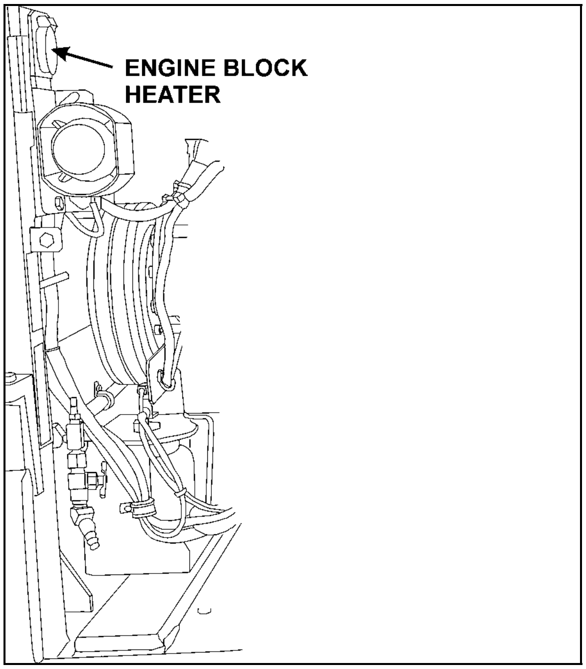


FIGURE 39: ELECTRIC HEATER PLUG LOCATION 18647

12. 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.

12.1 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 12.1.6.

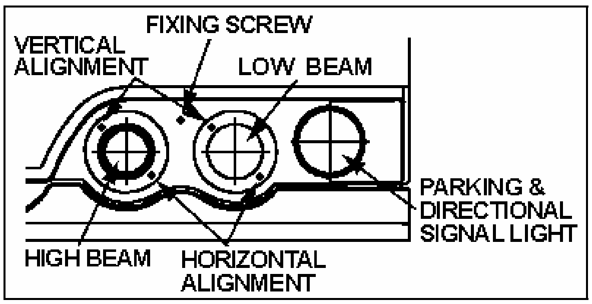


FIGURE 40: HEADLIGHT ASSEMBLY 06546

12.1.1 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.

12.1.2 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. 40). There is no adjustment for focus since the module is set for proper focus during manufacturing assembly.

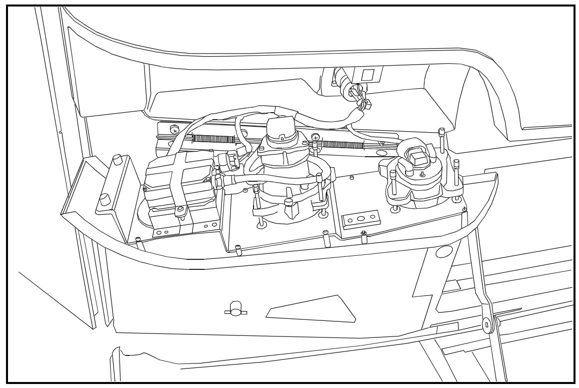


FIGURE 41: OPENING HEADLIGHT ASSEMBLY 06547

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.

12.1.3 Headlight Adjustment

The following is a general procedure for headlight adjustment using mechanical equipment, such as a *"Hoopy 100" Aligner.* If your mechanical equipment is different, refer to the manufacturer's instruction manual.

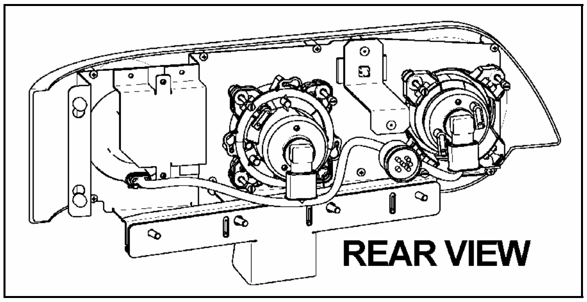


FIGURE 42: HEADLIGHT ASSEMBLY REAR VIEW 06548

Setting aligner according to slope

1. Park vehicle on a level floor.
2. Set the support rail (Prévost #29261) down (Fig. 43). Using shims, adjust its level to stabilize it.

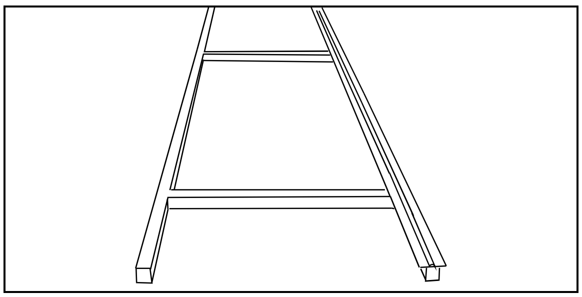


FIGURE 43: SUPPORT RAIL INSTALLATION 06501

3. Install jigs #29263 and #29262 onto the support rail. Position the support rail so that both stops are centered between the two beams (Fig. 44). Mark the position for future reference.

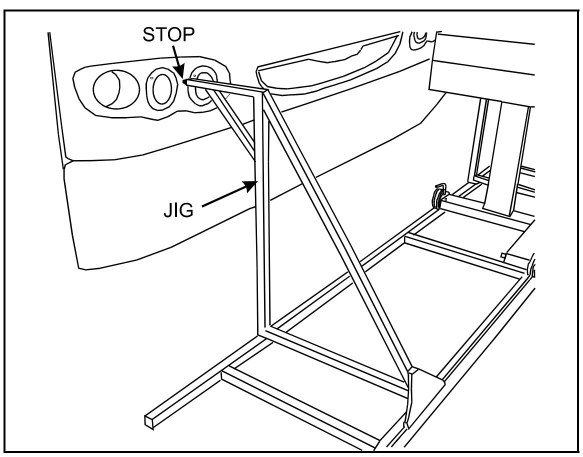


FIGURE 44: INSTALLATION OF JIGS 06499

NOTE
The stops will position the support rail between 16-24 inches of vehicle.

4. Remove the jigs.
5. Install *“Hoopy 100” Aligner* onto support rail (Fig. 45).
6. Using an Allen key on the front wheel, level Hoopy 100 aligner until spirit level bubble is centered (Fig. 46 and 47).
7. Install a calibration fixture in the axis of front axle wheel and one in the axis of rear axle wheel (Fig. 48).
8. Adjust mirrors so that lines are perfectly aligned.
9. Record reading.

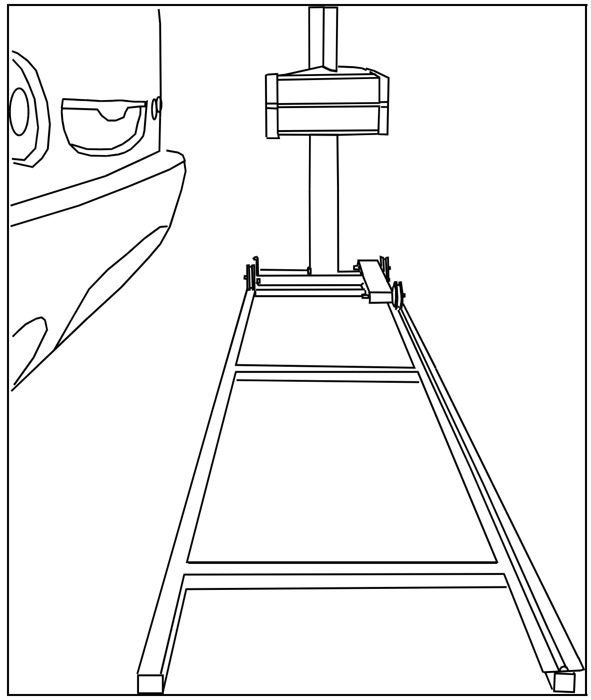


FIGURE 45: INSTALLATION OF HOOPY 100 ALIGNER 06496

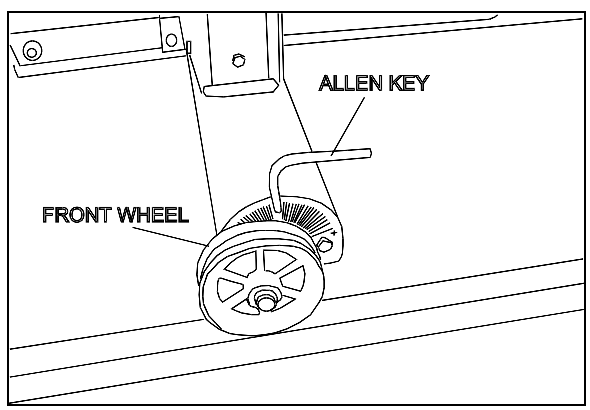


FIGURE 46: ADJUSTING HOOPY 100 LEVEL 06498

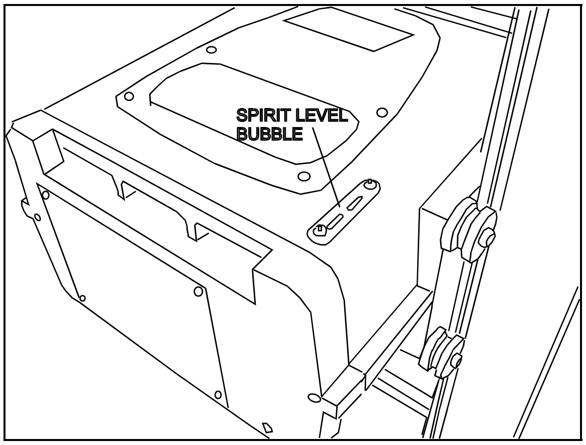


FIGURE 47: SPIRIT LEVEL 06500

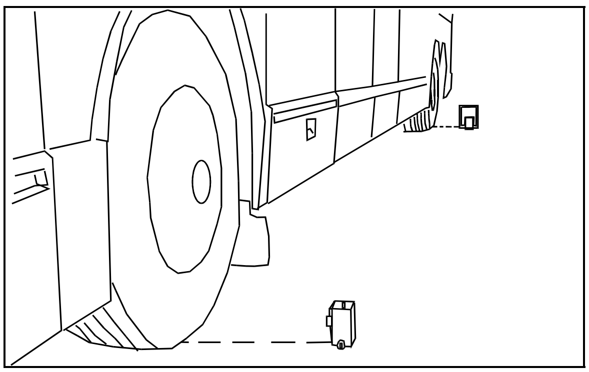


FIGURE 48: INSTALLING CALIBRATION FIXTURES 06497

NOTE
The floor level reading must be added to the aligner reading to ensure a precise alignment.

10. Transfer positive (+) or negative (-) reading of calibration fixtures to the front wheel of Hoopy 100 aligner. Add this reading to Hoopy 100 aligner level reading.
    - eg – level: 0.2, mirrors: 0.1 = 0.3
    - eg – level: -0.2, mirrors: 0.1 = 0.1

NOTE
If vehicle remains stationary during the headlight alignment procedure, it is not necessary to check floor slope each time.

Headlight Alignment

⚠ **CAUTION**
This mechanical equipment must be calibrated by metrology before initial set-up or after major overhaul. Calibration must be performed annually.

1. Set the support rail (Prévost #29261) down (Fig. 43). Using shims, adjust its level to stabilize it. Use previous reference marks to ensure proper positioning.
2. Make sure that headlight assembly fixing screw is properly fastened (Fig. 40).

NOTE
Make sure that the vehicle is at proper height (suspension) and that air pressure is above 90 psi.

3. Install *"Hoopy 100" Aligner* onto support rail (Fig. 45). Turn aligner ON.

⚠ **CAUTION**
Vehicle must be parked at the same location each time. If location is changed for any reason, floor slope alignment and aligner leveling must be redone. Refer to "Setting aligner according to slope".

NOTE
If aligner indicates LOW BATT, battery must be charged for 12 hours.

Low Beam Adjustment

1. Turn ON low beam lights.
2. Press ALIGN TO LAMP and move aligner in front of first beam.

NOTE
If beam is offset, a LOW CANDLES message will appear. Using vertical and horizontal alignment screws, adjust beam as needed (fig. 40).

3. Adjust aligner height (move aligner sideways if needed) so that XX appears in the aligner sight. Lock aligner side handle.
4. Open Hoopy 100 aligner door.
5. Press AIM LAMP down; press a second time so that LOW ADJUST appears in the sight. Arrows indicate in which direction to adjust the beam using the vertical and horizontal adjustment screws. Perform this adjustment until XX appears in the sight.
6. Aligner will reset after 5 minutes.
7. Repeat for other low beam light.

High Beam Adjustment

1. Turn ON high beam lights.
2. Press ALIGN TO LAMP and move aligner in front of first beam.
3. Adjust aligner height (move aligner sideways if needed) so that XX appears in the aligner sight. Lock aligner side handle.
4. Open Hoopy 100 aligner door.
5. Press AIM LAMP down; press a second time so that HIGH ADJUST appears in the sight. Arrows indicate in which direction to adjust the beam using the vertical and horizontal adjustment screws. Perform this adjustment until XX appears in the sight.
6. Aligner will reset after 5 minutes.
7. Repeat for other high beam light.
8. Store equipment away in a safe place.

If proper mechanical equipment is not available, perform adjustments as described hereafter:

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. 49).
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.

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

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. 50).
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. 51).

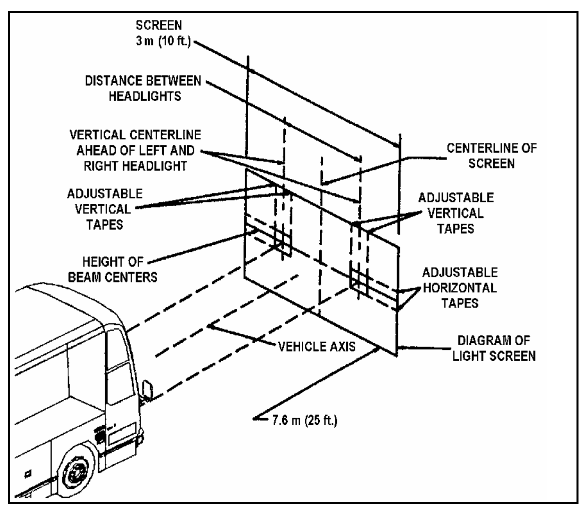


FIGURE 49: ALIGNMENT OF HEADLIGHT AIMING SCREEN 06502

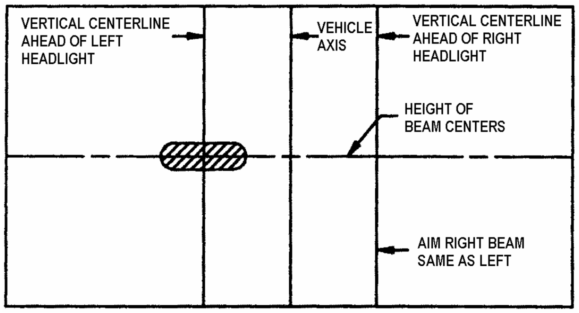


FIGURE 50: HIGH-INTENSITY ZONE (SHADED AREA) OF A PROPERLY AIMED UPPER BEAM ON THE AIMING SCREEN 7.6 M (25FT) IN FRONT OF VEHICLE 06503

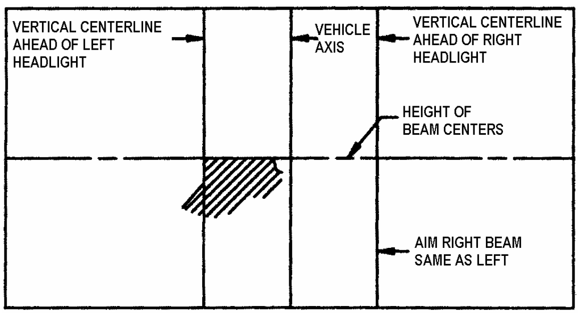


FIGURE 51: HIGH-INTENSITY ZONE (SHADED AREA) OF A PROPERLY AIMED LOWER BEAM ON THE AIMING SCREEN 7.6 M (25FT) IN FRONT OF VEHICLE 06504

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.52).

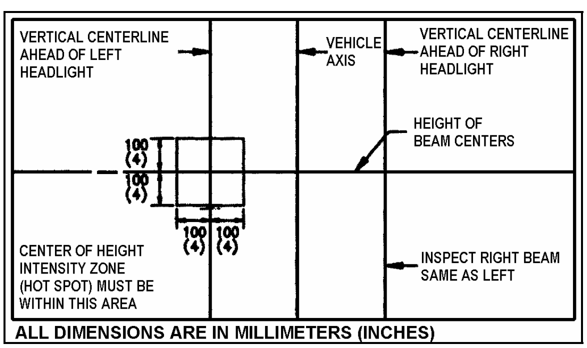


FIGURE 52: AIM INSPECTION LIMITS FOR UPPER-BEAM HEADLIGHTS 06505

8. 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. 53).

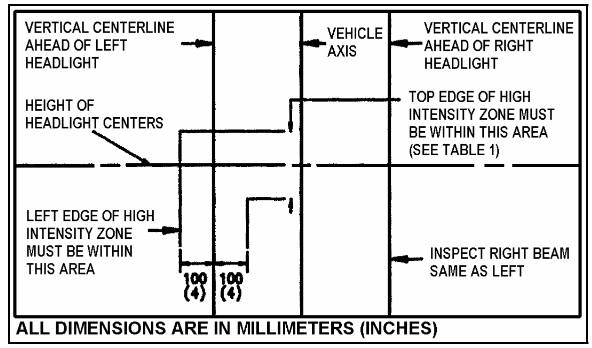


FIGURE 53: AIM INSPECTION LIMITS FOR LOWER-BEAM HEADLIGHTS 06506

12.1.4 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. 40 and 41).
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. 40 and 41).
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.

12.1.5 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. 40 and 41).
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.

12.1.6 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.

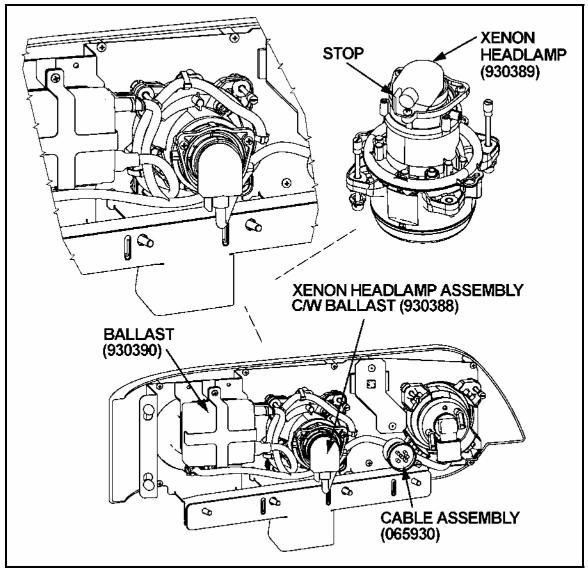


FIGURE 54: XENON HEADLAMP LOCATION 06549

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. 40 and 41).
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.

12.2 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.

12.2.1 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.

12.2.2 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.

12.3 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.

12.4 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.

12.4.1 Marker Light Removal and Replacement

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.

12.4.2 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.

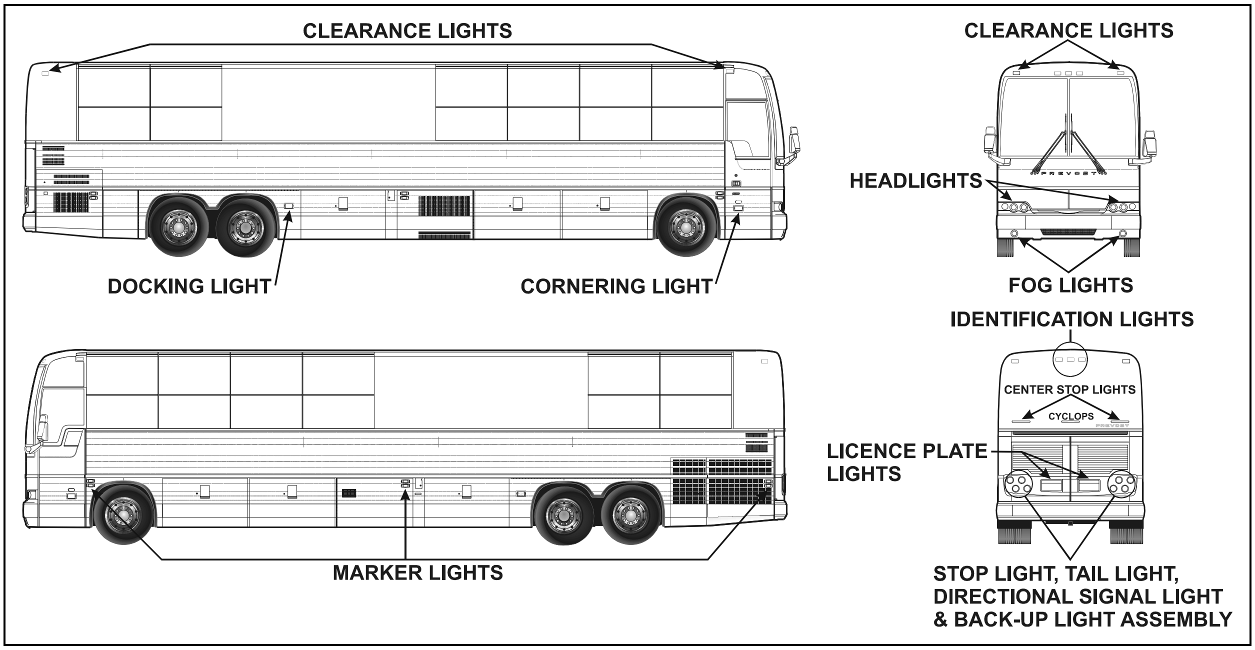


FIGURE 55: VARIOUS LIGHTS LOCATION 06544

12.5 DOCKING AND CORNERING LIGHTS

MTH vehicles are provided with two halogen sealed-beam units that serve as cornering lights. They are mounted on the vehicle as follows: one is mounted on the front L.H. side service compartment door, while the other is located on the entrance door on the R.H. side. The main function of these lights is to increase lateral visibility when turning a corner. These lights are energized simultaneously with the directional lights. A dashboard-mounted rocker switch may be actuated to cancel this system in special situations.

Two additional halogen sealed-beam units may be installed aft of the rear baggage compartment. These lights are used as docking lights and both will illuminate automatically when reverse range is selected to facilitate back-up or docking procedure. The cornering lights do not operate automatically when the reverse range is selected, but by means of a dashboard-mounted rocker switch. When the docking position is selected, the docking as well as the cornering lights illuminate.

12.5.1 Lamp Removal and Replacement

Both docking and cornering sealed-beam units can be changed in accordance with the following procedure:

1. Remove the two “Phillips” screws attaching the retaining ring.
2. Disconnect the light unit connection.
3. Remove the lamp.
4. Position new lamp.
5. Connect and position the light unit.
6. Finally, install the retaining ring.

12.6 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.

12.6.1 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.
6. Fasten the wing nut and securely close the bumper.

13. INTERIOR LIGHTING EQUIPEMENT

13.1 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.

13.1.1 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. 56).

NOTE

Switches are lighted by the use of LED. When lighting on a switch fails, replace defective switch as a unit.

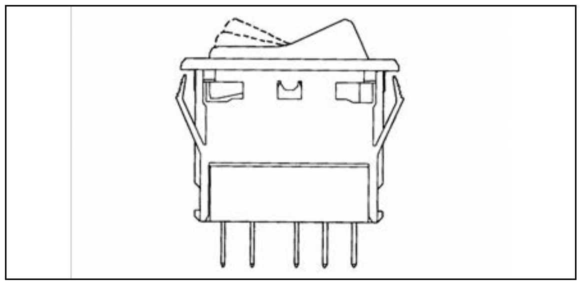


FIGURE 56: SWITCH 06321

13.1.2 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.

13.1.3 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.

13.2 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.

13.2.1 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.

13.2.2 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.

13.2.3 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.

13.3 ENGINE COMPARTMENT LIGHTING

A switch located in engine compartment on rear start panel, can be used to actuate the two oval engine compartment lights.

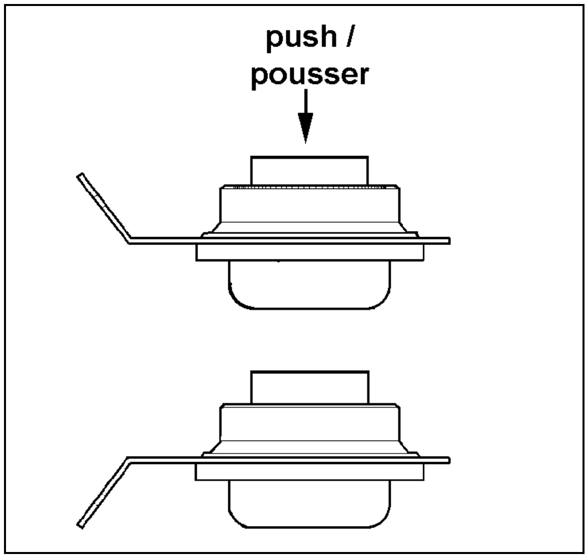


FIGURE 57: ENGINE COMPARTMENT LIGHT

Each light is sealed and can be replaced as follows:

1. Disconnect the light unit connection.
2. Remove the lamp.
3. Position new lamp.
4. Connect the light unit.
5. Make sure the retaining ring is installed properly.

14. 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
INTERIOR LIGHTING					
Instrument cluster lights	562838	2721 MFX (OSRAM)	---	---	---
Telltale panel assy.	562907	---	---	---	1
Step Light	562278	HELLA 78207 (OSRAM 6429)	10 W	24	3

15. SPECIFICATIONS

Battery

Make .... Volvo
Model 20359831
Prévost Number 563030
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)
Battery cover .... 45-50 Ft-lbs (5-6 Nm)

Alternator

Make .... Delco Remy
Model Number 1117702
Series 50DN
Type 600

Field current at 80°F (27°C)
-Amperes .... 7.2 – 8.0
-Volts 24

Hot output

-Amperes .... 270 at 80°F (27°C) ambient

-Volts 28

-Approximate rpm 3000

Ground .... negative

Prévost number 561723

Regulator

Make .... Delco-Remy
Model Number ....
Type .... Transistor
Voltage adjustment .... External screw
Prévost number 562775

Alternator

Make.. BOSCH
Model Number..0120689552
Series T1

Hot output

-Amperes.. 140 at 25°C (AMBIENT)
-Volts 28
-Approximate rpm.. 6000
Ground .... negative
Prevost Number 562752

Battery equalizer

Make.. Vanner
Model.. 60-100D
Amperes...100 amps
Prévost Number 563334

Starter

Make...Mitsubishi Electric Corporation (MELCO)
Model Number...M009T82479
Type 105P70
Voltage 24
Prévost 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)

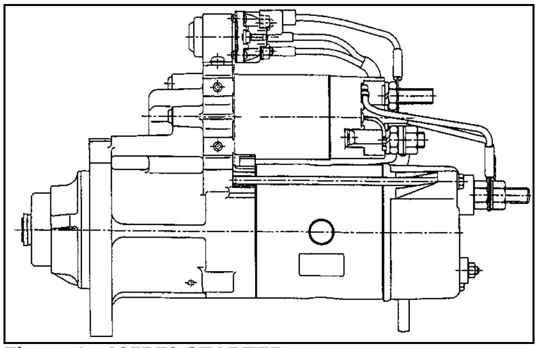


Figure 1 - 105P70 STARTER

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.

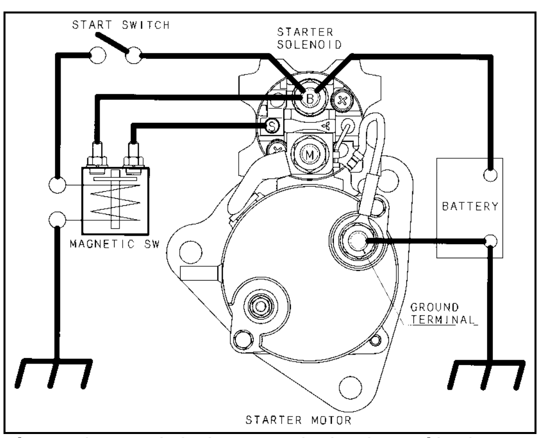


Figure 2 - BASIC STARTING CIRCUIT (GROUND-FLOAT TYPE)

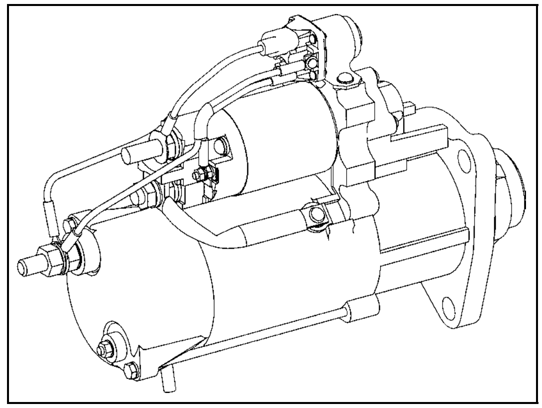


Figure 2 shows the circuit diagram for the 105P70 Ground-float type (sometimes referred to as Insulated or Isolated Ground).

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.

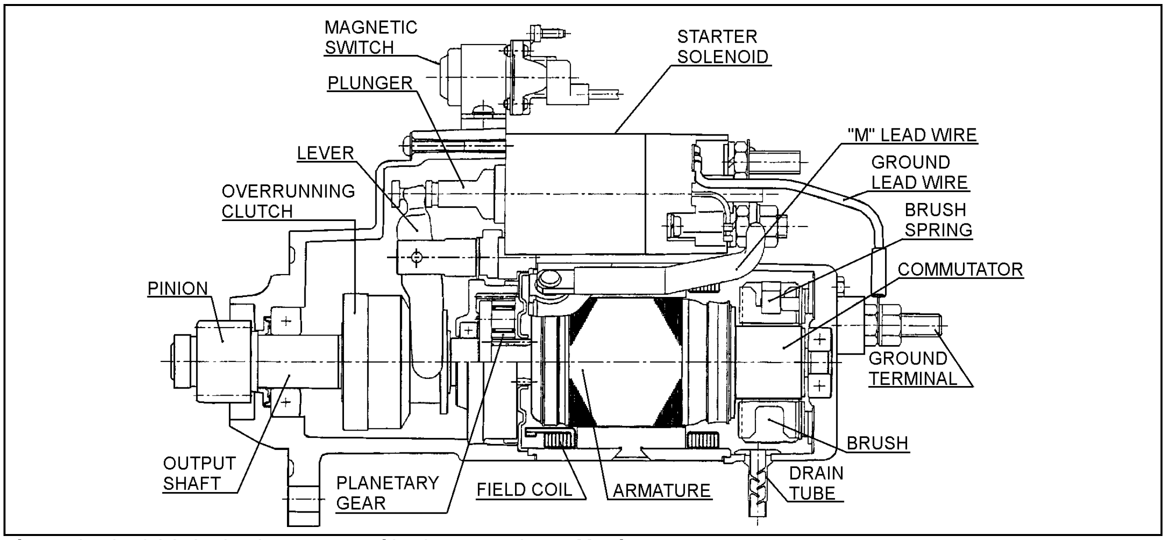


Figure 3 - CROSS-SECTIONAL VIEW (GROUND-FLOAT TYPE)

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.

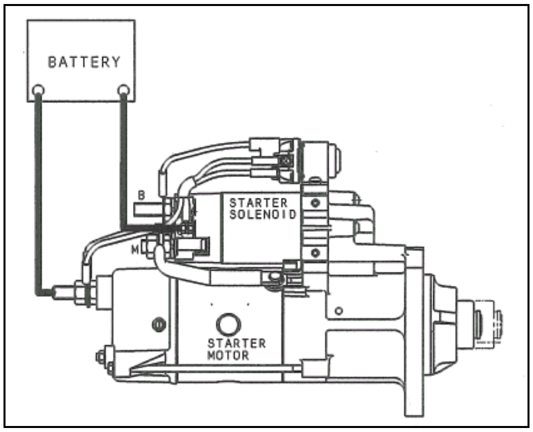


Figure 4 - TESTING PINION MOVEMENT AND PULL-IN WINDINGS (GROUND-FLOAT TYPE)

For the starter switch coils, refer to the switch circuit diagrams for the ground-wire type (ground-float type) shown in figures 5.

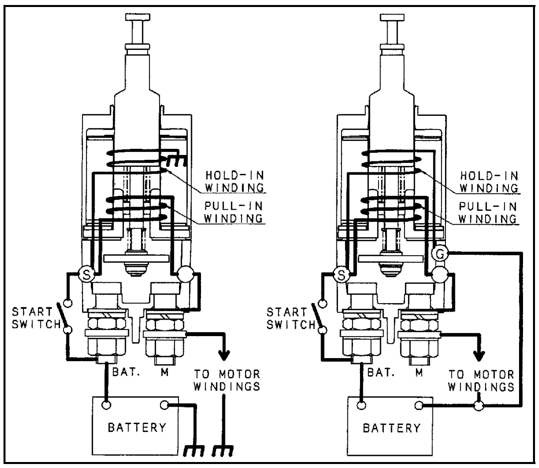


Figure 5 - SOLENOID CIRCUIT (GROUND-FLOAT TYPE)

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

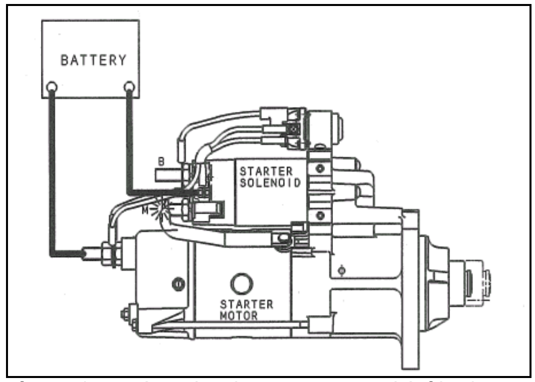


Figure 6 - TESTING HOLD-IN WINDINGS (GROUND-FLOAT TYPE)

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

<u>2.5.2 No-load test</u>

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.*

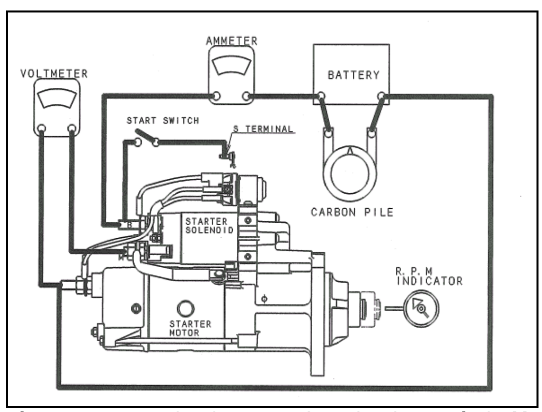


Figure 7 - NO-LOAD TEST CIRCUIT (BODY-GROUND TYPE)

* 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.

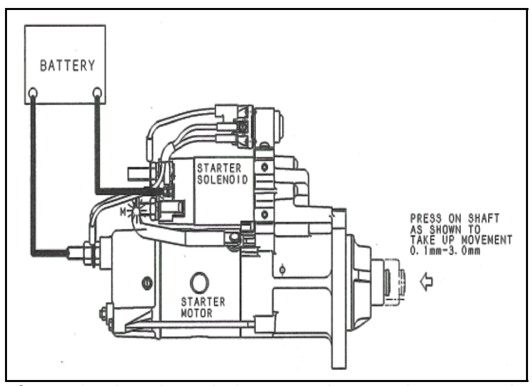


Figure 8 - CHECKING OUTPUT SHAFT CLEARANCE (GROUND-FLOAT TYPE)

Repair and Testing Instructions for T1 Alternator

0120 689 552

Modifications

Edition	Date	Name	Modifications
001	8/28/98	I. Serra	Original
002	12/4/98	I. Serra	Update 8.98 Instructions

Table of contents

1 General

This manual contains repair and testing instructions with corresponding test specifications for the 0 120 689 5... series alternators.

T1 (RL) 28V 70/140A

Note: Alternator 0 120 689 543 was utilized in preparing these instructions.

2 Safety Precautions

2.1 Special Tool Usage

The use of incorrect or unsuitable tools and test equipment can lead to personal injury and may damage the alternator or its component parts. Only use tools that are specified in this instruction or meet the specification of the recommended tools.

2.2 Fire Risk

To provide radio interference suppression, the alternator is equipped with capacitors with a long storage time. Cleaning of alternator components may cause and electrical discharge when they are immersed in cleaning fluid. This discharge may cause combustible liquids to ignite.

2.3 Skin Protection

To avoid skin irritation when handling oils and greases, apply protective gloves or creams before starting work and wash off hands with soap and water when servicing has been completed.

2.4 Compressed Air

Only use compressed air regulated to a maximum of 4 Bar (60 PSI), and a clean cloth for cleaning of the armature, excitation windings and alternator plates.

2.5 Explosion Risk

Avoid exposure to fire, open flame and sparks. Thoroughly dry all cleaned parts as gases could form from the cleaning process and may cause an explosion.

3 Specifications

3.1 Electrical Test Specifications

Interference suppression capacitor	1.8 … 2.6 μF (microfarad)
Load current less than/equal to 10A	27.6 … 28.4 V (volts, regulated)
Damping Resistance	3.1 … 3.5 kΩ (kilohms)
Stator Resistance	0.036 Ω (-0/+10%) T1 (RL) 28V70/140A
Rotor Resistance	7.5 Ω (-0/+10%) T1 (RL) 28V70/140A

Power Output Test

Alternator	Speed (RPM)	Load Current - Inductive (A)	Test Duration (Min)
T1 (RL) 28V70/140 A	1500	76	30
	6000	136	10

Following completion of the output test, allow alternator to run at 7000 rpm for one minute.

Oscilloscope Pattern

This image represents a properly functioning alternator. The D.C. voltage produced has a small harmonic wave.

Small spikes may be superimposed on the oscilloscope screen if the voltage regulator is regulating. Applying a load to the alternator output terminals can turn off the regulator.

In order to be able to compare oscilloscope images, the oscilloscope so the pattern fits between two vertical 10x divisions.

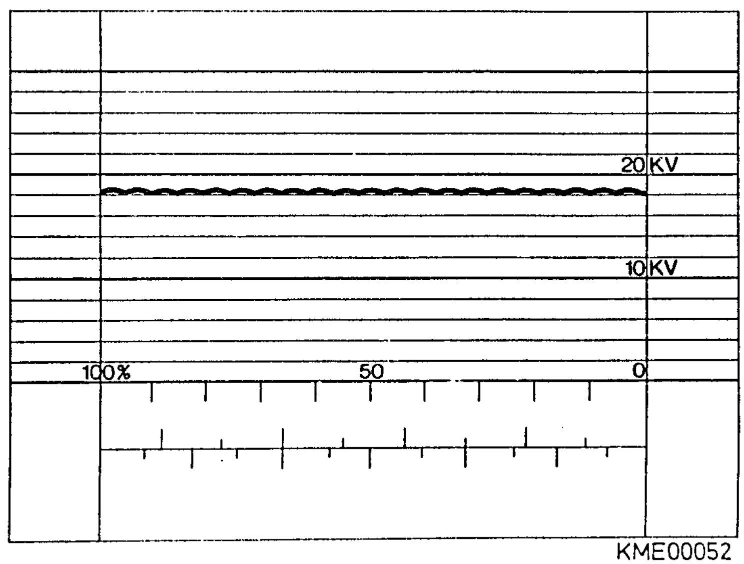


Figure 1 Normal Oscilloscope Pattern

3.2 Mechanical Test Specifications

Rotor to Stator Air Gap (Between any side of stator and rotor)		Greater than 0.3 mm (0.012 in)
Eccentricity (Rotor mounted at bearing points)	Outer Diameter Of Rotor	0.05 mm (0.002 in) maximum
	Outer Diameter Of Collector Rings	0.03 mm (0.0012 in) maximum
Collector ring diameter	New	32.5 mm (1.279 in)
	Used	31.5 mm (1.240 in) minimum
Carbon Brush Projection	New	16.0 mm (0.630 in) minimum
	Used	7.0 mm (0.275 in) minimum

3.3 Tightening Torques

Item Number	Description	Metric (Nm)	SAE
55	Air Intake Stud	3.0 … 3.4	26.5 … 30.1 in. lbs.
66	D+ Terminal	2.4 … 3.2	21.2 … 28.3 in. lbs.
29	B+ Terminal, B- Terminal	10.0 … 13.0	88.5 … 115 in. lbs.
37	W Terminal	4.1 … 5.5	36.3 … 48.7 in. lbs.
15	Voltage Regulator	1.3 … 1.7	11.5 … 15.0 in. lbs.
43	Capacitor Mounting Screw	4.3 … 5.7	38.0 … 50.4 in. lbs.
23	Rectifier Mounting Screw	1.3 … 1.7	11.5 … 15.0 in. lbs.
21	Drive End Shield to Collector Ring Shield	7.2 … 9.7	63.7 … 85.9 in. lbs.
5	Drive End Shield Bearing Cover Plate	4.1 … 5.5	36.3 … 48.7 in. lbs.
52	Pulley Retaining Nut	135 … 170	99.5 … 125.4 ft. lbs.

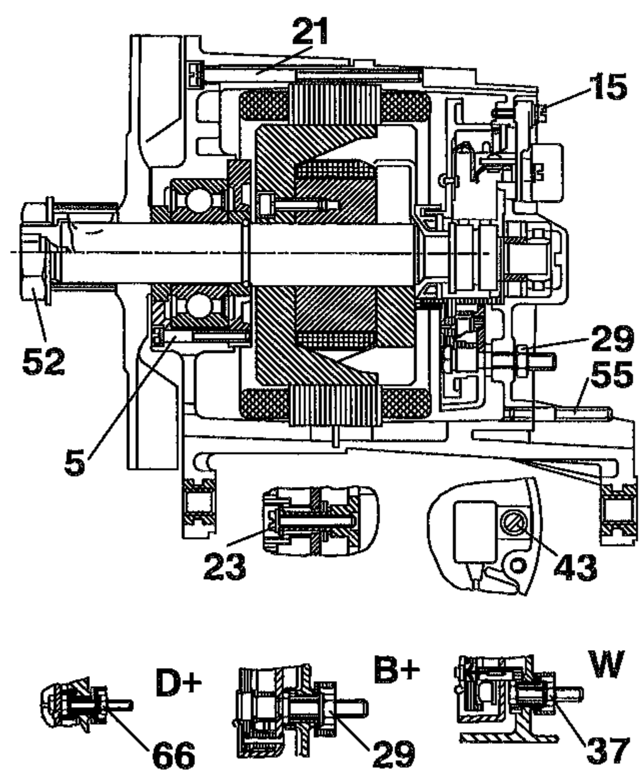


Figure 2 Fastener Torque Chart

4 Alternator Schematic

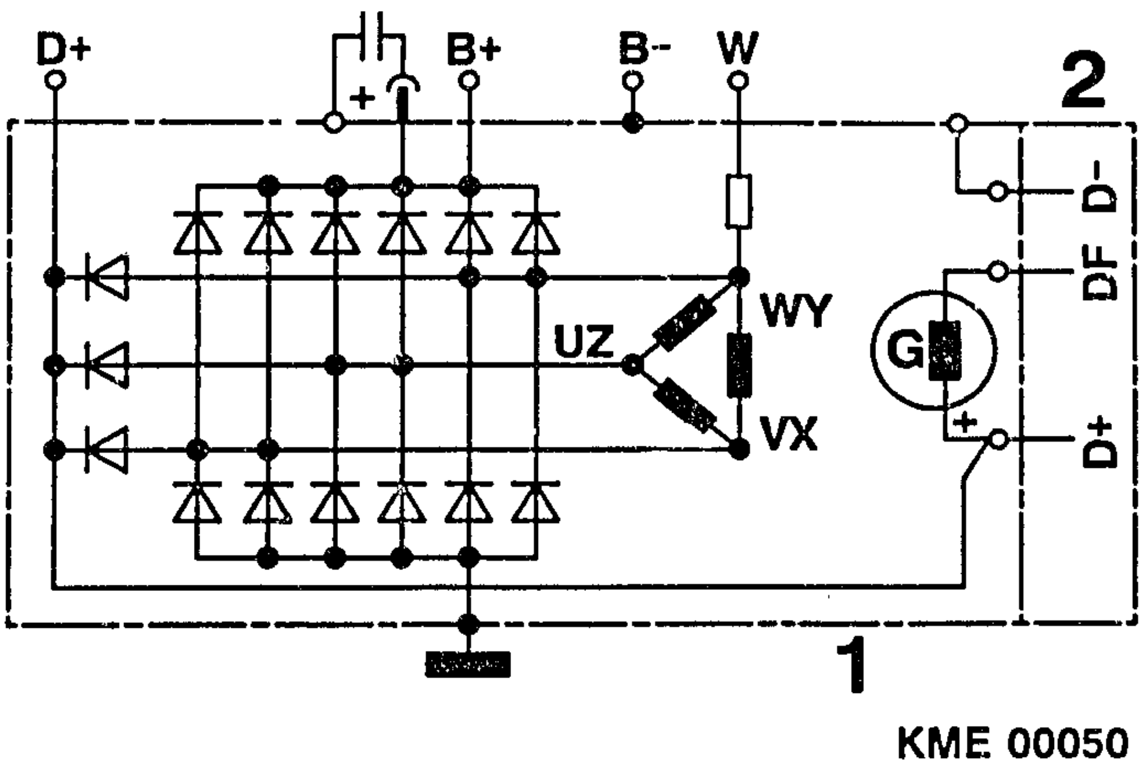


Figure 3 Alternator/Voltage Regulator Schematic

1 Alternator

B+ Battery Positive
B- Battery Negative
D+ Dynamo + (Warning Lamp Output)
W Tachometer Output

2 Voltage Regulator

D+ Dynamo + (Alternator Output)
DF Dynamo Field
D- Dynamo -

5 Alternator Coding

T 1 R 28V 70/ 140A

Rated current in amps measured at 6000 rpm

Rated current in amps measured at 1500 rpm

Alternator Voltage

Direction of Rotation

(→) Or R	Clockwise
(←) Or L	Counter Clockwise
(↔) Or RL	Multidirectional

1	Claw Pole Alternator
2	Salient Pole Alternator
3	Windingless Rotor Alternator

Outer Diameter of Alternator

G	100 … 109 mm
K	120 … 129 mm
N	130 … 139 mm
T	170 … 199 mm
U	more than 200 mm

6 Parts Cleaning

Caution: Fire Risk

To provide radio interference suppression, the alternator is equipped with capacitors with a long storage time. Cleaning of alternator components may cause and electrical discharge when they are immersed in cleaning fluid. This discharge may cause combustible liquids to ignite.

Alternator components with capacitors should only be cleaned with a non-combustible cleaner such as HAKU 1025/6.

Caution: Compressed Air

Only use compressed air regulated to a maximum of 4 Bar (60 PSI), and a clean cloth for cleaning of the armature, excitation windings and alternator plates.

Caution: Explosion Risk

Avoid exposure to fire, open flame and sparks. Thoroughly dry all cleaned parts as gases could form from the cleaning process and may cause an explosion.

7 Tools, Test Equipment Lubricants and Adhesives

7.1 Test Equipment

Description	Bosch Number	
Alternator Test Bench	Commercially Available	
Internal Short-Circuit Tester (Flash Tester)	KDAW 9978	0 986 619 110
Universal Multi-Meter	MMD 302	0 684 500 302
Alternator Tester	WPG 012.00	0 684 201 200

7.2 Special Tools

Description	Bosch Number	
Arbor Press	Commercially Available	
Soldering Iron	Commercially Available	
Universal Bearing Puller	Commercially Available	
V-Block *Note: 2 Required*	Commercially Available	
14mm Hex, 1/2" Drive Socket	Commercially Available	
Clamping Support	KDAW 9999	0 986 619 362
Die Spigot for Arbor Press (Used with KDLJ 6011, KDLJ 6012, KDLJ 6015)	KDLJ 6010	0 986 618 124
Bearing Remover	KDLJ 6009	0 986 618 121
Press Tool for Roller Bearing	KDLJ 6021	0 986 618 139
Bearing and Seal Installer	KDLJ 6011	0 986 618 125
Collector Ring Installer	KDLJ 6012	0 986 618 126
Drive End Shield Support Ring for Rotor Pressing	KDLJ 6013	0 986 618 127
Press Tool - Spacer Ring, Roller Bearing Inner Race and Collector Rings	KDLJ 6018	0 986 618 134
Alignment Pin - Drive End Shield and Collector Ring End Shield	KDLJ 6014	0 986 618 128
Removal Tool - Sliding Bushing	KDLJ 6015	0 986 618 129
Holding Tool - Sliding Bushing	KDLJ 6016	0 986 618 130
Inner Bearing Race Removal Tool	KDAW 9996	0 986 619 269
Puller Receiver Cup	KDAW 9995/0/1	0 986 619 214
Threaded Pin with Cone	KDAW 9995/14	0 986 619 250
Bearing Puller Spring Collet	KDAW 9995/6	0 986 619 233
Feeler Gauge 0.15 … 0.6 mm (.005 … .024 in) *Note: 4 required*	KDZV 7399	0 986 618 378
Dial Indicator	EFAW 7	1 687 233 011
Magnetic Indicator Stand	T-M 1	4 851 601 124

7.3 Lubricants and Adhesives

Description	Manufacturer Number	Bosch Number
Roller Bearing Grease	UNIREX N3	5 975 560 125
	Ft1 v 34	5 700 009 000
	VS 15164-Ft	5 975 560 000
Molycote Paste	Ft 70 v 1	5 700 040 000
Adhesive Dispersant	KK57v1	5 703 151 000
Silicon Paste	Ft2v4	5 700 083 005

7.3.1 Lubricant Quantities

Bottom of Roller Bearing	2 g (0.07 oz.)
Collector End Shield Radial Seal	2 g (0.07 oz.)
Roller Bearing	2…2.5 g (0.07…0.09 oz.)

8 Exploded View

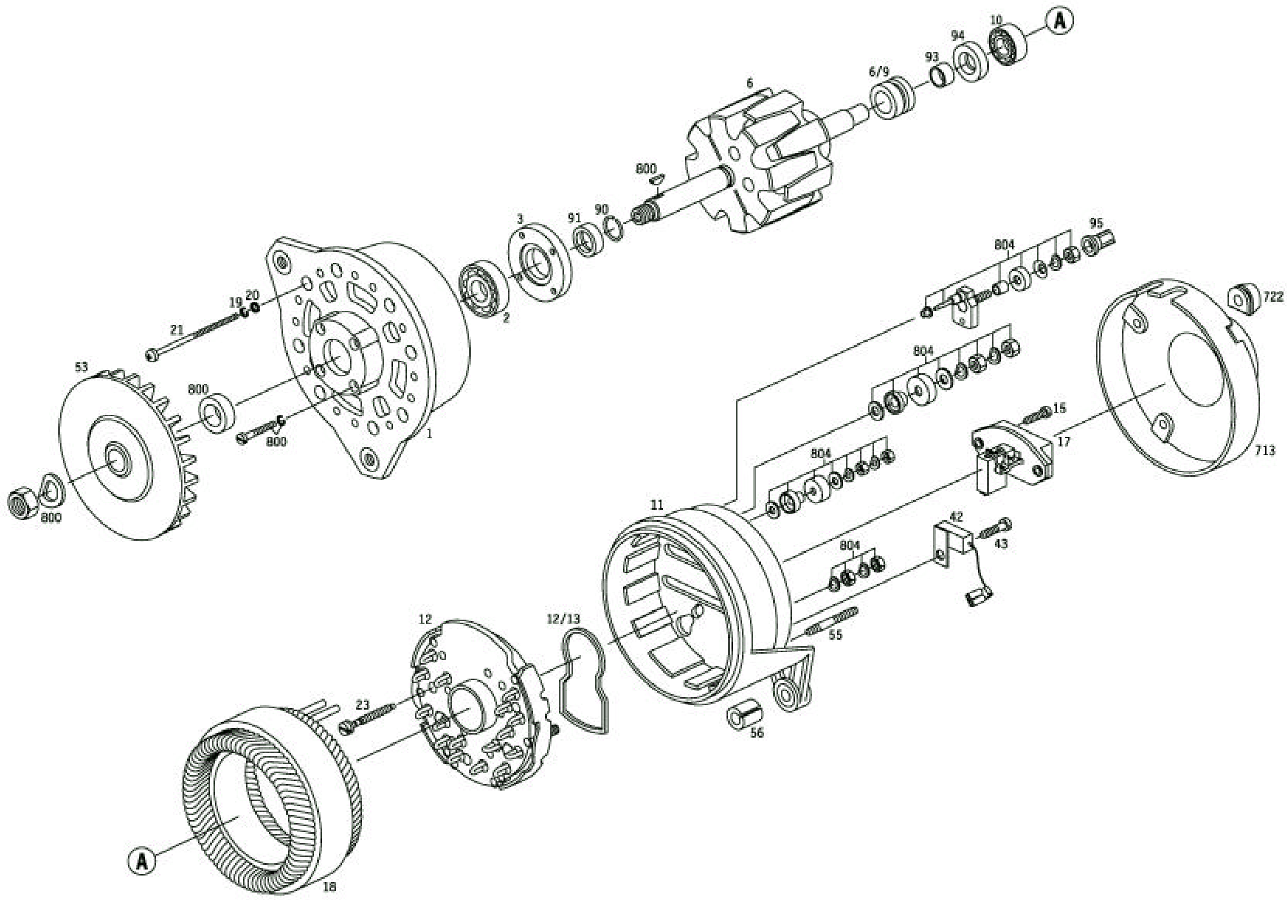


Figure 4 Alternator Exploded View

Item	Designation	Item	Designation
1	Drive End Shield	20	Plain Washer
2	Ball Bearing	21	Oval-Head Screw
3	Cover Plate	23	Washer & Screw Assembly
6	Rotor	42	Suppression Capacitor
6/9	Collector Ring	43	Oval-Head Screw
10	Roller Bearing	53	Fan
11	Collector-Ring End Shield	55	Stud
12	Rectifier	56	Expansion Bushing
12/13	Seal	90	Retainer
15	Washer & Screw Assembly	91	Support Ring
17	Transistor Regulator	93	Spacer Ring
17/3/8	Compression Spring	94	Radial Seal
17/3/801	Carbon-Brush Set	95	Protective Cap
17/10	Gasket	713	Air-Intake Cover
18	Stator	722	Grommet
19	Spring Lock Washer		

9 Alternator Disassembly and Testing

9.1 Rear Cover Removal

1. Clamp alternator in clamping fixture KDAW 9999 (Bosch Number 0 986 619 362).

2. Remove four nuts holding on the air intake cover. (Figure 5)

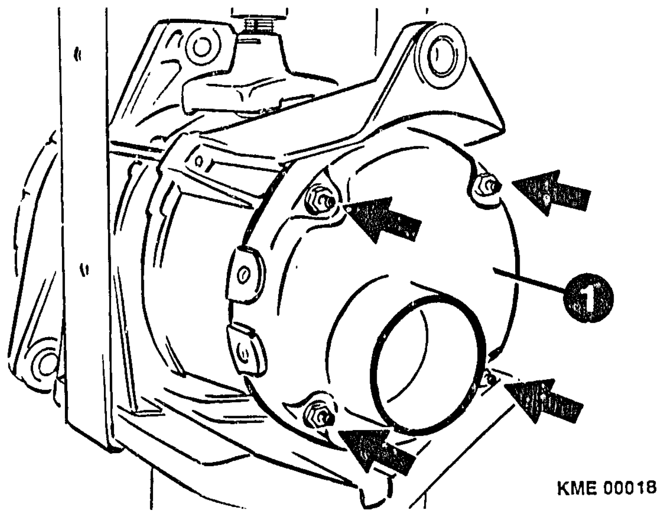


Figure 5 Air Intake Cover Removal (1)

Note: The voltage regulator must be removed before any further disassembly of the alternator takes place. The brushes of the regulator can break if the regulator is not removed before any other disassembly takes place.

9.2 Voltage Regulator Removal

1. Remove the three (3) screws that secure the regulator to the collector ring end shield. (Figure 6)

2. Carefully remove the voltage regulator from the collector ring end shield.

Note: The brushes of the regulator will break if the regulator is not removed before any other disassembly of the alternator takes place.

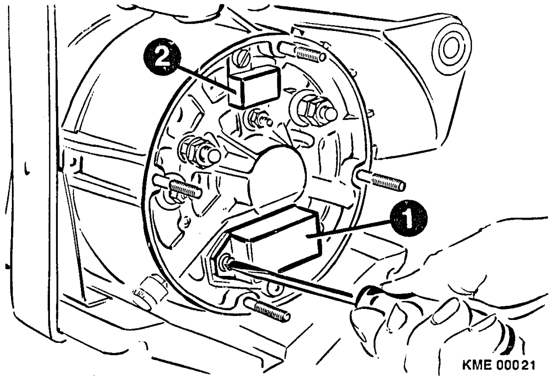


Figure 6 Voltage Regulator (1) and Suppression Capacitor (2)

9.2.1 Brush Replacement

1. The exposed length of the carbon brushes must be measured to determine if they require replacement. Measure the length of each brush. If the exposed brush length is less than 7 mm (0.276"), the brush must be replaced. (Figure 7)

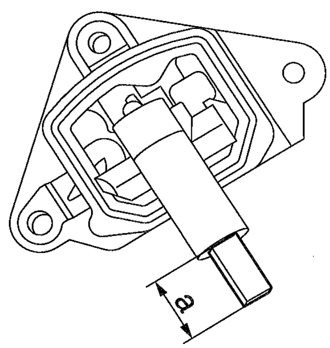


Figure 7 Brush Length Measurement

2. To replace the brushes, the brush lead must be unsoldered and the brush removed from the regulator.

3. Insert the new brush into the regulator and solder the brush lead to the regulator.

Note: Use only rosin-core solder to attached the brush lead.

4. Check the brushes for freedom of movement after they are soldered.

5. Measure the exposed length of the new brushes. The exposed length should be 16 mm (0.630")

9.3 Noise Suppression Capacitor Testing and Removal

1. Disconnect the suppression capacitor from terminal B+.

2. Connect Multimeter MMD 302 (Bosch Number 0 684 500 302) or equivalent to the lead of the suppression capacitor and the B- terminal of the alternator. (Figure 8)

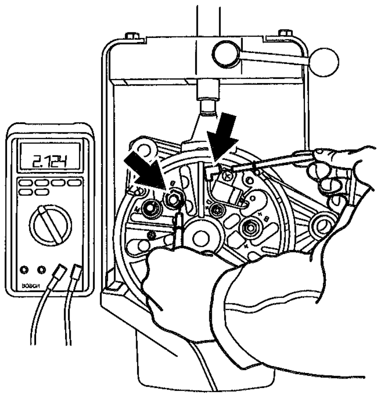


Figure 8 Testing of Suppression Capacitor

3. Measure the capacitance of the suppression capacitor. If the capacitance does not read between 1.8 and 2.6 μF (microfarad), the capacitor must be replaced.

4. Remove the screw that secures the suppression capacitor and remove capacitor.

Note: After removing the suppression capacitor from the alternator, the capacitor lead should be shorted to the capacitor-mounting strip to discharge the capacitor. Failure to do so may cause the capacitor to discharge while being cleaned.

9.4 Pulley and Fan Removal

1. Using a 14-mm hex socket to hold the rotor shaft. Loosen and remove pulley-retaining nut with a box wrench. (Figure 9)

Note: Do not use an air impact gun to remove the nut as the force of the impact may cause damage to the alternator bearings.

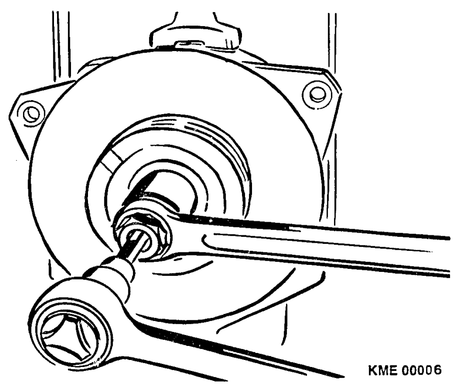


Figure 9 Pulley and Fan Removal

2. Remove the pulley and cooling fan from the alternator.

9.5 Separation of Drive Shield and Collector End Shield

Note: With a scribe, mark the relationship between the drive end shield and the collector ring end shield. This will assist in the realigning of the two shields upon reassembly.

1. Loosen and remove the four (4) outer Oval-head screws which hold the end shields together. (Figure 10)

2. Slide the drive end shield and rotor out of the collector end shield.

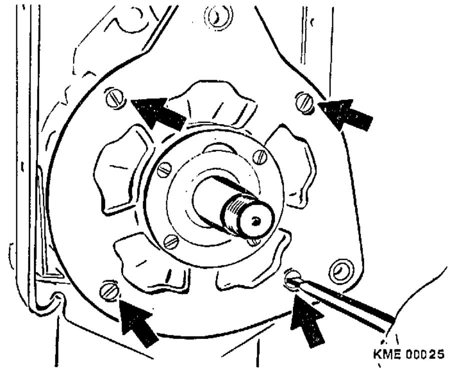


Figure 10 Drive End Shield Removal

9.6 Rectifier Assembly Testing

Note: The following testing of the rectifier is to be performed with the rectifier assembly installed and wired in to the stator.

1. With the rectifier assembly still installed in the collector end shield, testing of the rectifier is to be performed.

   a. Using tester WPG 012.00 (Bosch Number 0 684 201 200) (Figure 11)

      i) Connect the negative (black) lead of the tester to the collector end shield and the positive (red) lead to each of the stator connection solder joints.

      ii) Connect the positive (red) lead of the tester to the B+ Terminal and the negative (black) lead to each of the stator connection solder joints.

      iii) Connect the positive (red) lead of the tester to the D+ Terminal and the negative (black) lead to each of the stator connection solder joints.

The rectifier assembly is reusable if the tester remains in green zone. If the rectifier assembly fails any test, one or more of the diodes are defective and the whole assembly must be replaced.

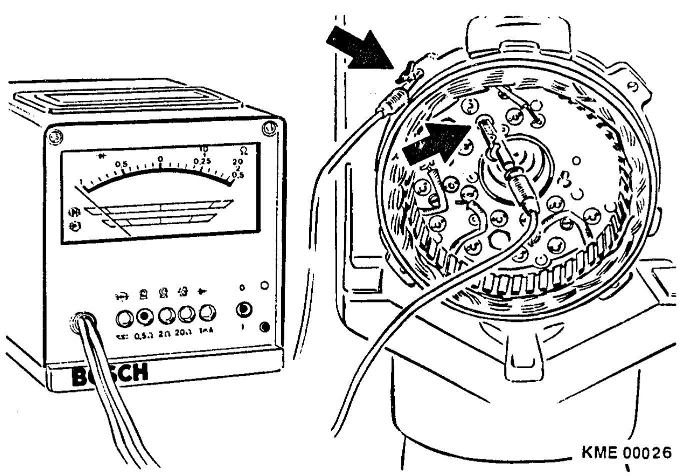


Figure 11 Testing of Rectifier Assembly

b. Using a Diode Tester

i) Connect the negative (black) lead of the tester to the collector end shield and the positive (red) lead to each of the stator connection solder joints. No current should pass through the rectifier assembly.

ii) Connect the positive (red) lead of the tester to the collector end shield and the negative (black) lead to each of the stator connection solder joints. Current should pass through the rectifier assembly.

iii) Connect the positive (red) lead of the tester to the B+ Terminal and the negative (black) lead to each of the stator connection solder joints. No current should pass through the rectifier assembly.

iv) Connect the negative (black) lead of the tester to the B+ Terminal and the positive (red) lead to each of the stator connection solder joints. Current should pass through the rectifier assembly.

v) Connect the positive (red) lead of the tester to the D+ Terminal and the negative (black) lead to each of the stator connection solder joints. No current should pass through the rectifier assembly.

vi) Connect the negative (black) lead of the tester to the D+ Terminal and the positive (red) lead to each of the stator connection solder joints. Current should pass through the rectifier assembly.

If the rectifier assembly fails any test, one or more of the diodes are defective and the whole assembly must be replaced.

9.7 Removal and Testing of Stator Assembly

1. With tester WPG 012.00 or Multimeter MMD 302 set to read 0 to 0.5 Ω, test the resistance of the stator while it is still attached to the rectifier assembly. Connect the test leads between the phase outputs of the stator. Repeat the test until all three phases of the stator has been tested. A good stator will read between 0.036 Ω and 0.040 Ω. (Figure 12)

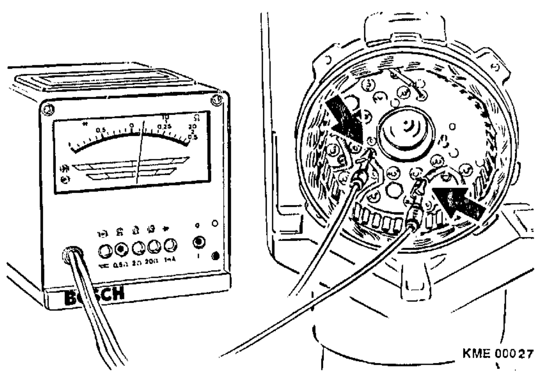


Figure 12 Stator Resistance Testing

2. Unsolder the stator phase connections from the rectifier assembly with a soldering gun or iron.

3. Bend open any bent-over lead connections with a screwdriver or pliers and pull the stator leads from the rectifier eyelets.

Note: The insulation tester applies a voltage of 80 VAC to the stator. Voltages of 80V can be fatal. When performing this test, observe care is used in handling the stator and any component or surface that is exposed to the stator. Use insulated gloves and do not touch the work surface until all tests are completed.

4. Using insulation tester KDAW 9983 (Bosch Number 0 986 619 110) or equivalent, apply 80 VAC to each of the stator phase leads with one probe while the other probe is in contact with the exterior of the stator. (Figure 13)

   No continuity should be present. Any continuity between the stator phase leads and the exterior of the stator indicates a breakdown of the stator insulation and a short to ground. If continuity is present, the stator must be replaced.

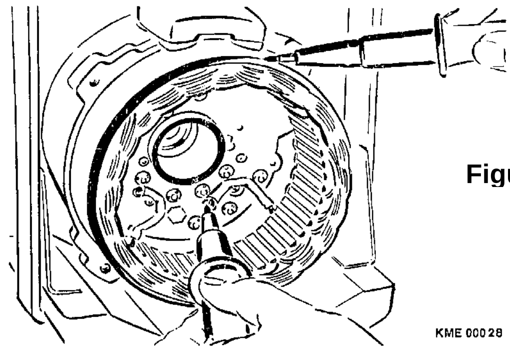


Figure 13 Stator Insulation Testing

9.8 Rectifier Assembly Removal

1. Loosen and remove the three screws that hold the rectifier to the collector end shield. (Figure 14)
2. Unsolder the W terminal from the rectifier assembly.

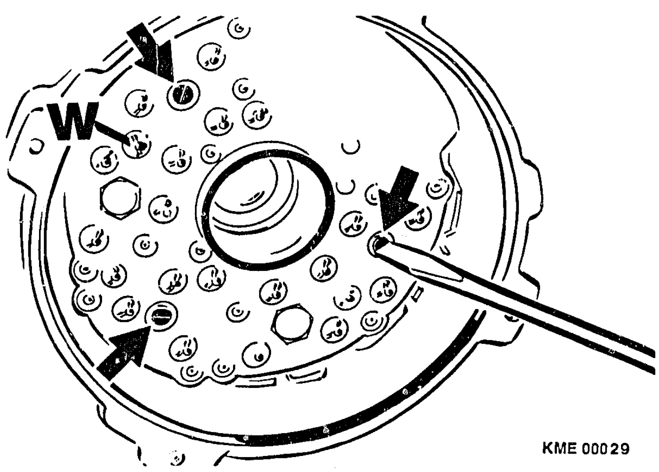


Figure 14 Rectifier Assembly Removal

3. Remove the nuts holding terminals B+, B- and D+ to the collector end shield.

   Note: Do not attempt to remove the studs from the rectifier assembly. Terminals B+, B- and D+ are permanently attached to the rectifier assembly. Terminal W is attached to the collector end shield. Do not loosen Terminal W.

4. Remove the rectifier assembly from the collector end shield.

9.9 Dampening Resistor Testing and Removal

1. The W Terminal incorporates a dampening resistor. Using a Multimeter MMD 302, connect one lead to the exterior portion of the W terminal and connect the other lead to the other side of the W Terminal. The Multimeter should read between 3.1 and 3.5 k (kilohm). If the resistance is above or below this range, the W terminal is to be replaced as an assembly. (Figure 15)

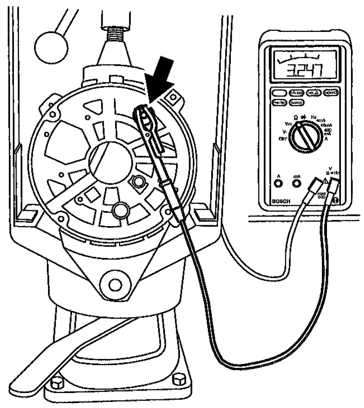


Figure 15 Testing of W Terminal Dampening Resistor

2. Loosen the nut retaining terminal W to the collector end shield.

3. Remove terminal W.

9.10 Removal of Collector End Shield Bearing and Seal

1. Insert extractor KDLJ 6009 (Bosch Number 0 986 618 121) into bearing.

2. Screw threaded rod KDAW 9995/14 (Bosch Number 0 986 618 214) into extractor KDLJ 6009.

3. Slide the receiver cup KDAW 9995/0/5 (Bosch Number 0 986 619 250) onto threaded rod.

4. Screw on the handle, rotate until the bearing, and seal come out of the collector end shield. (Figure 16)

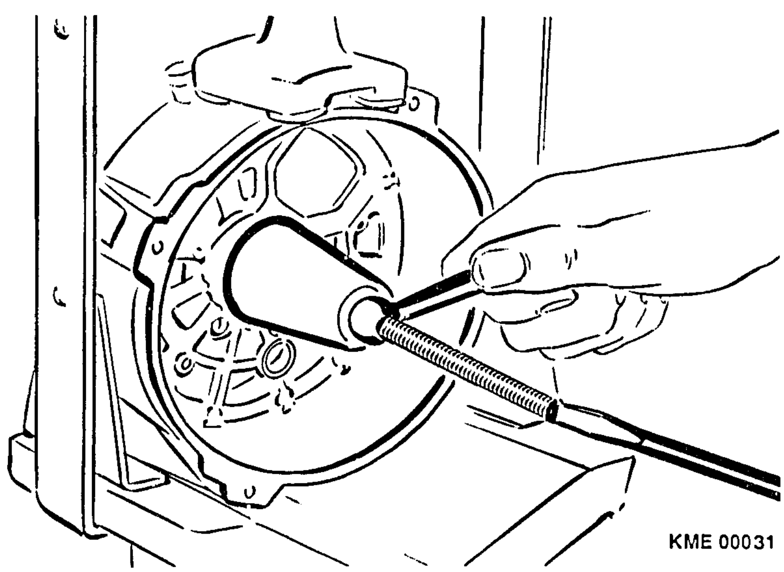


Figure 16 Bearing and Seal Removal

5. If the roller bearing is stuck in end shield, proceed as follows:

   a. Remove extractor KDLJ 6009 from the bearing.
   b. Destroy the bearing cage with a screwdriver or similar tool.
   c. Remove rollers from bearing.
   d. Insert spring collet KDAW 9995/6 (Bosch Number 0 986 619 233) into bearing outer race.
   e. Screw threaded rod KDAW 9995/14 into extractor KDAW 9995/6.
   f. Slide the receiver cup KDAW 9995/0/5 onto threaded rod.
   g. Screw on handle and rotate until the bearing race comes out of the collector end shield.

9.11 Removal of Sliding Bushing in Collector End Shield

1. Place collector end shield in an arbor press, support mounting/pivot boss on mandrel KDLJ 6016 (Bosch Number 0 986 618 130). (Figure 17)

2. Place bushing mandrel KDLJ 6015 (Bosch Number 0 986 618 219) on sliding bushing.

3. Press sliding bushing out of collector end shield into mandrel KDLJ 6016.

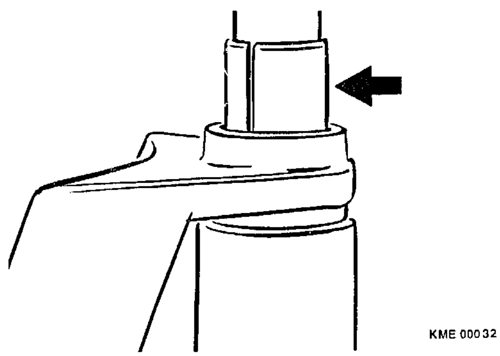


Figure 17 Sliding Bushing Removal

9.12 Removal of Rotor from Drive End Shield

1. Place drive end shield onto pressing ring KDLJ 6013 (Bosch Number 0 986 618 127).

2. Place pressing ring into an arbor press. (Figure 18)

3. Press out rotor.

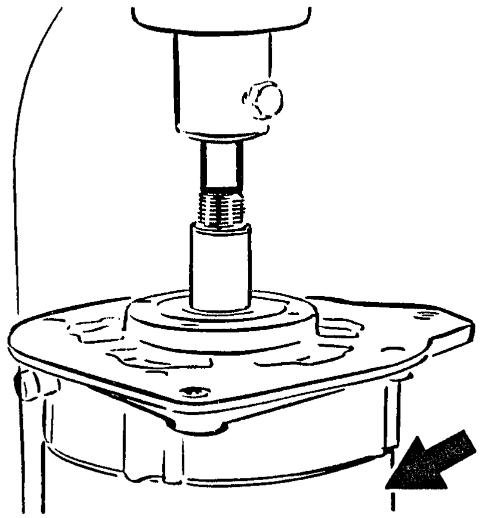


Figure 18 Pressing out Rotor

4. Remove spacer ring from rotor shaft.

Notes: Protect the threads of the rotor from damage prior to pressing. Always replace the drive end bearing if the rotor has been pressed out. Therefore, only remove the rotor if;

- *the rotor is to be replaced*
- *the excitation winding of the rotor is to be replaced*
- *the drive end bearing/spacer ring is to be serviced*
- *the rotor collector rings are to be replaced*

9.13 Removal of Bearing and Seal from Drive End Shield

1. Loosen and remove the four (4) screws holding the bearing cover plate. (Figure 19)
2. Remove the spacer ring (Refer to arrow in Figure 19).
3. Remove the bearing from the drive end shield.

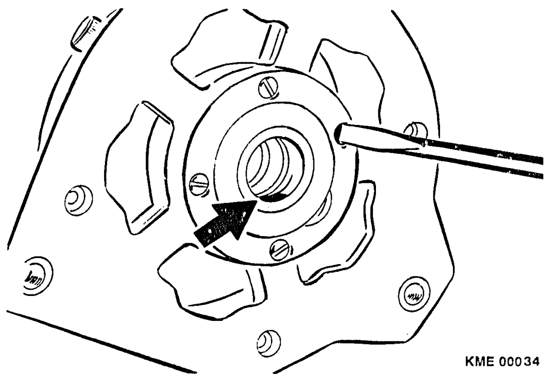


Figure 19 Drive End Bearing Removal

9.14 Removal of Collector Ring End Inner Bearing Race from Rotor

1. With a universal bearing puller, remove the inner race of the endshield bearing. (Figure 20)

Notes: *Place jaws of the puller yoke behind the inner-bearing race and pull the bearing race only. Do not place the yoke behind the spacer ring. Pulling both the bearing and the spacer ring at the same time may damage the rotor. The inner bearing race must be replaced anytime the collector end shield bearing is replaced.*

2. Reposition the puller and remove the spacer ring from the rotor shaft.

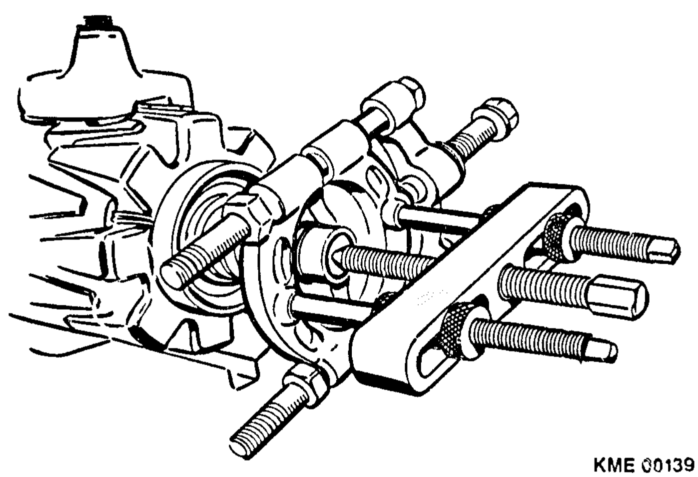


Figure 20 Inner Bearing Race Removal

9.15 Rotor Inspection

1. Using electric tester ETE 014.00 or Multimeter MMD 302, measure the resistance between the two collector rings of the rotor. The resistance measured should be between 7.5 and 8.3 . (Figure 21)

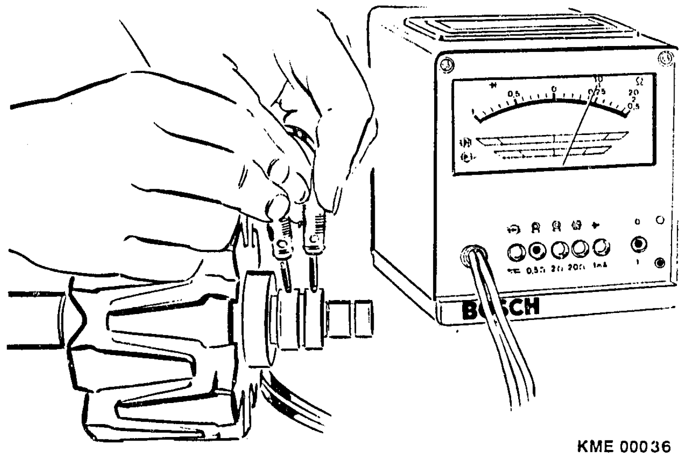


Figure 21 Rotor Resistance Testing

2. Using insulation tester KDAW 9983 or equivalent, apply 80 VAC to the rotor claw poles and each of the collector rings. If the insulation tester lights, there is a short to ground within the rotor. (Figure 22)

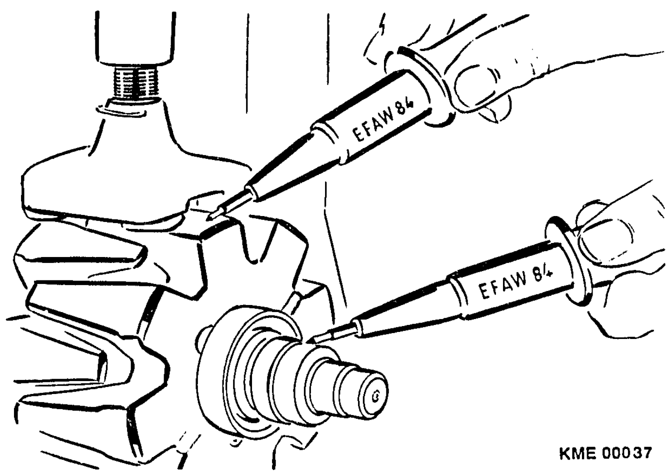


Figure 22 Rotor Insulation Testing

Note: The insulation tester applies a voltage of 80 VAC to the rotor. Voltages of 80V can be fatal. When performing this test, observe care is used in handling the rotor and any component or surface that is exposed to the rotor. Use insulated gloves and do not touch the work surface until all tests are completed.

3. Mount the rotor in a pair of V-Blocks at the rotor bearing points.

4. Position dial indicator (Magnetic Base T-M 1 (Bosch Number 4 851 601 124) and Dial Indicator EFAW 7 (Bosch Number 1 687 233 011)) to measure the concentricity of the rotor at:: (Figure 23)

   a. Outer diameter of rotor, maximum run-out 0.05 mm (0.002 in). If the run-out of the rotor exceeds the maximum, the rotor must be replaced.

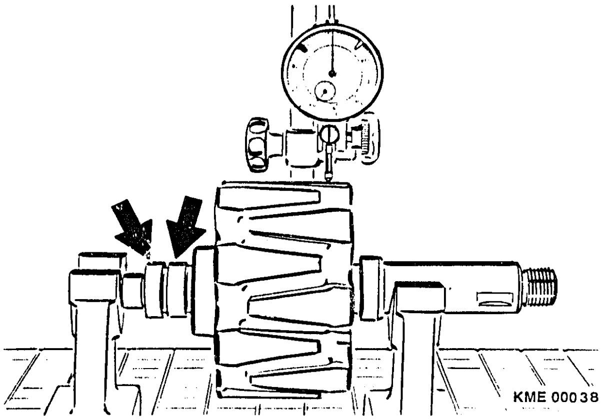


Figure 23 Rotor Concentricity Measurement

   b. Each collector ring, maximum run-out 0.03 mm (0.0012 in). If the run-out exceeds the maximum, the collector rings can be machined down to a minimum of 31.5 mm (1.240 in) diameter. If the required machining causes the collector ring diameter to drop below the minimum dimension, the collector ring(s) must be replaced.

9.16 Collector Ring Replacement

1. Before the collector rings can be removed, the spacer ring from the end of the rotor must be removed. Refer to Section 9.14 *"Removal of Inner Bearing Race from Rotor."*

2. Unsolder the rotor leads from each collector ring.

3. With a universal bearing puller, remove each collector ring one at a time from the rotor. (Figure 24)

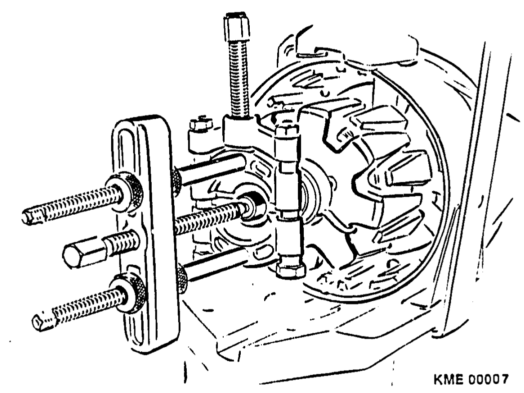


Figure 24 Collector Ring Removal

10 Alternator Assembly

10.1 Rotor Assembly

1. Position rotor in arbor press with the drive end pointing down.

2. Press the lead for the rotor winding into the slot of the rotor.

3. Slide the collector rings onto the rotor shaft as far as possible by hand. Make sure the lead for the rotor windings does not become damaged while sliding the collector rings over the lead.

4. Lining up the slot in tool KDLJ 6012 (Bosch Number 0 986 618 126) with the rotor lead, press the collector rings onto the rotor as far as possible. (Figure 25)

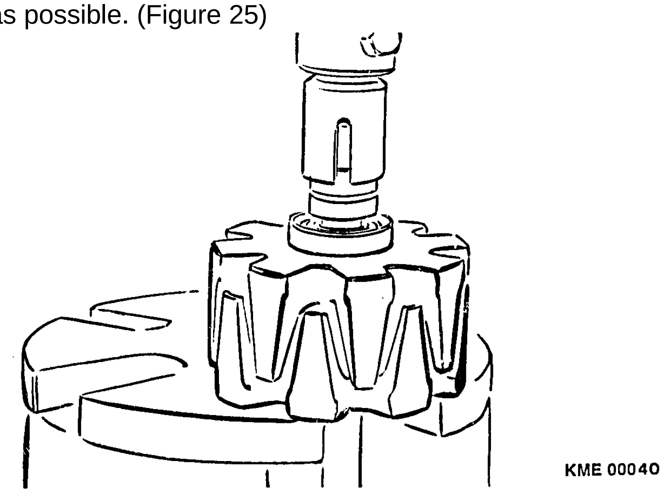


Figure 25 Pressing on Collector Rings

5. Solder each of the rotor winding leads to one of the collector rings with rosin core solder.

6. After soldering, touch up surface of collector ring to remove any excess solder from the brush contact surface.

7. Press on collector end shield bearing spacer ring with tool KDLJ 6018 (Bosch Number 0 986 618 134) until it contacts the stop on the rotor and no air gap is present. (Figure 26)

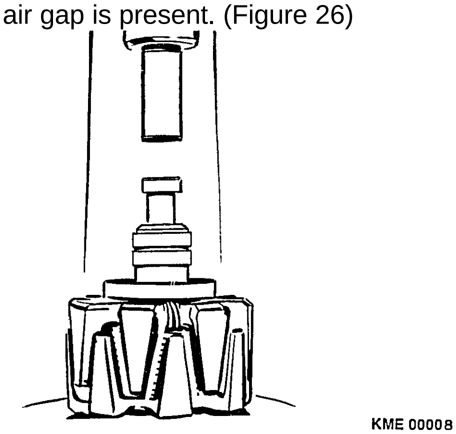


Figure 26 Spacer Ring

Note: Do not allow the spacer ring to twist while pressing onto the rotor.

8. Place the inner bearing race of the collector end shield bearing onto the rotor shaft.

9. Press the bearing onto the rotor shaft with tool KDLJ 6018. (Figure 26)

10.2 Drive End Shield Assembly

1. Insert sealed ball bearing into the drive end shield.

2. Align the holes of the bearing cover plate with the holes in the drive end shield.

3. Start the four screws which hold the bearing cover plate and tighten to 4.1 … 5.5 Nm (36.3 … 48.7 in. lbs.) (Figure 27)

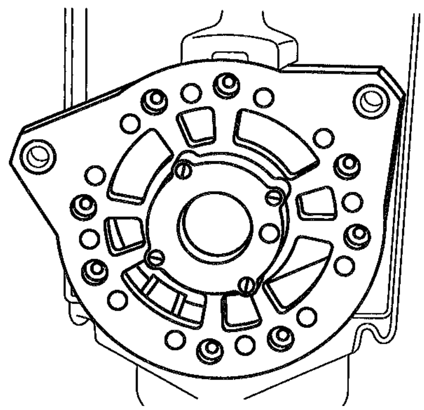


Figure 27 Drive End Bearing Retaining Screws

4. Insert bearing/fan spacer ring into the drive end shield from the fan side of the shield.

5. Place drive end shield on to an arbor press with the bearing/fan spacer ring pointed down. (Figure 28)

6. Slide support ring onto the drive end of the rotor. Make sure the under cut side of the ring faces the retaining ring on the rotor.

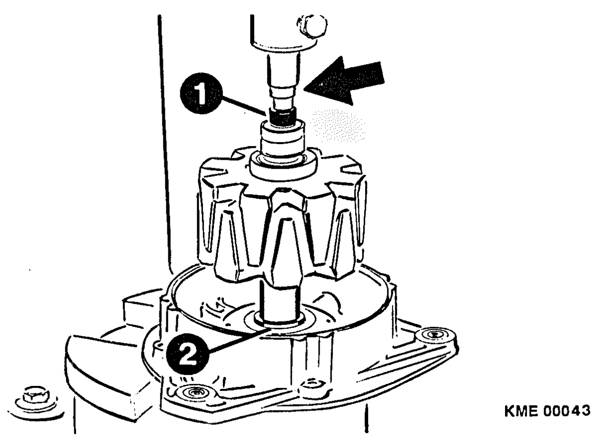


Figure 28 Installing Rotor into Drive End Shield
(1) Tool KDLJ 6018 (2) Support Ring

7. Place rotor into the drive end bearing.

8. Place tool KDLJ 6018 onto the end of the rotor and press the rotor into the drive end bearing until the bearing seats against the support ring.

10.3 Collector Ring End Shield Assembly

1. Pack the collector end roller bearing with 2 to 2.5 g (0.07 to 0.09 oz.) of UNIREX N3 grease.

2. Place the end shield on an arbor press.

3. Place tool KDLJ 6011 (Bosch Number 0 986 618 125) into bearing and press bearing into collector end shield. (Figure 29)

4. Pack the bottom of the collector end housing bearing bore with an additional 2 g (0.07 oz.) of UNIREX N3 grease.

5. Coat the sealing lip of the radial lip seal and pack the seal with 2 g (0.07 oz.) of UNIREX N3 grease.

Notes: Do not assemble the alternator with a dry radial seal as this will lead to seal failure and contamination of the brushes and collector rings.

Make sure there is no excess grease on the exterior of the seal before installation in the collector end shield. Excess grease on the exterior of the seal will cause contamination of the collector rings and brushes.

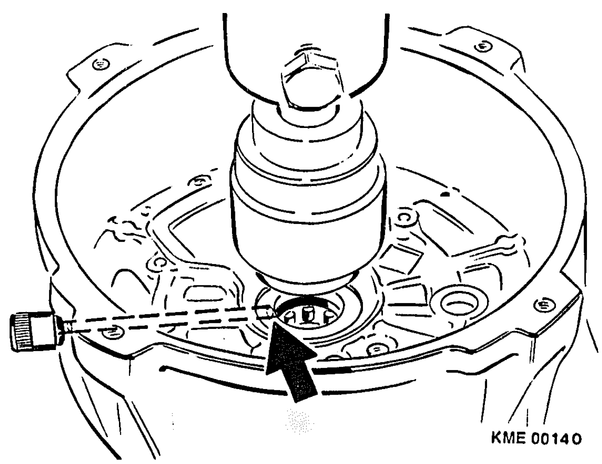


Figure 29 Installation of Bearing and Seal

6. Place seal onto tool KDLJ 6011 and press the seal into the collector end shield. (Figure 29)

7. Place collector end shield in an arbor press, support mounting/pivot boss on tool KDLJ 6016. (Figure 30)

8. Coat the inside of the collector end shield bore with Molycote.

9. Place sliding bushing into place on collector end shield.

10. With tool KDLJ 6015, press sliding bushing into end shield until the bushing is flush with the inner surface of the mounting/pivot boss. (Figure 30)

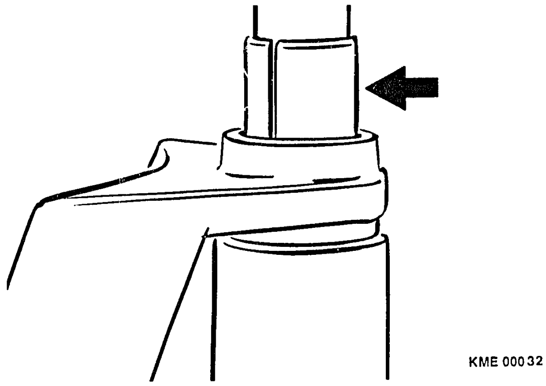


Figure 30 Sliding Bushing Installation

11. Insert terminal W into collector end shield in location marked W. Make sure the locating lug of the terminal assembly indexes the end shield correctly.

12. Place insulator and flat washer onto terminal W.

13. Install nut and torque to 4.1 to 5.5 Nm (36.3 to 48.7 in. lbs.)

14. Install protective cap onto terminal W. (Figure 31)

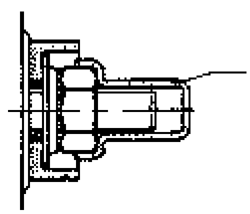


Figure 31 Terminal W Insulator, Washer, Nut and Cap

10.4 Rectifier Assembly

1. Place flat washer and insulator (a) onto terminal B+ and D+ studs of the rectifier assembly. (Figure 32)

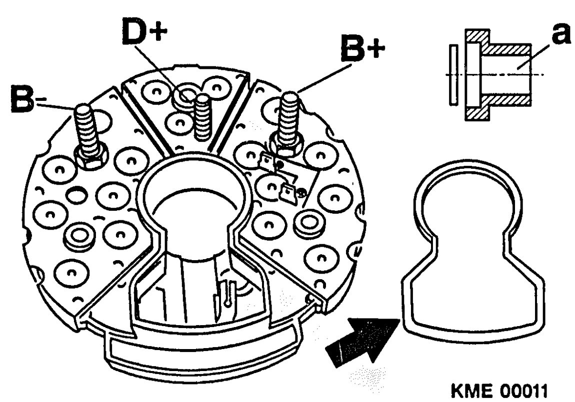


Figure 32 Rectifier Insulators and Seal

2. Coat the keyhole shaped surface of the rectifier with adhesive. (Figure 32)
3. Place the rectifier seal ring onto the keyhole shaped surface of the rectifier. Make sure the seal conforms to the shape of the keyhole.
4. Once the adhesive has cured, place the rectifier into the collector end shield. Make sure the solder lug of the W Terminal passes into the correct position of the rectifier assembly.
5. Install the insulating washer, flat washer and nut to terminal studs B+ and D+. (Figure 33)
6. Install flat washer and nut onto terminal stud B-. (Figure 33)
7. Check that the soldering lug of terminal W is still in the proper location of the rectifier assembly.

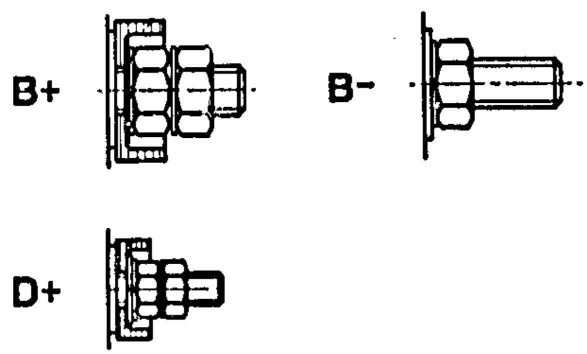


Figure 33 Terminal B+, B- and D+ Assembly

8. Torque terminal stud nuts B+, D+ and B- to:
   a. Terminal B+ and B-........ 10 to 13 Nm (88.5 to 115 in. lbs.)
   b. Terminal D+................... 2.4 to 3.2 Nm (21.2 to 28.3 in. lbs.)
9. Install the flat washer and second nut to terminal studs B+, D+ and B- and torque to:
   a. Terminal B+ and B-........ 10 to 13 Nm (88.5 to 115 in. lbs.)
   b. Terminal D+................... 2.4 to 3.2 Nm (21.2 to 28.3 in. lbs.)
10. Install the three (3) rectifier mounting screws and torque to 1.3 to 1.7 Nm (11.5 to 15 in. lbs.).
11. Solder the soldering lug of terminal W to the solder pad of the rectifier assembly with rosin core solder. (Figure 34)

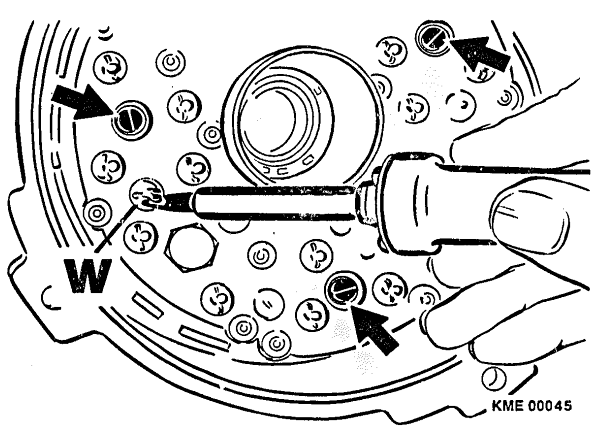


Figure 34 Rectifier Mounting and Soldering of Terminal W

10.5 Stator Assembly

1. Position the stator on the collector end shield. The side of the stator with the winding leads should be closest to the collector end shield.
2. Line up the scribed mark of the stator with the scribed mark of the collector end shield. If either the stator or collector end shield was replaced, a new mark should be scribe across the new part using the replaced component as a reference.

3. Place each of the stator leads into a corresponding soldering lug of the rectifier assembly. After the lead is through the soldering lug, bend the lead so it forms a U around the lug. (Figure 35)

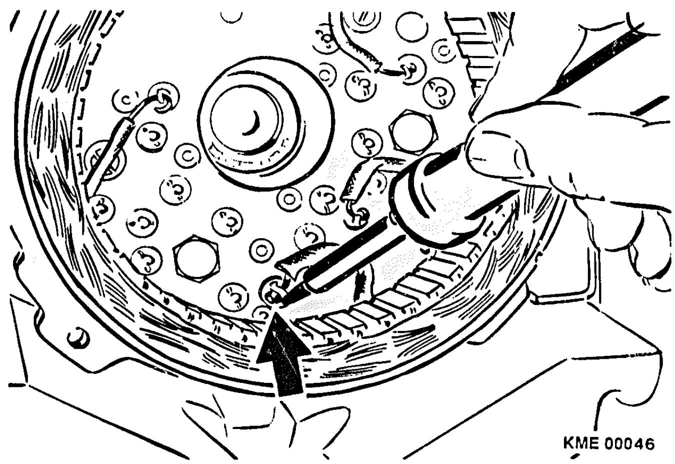


Figure 35 Soldering of Stator Leads

4. Solder each of the stator leads to the rectifier assembly with rosin core solder.

10.6 Rotor and Drive End Shield Installation

1. Place collector end shield and stator assembly on a suitable surface so the rotor and drive end shield assembly can be lowered into place

2. Guide the rotor and drive end shield assembly until the inner bearing race of the collector end bearing enters the roller bearing. Once the inner race enters the bearing, lower the assemblies completely into the collector end shield.

3. Insert guide pin KDLJ 6014 (Bosch Number 0 986 618 128) through the sliding bushing of the collector end shield and the bushing of the drive end shield. (Figure 36)

4. Start the four (4) drive end shield to collector end shield screws.

5. Place the alternator assembly into clamping fixture KDAW 9999.

6. Insert four (4) 0.3 mm (0.012 in) feeler gauges between the stator and the rotor. The feeler gauges should be place in four diametrically opposed positions. (Figure 36)

7. Torque the drive end shield to collector end shield screws to 7.2 to 9.7 NM (21.2 to 28.3 in. lbs.).

8. Remove the four feeler gauges from between the stator and rotor.

9. Turn the rotor by hand. The rotor should rotate freely by hand. If the rotor does not turn freely, loosen the drive end shield to collector end shield screws and repeat steps 6, 7, 8 and 9.

10. While rotating the rotor by hand, listen for contact between the rotor and the stator or stator leads. If any contact sound is heard, the rotor and drive end shield assembly must be removed, the cause determined and repaired before continuing. Once the problem has been corrected, start at step 1 of this section.

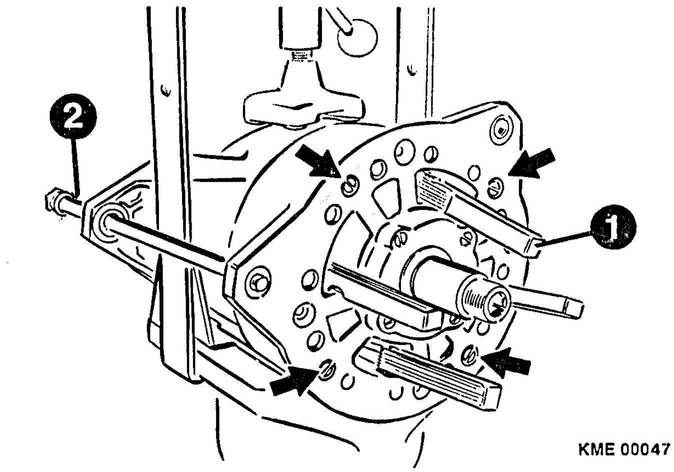


Figure 36 Drive End Shield, Stator and Collector End Shield Assembly
(1) Feeler Gauge (2) Tool KDLJ 6015

11. Remove the alignment pin KDLJ 6014 from the alternator.

10.7 Regulator and Capacitor Installation

1. Depress the carbon brush closest to the regulator into the regulator/brush holder.

2. Insert a straightened paper clip (1 to 1.3 mm dia. x 40mm) into the hole of the regulator until the pin holds the brush in place.

3. Pivot the regulator into the opening of the alternator. Once the brush holder is inside the alternator cavity, slowly remove the paper clip and allow the brushes to extend from the holder. (Figure 37)

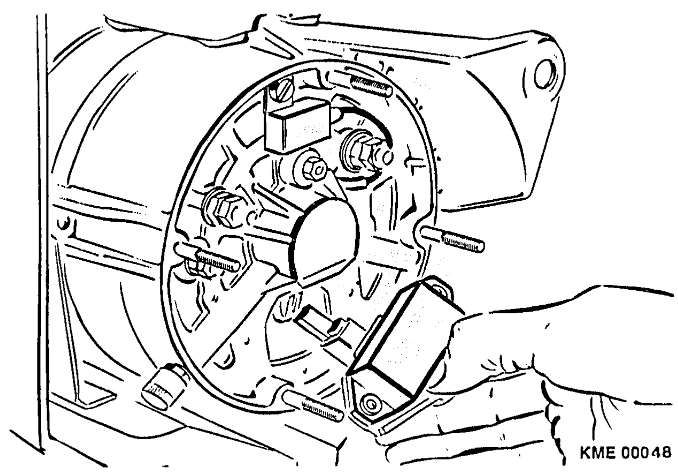


Figure 37 Regulator Installation

4. Align the mounting holes of the regulator to holes of the alternator housing.

Note: When aligning the mounting holes, pay attention to the force used as damage can occur to the brushes.

5. Install the three (3) regulator mounting screws and torque to 1.3 to 1.7 Nm (11.5 to 15 in. lbs.). (Figure 38)

6. Install capacitor on collector end shield and tighten mounting screw to 4.3 to 5.7 Nm (38.0 to 50.4 in. lbs.). (Figure 38)

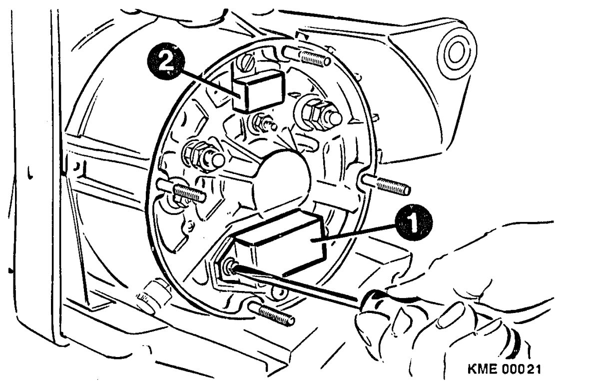


Figure 38 Capacitor Installation
(1) Voltage Regulator (2)

7. Connect lead of capacitor to spade terminal +.

8. Install air intake cover onto alternator. Do not torque cover until it has been installed on the vehicle/engine.

11 Functional Testing

11.1 General Information

The functional testing of the alternator is broken into two categories, Power Output and Voltage Trace Evaluation. All of the tests describe here are performed with the voltage regulator installed on the alternator.

11.1.1 Power Output Tests

The power output tests verify the capability of the alternator to produce rated current and voltage at different speeds. This test requires a test bench of sufficient horsepower to turn a fully loaded alternator at a given speed. Additionally, the test bench must have the ability to inductively load the alternator to its rated amperage for an extended amount of time.

The power output test is to be performed anytime the alternator is suspected of being defective or if the alternator has been disassembled.

11.1.1.1 Test Bench Requirements

To perform the power output test of this series alternator, a test bench must meet the following minimum criteria.

Characteristic	Minimum Specification
Variable Speed Control	0 - 12,000 RPM
Drive Motor	4 kW (5.4 hp)
Load Bank Capability	170 A @ 28 V for 10 minutes 80 A @ 28 V for 30 minutes
Output Voltage Capability	28 V

11.1.2 Voltage Trace Evaluation

The voltage trace evaluation compares the output of the alternator as viewed on an oscilloscope to know oscilloscope patterns. The voltage trace evaluation is an important tool for diagnostics of an alternator that cannot meet the criteria of the power output test. Proper interpretation of the waveforms obtained can lead a technician to the defective component of a failed alternator. The voltage trace evaluation is done while the alternator is still mounted to the alternator test bench. Most any oscilloscope, which is capable of accepting the alternator voltage output, is useable for this evaluation.

11.2 Power Output Testing

11.2.1 Test Bench Mounting

1. Mount the alternator to the test bench per the operating instructions of the test bench manufacturer.

2. Connect the drive system of the test bench to the alternator as per the instructions of the test bench manufacturer.

Note: Only perform the power output tests with the fan pulley installed on the alternator. Failure to test the alternator with the correct fan installed can cause the alternator to overheat and damage the internal components of the alternator.

3. Connect the test leads of the test bench to the alternator as follows:

a. Connect the +24 v lead of the test bench to the B+ terminal of the alternator.
b. Connect the -24 v lead of the test bench to the B- terminal of the alternator.
c. Connect the charging indicator lamp of the test bench to the D+ terminal of the alternator.

Note: Refer to test bench manufacturers operating instructions for correct terminology of test leads
Refer to figure 39 for a schematic outline of alternator to test bench connections. Compare this schematic to the hook-up schematic of your test bench.

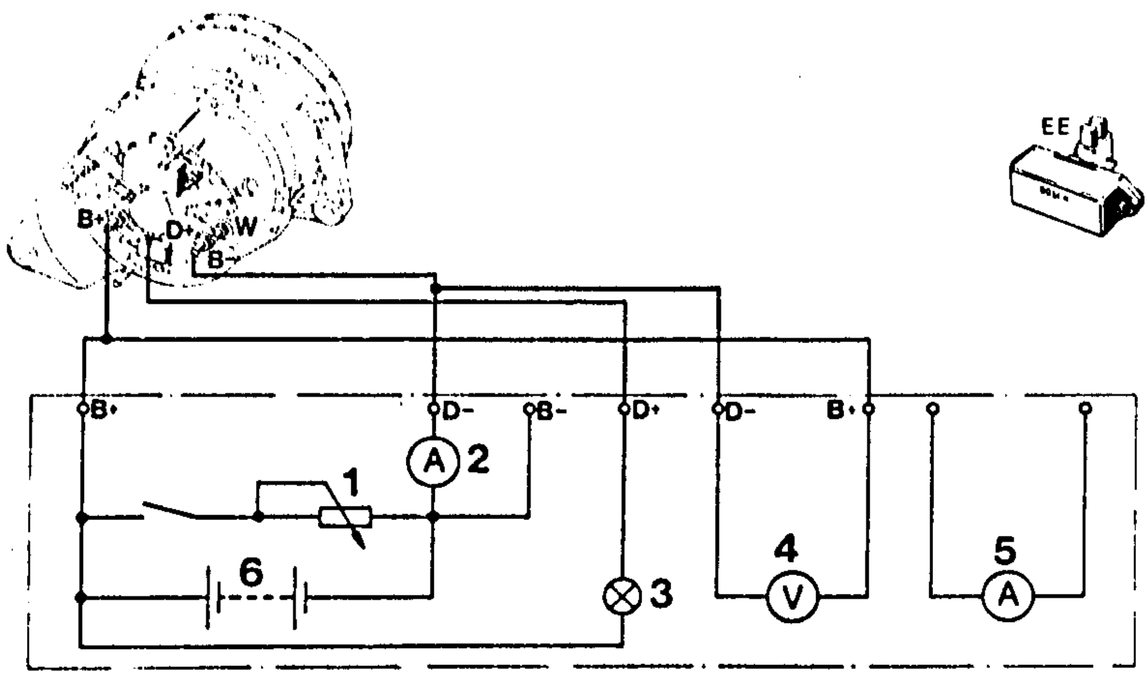


Figure 39 Alternator Test Bench Hook-up Schematic

(1) Variable Load Resistor
(2) Ammeter (Alternator Output)
(3) Charging Indicator Lamp
(4) Voltmeter (Regulated Voltage)
(5) Ammeter
(6) Test Bench Battery

4. Make sure the test bench is set for the correct voltage and rotation before starting tests.

11.2.2 Power Output Test

1. Start test bench and increase speed to 1500 rpm, alternator speed.

2. Increase inductive load on the alternator until 76A output is achieved. As load is increased, monitor test bench speed and correct if speed drops while applying load.

3. Hold test bench at this speed and load for 30 minutes. Monitor alternator output and speed during the test period.

4. Remove load and operate the alternator at 7000 rpm for one minute to allow the alternator to cool.

5. Refer to the test bench operating instructions and allow the load bank to cool the required amount of time before proceeding to the next test.

6. After the load bank has cooled, increase the test bench until the alternator has reached 6000 rpm.

7. Increase inductive load on the alternator until 136A alternator output is achieved. As load is increased, monitor test bench speed and correct if speed drops while applying load.

8. Hold test bench at this speed and load for 10 minutes. Monitor alternator output and speed during the test period.

9. Remove load and operate the alternator at 7000 rpm for one minute to allow the alternator to cool.

10. Refer to the test bench operating instructions and allow the load bank to cool the required amount of time before proceeding to the next test.

11. Apply a minimum load of 10A to the alternator.

12. Measure the regulated voltage of the alternator. The correct regulated voltage is between 27.6 and 28.4 volts.

13. If the alternator passes the three output tests, no further testing is required. If the alternator failed any of the three tests, proceed with the voltage trace evaluation.

11.3 Voltage Trace Evaluation

The voltage trace evaluation is a comparison of the voltage output of the alternator to know patterns. These know patterns will help identify different failed components.

11.3.1 Oscilloscope Hook-up

1. Following the manufacturer's instructions for your oscilloscope, connect the scope to the B+ and B- terminals of the alternator.

2. Adjust the oscilloscope to read 28 volts.

3. Turn on test bench and operate the alternator with a 10A load.

4. Compare oscilloscope display to the following test patterns.

11.3.2 Normal Pattern

This image represents a properly functioning alternator. The D.C. voltage produced has a small harmonic wave.

Small spikes may be superimposed on the oscilloscope screen if the voltage regulator is regulating. Applying a load to the alternator output terminals can turn off the regulator.

In order to be able to compare oscilloscope images, the oscilloscope so the pattern fits between two vertical 10x divisions.

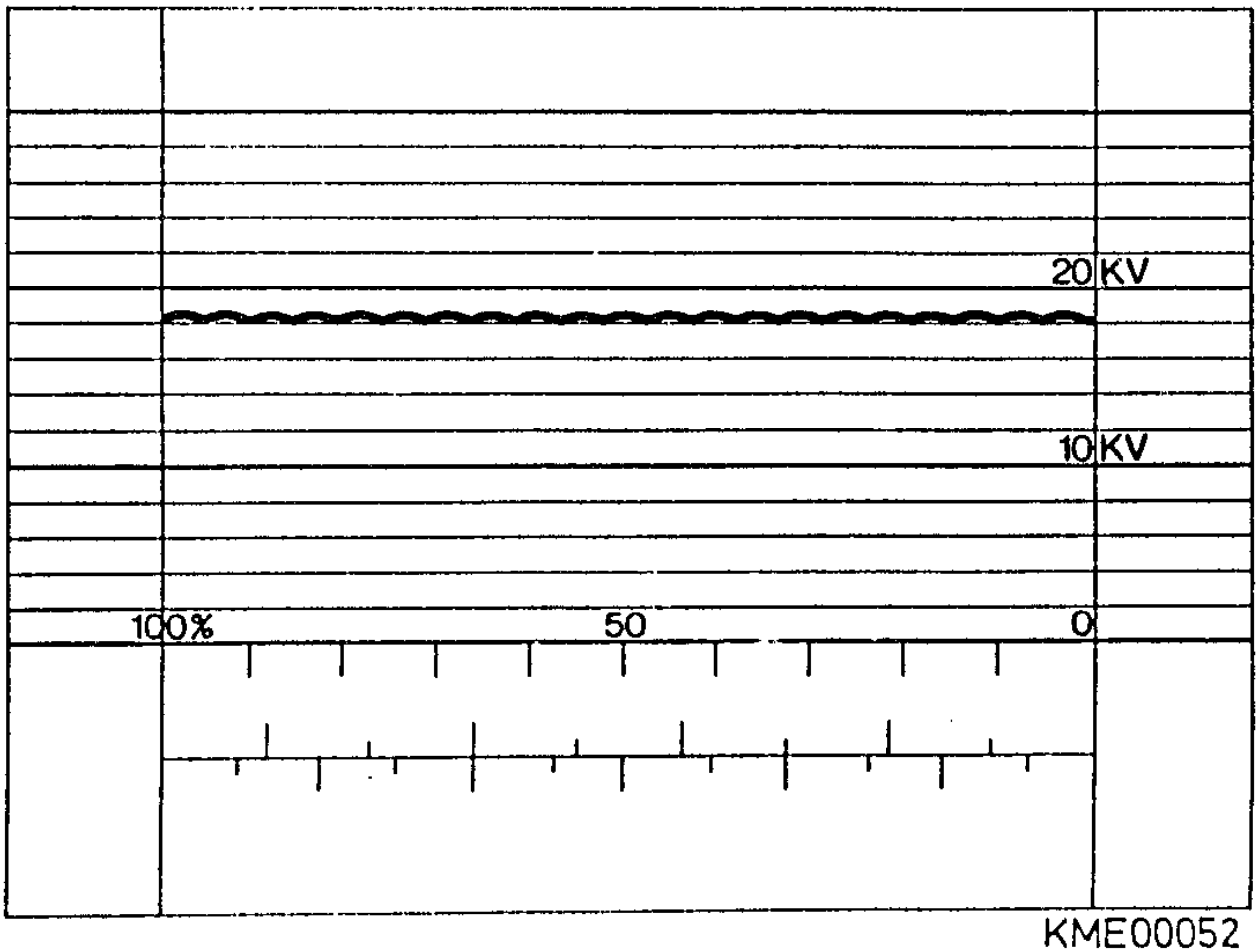


Figure 40 Normal Pattern

11.3.3 Open Exciter Diode

This pattern displays a characteristic dip in the normally smooth wave characteristic of a defective exciter diode. This would require disassembly of the alternator and replacement of the rectifier assembly.

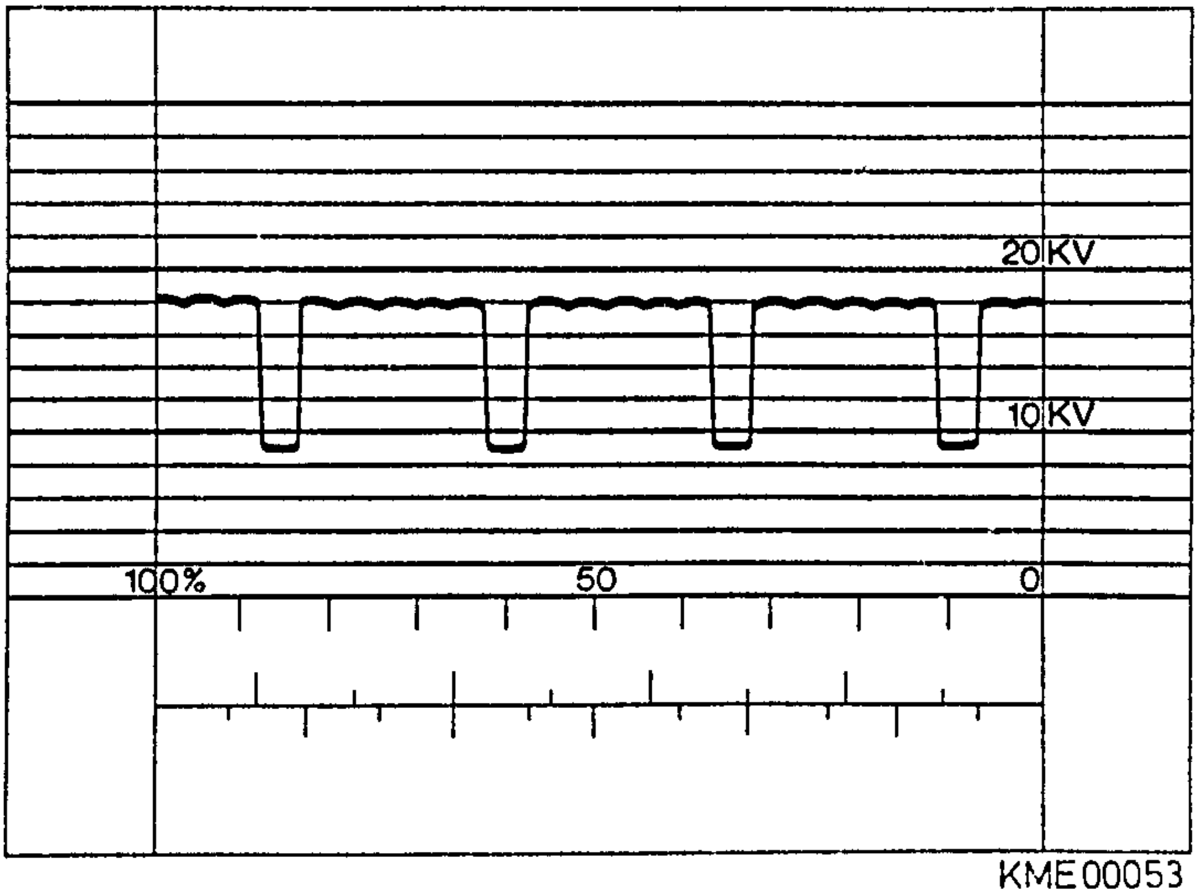


Figure 41 Open Exciter Diode

11.3.4 Open Positive Rectifier Diode

This pattern identifies an open positive rectifier diode. In the case of multiple diodes in parallel, all of the diodes on the circuit must be open. An example is:

There are two diodes in the rectifier for each phase of the stator. Both diodes must be open for this pattern to appear.

With this type of defect, the rectifier assembly must be replaced.

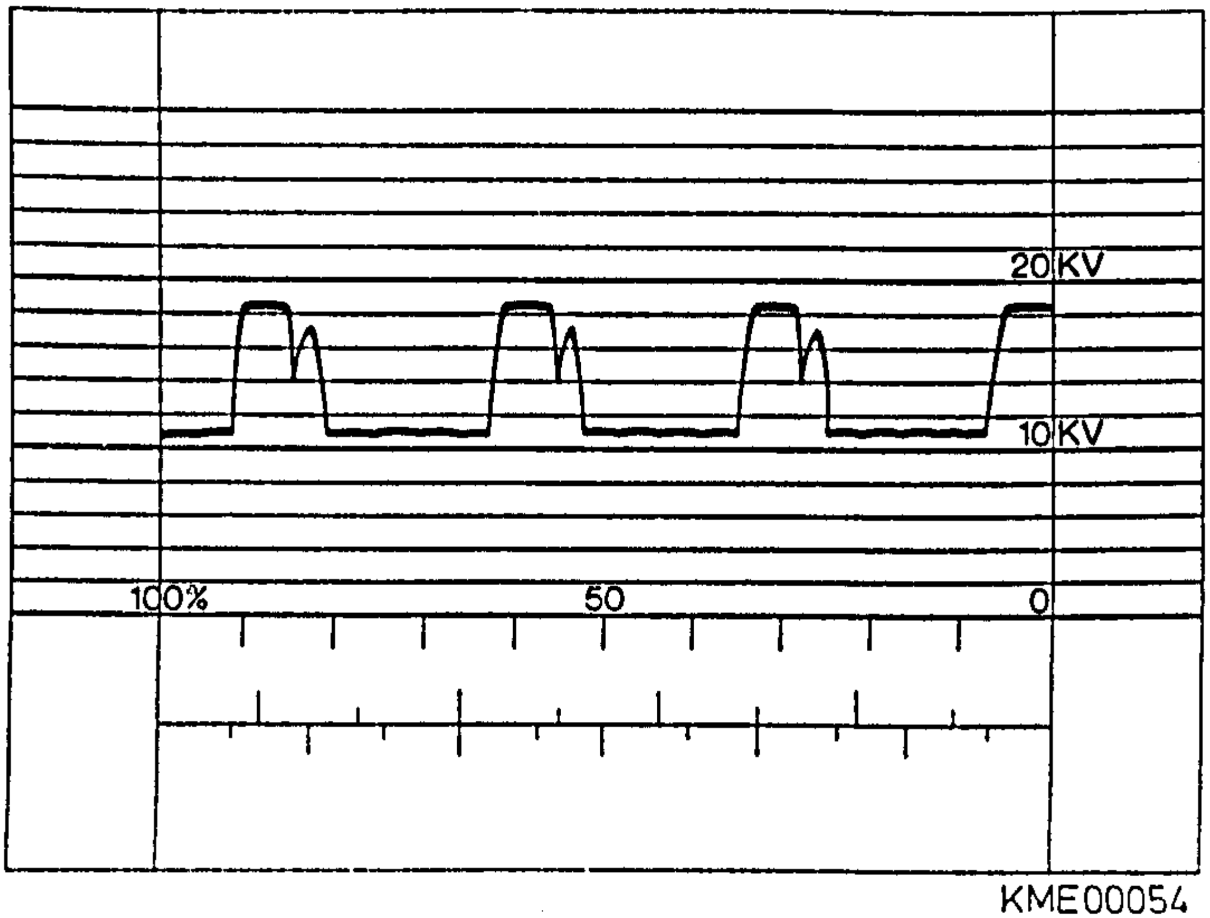


Figure 42 Open Positive Rectifier Diode

11.3.5 Open Negative Rectifier Diode

This pattern identifies an open negative rectifier diode. In the case of multiple diodes in parallel, all of the diodes on the circuit must be open. An example is:

There are two diodes in the rectifier for each phase of the stator. Both diodes must be open for this pattern to appear.

With this type of defect, the rectifier assembly must be replaced.

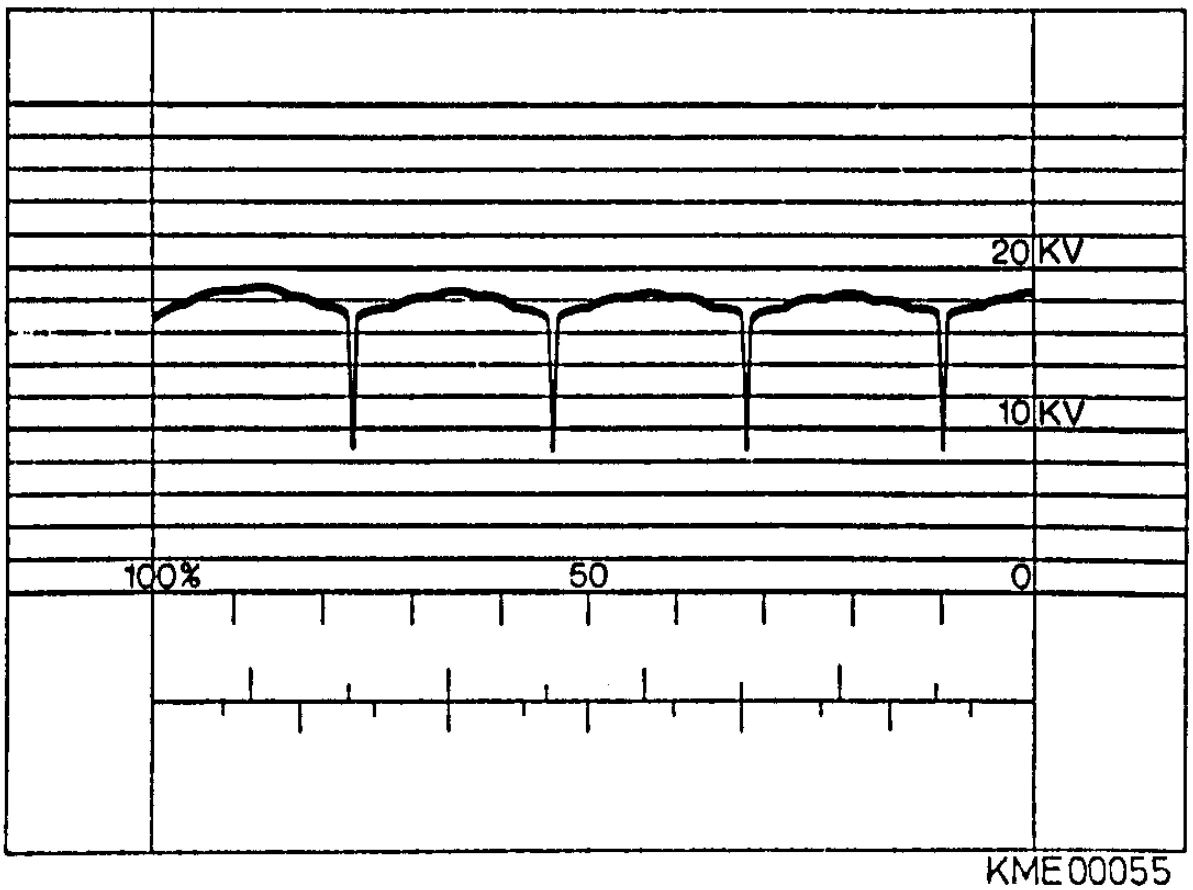


Figure 43 Open Negative Rectifier Diode

11.3.6 Shorted Exciter Diode

This pattern identifies a shorted exciter diode. This would require disassembly of the alternator and replacement of the rectifier assembly.

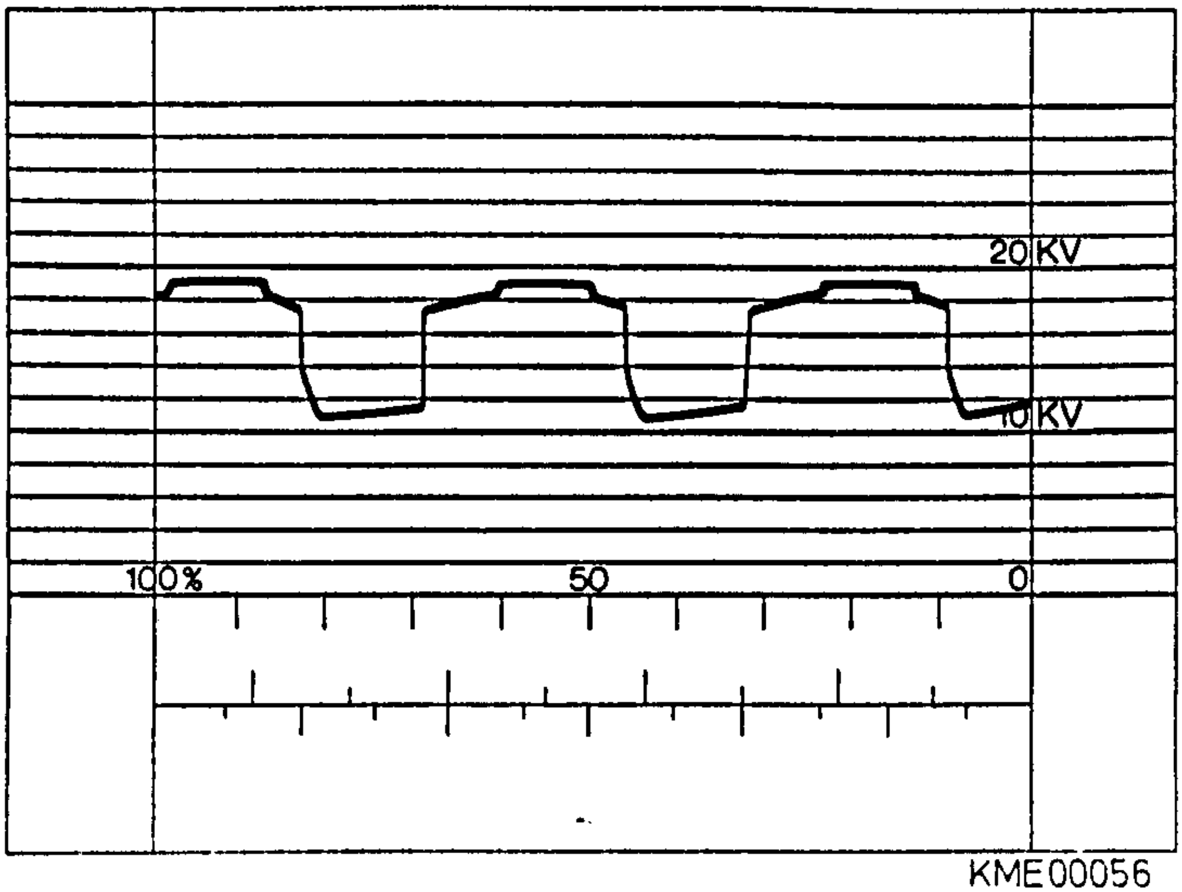


Figure 44 Shorted Exciter Diode

11.3.7 Shorted Positive Rectifier Diode

This pattern identifies a positive rectifier diode that is shorted. This defect requires replacement of the rectifier assembly.

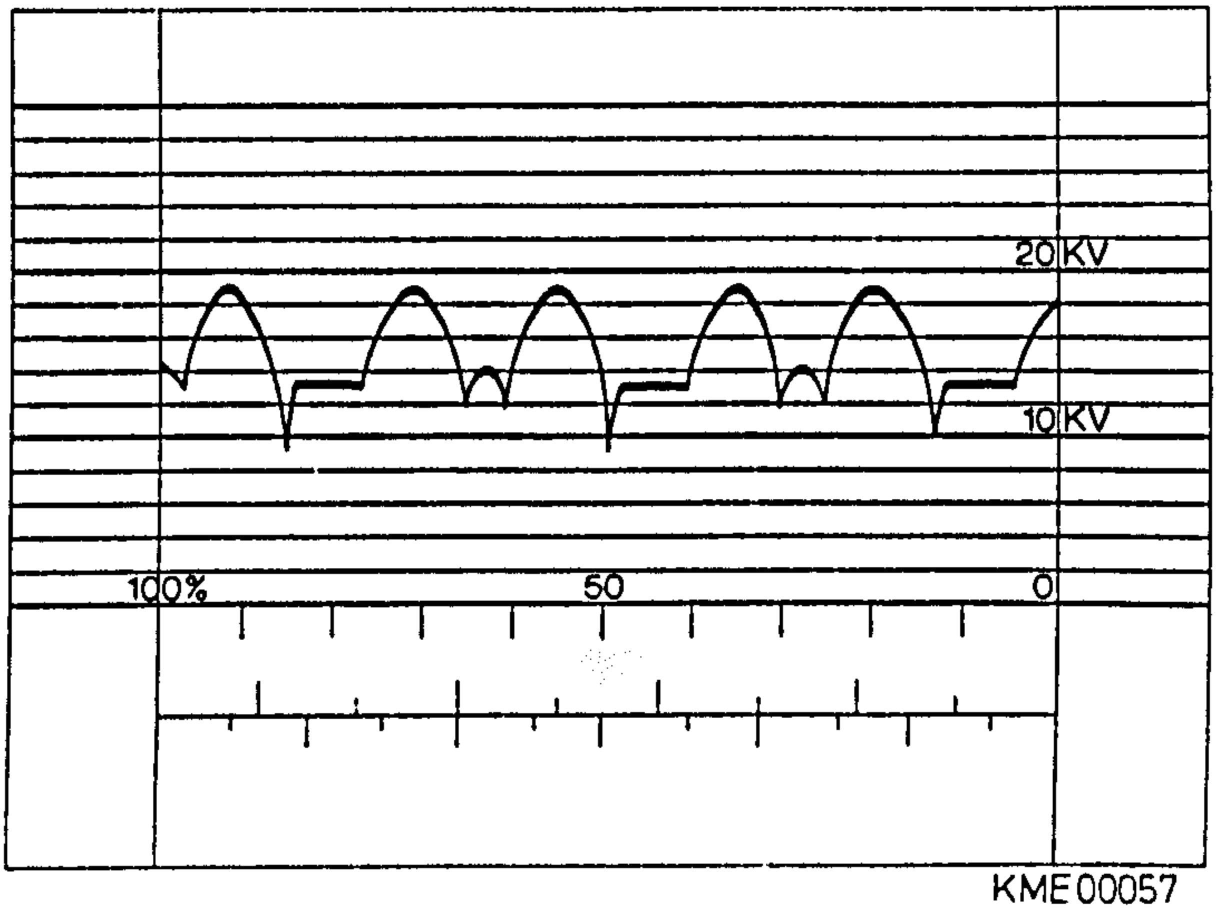


Figure 45 Shorted Positive Rectifier Diode

11.3.8 Shorted Negative Rectifier Diode

This pattern identifies a negative rectifier diode that is shorted. This defect requires replacement of the rectifier assembly.

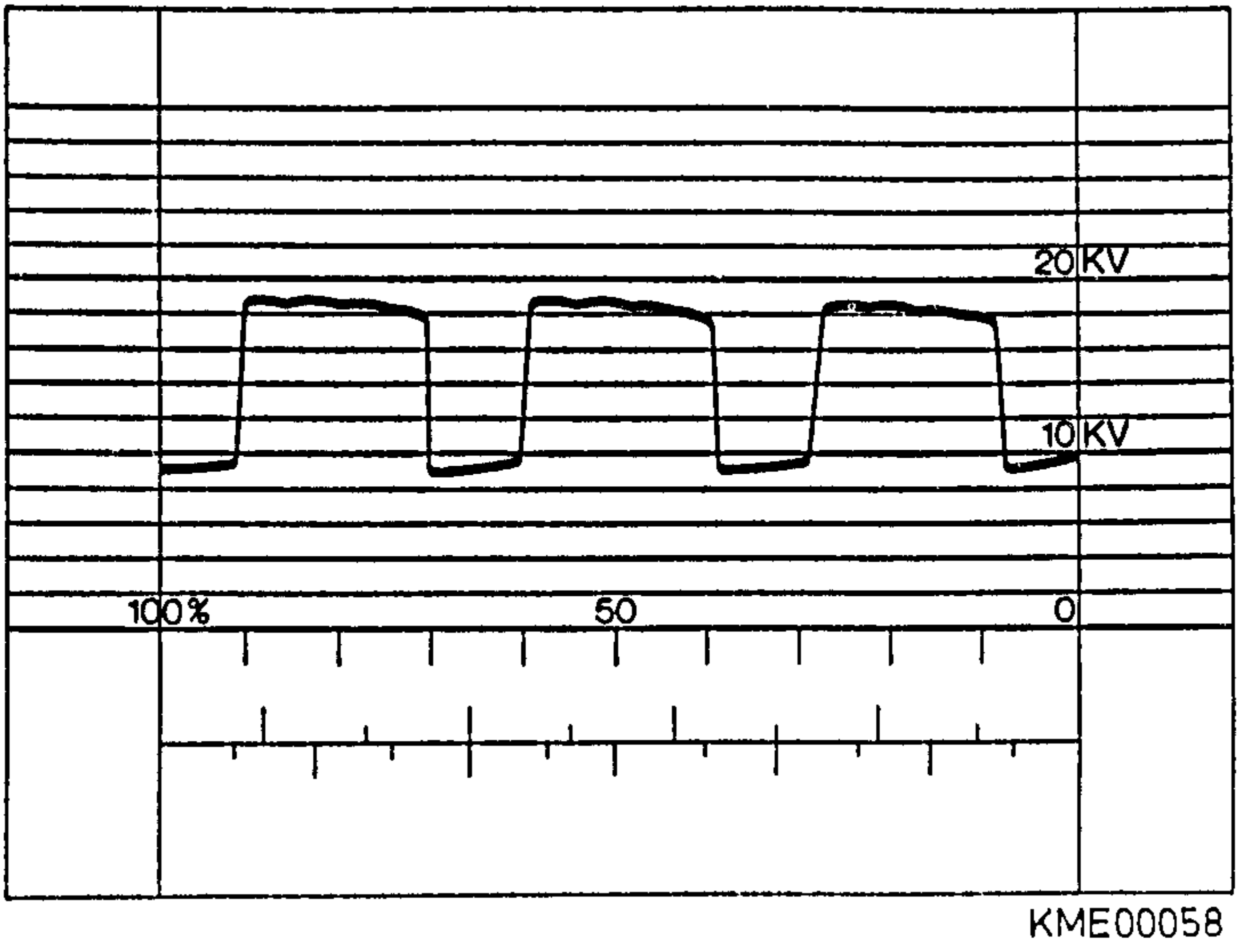


Figure 46 Shorted Negative Rectifier Diode

11.3.9 Open Phase of Stator

This pattern illustrates a stator with an open phase winding. This type of defect would require replacement of the stator.

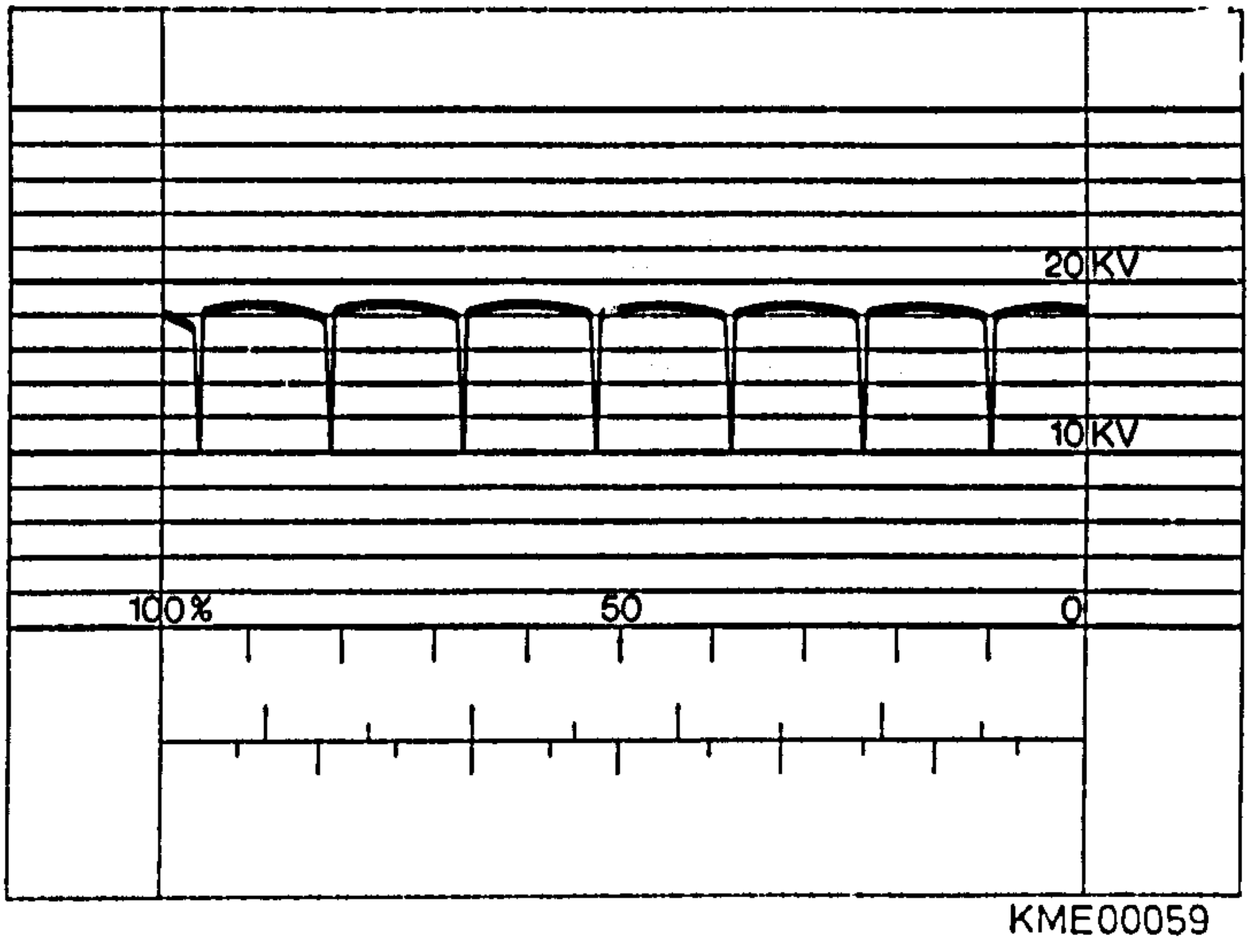
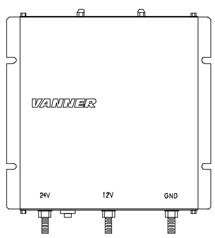
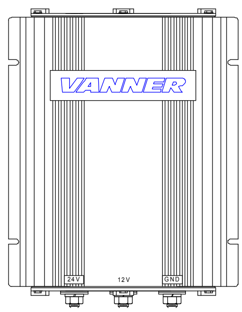
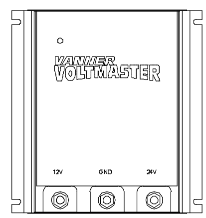


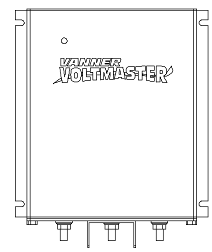
Figure 47 Open Stator Phase

VoltMaster Battery Equalizer









Family 1	Family 2	Family 3	Family 4	Family 5
60-10B	60-100C	60-60	65-60	66-60
60-20A	60-100D	60-60M	65-60M	66-80
60-50A	60-100E	60-80	65-80	66-100
60-50E		60-100	65-100	
60-50M				

Table of Contents

Introduction

Thank you for purchasing a Vanner ***VoltMaster*** Battery Equalizer. We are confident that you will be very pleased with its performance because our Battery Equalizers 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 ***VoltMaster*** 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 equalizer 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 ***VoltMaster*** Battery Equalizer is designed to save your batteries and the money you would spend replacing them. Users of the Vanner ***VoltMaster*** Battery Equalizer 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 ***VoltMaster*** Battery Equalizer. The Battery Equalizer connects to the 24 volt, 12 volt and ground terminals of the battery system. When the 12 volt loads require power, the Battery Equalizer 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.

Parallel Equalizers: Models are available which provide 10, 20, 60, 80 and 100 amps of 12 volt DC power. ***VoltMaster*** 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. Family 1, Family 3, Family 4, and Family 5 models may be paralleled in any combination. Family 2 models may be paralleled only with other Family 2 models.

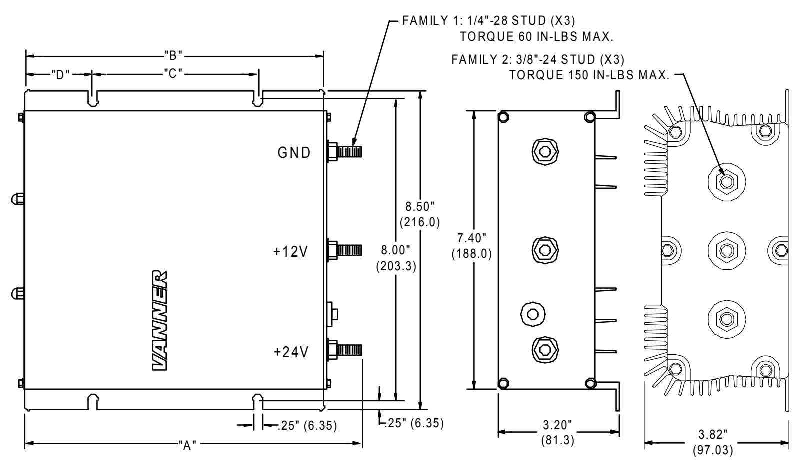
NOTE: The Vanner ***VoltMaster*** Battery Equalizer is an extremely reliable device and, when installed according to the instructions, will provide reliable operation for an indefinite period of time. However, if a system abnormality should develop that would cause a Battery Equalizer malfunction, damage to the battery system could result if 12 volt loads are present. If your system application is critical you may consider installing a Vanner **Model EM-70 Electrical System Monitor**. This module monitors the battery system' s voltages and balance, and provides fault signals that can be wired to warning lights, buzzers or other control/warning devices. Models 60-50M , 60-60M and 65-60M have the EM-70 built in. Call Vanner for more details.

Specifications

	Family 1			Family 2*	Family 3* / Family 4			Family 5		
Model Number	60-10B	60-20A	60-50A*	60-100E*	60-60*	60-80*	60-100*	66-60	66-80	66-100
					65-60	65-80	65-100			
Input Voltage 24v	20 to 35v			18 to 36v	18 to 32v			18 to 32 v		
Efficiency (Peak)	>91%	>92%	>92%	>94%	>97.5%	>97.5%	>97.5%	>97%	>97%	>97%
Max 24v Input Amps	6	12	28	55	32	43	53	32	43	53
Output Voltage	(Input Voltage/2) ±2% - 50mv									
Output Amps (12v)	0-10	0-20	0-50	0-100	0-60	0-80	0-100	0-60	0-80	0-100
Standby Current	17 milliamps nominal at 28.4V									
Operating Temp.	-40° C to +71° C (-40° F to 160° F)				-40° C to +75° C (-40° F to 167° F)					
Storage Temp.	-54° C to +85° C (-65° F to 185° F)				-54° C to +95° C (-65° F to 203° F)					
Serviceable	Yes	Yes	Yes	Yes	No	No	No	No	No	No
Environmental Considerations	Anodized aluminum enclosure provides protection against salt, fungus, dust, water, fuel vapors and all fluids associated with commercial and off-highway vehicle operations. Continuous exposure to splashes and spills should be avoided.									
Mounting Location	Mount on a flat surface close to the batteries to allow short cable runs. Vertical mounting with terminals down is recommended. Location should be protected from battery acid and gases.									
Weights	2.3 lbs	5.0 lbs	7.0 lbs	9.5 lbs	6.0 lbs	6.6 lbs	6.6 lbs	6.0 lbs	6.3 lbs	6.3 lbs
					7.0 lbs	7.6 lbs	7.6 lbs			

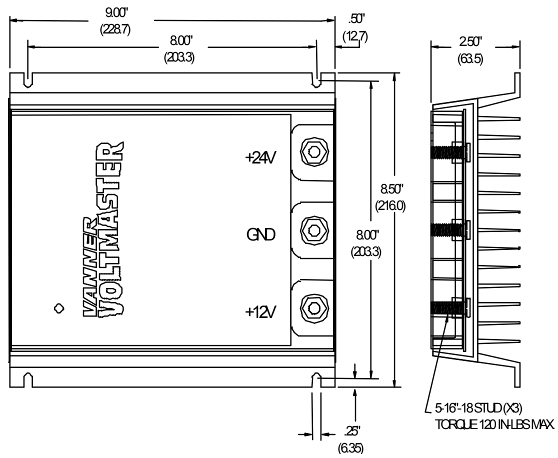
Unlisted models: Model 60-60M and 65-60M have built-in EM-70 Electrical System Voltage Monitor. Model 60-50M is a 60-50A with built-in EM-70. Model 60-50E is a 60-50A with weather resistant gasket. Model 60-100C is an early 60-100E. Model 60-100D is a 60-100C with circuit breakers instead of internal fuses. Older models not listed in the above table should be tested as Family 1 and should be considered non-repairable.
*Obsolete.

Family 1 and Family 2 Equalizer Dimensions

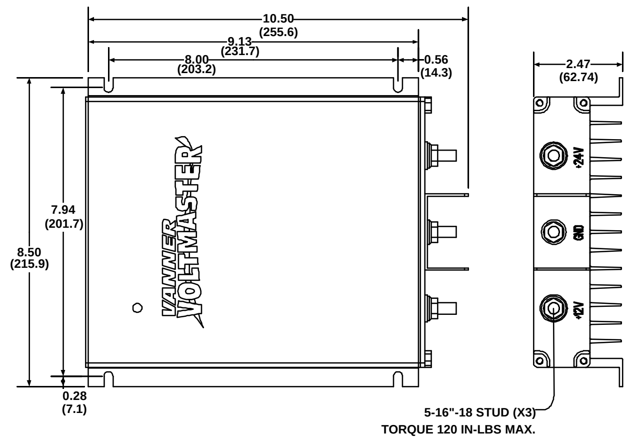


Model	"A"	"B"	"C"	"D"
60-10B	4.25 (107.9)	3.00 (76.3)	2.00 (50.80)	0.50 (12.7)
60-20A	9.38 (238.2)	8.00 (203.2)	4.50 (114.3)	1.75 (44.4)
60-50A	13.38 (339.8)	12.00 (304.8)	8.00 (203.2)	2.00 (50.8)
60-100C	13.46 (341.88)	12.00 (304.8)	8.00 (203.2)	2.00 (50.8)

Family 3 Equalizer Dimensions



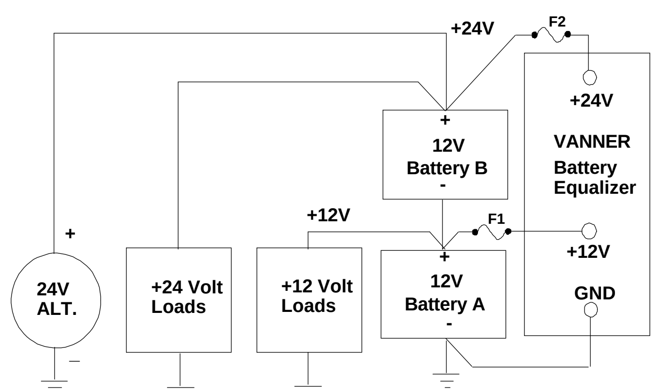
Family 4 and Family 5 Dimensions



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 ***VoltMaster*** Battery Equalizer is connected to the battery system at the +24 volt, +12 volt, and ground points. The Battery Equalizer makes the batteries look like they are in series and in parallel at the same time. The Battery Equalizer maintains the voltage balance and therefore the charge acceptance rate of each battery. Family 3 and Family 4 Equalizers hold Battery A and B voltages to within 0.05 volts under light loads and to within 0.1 volts at full rated load. Family 1 and Family 2 models hold Battery A and B voltages to within 0.10 volts under light loads and to within 0.50 volts under full rated load.



Note-Battery Banks A and B should have the same amp-hour capacity.

When the voltage of Battery A is higher than or equal to Battery B the Battery Equalizer 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 Battery Equalizer 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 ***VoltMaster*** Battery Equalizer, 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 Battery Equalizer, Battery A will supply the extra current to the load. The Battery Equalizer will then replenish the energy to Battery A after the surge has passed.

The ***VoltMaster*** Battery Equalizer is a completely automatic device that requires no human intervention when installed according to the recommended procedures. Family 1 Equalizers and some Family 2 Equalizers have a manually resetable circuit breaker. If the circuit breaker trips, due to a system overload or abnormality, it can be reset by pushing the white button. Note that on some units the white circuit breaker button may protrude slightly in its normal (non-tripped) position. A blown fuse on Family 2 Equalizers requires factory repair. There are no user operational devices on Family 3, Family 4 or Family 5 models.

The following scenarios describe the ***VoltMaster*** Battery Equalizer' s system operation.

Scenario #1 - 24 volt load present, no 12 volt load present. The system operates as a system would without the Battery Equalizer whether the alternator is ON or OFF. The Battery Equalizer is in the standby mode except for making small adjustments to keep the batteries in balance.

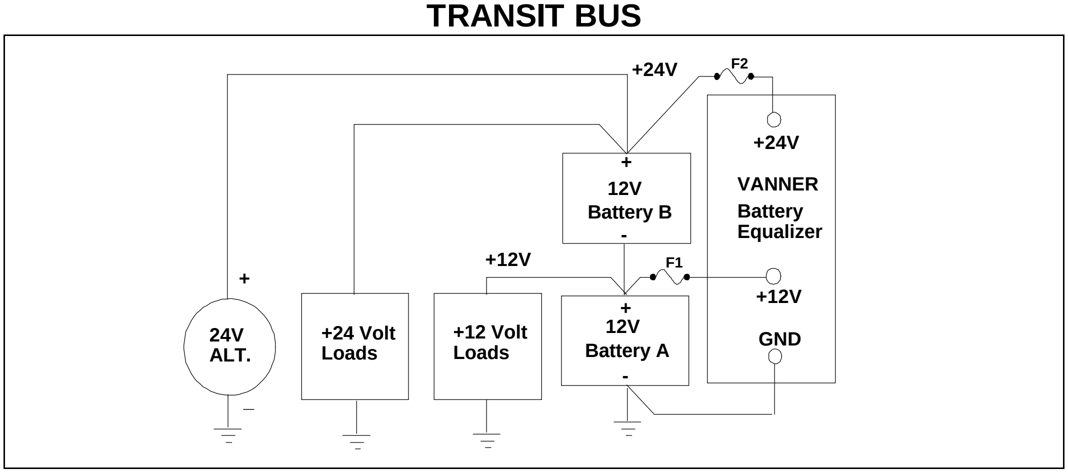
Scenario #2 - Both 24 volt and 12 volt loads present, alternator is OFF. The Battery Equalizer will insure that both batteries will discharge at the same rate even if different loads are present.

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 Battery Equalizer 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.

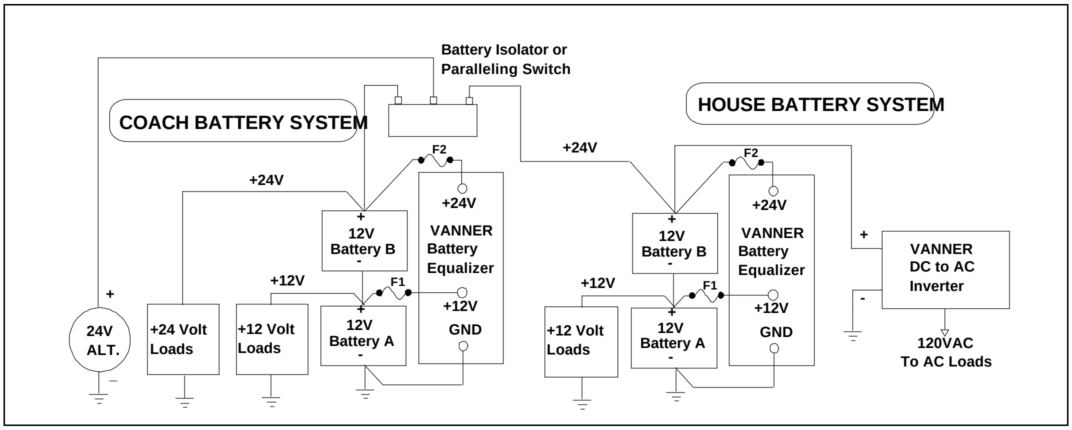
Typical Applications

Vanner ***VoltMaster*** Battery Equalizer 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 Battery Equalizers, 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.

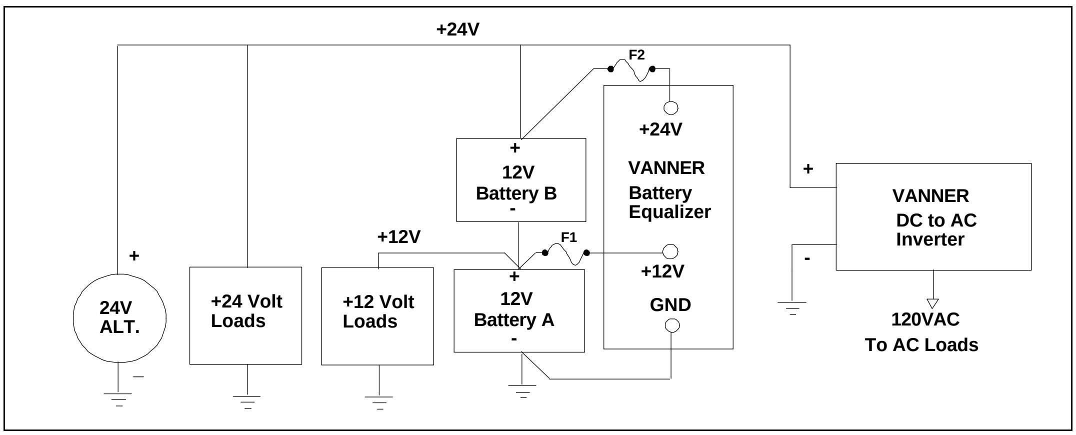
TRANSIT BUS



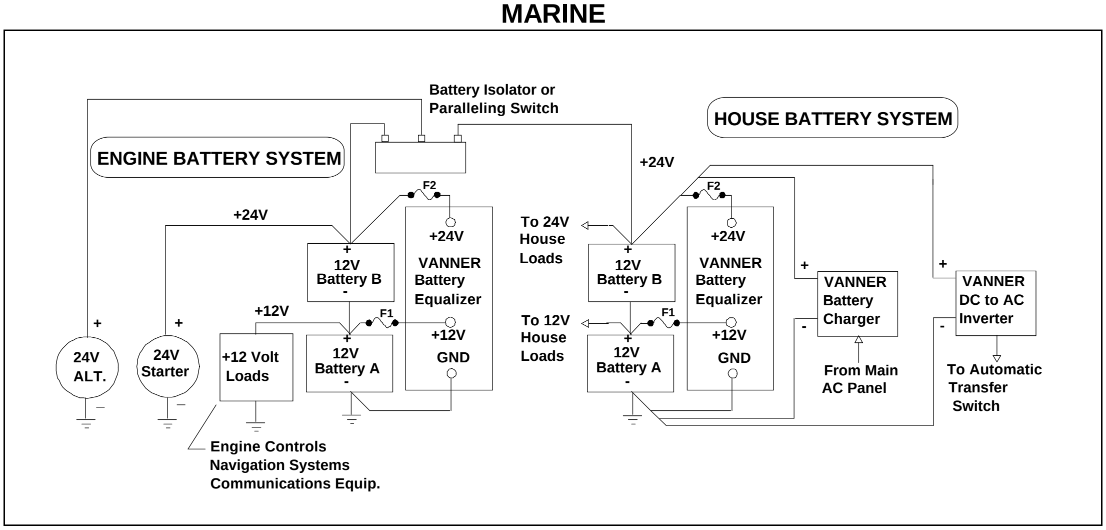
PRIVATE COACH



TOUR/CHARTER COACH



MARINE



Installation Instructions

When connecting wires or cables to the available post (+24, GND, +12) when installing Vanner Equalizer Models 60-60, 60-80, 60-100, do not exceed the specified torque of 120 in-lbs. This information is printed on the Product Label just above the connection post. Torque values higher than specified may damage the product, reducing performance or creating hazardous conditions. Products damaged by improper torque may not be covered by warranty.

Do not connect more than one conductor per available post on any model of Vanner Equalizer. 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 may not be covered by warranty.

Fault protection devices must be installed between the Equalizer 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 9 of this manual or contact Vanner at 1-800-227-6937 or pwrsales@vanner.com if assistance is needed in sizing fault protection devices.

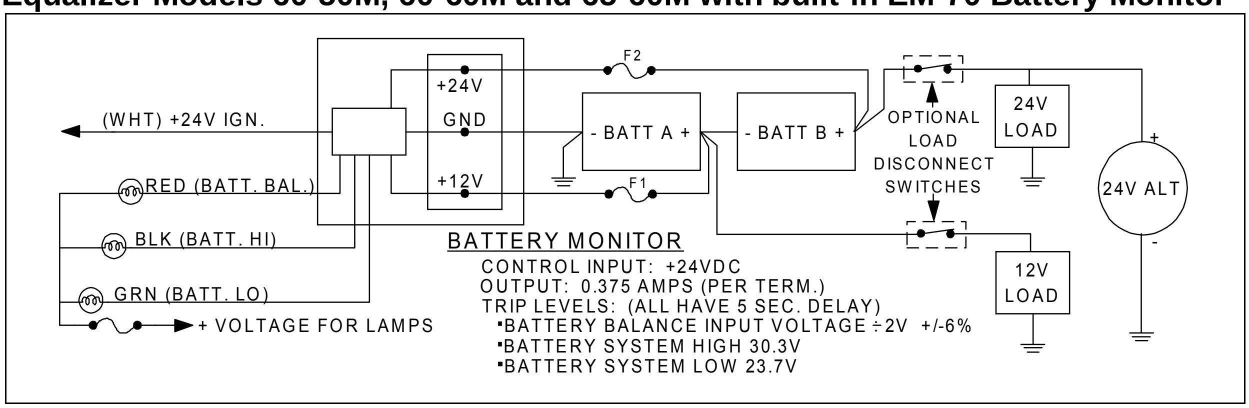
Caution: This equipment employs components that tend to produce arcs and sparks. To prevent fire or explosion, do not install in compartments containing batteries or flammable materials. Safety goggles should always be worn when working near batteries

Mounting Location –The Equalizer may be mounted in any orientation, however, the recommended orientation for optimum heat dissipation is vertical. It is recommended that the wiring terminals be down to prevent the possibility of a falling metal object shorting the terminals. Do not mount in zero-clearance compartment that may result in the Equalizer overheating. Locate so that contact by people is unlikely.

Environmental Protection – Do not expose to rain or moisture. The unit should be located in an area that will protect it from direct exposure to moisture such as high pressure washing, rain, etc.

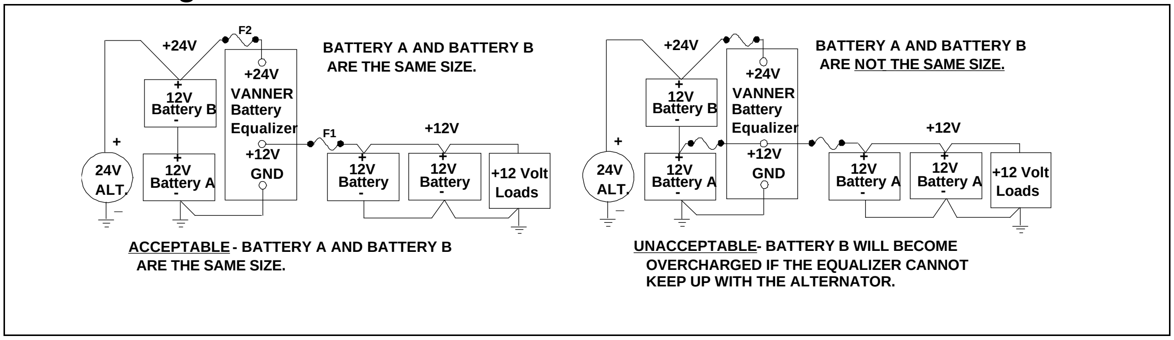
Wiring Sequence– To prevent reverse polarity damage on Family 1 and Family 2 models when connecting/disconnecting battery terminals: ALWAYS 1) Remove Equalizer ground terminal first, and 2) Replace Equalizer ground terminal last. The wiring sequence is not an issue with Family 3 or 4 models.

Equalizer Models 60-50M, 60-60M and 65-60M with built-in EM-70 Battery Monitor



The EM-70 Battery Monitor provides the following ground signals: Battery HI when +24 rises above 30.3V, Battery LO when +24 falls below 23.7V, Battery BALANCE when +12 is not within 6% of (+24 ÷ 2). Each ground signal is rated 0.375 amps and should be protected by a 1 amp fuse.

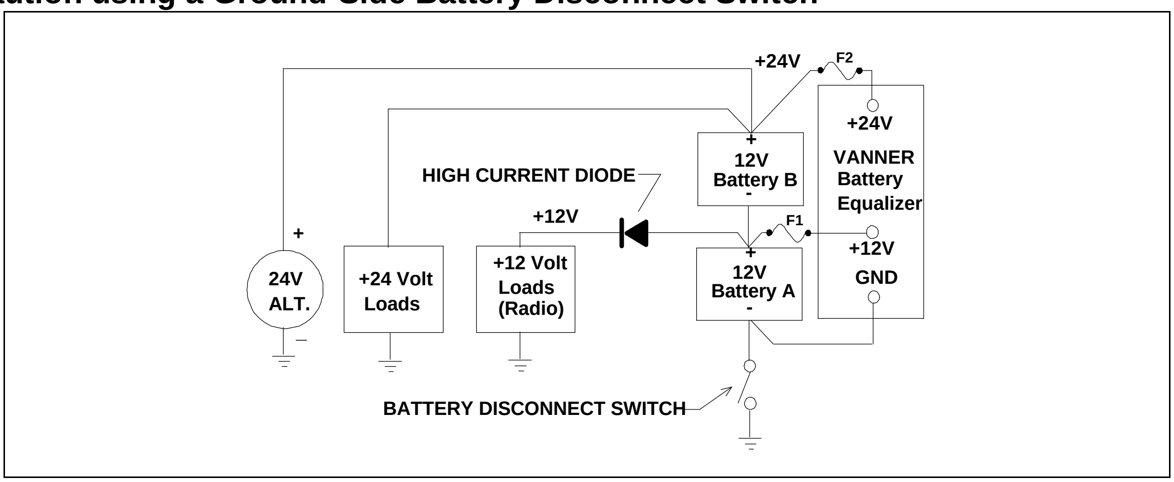
Caution adding 12volt batteries



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 Equalizer to charge the additional batteries.

Connect the Equalizer 12V terminal to the additional batteries only. Do not connect the Equalizer 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 equalizer 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 and Family 1 and Family 2 Equalizers while the ground-side disconnect switch is open. The equalizer' s GND terminal must be wired to the battery side of the ground-side disconnect switch circuit for the equalizer 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 Equalizer but from any 24 volt equipment that may be turned ON.

Wire Size and temperature rating

Cables connecting the Battery Equalizer to the batteries must be sufficiently large to prevent unwanted voltage drops. These voltage drops (loss) must be less than 0.05 VDC between the Equalizer' s +24 volt terminal and the battery +24 volt terminal (Battery B positive terminal), less than 0.10 VDC between the Equalizer' 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 Equalizer' s GND terminal and the battery ground terminal (Battery A negative terminal that is connected to chassis ground). In most installations, the Battery Equalizer' s terminals are wired directly to the battery terminals to prevent voltage loss that could occur in switch contacts, connections, and long wire runs. Since the equalizer can be operated in temperatures up to 71º or 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 Molex or UL recognized equal	Max wire length, in feet, between Equalizer 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.						
		60-10	60-20	60-50	60-60 65-60 66-60	60-80 65-80 66-80	60-100 65-100 66-100	2 x 60-100 2 X 65-100 2 X 66-100
#14	191930072	3.2	XXX	XXX	XXX	XXX	XXX	XXX
#12	191930134	5.0	2.5	XXX	XXX	XXX	XXX	XXX
#10	191930134	7.7	3.8	XXX	XXX	XXX	XXX	XXX
#8	191930157	12.8	6.4	2.6	2.1	XXX	XXX	XXX
#6	191930251	19.4	9.7	3.9	3.2	2.4	XXX	XXX
#4	191930278	35.2	17.6	7.0	5.9	4.4	3.5	XXX
#2	191930309	51.9	26.0	10.4	8.7	6.5	5.2	2.6
#1	191930333	65.4	32.7	13.1	10.9	8.2	6.5	3.3
#1/0	191930333	82.9	41.4	16.6	13.8	10.4	8.3	4.1
#2/0	191930346	105.5	52.7	21.1	17.6	13.2	10.5	5.3
Fuse F1		20 amp	30 amp	80 amp	80 amp	100 amp	125 amp	250 amp
Fuse F2		10 amp	15 amp	35 amp	40 amp	50 amp	80 amp	150 amp

Crimp the ring terminals using ***Molex*** tool 192840002 (14ga), 192840001 (10 -12ga), 192840035 (2 - 8ga) (phone 813-521-2700) and ***AC Terminal*** tool model 0280 (6 ga and larger) (phone 614-868-9828).

Testing and Troubleshooting

All Vanner equalizers fall into one of three distinct families. The three families operate differently and must be tested differently. The following three test procedures apply **only** to the equalizer family listed.

CAUTION
Servicing of electrical systems should only be performed by trained and qualified technical personnel.

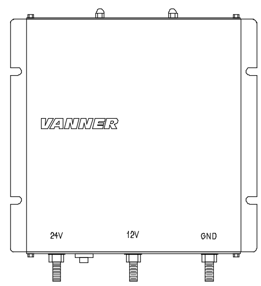
Equipment Required

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 for Family 1 and Family 2 models. (Family 3, 4 and 5 models are non-repairable.) 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 Family 1 Battery Equalizers



Models 60-10B, 60-20A, 60-50A

CAUTION
To avoid Reverse Polarity Damage to Family 1 and Family 2 Equalizers when servicing the electrical system or when performing any work which involves making battery connections always:

1. Remove Equalizer Ground terminal first.
2. Replace Equalizer Ground terminal last.

Family 1 Battery Equalizer Test Procedure:

1. Carefully remove the ground (GND) cable from the Equalizer. Do not allow this cable to touch any other connection on the Equalizer because the other terminals are connected to the batteries.
2. Make sure there is approximately 12 volts between the +24 and +12 terminals of the Equalizer by momentarily connecting the two terminals of a 12 volt light (headlight, marker light, etc.) to the +24 and +12 terminals of the Equalizer. The light should light and stay lit.
3. Next, connect that same 12 volt lamp between the +12 and GND terminals of the Equalizer. The lamp should light and stay lit. If the lamp does not light, the light then goes out, or the light dims, the Equalizer requires repair.
4. Further verification may be made by measuring the voltages on the Equalizer terminals. Be certain that the lamp used earlier is connected between the +12 and GND terminals.
5. Measure the voltage between +24 and +12 terminals. Note this reading.
6. Measure the voltage from the +12 terminal to GND. Note this reading.
7. Compare the two readings by subtracting the +12 to GND reading from the +24 to +12 reading. A properly functioning Equalizer is one where the difference is between -0.5 and +0.13 volts. For example, the +24 to +12 reading might be 12.85 volts. The +12 to GND voltage might read 12.75 volts. This Equalizer would be functioning properly with a 0.10 difference (12.85 minus 12.75 volts) which is within specs.

Common Questions for Family 1 Battery Equalizers

Q) Will operating loads which exceed the output rating of the Battery Equalizer cause the circuit breaker (white button near the wiring terminals on Family 1 or Family 2 equalizers) to trip?

A) No, the Battery Equalizer electronically limits the output current to a value less than the amount required to trip the circuit breaker. (Extreme conditions, such as 28 VDC input with 8 VDC output at very high ambient temperatures, may cause the circuit breaker to trip.)

Q) Why is the Battery Equalizer's circuit breaker value lower than its output current rating (35 amp circuit breaker in model 60-50A)?

A) The circuit breaker is in the ground circuit. Due to the equalizer's two to one (24/12 VDC) voltage conversion, the model 60-50A requires 25 amps at 24VDC input to produce about 50 amps output at 12 VDC. Therefore, a 35 amp circuit breaker in the GND circuit will properly protect for the maximum 25 amp rating.

Q) What causes the circuit breaker to trip on a Battery Equalizer?

A1) The Battery Equalizer's circuit breaker is designed to trip when the +12 volt to GND terminals are exposed to reverse polarity.

A2) With the Battery Equalizer's GND terminal connected to chassis and the battery negative terminal disconnected, a short between a +24 volt circuit and chassis will pull the chassis up to +24 volts, causing a reverse polarity on the +12 volt to GND circuits. The circuit breaker trips to protect the Battery Equalizer.

A3) With the Battery Equalizer's GND terminal connected to chassis and the battery negative cable disconnected, 24 volt loads (e.g., starter motor) will pull the chassis up to +24 volt causing a reverse polarity on the Battery Equalizer's +12 Volt to GND circuits. The circuit breaker will trip to protect the Battery Equalizer.

A4) Since the above reverse polarity conditions may occur during bus maintenance it is recommended that the service personnel verify the circuit breaker is IN before releasing the bus for service and the tour bus operator do the same in his “walk around”.

Q) What are some known conditions that could cause Battery Equalizer problems?

A1) Corrosive liquids or water forced into the Battery Equalizer's case from high pressure spray cleaning could shorten the normal life expectancy.

A2) Drilling into the case (except for the mounting flanges) can shorten the life or prevent the unit from operating. The installer may not realize the Battery Equalizer is not operating correctly unless a 12 volt load is applied to the system and the Battery Equalizer 12 volt current is measured.

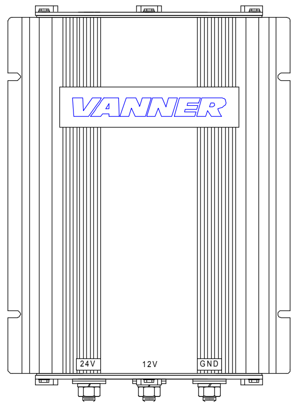
A3) Too small of wire or bad connections will allow the Battery balance to be less than optimum. Voltage loss in wire from the battery's +24 volt terminal to the Battery Equalizer's +24 volt terminal should be 0.05 VDC maximum; from the battery's +12 volt terminal to the Battery Equalizer's +12 volt terminal should be 0.10 VDC maximum, and from the battery ground terminal to the Battery Equalizer's GND terminal should be 0.05 VDC maximum, when the +12 volt load is causing the Battery Equalizer to operate at 100% capacity.

A4) Installing the Battery Equalizer in a location where it will be exposed to battery fumes will shorten its normal life. Acid fumes are heavier than air. Installation of Battery Equalizers on the battery mounting surface near the bottom of the batteries have caused severe corrosion to the Battery Equalizers. However, installation of Battery Equalizers 3 or more inches above the top of the batteries have not caused problems.

Q) Can different models of equalizers be paralleled?

A) Yes, any combination of models from Family 1, Family 3 and Family 4 may be paralleled. Family 2 models may only be paralleled with other Family 2 models.

Test Procedure for Family 2 Battery Equalizers



Models 60-100C, 60-100D and 60-100E

General: Family 2 Equalizers were designed to be more energy conservative during low power requirements compared to Family 1 models. This along with unique protection circuitry require Family 2 models to be tested differently than Family 1, or Family 3, 4 and 5 models.

CAUTION

To avoid Reverse Polarity Damage to Family 1 and Family 2 Equalizers when servicing the electrical system or when performing any work which involves making battery connections always:

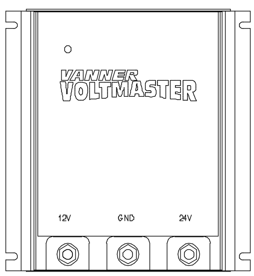
1. Remove Equalizer Ground terminal first.
2. Replace Equalizer Ground terminal last.

Family 2 Battery Equalizer Test Procedure:

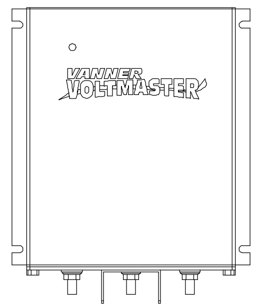
1. With the coach engine and vehicle loads OFF measure the voltage of Battery A. Replace or recharge Battery A if less than 11.5 volts.
2. Start the engine and turn ON a 12 volt load such as headlights.
3. Measure the input voltage between the +24 and GND posts of the equalizer. This voltage should be between 25.5 volts and 29.0 volts. If it isn't then check the alternator and 24 volt voltage regulator circuits.
4. Zero the DC Clamp-on ammeter as needed.
5. Put the jaws of the clamp-on ammeter around all wires connected to the equalizer +12 volt terminal stud.
6. Observe the DC amperage out of the equalizer with the clamp-on ammeter. If there are 3 amps or more showing on the ammeter, the equalizer is functioning and no further tests are needed.
7. Continue with the following steps ONLY if the ammeter shows less than 3 amps.
8. Measure the voltage between the +24 terminal (meter positive lead) and the +12 terminal (meter negative lead) of the equalizer. Record this voltage.
9. Subtract 0.60 volts from the number recorded in Step 8.
10. Measure the voltage between the equalizer +12 terminal (meter pos) and the GND terminal (meter neg).
11. Wait for this voltage to drop below the voltage calculated in Step 9 or the clamp-on ammeter reading jumps from approximately 0 to more than 3 amps. More than 3 amps means the equalizer is functioning.

12. If the voltage drops below the calculated value from Step 9 and the clamp-on ammeter has not jumper from approximately 0 to more than 3 amps of current wait for an additional 30 seconds.
13. If the equalizer does not turn ON after 30 seconds the unit is defective and should be sent in for repair.

Test Procedure for Family 3, 4 & 5 Battery Equalizers



Models 60-60, 60-80 and 60-100



Models 65-60, 65-80, 65-100
Models 66-60-66-80, 66-100

General: Family 3, Family 4 and Family 5 Equalizers contain an indicator light. If the indicator light is ON the equalizer is working.

The Equalizer is working properly if:

1. The Indicator Light is ON and;
2. The 12 volt DC loads are being operated continuously and are within the rated capacity of the equalizer and;
3. Battery A voltage is lower than Battery B by no more than 0.05 to 0.10 volts (measured at the equalizer +24, +12 and GND terminals).

Family 3, 4 and 5 Battery Equalizers are electronically protected against reverse polarity damage therefore the DC connection sequence is not an issue.

Family 3, 4 and 5 Equalizers 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.

Any combination of Family 1, Family 3, Family 4 and Family 5 models may be operated in parallel.

Please note that the 24V, 12V and GND stud position and orientation are different on Family 3, 4 and 5 models than on Family 1 or Family 2 models.

Family 3, Family 4 and Family 5 Battery Equalizer 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. Family 3, 4 and 5 Equalizers 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 equalizer rated capacity. Measure DC amps on the equalizer +12 cable to verify load amperages.
4. **At the equalizer** measure and record:
   a. Battery A voltage (voltage between the equalizer +12 and GND terminals)
   b. Battery B voltage (voltage between the equalizer +24 and +12 terminals)
   c. Equalizer Indicator Light status (ON or OFF)

5. Subtract Battery A voltage from Battery B voltage and compare readings.

Voltage Comparison		Indicator Light	Equalizer Status	
a.	Battery A is lower than Battery B but within 0.05 volt.	OFF	OFF	Stand-by Mode. The equalizer 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	ON	Normal Operating Mode
c.	Battery A is lower than Battery B by more than 0.10 volts	ON	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	OFF	The Equalizer 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 on Family 3, Family 4 and Family 5 Equalizers

An overload condition exists when the 12 volt loads exceed the equalizer's rated capacity. The overload condition will not damage the equalizer but may cause damage to the batteries.

During the overload, the equalizer output is limited by internal protection circuits to its Rated Output Amps. The 12 volt amps exceeding the equalizer output are drawn from Battery A which will begin to draw the batteries out of balance. The equalizer 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 equalizer output as the batteries become further out-of-balance. If Battery A voltage falls below approximately 8 volts the equalizer will shut itself OFF.

To correct the overload condition the 12 volt load must be reduced or the equalizer 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 Family 3, 4 or 5 Equalizer, 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 equalizer while jump starting even though the equalizer separately tests OK.

Cause:
The 12 volt load which could not be turned OFF first ran both batteries down until the equalizer shut itself OFF due to low voltage. (Family 3, 4 and 5 Equalizers 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 equalizer 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 or until the equalizer indicator light has turned ON which means the equalizer is ON. (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.

NORTH AMERICAN LIMITED WARRANTY

Vanner Inc., doing business as The Vanner Power Group, referred to herein as Vanner, warrants that this product is free from defects in materials and workmanship for a period of two (2) years from date of installation or two and one half (2 1/2) years from date of manufacture, whichever is less if and only if the following requirements are complied with:

1. The product is installed and checked out properly according to all guidelines, instructions, and checkout procedures set forth in the product Installation and Operating Manual.
2. The installer records all checkout data required and completes, signs, and returns the warranty registration card to Vanner within ten (10) days after installation.
3. The product was purchased after January 1, 2000.

Vanner does not warrant its products against any and all defects when: defect is a result of material or workmanship not provided by Vanner; normal wear and tear, or defects caused by misuse or use in contrary to instructions supplied, neglect, accident, reversed polarity, unauthorized repairs and/or replacements.

All warranties of merchantability and fitness for a particular purpose: written or oral, expressed or implied, shall extend only for a period of two (2) years from date of installation or two and one half (2 1/2) years from date of manufacture, whichever is first. There are no other warranties that extend beyond those described on the face of this warranty. Some states do not allow limitation on how long an implied warranty lasts, so the above limitations may not apply to you.

Vanner does not undertake responsibility to any purchaser of its product for any undertaking, representation, or warranty made by any dealers or distributors selling its products beyond those herein expressed unless expressed in writing by an officer of Vanner.

Vanner does not assume responsibility for incidental or consequential damages, including, but not limited to, responsibility for loss of use of this product, removal or replacement labor, loss of time, inconvenience, expense for telephone calls, shipping expense, loss or damage to property, or loss of revenue. Some states do not allow the exclusion or limitation of incidental or consequential damages, so these limitations may not apply to you.

Vanner reserves the right to repair, replace, or allow credit for any material returned under this warranty. Any damage caused by the customer will be charged or deducted from the allowance.

All warranty work will be performed at Vanner’s factory, or authorized repair facility utilizing a valid Warranty Authorization Number (WAN) prior to repair. Products shall be delivered to Vanner’s facility, freight prepaid and fully insured. Products repaired under warranty, or replacement parts or products will be returned to North American location prepaid via same transportation means and level of service as received, unless directed otherwise. Prepaid freight policy does not apply to locations outside North America.

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 D98761
July 15, 2002 Printed in U.S.A.

FAULT CODE MANUAL

B7L, B7TL, B12

Preface

The content of this manual has been based upon information from design department at Volvo Bus, Volvo Trucks and external suppliers. Due to problems with retrieving updated documents, new signal specifications etc. we cannot guarantee that the information is 100% correct. Therefore we are very grateful to retrieve any notification about occurance of incorrect information. We will however, update the manual as soon as we get new information and distribute revised versions to all parties concerned.

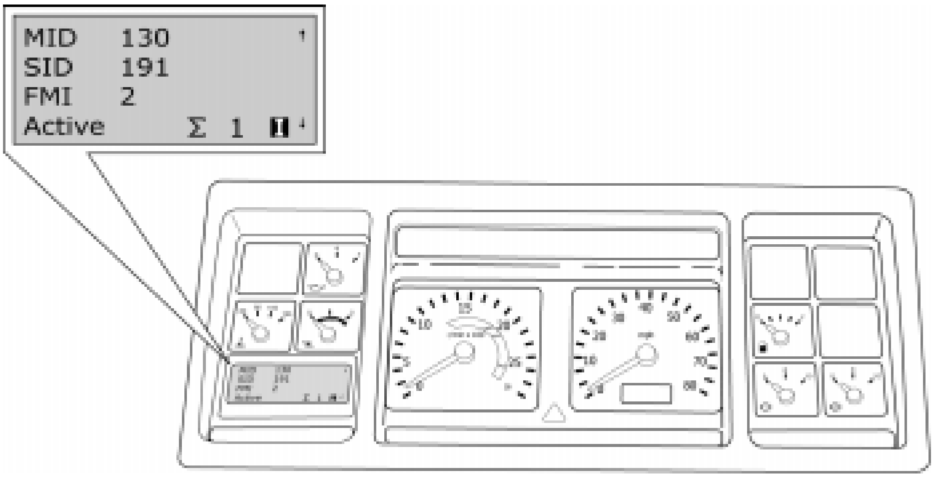
Table of contents

1. Bus Instrument Cluster (BIC)

The bus instrument cluster contains a number of indicators and lamps that shows the status of different parts of the bus. It can also be used to display faultcodes from the different control units by using the windscreen wiper handle. Normally this procedure is done by using a computer with related software but this manual offers an alternative to that as well as a complete list of all fault codes for each ECU.

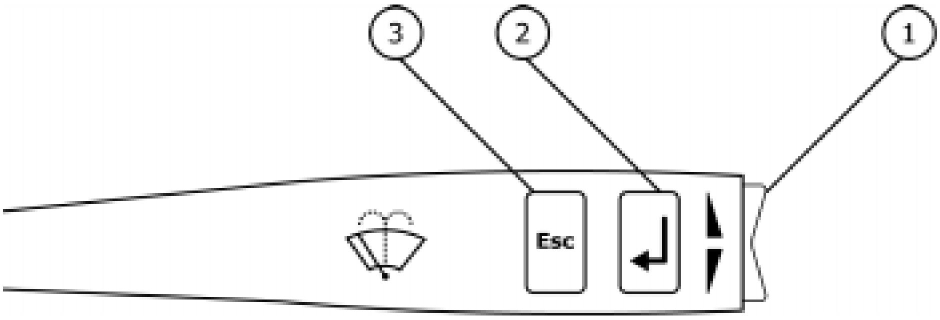
2. The instrument display

At the lower left corner of the instrument cluster there is a small display that can show various information about the bus. From this display it is possible to read the fault codes that may have been set in one or more of the different control units.



3. The windscreen wiper handle

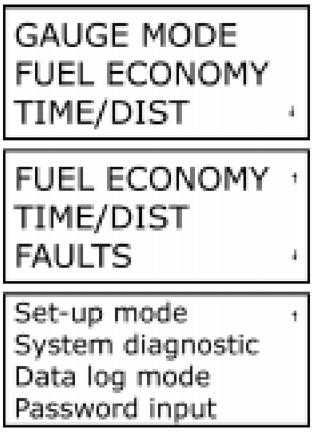
Using the the windscreen wiper handle at the right of the steeringwheel makes it possible to display the error at the lower left corner of the BIC. The errors can be displayed in numerical form and with help of the fault code table in this manual you can draw conclusions of what may have caused the errors.



1. Up/Down buttons, used to browse up or down through the menus.
2. “Return” button, confirms selected choice.
3. “Esc” button, regrets selected choice or moves one step up in the hierarchy.

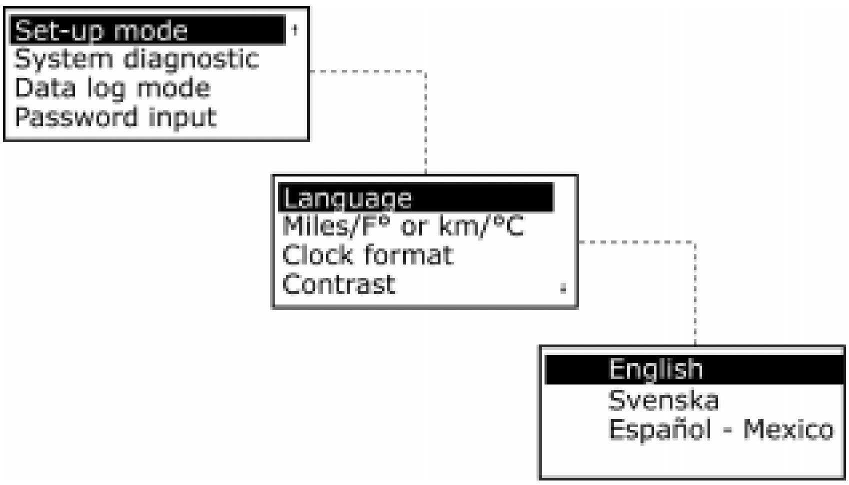
4. Display menus

The image below displays the main menus in the display window. The window can only display three items at once, therefore the up/down button on the windscreen wiper handle must be used to browse through the menus. Simply press the “Return” button on the windscreen wiper handle to enter a desired menu. If you wish to return to the level above just press the “Esc” button on the windscreen wiper handle.



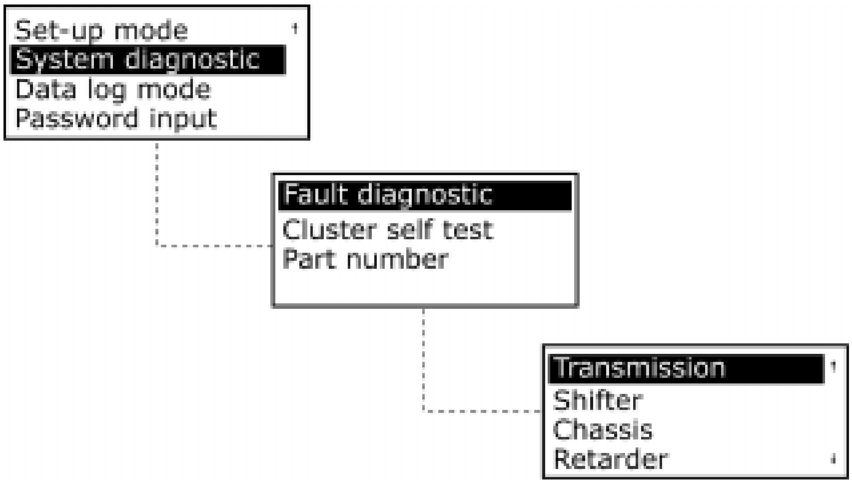
5. Setting the display language

Turn on the ignition on the bus. The display at the lower left corner of the instrument can display an icon of some sort depending on the bus status. If this is the case then press “Esc” on the windscreen wiper handle to go to the main menu. If the language of the display is not English we recommend that you change the language settings of the display. This is done by entering the set-up mode in the display menu. Simply use the up/down button on the windscreen wiper handle and press the “Return” button when the text “Set-up mode” is highlighted. The display now changes to display the submenus to the “Set-up mode” menu. Klick the up/down button to highlight the text “Language” if it is not alreadey highlighted. Press the “Return” button again to enter the choices of languages, select “English” and press the “Return” button once more.



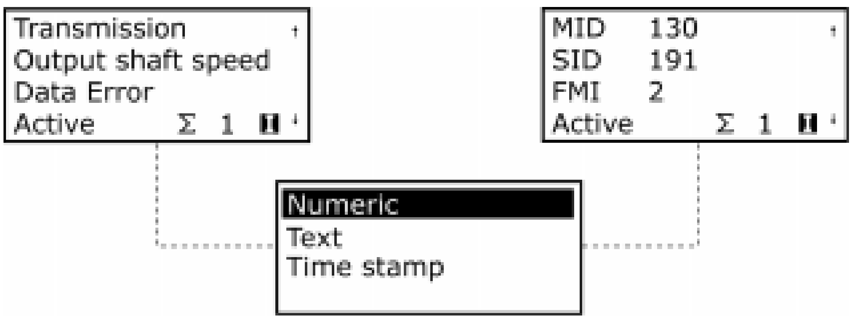
6. Read fault codes from ECU

From the main menu, use the up/down button on the windscreen wiper handle to move down to the “System diagnostic” menu and press the “Return” key.



The line “Fault diagnostic” should now be highlighted, if it’s not you can simply use the up/down button on the windscreen wiper handle to move to that line. Press the “Return” button again and the fault code set in the transmission ECU will now be displayed on the screen.

The fault codes can be displayed in both numeric and text mode. Since the text mode is default you have to change it to numeric manually. This is done by pressing the “Return” button when the display shows the fault code in text mode. A menu with three choices is now shown on the display. Press the “Return” button while the choice “Numeric” is highlighted (it should be highlighted by default).



As in the example above, you can see that the fault code is set in MID 130, the SID number is 191 and the FMI number is 2. By looking at the fault code table for MID 130 (which represents the TECU) you can see that SID number 191 means “Output speed level error” as well as the displaytext shown if your dipsplay would have been set to show faults in text mode.

9	130	PID 177	3	Transmission temperature sensor above	Transm. oil temp.
0	130	PID 177	4	Transmission temperature sensor below	Transm. oil temp.
[illegible]	130	PID 191	2	Output speed level error	Output shaft speed
2	130	PID 191	11	Output speed measuring overflow	Output shaft speed
3	130	SID 1	3	Solenoid valve B shorted high	Solenoid valve #1
4	130	SID 1	4	Solenoid valve B shorted ground	Solenoid valve #1
5	130	SID 1	5	Solenoid valve B circuit break	Solenoid valve #1

The information about the PID number (or SID, PPID or PSID) together with the explanation of the FMI number associated with the fault might help you to draw a conclusion of what may have caused the error. The image below shows the FMI table which tells what type of fault the FMI number represents.

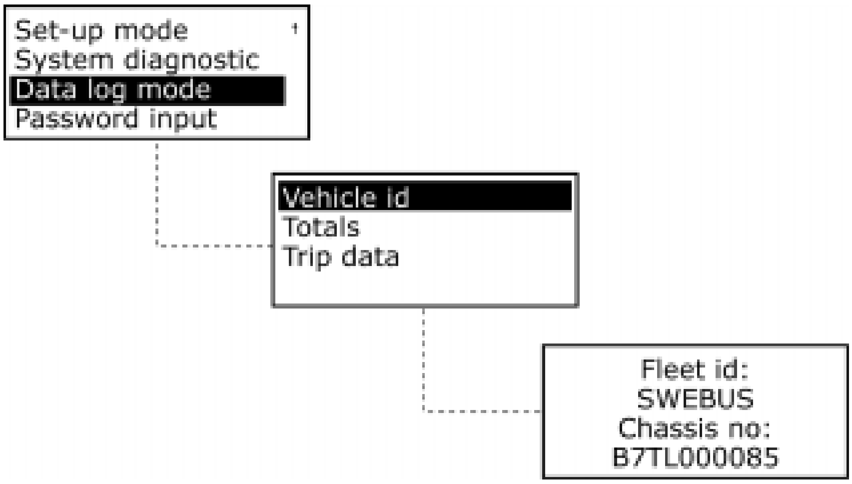
SAE-standard	
FMI	**SAE-text**
0	Data valid, but above normal operating range.
1	Data valid, but under normal operating range.
2	Intermittent or incorrect data.
3	Abnormally high voltage or short circuit to higher voltage.
4	Abnormally low voltage or short circuit to lower voltage.
5	Abnormally low current or break.
6	Abnormally high current or short circuit to earth.
7	Incorrect response from mechanical system.
8	Abnormal frequency
9	Abnormal update rate
10	Abnormally large variations.
11	Unknown fault.
12	Component fault
13	Out of calibration
14	Special instructions
15	Reserved for future use.

In this case the information MID 130, PID 191, FMI 2 means that the output shaft speed has retrieved intermittent or incorrect data, this gives an initial position to start the fault tracing from. Future revisions of this manual will contain more clearly instructions of how to fix the errors.

7. Comparing chassis number with the VIC

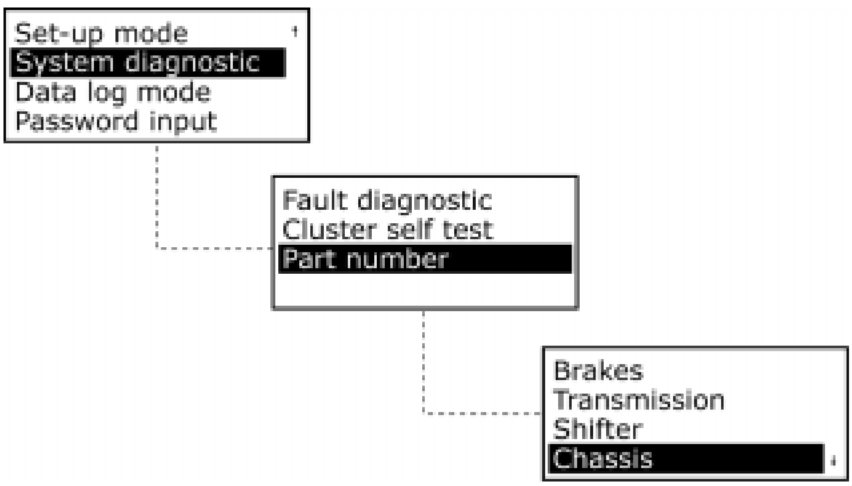
The VIC (Vehicle Identification Card) is a card that comes with every new bus that identifies the chassis number for the bus and the HW/SW id for each control unit.

To check chassis number, select “Data log mode” from the displays main menu and press the “Return” button on the windscreen wiper handle. You now move down one step in the hierarchy and three new choices are presented on the display, select “Vehicle id” and press the “Return” buton on the windscreen wiper handle. The fleet id and the chassis number should occur on the display.

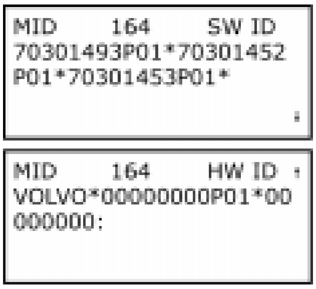


8. Comparing HW/SW id with the VIC

Just as with the chassis number the VIC can be used to verify HW/SW id for each ECU in the bus. To read the HW/SW id from a control unit you first select “System diagnostic” from the main menu of the display and press the “Return” button on the windscreen wiper handle. Then select “Part number” from the menu and press the “Return” button on the windscreen wiper handle once again. The menu now displays the different control units in the bus, in this case we want to see the HW/SW id for the chassis control unit (CECM) and therefore we select “Chassis” and press the “Return” button again.



The image below shows the HW/SW id for the CECM, the display cannot display both SW id and HW id at the same time, therefore you have to use the up/down buttons on the windscreen wiper handle to show SW id instead of HW id.



9. Fault codes, ABS (MID 136)

MID	(P)PID/SID	FMI	Seriousness	Component/Function	Display text
136	SID 1	1		Air gap	Sensor wheel sp LF
136	SID 1	2		Incorrect tyre	Sensor wheel sp LF
136	SID 1	3		Shorted to UBATT	Sensor wheel sp LF
136	SID 1	4		Shorted to ground	Sensor wheel sp LF
136	SID 1	5		Open circuit	Sensor wheel sp LF
136	SID 1	6		Short circuit	Sensor wheel sp LF
136	SID 1	7		Incorrect pole wheel	Sensor wheel sp LF
136	SID 1	8		Slip	Sensor wheel sp LF
136	SID 1	9		Wires mismatched	Sensor wheel sp LF
136	SID 1	10		Speed drop-out	Sensor wheel sp LF
136	SID 1	11		Abnormal speed (chatter)	Sensor wheel sp LF
136	SID 1	12		Frequency too high	Sensor wheel sp LF
136	SID 2	1		Air gap	Sensor wheel sp RF
136	SID 2	2		Incorrect tyre	Sensor wheel sp RF
136	SID 2	3		Shorted to UBATT	Sensor wheel sp RF
136	SID 2	4		Shorted to ground	Sensor wheel sp RF
136	SID 2	5		Open circuit	Sensor wheel sp RF
136	SID 2	6		Short circuit	Sensor wheel sp RF
136	SID 2	7		Incorrect pole wheel	Sensor wheel sp RF
136	SID 2	8		Slip	Sensor wheel sp RF
136	SID 2	9		Wires mismatched	Sensor wheel sp RF
136	SID 2	10		Speed drop-out	Sensor wheel sp RF
136	SID 2	11		Abnormal speed	Sensor wheel sp RF
136	SID 2	12		Frequency too high	Sensor wheel sp RF
136	SID 3	1		Air gap	Sensor wheel sp L1R
136	SID 3	2		Incorrect tyre	Sensor wheel sp L1R
136	SID 3	3		Shorted to UBATT	Sensor wheel sp L1R
136	SID 3	4		Shorted to ground	Sensor wheel sp L1R
136	SID 3	5		Open circuit	Sensor wheel sp L1R
136	SID 3	6		Short circuit	Sensor wheel sp L1R
136	SID 3	7		Incorrect pole wheel	Sensor wheel sp L1R
136	SID 3	8		Slip	Sensor wheel sp L1R
136	SID 3	9		Wires mismatched	Sensor wheel sp L1R
136	SID 3	10		Speed drop-out	Sensor wheel sp L1R
136	SID 3	11		Abnormal speed	Sensor wheel sp L1R
136	SID 3	12		Frequency too high	Sensor wheel sp L1R
136	SID 4	1		Air gap	Sensor wheel sp R1R
136	SID 4	2		Incorrect tyre	Sensor wheel sp R1R
136	SID 4	3		Shorted to UBATT	Sensor wheel sp R1R
136	SID 4	4		Shorted to ground	Sensor wheel sp R1R
136	SID 4	5		Open circuit	Sensor wheel sp R1R
136	SID 4	6		Short circuit	Sensor wheel sp R1R
136	SID 4	7		Incorrect pole wheel	Sensor wheel sp R1R
136	SID 4	8		Slip	Sensor wheel sp R1R
136	SID 4	9		Wires mismatched	Sensor wheel sp R1R
136	SID 4	10		Speed drop-out	Sensor wheel sp R1R
136	SID 4	11		Abnormal speed	Sensor wheel sp R1R
136	SID 4	12		Frequency too high	Sensor wheel sp R1R

MID	(P)PID/SID	FMI	Seriousness	Component/Function	Display text
136	SID 5	1		Air gap	-
136	SID 5	2		Incorrect tyre	-
136	SID 5	3		Shorted to UBATT	-
136	SID 5	4		Shorted to ground	-
136	SID 5	5		Open circuit	-
136	SID 5	6		Short circuit	-
136	SID 5	7		Incorrect pole wheel	-
136	SID 5	8		Slip	-
136	SID 5	9		Wires mismatched	-
136	SID 5	10		Speed drop-out	-
136	SID 5	11		Abnormal speed	-
136	SID 5	12		Frequency too high	-
136	SID 6	1		Air gap	-
136	SID 6	2		Incorrect tyre	-
136	SID 6	3		Shorted to UBATT	-
136	SID 6	4		Shorted to ground	-
136	SID 6	5		Open circuit	-
136	SID 6	6		Short circuit	-
136	SID 6	7		Incorrect pole wheel	-
136	SID 6	8		Slip	-
136	SID 6	9		Wires mismatched	-
136	SID 6	10		Speed drop-out	-
136	SID 6	11		Abnormal speed	-
136	SID 6	12		Frequency too high	-
136	SID 7	1		Open circuit in- and outlet	Modulator valve LF
136	SID 7	3		Shorted to UBATT	Modulator valve LF
136	SID 7	5		Open circuit	Modulator valve LF
136	SID 7	6		Shorted to ground	Modulator valve LF
136	SID 8	1		Open circuit in- and outlet	Modulator valve RF
136	SID 8	3		Shorted to UBATT	Modulator valve RF
136	SID 8	5		Open circuit	Modulator valve RF
136	SID 8	6		Shorted to ground	Modulator valve RF
136	SID 9	1		Open circuit in- and outlet	Modulator valve L1R
136	SID 9	3		Shorted to UBATT	Modulator valve L1R
136	SID 9	5		Open circuit	Modulator valve L1R
136	SID 9	6		Shorted to ground	Modulator valve L1R
136	SID 10	1		Open circuit in- and outlet	Modulator valve R1R
136	SID 10	3		Shorted to UBATT	Modulator valve R1R
136	SID 10	5		Open circuit	Modulator valve R1R
136	SID 10	6		Shorted to ground	Modulator valve R1R
136	SID 11	1		Open circuit in- and outlet	-
136	SID 11	3		Shorted to UBATT	-
136	SID 11	5		Open circuit	-
136	SID 11	6		Shorted to ground	-
136	SID 12	1		Open circuit in- and outlet	-
136	SID 12	3		Shorted to UBATT	-
136	SID 12	5		Open circuit	-
136	SID 12	6		Shorted to ground	-
136	SID 13	3		Shorted to UBATT	Retard contr relay
136	SID 13	5		Open circuit	Retard contr relay
136	SID 13	6		Shorted to ground	Retard contr relay
136	SID 14	3		Ground diagonal, shorted to UBATT	Valve relay

MID	(P)PID/SID	FMI	Seriousness	Component/Function	Display text
136	SID 14	4		Diag. 1 Voltage, low voltage/open circuit	Valve relay
136	SID 14	5		Ground diagonal, open circuit	Valve relay
136	SID 14	5		ECU-Ground or WL-Ground	Valve relay
136	SID 14	6		Ground diagonal 1, shorted to low	Valve relay
136	SID 14	7		Voltage feeding solenoid valve ABS	Valve relay
136	SID 15	3		Voltage feeding solenoid valve ABS	Valve relay
136	SID 15	4		Voltage feeding solenoid valve ABS	Valve relay
136	SID 15	5		Voltage feeding solenoid valve ABS	Valve relay
136	SID 15	6		Voltage feeding solenoid valve ABS	Valve relay
136	SID 15	7		Valve relay diagonal 2	Valve relay
136	SID 18	3		Diff. Brake Valve, shorted to UBATT	ATC valve L
136	SID 18	5		Diff. Brake Valve, open circuit	ATC valve L
136	SID 18	6		Diff. Brake Valve, shorted to ground	ATC valve L
136	SID 19	3		Diff, lock shorted to UBATT	ATC valve R
136	SID 19	5		Diff, lock open circuit	ATC valve R
136	SID 19	6		Diff, lock shorted to ground	ATC valve R
136	SID 23	5		Warning lamp ABS	Warning light bulb
136	SID 231	5		SAE J1939 Control link	SAE J1939 data link
136	SID 231	6		SAE J1939 Control link	SAE J1939 data link
136	SID 231	9		SAE J1939 Control link	SAE J1939 data link
136	SID 231	12		SAE J1939 Control link	SAE J1939 data link
136	SID 248	2		CAN plausibility	-
136	SID 248	5		CAN open circuit	-
136	SID 248	6		CAN grounded circuit	-
136	SID 248	9		CAN time-out	-
136	SID 248	12		CAN, internal error	-
136	SID 249	5		SAE-J1922 datalink open circuit	-
136	SID 249	6		SAE-J1922 datalink grounded circuit	-
136	SID 249	10		SAE-J1922 bus not free	-
136	SID 251	3		Overvoltage Diag. 1 or 2	Power supply
136	SID 253	1		ASR Configuration	Calibration memory
136	SID 253	2		ABS Configuration	Calibration memory
136	SID 253	2		EEPROM Wheel parameter incorrect	Calibration memory
136	SID 253	12		EEPROM Checksum	Calibration memory
136	SID 254	2		Internal Error	Controller #1
136	SID 254	5		ABS (ASR) ELECTRONIC no loads	Controller #1
136	SID 254	8		Excessive slip / dynotester	Controller #1
136	SID 254	9		Modulator-Valve activation-time	Controller #1
136	SID 254	12		Internal Error	Controller #1

10. Fault codes, BIC (MID 140 & 234)

MID	(P)PID/SID	FMI	Seriousness	Component/function	Display text
140	PID 84	9		Speed	Road speed
140	PID 190	9		Number of revolutions	Engine speed
140&234	SID 240	13		Program memory	Program memory
140&234	SID 253	12		EEPROM	Calibration memory
140&234	SID 253	13		EEPROM	Calibration memory
140&234	SID 254	12		Control unit	Controller #1
140&234	SID 254	13		Control unit	Controller #1
140&234	SID 254	14		Control unit	Controller #1
234	PID 117	9		Brake pressure #1	Brake pressure #1
234	PID 118	9		Brake pressure #2	Brake pressure #2
234	PID 120	9		ZF/Allison oiltemp	Hyd retard oil temp
234	PID 158	0	Yellow lamp	Control unit battery potential	Battery potential
234	PID 175	9		Engine oil temp.	Engine oil temp.
234	PID 177	9		Voith oil temp	Transm. oil temp.
234	PPID 91	9		Brake pressure circuit 3	Brake pressure #3
234	SID 250	2		SAE J1708 data link	SAE J1708 data link
234	SID 250	9	Yellow lamp	SAE J1708 data link	SAE J1708 data link
234	SID 250	12	Yellow lamp	SAE J1708 data link	SAE J1708 data link
234	PSID 1	6		Fuel indication, low level	Output LX:13
234	PSID 2	6	Yellow lamp	Alarm clock, activating	Alarm clock activ.
234	PSID 3	6		Buzzer, danger	Buzzer, alarm
234	PSID 4	6		Buzzer, warning	Buzzer, caution

11. Fault codes, CECM (MID 164)

MID	(P)PID/SID	FMI	Seriousness	Component/Function	Display text
164	PID 43	4			Starting sw. status
164	PID 43	5			Starting sw. status
164	PID 70	3			Park brake switch
164	PID 117	3			Brake pressure #1
164	PID 117	4			Brake pressure #1
164	PID 118	3			Brake pressure #2
164	PID 118	4			Brake pressure #2
164	PPID 191	3			Buzzer
164	PPID 191	4			Buzzer
164	PPID 191	5			Buzzer
164	PSID 20	3			Chassis data link
164	PSID 20	4			Chassis data link
164	PSID 23	3			D data link
164	PSID 23	4			D data link
164	PSID 31	3			Output CECM
164	PSID 31	4			Output CECM
164	PSID 31	5			Output CECM
164	PSID 32	5			Panel switch
164	PSID 33	3			Warning lamp output
164	PSID 34	3			Engine run signal
164	PSID 34	4			Engine run signal
164	PSID 35	3			Ignition output
164	PSID 35	4			Ignition output
164	PSID 35	5			Ignition output
164	PSID 36	3			Steer wheel adjust
164	PSID 36	4			Steer wheel adjust
164	PSID 36	5			Steer wheel adjust
164	PSID 37	3			Fuel shutoff valve
164	PSID 37	4			Fuel shutoff valve
164	SID 231	3			SAE J1939 kontrlänk
164	SID 231	4			SAE J1939 kontrlänk
164	SID 250	3			SAE J1708 infolänk
164	SID 250	4			SAE J1708 infolänk

12. Fault codes, CIM (MID 164)

MID	(P)PID/SID	FMI	Seriousness	Component/function	Display text
164	PSID 31	3			Short-circuit to battery
164	PSID 31	4			Short-circuit to ground
164	PSID 3	4			Alternator not charging
164	PSID 4	4			Alternator not charging
164	PSID 45	4			Alternator not charging
164	PSID 46	4			Alternator not charging

13. Fault codes, EECU (MID 128)

MID	(P)PID/SID	FMI	Seriousness	Component/function	Display text
128	PID 45	3	Yellow lamp	Starting heater status relay	Inlet air heat stat
128	PID 45	4	Yellow lamp	Starting heater status relay	Inlet air heat stat
128	PID 45	5	Yellow lamp	Starting heater status relay	Inlet air heat stat
128	PID 84	9	Yellow lamp	Vehicle speed	Road speed
128	PID 84	11	Yellow lamp	Vehicle speed	Road speed
128	PID 85	9	Yellow lamp	Cruise control, status switch	Cruise control stat
128	PID 91	9	Yellow lamp	Accelerator pedal percentage position	Acc. Pedal pos, %
128	PID 91	11	Yellow lamp	Accelerator pedal percentage position	Acc. Pedal pos, %
128	PID 94	1	Yellow lamp	Feed pressure, fuel	Fuel delivery pres.
128	PID 94	3	Yellow lamp	Feed pressure, fuel	Fuel delivery pres.
128	PID 94	4	Yellow lamp	Feed pressure, fuel	Fuel delivery pres.
128	PID 94	7	Yellow lamp	Feed pressure, fuel	Fuel delivery pres.
128	PID 98	1	Yellow lamp	Oil level sensor engine	Engine Oil Level
128	PID 98	3	Yellow lamp	Oil level sensor engine	Engine Oil Level
128	PID 98	4	Yellow lamp	Oil level sensor engine	Engine Oil Level
128	PID 100	1	Red lamp	Oil pressure sensor engine	Engine Oil Pressure
128	PID 100	3	Yellow lamp	Oil pressure sensor engine	Engine Oil Pressure
128	PID 100	4	Yellow lamp	Oil pressure sensor engine	Engine Oil Pressure
128	PID 102	3	Yellow lamp	Boost pressure sensor	Boost pressure
128	PID 102	4	Yellow lamp	Boost pressure sensor	Boost pressure
128	PID 105	3	Yellow lamp	Boost air temperature sensor	Intake manif temp
128	PID 105	4	Yellow lamp	Boost air temperature sensor	Intake manif temp
128	PID 107	0	Yellow lamp	Drop in pressure air filter	Air filt press drop
128	PID 107	3	Yellow lamp	Drop in pressure air filter	Air filt press drop
128	PID 107	4	Yellow lamp	Drop in pressure air filter	Air filt press drop
128	PID 107	5	Yellow lamp	Drop in pressure air filter	Air filt press drop
128	PID 108	3	Yellow lamp	Atmospheric pressure sensor	Barometric press
128	PID 108	4	Yellow lamp	Atmospheric pressure sensor	Barometric press
128	PID 110	0		Coolant temperature sensor	Eng coolant temp
128	PID 110	3		Coolant temperature sensor	Eng coolant temp
128	PID 110	4		Coolant temperature sensor	Eng coolant temp
128	PID 111	1	Red lamp	Coolant level sensor	Coolant level
128	PID 158	3	Yellow lamp	Battery voltage	Battery voltage
128	PID 172	3	Yellow lamp	Air temperature, inlet	Air inlet temp.
128	PID 172	4	Yellow lamp	Air temperature, inlet	Air inlet temp.
128	PID 174	3	Yellow lamp	Fuel temperature sensor	Fuel temperature
128	PID 174	4	Yellow lamp	Fuel temperature sensor	Fuel temperature
128	PID 175	0	Red lamp	Oil temperature	Engine oil temp
128	PID 175	3	Yellow lamp	Oil temperature	Engine oil temp
128	PID 175	4	Yellow lamp	Oil temperature	Engine oil temp
128	PID 224	2	Yellow lamp	Electronic immobilizer	Vehicle sec. Code
128	PID 224	12	Yellow lamp	Electronic immobilizer	Vehicle sec. Code
128	PID 228	11	Yellow lamp	Calibration Factor (K)	Calibration number

MID	(P)PID/SID	FMI	Seriousness	Component/function	Display text
128	PPID 100	3	Yellow lamp	Outer actuator	Ext. timing act.
128	PPID 100	4	Yellow lamp	Outer actuator	Ext. timing act.
128	PPID 100	5	Yellow lamp	Outer actuator	Ext. timing act.
128	PPID 109	3	Yellow lamp	Exhaust pressure governor EPG3	EPG # 3
128	PPID 109	4	Yellow lamp	Exhaust pressure governor EPG3	EPG # 3
128	PPID 109	5	Yellow lamp	Exhaust pressure governor EPG3	EPG # 3
128	PPID 122	3	Yellow lamp	Compression brake VCB	VCB Compr. Brake st.
128	PPID 122	4	Yellow lamp	Compression brake VCB	VCB Compr. Brake st.
128	PPID 122	5	Yellow lamp	Compression brake VCB	VCB Compr. Brake st.
128	PPID 123	3	Yellow lamp	Exhaust pressure governor EPG2	EPG2 Start/warmhold
128	PPID 123	4	Yellow lamp	Exhaust pressure governor EPG2	EPG2 Start/warmhold
128	PPID 123	5	Yellow lamp	Exhaust pressure governor EPG2	EPG2 Start/warmhold
128	PPID 124	3	Yellow lamp	Exhaust pressure governor EPG1	EPG # 1
128	PPID 124	4	Yellow lamp	Exhaust pressure governor EPG1	EPG # 1
128	PPID 124	5	Yellow lamp	Exhaust pressure governor EPG1	EPG # 1
128	SID 1-6	2	Yellow lamp	Injector	Injector Cylinder (SID#)
128	SID 1-6	3	Yellow lamp	Injector	Injector Cylinder (SID#)
128	SID 1-6	4	Yellow lamp	Injector	Injector Cylinder (SID#)
128	SID 1-6	5	Yellow lamp	Injector	Injector Cylinder (SID#)
128	SID 1-6	7	Yellow lamp	Injector	Injector Cylinder (SID#)
128	SID 1-6	11	Yellow lamp	Injector	Injector Cylinder (SID#)
128	SID 17	3		Fuel shut-off valve	Fuel Valve
128	SID 17	4		Fuel shut-off valve	Fuel Valve
128	SID 17	5		Fuel shut-off valve	Fuel Valve
128	SID 20	2	Yellow lamp	Actuator, injection angle	Timing actuator
128	SID 20	3	Red lamp	Actuator, injection angle	Timing actuator
128	SID 20	4	Red lamp	Actuator, injection angle	Timing actuator
128	SID 20	5	Red lamp	Actuator, injection angle	Timing actuator
128	SID 20	6	Red lamp	Actuator, injection angle	Timing actuator
128	SID 20	7	Red lamp	Actuator, injection angle	Timing actuator
128	SID 20	8	Red lamp	Actuator, injection angle	Timing actuator
128	SID 20	11	Red lamp	Actuator, injection angle	Timing actuator
128	SID 21	2	Yellow lamp	Neelde lifting sensor	Engine position
128	SID 21	3	Yellow lamp	Neelde lifting sensor	Engine position
128	SID 21	8	Yellow lamp	Neelde lifting sensor	Engine position
128	SID 22	2	Yellow lamp	Speed sensor, flywheel	Timing sens crank
128	SID 22	3	Yellow lamp	Speed sensor, flywheel	Timing sens crank
128	SID 22	8	Yellow lamp	Speed sensor, flywheel	Timing sens crank
128	SID 23	2	Yellow lamp	Control rod, actuator	Rack actuator
128	SID 23	3	Red lamp	Control rod, actuator	Rack actuator
128	SID 23	4	Red lamp	Control rod, actuator	Rack actuator
128	SID 23	5	Red lamp	Control rod, actuator	Rack actuator
128	SID 23	6	Red lamp	Control rod, actuator	Rack actuator
128	SID 23	7	Red lamp	Control rod, actuator	Rack actuator
128	SID 23	8	Red lamp	Control rod, actuator	Rack actuator
128	SID 23	11	Red lamp	Control rod, actuator	Rack actuator

MID	(P)PID/SID	FMI	Seriousness	Component/Function	Display text
128	SID 24	2	Red lamp	Control rod position	Rack positoin sens.
128	SID 24	13	Red lamp	Control rod position	Rack positoin sens.
128	SID 64	3	Yellow lamp	Engine speed pump	Tim. Sens inj. Pump
128	SID 64	8	Yellow lamp	Engine speed pump	Tim. Sens inj. Pump
128	SID 70	3	Yellow lamp	Starting heater 1	Air inlet heater 1
128	SID 70	4	Yellow lamp	Starting heater 1	Air inlet heater 1
128	SID 70	5	Yellow lamp	Starting heater 1	Air inlet heater 1
128	SID 230	3	Yellow lamp	Idle switch	Idle valid switch
128	SID 230	4	Yellow lamp	Idle switch	Idle valid switch
128	SID 231	2	Yellow lamp	SAE J1939 Control link	SAE J1939 data link
128	SID 231	9	Yellow lamp	SAE J1939 Control link	SAE J1939 data link
128	SID 231	11	Yellow lamp	SAE J1939 Control link	SAE J1939 data link
128	SID 231	12	Yellow lamp	SAE J1939 Control link	SAE J1939 data link
128	SID 232	3	Yellow lamp	5 V supply to sensor	5 V supply
128	SID 232	4	Yellow lamp	5 V supply to sensor	5 V supply
128	SID 240	2	Red lamp	Programme memory (Flash)	Program memory
128	SID 240	12		Programme memory (Flash)	Program memory
128	SID 250	12	Yellow lamp	SAE J1708 Information link	SAE J1708 data link
128	SID 253	2	Red lamp	Data set memory EEPROM	Calibration memory
128	SID 253	12	Red lamp	Data set memory EEPROM	Calibration memory
128	SID 254	2	Red lamp	Engine control unit (EECU)	Controller #1
128	SID 254	8	Red lamp	Engine control unit (EECU)	Controller #1
128	SID 254	9	Red lamp	Engine control unit (EECU)	Controller #1
128	SID 254	11	Red lamp	Engine control unit (EECU)	Controller #1
128	SID 254	12	Red lamp	Engine control unit (EECU)	Controller #1
128	SID 254	13		Engine control unit (EECU)	Controller #1

14. Fault codes, TECU Voith 863,3 retarders and transmission (MID 130)

MID	(P)PID/SID	FMI	Seriousness	Component/function	Display text
130	PID 40	2	-	Hand brake sensor	Retarder switches
130	PID 65	2	-	Foot brake sensor	Brake pedal switch
130	PID 92	2	-	Software	Engine load, %
130	PID 93	2	-	CAN	Engine torque
130	PID 93	14	-	CAN	Engine torque
130	PID 124	1	-	Low oil level	Transm. oil level
130	PID 152	14	-	ECU-Reset	No. of ECU resets
130	PID 158	1	-	Power supply	Battery potential
130	PID 162	2	-	Gear selector switch	Gear selected
130	PID 177	0	-	Temperature sensor	Transm. oil temp.
130	PID 177	5	-	Temperature sensor	Transm. oil temp.
130	PID 177	6	-	Temperature sensor	Transm. oil temp.
130	PID 177	13	-	Temperature sensor	Transm. oil temp.
130	PID 177	14	-	Temperature sensor	Transm. oil temp.
130	PID 190	11	-	Engine speed	Engine speed
130	PID 191	11	-	Output speed	Output shaft speed
130	PID 234	14	-	Frequency output	Software no.
130	SID 1	12	-	Control solenoid valve turbine brake	Solenoid valve #1
130	SID 4	12	-	Control solenoid valve 4 speed clutch	Solenoid valve #4
130	SID 6	12	-	Solenoid valve converter brake	Solenoid valve #6
130	SID 7	12	-	Control solenoid valve pump brake	Lockup sol.valve
130	SID 8	12	-	Control solenoid valve input clutch	Forward sol. valve
130	SID 17	11	-	Turbine speed	Turbine speed
130	SID 52	13	-	Pressure rise fault	Hydraulic system
130	SID 153	14	-		-
130	SID 153	14	-	-	-
130	SID 153	14	-	-	-
130	SID 153	14	-	-	-
130	SID 153	14	-	-	-
130	SID 221	14	-	Power supply for brake sensors	Int sensor supply
130	SID 231	9	-	CAN	SAE J1939 data link
130	SID 233	2	-	Message from safety computer	Controller #2
130	SID 238	14	-	Pushbutton switch lightning	Diagnostic lamp RED
130	SID 239	14	-	Central warning light	Diag. lamp AMBER
130	SID 240	14	-	Software	Program memory

15. Fault codes, ZF HP 502 retarder (MID 222) and transmission (MID 130)

MID	(P)PID/SID	FMI	Seriousness	Component/function	Display text
130	PID 1	0		Transmission slip	**Invalid data**
130	PID 155	3		Not used dig. Out shorted high	Aux. input/output 1
130	PID 155	12		Internal I/O safety switch error	Aux. input/output 1
130	PID 161	2		Turbine speed level error	Input shaft speed
130	PID 161	11		Turbine speed measuring overflow	Input shaft speed
130	PID 177	0		Transmission oil temperature high	Transm. oil temp.
130	PID 177	3		Transmission temperature sensor above	Transm. oil temp.
130	PID 177	4		Transmission temperature sensor below	Transm. oil temp.
130	PID 191	2		Output speed level error	Output shaft speed
130	PID 191	11		Output speed measuring overflow	Output shaft speed
130	SID 1	3		Solenoid valve B shorted high	Solenoid valve #1
130	SID 1	4		Solenoid valve B shorted ground	Solenoid valve #1
130	SID 1	5		Solenoid valve B circuit break	Solenoid valve #1
130	SID 2	3		Solenoid valve C shorted hig	Solenoid valve #2
130	SID 2	4		Solenoid valve C shorted ground	Solenoid valve #2
130	SID 2	5		Solenoid valve C circuit break	Solenoid valve #2
130	SID 225	3		Operating lamp shorted high	Green lamp
130	SID 225	4		Operating lamp shorted ground	Green lamp
130	SID 253	2		Operating time counter checktime error	Calibration memory
130	SID 253	11		Statistik memory checksum error	Calibration memory
130	SID 253	12		Error read error memory	Calibration memory
130	SID 254	11		Internal system error	Controller #1
130	SID 3	3		Solenoid valve D shorted high	Solenoid valve #3
130	SID 3	4		Solenoid valve D shorted ground	Solenoid valve #3
130	SID 3	5		Solenoid valve D circuit break	Solenoid valve #3
130	SID 4	3		Solenoid valve E shorted high	Solenoid valve #4
130	SID 4	4		Solenoid valve E shorted ground	Solenoid valve #4
130	SID 4	5		Solenoid valve E circuit break	Solenoid valve #4
130	SID 5	3		Solenoid valve F shorted high	Solenoid valve #5
130	SID 5	4		Solenoid valve F shorted ground	Solenoid valve #5
130	SID 5	5		Solenoid valve F circuit break	Solenoid valve #5
130	SID 55	2		D1 current resistor	Clutch actuator
130	SID 55	3		D1 current shorted high	Clutch actuator
130	SID 55	4		D1 current shorted ground	Clutch actuator
130	SID 55	5		D1 current circuit break	Clutch actuator
130	SID 6	3		Solenoid valve G shorted high	Solenoid valve #6
130	SID 6	4		Solenoid valve G shorted ground	Solenoid valve #6
130	SID 6	5		Solenoid valve G circuit break	Solenoid valve #6
130	SID 7	3		Torque converter clutch shorted high	Lockup sol.valve
130	SID 7	4		Torque converter clutch shorted ground	Lockup sol.valve
130	SID 7	5		Torque converter clutch circuit break	Lockup sol.valve
130	SID 8	3		Solenoid valve A shorted high	Forward sol. valve
130	SID 8	4		Solenoid valve A shorted ground	Forward sol. valve
130	SID 8	5		Solenoid valve A circuit break	Forward sol. valve
222	PID 1	3		U_Ret shorted high	**Invalid data**
222	PID 1	4		U_Ret shorted ground	**Invalid data**
222	PID 62	14		Reduction of retarder function active	Retard inhibit stat
222	PID 120	0		Retarder oil temperature high	Hyd retard oil temp
222	PID 120	3		Retarder temperature sensor above	Hyd retard oil temp
222	PID 120	4		Retarder temperature sensor below	Hyd retard oil temp
222	SID 10	3		Ret_On Valve shorted high	?

MID	(P)PID/SID	FMI	Seriousness	Component/function	Display text
222	SID 10	4		Ret_On Valve shorted ground	?
222	SID 10	5		Ret_On Valve current circuit break	?
222	SID 11	2		Retarder current resistor	?
222	SID 11	3		Retarder current shorted high	?
222	SID 11	4		Retarder current shorted ground	?
222	SID 11	5		Retarder current circuit break	?
222	SID 12	3		Retarder accumulator shorted high	?
222	SID 12	4		Retarder accumulator shorted ground	?
222	SID 12	5		Retarder accumulator circuit break	?
223	PID 163	2		Shifter encoding error	Gear attained
130, 222, 223	SID 231	2		CAN error	SAE J1939 data link
130, 222, 223	SID 250	2		J1708 busoff	SAE J1708 data link
130, 222, 223	SID 250	9		J1708 error warning	SAE J1708 data link

16. Fault codes, Voith 115v retarder (MID 222)

MID	(P)PID/SID	FMI	Seriousness	Component/function	Display text
222	PID 110	0		Eng. coolant temp.	Eng. coolant temp.
222	PID 110	4		Eng. coolant temp.	Eng. coolant temp.
222	PID 110	5		Eng. coolant temp.	Eng. coolant temp.
222	PID 110	13		Eng. coolant temp.	Eng. coolant temp.
222	PID 120	0		Hyd retard oil temp	Hyd retard oil temp
222	PID 120	4		Hyd retard oil temp	Hyd retard oil temp
222	PID 120	5		Hyd retard oil temp	Hyd retard oil temp
222	PID 120	13		Hyd retard oil temp	Hyd retard oil temp
222	PID 158	0		Control unit, battery potential	Battery potential
222	PID 158	1		Control unit, battery potential	Battery potential
222	PPID 30	13		Retarder current, PWM-valve	Retarder current
222	PPID 31	0		Retarder air press.	Retarder air press.
222	PPID 31	3		Retarder air press.	Retarder air press.
222	PPID 31	5		Retarder air press.	Retarder air press.
222	PPID 34	0		ECU, 12V Output	ECU, 12V Output
222	PPID 34	1		ECU, 12V Output	ECU, 12V Output
222	PPID 54	0		ECU +5V output	ECU +5V output
222	PPID 54	1		ECU +5V output	ECU +5V output
222	PPID 55	0		ECU temperature	ECU temperature
222	SID 2	3		Retard modul. Valve	Retard modul. valve
222	SID 2	4		Retard modul. Valve	Retard modul. valve
222	SID 2	5		Retard modul. Valve	Retard modul. valve
222	SID 2	6		Retard modul. Valve	Retard modul. valve
222	SID 231	2		SAE J1939 data link	SAE J1939 data link
222	SID 231	12		SAE J1939 data link	SAE J1939 data link
222	SID 240	2		Program memory	Program memory
222	SID 250	2		SAE J1708 data link	SAE J1708 data link
222	SID 250	4		SAE J1708 data link	SAE J1708 data link
222	SID 253	2		Calibration memory	Calibration memory
222	PSID 1	3		Power supply relay	Power supply relay
222	PSID 1	6		Power supply relay	Power supply relay
222	PSID 254	3		Controller #1	Controller #1

17. Fault codes, retarder 133

To the right of the bus instrument cluster there is a green checklamp (5022) for the retarder function and fault indications. At every voltage inflow the lamp will normally be lit for five seconds, if the lamp doesn't go out after five seconds have passed, a fault code is set in the retarder. The fault codes set in the retarder can be read via blink codes on the checklamp (5022) which can blink with two different intervals, long blink (2 seconds) to represent multiples of ten and short blink (0,5 seconds) to represent singular. For instance a combination of two long and two short blinks represents the number 22. A short look at the table below shows that 22 means "ABS signal internal control unit error".

The fault codes set in the retarder can be show by first turning the ignition on and off and then on again. Then press the lever to the position 1 and immediately back to position 0. The first fault code will now be displayed as an icon on the control lamp. Repeated movement of the lever between position 1 and position 0 will display the next fault code in line, if the same fault code is shown two times in a row there are no more fault codes set in the retarder.

Code	Description
1	Stop light relay short to ground
2	LS1 short to battery
3	HS 1 short to ground
4	HS 2 short to ground
5	Terminal 15 undervoltage
6	Terminal 15 overvoltage
7	Pilot valve short to ground
8	Tw sensor interruption or short to battery
9	Tw sensor short to ground
10	
11	To sensor interruption or short to battery
12	To sensor short to ground
13	RSS undefined switch condition (closing sequence)
14	RSS short to battery
15	RSS short to ground
16	Tachograph signal interruption
17	Pilot valve interruption or short to battery
18	Tachograph signal short to battery or undefined sign.
19	ABS short to ground
20	
21	ABS undefined level
22	ABS signal internal control unit error
23	Prop valve fault No. 1
24	Prop valve fault No. 2
25	Prop valve fault No. 3
26	Prop valve fault No. 4
27	Prop valve fault No. 5
28	Terminal 30 undervoltage
29	Internal fault conc. Safety component
30	
31	Data record/parameter: faulty coding
32	RKL interruption or short to ground
33	RKL short to battery
34	Missing engine speed signal

Code	Description
35	Internal fault concerning: ROM (CRC check). EEPROM (data record)
36	2/2-way valve fault
37	Non-plausibility of brake pedal operation
38	Pressure sensor fault
41	Time-out > 500ms press signal (VECU)
42	Time-out > 500ms ABS-signal (J1939)
43	J 1939 link "bus off".

18. Fault codes, VECU (MID 144)

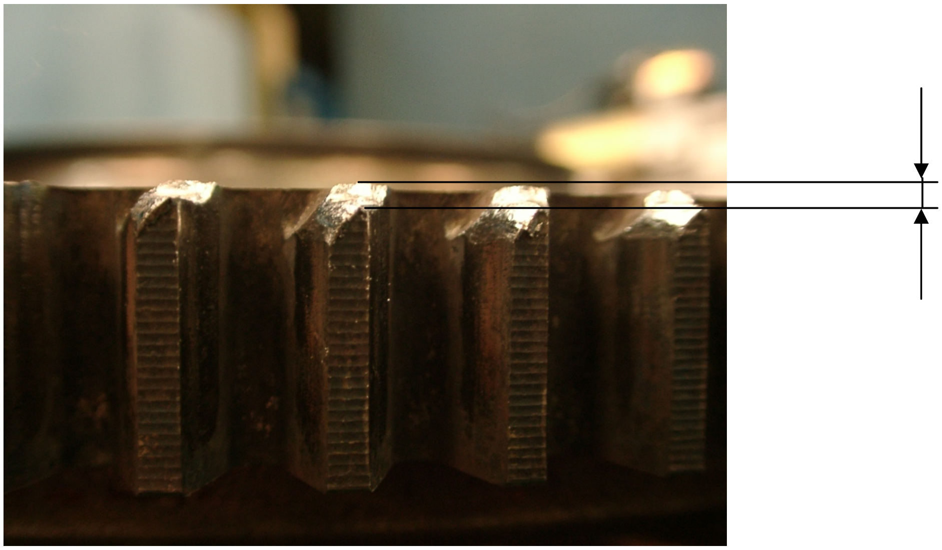
MID	(P)PID/SID	FMI	Seriousness	Component/Function	Display text
144	PID 29	3	Yellow lamp	Extra throttle, percentage mode	Second throttle
144	PID 29	4	Yellow lamp	Extra throttle, percentage mode	Second throttle
144	PID 46	1		Wet tank air pressure	Wet tank air press
144	PID 46	3	Yellow lamp	Wet tank air pressure	Wet tank air press
144	PID 46	4	Yellow lamp	Wet tank air pressure	Wet tank air press
144	PID 84	2	Yellow lamp	Road speed	Road speed
144	PID 84	5		Road speed	Road speed
144	PID 84	6		Road speed	Road speed
144	PID 84	8	Yellow lamp	Road speed	Road speed
144	PID 84	12	Yellow lamp	Road speed	Road speed
144	PID 84	13	Yellow lamp	Road speed	Road speed
144	PID 91	3	Yellow lamp	Accelerator pedal position, percentage mode	Acc. pedal pos., %
144	PID 91	4	Yellow lamp	Accelerator pedal position, percentage mode	Acc. pedal pos., %
144	PID 152	12		Control unit, number of resets	No. of ECU resets
144	PPID 69	4	Yellow lamp	Buffered idle switch	Buff. idle val. sw.
144	PPID 70	4	Yellow lamp	Pedal contact, feeding	Output supply #3
144	PPID 71	4	Yellow lamp	Constant speed keeper and retarder, feeding switch	Output supply #4
144	PPID 72	3	Yellow lamp	Accelerator pedal and retarder, feeding sensor	Output supply #1
144	PPID 72	4	Yellow lamp	Accelerator pedal and retarder, feeding sensor	Output supply #1
144	PPID 73	3	Yellow lamp	Extra throttle and wet tank, feeding sensor	Output supply #2
144	PPID 73	4	Yellow lamp	Extra throttle and wet tank, feeding sensor	Output supply #2
144	PPID 75	3	Yellow lamp	Range inhibitor	Range inhibitor
144	PPID 75	4	Yellow lamp	Range inhibitor	Range inhibitor
144	PPID 76	3	Yellow lamp	Brake light status relay	Brakelight output
144	PPID 77	3	Yellow lamp	Compressor, status solenoid valve	Compressor control
144	PPID 77	4	Yellow lamp	Compressor, status solenoid valve	Compressor control
144	PPID 79	3	Yellow lamp	Fault gear shift lock 3/1, status relay	Area inh. sol valve
144	PPID 79	4	Yellow lamp	Fault gear shift lock 3/1, status relay	Area inh. sol valve
144	SID 230	7	Yellow lamp	Idle switch 1	Idle valid switch
144	SID 231	2	Yellow lamp	Control link, SAE J1939	SAE J1939 data link
144	SID 231	12	Yellow lamp	Control link, SAE J1939	SAE J1939 data link
144	SID 240	2	Yellow lamp	Program memory	Program memory
144	SID 243	7	Yellow lamp	Constant speed keeper, set switch (SET+/SET-)	CC Set switch
144	SID 250	2	Yellow lamp	Information link SAE J1708	SAE J1708 data link
144	SID 253	2	Red lamp	Calibration memory	Calibration memory
144	SID 253	13	Red lamp	Calibration memory	Calibration memory
144	PSID 1	7	Yellow lamp	Retarder, set switch	Retard contr SET sw
144	PSID 2	7	Yellow lamp	Idle valid switch 2	Idle valid switch 2
144	PSID 3	7	Yellow lamp	Idle valid switch 3	Idle valid switch 3
144	PSID 4	3	Yellow lamp	Retarder, switch	Retard contr lever

Service Bulletin A1-M1N-1729EN - Flywheel Ring Gear Wear / Damage

(Sample of Maximum Ring Gear Wear /Damaged)

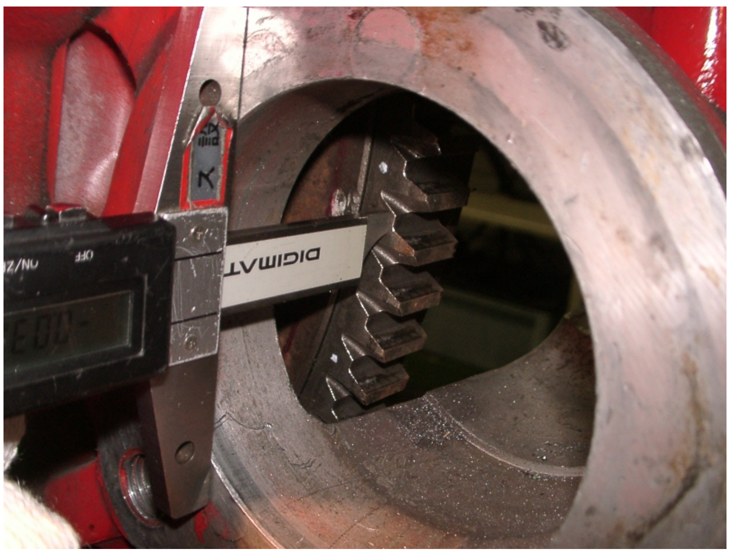
Please refer to the above photos and please replace the ring gear which has similar level of damage as these. See the next page for the method to measure the depth of the damage.

(Depth of wear / damage on ring gear)

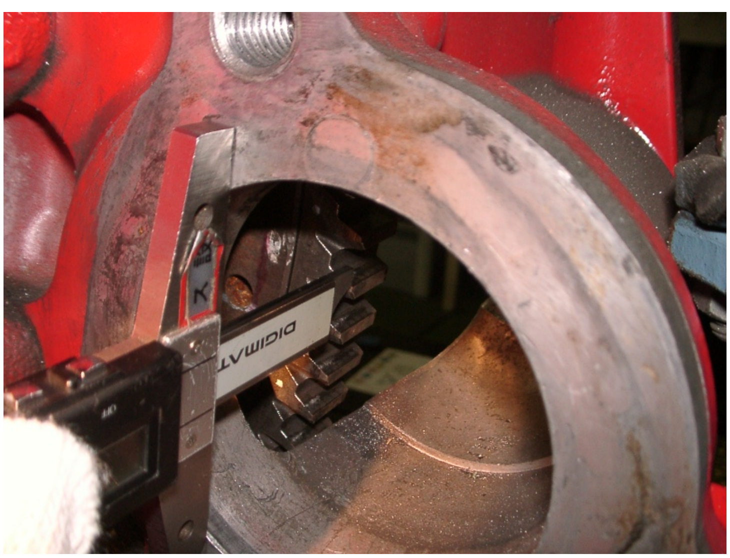


Less than 0.5mm

(Measurement method)



Dimension between the mounting surface and the end surface of ring gear



Dimension between the mounting surface and the damage depth portion of ring gear

SECTION 07: TRANSMISSION

CONTENTS

ILLUSTRATIONS

1. DESCRIPTION

XLII Series Bus Shells are provided with an Allison automatic transmission.

1.1 ALLISON AUTOMATIC TRANSMISSION

The B500 or B500R (with retarder) Allison Transmission has 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.

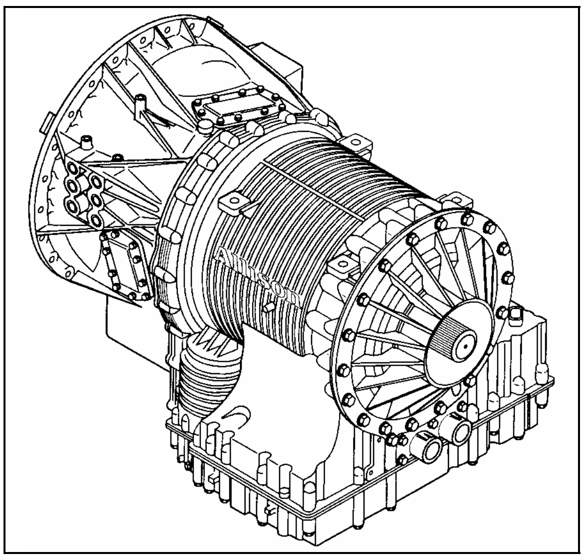


FIGURE 1: ALLISON TRANSMISSION 07075

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. Four-digit trouble codes greatly reduce the time it takes to pinpoint potential problems. (Refer to heading *"10. 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.

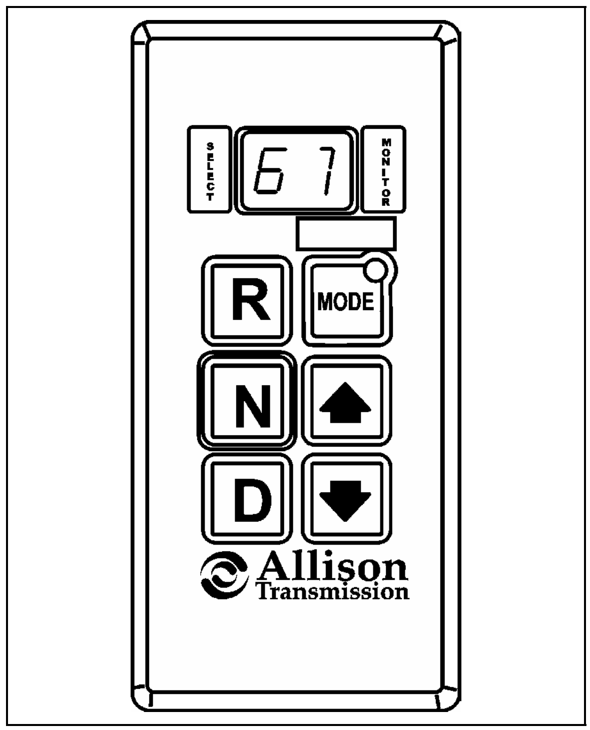


FIGURE 2: ALLISON TRANSMISSION CONTROL PAD 07025

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.

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. ALLISON TRANSMISSION MAINTENANCE

To gain access to the dipstick, open the engine compartment rear doors; dipstick is located on the radiator side of the engine (Fig. 3).

3.1 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.

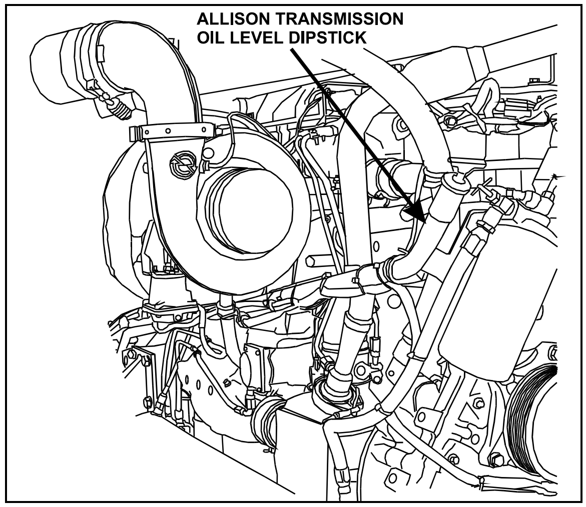


FIGURE 3: OIL LEVEL DIPSTICK (AUTO. TRANS.) 07113

3.2 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.

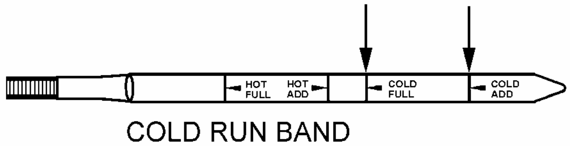


FIGURE 4: COLD CHECK 07050

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.

3.3 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. 5).

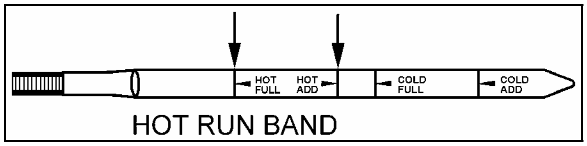


FIGURE 5: HOT CHECK 07049

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.***

3.4 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 hereafter:

CODE	CAUSE OF CODE
O L…O K	Oil level is correct
O L…L O…01	One quart low
O L…L O…02	Two quarts low
O L…H I…01	One quart high
O L…H I…02	Two quarts high

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.

CODE	CAUSE OF CODE
OL…0X	Waiting time too short
OL…50	Engine speed (rpm) too low
OL…59	Engine speed (rpm) too high
OL…65	Neutral must be selected
OL…70	Sump oil temperature too low
OL…79	Sump oil temperature too high
OL…89	Output shaft rotation
OL…95	Sensor failure

To exit the Oil Level Display Mode, press any range button: «R», «N» or «D».

3.5 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.

3.6 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.

3.7 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 Allison distributors and dealerships.

- To be sure a fluid is qualified for use in Allison transmission, check for the **DEXRON-III®** license numbers 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.

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.

3.8 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.

3.9 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.

3.10 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.

TABLE 1

Recommended Fluid and Filter Change Intervals Using Dexron-III / Non-TranSyndTM/Non-TES 295/Mixture							
Severe[3] MTH equipped with retarder				**General[4] MTH without retarder**			
Fluid	**Filters**			**Fluid**	**Filters**		
	Main	**Internal**	**Lube/ Auxiliary**		**Main**	**Internal**	**Lube/ Auxiliary**
12,000 Miles (20 000 km) 6 Months	12,000 Miles (20 000 km) 6 Months	Overhaul	12,000 Miles (20 000 km) 6 Months	25,000 Miles 40 000 km 12 Months	25,000 Miles 40 000 km 12 Months	Overhaul	25,000 Miles (40 000 km) 12 Months

2 inch Control Module (1.75 approximately) – Requires High-Capacity Filter kit Allison P/N 572050

TABLE 2

Recommended Fluid and Filter Change Intervals[1] Using 100% TranSyndTM/TES 295 Approved Fluid[2]							
Severe[3] MTH equipped with retarder				**General[4] MTH without retarder**			
Fluid	**Filters**			**Fluid**	**Filters**		
	Main	**Internal**	**Lube/ Auxiliary**		**Main**	**Internal**	**Lube/ Auxiliary**
150,000 Miles (240 000 km) 48 Months	75,000 Miles (120 000 km) 36 Months	Overhaul	75,000 Miles (120 000 km) 36 Months	300,000 Miles 480 000 km 48 Months	75,000 Miles (120 000 km) 36 Months	Overhaul	75,000 Miles (120 000 km) 36 Months

TABLE 3

Recommended Fluid and Filter Change Intervals Using 100% TranSyndTM/TES 295 Approved Fluid And Gold Series Filters							
MTH equipped with retarder				**MTH without retarder**			
Fluid	**Filters**			**Fluid**	**Filters**		
	Main	**Internal**	**Lube/ Auxiliary**		**Main**	**Internal**	**Lube/ Auxiliary**
	Initial Break-in 5,000 miles (8,000 km)				**Initial Break-in** 5,000 miles (8,000 km)		
50,000 Miles (80 000 km) 24 Months	50,000 Miles (80 000 km) 24 Months	Overhaul	50,000 Miles (80 000 km) 24 Months	150,000 Miles 240 000 km 48 Months	50,000 Miles 80 000 km 24 Months	Overhaul	50,000 Miles (80 000 km) 24 Months

[1] Extended TrandSynd™/TES 295 fluid and filter change intervals are only allowed with Allison High-Capacity filters.

[1] 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.

3.11 OIL AND FILTER CHANGE

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.

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. 6) 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. 6).
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

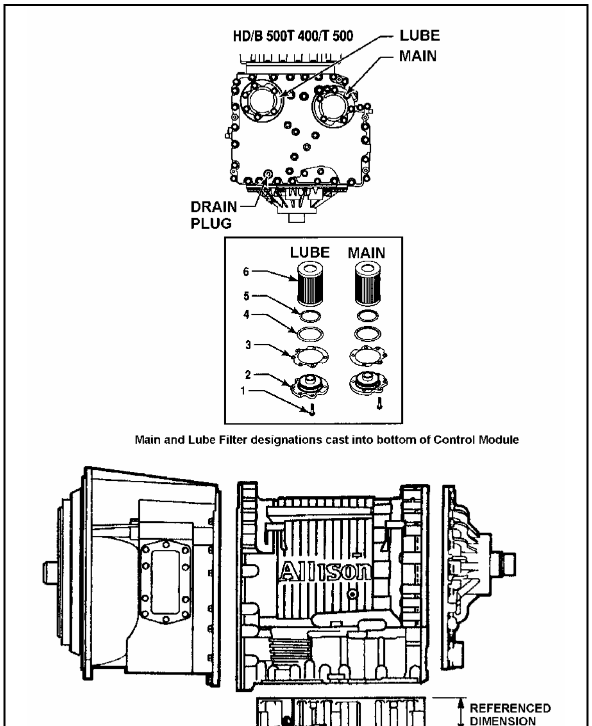


FIGURE 6: DRAIN PLUG AND FILTERS 07074

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.

4. INSTALLATION OF ALLISON TRANSMISSION BRACKETS

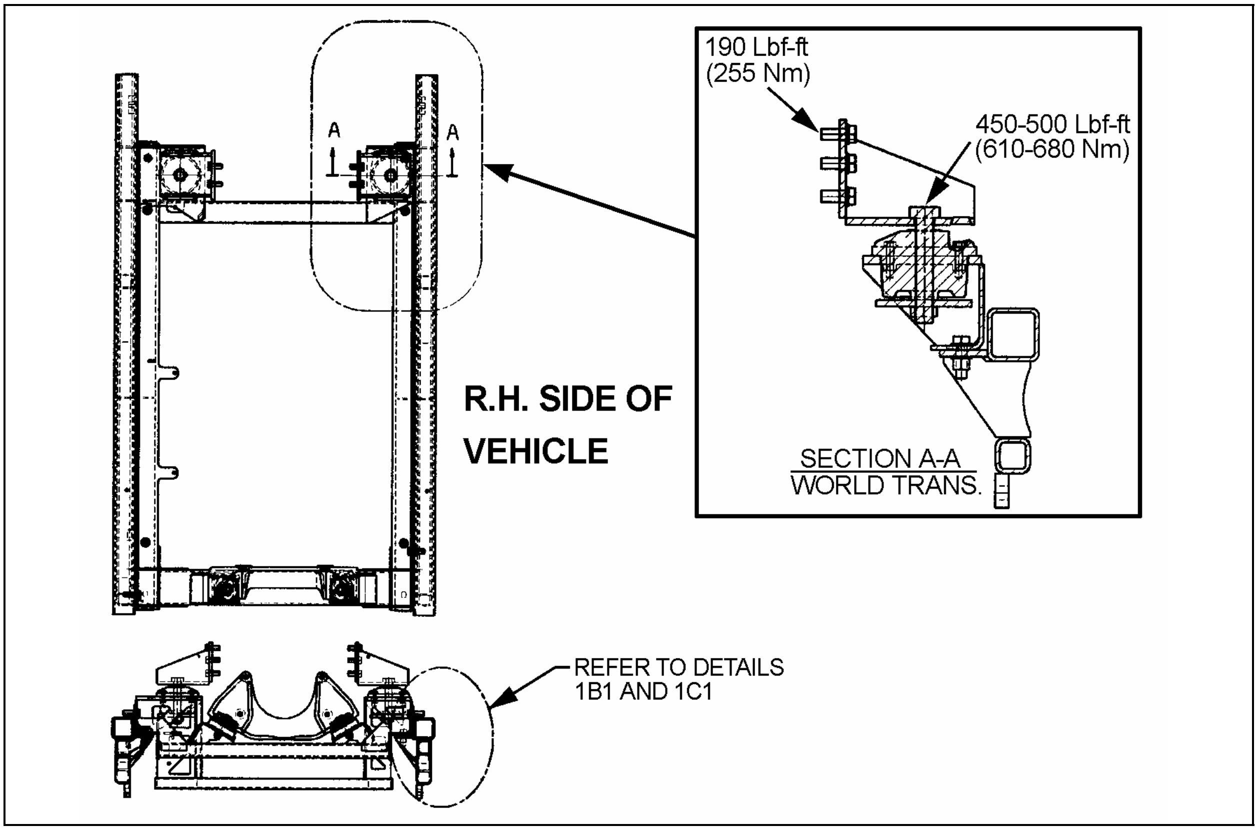


FIGURE 7: ALLISON TRANSMISSION BRACKETS 07133

5. 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 *"3.11 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.
14. Remove the access plug from the flywheel housing on the R.H. side below starter. From access plug, remove the 12 converter-to-flexible plate attaching screws. Cranking the engine to gain access to the attaching screws may be done by turning the crankshaft pulley using a suitable adapter (fig. 9).

CAUTION
Do not rotate alternator shaft clockwise to avoid removing tension on belt.

15. Remove the 12 screws retaining the torque converter housing to the flywheel housing.

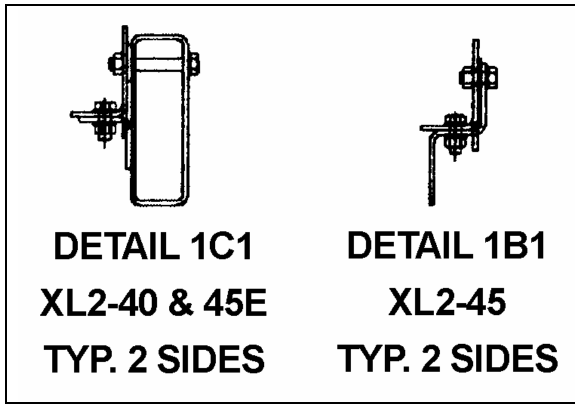


FIGURE 8: DETAILS FOR XLII VEHICLES 07116

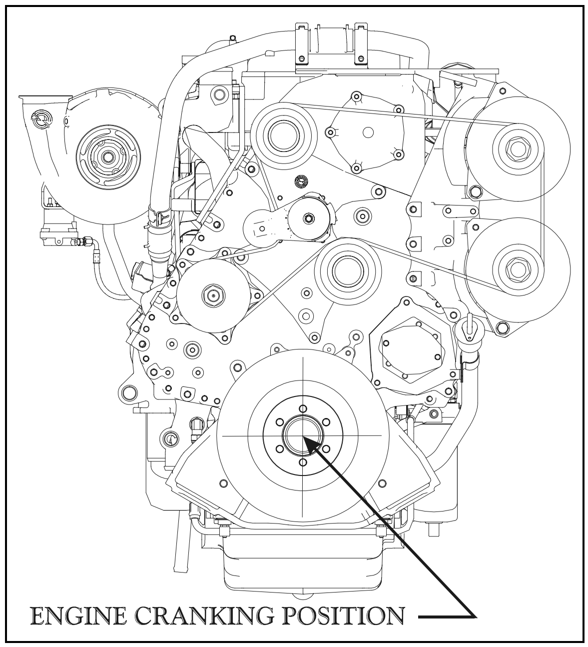


FIGURE 9: ENGINE CRANKING POSITION 01153

CAUTION
Make sure transmission-to-engine alignment is maintained when removing screws to avoid damaging torque converter housing.

