

# PREVOST

## COACH MANUFACTURER

### **MAINTENANCE MANUAL**

H3-41, H3-45, VIP



# PA1561

March 2009

PA1561

March 2009

Beginning with vehicle: A-1470

Featuring:

- New headlights and bumper design



# SECTION 00: GENERAL INFORMATION

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## Section 00 : GENERAL INFORMATION

### 1. FOREWORD

This manual includes procedures for diagnosis, service, maintenance and repair for components of the H3 series coaches or VIP model 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 24 pertains to standard equipment items, systems and components as well as the most commonly used optional equipment and special equipment offered on the coach 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 Operator'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.*

Prevost 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 and 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

*Execute procedure no: SAV060034 "MULTIPLEX MODULES DISCONNECTION PROCEDURE PRIOR TO WELDING" included at the end of this section.*

#### CAUTION

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

#### CAUTION

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

#### CAUTION

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

#### CAUTION

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

**STEEL – STEEL WELDING**

**Caution:** Before welding, disconnect electronic modules and battery terminals.

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

**Warning:** 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 1/2"	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.

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

**Warning:** Only a qualified and experienced person must do welding.

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

**STEEL - STAINLESS STEEL WELDING**

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

**STAINLESS STEEL - STAINLESS STEEL WELDING**

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

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

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

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

## Section 00 : GENERAL INFORMATION

### 4. SAFETY NOTICE

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

This manual covers only the procedures as of manufacturing date.

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

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

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

**Warning:** Identifies an instruction which, if not followed, could cause personal injuries.

**Caution:** Outlined an instruction which, if not followed, could severely damage vehicle components.

**Note:** Indicates supplementary information needed to fully complete an instruction. 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

#### DDC Series 60 Engine

The engine serial and model number 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).

#### Volvo D13 Engine

Volvo D13 engine serial and model numbers are stamped on the cylinder head (Fig. 2).

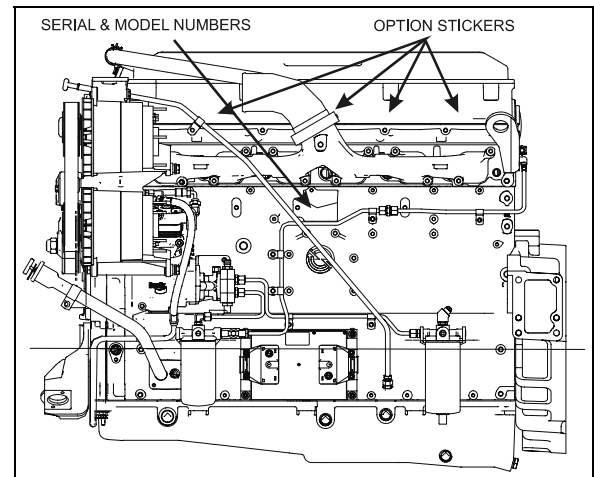


FIGURE 1 : DETROIT DIESEL SERIES 60

00043

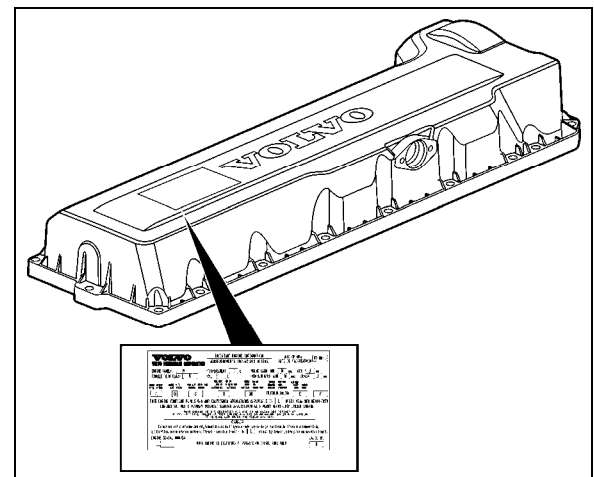


FIGURE 2: VOLVO D13 ENGINE DATA PLATE

00052

##### 4.1.2 Transmission

The transmission identification plate is located:

Allison - on the oil level dipstick side.

ZF - on the transmission housing, on the vehicle R.H. side.

The identification plate shows the transmission serial number, part number (assembly number), and model number. Use all three numbers when ordering parts.

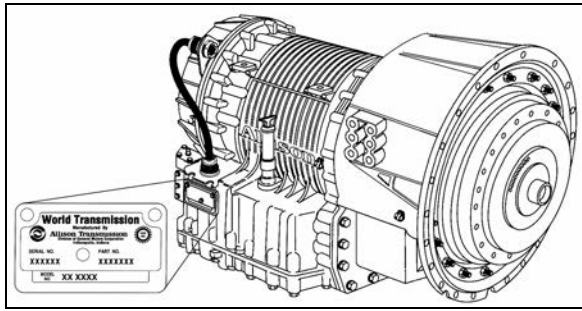


FIGURE 3: WORLD TRANSMISSION 07076

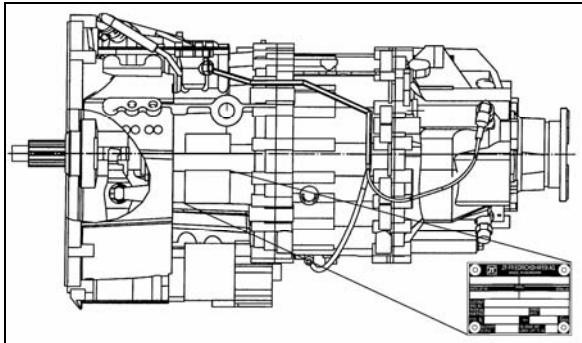


FIGURE 4: ZF-ASTRONIC TRANSMISSION 00040

4.1.3 Drive Axle

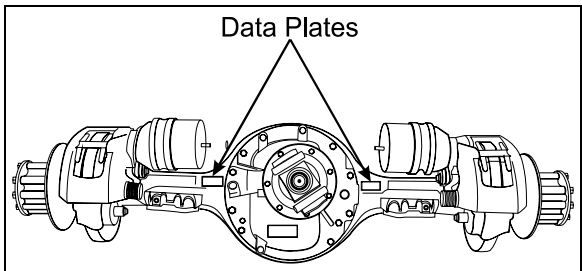


FIGURE 5: TYPICAL SERIAL & MODEL NUMBERS 11019

4.1.4 Front Axle

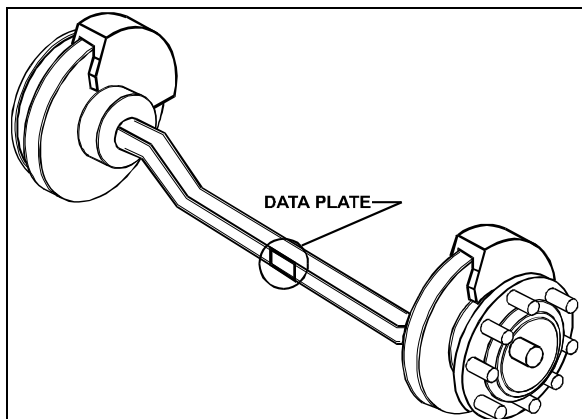


FIGURE 6 : TYPICAL SERIAL AND MODEL NUMBERS 10024

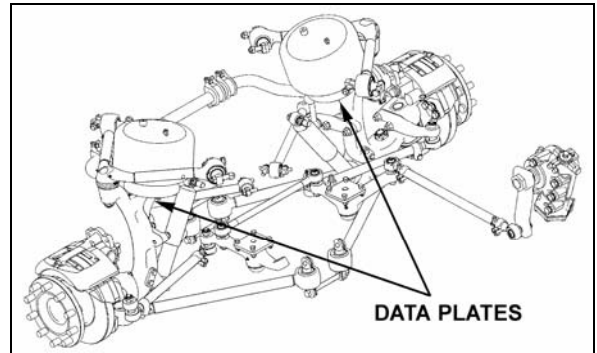


FIGURE 7: ISS TYPICAL SERIAL & MODEL NUMBERS 0025

4.1.5 Power Steering Pump

- DDC Series 60 Engine

Power steering pump serial number is engraved on the pump casing (Fig. 8). The pump is mounted on the engine beside the crankshaft pulley.

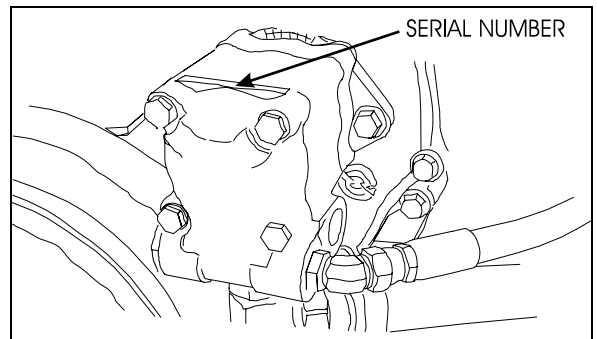


FIGURE 8 : POWER STEERING PUMP SERIAL NUMBER 00035

- Volvo D13 Engine

Power steering pump is mounted on the engine and located underneath the air compressor (Fig.9).

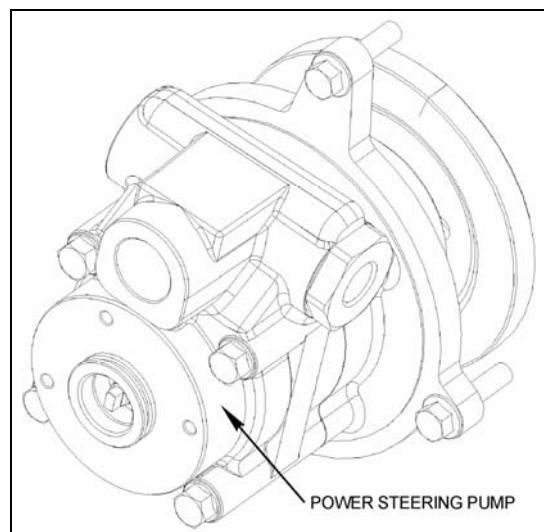


FIGURE 9: POWER STEERING PUMP

## Section 00 : GENERAL INFORMATION

### 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. The DOT Certification label is affixed on the wall, behind the driver's seat.

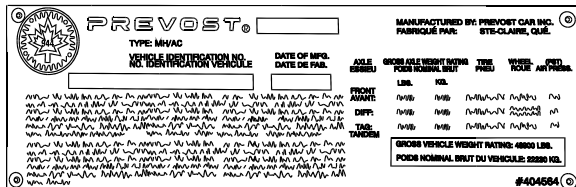


FIGURE 10: DOT CERTIFICATION PLATE 00016

### 4.1.9 Fuel Tank Label

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

### 4.1.10 EPA Engine Label

The exhaust emission certification label affixed above the oil reserve tank certifies that the engine conforms to federal and any state exhaust emission regulations (Fig. 11). It gives the operating conditions under which certification was made.

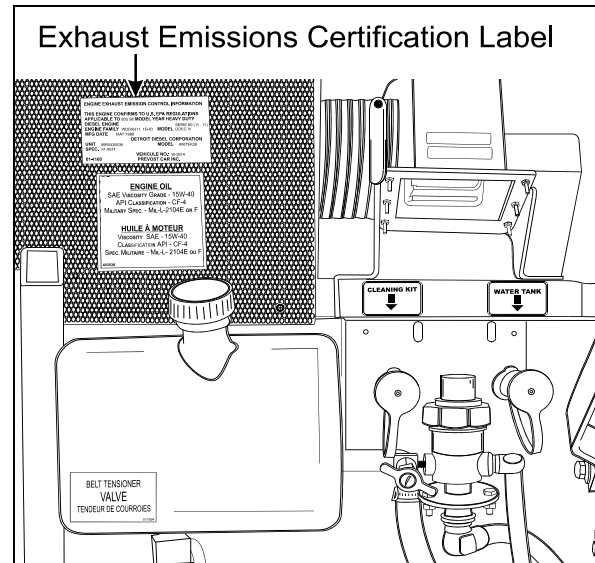


FIGURE 11: ENGINE COMPARTMENT 23229

### 4.1.11 Vehicle Identification Number (VIN)

The seventeen digit vehicle identification number (VIN) is located on a plate (Fig. 12) 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.

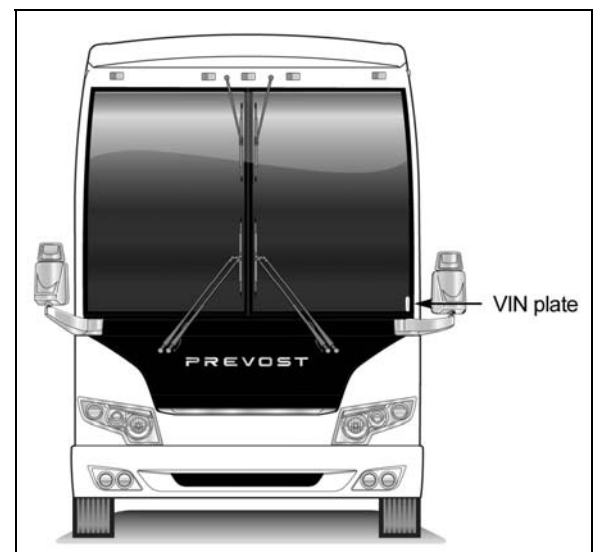


FIGURE 12 : VEHICLE I.D. 18680

**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.

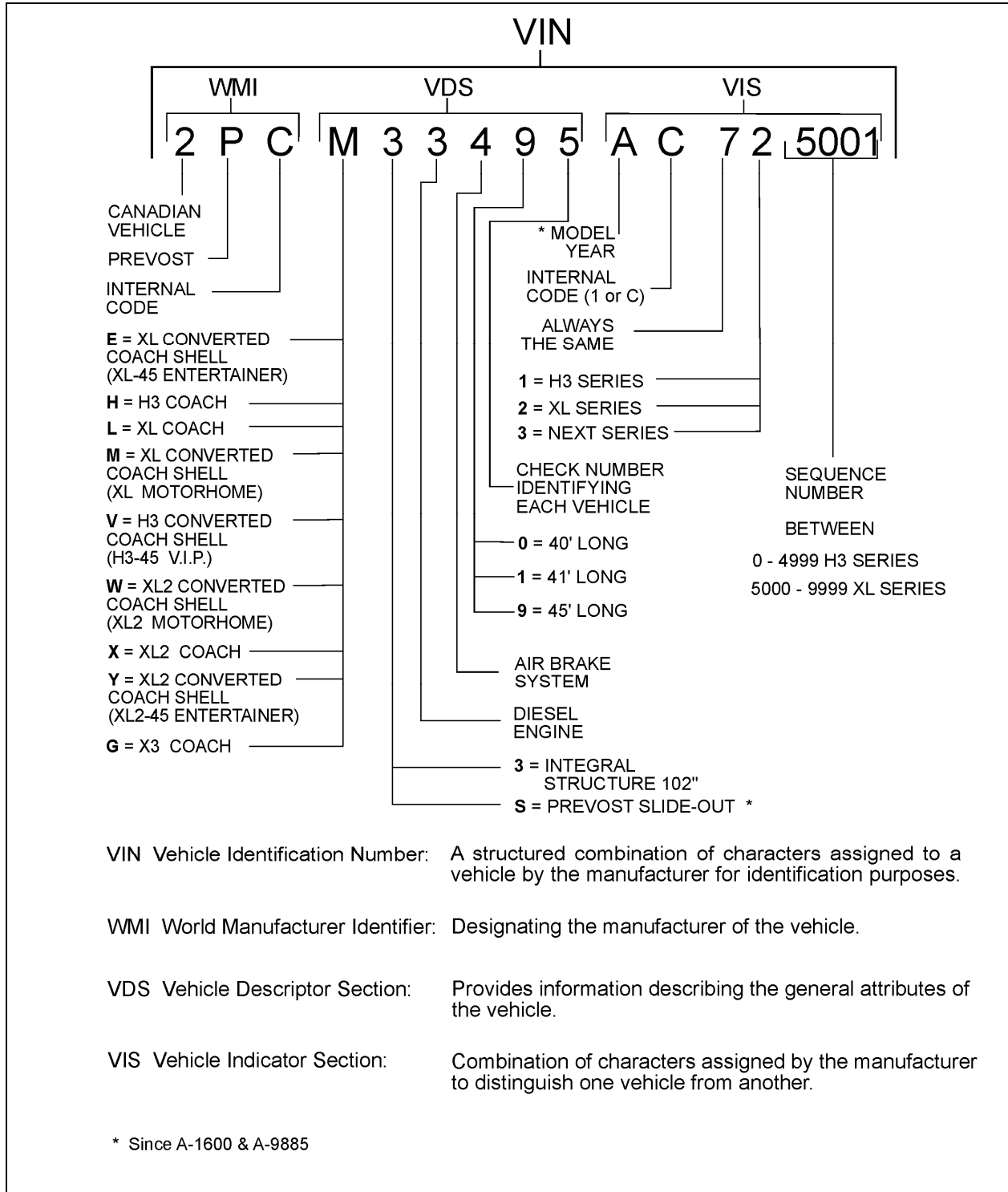


FIGURE 13 : VEHICLE IDENTIFICATION NUMBER

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

## Section 00 : GENERAL INFORMATION

### 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. 15 shows the different strength markings.

When replacing metric fasteners, be careful to use fasteners of the same or greater strength than the original fasteners (the same number marking or higher). It is also important to select replacement fasteners of the correct size. Correct replacement fasteners are available through the parts division. Some metric fasteners available in after-market parts sources were designed to metric standards of countries other than the United States and may be of a lower strength, may not have the numbered head marking system, and may be of a different thread pitch.

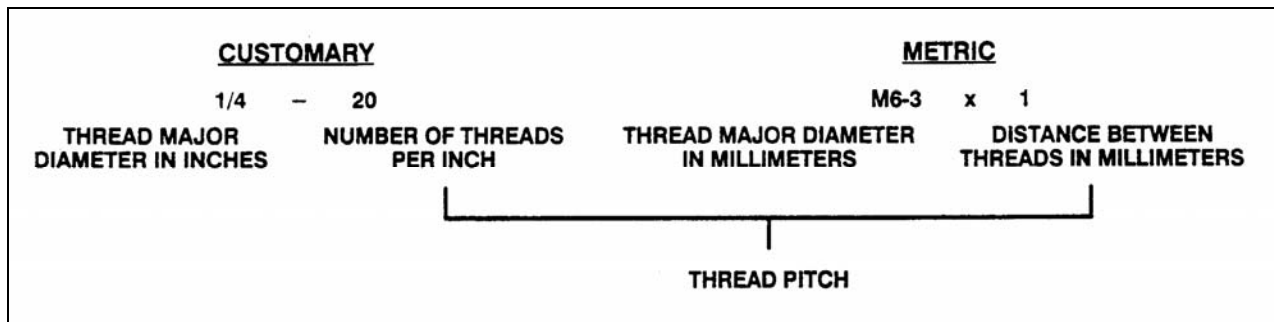


FIGURE 14 : THREAD NOTATION

00002

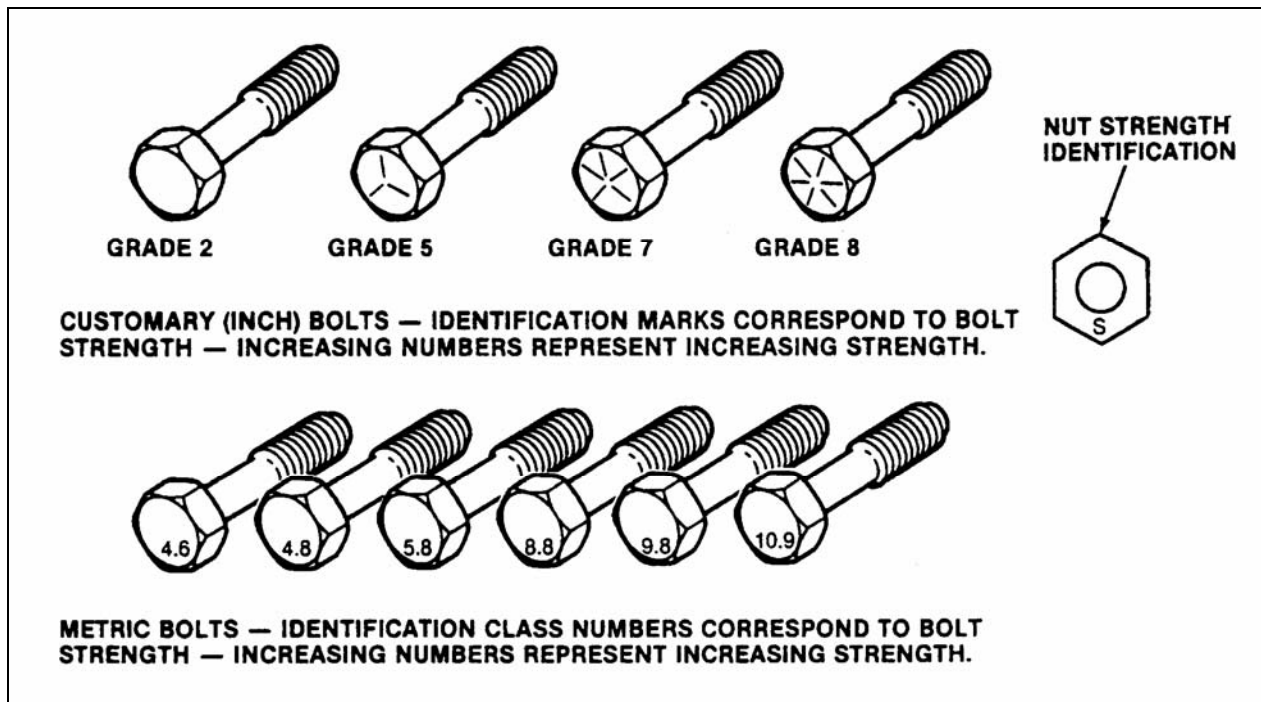


FIGURE 15: BOLT STRENGTH MARKINGS

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. 16).

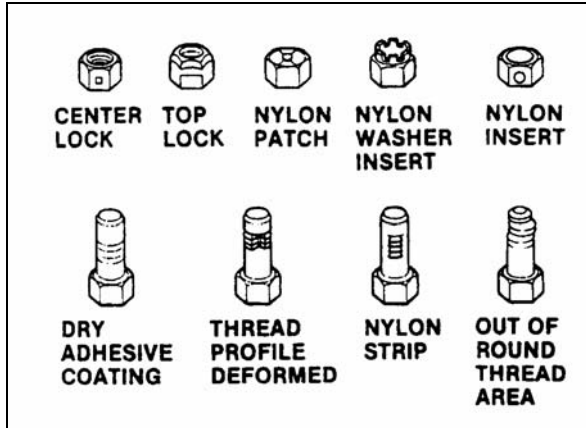


FIGURE 16 : SELF-LOCKING FASTENERS 00004

5.2 RECOMMENDATIONS FOR REUSE

Clean, unruined 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.



## 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 18: CONVERSION CHART

00006



# PREVOST

## MULTIPLEX MODULES DISCONNECTION PROCEDURE PRIOR TO WELDING

**PROCEDURE NO: PR060034**

**REVISION 4  
2007-05-31**

**Material :** N/A

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

**Reference schematics:** N/A

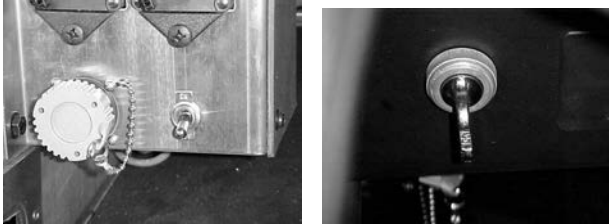
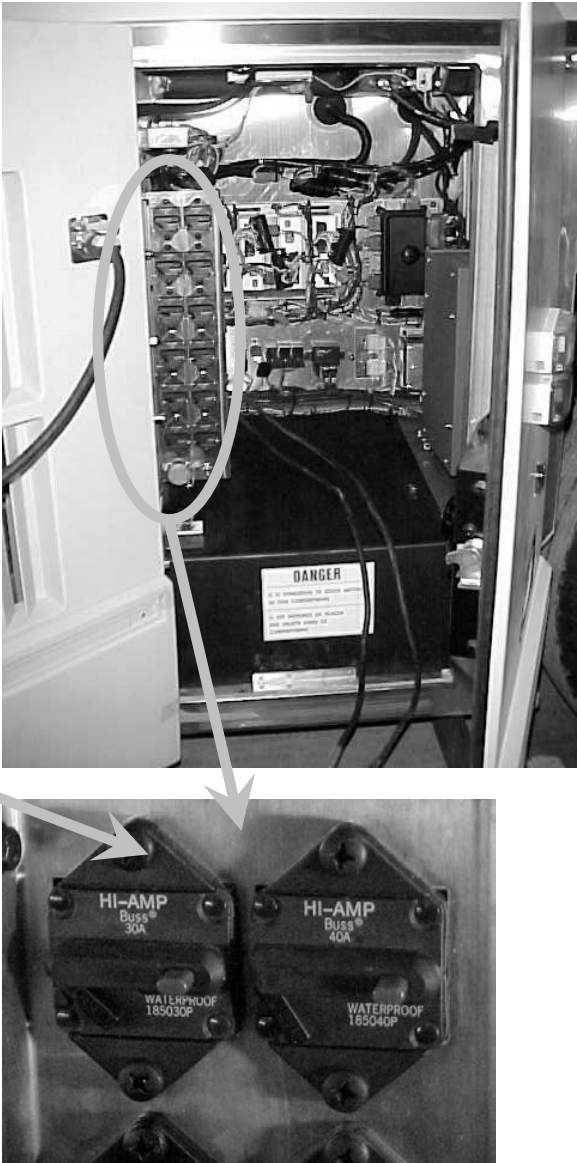
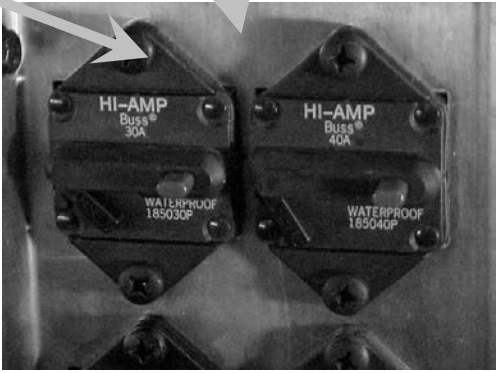
**Safety rules :**

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

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

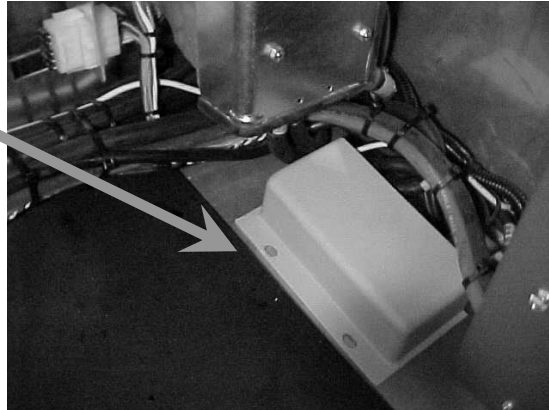
	Effective
<b>Revision 0 : Issued with multiplex</b>	
<b>Revision 1 : Modified for Fire Protection System and also for VIP with multiplex</b>	
<b>Revision 2 : Step 5 modified for introduction of VIP with multiplex</b>	<b>-0436</b>
<b>Revision 3 : Step 1.15 added C397 Addition of SECTION 2 for X3 Coaches Addition of SECTION 3 for XLII MTH</b>	
<b>Revision 4 : Modified for introduction of CPC module for VIP &amp; H3 Coach</b>	<b>7-0942VIP 8-1037 H3</b>

SECTION 1 H3 Coaches & VIP

<p>1.00 <b>Location: Main power compartment and dashboard</b></p> <p>Set the battery master switch to the OFF position.</p> <p>Place the ignition switch to the OFF position.</p>	
<p>1.05 <b>Location: Main power compartment</b></p> <p>Trip circuit breakers CB2, CB4, CB6</p> <p>Push the red button to open the circuit</p>	 

1.10 Location: Main power compartment

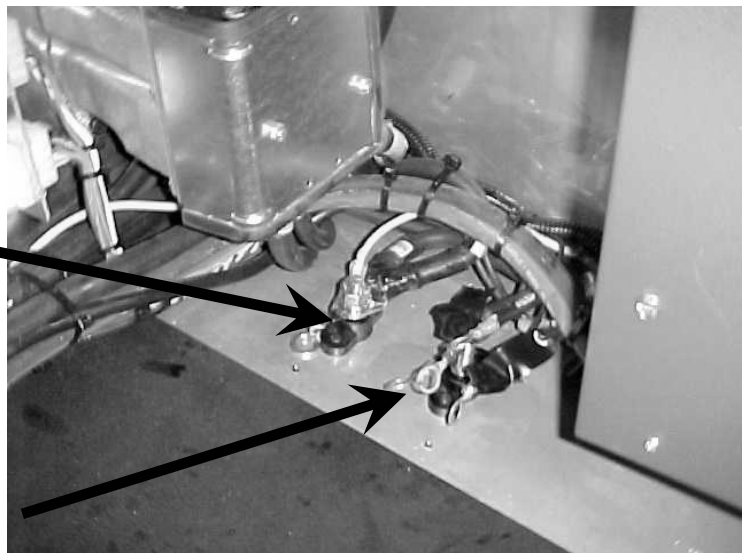
Remove the protective cover



⚠ WARNING ⚠

LIVE WIRE

This 12-volt terminal remains energized

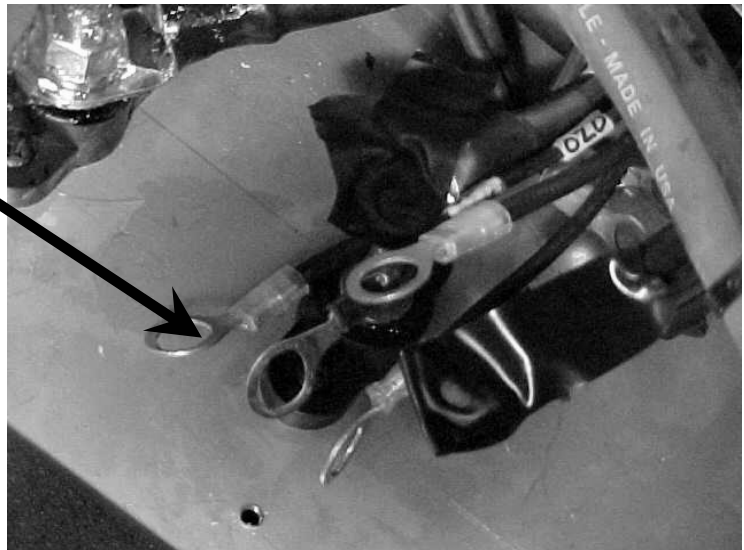


Disconnect the electronic ground terminals from the stud

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

*NOTE*

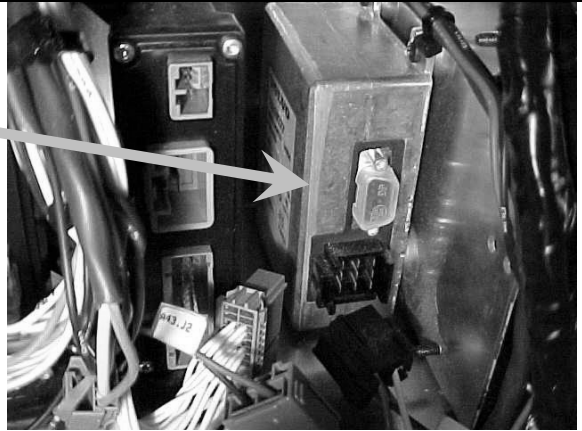
*With disconnection of the electronic ground terminals, disconnecting the engine ECM, transmission TCM and the dashboard electronic components (telltale module, HVAC module, radio, control head, ...) is not required.*



<p>1.15 <b>Location: Main power compartment</b></p> <p>Disconnect the electronic modules :</p> <hr/> <p>Disconnect the I/O A and I/O B modules</p> <p style="padding-left: 40px;">Disconnect C397</p> <p>Disconnect connector C717</p> <p>Unplug 3 connectors per I/O B modules</p> <p>Unplug 3 connectors on the I/O A module</p>	
<p>1.20 <b>Location: Front electrical compartment</b></p> <p><b>VIP + COACH:</b> Disconnect the I/O A, I/O B, ABS, master ID, CECM and CPC modules. Unplug connector C92</p> <p><b>VIP:</b> Disconnect all keyless module connectors.</p> <p>Unplug 3 connectors per I/O B modules and 3 connectors per I/O A modules.</p> <p>Unplug 2 connectors from the ABS module</p>	



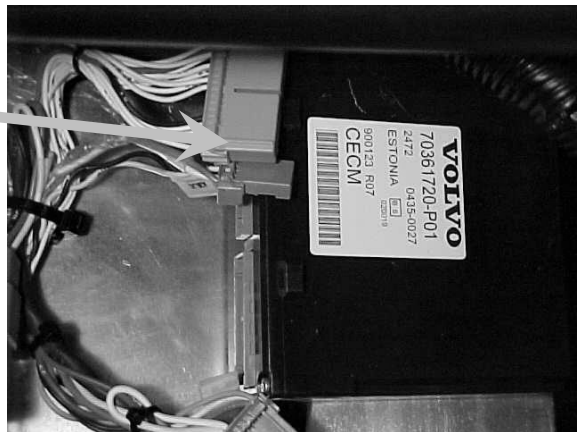
Unplug 1 connector from the master ID



Disconnect CPC connectors


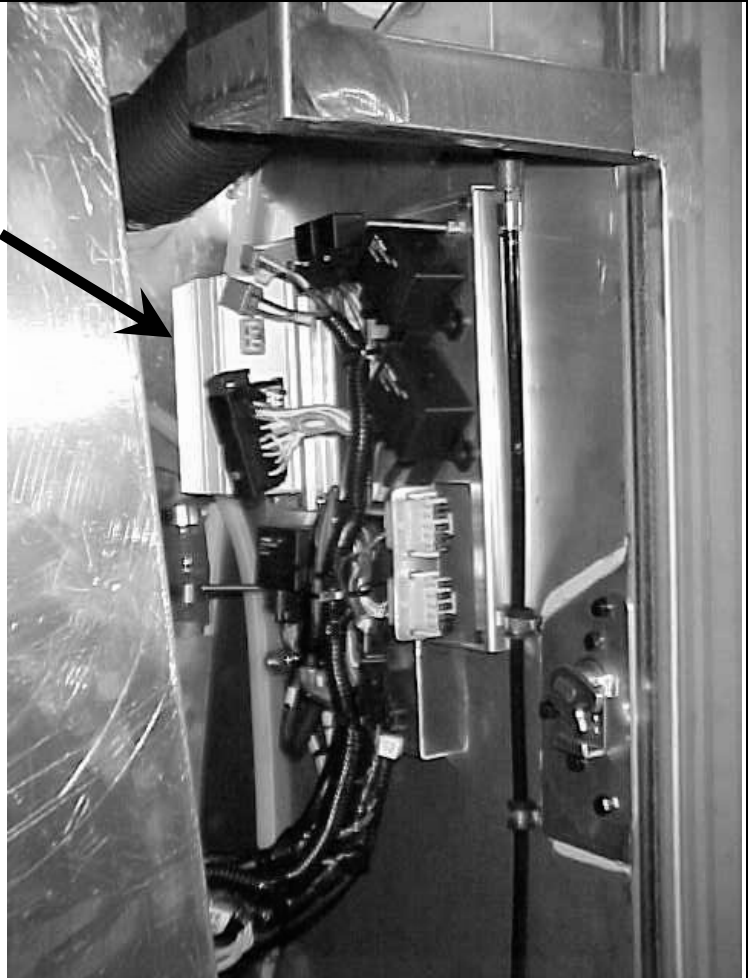


Unplug 3 connectors from the CECM



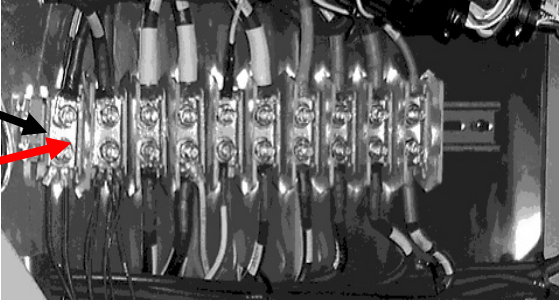
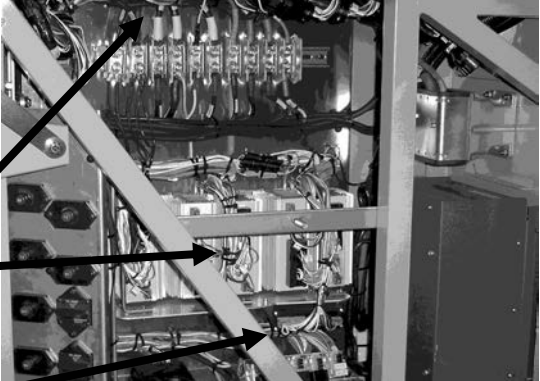
Unplug connector C92

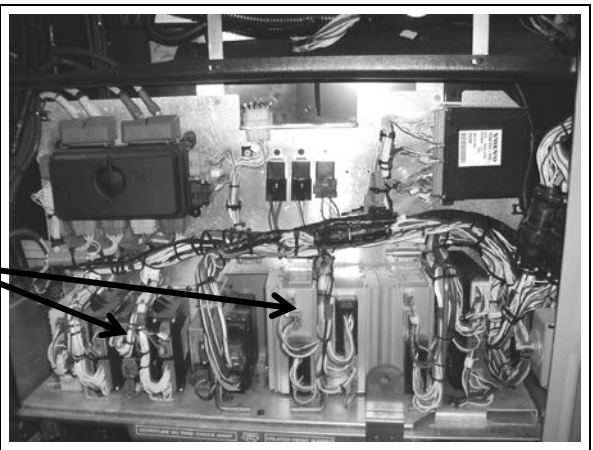
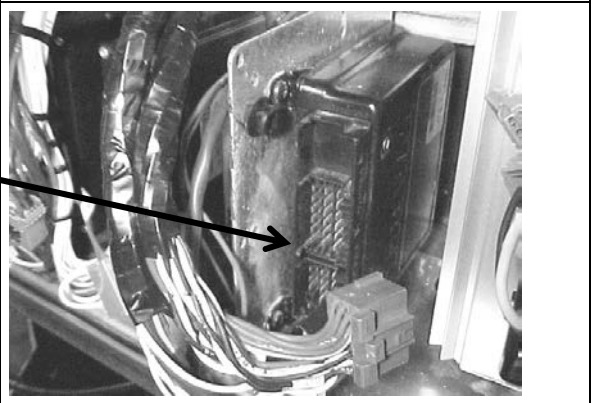
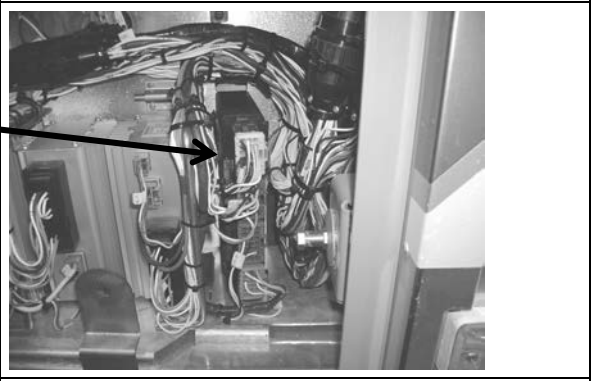
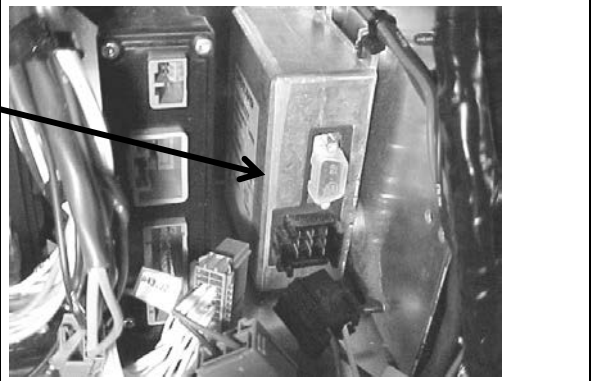