16. Slowly pull transmission straight out to clear the engine.
17. Remove the transmission.

6. TRANSMISSION OIL COOLER REMOVAL

6.1 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. Disconnect and remove the engine air intake duct mounted between the air cleaner housing and the turbocharger inlet.

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

2. Disconnect the two transmission hoses from oil cooler. Cover hose ends and fittings to prevent fluid contamination.

> **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.

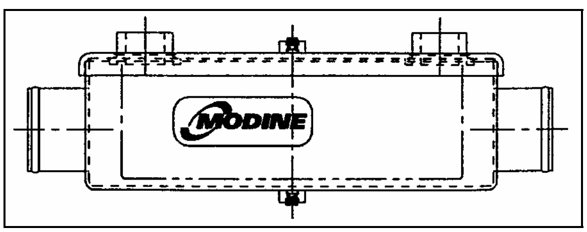


FIGURE 10: MODINE OIL COOLER 07072

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.

6.2 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. Disconnect and remove the engine air intake duct mounted between the air cleaner housing and the turbocharger inlet.

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

3. Disconnect the transmission hoses from oil cooler. Cover hose ends and fittings to prevent fluid contamination.

> **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.

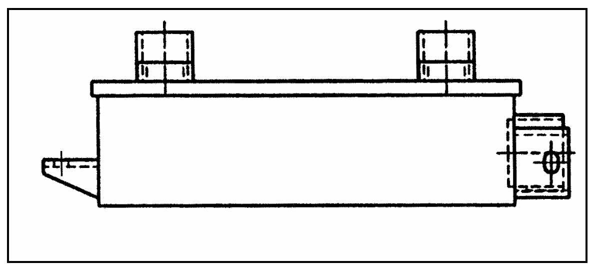


FIGURE 11: COOLER WITH RETARDER 07073

6. Reinstall transmission oil cooler by using reverse procedure.

7. CLEANING AND INSPECTION OF THE 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.

7.1 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.

8. 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 access plug removed, align one of the 12 attaching screw holes in the flexible plate with the access opening (starter side).
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.

6. 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.

7. 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).
8. 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). Place a wrench on the crankshaft pulley attaching screw to turn the converter to gain access to the threaded holes.
9. Reinstall the access plug.
10. Remove jack from under transmission.
11. Connect all sensors.
12. Connect the main wiring harness.
13. Connect the air supply line (steel-braided hose) to the retarder control valve (if applicable).
14. Connect the two transmission oil cooler hoses as they were previously.
15. Reinstall clamps and brackets, and replace locking ties previously removed during removal procedure.
16. Install propeller shaft and its safety guard. Refer to Section 09, *"PROPELLER SHAFT".*

17. Install transmission dipstick and filler tube.
18. Install cross member under transmission.
19. Install engine splash guards.
20. Adjust the retarder pressure to 80 ± 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, above the rear junction box (Fig. 12).

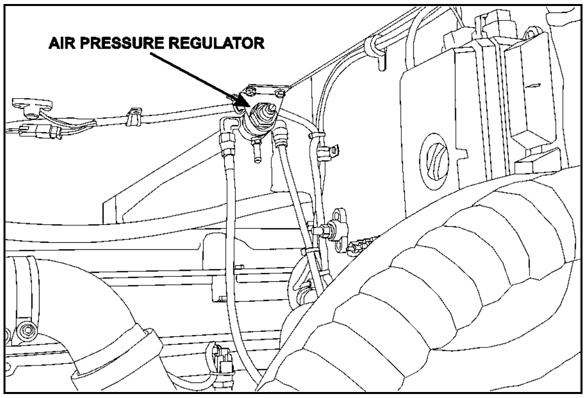


FIGURE 12: AIR PRESSURE REGULATOR (TYPICAL) 07037

23. 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.

9. TROUBLESHOOTING

9.1 ALLISON AUTOMATIC TRANSMISSION

For complete information about Allison transmission troubleshooting, refer to ''Allison 4th Generation Controls – Troubleshooting Manual: 3000 and 4000 Product families (TS3989)".

9.1.1 4th Generation Transmission Control Module

The Allison automatic transmission has a new Transmission Control Module (TCM) which involves specific diagnostic incident codes. The TCM is located in the coach rear junction box.

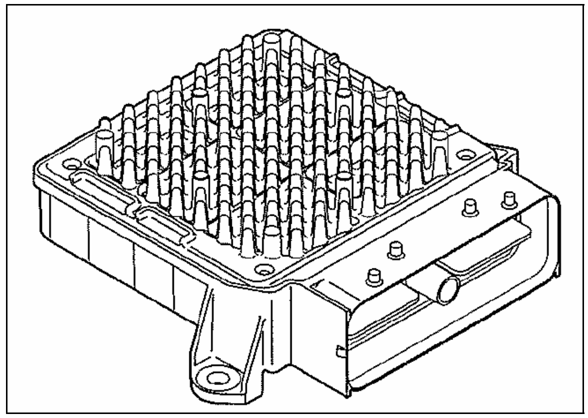


FIGURE 13: TRANSMISSION CONTROL MODULE 07140

TCM Replacement

The TCM is a non-serviceable electronic device. When it fails, it must be replaced using the following procedure:

- o Open the coach engine compartment R.H. side door;
- o Open the rear junction box in order to get access to the TCM;
- o Remove the electrical cable connectors;
- o Unscrew the TCM unit;
- o Replace by reversing the procedure.

> **CAUTION**
>
> Place the ignition key switch to the ''OFF'' position.

9.1.2 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.

9.1.3 Diagnostic Codes – Allison 4th Generation Controls

When the diagnostic mode is entered, the first code (position d1) is displayed as follows:

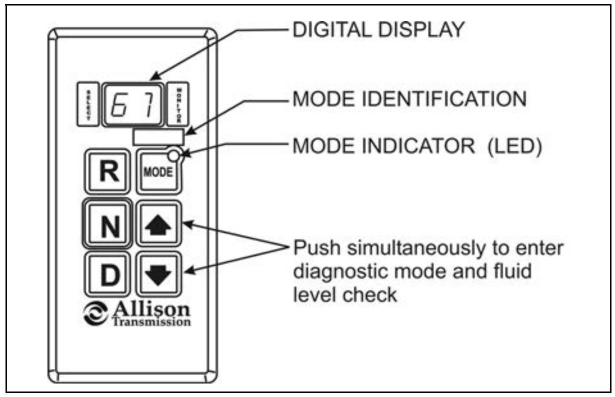
Example: Code P0722

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	d	1	MONITOR
		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.



9.1.4 Diagnostic Code Display And Clearing Procedure – Allison 4th Generation Controls

Diagnostic codes can be read and cleared by two methods:

- o Using an Allison DOC™ diagnostic tool. For specific instructions on how to use an Allison DOC™ diagnostic tool, refer to the User Guide.
- o 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.
2. Observe the digital display for code (d1).

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.*

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:

- o Press simultaneously the ⬆ (Up) and ⬇ (Down) arrow buttons at the same time on the pushbutton shift selector.
- o 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).
- o Wait until the calibrated time (approximately 10 minutes) has passed. The system will automatically return to the normal operating mode.
- o 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.

9.1.5 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 - <u>Do Not Shift</u> 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 - <u>Do Not Adapt</u> Response

The TCM stops adaptive shift control while the code is active.

SOL OFF - <u>SOLenoid OFF</u> 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.

9.1.6 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.
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)
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
P071A	RELS Input Failed On	Yes	Inhibit RELS operation
P071D	General Purpose Input Fault	Yes	None
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
P0731	Incorrect 1st Gear ratio	Yes	DNS, Attempt 2nd, then 5th

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
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
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
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)
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)
P0970	Pressure Control Solenoid 3 (PCS3) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
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)

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
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)
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)
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
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
P2763	TCC PCS Control Circuit High	Yes	Inhibit TCC operation
P2764	TCC PCS Control Circuit Low	Yes	7-speed: Allow 2 through 6, N, R. Inhibit TCC operation
P278A	Kickdown Input Failed ON	No	Inhibit kickdown operation
P2793	Gear Shift Direction Circuit	Yes	Ignores PWM input from shift selector
P2808	Pressure Control Solenoid 6 (PCS6) Stuck Off	Yes	DNS, RPR
P2809	Pressure Control Solenoid 6 (PCS6) Stuck On	Yes	DNS, RPR
P2812	Pressure Control Solenoid 6 (PCS6) Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P2814	Pressure Control Solenoid 6 (PCS6) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P2815	Pressure Control Solenoid 6 (PCS6) Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
U0001	Hi Speed CAN Bus Reset Counter Overrun (IESCAN)	No	Use default values, inhibit SEM
U0010	CAN BUS Reset Counter Overrun	No	Use default values, inhibit SEM
U0100	Lost Communications with ECM/PCM (J1587)	Yes	Use default values
U0103	Lost Communication with Gear Shift Module (Shift Selector) 1	Yes	Maintain range selected, observe gear shift direction circuit
U0115	Lost Communication with ECM	Yes	Use default values
U0291	Lost Communication with Gear Shift Module (Shift Selector) 2	Yes	Maintain range selected, observe gear shift direction circuit
U0304	Incompatible Gear Shift Module 1 (Shift Selector) ID	Yes	Ignore shift selector inputs
U0333	Incompatible Gear Shift Module 2 (Shift Selector) ID	Yes	Ignore shift selector inputs
U0404	Invalid Data Received From Gear Shift Module (Shift Selector) 1	Yes	Maintain range selected, observe gear shift direction circuit
U0592	Invalid Data Received From Gear Shift Module (Shift Selector) 2	Yes	Maintain range selected, observe gear shift direction circuit

10. SPECIFICATIONS

ALLISON AUTOMATIC TRANSMISSION WITH OR WITHOUT RETARDER

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/VI
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
Prévost number (2-filter replacement kit) 572050

CONTENTS

ILLUSTRATIONS

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 1810" type with tubular shafts. It is provided with two heavy-duty universal joints (Fig. 1).

The propeller shaft has a full round end yoke at one end and a half round end yoke at the other end. The tube yoke is connected to the differential by a full round end yoke with four needle bearings.

The other extremity (slip yoke assembly) is connected to the transmission by a half round end yoke with two needle bearings.

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 UNIVERSAL JOINTS AND DRIVESHAFTS"* annexed to this section, under headings *"Heavy Duty - removal, disassembly, reassembly and installation".*

Where applicable:

- Remove or install propeller shaft safety guard.
- Screw bolts to the specified torque (Fig. 1).

NOTE
Disregard the procedure on "Lock straps" mentioned in the "Spicer Universal Joints and Driveshafts Manual".

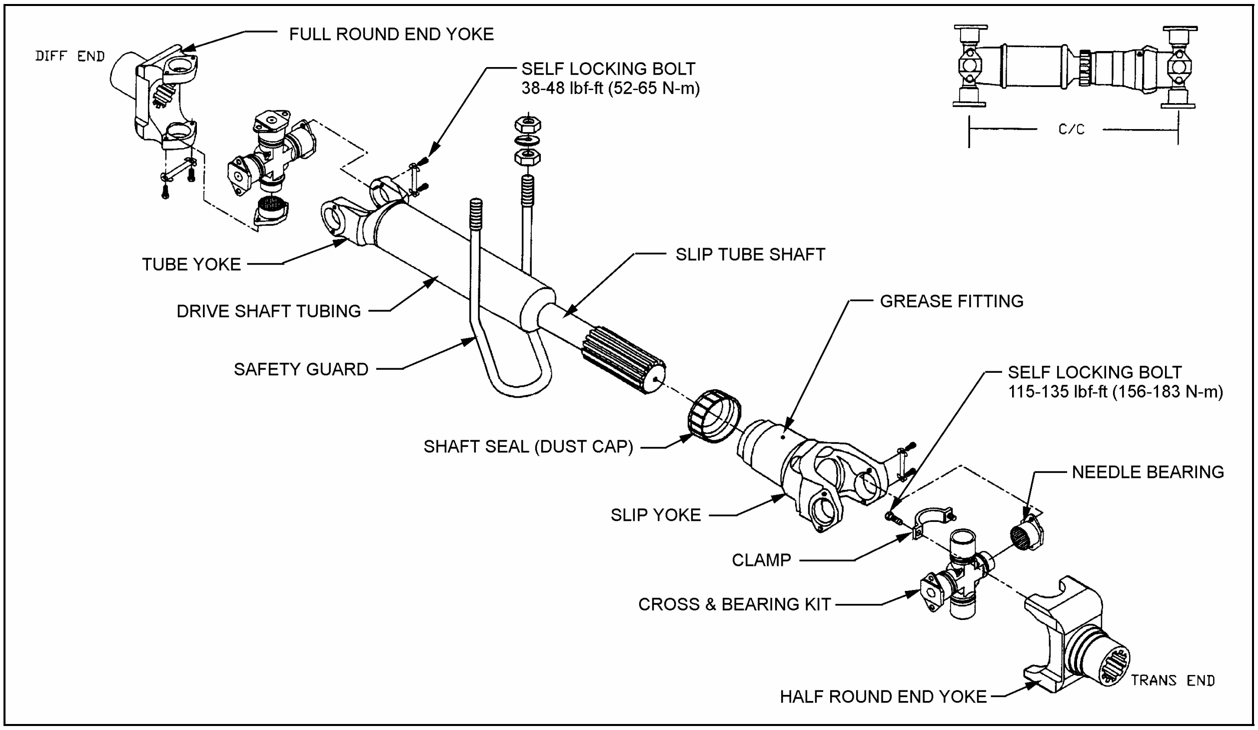


FIGURE 1: PROPELLER SHAFT ASSEMBLY 09002

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 the paragraph "6. Specifications" of this section.

3.2 LUBRICATION

Lubricate propeller shaft universal joints and slip yoke periodically, every 6,250 miles (10 000 km) or twice a year, whichever comes first. Apply grease gun pressure to the lube fitting. Use a good quality lithium-base grease such as: NLGI No.2 (suitable for most temperatures) or NLGI No.1 (suitable for extremely low temperatures). Refer to "Spicer Universal Joints and Driveshafts, Service Manual", under heading, "Inspection and Lubrication". See lubrication procedures for U-joints and lubrication for slip splines.

NOTE
Do not assume that bearing cavities have been filled with new grease unless it has expelled around all seals.

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 Service Manual - Universal Joints and Driveshafts"* under heading *"Troubleshooting".*

6. SPECIFICATIONS

PROPELLER SHAFT

VEHICLES EQUIPPED WITH ALLISON WORLD TRANSMISSION

W-45 MOTORHOMES

Make ..... Hayes-Dana Inc.
Series 1810
Supplier number 819325-2200
Prevost number 580070

W-40 AND Y-45E MOTORHOMES

Make ..... Hayes-Dana Inc.
Series 1810
Supplier number 819299-1
Prevost number 580075

Repair kits

Make ..... Hayes-Dana Inc.
U-joint kit (tube yoke), Supplier number 5-281X
U-joint kit (tube yoke), Prevost number 580043
U-joint kit (slip yoke), Supplier number 5-510X
U-joint kit (slip yoke), Prevost number 580062
Cap and bolt kit, bolt torque 115-135 lbf•ft (156-183 N•m), Supplier number 6.5-70-18X
Cap and bolt kit, bolt torque 115-135 lbf•ft (156-183 N•m), Prevost number 580063
Bolts kit, bolt torque 38-48 lbf•ft (52-65 N•m), Supplier number 6-73-209
Bolts kit, bolt torque 38-48 lbf•ft (52-65 N•m), Prevost number 580071

Half Round End Yoke

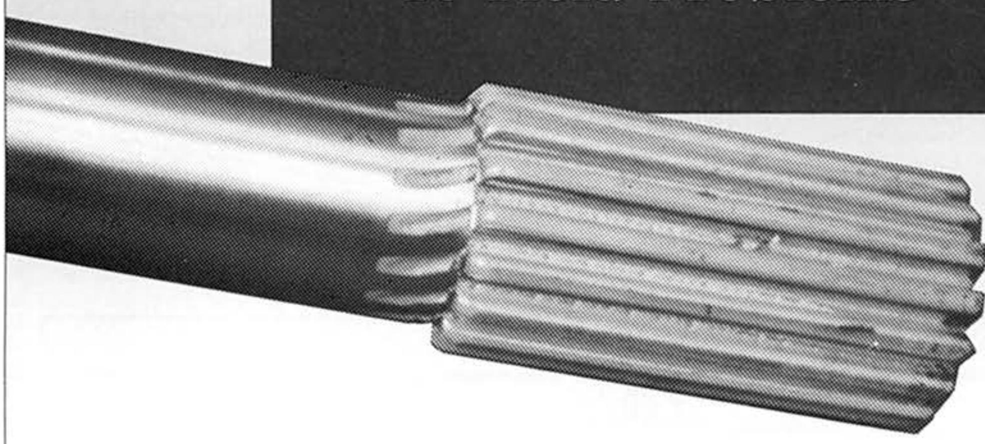
Make ..... Covington Detroit Diesel
Supplier number 29511516

NOTE
U-joint kits will come equipped with the serrated bolt and lock patch and will no longer contain a lock strap.

Spicer Driveline Components

Troubleshooting Guidelines

Causes and Solutions To Field Problems



SPICER®

DANA

SAFETY PRECAUTIONS

GENERAL SAFETY INFORMATION

To prevent injury to yourself and/or damage to the equipment:

- ➤ Read carefully all owners manuals, service manuals, and/or other instructions.
- ➤ Always follow proper procedures and use proper tools and safety equipment.
- ➤ Be sure to receive proper training.
- ➤ Never work alone while under a vehicle or while repairing or maintaining equipment.
- ➤ Always use proper components in applications for which they are approved.
- ➤ Be sure to assemble components properly.
- ➤ Never use worn-out or damaged components.
- ➤ Always block any raised or moving device that may injure a person working on or under a vehicle.
- ➤ Never operate the controls of the power take-off or other driven equipment from any position that could result in getting caught in the moving machinery.

WARNING: ROTATING DRIVESHAFTS

- ➤ Rotating auxiliary driveshafts are dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.
- ➤ Do not go under the vehicle when the engine is running.
- ➤ Do not work on or near an exposed shaft when engine is running.
- ➤ Shut off engine before working on power take-off or driven equipment.
- ➤ Exposed rotating driveshafts must be guarded.

WARNING: GUARDING AUXILIARY DRIVESHAFTS

We strongly recommend that a power take-off and a directly mounted pump be used to eliminate the auxiliary driveshaft whenever possible. If an auxiliary driveshaft is used and remains exposed after installation, it is the responsibility of the vehicle designer and PTO installer to install a guard.

WARNING: USING SET SCREWS

Auxiliary driveshafts may be installed with either recessed or protruding set screws. If you choose a square head set screw, you should be aware that it will protrude above the hub of the yoke and may be a point where clothes, skin, hair, hands, etc. could be snagged. A socket head set screw, which may not protrude above the hub of the yoke, does not permit the same amount of torquing as does a square head set screw. Also, a square head set screw, if used with a lock wire, will prevent loosening of the screw caused by vibration. Regardless of the choice made with respect to a set screw, an exposed rotating auxiliary driveshaft must be guarded.

THIS SYMBOL WARNS OF POSSIBLE PERSONAL INJURY.

Introduction

Universal joint failures, as a rule, are of a progressive nature, which, when they occur, generally accelerate rapidly resulting in a mass of melted trunnions and bearings.

Some recognizable signs of universal joint deterioration are:

1) Vibrations - Driver should report to maintenance.
2) U-joint Looseness - End play across bearings.
3) U-joint discoloration due to excessive heat build-up.
4) Inability to purge all four trunnion seals when relubing U-joint.

Items 2) thru 4) should be checked at re-lube cycle and if detected, reported to the maintenance supervisor for investigation.

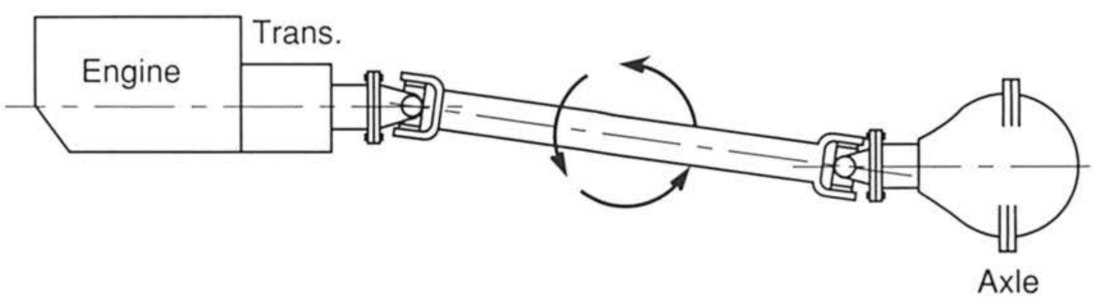
Experience with universal joint failures has shown that a significant majority are related to lubricating film breakdown. This may be caused by a lack of lubricant, inadequate lube quality for the application, inadequate initial lubrication or failure to lubricate properly and often enough.

Failures which are not the result of lubrication film breakdown are associated with the installation, angles and speeds and manufacturing discrepancies.

Driveshaft failures through torque, fatigue and bending are associated with overload, excessively high U-joint angles and drive shaft lengths excessive for operating speeds.

The trouble shooting chart in this bulletin is intended to provide service people with an aid to enable them to associate complaints with some of the **probable causes** and **probable corrections**. Through normal vehicle maintenance and recognition of discrepancies, this may enable them to make necessary corrections to ward off a serious breakdown.

Driveshaft Torque



Twisted driveshaft tube?
Broken yoke shaft?
Broken journal cross?

Usually a result of torque overload– How much torque can be generated in your application?

Here is how to figure torque:

L.G.T. = N.E.T. x Trans L.G.R. x .85 (efficiency factor)

$$\text{D.L.T. (to Slip Wheels)} = \frac{W_R \times \text{C.O.F.} \times \text{R.R.}}{12 \times \text{A.R.}}$$

A.R. = Axle ratio
C.O.F. = Coefficient of friction (.7)
D.L.T. = Drive line torque
L.G.R. = Low gear ratio
L.G.T. = Low gear torque
N.E.T. = Net engine torque
R.R. = Tire loaded rolling radius
W_R = Weight on drive axle

Relate the lesser of above to Spicer U-joint ratings. If your torque exceeds the Spicer rating for the U-joint used in your application, switch to a size with a rating compatible to your calculation.

U-Joint Operating Angles

U-joint operating angles are a primary source of problems contributing to:

- Vibrations
- Reduced U-joint life
- Problems with other drivetrain components that may include:
  - Transmission gear failures
  - Synchronizer failures
  - Differential problems
  - Premature seal failures in axles, transmissions, pumps or blowers
  - Premature failure of gears, seals and shafts in Power Take-Offs

Every U-joint that operates at an angle will vibrate.

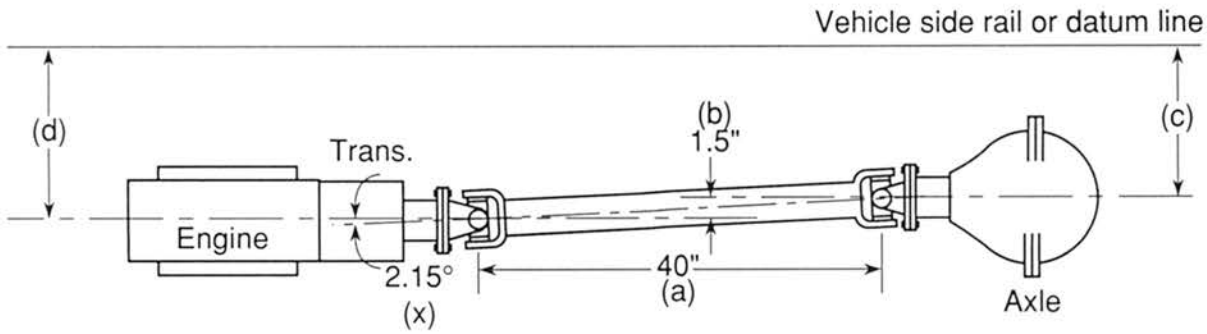
U-joint operating angles are probably the most common causes of driveline vibrations in vehicles that have been re-worked or in vehicles that have had auxiliary equipment installed.

To correct or eliminate these causes of driveline vibrations from your vehicle or new installation, you must determine the TRUE OPERATING ANGLE of each U-joint in your system.

The TRUE OPERATING ANGLE of a U-joint is a combination of the angle that occurs in the top view and the angle that occurs in the side view.

To determine the TRUE OPERATING ANGLE of a U-joint you must follow the instructions outlined in the following sections, numbered I and II, and calculate the TRUE OPERATING ANGLE using the information detailed in Section III.

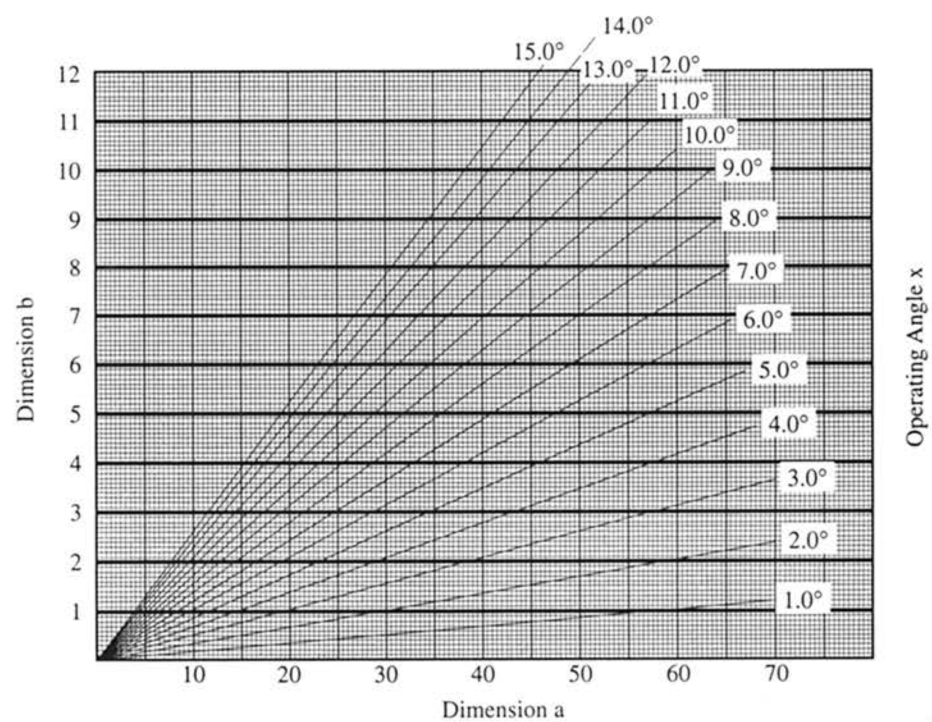
I. To determine operating angles in top view



1. From side rail or convenient datum, measure offset dimensions c & d.
2. Calculate dimension b = d - c
3. Measure dimension a
4. Using dimensions a & b, determined through measurement, calculate U-joint angle x by using the chart provided.

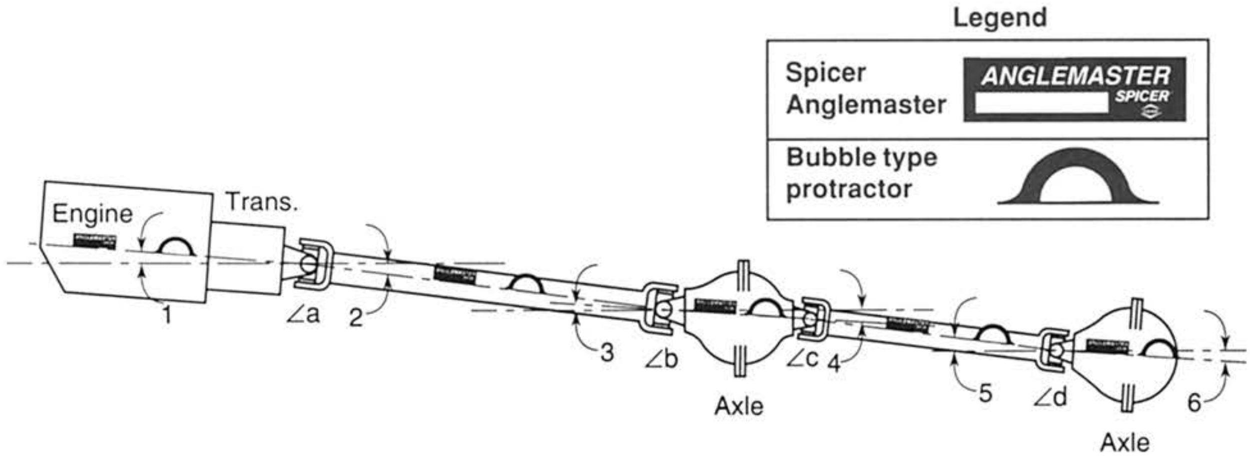
Example:

Where a = 40.0"
b = 1.5"
X = 2.15° operating angle



U-Joint Operating Angles

II. To determine operating angles in side view



The most convenient way to determine U-joint angles in the side view is through use of a Spicer Anglemaster™ or a bubble type protractor. Procedure is as follows:

Step I. Using an Anglemaster or a bubble protractor, record inclination angles of drivetrain components. Set Anglemaster or protractor on machined surfaces of engine, transmission, axle or on machined lugs of transmission output and axle input yokes.

Note: U-joint angles can change significantly in a loaded situation. Therefore, check vehicle loaded and unloaded to achieve the accepted angle cancellation. (See Step IV.)

Example:

Eng-Trans Output	4°30' Down (1)
Main Drive Shaft	7°00' Down (2)
Input 1st Rear Axle	4°00' Up (Input Shaft Nose Up) (3)
Output 1st Rear Axle	4°00' Down (4)
Inter-axle Shaft	7°00' Down (5)
Input 2nd Rear Axle	4°15' Up (Pinion Shaft Nose Up) (6)

Note: If inclination of driveshaft is opposite connecting component, add angles to obtain the U-joint operating angle.

$\angle$ a = (2) - (1) = 7°00' - 4°30' = 2°30' (2.50°)
$\angle$ b = (2) - (3) = 7°00' - 4°00' = 3°00' (3.00°)
$\angle$ c = (5) - (4) = 7°00' - 4°00' = 3°00' (3.00°)
$\angle$ d = (5) - (6) = 7°00' - 4°15' = 2°45' (2.75°)

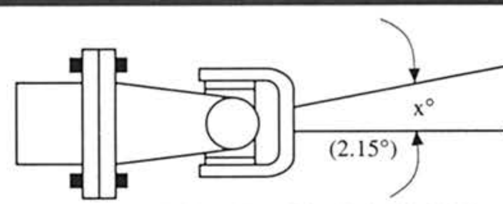
III. Calculating the True U-Joint Operating Angle

The true U-joint operating angle is the sum of the U-joint angles in both the top view and the side view. The true U-joint operating angle is calculated in the following manner:

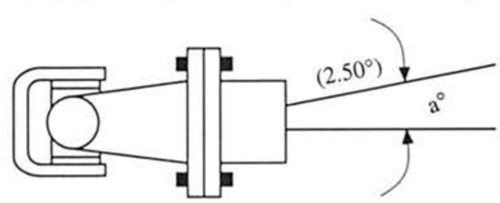
True operating angle = $\sqrt{x^{\circ 2} + a^{\circ 2}}$
Where x = 2.15° as determined by use of chart in Section I.

a = 2.5° as determined in Section II.

True operating angle = $\sqrt{2.15^2 + 2.5^2}$
= 3.297° or 3°18'



ANGLE IN TOP VIEW (FROM CHART)



ANGLE IN SIDE VIEW (MEASURED)

IV. U-Joint Angle Cancellation

After calculating the TRUE OPERATING ANGLE of each U-joint in your driveline:

- Make sure the inboard yoke ears of each driveshaft are in line within each other.
- Compare the TRUE OPERATING ANGLE of each U-joint on each end of each shaft. They must be within one degree of each other or they will be a potential source of vibration.

If adjustments must be made to the system:

- Install shims between the axle housing and springs to rotate the axle input yoke to change operating angles.
- Change operating angle on torque arm type suspensions by lengthening or shortening torque arms.
- Raise, lower, or shift side to side a pump, blower or other piece of auxiliary equipment to change operating angles.

IMPORTANT TO REMEMBER: Keep the centerlines of two components that are connected by a driveshaft parallel in both the top and side views, so the operating angles will ALWAYS be equal.

V. Maximum True Operating Angles*

For Two Joint Shafts with Equal or Intersecting Angles

When you settle on a true operating angle that is correct, make sure it doesn't exceed the angles shown in this chart for the driveshaft RPM.

R.P.M. is the main factor in determining maximum allowable operating angles. As a guide to maximum normal operating angles, refer to the chart below.

Driveshaft RPM	Max. Normal Operating Angles	Driveshaft RPM	Max. Normal Operating Angles
5000	3.2°	3000	5.8°
4500	3.7°	2500	7.0°
4000	4.2°	2000	8.7°
3500	5.0°	1500	11.5°

*Based on application experience (1000 rad/sec acceleration).

Universal Joints Trouble Shooting Chart

Complaints \ Probable Causes	Lack of Lubrication	Inadequate Initial Lubrication	Inadequate Grease Quality for Application	Inadequate Relube Cycles for Application Environment	Failure to Lubricate Properly	Defective or Worn Seals	Yoke Distortion Due to Initial Failure	Continuous Operation at High Angle — High Speed	Excessive Continuous Running Load	End Galling of Cross Trunnion and Bearing Cup	Contamination (Abrasion)	Lubricating Film Breakdown	Excessive Thrust Fit	Yoke Cross Hole Alignment	Yoke Lug Face Squareness	No U-Joint Operating Angle	Long Shaft with Loose U-Joint Thrust Fit and Unbalance	Roller Lock	Roller Skewing	Frettage Corrosion Due to Yoke Working Under Load	Galling (Adhesive Wear)	Slip Member Working In Extreme Extended	Excessive Loose O.D. Fit	Male Spline Head	Exce
Low Mileage U-Joint Failure	1	1	1 6	1	1	2 11		4	5	1 4 6 7															
Repeat U-Joint Failure	1	1	1 6	1	1	2 11	13 3	4	5	1 4 6 7															
End Galling of Cross Trunnion and Bearing Cup								4			1 8 11	1 6	7	7	7										
Frettage (Also: False Brinelling, Wear Oxidation, Friction Oxidation, and Chaffing Fatigue)											1 8 11	1 5 6 8				10	18 22 25 26	11 13	11 12 13						
Bearing Race O.D. Seizure in Yoke Cross Holes																				9					
Slip Spline Seizures	1	1	1	1	1						8	1 6 8									1 5 6 8 14	15			5
Slip Spline Galling											8	1 6 8										15		16 17	5
Slip Spline O.D. Wear at Extremities and at 180°																						15	11 32	16 17	
Slip Spline Shaft or Tube Broken in Torsion																									5 19
Shaft Broken in Bending																									
Tube Split in Longitudinal Seam Weld																									
Tube Circle Weld Failure																									5 19
Yoke Broken in Hub																									5
Yoke Broke at Ear Tip																									
Broken Cross or Cups																									5
Needle Rollers Brinelled into Cups and Cross Trunnion																									5
Shaft Support Brg. Failure	11 32	11				11 32					11 32														
Shaft Support Rubber Insulator Failure																									
Transmission Extension Bell Housing and Clutch Housing Failures																									
Vibrations																									
Low Gear Shudder																									
Vibrations in Short Speed Ranges Under Full Drive or Full Coast																									

1. See Spicer Universal Joint Lube specs #3306.
2. If new kit...Replace seals. If used...Replace complete kit.
3. Replace yoke if distorted.
4. Reduce U-Joint's continuous running angles.
5. Replace with higher capacity U-joint and driveshaft.
6. Use Hi-Temp grease.
7. Check U-joint flex effort. If sticks, binds or grabs...Replace U-Joint kit. If still sticks, binds or grabs...Check yokes for span, lug squareness, cross hole alignment, etc. Replace as needed.
8. Check components. If serviceable...Clean and relubricate per lube specs. If not serviceable...Replace.
9. No immediate fix. Anti-seize lubricant on bearing O.D. will initially help.
10. Re-align for a minimum 1° running angle.
11. Replace.
12. Replace roller lock assembly.
13. Yoke deflections under load...Use larger joint.
14. Use Spicer "Glidecote" on slip spline.
15. Increase driveshaft assembly length. Position slip spline head towards U-joint.
16. Check for male slip member with longer spline.
17. Design is inadequate for application.

...ded Position	...ad Engagement Length too Short for Application	...cessive Torque Load for U-Joints and Driveshaft Size	Improper Slip Spline Shaft Neck Heat Treatment	Inadequate Radius at Slip Spline Shaft Neck Runout — Stress Riser	Tube Size Inadequate	Defective or Worn Part	Driveshaft Too Long for Operating Speeds	Bending Fatigue Due to Secondary Couple Loads	Defective Circle Weld	Balance Weight Too Close To Circle Weld	Balance Weight Located in Apex of Weld Yoke Lug Area	Inadequate Hub and Radius For Application	Defective Forging or Casting	Mating Yoke Lug Interference at Full Jounce and Rebound	Excessive U-Bolt Torque on Retaining Nuts — Pinching Rollers	Inadequate Torque on Cap Screws Retaining Brg. Plate	Worn Universal Joints	Continuous Running U-Joint Angles — Too Large	Unequal U-Joint Angles	Driveshaft Balance and Straightness	Damaged Driveshaft Tube	Runout on Drive and Driven Support Shafts	Excessively Loose U-Joint for Operating Speed and Length	Loose O.D. Fit on Slip Spline	Drive Shaft Too Long for Speed — Operating in Critical	Driveshaft Weight Not Compatible with Eng. — Transmission Mounting	Driveshaft Yoke Phasing	Secondary Couple Load Reaction at Shaft Support Brg.	Torsional Excitation	Inertia Excitation	Shaft Support Brg. Misaligned — Interference with Slinger	Improper Shaft Length and Slip
															26																	
															26																	
			11	5 17	5 19	11																										
							18 19	4																								
						11																										
									11	11	11																					
								4				20																				
													11	4 27																		28
						11 32																										
																															29	
																	30	4	21	22	22 31	23	18 22 25 26	11 32	18 19	18 24	33					
																26	30	4	21	22	22 31	23	18 22 25 26	11 32	18 19	18 24	33					
																												4 21 33 34 35				
																													4 21			

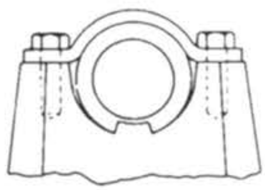
18. Install two piece driveshaft with shaft support bearing.
19. Use larger diameter tube.
20. Design limitation due to axle's or transmission shaft's requirement.
21. Shim drivetrain components to equalize U-joint angles.
22. Straighten and balance.
23. Check with transmission or axle manufacturer ...Replace shaft bearing.
24. Revise power plant mounting scheme.
25. Check U-joint flex effort for looseness.
26. Torque bearing retention to spec.
27. Use wide angle yokes.
28. Check installed length. Adjust driveshaft length to provide proper slip conditions.
29. Re-align mounting bracket to frame cross member and eliminate interference.
30. Replace U-joint kits.
31. Replace tube.
32. If normal wear...Replace.
33. Check O.E.M. maintenance manual or alignment arrows on slip yoke and male slip shaft for correct yoke phasing.
34. If 2 piece-3JT driveshafts...Adjust shaft lengths to 50-50 or 40-60 split.
35. Re-position shaft support bearing.

SPICER UNIVERSAL JOINT KIT ATTACHING HARDWARE & TORQUE SPECIFICATIONS CHART

U-BOLT

Series	Spicer Kit No.	U-Bolt Ass'ys.	Recommended Nut Torque
1280	5-200X	2-94-28X	14-17 Lb. Ft.
1310	5-153X	2-94-28X	14-17 Lb. Ft.
1330	5-213X	2-94-28X	14-17 Lb. Ft.
1350	5-178X	3-94-18X	20-24 Lb. Ft.
1410	5-160X	3-94-18X	20-24 Lb. Ft.
1480	5-188X	3-94-28X	32-37 Lb. Ft.
1550	5-155X	3-94-28X	32-37 Lb. Ft.

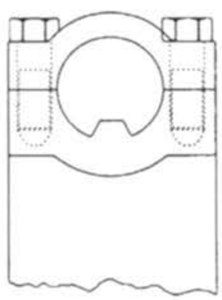
BEARING STRAP



WARNING: Bearing Strap Retaining Bolts Should **NOT** Be Reused.

Series	Spicer Kit No.	Strap Kit Ass'ys.	Recommended Bolt Torque
SPL90	SPL90X	90-70-28X	45-60 Lb. Ft.
1210	5-443X	2-70-18X	13-18 Lb. Ft.
1280	5-200X	2-70-18X	13-18 Lb. Ft.
1310	5-153X	2-70-18X	13-18 Lb. Ft.
1330	5-213X	2-70-18X	13-18 Lb. Ft.
1350	5-178X	3-70-28X	30-35 Lb. Ft.
1410	5-160X	3-70-28X	30-35 Lb. Ft.
1480	5-188X	3-70-38X	55-60 Lb. Ft.
1550	5-155X	3-70-38X	55-60 Lb. Ft.
1610	5-438X	5-70-28X	55-60 Lb. Ft.
1710	5-515X	6.5-70-18X	130-135 Lb. Ft.
1760	5-469X	6.5-70-18X	130-135 Lb. Ft.
1810	5-510X	6.5-70-18X	130-135 Lb. Ft.

CAP & BOLT



Series	Spicer Kit No.	Cap & Bolt Ass'ys.	Recommended Bolt Torque
1650	5-165X	5-70-18X	77-103 Lb. Ft.
1850	5-185X	8-70-18X	110-147 Lb. Ft.
1850	5-227X	8-70-18X	110-147 Lb. Ft.
1910	5-316X	N.S.S.	110-147 Lb. Ft.
1950	5-339X	9-70-18X	271-362 Lb. Ft.
2010	5-371X	N.S.S.	102-118 Lb. Ft.
2050	5-340X	9-70-28X	744-844 Lb. Ft.
2110	5-372X	N.S.S.	171-197 Lb. Ft.
2150	5-298X	9-70-38X	744-844 Lb. Ft.
2210	5-373X	N.S.S.	260-298 Lb. Ft.

BEARING PLATE

WARNING: Self Locking Bolts Should **NOT** Be Reused

Series	Spicer Kit No.	Bolt Part No.	Lockstrap Part No.	Recommended Bolt Torque
1610	*5-279X	5-73-709	N.A.	26-35 Lb. Ft.
1710	*5-280X	6-73-209	N.A.	38-48 Lb. Ft.
1760	*5-407X	6-73-209	N.A.	38-48 Lb. Ft.
1810	*5-281X	6-73-209	N.A.	38-48 Lb. Ft.
1880	*5-308X	7-73-315	N.A.	60-70 Lb. Ft.
New part nos. for kits with lockstraps available after Spring, 1994				
1610	5-654X	5-73-109	98-1741	17-24 Lb. Ft.
1710	5-656X	6-73-109	230323	32-42 Lb. Ft.
1760	5-658X	6-73-109	230323	32-42 Lb. Ft.
1810	5-660X	6-73-109	230323	32-42 Lb. Ft.
1880	5-668X	7-73-115	231009	50-66 Lb. Ft.

* THESE U-JOINT KITS WILL USE SELF-LOCKING BOLTS WITH LOCK PATCH™ AFTER SPRING, 1994. A LOCKSTRAP WILL NO LONGER BE NEEDED.

Spicer Flange Bolt Information

Series	Part Numbers: Bolt	Washer	Nut	Diameter, Thread, & Length Under Head	Recommended Torque
1000/1100	5-73-414	500357-10	231421-2	.312" - 24 x 0.875"	22-26 Lb. Ft.
1350/1410/1550	5-73-2216	"	"	- 24 x 1.000"	"
1550 *	5-73-1125	"	"	- 24 x 1.562"	"
1280/1310	6-73-316	500357-11	231421-3	.375" - 24 x 1.000"	40-48 Lb. Ft.
SPL90/1610	6-73-1219	"	"	- 24 x 1.188"	"
1710	6-73-220	"	"	- 24 x 1.250"	"
SPL90/1610 *	6-73-325	"	"	- 24 x 1.562"	"
1710 *	6-73-1227	"	"	- 24 x 1.688"	"
1350/1410	7-73-219	500357-12	231421-4	.438" - 20 x 1.188"	63-75 Lb. Ft.
1810	7-73-122	"	"	- 20 x 1.375"	"
1350/1410 *	7-73-126	"	"	- 20 x 1.625"	"
1760/1810 *	7-73-228	"	"	- 20 x 1.750"	"
1480/1550	8-73-122	500357-13	231421-5	.500" - 20 x 1.375"	97-116 Lb. Ft.
1650	8-73-123	(Bearing Race Cap)		- 20 x 1.438"	"
1480/1550 *	8-73-228	500357-13	231421-5	- 20 x 1.750"	"
1880/1910	10-73-131	500358-15	231421-7	.625" - 18 x 1.938"	194-232 Lb. Ft.
1950	12-73-140	500358-17	231421-8	.750" - 16 x 2.500"	341-409 Lb. Ft.
2010	9.55-73-11	———	231483	18mm x 75mm	277-319 Lb. Ft.
2050	14-73-264	500358-19	231421-9	.875" - 9 x 3.500"	543-652 Lb. Ft.
2110	9.60-73-11	———	231482	20mm x 80mm	397-457 Lb. Ft.
2150	16-73-164	500358-21	231421-10	1.000" - 12 x 4.000"	810-976 Lb. Ft.
2210	9.65-73-11	———	231481	22mm x 90mm	534-575 Lb. Ft.

* - Tru Stop Brake Applications

Spicer Flange Bolts are **Special, Heat Treated, Grade 8 Bolts.**
Do not substitute inferior grade bolts.

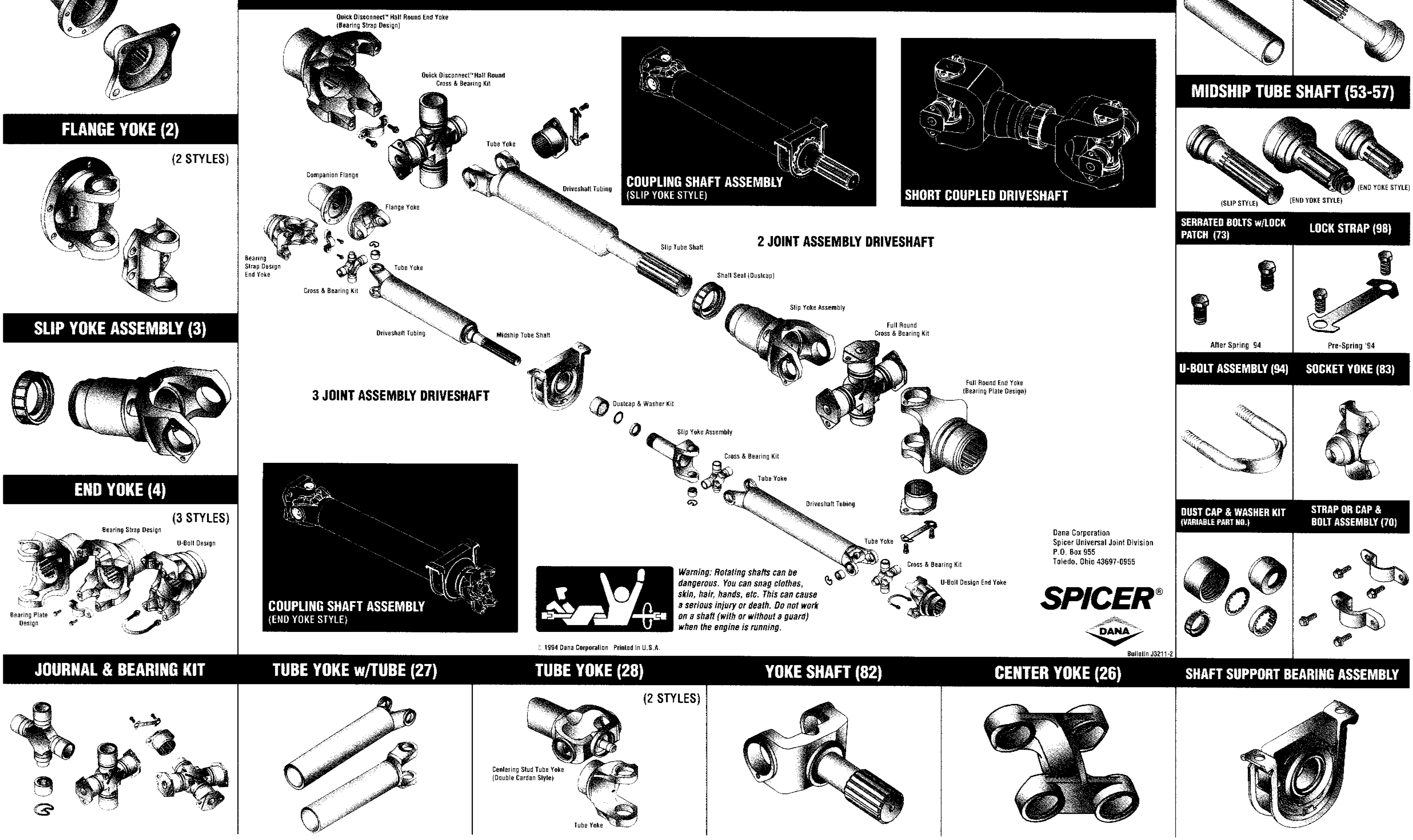
Dana Corporation
Drivetrain Service Division
P.O. Box 321
Toledo, Ohio 43697-0321

SPICER®

DANA

3119-5 DSD 4/94

SPICER® LIFE™ DRIVELINE COMPONENTS



Warning: Rotating shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause a serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.

Dana Corporation
Spicer Universal Joint Division
P.O. Box 955
Toledo, Ohio 43697-0955

SPICER®
DANA

Bulletin J3211-2

CONTENTS

ILLUSTRATIONS

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.

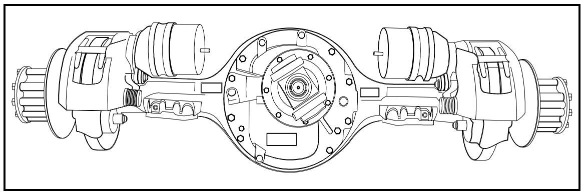


FIGURE 1: DRIVE AXLE 11019

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.

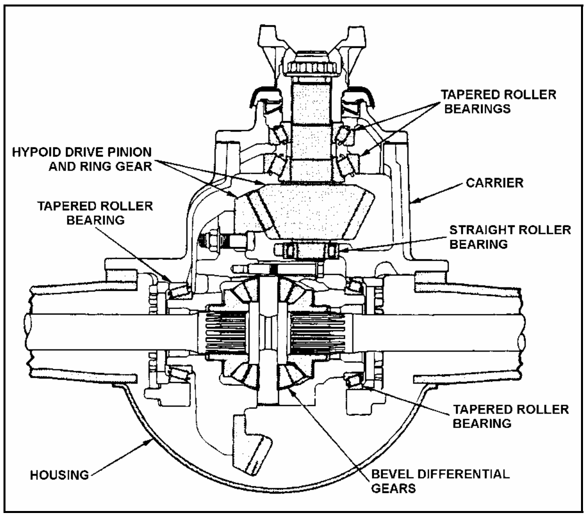


FIGURE 2: DIFFERENTIAL ASSEMBLY 11024

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.

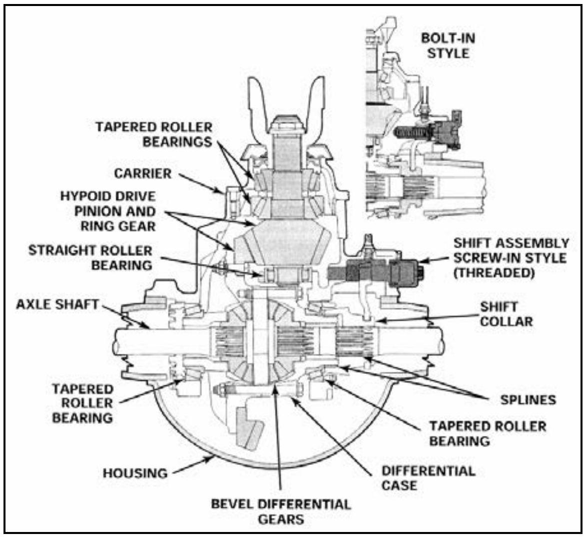


FIGURE 3: DRIVER-CONTROLLED DIFFERENTIAL LOCK 11028

1.3 DRIVE AXLE LUBRICATION

Additional lubrication information is covered in the Meritor Technical Bulletin TP-9539: “Approved Rear Drive Axle Lubricants” annexed to this section. During initial stage of normal operation, tiny metal particles originating from moving parts can be found on mating surfaces. These particles are carried by the lubricant through the assembly and act as lapping compound, which accelerates wear of all parts. To ensure maximum life of the differential and prevent premature failure, the original "factory fill" lubricant should be drained. Change break-in oil before 3,000 miles (4 800 km) of initial operation (drain the unit while it is still warm from operation), in accordance with the lubrication and servicing schedule.

Change differential oil and clean the breathers, magnetic fill and drain plugs, every 100,000 miles (160 000 km) or once every two years, whichever comes first.

Use Multigrade gear oil MIL-L-2105-D. Use the 75W90-gear oil for northern climates and the 80W140 for southern climates. In extreme conditions, or for better performance, fill with synthetic gear oil. Check oil level and add (if necessary) every 6,250 miles (10 000 km) or twice a year, whichever comes first (Fig. 4).

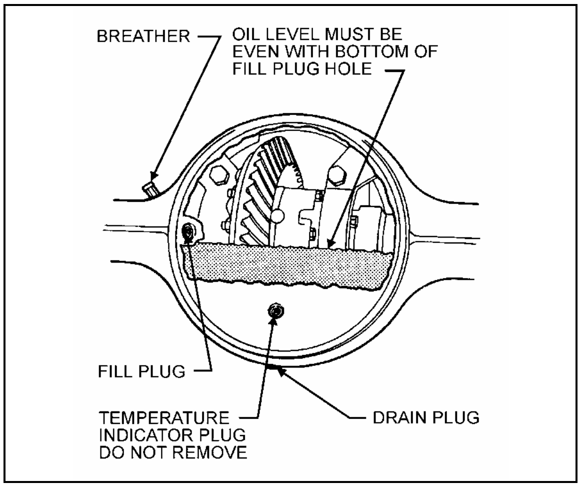


FIGURE 4: DIFFERENTIAL HOUSING BOWL 11007

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".*

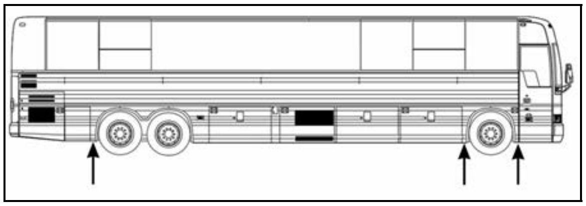


FIGURE 5: JACKING POINTS ON FRAME 11020

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).

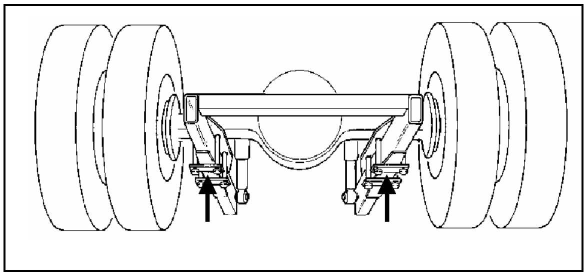


FIGURE 6: JACKING POINTS ON DRIVE AXLE H3B762

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 and drive axle wheels (fig. 7). Adjust front wheels according to paragraph: “Front End Alignment” in Section 16: Suspension.

NOTE
See reference numbers on wheel mount sensors (fig.7).

NOTE
Select axle specifications in the appropriate chart

DRIVE AXLE ALIGNMENT

o With the system installed as for front end alignment (fig.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

o 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 7. For example, the sensor from the right side of the front wheel is mounted on the right side of the tag axle. For corresponding wheel mount sensor reference numbers, refer to figure 7.

o 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

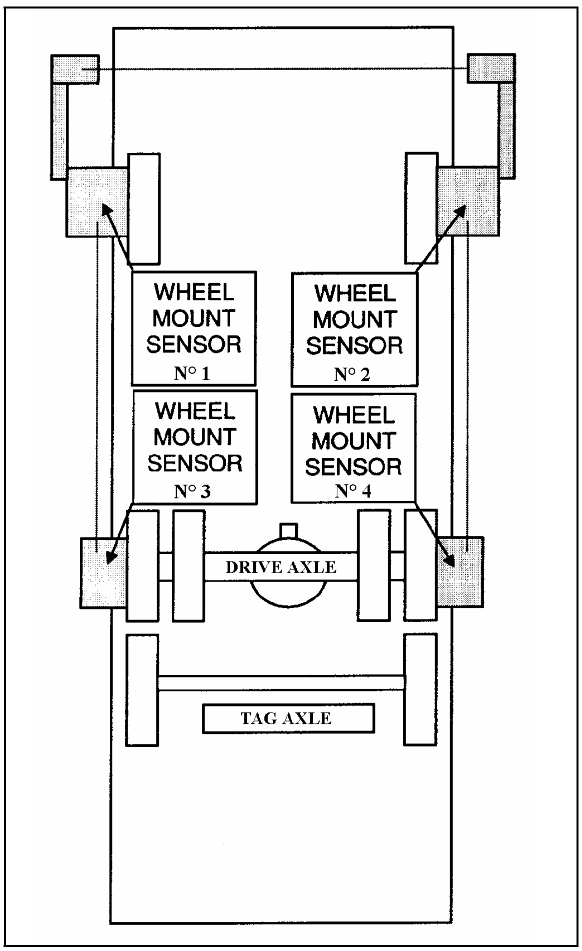


FIGURE 7: DRIVE AXLE ALIGNMENT 11025

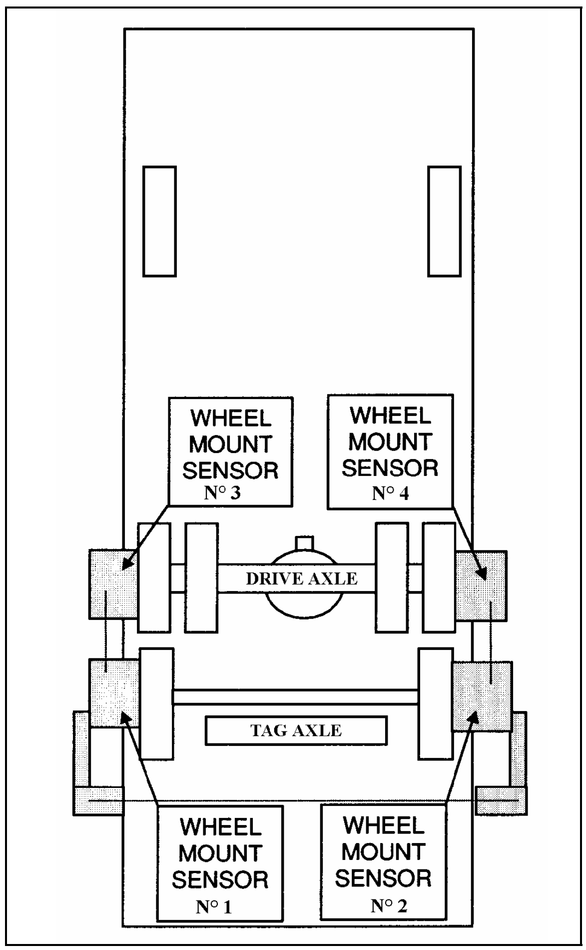


FIGURE 8: TAG AXLE ALIGNMENT 11026

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:

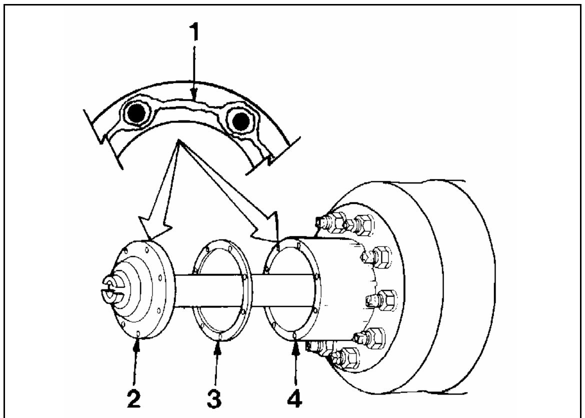


FIGURE 9: AXLE SHAFT INSTALLATION 11003

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, 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)

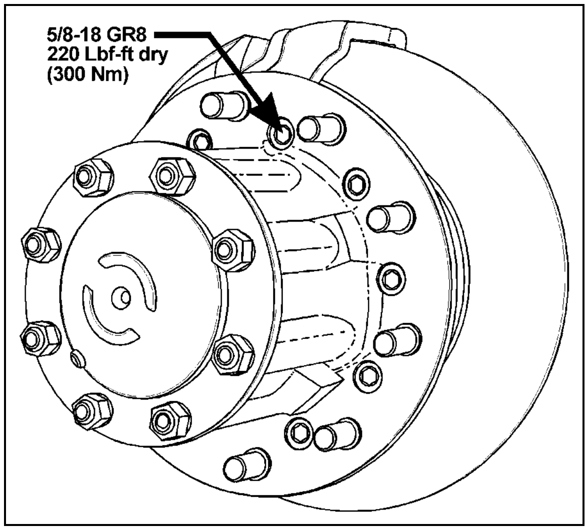


FIGURE 10: TORQUE SPECIFICATION 11030

2. TAG AXLE

The tag axle is located behind the drive axle. It carries a single wheel and tire on each side.

2.1 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 *"OWNER'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.

> **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 9mph (15 km/h).
>
> In order to prevent damage to the suspension, always raise the tag axle before lifting the coach.

The tag axle service brakes operate only when the axle is in normal driving (loaded) position.

2.2 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.

2.3 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 wheel hub bearings need to be checked every 30,000 miles (48 000 km).

> *NOTE*
>
> *For more information on front and tag axle wheel hubs, refer to "DANA SPICER Maintenance Manual Model NDS and Maintenance Manual NDS Axles" annexed at the end of this Section.*

2.4 REMOVAL AND INSTALLATION

2.4.1 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.

2.4.2 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 10).

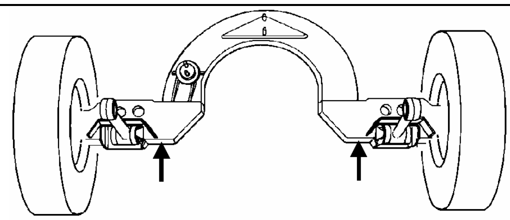


FIGURE 11: JACKING POINTS ON TAG AXLE 11023

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 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 instructions 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

4.88:1 Standard
4.56:1 Optional

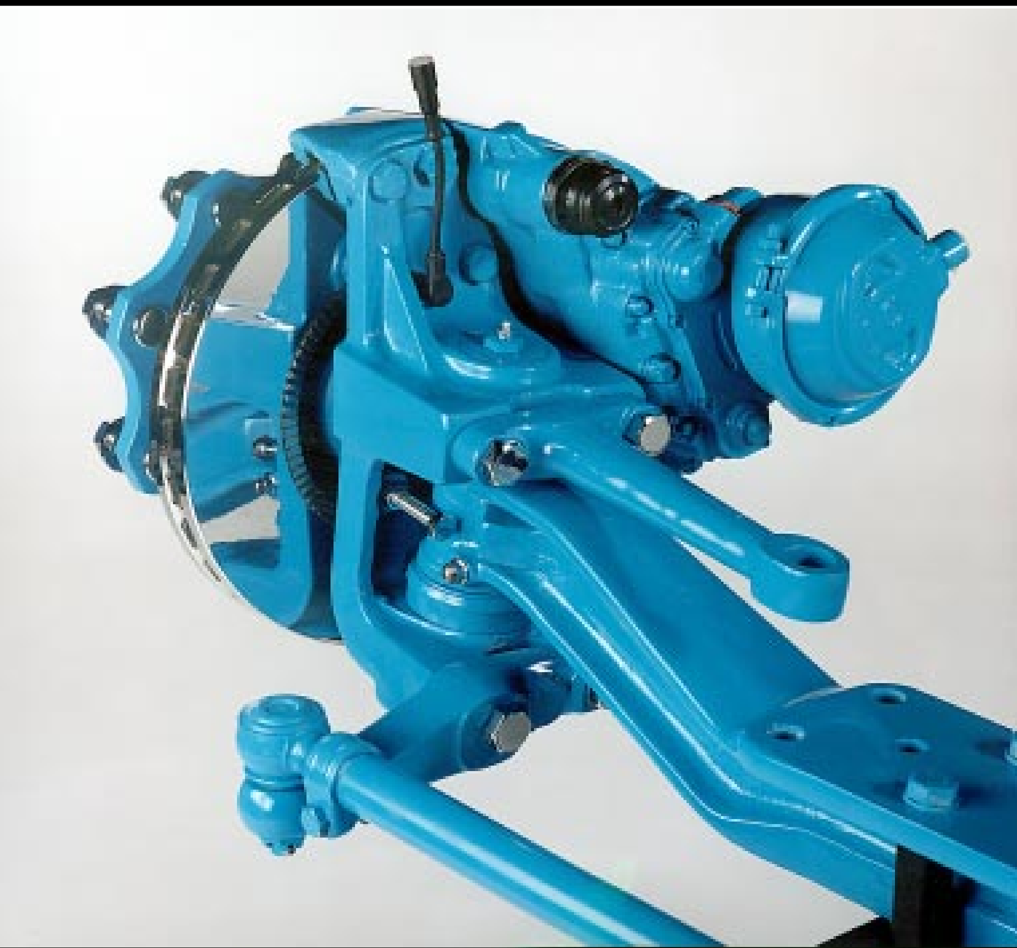
NOTE
The drive axle alignment consists in aligning the axle with reference to the frame. The axle must be perpendicular to the frame.

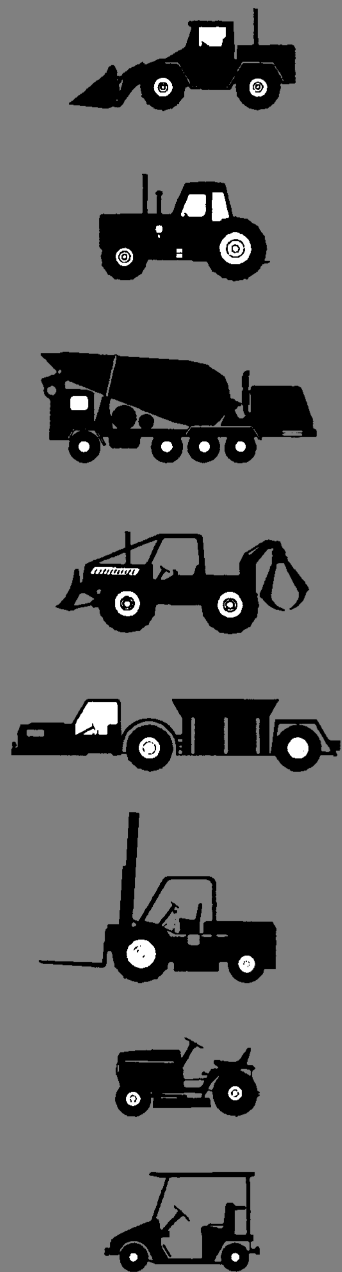
Tag Axle

Make .... Prévost
Rear track .... 83.6 inches (2 124 mm)
Axle type .... Dana Spicer Europe TS8U Hub Unit

NOTE
The tag axle alignment consists in aligning the tag axle parallel to the drive axle.

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.

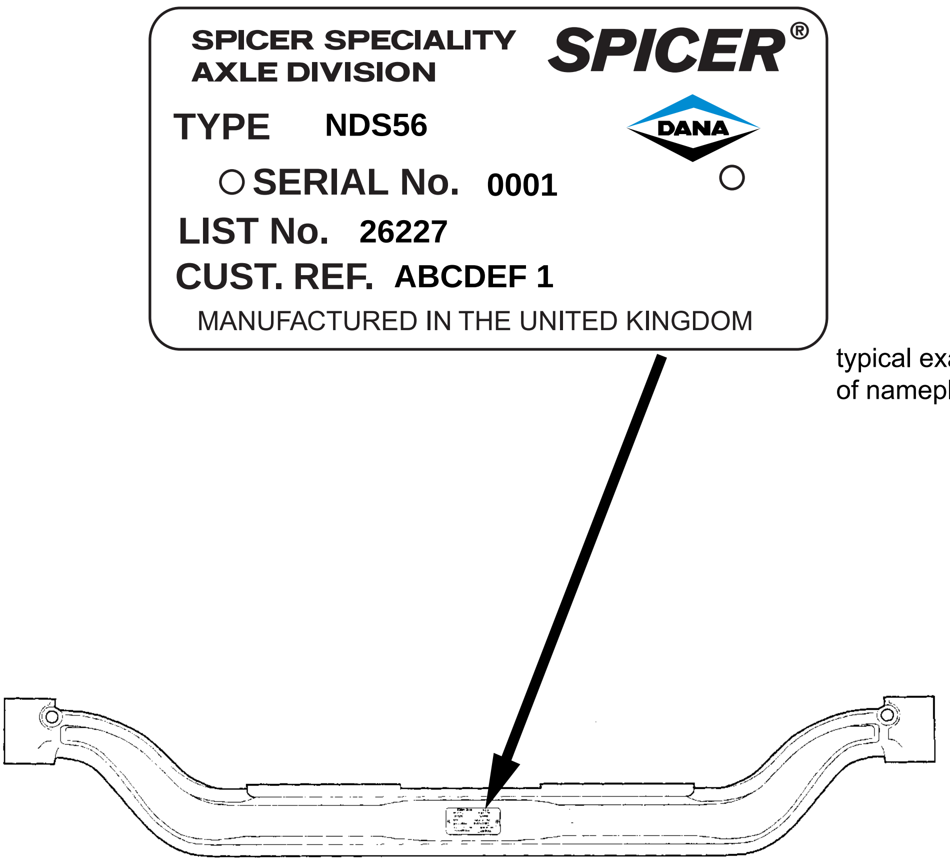
The items included in the spare parts section of this manual are currently available as service spare parts at the time of printing.
The part numbers and illustrations are provided specifically as a guide only.

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:-



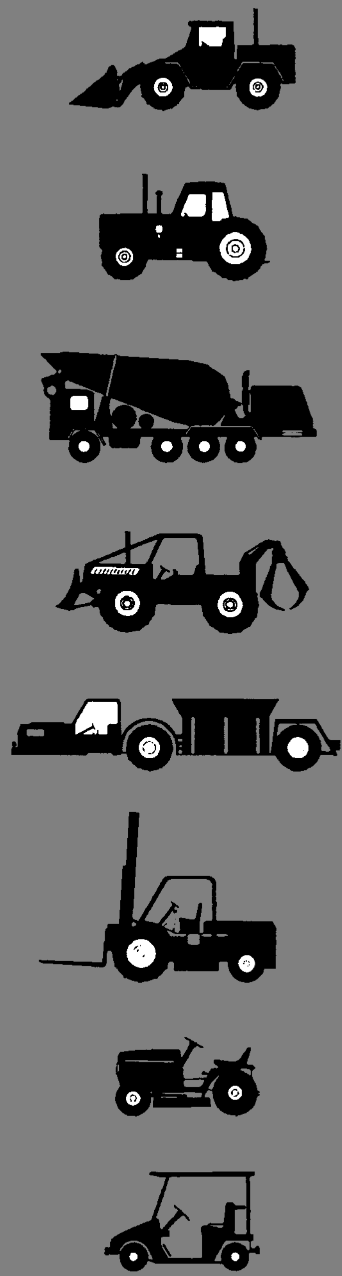
typical example of nameplate

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

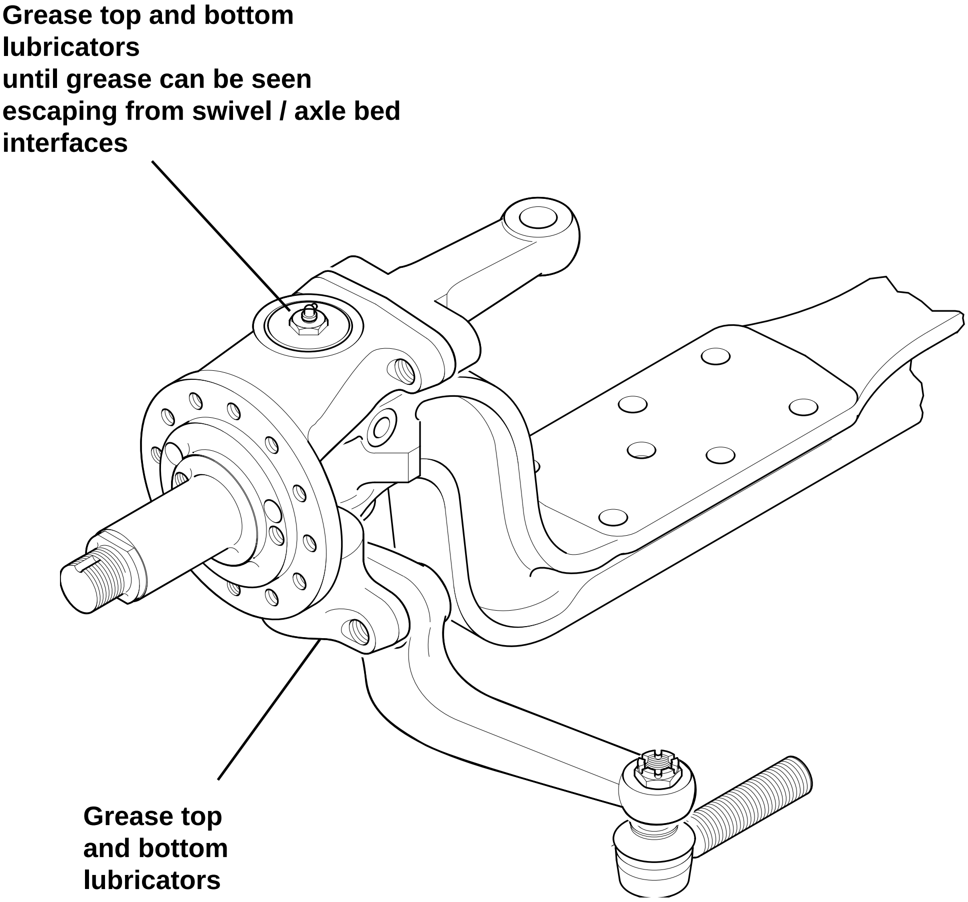
Page No.	Issue	Description / Alteration	Reason	Date
All	A	New Manual		Nov. 99
5	B	Mileage interval altered	Updated spec.	Mar.2000
9	B	Mileage interval altered	Updated spec.	Mar.2000
13	B	Tie rod torques added	New tie rod	Mar.2000
14	B	Tie rod torques added	New tie rod	Mar.2000
15	B	Air cylinder torques 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

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

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.

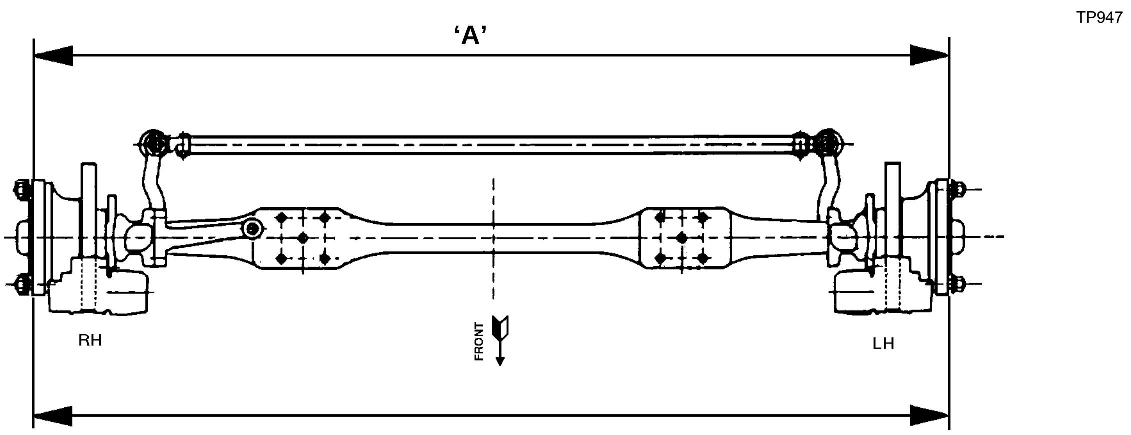
To check front wheel ' Toe In '

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.

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).

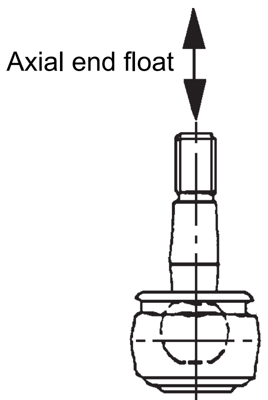


Fig. No. 3

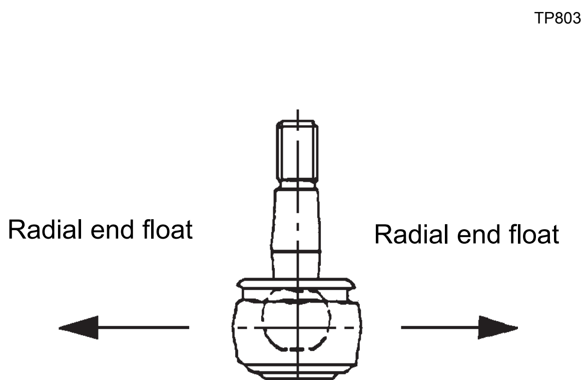


Fig. No. 4

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.

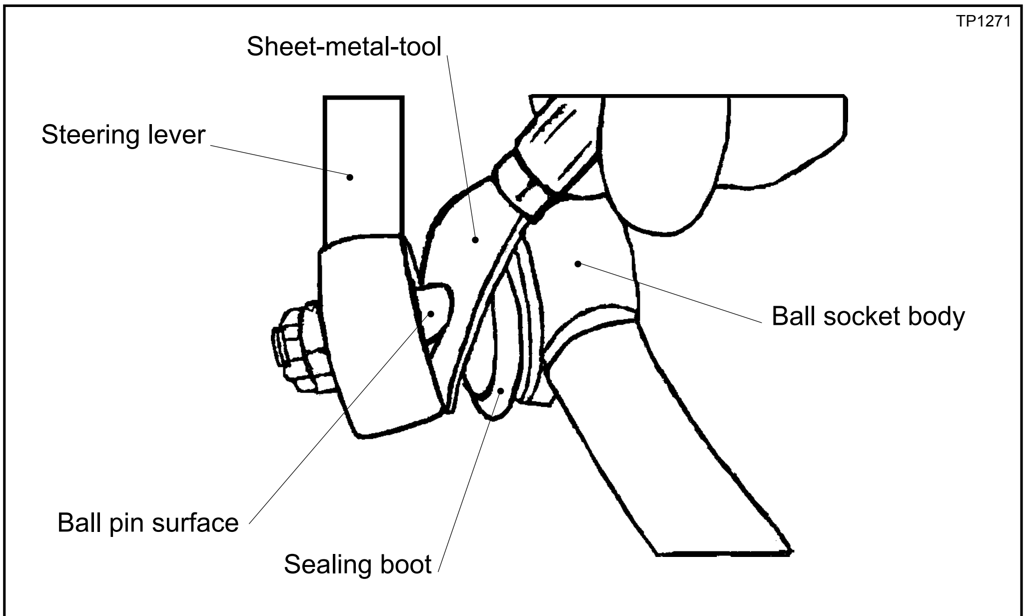


Fig. No. 5

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.

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.

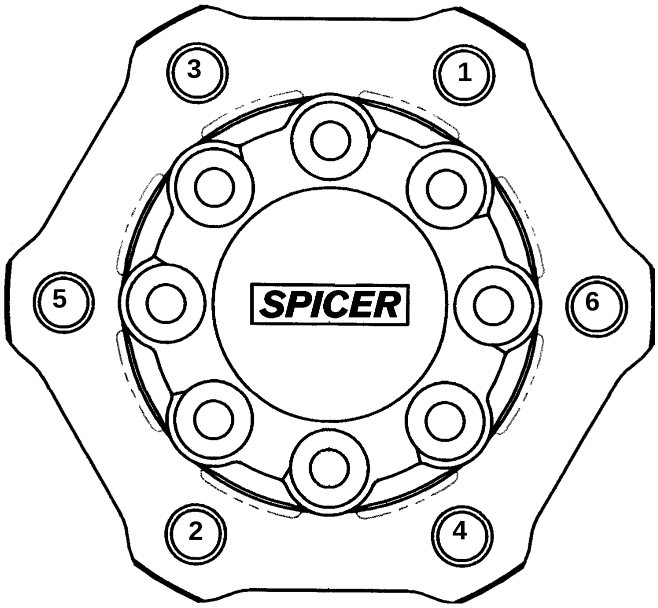
NOTE :-
FURTHER DETAILS ARE GIVEN IN BRITISH STANDARD CODE OF PRACTICE FOR THE SELECTION AND CARE OF TYRES AND WHEELS FOR COMMERCIAL VEHICLES:- BSAU50 : PART2 : SECTION 7A : 1995

3.2 PROTECTION OF SPIGOT WHEEL FIXING DIAMETERS AND PRESSURE SURFACES.

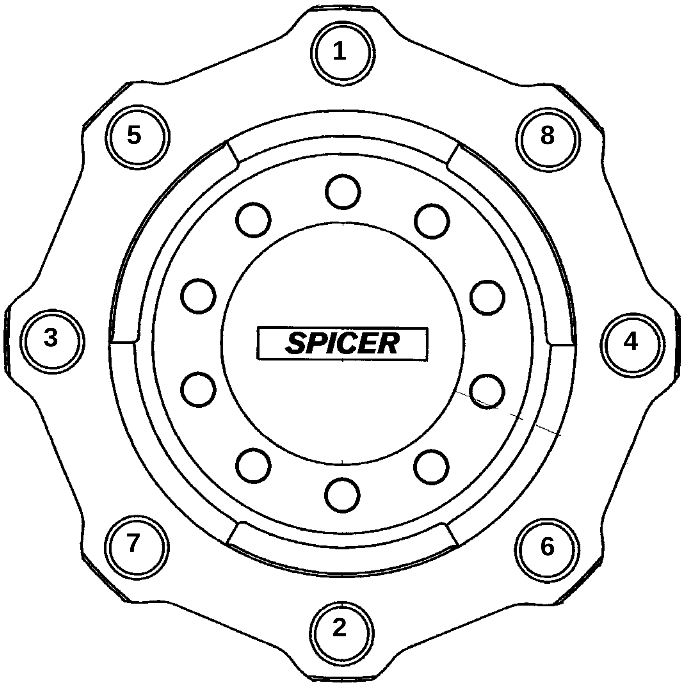
Although **Spicer Speciality Axles Division** apply an initial surface coating to wheel rim mating faces on spigot to stop rusting and facilitate easy removal of wheels. The application of P.B.C. grease such as 'Rocol Tufgear' or equivalent to wheel register is recommended.

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.

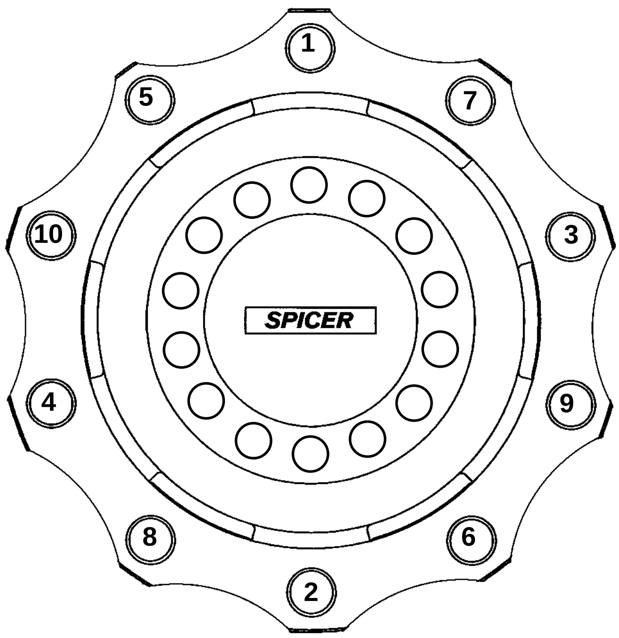
WHEELNUT TIGHTENING
TORQUE SEQUENCE
6 - STUD FIXING



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

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.**

TP1627

Fig. 9

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

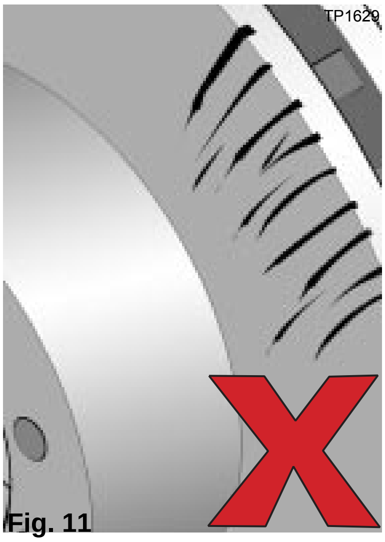


Fig. 11

If any **Through** cracks are found in the brake disc as shown in fig. 12. then the disc **must be replaced.**.

TP1630

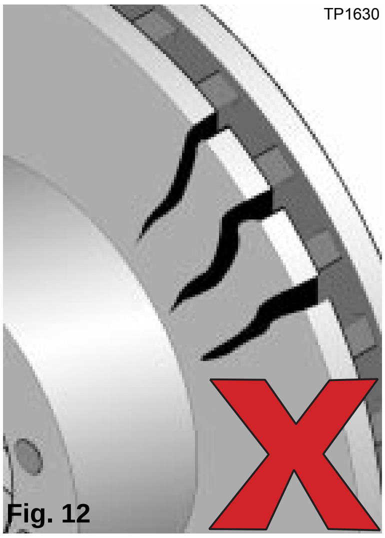


Fig. 12

EVALUATION OF BRAKE DISC SURFACE CONTINUED

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.

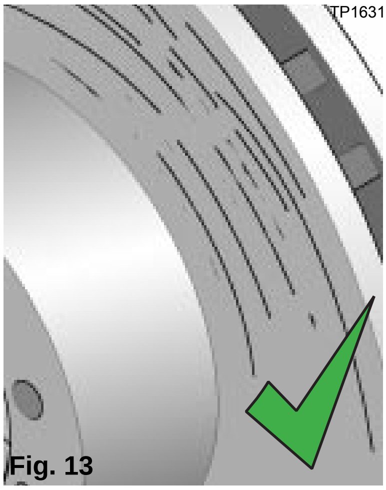


Fig. 13

If **Heavy** grooving is found as shown in Fig. 14 then the disc must be replaced.

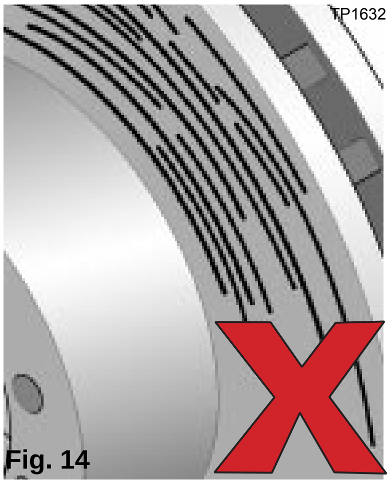


Fig. 14

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. 15

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.

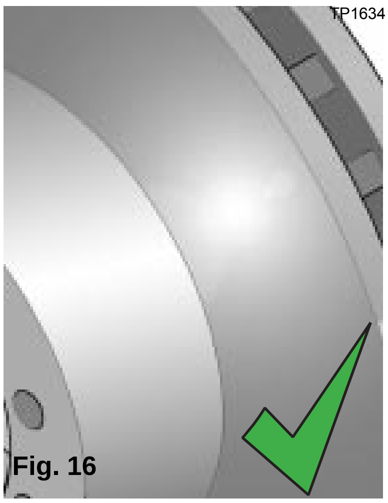
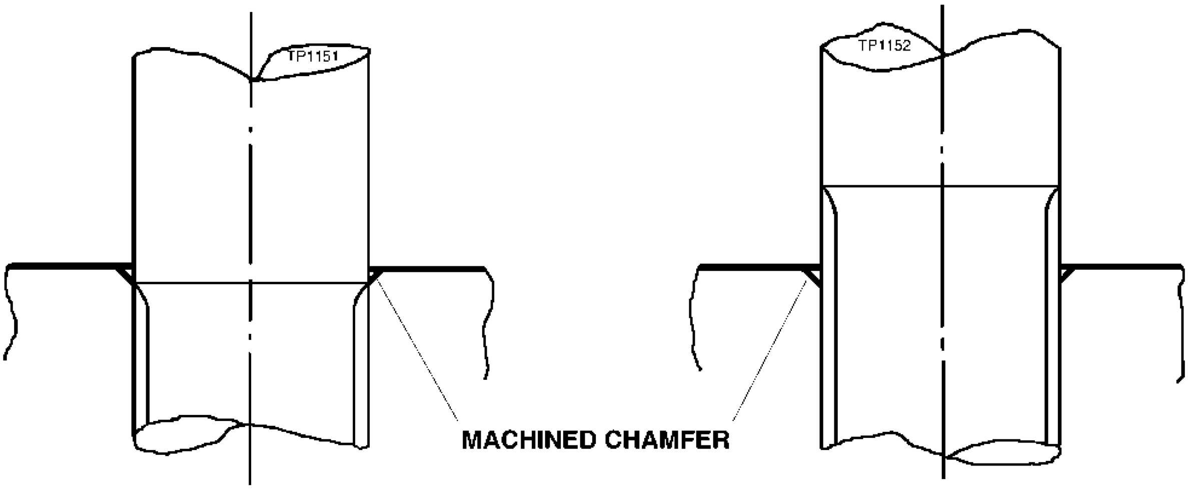


Fig. 16

SPICER SPECIALITY AXLE DIVISION

STANDARD STUDS - FITTED INTO MACHINED CHAMFERED HOLES

STUDS TO BE INSERTED UNTIL THREAD RUN-OUT LOCKS INTO PARENT METAL

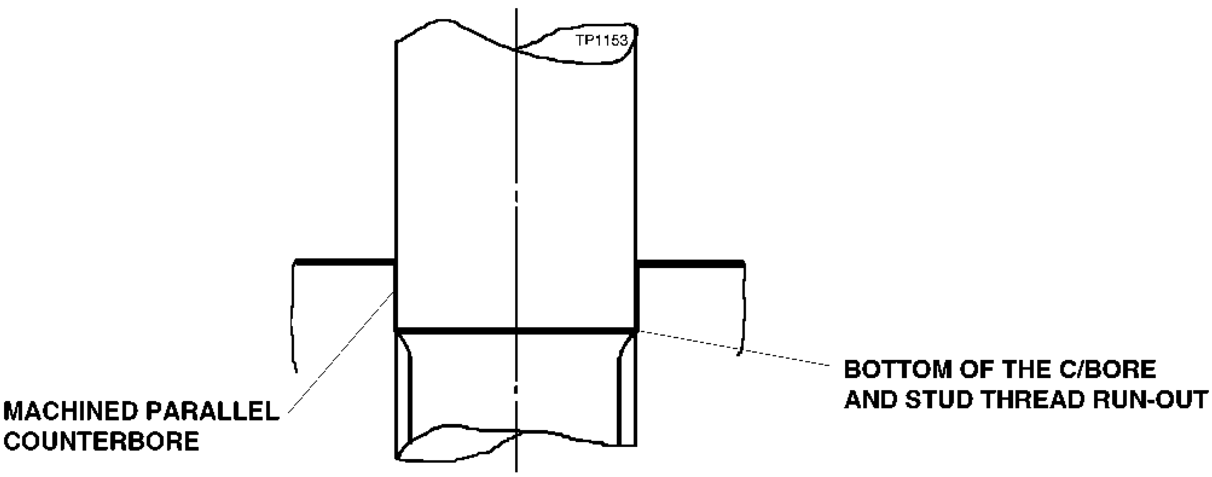


CORRECT INCORRECT

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

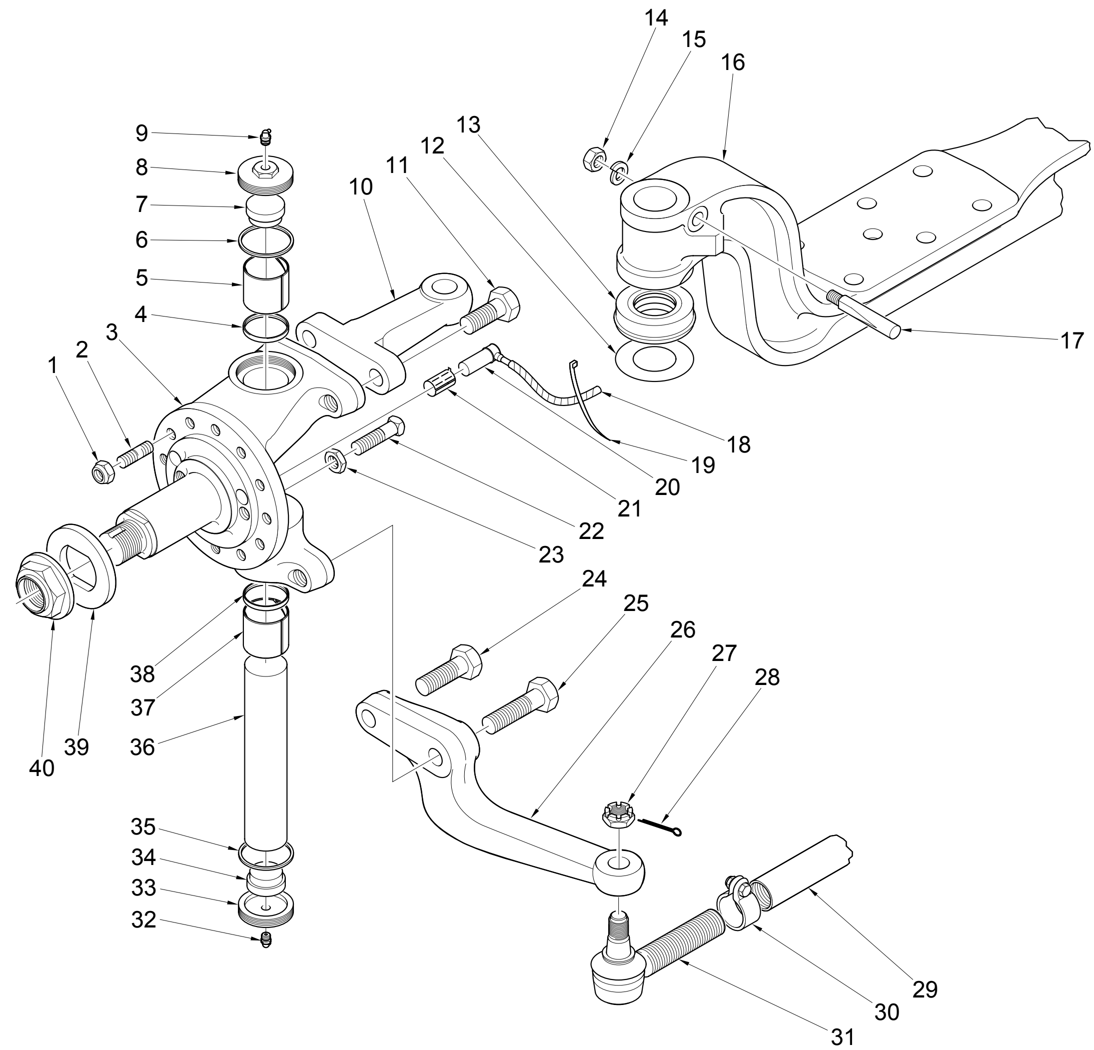


Fig.No.17

PART Nº	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

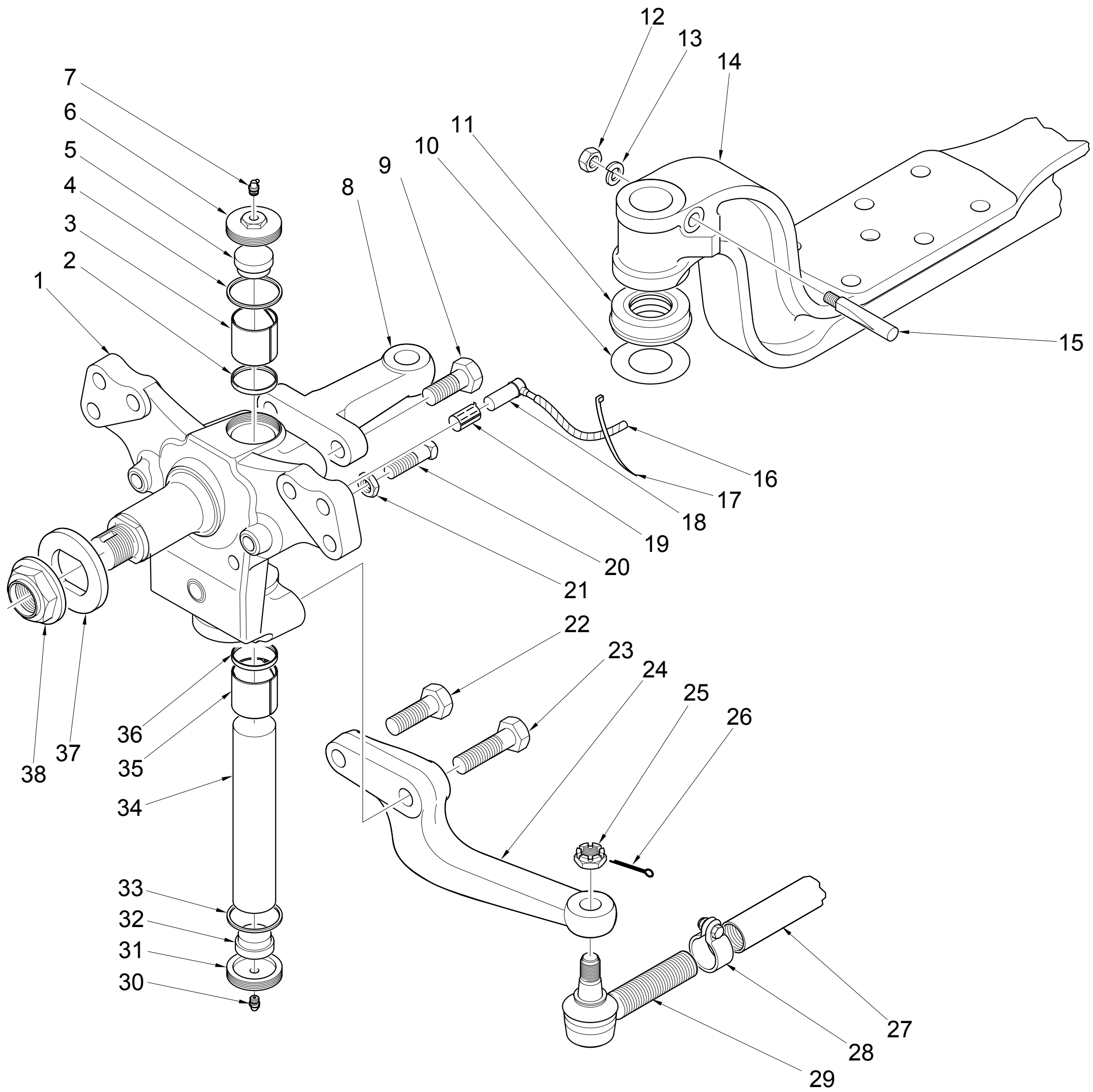


Fig.No.18

PART Nº	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

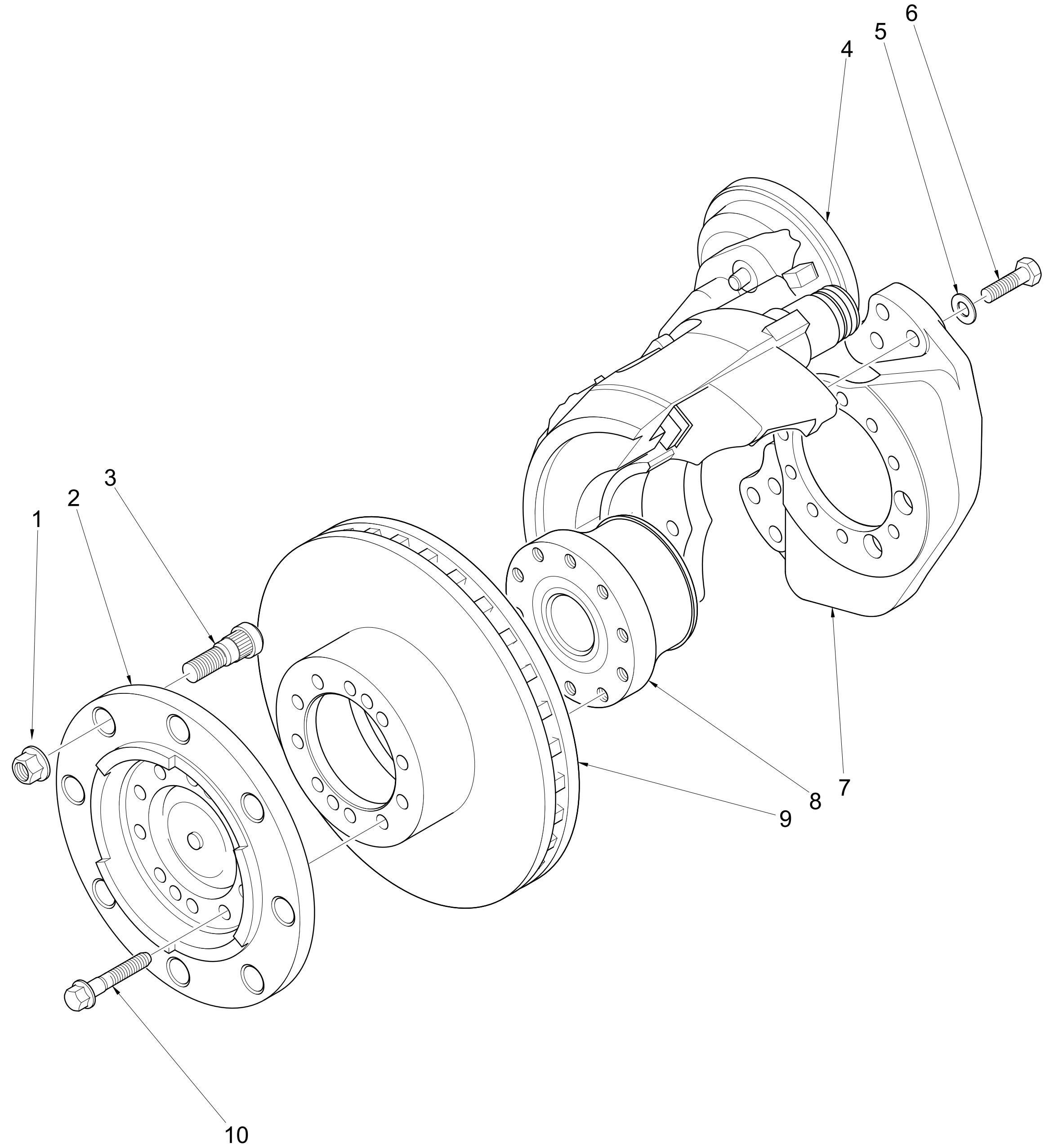


Fig.No.19

PART Nº	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

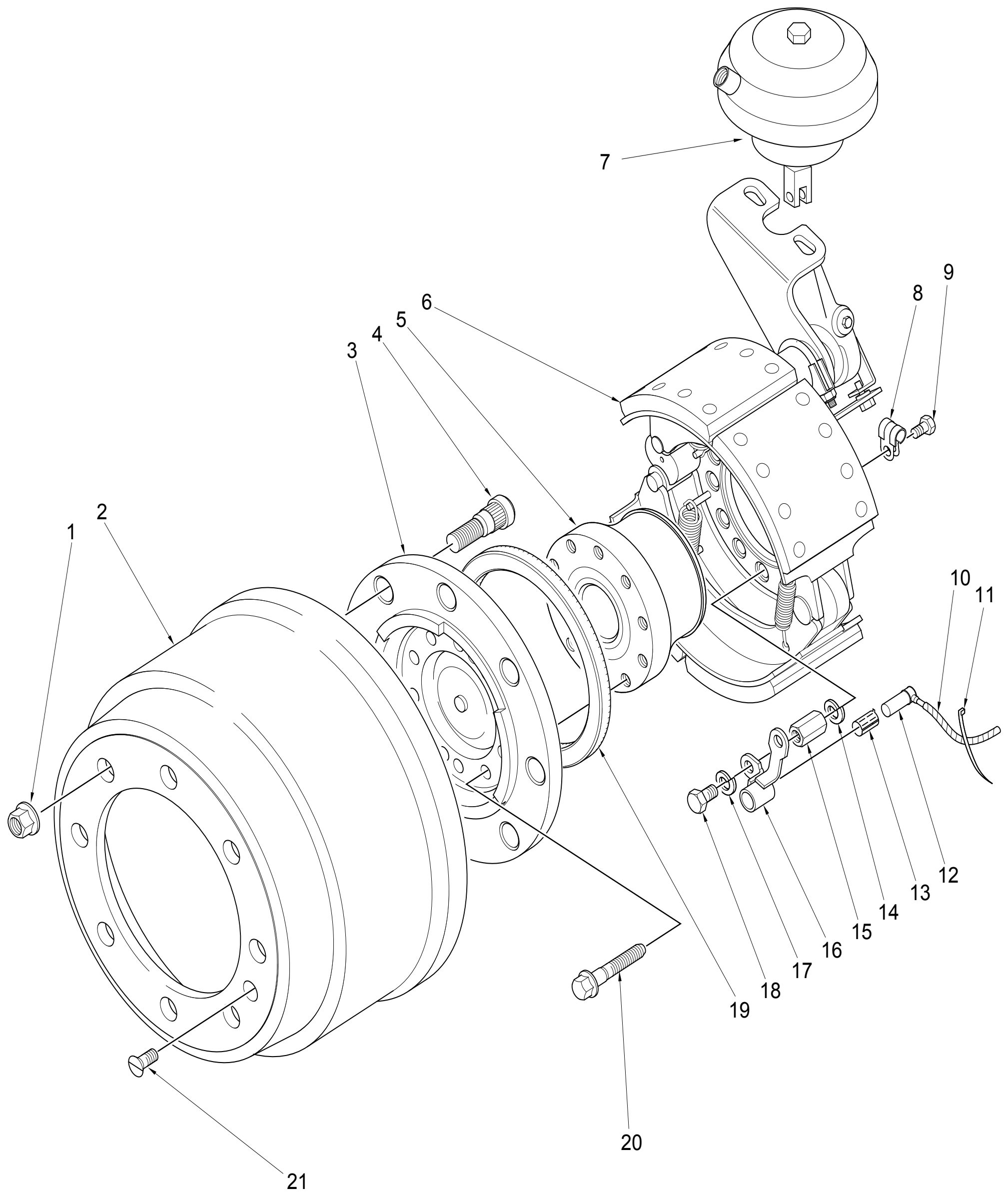


Fig.No.20

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

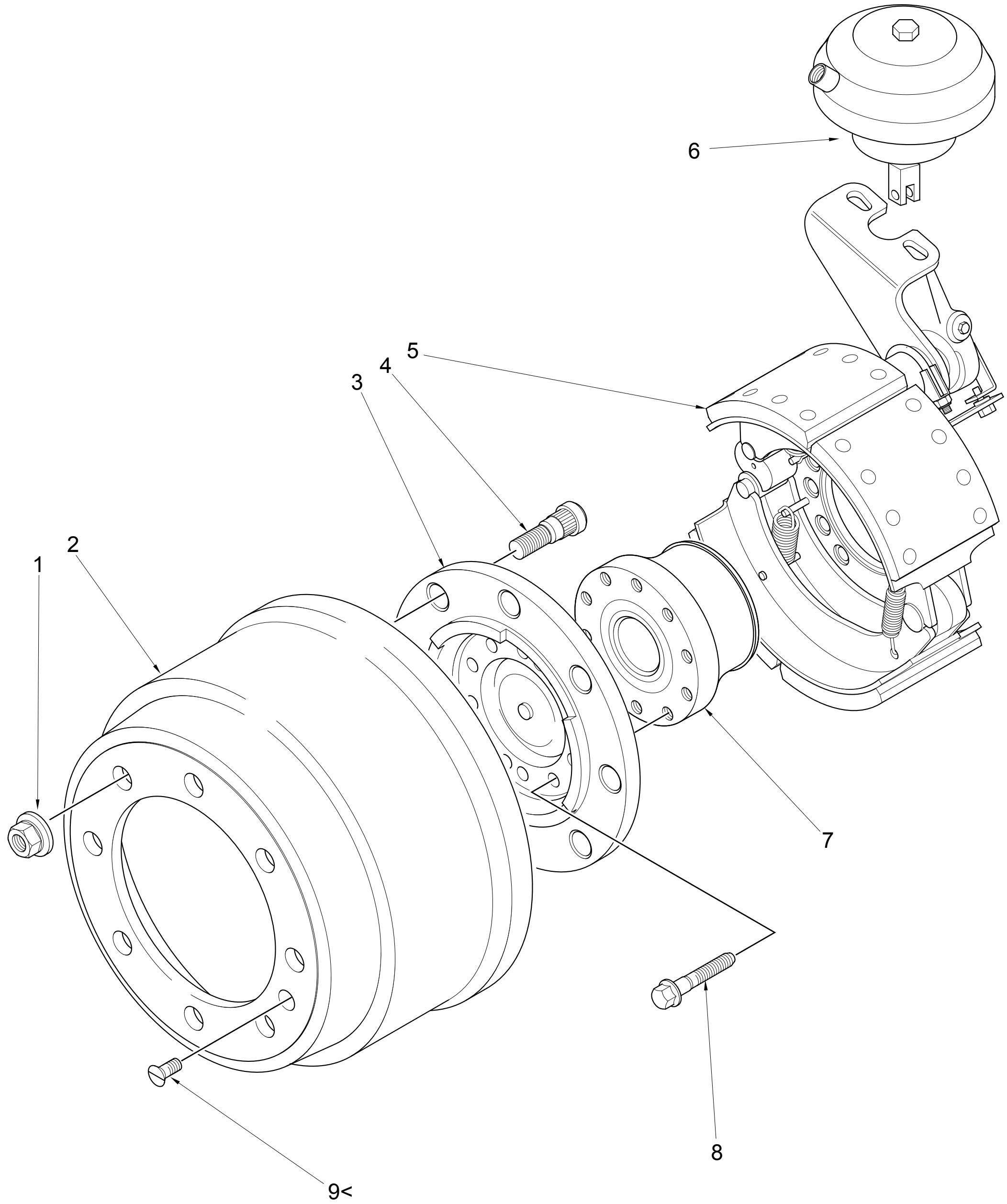


Fig.No.21

PART N°	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

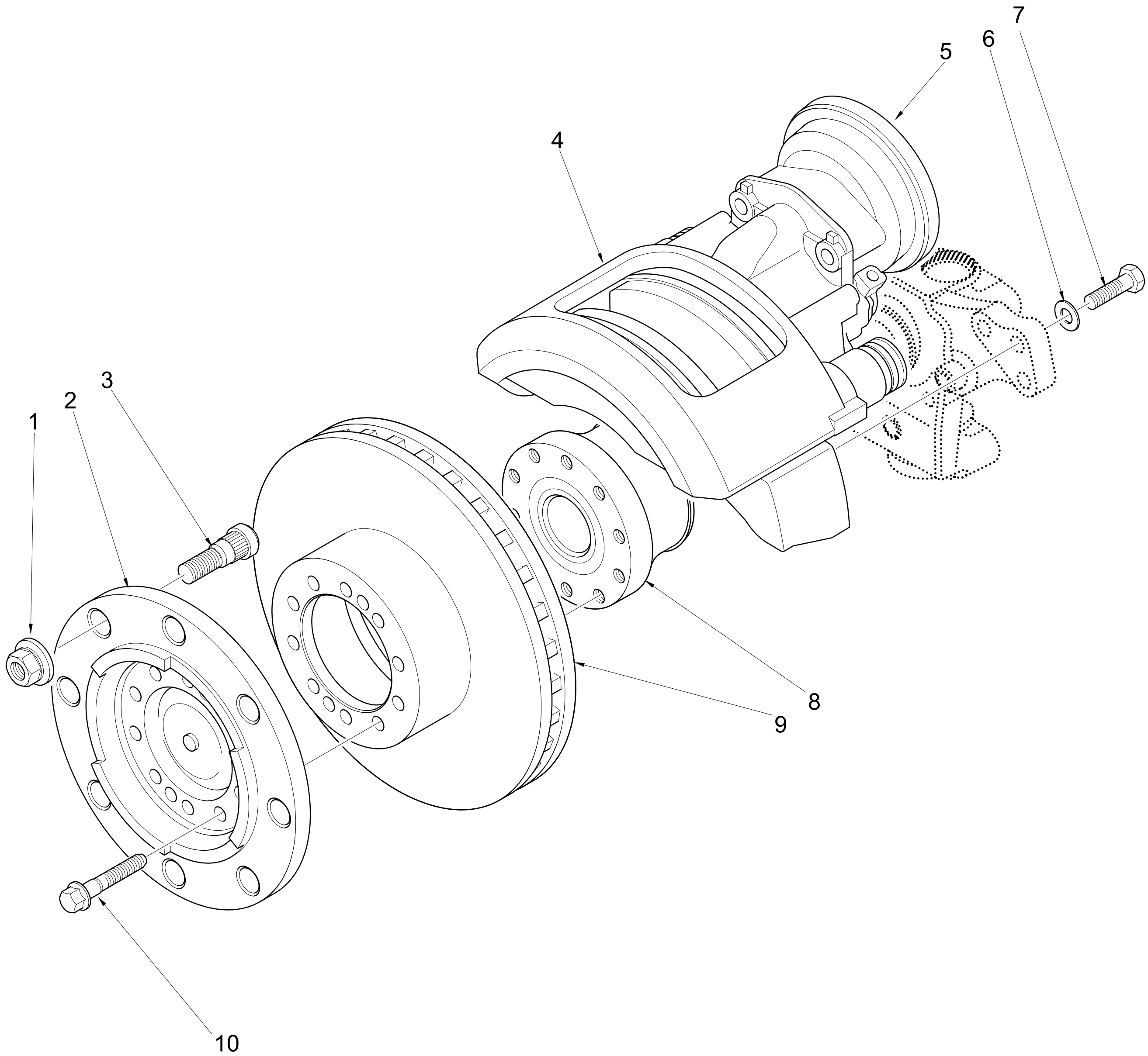


Fig.No.22

PART N°	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

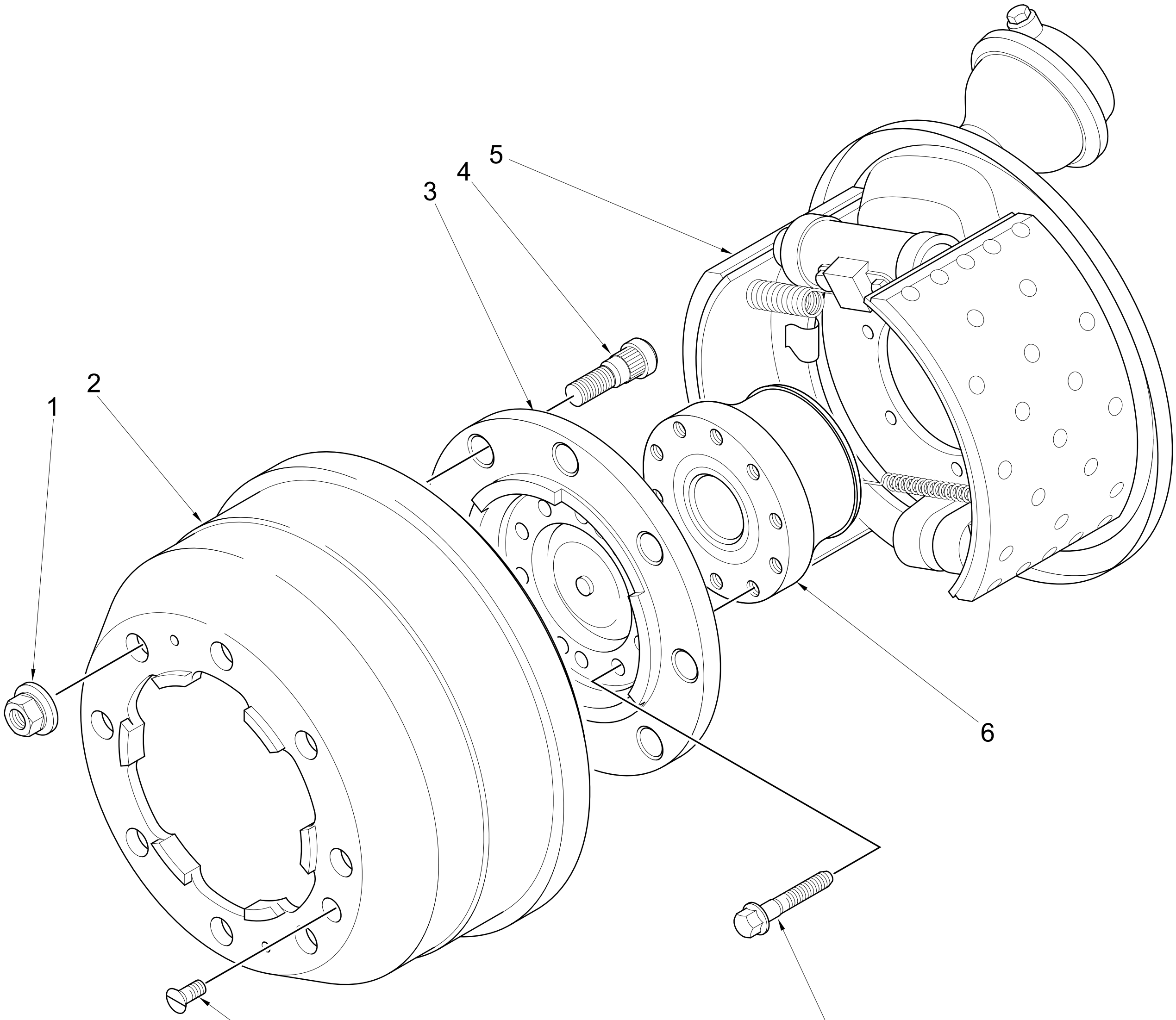


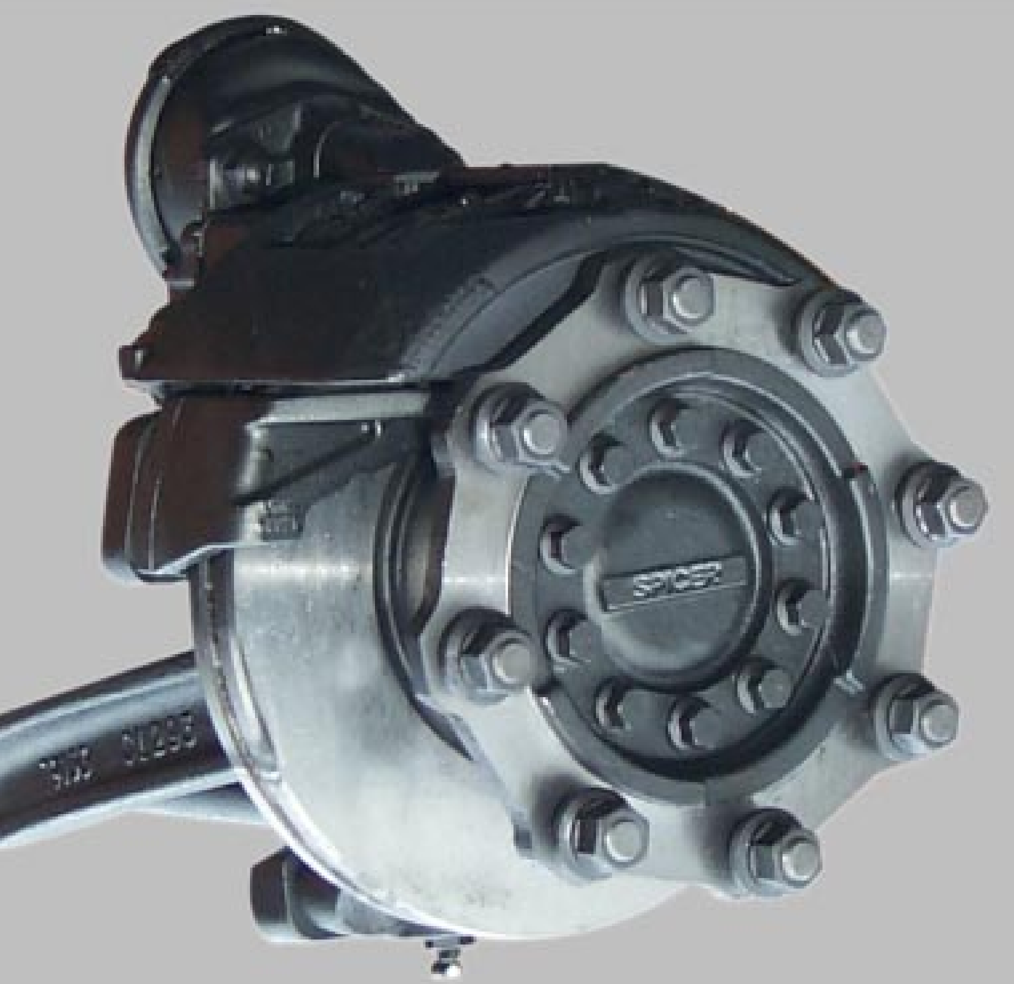
Fig.No.23

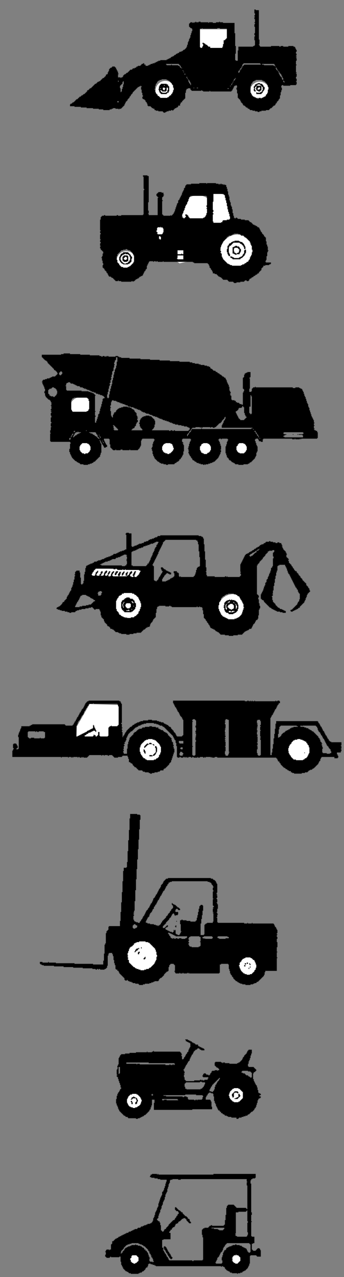
PART N°	DESCRIPTION	TIGHTENING TORQUE	
1	Wheel nut M18 x 1.5	235 - 260 lbs.ft	318 - 352NM
	Wheel nut M20 x 1.5	285 - 315 lbs.ft	386 - 427NM
	Wheel nut M22 x 1.5	475 - 525 lbs.ft	644 - 712NM
7	Hub flange retaining bolt M14 x 1.5	174 - 192 lbs.ft	236 - 260NM
8	Brake drum retaining screw	26 - 32 lbs.ft	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.

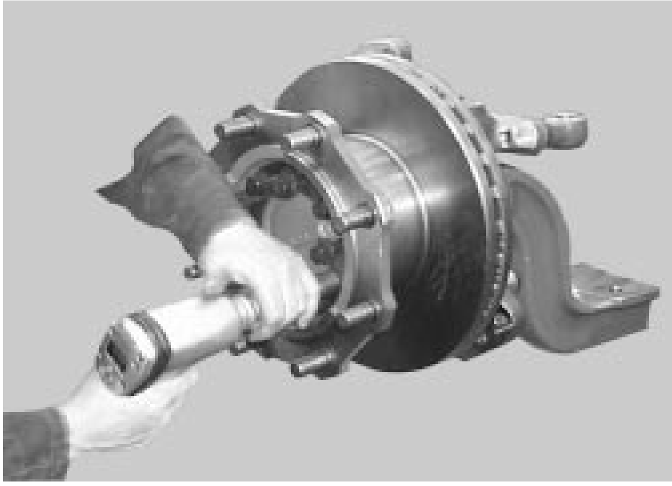
NOTE:-
BRAKE CALIPERS ARE HANDED!
SPICER SPECIALITY AXLE DIVISION RECOMMENDS MARKING CALIPERS WITH PAINT OR MARKER PEN TO FACILITATE CORRECT REFITTING

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

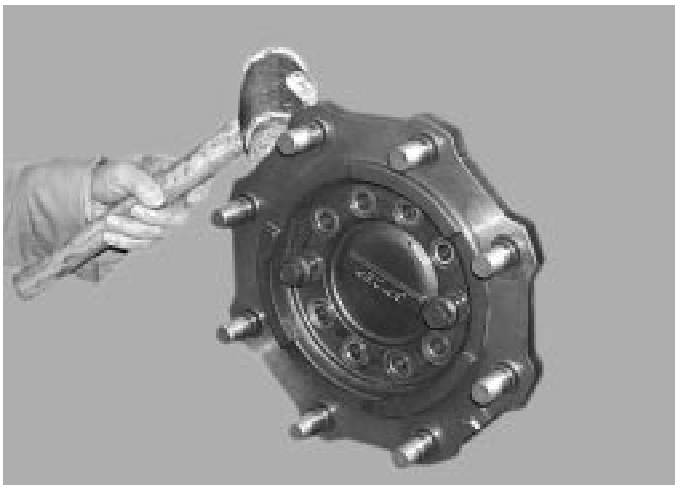


5. Loosen but do not remove hub flange bolts.

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

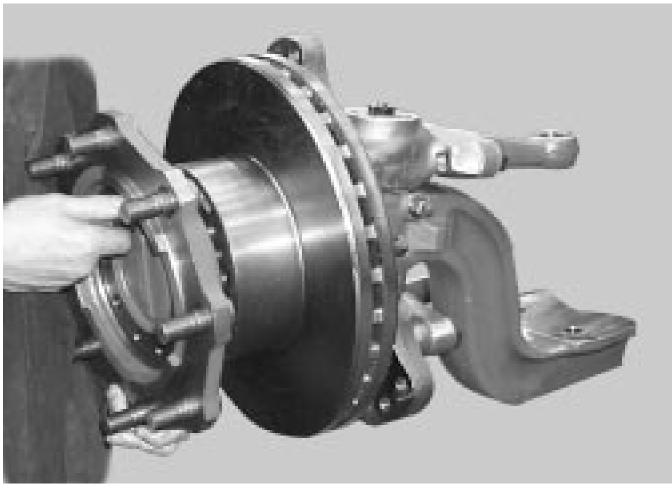


8. Gently tap hub flange outwards using a hide faced hammer.

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

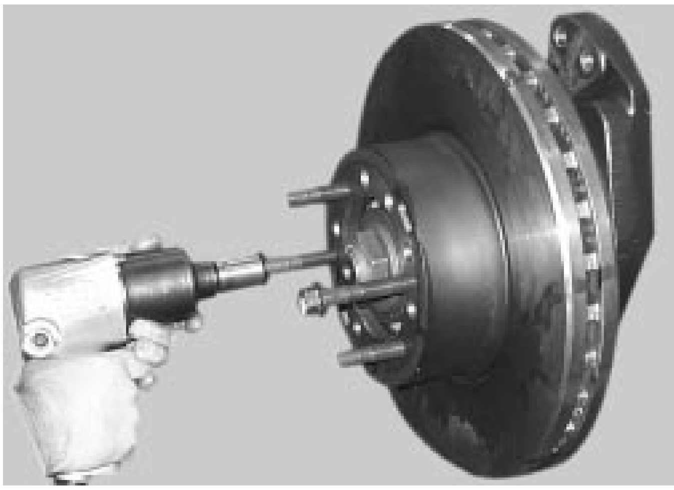
13. Tighten to free brake disc from hub bearing.

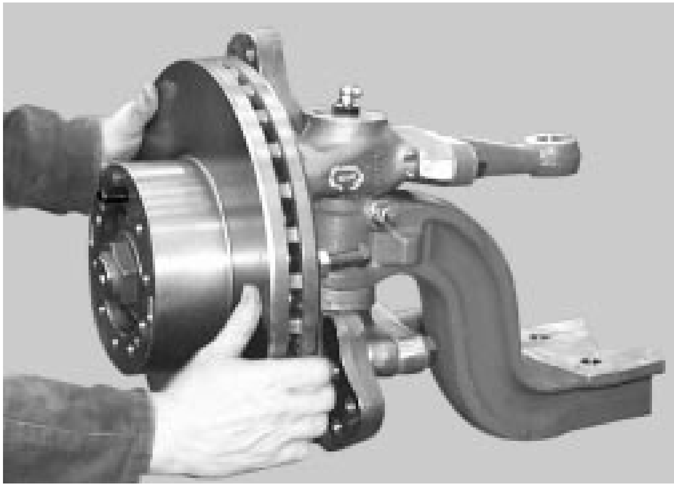
14. Support weight of brake disc and carefully slide along dummy studs to remove.

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!

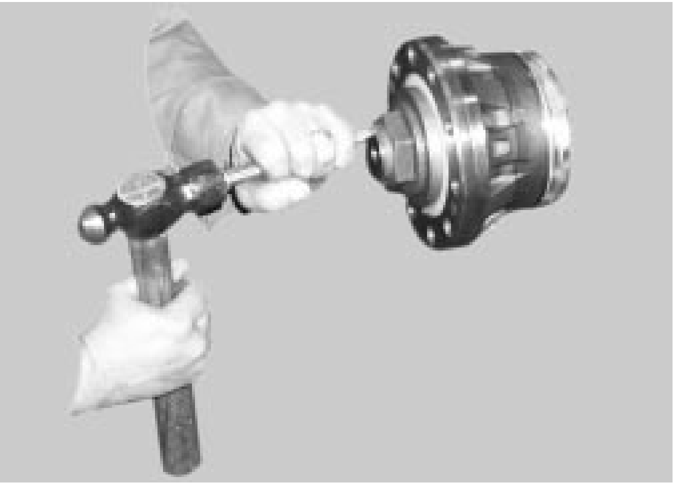




Brake disc type	Original thickness	Minimum thickness
SB5000	34MM	28MM
SB6000	45MM	37MM
SB7000	45MM	37MM

OVERHAUL PROCEDURES

HUB END DISASSEMBLY



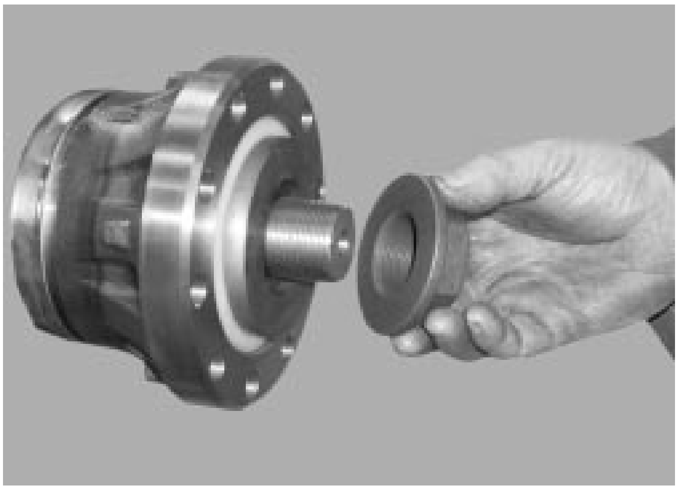
16. Using a small ended chisel, pry off the "staking" on the hub nut.

17. Remove hub nut and discard.

18. Remove bearing thrust washer.

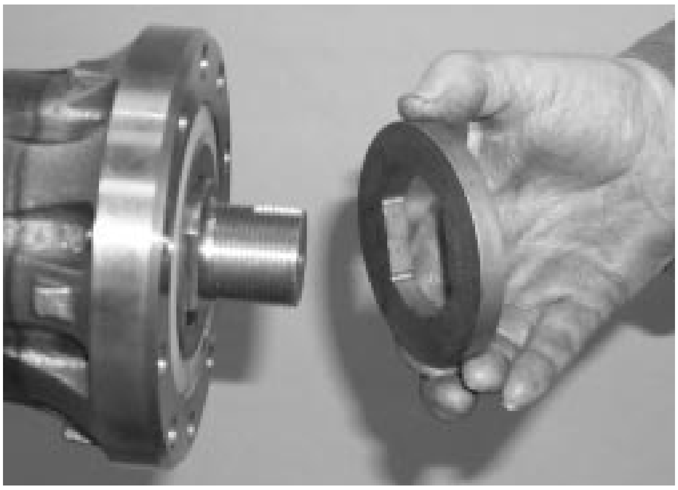
19. Fit bearing guide sleeve onto swivel thread. (See chart at front of swivel assembly)

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.

OVERHAUL PROCEDURES

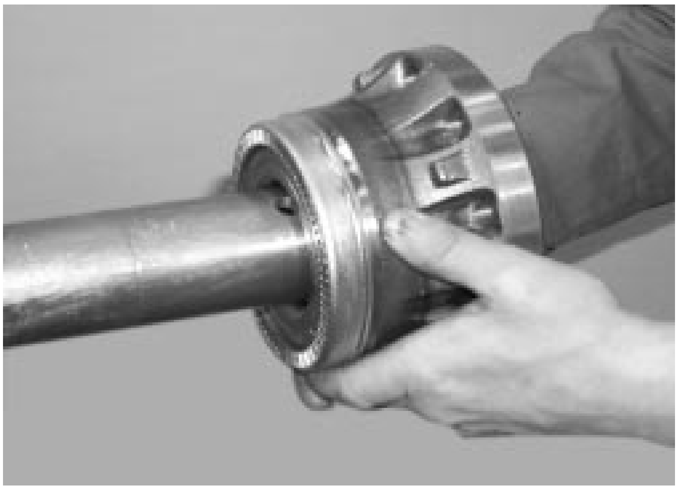
HUB END REASSEMBLY

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

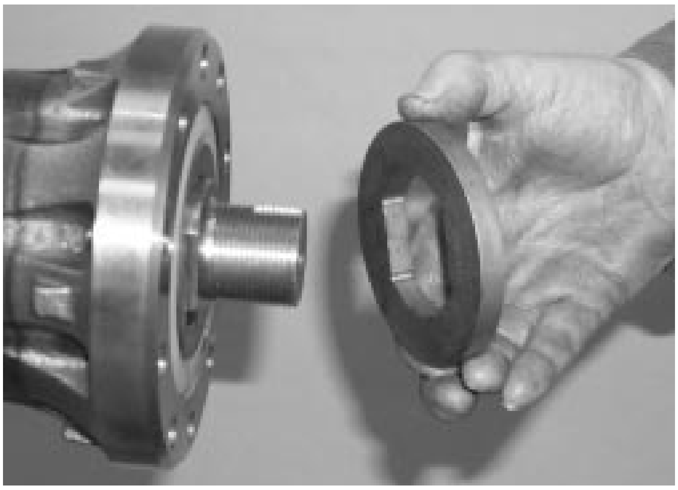
HUB END REASSEMBLY CONTINUED

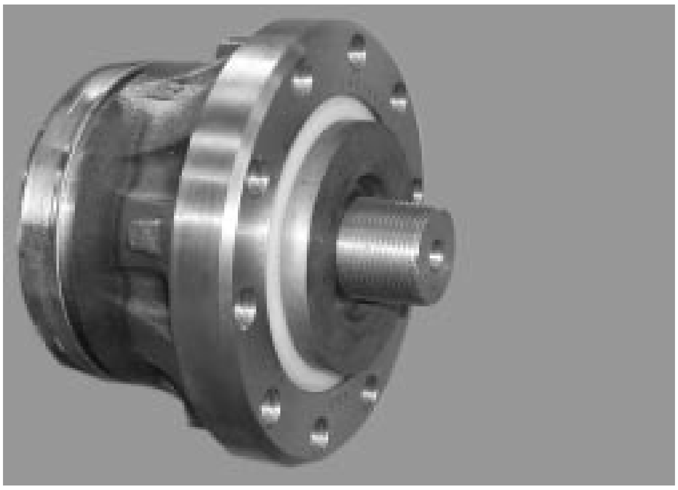
5. Place unitised hub bearing thrust washer onto axle stub.

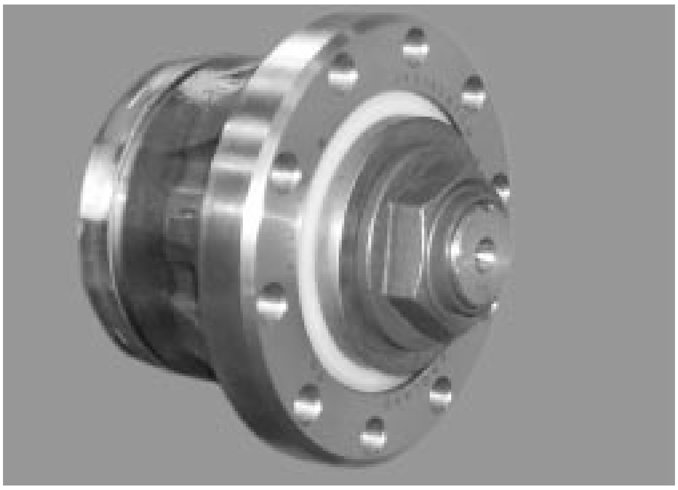
6. Fit hub nut.

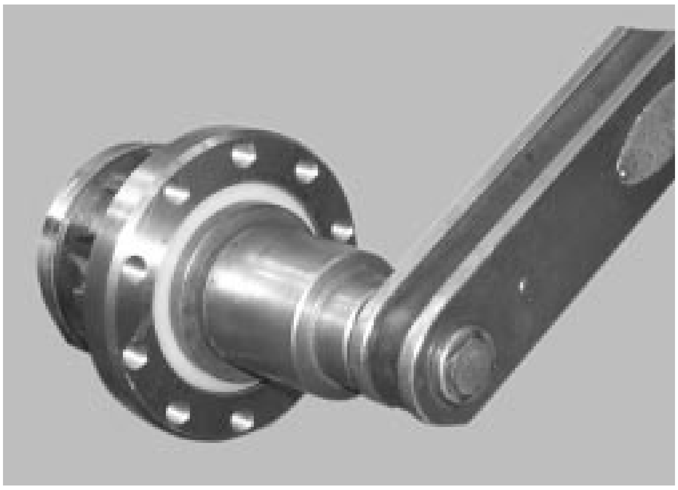
7. Tighten to specified torque.

NOTE:-
ROTATE UNITISED HUB BEARING WHILST TIGHTENING.



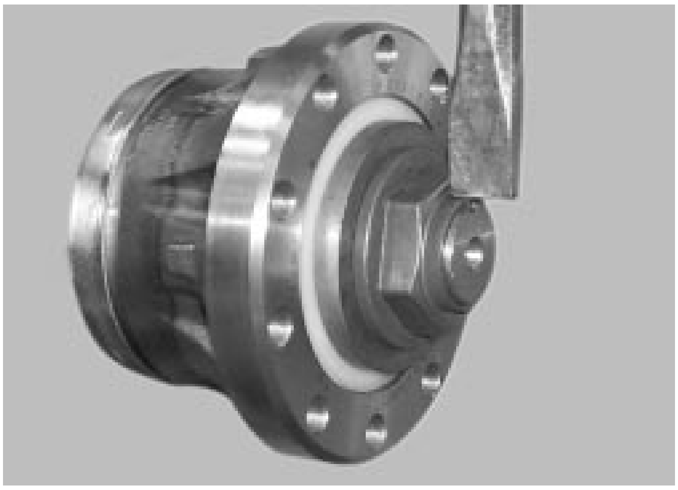






OVERHAUL PROCEDURES

HUB END REASSEMBLY CONTINUED

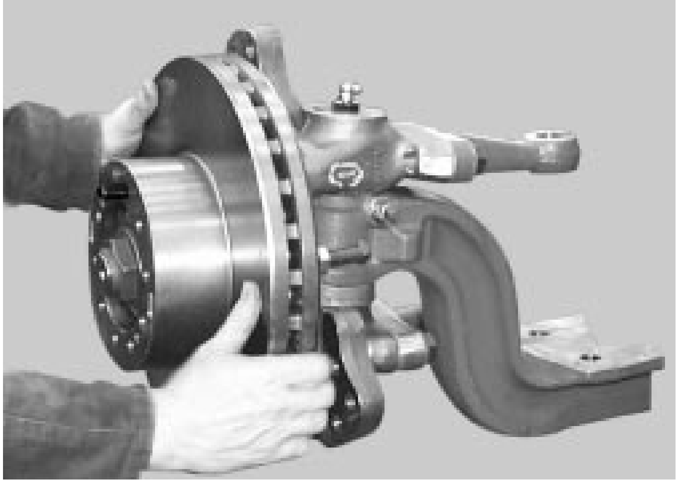


8. Stake the hub nut by deforming with a round nosed chisel.

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.)

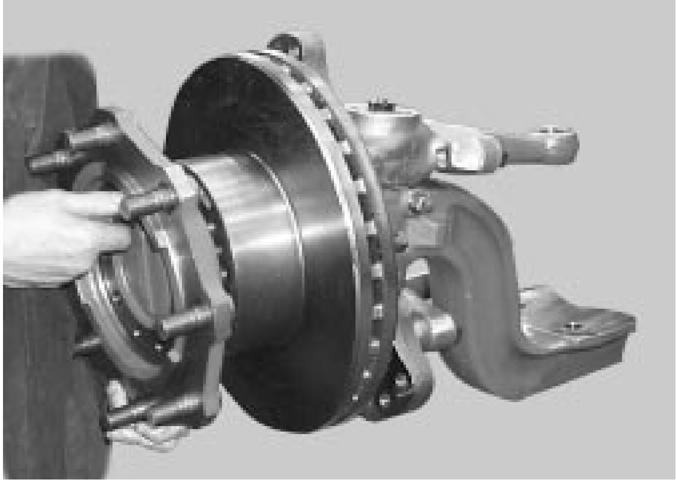
11. Remove the modified hub flange bolt at this point.



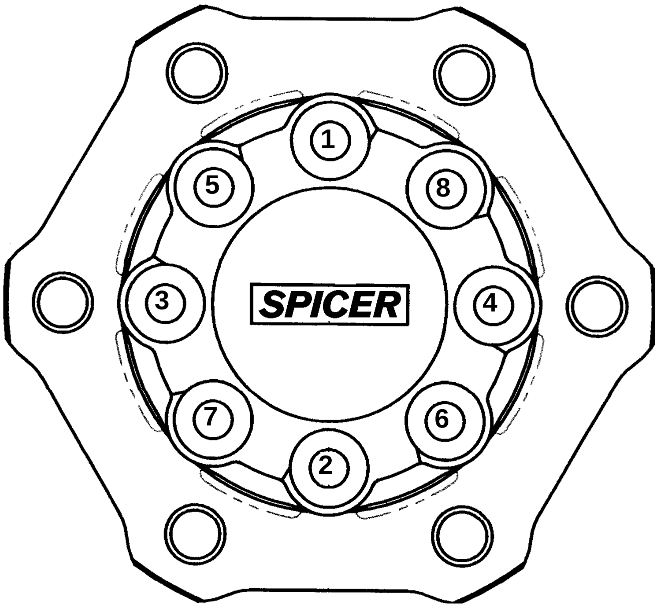
12. Carefully offer hub flange up to
brake disc / unitised hub bearing assembly and hold in position by inserting 1 - off hub flange bolt and tightening hand tight.

13. Insert remainder of hub flange bolts.

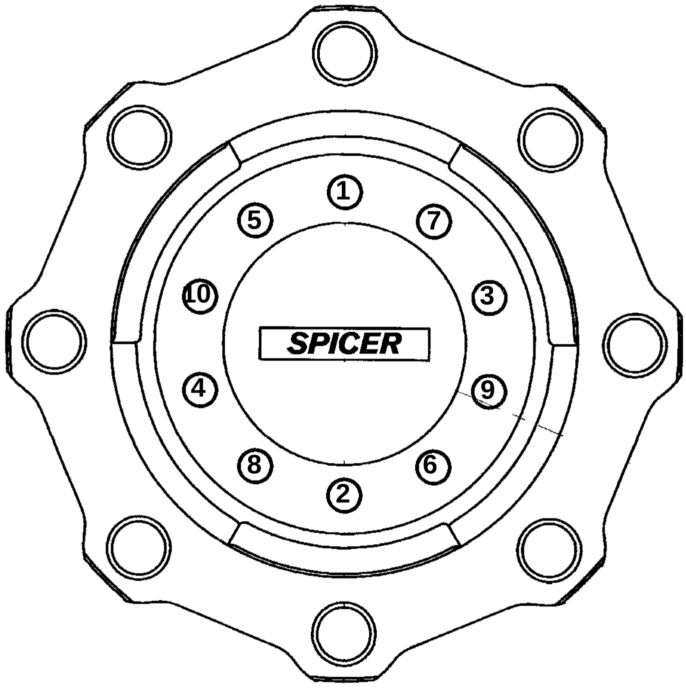
14. Tighten to correct torque using selection procedure as shown on following page.



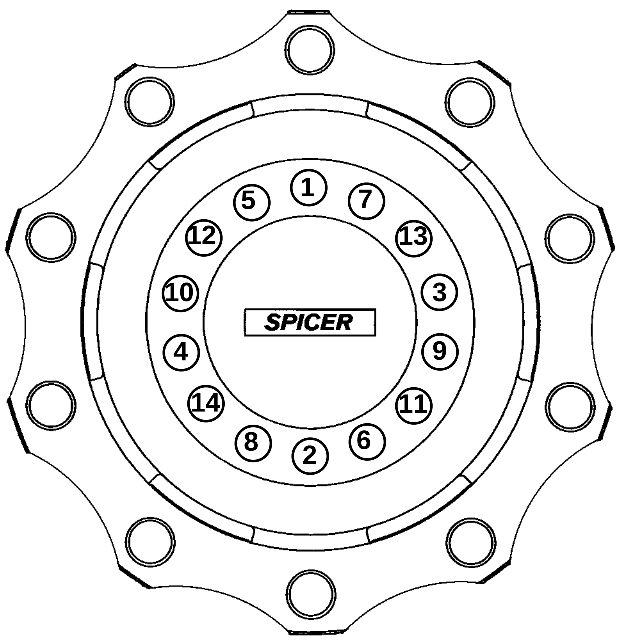
HUB FLANGE BOLT
TIGHTENING TORQUE SEQUENCE
FOR 8 BOLT FIXING



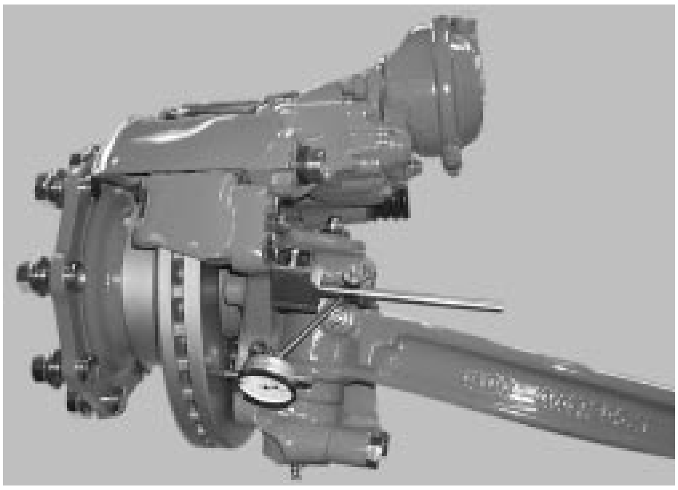
HUB FLANGE BOLT
TIGHTENING TORQUE SEQUENCE
FOR 10 BOLT FIXING



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.

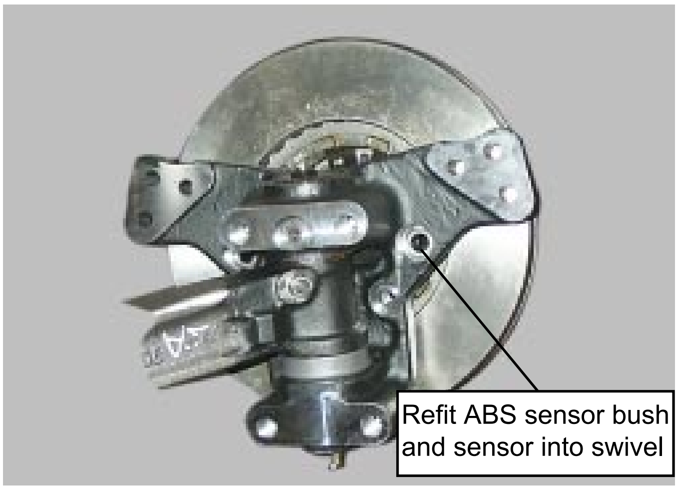
21. Remove any dirt found on the mounting faces and refit and re check disc.

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.

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 ;

$$\boxed{\text{RPM} = \frac{60\text{Hz}}{z} \times 60 \text{ secs}}$$

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.

$$\boxed{\frac{V\text{max}}{V\text{min}} \leq 1.8}$$

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.

$$\boxed{\frac{V\text{max}}{V\text{min}} > 1.8}$$

e) The minimum reading must be greater than the voltage threshold (Vt) ie.

$$\boxed{V\text{min.} > Vt} \qquad \boxed{Vt. = 60\text{mV}}$$

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.

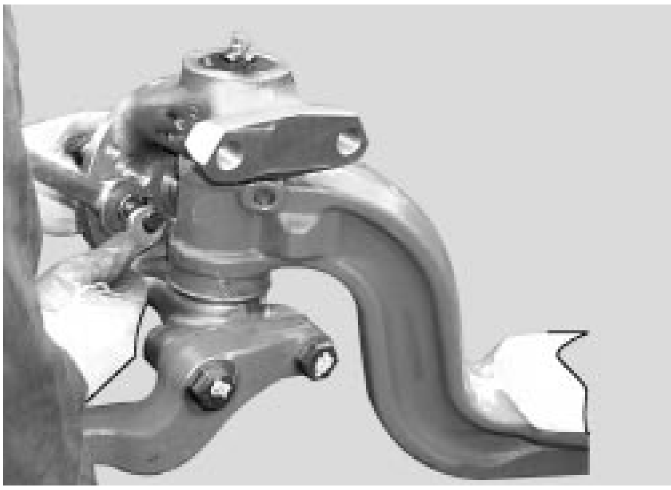
OVERHAUL PROCEDURES

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 :-

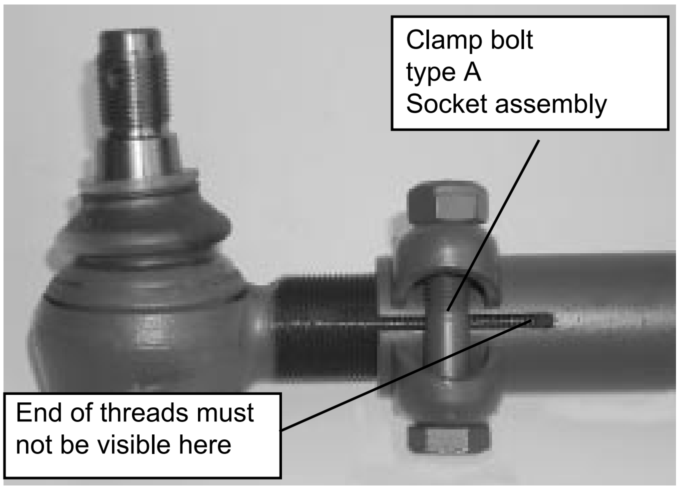
a) Set axle in straight ahead position.

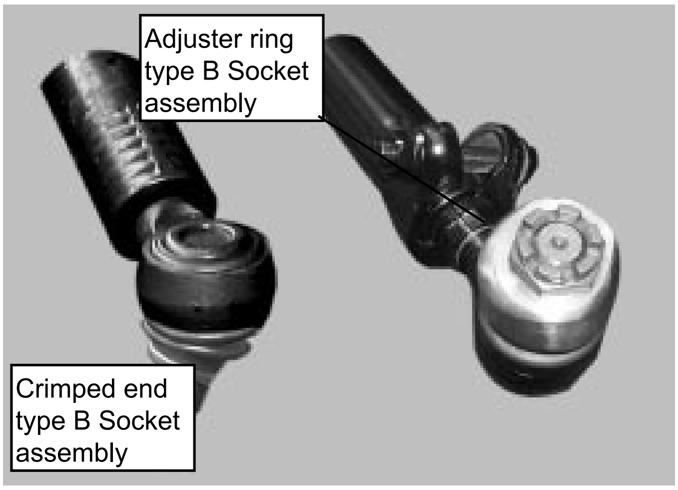
b) At a point level with wheel centre, measure distance over hubs / wheel rims, both in front and behind axle centre.

c) Front measurement ‘B’ should be 0.0" to 0.04" (0.0 to 1mm) **LESS** than rear measurement ‘A’.

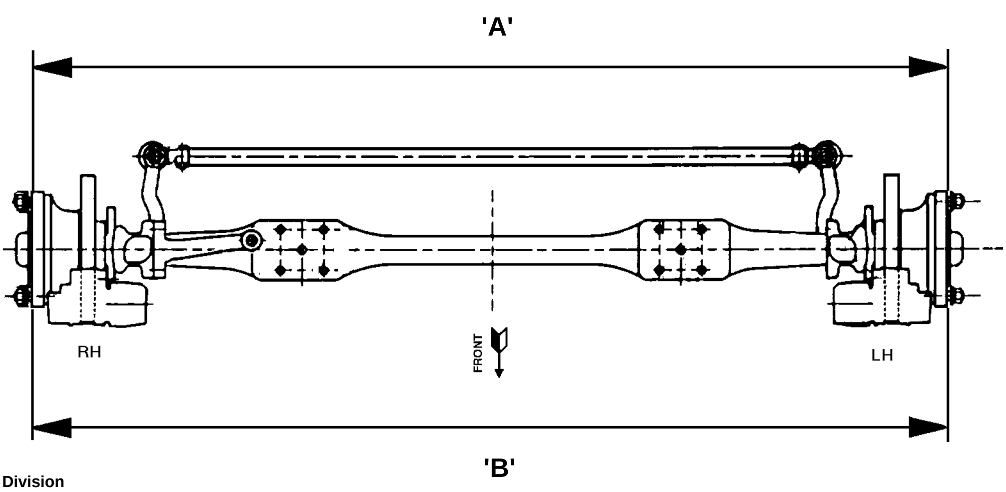
d) Any adjustment on type A socket and tie rod assemblies can be effected by slackening clamp bolts in ball sockets and rotating track rod tube.
For type B socket and tie rod assemblies, slacken the clamped end of the assembly and use the adjuster ring.

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

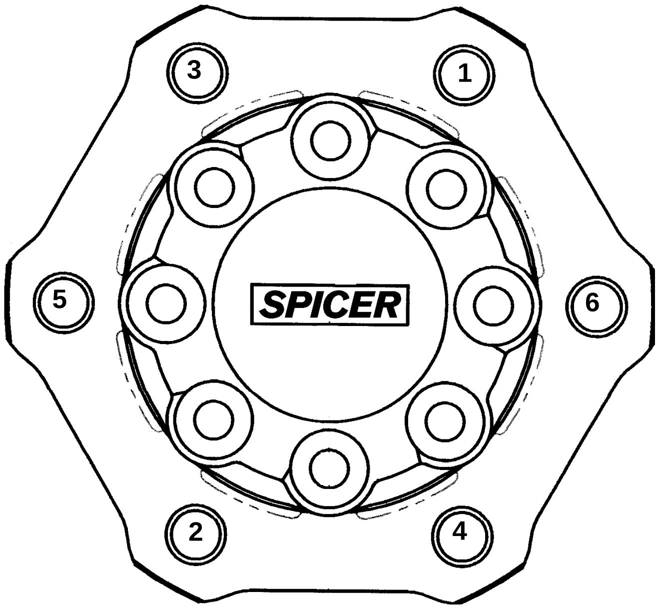
37. Re-connect brake to vehicle hydraulic system as recommended in brake manufacturer's manual.

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.

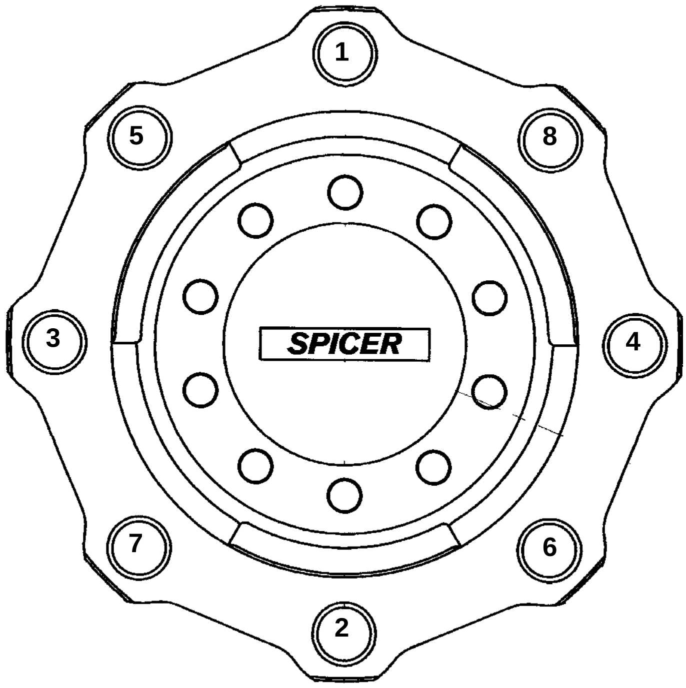
NOTE:-
INTERFACES MUST BE FREE FROM DIRT, INCLUDING BRAKE LINER MATERIAL DEBRIS, RUST AND PAINT. FAILURE TO KEEP INTERFACES CLEAN CAN AND WILL CAUSE WHEEL RIM TO DISTORT UPON TIGHTENING OF WHEEL NUTS
FOR FURTHER DETAILS SEE BS AU50 : part 2 : section 7A : 1995

39. Remove axle supports and lower vehicle to ground.

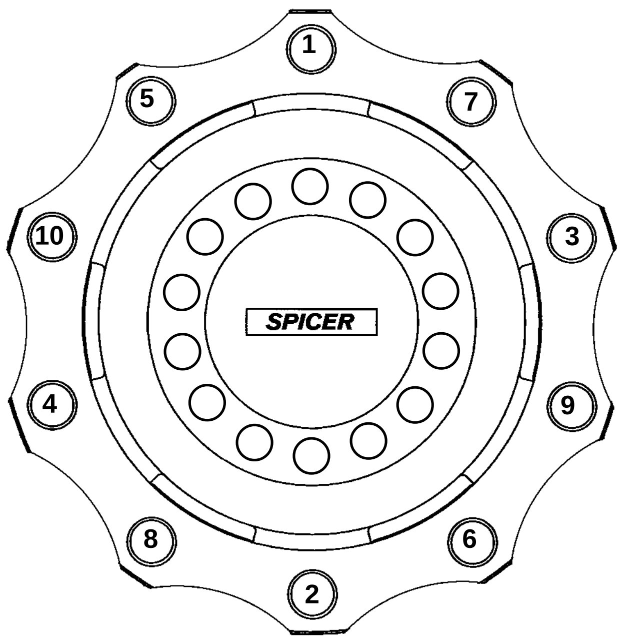
WHEELNUT TIGHTENING
TORQUE SEQUENCE
FOR 6 STUD FIXING



WHEELNUT TIGHTENING
TORQUE SEQUENCE
FOR 8 STUD FIXING



WHEELNUT TIGHTENING
TORQUE SEQUENCE
FOR 10 STUD FIXING

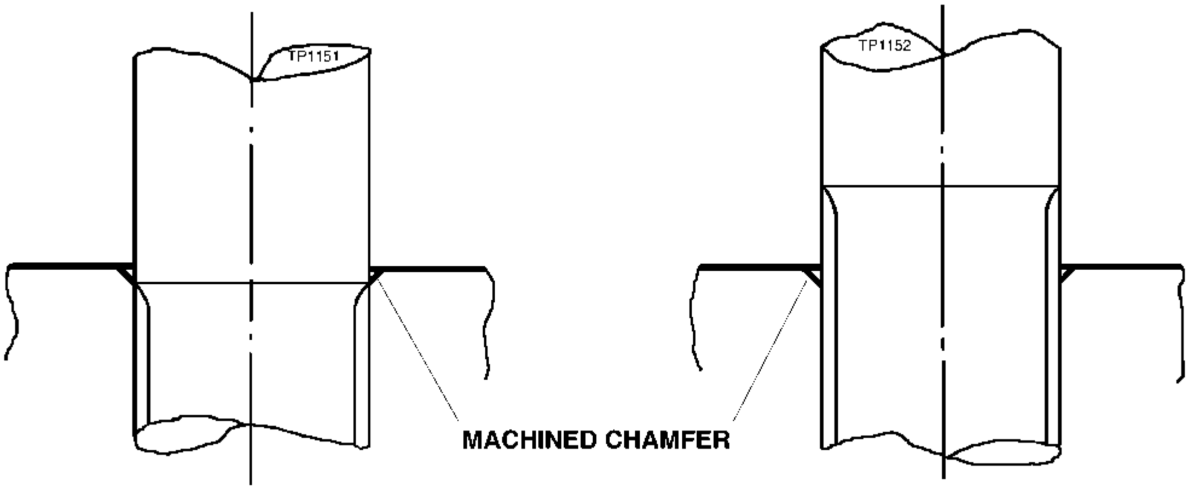


TP1193

SPICER SPECIALITY AXLE DIVISION

STANDARD STUDS - FITTED INTO MACHINED CHAMFERED HOLES

STUDS TO BE INSERTED UNTIL THREAD RUN-OUT LOCKS INTO PARENT METAL

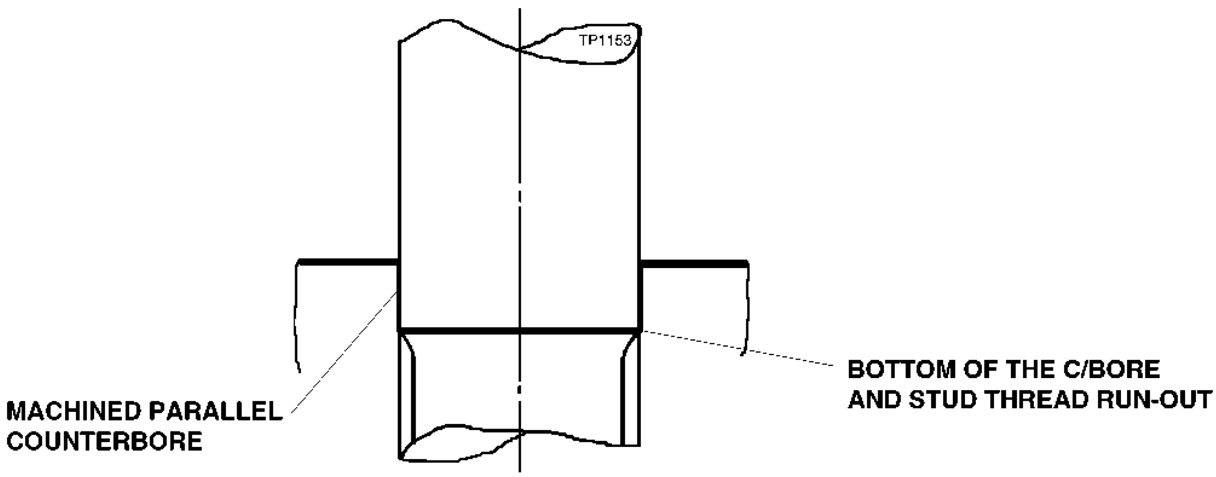


CORRECT INCORRECT

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



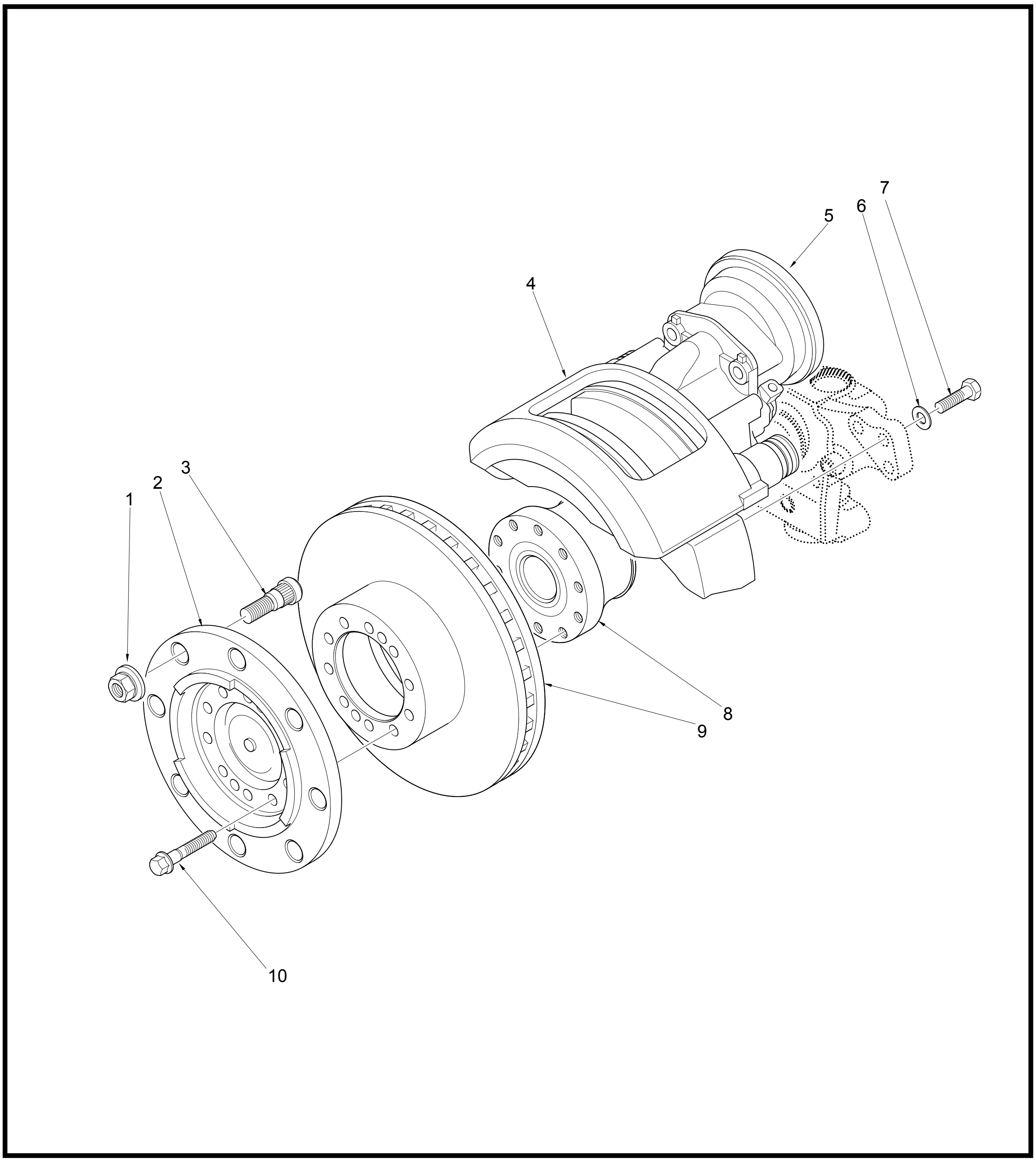
THIS SPECIFICATION IS FOR STUD FITTING ONLY ;
NUTS & SETSCREWS MUST BE TORQUED TO VALUE SPECIFIED

Alteration Numbers

ISSUE A									

DISTRIBUTION Front Axle B.U. Drive Axle B. U. Production	STUD FITTING PROCEDURES	TD183/1 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

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 the Tech Library on our website at arvinmeritor.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 RPM Synthetic Gear Lube	75W/90, 80W/140	ChevronTexaco 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
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
Gibraltar Syn-Gear	75W/90, 80W/140	David Weber Oil Company
Gulf Syngear	75W/90, 80W/140	Gulf Oil

continued

Table C: Extended-Drain-Approved Synthetic Axle Oil Suppliers — United States Distributors

Name of Lubricant	Viscosity	Manufacturer
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
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.
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	ChevronTexaco 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 ESI	80W/90, 85W/140	ChevronTexaco Global Lubricants
PED 6449	75W/90	ChevronTexaco 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	ChevronTexaco Global Lubricants
Triton Syn Lube LDO	75W/90, 80W/140	76 Lubricants
Super Three Star	75W/90, 80W/140	Kendall

(16579/24240)
Printed in USA

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
arvinmeritor.com

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SECTION 12: BRAKE AND AIR SYSTEM

CONTENTS

ILLUSTRATIONS

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 breaking 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 and tag axles are 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).

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 driving day. The remaining reservoirs must be purged at every 12,500 miles (or 20 000 km) or once every year, whichever comes first.

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 at the end of every driving day.

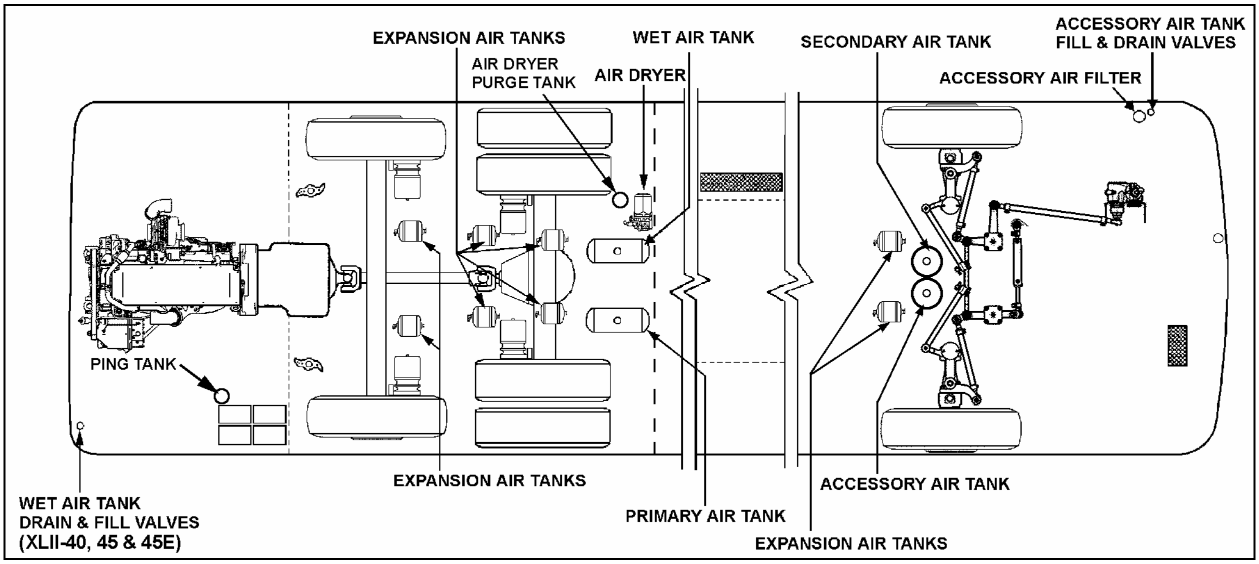


FIGURE 1: AIR RESERVOIRS LOCATION

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). It is recommended to purge the primary air tank every 12,500 miles (20 000 km) or once a year, whichever comes first.

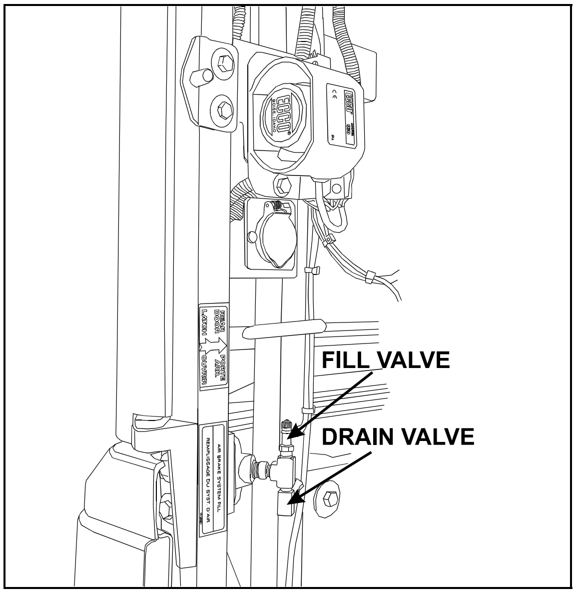


FIGURE 2: REAR VALVE LOCATION (TYPICAL) 12202

3.1.3 Accessory Air Tank

The accessory air tank is installed close to the independent front suspension and is provided with a bottom drain valve (Fig. 1).

Purge the reservoir by its drain valve every 12,500 miles (20 000 km) or once a year, whichever comes first.

3.1.4 Secondary Air Tank

This tank is located in the front wheelhousing, behind the independent front suspension (Fig. 1). 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.

3.2 PING TANK

The ping tank is located in the engine compartment and 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.

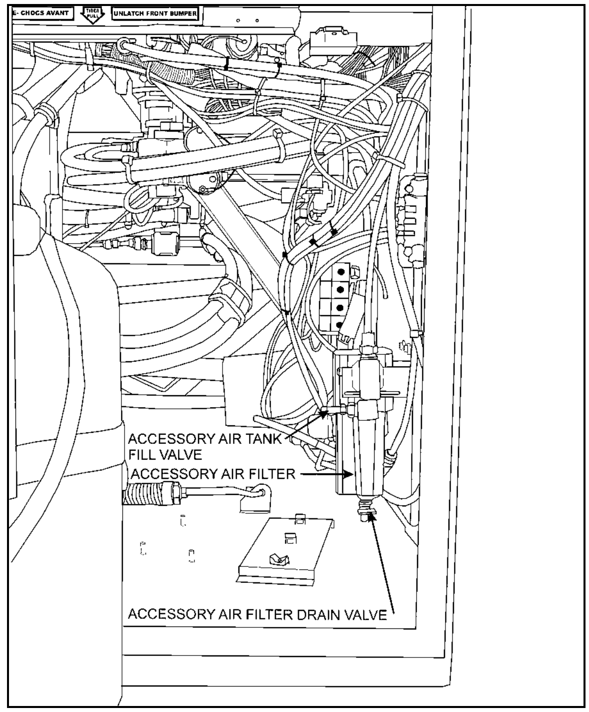


FIGURE 3: FRONT SERVICE COMPARTMENT 12218

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 2.). It can be positioned close to the door hinge or 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. 3).

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

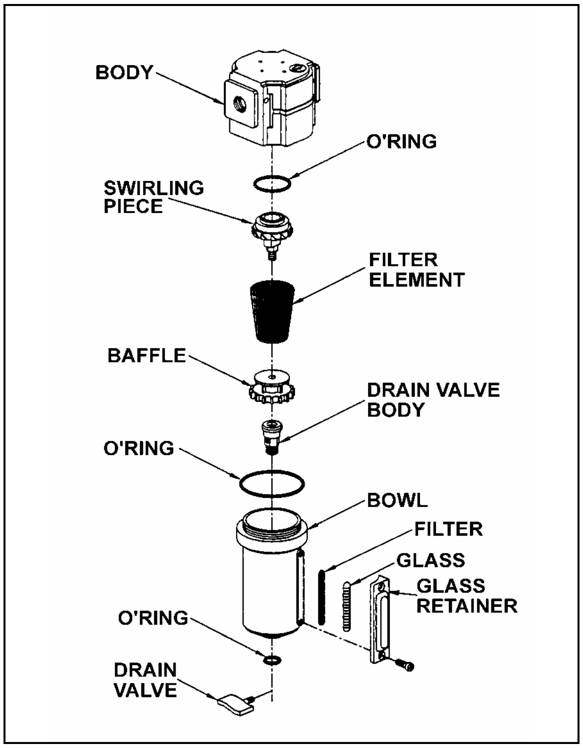


FIGURE 4: ACCESSORY AIR FILTER 12088

This filter is located inside the front service compartment (Fig. 3). 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. 4).

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 *"Owner'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

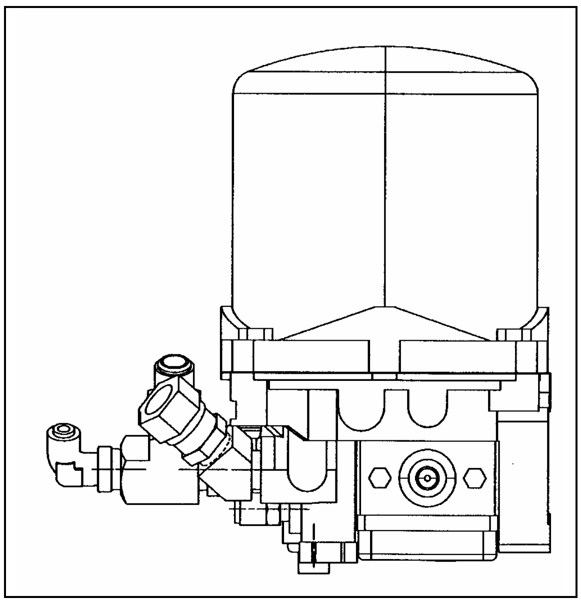


FIGURE 5: HALDEX AIR FILTER DRYER 12194

The air filter/dryer is located in front of rear wheelhousing above drive axle (Fig. 1 & 5). 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 over the battery assembly, close to the door hinge or close to the L.H. side of door opening depending on type of vehicle (Fig. 2). 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^{o}F (93^{o}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 Allison transmission output retarder.

The belt tensioner pressure regulating valve is located in the engine compartment above the doors and is used to limit the air pressure in belt tensioners to 50 ± 2 psi (345 ± 15 kPa) for WE and W0 MTH and to 45 ± 2 psi (310 ± 15 kPa) for W5 MTH (Fig. 7).

The optional regulator is located above the rear junction box in the engine compartment (accessible through the engine R.H. side door). It is used for transmission retarder and should be adjusted to 80 ± 3 psi (550 ± 20 kPa).

	Air Pressure (psi)	Air Pressure (kPa)
Belt Tensioner	**Series 60** 50 (WE & W0) 45 (W5)	**Series 60** 345 310
Retarder	80 ± 3	550 ± 20

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. 6). 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.

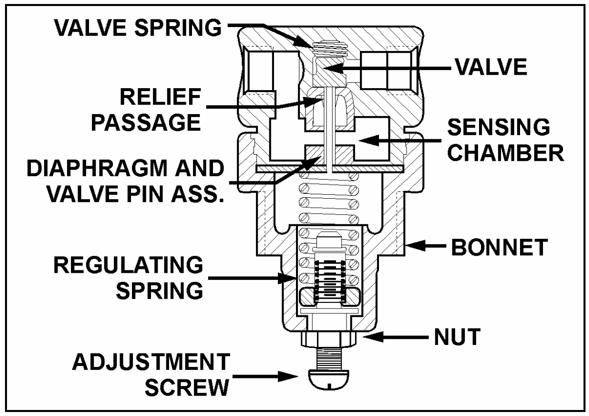


FIGURE 6: AIR PRESSURE REGULATING VALVE 12141B

9.2 PRESSURE SETTING PROCEDURE

Remove the dust cap from the pressure check valve (Fig. 7). Attach a pressure gauge at this port and check the pressure reading. If the pressure reading is incorrect, adjust as follows:

1. Loosen the locking nut, turn the adjustment screw counterclockwise to decrease pressure by approximately 10 psi (70 kPa) below the required pressure.

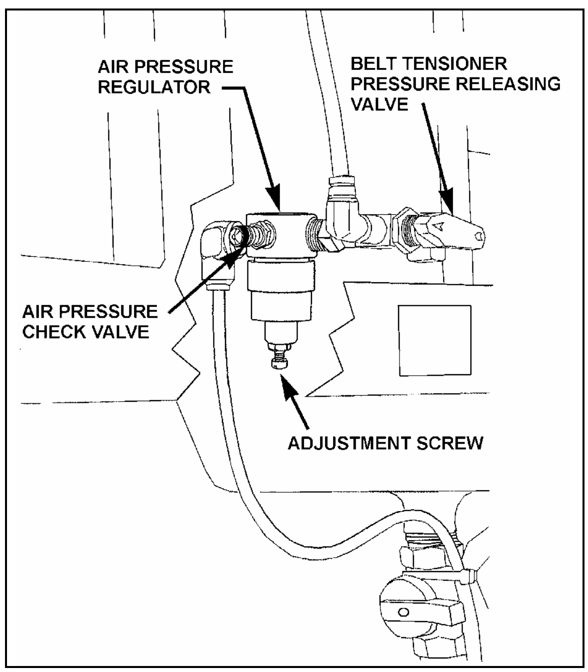


FIGURE 7: AIR PRESSURE REGULATOR 12200

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 (BA-921)

The air compressor is located on starter side of the engine, on the rear of the engine gear case (Fig. 8). Its function is to provide and maintain air under pressure to operate devices in brake and air systems.

This air compressor also drives the engine fuel pump which is bolted to the rear end of the compressor. The compressor crankshaft is designed to accept a drive coupling which is placed between the compressor and fuel pump.

The compressor is driven by the bull 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 Bendix BA-921 air compressor is supplied in the applicable booklet annexed to this section under reference number SD-01-676.

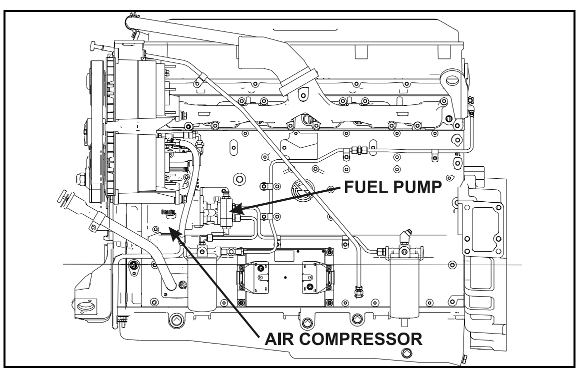


FIGURE 8: AIR COMPRESSOR LOCATION 03061

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. Identify and disconnect all air, coolant and oil lines from the compressor assembly.
4. Access the compressor by the engine R.H. side compartment. Remove the four compressor mounting bolts and the two fuel pump support bracket bolts.
5. Slide air compressor rearward to disengage the hub from coupling. Remove the air compressor.

Reverse removal procedure for installation.

11. EMERGENCY/PARKING BRAKE CONTROL VALVE (PP-1)

A push-pull control valve mounted on the L.H. lateral console is provided for parking brake application or release. The spring brakes are self-actuated whenever the control valve supply pressure drops below 40 psi (275 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.

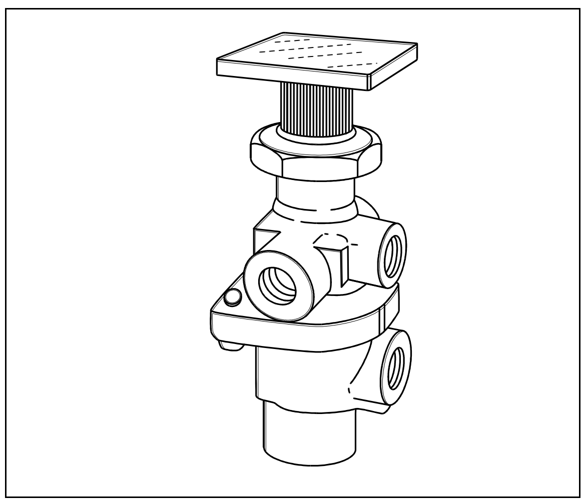


FIGURE 9: PP-1 12142

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. 9).
3. Disconnect the air tubes.
4. Remove the retaining screws.
5. Service or replace the valve.
6. Installation is the reverse of removal.

12. FLIP-FLOP CONTROL VALVE (TW-1)

A flip-flop control valve mounted on the L.H. lateral console is provided to unload and to lift tag axle air springs. 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.

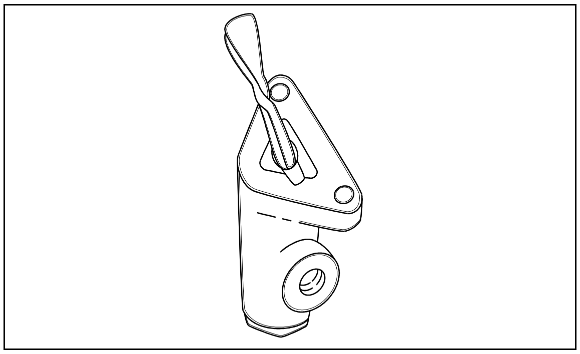


FIGURE 10: TW-1 12138

13. 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. 11).

13.1 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. 11).
2. Tighten threaded rod lock nuts.

13.1.1 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.

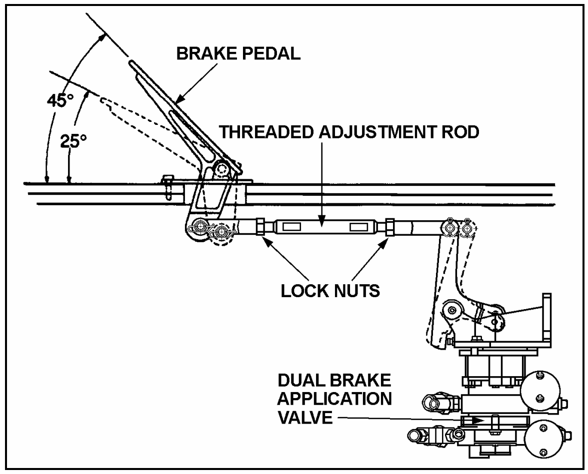


FIGURE 11: BRAKE PEDAL ADJUSTMENT 12208

14. 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. 12), while the lower one (Bendix, SL-5) closes its contact at 4 psi (28 kPa) (Fig. 13). The switches are not serviceable items; if found defective, the complete unit must be replaced.

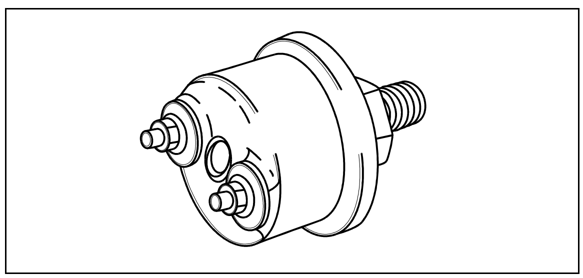


FIGURE 12: DELCO SWITCH 12139

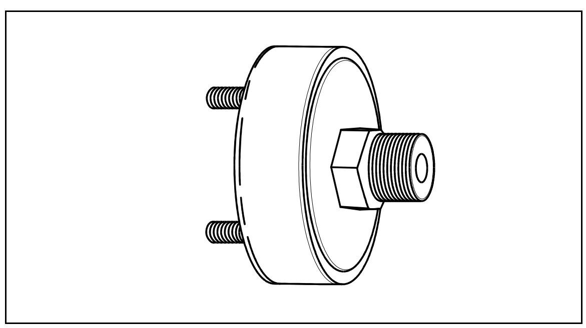


FIGURE 13: BENDIX SWITCH 12140

15. 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.

16. 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.

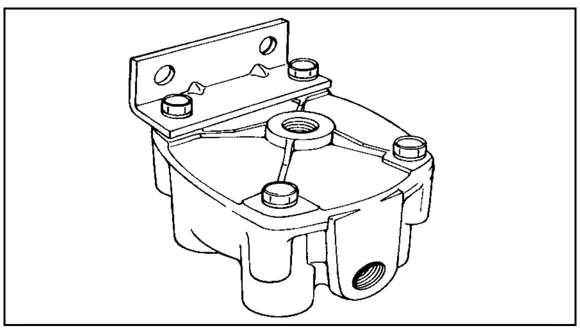


FIGURE 14: R-12 12074

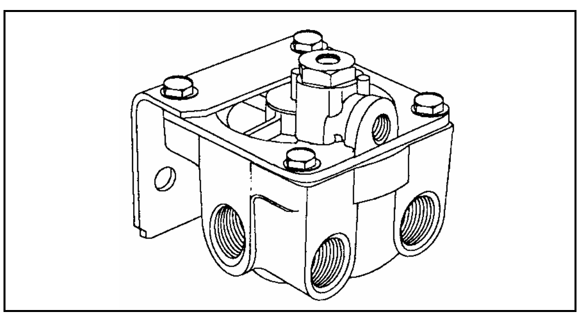


FIGURE 15: R-14 12207

17. 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.

Maintenance and repair information on this valve is supplied in the applicable booklet annexed to this section under reference number SD-03-901.

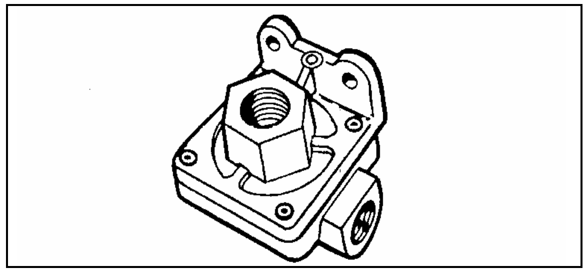


FIGURE 16: QR-1 12075

18. 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:

- o Provides a rapid application of the spring brake actuator when parking.
- o Modulates the spring brake actuator application using the dual brake valve should a primary failure occur in the service brake system.
- o 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.

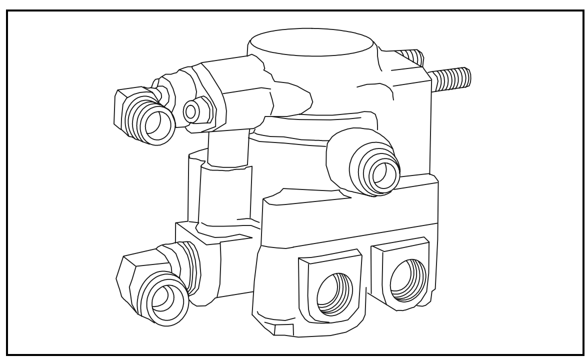


FIGURE 17: SR-7 12206

19. 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. 18). 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.

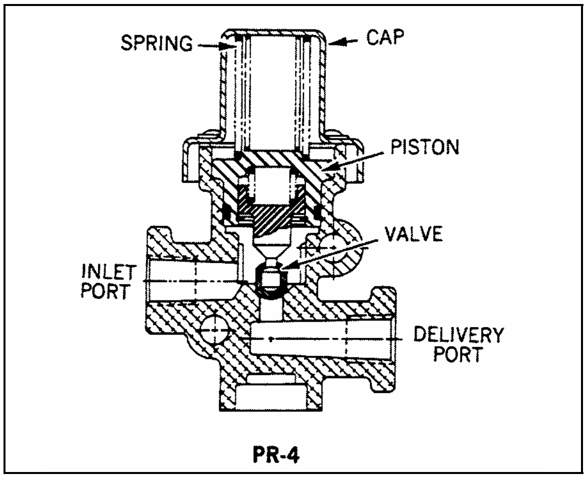


FIGURE 18: PR-4 12174

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 for accessory air tank location).

20. 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. 19), 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).

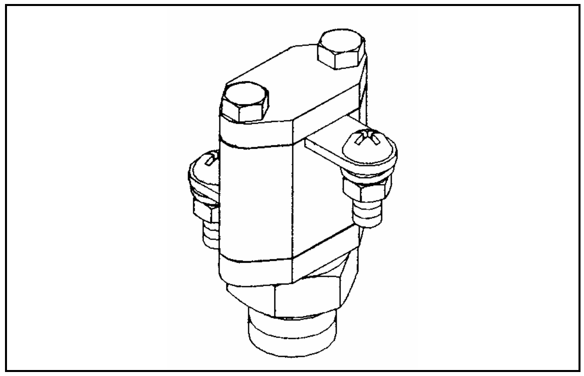


FIGURE 19: LP-3 12078

21. 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.

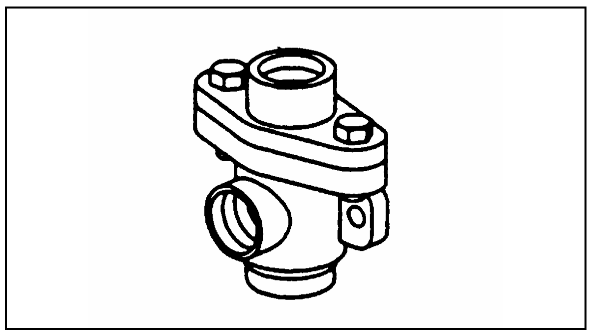


FIGURE 20: DC-4 12134

22. 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.

23. 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:

- o Defective air gauge (registering incorrectly).
- o Excessive leaking in air system.
- o Reservoir drain cock open.
- o Governor poorly adjusted or defective.
- o Defective compressor.
- o Worn compressor or excessive wear on piston and/or ring.
- o Air pressure rises to normal setting too slowly.

Excessive leaking in air system:

- o Clogged engine air cleaner.
- o Worn compressor or excessive wear on piston and/or ring.
- o Engine speed too low.

Air pressure rises above a normal setting:

- o Defective air gauge (registering incorrectly).
- o Governor poorly adjusted or defective.
- o Restriction in line between governor and compressor unloading mechanism.

Air pressure drops quickly when engine is stopped:

- o Leaks in compressor discharge valve.
- o Leaks in governor.
- o Leaks in air lines.
- o Leaks in air system valves.

24. 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 and tag axles, 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).

25. AIR BRAKES

25.1 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 16 square inch effective area for service brake and a 16 square inch effective area for emergency/parking brakes. 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 maintenance, refer to the manufacturer's brochure at the end of this section.

25.1.1 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). To check pad condition without removing the wheel, verify the position of guide bushing (6) relatively to guide sleeve (4) (see Fig. 21). When guide sleeve is in alignment with guide bushing, brake pad thickness has to be checked more precisely with the wheel removed. 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.

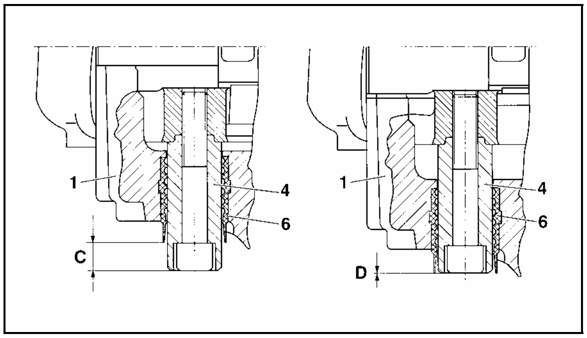


FIGURE 21: BRAKE PAD CHECK 12117

25.1.2 Caliper Maintenance

Use the following procedure for brake calipers servicing. The procedure must be followed in proper sequence to ensure that only needed repairs or replacements are performed on calipers. Problems such as hot brakes or cracked rotors may be effects of sticking calipers, too-small clearance between rotor and pad or possible trapped air pressure in the brake chamber. If any of these symptoms occur, perform this procedure before replacing the rotor to ensure the cause of the problem is properly solved.

1. Check for presence of residual pressure:

To check if there is any residual air pressure in the brake chamber, make four or five brake applications, then try to turn the wheel manually, if the wheel does not turn, use a wrench to crack the air line and listen for trapped air in the brake chamber then try to turn the wheel manually again. If you find trapped air in the brake booster, ensure that all pneumatic components in the braking system are functioning properly.

NOTE
A residual pressure of 2-3 PSI in the system is sufficient to prevent the brakes from releasing. Also the stop light switch can operate with as little as 1 PSI, therefore an illuminated brake light does not mean brakes are dragging.

2. Pad to rotor clearance inspection:

Remove clip and washer (26 & 45, Fig. 22), push down retainer bar (11), pull out pin (44) and remove retainer bar. Push caliper toward actuator (center of vehicle) for maximum clearance.

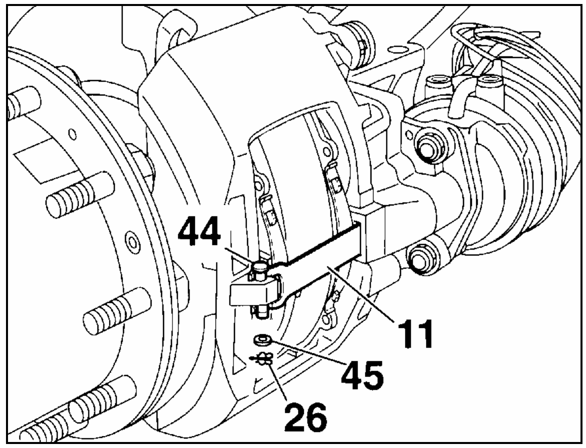


FIGURE 22: CLEARANCE INSPECTION 12119

3. Measure pad to rotor clearance:

Place a long feeler gauge (long enough to measure across entire tappet surface) between the tappet and the backing plate of the pad, measure clearance at both tappets. Clearance should range between 0.020 and 0.035 inch (0.5 mm and 0.9 mm), with a maximum difference between tappet measurements on same brake of 0.008 inch (0.2 mm).

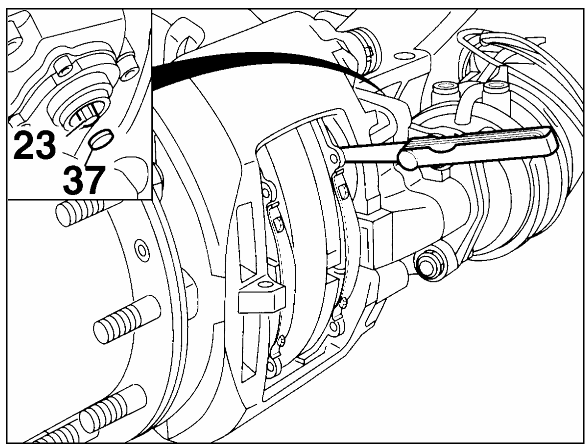


FIGURE 23: RUNNING CLEARANCE 12116

4. Checking the adjuster

⚠ CAUTION
Use only a standard box wrench on the adjuster hexagonal pinion. Do not overtorque the pinion as overtorquing will damage the pinion.

a) Remove cap (37, Fig. 23).

b) Using a box wrench (8 mm), turn the adjuster pinion (23, Fig. 23) counterclockwise about 2 - 3 clicks to increase running clearance. By operating the braking system about 5 - 10 times (30 PSI or 2 bar), the wrench should turn clockwise in small increments if the adjuster is functioning correctly (Figs. 24 and 25).

NOTE
With increasing number of applications, the incremental adjustment will decrease.

c) In case of malfunction, i. e. the pinion or box wrench:

i) Does not turn.

ii) Turns only with the first application.

iii) Turns forwards then backwards with every application.

In any of the above cases, the automatic adjuster has failed and the caliper must be replaced. In such cases the brakes can be adjusted manually to run a short distance.

d) Take the box wrench off. Replace the cap and check for proper sealing.

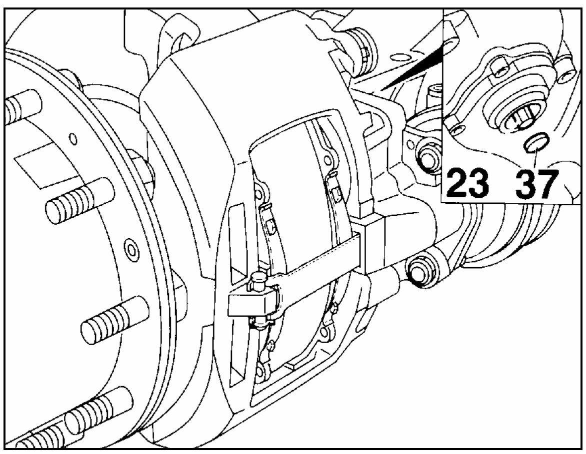


FIGURE 24: ADJUSTER PINION 12120

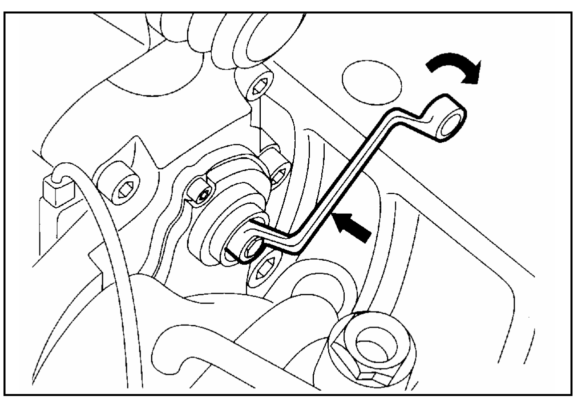


FIGURE 25: BOX WRENCH ON ADJUSTER PINION 12118

25.1.3 Roadside Inspection for Knorr/Bendix Air Disc Brakes

The coach is equipped with air disc brakes and therefore, cannot be inspected using the requirements for chamber stroke or visible lining clearance or lining thickness as specified for drum brakes. The roadside inspector should use the following instructions to determine that the air disc brakes are within proper adjustment and have sufficient pad wear thickness.

The Knorr/Bendix air disc brake is designed to move freely, with minimal force, in the axial direction on the two sliding pins as identified in figure 26. The movement in the axial direction should not exceed 2 mm (5/64”).

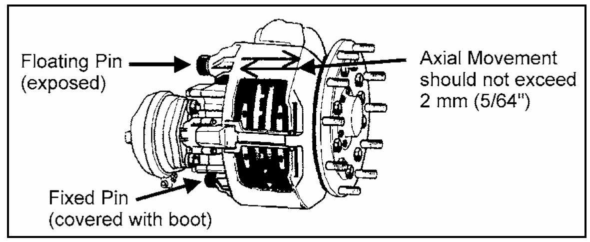


FIGURE 26: CALIPER AXIAL MOVEMENT 12132

The pad thickness can be seen but would require removal of the tire and rim. An indicator of the pad wear condition is available by inspecting the floating pin location in relation to the rubber bushing as shown in figure 27. When pads are in new thickness condition, the pin will be exposed (C) 19 mm (¾”). When the pads are worn to replacement conditions, the pin will be nearly flush to the bushing (D) or within 1 mm (3/64”) of the edge of the rubber bushing.

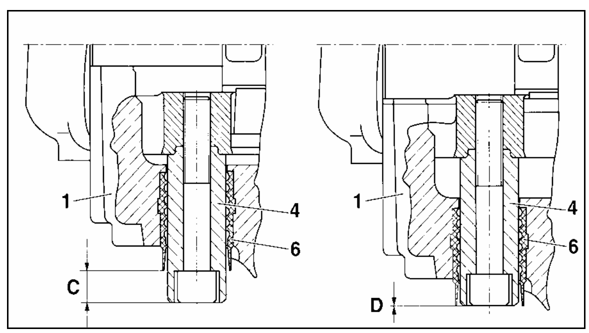


FIGURE 27: BRAKE PAD CHECK 12117

25.1.4 Pad Removal

Turn adjuster pinion (23) counterclockwise to increase pad to rotor clearance (a clicking noise will be heard). Push caliper toward actuator and remove pads (12).

> ⚠ **CAUTION**
>
> Do not apply brakes while pads are removed as this could cause over stroke damage to the adjusting mechanism.

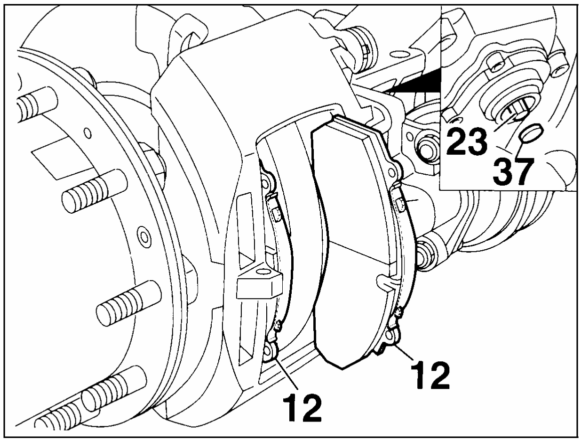


FIGURE 28: PAD REMOVAL 12111

25.1.5 Checking Pad Wear

Minimum friction material thickness is 2 mm (A, Fig. 29)

New friction material has a thickness of 21 mm (B, Fig. 29)

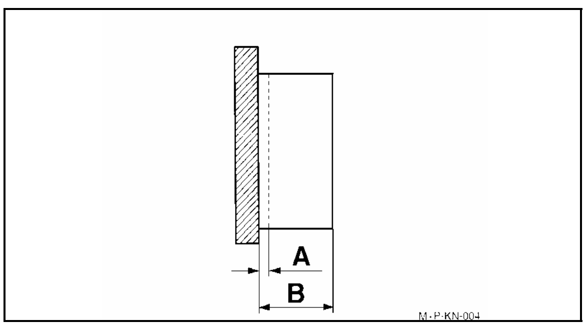


FIGURE 29: PAD WEAR 12112

25.1.6 Important Pad and Rotor Measurements

A = Rotor thickness (new): 45 mm;

B = Rotor thickness (worn): 37 mm. Requires replacement;

C = Overall thickness of pad (new): 30 mm;

D = Backplate: 9 mm;

E = Minimum thickness of pad material: 2 mm;

F = Minimum allowed thickness of overall backplate and friction material: 11 mm. **Replacement necessary**.

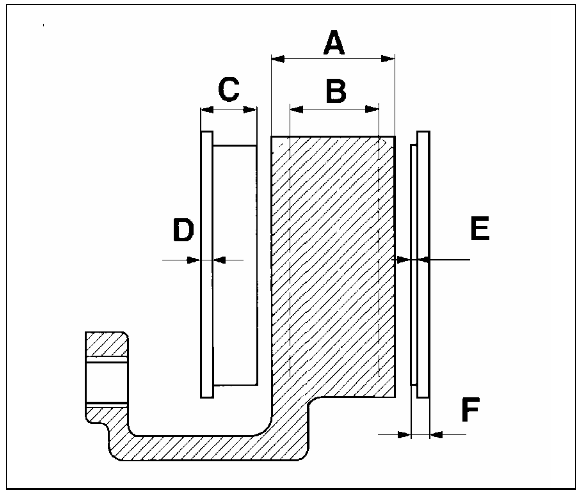


FIGURE 30: ROTOR AND PAD WEAR LIMITS 12113

25.1.7 Checking Caliper Guidance and Seal Condition

Perform sliding test. You must be able to slide the caliper easily at any time. Sliding test should be performed at least every three months or more often depending on the type of operation.

Sliding Test (Refer to Fig. 31):

a) Using hand pressure only, the caliper (1) must slide freely with its guide pin arrangements (4-7) across a distance of 1 3/16 inch (30 mm) when the pads are removed. The sleeve (5) is sealed using the boot (9) and the cap (10).

b) The rubber components (9 and 10) should show no damage. The positioning must be checked. If necessary the caliper has to be repaired using the guide kit (part #611168) or with the seal and guide kit (part #611199). When repairing a caliper with the above kits, make sure all parts in the kit are used. Use special green grease (Prévost #683344) to reassemble the slide pin into the bushing, white or yellow grease (Prévost #683345) may be used for all other lubrication needs.

c) Depending on caliper manufacturing date, black paint may be present on the unsealed pin (short pin). Paint on the slide pin can prevent the caliper from sliding properly especially when the pad starts to wear. If paint is present on the pin, separate the pin from the bushing, clean and reinstall the pin according to procedure.

NOTE
Do not attempt to use thinner or alcohol to clean the pin without removing it as it may damage the rubber bushing.

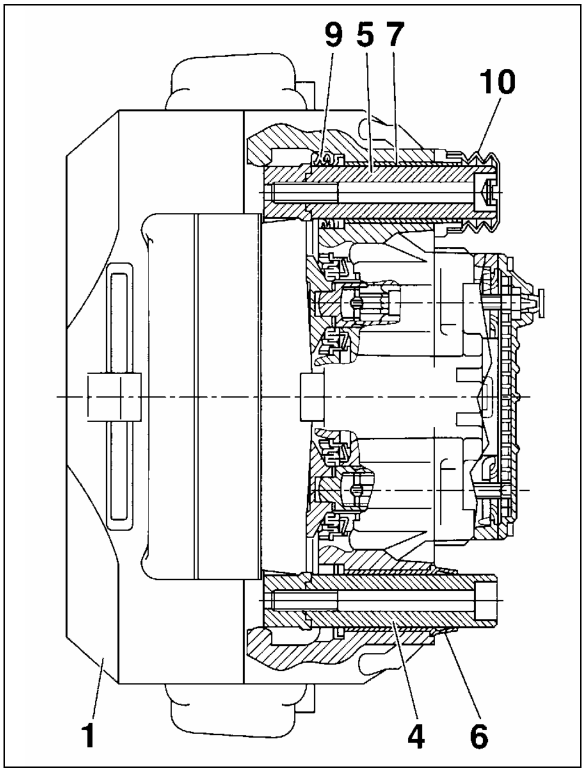


FIGURE 31: CALIPER GUIDANCE 12114

25.1.8 Checking the Tappet Boots

a) The rubber boots (13, Fig. 32) should show no damage, check the attachment.

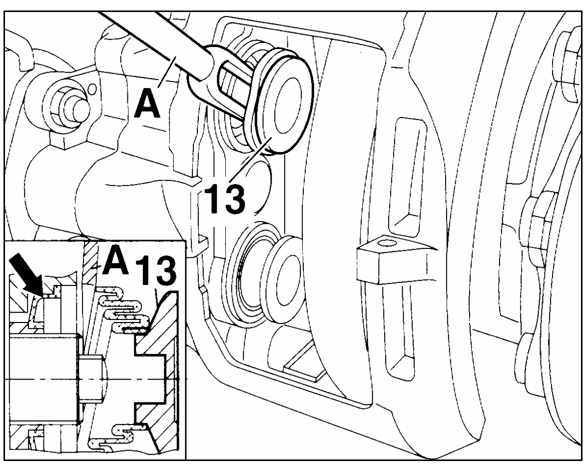


FIGURE 32: RUBBER BOOTS 12115

CAUTION
Any ingress of water and dirt will lead to corrosion and may affect the function of the actuation mechanism and adjuster unit.

b) If boots are damaged but show no corrosion, the boots and tappets should be replaced (Prévost #611177).

25.1.9 Pad Installation

Turn adjuster pinion (23, Fig. 33) counterclockwise until tappets are fully retracted and clean pad seat area. Slide caliper to full outboard position and install outside pad. Slide caliper to full inboard position and install inside pad.

WARNING
It is recommended to change all pads on an axle at the same time.

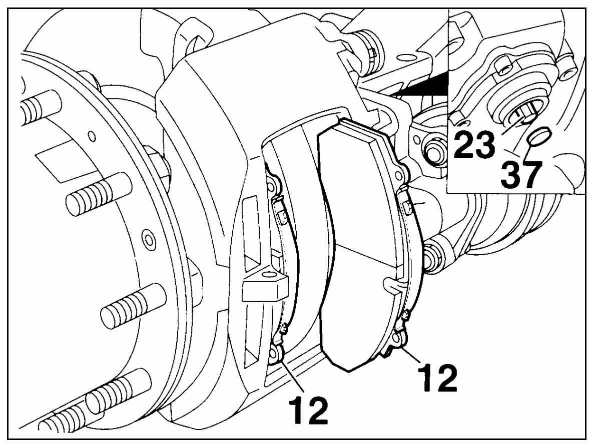


FIGURE 33: PAD INSTALLATION 12111

25.1.10 Adjusting the Running Clearance

a) Insert a feeler gauge 0.028 inch (0.7 mm thickness) between tappet and pad backplate (Fig. 34). Turn adjuster pinion clockwise until 0.028 inch (0.7 mm) clearance is achieved. Replace cap (37) (Prévost # 641313).

b) To ensure a constant running clearance between the rotor and pads, the brake is equipped with an automatic adjuster unit. When the pads and rotor wear, the running clearance between the pads and rotor increases. The adjuster (23, Fig. 34) and turning device turn the threaded tubes by the amount necessary to compensate the wear.

Total running clearance should be between 0.020 and 0.035 inch (0.5 and 0.9 mm). Smaller clearances may lead to overheating problems.

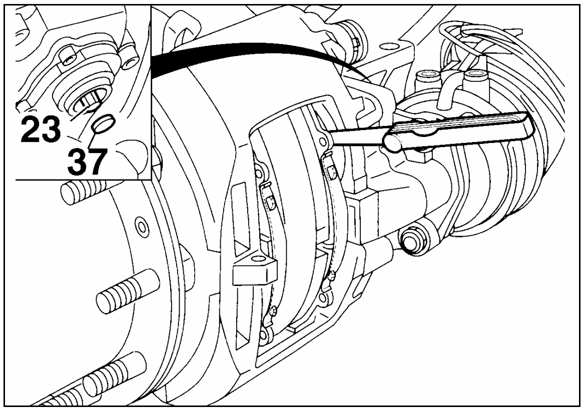


FIGURE 34: RUNNING CLEARANCE 12116

25.1.11 Brake Tools

Four brake tools are available from Prévost to facilitate disc brake maintenance:

a) #641321, Tappet with boot (item 13).
b) #641322, Caliper inner boot (item 9).
c) #641323, Caliper bushing (item 7).
d) #641435, Fork for boot tappet (item 13).

Maintenance tip

Using the following procedure, pad wear can be determined without removing the wheel.

25.1.12 Checking 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 inch (2 mm). To check pad condition without removing the wheel, verify the position of guide bushing (6) relatively to guide sleeve (4) (Fig. 35). When guide sleeve is in alignment with guide bushing, brake pad thickness must be checked more precisely with wheel removed. When replacing the 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. Worn pads should be replaced in the same position.

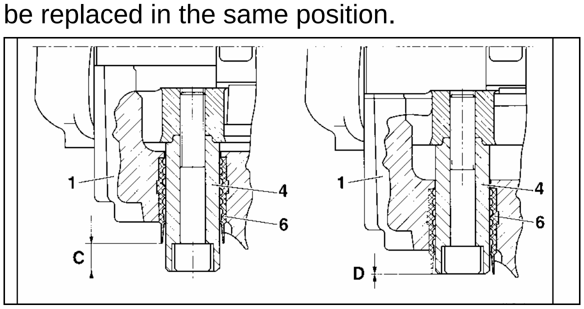


FIGURE 35: BRAKE PAD CHECK 12117

25.1.13 Torque specifications

For proper caliper maintenance, refer to the following figures.

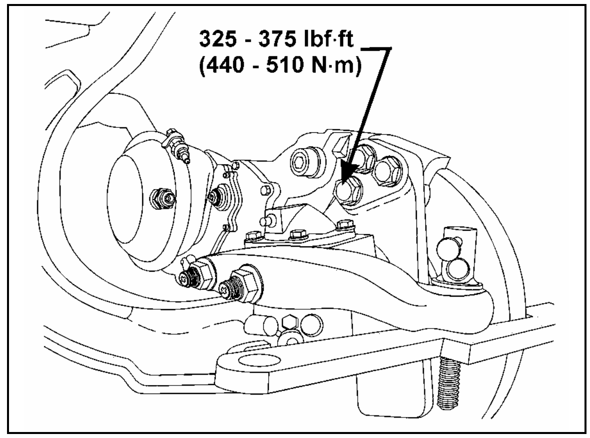


FIGURE 36: TORQUE SPECIFICATION 12145

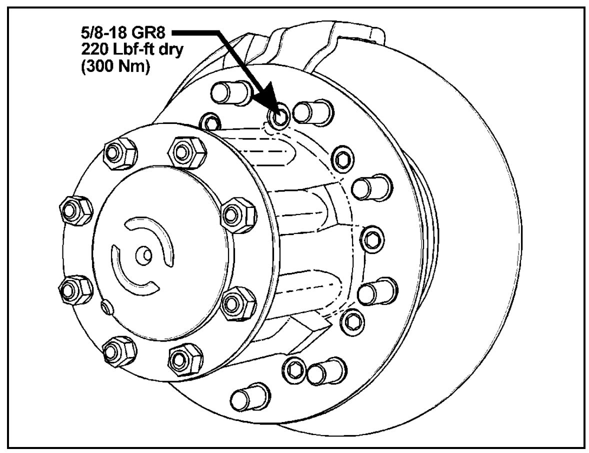


FIGURE 37: TORQUE SPECIFICATION 11030

26. 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.

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.

27. 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 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.

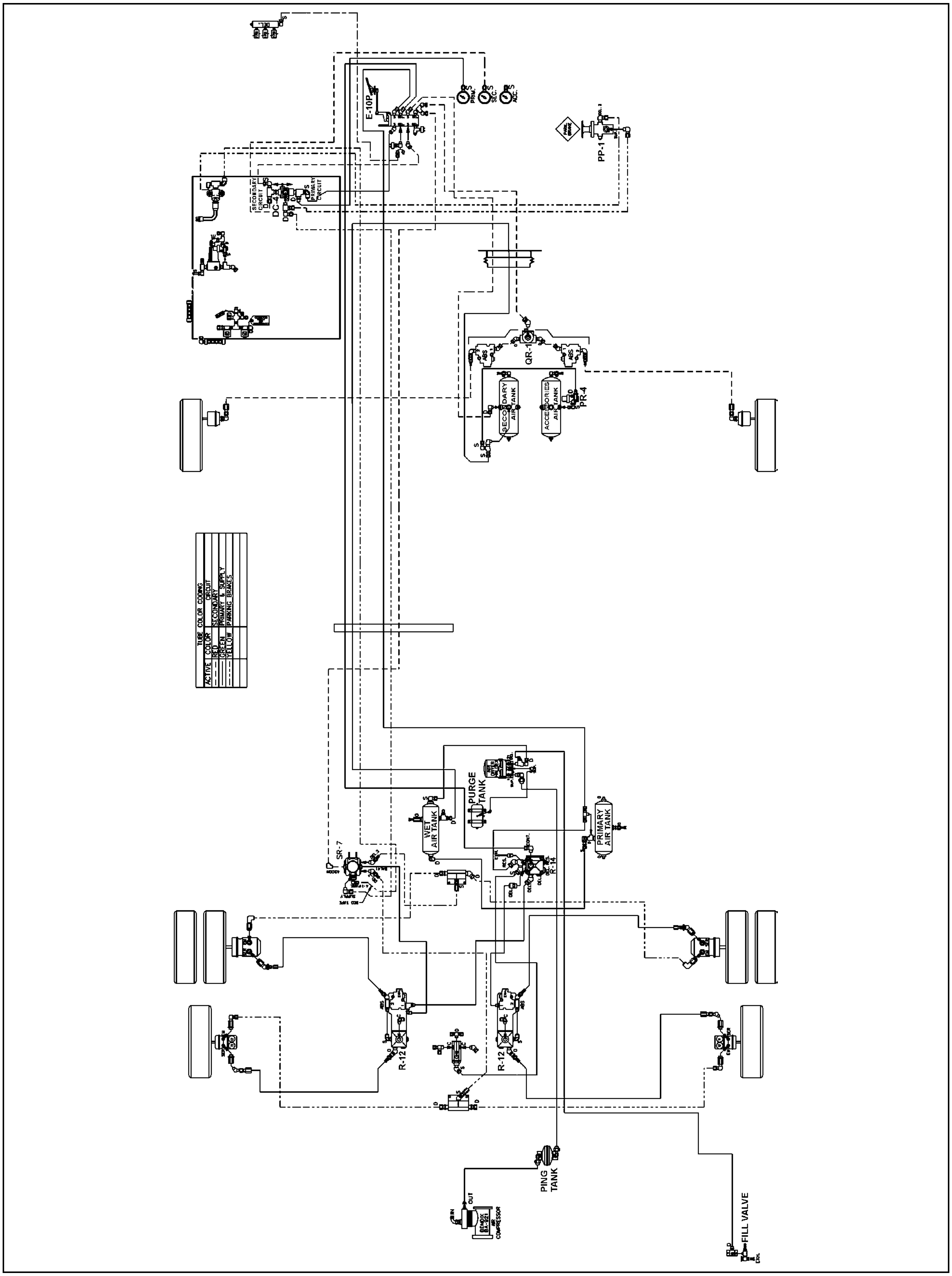


FIGURE 38: AIR-OPERATED BRAKING SYSTEM (W0 & WE)

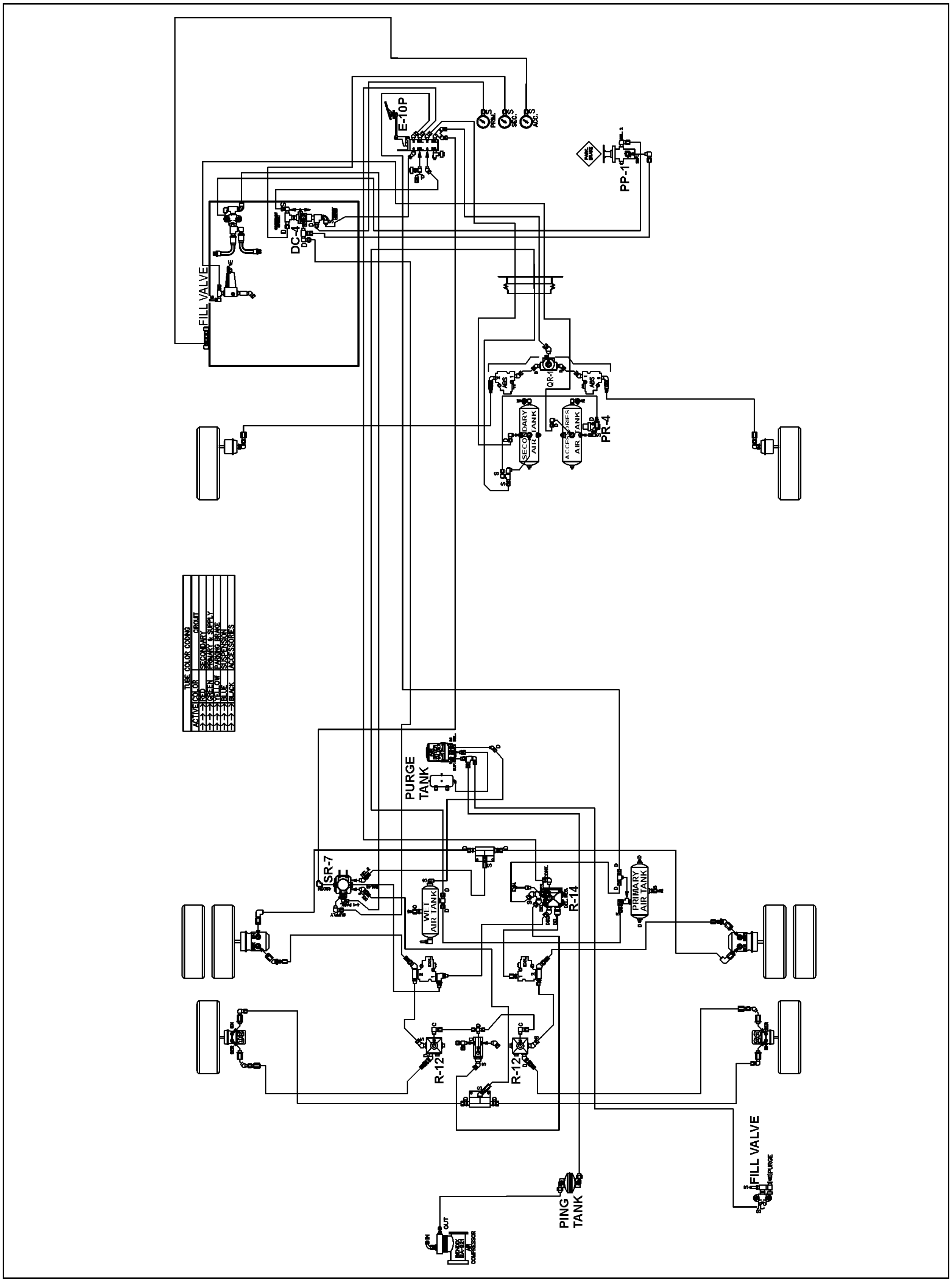


FIGURE 39: AIR-OPERATED BRAKING SYSTEM (W5)

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

- o Perform a telltale light and gauge test. Replace entire cluster if found defective.

High or Low Air Filter/Dryer Built-in Governor Cutout Point

- o Perform a telltale light and gauge test. Replace entire cluster if found defective.

OR

- o 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

- o Perform a telltale light and gauge test. Replace entire cluster if found defective.
- o Check compressor strainer or inlet line. If restricted, clean or replace element or faulty line.
- o Check compressor head or discharge line for carbonization or restriction. Clean or replace as necessary.
- o If discharge valves leak, pull head and correct or replace cylinder head.
- o If drive is slipping, replace gear.
- o If inlet valves are stuck, open or leaking severely, replace unloader kit, inlet valves and/or seats as necessary.
- o If drain cock is found open, close it.
- o Listen for air leaks and repair.
- o 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:

- o 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.
- o Listen for leaks and correct as required.
- o 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 Prévost 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-Prévost product notification annexed at the end of Section 12 of Maintenance Manual.*

28. BRAKE AIR CHAMBER

Since this vehicle is equipped with *Knorr-Bremse SN7000* disc brakes on all axles, it also uses "Knorr-Bremse" brake chambers. The tag and 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 40 and 41.

The front wheel brake air chambers are used only for service brake duty (Fig. 40).

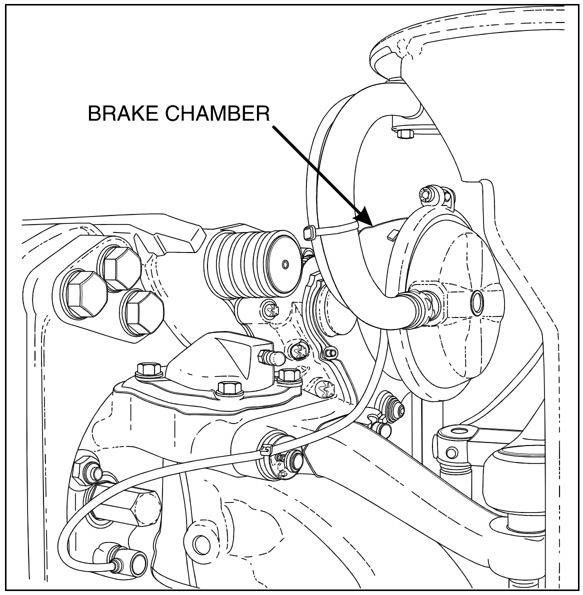


FIGURE 40: FRONT WHEEL BRAKE AIR CHAMBER 12158

28.1 MAINTENANCE

Every 6,250 Miles (10 000 km) or twice a year, whichever comes first depending on type of operation:

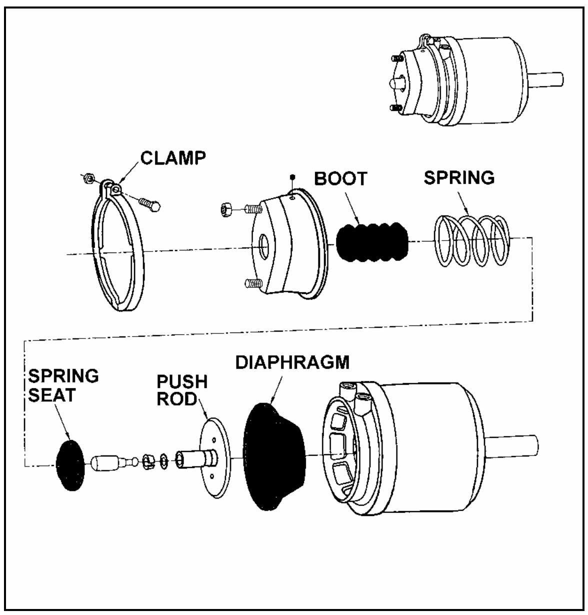


FIGURE 41: TAG AXLE BRAKE AIR CHAMBER 12126

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.

28.2 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, 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.

Tag Axle

1. Block the wheels to prevent the vehicle from moving.
2. Turn the release bolt counterclockwise to cage the power spring (approx. 2.5 inches (6 cm)). Repeat on the opposite side.
3. To manually reset the emergency/parking brake, turn the bolt clockwise.

28.3 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 and tag axles 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.

28.4 BRAKE CHAMBER INSTALLATION

Reverse removal procedure, then check brake adjustment.

CAUTION
Always clean air lines and fittings, and coat pipe threads with teflon pipe sealant before reconnecting air lines.

28.5 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:

- Prévost 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 and tag axles 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.

29. 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.

29.1 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.

29.2 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.

29.2.1 Electronic Control Unit (ECU)

This control unit is located in the front service compartment, (refer to figure 42 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.

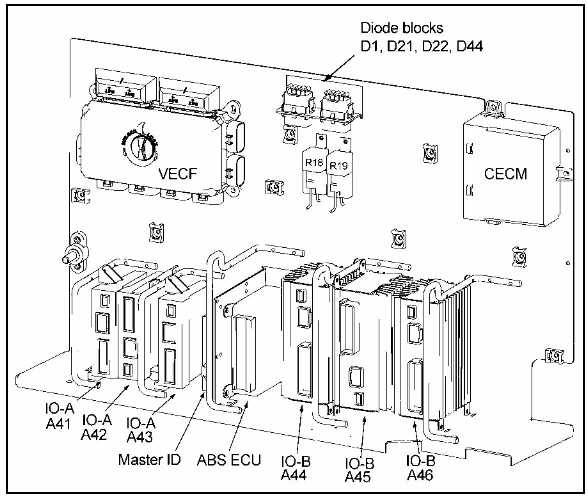


FIGURE 42: ABS ECU LOCATION 12147

⚠ CAUTION
In order to protect the ABS electronic control unit from voltage surges, always disconnect before performing any welding procedure on vehicle.

29.2.2 ABS Modulator Valve

This ABS system is equipped with four modulator valves, located between the brake chamber and the relay valve or quick release valve (Fig. 43). Note that there is only one solenoid valve controlling the drive and tag axle wheels on the same side (tag axle is slave to drive axle).

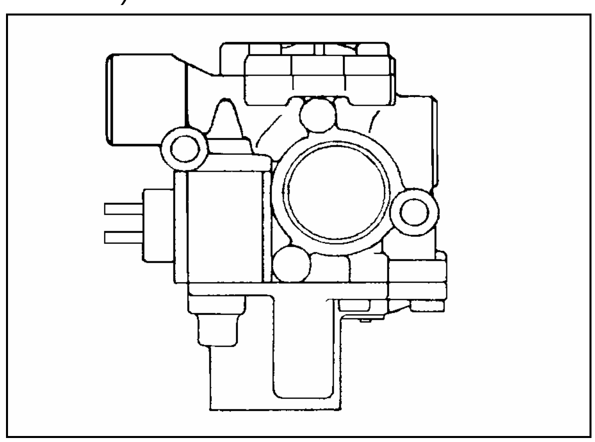


FIGURE 43: ABS MODULATOR VALVE 12084

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.

Maintenance

No specific maintenance is required for the solenoid control valve.

29.2.3 Sensors

The sensors are mounted on the front and drive axle wheel hubs (Fig. 44). 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 (Prévost #680460) before reinstallation. Refer to paragraph *"Sensor Installation"* for details.

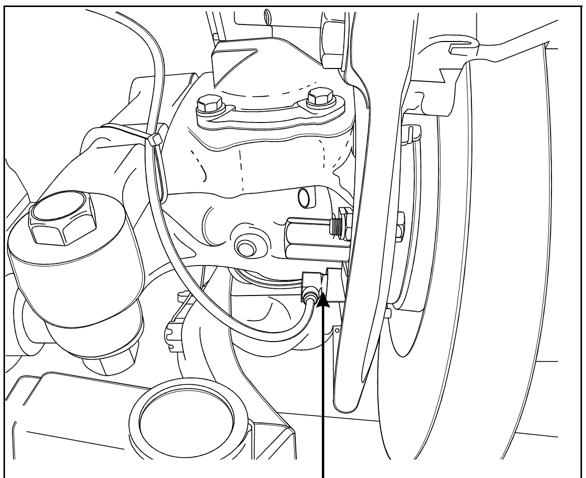


FIGURE 44: ABS SENSOR LOCATION 12153

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.

29.2.4 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 (Prévost #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.

29.2.5 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. 45).

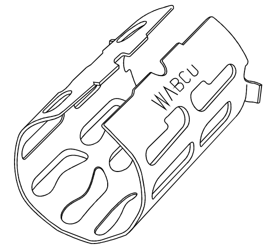


FIGURE 45: SPRING CLIP 12161

Maintenance

The spring clip requires no specific maintenance.

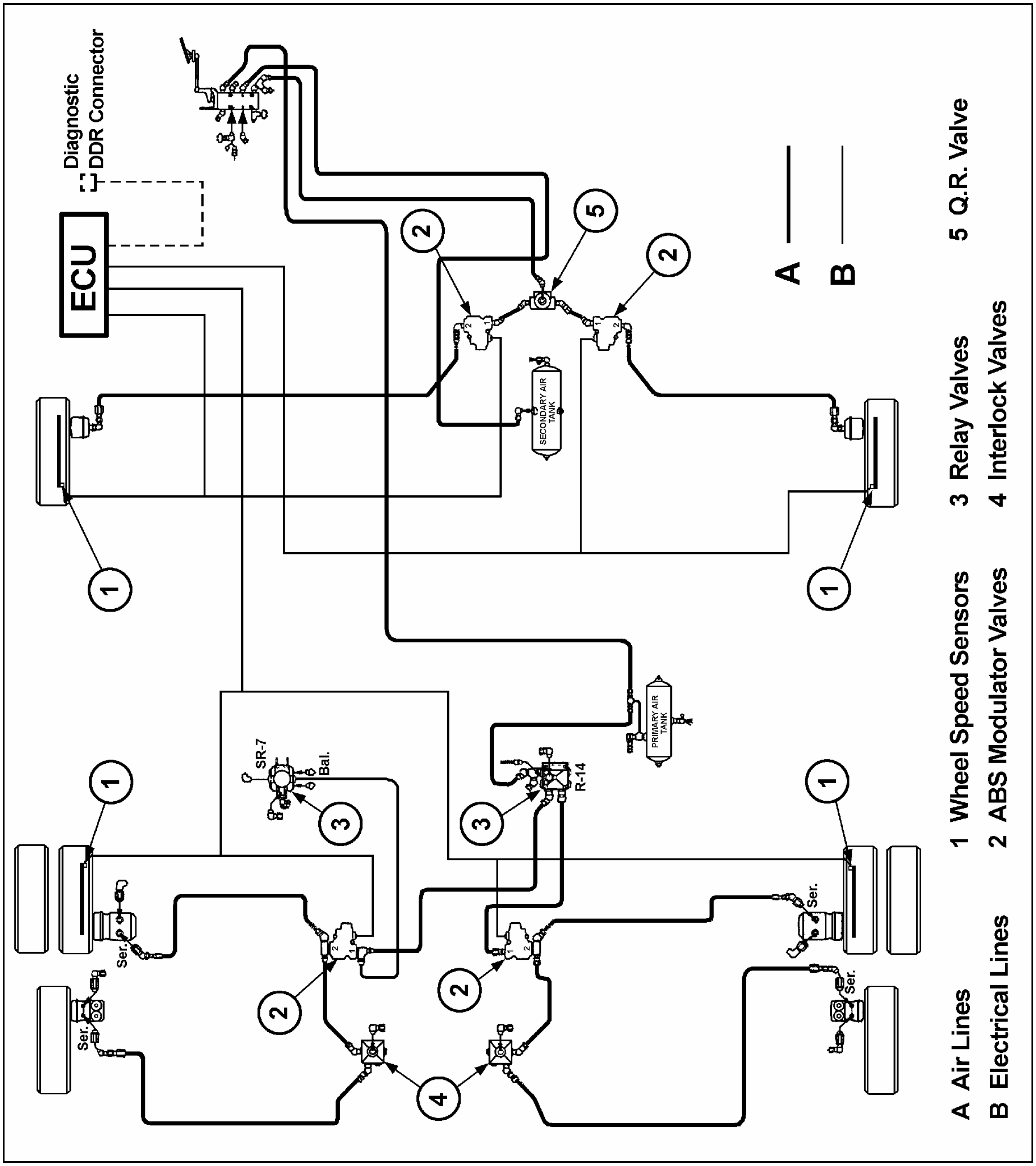


FIGURE 46: ABS 4S/4M CONFIGURATION

30. 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. 47).

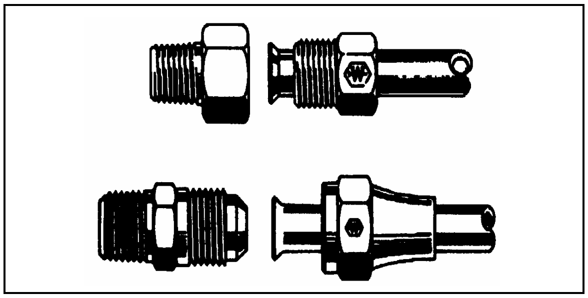


FIGURE 47: HOSE FITTINGS 12053

Compression: Tighten nut by hand (Fig. 48). 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

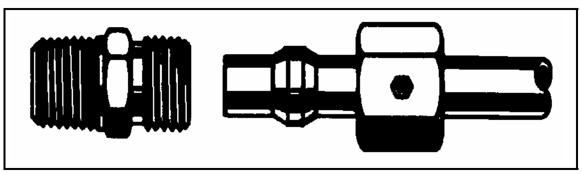


FIGURE 48: HOSE FITTING 12054

NTA-Type Plastic Tubing: Hand tighten nut (Fig. 49). 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

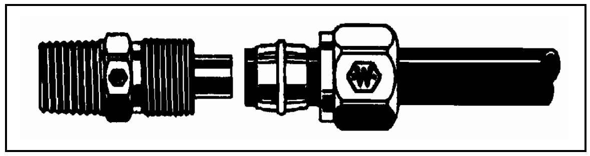


FIGURE 49: HOSE FITTING 12055

AB-Type Copper Piping: Hand tighten nut (Fig. 50). 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

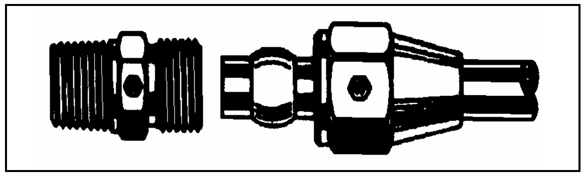


FIGURE 50: HOSE FITTING 12056

Pipe Tightening: All connections must be hand tightened. From that point, tighten a minimum of 2 ½ additional turns.

NOTE
Use Locktite (Prévost number 680098) pipe sealant to seal pipe thread.

31. SPECIFICATIONS

Air Compressor

Make.. Bendix Westinghouse
Model... BA-921
Capacity (at 1250 rpm) ....15.7 cfm (0,445 m^3/min.)
Prévost number.. 641990

BA-921 Service Kits

ST-4 Safety Valve
Prévost number.. 641989

Series 60 Seal Kit
Prévost number.. 641988

Compressor Seal Kit
Prévost number.. 641987

Cylinder Head Gasket Kit
Prévost number.. 641986

Air Dryer

Make.. Haldex
Model...AT-87192
Prévost number.. 70303498
Desiccant cartridge Prévost number.. 3097369

Flip-Flop Control Valve

Make.. Bendix Westinghouse
Model..TW-1
Type ....On-Off
Prévost number.. 640136

Emergency/Parking Brake Control Valve

Make.. Bendix Westinghouse
Model.. PP-1
Automatic release pressure .... 40 psi (275 kPa) nominal
Prévost number.. 641128

Dual Brake Application Valve

Make.. Bendix Westinghouse
Model... E-10P
Prévost number.. 641856

Stoplight Switches

Make.. Bendix Westinghouse
Model..SL-5
Contact close (ascending pressure) ....4 psi and more (28 kPa)
Prévost number.. 641462

Brake Relay Valves

Make.. Bendix Westinghouse
Model..R-12
Prévost number..

Brake Relay Valve

Make...Meritor Wabco
Model..R-14
Prévost number..

Quick Release Valve

Make.. Bendix Westinghouse
Model..QR-1
Prévost number.. 641429

Spring Brake Valve

Make.. Bendix Westinghouse
Model.. SR-7
Prévost number...

Pressure Protection Valve

Make.. Bendix Westinghouse
Model.. PR-4
Nominal closing pressure.. 70 psi (482 kPa)
Prévost number.. 641137

Shuttle-Type Double Check Valve

Make.. Bendix Westinghouse
Model..DC-4
Prévost number.. 641015

Low Pressure Indicators

Make.. Bendix Westinghouse
Model..LP-3
Contact close .... 66 psi (455 kPa)
Prévost 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)
Prévost number.. 641472

Air Filter Element

Make.. Norgren
Type .... With manual drain
Prévost number.. 641338

Front Wheel Brake Chambers

Make...Knorr-Bremse
Type 24
Prévost number (R.H.) 641414
Prévost number (L.H.)... 641413

Drive Axle Brake Chambers

Make...Knorr-Bremse
Type .... 24 as service -24 as emergency
Prévost number.. 641432

Piggy Back (On Drive Brakes)

Make...Knorr-Bremse
Type .... 24 as emergency
Prévost number.. 641433

Tag Axle Brake Chambers

Make .... Knorr-Bremse
Type .... 16 as service – 16 as emergency
Prévost number 641308

Piggy Back (On Tag Brakes)

Make .... Knorr-Bremse
Type .... 16 as emergency
Prévost number 641431

Brake Lining (All Axles)

Make .... Knorr-Bremse
Prévost number 611049
Prévost number 641226

ABS (ANTILOCK BRAKING SYSTEM)

ABS MODULATOR VALVE

Make .... Rockwell Wabco
Voltage .... 24 V
Prévost number 641097

Sensor, Front Wheel

Prévost number 641288

Sensor, Drive Axle (In Wheel End)

Prévost number 641095

Bendix® PREVOST

Effective Date: 12/02/05

Subject: **Bendix Air Disc Brake Pad Replacement on Prévost Car Vehicles**

Prévost 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.

Prévost 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. Prévost 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, Prévost 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 Prévost 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:

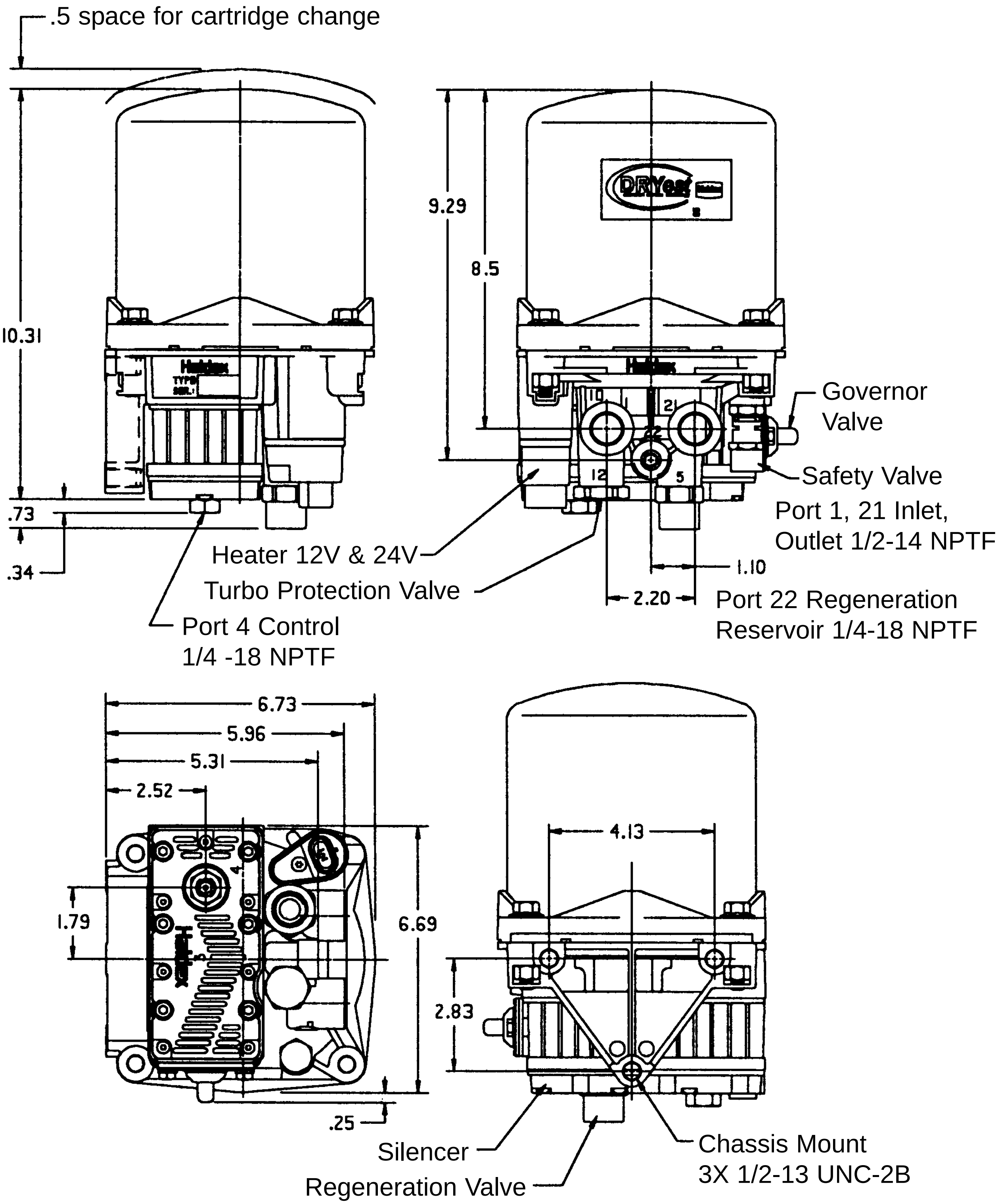
- Avoid creating dust. Compressed air or dry brushing must never be used to clean brake assemblies or the work area.

(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.

Haldex

DRY*est* Air Dryer
Installation and Maintenance



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

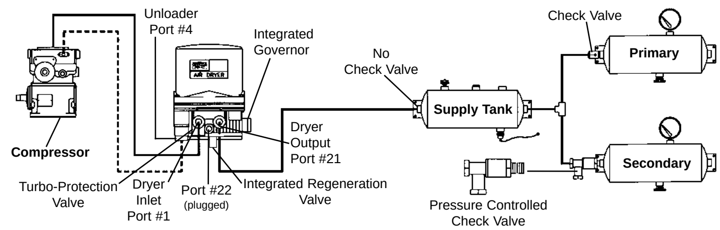


FIG. 2.B System Regeneration with External Governor

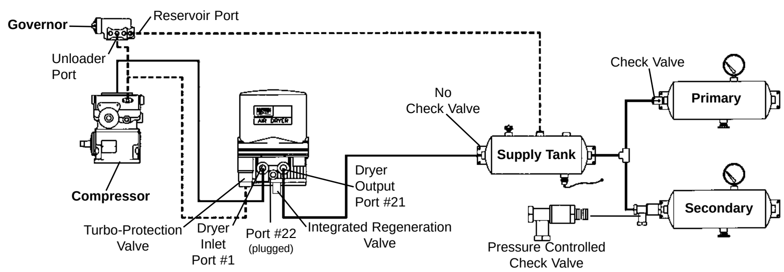


FIG. 2.C External Purge Tank Regeneration with Integrated Governor

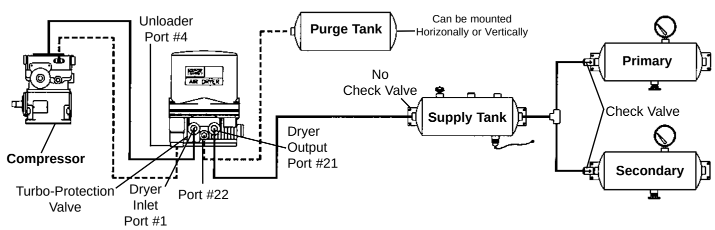


FIG. 2.D External Purge Tank Regeneration with External Governor

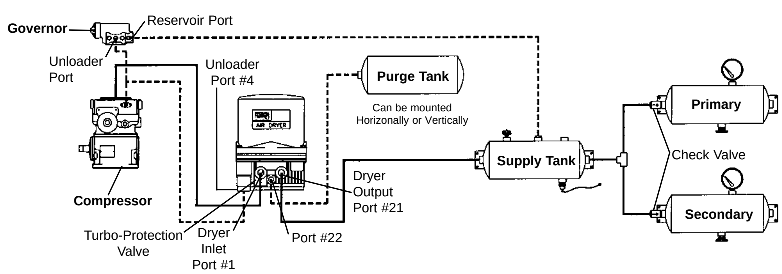


FIG. 2.E. Blow Thru: External Purge Tank with Integrated Governor

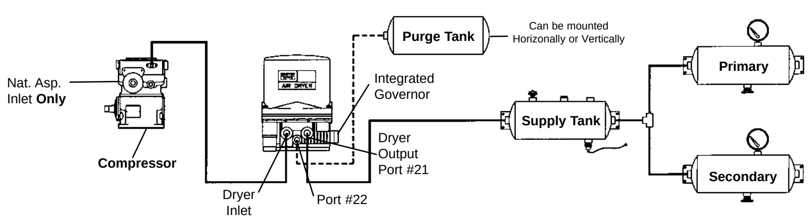
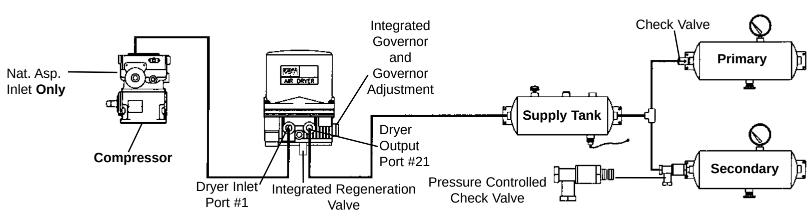


FIG. 2.F. Blow Thru: System Regeneration with Integrated Governor



<u>Installing the DRY*est*</u>

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".

<u>Installing the DRY*est*</u> (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.

<u>Testing the DRY*est*</u>

Before placing the vehicle in service, perform the following tests.

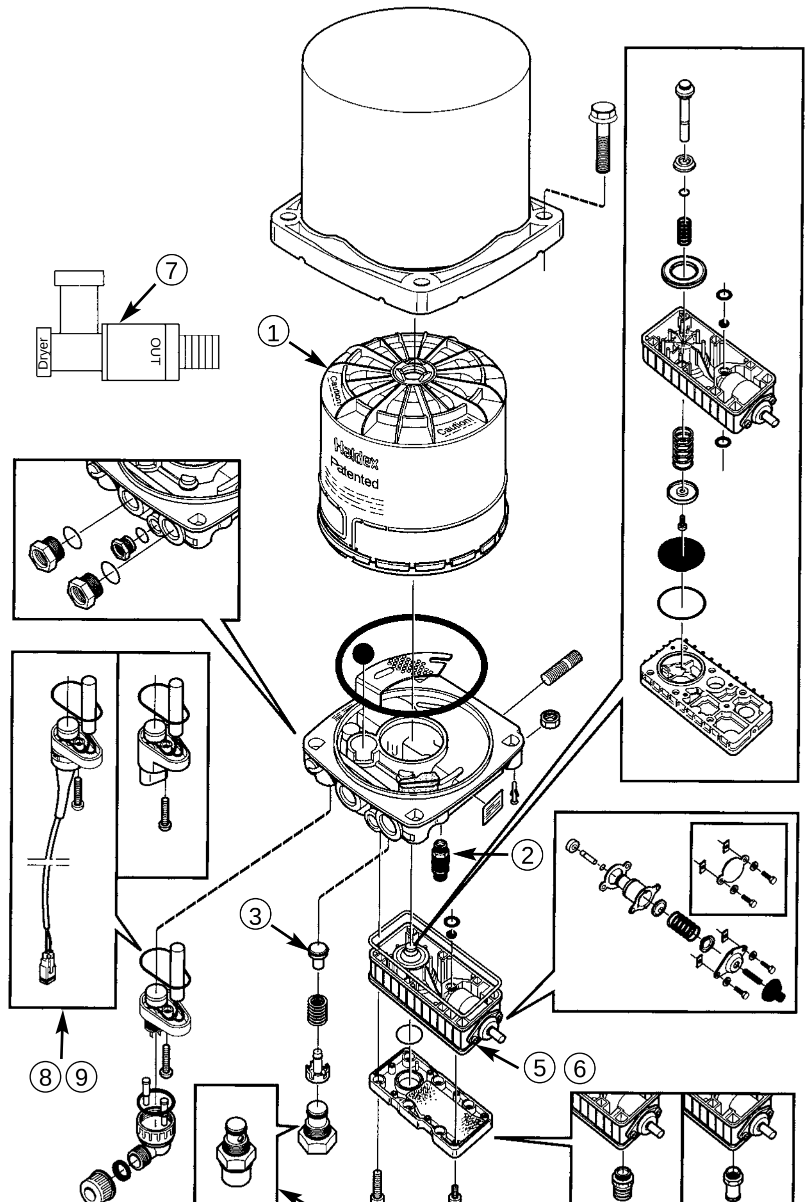
1. Close all reservoir drain cocks.
2. Build up system air pressure to governor cut-out and note that the air dryer purges with an audible exhaust of air. If system 2.E or 2.F is used, the purge will be followed by a steady pulsating flow of air indicating that the system is "unloaded" and is venting 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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Bendix

Service Data

BA-921BENDIX AIR POWER COMPRESSOR

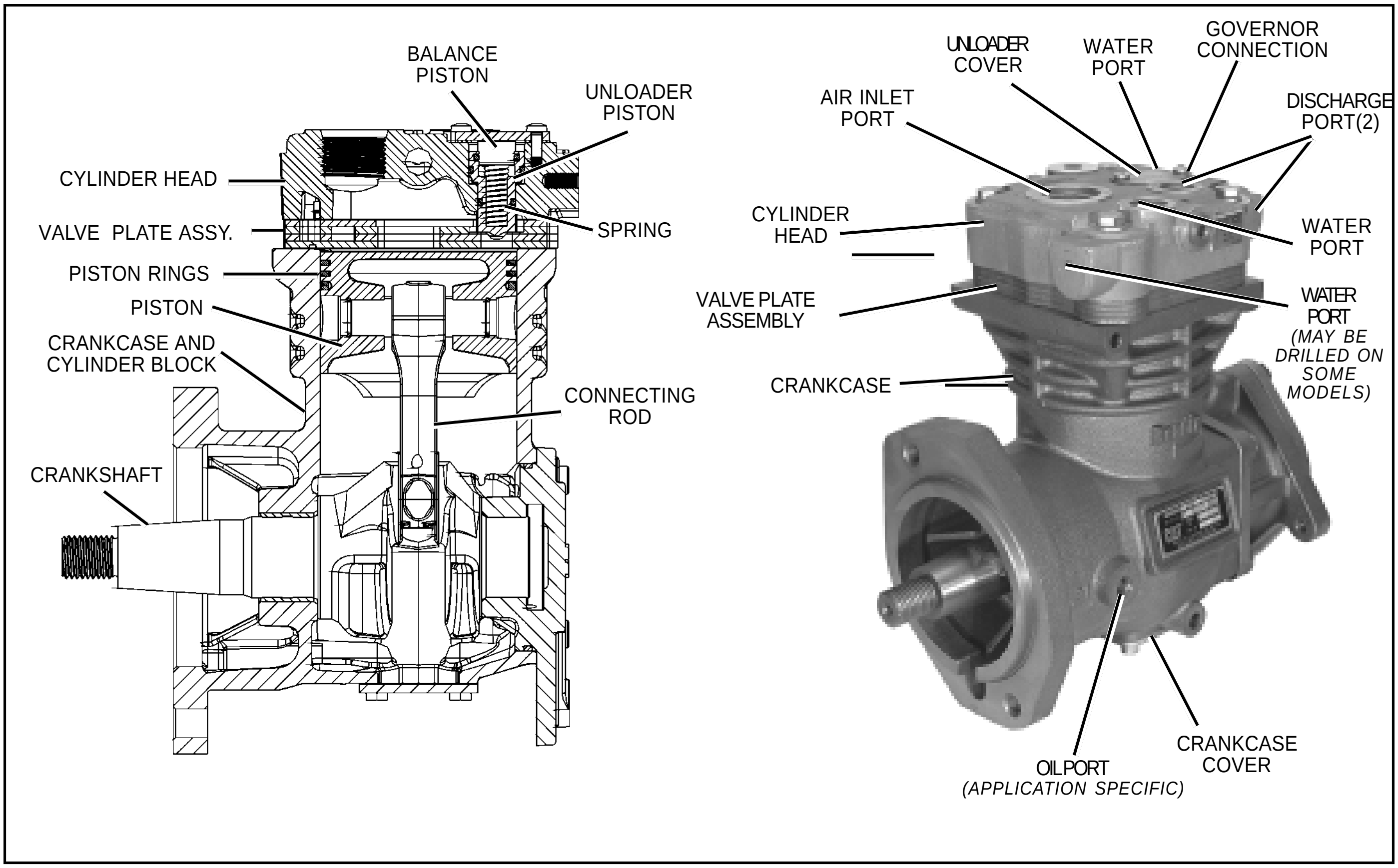


FIGURE 1 - BA-921 COMPRESSOR

DESCRIPTION

The function of the air compressor is to provide and maintain air under pressure to operate devices in the air brake and/or auxiliary air systems. The BA-921 compressor is a single cylinder reciprocating compressor with a rated displacement of 15.8 cubic feet per minute at 1250 RPM.

The compressor consists of a water cooled cylinder head and valve plate assembly and an air cooled integral crankcase and cylinder block. The cylinder head is an aluminum casting which contains the required air and water ports as well as an unloader piston. The valve plate assembly consists of laminated and brazed steel plates which incorporate various valve openings and channels for conducting air and engine coolant into and out of the cylinder head.

The discharge valves are part of the valve plate assembly. The cylinder head, with the valve plate comprise a complete cylinder head assembly.

The cast iron crankcase and cylinder block assembly, houses the piston, connecting rod, crankshaft and related bearings.

The BA-921 crankcase cover is stamped with information identifying the compressor model, customer piece number, Bendix piece number and serial number. See figure 2.

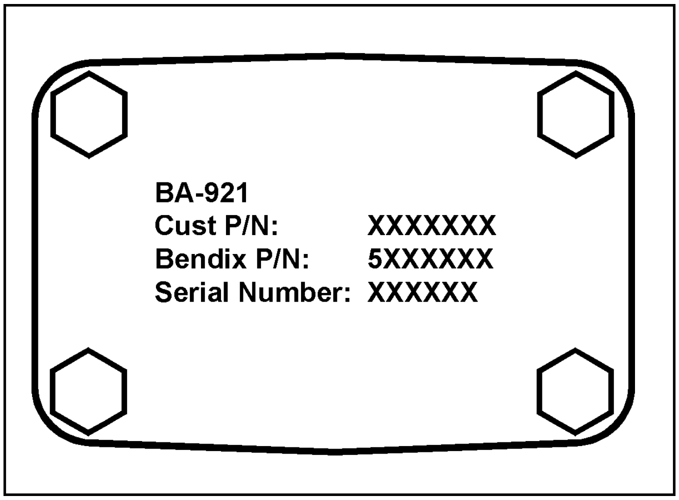


FIGURE 2 - BA-921 CRANKCASE COVER

OPERATION

The compressor is driven by the vehicle engine and functions continuously while the engine is in operation. Actual compression of air is controlled by the compressor unloading mechanism operating in conjunction with a governor.

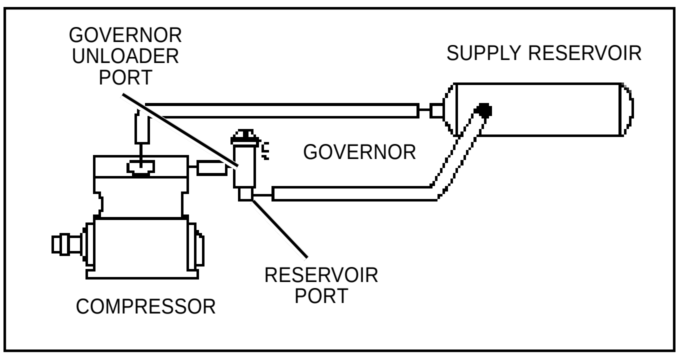


FIGURE 3 - BA-921 COMPRESSOR UNLOADER SYSTEM

AIR INTAKE (LOADED)

During the piston down stroke, a vacuum is created in the cylinder bore above the piston. The vacuum causes the inlet reed valve to flex open. Atmospheric air flows through the open inlet valve and fills the cylinder bore above the piston. See figures 4 & 7.

AIR COMPRESSION (LOADED)

When the piston reaches approximately bottom dead center (BDC), the inlet reed valve closes. Air above the piston is trapped by the closed inlet reed valve and is compressed as the piston begins to move toward top dead center (TDC). When air in the cylinder bore reaches a pressure greater than that of the system pressure the discharge reed valves open and air flows into the discharge line and air brake system.

Air, during the compression stroke, flows into the hollow center of the unloader piston through an opening in the end of the piston. Compressed air acts on the interior surfaces

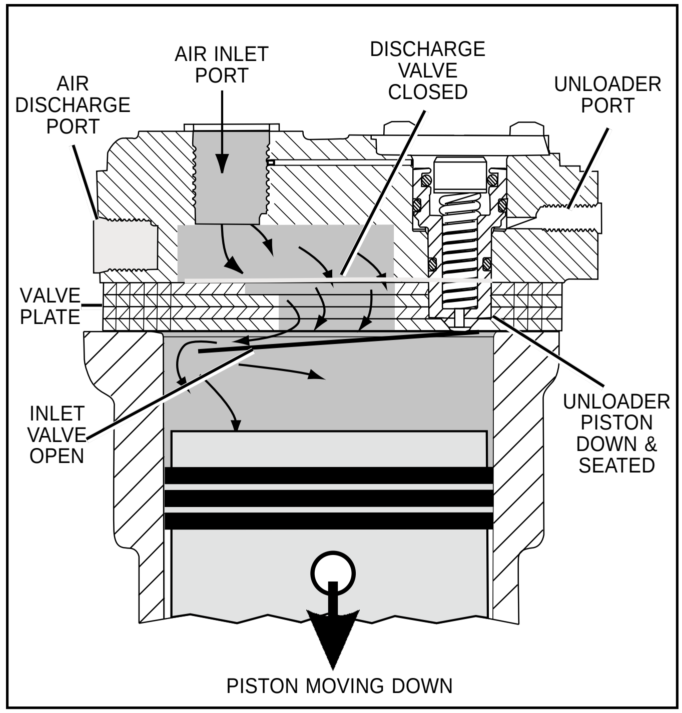


FIGURE 4 - OPERATIONAL-LOADED (INTAKE)

of the unloader piston and, along with the unloader piston spring, holds the unloader piston against its seat on the valve plate. See figures 5 & 7.

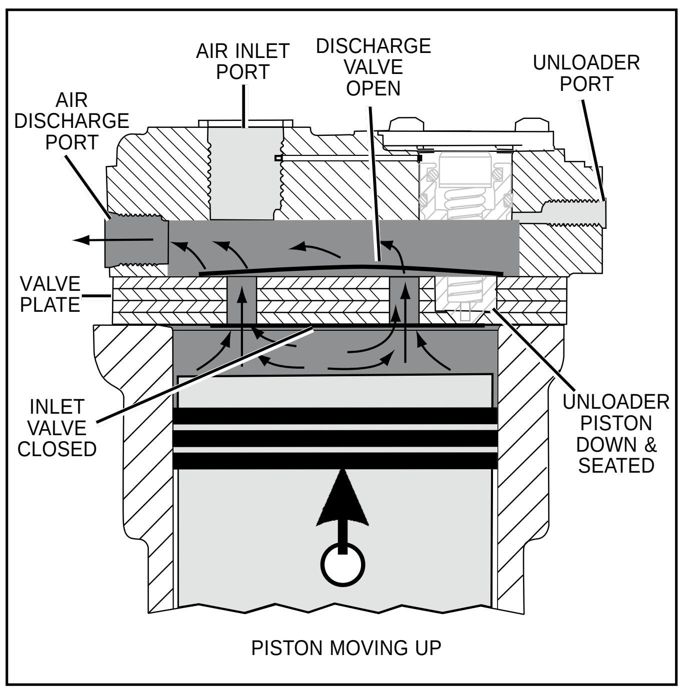


FIGURE 5 - OPERATIONAL-LOADED (COMPRESSION)

NON-COMPRESSION OF AIR (UNLOADED)

When air pressure in the supply reservoir reaches the cut-out setting of the governor, the governor delivers system air to the compressor unloader port. Air entering the unloader port acts on the unloader piston causing it to move away from its seat on the valve plate assembly. When the

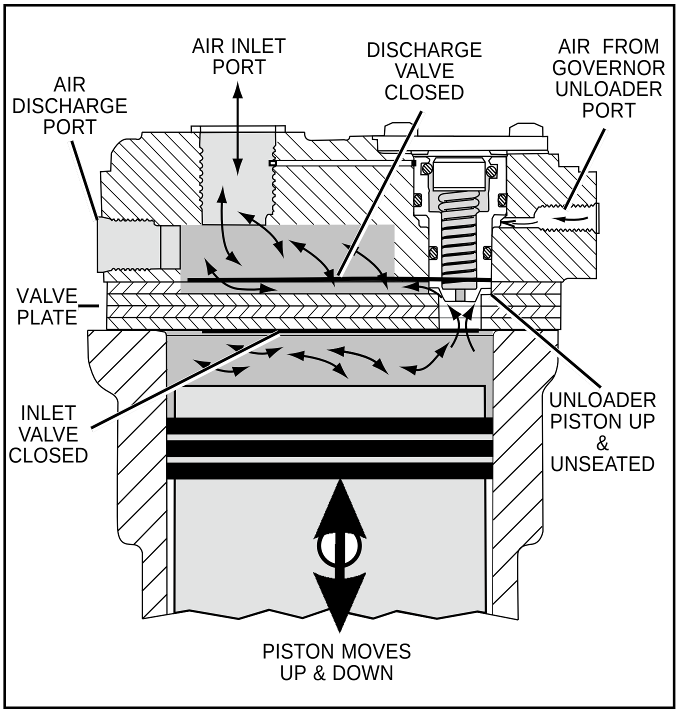


FIGURE 6 - OPERATIONAL-UNLOADED

unloader piston is unseated a passage is opened between the cylinder bore and the air inlet cavity in the cylinder head. Air compression ceases. See figures 6 & 7.

As the piston moves from bottom dead center (BDC) to top dead center (TDC) air in the cylinder bore flows past the unseated unloader piston, into the cylinder head inlet cavity and out the inlet port. On the piston down stroke (TDC to BDC) air flows in the reverse direction, from the inlet cavity past the unseated unloader piston and into the cylinder bore.

LUBRICATION

The vehicle's engine provides a continuous supply of oil to the compressor. Oil is routed from the engine to the compressor oil inlet. An oil passage in the crankshaft conducts pressurized oil to precision sleeve main bearings and to the connecting rod bearings. Spray lubrication of the cylinder bores, connecting rod wrist pin bushings, and ball type main bearings is obtained as oil is forced out around the crankshaft journals by engine oil pressure. Oil then falls to the bottom of the compressor crankcase and is returned to the engine through drain holes in the compressor mounting flange.

COOLING

Cooling fins are part of the crankcase/cylinder block casting. Coolant flowing from the engine cooling system through connecting lines enters the head and passes through internal passages in the cylinder head and valve plate assembly and is returned to the engine. Proper cooling is important in maintaining discharge air temperatures below the maximum recommended 400 degrees Fahrenheit. Figure 8 illustrates

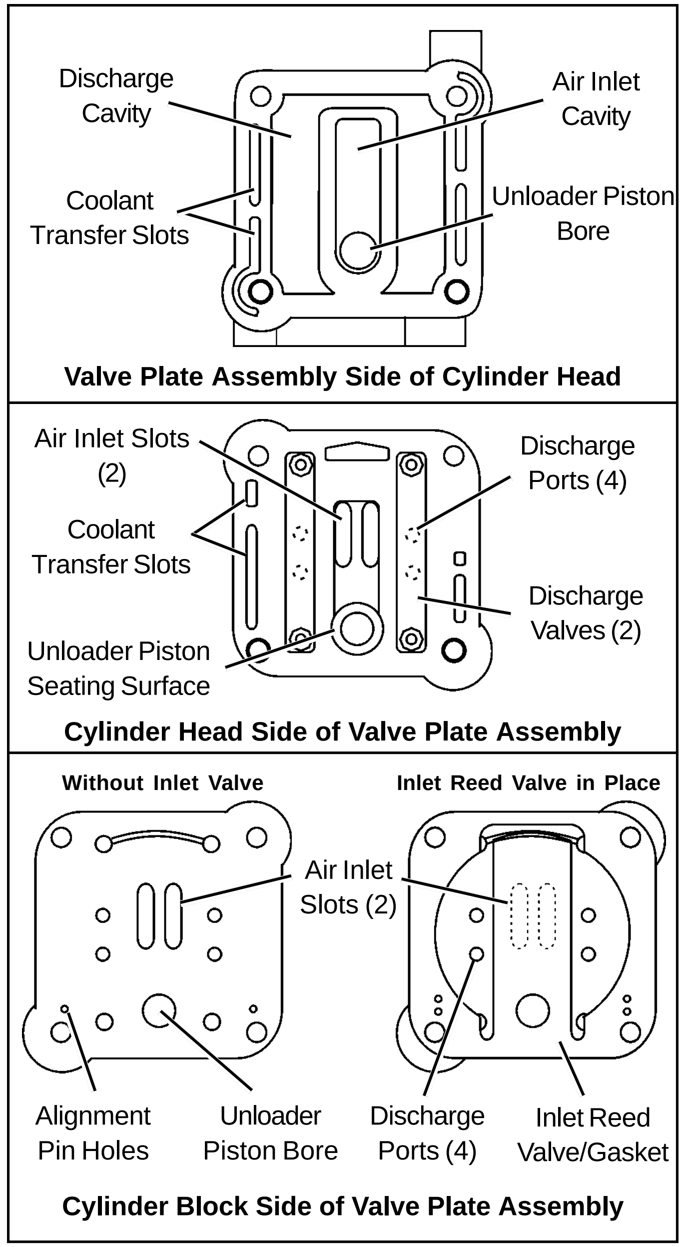


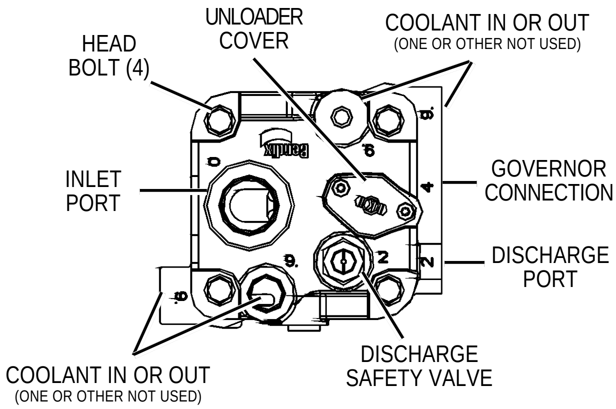
FIGURE 7 - CYLINDER HEAD AND VALVE PLATE ASSY.

the various approved coolant flow connections. See the tabulated technical data in the back of this manual for specific requirements.

PREVENTATIVE MAINTENANCE

Important Note: Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period.

EVERY 6 MONTHS, 1800 OPERATING HOURS OR AFTER EACH 50,000 MILES WHICHEVER OCCURS FIRST PERFORM THE FOLLOWING INSPECTIONS AND TESTS.



CYLINDER HEAD PORT IDENTIFICATION

The cylinder head connection ports are identified with cast in numerals as follows:

Atmospheric AIR IN	0
Compressed AIR OUT	2
Coolant IN or OUT	9
Governor Control	4

FIGURE 8- TYPICAL BA-921 CYLINDER HEAD

AIR INDUCTION

The BA-921 compressor is designed for either natural aspiration (connection to the vacuum side of the engine's air induction system) or turbocharging. When attached to the pressure side of the turbocharger, pressure at the BA-921 inlet port must not exceed 45 psig. See the tabulated technical data in the back of this manual.

One of the single most important aspects of compressor preventive maintenance is the induction of clean air. Since the BA-921 is connected to the engine air cleaner, proper periodic maintenance of the engine air filter eliminates the need for separate filter maintenance.

Inspect the compressor intake fittings, and the connecting hoses each time engine air cleaner maintenance is performed.

1. Inspect the intake hose adapters for physical damage. Make certain to check the adapters at both ends of the intake hose or tubing.
2. The intake hose clamps and tighten them if needed.
3. Inspect the intake hose or line for signs of drying, cracking, chafing and ruptures and replace it if necessary.

COMPRESSOR COOLING

Inspect the compressor discharge port, inlet cavity and discharge line for evidence of restrictions and carboning. If excessive buildup is noted, thoroughly clean or replace the affected parts. Since carbon buildup generally indicates inadequate cooling, closely inspect the compressor cooling system. Check all compressor coolant lines for [redacted]nks and restrictions to flow. **Minimum** coolant line size is 3/8" I.D. Check coolant lines for internal clogging from rust scale. If coolant lines appear suspicious, check the coolant flow and compare to the tabulated technical data present in the back of this manual. Carefully inspect the air induction system for restrictions.

LUBRICATION

Check the external oil supply line for kinks, bends, or restrictions to flow. Supply lines must be a minimum of 3/16" I.D. Refer to the tabulated technical data in the back of this manual for oil pressure minimum values.

COMPRESSOR DRIVE

Check for noisy compressor operation, which could indicate excessive drive component wear. Adjust and/or replace as necessary. Check all compressor mounting bolts and retighten evenly if necessary. Check for leakage and proper unloader mechanism operation. Repair or replace parts as necessary.

COMPRESSOR UNLOADER & GOVERNOR

Test and inspect the compressor and governor unloader system for proper operation and pressure setting.

1. Make certain the unloader system lines are connected as illustrated in figure 3.
2. Cycle the compressor through the loaded and unloaded cycle several times. Make certain that the governor cuts out at its specified pressure (cut in should be approximately 15-20 psi less than cutout pressure). Adjust or replace the governor as required.
3. Note that the compressor cycles to the loaded and unloaded conditions promptly. If prompt action is not noted, repair or replace the governor and/or repair the compressor unloader.

SERVICE TESTS

GENERAL

The following compressor operating and leakage tests need not be performed on a regular basis. These tests should be performed when; it is suspected that leakage is substantially affecting compressor buildup performance, or when it is suspected that the compressor is "cycling" between the load and unloaded modes due to unloader plunger leakage.

OPERATING TESTS

Compressor Performance

Vehicles manufactured after the effective date of FMVSS 121 must have a compressor capable of raising air system pressure from 85-100 psi in 25 seconds or less, with the minimum required reservoir volume for the vehicle. This test is performed with the engine operating at maximum recommended governed speed. The vehicle manufacturer must certify this performance on new vehicles with appropriate allowances for air systems with greater than the minimum required reservoir volume. As a less severe alternative to running a high RPM test, a new compressor's buildup time can be measured and recorded at high idle. Subsequent testing throughout the compressor's service life can be compared to the base line new compressor performance. Compressor buildup times should be recorded and kept with the vehicle maintenance files for reference. When testing compressor buildup times it is essential that air system leakage be kept below the allowed maximum for the vehicle type being tested. Before running buildup tests check the service and supply systems for excessive leakage and repair as necessary.

> **Note:** Supply system leakage is not displayed on the vehicle dash gauges and must be tested separately. Supply system components such as the governor, air dyer, reservoir drain cocks, safety valve and check valves can leak without indication on the dash gauges. These components must be checked for leakage separately and individually. Refer to the various maintenance manuals for individual component leakage tests and the Bendix "Test and Checklist" published in the Air Brake System Handbook (BW5057) for air system leakage testing.

LEAKAGE TESTS

Cylinder Head

Check for cylinder head gasket air leakage.

1. With the engine running, lower air system pressure to 60 psi and apply a soap solution around the cylinder head. Check the gasket between the cylinder head and valve plate assembly and the reed valve/gasket between the valve plate assembly and cylinder block for air leakage.
2. No leakage is permitted. If leakage is detected replace the compressor or repair the cylinder head using a genuine Bendix maintenance kit available from an authorized Bendix parts outlets.

Unloader

In order to test the inlet and discharge valves and the unloader piston, it is necessary to have shop air pressure and an assortment of fittings. A soap solution is also required.

Build-Up tests

1. With the engine running, lower air system pressure to 90 psi and raise engine RPM to 1800. Measure and record the time required to raise system pressure from 100 psi to 130 psi Run this test three times and use the average time.

   Note: This test should be run with the engine and air system at normal operating temperature (i.e. not cold).
2. Compare the average time recorded in step 2 with previously recorded build up times to evaluate compressor performance.

Unloader leakage is exhibited by excessive compressor cycling between the loaded and unloaded condition.

1. With service and supply system leakage below the maximum allowable limits and the vehicle parked, bring system pressure to governor cutout and allow the engine to idle.
2. The compressor should remain unloaded for a minimum of 5-10 minutes. If compressor cycling occurs more frequently and service and supply system leakage is within tolerance replace the compressor or repair the compressor unloader system using a genuine Bendix maintenance kit available from authorized Bendix parts outlets.

COMPRESSOR REMOVAL & DISASSEMBLY

GENERAL

The following disassembly and assembly procedure is presented for reference purposes and presupposes that a rebuild or repair of the compressor is being undertaken. Several maintenance kits are available and the instructions provided with these parts and kits should be followed in lieu of the instructions presented here.

MAINTENANCE KITS & SERVICE PARTS

Cylinder Head Gasket Kit.

Unloader Kit.

Governor Adapter Kit.

Safety Valve.

Seal Kits.

All components shown in figure 9 with a key number are available in kits and/or as individual service parts.

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.**

REMOVAL

In many instances it may not be necessary to remove the compressor from the vehicle when installing the various maintenance kits and service parts. The maintenance technician must assess the installation and determine the correct course of action.

These instructions are general and are intended to be a guide. In some cases additional preparations and precautions are necessary. In all cases follow the instructions contained in the vehicle maintenance manual in lieu of the instructions, precautions and procedures presented in this manual.

1. Block the wheels of the vehicle and drain the air pressure from all the reservoirs in the system.
2. Drain the engine cooling system and the cylinder head of the compressor. Identify and disconnect all air, water and oil lines leading to the compressor.
3. Remove as much road dirt and grease from the exterior of the compressor as possible.
4. Remove the discharge and inlet fittings, if applicable, and note their position on the compressor to aid in reassembly.

   Note: If a cylinder head maintenance kit is being installed, stop here and proceed to PREPARATION FOR DISASSEMBLY. If replacing the compressor continue.
3. Remove any supporting bracketing attached to the compressor and note their positions on the compressor to aid in reassembly.
5. Remove the flange mounting bolts and remove the compressor from the vehicle.
6. Inspect gear and associated drive parts for visible wear or damage. Since these parts are precision fitted, they must be replaced if they are worn or damaged. If replacing the compressor or replacing the drive gear, remove the drive gear from the compressor crankshaft using a gear puller.
7. If the compressor is being replaced stop here and proceed to "Installing The Compressor" at the end of the assembly procedure.

PREPARATION FOR DISASSEMBLY

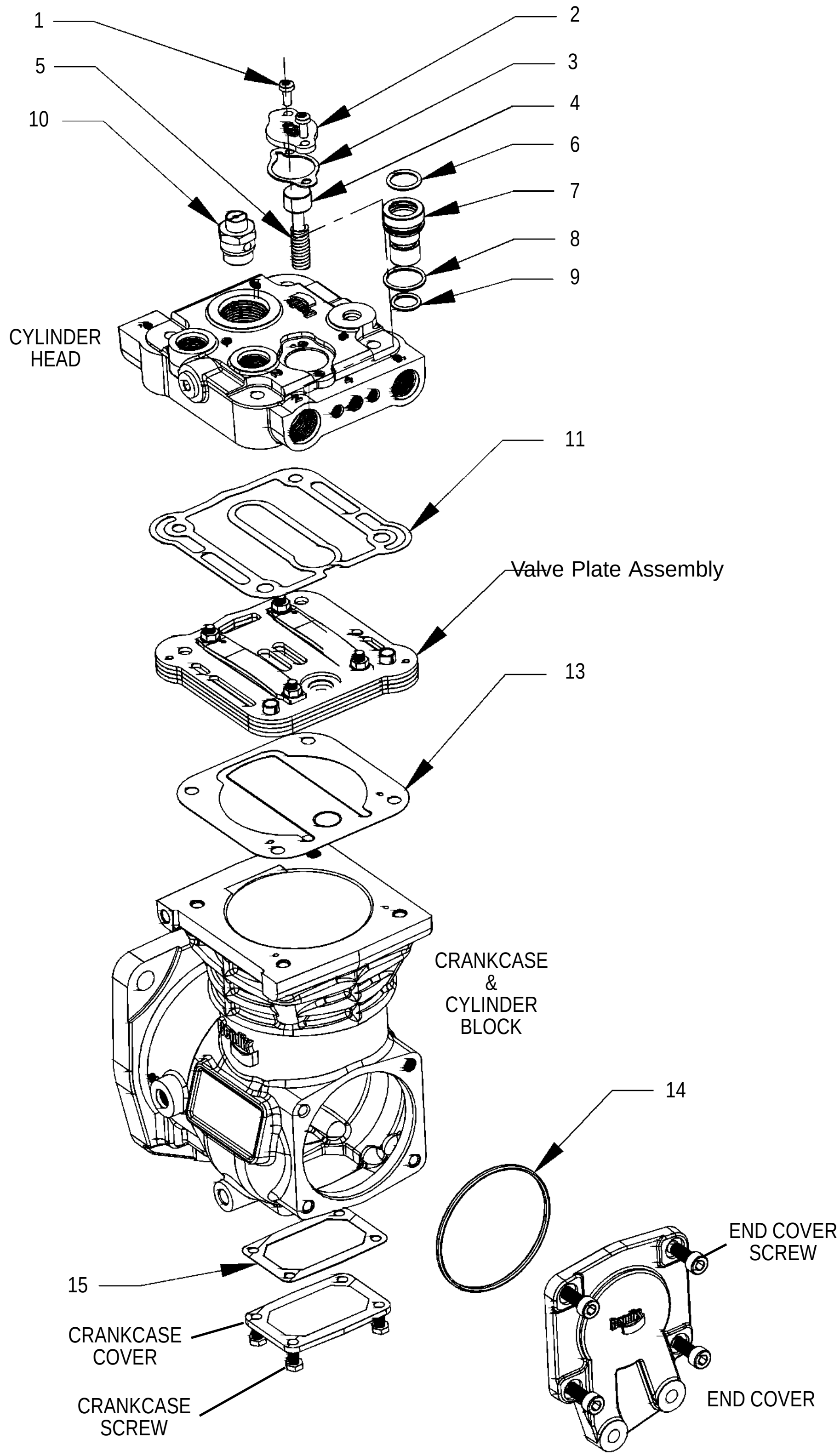
Remove the balance of road dirt and grease from the exterior of the compressor with a cleaning solvent. Mark the rear end cover or end cover adapter in relation to the crankcase. It is recommended but not specifically necessary to mark the relationship of the cylinder head to the valve plate assembly and crankcase and cylinder block assembly.

A convenient method to indicate the above relationships is to use a metal scribe to mark the parts with numbers or lines. Do not use marking methods such as chalk that can be wiped off or obliterated during rebuilding.

Prior to disassembly make certain that the appropriate kits and or replacement parts are available. Refer to figure 9 during the entire disassembly and assembly procedure.

CYLINDER HEAD

1. Remove the discharge safety valve (10) from the cylinder head.
2. To restrain the spring force exerted by balance piston spring (5), hold the unloader cover (2) in place while removing the two unloader cover cap screws (1). Carefully release the hold on the unloader cover until the spring force is relaxed, then remove the unloader cover (2).
3. Remove the unloader cover gasket (3).



Item	Qty.	Description	Item	Qty.	Description	Item	Qty	Description
1	2	Unloader Cover Cap Screw	6	1	O-Ring	11	1	Head Gasket
2	1	Unloader Cover	7	1	O-Ring	12	--	Intentionally Left Blank
3	1	Unloader Cap Gasket	8	1	Unloader Piston	13	1	Inlet Reed Valve/Gasket
4	1	Unloader Balance Piston	9	1	O-Ring	14	1	O-Ring
5	1	Spring	10	1	Safety Valve	15	1	Bottom Cover Gasket

FIGURE 9- BA-921 EXPLODED VIEW OF SERVICEABLE PARTS

4. Remove the balance piston (4) and its spring (5) from the cylinder head.
5. Remove the four hex head bolts and washers from the cylinder head.
6. Gently tap the head and valve plate assembly with a soft mallet to break the gasket seal. Lift the cylinder head and valve plate assembly (12) off the cylinder block.
7. Remove the metal reed valve/gasket (13).
8. Gently tap the head and valve plate assembly (12) with a soft mallet to break the gasket seal. Then separate the cylinder head from the valve plate assembly (12) and remove the gasket (11).
9. Turn the aluminum cylinder head over to expose the interior portion of the head. Push the unloader piston (8) along with its o-rings (6, 7 & 9) out of the cylinder head.

CRANKCASE COVER

1. Remove the four crankcase cover cap screws securing the crankcase cover to the crankcase. Using a soft mallet, gently tap the crankcase cover to break the gasket seal. Remove the crankcase cover gasket (15).

REAR END COVER OR END COVER ADAPTER

1. Remove the four end cover cap screws that secure the rear end cover or end cover adapter to the crankcase.
2. Remove the rear end cover or end cover adapter from the crankcase. Remove the o-ring seal (14) from the end cover.

CLEANING OF PARTS

GENERAL

All parts should be cleaned in a good commercial grade of solvent and dried prior to inspection.

CYLINDER HEAD

1. Carefully remove all gasket material adhering to the aluminum cylinder head, steel valve plate assembly and cast iron cylinder block. Make certain not to deeply scratch or mar the gasket surfaces. Pay particular attention to the gasket surfaces of the aluminum head.
2. Remove carbon deposits from the discharge and inlet cavities of the cylinder head and valve plate assembly. They must be open and clear in both assemblies. Make certain not to damage the aluminum head.
3. Remove rust and scale from the cooling cavities and passages in the head and valve plate assembly (12) and use shop air to clear debris from the passages.
4. Check the threads in all cylinder head ports for galling. Minor chasing is permitted.
5. Make certain the unloader vent passage under the unloader cover (2) in the head is open and free of debris.

INSPECTION OF PARTS

CYLINDER HEAD & VALVE PLATE

1. Carefully inspect the cylinder head gasket surfaces for deep gouges and nicks. If detected, the compressor must be replaced.
2. Carefully inspect the valve plate assembly gasket surfaces for deep gouges and nicks. Pay particular attention to the metal gasket surface. A metal gasket (18) is used between the valve plate assembly and cylinder block. This surface must be smooth and free of all but the most minor scratching. If excessive marring or gouging is detected, the compressor must be replaced.
3. Inspect the cylinder head for cracks or damage. With the cylinder head and head gasket secured to the valve plate assembly, apply shop air pressure to one of the coolant ports with all others plugged, and check for leakage by applying a soap solution to the exterior of the head. If leakage is detected in the cylinder head casting, replace the compressor.

END COVER OR END COVER ADAPTER

Check for cracks and external damage. Check the crankshaft main bearing surface in the end cover or end cover adapter, check for excessive wear and flat spots and replace the end cover if necessary. Check for galling of the oil port threads and replace the end cover or end cover adapter if necessary. Minor thread chasing is permitted but do not “recut” the threads if they are badly damaged.

CYLINDER BLOCK

1. Check the cylinder head gasket surface on the cylinder block for nicks, gouges, and marring. A metal gasket is used to seal the cylinder head to the cylinder block. This surface must be smooth and free of all but the most minor scratching. If excessive marring or gouging is detected, the compressor must be replaced.

ASSEMBLY

General Note: All torques specified in this manual are assembly torques and typically can be expected to fall off after assembly is accomplished. **Do not re-torque** after initial assembly torques fall unless instructed otherwise. A compiled listing of torque specifications is presented at the end of this manual.

INCH POUNDS TO FOOT POUNDS

To convert inch pounds to foot pounds of torque, divide inch pounds by 12.

Example: $\frac{12 \text{ Inch Pounds}}{12} = 1 \text{ Foot Pound}$

FOOT POUNDS TO INCH POUNDS

To convert foot pounds to inch pounds of torque, multiply foot pounds by 12.
Example: 1 Foot Pound x 12 = 12 Inch Pounds

CRANKCASE COVER

1. Position the crankcase cover gasket (15) on either the crankcase or crankcase cover and install the crankcase cover on the crankcase using the four cap screws. "Snug" the four cap screws then torque to 62-71 inch pounds using a crossing pattern.

CRANKCASE END COVER OR ADAPTER

1. Install the end cover o-ring (14) on the crankcase end cover.
2. Orient the crankcase end cover or end cover adapter to the crankcase using the reference marks made during disassembly. Carefully install the end cover or end cover adapter in the crankcase making certain not to damage the crankshaft bearing surface in it.
3. Install the four end cover screws or studs. "Snug" the screws then tighten to 195 to 213 inch pounds using a crossing pattern.

CYLINDER HEAD

1. Note the position of the protruding alignment pins on the cylinder block. Install the metal inlet reed valve/gasket (13) over the alignment pins on the cylinder block.
2. Position the valve plate assembly (12) on the cylinder block so that the alignment pins in the cylinder block fit into the corresponding holes in the valve plate assembly (12).
3. Position and install the metal gasket (11) over the alignment bushings protruding from the valve plate assembly (12). When properly installed, the outline of the gasket matches the outline of the valve plate.
4. Position and install the cylinder head over the alignment bushings protruding from the valve plate assembly (12).

   Note: The alignment bushings will only fit into two of the four cylinder head bolt holes.
5. Install the four hex head cylinder head bolts and washers and snug them, then tighten evenly to a torque of 265 to 292 inch pounds using a crossing pattern.
6. Install the unloader piston (8) with its pre-installed o-rings in the cylinder head making certain not to damage them in the process.
7. Install the balance piston spring (5) in the unloader piston (8), then install the small diameter of the balance piston (4) through the center of the spring.
8. Install the unloader cover gasket (3) on the cylinder head making certain the unloader vent passage and both screw holes align.
9. Position the unloader cover (2) on top of the balance piston (4) making certain the stamped logo is visible.
10. Press and hold the unloader cover (2) in place on the cylinder head and install both unloader cover cap screws (1). Torque the cover cap screws (1) to 62 to 71 inch pounds.

INSTALLING THE COMPRESSOR

1. If the compressor was removed for replacement, install the drive components. **Torque the crankshaft nut to 250 foot pounds.**
2. Install any supporting bracketing on the compressor in the same position noted and marked during removal.
3. Install the gasket on the drive flange of the compressor. Make certain oil supply or return holes in the gasket are properly aligned with the compressor and engine. Gasket sealants are not recommended. Secure the compressor on the engine and tighten the mounting bolts.
4. Install the discharge, inlet and governor adapter fittings, if applicable, in the same position on the compressor noted and marked during disassembly. Make certain the threads are clean and the fittings are free of corrosion. Replace as necessary. See the Torque Specifications for various fitting sizes and types of thread at the rear of this manual.
5. Inspect all air, oil, and coolant lines and fittings before reconnecting them to the compressor. Make certain o-ring seals are in good or new condition. Tighten all hose clamps.
6. Clean oil supply line. Before connecting this line to the compressor. Run the engine briefly to be sure oil is flowing freely through the supply line.
7. Before returning the vehicle to service, perform the Operation and Leakage Tests specified in this manual. Pay particular attention to all lines reconnected during installation and check for air, oil, and coolant leaks at compressor connections. Also check for noisy operation.

TESTING REBUILT COMPRESSOR

In order to properly test a compressor under operating conditions, a test rack for correct mounting, cooling, lubricating, and driving the compressor is necessary. Such tests are not compulsory if the unit has been carefully rebuilt by an experienced person. A compressor efficiency or build up test can be run which is not too difficult. An engine lubricated compressor must be connected to an oil supply line of at least 15 psi. pressure during the test and an oil return line must be installed to keep the crankcase drained. Connect to the compressor discharge port, a reservoir with a volume of 1500 cubic inches, including the volume of the connecting line. With the compressor operating at 2100

RPM., the time required to raise the reservoir(s) pressure from 85 psi to 100 psi should not exceed 5 seconds. During this test, the compressor should be checked for gasket leakage and noisy operation, as well as unloader operation and leakage. If the compressor functions as indicated reinstall on the vehicle connecting all lines as marked in the disassembly procedure.

BA-921 SPECIFICATIONS

Typical weight .... 28 lbs.
Number of cylinders 1
Bore Diameter .... 92mm (3.622 in.)
Stroke .... 54 mm (2.125 in.)
Calculated displacement at 1250 RPM .... 15.8 CFM
Flow Capacity @ 1800 RPM & 120 PSI .... 11.8 CFM
Flow Capacity @ 3000 RPM & 120 PSI .... 18.0 CFM
Maximum recommended RPM .... 3000 RPM
Minimum coolant flow maximum RPM ...... 1.3 Gals./Min.
Approximate horsepower required:
Loaded 1800 RPM at 120 PSIG .... 4.5 HP
Unloaded 1800 RPM .... 1.3 HP
Maximum inlet air temperature .... 250 F°
Maximum discharge air temperature .... 400 F°
Minimum oil pressure required at
engine idling speed .... 15 PSI
Minimum oil pressure required at
maximum governed engine speed .... 15 PSI
Minimum oil-supply line size .... 3/16" I.D.
Minimum unloader-line size .... 3/16" I.D.
Minimum Governor Cutout Pressure .... 90 PSI

TORQUE SPECIFICATIONS

Assembly Torques in inch pounds (in. lbs.)
M8x1.25-6g Cylinder Head .... 265 - 292
M5x0.75-6g Unloader Cap .... 62 - 71
M8x1.25-6g Governor Adapter .... 133 - 142
M8x1.25-6g Rear End Cover .... 195 - 213
M6x1.00-6g Crankcase Cover .... 62 - 71
M20x2.50-6g Crankshaft Nut .... 1858 - 2567
Inlet Port Fittings
7/8"-12 UNF .... 221 - 248
3/4"-14 NPT .... 2 - 3 TFFT[1]
Discharge Port Fittings
7/8"-12 UNF .... 221 - 248
3/4"-14 NPT .... 2 - 3 TFFT[1]
Water Port Fittings
3/4"-16 UNF .... 221 - 248
3/8"-18 NPT .... 2 - 3 TFFT[1]
Unloader Port Fittings
1/8"-27 NPT .... 2 - 3 TFFT[1]
Safety Valve Port
3/4"-16 UNF .... 221 - 248
1/2"-14 NPT .... 2 - 3 TFFT[1]
Oil Port 7/16"-16 UNF .... 177 - 204

[1]Note: TFFT = Turns From Finger Tight

COMPRESSOR TROUBLESHOOTING CHART

SYMPTOMS	CAUSE	REMEDY
1. Compressor passes excessive oil as evidenced by presence of oil at the exhaust ports of valving.	A. Restricted air intake.	A. Check engine air cleaner and replace if necessary. Check compressor air inlet for kinks, excessive bends and be certain inlet lines have minimum specified inside diameter. Recommended maximum air inlet restriction is 25" of water.
	B. Restricted oil return to engine.	B. Oil return to the engine should not be in any way restricted. Make certain oil drain passages in the compressor and mating engine surfaces are unobstructed and aligned. Correct gaskets must be used. Special care must be taken when seal ants are used with, or instead of, gaskets.
	C. Poorly filtered inlet air.	C. Check for damaged, defective or dirty air filter on engine or compressor. Check for leaking, damaged or defective compressor air intake components (e.g. induction line, fittings, gaskets, filter bodies, etc.). The compressor intake should not be connected to any part of the exhaust gas recirculation (E.G.R.) system on the engine.
	D. Insufficient compressor cooling (compressor runs hot).	D. For water-cooled portions of the compressor: 1. Check for proper coolant line sizes. Minimum recommended size is 3/8" I.D. tubing. 2. Check the coolant flow through the compressor. Minimum allowable flow is 2.5 gallons per minute at engine governed speed. If low cool ant flow is detected, inspect the coolant lines and fittings for accumulated rust scale, kinks and restrictions. 3. Water temperature should not exceed 200 degrees Fahrenheit. 4. Optimum cooling is achieved when engine coolant flows, as shown in Figure 8 of this manual.
	E. Contaminants not being regularly drained from system reservoirs.	E. Check reservoir drain valves to insure that they are functioning properly. It is recommended that the vehicle should be equipped with functioning automatic drain valves, or have all reservoirs drained to zero (0) psi daily, or optimally to be equipped with a desiccant-type air dryer prior to the reservoir system.

COMPRESSOR TROUBLESHOOTING CHART (Continued)

SYMPTOMS	CAUSE	REMEDY
1. (Continued.)	F. Compressor runs loaded an excessive amount of time.	F. Vehicle system leakage should not exceed industry standards of 1 psi pressure drop per minute without brakes applied and 3 psi pressure drop per minute with brakes applied. If leakage is excessive, check for system leaks and repair.
	G. Excessive engine crankcase pressure.	G. Test for excessive engine crankcase pressure & replace or repair ventilation components as necessary. (An indication of crankcase pressure is a loose or partially lifted dipstick.)
	H. Excessive engine oil pressure.	H. Check the engine oil pressure with a test gauge and compare the reading to the engine specifications. Bendix does not recommend restricting the compressor oil supply line because of the possibility of plugging the restriction with oil contaminants. Minimum oil supply line size is 3/16" I.D. tubing.
	I. Faulty compressor.	I. Replace or repair the compressor only after making certain none of the preceding installation defects exist.
2. Noisy compressor operation.	A. Loose drive gear or components.	A.. Inspect the fit of the drive gear on the compressor crankshaft. The gear or coupling must be completely seated and the crankshaft nut must be tight. If the compressor crankshaft surface is damaged, it is an indication of loose drive components. If damage to the compressor crankshaft is detected, replace the compressor. When installing the drive gear or pulley, torque the crankshaft nut to the appropriate torque specifications and use care when pressing drive components onto the crankshaft. Do not back off the crankshaft nut once it is tightened to the proper torque. Do not use impact wrenches to install the crankshaft nut.
	B. Excessively worn drive couplings or gears.	B. Inspect drive gear and couplings and engine for excessive wear. Replace as necessary. (Nonmetallic gears should be replaced when the compressor is changed.)
	C. Compressor cylinder head or discharge line restrictions.	C. Inspect the compressor discharge port and discharge line for carbon build-up. If carbon is detected, check for proper cooling to the compressor. (See Cause and Remedy (D) under Symptom #1.) Inspect the discharge line for kinks and restrictions. Replace discharge line as necessary.

COMPRESSOR TROUBLESHOOTING CHART (Continued)

SYMPTOMS	CAUSE	REMEDY
2. (Continued.)	D. Worn or burned out bearings.	D. Check for proper oil pressure in the compressor. Minimum required oil pressure; 15 psi engine idling, 15 psi maximum governed engine rpm. Check for excessive oil temperature—should not exceed 240 degrees Fahrenheit.
	E. Faulty compressor.	E. Replace or repair the compressor after determining none of the preceding installation defects exist.
3. Excessive build-up and recover time. Compressor should be capable of building air system from 85-100 psi in 40 seconds with engine at full governed rpm. Minimum compressor performance is certified to meet Federal requirements by the vehicle manufacturer. Do not downsize the original equipment compressor.	A. Dirty induction air filter.	A. Inspect engine or compressor air filter and replace if necessary.
	B. Restricted induction line.	B. Inspect the compressor air induction line for kinks and restrictions and replace as necessary.
	C. Restricted discharge line or compressor discharge cavity.	C. Inspect the compressor discharge port and line for restrictions and carbon build-up. If a carbon build-up is found, check for proper compressor cooling. Replace faulty sections of the discharge line.
	D. Slipping drive components.	D. Check for faulty drive gears and couplings and replace as necessary. Check the condition of drive belts and replace or tighten, whichever is appropriate.
	E. Excessive air system leakage.	E. Test for excessive system leakage and repair as necessary. Use the following as a guide: Build system pressure to governor cutout and allow the pressure to stabilize for one minute. Using the dash gauge, note the system pressure and the pressure drop after two minutes. The pressure drops should not exceed: 1. 2 psi in each reservoir for a single vehicle. 2. 6 psi in each reservoir for a tractor and trailer. 3. 8 psi in each reservoir for a tractor and 2 trailers.
	F. Sticking unloader pistons.	F. Check the operation of the unloading mechanism. Check for proper operation of the compressor air governor. Make certain the air connections between the governor and compressor are correct. Refer to figure 3. If the governor is operating properly, replace the unloader mechanism. Inspect for bent, linked or blocked tubing leading to or from the governor.
	G. Faulty compressor.	G. Replace or repair the compressor after determining none of the preceding installation defects exist.

COMPRESSOR TROUBLESHOOTING CHART (Continued)

SYMPTOMS	CAUSE	REMEDY
4. Compressor fails to unload.	A. Faulty governor or installation.	A. Test the governor for proper operation and inspect air lines to and from it for kinks or restrictions. Replace or repair the governor or connecting air lines
	B. Faulty or worn unloader pistons or bores.	B. Inspect for worn, dirty or corroded unloader piston and bore. Replace as necessary.
5. Compressor leaks oil.	A. Damaged mounting gasket.	A. Check the compressor mounting bolt torque. If the mounting bolt torque is low, replace the compressor mounting gasket before re-torquing the mounting bolts.
	B. Cracked crankcase or end cover.	B. Visually inspect the compressor exterior for cracked or broken components. Cracked or broken crankcases or mounting flanges can be caused by loose mounting bolts. The end cover can be cracked by over-torquing fitting or plugs installed in the end cover. Replace or repair the compressor as necessary.
	C. Loose crankcase end cover or bottom cover.	C. Check the cap screw torques and tighten as necessary. Replace gaskets or o-ring.
	D. Loose oil supply or return line fittings.	D. Check the torque of external oil line fittings and tighten as necessary.
	E. Porous compressor casting.	E. Replace the compressor if porosity is found.
	F. Mounting flange or end cover, o-ring or gasket missing, cut or damaged.	F. Replace as necessary.
6. Compressor constantly cycles (compressor remains unloaded for a very short time).	A. Leaking compressor unloader piston.	A. Repair or replace as necessary. Remove the compressor inlet air strainer or fitting. With the compressor unloaded (not compressing air), listen for air escaping.
	B. Faulty Governor installation.	B. Test the governor for proper operation and inspect air lines for kinks or restrictions. Replace or repair the governor or connecting air lines as required.
	C. Excessive system leakage.	C. Test for excessive system leakage as instructed in Symptom #3 Remedy E. Reduce leakage wherever possible.
	D. Excessive reservoir contaminants.	D. Drain reservoirs.

COMPRESSOR TROUBLESHOOTING CHART (Continued)

SYMPTOMS	CAUSE	REMEDY
7. Compressor leaks coolant.	A. Improperly installed plugs and coolant line fittings.	A. Check torque of fittings and plugs and tighten as necessary. Over torqued fittings and plugs can crack the head or block casting.
	B. Freeze cracks due to improper antifreeze strength.	B. Test antifreeze and strengthen as necessary. Check coolant flow through compressor to as sure the proper antifreeze mixture reaches the compressor.
	C. Faulty compressor (porous castings).	C. If casting porosity is detected, replace the compressor.
8. Compressor head gasket failure.	A. Restricted discharge line.	A. Clear restriction or replace line.
	B. Loose head bolts	B. Tighten evenly to a torque of 265-292 inch pounds.
	C. Faulty compressor or head gasket.	C. Check for rough or poorly machined head or block surfaces. Replace compressor as necessary.

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Service Data

SD-06-1600*

LOW PRESSURE INDICATORS

*Formerly SD-06-2

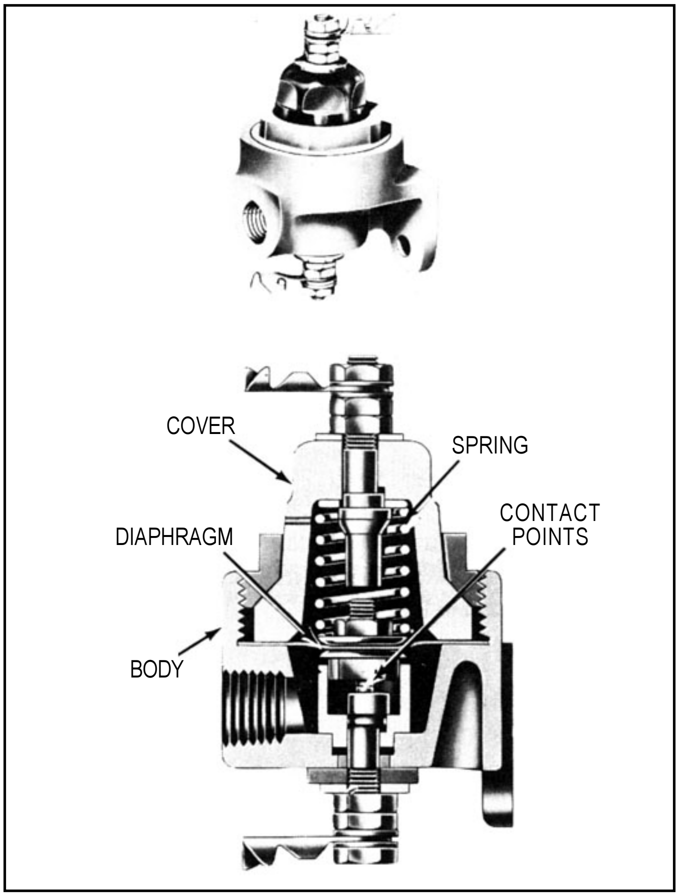

FIGURE 1 - LP-2

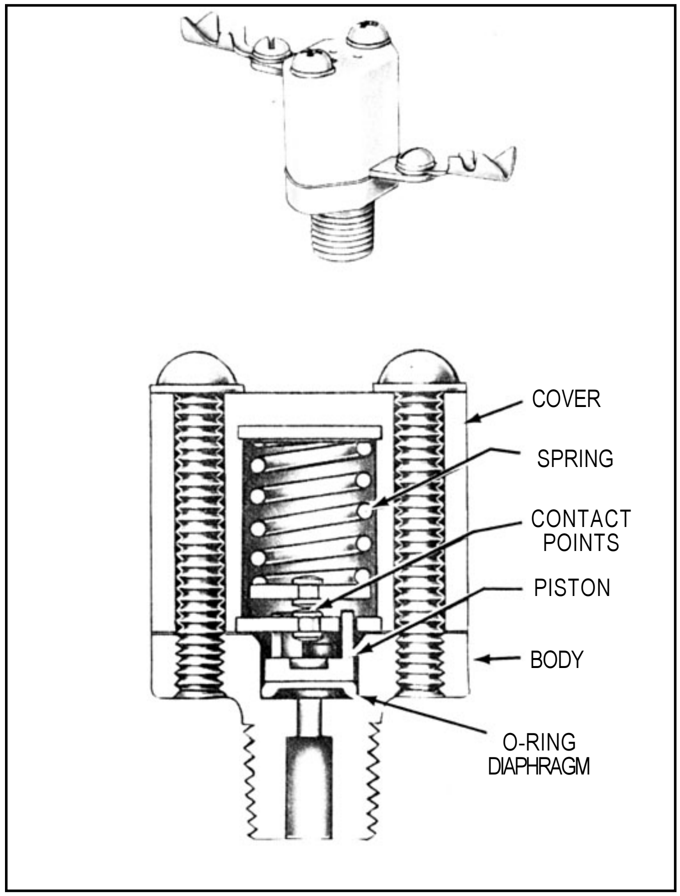

FIGURE 2 - LP-3

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

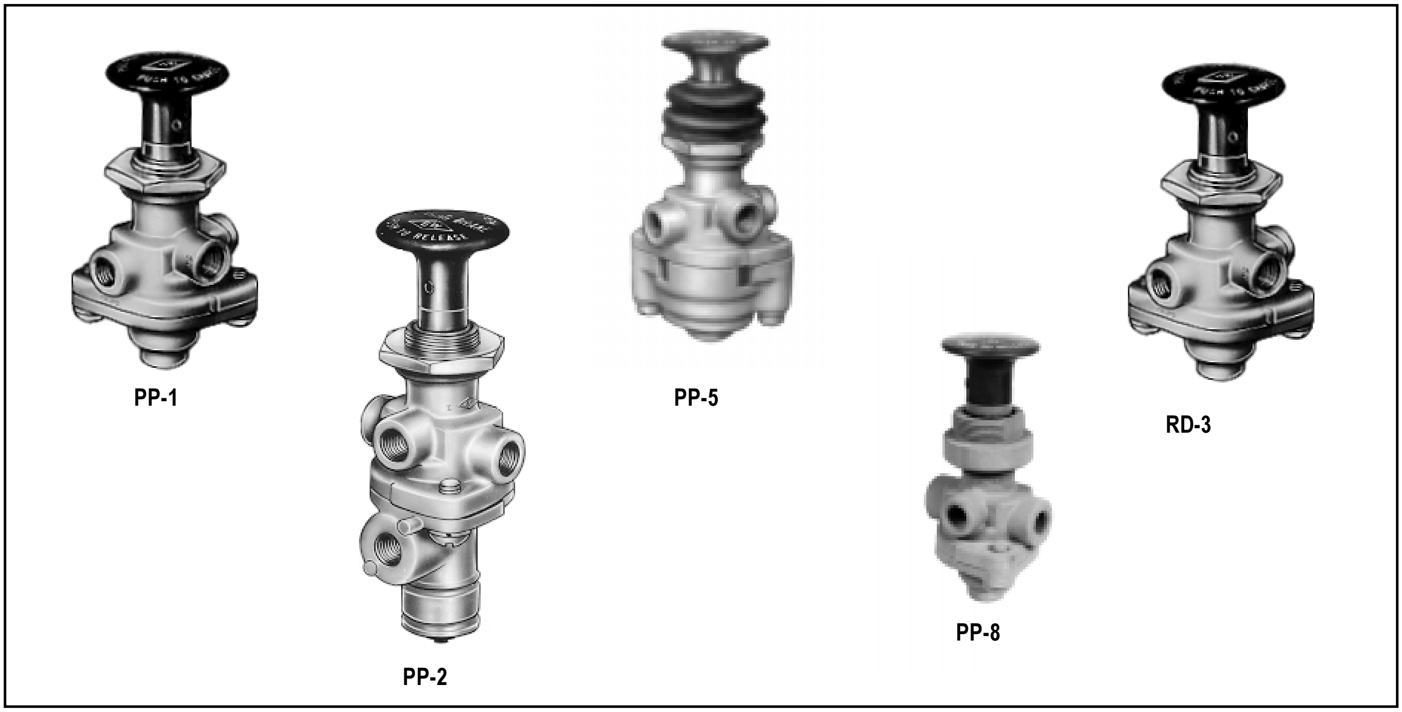


*FIGURE 1 - **PUSH-PULL TYPE CONTROL VALVES***

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 EXHAUST	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.**

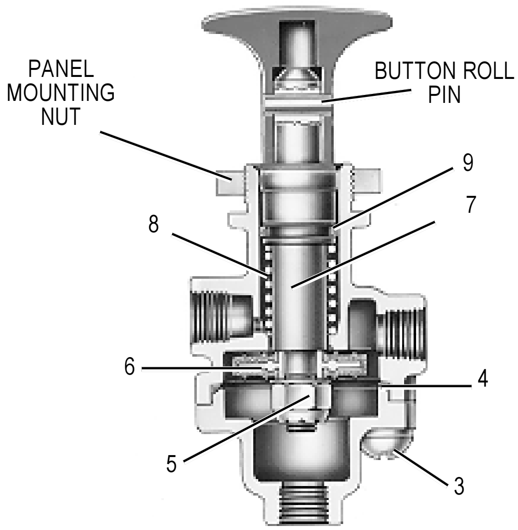


FIGURE 2 **PP-1**

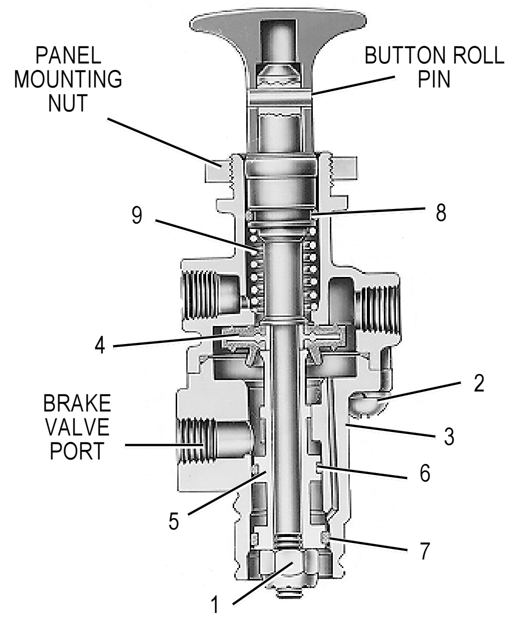
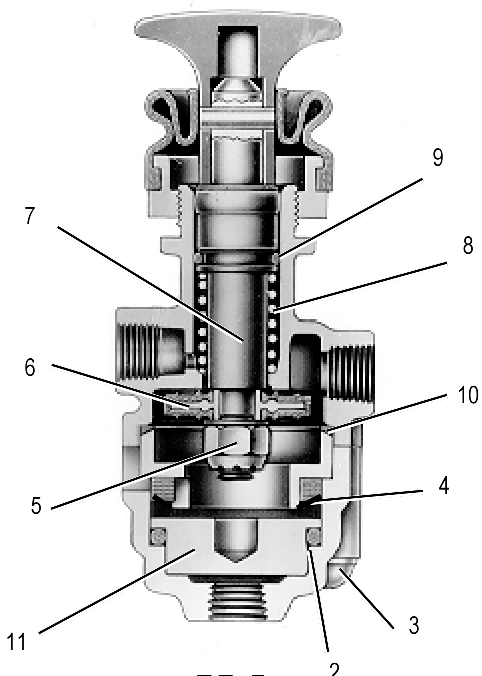
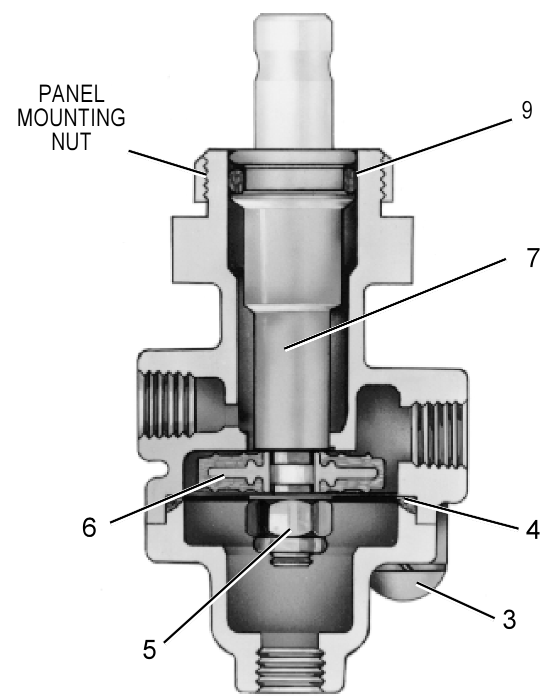


FIGURE 3 **PP-2**



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.

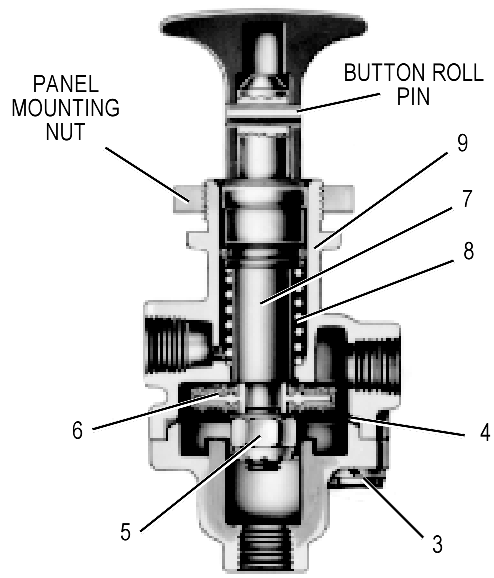
7. Never exceed recommended pressures and always wear safety glasses.

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

AlliedSignal
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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

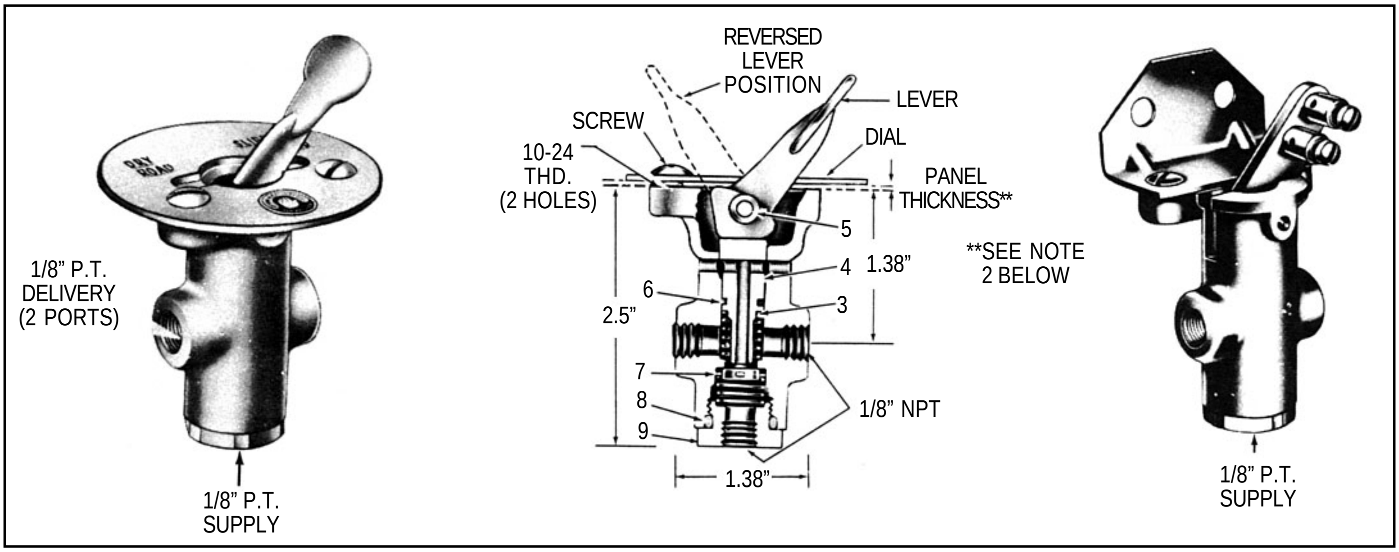

FIGURE 1 - TW-1

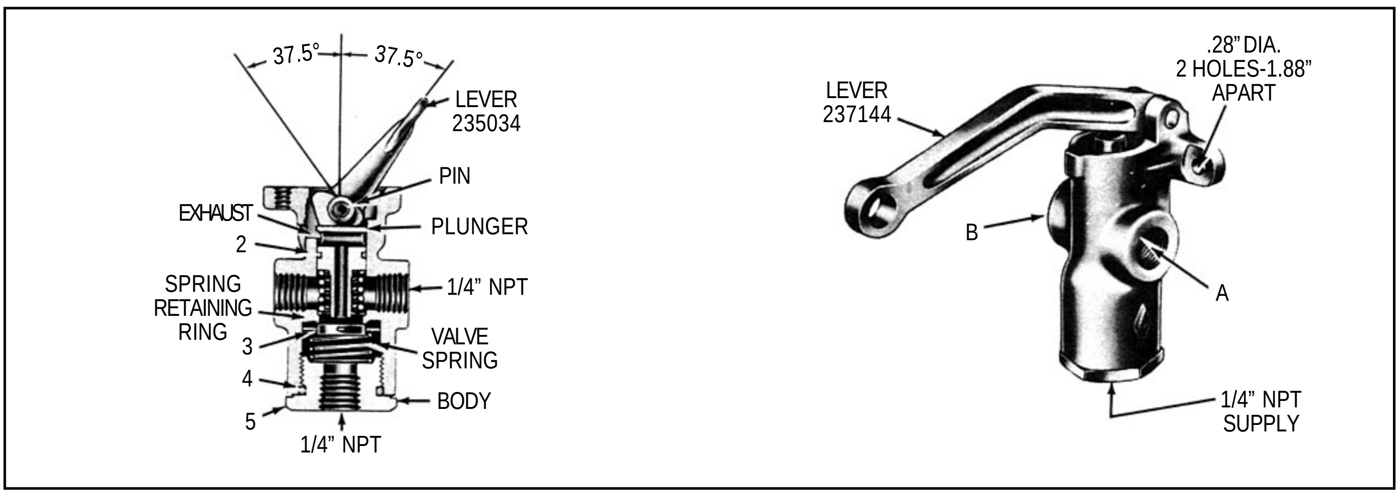

FIGURE 2 - TW-3

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.

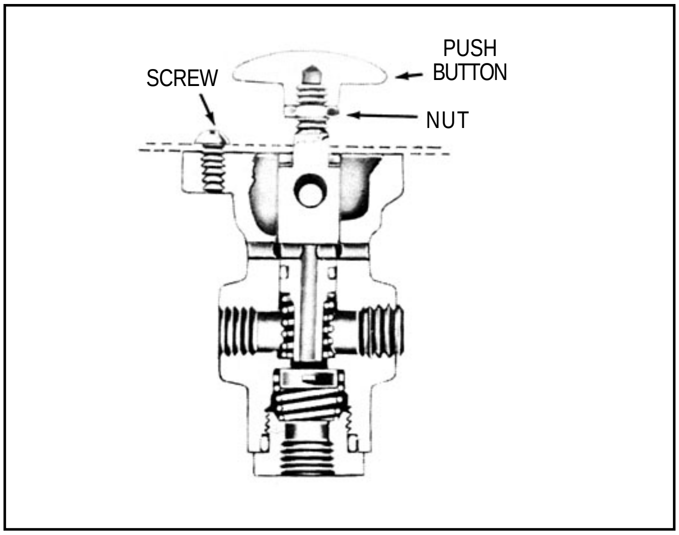

FIGURE 3 - TW-4

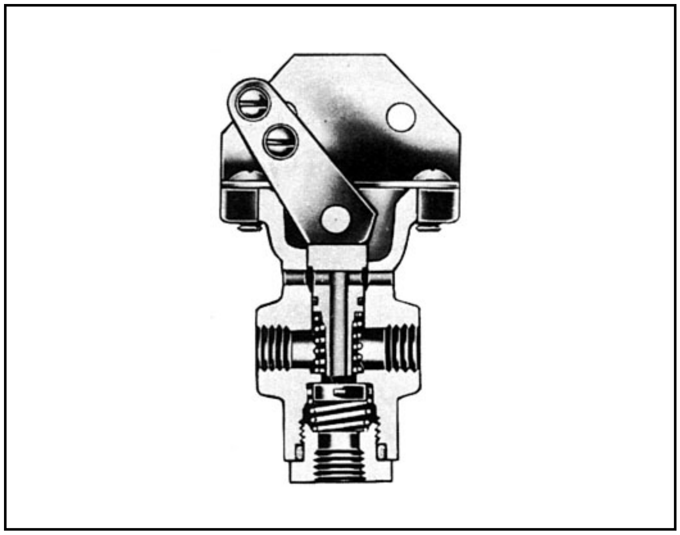

FIGURE 4 - TW-6

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

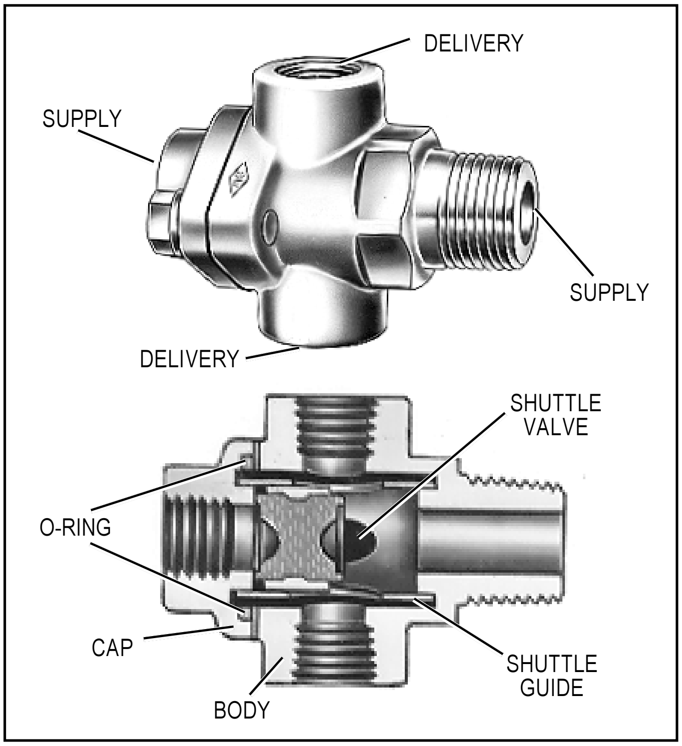

*FIGURE 1 - **DOUBLE CHECK VALVE (SHUTTLE TYPE)***

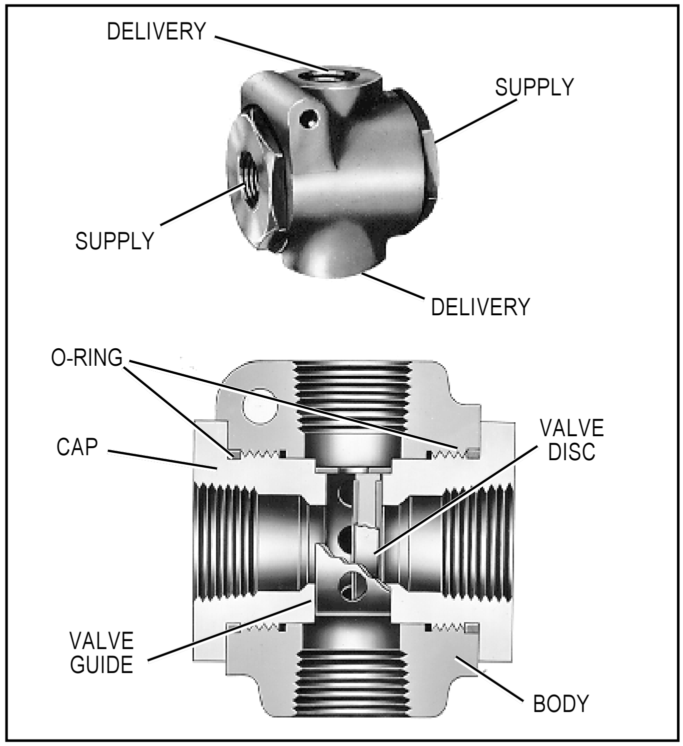

*FIGURE 2 - **DOUBLE CHECK VALVE (DISC TYPE)***

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.

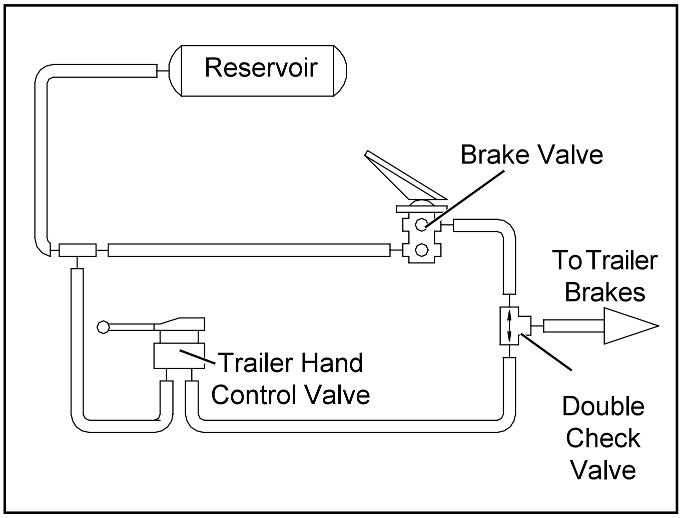

*FIGURE 3 - **DOUBLE CHECK VALVE: CONTROL OF SYSTEM FROM EITHER OF TWO CONTROL SOURCES***

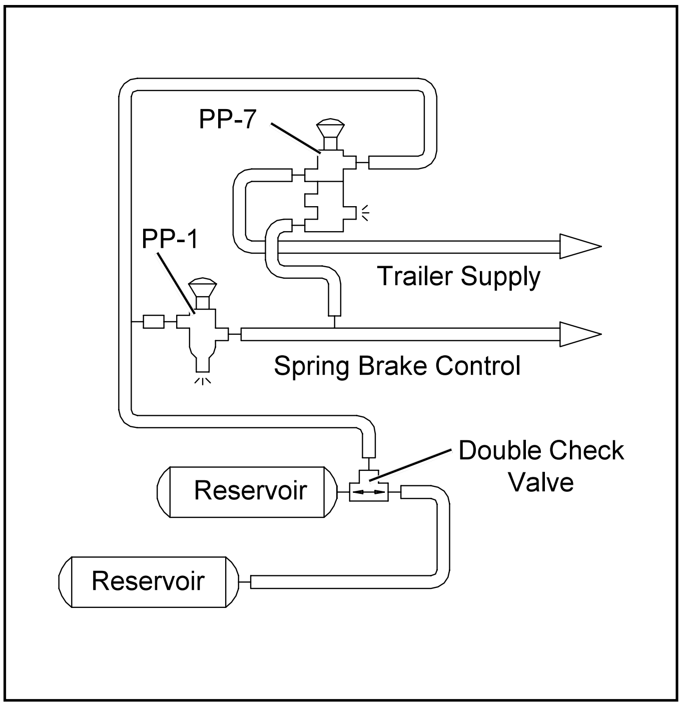

*FIGURE 4 - **DOUBLE CHECK VALVE: SYSTEM WITH TWO SUPPLY SOURCES***

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
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Service Data

SD-03-2010*

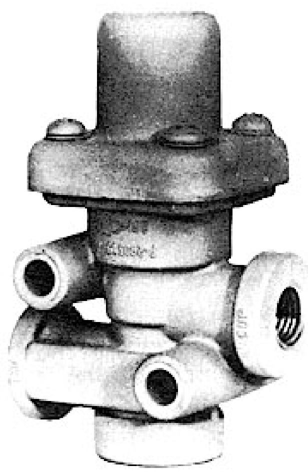
PRESSURE PROTECTION VALVES

*Formerly SD-03-55

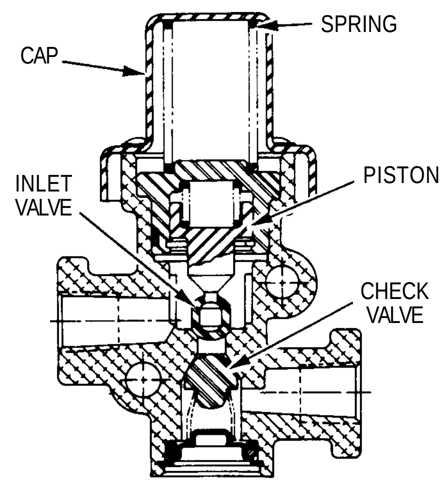
DESCRIPTION

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.

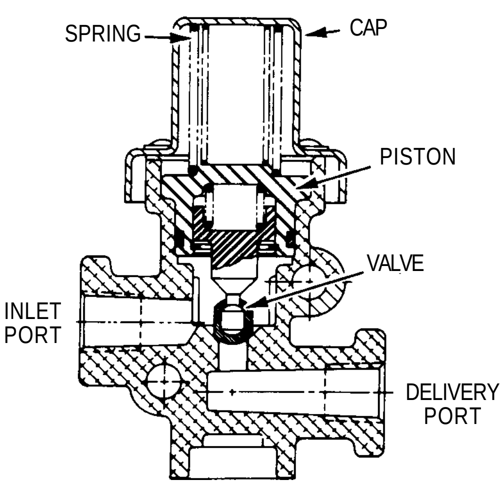
The PR-2 and PR-4 pressure protection valves have one 1/4" N.P.T.F. supply port and one 1/4" N.P.T.F. delivery port which are identified. Both valves are provided with two 9/32" mounting holes through the body. The closing pressure of the PR-2 is externally adjustable while the PR-4 has a fixed setting.



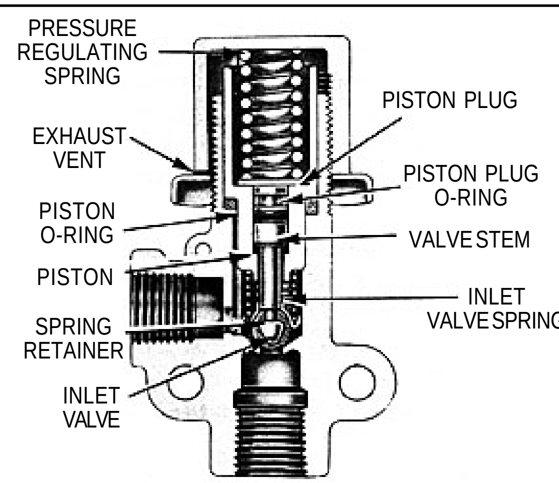
PR-3 OR PR-4



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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Bendix™

Service Data

SD-03-1064*

R-12 & R-14 RELAY VALVES

* FORMERLY SD-03-31

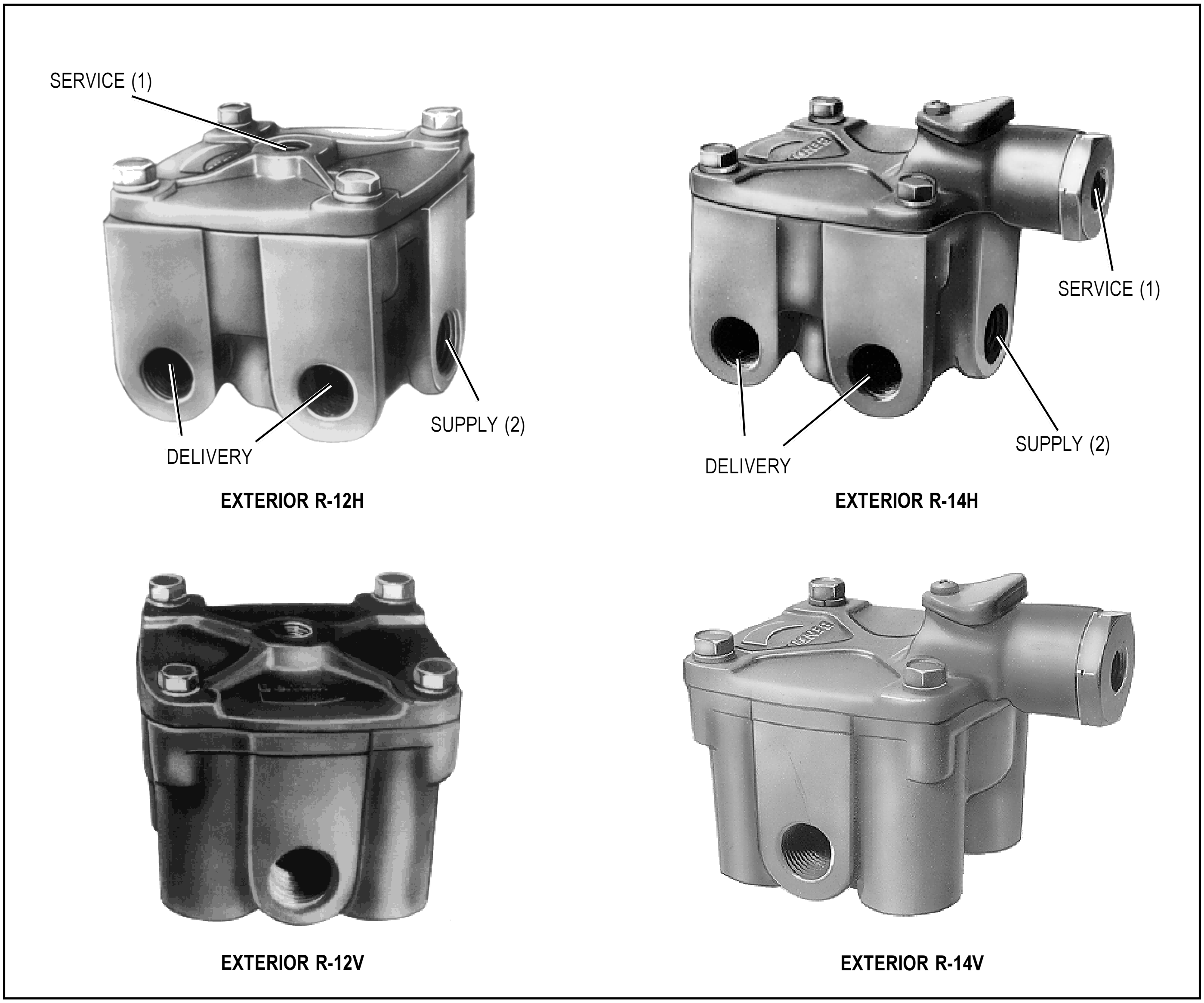

*FIGURE 1 - **EXTERIOR VIEWS***

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

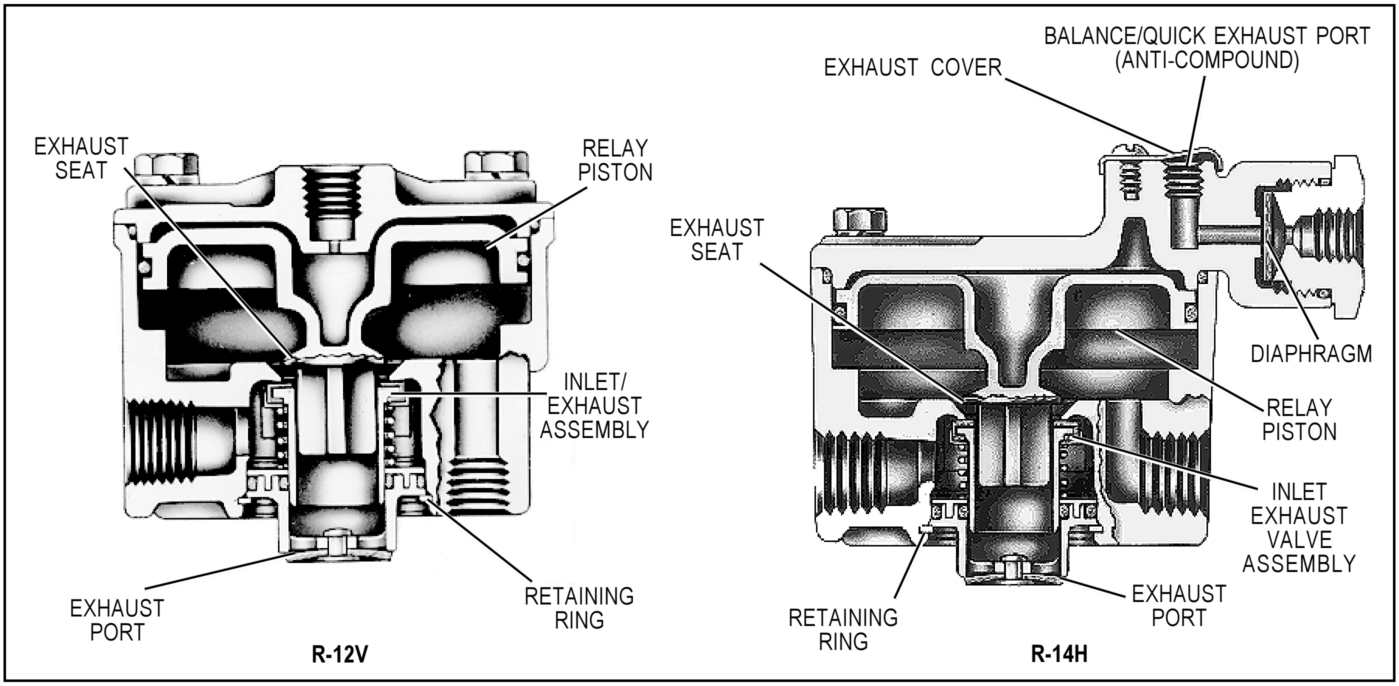

*FIGURE 2 - **SECTIONAL VIEWS***

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.

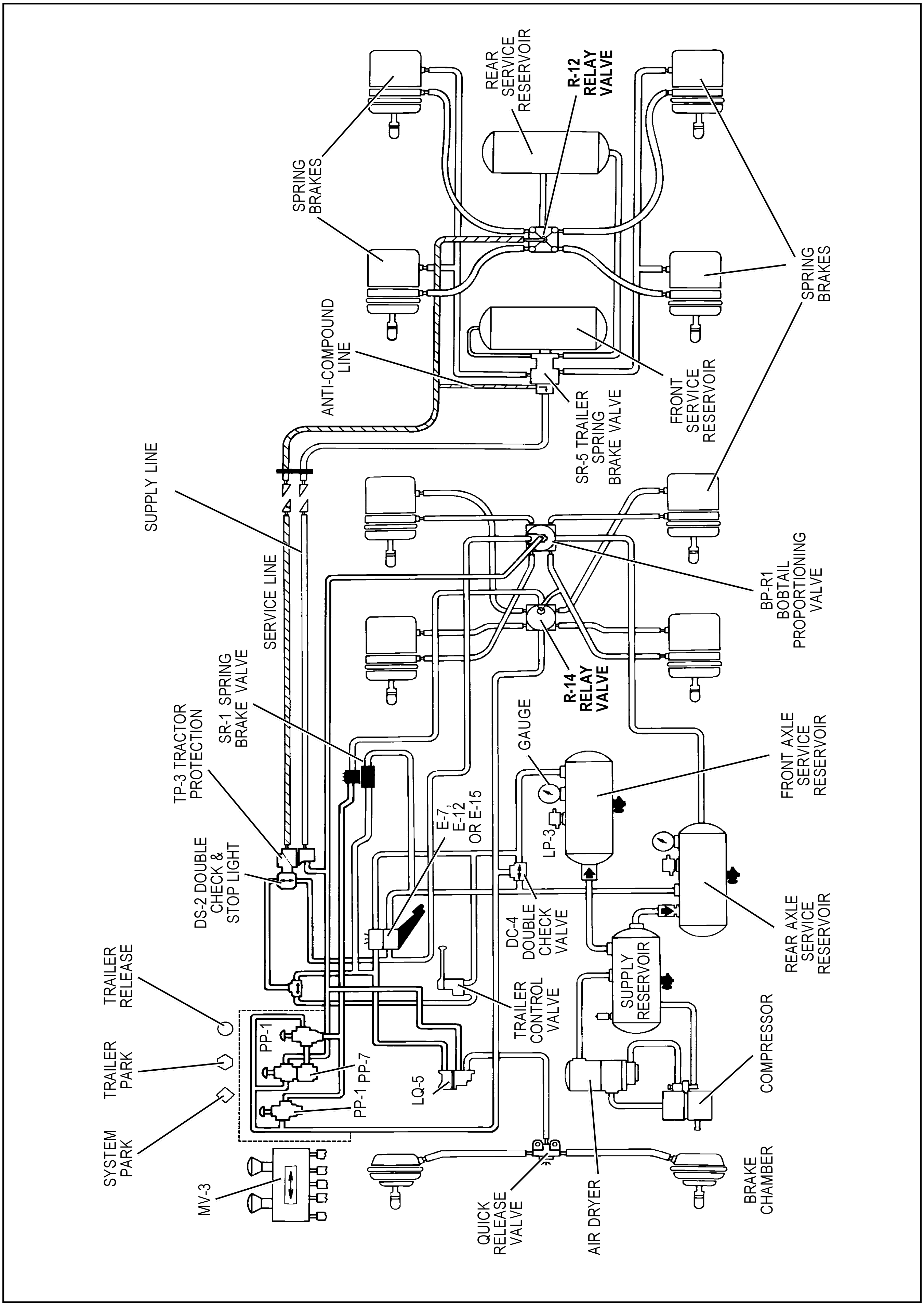

FIGURE 3 - TYPICAL PIPING SCHEMATIC

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.**

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Service Data

SD-03-901*

QR AND QR-1 QUICK RELEASE VALVES

*Formerly SD-03-69

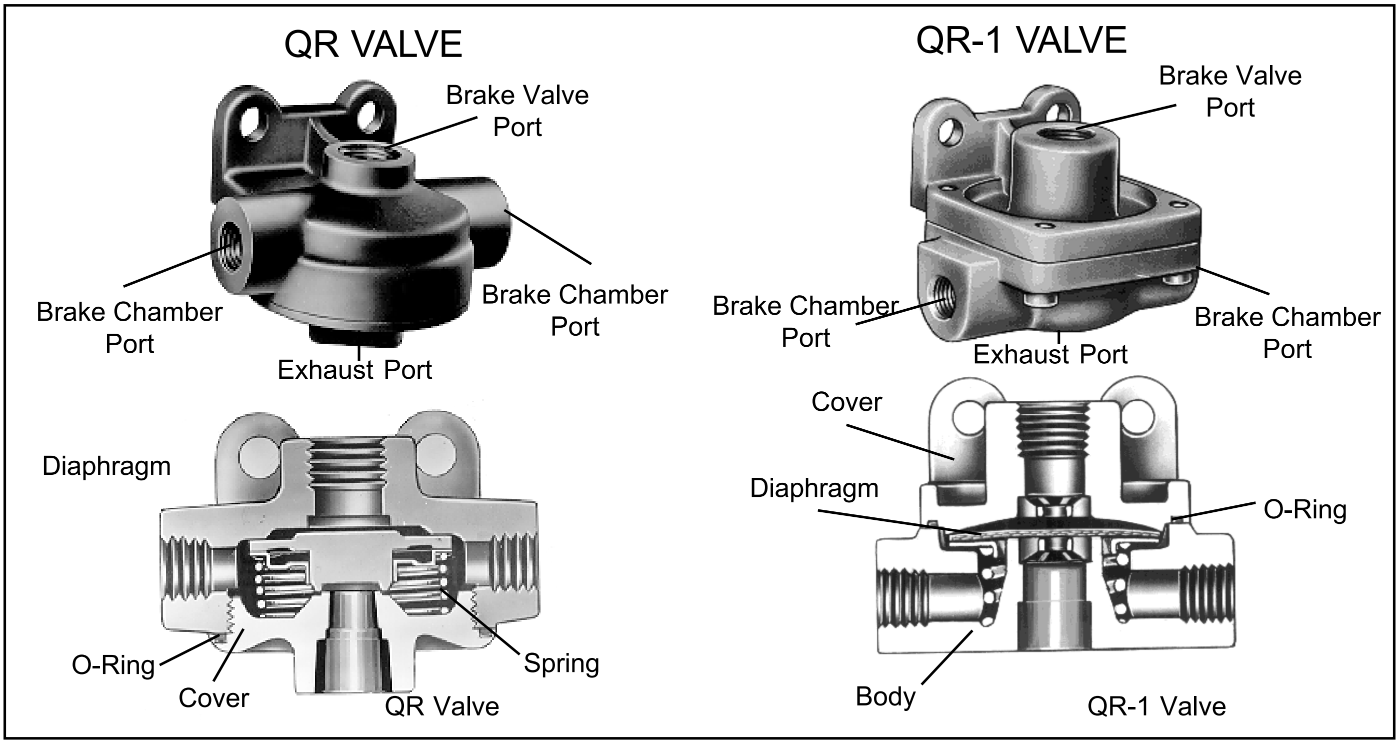

FIGURE 1

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 permitted 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.

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Service Data

SD-03-830

E-8P & E-10P DUAL BRAKE VALVES

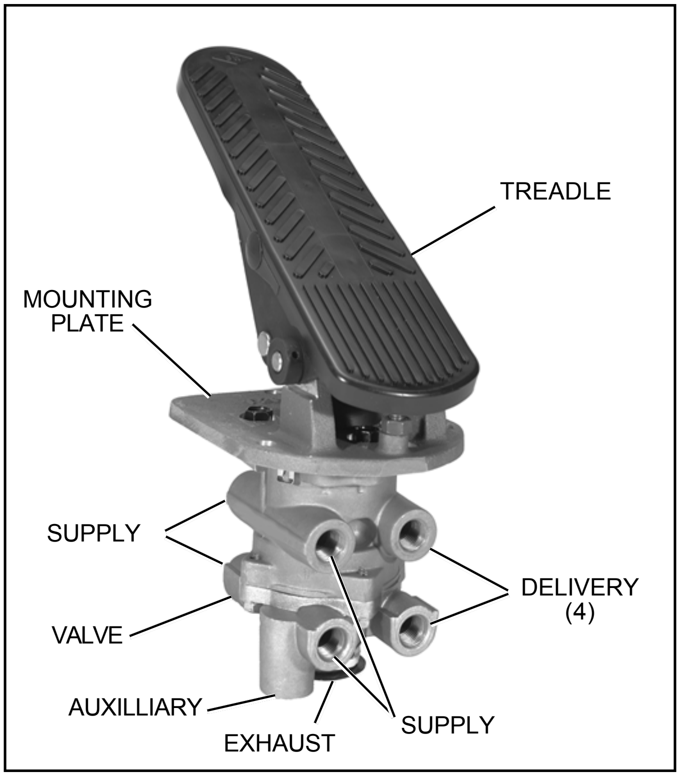


*FIGURE 1 - **E-8P***

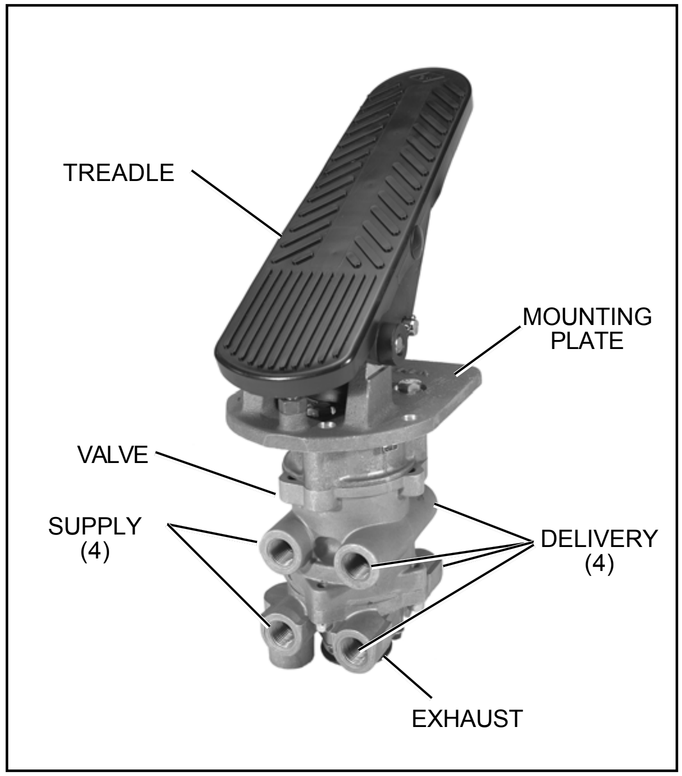


*FIGURE 2 - **E-10P***

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.

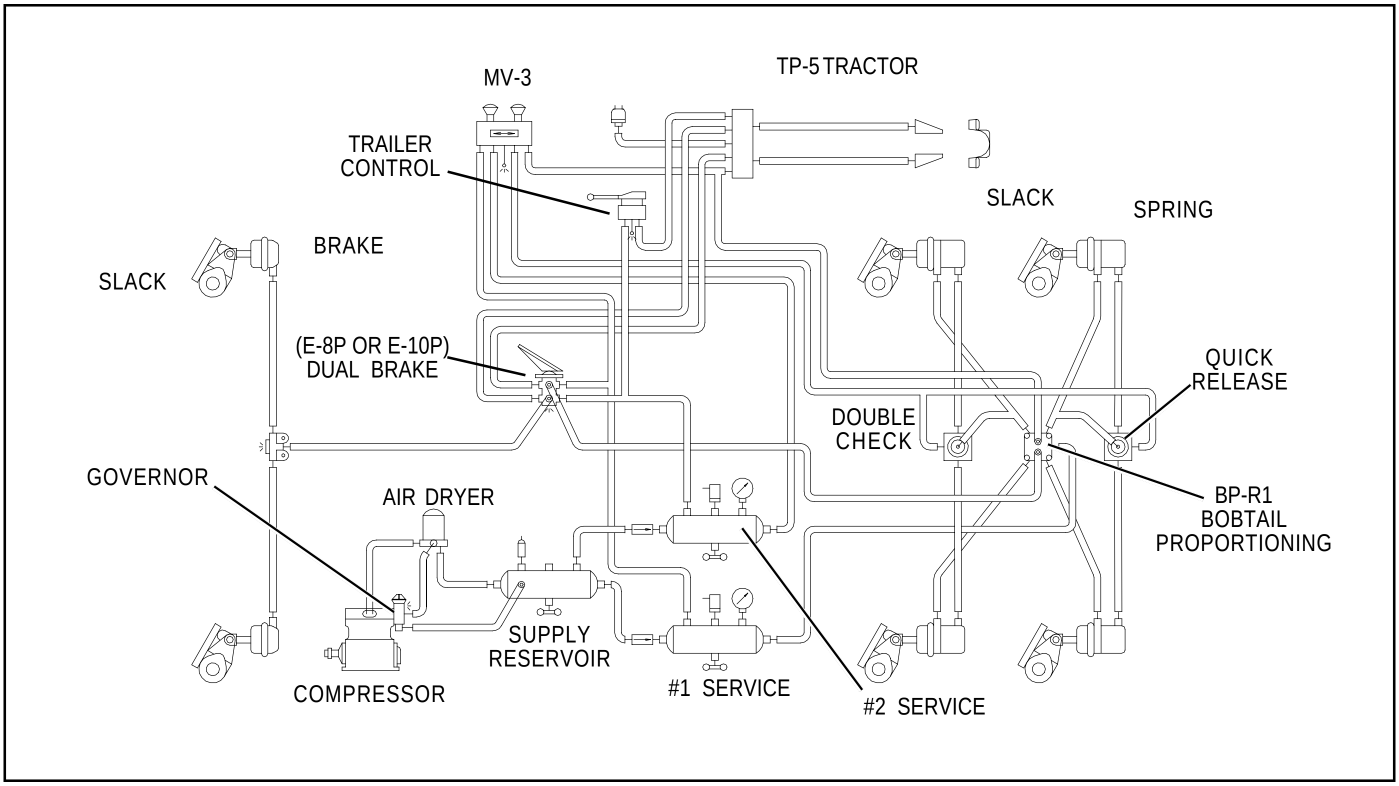


FIGURE 3 - **TYPICAL PIPING SCHEMATIC**

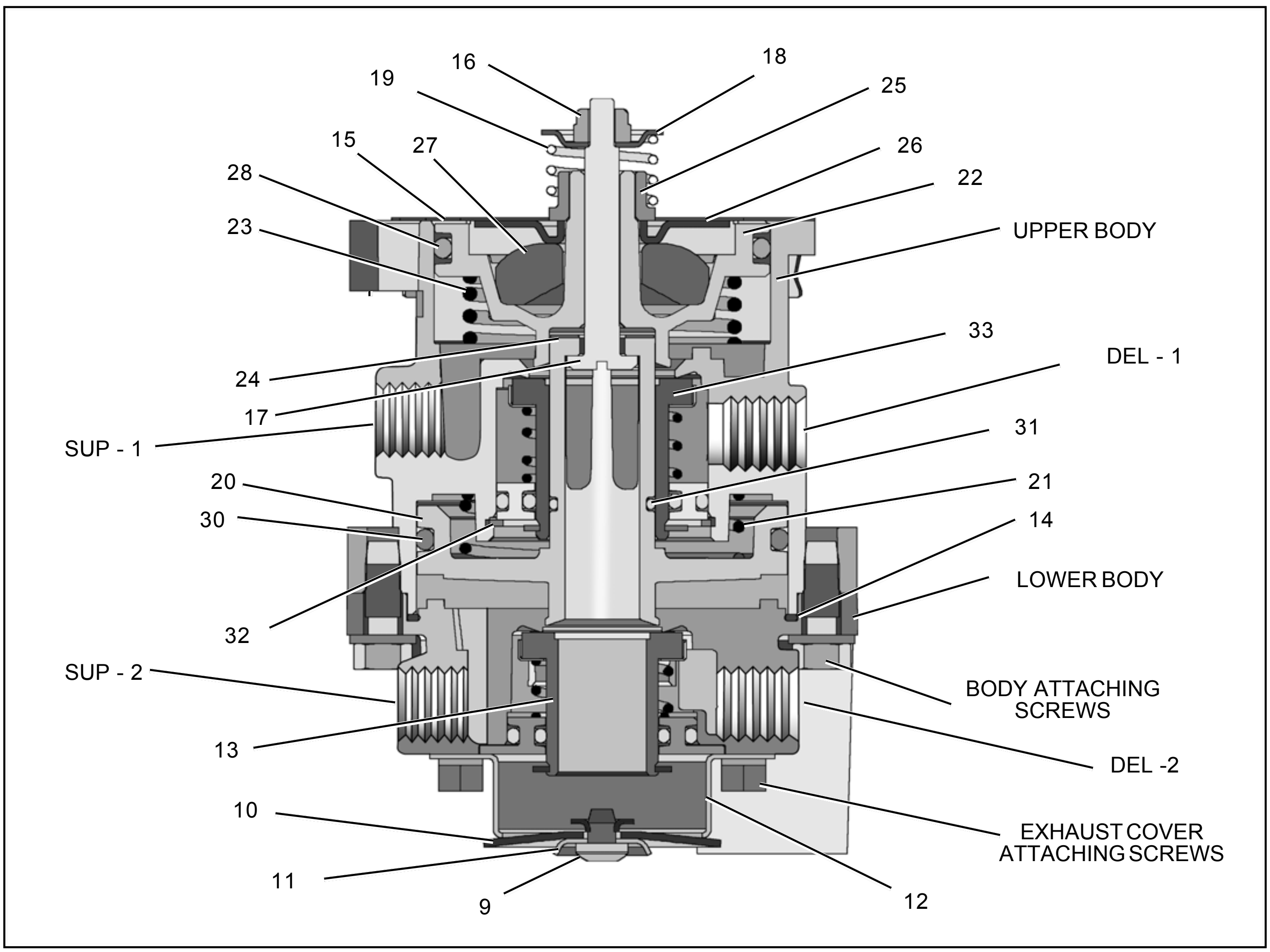


FIGURE 4 - **E-8P SECTIONAL VIEW**

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).

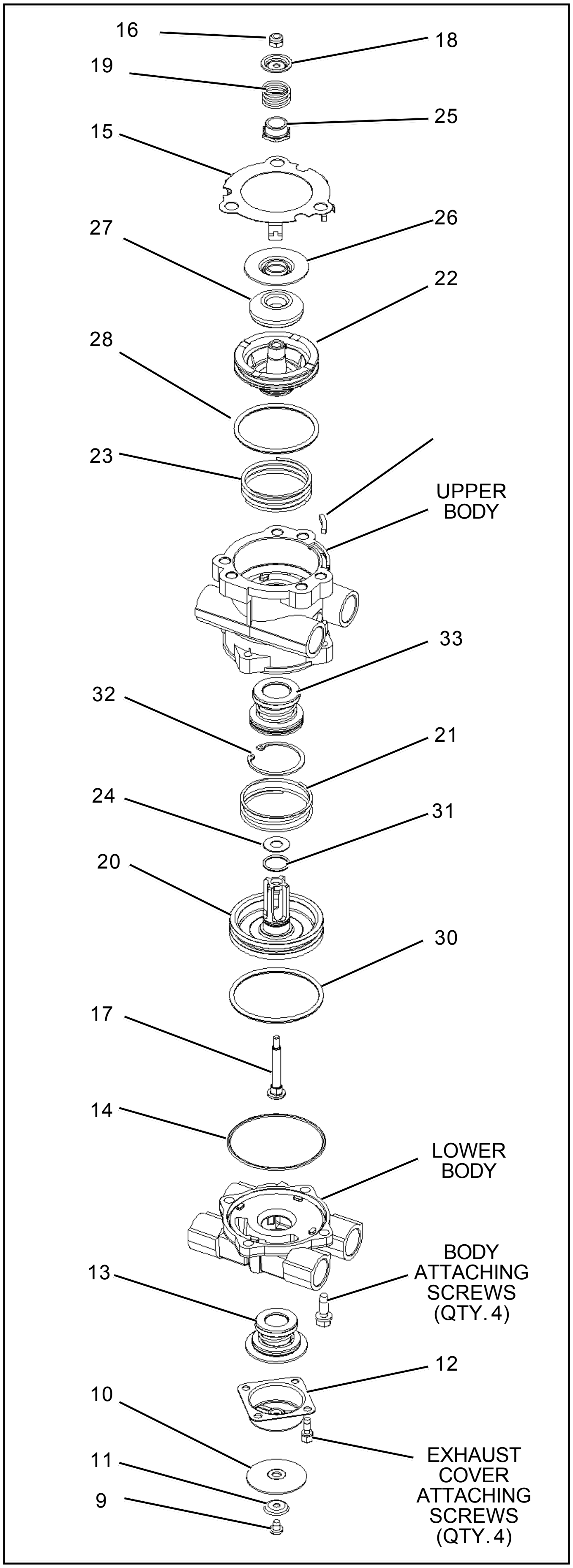


FIGURE 5 - ***E-8P BRAKE VALVE - EXPLODED VIEW***

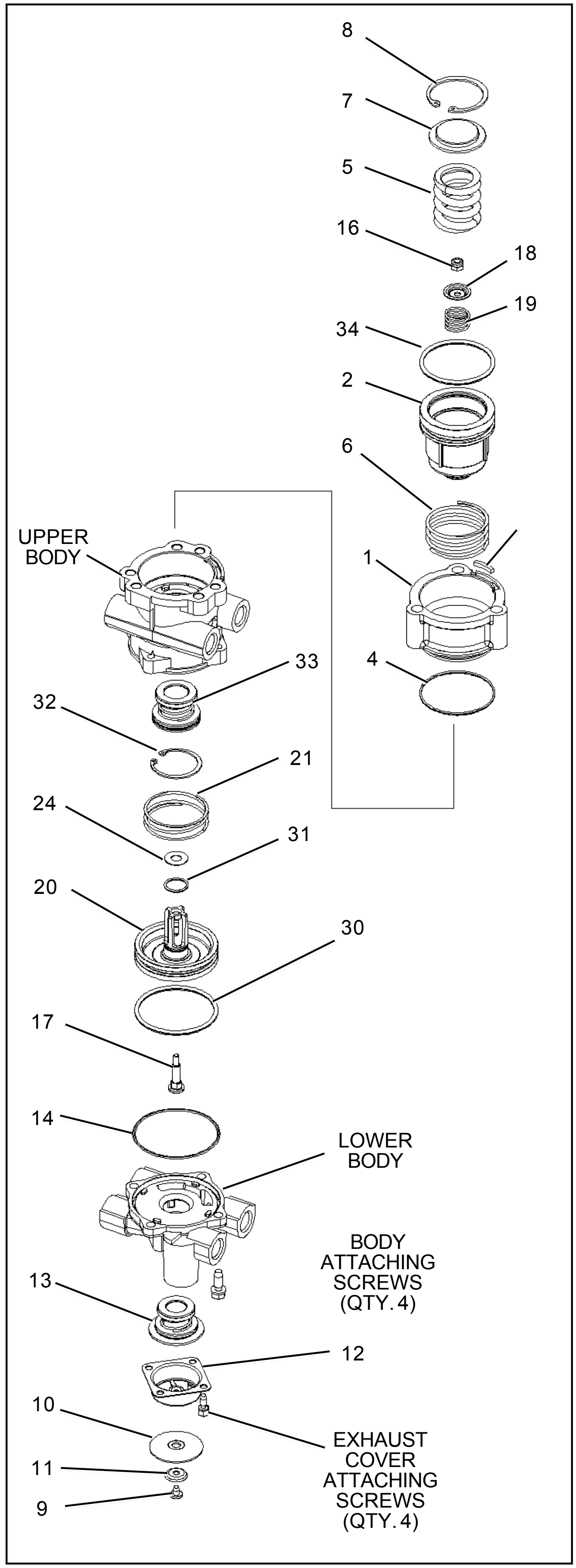


FIGURE 6 - ***E-10P BRAKE VALVE - EXPLODED VIEW***

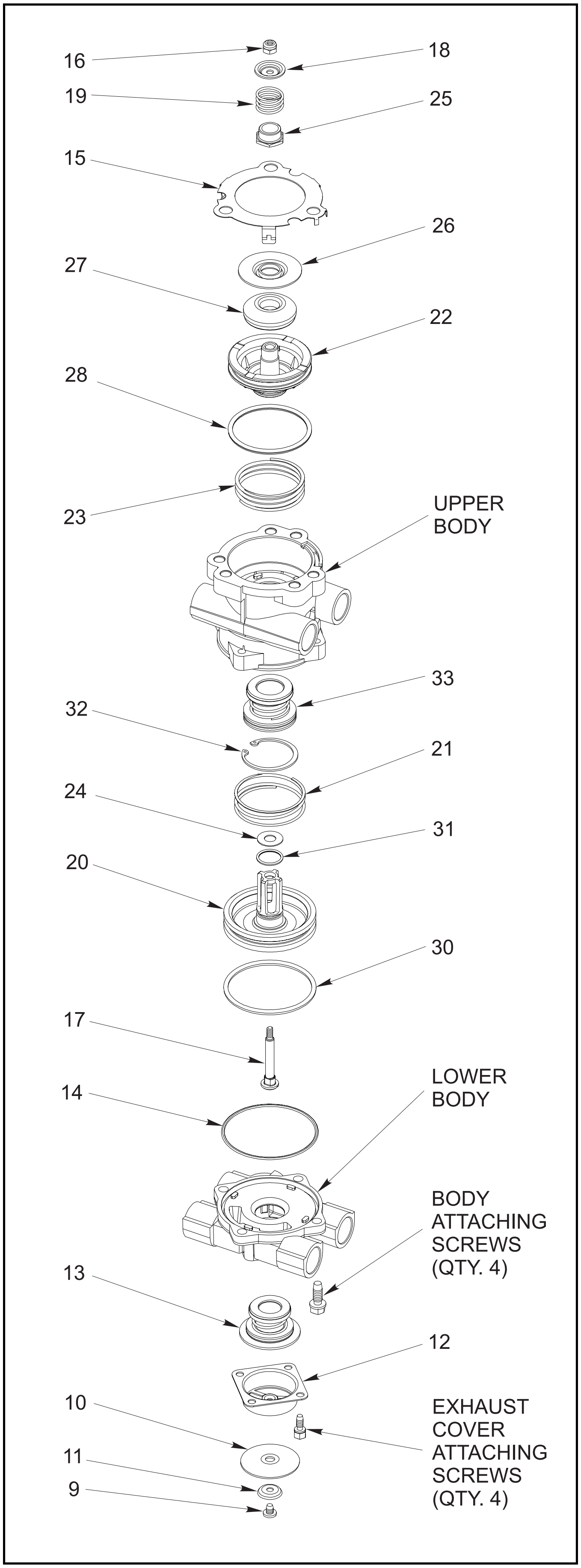


FIGURE 5 - ***E-8P BRAKE VALVE - EXPLODED VIEW***

FIGURE 5 - ***E-8P BRAKE VALVE - EXPLODED VIEW***

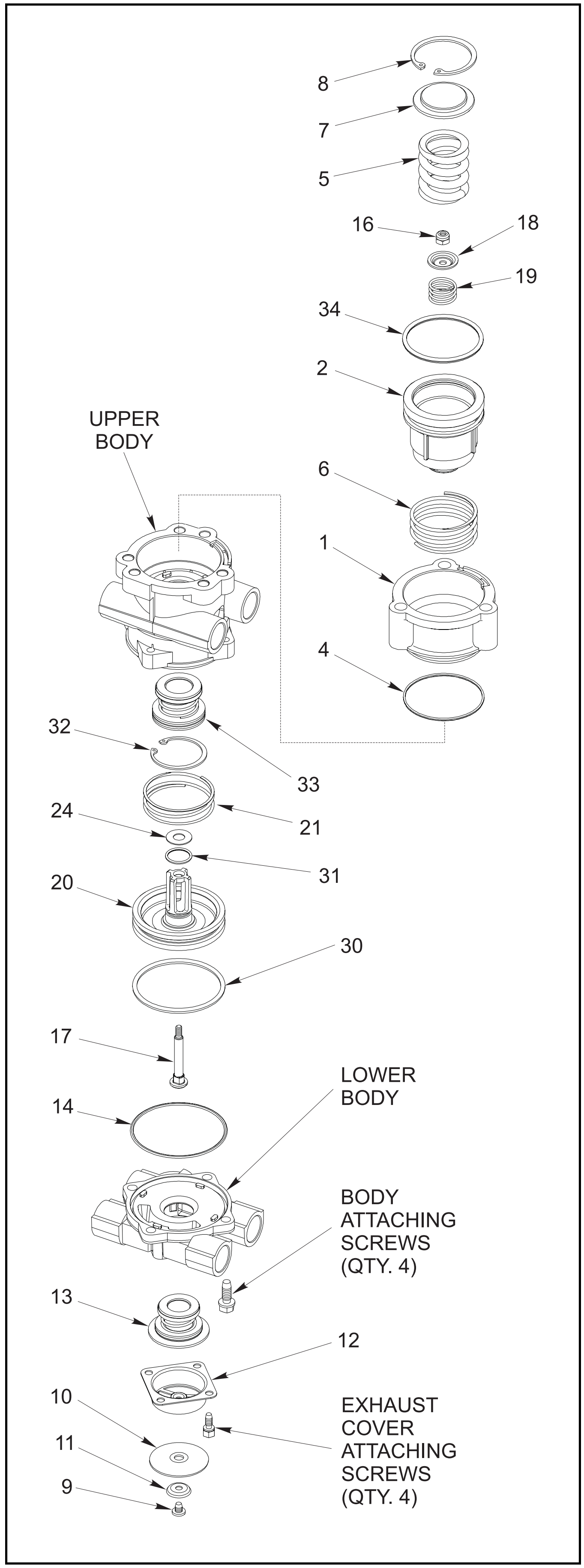


FIGURE 6 - ***E-10P BRAKE VALVE - EXPLODED VIEW***

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.**

Bendix

Service Data

SD-03-9043

SR-7 SPRING BRAKE MODULATING VALVE

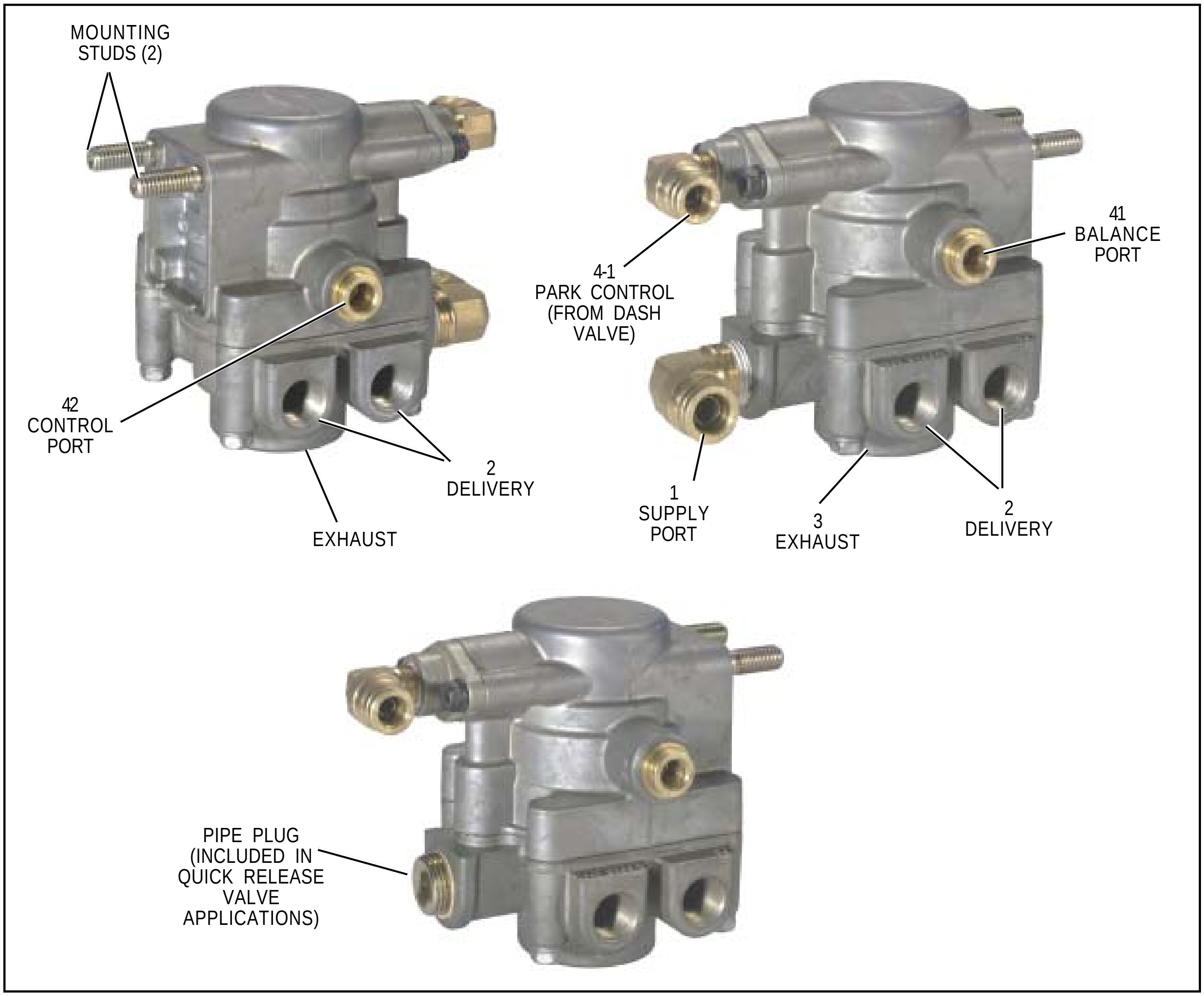


FIGURE 1 - EXTERIOR VIEW

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).

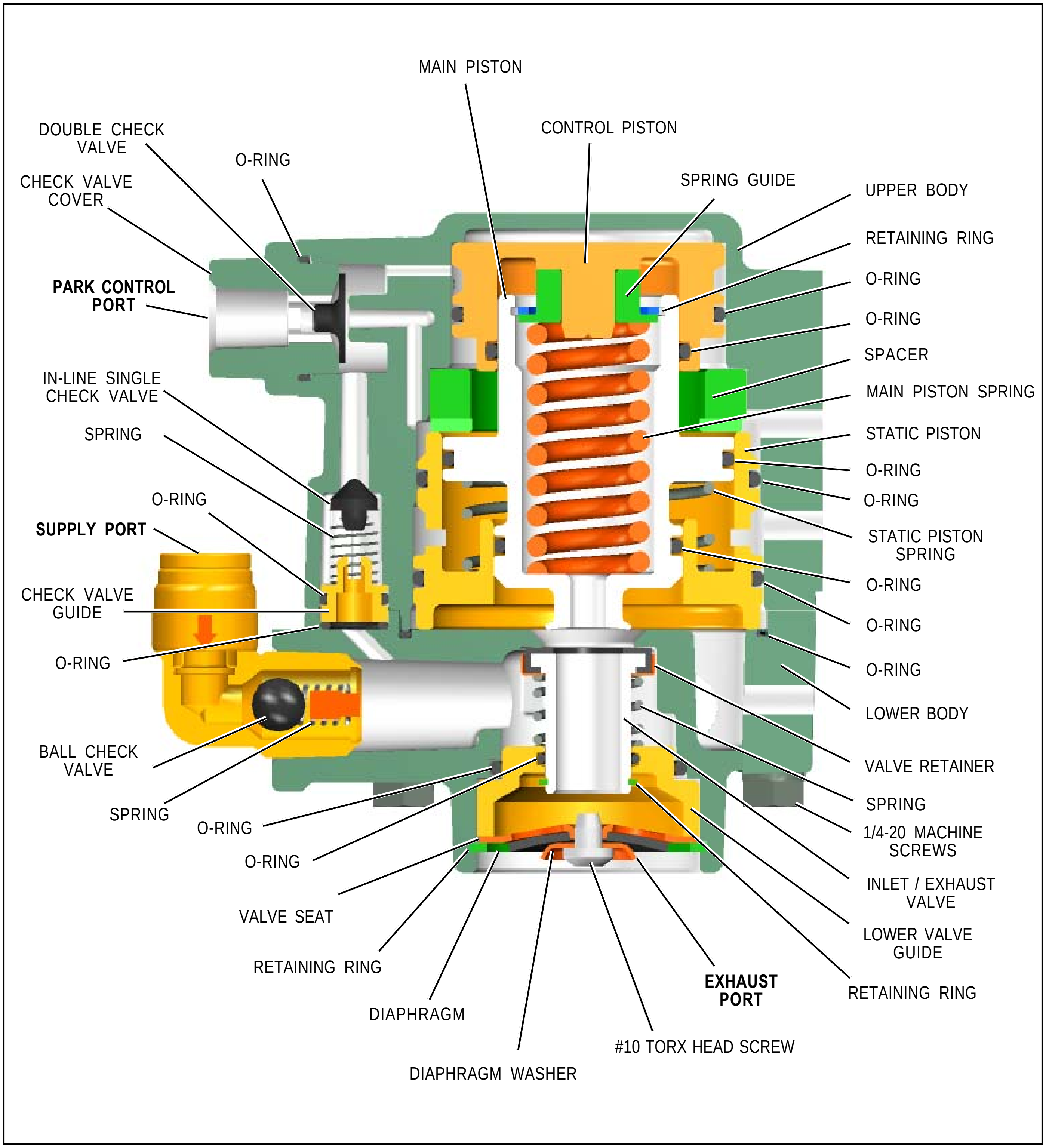


FIGURE 2 - SECTIONAL VIEW OF SR-7 USED IN RELAY VALVE APPLICATIONS

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.

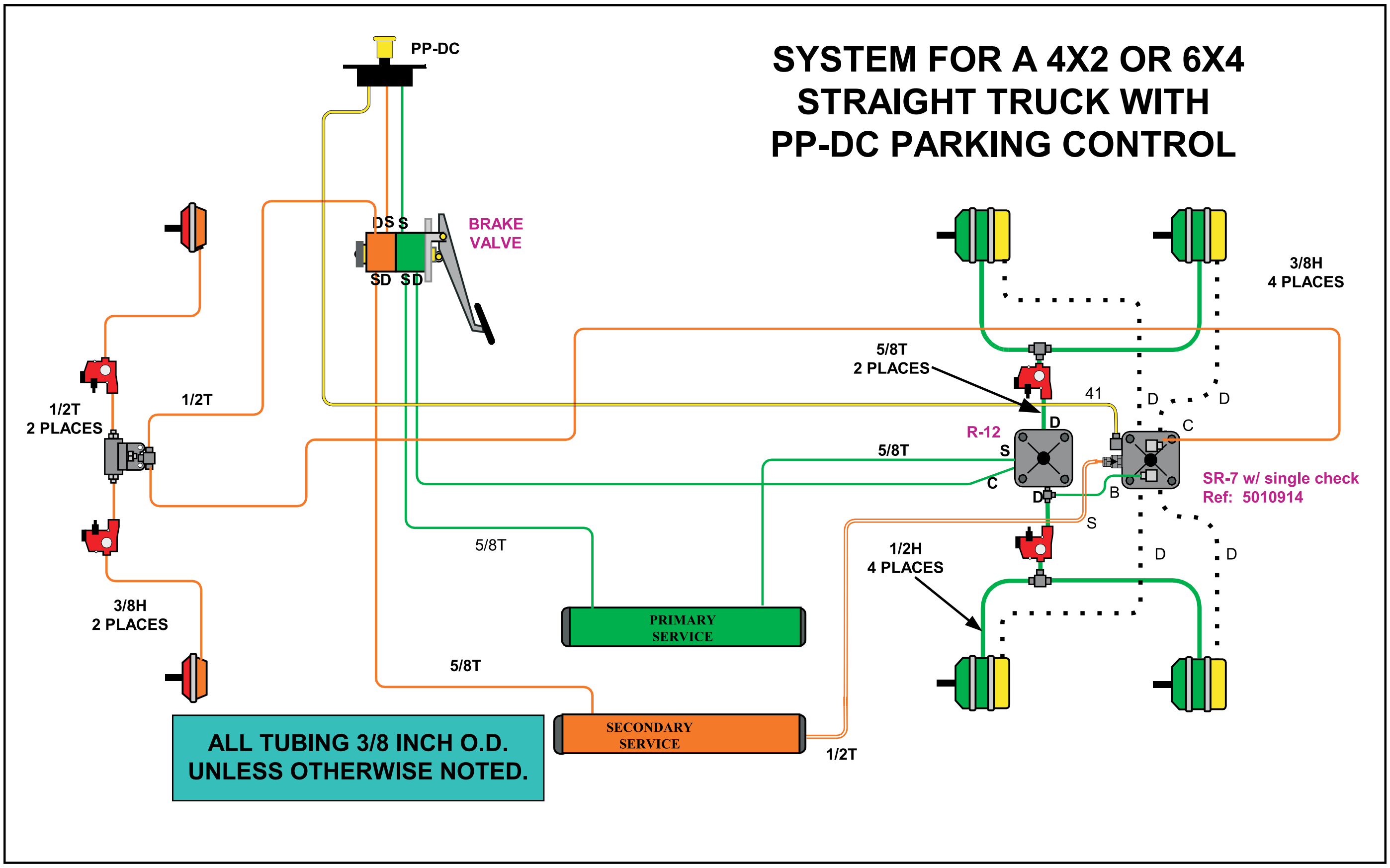


FIGURE 3 - SYSTEM SCHEMATIC WITH PP-DC PARK CONTROL

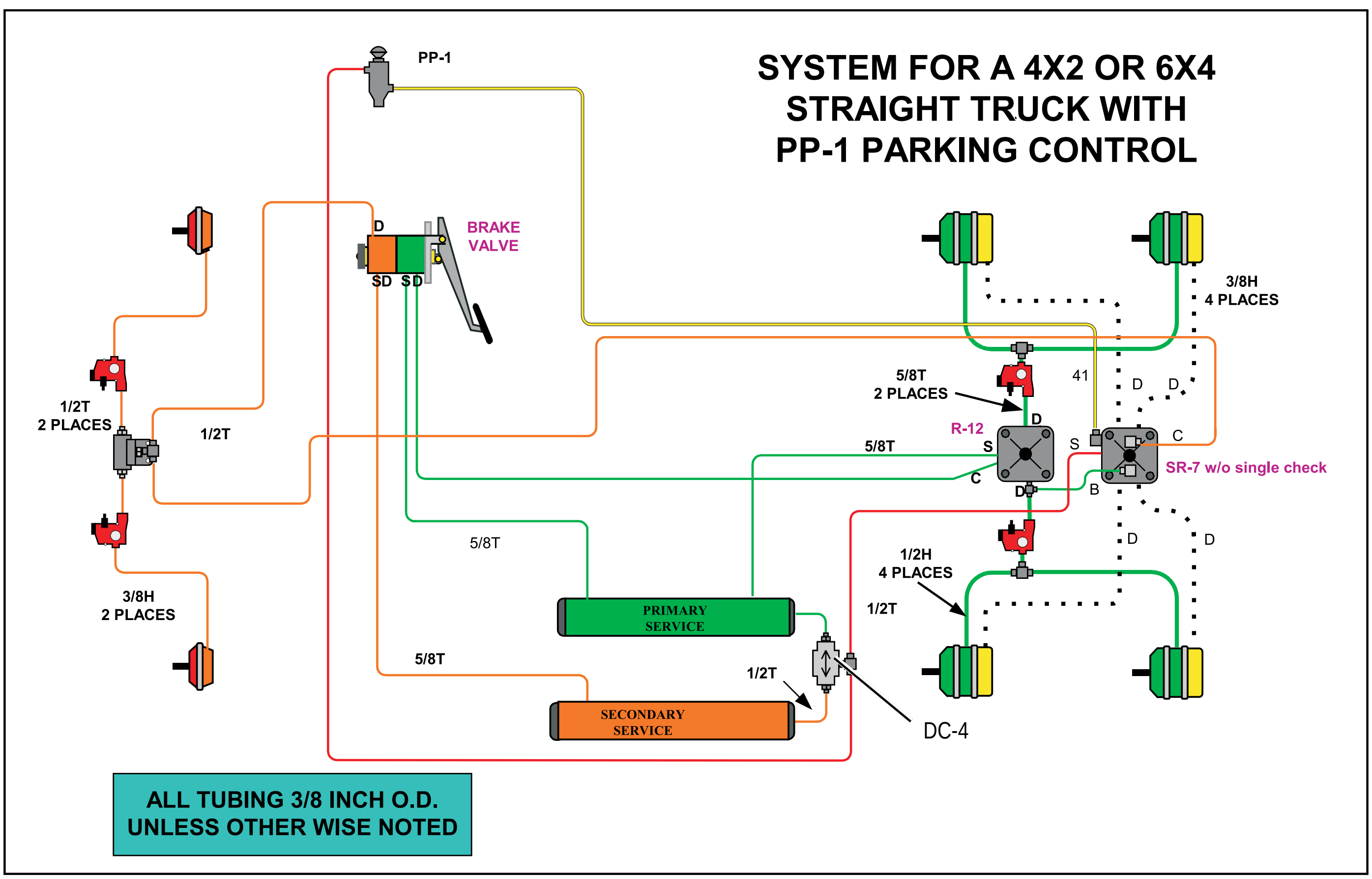


FIGURE 4 - SYSTEM SCHEMATIC WITH PP-1 PARK CONTROL AND DC-4 DOUBLE CHECK VALVE

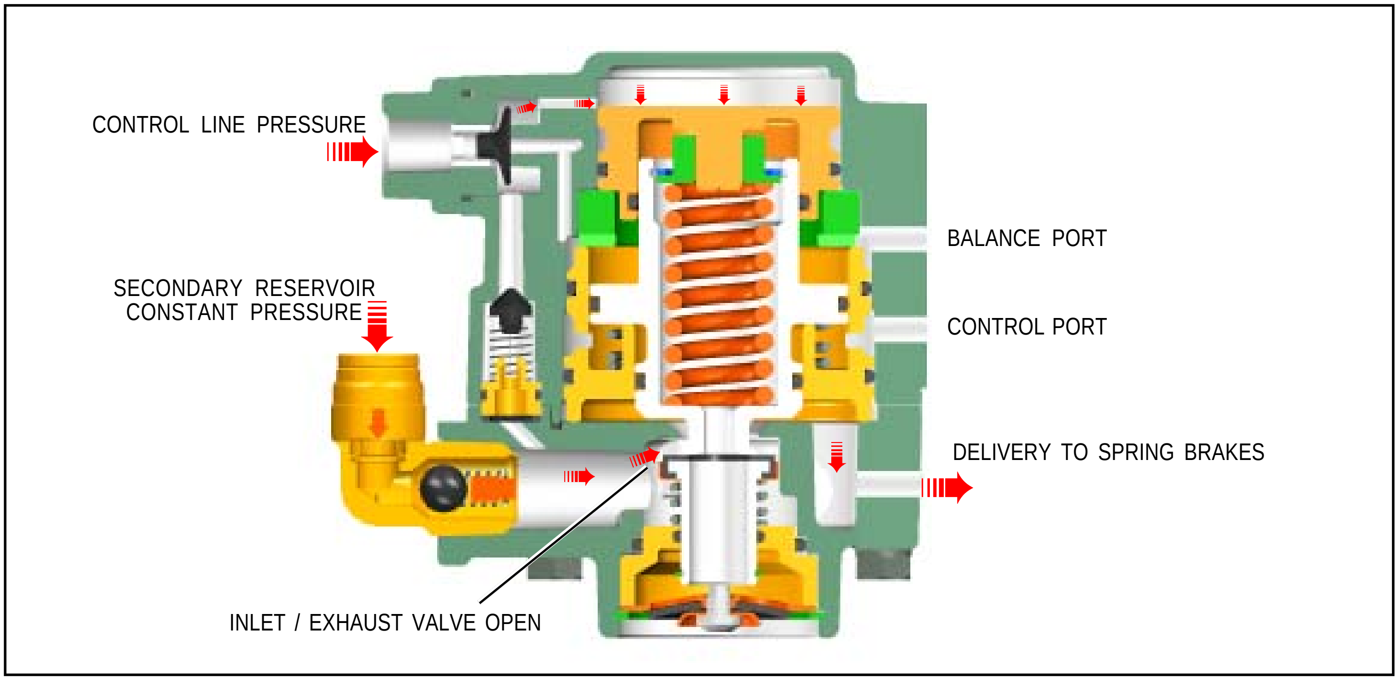


FIGURE 5 - CHARGING LESS THAN 107 PSI

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).

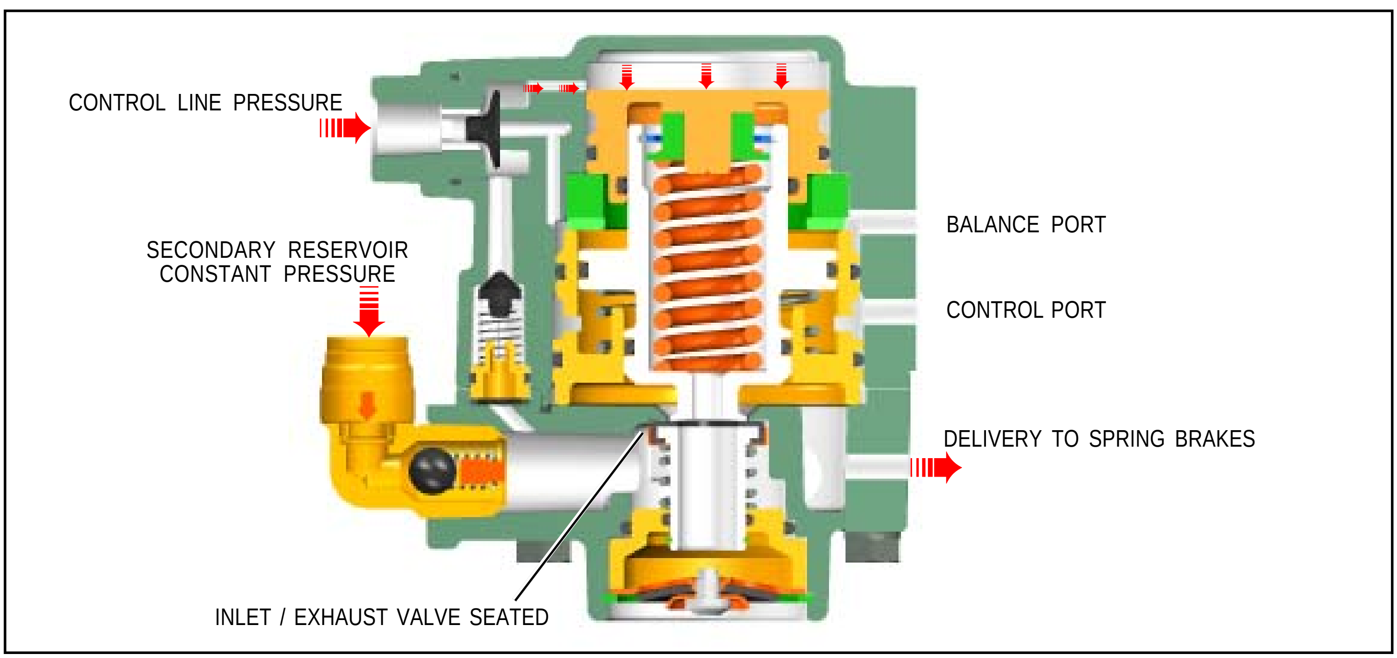


FIGURE 6 - CHARGING GREATER THAN 107 PSI

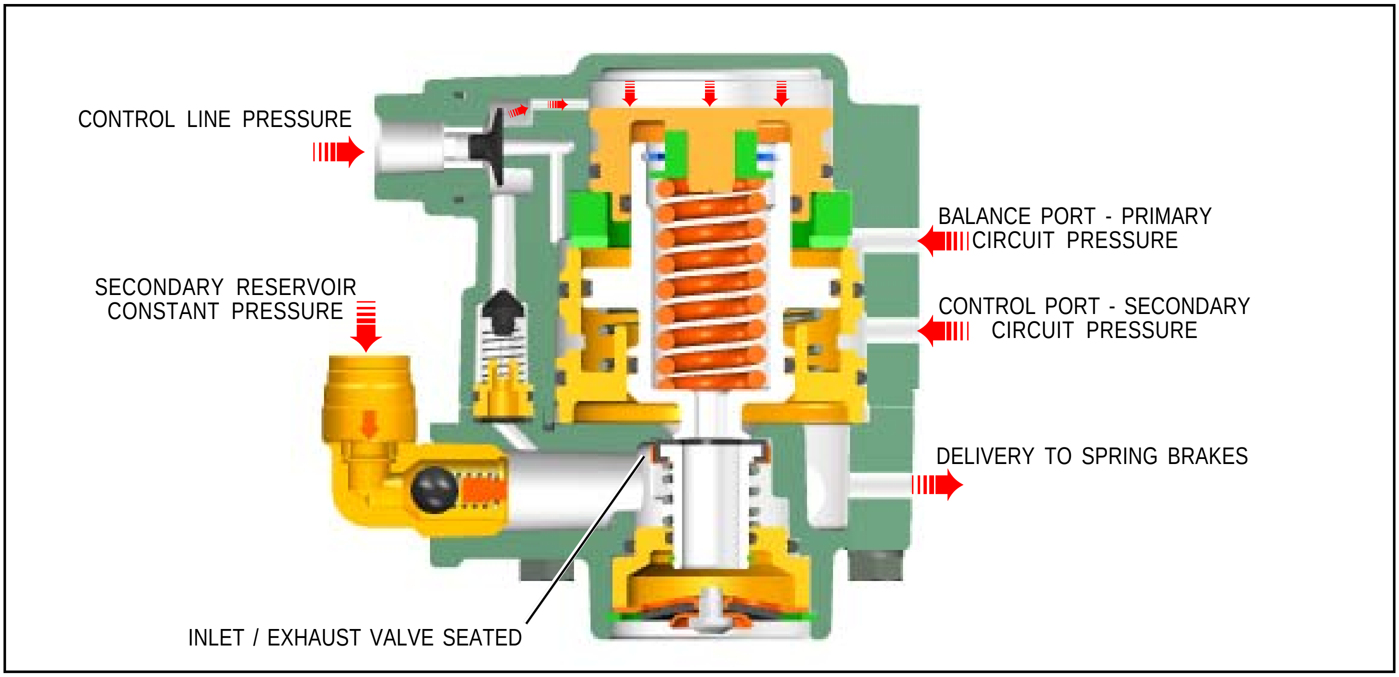


FIGURE 7 - NORMAL SERVICE APPLICATION

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.

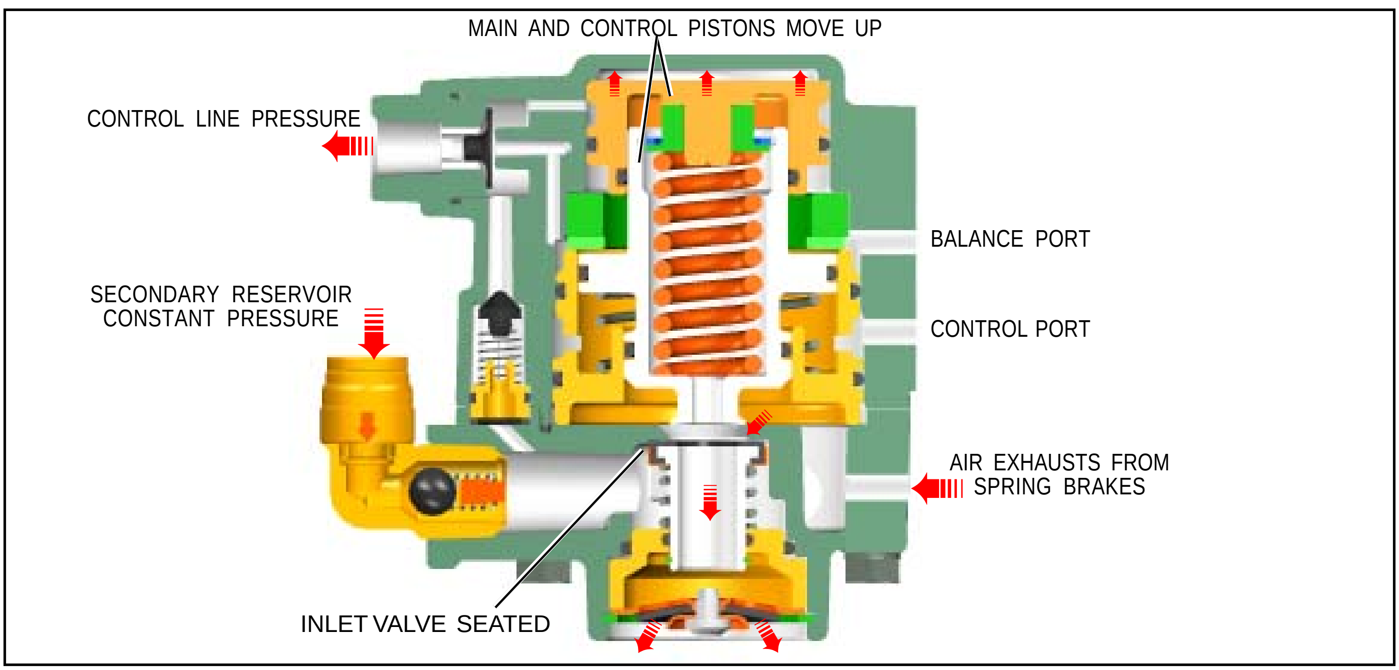


FIGURE 8 - PARKING

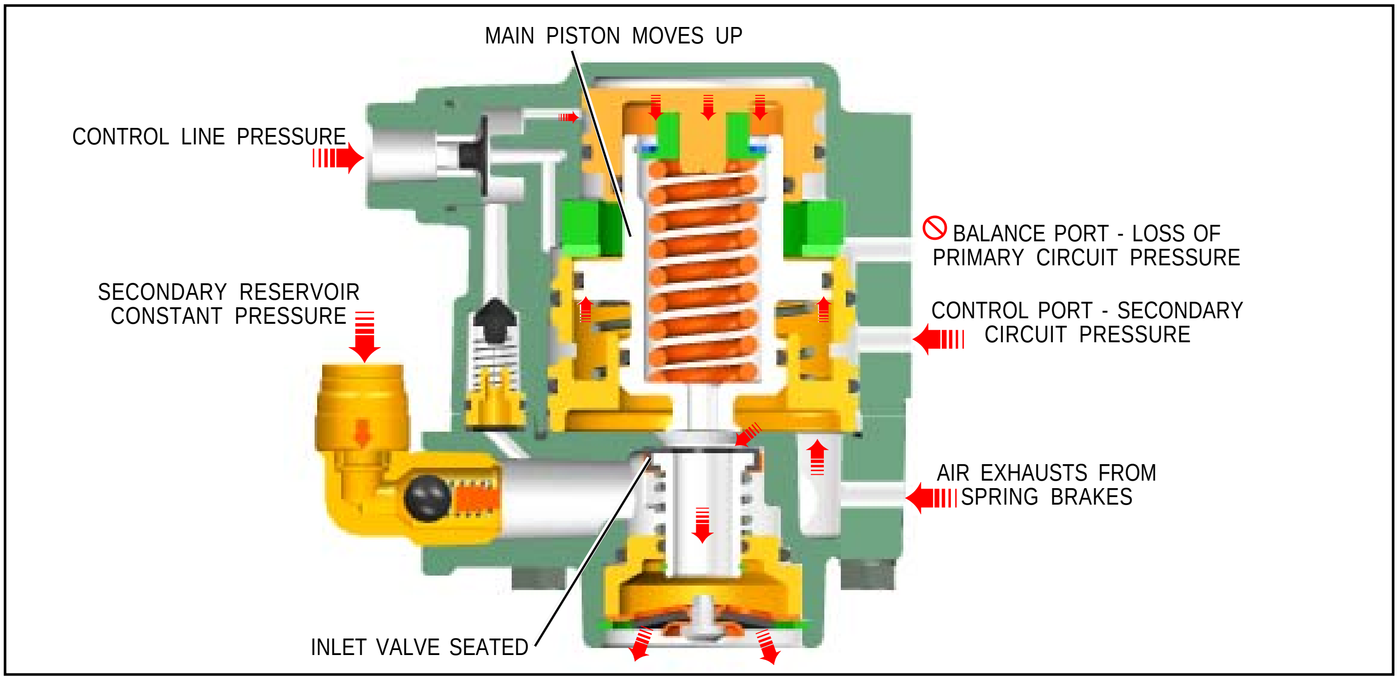


FIGURE 9 - SERVICE APPLICATION LOSS OF PRIMARY CIRCUIT

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.

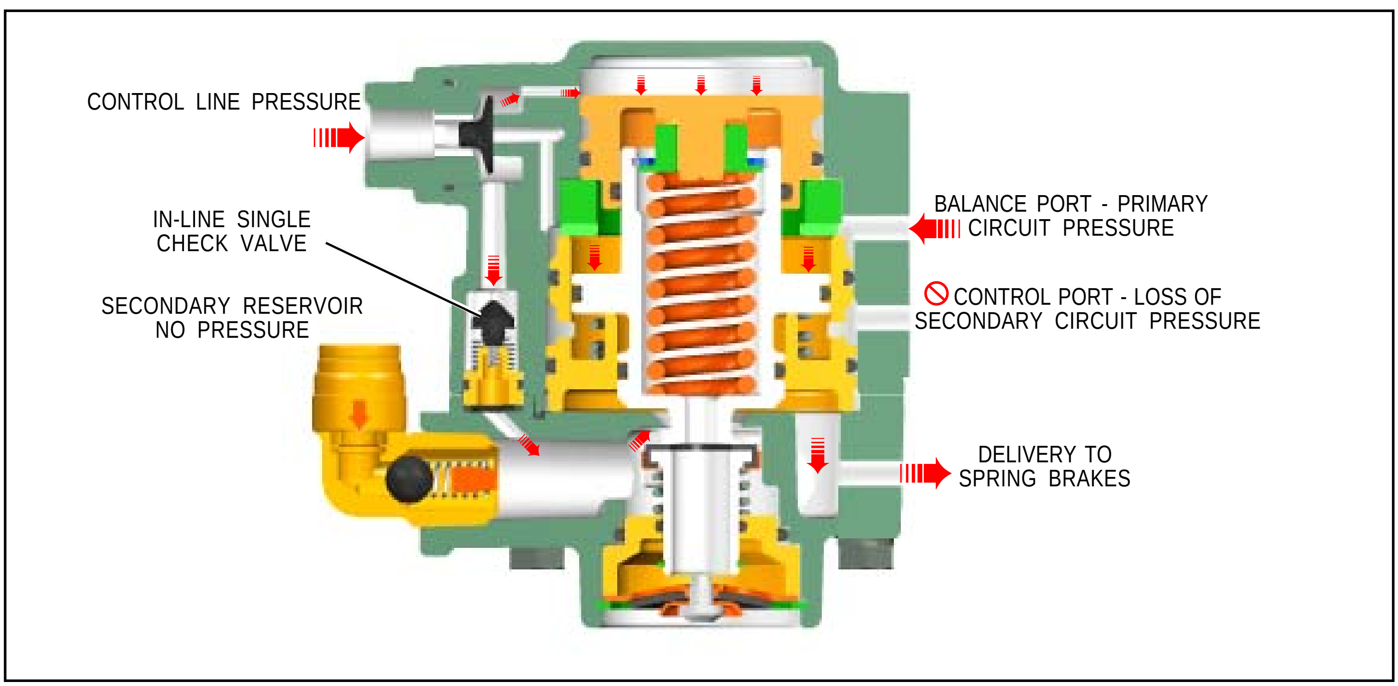


FIGURE 10 - SERVICE APPLICATION LOSS OF SECONDARY CIRCUIT

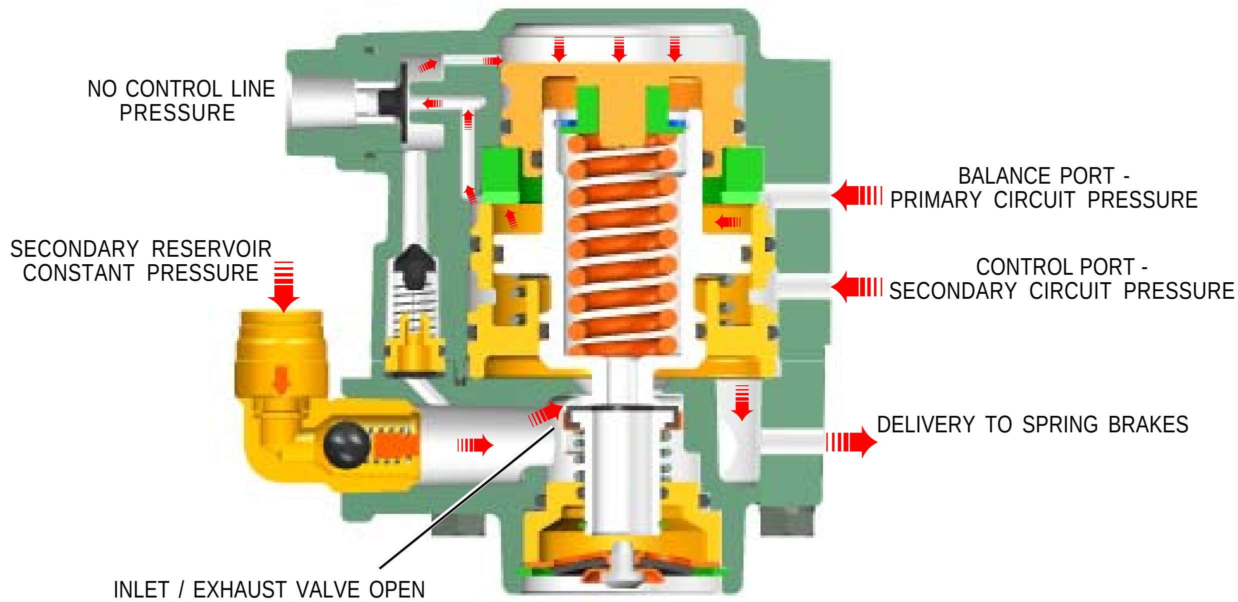


FIGURE 11 - ANTI-COMPOUNDING

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.

CONTENTS

ILLUSTRATIONS

1. WHEELS

When the vehicle is provided with stud-mounted wheels, wheel studs and nuts on the left side of the vehicle have left-hand threads whereas those on the right side have right-hand threads. If equipped with hub-mounted wheels, all studs and nuts have right-hand threads. Aluminum-polished wheels are installed on the vehicle and are mounted with radial tubeless tires.

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.

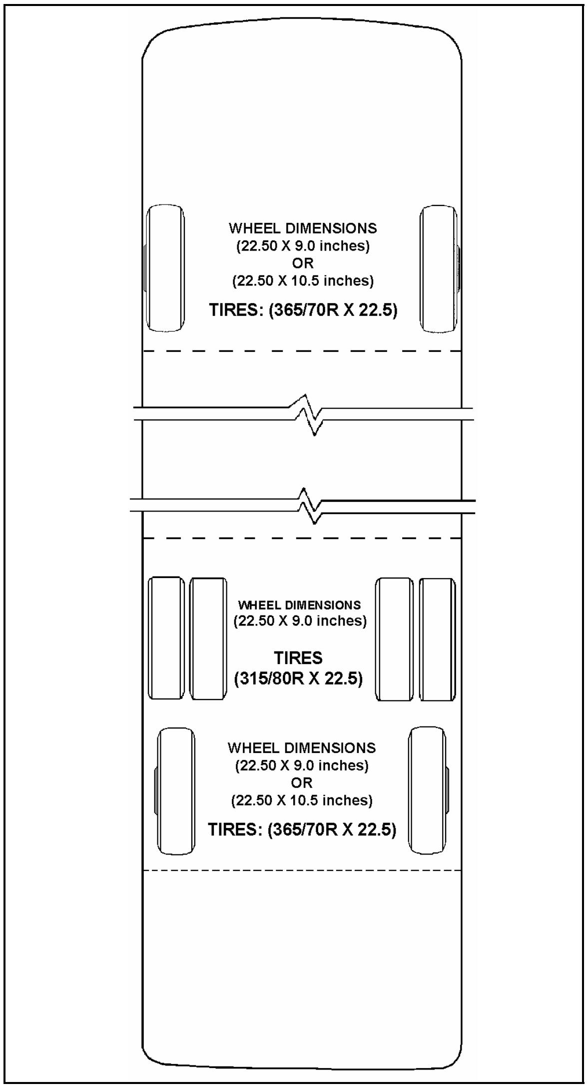


FIGURE 1: WHEEL ARRANGEMENT 13037

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 2 for the suggested tightening sequence.

2.1 INSPECTION

Tighten stud nuts progressively as shown in Figure 2. The final tightening should be done with a torque wrench. Tighten stud nuts to 450 - 500 lbf-ft (610 - 680 Nm) for aluminum wheels.

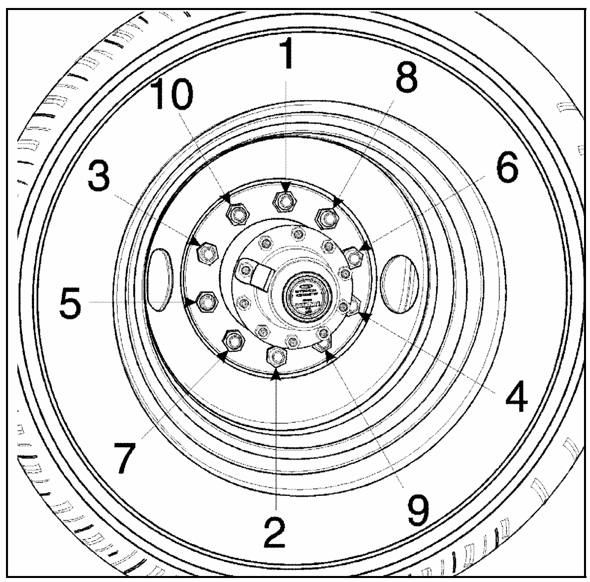


FIGURE 2: TIGHTENING SEQUENCE 13018

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.

NOTE
For stud-mounted wheels, turn nuts counterclockwise for R.H. side and clockwise for the L.H. side of vehicle. For hub-mounted wheels, turn nuts counterclockwise on both sides of the vehicle.

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 2 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 2. The final tightening should be done with a torque wrench. Tighten stud nuts to 450 - 500 lbf-ft (610 - 680 Nm) for aluminum 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

1. Remove outer wheel;
2. Unscrew inner cap nuts
3. Remove inner wheel.

3.3 INNER WHEEL INSTALLATION

1. Mount the wheel over studs, being careful not to damage stud threads;
2. Screw in the inner cap nuts (Fig. 3), so that wheel will position itself concentrically with hub. Refer to Figure 2 for sequence;
3. Tighten inner cap nuts progressively according to sequence shown in Figure 2. Final tightening should be done with a torque wrench. Tighten inner cap nuts to 450 - 500 lbf-ft (610 - 680 Nm) for aluminum 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.

3.4 OUTER WHEEL INSTALLATION

With inner wheel installed, tighten the hex stud nuts (Fig. 4) using the single wheel installation procedure described previously.

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. 4);
2. Tighten the inner cap nut to 450 - 500 lbf-ft (610 - 680 Nm);
3. Tighten the hex stud nut to 450 - 500 lbf-ft (610 - 680 Nm).

Repeat for each of the 10 *"hex stud nut - inner cap nut assemblies"* according to the tightening sequence in Figure 2.

CAUTION

Do not attempt to tighten an inner cap nut without having previously loosened the hex stud nut.

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 runout. Install a dial gauge as shown in Figure 3, 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 runout exceeds 0.0625 inch (1,6 mm), the wheel must be replaced.

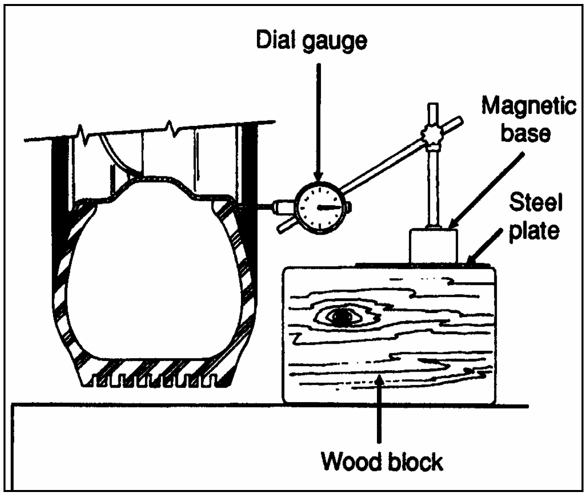


FIGURE 3: DIAL GAUGE INSTALLATION 13008

If doubt exists whether wheel or hub is distorted, hub may be checked as follows:

- o Replace the existing wheel with a wheel known to be correct;
- o Check wheel lateral runout as outlined in step 2;
- o 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).

NOTE

For stud-mounted wheels, turn nuts counterclockwise for R.H. side and clockwise for the L.H. side of vehicle. For hub-mounted wheels, turn nuts counterclockwise on both sides of the vehicle.

6.1 DRIVE AXLE STUDS

Stud-mounted wheels are mounted on the drive axle with ¾"-16 studs with an inner cap nut, and a 1-1/8”-16 nut. Hub-mounted wheels are mounted with M22 x 1.5 studs and an M22 flange nut.

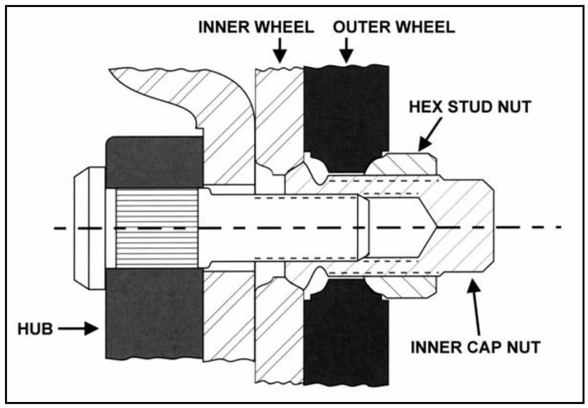


FIGURE 4: STUD-MOUNTED WHEELS 13007

6.2 FRONT AND TAG AXLE STUDS

Wheel can be mounted on tag axle with studs (1-1/8"-16 thread) or hub mounted (M22 x 1.5 thread).

NOTE

Wheel studs and nuts must be kept free from grease and oil. No lubricant whatsoever should be used.

WARNING

The two wheel mounting systems are not interchangeable. They have their specific wheel, nut and stud types. Use only the specific hardware suitable for a mounting type. Always install a wheel to the corresponding mounting type hub.

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.

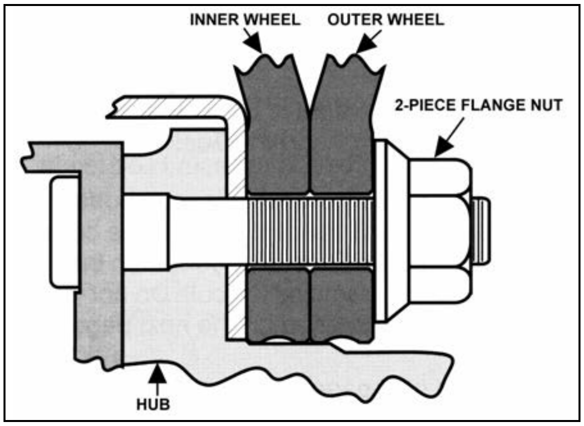


FIGURE 5: HUB-MOUNTED WHEELS 13025

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 2.

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.

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).

- o 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.
- o 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.
- o With dial indicator in position pull hard but steadily on hub flange and oscillate at same time until a steady reading is achieved.
- o Without releasing the pressure, turn bearing so that dial indicator stem contacts marked spot and note reading on indicator.
- o Push bearing flange hard and oscillate as before until a steady reading is achieved.
- o Without releasing the pressure, turn bearing so that indicator stem again contacts the marked spot and note new reading on indicator.
- o The difference between readings is the amount of mounted end play in bearing unit.
- o The mounted end play figure should not exceed 0.050 mm for a new bearing.

NOTE
If original bearing unit is re-fitted, and end-float is measured at 1 mm, with hub not fully tightened to correct torque, 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 and to Section 16 "Suspension".

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. CHANGING A FLAT TIRE

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.

11. TIRE MAINTENANCE

The most critical factor in tire maintenance is proper inflation (Fig. 6). 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.

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

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"

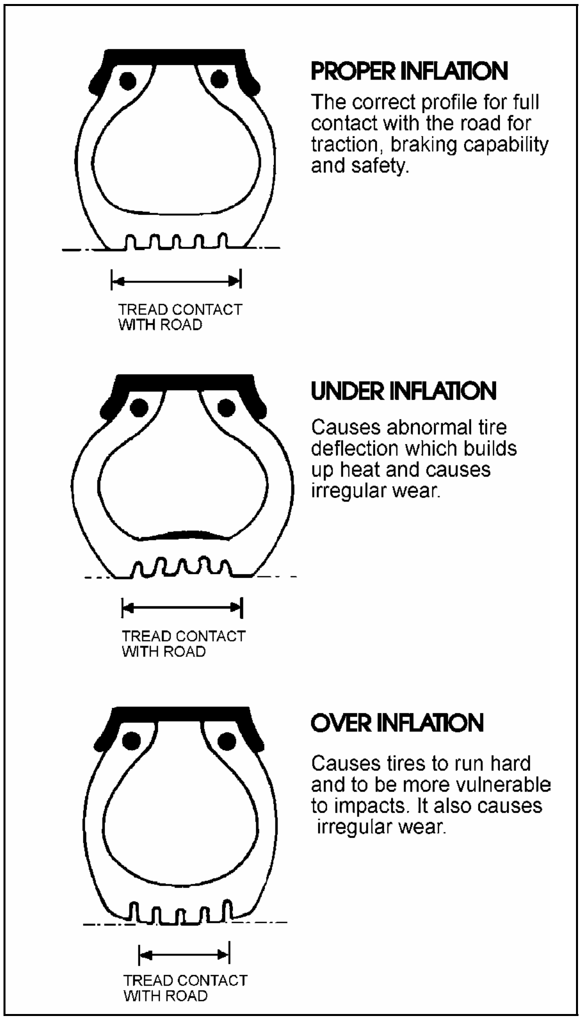


FIGURE 6: TIRE INFLATION 13009

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.

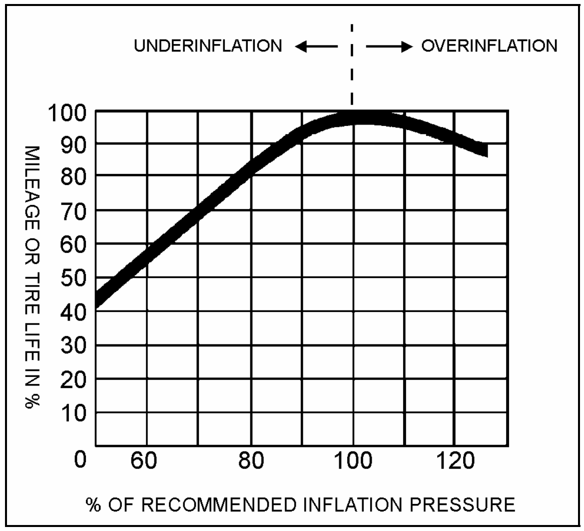


FIGURE 7: TIRE LIFE / INFLATION PRESSURE 13010

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

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.

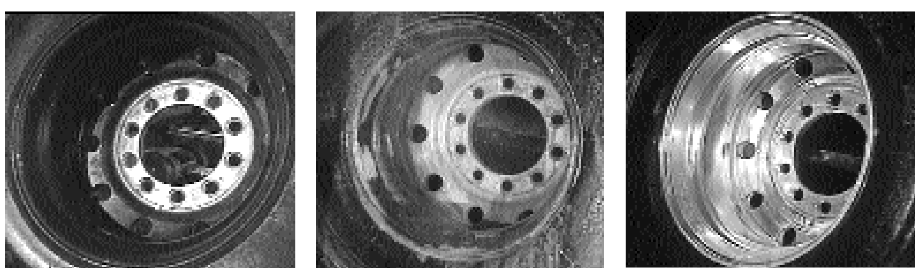
CAUTION
Bus shell vehicles should be weighed fully loaded and tires pressurized according to tire manufacturer's recommendations.

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.

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.

Do not exceed maximum wheel load. Customer must compare OEM vehicle load raiting 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 ensure proper clearance from any obstructions.

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).

Wheel Load Rating (Pounds) — Maximum Inflation Pressure — FMVSS 120 Designation

ALCOA® FORGED $\underbrace{\text{MAX LOAD 7300}}$ $\underbrace{\text{MAX PSI 120}}$ $\underbrace{\text{T-DOT}}$

$\underbrace{\text{060602}}$ PART NO 883620DB $\underbrace{\text{22.5X8.25 15° DC}}$

Date of Manufacture (Day/Month/Year) — Wheel Description

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

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.

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.

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.

TRUCK AND TRAILER

Alcoa Dura-Bright® Wheels

More shine. Less maintenance.

You said you wanted aluminum wheels that kept their brilliant good looks with as little effort as possible. And, we listened.

Introducing the first aluminum wheels you don't polish or scrub – just spray with soap and water. And, of course, they're from the aluminum wheel experts, Alcoa.

It's not a coating. It's not a finish. It's a patented treatment that penetrates the aluminum. Alcoa Dura-Bright® wheels need no painting, no polishing, no special chemicals. We think you'll agree. Alcoa Dura-Bright® wheels are the closest to a maintenance-free shine you'll ever see.

Available exclusively from Alcoa, Dura-Bright® wheel treatment:

- protects wheels against oxidation and corrosion.
- cleans easily, so brake dust, road salt, dirt and oil residue quickly wash away.
- brightens the wheel.

Now your wheels can look their best with less effort than with any previous steel or aluminum wheel. That lets you save money and time – and still hit the road with clean, bright, good-looking wheels on your trucks and trailers.

Along with faster, easier cleaning and maintenance, you get all the advantages you've come to expect from Alcoa aluminum wheels, including:

- less weight for increased payload and greater fuel efficiency.
- better heat dissipation for extended tire and brake life.
- higher resale value (historically up to $1,500 on trucks with regular Alcoa aluminum wheels. Alcoa Dura-Bright® wheels may result in even more).
- one-piece, forged-in strength.
- the widest selection of wheels and wheel accessories in the industry.

Leave it to the company that invented the first practical aluminum truck wheel in 1948 to come up with Dura-Bright® wheels – the next revolution in wheel maintenance.

Alcoa Wheels – Look Smart

ALCOA

Dura-Bright® Wheel Specifications

Alcoa aluminum disc wheel mounting dimensions are consistent with SAE Recommended Practice J694 August '98. Part numbers listed for all sizes are Dura-Bright® brushed finish. Buffed finishes are indicated by changing the last digit of the part number listed to one of the following: For buffed outside only, part number should end in "1". For buffed inside only, part number should end in "2". For buffed both sides, part number should end in "3". Valve hole is on the inside. To protect the surface of Dura-Bright® wheels used in dual applications, Alcoa recommends the use of Alcoa DiscMate™ wheel spacers.

Dura-Bright® finished wheels currently available are listed below. Other wheel part numbers may be available upon request. Contact your Alcoa sales representative for availability.

CLASSIC TUBELESS WHEELS (round hand holes) – ENGLISH UNITS

Wheel description	Maximum wheel load[1] in pounds	Wheel wt. lbs.	Outset inches[3]	Inset inches	Maximum inflation PSI – cold	Valve stem	Part number[2]	DiscMate™	Stabilizer	Front outer cap nuts	Rear inner cap nuts Al/Al	Rear inner cap nuts Al/Stl	Rear outer cap nuts	Lug nut covers	Hub cover system kits front/rear
10-hole, stud located ball seat mounting – 11.25 in. bolt circle, 8.73 in. hub bore, 1.219 in. bolt hole diameter															
22.5x8.25-15°DC	7200	53	6.66	5.68	120	TR545D	883110DB	3/4" - 016000 1-1/8" - 017000	2225	3/4" Stud 5995 L&R 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	5996 L&R	150	Front - 076015 Rear - 077015
22.5x9.00-15°DC	9000	60	6.94	5.94	130	TR543C	893000DB	3/4" - 016000 1-1/8" - 017000	2127	3/4" Stud 5995 L&R 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	5996 L&R	150	Front - 076015 Rear - 077015
24.5x8.25-15°DC**	7200	59	6.6	5.59	120	TR545D	983120DB	3/4" - 016000 1-1/8" - 017000	—	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	150	Front - 076015 Rear - 077015
10-hole, hub piloted mounting – 285.75mm bolt circle, 220.1mm hub bore, 26.75mm bolt hole diameter (use two-piece flange nuts)															
22.5x8.25-15°DC**	7300	47	6.66	5.81	120	TR545D	883620DB	011000	2227	39874	—	—	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
22.5x9.00-15°DC**	9000	60	6.94	6.04	130	TR543C	893600DB	011000	2127	39874	—	—	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
24.5x8.25-15°DC**	7300	55	6.6	5.73	120	TR545D	983620DB	011000	2247	39874	—	—	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
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)															
22.5x8.25-15°DC	7300	53	6.66	5.82	120	TR545D	883610DB	015000	2225	—	—	—	—	1821	—
24.5x8.25-15°DC	7300	62	6.6	5.77	120	TR545D	983610DB	015000	2245	—	—	—	—	1821	—

CLASSIC TUBELESS WHEELS (round hand holes) – ENGLISH UNITS (METRIC UNITS)

Wheel description	Maximum wheel load[1] in lbs. (kgs)	Wheel wt. lbs. (kgs)	Outset inches[3] (mm)	Inset inches (mm)	Maximum inflation PSI–cold (Kpa)	Valve stem	Part number[2]	DiscMate™	Stabilizer	Front outer cap nuts	Rear inner cap nuts Al/Al	Rear inner cap nuts Al/Stl	Rear outer cap nuts	Lug nut covers	Hub cover system kits front/rear
10-hole, hub piloted mounting – 335mm bolt circle, 281.2mm hub bore, 26.75mm bolt hole diameter (use two-piece flange nuts)															
22.5x8.25-15°DC (26mm)	7830* (3550)	55.1 (25.0)	6.60 (168)	5.70 (145)	138 (952)	60MS27	885530DB†	013000	—	39874	—	—	39874	181	—
22.5x9.00-15°DC (26mm)	8820* (4000)	58.0 (26.3)	6.93 (176)	6.02 (153)	142 (978)	60MS27	894530DB†	013000	—	39874	—	—	39874	181	—
10-hole, hub piloted mounting – 335mm bolt circle, 281.2mm hub bore, 32.87mm bolt hole diameter (use two-piece flange nuts)															
22.5x8.25-15°DC (32mm)	7830* (3550)	55.1 (25.0)	6.60 (168)	5.70 (145)	138 (952)	60MS27	885550DB†	018000	—	430632	—	—	430732	—	—
22.5x9.00-15°DC (32mm)	8820* (4000)	57.1 (25.9)	6.93 (176)	6.02 (153)	142 (978)	60MS27	894550DB†	018000	—	430632	—	—	430732	—	—

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. Valve hole is on the inside unless noted otherwise.

1 Capacity ratings as dual or single in highway service – bias-ply or radial. Load ratings in lbs. for items 6 and 7 are rounded to nearest multiple of 5.

2 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 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 (1/2 dual spacing = offset).

** The lighter-weight Alcoa New Generation wheels.

† Indicates European Mount New Generation wheel for North American market.

‡ 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.

Dura-Bright® wheels should be cleaned with soap and water only. No abrasives or brushing. Detailed care and maintenance instructions for Dura-Bright® finished wheels are available in the Alcoa Dura-Bright® Wheel Finish Care and Maintenance publication by Alcoa. For your free copy, contact Alcoa Wheel Products, 1600 Harvard Avenue, Cleveland, OH 44105, (800) 242-9898.

Alcoa Wheel Products
1600 Harvard Avenue
Cleveland, Ohio 44105
800.242.9898

ALCOA
www.alcoawheels.com

Alcoa Inter-America, Inc.
115-A Matheson Blvd. West, Suite 207
Mississauga, Ontario L5R 3L1
800.668.1150

WHEEL SERVICE MANUAL

SAFETY AND MAINTENANCE INSTRUCTIONS FOR ALCOA TRUCK, TRAILER, BUS AND MOTOR HOME WHEELS

March 2005

Supersedes July 2004

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. 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 Heavy Duty 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) 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 and Forged Products, 1600 Harvard Avenue, Cleveland, Ohio 44105, (800) 242-9898 and on the web at www.alcoawheels.com.

How to use this manual

This manual is written in a style called structured text.

Throughout the manual you will find numbers which look like this (See 3-1, page 18). These numbers are cross references to other sections of the manual. The numbers (3-1) refer to section 3, subtopic 1. When you turn to page 18 you will find the section number and subtopic number under the heading in each section as shown below:

Recommendations for mounting tubeless tires

3-1

The cross references will help you find related information in the manual. For example in section 4-1 you will read the following sentence...

"Make sure all wheel cap nuts are properly torqued–check them often (see 4-9, page 29)."

By turning to section 4, subtopic 9, on page 29 you will find information on proper torquing.

Note: The **Alcoa Heavy Duty Wheel Service Manual** contains information for proper service and operation of Alcoa heavy duty wheels. Alcoa heavy duty wheels for heavy duty trucks, truck trailers and buses are Alcoa tubeless wheels with bead seat diameters measured in .5 inch increments and Alcoa tube type wheels.

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.

WARNING

WARNING Wheels that are not properly installed or maintained may not work properly.

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 Service Manual. For additional copies of the manual, available free of charge from Alcoa, or for the most recent updates, contact Alcoa Wheel and Forged Products at 1-800-242-9898 option 1 or on the web at www.alcoawheels.com.

To obtain Alcoa rim flange wear gauge(s) at no charge and information on free training on proper installation and maintenance procedures, contact Alcoa Wheel and Forged Products at (800) 242-9898 option 1 or on the web at www.alcoawheels.com.

Table of Contents

1 Specifications

Alcoa aluminum disc wheel mounting dimensions are consistent with SAE Recommended Practice J694 February 2001. Part numbers listed for all sizes are satin finish. 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." Valve hole is on the inside. Only for item numbers marked with an asterisk(*), part numbers ending in "9" are inset position wheels satin finished (see footnote).

Dura-Bright® surface treatment wheels 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 buffed outside only, the number is "1." For buffed inside only, the number is "2." For buffed both sides, the number is "3." Currently, only the wheel item numbers marked with "DB" are available with the Dura-Bright® surface treatment. Dura-Flange® wheels are identified by using the regular numerical part number and the addition of "DF" at the end. Only the wheel item numbers marked with DF are available with the Dura-Flange® option and are available in all polished finishes.

TUBELESS WHEELS (round hand holes) ENGLISH UNITS

Item no.	Wheel description	Maximum wheel load[1] in lbs.	Wheel wt. lbs.	Outset inches[3]	Inset inches	Maximum inflation PSI—cold	Valve stem	Part number[2]	DiscMate	Stabilizer	Front outer cap nuts	Rear inner cap nuts Al/Al	Rear inner cap nuts Al/Stl	Rear outer cap nuts	Lug nut covers	Hub cover system kits front / rear
Six-hole, stud located, ball seat mounting—8.750 in. bolt circle, 6.495 in. hub bore, 1.219 in. bolt hole diameter																
1	17.5x6.75-15°DC	5070	32	5.55	4.72	125	TR543C	**663170**	-	2125	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	5996 L&R	150	-
10-hole, stud located, ball seat mounting—8.750 in. bolt circle, 6.495 in. hub bore, 1.219 in. bolt hole diameter																
2	17.5x6.75-15°DC	5070	31	5.55	4.72	125	TR543C	**663070**	-	2125	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	5996 L&R	150	-
10-hole, stud located, ball seat mounting—11.25 in. bolt circle, 8.73 in. hub bore, 1.219 in. bolt hole diameter																
3	22.5x7.50-15°DC	7200	53	6.28	5.32	120	TR545D	**873100**	3/4" - 016000, 1-1/8" 017000	2225	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	5996 L&R	150	Front - 076015 Rear - 077015
[DB]4	22.5x8.25-15°DC	7200	53	6.66	5.68	120	TR545D	**883110**	3/4" - 016000, 1-1/8" 017000	2225	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	5996 L&R	150	Front - 076015 Rear - 077015
5	22.5x9.00-15°DC	9000	60	6.94	5.94	130	TR543C	**893000**	3/4" - 016000, 1-1/8" 017000	2127	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	5996 L&R	150	Front - 076015 Rear - 077015
6	22.5x12.25-15°DC	11,400	62	.56 Reversible	—	125	TR543E	**823000**	3/4" - 016000, 1-1/8" 017000	-	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	150	Front - 076015 Rear - 077015
*7	22.5x12.25-15°DC	11,400	66	3.88	2.76	125	TR543E outset TR545E inset	**823050**	3/4" - 016000, 1-1/8" 017000	-	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	150	Front - 076015 Rear - 077015
8	22.5x12.25-15°DC	11,000	70	5.84	4.68	120	TR545E	**823060A**	3/4" - 016000, 1-1/8" 017000	-	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	150	Front - 076015 Rear - 077015
9	22.5x13.00-15°DC	12,300	72	3.5	2.38	125	TR543E	**833050**	3/4" - 016000, 1-1/8" 017000	-	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	150	Front - 076015 Rear - 077015
*[††]10	22.5x14.00-15°DC	12,800	71	2.0	0.87	125	TR543E outset TR545E inset	**841100**	3/4" - 016000, 1-1/8" 017000	-	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	150	Front - 076015 Rear - 077015
11	24.5x8.25-15°DC	7200	59	6.6	5.59	120	TR545D	**983120**	3/4" - 016000, 1-1/8" 017000	-	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	150	Front - 076015 Rear - 077015
10-hole, stud located, ball seat mounting—13.19 in. bolt circle, 10.65 in. hub bore (valve hole is on outside), 1.360 in. bolt hole diameter																
[4]12	22.5x13.00-15°DC	11,000	76	—	6.12	120	TR543	**833070A**	-	-	-	-	-	-	-	-
Eight-hole, hub piloted mounting—275mm bolt circle, 221.1mm hub bore, 26.75mm bolt hole diameter (use two-piece flange nuts)																
[DB]13	22.5x7.50-15°DC	7300	53	6.28	5.44	120	TR545D	**873400**	014000	2225	39874	-	-	39874	181	-
[DF]**14	22.5x8.25-15°DC	7300	50	6.66	5.82	120	TR545D	**883420**	014000	2227	39874	-	-	39874	181	-
[DB DF]**15	22.5x8.25-15°DC	7400	50	6.66	5.82	130	TR544D	**883440**	014000	8344	39874	-	-	39874	181	-
*[††]16	22.5x14.00-15°DC	12,800	71	2.0	0.87	125	TR543E outset TR545E inset	**841400**	014000	-	39874	-	-	39874	181	-
17	24.5x8.25-15°DC	7300	62	6.6	5.77	120	TR509	**983400**	014000	2245	39874	-	-	39874	181	-

Continued on next page

TUBELESS WHEELS (round hand holes) ENGLISH UNITS *continued*

Item no.	Wheel description	Maximum wheel load[1] in lbs.	Wheel wt. lbs.	Outset inches[3]	Inset inches	Maximum inflation PSI—cold	Valve stem	Part number[2]	DiscMate	Stabilizer	Front outer cap nuts	Rear inner cap nuts Al/Al	Rear inner cap nuts Al/Stl	Rear outer cap nuts	Lug nut covers	Hub cover system kits front / rear
10-hole, hub piloted mounting—285.75mm bolt circle, 220.1mm hub bore, 26.75mm bolt hole diameter (use two-piece flange nuts)																
DB 18	22.5x7.50-15°DC	7300	53	6.28	5.44	120	TR545D	**873600**	011000	2225	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
DB DF **19	22.5x8.25-15°DC	7400	48	6.66	5.81	130	TR544D	**883640**	011000	8364	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
DB DF **§20	22.5x8.25-15°DC	8000	55	6.66	5.69	120	TR543C	**885600**	011000	-	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
DB **21	22.5x9.00-15°DC	9000	60	6.94	6.04	130	TR543C	**893600**	011000	2127	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
DB **22	22.5x9.00-15°DC	9000	60	6.94	6.04	130	TR544D	**893640**	011000	8964	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
DB 23	22.5x9.00-15°DC	10,000	53	—	3.12	130	TR545E	**893630**	011000	-	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
DB 24	22.5x10.50-15°DC	10,500	68	6.61	5.5	130	TR543	**803600**	011000	-	39874	-	-	-	181	Front - 076018 or 076085‡
25	22.5x12.25-15°DC	12,300	63	.56 Reversible	—	125	TR543E	**823600**	011000	-	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
DB DF *26	22.5x12.25-15°DC	11,400	66	3.88	2.75	125	TR543E outset TR545E inset	**823650**	011000	-	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
DB DF **27	22.5x12.25-15°DC	11,000	71	5.8	4.68	120	TR545E	**823660A**	011000	-	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
10-hole, hub piloted mounting—285.75mm bolt circle, 220.1mm hub bore, 26.75mm bolt hole diameter (use two-piece flange nuts) — *continued from previous page*																
DB DF **28	22.5x12.25-15°DC	11,000	71	5.8	4.68	130	TR542	**823640**	011000	-	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
29	22.5x12.25-15°DC	10,000	74	6.24	5.12	120	TR545E	**823670A**	011000	-	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
*30	22.5x13.00-15°DC	12,300	73	3.5	2.38	125	TR543E outset TR545E inset	**833650**	011000	-	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
**31	22.5x13.00-15°DC	11,000	74	6.42	5.3	120	TR545E	**833660A**	011000	-	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
**32	22.5x13.00-15°DC	11,000	74	6.42	5.3	130	TR542	**833640**	011000	-	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
DF DB †† *33	22.5x14.00-15°DC	12,800	71	2.0	0.87	130	TR543E outset TR545E inset	**841600**	011000	-	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
DF DB †† *34	22.5x14.00-15°DC	12,800	71	1.13	0	130	TR545E outset TR543E inset	**841610**	011000	-	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
DB DF **35	24.5x8.25-15°DC	7400	56	6.6	5.73	130	TR545D	**983640**	011000	9364	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
DF§ 36	24.5x8.25-15°DC	8000	65	6.6	5.63	120	TR545D	**985600**	011000	2245	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
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)																
DB DF 37	22.5x8.25-15°DC	7300	53	6.66	5.82	120	TR545D	**883610**	015000	2225	-	-	-	-	182	-
DB 38	24.5x8.25-15°DC	7300	62	6.6	5.77	120	TR545D	**983610**	015000	2245	-	-	-	-	182	-

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1 Specifications cont'd.

TUBELESS WHEELS (round hand holes) ENGLISH UNITS (METRIC UNITS)

Item no.	Wheel description	Maximum wheel load[1] in lbs. (kilograms)	Wheel wt. lbs. (kilograms)	Outset inches[3] (mm)	Inset inches (mm)	Maximum inflation PSI—cold (KPa)	Valve stem	Part number[2]	DiscMate	Stabilizer	Front outer cap nuts	Rear inner cap nuts Al/Al	Rear inner cap nuts Al/Stl	Rear outer cap nuts	Lug nut covers	Hub cover system kits front / rear
Eight-hole, hub piloted mounting—275mm bolt circle, 221.1mm hub bore, 24.75mm bolt hole diameter (use two-piece flange nuts)																
39	17.5x6.75-15°DC	5515 (2500)	29.5 (13.4)	5.55 (141)	4.72 (120)	142 (978)	TR543C	**663470**	014000	2126	39874	-	-	39874	181	-
40	19.5x6.75RW-15°DC	5515 (2500)	37.0 (16.8)	5.55 (141)	4.72 (120)	142 (978)	TR543C	**764480**	014000	2126	39874	-	-	39874	181	-
41	19.5x7.50RW-15°DC	6615 (3000)	37.7 (17.1)	6.10 (155)	5.28 (134)	142 (978)	TR543C	**773400**	014000	2126	39874	-	-	39874	181	-
10-hole, hub piloted mounting—225mm bolt circle, 176.1mm hub bore, 26.50mm bolt hole diameter (use two-piece flange nuts)																
42	17.5x6.00-15°DC	5515 (2500)	28.0 (12.7)	5.24 (133)	4.49 (114)	142 (976)	TR543D	**663200**	**-**	2125	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)																
43	19.5x7.50RW-15°DC	6615 (3000)	37.7 (17.1)	6.10 (155)	5.28 (134)	142 (978)	TR543C	**773600**	011000	2126	39874	-	-	39874	181	Front - 076018 or 076085‡ Rear - 077018 or 077085‡
10-hole, hub piloted mounting—335mm bolt circle, 281.2mm hub bore, 26.75mm bolt hole diameter (use two-piece flange nuts)																
DB †44	22.5x8.25-15°DC	7830 (3550)	55.1 (25.0)	6.60 (168)	5.70 (145)	138 (952)	60MS27	**885530**	013000	-	39874	-	-	39874	181	-
DB †45	22.5x9.00-15°DC	8820 (4000)	58.0 (26.3)	6.93 (176)	6.02 (153)	142 (978)	60MS27	**894530**	013000	-	39874	-	-	39874	181	-
‡‡46	22.5x13.00-15°DC	12,800 (5806)	76.0 (34.5)	—	6.12 (155)	120 (827)	TR543	**833580**	013000	-	39874	-	-	39874	181	5811 polished with view port
47	24.5x8.25-15°DC	8500 (3855)	62.6 (28.4)	6.79 (172.5)	5.81 (147.5)	120 (827)	TR544D	**983500**	013000	-	39874	-	-	-	181	-
10-hole, hub piloted mounting—335mm bolt circle, 281.2mm hub bore, 32.87mm bolt hole diameter (use two-piece sleeved cap nuts)																
DB †48	22.5x8.25-15°DC (32mm bolt hole)	7830 (3550)	55.1 (25.0)	6.60 (168)	5.70 (145)	138 (952)	60MS27	**885550**	018000	-	4306.32	-	-	4307.32	-	-
DB †49	22.5x9.00-15°DC (32mm bolt hole)	8820 (4000)	57.1 (25.9)	6.93 (176)	6.02 (153)	142 (978)	60MS27	**894550**	018000	-	4306.32	-	-	4307.32	-	-
6-hole, hub piloted mounting—205mm bolt circle, 160.2mm hub bore, 21.5mm bolt hole dia. (use two-piece flange nuts)																
50	17.5x6.00-15°DC	4000 (1814)	29.6 (13.4)	5.0 (127)	4.25 (108)	110 (758)	60MS27	**664220**	-	-	-	-	-	-	-	-

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. Valve hole is on the inside unless noted otherwise.

[1]Capacity ratings as dual or single in highway service — bias-ply or radial. Load ratings in lbs. for items 39 through 50 rounded to nearest multiple of 5.

[2]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 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]These wheels must be installed only in the inset position because spherical ball seats are on only one side of the disc.

* Part numbers should end in "1" or "9" when used in an inset position and "0" or "2" when used in an outset position.

** Disc Brake Compliant — As of January 2005: 883640 replaces 883620 and 884620, 983640 replaces 983620; As of March 2005: 883440 replaces 883420, 893640 replaces 893600, 823640 replaces 823660A, 833640 replaces 833660A

† Indicates European New Generation Wheels. ††Check with vehicle manufacturer or axle manufacturer before retrofitting to outset wide base wheels to insure compatibility with axle and wheel end components. P/Ns 841100, 841400, 841600 and 841610 are recommended for use on drive axle and trailer axle positions, but with some restrictions on "N" trailer spindles.

‡ 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/N 833570 will be phased out 1st quarter 2005 and will be replaced by the higher load rated 833580.

§ P/Ns 885600 and 985600 are Alcoa Severe Service Wheels.

Specifications 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, option 1. 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 1-800-242-9898, option 4.

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.

Note: The Dura-Bright® surface treatment and the Dura-Flange® options are not currently available together on the same wheel. Dura-Bright® and Dura-Flange®are available in all polished finishes.

2 Inspection

2

Inspect thoroughly and frequently

2-1

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.

Like tires and other vehicle components that work hard, wheels will eventually wear out. It isn't always possible to predict exactly when the useful life of a wheel will end. But generally, older wheels and wheels operating in extreme conditions should be examined more frequently for obvious signs that they should be removed from service.

As an aid to the owner in determining the period of time a wheel has been in service, it is recommended the owner stamp an "in service" date onto the wheel at the time of receipt. See 5-5, page 36 for recommended stamping locations.

Pay particular attention to front-end assemblies. 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. On tube-type wheels, carefully inspect the gutter area normally concealed by the side rings.

Be sure that the best wheels are on the front of the vehicle.

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 1 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 2-5, page 9). Dirt streaks radiating from stud holes may indicate loose cap nuts (see 4-9, page 29).

Excessive heat damage

2-2

WARNING **Excessive heat from fire, brake malfunction, wheel bearing failure or other sources may weaken the metal and cause the wheel/tire assembly to separate explosively.**

Exploding wheel/tire assembly can cause death or serious injury.

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. Even if a wheel does not appear to be obviously burned, check the valve hole and labels 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.

A blistered, charred, blackened or cracked-looking logo decal on an Alcoa wheel may indicate that the wheel has been exposed to excessive heat.

Dimension checks

2-3

Open side circumference check

WARNING

WARNING Wheels that have been subjected to high pressure tire and rim separation, run flat, excessive heat or other physical damage may no longer have sufficient dimension and contour to retain tire bead while under pressure.

Rims that lack proper dimension and contour can lead to explosive separation of tire and rim, causing injury or death.

Follow dimension check procedures described in this section during each wheel inspection.

2

The circumference of the bead seat on the open side of the wheel should be checked with 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. Measure the circumference of the bead seat on the open side (see illustration below) with a ball tape. Ball tapes used for measuring wheel circumference can be purchased from the Tire and Rim Association, Inc., 175 Montrose West Avenue, Copley, Ohio 44321.

If the circumference of the bead seat does not match the required dimension as indicated by the ball tape, remove the wheel from service. Be sure to clearly mark the wheel as out-of-service or otherwise render the wheel unusable.

Any wheel known to have been run with a flat tire or operated under abnormal conditions should be checked before continued service. If a ball tape is unavailable, roll the unmounted wheel without a tire several revolutions over a smooth, flat, level, clean surface. 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.

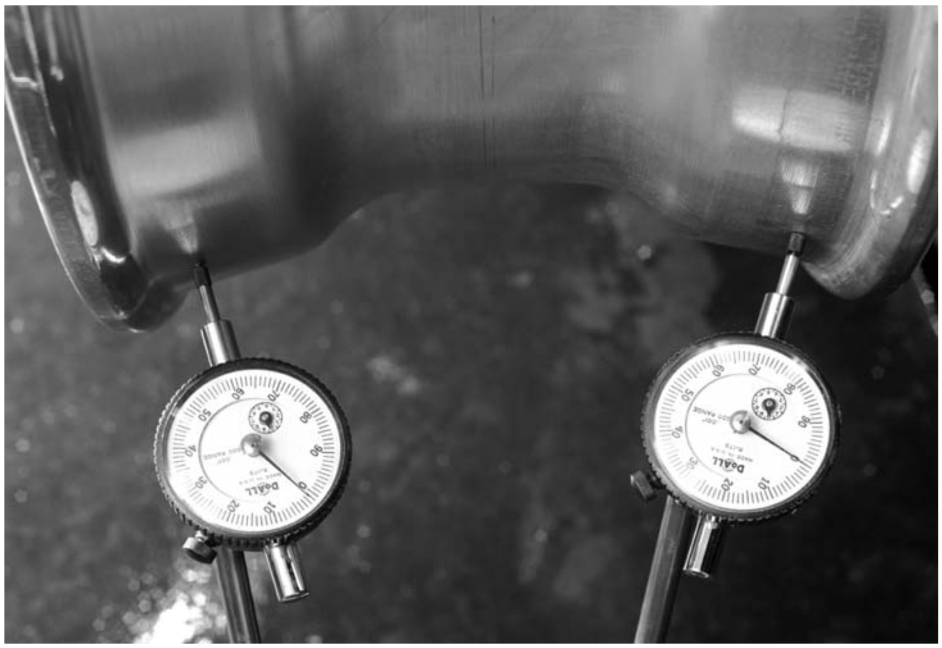
Continued on the next page

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 3-5, page 22 for recommendations and instructions for demounting tubeless tires and 6-5, page 43 for recommendations and instructions for demounting tube-type 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 .045 inches 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 3-5, page 22 for recommendations and instructions for demounting tubeless tires and 6-5, page 43 for recommendations and instructions for demounting tube-type 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, page 44).

Cracked or damaged wheel checks

2-4

WARNING

WARNING Cracked or damaged wheels may cause wheels to fail or come off the vehicle while the vehicle is moving.

Wheels that fail or come off the vehicle while it is moving can cause serious injury or death.

Immediately remove cracked or damaged wheels from service.

Inspect wheels for cracks or damage according to the following sections of Chapter 2. Remove wheels from service with known or suspected damage.

Mounting area

2-5

Stud hole cracks are usually caused by improper torquing (see 4-9, page 29 and 5-2, page 35), 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 stud hole to stud hole. Causes are: undersized diameter of wheel support surface (see specifications below), support surface not flat, incorrect attachment parts (see 4-12, page 34) and insufficient torque (see 4-9, page 29 and 5-2, page 35). 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.

2

2

Mounting area (continued)

Support surface diameters

Support surface (backup diameter) should be flat to the diameter recommended on the chart below:

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

2-6

Due to aluminum's natural resistance to corrosion, Alcoa aluminum disc wheels do not need to be painted for most operating conditions. However, certain environments can lead to corrosion. Some of these are: salt, 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.

Bead seat and valve stem corrosion often are caused by entrapped moisture which contains corrosive elements. Mild corrosion should be removed thoroughly by wire brush and the rim protected with a coating of non-water-based lubricant (see 3-1, page 18). Remove any severely corroded wheel from service.

CAUTION

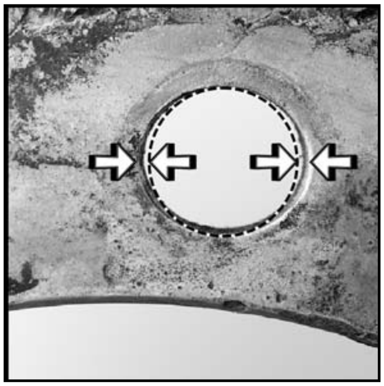
CAUTION The use of liquid tire balancers or sealants in Alcoa wheels may cause extremely rapid corrosion of the wheel rim surface.

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.

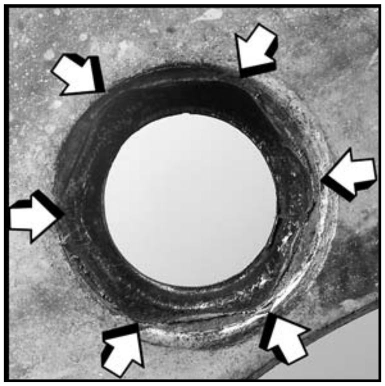
Stud holes

2-7

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.



Damaged hub piloted bolt hole. Elongation from true round (dashed circle) indicated by arrows.



Damaged ball seat contact area. Pounding of nut on ball seat contact area identified by arrows.

2

Disc area

2-8

Inspect both sides of disc area for hand hole cracks. If cracks are found, remove the wheel from service.

2

Rim area

2-9

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.

Gutter area

2-10

Projections on the side of the wheel gutter area on tube type wheels can cause uneven seating of the side and lock ring and chipping of the gutter. Such projections must be removed. Remove the wheel from service if damaged.

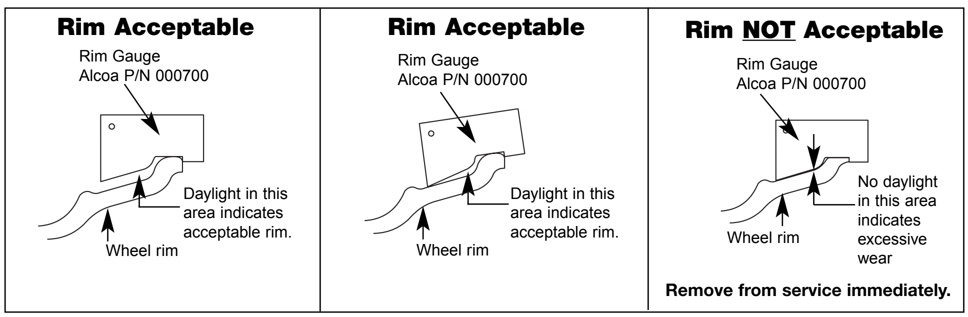
Cracking in bottom of gutter flange. Occasionally, circumferential cracks may appear in the bottom of the gutter area. This area should be thoroughly cleaned and carefully inspected after a tire is removed from the wheel. Also check the side underneath gutter flange for circumferential cracks. Gutter flange cracks can ultimately lead to the separation of the rim area from the disc. Immediately remove from service a wheel that exhibits any cracks.

Rim flange wear

2-11

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



To obtain a gauge(s) at no charge and information on free training on proper installation and maintenance procedures, contact **Alcoa Wheel and Forged Products** at (800) 242-9898 option 1 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.

Photo 1. Acceptable Rim Flange Wear Condition

2

Rim flange wear (continued)

STEP 2. After the wheel is separated from the tire, use a ball tape to verify the circumference of the bead seat on the open side is acceptable (see 2-3, page 7). 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 page 13).

See **Rim Flange Wear Gauge Instructions** illustrations above to make this determination. If you do not have an Alcoa Rim Flange Wear Gauge, contact Alcoa Wheel and Forged Products to obtain a gauge(s) at no charge.

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 constructed from a section of tire side wall or a suitable piece of rubber attached to a block of wood.

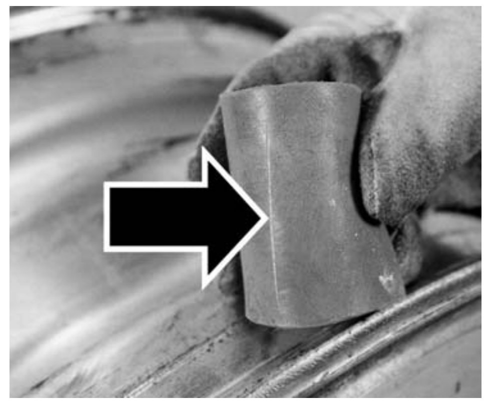


Photo 3. Run the sharpness indicator gauge along the wheel in the area of the wear to determine if the wear is sharp enough to cut or damage the rubber on the sharpness indicator.

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.

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.

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.

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.

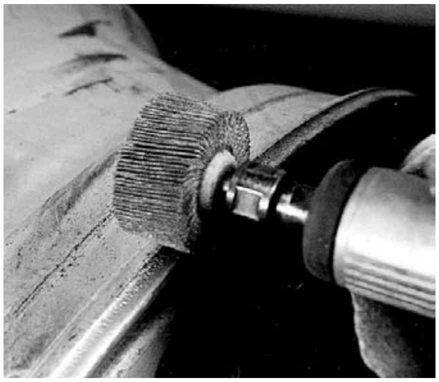


Photo 5. Air or electric power sander.

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 page 15).

> 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.

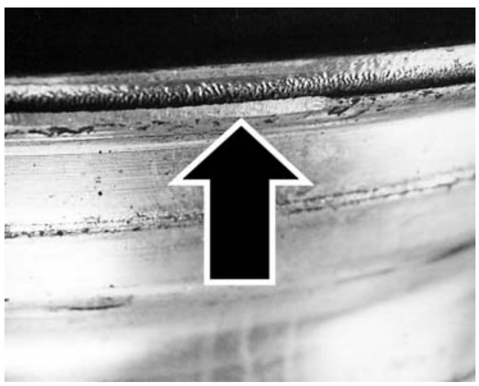


Photo 8. Adequate repair for sharp edge resulting from rim flange wear removes just enough metal to smooth the edge.

STEP 4. The photographs show the process of removing the edge. With 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 the there is evidence of sharpness.

Regardless of the method which you choose, the objective is to remove the sharp edge (photo 8). 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

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 injuries or death.

Never attempt to weld or braze any surface of an Alcoa aluminum wheel.

WARNING

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 result in 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. Permanently remove any wheel from service that has inadequate rim flange height.

WARNING

WARNING Excessive heat from fire, brake malfunction, wheel bearing failure or other sources may weaken the metal and cause the wheel/tire assembly to separate explosively.

Exploding wheel/tire assembly can cause death or serious injury.

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.

3 Alcoa 15° Drop Center Wheel for Tubeless Tires

Recommendations for mounting tubeless tires

3-1

NOTICE: For complete information on tube type wheels, contact Alcoa.

WARNING

WARNING Damaged tires or wheels can lead to an explosive separation of tires and wheels.

Explosive separation can result in 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. Remove damaged tires or wheels from service.

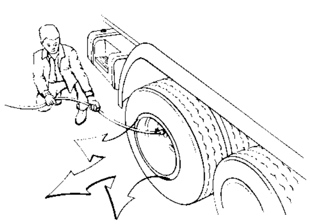
WARNING

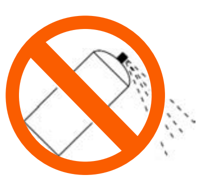
WARNING Use of inner tubes in tubeless wheels will hide slow leaks. Slow leaks may indicate cracked (see section 2-9, page 12) or damaged wheels which lead to wheel failures.

Wheel failures can cause accidents which may result in serious injury or death.

Never use an inner tube on an Alcoa tubeless wheel, and always remove cracked or damaged wheels from service.

NOTICE: Alcoa aluminum 19.5" RW and non-symetrical well wide base wheels require special tire mounting techniques, See Section 3-2.





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 5-8, pages 37 & 38 for specific cautions, care and maintenance procedures). DiscMate 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 2, page 5).

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 3-2, page 19).

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 below).**

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 1 Specifications** of this manual (see page 2).

12. When inflating a tire in an inflation cage or while mounted on a vehicle, always use a clip-on air chuck or threaded straight chuck and a remote valve with pressure gauge. Securely anchor the inflation cage and during inflation or handling of an inflated wheel and tire assembly, stay out of the path of potential exploding parts or air blasts.

Recommendations for mounting tubeless tires (continued)

WARNING

WARNING Use of 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.

Use only 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.

3

Mounting tubeless tires

3-2

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.

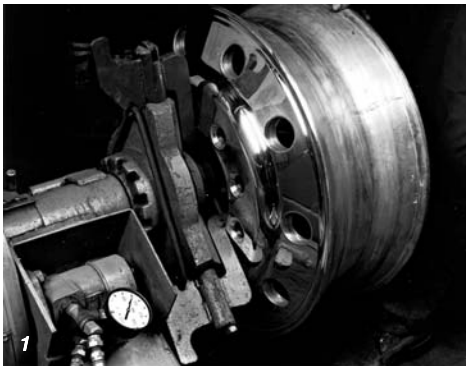
NOTICE: Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

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" RW and non-symmetrical wide base 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.



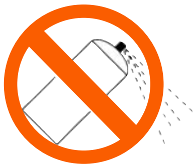
Position wheel on machine. Lubricate wheel (entire air chamber surface) and tire bead using approved lubricant. Tire beads should be mounted over the rim flange closest to the wheel well. Push bead over flange as far as possible.

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, page 44). **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



NOTICE: Alcoa aluminum 19.5"RW and non-symetrical well wide base wheels require tires be mounted and demounted **over the disc side of the wheel only.** For a free instruction wall chart, contact: Alcoa Inquiry Fulfillment, Markinetics Inc., P.O. Box 809, Marietta, OH 45750.

WARNING

WARNING Use of 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 or later on the road. Loss of vehicle control can result, which can cause serious injury or death.

Use only approved mechanical or pneumatic bead seating devices.

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.

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.

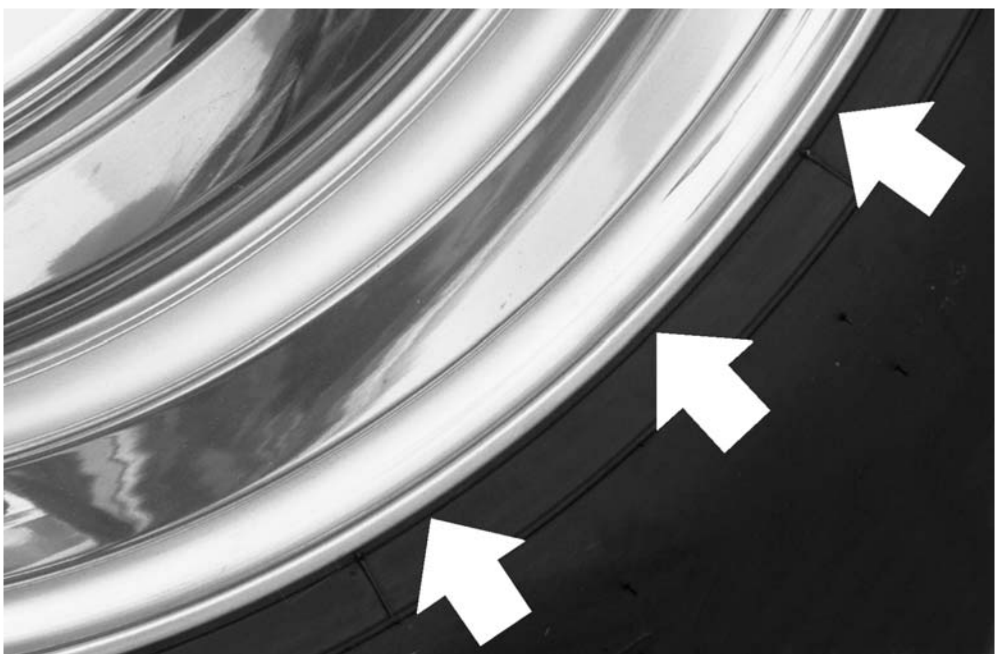
NOTICE: Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

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" RW and non-symmetrical wide base 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.



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.

Rim width to tire matching

3-3

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
8R	17.5HC	6.00HC	8	22.5	5.25, 6.00, 6.75
215/75R	17.5	6.00, 6.75	9	22.5	6.00, 6.75, 7.50
9R	17.5HC	6.75HC	10	22.5	6.75, 7.50, 8.25
10R	17.5HC	6.75HC, 7.50HC	245/75R	22.5	6.75, 7.50
245/75R	17.5	6.75, 7.50	11	22.5	7.50, 8.25
11R	17.5HC	8.25HC	255/70R	22.5	7.50, 8.25
			265/75R	22.5	7.50, 8.25
			12	22.5	8.25, 9.00
			295/75R	22.5	8.25, 9.00
			305/85R	22.5	8.25, 9.00
			315/80R	22.5	9.00, 9.75
			15	22.5	11.75, 12.25
			385/65R	22.5	11.75, 12.25
			425/65R	22.5	11.75, 12.25, 13.00
			16.5	22.5	12.25, 13.00
			18	22.5	13.00, 14.00
			445/50R	22.5	14.00
			445/55R	22.5	14.00
			445/65R	22.5	12.25, 13.00, 14.00
8	19.5	5.25, 6.00, 6.75	11	24.5	7.50, 8.25
225/70R	19.5	6.00, 6.00RW, 6.75, 6.75RW	275/80R	24.5	7.50, 8.25
245/70R	19.5	6.75, 6.75RW, 7.50, 7.50RW	285/75R	24.5	8.25
265/70R	19.5	7.50, 7.50RW, 8.25, 8.25RW	12	24.5	8.25, 9.00
285/70R	19.5	8.25, 8.25RW, 9.00	305/75R	24.5	8.25, 9.00
305/70R	19.5	8.25, 8.25RW, 9.00			
445/65R	19.5	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

3-4

WARNING

WARNING An aluminum wheel can be structurally weakened by uncontrolled 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 uncontrolled 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 result in 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. 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. 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 5-8, pages 37-38 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

3-5

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.

4 Wheel Installation

Recommendations for proper installation of wheels

4-1

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.

1. For the same reason the best tires are run on the front axle, the best wheels also should be used on the front axle.

2. Make sure all wheel cap nuts are properly torqued — check them often (see section 4-9, page 29). 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. Dirt streaks radiating from stud holes can indicate loose nuts (see Section 2, pages 5-17).

3. 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.

4. 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.

5. 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.

6. Do not introduce any foreign objects such as spacers or high hats into the contact surface areas of the mounting system unless approved by Alcoa. Do not paint Alcoa forged aluminum wheels.

7. Additional care should be used when mounting Alcoa Dura-Bright® surface treated wheels since minor nicks and scratches cannot be polished out (see section 5-8, page 37-38 for specific cautions, care and maintenance procedures).

8. DiscMates are a protection gasket designed to be placed between the wheels and also the brake drum/wheel contact surfaces (see sections 4-5, page 24; 4-6, page 25; 4-7, page 26 and 4-10, page 31). DiscMates are recommended to be replaced when the tire/wheel assemblies are removed and reinstalled.

WARNING

WARNING Wheels that are not properly installed or maintained may not work properly.

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 training on proper installation and maintenance, available free of charge from Alcoa, or for the most recent updates, contact Alcoa Wheel and Forged Products at 1-800-242-9898 option 1 or on the web at www.alcoawheels.com.

Wheel cap nuts

4-2

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 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

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).

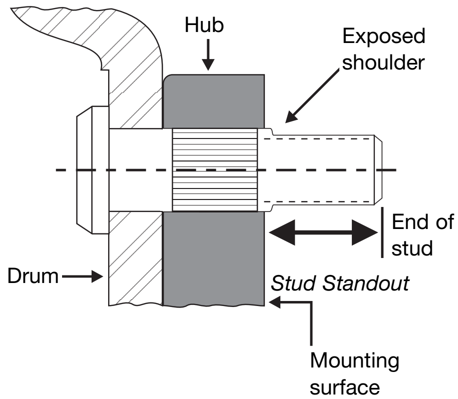
Inner cap nut, inner thread 3/4"x16, outer thread 1-1/8"x16. For use with standard length studs (1.31" [1-5/16] to 1.44" [1-7/16]) stud stand-out) or longer studs not to exceed 1.88" [1-7/8] stud standout. Full internal and external threads. P/N 5978R, 5978L (Grade 8). For studs without exposed shoulders. 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.

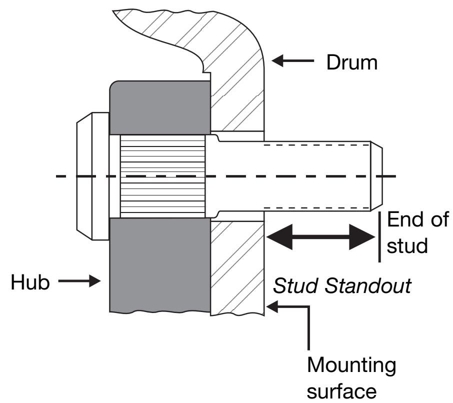
How to measure stud standout

4-3

Stud standout is measured from the axle end mounting surface to the end of the stud.



Inboard mounted drum

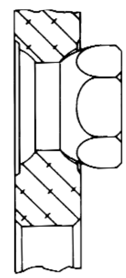


Outboard mounted drum

Stud located ball seats are spherical

4-4

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 4-12, page 34). Ball seat cap nuts may be obtained from your Alcoa Wheel Distributor.



Single wheel, stud located, ball seat mounting

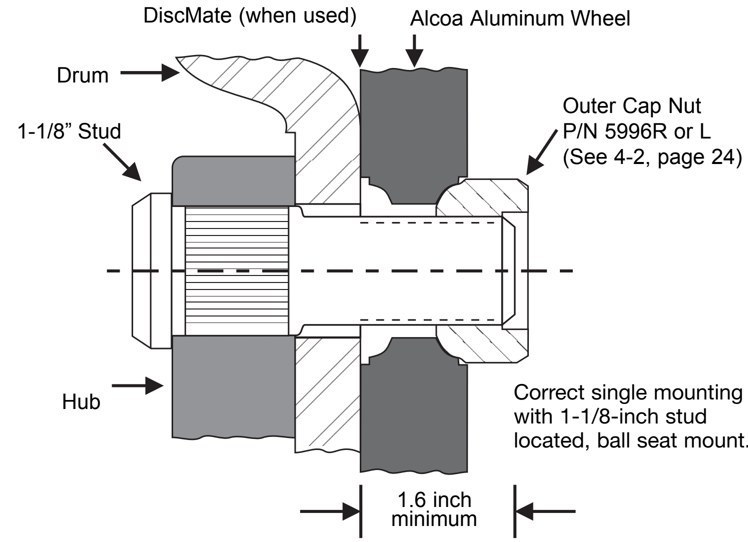
4-5

NOTICE: Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

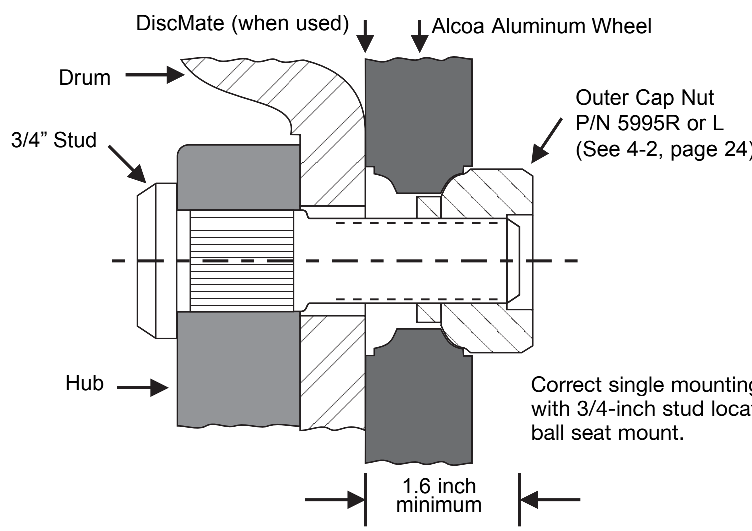
Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

Front wheels are mounted as singles and require 1.6" (1-39/64") 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.

DiscMate wheel spacers are recommended for use with Alcoa Dura-Bright® surface treated wheels to protect the wheel contact surfaces from marring. DiscMate wheel spacers are placed between the contact surfaces of the Dura-Bright® wheel and the brake drum as shown below.



Correct single mounting with 1-1/8-inch stud located, ball seat mount.



Correct single mounting with 3/4-inch stud located, ball seat mount.

Dualed wheels, stud located, ball seat mounting

4-6

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 4-2, page 24).

Cap nuts recommended by Alcoa are compatible with Alcoa wheels. Hardware of equal dimensions and strength may be used.

Continued on next page.

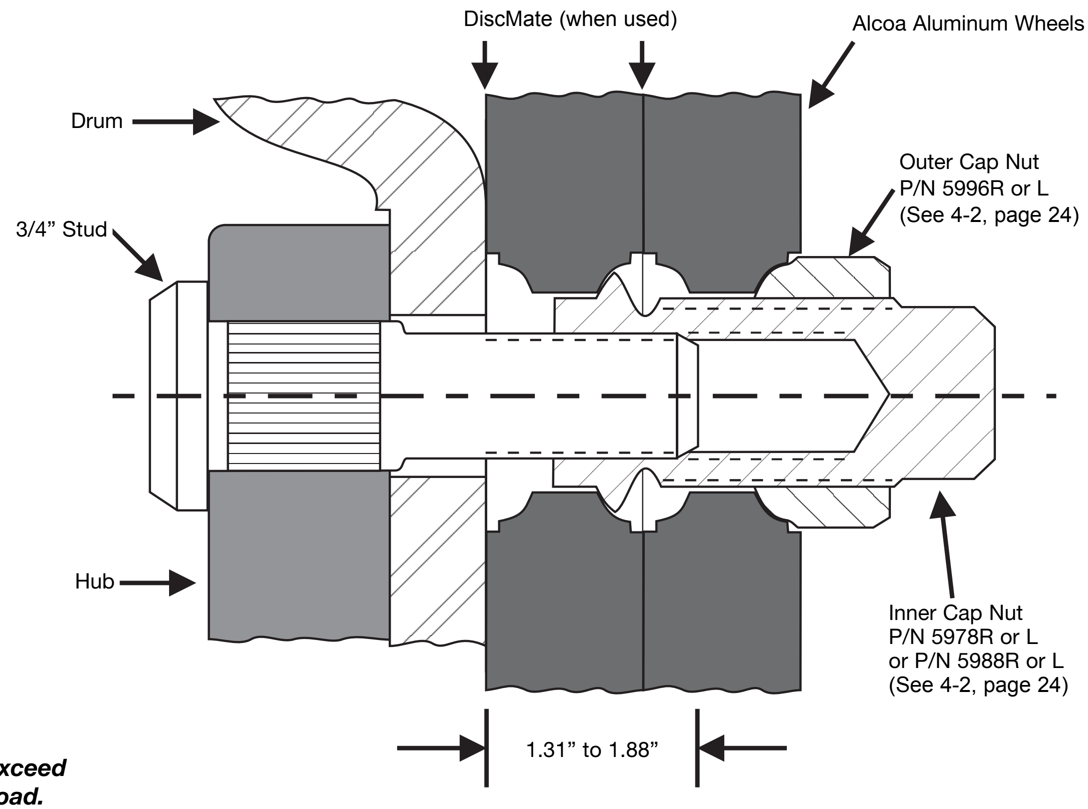
Dualed wheels, stud located, ball seat mounting (continued)

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"]). 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 stems180° apart.

DiscMate wheel spacers are recommended for use with Alcoa Dura-Bright® surface treated wheels to protect the wheel contact surfaces from marring. DiscMate wheel spacers are placed between the contact surfaces of the Dura-Bright® wheel and the brake drum and between the dual aluminum wheels as shown below.



Correct mounting for dual aluminum, stud located, ball seat mount, wheels.

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.

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. 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.

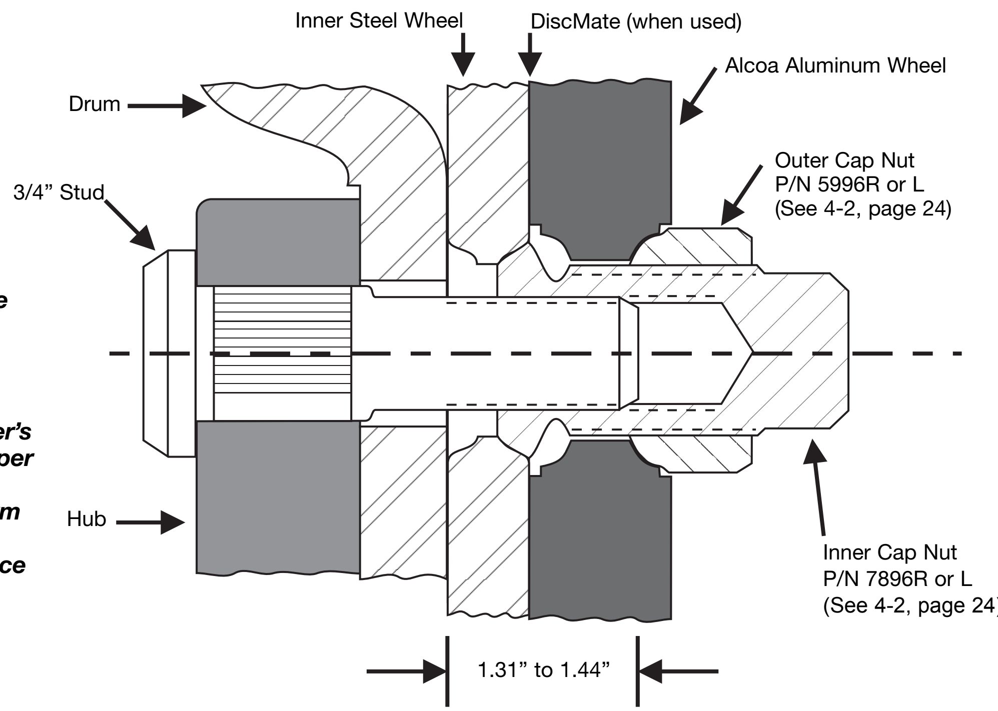
Dualed wheels, steel inner/ aluminum outer stud located ball seat mounting

DiscMate wheel spacers are recommended for use with Alcoa Dura-Bright® surface treated wheels to protect the wheel contact surfaces from marring. DiscMate 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.

4-7

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.



Correct dual mounting for steel inner/aluminum outer stud located ball seat mount.

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 cause 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 **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 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, remove the wheel from service. For the support surface diameter required by other bolt circle sizes, ask your Alcoa representative.

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 injury or death.

Use only hardware designed specifically for each wheel type. See 4-2, page 24 for proper hardware assemblies.

Cap nut thread engagement, stud located wheels, ball seat mounting

4-8

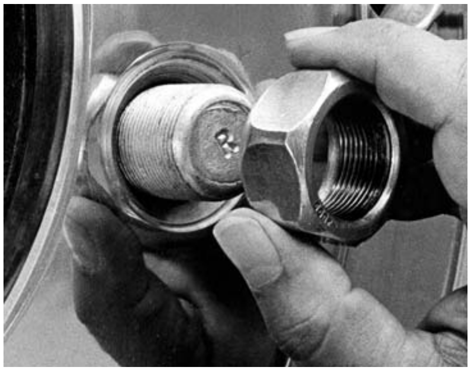
The actual length of thread engagement present in an assembled wheel can not always be determined by visual inspection or measurement of a tightened assembly. The relationship of the wheel cap nut seat to the end of the stud may vary. If there is any doubt that enough thread engagement is present, the 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 3/4-inch 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.

Cap nuts made to Alcoa specification usually give more than the necessary thread engagement on a given stud.

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.

Tightening stud located, ball seat cap nuts

4-9



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 3/4-inch nut.

WARNING

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 injury or death.

Lubricants must be completely removed from the cap nut seats and contact surfaces if applied accidentally.

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.

WARNING

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 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.

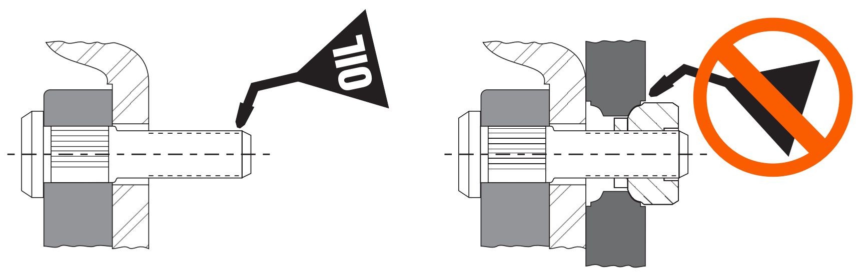
Continued on next page

Tightening stud located, ball seat cap nuts (continued)

Stud located, ball seat mounting system.

It is recommended that stud threads on stud located mounting systems be lubricated with SAE 30W oil and torqued between 350 and 400 foot-pounds. If threads are not lubricated, torque to between 450 and 500 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.

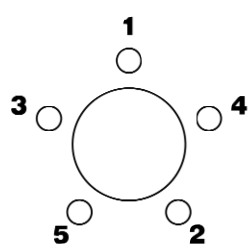
> **WARNING**
>
> **WARNING Application of lubricant to the ball seats can cause excessive torque. Over torque can stretch studs causing them to fail.**
>
> **Overtorquing can lead to wheel disengagement causing injury or death.**
>
> **Do not allow oil to contact ball seats or mounting surfaces of the wheel, hub or drum. Do not use aerosol cans for lubrication of stud threads.**



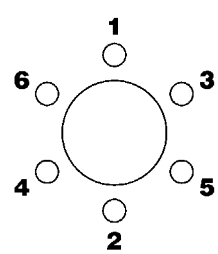
On vehicles equipped to accept wheels manufactured for use with the stud located ball seat mounting system, wheel studs on the right side of the vehicle have right-hand threads and those on the left have left-hand threads. The "R" and "L" on the studs and nuts indicate right and left-hand threads respectively (see 4-2, page 24).

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.

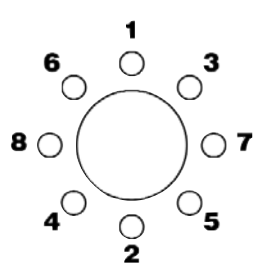
NOTICE: In service, stud dimensions and condition may change over time due to environmental conditions, multiple re-installations, improper torquing and other factors. Consult with your hub and stud manufacturer for maintenance and replacement recommendations.



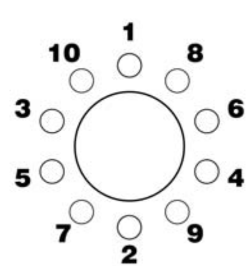
Five Stud



Six Stud



Eight Stud



Ten Stud

Continued on the next page

Tightening stud located, ball seat cap nuts (continued)

After 50-100 miles of operation, torque should be rechecked. 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

4-10

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.

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.

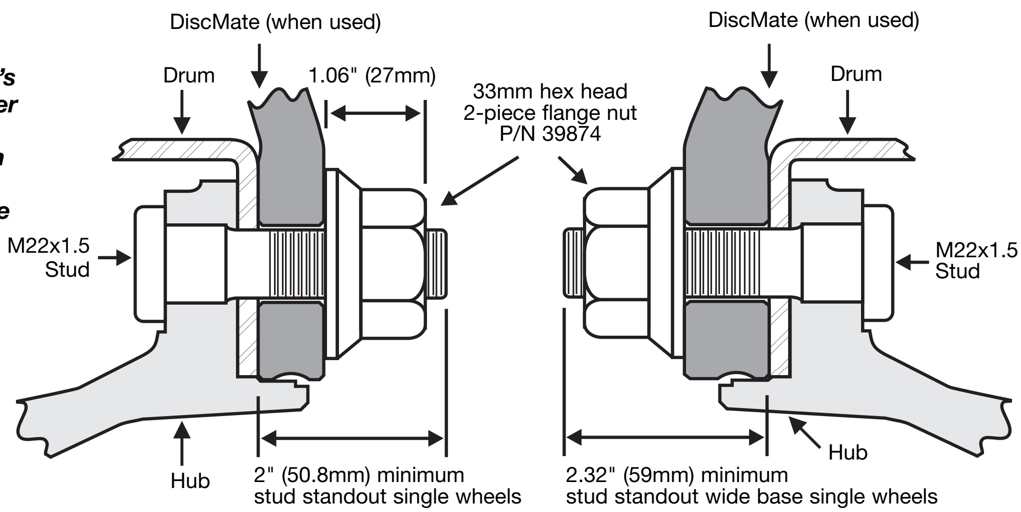
Generally the same diameter stud is used to mount either single or dualed wheels.

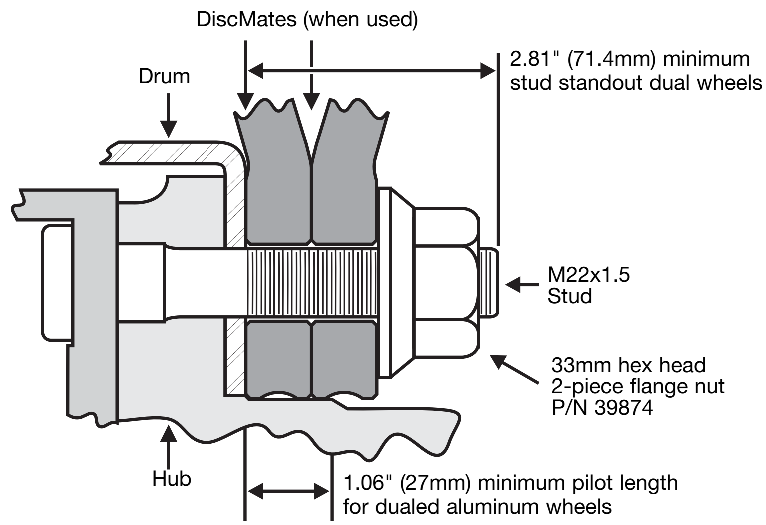
Studs on both sides of the vehicle are right-hand threads thereby eliminating the need for flange nuts peculiar to either the right or left side of the vehicle. The same flange nut is used to mount dualed or single wheels. Proper stud standout for single wheels is 2-inch (50.8mm) minimum, dualed wheels require 2.81-inch (71.4mm) minimum and single wide base wheels require 2.32-inch (59mm).

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.

DiscMate wheel spacers are recommended for use with Alcoa Dura-Bright® surface treated wheels to protect the wheel contact surfaces from marring. DiscMate 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 1.06-inch or 27mm 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.

Match mounted dual wheels should be put on the vehicle with the valve stems 180° apart.

Tightening hub piloted mounting, two-piece flange nuts

4-11

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.

WARNING

WARNING Undertorqued flange nuts allow wheels to run loose and fatigue studs or lose nuts. Overtorquing can stretch studs causing them to fail.

Both under and overtorquing can lead to wheel disengagement causing 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 4-2, page 24), 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.

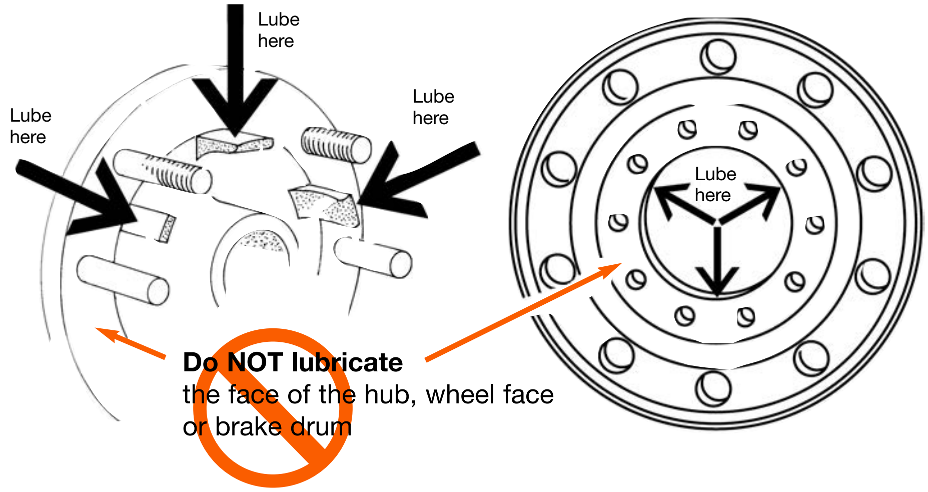
Wheel studs on both the right and left side hubs of vehicles utilizing the hub piloted wheel system have right-hand threads.

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).

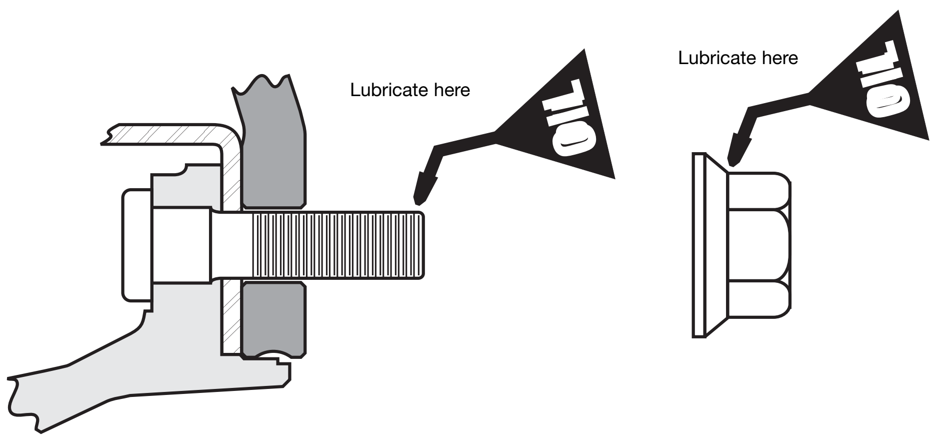
Continued on the next page.

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.

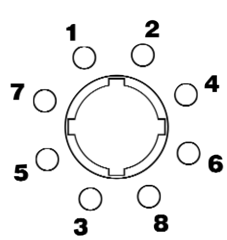


Before installing two-piece flange nuts, lightly lubricate the stud threads and the contact surfaces between the cap nut and the washer as illustrated below with an SAE 30W oil. This will minimize corrosion between the mating surfaces. Lubrication is not necessary with new hardware.

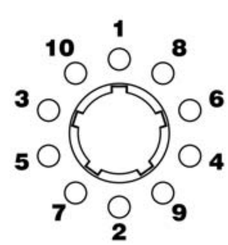


Position one of the hub's pilot pads at the twelve o'clock position. After positioning wheels on the pilot pads, hand tighten all two-piece flange nuts, then tighten to the recommended torque following the proper sequence shown below for your type wheel. After 50-100 miles of operation, torque should be rechecked. **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.



Eight Stud



Ten Stud

Incorrect assemblies

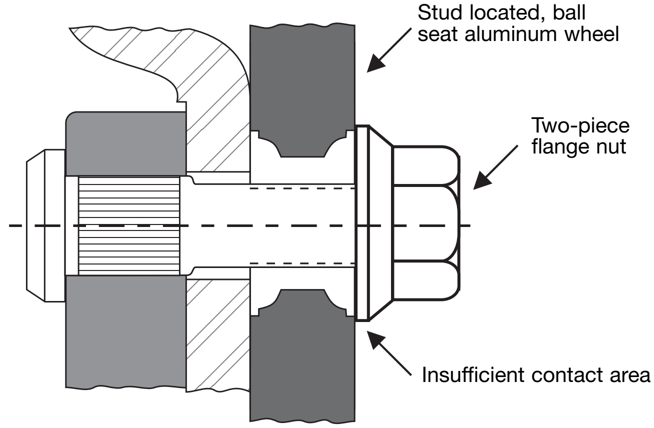
4-12

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.**

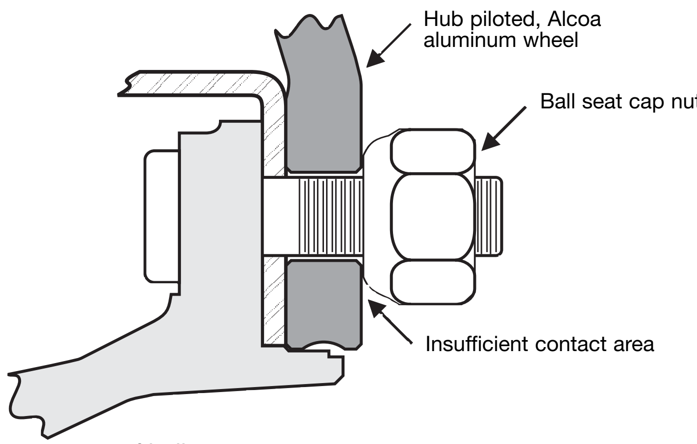
Using the wrong wheel nuts can cause loss of torque, broken studs and cracked wheels, conditions which can lead to injury or death.

Use only hardware designed specifically for each wheel type. **See 4-2, page 24 for proper hardware assemblies.**

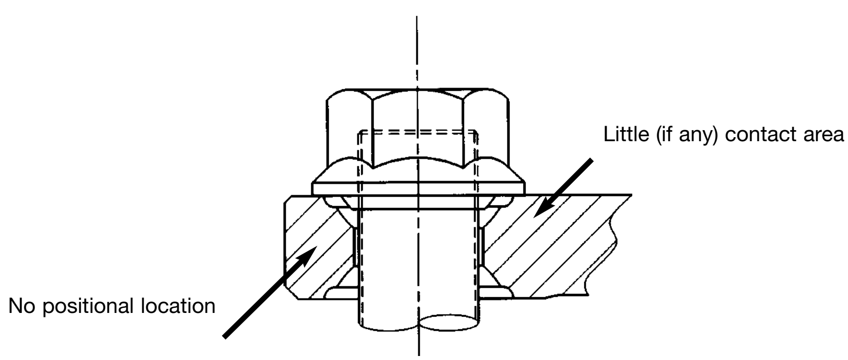
The following are examples of **incorrect** wheel assemblies.



Incorrect use of two-piece flange nut.
Do not use two-piece flange nuts with ball seat wheels.



Incorrect use of ball seat cap nut.
Do not use ball seat cap nuts with hub piloted wheels.



Incorrect use of one-piece flange nut positioned on Alcoa ball seat wheel.
Do not use one-piece flange nut on ball seat wheels.

4

5 Proper Torque, Wheel Identification, Valves and Surface Maintenance

Avoid abuse

5-1

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 tire pressures listed in Section 1 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

5-2

Wheel cap nuts must be kept tight (see 4-9, page 29). 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 2, page 5). 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 M20 x 1.5 M22 x 1.5	300-400 280-330 450-500	
Stud piloted, double cap nut standard type (7/8" radius)	3/4" - 16 1-1/8" - 16	350-400 350-400	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	650-800	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 4-11, page 32).*

*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 4-9, page 29).*

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. Regardless of the torque method used, all torque wrenches, air wrenches and any other tools should be calibrated periodically to ensure the proper torque is applied.

Lead balance weights (clip on)

5-3

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 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 2-11, pages 13-17) 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.

Do not straighten wheels

5-4

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.

WARNING

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 injuries or death.

Never attempt to weld or braze any surface of an Alcoa aluminum wheel.

Owner/in-service identification

5-5

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

5-6

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.

10-14 foot-pounds for Part Nos.	7-11 foot-pounds for Part Nos.
TR 509 TR 510 TR 511	TR 542 Series TR 543 Series TR 544 Series TR 545 Series 60MS27N

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 instead of plastic.

When replacing valve stems, it is recommended to lubricate the threads and o-ring with a non-waterbased lubricant.

Maintenance against corrosion (non-Dura-Bright® surface treated wheels)

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 ensure proper clearance from any obstructions.

The following information is for standard Alcoa forged aluminum wheels **without** the Dura-Bright® surface treatment. See section 5-8, page 37 for specific instructions on the care and clearing 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 harsh alkaline cleaners.

2. When tires are removed the entire wheel must be cleaned and inspected. (See Section 2, page 5). 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 3-1, page 18).

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 Simonize, Mothers, California Gold paste wax, No. 7 Car Wax or equivalent.

e. Clean your Alcoa truck wheels as frequently as required to maintain their appearance.

Dura-Bright® surface treated wheels cleaning and maintenance

5-8

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 ensure proper clearance from any obstructions.

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 5). 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 18 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. Warm water and a mild detergent will speed the cleaning process.

b. Rinse thoroughly with clean water.

c. Wipe dry to avoid water spots.

Dura-Bright® surface treated wheels cleaning and maintenance (continued)

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.

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 an Alcoa Dura-Bright® wheel 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. 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.

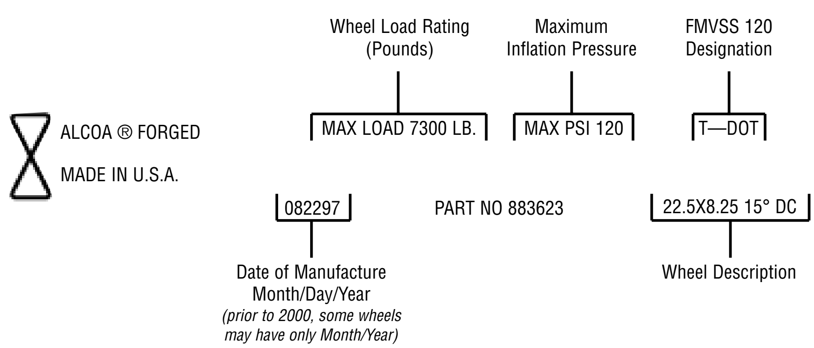
Identification

5-9

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 883620DB.

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 883620DF.

6 Flat Base Wheel for Tube-type Tires

Tube-type wheel part interchangeability

WARNING **Mismatched rim/wheel components can lead to explosive separation of wheel components.**

Explosive separation of wheel parts can cause serious injury or death.

See chart below for matching components.

6-1

Multipiece Rim Matching Chart

The following is the Alcoa Aluminum Wheel interchangeability information from the OSHA Multipiece Rim Matching Chart. For a complete matching chart, write to: **U.S. Department of Labor, Occupational Health and Safety Administration, Publications Department, Room N4101, Washington, DC 20210**

Read across the chart to find interchangeable components for specific size and type of Alcoa wheel. The information which is found in the shaded areas of the OSHA Multipiece Rim Matching Chart is represented in the table below.

RIM SIZE	RIM BASE IDENTIFICATION STAMPING	2 PIECE ASSEMBLIES	3 PIECE ASSEMBLIES	
		SIDE RING IDENTIFICATION STAMPING	LOCK RING IDENTIFICATION STAMPING	FLANGE IDENTIFICATION STAMPING
20 x 7.5	20x7.5FL; B7520FL	20x7.5FL; R20X7.5FL; R7520FL	20X7.5FL; LR20X7.5FL; LR7520FL	20X7.5-5° -FL; 20X7.5-8.05° -7.5FL; F20X7.5FL; F7520FL
	1020 20-7.5; T/M 20-7.5 8-A3-190	1020 RC20-7.5; T/M 20-7.5 8-A3-190	NONE	NONE
	1120 10-7.5; D-13520 20-7.5; A-AA2951 20-7.5; K-H 20X7.5	1120 RC 20-7.5; D 20-7.5 D 13520SR; F20-7.5 A-AA2951-1	NONE	NONE
	20X7.5-5°; 20X7.50-5°; F20750B (2)	NONE	20X7.0-7.5-8.0-5°	20X7.5-5° -FL; 20X7.5-8.05° -7.5FL; F7520FL
	20X7.5LA; 20X7.5MS; B7520LA	R20X7.5LA; 20X7.5MS; R7520LA	NONE	NONE
	20X7.5LB; 20X7.5DT-LB (3); B7520LB; G20750B (2)	R20X7.5-8.0-9.0LB-LW; 20X7.5-8.0DT-LB-LW (3); R8020LW	NONE	NONE
	20X7.5LW; 20X7.50LW; B7520LW; G20750B (2)	20X7.5-8.0-9.0LW; 20X7.5-8.0-DT-LB-LW (3); R8020LW	NONE	NONE
	20X7.5M	R20X7.5-8.0-9.0LB-LW; 20X7.5-8.0DT-LB-LW (3); R8020LW	LR20X7.5-8.5-10.0M; LR20M	F20X7.5-8.5M; F7520M
	20X7.5DA5°	20X7.5DA5°; 20X7.5FLN; 20X7.5N5°	NONE	NONE
	20X7.5FLN	20X7.5FLN; 20X7.5DA5°; 20X7.5N5°	NONE	NONE
	20X7.5N5°	20X7.5N5°; 20X7.5FLN; 20X7.5DA5°	NONE	NONE
	B7520KB	R8020KW	NONE	NONE
	B7520KW	R8020KW	NONE	NONE
	B7520KWX	R8020KW	NONE	NONE
	BW-5 20X7.5	BW-5 20X7.5	BW-5 20X7.5-8.0V-8.5V	B-5° 20X7.5
20 x 8.0	20X8.0-5°; 20X8.00-5°; F20800B (2)	NONE	20X7.0-7.5-8.0-5.0°	20X8.0-5°; 20X7.5-8.05° -7.5FL
	20X8.0LW; 20X8.00LW; B8020LW; G20800B (2)	R20X7.5-8.0-9.0LB-LW; 20X7.5-8.0DT-LB-LW (3); R8020LW	LR20X7.5-8.5-10.0M; LR20M	F20X7.5-8.5M; F7520M
	B8020KW	R7520K	NONE	NONE
	BW-5 20X8.0	NONE	BW-5 20X7.5-8.0V-8.5V	BW-5 20X8.0V-8.5V
22 x 7.5	1022 22-7.5; T/M 22-7.5 8-A3-191	1022 RC22-75; T/M 22-7.5 8-A3-191	NONE	NONE
	1122 22-7.5; D-13522 22-7.5; A-AA2952 22-7.5	1122 RC22-7.5; D 22-7.5 D 13522-SR; F 22-7.5 A-AA2952-1	NONE	NONE
	22X7.5-5°; 22X7.50-5°; F22750B (2)	NONE	22X7.0-7.5-8.0-5°	22X7.5-5° -FL; 22X7.5-8.05° -7.5FL; F7522FL
	22X7.5FL; B7522FL	22X7.5FL; R22X7.5FL; R7522FL	22X7.5FL; LR22X7.5FL; LR7522FL	22X7.5-5° -FL; 22X7.5-8.05° -FL; F22X7.5FL; F7522FL
	22X7.5LB; 22X7.5DT-LB (3); B7522LB; G22750B (2)	R22X7.5-8.0-9.0LB-LW, 22X7.5-8.0DT-LB-LW (3); R8022LW	NONE	NONE
	22X7.5LW; 22X7.50LW; B7522LW; G22750B (2)	R22X7.5-8.0-9.0LB-LW, 22X7.5-8.0DT-LB-LW (3); R8022LW	NONE	NONE
	22X7.5M	R22X7.5-8.0LB-LW; R8022LW	LR22M; LR22X7.5-8.5-10.0M	F7522M
	22X7.5DA5°	22X7.5DA5°; 22X7.5FLN; 22X7.5N5°	NONE	NONE
	22X7.5FLN	22X7.5FLN; 22X7.5DA5°; 22X7.5N5°	NONE	NONE
	22X7.5N5°	22X7.5N5°; 22X7.5FLN; 22X7.5DA5°	NONE	NONE
	B7522KB	R8022KW	NONE	NONE
	B7522KW	R8022KW	NONE	NONE
	B7522KWX	R8022KW	NONE	NONE
	BW-5 22X7.5	BW-5 22X7.5	BW-5 22X7.5-8.0V-8.5V	B-5° 22X7.5
22 x 8.0	22X8.0-5°; 22X8.00-5°; F22800B (2)	NONE	22X7.0-7.5-8.0-5°	22X8.0-5°
	22X8.0LW; 22X8.00LW; B8022LW; G22800B (2)	R22X7.5-8.0-9.0-LB-LW; 22X7.5-8.0DT-LB-LW (3); R8022LW	LR22M	F7522M
	B8022KW	R7522KW	NONE	NONE
	BW-5 22X8.0	NONE	BW-5 22X7.5-8.0V-8.5V	BW-5 22X8.0V-8.5V

Part numbers listed by Alcoa are followed by one of the characters X-T-N-B, or current Alcoa part numbers (i.e., 371010) end in 0-1-2 or 3, indicating a finish condition which does not affect the interchangeability of parts as shown on the chart.

6

Mounting recommendations for tubed tires

6-2

1. Inspect the wheel for damage. Do not use a bent, cracked, damaged or severely corroded wheel. (See Section 2, page 5).

2. Inspect ring(s) for corrosion, bending or other damage and discard if any is apparent.

3. Thoroughly clean the wheel and rings. Clean the wheel face with a mild detergent. Clean the tire bead seat areas and gutter flange with a wire brush.

4. Do not gouge or nick the wheel. Place wheels on a wooden floor or rubber mat. Always use a rubber, leather-faced or plastic mallet.

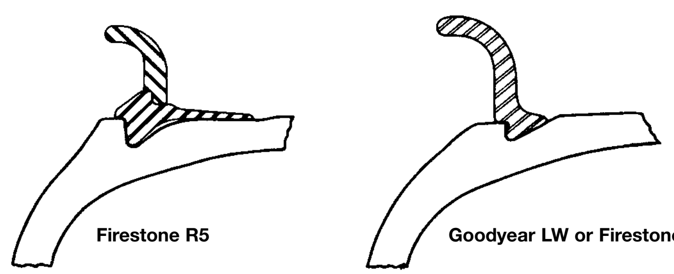
5. Inspect and clean the tire, tube, and flap before mounting — replace if damaged, badly worn or defective.

6. Insert lubricated tube and flap in tire.

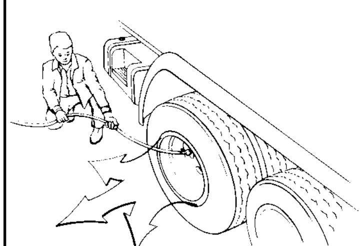
7. Lubricate the tire beads and rim, then mount tire, tube and flap assembly onto rim. Do not use any lubricant which contains water or a solvent which can injure rubber.

8. Select the proper rim components and assemble to rim (see 6-3, page 41). Discard bent, damaged or corroded side and lock rings. Do not use any side or lock ring which is not clearly identifiable.