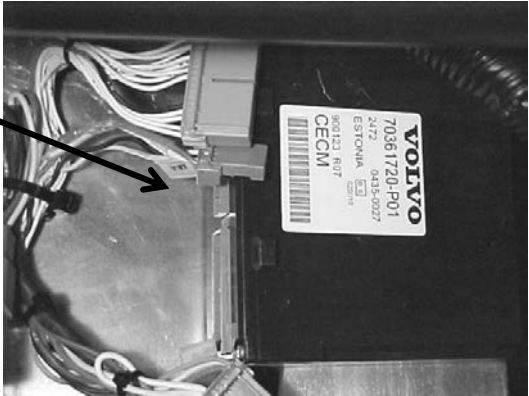


<p>1.25 <b>Location: pneumatic accessory panel inside right console</b></p> <p>Remove the access panel on the right console (R.H. side of dashboard)</p> <p>Disconnect both I/O B modules</p>	
<p>1.30 <b>Location: Evaporator compartment</b></p> <p>Remove the protective cover and disconnect the I/O B module</p>	

<p>1.40</p>	<p><b>Kidde Automatic Fire Detection and Suppression System (optional)</b></p> <p>Disconnect C466</p> <p>Kidde AFSS module is located on the lateral control panel.</p>	
<p>1.45</p>	<p>When all the previous steps are done, you can do welding on the vehicle</p>	<p><b>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.</b></p>
<p>1.50</p>	<p><b>When welding is completed, reconnect all the modules.</b></p> <p>Make sure that the connectors locking tab are well engaged</p>	<p><b>BE CAREFUL TO MAKE THE PROPER CONNECTIONS, IF NOT, SOME SYSTEMS OR COMPONENTS MAY NOT BE USABLE</b></p>


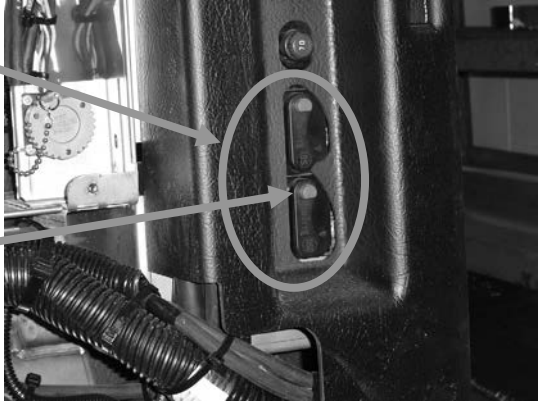
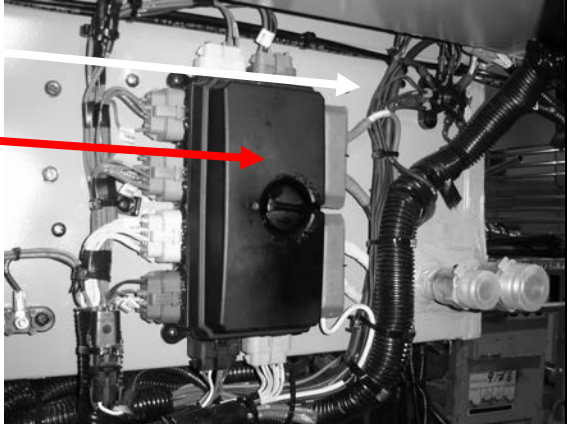


<p>2.10</p>	<p><b>Location: Rear electrical compartment</b></p> <p>Disconnect the electronic ground terminals from this stud</p> <div style="border: 2px solid red; padding: 5px; margin: 10px 0;"> <p><b>Warning: The remaining terminals may still be energized</b></p> </div> <p>Use electric tape; make sure that cables do not touch each others and the vehicle body.</p> <p style="text-align: center;"><i>NOTE</i></p> <p><i>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.</i></p>	
<p>2.15</p>	<p><b>Location: Rear electrical compartment</b></p> <p>Disconnect the electronic modules:</p> <p>Disconnect all I/O A and I/O B modules</p> <p style="padding-left: 40px;">Disconnect C397 and C717</p> <p>Disconnect 3 connectors from each I/O B module</p> <p>Disconnect 3 connectors from each I/O A module</p>	

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

<p>Disconnect the 3 connectors from CECM</p>	
<p>Disconnect connector C92</p>	
<p>2.25 <b>Location: Entrance door &amp; wiper control panel</b> Remove windshield wiper motor access panel and disconnect both I/O B modules</p>	
<p>2.30 When all the previous steps are done, you can do welding on the vehicle</p>	<p><b>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</b></p>
<p>2.40 <b>When welding is completed, reconnect all the modules.</b> Make sure that the connectors locking tab are well engaged!</p>	<p><b>BE CAREFUL TO MAKE THE PROPER CONNECTIONS, IF NOT, SOME SYSTEMS OR COMPONENTS MAY NOT BE USABLE</b></p>

**SECTION 3 XLII MTH**

<p>2.00</p>	<p><b>Location: Dashboard</b></p> <p>Place the ignition switch to the OFF position.</p>	
<p>2.05</p>	<p><b>Location: Engine compartment R. H. side area</b></p> <p>Trip circuit breakers CB1-CB2 located on circuit breaker panel.</p> <p>Push the blue button in to open the circuit</p>	
<p>2.10</p>	<p><b>Location: Rear Junction Box</b></p> <p>Disconnect the electronic ground terminals from this stud.</p> <div style="border: 2px solid red; padding: 5px; margin: 10px 0;"> <p><b>Warning: The remaining terminals may still be energized.</b></p> </div> <p>Use electric tape; make sure that cables do not touch each others and the vehicle body.</p> <p style="text-align: center;"><i>NOTE</i></p> <p><b><i>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.</i></b></p>	

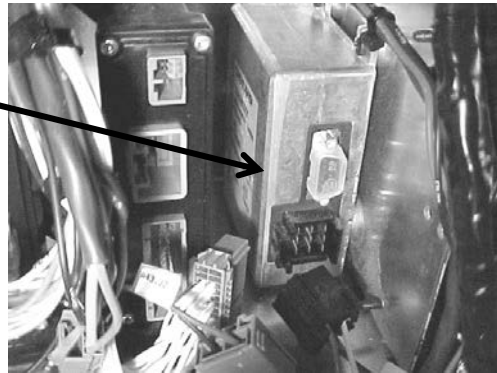




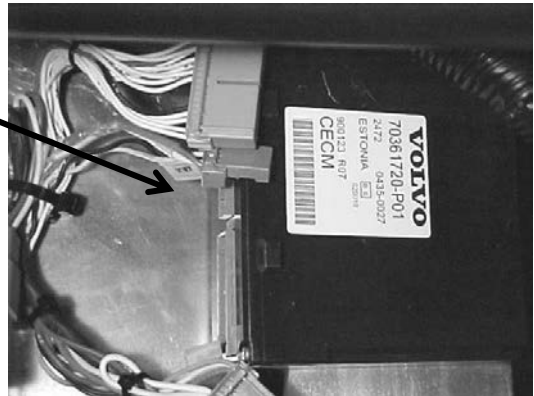
Disconnect connectors from CPC



Disconnect connector from master ID



Disconnect 3 connectors from CECM



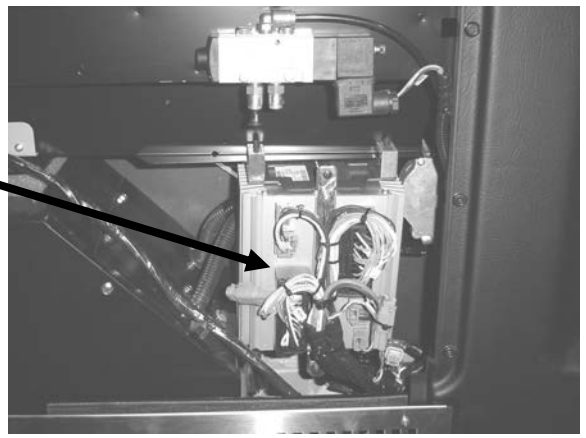
Disconnect connector C92



**Location: Wiper Control Panel**

Remove windshield wiper motor access panel

And disconnect I/O B modules



<p>2.30</p>	<p>When all the previous steps are done, you can do welding on the vehicle</p>	<p><b>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</b></p>
<p>2.35</p>	<p><b>When welding is completed, reconnect all the modules.</b> Make sure that the connectors locking tab are well engaged!</p>	<p><b>BE CAREFUL TO MAKE THE PROPER CONNECTIONS, IF NOT, SOME SYSTEMS OR COMPONENTS MAY NOT BE USABLE</b></p>



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## 1. VOLVO D13 ENGINE

### 1.1 SYSTEM OVERVIEW

#### **NOTE**

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

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

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

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

For diagnostic software, contact your local dealer.

The following is a list of engine sensors that

provide input to the EMS:

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

#### **Sensors**

##### **Ambient Air Temperature Sensor**

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

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

##### **Ambient (Atmospheric) Pressure Sensor**

The Ambient (Atmospheric) Pressure Sensor contains a pressure sensitive diaphragm and an electrical amplifier. Mechanical pressure applied

to the diaphragm causes the diaphragm to deflect and the amplifier to produce an electrical signal proportional to the deflection.

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

### **Camshaft Position Sensor**

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

### **Crankshaft Position (Engine Speed) Sensor**

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

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

### **Differential Pressure DP Sensor**

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

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

### **EGR Differential Pressure Sensor**

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

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

### **EGR Temperature Sensor**

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

The EGR Temperature Sensor is located near the EGR valve.

### **Engine Coolant Level (ECL) Sensor**

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

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

### **Engine Coolant Temperature (ECT) Sensor**

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

### **Engine Oil Pressure (EOP) Sensor**

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

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

### **Engine Oil Level (EOL) Sensor**

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

### **Engine Oil Temperature (EOT) Sensor**

The Engine Oil Temperature Sensor is a thermistor whose resistance varies inversely to temperature. The sensor has a negative



temperature coefficient, which means the sensor resistance will decrease as the engine oil temperature increases.

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

### **Exhaust Temperature Sensor (DPF Sensors)**

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

The Exhaust Temperature Sensors are located in the DPF assembly.

### **Fuel Pressure Sensor**

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

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

### **Intake Air Temperature and Humidity (IATH) Sensor**

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

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

### **Intake Manifold (Boost) Temperature Sensor**

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

air temperature increases.

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

### **Intake Manifold Pressure Sensor**

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

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

### **Throttle Position (TP) Sensor**

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

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

### **Turbo Speed Sensor**

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

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

### **Variable Geometry Turbocharger Smart Remote Actuator (VGT SRA)**

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

## Section 01: ENGINE

### 1.2 ENGINE OVERVIEW

#### **NOTE**

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

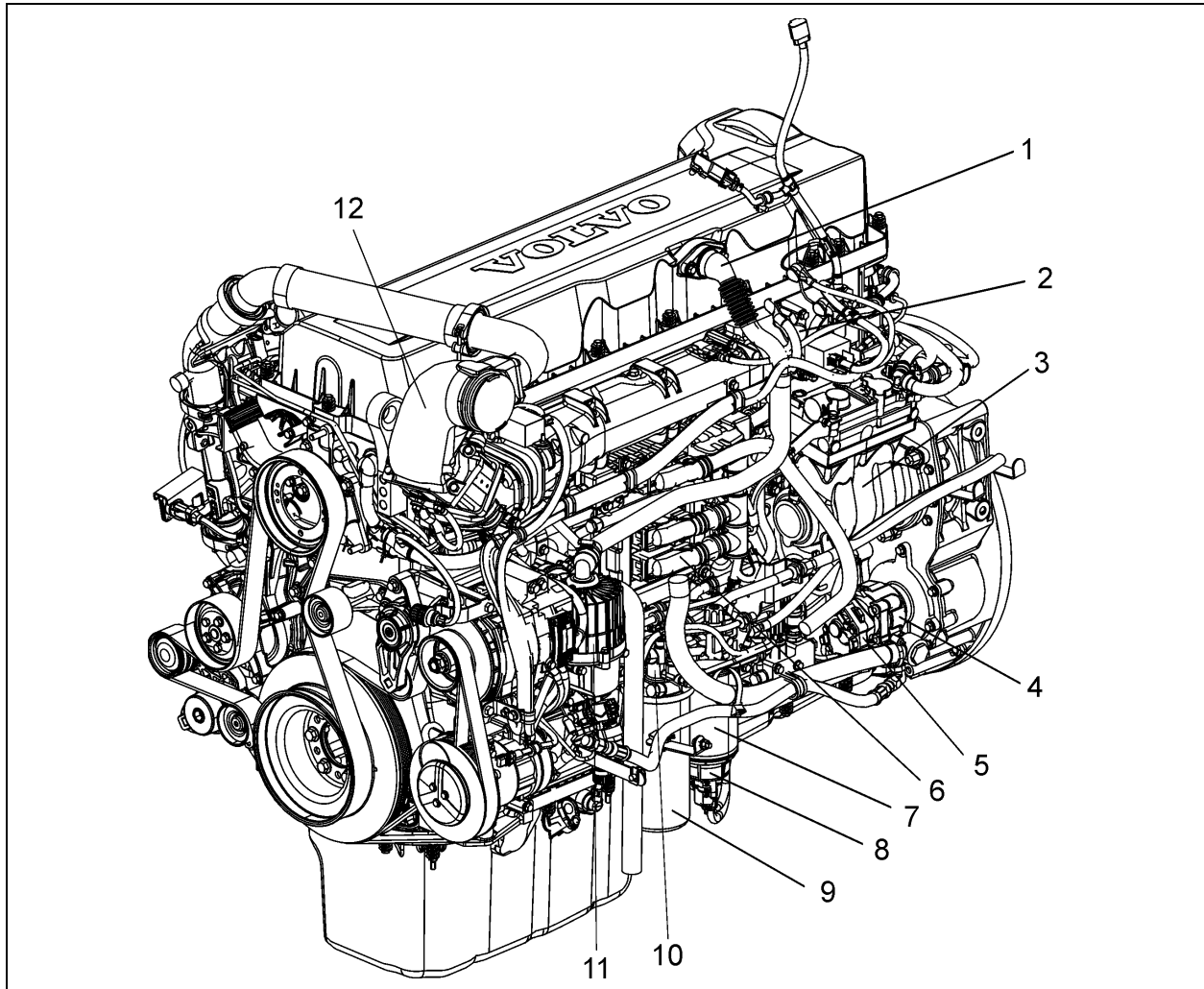


FIGURE 1: D13F ENGINE, ALTERNATOR SIDE (TYPICAL)

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

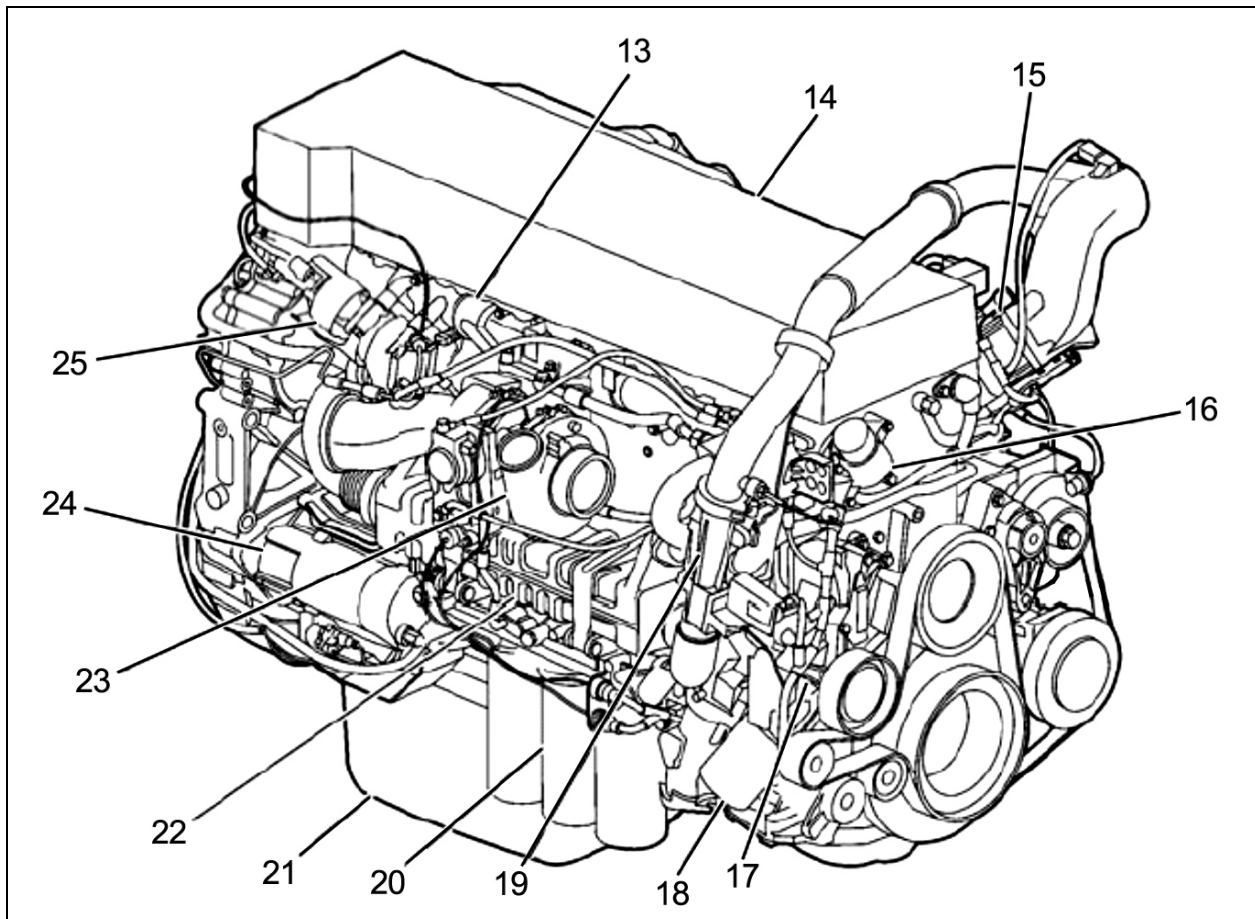


FIGURE 2: D13F ENGINE, TURBO SIDE (TYPICAL)

13. Exhaust Manifold	20. Oil Filters
14. Valve Cover	21. Oil Pan
15. Engine Pre-Heater Element (Optional)	22. EGR Cooler
16. DRV Valve	23. Turbocharger
17. Coolant Pump	24. Starter Motor
18. Coolant Filter	25. EGR Valve
19. Venturi Pipe	

### 1.3 ENGINE OIL

#### 1.3.1 General

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

#### 1.3.2 Oil Quality

Volvo North America recognizes engine oils that meet or exceed the standards given by American Petroleum Institute (API) for the oil classifications listed in this manual. Only oils licensed to carry the API

## Section 01: ENGINE

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symbol should be used. Lubricants meeting API standards have provided maximum engine life when used together with the recommended oil and oil filter change intervals.

EO-O Premium Plus (or VDS-4) diesel engine oil is mandatory for use in all 2007 emission compliant Volvo engines. Chassis equipped with a 2007 emission compliant engine, which can be identified by the presence of a Diesel Particulate Filter (DPF), also require the use of Ultra Low Sulfur Diesel (ULSD) fuel. EO-O Premium Plus oils exceed the new API service category CJ-4.



### CAUTION

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

#### 1.3.3 Oil Change Intervals

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

#### **NOTE**

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

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

**NOTE**

*Oil filters should always be changed when changing the oil.*

1.3.4 Oil Filters

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



**CAUTION**

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

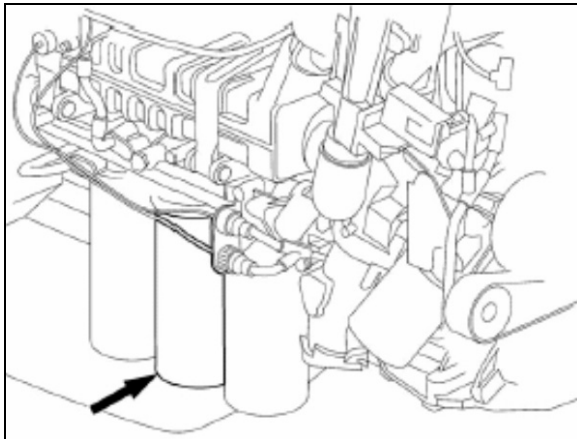


FIGURE 3: D13F OIL FILTERS

1.3.5 Synthetic Lubrication

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

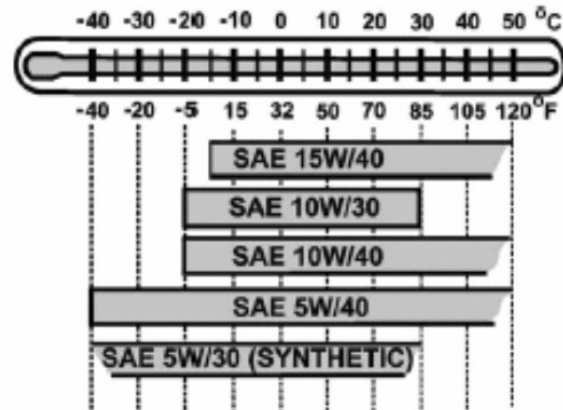
**The use of synthetic oils does not permit the extension of the recommended oil change intervals.**

1.3.6 Oil Viscosity

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

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

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



1.3.7 Oil Additives



**CAUTION**

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

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

1.3.8 Oil Consumption

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




**CAUTION**

**DO NOT** overfill engine with oil.


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

## Section 01: ENGINE


### 1.3.9 Oil Change

 **WARNING**


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

 **WARNING**

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

 **CAUTION**

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

 **WARNING**

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


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

Component	Capacity (L)
Oil pan	24 min - 32 max
Engine block	4.5
Filters (3)	6
Total oil fill (empty)	42.5


**NOTE**

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

### 1.3.10 Oil Filters Change

 **WARNING**

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

 **CAUTION**

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

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

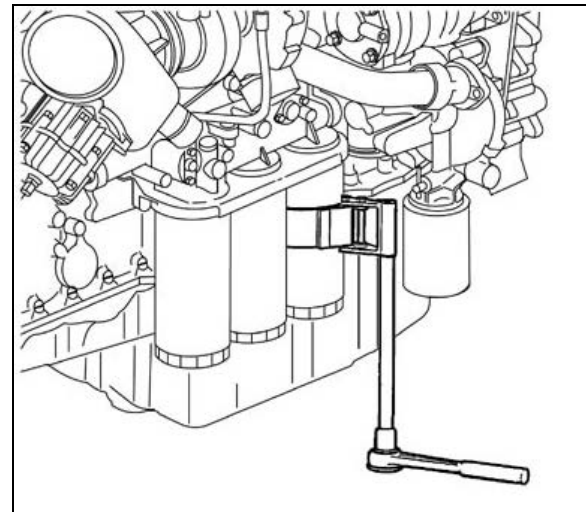
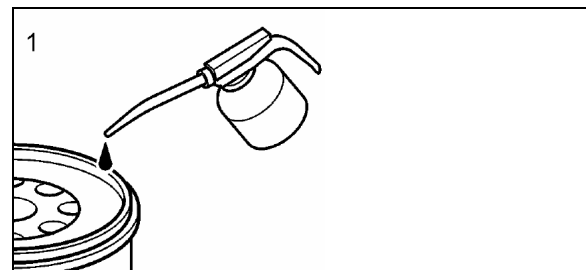


FIGURE 4: OIL FILTER WRENCH

- Prefill the new oil filters with approved engine oil. Also, lubricate the filter gaskets with engine oil (1). Hand tighten the oil filters until they contact the sealing surface of the oil filter housing (2). Manually tighten the oil filters an additional  $\frac{3}{4}$  to 1 full turn (3).



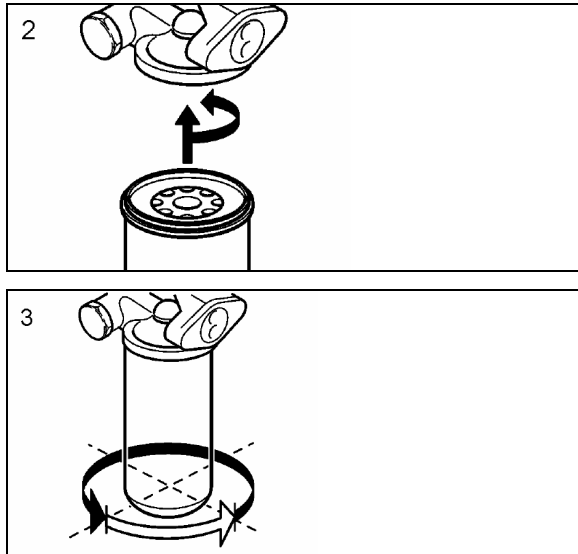



FIGURE 5: OIL FILTER REPLACEMENT

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

### 1.3.11 Checking the Oil Level

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

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

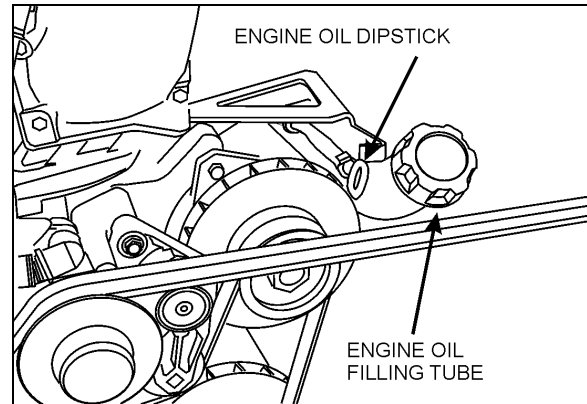


FIGURE 6: ENGINE OIL FILLING TUBE

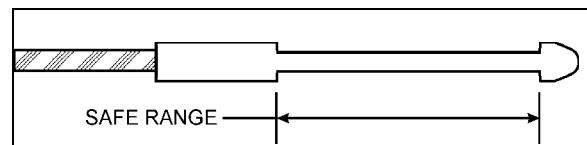



FIGURE 7: ENGINE OIL LEVEL DIPSTICK

### 1.4 POWER PLANT ASSEMBLY REMOVAL

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

Remove the power plant assembly as follows:

 <b>CAUTION</b>
<p>Tag hoses and cables for identification before disconnecting in order to facilitate reinstallation. Plug all openings to prevent dirt from entering the system.</p>

<p><b>NOTE</b></p> <p><i>No parts within the EECU are serviceable. If found defective, replace the EECU as a unit.</i></p>
--

#### • Preparation

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



**WARNING**

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

3. Remove the rear bumper assembly from the vehicle. Refer to Section 18 BODY, under "Rear Bumper Removal".
4. If applicable, disconnect the block heater connector located near the EGR mixing chamber.

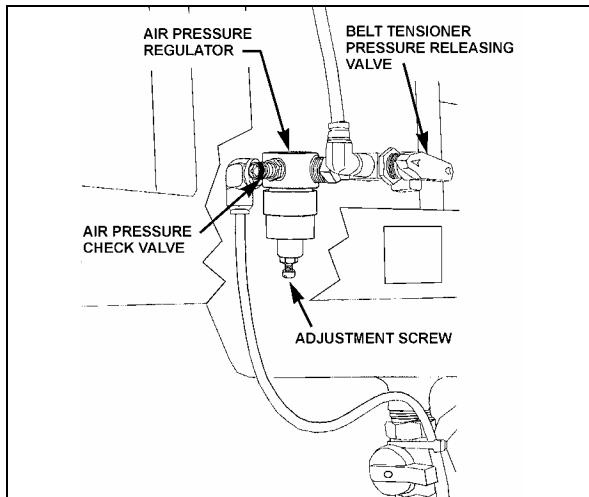


FIGURE 8: BELT TENSIONER VALVE 12200

5. Locate the A/C compressor belt tensioner pressure releasing valve (Fig. 8). Turn pressure releasing valve handle counterclockwise in order to release pressure in belt-tensioner air bellows and loosen belt. Remove the A/C compressor belt.
6. To release all pressure from the air system. Refer to Section 12, BRAKES & AIR SYSTEM for instructions.
7. Disconnect and remove the engine-air intake duct mounted between air cleaner housing and turbocharger inlet.



**CAUTION**

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

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

9. Disconnect and remove the air intake duct mounted between the turbocharger outlet and the air cooler inlet.
10. Disconnect and remove section of coolant pipe assembly mounted between the radiator outlet and the water pump inlet.
11. Disconnect and remove a section of coolant pipe assembly mounted between the thermostat housing and the radiator inlet, if applicable.
12. Disconnect the electric fan-clutch connector located near the cooling fan right angle gearbox.
13. Disconnect the cooling fan drive shaft.



**CAUTION**

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

14. Disconnect surge tank hoses connected to the thermostat housing, the pump inlet and to the transmission oil cooler.
15. Disconnect and remove the exhaust pipe mounted between the flexible coupling and the pipe going to the Aftertreatment Device (ATD). If necessary, refer to Section 04 EXHAUST SYSTEM under "Muffler Removal and Installation".



**CAUTION**

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

16. Remove the power steering pump.
17. Close engine fuel supply shutoff valve on primary fuel filter or Fuel Pro. Disconnect the fuel line located above fuel filters and connected to inlet port. On vehicles equipped with the optional fuel filter/water separator, disconnect the connector and remove cable ties from cradle.

• **With Vehicle Raised**

18. Using the quick-connect drain hose, drain the engine cooling system. Refer to Section 05 COOLING under "Draining Cooling System".



19. From under the vehicle, disconnect the propeller shaft as detailed in Section 09, under heading "Propeller Shaft Removal".
  20. On vehicles equipped with an automatic transmission provided with a hydraulic output retarder, disconnect steel-braided airline from pressure regulator output. The pressure regulator is mounted in the upper section of engine compartment backwall and is accessible through the engine compartment R.H. side door.
  21. Remove the retaining bolts, washers and nuts securing the power plant cradle to the vehicle rear subframe.
  22. Disconnect transmission harness from transmission housing.
- **With Vehicle Lowered**
23. Disconnect the air compressor discharge, governor steel-braided airlines and manual filling airlines from compressor. Remove retaining clips.
  24. Disconnect the hose connecting the compressor head to the sump tank, if applicable.
  25. Disconnect ground cables from rear subframe ground-stud located close to the starter motor.
  26. Disconnect alternators cooling duct and put aside.
  27. Inside rear electrical compartment, disconnect starter, alternators and heater cables. Also disconnect AFSS cable if applicable.
  28. Disconnect Aftertreatment Device (ATD) control cable.
  29. Disconnect VIH (vehicle interface harness) connector.
  30. Disconnect fuel return line from bulkhead fixed on engine cylinder head end.
  31. Unfasten and put aside engine compartment lighting fixture and turbocharger fire suppression nozzle if applicable.
  32. Disconnect turbo boost pressure gauge airline from engine air intake, if applicable.
  33. Disconnect the engine coolant hose near the starter.

34. On partition wall, disconnect connector C397 located between engine compartment and main power compartment.
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.

**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.*

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



**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).

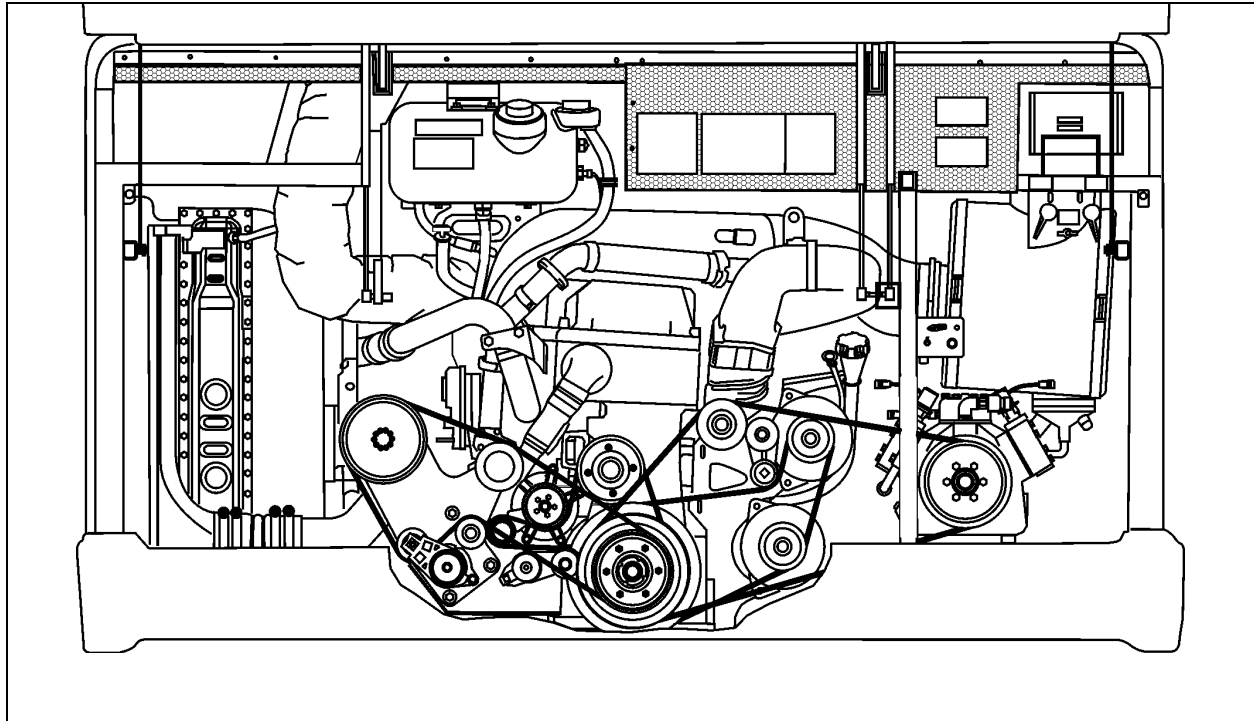


FIGURE 9: ENGINE COMPARTMENT H3 COACHES (TYPICAL)

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### 1.5 POWER PLANT ASSY. INSTALLATION

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

1. Torque the power plant cradle mounting bolts to 190 lbf-ft (255 Nm).
2. Refill cooling system with saved fluid (refer to Section 05 COOLANT SYSTEM).
3. 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).
4. Start engine for a visual check. Check fuel, oil, cooling, pneumatic and hydraulic system connections for leakage. Test operation of engine controls and accessories.

### 1.6 ENGINE MOUNTS

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

Two engine support brackets are used at the front of the engine while two rubber mounts are mounted underneath the engine & radiator fan drive mechanism support and the engine & alternator support (Fig. 10).

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

#### **NOTE**

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

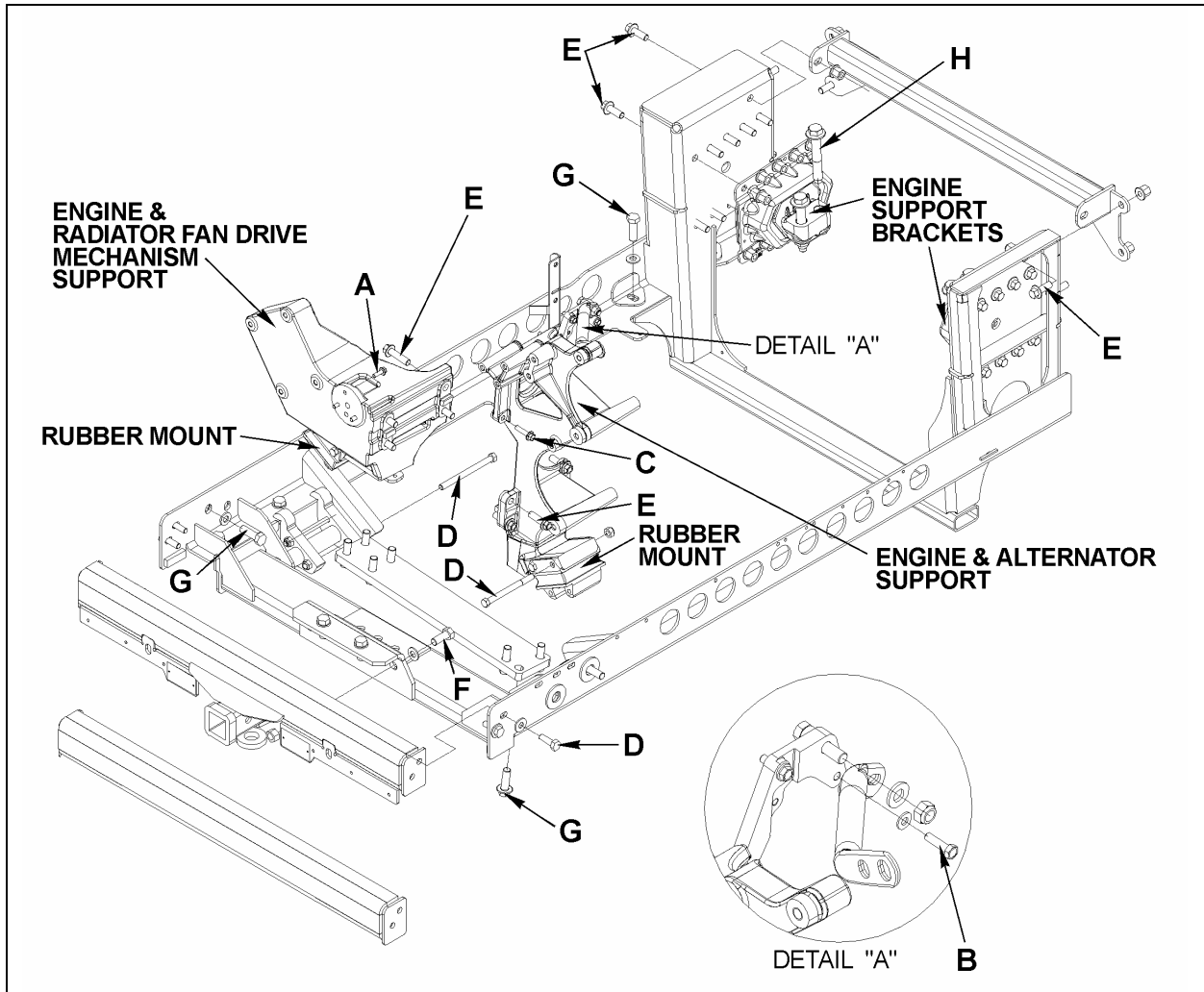


FIGURE 10: VOLVO ENGINE POWER PLANT CRADLE INSTALLATION

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

**2. DETROIT DIESEL SERIES 60 ENGINE**

The DDC series 60 engine is a 6-cylinder, four-cycle, 14.0 liters Detroit Diesel series 60 engine, equipped with an electronic control system (DDEC VI).

Complete maintenance and repair information on the engine will be found in the current **DETROIT DIESEL SERIES 60 2007 ON-HIGHWAY SERVICE MANUAL 6SE2007**. This essential manual contains complete instructions on operation, adjustment (tune-up), preventive maintenance and lubrication, parts verification, repair or replacement. This manual's sections cover complete systems such as:

- Engine main assembly;
- Fuel system;
- Lubrication system;
- Cooling system;
- Fuel, lubricating oil and coolant;
- Air intake system;
- Exhaust system;
- Exhaust gas recirculation components;
- Electrical equipment;
- Operation and verification;
- Engine tune-up;
- Preventive maintenance;
- Storage;

Refer to **Series 60 DDEC VI Troubleshooting Guide** published by Detroit Diesel for more complete information on diagnosis of components and system problems.

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 diagnostic codes.

**2.1 DDEC VI SYSTEM**

DDEC VI (**D**etroit **D**iesel **E**lectronic **C**ontrol) is a system that monitors and determines all values required for the operation of the engine. A diagnostic interface is provided to connect to an external diagnosis tester. Besides the engine related sensors and the engine-resident control unit, the Motor Control Module (MCM), this

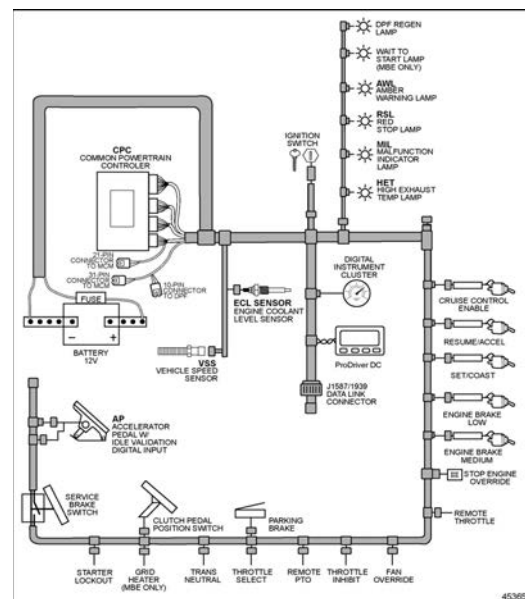
system has a chassis-mounted control unit for vehicle engine management, the Common Powertrain Controller (CPC). The connection to the vehicle is made via a CAN interface which digitally transmits the nominal values (e.g. torque, engine speed specification, etc.) and the actual values (e.g. engine speed, oil pressure, etc.).