> **WARNING**
>
> **WARNING Use of a Firestone 5° side and lock ring assembly with a wheel machined for Firestone DT or Goodyear LW split side ring and vice versa can lead to explosive separation of wheel and tire.**
>
> **An explosive separation of miss-matched wheel components can lead to injury or death.**
>
> **Alcoa Aluminum Disc Wheels are available to accept (1) Firestone 5° side and lock rings or (2) Goodyear LW and Firestone DT split side rings. Select the proper side and lock rings by referring to the Multipiece Rim/Wheel Matching Chart on page 39 of this manual.**



Always use the proper side and lock ring assembly or split side rings required for each particular wheel.



9. Do not overinflate. Use the tire manufacturer's recommended pressure, but under no circumstances exceed cold tire pressures listed in **Section 1 Specifications** of this manual (see page 2).

10. When inflating a tire in an inflation cage or while mounted on a vehicle, always use a clip-on air chuck and a remote valve with pressure gauge. During inflation or handling an inflated wheel and tire assembly, stay out of the path of potential exploding parts or air blasts.

Mounting of tubed tires

6-3

When mounting Alcoa flat base wheels for tube-type tires you must use the proper side ring or side and lock ring required for each wheel. The table below lists the Alcoa tube-type wheels currently in production and the proper side ring or side and lock ring identification recommended for each wheel. See the Multipiece Rim Matching Chart on page 39 for information on older wheels with part numbers not shown here.

Alcoa Flat Base Wheels for Tube-type Tires That Use Goodyear LW or Firestone DT Split Side Rings Only (2 Piece Assemblies)		
Wheel Size	Alcoa Part Number Identification Stamping	Side Ring Identification Stamping
22x8.00 LW	481010	R8022LW recommended or: R22X7.5-8.0-9.0LB-LW 22X7.5-8.0DT-LB-LW (3)
22x7.50 LW	471010	R8022LW recommended or: R22X7.5-8.0-9.0LB-LW 22X7.5-8.0DT-LB-LW (3)
Current Alcoa part numbers (i.e., 481010) end in 0-1-2 or 3, indicating a finish condition which does not affect the compatibility of parts as shown in the table.		

1

Lubricate tube, flap and wheel. Insert tube and flap into tire. Place them on the wheel so that the valve is aligned with the valve slot.

Place side ring on wheel and tire and stand on the ring to position it below the lock ring groove. If a split side ring is required, start the leading edge and walk the side ring onto the wheel

2

If the wheel requires a lock ring, start the leading edge of the lock ring being sure that it is seating in the machined groove. Then walk the lock ring onto the wheel, as illustrated

3

Seat the second end of the split side ring or lock ring with a rubber, plastic or leather-facet mallet as shown. Check carefully to see that the split side ring or side ring and lock ring assembly is in the proper position. If not, completely remove the components and start over.

4

Inflate to 10 psi. Check to see that all components are properly in place. If not, deflate the tire by removing the valve core and reposition components properly. Place in a safety cage or other suitable restraining device (refer to OSHA rule 1910.177, paragraph B, see Section 7, page 44). Use clip-on chuck and stand behind barrier during inflation. Do not lean on cage. Inflate to recommended pressure. Deflate completely to avoid localized over-stretching of the tube. Reinflate to the tire manufacturer's recommended pressure.

6

Demounting recommendations for tubed tires

6-4

WARNING **An inflated tire contains air under pressure which can be a dangerous explosive force.**

Explosive separation of a tire and wheel can cause serious injury or death.

Follow proper service procedures to avoid injury or death.

WARNING **An aluminum wheel can be structurally weakened by uncontrolled 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 uncontrolled excessive heat (such as a tire fire, wheel bearing failure or braking system drag/seize) or a high pressure tire/wheel separation.

1. Before removing wheel from vehicle, remove the valve core from the valve stem to ensure complete deflation of tire.

2. Do not gouge or nick the wheel. Place aluminum wheels on a clean wooden floor or rubber mat.

3. Always use a rubber, leather-faced or plastic mallet.

4. Keep tire tools smooth. Use them with care. Rim gouges or nicks near the fixed flange can cause cracks.

5. Remove steel side rings carefully. If bead is well-loosened, rings can be removed without gouging the wheel.

6. Discard bent, damaged or corroded side and lock rings. Using bent, damaged or corroded rings can shorten service life of wheel and introduce the danger of an explosive separation.

Demounting of tubed tires

6-5

NOTICE: Tire must be completely deflated and valve core removed before demounting.

If manually breaking the tire beads from the wheel, it is important to use the proper tools. Tire tools may be inserted next to the tire side wall and the side ring or locking ring. Tools must be smooth and used with care if gouging the rim is to be avoided. A stop, welded to the tool, is recommended.

Once the tool is inserted, pry down and out as illustrated. Leaving one tool in position, work the other around the tire until the bead is completely free.

Insert the tapered end of the tire tool into the notch on the locking ring. Pry up carefully to avoid bending the ring and gouging the wheel.

Using the same procedures as outlined in Step 1, loosen the bead on the opposite side of the wheel. Do not drive tools into rim area. Lift wheel from tire.

7 OSHA Regulations

OSHA Regulations

7-1

Sec. 1910.177 Servicing multi-piece and single piece rim wheels.

(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.

OSHA Regulations (continued)

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.

(f) 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.

[GRAPHIC] [TIFF OMITTED] TC27OC91.036

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 9239, 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.

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 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.

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 diameter 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 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.

OFFSET - See “OUTSET.”

OPEN SIDE - The side of the wheel opposite the disc face.

OSHA - Abbreviation for the U.S. Department of Labor, Occupational Health and Safety Administration.

OUTER CAP NUT - A cap nut used to secure the outer stud located wheel in a dualed wheel pair and thread 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.

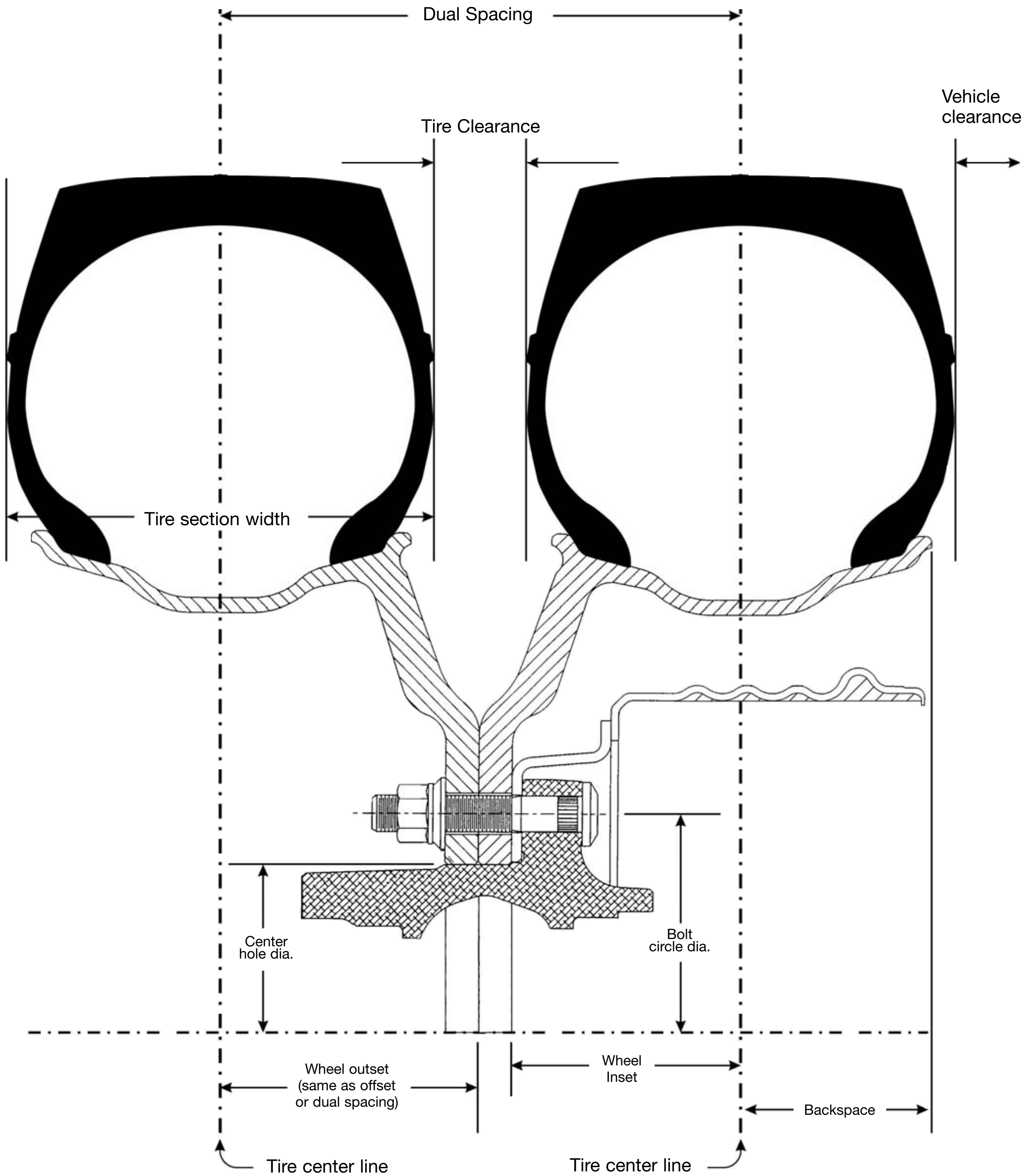
TORQUE - The amount of force used to tighten cap nuts. Usually stated in foot-pounds or kilograms and measured with a torque wrench.

WHEEL MOUNTING FACE - That portion of the wheel face which contacts the hub or brake drum.

wt. - Abbreviation for weight.

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	Inches	Decimals	Millimeters
1/64	0.0156	0.3969	33/64	0.5156	13.0969
1/32	0.0313	0.7938	17/32	0.5313	13.4938
3/64	0.0469	01.1906	35/64	0.5469	13.8906
1/16	0.0625	1.5875	9/16	0.5625	14.2875
5/64	0.0781	1.9844	37/64	0.5781	14.6844
3/32	0.0938	2.3813	19/32	0.5938	15.0813
7/64	0.1094	2.7781	39/64	0.6094	15.4781
1/8	**0.1250**	**3.1750**	**5/8**	**0.6250**	**15.8750**
9/64	0.1406	3.5719	41/64	0.6406	16.2719
5/32	0.1563	3.9688	21/32	0.6563	16.6688
11/64	0.1719	4.3656	43/64	0.6719	17.0656
3/16	0.1875	4.7625	11/16	0.6875	17.4625
13/64	0.2031	5.1594	45/64	0.7031	17.8594
7/32	0.2188	5.5563	23/32	0.7188	18.2563
15/64	0.2344	5.9531	47/64	0.7344	18.6531
1/4	**0.2500**	**6.3500**	**3/4**	**0.7500**	**19.0500**
17/64	0.2656	6.7469	49/64	0.7656	19.4469
9/32	0.2813	7.1438	25/32	0.7813	19.8438
19/64	0.2969	7.5406	51/64	0.7969	20.2406
5/16	0.3125	7.9375	13/16	0.8125	20.6375
21/64	0.3281	8.3344	53/64	0.8281	21.0344
11/32	0.3438	8.7313	27/32	0.8438	21.4313
23/64	0.3594	9.1281	55/64	0.8594	21.8281
3/8	**0.3750**	**9.5250**	**7/8**	**0.8750**	**22.2250**
25/64	0.3906	9.9219	57/64	0.8906	22.6219
13/32	0.4063	10.3188	29/32	0.9063	23.0188
27/64	0.4219	10.7156	59/64	0.9219	23.4156
7/16	0.4375	11.1125	15/16	0.9375	23.8125
29/64	0.4531	11.5094	61/64	0.9531	24.2094
15/32	0.4688	11.9063	31/32	0.9688	24.6063
31/64	0.4844	12.3031	63/64	0.9844	25.0031
1/2	**0.5000**	**12.7000**	**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	2.2050	=	Pounds

Foot-pounds to Kilogram Meters

Ft-lbs	x	0.13826	=	kgm

Kilogram Meters to Foot-pounds

kgm	x	7.23	=	Ft-lbs

Alcoa Wheel and Forged Products
1600 Harvard Avenue
Cleveland, Ohio 44105
(800) 242-9898

www.alcoawheels.com

Form E37-13584
Printed in USA 03/05/30M

CONTENTS

ILLUSTRATIONS

1. STEERING SYSTEM

1.1 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. 1). 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. 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 hydraulic power cylinder;
2. A vane type hydraulic pump; and
3. Hydraulic reservoir and hoses.

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.

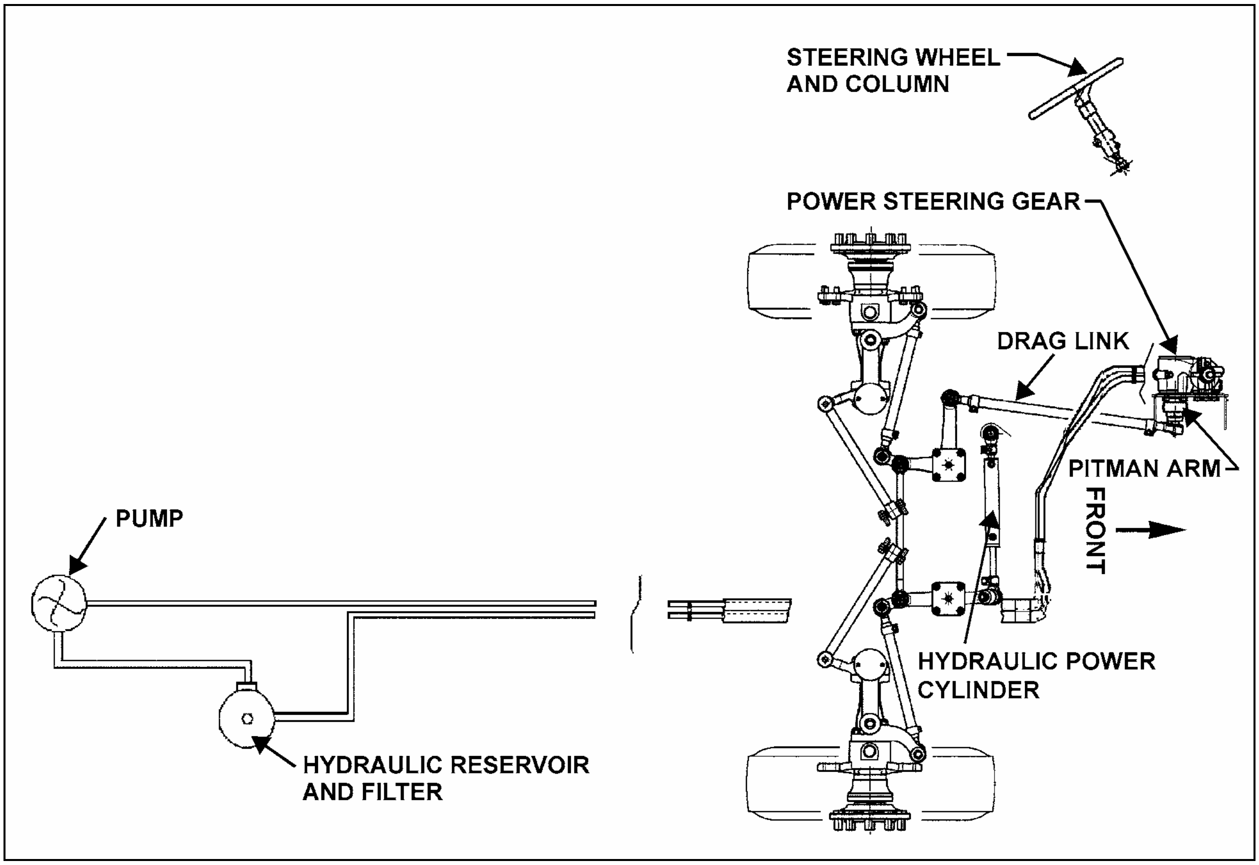


FIGURE 1: STEERING SYSTEM AXLE SETUP

2. POWER STEERING GEAR

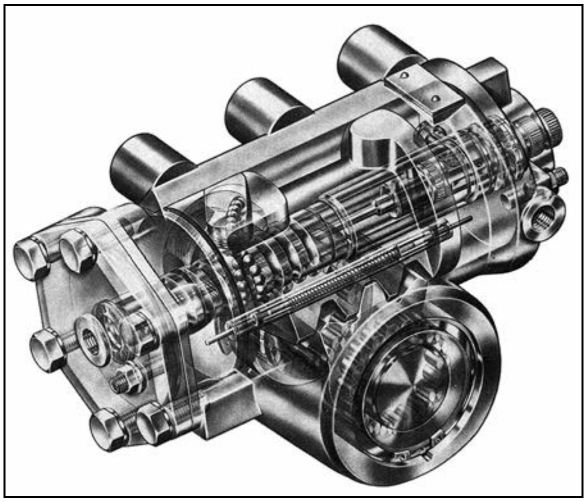


FIGURE 2: POWER STEERING GEAR 14035

2.1 DESCRIPTION

The power steering gear is located in the lower part of front service compartment (Figs. 2 & 3). 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.

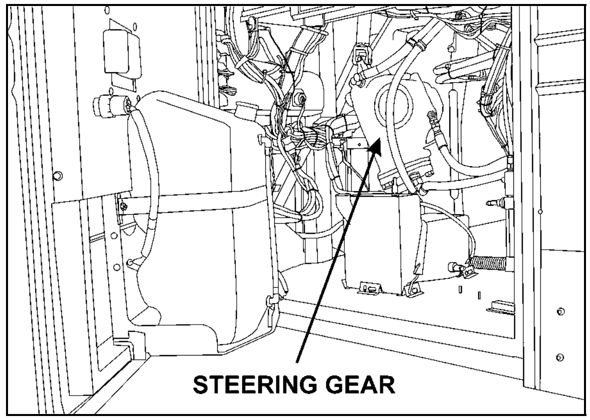


FIGURE 3: FRONT SERVICE COMPARTMENT 14039

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.

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"*.

5. TROUBLESHOOTING

Perform troubleshooting of the steering gear as outlined in the *"ZF-SERVOCOM Repair Manual"*, the *"ZF-SERVOCOM Operating, Servicing /Maintenance and Inspection Instructions* and the *"TRW - Power Steering Pump Service Manual"*.

NOTE

For vehicles equipped with ZF-SERVOCOMTRONIC unit, refer to the supplement to the repair manual ZF-SERVOCOM.

6. POWER STEERING HYDRAULIC PUMP

6.1 DESCRIPTION

The power steering pump is a vane type, gear driven, hydraulic unit which supplies hydraulic pressure for the operation of the steering gear. The pump is mounted on the engine, on the crankshaft pulley's R.H. side.

6.2 REMOVAL AND INSTALLATION

The pump is accessible through the engine compartment rear door.

To remove the pump, proceed as follows:

1. Put an empty container directly below pump, then disconnect both the inlet and outlet hoses from the pump. Block fitting cavities to prevent fluid contamination.
2. Remove the two (2) mounting screws, then slowly pry out the pump.
3. Remove and discard gasket.

CAUTION

Inspect the drive coupling thoroughly, and replace if necessary (the drive coupling is a fiber component located between the engine and the pump).

For pump installation, reverse the removal procedure paying particular attention to the following:

CAUTION

Ensure that drive coupling is correctly positioned before reinstalling the pump.

1. Install a new gasket (Prévost P/N 510488).
2. Bleed air from the system as per step 3, *"Bleeding Power Steering Hydraulic System"*.

6.3 MAINTENANCE

Refer to the *"ZF-SERVOCOM Repair Manual"* and the *"TRW - Power Steering Pump Service Manual"* annexed to this section.

7. STEERING WHEEL

7.1 REMOVAL

1. Set the battery master switch located in the R.H. side rear service compartment, or the engine compartment to the *"OFF"* position.
2. Using a tool, such as a small flat head screwdriver, pry off the air horn cap.
3. Loosen the small screw in center of cap and the other retaining the black wire, then disconnect the white terminal. Remove horn cap.
4. Loosen and remove the steering wheel nut.
5. Using a suitable puller, remove the steering wheel.

7.2 INSTALLATION

To install, reverse the removal procedure. Torque steering wheel nut to 35-45 lbf-ft (47-60 Nm).

8. STEERING COLUMN

8.1 REMOVAL

To disassemble the steering column from system, refer to Figure 4. 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:

1. From the front driver's compartment area, remove the three plastic fasteners on steering column lower cover. Remove the lower cover (Fig. 4).
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.

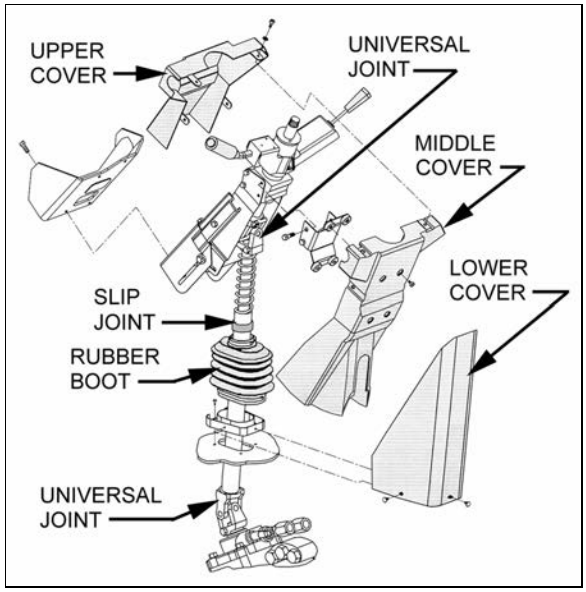


FIGURE 4: STEERING COLUMN 14040

9. TURNING ANGLE ADJUSTMENT

The maximum turning angle is set through two (2) steering stop screws installed on the knuckles. 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 16 *"Suspension"* under heading *"2.2 "Steering Linkage Adjustment".*

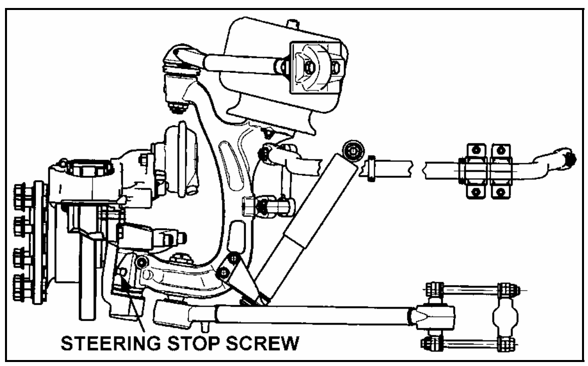


FIGURE 5: STEERING STOP SCREW 14063

Hydraulic Stop

⚠ 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 end 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").

CAUTION

Never maintain the relief pressure for more than 5 seconds, since damage to the power steering pump may occur.

10. STEERING LINKAGE ADJUSTMENT

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.

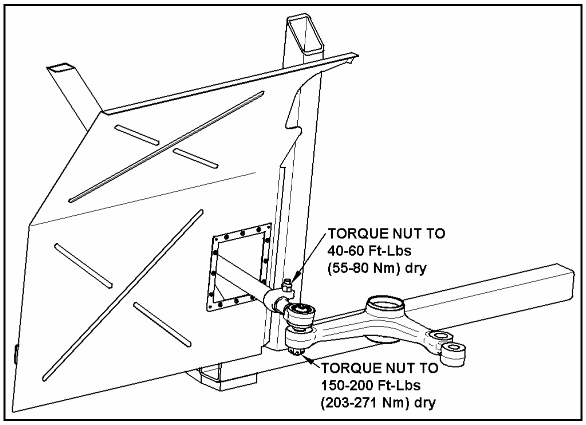


FIGURE 6: DRAG LINK TO BELL CRANK CONNECTION

Perform lubrication according to *"DANA SPICER NDS Axles Lubrication and Maintenance"* annexed to section 11 *"Rear Axles".*

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.

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 7. "Front End Alignment".

11. PITMAN ARM

11.1 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.

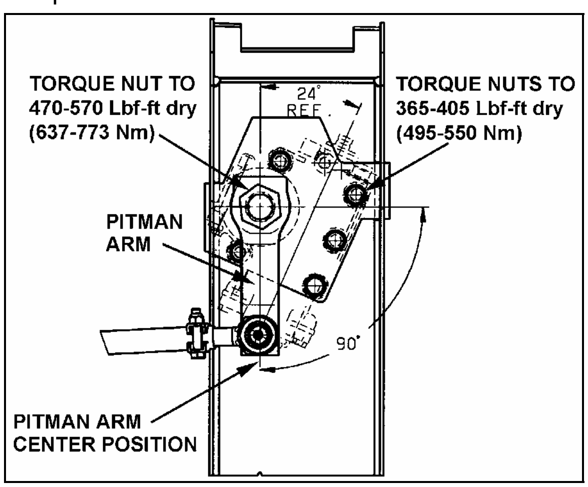


FIGURE 7: PITMAN ARM ADJUSTMENT 14057

6. Add reference marks to the arm and shaft if necessary to ensure correct alignment at reassembly.

7. You must use a puller to remove pitman arm.

11.2 INSTALLATION

1. Position pitman arm on sector gear shaft with reference marks aligned.
2. Install fixing nut (Prévost #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 figure 8).

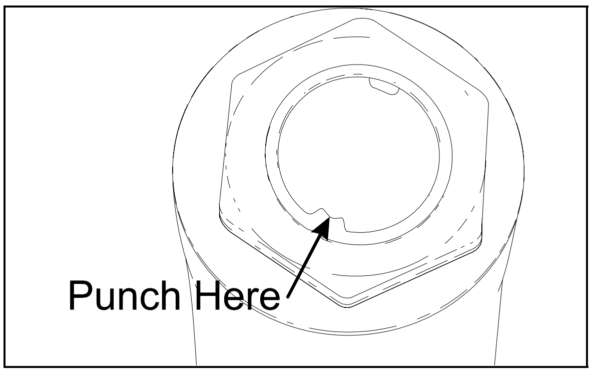


FIGURE 8: FIXING NUT PUNCH MARK 16098

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.

CAUTION
Input shaft marks must be aligned before adjusting pitman arm.

11.3 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. 7 for details).
3. The pitman arm should be adjusted with reference marks aligned or to an angle of 90° in relation with the vertical axis (towards front of vehicle). 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).

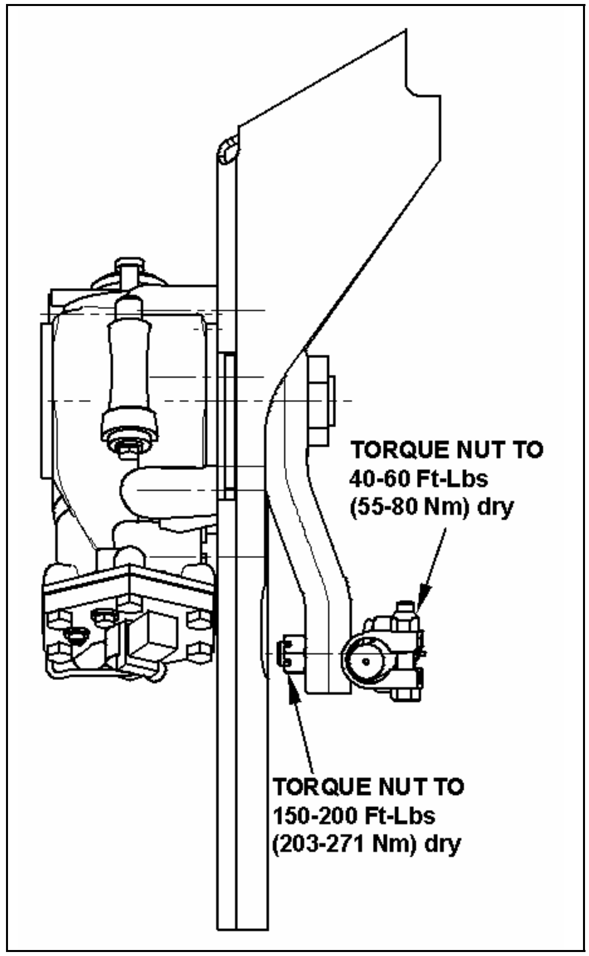


FIGURE 9: DRAG LINK INSTALLATION 14065

12. 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. 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 *16* "Suspension" *under heading* 7. "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.

12.1 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. 10).

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.

12.1.1 Oil Level Check Procedure

1. Stop engine. Open engine compartment R.H. side door.
2. Unscrew and remove the dipstick located on top of reservoir and wipe with a clean rag.

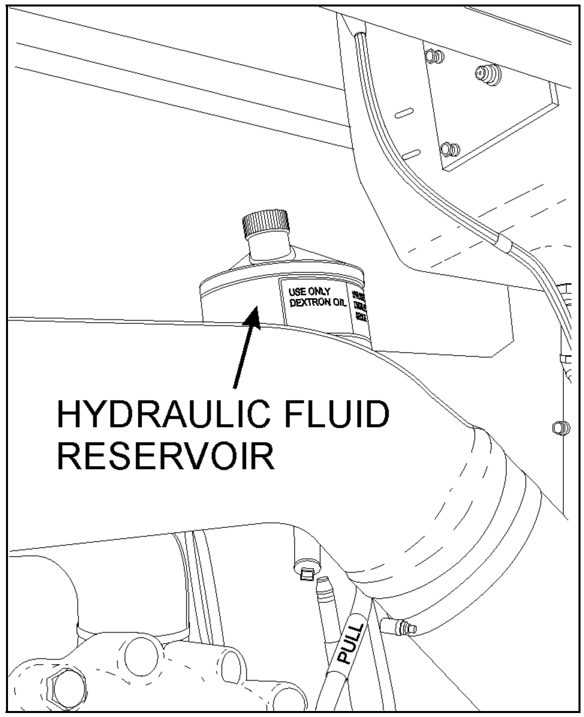


FIGURE 10: HYDRAULIC FLUID RESERVOIR LOCATION
14044

3. Insert dipstick in reservoir. Remove it again to check fluid level (Fig. 11).
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.

12.1.2 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.

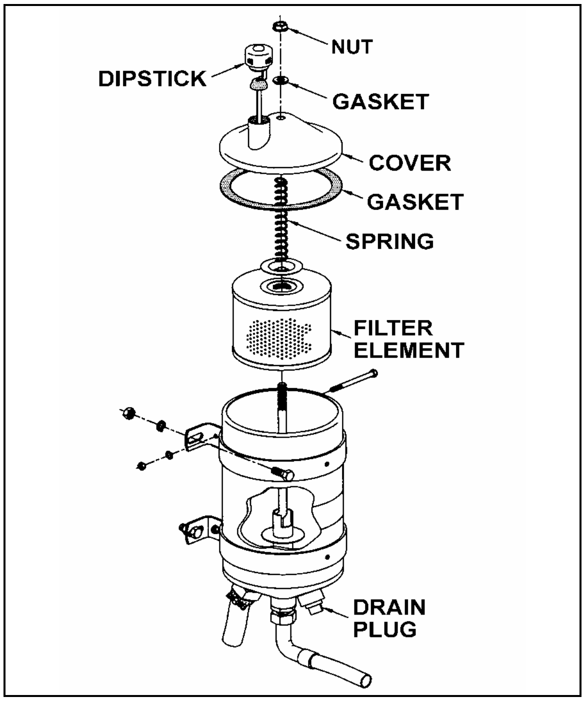


FIGURE 11: POWER STEERING FLUID RESERVOIR
14018A

12.2 DRAG LINK

Lubricate the fittings every 6,250 miles (10 000 km) or twice a year, whichever comes first. Good quality lithium-base grease NLGI No. 1 and 2 are recommended (refer to section 24 *"Lubrication")*.

12.3 POWER STEERING HYDRAULIC PUMP

For maintenance of the power steering hydraulic pump, refer to the *"TRW - Power Steering Pump Service Manual"* annexed to this section.

13. 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.

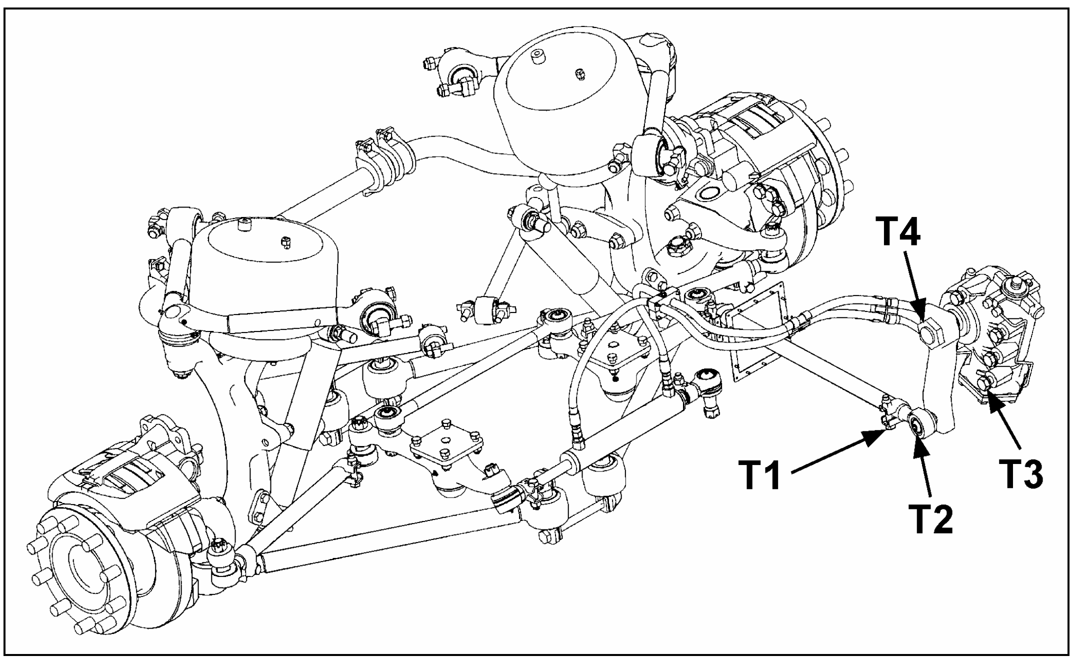


FIGURE 12: DRAG LINK COMPONENTS 16175

14. TORQUE SPECIFICATIONS

DRY TORQUES			
Description	**Reference**	**Lbf-ft**	**Nm**
Drag Link Socket End Clamp Bolt Nut (2)	Fig. 12, T1	40-60	55-80
Drag Link End Stud Nut (on steering arm)	Fig. 12, T2	150-200	203-271
Steering Gear Fixing Bolts (5)	Fig. 12, T3	365-405	495-550
Pitman Arm Fixing Nut	Fig. 12, T4	470-570	637-773

15. SPECIFICATIONS

Power Steering Gear

Make .... ZF-SERVOCOMTRONIC
Model 8098
Supplier number 8098-988-571
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
Model 8098
Supplier number 8098-988-570
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 Pump

Make .... TRW
Type .... PS Series
Relief valve setting .... 2,175 psi (14 990 kPa)
Controlled flow rate .... 4.23 gpm (16 lpm)
Inlet port .... 1 1/4 NPT
Outlet port .... 3/4-16 straight thread SAE O' ring boss conn.
Supplier number PS251615L10200
Prevost number 661009
Gasket - Supplier number 23516100
Gasket - Prevost number 510488

Power Steering Reservoir

Make .... Nelson Muffler
Oil capacity .... 4 US qts (3.7 liters)
Supplier number 91410A
Prevost number 660982
Make .... Nelson Muffler
Element filter - Supplier number .... 83804 E
Element filter - Prevost number 660987

Power Steering Hydraulic Cylinder

Make .... Hyco
Supplier number 007-0300-0
Prévost number 661076

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

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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.

Page

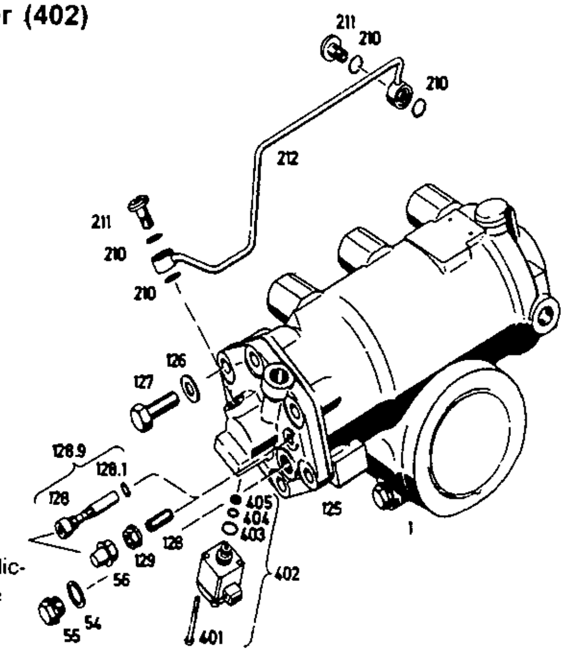
Notes:

→ 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).

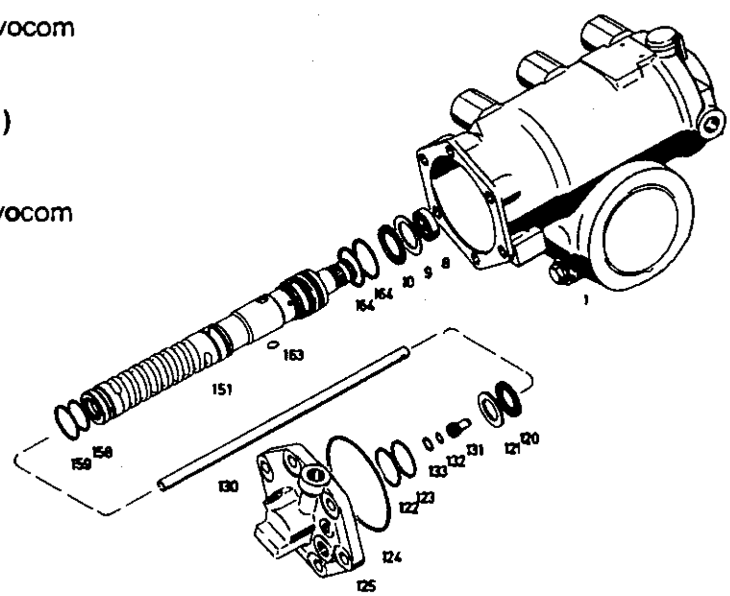
Pull pipe (130) together with reaction piston (131) out of worm (151).

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)

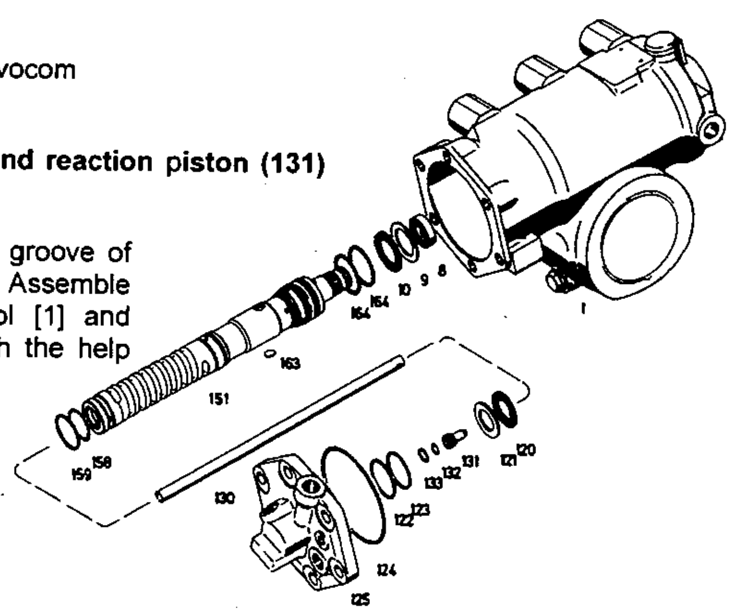
See Repair Manual ZF–Servocom

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)

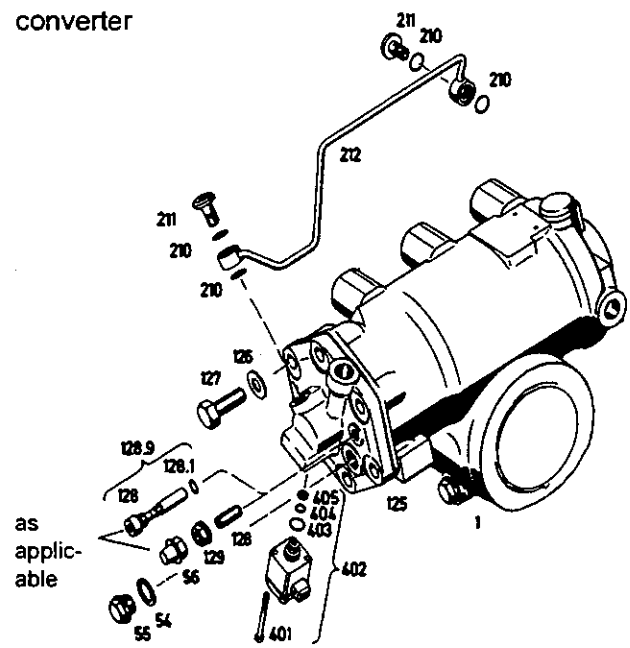
See Repair Manual ZF–Servocom

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.

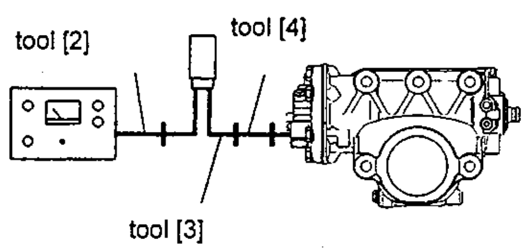
The following functional test refers to the separate checking of the converter and of the control unit. The joint checking of both units is described in the above–mentioned operating instructions.

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.

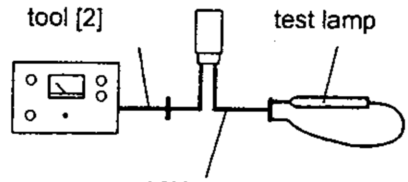
2.2 Functional test of the control unit:

→ 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]).

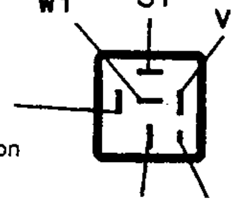
→ Connect the test lamp directly to the control unit or to the cable leading to the converter as accessibility allows.



→ 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 $\boxed{1}$ → replace speedometer signal $\boxed{1}$
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 $\boxed{1}$
	→ cable connection to converter in contact with on–board voltage	→ check and replace, if necessary –remove control unit –measure at the socket $\boxed{2}$ voltage from pin W1 to 31 nom. value: 0V resistance from pin W2 to 31 nom. value: $\infty\,\Omega$ i.e. no connection

$\boxed{1}$ see vehicle manufacturer's manual

$\boxed{2}$ **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

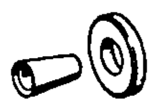
[2] **Attention!** Any measurement between V and 31 must be performed only with a voltmeter. Otherwise the speed signal sensor will be destroyed.

VI. Special tools

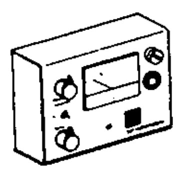
Note:
The special tools listed below refer to the standard version and the design state of the ZF–Servocomtronic on the basis of which the entire manual has been compiled.

Other tools may consequently be required for the particular ZF–Servocomtronic unit to be repaired.

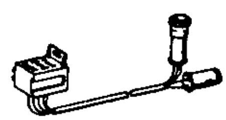
Tool [1]	Part-No.
Guide bush	8098 798 004
Mounting ring	8098 798 655



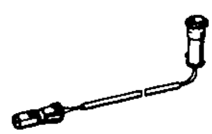
Tool [2]	
Servotronictest	7418 798 545
Power supply unit	7418 798 546



Tool [3]	
Adapter	7038 340 201

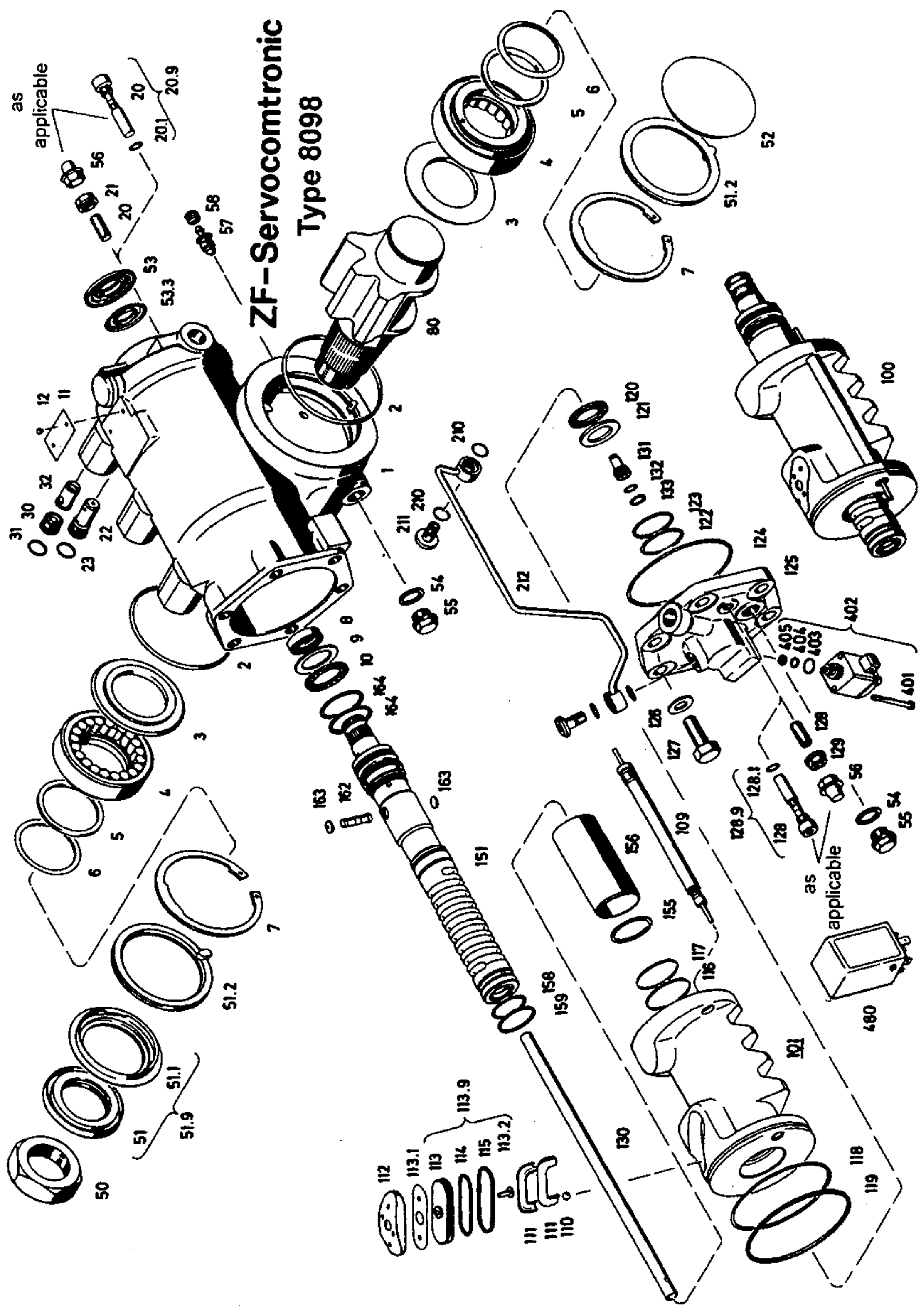


Tool [4]	
Adapter cable	7418 798 543



VII.Key to numbers in figures and exploded drawing

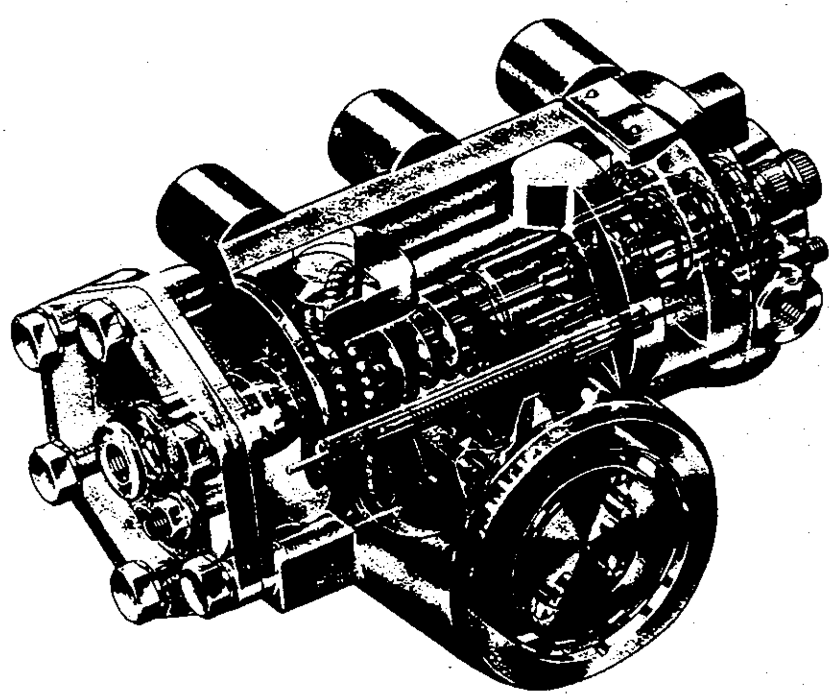
130.0	pipe
131.0	reaction piston
132.0	O–ring
133.0	sealing ring
401.0	cap screw
402.0	converter
403.0	O–ring
404.0	O–ring
405.0	oil screen


ZF-Servocomtronic
Type 8098
as applicable
as applicable

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 service

G 8090 R–KTI 10/96 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.

Contents

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).

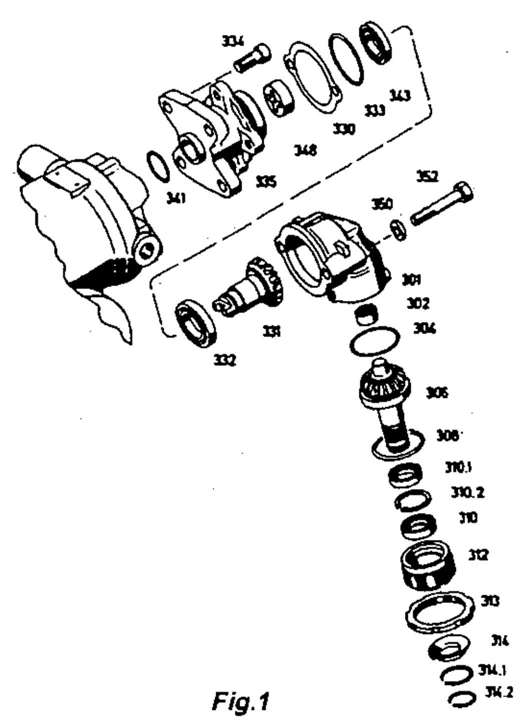


Fig.1

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).

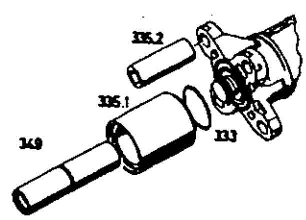


Fig.2

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)*.

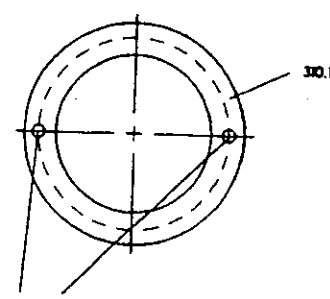


Fig.3

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).

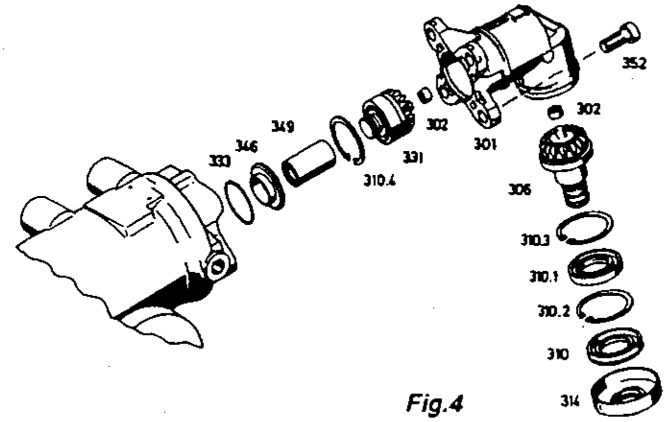


Fig.4

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).

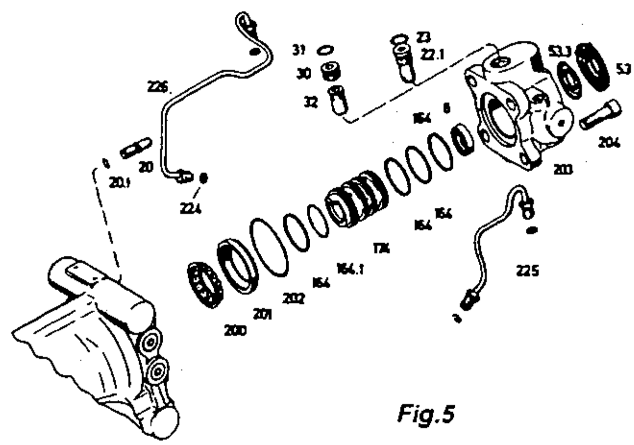


Fig.5

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)*.

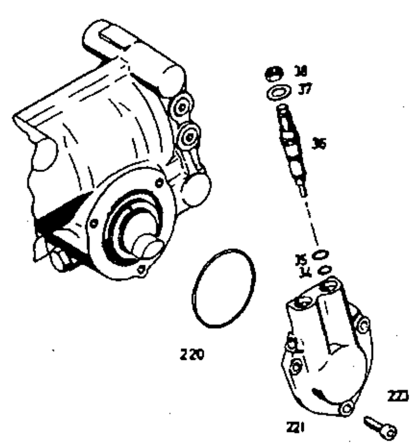


Fig.6

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).

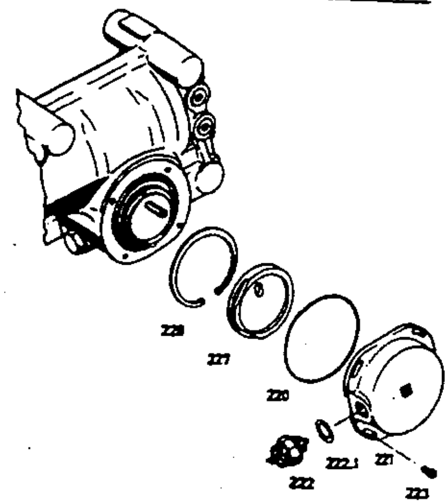


Fig.7

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).

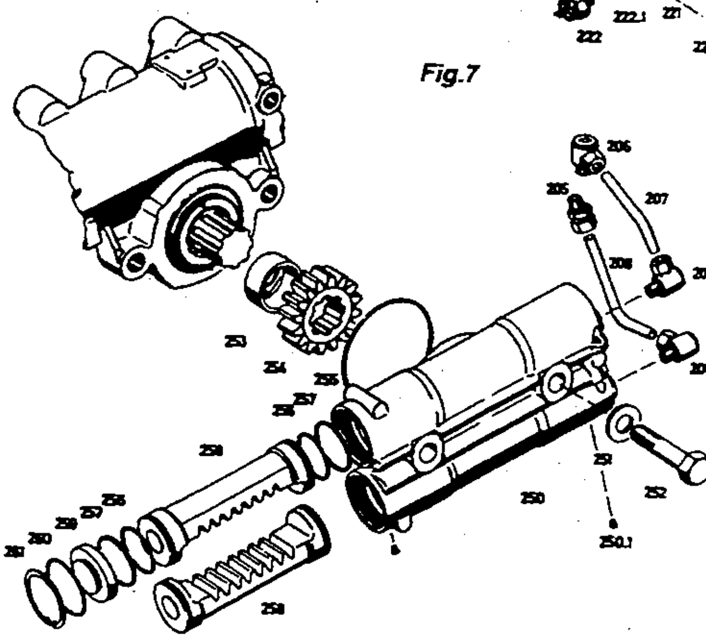


Fig.8

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).

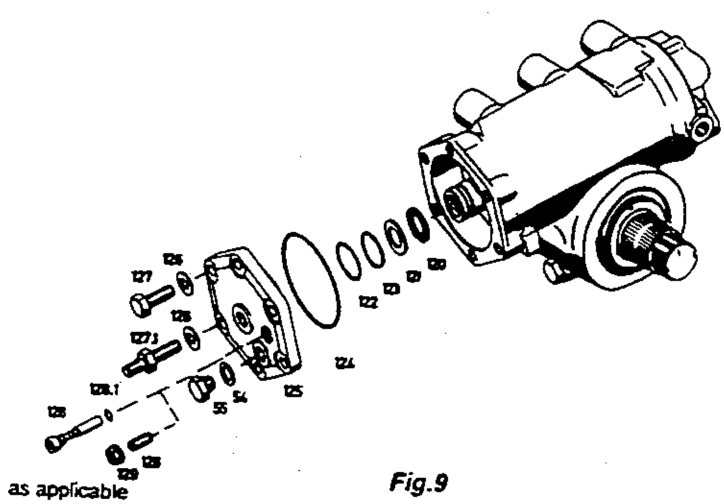


Fig.9

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)*.

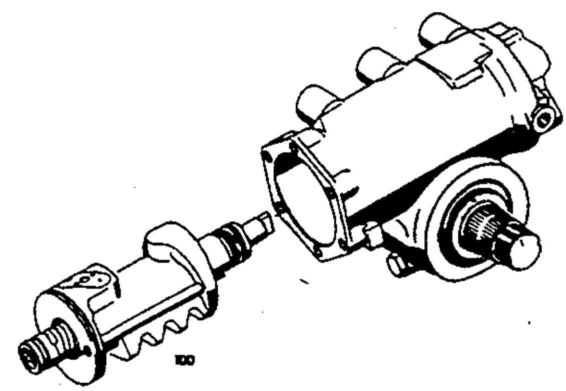


Fig.10

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)*.

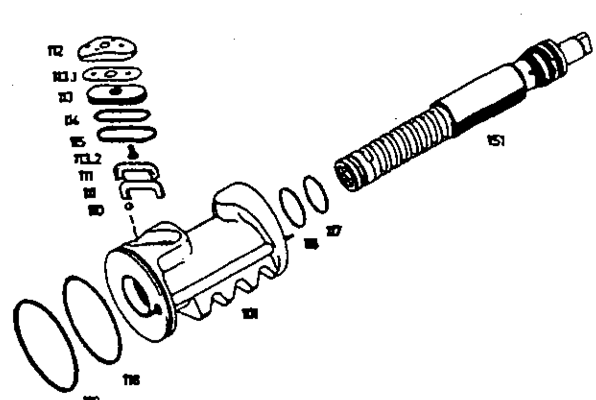


Fig.11

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)*.

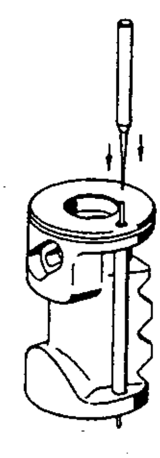


Fig.12

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

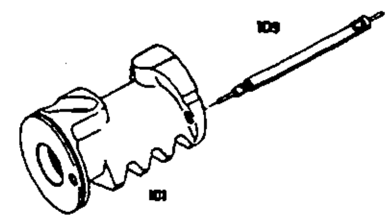


Fig.13

Release caulking and screw valve insert (109) out of piston (101) with tool [2] *(Fig.13)*.

8 Disassembly of worm (151)

8.1 Unspring snap ring (155) and pull off sliding tube (156) *(Fig.14)*.

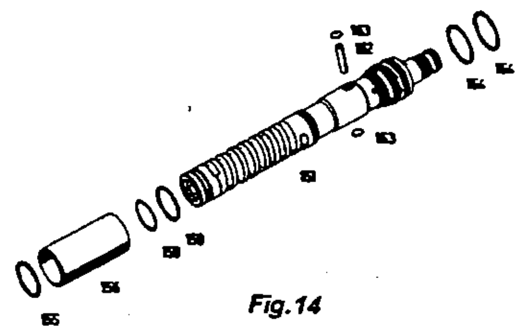


Fig.14

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.

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).

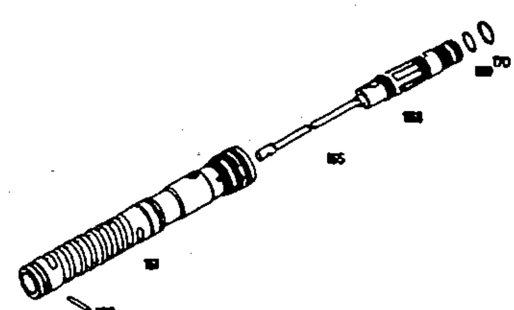


Fig.15

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).

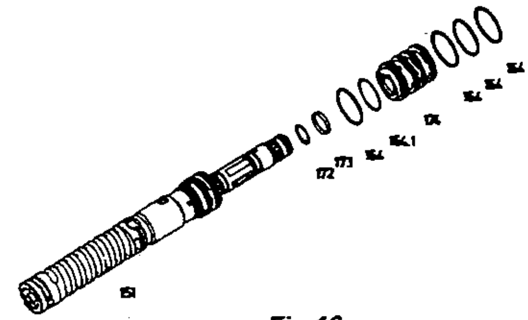


Fig.16

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)*.

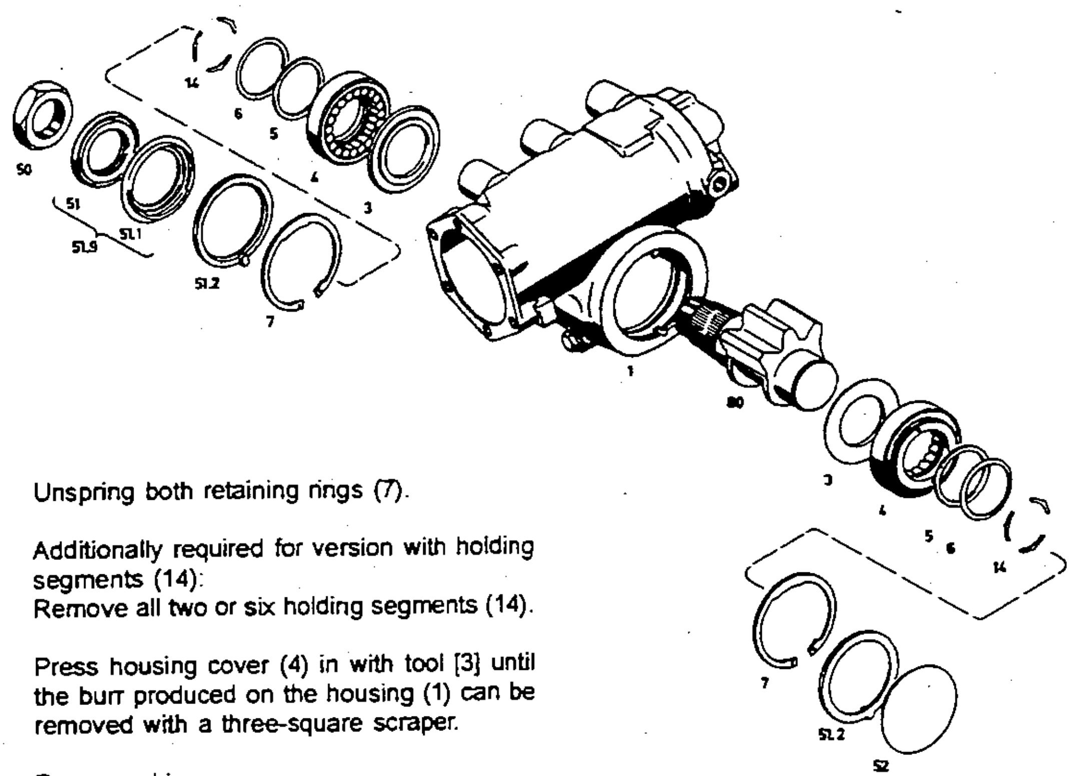


Fig.17

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).

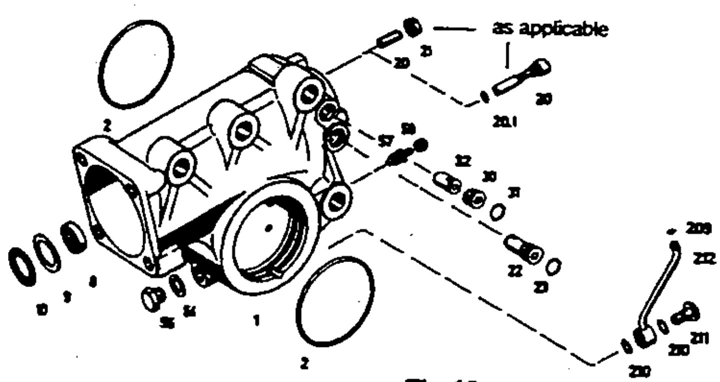


Fig.18

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).

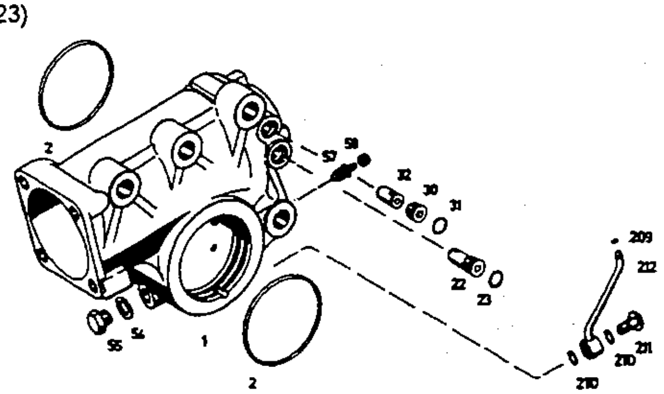


Fig.19

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)*.

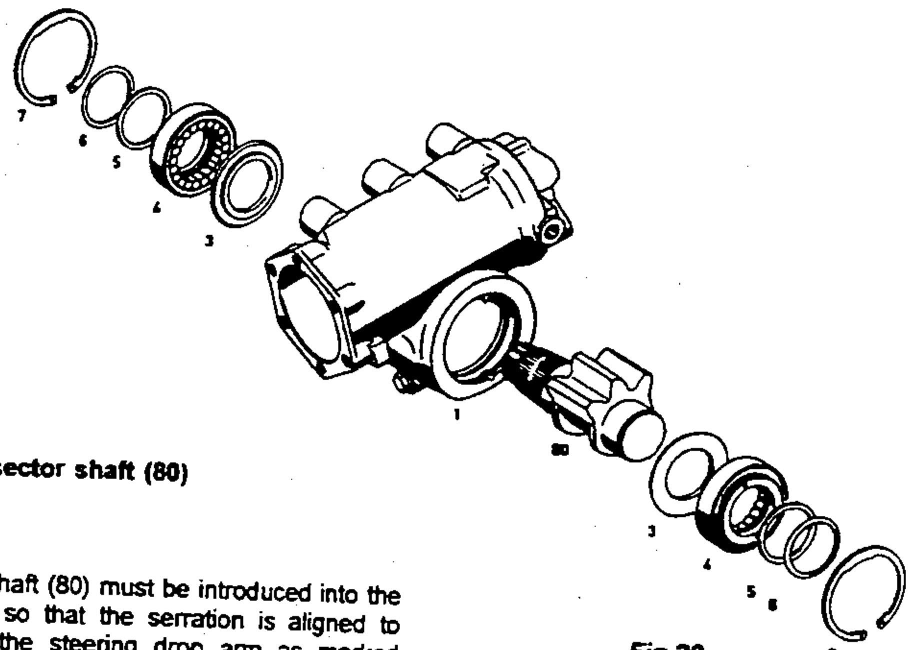


Fig.20

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)*.

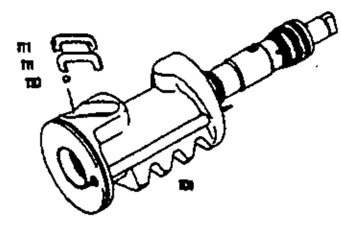


Fig.21

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

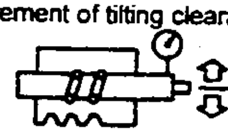


Fig.22

→ 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)***.

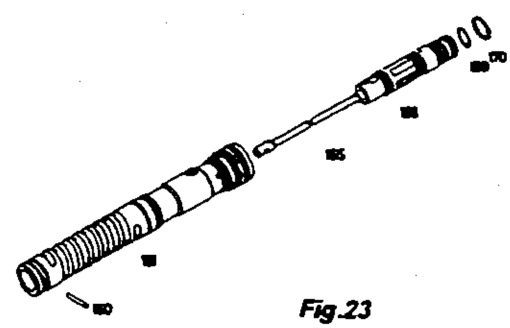


Fig.23

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].

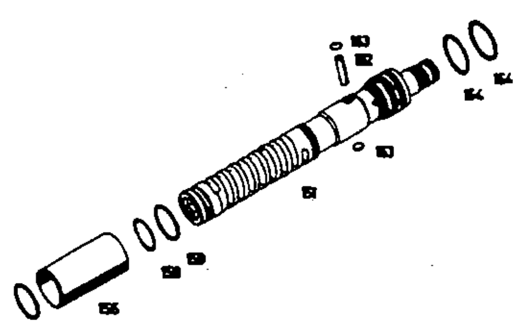


Fig.24

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).

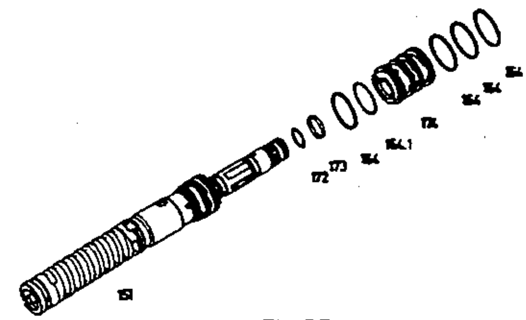


Fig.25

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)*.

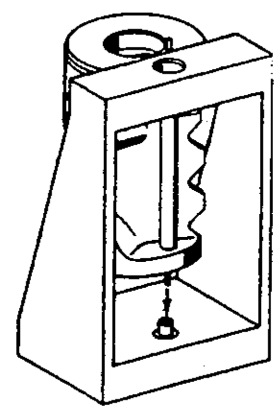


Fig.26

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.

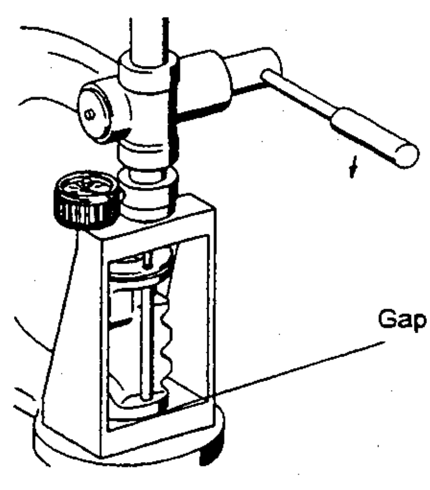


Fig.27

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.

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).

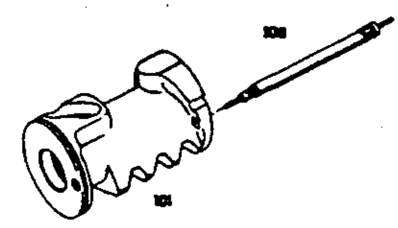


Fig.28

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).

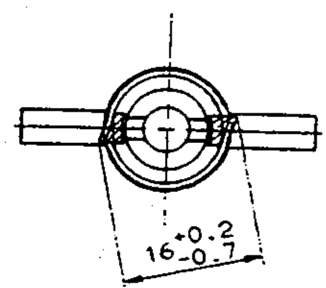


Fig.29

Attention:
Check that the valve insert (109) is tightly seated and that the valve tappet moves easily.

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).

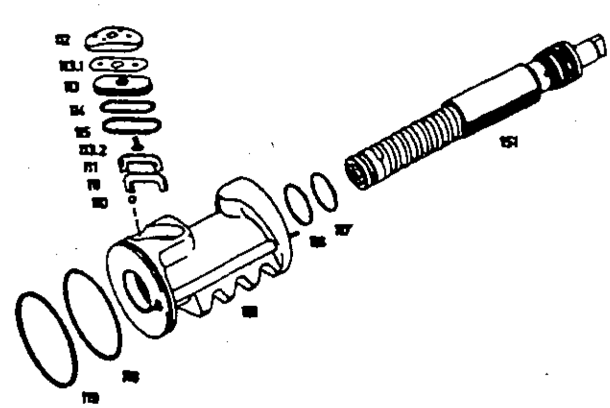


Fig.30

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

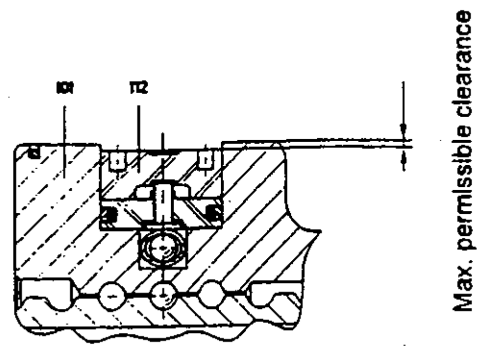


Fig.31

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).

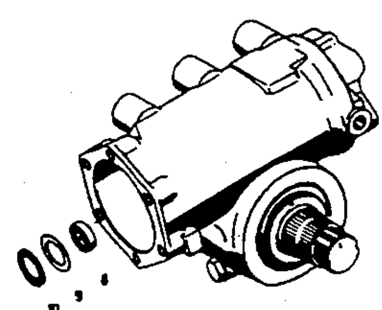


Fig.32

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.

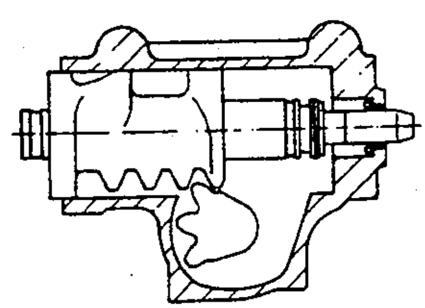


Fig.33

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)*.

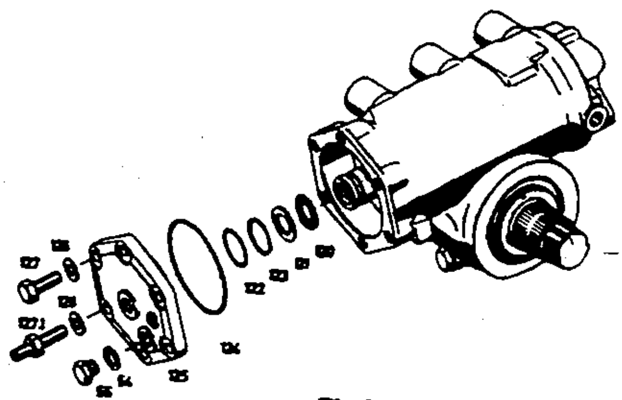


Fig.34

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).

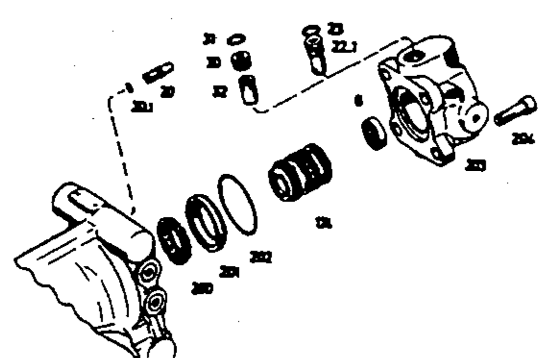


Fig.35

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)***.

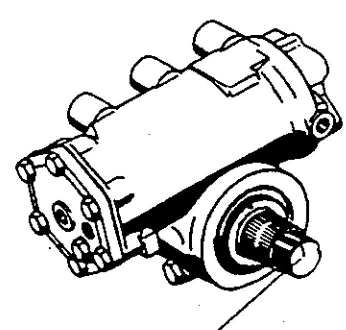


Fig.36

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.

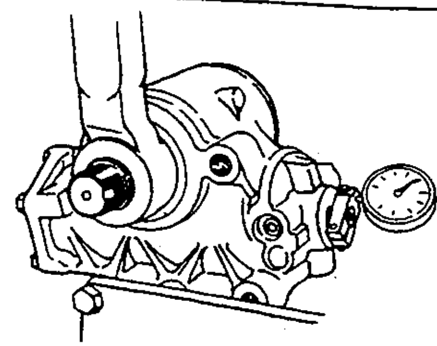


Fig.37

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

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)*.

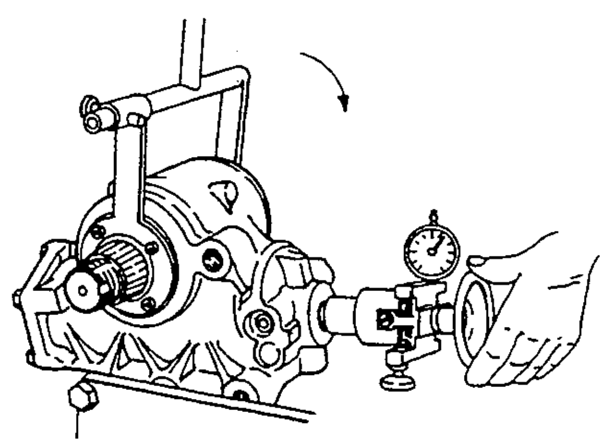


Fig.38

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.

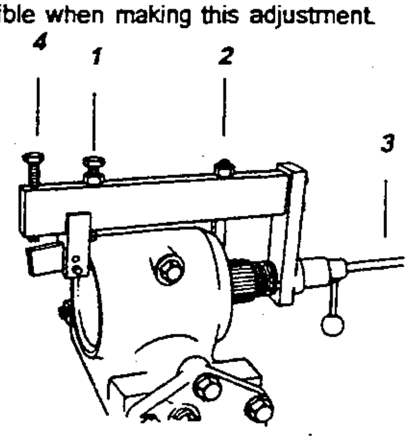


Fig.39

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)*.

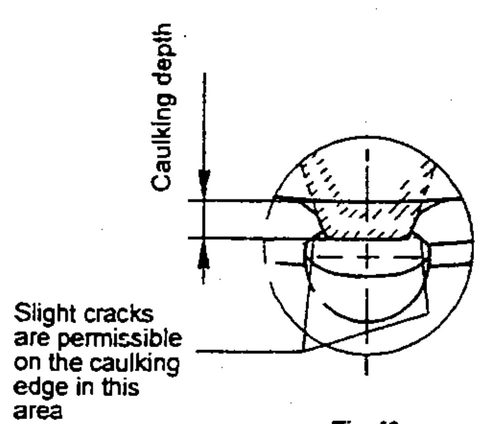


Fig.40

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.

14.1.2 Repeat the complete procedure for the other side as described in section 14.1.1.

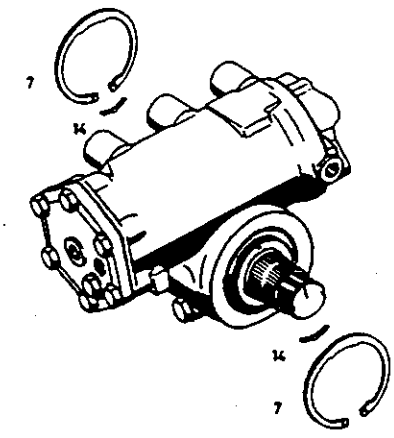


Fig.41

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.

14.2.2 Repeat the complete procedure for the other side as described in section 14.1.1.

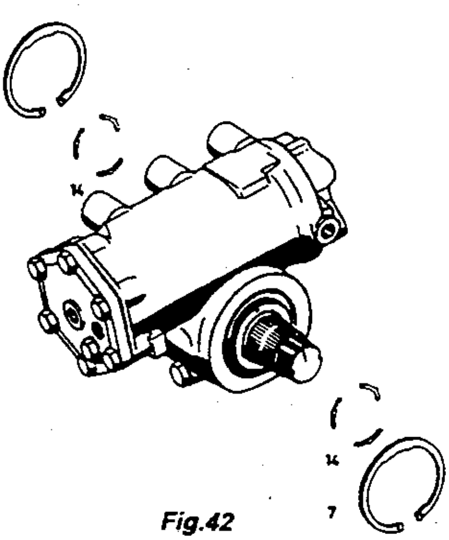


Fig.42

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).

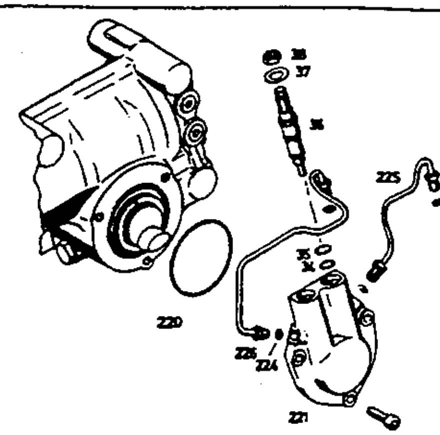


Fig.43

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)*.

Fit retaining ring (228).

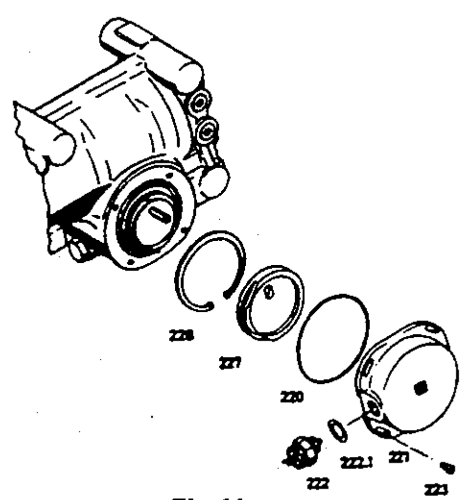


Fig.44

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)***.

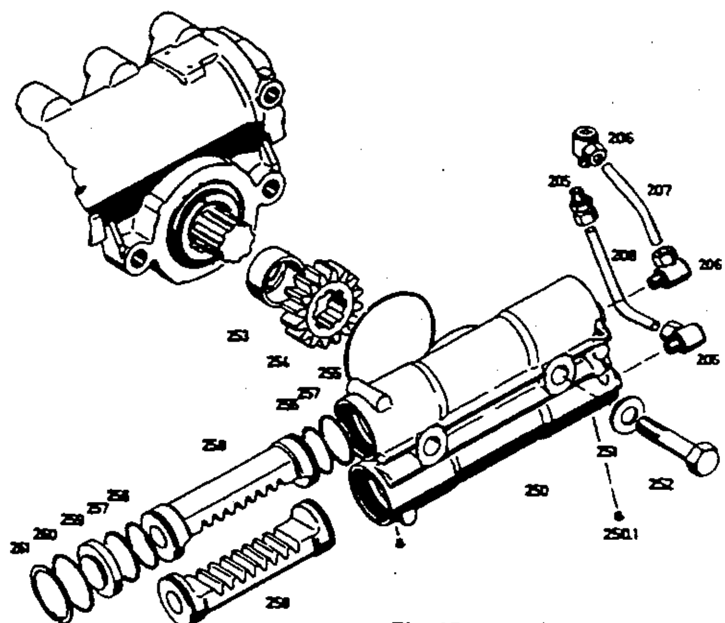


Fig.45

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)***.

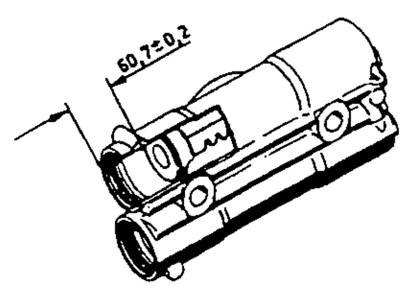


Fig.46

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).

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).

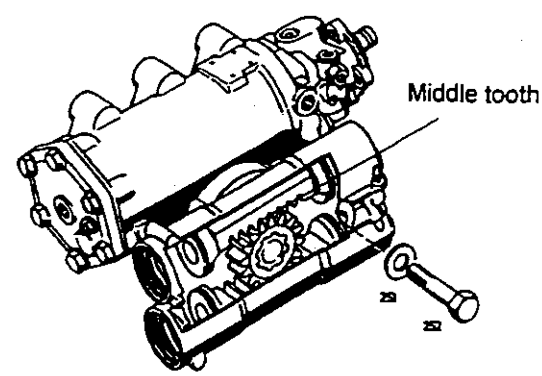


Fig.47

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)***.

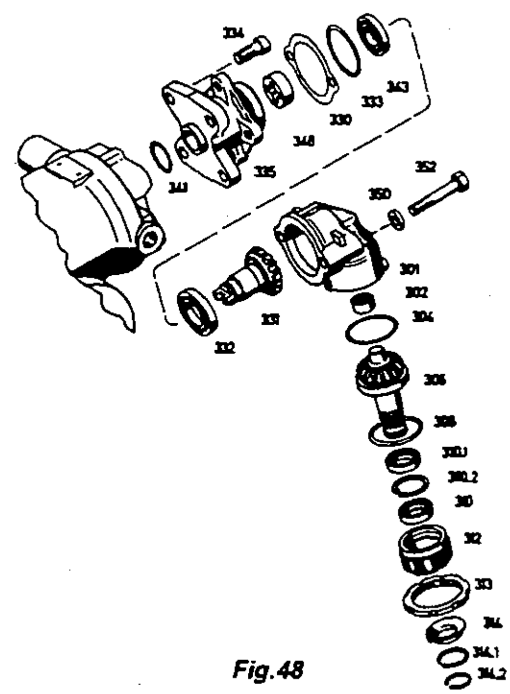


Fig.48

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)***.

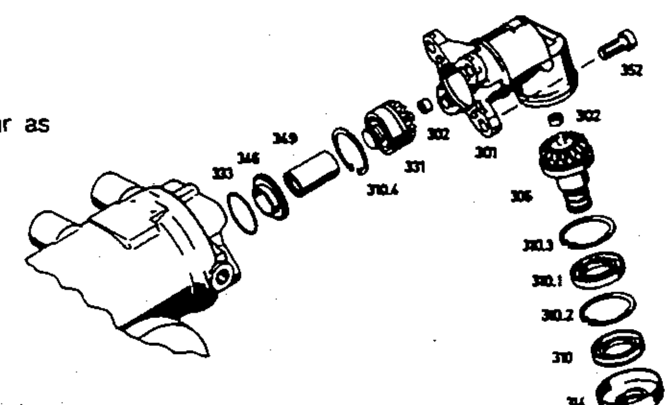


Fig.49

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.

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.

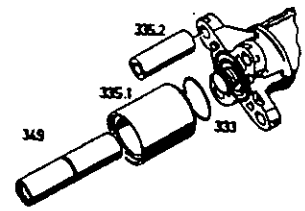


Fig.50

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.

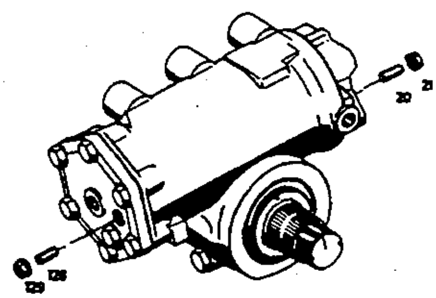


Fig.51

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).***

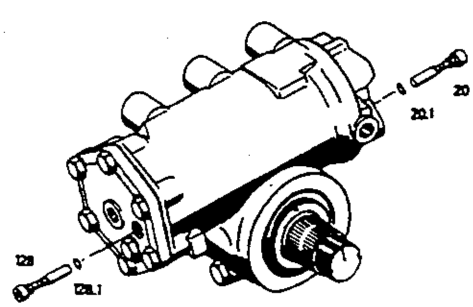


Fig.52

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).

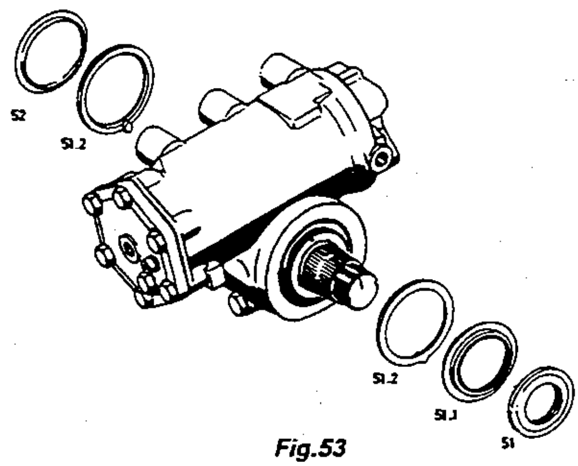


Fig.53

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)***.

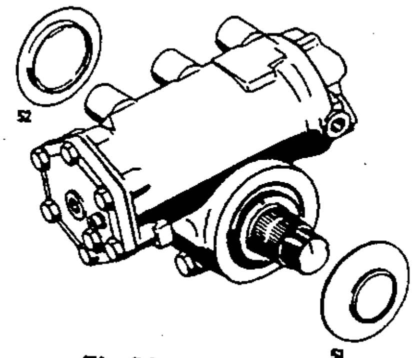


Fig.54

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).

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)***.

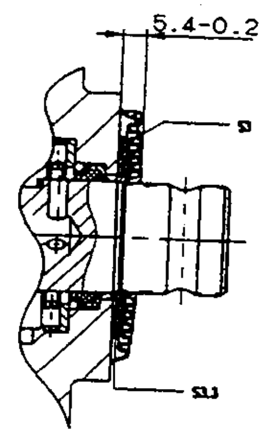


Fig.55

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)***.

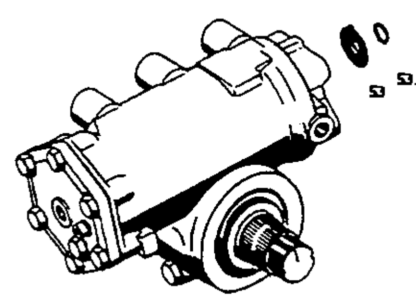


Fig.56

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.

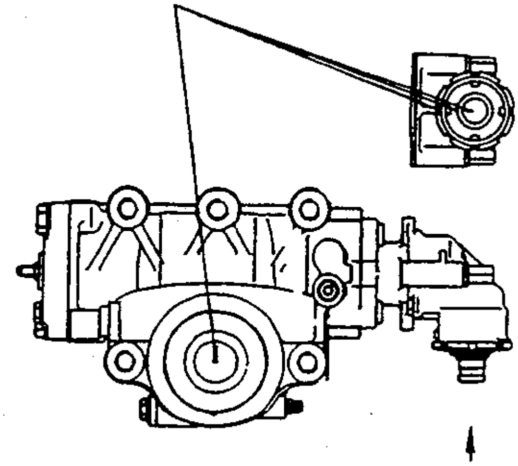


Fig.57

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)*.

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.

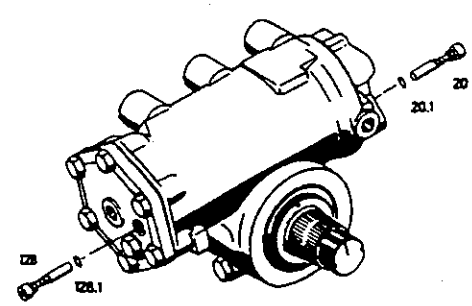


Fig.58

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

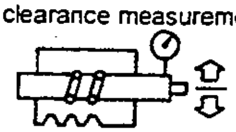
VI. Friction torques, adjustment values and tightening torques

❑ 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 iv_1 = 16.6 : 1 / 14.0 :1	max. 160	max. 240
i_2 = 18.0 : 1 iv_2 = 19.6 : 1 / 16.6 : 1	max. 140	max. 220

8095		
i_1 = 17.0 : 1	max. 180	max. 260
iv_1 = 18.5 : 1 / 15.6 :1		
i_2 = 19.6 : 1	max. 160	max. 240
iv_2 = 21.3 : 1 / 18.1 :1		
i_3 = 23.1 : 1	max. 140	max. 220
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	 + add-on cylinder	 with bevel box - add-on cylinder	 + add-on cylinder
8096				
i_1 = 17.0 : 1	max. 210	-	max. 290	-
iv_1 = 18.5 : 1 / 15.6:1				
i_2 = 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

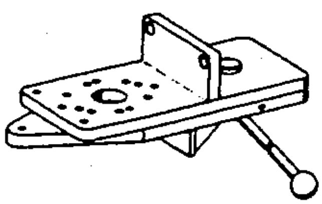
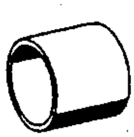
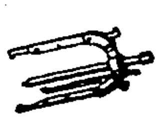
Tightening torques:

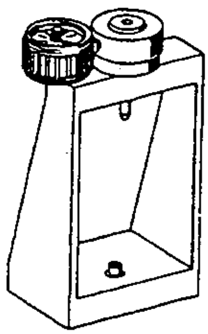
Screw (20)			12+3 Nm
Collar nut (21)			20+10 Nm
Valve insert (22)			30+10 Nm
Valve insert (22.1)			30+10 Nm
Screw (30)			30+10 Nm
Hex nut (38)			25-35 Nm
Screw plug (55)		M16:	40 Nm
		M18:	50 Nm
Breather (57)			30 Nm
Valve insert (109)			15±1 Nm
Hexagon screws (127)	Type	8090 (M12x1.5):	135 Nm
	Types	8095/8096/8097 (M16x1.5):	285 Nm
	Types	8098/8099 (M14x1.5):	189 Nm
Screw (128)			12+3 Nm

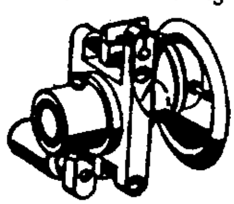
Collar nut (129)		20+10 Nm
Cap screws (204)		140 Nm
Pipe union (205)		50 Nm
Pipe union (206)		50 Nm
Screw plug for pipe unions (205) and (206)		59 Nm
Union screws (211)		20±2 Nm
Switch (222)		50 Nm
Cap screw (223)	Type 8096 (M8):	37 Nm
	Type 8098 (M6) (version with switch):	5.5 Nm
Pipes (225)	Type 8096:	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.

<table>
<tr><th></th><th>8090</th><th>8095</th><th>8096</th><th>8097</th><th>8098</th><th>8099</th></tr>
<tr><td>**Tool [1]**
Assembly vice
</td><td colspan="6">7418 798 654</td></tr>
<tr><td>**Tool [2]**
Insert for screw–out and screw–in the valve insert (109)
</td><td colspan="6">8098 798 151</td></tr>
<tr><td>**Tool [3]**
Sleeve for pressing the housing covers (4)
</td><td>8090
798
006</td><td colspan="2">8095
798
002</td><td>8097
798
002</td><td colspan="2">8098
798
002</td></tr>
<tr><td>**Tool [4]**
Puller for housing cover (4)
</td><td colspan="6">8090 798 201</td></tr>
</table>

	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

Tool	8090	8095	8096	8097	8098	8099
				Valve slide ø25	Valve slide ø25,99	
				7421 798 551	8097 798 554	
				Valve slide ø25,99	serration 24/48x22	
				8097 798 554	8038 798 551	
Tool [9] Torque measuring device 	7470 798 703					
Tool [10] Dial gauge: Graduation 0.01 mm 	7470 798 706					
Tool [11] Guide bush for sealing rings (164) 	8090 798 004	8090 798 001				
for dual-circuit version			8090 798 005			8090 798 005

<table>
<tr><th></th><th>8090</th><th>8095</th><th>8096</th><th>8097</th><th>8098</th><th>8099</th></tr>
<tr><td>Tool [12]
Pliers for pressing on the sealing rings (164)
</td><td>8090
798
652</td><td colspan="5">8090 798 651</td></tr>
<tr><td>Tool [13]
Sleeve for mounting the O–ring (172) and the sealing ring (173)
</td><td colspan="2"></td><td>8096
798
001</td><td colspan="2"></td><td>8096
798
001</td></tr>
<tr><td>Tool [14]
Mandrel for shaft seal (8)
</td><td>8090
798
052</td><td colspan="5">8090 798 051</td></tr>
<tr><td>Tool [15]
Guide bush for shaft seal (8)
</td><td>8090
798
002</td><td colspan="5">8090 798 003</td></tr>
</table>

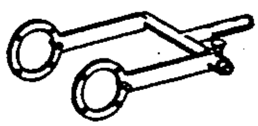
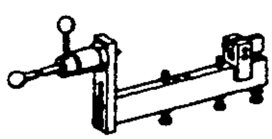
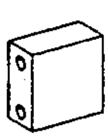
Tool [16]

Dial gauge holder for adjustment of axial play–worm

Tool [17]

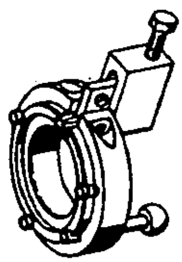
Dial gauge graduation 0.001 mm for tool [16]

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		
7016 798 704					

	8090	8095	8096	8097	8098	8099
Tool [18] Adjusting device for pressure point setting 	8090 798 151					
Tool [19] Insert for tool [18] (2 pieces are required) 	8090 798 551	8095 798 551		8097 798 551	8098 798 551	
Tool [20] Assembly tool for prying over of housing covers (4) 	8090 798 654					
Tool [21] Extension for tool [20] for steerings with C–mass >137 mm 					8090 798 656	

Tool [22]

Assembly tool for threefold prying

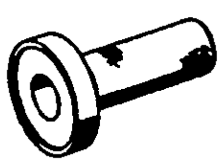


Tool [23]

Insert for torx screw (250.1)

Tool [24]

Mandrel for pressing the protecting cap (53)

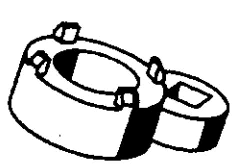


Tool	8090	8095	8096	8097	8098	8099
[22]			8096 798 651		8098 798 651	
[23]						7016 798 152
[24]	8090 798 053	8095 798 051				

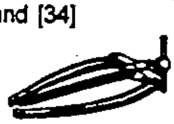
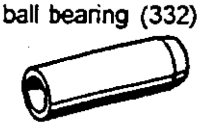
Bevel box with cross disc (348)

Tool [25]

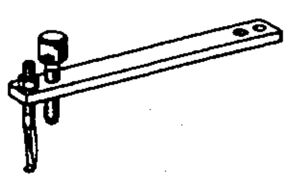
Grooved nut wrench for adjusting screw (312)

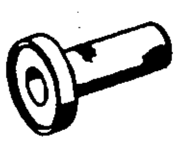


Tool	8096	8097	8098	8099
[25]	1249 898 151			

Tool	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			

<table>
<tr><th></th><th>8096</th><th>8097</th><th>8098</th><th>8099</th></tr>
<tr><td>Tool [31]
Mandrel for shaft seal
(310 and 310.1)
</td><td colspan="4">7418 798 051</td></tr>
<tr><td>Tool [32]
Guide bush for shaft seal
(310 und 310.1)
</td><td colspan="4">8090 798 003</td></tr>
<tr><td>Bevel box with coupling sleeve (349)

Tool [33]
Puller for shaft seal (310)
</td><td colspan="4">8052 798 201</td></tr>
<tr><td>Tool [34]
Puller for needle sleeve (302)
</td><td colspan="4">8098 798 201</td></tr>
<tr><td>Tool [35]
Extension for tool [34]
</td><td colspan="4">8098 798 202</td></tr>
</table>

	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			

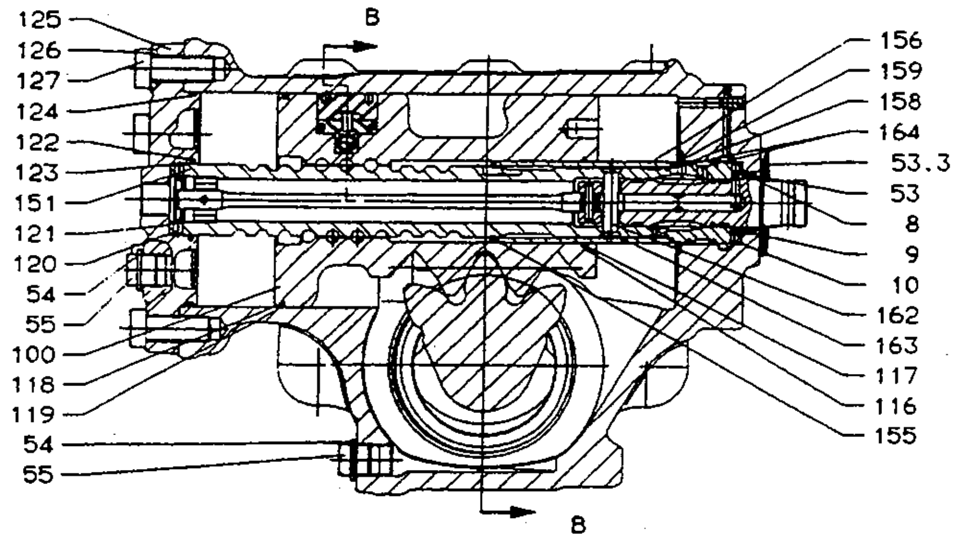
VIII. Key to numbers in figures, sectional drawings and exploded drawings

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

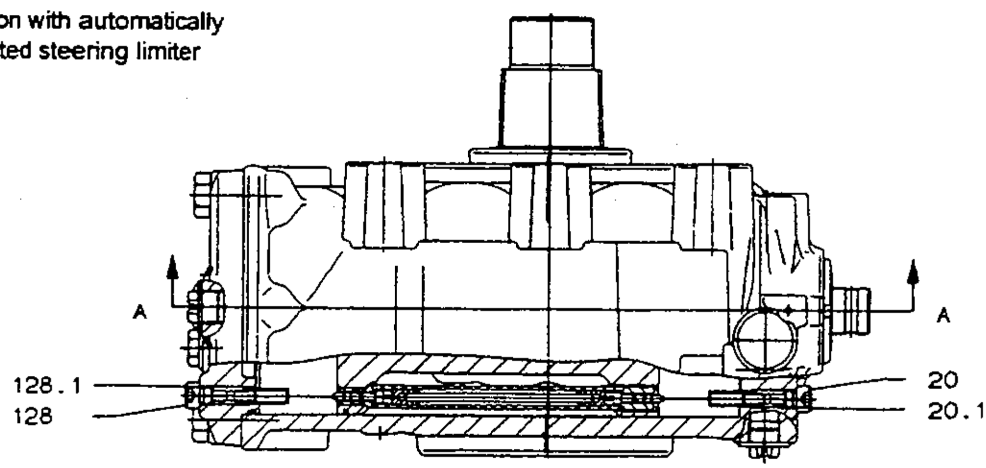
163.0	Plug
164.0	Sealing ring
164.1	O-ring
165.0	Torsion bar
166.0	Needle cage
166.1	Snap ring
167.0	Pin
168.0	Valve slide
169.0	O-ring
170.0	Sealing ring
171.0	Needle cage
172.0	O-ring
173.0	Sealing ring
174.0	Control sleeve
200.0	Ball cage
201.0	Bearing ring
202.0	O-ring
203.0	Valve housing
204.0	Cap 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

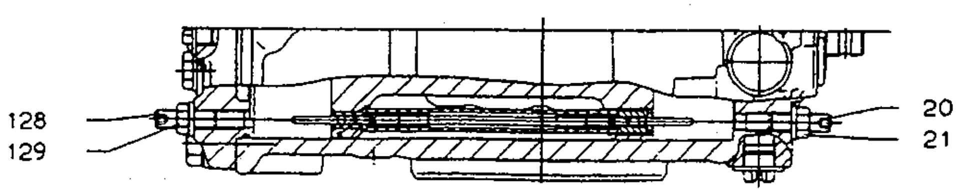
Section A-A



Version with automatically adjusted steering limiter

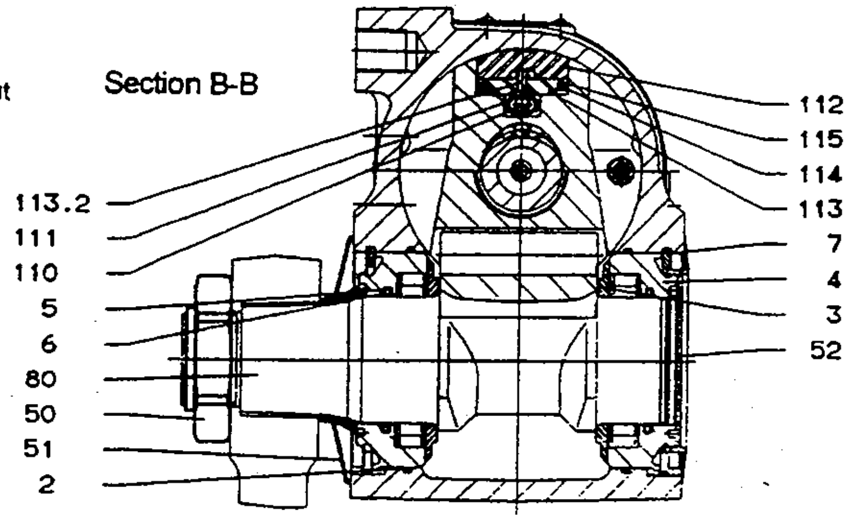


Version with manually adjusted steering limiter



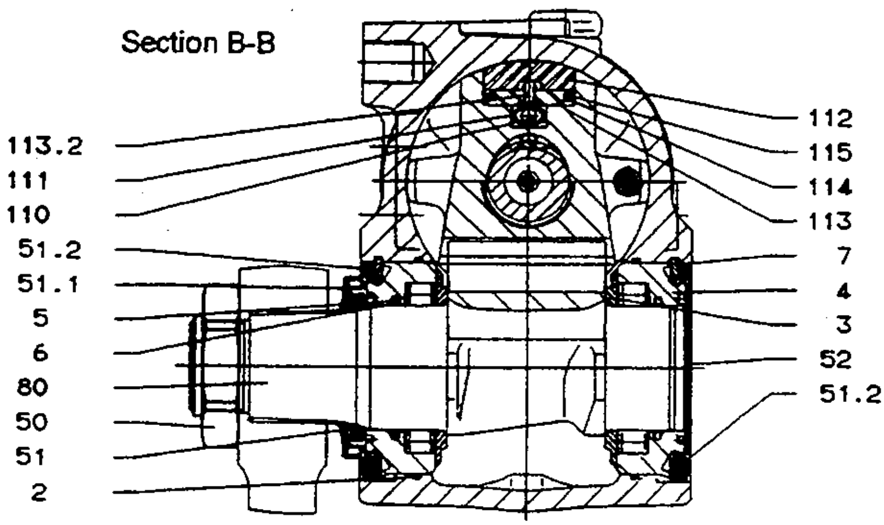
Version without gasket (51.2)

Section B-B



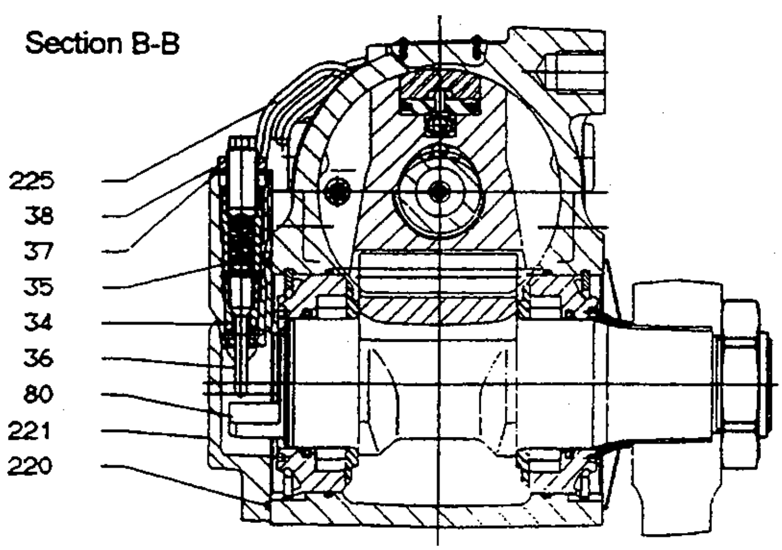
Version with gasket (51.2)

Section B-B

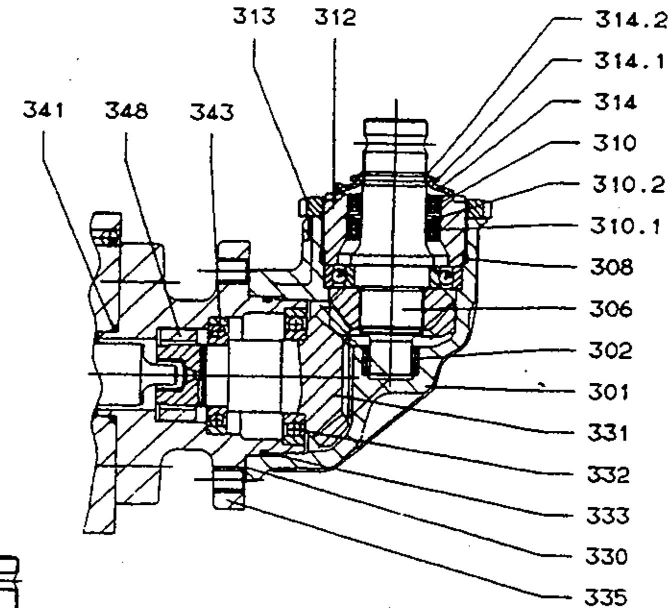


Section B-B

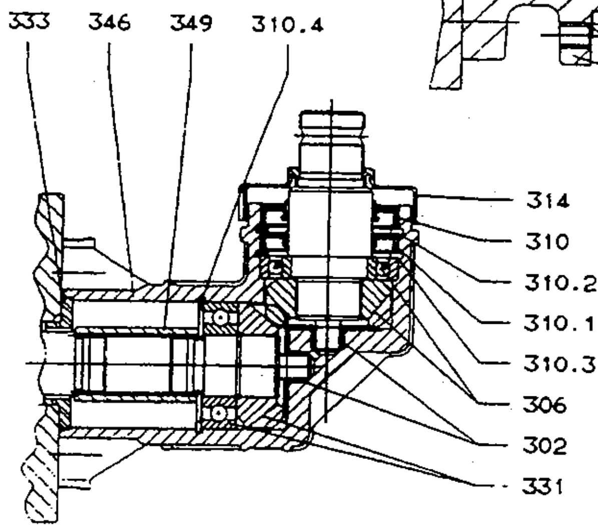
Dual-circuit version with steering limiter in housing cover (221)



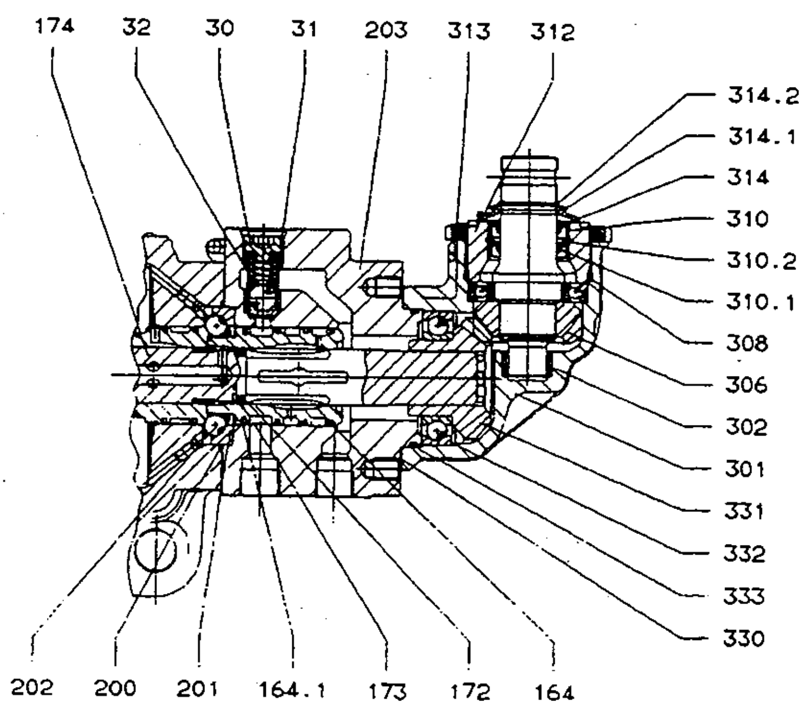
Bevel box with cross disc (348)

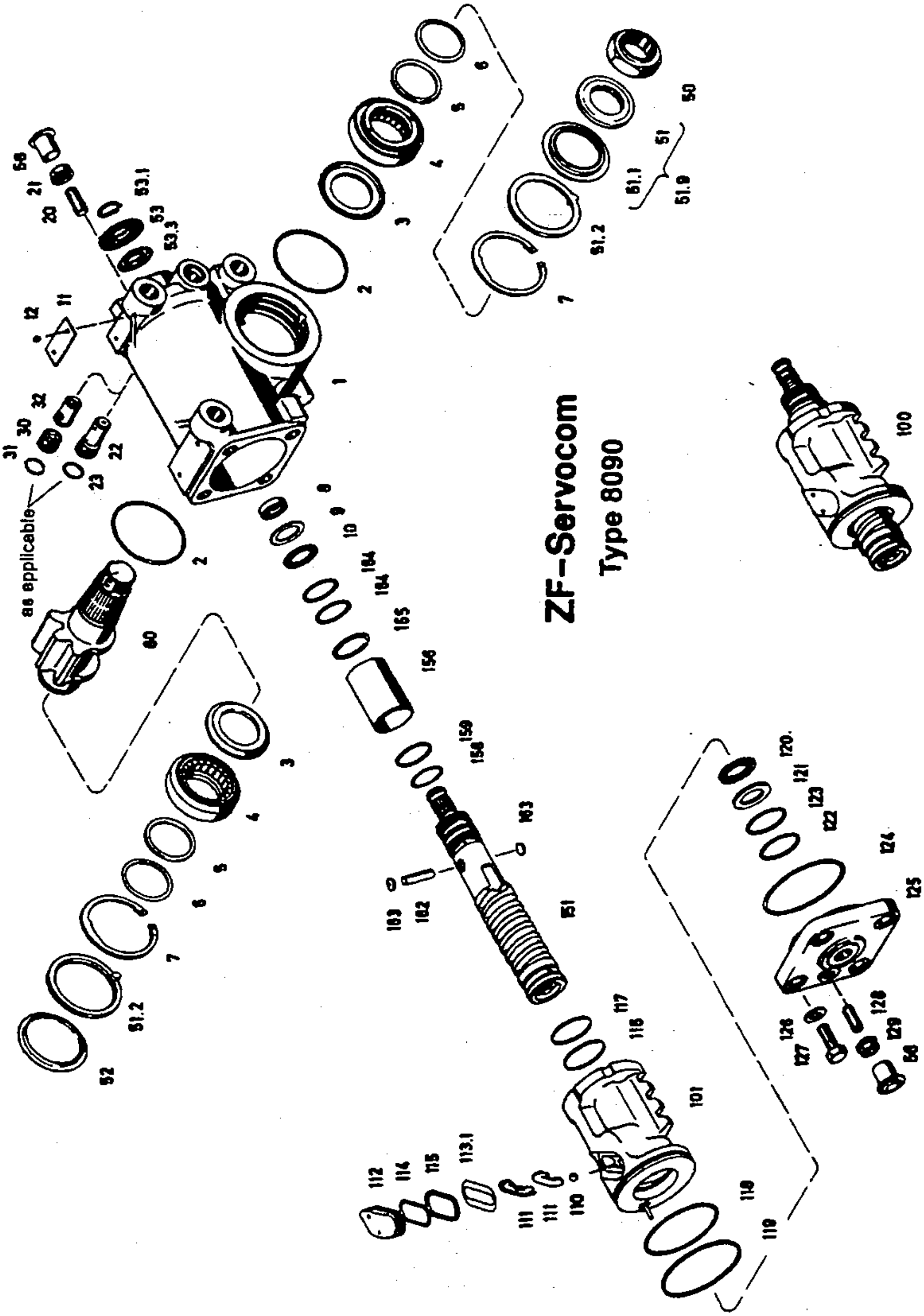


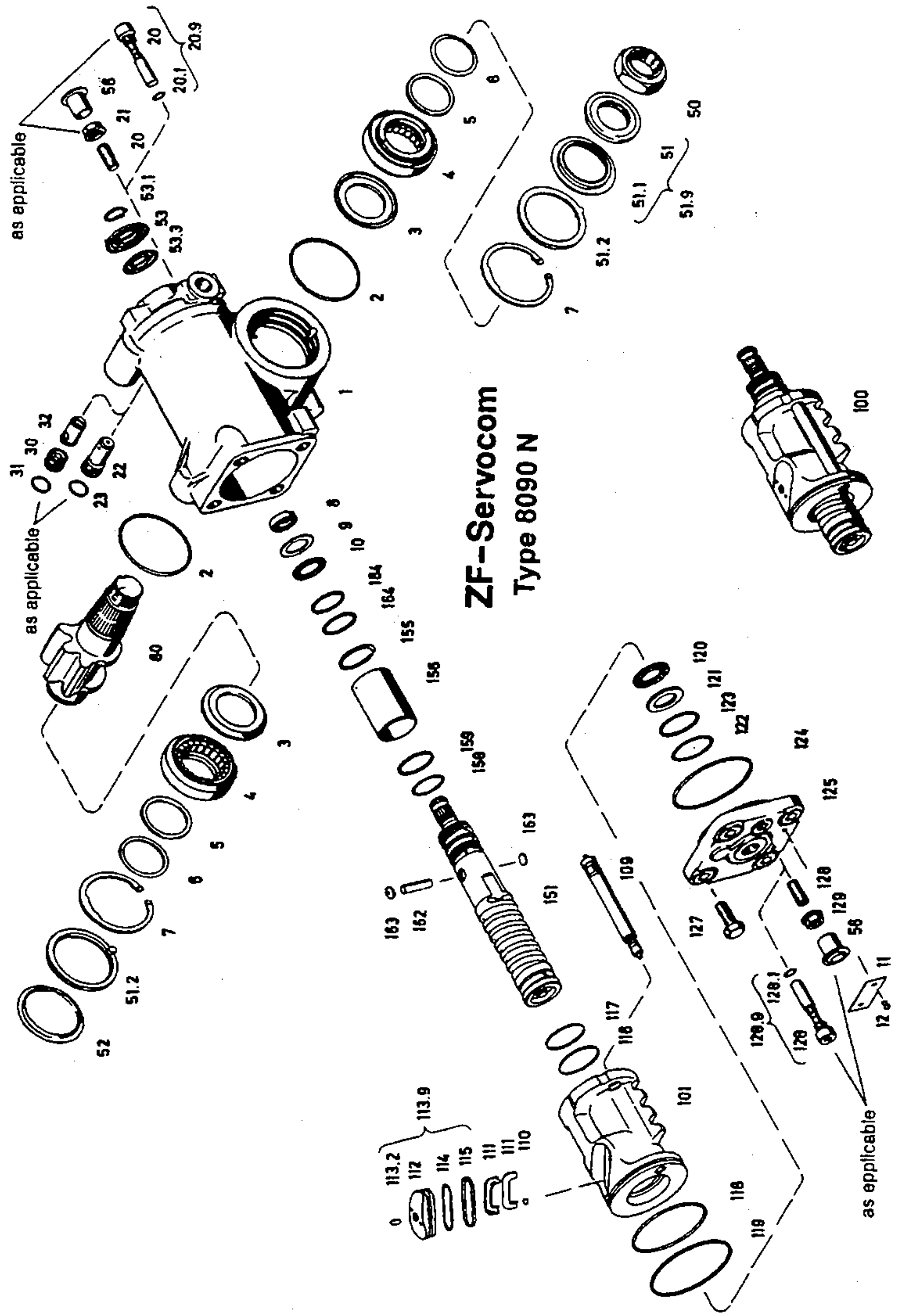
Bevel box with coupling sleeve (349)



Dual-circuit version with bevel box




ZF-Servocom
Type 8090
as applicable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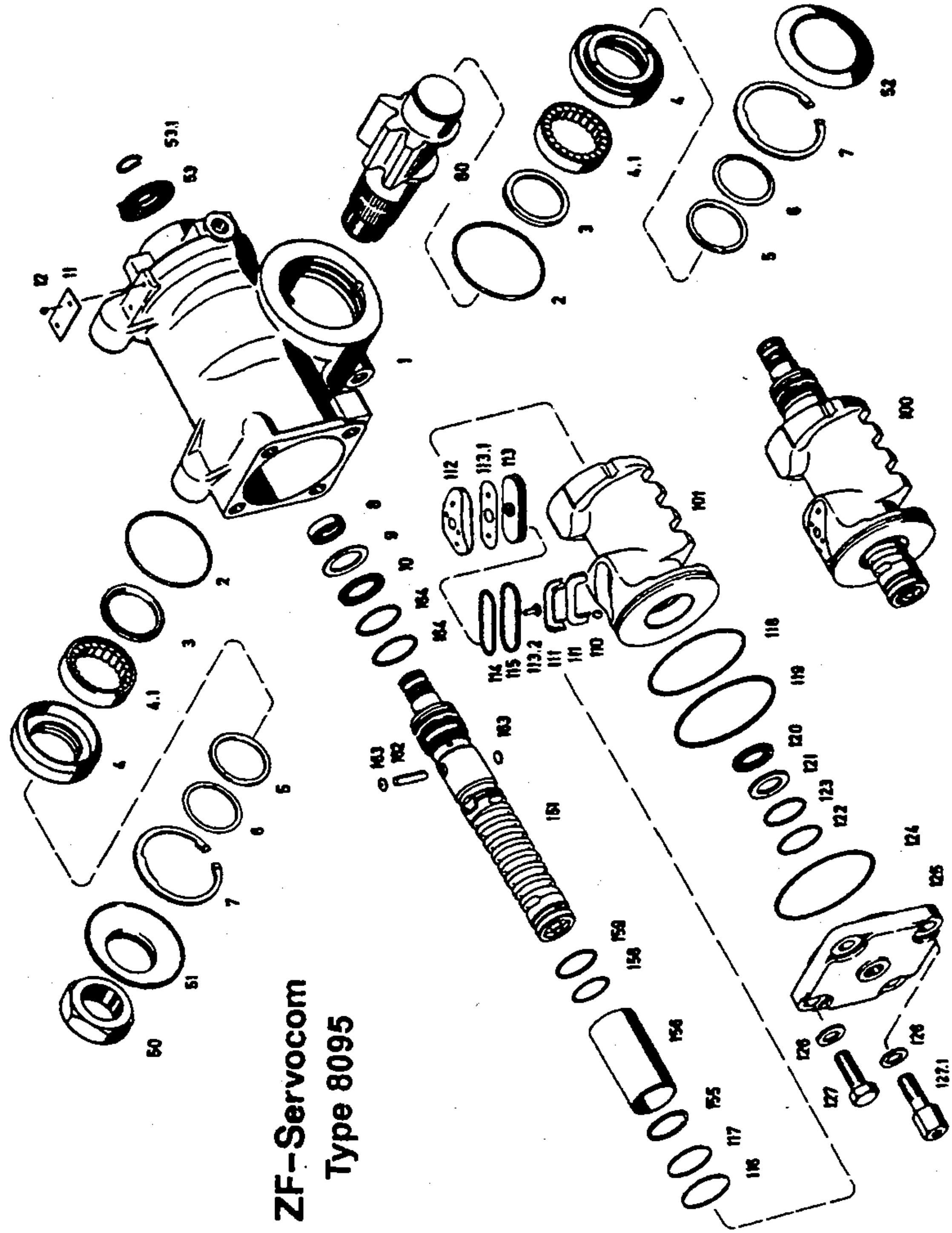
Type 8090 N
as applicable
as applicable
as applicable
as applicable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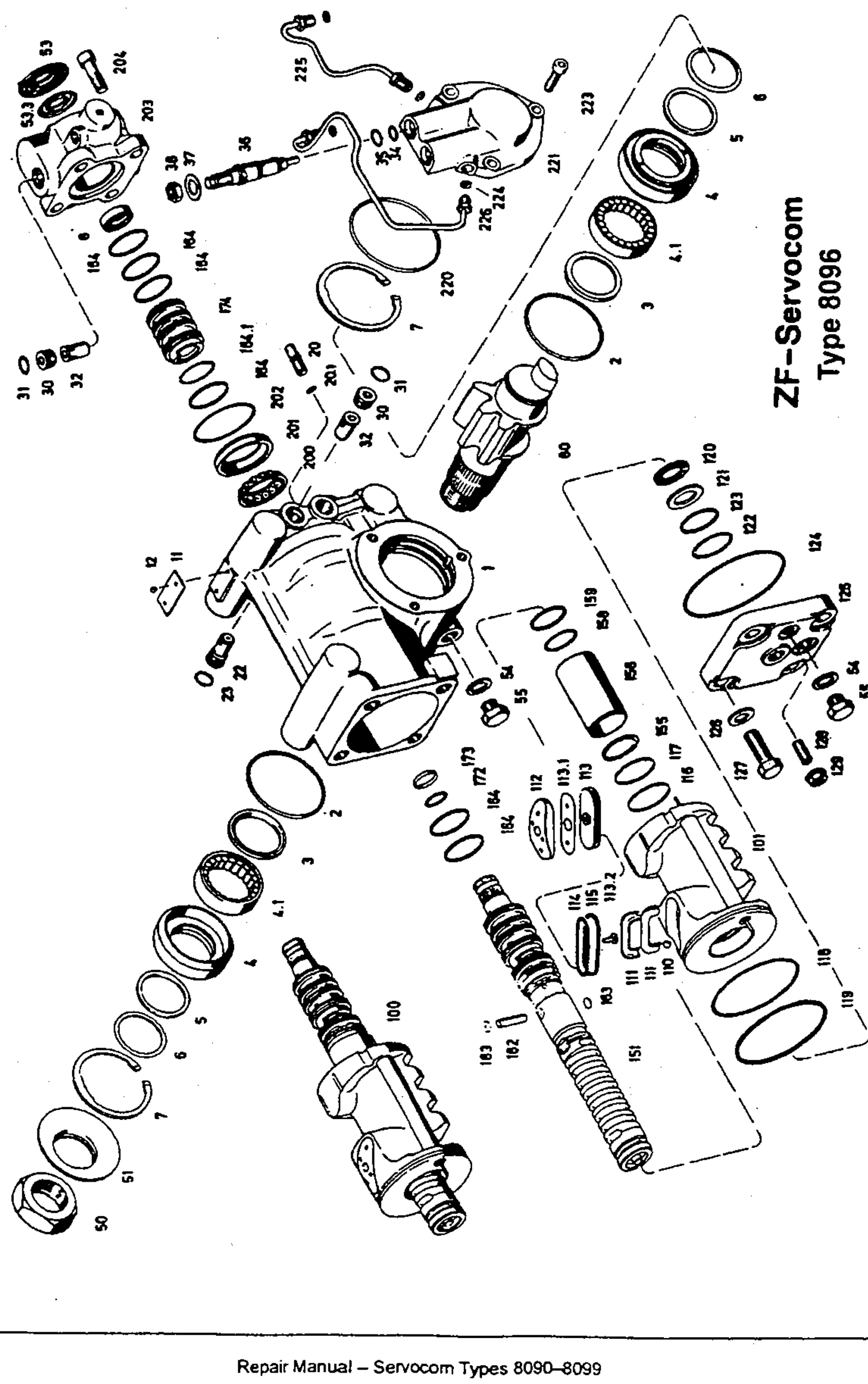
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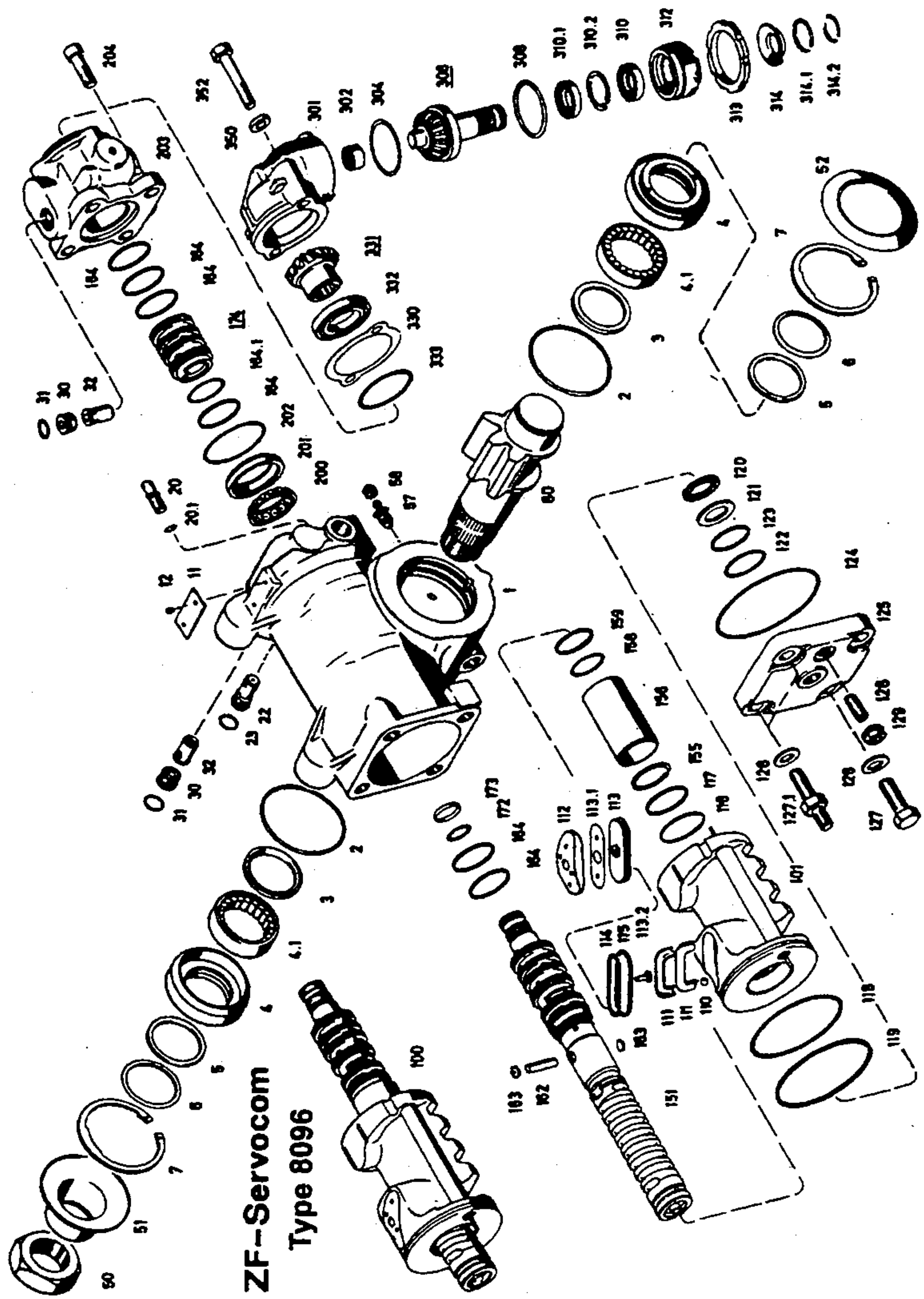
Type 8096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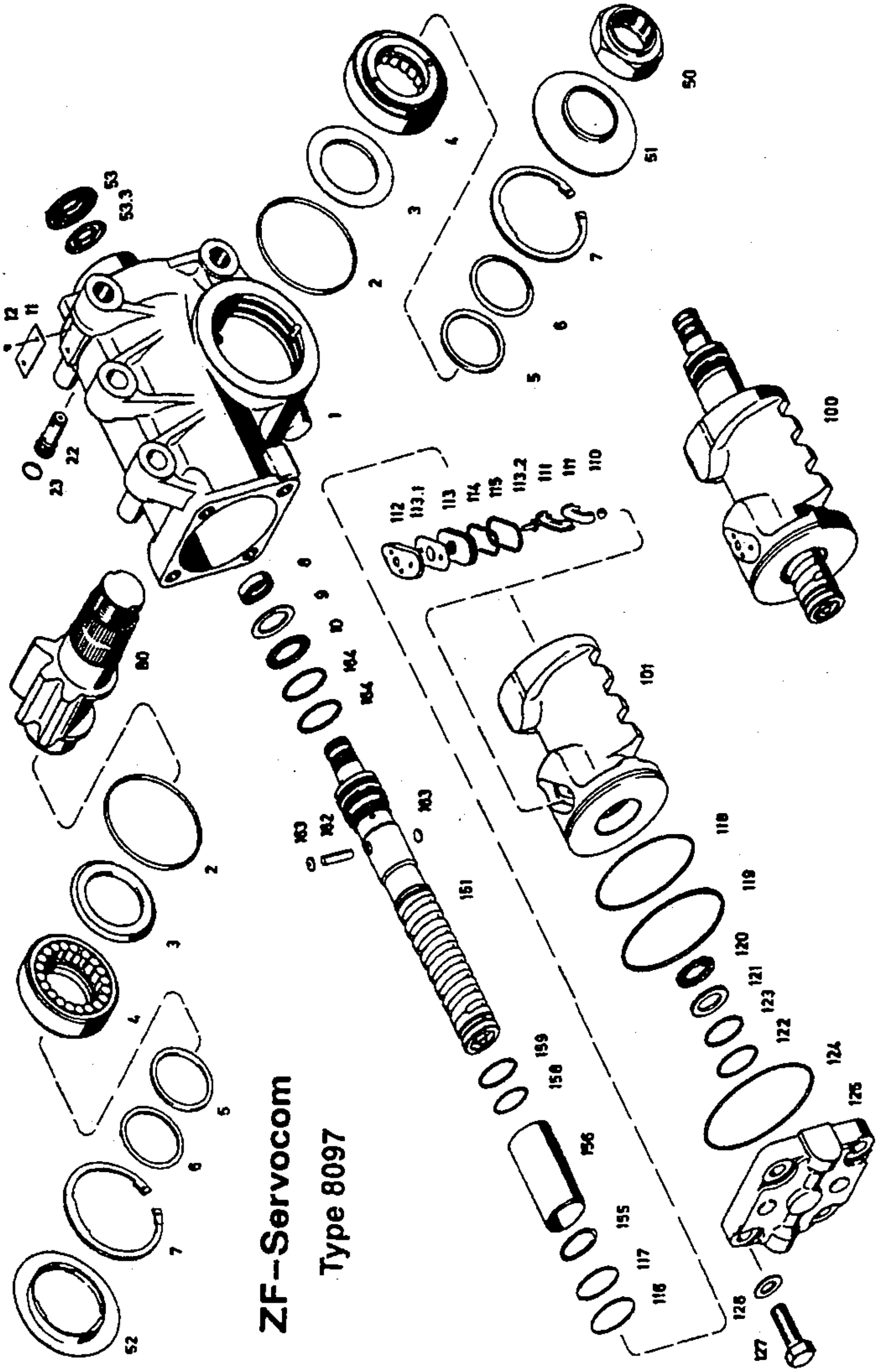
Type 8096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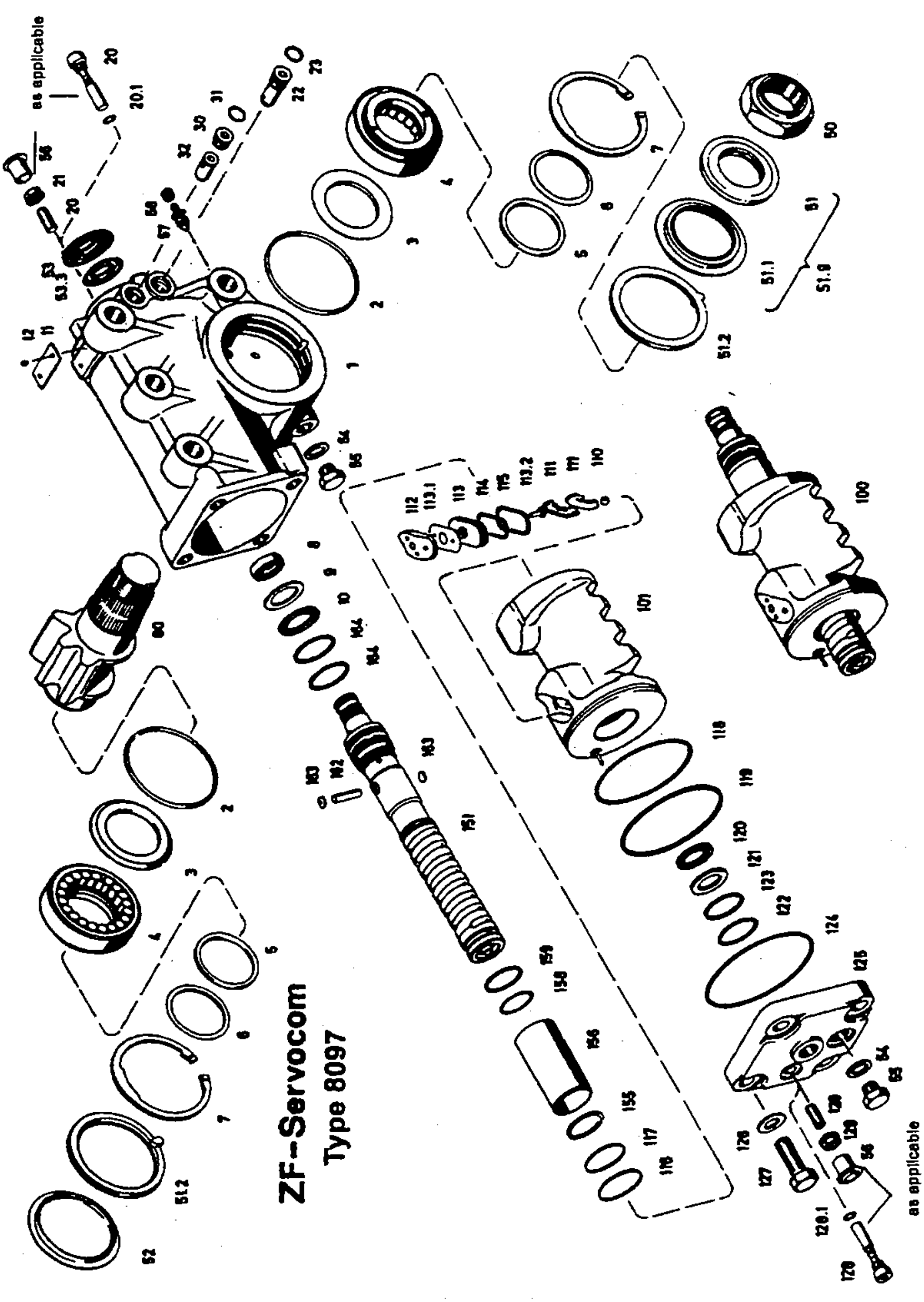
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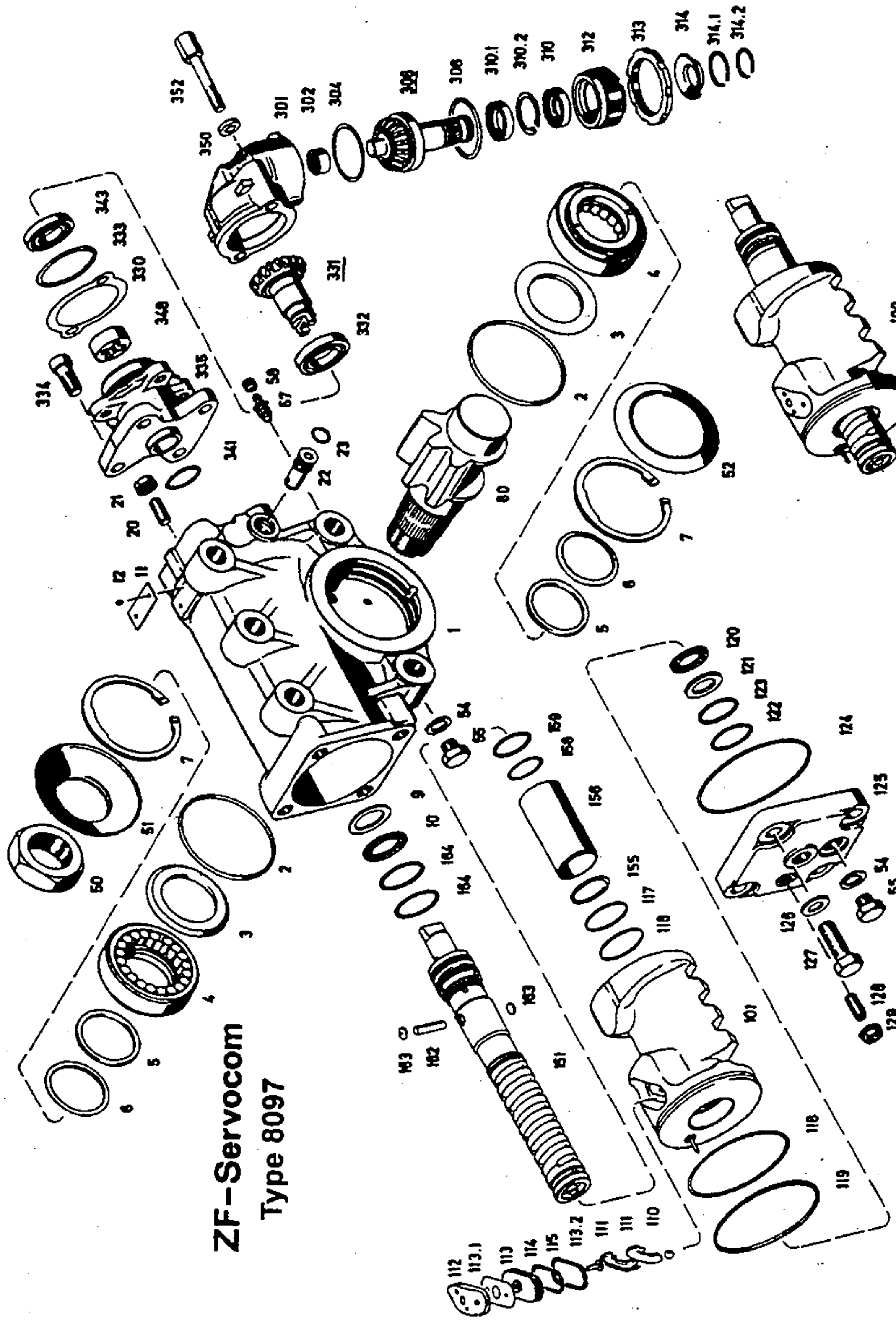
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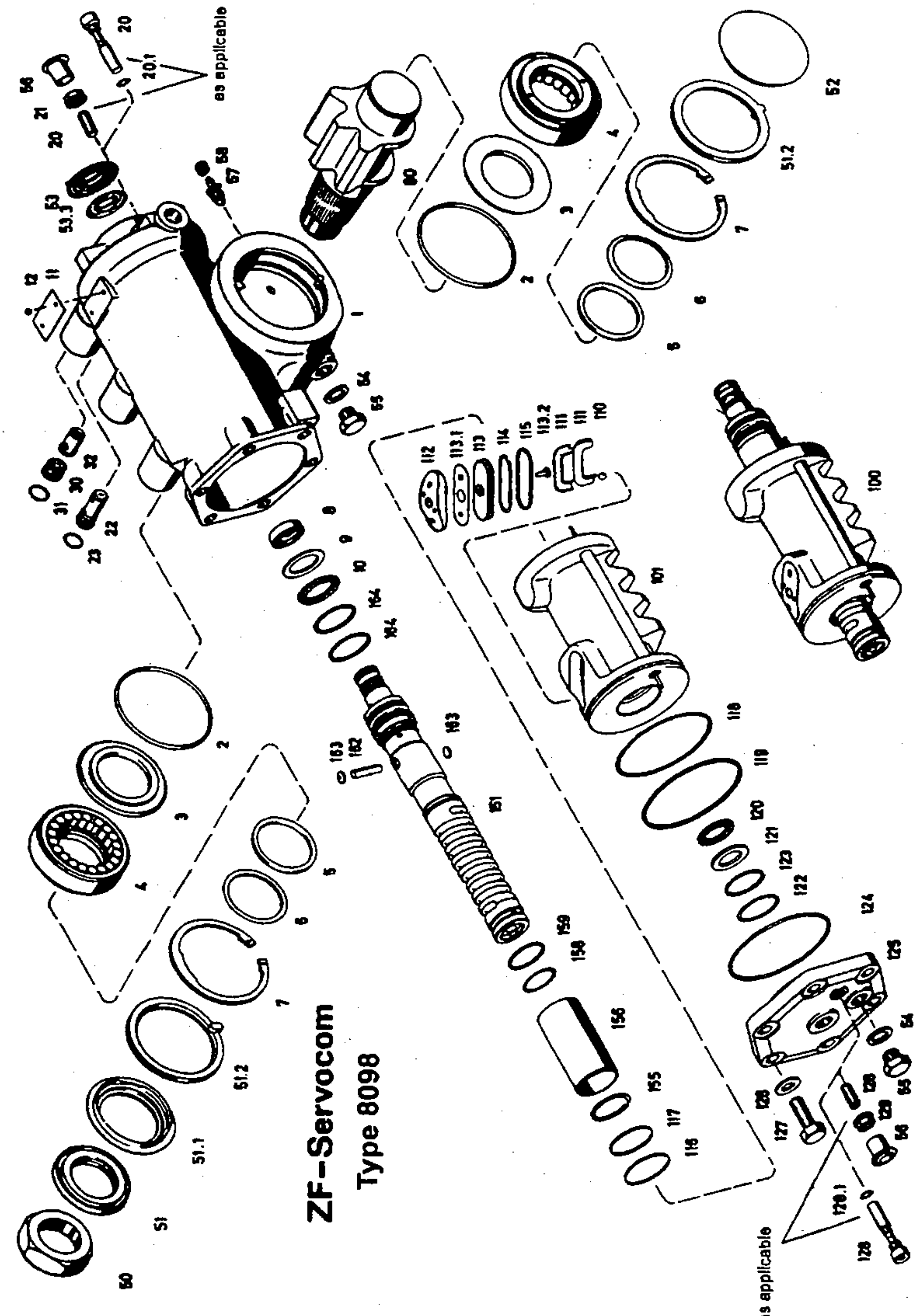
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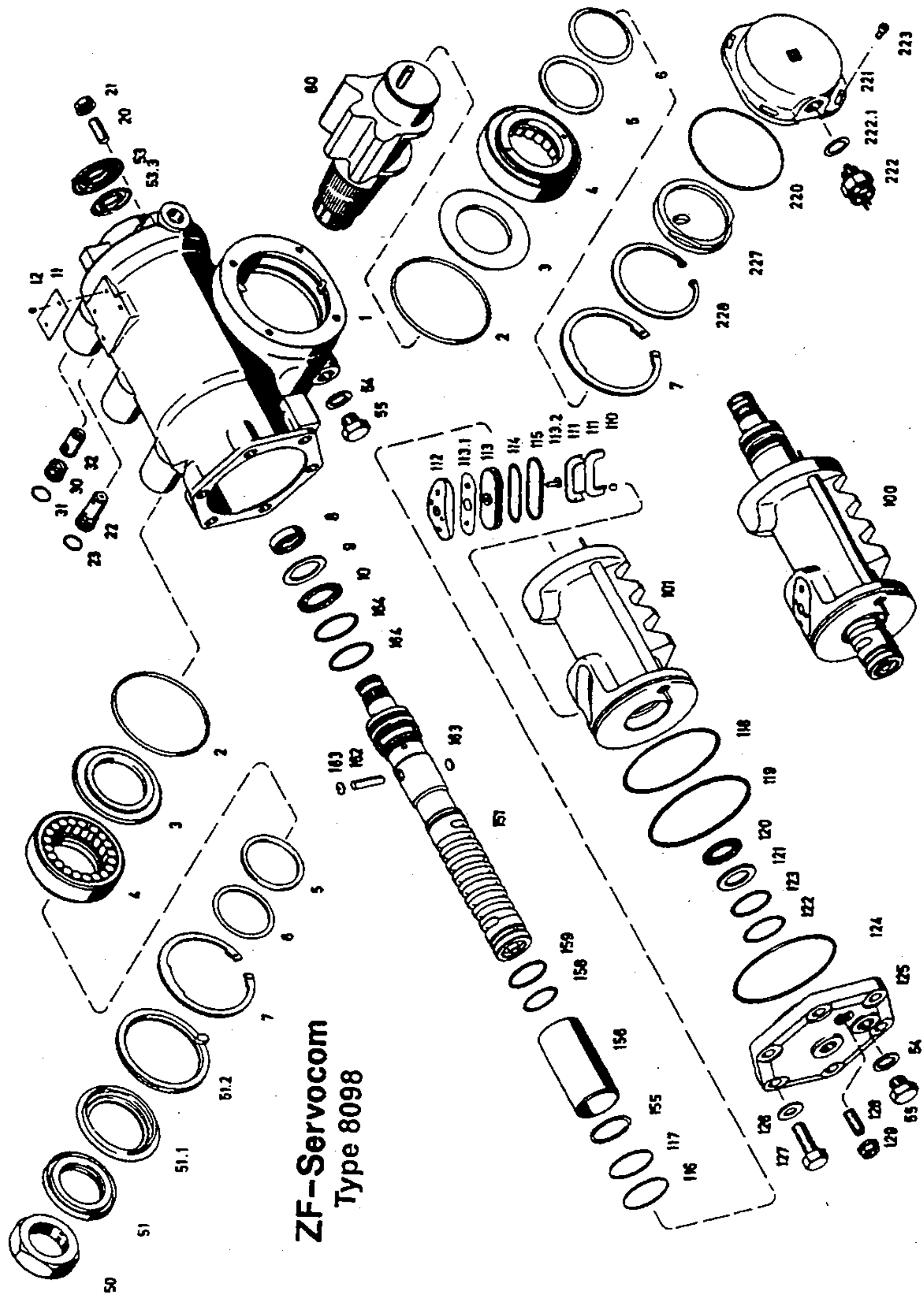
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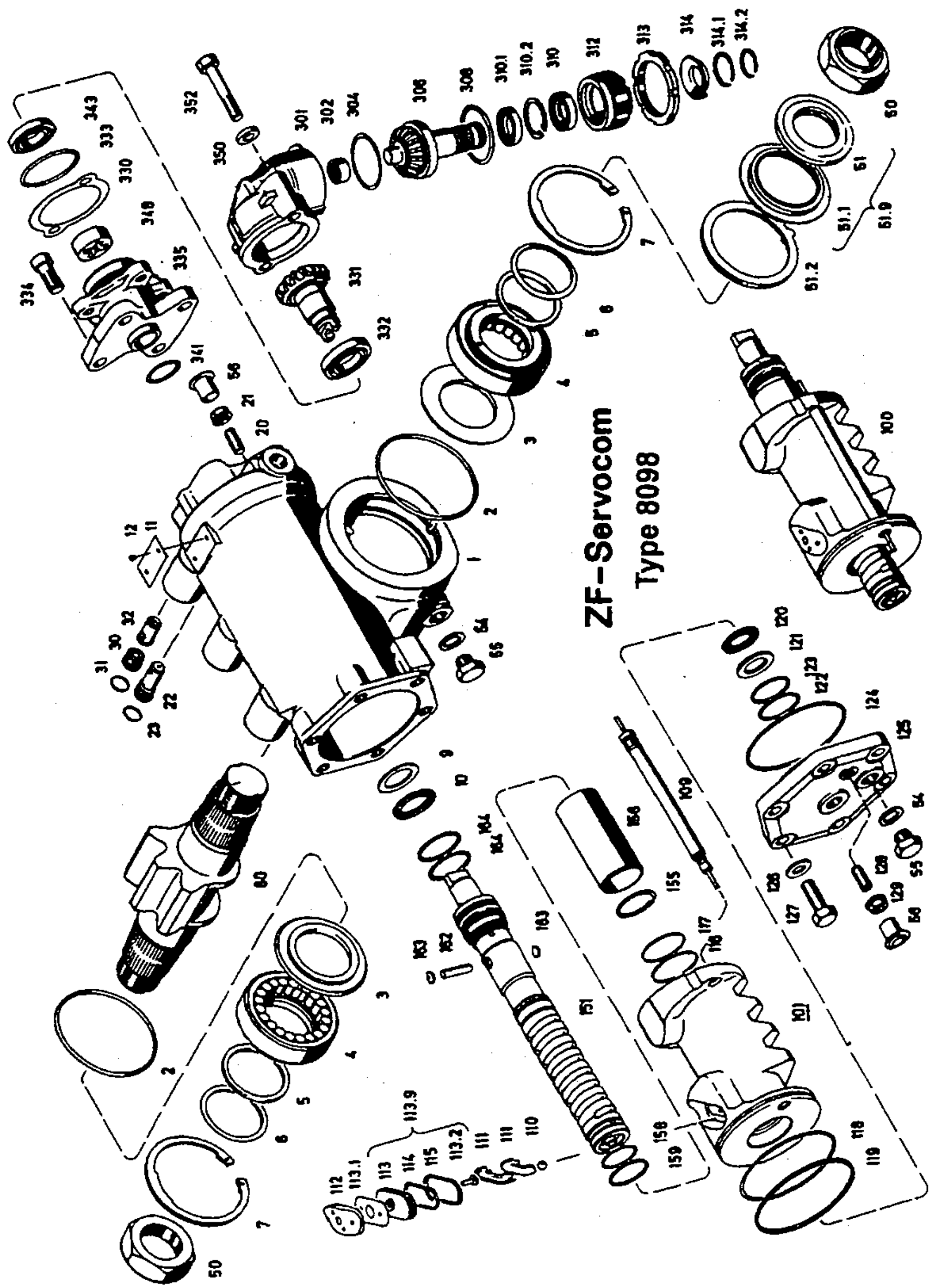
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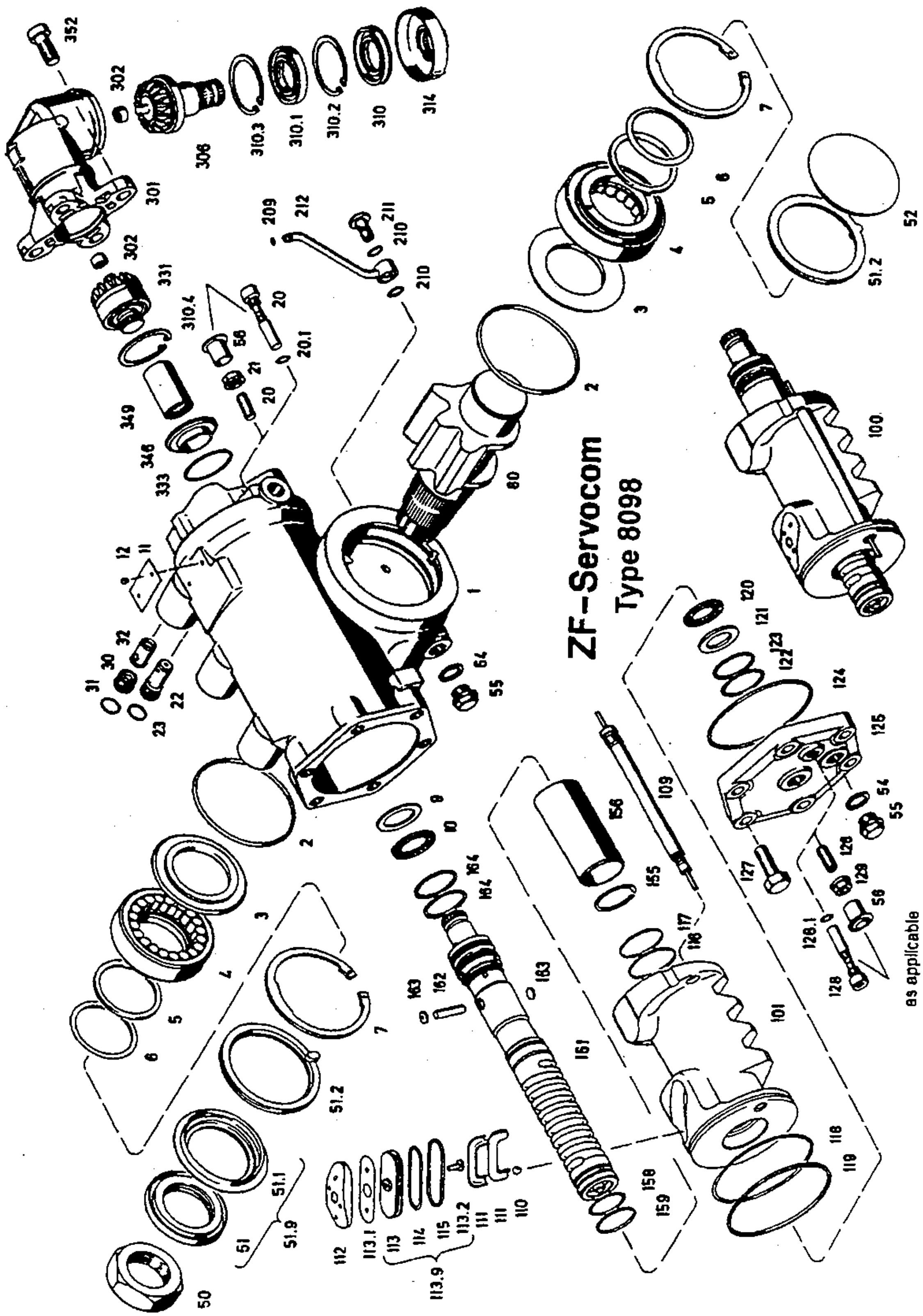
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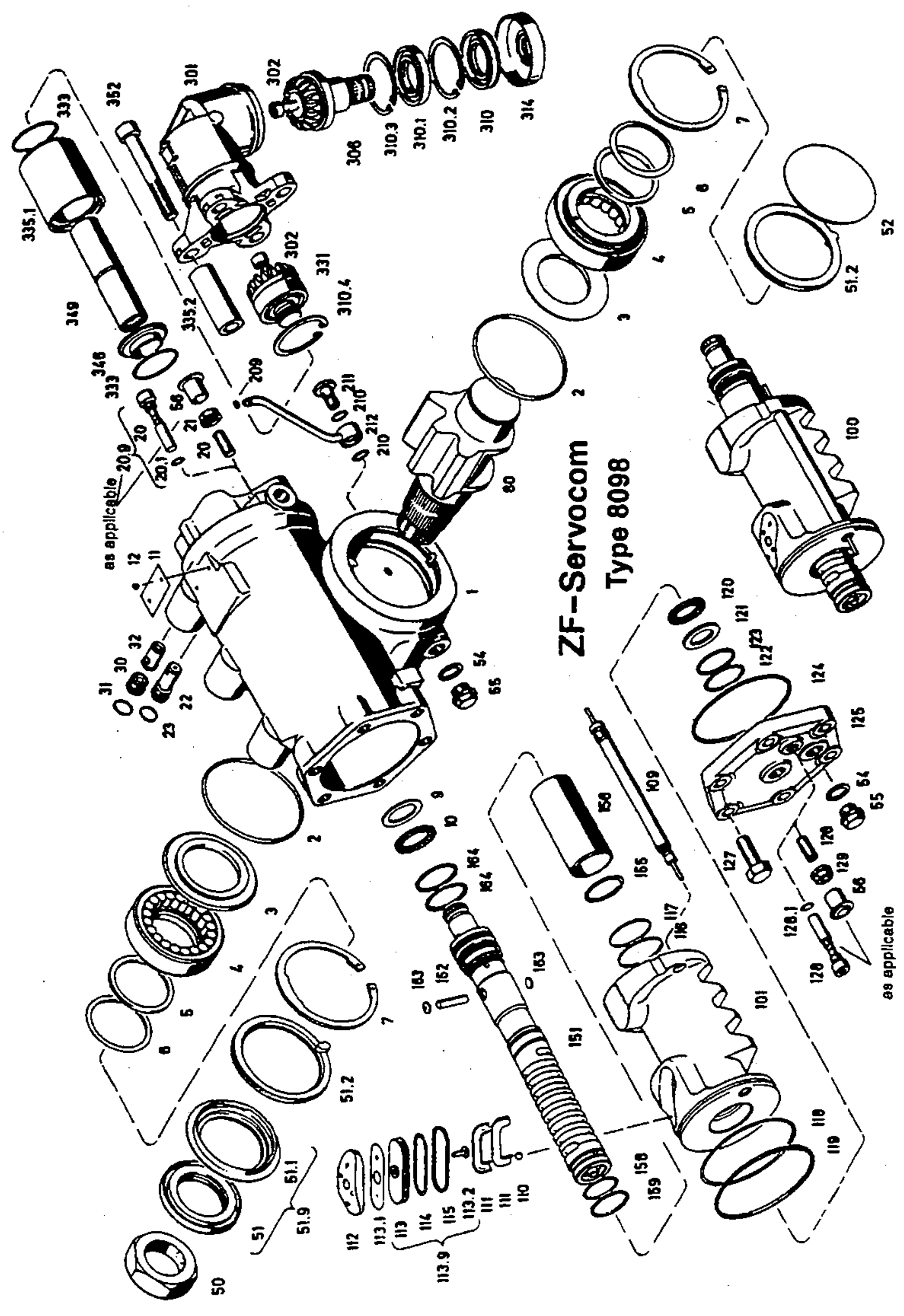
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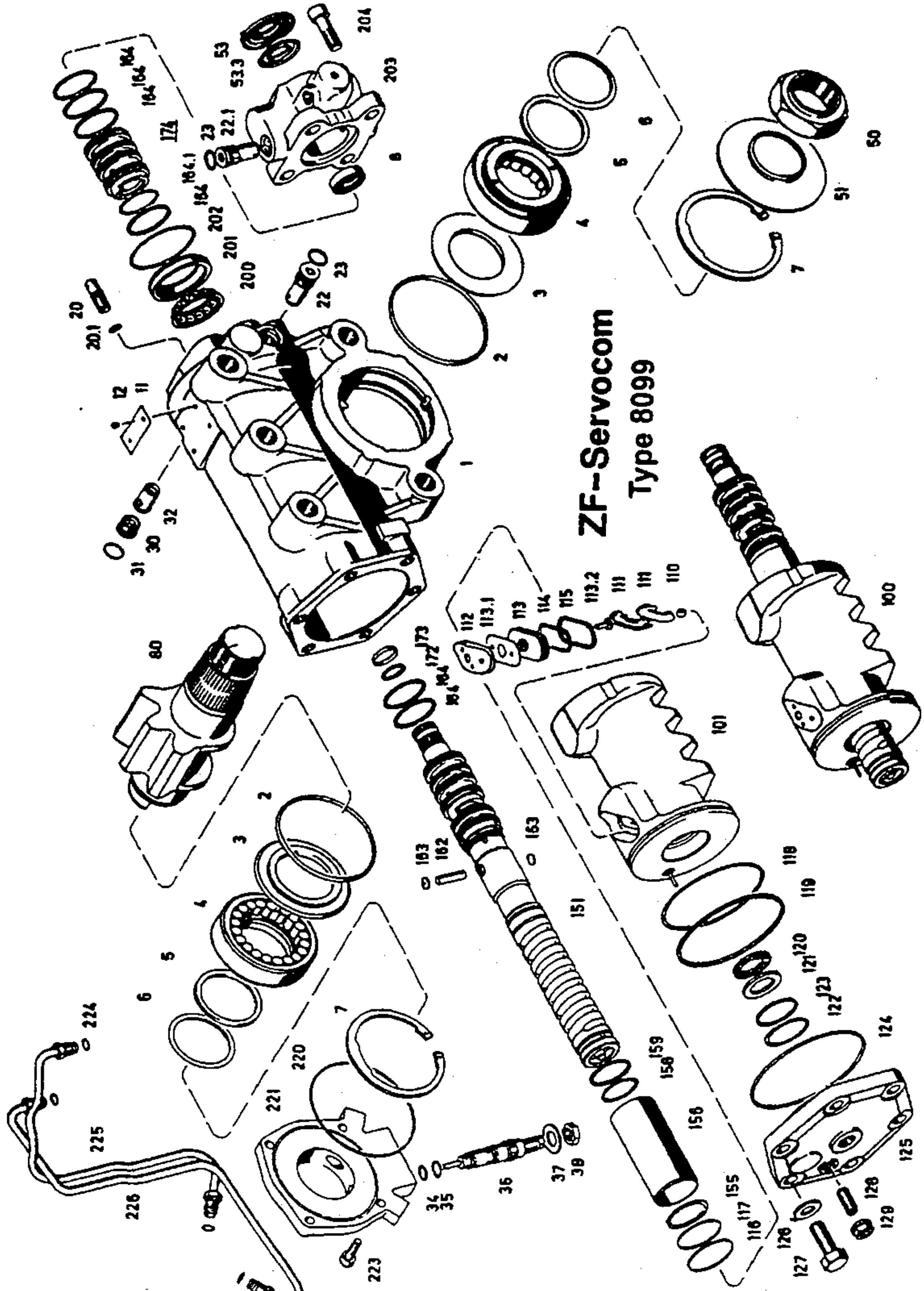
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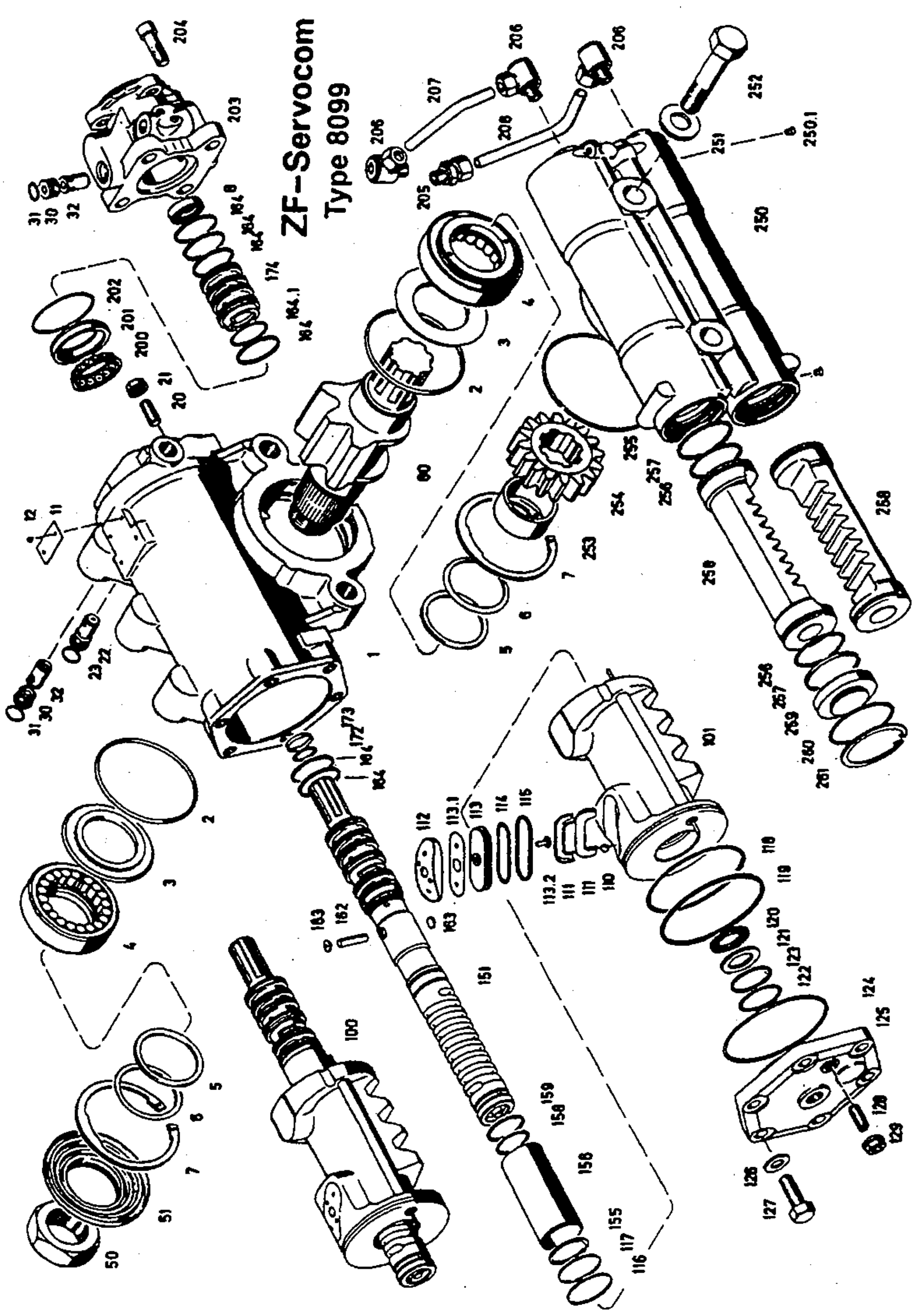
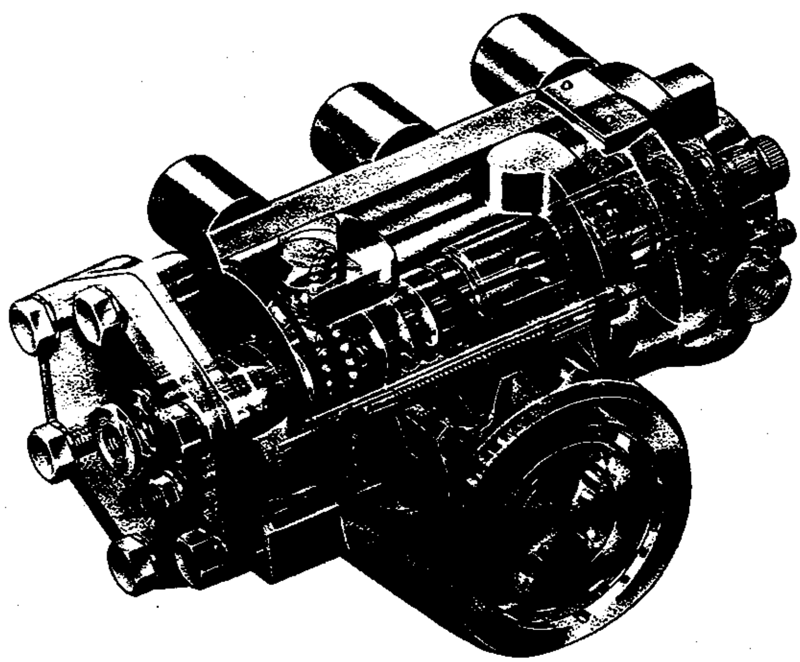

ZF-Servocom
Type 8099

ZF-Servocom®

and ZF Recirculating ball power steering (CV)

Operating, servicing/maintenance and inspection instructions



ZF-FRIEDRICHSHAFEN AG
GESCHÄFTSBEREICH LENKUNGSTECHNIK

D-73522 Schwäbisch Gmünd

Telephone: (07171)31-0 Telefax: (07171)31-4396

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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.

Table of contents:

I. Operation

Attention: important safety information for the driver and workshop personnel

If correctly installed, properly maintained and free of accidents, ZF hydraulic power steering can have a long service life. To ensure complete operativeness, we recommend that the mechanical steering parts are checked (visual examination of all parts, check for cracks in parts under stress) and the seals replaced at the 3rd inspection (does not apply for Servocom steering manufactured after 01.94) (see Section VIII).

The size of the steering and the mechanical steering transmission are selected in consultation with the vehicle manufacturer in such a way that in the event of failure of the hydraulic steering booster, the actuating force to be applied to the steering wheel does not exceed the maximum considered to be reasonable by the law.

Under ECE–R79, this force, which depends on the permissible total weight of the vehicle, is max. 450 N on the steering wheel turn when the vehicle is steered from straight–ahead driving into a circle of radius 20 m. The speed in this case is approx. 10 km/h and the steering action must take no more than 6 seconds.

The driver should know that if the hydraulic power steering suddenly fails, e.g. through failure of the pump drive, his vehicle can still be steered but will require a considerably greater force to be applied for steering. Since such a situation occurs extremely rarely, and then usually completely unexpectedly, the driver may jump to the mistaken conclusion that the steering system is locked. However, this is not the case. The driver must simply apply the necessary force to carry out the steering action.

In order to avoid damage in the steering gear and steering column, the operating force on the steering wheel (diameter 500 mm) when steering while stationary without hydraulic assistance must not exceed 1000 N (approx. 100 kg).

This important safety information is given for the purpose of clarifying the context and preventing the driver making an incorrect diagnosis.

II. Construction and functioning

1 ZF Servocom, Type 8090-98

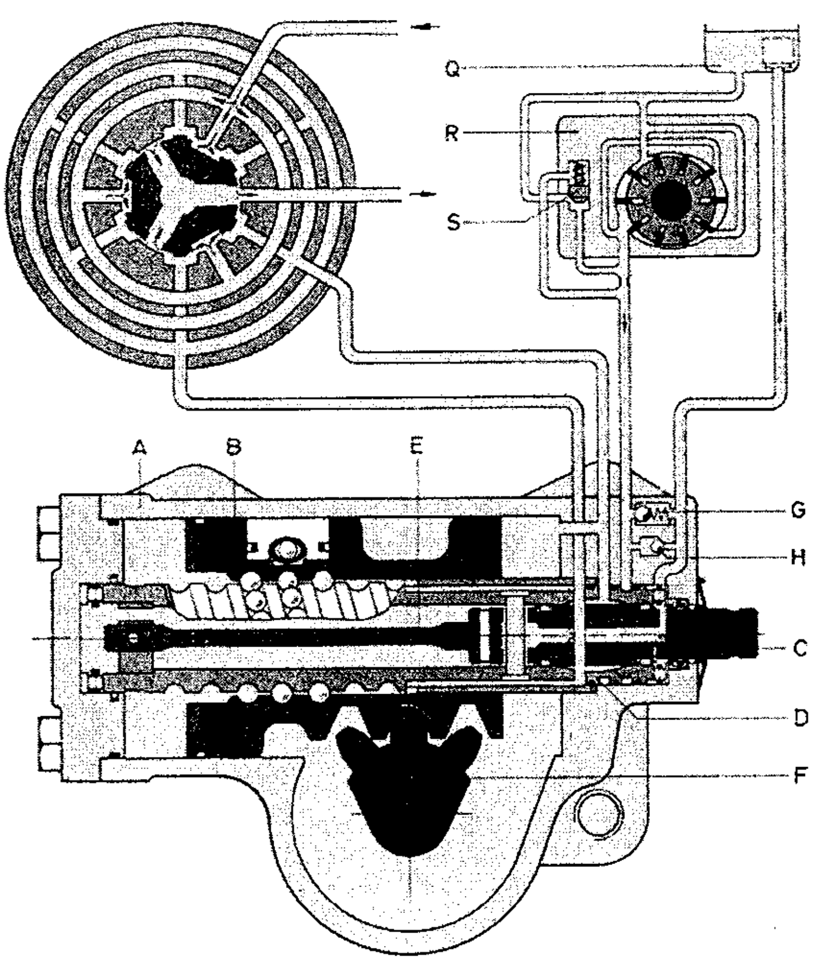
1.1 Construction

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 (A) – see also ***Illus. 1*** – is designed as a cylinder for the piston (B), which converts the rotation of the steering shaft (C) and the worm (D) into an axial movement and transfers this to the steering worm sector shaft (F). The toothings of the sector shaft and piston are 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 (B) and worm (C) 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.



Illus. 1 Valve slide in neutral position

A Housing
B Piston
C Valve slide / steering shaft
D Control sleeve / worm
E Torsion bar
F Steering worm sector shaft

G Pressure relief valve
H Replenishing valve
J Induction port
K Induction port
L Return port
M Return port

N Axial groove
O Axial groove
P Return groove
Q Oil tank
R Wing pump
S Flow control valve

The control valve consists of the valve slide (C) in a needle bearing in the worm, with six control grooves on the circumstance and the control sleeve (D) 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.

A torsion bar (E), which is pinned with the valve slide (C) and the worm (D), 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 (G) which limits the discharge pressure of the oil pump to the maximum value required. A replenishing valve (H) can also be used, through which oil is sucked from the return if steering is not hydraulically boosted.

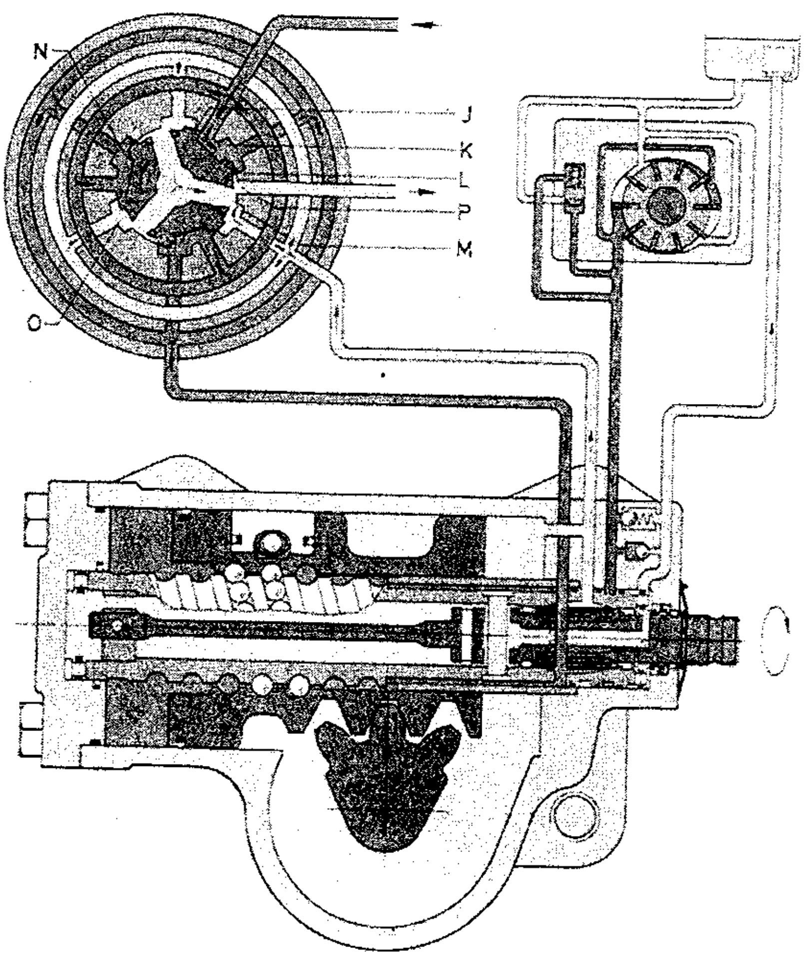
Compared with constant transmission, steering versions with variable transmission are more directly designed in the centre area than outside the centre area. The resulting smaller steering corrections benefit steering behaviour in straight–ahead driving. At the same time, the indirect transmission means 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 toothing with differing modulus and angle of pressure.

1.2 Function

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. The control grooves of the valve slide are thereby displaced from the central (neutral) position compared with the control grooves of the control sleeve.

When the steering wheel is released, the torsion bar ensures that the valve is returned to the neutral position.



Illus. 2
Valve slide in working position
Steering wheel turned in clockwise direction

operating pressure

return flow pressure

J Induction port
K Induction port
L Return port
M Return port

N Axial groove
O Axial groove
P Return groove

The 3 functional diagrams of ***Illus. 1*** to ***3*** show valve and oil flow in a simplified way for ease of comprehension. These diagrams also show the valve in cross–section so that the connections from the control valve to the cylinder compartments and the functioning of the valve can be shown schematically.

The pressure oil flows into the ring–shaped groove of the control sleeve. It is fed to the arch–shaped control grooves of the internal valve slide through three symmetrically arranged radial holes. The position of the control grooves in the valve slide and control sleeve is set in such a way that if the valve is in a neutral position, the pressure oil can run into the axial grooves (N and O) of the control sleeve, which are also arch–shaped, through the induction ports (J and K). From there the oil is released to each side of the working cylinder via radial holes. As long as the steering valve is in the neutral position, the oil can run into both sides of the working cylinder and to the three return grooves (P) in the valve slide, from where it returns to the oil tank.

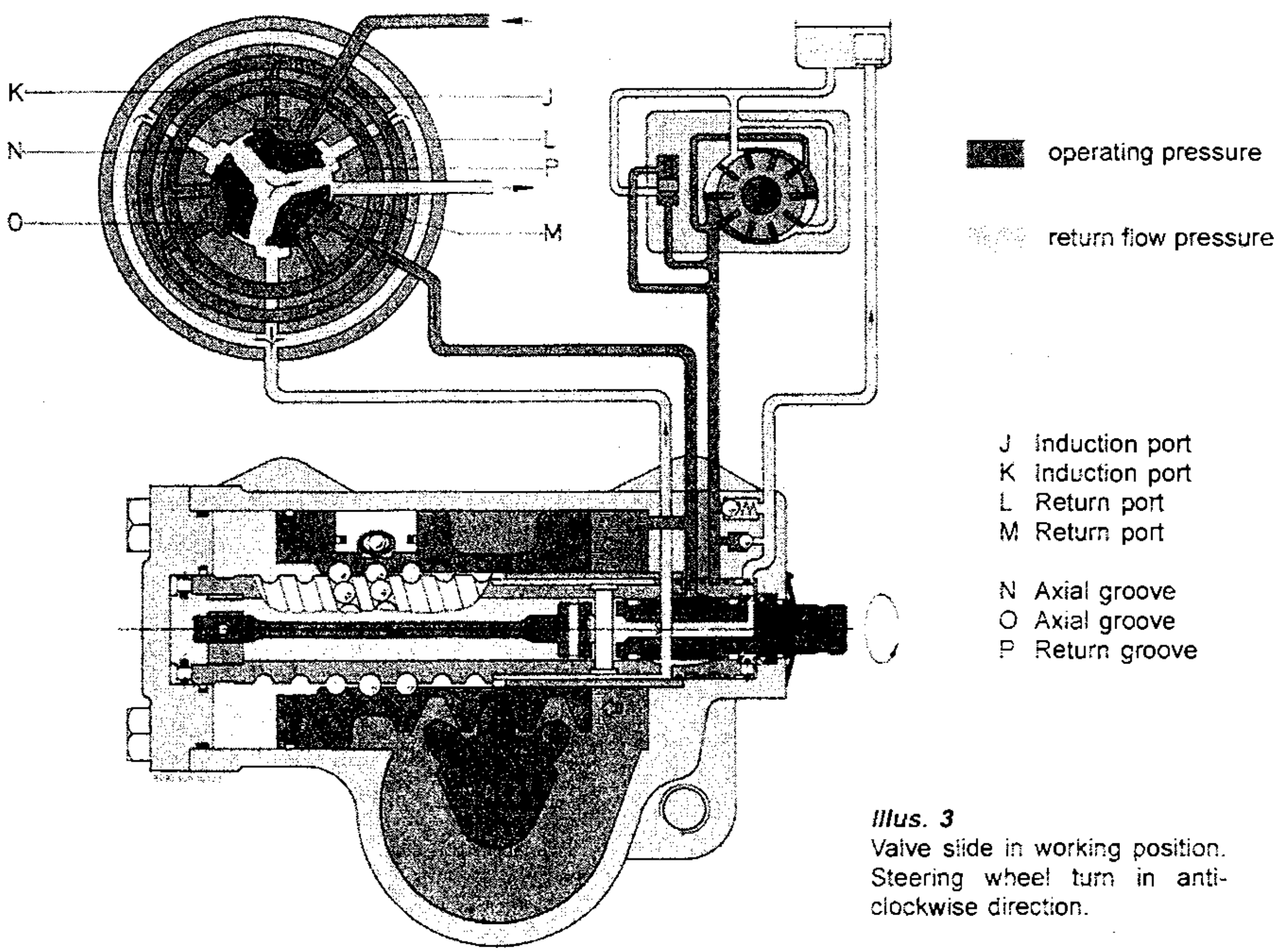
When the steering wheel is turned in a clockwise direction, the piston with a right–handed thread is pushed to the right ***(Illus. 2)***. Since the movement of the piston is to be assisted through pressure oil, the oil must now be directed to the left cylinder side.

The control grooves of the valve slide are pushed in a clockwise direction and the induction ports (K) are opened further for the pressure oil supply. However, the induction ports (J) close and block the supply of pressure oil to the axial grooves (O) and the control sleeves.

In the position of the valve described in ***Illus. 2***, the pressure oil flows through the induction ports (K) into the axial grooves (N) of the control sleeve and from there reaches the left cylinder via the planetary thread, so that piston movement is ensured for the hydraulic assistance. The closed induction ports (J) prevent the oil flowing to the oil tank.

The oil from the right cylinder side is compressed. It flows via the opened return ports (M) to the return grooves (P) of the valve slide. From here constant return to the oil tank is ensured through the centrally positioned oil hole in the valve slide.

If the steering wheel is turned in the opposing direction ***(Illus. 3)***, the piston of the working cylinder moves to the left and should be assisted through pressure oil in the right cylinder. The control grooves of the valve slide are pushed in an anticlockwise direction and let the pressure oil flow through the opened induction ports (J) into the axial grooves (O), from where connection to the right cylinder is established. The oil from the left cylinder flows via the planetary thread and the opened return ports (L) to the return grooves (P) of the valve slide. Access to the oil tank is open via the centrally positioned oil hole in the valve slide.



J Induction port
K Induction port
L Return port
M Return port

N Axial groove
O Axial groove
P Return groove

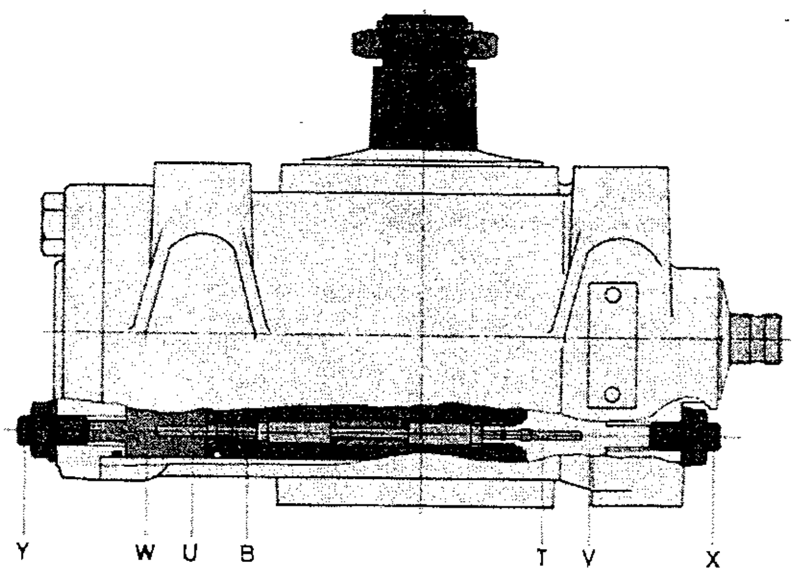
Illus. 3
Valve slide in working position. Steering wheel turn in anticlockwise direction.

1.3 Functioning of the hydraulic steering limiter

The hydraulic steering limiter prevents steering to the wheel locks at full hydraulic pressure. It serves to protect the pump and steering linkage and prevents high oil temperatures.

A double–acting steering limiter valve with spring–weighted valve pins (T and U) extending beyond the right and left piston faces is located in the piston (B) along its longitudinal axis *(Illus. 4)*.

Illus. 4 Steering limiter valves closed



T right valve pin of steering limiter valve
U left valve pin of steering limiter valve

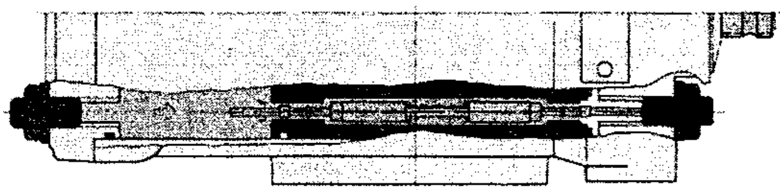
V right cylinder compartment
W left cylinder compartment

X right setting screw
Y left setting screw

When the piston is pushed to the right or left towards the final stop, the valve pins (T and U) are actuated by the setting screws (X and Y) fixed in the housing and cylinder cover. The steering limiter valve remains closed until a valve pin contacts the setting screw.

When the piston moves to the right, for example *(Illus. 5)*, the right valve pin (T) contacts the setting screw (X) before the piston limit position is reached. The valve pin (U) is thereby pushed by the pressure oil, whereby the oil flows from working cylinder compartment (W) into working cylinder compartment (V) and can reach the return. If the piston moves to the left, the process is reversed.

Illus. 5 Piston moves to the right. Right valve pin opened. Oil pressure greatly reduced.



reduced operating pressure — return flow pressure

When the steering limiter valve is opened, the steering can continue to be turned with increased force and greatly reduced hydraulic assistance up to the wheel lock or the stop in the steering.

1.4 Setting the mechanically adjustable hydraulic steering limiter, type 8090–98

Note:
In principle, the hydraulic steering limiter is first set by the manufacturer in the test bay according to the engineering instructions of the vehicle companies.
Further setting is carried out after the steering has been installed in the vehicle and in the prescribed inspections by means of a manometer. Adhere to the setting instructions of the vehicle manufacturer.

Setting the hydraulic steering limiter in vehicles using a manometer:

A manometer (pressure range up to 250 bar or hydraulic steering tester) is screwed into the pressure line between the pump and the steering system ***(Illus. 6)*** and the steering axle, if designed as a rigid axle, is relieved through jacking–up.

Attach jack to axle. If the vehicle has independent suspension, the steered wheels must stand on rotary tables for setting of the hydraulic steering limiter; in any case, the steering axle must be loaded in order to compensate approximately for possible deflection errors in measurement.

Turn steering up to wheel lock with engine running at idle speed, oil temperature of steering system above **50°C or 30°C**, without exerting great force.

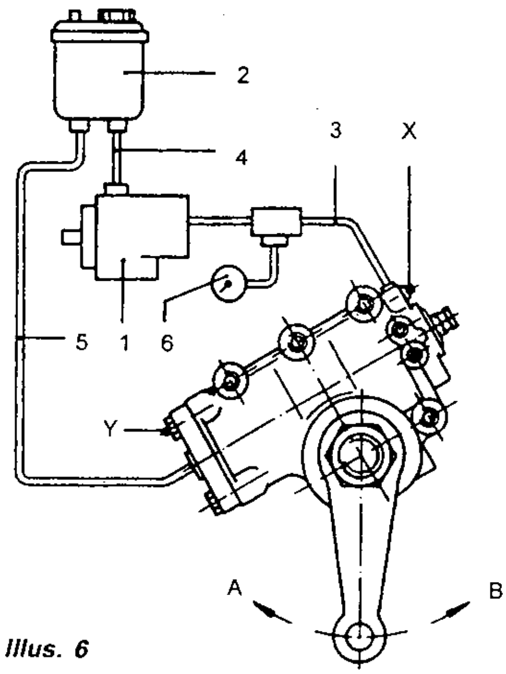
Once the wheel lock has been reached, a brief (max. 5 seconds) continued turning of the steering wheel will overcome the self–aligning force of the steering valve until a fixed steering wheel lock is achieved.

An actuating force on the steering wheel of 100 – 200 N is required to do this.

If the steering limiter is set correctly and the flow rate while the engine is at idle speed does not exceed 16 dm^3/min, e.g. with steering systems with an additional working cylinder, the manometer must now show an oil pressure of

40 to 45 bar at an oil temperature of 50°C, or
45 to 50 bar at an oil temperature of 30°C.

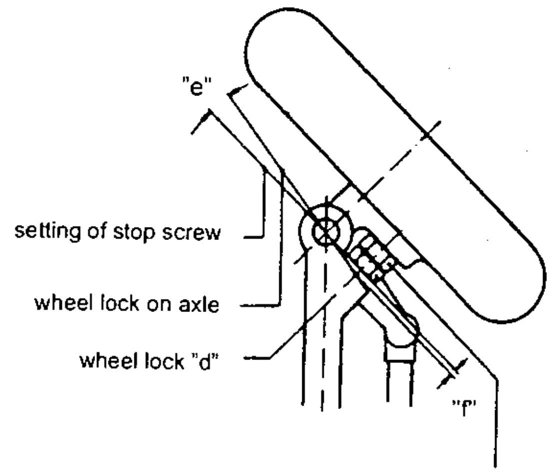
The vehicle manufacturer may prescribe a mode of setting that differs from the abovedescribed (e. g. insertion of a spacer), ***see Illus. 26***.



Illus. 6

X Setting screw of hydraulic steering limiter for steering arm deflection in direction "A"

Y Setting screw of hydraulic steering limiter for steering arm deflection in direction "B"



Illus. 7

Illus. 7 shows the distance "f" which should exist between the wheel lock parts upon response of the hydraulic steering limiter, provided that the vehicle manufacturer prescribes a distance

1 Pump
2 Oil pump
3 Pressure line
4 Suction line
5 Return line
6 Manometer

If the above examination shows that the desired pressure drop has not been achieved, the reason may be that the flow rate is too great (above 16 dm^3/min) or the oil temperature too low. In this case the flow rate of the pump with the engine at idle speed must be measured or the oil temperature increased. For steering systems with higher flow rates, the following setting values apply:

above 16 dm^3/min:	50 to 55 bar at 50°C
	55 to 60 bar at 30°C
above 20 dm^3/min:	70 to 75 bar at 50°C
	75 to 80 bar at 30°C

To make corrections, release the corresponding lock nut and screw the setting screw (X or Y) in or out ***(Illus. 6)***. Release the steering wheel at the same time, so that only the flow pressure builds up during this operation. Then tighten lock nut with 30 Nm.

Attention:
During the setting as soon as in the installed condition it must be secured that the setting screws (x and y) are at least screwed in 3 pitches. Otherwise the caution is present that the screws will be exploded out in the case of maximum pressure.

The second wheel lock is set in a similar fashion.

The setting screw (X) in ***Illus. 6*** must be adjusted if the steering column is moved towards "A" according to ***Illus. 6***. In the same way, setting screw (Y) is adjusted if the steering column turns towards "B".

After this setting, the hydraulic assistance should be active until the wheel lock is reached. To check the setting appropriately, turn the steering wheel, while driving the vehicle slowly and under normal load, until the hydraulic assistance is disconnected.

If the pressure falls too early or too late when the steering column is turned towards "A" or "B", the setting screws (X or Y) must be twisted as described below.

If a higher pressure is measured, the corresponding setting screw must be **screwed in** again (clockwise).

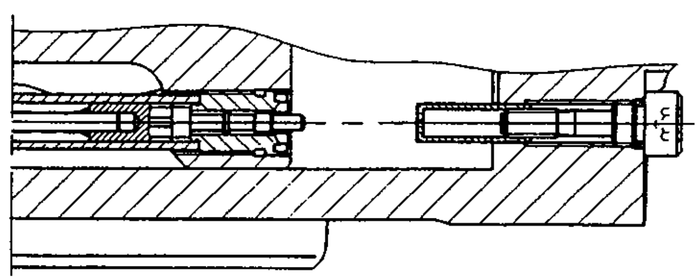
If a lower pressure is measured, the corresponding setting screw must be **screwed out** again (anticlockwise).

Check:
To check this setting appropriately, turn the steering wheel, while driving the vehicle slowly and under normal load, until the hydraulic assistance is disconnected.

1.5 Automatically adjustable hydraulic steering limiter, type 8090–98 (visible externally by hexagon instead of lock nut)

Attention:
Steering systems with automatically adjustable steering limiters must not be mechanically turned to the limit positions if the steering linkage has been removed or the system dismantled. The sliding sleeves would then be pushed into the maximum possible cut–off position and automatic setting in the vehicle would only be possible with new sliding sleeve assemblies (X or Y) ***(Illus. 8)***. If necessary, fit new sliding sleeve assemblies.
Sliding sleeve assemblies and normal setting screws are not interchangeable.

Illus. 8 Starting position of sliding sleeves not yet set



1.5.1 Functioning of automatically adjustable hydraulic steering limiter

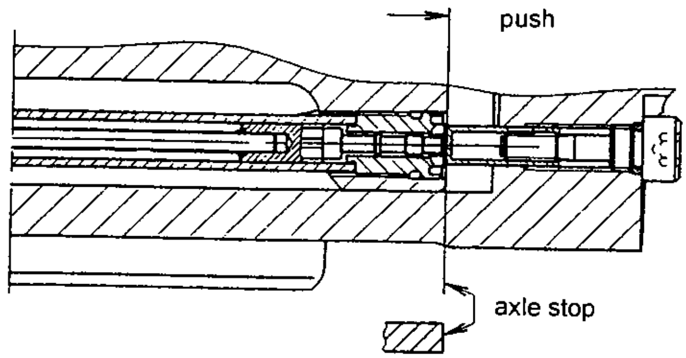
With the automatically adjustable hydraulic steering limiter, screws (X and Y) with pressed–on sliding sleeves are located in place of setting screws.
These function in the same way as with the manually adjustable hydraulic steering limiter. In the limit positions, the valve piston tappets meet the sliding sleeves and open the steering limiter valves (U and T). The opening point is determined by the position of the sliding sleeves on the screws.

1.5.2 Setting

Note:
Setting ***(Illus. 9)*** is only possible after the steering system has been installed in the vehicle. The steering linkage and the axle stops must be mounted and set.

Illus. 9 Setting process

Positioning the sliding sleeves

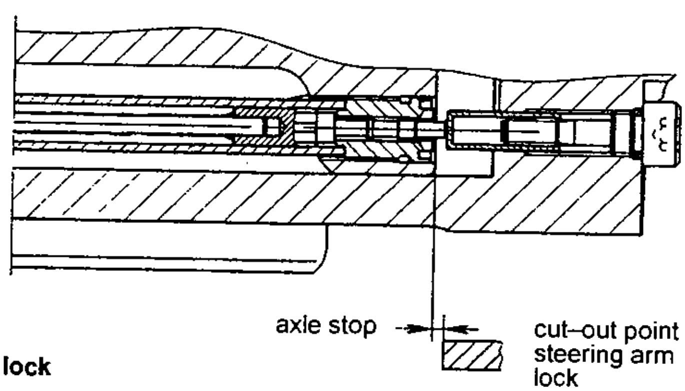


When the above conditions have been met, the steering wheel must be turned to the maximum wheel lock with or without hydraulic assistance. This causes the piston to push the sliding sleeve on the screw to the cut–out position *(Illus. 9)*. The steering limiter valve is permanently open during this setting process, which is why the steering wheel can only be turned with increased force whether or not there is hydraulic assistance. In order to allow mechanical steering and roughly compensate for errors of deflection which may occur in measurement, for vehicles with independent suspension the steered wheel must be on rotary plates; if the steering axle is designed as a rigid axle, it is sufficient to support the axle with a jack. The steering axle must be loaded in any case.

This process must be carried out in both directions of rotation until a fixed stop has been reached. The sliding sleeves are automatically returned to the correct cut–out position *(Illus. 10)*.

Illus. 10

Left steering limiter valve open, oil pressure greatly reduced



1.5.3 Correcting the steering arm steering lock

To **increase the steering arm steering lock** (the space between the wheel lock parts is too great): carry out setting as described above.

To **reduce the steering arm steering lock** (the oil pressure at the axle stop does not fall to the value given in Section II Para. 1.4):

Fit new sliding sleeves assembly (20 or 128) ◻.

Attention:
It is not permitted to pull the sliding sleeve back to the press fit of the screw.

Tightening torque for sliding sleeve assembly: 15^{+3} Nm.

◻ The numbers in square brackets refer to the key to numbers in figures at the end of the instructions.

2 ZF recirculating ball power steering systems, type 8033–46

2.1 Construction:

The housing contains a control valve, working cylinder and a complete mechanical steering gear. The pressure oil for the steering is delivered by a motor–driven pressure oil pump which is supplied with oil from an oil tank. The housing (1 or A) is designed as a cylinder for the piston (2 or B) which carries out the task of converting the rotation of the steering shaft into an axial movement and transferring this to the steering worm sector shaft (5 or D). To ensure perfect power transmission, the toothing of the sector shaft is designed in such a way that when the shaft transverse to the piston is adjusted axially, any possible backlash is eliminated. This free play is adjusted using a setting screw and this can be carried out in the vehicle (see Section IV).

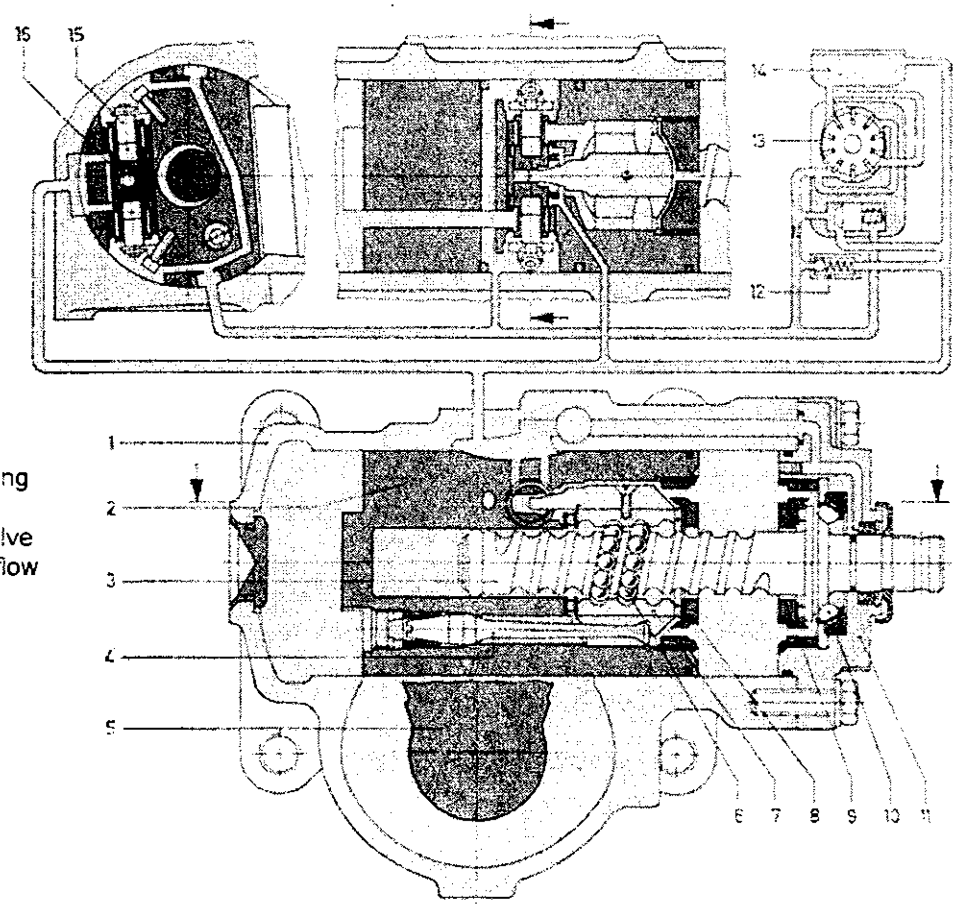
The threaded hole of the piston is connected to the worm (3 or E) via a ball chain. When the worm is turned, the balls (6 or F) on one end of the chain are taken up by a circulating pipe and fed back to the other end, thus forming an endless ball chain. The control valve is transverse to the piston. It comprises a valve piston (16) and two fixed recoil pistons (15). One finger of the steering nut (7) meshes with great accuracy into the hole of the valve piston.

2.2 Functioning:

In order to obtain hydraulic assistance while steering, which should be started when the steering wheel is turned, the valve piston must be displaced from the neutral position.

Illus. 11

Recirculating ball power steering, type 8043, steering valve centralised through flexible rod, neutral position



1 Housing
2 Piston
3 Worm
4 Flexible rod
5 Sector shaft
6 Balls
7 Steering nut
8 Threaded ring
9 Threaded ring
10 Angular ball bearing
11 Cover
12 Pressure relief valve
13 Wing pump with flow control valve
14 Oil tank
15 Recoil piston
16 Valve piston

The valve is kept in the neutral position by means of a spring element which may, according to design, be a centralizing spring, a leaf spring or a flexible rod. For this reason force must be applied in order to overcome the pretension.

The piston, interlocked with the sector shaft and the steered wheels, resists any rotary motion. During steering, the steering nut is therefore stressed via the worm and ball chain in the circumferential direction and the elastic threshold overcome. The pressure oil flowing into the steering housing from the motor–driven pump is then directed into the cylinder from which the steering process is being hydraulically assisted.

The pressure oil flows laterally underneath the valve into a longitudinal groove of the piston. To provide a balance of pressure, it is led into an equally large longitudinal groove on the opposite side and passes through transverse holes to reach the faces of the valve piston which are separated from the cylinders by seals. With the valve in a neutral position, the oil flows towards the centre of the valve piston after flowing through feed and return leading edges and from there upwards into a recess of the piston through the corresponding holes. From here it flows out into the return ***(Illus. 11)***. When the valve is displaced, the pressurized side of the piston is separated from the return and the opposite side of the cylinder is connected with the return. The steering valve is fitted with 2 recoil pistons, whose function is to make it more difficult to displace the valves from the neutral position through the oil pressure. The actuating force on the steering wheel thus rises in proportion to the forces acting on the wheels. Steering systems in which a proportional rise of the actuating force is only desired up to a predetermined oil pressure are fitted with an actuating force limiting valve. The valve fitted in the recoil valve ensures that the force on the steering wheel does not rise much further after the cut–off pressure has been reached.

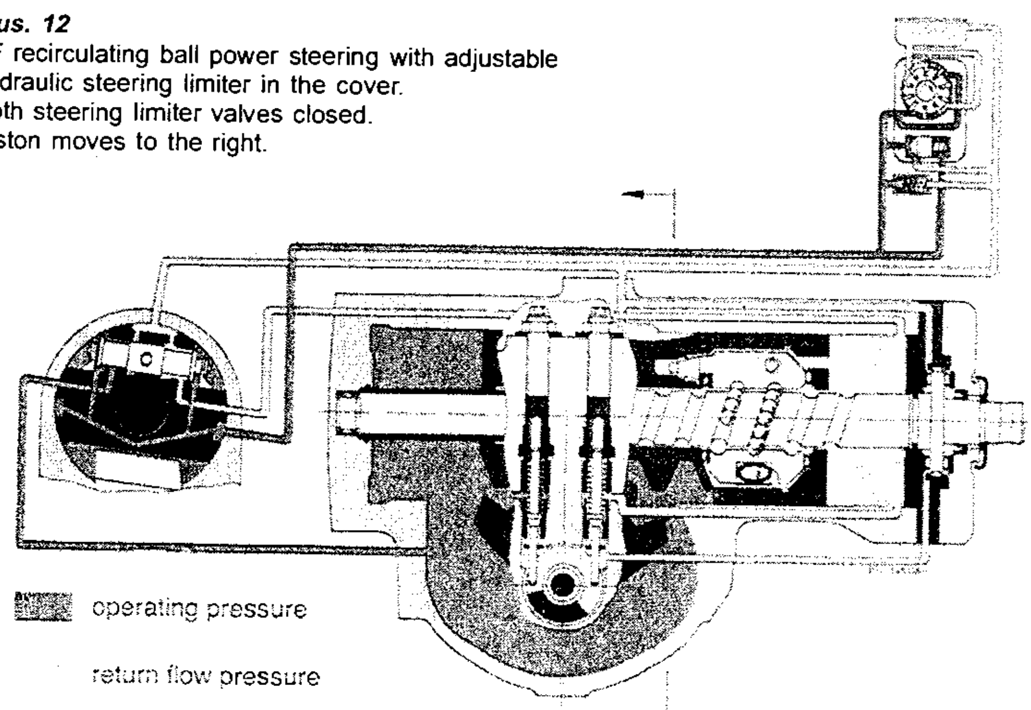
Action of the recoil pistons:
These have a floating bearing in the hole of the valve piston. But they are held axially and secured through connection with retaining plates. The outer faces of both pistons are constantly charged with pressure oil, whereas only one of the inner faces in the working position of the valve is charged with pressure oil. The same applies for the faces in the holes of the valve piston. This produces a force which tries to bring the valve piston back into the neutral position. This property is called "hydraulic reaction".

2.3 Functioning of the hydraulic steering limiter

2.3.1 Adjustable steering limiter

The housing cover is fitted with two valves (55), in each of which 1 valve piston is guided ***(Illus. 12)***. Both valve pistons are actuated by the cam located on the face of the sector shaft. When the sector shaft is turned, the valves remain closed until the cam of the sector shaft meets a valve piston, lifts it and thereby opens the valve ***(Illus. 13)***. The pressure oil of the left cylinder flows through a hole in the housing cover to the left valve, while the pressure oil of the right cylinder reaches the right valve through a hole in the housing.

Illus. 12
ZF recirculating ball power steering with adjustable hydraulic steering limiter in the cover.
Both steering limiter valves closed.
Piston moves to the right.

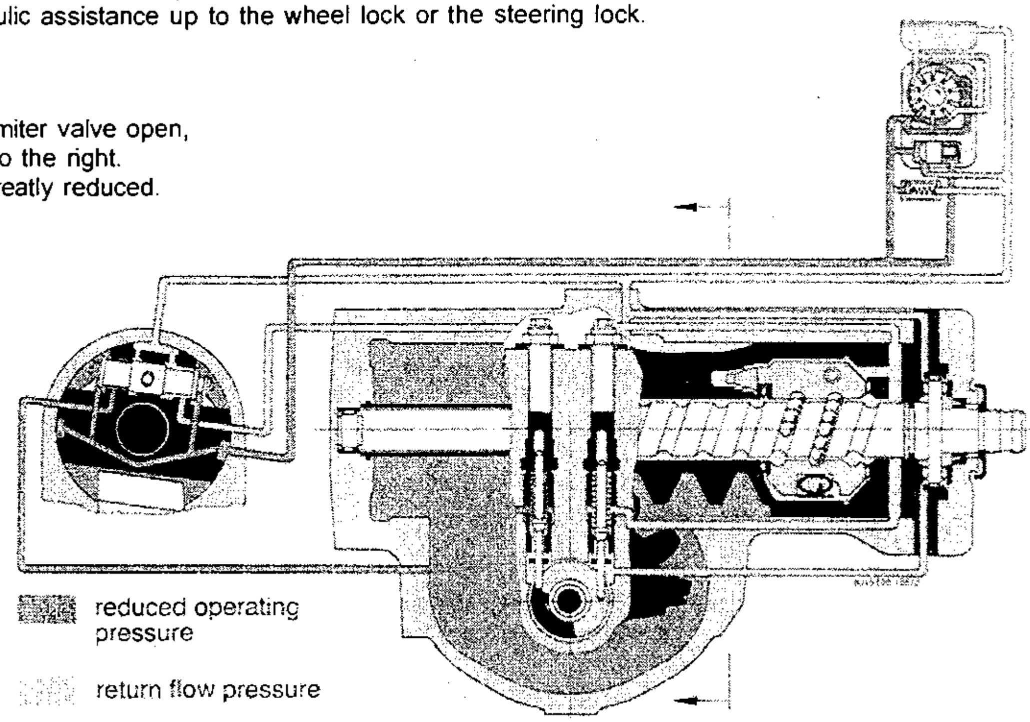


When the sector shaft is turned in a clockwise direction (see ***Illus. 13***, piston moves to the right), the left valve piston is actuated according to a defined steering arm lock, which can be altered by screwing the valve in or out. The pressure oil can then flow through the valve seat from the left cylinder to the return. The position of the steering valve is not changed. The right steering limiter valve remains closed during this process.

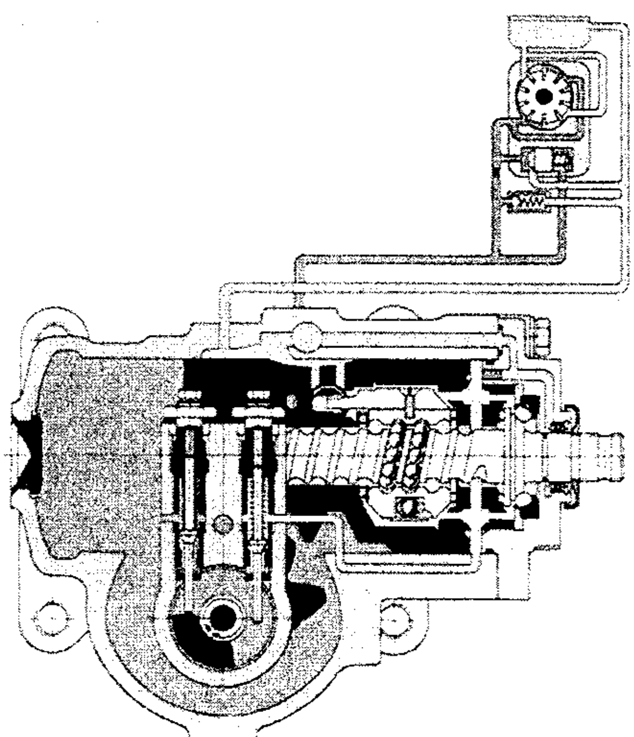
When the sector shaft is turned in an anticlockwise direction, the right valve opens according to a predetermined path, so that the pressure oil can flow from the right cylinder to the return.

If the steering limiter valve is open, the steering can be turned further with increased force and greatly reduced hydraulic assistance up to the wheel lock or the steering lock.

Illus. 13
Left steering limiter valve open,
piston moves to the right.
Oil pressure greatly reduced.



Illus. 14
Recirculating ball power steering, type 8043.
Oil is fed to unpressurized cylinder compartment via two steering limiter valves.



When the left valve piston is actuated, the pressure oil flows out of the left cylinder into the compartment below the steering limiter valve. The oil pressure building up there lifts the right valve piston from its seat against the spring resistance and permits access to the right cylinder compartment connected with the return.

2.3.2 Non–adjustable steering limiter

a) Steering version 8036 and 8038

The piston head is fitted with a ball valve which is always closed because of the oil pressure in the left or right working cylinder. Not until just before the piston reaches the housing on the left or the worm on the right is the valve actuated by a pin and pressure oil allowed to flow to the return.

b) Steering version 8033 and 8037

When the piston moves to the left, the pressure oil can flow into the housing return channel before the stop is reached via a piston hole located at right angles to the piston axis. When the piston moves to the right, the edge of the piston head releases the return channel in the housing.

2.4 Setting the hydraulic steering limiter, type 8033–46

Note
In principle, the hydraulic steering limiter is first set by the manufacturer in the test bay according to the engineering instructions of the vehicle companies.
Further setting is carried out after the steering is installed in the vehicle and on the prescribed inspections by means of a manometer. Adhere to the setting instructions of the vehicle manufacturer.

Setting the hydraulic steering limiter in the vehicle using a manometer:

A manometer (pressure range up to 250 bar or hydraulic steering tester) is screwed into the pressure line between the pump and the steering gear ***(Illus. 15)***. The steering axle, if designed as a rigid axle, is relieved through jacking. Adhere to instructions of the vehicle manufacturer. If the vehicle has independent suspension, the steered wheels must stand on rotary tables for setting of the hydraulic steering limiter; in any case, the steering axle must be loaded in order to compensate roughly for possible deflection errors in measurement. Without exerting great force, turn steering up to wheel lock with engine running at idle speed, oil temperature of steering system above 50°C.

Once the wheel lock has been reached, a brief (max. 5 seconds) continued turning of the steering wheel will overcome the resetting force of the steering valve until a fixed steering wheel lock is achieved. To reach this, and depending on the size of the hydraulic reaction, a peripheral force on the steering wheel of approx. 100 – 200 N is required. If the steering limiter is set correctly, the manometer must now show an oil pressure of between **30 and 35 bar**. To make corrections, release the lock nut (a1 or b1) and screw the corresponding valve sleeve (a2 or b2) in and out. Release steering wheel at the same time, so that only the flow pressure builds up during this work. Then tighten lock nut a1 or b1.

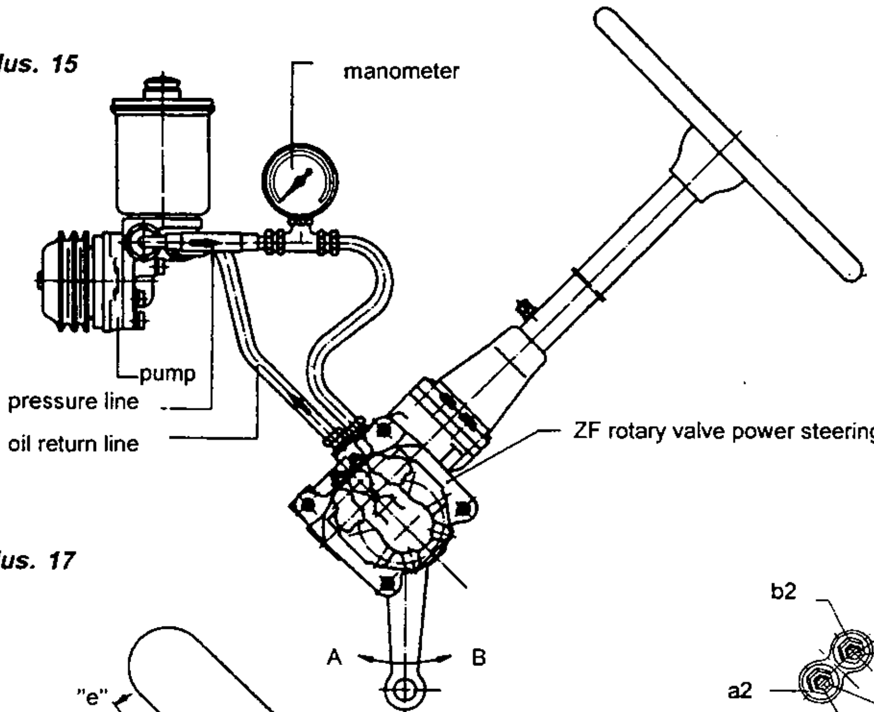
Tightening torque for lock nut: 25 to 35 Nm.

The second wheel lock is set in a similar fashion. The valve (a2) and lock nut (a1) in ***Illus. 16*** must be adjusted if the steering arm is moved towards "A" according to ***Illus. 15***. In the same way, valve (b2) and lock nut (b1) are adjusted if the steering arm turns towards "B".

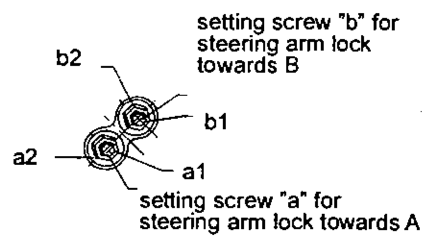
The vehicle manufacturer may prescribe a mode of setting that differs from the abovedescribed (e. g. insertion of a spacer), ***see Illus. 26***.

After this setting, the hydraulic assistance should be active until the wheel lock is reached. To check the setting appropriately, turn the steering wheel, while driving the vehicle slowly and under normal load, until the hydraulic assistance is disconnected.

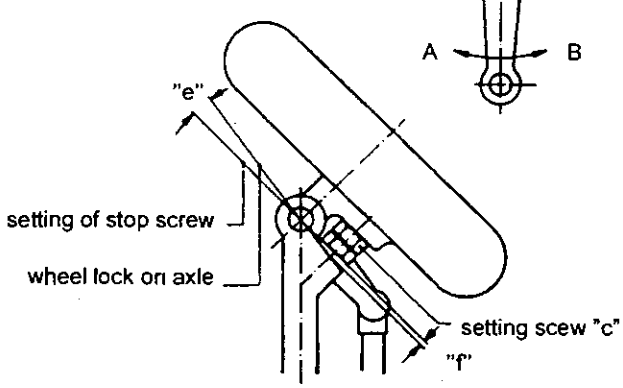
Illus. 15



Illus. 16



Illus. 17



Illus. 17 shows the distance "f" which should exist between the wheel lock parts upon response of the hydraulic steering limiter, provided that the vehicle manufacturer prescribes a distance.

In this position a distance should exist between the wheel lock parts ***(see Illus. 17)***, provided that the vehicle manufacturer prescribes a distance.

If the pressure falls too early or too late when the steering arm is turned towards "A" or "B", the valve sleeves (a2 and b2) must be twisted as described below.

If a pressure greater than 35 bar is measured, the corresponding steering limiter valve (55) must be **screwed** further **into** the cover (clockwise).

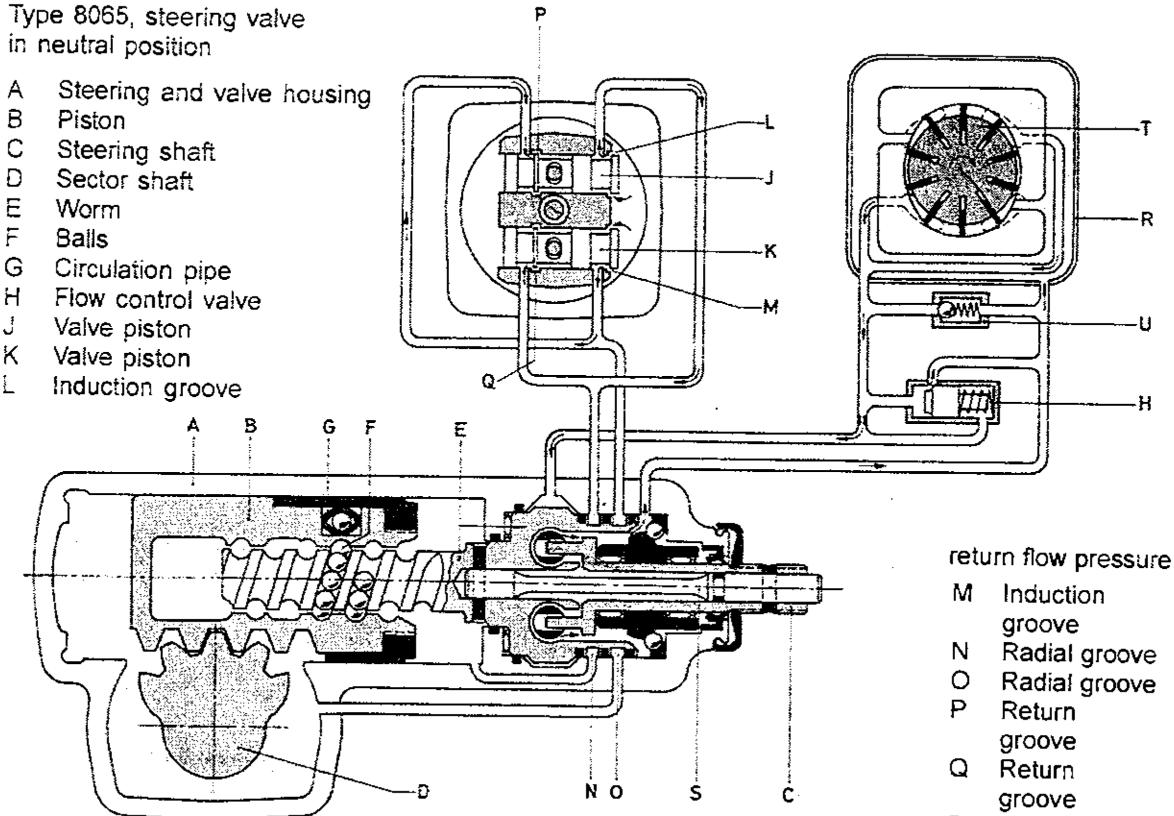
If a pressure lower than 30 bar is measured, the corresponding steering limiter valve (55) must be **screwed** further **out** (anticlockwise).

Check:
To check this setting appropriately, turn the steering wheel, while driving the vehicle slowly and under normal load, until the hydraulic assistance is disconnected.

3. ZF recirculating ball power steering, type 8056–70

Illus. 18
Type 8065, steering valve in neutral position

A Steering and valve housing
B Piston
C Steering shaft
D Sector shaft
E Worm
F Balls
G Circulation pipe
H Flow control valve
J Valve piston
K Valve piston
L Induction groove



return flow pressure
M Induction groove
N Radial groove
O Radial groove
P Return groove
Q Return groove
R Oil tank
S Torsion bar
T Pressure oil pump
U Pressure relief valve

3.1 Construction

Design as for steering types 8033–46, but with a different steering valve. The worm head accommodates two valve pistons (J and K) lying transverse to the worm axis, and these rotate together with the worm and the steering shaft in the valve housing of the steering system when the steering wheel is turned. The valve pistons have a cross hole in the centre in which two arms of the steering shaft (C) engage. There is therefore a connection without play between the valve pistons and the steering shaft, which is also connected to the worm via a torsion bar.

3.2 Functioning

When the steering wheel is turned in a clockwise direction, the piston with left–handed thread is pushed to the right. Since the movement of the piston is to be assisted by pressure oil, the oil must now be fed to the right cylinder side. The upper valve piston (J) is pushed to the right and the induction port (L) for the pressure oil supply opened further. By contrast, the lower valve piston (K) moves to the left and the pressure oil supply is interrupted by the closing of the induction groove (M). The return grooves (P and Q) can be seen in the upper valve representation for both valve pistons on the left of the valve piston centre. The pressure oil line of the upper valve piston is connected to the left radial groove (N) in the head of the worm and to the return groove of the lower valve piston (Q). Likewise, the pressure oil line of the lower valve piston is connected to the right radial groove (O) of the worm and the return groove (P) of the upper valve piston.

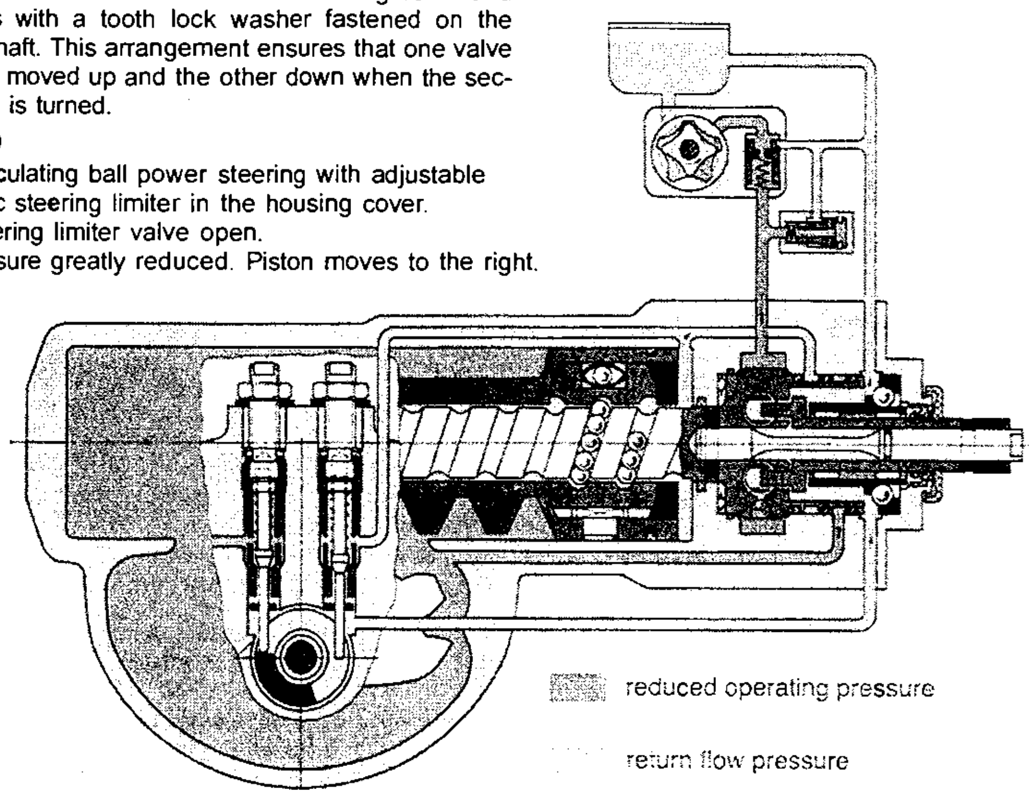
The pressure oil flows through the induction groove (L) of the upper valve piston to the left radial groove (N) and from there into the right cylinder, so that the piston movement is hydraulically assisted. However, at the same time the pressure oil reaches the return groove (Q) of the lower valve piston, but this is closed and blocks the return of this oil. The oil from the left cylinder is compressed. It flows via the radial groove (O) in the worm to the induction groove (M) of the lower valve piston. This is closed. However, at the same time the oil flows further to the return groove (P) of the upper valve piston, which is open, thus allowing the oil to reach the valve piston centre. From here constant return to the oil tank is guaranteed, as the diagram of the steering system ***(Illus. 18)*** shows.
If the steering wheel is turned in the opposite direction, the piston moves to the right ***(Illus. 19)*** and should be hydraulically assisted through pressure oil in the left cylinder. The lower valve piston is pushed to the right and allows the pressure oil to reach the right radial groove (O) in the worm, from where connection to the left cylinder is established. The pressure oil is also allowed to flow to the return groove (P) of the upper valve piston, but this is closed and prevents the oil flowing out to the valve piston centre. The oil from the right cylinder flows via the left radial groove (N) in the worm to the return groove (Q) of the lower valve piston, which is open, thus permitting access to the valve piston centre and from there to the oil tank.

3.3 Functioning of the hydraulic steering limiter

The housing cover is fitted with two valves, in each of which 1 valve piston is guided. Both valve pistons are actuated by the cam located on the face of the sector shaft (60). When the sector shaft is turned, the valves remain closed until the cam of the sector shaft meets a valve piston, lifts it and thereby opens the valve ***(Illus. 19)***.

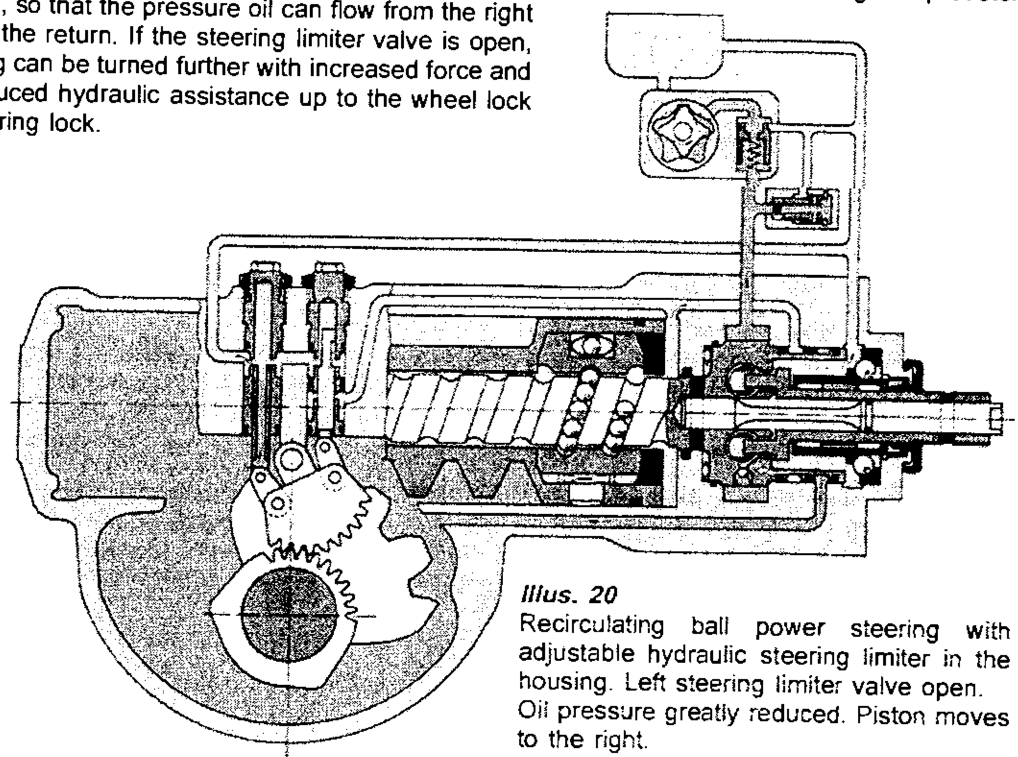
The valves are connected to the return by holes. The pressure oil of the left cylinder flows through a hole in the housing cover to the left valve, while the pressure oil of the right cylinder reaches the right valve through a hole in the housing.
If the steering limiter valves are located in the housing – ***see Illus. 20*** – the valve pistons in the two valve sleeves are connected to a toothed quadrant by means of connecting elements. The toothed quadrant is swivel mounted in the housing cover and engages with a tooth lock washer fastened on the sector shaft. This arrangement ensures that one valve piston is moved up and the other down when the sector shaft is turned.

Illus. 19
ZF recirculating ball power steering with adjustable hydraulic steering limiter in the housing cover.
Left steering limiter valve open.
Oil pressure greatly reduced. Piston moves to the right.



When the sector shaft is turned in an anticlockwise direction (see ***Illus. 19***, piston moves to the right), the left valve piston is actuated according to a defined steering arm lock, which can be altered by screwing the valve in or out. The pressure oil can then flow through the valve seat from the left cylinder compartment to the return. The position of the steering valve is not changed. The right steering limiter valve remains closed during this process.

If the sector shaft is turned in an anticlockwise direction, the right valve opens according to a predetermined path, so that the pressure oil can flow from the right cylinder to the return. If the steering limiter valve is open, the steering can be turned further with increased force and greatly reduced hydraulic assistance up to the wheel lock or the steering lock.



Illus. 20
Recirculating ball power steering with adjustable hydraulic steering limiter in the housing. Left steering limiter valve open. Oil pressure greatly reduced. Piston moves to the right.

3.4 Setting the hydraulic steering limiter, type 8056–70

Install manometer (pressure range up to 250 bar or hydraulic steering tester) as described under Section 2 for ZF rotary valve power steering ***(Illus. 15*** to ***17)*** and carry out setting.

If the pressure falls too early or too late when the steering arm is turned towards "A" or "B", the valve sleeves (a2 and b2) must be twisted as described below.

a) For steering systems in which the steering limiter valves are installed in the housing cover ***(Illus. 19)***: **If a pressure greater than 35 bar is measured**, the corresponding steering limiter valve (36) must be **screwed** further **into** the cover (clockwise).

   If a pressure lower than 30 bar is measured, the corresponding steering limiter valve (36) must be **screwed** further **out** (anticlockwise).

b) For steering systems in which the steering limiter valves are installed in the housing (Illus. 20): **If a pressure greater than 35 bar is measured**, the corresponding valve sleeve (36) must be **screwed** further **out** (anticlockwise).

   If a pressure lower than 30 bar is measured, the corresponding valve sleeve must be **screwed** further **into** the housing (clockwise).

Tighten lock nut a1 or b1 with **25 to 35 Nm**.

Illus. 17 shows the distance "f" which should exist between the wheel lock parts and be approx. 2mm upon response of the hydraulic steering limiter, provided that the vehicle manufacturer prescribes a setting with spacer.

Check:

To check this setting appropriately, turn the steering wheel, while driving the vehicle slowly and under normal load, until the hydraulic assistance is disconnected.

III. Maintenance, oil change and ventilation

Note:
When the steering system is being filled with hydraulic fluid, there is a danger that particles of dirt will get into the steering oil circuit. In order to avoid malfunctions caused by foreign bodies in the system, the utmost cleanliness must be ensured both on first filling and on refilling.

Before removing the oil tank cover, thoroughly clean the tank and its immediate surroundings so that no dirt can get into the hydraulic fluid.

When cleaning the vehicle with steam–cleaning devices:
Do not direct the steam cleaner straight onto exposed sealing parts of the aggregates belonging to the steering system. Water penetrating protecting caps, shaft seals or seals of universal joints can cause corrosion damage.

Recommendation for cold starts:
For vehicles with long hydraulic pipes, e.g. buses, an increased flow pressure is required for cold starts under 0°C ambient temperature. In order not to damage the pump through too great a pressure, the engine and with it the pump should be run for a few minutes without any movement of the steering wheel. This brings heated oil into circulation and the flow pressure will then normalize.

The following sections show the intervals for inspections of ZF power steering systems in kilometres per hour and in working hours. The figures in km/h must be applied for road vehicles, the figures in working hours for off–road vehicles. With vehicles having neither a tachometer nor a working hour meter, a fuel flow volume corresponding to the intervals should be taken as a guideline (Section VIII, Instructions for inspection).
For single–circuit hydraulic steering systems, the sections referring to the mobility–dependent pump are omitted.

1. Inspection

The general customer service for the respective vehicle encompasses checking all screwed connections and pipes of the power steering system, pumps (depends on engine and mobility), valves and working cylinders for tightness. A thin film of oil can be applied to the piston rods of the working cylinder, but no drops should be allowed to form.

If the steering system is installed subsequently, the installing workshop should carry out this inspection after the first 1000 kilometres or 25 hours of operation.

2. Oil grades

A suitable hydraulic fluid is required for the perfect functioning of the steering system and the pump. The hydraulic fluid also lubricates the steering gear and the pump; only one oil is therefore required for the whole system.

ATF oils, with a viscosity of approx. 26 mm²/s at 50°C, setting point under –35°C and low frothing inclination, are suitable for filling. Oils with higher viscosity can lead to the ventilating pressure in the suction being too great, producing noises in the pump. For permissible oil grades see list of lubricants TE–ML 09.

3. Oil volume

The hydraulic power steering is supplied from the factory without oil. The volume of oil required for the steering gear, without pipes, oil tank and pump, for the individual steering sizes is:

Type 8033:	0.5 dm^3	Type 8056:	0.8 dm^3	Type 8090:	0.6 dm^3
Type 8036/37:	0.7 dm^3	Type 8058:	1.0 dm^3	Type 8095:	1.5 dm^3
Type 8038:	0.9 dm^3	Type 8060:	1.2 dm^3	Type 8096:	1.7 dm^3
Type 8042:	1.5 dm^3	Type 8062:	1.4 dm^3	Type 8097:	1.9 dm^3
Type 8043/44:	1.4 dm^3	Type 8065:	1.7 dm^3	Type 8098:	2.4 dm^3
Type 8045:	1.9 dm^3	Type 8066:	1.5 dm^3		
Type 8046:	1.6 dm^3	Type 8070/72:	2.6 dm^3		

4. Oil change

Attention
An oil change is only recommended if the steering gear or pump or both have to be repaired or replaced. When doing so, the filters in the oil tanks should also be replaced and the pipes cleaned. An oil change is also required if other oils are used instead of the prescribed ATF oils (see Para. 2, Oil grades), e.g. engine oils or hydraulic fluids.

Before removing the cover of the oil tank, thoroughly clean the tank and its immediate surroundings so that no dirt can get into the hydraulic fluid.

Do not reuse oil that has been drained. Avoid mixing oils.

The oil can be drained as follows:

ZF Servocom:
Jack up steering axle as instructed by the vehicle manufacturer. Unscrew pressure and return pipes. If necessary, remove plug screws (55) from cylinder cover or housing. Then start engine briefly, no more than 10 seconds, until oil is drained from pump and tank. To check, switch engine off and turn steering once more from lock to lock until no more oil runs out. There should be a sizeable residual volume of oil in the steering system. Depending on the degree of contamination of the oil, e.g. scuff from the abrasion of internal parts of the pump, the steering system may need to be evacuated completely. The steering must then be dismounted and opened by a ZF service agency.

ZF recirculating ball power steering with oil drain screw:
Jack up steering axle as instructed by vehicle manufacturer. Unscrew oil drain screw on underside of housing.

ZF recirculating ball power steering without oil drain screw:
Undo the plug screw located on the side of the housing cover. Turn steering until the piston is pushed up to the stop. Then start engine briefly, no more than 10 seconds, until oil is drained from pump and tank.
It is possible that a rather large volume of oil will remain in the steering system. If necessary, we recommend that an oil change is followed by another rinse, i.e. that a second oil change is carried out.

To check, switch engine off and turn steering once more from lock to lock until no more oil runs out. Screw in oil drain screw or plug screw M 12x1.5 and tighten with 40 to 45 Nm.

Avoid mixing oils.

5. Filter change

The filter cartridges in single or multi–chamber oil tanks should be replaced at the same time as the inspection [2].

Attention
Before removing the cover of the oil tank, thoroughly clean the tank and its immediate surroundings so that no dirt can get into the hydraulic fluid.

When removing the used filter cartridges, ensure by closing the lower hole that dirty oil does not run from the filter cartridges back into the oil tank or into the oil circuit. Lubricate filter holders before use. If oil tanks are plastic, remove suction and return pipe. Disassemble oil tank, evacuate, clean and use new filter cartridges.

[2] Slight deviations are permissible if desired by the vehicle manufacturer in order to be able to record the intervals in the vehicle log.

6. Oil filling and ventilation

6.1 Oil filling

Attention:
When the steering system is being filled with hydraulic fluid, there is a danger that particles of dirt will get into the steering oil circuit. In order to avoid malfunctions caused by foreign bodies in the system, the utmost cleanliness must be ensured both on first filling and on refilling.

The steering system and the pump are filled through the filler necks on single and multi–chamber oil tanks. On first filling and oil changes, it is expedient to remove the tank cover (possible for sheet metal oil tanks) and fill hydraulic fluid up to the neck of the tank.

Start the engine at low speed and allow to work at idle speed (for vehicles with mobility–dependent emergency steering pump: drive axle with gear engaged for mobility–dependent drive axle jacked up) in order to fill the complete hydraulic system with oil. During this process, the oil level in the tank falls rapidly. The oil tank must therefore be constantly refilled to avoid the intake of air. We recommend that one mechanic runs the engine while a second pours in as much oil as is drained by the pump.

At a higher engine speed or strong suction flow, smallish air bubbles would be sucked into the pump again and be broken down into tiny bubbles by the working of the pump; this can lead to frothing and prolong the ventilation process accordingly.

When the steering system must be filled for the first time or after repairs, oil must be poured in before the suction pipe is fastened in the pump connection in order to prevent dry running in the start–up phase. Ensure particularly careful ventilation of the suction pipe. In cases where free suction of the radial piston pump is hampered, it is recommended that the suction pipe is first filled with oil.

6.2 Ventilation

When the steering system has been filled so that the oil level no longer falls below the upper marking on the dipstick, run the engine for some time (2–3 minutes) at low speed (for vehicles with mobility–dependent emergency steering pump: drive axle with gear engaged for mobility–dependent drive axle jacked up). The majority of the air will escape from the cylinder compartments. The oil level should be observed during this process. If it falls still further, top up with oil immediately. To accelerate the ventilation process, it is recommended that the steering wheel is turned several times from lock to lock. At the limit positions, do not pull on the steering wheel any more than is necessary to turn the steering. Top up with oil if necessary until the oil remains constant at the upper mark of the dipstick and no air bubbles rise in the oil tank when the steering wheel is turned.

In vehicles with an additional working cylinder, the pipe connections must point up so that the air in the cylinders and pipes can escape. Undo or remove working cylinder if necessary.

For steering versions with automatic ventilation:

Steering versions with automatic ventilation no longer have vent screws. These steering systems automatically force out the air remaining in the housing after the above ventilation process. Automatic bleeder valves only operate in the flow pressure area, which is why unnecessary pressure build–up is to be avoided.

For steering versions with vent screw:

Note:
Do not turn the steering wheel during the ventilation process and run the engine at low speed. Remove plug cap on vent screw. Then open vent screw 1/2–1 revolutions so that air remaining in this part of the housing can escape. As soon as it is only oil that runs out of the hole of the vent screw, close this again and top up with oil. Then turn steering wheel several times by jerks from lock to lock and repeat ventilation process. Top up with oil. Tighten vent screw with 5 Nm. Replace plug cap.

With Servocom steering systems without automatic ventilation (horizontal fitting position of steering shaft bottom), the upper steering limiting screw (20 or 128) provides the ventilation. The lock nut must be loosened for this purpose. The hydraulic steering limiter must be inspected after the ventilation process.

If the above instructions were observed, the oil level in the oil tank must not rise more than 1 to 2 cm when the engine is stopped, depending on the size of the steering system. The residual air still remaining in the housing is not noticeable when driving. It is absorbed and expelled by the oil during driving operation.

Turn engine off and lower steering axle or drive axle.

7. Checking the oil level

The oil level should be checked at intervals of 5000–6000 kilometres or 100–120 hours of operation. Before removing the oil tank cover, thoroughly clean the tank and its immediate surroundings so that no dirt can get into the hydraulic fluid.

Attention:
Too low an oil level can lead to malfunctions causing partial or complete failure of the steering system. If oil has been lost, it is essential that the point of leakage is located and the damage repaired. Repairs to the steering gear should only be carried out in our ZF service agencies.
For vehicles with ZF Servocom RAS (rear axle steering system):
If the oil level is above the upper mark, there may be a leak in the master cylinder of the ZF Servocom RAS. This leads to oil being forced from the ZF Servocom RAS into the front axle steering system.

7.1 Checking oil level with engine stationary

To ensure that no air is sucked in when the engine is started, determine first whether there is any loss of oil with the engine stationary (vehicles for mobility–dependent emergency steering pump: drive axle for mobility–dependent pump not driven). The tank must be topped up with enough oil so that the oil level is approx. 1 to 2 cm above the upper mark of the dipstick.

7.2 Checking oil level with engine running

With the engine running (vehicles with mobility–dependent emergency steering pump: gear engaged and drive axle for the mobility–dependent pump jacked up as instructed by the vehicle manufacturer), the oil level falls a little because the oil requires a pressure of 2 to 4 bar as a result of the flow resistances in order to flow through the steering gear.

Now enough oil is poured in for the oil level to be constantly at the upper mark. The engine can then be stopped again. The oil level must rise max. 1 to 2 cm. If this is exceeded, it shows that air is still trapped in the oil.

Irksome noises may be produced in the steering system if:

1. A filter cartridge is contaminated, replace with new one.
2. Screwed connections on suction side are not sufficiently tightened, so that air is sucked in. Tighten connections, apply varnish paint if necessary.
3. There is too little oil in the system. Top up with oil.

IV. Adjustments to the steering system installed in the vehicle, types 8033–46 and 8056–70

Note:
The measuring and setting tools used must be inspected regularly for accuracy.

1. Eliminating steering free play in straight–ahead driving (setting pressure point)

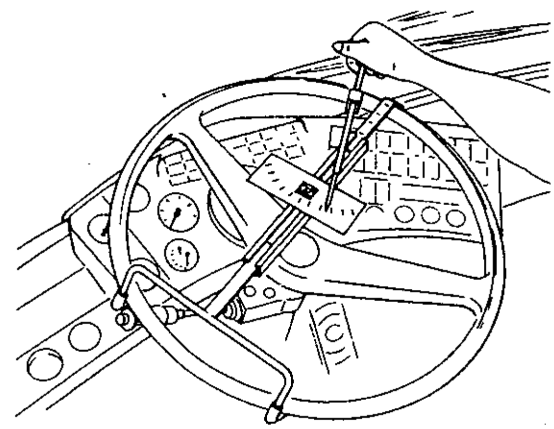
   a) Jack up steering axle.

   b) Turn steering into centre position (roughly found by halving the total number of revolutions of the steering wheel) and remove eccentric rod of steering arm (Section IX).

   c) Undo sealing nut (50 or 27) on housing cover.

   d) Turn steering into limit position and measure the moment of friction required to turn the steering out of straight–ahead driving (approx. 1/2 revolution before end lock). To turn the steering, the tool [6] should be used and this is placed and clamped to the rim of the steering wheel ***(Illus. 21)***.

   e) Then measure moment of friction of steering in pressure point area (centre position). To do this, make 1/2 revolution on tool [6] to left and to right across straight–ahead driving and tighten the adjusting screw (31 or 62) until an increase in moment of friction of 40–60 Ncm is measured over the value measured under Para. d).



Illus. 21

   f) Tighten sealing nut (50 or 27) with a torque of 90 Nm (for lock nut without seal, 70 Nm), while holding the adjusting screw tight. Check set torque again.

It will not improve steering property and the contact ratio in any way if the moment of friction in the straight–ahead driving area is set to be greater than 60 Ncm. Instead, it will produce too great a pressure on the adjacent parts and thereby unnecessary abrasion.

Mount and secure eccentric rod (adhere to tightening torques of vehicle manufacturer).

2. For setting of steering limiter, see Section II.

Free play in the hydraulic power steering with pump stationary and operating

In normal driving, i.e. when the oil pump discharges pressure oil, the torsion bar is twisted and the steering valve offset when the steering wheel is turned or there is a bump. This causes the hydraulic booster to engage. Only a very slight turn of the steering wheel or the sector shaft is required for this control process, so that a perceptible assistance becomes effective.

It is different if the power steering is actuated while the pump is stationary, e.g. when towing. With greater steering forces the whole valve lift of the control valve up to the stop must be overcome before the rotary movement of the steering wheel is transmitted to the sector shaft. There is then a perceptible free play when steering without hydraulic assistance on the steering wheel.

V. Instructions for eliminating external leaks

Attention:
To guarantee safe functioning of the steering system, ensure the utmost cleanliness when carrying out installation. Under no circumstances must force be used when assembling. The resulting damage could lead to the partial or complete failure of the steering function.
The measuring and adjusting tools used for repair must be subjected to a regular inspection for accuracy.

Note:
The numbers in brackets, e.g. (22), refer to the numbers in exploded views and the list of replacement parts.

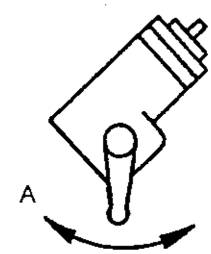
Grades of oil used: Spectron FO 20 from DEA or equivalent calcium complex grease of consistency class 2.

1. Replacing the shaft seal on the steering arm, type 8033–46

1.1 Mark position of universal joint, arrow of protecting cap and steering arm stump to each other and/or check agreement of marking stroke on steering arm stump with clamping slot of universal joint. Remove lower fastening screw on universal joint and pull universal joint from serration of lower steering column. Remove protecting cap (70).

1.1.1 For steering version with intermediate cover

Attention:
When carrying out the following operation, ensure that the worm is not screwed out of the thread of the piston, as there is otherwise the possibility that balls from the planetary thread will fall into the piston hole, which may lead to the steering being locked. This is best prevented if the steering wheel is turned to the full lock at which the piston is in the upper position or the steering arm swings forwards in direction "A" ***(Illus. 22)***. At the same time, the intermediate cover remains on the housing.



Illus. 22

a) Unscrew fastening screws (132). Remove cover (128). Press out shaft seal (129).

b) Use tool [8] to press new shaft seal (129) into cover (128) with sealing lip pointing into housing. Fill cavity between sealing lip and dust lip with grease (see note).

c) Place tool [9] on lower steering arm and fit cover (128). Screw in fastening screws (132) and tighten.

Tightening torques:	M 10:	62 Nm
	M 12x1.5:	115 Nm
	M 14x1.5:	190 Nm

1.2 For steering versions with ring nut in cover or short radius

a) Disconnect retaining ring (130). Remove shaft seal (129) using a suitable hook. Do not damage seal seat while doing so.

b) Place tool [9] on steering arm. Use tool [8] to press new shaft seal (129) into cover (128) with sealing lip pointing into housing. Only insert seal far enough to just guarantee that the retaining ring (130) is in the correct groove and that the vent groove is not covered.

Fill cavity between sealing and dust lip with grease (see note).

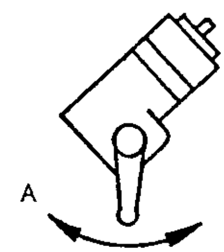
1.2 Apply grease to shaft seal (see note) and fit protecting cap (70). Protecting caps of new design on the housing must be pretensioned. Push universal joint on serration in such a way that the slot of the lower yoke aligns with the marking on the steering arm.

Put hexagon screw through hole of yoke; ensure that hole and free rotation of steering arm stump are congruent. Tighten nut.

Tightening torques:	M 8:	24 Nm
	M 10 x 1.25:	48 Nm

2. Replacing the shaft seal on the steering arm, type 8056–70

Attention:
When carrying out the following operation, ensure that the worm is not screwed out of the thread of the piston, as there is otherwise the possibility that balls from the planetary thread will fall into the piston hole, which may lead to the steering being locked. This is best prevented if the steering wheel is turned to the full lock at which the piston is in the upper position or the steering arm swings forwards in direction "A" ***(Illus. 23)***. At the same time, the intermediate cover remains on the housing.



Illus. 23

a) Mark position of universal joint, arrow of protecting cap and steering arm stump to each other and/or check agreement of marking stroke on steering arm stump with clamping slot of universal joint. Remove lower fastening screw on universal joint and pull universal joint from serration of lower steering arm. Remove protecting cap (160).

b) Disconnect pressure and return line from steering system.

c) Unscrew fastening screws (95 and 134). Remove valve housing. Press out shaft seal (131) from outside in.

d) Use tool [12] to press new shaft seal (131) into valve housing with sealing lip pointing into housing. Fill cavity between sealing lip and dust lip with grease (see note).

e) Place tool [13] on lower steering arm and then fit valve housing carefully. Screw in fastening screws (95 and 134).

Tightening torques:	M 8 x 1- 8.8:	25 Nm
	M 8 x 1- 10.9:	35 Nm
	M 12 x 1.5:	115 Nm
	M 14 x 1.5:	206 Nm

f) Apply grease to shaft seal (see note) and fit protecting cap (160). Push universal joint onto serration in such a way that the slot of the lower yoke aligns with the marking on the steering column.

g) Put hexagon screw through hole of yoke; ensure that hole and free rotation of steering arm stump are congruent. Tighten nut.

Tightening torques:	M 8:	24 Nm
	M10 x1.25:	48 Nm

3. Replacing the shaft ring on the drive bevel gear for versions with angle gear, type 8090–98 and 8056–70

a) Remove lower fastening screw on universal joint. Pull universal joint from serration of bevel gear. Remove protecting cap (314).

b) Undo slotted nut (313) and remove setting screw (312) from housing (301).

c) Press shaft seals (310 and 310.1) from setting screw. Pull o–ring (308) from housing slot.

Attention:
The bevel gear should only be extracted from the housing if absolutely necessary, e.g. for polishing the seal surface, as otherwise the meshing, which must have no free play when the steering gear is in straight–ahead driving position, will no longer be true. In this case, first turn the steering into straight–ahead driving position and then bring the notch on the steering arm congruent with the housing marking.

d) Fit o–ring (308) into radial slot of the housing, behind the tapped hole. Press the two shaft rings (310 and 310.1) into the setting screw (312) (the dust lips seal first) with the sealing lips pointing into the housing. Fill the cavities between the sealing lips with grease (see note).

e) To protect the sealing lips of the shaft seals, place tool [13] on the serration of the bevel gear. Push setting screw (312) on and screw in. Only tighten setting screw until the bevel gear is free of axial play. (The moment of friction of the bearing setting when the angle gear is dismantled must be 40 to 70 Ncm). Fit slotted nut (313) and tighten with 50 Nm, while holding setting screw firmly. Apply grease to shaft seal (see note), slide on protecting cap (314 and 70 or 160).

f) Push universal joint on serration in such a way that the slot in the lower yoke and the marking notch on the bevel gear agree.

g) Put hexagon screw through hole of yoke. Tighten nut.
Tightening torques: M 8: 24 Nm and M 10x1.25: 48 Nm

4. Replacing the shaft seal on the steering shaft, type 8033–46 and 8056–70

Note:
The following operation only applies to steering versions in which the steering shaft is sealed by means of shaft seals (4 or 6) instead of oval seals together with back–up rings, e.g. types 8043 and 8066. If the oval seals are not tight, the steering system must be disassembled. This should only be carried out by ZF service agencies.

a) Remove mounting of steering arm and remove steering arm using tool [7].

Attention:
Under no circumstances should the steering arm be removed by heating or driving in a wedge between the neck of the housing and the steering arm or by hammering, as this causes damage within the steering gear and material changes to the steering arm.

b) Disconnect retaining ring (7 or 3) on housing neck.

c) Remove shaft seal (6 or 4) from the housing neck using a suitable screwdriver or hook.

d) Plush tool [10] or [13] onto steering shaft. Push shaft seal with sealing lip to housing and with grease (see note) between sealing lip and dust lip over the sleeve and press into housing neck using tool [11] or [15].

e) Replace retaining ring (3 or 7). Push dust seal (1.1) with grease (see note) between dust seal and housing up to location on the sector shaft.

f) Push steering arm onto steering shaft; the marks on the steering arm and the shaft must agree. Tighten and secure hexagon nut with torques given in Section X.

VI. Removing and installing pressure relief valve and replenishing valve

1. Pressure relief valve – ZF Servocom and ZF recirculating ball power steering, type 8033–46

a) Unscrew valve core (22 or 23) from housing. The valve core cannot be disassembled. In the event of wear or pressure deviation, the complete valve must be replaced.

b) Fit greased o–ring (23 or 22) into slot of valve core (22 or 23). Screw in valve core.

c) Tightening torque: 30 Nm.

2. Replenishing valve – ZF Servocom, type 8090–98

a) Unscrew screw (30) and valve core (32).

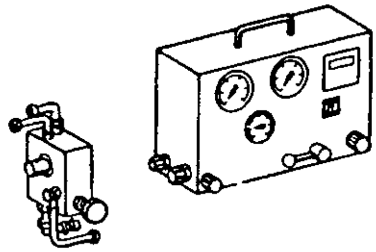
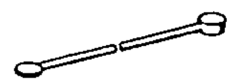
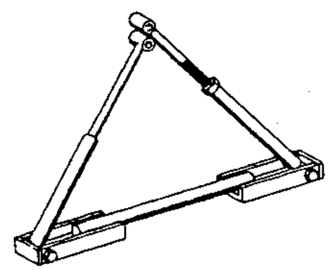
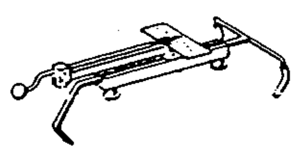
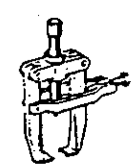
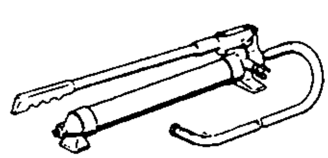
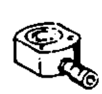
b) Insert valve core (32) into housing hole. Screw in screw (30) with fitted and greased o–ring (21).

c) Tightening torque: 30 Nm.

Attention:
With the exception of the work given under Sections IV, V and VI, no other repairs necessitating disassembly of the power steering should be carried out. Repairs going beyond the work described above should be carried out by a ZF service agency.

VII. Special tools

a) Tools for inspection

		Tool number
Tool [1] a) Servotest 550 hydraulic steering tester b) Sep. flow control valve 2 dm^3/min - Servocom only		7418 798 550 7418 798 539
Tool [2] Dial with pointer for checking free play on steering wheel		7418 798 452
Tool [3] Thrust piece for limiting wheel turn (use special tool prescribed by vehicle manufacturer)		7418 798 556
Tool [4] 1 pair spreaders (use special tool prescribed by vehicle manufacturer)		7418 798 653
Tool [5] Locking device for steering arm (use special tool prescribed by vehicle manufacturer)		7418 798 652
Tool [6] Torque meter for setting pressure point		7418 798 703
Tool [7] Extracting device for steering arm a) Extracting device		7418 798 202
b) Hydr. extracting device consisting of: Hand pump		7016 798 201
Cylinder		0646 121 048
Bell for steering shaft diameters up to 45 mm		418 798 214
for steering shaft diameters from 55 mm, useful width 102 mm		7418 798 213
for steering shaft diameters from 55 mm, useful width 120 mm		7418 798 216

b) Tools for repair, type 8033–46

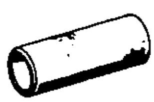
Tool [8]
Inserting sleeve or mandrel for shaft seal (129) – steering arm
a) for version with intermediate cover (122)

b) for version with ring nut in cover (128) or short radius

Tool [9]
Sleeve for protecting shaft seal (129) on lower steering arm

Tool [10]
Guide sleeve for protecting shaft seal (6) on sector shaft

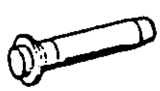
Tool [11]
Guide sleeve or inserting sleeve for shaft seal (6) in housing neck



Tool	8033	8036	8037	8038	8042	8043 8044	8045	8046
[8] a)		8052 798 056		7418 798 051			7418 798 051	
[8] b)	8033 798 001		8037 798 002	7404 798 001				
[9]	7832 798 001	8052 798 003	7359 798 001	7418 798 006				
[10]		7409 798 001		7425 798 002	8065 798 001		7438 798 002	
[11]		7419 798 003		7425 798 002	8065 798 002		7438 798 003	

c) Tools for repair, type 8056–70

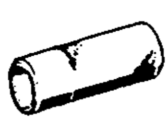
Tool [12]
Mandrel for shaft seal (131) in valve housing



Tool [13]
Guide sleeve for protecting shaft seal (131) on lower steering arm

Tool [14]
Guide sleeve for protecting shaft seal (4) on sector shaft

Tool [15]
Inserting sleeve for shaft seal (4) in housing neck



Tool	8056	8058	8060 8062	8065	8066	8070
[12]	8052 798 051		7418 798 051			
[13]	8052 798 003		7418 798 006			
[14]	8056 798 001	7409 798 001	7425 798 002	8065 798 001		7438 798 002
[15]	8056 798 002	7419 798 003	7425 798 003	8065 798 002		7438 798 003

VIII. Instructions for inspection

Vehicles with ZF hydraulic power steering should be taken to the workshops of the vehicle manufacturer or the ZF service agencies for inspection of the ZF steering systems and ZF oil pumps according to the following mileages and operating hours.

The inspection intervals given below depend on the type of use of the vehicle. For vehicles fitted with neither a tachometer nor an operating hours counter, a fuel flow volume corresponding to the intervals should be used as a guideline.

- ❑ **For ZF recirculating ball power steering systems, types 8033–8046, types 8056–8070 and ZF Servocom steering systems produced up to 12/93**

Type of use	**1st inspection** Inspection in vehicle	**2nd inspection** Inspection in vehicle	**3rd inspection**
- Long–distance vehicles	100 000 km 60 000 miles	200 000 km 120 000 miles	300 000 km 180 000 miles
- Vehicles in highway and short–distance use	100 000 km 60 000 miles	175 000 km 105 000 miles	250 000 km 150 000 miles
- Construction vehicles and off–road vehicles	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.

To increase road safety, we recommend that the steering system and pump are disassembled in the 3rd inspection, the mechanical steering parts examined (visual examination of all parts and check for cracks on parts under stress) and new sealing parts are fitted. This work should be carried out by a ZF service agency.

- ❑ **For ZF Servocom steering systems produced from 1/94**

Type of use	**1st inspection** Inspection in vehicle	**Additional inspection** Inspection in vehicle
- Construction vehicles - Vehicles for short–distance use - Vehicles with high load population	200 000 km 6 000 op. hrs or after no more than 5 years	every 200 000 km 6 000 op. hrs or after no more than 5 years
- Long–distance vehicles - Buses	500 000 km	after every additional 250 000 km

Carrying out the 1st and 2nd inspection

Note:

a) In order to be able to form an idea of the condition of the vehicle and the power steering before carrying out the following inspection, and to compare the performance of the power steering before and after inspection, we recommend a test drive. This is particularly recommended if the driver has a poor opinion of the steering system. Before going on a test drive, check the oil level and ventilation of the steering system.

b) The measuring and adjusting tools used must be subjected to regular inspection.

1. Checking the mechanical functioning of the steering

Attention:
Do not turn steering systems with automatically adjustable hydraulic steering limiter into limit positions when the steering linkage has been removed (see Section II, Para. 1.5).

1.1 Checking seat of the fastening screws

Tighten screws on steering and steering mounting with the torque prescribed by the vehicle manufacturer. Check sheet metal and splint mounting for perfect performance. By alternately turning and straightening the steering wheel while the vehicle is stationary, check whether the steering arm still has a firm seat on the serration of the sector shaft.

1.2 Checking straight–ahead driving position of steering and vehicle

Jack up steering axle as instructed by vehicle manufacturer (if the vehicle does not have a rigid steering axle, the wheels should be on rotary tables). Bring steering into centre position by halving the total number of steering wheel revolutions. Then turn further until markings on steering shaft and housing agree. The wheels steered should be in straight–ahead driving position (this can be checked roughly by placing a measuring strip on both front wheels and back wheels and noting toe–in). Correction is effected by screwing ball joint on eccentric rod in or out.

Attention:
If the steering linkage must be corrected longitudinally, the reason for this may be a previous accident–type incident. It is recommended therefore that the serration on the sector shaft (30) is examined for torsion (remove steering arm to do this), the steering shaft for distorted installation and all other transmission parts for bending or cracks and that the free play is measured according to Para. 7.7. Deformed parts must not be bent straight but should be replaced.

For versions with automatically adjustable hydraulic steering limiter ZF Servocom:
If necessary, install new valve sleeve assemblies (20 or 128) and reset steering limiter – see Section II Para. 1.5.

1.3 Checking free play between piston and sector shaft in centre position

a) Turn steering into centre position (see 1.2) and remove eccentric rod from steering arm.

b) Measure moment of friction when turning across the pressure point area. It should be greater by the following values than outside the pressure point:

Type 8090: 20 - 60 Ncm
Type 8095: 20 - 80 Ncm
Type 8097/8098: 20 - 100 Ncm
Type 8033–46: 40 – 60 Ncm
Type 8056–70: 40 – 60 Ncm

To set pressure point (only types 8033–46 and 8056–70), see Section IV. Adjustment of pressure point with ZF Servocom is only possible when dismounted (ZF service agencies).

1.4 Checking steering lock

Connect eccentric rod temporarily. Turn steering to the left up to lock. Disconnect eccentric rod and turn steering wheel further to ascertain whether there is still steering reserve. Repeat measurement to right. There must be steering reserve on both sides. If this is not the case, the wheel lock screws must be reset. Connect eccentric rod again.

Note:
When the steering linkage has been removed, steering systems with automatically adjustable hydraulic steering limiter (ZF Servocom) may only be turned into limit positions if there is to be a subsequent resetting with new valve sleeve assemblies (128); if necessary, remove valve sleeves and fit plugs for this inspection.

1.5 Checking free play of steering shaft support in steering column

Check whether there is free play by making lateral movements (shaking) on the steering wheel. If there is free play, replace bearing bush.

1.6 Checking circumferential backlash or sluggishness in universal joint or in flexible disk between upper steering shaft and steering gear

If there is free play (produces audible rattling on shaking) or sluggishness, fit new part.

1.7 Checking steering shaft and jacket tube for maximum permissible bend

Jack up steering axle as instructed by vehicle manufacturer. Remove steering wheel and self–aligning bearing ring or ball bearing bush from the jacket tube. Check the permissible bend of steering shaft and jacket tube in accordance with Section X.

2. Checking for external tightness

a) Start engine.

b) Check whether all screwed connections and lines of steering system and seals on steering and pumps are tight. Tighten screwed connections and replace seals if necessary. When fitting new seals, we recommend that you use our special tools.

c) Check all hoses and lines for possible abrasion points and brittle cracks. Replace defective parts.

Attention:
For hose lines and externally visible damage such as cracks, fit only pressure–tested replacement parts recommended by the manufacturer. Note replacement part numbers of vehicle manufacturer.

d) Stop engine.

3. Checking V–belt tension

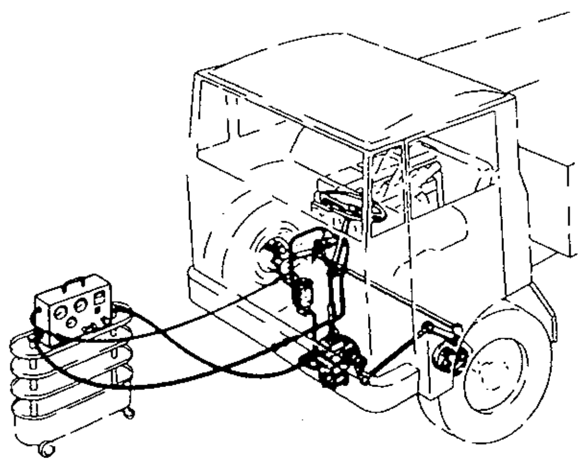
Check tension of V–belts using the usual thumb tests (adhere to instructions of vehicle manufacturer). The V–belts must not overrun even under maximum pressure. Replace defective V–belts.

4. Fitting hydraulic steering tester

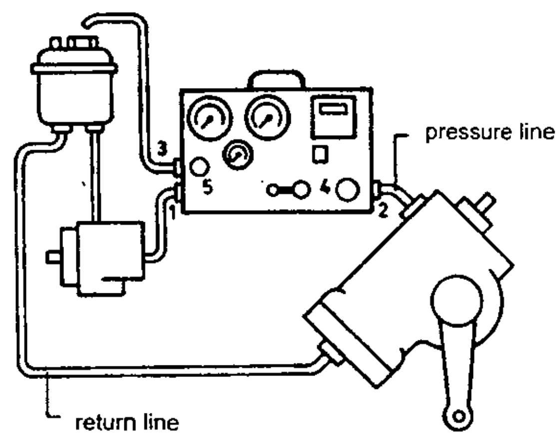
Fit Servotest 550 hydraulic steering tester in the pressure line between oil pump and ZF power steering (see ***Illus. 24*** and ***25***) in such a way that the display instruments can be easily observed from the driver's seat. Connect pressure line from pump with connection "input 1" of tester and connection "output 2" with line to the steering (see separate operating instructions for Servotest 550). Steering systems which have a pressure relief valve positioned according to Section 7 Para. 2b) must be connected to the oil tank from connection "tank 3" of the tester.

It is enough to insert the hose end into the opening of the removed tank cover. See ***Illus. 25*** for diagram of connections. Note oil level and top up if necessary. Ventilate steering system.

Illus. 24
Hydraulic connection diagram for hydraulic steering tester using ZF Servocom steering system as example



Illus. 25
Position of hydraulic steering tester valves after connection (idle position):
pressure relief valve 120 bar,
throttle valve closed, shutoff valve open.



5. **Oil filling**
   See Section III (maintenance and oils).

6. **Ventilation**
   See Section III (maintenance and oils).

7. **Checking hydraulic functioning of steering and pump**

Note:
To carry out the following pressure and overflow oil checks, 2 types of steering must be differentiated.

a) Steering systems in which **the pressure relief valve** is located **in the pump or pressure line**. This means that the pressure is relieved before the installed tester. In these steering systems, the maximum pressure, e.g. 100 bar, is indicated on the rating plate of the pump or pressure relief valve.

b) Steering systems in which the **pressure relief valve** is installed **in the steering system or separately in the pressure line between tester and steering**. The valve can thus no longer control the oil pressure if the pressure lines are blocked by the installed shutoff valve of the test device. In these steering systems, the maximum pressure is indicated on the rating plate of the steering or pressure relief valve.

7.1 Checking ZF pump for pressure

Read the maximum pressure from the rating plate of the steering or the pump or the separate pressure relief valve. Run engine until warm. Oil temperature 50°C.

a) For steering systems with pressure relief **before** tester:

With the engine at idle speed, close shutoff valve of tester. Read pressure from manometer.

Attention:
Only operate maximum pressure for a short time, no more than 5 seconds, as otherwise the internal parts of the pump will be too hot, leading to premature wear. Bring shutoff valve into starting position again. The permissible deviation from nominal pressure must be no more than ± 10%.

If the difference is greater, the functioning of the pressure relief and flow control valve must be checked and the valve adjusted if necessary.

Checking the valve:
Remove pressure relief and flow control valve from ZF oil pump. Check valve piston and hole in valve housing for visible wear. The holes in the valve piston must not be clogged. The piston must be able to be moved slightly and must not stick. If necessary, a new valve must be fitted.

If the maximum pressure of the pump is still too low after this check, the internal parts of the pump must be examined for wear. In this case we recommend that the pump is exchanged.

b) For steering systems with pressure relief **behind** tester:

Attention:
If the tester has been installed as described in b), ensure that the engine is only run at idle speed for the complete duration of the pressure testing. An increase in engine speed would result in an immediate, jerky rise in the oil pressure. In this case there is a danger that the pressure line will become defective or the pump will seize up.

With the engine at idle speed and while observing the manometer, close the shutoff valve of the tester slowly until the maximum pressure has been reached. Do not close valve any more (only operate maximum pressure for a short time, no more than 5 seconds, as otherwise the internal parts of the pump will be too hot, leading to premature wear). Bring shutoff valve into starting position again. If the measurement does not show nominal pressure, the functioning of the flow control valve must be checked and the valve adjusted if necessary.

Checking the valve:
Remove flow control valve from ZF oil pump. Check flow control valve piston and hole in valve housing for visible wear. The holes in the valve piston must not be clogged. The piston must be able to be moved slightly and must not stick. If necessary, a new valve must be fitted.

If the maximum pressure of the pump is still too low after this check, the internal parts of the pump must be examined for wear. In this case we recommend that the pump is exchanged.

7.2 Checking ZF oil pump for flow rate using Servotest 550 hydraulic steering tester

Note:
For setpoint values for flow rate, test pressure and test speed, see table. For descriptions and operation of hydraulic steering tester, see separate operating instructions for Servotest 550.

a) Checking minimum flow rate

With engine at idle speed, close shutoff valve until test pressure for pump type is reached. Read off flow rate. Note conversion of engine speed to pump speed.

At a pump pressure of 50 bar (120 bar for pump type 8601), the minimum flow rate is:

for pump type	minimum flow rate dm^3/min	speed rpm
7633	6.0	800
7634	6.0	700
7636	6.0	500
7638	6.0	400
7646	6.5	350
7671	2.6	500
7672	4.5	500
7673	6.1	500
7674	7.5	500

for pump type	minimum flow rate dm^3/min	speed rpm
7677	8.5	500
7681	3.1	500
7683	4.5	500
7684	5.9	500
7685	7.0	500
7686	9.4	500
8601	2.0	1000
8605	5.0	350
8607	5.0	350

b) Checking the controlled flow rate

Increase speed until the capacity of the pump remains constant despite a further increase in speed, approx. 1300 rpm. The pump is now in the limiter area. The setpoint value of the capacity can be read from the respective list of replacement parts for the oil pump.

7.3 Checking the hydraulic steering limiter

a) Mechanically adjustable hydraulic steering limiter

Tum steering wheel clockwise as described under Section II, with steering axle under stress (jack up rigid axle or use rotary tables for independent suspension). Once the wheel lock has been reached, a brief (max. 5 seconds) continued turning of the steering wheel will overcome the resetting force of the steering valve until a fixed steering wheel lock is achieved. To reach this a peripheral force on the steering wheel of approx. 100–200 N is required. In this position, read off the oil pressure on the manometer; this should be no greater than indicated under Section II. For setting of the steering limiter, please refer to Section II. Para 1.4.

b) Automatically adjustable hydraulic steering limiter – ZF Servocom

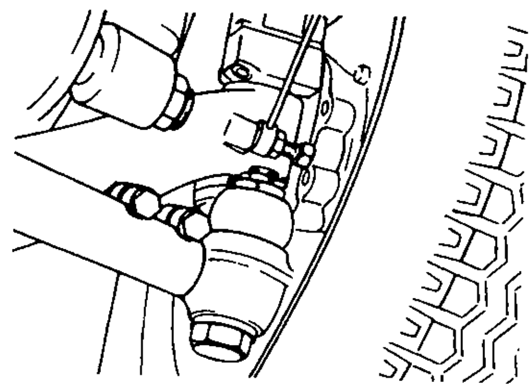
Carry out check as described under a), but with no spacers inserted. If there is no space on the wheel lock parts or the oil pressure does not fall to the value given in Section II Para. 2, fit new sliding valve assemblies (20 or 128) and reset steering limiter according to Section II Para. 1.5.

If the space on the wheel lock parts is too great and the oil pressure falls to the prescribed value, reset steering limiter according to Section II Para. 1.5.

Carry out check in the same way while steering anticlockwise.

7.4 Checking steering system for pressure

Tool [3] or thrust pieces approx. 15 mm thick ***(Illus. 26)*** are inserted between the wheel lock parts in such a way that the steering lock is restricted 1/2 to 3/4 of a steering wheel revolution before reaching full lock. Restriction of the steering lock should therefore be effected using these thrust pieces, but not in the hydraulic power steering through the working piston on the cylinder.



Illus. 26

Attention:
A tool under pressure may be ejected – avoid direct eye contact with the tool. If the tool locks during steering lock, it is essential that there is sufficient clearance between the wheel and the vehicle chassis for this. There is a danger of the hand being squeezed e.g. when the tool is ejected and the wheel subsequently resettles. Depending on the type of axle, use the special thrust piece specified by the vehicle manufacturer.

With engine at idle speed, turn steering wheel to the right until full lock and continue turning right for approx. 5 seconds with a force of 100–200 N on the steering wheel until the self–aligning force of the steering valve is overcome. The oil pressure is read off on the manometer. The same measurement is carried out steering to the left. If, when steering left or right or in both directions, it is discovered that the oil pressure at a steering force of 100–200 N is below the previously measured oil pressure of the pump, the steering hydraulics are not functioning properly. The cause of the pressure drop may be:

a) Pressure relief valve in the steering system (or separate) is not working properly.

b) There is too much overflow oil in the steering hydraulics (measure overflow oil flow).

7.5 Checking overflow oil using hydraulic steering tester

Note:
For descriptions and operation of hydraulic steering tester, see separate operating instructions for Servotest 550.

a) For steering systems with pressure relief before tester:

Keep 15 mm thick thrust piece between the wheel lock parts. With engine at idle speed, turn steering to full lock and pull on steering wheel with approx. 100–200 N (max. 5 seconds) so that steering valve is fully closed. Read off overflow oil flow and release steering wheel. Repeat check turning in opposite direction.

Attention:
A tool under pressure may be ejected – avoid direct eye contact with the tool. Depending on the type of axle, use the special thrust piece specified by the vehicle manufacturer.

b) For steering systems with pressure relief **behind** tester:

Close shutoff valve (4) completely and throttle valve (5) until there is back pressure 30 bar lower than the maximum pressure measured under 7.1. Open shutoff valve (4) again.

Keep 15 mm thick thrust piece between the wheel lock parts. With engine at idle speed, turn steering to full lock and pull on steering wheel with approx. 100–200 N (max. 5 seconds) so that steering valve is fully closed. Read off overflow oil flow and release steering wheel. Repeat check turning in opposite direction.

Max. permissible overflow oil values:	Type 8033 to 8037:	2.8 dm^3/min
	Type 8038 to 8044:	3.0 dm^3/min
	Type 8045 to 8046:	3.2 dm^3/min
	Type 8056 to 8058:	2.0 dm^3/min
	Type 8060 to 8070:	2.5 dm^3/min
	Type 8090:	2.0 dm^3/min
	Type 8095 to 8098:	2.5 dm^3/min

For ZF–Servocom type 8090–98:

For Servocom steering systems, the functioning of the high–pressure seals must also be checked while the flow rate is low.
Set hydraulic steering tester to flow rate of 2 dm^3/min. Connect separate flow control valve tool [1b] in series.
Repeat overflow oil check as described under a) or b). The overflow oil should not exceed the previously measured value. If this measurement shows a greater overflow oil value than was the case for measurement under a) or b), the cause may be that seals, especially the seals (117 and 123) in the piston or housing cover, are not in exact contact.

For ZF recirculating ball power steering, type 8033–46 and 8056–70:

Repeat overflow oil measurement with pressure of 20 to 30 bar.

The cause of excess overflow oil may be:

a) Pressure relief or replenishing valve in steering not working properly – replace.

b) Steering limiter valve switches off too early – to set, see Section II.

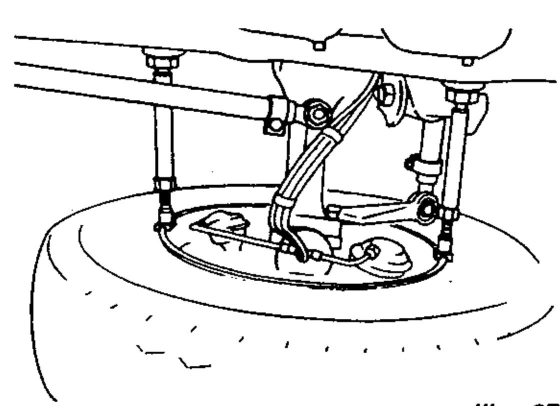
c) Seals in steering are defective – dismantle steering and have repaired by ZF service agency.

7.6 Checking valve restoring force

With the steering arm locked in the centre position, close the control valve by turning the steering wheel, thereby building up the maximum pump pressure. Then slowly release the steering wheel and again set a pump pressure of 10 bar above the flow pressure. The valve must then return to its original position within 1 second, i.e. the oil pressure must fall to at least 0.5 bar above the flow pressure.

7.7 Measuring the free play on the steering wheel with engine running and vehicle stationary in straight–ahead driving position

a) Lock front left wheel (front right wheel in right–hand drive vehicles) into straight–ahead driving position by fitting two expanding devices between wheel rim (front and back) and front spring ***(Illus. 27)***.



Illus.27

b) Place dial on steering wheel and attach pointer on dashboard or windscreen *(Illus. 28)*.

c) With the engine running, begin to turn steering wheel slowly to the left while observing the manometer.

For ZF–Servocom:
higher engine speed, approx. 1000 rpm
oil temperature: 50–60°C

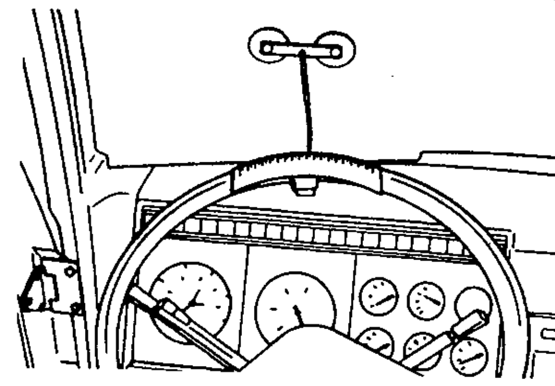
d) When a pressure rise of 1 bar above flow pressure has been reached *(Illus. 29)*, hold the steering wheel firmly and mark value on scale.
Then turn steering wheel to right, again until a pressure rise of 1 bar has been reached. The total path travelled on the scale is measured.

Max. permissible travel:
Type 8090-98: 40 mm
Type 8033-46: 40 mm
Type 8056-70: 20 mm

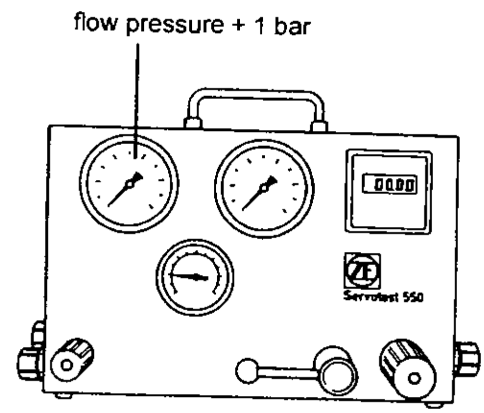
For steering versions with flange–connected or separate angle gear, the free play may be 5 mm greater.

If these conditions are not fulfilled, the measurement must be repeated with the steering arm locked *(Illus. 30)*, since in the measurement carried out the free play in the ball joints of eccentric and track rods and in the other transmission parts was not eliminated. This check requires a good, play–free condition of the eccentric rod and the ball joint.

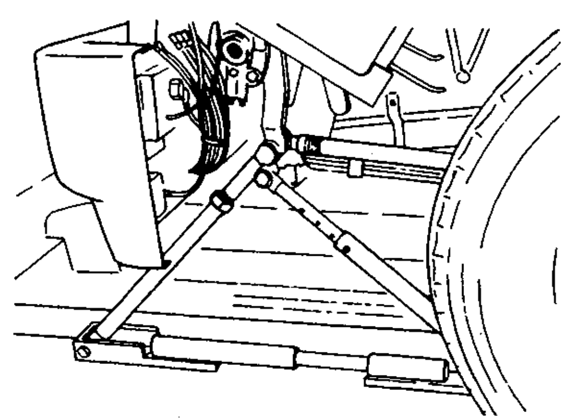
If the travel is greater than indicated even with the steering arm locked, there is mechanical play in the steering gear. This may also be the result of an accident–type impact. The steering gear should then be reconditioned or examined for accident damage by a ZF service agency (check for cracks). Switch off engine. Dismount hydraulic steering tester.



Illus.28



Illus.29



Illus.30

8. Filter change

Attention:
Before removing the oil tank cover, thoroughly clean the tank and its immediate surroundings so that no dirt can get into the hydraulic fluid.

a) Unscrew plug screw from cover of oil tank and remove tank cover.

b) Pull out used cartridge on metal collar. When removing the used filter cartridge, close the lower hole so that dirty oil does not run back into the tank.

If oil tanks are plastic, remove suction and return pipe. Disassemble oil tank, evacuate, clean and fit new filter cartridge.

c) Grease filter holders and fit new filter cartridge with metal collar pointing up.

d) Fill tank with oil up to neck.

e) Start engine. The oil level will fall rapidly. To avoid the intake of air, top up tank with oil immediately. Then ventilate steering system as described in Section III.

Note:
Illus. 26, ***27*** and ***30*** show universal devices provided by ZF. Depending on the type of vehicle, special devices approved by the vehicle manufacturer may also be required.

9. Test drive

After inspection work, a test drive should be carried out to check the vehicle and steering system for perfect functioning and external tightness.

IX. Removing the steering system from the vehicle

1. Thoroughly clean steering system and the directly surrounding area, especially the line connections.
2. Discharge oil as described in Section III, Para. 4.
3. Disconnect pressure and return lines.
4. Close all oil lines to avoid contamination.
5. Pull off steering arm using tool [7].

Attention:
Under no circumstances should the steering arm be removed by heating or by driving in a wedge between the neck of the housing and the steering arm or by hammering, as this causes damage within the steering gear and material changes to the steering arm.
Do not turn steering systems with automatically adjustable hydraulic steering limiters into limit positions when the steering linkage has been removed – see Section II Para. 1.5. If necessary, fit new sliding sleeve assemblies (20 or 128).

6. Disconnect universal joint or flexible coupling between steering gear and steering column or separately installed angle gear. Do not hit the steering shaft axially when dismounting the steering wheel.
7. Remove fastening screws on housing and extract steering system.

X. Installing the steering system in the vehicle

Attention:
To guarantee safe functioning of the total steering system, ensure absolute cleanliness when fitting all aggregates belonging to the system and when connecting the lines. To avoid malfunctions due to foreign bodies or dirt in the steering oil circuit, the sealing plugs on the line connections of steering system, oil pump, working cylinder, valves etc. should only be removed when connecting the lines. If possible, do not remove protective sheaths until installation is complete. Connecting lines and screwed connections must be cleaned and deburred carefully.
Do not turn steering systems with automatically adjustable hydraulic steering limiters into limit positions when the steering linkage has been removed – see Section II Para. 1.5. If necessary, fit new sliding sleeve assemblies (20 and 128).

1. Ensure that contact surfaces of mounting eyes of bearing block and steering system are free of paint and dirt.

2. Place steering gear in bearing block and screw down. Tighten screws with corresponding torque. Depending on the type of vehicle, the steering arm may require prior mounting for reasons of space (see Para. 7).

Attention:
When fastening jacket tube and steering shaft, particularly in the case of a separately installed angle gear with flange–connected jacket tube, it is essential to avoid pretensions which may occur in the steering gear/bearing block due to the retaining connection to the bulkhead or dashboard.
Pretensions can be generated through bending torques, especially in the steering shaft, and depending on size and frequency can in some cases lead to permanent fractures or impair the freedom of the steering gear.

3. To check whether the steering has been correctly installed, proceed as follows:

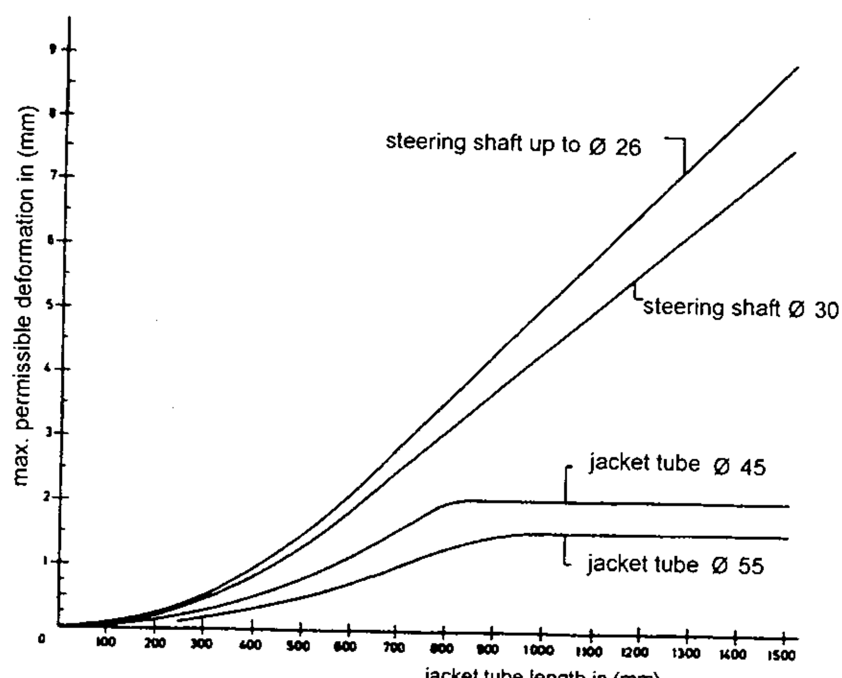
3.1 Check freedom of the steering gear or separately installed angle gear in the assembly with bearing block, steering arm and eccentric rod(s).

3.2 **Checking the permissible deformation of the steering shaft**

a) Raise steering axle in accordance with the instructions of the vehicle manufacturer so that the steering system can be easily turned by hand.

b) Remove steering wheel and dismount ball bearing sleeve or self–aligning bearing from the jacket tube of the separately installed angle gear.

c) By turning the steering shaft at least 360 degrees, establish whether the steering shaft is deformed. The measurement can be carried out using a dial gauge or a depth gauge, although the measurement must always be taken from the same point on the periphery of the jacket tube. The radial run–out measured, divided by 2, gives the deformation of the steering shaft. The maximum permissible deformation depends on the length of the jacket tube and the diameter of the steering shaft (see ***Illus. 31*** and the procedure for determining the length of the jacket tube).



Maximum permissible deformation of jacket tube and steering shaft ***Illus. 31***

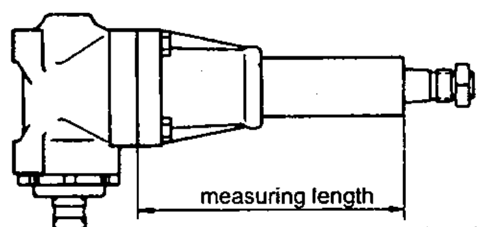
3.3 **Checking the permissible deformation of the jacket tube**

To do this, the steering shaft must be marked on one point on the periphery. Then tum the steering shaft in stages (at least 4 stages) and after each stage, use the depth gauge to measure the distance always from the external diameter of the jacket tube to the point marked on the steering shaft. Since the same steering shaft side faces the measuring point on the periphery of the jacket tube, the run–out of the steering shaft itself is not measured as well. The difference of the distance, largest measurement to smallest measurement, divided by 2, gives the deformation of the jacket tube. The maximum permissible deformation depends on the length and diameter of the jacket tube (see ***Illus. 31*** and the procedure for determining the length of the jacket tube).

Note:
This check must also be carried out during main inspection of the steering system and for vehicles with previous accident damage in the front area.

3.4 Determining the jacket tube length

Measure the length of the jacket tube including jacket tube flange – parting plane jacket tube flange/ housing ***(Illus. 32)***.



measuring length = jacket tube length ***Illus. 32***

4. Tum steering system into straight–ahead driving position (determined by halving the total number of steering wheel revolutions). The markings on the steering shaft and jacket tube or valve housing must agree.

5. a) Applies for separately installed angle gear with rigid steering column:

Screw in sliding contact and tighten with 5 Nm. Tightening torques for steering wheel nuts:

with cylindrical serration and cone 1:6:

M 18 x1.5:	35 - 45 Nm
M 22 x1.5:	40 - 50 Nm
M 26 x1.5:	60 - 70 Nm

Attention:
Do not hit the steering shaft axially when mounting and dismounting the steering wheel.

b) Applies for steering systems with separate steering column:

Fit universal joint or flexible coupling between steering column and steering gear. In the straight–ahead driving position, the offset yoke part must be at a right angle to the markings on the steering shaft and jacket tube or valve housing. If two joints are used, the diffraction angle should be the same and the yokes on a plane. If such an installation is impossible, parallelity can be reached by offsetting the yokes to each other on the serration.

With aluminium universal joints, hammer blows on the yokes should be avoided as this can lead to destruction or sluggishness. Connect both by using fit bolts and tightening the nuts. Tightening torques for fit bolts:

M 8:	24 Nm
M 10 x 1.25:	48 Nm

When fitting telescopic shafts, note max. permissible lift range.

6. Bring steered wheels of vehicle into straight-ahead driving position. This is reached when the steered wheels are flush or parallel to the second pair of wheels (use measuring strip on front and rear wheel).

7. Push dust seal (1.1) with Spectron FO 20 grease from DEA or equivalent calcium complex grease of consistency class 2 into spaces on sector shaft. Then place steering arm on serration so that markings on steering arm and sector shaft agree. Provisionally tighten nut securing steering arm and turn steering to the left until full lock. Remove steering arm and continue turning steering wheel to determine if there is still steering reserve available. Repeat measurement turning to the right. Tighten nut securing steering arm with the torque listed below and secure to prescribed place by caulking (peening depth: min. 1.5 mm). Connect and tighten eccentric rod.

   For versions with automatically adjustable hydraulic steering limiter:

   Remove steering arm and continue turning steering wheel to determine if there is still steering reserve available. Repeat measurement turning to the right.

   Screw in sliding sleeve assembly (20 and 128) (tightening torque 15+3 Nm).

   Tighten nut securing steering arm with the torque listed below and secure to prescribed place by caulking (peening depth: min. 1.5 mm). Connect and tighten eccentric rod.

   Do not turn steering systems with automatically adjustable steering limiter into limit positions when the steering linkage is dismounted – see Section II Para. 1.5. If necessary, fit new sliding sleeve assemblies (20 or 128).

☞ For versions with conical serration:

Thread	Gear	Tightening torques	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%

☞ For cylindrical serration or binding screws:

see tightening torques prescribed by vehicle manufacturer

If the vehicle manufacturers specifies other values, these values must be applied.

8. Connect pressure and return line between pump, steering and working cylinder. If lines must be bent, this should be done when cold in order to avoid scaling.

   For hose lines with externally visible damage such as cracks, only pressure-tested replacement parts released by the manufacturer should be used. Note replacement part number of vehicle manufacturer.

9. Fill system with hydraulic fluid through oil tank.
   See Section III Para. 6.

10. Startup of steering system

    To avoid any particles of dirt still in the steering system getting into the pressure relief valve on first startup, it is recommended that oil flows through the steering system for some minutes at different engine speeds and without the steering wheel being turned. The steering should then be turned several times in both directions, but not to full lock, at average engine speed (until operating temperature is reached).
    Then ventilate steering system (see Section III).

11. Set hydraulic steering limiter.

    See Section II.

12. Check oil level.

    See Section III.

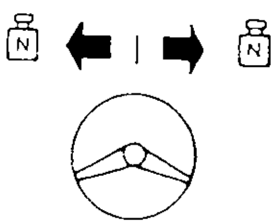
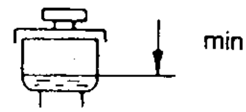
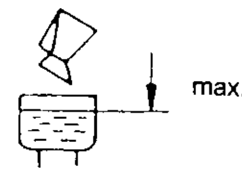
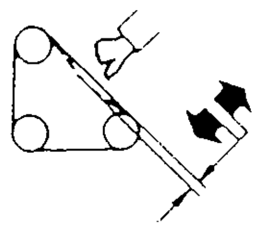
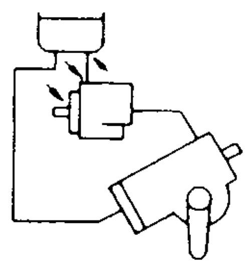
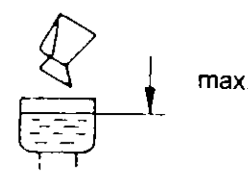
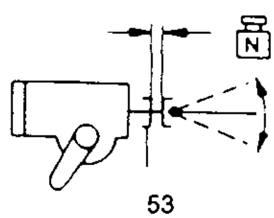
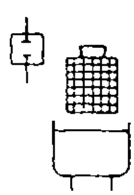
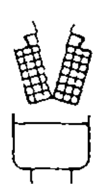
XI. Troubleshooting

ZF hydraulic power steering systems have been developed for heavy use. They are constructed so that no malfunctions can occur with perfect maintenance and under normal operation.

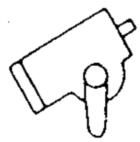
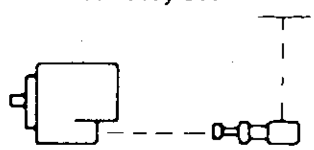
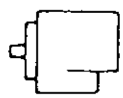
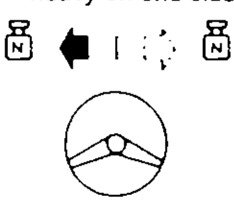
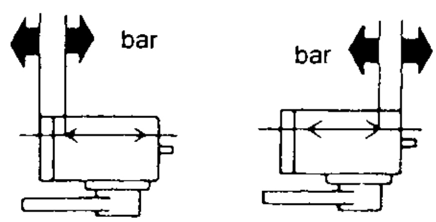
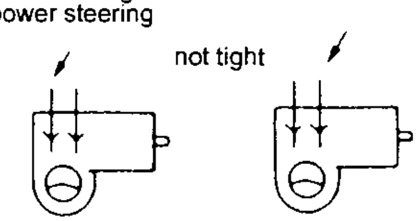
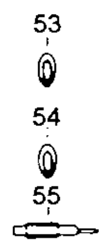
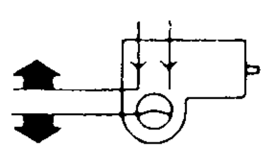
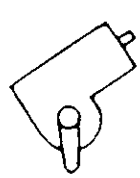
However, if this should not be the case, the following information should help locate and eliminate any problems.

Before examining the steering system for the individual faults, check the oil level with the engine running. The exact procedure for oil filling is described in detail in a separate section.

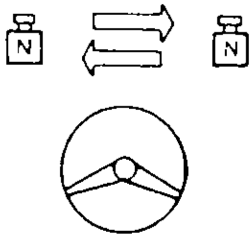
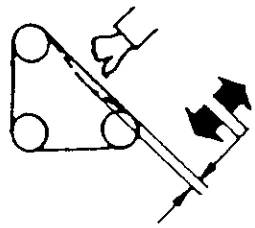
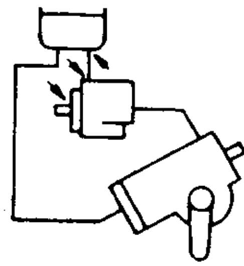
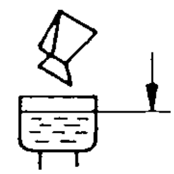
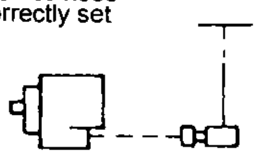
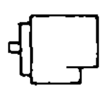
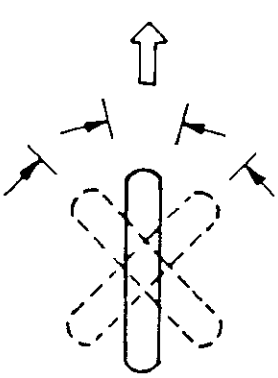
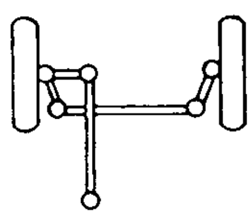
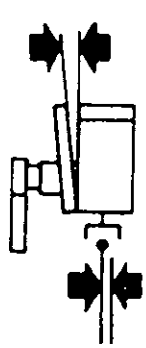
We must also point out that the use of very frothy oils can lead to faults, since such oils can only release air with difficulty, or not at all, once it has penetrated the steering system.

Fault	Cause	Remedy
heavy on both sides 		eliminate leakage 
		tension V–belt [1]
		replace seals [1]  ventilate
		grind off / replace [1]
	 contaminated/ broken	replace, clean control valve, suction line
		replace, clean control valve, suction line

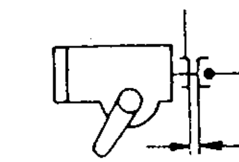
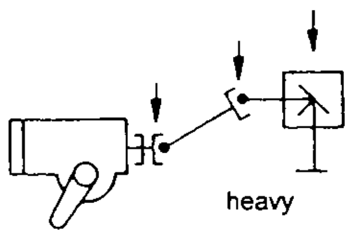
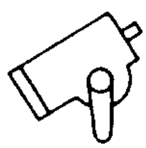
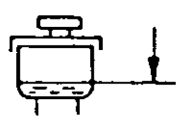
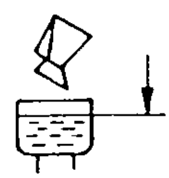
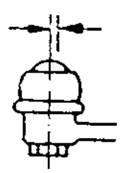
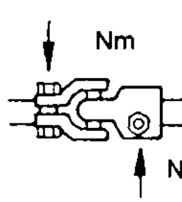
[1] refer to instruction of vehicle manufacturer

Fault	Cause	Remedy
	 internal fault	exchange steering ☐1
	does not close – incorrectly set  729	clean replace
	 internal fault	exchange pump ☐1
heavy on one side 	Servocom 	set section II
	Recirculating ball power steering not tight  	replace
	bar 	set section II
	internal fault 	exchange steering ☐1

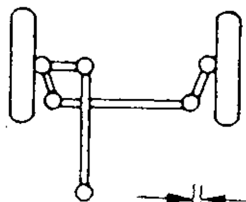
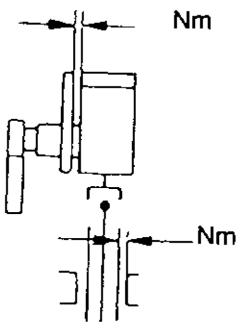
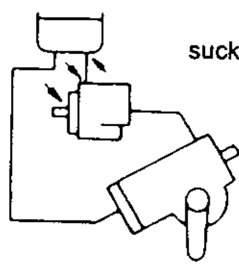
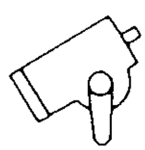
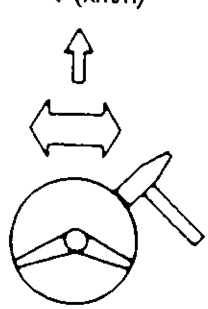
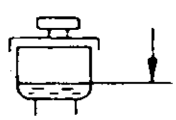
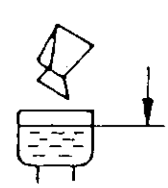
☐1 refer to instructions of vehicle manufacturer

Fault	Cause	Remedy
heavy on quick steering 		tension V–belt [1]
	sucks in air 	replace seal  ventilate
	does not close – incorrectly set 	clean; replace
	 internal fault	exchange pump [1]
inhibiting return V (km/h) 	 heavy	lubricate [1]
	distorted 	loosen bracing [1]

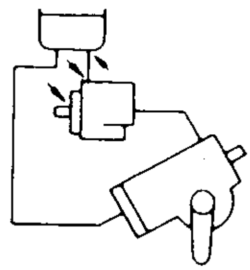
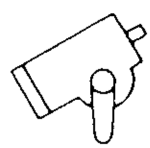
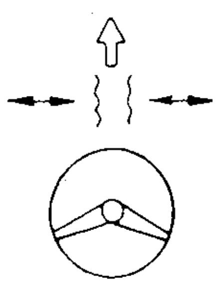
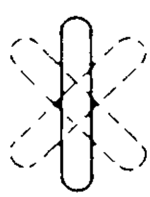
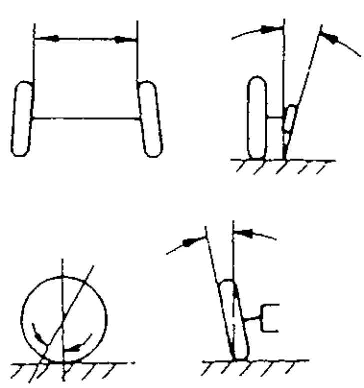
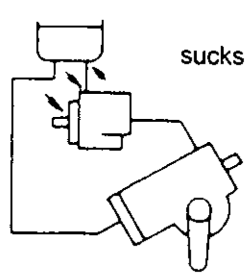
[1] refer to instructions of vehicle manufacturer

Fault	Cause	Remedy
	53  sticks	grind off / replace ☐1
	 heavy	lubricate / replace ☐1
	 internal fault	exchange steering ☐1
not exact V (km/h) 	 min.	eliminate leakage  max. ventilate
		tighten / exchange ☐1
	 Nm	tighten / exchange ☐1
	Nm  Nm	tighten / exchange ☐1

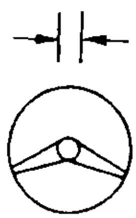
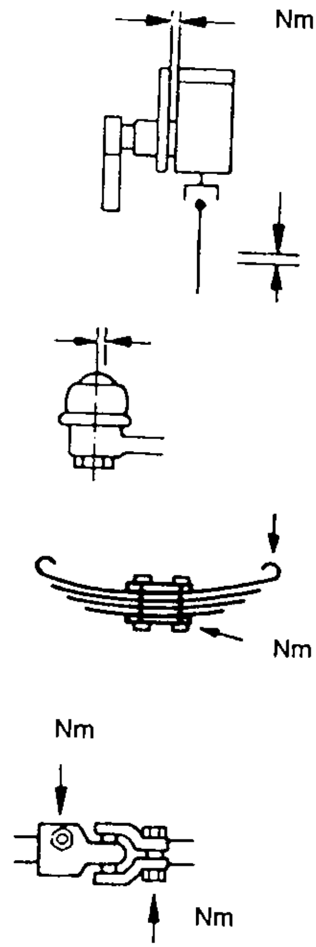
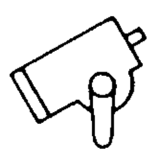
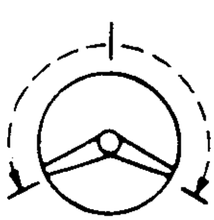
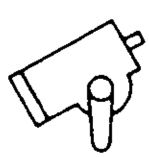
☐1 refer to instructions of vehicle manufacturer

Fault	Cause	Remedy
	 heavy	lubricate [1]
		tighten [1]
	 sucks in air	replace seals ventilate
	 internal fault	exchange steering [1]
steering wheel locks V (km/h) 		eliminate leakage 
		replace [1]

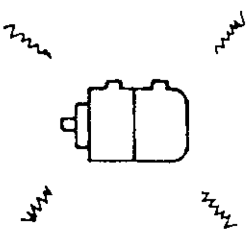
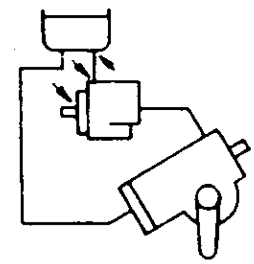
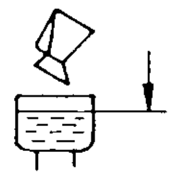
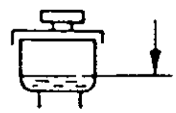
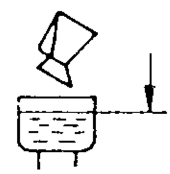
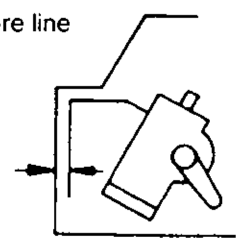
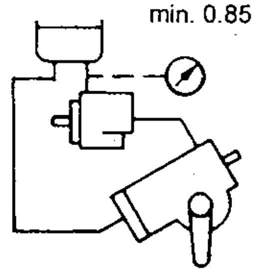
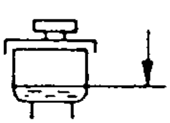
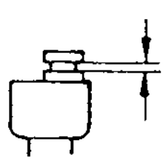
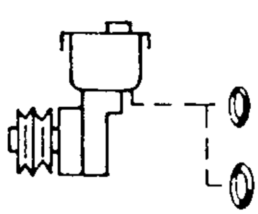
[1] refer to instructions of vehicle manufacturer

Fault	Cause	Remedy
	 sucks in air	replace seals ventilate
	 internal fault	exchange steering [1]
torsional vibrations V (km/h) 	 imbalance	balance [1]
		set [1]
	 sucks in air	replace seals ventilate

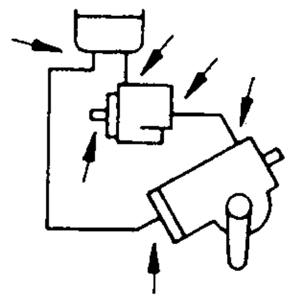
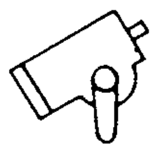
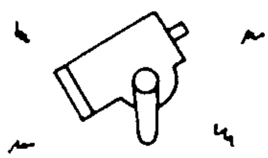
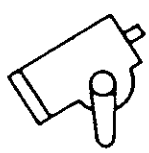
[1] refer to instructions of vehicle manufacturer

Fault	Cause	Remedy
play in steering wheel 		tighten / replace [1]
	 internal fault	exchange steering [1]
runs out 	 internal fault	exchange steering [1]

[1] refer to instructions of vehicle manufacturer

Fault	Cause	Remedy
noises 	sucks in air 	replace seals  max. ventilate
	 min.	eliminate leakage  max.
	pressure line 	rubber retainer [1]
	min. 0.85 bar 	ZF service agency
loss of oil  min.		close
	 616 617	replace

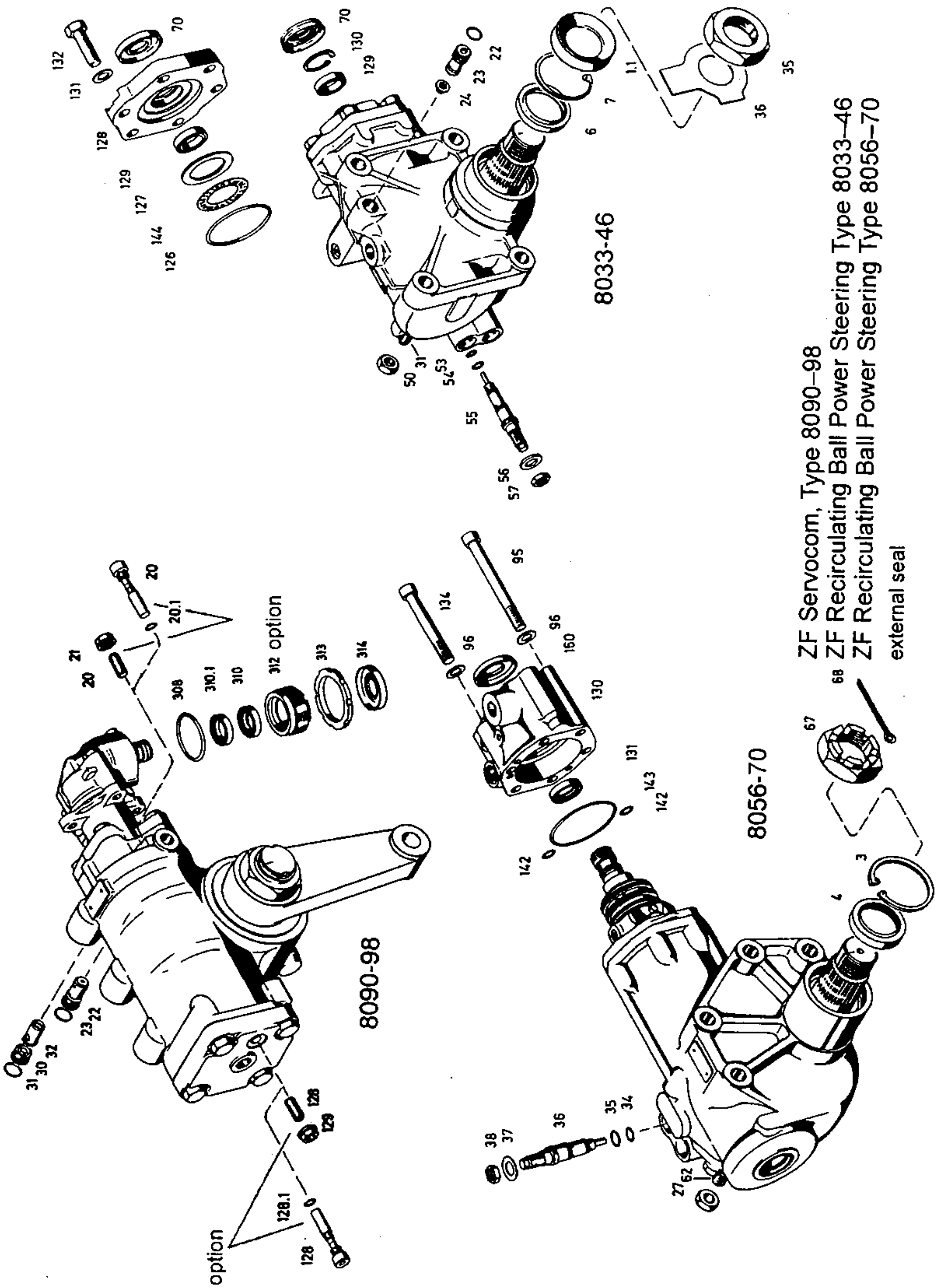
[1] refer to instructions of vehicle manufacturer

Fault	Cause	Remedy
		replace seals tighten lines
	 internal fault	exchange steering [1]
noises 	 internal fault	exchange steering [1]

[1] refer to instructions of vehicle manufacturer

XII. Key to numbers in illustrations and exploded views

1.	Housing
1.1	Dust seal
3	Circlip / Locking ring
4	Shaft seal
6	Shaft seal
7	Circlip / Locking ring
20	Stud / screw
20.1	O–ring
21	Flanged nut / Collar nut
22	Pressure control valve
23	O–ring
24	Screen filter
27	Hexagon nut
30	Screw
31	O–ring / Adjusting screw
32	Feeder valve / Suction valve
34	O–ring
35	O–ring
36	Valve accessories
37	Washer / Disk
38	Hexagon nut
50	Grommet nut
51	Dust seal
53	O–ring
54	O–ring
55	Valve
56	Washer / Disk
57	Hexagon nut
62	Adjusting screw
70	Protective cap
95	Cheese head screw
96	Washer / Disk
122	Intermediate cover
126	O–ring
127	Bearing plate
128	Stud / Cover / Screw
128.1	O–ring
129	Flanged nut / Collar nut
130	Valve housing / Circlip / Locking ring
131	Washer / Shaft seal
132	Hexagon screw
134	Cheese head screw
142	O–ring
143	O–ring
144	Thrust needle cage / Axial needle cage
151	Valve body
152	Valve spring
153	O–ring
154	Setting plate / Adjusting plate
155	Valve guide
156	O–ring
157	Circlip / Locking ring
158	Plug screw
160	Protective cap
306	Bevel gear wheel
308	O–ring
310	External shaft seal
310.1	Internal shaft seal
312	Adjusting screw
313	Slotted nut / Grooved nut
314	Protective cap



ZF Servocom, Type 8090–98
ZF Recirculating Ball Power Steering Type 8033–46
ZF Recirculating Ball Power Steering Type 8056–70

CONTENTS

ILLUSTRATIONS

1. INTRODUCTION

The vehicle is provided with an air suspension system. The system consists of air springs, height control valves, tie rods, radius rods, sway bars, tripod and shock absorbers. The system operation is fully automatic and maintains a constant vehicle height regardless of load, or load distribution.

2. 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 bus shell, and to the idler arm and steering arm at the right side of the bus shell. 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. 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 (Fig. 1).

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.

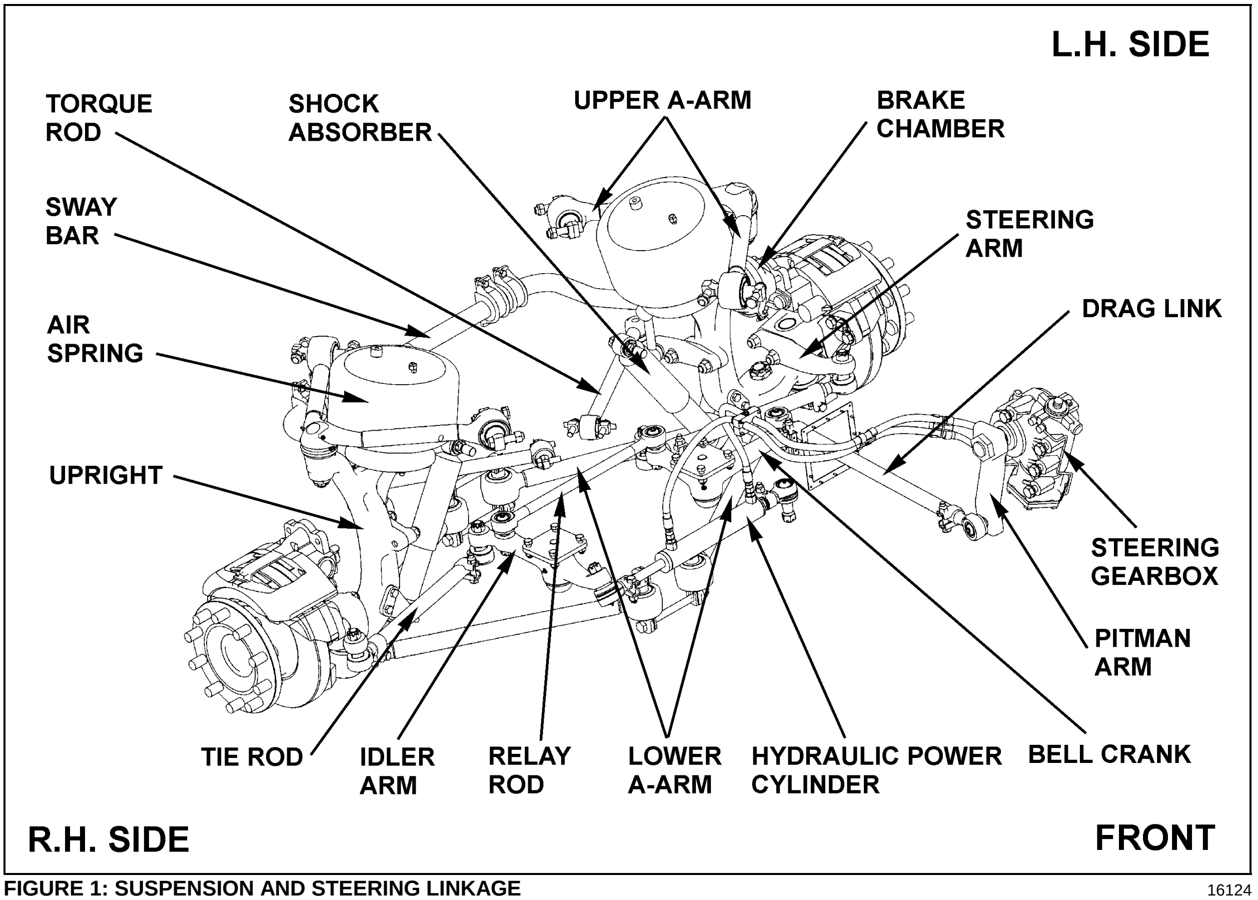


FIGURE 1: SUSPENSION AND STEERING LINKAGE 16124

Turning Angle

The maximum turning angle is set mechanically through the two steering stop screws installed on the swivel assembly. The turning angle (56° + 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 "4. 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 2 to 7 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 Maintenance Manual, Section 14, "Steering", under heading: "Setting and Functional Test".

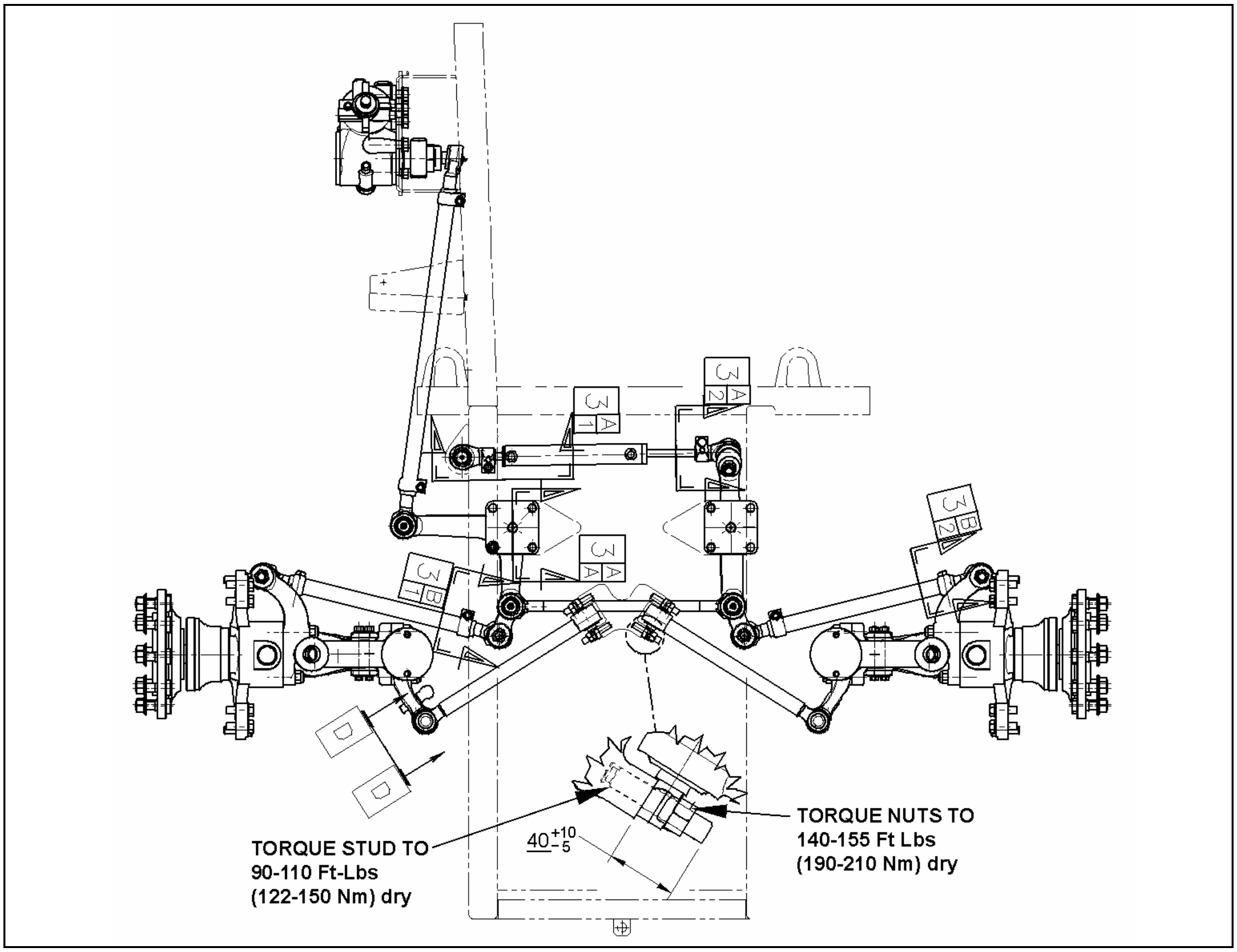


FIGURE 2: LOCATION OF CLAMPS 16177

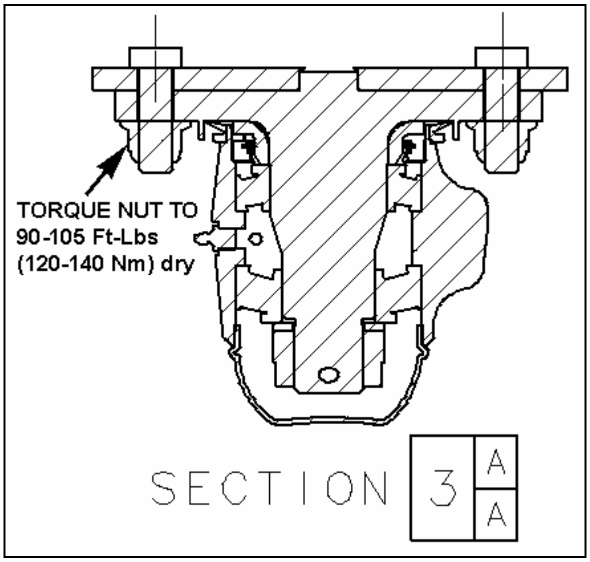


FIGURE 3: CLAMP POSITIONING 16169

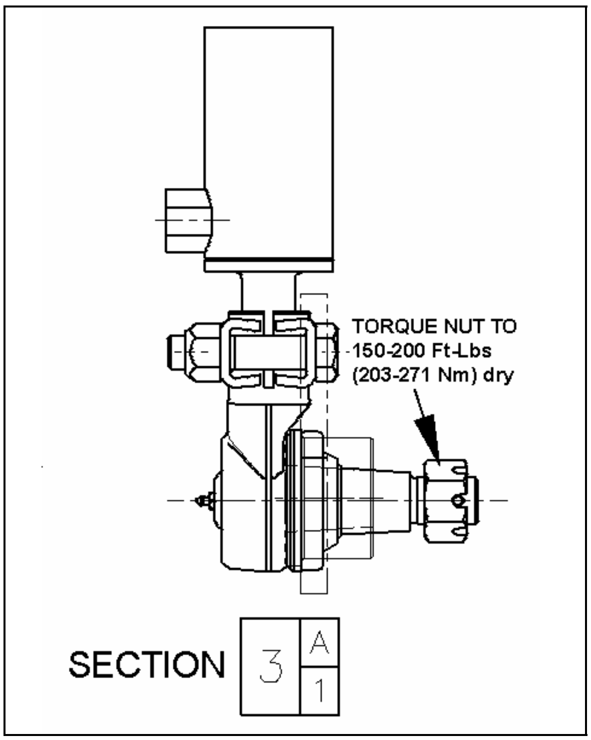


FIGURE 4: CLAMP POSITIONING 16178

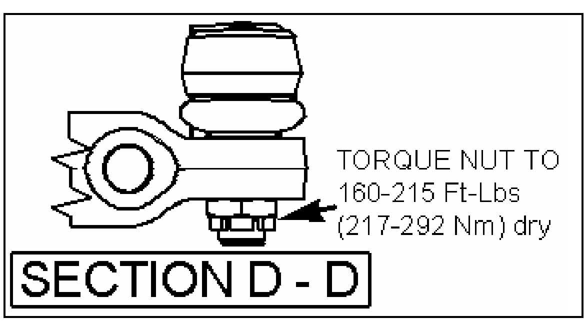


FIGURE 5: CLAMP POSITIONING 16172

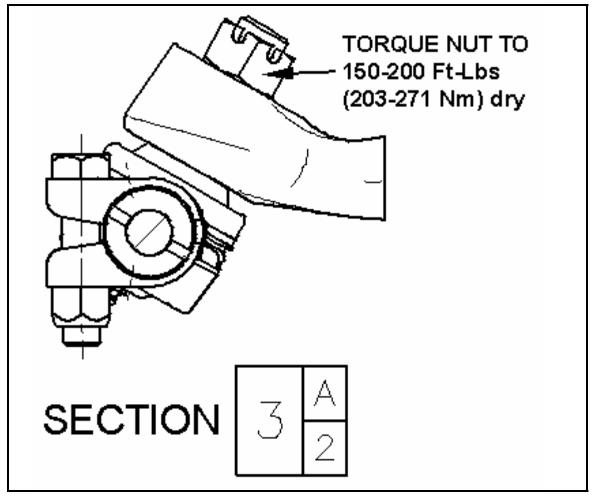


FIGURE 6: CLAMP POSITIONING 16179

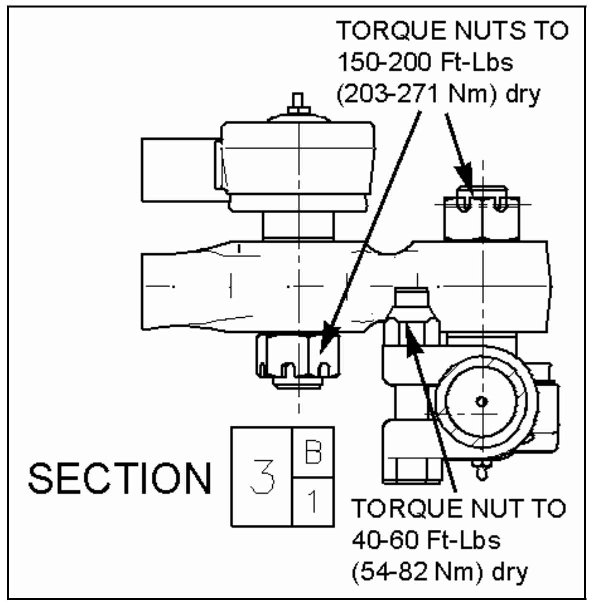


FIGURE 7: CLAMP POSITIONING 16170

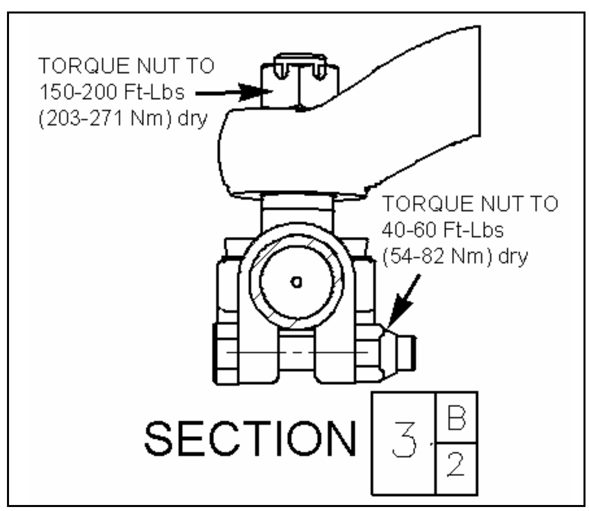


FIGURE 8: CLAMP POSITIONING 16171

2.1 POWER STEERING HYDRAULIC PUMP

Refer to the "TRW Power Steering Pump Service Manual" annexed at the end of Section 14

2.2 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 Table" at the end of this section.

1. First, align the input shafts marks.
2. Afterwards, the pitman arm should be adjusted with reference marks aligned or to an angle of 90° in relation with the horizontal axis (Fig. 9).
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.

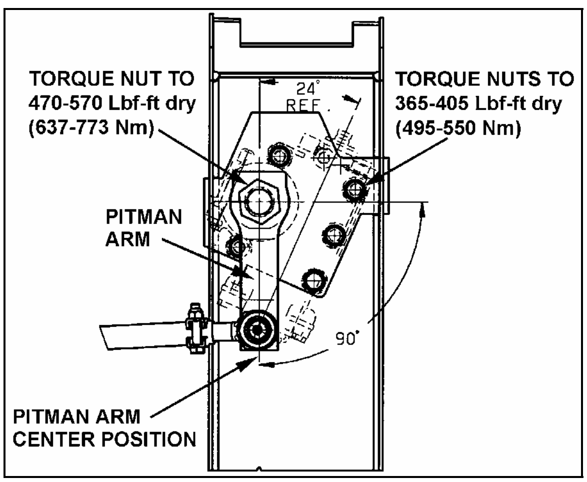


FIGURE 9: PITMAN ARM ALIGNMENT 14057

2.3 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.

2.4 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.

CAUTION

Lock nut with sector shaft using a punch mark into the groove (Refer to figure 10).

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.

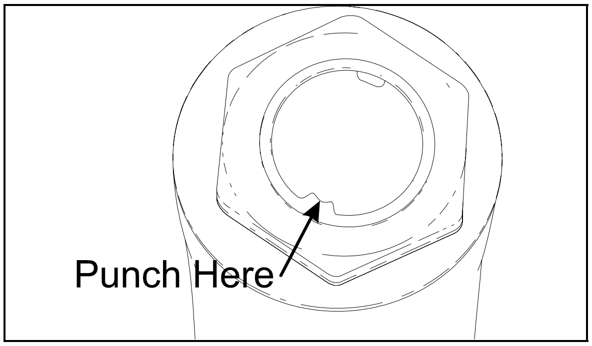


FIGURE 10: FIXING NUT PUNCH MARK 16098

2.5 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.

2.5.1 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 "2.2 Steering Linkage Adjustment".
3. Remove cotter pin, nut 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 with 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.

2.6 BELL CRANK AND IDLER ARM

Bell crank and idler arm are equipped with one lubrication fitting and should be lubricated as directed in paragraph "2.10 Lubrication Fittings" at the end of this Section.

2.6.1 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 and nuts from ball studs. Separate socket assemblies from the bell crank.

Idler arm: Remove cotter pins and nuts from ball studs connecting relay rod, tie rod and hydraulic power cylinder to idler arm. Separate socket assemblies from idler arm.

Remove nuts from bolts attaching bell crank or idler arm mounting spindle to suspension subframe. Remove bell crank or idler arm mounting spindle.

2.6.2 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. 11).
3. Remove the cotter pin, nut and thrust washer. Remove bearings, grease retainer, backup ring and the bell crank or idler arm from its mounting spindle (Fig. 11).

2.6.3 Bell Crank or Idler Arm Ball Joint Reassembly

NOTE
For bearing installation use Prévost tool # 110684.

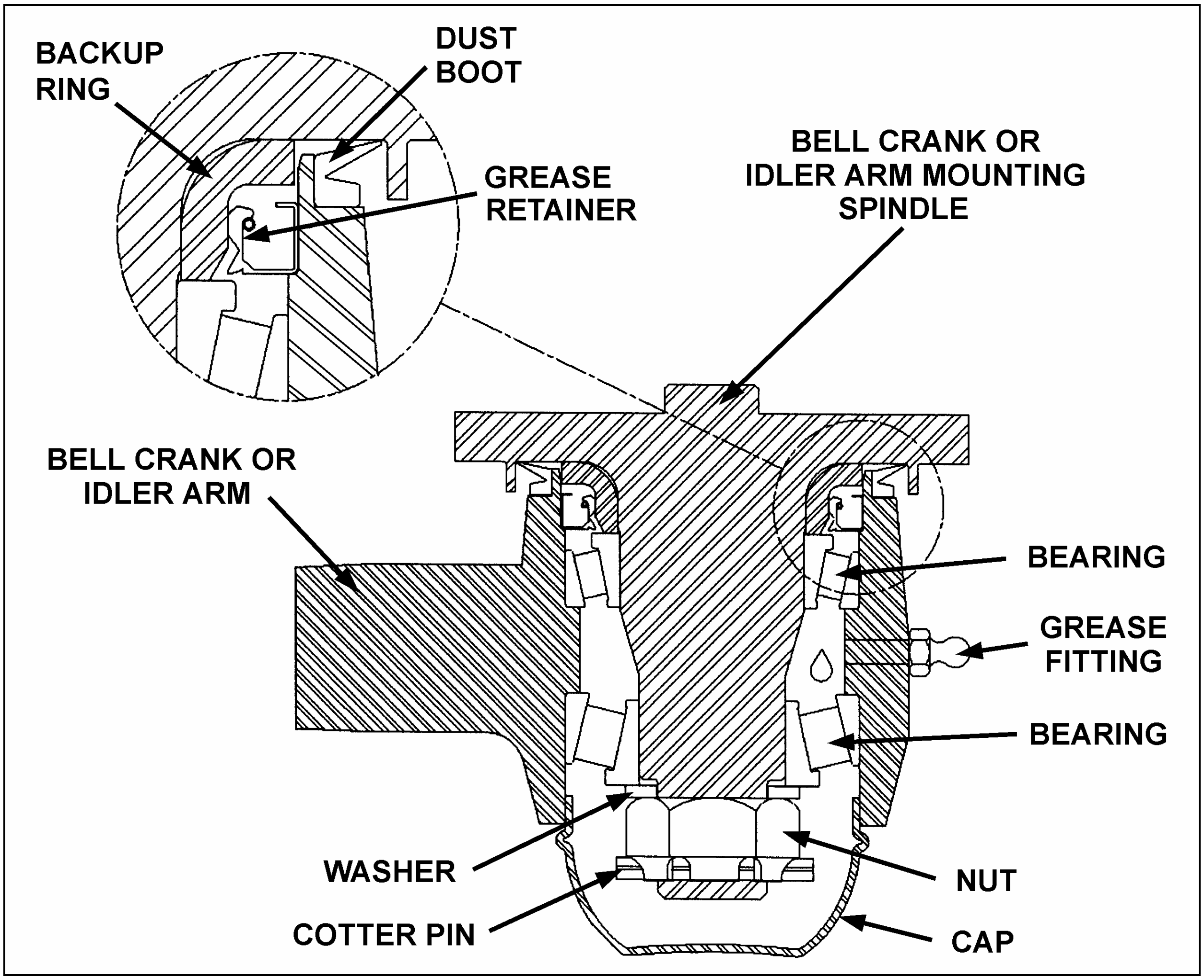


FIGURE 11: BELL CRANK AND IDLER ARM 16109

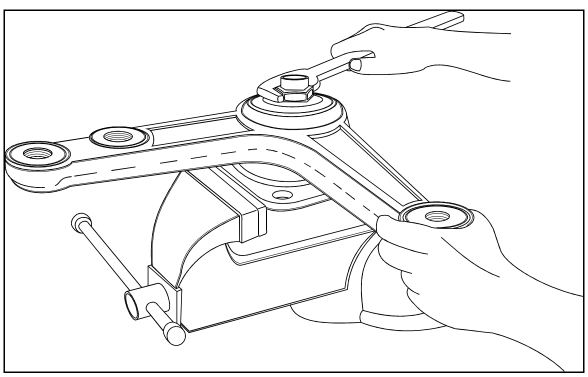


FIGURE 12: BELL CRANK 16044

1. Install backup ring on bell crank or idler arm mounting spindle.
2. Install grease retainer and bearing in bell crank or idler arm eye (Fig. 11).

NOTE
Install grease retainer according to figure 11. Grease must be able to exit the bell crank or idler arm mechanism. For grease retainer installation use tool Prévost # 110683.

3. Install bell crank or idler arm onto its mounting spindle, while holding the bell crank or idler arm, slide on the bearing assembly, thrust washer and secure using nut. (Fig. 12).

NOTE
Apply grease on bearing before installation.

4. Unscrew nut until bell crank or idler arm starts to turn by the application of 1 to 3 pounds load (Fig. 13).

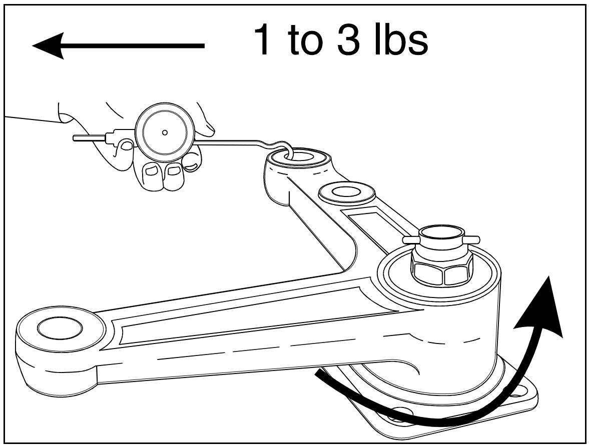


FIGURE 13: BELL CRANK 16045

5. Check for loose bearings by applying an up and down load on bell crank or idler lever. The lever is not supposed to move in the vertical axis direction.
6. Align nut with cotter pin slot (tighten) and install a new cotter pin.

NOTE
Bend cotter pin around the nut (Fig. 11). Do not bend the cotter pin in the direction of the cap, because it may interfere with the cap.

7. Install the cap.
8. **Bell crank:** Install drag link, tie rod and relay rod as directed herein under each specific subject.
9. **Idler arm:** Install hydraulic power cylinder, tie rod and relay rod as directed herein under each specific subject.
10. Adjust turning angle as previously directed under paragraph "**Turning Angle**" and check front end alignment as specified in paragraph "4. Front End Alignment" of this Section.

2.7 RELAY ROD

Relay rod ends are equipped with lubrication fittings and should be lubricated as directed in paragraph "2.10 Lubrication Fittings" in this Secttion.

NOTE
The relay rod is crimped in place and it is not possible to remove the ball joints.

2.7.1 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 then remove studs.
4. Position new relay rod studs into bell crank and idler arm then tap stud ends with a brass hammer to seat tapered surfaces.
5. Install stud nuts. Tighten nuts to 150-200 lbf-ft (203-271 Nm) torque. Align cotter pin slot (tighten) and install a new cotter pin.

2.8 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 interchangeable from the right to the left side of the coach.

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 "2.10 Lubrication Fittings" in this section.

2.8.1 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.

2.8.2 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 "4.4.2 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.

2.9 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.

2.9.1 Removal

1. Remove wheel as directed in Section 13, "Wheel, Hubs And Tires" of the maintenance manual.
2. Remove cotter pin 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 bolts securing steering arm to steering knuckle assembly. Remove steering arm from steering knuckle.

2.9.2 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 (M24 X 100) to 751-830 lbf-ft (1018-1125 Nm).
3. Position tie rod ball stud in steering arm and tap with a brass hammer to seat ball stud in steering arm. Install nut on stud. Torque nut to 150-200 lbf-ft dry (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 "3.2 Installation" of the maintenance manual.

2.10 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. 14) 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. **Swivel Assembly:** Refer to DANA SPICER MAINTENANCE MANUAL NDS AXLES Lubrication and Maintenance" annexed at the end of section 11.

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).

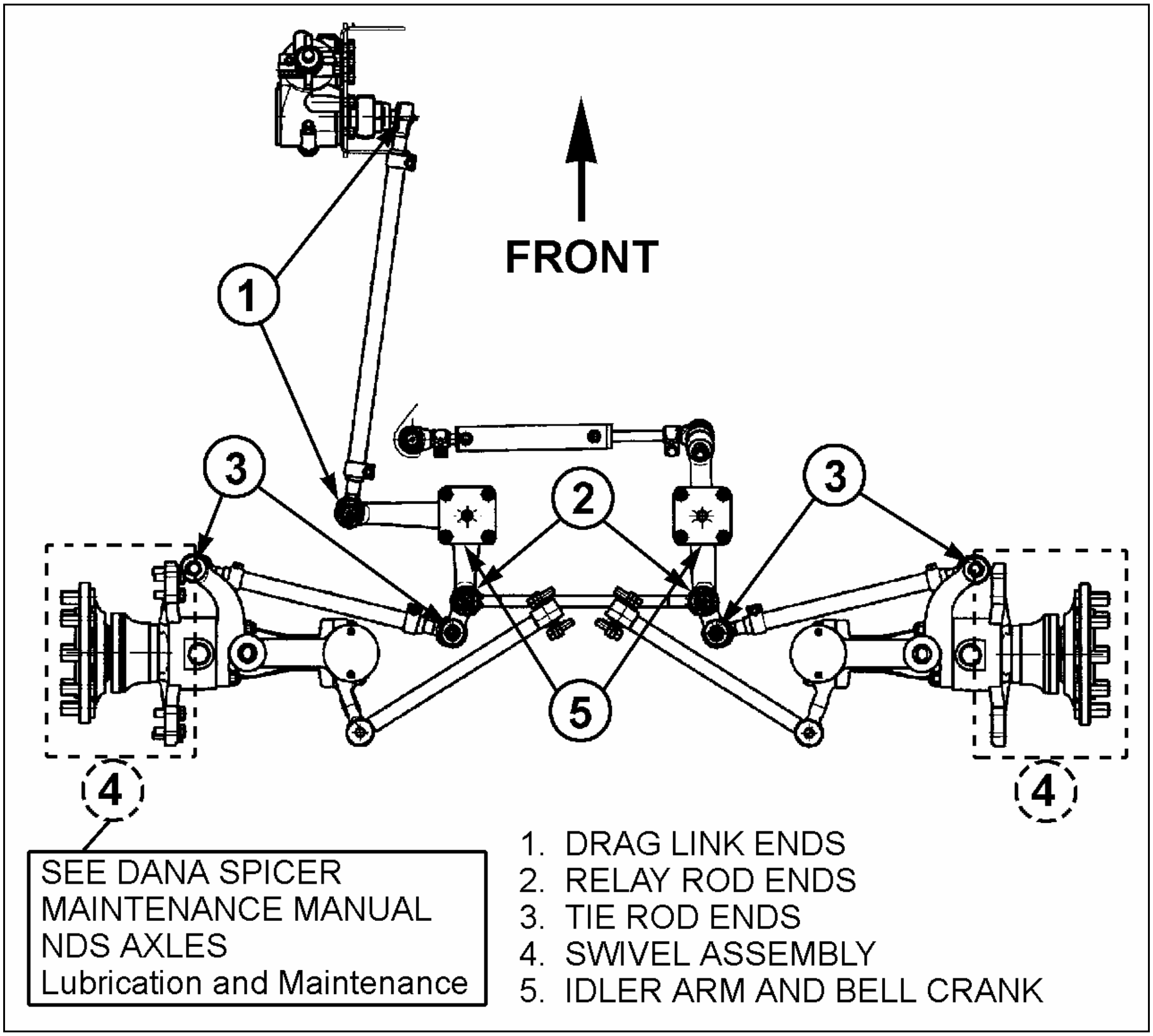


FIGURE 14: LUBRICATION FITTINGS' LOCATION DIAGRAM 16118

3. BALL JOINTS

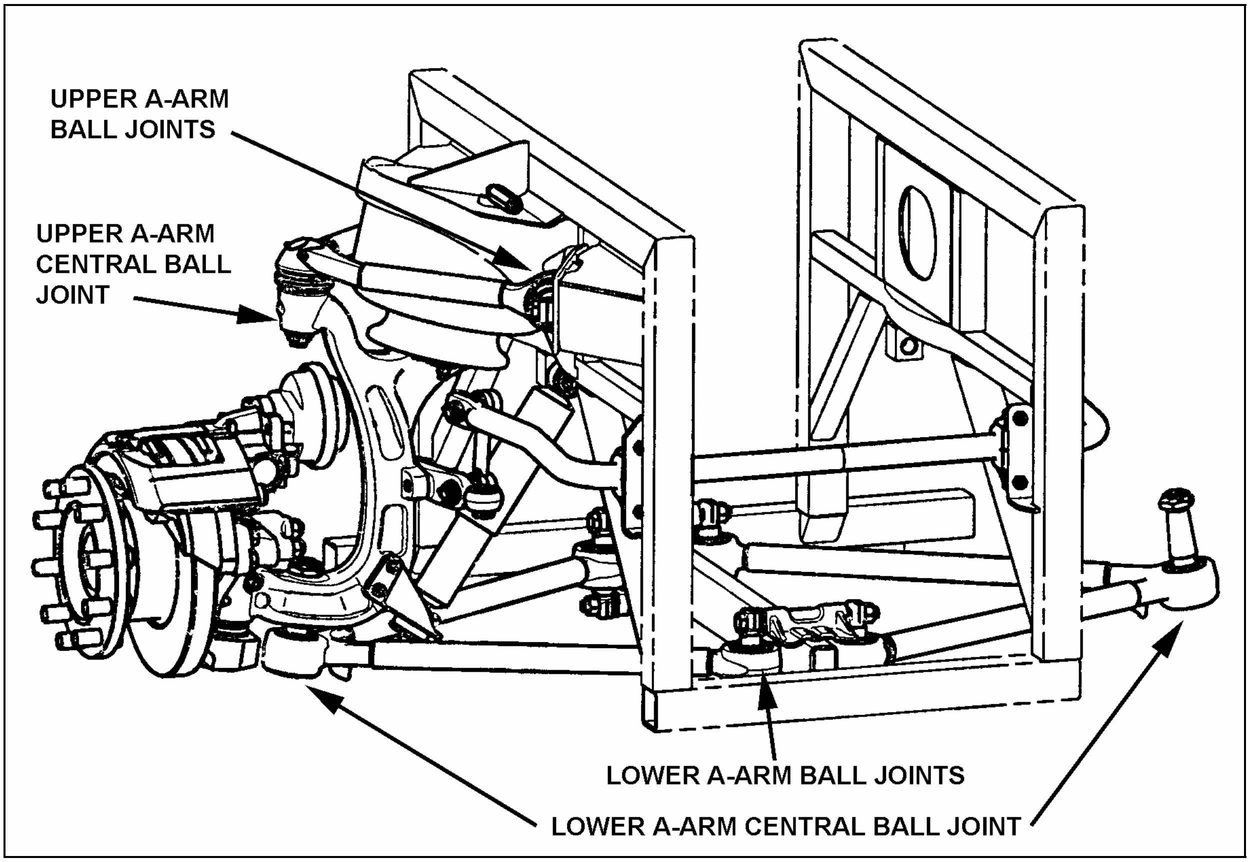


FIGURE 15: BALL JOINTS LOCATION 16137

3.1 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.

3.1.1 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. <u>Free play is not acceptable</u>.

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.

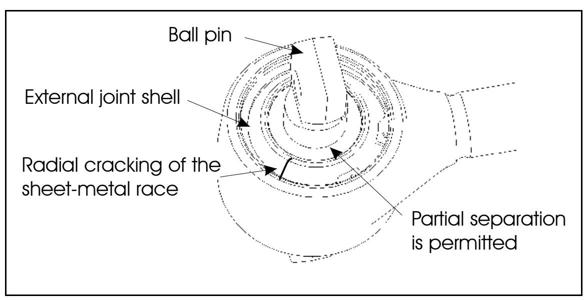


Figure 16: A-ARM BALL JOINTS

3.1.2 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.

3.1.3 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 (Prévost # 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.

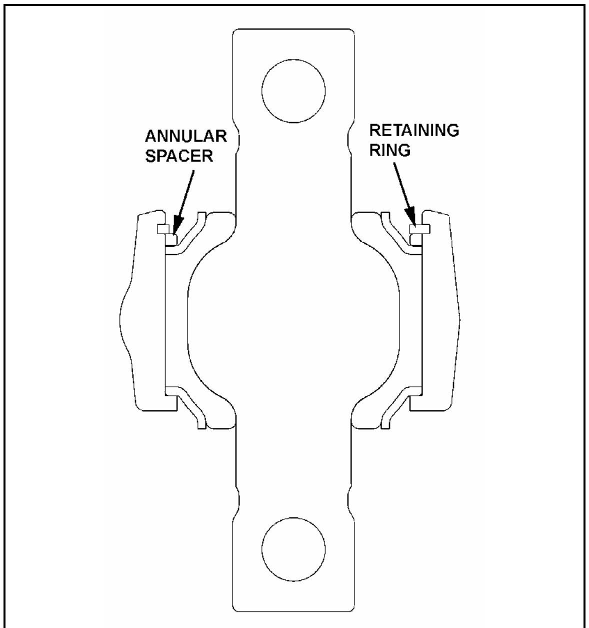


FIGURE 17: LOWER A-ARM BALL JOINT 16114

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.

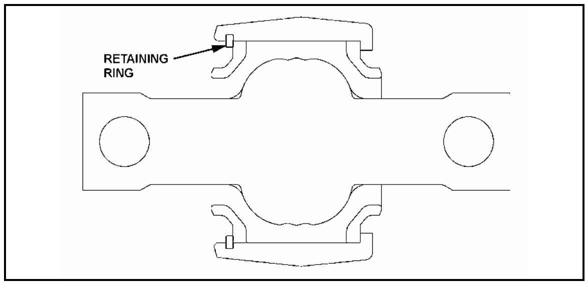


FIGURE 18: UPPER A-ARM BALL JOINTS 16115

3.2 LOWER A- ARM CENTRAL BALL JOINT

3.2.1 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.

3.2.2 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

3.2.3 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.

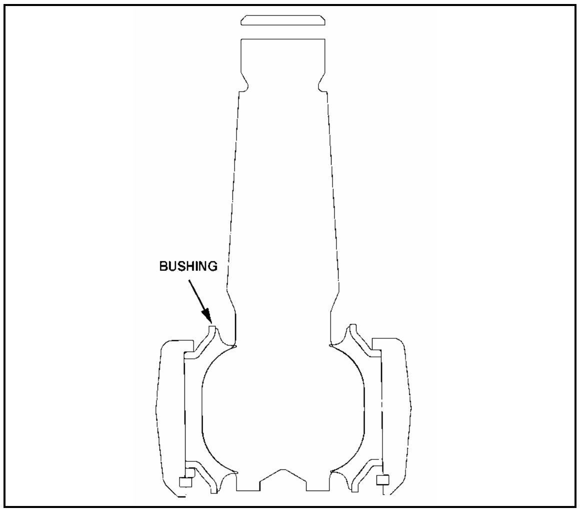


FIGURE 19: LOWER A-ARM CENTRAL BALL JOINT

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.

3.3 UPPER A-ARM CENTRAL BALL JOINT

3.3.1 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.

3.3.2 Play Measurement

1. Raise the vehicle and support through axle jacking points.
2. Using a caliper, measure dimension A on figure 20.
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" (1.5mm), then the ball joint should be replaced.

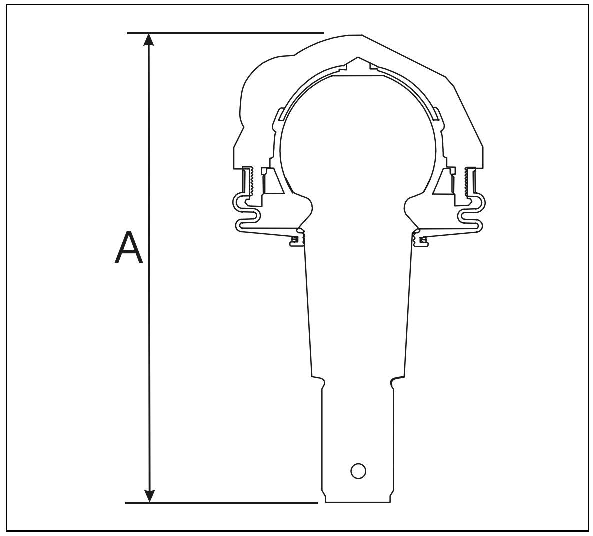


FIGURE 20: UPPER A-ARM CENTRAL BALL JOINT 16116

4. 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 ISS suspension. 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 24.
- 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.

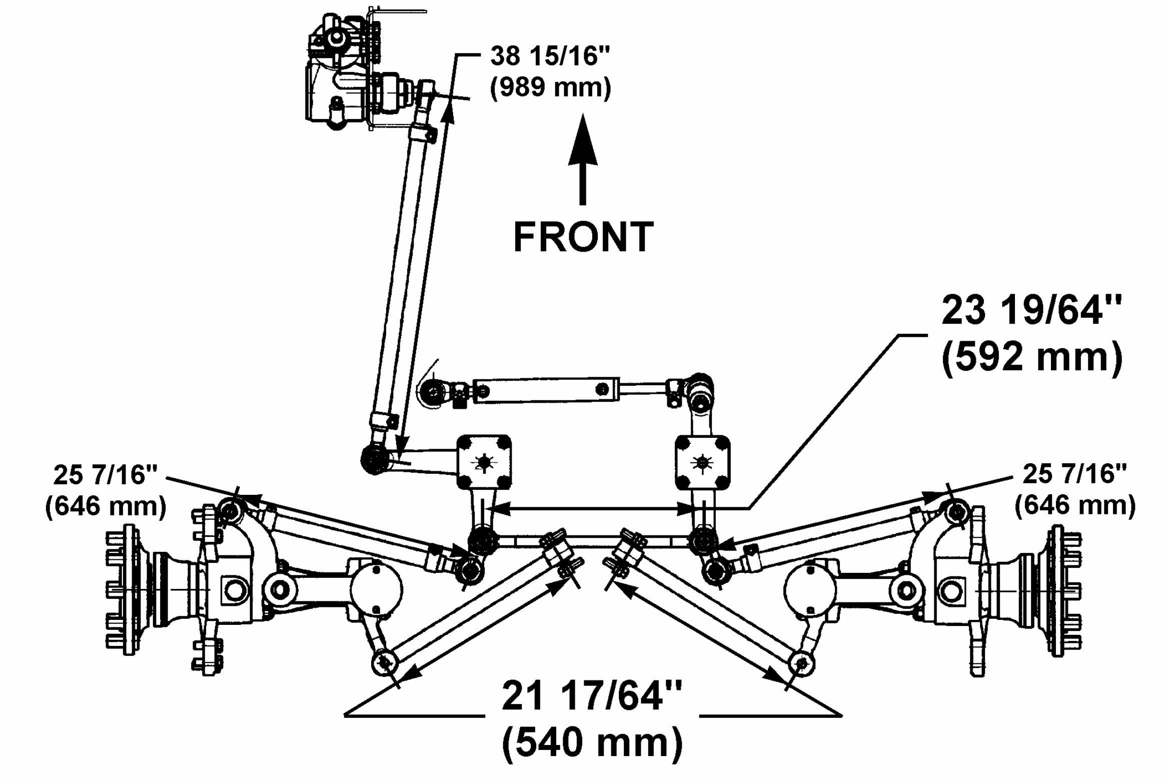


FIGURE 21: STEERING LINKAGE MEASURE 16132

4.1 ALIGNMENT TERMINOLOGY

Wheel Camber

The amount the wheels are inclined from the vertical plane (A, Fig. 22).

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. 22).

King Pin Inclination

The inclination of the king pin from vertical toward the center of the vehicle at the top and outward at the bottom (B, Fig. 22).

Front Axle Caster

The inclination of the king pin from vertical in the fore and aft direction (C, Fig. 22).

4.2 FRONT END INSPECTION

Before checking front end alignment, make the following inspection:

1. Check that the vehicle is at normal ride height (see paragraph "9. 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 king pins for looseness.
7. Check if the length of the torque rods is 21 17/64" (540 mm) (Fig. 21). Check if the length of the relay rod is 23 19/64" (592 mm).

4.3 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 King pin inclination. If King pin inclination is incorrect, readjust the camber and check king pin inclination again.

NOTE
Camber is more important than king pin inclination, so adjust camber and verify king pin inclination.

Shim the lower suspension arm to adjust camber. If the king pin inclination is incorrect, the wheel king 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.

4.4 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.

4.4.1 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.

4.4.2 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 "4.4.1 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 9.

NOTE
Use only tie rods to adjust toe-in.

4.5 FRONT AXLE CASTER

Positive caster is the inclination of the top of the king pins toward the rear of the vehicle. Negative or reverse caster is the inclination of the king 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 king 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.

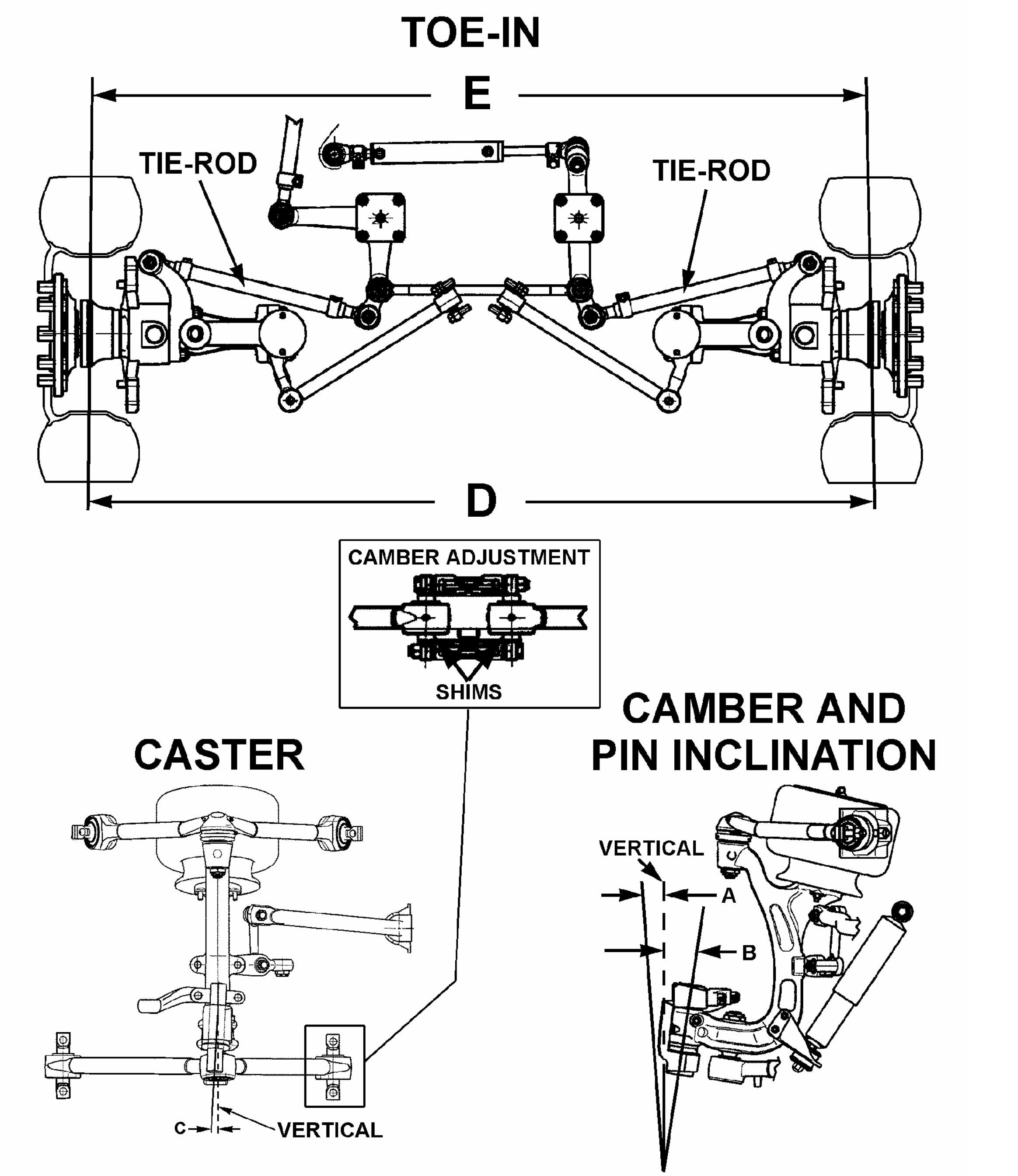


FIGURE 22: FRONT END ALIGNMENT DIAGRAM 16133

ALIGNMENT SPECS (See Figure 22)							
		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	KING 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 reduce returnability when pulling out of curves.

4.6 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 "4. Front End Alignment".

5. 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.

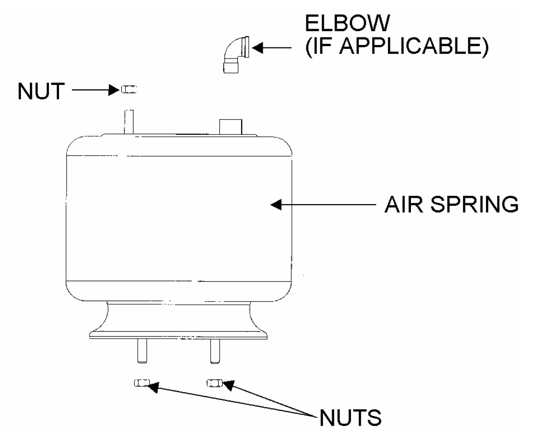


FIGURE 23: AIR SPRINGS 16052

5.1 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.

5.2 REMOVAL

> NOTE
>
> *Front air springs can be removed without removing the entire suspension assembly.*

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.

5.3 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.*

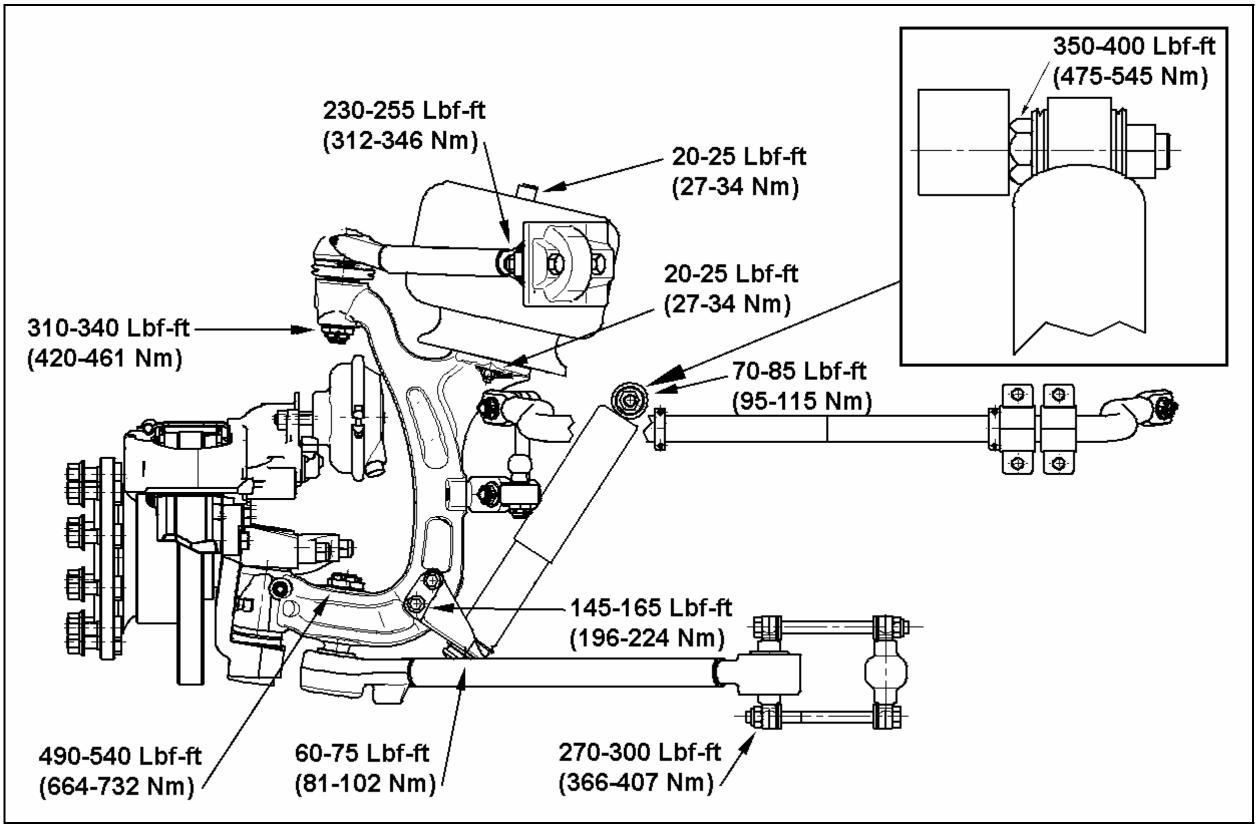


FIGURE 24: AIR SPRING AND SHOCK ABSORBER 16180

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.

6. 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.

6.1 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 25 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.

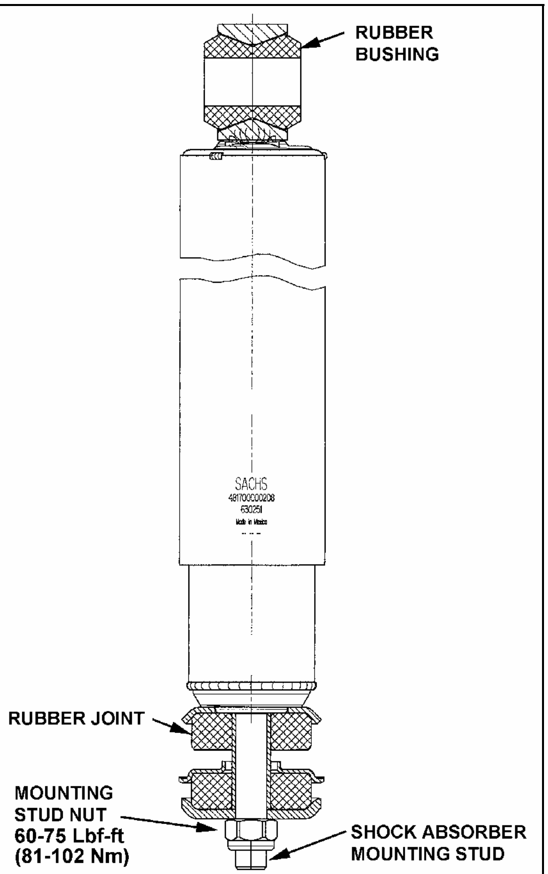


FIGURE 25: SHOCK ABSORBER 16181

6.2 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. 25).
4. Install washer and rubber joint on shock absorber mounting stud (lower side).
5. Install the shock absorber as shown in figure 24 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 60-75 lbf-ft (81–102 Nm).
7. Place the upper mounting pin stud nut and torque to 70-85 lbf-ft (95–116 Nm).

7. 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.

7.1 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.

7.2 INSTALLATION

1. Loosely install the sway bar.
2. Torque bushing collar nuts to 80-100 lbf-ft dry (110-135 Nm).
3. Torque sway bar link upper nuts to 165-200 lbf-ft dry (225-270 Nm) on front suspension and to 100-120 lbf-ft dry (135-163 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 70-80 lbf-ft dry (95-110 Nm) on rear suspension.

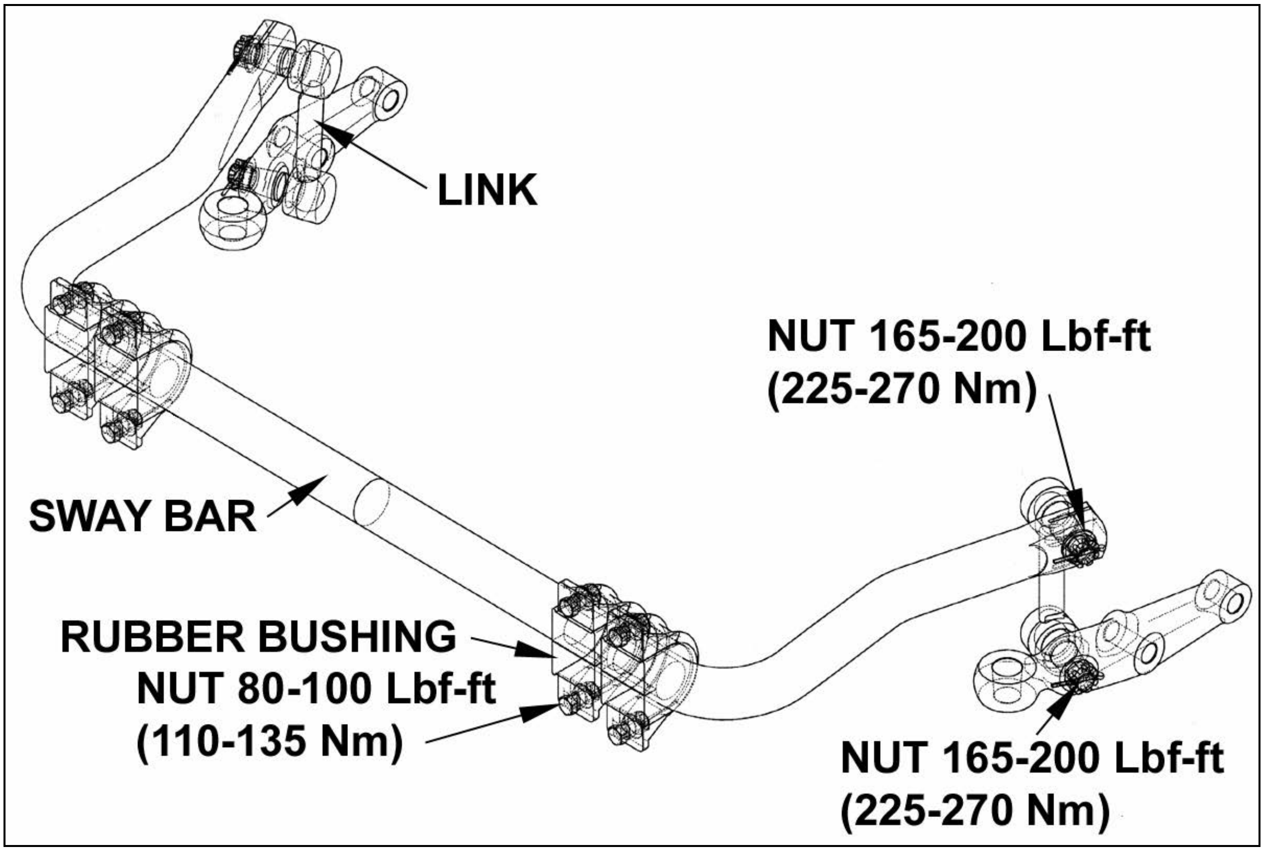


FIGURE 26: SWAY BAR (FRONT SUSPENSION) 16138D

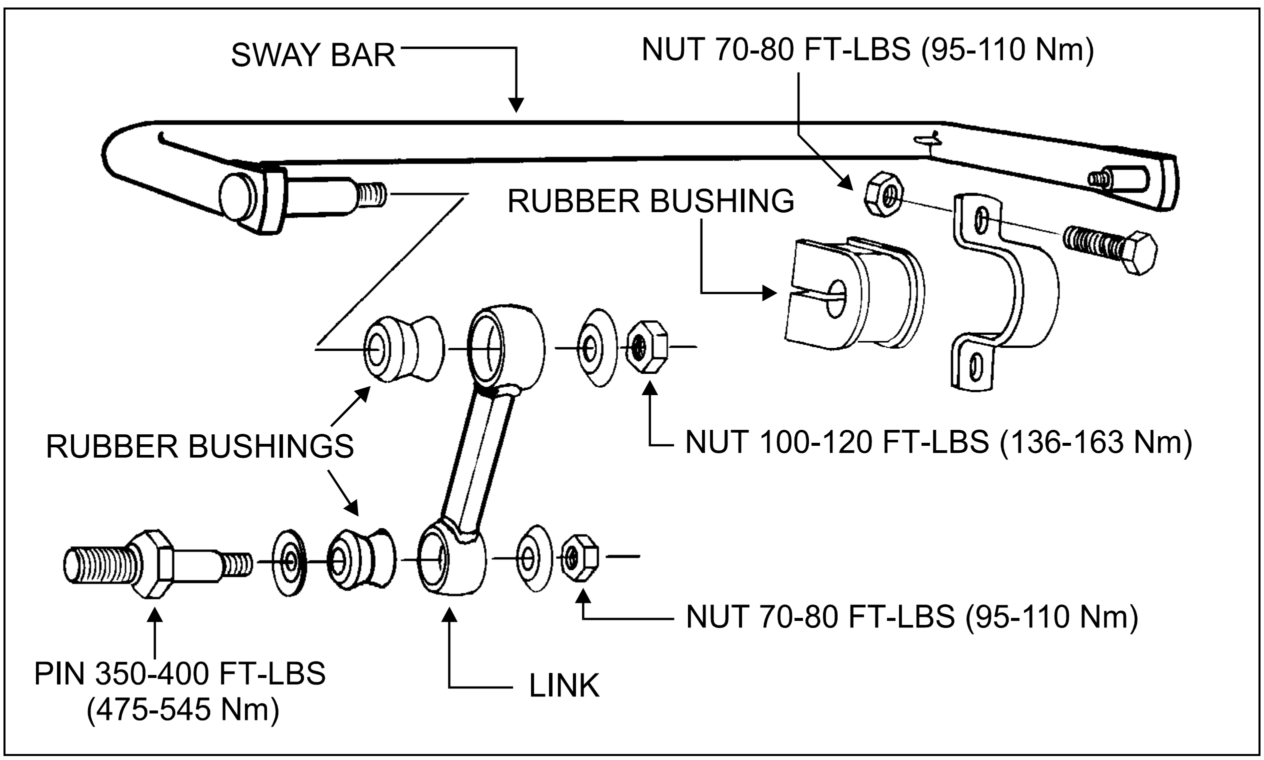


FIGURE 27: SWAY BAR (REAR SUSPENSION) 16014

8. REAR SUSPENSION

For a description of all these systems, refer to the appropriate heading in this section.

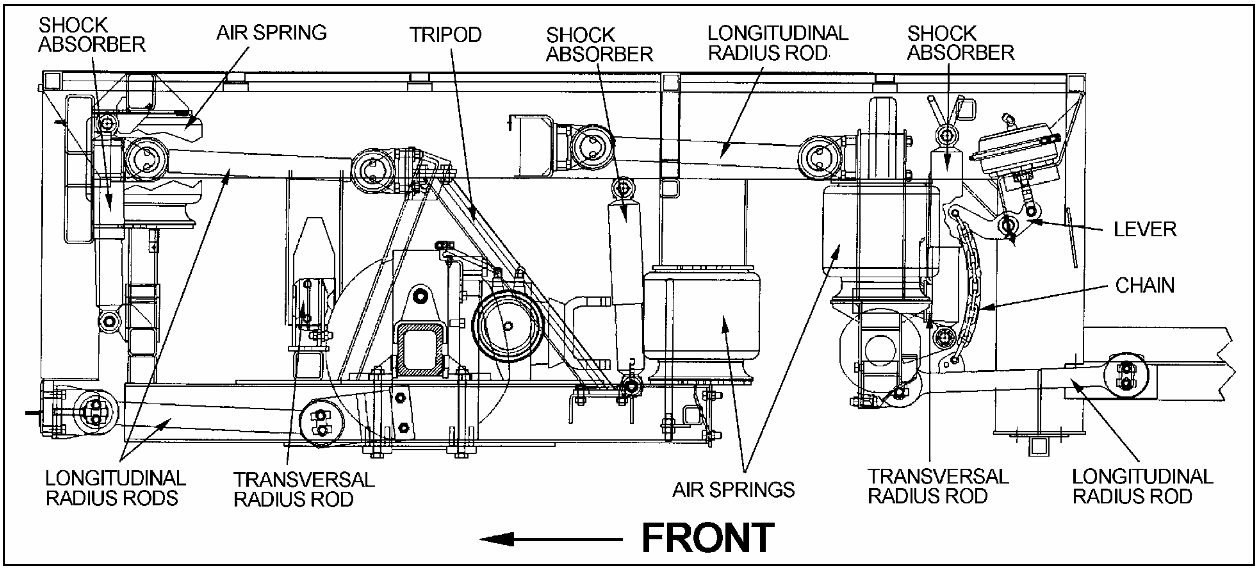


FIGURE 28: REAR SUSPENSION COMPONENTS 16140

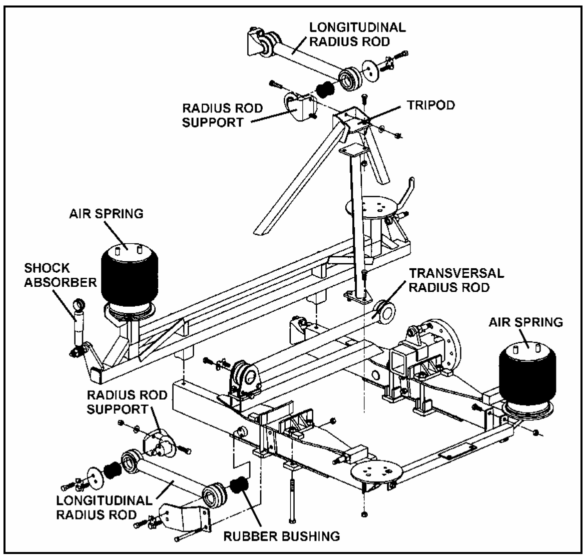


FIGURE 29: DETAILS OF REAR SUSPENSION 16106

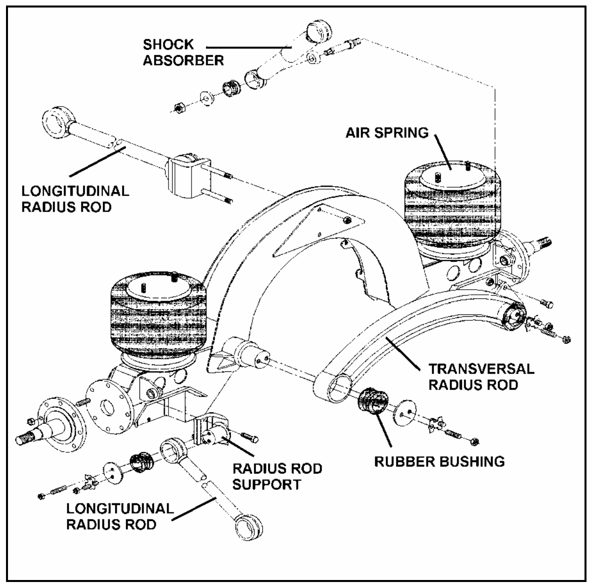


FIGURE 30: TAG AXLE SUSPENSION 16107

8.1 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. Each of the two axles is provided with air springs that are attached to the subframe and to the axles (Fig. 31).

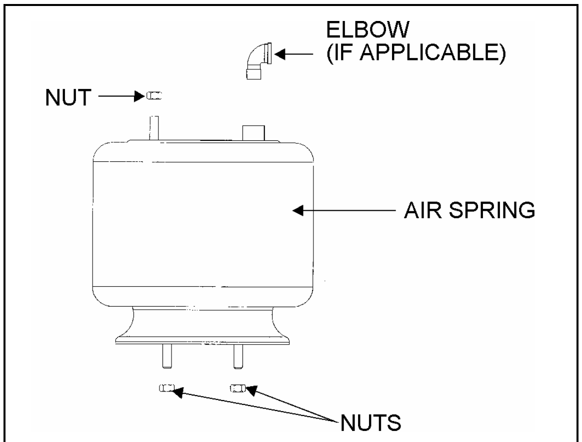


FIGURE 31: AIR SPRING 16052

8.1.1 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.

8.1.2 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.

8.1.3 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.

8.2 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. 28, 29 and 30).

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.

8.2.1 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.

8.2.2 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 32 for details.
2. Remove the shock absorber assembly from pins.
3. Remove the two inner bushings from the shock absorber and discard them.

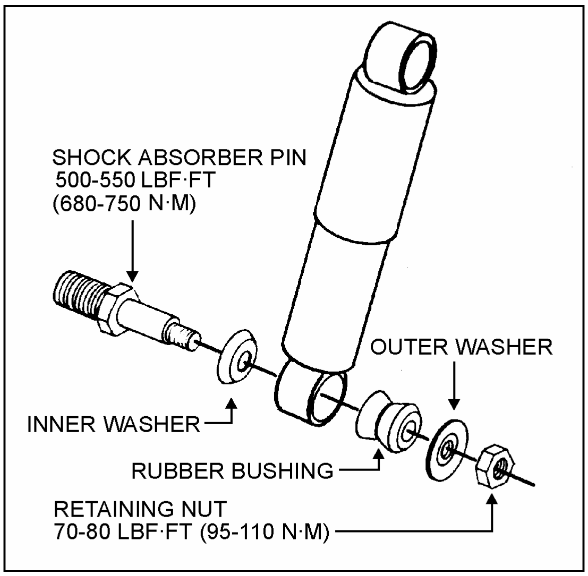


FIGURE 32: SHOCK ABSORBER 16008

8.2.3 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. 33).
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).

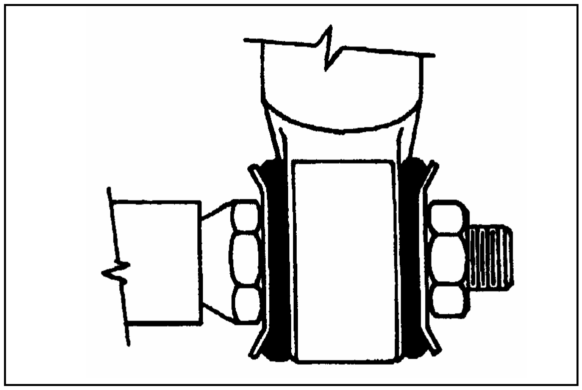


FIGURE 33: TYPICAL SHOCK ABSORBER SETUP 16009

5. Place the lower and upper mounting pin stud nuts and torque to 70 - 80 lbf-ft (95 – 110 Nm).

8.3 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 28, 29 and 30 for details. These rods transmit both braking and driving forces from the axles to the vehicle body.

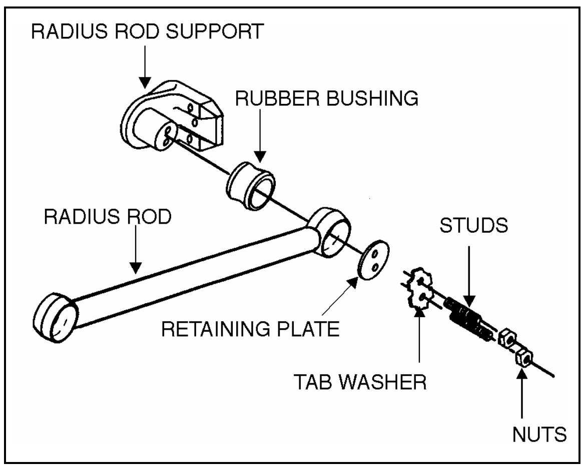


FIGURE 34: TYPICAL RADIUS ROD SETUP 16010

8.3.1 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.

8.3.2 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. 34).
2. Remove the tab washer and the retaining plates and radius rod ends from anchor pins, and then remove the radius rod.

8.3.3 Bushing removal

1. Safely support the radius rod as shown in figure 35.

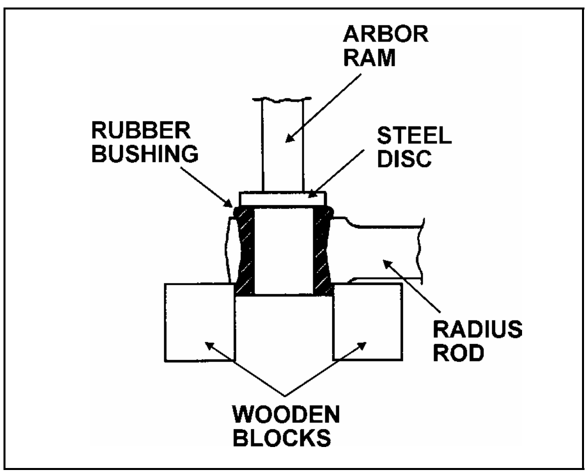


FIGURE 35: RADIUS ROD BUSHING REMOVAL 16011

2. Place a flat steel disc, slightly smaller than the outside diameter of the bushing (Fig. 35).
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.

8.3.4 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. 36).
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.

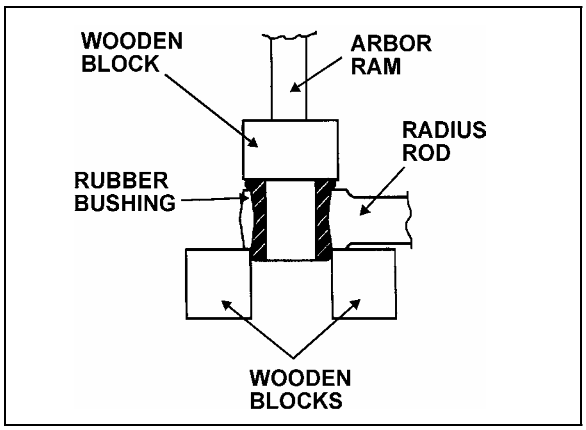


FIGURE 36: RADIUS ROD BUSHING INSTALLATION 16012

8.3.5 Installation

1. Lightly spray the radius rod support with water. Place the radius rod end over the radius rod support (Fig. 36).
2. Position the retaining plate. Install the tab washer and nuts (or bolts).

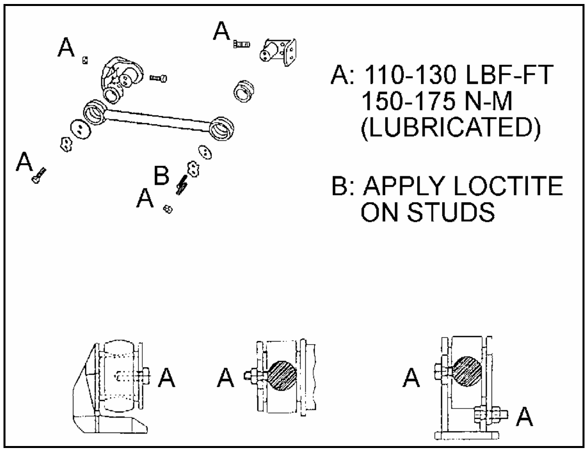


FIGURE 37: RADIUS ROD INSTALLATION 16028

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.

9. 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, one on each inner side of rear wheelhousing and connected to the rear axles through an arm and link connection. The front valve is mounted to the subframe **at center of front sway bar** and connected to the front air tank support (Fig. 38). The front height control valve regulates air to front suspension air springs in order to maintain the vehicle at the required height. 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.

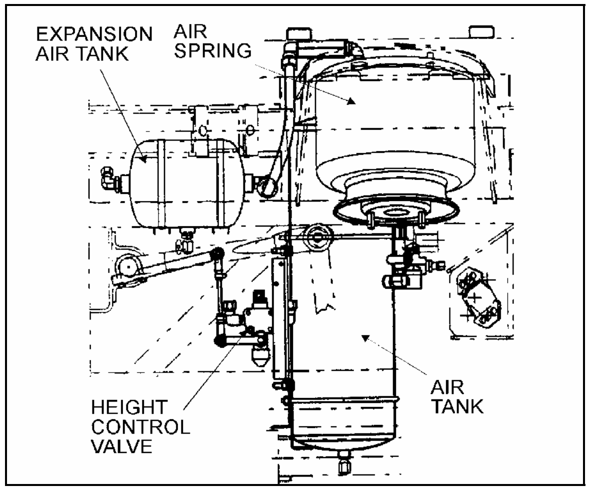


FIGURE 38: HEIGHT CONTROL VALVE LOCATION 16057

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 39 to identify the correct area to take measurement. The rear air springs clearance should be 11 ½ ± ¼" (292 ± 6 mm).

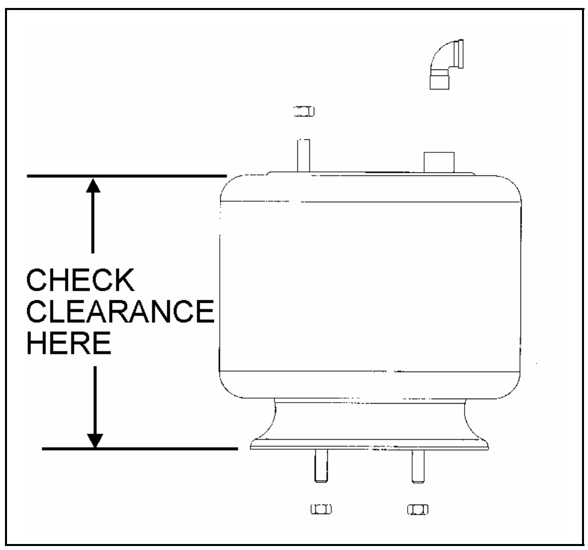


FIGURE 39: TYPICAL AIR SPRING CLEARANCE 16058

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.

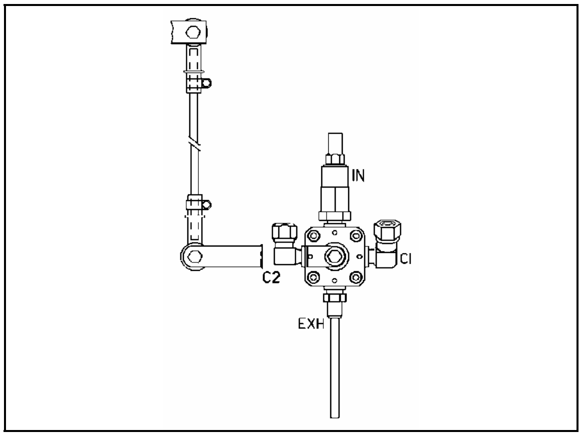


FIGURE 40: FRONT HEIGHT CONTROL VALVE 16100

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 39 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. 40).

NOTE

Allow suspension to stabilize before taking reading.

When the desired height is obtained, tighten clamp.

Rear air springs 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 39 for more details).

2. Loosen the clamp on the height control valve rubber coupling and bring it up or down (Fig. 41).

NOTE

Allow suspension to stabilize before taking reading.

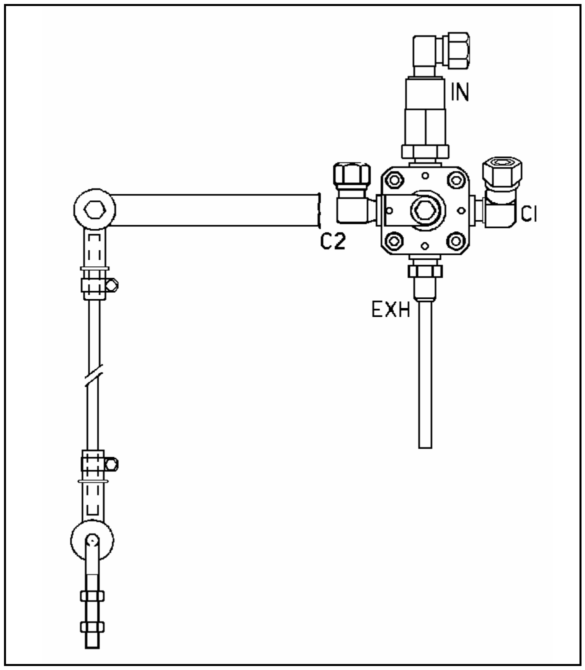


FIGURE 41: REAR HEIGHT CONTROL VALVE 16093

When the desired height is obtained, tighten clamp.

10. 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:

10.1 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.

10.2 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.

10.3 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.

10.4 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.

10.5 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.

11. "LEVEL-LOW" LEVELING SYSTEM

Bus shells are equipped with "LEVEL-LOW" leveling system. The purpose of the "LEVEL-LOW" is to adjust suspension in three separate points (front, rear right and rear left air springs) in order to level vehicle body. Three height control valves, automatically control air pressure in the three separate points (air springs) and maintains 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 (Fig. 1).

NOTE

Only for preliminary adjustment, refer to figure 21. 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 suspension in three separate points (front, rear right and rear left) in order to level 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.

11.1 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.

11.2 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”*.

12. 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. 42).

In addition, an expansion air tank is installed in series with each air spring.

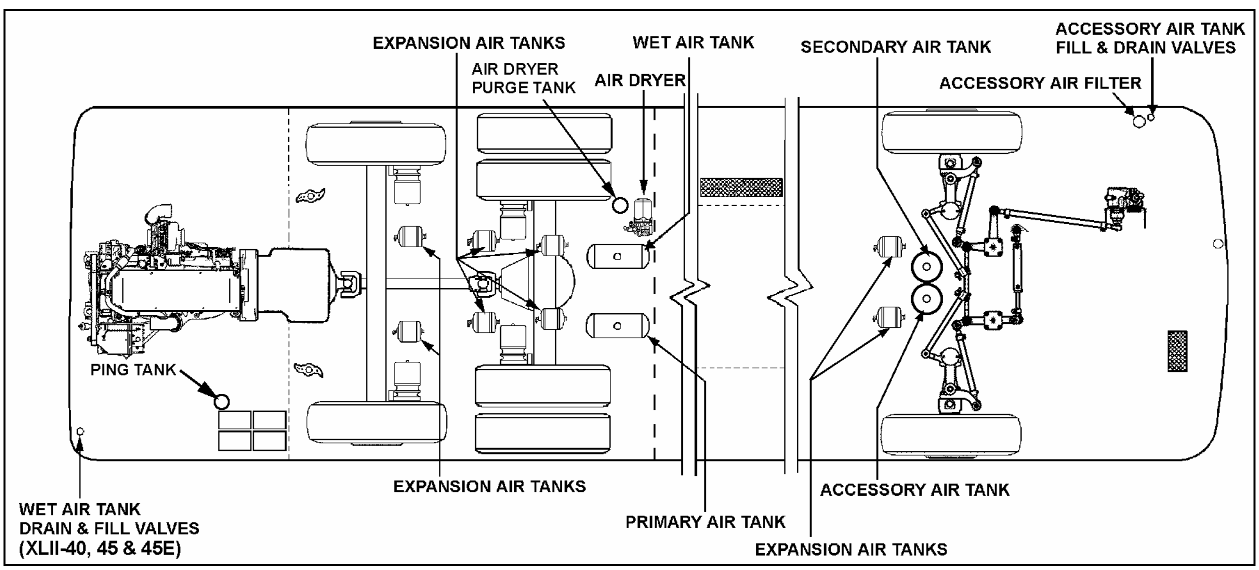


FIGURE 42: LOCATION OF AIR TANKS

12.1 AIR TANK MAINTENANCE

Ensure that the accessory 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 steering compartment (Fig. 42).

Moreover, purge all tanks by their bottom drain valves at specified intervals.

12.1.1 Wet Air Tank

This tank is installed above L.H. wheel of drive axle, 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. 43).

12.1.2 Primary Air Tank

The primary air tank is located above R.H. wheel of drive axle.

This tank is provided with a bottom drain valve (Fig. 42). 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.

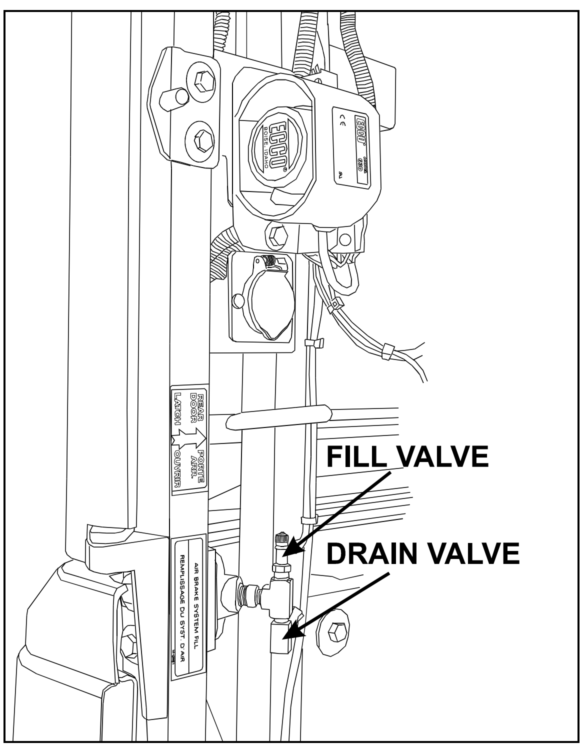


FIGURE 43: REAR VALVE LOCATION 12202

12.1.3 Secondary Air Tank

This tank is located in front wheelhousing, between air springs. The tank is installed vertically and is provided with a bottom drain valve (Fig. 42).

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.

12.1.4 Accessory Air Tank

The accessory air tank is installed next to the secondary air tank. The tank is installed vertically and is provided with a bottom drain valve (Fig. 42).

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. 44) underneath the accessory air filter. Refer to Section 12, paragraph "5. Accessory Air Filter" of the maintenance manual for daily purge procedure.

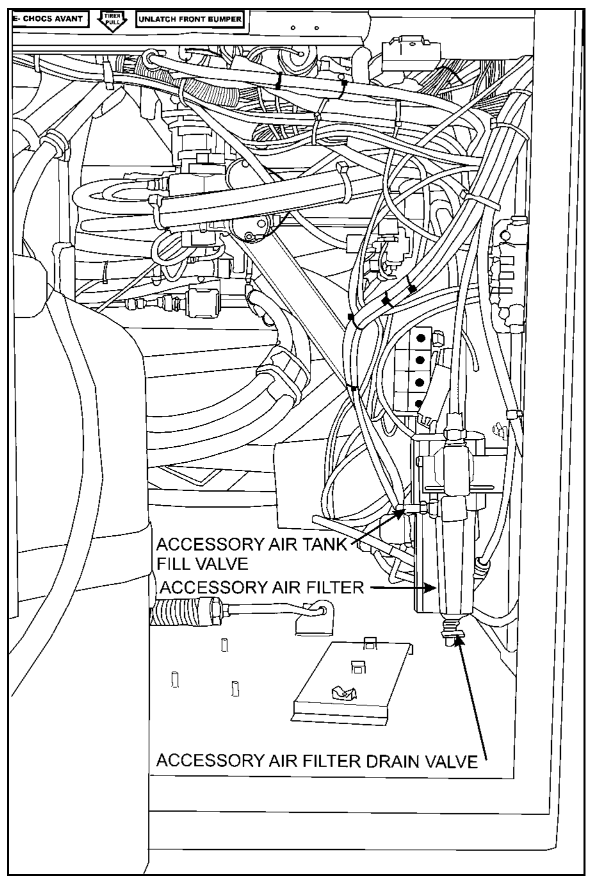


FIGURE 44: FRONT VALVE LOCATION 12218

12.1.5 Expansion Air Tank

Two expansion tanks are located in front wheelhousing. These air tanks are located behind secondary and accessory air tank. Also, six expansion tanks are located near rear air springs (Fig. 42). 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.

12.2 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. 43).

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. 44).

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 Prévost. Do not fill air through any other points.

13. HUB UNIT AND SWIVEL ASSEMBLY

Refer to “DANA SPICER Service Manual General Information, Maintenance Manual Model NDS and Maintenance Manual NDS Axles” annexed to section 11 *"Rear Axles".*

14. TORQUE TABLE

DESCRIPTION	QTY	TORQUE (DRY)	
		Lbf-ft	Nm
Pitman Arm to Steering Gear Fixing Nut	1	470-570	637-773
Steering Gear to Mounting Bracket Bolts	5	365-405	495-550
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
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 (M24 X 100)	2	751-830	1018-1125
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	110-135
Sway Bar Link Upper and Lower Nuts (Front Suspension)	2	165-200	225-270
Sway Bar Link Upper Nuts (Rear Suspension)	2	100-120	135-160
Sway Bar Link Lower Nuts (Rear Suspension)	2	70-80	95-110
Shock Absorber Pin	2	350-400	475-545
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. SPECIFICATIONS

Front Axle Air Springs

Make....................Goodyear Tire and Rubber
Model....................1400
Type....................Mae West
Diameter....................14.5 inches
Air Inlet....................1/2''- 14 NPTF
Supplier number....................1R14-167
Prévost number....................630239

Tag Axle Air Springs (WE)

Make....................Goodyear Tire and Rubber
Model....................1200
Type....................Mae West
Nominal diameter....................12” (304 mm)
Supplier number....................1R12-319
Prévost number....................630151

Tag Axle Air Springs (W0 & W5)

Make....................Goodyear Tire and Rubber
Model....................1100
Type....................Mae West
Nominal diameter....................11.5” (304 mm)
Supplier number....................1R12-319
Prévost number....................630259

Drive axle air springs

Make....................Goodyear Tire and Rubber
Model....................1100
Type....................Double Flare
Nominal diameter....................11.5” (292 mm)
Supplier number....................1R11-088
Prévost number....................630105

Front axle shock absorbers

Make....................Arvin
Color....................Black
Piston Diam.....................1 5/8 inch
Collapsed length....................14.16 inches
Extended length....................22.44 inches
Supplier number....................680510-40J
Prévost number....................630136

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)
Supplier number....................481700000209
Prévost number....................630253

Height control valve (Front)

Make...Barksdale
Quantity used 1
Supplier number 52321POAQ3-Q62
Prévost number 630157

Height control valve (Rear)

Make...Barksdale
Quantity 2
Supplier number 52321POAQ3-Q26
Prévost number 630156

Radius rod bushing

Make...Prévost
Prévost number 630021

Loctite

Make.. Loctite
Prévost number 680039

Sway bar bushing (Front Suspension)

Make...Prévost
Prévost number 630020

Sway bar bushing (Drive Axle)

Make...Prévost
Prévost number 130953

Sway bar link

Make...Tennaco Automotive
Supplier number 934400
Prévost number 630230

Shock absorber bushings

Make...Monroe
Supplier number 45380
Prévost number 630062

Air regulator

Make...Norgren
Recommended pressure sett. ....90 psi (621 kPa)
Supplier number R74G-4AT-RMN
Prévost number 641352

Shim (Camber Adjustment)

Thickness ....3.175 mm
Prévost number 160993
Thickness ....6.35 mm
Prévost number 160992

SACHS

Guideline to Evaluate Warranty Claims
Heavy-duty Shock Absorbers

Index:

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

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

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

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

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

CONTENTS

ILLUSTRATIONS

1. VEHICLE EXTERIOR

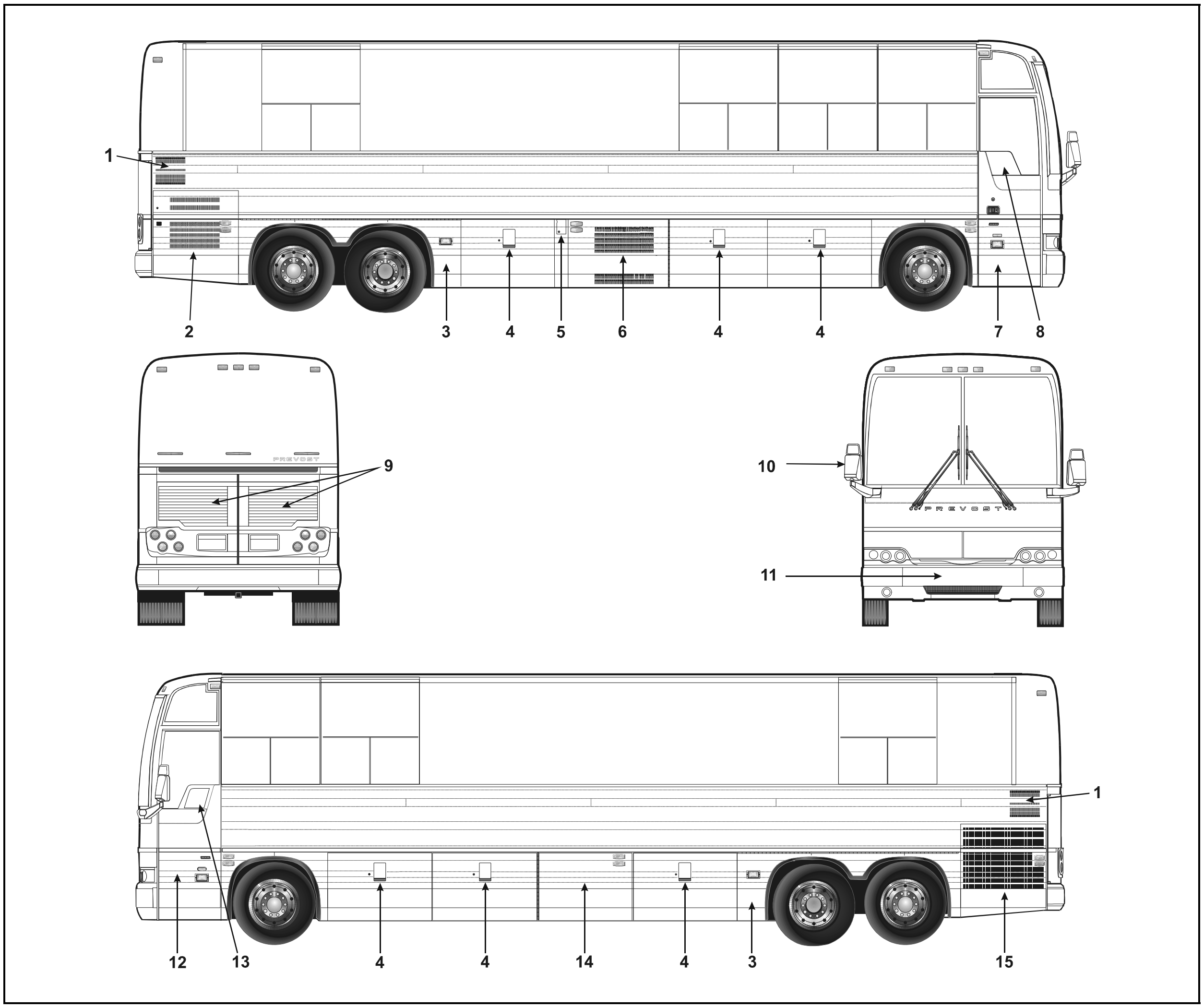


FIGURE 1: XL2-40 CONVERTED VEHICLE EXTERIOR VIEW (TYPICAL)

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

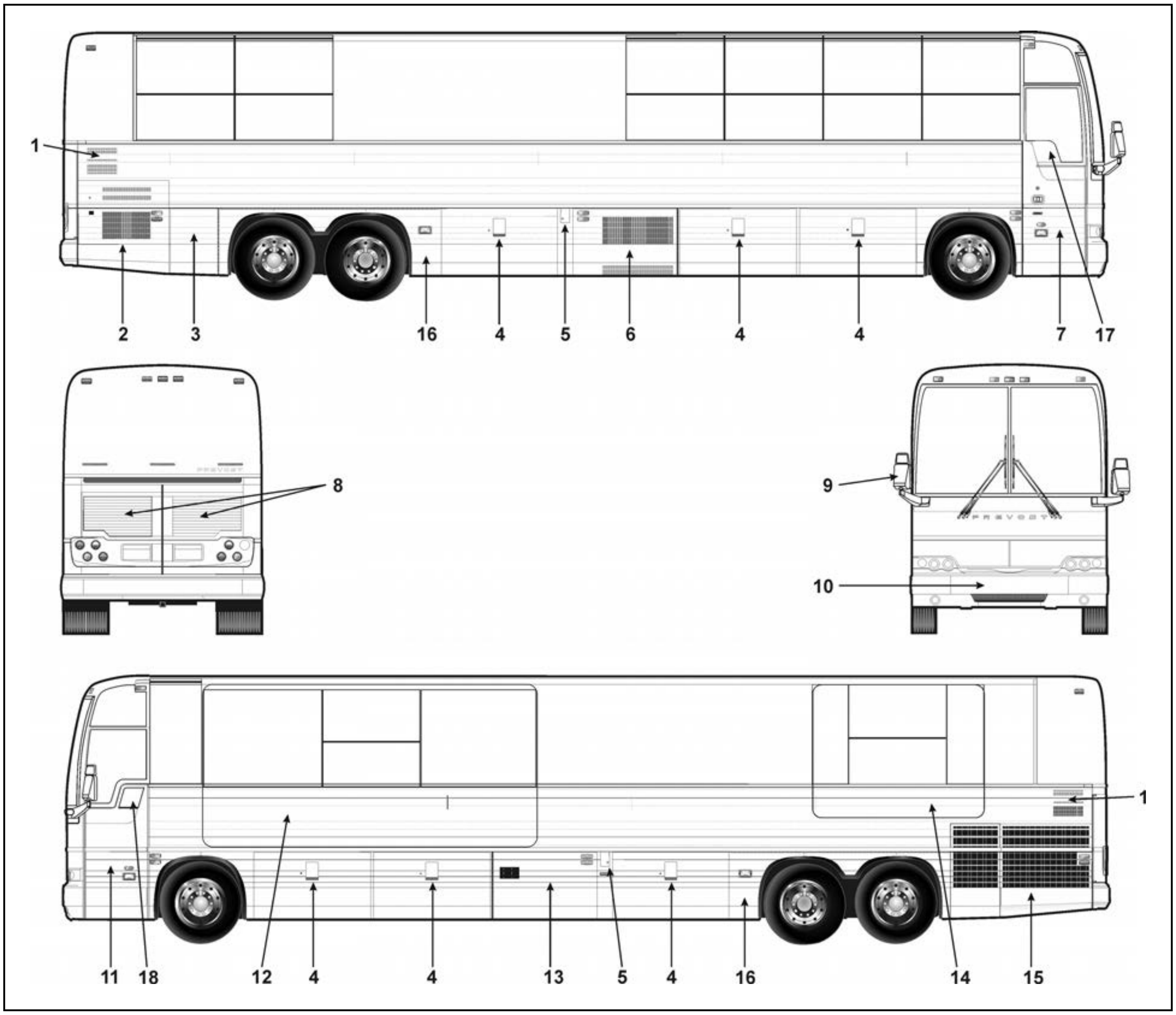


FIGURE 2: XL2-45 CONVERTED VEHICLE EXTERIOR VIEW (TYPICAL) 18362

1. Engine air intake
2. Engine compartment R.H. side door
3. R.H. side rear service compartment
4. Baggage compartment
5. Fuel filler door
6. Condenser compartment or Baggage compartment
7. Entrance door
8. Engine compartment rear doors
9. Rear-view mirror
10. Reclining bumper
11. Front electrical & service compartment
12. Front Slide-Out (Optional)
13. Evaporator compartment or Baggage compartment and access to Slide-out electrical panel
14. Rear Slide-Out (Optional)
15. Radiator door
16. Hinged rear fender
17. Entrance door power window
18. Driver's power window

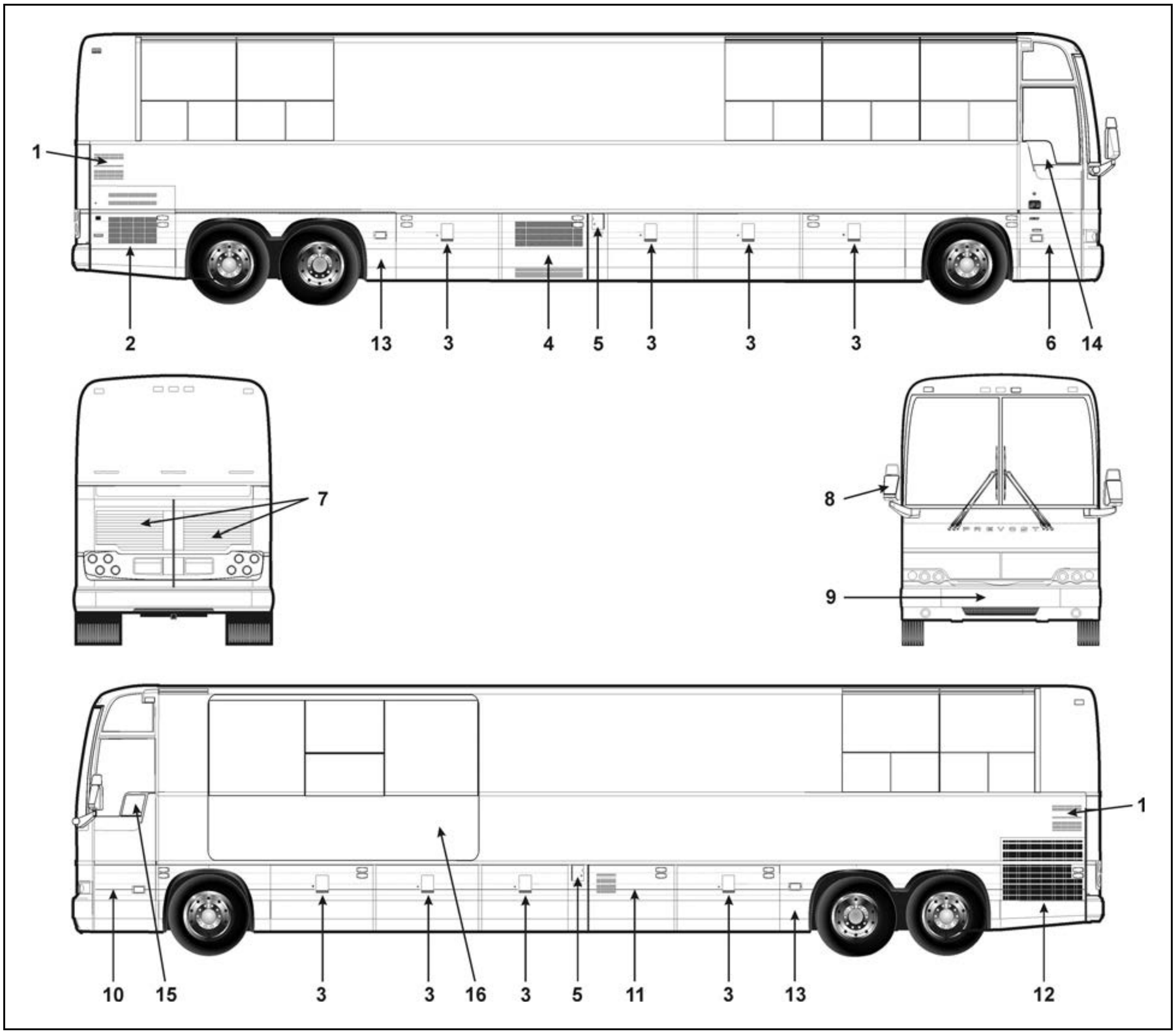


FIGURE 3: XL2-45E CONVERTED VEHICLE EXTERIOR VIEW (TYPICAL) 18369

1. Engine air intake
2. Engine compartment R.H. side door
3. Baggage compartment
4. Condenser compartment or Baggage compartment
5. Fuel filler door
6. Entrance door
7. Engine compartment rear doors
8. Rear-view mirror
9. Reclining bumper
10. Front electrical & service compartment
11. Evaporator compartment or Baggage compartment
12. Radiator door
13. Hinged rear fender
14. Entrance door power window
15. Driver's power window
16. Front Slide-Out (Optional)

2. VEHICLE STRUCTURE

The body of the XLII 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 Prévost 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.

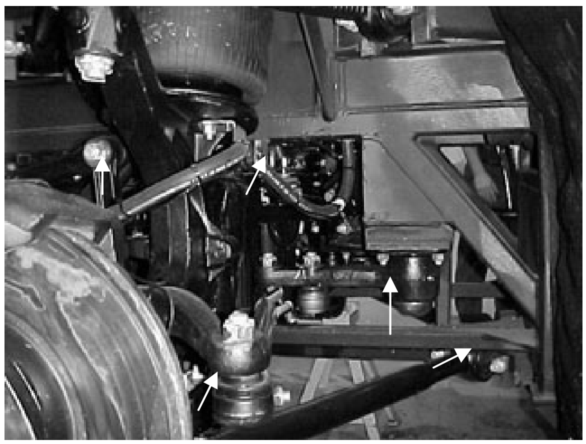
DESCRIPTION	INTERVALS		MAINTENANCE	CORRECTIVE ACTION	REFERENCE
	MONTHS	KM MILES			
BODY, EXTERNAL WINDOW FRAME	6	40 000 25 000	VISUALLY INSPECT SEALING BEADS CONDITION	REPAIR OR REPLACE SEALING BEADS IF NECESSARY	
VEHICLE UNDERBODY	12	100 000 60 000	USE A LOW PRESSURE SPRAY TO CLEAN UNDER-STRUCTURE AND 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 UNDERSTRUCTURE	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.

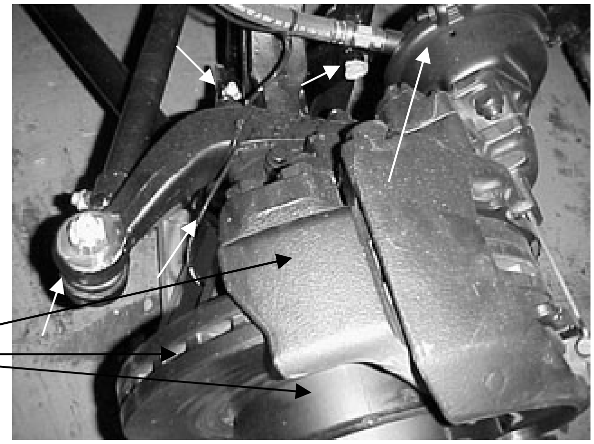
3.3 RUST INHIBITOR APPLICATION

Material: Tectyl 185 GW R1KG21

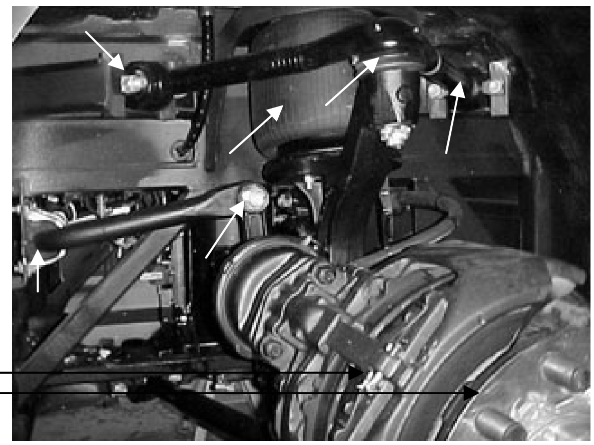
Safety Rules: Use safety glasses
Supplied air hood
Solvent-resistant rubber gloves

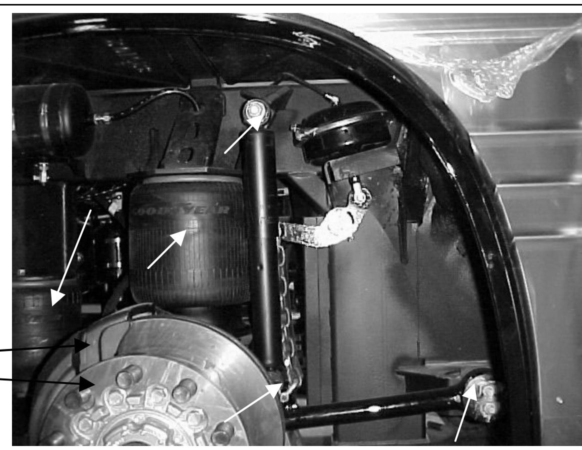
1.0 Wash both wheelhousing mechanical parts before masking.	A water-hose nozzle is recommended. Water may be hot to reduce washing time especially during winter. If parts are soiled with oil, clean using R1KG21. Avoid rubber parts.
2.0 Dry all water sprayed parts. Surface temperature and dew point must 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**	

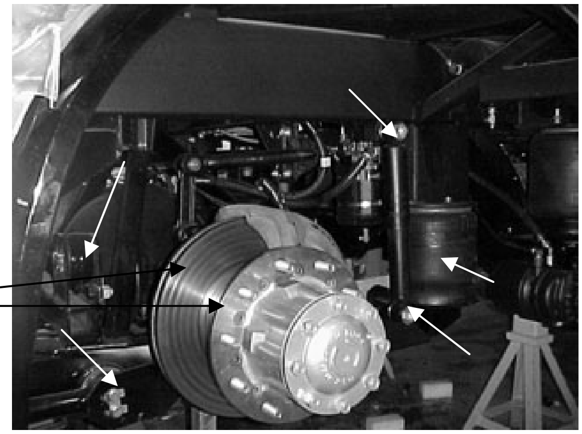
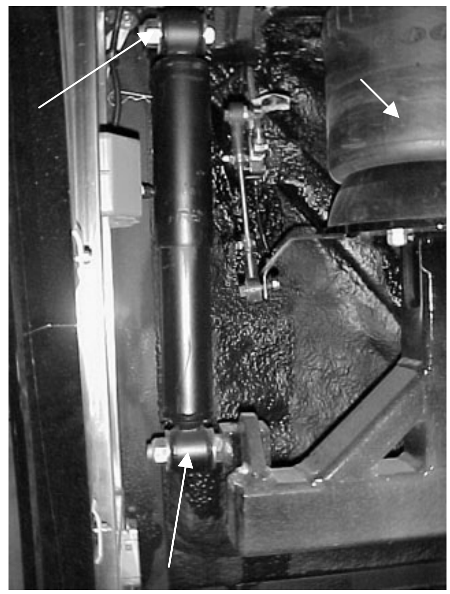
<table>
<tr><td>3.3 Front wheelhousing

(Entire braking system)</td><td></td></tr>
<tr><td>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)</td><td></td></tr>
<tr><td>4.1 Rear wheelhousing

(Entire braking system)</td><td></td></tr>
</table>

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).

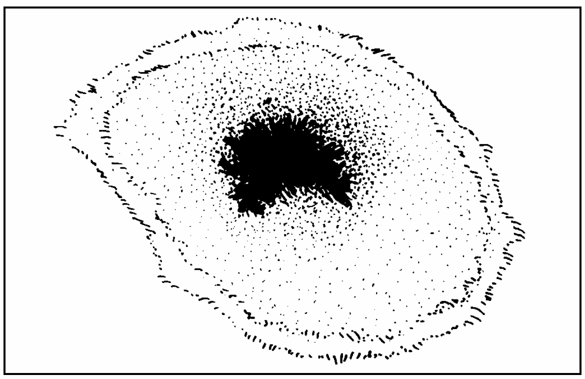


FIGURE 4: FIBERGLASS REPAIR 18089

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).

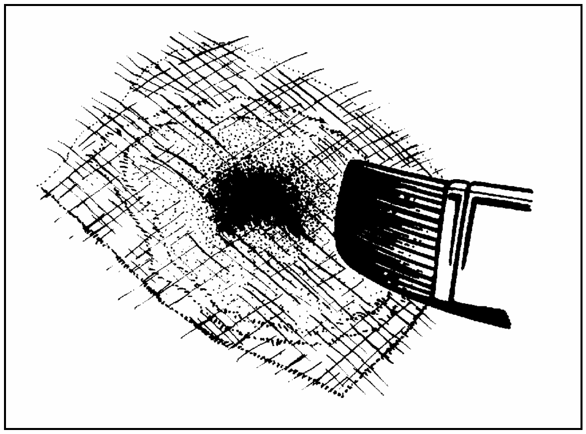


FIGURE 5: FIBERGLASS REPAIR 18090

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).

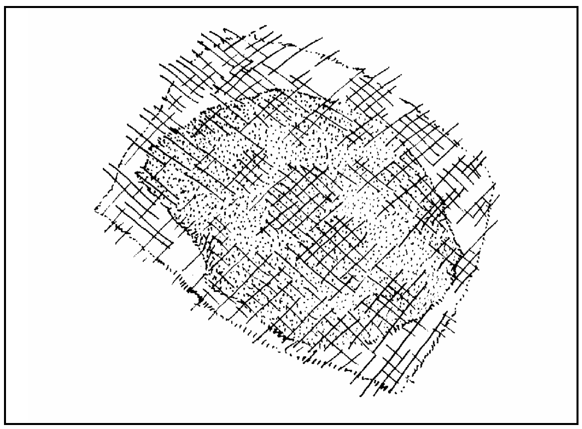


FIGURE 6: FIBERGLASS REPAIR 18091

Allow area to harden and contour the area with coarse sandpaper #100 (Fig. 7).

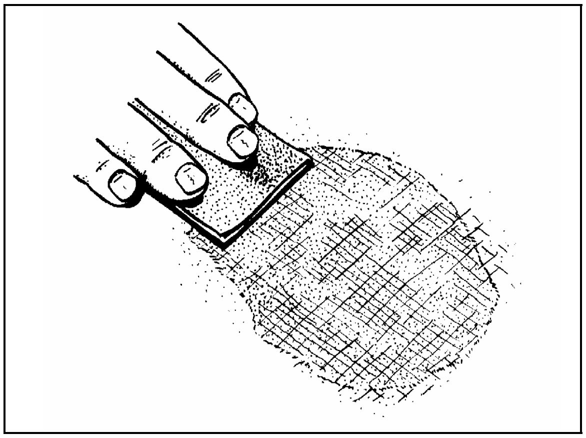


FIGURE 7: FIBERGLASS REPAIR 18092

Cover the area with a layer of resin putty and allow drying for approximately 15 to 20 minutes (Fig. 8).

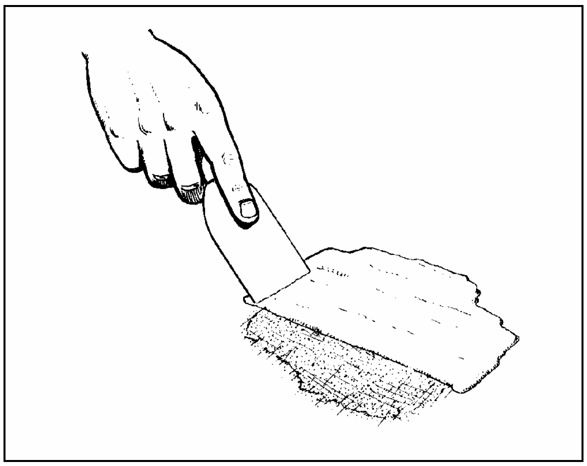


FIGURE 8: FIBERGLASS REPAIR 18093

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.

Prévost 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. W5 MTH 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 W5 MTH. 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.

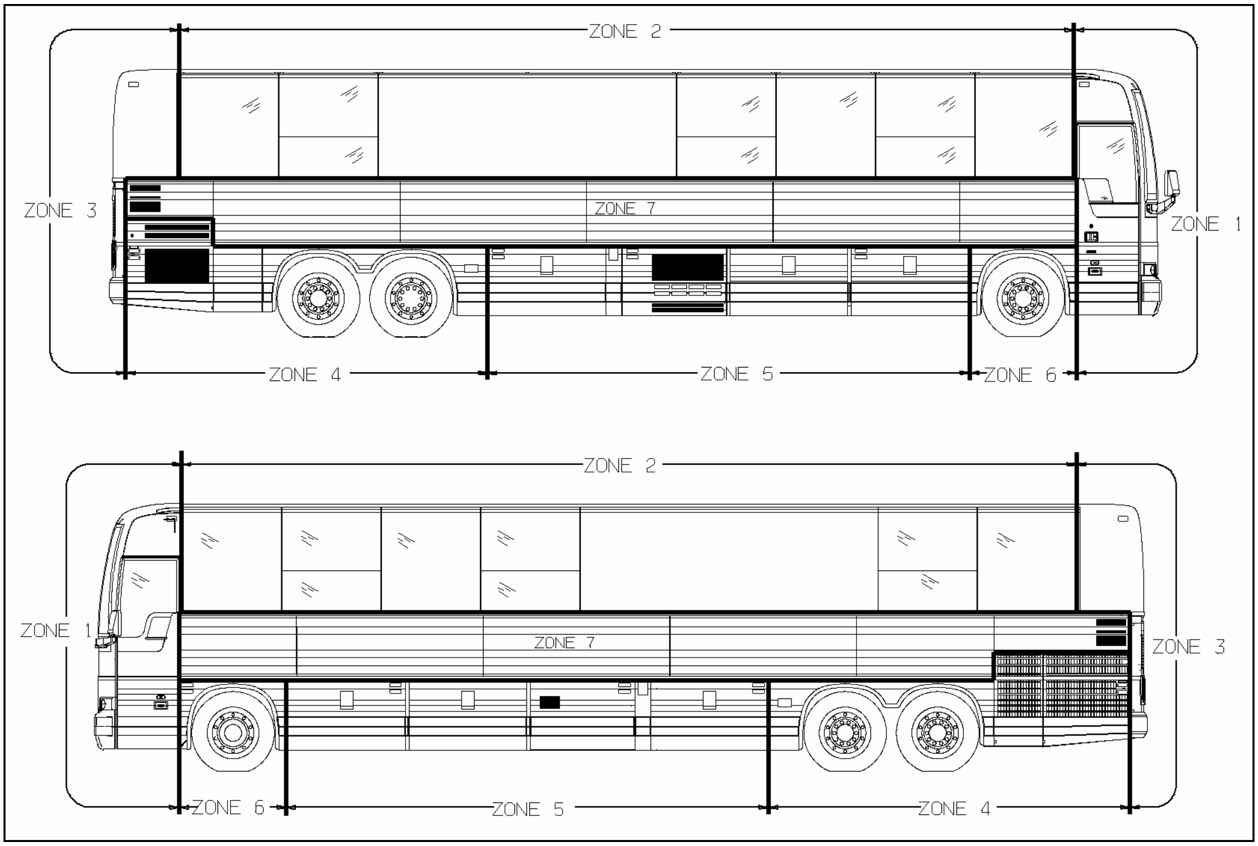


FIGURE 9: W5 MTH ZONING

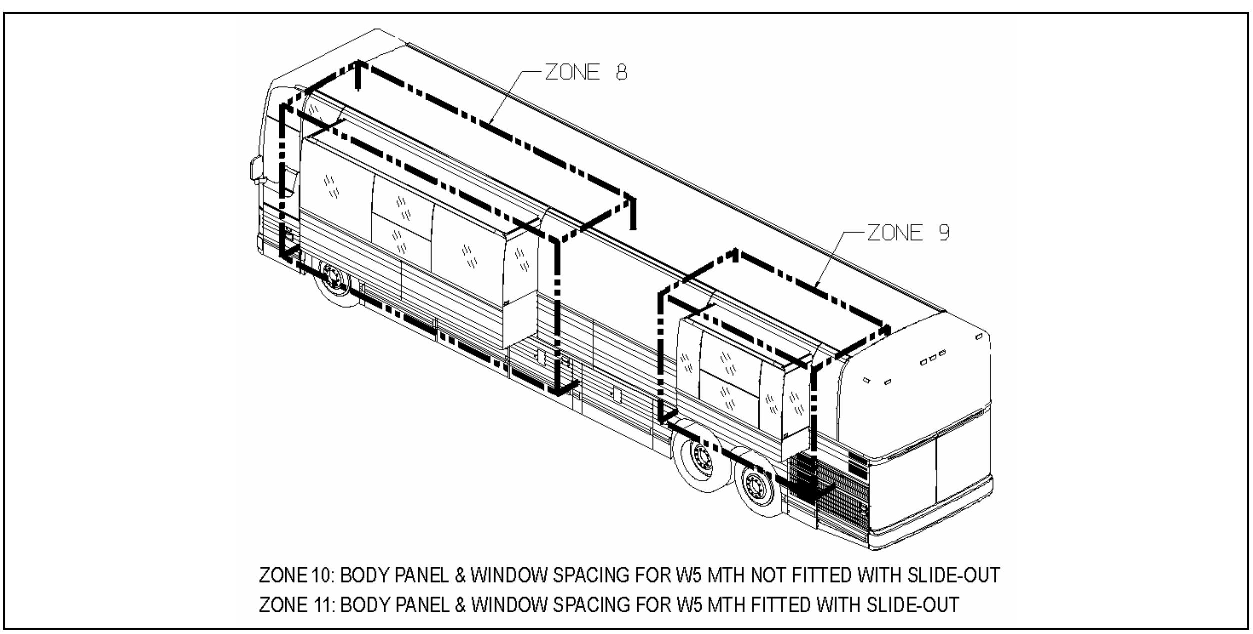


FIGURE 10: W5 MTH FITTED WITH SLIDE-OUT

6.1 ZONE 1

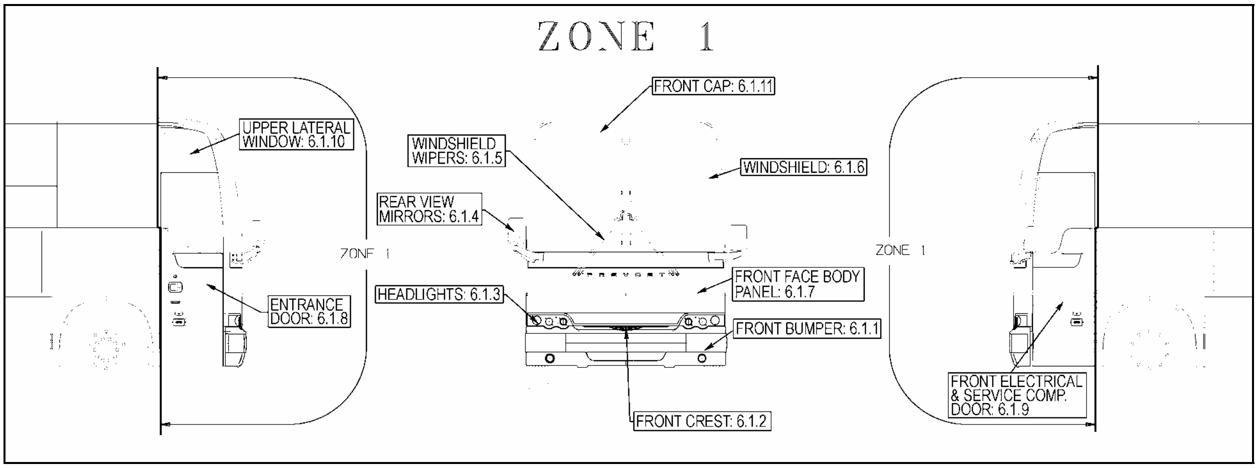


FIGURE 11: ZONE 1

6.1.1 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.

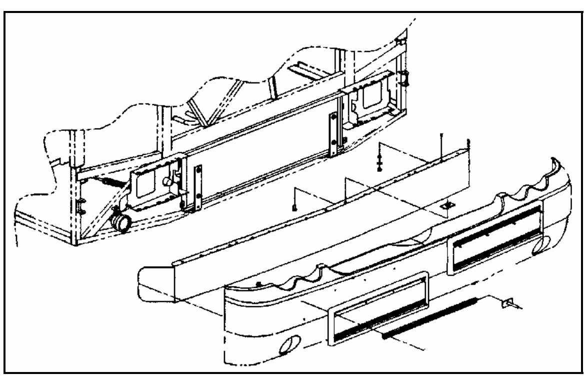


FIGURE 12: FRONT BUMPER REMOVAL

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.

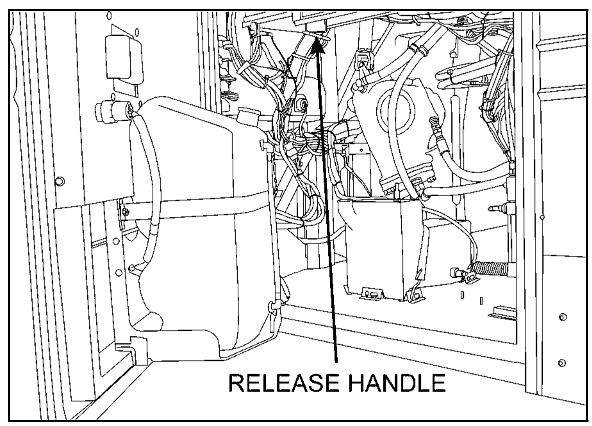


FIGURE 13: FRONT BUMPER RELEASE HANDLE 18613

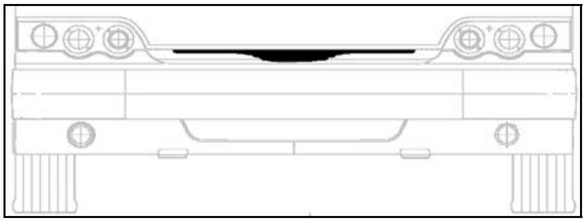
For gluing of front bumper panel refer to procedure **PR00198** included at the end of this section.

6.1.2 Front Crest

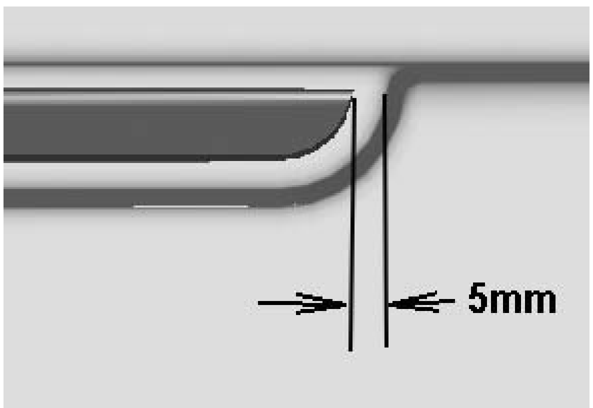
- o Use a Chix cloth and anti-silicone to clean the surface where the crest will be applied.

CAUTION

Do not exceed the crest dedicated surface.



- o Peel the back from the self adhesive crest side pieces.



- o Peel the back from the self adhesive crest center piece. Center crest and apply.
- o Compress the crest three pieces using your hands.

6.1.3 Headlights

Refer to Paragraph 12.1 Headlights, included in Section 06: Electrical of the Maintenance Manual for complete information on headlights.

6.1.4 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.

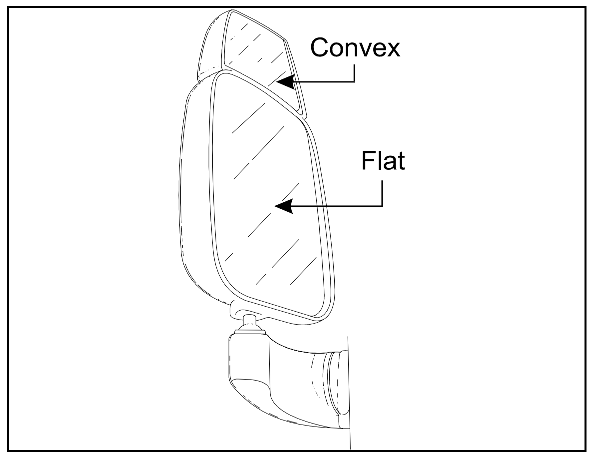


FIGURE 14: REAR VIEW MIRROR (RAMCO) 18398A

❖ **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 23.7 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.

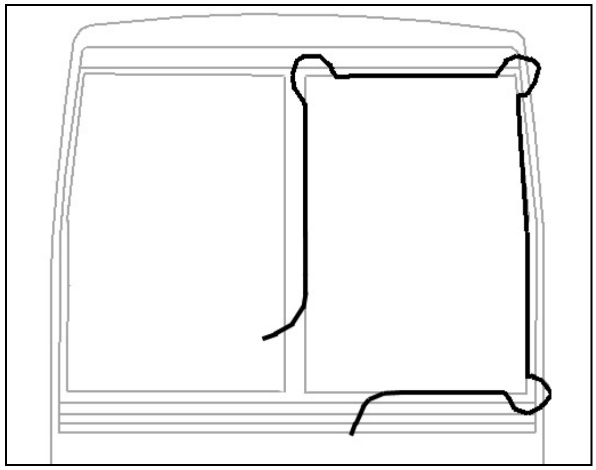


FIGURE 15: WINDSHIELD INSTALLATION USING ROPE

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.

- 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.

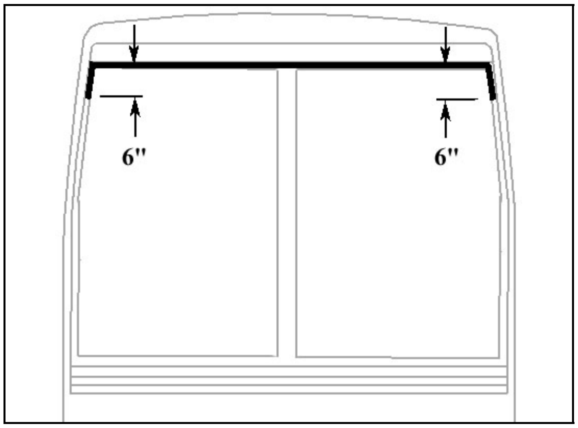


FIGURE 16: APPLICATION 0F SIKA 221 BLACK

- o Reinstall center post and interior finishing panels.
- o Clean windshield surface of butyl residue.

6.1.7 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**

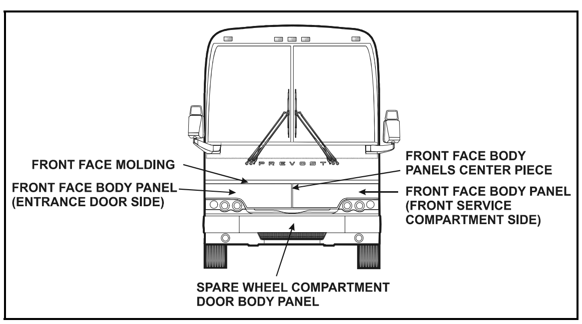


FIGURE 17: VIEW OF FRONT FACE

- o First of all, pry loose the front face molding using the lever. Save molding if only the body panel needs to be changed.
- o 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**

- o 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.
- o 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.
- o Pry loose the front face body panel using the lever.
- o 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.
- o 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 **PR00212** included at the end of this section.

❖ **Front face Body Panel Installation**

For gluing of front face body panels, refer to procedure **PR470047** included at the end of this section.

6.1.8 Entrance Door

For the removal of entrance door body panel, you will need:

Pneumatic "Zip gun" type tool;
Razor sharp window scraper;

- o Before removing body panel, you can to ease repair uninstall entrance door from vehicle. If applicable, remove reflector, keyless system keyboard and cornering light.
- o 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.
- o Remove interior finishing panel to access rub rail fixing bolts, then remove rub rail.
- o Using the "**Zip Gun**", cut Sika bead located ¼ inch (7-8 mm) from each body panel edge and around cornering light.

- o Separate body panel from door.
- o Remove from door surface Sika bead and double-face self adhesive tape residue using a razor sharp window scraper.
- o 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 **PR280020** included at the end of this section.

For gluing of entrance door horizontal finishing molding, refer to procedure **PR00213** included at the end of this section.

For the installation of entrance door, refer to procedure **PR280022** included at the end of this section.

6.1.9 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;

- o Before removing body panel, you can to ease repair uninstall front electrical & service door from vehicle. If applicable, remove reflector and cornering light.
- o 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.
- o Remove interior finishing panel to access rub rail fixing bolts, then remove rub rail.
- o Using the "**Zip Gun**", cut Sika bead located ¼ inch (7-8 mm) from each body panel edge and around cornering light.
- o Separate body panel from door.
- o Remove from door surface Sika bead and double-face self adhesive tape residue using a razor sharp window scraper.
- o 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 **PR280021** included at the end of this section.

For gluing of driver's window, refer to procedure **PR290013** included at the end of this section.

For gluing of front electrical & service compartment door horizontal finishing molding, refer to procedure **PR00213** included at the end of this section.

For the installation of front electrical & service compartment door, refer to procedure **PR280022** included at the end of this section.

6.1.10 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.

- o In the case of driver's window only, open front service compartment door.
- o Mark the position of the driver's window for future reference.
- o 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.

- o Then, move outside of vehicle and cut Sika bead to free window while somebody else hold the window from the inside.
- o Carefully remove window from frame, ask for help if needed.
- o Using a razor sharp window scraper, remove from window frame Sika bead and double-face self adhesive tape residue.
- o First of all, check Sika 205 cleaner expiration date.
- o Before applying Sika cleaner, fold "Chix" cloth twice for proper width.
- o Apply an even coat onto the inside of window frame and allow drying for 2 minutes (maximum 2 hours).
- o Discard waste according to applicable environmental regulations, use dangerous waste containers.

- o 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 **PR290016** included at the end of this section.

6.1.11 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".

6.2 ZONE 2

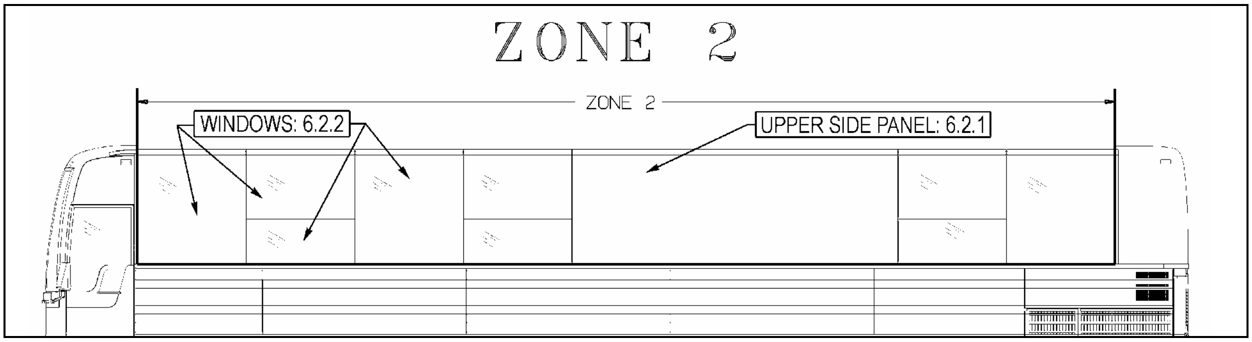


FIGURE 18: ZONE 2

6.2.1 Upper Side Panel

For structure preparation, refer to procedure **PR00035** included at the end of this section.

For installation of upper side panel neoprene foam tapes, refer to procedure **PR00036** included at the end of this section.

For installation of upper side panel, refer to procedure **PR00041** included at the end of this section.

6.2.2 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.

- o Apply a sticky plastic film onto all of window outside surface for safety reason.
- o 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.
- o 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.
- o 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.
- o Attach the wire ends to the specially designed handles.
- o Pull in turn from the inside and the outside of vehicle to gradually cut the Sika bead on the window perimeter.
- o 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.
- o Detach wire from fish wire and continue cutting using the handle.

- o 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

- o Apply a sticky plastic film onto all of window outside surface.
- o 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.

- o Using a ball peen hammer, hit one of the window bottom corners from the **outside**.
- o Carefully push window out and lift it up sufficiently to separate it from the aluminum molding.
- o Attach the windshield wire to a fish wire and thread it underneath the aluminum molding behind the rivets.
- o Detach wire from fish wire and continue cutting using the handle.
- o Make a notch at each window top corner to make sure you pass underneath the remaining pieces of glass.
- o Remove the aluminum molding and clean up the frame using the window scraper.

For gluing of lateral fixed window behind driver, refer to procedure **PR00046** included at the end of this section.

For gluing of lateral fixed half-window, refer to procedure **PR00045** included at the end of this section.

For the installation of awning or sliding window, refer to procedure **PR00038** included at the end of this section.

For gluing of lateral fixed window, refer to various procedures: **PR00037** for gluing vertical and bottom rubber seals; **PR00043** for the installation of lateral fixed window and **PR00044** for making the Simson joint around fixed windows.

All these procedures are included at the end of this section.

6.2.3 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 20) (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.

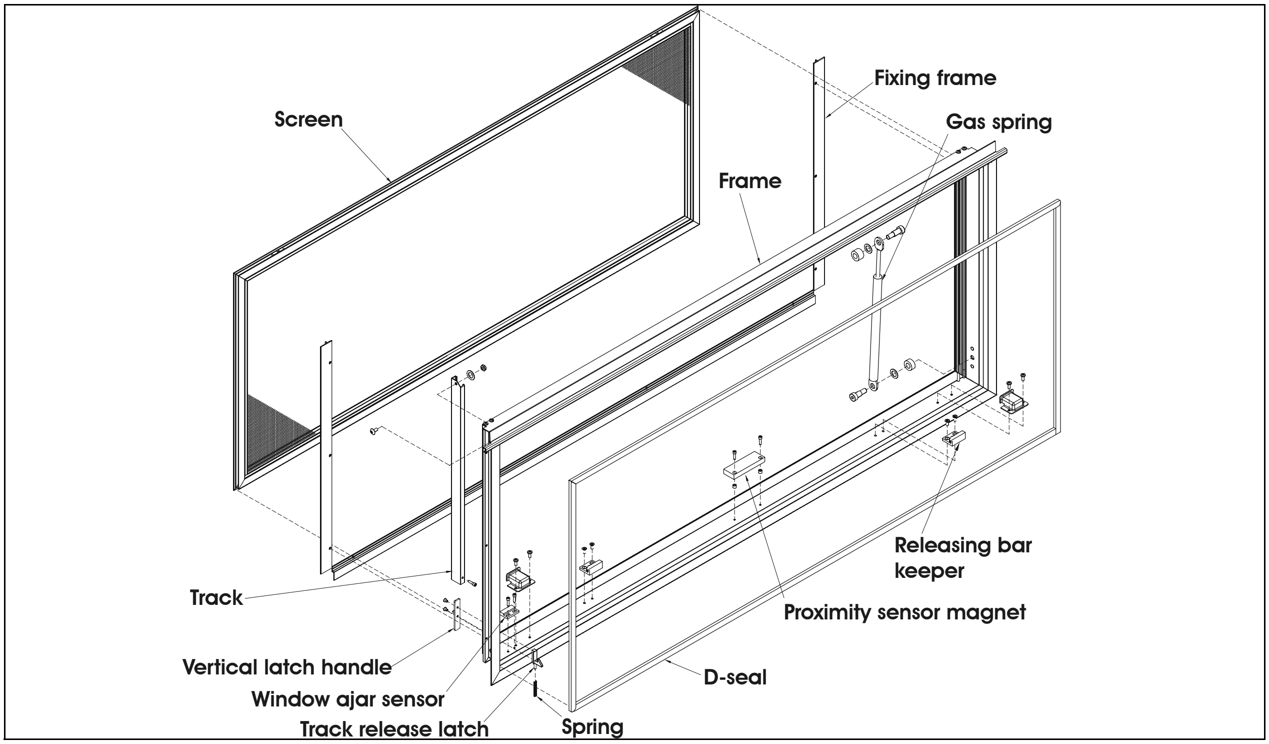


FIGURE 19: ELECTRIC AWNING WINDOW EXPLODED VIEW (FRAME) 18586

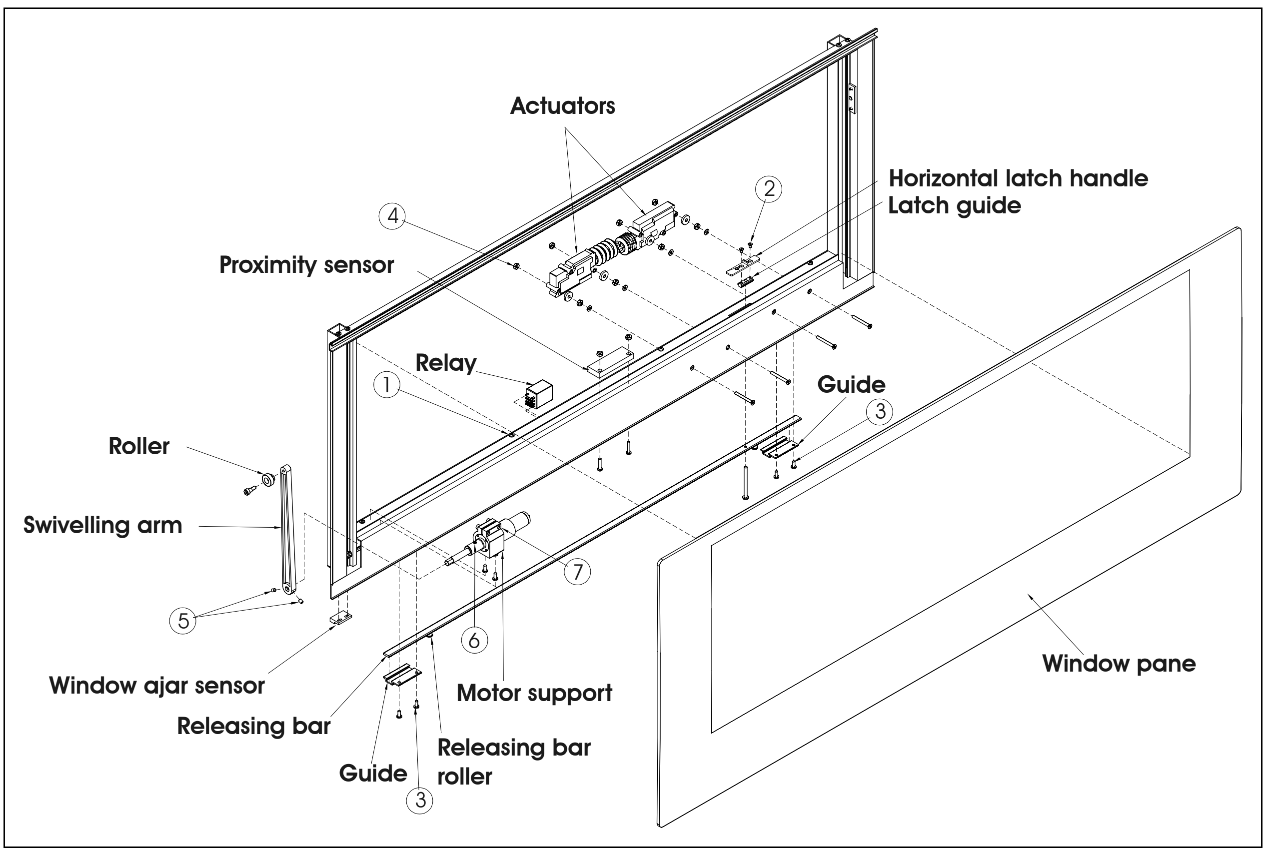


FIGURE 20: ELECTRIC AWNING WINDOW EXPLODED VIEW (SASH) 18583

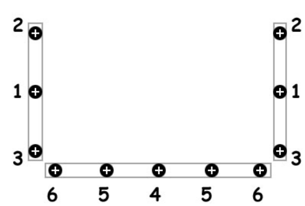
Actuator Replacement

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.

6.2.4 Electric Sliding Windows

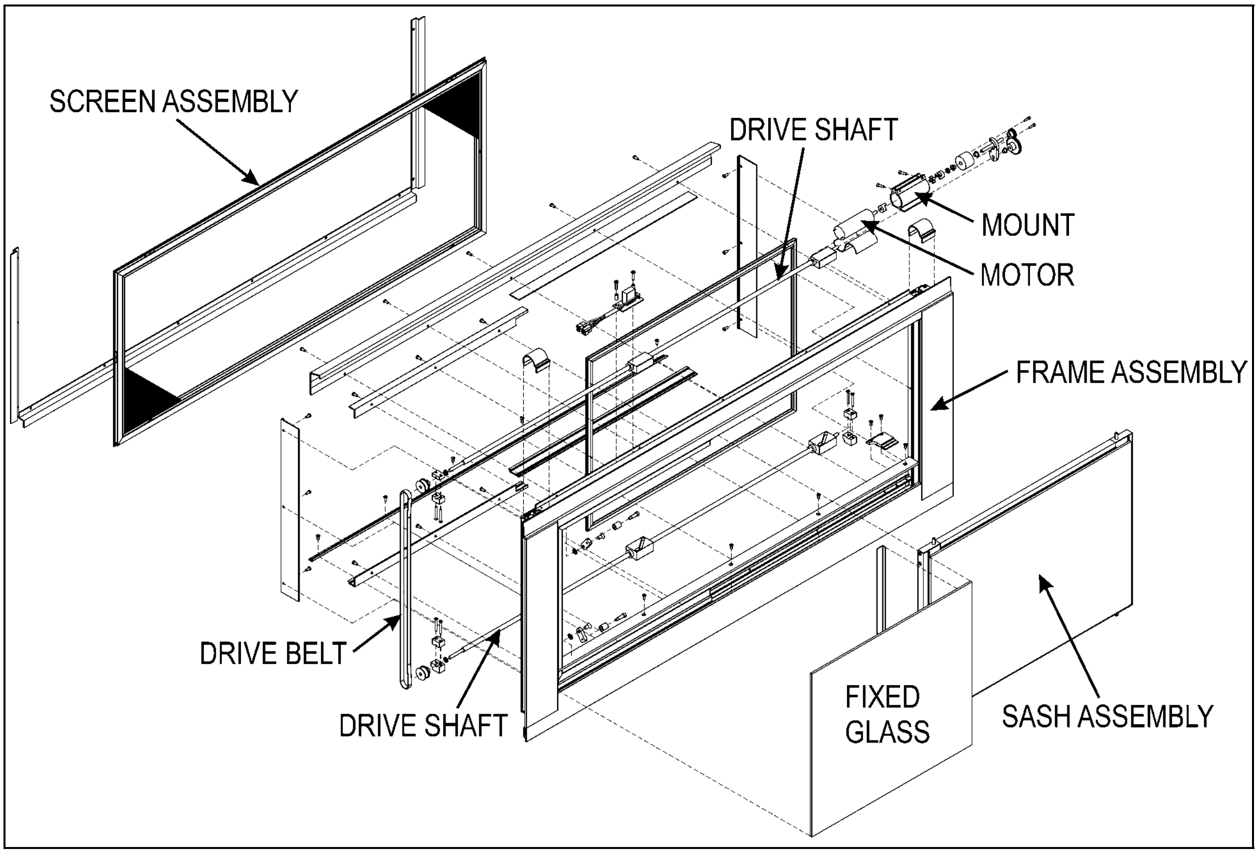


FIGURE 21: ELECTRIC SLIDING WINDOW EXPLODED VIEW

Sash Removal

1. Remove the Screen Assembly
2. Pull down on both release latches simultaneously and rotate the sash inwards approximately 10 degrees.(Figure 22)

FIGURE 22: REMOVING THE SASH

3. Lift the sash up and out to disengage the bottom of the sash from the window frame. (Figure 23)

FIGURE 23: 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 24)

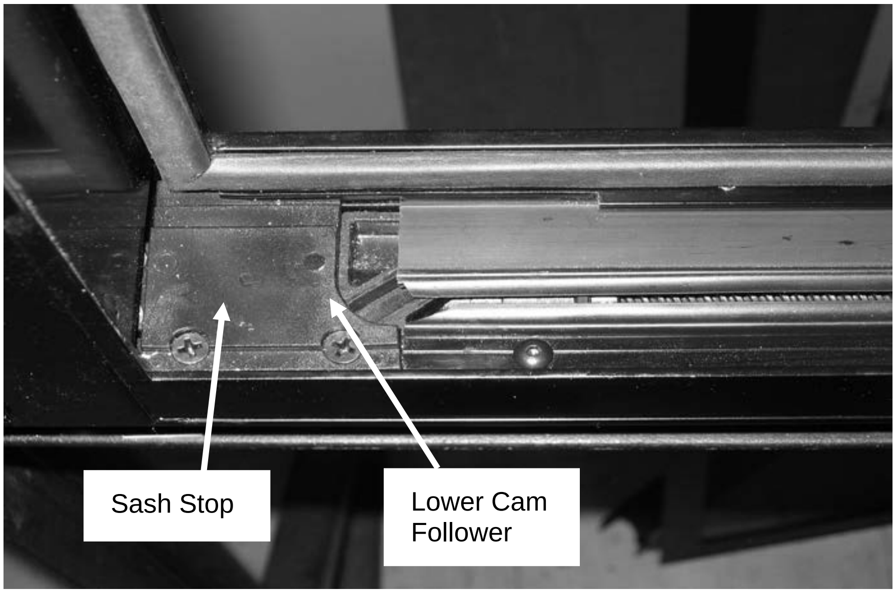


FIGURE 24: PROPER ALIGNMENT

2. Position the left hand lower corner of the sash over the front cam follower block (Figure 25)


FIGURE 25: 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 26)

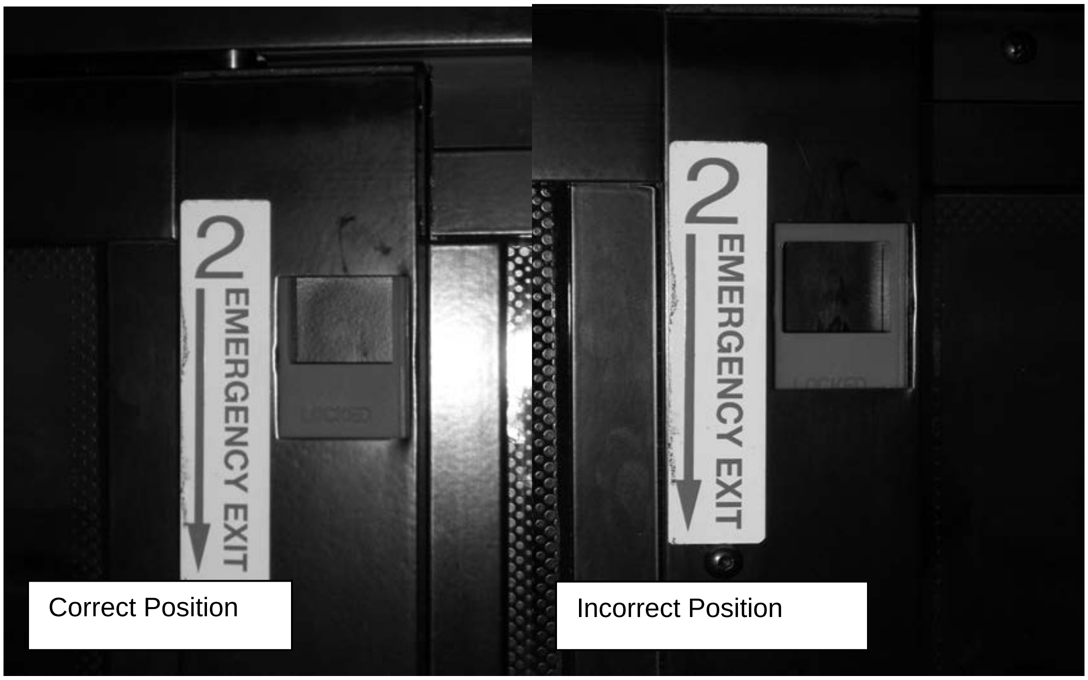


FIGURE 26: RELEASE LATCH PROPER POSITION

7. <u>* Failure to confirm this step may lead to the sash becoming disengaged with the frame and could result in personal injury.</u>
8. Operate the window to confirm that it opens and closes properly.

Install the screen assembly.

6.3 ZONE 3

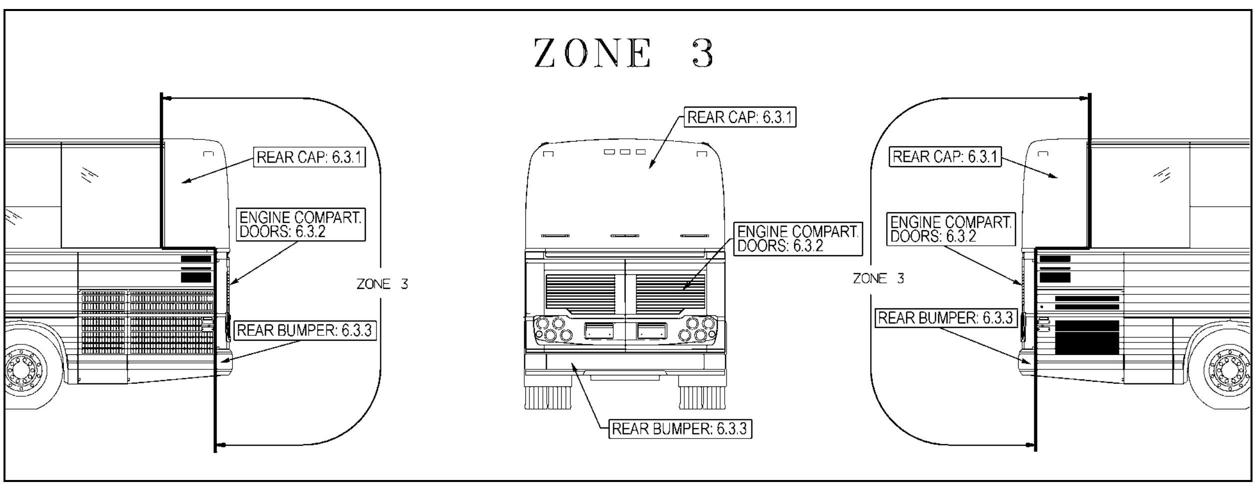


FIGURE 27: ZONE 3

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 Prévost 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 Adjustment**

Engine compartment doors may be adjusted for proper fit by untightening hinge bolts:

1. Loosen the bolts, (1, 2 Fig. 28) holding the hinge to the vehicle structure to shift the door "UP or DOWN".
2. Loosening the bolts (3, Fig. 28) 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. 28) 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.

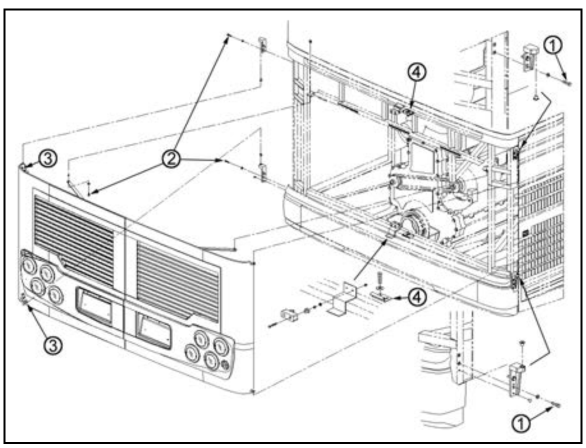


FIGURE 28: ENGINE COMPARTMENT DOORS 18633

❖ **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 **PR00211** included at the end of this section.

For engine compartment door body panel installation, refer to procedure **PR280032** included at the end of this section.

6.3.3 Rear Bumper

Remove three bolts on each side holding bumper to vehicle and remove bumper.

To install bumper, reverse the procedure.

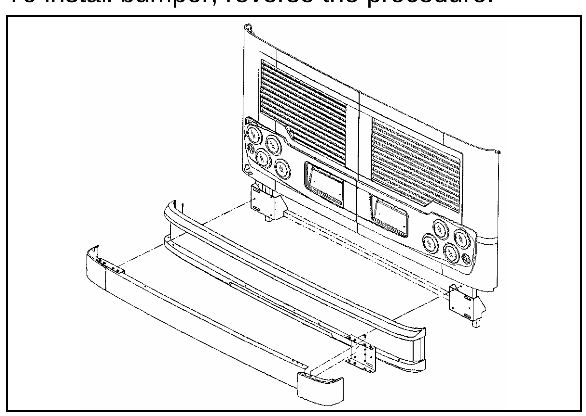


FIGURE 29: REAR BUMPER

6.4 ZONE 4

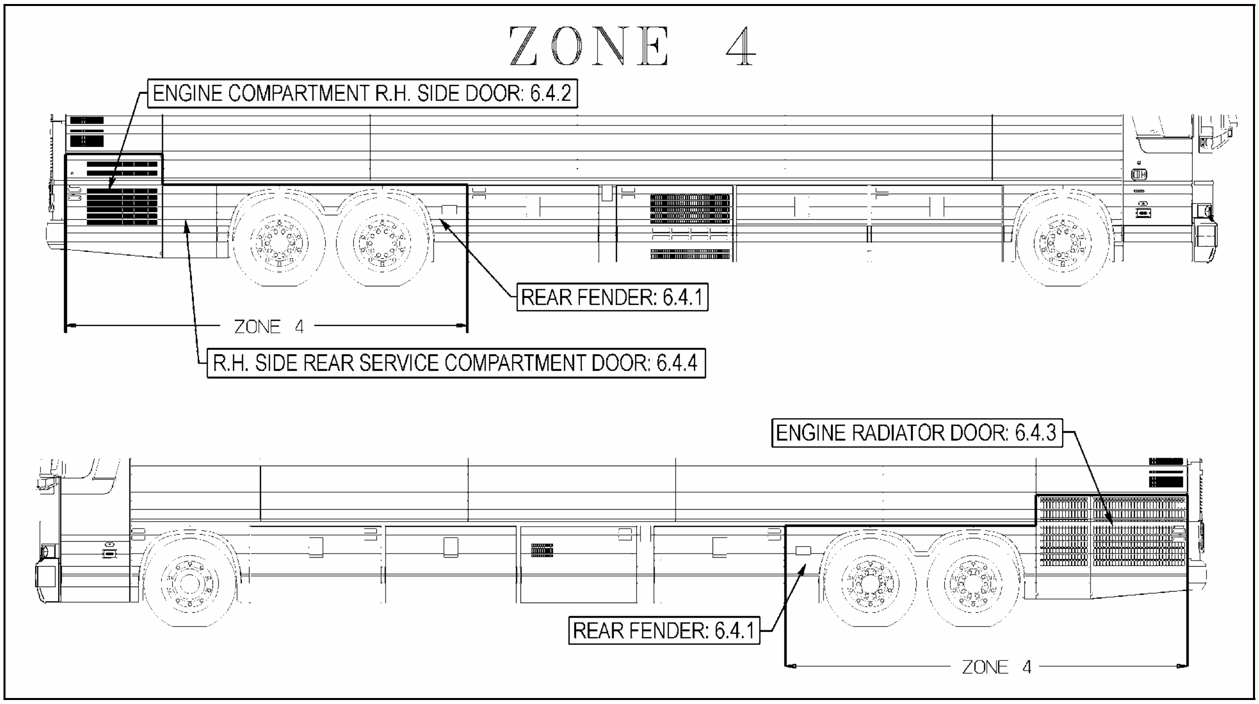


FIGURE 30: ZONE 4

6.4.1 Rear Fender

On the "XLII MTH" series 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 **PR470046** included at the end of this section.

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. 31) holding the hinge to the vehicle structure to shift the door "IN or OUT" and "UP or DOWN".
2. Loosening the bolts (2, Fig. 31) 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.

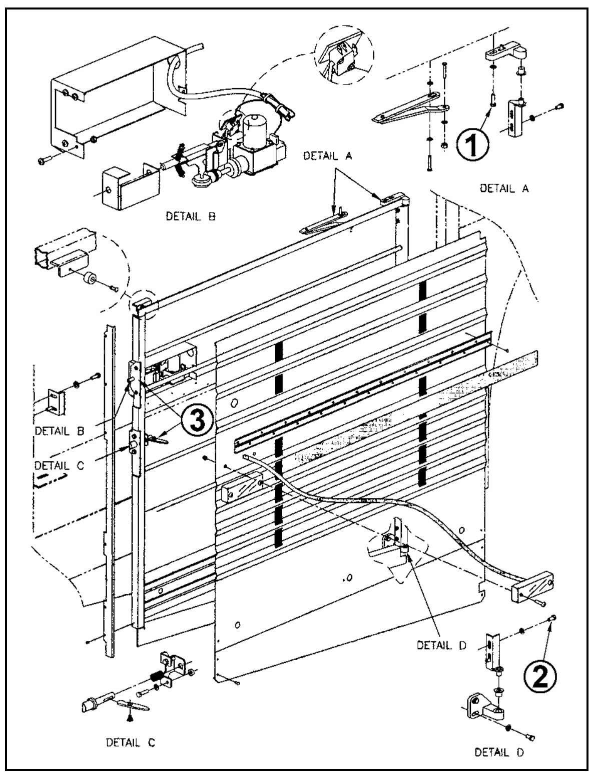


FIGURE 31: ENGINE COMPARTMENT R.H. SIDE DOOR 18635

To adjust the latch mechanism (3, Fig. 31) 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 **PR00210** included at the end of this section.

6.4.3 Engine Radiator Door

Radiator door may be adjusted for proper fit by untightening hinge bolts:

1. Loosen the bolts, (1, Fig. 32) holding the hinge to the vehicle structure to shift the door "IN or OUT" and "UP or DOWN".
2. Loosening the bolts (2, Fig. 32) allows the door to be shifted "LEFT or RIGHT" and "UP or DOWN".

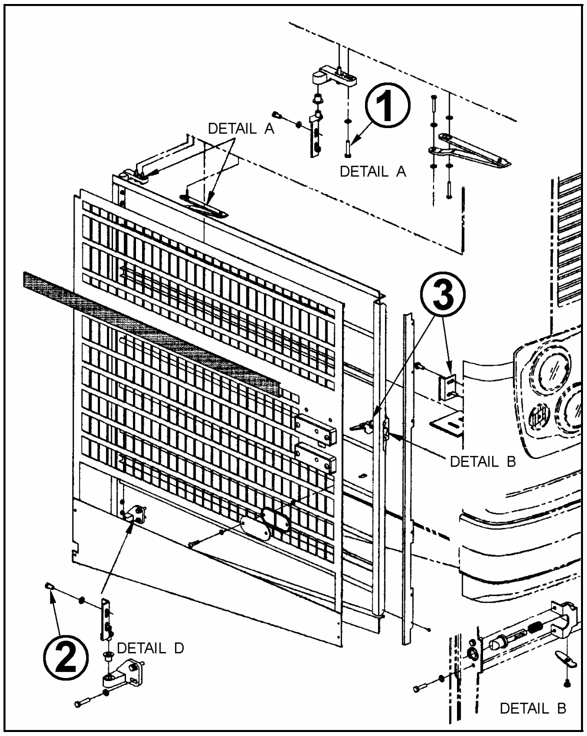


FIGURE 32: RADIATOR DOOR 18636

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. 32) 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.

❖ **Engine Small Radiator Door**

Small radiator door may be adjusted for proper fit by untightening hinge bolts:

1. Loosen the bolts, (1, Fig. 33) holding the hinge to the vehicle structure to shift the door "IN or OUT" and "UP or DOWN".
2. Loosening the bolts (2, Fig. 33) allows the door to be shifted "LEFT or RIGHT" and "UP or DOWN".

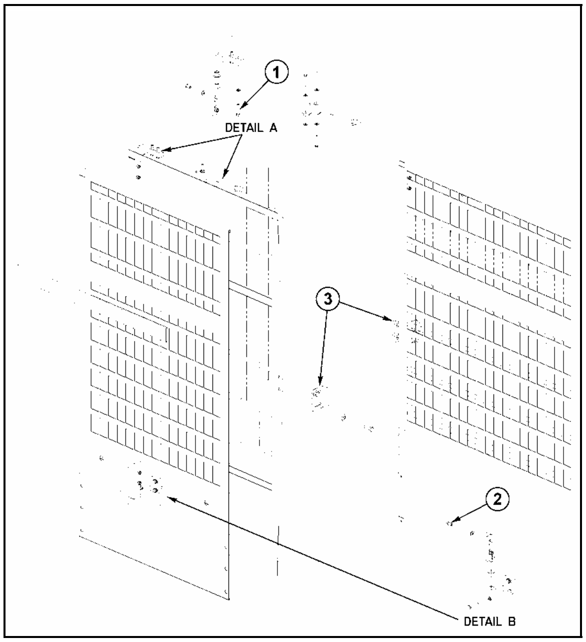


FIGURE 33: SMALL RADIATOR DOOR 18636

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. 33) 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 **PR00210** included at the end of this section.

6.4.4 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.

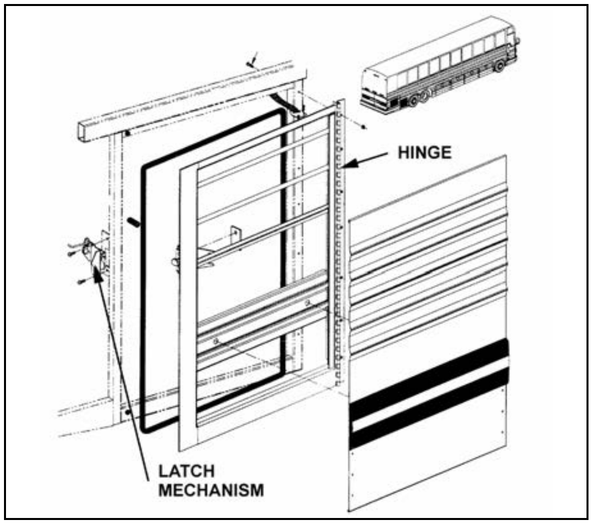


FIGURE 34: R.H. SIDE REAR SERVICE COMPARTMENT DOOR

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.

6.5 ZONE 5

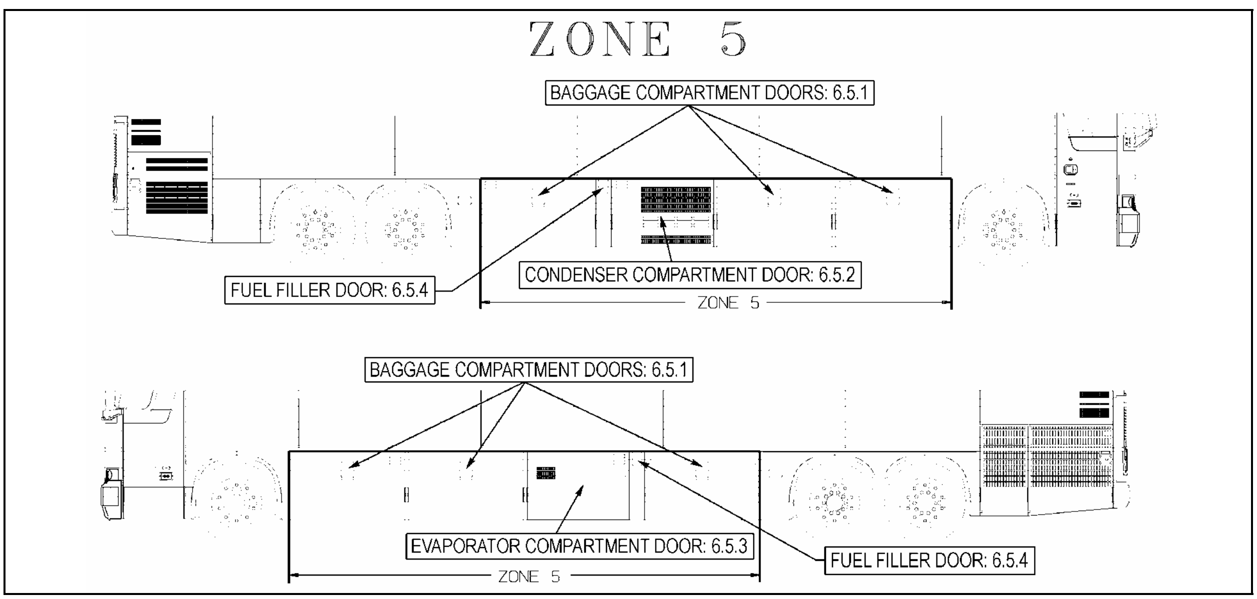


FIGURE 35: ZONE 5

6.5.1 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. 36).

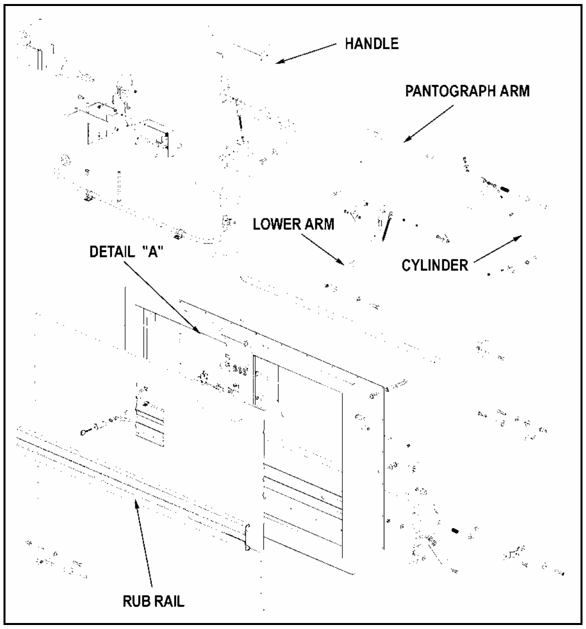


FIGURE 36: BAGGAGE COMPARTMENT DOOR 18145

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 panto-graph 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 panto-graph 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. 37).

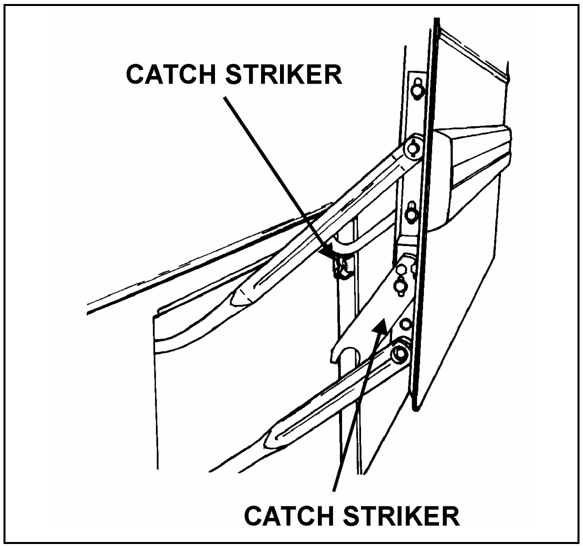


FIGURE 37: BAGGAGE DOOR CATCH STRIKER 18146

For the removal and installation of baggage compartment door body panels, refer to procedure **PR00177** included at the end of this section.

6.5.2 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.

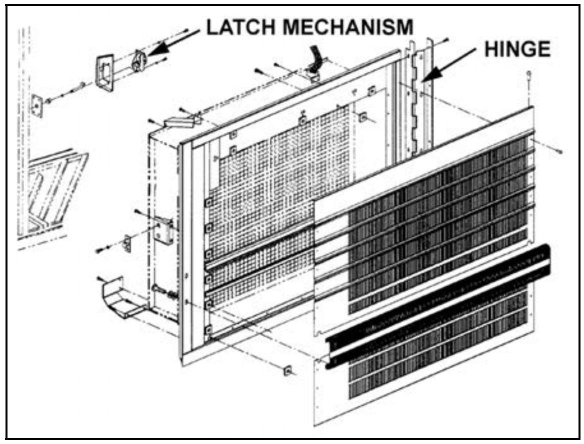


FIGURE 38: CONDENSER DOOR

For the installation of condenser compartment door body panel, refer to procedure **PR00131** included at the end of this section.

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.

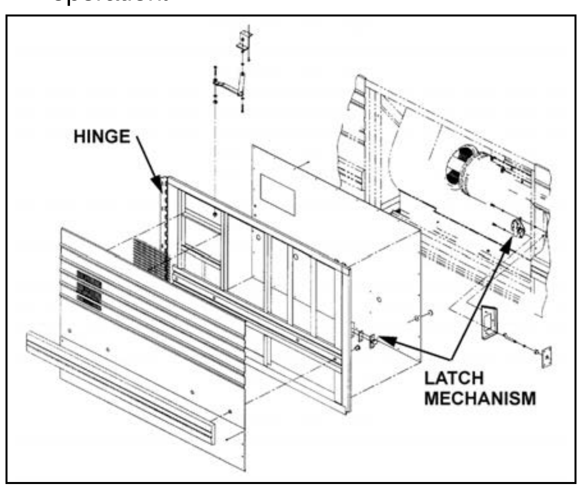


FIGURE 39: EVAPORATOR DOOR

For the installation of evaporator compartment door body panel, refer to procedure **PR00133** included at the end of this section.

6.5.4 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.

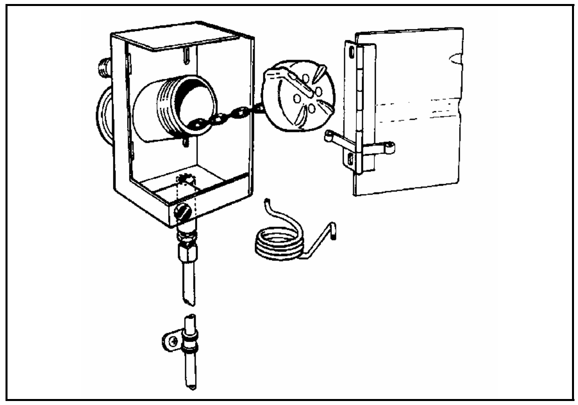


FIGURE 40: FUEL FILLER DOOR 03046

6.6 ZONE 6

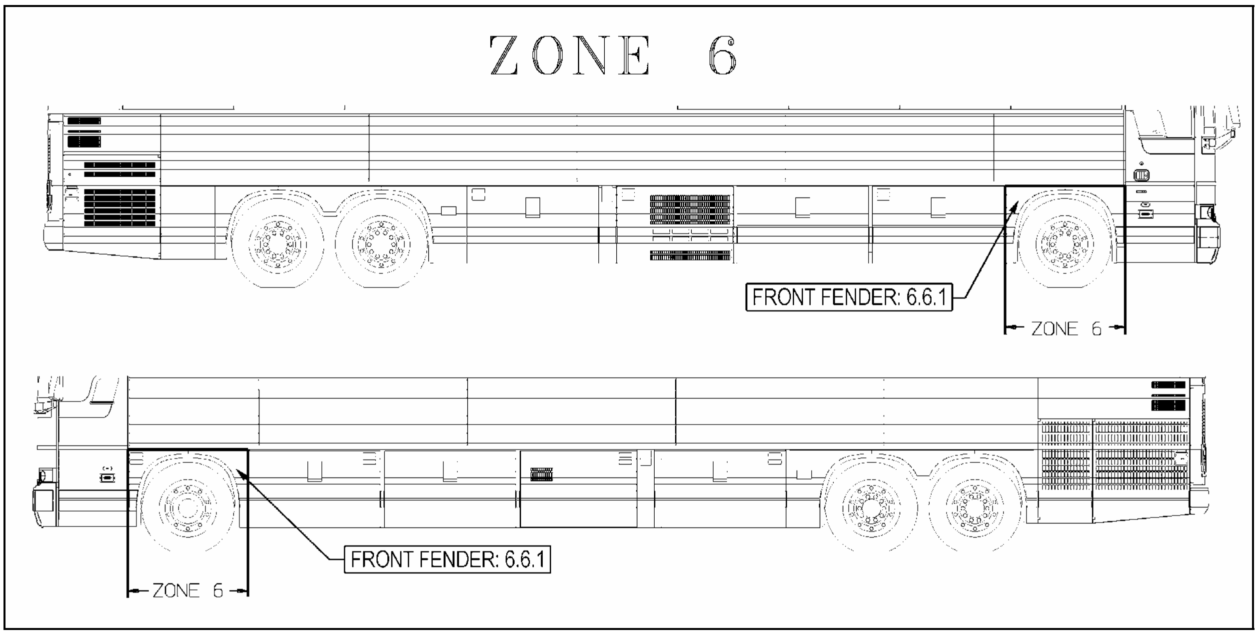


FIGURE 41: ZONE 6

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.

For the installation of front fender body panel, refer to procedure **PR470024** included at the end of this section.

6.7 ZONE 7

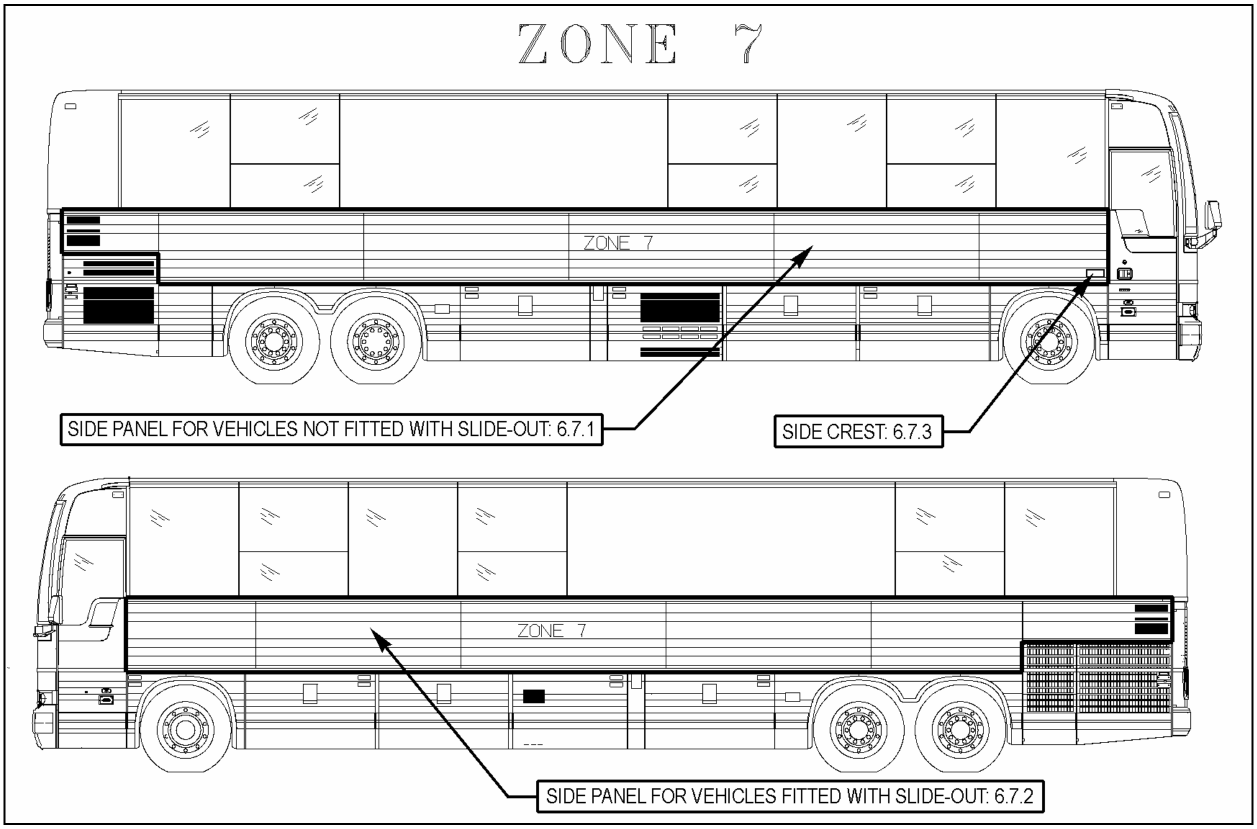


FIGURE 42: ZONE 7

6.7.1 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 **PR00027** included at the end of this section.

For gluing of ridged side panels, refer to procedure **PR00028** included at the end of this section.

For sealing the side panels' upper portion, refer to procedure **PR00030** included at the end of this section.

For gluing of horizontal finishing molding, refer to procedure **PR00208** included at the end of this section.

6.7.2 Side Panel for Vehicles Fitted With Slide-Out

❖ **Removal**

Refer to paragraph 6.7.1 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 **PR00031** included at the end of this section.

For gluing of ridged side panels on vehicles fitted with slide-out, refer to procedure **PR00029** included at the end of this section.

6.7.3 Side Crest

- o Clean vehicle surface using anti-silicone where the side crest and stickers will be applied.
- o Using hands apply and compress side crest.
- o Apply required stickers.

6.8 ZONE 8

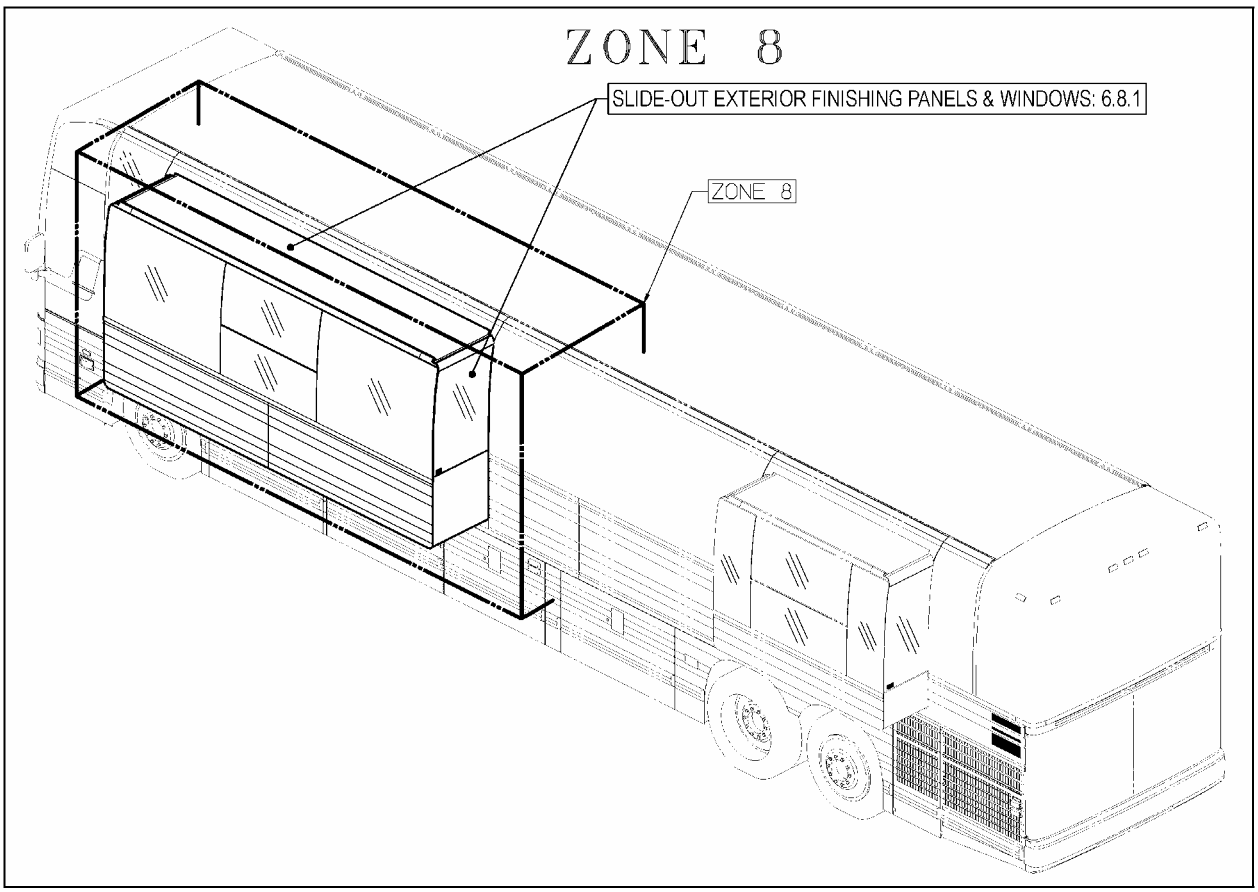


FIGURE 43: ZONE 8

6.8.1 Slide-Out Exterior Finishing Panels & Windows

Refer to Maintenance Manual, Section 26: Paragraph 16 for the procedure on slide-out exterior finishing panels & windows.

6.9 ZONE 9

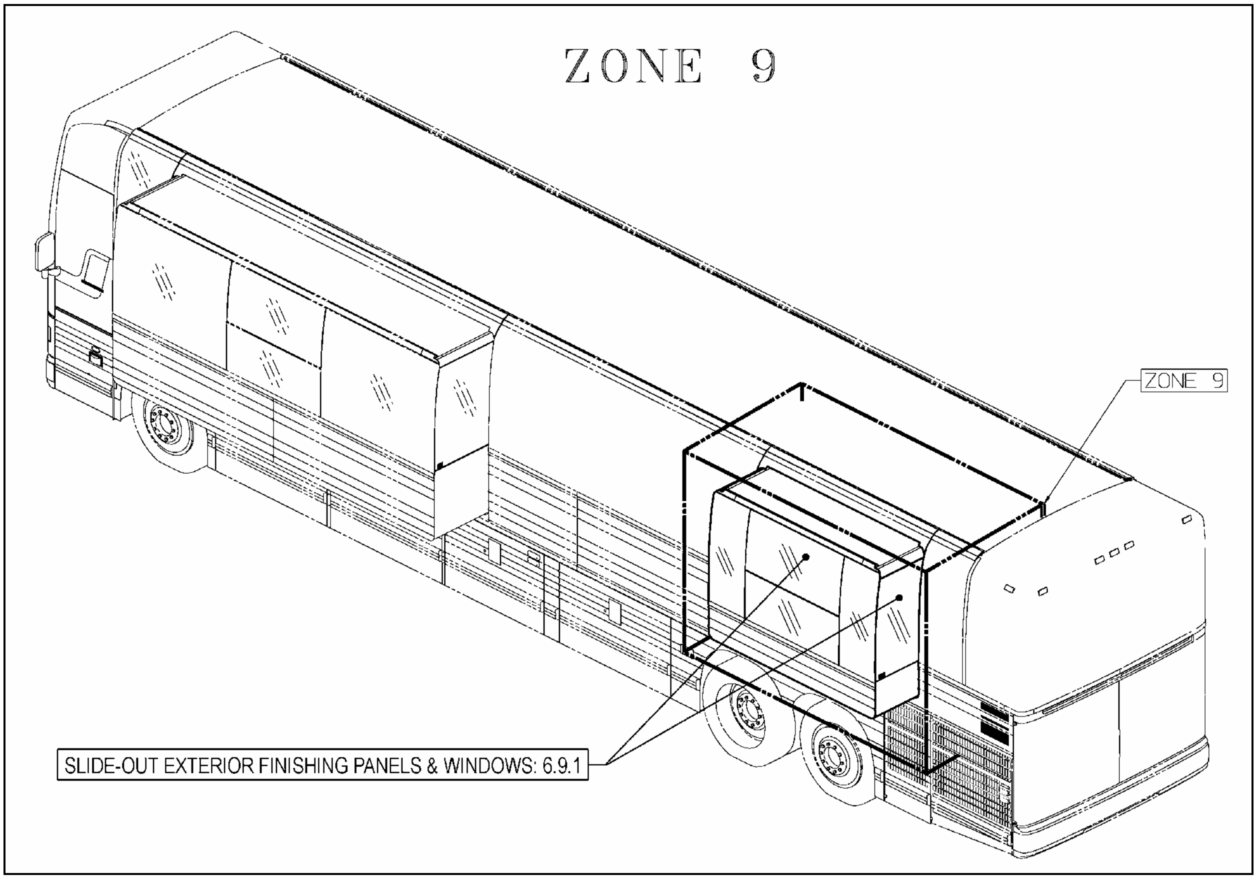


FIGURE 44: ZONE 9

6.9.1 Slide-Out Exterior Finishing Panels & Windows

Refer to Maintenance Manual, Section 26: Paragraph 16 for the procedure on slide-out exterior finishing panels & windows.