DDEC VI controls the timing and amount 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 Motor Control Module (MCM). The MCM computes the electrical signals and determines the correct fuel output and timing for optimum power, fuel economy and emissions. The MCM 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 or high engine temperature.

**2.2 HARNESSSES**

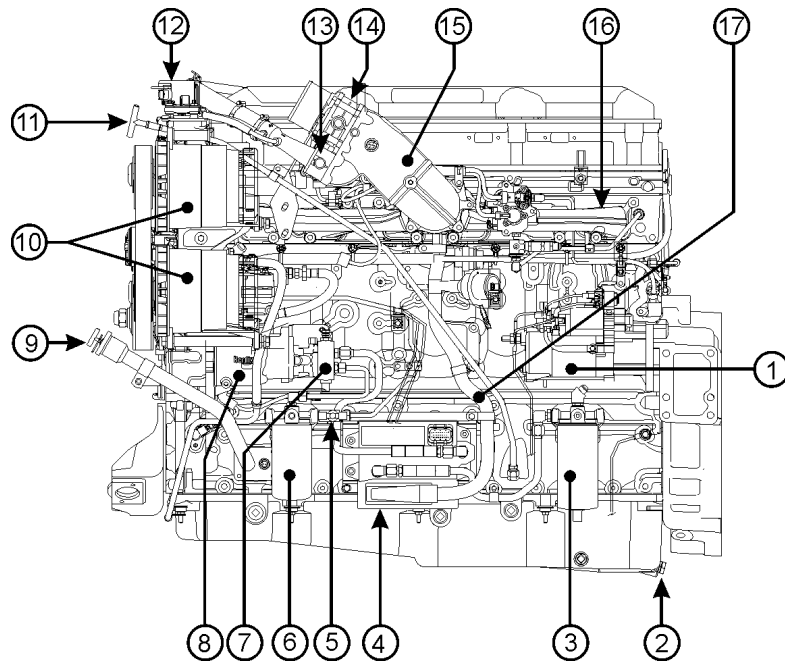
There are two major harnesses: the Engine Harness (EH) and the Vehicle Interface Harness (VIH). The Engine Harness is installed at the Detroit Diesel factory and is delivered connected to all engine sensors, the fuel injection system, and the MCM.

The OEM supplied Vehicle Interface Harness connects the CPC to other vehicle systems.



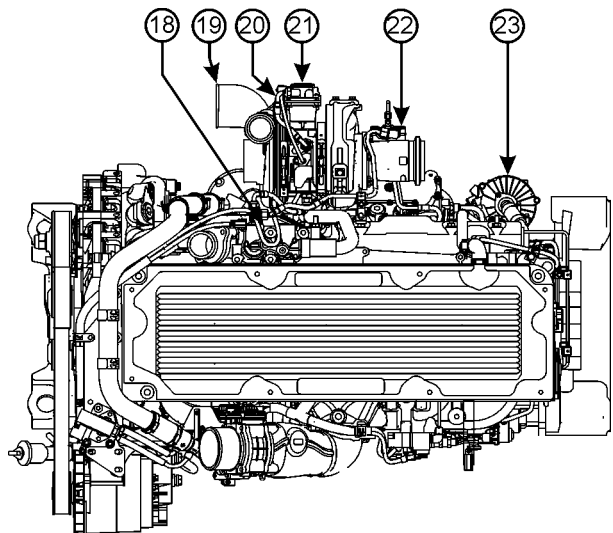
**FIGURE 11: VEHICLE INTERFACE HARNESS (GENERAL APPLICATION SHOWN)**

2.3 ENGINE OVERVIEW



- 1- Starter motor
- 2- Oil pan drain plug
- 3- Primary fuel-filter/water-separator
- 4- MCM (DDEC VI Electronics)
- 5- Secondary fuel filter shutoff valve
- 6- Secondary fuel filter
- 7- Fuel pump
- 8- Air compressor
- 9- Engine oil filling tube
- 10- Bosch alternators (2)
- 11- Engine oil dipstick
- 12- EGR delta pressure sensor
- 13- EGR valve
- 14- Intake throttle
- 15- EGR mixer
- 16- Intake manifold
- 17- Engine Harness

- 18- Thermostat housing
- 19- Turbo compressor outlet
- 20- Actuator coolant return line
- 21- Electrically controlled actuator
- 22- HC doser
- 23- Closed-crankcase breather/oil separator



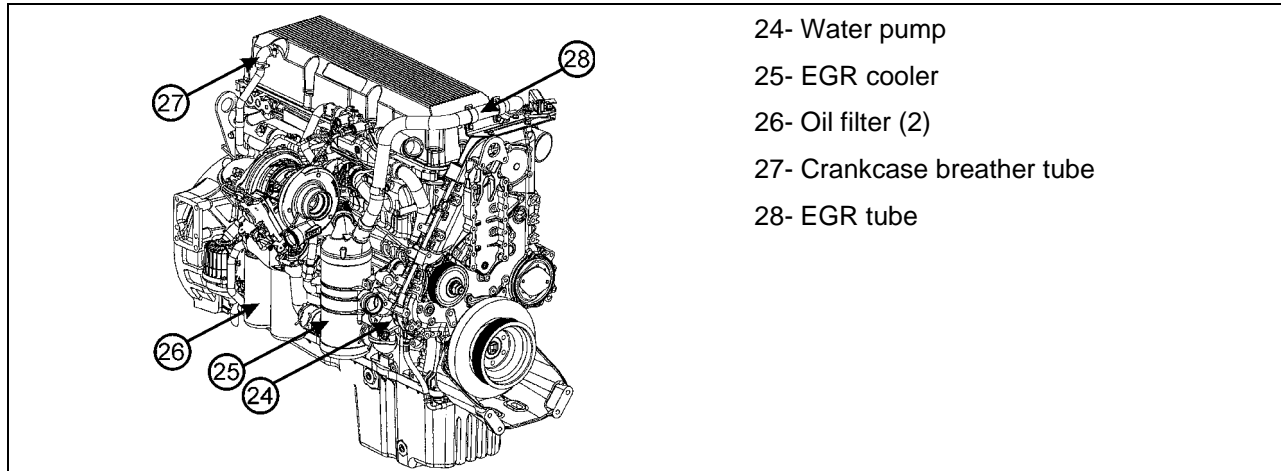


FIGURE 12: DETROIT DIESEL 2007 SERIES 60 ENGINE (TYPICAL)

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## 2.4 DDEC VI SENSORS

- **Camshaft Position Sensor (CMP Sensor):** Indicates a specific cylinder in the firing order.
- **Crankshaft Position Sensor (CKP Sensor):** Senses crankshaft position and engine speed for functions such as fuel control strategy.
- **DPF Inlet Pressure Sensor** Measures pressure between the Diesel Oxidation Catalyst (DOC) and the Diesel Particulate Filter (DPF) in the aftertreatment assembly.
- **DPF Outlet Pressure Sensor:** Measures pressure on the outlet of the aftertreatment device in the exhaust system of the vehicle.
- **DPF Outlet Temperature Sensor:** Temperature measured at the outlet of the after-treatment system that is installed within the exhaust system of the vehicle.
- **DOC Inlet Temperature Sensor:** Temperature measured at the outlet of the after-treatment.
- **DOC Outlet Temperature Sensor:** Temperature measured between the DOC and the DPF in the aftertreatment assembly.
- **EGR Delta Pressure Sensor:** Senses EGR pressure for EGR control.
- **EGR Temperature Sensor:** Senses EGR exhaust temperature after EGR cooler. Used for EGR system diagnosis.
- **Engine Coolant Temperature Sensor (ECT Sensor):** Senses coolant temperature for functions such as engine protection, fan control and engine fueling.

- **Engine Oil Pressure Sensor (EOP Sensor):** Senses gallery oil pressure for functions such as engine protection.
- **Engine Oil Temperature Sensor (EOT Sensor):** Senses oil temperature for functions such as reducing variation in fuel injection and fan control.
- **Fuel Line Pressure Sensor:** Senses fuel line pressure.
- **Fuel Compensation Pressure Sensor:** Compensates fuel line pressure.
- **Intake Manifold Pressure Sensor (IMP Sensor):** Senses turbo boost for functions such as smoke control and engine protection.
- **Intake Manifold Air Temperature Sensor (IMT Sensor):** Senses pressure. The MCM uses this information to compute the amount of air entering the engine.
- **Supply Fuel Temperature Sensor (SFT Sensor):** Senses fuel temperature for functions such as engine fueling.
- **Turbo Compressor Temperature Out Sensor:** Senses turbo out air temperature.
- **Turbo Speed Sensor (TSS):** Monitors turbo speed for overspeed conditions.
- **VGT Position Sensor/EGR Valve Position Sensor.**
- **Intake Air Throttle Valve Sensor.**
- **Exhaust Valve Recirculation Valve (EGR) Sensor.**

2.5 PREVOST INSTALLED SENSORS

- **Engine Coolant Level Sensor (ECL Sensor):** Senses coolant level for engine protection (mounted on coolant surge tank).
- **Turbo Compressor In Temperature Sensor:** Senses the air temperature at the turbo compressor inlet.
- **Vehicle Speed Sensor (VSS):** Provides a vehicle speed signal (connected to transmission).

2.6 MOTOR CONTROL MODULE (MCM)

The Motor Control Module is mounted, on the starter side of the engine (Fig. 13). Considered the "Brain" of the DDEC VI 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 (Electrically Erasable, Programmable, Read-Only Memory) within the Motor Control Module. After comparing the input data with the calibration data, the MCM sends high-current command pulses to the Electronic Unit Injectors (EUI) to initiate fuel injection. The MCM also receives feedback regarding the start and end of injection for a given cylinder. The EEPROM within the Motor 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 VI Diagnostic Codes" in this section).

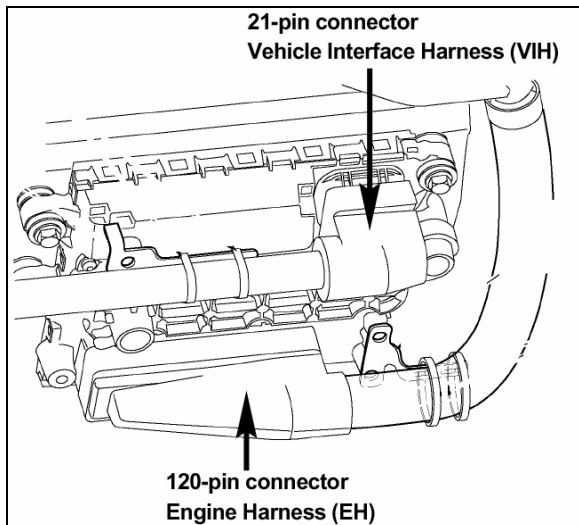


FIGURE 13: MOTOR CONTROL MODULE (MCM) 01145

2.7 COMMON POWERTRAIN CONTROLLER (CPC)

The CPC is the interface between the MCM and the vehicle/equipment for engine control and manages other vehicle/equipment functions.

Within the CPC, sets of data for specific applications are stored. These include idle speed, maximum running speed, and speed limitation. Customer programmable parameters are also stored here. The CPC receives data from the operator (accelerator pedal position, switches and various sensors) and other electronic control units. From this data, instructions are computed for controlling the engine and transmitted to the MCM via the proprietary data link.

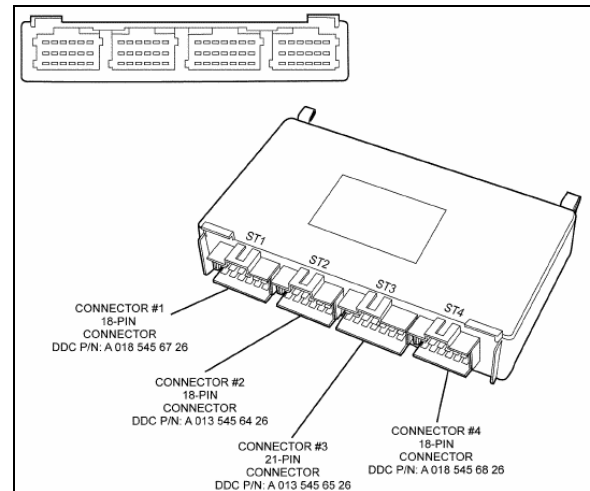


FIGURE 14: CPC

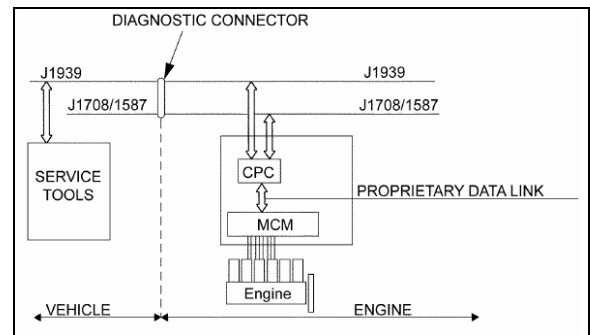


FIGURE 15: THE CPC COMMUNICATES OVER THE J1587 AND J1939 DATA LINKS TO THE VEHICLE

2.8 DDEC VI DIAGNOSTICS

2.8.1 Diagnostic system

Diagnostics is a standard feature of DDEC VI. The purpose of this feature is to provide information for problem identification and

problem solving in the form of a code. The MCM and CPC continuously perform self diagnostic checks and monitor the other system components. Information for problem identification and problem solving is enhanced by the detection of faults, retention of fault codes and separation of active from inactive codes.

The engine-mounted MCM includes control logic to provide overall engine management. System diagnostic checks are made at ignition on and continue throughout all engine operating modes.

Sensors provide information to the MCM and CPC regarding various engine and vehicle performance characteristics. The information is used to regulate engine and vehicle performance, provide diagnostic information, and activate the engine protection system.

The DDEC VI on-board diagnostic system accessories include the following:

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

The AWL is illuminated and a code is stored if an electronic system fault occurs. This indicates the problem should be diagnosed as soon as possible. The CPC illuminates the AWL and RSL and stores a malfunction code if a potentially engine damaging fault is detected. These codes can be accessed in one of four ways:

- Commercially available J1587/J1939 diagnostic tools.
- Detroit Diesel Diagnostic Link® (DDDL 7.0).
- Flashing the AWL and RSL with the SEO/Diagnostic Request Switch.
- Dashboard's Message Center Display (MCD).

### 2.8.2 Check Engine Telltale Light (AWL)

The CPC illuminates the Check Engine telltale, mounted on the telltale light panel to indicate that a problem has been detected and that a code has been stored in the MCM memory. This light also has a 5-second bulb check when the ignition is first turned on.

### 2.8.3 Stop Engine Warning Light (RSL)

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).

### 2.8.4 Stop Engine Override Switch (SEO)

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.

### 2.8.5 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 #6SE492.

## 2.9 READING DIAGNOSTIC CODES – FLASHING LIGHT METHOD:

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

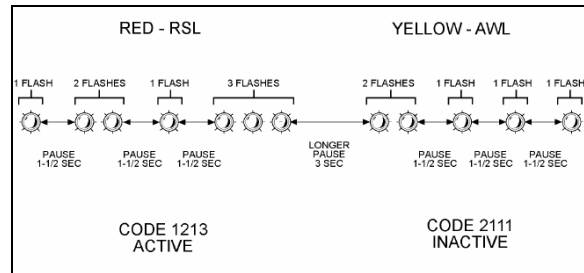


**Active Codes:** Codes that are currently keeping the Check Engine or Stop Engine telltale light illuminated. Active codes are flashed via the Stop Engine Light when checked with the stop-engine-override switch.

**Inactive Codes:** These are all the codes logged in the CPC, which have previously occurred, (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 (SEO) 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.

Flashing codes provide a four digit number. Each fault code is flashed twice in order to help with counting the flashes. If there are no active faults or if there are no inactive faults the number "3" is flashed once followed by an ~3s delay.



**FIGURE 16: FLASHING FAULTS CODES**

Refer to DDEC Troubleshooting Manual 6SE567 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 MCM to provide for engine operation if a sensor failure is present.

2.10 DDEC VI CPC DIAGNOSTIC CODES LIST

SPN	FMI	PID/SID	PID/SID ID	FLASH CODES	FAULT DESCRIPTION
70	2	PID	70	2111	Park Brake Status Not Plausible (Vehicle Moving)
70	19	SID	234	2112	J1939 Park Brake Switch Signal from Source #1 is erratic
70	13	SID	234	2112	J1939 Park Brake Switch Signal from Source #1 is missing
70	19	SID	234	2112	J1939 Park Brake Switch Signal from Source #2 is erratic
70	13	SID	234	2112	J1939 Park Brake Switch Signal from Source #2 is missing
70	19	SID	234	2112	J1939 Park Brake Switch Signal from Source #3 is erratic
70	13	SID	234	2112	J1939 Park Brake Switch Signal from Source #3 is missing
84	21	PID	84	2113	Vehicle Speed Failure

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SPN	FMI	PID/SID	PID/SID ID	FLASH CODES	FAULT DESCRIPTION
84	3	PID	84	2113	Vehicle Speed Sensor Circuit Failed High
84	4	PID	84	2113	Vehicle Speed Sensor Circuit Failed Low
84	2	PID	84	2113	VSS Anti Tamper Detection via Virtual Gear Ratio
84	8	PID	84	2113	VSS Anti Tamper Detection via Fixed Frequency Device
84	6	PID	84	2113	VSS Anti-Tamper Detection via ABS Vehicle Speed Comparison
84	19	PID	84	2113	J1939 Wheel-Based Vehicle Speed Signal from Source#1 is erratic
84	13	PID	84	2113	J1939 Wheel-Based Vehicle Speed Signal from Source#1 is missing
84	19	SID	84	2113	J1939 Wheel-Based Vehicle Speed Signal from Source#2 is erratic
84	13	PID	84	2113	J1939 Wheel-Based Vehicle Speed Signal from Source#2 is missing
84	19	PID	84	2113	J1939 Wheel-Based Vehicle Speed Signal from Source#3 is erratic
84	13	PID	84	2113	J1939 Wheel-Based Vehicle Speed Signal from Source#3 is missing
84	20	PID	84	2113	Vehicle Speed Sensor Drifted High Error (VSS signal not plausible)
91	13	PID	91	2114	Accelerator Pedal Learn Error
91	3	PID	91	2114	Accelerator Pedal Circuit Failed High
91	4	PID	91	2114	Accelerator Pedal Circuit Failed Low
91	8	PID	91	2114	Pwm Accelerator Pedal Signal 1 Frequency Out Of Range
91	14	PID	91	2114	Pwm Accelerator Pedal Not Learned
91	7	PID	91	2114	Pwm Accelerator Pedal Idle Not Recognized
91	31	PID	91	2114	Pwm Accelerator Pedal Learned Range to Large
91	3	PID	91	2114	Accelerator Pedal Signal Circuit Failed High
91	9	SID	231	2615	J1939 EEC2 Message is missing
98	0	PID	98	2115	Oil Level High
98	18	PID	98	2115	Oil Level Low
98	1	PID	98	2115	Oil Level Very Low
100	18	PID	100	2121	Oil Pressure Low
100	1	PID	100	2121	Oil Pressure Very Low
107	0	PID	107	2122	Air Filter Restriction High
107	4	PID	107	2122	Air Filter Signal Circuit Failed Low
107	3	PID	107	2122	Air Filter Signal Circuit Failed High
110	16	PID	110	2123	Coolant Temperature High

SPN	FMI	PID/SID	PID/SID ID	FLASH CODES	FAULT DESCRIPTION
110	0	PID	110	2123	Coolant Temperature Very High
111	18	PID	111	2124	Coolant Level Low
111	3	PID	111	2124	Coolant Level Circuit Failed High
111	4	PID	111	2124	Coolant Level Circuit Failed Low
111	1	PID	111	2124	Coolant Level Very Low
168	0	PID	168	2125	Battery Voltage Very Low
168	0	PID	168	2125	Battery Voltage High
168	18	PID	168	2125	Battery Voltage Low
168	14	PID	168	2125	Opt Idle Detected Charging System or Battery Failure
168	14	PID	168	2125	ECU powerdown not completed (Main Battery Terminal Possibly Floating)
171	2	PID	171	2131	Ambient Temperature Sensor Data Erratic
171	14	PID	171	2131	J1587 Ambient Air Temp Sensor Data Not Received This Ign Cycle
171	9	PID	171	2131	J1587 Ambient Air Temp Sensor Data Message Stopped Arriving
191	9	SID	231	2615	J1939 ETC1 Message is missing
191	19	SID	231	2132	J1939 Transmission Output Shaft Speed Signal is erratic
191	13	SID	231	2132	J1939 Transmission Output Shaft Speed Signal is missing
247	9	PID	247	2615	MCM Engine Hours Data not received or stopped arriving
247	10	PID	247	2615	MCM Engine Hours Data increasing at an implausible rate
247	0	PID	247	2615	MCM Engine Hours Data higher than expected
247	1	PID	247	2615	MCM Engine Hours Data lower than expected
523	19	PID	163	2133	J1939 Transmission Current Gear Signal is erratic
523	13	PID	163	2133	J1939 Transmission Current Gear Signal is missing
524	9	SID	231	2615	J1939 ETC2 Message is missing
527	9	SID	231	2615	J1939 CCVS Message from Source #1 is missing
527	9	SID	231	2615	J1939 CCVS Message from Source #2 is missing
527	9	SID	231	2615	J1939 CCVS Message from Source #3 is missing
558	2	SID	230	2134	Idle Validation Switch Inputs Reversed
558	5	SID	230	2134	Idle Validation Switch 2 Circuit Failed Low
558	6	SID	230	2134	Idle Validation Switch 2 Circuit Failed High
558	4	SID	230	2134	Idle Validation Switch 1 Circuit Failed Low
558	3	SID	230	2134	Idle Validation Switch 1 Circuit Failed High

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SPN	FMI	PID/SID	PID/SID ID	FLASH CODES	FAULT DESCRIPTION
596	19	SID	244	2135	J1939 Cruise Control Enable Switch Signal from Source #1 is erratic
596	13	SID	244	2135	J1939 Cruise Control Enable Switch Signal from Source #1 is missing
596	19	SID	244	2135	J1939 Cruise Control Enable Switch Signal from Source #2 is erratic
596	13	SID	244	2135	J1939 Cruise Control Enable Switch Signal from Source #2 is missing
596	19	SID	244	2135	J1939 Cruise Control Enable Switch Signal from Source #3 is erratic
596	13	SID	244	2135	J1939 Cruise Control Enable Switch Signal from Source #3 is missing
597	2	SID	246	2141	Service Brake Status Not Plausible
597	19	SID	246	2141	J1939 Service Brake Switch Signal from Source #1 is erratic
597	13	SID	246	2141	J1939 Service Brake Switch Signal from Source #1 is missing
597	19	SID	246	2141	J1939 Service Brake Switch Signal from Source #2 is erratic
597	13	SID	246	2141	J1939 Service Brake Switch Signal from Source #2 is missing
597	19	SID	246	2141	J1939 Service Brake Switch Signal from Source #3 is erratic
597	13	SID	246	2141	J1939 Service Brake Switch Signal from Source #3 is missing
599	4	SID	243	2142	Cruise Control SET and RESUME Circuits Failed Low
600	19	SID	243	2143	J1939 Cruise Control Coast Switch Signal from Source #1 is erratic
600	13	SID	243	2143	J1939 Cruise Control Coast Switch Signal from Source #1 is missing
600	19	SID	243	2143	J1939 Cruise Control Coast Switch Signal from Source #2 is erratic
600	13	SID	243	2143	J1939 Cruise Control Coast Switch Signal from Source #2 is missing
600	19	SID	243	2143	J1939 Cruise Control Coast Switch Signal from Source #3 is erratic
600	13	SID	243	2143	J1939 Cruise Control Coast Switch Signal from Source #3 is missing
602	19	SID	242	2144	J1939 Cruise Control Accelerate Switch Signal from Source #1 is erratic
602	13	SID	242	2144	J1939 Cruise Control Accelerate Switch Signal from Source #1 is missing
602	19	SID	242	2144	J1939 Cruise Control Accelerate Switch Signal from Source #2 is erratic
602	13	SID	242	2144	J1939 Cruise Control Accelerate Switch Signal from Source #2 is missing

SPN	FMI	PID/SID	PID/SID ID	FLASH CODES	FAULT DESCRIPTION
602	19	SID	242	2144	J1939 Cruise Control Accelerate Switch Signal from Source #3 is erratic
602	13	SID	242	2144	J1939 Cruise Control Accelerate Switch Signal from Source #3 is missing
608	14	SID	250	2145	J1708 Data Link Failure
609	12	SID	233	2145	CPC2 Hardware Failure
615	9	SID	231	2615	J1939 DM1 Message from Transmission is missing
625	13	SID	248	2151	ECAN ID_1629 Diagnostic Message Not Received This Ignition Cycle
625	9	SID	248	2151	ECAN ID_1629 Diagnostic Message No Longer Being Received
625	10	SID	248	2151	ECAN ID_1629 Reporting Inconsistent Number of Frames
625	2	SID	248	2151	ECAN ID_1629 Diagnostic Message Reporting Data Not Available
625	14	SID	248	2151	ECAN ID_1629 Diagnostic Message Reporting an Unknown MUID
625	9	SID	248	2151	Incorrect MCM System ID Received
625	9	SID	248	2151	MCM System ID Not Received or Stopped Arriving
625	4	SID	248	2151	ECAN Link Circuit Failure
628	14	SID	254	2151	XFLASH Static Fault Code Memory Page Read Write Failure
628	13	SID	155	2615	20ms ECU OS Task Locked in an Endless Loop
628	13	SID	155	2615	20ms ECU OS Task Timed out Prior to Completion
628	13	SID	155	2615	1000ms ECU OS Task Locked in an Endless Loop
628	13	SID	155	2615	1000ms ECU OS Task Timed out Prior to Completion
629	2	SID	254	2151	CPC Hardware/Software Mismatch
629	12	SID	254	2151	DDEC Data Xflash Write Error. Replace CPC2.
630	2	SID	253	2152	EEPROM Checksum Failure
630	2	SID	253	2152	EEPROM Checksum Failure for the SCR Block
630	13	SID	253	2152	SCR Number Out of Range
630	14	SID	155	2615	MCM Fault Codes Unavailable via J1939 and J1587
630	14	SID	155	2615	MCM Fault Code Table Inconsistent - Upgrade MCM Software
630	14	SID	155	2615	Insufficient Static Fault Code Storage Memory - Upgrade CPC Software

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SPN	FMI	PID/SID	PID/SID ID	FLASH CODES	FAULT DESCRIPTION
630	14	SID	155	2615	MCM Fault Code Table Inconsistent - Upgrade MCM Software
639	14	SID	231	2153	J1939 Data Link Failure
701	3	SID	26	2211	Digital Output 4 09 Circuit Failed High
701	4	SID	26	2211	Digital Output 4 09 Circuit Failed Low
702	3	SID	40	2212	Digital Output 3 17 Circuit Failed High
702	4	SID	40	2212	Digital Output 3 17 Circuit Failed Low
703	3	SID	51	2213	Digital Output 3 09 Circuit Failed High
703	4	SID	51	2213	Digital Output 3 09 Circuit Failed Low
704	3	SID	52	2214	Digital Output 4 07 Circuit Failed High
704	4	SID	52	2214	Digital Output 4 07 Circuit Failed Low
705	3	SID	53	2215	Digital Output 1 13 Circuit Failed High
705	4	SID	53	2215	Digital Output 1 13 Circuit Failed Low
706	3	SID	54	2221	Digital Output 3 10 Circuit Failed High
706	4	SID	54	2221	Digital Output 3 10 Circuit Failed Low
707	3	SID	55	2222	Digital Output 2 10 Circuit Failed High (CEL / AWL Lamp)
707	4	SID	55	2222	Digital Output 2 10 Circuit Failed Low (CEL / AWL Lamp)
708	3	SID	56	2223	Digital Output 3 12 Circuit Failed High
708	4	SID	56	2223	Digital Output 3 12 Circuit Failed Low
709	3	SID	257	2224	Digital Output 3 16 Circuit Failed High
709	4	SID	257	2224	Digital Output 3 16 Circuit Failed Low
710	3	SID	258	2225	Digital Output 4 06 Circuit Failed High
710	4	SID	258	2225	Digital Output 4 06 Circuit Failed Low
711	3	SID	259	2231	Digital Output 1 05 Circuit Failed High
711	4	SID	259	2231	Digital Output 1 05 Circuit Failed Low
712	3	SID	260	2232	Digital Output 1 04 Circuit Failed High
712	4	SID	260	2232	Digital Output 1 04 Circuit Failed Low
713	3	SID	261	2234	Digital Output 3 07 Circuit Failed High
713	4	SID	261	2234	Digital Output 3 07 Circuit Failed Low
713	5	SID	261	2234	Digital Output 3 07 Open Circuit
713	7	SID	261	2234	TOP2 Shift Failure
714	3	SID	262	2235	Digital Output 3 08 Circuit Failed High
714	4	SID	262	2235	Digital Output 3 08 Circuit Failed Low
714	5	SID	262	2235	Digital Output 3 08 Open Circuit
715	3	SID	263	2241	Digital Output 4 10 Circuit Failed High
904	9	SID	231	2615	J1939 EBC2 Message from ABS is missing
904	19	SID	231	2242	J1939 Front Axle Speed Signal is erratic
904	13	SID	231	2242	J1939 Front Axle Speed Signal is missing
972	2	SID	203	2243	Throttle inhibit switch signal not plausible due to excess vehicle speed
973	9	SID	231	2615	J1939 EBC1 Message is missing
973	13	SID	231	2244	J1939 Engine Retarder Selection Signal Missing

SPN	FMI	PID/SID	PID/SID ID	FLASH CODES	FAULT DESCRIPTION
973	19	SID	231	2244	J1939 Engine Retarder Selection Signal Erratic
974	2	PID	372	2245	Remote Accelerator Pedal Supply Voltage Out of Range
974	3	PID	372	2245	Remote Accelerator Pedal Circuit Failed High
974	4	PID	372	2245	Remote Accelerator Pedal Circuit Failed Low
981	0	SID	155	2311	PTO CC+ and CC- Switches Pressed Simultaneously
986	9	SID	231	2615	J1939 CM1 Message is missing
1267	4	SID	123	2312	Digital Output 4 10 Circuit Failed Low
1267	3	SID	123	2312	Digital Output 4 10 Circuit Failed Open
1321	4	SID	128	2314	Starter Lockout Output Shorted to Ground
1321	3	SID	128	2314	Starter Lockout Output Open Circuit
1590	19	SID	155	2615	Adaptive Cruise Control Message Not Received
1590	9	SID	231	2615	Adaptive Cruise Control Device Reporting Error
1624	9	SID	231	2615	J1939 TCO1 Message is missing
1624	19	SID	231	2315	J1939 Tachograph Vehicle Speed Signal is erratic
1624	13	SID	231	2315	J1939 Tachograph Vehicle Speed Signal is missing
1663	7	SID	123	2321	Optimized Idle Safety Loop Faulted
1716	9	SID	231	2615	J1939 ERC1 Message is missing
1845	9	SID	231	2615	J1939 TCFG2 Message is missing
2623	14	PID	91	2322	Pwm Accelerator Pedal GAS1 and GAS2 Signal Missing
2623	8	PID	91	2322	Pwm Accelerator Pedal Signal 2 Frequency Out Of Range
2900	9	SID	231	2615	J1939 ETC7 Message is missing
3510	3	SID	211	2333	Accelerator Pedal Supply Voltage Circuit Failed High
3510	4	SID	211	2333	Accelerator Pedal Supply Voltage Circuit Failed Low
3510	4	SID	211	2333	Pwm Accelerator Pedal Supply Voltage Missing
3510	3	SID	211	2333	Accelerator Pedal Supply Voltage Circuit Failed High
3606	9	SID	231	2615	J1939 ESS Message is missing
3695	2	SID	155	2334	Manual DPF Regen and DPF Inhibit Switch Rationality Fault
3695	19	SID	155	2334	DPF Regen Inhibit MUX Switch Message Contains Data Error Indicator
3695	13	SID	155	2334	DPF Regen Inhibit MUX Switch Message Contains SNV Indicator
3695	9	SID	155	2334	DPF Regen Inhibit MUX Switch Message Stopped Arriving

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SPN	FMI	PID/SID	PID/SID ID	FLASH CODES	FAULT DESCRIPTION
3695	14	SID	155	2334	DPF Regen Inhibit MUX Switch Message Not Received this Ign Cycle
3696	19	SID	155	2335	DPF Regen Force MUX Switch Message Contains Data Error Indicator
3696	13	SID	155	2335	DPF Regen Force MUX Switch Message Contains SNV Indicator
3696	9	SID	155	2335	DPF Regen Force MUX Switch Message Stopped Arriving
3696	14	SID	155	2335	DPF Regen Force MUX Switch Message Not Received this Ign Cycle

### 2.11 DDEC VI MCM DIAGNOSTIC CODES LIST

SPN	FMI	PID/SID	PID/SID ID	FLASH CODE	FAULT DESCRIPTION
27	4	PID	27	1111	EGR Valve Position Circuit Failed Low
27	3	PID	27	1111	EGR Valve Position Circuit Failed High
27	2	PID	27	1111	EGR Valve Position Feedback Failed
27	0	PID	27	1111	EGR Valve Position Feedback Failed (High Box)
27	1	PID	27	1111	EGR Valve Position Feedback Failed (Low Box)
27	14	PID	27	1111	EGR Valve Position Positive Torque Error
27	7	PID	27	1111	EGR Valve Stuck Open
27	19	PID	27	1521	Smart Actuator Indicates EGR Position Error
51	4	SID	51	1112	Intake Air Throttle Circuit Failed Low
51	3	SID	51	1112	Intake Air Throttle Circuit Failed High
51	2	PID	51	1112	Intake Throttle Position Deviation Error
51	0	PID	51	1112	Intake Air Throttle Position High
51	1	PID	51	1112	Intake Air Throttle Position Low
51	7	PID	51	1112	Intake Throttle Auto Calibration Error
94	4	PID	94	1112	Fuel Compensation Pressure Sensor Circuit Failed Low
94	3	PID	94	1112	Fuel Compensation Pressure Sensor Circuit Failed High
94	1	PID	94	1112	Fuel Pressure Too High/Too Low
97	4	PID	97	1615	Water in Fuel Circuit Failed Low
97	3	PID	97	1615	Water in Fuel Circuit Failed High
98	1	PID	98	1114	Oil Level Circuit Failed Low
98	0	PID	98	1114	Oil Level Circuit Failed High
98	13	PID	98	1634	Oil Level Measurement, Configuration Error
98	14	PID	98	1634	Oil Level Measurement, Oil Level Too Low or Too High
100	4	PID	100	1114	Engine Oil Pressure Circuit Failed Low
100	3	PID	100	1114	Engine Oil Pressure Circuit Failed High
100	1	PID	100	1114	Engine Oil Pressure Low
100	2	PID	100	1114	Oil Pressure Plausibility - Engine Running
100	2	PID	100	1114	Oil Pressure Plausibility - Stop
103	2	PID	103	1115	Turbocharger Speed Not Plausible
103	1	PID	103	1115	Turbo Charger Speed Below Threshold (High Box)
103	0	PID	103	1115	Turbo Charger Speed Above Threshold (Low Box)
103	4	PID	103	1115	Turbo Charger Speed Sensor Circuit Failed Low
103	3	PID	103	1115	Turbo Charger Speed Sensor Circuit Failed High
108	4	PID	108	1211	Barometric Pressure Circuit Failed Low
108	3	PID	108	1211	Barometric Pressure Circuit Failed High
108	2	PID	108	1211	Ambient Pressure Plausibility Fault (Low Box)
108	20	PID	108	1211	Ambient Pressure Plausibility Fault (High Box)



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SPN	FMI	PID/SID	PID/SID ID	FLASH CODE	FAULT DESCRIPTION
110	4	PID	110	1212	Engine Coolant Outlet Temperature Circuit Failed Low
110	3	PID	110	1212	Engine Coolant Outlet Temperature Circuit Failed High
110	0	PID	110	1212	Coolant Temperature High
110	14	PID	110	1212	Coolant Temperature / Engine Oil Temperature Plausibility Fault
110	2	PID	110	1212	Engine Coolant Sensor (OUT), General Temp. Plausibility Error
132	7	PID	132	1213	Intake Air Throttle Valve Closure Detection- Positive Torque
132	14	PID	132	1213	Intake Air Throttle Valve Closure Detection -Braking Condition
132	14	PID	322	1635	HC-Doser Fuel Pressure Not Plausible
132	1	PID	322	1213	Air Mass Flow Too Low
132	13	PID	132	1213	Air Mass Auto Calibration Failed
158	2	PID	43	1214	Ignition Switch Not Plausible
164	4	PID	164	1215	Rail Pressure Governor Sensor Circuit Failed Low
164	3	PID	164	1215	Rail Pressure Governor Sensor Circuit Failed High
164	0	PID	164	1215	Rail Pressure Governor (High Side) Error
164	0	PID	164	1215	Rail Pressure Governor (Low Side) Error
168	1	PID	168	1221	Battery Voltage Low
168	0	PID	168	1221	Battery Voltage High
171	4	PID	171	1222	Ambient Temperature Circuit Failed Low
171	3	PID	171	1222	Ambient Temperature Circuit Failed High
174	4	PID	174	1223	Fuel Temperature Circuit Failed Low
174	3	PID	174	1223	Fuel Temperature Circuit Failed High
174	2	PID	174	1223	Fuel Temperature Sensor, General Temp. Plausibility
174	0	PID	174	1223	Fuel Temperature Too High
175	4	PID	175	1224	Engine Oil Temperature Circuit Failed Low
175	3	PID	175	1224	Engine Oil Temperature Circuit Failed High
175	14	PID	175	1224	Engine Oil Temperature Sensor Plausibility Fault
175	2	PID	175	1224	Engine Oil Temperature Sensor, General Temp. Plausibility
190	2	PID	190	1225	Engine Speed High
354	4	PID	354	1231	Relative Humidity Circuit Failed Low
354	3	PID	354	1231	Relative Humidity Circuit Failed High
411	4	PID	411	1232	EGR Delta Pressure Sensor Circuit Low
411	3	PID	411	1232	EGR Delta Pressure Sensor Circuit High
411	0	PID	411	1232	EGR Differential Pressure Failed (High Box)
411	1	PID	411	1232	EGR Differential Pressure Failed (Low Box)
411	5	PID	411	1232	EGR Sampling Range Failed
411	13	PID	411	1232	EGR Delta Pressure Sensor Out Of Calibration
411	13	PID	411	1232	EGR Delta Pressure Sensor Out Of Calibration
412	3	PID	412	1233	EGR Temperature Sensor Circuit Failed High
412	4	PID	412	1233	EGR Temperature Sensor Circuit Failed Low
412	20	PID	412	1233	EGR Temperature Drift (High Box)
412	21	PID	412	1233	EGR Temperature Drift (Low Box)
412	2	PID	412	1233	EGR Temperature Sensor, General Temp. Plausibility Error
412	0	PID	412	1512	EGR Temperature Very High
412	16	PID	412	1233	EGR Temperature Sensor / Temperature Too High
615	4	SID	155	1615	Reserved Monitoring Unit For Temperature Diagnostics, Circuit Failed Low MU_ISP_T_TBD4_SRL
615	3	SID	155	1615	Reserved Monitoring Unit For Temperature Diagnostics, Circuit Failed High MU_ISP_T_TBD4_SRH
615	4	SID	155	1615	Reserved Monitoring Unit For Temperature Diagnostics, Circuit Failed Low MU_ISP_T_TBD1_SRL
615	3	SID	155	1615	Reserved Monitoring Unit For Temperature Diagnostics, Circuit Failed High MU_ISP_T_TBD1_SRH
615	4	SID	155	1615	Reserved Monitoring Unit For Temperature Diagnostics, Circuit Failed Low MU_ISP_T_TBD2_SRL