6.10 BODY PANEL AND WINDOW SPACING FOR W5 MTH NOT FITTED WITH SLIDE-OUT

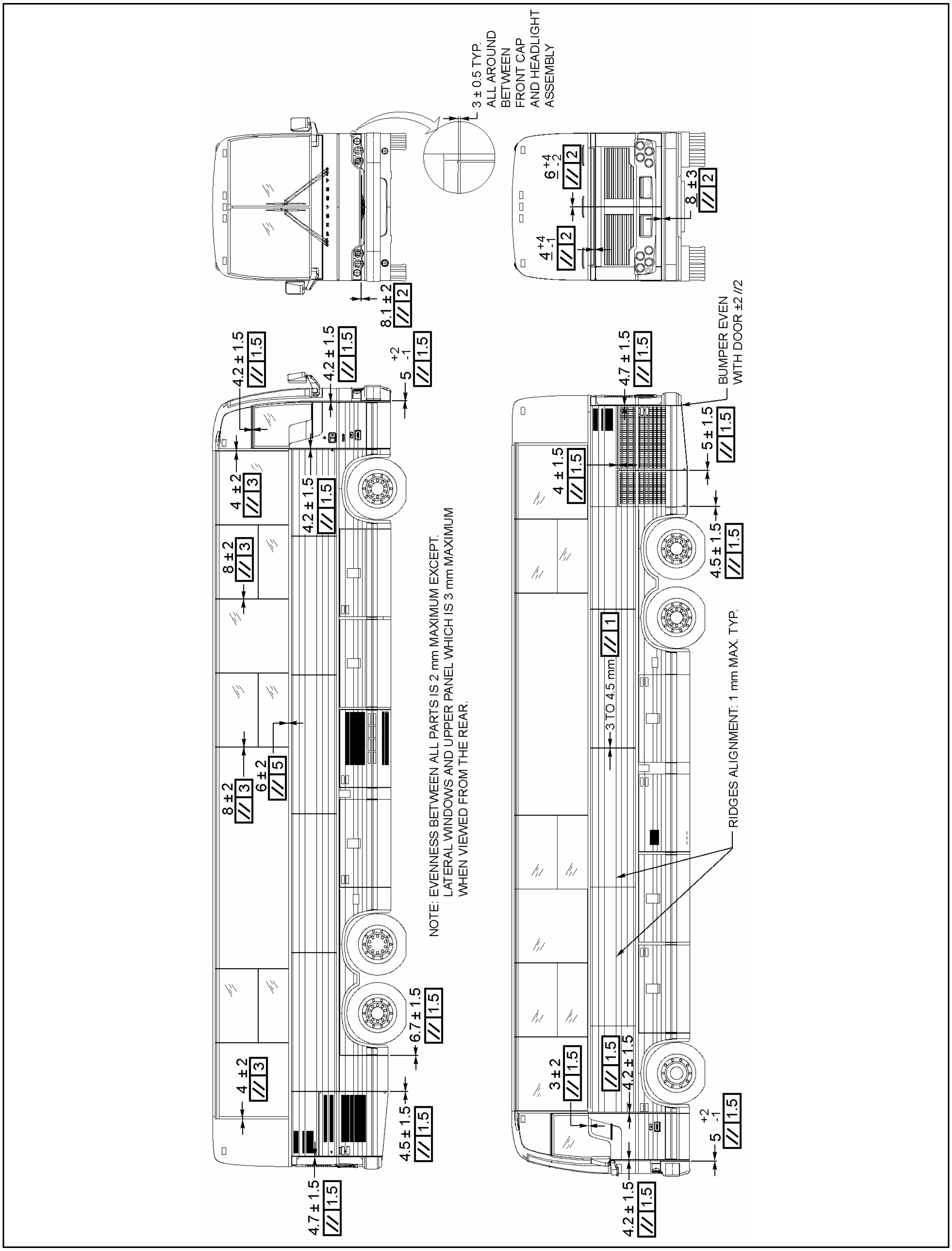


FIGURE 45: BODY PANEL & WINDOW SPACING FOR W5 MTH NOT FITTED WITH SLIDE-OUT

6.11 BODY PANEL AND WINDOW SPACING FOR W5 MTH FITTED WITH SLIDE-OUT

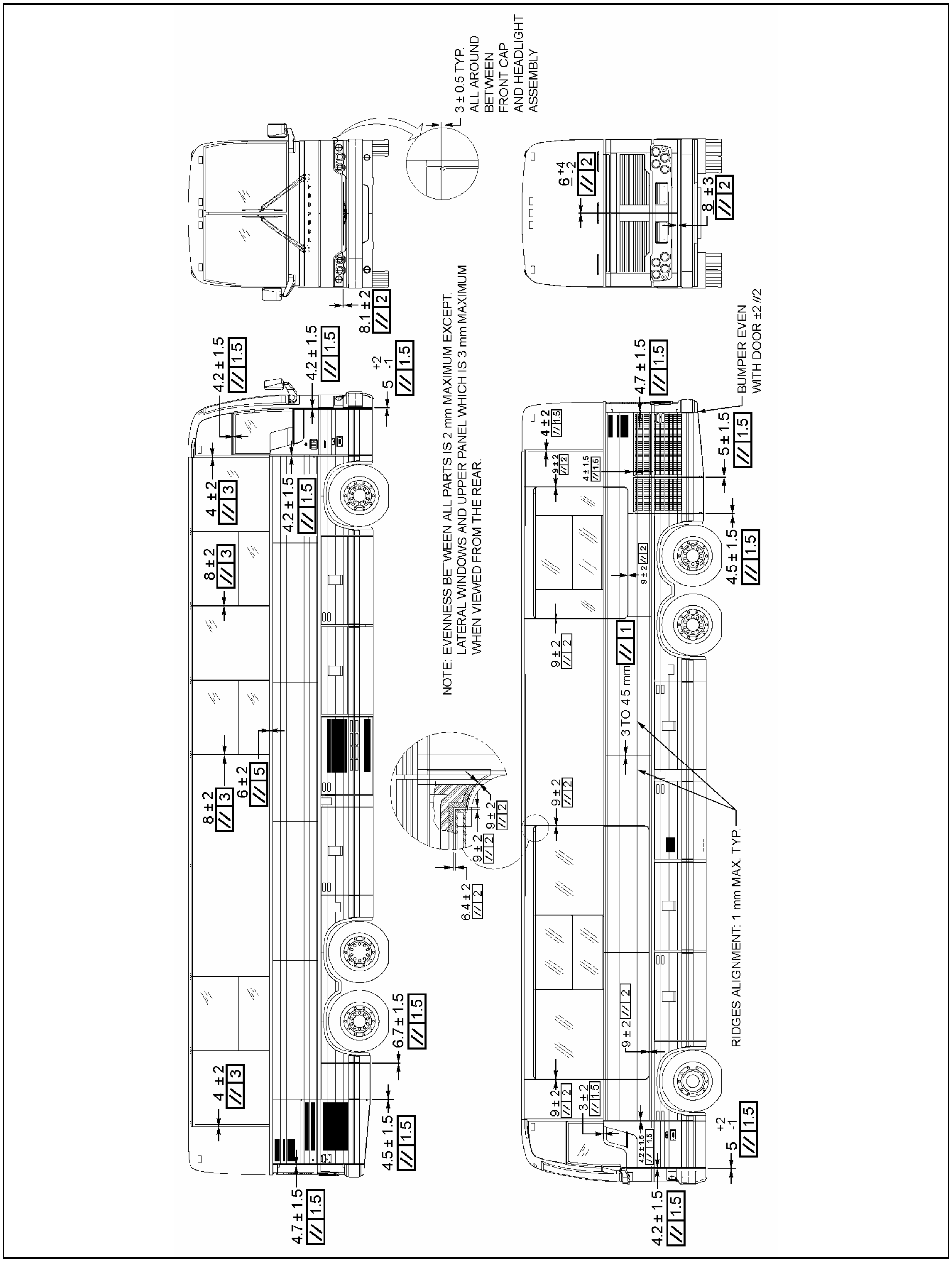


FIGURE 46: BODY PANEL & WINDOW SPACING FOR W5 MTH FITTED WITH SLIDE-OUT

7. W0 MTH EXTERIOR FINISHING AND BODY REPAIR

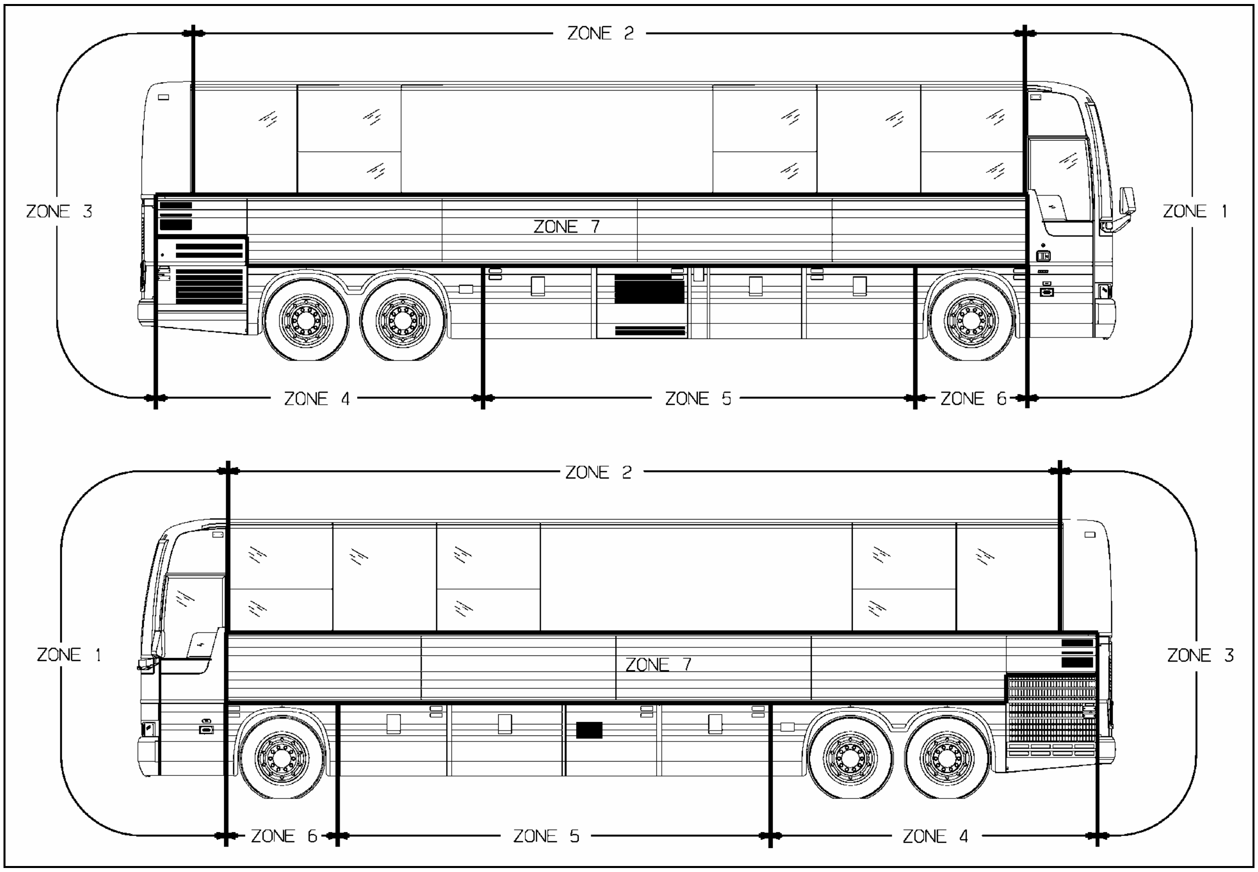


FIGURE 47: W0 MTH ZONING

7.1 ZONE 1

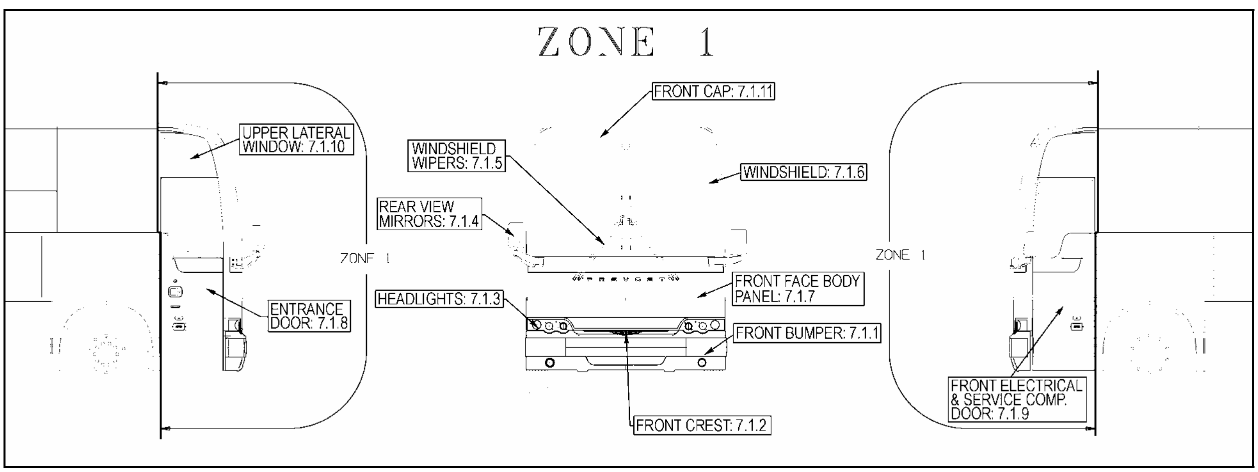


FIGURE 48: ZONE 1

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.

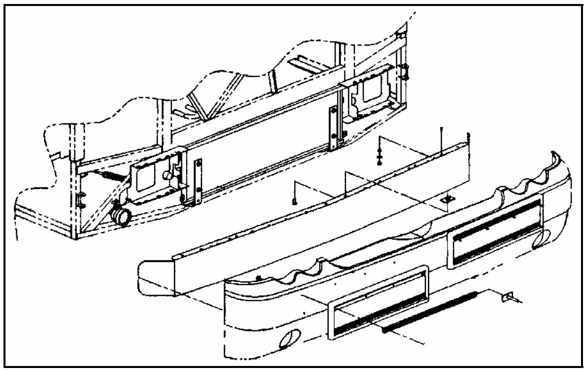


FIGURE 49: FRONT BUMPER REMOVAL

> **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.

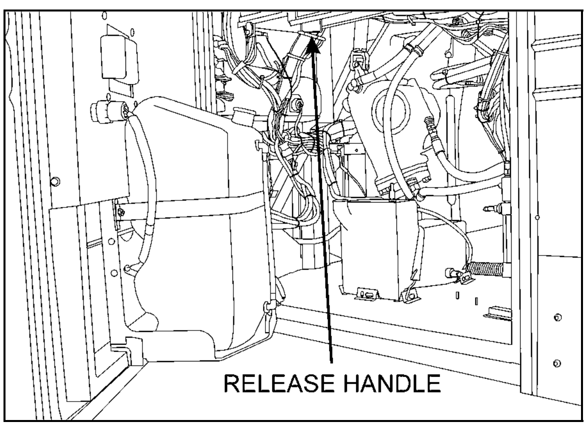


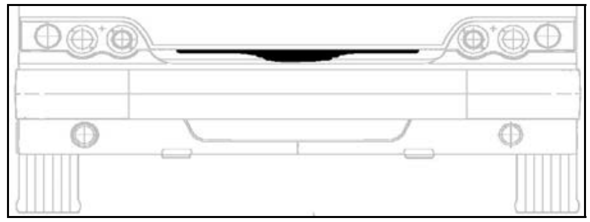
FIGURE 50: FRONT BUMPER RELEASE HANDLE 18613

For gluing of front bumper panel refer to procedure **PR00198** included at the end of this section.

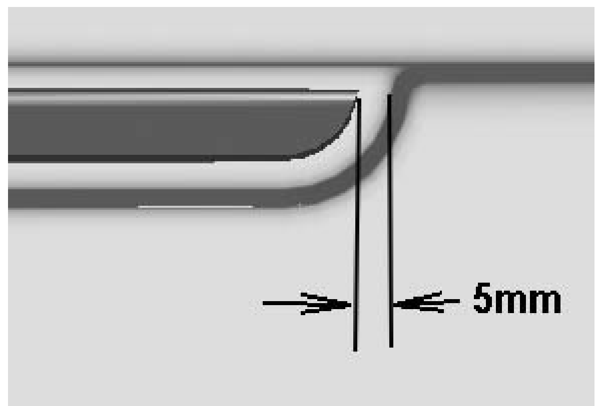
7.1.2 Front Crest

- 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 12.1 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.

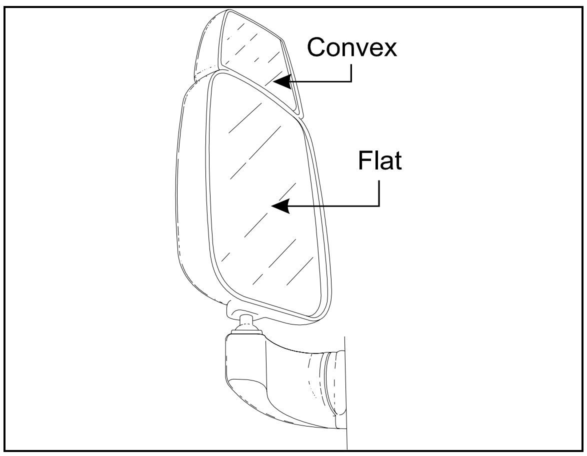


FIGURE 51: REAR VIEW MIRROR (RAMCO) 18398A

❖ **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.

  - 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. 52).

- 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.

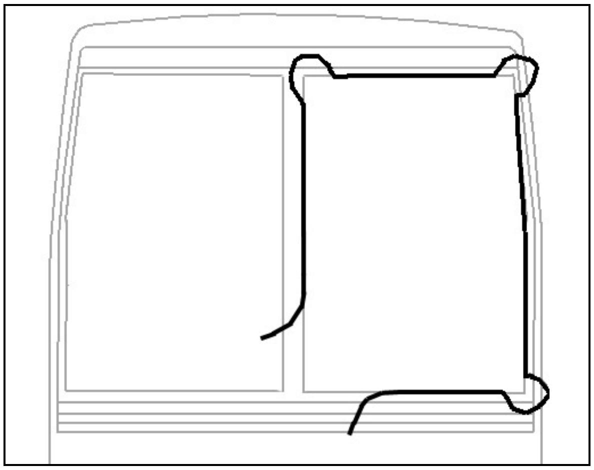


FIGURE 52: WINDSHIELD INSTALLATION USING ROPE

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. 53).
- 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.

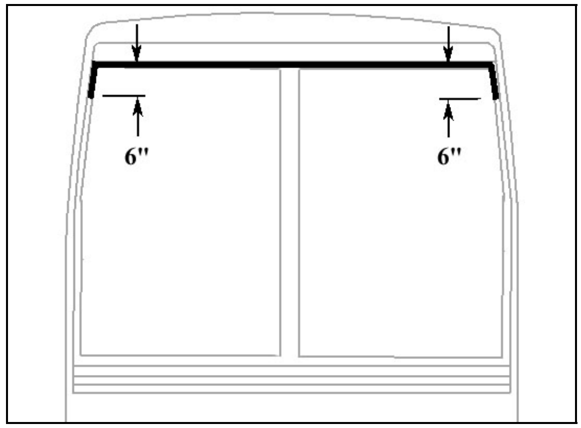


FIGURE 53: APPLICATION 0F SIKA 221 BLACK

- 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**

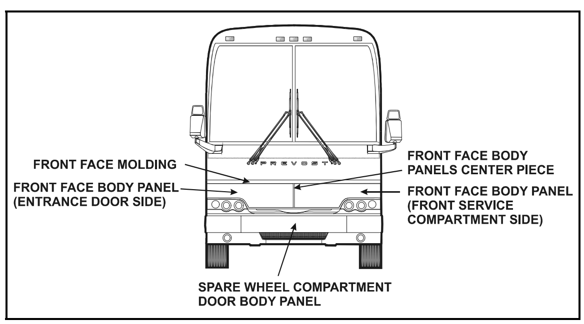


FIGURE 54: VIEW OF FRONT FACE

- 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 **PR00212** included at the end of this section.

❖ **Front face Body Panel Installation**

For gluing of front face body panels, refer to procedure **PR470047** 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 **PR280020** included at the end of this section.

For gluing of entrance door horizontal finishing molding, refer to procedure **PR00213** included at the end of this section.

For the installation of entrance door, refer to procedure **PR280022** 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.

- o 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 **PR280021** included at the end of this section.

For gluing of driver's window, refer to procedure **PR290013** included at the end of this section.

For gluing of front electrical & service compartment door horizontal finishing molding, refer to procedure **PR00213** included at the end of this section.

For the installation of front electrical & service compartment door, refer to procedure **PR280022** 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.

- o In the case of driver's window only, open front service compartment door.
- o Mark the position of the driver's window for future reference.
- o 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.

- o Then, move outside of vehicle and cut Sika bead to free window while somebody else hold the window from the inside.
- o Carefully remove window from frame, ask for help if needed.
- o Using a razor sharp window scraper, remove from window frame Sika bead and double-face self adhesive tape residue.
- o First of all, check Sika 205 cleaner expiration date.
- o Before applying Sika cleaner, fold "Chix" cloth twice for proper width.
- o Apply an even coat onto the inside of window frame and allow drying for 2 minutes (maximum 2 hours).
- o Discard waste according to applicable environmental regulations, use dangerous waste containers.
- o 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 **PR290016** 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

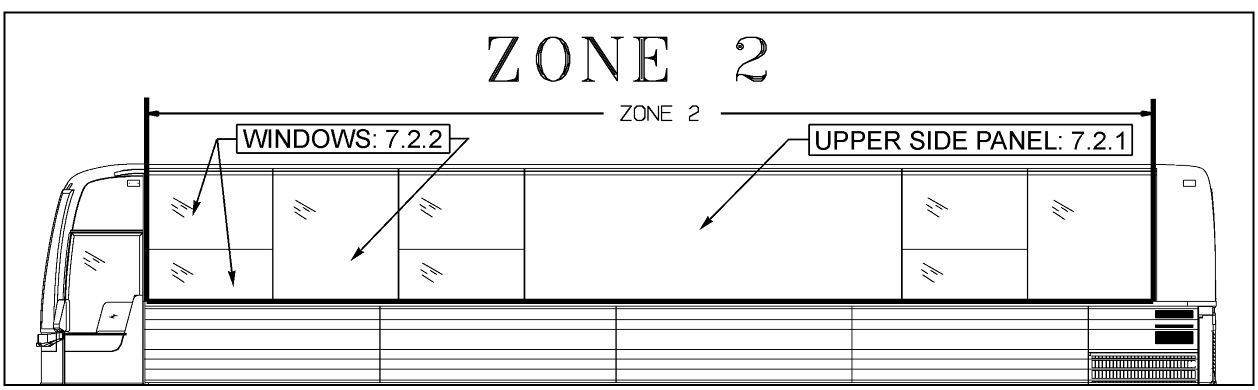


FIGURE 55: ZONE 2

7.2.1 Upper Side Panel

For structure preparation, refer to procedure **PR00035** included at the end of this section.

For installation of upper side panel neoprene foam tapes, refer to procedure **PR00036** included at the end of this section.

For installation of upper side panel, refer to procedure **PR00041** 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.

- o Apply a sticky plastic film onto all of window outside surface for safety reason.
- o 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.
- o 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.
- o 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.
- o Attach the wire ends to the specially designed handles.
- o Pull in turn from the inside and the outside of vehicle to gradually cut the Sika bead on the window perimeter.
- o 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.
- o Detach wire from fish wire and continue cutting using the handle.
- o 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

- o Apply a sticky plastic film onto all of window outside surface.
- o 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.

- o Using a ball peen hammer, hit one of the window bottom corners from the **outside**.
- o Carefully push window out and lift it up sufficiently to separate it from the aluminum molding.
- o Attach the windshield wire to a fish wire and thread it underneath the aluminum molding behind the rivets.
- o Detach wire from fish wire and continue cutting using the handle.
- o Make a notch at each window top corner to make sure you pass underneath the remaining pieces of glass.
- o Remove the aluminum molding and clean up the frame using the window scraper.

For gluing of lateral fixed half-window, refer to procedure **PR00045** included at the end of this section.

For the installation of awning or sliding window, refer to procedure **PR00038** included at the end of this section.

For gluing of lateral fixed window, refer to various procedures: **PR00037** for gluing vertical and bottom rubber seals; **PR00043** for the installation of lateral fixed window and **PR00044** 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

For window or components replacement, refer to paragraph 6.2.3.

7.2.4 Electric Sliding Windows

For sash removal or replacement, refer to paragraph 6.2.4.

7.3 ZONE 3

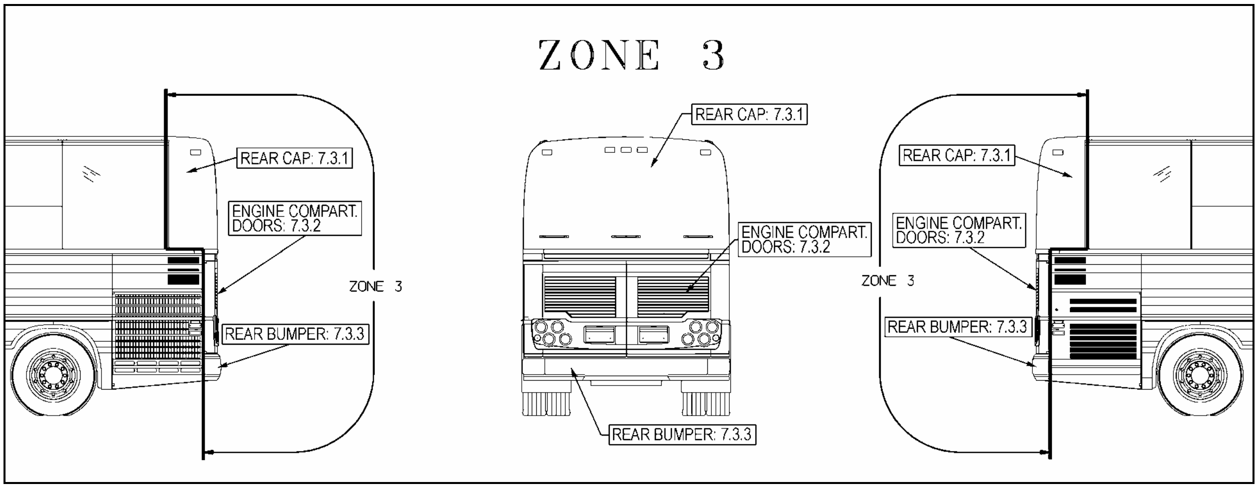


FIGURE 56: ZONE 3

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 Prévost 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:

1. Loosen the bolts, (1, 2 Fig. 57) holding the hinge to the vehicle structure to shift the door "UP or DOWN".
2. Loosening the bolts (3, Fig. 57) 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. 57) 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.

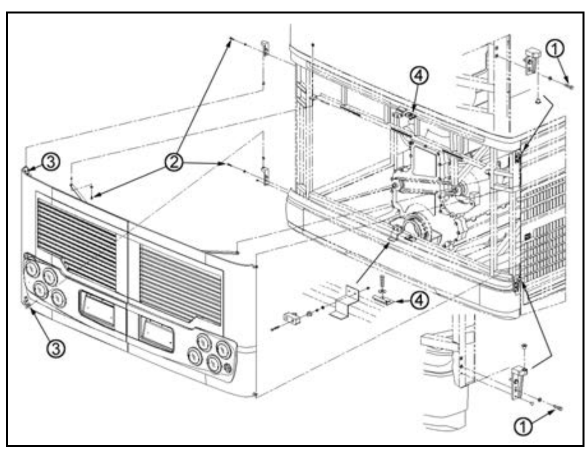


FIGURE 57: ENGINE COMPARTMENT DOORS 18633

❖ **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 **PR00211** included at the end of this section.

For engine compartment door body panel installation, refer to procedure **PR280032** 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, refer to figure 21.

To install bumper, reverse the procedure.

7.4 ZONE 4

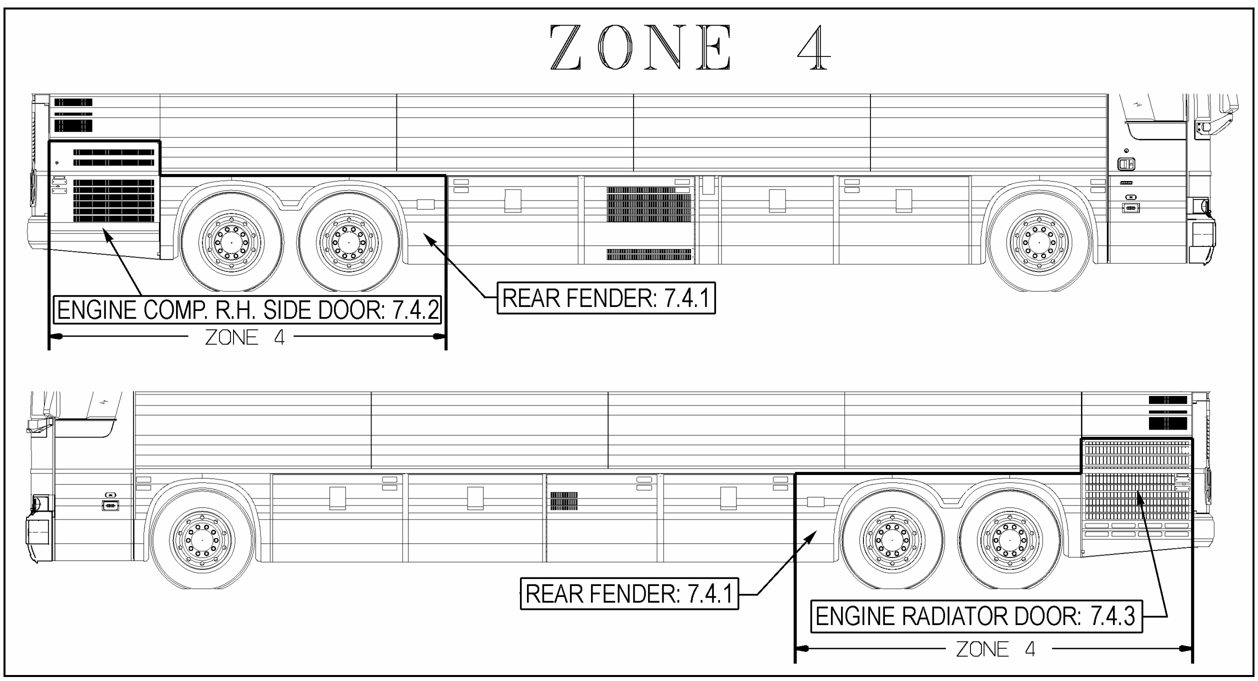


FIGURE 58: ZONE 4

7.4.1 Rear Fender

On the "XLII MTH" series 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 **PR470046** 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. 59) holding the hinge to the vehicle structure to shift the door "IN or OUT" and "UP or DOWN".
2. Loosening the bolts (2, Fig. 59) 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.

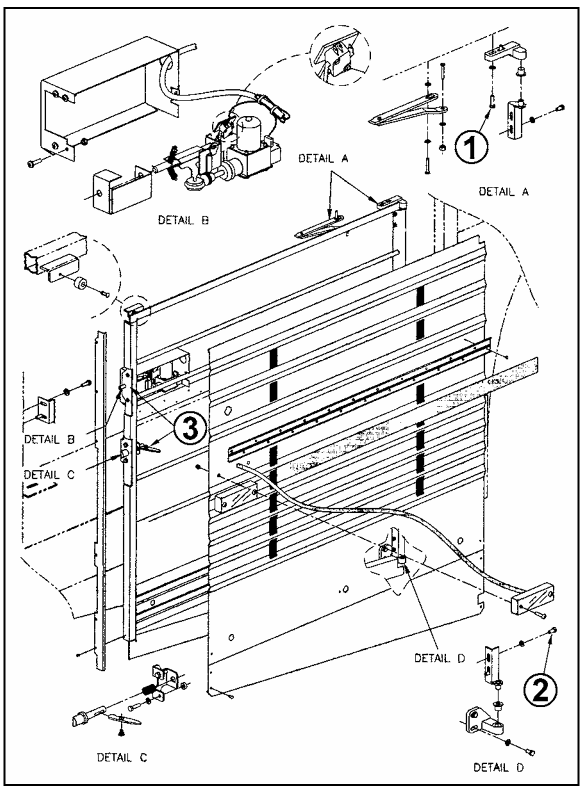


FIGURE 59: ENGINE COMPARTMENT R.H. SIDE DOOR 18635

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. 59) 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 **PR00210** 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:

1. Loosen the bolts, (1, Fig. 60) holding the hinge to the vehicle structure to shift the door "IN or OUT" and "UP or DOWN".
2. Loosening the bolts (2, Fig. 60) allows the door to be shifted "LEFT or RIGHT" and "UP or DOWN".

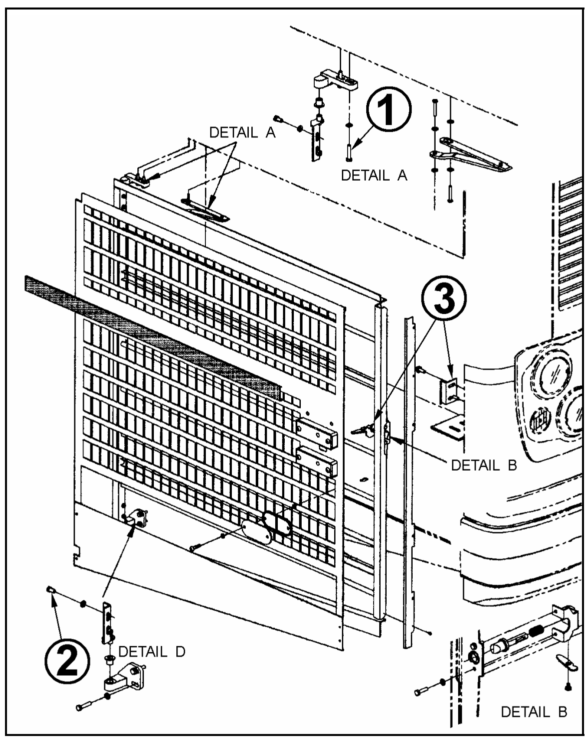


FIGURE 60: RADIATOR DOOR 18636

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. 60) 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 radiator door finishing molding, refer to procedure **PR00210** included at the end of this section.

7.5 ZONE 5

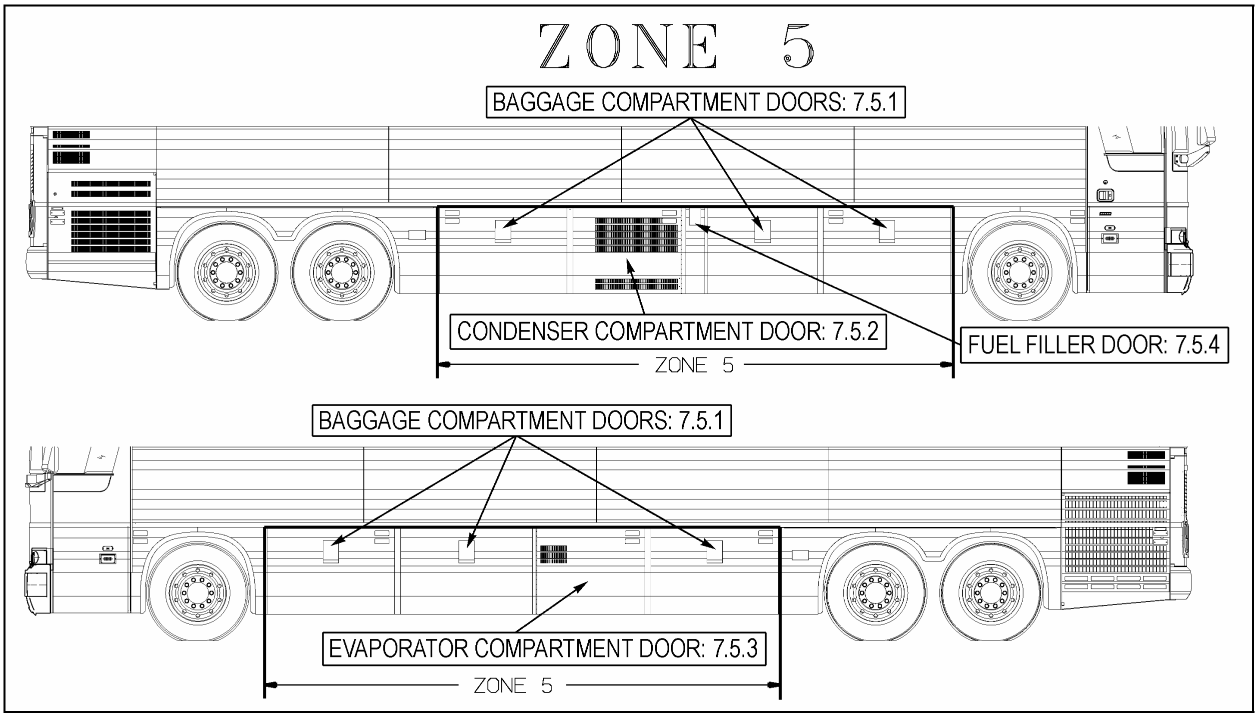


FIGURE 61: ZONE 5

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. 62).

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.

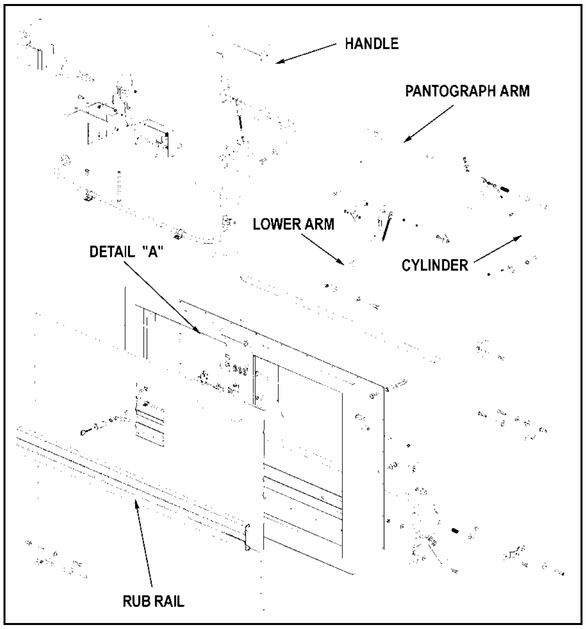


FIGURE 62: BAGGAGE COMPARTMENT DOOR 18145

❖ 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.

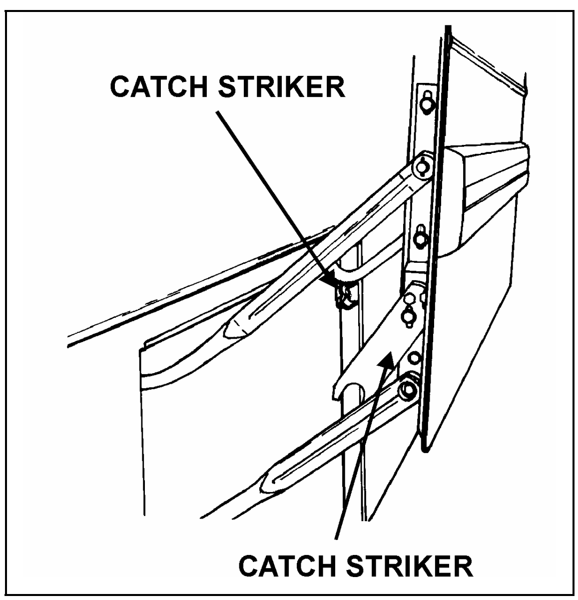


FIGURE 63: BAGGAGE DOOR CATCH STRIKER 18146

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. 63).

For the removal and installation of baggage compartment door body panels, refer to procedure **PR00177** 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.

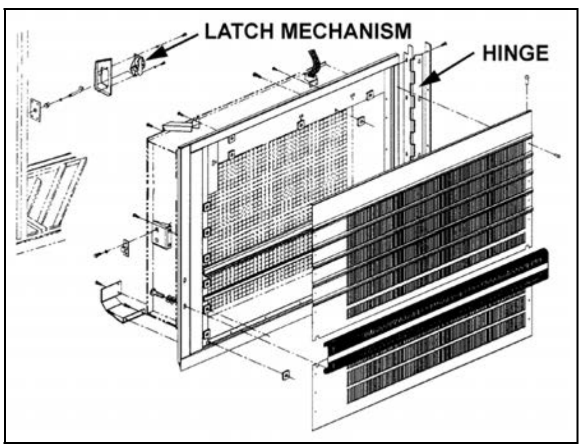


FIGURE 64: CONDENSER DOOR

For the installation of condenser compartment door body panel, refer to procedure **PR00131** 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.

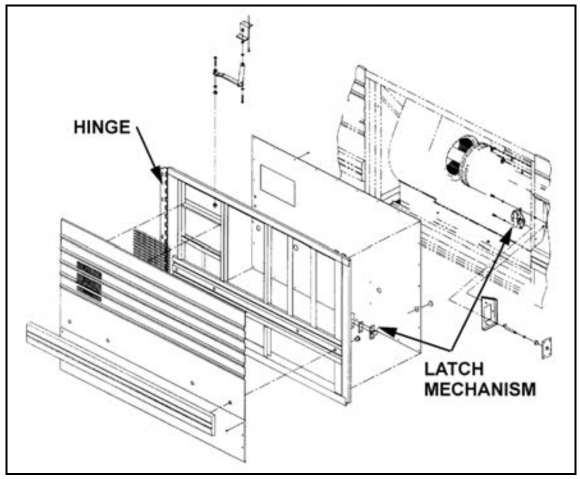


FIGURE 65: EVAPORATOR DOOR

For the installation of evaporator compartment door body panel, refer to procedure **PR00133** 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.

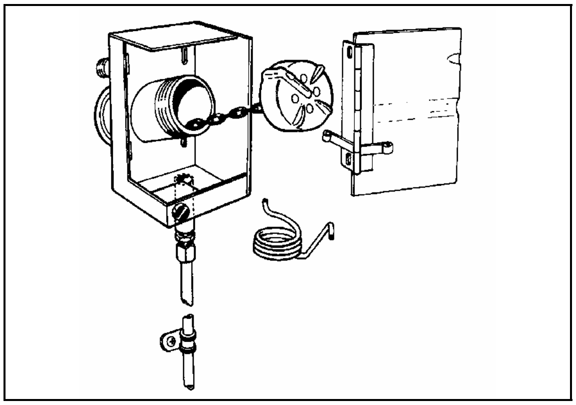


FIGURE 66: FUEL FILLER DOOR 03046

7.6 ZONE 6

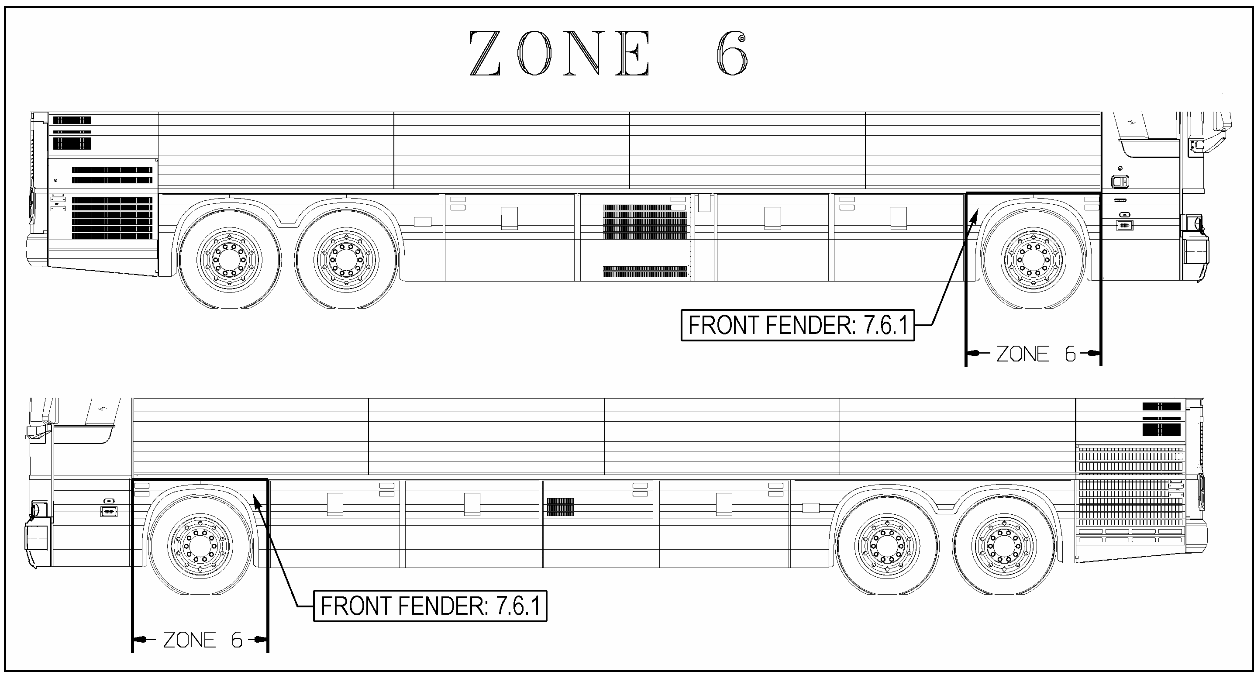


FIGURE 67: ZONE 6

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 **PR470024** included at the end of this section.

7.7 ZONE 7

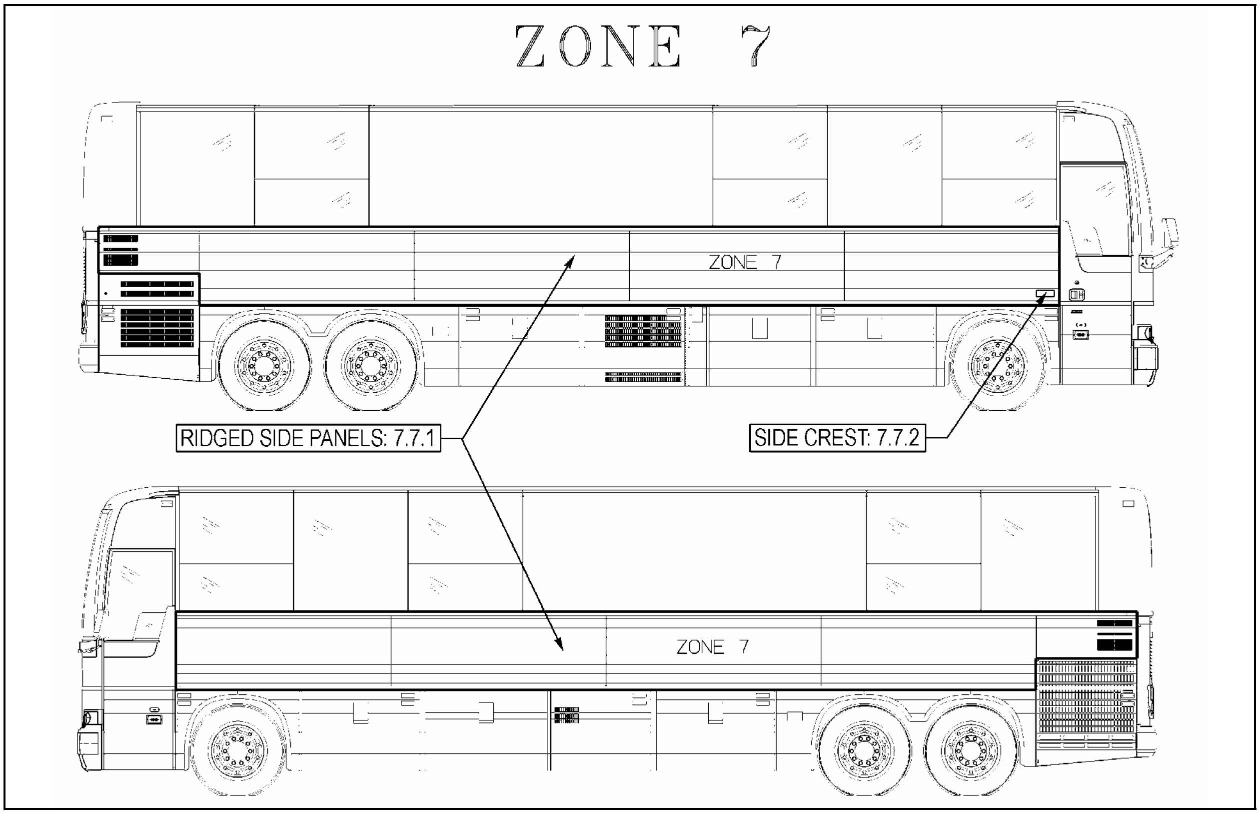


FIGURE 68: ZONE 7

7.7.1 Ridged Side Panels

❖ **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 **PR00027** included at the end of this section.

For gluing of ridged side panels, refer to procedure **PR00028** included at the end of this section.

For sealing the side panels' upper portion, refer to procedure **PR00030** included at the end of this section.

For gluing of horizontal finishing molding, refer to procedure **PR00208** included at the end of this section.

7.7.2 Side Crest

- o Clean vehicle surface using anti-silicone where the side crest and stickers will be applied.
- o Using hands apply and compress side crest.
- o Apply required stickers.

8. WE MTH EXTERIOR FINISHING AND BODY REPAIR

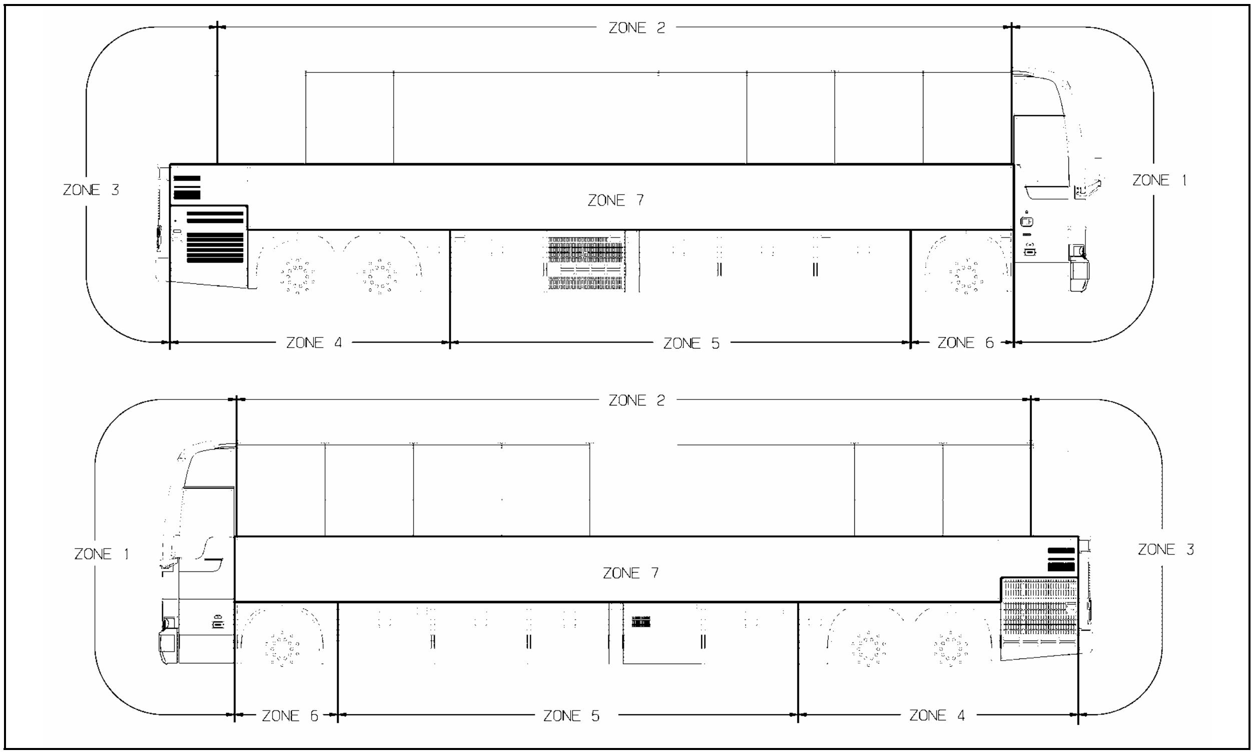


FIGURE 69: WE MTH ZONING

8.1 ZONE 1

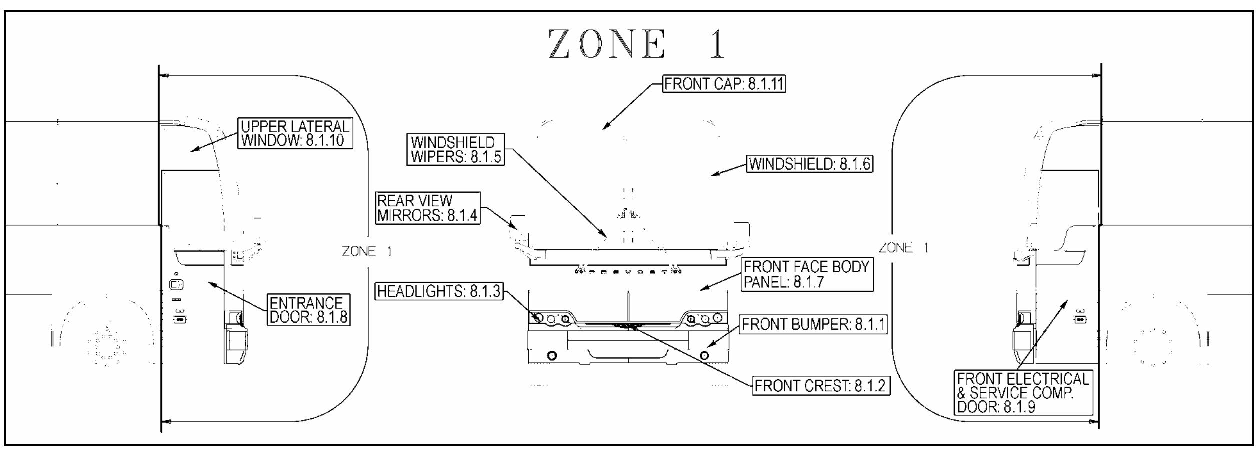


FIGURE 70: ZONE 1

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.

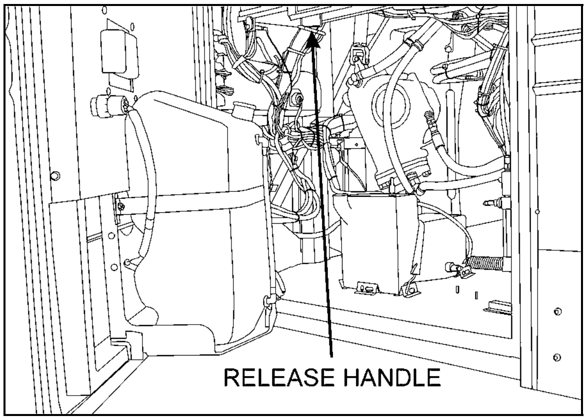


FIGURE 71: FRONT BUMPER RELEASE HANDLE 18613

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.

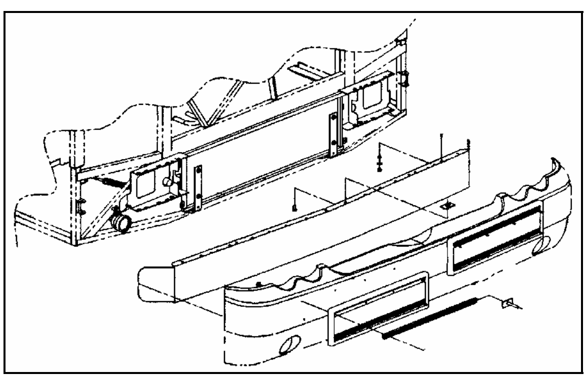


FIGURE 72: FRONT BUMPER REMOVAL

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.

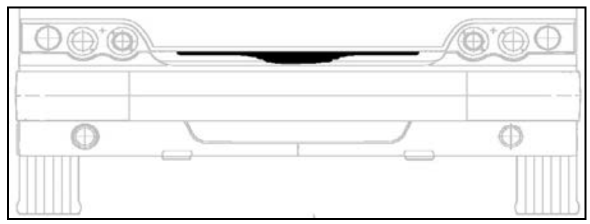
For gluing of front bumper panel refer to procedure **PR00198** included at the end of this section.

8.1.2 Front Crest

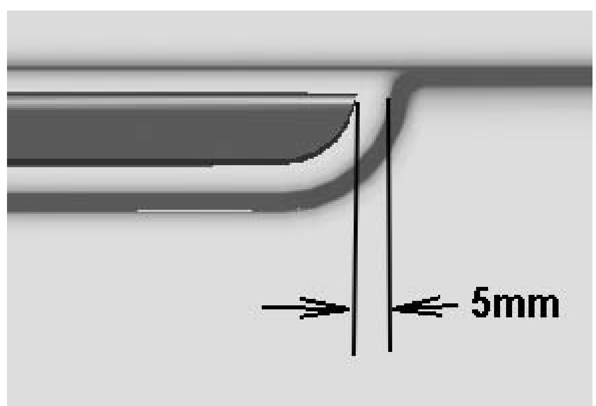
- o Use a Chix cloth and anti-silicone to clean the surface where the crest will be applied.

CAUTION

Do not exceed the crest dedicated surface.



- o Peel the back from the self adhesive crest side pieces.



- o Peel the back from the self adhesive crest center piece. Center crest and apply.
- o Compress the crest three pieces using your hands.

8.1.3 Headlights

Refer to Paragraph 12.1 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.

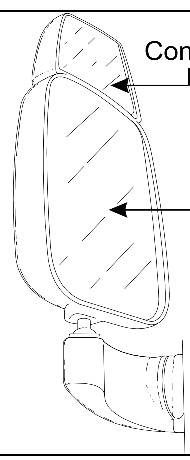


FIGURE 73: REAR VIEW MIRROR (RAMCO) 18398A

❖ **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. 74).
- 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.

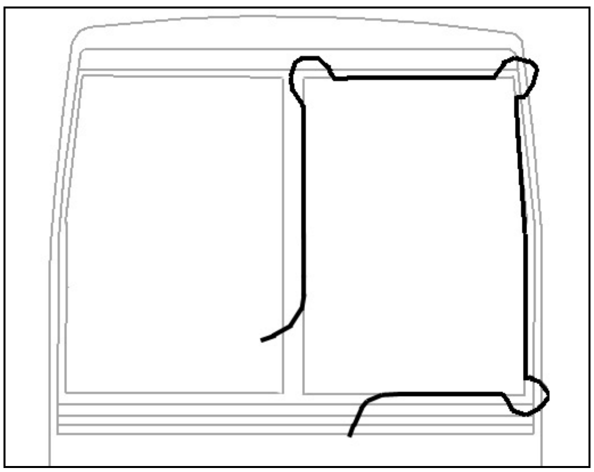


FIGURE 74: WINDSHIELD INSTALLATION USING ROPE

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.75).
- 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.

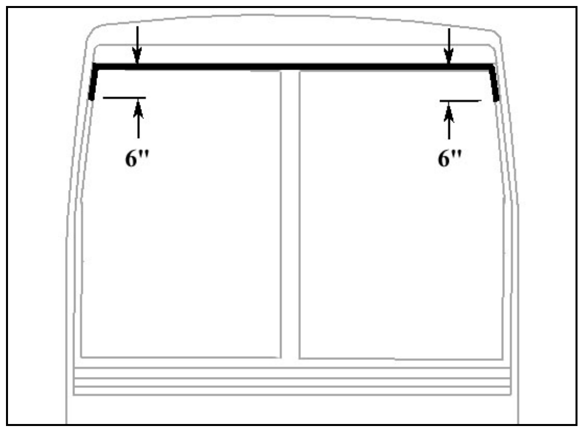


FIGURE 75: APPLICATION 0F SIKA 221 BLACK

- 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

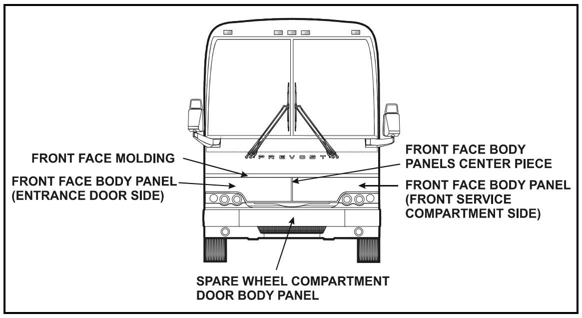


FIGURE 76: VIEW OF FRONT FACE

- 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 **PR00212** included at the end of this section.

❖ Front face Body Panel Installation

For gluing of front face body panels, refer to procedure **PR470047** 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 **PR280020** included at the end of this section.

For gluing of entrance door horizontal finishing molding, refer to procedure **PR00213** included at the end of this section.

For the installation of entrance door, refer to procedure **PR280022** 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.

- o Remove interior finishing panel to access rub rail fixing bolts, then remove rub rail.
- o Using the "**Zip Gun**", cut Sika bead located ¼ inch (7-8 mm) from each body panel edge and around cornering light.
- o Separate body panel from door.
- o Remove from door surface Sika bead and double-face self adhesive tape residue using a razor sharp window scraper.
- o 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 **PR280021** included at the end of this section.

For gluing of driver's window, refer to procedure **PR290013** included at the end of this section.

For gluing of front electrical & service compartment door horizontal finishing molding, refer to procedure **PR00213** included at the end of this section.

For the installation of front electrical & service compartment door, refer to procedure **PR280022** 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.

- o In the case of driver's window only, open front service compartment door.
- o Mark the position of the driver's window for future reference.
- o 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.

- o Then, move outside of vehicle and cut Sika bead to free window while somebody else hold the window from the inside.
- o Carefully remove window from frame, ask for help if needed.
- o Using a razor sharp window scraper, remove from window frame Sika bead and double-face self adhesive tape residue.
- o First of all, check Sika 205 cleaner expiration date.
- o Before applying Sika cleaner, fold "Chix" cloth twice for proper width.
- o Apply an even coat onto the inside of window frame and allow drying for 2 minutes (maximum 2 hours).
- o Discard waste according to applicable environmental regulations, use dangerous waste containers.
- o 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 **PR290016** 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

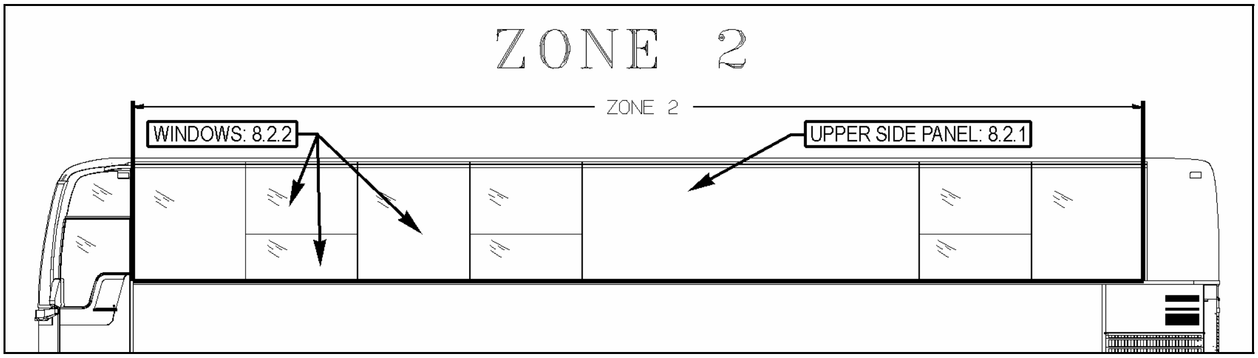


FIGURE 77: ZONE 2

8.2.1 Upper Side Panel

For structure preparation, refer to procedure **PR00035** included at the end of this section.

For installation of upper side panel neoprene foam tapes, refer to procedure **PR00036** included at the end of this section.

For installation of upper side panel, refer to procedure **PR00041** 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.

- o Apply a sticky plastic film onto all of window outside surface for safety reason.
- o 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.
- o 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.
- o 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.
- o Attach the wire ends to the specially designed handles.
- o Pull in turn from the inside and the outside of vehicle to gradually cut the Sika bead on the window perimeter.
- o 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.
- o Detach wire from fish wire and continue cutting using the handle.
- o 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

- o Apply a sticky plastic film onto all of window outside surface.
- o 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 **PR00045** included at the end of this section.

For the installation of awning or sliding window, refer to procedure **PR00038** included at the end of this section.

For gluing of lateral fixed window, refer to various procedures: **PR00037** for gluing vertical and bottom rubber seals; **PR00043** for the installation of lateral fixed window and **PR00044** 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 6.2.3.

8.2.4 Electric Sliding Windows

For sash removal or replacement, refer to paragraph 6.2.4.

8.3 ZONE 3

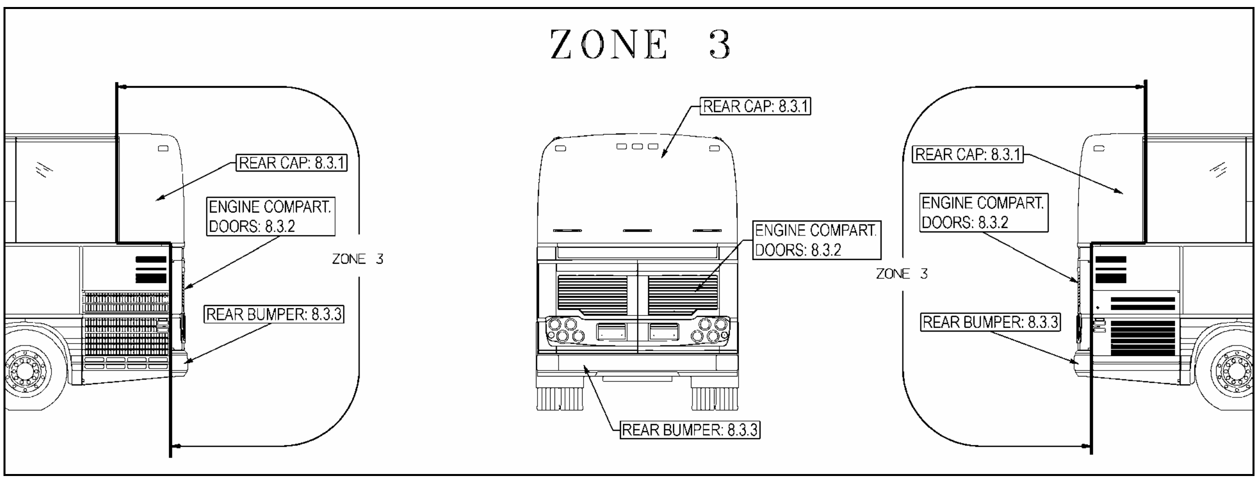


FIGURE 78: ZONE 3

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 Prévost 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. 79) holding the hinge to the vehicle structure to shift the door "UP or DOWN".
2. Loosening the bolts (3, Fig. 79) 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. 79) 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.

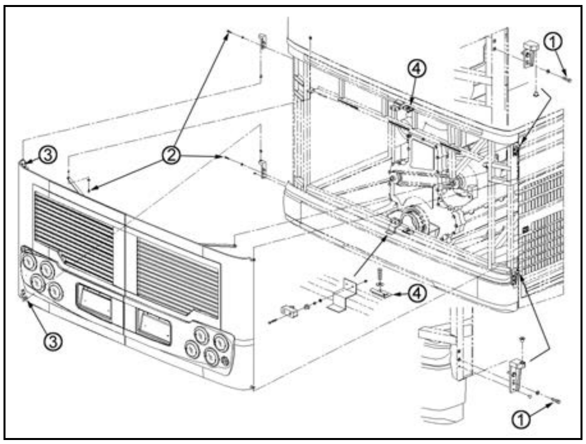


FIGURE 79: ENGINE COMPARTMENT DOORS 18633

❖ **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.

- Remove damaged engine compartment door from vehicle.
- Install the damaged door onto an appropriate support.
- Wearing gloves, goggles and ear plugs, pry loose body panel using a “Zip gun” or lever starting from the edge opposite the curved side.
- Use the “Zip gun” to detach completely the stainless steel body panel from door frame.

CAUTION

Do not damage painted surface.

- 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.

- 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 **PR00211** included at the end of this section.

For engine compartment door body panel installation, refer to procedure **PR280032** 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.

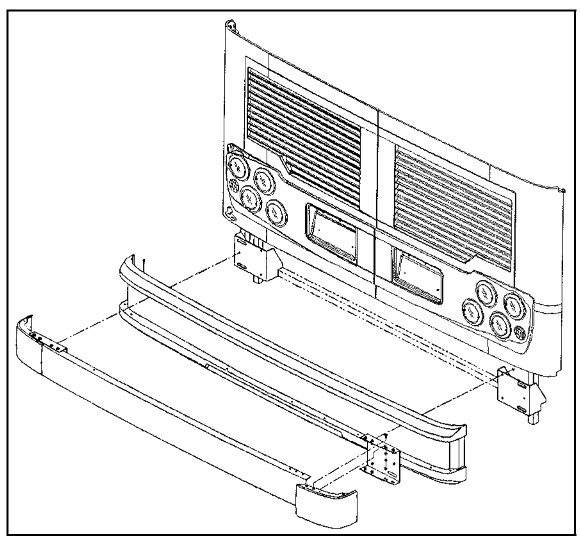


FIGURE 80: REAR BUMPER

8.4 ZONE 4

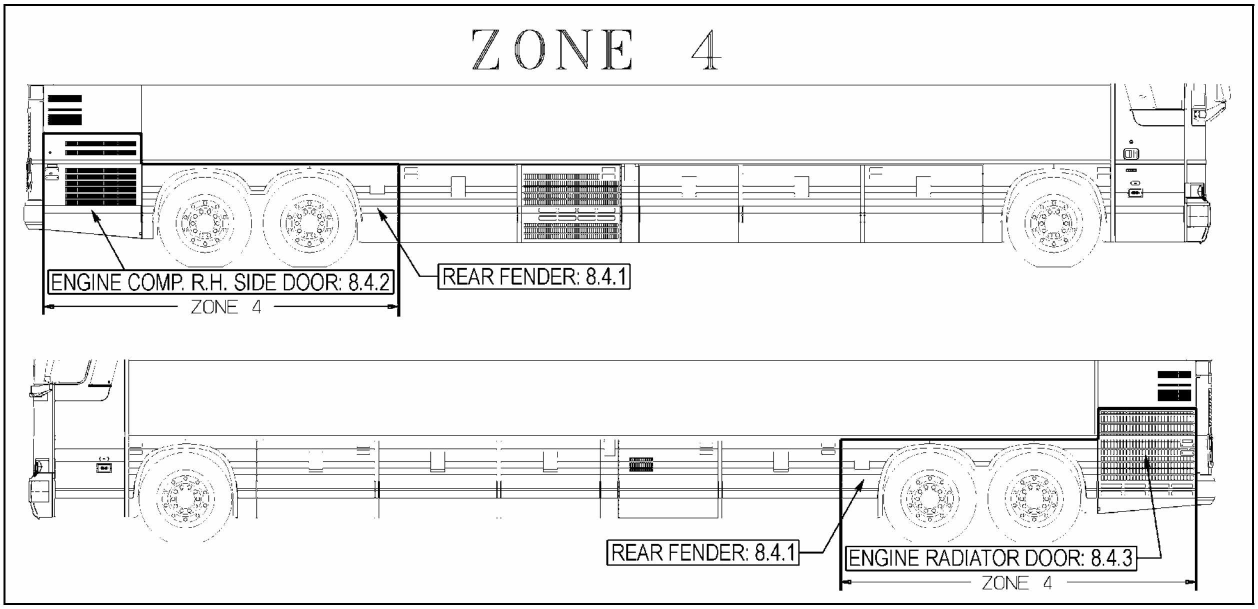


FIGURE 81: ZONE 4

8.4.1 Rear Fender

On the "XLII MTH" series 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 **PR470046** 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. 82) holding the hinge to the vehicle structure to shift the door "IN or OUT" and "UP or DOWN".
2. Loosening the bolts (2, Fig. 82) 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.

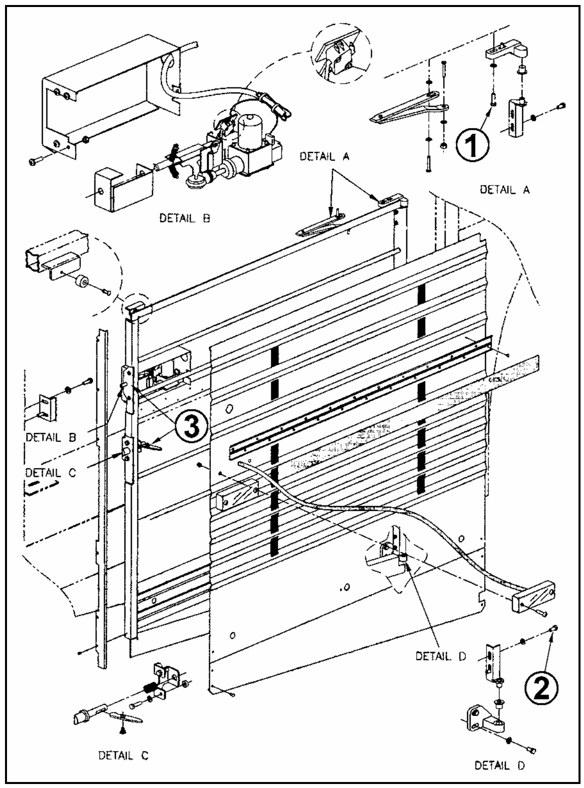


FIGURE 82: ENGINE COMPARTMENT R.H. SIDE DOOR18635

To adjust the latch mechanism (3, Fig. 82) 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 **PR00210** 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. 83) holding the hinge to the vehicle structure to shift the door "IN or OUT" and "UP or DOWN".
2. Loosening the bolts (2, Fig. 83) 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. 83) and the striker pin:

1. Open the door to access the striker pin.

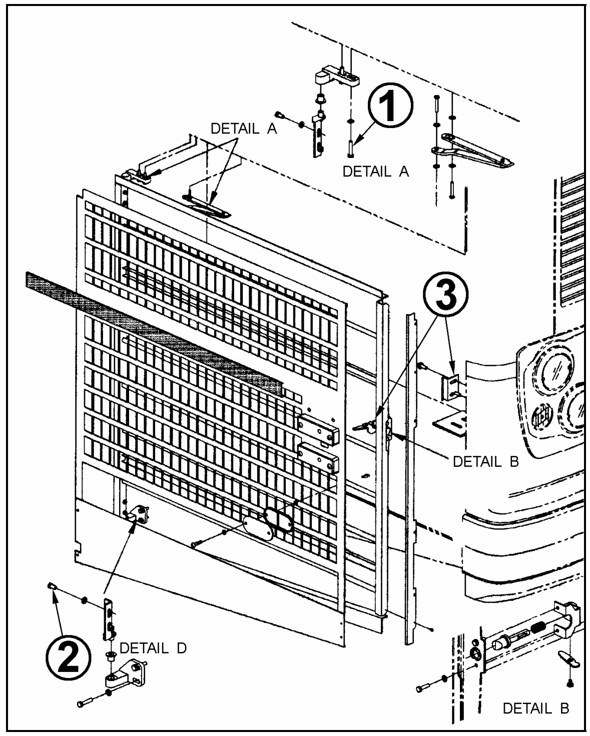


FIGURE 83: RADIATOR DOOR 18636

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 **PR00210** included at the end of this section.

8.5 ZONE 5

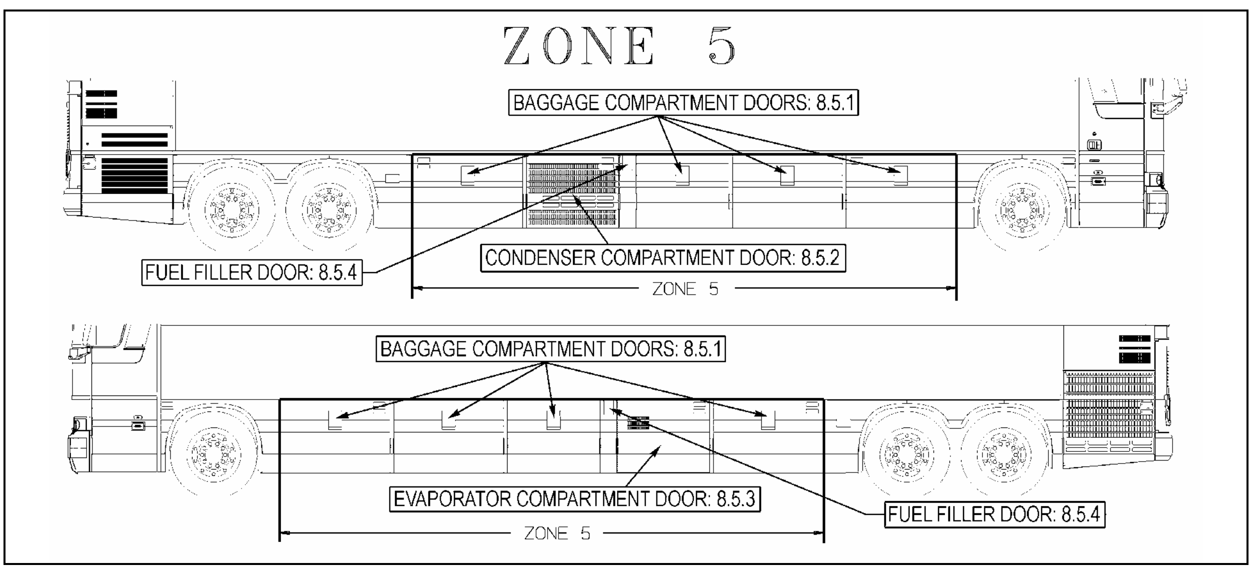


FIGURE 84: ZONE 5

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. 85).

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.

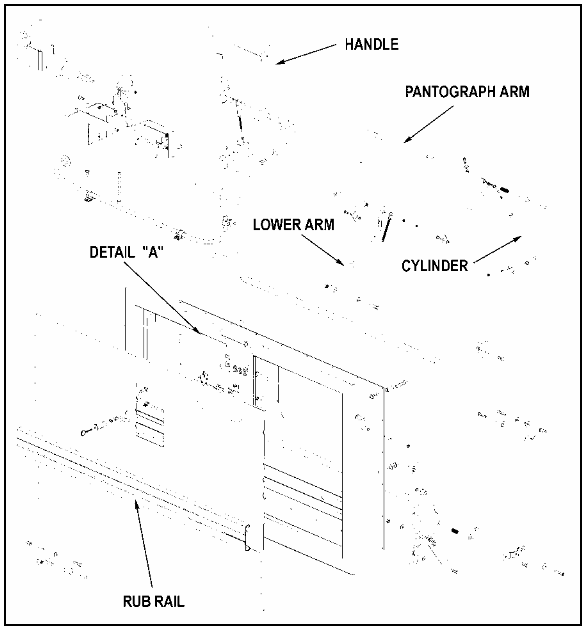


FIGURE 85: BAGGAGE COMPARTMENT DOOR 18145

❖ **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 panto-graph 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 panto-graph 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.

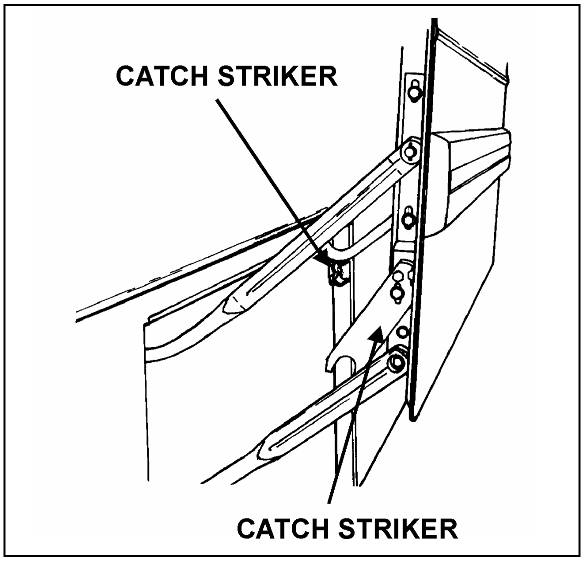


FIGURE 86: BAGGAGE DOOR CATCH STRIKER 18146

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. 86).

For the removal and installation of baggage compartment door body panels, refer to procedure **PR00177** 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.

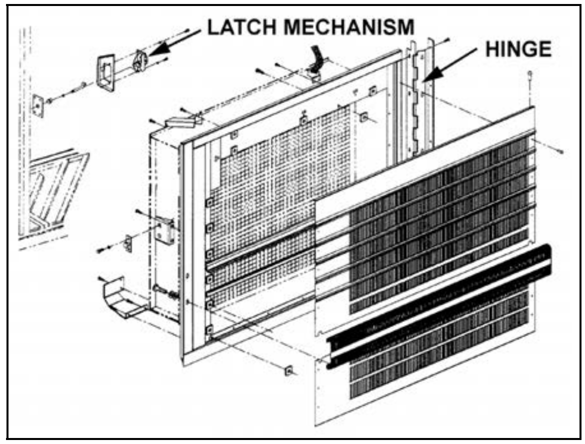


FIGURE 87: CONDENSER DOOR

For the installation of condenser compartment door body panel, refer to procedure **PR00131** 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.

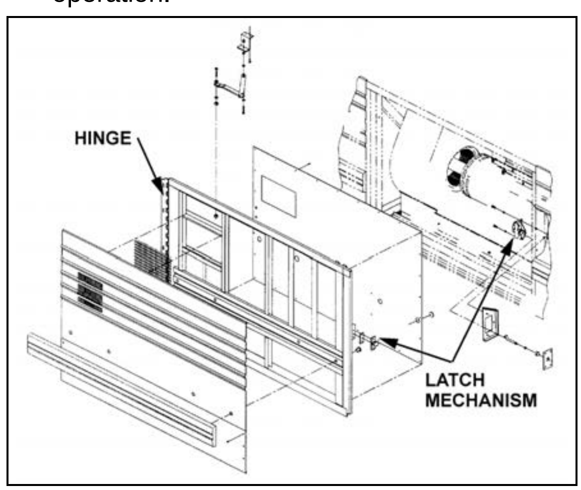


FIGURE 88: EVAPORATOR DOOR

For the installation of evaporator compartment door body panel, refer to procedure **PR00133** 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.

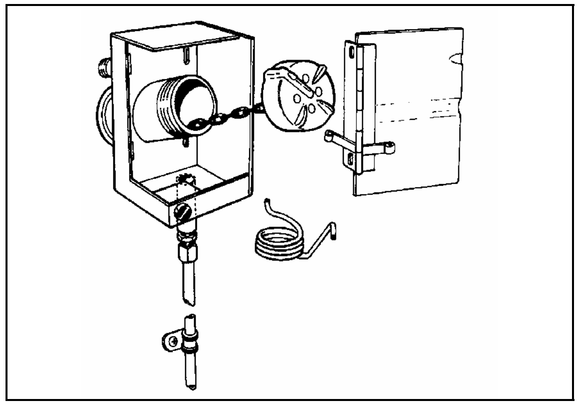


FIGURE 89: FUEL FILLER DOOR 03046

8.6 ZONE 6

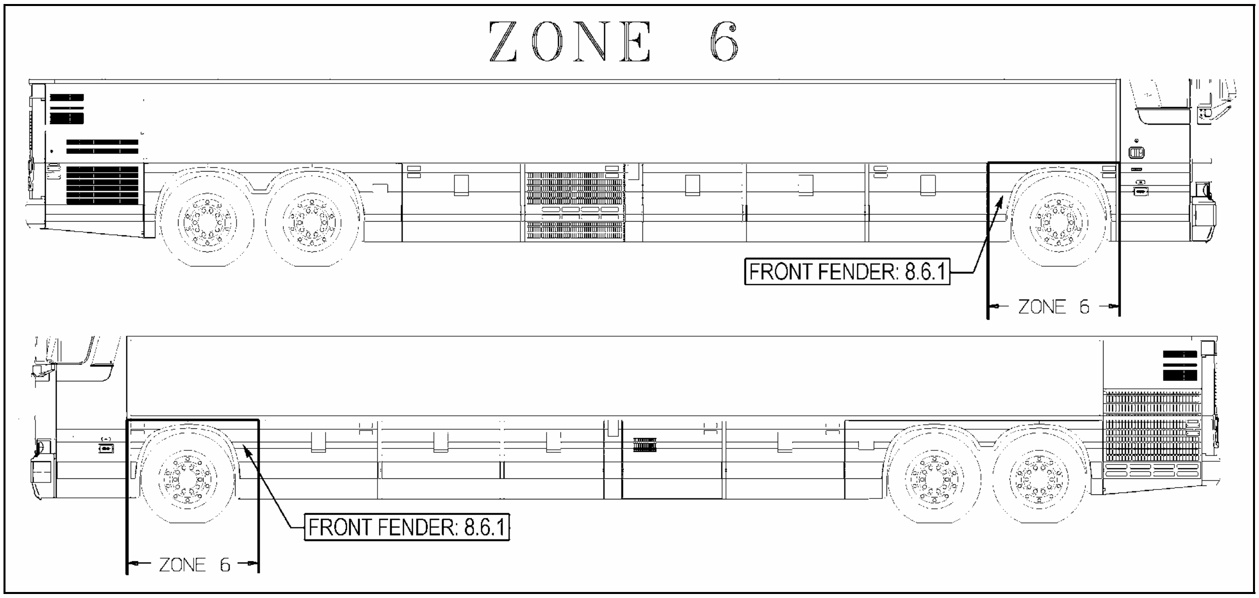


FIGURE 90: ZONE 6

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 **PR470024** included at the end of this section.

8.7 ZONE 7

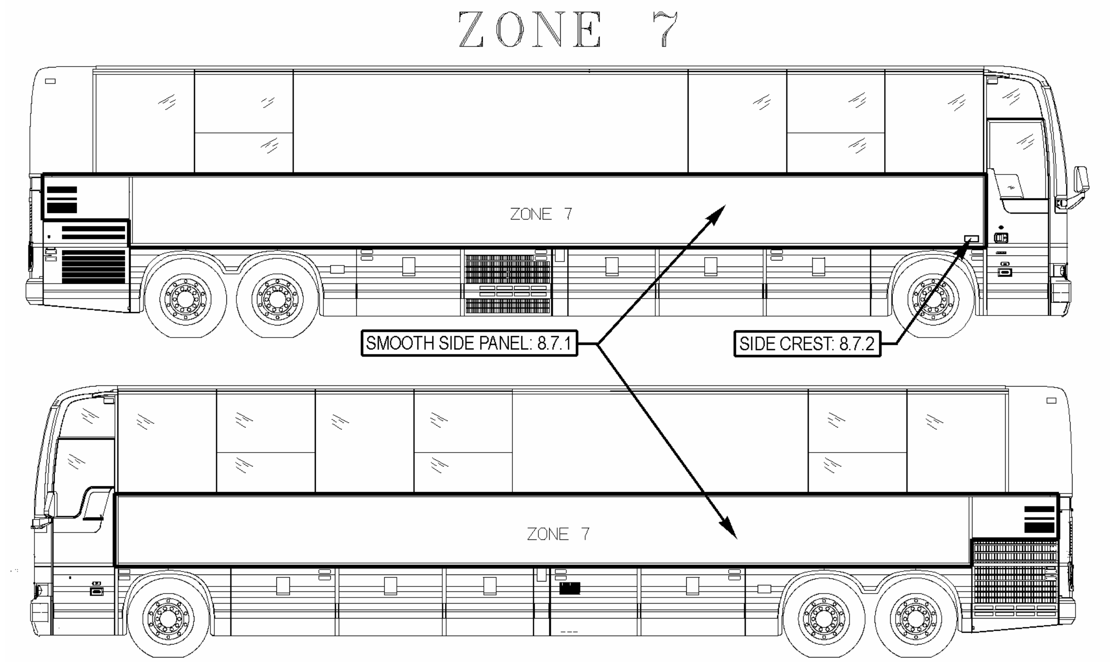


FIGURE 91: ZONE 7

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	**PR00072**
SMOOTH SIDE PANEL – INSTALLATION	**PR00073**
ENGINE AIR INTAKE PANEL - GLUING	**PR00074**
SMOOTH SIDE PANEL – FINISHING JOINT	**PR00075**
SMOOTH SIDE PANEL – GLUING MOLDINGS	**PR00214**
SMOOTH SIDE PANEL – REAR MOLDING GLUING	**PR00215**
SMOOTH SIDE PANEL – PROTECTION OF UNPRIMED TIG WELDING SPOTS	**PR00216**
SMOOTH SIDE PANEL – GLUING SLIDE-OUT VERTICAL MOLDING	**PR00217**
SMOOTH SIDE PANEL – CUTTING HORIZONTAL FINISHING MOLDING AT SLIDE-OUT LEVEL	**PR00220**

8.7.2 Side Crest

- o Clean vehicle surface using anti-silicone where the side crest and stickers will be applied.
- o Using hands apply and compress side crest.
- o Apply required stickers.

8.8 ZONE 8

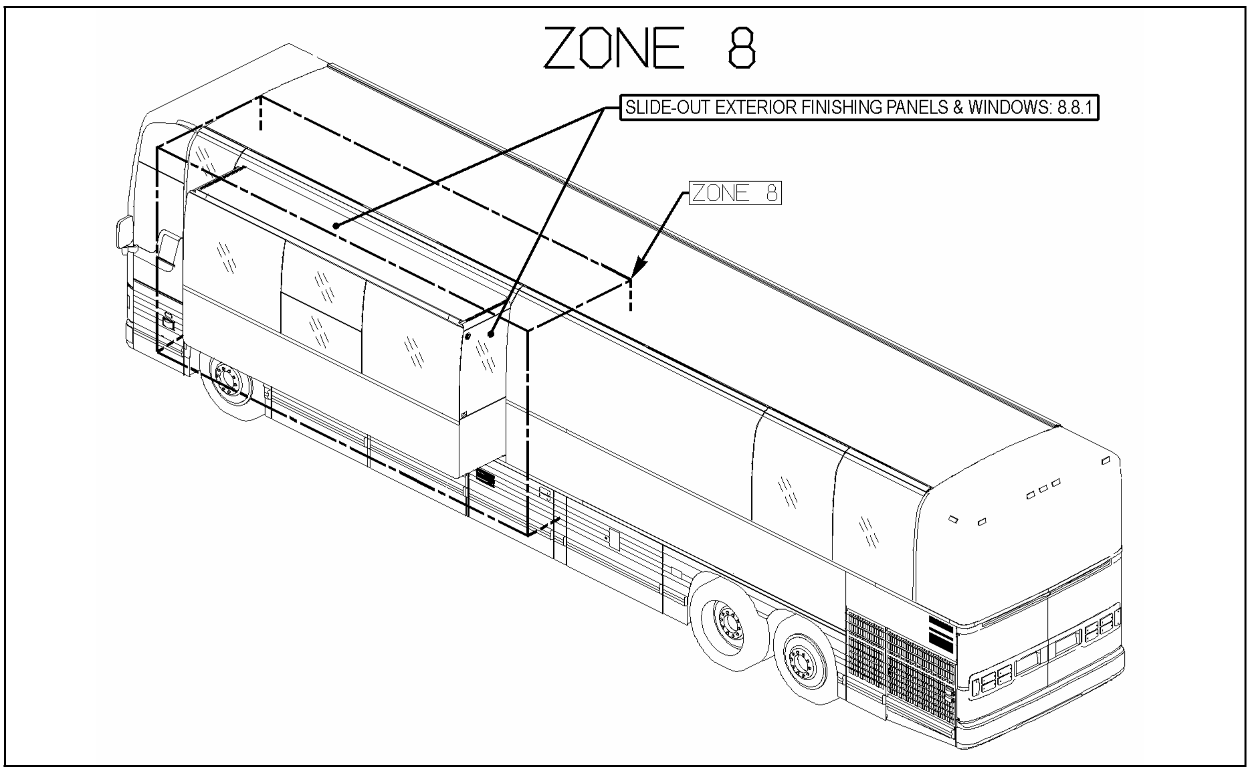


FIGURE 92: ZONE 8

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 WE MTH FITTED WITH SLIDE-OUT

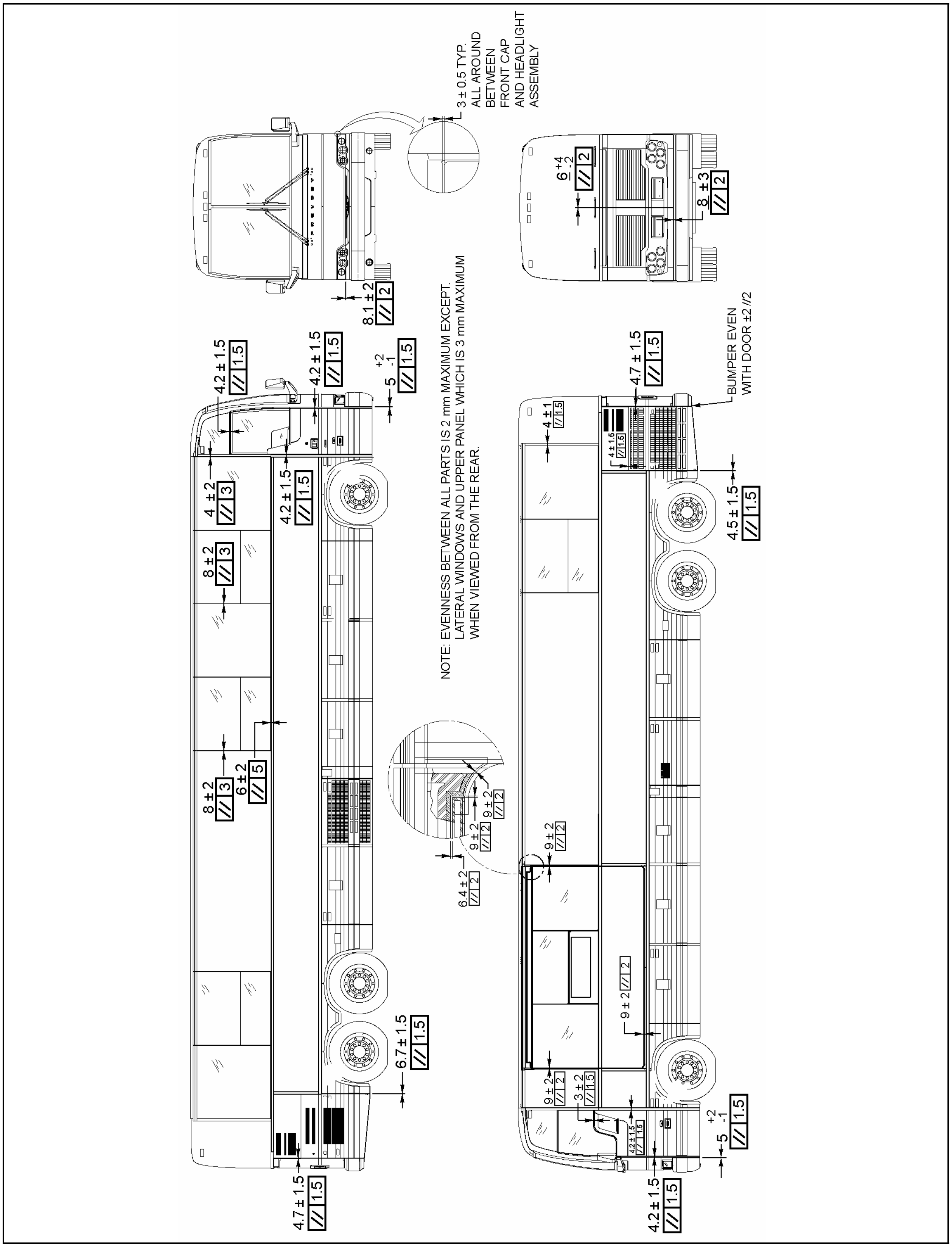


FIGURE 93: BODY PANEL & WINDOW SPACING FOR WE MTH FITTED WITH SLIDE-OUT

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 94 to 99.

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 a motorcoach 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.

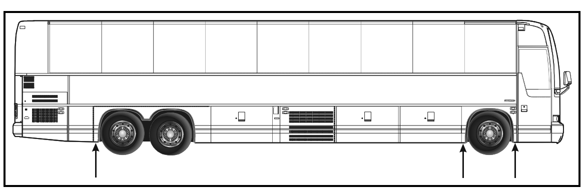


FIGURE 94: JACKING POINTS ON FRAME

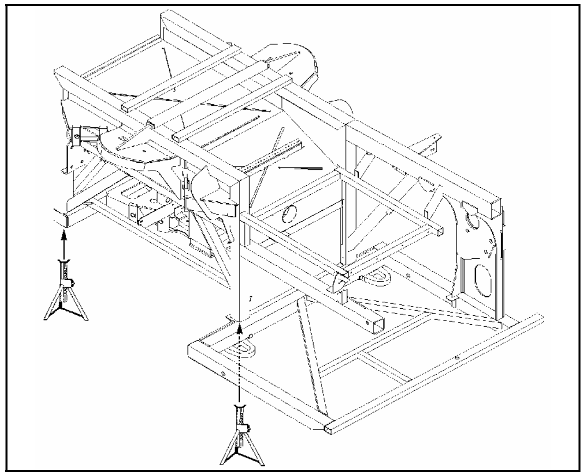


FIGURE 95: FRONT SUBFRAME JACKING POINTS 18592

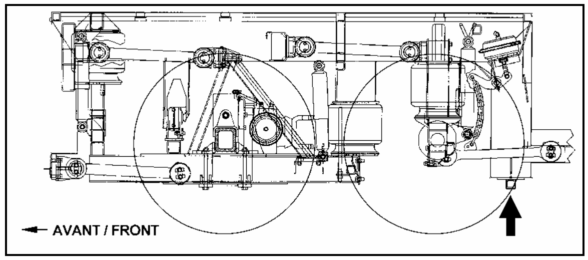


FIGURE 96: REAR SUBFRAME JACKING POINTS

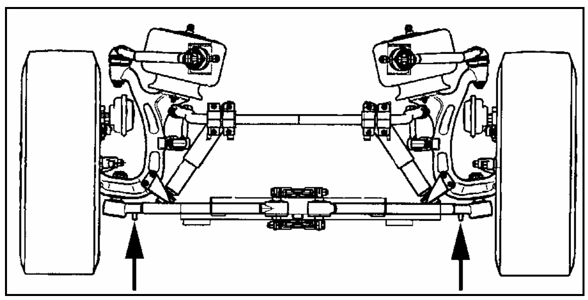


FIGURE 97: JACKING POINTS ON IND. SUSPENSION 16095

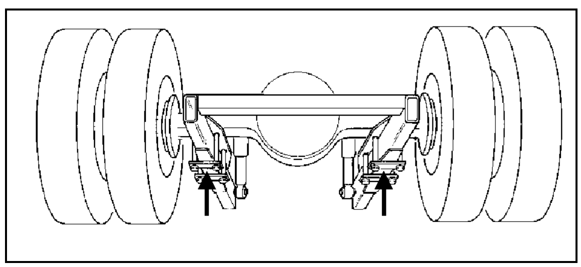


FIGURE 98: JACKING POINTS ON DRIVE AXLE OEH3B762

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.

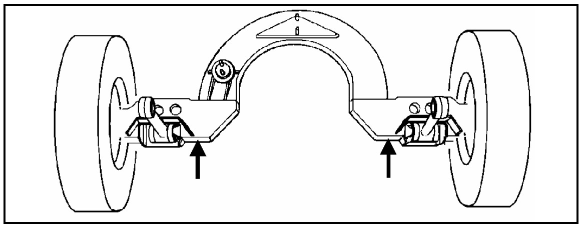


FIGURE 99: JACKING POINTS ON TAG AXLE OEH3B764

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.

NOTE

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 Rockwell's *"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.

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 Rockwell's *"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.

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.

MEMORANDUM

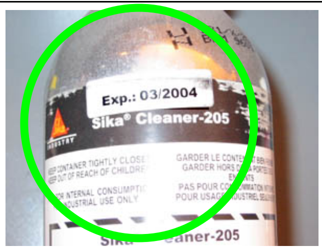
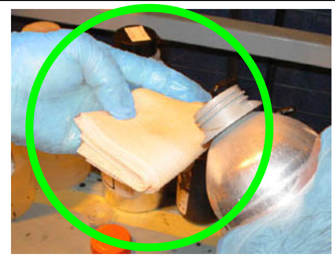
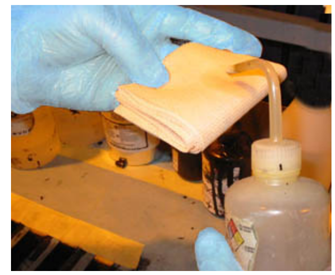
SEALANT / GLUING PRODUCT

PROCEDURE NO: PR000001	REVISION 14 2006-06-09

GLUING PROCEDURE (QUALIFIED PERSONNEL ONLY)

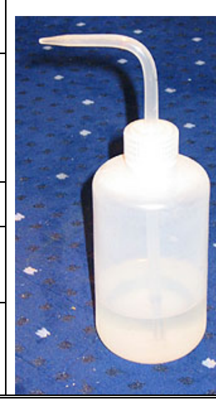
DISCARD  AS PER P908	WEAR  GLOVES	WEAR  SAFETY GLASSES

Section 1 Sealant / Gluing Products General Remarks

			
No Back and forth	**Verify expiration date** **See section 3**	**Do not use straight from the bottle**	

Work Place	- Without excessive dust (mind the ventilation). - Air blast forbidden. (Spray dust in the work environment and contaminate surfaces by oil in the pneumatic system). - All products containing silicone are forbidden.
	Temperature and humidity %: Standard is 23°C and 50% of relative humidity. Effects of temperature; >23°C and/or >50% drying time and job time are reduced <23°C and/or <50% drying time and job time are increased Keep in mind that it is forbidden to use products, parts, to prepare and/or glue surfaces if temperature is below 15°C.

Using Sika Products and Solvent in Nalgene Bottles

Primer 206G+P	Insert a ball in Nalgene bottle. This will enable mixing of product.	
Cleaning of bottles	Use thinner to clean bottle. Allow drying. Never put Sika product back in bottle with thinner inside. Never use water to clean or rinse bottles (will cause product to curdle).	
	Never mix products within same bottle (before it is thoroughly clean).	
Preservation of all products	Put a cap when not in use. Surrounding air and humidity will cause product to dry and evaporate.	
	Discard all products starting to curdle (liquid state becoming gelatinous or lumpy).	

Section A Anti-silicone (or alcohol)

1. Apply

CHIX cloth

2. Dry immediately

Blue cloth

Note: Do not use over long distances. Turn cloth over. Clean until Chix cloth comes out clean.

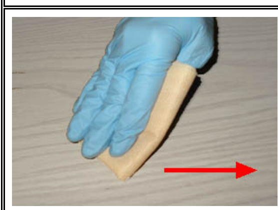
Unacceptable

Unacceptable

Maximum acceptable

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.

Section B Sika 205



1. Apply

CHIX cloth

2. Allow to evaporate (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.		

Section C Sika Aktivator

Glass	Other material (plastic, paint, etc)
 Plastic spatula CHIX cloth CHIX cloth	 CHIX cloth CHIX cloth **1.** Apply & wipe immediately Leave ½" to 2" between the 2 clothes
2. Allow to evaporate	Do not use pads supplied in the box. 

Mandatory	Minimum time:5 minutes
	After 2 hours : Remove dust using Chix cloth & repeat application

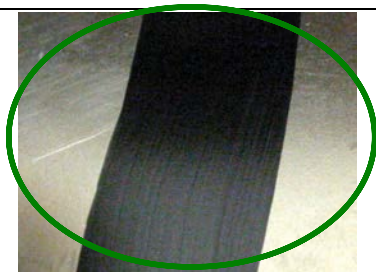
Before applying any other product	If surface seems dusty, dust using dry Chix cloth & repeat application.
	If surface seems greasy or with finger marks, start operation again.

Section D Sika Primer 206 G+P, 210-T or 215

1. **Shake bottle to mix product**

2. **Apply a thin layer**

CHIX cloth

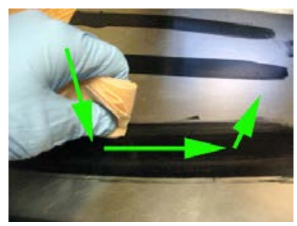


Even application, no drips no miss.

Uneven. Apply again locally onto missing areas after waiting drying time

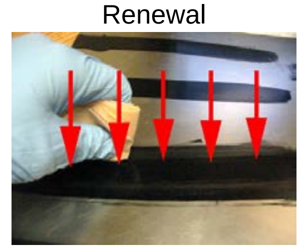
Dripping, avoid excessive accumulation

Renewal



Continuous Movement

Renewal



No tapping

3. **Allow drying**

Do not use pads supplied in the box.

Mandatory	**206 G+P**	**Minimum time : 10 minutes**
		After 2 hours: Remove dust using damp CHIX cloth (pure water)
		After 8 days : Reactivate with Aktivator as per section "C"
Mandatory	**210-T**	**Minimum time: 10 minutes**
		After 2 hours: Remove dust using damp CHIX cloth (pure water)
		After 8 days : Reactivate with Aktivator as per section "C"
		After 1 year : Throw away the part
Mandatory	**215**	**Minimum time : 20 minutes**
		After 2 hours : Remove dust using damp CHIX cloth (pure water)

Before applying any other product	If surface seems dusty, dust using damp Chix cloth (pure water).
	If surface seems greasy or with finger marks, reactivate with Aktivator.

Section E Glass cleaner

	**1. Spray** **(Essex, Spray Away or Sika)**		**2. Dry** **BLUE cloth**

3. Allow to evaporate

Mandatory	Minimum time : Complete evaporation of product
	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 F Sika Remover 208

This product is specially designed to remove fresh sealant and Sika adhesive from a surface.
This product has the advantage of not contaminating the sealant.

Section G Sanding

	 **Scotchbrite grey 7446 or SIA P-110**	 **Sand belt grit coarse**
Smooth surface:	Use orbital sander 	Use belt sander 
Ridged surface:	Sand bottom of creases by hand 	
Important aspects to follow	Change paper or belt on a regular basis as per procedure.	
	In the case of Stainless steel, eliminate reflection (mirror image).	
	Maximum delay between sanding and surface preparation, otherwise start operation again. Stainless = 7 days Aluminum and 3cr12 = 4hrs Fiberglass = No delay	

Section H Simson Primer M

1. Apply

CHIX cloth

2. Allow to evaporate

Mandatory	**Minimum time** **Maximum time; to follow**	**10 minutes**
Before applying any other product	If surface seems dusty, greasy or with finger marks, start operation again.	

Section 2 Repair (Sika product or Simson)

During winter season, condensation and cold can influence the gluing parameters. The working area must be at a sufficient temperature. It will be necessary to preheat the zone mechanically (radiant heat lamp, hot air gun) or bring the vehicle to room temperature. See Section 1: General Remarks.

Remove part	**Use a knife, Zip Gun or braided windshield wire**	
Cleaning	**If required, remove dirt, dust, sand, calcium, grease using Anti-silicone**	
Remove former glue	**Good adherence of glue to surface**	**If glue or primer become unstuck**
	Remove excess of glue using a scraper. It is acceptable and recommended to keep a small layer of glue on the surface instead of breaking the surface of adherence with the blade. If primed surface is slightly scratched: Accept as it is.	Remove glue locally and sand defective area
Surface Preparation	1. Make sure surfaces are clean. Use anti-silicone if necessary.	Prepare surface locally as per procedure.
	2. Sika only; if primer was partially removed: Add primer locally.	
	3. Sika only; reactivate all surfaces with Sika Aktivator	
Paint / waiting time	See section 3 depending on glue/sealant type used.	

Section 3 Use of glue / sealant

Section 3a) Sika Products

Heating of Sika Ultrafast II

Authorized oven: Sika F00549 (80^{o}c max). Minimum time 1hr. Maximum time 5hrs. Note: Cartridge may be heated up several times but keep in mind the maximum time.

Glue	Job time*	Clamping time	Time before moving vehicle (taking the road)
Sika 252	30 minutes max.	See specific PR	24 hrs minimum
Sika 221(black) + booster	20 minutes max.	90 min	4 hrs minimum
Sika 254 + booster (pump)	25 minutes max.	See specific PR	2.5 hrs minimum
Sika Ultrafast II	10 minutes max.	See specific PR	6 hrs minimum
Sika 255	15 minutes max.	See specific PR	24 hrs minimum
Sika STP or PC + booster (pump)	15 minutes max.	See specific PR	2 hrs minimum
Sika 221	30-45 minutes max.	See specific PR	24 hrs minimum

* Temperature and moisture content will vary job time. See Section 1 “Sealant/Gluing Products General Remarks” under “Work Place” for more details.

Smoothing down	Water or soapy water [Authorized soap: Transparent Liquid Sunlight #680339 (concentration ± 5%)].
Cleaning **((glue/sealant removal))**	Use Sika 208 See section F. Do not use anti-silicone or alcohol.
Expiration Date	***Sika products made in Europe: month/year*** ***Sika products made in USA: month/day/year***
Paint (Minimum drying time before paint/primer application)	Sealant joint may be painted or primed once the joint is dry to the touch.

Section 3b) Simson Product

Open time	Simson 70-03; 10 min maximum
Cleaning (sealant removal)	Anti-silicone
Smoothing down	Water or soapy water [Authorized soap: Transparent Liquid Sunlight #680339 (concentration ± 5%)].
Paint	Sealant joint may be painted or primed once the joint is dry to the touch.
Expiration Date	***BB. = month/year***

Section 3c) Plexus Product

Open time	MA-832; 12 à 15 minutes
Cleaning (glue removal)	Anti-silicone
Expiration Date	Manufacturing date is indicated on the tube. This product is good for 9 months. Coding (example 601251) ; - First number indicates year; 6 = 2006 - Next 2 numbers indicate month; 01 = January - Next 2 numbers indicate day; 25 = 25th Add 9 months to the manufacturing date to get the expiration date, (example; Manuf. January 25th, 2006 + 9 months = expires October 25th, 2006

Section 3d) Liquid Butyl 680096

Expiration Date	Manufacturing date is indicated on the tube. This product is good for 18 months. Coding (example C-4); - Letter indicated manufacturing month; A-January, B-February, C-March, etc. - Number indicates manufacturing year: 0-2000, 1-2001, 2-2002, etc. Add 18 months to the manufacturing date to get the expiration date, (example C-4 (Manuf. March 2004 + 18 months = expires in September of 2005

PREVOST

MEMORANDUM

SEALANT/GLUE APPLICATION

PROCEDURE NO: PR000001A	REVISION 00 2006-06-09

GLUING PROCEDURE (QUALIFIED PERSONNEL ONLY)

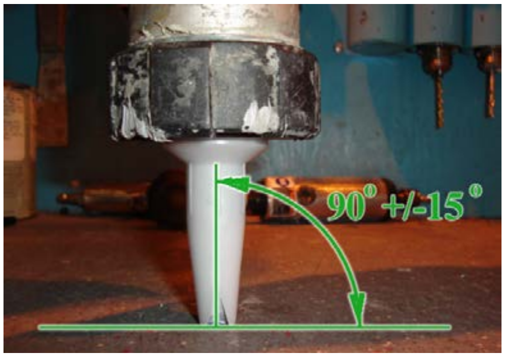
Section 1: Triangular Beads Application

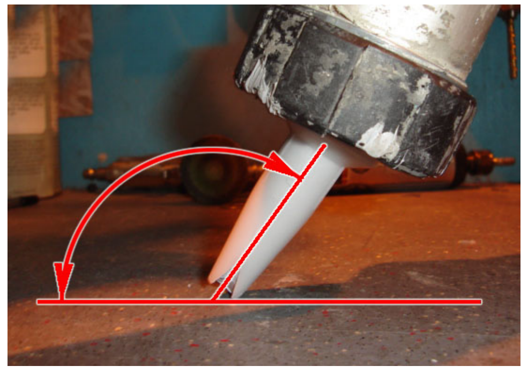
Section 2: Irrelevant

Section 3: Finishing Joint around glass (aesthetic appearance)

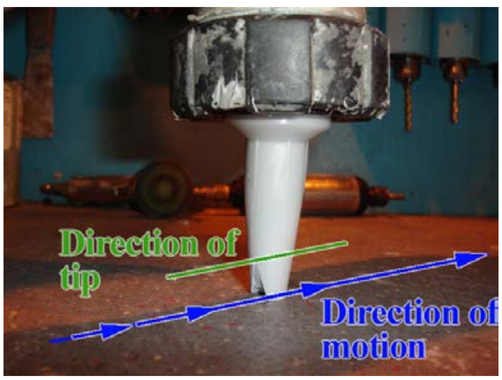
Section 1 Triangular Beads Application Rules

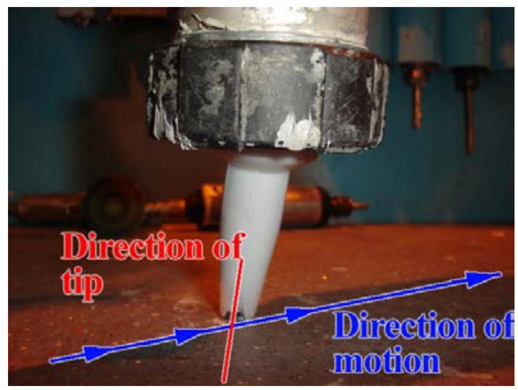
Nozzle must be as perpendicular to the surface as possible



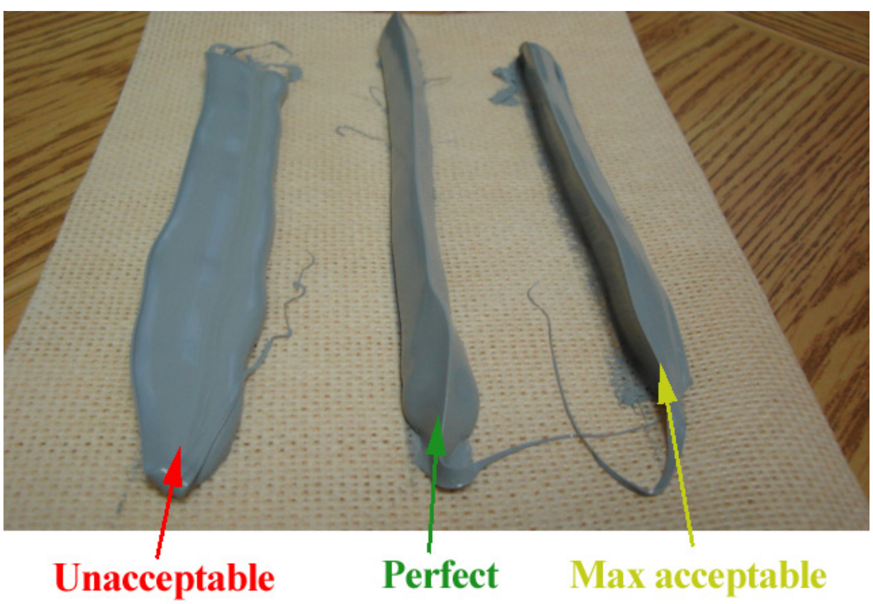


Nozzle must be positioned to follow the direction of movement (towards the rear not side)



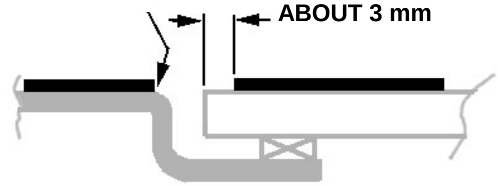
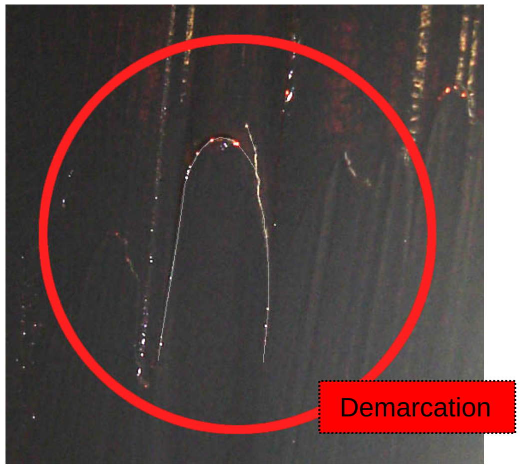


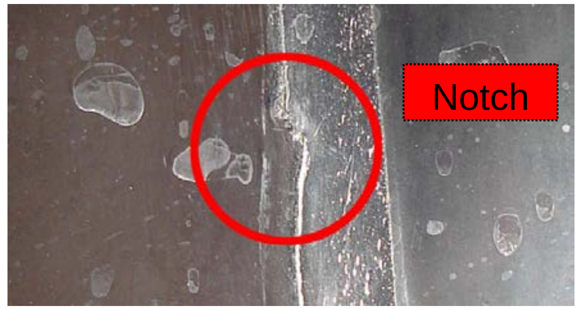
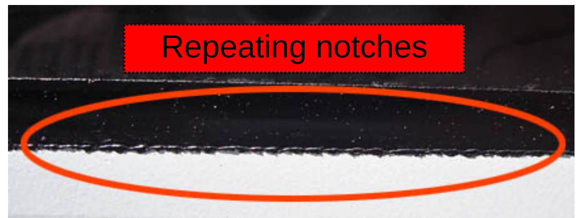
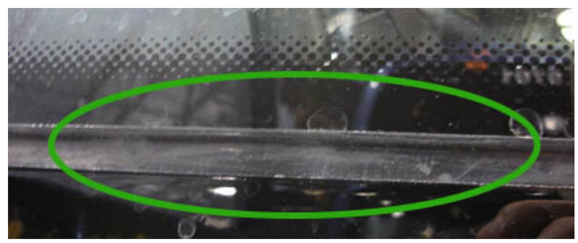
Bead Appearance



Section 2 Irrelevant

Section 3 Finishing Joint around glass (aesthetic appearance)

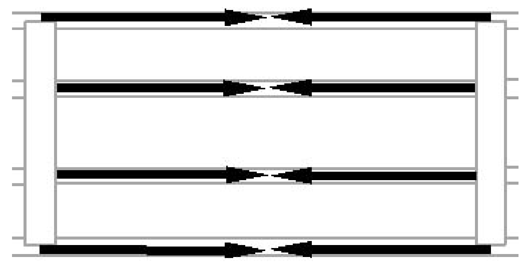
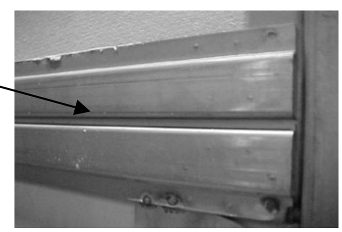
3.00	A)	Apply masking tape beside the joint.. Glass side; apply about 3 mm from the edge for better sealant adherence. Fiberglass side; apply near the edge of the radius.	EDGE OF RADIUS 
	B)	If required, remove excess. Add sealant as needed.	
	C)	Maker and/or smooth down the joint using a plastic spatula.	
	D)	As needed; remove the small lines left by the plastic spatula by smoothing down the joint with a finger and water or soapy water.	
	E)	Carefully remove masking tape.	
	F)	As needed; finish smoothing down the joint with a finger and water.	
	G)	Clean if necessary using Sika 208.	
3.05	**Mandatory Result**		
	A)	Must be smooth. No bubbles. No dirt or lumps. No start or boundary lines left by the plastic spatula (demarcation). No miss or holes in the joint.	
	B)	No small lines left by the plastic spatula.	

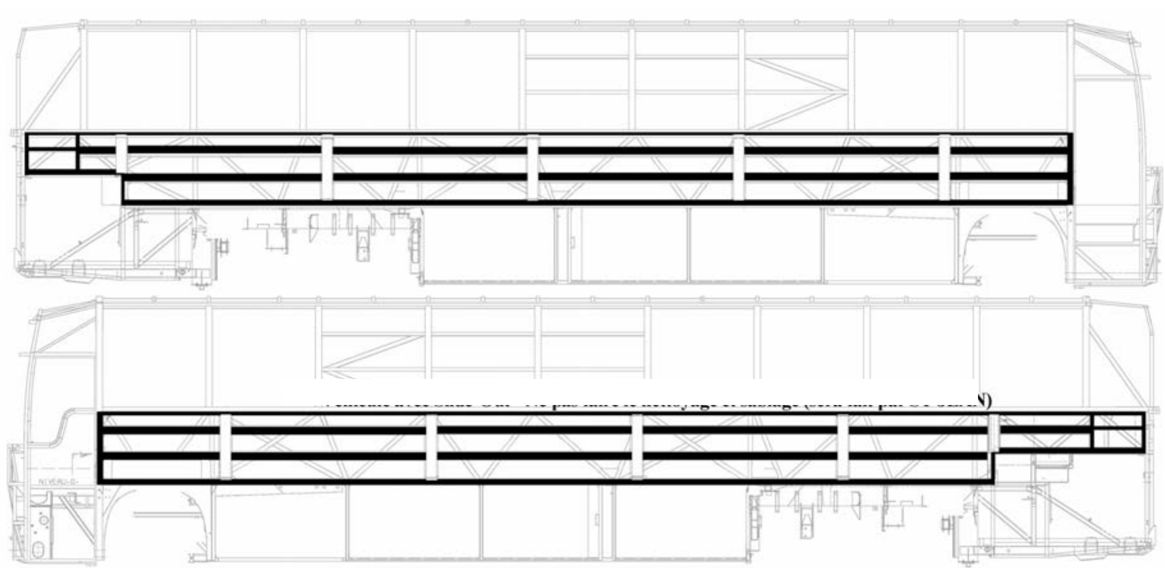
	C)	Joint must be parallel (visually), straight and without notch.	
			
	D)	Cavity in the sealant joint due to the plastic spatula and/or sealant shrinking (Accepted).	

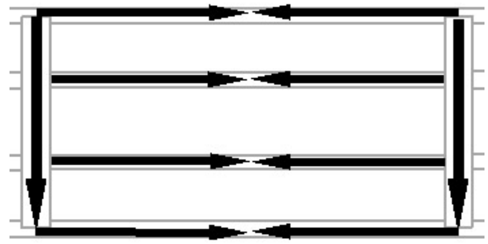
PR00027 RIDGED SIDE PANEL – STRUCTURE PREPARATION		PREVOST	
	Effective: 9052	**REVISION 00**	LVA077
		DATE 06-08-31	Spec 15.0

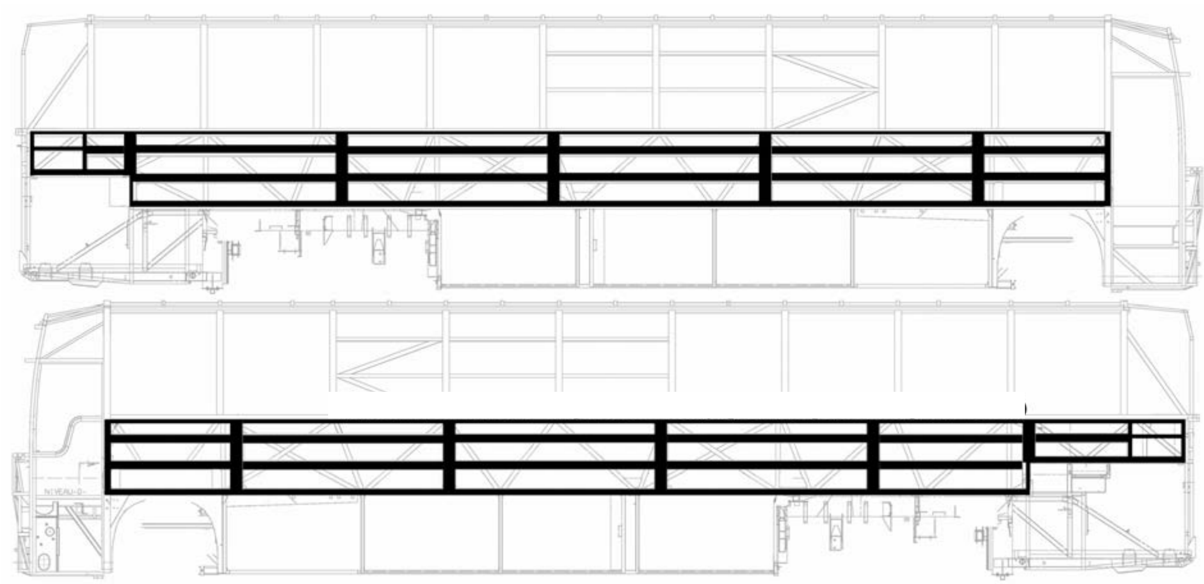
Section 1 Structure Preparation

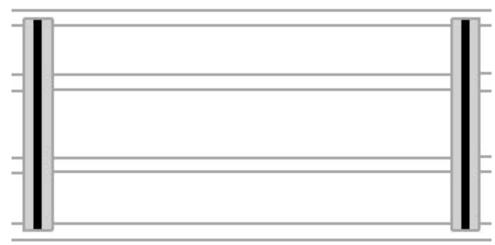
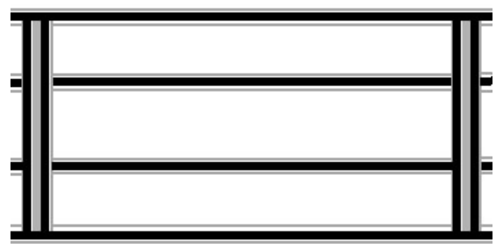
Important: Before cleaning, make sure there is no paint, gravel guard or urethane residue. If necessary, remove using sander.

1.00	**Structure Sanding**		
	A)	Clean using anti-silicone in the direction of the arrows. *(See PR000001, Section A)* Make sure that grooves are very clean.	
	B)	Sand using belt sander “grit coarse belt”. *(See PR000001, Section G)*	



1.05	**Structure Cleaning** Clean using anti-silicone *Use white clothes #684009 for vertical backers.*	

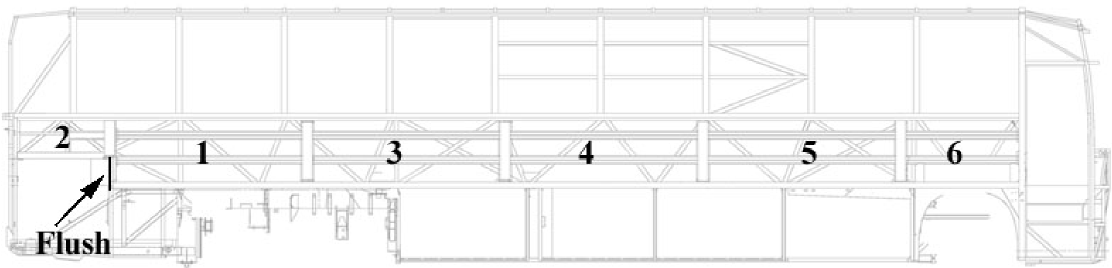


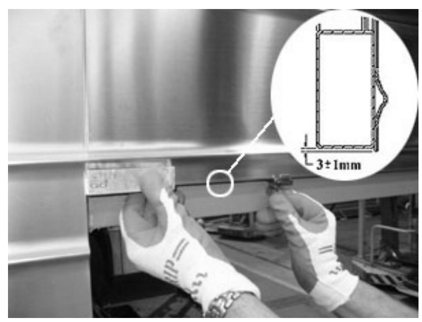
1.10	**Application of Sika 206 G+P onto structure**		
	A)	Apply 3/4" wide masking tape in the center of vertical backers. - Make sure that grit blasting is uniform on the whole surface.	
	B)	Apply Sika 206 G+P *Use white clothes #684009 for vertical backers.* *(See PR000001, Section D)*	
	C)	Remove protective tape.	
1.15	Apply foam tape 1/8 x 1/4 in the center of side panel horizontal supports and at each end if needed.		

PR00028 RIDGED SIDE PANEL – GLUING		PREVOST	
	Effective: 9052	REVISION 00	Spec 15.0 LVA173 LVA085
		DATE 06-08-31	

Section 1 Side Panel Pre-Adjustment

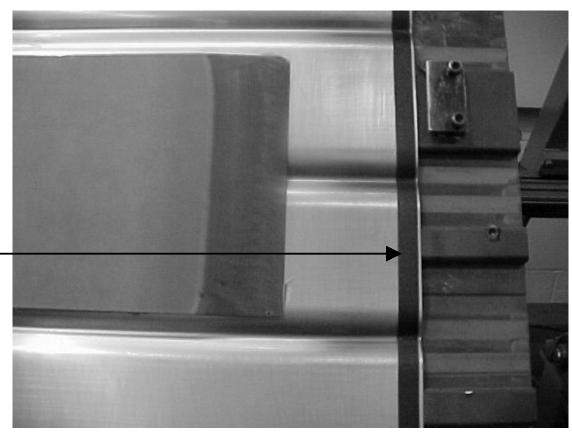
1.00



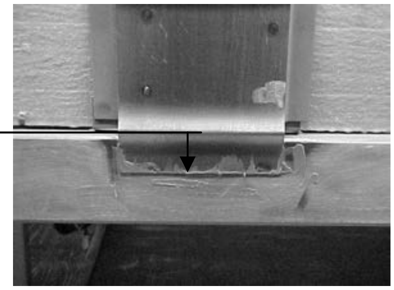
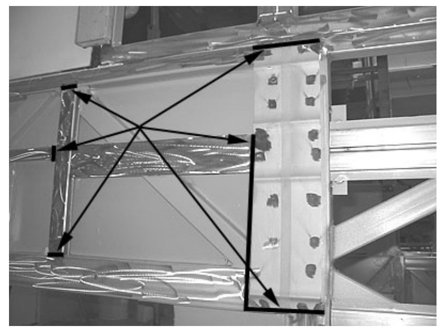
A)	Install some kind of supports for temporary side panel holding.	
B)	Install side panel in position 1, install a U-shape clamp to hold upper portion. Vertically: Adjust side panel with reference to backer ridges **max.1mm.** Horizontally: Side panel must be "**flush"** with rear structural tubing (without seeing structural tubing underneath).	
C)	Install engine air intake panel in position 2. Vertically: Adjust side panel with reference to #1 side panel ridges **max.1mm**. Make sure to meet standard **3mm +/-1** with reference to structural tubing. Horizontally: Adjust gap **3-4.5mm** with reference to #1 side panel. Drill through structure using side panel pre-drilled holes. (2 R.H. side and 3 L.H. side).	
D)	Side panel positions 3 and 4 Vertically: Adjust side panel with reference to backer ridges **max.1mm.** Horizontally: 3mm from previous pencil line.	
E)	Side panel position 5, same as above but leave side panel in place and install side panel position 6. Line up side panel ridges positions 5 and 6.	

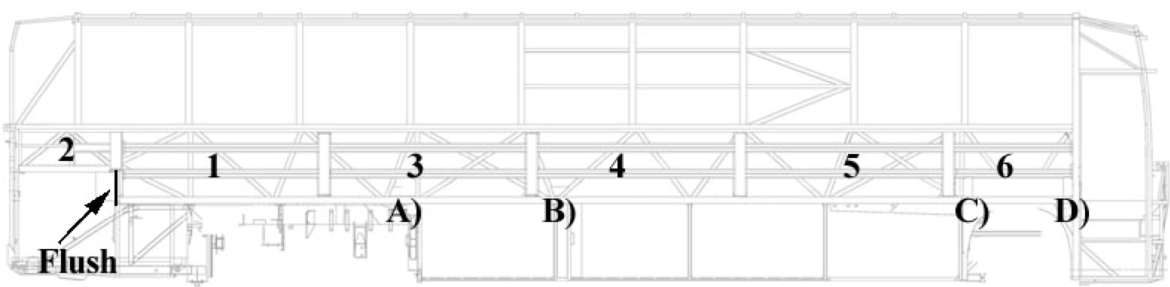
Section 2 Preparation before Side Panel Gluing

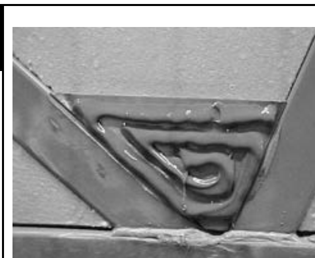
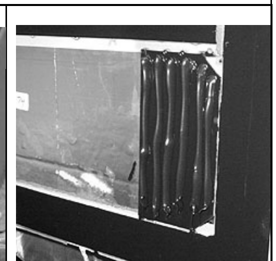
<u>Important</u>: Make sure that all bonding surfaces are clean and free of dust, residue or dry glue. If required, clean using a scraper or damp cloth.

2.00	Make sure that structure is sealed at the back of engine air intake panel location. Add some Sikaflex 221, if required.	
2.05	Check side panel for defects	
2.10	**S/S Side panel Preparation** Reactivate surface as per PR000001 section D.	
2.15	Apply foam tape 1/16 x 1/4 at each side panel end. Make sure foam tape reaches bottom of creases Install foam tape **1mm+1/-0** from side panel edge.	

Section 35 Side Panel Gluing

3.00	A)	Apply Sika 221 grey to seal vertical "backers". Smooth down with a finger.	
	B)	If accessible, seal the back of vertical "backers" as indicated in picture. Use Sika 221 grey	

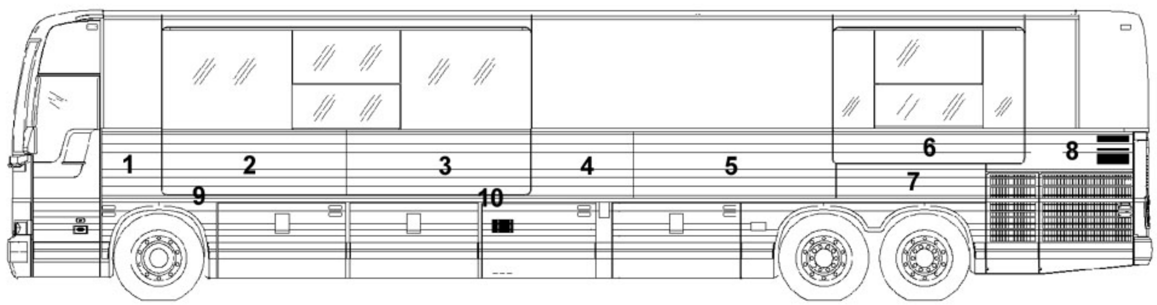


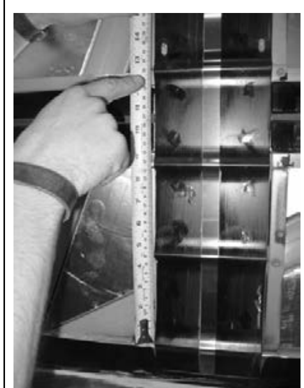
3.05	**Awnings Reinforcement Plates** Apply Sika 252 or 255 onto the awnings reinforcement plates A, B, C, D *Height of bead = **3/8" +1/8 / -0*** Perform before installing side panels 3, 4, 6		
3.10	Apply Sika 221 + booster		

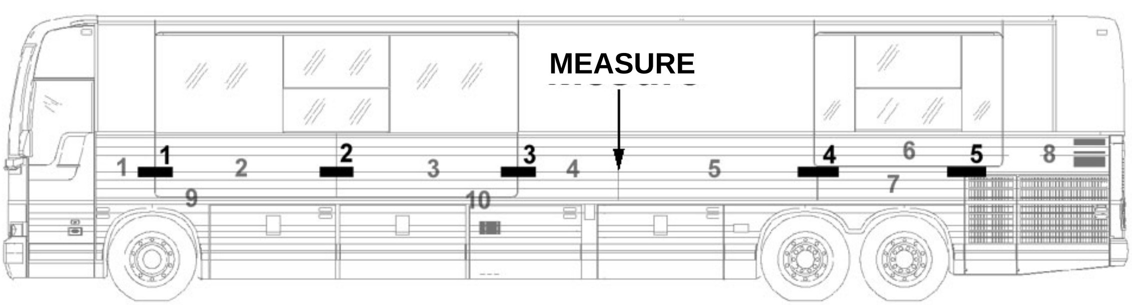
3.15	Install side panel in position 1 and rivet, install engine air intake panel in position 2 and rivet. Check gap between 2 panels. Install side panels 3, 4, 5, 6 and rivet, making sure to check the gap **3-4.5mm** between side panels Check adjustment with vertical "backers". Horizontal alignment: **max. 1 mm**	Curing time: 4 hours minimum

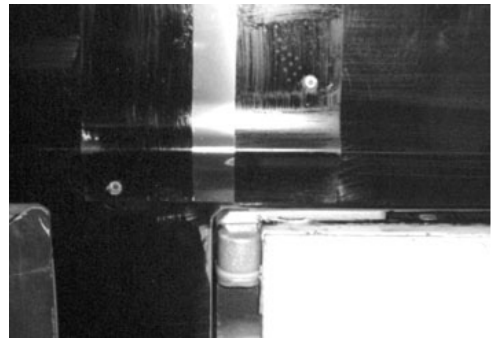
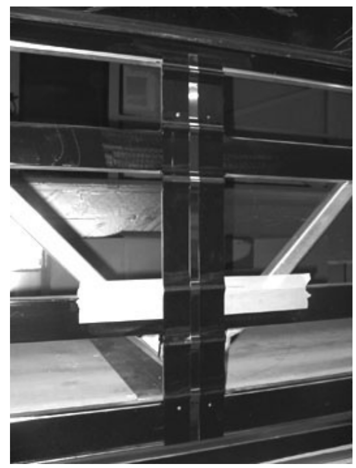
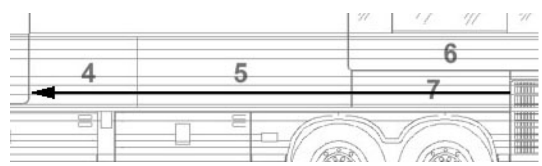
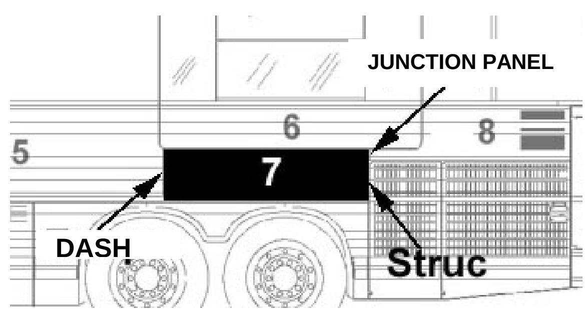
Section 1 Side Panel Pre-Adjustment

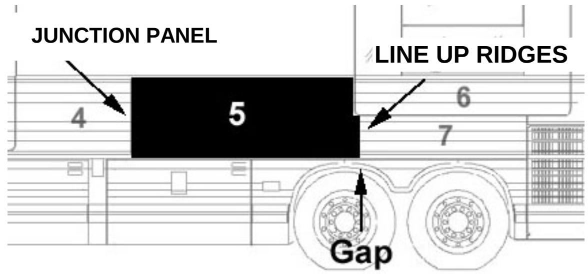
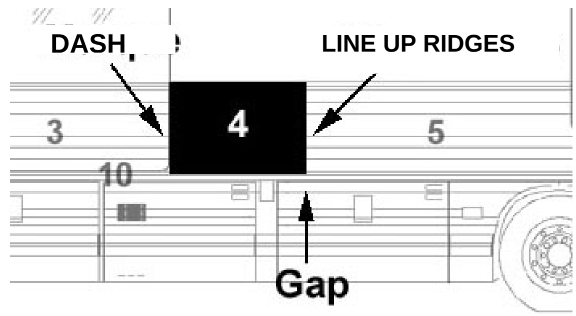
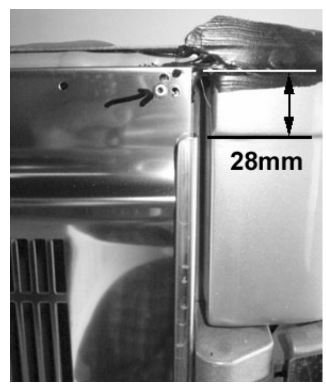
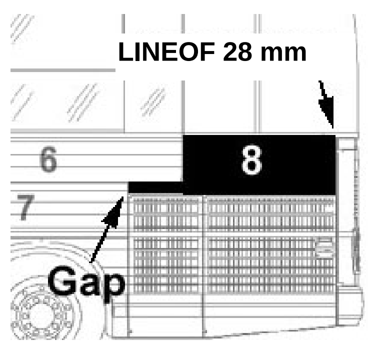
1.00

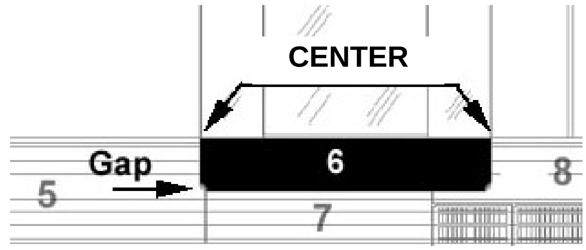
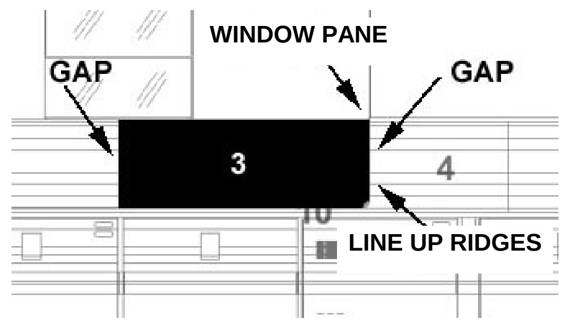
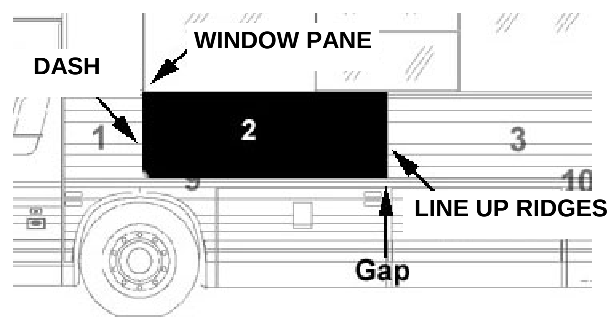
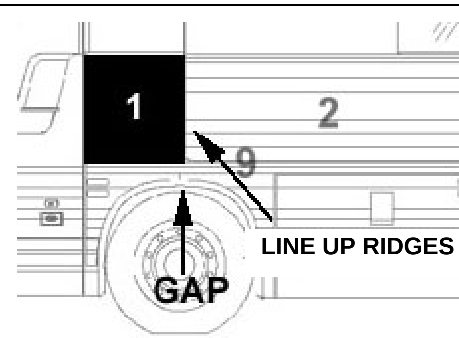


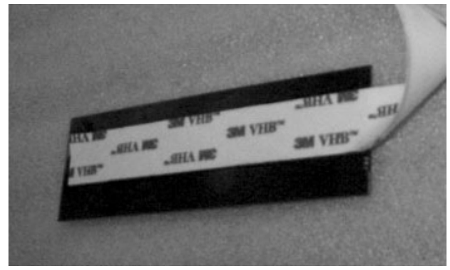
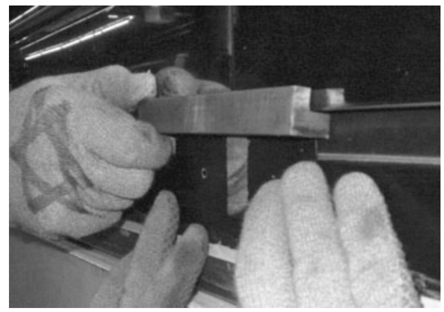
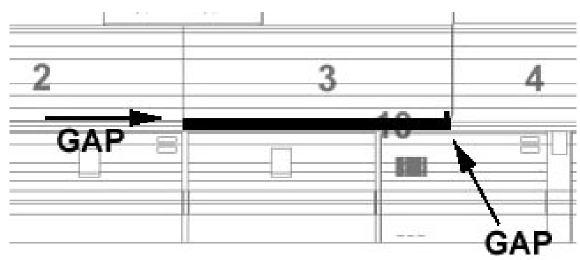
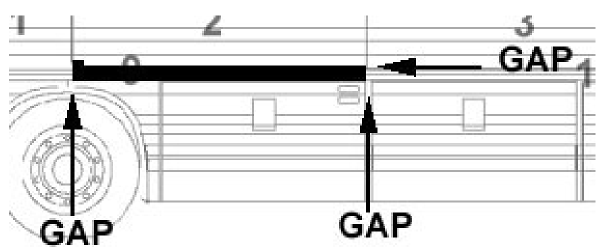
A)	Install some kind of supports for temporary side panel holding.	
B)	Measure height of 4th ridge from top of structural tubing, on backer located between side panels 4 and 5 (should be **320.5 mm**). Take the measurement for the other junction panels. Connect dashes 4 and 5 with a chalk line (Note: Make sure to overrun dash 5 by **6 inches** towards the rear, side panel width will hide the dash).	 



	C)	Locate junction panel between side panels 7 and 8. **Vertically**: Follow chalk line. **Horizontally**: Centered with reference to structural tubing *Note: Temporary secure junction panel using a rivet #**504108** and drill bit #**30.***	
	D)	Locate junction panel between side panels 2 and 3. **Vertically:** As per dash 2 **Horizontally:** Centered with reference to slide-out structure. Note: Make sure that junction panel does not overrun the bottom of Slide-out by more than **3mm**	
1.05	A)	Measure distance between rear tubing and slide-out (**5439 mm)**. This measurement should be **3 mm** longer than structure (side panel overrun by **3 mm**). **If measurement is different, readjust gaps between side panels.** *Note: Temporary secure junction panel using a rivet #**504108** and drill bit #**30** and/or clamp.*	
	B)	Side Panel # 7: **Vertically:** - Rear installed onto junction panel located between side panels 7 and 8. - Front follows dash 4 **Horizontally:** - Flush with reference to structure	

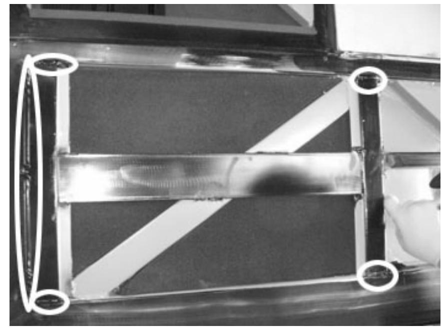
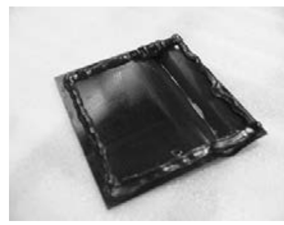
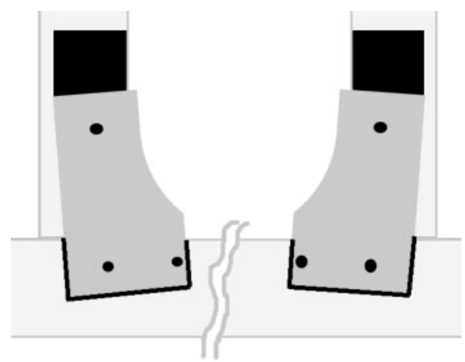
	C)	Side Panel # 5: **Vertically:** - Front installed onto junction panel located between side panels 4 and 5 - Rear line up with side panel # 7 ridges +/-1mm **Horizontally:** - gap of 3 mm +1.5/-0 with reference to side panel # 7, horizontal alignment of 1 mm max.	
	D)	Side Panel # 4: **Horizontally:** - gap of 3 mm +1.5/-0 with reference to side panel # 5, horizontal alignment of 1 mm max. **Vertically:** - Rear line up with side panel # 5 ridges +/-1mm - Check that 4th ridge is lined up with dash 3. If difference is too big, readjust side panel # 5 horizontally.	
	E)	Side Panel #8: Draw a line 28 mm from the top of vertical molding.	
		Vertically: - Front line up with side panel # 7 ridges +/-1mm - Rear line up with marking of 28mm **Horizontally:** - gap of 3 mm +1.5/-0 with reference to side panel # 7, horizontal alignment of 1 mm max.	

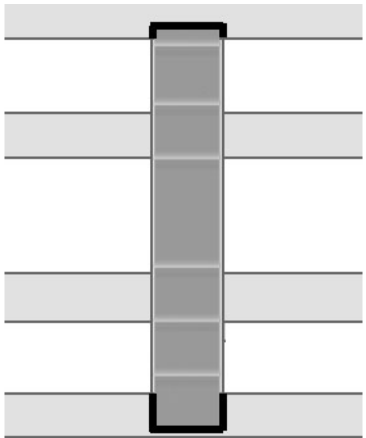
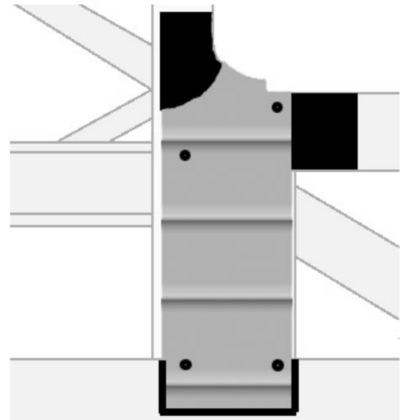
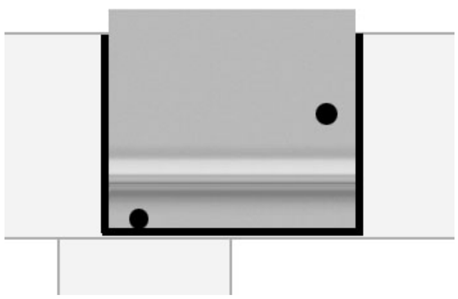
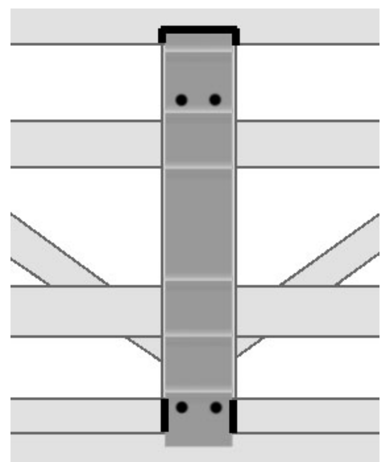
	F)	Side Panel # 6: **Horizontally:** - Centered with reference to slide-out window panes +/-1 mm. Gap should be 9 mm +/-2, horizontal alignment of 2 mm max. **Vertically:** - Gap of 9 mm +/-2 with reference to side panels 7 and 8.	
	G)	Side Panel # 3: **Horizontally:** - Lined up with reference to slide-out window pane +/-1 mm. - Gap of 9 mm +/-2 with reference to side panel 4, horizontal alignment of 2 mm max. **Vertically:** - I Front installed onto junction panel located between side panels 2 and 3. - Rear line up with side panel # 4 ridges +/-1mm	
	H)	Side Panel # 2: **Horizontally:** - Lined up with reference to slide-out window pane +/-1 mm. - gap of 3 mm +1.5/-0 with reference to side panel # 3, horizontal alignment of 1 mm max. **Vertically:** - Rear line up with side panel # 3 ridges +/-1mm - Check that front of side panel is lined up with dash 1. If difference is too big, readjust side panel # 3 horizontally.	
	I)	Side Panel # 1: **Horizontally:** - Gap of 9 mm +/-2 with reference to side panel 2, horizontal alignment of 2 mm max. **Vertically:** - Rear line up with side panel # 2 ridges +/-1mm	

J)	Install junction panel between metal strips 9 and 10. Apply a VHB tape at the back.	
	Vertically: Install junction panel 10 mm underneath side panels 2 and 3 **Horizontally:** Center junction panel between side panels 2 and 3.	
K)	Metal Strip 10: **Vertically:** - Gap of 8mm with reference to side panel # 3 **Horizontally:** - Gap of 3.5 – 5 mm with reference to side panel # 4	
L)	Metal Strip 9: **Vertically:** - Gap of 8mm with reference to side panel # 2 **Horizontally:** - Gap of 3.5 – 5 mm with reference to side panel # 4 - Gap of 3mm +1.5/-0 with reference to metal strip 10	
M)	Visually check ridges alignment. Readjust side panels as required.	

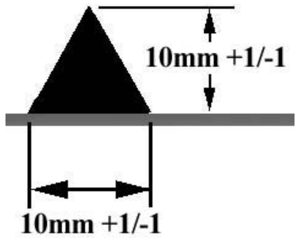
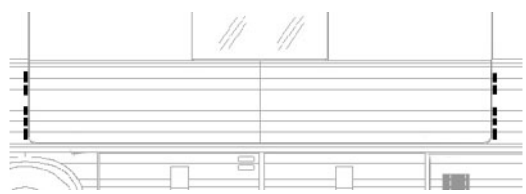
Section 3 Junction Panels Gluing

3.00	A)	Remove all side panels with the exception of metal strips 9 and 10 and side panel # 7.	
	B)	Install large slide-out (front) front and rear junction panels.	
	C)	Install junction panel between side panels 5 and 7.	
	D)	Remove side panel # 7and metal strips 9 and 10 and junction panels	
3.05	A)	Reactivate side panels, junction panels and structure. *(See PR000001, section D)* *Important: Do not apply Sika Aktivator onto seals, side panels and junction panels' visible portion.*	
	B)	Make sure that structure behind engine air intake panel is sealed. Add Sikaflex 221, if required.	

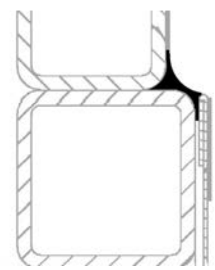
	C)	Apply Sika 221 black onto structure where engine air intake panel will be located.	
	D)	Apply Sika 221 onto all junction panels perimeter. Make sure to fill creases. Rivet junction panels onto structure. Hand press junction panels to flatten Sika bead.	 
	E)	Apply Sika 221 black to seal junction panels. Smooth down the ends with a spatula to give a gentle slope.	Junction Panel 1-9 Junction Panel 10-4 

		Junction Panel 4-5 	Junction Panel 5-7 
		Junction Panel 7-8 	Junction Panel 2-3 

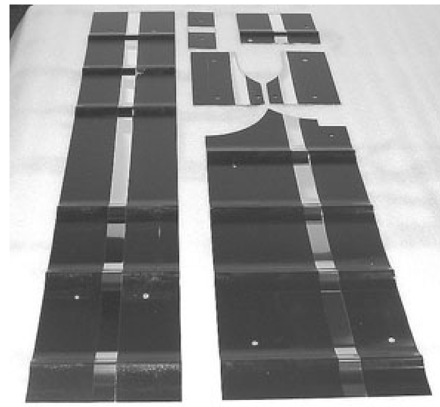
Section 4 Glue Application

4.00	A)	Apply Sika 221 + Booster onto side panels.  	
	B)	Curing time: 4 hours	
	C)	Seal corners between metal strips and structure using Sika 221 black.	
	D)	Seal side panel ridges using Sika 221 (vehicle, not slide-out). If side panel is too far from structure, apply a bead of Sika over the total length.	

PR00030 RIDGED SIDE PANEL – SEALING JOINT		PREVOST	
	Effective: 9052	**REVISION 00**	Spec 15.0
		DATE 06-08-31	

1.00		**Sealing Side Panel Upper Portion**	
	A)	If applicable, remove excess of Sika glue in the upper portion of side panels.	
	B)	Caution; - No Sika 205 on the front part of side panels (will stain the S/S). - Sealing joint height onto vertical tubing **6mm maximum.**	
	C)	Clean using anti-silicone *(See PR000001, Section A)*	
	D)	Apply Sika 205 Use a plastic spatula and a Chix cloth to get to the bottom of structural tubing. *(See PR000001, Section B)*	
	E)	Apply Sika 252 black and smooth down the joint.	
1.05		**Seal the front of the first side panel and the back of the last.**	
	A)	Apply Sika 205. *(See PR000001, Section B)*	
	B)	Apply Sika 221 grey. **(aesthetic joint)**	

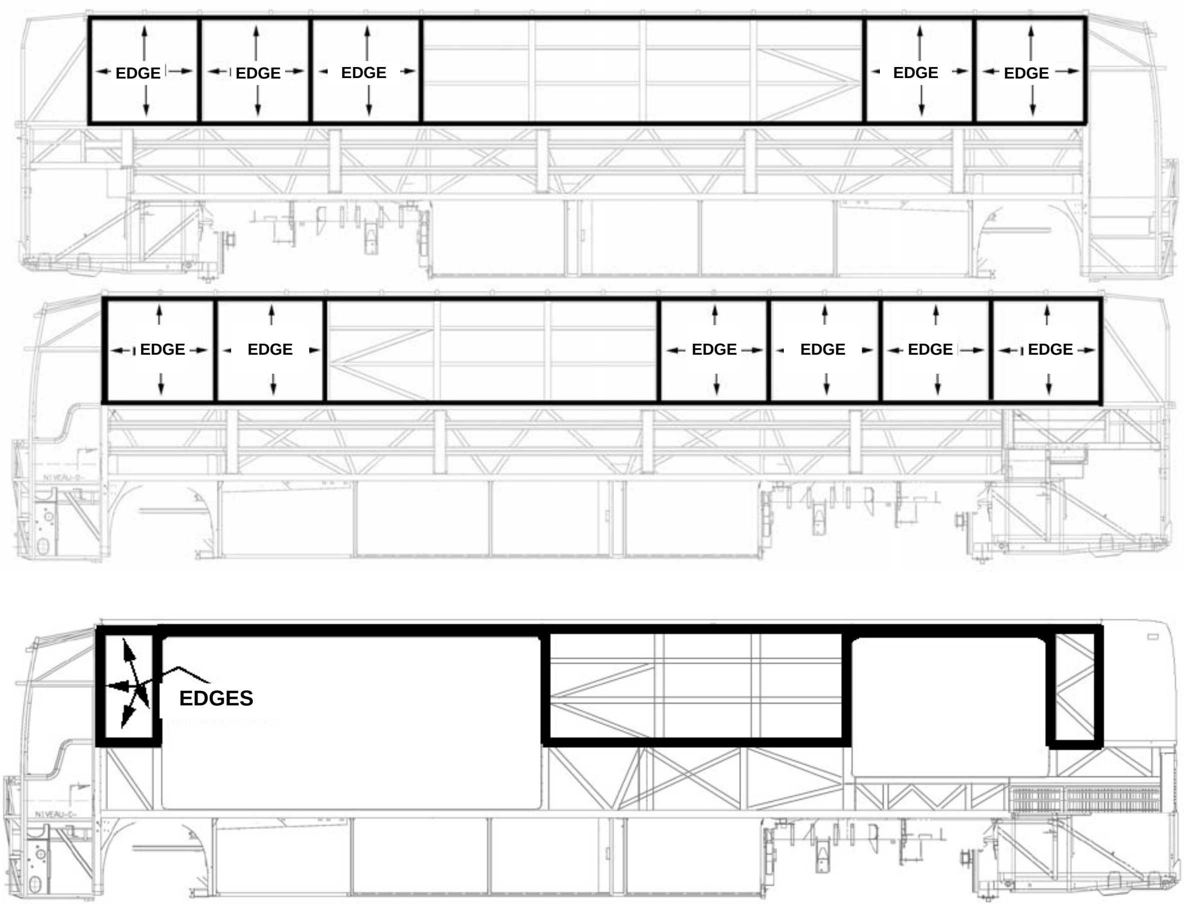
PR00031 RIDGED SIDE PANEL – SLIDE-OUT JUNCTION PANEL PREPARATION		PREVOST	
	Effective: 9064	REVISION 00	Spec 15.0 LVA173
		DATE 06-09-07	

1.00		**Junction Panel Preparation**	
	A)	Clean using anti-silicone both junction panel sides. *(See PR000001, Section A)*	
	B)	Normally in the center of the junction panel, there is a ¾" masking tape. Apply one if this is not the case.	
	C)	Apply Sika 206 G+P onto both junction panel sides *(See PR000001, Section D)*	
	D)	Remove masking tape.	

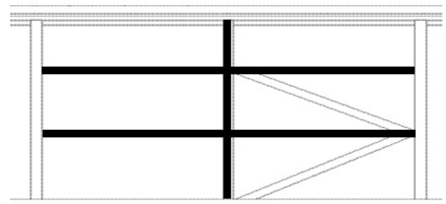
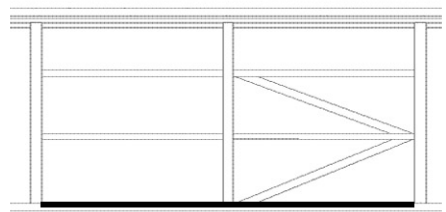
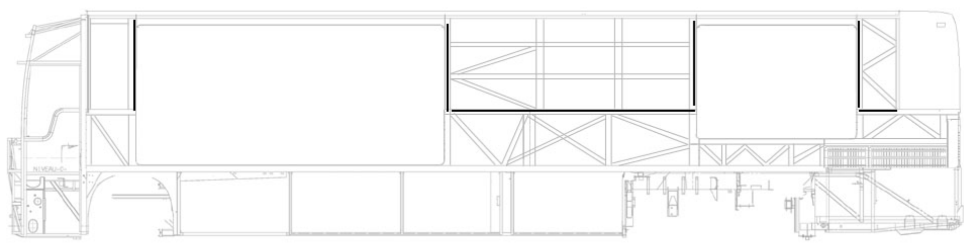
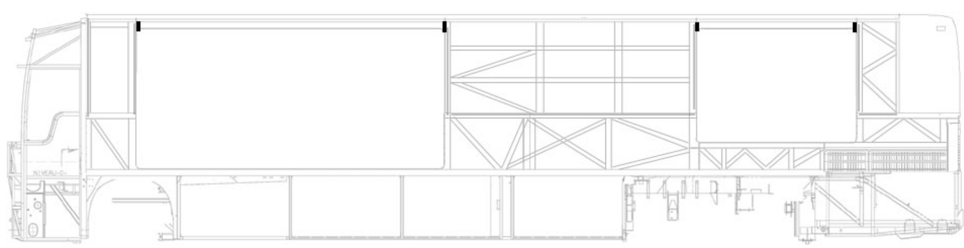
PR00035 STRUCTURE PREPARATION		PREVOST	
	Effective: 9082	**REVISION 01**	Spec 15.0
		DATE 06-10-11	LVA077

1.00	A)	Clean structure using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand structure using Scotchbrite. *(See PR000001, Section G)*	

	C)	Clean structure and window frames using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 206G+P onto structure and window frames. *(See PR000001, Section D)*	

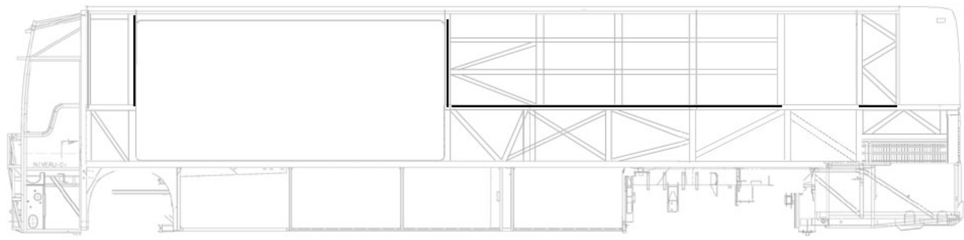


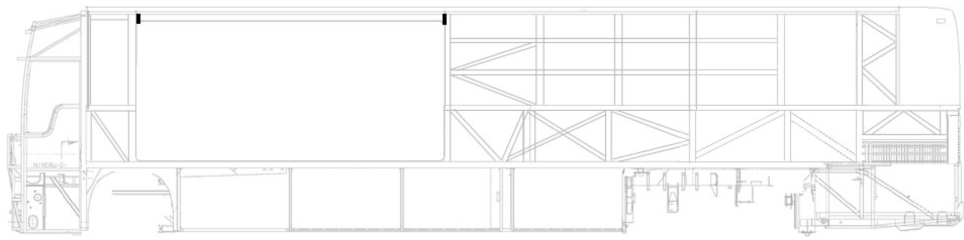
PR00036 UPPER SIDE PANEL – GLUING OF NEOPRENE FOAM TAPES		PREVOST	
	Effective: 9082	**REVISION 01**	
		DATE 06-10-11	

1.00	Affix neoprene foam tape 3/16 x 1 onto structure where the side panel will be glued. Affix foam tape in the center of vertical and horizontal members.	
1.05	Not fitted with slide-out Affix a double-face self adhesive tape **3/16″x1/4″** at the bottom of the structure, where the side panel will be glued.	
1.10	W5 Fitted with front and rear slide-out Affix a neoprene foam tape 3/16x1/2	
	Glue a piece of window rubber seal at the top (in the curvature). 	

<table>
<tr><td rowspan="2">1.15</td><td>WE OR W5

Fitted with front slide-out

Glue a neoprene foam tape 3/16x1/2</td><td></td></tr>
<tr><td>Glue a piece of window rubber seal at the top (in the curvature).

</td><td></td></tr>
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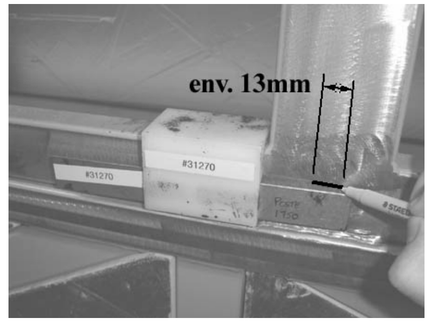
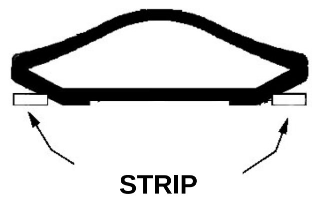
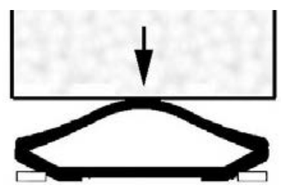
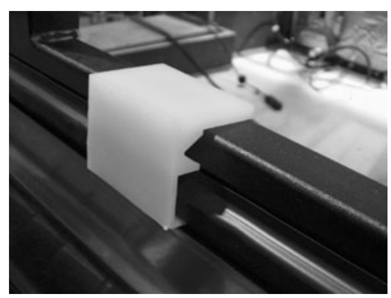
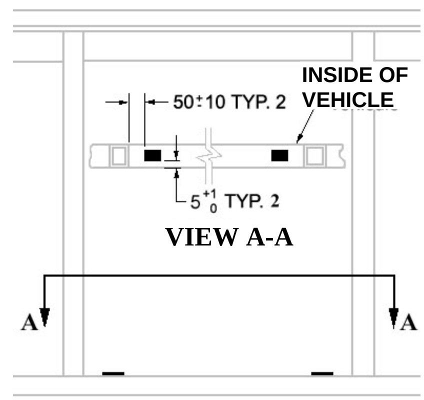
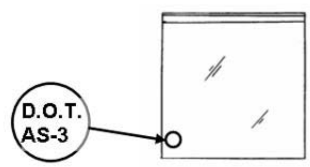
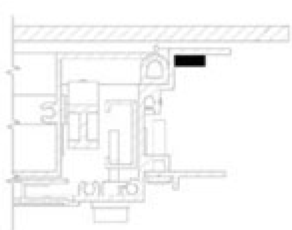
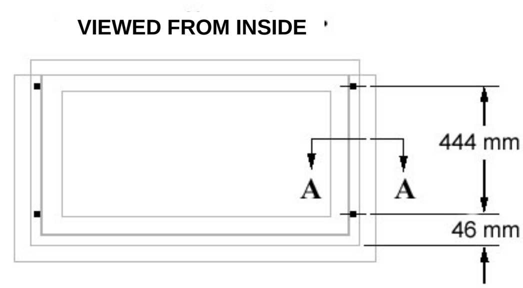
PR00037 LATERAL FIXED WINDOW RUBBER SEAL – GLUING		PREVOST	
	Effective: 9055	**REVISION 00**	
		DATE 06-09-06	

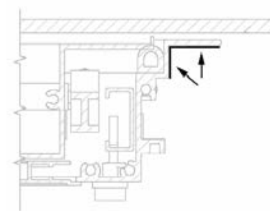
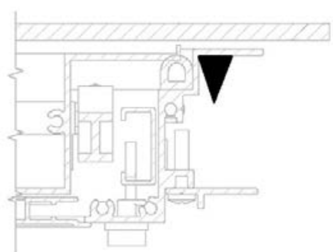
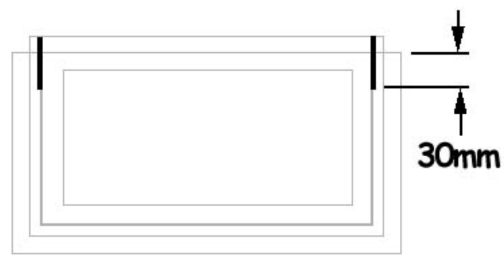
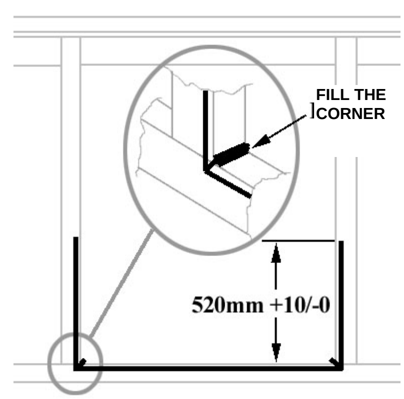
Gluing Vertical and Bottom Rubber Seals

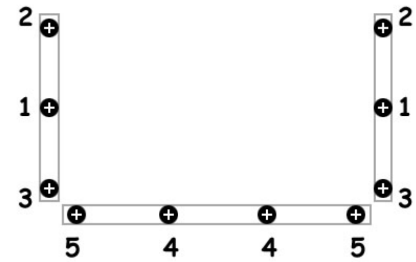
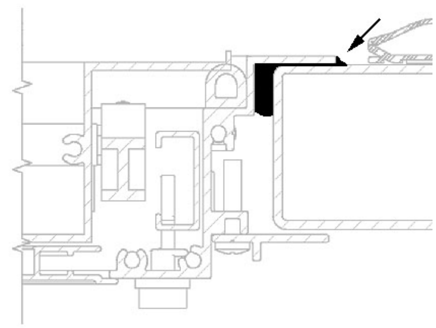
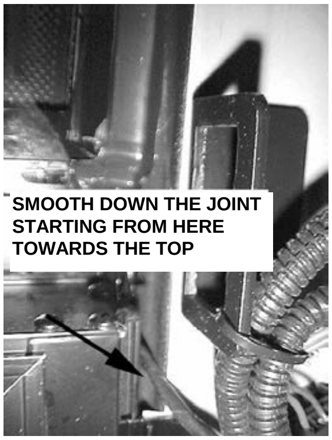
1.00	A)	Mark the position of each rubber seal. Draw a **13mm (about) long line** in the center of the post.	
	B)	Glue the vertical rubber seals in the center of the post, where fixed windows will be installed. **MTH: R**emove strips from rubber seal.	
	C)	Compress rubber seal using roller.	
1.05	A)	Glue the bottom rubber seal, where fixed windows will be installed.	
	B)	Compress rubber seal using roller.	

PR00038 AWNING OR SLIDING WINDOW INSTALLATION		PREVOST	
	Effective: 9055	REVISION 00	LVA050 LVA081 Spec 15.0
		DATE 06-09-01	

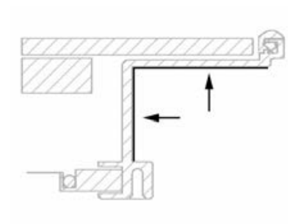
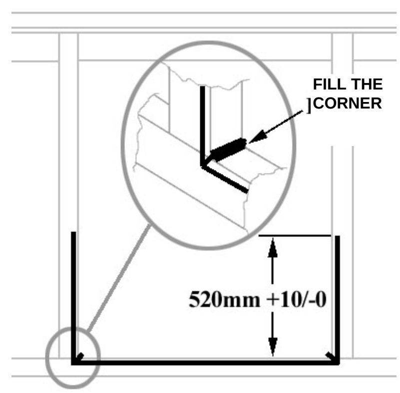
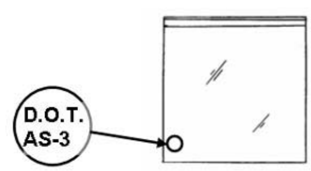
Section 1 Awning Window Installation

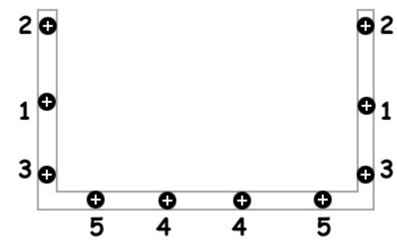
1.00	Glue 2 stops onto the horizontal structure tubing or underneath the window.		
1.03	A)	Check that D.O.T. AS-3 is present and readable.	
	B)	Glue 4 stops # **790602** onto window frame.  **Section A-A**	

1.05	**Interior of Frame Preparation (powder paint)** A) Clean using anti-silicone. *(See PR000001, Section A)* B) Apply Sika Aktivator. *(See PR000001, Section C)*	 
1.07	Add a bead of Sika 252 on each side 	
1.10	Apply Sika 252 onto structure and onto 2 welding joints in the lower bottom corners. *Triangular bead = **12mm X 10mm***	
1.15	Install and center window into the opening, compressing it lightly.	

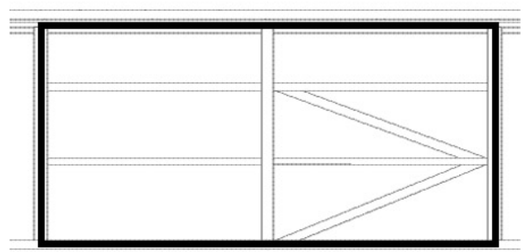
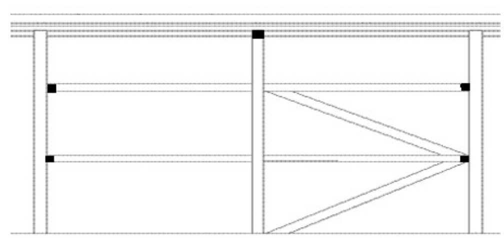
1.20	Install retaining support inside the vehicle. Tighten as per the following sequence. *Note: One person should push the window from outside the vehicle while another one tightens the frame from inside.*		
1.25	A)	Manually open the window and smooth down the excess of Sika. **Important**: Do not remove the white blocks. They will be removed when the batteries will be connected.	
	B)	If required, clean up surfaces using Sika 208.	
	C)	Manually close window.	
1.30	Smooth down the excess from inside the vehicle. Add a bead of Sika 252 or 255 in the window upper corners as required. Smooth down the joint of Sika 252 or 255 starting about 25mm lower than awning window frame .		 

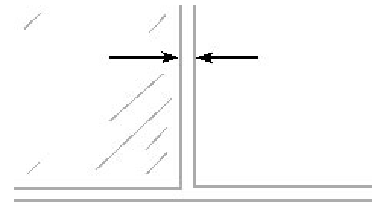
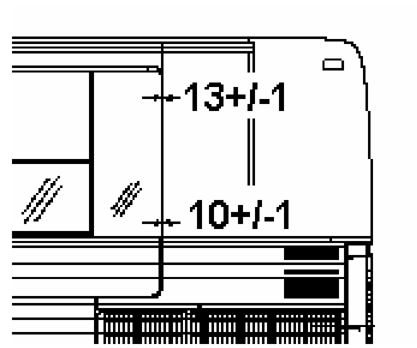
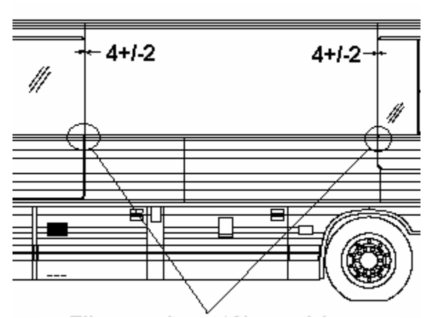
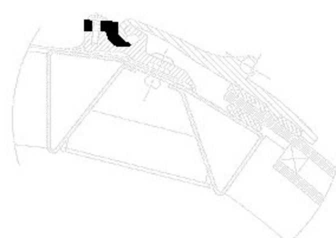
Section 2 Sliding Window Installation

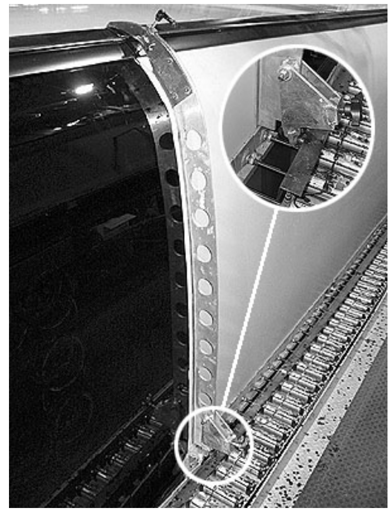
2.00		**Interior of Frame Preparation (powder paint)**	 
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Apply Sika Aktivator. *(See PR000001, Section C)*	
2.05		Apply Sika 252 onto structure and onto 2 welding joints in the lower bottom corners. *Triangular bead = **12mm X 10mm***	
2.10	A)	Check that D.O.T. AS-3 is present and readable.	
	B)	Install and center window into the opening, compressing it lightly. *Note: The opening portion of the sliding window must be facing the rear of vehicle. The arrow (decal on window) should be pointing towards the front of vehicle, in the direction to open the window.*	

2.15	Install retaining support inside the vehicle. Tighten as per the following sequence. *Note: One person should push the window from outside the vehicle while another one tightens the frame from inside.*		
2.20	A)	From inside the vehicle, add a bead of Sika 252 or 255 in the window upper corners as required.	
	B)	From inside the vehicle, fill the space between the bead of Sika and the vertical rubber in the window front upper corners. Use Sika 252 or 255.	

PR00041	**UPPER SIDE PANEL** **GLUING**		**PREVOST**
		Effective: 9082	**REVISION 01** / **DATE 06-11-10** — LVA166 Spec 15.0

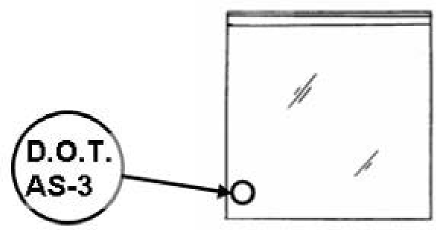
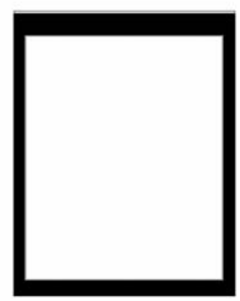
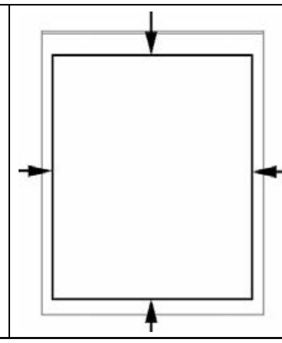
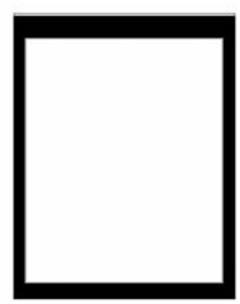
D470604-2-1, D470605-2-1		
1.00	**Fiberglass Panel Preparation** A) Clean using anti-silicone. *(See PR000001, Section A)* B) Apply 206 G+P primer. *(See PR000001, Section D)*	
1.05	Apply Sika 221 black + Booster onto structure. *Triangular bead at the top (Use the applicator) =* ***25mm x 15mm*** *Triangular bead in the radius =* ***20mm x 10mm*** *Triangular bead at the bottom and onto the vertical members =* ***15mm x 10mm*** **Apply also onto the 2 samples as per PR000001A section 2.**	
1.10	Apply an additional bead of glue at each tubing ends where the panel will be glued.	

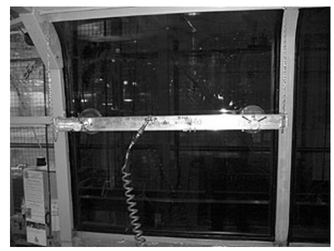
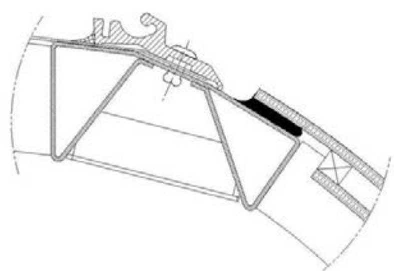
1.15	A)	Install panel on the vehicle. Make sure it is well centered before pressing it against the structure. Use **go-nogo #31133.** ***Note:*** *If you are not sure if the glue is cured, verify with a finger that it is "Tack Free".*	Distance between panel and windows = **8±2mm** 
		WE only Adjust gaps between slide-out box-frame windows and fiberglass panel as per the following standard: 9+/-2mm	
		W5 small rear side panel *Adjust gaps*	
		W5 center side panel *Adjust gaps*	 Fiberglass even with side panels ± 1mm
	B)	Install two retaining blocks onto panel about **600mm** from ends.	

1.20	A)	Compress bottom of panel starting by the center.	
	B)	Install a curved jig at each panel end or other mean of compressing the panel. *Curing time* = ***90 minutes minimum***	
	C)	Check panel alignment (flatness) with adjacent panel or windows **2mm max at the front and 3mm max at the rear.** Use **go-nogo #31133.** *Do not use a metal ruler onto glass to prevent scratching.*	
Important: Vehicle must not move until 90 minutes after compressing last panel or window			
1.25		Smooth down, using a brush, excess of glue inside the vehicle all around the panel. If required, add Sika 252 or 255. *Note: do not use Simson glue.*	

PR00043 LATERAL FIXED WINDOW – GLUING		PREVOST	
	Effective: 9055	**REVISION 00**	LVA050 LVA075 LVA081 Spec 15.0
		DATE 06-09-05	

Fixed Window Installation

1.00		**Window Preparation**	
		Bonding surface must be clean. If it is greasy, clean using anti-silicone as per PR000001, Section A and/or use a scraper to remove glue residue.	
	A)	Check that D.O.T. AS-3 is present and readable.	
	B)	Clean using glass cleaner. *(See PR000001, Section E)*	 
	C)	Apply Sika Aktivator. *(See PR000001, Section C)*	
1.20		**Windows Installation**	
	A)	Apply Sika 255 or Ultrafast onto fixed window perimeter. Triangular bead = **20mm X 10mm**	
	B)	Install fixed window into the opening. Center window and line up sides before pressing fixed window against structure. ***Important****: Never raise a window once it has been pressed against the structure because the joint would be too damaged.*	
	C)	Check window alignment (flatness) with adjacent panel or windows **2mm max at the front and 3mm max at the rear.** Use **go-nogo #31133.** *Do not use a metal ruler onto glass to prevent scratching.*	

	D)	Compress bottom of window using two “Quick Grip”. Compress top of window. *Note: If necessary, use hands to compress window to reach required flatness.*	
	E)	Install a curved jig at each window end or other mean of compressing the window. Compression time= **8 hours** minimum (30 minutes with Ultrafast)	
	F)	Install suction cup puller onto fixed window in order to compress the bead. Compression time= **8 hours** minimum (30 minutes with Ultrafast) *Important: Make sure that window flatness with reference to the adjacent windows remains acceptable.*	
	G)	Smooth down, using a brush, excess of glue inside the vehicle all around the window. Remove excess using a spatula.	
1.30	Add some Sika 252 at the top of fixed window. Smooth down the joint.		

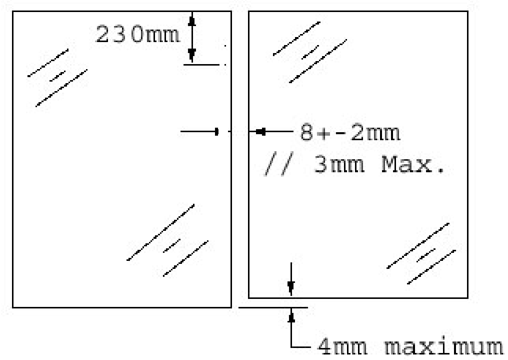
Appendix

Exterior Tolerance:

1- A gap of **8±2mm** with an out of parallelism of 3mm max. Take measurements about **230mm** from window extrusion and approximately **25mm** from bottom of window.

2- A gap of **4mm** is the maximum distance between two windows. When there are 2 “Awning” windows, one beside the other, the maximum gap between the 2 “Awning” windows is **2mm**.

Note: These dimensions are references given by engineering. If the assembly is out of tolerance, the aesthetic aspect will have to be evaluated.

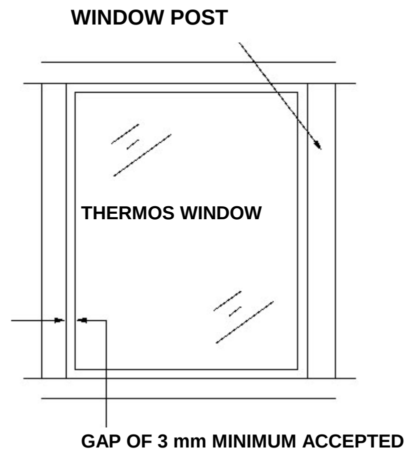


Interior Tolerance (Thermos Window Only):

If the thermos window is too close to the post (less than 6mm), fill the gap between the thermos window and the post with Sika 252 (fill the whole window perimeter to ensure watertightness.

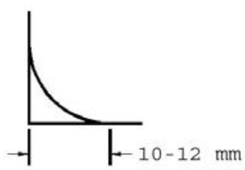
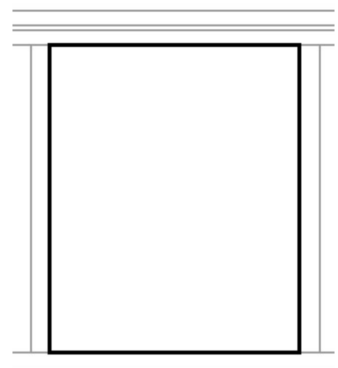
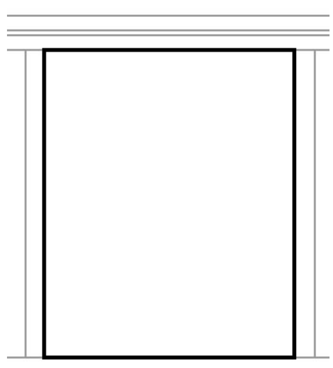
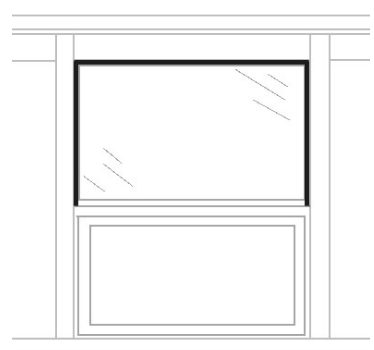
Interior Tolerance:

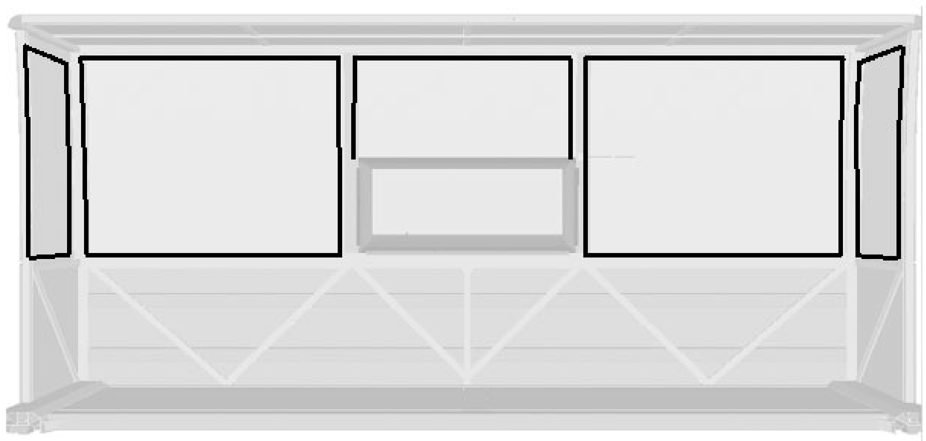
A gap of **3mm minimum** must be met between thermos window and structural post.



PR00044 LATERAL FIXED WINDOW – JOINT		PREVOST	
	Effective: 9055	**REVISION 00**	LVA075
		DATE 06-09-06	Spec 15.0

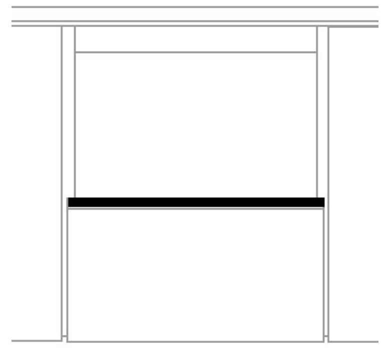
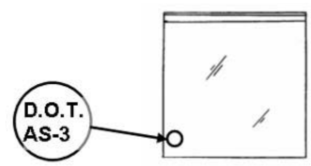
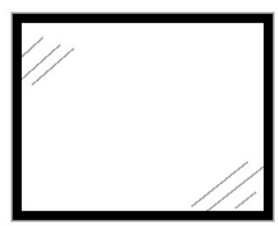
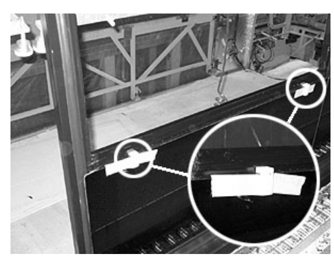
Simson Joint Around Fixed Windows

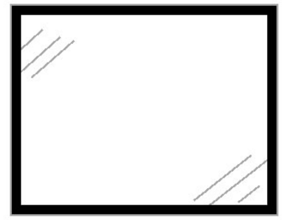
1.00	A)	Smooth down, using a brush, excess of glue inside the vehicle all around the window.	
	B)	**Single Glass:** Add a bead of Sika 252 or 255 if necessary to get a joint of 10-12 mm. *Note: Do not use Simson glue.* 	
	C)	**Thermos Glass:** Add Simson glue black 70-03. Remove the excess using a spatula. Smooth down the joint with finger. *Note: Wait **60 minutes** between gluing of window and Simson glue application.*	
		Fixed Window 	Fixed Half-Window 

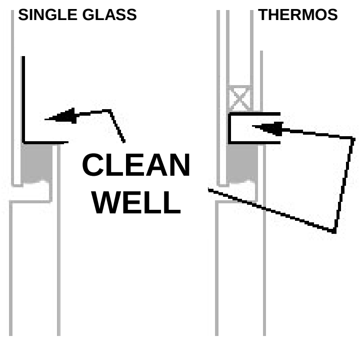
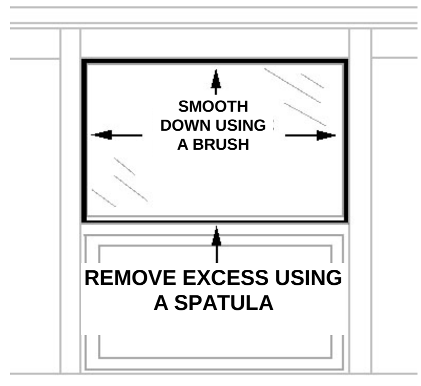
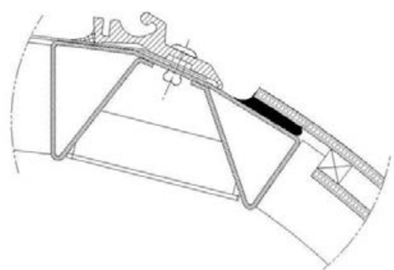
	Slide-out 

PR00045 LATERAL FIXED HALF-WINDOW – GLUING		PREVOST	
	Effective: 9055	**REVISION 00**	LVA050 LVA081 Spec 15.0
		DATE 06-09-06	

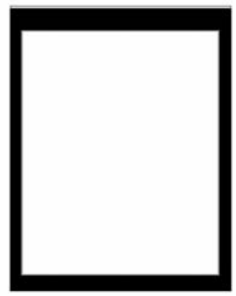
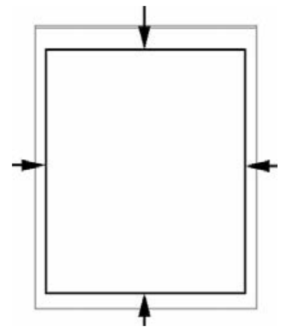
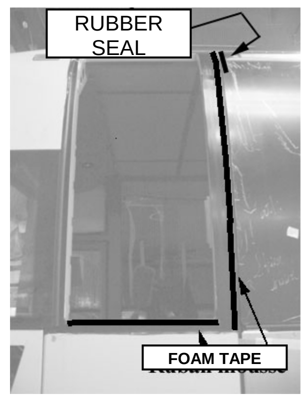
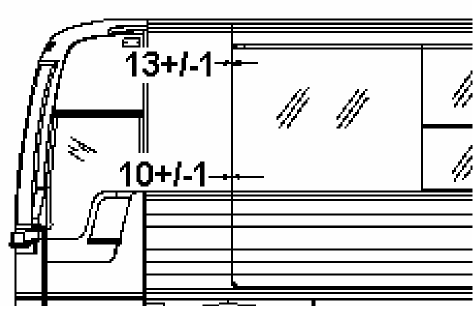
Fixed Half-Window Installation

1.00	**Window Frame Exterior Preparation Awning or Sliding (powder paint)**		
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Apply Sika Aktivator. *(See PR000001, Section C)*	
1.05	**Half-Window Preparation**		
	Bonding surface must be clean. If it is greasy, clean using anti-silicone as per PR000001, Section A and/or use a scraper to remove glue residue.		
	A)	Check that D.O.T. AS-3 is present and readable.	
	B)	Clean using glass cleaner. *(See PR000001, Section A)*	
	C)	Apply Sika Aktivator. *(See PR000001, Section C)*	
1.10	Install some shims on top of awning or sliding window and fix using masking tape.		

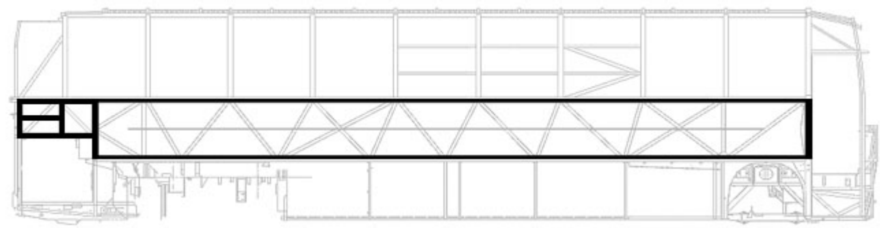
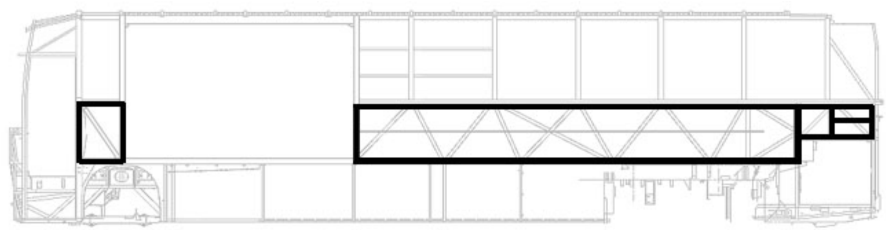
1.15	A)	**Half- Window Installation** Apply Sika 255 or Ultrafast onto half-window perimeter. Triangular bead = **20mm X 10mm**	
	B)		
	C)	Line up half-window sides with sliding or awning window sides before pressing half-window against structure. ***<u>Important</u>****: Never raise a window once it has been pressed against the structure because the joint would be too damaged.*	
	D)	Check window alignment (flatness) with adjacent panel or windows **2mm max at the front and 3mm max at the rear.** Use **go-nogo #31133.** *Do not use a metal ruler onto glass to prevent scratching.*	
	E)	Compress bottom of window using two “Quick Grip”. Compress top of window. *Note: If necessary, use hands to compress window to reach required flatness.*	
	F)	Install a curved jig at each window end or other mean of compressing the window. Compression time= **8 hours** minimum (30 minutes with Ultrafast)	

	G)	Install suction cup puller **6"** from bottom of half-window in order to compress the bead. Compression time= **8 hours** minimum (30 minutes with Ultrafast) *Important: Make sure that half-window flatness with reference to the adjacent windows remains acceptable.*	
	I)	Smooth down, using a brush, excess of glue inside the vehicle all around the window. Remove excess using a spatula. 	
1.20	Add some Sika 252 at the top of half-window. Smooth down the joint.		

PR00046	**LATERAL FIXED WINDOW BEHIND DRIVER** **GLUING**	PREVOST
	Effective: 9082	**REVISION 01** **DATE 06-11-07** / Spec 15.0

1.00		**Window Preparation**	  + edge
		Bonding surface must be clean. If it is greasy, clean using anti-silicone as per PR000001, Section A before proceeding with steps A) & B).	
	A)	Clean using glass cleaner. *(See PR000001, Section E)*	
	B)	Apply Sika Aktivator. *(See PR000001, Section C)*	
1.05		**Structure Preparation**	
	A)	Affix neoprene foam tape 3/16x1/2	
	B)	Affix another piece in the corner onto the rubber seal.	
1.10		**Window Gluing**	
	A)	Apply Sika 255 or Ultrafast Triangular bead = **20mm X 10mm**	
	B)	Install some type of conforming jig. Align window exterior (flatness) with adjacent windows (tolerance of **2mm maximum**). *WE* Make sure that gap is **9+/-2** with slide-out *W5* Make sure that gap at bottom is **10mm +/-1** and **13mm +/-1** at the top. Conforming time: **8 hours** minimum (30 minutes with Ultrafast)	

PR00072 SMOOTH SIDE PANEL – STRUCTURE PREPARATION		PREVOST	
	Effective: 9062	**REVISION 00**	Spec 15.0 LVA174
		DATE 06-09-13	

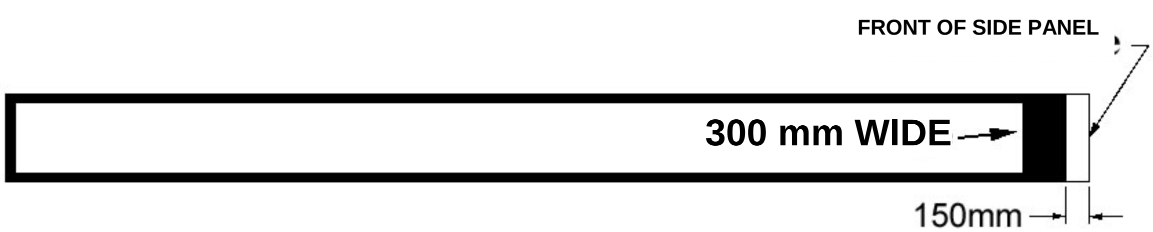
1.00	**Structure Preparation (S/S)**	
	A)	Clean using anti-silicone *(See PR000001, Section A)*
	B)	Sand using belt sander *(See PR000001, Section G)* Sand using “grit coarse belt”. Change paper on a regular basis.
	C)	Clean using anti-silicone *(See PR000001, Section A)*
	D)	Apply Sika 205. *(See PR000001, Section B)*
WE L.H. AND R.H. SIDE		
WE FITTED WITH SLIDE-OUT		

PR00073 SMOOTH SIDE PANEL – INSTALLATION		PREVOST	
	Effective: 9062	**REVISION 00**	Spec 15.0 Spec 36.0 LVA174
		DATE 06-09-13	

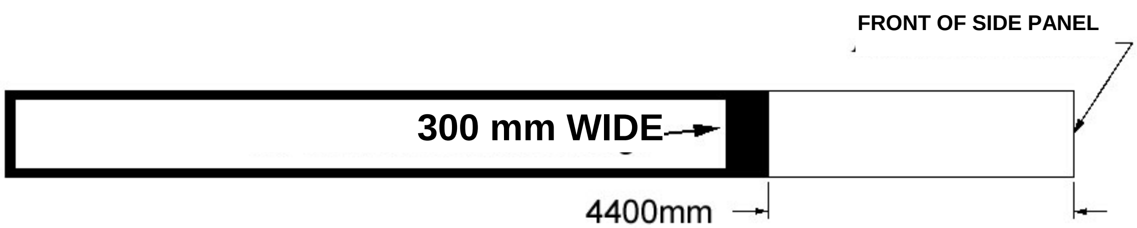
Section 1 Smooth Side Panel Preparation

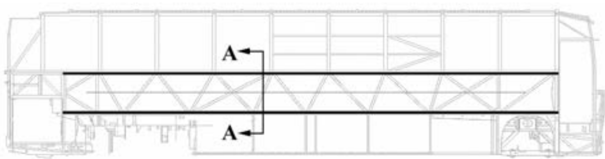
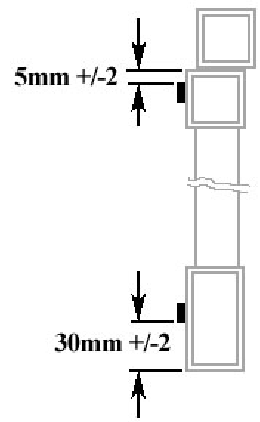
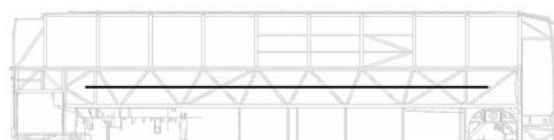
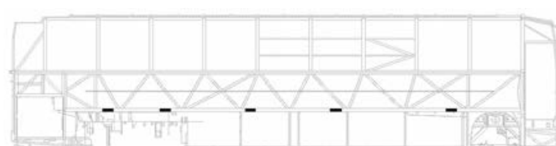
1.00		**Smooth Side Panel Preparation (S/S)**
	A)	Clean using anti-silicone *(See PR000001, Section A)*
	B)	Sand using belt sander *(See PR000001, Section G)* Sand using “grit coarse belt”. Change paper on a regular basis.
	C)	Clean using anti-silicone *(See PR000001, Section A)*
	D)	Apply Sika 205. *(See PR000001, Section B)*

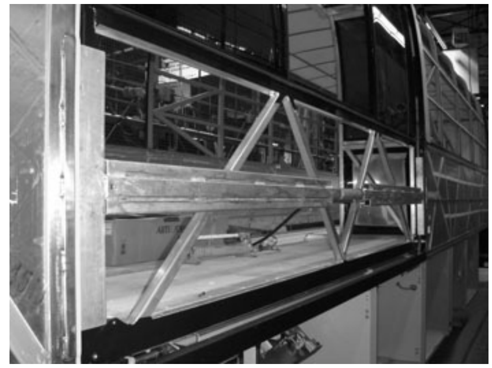
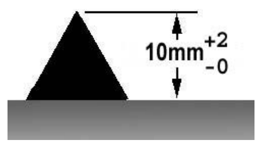
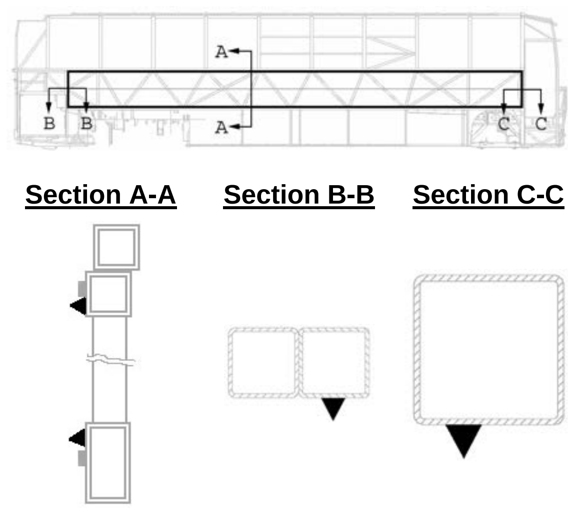
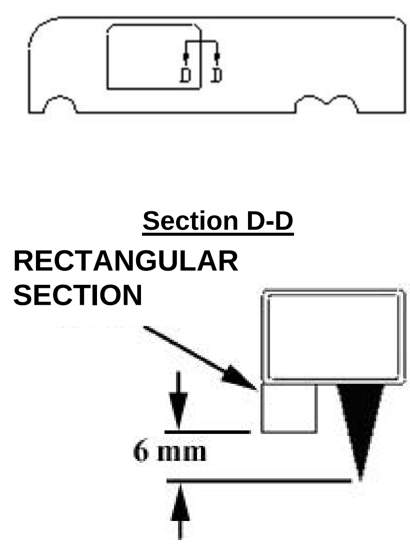
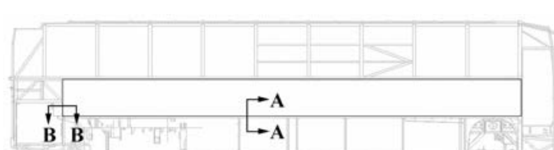
WE

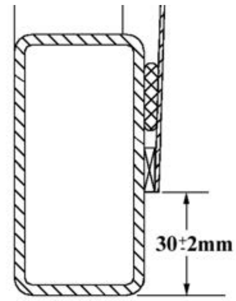
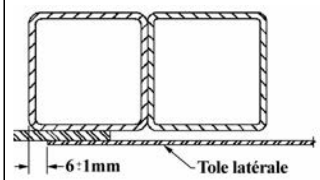


WE FITTED WITH SLIDE-OUT

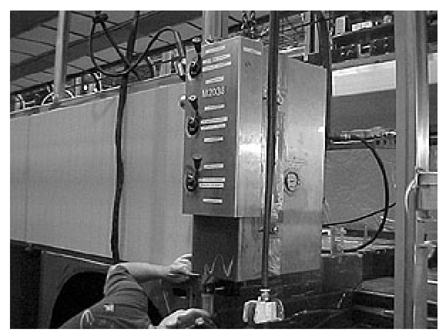


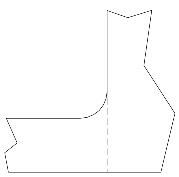
Section 2 Smooth Side Panel Gluing			
2.00		Apply and compress foam tape 1/8'' x 1/2'' as per indications.  	**SECTION A-A** 
2.05	A)	Clean using anti-silicone *(See PR000001 section A)*	
	B)	Apply and compress foam tape 1/8'' x1/2'' onto mid reinforcement.	
2.10	A)	Use supports to hold up side panel weight. Adjust height to ensure proper panel positioning.	 
	B)	Use upper supports to hold up side panel upper portion.	

2.20	**Reinforcement Bar Installation WE Slide-out**		
	A)	Bolt 1 bar in the box-frame.	
	B)	Install cylinder in the centre.	
	C)	Bolt the 2nd bar in the box-frame.	
2.25	A)	Apply Sika 252 onto structure. **(Watertight Joint)** 	
	B)	<u>**WE ''Slide Out'' L.H. side only:**</u> Apply a bead near the rectangular section: - Bead height in the area of the rectangular section: **6 mm higher than rectangular section.**	
	C)	Position side panel onto structure. 1- Adjust lower supports so that side panel is 30±2mm above tubing bottom.	

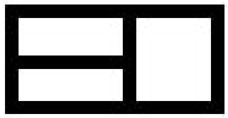
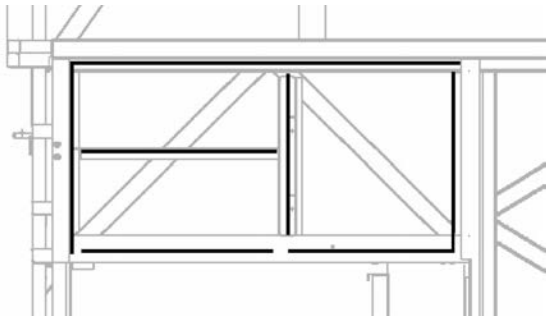
			Section A-A	Section B-B
		2- Position side panel 6±1mm from vertical tubing.		

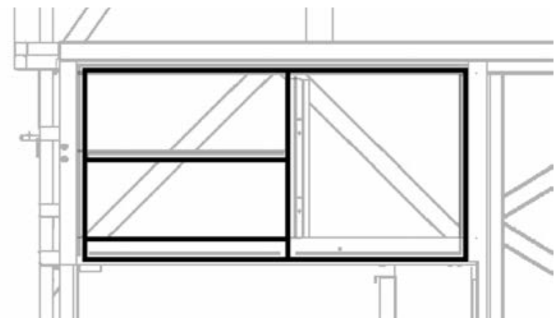
2.30	Rear of vehicle		
	A)	Sand back of side panel **2 inches** wide for TIG-arc welding.	
	B)	Make **36** “TIG spots. **WE**	

2.35	A)	Install pulling equipment at the other end of side panel.	
	B)	Make a final adjustment in height	
	C)	**WE Slide-out** Adjust pressure in the box-frame cylinder to 6600 PSI +100/-0	
	D)	Pull side panel so that panel moves 3/16” **WE :** 2800 +/- 50 psi	
	E)	Ensure proper side panel positioning	
	F)	**Remove upper supports**	
2.45	**WE**		
	A)	Sand front of side panel **2 inches** wide for TIG-arc welding.	

	B)	Perform TIG-arc welding Make **36** TIG spots **WE**	
	C)	Remove pulling equipment	
	D)	Remove pressure from WE slide-out reinforcement bar.	
	E)	Remove protective film from double-face self adhesive tape.	
	F)	Compress top and bottom section of side panel	
2.50	A)	Cut excess of side panel. Make sure that cut is parallel with tubing. **<u>WE Slide-out:</u>** Cut even with tubing. 	
	B)	Grind side panel end to line up with door tubing	

Engine Air Intake Panel Gluing

1.00	Make sure that sealing of structure has been performed properly	
1.05	**Engine Air Intake Panel Preparation (S/S)**	**Entertainer** 
1.10	Install foam tape 1/8" X ¼" onto structure, as shown in picture.	
1.15	Install foam tape 1/16" X ¼ onto air intake panel pleat	

<table>
<tr>
<td>1.20</td>
<td colspan="2">Apply a bead of 252 onto structure as per picture
Important: Make sure bead is continuous
Triangular bead: 10mm x 8mm</td>
<td colspan="2"></td>
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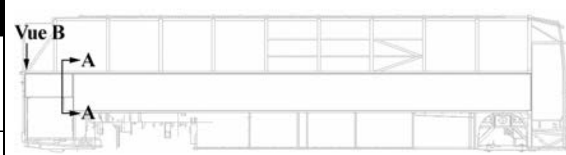
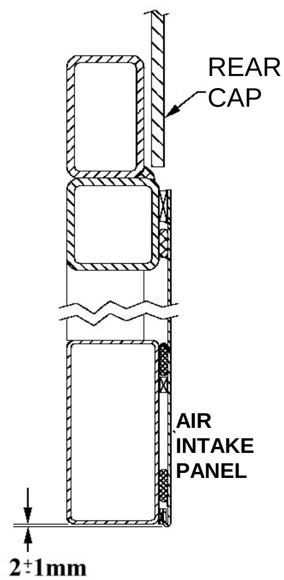
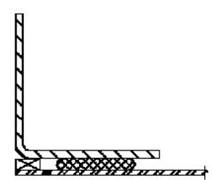
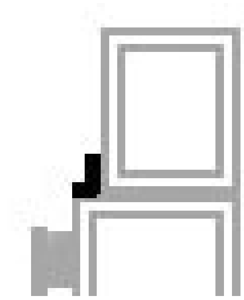
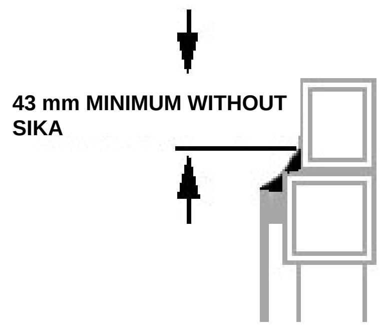
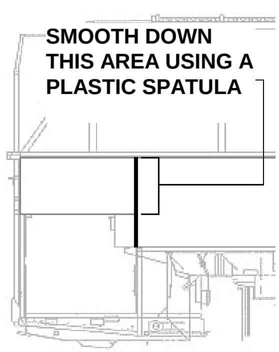
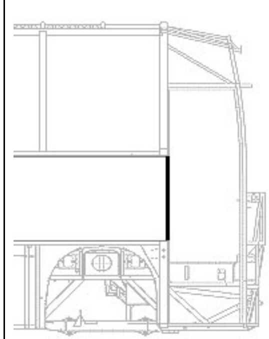
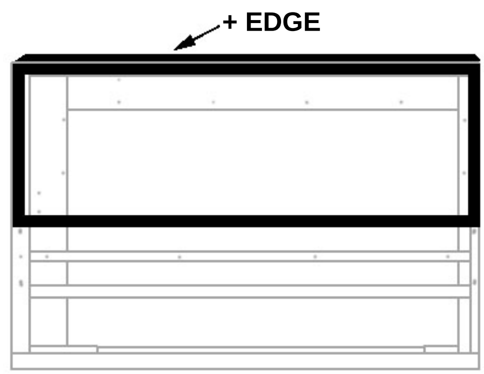
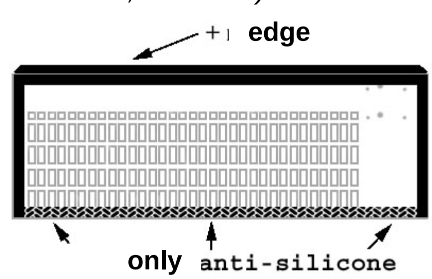
<tr>
<td rowspan="5">3.30 *</td>
<td colspan="2">Panel Installation</td>
<td colspan="2" rowspan="3">
</td>
</tr>
<tr>
<td>A)</td>
<td>Install 2 supports onto structure and lay down panel.</td>
</tr>
<tr>
<td>B)</td>
<td>Adjust supports so that panel is 2±1mm lower than tubing.</td>
</tr>
<tr>
<td>C)</td>
<td>Position panel flush without projecting beyond rear structural tubing, see view B</td>
<td rowspan="2"><u>SECTION A-A</u>

</td>
<td rowspan="2"><u>View B</u>
</td>
</tr>
<tr>
<td>D)</td>
<td>Use a brush to compress Sika bead</td>
</tr>
</table>

Finishing Joint

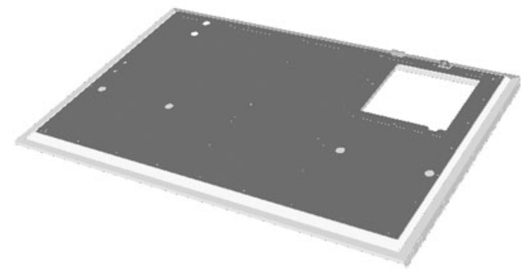
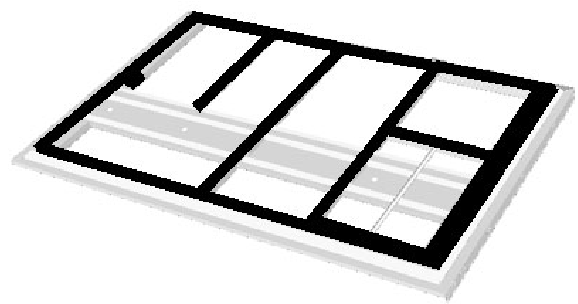
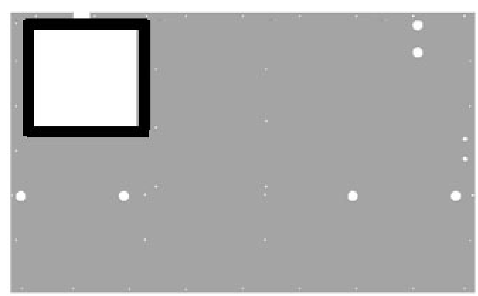
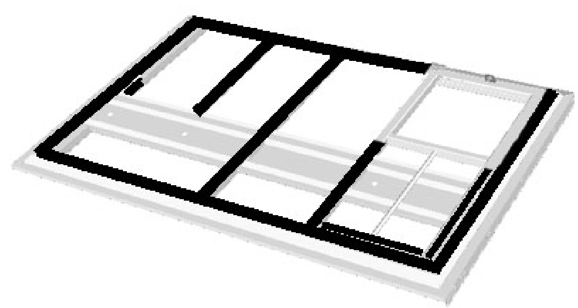
1.00	A)	Apply Sika 205 Use a plastic spatula inside a Chix cloth to ensure that Sika 205 reaches as far as the corner. See PR000001 section B.	
	B)	Apply Sika 252 black at the junction of both tubing (leave 43 mm minimum without Sika to ensure gluing of window rubber). On top of smooth side panel. Smooth down the joint	
1.05	A)	Perform finishing joints using Sika 221 grey at each side panel end.	**Rear**  / **Front** 
	B)	Smooth down the joint.	

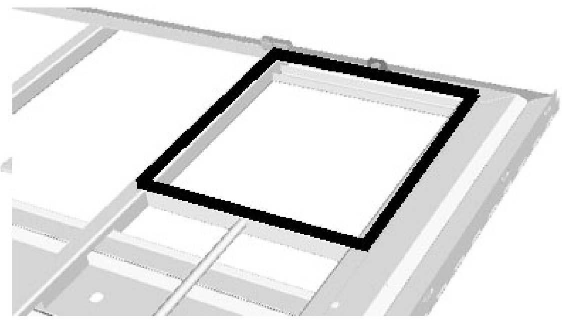
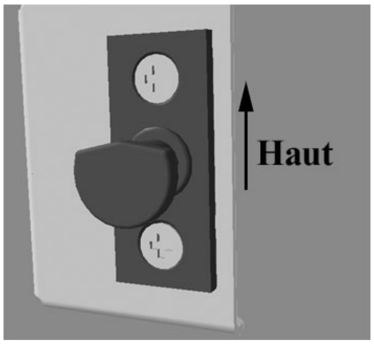
PR00131 CONDENSER COMPARTMENT DOOR - ASSEMBLY		PREVOST	
	Effective: 9064	**REVISION 00**	Spec 15.0
		DATE 06-09-19	LVA175

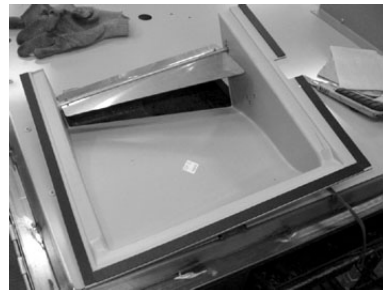
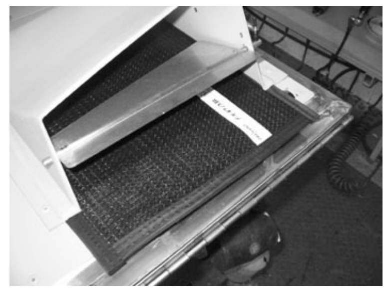
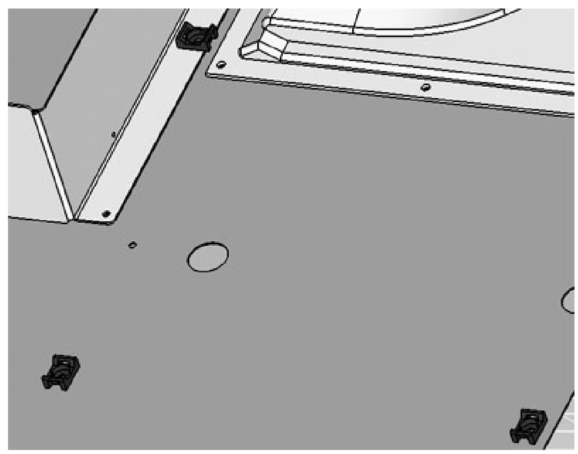
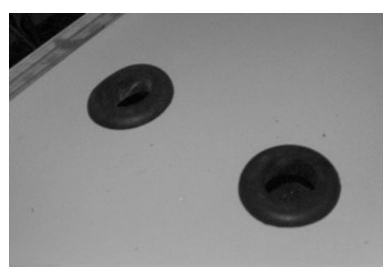
Condenser Compartment Door

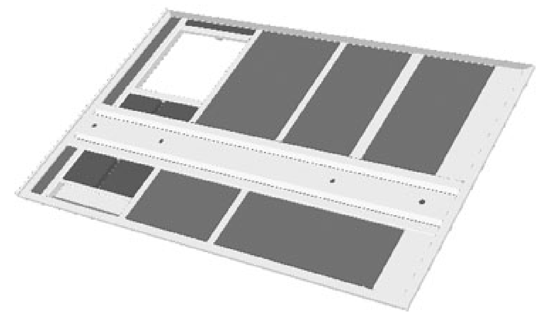
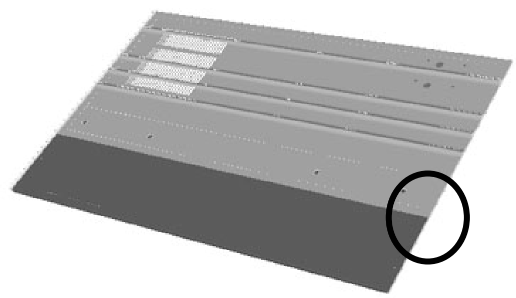
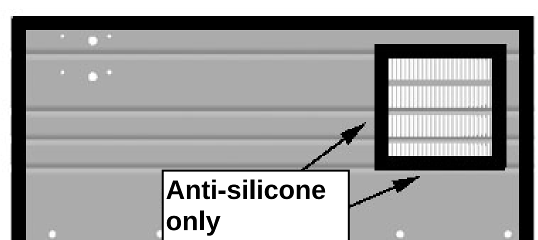
1.00	Apply some masking tape to protect the hinge (to prevent staining with Sika 206 G+P).		
1.05	**S/S Frame Preparation**		
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 206 G+P. *(See PR000001, Section D)*	
1.10	**S/S Body Panel Preparation**	**OR**	**E-Coat Body Panel Preparation (black)**
	A) Clean using anti-silicone. *(See PR000001, Section A)*		Clean using anti-silicone. *(See PR000001, Section A)* 
	B) Sand using Scotchbrite. *(See PR000001, Section G)*		
	C) Clean using anti-silicone. *(See PR000001, Section A)*		
	D) Apply Sika 206 G+P. *(See PR000001, Section D)*		
1.15	A)	Apply Sika 221 + booster.	
	B)	Position body panel onto door frame.	
	C)	Compress using hands. Hold using masking tape. ⌛ Curing time = 4 HOURS minimum	
	D)	Inspect body panel	

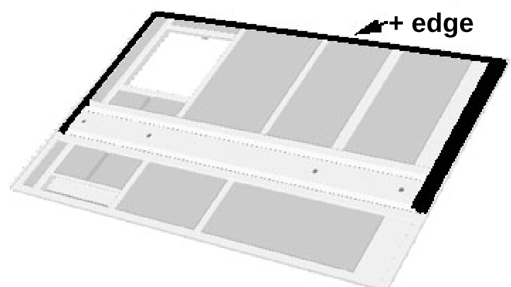
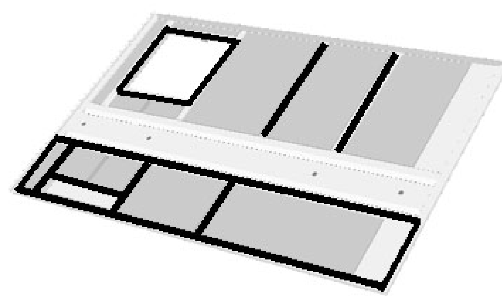
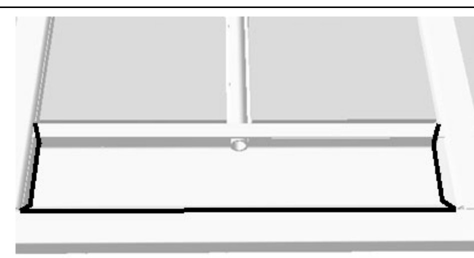
Door Assembly

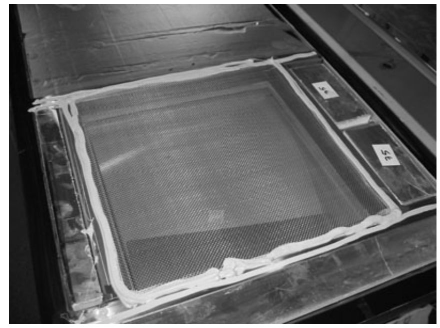
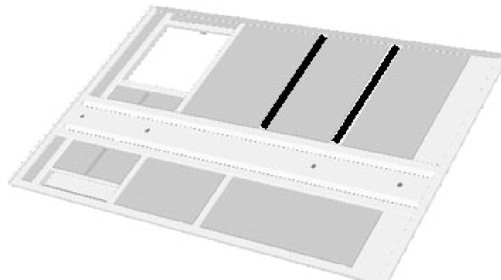
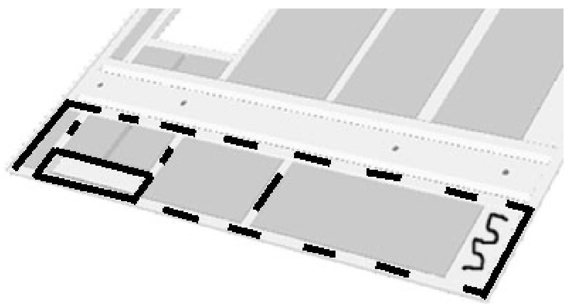
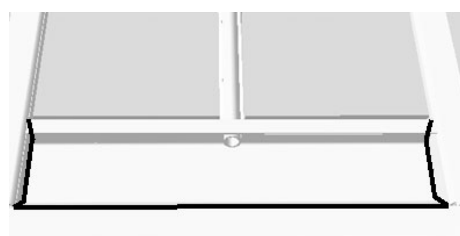
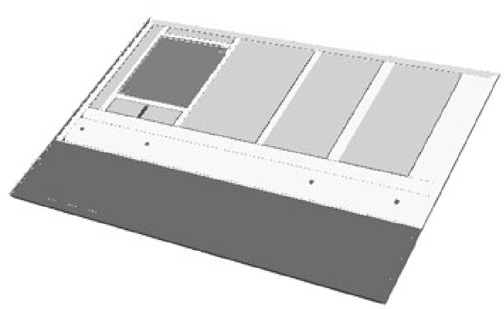
1.00		**Drilling Back Panel**	
		Install back panel onto frame and drill	
1.05		**Back Panel**	
	A)	Clean frame using anti-silicone. *(See PR000001, Section A)*	
	B)	Apply Sika 205 onto body panel and frame perimeter. *(See PR000001, Section B)*	
	C)	Install insulation behind rub rail.	
	D)	Apply some black butyl tape onto the frame and remove protective tape (liner)	

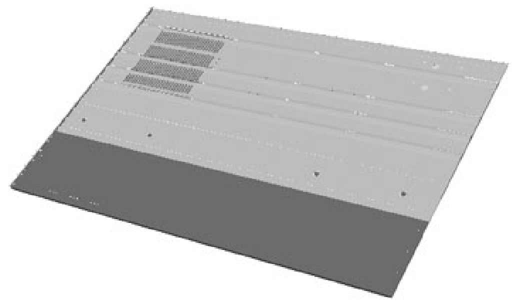
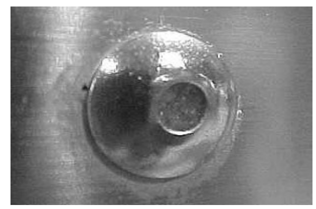
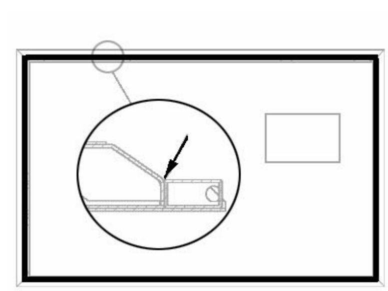
	E)	Apply Sika 205 aound the opening in the frame *(See PR000001, Section B)*	
	F)	Apply Sika 221 gey onto the perimeter Bead diameter, about **4mm**	
	G)	Lay down back panel and rivet	
1.10	Install latch Caution: Install the tip of the latch towards the top  		MTH 

1.15	**Damper**		
	A)	Apply foam tape 1/16x1/2 underneath damper box	
	B)	Install and rivet	
	C)	Install filter.	
1.20	**A/C Junction Box**		
	Install A/C junction box. Install 3 tie-mount and rivet		
1.25 *	**Marker Light Grommets**		
	Install grommets		

1.35	Install insulating pieces.		
1.40	**Body Panel Adjustment**		
	A)	Install and adjust lower and upper body panels. Make sure that the 2 panels are flush one compared to the other. Check hinge squareness with regards to panels.	
	B)	Hold down using clamps. Drill 6 holes into lower body panel. Countersink 6 holes. **Caution: Drill only through the first metal layer in the frame.**	
	C)	Remove body panels.	
	D)	Remove metal burrs using a disc sander.	
1.45	**Lower Body Panel Preparation**		
	A)	Remove blue plastic film and inspect body panel. Reinstall transparent plastic film.	
	B)	Apply Sika 205 *(See PR000001, Section B)*	
1.50	**Upper S/S Body Panel Preparation**		
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 206 G+P. *(See PR000001, Section D)*	
	E)	Remove blue plastic film and inspect body panel. Reinstall transparent plastic film.	

1.55		**E-Coat Upper Body Panel Preparation**	
		Clean using anti-silicone. *(See PR000001, Section A)*	
1.60		**S/S Frame Preparation**	
	A)	Apply masking tape onto hinge	
	B)	Clean using anti-silicone. *(See PR000001, Section A)*	
	C)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	D)	Clean using anti-silicone. *(See PR000001, Section A)*	
	E)	Apply Sika 206 G+P. *(See PR000001, Section D)*	
	F)	Apply Sika 205 onto frame. *(See PR000001, Section B)*	 

1.65	**Grid Installatione**		
	A)	Apply Sika 221 grey around the opening	
	B)	Install grid	
	C)	Apply Sika 221 grey again aroud the grid.	
1.70	**Body Panel Installation**		
	A)	Apply some butyl tape onto the frame and remove protective tape (liner)	
	B)	Apply Sika 221 grey onto lower body panel and frame. Bead diameter, about 4mm.	 
	C)	Install lower body panel and rivet.	

	D)	Apply Sika 221 + booster onto upper body panel.	
	E)	Install upper body panel. Compress glue using hands. **Make sure that upper portion of body panel rests perfectly against the frame.** Remove protective tape from hinge. Hold down body panel using masking tape. Curing time 4 hours minimum	
	F)	**<u>If upper body panel is ridged</u>** : Seal lower body panel rivets using silver sealant.	
1.75		**Finishing Joint**	
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Apply Sika 205 *(See PR000001, Section B)*	
	C)	Apply Sika 221. Bead diameter 6mm	
	D)	Smooth down the joint.	

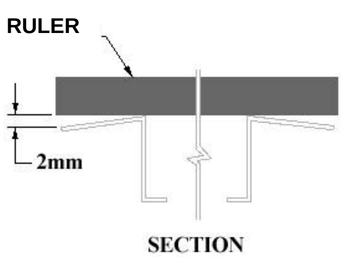
PR00177 BAGGAGE COMPARTMENT DOOR – BODY PANEL INSTALLATION		PREVOST	
	Effective: MTH 9070	**REVISION 00**	Spec 15.0 LVA171
		DATE 06-10-06	

Section 1 Baggage Door Back Panel Positioning		
1.00	Position back panel. Apply masking tape to hold it in place.	
1.05	Drill using a **#11** drill bit.	
1.10	Remove masking tape and back panel.	

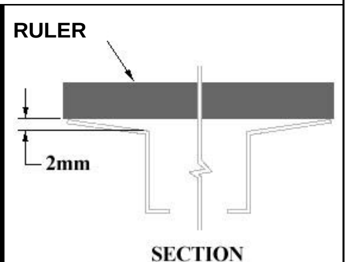
Section 2 Frame Squareness and Flatness Verification

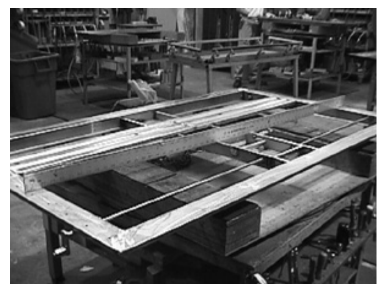
2.00 Verify that frame is square and flat using a long ruler.

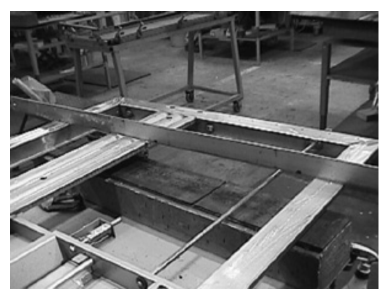
Important: Frame edges must be flat (tolerance of **2mm maximum**). If this is not the case, straighten the frame out.



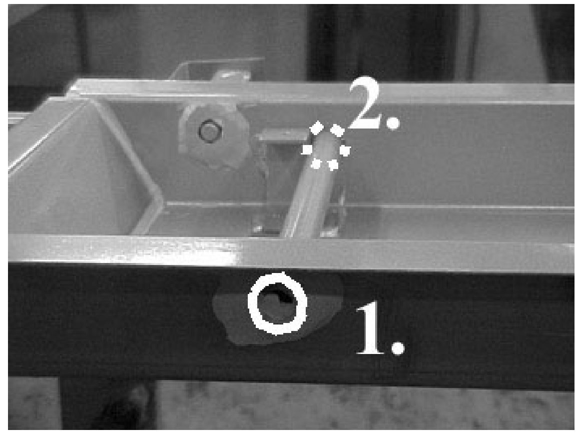
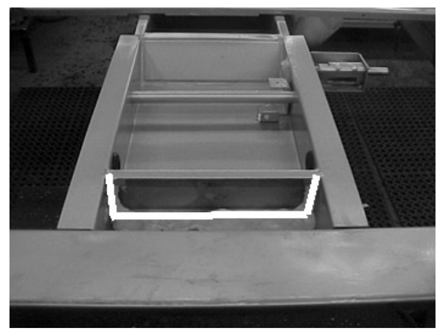
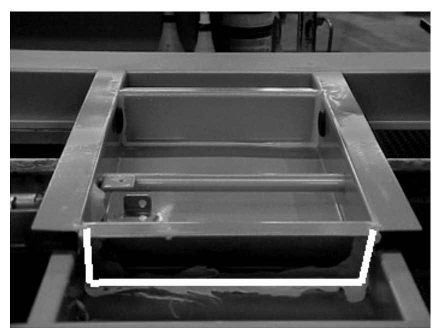
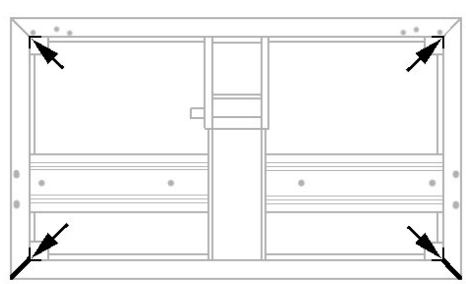
OR

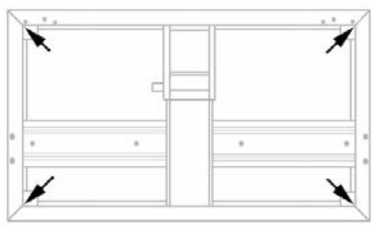
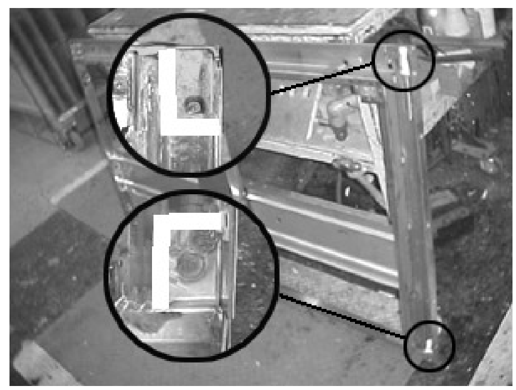




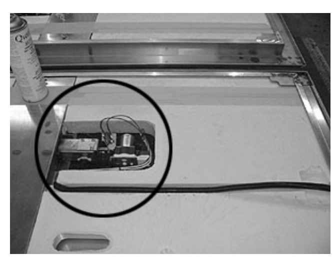


Section 3 Door Structure Sealing

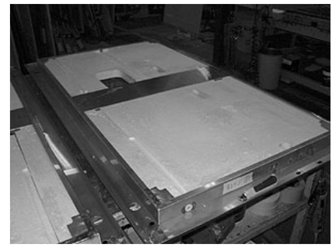
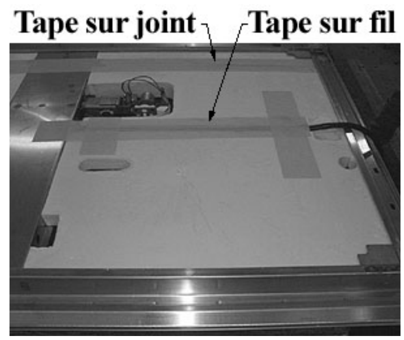
3.00	A)	Apply Sika 205 around door handle pipe exterior ends (#1 & #2). *(See PR000001, Section B)*	
	B)	Apply Sika 221 around door handle pipe exterior ends (#1 & #2)	
3.05	A)	Apply Sika 205 at the top of the handle (handle exterior side)	
	B)	Apply Sika 221. *Bead diameter =* ***Ø3/16"***	
	C)	Smooth down the joint with your finger.	
3.10	A)	Apply Sika 205 at the bottom of the handle (handle exterior side) *(Voir PR000001, Section B)*	
	B)	Apply Sika 221. *Bead diameter =* ***Ø3/16"***	
	C)	Smooth down the joint with your finger.	
3.20	A)	Apply Sika 205 Into the 4 interior corners of the frame. Into the 2 lower corners, on top of the frame. *(See PR000001, Section B)*	

	B)	Apply Sika 221 Into the 4 interior corners of the frame. *Bead diameter = **Ø3/16"*** 	
3.25	**Hinged Door Frame (Slide-Out)**		
	A)	Apply Sika 205 from the interior of the frame, hinge side. *(See PR000001, Section B)*	
	B)	Apply Sika 221. *Bead diameter = **Ø3/16"***	
	C)	Smooth down the joint with your finger.	

Section 4 Locking System Installation

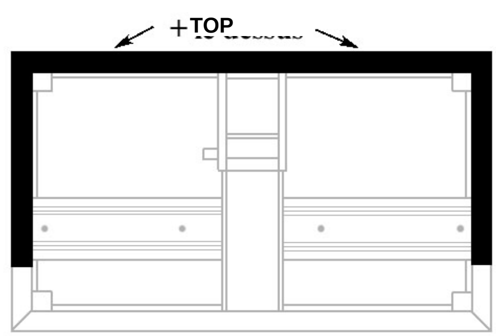
4.00	If required, tap 3 motor support holes using a **M4 X 0.7** screw tap.	
	Install locking system, fixing plates and electric motor (if applicable).	
4.05	Check locking system operation.	

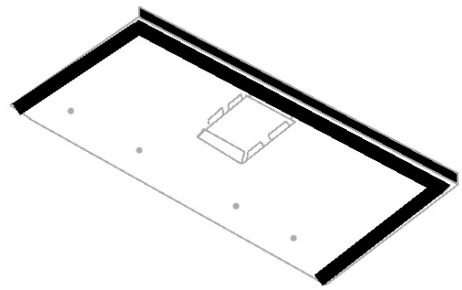
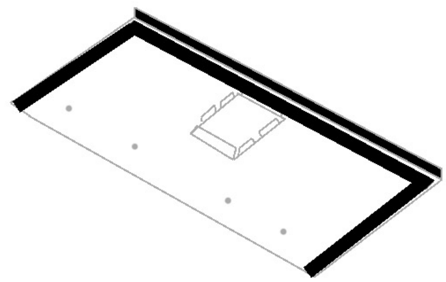
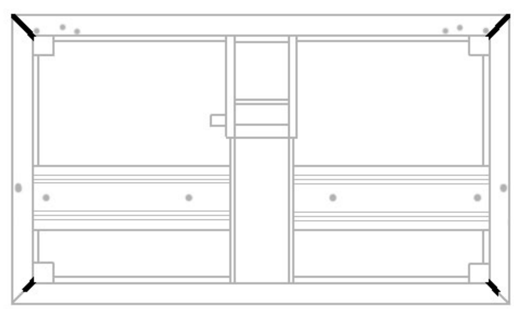
Section 5 Insulation Installation (optional)

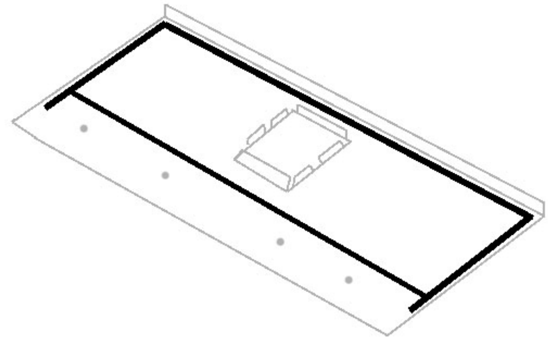
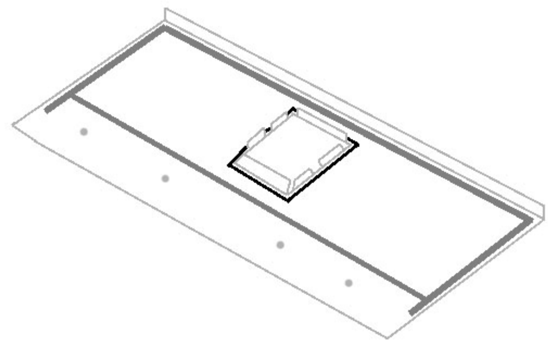
5.00	Install pieces of insulation onto door structure.		
5.05	A)	Apply some green tape onto the joint between the two pieces of insulation.	
	B)	Apply some green tape in order to hold the electric motor cable into the insulation cavity.	
5.10	Reinstall back panel and rivet.		

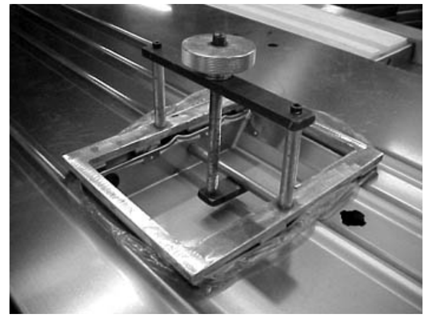
Section 6 Upper Panel Installation

Important: Make sure that all bonding surfaces are clean and free of dust, residue or dry glue. If required, clean using a scraper or damp cloth.

6.00	**SS Frame Preparation**		
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 206 G+P. *(See PR000001, Section D)*	

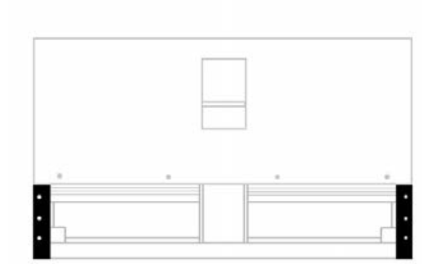
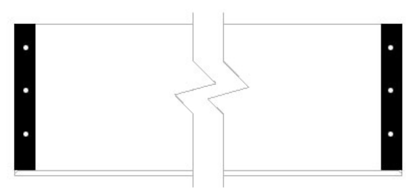
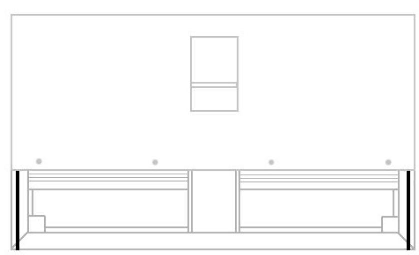
6.05	**SS Body Panel Preparation**		
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 206 G+P. *(See PR000001, Section D)*	
6.10	**E-Coat Body Panel Preparation**		
	Clean using anti-silicone. Repeat this step if panel seems greasy. *(See PR000001, Section A)*		
6.15 *	A)	Apply Sika 221 grey into the 4 corners on top of the frame. **Caution : Apply only onto half of 2 lower corners**	
	B)	Smooth down the joints using a plastic spatula.	

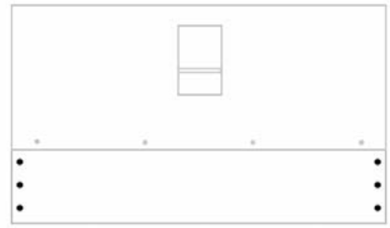
6.20	A)	Apply Sika 221+ booster. *Triangular bead = **8mm wide X 9mm high.*** **<u>Important</u>: There should be no more than 18 minutes between the beginning of the glue application and the panel installation onto the frame.**	
	B)	Apply Sika 221 around the handle.	
6.25	Position the body panel onto the door frame. Compress and hold. *Curing time = **4 hours***		

6.35	A)	If necessary, install door handle onto frame to install the rivets	
	B)	Drill door structure using a **#30** drill bit using the holes in the body panel pleats. Rivet body panel onto structure. **<u>Important</u>:** If equipped with a smooth body panel, soak rivets into Sika 221 before riveting.	
	C)	Apply Sika 221 onto the rivet heads.	
	D)	Clean the excess of sealant and rivet heads using Sika 208.	
6.40	Install and adjust handle.		
6.45	Install the lock. **<u>Important</u>**: Make sure that the lock gasket rests perfectly against the body panel.		

Section 7 Lower Body Panel Installation

7.00	A)	Position lower body panel onto door structure.	
	B)	Fix body panel using c-clamps.	
	C)	Drill structure using a **#11** drill bit.	
	D)	Counter sink the holes (top of body panel). *Note: This is to make sure that the rivet heads will rest perfectly against the body panel.*	

7.05	A)	Remove lower body panel	
	B)	Grind metal burrs from the top of the frame and also at the back of the body panel.	
	C)	Remove blue paper from the body panel ends (so that the holes are free) and also at the top (so that the portion inserted underneath the upper panel is free).	
	D)	Inspect the body panel to make sure that it is free of bumps or defects.	
7.10	A)	Apply Sika 205 onto frame & back of panel. *(See PR000001, Section B)*	**<u>Frame</u>** 
			<u>Panel</u> 
	B)	Apply Sika 221 onto frame in front of the holes. *Bead diameter = **Ø3/16”***	
7.15	Insert lower body panel underneath upper body panel. *Note: To insert body panel, use a spatula and a punch.*		

7.20	Insert a rivet into each hole and rivet starting from the top. *Note: Make sure the rivet shank does not excess its head.*	

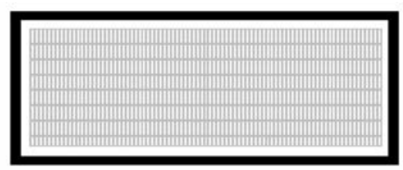
Section 8 Body Panel Replacement Procedure

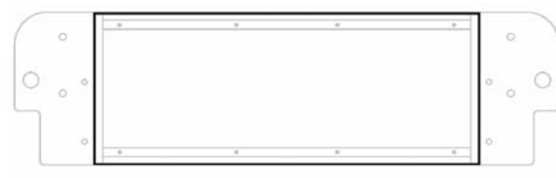
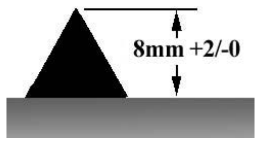
UPPER BODY PANEL REMOVAL		
8.00	Remove door lock and handle.	
8.05	Cut beads of Sika 221 on the body panel L.H. and R.H. sides using an Olfa knife or a pneumatic zip gun. *Note: You can heat the glue up to help removal using a blowtorch.*	
8.10	Lift body panel edge using a pair of pliers. Pull the panel while cutting the Sika bead. **Important**: Remove rivet shanks fell inside the door.	
8.15	Prepare surface. *(See PR000001, Section 2)*	
8.20	Install the new panel as per section 6.	
LOWER BODY PANEL REMOVAL		
8.25	Remove rivets.	
8.30	Cut beads of Sika 221 on the body panel L.H. and R.H. sides using an Olfa knife or a pneumatic zip gun. *Note: You can heat the glue up to help removal using a blowtorch.*	
8.35	Slide body panel down using a screwdriver and hammer.	
8.40	Prepare surface. *(See PR000001, Section 2)*	
8.45	Install the new panel.	

Appendix 1 Replacement/Repair

A1.00	Remove part. See PR000001, Section 2.
	Preparation and gluing. See PR000001, Section 2 and/or do procedure again.

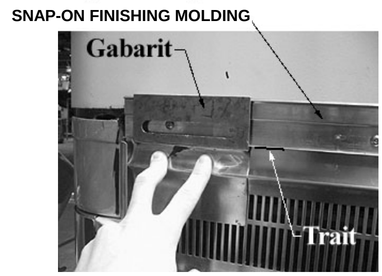
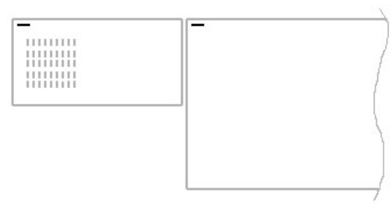
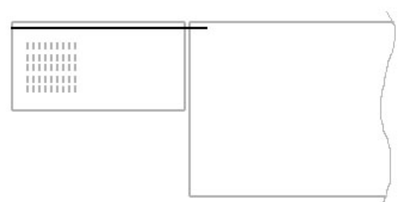
PR00198 FRONT BUMPER PANEL - GLUING		PREVOST	
	Effective : 9090	**REVISION 00**	Spec 15.0
Engineering Change :		**DATE 06-10-16**	

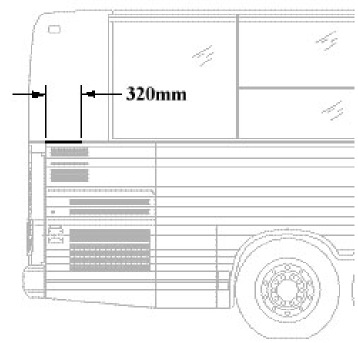
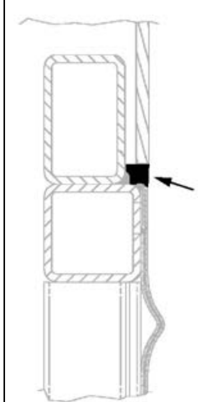
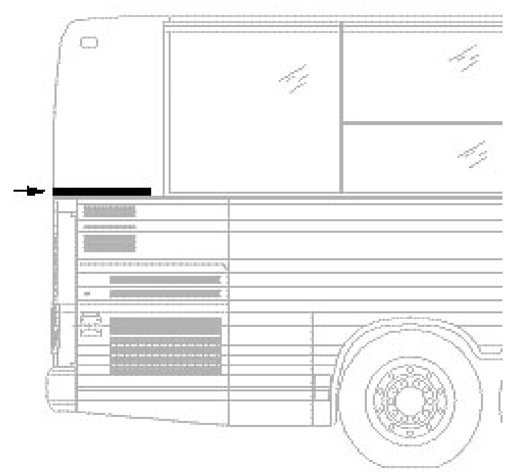
1.00	**S/S Frame Preparation**		
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Use Scotchbrite to sand frame. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 205. *(See PR000001, Section B)*	
1.05	**S/S Panel Preparation**		
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Use Scotchbrite to sand panel. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 205. *(See PR000001, Section B)*	
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Apply Sika 215 primer *(See PR000001, Section D)*	

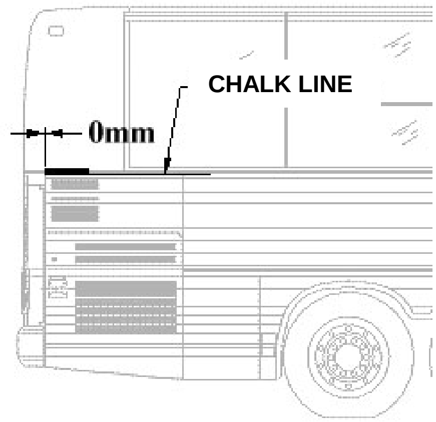
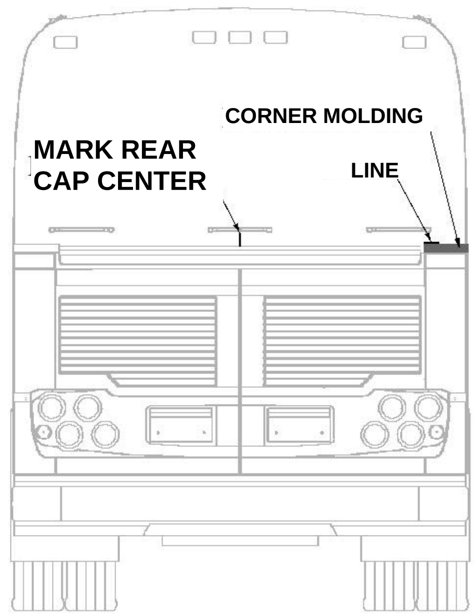
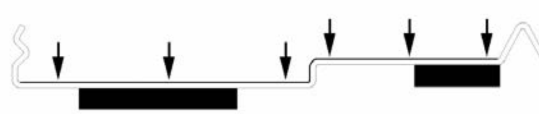
1.15	A)	Apply double face self adhesive tape **1/16 x 1/4** onto perimeter of frame.	
	B)	Apply Sika 252. 	
1.20	A)	Remove protective film from double face self adhesive tape and lay down panel onto frame.	
	B)	Press panel against frame to compress the glue and double-face self adhesive tape.	

PR00208 RIDGED SIDE PANEL – GLUING OF HORIZONTAL FINISHING MOLDING		PREVOST	
	Effective: 9090	REVISION 00	Spec 15.0 L00014
		DATE 06-10-20	

Section 1 Rear Cap and Engine Air Intake Snap-on Finishing Molding Installation

1.00	**Snap-On Finishing Molding Pre positioning**		 
	A)	Position snap-on finishing molding and put a pencil mark underneath the snap-on finishing molding where indicated (onto engine air intake panel and 1st side panel).	
	B)	Draw a chalk line between the 2 marks.	

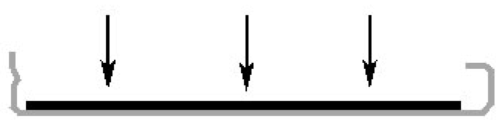
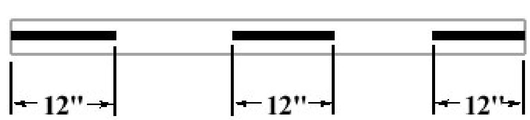
1.05		**Sealing the cavity**		**Section View** 
	A)	Clean using anti-silicone *(See PR000001, Section A)*		
	B)	Apply Sika 205. *(See PR000001, Section B)*		
	C)	If necessary, apply masking tape onto each cavity side to pick up the excess.		
	D)	Fill the cavity with Sika 221 or 252. Apply Sika **320 mm** long from the edge of engine air intake panel.		
	E)	Smooth down the joint using a plastic spatula. If necessary, remove masking tape.		
1.10		Clean using anti-silicone, the area on the rear cap where the snap-on finishing molding will be installed and also underneath the snap-on finishing molding. *(See PR000001, Section A)*	 	
1.15		Apply double-face self adhesive tape 1/16" X ¼" and double-face self adhesive tape 1/16'' X ½" onto snap-on finishing moldings		

1.20	**Snap-On Finishing Molding Installation**		
	A)	Position snap-on finishing molding as per chalk line of step 1.00 B). Position snap-on finishing molding "flush" with the edge of the engine air intake panel.	
	B)	Pre-drill using a **1/8"** dia. bit. Drill using a **#11** drill bit and rivet.	
1.25	**Rear Snap-On Finishing Molding Installation**		
	A)	Mark the center of snap-on finishing molding and the rear cap center using a felt pen.	
	B)	Position corner molding onto snap-on finishing molding. Level corner molding and draw a line above it to establish the rear snap-on finishing molding proper positioning. **Important**: Make sure corner molding follows the rear cap round.	
	C)	Remove corner molding.	
	D)	Line up snap-on finishing molding with the pencil lines. Level finishing molding. Drill using a **#11** drill bit and rivet.	
1.30	**(S/S) Snap-On Finishing Molding Preparation**		
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 205. *(See PR000001, Section B)*	

Section 2 Corner Molding Gluing

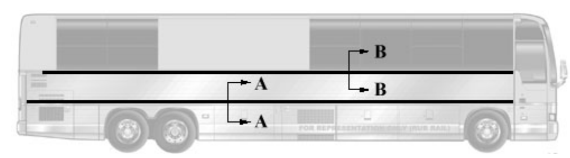
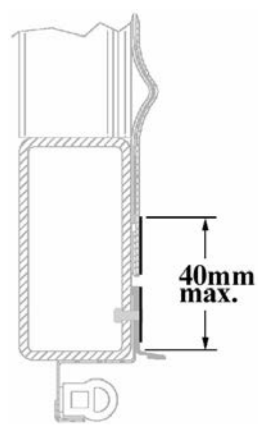
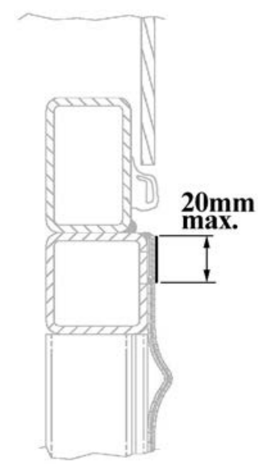
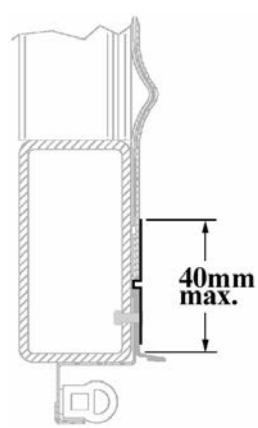
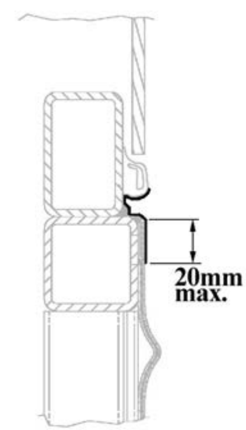
2.00	**(S/S) Corner Molding Preparation**		
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 205. *(See PR000001, Section B)*	
2.05	Apply Sika 252. 		
2.10	A)	Glue corner molding onto snap-on finishing molding.	
	B)	Compress molding with a nylon block.	

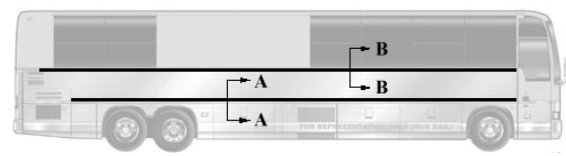
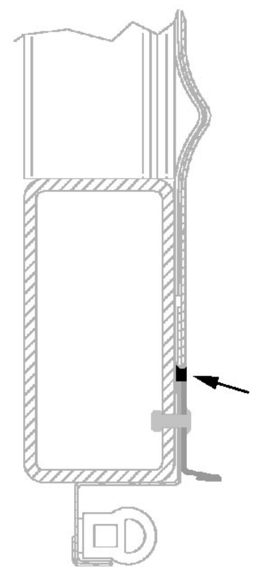
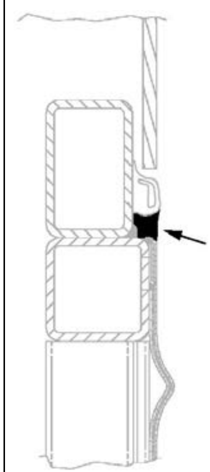
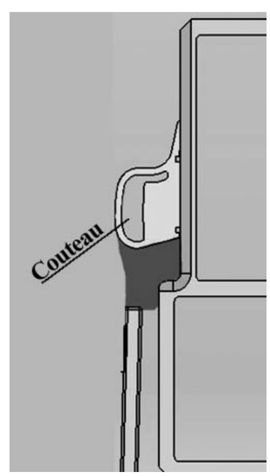
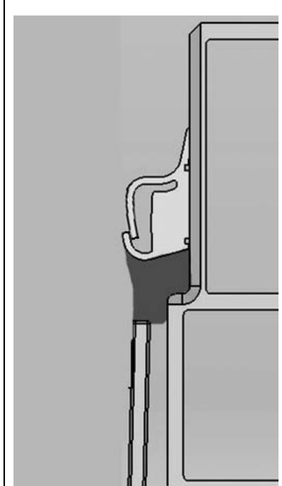
Section 3 Rear Finishing Molding Gluing

3.00	Measure distance between 2 corner moldings and cut the excess of rear finishing molding.		
3.05	**(SS) Molding Preparation**		
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 205. *(See PR000001, Section B)*	
3.10	Apply Sika 252 onto finishing molding. *Triangular bead = **13±1mm***		

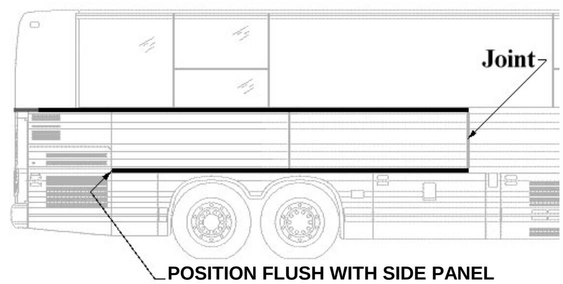
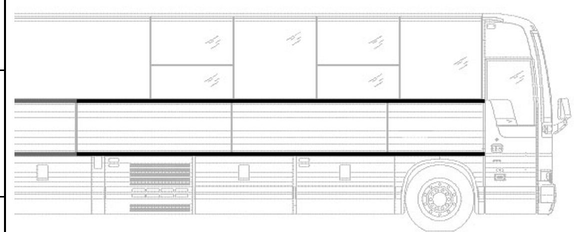
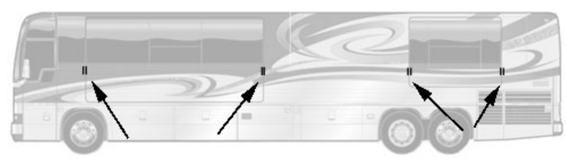
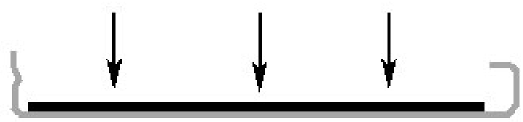
3.15	A)	Glue finishing molding.	
3.20	B)	Compress molding with a nylon block.	

Section 4 Vehicle Preparation

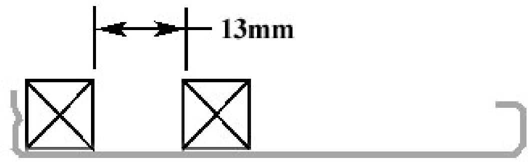
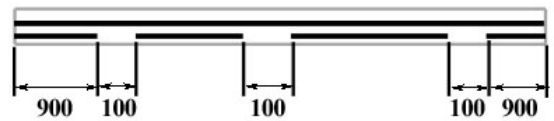
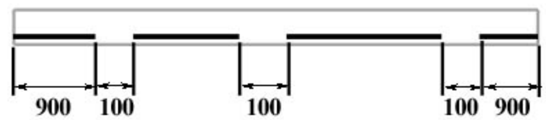
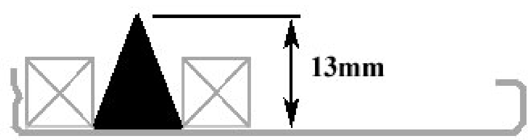
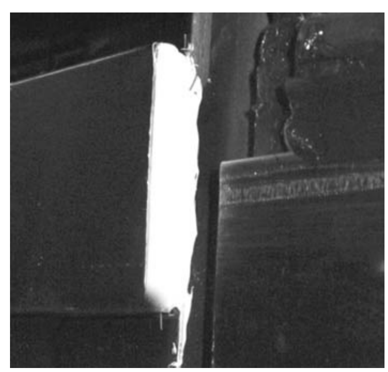
4.00	**Vehicle Preparation (S/S)**			
	A)	Clean using anti-silicone side panels and gutters, under masking tape. *(See PR000001, Section A)*	**Section A-A**	**Section B-B**
	B)	Sand using orbital sander. *(See PR000001, section G.)* Be careful not to scratch side panels (apparent area not hidden by finishing molding).		
	C)	Clean using anti-silicone side panels, gutters and cavities. *(See PR000001, Section A)*		
	D)	Apply Sika 205. *(See PR000001, Section B)* Be careful not to stain side panels (apparent area not hidden by finishing molding).		
5.10	Seal engine air intake panel and drip molding rivet heads with Sika 221.			

5.15	**Sealing cavities**			
	A)	Fill cavities with Sika 221 or 252.	**Section A-A**	**Section B-B**
	B)	Smooth down the joint with a plastic spatula. **Important: There must be no more than 15 minutes between the start of cavity filling and the installation of molding.**		
	C)	**W5 Fitted With Slide-out** If required, cut the Slide-out rubber seal with a knife (just above the joint of sealant). Push the lip inside.		

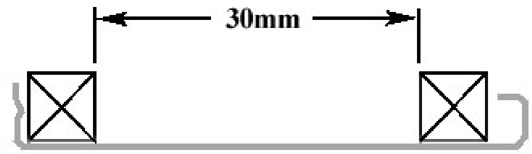
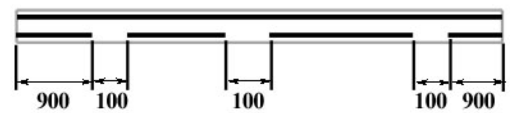
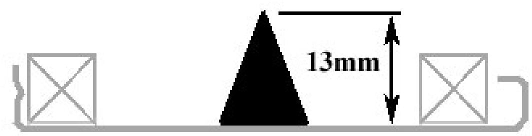
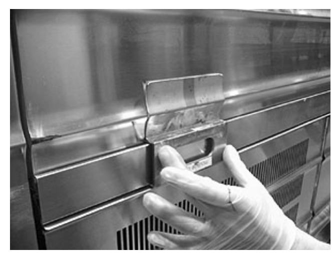
Section 6 Upper & Lower Finishing Moldings Preparation

6.00	A)	Position rear upper and lower finishing moldings onto vehicle.	
	B)	Draw a line onto moldings in line with the joint between the 2nd and 3rd side panels. Cut the excess of molding and file down the end.	
	C)	👁 Remove blue plastic paper and inspect moldings	
6.05	A)	Position front upper and lower finishing moldings onto vehicle.	
	B)	Draw a line onto moldings in line with the end of the last side panel. Cut the excess of molding and file down the end.	
	C)	👁 Remove blue plastic paper and inspect moldings	
6.10	***W5 Fitted With Slide-out*** Line up molding ends with windows and side panels		
6.15	**S/S Finishing Moldings Preparation**		
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using orbital sander.	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 205. *(See PR000001, Section B)*	

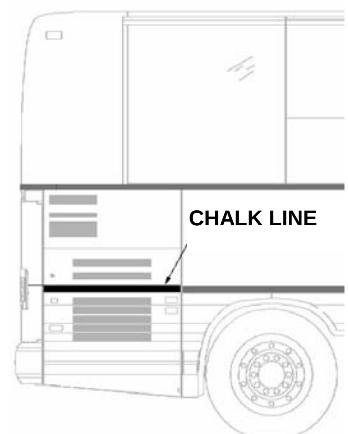
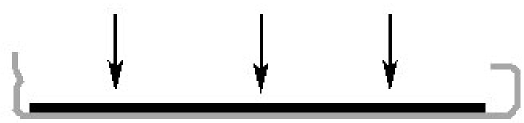
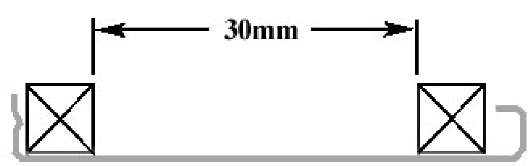
Section 7 Upper Finishing Molding Installation

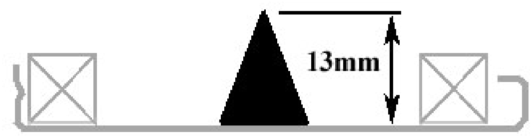
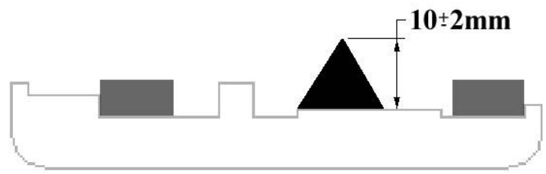
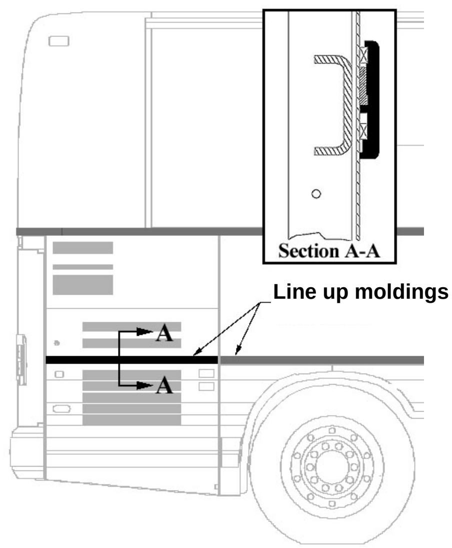
7.00	A)	Apply foam tape 1/4″x1/4″.	
	B)	Make 3-**100mm (+/- 25)** long clearings in the bottom foam tape.	
	C)	**W5 Fitted With Slide-out** **Upper Finishing Molding in front of slide-out.** Apply foam tape 1/4″x1/4″ at the bottom. There must be 3-**100mm (+/- 25)** long clearings.	
7.05	Apply Sika 252. Do not apply Sika in front of the previous clearings.		
7.10	**Upper Finishing Molding Installation**		
	A)	Install finishing moldings	
	B)	Compress finishing molding using a nylon block.	
	C)	**W5 Fitted With Slide-out** Seal Slide-out finishing molding ends using Sika 221 grey.	

Section 8 Lower Finishing Molding Installation

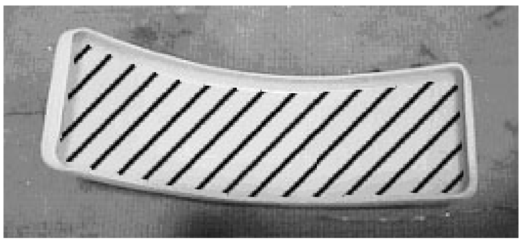
8.00	A)	Apply foam tape 1/4″x1/4″.	
	B)	Make 3-**100mm (+/- 25)** long clearings in the bottom foam tape.	
8.05	Apply Sika 252. Do not apply Sika in front of the previous clearings.		
8.10	**Lower Finishing Molding Installation**		
	A)	Install finishing moldings.	
	B)	Compress lower finishing molding using a nylon block.	

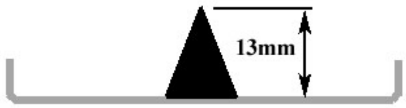
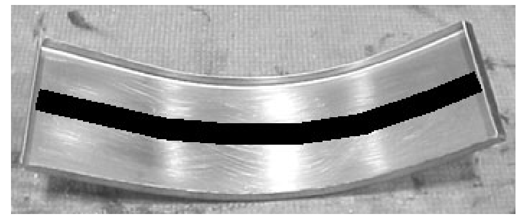
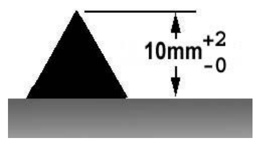
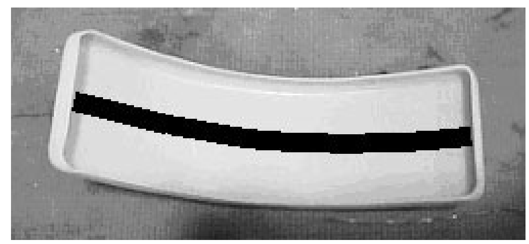
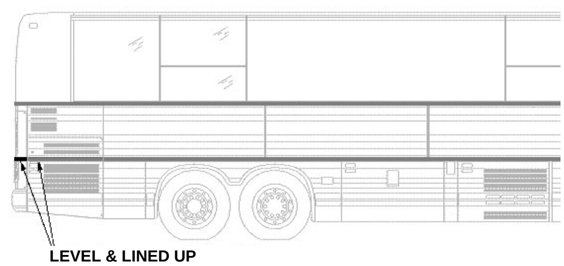
PR00210 ENGINE RADIATOR DOOR MOLDING OR ENGINE COMPARTMENT R. H. SIDE DOOR MOLDING – GLUING		PREVOST	
	Effective: MTH 9090	**REVISION 00**	Sepc 15.0
		DATE 06-10-17	

1.00		**Door Preparation (SS)**	
	A)	Clean using anti-silicone (See PR000001 section A)	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone (See PR000001 section A)	
	D)	Apply Sika 205. *(See PR000001, Section B)*	
1.05		**W5 W0 Molding Preparation (SS)**	
	A)	Clean using anti-silicone (See PR000001 section A)	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone (See PR000001 section A)	
	D)	Apply Sika 205. *(See PR000001, Section B)*	
	E)	Apply some foam tape 1/4″x1/4″.	
		WE Molding Preparation	
	F)	Clean inside of molding using a damp cloth (pure water).	

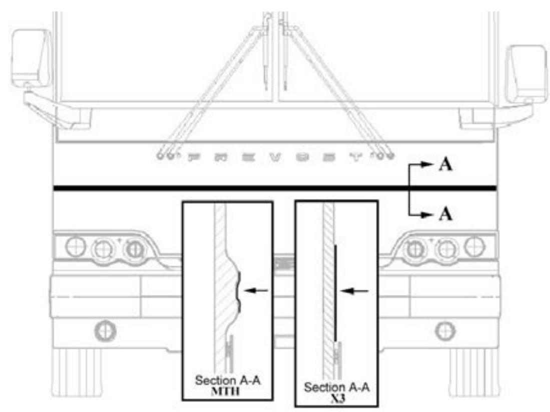
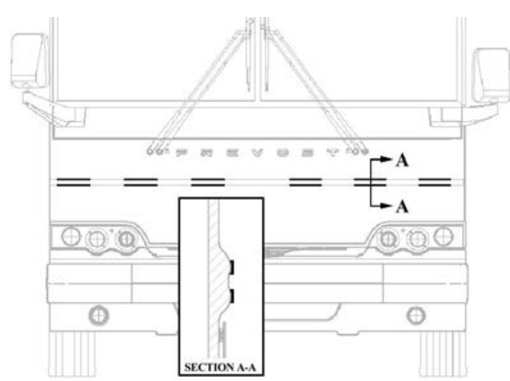
1.10	A)	***W5 W0*** Apply Sika 252.	
	B)	***WE*** Apply 252.	
1.15	A)	***W5 W0*** Position and glue the molding underneath the chalk line making sure it is lined up with the horizontal side molding **(maximum 1mm)**	
	B)	***WE*** Position and glue the molding making sure it is lined up with the horizontal side molding **(maximum 1mm)**	
	C)	Compress the molding	
	D)	If necessary, remove the excess using Sika 208.	

PR00211 ENGINE COMPARTMENT DOORS MOLDING – GLUING		**PREVOST**	
	Effective: MTH 9090	**REVISION 00**	Spec 15.0
		DATE 06-1017	

1.00		**Door Preparation (SS)**	
	A)	Clean using anti-silicone *(PR000001 Section A)*	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone *(PR000001 Section A)*	
	D)	Apply Sika 205 *(PR000001 Section B)*	
		Door Preparation (Primer)	
	E)	Sand using Scotchbrite *(PR000001 Section G)*	
	F)	Clean using anti-silicone *(PR000001 Section A)*	
1.05		**W5 W0 Corner Molding Preparation (SS)**	
	A)	Clean using anti-silicone *(PR000001 Section A)*	
	B)	Sand using Scotchbrite (*PR000001 Section G)*	
	C)	Clean using anti-silicone *(PR000001 Section A)*	
	D)	Apply Sika 205 *(PR000001 Section B)*	
		WE Corner Molding Preparation (Triax)	
	E)	Remove sticker from corner.	
	F)	Sand using Scotchbrite *(PR000001 Section G)*	
	G)	Clean using anti-silicone *(PR000001 Section A)*	
	H)	Apply Sika Aktivator *(PR000001 Section C)*	

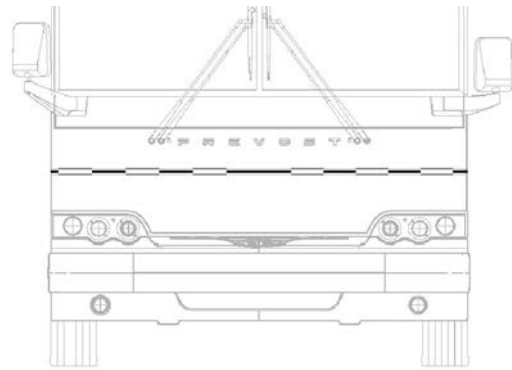
1.10	***W5 W0*** Apply Sika 252. 		
	WE X3 Apply Sika 252 		
1.15	A)	Apply corner molding so that it is level and lined up **(maximum 1mm**) with engine compartment R.H. side door molding or radiator door molding.	
	B)	Apply some masking tape onto the corner molding in order to hold it in place during curing.	

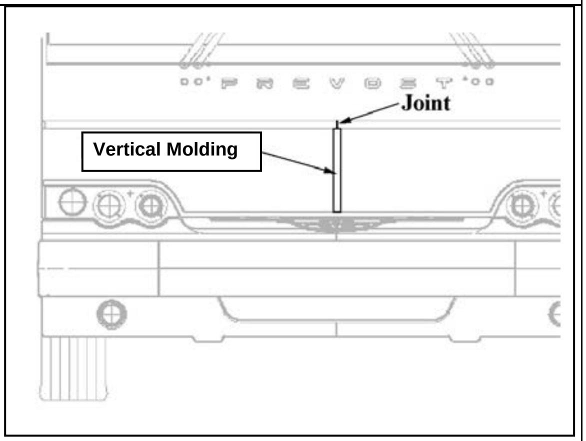
PR00212 FRONT FACE MOLDING – GLUING		PREVOST	
	Effective : MTH 9090	**REVISION 00**	Spec 15.0
Engineering Change:		**DATE 06-10-17**	

1.00	Mark molding position onto front face using a felt-tip pen (refer to side moldings for proper height).	
1.05	**Molding Preparation (SS)** A) Clean using anti-silicone. *(See PR000001, Section A)* B) Use Scotchbrite to sand frame. *(See PR000001, Section G)* C) Clean using anti-silicone. *(See PR000001, Section A)* D) Apply Sika 205. *(See PR000001, Section B)*	
1.10	**Front Face Preparation (beige primer)** A) Use Scotchbrite to sand frame. *(See PR000001, Section G)* B) Clean using anti-silicone. *(See PR000001, Section A)*	
1.15	**MTH**: Affix some neoprene foam tape 1/16 x 1/4 onto front face. Make sure that there is a **minimum of 3" +1/-0** without foam tape at each front face end to apply some Sika.	**MTH** 

<table>
<tr><td>1.20</td><td colspan="2">Apply Sika 252

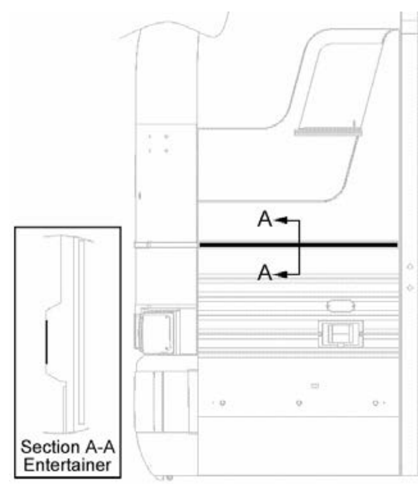
<u>MTH</u>: Onto front face.

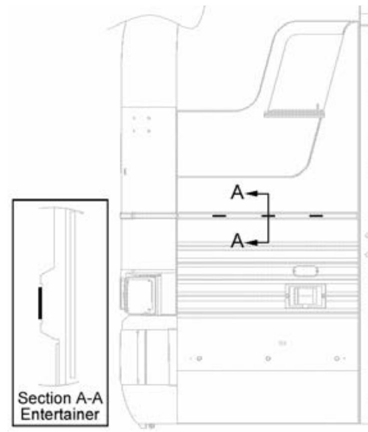
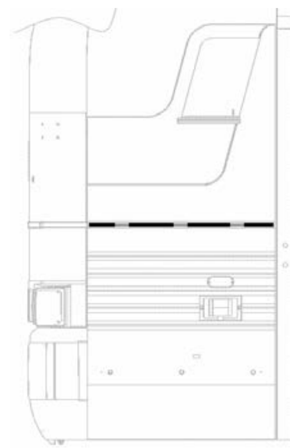
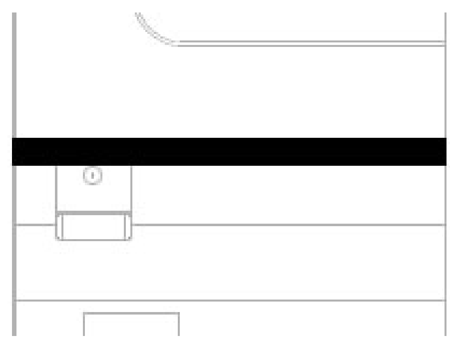
Triangular bead = 8mm</td><td><u>MTH</u>
</td></tr>
<tr><td rowspan="3">1.25</td><td>A)</td><td>Affix moldings

Note: Affix moldings so that the joint falls on the center of the vertical molding.</td><td rowspan="3"></td></tr>
<tr><td>B)</td><td>Compress moldings using hands.</td></tr>
<tr><td>C)</td><td>Use masking tape to hold moldings in place during curing process.</td></tr>
</table>

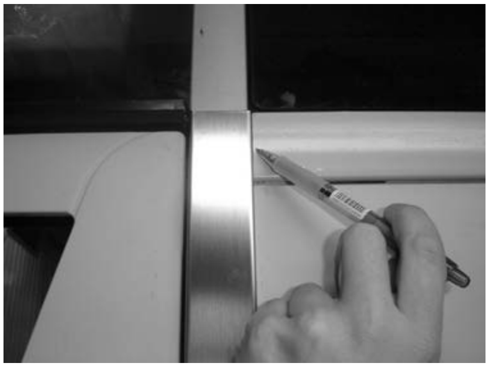
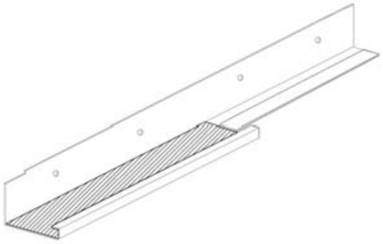
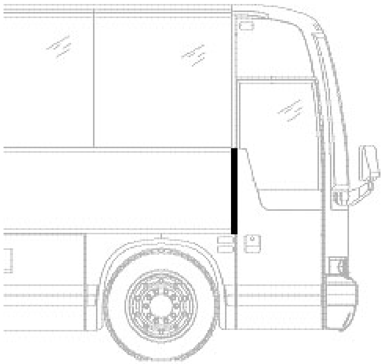
PR00213 ENTRANCE DOOR OR FRONT ELECTRICAL& SERVICE COMPARTMENT DOOR MOLDING– GLUING		PREVOST	
	Effective: MTH 9090	**REVISION 00**	Spec 15.0
Engineering Change:		**DATE 06-10-17**	

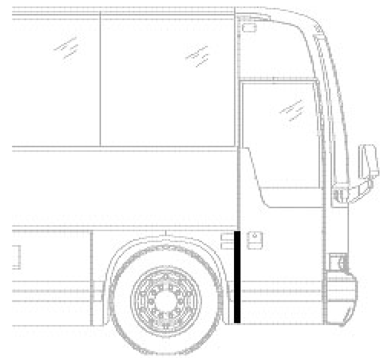
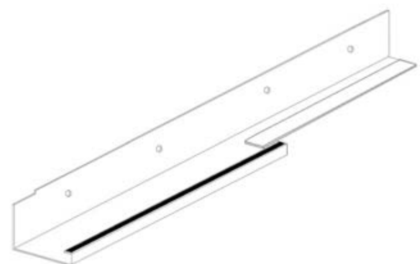
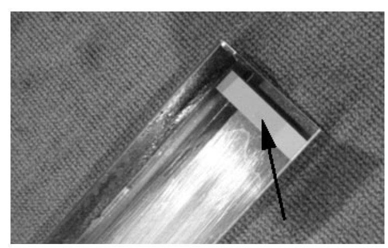
1.00	**Molding Preparation**		
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Use Scotchbrite to sand molding. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 205. *(See PR000001, Section B)*	

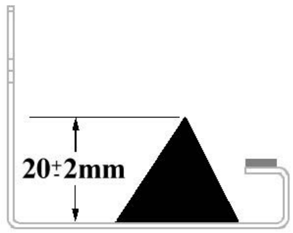
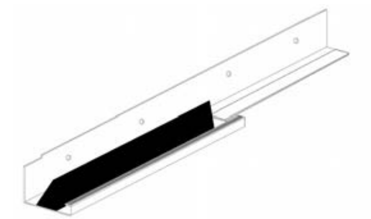
1.05	**Entrance Door or Front Electrical & Service Compartment Door Preparation Entertainer (SMC)**		
	A)	Use Scotchbrite to sand frame. *(See PR000001, Section G)*	
	B)	Clean using anti-silicone. *(See PR000001, Section A)*	
	C)	Apply Sika 206 G+P. *(See PR000001, Section B)*	

1.15	**MTH**: Glue 3-**50mm** long pieces of foam tape **1/16 x 1/2** onto the door.	**MTH** 
1.20	Apply Sika 252 onto the door *Triangular bead = **8mm***	**MTH** 
1.25	**Molding Installation** Line up with front and side moldings Even within **1mm.**	
1.35	**MTH**: If necessary, adjust entrance door handle so that it is parallel with finishing molding. Use a hammer and plastic bloc to make the adjustment.	

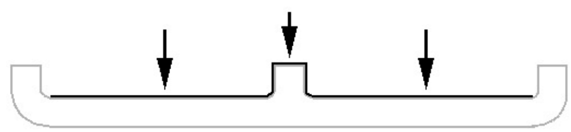
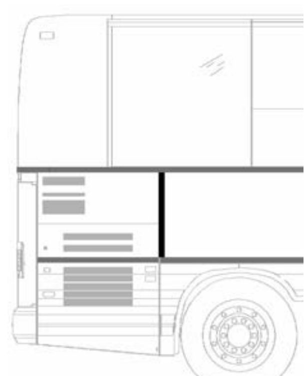
PR00214 SMOOTH SIDE PANEL – GLUING MOLDINGS		PREVOST	
	Effective: MTH 9090	REVISION 00	Spec 15.0 L00016
		DATE 06-10-18	

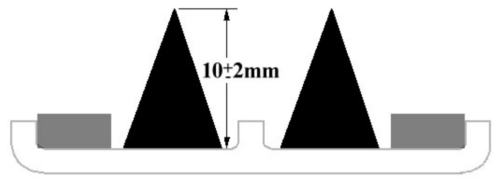
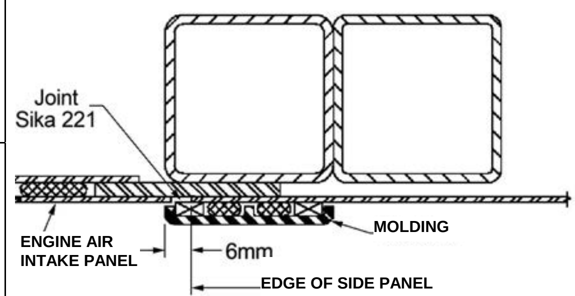
1.00	A)	Temporarily position front vertical molding and mark horizontal moldings (top & bottom) with a pencil	
	B)	Remove vertical molding and cut the excess of horizontal moldings	
	C)	If required, straighten horizontal moldings using a grinder.	
1.05	**Molding Preparation (SS)**		**WE** 
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using a Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 205. *(See PR000001, Section B)*	
1.10	**Side Panel Preparation (primer)**		
	Important: If there is no primer on top of the TIG welding spots, perform PR00216.		
	A)	Sand using a Scotchbrite. *(See PR000001, Section G)*	
	B)	Clean using anti-silicone. *(See PR000001, Section A)*	

1.15		**Front Fender Preparation (SS)**	
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using a Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 205. *(See PR000001, Section B)*	
		Front Fender Preparation (E-coat)	
	E)	Clean using anti-silicone. *(See PR000001, Section A)*	
1.20		***WE*** Apply foam tape 1/32 x 1/4 onto molding.	
		In the top of the molding, apply foam tape 1/4x1/4.	

<table>
<tr><td>1.25</td><td colspan="2">Apply Sika 252.

</td><td>
</td></tr>
<tr><td rowspan="4">1.30</td><td colspan="2">Molding Installation</td><td rowspan="4"></td></tr>
<tr><td>A)</td><td>Position top of the molding even with (1mm maximum) top of horizontal finishing molding.</td></tr>
<tr><td>B)</td><td>Drill molding using a #30 drill bit and rivet.</td></tr>
<tr><td>C)</td><td>Seal rivet heads using Sika 221.</td></tr>
<tr><td>1.35</td><td colspan="2">Seal top of molding using Sika 252.</td><td></td></tr>
<tr><td>1.40</td><td colspan="2">If required, clean excess usingSika 208.</td><td></td></tr>
</table>

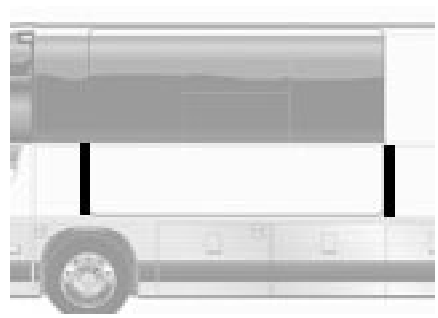
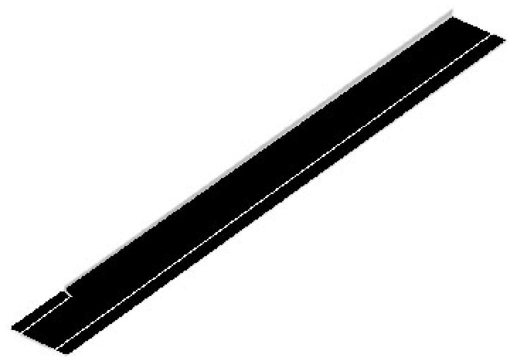
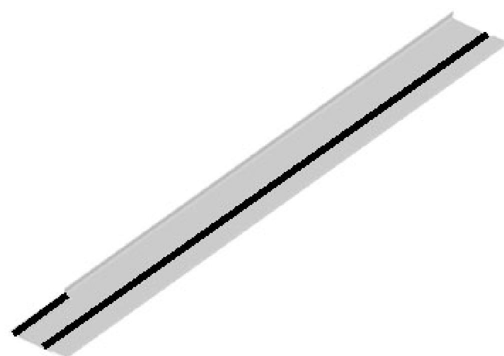
PR00215 SMOOTH SIDE PANEL – REAR MOLDING GLUING		PREVOST	
	Effective: MTH 9090	**REVISION 00**	Spec 15.0 L00016
		DATE 06-10-18	

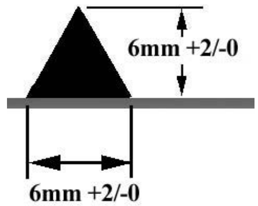
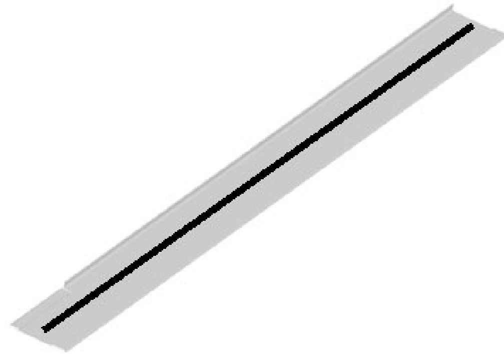
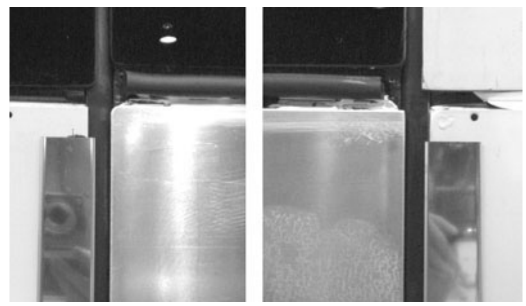
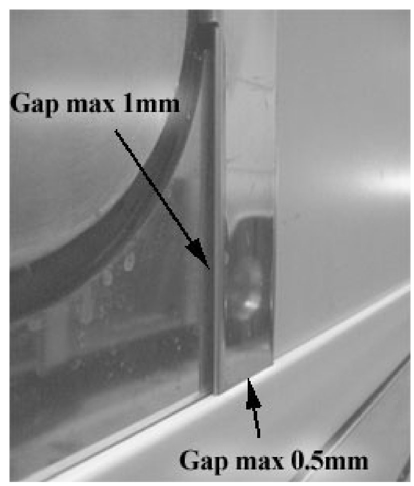
1.00	A)	Measure the distance between upper and lower horizontal finishing moldings, where the vertical molding will be installed.	
	B)	If required, cut the excess.	
1.05		**Molding Preparation (aluminum)**	
	A)	Sand using a Scotchbrite. *(See PR000001, Section G)*	
	B)	Clean using anti-silicone. *(See PR000001, Section A)*	
	C)	Apply Sika 205. *(See PR000001, Section B)*	
1.10		Apply double-face self adhesive tape 1/8 x 1/4.	
1.15		**Side Panel Preparation (primer)**	
		<u>Important</u>: If there is no primer on top of welding spots, perform PR00216.	
	A)	Sand using a Scotchbrite. *(See PR000001, Section G)*	
	B)	Clean using anti-silicone. *(See PR000001, Section A)*	

1.20		Apply Sika 252 onto molding.	
1.25	A)	Glue molding **6mm** from side panel. **Important**: Make sure that molding hides Sika 221 bead.	
	B)	Compress molding with hands.	

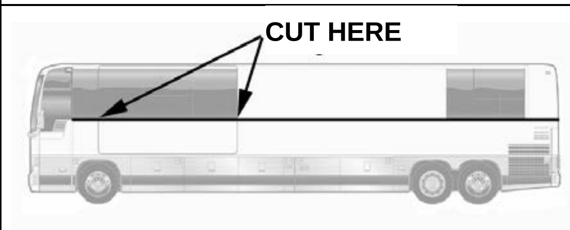
Applicable only if there is no primer on the TIG welding spots (before gluing vertical moldings)			
1.00	A)	Apply masking tape on each side of the welding spots.	
	B)	Clean using anti-silicone. *(See PR000001, Section A)*	
	C)	Sand side panel using a Scotchbrite. *(See PR000001, Section G)*	
	D)	Clean using anti-silicone. *(See PR000001, Section A)*	
	E)	Apply Sika 205. *(See PR000001, Section B)*	
	F)	Apply Sika 252 onto side panel along the welding spots.	
	G)	Compress joint using a plastic spatula.	
	G)	Remove masking tape	

PR00217 SMOOTH SIDE PANEL – GLUING SLIDE-OUT VERTICAL MOLDING		PREVOST	
	Effective: MTH 9090	REVISION 00	Spec 15.0
		DATE 06-10-18	

1.00		**Vehicle Preparation (primer)**	
		<u>Important</u>: If there is no primer on top of welding spots, perform PR00216.	
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using a Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
		Molding Preparation (stainless)	
	D)	Clean using anti-silicone. *(See PR000001, Section A)*	
	E)	Sand using a Scotchbrite. *(See PR000001, Section G)*	
	F)	Clean using anti-silicone. *(See PR000001, Section A)*	
	G)	Apply Sika 205. *(See PR000001, Section B)*	
	H)	Apply double-face self adhesive tape 1/16x1/4. Remove protective tape (liner).	

	I)	Apply Sika 252 black 	
	J)	Apply moldings. Distance of 9mm+/-2 with reference to slide-out panel and line up at the top with fiberglass or lateral fixed window behind driver.	
	K)	If applicable, clean up the excess with Sika 208. Adjust evenness of moldings if required.	

PR00220 SMOOTH SIDE PANEL – CUTTING HORIZONTAL FINISHING MOLDING AT SLIDE-OUT LEVEL		PREVOST	
	Effective: MTH 9090	REVISION 00	L00015
		DATE 06-10-20	

1.00	**Cutting Upper Horizontal Finishing Molding**		
	A)	Wait 24 hours before cutting horizontal molding at ‘’Slide-Out’’ level.	
	B)	Using a circular saw, cut molding even with the box-frame and structure.	

PREVOST

ENTRANCE DOOR ASSEMBLY PROCEDURE (MTH)

PROCEDURE NO: PR280020

REVISION 14

2004-06-11

GLUING PROCEDURE (QUALIFIED PERSONNEL ONLY)

Material:

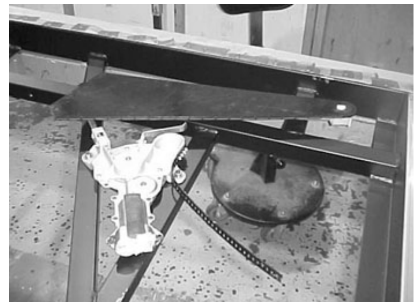
		Scotchbrite grey (680226)	√	Sika 206 G+P 1 liter (683446)	√
Anti-silicone (682989)	√	Silver sealant (680462)	√		
Tack cloth	√	Blue Loctite	√	Sika 221 grey	√
CHIX cloth (682384)	√	Glass cleaner (683926)	√		
Blue cloth (682383)	√	Sika 205 1 liter (683097)	√	Sika 252 black	√
Sika Remover 208 (685101)	√	Sika Aktivator (683661)	√	Sika 255 black	√
Soapy water	√	Simson glue grey (684517)	√		
Pure water	√	Masking tape	√	Loctite glue 430 (680042)	√

Equipments:

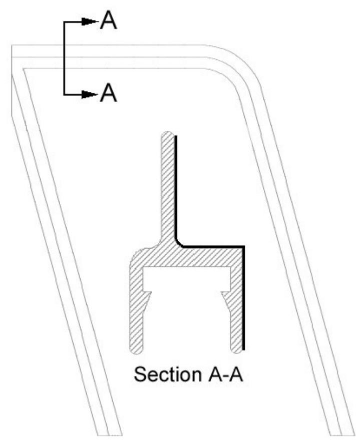
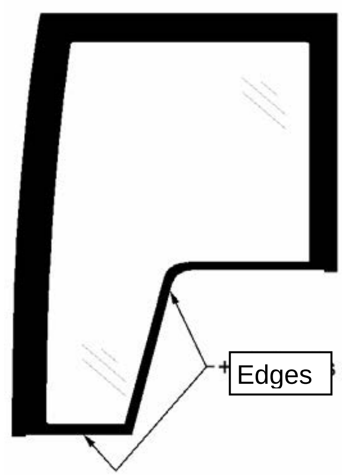
Glue Applicator	√	

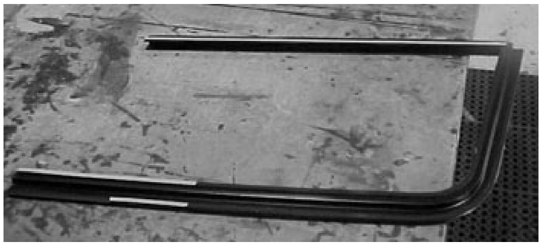
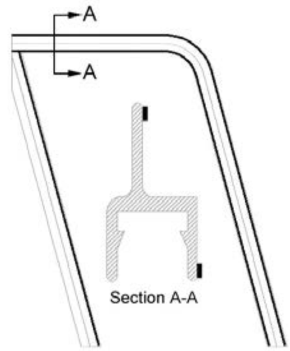
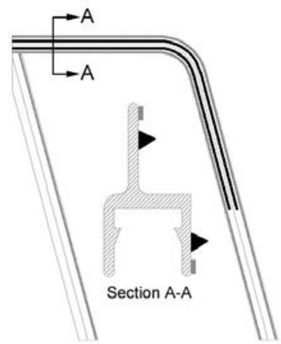
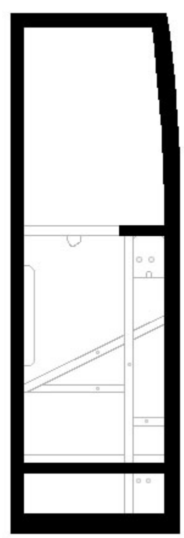
Safety rules: See PR000001

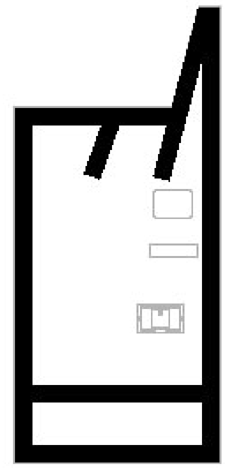
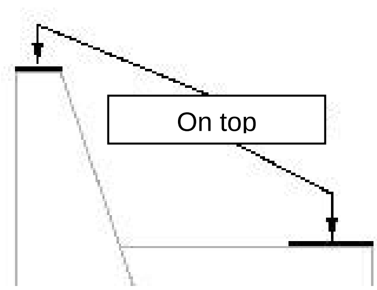
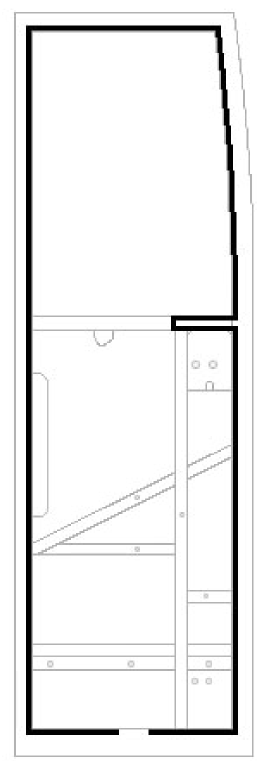
Section 1 Motor Installation

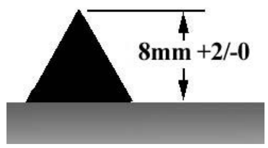
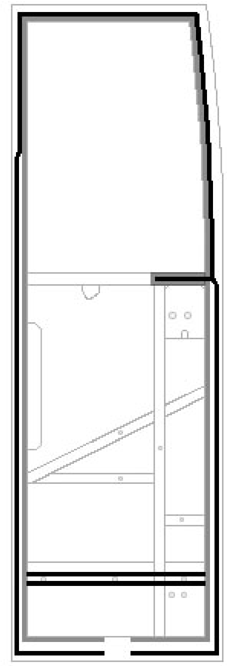
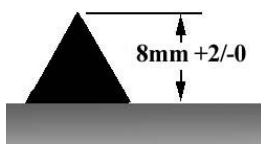
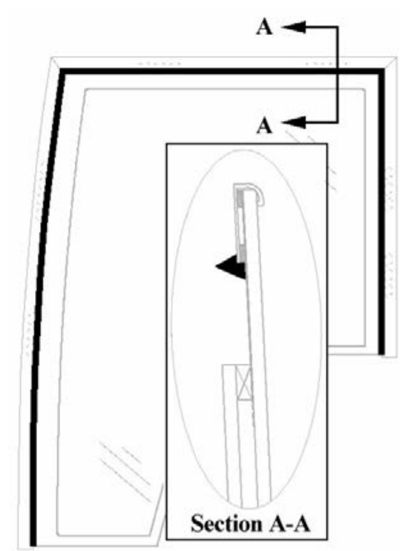
1.00	Install plastic piece onto power window motor.	
1.05	Install electric motor onto door frame.	

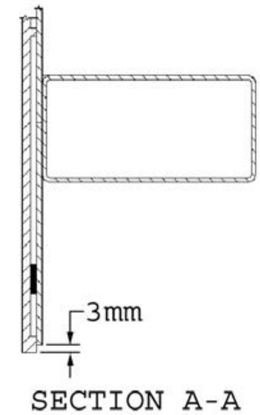
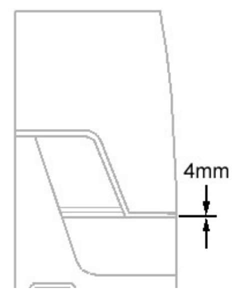
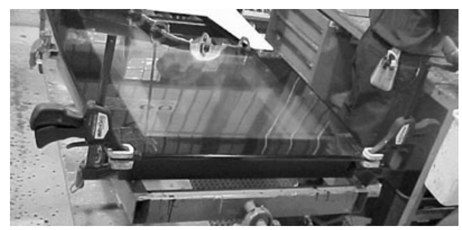
Section 2 Door Assembly

2.00	**Power Window Frame Preparation (E-Coat)**		
	Clean bonding area using anti-silicone. *(See PR000001, Section A)*		
2.05	**Window Preparation**		
	A)	Clean using glass cleaner. *(See PR000001, Section E)*	
	B)	Apply Sika Aktivator. *(See PR000001, Section C)*	

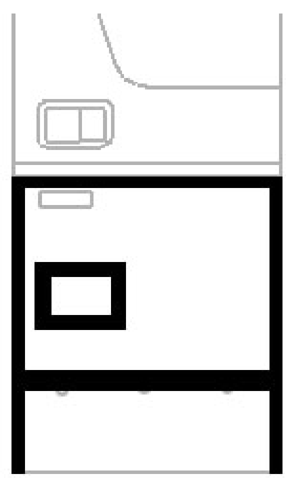
2.10	Affix double-face self adhesive tape 1/8 x 1/4 onto power window frame. Peel back from tape where it comes in contact with window pane. 		
2.15	A)	Apply Sika 255 onto frame.	
	B)	Affix the frame onto window pane.	
	C)	Secure assembly using clamps.	
2.20	**Door Frame Preparation (SS)**		
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 206 G+P. *(See PR000001, Section D)*	

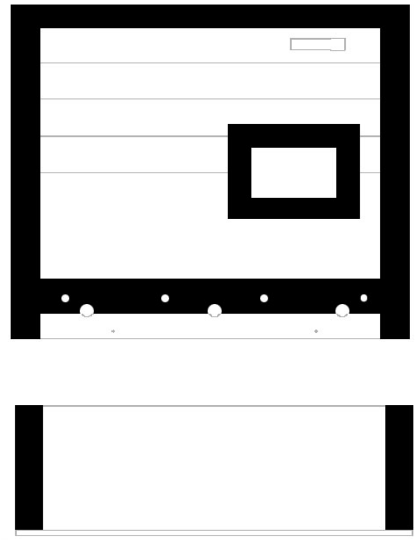
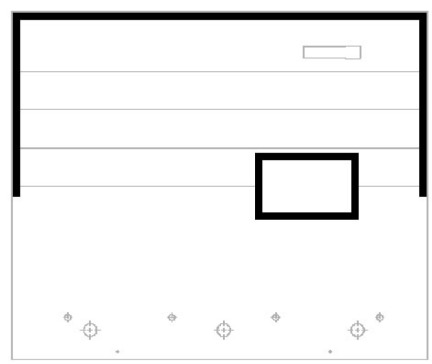
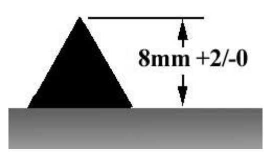
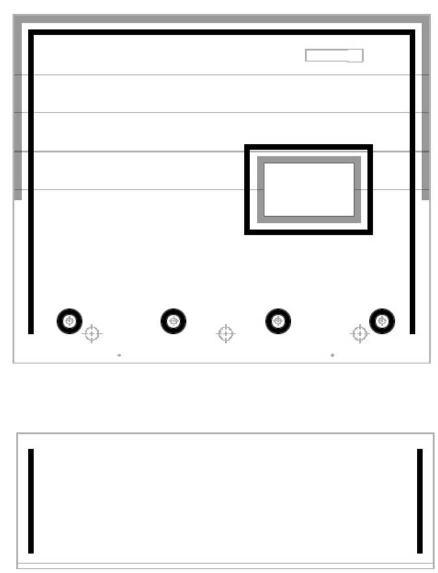
2.25	**Fiberglass Preparation (LPLT)**		
	A)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	B)	Clean using tack cloth	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 206 G+P. *(See PR000001, Section D)*	
2.30	**Fiberglass Preparation (beige primer)**		
	A)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	B)	Clean using anti-silicone. *(See PR000001, Section A)*	
2.35	Affix double-face self adhesive tape 1/8 x ¼ onto door frame. *Note: Leave a gap at the bottom (about **50mm**) for water dripping.*		

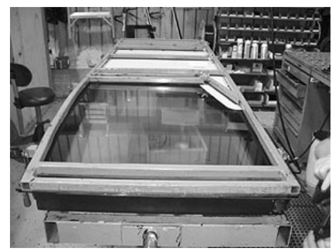
2.40	Apply Sika 255 onto door frame. *Note: Leave a gap at the bottom (about* ***50mm****) for water dripping.* 	
2.45	Apply Sika 255 onto window pane. 	
2.50	Lay down and center window pane onto door frame. Window pane must extend **1mm** at the frame top. *Note: Do not compress window pane at this moment.*	

2.55	A)	Lay down and center fiberglass panel onto door frame (panel exceeds **3mm** at the frame bottom and sides).	
	B)	Compress panel using hands.	
2.60	A)	If needed, readjust window pane so that it is even with panel. Tolerance is **4±2mm** between window pane and fiberglass panel.	
	B)	Compress window pane using hands. Compress window pane upper corners using clamps.	

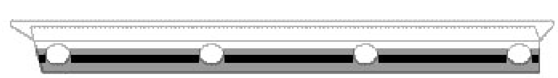
Section 3 Gluing of SS Body panels

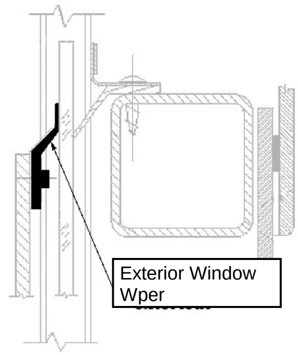
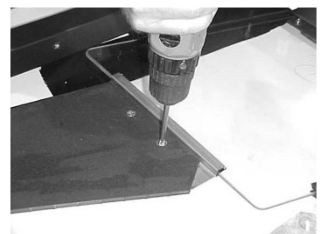
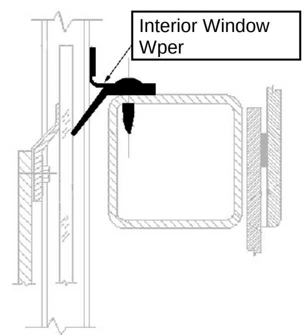
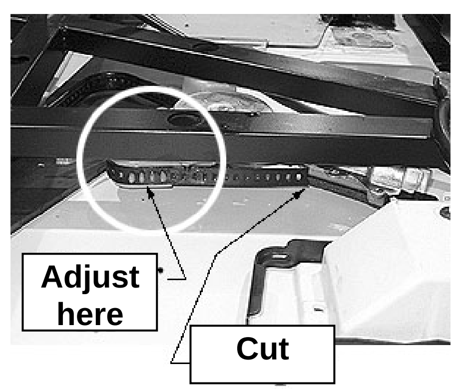
3.00	**Fiberglass Preparation (LPLT)**		
	A)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	B)	Clean using a tack cloth	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 206 G+P. *(See PR000001, Section B)*	

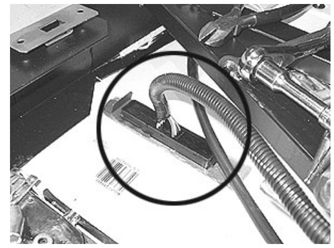
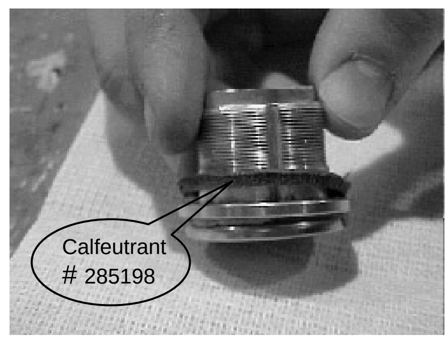
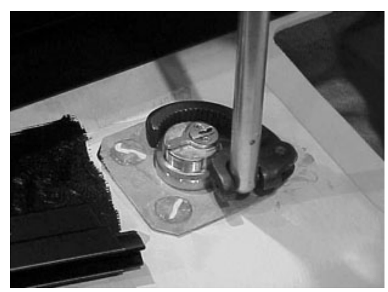
3.05	**Steel Sheet Preparation (SS)**		
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 205. *(See PR000001, Section B)*	
3.10	Affix double-face self adhesive tape (1/16 x ½) **3mm** from panel edge.		
3.15	A)	Apply Sika 252 onto body panels.  	

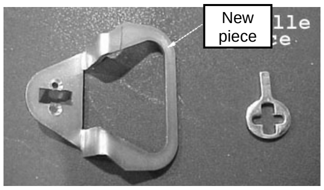
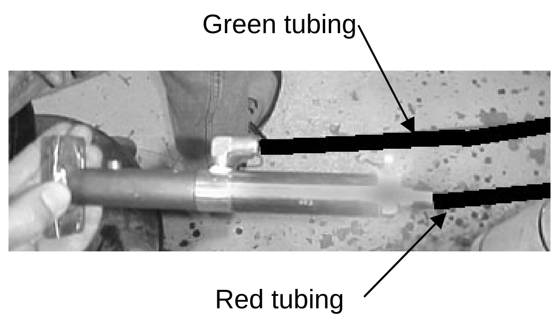
3.20	A)	Lay down and center lower body panel onto fiberglass panel and then, compress body panel using hands.	
	B)	Lay down and center upper body panel onto fiberglass panel and then, compress body panel using hands.	
	C)	Drill 2 holes and rivet.	
	D)	Seal rivets using silver sealant.	
3.25		Compress panels using evenly distributed clamps. *Curing time = **8 hours minimum***	

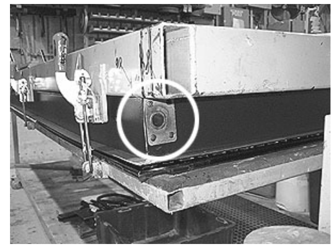
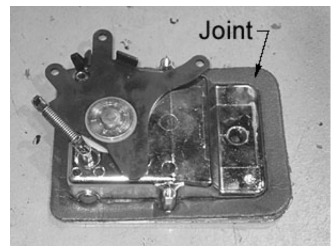
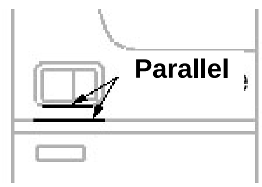
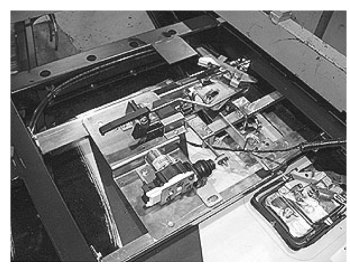
Section 4 Installation of mechanisms

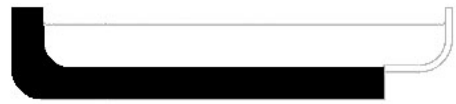
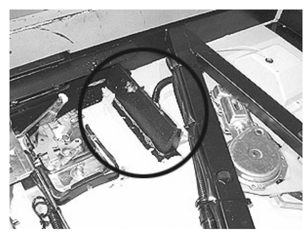
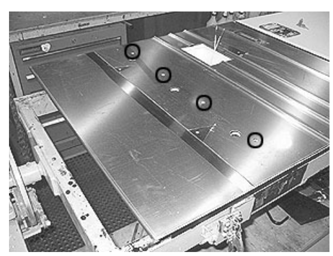
4.00			**Power Window Installation**	
	A)		Insert two seals in the power window frame.	
	B)		Apply some loctite glue at the intersection of the 2 seals and also sparingly in order to fix the seals to the window frame.	
	C)		**Exterior Window Wiper Installation**	
		1)	Use Scotchbrite to sand molding. *(See PR000001, Section G)*	
		2)	Clean using anti-silicone. *(See PR000001, Section A)*	
		3)	Apply Sika 206 G + P. *(See PR000001, Section D)*	
		4)	Apply Sika 255.	

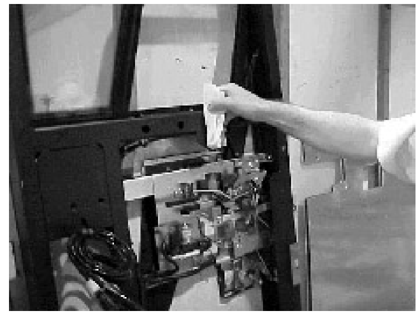
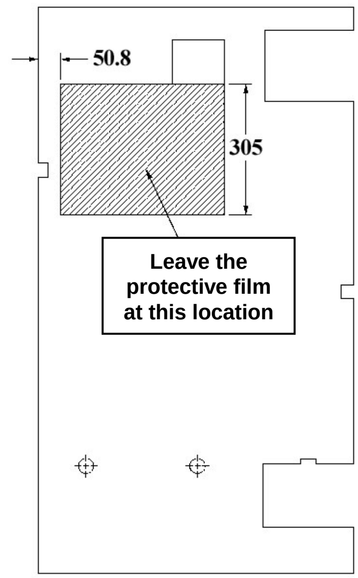
		5)	Position & fasten wiper using screws.	
	D)		Insert pane in the frame.	
	E)		Fix window pane to its support. *Note: Apply some blue “loctite” to the screws.*	
	F)		**Interior Window Wiper Installation**	
		1)	Position window wiper. *Note: If rubber is too long, cut the excess.*	
		2)	Drill three **Ø5/32’’** holes into the molding and secure using screws.	
4.05	Fix cable harness			
4.10	A)		Adjust power window travel. When it is lowered, it must be at the same height than the interior wiper molding. *Note: Once adjusted, raise the window.* 	
	B)		Cut excess of strap.	

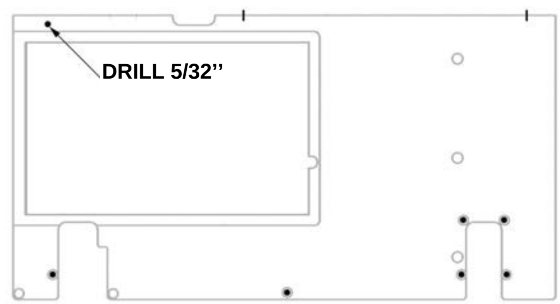
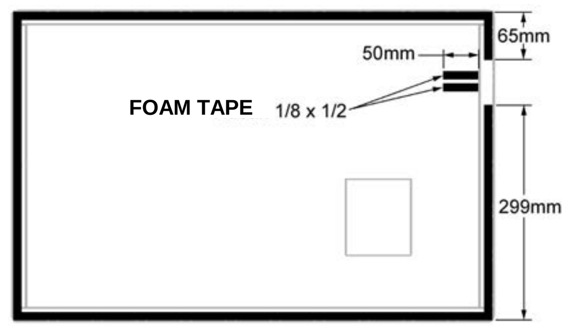
4.15	Do the finishing joints (See Section 5, steps 5.15 & 5.20).		
4.20	Install “Keyless” pad.		
4.25	Install locking plates.		
4.30	**Lock Installation**		
	A)	If necessary, put together the lock.	
	B)	Install lock. *Note: Make sure that lock is even with door once fixed.*	

	C)	Remove existing piece on top of lock (will not be used) and replace with the new one. 	
	D)	Glue some “Strip calk” onto the new piece.	
4.35	Insert a plastic grommet into the frame.		
4.40	A)	Cut pneumatic tubing. *Note: The green tubing is shorter than the red one.*	
	B)	Identify both tubing at each end. A green one and a red one.	
4.45	**Upper Lock Installation**		
	A)	Feed both pneumatic tubing through the grommet and connect to cylinder.	
	B)	Insert the cylinder into a water container to perform an air leak test. *Not: There should be no bubble.*	

	C)	Fix the locking cylinder.	
4.50 *	**Door Handle Installation**		
	A)	Clean using anti-silicone. The handle perimeter (where the gasket will be glued). *(See PR000001, Section A)*	
	B)	Glue the gasket onto the handle.	
	C)	Install door handle. *Note: Make sure that door handle is parallel with fiberglass panel.*	
4.55	**Door Handle Mechanism Installation & adjustment**		
	A)	Install door handle mechanism.	
	B)	Adjust mechanical parts and micro-switches. Finish installing rods. **<u>Important</u>**: Door handle must be ± at mid course when door unlatches. Adjust by changing rod angles.	
	C)	Lubricate (grease) mechanical parts.	
4.60	Finish installing electric cables.		
4.65	Apply some urethane into the door structural tubing (tubing in front of the door handle).		

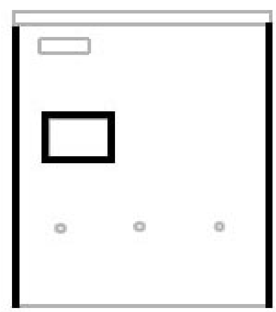
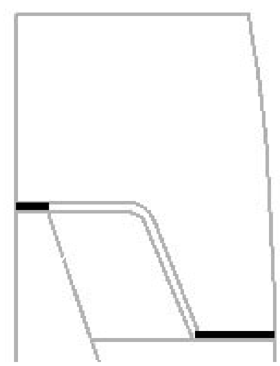
4.70	**Water Deflector Gluing**		
	A)	Use Scotchbrite to sand fiberglass panel and deflector bonding surfaces. *(See PR000001 section G)*	
	B)	Clean bonding surfaces using anti-silicone. *(See PR000001, Section A)*	
	C)	Apply double face self adhesive tape 1/8 x 1/4 onto deflector.	
	D)	Apply some grey Simson glue onto deflector.	
	E)	Position & glue deflector.	
	F)	Using soapy water, smooth down the joint with your finger.	
4.72	Perform finishing joints (See Section 5, steps 5.00, 5.05, 5.07 & 5.10).		
4.75	Make sure that glue is not blocking up drip holes. If this is the case, remove the glue.		
4.77	Install all other mechanical and electrical parts.		

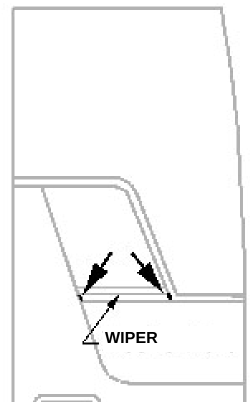
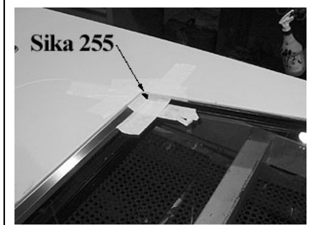
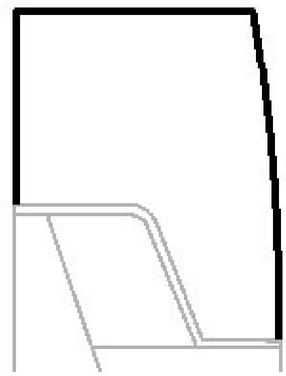
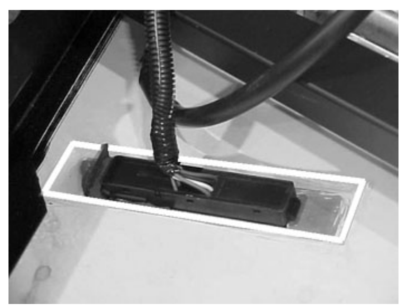
4.80		**Membrane Installation**	
	A)	Clean door frame where membrane will be glued, using anti-silicone. *(See PR000001, Section A)*	
	B)	Peel back from the membrane with the exception of the area where the mechanism is located (prevent mechanism from bonding to the membrane).	
	C)	Glue the membrane so that it bonds **100%** with the frame.	
	D)	Heat the membrane using a heat gun and compress using a plastic spatula to remove pleats.	

4.82	**Interior Finishing Panel Installation**		
	A)	Unscrew lock guide.	
	B)	Install finishing panel and fasten guide on top of panel using screws.	
	C)	Drill 8-**1/8"** dia. holes and fasten panel using screws.	
	D)	Drill 1-**5/32"** dia. hole	
4.85	**Closing Plate Installation**		
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Affix 1/16 x 1/2 foam tape **2mm** from edge of plate. Also, affix 2 pieces of foam tape 1/8 x 1/2.	
	C)	Position plate onto the door. Drill 9-**7/64"** dia. holes and fasten plate using screws.	
4.87	**Installation of Window Interior Finishing Molding**		
	A)	Position plastic molding onto the door frame to check for proper fit. *Note: If it does not fit properly, grind the radius.*	
	B)	Clean the area where the double-face self adhesive tape will be applied using anti-silicone. *(See PR000001, Section A)*	
	C)	Affix some double-face self adhesive tape 1/16 x 3/8. *Note: Peel back of self-adhesive tape at each end to be able to screw in the "Norryl" molding and then peel the back of the tape afterwards.*	
	D)	Position Norryl molding even with top of door frame.	
	E)	Drill 4-**1/8''** dia. holes & fasten using screws.	

	F)	Peel the back of double-face self adhesive tape then compress ''Norryl'' molding.	
4.90	Install door handle plastic cover, door handle then hinges.		
4.92	Perform power window, light and electric lock final testing.		
4.95	Glue some blue protective paper onto the door interior.		

Section 5 Finishing Joints

5.00	A)	Apply Sika 221 to fill in the pleats and light perimeter.	
	B)	Using soapy water, smooth down the joints with your finger.	
	C)	If necessary, clean up the excess using Sika 208.	
5.05	A)	Apply masking tape **1mm** from window pane and fiberglass panel edges.	
	B)	Apply Sika 255 into the cavity between the fiberglass and window panel.	
	C)	Smooth down the joint with a plastic spatula then carefully remove the masking tape.	
	D)	Spray pure water onto the joint then smooth down the joint with your finger.	

5.07	A)	Clean using anti-silicone the area to be sealed. *(See PR000001, Section A)*		
	B)	Apply masking tape around the area to be sealed.		
	C)	Apply Sika 255 at each exterior window wiper end (S/S portion).		
	D)	Smooth down the joint with your finger then remove masking tape.		
5.10	A)	Apply Sika 221 at the top of the door and on the window pane sides.		
	B)	Using soapy water, smooth down the joint with your finger.		
	C)	If necessary, clean up the excess using Sika 208.		
5.15	A)	Apply Sika 221 around Keyless pad		
	B)	Using soapy water, smooth down the joint with your finger.		
5.20	Apply Sika 221.			

Section 6 Replacement / Repair	
6.00	Remove part. See PR000001, Section 2.
	Preparation and gluing. See PR000001, Section 2 and/or do procedure again.

PREVOST

FRONT ELECTRICAL & SERVICE COMPARTMENT DOOR ASSEMBLY

PROCEDURE NO: PR280021

REVISION 18

2006-02-17

GLUING PROCEDURE (QUALIFIED PERSONNEL ONLY)

Material:

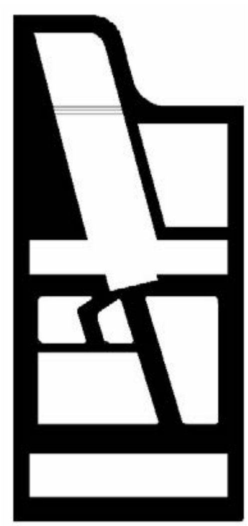
		Scotchbrite grey (680226)	√	Sika 206 G+P 1 liter (683446)	√
Anti-silicone (682989)	√	Silver sealant (680462)	√		
CHIX cloth (682384)	√			Simson 70-03 grey	√
Blue cloth (682383)	√	Glass cleaner	√		
Sika Remover 208 (685101)	√	Sika 205 1liter (683097)	√	Sika 252 black	√
				Sika 255 black	√
		Glue #680066	√		

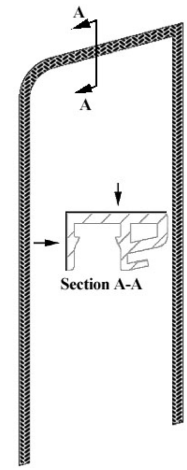
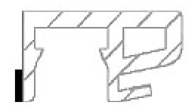
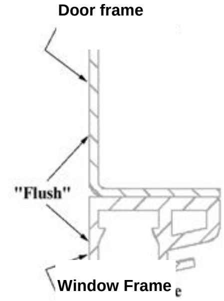
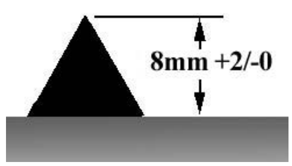
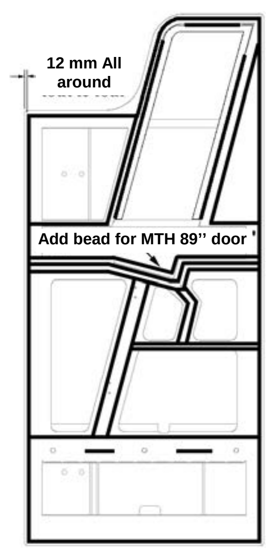
Equipments:

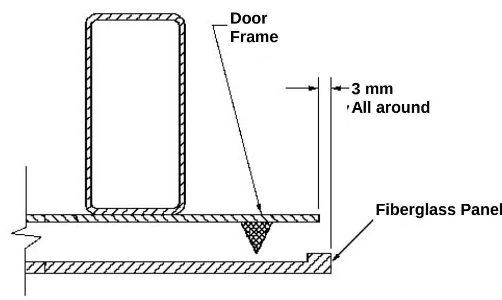
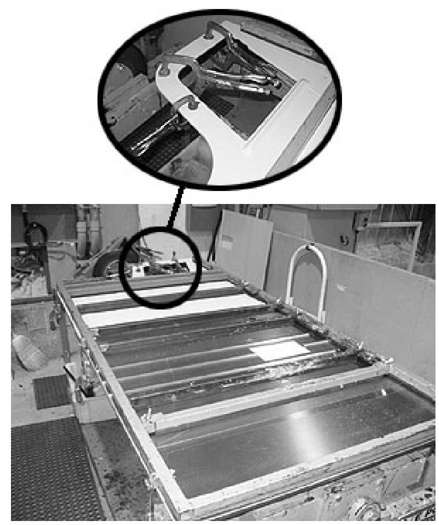
Glue Applicator	√	
Ruler	√	

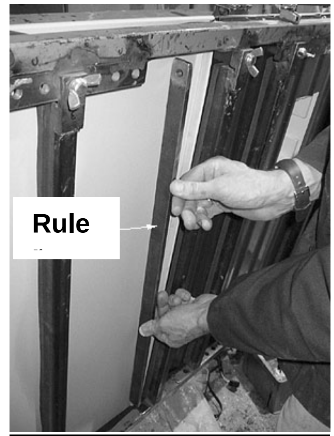
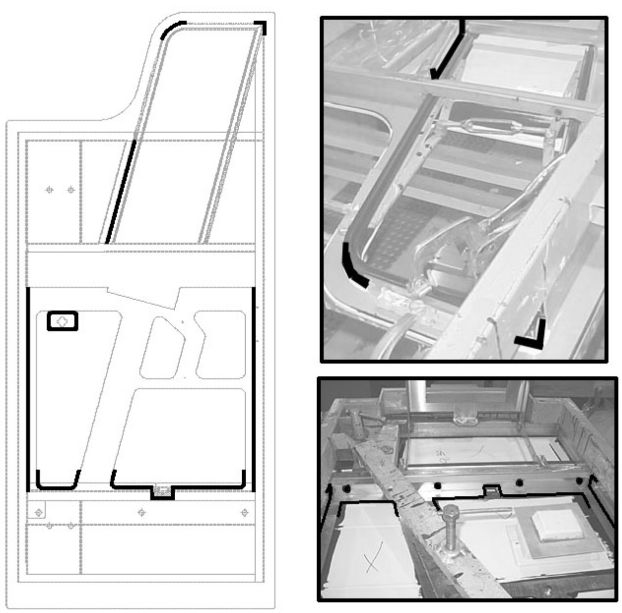
Safety rules: See PR000001

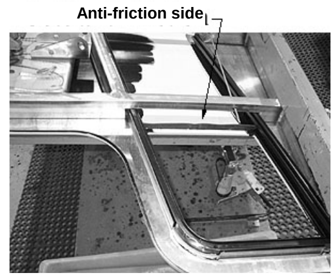
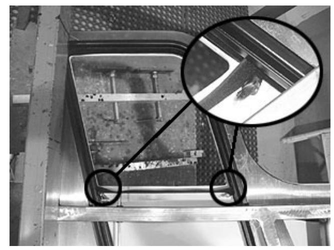
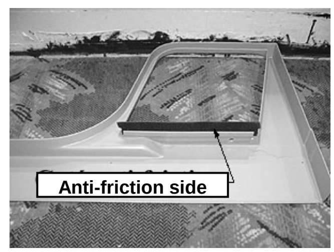
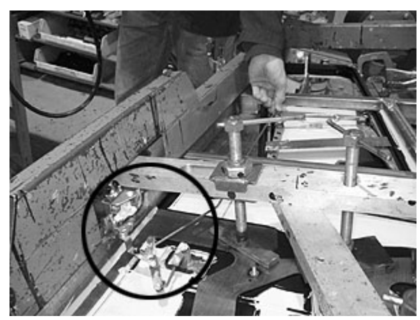
Section 1 Door Assembly

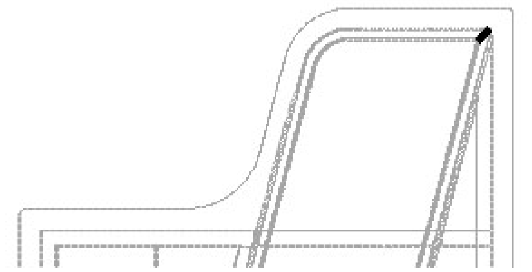
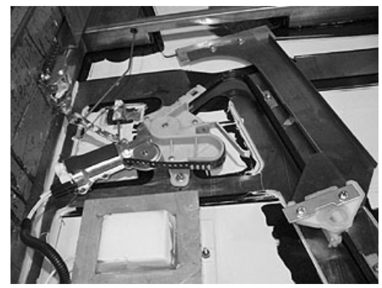
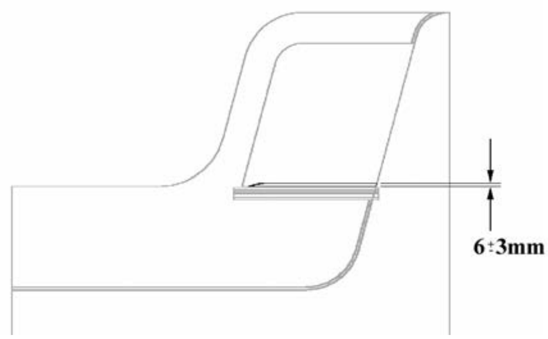
1.00	A)	Position fiberglass panel onto door frame.	
	B)	Mark bonding areas onto fiberglass panel.	
1.10		**Door Frame Preparation (S/S)**	**MTH** 
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 206 G+P. *(See PR000001, Section D)*	
1.15 *		**Fiberglass Panel Preparation (SMC)**	**MTH** 
	A)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	B)	Clean using anti-silicone. *(See PR000001, Section A)*	
	C)	Apply Sika 206 G+P. *(See PR000001, Section D)*	

1.20	**Window Frame Preparation** Clean using anti-silicone bonding area (top and edges) *(See PR000001, Section A)*	
1.22	Affix a double-face self adhesive tape 1/32 x 1/4 onto the whole window frame perimeter.	 Section A-A
1.25	Fix window frame onto door frame. **Important**: Make sure that top of window frame is lined up with top of door frame.	 **Section View** 
1.30	Apply Sika 255 onto door frame.  *Note: Apply an additional bead of Sika 255 in the center of a MTH 89'' door.*	**MTH** 

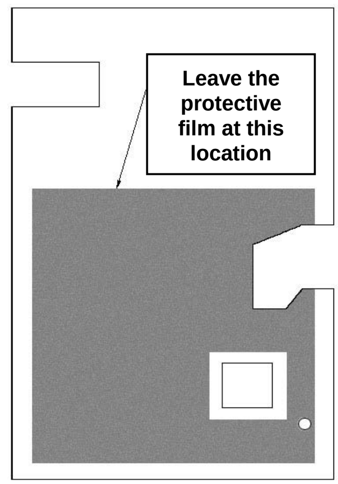
<table>
<tr><td>1.35</td><td colspan="2">Position fiberglass panel onto door frame and compress using hands. Use a ruler.</td><td>
</td></tr>
<tr><td>1.40</td><td colspan="2"><u>Perform</u> steps in section 3.</td><td></td></tr>
<tr><td rowspan="3">1.45</td><td>A)</td><td><u>Door Exterior</u>: Install appropriate number of c-clamps and wooden blocks all around.</td><td></td></tr>
<tr><td>B)</td><td><u>Door Interior</u>: Install appropriate number of c-clamps and wooden blocks all around.</td><td></td></tr>
<tr><td colspan="3">Compression time = 120 minutes minimum</td></tr>
</table>

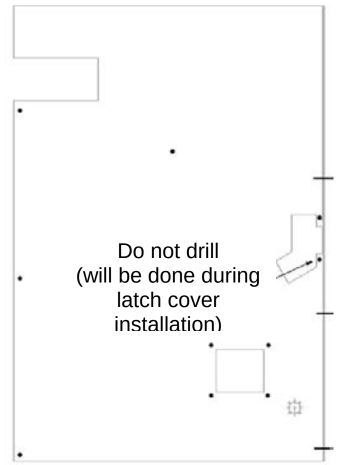
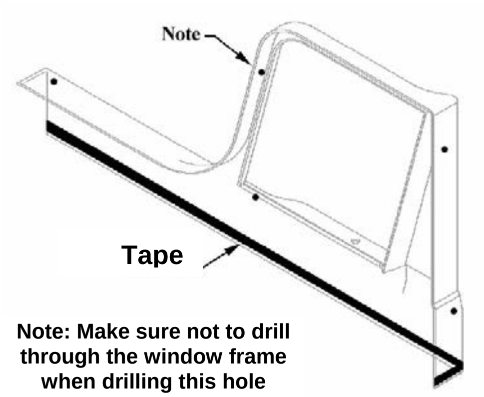
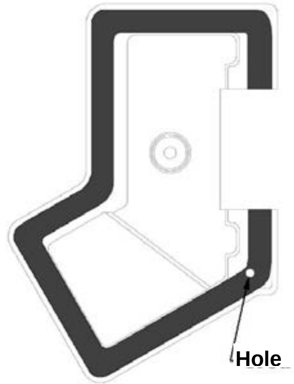
	C) Check fiberglass panel flatness using a **24"** ruler (must be within **2mm**).	
1.50	**Important** : Make sure window pane slides perfectly within its frame.	
1.55	If necessary, clean up the excess all around door frame using Sika 208.	
1.60 *	Clean using anti-silicone (see PR000001 section A) and apply Simson 70-03 grey, from the inside, between bottom tubing and fiberglass panel. Apply also onto "spot welding".	
		

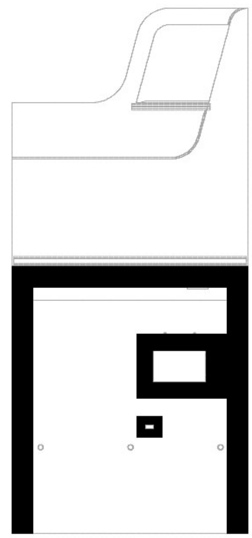
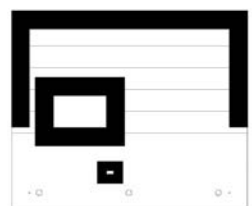
1.65	**Window Wipers Gluing**		
	A)	Apply glue **#680066** into fiberglass groove and affix window wiper. ***Important****: Anti-friction side must be on window pane side.*	
	B)	Apply Sika 252 into the window wiper corners, from the inside.	
	C)	Apply glue **#680066** into ''Norryl'' molding and affix window wiper. ***Important****: Anti-friction side must be on window pane side.*	
1.70	Install door locking mechanism components. *Note 1: Do not forget to replace latch spring.* *Note 2: Check lock operation using key.* *Note 3: Grease mechanism components.*		
1.75	Install hinge supports.		
1.80	When compression time is over, remove clamps.		

1.85		**Power Window Installation**	
	A)	Insert 2 seals in power window frame.	
	B)	Apply some “loctite” glue **#680066** at the intersection of the 2 seals and also sparingly in order to fix the seals to the window frame.	
	C)	Clean window using glass cleaner.	
	D)	Insert pane into window frame.	
	E)	Fix electric motor and all components connected to the window.	
	F)	Fix electric components and test window operation.	
	G)	Adjust power window travel (**6±3mm** above wiper).  	

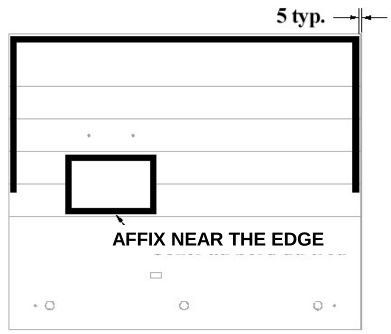
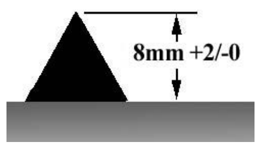
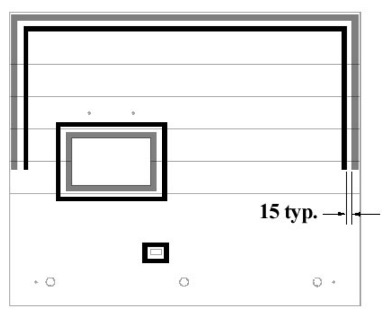
Section 2 Door Finishing

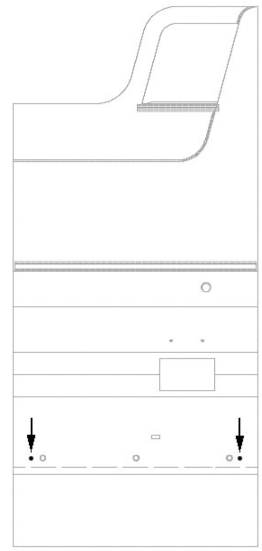
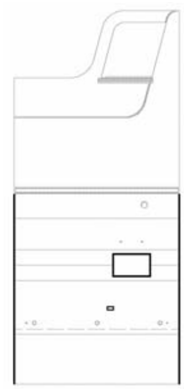
2.00	Install docking lamp and reflector.		
2.10	**Membrane Installation**		
	A)	Clean door frame where membrane will be glued, using anti-silicone. *(See PR000001, Section A)*	
	B)	Peel back from the membrane with the exception of the area where the mechanism is located (prevent mechanism from bonding to the membrane).	
	C)	Glue the membrane so that it bonds **100%** with the frame.	
	D)	Heat the membrane using a heat gun and compress using a plastic spatula to remove pleats.	

2.15	**Interior Finishing Panel Installation**		
	A)	Position top of interior finishing panel even with top of window frame.	
	B)	Drill 12-**#30** holes and screw in panel.	
2.20	**Interior Finishing Molding (Norryl) Installation**		
	A)	Clean the area where the double-face self adhesive tape will be applied using anti-silicone. *(See PR000001, Section A)*	
	B)	Affix double-face self adhesive tape 1/16 x 1/2 inside “Norryl”.	
	C)	Position “Norryl » onto door and temporary fix using Quick grip.	
	D)	Drill 5-**#30** holes and screw in molding.	
2.25	**Latch Cover Installation**		
	A)	Clean the area where the foam tape will be applied using anti-silicone. *(See PR000001, Section A)*	
	B)	Affix some foam tape 3/16 x 1/2 inside the cover.	
	C)	Position the cover onto the door. Drill 1-**#30** hole and fix using screw.	

Section 3 Gluing of SS Body panels			
3.00 *	**Fiberglass Preparation (LPLT)**		**MTH** 
	A)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	B)	Clean using anti-silicone. *(See PR000001, Section A)*	
	C)	Apply Sika 206 G+P. *(See PR000001, Section D)*	
3.05	**Body Panels Preparation (S/S)**		**MTH** 
	A)	Cut and remove from the appropriate areas on the 2 panels, the blue protective film.	
	B)	Clean using anti-silicone. *(See PR000001, Section A)*	
	C)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	D)	Clean using anti-silicone. *(See PR000001, Section A)*	
	E)	Apply Sika 205. *(See PR000001, Section B)*	

<table>
<tr><td>3.10</td><td colspan="3">Affix double-face self adhesive tape 1/16 x 1/2.

<u>MTH</u>
</td></tr>
<tr><td rowspan="2">3.15</td><td rowspan="2">A)</td><td>Apply Sika 252 onto panels.
</td><td></td></tr>
<tr><td colspan="2"><u>MTH</u>
</td></tr>
</table>

<table>
<tr><td rowspan="5"></td><td>B)</td><td>Position and glue bottom body panel.</td><td rowspan="5"><u>MTH</u>
</td></tr>
<tr><td>C)</td><td>Position and glue upper body panel.</td></tr>
<tr><td>D)</td><td>Compress body panels using hands.</td></tr>
<tr><td>E)</td><td>Drill 2-#30 holes and rivet.</td></tr>
<tr><td>F)</td><td>Seal rivets using silver sealant.</td></tr>
<tr><td rowspan="3">3.20 *</td><td colspan="2">Finishing Joint</td><td rowspan="3"><u>MTH</u>
</td></tr>
<tr><td>A)</td><td>Apply Simson 70-03

Fill in the space between body panels and fiberglass panel at the indicated location.</td></tr>
<tr><td>B)</td><td>Using soapy water, smooth down the joints with your finger.</td></tr>
</table>

<table>
<tr><th colspan="2">Appendix 1 Replacement/Repair</th></tr>
<tr><td rowspan="2">A1.00</td><td>Remove part. See PR000001, Section 2.</td></tr>
<tr><td>Preparation and gluing. See PR000001, Section 2 and/or do procedure again.</td></tr>
</table>

PREVOST

ENTRANCE DOOR OR FRONT ELECTRICAL & SERVICE COMPARTMENT DOOR INSTALLATION PROCEDURE

PROCEDURE NO: PR280022

REVISION 10

2006-06-04

GLUING PROCEDURE (QUALIFIED PERSONNEL ONLY)

Material:

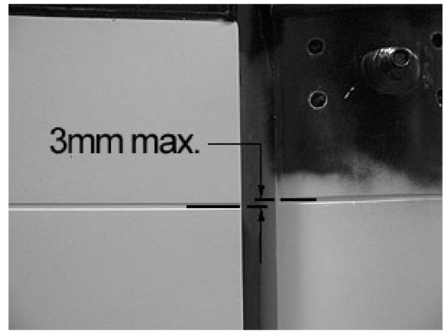
Anti-silicone (682989)	√				
Chiffon CHIX (682384)	√			Sika 215 1 liter (683916)	√
Chiffon Bleu (682383)	√				
		Sika 205 1liter (683097)	√	Simson 70-03 black	√
				Sika 252 black	√

Equipments:

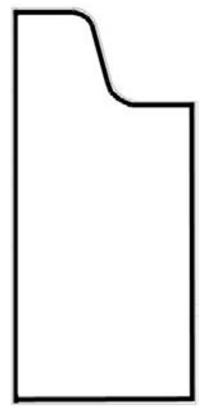
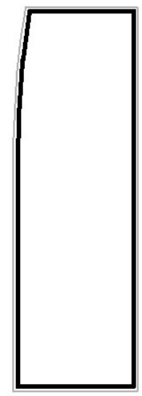
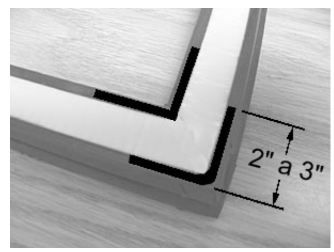
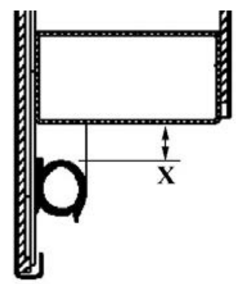
Compression roller 1''	√	

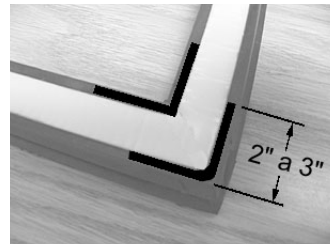
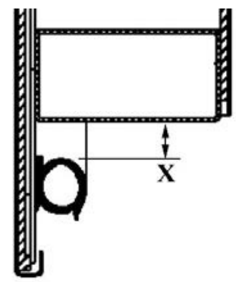
Safety Rules: See PR000001

Section 3 Entrance Door or Front Service Door Final Adjustment

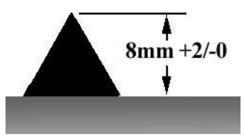
3.00	**Door Adjustment with reference to front face** Line up each door groove with front face groove within **3mm max**.	
	Aligning door pleats with front fender pleats Line door pleats with front fender pleats within **2mm max**.	

Section 4 Gluing Entrance Door and Service Door Seal

4.00	A)	Clean using anti-silicone seal bonding surface *(See PR000001, Section A)*	**Service Door**  **Entrance Door** 
	B)	Apply Sika 205. *(See PR000001, Section B)*	
4.05 *		**Gluing Service Door Seal**	
	A)	Apply Simson 70-03 black at the seal 4 corners, each side of the tape.	
	B)	Glue seal 4 corners. **Upper corners**: Press corners against door frame. **Lower corners**: Glue onto bottom of door frame (may vary depending on seal length).	
	C)	Glue the rest of the seal. **Important**: Seal must be positioned correctly the first time; otherwise it will not bond as well the second time.	
	D)	Compress seal using roller. Compress seal 3 times.	
	E)	If necessary, clean up the excess PR000001 section 3.	

4.10 *		**Gluing Entrance Door Seal**	
	A)	Apply Simson 70-03 black at the seal 4 corners, each side of the tape.	
	B)	Glue seal 4 corners. **<u>Upper corners</u>**: Press corners against door frame. **<u>Lower corners</u>**: Glue **10mm** lower than bottom of door frame (may vary depending on seal length).	
	C)	Glue the rest of the seal. **<u>Important</u>**: Seal must be positioned correctly the first time; otherwise it will not bond as well the second time.	
	D)	Compress seal using roller. Compress seal 3 times.	
	E)	If necessary, clean up the excess PR000001 section 3.	

Section 6 Collage du cache penture intérieur

6.00	**Interior Hinge Cover Preparation (ABS)** A) Clean using anti-silicone. *(See PR000001, Section A)* B) Apply Sika 215. *(See PR000001, Section D)*	
6.05	**Hinge Preparation (E-Coat)** Clean using anti-silicone. *(See PR000001, Section A)*	
6.10	Apply Sika 252 black. 2 triangular joints 	
6.15	Position and glue.	

PREVOST

ENGINE COMPARTMENT DOOR BODY PANEL INSTALLATION

PROCEDURE NO: PR280032

REVISION 4

2006-05-30

GLUING PROCEDURE (QUALIFIED PERSONNEL ONLY)

Material:

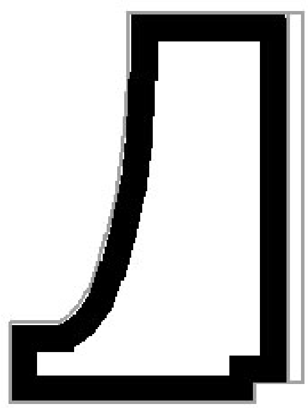
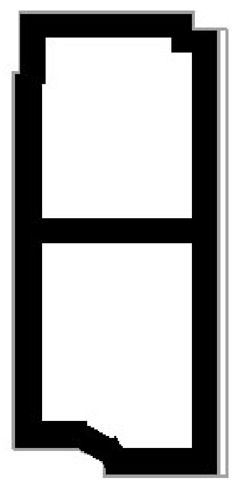
Anti-silicone (682989)	√	**Scotchbrite grey (680226)**	√		
CHIX cloth (682384)	√				
Blue cloth (682383)	√				
		Sika 205 1liter (683097)	√	**Sika 252 black**	√
				Simson 70-03 grey	√

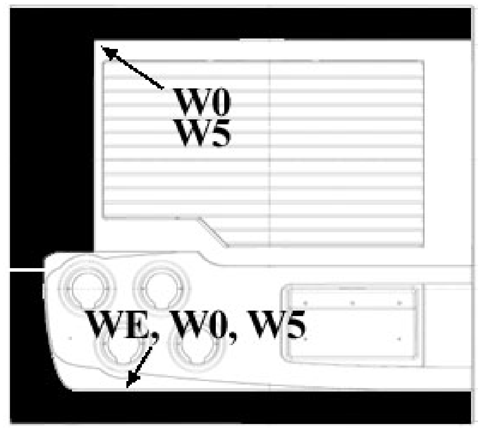
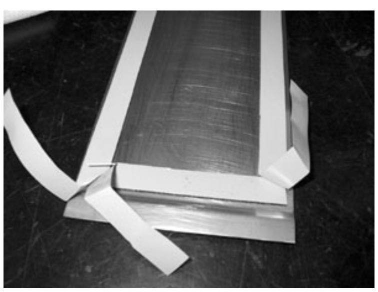
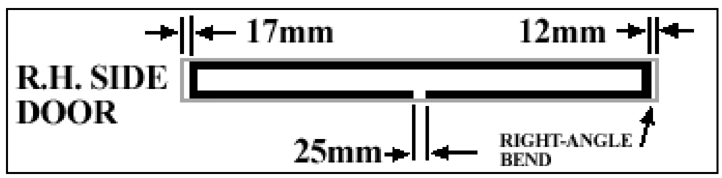
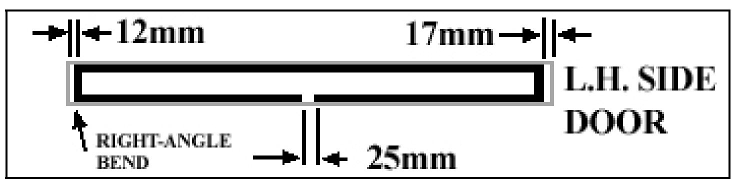
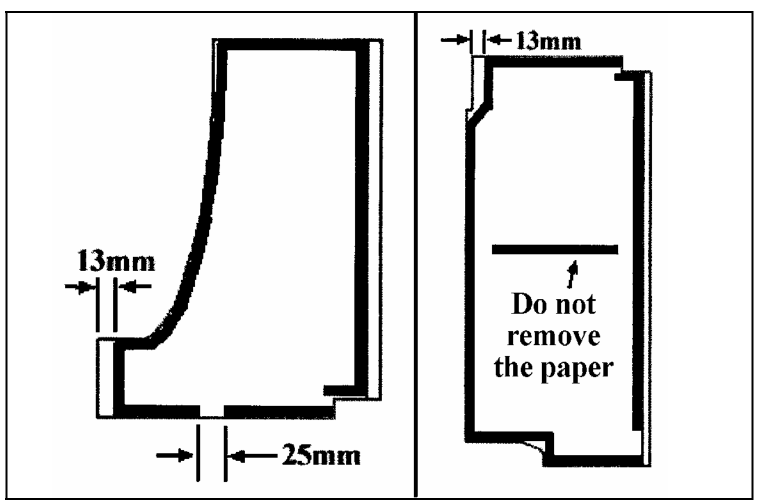
Equipments:

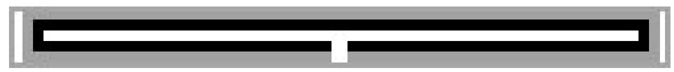
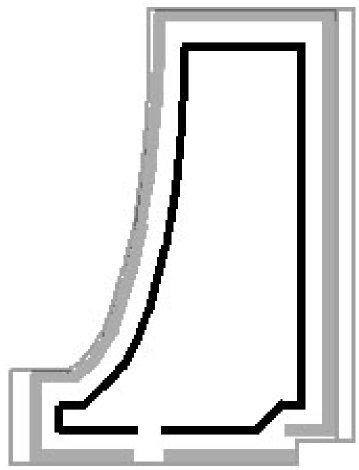
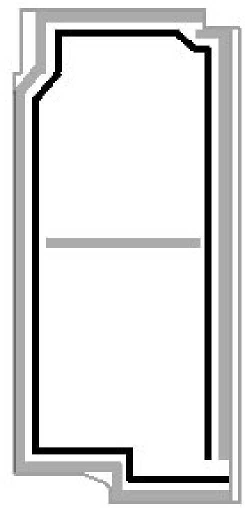
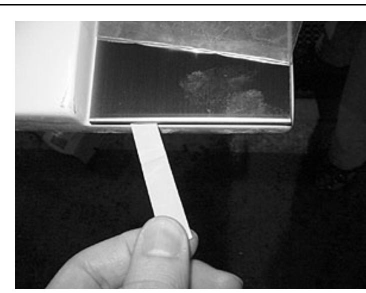
Glue Applicator	√	
Compression Roller	√	
		Protective grease #680111
Conforming jig	√	
Pencil	√	

Safety Rules: See PR000001

Section 1 Stainless Steel Body Panel Gluing MTH

1.00	Make sure that panel is in perfect shape before gluing. Verify especially the corners by lifting the blue paper. Remove blue paper from the adhesion side.	
1.05	**Stainless Steel Panel**	
	A) Clean using anti-silicone See PR000001 section A.	
	B) Sand using "scotchbrite" See PR000001 section G.	 
	C) Clean using anti-silicone See PR000001 section A.	
	D) Clean using Sika 205. See PR000001 section B.	

1.10	**Door Preparation** **Painted door (clear coat of polyurethane)** Clean using anti-silicone See PR000001 section A. **OR** **Primed door (beige primer)** A) Sand using Scotchbrite See PR000001 section G. B) Clean using anti-silicone See PR000001 section A.	
1.15	Install double-face self adhesive tape onto body panel. Cut double-face self adhesive tape leaving the back sticking out. 	CAUTION: Make sure that drip hole is in the bottom.   

1.20	Apply Sika 252 onto body panel.	  
1.25	Lay down stainless steel body panel onto fiberglass door. Note: Be careful upon installing the upper or lower small body panel. Make sure that drip hole is in the bottom.	
1.30	Check body panel proper positioning.	
1.35	Peel back from double-face self adhesive tape.	

Appendix 1 Replacement		
A1.00	Remove body panel	
A1.05	See PR000001 section 2.	
A1.10	For gluing procedure, refer to section 1.	

PREVOST

DRIVER'S WINDOW GLUING PROCEDURE

PROCEDURE NO: PR290013

REVISION 22

2006-06-16

GLUING PROCEDURE (QUALIFIED PERSONNEL ONLY)

Material:

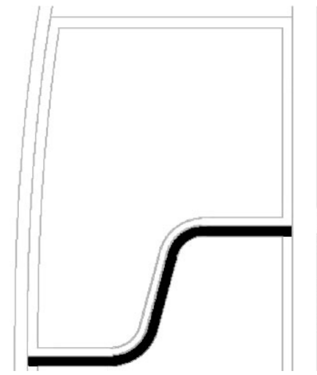
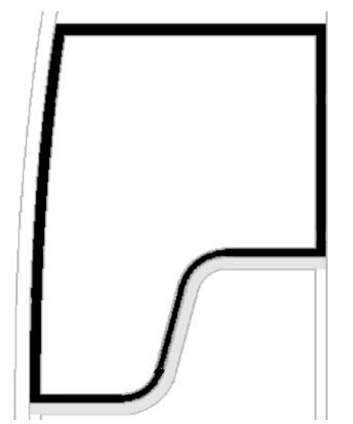
		Scotchbrite grey (680226)	√	Sika 206 G+P 1 liter (683446)	√
Anti-silicone (682989)	√				
CHIX cloth (682384)	√				
Blue cloth (682383)	√	Glass cleaner (683926)	√	Sika 221 black + booster	√
Sika Remover 208 (685101)	√	Sika 205 1liter (683097)	√		
		Sika Aktivator (683661)	√	Sika 255 black	√
Pure water	v	Masking tape	√		

Equipments:

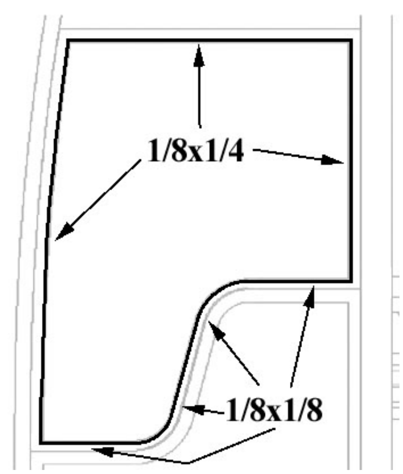
Glue Applicator	√	
Suction Cup Puller	√	
Cartridge oven	√	
Plastic spatula	√	

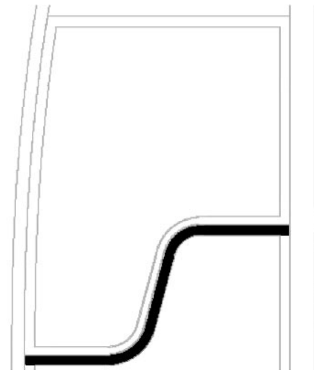
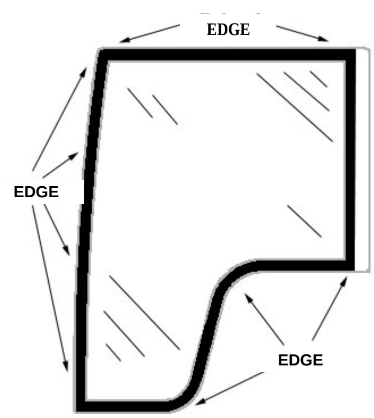
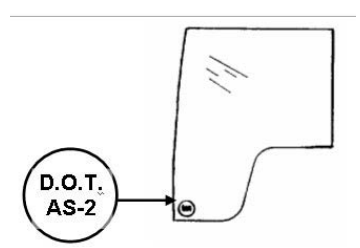
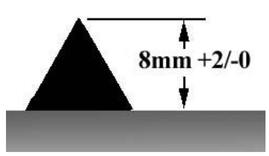
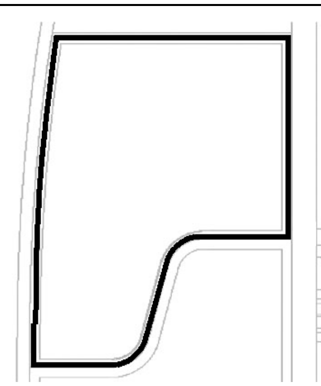
Safety Rules: See PR000001

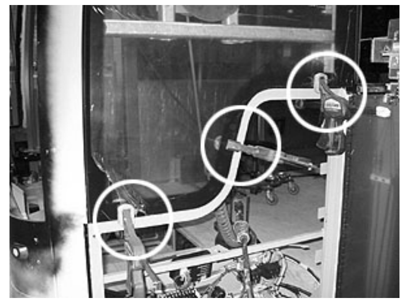
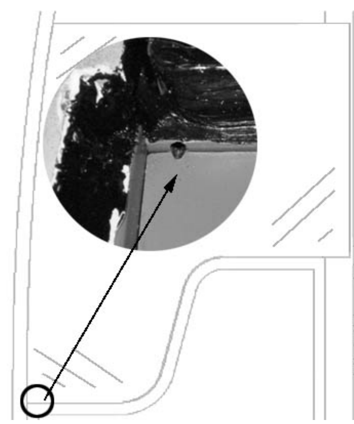
Section 1 Window Installation

1.00	There should be <u>no Primer 206G+P</u> in this zone. If required, apply some masking tape.	
1.05	**Structure Preparation** A) Clean using anti-silicone. *(See PR000001, Section A)* B) Sand using Scotchbrite. *(See PR000001, Section G)* C) Clean using anti-silicone. *(See PR000001, Section A)* D) Apply primer 206 G+P. *(See PR000001, Section D)*	

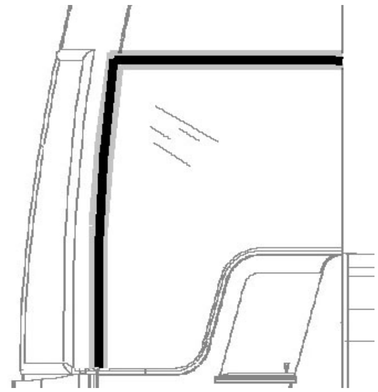
Section 2 Window Installation

2.00	Affix double-face self adhesive tape onto edge of structure.	

2.02		There should be <u>no glue</u> in this zone. If required, apply some masking tape.	
2.05		Install 3 positioning shims onto structure.	
2.10		**Window Pane Preparation**	
	A)	Clean using glass cleaner interior surface and edges. *(See PR000001, Section E)* 👁 *DOT AS2 inscription must be present at the bottom left corner of the window.*	
	B)	Apply Sika Aktivator onto interior surface and edges. *(See PR000001, Section C)*	
	C)	Make sure DOT AS-2 is present and readable.	
2.15		Apply Sika 221 black + booster onto structure. 	

2.20	A)	Press window against the shims	
	B)	Install suction cup puller in the center of window, from the inside.	
	C)	Compress window using hands and adjust puller. Line up window exterior (flatness) with adjacent surfaces. If necessary, use ''quick grip'' at bottom of window. *Conforming time* = ***90 minutes minimum***	
2.30	A)	Remove excess of glue on the window exterior.	
	B)	Remove masking tape	
	C)	If required, clean up surfaces with Sika 208.	
2.35	If necessary, excess of glue inside the vehicle with Sika 208.		
2.40	Drill small **9/64” hole** into the tubing for water dripping.		

Section 3 Finishing Joint (esthetic)

3.00 *	**See PR000001A section 3 for details of finishing joint**		
	A)	Apply Sika 205 into cavity. *(See PR000001, Section B)*	
	B)	Fill cavity with Sika 255	

Appendix 1 Replacement/Repair

A1.00	Remove part. See PR000001, Section 2.
	Preparation and gluing. See PR000001, Section 2 and/or do procedure again.

PREVOST

FRONT FACE UPPER LATERAL WINDOWS GLUING PROCEDURE

PROCEDURE NO: PR290016

REVISION 18

2006-06-16

GLUING PROCEDURE (QUALIFIED PERSONNEL ONLY)

Material:

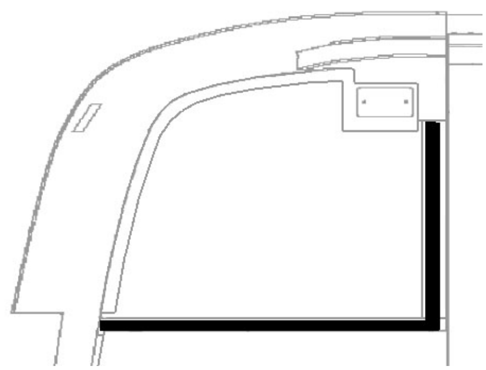
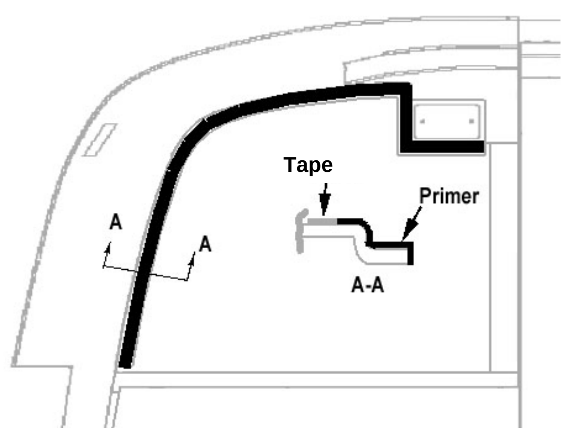
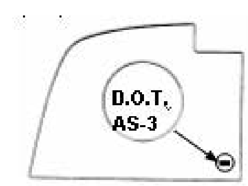
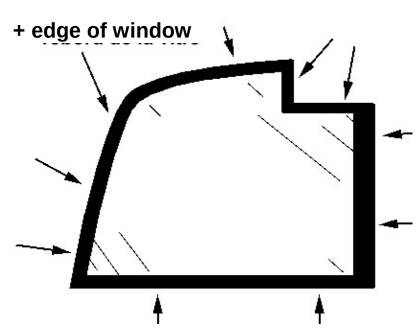
				Sika 206 G+P 1 liter (683446)	√
Anti-silicone (682989)	√				
CHIX cloth (682384)	√				
Blue cloth (682383)	√	Glass cleaner (683926)	√		
Sika Remover 208 (685101)	√	Sika 205 1liter (683097)	√	Sika 252 black	√
Soapy water	√	Sika Aktivator (683661)	√	Sika 255 black	√
Pure water	√	Masking tape	√		

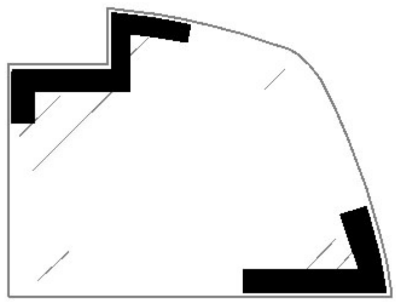
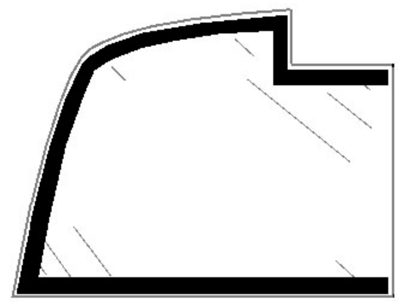
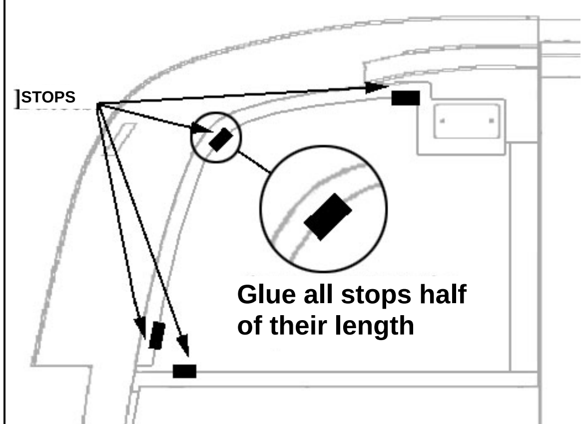
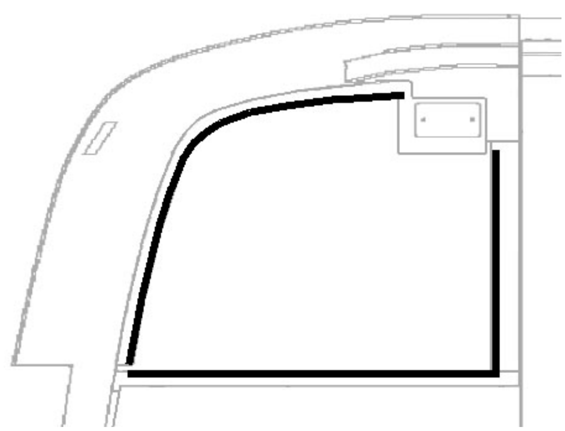
Equipments:

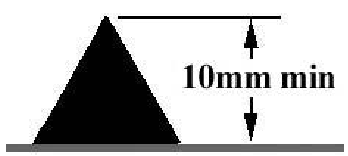
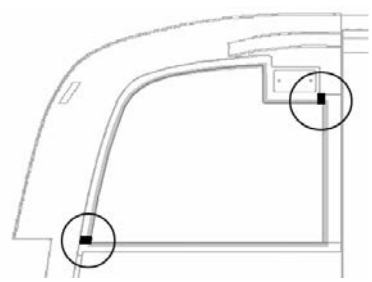
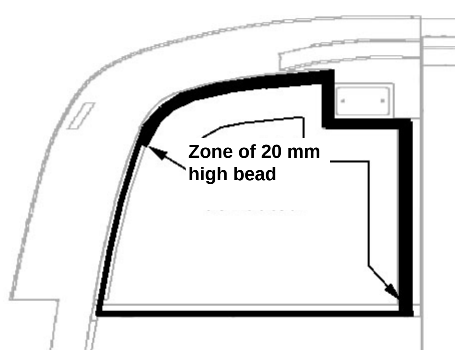
Glue Applicator	√	
		Spatula

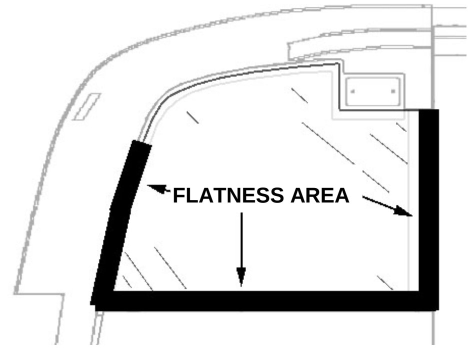
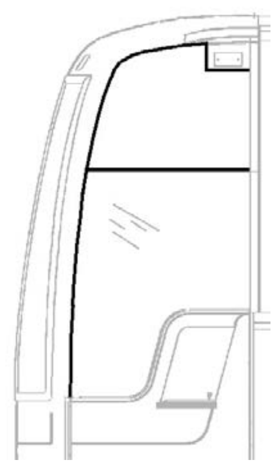
Safety Rules: See PR000001

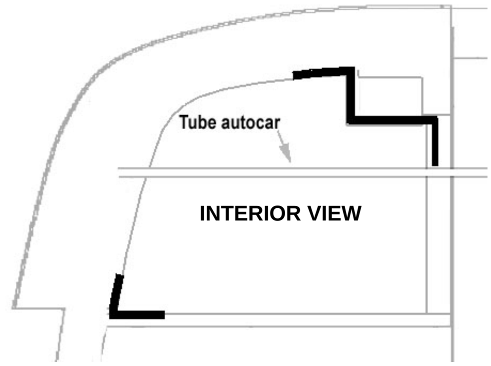
Section 1 Windows Installation

1.00	A)	Remove markers lights.	
	B)	If applicable, remove excess of sealant and urethane from bonding areas. Use an air gun to clean up.	
1.02		**Structure Preparation (primer 206 G+P)**	
		Reactivate Sika 206G+P primer as per PR000001 section D.	
1.05		**Fiberglass Preparation (Gel Coat side)** **(Faire le côté intérieur & extérieur de la lunette)**	
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Apply masling tape onto front face.	
	C)	Apply Sika 206 G+P. *(See PR000001, Section D)*	
1.10		**Window Preparation**	
	A)	Make sure DOT AS-3 is present and readable.	
	B)	Clean using glass cleaner bonding area and edges. *(See PR000001, Section E)*	
	C)	Apply Sika Aktivator. *(See PR000001, Section C)*	

<table>
<tr><td rowspan="2">1.15</td><td colspan="2">Apply masking tape onto window pane.</td><td></td></tr>
<tr><td colspan="2"><u>**Interior**</u>
</td><td><u>**Exterior**</u>
</td></tr>
<tr><td rowspan="2">1.20</td><td>A)</td><td>Glue 4 stops **#790392** onto fiberglass.</td><td>
</td></tr>
<tr><td>B)</td><td>Affix a double-face self adhesive tape 1/8’’ x 1/8’’ onto fiberglass structure perimeter.</td><td></td></tr>
</table>

1.25		Install shims at the bottom of window.	
1.30	A)	Install window into the opening to check the window pane curvature with reference to the front cap. **<u>L.H. side</u>**: Align front of window with front of driver's window. If necessary, adjust window height by adding shims. **<u>R.H. side</u>**: Once centered, apply some masking tape at the bottom of the window and mark for future reference (will help for centering when gluing window).	**<u>R.H. side</u>** 
	B)	Peel back from double-face self adhesive tape.	
1.35		Apply Sika 255 onto fiberglass *Note: Make sure to fill the 2 small cavities between fiberglass and structure.* 	 

1.40	Install window. Compress window all around in order to glue it to the double-face self adhesive tape. Make sure to respect flatness in the indicated area, must be flush within **2mm**.	
1.45	A) Install suction cup puller in the window center from inside of vehicle. *Note: Make sure window rests against structure frame (without deforming window pane).* B) *Conforming time = **60 minutes minimum***	
1.50	See PR290013 for driver's window finishing joint.	
1.55 *	**Finishing Joint** **For more details on finishing joint see PR000001A section3** Apply Sika 255	

1.60	A)	Apply Sika 255 from inside of vehicle (make two joints).	
	B)	Smooth down the joints and remove masking tape.	
1.65	Reinstall markers light.		

Appendix 1 Replacement/Repair

A1.00	Remove part. See PR000001, Section 2.
	Preparation and gluing. See PR000001, Section 2 and/or do procedure again.

PREVOST

FRONT FENDER BODY PANEL

PROCEDURE NO: PR470024

REVISION 10

2006-04-25

GLUING PROCEDURE (QUALIFIED PERSONNEL ONLY)

Material:

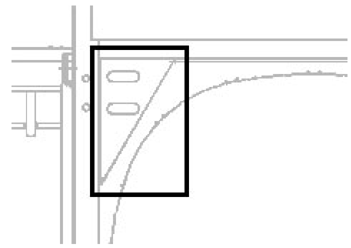
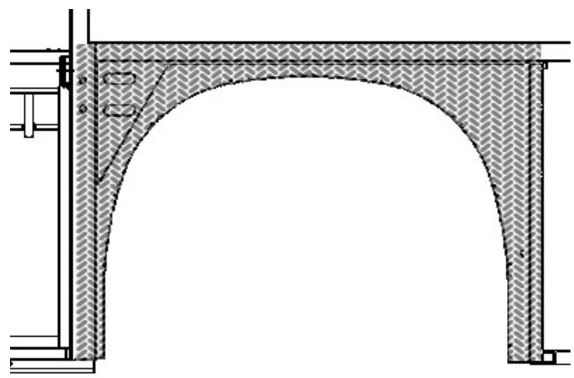
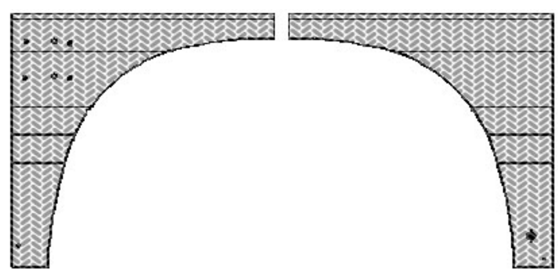
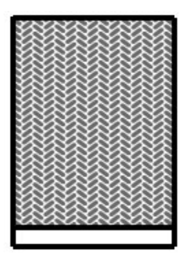
Alcohol (680536)		**Scotchbrite grey (680226)**	√		
Anti-silicone (682989)	√				
CHIX cloth (682384)	√			**Sika 221 grey**	√
Blue cloth (682383)	√			**Sika 221 black + booster**	√
Sika Remover 208 (685101)	√	**Sika 205 1 liter (683097)**	√	**Sika 252 black**	√
Soapy water	√				
		Masking tape	√		

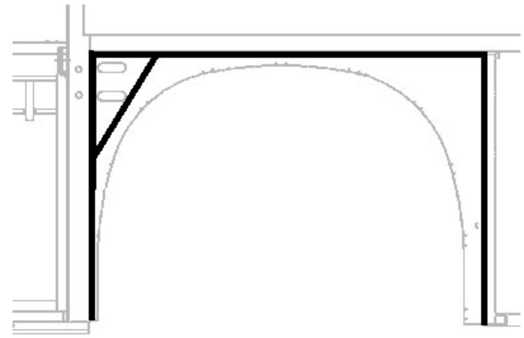
Equipments:

Glue applicator	√	
Compression roller	√	
Pencil	√	
Ruler	√	

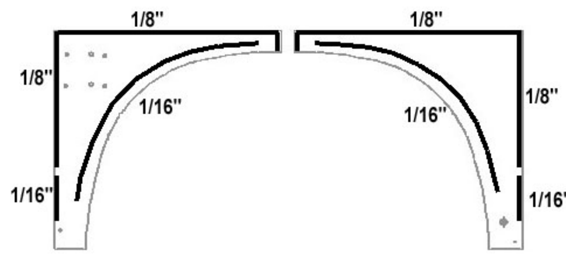
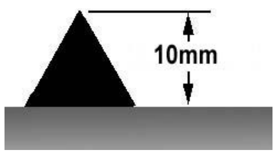
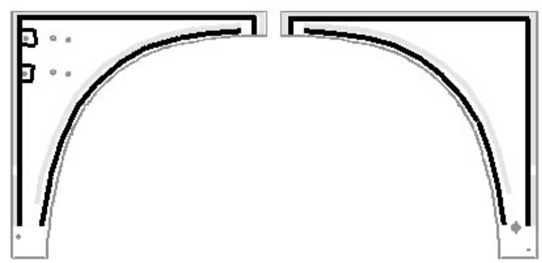
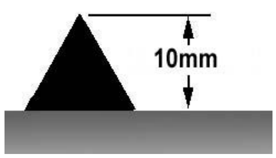
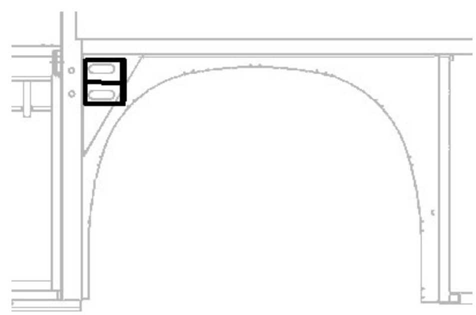
Safety Rules: See PR000001

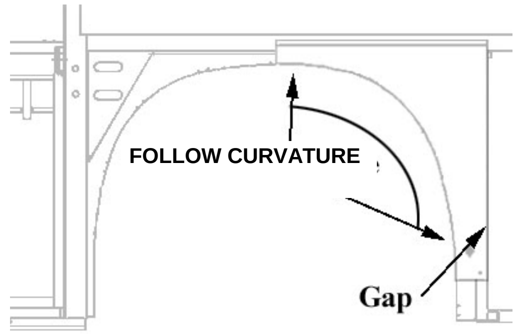
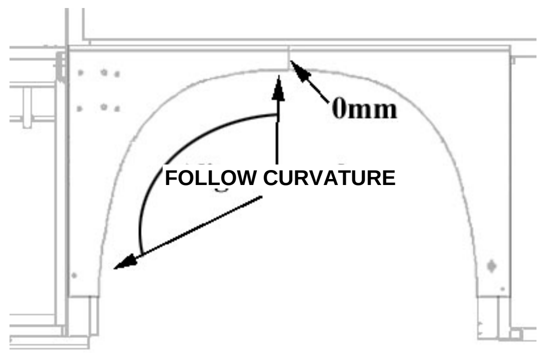
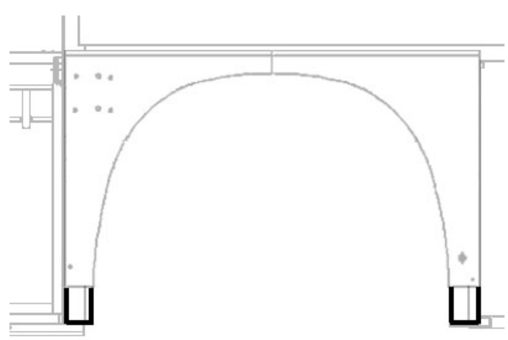
Section 1 Surface Preparation

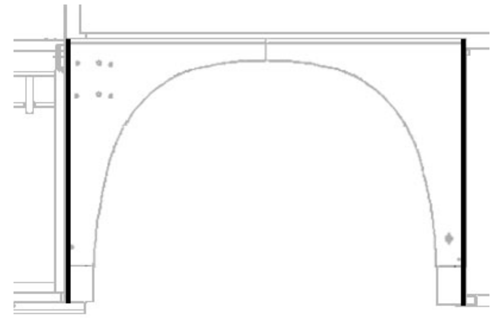
1.00	A)	Check the state of the parts bonding surface (visually and with a scraper. Remove blue paper from the body panels bonding side.	
	B)	Check plate flatness. Use a hammer if necessary to prevent the plate from exceeding the structure surface.	
1.05 *	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 205. *(See PR000001, Section B)*	
1.10 *	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 205. *(See PR000001, Section B)*	
1.12	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Apply Sika 205 onto small lower body panel.	

1.20	A)	Apply Sika 252 black onto structure.	
	B)	Smooth down the joint with a finger or spatula to prevent bumps.	

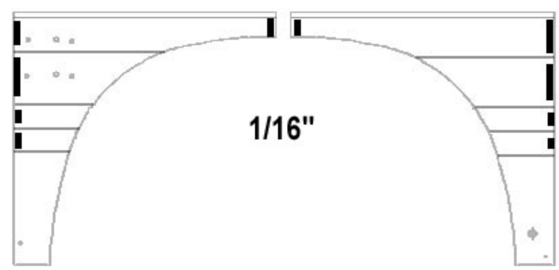
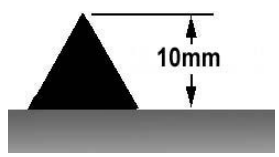
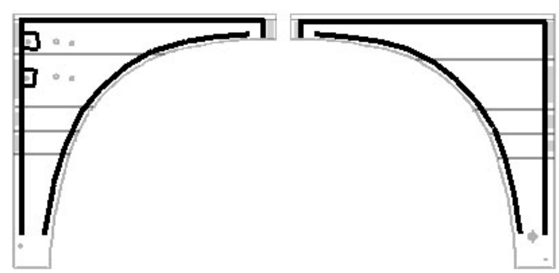
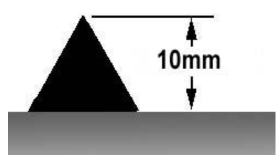
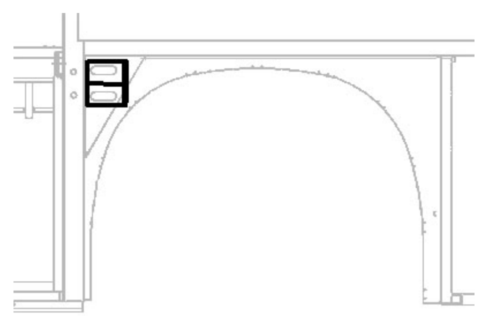
Section 2 Smooth Body Panel Gluing

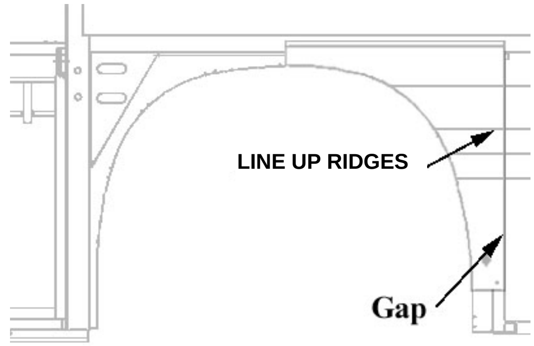
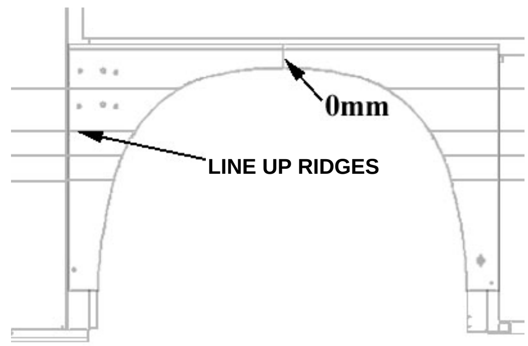
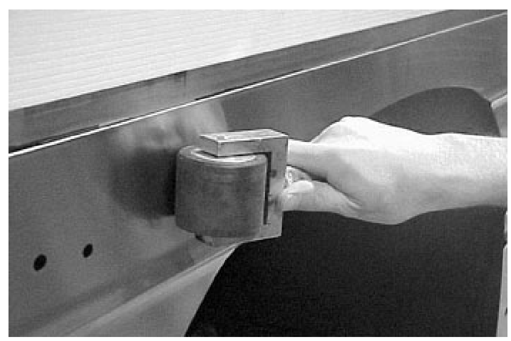
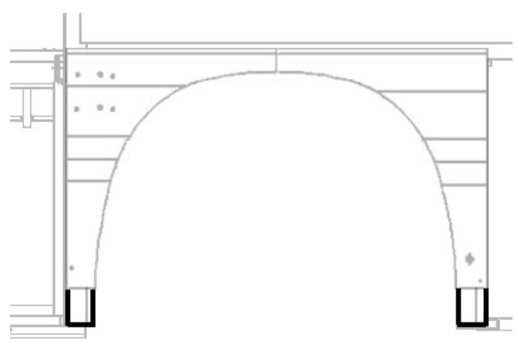
2.00	Apply a foam tape onto body panel and peel back.		
2.05	A)	Apply Sika 221 + booster onto panels.. 	
	B)	Apply Sika 221 + booster onto structure. 	

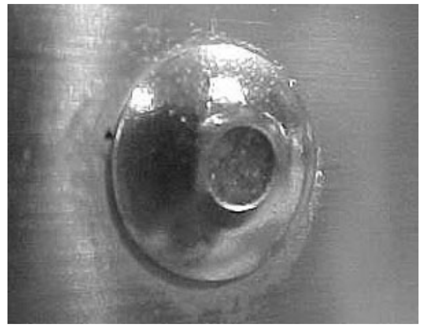
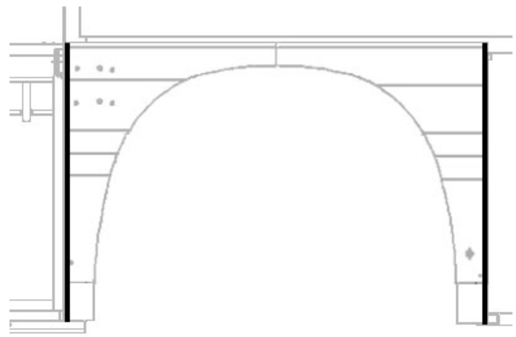
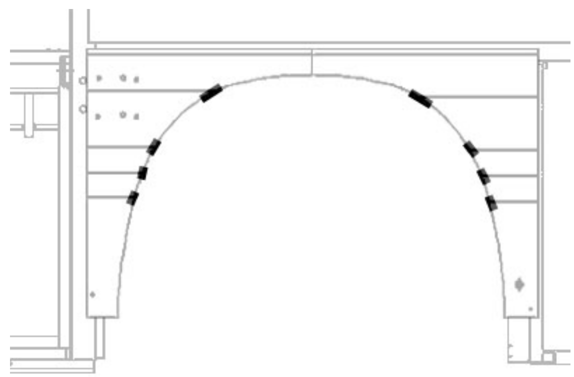
2.10 *	A)	Body panel adjacent to baggage compartment door. Install body panel in the best possible position. Allow the panel to float on the glue. Make the final adjustment and then press body panel using hands. 1) Check for proper gap between body panel and baggage compartment door and hide structure post. 2) Follow as much as possible the structure curvature.	
	B)	Front Body Panel. Install body panel in the best possible position. Allow the panel to float on the glue. Make the final adjustment and then press body panel using hands. 1) Lean the body panel against the other to get a 0 mm gap. 2) Follow as much as possible the structure curvature.	
	C)	Using a roller, compress body panel along Sika joints. Make sure body panels and foam tape rest perfectly against structure.	
2.15	Install lights.		
2.25	Rivet body panel.		
2.30	A)	Apply Sika 221 grey onto structure.	
	B)	Position lower body panels. Drill & rivet.	

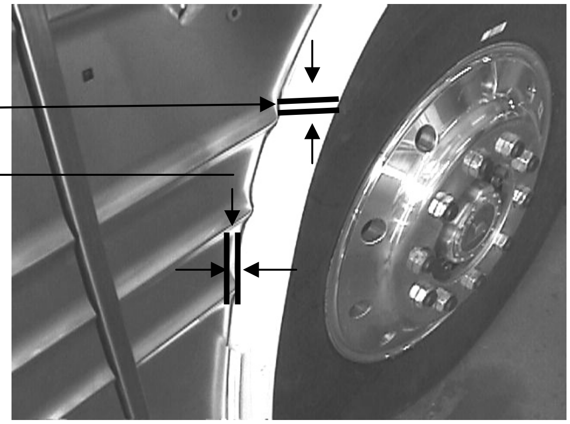
2.35	**Finishing Joint**		
	A)	Apply masking tape onto body panel edge and structure.	
	B)	Apply Sika 221 grey in order to fill the space between body panel and structure.	
	C)	Smooth down the joints with a finger and soapy water.	
	D)	Remove masking tape. If required, clean up surfaces with Sika 208.	

Section 3 Gluing of Ridged Body Panels

3.00	Apply double-face self adhesive tape onto body panel and remove protective tape.		
3.05	A)	Apply Sika 221 + booster onto body panel 	
	B)	Apply Sika 252 onto structure. 	

3.10 *	A)	Body panel adjacent to baggage compartment door. Install body panel in the best possible position. Allow the panel to float on the glue. Make the final adjustment and then press body panel using hands. 1) Check for proper gap between body panel and baggage compartment door and hide structure post. 2) Line up body panel ridges with baggage compartment door +/-1mm	
	B)	Front Body Panel. Install body panel in the best possible position. Allow the panel to float on the glue. Make the final adjustment and then press body panel using hands. 1) Lean the body panel against the other to get a 0 mm gap 2) Line up body panel ridges with entrance door or front service compartment door +/-1mm	
	C)	Using a roller, compress body panel along Sika joints. Make sure body panels and foam tape rest perfectly against structure.	
3.15	Install lights.		
3.25	Rivet body panels.		
3.30	A)	Apply Sika 221 grey onto structure.	
	B)	Position lower body panels. Drill & rivet.	

	C)	Seal lower body panel rivets using silver sealant.	
3.35	**Finishing Joint**		
	A)	Apply masking tape onto body panel edge and structure	
	B)	Apply Sika 221 grey in order to fill the space between body panel and structure.	
	C)	Smooth down the joints with a finger and soapy water.	
	D)	Remove masking tape. If required, clean up surfaces with Sika 208.	
3.40	Apply Sika 252 black to fill ridges.		

Section 4 Front Fender With Reference To Body Panel		
4.00	Front fender with reference to body panel. Out of alignment between body panel ridge and front fender ridge ± **2mm**. **2mm** maximum between body panel and front fender	

Appendix 1 Repair	
A1.00	See PR000001, Section 2.

PREVOST

REAR FENDER BODY PANEL

PROCEDURE NO: PR470046

REVISION 5

2006-02-21

GLUING PROCEDURE (QUALIFIED PERSONNEL ONLY)

Material:

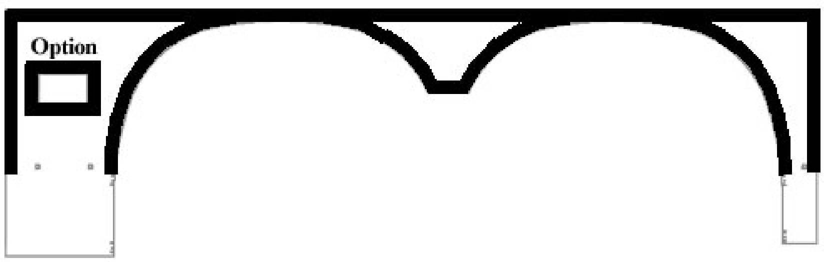
Anti-silicone (682989)	√	**Scotchbrite grey (680226)**	√	**Sika 206 G+P 1 liter (683446)**	√
CHIX cloth (682384)	√			**Sika 221 + booster**	√
Blue cloth (682383)	√				
Sika Remover 208 (685101)	√				
				Sika 252 black	√

Equipments:

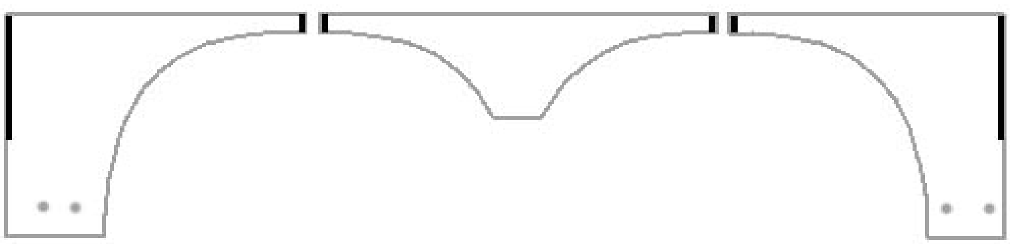
Glue applicator	√	

Safety Rules: See PR000001

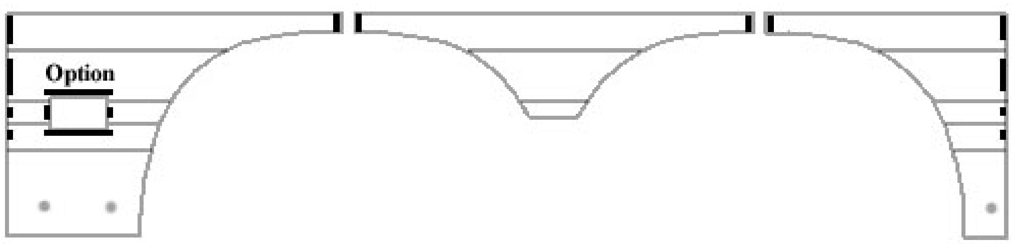
Section 1 S/S Structure Preparation

1.00	A)	Clean using anti-silicone. *(See PR000001, Section A)*
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*
	C)	Clean using anti-silicone. *(See PR000001, Section A)*
	D)	Apply Sika 206 G+P. *(See PR000001, Section D)*
		

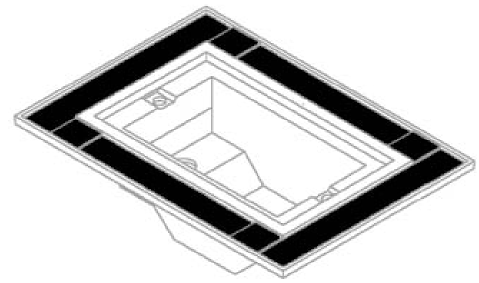
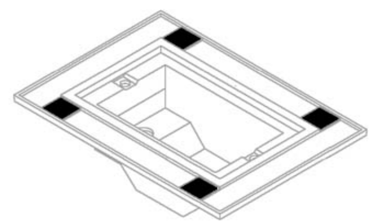
Section 2 E-Coat (black) Body Panel Preparation

2.00	Clean using anti-silicone. *(See PR000001, Section A)*
	
2.05	Apply double-face self adhesive tape 1/16 x 1/2 onto edges and remove protective tape.
	

Section 3 S/S Body Panel Preparation

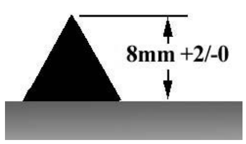
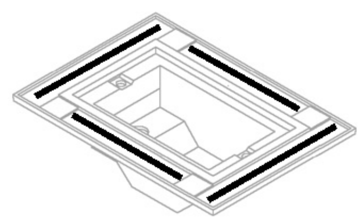
3.00	A)	Clean using anti-silicone. *(See PR000001, Section A)*
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*
	C)	Clean using anti-silicone. *(See PR000001, Section A)*
	D)	Apply Sika 206 G+P. *(See PR000001, Section D)*
	 	
3.05	Apply double-face self adhesive tape 1/16 x 1/2 **6mm** from panel edges and remove protective tape (do not apply into the grooves).	
	 	

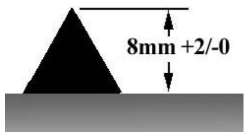
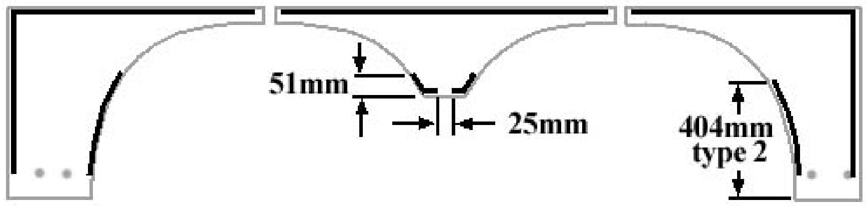
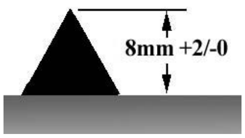
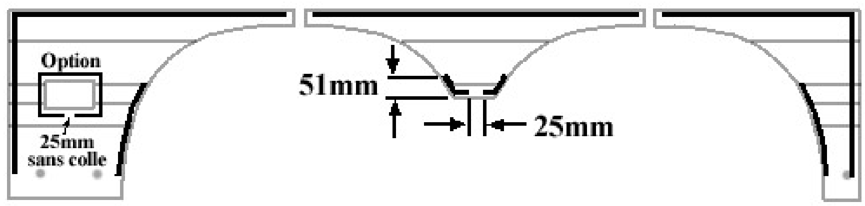
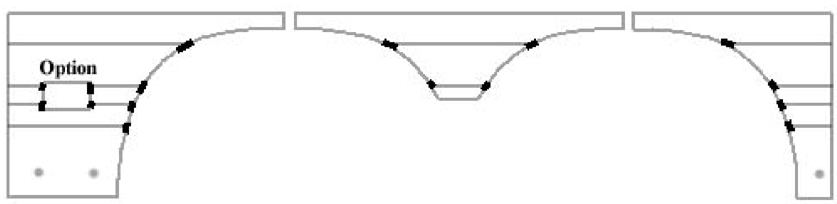
Section 4 Docking Lamp casing Preparation

4.00 *	**SMC Lamp Casing Preparation**		
	A)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	B)	Clean using anti-silicone. *(See PR000001, Section A)*	
	C)	Apply Sika 206 G+P. *(See PR000001, Section D)*	
4.10	Apply double-face self adhesive tape 1/16 x 1/2.		

SECTION 5 GLUING

<u>Important</u>: Make sure that all bonding surfaces are clean and free of dust, residue or dry glue. If required, clean using a scraper or damp cloth.

5.00	**Lamp Casing Gluing (SI APPLICABLE)**		
	A)	Apply Sika 252 	
	B)	Install casing. If necessary, remove excess using Sika 208.	

5.10	**SMOOTH BODY PANEL GLUING**	
	Apply Sika 221 + booster. 	
5.15	**RIDGED BODY PANEL GLUING**	
	Apply Sika 221 + booster. 	
5.20	Install body panels Compress for 4 **hours minimum**.	
5.25	**RIDGED BODY PANELS**	
	Apply Sika 252 to fill the ridges.	

Appendix 1 Repair

A1.00	See PR000001, Section 2.	
A1.05	A)	Prepare structure.
	B)	Prepare body panel.
	C)	Perform required steps described in the procedure.

PREVOST

S/S FRONT FACE BODY PANEL GLUING PROCEDURE

PROCEDURE NO: PR470047

REVISION 3

2006-02-15

GLUING PROCEDURE (QUALIFIED PERSONNEL ONLY)

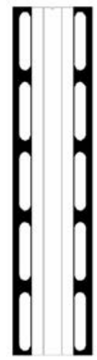
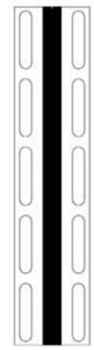
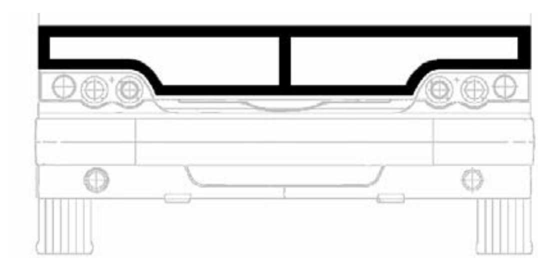
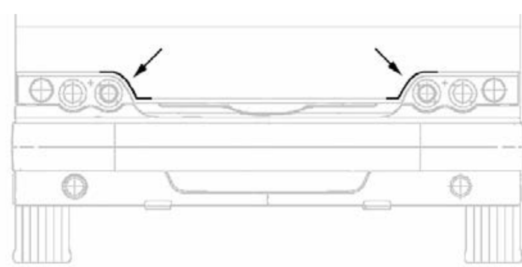
Material:

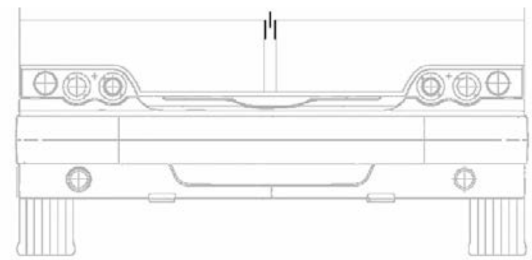
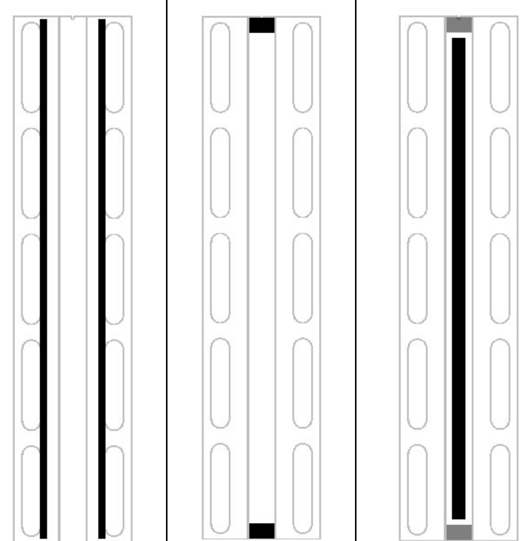
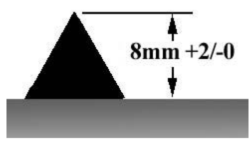
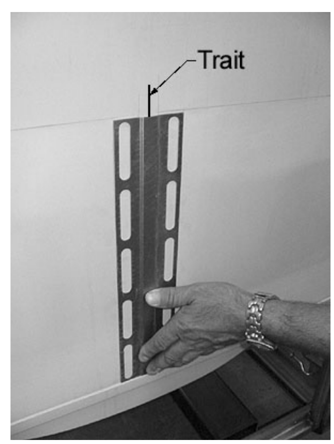
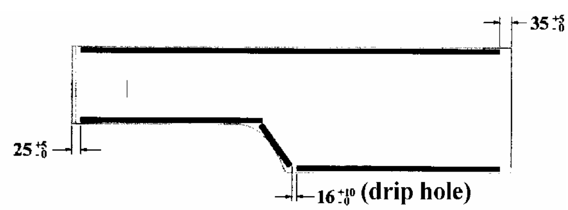
		Scotchbrite grey (680226)	√		
Anti-silicone (682989)	√				
CHIX Cloth(682384)	√				
Blue Cloth (682383)	√	**Sika 205 1litre (683097)**	√		
Sika Remover 208 (685101)	√			**Sika 252 black**	√
		Double-face tape	√		

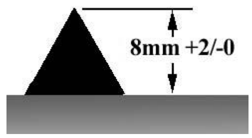
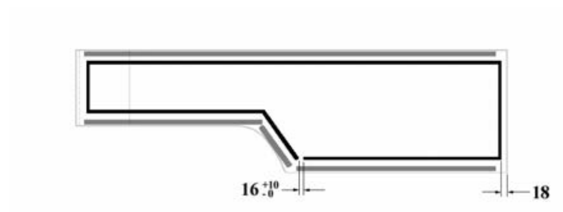
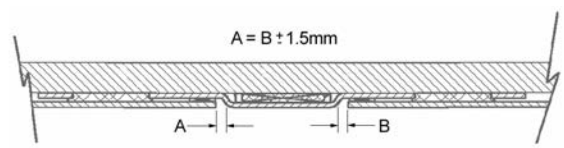
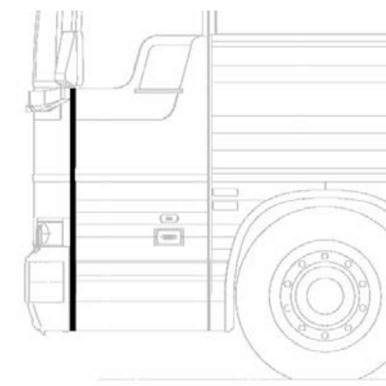
Equipment:

Glue applicator	√	
Pencil	√	
Eraser	√	

Safety rules: See PR000001

1.00	Check condition of panels.		
1.05	**S/S Panel Preparation**		**Top**  **Bottom** 
	A)	Clean using anti-silicone. *(See PR000001, Section A)*	
	B)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	C)	Clean using anti-silicone. *(See PR000001, Section A)*	
	D)	Apply Sika 205. *(See PR000001, Section B)*	
1.10 *	**Fiberglass Preparation**		
	A)	Sand using Scotchbrite. *(See PR000001, Section G)*	
	B)	Clean using anti-silicone. *(See PR000001, Section A))*	
	C)	Apply Sika 205. *(See PR000001, Section B)*	
1.15	**Panel Positioning**		
	A)	Position the panel so that its outline follows the contour of the headlamp.	

	B)	Draw a line on the side of each panel for reference (left and right). Draw another line in the center of the 2 previous lines to define center piece positioning.	
1.20		**Center Piece Installation**	A) B) C) 
	A)	Apply double-face tape **1/32 x ¼** on top of center piece.	
	B)	Apply double-face tape **1/8 x ¼** underneath center piece.	
	C)	Apply Sika 252. 	
	D)	Center and position center piece with reference to the lines performed at step 1.15b) and affix center piece. *Note: Position center piece before compressing* double-face tape.	
1.25		**L.H. & R.H. Panel Installation**	
	A)	Apply double-face tape **1/16 X 1/4** about 1mm from panel edge.	

	B)	Apply Sika 252.  	
	C)	Position and glue side panels with reference to the lines draw at step 1.15b) (make sure tolerance of **±1.5mm** is met). Compress side panel using a blackboard eraser. *Note: Position side panel before compressing double-face tape..*	
	D)	If applicable, remove excess of Sika and clean surfaces using Sika 208.	**<u>Section view</u>** 
1.30	A)	Position entrance door and service door frame vertical molding.	
	B)	Drill using a **#30** drill bit & rivet.	

Section 2 Replacement/Repair

2.00	Panel removal. See la PR000001, Section 2.
	Preparation and installation. See PR000001, Section 2 and/or do procedure again.

SECTION 22: HEATING AND AIR CONDITIONING

CONTENTS

ILLUSTRATIONS

1. HEATING AND AIR CONDITIONING

The vehicle interior is pressurized by its Heating, Ventilation and Air Conditioning (HVAC) system. Two HVAC systems are available: Small HVAC System and Central HVAC System. The vehicle interior should always be slightly pressurized to prevent dust and moisture from entering. If the vehicle is equipped with a Central HVAC System; air flow and controls divide the vehicle into two areas: driver's area and cabin area. Each area has its own fresh air, returning air and discharge air ducting; exhaust is mainly done through normal air-tightness losses.

2. AIR CIRCULATION WITH CENTRAL HVAC SYSTEM

2.1 DRIVER'S AREA

Fresh air is taken from a plenum behind the front bumper and enters the mixing box through an ON/OFF damper. Returning air is taken through the right console 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 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 figure 1 and Owner's manual)

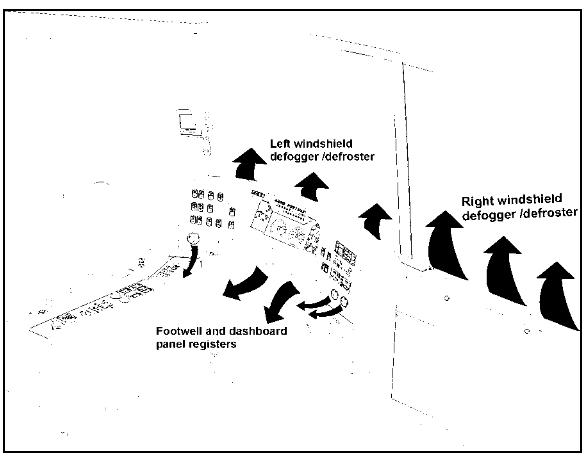


FIGURE 1: DRIVER'S AIR CIRCULATION 22171

2.2 CABIN 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 Manual for more details). The recirculation REC button is located on the HVAC control module. Press down the button to partially close the fresh air damper. Return air is drawn from inside the vehicle through a wire mesh opening in the floor located amidships on L.H. side of vehicle (Fig. 3).

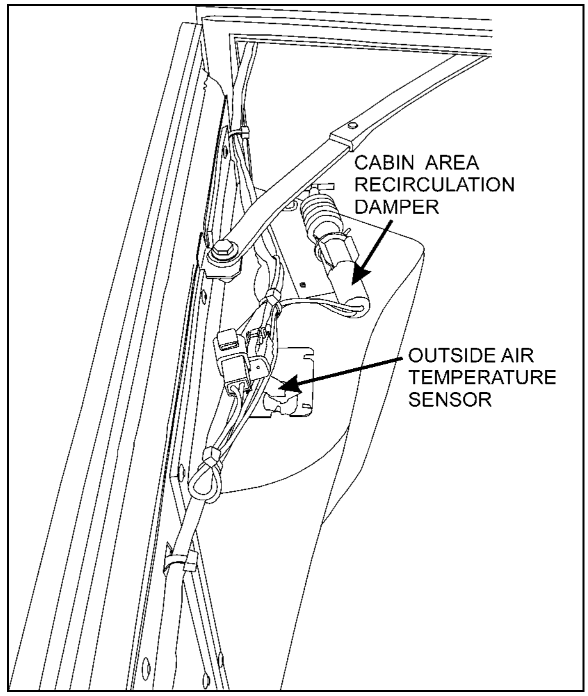


FIGURE 2: CABIN AREA RECIRCULATION DAMPER 22339

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.

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 module (Figure 4). 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 figure 1 and Owner's manual).

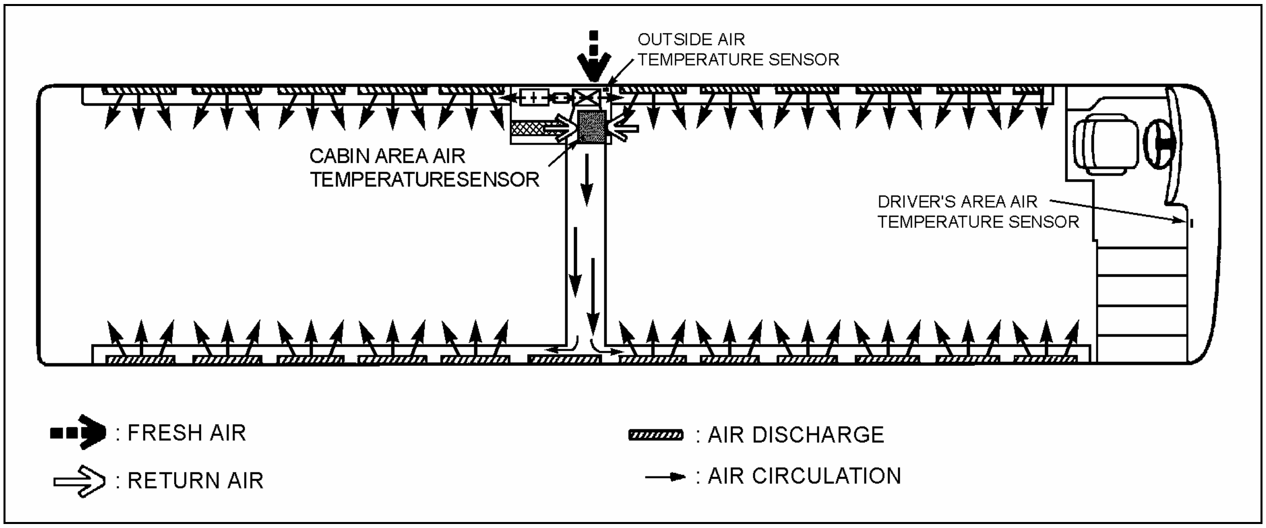


FIGURE 3: CENTRAL HVAC SYSTEM AIR CIRCULATION 22334

4. SMALL HVAC SYSTEM OPERATION

Only the temperature in the driver's area is controlled by the HVAC control module mounted on the R.H. dashboard panel (Fig. 4).

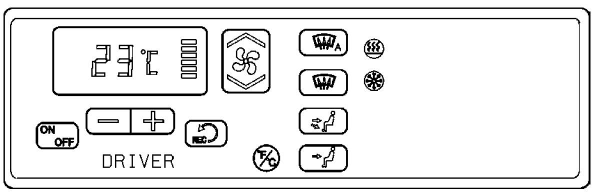


FIGURE 4: SMALL HVAC SYSTEM CONTROL MODULE 22184

Using the Up/Down type switch sets the fan speed and the speed chosen is displayed on the HVAC control module.

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 coach 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 UNIT OPERATION

The temperature control in the driver's area is provided directly by the L.H. portion of the HVAC control module mounted on the R.H. dashboard panel (Fig. 5).

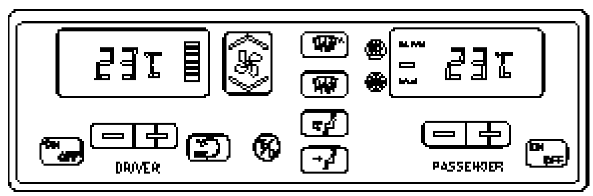


FIGURE 5: CENTRAL HVAC SYSTEM CONTROL MODULE

The driver's HVAC unit piping is paralleled with the cabin HVAC unit piping. Both units use the same refrigerant and coolant, and are linked to the same condenser and compressor, even if they are individually controlled. It requires the cabin HVAC unit to engage the A/C compressor magnetic clutch. Consequently, the driver's unit cannot be operated in the A/C mode alone.

NOTE
The driver's HVAC unit 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 area air 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.

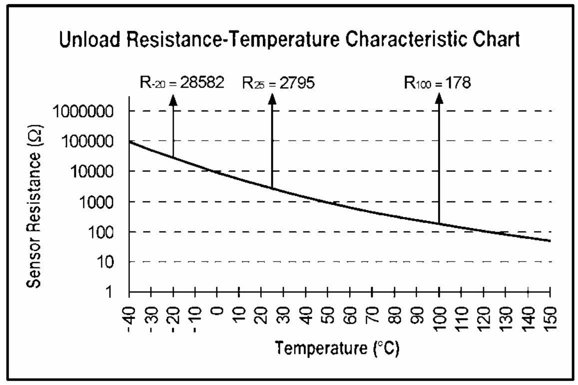
NOTE
Upon starting, if the outside temperature is above 32°F (0°C) and then drops below 32°F (0°C), the compressor will keep running up to a temperature of 15°F (-9°C) to prevent condensation from forming on the windows.

NOTE
To perform a test of the driver's unit 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.12).

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 CABIN UNIT OPERATION

The HVAC control module located on the R.H. dashboard panel (Fig. 5), enables the selection of the temperature in the cabin area (refer to the Owner's Manual for details).

Temperature control is provided in conjunction with a thermistor air temperature sensor located amidships on L.H. side of vehicle, underneath the wire mesh opening in the floor (Figs. 3 & 6).

The flow of water to the vehicle's main heater core is controlled by an electric water valve which varies the cycling rate depending on selected temperature. A red LED, located on HVAC control module illuminates when heating mode is selected. A green LED illuminates when compressor clutch is in operation.

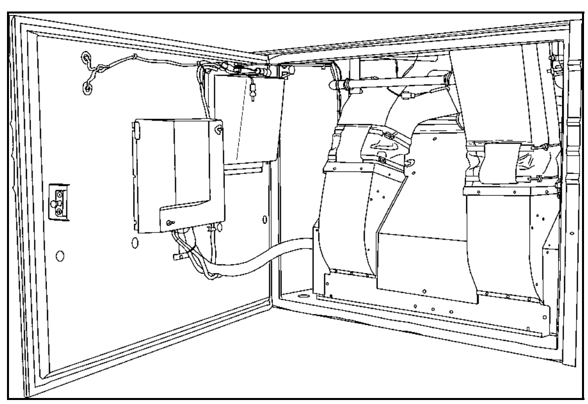


FIGURE 6: EVAPORATOR COMPARTMENT 22178F

The evaporator fan motor, located in the evaporator compartment, is protected by a 90 amps, manually-resettable (CB4) circuit breaker mounted in the engine compartment, on the circuit breakers panel (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 two axial fans. The fan motors are protected by a manually-resettable 70 amp circuit breaker (CB 5) and a 40 amp circuit breaker (CB 8) also mounted in the engine compartment, on the circuit breakers panel (Fig. 7).

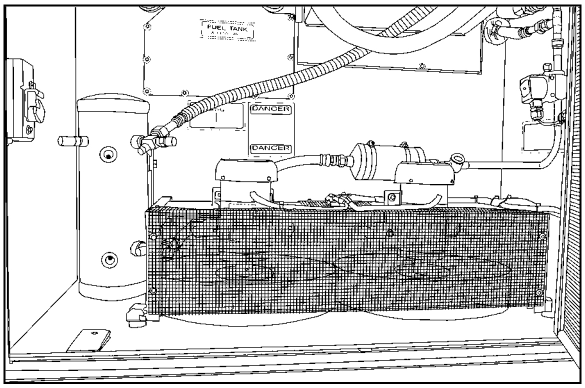


FIGURE 7: CONDENSER COMPARTMENT

Furthermore, the following relays, diodes and multiplex module are located in the evaporator compartment (Fig. 8). They are mounted in the HVAC junction box located inside the evaporator compartment door.

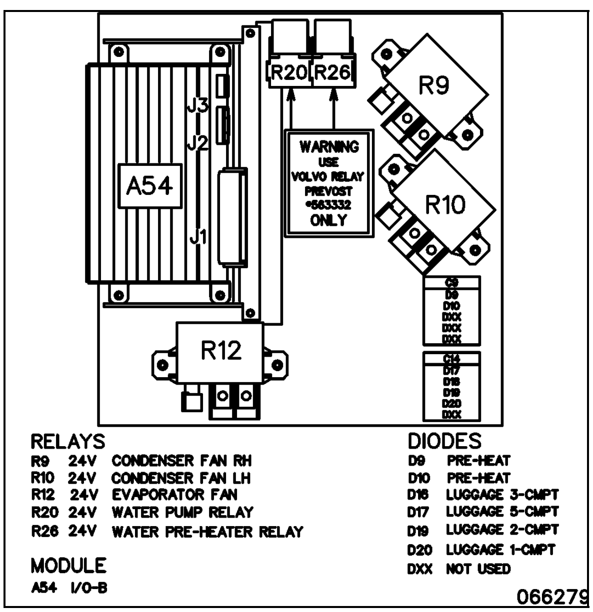


FIGURE 8: A/C JUNCTION BOX

Multiplex Module (evaporator compartment)	
A54	I/O-B
Relays (evaporator compartment)	
R9	24V Condenser fan R.H.
R10	24V Condenser fan L.H.
R12	24V Evaporator fan
R20	Water pump
R26	Pre-heating
Diodes (evaporator compartment)	
D9	Pre-heating
D10	Pre-heating
D16	Baggage compartment -3
D17	Baggage compartment -5
D19	Baggage compartment -2
D20	Baggage compartment -1
DXX	Not used

6. HVAC UNIT MAINTENANCE

No special maintenance is required on the cabin and driver's 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.

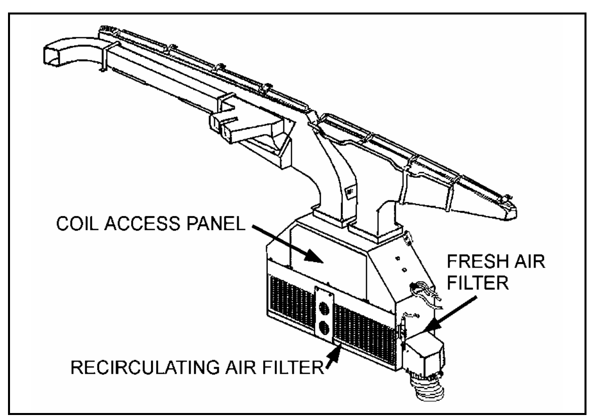


FIGURE 9: DRIVER'S HVAC UNIT COIL ACCESS PANEL

For the cabin HVAC unit evaporator, remove the evaporator motor & coil access panel. Back flush the coil (Fig. 10 & 11) every 12,500 miles (20 000 km) or once a year, whichever comes first.

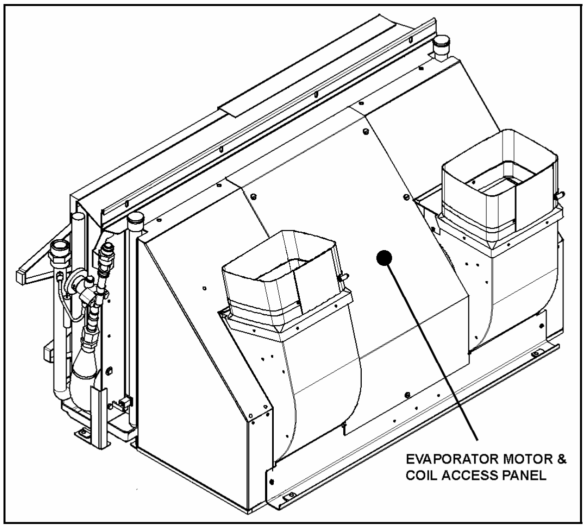


FIGURE 10: EVAPORATOR COIL ACCESS PANEL 22244

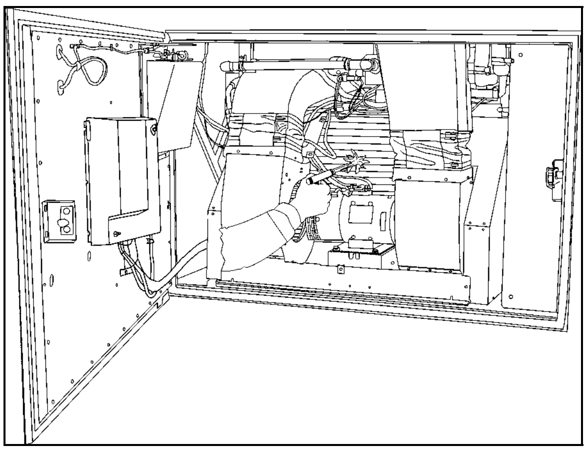


FIGURE 11: EVAPORATOR COIL CLEANING

For the condenser coil, back flush the coil (Fig. 12) 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.

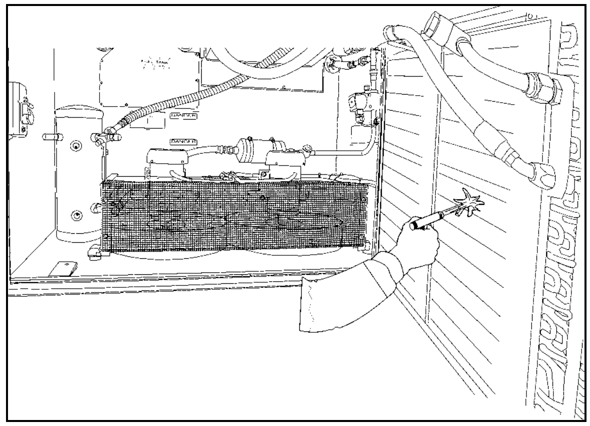


FIGURE 12: CONDENSER COIL CLEANING 22243A

⚠ **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.

6.2 DRIVER'S HVAC UNIT & CABIN HVAC UNIT AIR FILTERS

The driver’s HVAC unit 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 R/A and F/A filters. To clean filters back flush with water, then dry with air, every 12,000 miles (20 000 km) or once a year, which-ever comes first (Fig. 13 & 14).

NOTE
If the windshield is continuously fogged, check that the driver’s air filter is not clogged.

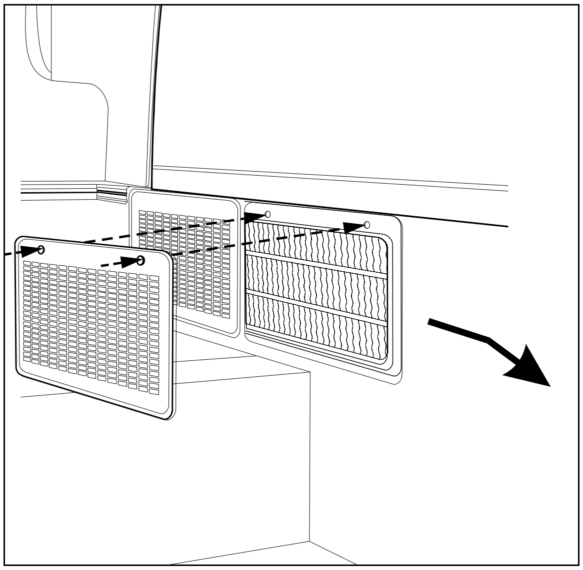


FIGURE 13: ACCESS TO DRIVER'S HVAC UNIT AIR FILTERS 22172

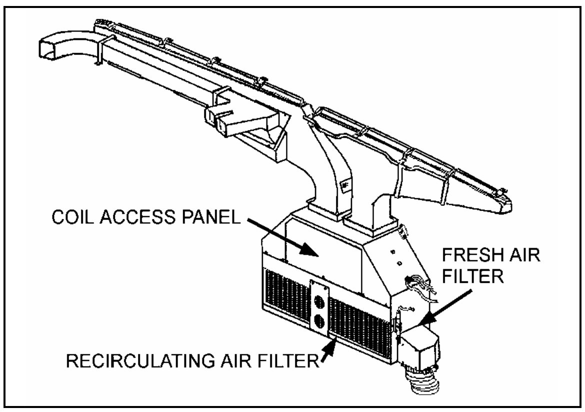


FIGURE 14: DRIVER'S HVAC UNIT AIR FILTERS

The cabin HVAC unit air filters are located in the evaporator compartment on driver's side of the vehicle. To access, open the baggage compartment forward of the evaporator compartment. An access door held shut by three retaining tabs is located in the wall separating the baggage compartment and the evaporator compartment. Remove the access door, slide out the top then bottom filter for maintenance purposes. (Fig. 15). To clean filters, back flush with water or soapy water, then dry with air every 12,000 miles (20 000 km) or once a year, whichever comes first.

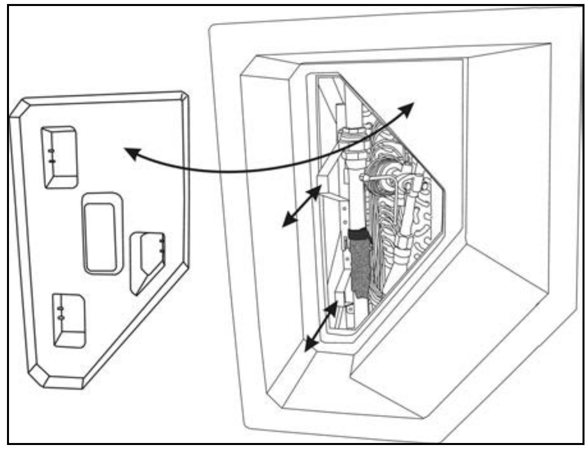


FIGURE 15: CABIN HVAC UNIT AIR FILTERS 22179

CAUTION

Do not use high pressure water jet to avoid damaging filter.

CAUTION

Be sure not to reverse filter upon installation.

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, and hot water solenoid valve.

7.3 PARTICULARITIES

Conditions for engaging the 2nd speed on the evaporator motor (cooling demand).	The 2nd speed engages if the cabin area air 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 cabin area air temperature and the set point.	**2 left compressor cylinders:** Stop if: Cabin area air 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 area air 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 area air temperature is at less than 0.2°C above the set point or if the compressor input falls below 23 psi. Restart if: Cabin area air 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 area Cabin temperature display indicates two dashes "--"	Problem with the temperature sensor located on L.H. side of vehicle, underneath the wire mesh opening in the floor or the sensor wiring	Driver must manually control the temperature by playing with the cabin 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 3. Check / replace fuse F5
HVAC condenser fans not functioning in speed 1	Circuit breaker CB5 was manually tripped and not reset Seized bearing Faulty brushes Bad wiring	Check / reset circuit breaker CB9
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 CB7 3. Check / replace fuse F67 , F68
HVAC condenser fans not functioning in speed 2	Circuit breaker CB5 was manually tripped and not reset Seized bearing Faulty brushes Bad wiring	Check / reset circuit breaker CB5
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.

Problem/Symptom	Probable Causes	Actions
		2. Check / reset circuit breaker CB7 3. Check / replace fuse F12
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 CB7 3. Check / replace fuse F65
Evaporator fan not functioning	Circuit breaker CB4 tripped Module A54 is not powered or is faulty Faulty brushes	1. Check / reset circuit breaker 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 4. Check / replace fuse F67 , F68

8. CENTRAL HVAC SYSTEM - AIR CONDITIONING

The schematic of Figure 16 shows the central A/C system and its components. The central system is equipped with a 6 cylinder, 05G-134A Carrier compressor with an air conditioning capacity of 7½ tons. The receiver tank and filter dryer are mounted inside the condenser compartment.

XLII Converted vehicles may be supplied with a central or small A/C system (Fig. 16 and 40). For vehicles equipped with a small A/C system, refer to paragraph 10: SMALL HVAC SYSTEM – AIR CONDITIONING 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 Figures 16 and 41.

The air conditioning system used on XLII series vehicle 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 back to the condenser sub-cooler. It leaves the condenser and 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 main 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 metal cylinders. It is serviced in 30 and 100 pound (13,6 and 45 kg) cylinders. Approximately 24 pounds (10,9 kg) are used in the system.

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.

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.

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.

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.

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 there happens to be liquid refrigerant 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.

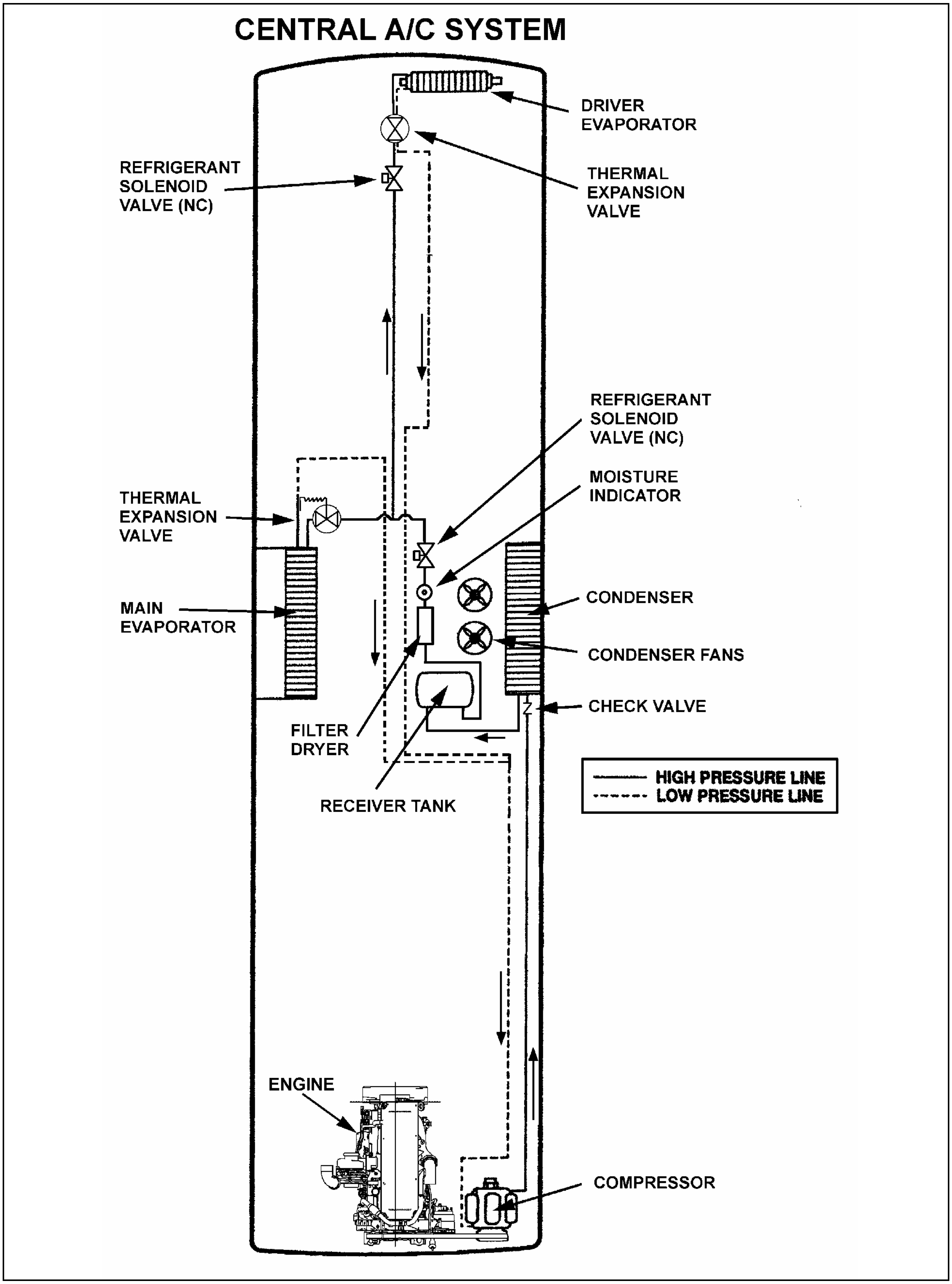


FIGURE 16: REFRIGERANT CIRCUIT (CENTRAL SYSTEM)

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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.

8.3 PUMPING DOWN

This procedure is intended to reduce refrigerant loss, on 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 a small A/C system only, refer to "Small HVAC System - Air Conditioning Components": paragraph 10.9 "OIL RETURN OPERATION" and 10.3.4 "Refrigerant Recovery", further in this section.

WARNING
To prevent any injury, when air conditioning system must be opened, refer to previous paragraph "Precautions in Handling Refrigerant Lines".

CAUTION
The filter dryer must be changed each time a line in the system is opened.

Procedure

1. Energize cabin side 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 the A/C switch, adjust *"A/C 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.
10. After the second “sweep”, change the filter drier (if you have not 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.

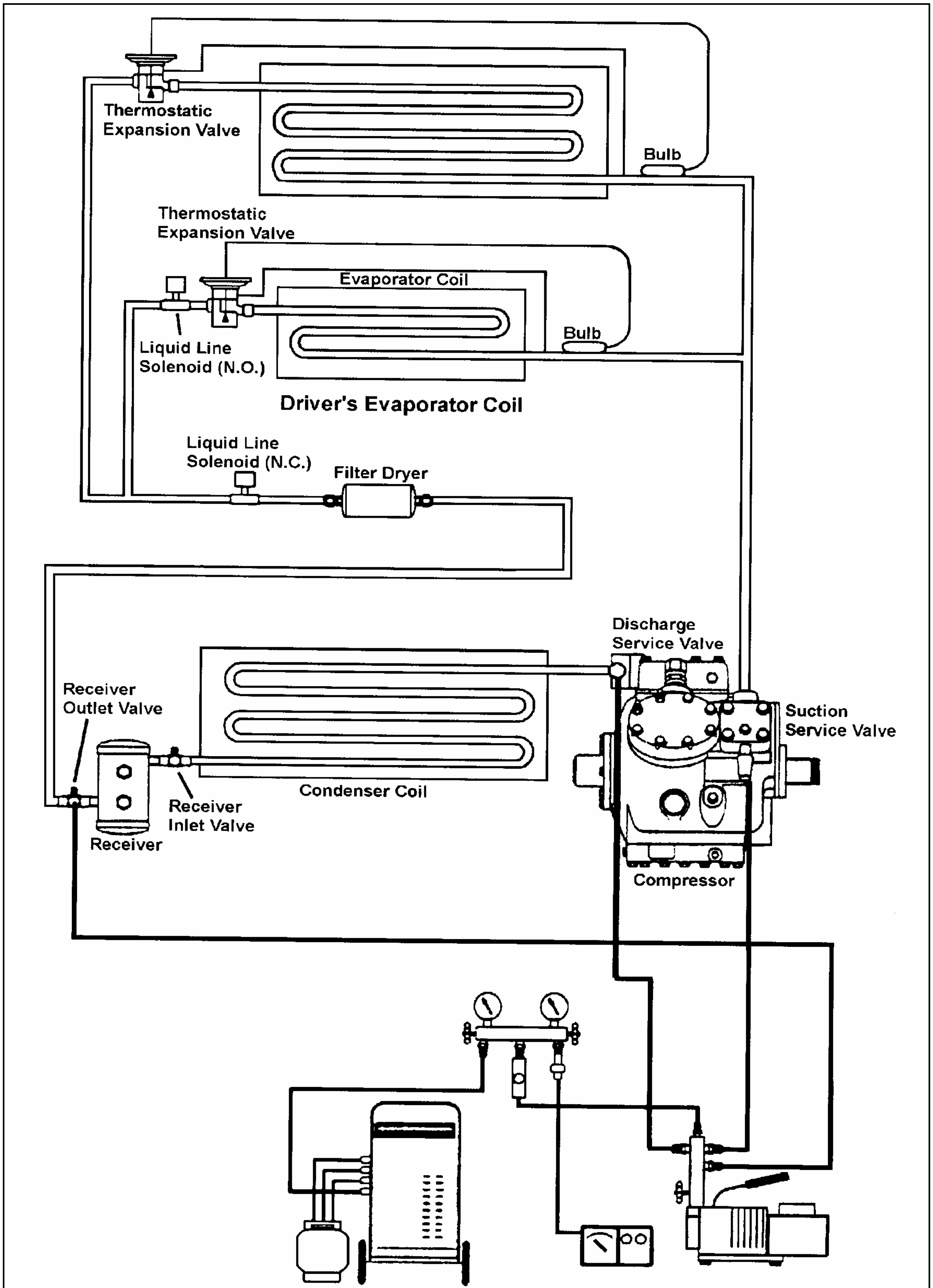


FIGURE 17: DOUBLE SWEEP EVACUATION SET-UP

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).

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 with the reclaimer 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 HVAC SYSTEM – AIR CONDITIONING COMPONENTS

9.1 COMPRESSOR (CENTRAL SYSTEM)

9.1.1 Belt Replacement

DANGER

Turn the ignition key switch to the “Off” position. For greater safety, trip circuit breakers CB1 & CB2 and 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. 18), 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. Slip the old belts off and the new ones on.
3. Reset belt tensioner pressure releasing valve (Fig. 18) to 45 psi (310 kPa) to apply tension on the new belts as explained in Section 12.

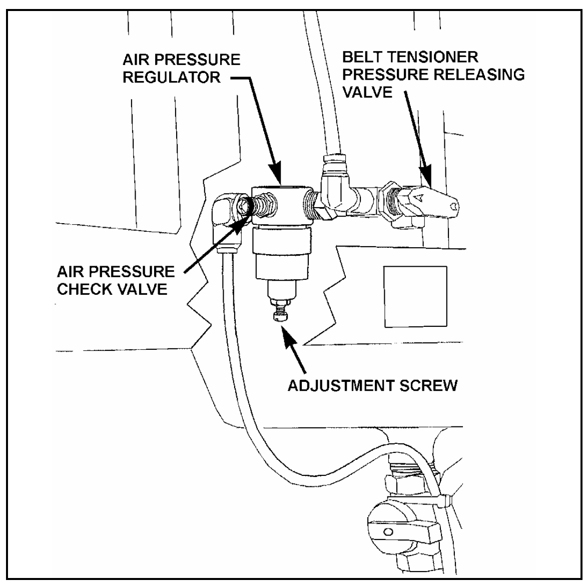


FIGURE 18: AIR PRESSURE REGULATOR 12200

NOTE

Both belts must always be replaced simultaneously to ensure an equal distribution of load on each of them.

NOTE

For proper operation of the air bellows, adjust the ***upper*** *tensioning bracket to provide a ¼ inch (7 mm) gap between stopper and bracket with the pneumatic system under normal pressure and the air pressure regulator set as per paragraph #3 (Fig. 19).*

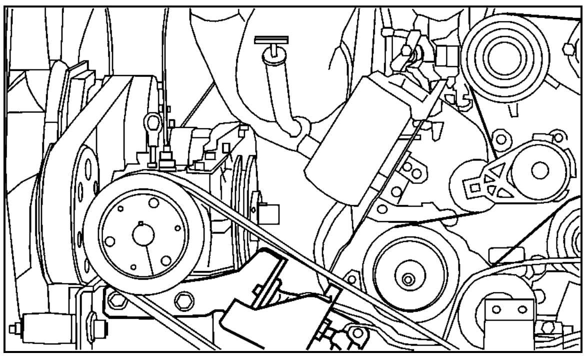


FIGURE 19: BELT TENSIONER 01059

9.1.2 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 tensioners by means of the air pressure releasing valve. After completing these procedures reset belt tensioner air pressure regulator to 45 psi (310 kPa).

9.1.3 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. 20 & 21).
2. Check the distance between each extremity of straight edge (1. Fig. 21) 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.

9.1.4 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. 21) 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.

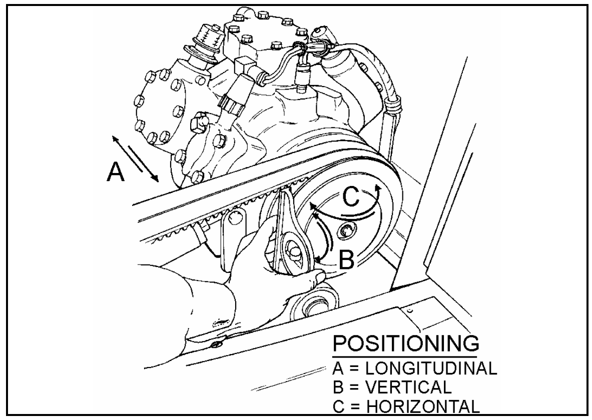


FIGURE 20: COMPRESSOR ALIGNMENT 22072

9.1.5 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 (Figs. 20 & 21). If it is not the same, shim under the appropriate pillow block in order to obtain the correct angle.

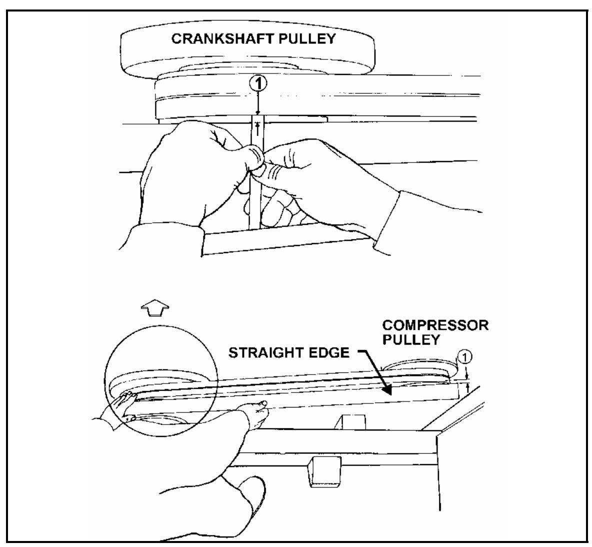


FIGURE 21: COMPRESSOR ALIGNMENT 22040

9.1.6 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.

9.1.7 Troubleshooting Guide

A preliminary check may be made by simply feeling the cylinder heads with the unit in operation at ambient temperatures of 35°F (2°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
(Central HVAC system only)

The evaporator motor is installed in the evaporator compartment (L.H. side of vehicle) (Fig. 16). It is a 27.5 volt, 2 HP (1.5 kW) motor which activates a double blower fan unit.

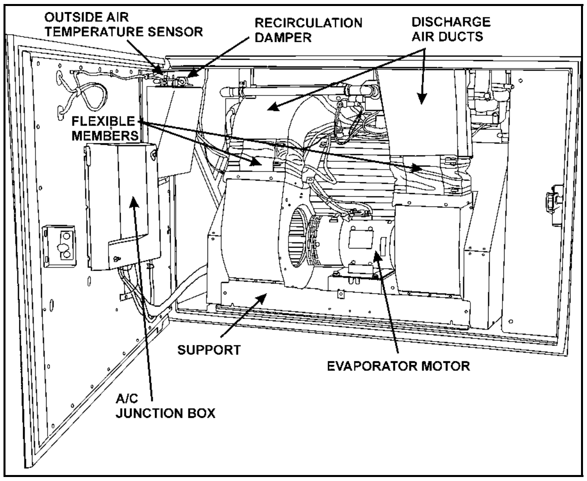


FIGURE 22: EVAPORATOR COMPARTMENT 22314

9.3.1 Removal

1. Set the ignition key switch to the *"OFF"* position and trip circuit breakers CB1 & CB2.
2. 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.
3. Remove the evaporator motor and coil access panel.
4. Identify the L.H. side discharge duct inside compartment and remove the Phillips head screws retaining the flexible member to duct.

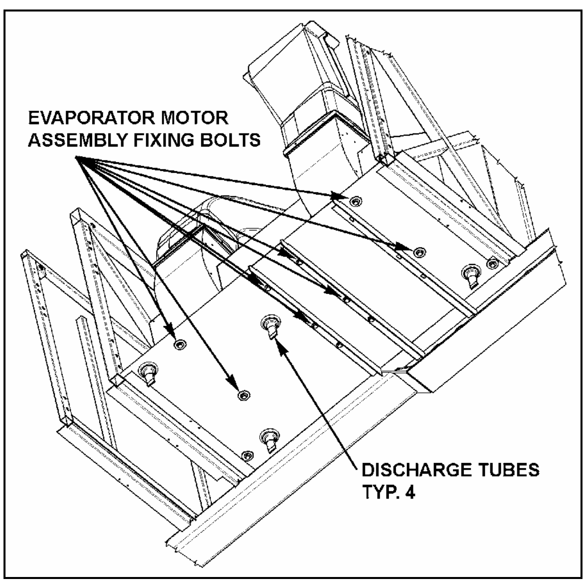


FIGURE 23: EVAPORATOR MOTOR ASSY FIXING BOLTS

5. Repeat step 4 for the R.H. side air duct.
6. Disconnect the electrical motor speed control connections on the motor plate.
7. From under the vehicle, remove the eight bolts retaining the evaporator fan motor support. Remove the complete unit from the evaporator compartment (Fig. 23 & 24).

⚠ CAUTION
Never support evaporator motor by its output shafts while moving it.

8. 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.

9.3.3 Checking Operation of Brush in Holder

Lift brush slightly 1/8 inch (3 mm) and release it. The spring should push the brush freely back into the holder securing it against the commutator.

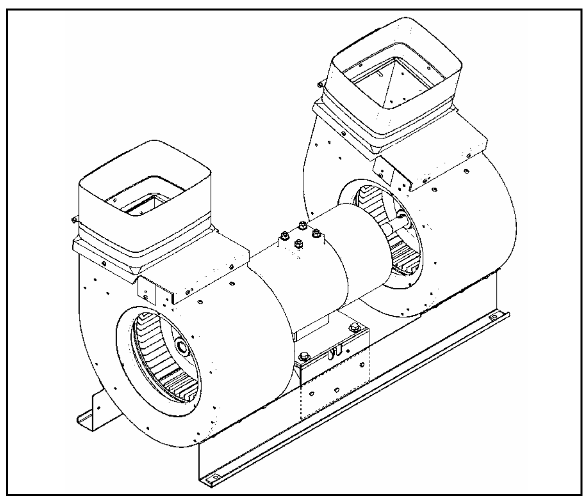


FIGURE 24: EVAPORATOR MOTOR ASSEMBLY 22316

9.3.4 Brush Wear Inspection and Replacement

⚠ CAUTION
Only use replacement brushes recommended by the manufacturer. Not doing so will void warranty.

Replace the brushes if less than ¾ inch (19 mm). New brush length is 1-¼ inch.

To replace brushes, proceed as follows:

1. Set ignition key switch to the “OFF” position.
2. Remove the protective screen band from the motor housing by pulling down the spring loaded fastener.
3. Lift the spring, remove and replace brushes as per the following procedure: “SEATING BRUSHES”.
4. Reverse installation procedure.

9.3.5 Seating Brushes

Grinding consists in giving to the seating face of a new brush the exact same curvature of the commutator so that good mechanical and electric contact of the brush is made.

For best results, remove oil and grease from commutator before applying brush seater.

NOTE
The new motor brushes are provided with a preformed seating face which is approximately the same curvature as the commutator. Grinding/honing will give an exact match in curvature. The advantage of preforming is to appreciably shorten the time required for grinding.

Grinding is generally done on the machine itself, in accordance with various processes' and conformably to the importance and the type of machines:

a) Grinding with abrasive cloth (60 grit sandpaper) applied to the commutator must be done by hand. With the new brushes installed in brush holders and pressing against the abrasive cloth, rotate the armature (by hand) until satisfactory seating of each brush is achieved (Refer to figure 25). It is necessary to avoid raising the cloth under the brushes otherwise it would result, after grinding, to reduce and badly definite surfaces (Refer to figure 26).

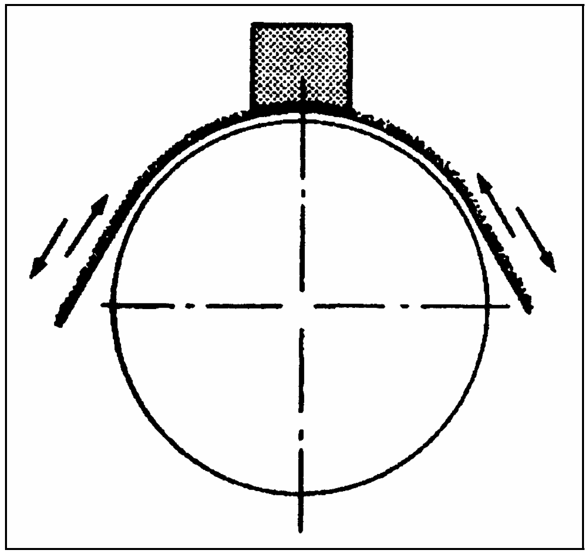


FIGURE 25: PROPER GRINDING TECHNIQUE 22317

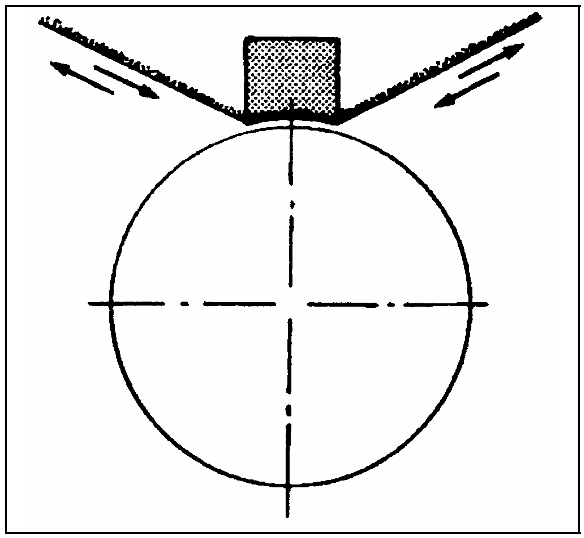


FIGURE 26: IMPROPER GRINDING TECHNIQUE 22318

CAUTION
If grinding with a honing stone, you must disconnect the time delay in order to keep the motor in 1st speed. If you prefer, you may also install a jumper on the evaporator motor between terminal E2 and A1 to bypass relay R60 and keep the motor in 1st speed as well.

b) Grinding with the honing stone is always done under reduced voltage. Dust particles act like abrasive and wear down the brushes exactly with the profile of the commutator. **Caution is advised here as prolonged honing could wear the brushes and commutator prematurely.**

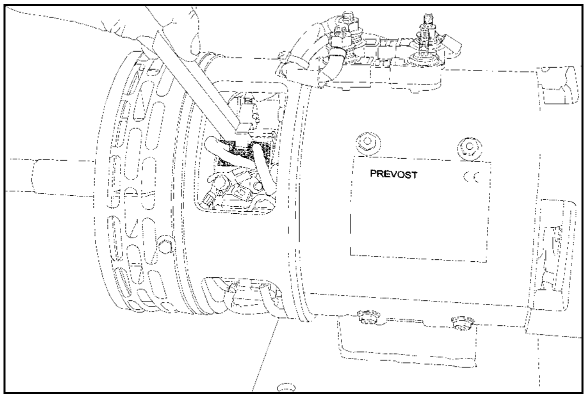


FIGURE 27: GRINDING WITH THE BRUSH SEATER STONE 22319

Repeat method a or b until brushes are fully seated. **Seating surface of the brush must be no less than 80% of the face (Refer to figure 28).**

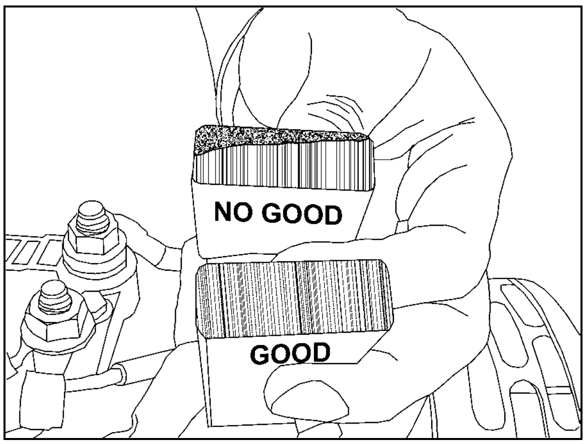


FIGURE 28: SEATING SURFACE OF THE BRUSH 22320

CAUTION

After grinding with the sandpaper or the honing stone, it is necessary to remove the brushes from the brush holders and vigorously clean with an air gun the commutator and the seating faces of the brushes to eliminate abrasive dust and dust from brushes.

DANGER

Use a dust mask to prevent inhalation of dust particles. Protect against electrical shock when working on energized equipment. Protect against falling or slipping when working on rotating equipment.

CAUTION

If grinding is not carried out or is carried out in an incorrect way, the brush may seat against a restricted zone only, which will create a high amperage situation for the commutator as for the brushes and could seriously damage the motor.

After grinding is completed, it is necessary to check the evaporator motor amperage in 1st speed and in 2nd speed. **Make sure that the evaporator compartment door is closed and that the reading is 30 A ± 3 in 1st speed.**

Confirm that the reading is 64 A ± 4 (MAX 68 A) in 2nd speed.

9.3.6 Brush Holder Adjustment

NOTE

The brush holders are mounted on a support that can rotate. Rotating that rocker ring will move all the brush holders at the same time.

1. Remove the screws securing the grid and remove the grid. Locate the 2 bolts fixing the mechanism permitting the rotation of the brush rocker ring.
2. Loosen (do not remove) the bolts just enough to release the mechanism.
3. Move gently the exposed brush holder in order to have **30 A ± 3 in 1st speed and 64 A ± 4 in 2nd speed when the door is closed** and a maximum distance of 10 mm (3/8 inch) between the brush face and a reference line passing through the center of the 2 bolts on the motor housing.

CAUTION

If rotating the rocker ring is necessary, it is preferable to mark off the angular position of the rocker ring before unfastening the bolts fixing the mechanism in order to get back to the factory setting at the end of the operation.

NOTE

Take a final reading in 1st and in 2nd speed after tightening the brush holder bolts. The amperage may have changed.

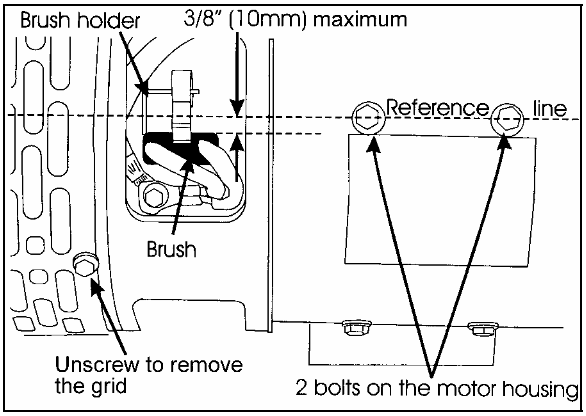


FIGURE 29: EVAPORATOR MOTOR 22321

> **CAUTION**
>
> To avoid damaging the motor, make sure all vehicle doors are closed when taking the readings.

9.3.7 Checking Commutator

The surface must be polished. A brown-black colored surface is normal and indicates a good switching. Ensure there is no evidence of arcing or metal chips.

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. 31). 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

Two fan motors (Fig. 30), 28.5 V - (0.6 HP - 0.42 kW) and cages 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 floor. 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.

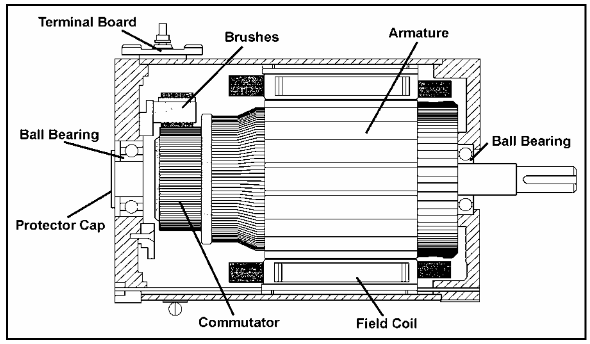


FIGURE 30: CONDENSER FAN MOTOR 22234

9.4.2 Condenser Fan Motor Removal

1. Set the ignition key switch to the *"Off"* position.
2. Remove the two *"Phillips"* head screws retaining the fan motor protective cover to the square tubing. Remove the protective grill from mounting support.
3. Disconnect wiring from terminals on motor. Tag each wire to aid in identification at time of reconnection.
4. Support motor, and remove bolts which attach motor to mounting bracket. Remove the motor.

9.4.3 Preliminary Disassembly

1. Remove the brushes.
2. Unscrew the flange retaining screws on the shaft end side (opposite to the commutator end frame), and separate flange from frame (Fig. 30).
3. Remove flange and armature assembly by pushing bearing shaft toward the commutator end frame.
4. Separate flange from armature.

9.4.4 Disassembly

1. Perform preliminary disassembly.
2. Carefully note the position of the brush holder ring and the connections on the flange support.
3. Unscrew and remove the flange on the commutator end frame.

4. Remove the brush holder ring.
5. Finally, separate the following parts: brush holders, brush boxes, terminal board, bearings, etc.

9.5 RECEIVER TANK

The receiver tank is located in the condenser compartment (Fig. 31). 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.

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.

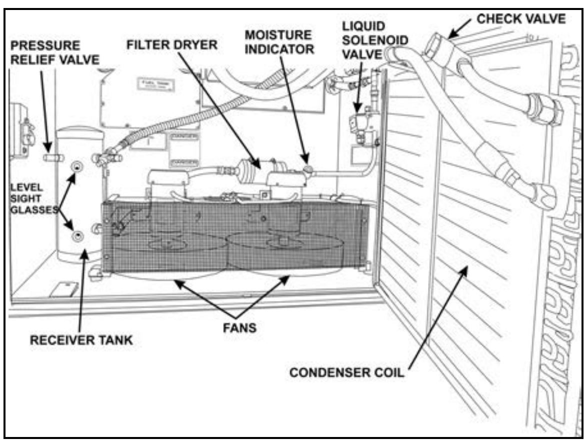


FIGURE 31: A/C CONDENSER COMPARTMENT 22243B

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.

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.

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)			

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.

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 (Refer to fig. 31 & 32). The driver's liquid refrigerant solenoid valve is located on the ceiling of the spare wheel and tire compartment and is accessible through the reclining bumper.

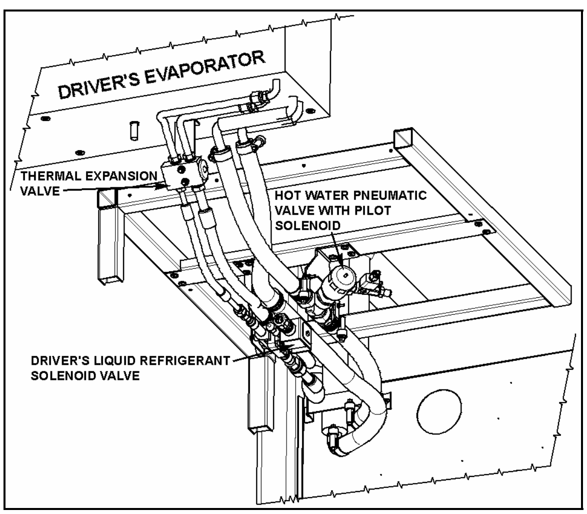


FIGURE 32: DRIVER'S LIQUID REFRIGERANT SOLENOID VALVE 22181

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. 33).
4. Carefully lift the bonnet assembly off (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.

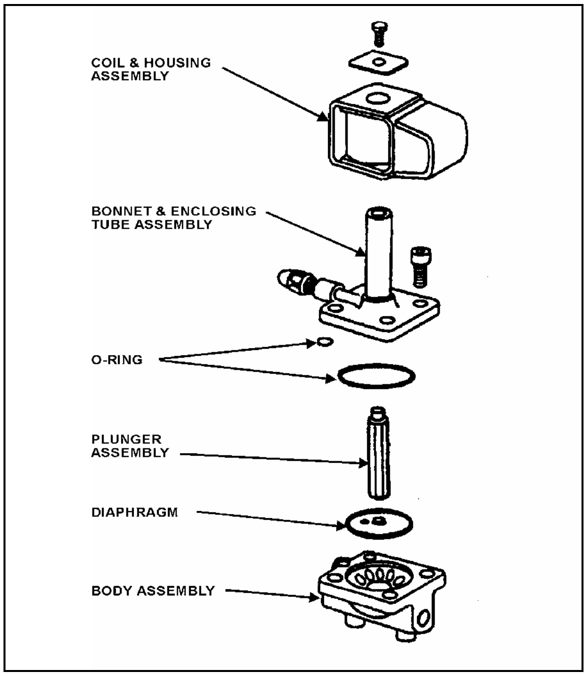


FIGURE 33: REFRIGERANT SOLENOID VALVE 22044

9.8 EXPANSION VALVE

9.8.1 Cabin HVAC Unit

The expansion valve for the cabin HVAC unit is a thermo-sensitive valve with a remote control bulb head attached to the evaporator outlet line and is accessible by the cabin air filters access door (Fig. 15 & 16). 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.

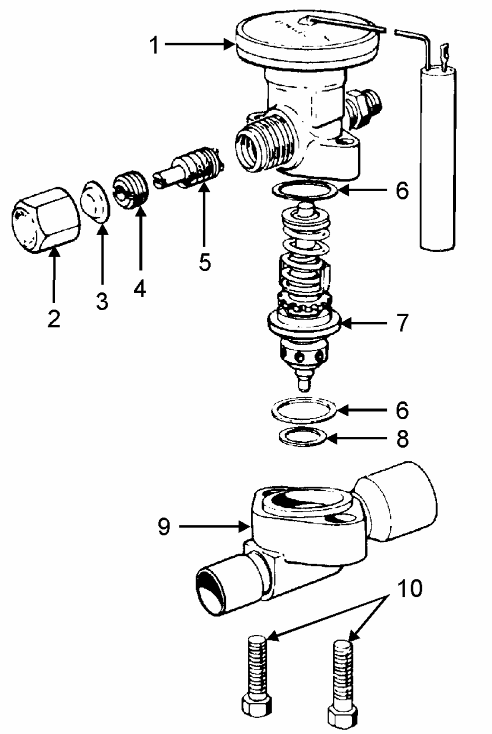
The remote bulb and power assembly is a closed system. The pressure within the remote bulb and power assembly corresponds to the saturation pressure of the refrigerant temperature leaving the evaporator and moves the valve pin in the opening direction. Opposed to this force, on the under side of the 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.

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^{o} F (-11.1 to -8.8 ^{o} 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.



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
10. CAPSCREW

FIGURE 34: EXPANSION VALVE 22045

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. 35). Afterwards, the following procedure should be followed:

1. Operate vehicle 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.

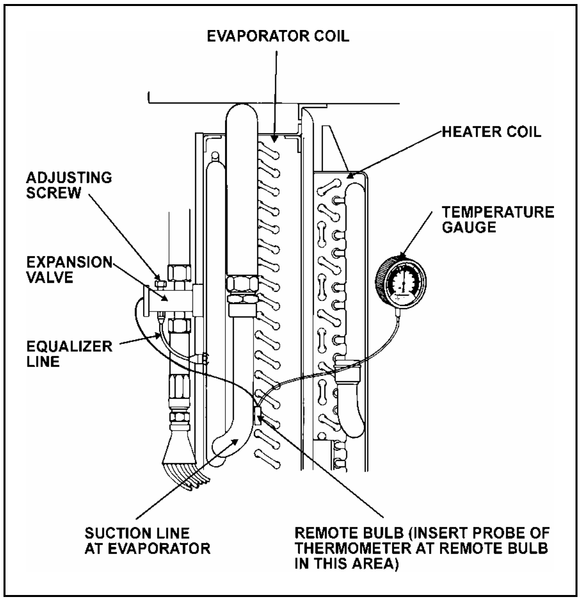


FIGURE 35: SUPERHEAT ADJUSTMENT INSTALLATION 22046

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.
3. Install a remote reading thermometer to the evaporator outlet line near the existing remote bulb (Fig. 35).
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.
6. Check approximately 5 readings of pressure at 2-minute intervals and convert to temperature using the temperatures & pressures table (page 31). 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. 36).

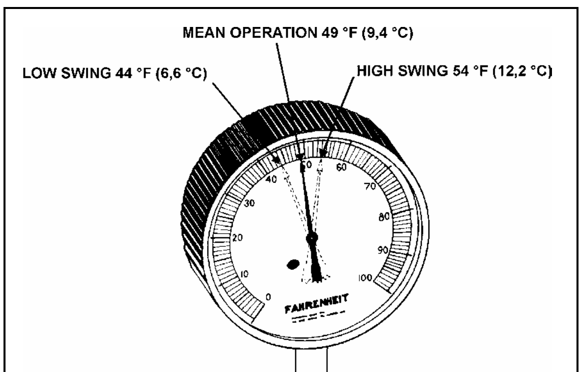


FIGURE 36: HIGH & LOW SWING TEMPERATURE AT REMOTE BULB 22047

Example of readings taken at fig. 36:

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 clogged up 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 HVAC unit but no superheat adjustment is required (see figures 16 and 32).

9.9 TORCH BRAZING

Use an electrode containing 35% silver.

CAUTION

When using heat near a valve, wrap with a rag saturated with water 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 screens clogged.	Clean or replace air filter screens.
Clogged 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 coil dirty.	Clean condenser coil.

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. Clogged return air ducts.	Dirty or iced evaporator coil. Clean air filter screens. 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.)

<table>
<tr><th>TROUBLE</th><th>CAUSE</th></tr>
<tr><td></td><td>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.</td></tr>
<tr><td colspan="2">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.</td></tr>
</table>

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

VAPOR-PRESSURE			
TEMPERATURE		PRESSURE	
°F	°C	psi	kPa
180	82.2	385.9	2660.8
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 and 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 HVAC SYSTEM - AIR CONDITIONING COMPONENTS

Small A/C system comes with a 6 cylinder, TM-16HD Seltec compressor with an air conditioning capacity of 2 tons.

10.1 COMPRESSOR

MODEL	TM-16HD
TYPE	Swash-plate type
Number of cylinders	6
Bore	36 mm (1.42”)
Stroke	26.7 mm (1.05”)
Displacement	163 cm³ (10cu.in)
Permissible speed	700-6000 rpm
Refrigerant	HFC-134a
Lubricant	ZXL100PG 180 cm³
Mass	4.9 kg (10.9 lbs)

10.2 MAGNETIC CLUTCH

TYPE	Electromagnetic single-plate dry clutch
Rated Voltage	24 volts DC
Current consumption	3.75 amperes (max)
Stalling torque	49 Nm (36.1 Lbf-ft) min.
Rotation	CW/CCW
Mass	2.2 kg (4.9 lbs)

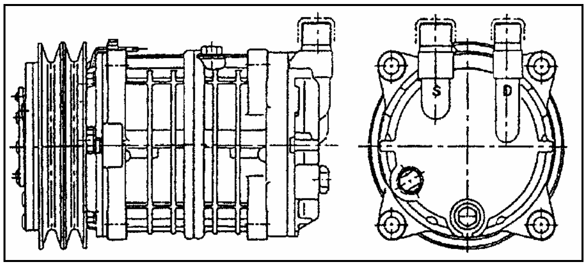


FIGURE 37: SELTEC TM-16HD COMPRESSOR

10.3 MAINTENANCE PRECAUTIONS

10.3.1 Work Area

Because the components of air conditioning systems are especially sensitive to moisture, dirt and dust, always observe the following procedures:

* Work indoors whenever possible.
* Select a level work area.
* Keep work area clean.
* Select a work area with adequate ventilation.

DANGER

Refrigerant itself is not harmful, but excessive accumulation in a closed area can cause oxygen deficiency.

* Keep open flame and flammables away from the vehicle in which the air conditioning system is being serviced. **Open flame is especially dangerous during Freon leak testing.**

DANGER

Contact with flame and high temperatures can generate toxic gases.

10.3.2 Refrigerant Handling

Never directly heat refrigerant cylinder or put in hot water heated above 40°C (104°F) since it may cause release of the safety plug or the cylinder may burst. When it is necessary to heat refrigerant cylinder for charging in cold weather, use warm water at a temperature below 40°C (104°F).

DANGER

Do not put the charge valve in warm water.

* Never store refrigerant cylinder in direct sunlight, near flame, or where the temperature exceeds 40°C (104°F). Always store refrigerant cylinder in a cool dry place.
* Never throw or strike refrigerant cylinder and never handle roughly.

10.3.3 PAG Oil Handling

Whenever a part replacement has to be done on the system, additional task about PAG oil will have to be performed.

The compressor has little reserve and is lubricated by the oil refrigerant mixture. To perform correctly, the compressor needs the mixture to be from 3% to 6% of Poly Alkaline Glycol (PAG) oil.

When a compressor has to be top off due to a severe lost, the amount of oil to be added should be evaluated with the refrigerant charge or a compressor oil change should be performed to rise up the compressor oil charge to 180 ml or the written charge on the nameplate.

* The oil should be free from moisture, dust, metal shavings, etc.
* Do not mix with other oils.
* The moisture content of the oil increases when exposed to the air for prolonged period. Therefore, after use, seal the container immediately.

DO NOT MIX PAG AND POE OR MINERAL OILS!

10.3.4 Refrigerant Recovery

Some air conditioning system refrigerant compounds are chlorofluorocarbons, and therefore may be damaging the earth's ozone layer. Consequently, the release of refrigerant into the atmosphere must be avoided. Whenever refrigerant is to be released from the air conditioning system, a refrigerant recovery unit must be used to recover the refrigerant. This refrigerant can then be recycled and reused, which is both environmentally safe and economical.

Approximately 7.0 lbs (3,2 kg) (W0) or 7.5 lbs (3,4 kg) (W5 and WE) are used in the system.

For complete system recovery, any of the High and Low service ports can be used (Refer to fig. 38, 42 & 43). Energize liquid refrigerant solenoid valve and measure the quantity of oil recovered. For the compressor only, use the service valve port and close the valves. The service valves open permits full flow of refrigerant to service port. Service valve closed permits flow of refrigerant from compressor to service port.

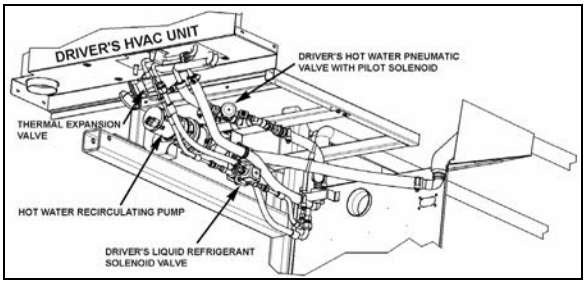


FIGURE 38: SMALL HVAC SYSTEM FRONT COMPONENTS

10.3.5 Compressor Handling

Do not strike, drop or turn the compressor upside down. If the compressor is knocked over or turned upside down, rotate the compressor's magnetic clutch 5 to 6 times by hand to circulate the oil which has settled in the cylinder. Sudden rotation with oil in the cylinder can cause valve damage and adversely affect durability.

10.4 COMPRESSOR REMOVAL

10.4.1 When the compressor is operational

* Perform the "OIL RETURN OPERATION" (Refer to paragraph 10.9).

10.4.2 When the compressor is inoperable

* Perform the "Refrigerant Recovery" operation (Refer to paragraph 10.3.4).

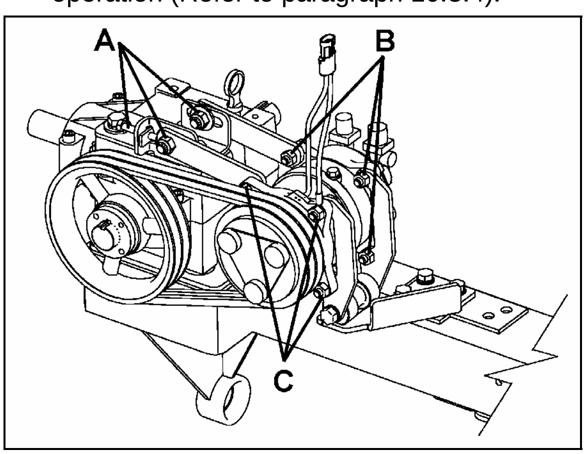


FIGURE 39: COMPRESSOR REMOVAL OR INSTALLATION 22285

* Slacken bolts A (Refer to figure 39).
* Remove bolts B & C (Refer to figure 39).
* Remove the compressor.

10.5 INSTALLATION PRECAUTIONS

The new compressor is filled with the specified quantity of compressor oil and nitrogen gas (N^2). When mounting the compressor on the vehicle, take the following steps:

* Loosen the discharge side connector's cap and gently release N^2 from compressor (Refer to figure 40).

NOTE
Take care not to let the oil escape.

* Slowly rotate the compressor's magnetic clutch several times by hand to distribute the oil which has settled in the cylinders (Refer to figure 41).

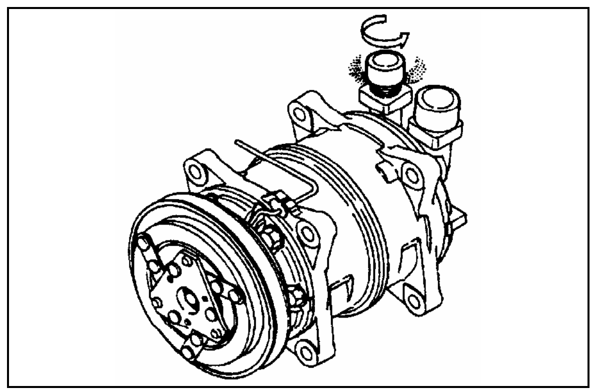


FIGURE 40: LOOSENING THE DISCHARGE SIDE CONNECTOR'S CAP

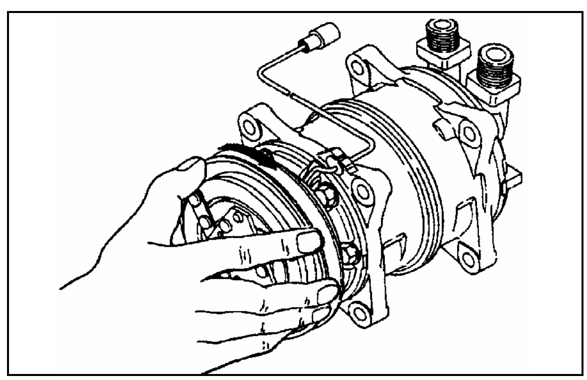


FIGURE 41: ROTATING MAGNETIC CLUTCH

* When using the old compressor in the system, the compressor should be installed after changing the oil.

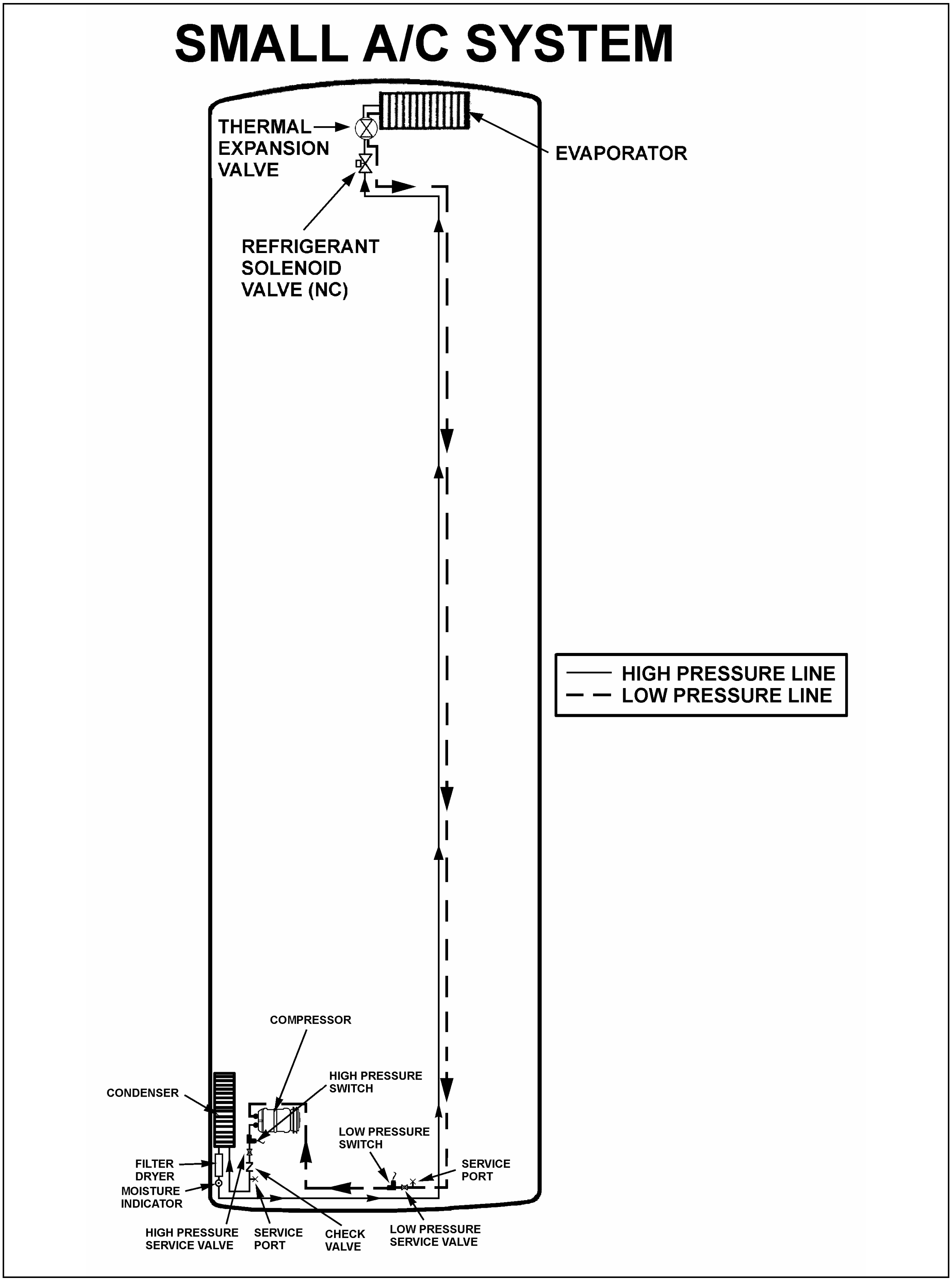


FIGURE 42: REFRIGERANT CIRCUIT (SMALL SYSTEM)

22336

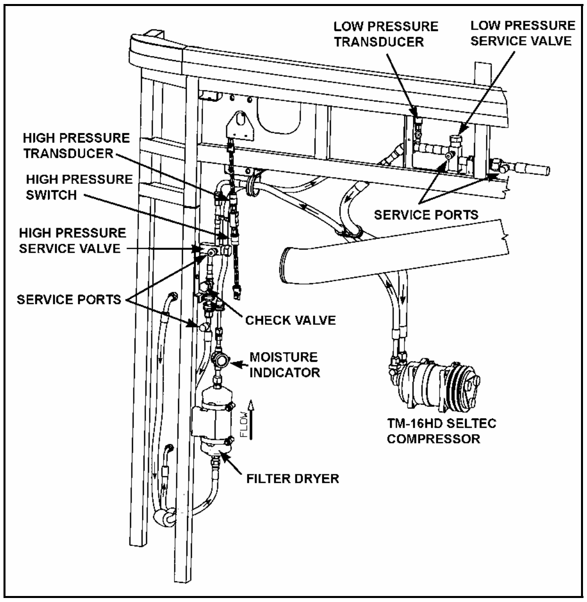


FIGURE 43: SMALL A/C SYSTEM REAR COMPONENTS

10.6 COMPRESSOR OIL CHANGE

Each compressor is delivered filled with the specified quantity of compressor oil, depending on the type of air conditioning system. A label describing the amount/type of compressor oil is attached to the compressor.

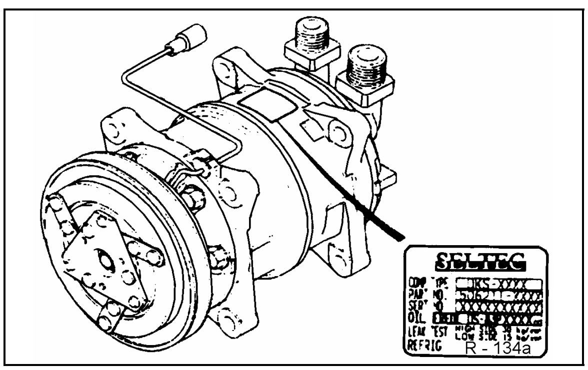


FIGURE 44: COMPRESSOR OIL LABEL

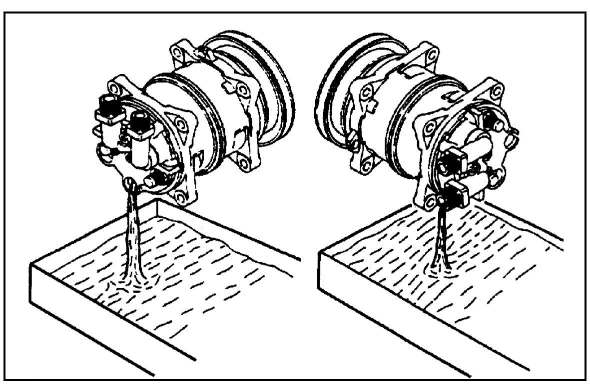


FIGURE 45: DRAINING THE OIL

* Check oil for contamination. Refer to PARAGRAPH 10.8: “COMPRESSOR OIL CONTAMINATION”.

* Tighten the oil drain plug with a new o-ring lightly coated with clean compressor oil to specified torque.

Torque: 13-15 Nm (9.4-10.8 Lbf-ft)

* Add new compressor oil through the suction-side connector with the amount specified on the label (180 ml).

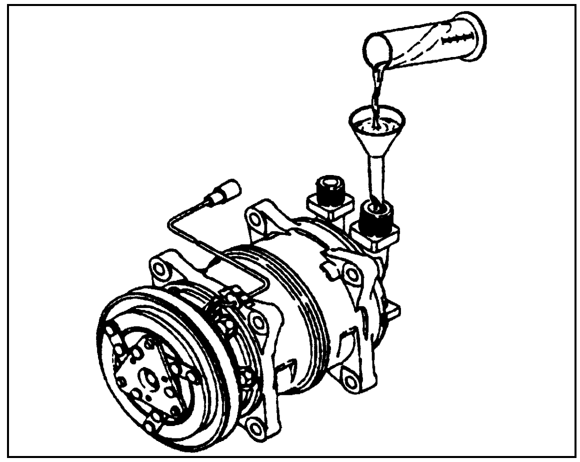


FIGURE 46: ADDING NEW COMPRESSOR OIL

10.6.1 Evacuating System Before Adding Refrigerant (Small System)

When a system has been opened for repairs, change the filter dryer and evacuate the system. XL2 MTH equipped with a small system must use high-pressure service port located on the other side of check valve and low-pressure port located alongside rear truss. (Figs. 42 and 43). 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.

10.7 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 cm^3 (1.7 ozs)
Condenser	30 cm^3 (1.0 ozs)
Filter-Dryer	10 cm^3 (0.3 ozs)

The amount of oil recovered with the refrigerant recovery should be added at the same time.

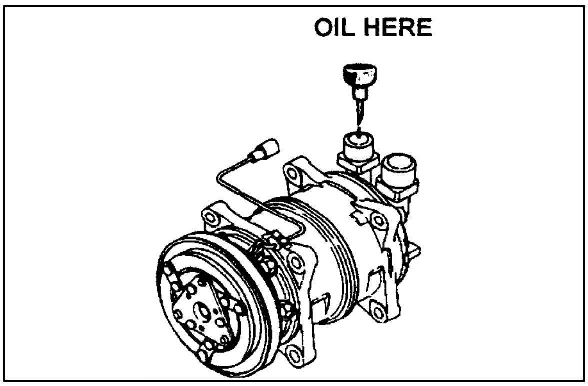


FIGURE 47: ADDING OIL AFTER REPLACING A COMPONENT

10.8 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.
  2. Replace the filter-dryer.
  3. Supply with new oil as specified in paragraph 10.6: “COMPRESSOR OIL CHANGE”.

10.9 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.

10.10 OIL CHECK INTERVAL

Unlike engine oil, it is not necessary to frequently check or change the compressor oil. However, it is necessary to check and replenish or replace the compressor oil in the following cases:

* Whenever the compressor, evaporator, condenser or filter-dryer is replaced.
* Whenever refrigerant has leaked from the system, evaluate the amount of oily spot.
* Whenever refrigerant is suddenly released from the cooling cycle, replenish the compressor (180 ml) plus 150 ml.
* Whenever any oil-related problems occur in the cooling cycle.

10.11 LEAK TEST PROCEDURE WITH COMPRESSOR REMOVED

When a compressor is repaired, it must be checked prior to installation.

* Install the discharge and suction caps to the connector.

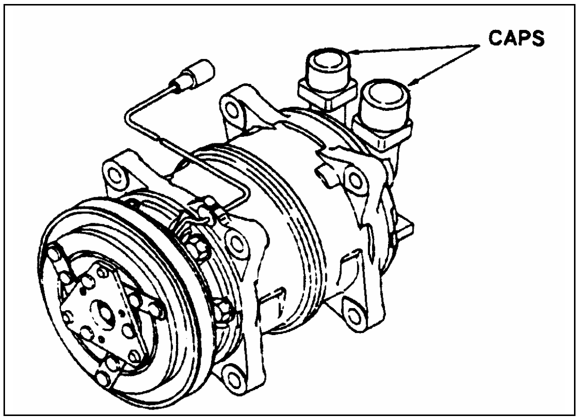


FIGURE 48: DISCHARGE AND SUCTION CAPS

* Fill the compressor with refrigerant through connector's suction port raising the pressure to at least 0.5 Mpa (70 psi).

* Check the compressor for leaks using a leak detector.

NOTE
Never leave the compressor upside down for longer than 30 seconds. This is because the oil inside the compressor will enter the cylinders, causing liquid compression which will damage the compressor's suction and delivery valves.

10.12 TIGHTENING TORQUES

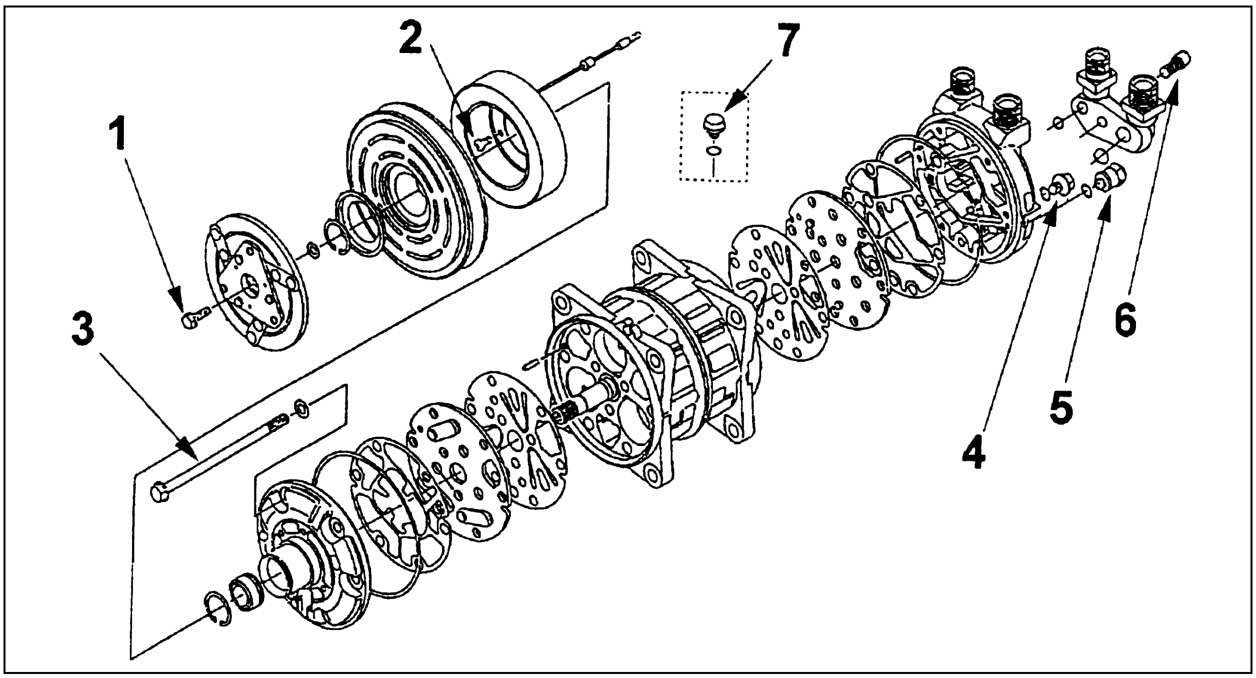


FIGURE 49: TIGHTENING TORQUES

PART	THREAD SIZE	TIGHTENING TORQUE
1. Bolt Armature	M6 x 1.0	12 - 14 Nm (8.7 - 10.1 Lbf-Ft)
2. Field Coil Screw	M5 x 0.8	4 - 6 Nm (2.9 - 4.3 Lbf-Ft)
3. Body Bolt	M8 x 1.25	20 – 24 Nm (14.5 – 17.3 Lbf-Ft)
4. Oil Drain Plug	M8 x 1.25	13 – 15 Nm (9.4 – 10.8 Lbf-Ft)
5. Pressure Relief Valve	3/8 – 24UNF	13 – 15 Nm (9.4 – 10.8 Lbf-Ft)
6. Connector Bolt	M8 x 1.25	20 – 24 Nm (14.5 – 17.3 Lbf-Ft)
7. Oil Filler Plug	M8 x 1.25	13 – 15 Nm (9.4 – 10.8 Lbf-Ft)

10.13 CONDENSER COIL

The condenser coil, for vehicles equipped with a small 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.

10.14 FILTER DRYER

The filter dryer is located close to engine compartment L.H. side door on vehicles equipped with the small A/C system (Refer to fig. 43). Its function is similar to that of filter used on central system. Replace only when system is opened or a problem occurs.

10.15 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.

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)			

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.

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.

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 area.

The schematic of Figure 50 shows the central heating system with its components.

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 HVAC unit or cabin 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. 51), 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. 52) to ensure an efficient draining.

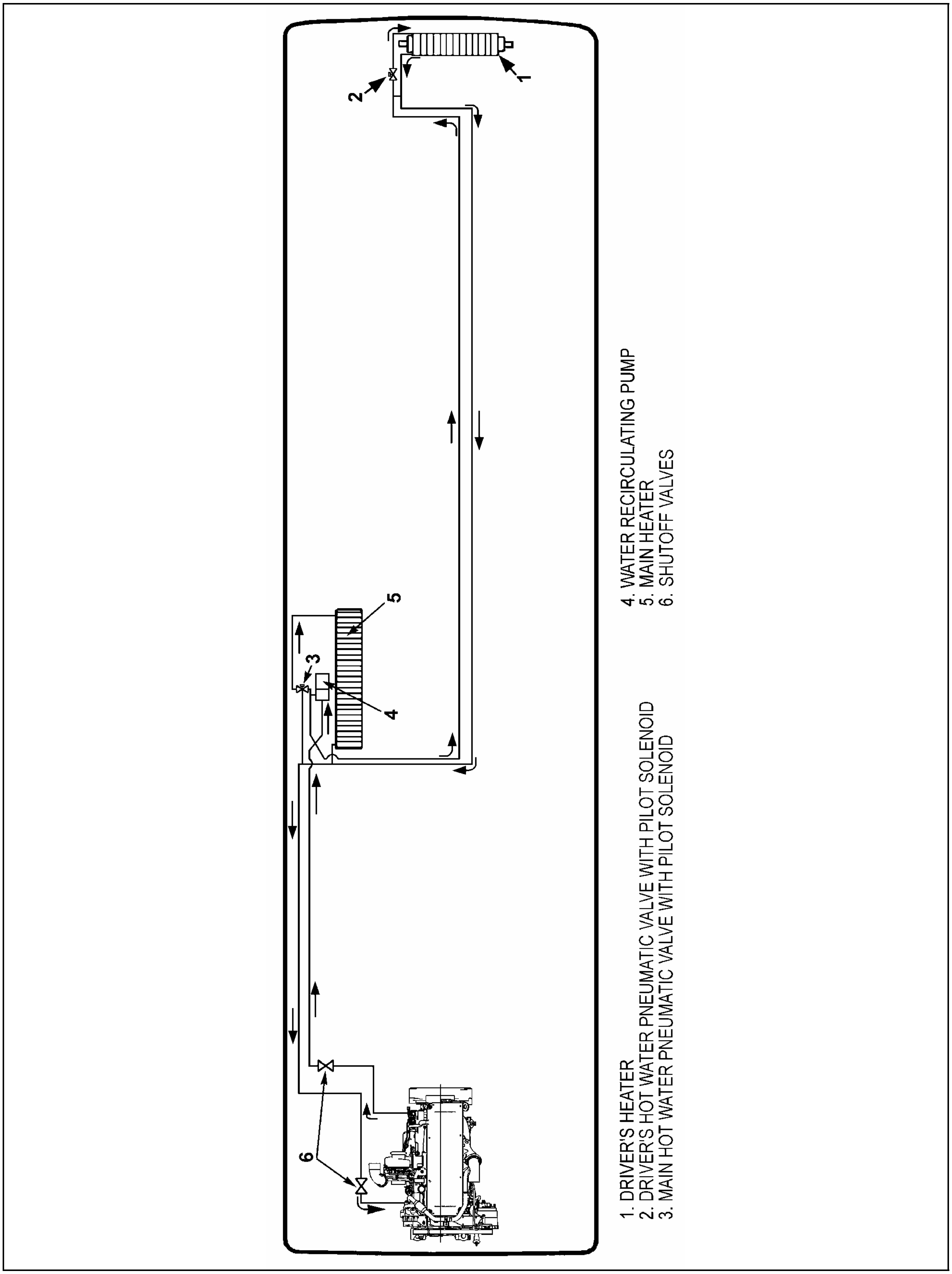


FIGURE 50: CENTRAL HEATING SYSTEM COMPONENTS 22338

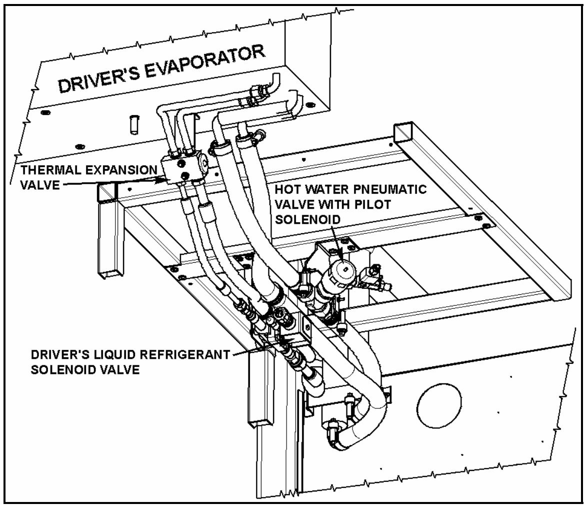


FIGURE 51: CEILING OF THE SPARE WHEEL COMPARTMENT 22181

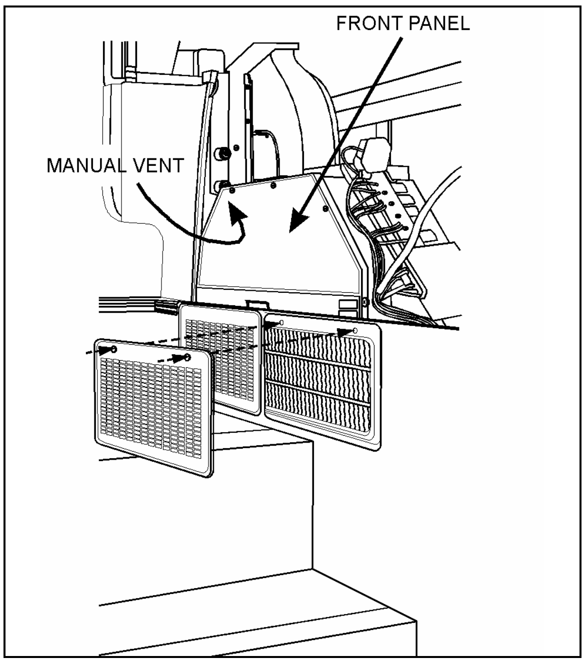


FIGURE 52: DRIVER'S HVAC UNIT 22172

- **Draining Cabin HVAC Unit Heater Core**

a) Stop engine and allow engine coolant to cool.

b) Close both heater line shutoff valves.

On XLII-40 & 45E vehicles, the valves are located in 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. 53).

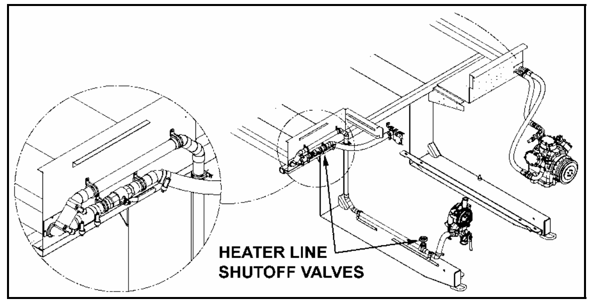


FIGURE 53: HEATER LINE SHUTOFF VALVES 05070

On XLII-45 vehicles, the valves are located in 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. 54).

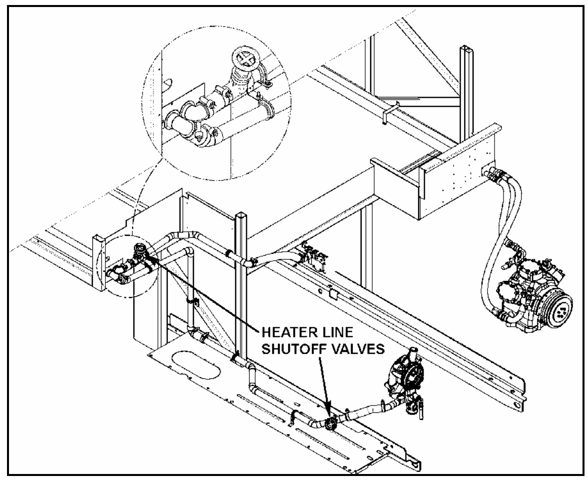


FIGURE 54: HEATER LINE SHUT-OFF VALVES 05067

c) The main heater core drain cock is located in the evaporator compartment. To access, open the baggage compartment forward of the evaporator compartment. An access door held shut by three retaining tabs is located in the wall separating the baggage compartment and the evaporator compartment (Fig. 15).

WARNING

Before proceeding with the following step, check that coolant has cooled down.

d) Open drain cock in bottom of heater core, you can unfasten a hose connection on top of heater core (Fig. 55) in order to allow air to enter while draining.

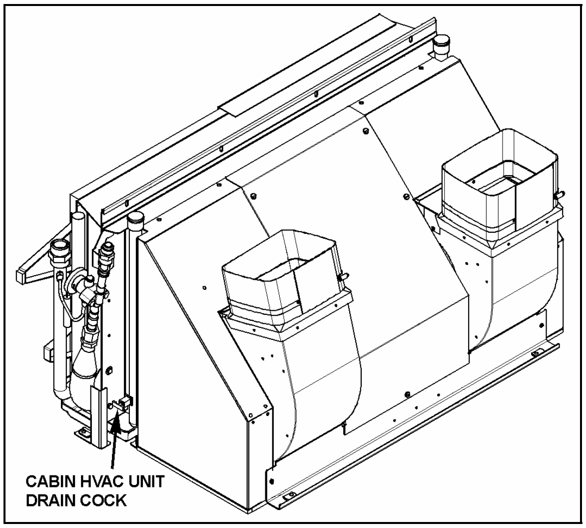


FIGURE 55: CABIN HVAC UNIT DRAIN COCK 22128

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 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 module, both driver's and cabin (passenger) areas, and set temperature to their maximum positions in order to request the heating mode in each of these areas.
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 52 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 [3,1 mm]). After completing repairs, test for leaks.

When using heat at or near a valve, wrap with a water saturated rag to prevent overheating of vital parts.

11.1.5 Driver's Hot Water Pneumatic valve Assembly

o **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.

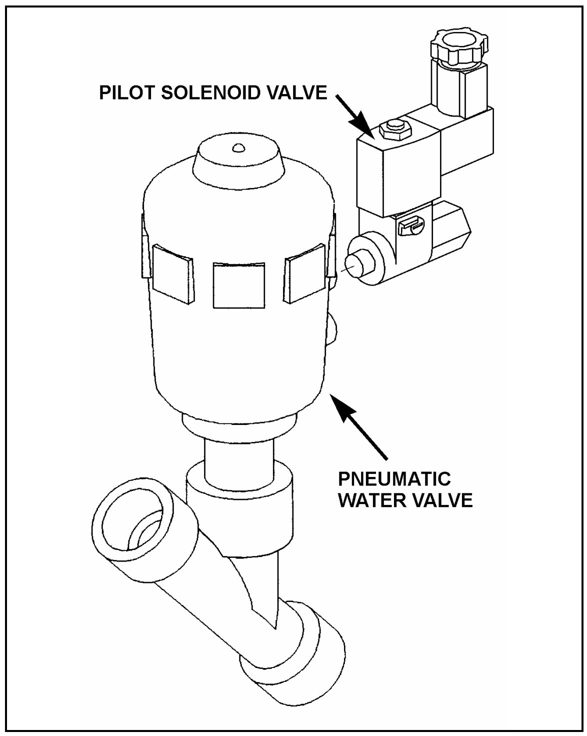


FIGURE 56: DRIVER'S HOT WATER PNEUMATIC VALVE ASSEMBLY 22240

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.

o **Pneumatic Water Valve Disassembly**

a) Shut off air supply pressure and electrical current to the pilot solenoid valve. Disconnect wires.

b) The water valve need not be removed from the line. Unscrew nipple, the actuator casing, tube, spindle and closure member can be removed (Fig. 54).

c) Remove the snap ring using a pair of pliers.

d) You can now access all seals for replacement

Pneumatic water valve replacement seal kits:

❖Water Side: 871311

❖Actuator Side: 871312

o **Pneumatic Water Valve Reassembly**

a) Assemble the actuator casing, tube, nipple, spindle and closure member.

b) Tighten the nipple in place in the body cavity as per figure 54. Fasten pilot solenoid vale to the pneumatic water valve. Reconnect air supply pressure and electrical current to the pilot solenoid valve.

c) Check for proper operation.

o **Pilot Solenoid Valve**

a) No maintenance is needed unless a malfunction occurs.

b) A pilot solenoid valve replacement seal kit is available: 871313.

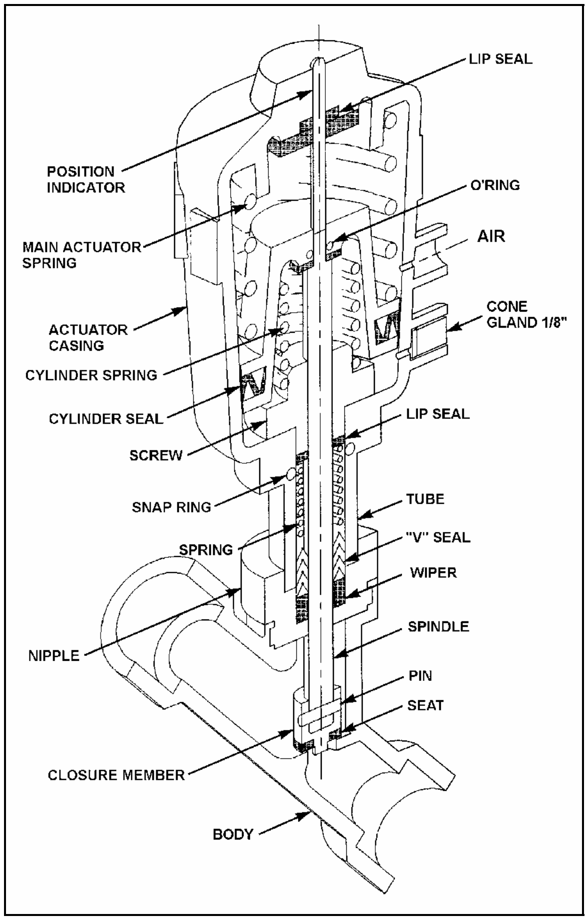


FIGURE 57: PNEUMATIC WATER VALVE 22241

o **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.

11.1.6 Central Hot Water Pneumatic Valve Assembly

o **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.

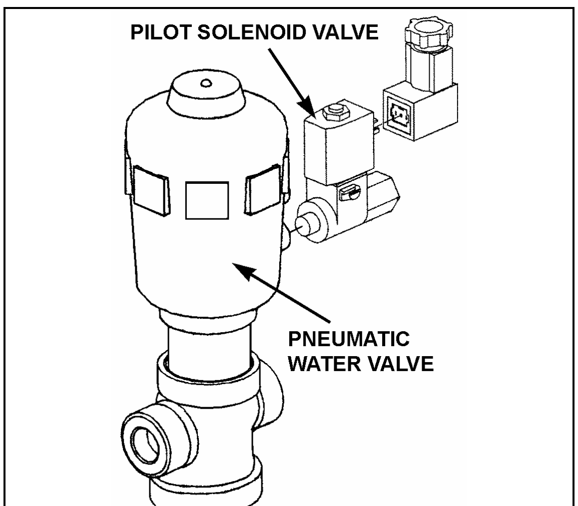


FIGURE 58: CENTRAL HOT WATER PNEUMATIC VALVE ASSEMBLY 22240

o **Pneumatic Water Valve Disassembly**

a) Shut off air supply pressure and electrical current to the pilot solenoid valve. Disconnect wires.

b) The water valve need not be removed from the line. Unscrew nipple, the actuator casing, tube, spindle and closure member can be removed (Fig. 59).

c) Remove the snap ring using a pair of pliers.

d) You can now access all seals for replacement.

Pneumatic water valve replacement seal kits:

❖Water Side: 871389

❖Actuator Side: 871388

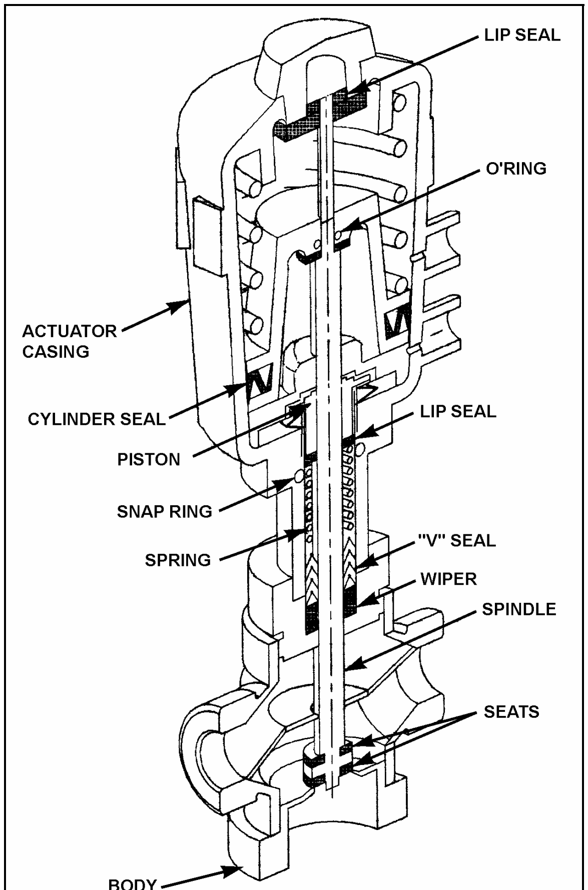


FIGURE 59: PNEUMATIC WATER VALVE 22241

o **Pneumatic Water Valve Reassembly**

a) Assemble the actuator casing, tube, nipple, spindle and closure member.

b) Tighten the nipple in place in the body cavity as per figure 59. Fasten pilot solenoid vale to the pneumatic water valve. Reconnect air supply pressure and electrical current to the pilot solenoid valve.

c) Check for proper operation.

o **Pilot Solenoid Valve**

a) No maintenance is needed unless a malfunction occurs.

b) A pilot solenoid valve replacement seal kit is available: 871390.

o **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 evaporator compartment (Fig. 60). The water recirculating pump consists of a centrifugal pump and an electric motor which are mounted on a common shaft in a compact assembly.