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SPN	FMI	PID/SID	PID/SID ID	FLASH CODE	FAULT DESCRIPTION
615	3	SID	155	1615	Reserved Monitoring Unit For Temperature Diagnostics, Circuit Failed High MU_ISP_T_TBD2_SRH
615	4	SID	155	1615	Reserved Monitoring Unit For Temperature Diagnostics, Circuit Failed Low MU_ISP_T_TBD3_SRL
615	3	SID	155	1615	Reserved Monitoring Unit For Temperature Diagnostics, Circuit Failed High MU_ISP_T_TBD3_SRH
615	4	SID	155	1615	Catalyst Temperature Sensor Circuit High Input (Bank 1 Sensor 1)
615	3	SID	155	1615	Catalyst Temperature Sensor Circuit Low Input (Bank 1 Sensor 1)
615	4	SID	155	1615	Catalyst Temperature Sensor Circuit High (Bank 1 Sensor 2)
615	3	SID	155	1615	Catalyst Temperature Sensor Circuit Low (Bank 1 Sensor 2)
615	4	SID	51	1322	Water Pump 1 Circuit Failed Low
615	3	SID	51	1322	Water Pump 1 Circuit Failed High
615	5	SID	51	1322	Water Pump 1 Circuit Failed Open
615	4	SID	55	1331	Turbo Compound Valve Circuit Failed Low
615	3	SID	55	1331	Turbo Compound Valve Circuit Failed High
615	5	SID	55	1331	Turbo Compound Valve Circuit Failed Open
615	4	SID	259	1335	Turbo Brake Sleeve Circuit Failed Low
615	3	SID	259	1335	Turbo Brake Sleeve Circuit Failed High
615	5	SID	259	1335	Turbo Brake Sleeve Circuit Failed Open
615	4	SID	261	1355	Function 20 Circuit Failed Low
615	3	SID	261	1355	Function 20 Circuit Failed High
615	5	SID	261	1355	Function 20 Circuit Failed Open
615	3	SID	155	1451	Service Push Button Circuit Failed High
615	14	SID	155	1615	Turbocharger/Supercharger Boost System Performance
615	14	SID	155	1615	Starter Electronic Fault / ECU internal (Res)
615	14	SID	155	1615	Starter Jammed (Tooth to Tooth Jam)
615	14	SID	155	1615	Rail Pressure Governor, Valve Stays Open
615	14	SID	155	1615	MU_RPG_INT_MON_SRH, I Term Value Too High
615	14	SID	155	1615	Rail Pressure Governor, Leakage in High Pressure Too High
615	14	SID	155	1615	Rail Pressure Governor Sensor, Signal Drift
615	14	SID	155	1615	Rail Pressure Governor Sensor, Sensor Supply Line Broken
615	4	SID	155	1615	Compressor Differential Pressure Outlet Failed Low
615	3	SID	155	1615	Compressor Differential Pressure Outlet Failed High
615	14	SID	155	1615	Doser Metering and Safety Unit Valve Seals Check
615	14	SID	155	1615	High Pressure Pump, Leakage or TDC Position Wrong
615	4	SID	155	1615	Flap In Front of EGR Cooler Circuit Failed Low
615	3	SID	155	1615	Flap In Front of EGR Cooler Circuit Failed High
615	5	SID	155	1615	Flap In Front of EGR Cooler Circuit Failed Open
615	4	SID	155	1615	Water Pump 2 Circuit Failed Low
615	3	SID	155	1615	Water Pump 2 Circuit Failed High
615	5	SID	156	1615	Water Pump 2 Circuit Failed Open
615	4	SID	157	1615	RCP Test Function 1 Circuit Failed Low
615	3	SID	158	1615	RCP Test Function 1 Circuit Failed High
615	5	SID	159	1615	RCP Test Function 1 Circuit Failed Open
615	4	SID	160	1615	RCP Test Function 2 Circuit Failed Low
615	3	SID	161	1615	RCP Test Function 2 Circuit Failed High
615	5	SID	162	1615	RCP Test Function 2 Circuit Failed Open
615	4	SID	163	1615	Volute Control Valve, Shorted to Ground
615	3	SID	164	1615	Volute Control Valve, Shorted to Battery
615	5	SID	165	1615	Volute Control Valve, Open Load
615	4	SID	166	1615	Volute Shut Off Valve, Shorted to Ground

SPN	FMI	PID/SID	PID/SID ID	FLASH CODE	FAULT DESCRIPTION
615	3	SID	167	1615	Volute Shut Off Valve, Shorted to Battery
615	5	SID	168	1615	Volute Shut Off Valve, Open Load
615	4	SID	169	1615	Function 30 Circuit Failed Low
615	3	SID	170	1615	Function 30 Circuit Failed High
615	5	SID	171	1615	Function 30 Circuit Failed Open
615	4	SID	172	1615	Function 31 Circuit Failed Low
615	3	SID	173	1615	Function 31 Circuit Failed High
615	5	SID	174	1615	Function 31 Circuit Failed Open
615	14	SID	155	1453	Smart Remote Actuator 2, No Failsafe Mode, Motor Off
615	9	SID	155	1453	Smart Remote Actuator 2, Failsafe Mode, Motor Off
615	16	SID	155	1453	Smart Remote Actuator 2, Temperature Fault
615	7	SID	155	1453	Smart Remote Actuator 2, Failsafe Mode, Motor On
615	11	SID	155	1453	Smart Remote Actuator 2, Restricted Operability
615	15	SID	155	1453	Smart Remote Actuator 2, Temperature Warning
615	8	SID	155	1453	Smart Remote Actuator 2, Internal Test Running
615	31	SID	155	1453	Smart Remote Actuator 2, Unknown Error Code
615	13	SID	155	1454	Turbocharger Compressor Outlet Differential Pressure Sensor Out Of Calibration
615	13	SID	155	1454	Turbocharger Compressor Outlet Differential Pressure Sensor Out Of Calibration
615	19	SID	155	1637	Smart Actuator Indicates Actuator Position Error
625	2	SID	248	1234	Invalid Data on Engine CAN Link
625	9	SID	248	1234	No Data Received from Engine CAN Link
625	9	SID	248	1234	Engine CAN Low Wire Defect - (wire 1)
625	9	SID	248	1234	Engine CAN High Wire Defect - (wire 2)
630	12	SID	253	1452	EEPROM Read / Write Operation Failed
630	13	SID	253	1455	Calibration Data Not Plausible
630	13	SID	253	1455	Calibration Data Not Plausible (CPLD)
634	4	SID	40	1321	Constant Throttle Valve Circuit Failed Low
634	3	SID	40	1321	Constant Throttle Valve Circuit Failed High
634	5	SID	40	1321	Constant Throttle Valve Circuit Failed Open
636	1	SID	21	1235	Crankshaft Position Sensor Signal Voltage Too Low
636	3	SID	21	1235	Crankshaft Position Sensor Open Circuit
636	4	SID	21	1235	Crankshaft Position Sensor Short to Ground
636	8	SID	21	1235	Crankshaft Position Sensor Time Out
636	14	SID	21	1235	Crankshaft Position Sensor Pins Swapped
636	2	SID	21	1235	No Match of Camshaft and Crankshaft Signals
641	4	SID	27	1542	Turbo Control Circuit Failed Low
641	3	SID	27	1542	Turbo Control Circuit Failed High
641	5	SID	27	1542	Turbo Control Circuit Open
641	14	SID	147	1241	Smart Remote Actuator 5 (VGT), No Failsafe Mode, Motor Off
641	9	SID	147	1241	Smart Remote Actuator 5 (VGT), Failsafe Mode, Motor Off
641	7	SID	147	1241	Smart Remote Actuator 5 (VGT), Failsafe Mode, Motor On
641	11	SID	147	1241	Smart Remote Actuator 5 (VGT), Restricted Operability
641	8	SID	147	1241	Smart Remote Actuator 5 (VGT), Internal Test Running
641	31	SID	147	1241	Smart Remote Actuator 5 (VGT), Unknown Error Code
647	4	SID	33	1334	Fan Stage 1 Circuit Failed Low
647	3	SID	33	1334	Fan Stage 1 Circuit Failed High

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SPN	FMI	PID/SID	PID/SID ID	FLASH CODE	FAULT DESCRIPTION
647	5	SID	33	1334	Fan Stage 1 Circuit Failed Open
651	14	SID	1	1242	Injector Cylinder #1 Needle Control Valve Abnormal Operation
651	10	SID	1	1242	Injector Cylinder #1 Needle Control Valve Abnormal Rate of Change
651	5	SID	1	1242	Injector Cylinder 1, Nozzle Control Valve or Spill Control Valve, Jammed Closed
651	7	SID	1	1242	Injector Cylinder 1, Nozzle Control Valve or Spill Control Valve, Jammed Open or Leakage
651	6	SID	1	1242	Injector Cylinder #1 Needle Control Valve, Valve Shorted Circuit
651	31	SID	1	1242	Engine Smoothness Control / Cylinder #1 Value Out of Range
652	14	SID	2	1243	Injector Cylinder #2 Needle Control Valve Abnormal Operation
652	10	SID	2	1243	Injector Cylinder #2 Needle Control Valve Abnormal Rate of Change
652	5	SID	2	1243	Injector Cylinder 2, Nozzle Control Valve or Spill Control Valve, Jammed Closed
652	7	SID	2	1243	Injector Cylinder 2, Nozzle Control Valve or Spill Control Valve, Jammed Open or Leakage
652	6	SID	2	1243	Injector Cylinder #2 Needle Control Valve, Valve Shorted Circuit
652	31	SID	2	1243	Engine Smoothness Control / Cylinder #2 Value Out of Range
653	14	SID	3	1244	Injector Cylinder #3 Needle Control Valve Abnormal Operation
653	10	SID	3	1244	Injector Cylinder #3 Needle Control Valve Abnormal Rate of Change
653	5	SID	3	1244	Injector Cylinder 3, Nozzle Control Valve or Spill Control Valve, Jammed Closed
653	7	SID	3	1244	Injector Cylinder 3, Nozzle Control Valve or Spill Control Valve, Jammed Open or Leakage
653	6	SID	3	1244	Injector Cylinder #3 Needle Control Valve, Valve Shorted Circuit
653	31	SID	3	1244	Engine Smoothness Control / Cylinder #3 Value Out of Range
654	14	SID	4	1245	Injector Cylinder #4 Needle Control Valve Abnormal Operation
654	10	SID	4	1245	Injector Cylinder #4 Needle Control Valve Abnormal Rate of Change
654	5	SID	4	1245	Injector Cylinder 4, Nozzle Control Valve or Spill Control Valve, Jammed Closed
654	7	SID	4	1245	Injector Cylinder 4, Nozzle Control Valve or Spill Control Valve, Jammed Open or Leakage
654	6	SID	4	1245	Injector Cylinder #4 Needle Control Valve, Valve Shorted Circuit
654	31	SID	4	1245	Engine Smoothness Control / Cylinder #4 Value Out of Range
655	14	SID	5	1251	Injector Cylinder #5 Needle Control Valve Abnormal Operation
655	10	SID	5	1251	Injector Cylinder #5 Needle Control Valve Abnormal Rate of Change
655	5	SID	5	1251	Injector Cylinder 5, Nozzle Control Valve or Spill Control Valve, Jammed Closed
655	7	SID	5	1251	Injector Cylinder 5, Nozzle Control Valve or Spill Control Valve, Jammed Open or Leakage
655	6	SID	5	1251	Injector Cylinder #5 Needle Control Valve, Valve Shorted Circuit
655	31	SID	5	1251	Engine Smoothness Control / Cylinder #5 Value Out of Range
656	14	SID	6	1252	Injector Cylinder #6 Needle Control Valve Abnormal Operation
656	10	SID	6	1252	Injector Cylinder #6 Needle Control Valve Abnormal Rate of Change
656	5	SID	6	1252	Injector Cylinder 6, Nozzle Control Valve or Spill Control Valve, Jammed Closed
656	7	SID	6	1252	Injector Cylinder 6, Nozzle Control Valve or Spill Control Valve, Jammed Open or Leakage
656	6	SID	6	1252	Injector Cylinder #6 Needle Control Valve, Valve Shorted Circuit
656	31	SID	6	1252	Engine Smoothness Control / Cylinder #6 Value Out of Range
657	14	SID	7	1253	Injector Cylinder #7 Needle Control Valve Abnormal Operation

SPN	FMI	PID/SID	PID/SID ID	FLASH CODE	FAULT DESCRIPTION
657	10	SID	7	1253	Injector Cylinder #7 Needle Control Valve Abnormal Rate of Change
657	6	SID	7	1253	Injector Cylinder #7 Needle Control Valve, Valve Shorted Circuit
657	31	SID	7	1253	Engine Smoothness Control / Cylinder #7 Value Out of Range
658	14	SID	8	1254	Injector Cylinder #8 Needle Control Valve Abnormal Operation
658	10	SID	8	1254	Injector Cylinder #8 Needle Control Valve Abnormal Rate of Change
658	6	SID	8	1254	Injector Cylinder #8 Needle Control Valve, Valve Shorted Circuit
658	31	SID	8	1254	Engine Smoothness Control / Cylinder #8 Value Out of Range
677	2	SID	39	1255	Starter Switch Inconsistent
677	5	SID	39	1255	Engine Starter Relay Circuit Failed Low
677	4	SID	39	1255	Engine Starter Relay Open Circuit
677	14	SID	39	1255	Starter Electronic Fault / ECU internal (Main)
677	7	SID	39	1255	Engine Starter Relay - Starter Does Not Engage
677	3	SID	39	1255	Engine Starter Relay Shorted to High Source
677	7	SID	39	1255	Engine Starter Relay Jammed
698	4	SID	58	1312	Gridheater Circuit Failed Low
698	3	SID	58	1312	Gridheater Circuit Failed High
698	5	SID	58	1312	Gridheater Circuit Failed Open
715	4	SID	263	1412	High Side Digital Output # 1 Circuit Failed Low
715	3	SID	263	1412	High Side Digital Output # 1 Circuit Failed High
715	5	SID	263	1412	High Side Digital Output # 2 Circuit Failed Open
716	4	SID	264	1413	High Side Digital Output # 2 Circuit Failed Low
723	1	SID	64	1415	Camshaft Position Sensor Signal Voltage Too Low
723	3	SID	64	1415	Camshaft Position Sensor Open Circuit
723	4	SID	64	1415	Camshaft Position Sensor Short to Ground
723	8	SID	64	1415	Camshaft Position Sensor Time Out
723	14	SID	64	1415	Camshaft Position Sensor Pins Swapped
729	4	PID	45	1421	Grid Heater Circuit Failed Low
729	14	PID	45	1421	Grid Heater Special Instructions
729	3	PID	45	1421	Grid Heater Circuit Failed High
729	7	PID	45	1421	Grid Heater Defect
729	0	PID	45	1421	Grid Heater Permanently On
1071	4	SID	60	1314	Fan Stage 2 Circuit Failed Low
1071	3	SID	60	1314	Fan Stage 2 Circuit Failed High
1071	5	SID	60	1314	Fan Stage 2 Circuit Failed Open
1072	4	SID	79	1422	Jake Brake Stage 1 Circuit Failed Low
1072	3	SID	79	1422	Jake Brake Stage 1 Circuit Failed High
1072	5	SID	79	1422	Jake Brake Stage 1 Circuit Failed Open
1073	4	SID	80	1315	Jake Brake Stage 2 Circuit Failed Low
1073	3	SID	80	1315	Jake Brake Stage 2 Circuit Failed High
1073	5	SID	80	1315	Jake Brake Stage 2 Circuit Failed Open
1074	4	SID	81	1345	Exhaust Brake Circuit Failed Low
1074	3	SID	81	1345	Exhaust Brake Circuit Failed High
1074	5	SID	81	1345	Exhaust Brake Circuit Failed Open
1077	14	PID	164	1241	Rail Pressure Governor Error, Open Loop Error
1077	5	PID	164	1423	Rail Pressure Governor Error, Current Governor, Current Too Low
1077	7	PID	164	1423	Rail Pressure Governor Error, Pressure Governor, Pressure Not Plausible
1077	6	SID	155	1423	Rail Pressure Governor Error, Current Too High
1127	4	SID	273	1424	Turbocharger Compressor Outlet Pressure Circuit Failed Low
1127	3	SID	273	1424	Turbocharger Compressor Outlet Pressure Circuit Failed High
1172	4	PID	351	1425	Turbocharger Compressor Inlet Temperature Circuit Failed Low

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SPN	FMI	PID/SID	PID/SID ID	FLASH CODE	FAULT DESCRIPTION
1172	3	PID	351	1425	Turbocharger Compressor Inlet Temperature Circuit Failed High
1172	2	PID	351	1425	Coolant Temp/Compressor Inlet Temp Plausibility Error
1172	2	PID	351	1425	Turbocharger Compressor Inlet Temp. Sensor, General Temp. Plausibility Error
1176	4	SID	314	1431	Turbocharger Compressor Inlet Pressure Circuit Failed Low
1176	3	SID	314	1431	Turbocharger Compressor Inlet Pressure Circuit Failed High
1176	2	PID	314	1431	Compressor Pressure Plausibility Fault (High Box)
1176	5	PID	314	1431	Compressor Inlet Pressure Plausibility Fault (Delta)
1176	20	SID	314	1431	Compressor Inlet Pressure Plausibility Error, Pressure Too High (High Box)
1188	4	SID	32	1325	Waste Gate Circuit Failed Low
1188	3	SID	32	1325	Waste Gate Circuit Failed High
1188	5	SID	32	1325	Waste Gate Circuit Failed Open
1188	14	SID	32	1432	Smart Remote Actuator 1 (Wastegate), No Failsafe Mode, Motor Off
1188	9	SID	32	1432	Smart Remote Actuator 1 (Wastegate), Failsafe Mode, Motor Off
1188	16	SID	32	1432	Smart Remote Actuator 1 (Wastegate), Temperature Fault
1188	7	SID	32	1432	Smart Remote Actuator 1 (Wastegate), Failsafe Mode, Motor On
1188	11	SID	32	1432	Smart Remote Actuator 1 (Wastegate), Restricted Operability
1188	15	SID	32	1432	Smart Remote Actuator 1 (Wastegate), Temperature Warning
1188	8	SID	32	1432	Smart Remote Actuator 1 (Wastegate), Internal Test Running
1188	31	SID	32	1432	Smart Remote Actuator 1 (Wastegate), Unknown Error Code
1188	19	SID	32	1432	Smart Actuator Indicates Turbocharger Wastegate Position Error
1213	4	SID	257	1333	MIL Lamp Circuit Failed Low
1213	3	SID	257	1333	MIL Lamp Circuit Failed High
1213	5	SID	257	1333	MIL Lamp Circuit Failed Open
1323	31	SID	155	1433	Cylinder 1 Misfire detected
1323	14	SID	156	1434	Misfire Detected
1324	31	SID	155	1435	Cylinder 2 Misfire detected
1325	31	SID	155	1441	Cylinder 3 Misfire detected
1326	31	SID	155	1442	Cylinder 4 Misfire detected
1327	31	SID	155	1443	Cylinder 5 Misfire detected
1328	31	SID	155	1444	Cylinder 6 Misfire Detected
1329	31	SID	155	1445	Cylinder 7 Misfire Detected
1330	31	SID	155	1446	Cylinder 8 Misfire Detected
1351	4	SID	155	1615	Switchable Air Compressor Circuit Failed Low
1351	3	SID	155	1615	Switchable Air Compressor Circuit Failed High
1351	5	SID	155	1615	Switchable Air Compressor Circuit Failed Open
1636	4	PID	105	1511	Intake Manifold Temperature Circuit Failed Low
1636	3	PID	105	1511	Intake Manifold Temperature Circuit Failed High
1636	2	PID	105	1511	Intake Manifold Temperature Plausibility Error
1636	21	PID	105	1511	Difference Intake Manifold Temperature and EGR Temp. Less Than Threshold (Low Box)
1636	2	PID	105	1511	Difference Intake Manifold and I Cooler Temperature Out Less Than Threshold (Low Box)
1636	2	PID	105	1511	Difference Intake Manifold and I Cooler Temperature Out Less Than Threshold (High Box)
1636	20	PID	105	1511	Intake Manifold Temperature Drift (Low Box)
1636	21	PID	105	1511	Intake Manifold Temperature Drift (High Box)
2629	4	PID	404	1513	Turbocharger Compressor Outlet Temperature Circuit Failed Low
2629	3	PID	404	1513	Turbocharger Compressor Outlet Temperature Circuit Failed High
2629	20	PID	404	1513	Turbocharger Out Temperature, Temperature Too High (Low Box)

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SPN	FMI	PID/SID	PID/SID ID	FLASH CODE	FAULT DESCRIPTION
2629	21	PID	404	1513	Turbocharger Out Temperature, Temperature Too Low (High Box)
2629	2	PID	404	1513	Turbocharger Compressor Outlet Temp. Sensor, General Temp. Plausibility Error
2630	4	SID	272	1514	Charge Air Cooler Outlet Temperature Circuit Failed Low
2630	3	SID	272	1514	Charge Air Cooler Outlet Temperature Circuit Failed High
2630	2	SID	272	1514	Charge Air Cooler Outlet Temperature Sensor Plausibility Error
2630	20	SID	272	1514	Charge Air Outlet Temperature Drift (Low box)
2630	21	SID	272	1514	Charge Air Outlet Temperature Drift (High box)
2631	4	SID	273	1515	Charge Air Cooler Outlet Pressure Circuit Failed Low
2631	3	SID	273	1515	Charge Air Cooler Outlet Pressure Circuit Failed High
2659	1	SID	277	1515	EGR Flow Target Error Diagnostic - Low Flow
2659	0	SID	277	1515	EGR Flow Target Error Diagnostic - High Flow
2791	4	PID	146	1521	EGR Valve Circuit Failed Low
2791	3	PID	146	1521	EGR Valve Circuit Failed High
2791	5	PID	146	1521	EGR Valve Circuit Failed Open
2791	7	SID	146	1521	EGR Valve Position Incorrect
2791	14	SID	146	1521	Smart Remote Actuator 3 (EGR), No Failsafe Mode, Motor Off
2791	9	SID	146	1521	Smart Remote Actuator 3 (EGR), Failsafe Mode, Motor Off
2791	16	SID	146	1521	Smart Remote Actuator 3 (EGR), Temperature Fault
2791	7	SID	146	1521	Smart Remote Actuator 3 (EGR), Failsafe Mode, Motor On
2791	11	SID	146	1521	Smart Remote Actuator 3 (EGR), Restricted Operability
2791	15	SID	146	1521	Smart Remote Actuator 3 (EGR), Temperature Warning
2791	8	SID	146	1521	Smart Remote Actuator 3 (EGR), Internal Test Running
2791	31	SID	146	1521	Smart Remote Actuator 3 (EGR), Unknown Error Code
2795	9	SID	269	1241	CAN3 Communication Error
2795	4	SID	269	1522	Position Waste Gate (VNT) Failed Low
2795	3	SID	269	1522	Position Waste Gate (VNT) Failed High
2795	2	SID	269	1522	VNT Valve Position Feedback Failed
2795	0	SID	269	1522	VNT Valve Position Feedback, Position Too Low (High Box)
2795	1	SID	269	1522	VNT Valve Position Feedback, Position Too High (Low Box)
2795	19	SID	147	1522	Smart Actuator Indicates Turbocharger Vane Position Error
2797	4	SID	317	1523	Injector Needle Control Valve Cylinder 1, 2, 3 Shorted to Ground
2797	4	SID	317	1524	Injector Needle Control Valve Cylinder 4, 5, 6 Shorted to Ground
2797	4	SID	317	1615	Injector Needle Control Valve Bank 3, Shorted to Ground
2797	3	SID	317	1523	Injector Needle Control Valve Cylinder 1,2,3 Shorted to Battery
2797	3	SID	317	1524	Injector Needle Control Valve Cylinder 4,5,6, Shorted to Battery
2797	3	SID	317	1615	Injector Needle Control Valve Bank 3, Shorted to Battery
2798	4	SID	317	1615	Injector Spill Control Valve Cylinder 1, 2, 3 Shorted to Ground
2798	4	SID	317	1615	Injector Spill Control Valve Cylinder 4, 5, 6 Shorted to Ground
2798	4	SID	317	1615	Injector Spill Control Valve ("Amplifier") Bank 6, Shorted to Ground
2798	3	SID	317	1615	Injector Spill Control Valve Cylinder 1,2,3, Shorted to Battery
2798	3	SID	317	1615	Injector Spill Control Valve Cylinder 4,5,6, Shorted to Battery
2798	3	SID	317	1615	Injector Spill Control Valve ("Amplifier") Bank 6, Shorted to Battery
2988	4	SID	262	1411	EGR Water Cooling Regulator Circuit Failed Low
988	3	SID	262	1411	EGR Water Cooling Regulator Circuit Failed High
2988	5	SID	262	1411	EGR Water Cooling Regulator Circuit Failed Open

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SPN	FMI	PID/SID	PID/SID ID	FLASH CODE	FAULT DESCRIPTION
3050	0	SID	155	1525	Engine Air Flow Out of Range Low
3050	1	SID	324	1525	Active Regen Temp Out of Range Low
3058	13	PID	146	1615	EGR System Parametrization Failure
3064	13	SID	155	1615	DPF System Parametrization Failure
3242	4	PID	318	1531	DOC Inlet Temperature Circuit Failed Low
3242	3	PID	318	1531	DOC Inlet Temperature Circuit Failed High
3242	10	SID	318	1531	DOC Inlet Temperature Sensor Stuck
3242	2	SID	318	1531	DOC Inlet Temperature Sensor - Plausibility Error
3246	4	SID	320	1532	DPF Outlet Temperature Circuit Failed Low
3246	3	SID	320	1532	DPF Outlet Temperature Circuit Failed High
3246	14	SID	320	1532	Abnormal DPF Temperature Rise b)
3246	0	SID	320	1532	DPF Outlet Temperature High
3246	10	SID	320	1532	DPF Outlet Temperature Sensor Stuck
3246	2	SID	320	1532	DPF Outlet Sensor, General Temp. Plausibility
3246	31	SID	323	1532	Abnormal DPF Temperature Rise
3250	4	PID	322	1533	DOC Outlet Temperature Circuit Failed Low
3250	3	PID	322	1533	DOC Outlet Temperature Circuit Failed High
3250	14	PID	322	1533	Abnormal DOC Temperature Rise
3250	10	SID	322	1533	DOC Outlet Temperature Sensor Stuck
3250	2	SID	322	1533	DOC Outlet Temperature Sensor - Plausibility Error
3250	31	PID	322	1533	Abnormal DOC Temperature Rise
3250	0	PID	322	1533	DOC Outlet Temperature High
3251	0	SID	324	1534	DPF Pressure - Out of Range Very High
3251	1	SID	324	1534	DPF Pressure - Out of Range Low
3251	9	SID	324	1534	Abnormal Soot Rate
3251	16	SID	324	1534	DPF Pressure - Out of Range High
3358	4	SID	155	1535	EGR Pressure Failed Low
3358	3	SID	155	1535	EGR Pressure Failed High
3464	4	SID	59	1313	Intake Throttle Valve Circuit Failed Low
3464	3	SID	59	1313	Intake Throttle Valve Circuit Failed High
3464	5	SID	59	1313	Intake Throttle Valve Circuit Failed Open
3464	14	SID	59	1615	Intake Air Throttle Control Electrical Fault
3464	2	PID	51	1541	Intake Throttle Valve, Spring Response Time Not Plausible
3464	7	PID	51	1541	Intake Throttle Valve, Stuck
3464	14	PID	51	1541	Intake Throttle Valve, Integrated Absolute Error Plausibility
3464	8	PID	51	1541	Intake Throttle Valve, Current Deviation Too High
3470	4	SID	57	1311	Actuator Turbo Compound Bypass Circuit Failed Low
3470	3	SID	57	1311	Actuator Turbo Compound Bypass Circuit Failed High
3470	5	SID	57	1311	Actuator Turbo Compound Bypass Circuit Failed Open
3471	4	SID	334	1323	HC Doser Circuit Failed Low
3471	3	SID	334	1323	HC Doser Circuit Failed High
3471	5	SID	334	1323	HC Doser Circuit Failed Open
3471	1	SID	155	1542	EDV Failed Self Test
3480	2	SID	332	1543	Doser Fuel Line Pressure Abnormal
3480	1	SID	332	1543	Doser Fuel Supply Pressure Abnormal
3480	14	SID	332	1543	Doser FLP Sensors Failed Self Test
3482	4	SID	56	1332	Fuel Cut Off Valve Circuit Failed Low
3482	3	SID	56	1332	Fuel Cut Off Valve Circuit Failed High
3482	5	SID	56	1332	Fuel Cut Off Valve Circuit Failed Open
3482	7	SID	155	1544	FCV Failed Self Test
3509	3	SID	212	1631	Multiplexer 1 Channel 1, Shorted High




SPN	FMI	PID/SID	PID/SID ID	FLASH CODE	FAULT DESCRIPTION
3509	3	SID	212	1631	Multiplexer 1 Channel 2, Shorted High
3510	3	SID	211	1632	Multiplexer 2 Channel 1, Shorted High
3510	3	SID	211	1632	Multiplexer 2 Channel 2, Shorted High
3511	3	SID	211	1633	Multiplexer 3 Channel 1, Shorted High
3511	3	SID	211	1633	Multiplexer 3 Channel 2, Shorted High
3556	1	SID	155	1545	Regen Temperature - Out of Range Low
3556	0	SID	155	1551	Regen Temperature - Out of Range High
3563	4	PID	106	1551	Intake Manifold Pressure Circuit Failed Low
3563	3	PID	106	1551	Intake Manifold Pressure Circuit Failed High
3563	20	PID	106	1551	Ambient and Inlet Manifold Pressure Difference (Low Box)
3563	21	PID	106	1551	Ambient and Inlet Manifold Pressure Difference (High Box)
3563	1	PID	106	1551	Inlet Manifold Pressure Failed Low
3563	0	PID	106	1551	Inlet Manifold Pressure Failed High
3563	3	PID	106	1551	Inlet Manifold Pressure Sampling Range Failed
3563	20	PID	106	1551	Intake Manifold Pressure Plausibility (Low Box)
3563	21	PID	106	1551	Intake Manifold Pressure Plausibility Error, Pressure Too Low (High Box)
3588	4	SID	156	1552	Ether Start, Shorted to Ground
3588	3	SID	157	1552	Ether Start, Shorted to Battery
3588	5	SID	158	1552	Ether Start, Open Load
3597	3	SID	155	1553	Proportional Valve Bank 1 Circuit Failed Low
3597	3	SID	155	1615	Proportional Valve Bank 1 Circuit Failed High
3597	6	SID	155	1325	Current Flow on HS1 IM1 Too High
3598	4	SID	155	1615	Proportional Valve Bank 2 Circuit Failed Low
3598	3	SID	155	1615	Proportional Valve Bank 2 Circuit Failed High
3599	4	SID	317	1615	Switching Power Supply Voltage Failed Low
3599	3	SID	317	1615	Switching Power Supply Voltage Failed High
3609	4	PID	370	1554	DPF Inlet Pressure Circuit Failed Low
3609	3	PID	370	1554	DPF Inlet Pressure Circuit Failed High
3609	10	SID	370	1554	DPF Inlet Pressure Sensor Stuck
3609	20	SID	370	1554	DPF Inlet Pressure Sensor Drifted High In Range Fault (Low Box)
3609	2	SID	370	1554	DPF Inlet Pressure Sensor Drifted High In Range Fault (High Box)
3609	21	SID	370	1554	DPF Inlet Pressure Sensor Drifted Low In Range Fault (Low Box)
3609	21	SID	370	1554	DPF Inlet Pressure Sensor Drifted Low In Range Fault (High Box)
3610	3	SID	371	1555	DPF Outlet Pressure Circuit Failed High
3610	4	SID	371	1555	DPF Outlet Pressure Circuit Failed Low
3610	0	SID	371	1334	DPF System Back Pressure Too High
3610	10	SID	371	1555	DPF Outlet Pressure Sensor Stuck
3610	2	SID	371	1555	DPF Pressure Sensors - Plausibility Error
3610	20	SID	371	1555	DPF Outlet Pressure Sensor Drifted High In Range Fault (Low Box)
3610	14	SID	371	1555	DPF Outlet Pressure Sensor Drifted High In Range Fault (High Box)
3610	21	SID	371	1555	DPF Outlet Pressure Sensor Drifted Low In Range Fault (Low Box)
3610	31	SID	371	1555	DPF Outlet Pressure Sensor Drifted Low In Range Fault (High Box)
3659	14	SID	362	1611	Injector Cylinder #1 Spill Control Valve Abnormal Operation
3659	10	SID	362	1611	Injector Cylinder #1 Spill Control Valve ("Amplifier") Abnormal Rate of Change
3659	6	SID	362	1611	Injector Cylinder #1 Spill Control Valve ("Amplifier"), Valve Shorted Circuit
3660	14	SID	363	1612	Injector Cylinder #2 Spill Control Valve Abnormal Operation
3660	10	SID	363	1612	Injector Cylinder #2 Spill Control Valve ("Amplifier") Abnormal Rate of Change
3660	6	SID	363	1612	Injector Cylinder #2 Spill Control Valve ("Amplifier"), Valve Shorted Circuit

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SPN	FMI	PID/SID	PID/SID ID	FLASH CODE	FAULT DESCRIPTION
3661	14	SID	364	1613	Injector Cylinder #3 Spill Control Valve Abnormal Operation
3661	10	SID	364	1613	Injector Cylinder #3 Spill Control Valve ("Amplifier") Abnormal Rate of Change
3661	6	SID	364	1613	Injector Cylinder #3 Spill Control Valve ("Amplifier"), Valve Shorted Circuit
3662	14	SID	365	1614	Injector Cylinder #4 Spill Control Valve Abnormal Operation
3662	10	SID	365	1614	Injector Cylinder #4 Spill Control Valve ("Amplifier") Abnormal Rate of Change
3662	6	SID	365	1614	Injector Cylinder #4 Spill Control Valve ("Amplifier"), Valve Shorted Circuit
3663	14	SID	366	1615	Injector Cylinder #5 Spill Control Valve Abnormal Operation
3663	10	SID	366	1615	Injector Cylinder #5 Spill Control Valve ("Amplifier") Abnormal Rate of Change
3663	6	SID	366	1615	Injector Cylinder #5 Spill Control Valve ("Amplifier"), Valve Shorted Circuit
3664	14	SID	367	1621	Injector Cylinder #6 Spill Control Valve Abnormal Operation
3664	10	SID	367	1621	Injector Cylinder #6 Spill Control Valve ("Amplifier") Abnormal Rate of Change
3664	6	SID	367	1621	Injector Cylinder #6 Spill Control Valve ("Amplifier"), Valve Shorted Circuit
3665	14	SID	368	1622	Injector Cylinder #7 Spill Control Valve Abnormal Operation
3665	10	SID	368	1622	Injector Cylinder #7 Spill Control Valve ("Amplifier") Abnormal Rate of Change
3665	6	SID	368	1622	Injector Cylinder #7 Spill Control Valve ("Amplifier"), Valve Shorted Circuit
3666	14	SID	369	1623	Injector Cylinder #8 Spill Control Valve Abnormal Operation
3666	10	SID	369	1623	Injector Cylinder #8 Spill Control Valve ("Amplifier") Abnormal Rate of Change
3666	6	SID	369	1623	Injector Cylinder #8 Spill Control Valve ("Amplifier"), Valve Shorted Circuit
3719	16	SID	155	1624	Soot Level High
3719	0	SID	155	1624	Soot Level Very High
3719	31	SID	155	1635	DPF Zone 2 Condition
3719	15	SID	155	1636	DPF Zone 3 Condition
3720	15	SID	155	1625	DPF Ash Clean Request
3720	16	SID	155	1625	DPF Ash Clean Request - Derate
4076	4	PID	110	1212	Engine Coolant Inlet Temperature Circuit Failed Low
4076	3	PID	110	1212	Engine Coolant Inlet Temperature Circuit Failed High
4076	2	SID	155	1615	Engine Coolant Sensor (IN), General Temp. Plausibility Error
4077	4	SID	332	1543	Doser Fuel Line Pressure Sensor Circuit Failed Low
4077	3	SID	332	1543	Doser Fuel Line Pressure Sensor Circuit Failed High
4077	14	SID	332	1543	Doser Fuel Line Pressure Failed Self Test
4226	4	SID	155	1615	Compressor Differential Pressure Inlet Failed Low
4226	3	SID	155	1615	Compressor Differential Pressure Inlet Failed High
4226	0	SID	155	1615	Turbocharger Compressor Inlet Differential Pressure Too High (Low Box)
4226	1	SID	155	1615	Turbocharger Compressor Inlet Differential Pressure Too Low (High Box)
4226	5	SID	155	1615	Turbocharger Compressor Inlet Differential Pressure Sampling Range Failure
4226	13	SID	155	1454	Turbocharger Compressor Inlet Differential Pressure Sensor Out Of Calibration
4226	13	SID	155	1454	Turbocharger Compressor Inlet Differential Pressure Sensor Out Of Calibration
4227	4	SID	53	1324	Electrostatic Oil Separator Circuit Failed Low
4227	3	SID	53	1324	Electrostatic Oil Separator Circuit Failed High


SPN	FMI	PID/SID	PID/SID ID	FLASH CODE	FAULT DESCRIPTION
4227	5	SID	53	1324	Electrostatic Oil Separator Circuit Failed Open
4227	4	SID	155	1615	Oil Separator Circuit Failed Low
4227	3	SID	155	1615	Oil Separator Circuit Failed High
4227	7	SID	155	1615	Oil Separator, Max. Duration Time Reached
4228	16	SID	147	1241	Smart Remote Actuator 5 (VGT), Temperature Fault
4228	15	SID	147	1241	Smart Remote Actuator 5 (VGT), Temperature Warning

2.12 ENGINE OIL LEVEL




**MAINTENANCE**

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. 17). 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.

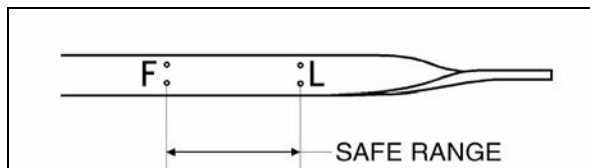



FIGURE 17: ENGINE OIL LEVEL DIPSTICK 01027



**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 is provided with an oil reserve tank with a capacity of 2.2 US gallons (8,3 liters). This reserve tank is connected to the crankcase by a hose with a shutoff valve, allowing oil to be added to crankcase. To adjust oil level, open the oil reserve tank shutoff 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. 18). Comparison of oil levels in sight gauge, before and after adding oil to crankcase, shows approximately how much oil has been added.

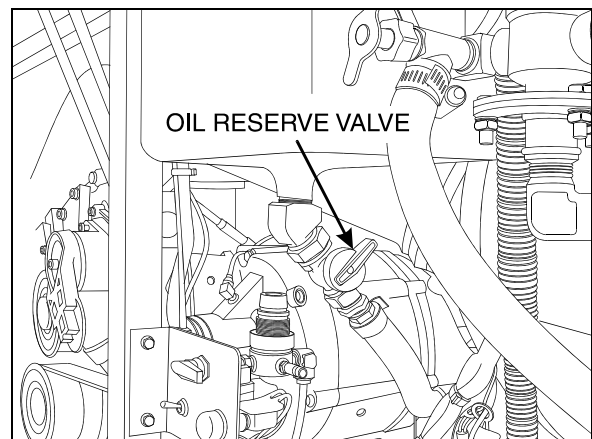




FIGURE 18: OIL RESERVE TANK 01050

2.13 ENGINE OIL AND FILTER CHANGE


 <b>MAINTENANCE</b>
Both the engine oil and filter should be changed according to the following maximum interval (based on an oil analysis program).
<b>Short Haul:</b> 15,000 miles (24,000km) or once a year, whichever comes first.
<b>Long Haul:</b> 30,000 miles (48,000km) or once a year, whichever comes first.
Oil analysis program may be used to determine whether this interval should be shorter, but should not be used to lengthen the interval.
Short haul: 6,000 miles (10,000km) to 60,000 miles (100,000 km) annual.
Long haul: over 60,000 miles (100,000 km) annual.

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).

 <b>CAUTION</b>
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. 19).

 <b>WARNING</b>
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 1/2" 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.
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.

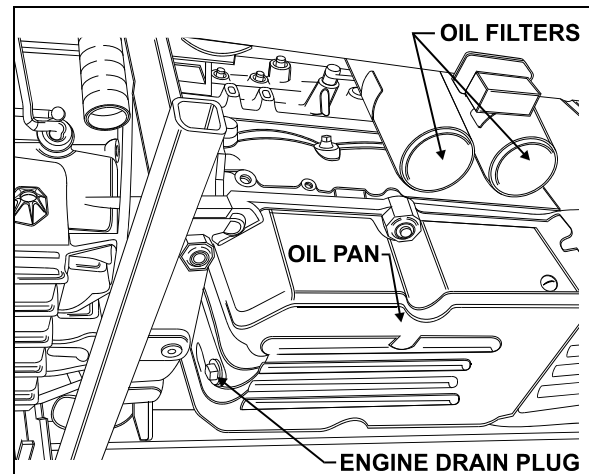



FIGURE 19: UNDER VEHICLE VIEW

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 <b>CAUTION</b>
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. 17).
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.