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.

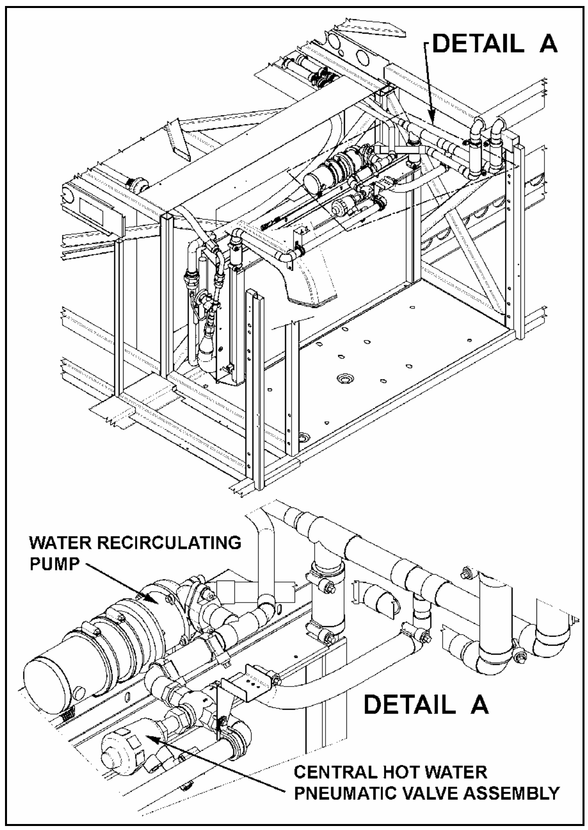


FIGURE 60: PUMP LOCATION 22178G

- **Removal**

a) Stop engine and allow engine coolant time to cool.

b) Close shutoff valves. Refer to *"05 COOLING"* under heading *"Draining Cooling System"* for location of valves.

c) Disconnect the electrical wiring from the motor.

WARNING

Before proceeding with the following steps, check that coolant has cooled down.

d) Disconnect water lines from pump at flange connections. Place a container to recover the residual coolant in the line.

e) Remove the two clamps holding the pump motor to its mounting bracket. Remove the pump with the motor as an assembly.

- **Disassembly**

a) Separate the housing (1) from the adapter (7) by first removing the 4 capscrews. Remove housing carefully to prevent damaging the O-ring (2).

b) 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:

<u>a. Wear</u>
Replace the brushes if less than 25% of the usable brush is left (less than 0.300 inch [8 mm]).

<u>b. Chipped edges</u>
Chips can be caused by improper handling or installation. Badly chipped brushes should be replaced regardless of their length.

<u>c. Annealed brush spring</u>
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.

<u>d. Frayed or broken pigtail</u>

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**

a) Install washer (3), shaft (5) and rotor assembly (4) into adapter (7).

b) Install O-ring (2) into housing (1) and assemble housing to the adapter.

c) Secure housing to adapter using 4 capscrews (6).

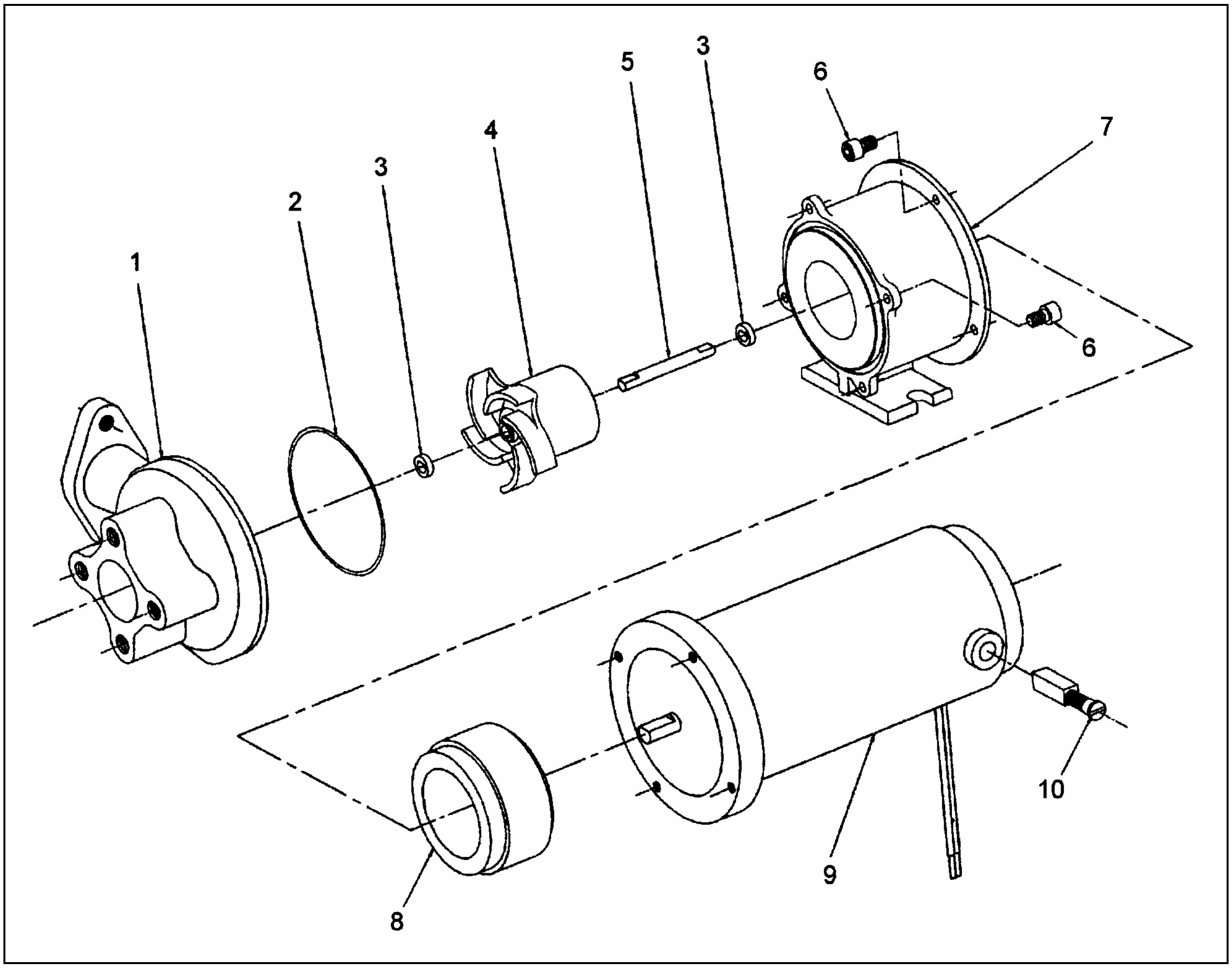


FIGURE 61: WATER RECIRCULATING PUMP (CENTRAL HVAC SYSTEM) 22091

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

o **Installation**

a) 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.

b) Connect electrical wiring to the pump motor.

c) Open shutoff valve. Refer to *"05 COOLING"* under heading *"Draining Cooling System"* for location of valves.

d) Fill the cooling system as previously instructed in this section under *"11.1.2 Filling Heating System"*, then bleed the system as previously instructed in this section under *"11.1.3 Bleeding Heating System"*.

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.

o **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. 62), 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. 52) 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 62 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 62 for pump location and to paragraph 11.1.7 for more information.

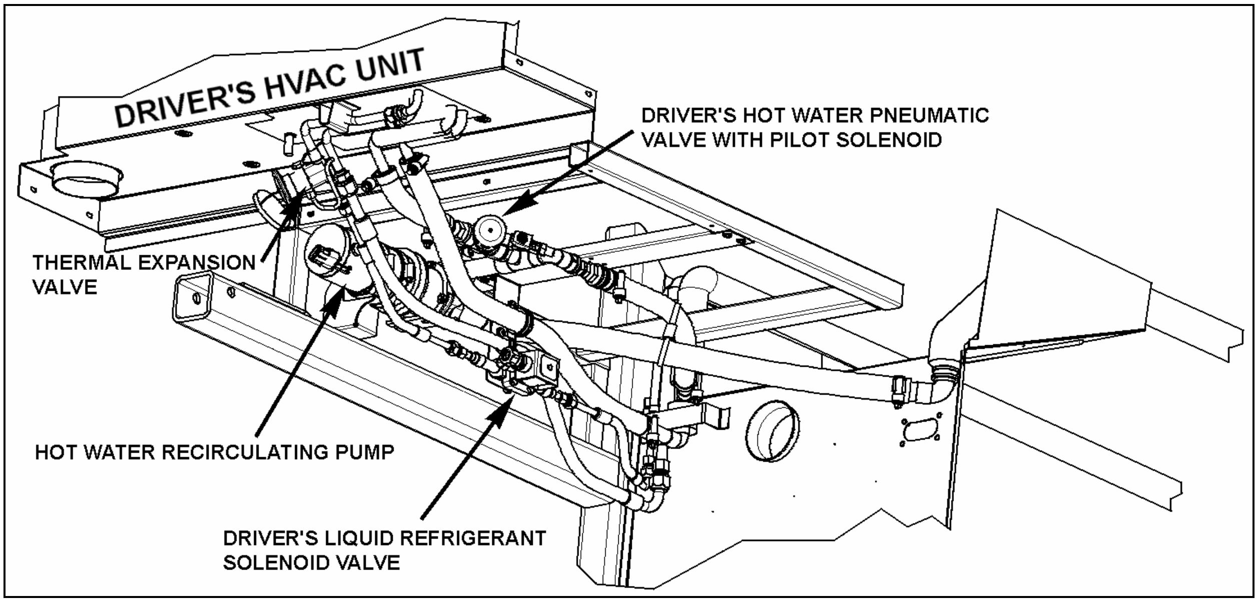


FIGURE 62: CEILING OF THE SPARE WHEEL COMPARTMENT

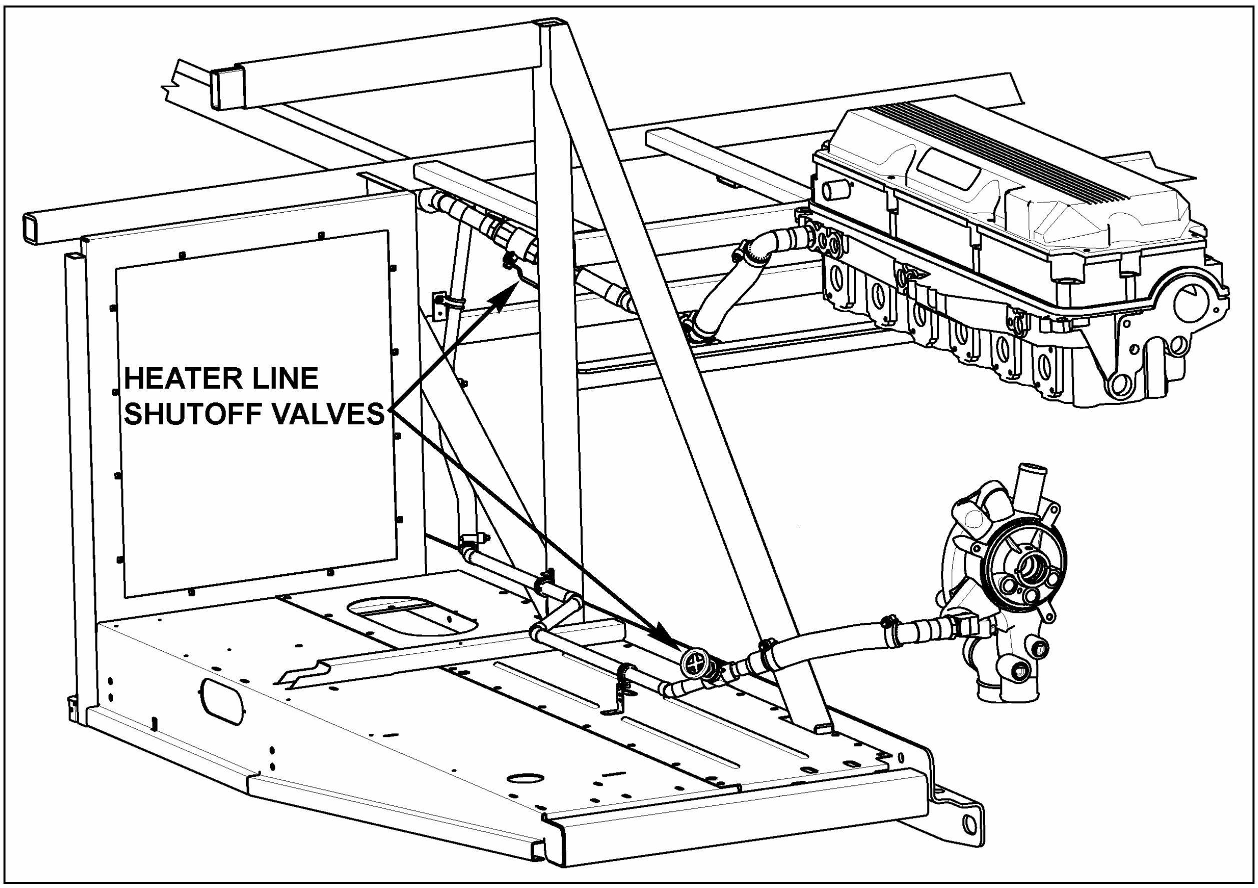


FIGURE 63: HEATER LINE SHUTOFF VALVES (W5)

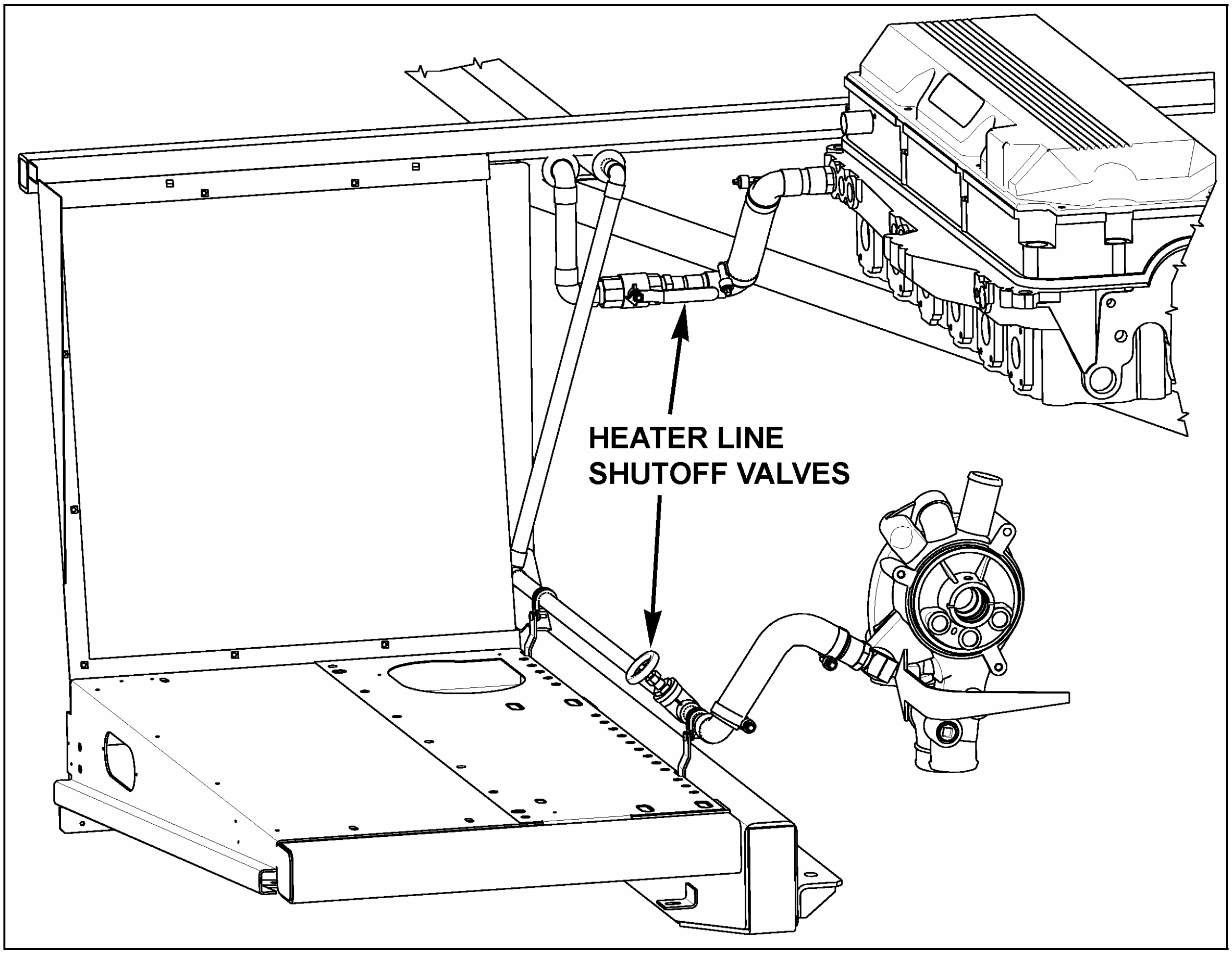


FIGURE 64: HEATER LINE SHUTOFF VALVES (WE & W0)

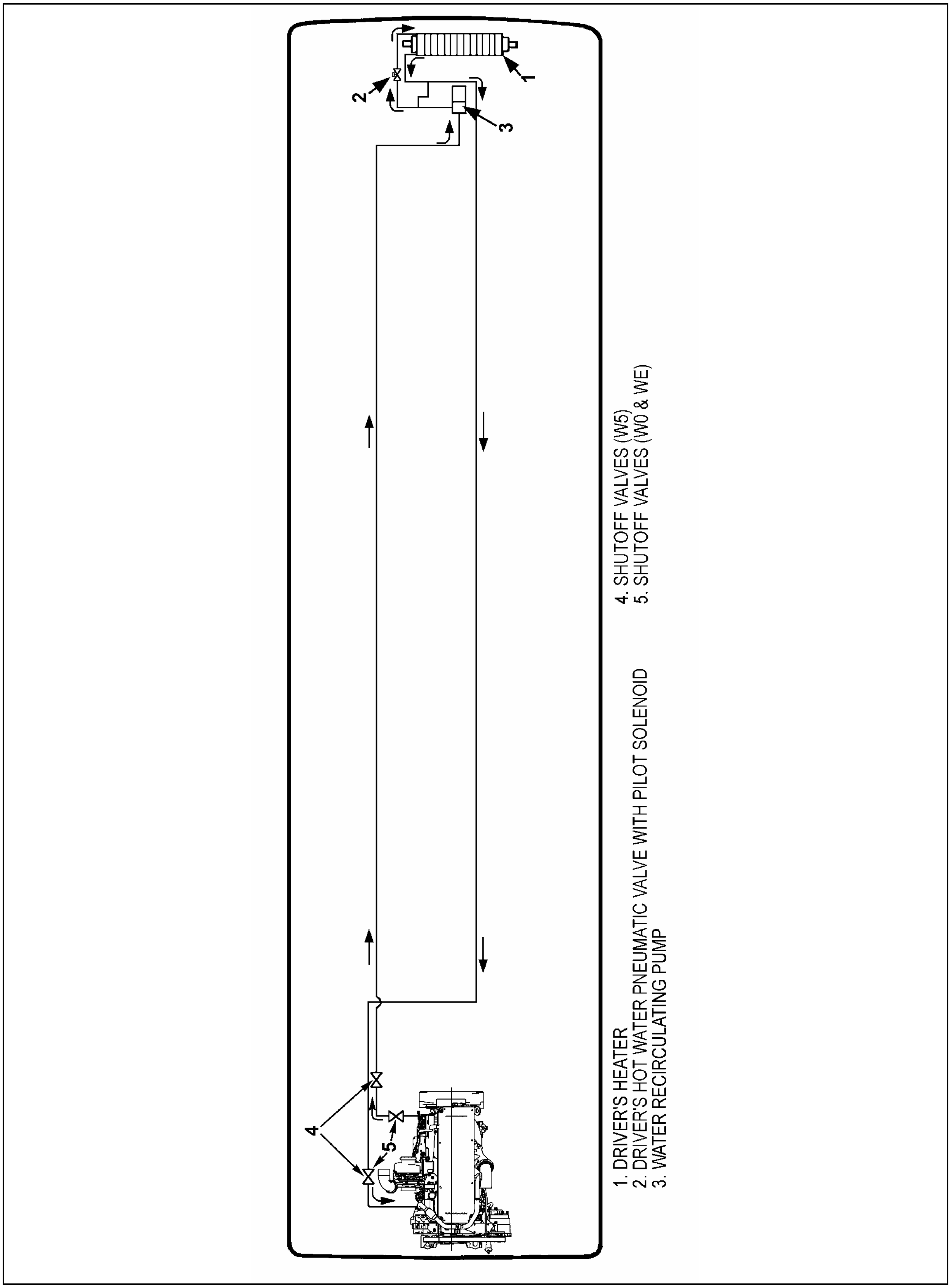


FIGURE 65: SMALL HEATING SYSTEM COMPONENTS 22337

12. SPECIFICATIONS

Main evaporator motor

Make....US MOTOR
Type T-17
Voltage .... 27.5 V DC
Current draw .... 68 amps
Horsepower....2
Revolution .... 1st :1400 rpm, 2nd : 1880 rpm nominal
Insulation....Class F
Motor Life ....20 000 hours
Brush life ....10 000 hours
Motor Prevost number....563008
Brush Prevost number 562951

Condenser fan motors

Make....US MOTOR
Type TF-12
Voltage .... 28.5 V DC
Current draw .... 20 amps
Horsepower....0.57
Revolution ....1950 rpm
Insulation....Class F
Motor ....20 000 hours
Brush life ....10 000 hours
Qty....2
Prevost number....562579
Brush Prevost number 561914

Evaporator air filters (Central system)

Make.... Permatron Corp.
Type .... Polypropylene
Prevost number....871383

Driver's HVAC unit evaporator motors

Make....MCC
Voltage .... 24 V DC
Quantity....1
Prevost number....871135

Driver’s HVAC unit evaporator air filter

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....................41 CFM
Model....................05G-134A
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

A/C Compressor (Small system)

Make……………………………………………………………………………………………..Selte
c
Model…………………………………………………………………………………………...TM-
16HD
Weight....................10.9 lbs (4,9 kg)
Supplier number....................18-00074-11
Prevost number....................950372

Approved oil....................ZXL100PG (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 belts

Make..Dayco

Model (matching set of 2) BX97

Prevost number (with Delco 270/300 Amp Alternator) 506664

Compressor V belt

Make..Dayco

Model.. BX100

Prevost number (with two BOSH Alternators) 506681

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

Filter Dryer assembly

Make.. AC&R HENRY
Prevost number... 950262

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

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

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

Water recirculating pump

Make .... M.P. pumps
Voltage .... 24 V DC
Prevost number 871342

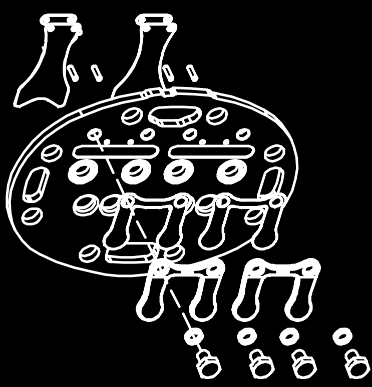
Driver's expansion valve

Prevost number 950221

Expansion valve (Central system)

Make .... Alco
Model .... TCLE 5-1/2
Prevost number 950320

Compressor



WORKSHOP MANUAL

for

MODEL 05G TWIN PORT COMPRESSOR

62-11052 Rev A

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).

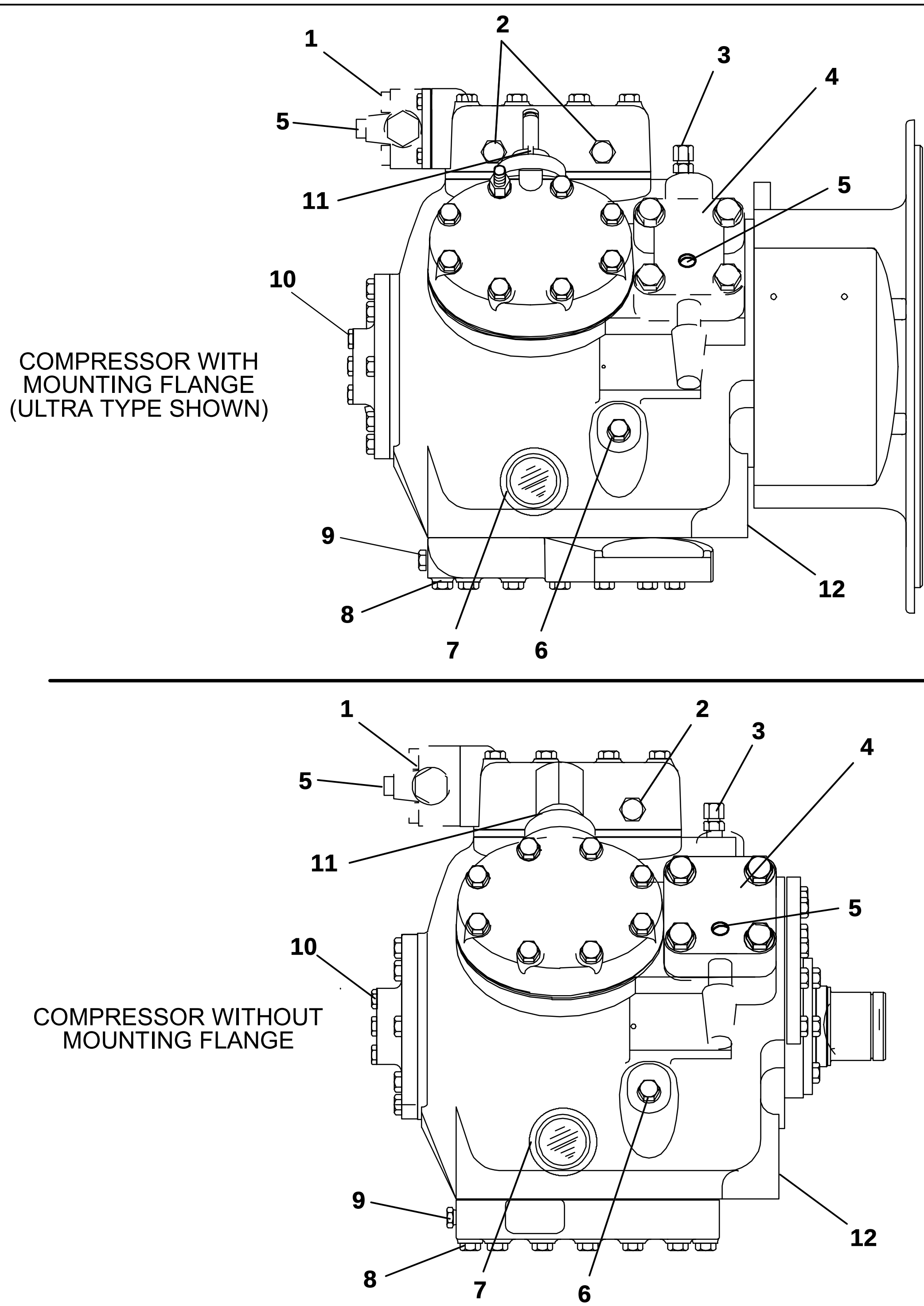
Table 1-2. Oils

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.



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.

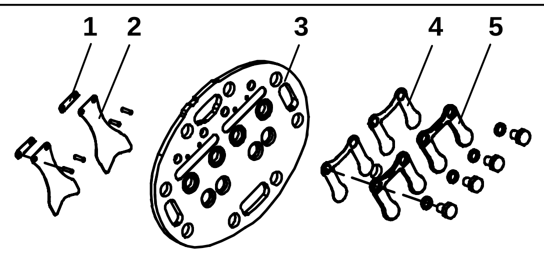
Turning the valve stem clockwise (all the way forward) will *frontseat* the valve to close off the suction or discharge line to isolate the compressor and open the gauge connection.

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.

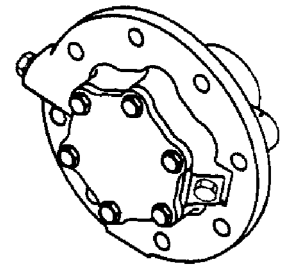


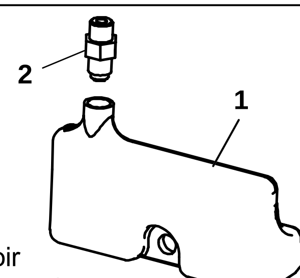
Figure 1-3. Oil Pump

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.

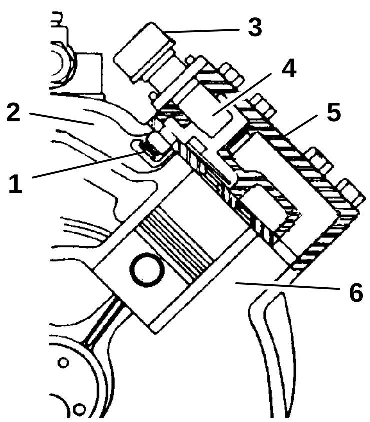
1.5 COMPRESSOR UNLOADERS

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.

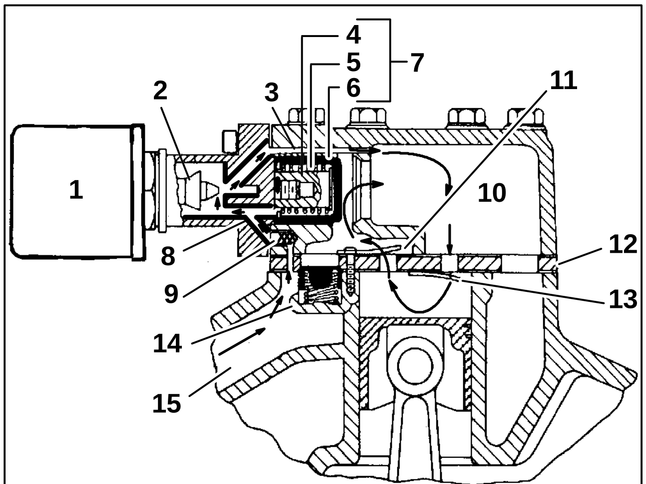
With the solenoid valve (1) *energized* the solenoid valve stem (2) will *open* the gas bypass port (3).

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

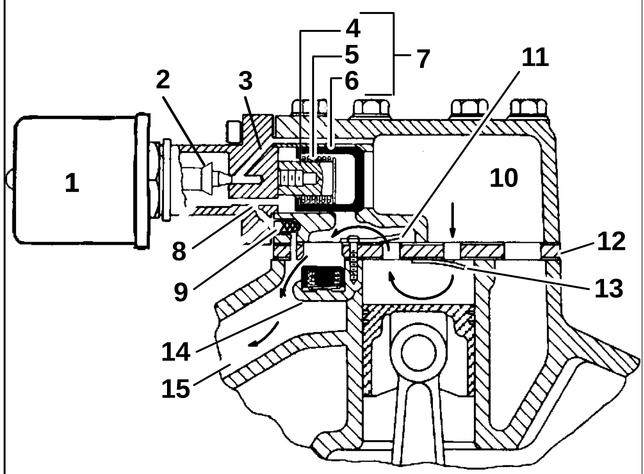
Discharge pressure bleeds from the discharge manifold (Figure 1-7, item 15) through the strainer (9) and bleed orifice (8) to the solenoid valve stem (2) chamber and the back of the piston bypass valve (7).

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

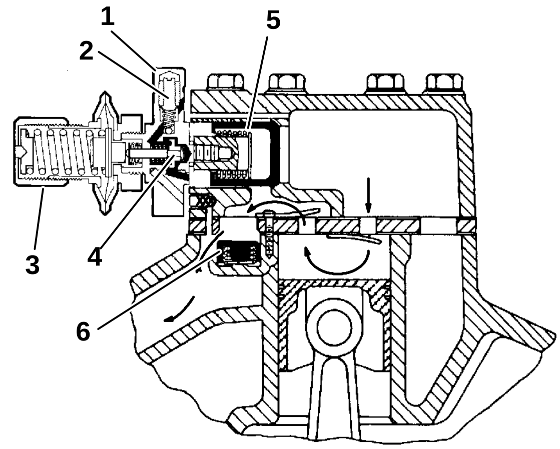
Figure 1-7. Electric-Operated Unloader- Loaded Operation

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).

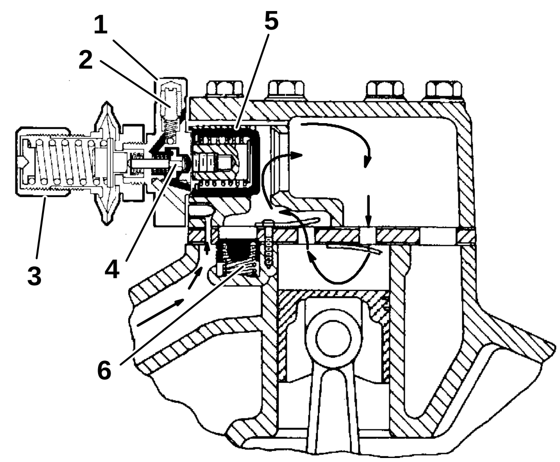
During *loaded operation*, (Figure 1-8) when suction pressure is above the valve control point, the poppet valve (4) will close. Discharge gas bleeds into the valve chamber; the pressure closes the piston bypass valve (5) and the cylinder bank loads up. Discharge gas pressure forces the discharge piston 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.

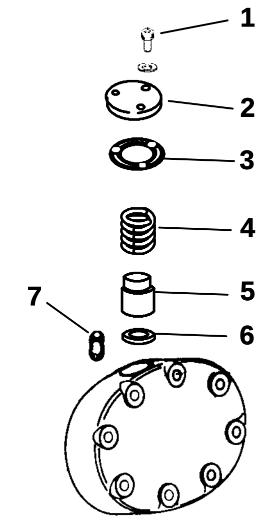
Service replacement compressors are furnished without suction and discharge service valves and unloader valves. The service valves are normally retained on the unit to isolate the refrigerant lines during compressor replacement. Blank-off pads are installed on the service replacement compressor valve 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).

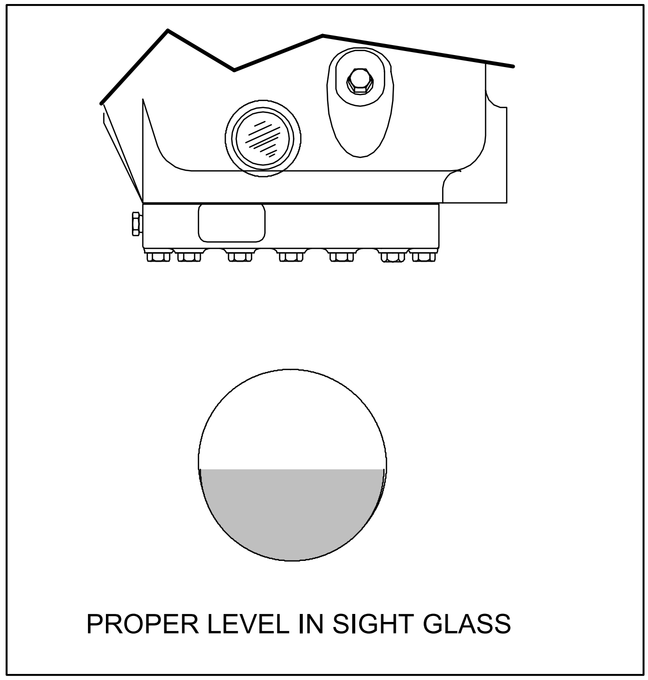


Figure 2-2. Oil Level in Sight Glass

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.

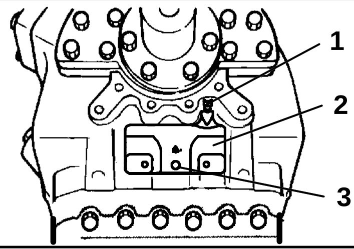


Figure 3-1. Shaft Seal Reservoir

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

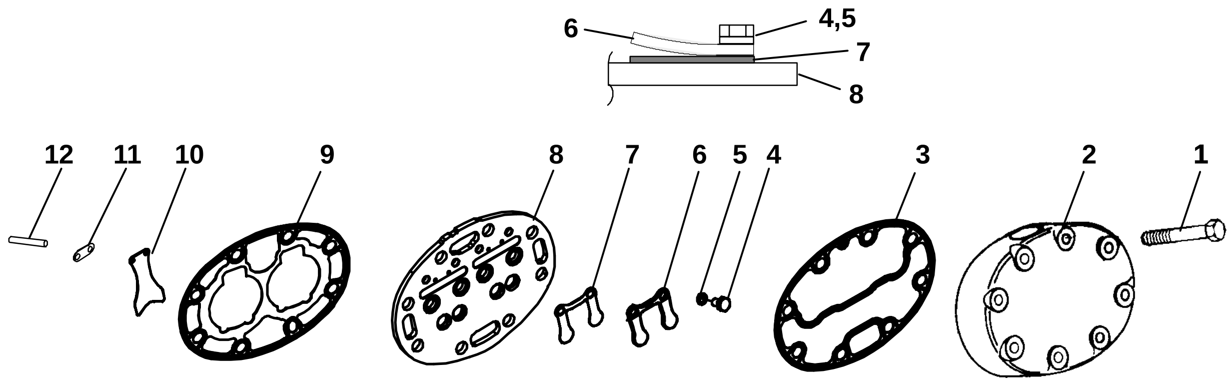
Install only new valves and gaskets, do not interchange valves.

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.

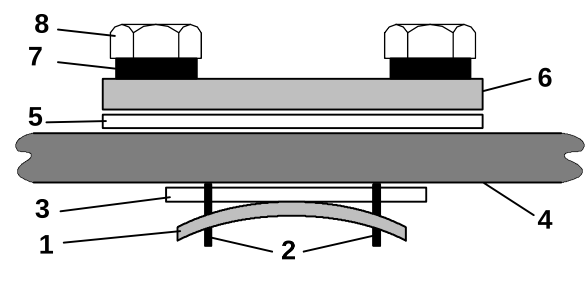
c. Place suction valve on dowel pins.

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
2 Cylinder Head
3 Cylinder Head Gasket
4 Capscrew
5 Lockwasher
6 Discharge Valve Backer
7 Discharge Valve
8 Valve Plate
9 Valve Plate Gasket
10 Suction Valve
11 Suction Valve Spring
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

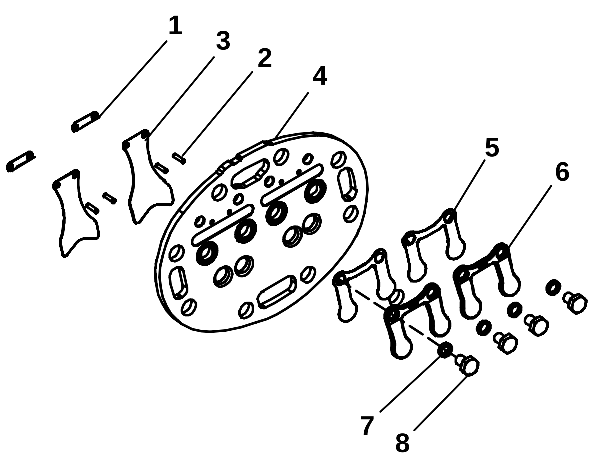


Figure 3-3. Installing Suction Valves

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.

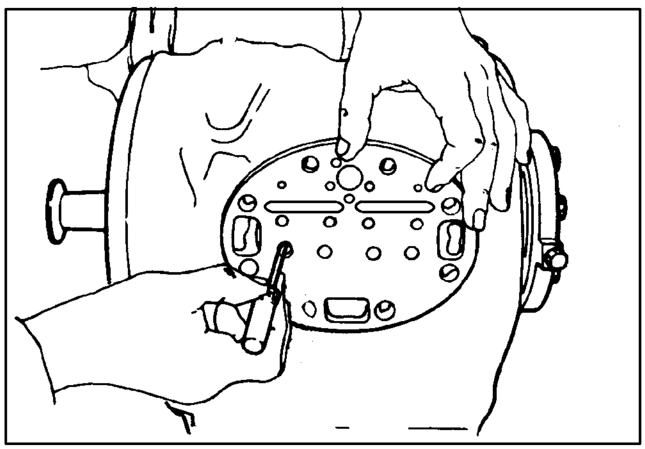


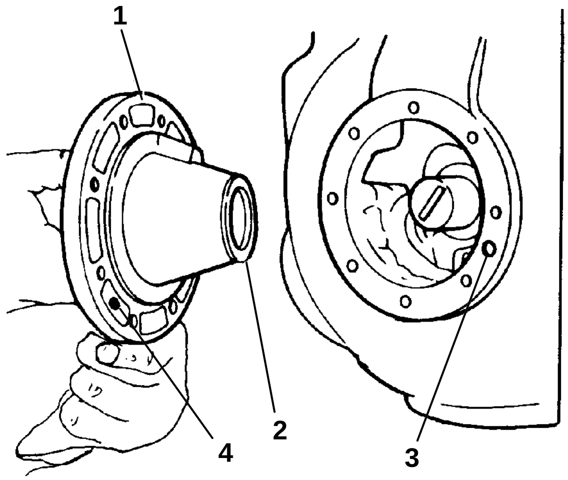
Figure 3-4. Checking Suction Valve

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.)

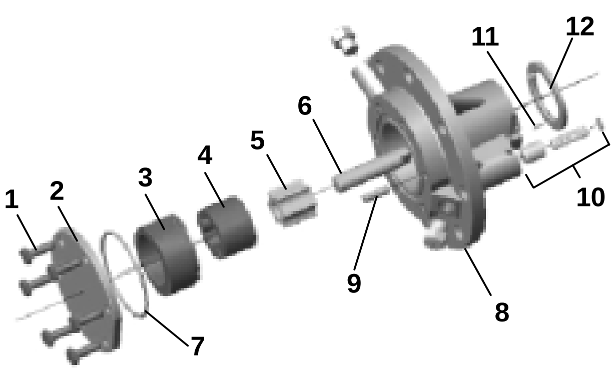


1. Oil Pump & Bearing Head
2. Thrust Washer
3. Oil Pickup Tube
4. Oil Inlet Port

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.

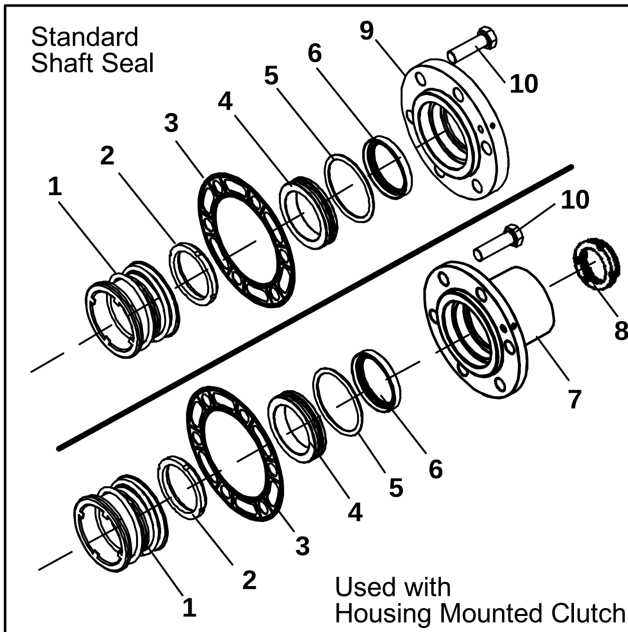
b. Install the bearing head assembly with a new gasket on the compressor crankshaft. Carefully push oil pump on by hand ensuring that the thrust washer remains on the dowel pins, the tang on the end of the drive engages the slot in the crankshaft, and the oil inlet port on the pump is aligned with the 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)

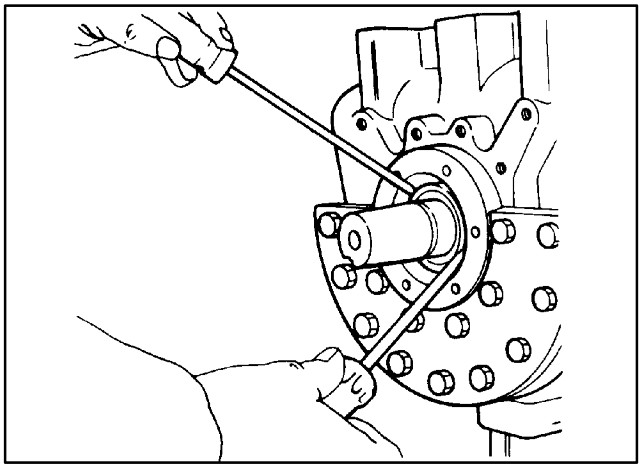


Figure 3-8. Shaft Seal Removal

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).

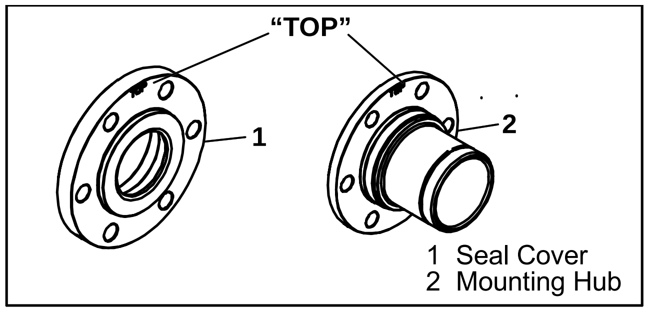


Figure 3-9. TOP Orientation

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.

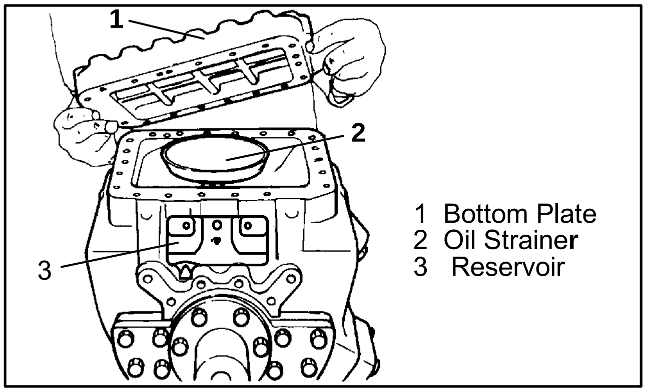


Figure 3-10. Bottom Plate Removal

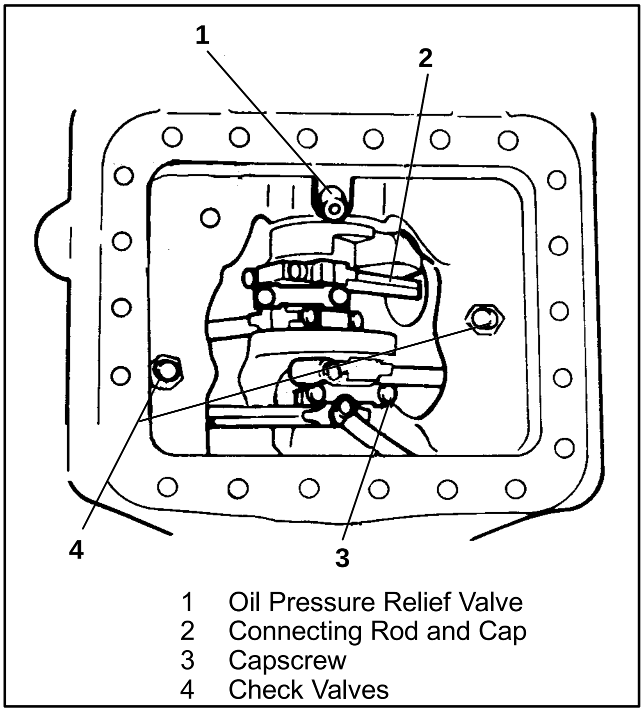


Figure 3-11. Bottom Plate and Oil Strainer Removed

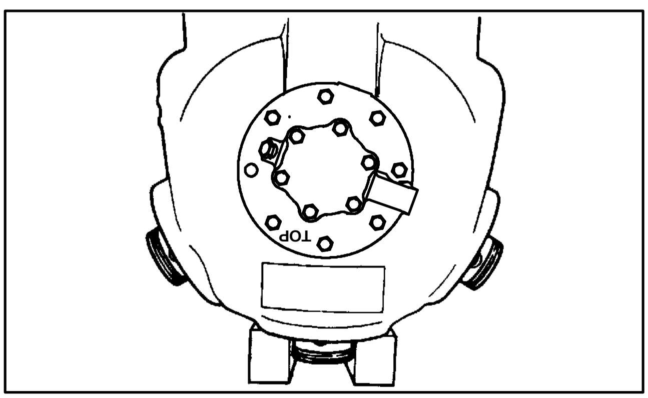


Figure 3-12. Piston Rings Removed

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)

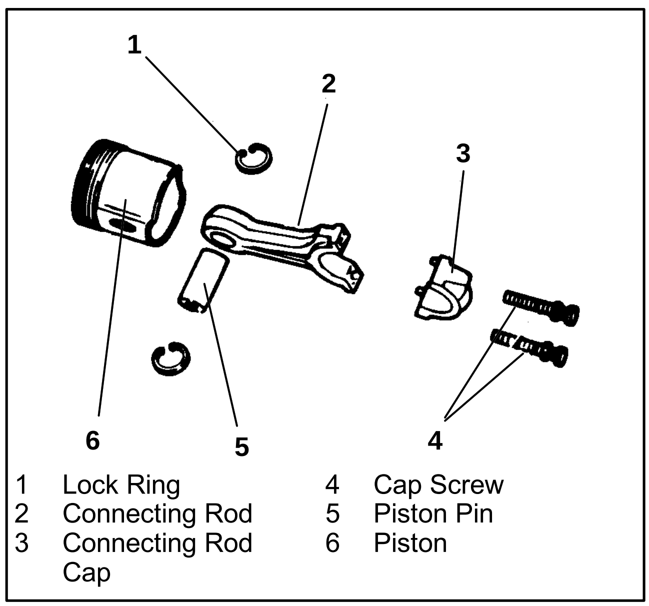


Figure 3-13. Connecting Rod, Piston, and Pin

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.

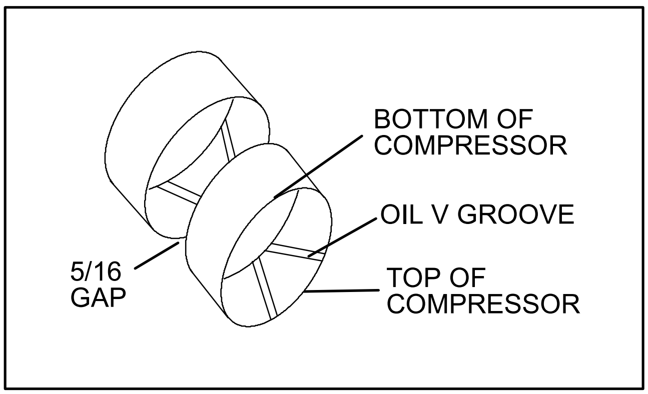


Figure 3-14. Seal End Main Bearings

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.

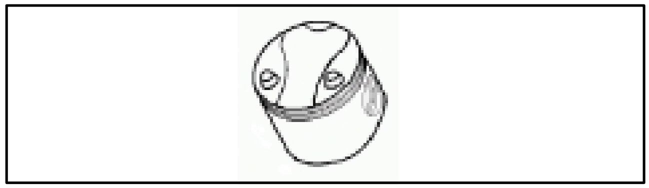


Figure 3-15. Piston

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.

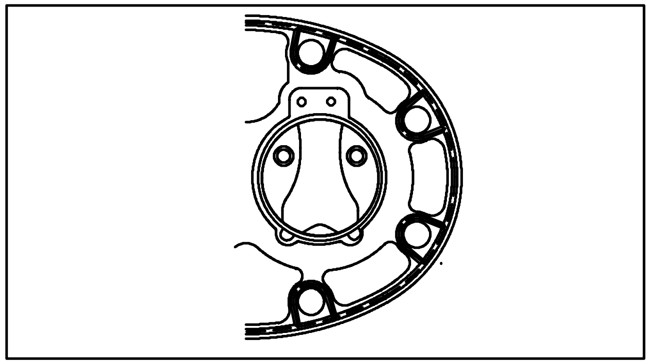


Figure 3-16. Correct Piston in Cylinder Orientation

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)

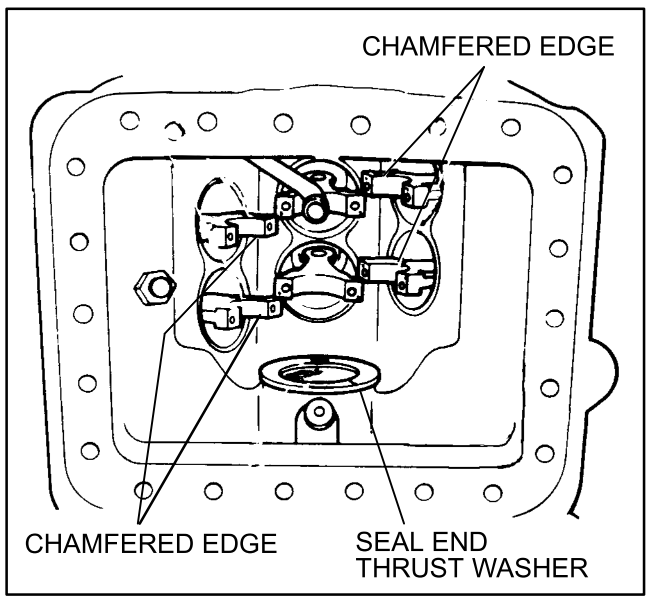


Figure 3-17. Installing Piston Rod Assemblies and Seal End Thrust Washer

c. The compressor will be fitted with double ring pistons.

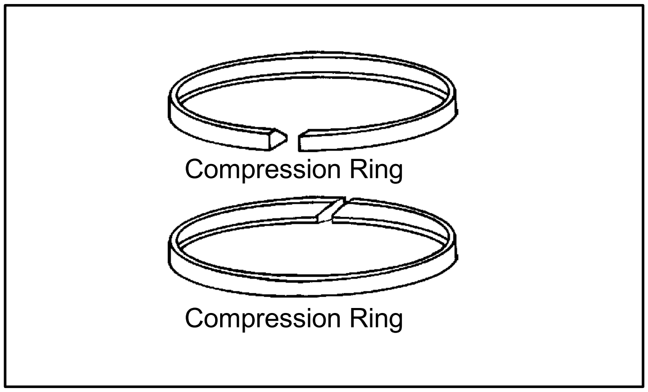


Figure 3-18. Piston Rings

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.

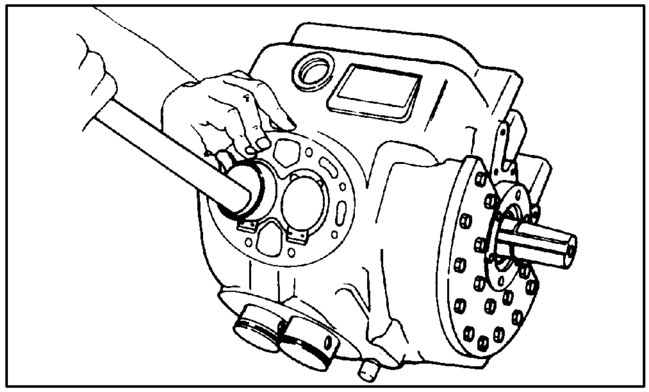


Figure 3-19. Installing Pistons

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.

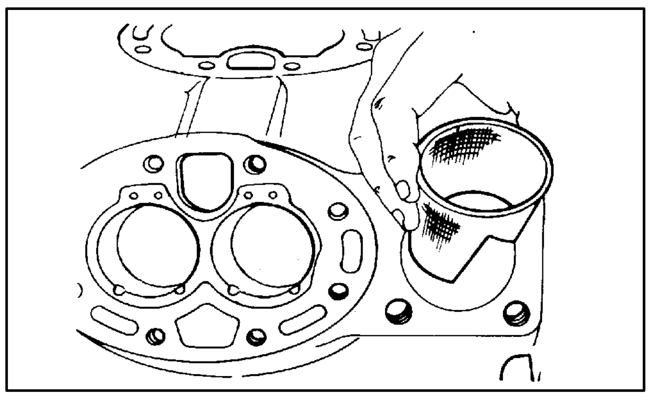


Figure 3-20. Installing Suction Strainer

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

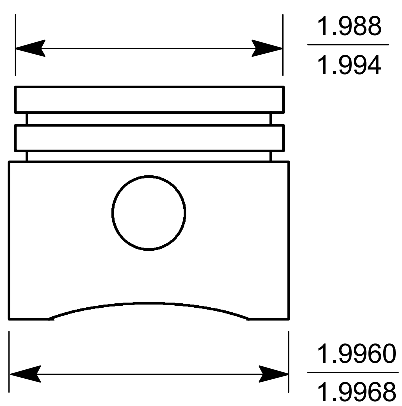


Figure 3-21. Piston Dimension (Wear Limits)

INDEX

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.
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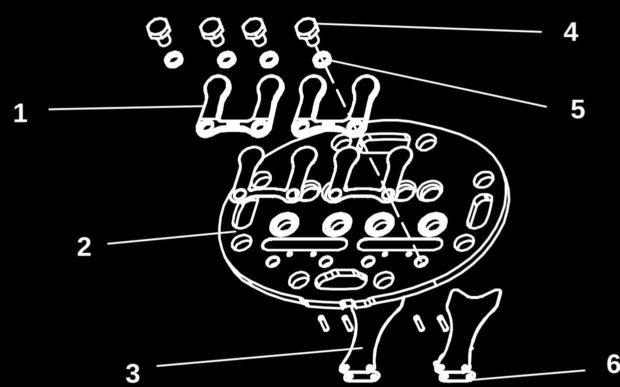
Carrier TRANSICOLD

Carrier Compressor



SERVICE PARTS LIST

for

MODEL 05G TWIN PORT COMPRESSOR

62−11053 Rev B

Carrier

TRANSICOLD

Service Parts List

Model
05G Twin Port Compressor

CONTENTS

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.

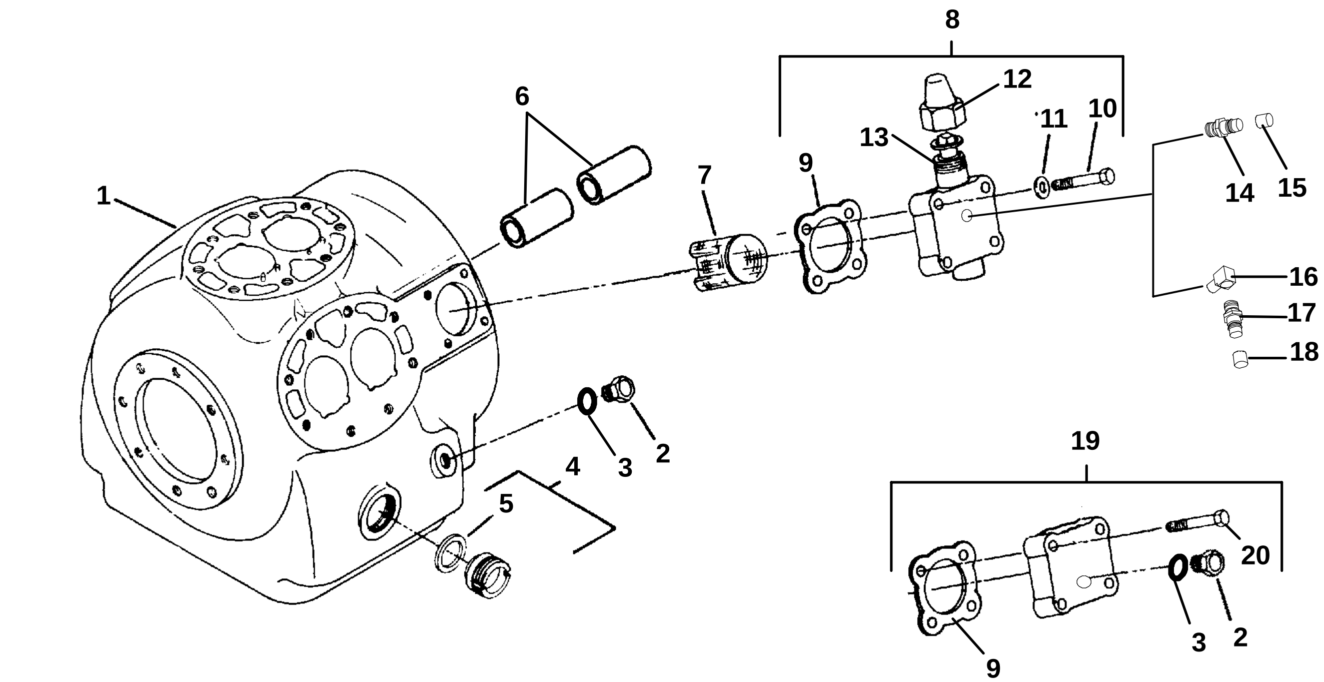
COMPRESSOR OIL CHART

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

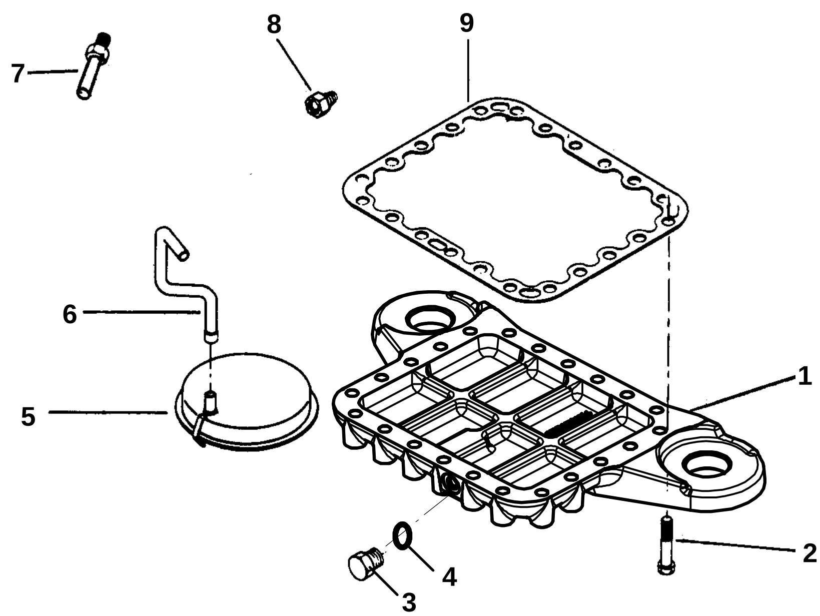
Refer to the unit operation and service manual for the correct procedure for checking compressor oil level.

1 CRANKCASE AND SUCTION SERVICE VALVE



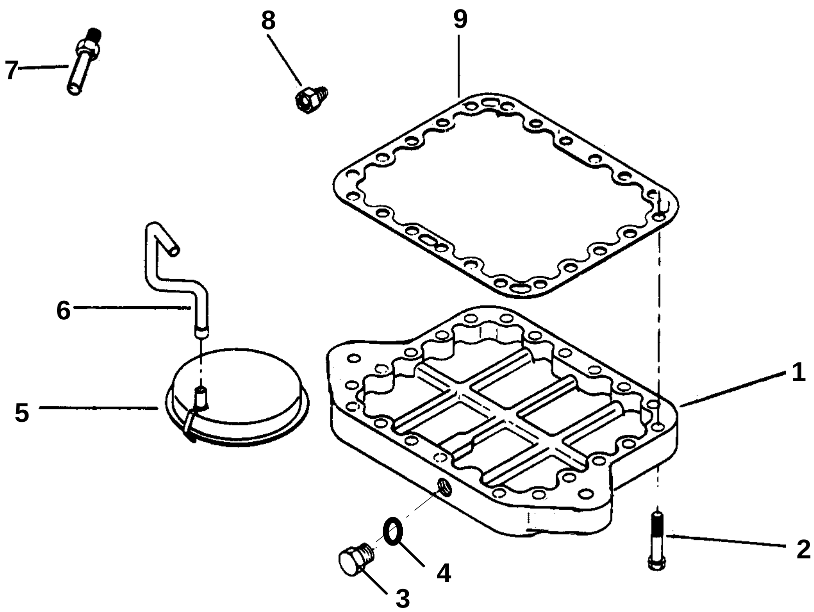
Item	Part Number	Description	Qty
1	NSA	Crankcase	1
2	17-44037-00	Plug, O-Ring, 7/16-20 - Includes:	1
3	42-00243-07	O-Ring	1
4	17-10218-00	Sight Glass, Oil Level - Includes:	2
5	17-10218-02	Gasket (Fiber)	1
	17-44021-00	Gasket (Metal)	
6	17-44015-00	Bearing, Main Seal End (Requires Line Boring)	2
7	17-44005-00	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



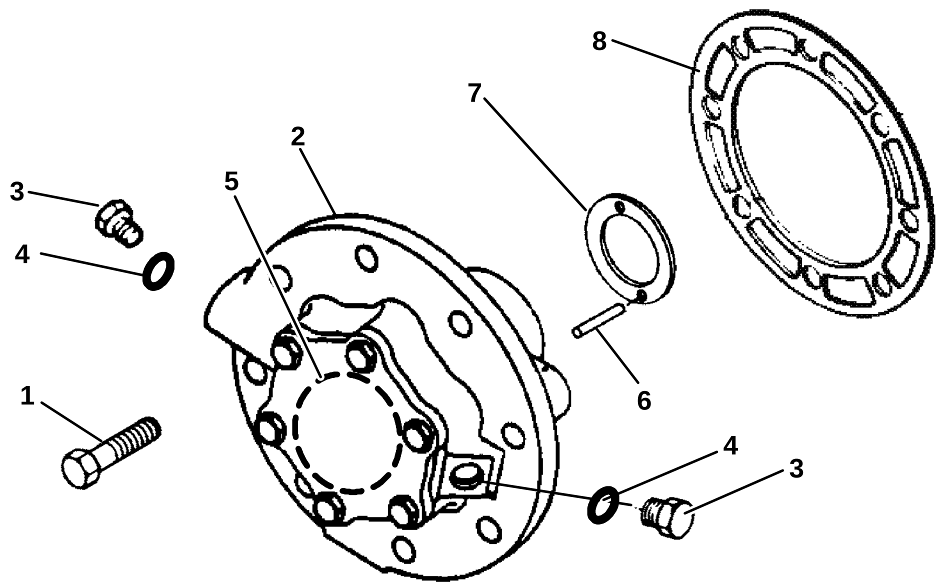
Item	Part Number	Description	Qty
1	17-44026-00	Plate, Bottom, Aluminum, (Ultra Style Compressors)	1
2	17-44117-00	Capscrew, Hex Head, 3/8-16 x 2-1/4 Inches Long - SAE Grade 8	22
3	17-44037-00	Plug, O-Ring, 7/16-20 - Includes:	1
4	42-00243-07	O-Ring	1
5	17-40020-00	Oil Filter Screen Assembly	1
6	17-40021-00	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



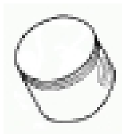
Item	Part Number	Description	Qty
1	17-44035-00	Plate, Bottom, Aluminum, (Non-Ultra Style Compressors)	1
2	17-44117-00	Capscrew, Hex Head, 3/8-16 x 2-1/4 Inches Long - SAE Grade 8	22
3	17-44037-00	Plug, O-Ring, 7/16-20 - Includes:	1
4	42-00243-07	O-Ring	1
5	17-40020-00	Oil Filter Screen Assembly	1
6	17-40021-00	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

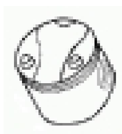


Item	Part Number	Description	Qty
1	17-10308-00	Capscrew, Hex Head, 3/8-16 x 1-1/4 Inches Long - SAE Grade 5	8
2	17-44137-00	Oil Pump and Bearing Head - Includes:	1
3	17-44037-00	Plug, O-Ring, 7/16-20 - Includes:	2
4	42-00243-07	O-Ring	2
5	17-44139-00	O-Ring, Pump Cover Plate	1
6	17-40204-00	Pin, Roll, 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)	

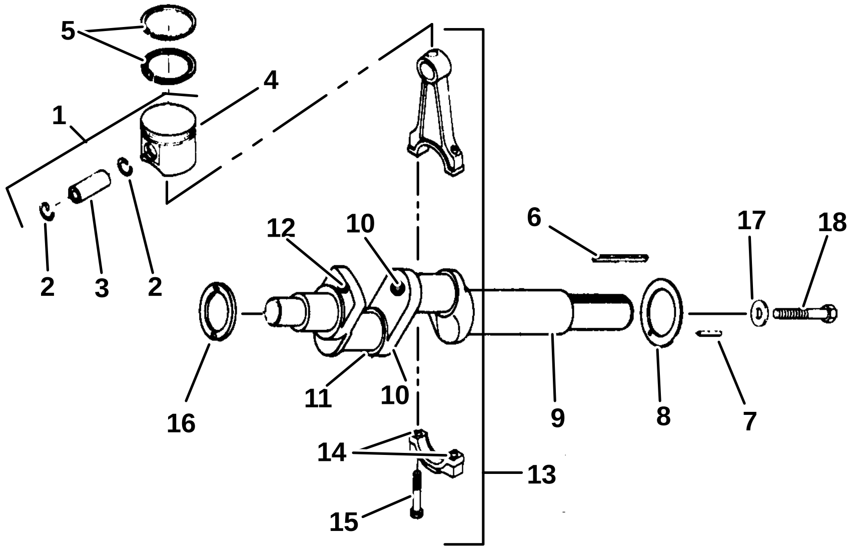
5 CRANKSHAFT, ROD AND PISTON GROUP



Flat (Bus)

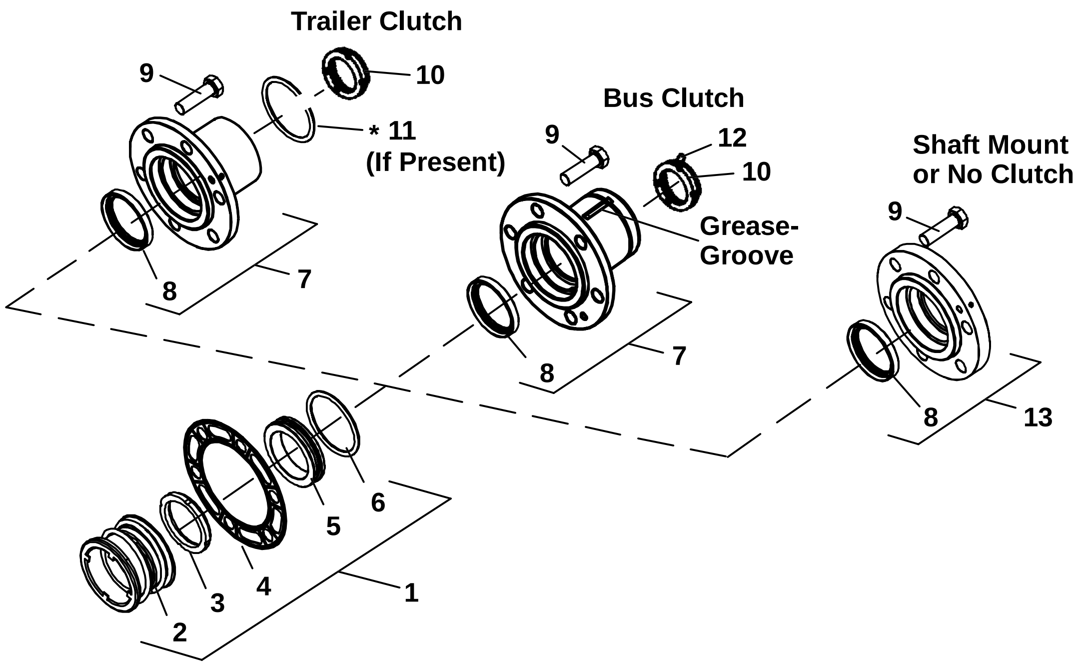


Contoured (Truck/Trailer)



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

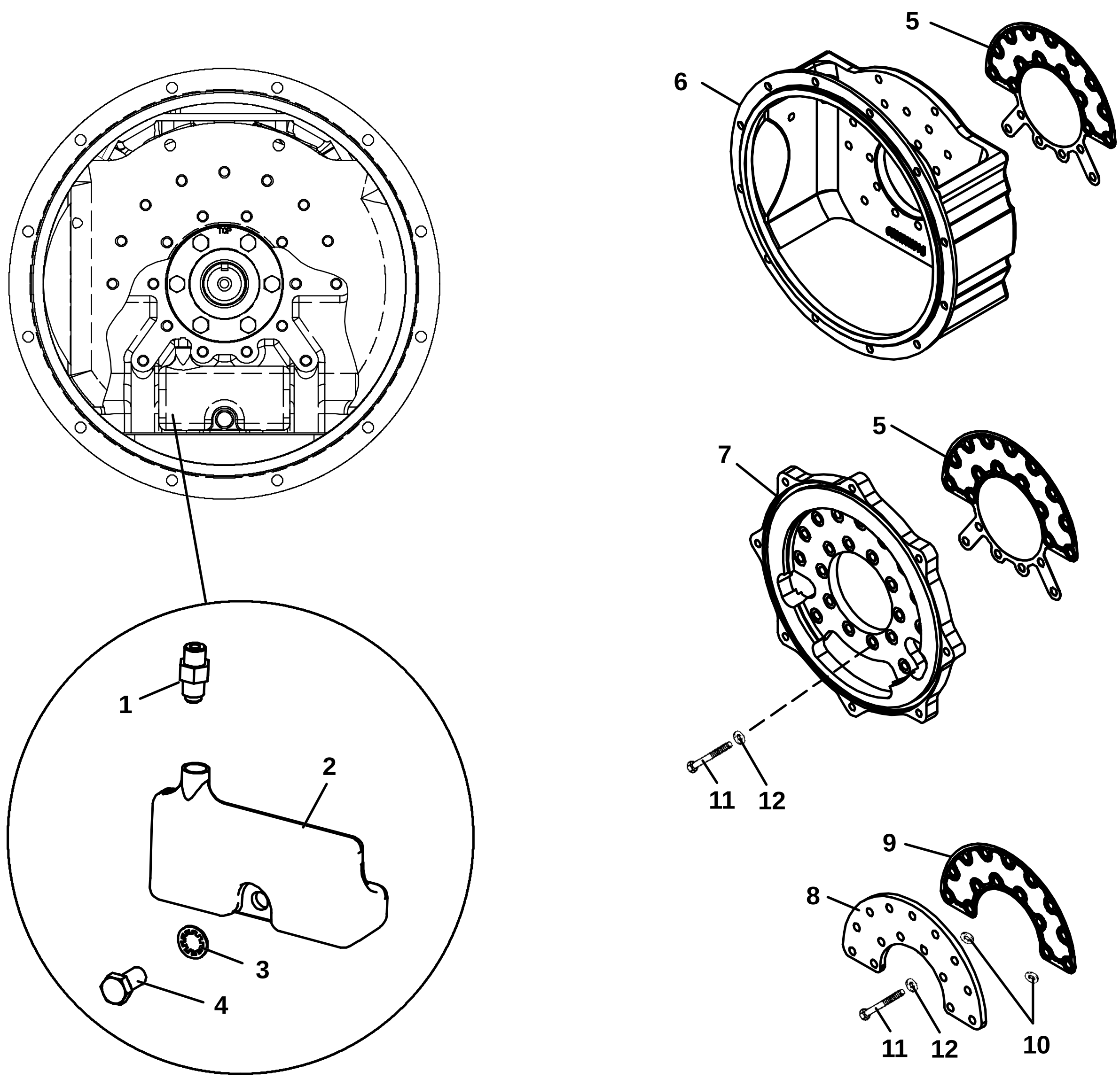
6 SHAFT END GROUP



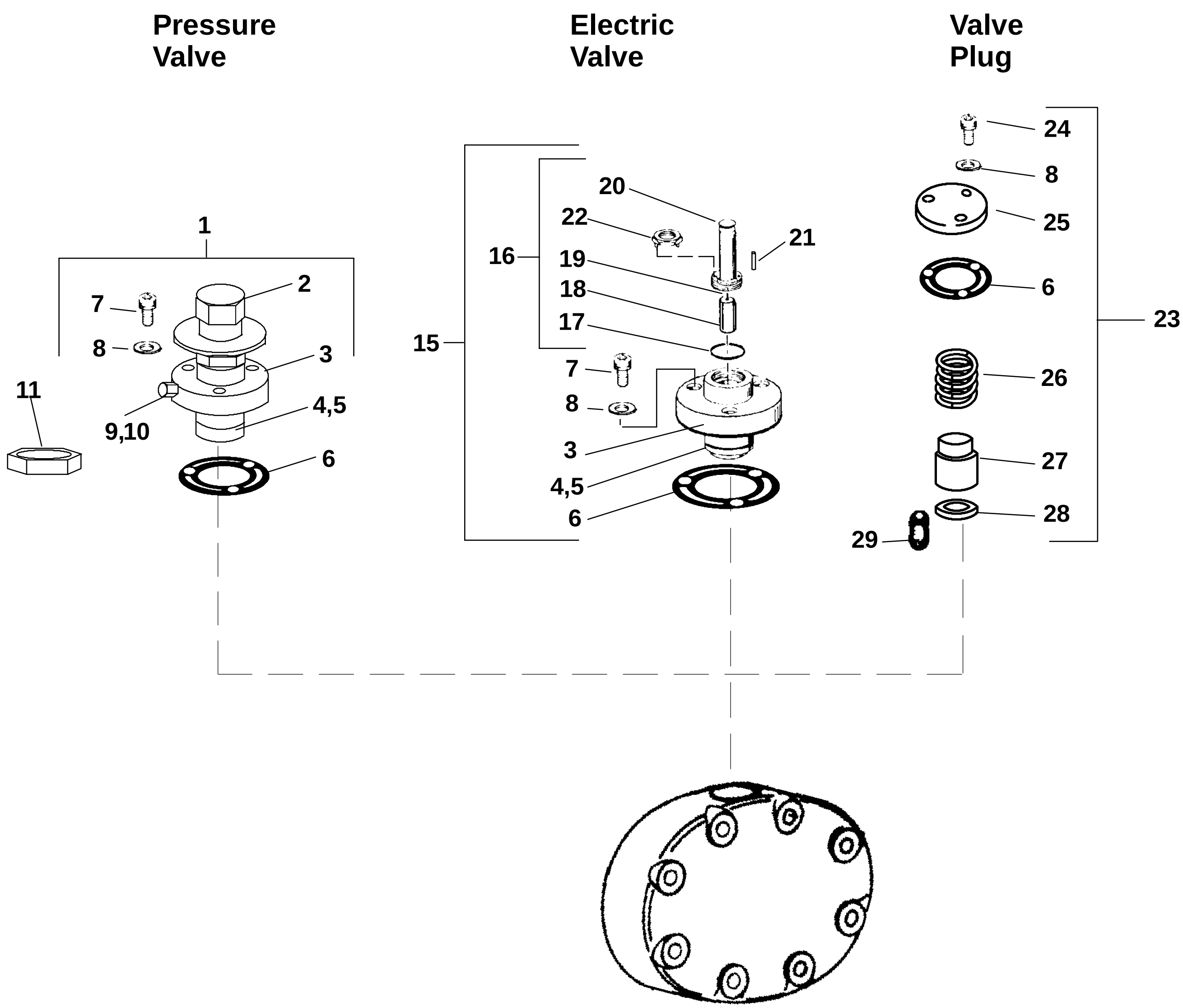
*NOTE: Early production trailer compressors may have had the snap ring style clutch hub. Should the hub require replacement, it must be converted to the threaded clutch hub (Item 7).

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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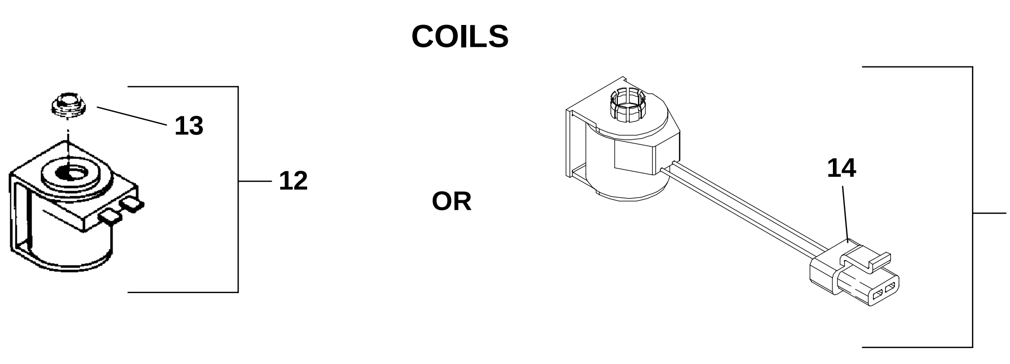
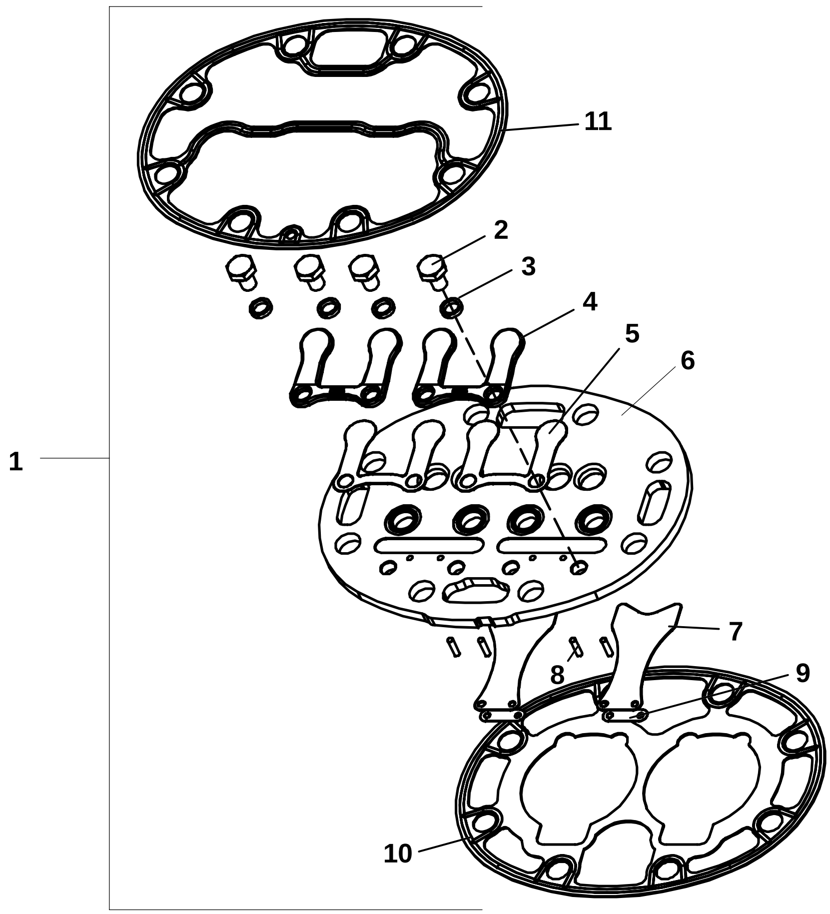

COILS
13
12
OR
14
12

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

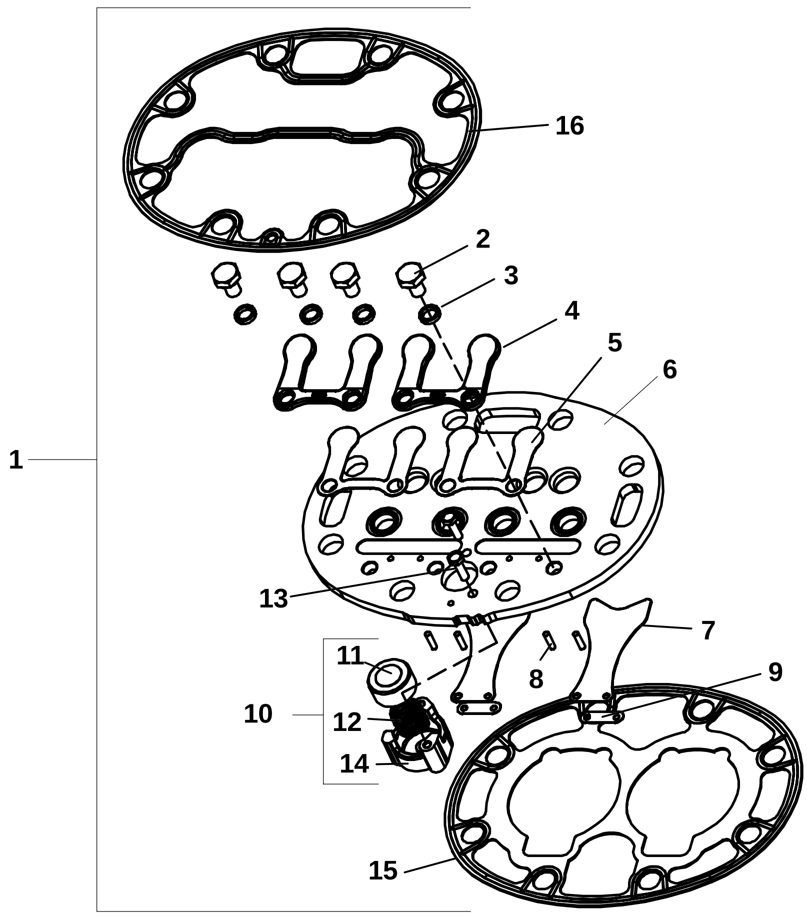
9 VALVE PLATE ASSEMBLY



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

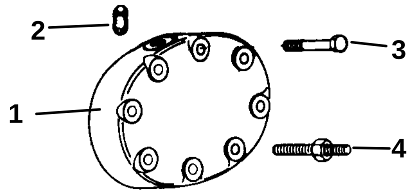
10 UNLOADER VALVE PLATE ASSEMBLY



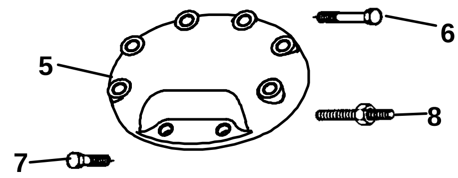
CAUTION: The above valve plate can only be used on the Twin Port 05G compressor.
<u>It will not function in</u> the previous design (3 port) 05G compressor.

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)



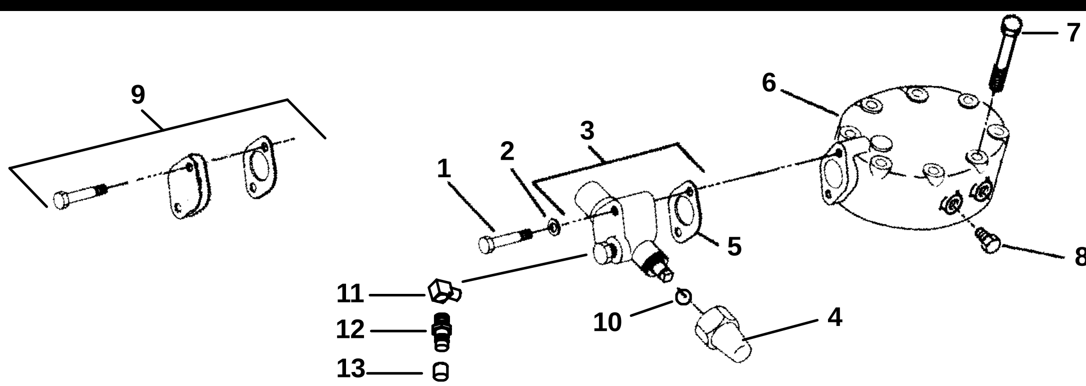
UNLOADER CYLINDER HEAD



STANDARD SHAVED CYLINDER HEAD

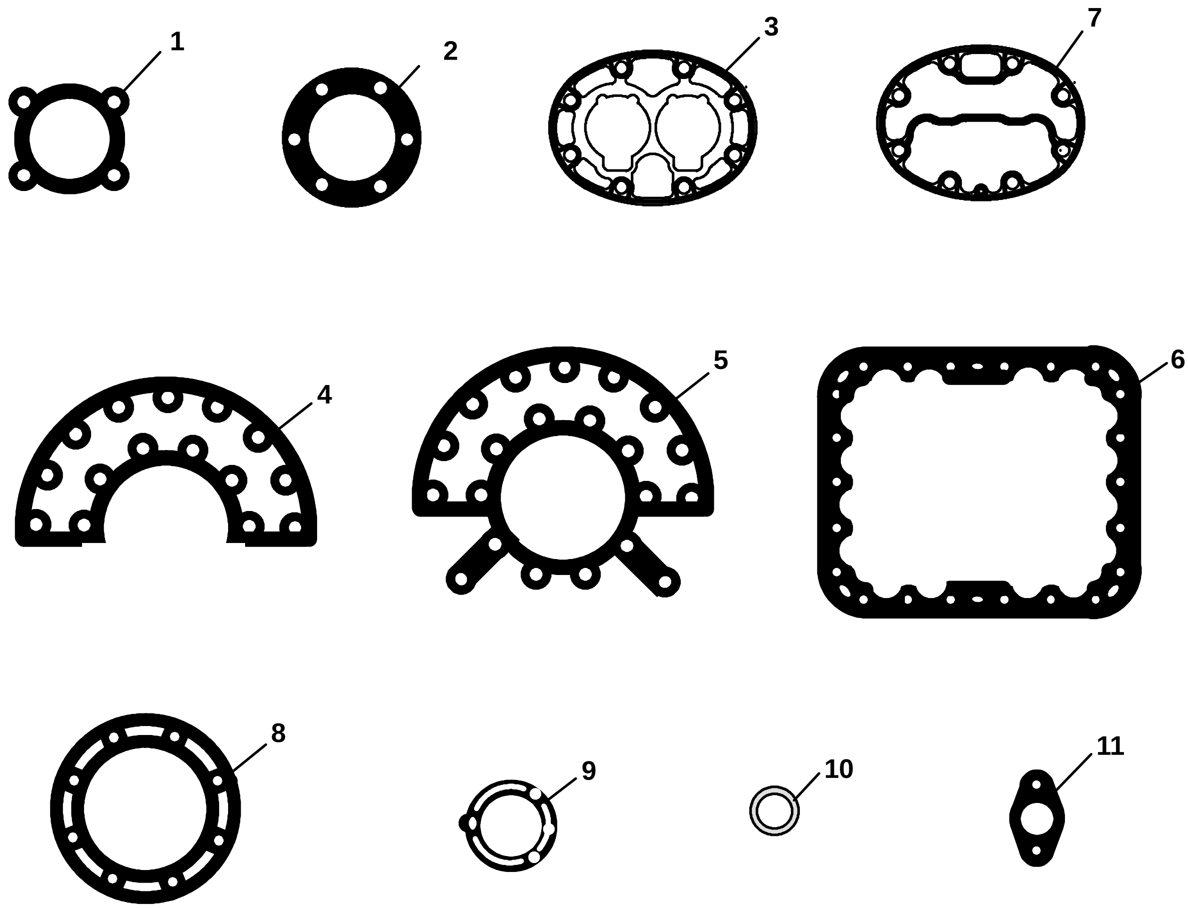
Item	Part Number	Description	Qty
1	17-44743-00	Cylinder Head, Unloader - Side Banks	2
2	17-40108-00	Strainer	1
3	17-10224-05	Capscrew, Hex Head, 3/8 -16 x 3-1/4 Inches Long - SAE Grade 8	8
4	17-44017-00	Stud, Cylinder Head (Unloader or Center), 3/8 -16 x 4-1/4 Inches Long	A/R
5	17-44753-00	Cylinder Head - 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)



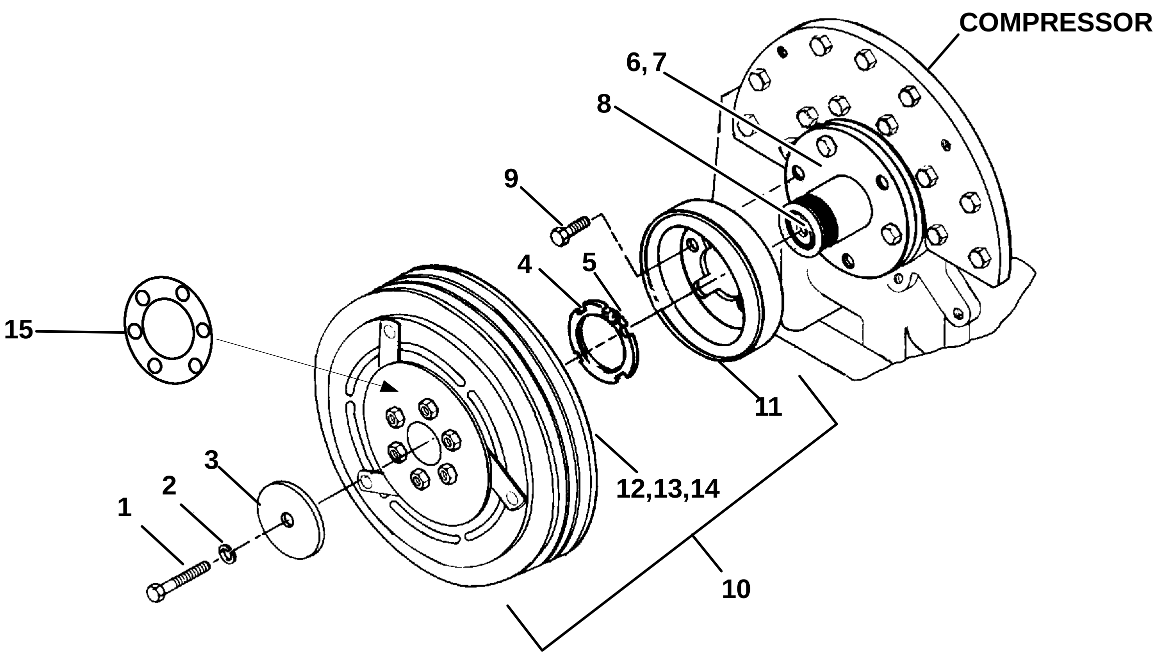
Item	Part Number	Description	Qty
1	17-40012-00	Capscrew, Hex Head, 5/16 -18 x 2 Inches Long - SAE Grade 8	2
2	17-40013-00	Gasket, Capscrew, 5/16 Inch	2
3	17-01042-04	Valve, Service 7/8 Inch ODF (1/8 Inch FPT Gauge Port)- Includes:	1
	14-00206-01	Valve, Service 7/8 Inch ODF (M15 Gauge Port For R-134a) - 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)

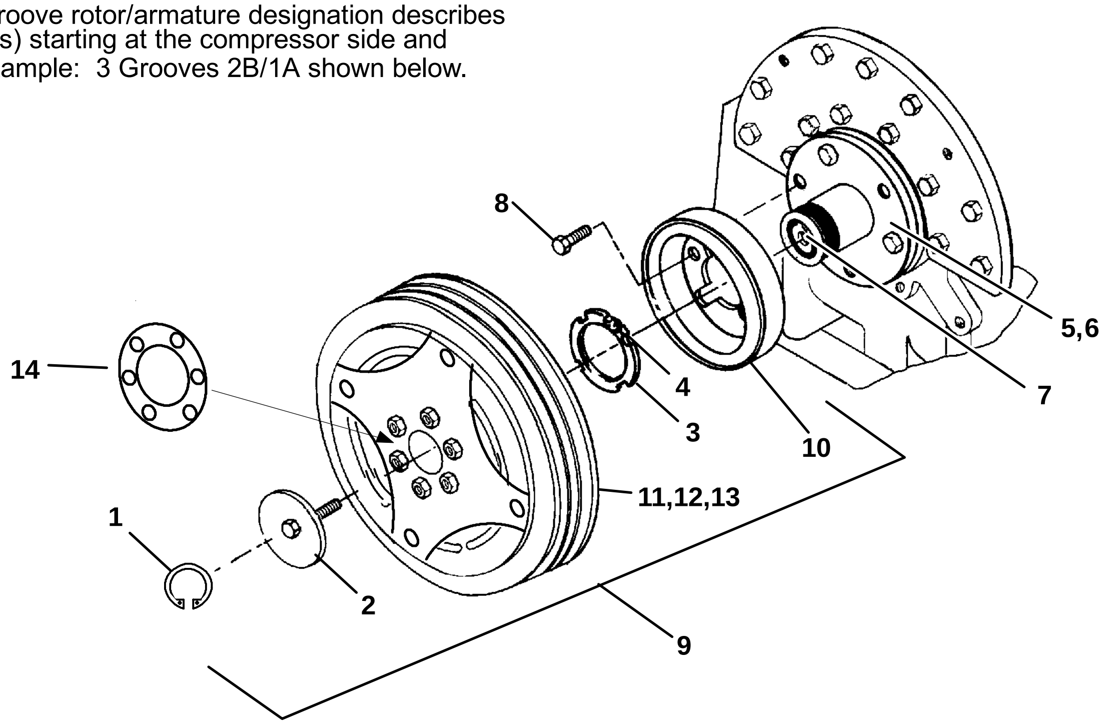


Item	Part Number	Description	Qty
NS	76-50013-00	Kit, Conversion Shaft to Housing Mounted Clutch	A/R
1	34-00613-07	Capscrew, Hex Head, 3/8-24 x 7/8 Inch Long - SAE Grade 8	1
2	--AU--11AR-241	Washer, Lock, Spring, 3/8 Inch	1
3	34-00616-00	Washer, 13/32 ID x 1-1/2 OD x 3/16 Inch Thick	1
4	34-01161-00	Nut, 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)

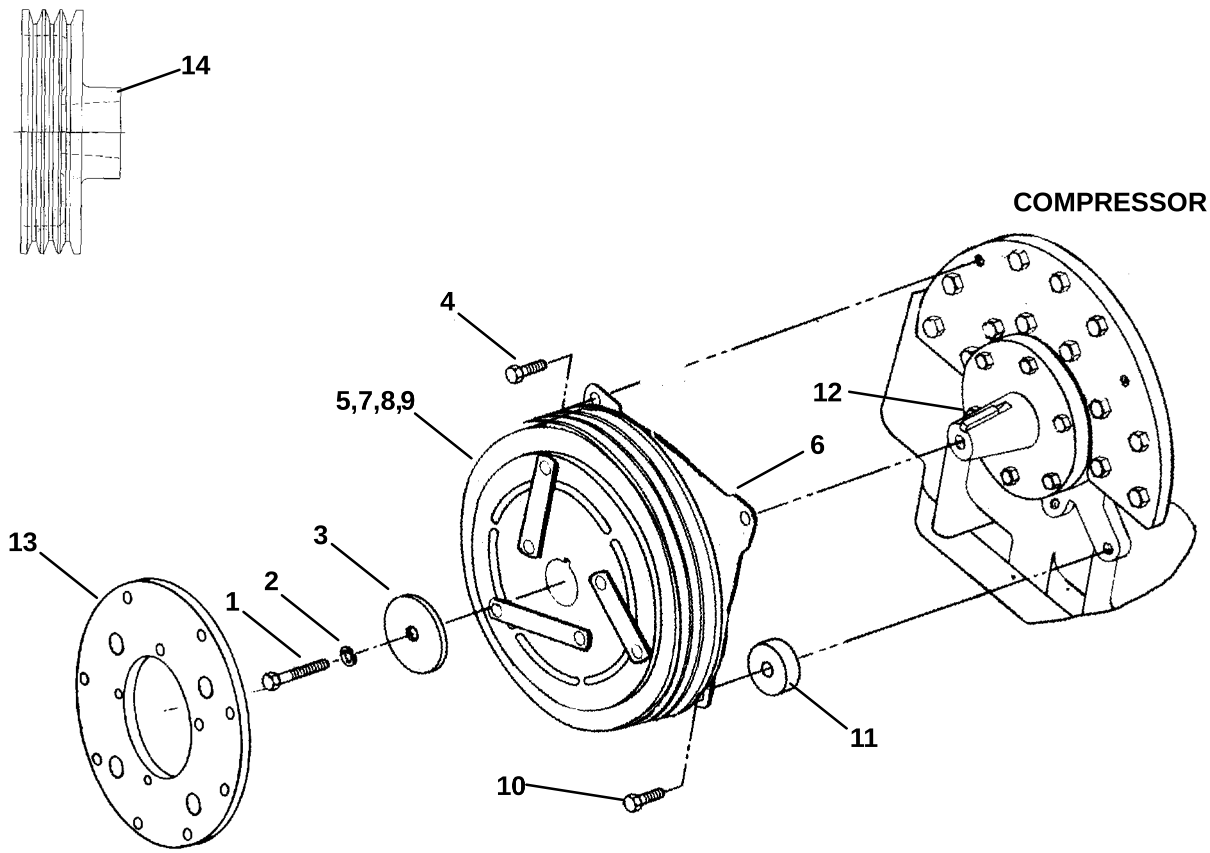
Note: Multiple groove rotor/armature designation describes groove location(s) starting at the compressor side and working out. Example: 3 Grooves 2B/1A shown below.



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

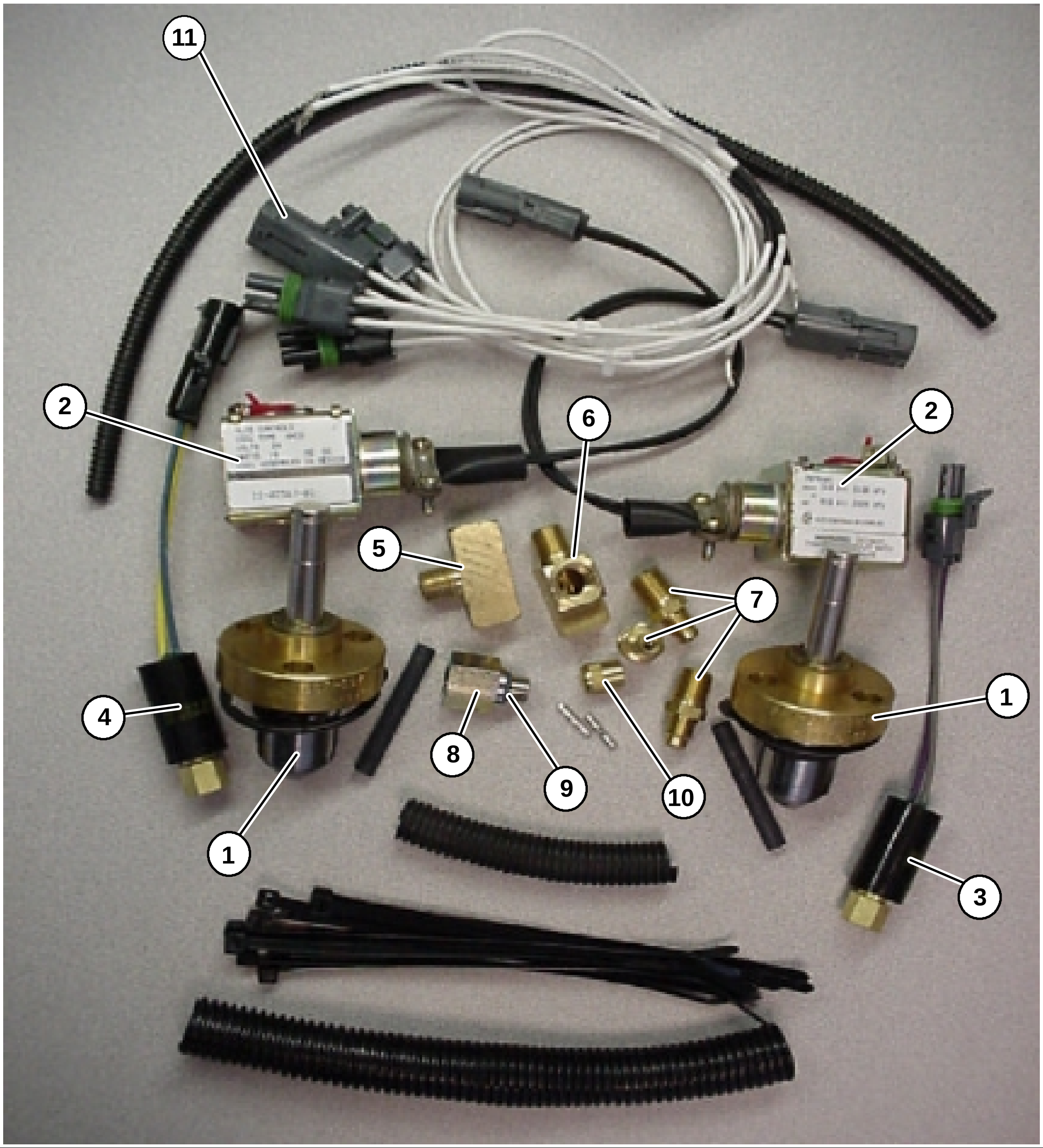
16 CLUTCH ASSEMBLY - SHAFT MOUNTED



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
17 UNLOADER KIT - PRESSURE TO ELECTRIC - R-134a ONLY - 36 VDC			
	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

PART NUMBER INDEX

PART NUMBER INDEX

A

C

D

Symbols

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

www.carrier.transicold.com

Carrier TRANSICOLD

Housing-Mounted Clutch Installation

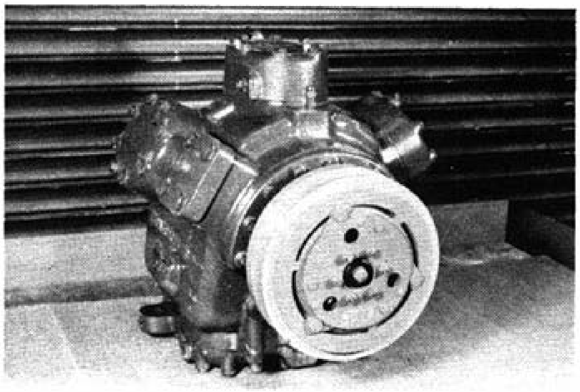
The procedure on the attached pages should be followed carefully when servicing the Carrier Transicold housing-mounted clutch. The following tools are recommended when removing and replacing this clutch:

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

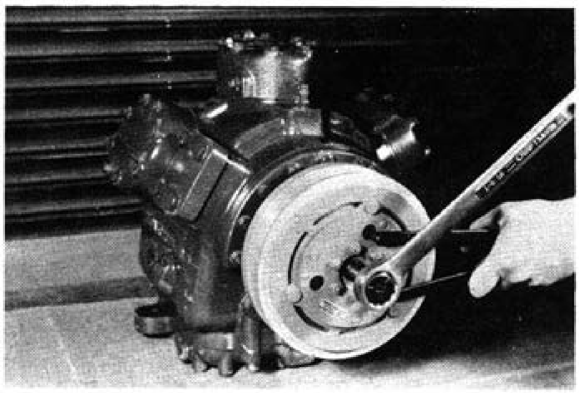
The new housing-mounted electric clutch, HMC, eliminates drive belt loading on the 05G crankshaft, and applies this load directly to the crankcase of the compressor. The following procedure should be followed carefully whenever it becomes necessary to remove and replace the HMC.



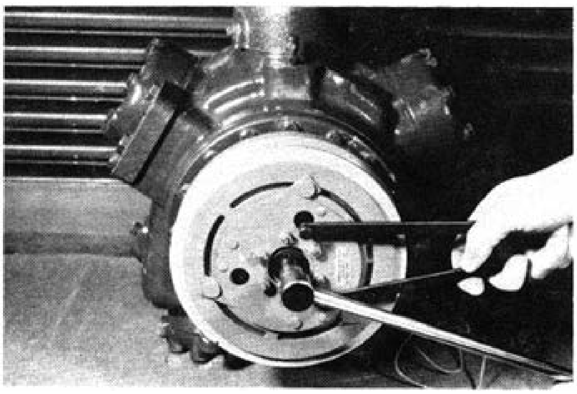
Housing-Mounted Clutch Removal

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.

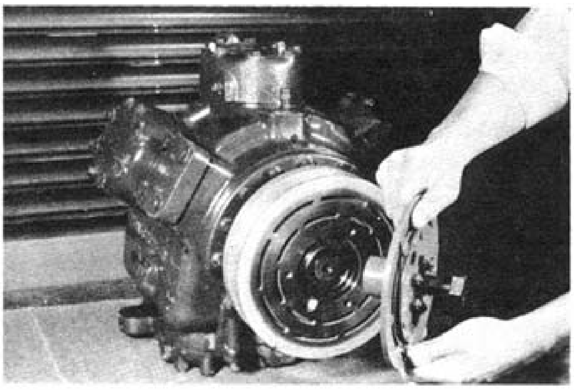


2. Install a 7/8-14 x 2″ capscrew into the center hole of the armature assembly. Use this capscrew as a jacking bolt to remove the armature assembly. Use tool 07-00240-01 as in Step 1 to prevent crankshaft rotation.

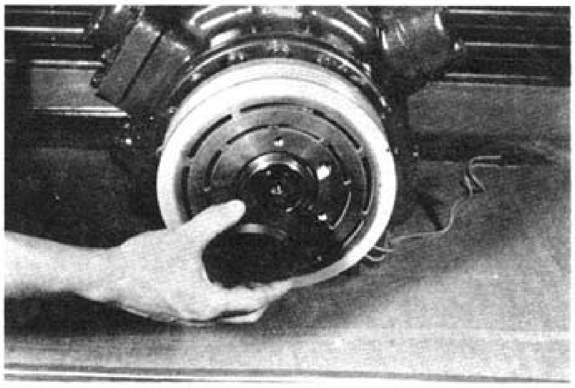


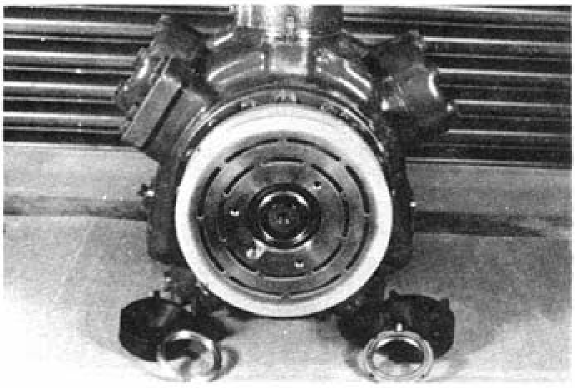
Note: Do not use a puller or pry against the armature hub or bumper plate, as this could cause damage to these parts.

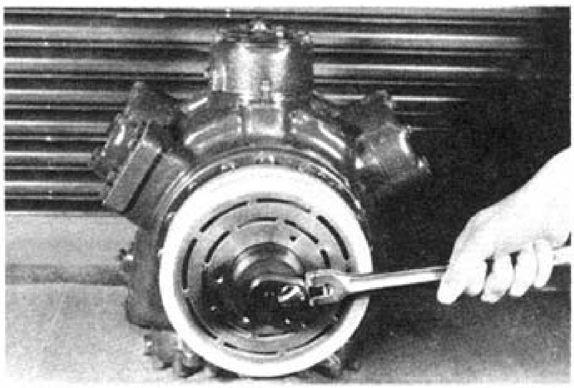
3. Remove the clutch armature assembly from the compressor crankshaft as a complete assembly, as shown.



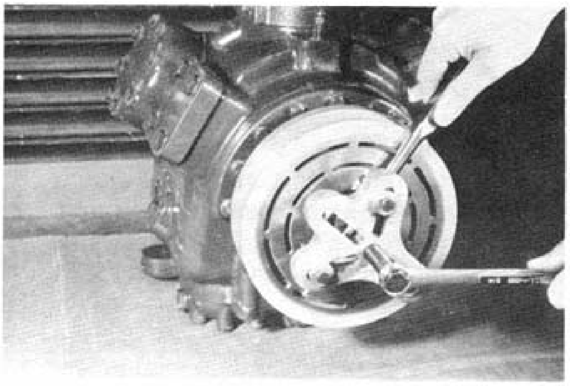
4. Remove the rotor retaining nut with special CTD tool P/N 07-00242-01.





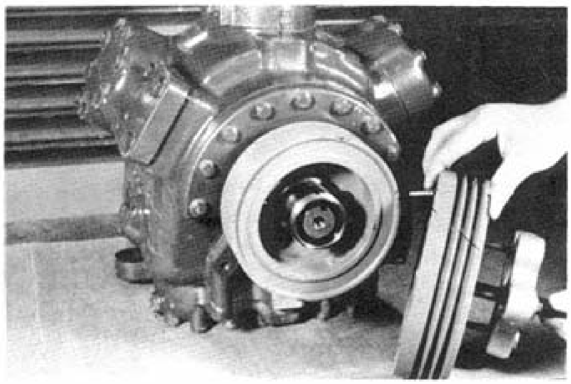


5. Install a flange-type gear puller into the three 5/16-18 tapped holes in the clutch rotor assembly, as shown.

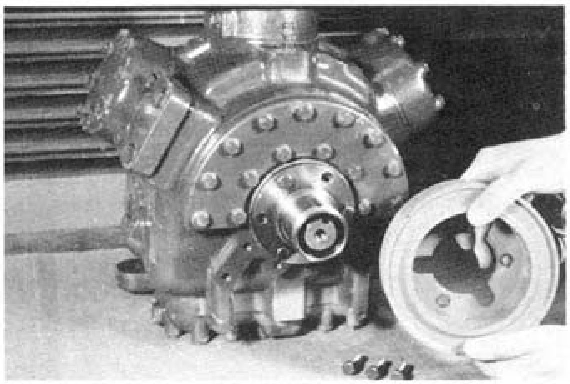


CAUTION: Use a washer or other protective device to prevent damage to crankshaft and threaded hole in the crankshaft by the puller. Never use a puller in the belt grooves, as damage to the rotor may result. Use a pry bar as shown to prevent rotation of the clutch rotor.

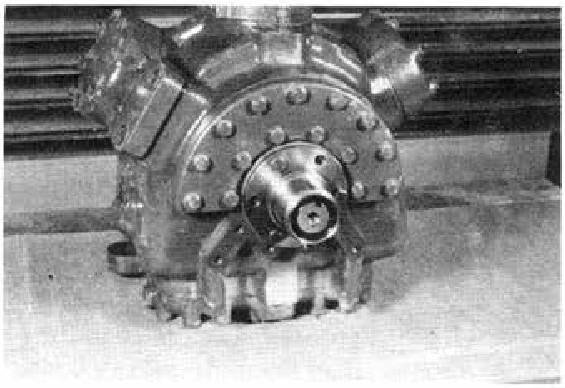
6. Once the rotor has been pulled from the clutch bearing mounting hub, carefully lift the rotor assembly away from the compressor, as shown.



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.

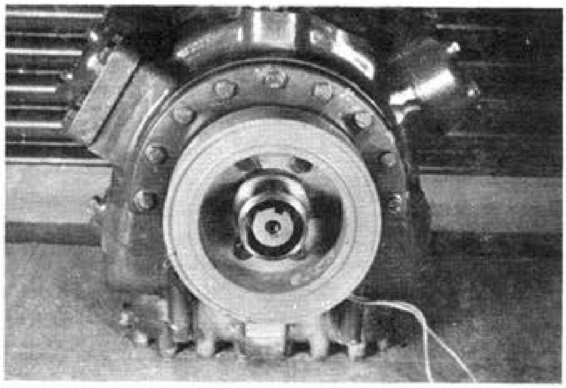
2. Inspect coil for damaged power leads, bent or cracked mounting plate, or burned or cracked potting material.

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.



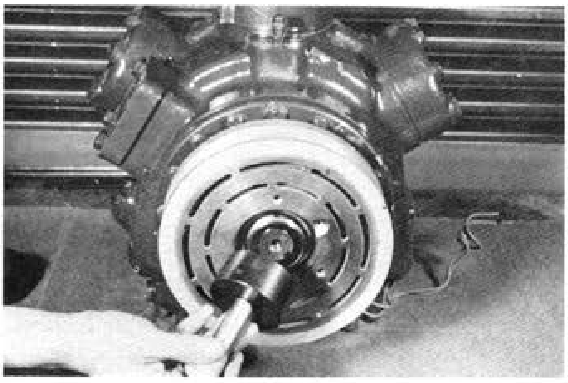
5. Secure the coil to the bearing mounting hub flange with the three 3/8-16 capscrews removed in Step 7 of Clutch Removal. Torque capscrews to 25-30 ft-lb (3.46-4.15 MKG).

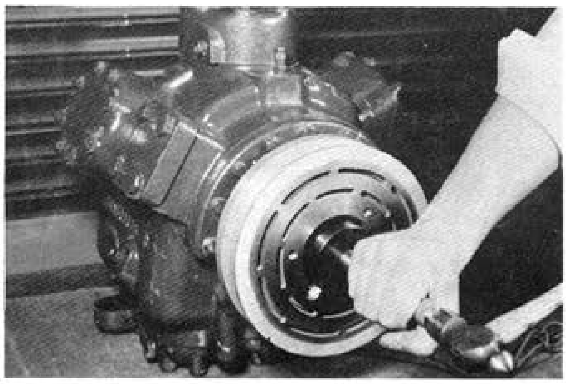
   CAUTION: Do not draw coil onto the clutch bearing mounting hub flange with the capscrews, as this may distort the coil.

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.

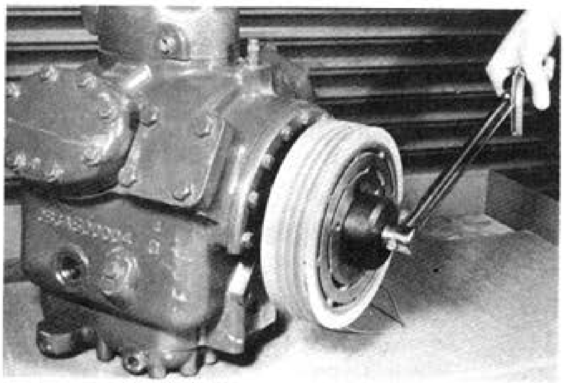




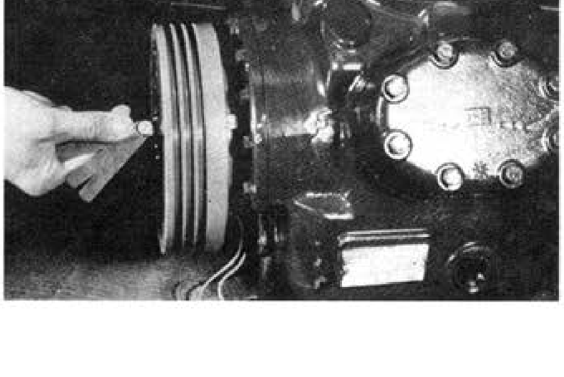
8. Install bearing retaining nut on clutch mounting hub and use torque wrench to tighten.

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.

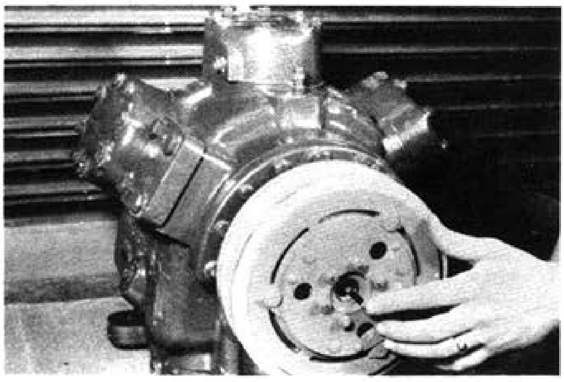


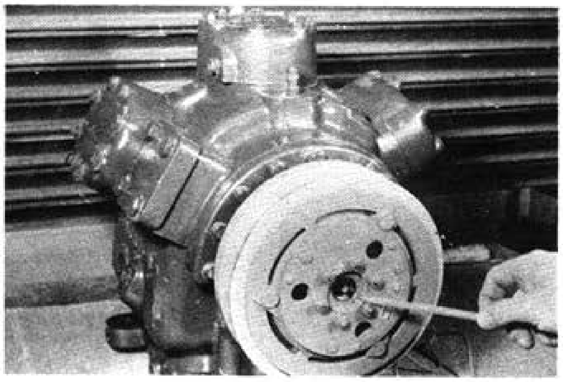
9. Check coil to rotor clearance by inserting .020 thick by .156 wide (max.) feeler gauge through an outer slot in rotor, as shown. Insert the feeler gauge so it extends beyond the rear face of the rotor and rotate the rotor one full turn. There should be no rubbing or binding.



10. Place armature and hub assembly onto the compressor crankshaft and insure the hub seats on the crankshaft properly.

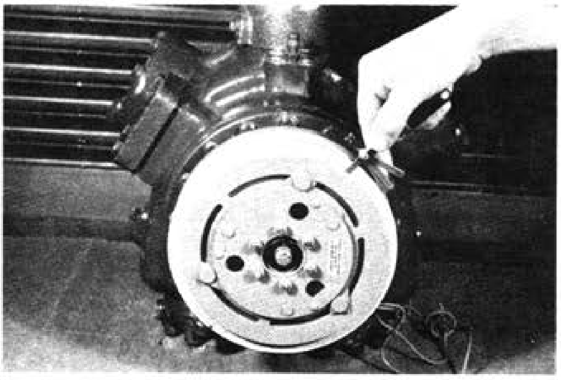
11. Insert the special key CTD P/N 68G2-9072 (1.75 x .250 x .199) in the keyway until outer end of key is flush with the hub's counter bore, as shown.





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.

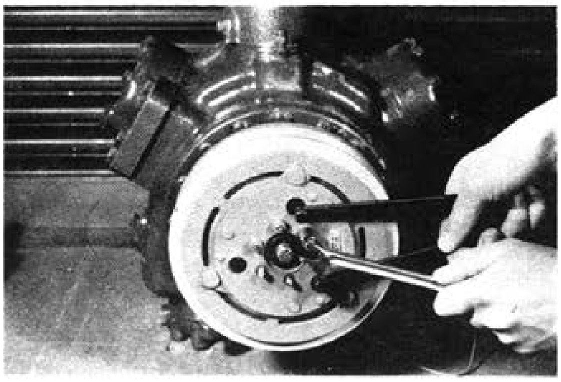
Steps 13-19 are for new clutch installation only. After the initial adjustment, shim stack should not be changed.



13. Measure the air gap between the armature and rotor surfaces, as shown.

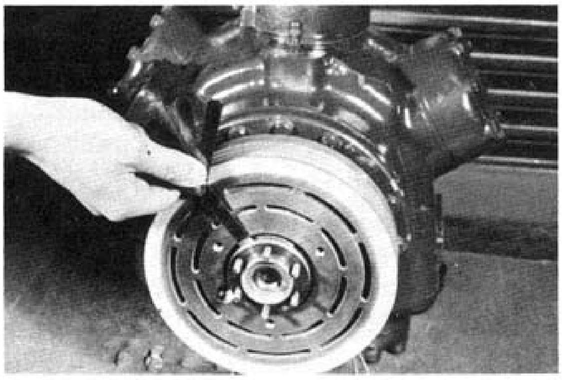
14. Record this measurement and determine the amount of shims that must be removed to obtain a 030/.060 air gap. The shims consist of (one) .010 and (six) .020 shims.

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).

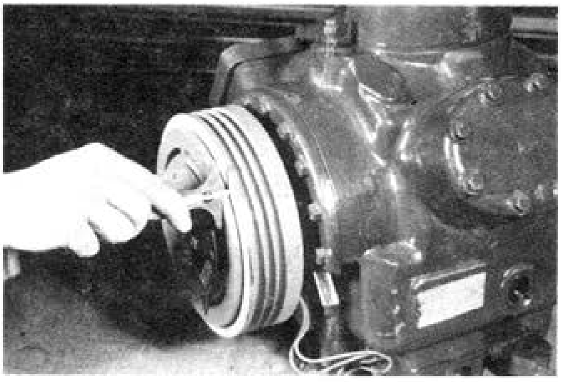
CAUTION: Do not give extra strokes "for good measure" as premature clutch performance degradation may result.

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.

CONTENTS

ILLUSTRATIONS

1. ROOF ANTENNA INSTALLATION

- o Find the desire location and drill a hole according to specification.
- o To remove dirt and grease, wash hole edge with alcohol.
- o If so equipped, remove foam padding ring from antenna to free the metal surface (foam can produce air bulbs in new rubber seal).
- o With SIKA 205, wash the edge of the hole and the antenna base surface, wait at least two (2) minutes for chemical evaporation.
- o Apply new seal SIKA 221 on both, edge of the hole and antenna base.
- o Fix the antenna in place.
- o Remove excess seal and complete a finishing joint all around the antenna base.

2. HUBODOMETER

2.1 DESCRIPTION

An optional wheel hubodometer (Fig. 1) 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.

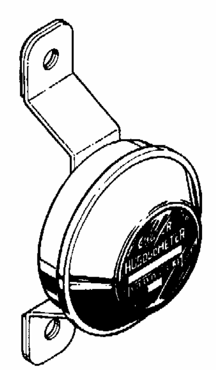


FIGURE 1: HUBODOMETER 23024

2.2 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.

2.3 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.

2.4 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).

3. 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". The TV monitor is mounted on top of the dashboard. Refer to the Owner’s Manual under “Controls & Instruments".

4. COLD STARTING AID (ETHER)

The vehicle can be equipped with an electrically-operated type ether cold starting aid designed to ease engine starting when temperature is low.

On vehicles equipped with cold starting aid, the system consists of the main following parts:

- o Ether starting aid switch
- o Ether cylinder
- o Solenoid valve (24 V)
- o Thermal cutout valve
- o Atomizer

The control rocker switch is located on the dashboard. This switch is provided with a locking mechanism to avoid accidental use when engine is running. To activate the ether starting aid, proceed as follows:

1. Prior to cranking engine, press down rocker switch for three seconds to fill solenoid valve.
2. Release switch to discharge shot.

3. Allow three seconds for shot to discharge.
4. Start engine, use additional shots if necessary to keep engine running.

CAUTION

This practice should be performed only when absolutely necessary. Excessive use of fluid could result in serious engine damage.

The ether cylinder and solenoid valve assembly are mounted on the engine compartment wall and are accessible from the engine compartment R.H. side door.

The thermal cutout valve is mounted on the engine (radiator side). Its function is to prevent discharge of ether when engine is warm (over 90 F (32 C)). The atomizer is installed on top of the air intake duct (Fig. 2).

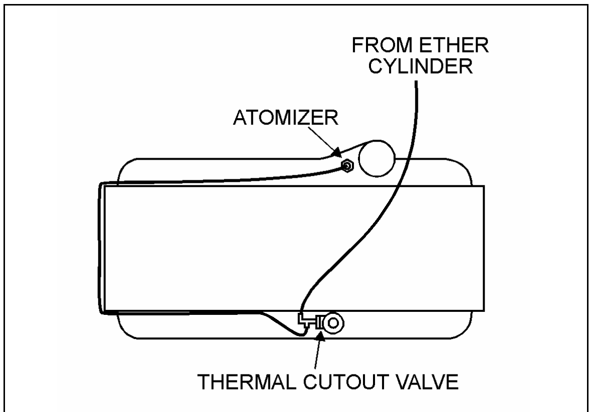


FIGURE 2: ENGINE 23032

4.1 PREVENTIVE MAINTENANCE

During the summer months, remove cylinder to avoid high temperature actuation of the cylinder safety relief device. Always screw valve cap into solenoid valve opening to prevent entrance of road dirt. When removing cylinder, be careful to prevent dirt from entering the valve.

4.2 TROUBLESHOOTING (IF SYSTEM IS NON-FUNCTIONING)

DANGER

During the following test, direct free end of tube away from personnel and all sources of ignition as this fuel is extremely flammable. Avoid breathing vapors and contacting fuel with skin. Never smoke during test.

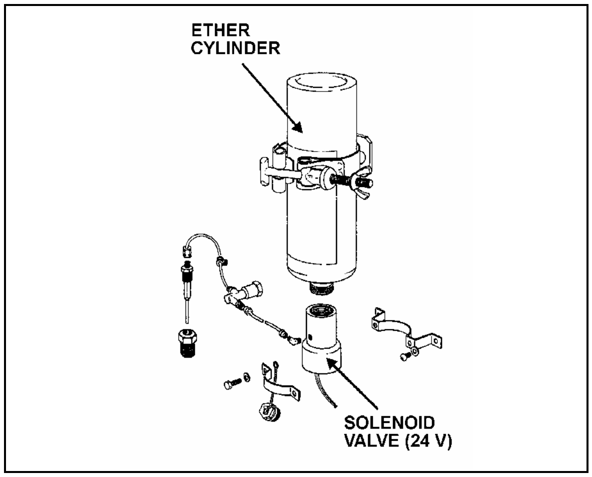


FIGURE 3: COLD STARTING AID 23048

1. Check cylinder for hand tightness and fuel supply (Fig. 3). Empty cylinder weight is approximately 17 oz (480 g); full cylinder weight is approximately 35 oz (990 g). If cylinder is empty, replace it. Before replacing cylinder, install new valve gasket in solenoid valve.
2. If still not functioning, disconnect tubing at solenoid valve fitting. Actuate solenoid valve. (Ask an assistant to actuate solenoid valve using the rocker switch on the dashboard).
   - o If solenoid valve is non-functioning, check electric circuit, (refer to wiring diagrams). If sound, remove and replace the solenoid valve. If not, repair electric circuit.
   - o If valve is functioning, reassemble valve fitting and connect tube. Disconnect tube at thermal cutout valve from port "Tube from valve".
3. Actuate the solenoid valve.
   - o If fuel is not discharged from tube, remove tube and blow out or replace.
   - o If fuel is discharged, connect tube to thermal cutout valve, and disconnect other tube.
4. Actuate the solenoid valve.
   - o If fuel is not discharged, replace the cut-out valve.

NOTE

If engine coolant temperature is 90°F (32°C) or over, it is normal that fuel is not discharged as the valve is in closed position.

- o If fuel is discharged, connect tube to thermal cutout valve, and disconnect tube from atomizer.

5. Actuate the solenoid valve.
   - o If fuel is not discharged from tube, fuel line is clogged. Remove tube and blow out or replace.
   - o If fuel is discharged, replace the atomizer.

5.3 THERMAL CUTOUT VALVE QUICK TEST

1. Engine coolant temperature must be below 90 F (32 C).
2. Temporarily disconnect tube at thermal cutout valve from port *"Tube to atomizer"*.
3. Actuate solenoid valve (Ask an assistant to actuate solenoid valve by means of the rocker switch on the dashboard). Fuel should be discharged through the thermal cutout valve.

DANGER

Avoid breathing vapors and contacting fuel with skin. Never smoke during test.

4. Reconnect tube to thermal cutout valve.
5. Start engine, using cold starting aid if necessary. Stop engine when it reaches operating temperature.
6. Disconnect tube at thermal cutout valve as in step 2, and repeat step 3. No fuel should be discharged.

5. AIR HORN VALVE

The air horn valve is located in the front service compartment and the air horn valve button is on the steering wheel center.

5.1 AIR HORN VALVE MAINTENANCE

When needed, the air horn valve can be serviced or replaced using the following procedure:

1. Unplug the cable connector;
2. Disconnect the air tubes;
3. Loosen the retaining bolts;
4. Service or replace the air horn valve;
5. Reinstall by reversing procedure.

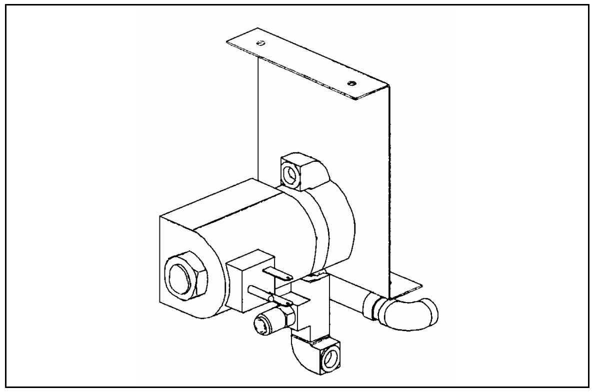


FIGURE 4: AIR HORN VALVE 23230

6. HEADLIGHTS CLEANING SYSTEM

6.1 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.

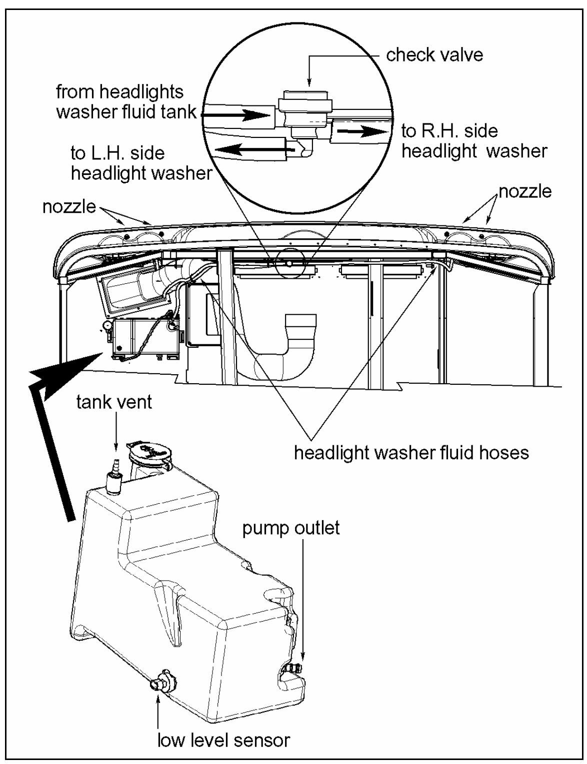


FIGURE 5: HEADLIGHTS CLEANING SYSTEM 23380

However, this system shares the same telltale light than the windshield washer low level sensor (refer to Owner'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.

6.2 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.

6.3 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 7. 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.

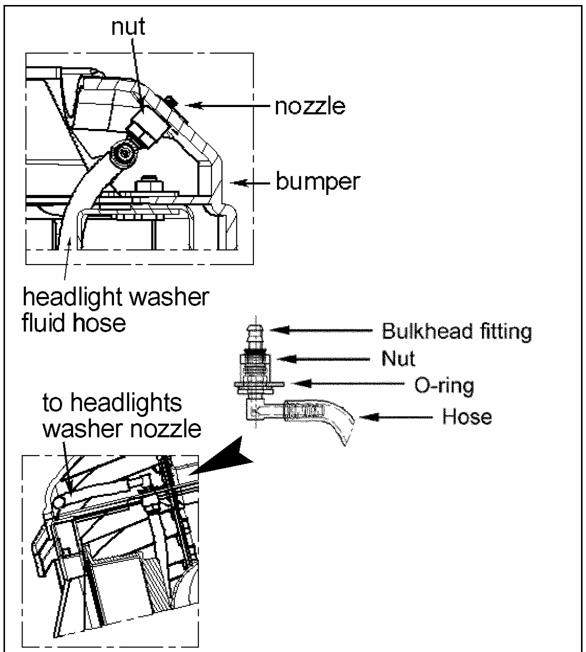


FIGURE 6: TUBING AND FITTINGS 23381

CAUTION

Because they are made of plastic, firmly tighten nozzle and bulkhead fittings by hand only.

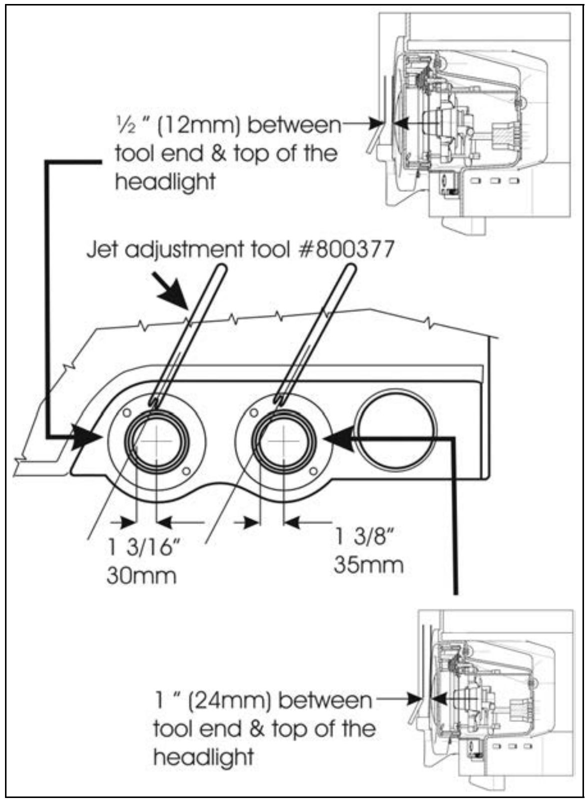


FIGURE 7: WASHER NOZZLES ADJUSTMENT 23382

7. WINDSHIELD WIPERS AND WASHERS

7.1 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 8).

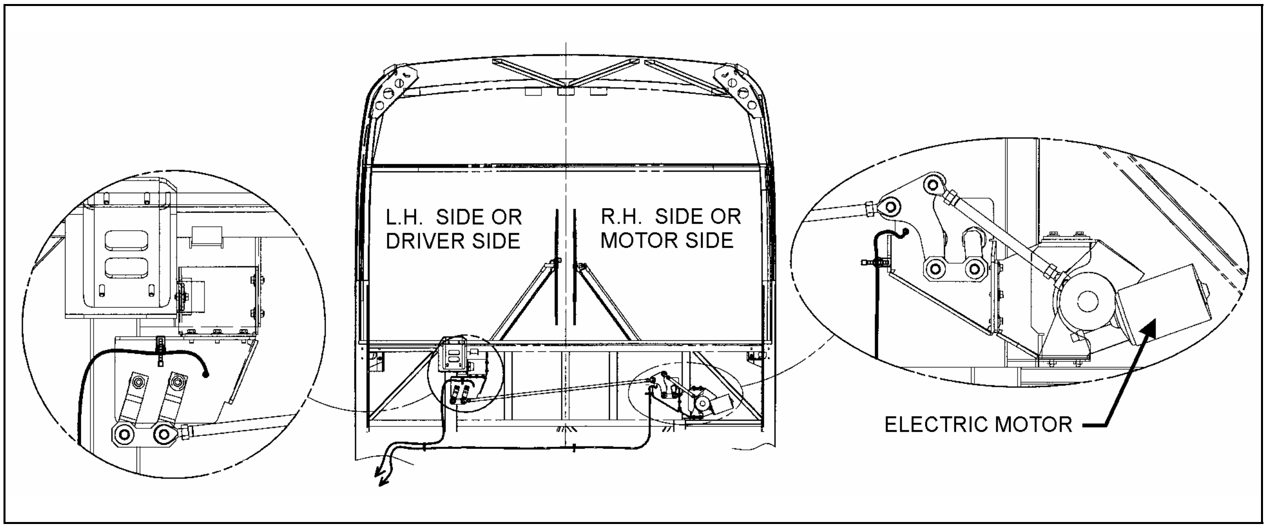


FIGURE 8: WINDSHIELD WIPER INSTALLATION 23287

Turn the multifunction lever forward to activate windshield wipers (item 2, fig. 9). 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.

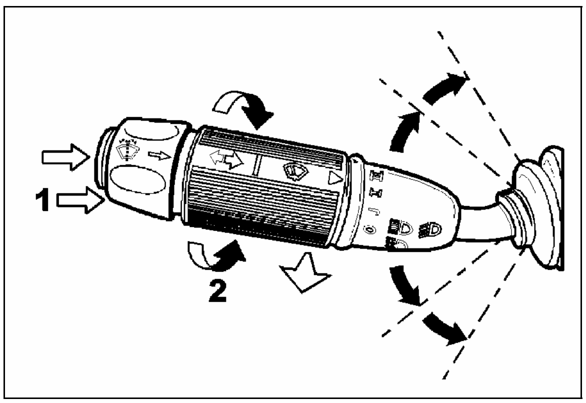


FIGURE 9: MULTIFUNCTION LEVER 23133

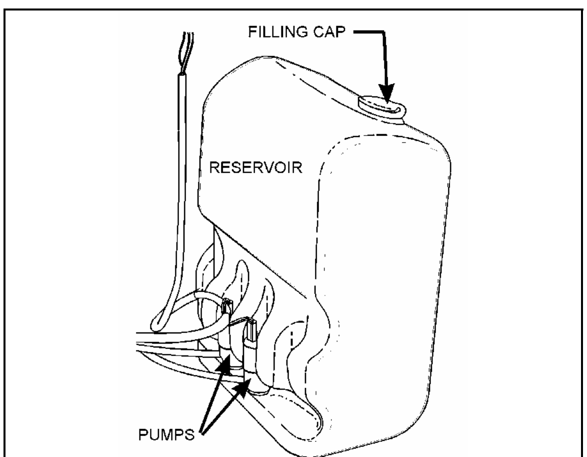


FIGURE 10: WINSHIELD WASHER RESERVOIR 23220

The windshield washer pumps are electrically operated and are controlled by a washer control ring on the multifunction lever (item 1, fig. 9).

The windshield washer reservoir is located in the front service compartment (fig. 10). This unit pumps the washer liquid to the spray nozzles where it is dispersed across the windshield.

7.2 WIPER ARM

Check operation of the wipers for proper blade sweep and angle.

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.

7.2.1 Wiper Arms Positioning

1. Reinstall the wiper arms and position as shown in figure 15. 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

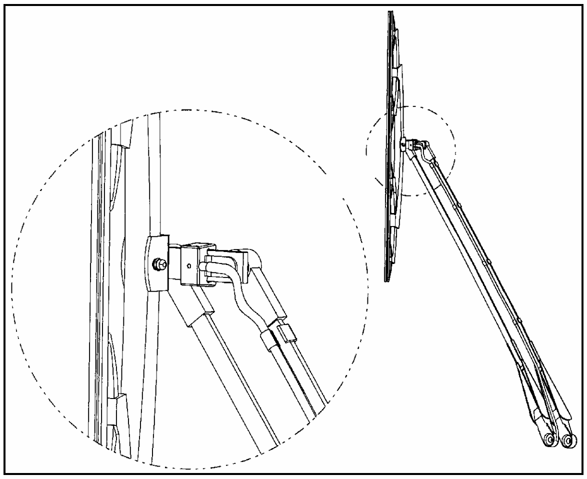


FIGURE 11: WINDSHIELD WIPER (MOTOR SIDE) 23335

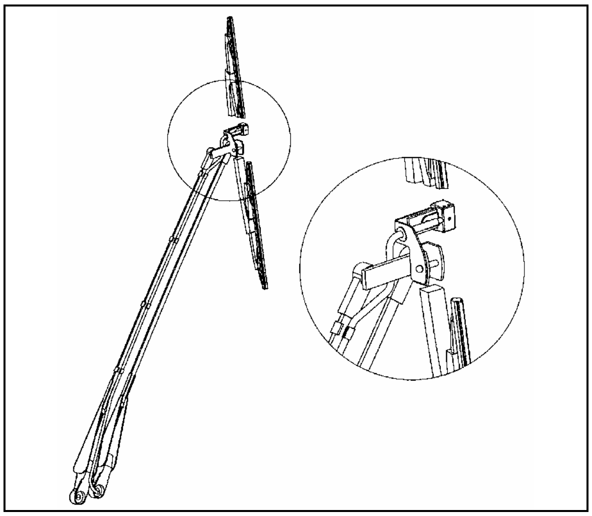


FIGURE 12: WINDSHIELD WIPER (DRIVER SIDE) 23334

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.

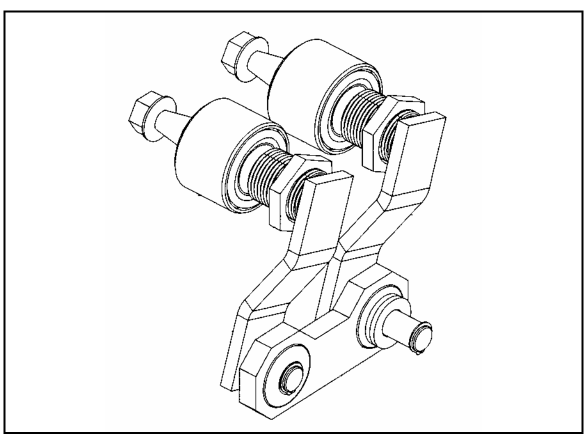


FIGURE 13: DRIVING MECHANISM (DRIVER SIDE) 23334

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.

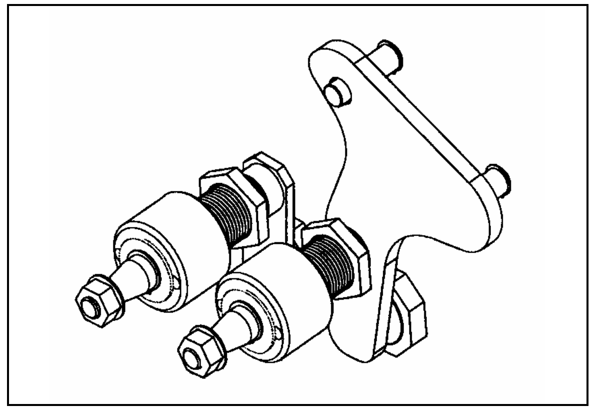


FIGURE 14: DRIVING MECHANISM (MOTOR SIDE) 23254

7.3 WINDSHIELD WIPER MOTOR

7.3.1 Windshield Wiper Motor Replacement

The windshield wiper motor is located at lower front of the vehicle, behind the defroster panel. Refer to figure 8 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.

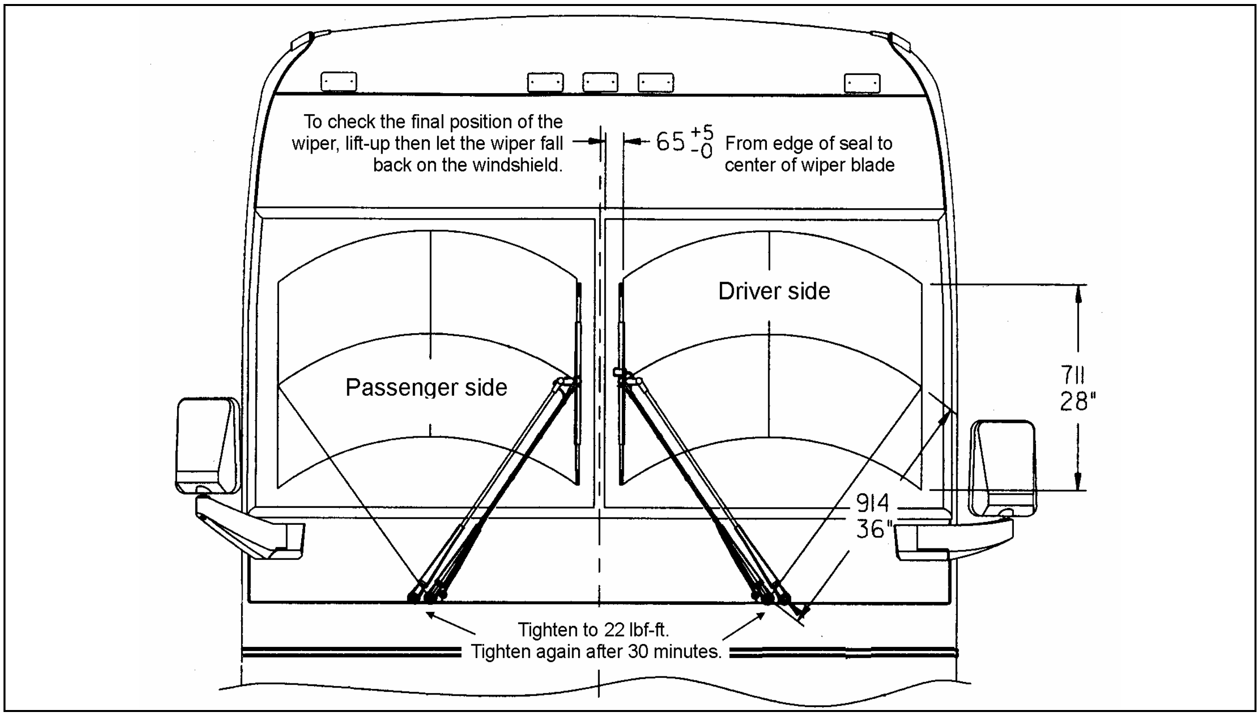


FIGURE 15: WIPER ARMS POSITIONING 23253

7.4 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 re-place.
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.

8. SPECIFICATIONS

HUBODOMETER (US model: miles)
Make..Stemco
Prevost number..650002

HUBODOMETER (Canada model: km)
Make..Stemco
Prevost number..650117

AIR HORN
Make.. Allied Signal Inc.
Prevost number..640093

AIR HORN VALVE
Make.. Allied Signal Inc.
Prevost number..640128

WINDSHIELD WIPER MOTOR
Make..BOSCH
Prevost number..800328

WIPER (BLADE)
Make..BOSCH
Prevost number..800329

WIPER ARM
Make..BOSCH
Prevost number..800331

SECTION 24: LUBRICATION

CONTENTS

ILLUSTRATIONS

1. LUBRICATION

The efficiency and life expectancy of mechanical equipment is largely dependent upon 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.

1.1 FIRST SERVICE ON NEW VEHICLE

Perform the following maintenance procedures after the first 3,000 miles (4 800 km) of operation (unless otherwise specified). Once initial maintenance is performed, refer to recommended intervals in the lubrication schedule.

Repeat a component's initial maintenance procedure when it has undergone a major repair.

1.1.1 Differential

No initial oil or filter change necessary. Refer to regular lubrication and servicing schedule.

1.1.2 Coolant Strainer

The coolant strainer is designed to recover the soldering residues trapped inside the coolant lines during their initial assembly; perform initial cleaning once vehicle has run approximately 3,000 miles (4 800 km), then according to the lubrication and servicing schedule.

NOTE
If additional soldering has been performed on any point of coolant piping, clean coolant system strainer as outlined for a new vehicle at 3,000 miles (4 800 km).

1.1.3 Allison Automatic Transmission

No initial oil or filter change necessary. Refer to regular lubrication and servicing schedule.

1.1.4 Engine

Since engine break-in has been done in factory, there is no special break-in, so oil should be changed according to the lubrication and servicing schedule intervals. Since some oil consumption by engine is normal, check oil level daily with engine stopped and add to FULL mark on dipstick if necessary. Furthermore, the engine oil filter should be replaced each time the engine oil is changed.

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 ENGINE OIL CHANGE INTERVALS

The engine oil change intervals are related to the operating conditions, such as vehicle load, speed, etc., and may vary. It is recommended however, that the oil change be performed after every 12,500 miles (20 000 km).

The drain intervals may then be gradually increased or decreased with experience on a specific lubricant, considering the recommendations of the oil supplier (analysis of drained oil can be helpful), until the most practical service condition has been established.

Solvents should not be used as flushing oils. Dilution of the fresh refill oil supply can occur, which may be detrimental for the engine.

Engine oil temperature should be checked every 25,000 miles (40 000 km) to determine oil cooler efficiency. This check should be made by inserting a steel jacketed thermometer in the dipstick opening, immediately after stopping a hot, loaded engine. If the oil temperature exceeds the coolant temperature by more than 60 °F (33 °C), the oil cooler may be clogged.

For detailed oil specifications, refer to *"Detroit Diesel Series 60 Service Manual"* under heading *"Lubricating Oil for Detroit Diesel Engines"*.

2.1.1 Engine Oil Reserve Tank

An oil reserve tank with a capacity of 8.4 US quarts (8,0 liters) (optional) is connected to the crankcase by a hose with a shutoff valve, allowing oil to be added to crankcase by opening valve. Comparison of oil levels in sight gauge, before and after adding oil to crankcase, shows approximately how much oil has been added.

Filling of this tank can be made by opening the rear engine doors. The tank is mounted on R.H. side of engine compartment, over the A/C compressor.

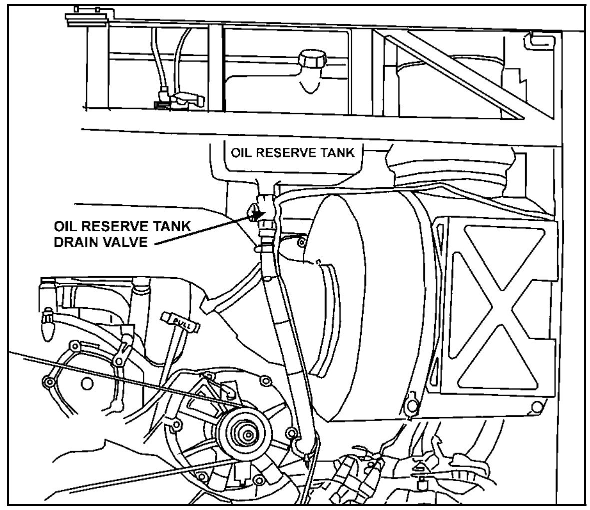


FIGURE 1: ENGINE OIL RESERVE TANK 01172

2.2 COLD WEATHER OPERATION

The proper selection of the engine oil grade will ease cold weather starting (refer to the lubrication and servicing schedule for the engine oil grade recommendation). Other practical considerations, such as the use of batteries, cables and connectors of adequate size, proper setting of voltage regulator, ether starting aid, oil and coolant heater systems, and proper fuel selection will ease cold weather starting.

2.3 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.

2.3.1 Pre-Starting 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.

2.3.2 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.

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.

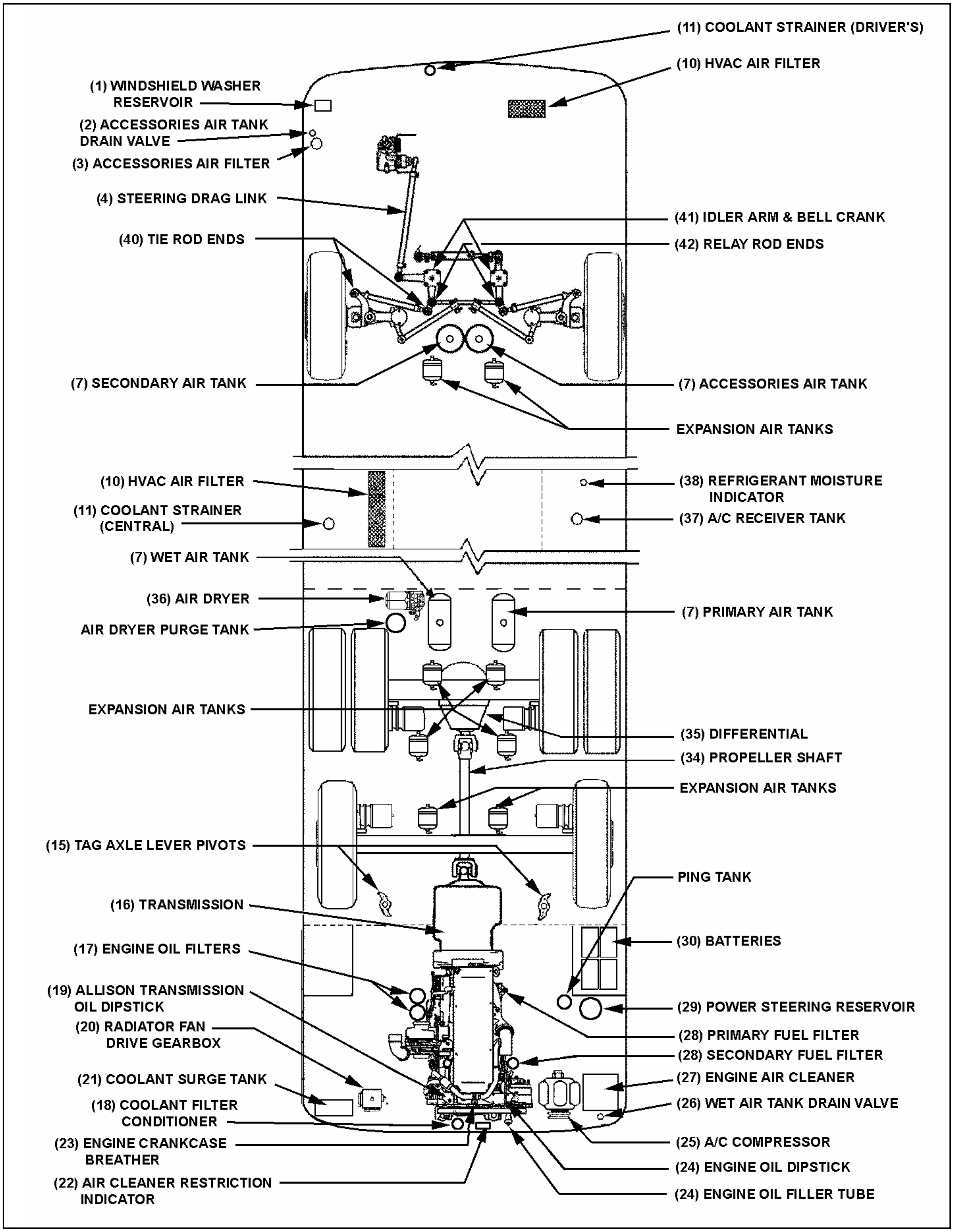


FIGURE 2: LUBRICATION AND SERVICING POINTS ON INDEPENDENT FRONT SUSPENSION VEHICLES 24036

2.4 WALK-AROUND INSPECTION

It is good practice to make a basic visual inspection of key areas on the vehicle every day (or before every trip for private coaches) and to correct any problem found.

OUTSIDE THE VEHICLE	
ITEM*	DESCRIPTION
---	Check for leaks under vehicle and in engine compartment.
---	Check that baggage and service compartment doors close properly.
---	Inspect tires and wheels for correct tire pressure, wear or damage and for missing wheel studs and nuts.
1	Check windshield washer fluid level and add if necessary.
---	Check condition of windshield wiper blades.
---	Verify proper operation of all road lights, signal lights, brake lights, marker lights and back-up lights; Replace light bulbs as required.
2, 26	Drain accumulated water in accessory and wet air tanks.

ENGINE COMPARTMENT	
ITEM*	DESCRIPTION
24	Check engine crankcase oil level; Add if necessary.
19	Check Allison transmission oil level (can be checked from push-button shift selector); Add if necessary.
29	Check power steering reservoir fluid level; Add if necessary.
21	Check coolant surge tank fluid level; Add if necessary.
28	Drain accumulated water in primary fuel filter/water separator (if equipped). Visually check fuel filter cartridge (Fuel-Pro 382 equipped vehicles only).
22, 27	Check air cleaner restriction indicator; Replace air cleaner when red signals locks in full view.

INSIDE THE VEHICLE	
ITEM*	DESCRIPTION
---	Verify proper operation of windshield wiper/washer.
---	Adjust and clean mirrors as needed for adequate rear-view vision.
---	Start engine and check for proper operation of all gauges and indicator lights.
---	Check for proper operation of electric and air horns and back-up alarm.
---	Perform a brake test. Check both primary and secondary pressure gauges.

- Item numbers refer to figure 2.

2.5 LUBRICANT AND COOLANT SPECIFICATIONS

ITEM*	DESCRIPTION	SPECIFICATIONS
24	Engine Oil	SAE Viscosity Grade: 15W40 API Classification: CI-4
29	Power Steering Oil	Automatic Transmission Oil (Dexron-III)
18, 21	Engine Coolant	Low silicate, ethylene glycol coolant 50% antifreeze/water solution is normally used Antifreeze concentration should be between 30% and 67%
25	A/C Compressor Oil	Polyolester Oil, HFC 134a compatible: Castrol SW-68 (POE) or equivalent
35	Differential Oil	Multigrade gear oil meeting MIL-L-2105-D: 85W/140. 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.)
20	Fan Gearbox Oil	Synthetic oil: ISO VG (viscosity grade) 460 Natural oil: Mobil SHC 630
19	Allison Automatic Transmission Oil	Dexron-III® or Castrol TranSynd™ Synthetic Transmission Fluid for Allison, specification TES 295
---	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

* Item numbers refer to figure 2.

2.6 PART NUMBER SPECIFICATIONS

ITEM*	DESCRIPTION	PRÉVOST NO
17	Engine Oil Filters	#510458
29	Power Steering Reservoir Oil Filter	#660528
27	Engine Air Cleaner Filter	#530197
38	Refrigerant Filter Dryer Unit	#950262
28	Engine Primary Fuel Filter	#510137
28	Engine Primary Fuel Filter With Water Separator (Optional)	#531407
28	Engine Secondary Fuel Filter	#510128
28	Secondary “Racor” Fuel Filter	#531390
18	Engine Coolant Precharge Unit	#550629
18	Engine Coolant Filter/Conditioner	#550630
10	A/C And Heating Driver's Air Filter	#871147--871144
10	A/C And Heating Cabin's Air Filter	#871051
16	Allison Automatic Transmission Oil Filter Kit	#572050
11	Coolant Strainer	#871029
3	Accessories Air Filter	#641340
36	Air Dryer Cartridge	#641244
---	Alternator drive belt, 72 in. (Delco alternator)	#5060056
---	Fan gearbox drive belt	#506688
---	Compressor drive belt BX100	#506864
---	Windshield wiper blade	#800329

* Item numbers refer to figure 2.

LUBRICATION AND SERVICING SCHEDULE	Item	Months	DISTANCE TRAVELED [1] (miles/km)																																LUBRICANT &/OR PART [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	156250 / 250 000	162 500 / 260 000	168 750 / 270 000	175 000 / 280 000	181 250 / 290 000	187 500 / 300 000	193 750 / 310 000	200 000 / 320 000	
GENERAL																																			
Flexible hoses, thoroughly inspect all hoses	-	12								•								•								•								•	-------
Front discharge tube, qty:2, check to see if clogged [3]	-	3																																	-------
01 ENGINE																																			
Air cleaner, inspect, clean, replace element if required	27	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Filter #530197
Air Pre-Cleaner, check discharge tube	24	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	-------
Engine, change oil and filters. Oil SAE 15W40, API CI-4	17	12		•		•		•		•		•		•		•		•		•		•		•		•		•		•		•		•	Filter #510458
Engine crankcase breather, clean breather steel mesh	23	12								•								•								•								•	-------
03 FUEL																																			
Change primary & secondary fuel filters, fill with clean fuel before installation	28	12		•		•		•		•		•		•		•		•		•		•		•		•		•		•		•		•	Primary #510137 ; prim. w/sep #531390 ; secondary #510128
05 COOLING																																			
Radiator fan drive gearbox, check oil level, add if necessary	20	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Mobil SHC 630 #180217
Radiator fan drive gearbox, change oil	20	12								•								•								•								•	Mobil SHC 630 #180217
Coolant filter/Conditioner, replace element	18	12		•		•		•		•		•		•		•		•		•		•		•		•		•		•		•		•	Filter #550630
Coolant surge tank, test coolant solution	21	12		•		•		•		•		•		•		•		•		•		•		•		•		•		•		•		•	-------
Cooling system, drain, flush and refill	18/21	24																																•	Engine coolant
06 ELECTRICAL																																			
Battery terminals, clean and coat terminals	30	12																																	Battery terminal coating
Bosch alternators, replace brushes & voltage regulator		24																•																•	Regulator #562981 Brush set #562983
Bosch alternators, replace bearings		48																																•	Bearing, Ball #562972 Bearing, Roller #562976

[1] Proceed to maintenance operation at distance indicated on odometer or specified number of months, whichever comes first.

[2] See paragraph 2.5 & 2.6 of this section for lubricant and part number specifications.

[3] Discharge tubes are rubber tubes located under vehicle.

LUBRICATION AND SERVICING SCHEDULE	Item	Months	DISTANCE TRAVELED [1] (miles/km)																																		LUBRICANT &/OR PART [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	156250 / 250 000	162 500 / 260 000	168 750 / 270 000	175 000 / 280 000	181 250 / 290 000	187 500 / 300 000	193 750 / 310 000	200 000 / 320 000	250 000 / 400 000	300 000 / 480 000	
07 TRANSMISSION																																					
Allison Automatic transmission **equipped with retarder**, change oil and filters (if filled with standard oil)	16	6		•		•		•		•		•		•		•		•		•		•		•		•		•		•		•			Dexron-III
Allison transmission **equipped with retarder**, change oil (if filled with TranSynd™ / TES 295 Synthetic Fluid only) [3]	16	48																							•										TranSynd™ Synthetic Fluid / TES 295
Allison Automatic transmission **without retarder**, change oil and filters (if filled with standard oil)	16	12				•				•				•				•				•				•				•				•			Dexron-III
Allison transmission **without retarder**, change oil (if filled with TranSynd™ / TES 295 Synthetic Fluid only) [3]	16	48																																•	TranSynd™ Synthetic Fluid / TES 295
Allison transmission **with or without retarder**, change filters (if filled with TranSynd™ / TES 295 Synthetic Fluid only)	16	12												•												•											Filters #572050
Transmission oil cooler, replace unit if vehicle is equipped with transmission retarder	43	24																													•					Castrol Syntrans grade SAE 75W-85
09 PROPELLER SHAFT																																					
Grease one fitting on each universal joint and slip joint	34	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			Multipurpose grease
11 REAR AXLE																																					
Differential, check oil level, add if necessary	35	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			Multigrade gear oil
Differential, change oil, clean breathers	35	12																•																•			Multigrade gear oil
Differential, change oil, clean breathers	35	48																																	•		Full synthetic gear oil
Tag axle lever pivot, grease one fitting on each pivot	15	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			Multi purpose grease
12 BRAKE & AIR																																					
Air tanks, drain water from all tanks	7	12		•		•		•		•		•		•		•		•		•		•		•		•		•		•		•		•			-------
Accessories air filter, change filter element	3	24																•																•			Filter element #641340
Air dryer, change cartridge	36	24																•																•			Cartridge #3097369
Brake pads, check pad wear indicator and perform caliper slide check	-	12		•		•		•		•		•		•		•		•		•		•		•		•		•		•		•		•			Section 12 of Maintenance Manual

[1] Proceed to maintenance operation at distance indicated on odometer or specified number of months, whichever comes first.

[2] See paragraph 2.5 & 2.6 of this section for lubricant and part number specifications.

[3] When the transmission contains a mixture of fluids (defined as the quantity of non-TranSynd / 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-TranSyndTM / non-TES 295 intervals.

LUBRICATION AND SERVICING SCHEDULE	Item	Months	DISTANCE TRAVELED [1] (miles/km)																																LUBRICANT &/OR PART [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	156250 / 250 000	162 500 / 260 000	168 750 / 270 000	175 000 / 280 000	181 250 / 290 000	187 500 / 300 000	193 750 / 310 000	200 000 / 320 000	
14 STEERING																																			
Drag link ends, grease one fitting at each end	4	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Multi purpose grease
Relay rod ends, grease one fitting at each end	42	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Multi purpose grease
Steering tie rod ends, grease one fitting at each end	40	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Multi purpose grease
Idler arm, grease fitting	41	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Multi purpose grease
Bell crank, grease fitting	41	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Multi purpose grease
Steering damper cylinder, grease one fitting at rod end	39	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Multi purpose grease
Steering knuckle pins, grease two fittings per knuckle	9	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Multi purpose grease
Power steering reservoir, replace oil and filter cartridges	29	12								•								•								•								•	Cartridge #660987
16 SUSPENSION																																			
Upper A-Arm Ball Joint, grease fitting	-	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Molykote longterm 2/78 grease (preferably) or lithium NLGI no2 or no1
Hub unit and Swivel assembly-		12								•								•								•								•	See Dana Maintenance Manuals
22 HEATING & AIR CONDITIONING																																			
A/C compressor, check oil level, add if necessary	25	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Polyolester oil
A/C receiver tank, check refrigerant level, add if necessary	37	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	HFC 134A
Refrigerant moisture indicator, replace filter dryer unit according to moisture indicator (as needed)	38	6	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Filter #950262
A/C and Heating air filters, clean or replace all elements	10	6		•		•		•		•		•		•		•		•		•		•		•		•		•		•		•		•	Driver #871147 , passenger #871051
Coolant strainer, check, clean, change cartridge if required	11	12								•								•								•								•	Cartridge #871029
Condenser discharge tube, qty:2, check to see if clogged [3]	-	3																																	-------
Evaporator discharge tube, qty:6, check to see if clogged [3]	-	3																																	-------
Evaporator motor, condenser motor, recirculating pump drive motor, inspect brush, replace if necessary	-	12								•								•								•								•	Refer to parts manual

[1] Proceed to maintenance operation at distance indicated on odometer or specified number of months, whichever comes first.

[2] See paragraph 2.5 & 2.6 of this section for lubricant and part number specifications.

[3] Discharge tubes are rubber tubes located under vehicle.

CONTENTS

LIST OF ILLUSTRATIONS

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 (figure 1 and figure 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 (figure 1 & 2).

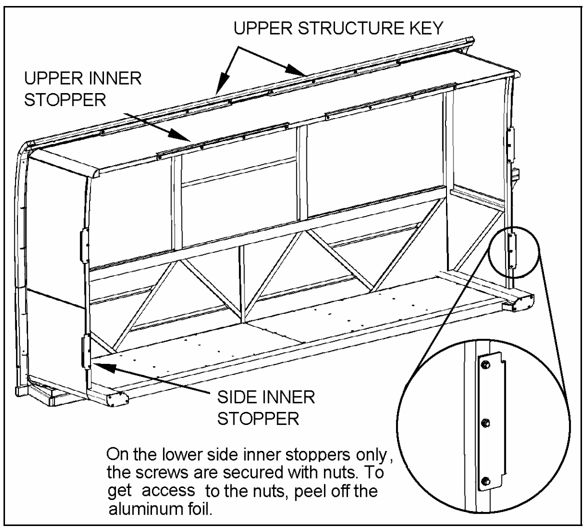


FIGURE 1 : FRONT SLIDE-OUT

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 <u>the seal deflated</u>. 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

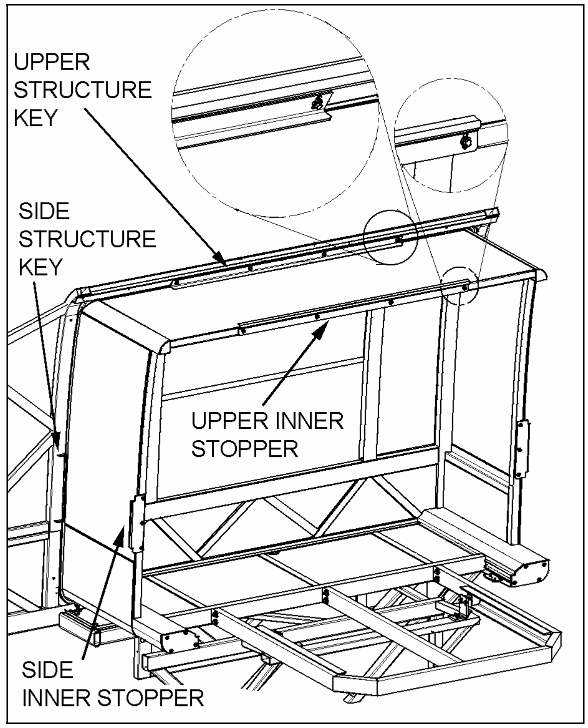


FIGURE 2 : REAR SLIDE-OUT

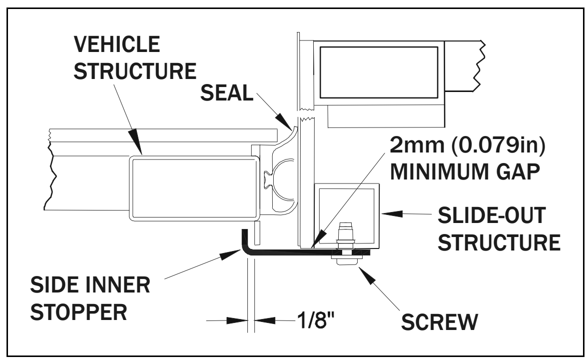


FIGURE 3 : SIDE INNER STOPPER ADJUSTMENT

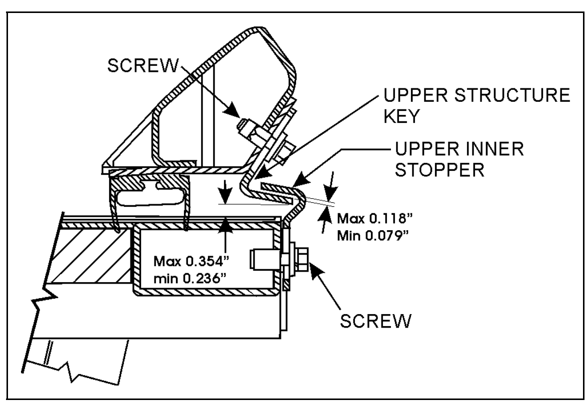


FIGURE 4: UPPER INNER STOPPERS ADJUSTMENT

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.

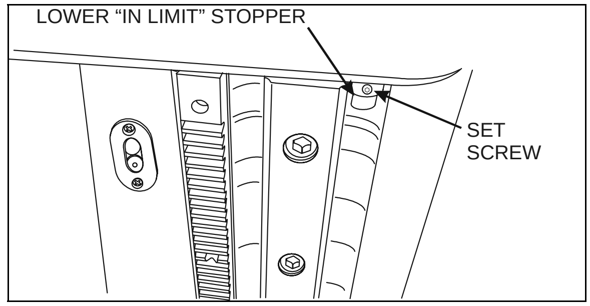


FIGURE 5: LOWER "IN LIMIT" STOPPER

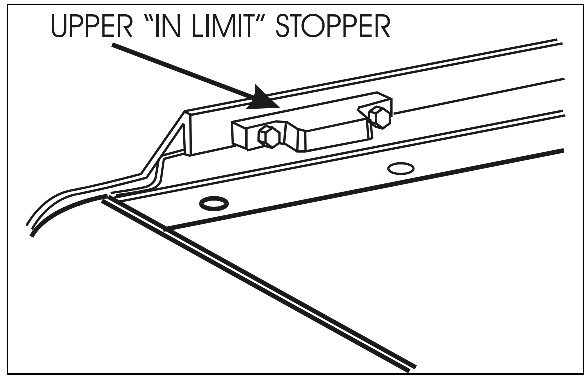


FIGURE 6: UPPER "IN LIMIT" STOPPER

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.

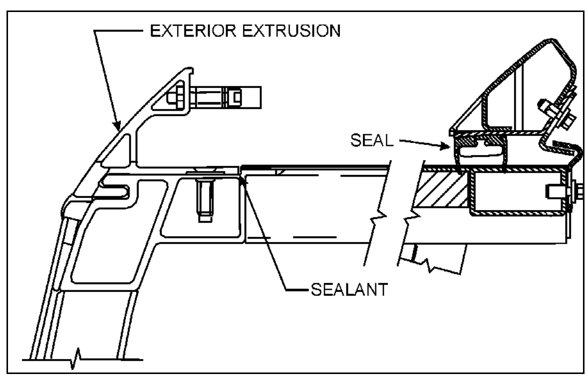


FIGURE 7 : EXTERIOR EXTRUSION

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.

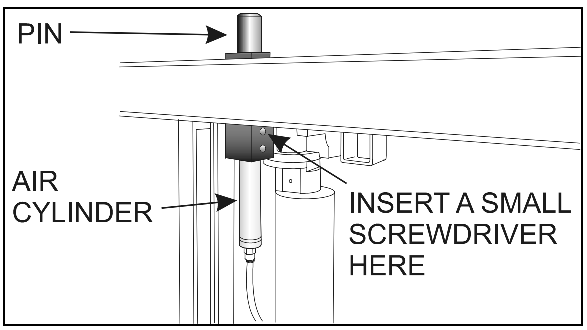


FIGURE 8: SECURITY PIN AIR CYLINDER REMOVAL

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).

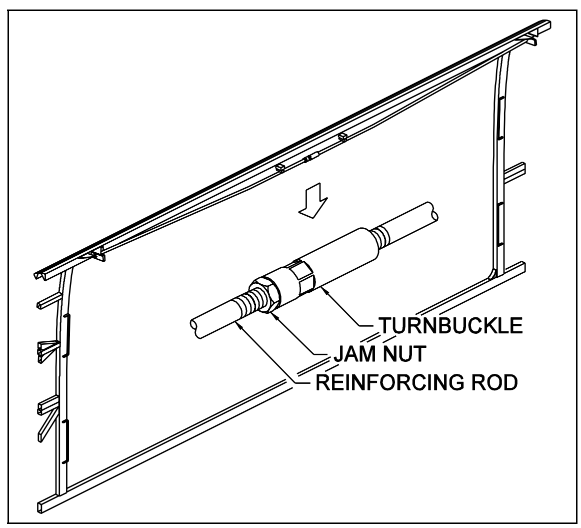


FIGURE 9 : FRONT SLIDE-OUT ROOF REINFORCING ROD

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.

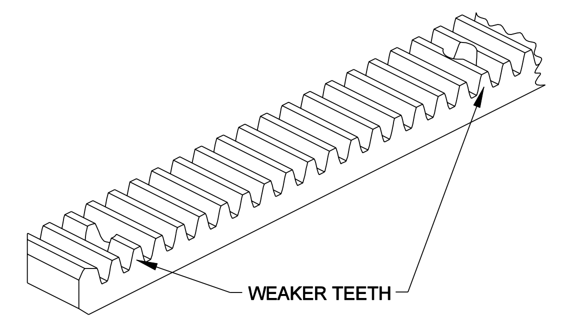


FIGURE 10 : RACK

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 <u>maximum torque of 2 ft-lbs</u>. 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 <u>maximum torque of 2 ft-lbs</u>. 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 <u>maximum torque of 2 ft-lbs</u>. 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.

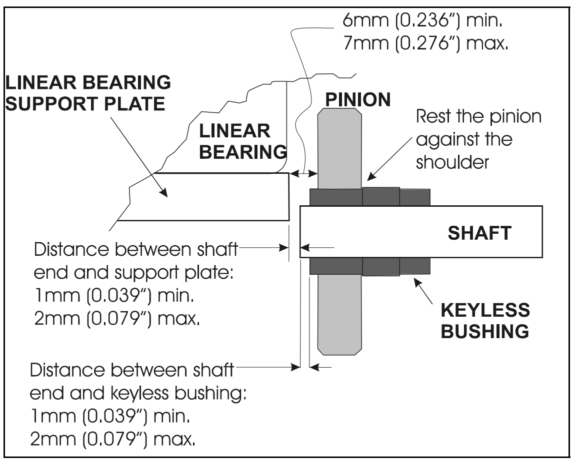


FIGURE 11: PINION AND KEYLESS BUSHING POSITIONING

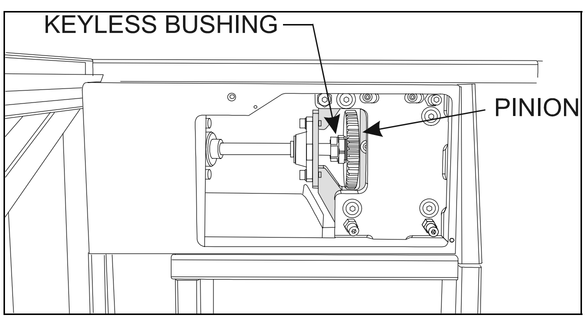


FIGURE 12: PINION AND KEYLESS BUSHING AS SEEN FROM EVAPORATOR COMPARTMENT

5.2 FRONT SLIDE-OUT SHAFT PINION REPLACEMENT

CAUTION

Before reinstalling the pinion, clean the following surfaces with alcohol to prevent slippage.

- o Pinion bore;
- o Keyless bushing I.D. and O.D.;
- o 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);

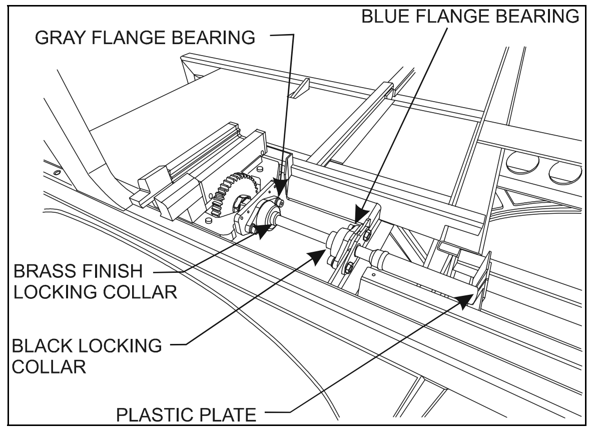


FIGURE 13: MECHANICAL COMPONENTS (TYPICAL)

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

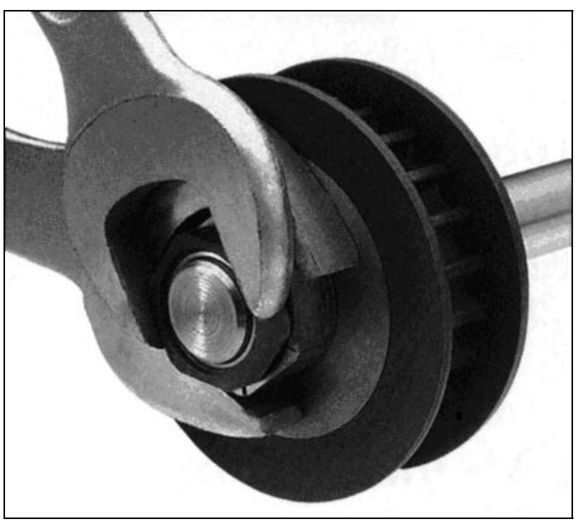


FIGURE 14 : KEYLESS BUSHING TIGHTENING

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.

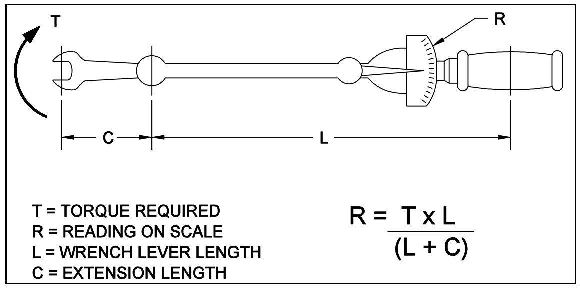


FIGURE 15 : TORQUE WRENCH FORMULA

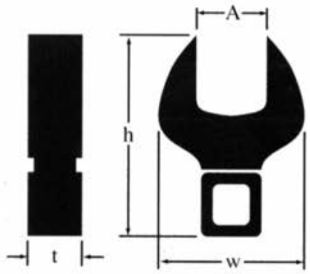
CAUTION

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.

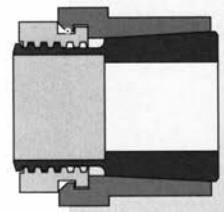


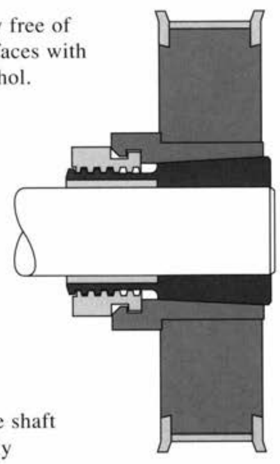
Figure 1

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.

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.



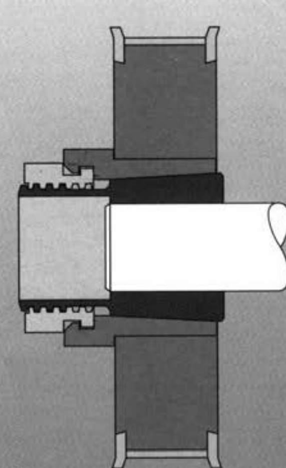


Figure 2

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.

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 INSTRUCTION

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 (FIGURE 18).

6.2 REPLACEMENT

1. The slide-out must be retracted.
2. Unplug the electric cable connector.

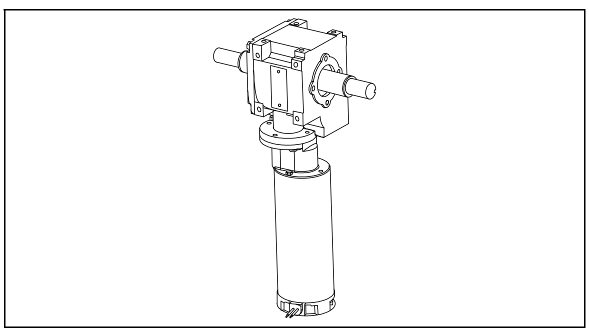


FIGURE 17: ELECTRIC MOTOR AND SPEED REDUCTION GEARBOX

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.

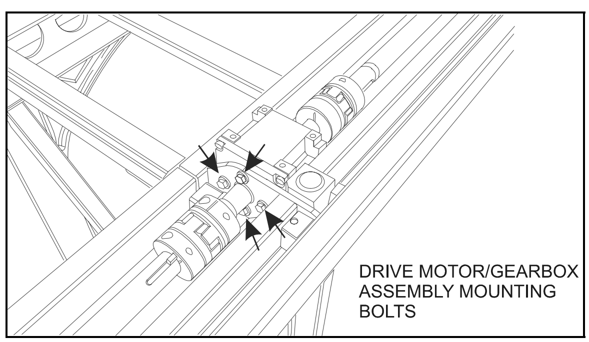


FIGURE 18: DRIVE MOTOR/GEARBOX ASSEMBLY MOUNTING BOLTS

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 (see FIGURE 19).

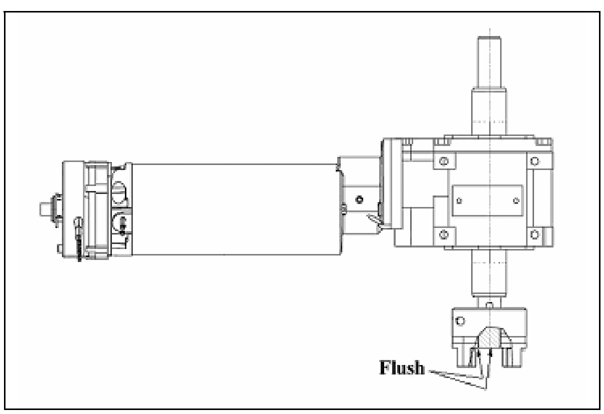


FIGURE 19: CLAMPING HUB POSITION ON GEARBOX SHAFT

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.

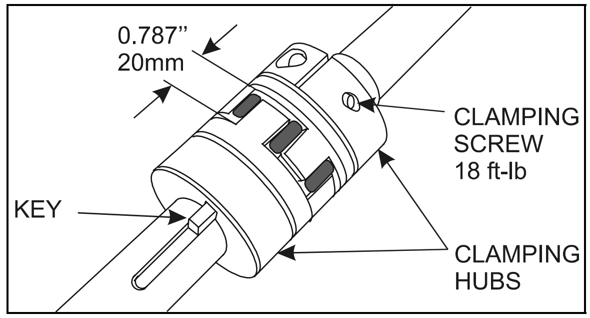


FIGURE 20: JAW COUPLING

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 to 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 <u>upper "in limit" stoppers touch first</u> 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.

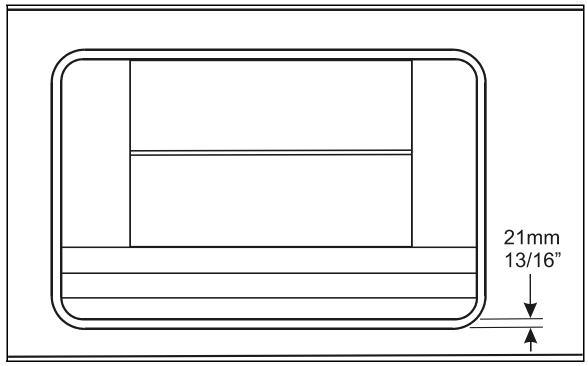


FIGURE 21: SLIDE-OUT LEVEL ADJUSTEMENT

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 section1.2).

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").

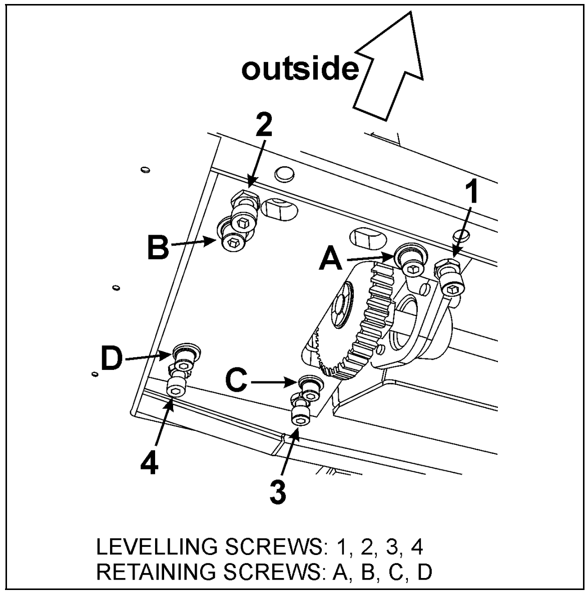


FIGURE 22 : SLIDE-OUT LEVELING

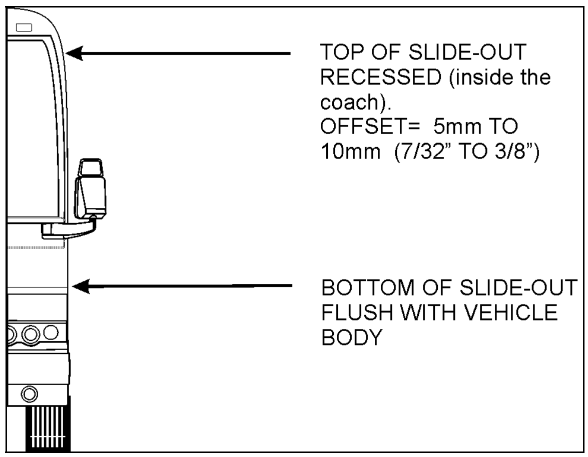


FIGURE 23: TILT ADJUSTMENT

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.

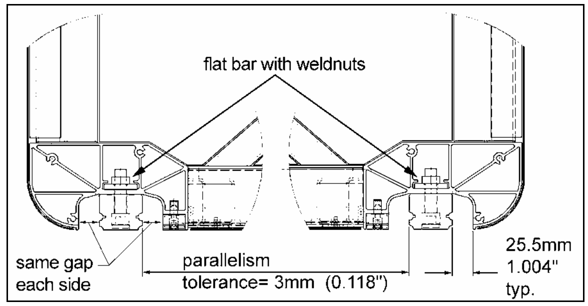


FIGURE 24 : RAIL POSITIONING

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.

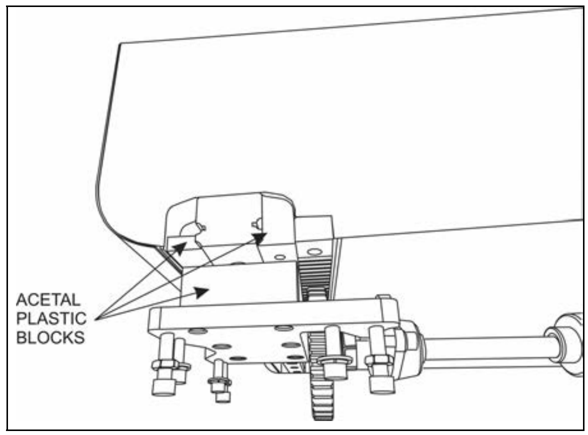


FIGURE 25: ACETAL PLASTIC BLOCKS

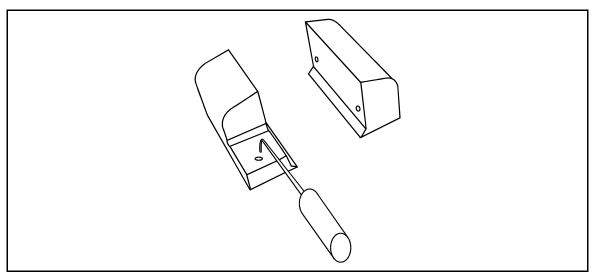


FIGURE 26: REMOVE THE UPPER ACETAL PLASTIC BLOCKS WITH A PICKING TOOL

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.

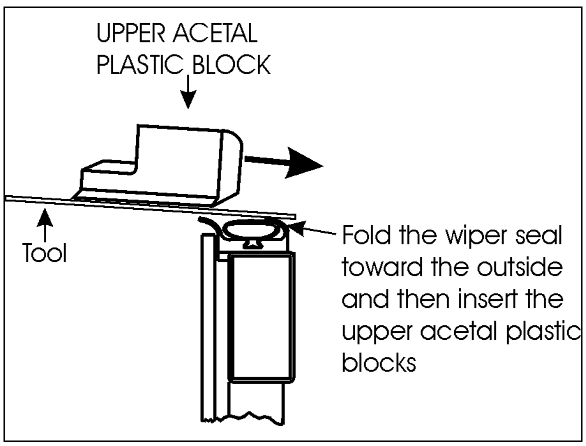


FIGURE 27: LOWER ACETAL PLASTIC BLOCK INSERTION

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.

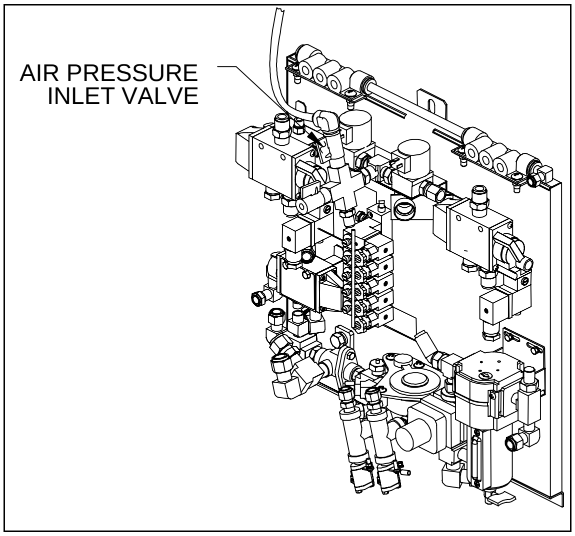


FIGURE 28 : FRONT SERVICE COMPARTMENT

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.

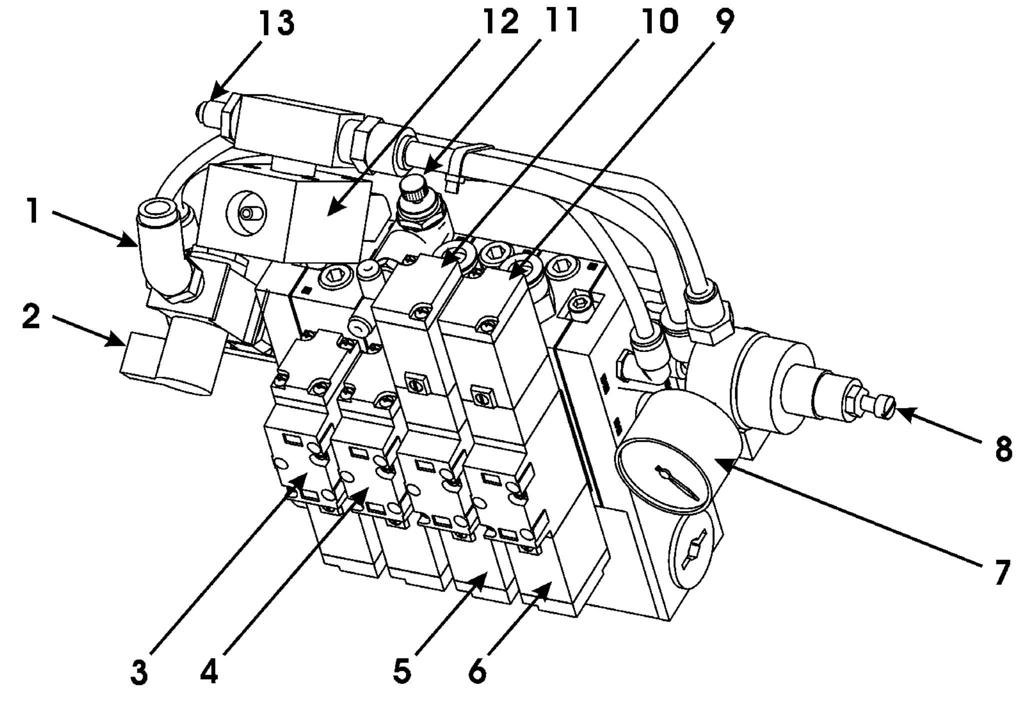


FIGURE 29: PNEUMATIC COMPONENT PANEL

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.

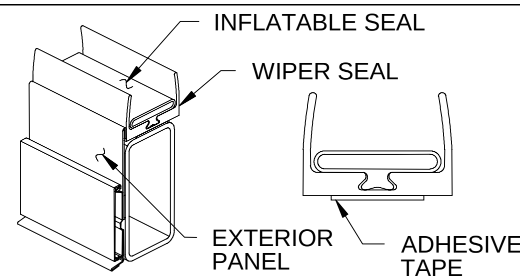


FIGURE 30 : SEAL ASSEMBLY

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.

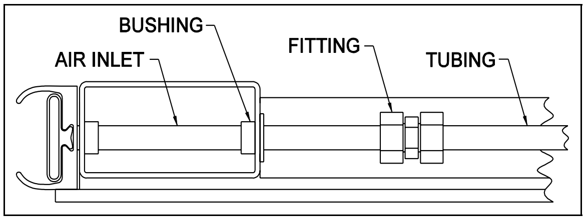


FIGURE 31: REAR SLIDE-OUT INFLATABLE SEAL AIR INLET

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).

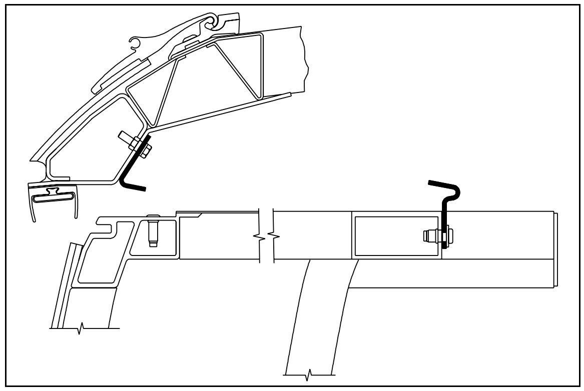


FIGURE 32: SLIDE-OUT 2" INSIDE – UPPER PART

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.

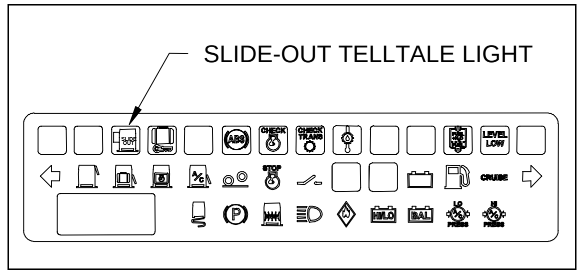


FIGURE 33 : DASHBOARD SLIDE-OUT TELLTALE LIGHT

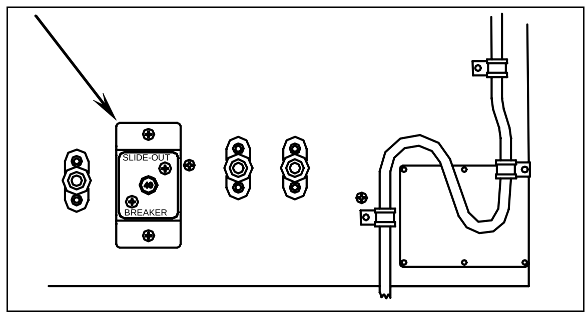


FIGURE 34: MAIN BREAKER IN ENGINE R.H. SIDE ACCESS COMPARTMENT

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).

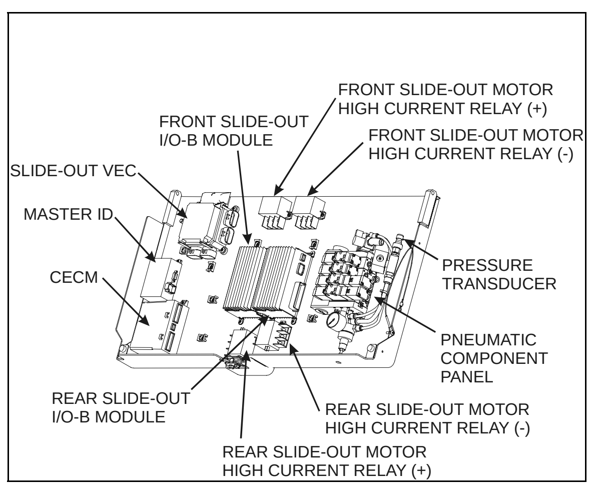


FIGURE 35 : SLIDE-OUT CONTROL PANEL

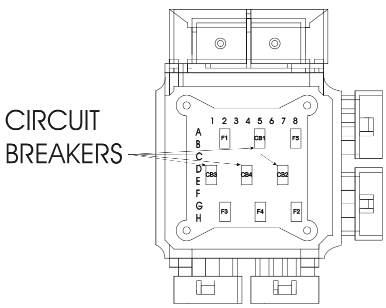


FIGURE 36 : VEC CIRCUIT BREAKERS & FUSES

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 MasterID 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 adjust 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.

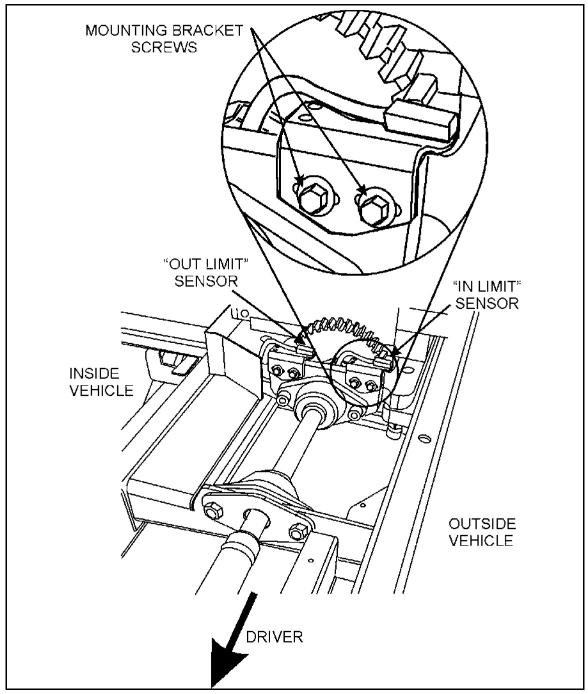


FIGURE 37 : FRONT SLIDE-OUT SENSORS

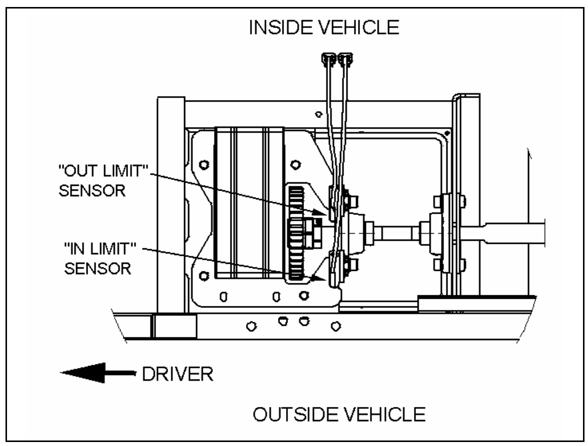


FIGURE 38: REAR SLIDE-OUT SENSORS

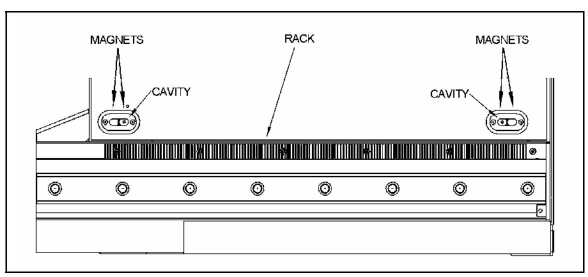


FIGURE 39 : MAGNETS ON SLIDE-OUT UNDERBODY

To adjust the "out limit" sensors:

Prior to adjust 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: BOBY. 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.

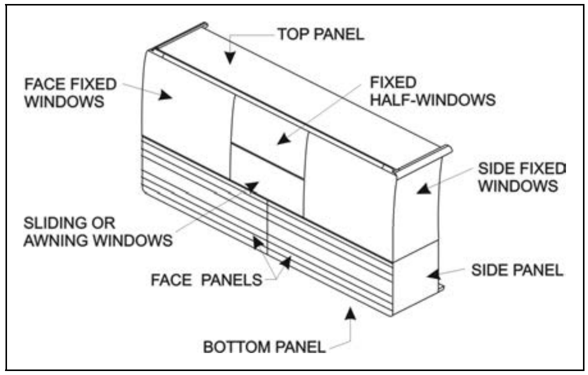


FIGURE 40 : SLIDE-OUT PANELS AND WINDOWS

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.

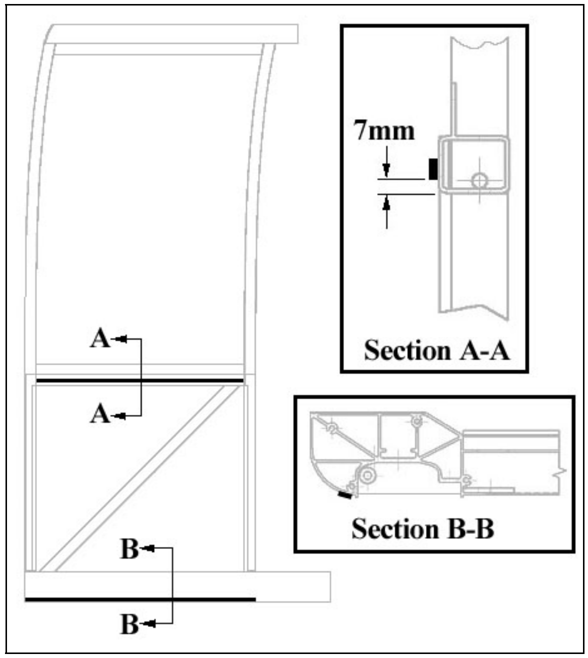


FIGURE 41 : SIDE PANEL INSTALLATION – DOUBLE FACE ADHESIVE TAPE APPLICATION ON THE SLIDE-OUT STRUCTURE

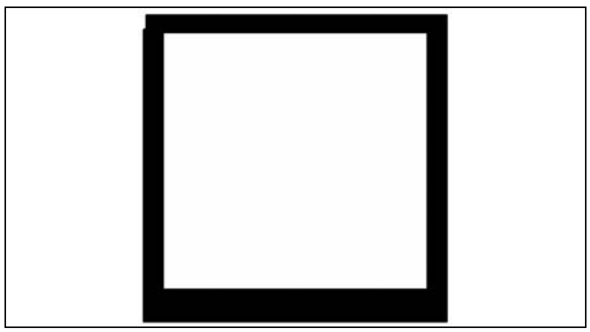


FIGURE 42 : SIDE PANEL INSTALLATION – SIKA 206 G+P APPLICATION

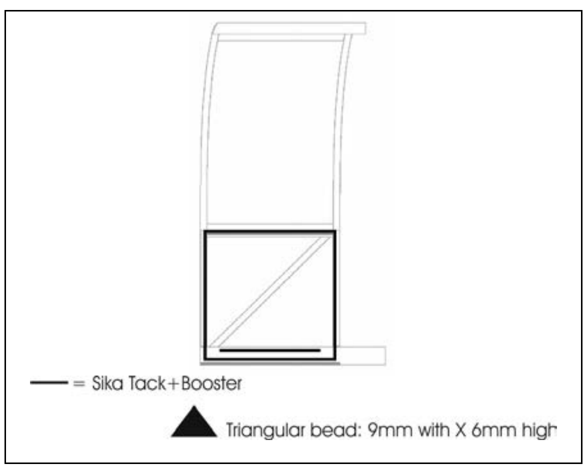


FIGURE 43 : SIDE PANEL INSTALLATION – SIKA TACK+BOOSTER APPLICATION

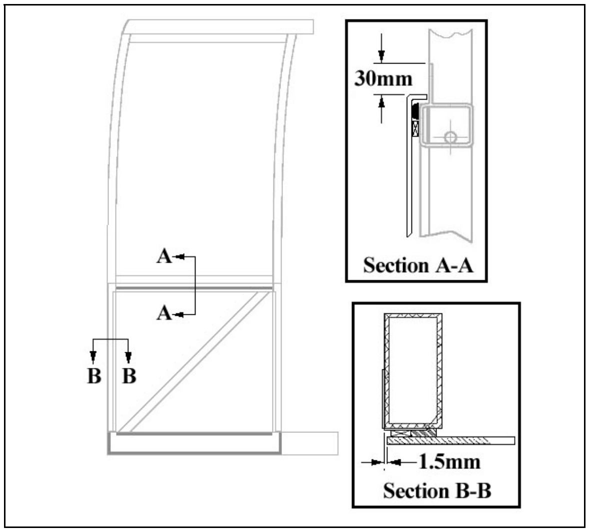


FIGURE 44 : SIDE PANEL INSTALLATION

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.

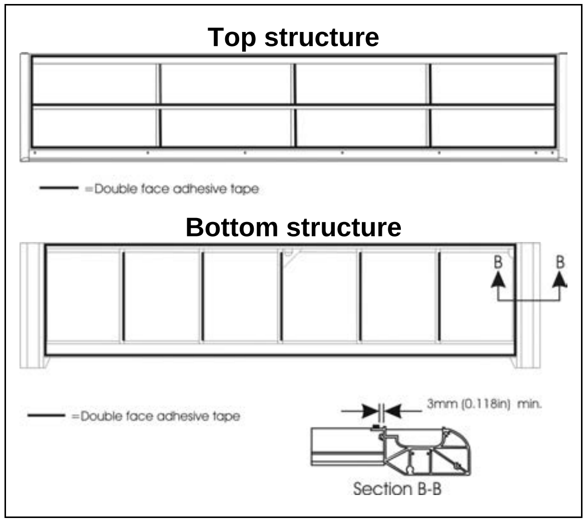


FIGURE 45 : TOP AND BOTTOM PANEL INSTALLATION - DOUBLE FACE ADHESIVE TAPE APPLICATION

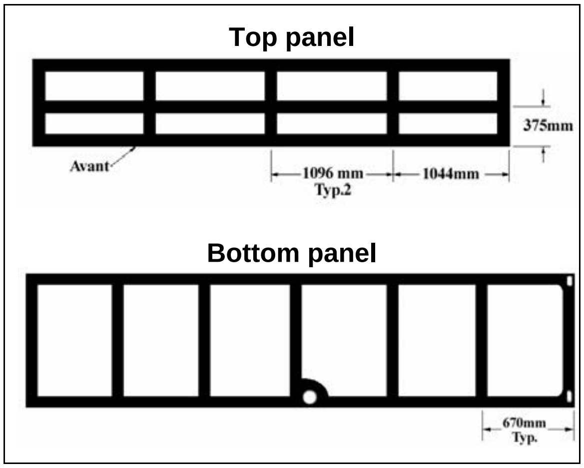


FIGURE 46 TOP AND BOTTOM PANEL INSTALLATION - SIKA 206 G+P APPLICATION

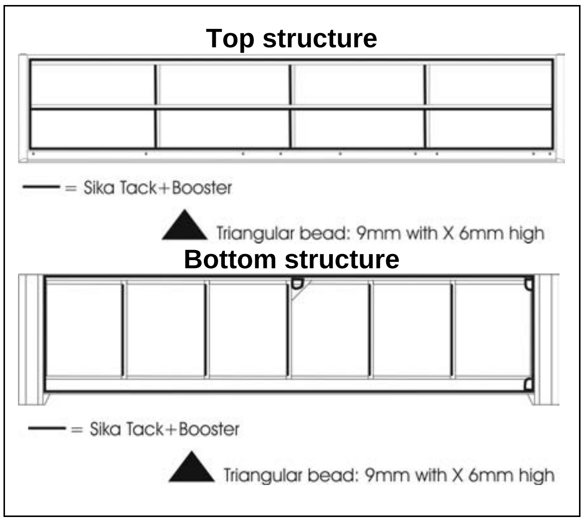


FIGURE 47 : TOP AND BOTTOM PANEL INSTALLATION - SIKA TACK+BOOSTER APPLICATION

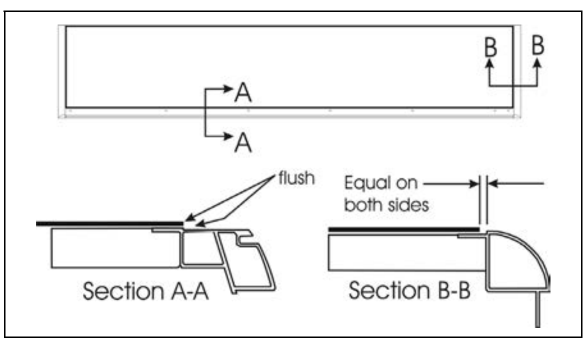


FIGURE 48 : TOP PANEL INSTALLATION

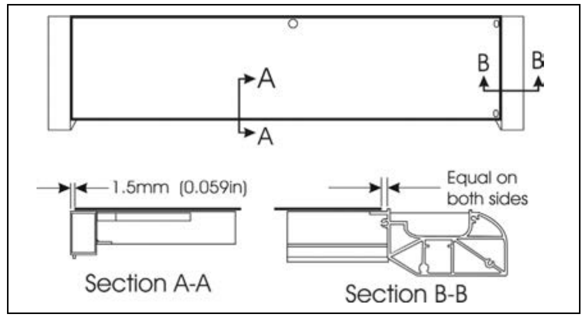


FIGURE 49 : BOTTOM PANEL INSTALLATION

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.

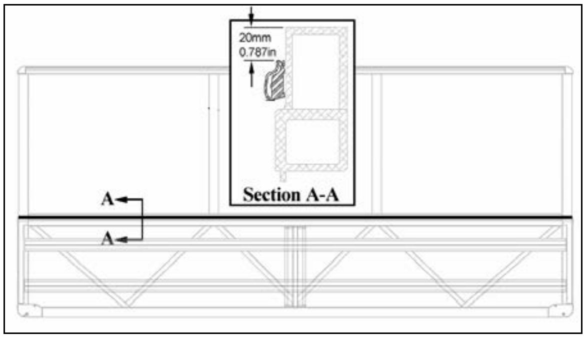


FIGURE 50 : FACE FIXED WINDOWS - RUBBER SEAL INSTALLATION

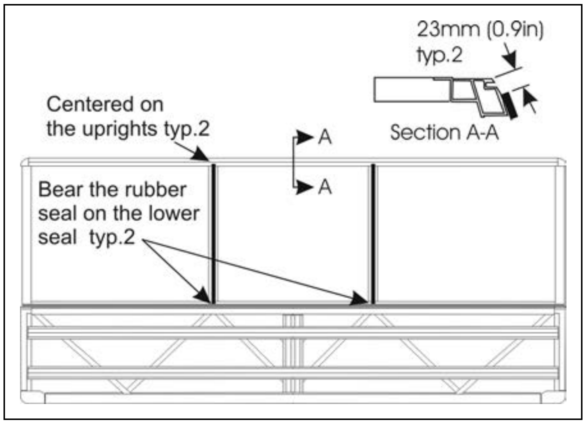


FIGURE 51 : FACE FIXED WINDOWS - RUBBER SEAL INSTALLATION

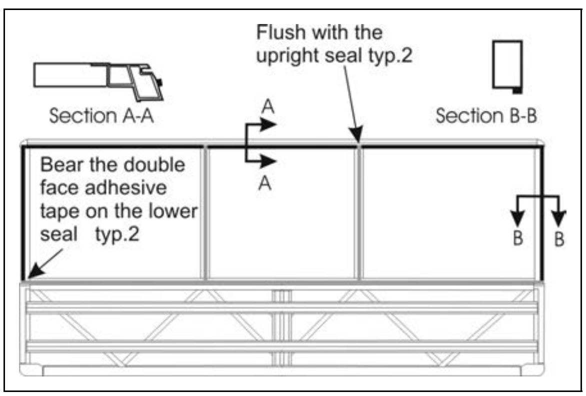


FIGURE 52 : FACE FIXED WINDOWS – 3/16 X 1/2 DOUBLE FACE ADHESIVE TAPE INSTALLATION

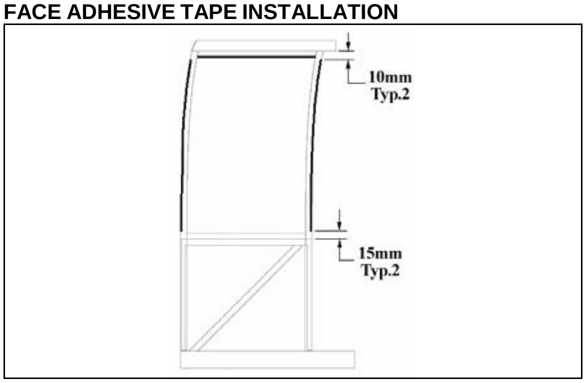


FIGURE 53 : SIDE FIXED WINDOW – ¼ X ½ DOUBLE FACE ADHESIVE TAPE INSTALLATION

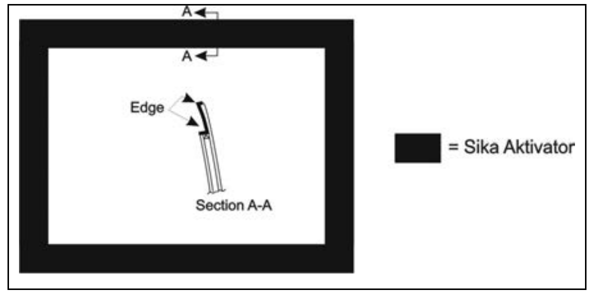


FIGURE 54 : FACE FIXED WINDOW AND HALF-WINDOW – SIKA AKTIVATOR

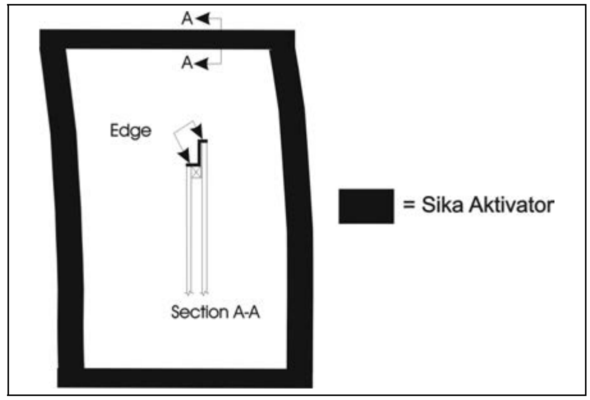


FIGURE 55 : SIDE FIXED WINDOW – SIKA AKTIVATOR

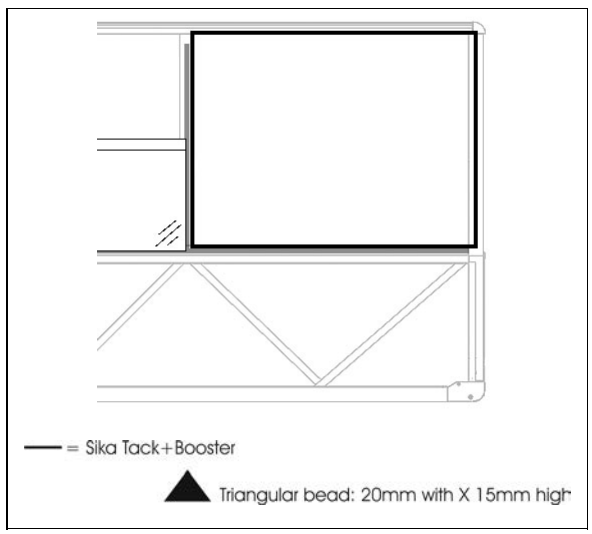


FIGURE 56 : FACE FIXED WINDOW INSTALLATION – SIKA TACK+BOOSTER

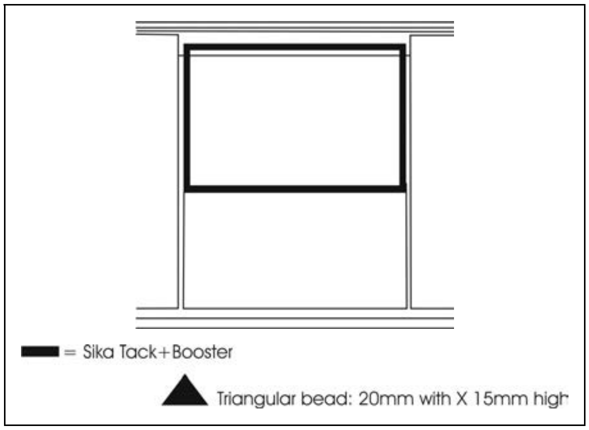


FIGURE 57 : FACE FIXED HALF-WINDOW INSTALLATION – SIKA TACK+BOOSTER

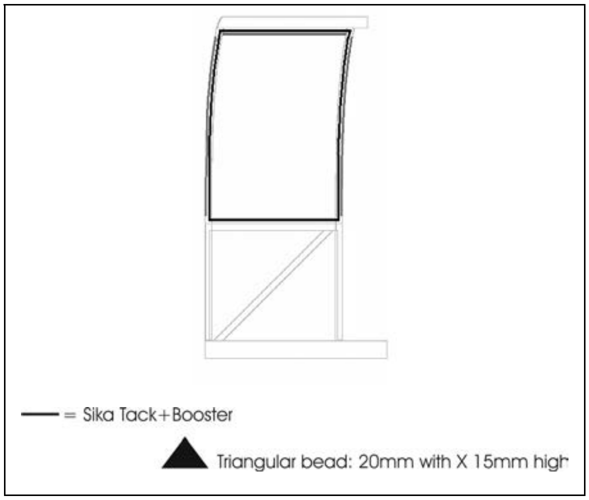


FIGURE 58 : SIDE FIXED WINDOW – SIKA TACK + BOOSTER

3. Apply appropriate double face self adhesive tape on the slide-out structure (sees 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.

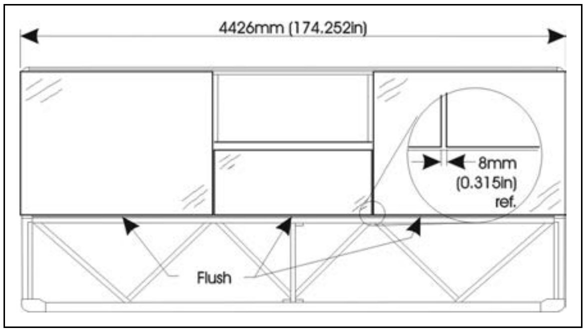


FIGURE 59 : FACE FIXED WINDOW INSTALLATION

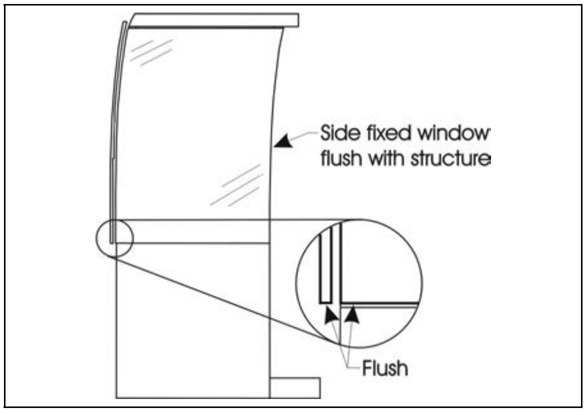


FIGURE 60 : SIDE FIXED WINDOW

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).

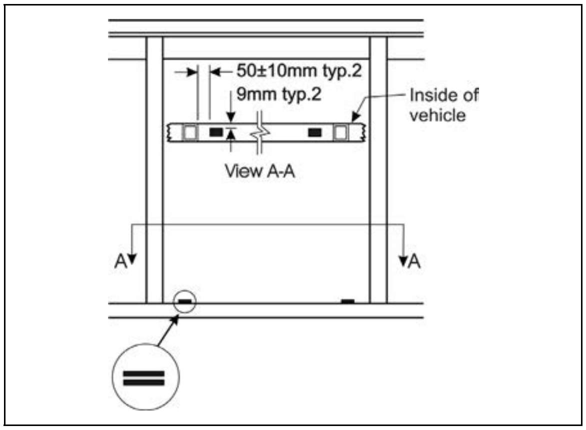


FIGURE 61: AWNING WINDOW - RUBBER BUMPER INSTALLATION

3. Glue 4 rubber bumpers (#790610) on the awning window frame as per FIGURE 62.

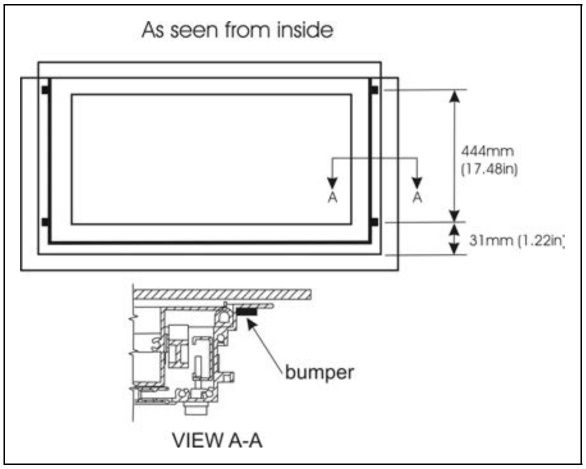


FIGURE 62: SIDE BUMPERS

4. Place masking tape on the inside of the frame as per FIGURE 63.

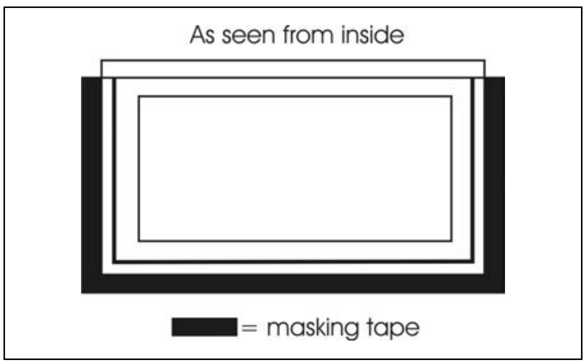


FIGURE 63: MASKING TAPE APPLICATION

5. Apply Sika 255 in the upper and lower frame corner as per FIGURE 64.

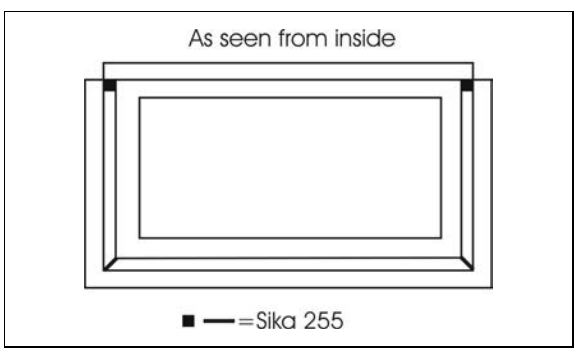


FIGURE 64: SIKA 255 APPLICATION

6. Apply Sika Aktivator as per FIGURE 65.
7. Apply Sika 255 as per FIGURE 66 (triangular bead: 10mm width X 10mm high).

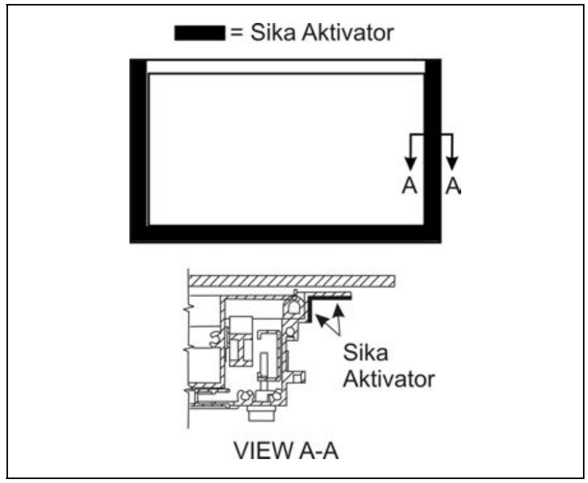


FIGURE 65 : AWNING WINDOW – SIKA AKTIVATOR

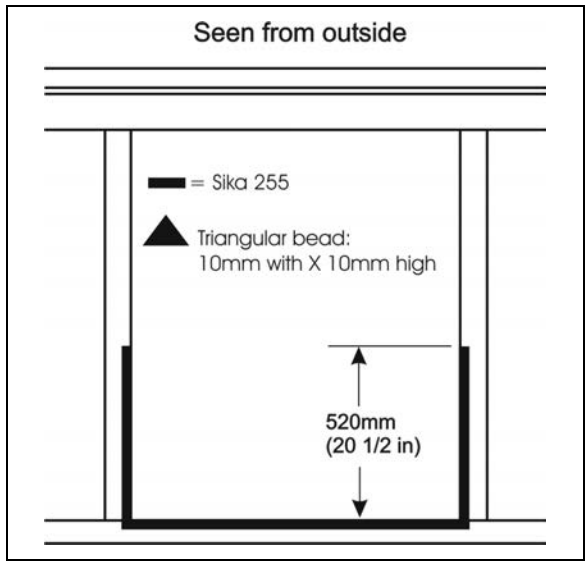


FIGURE 66: AWNING WINDOW – SIKA 255 APPLICATION

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.

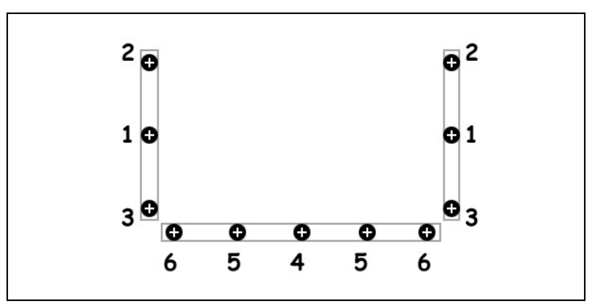


FIGURE 67 : CORRECT TIGHTENING SEQUENCE

10. Open the awning window manually and smooth down the joint (FIGURE 68) and remove glue in excess with Sika 208.

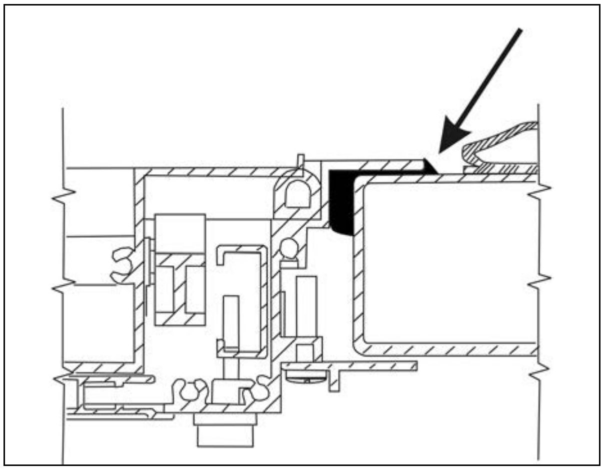


FIGURE 68 : SMOOTH DOWN THE JOINT

11. Using Sika 252 or 255, seal the upper corner of the awning window, both side (FIGURE 69).
12. Using Sika 252 or 255, seal the chink between the structure vertical member and the awning window, both side (FIGURE 70).

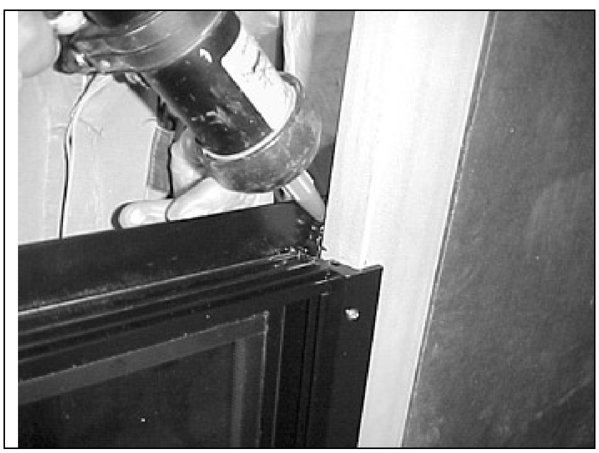


FIGURE 69 : AWNING WINDOW – SEAL THE UPPER CORNERS

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 side (FIGURE 75).
9. Using Sika 252 or 255, seal the chink between the structure vertical rubber seal and the sliding window, both side (FIGURE 76).

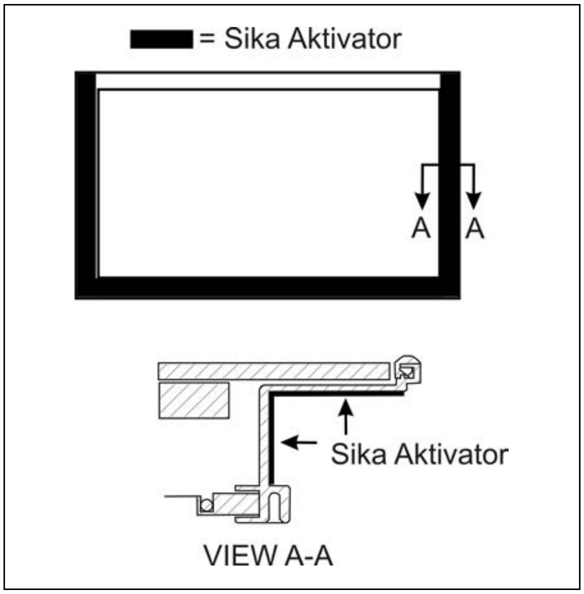


FIGURE 71 : SLIDING WINDOW - SIKA AKTIVATOR

FIGURE 72 : SLIDING WINDOW - SIKA AKTIVATOR

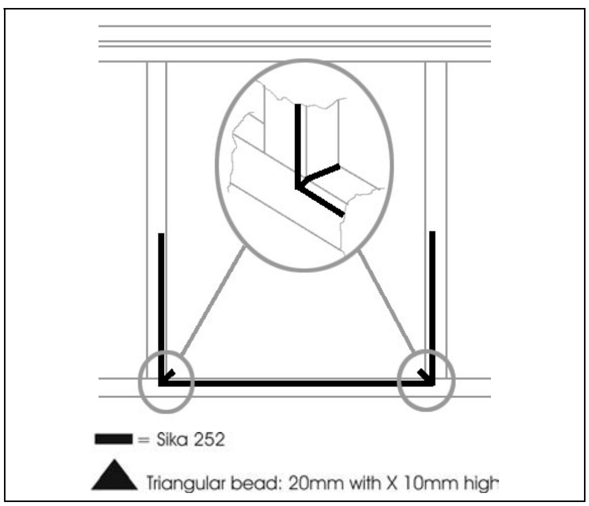


FIGURE 73: AWNING WINDOW – SIKA 252 APPLICATION

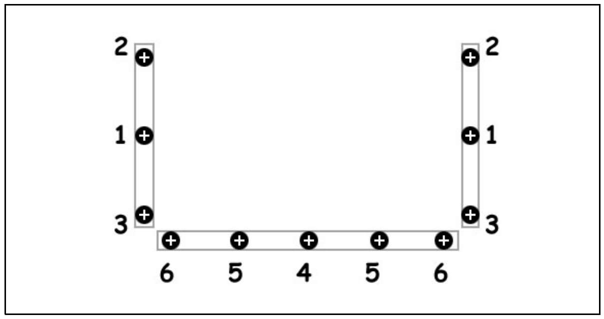


FIGURE 74 : CORRECT TIGHTENING SEQUENCE

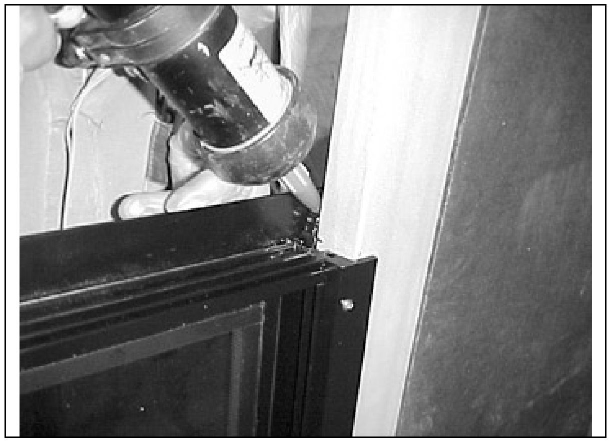


FIGURE 75 : SLIDING WINDOW – SEAL THE UPPER CORNERS

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

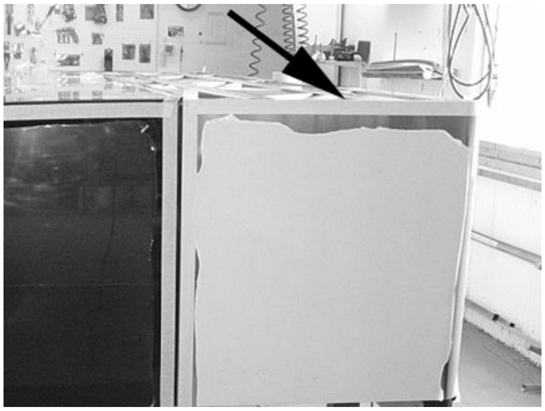


FIGURE 77

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

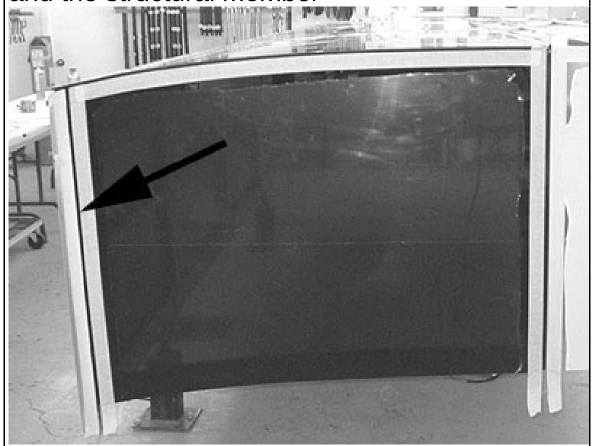


FIGURE 79

Apply Sika 221 between the bottom of side window and top of side panel

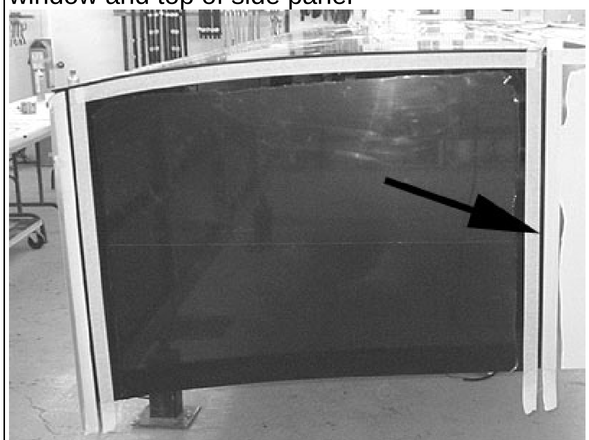


FIGURE 80

Apply Sika 221 between side window and top of face fixed window

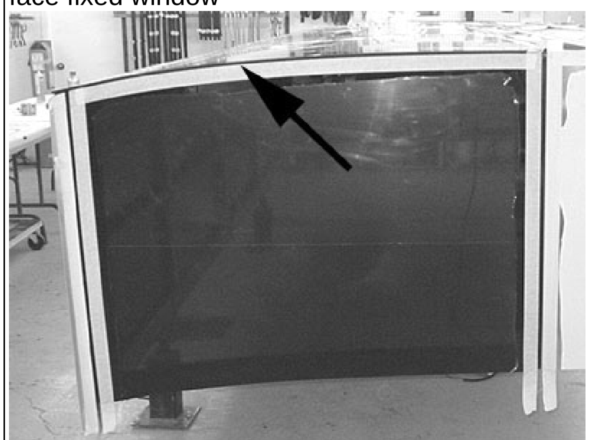


FIGURE 81

16.11.3 Slide-out bottom

Apply Sika 221 between bottom edge of side panel and structural member

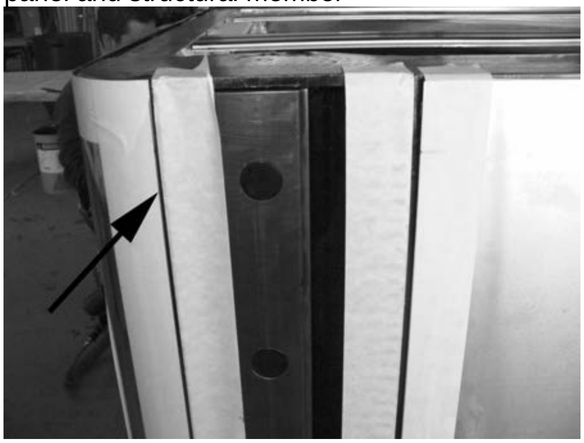


FIGURE 82

Apply Sika 221 between edge of bottom panel and structural member

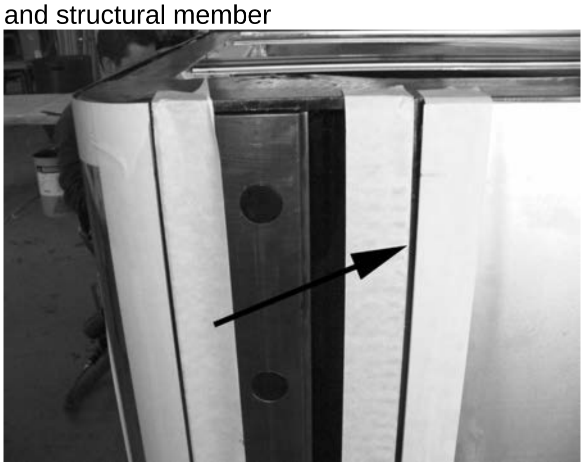


FIGURE 83

Apply Sika 221 between the bottom panel and the magnets

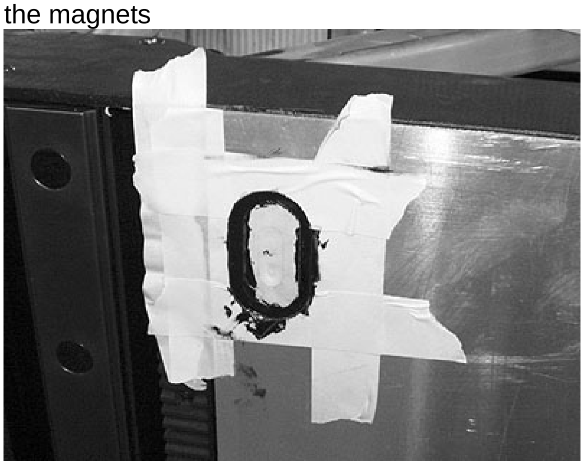


FIGURE 84

Apply Sika 221 around the security pin cavity

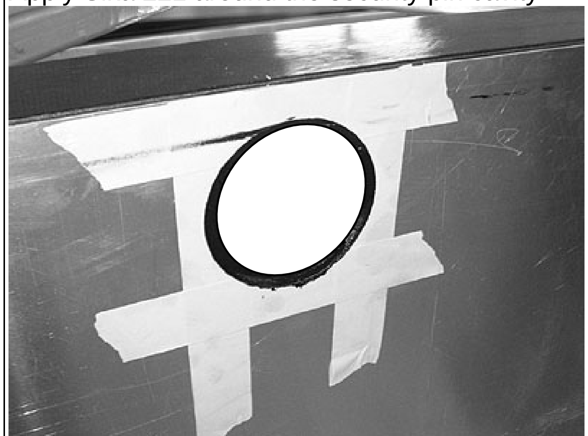


FIGURE 85

16.11.4 Top of Slide-out

Apply Sika 221 between edge of top panel and structural member

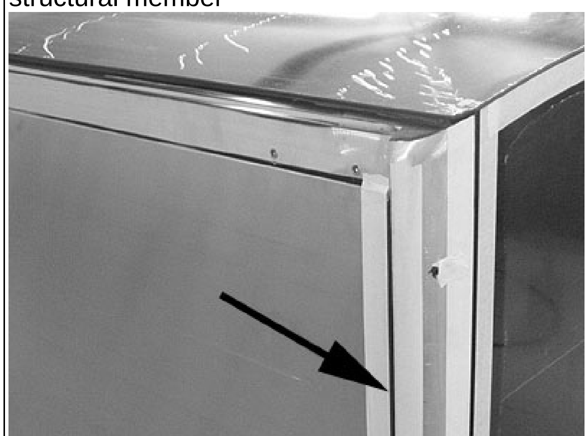


FIGURE 86

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.

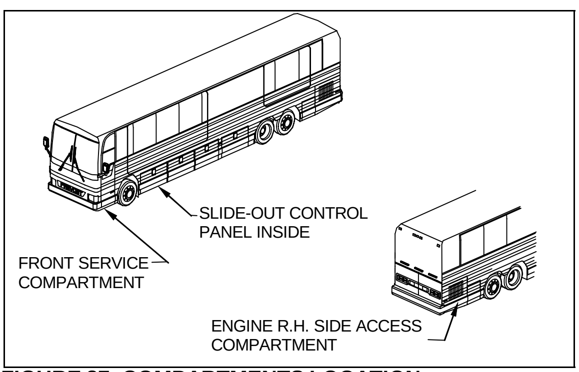


FIGURE 87: COMPARTMENTS LOCATION

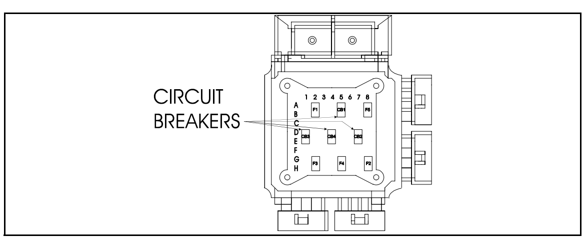


FIGURE 88: VEC CIRCUIT BREAKERS ON SLIDE-OUT CONTROL PANEL

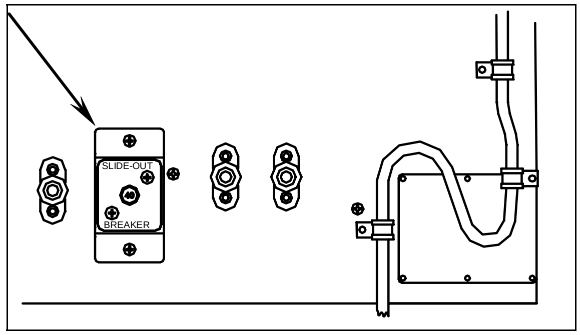


FIGURE 89: MAIN SLIDE-OUT BREAKER IN ENGINE R.H. SIDE ACCESS COMPARTMENT

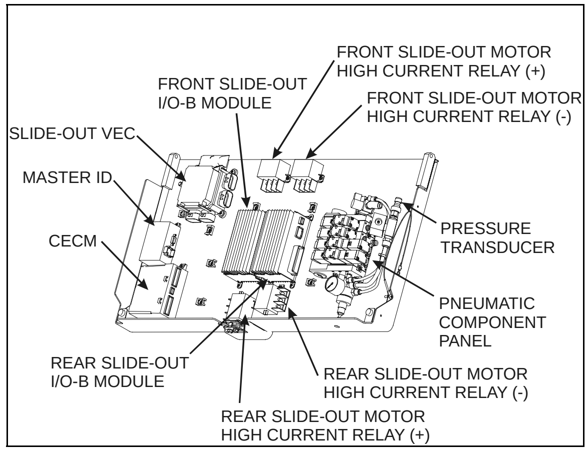


FIGURE 90: SLIDE-OUT CONTROL PANEL

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.
5. Rotate the slide-out motor shaft extension with the power drill until the slide-out comes to its closed position (FIGURE 92).
6. Once the slide-out room is lined up to its closed position, remove the tool from the motor.

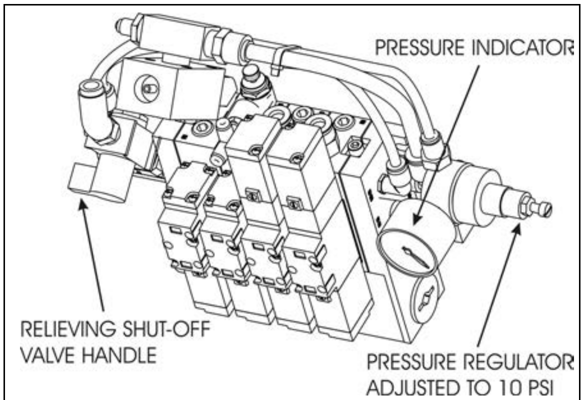


FIGURE 91: INFLATABLE SEAL RELIEVING SHUT-OFF VALVE

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.*

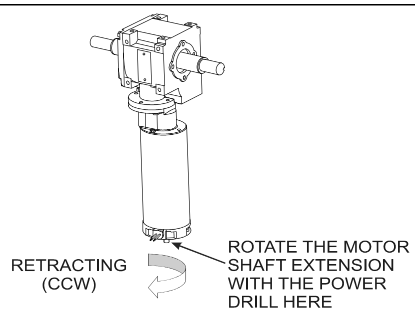


FIGURE 92: SLIDE-OUT MOTOR ROTATION

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).

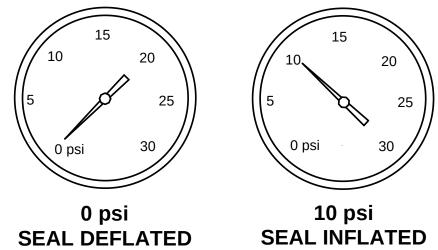


FIGURE 93: INFLATABLE SEAL PRESSURE GAGE

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 barking 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.

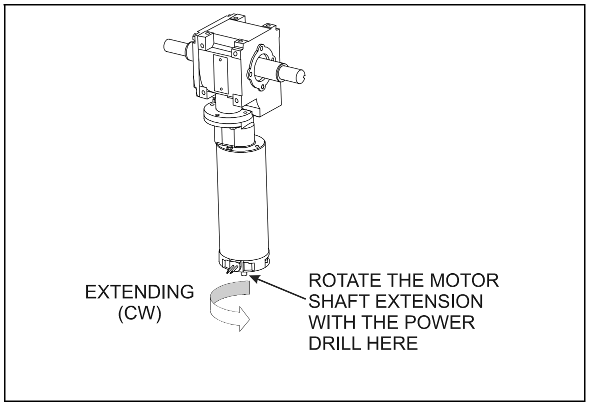


FIGURE 94: SLIDE-OUT MOTOR ROTATION

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 94).

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

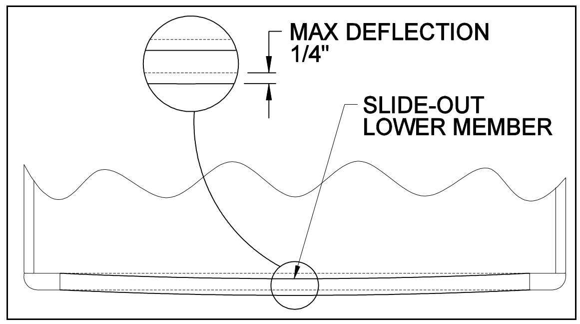
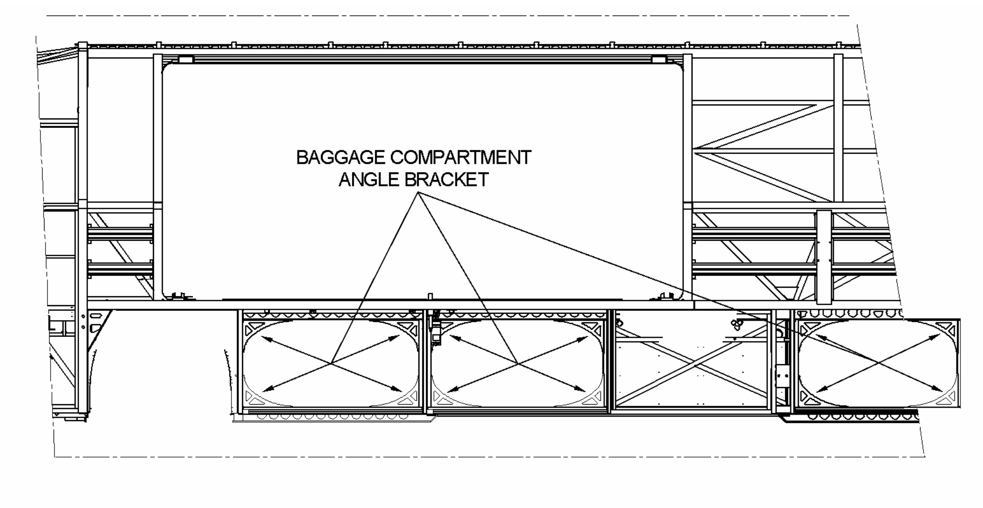


FIGURE 95 : FRONT SLIDE-OUT DEFLECTION

[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
		Shorted Low	Relay coil or wiring harness shorted to ground	Fix relay coil or wiring harness

SID #	FAULT MESSAGE	TEXT	PROBABLE CAUSE	CORRECTIVE ACTION
		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.