## MAINTENANCE

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 2007 ON-HIGHWAY SERVICE MANUAL 6SE2007 under heading «*Lubricating Oil for Detroit Diesel Engines*».

### 2.14 RECOMMENDED ENGINE OIL TYPE

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



## CAUTION

Low ash oil formulation designated API CJ-4 is required in EPA-07 engines.

CJ-4 contains less than 1% ash which is the key to achieving maximum diesel particulate filter cleaning intervals. Use of high ash engine oils will reduce the cleaning interval on the Diesel Particulate Filter (DPF). DPF regenerates the combustible soot, but the ash (a product of the oil lubricant package) slowly accumulates in the channels of the DPF.

### 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.

### NOTE

#### COLD WEATHER STARTING

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.

### 2.15 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

*The MCM is non-serviceable. If found defective, replace as a unit.*

1. Disconnect the battery cables from the batteries. 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 And Installation".

## Section 01: ENGINE

3. Drain the engine cooling system. Refer to Section 05 COOLING under "Draining Cooling System".

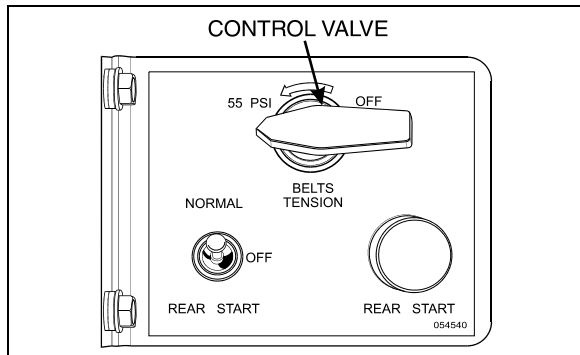


FIGURE 20: ENGINE COMPARTMENT

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4. Locate the A/C compressor drive belt tensioner control valve (Fig. 23). Turn handle clockwise in order to release pressure in belt-tensioner air bellows and loosen belts. Remove the belt.
5. 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.



### 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 turbocharger outlet and the charge air cooler inlet.
8. Disconnect and remove the air intake duct mounted between the charge air cooler outlet and the engine intake.
9. Disconnect and remove section of coolant pipe assembly mounted between the radiator outlet and the water pump inlet.
10. Disconnect and remove a section of coolant pipe assembly mounted between the thermostat housing and the radiator inlet.
11. Disconnect the coolant delivery hose mounted between the coolant surge tank and the water pump.
12. Disconnect two vent hoses from the thermostat housing and from the coolant pipe assembly.

13. Disconnect the fan-clutch electrical connector.
14. Disconnect the radiator fan drive shaft.
15. Disconnect the small heater hose located on the cylinder head at the back of the engine.
16. Disconnect and remove the exhaust pipe mounted between the turbocharger outlet and the exhaust bellows. If necessary, refer to Section 04 EXHAUST SYSTEM under "AFT Removal and Installation".



### CAUTION

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

17. Disconnect the block heater connector above the power steering pump.
18. Disconnect the steel-braided airline from the A/C compressor air bellows.
19. Disconnect the oil delivery hose from the valve located at the reserve tank drain.
20. Remove the power steering pump, leaving the supply and discharge hoses connected to it.
21. 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.
22. Disconnect fuel return line from bulkhead fixed on engine cylinder head end.
23. Disconnect the air compressor discharge airline.
24. Disconnect the coolant hose to the sump tank heater system.
25. Disconnect positive (+) cable (red terminal) from starter motor solenoid.
26. Disconnect starter motor ground cables from rear subframe ground-stud located close to the starter motor.
27. Disconnect VIH (vehicle interface harness) main connectors from MCM and VSS (vehicle speed sensor).
28. On vehicles equipped with an automatic transmission provided with a hydraulic output retarder, disconnect steel-braided airline from

pressure regulator output. The pressure regulator is mounted in the upper section of engine compartment backwall and is accessible through the engine compartment R.H. side door.

29. 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.
30. Disconnect the transmission harness (Allison: 2 main connectors, 1 connector to the retarder accumulator solenoid) (ZF transmission: 3 connectors).
31. From under the vehicle, disconnect the propeller shaft as detailed in Section 09, under heading "Propeller Shaft Removal".
32. 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.
33. Remove the six retaining bolts, washers and nuts securing the power plant cradle to the vehicle rear subframe (Fig. 23).

**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.*

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

**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 1/4" and 1/2" (6-12 mm).

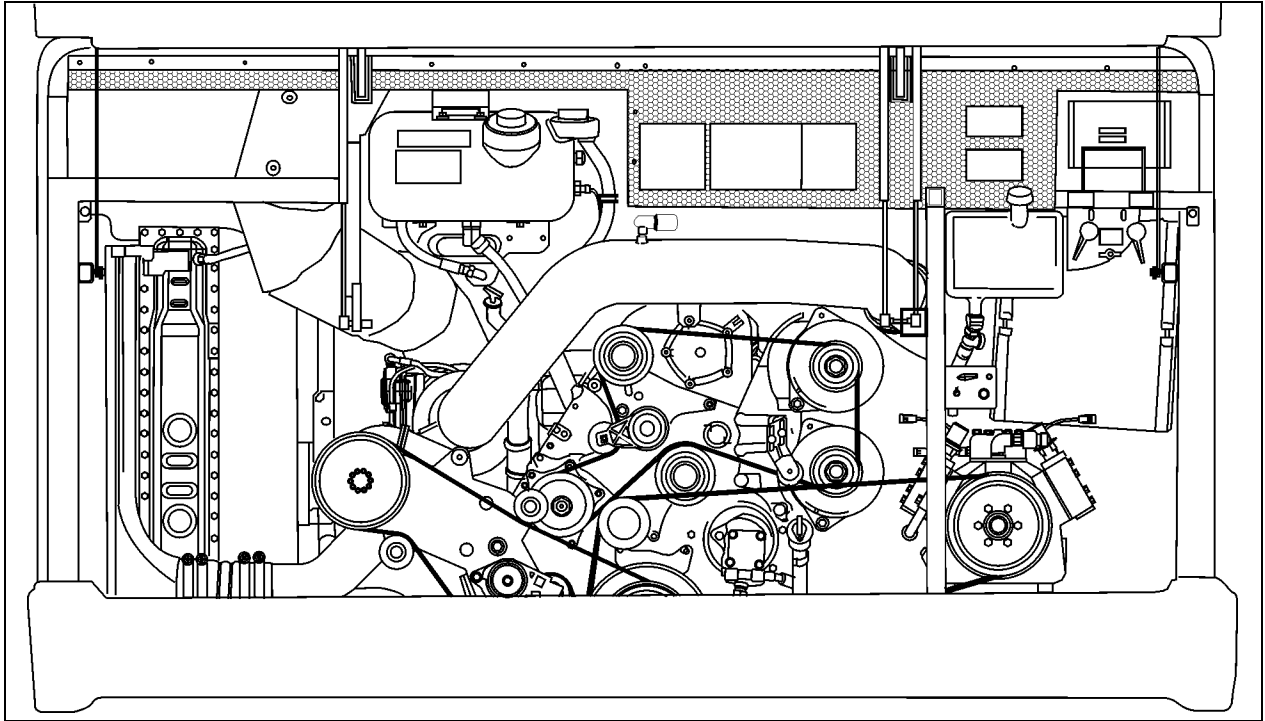


FIGURE 21: ENGINE COMPARTMENT H3 COACHES (TYPICAL)

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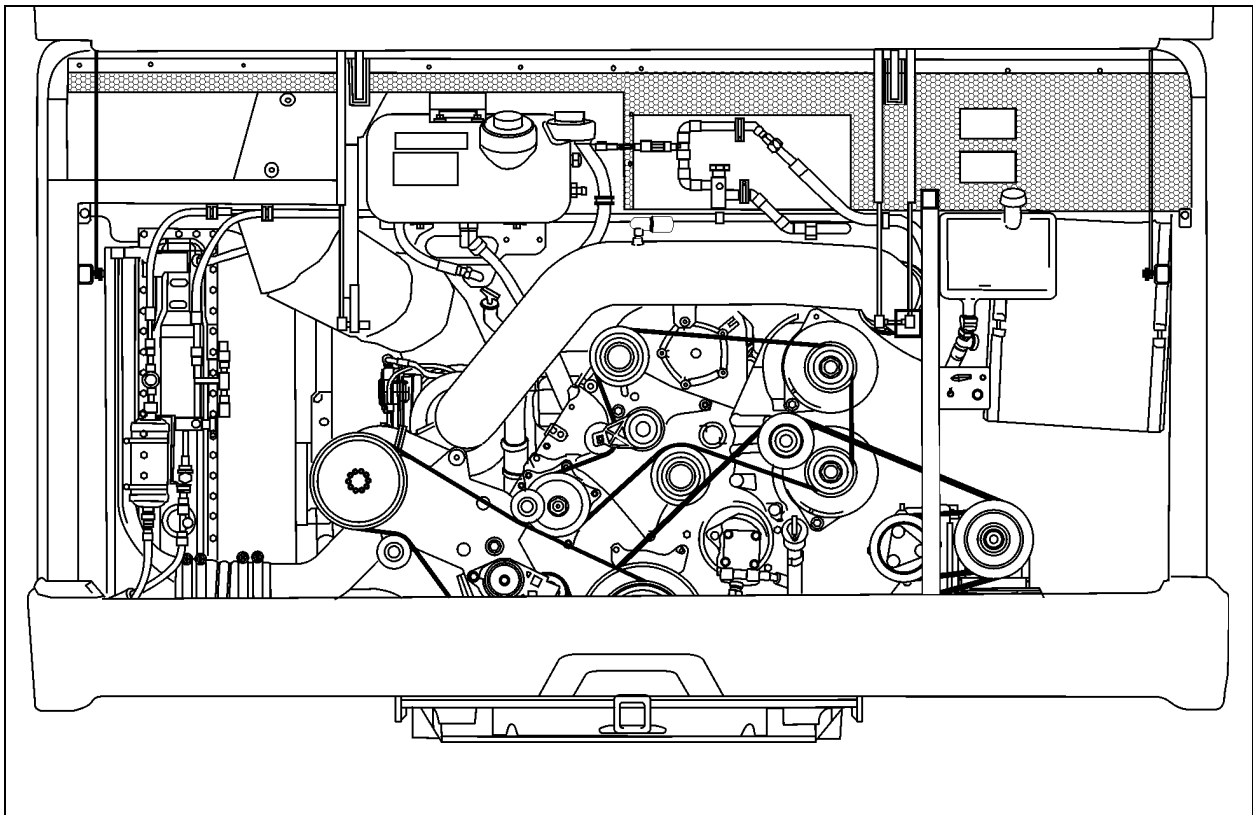


FIGURE 22: ENGINE COMPARTMENT VIP (TYPICAL)

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## 2.16 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:

5. Torque the power plant cradle mounting bolts to 190 lbf-ft (255 Nm).
6. If fan drive has been removed, reinstall and align as per Section 05 COOLING SYSTEM, under "Fan Drive Alignment".
7. Refill cooling system with saved fluid (refer to Section 05 COOLANT SYSTEM).
8. 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).
9. Start engine for a visual check. Check fuel, oil, cooling, pneumatic and hydraulic system connections for leakage. Test operation of engine controls and accessories.

## 2.17 JAKE BRAKE

Refer to both "The Jake Brake Troubleshooting and Maintenance Manual" and "Installation Manual for Model 797 Engine Brakes" for troubleshooting and installation procedures. They are annexed at the end of this section.

## 2.18 ENGINE MOUNTS

The power plant assembly on a vehicle powered with a series 60 engine 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. 23).

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

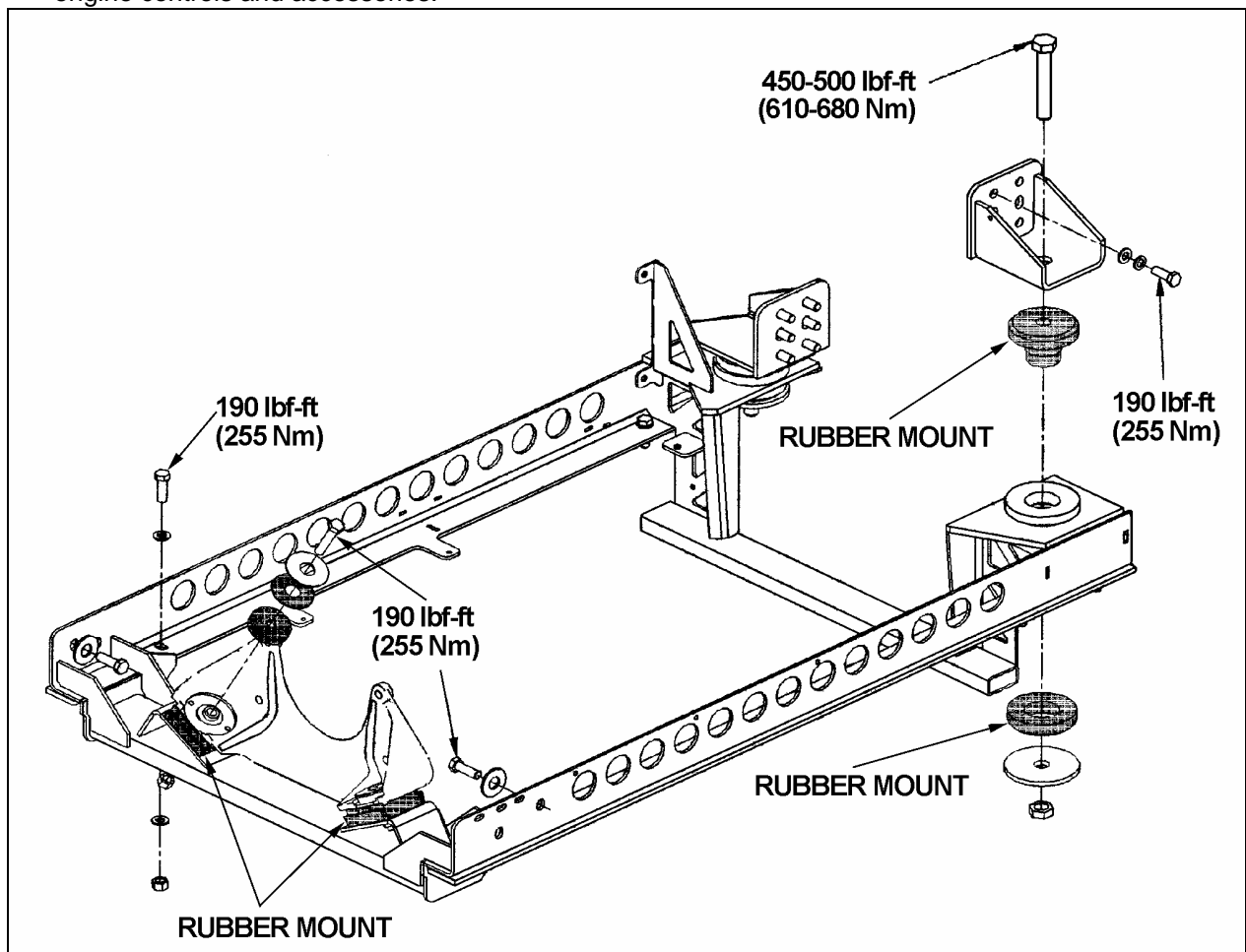


FIGURE 23: POWER PLANT CRADLE INSTALLATION

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

The Electronic Foot Pedal Assembly (EFPA) connects the accelerator pedal to a Throttle Position Sensor (TPS). The (TPS) is a device, which sends an electrical signal to the Motor Control Module (MCM). The TPS varies in voltage depending on how far the pedal is depressed. The system is installed in the space normally occupied by a mechanical foot pedal. The (EFPA) has maximum and minimum stops that are built into the unit during manufacturing (Fig. 24). The (TPS) converts the operator's foot pedal input into a signal for the MCM.

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

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

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

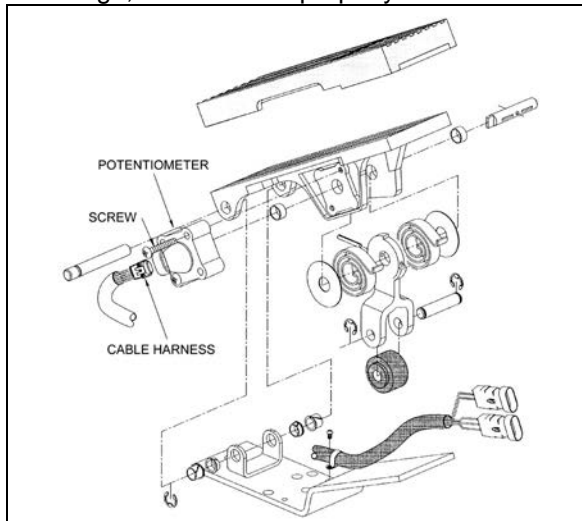
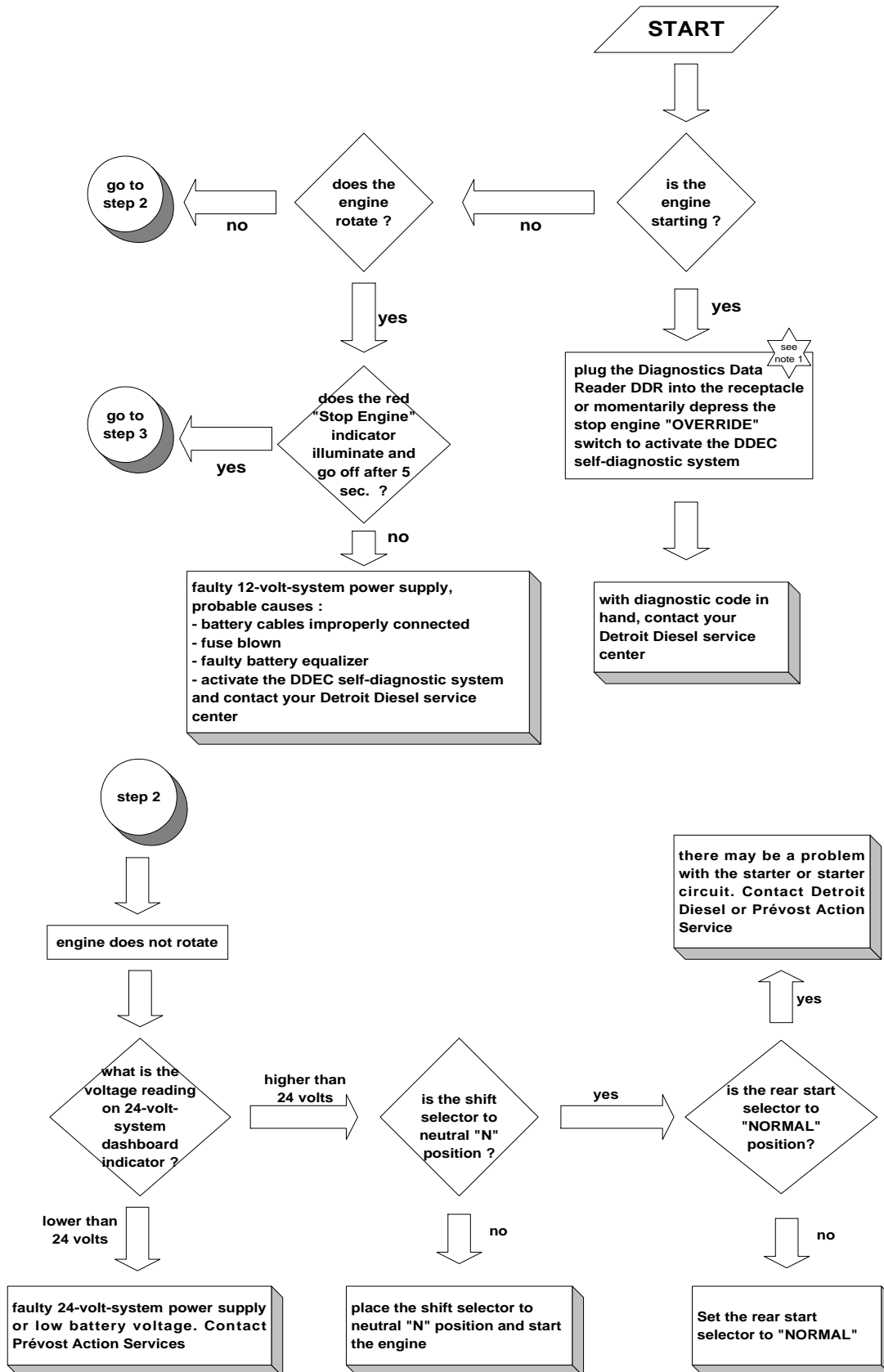


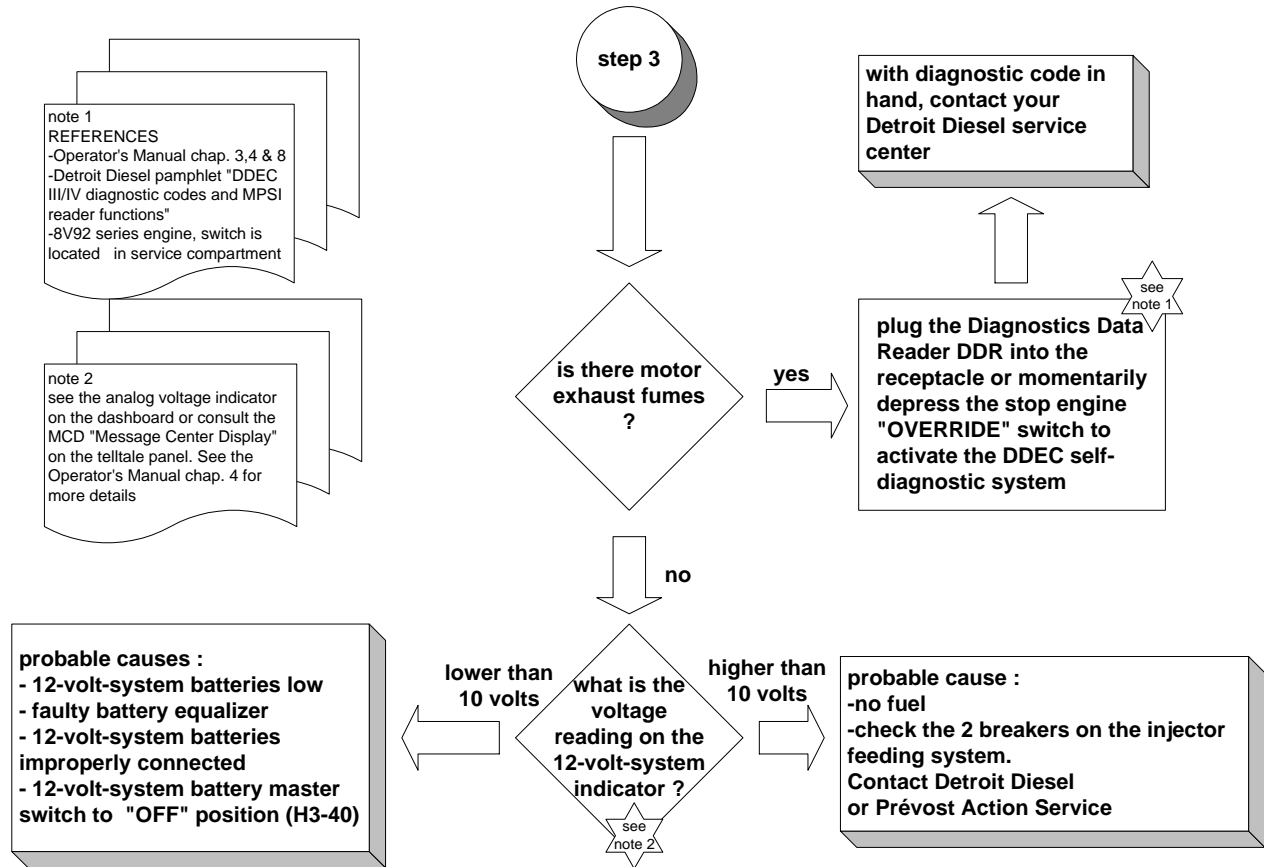
FIGURE 24: ELECTRONIC FOOT PEDAL ASSEMBLY 03035

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,

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**5. SPECIFICATIONS**

5.1 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

 <b>CAUTION</b>
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 VI system reprogrammed.

<b>Coach Engine (14.0L)</b>	
425 HP	@1800 rpm; 1450 lb-ft @1200 rpm
<b>445 HP</b>	<b>@1800 rpm; 1450 lb-ft @1200 rpm</b>

<b>Entertainer Engine (14.0L)</b>	
<b>455 HP</b>	<b>@1800 rpm; 1550 lb-ft @1200 rpm</b>
490 HP	@1800 rpm; 1550 lb-ft @1200 rpm
515 HP	@1800 rpm; 1550 lb-ft @1200 rpm

<b>Motorhome (14.0L)</b>	
470 HP	@1800 rpm; 1650 lb-ft @1200 rpm
<b>515 HP</b>	<b>@1800 rpm; 1650 lb-ft @1200 rpm</b>

**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

Prevost number ..... 510458

## Section 01: ENGINE

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### Torque specification

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

### Filters

Engine Air Cleaner Filter

Make ..... Nelson # 70337-N

Prevost number ..... 530197

Engine Coolant Filter/Conditioner

Make ..... Nalco Chemical Company # DDF3000

Make ..... Detroit Diesel # 23507545

Prevost number..... 550630

<b>NOTE</b>
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For primary and secondary fuel filters, refer to Specifications in section 03.
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## 5.2 VOLVO D13 ENGINE

Make ..... Volvo Powertrain

Type ..... Diesel four cycle

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

No. of cylinders ..... 12.8 L inline 6

Recommended cruise speed range ..... 1300-1500 RPM

Maximum RPM..... 2100

### Engine oil level quantity

Oil Pan Capacity; Low Limit ..... 25 quarts/24 liters

Oil Pan Capacity; High Limit ..... 34 quarts/32 liters

Total Engine Oil Capacity with Filters ..... 45 quarts/42.5 liters

### Lubricating oil filter elements

Prevost number ..... 478736 (Full Flow)

Prevost number ..... 510938 (By-pass)

### Torque specification

Engine oil filter..... Tighten 3/4 to 1 turn after gasket contact

### Filters

Engine Air Cleaner Filter

Prevost number ..... 530197

Engine Coolant Filter

Make ..... Volvo

Number ..... 20458771

***NOTE***

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





# SECTION 03: FUEL SYSTEM

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1. FUEL SYSTEM WITH DETROIT DIESEL SERIES 60 ENGINE

1.1 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 (fuel-filter/water-separator) before it enters the MCM and the fuel pump. If the vehicle is equipped with the optional “Davco Fuel Pro 382”, this one replaces the primary fuel filter. 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. One preheater is available: 104 000 BTU. If the vehicle is equipped with the 104 000 BTU preheater, the fuel is drawn from the fuel tank through the fuel filter to the preheater. Excess fuel returns to the fuel tank.

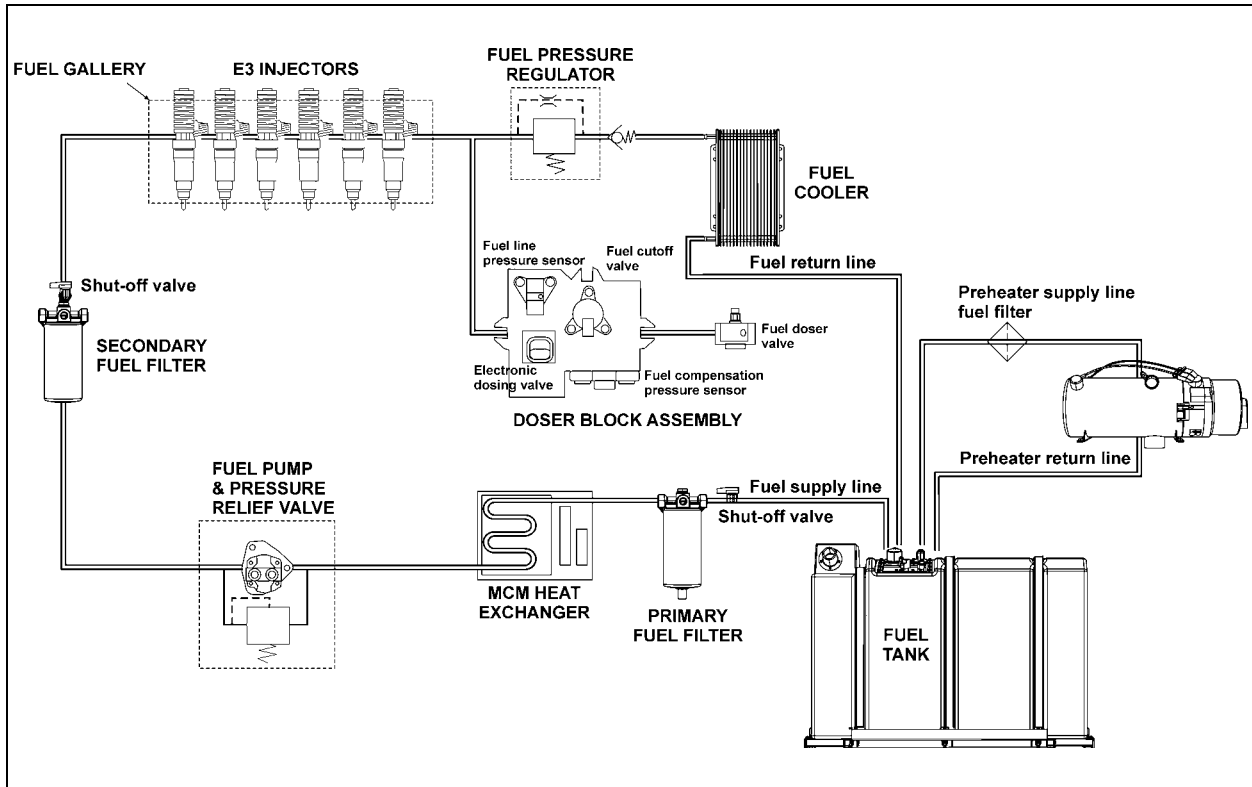


FIGURE 1: FUEL SYSTEM SCHEMATIC (DDC S60 ENGINE)

03075

1.2 FUEL VALVES

Manual shut-off valves on engine fuel-supply line are located on the R.H. side of engine compartment. A manual shut-off valve is located at the inlet side of the primary fuel filter under the starter or at the inlet side of Davco Fuel Pro 382 fuel filter. Another manual shut-off valve is located at the outlet side of the secondary fuel filter. Shut-off valve are designed to prevent loss of fuel prime at time of filter replacement. No manual valve is required on preheater fuel-supply line, since the positive-displacement fuel pump (located close to the fuel tank) prevents fuel flow when not activated.

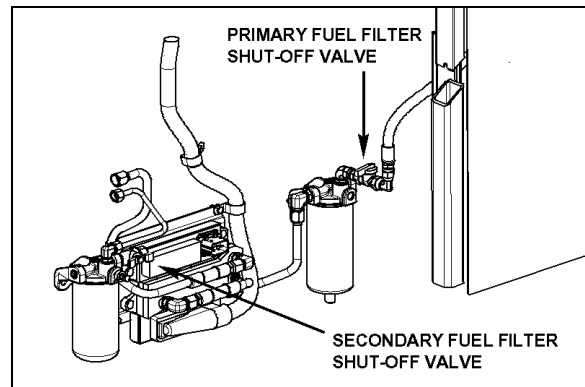


FIGURE 2: MANUAL SHUT-OFF VALVES LOCATION (DDC S60 ENGINE)

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## Section 03: FUEL SYSTEM

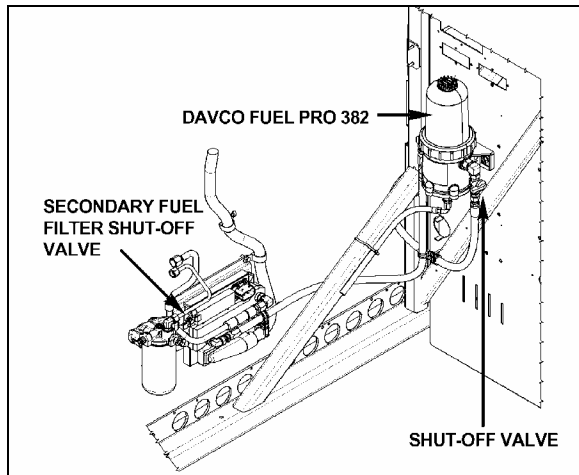


FIGURE 3: MANUAL SHUT-OFF VALVE WITH DAVCO FUEL PRO 382 (DDC S60 ENGINE) 03073

### 1.3 FUEL FILTERS

The fuel system is equipped with primary (strainer or optional fuel/water separator) and secondary fuel filters for additional protection of the injectors. A Racor fuel/water separator may be installed in primary filter location (Fig. 4).

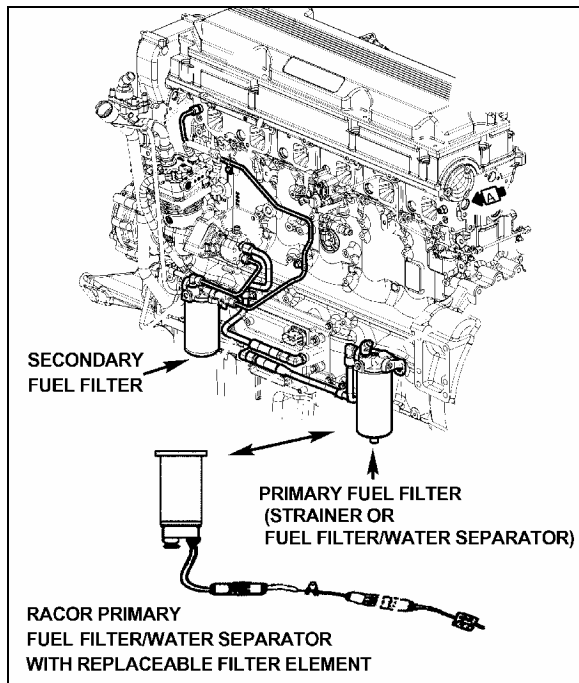


FIGURE 4: ENGINE R.H. SIDE 03069

#### 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.

#### NOTE

For information on the Davco Fuel Pro 382 fuel filter, refer to paragraph 4.3.

### 1.4 RACOR FUEL/WATER SEPARATOR SERVICING



#### MAINTENANCE

The Racor fuel/water separator should be drained periodically, or when the water separator telltale light on the dashboard illuminates.

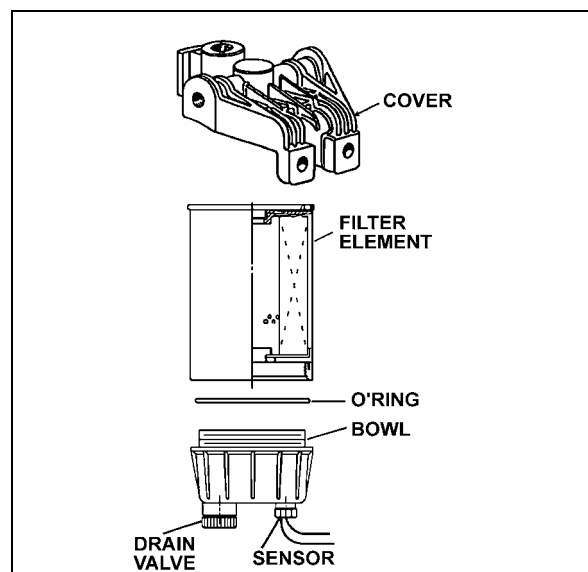


FIGURE 5: RACOR FUEL /WATER SEPARATOR 03025

Replace the fuel/water separator element as follows:

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

#### NOTE

Bowl is reusable, do not discard.

4. Lubricate O-ring with clean diesel fuel or motor oil and place it in bowl groove.
5. Screw bowl onto new filter cartridge 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.
7. Fill filter cartridge with clean diesel fuel and attach onto cover. Handtighten an additional 1/3 to 1/2 turn after making full seal contact.
8. Open shut-off valves of the engine fuel supply line.
9. Run the engine and check for leaks.

**CAUTION**

If the fuel/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.

### 1.5 SPIN-ON TYPE FUEL FILTER SERVICING (PRIMARY & 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. The threaded sleeves that accept the filters body are different sizes to prevent mismatching. Primary filter thread is 1in.X12 while secondary is 13/16in.X12. The word "primary" or "secondary" is cast onto the top of the respective adaptor.

**NOTE**

*The fuel filter adaptors are mounted to the engine block with two bolts each. Torque these bolts to 43-54 lbf•ft (58-73 N•m).*

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 fuel pressure regulator, the fuel

pressure at the cylinder head inlet is 58-72 psi (400-50 kPa). Change the fuel filters whenever the inlet restriction at the fuel pump reaches 12 inches of mercury (41 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.

**MAINTENANCE**

The primary and secondary fuel filters are of a spin-on type and must be replaced every 12,500 miles (20 000 km) or once a year, whichever comes first. If the primary fuel filter is a fuel filter/water separator type, it 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.

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, place a suitable container under the filter.
2. Close the secondary and primary filter shut-off valve (for valve location, See paragraph 3. FUEL VALVES").
3. Using a band filter wrench, unscrew and discard filters.
4. Fill new filter cartridge(s) with clean fuel oil. Apply a thin coat of clean fuel oil on gasket.
5. Install new filters. Tighten until filter is snug against the gasket, with no side movement. Rotate an additional 1/2 turn by hand.

**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.

6. Open engine fuel supply line shut-off valves.
7. Start the engine and check for leaks.

## Section 03: FUEL SYSTEM

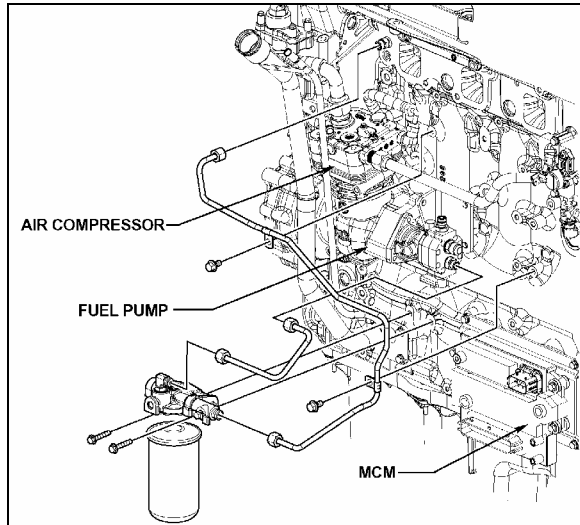
### **NOTE**

*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.*

Connect the fuel inlet and outlet lines to the fuel pump and tighten.

### 1.6 FUEL PUMP INSTALLATION

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



**FIGURE 6: FUEL PUMP LOCATION**

03070

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 Loctite 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.*

*Install drive coupling in drive hub of the fuel pump. Install a new gasket to the mounting flange of the pump.*

2. 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.
3. 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).

## 2. FUEL SYSTEM WITH VOLVO D13 ENGINE

### 2.1 DESCRIPTION

#### **NOTE**

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

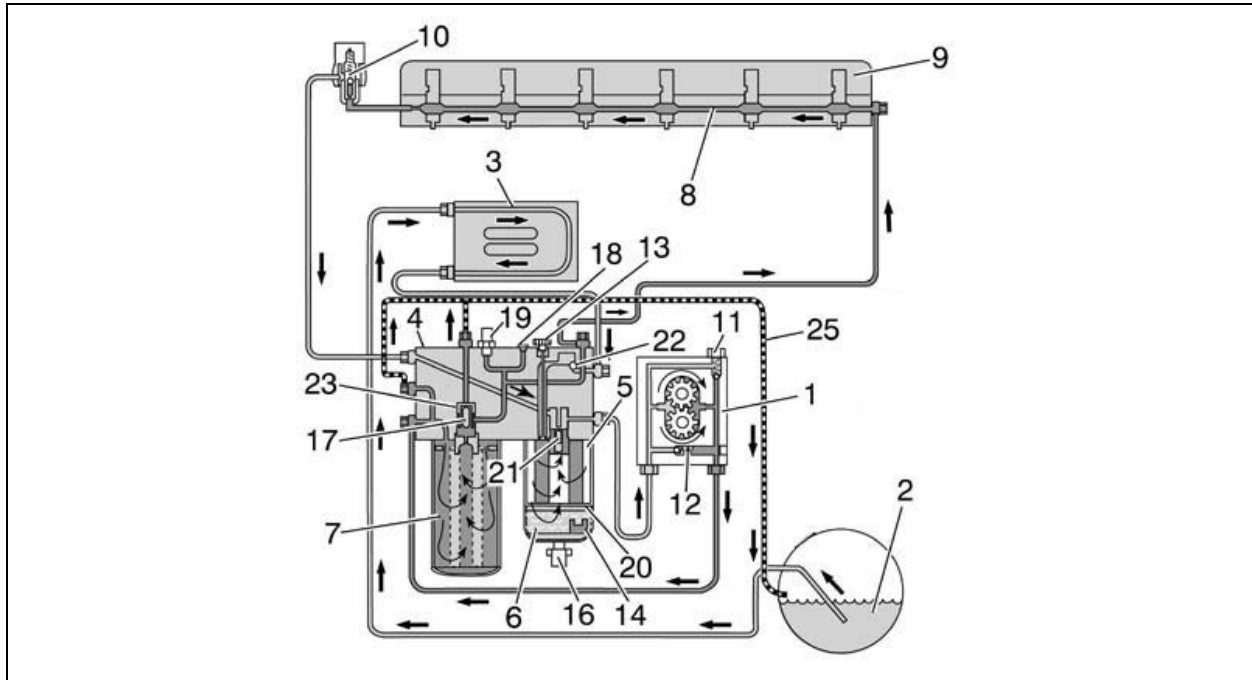


FIGURE 7: FUEL SYSTEM SCHEMATIC (VOLVO D13 ENGINE)

03086

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

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

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

#### Supply Pump Valves

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

#### Automatic Bleeding

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

#### Other

The fuel filter housing eliminates the need to drain the fuel when replacing the filter. The valve pegs (17) and (21) close when the fuel filter is

## Section 03: FUEL SYSTEM

removed. It is not necessary to bleed the fuel system after replacing the filter, since this is performed automatically when the engine is started and runs for more than 2 minutes.

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

### Hand Priming Pump

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

### 2.2 FUEL VALVES

The manual shut-off valve on engine fuel-supply line is located on the R.H. side of engine compartment. A manual shut-off valve is located at the inlet side of the primary fuel filter or at the inlet side of Davco Fuel Pro 382 fuel filter. Shut-off valve is designed to prevent loss of fuel prime. No manual valve is required on preheater fuel-supply line, since the positive-displacement fuel pump (located close to the fuel tank) prevents fuel flow when not activated.

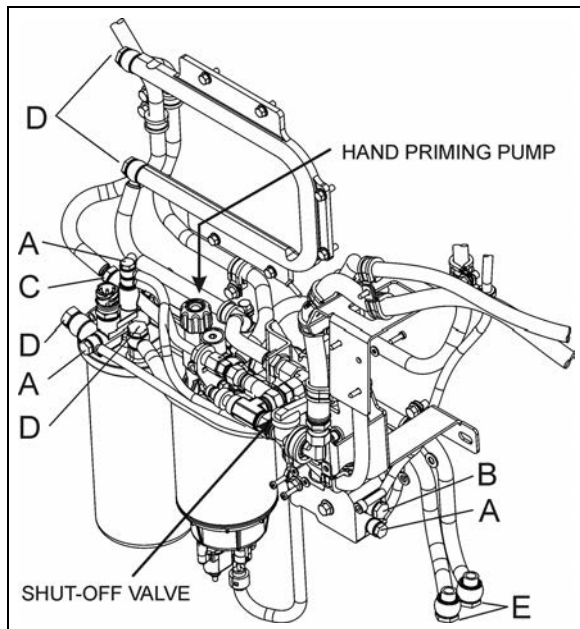


FIGURE 8: MANUAL SHUT-OFF VALVE (VOLVO D13 ENGINE)

03088

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

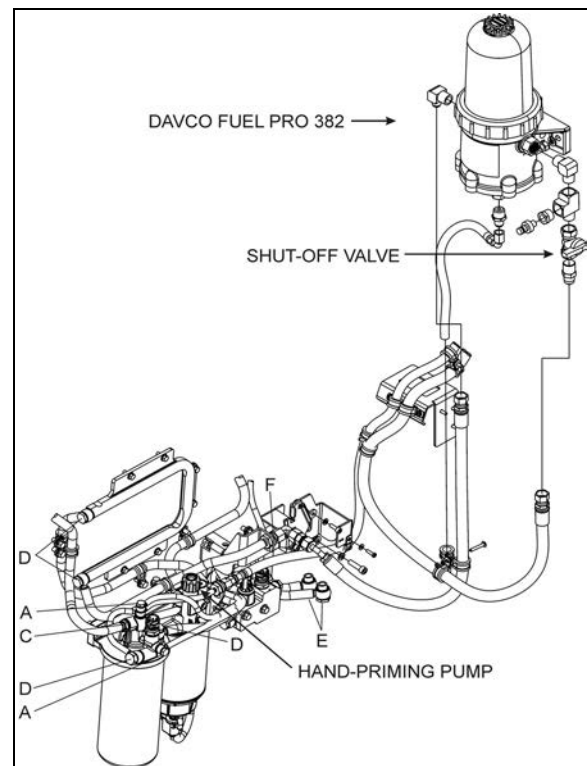


FIGURE 9: MANUAL SHUT-OFF VALVE LOCATION WITH DAVCO FUEL PRO 382 (VOLVO D13 ENGINE)

03087

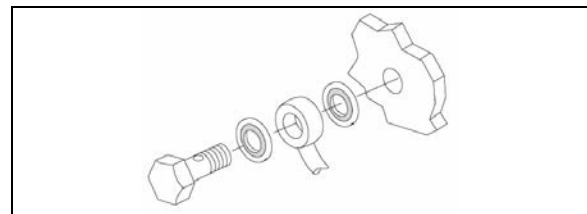


FIGURE 10: FUEL LINE COMPRESSION FITTING - ALWAYS REPLACE THE FUEL LINE COMPRESSION SEALING WASHERS WHEN TROUBLESHOOTING FOR FUEL AERATION OR PERFORMING ANY SERVICE PROCEDURE THAT REQUIRES THE REMOVAL OF ENGINE FUEL LINES

### 2.3 FUEL FILTERS

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





## MAINTENANCE

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

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

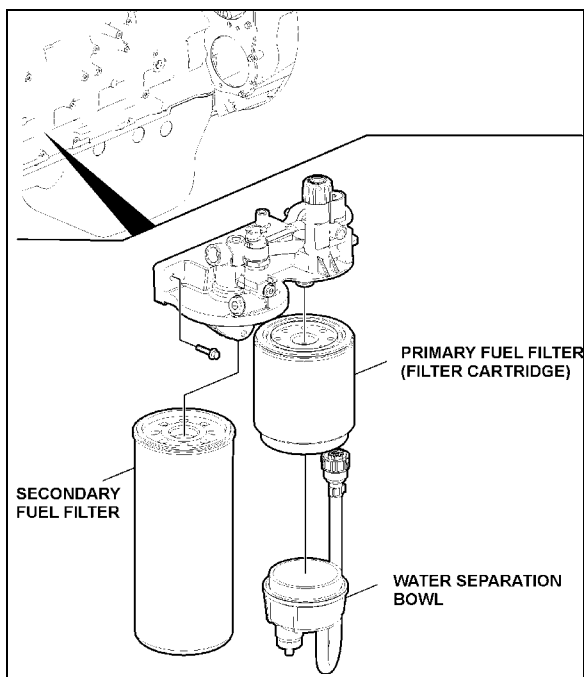
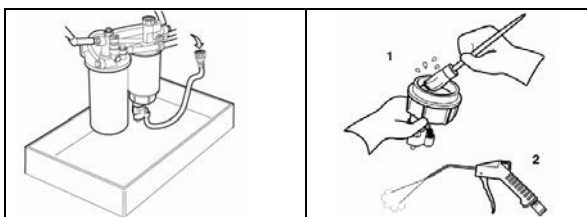


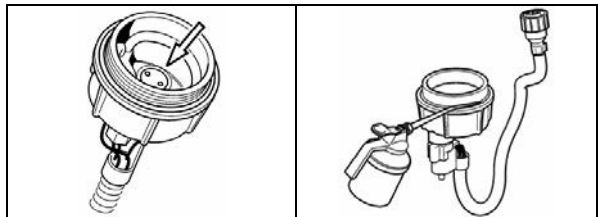
FIGURE 11: FUEL FILTERS WITH VOLVO D13 ENGINE  
03085

### 2.3.1 Primary Fuel Filter Replacement

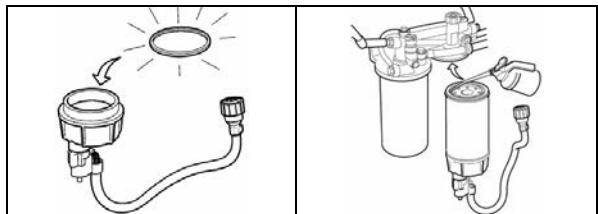
1. Stop engine, close the fuel supply line shut-off valve.
2. Place an appropriate container under the fuel filter housing, then drain the water from the water separation bowl.
3. Disconnect the fuel/water separator indicator electrical connector.



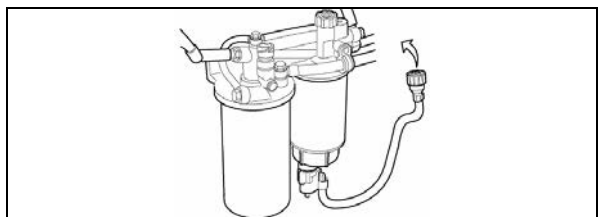
4. Unscrew and remove the primary fuel filter from the fuel filter housing. Drain filter.
5. Unscrew and remove the separation bowl from the filter cartridge.
6. Remove and discard the old gasket from the water separation bowl. Clean the bowl thoroughly and then blow dry with filtered compressed air.



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



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



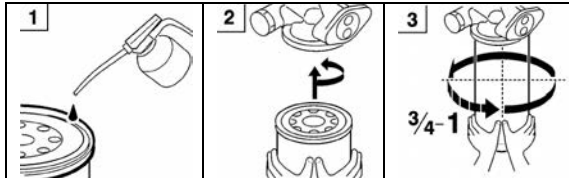
11. Connect the electrical connector for the water/fuel separation bowl indicator.
12. Open the fuel supply line shut-off valve.
13. Purge air from the filter by operating the priming pump to draw fuel and fill the filter. When using the hand priming pump, approximately 100 strokes will be required.
14. Start the engine and carry out a fuel-tightness check. Let the engine run for

## Section 03: FUEL SYSTEM

about 5 minutes to remove air pockets from the fuel system.

### 2.3.2 Secondary Fuel Filter Replacement

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



### CAUTION

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

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

### 2.4 PRIMING THE FUEL SYSTEM

The fuel system will need to be bled if:

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



### CAUTION

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

### NOTE

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

1. Stop engine;
2. Unlock the hand pump by turning the handle counterclockwise.
3. Prime the system by moving the primer pump in an up and down pumping motion. Avoid putting any side load on the pump or causing a binding condition.
4. Lock the hand primer pump by retracting it into the housing and turning it clockwise.
5. Start the engine and run it at an increased idle speed for approximately 5 minutes to remove any remaining air in the system. Check the fuel system for leaks.

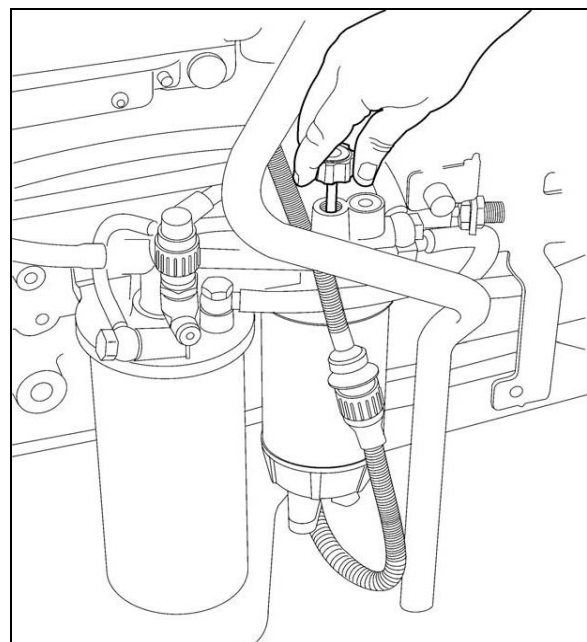



FIGURE 12: HAND PRIMING PUMP

### 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. The filter serves as a water separator as well as a fuel filter (Fig. 13).

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

Fuel level rises as dirt collects on the filter from the bottom up. Restriction remains consistently low because fuel always flows through clean, new media.

 <h2 style="margin: 0;">MAINTENANCE</h2>
<p>Replace Fuel Pro 382 filter element when the fuel level in the see-thru filter cover reaches the top of the filter element or after one year of service, whichever comes first.</p>

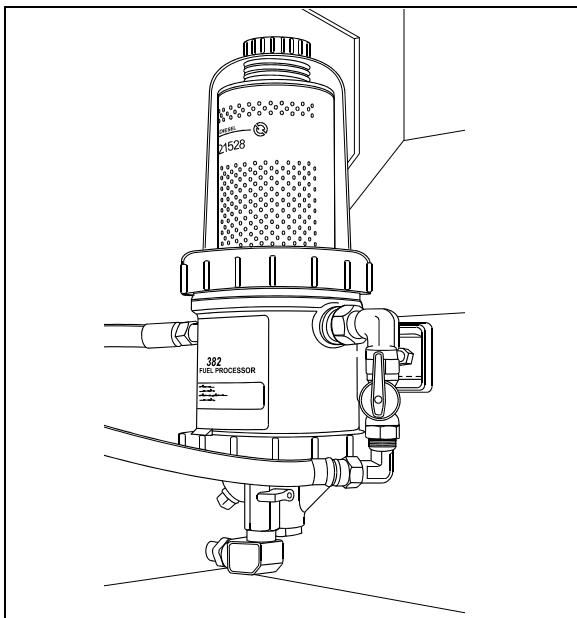


FIGURE 13: DAVCO FUEL PRO 382 INSTALLATION 03032

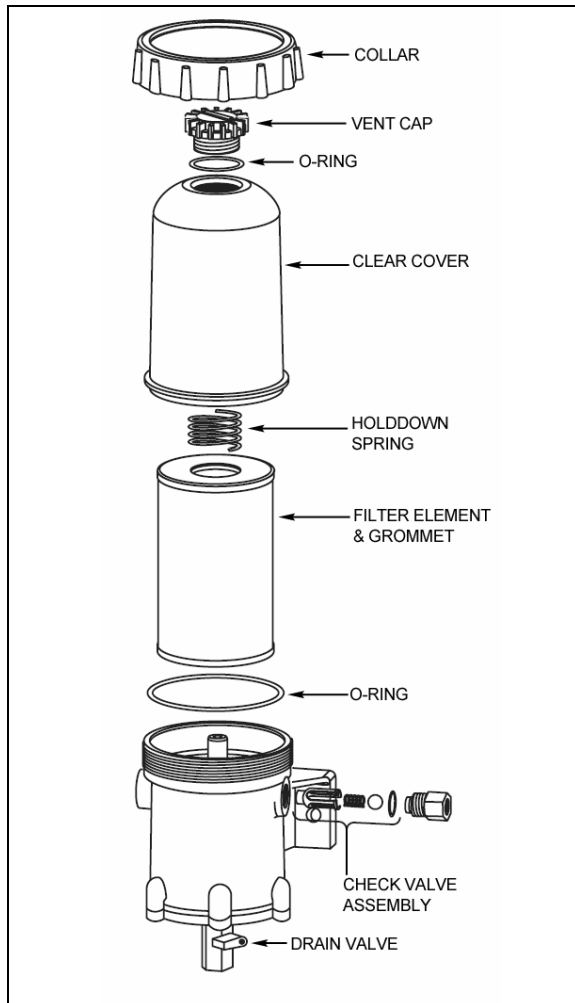
Filter replacement:

1. Stop engine;
2. Place a suitable container under the fuel processor;
6. Close the shut-off valve on the discharge side of the fuel filter;
7. Open the drain valve at the base of the fuel processor and drain the fuel until it is below the level of the filter;
8. Untighten upper collar, remove cover, filter spring, filter element and cover seal;
9. Dispose of used filter element;
10. Ensure the filter grommet is included in the base of the new filter element and then install the element onto the center stud;
11. Ensure the filter spring is installed at the top of the cover. If missing, the spring must be replaced to insure proper filter operation. Wipe the cover lid and seal clean. After ensuring the seal is properly positioned at the base of the cover, install the cover and collar onto the fuel processor. Tighten the collar by hand until secure;
12. Fill the cover full of clean fuel through spin off cap located on top of cover. Install vent cap seal and then reinstall the cap and tighten by hand only;
13. Open the shut-off valve;
14. Start engine, raise rpm for 2-3 minutes, hand tighten collar again.
15. After the air is purged and with the engine still running, slowly loosen the vent cap on the filter cover. The fuel level in the cover will start falling. When the fuel level falls to the top of the collar, tighten the vent cap quickly by hand.
16. Shut down the engine and hand-tighten the collar again.

#### **NOTE**

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

**Environmental Notice:** Diesel fuel is an environmentally hazardous product. Dispose in an environmentally friendly manner.



**FIGURE 14: DAVCO FUEL PRO 382 EXPLODED VIEW**  
03076

**4. FUEL LINES AND FLEXIBLE HOSES**

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



**MAINTENANCE**

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

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



**CAUTION**

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

**5. PREHEATER FUEL FILTER**

The preheater fuel filter is located beside the preheater in the dedicated compartment above the rear wheelhousing, on the L.H. side of vehicle.



**MAINTENANCE**

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

**6. FUEL TANK**

All H3 series vehicles are equipped with a high-density cross-link polyethylene fuel tank with a capacity of 235 US gallons (890 liters). The tank is located just forward of the last baggage compartment, between the A/C condenser and evaporator.

Fuel filling access doors on both sides of vehicle 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.

### 6.1 TANK REMOVAL



#### WARNING

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

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.

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

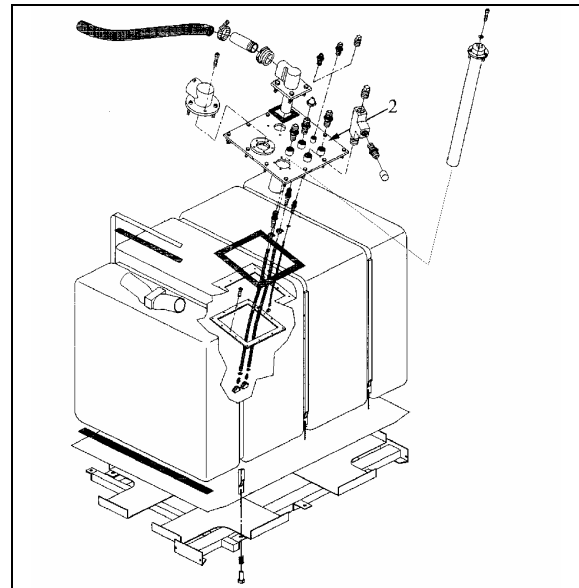


FIGURE 15: FUEL TANK ARRANGEMENT

03048



#### WARNING

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

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

### 6.2 TANK INSTALLATION

Tank installation is the reverse of removal.

#### NOTE

*Fastening of rubber flap must always be on top, in line with clamp screw.*

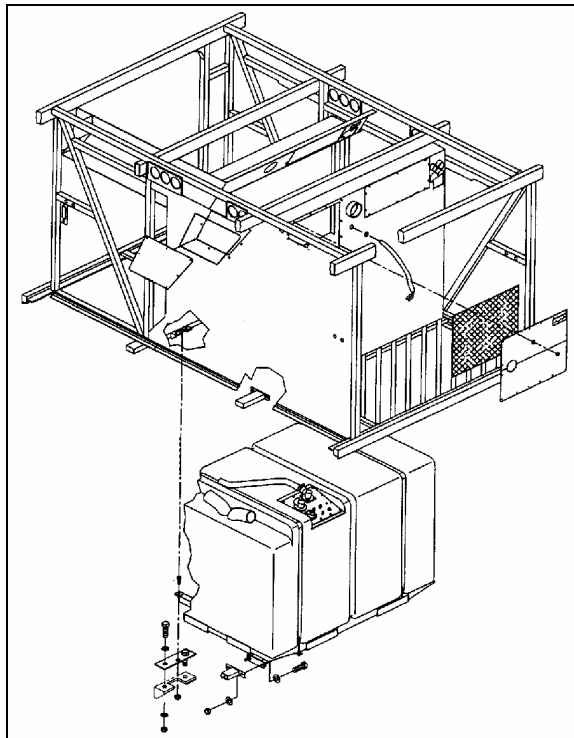


FIGURE 16: FUEL TANK INSTALLATION 03049

**NOTE**

Insert check valve assembly in right-side filler hose, use hose clamp to fix it. Repeat with left side filler hose.

**NOTE**

When reinstalling lines, use Loctite 567 type thread sealant on line fittings.



**WARNING**

For proper assembly, check connections and fasteners for tightness.

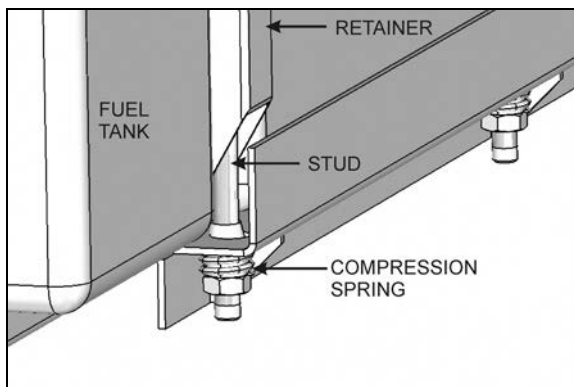


FIGURE 17: FUEL TANK RETENTION 03019

For each fuel tank retainers (Fig. 17):

1. Clean nuts and stud threads.
2. Apply a Loctite 242 type thread adhesive on stud threads.

Fix the retainers to the tank platform. Tighten the nuts to compress the spring completely and then loosen 3 turns.

6.3 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.



**WARNING**

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

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

6.4 POLYETHYLENE FUEL TANK REPAIR

**NOTE**

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



**WARNING**

Park vehicle safely, apply parking brake, stop engine and set battery master switches to the OFF position before working on the vehicle.

1. Locate perforation on fuel tank.
2. If necessary, remove fuel tank as per instructions in this section.
3. Drill perforation with a 23/64" bit. Make sure drill hole is perfectly round.
4. Insert a screw (Prevost #500196) and a washer (Prevost #5001244) into anchor nut (Prevost #500331).
5. Place assembly in drill hole. Tighten screw by 10 complete turns. Refer to Fig. 16.
6. Apply sealant on head plug (Prevost #507300) and seal hole with the head plug.

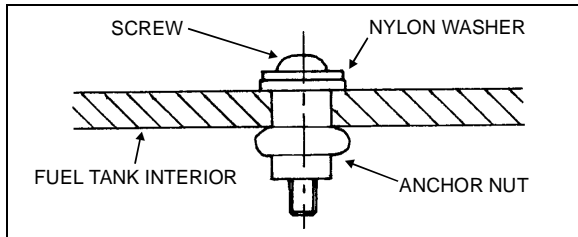


FIGURE 18: FUEL TANK REPAIR 03014

**7. FUEL SPECIFICATIONS**

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

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


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


On-highway diesel engines meeting 2007 emission regulations are designed to operate **ONLY** with ULSD fuel. ULSD fuel will enable the use of cleaner technology diesel engines and vehicles with advanced emissions control devices, resulting in significantly improved air quality.

**7.1 FUEL TYPE**

EPA-07 engines like the DDC 2007 Series 60 are designed to run on **Ultra Low Sulfur Diesel** (ULSD) fuel, which can contain no more than 15 ppm sulfur.

Fuel used must meet engine manufacturer's specification. For Detroit Diesel engines refer to "Diesel Fuel Specifications" as stated in DDC publication 7SE270 LUBRICATING OIL, FUEL, AND FILTERS. Similarly for Volvo engine.

 <p><b>CAUTION</b></p>
<p>ULSD fuel is necessary to avoid fouling the engine's Aftertreatment Device (ATD). Improper fuel use will reduce the efficiency of the engine's Aftertreatment System and may permanently damage the system.</p>

 <p><b>CAUTION</b></p>
<p>Owners of 2007 and later model year on-highway diesel engine must refuel only with ULSD fuel.</p>

<p><b>NOTE</b></p>
<p><i>Burning Low Sulfur Diesel fuel (instead of ULSD fuel) in 2007 and later model year diesel engines is illegal and punishable with civil penalties.</i></p>

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

<p><b>NOTE</b></p>
<p><i>Like Low Sulfur Diesel fuel, ULSD fuel requires good lubricity and corrosion inhibitors to prevent unacceptable engine wear. As necessary, additives to increase lubricity and to inhibit corrosion will be added to ULSD fuel <b>prior</b> to its retail sale.</i></p>

**7.2 BLENDING**

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

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

**7.3 BIODIESEL FUELS**

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

Fuel used must meet engine manufacturer's specification for biodiesel fuel. For Detroit Diesel


engines refer to “Diesel Fuel Specifications” as stated in DDC publication 7SE270 LUBRICATING OIL, FUEL, AND FILTERS. Similarly for Volvo engines.

Biodiesel fuels are alkyl esters of long chain fatty acids derived from renewable resources. Detroit Diesel highly recommends biodiesel fuels made from soybean or rapeseed oil through the proper transesterification reaction process. Other feedstock source of biodiesel fuels such as animal fat and used cooking oils are not recommended by Detroit Diesel. Biodiesel fuels meeting ASTM D6751 specification and from BQ-9000 accredited producer, prior to blending can be mixed up to 5% maximum by volume in petroleum diesel fuel. The resulting mixture must meet the fuel properties listed in Table 5-1 (see Detroit Diesel publication 7SE270 LUBRICATING OIL, FUEL, AND FILTERS.) and ASTM D975 specification. Failures attributed to the use of biodiesel fuel will not be covered by Volvo, Detroit Diesel or Prevost product warranty. Also, any engine performance problem related to the use of biodiesel fuel would not be recognized nor considered as Volvo, Detroit Diesel or Prevost’s responsibility.

### 8. 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 an intake duct on the R.H. side of the rear cap, next to the last window. 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).

#### 8.1 PRE-CLEANER SERVICING

	<b>MAINTENANCE</b>
<p>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.</p>	

#### 8.2 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.

#### 8.3 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.

**8.4 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.

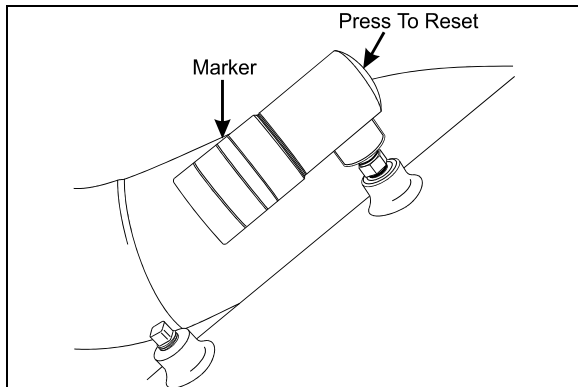


FIGURE 19: RESTRICTION INDICATOR 01052

**9. FUEL COOLER – DETROIT DIESEL SERIES 60 ONLY**

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 is located just in front of the Charge Air Cooler (Fig.19).

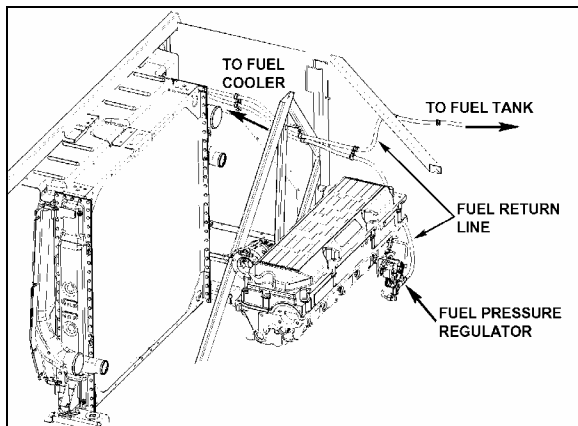


FIGURE 20: FUEL RETURN LINE 03074

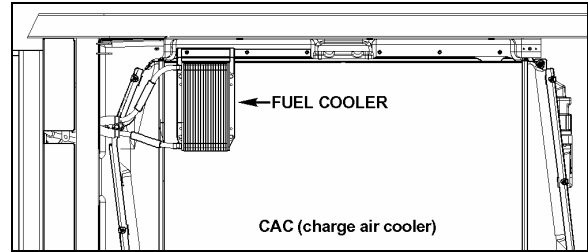


FIGURE 21: FUEL COOLER LOCATION 03071

**10. FUEL PEDAL**

The EFPA (Electronic Foot Pedal Assembly) connects the accelerator pedal to a potentiometer (a device that sends an electrical signal to the CPC, 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.

**10.1 FUEL PEDAL ADJUSTMENT**

The EFPA contains a throttle position sensor that varies the electrical signal sent to the CPC. 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.

**10.2 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.

### Section 03: FUEL SYSTEM

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2. Loosen the two screws and remove potentiometer. Retain for re-assembly.
3. Discard potentiometer (Fig. 20).
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. 20) 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 CPC 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.

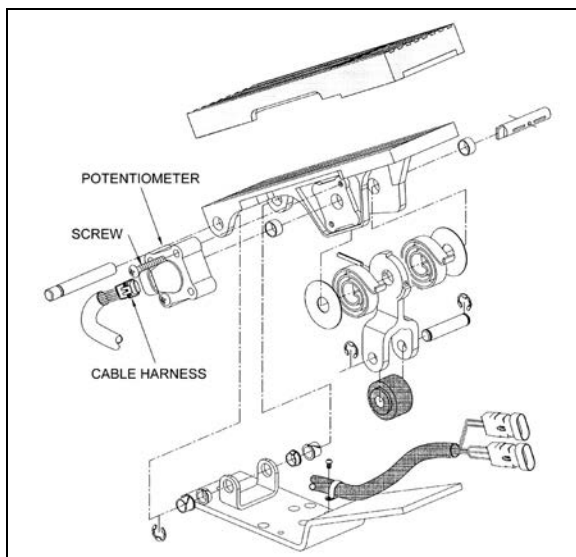


FIGURE 22: ELECTRONIC FOOT PEDAL ASSEMBLY 03035

11. SPECIFICATIONS

**Davco Fuel Pro 382 Fuel Filter / Water Separator Element**

Prevost number .....510795

**Racor Primary Fuel Filter / Water Separator (optional)**

(May be used instead of regular spin-on primary filter).

Make ..... Racor

Type ..... Replaceable element filter

ELEMENT

Prevost number .....531390

RECOVERY BOWL

Prevost number .....531389

DRAIN VALVE AND SEAL

Prevost number .....531397

O-RING

Prevost number .....531398

PROBE/WATER SENSOR

Prevost number .....531391

**Primary Fuel Filter (Fuel/Water Separator) With Detroit Diesel Series 60 Engine**

Make ..... AC

Type ..... Spin-on

Filter No. .... T-915D

Prevost number .....032700

Filter torque..... 1/2 turn after gasket contact

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

Part number .....20879806

Filter torque..... 1/2-3/4 turn after gasket contact

**Secondary Fuel Filter With Detroit Diesel Series 60 Engine**

Make ..... AC

Type ..... Spin-on

Filter No. .... T-916D

Prevost number .....510794

Filter torque..... 1/2 turn after gasket contact

**Secondary Fuel Filter With Volvo D13 Engine**

Part number .....20405160

Filter torque..... 3/4- 1 turn after gasket contact

**Section 03: FUEL SYSTEM**

---

**Fuel tank**

Capacity ..... 235 US gal (890 liters)

**Air Cleaner**

Make ..... Nelson

Prevost Number .....530206

Service Part No ..... 7182 8N

Prevost number (element cartridge) .....530197

**Air Cleaner Restriction Indicator**

Make ..... Donaldson

Model .....RBX00-2220

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

Prevost number .....530161

**Preheater Fuel Filter**

Make ..... Webasto

Prevost number .....871037

**Fuel Cooler**

Make ..... Long Manufacturing

Prevost number .....531422

# SECTION 04: EXHAUST SYSTEM

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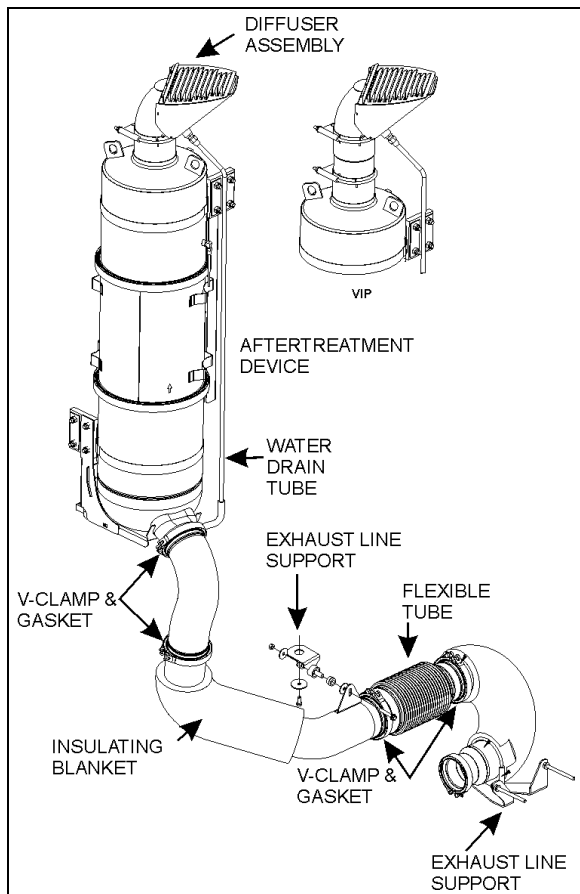
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**1. EXHAUST AND AFTERTREATMENT SYSTEM OVERVIEW**

The technology behind clean emissions technology is an exhaust **Aftertreatment Device (ATD)**, which replaces today's muffler. The ATD primary function is to capture and oxidize (regenerate) the particulate matter (soot) in the engine exhaust gases. The ATD splits into two main sections. The exhaust gases first enter the **Diesel Oxidation Catalyst (DOC)** and then flow through the **Diesel Particulate Filter (DPF)**; together they capture and regenerate the soot on a regular or passive basis. Through constant monitoring of the exhaust gas temperature and the system backpressure, DDEC VI (Detroit Diesel) or EMS (Volvo) are able to manage regeneration.

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



**FIGURE 1: EXHAUST SYSTEM (DDC S60 SYSTEM SHOWN, VOLVO D13 SIMILAR)** 04017


**1.1 MAINTENANCE**

Inspect the exhaust system periodically for restrictions and leaks. Figure 1 presents the major components of the exhaust system. Exhaust leaks are commonly the result of loose clamp bolts, corroded or punctured pipes. In addition to excessive noise, a leaking exhaust system could allow toxic gases to enter the vehicle. Damage to surrounding components from hot gases could result as well. Replace damaged or corroded exhaust components immediately.

Inspect the exhaust system as follows:

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

When operating the engine in a closed area such as a service garage, vent exhaust gases to the outside by means of a shop vent hose placed over the exhaust outlet pipe.

	<h2>WARNING</h2>
<p>Avoid breathing exhaust gases. Exhaust gases are poisonous and contain carbon monoxide, an odorless and colorless gas that can cause unconsciousness or death. If exhaust gases enter the vehicle, the cause(s) must be located and corrected immediately.</p>	

<p><b>NOTE</b></p> <p><i>The key to successful regeneration is high exhaust temperature for an extended period. For this reason, insulating blankets must remain permanently on the exhaust system.</i></p> <p><i>If insulating blankets are removed from the system, the exhaust gases temperature may not be high enough to permit efficient particulate oxidation during passive regeneration, resulting in increased fuel consumption due to overuse of active or stationary regeneration.</i></p>
--

**1.2 FLEXIBLE COUPLING INSTALLATION**

The flexible coupling contains a rigid interior pipe (Fig. 2). To allow appropriate flexibility once installed, be sure interior pipe is concentric to flexible part and that the flexible coupling is

straight when installed. This piece of equipment handles vibration and thermal expansion.

**CAUTION**

Adequately support the exhaust system line. **Do not** transfer the load of the exhaust line to the turbocharger.

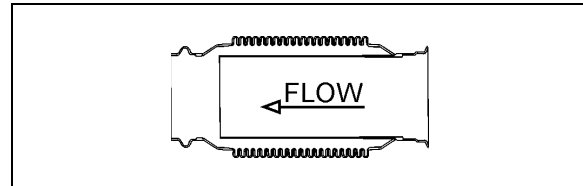


FIGURE 2: FLEXIBLE COUPLING 04022

**2. AFTERTREATMENT DEVICE (ATD)**

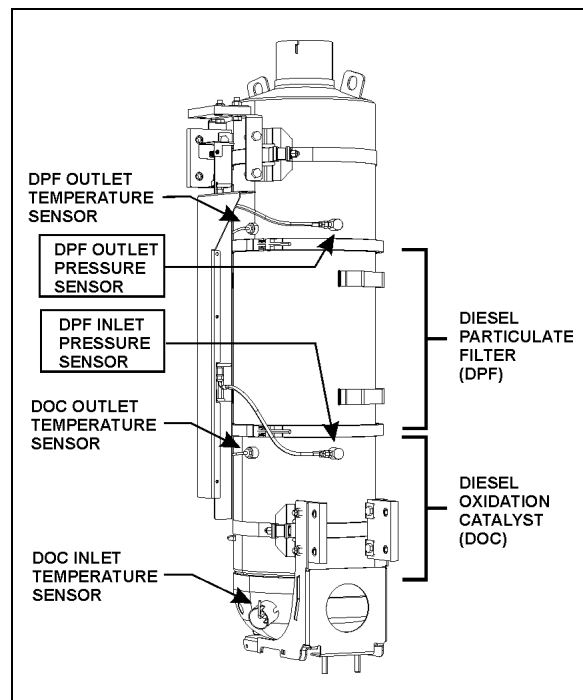


FIGURE 3: AFTERTREATMENT DEVICE (ATD USED WITH DDC S60 ENGINE SHOWN, ATD USED VOLVO D13 ENGINE IS SLIGHTLY DIFFERENT) 04016

Besides trapping soot, the **DPF (Diesel Particulate Filter)** also traps the ash generated during burning of additives in engine oil. However, unlike soot, ash cannot oxidize. The ash that accumulates in the filter will eventually cause an increase in exhaust backpressure. DDEC VI or EMS will constantly monitor the ash accumulation and forecast the approximate time until DPF ash cleaning is required. This allows

you the opportunity to plan for the DPF ash-cleaning interval. If ash cleaning is not performed proactively, and the backpressure increases beyond the system limit, DDEC VI or EMS will flag the amber warning light on the telltale panel, notifying the operator that an ash cleaning is required. Clean remanufactured DPF cartridge will be available on an exchange basis. For most vehicle applications and duty cycle, this will occur after approximately 200,000-400,000 miles (320,000-640,000 km) of operation.

**WARNING**

**HOT SURFACES**

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

Make sure Aftertreatment System components are cold before handling.

**WARNING**

**HOT EXHAUST**

During stationary regeneration, exhaust gases temperature may reach up to 1200°F (650°C) at the DPF outlet. Do not direct at combustible materials. Before initiating stationary regeneration, make sure that the DPF outlet diffuser is clear of objects and that no one is working near the DPF outlet diffuser. Stationary regenerations must be undertaken outdoors only.

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

**WARNING**

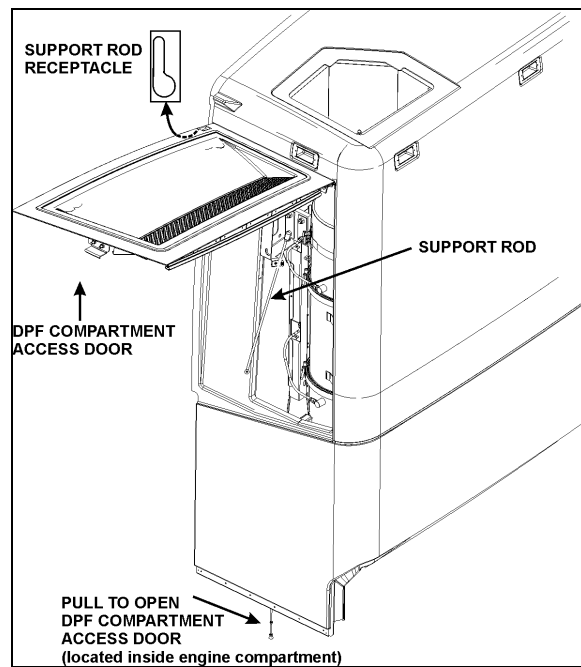
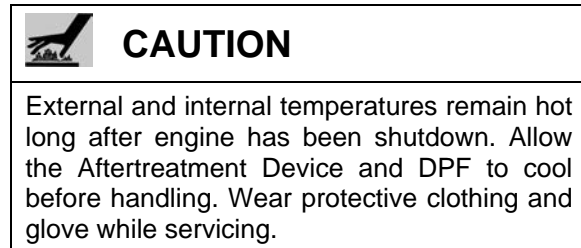
**TOXICITY**

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

## Section 04: EXHAUST SYSTEM

### 2.1 DIESEL PARTICULATE FILTER (DPF) REMOVAL – BOTH ENGINES

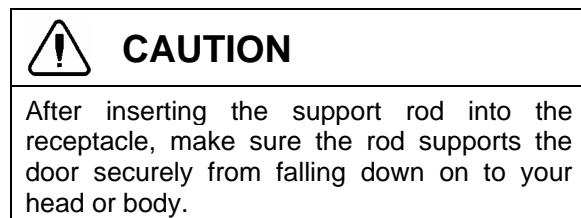
To remove the DPF, proceed as follow:



**FIGURE 4: OPENING DPF COMPARTMENT ACCESS DOOR**

04018

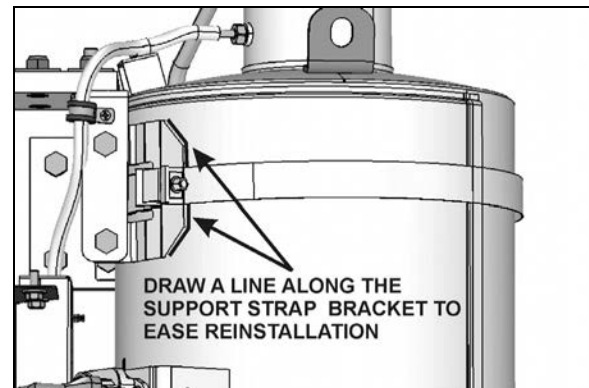
1. First, open the engine compartment door;
2. Under the ATD (Aftertreatment Device), on the left wall, pull the catch connecting rod to unlock the DPF compartment access door and lift the door open.
3. Hold the door open by inserting the support rod's free end into the receptacle located on the left side of the door;



4. From under the ATD, loosen the water drain tube's hose clamp to set free the tube, as it

will move up with the ATD later in this procedure.

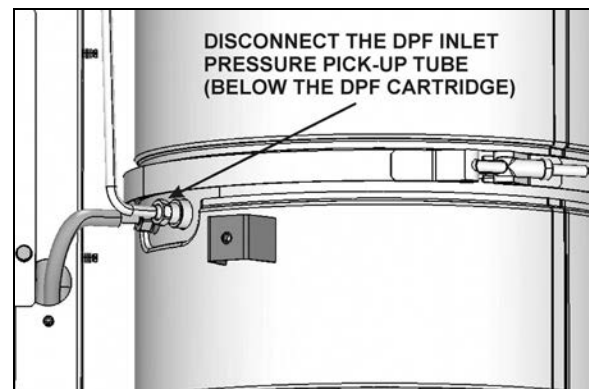
5. To ease proper positioning of the ATD and the diffuser at the time of reinstallation, using a marker, draw a line along the support strap bracket on the ATD. This will be helpful to reposition the ATD exactly as it was before removal (figure 5).



**FIGURE 5: MARKING THE SUPPORT STRAP BRACKET**

04024

6. **With Volvo D13 engine:** Disconnect the DPF inlet pressure pick-up tube, this will help to clear the way off for removal of the DPF cartridge from the compartment (figure 6).



**FIGURE 6: DISCONNECTING THE LOWER PRESSURE PICK-UP TUBE (VOLVO D13 ONLY)**

04025

7. **With Volvo D13 engine;** Dismount the differential pressure sensor and detach the two hoses from the differential pressure sensor. Detach the two pressure pick-up tubes from the support bracket. This will help to clear the way off for removal of the DPF cartridge from the compartment (figure 7).



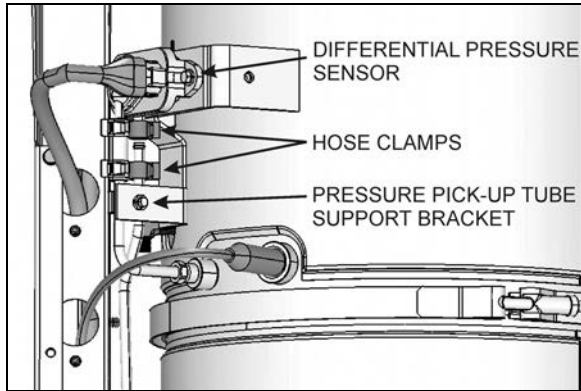


FIGURE 7: PRESSURE DIFFERENTIAL SENSOR AND TAKE UP TUBES (VOLVO D13 ONLY) 04026

8. Loosen the support strap surrounding the upper part of the Aftertreatment Device (ATD).
9. Loosen the upper V-band clamp joining the DPF to the upper part of the ATD. Slide the V-band clamp out of the way.

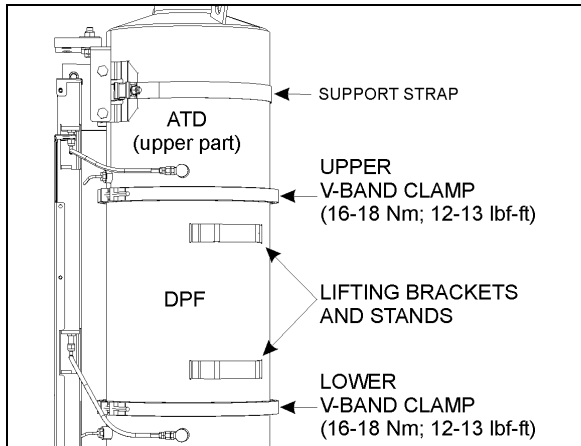


FIGURE 8: DPF REMOVAL 04019

10. Lift up the upper part of the ATD about 1" to 1 1/2" and then tighten the strap to maintain it in that raised position;

**NOTE**

*On vehicles equipped with Volvo D13 engines, you can use the vehicle's hydraulic jack to lift the upper part of the ATD. Install the jack on a wood block inside the DPF compartment and lift the upper part at the differential sensor bracket. Use a 1 1/2"X1 1/2" angle to reach the bracket after having fixed it with a C-clamp on the bracket.*

11. Loosen the lower V-band clamp and slide it out of the way;
12. Set the pressure pick-up tubes aside and pull the DPF cartridge out of the

compartment. Use appropriate handling equipment.



**CAUTION**

**HEAVY DEVICE**

A suitable lifting or holding device is required. Properly support and attach lifting equipment to prevent the DPF from falling when servicing. The DPF cartridge weighs between 50 to 54 lbs.



**CAUTION**

**FRAGILE - HANDLE WITH CARE**

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

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

**NOTE**

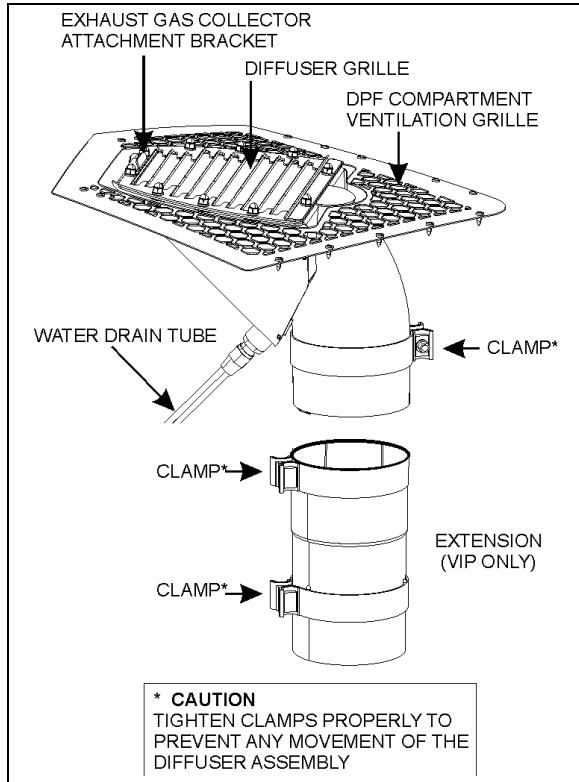
*When replacing the DPF cartridge, refer to the specifications on the DPF attached tag for proper replacement DPF selection.*

Installation of the DPF is the same as removal, but in reverse order. However, take note of the following points:

1. To prevent exhaust losses, make sure to align the DPF section with the DOC and the upper part of the ATD before tightening the V-band clamps.
2. **On Volvo D13 equipped vehicles**, the DPF cartridge uses two gaskets. Before reinstalling the DPF cartridge, maintain the gaskets in position using masking tape. Place the masking tape outside the DPF cartridge shoulder in order to avoid tape residue inside the filtering cells. Take note that the definite DPF cartridge positioning is done by the use of pins and receptacles on the DPF cartridge and ATD upper and lower sections.
3. Properly tighten all fasteners.
4. Be sure to return the support rod to its clip before closing the door, this prevents rattles.

**3. DIFFUSER ASSEMBLY**

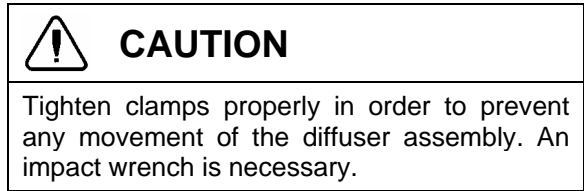
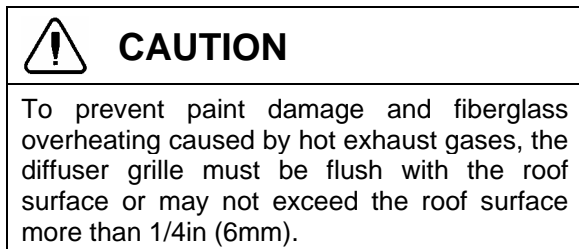
During stationary regeneration, exhaust gases temperature may reach up to 1200°F (650°C) at the DPF outlet. The diffuser decreases the exhaust gasses temperature to 475°F (246°C) approximately, at 6 inches above the diffuser. The diffuser is an important component of the exhaust system and must remain on the vehicle at all times. Operating the vehicle without the diffuser may seriously damage the vehicle.



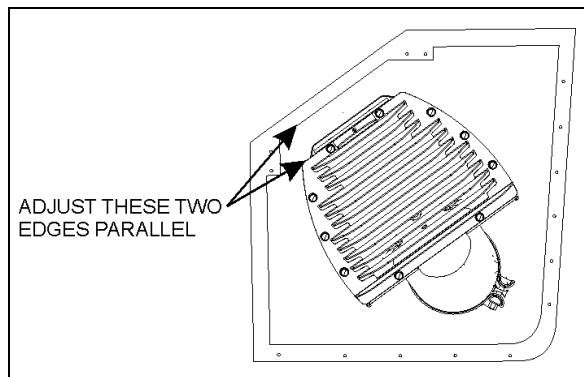
**FIGURE 9: DIFFUSER ASSEMBLY OVERVIEW** 04014

**3.1 DIFFUSER ADJUSTMENT**

Should an adjustment of the diffuser position be necessary, first remove the DPF compartment ventilation grille.

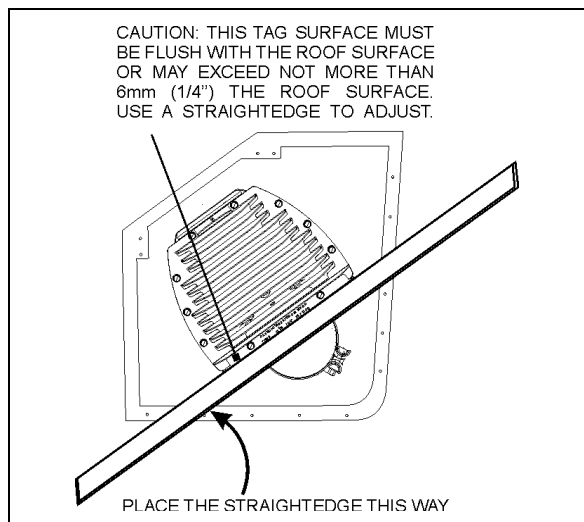


1. Loosen the clamp securing the diffuser assembly to the ATD.
2. For proper angular position, make sure that the two edges shown on figure 7 are parallel with each other.



**FIGURE 10: DIFFUSER POSITION ADJUSTMENT** 04015\_1

3. Using a straightedge, adjust the diffuser assembly level. The top surface of the tag fixed on the diffuser grille must be flush with the roof surface (fig.8). It may exceed about 1/4in (6mm). Place the straightedge as shown on figure 8.



**FIGURE 11: DIFFUSER POSITION ADJUSTMENT** 04015\_2

4. Tighten the clamp securing the diffuser assembly to the ATD.
5. Reinstall the DPF compartment grille. Put a small quantity of Sika 221 on screws (fig.9).

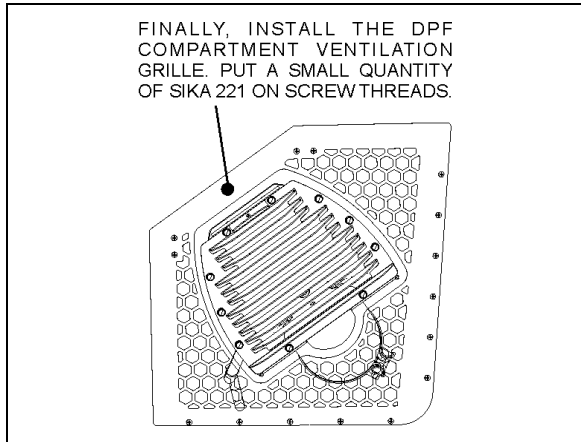


FIGURE 12: DIFFUSER POSITION ADJUSTMENT  
04015\_3

### 3.2 MAINTENANCE

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

- Inspect diffuser grille for stress cracking;
- Check for presence of foreign matter and debris inside the diffuser housing, remove and clean if applicable;
- Check for proper functioning of the rain cap inside the diffuser housing, make sure that it moves freely;
- Make sure that the water drain tube is not clogged. Pour a cup of water into the diffuser housing and assure that all the water drains at once at the other end of the drain tube. If tube is clogged, remove tube and blow compressed air inside, in reverse flow;
- Check that the warning plate “this diffuser surface must be flush with the roof surface” is still in place.

### 3.3 DIFFUSER EXTENSION - VIP

A diffuser extension is available for converters. To install:

1. Remove the existing diffuser grille;
2. Mount the extension on the diffuser housing. Secure with the 10 existing cap nuts;
3. Slide the heat shield over the extension;
4. Place the diffuser grille over the assembly and secure with a second set of 10 identical cap nuts.

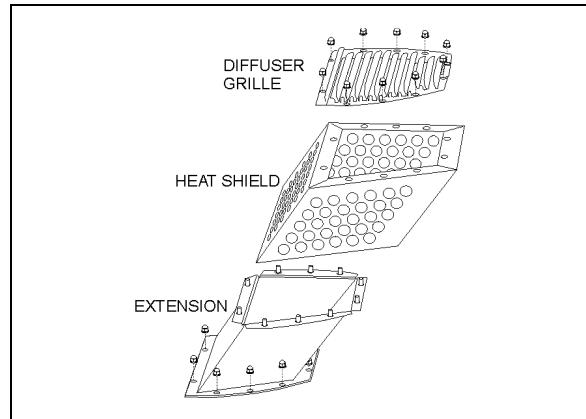


FIGURE 13: DIFFUSER EXTENSION

04021

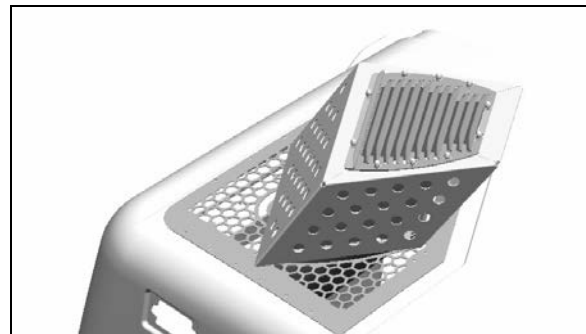


FIGURE 14: DIFFUSER EXTENSION FOR MOTORHOMES

### 3.4 EXHAUST GAS COLLECTION ADAPTER

A diffuser adapter (Prevost #040710) is available through Prevost Parts to permit connection with current exhaust gas collecting system.



#### CAUTION

To prevent paint damage and fiberglass overheating caused by hot exhaust leaks or back drafts that other collection device may produce, always use Prevost adapter #040710.

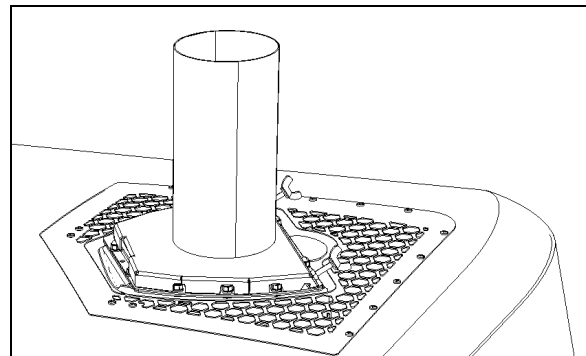


FIGURE 15: EXHAUST GAS COLLECTION ADAPTER  
#040710

04020



# SECTION 05: COOLING SYSTEM

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## 1. DESCRIPTION

A radiator and thermo-modulated fan are used to effectively dissipate the heat generated by the engine. A centrifugal-type water pump is used to circulate the engine coolant (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 oil cooler before going through the oil cooler and the cylinder block.

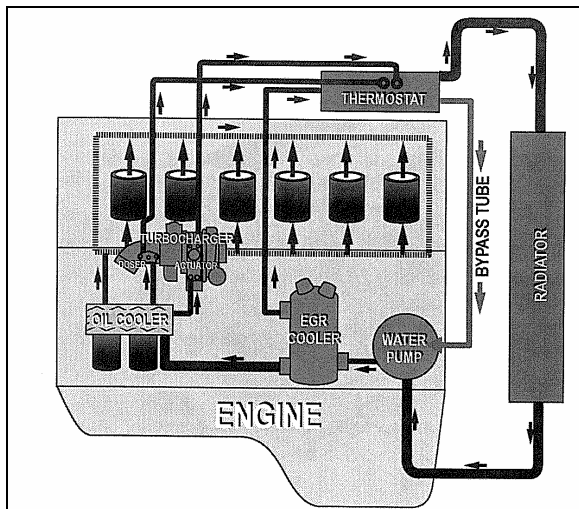


FIGURE 1: COOLANT FLOW SCHEMATIC (IMAGE DDC)

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.

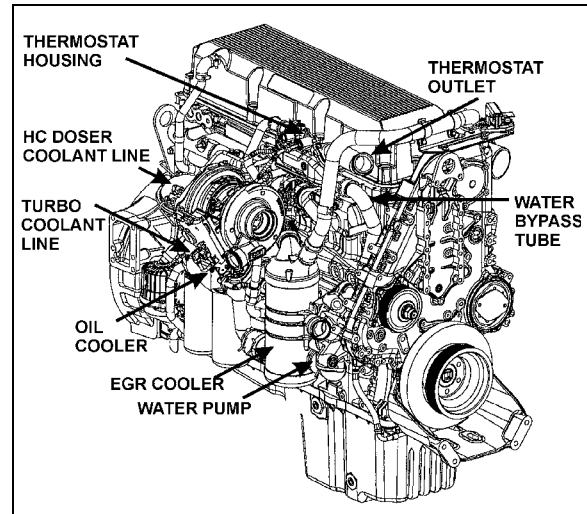


FIGURE 2: COOLING SYSTEM COMPONENTS (DDC S60 ENGINE)

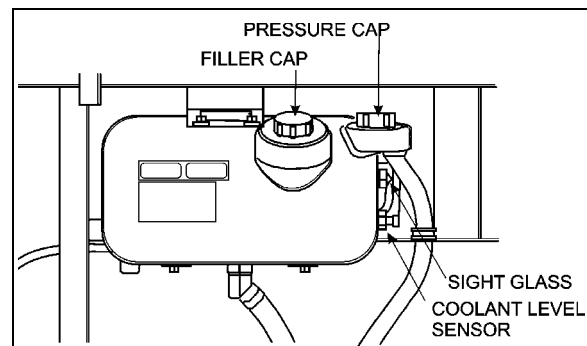


FIGURE 3: SURGE TANK - ENGINE COMPART. 05113

The cooling system is filled through a filler cap on the surge tank (Fig. 3). A pressure cap on top of 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. 4). Two thermostats are located in the housing attached to the right side of the cylinder head (Fig. 2). Furthermore, a water temperature sensor mounted on the cylinder head (radiator side) is also supplied for engine protection purposes (DDC S60).

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

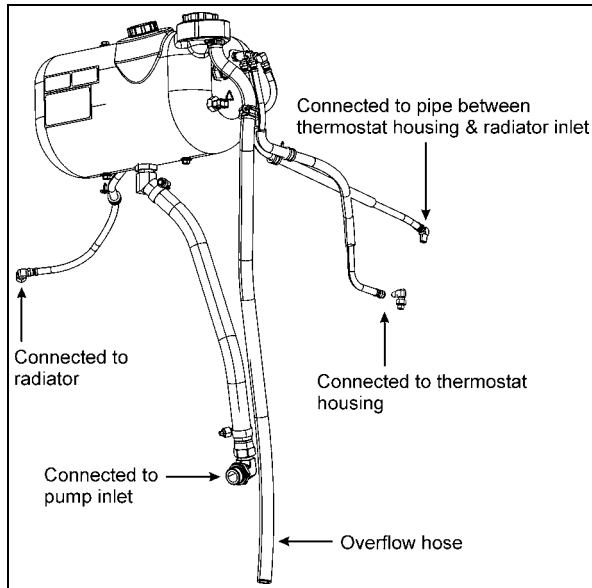


FIGURE 4: SURGE TANK (WITH DDC S60) 05115

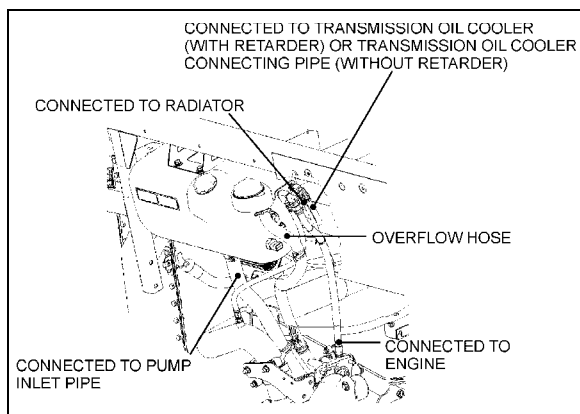


FIGURE 5: SURGE TANK (WITH VOLVO D13) 05143

## 2. MAINTENANCE

### 2.1 GENERAL RECOMMENDATIONS

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

- Check coolant level in the surge tank daily, and correct if required. Test antifreeze strength.
- Check belts for proper tension; adjust as necessary and replace any frayed or badly worn belts.
- Check radiator cores for leaks and make sure the cores are not clogged with dirt or insects. To avoid damaging the fins, clean cores with a low-pressure air hose. Steam clean if required.

- Inspect the water pump operation. A leaky pump sucks in air, increasing corrosion.
- Repair all leaks promptly. Unrepaired leaks can lead to trouble. Inspect and tighten radiator mounts periodically. Test and replace 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.

### 2.2 WITH DETROIT DIESEL SERIES 60



#### MAINTENANCE

Maintain the prescribed inhibitor strength levels as required. Coolant and inhibitor concentration must be checked at each engine 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 "SPIN-ON COOLANT FILTER" in this section. If the vehicle is not equipped with a filter, add the recommended inhibitor concentration to the antifreeze/water solution.





## MAINTENANCE

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 precharge 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 containing Supplemental Coolant Additives (SCA).*

Coolant must be discarded in an environmentally safe manner.

#### 2.2.1 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).

#### 2.2.2 Vehicles with coolant filters

Replace the coolant precharge element filter with 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 "*SPIN-ON 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.

### NOTE

*The precharge coolant filter contains inhibitors.*

#### 2.3 WITH VOLVO D13 ENGINE

### NOTE

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



## MAINTENANCE

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

### 3. HOSES

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

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

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

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

#### 3.1 CONSTANT-TORQUE HOSE CLAMPS ON COOLANT LINES - DDC S60 & VOLVO D13

All hose clamps of 1 3/8" ID (Fig. 6) and over, used on the heating and cooling systems, are of the "*Constant-torque*" type. These two types of clamps are worm-driven, made of stainless steel, supplied with a spring or with a series of Belleville spring washers.

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

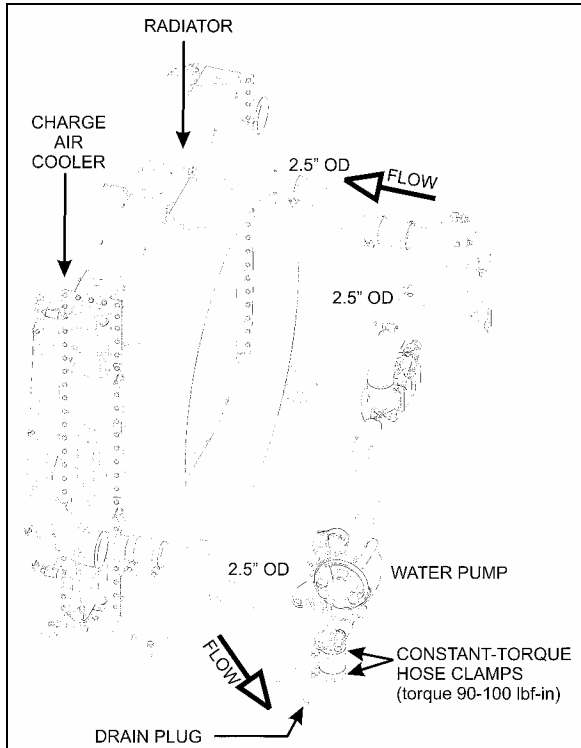


FIGURE 6: COOLANT FLOW TO RADIATOR 05119

**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 1/4" (6 mm) beyond the housing (Fig. 7).

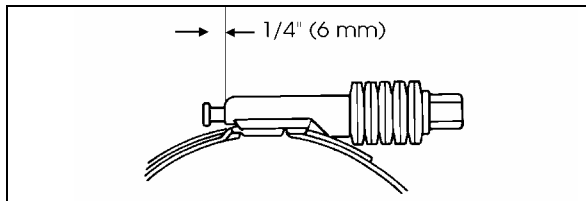


FIGURE 7: CONSTANT-TORQUE CLAMP 05037

**CAUTION**

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

**Maintenance**

The constant-torque clamps contain a "Visual torque check" feature. When the tip of the screw is extending 1/4" (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 retorque hose clamps on a regular basis. During vehicle operation and shutdown, the screw tip will adjust according to the temperature and pressure changes.

**Checking for proper torque should be done at room temperature.**

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

If for any reason such as an accident, hose clamps need to be changed; install and tighten hose clamps to 10±1 lbf-ft (dry) (Fig. 8).

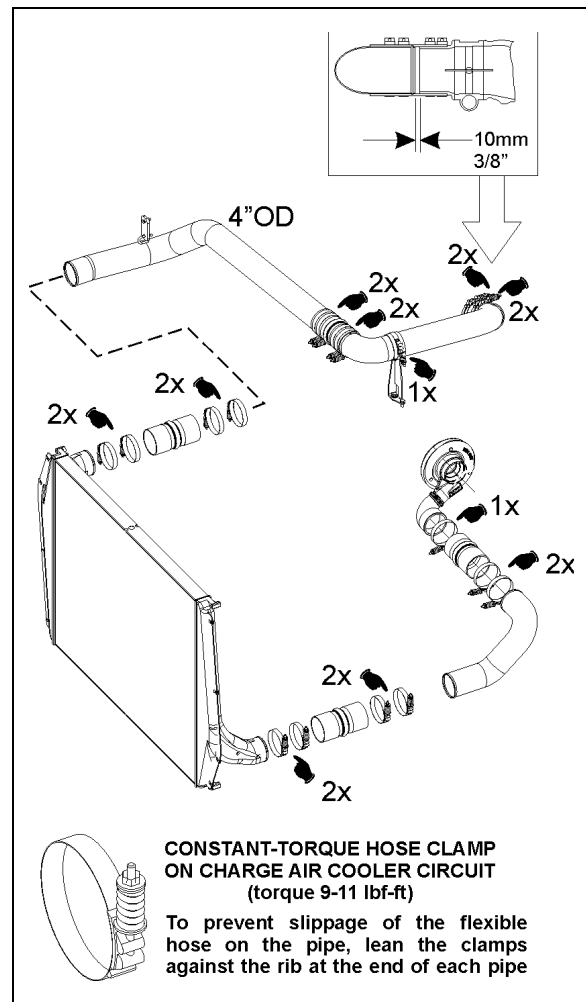


FIGURE 8: CHARGE AIR COOLER HOSE CLAMPS 05120

**NOTE**

Detroit Diesel Series 60 and Volvo D13 engines have similar CAC piping designs and they use the same constant-torque hose clamps. Tighten hose clamps as specified above.



**CAUTION**

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

**Maintenance**

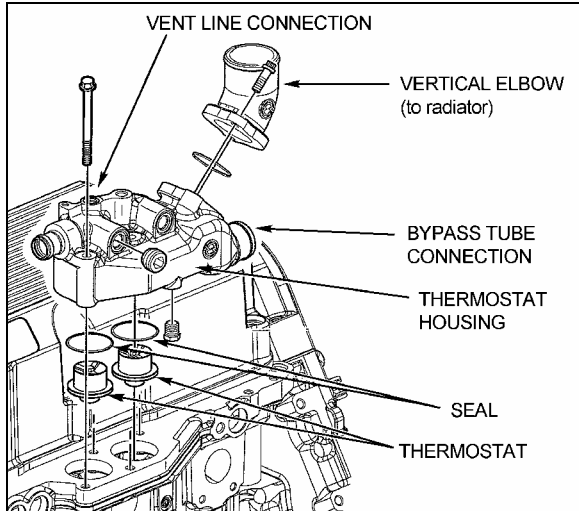
Since the constant-torque clamp automatically adjusts to keep a consistent sealing pressure, there is no need to retorque hose clamps on a regular basis. During vehicle operation and shutdown, the screw tip will adjust according to the temperature and pressure changes.

**Checking for proper torque should be done at room temperature.**

**4. THERMOSTAT OPERATION**

**4.1 WITH DETROIT DIESEL SERIES 60**

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. 9).



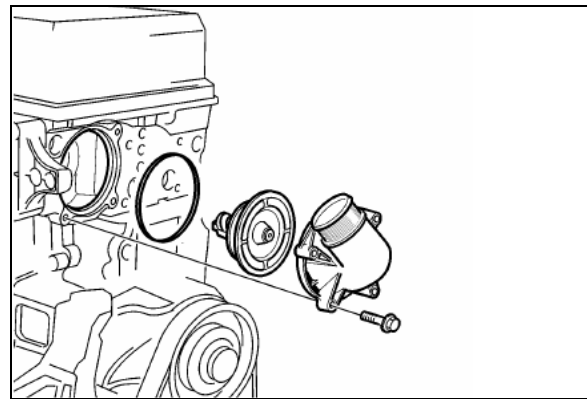
**FIGURE 9: THERMOSTAT HOUSING (DDC S60 ENGINE)**  
05117

At coolant temperature below approximately 182°F -188°F (83°C-86°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 182°F -188°F (83°C-86°C) the thermostat valves start to open, restricting the bypass

system, and allowing a portion of the coolant to recirculate through the radiator. When the coolant temperature reaches approximately 202°F (95°C) thermostat valves are fully open, the bypass system is blocked off and the coolant is directed through the radiator.

**4.2 WITH VOLVO D13 ENGINE**

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



**FIGURE 10: THERMOSTAT HOUSING (VOLVO D13 ENGINE)**

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

**4.2.1 Thermostat Checking**

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

**NOTE**

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

## Section 05: COOLING SYSTEM

1. Warm up water in a receptacle to 75°C (167°F) and immerse the thermostat in the water. Use a piece of wire attached to the thermostat.
2. After at least 30 seconds, check that the thermostat is still closed.
3. Now warm the water to 100°C (212°F). After at least 30 seconds at the boiling point, check that the thermostat has opened at least 7mm (9/32in). If the thermostat has not opened, it must be replaced. A good thermostat starts to close at 95°C (203°F) and is fully closed at approximately 85°C (185°F).

### 5. COOLANT

#### 5.1 COOLANT LEVEL VERIFICATION

Coolant level is correct when cold coolant is visible through the surge tank sight glass (Fig. 11). If coolant level is low, fill cooling system.

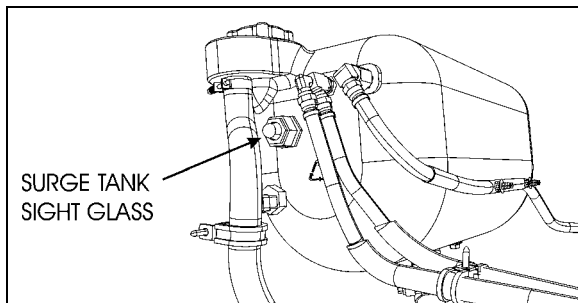
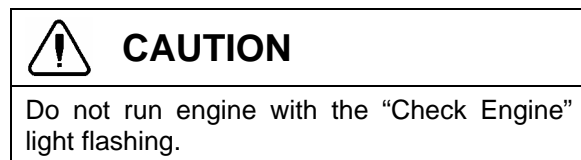


FIGURE 11: SURGE TANK SIGHT GLASS 05114

#### 5.2 COOLANT LEVEL SENSOR

This warning device consists of a fluid level probe mounted on the surge tank. The probe sends a signal to the engine control module to indicate coolant level. If the coolant level drops below the probe, the "Check Engine" light flashes and a diagnostic code is registered (see section 01 "ENGINE").



The level probe is mounted on the R.H. side of the surge tank.

#### 5.3 THAWING COOLING SYSTEM

If the cooling system becomes frozen solid, place the coach in a warm area until the ice is completely thawed. Under no circumstances should the engine be operated when the cooling system is frozen, as it will result in engine overheating due to insufficient coolant.

Once thawed, check engine, radiator and related components for damage caused by expansion of frozen coolant fluid.

#### 5.4 COOLING SYSTEM RECOMMENDATIONS

Always maintain cooling system at the proper coolant level. Check daily.

The cooling system must be pressurized to prevent localized boiling of coolant. The system must be kept clean and leak-free. The filler and pressure caps must be checked periodically for proper operation.

The coolant provides a medium for heat transfer and controls the internal temperature of the engine during operation. In an engine having proper coolant flow, some of the combustion heat is conveyed through the cylinder walls and the cylinder head into the coolant. Without adequate coolant, normal heat transfer cannot take place within the engine, and engine temperature rapidly rises. Coolant must therefore be carefully selected and properly maintained.

Select and maintain coolant in order to meet the following basic requirements:

- Provide for adequate heat transfer.
- Provide protection from cavitation damage.
- Provide a corrosion and erosion resistant environment within the cooling system.
- Prevent formation of scale or sludge deposits in the cooling system.
- Be compatible with the cooling system hose and seal materials.
- Provide adequate freeze protection during cold weather operation.

When freeze protection is required, a mixture of suitable water and antifreeze containing adequate inhibitors will provide a satisfactory coolant fluid.

Freeze protection down to:	percentage of antifreeze in mixture
-13°F (-25°C)	40%
-22°F (-30°C)	46%
-36°F (-38.5°C)	54%
-51°F (-46°C)	60%

5.5 COOLANT RECOMMENDATIONS FOR DETROIT DIESEL SERIES 60 ENGINE

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



**Recommended phosphate free coolants for Detroit Diesel S60 engine:**

- Prevost #685125;
- Detroit Diesel "DDC Power Cool" (P/N 23512138);
- Prestone AF977 (bulk), 72702 (3.78 L), 70119 (205L), 70102 (4L).

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).

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.

5.5.1 Coolant Not Recommended

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

5.5.2 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

## Section 05: COOLING SYSTEM

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.

### 5.5.3 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 below:

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)

#### **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.*

### 5.5.4 Additives Not Recommended

- Soluble Oils;
- 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 ¼ 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.

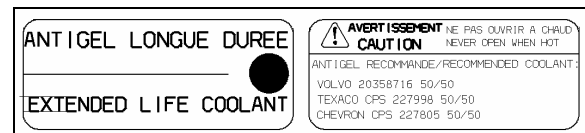
### 5.6 COOLANT RECOMMENDATIONS FOR VOLVO D13 ENGINE

Coolant mixture consisting of 50/50 antifreeze and deionized water solution should be used year-round to provide freeze and boil-over protection as well as providing a stable environment for seals and hoses.

When topping up coolant, use the same coolant mixture type as the mixture already in the cooling system. Do not mix two different types of coolant.

Do not use antifreeze formulated for automobile gasoline engines, these have a very high silicate content that will clog the radiator and leave unwanted deposits in the engine.

A decal (053487) located on the surge tank provides information on recommended coolants.



#### **Recommended coolants for Volvo D13 engine:**

- Prevost #685241 (pre-diluted 50/50 mixture);
- Texaco CPS#227998 (pre-diluted 50/50 mixture);
- Chevron CPS#2227805 (pre-diluted 50/50 mixture);
- Volvo 20358716 (pre-diluted 50/50 mixture);

**CAUTION**

On Volvo D13 engine, use **only** Extended Life Coolant (ELC). **Do not** add supplemental coolant additives (SCA) to extended life coolant. **Do not** use a coolant filter containing Supplemental Coolant Additives (SCA).

**CAUTION**

Extended Life Coolant (ELC) will test as out of additives (SCA), but SCA should not be added. Shortened engine life may be the result of adding SCA.

**6. DRAINING COOLING SYSTEM**

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

To drain engine and related components:

1. Stop engine and allow engine to cool. Close both heater line shut-off valves. One valve is located in the engine compartment near the water pump (Fig. 12). Another valve is located behind rear fender, above the L.H. rear wheelhousing near the optional coolant heater.

**NOTE**

Refer to section 22 under "Preheating System" for information about preheater access and heater line shutoff valve.

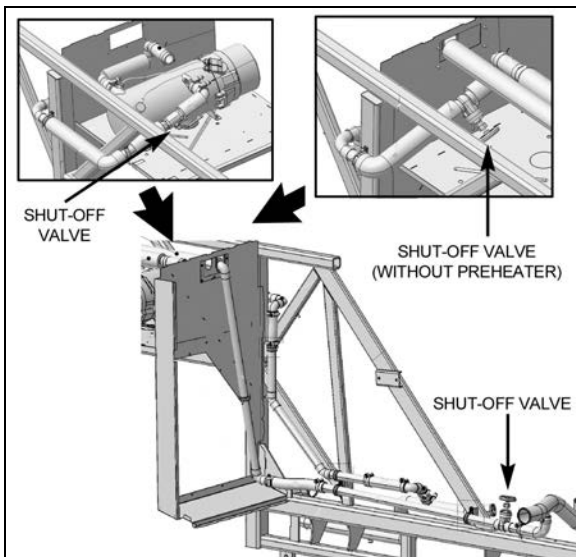


FIGURE 12: HEATER LINE SHUTOFF VALVES 05144

**WARNING**

Before proceeding with the following steps, make sure the coolant has cooled down. The sudden release of pressure from a heated cooling system can result in loss of coolant and possible personal injury (scalding) from the hot liquid.

2. Close the shut-off valves on the coolant filter mounting head (if applicable) and remove filter (perform only if filter as to be replaced).
3. Open the shut-off valves on the coolant filter mounting head (if applicable) and drain the coolant into a suitable container. Close the shut-off valves.
4. Unscrew the surge tank pressure cap counterclockwise, ¼ turn to let air enter the system and permit the coolant to drain completely from system.
3. Remove the water pump inlet pipe drain plug, plus the transmission oil cooler delivery line drain plug (Fig. 13). Drain the coolant into an approved container.

**NOTE**

On Volvo D13 engine, the regular drain plugs are replaced by quick connect fittings to ease draining and filling of coolant system.

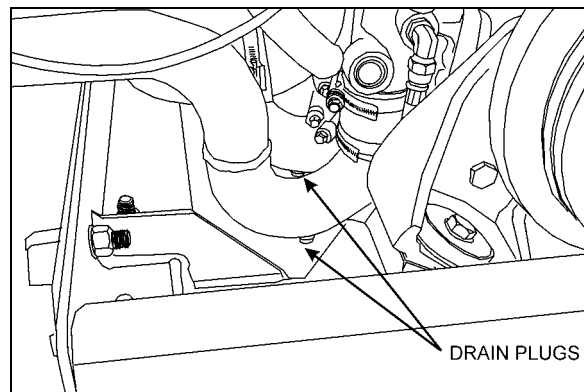


FIGURE 13: DRAIN PLUGS 05093

4. Unscrew drain plug at bottom of thermostat housing (if applicable) to drain coolant trapped above the thermostats (Fig. 9).
5. Unscrew the transmission oil cooler drain plug (if applicable). Remove oil cooler, flush and inspect. Refer to Section 7, "TRANSMISSION" for oil cooler maintenance or preventive replacement.



**CAUTION**

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.

**NOTE**

To drain the entire system, do the previous steps while maintaining the shutoff valves in the open position; then follow the procedure under "Draining Heating System" in Section 22.

**7. FILLING COOLING SYSTEM**

If only the engine and related components were drained, maintain the two heater line shutoff valves in their closed position, then proceed as follows:

1. Close all drain cocks. Reinstall the drain plugs with new seals. Refer to draining procedure for the location of draining points.
2. Open the shut-off valves on the coolant filter mounting head (if applicable).
3. Refill cooling system from the surge tank filler cap inlet with the recommended ethylene glycol-based antifreeze and water solution of the required concentration.

**NOTE**

*On Volvo D13 engine, the regular drain plugs are replaced by quick connect fittings to ease draining and filling of coolant system. Coolant system may be refilled by the use of the quick connect fittings.*

**NOTE**

*Make sure the purge lines are properly connected and not obstructed. The purge lines (thermostat housing dome, radiator top tank, transmission oil cooler or delivery line) are required to ensure complete engine fill and proper purging of air in the system.*

**NOTE**

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

4. Install the filler and pressure 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 warning light will illuminate.*

5. Stop engine and allow cooling.
6. Open the two heater line shutoff valves, check the coolant level in the surge tank, and then add as required.



**CAUTION**

Never pour cold coolant into a hot engine. The sudden change in temperature may 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. If the vehicle is equipped with a windshield upper section defroster, momentarily pinch the hose located between the recirculating pump suction and the defroster outlet connector to ensure windshield upper section defroster complete filling. Complete the procedure by bleeding the heater cores as explained in Section 22, under "9.4 Bleeding Heating System".

**8. FLUSHING**

If the cooling system is contaminated, flush the cooling system as follows:

1. Drain the coolant from the engine.
2. Refill with clean water.



**CAUTION**

If the engine is hot, fill slowly to prevent rapid cooling and distortion of the engine castings.

3. To thoroughly circulate the water, start and run the engine for 15 minutes after the thermostats have opened.



4. Fully drain system.
5. Refill with clean water and operate for 15 minutes after the thermostats have opened.
6. Stop engine and allow cooling.
7. Fully drain system.

Vehicles without coolant filters:

Fill with a 50/50-antifreeze/water solution and add required inhibitors.

Vehicles with coolant filters (DDC Series 60 engine):

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

Vehicles with coolant filters (Volvo D13 engine):

Fill with a 50/50-antifreeze/water solution. Replace coolant filter as per the Lubrication And Servicing Schedule in section 24 if required.

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

COOLING SYSTEM CAPACITY (approximation)
Includes heating system: 24 US gal (91 liters)

### 8.1 COOLING SYSTEM DESCALERS

If the engine overheats and the fan belt tension, coolant level and thermostat operation have been found to be satisfactory, it may be necessary to de-scale and flush the entire cooling system.

Remove scale formation by using a reputable and safe de-scaling solvent. Immediately after using the de-scaling solvent, neutralize with a neutralizing agent. It is important that product directions be thoroughly read and followed.

After using the solvent and neutralizer, fully drain the system, and then reverse flush the engine and radiator (see "Reverse Flushing" in this section) before filling the system with coolant solution.

### 8.2 REVERSE FLUSHING

After the engine and radiator have been thoroughly de-scaled, they should be reverse-flushed. The water pump should be removed and the radiator and engine reverse-flushed separately to prevent dirt and scale deposits

from clogging the radiator tubes or being forced through the pump. Reverse flushing is accomplished by hot water, under pressure, being forced through the cooling system in a direction opposite to the normal flow of coolant, loosening and forcing deposits out.

The radiator is reverse flushed as follows:

1. Remove the radiator inlet and outlet hoses and replace existing radiator cap with a new one.
2. Attach a hose to the top of the radiator to lead water away from the engine.
3. Attach a hose at the bottom of the radiator and insert a flushing gun in the hose.
4. Connect the water hose of the gun to the water outlet and the air hose to the compressed air outlet.
5. Turn on the water and when the radiator is full, turn on the air in short blasts, allowing the radiator to fill between blasts.

**NOTE**  
*Apply air gradually. Do not exert more than 138 kPa (20 psi) air pressure. Too great a pressure may rupture a radiator tube.*

6. Continue flushing until only clean water is expelled from the radiator.

The cylinder block and cylinder head water passages are reverse flushed as follows:

1. Remove the thermostats and the water pump.
2. Attach a hose to the water inlet of oil cooler housing to drain water away from engine.
3. Attach a hose to the water outlet at the top of the cylinder head (thermostat housing) and insert the flushing gun in the hose.
4. Turn on the water until the jackets are filled, and then turn on the air in short blasts. Allow jackets to fill with water between air blasts.
5. Continue flushing until the water from the engine runs clean.


If scale deposits in the radiator cannot be removed by chemical cleaners or reverse flushing as outlined above, it may be necessary to remove the upper tank and rod out the individual radiator tubes with flat steel rods. Circulate the water through the radiator core from the bottom to the top during this operation.

**9. SPIN-ON COOLANT FILTER**


The optional engine cooling system filter is used to filter out impurities such as scale or sand from the coolant. On Detroit Diesel S60 engines it also eliminates the process of adding inhibitors to the antifreeze/water solution. The filter is mounted onto the cooling fan drive mechanism aluminum casting (Fig. 14).

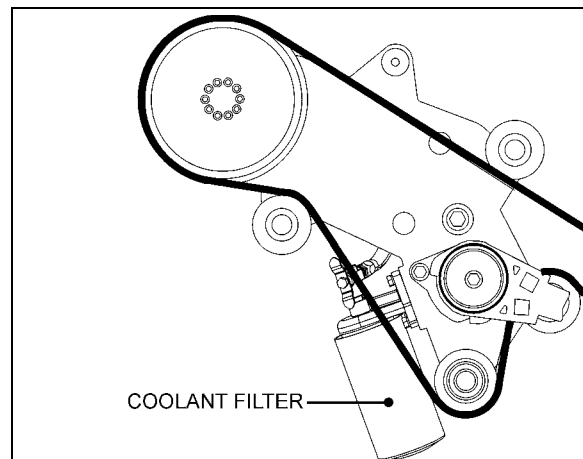
**To replace a filter:**

1. Close the filter shut-off valves (two on DDC S60, one on Volvo D13) on the filter mounting head (if applicable) and unscrew the old filter from mounting.

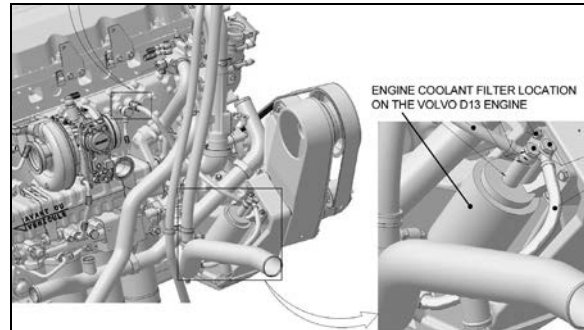
	<p><b>WARNING</b></p>
<p>Failure to relieve cooling system pressure may result in personal injury.</p>	

2. Remove and discard the filter. Recover the coolant remaining in the filter with a suitable container.
3. Clean the filter adapter with a clean, lint-free cloth.
4. Coat surface of gasket with clean antifreeze, tighten 2/3 to 1 turn after gasket makes contact with head.
5. Open the filter shut-off valves.
6. Start engine and check for leaks. After shutdown, replenish fluid as necessary.


	<p><b>CAUTION</b></p>
<p>Do not exceed recommended service intervals.</p>	




**FIGURE 14: COOLANT FILTER (DDC S60 ENGINE)** 05122



**FIGURE 15: COOLANT FILTER (VOLVO D13)** 05145

	<p><b>MAINTENANCE</b></p>
<p><b>VOLVO D13 ENGINE</b></p>	
<p>Replace the coolant filter cartridge after 150,000 miles (240 000 km) or one year to prevent external rust damage to the filter walls. <b>Do not</b> use a coolant filter containing Supplemental Coolant Additives (SCA).</p>	
<p><b>Coolant filter cartridge</b> (Volvo D13): #20458771</p>	


	<p><b>MAINTENANCE</b></p>
<p><b>DETROIT DIESEL S60 ENGINE</b></p>	
<p>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.</p>	
<p><b>PRECHARGE ELEMENT FILTER</b> Prevost number: 550629</p>	
<p><b>MAINTENANCE ELEMENT FILTER</b> Prevost number: 550630</p>	
<p><b>CORROSION INHIBITOR &amp; COOLANT STABILIZER</b></p>	
<p>Make: Detroit Diesel</p>	<p>Number: 23507857</p>
<p>Make: Nalco</p>	<p>Number: DD3000-15</p>

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

### 10. RADIATOR

The radiator is mounted at the L.H. side of engine compartment. It is designed to reduce the temperature of the coolant under all operating conditions. It is essential that the radiator core be kept clean and free from corrosion and scale at all times.

#### 10.1 MAINTENANCE



### MAINTENANCE

Inspect the exterior of the radiator core every 25,000 miles (40 000 km) or once a year, whichever comes first. Clean with a quality grease solvent, such as a mineral spirits and dry with compressed air. Do not use fuel oil, kerosene, gasoline, or any caustic material. It may be necessary to clean the radiator more frequently if the vehicle is operated in extremely dusty or dirty areas. Refer to coolant system flushing and reverse flushing in this section for maintenance of radiator interior.

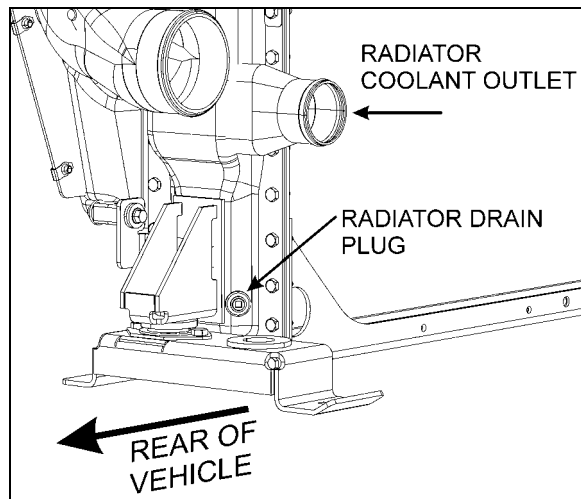


FIGURE 16: RADIATOR DRAIN PLUG 05129


### 11. CHARGE AIR COOLER (CAC) LEAKAGE

Spec for CAC acceptable leakage: The CAC is considered acceptable if it can hold 30 psi (206 kPa) gauge pressure with not more than 5 psi (34 kPa) loss in 15 seconds after turning off the hand valve.

**NOTE**


*This spec does not apply if there is any evidence that the leak was caused by a foreign object impact.*

### 12. RADIATOR & CHARGE AIR COOLER REMOVAL



### WARNING

Potential Accident Risk. Always use extreme caution when working in the vicinity of hot, rotating or moving parts.



### WARNING

Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine.

1. Remove the left rear fender. Refer to paragraph REAR FENDER REMOVAL in section 18 of this manual for the complete procedure. Remove the panel giving access to the radiator & charge air cooler. This panel is located just next to the left tag axle wheel.

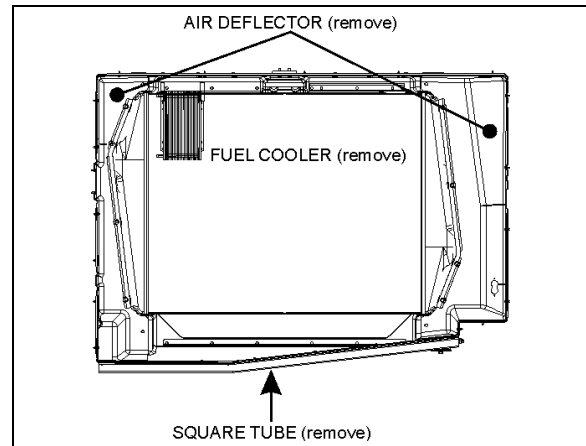


FIGURE 17: LOCATION OF SQUARE TUBE 05131

2. Close the heater line shutoff valves. One valve is located in the engine compartment near the water pump (Fig. 12). The other valve is located behind rear fender, above the L.H. rear wheelhousing near the optional coolant heater.
3. Disconnect the radiator overflow line at the top of it.
4. Drain the radiator. To do so, unscrew and remove the drain plug located under the coolant line elbow, at the water pump inlet (see fig. 6).

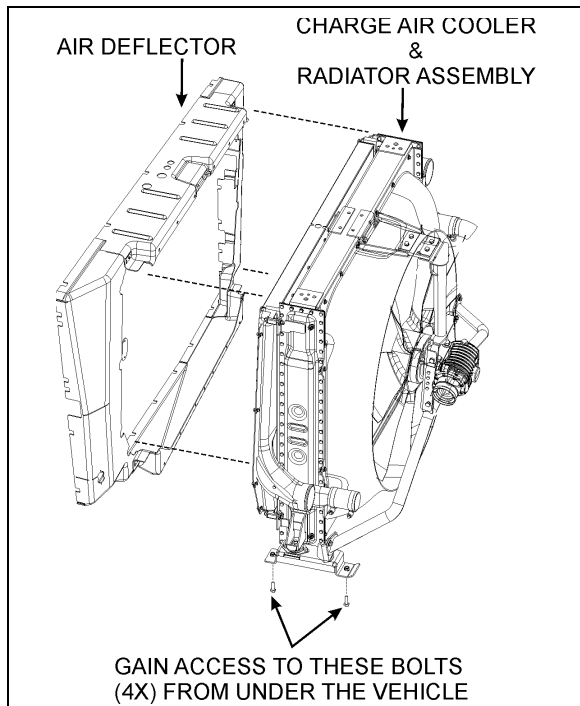


FIGURE 18: REMOVAL OF THE RADIATOR & THE CHARGE AIR COOLER

05130

5. Open the radiator door and remove the door auxiliary arm (not the hinges) and lower square tube (see fig. 17).
6. Remove the air deflector (4 pieces).
7. Dismount the fuel cooler without disconnecting the fuel lines from the cooler.
8. Remove the blue flexible hose connections at the inlet and outlet of the charge air cooler and radiator. Place a plastic bag around the inlet and outlet tubes to prevent foreign matter from entering inside these components.
9. Disconnect the universal joint shaft at the right angle gearbox and dismount the drive pulley (refer to paragraph DRIVE PULLEY AND UNIVERSAL JOINT SHAFT in this section).
10. Unplug the magnetic fan clutch connector.
11. From under the vehicle, unscrew bolts securing the radiator & charge air cooler assembly to the vehicle (see fig. 18).
12. Dismount the bracket securing the upper part of the radiator & charge air cooler assembly.
13. With the help of a fork lift truck, take out the radiator & charge air cooler assembly from the vehicle.

### 13. COOLING FAN DRIVE MECHANISM

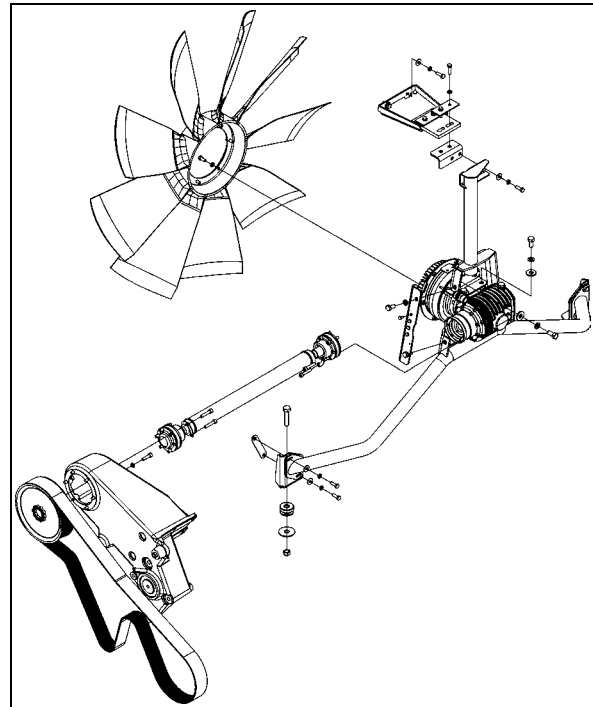


FIGURE 19: COOLING FAN DRIVE MECHANISM

#### 13.1 DRIVE PULLEY AND UNIVERSAL JOINT SHAFT

To disconnect the universal shaft, proceed as follow:



#### WARNING

Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine.

1. Unwrap the drive belt from around the pulley (see paragraph MOUNTING THE DRIVE BELT).
2. Dismount the drive pulley. Gain access to the 6 mounting bolts from behind the pulley, through the opening in the cast aluminum support (Fig. 19).
3. Unscrew and remove the universal joint shaft mounting bolts (6) at the right angle gearbox.
4. Slowly, move the shaft toward the rear of the vehicle.
5. Finally, dismount the universal joint shaft from the drive pulley (6 bolts).

Installation of the universal joint shaft is the same as removal, but in reverse order.

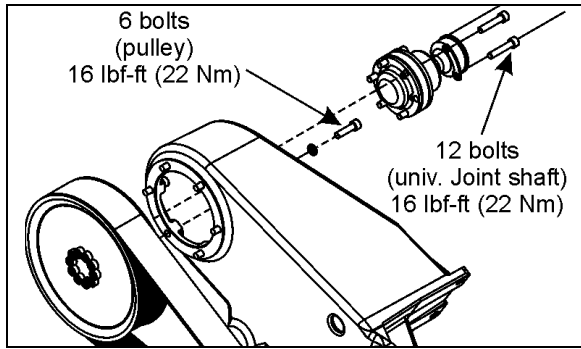


FIGURE 20: TIGHTENING SPECIFICATION 05123A

### 13.2 IDLER REPLACEMENT

If an idler is defective, replace as follow:

**WARNING**

Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine.

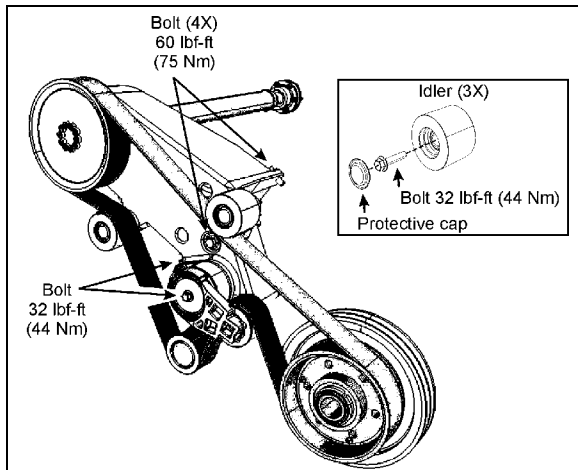


FIGURE 21: TIGHTENING SPECIFICATION (DDC S60 ENGINE) 05128

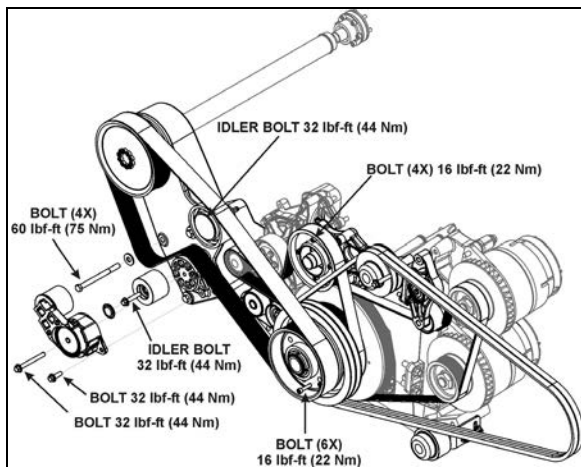


FIGURE 22: TIGHTENING SPECIFICATION (VOLVO D13 ENGINE) 05146

1. Remove the protective cap (replace with a new one).
2. Unscrew the idler mounting bolt.
3. Replace idler with a new one.

**CAUTION**

When installing the idler, make sure it rests perfectly against the bearing surface on the cast aluminum support. If not, the drive belt may slip out of the idler. See figure below.

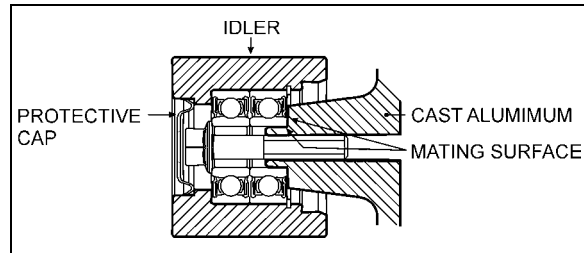


FIGURE 23: IDLER MOUNTED ON THE CAST ALUMINUM SUPPORT



4. Bolt the new idler on the cast aluminum support. Tighten to 32 lbf-ft (44 Nm).
5. Place a new protective cap.



### 14. VARIABLE SPEED COOLING FAN


The cooling fan clutch has two thermostatically controlled speeds, plus a neutral (clutch disengaged). The engine control module controls the speed by comparing data from engine coolant temperature, charge air temperature, Allison transmission oil temperature and small A/C High side pressure to a set of calibration data. The fan drive clutch is electromagnetic; the engine control module sends an electric current to regulate speed by activating one magnetic coil for the first speed and two magnetic coils for the second speed.

## Section 05: COOLING SYSTEM

The settings are (values below are for DDC S60 engine):

	Engine coolant temp.	Air intake temp.	Allison trans. oil temp.
temperature rising 	208°F: fan engages in HIGH SPEED	194°F: fan engages in HIGH SPEED	230°F: fan engages in HIGH SPEED
	203°F: fan engages in LOW SPEED	176°F: fan engages in LOW SPEED	216°F: fan engages in LOW SPEED
temperature dropping 	203°F: fan HIGH SPEED disengages	189°F: fan HIGH SPEED disengages	225°F: fan HIGH SPEED disengages
	198°F: fan LOW SPEED disengages	170°F: fan LOW SPEED disengages	210°F: fan LOW SPEED disengages

	Small A/C high side pressure
pressure rising 	170 psi: fan engages in HIGH SPEED
	120 psi: fan engages in LOW SPEED
pressure dropping 	130 psi: fan HIGH SPEED disengages
	90 psi: fan LOW SPEED disengages

 **WARNING**

DO NOT work near the fan with the engine running or the ignition in the ON position. The engine fan can engage at any time without warning. Anyone near the fan when it turns on could be seriously injured.


### 14.1 LOCKING RADIATOR FAN FOR EMERGENCY OPERATION

#### 14.1.1 Electrical Locking

If the cooling fan clutch does not function due to an electrical control system malfunction and the engine is overheating, execute the following procedure:

1. Set the ignition key to the ON position.
2. Activate the dashboard Telltale Light Test switch 3 times within 4 seconds.

3. In the engine compartment, set the starter selector switch to REAR START and then start the engine from the rear.

 **WARNING**

Potential Accident Risk. Always use extreme caution when working in the vicinity of hot, rotating or moving parts.

While in this mode, the rear start push-button can be used to manually engage the fan clutch. The multiplex system knows when the engine is already running, and it will not activate the starter.

4. Press the push-button one time to engage the clutch to 1<sup>st</sup> speed, press a second time to engage to 2<sup>nd</sup> speed, press a third time to stop the fan, press once again to return to 1<sup>st</sup> speed.

**NOTE**

*If the fan clutch does not engage using this procedure then the clutch is faulty or the wiring between the multiplex module and the clutch is faulty. Mechanically lock the fan as described in section 14.1.2.*

#### 14.1.2 Mechanical Locking

Once mechanically locked, the fan is rigidly connected to the drive mechanism and will rotate continuously, with no considerations for the cooling needs. This is an emergency situation and the vehicle shall not be operated in that situation for an extended period.

In case of a magnetic clutch malfunction:

1. Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine.
2. Disconnect the fan clutch electrical connector.
3. Unscrew and remove the 4 spare bolts screwed to the angle on the fan gearbox mounting support.
4. Turn the fan blades in order to position the locking plate bores over the rotor's threaded sockets.
5. Screw in and tighten the spare bolts (Fig. 24).
6. Using the automatic belt tensioner, release tension on the drive belt in order to be able to

rotate the fan clutch drive mechanism by hand.

7. Rotate the shaft to get access to the second locking plate and rotor threaded sockets.
8. Screw in and tighten the spare bolts.

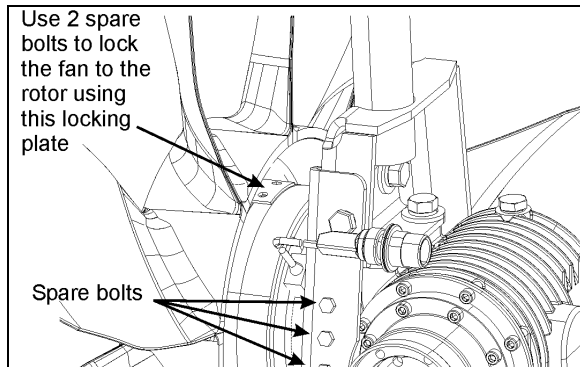


FIGURE 24: MECHANICAL LOCKING

05124

#### 14.2 MAINTENANCE

1. Clean the fan and related parts with clean fuel oil and dry them with compressed air. Do not clean with steam or high-pressure jet.
2. Check the fan blades for cracks or other damage. Replace the fan if the blades are cracked or deformed.
3. Remove any rust or rough spots in the grooves of the fan pulley. If the grooves are damaged or severely worn, replace the pulley.
4. Do not restrict fan rotation during engine operation for any reason.
5. Do not operate fan driving mechanism with a damaged fan assembly. Replace a damaged fan as soon as the fault is noted.
6. Immediately investigate and correct any operator complaint involving driving mechanism or cooling system performance.
7. When questions arise, obtain answers before proceeding. Assistance is available through the Prevost After-Sales Service support serving your area.

#### 14.3 INSPECTION



### WARNING

Set the starter selector switch in engine compartment to the "OFF" position to prevent accidental starting of the engine.

- Check security of fasteners securing fan blade assembly to fan clutch.
- Visually inspect fan driving mechanism, fan blade assembly, shroud, radiator, and surrounding area for evidence of contact between rotating and non-rotating parts.
- Check drive belt for fraying, cracking, and proper tension.
- Turn fan through at least 360° of rotation. It should turn smoothly with no resistance.

#### 14.4 FAN REMOVAL / INSTALLATION

The fan is bolted to the magnetic clutch. To remove the fan:

1. Unscrew and remove the mounting bolts and washers.

To reinstall the fan:

1. If the fan is still in the radiator fan shroud, place 2 of the mounting bolts on the opposite side of the clutch, in reverse direction, in order to use them as guide pins to position the fan.
2. Once properly positioned, screw the 4 remaining bolts back in and tighten properly (16 lbf-ft; 22 Nm).
3. Finally, take the 2 bolts that were used as guide pins and screw them back in on the proper side of the clutch and tighten properly.

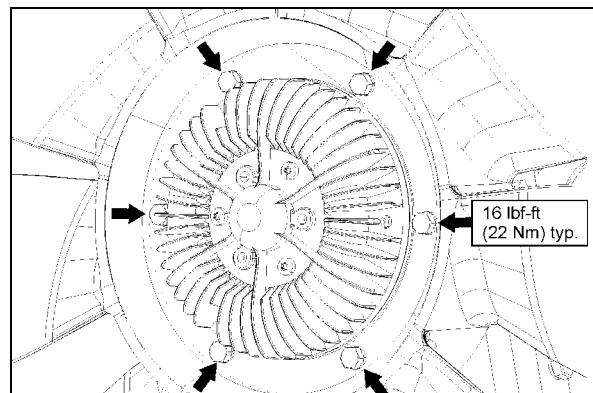


FIGURE 25: RADIATOR FAN MOUNTING BOLTS

05125

### 15. FAN RIGHT ANGLE GEARBOX

The radiator fan is belt driven from the engine crankshaft pulley through a drive belt, a universal joint shaft, a right angle gear and clutch assembly.

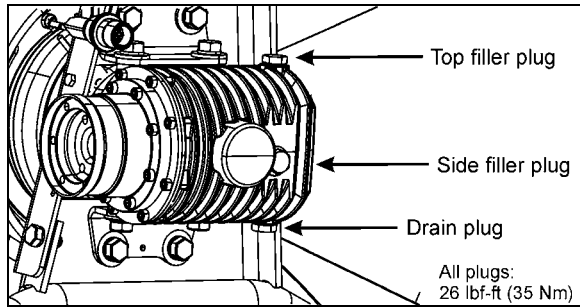



FIGURE 26: RIGHT ANGLE GEARBOX 05118

#### 15.1 MAINTENANCE

 <h2 style="margin: 0;">MAINTENANCE</h2>
<p>Change the right angle gearbox oil every 50,000 miles (80,000-km) or once a year, whichever comes first.</p> <p>Use <b>Synthetic Gear Lubricant SAE 75W-90</b>.</p>

#### 15.2 OIL CHANGE

1. Stop engine and make sure that all engine safety precautions have been observed.
2. Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine or set the rear start panel selector switch to the OFF position.
3. Remove the drain plug located underneath the right angle gearbox case and allow the oil to drain into a suitable container.
4. Replace the seal and screw the drain plug back in (torque: 26 lbf-ft).
5. Unscrew and remove the side filler plug.
6. Unscrew and remove the top filler plug.
7. Add gear lubricant. The oil level is correct once the top of the oil has reached the bottom of the side filling point.
8. Replace the seals and screw side and top filler plug back in (torque: 26 lbf-ft).
9. Clean gear case carefully.

10. Start the engine and allow running a few minutes. Stop the engine and check for leaks.

#### 15.3 REMOVAL / INSTALLATION

To remove the right angle gearbox, proceed as follow:

1. Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine.
2. Disconnect the fan clutch electrical connector.
3. Dismount the fan and lean it against the radiator (refer to previous paragraph).
4. Disconnect the universal joint shaft.

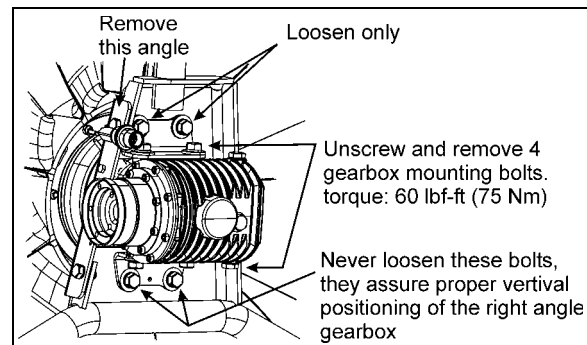


FIGURE 27: RIGHT ANGLE GEARBOX MOUNTING 05126


5. Dismount the angle (see fig. 27).
6. Loosen the gearbox support bracket top bolts.
7. Unscrew and remove 4 gearbox mounting bolts.
8. Slide the gearbox out of the support assembly.

Installation procedure is the same as removal but in reverse order. Tighten the 4 mounting bolts as specified.

### 16. COOLING FAN DRIVE BELT

#### 16.1 MOUNTING THE DRIVE BELT

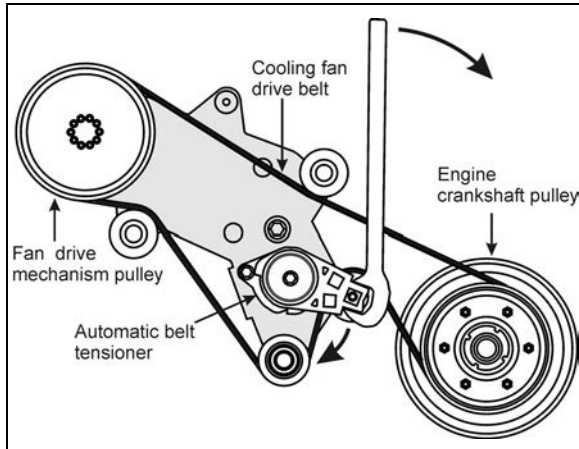
To install the cooling fan drive belt, proceed as follow:

 <h2 style="margin: 0;">WARNING</h2>
<p>Set the ignition to the OFF position and remove the key from the contact switch to prevent accidental starting of the engine.</p>

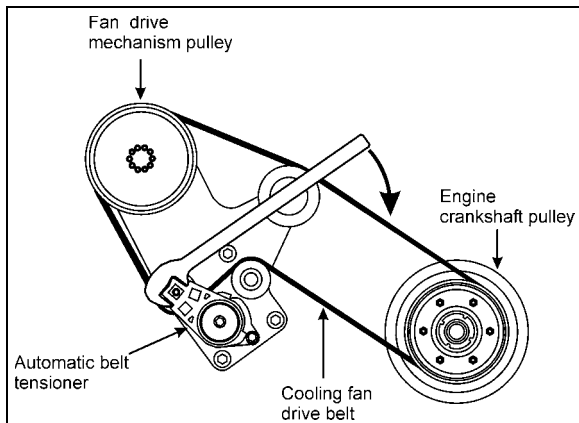


**WARNING**

Potential Accident Risk. Always use extreme caution when working in the vicinity of hot, rotating or moving parts.



**FIGURE 28: DRIVE BELT ROUTING (DDC S60 ENGINE)**  
05127



**FIGURE 29: DRIVE BELT ROUTING (VOLVO D13 ENGINE)**  
05127

4. Release the tensioner slowly and let it return to its natural position.

**COOLING FAN DRIVE BELT****With Detroit Diesel Series 60 engine**

Type: 14PK2310

Prevost number: 550921

**With Volvo D13 engine**

Type: 14PK2172

Prevost number: 5060096

1. Wrap the new drive belt around the fan drive mechanism pulley, the idlers and the automatic tensioner idler as shown on figure 28 & 29.
2. Using the special tool included with your vehicle (see inside the Warning Reflectors box located in the first curb-side baggage bay), rotate the automatic tensioner in clockwise direction to relieve tension on the belt and hold the tensioner in that position (Fig. 28 & 29).
3. Finally, place the drive belt around the engine crankshaft pulley.

## Section 05: COOLING SYSTEM

---

### 17. SPECIFICATIONS

#### Cooling System Capacity (Approximation)

Includes heating system..... 24 US gal (91 liters)

#### Thermostat - Detroit Diesel Series 60 Engine

Number used..... 2

Start to open ..... 182-188°F (83-86°C)

Fully open ..... 202°F (95°C)

#### Thermostat - Volvo D13 Engine

Number used..... 1

Start to close..... 203°F (95°C)

Fully closed..... 185°F (85°C)

#### Cooling Fan Drive Belt - Detroit Diesel Series 60 Engine

Type ..... Poly-Rib 14PK2310

Qty ..... 1

Prevost number ..... 550921

#### Cooling Fan Drive Belt – Volvo D13 Engine

Type ..... Poly-Rib 14PK2172

Qty ..... 1

Prevost number ..... 5060096

#### Coolant - Detroit Diesel Series 60 Engine

Prevost Number ..... 685125

DDC (Power Cool) ..... 23512138

Prestone (Heavy Duty)..... AF977 (bulk), 72702 (3.78 L), 70119 (205L), 70102 (4L)

#### Coolant - Volvo D13 Engine

Prevost Number ..... 685241

Texaco CPS ..... 227998

Chevron CPS ..... 2227805

#### Corrosion Inhibitor and Coolant Stabilizer - Detroit Diesel Series 60 Engine

Supplier number.....Detroit Diesel ..... 23507857

Supplier number.....Nalco..... DD3000-15

#### Coolant Filter - Detroit Diesel Series 60 Engine

Number used..... 1

Make ..... Nalco

Type ..... Spin-on

#### MAINTENANCE ELEMENT FILTER

Supplier number. ....Detroit Diesel ..... 23507545

Supplier number.....Nalco..... DDF3000

Prevost number ..... 550630

#### PRECHARGE ELEMENT FILTER

Supplier number.....Detroit Diesel ..... 23507189

Supplier number.....Nalco..... DDF60

Prevost number ..... 550629

**Coolant Filter Cartridge – Volvo D13 Engine**

Number used ..... 1  
Type ..... Spin-on  
Prevost number ..... 20458771





**LINNIG**<sup>®</sup>  
Antriebstechnik

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## Reparaturanleitung

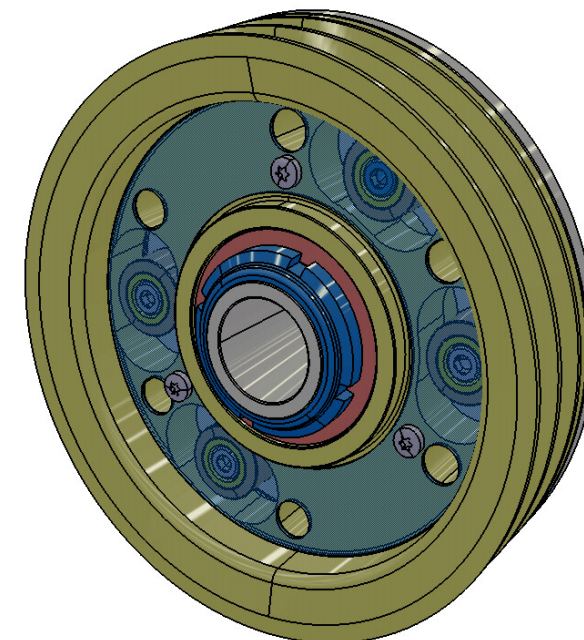
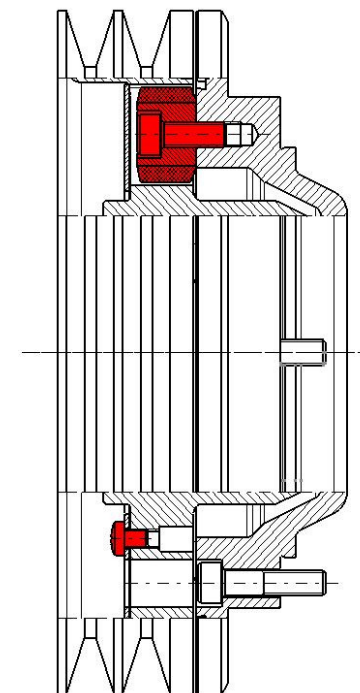
*LINNIG Drehschwingungsdämpfer LDD (außer LDD12)  
Austausch Gummidämpfer 127.032 mit EB0112*

## Repair instructions

*LINNIG Torsional vibration damper LDD (except LDD12)  
Replacement of the rubber damper 127.032 with EB0112*

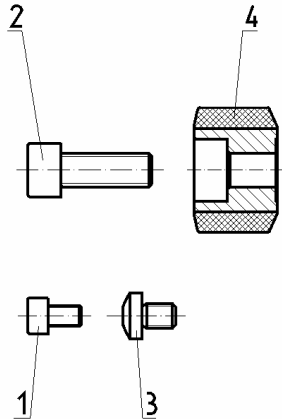
## Instrucciones de servicio

*LINNIG Polea antivibratoria LDD (excepto LDD12)  
Reemplazo de amortiguadores de goma 127.032 con EB0112*



# Lieferumfang / Delivery / Volumen de suministro

## Ersatzteilbaugruppe / Assembly group / Juego de refacciones EB0112



Schrauben 50.002 (Pos.1), 50.099 (Pos.2) und 65.003 (Pos.3) zusammen mit Gummidämpfer 127.032 (Pos.4) und Reparaturanleitung 142.219 (Pos.6) in Minigripbeutel 141.018 (Pos.5) verpacken.

Pos.5 und 6 nicht dargestellt.

**6 × 127.032**  
Gummidämpfer  
Rubber damper  
Amortiguadores de goma

**6 × 50.099**  
Zyl.-Schraube  
Socket head cap screw  
Tornillo cabeza allen

**3 × 65.003**  
IN-STAR LIKO-Schraube  
IN-STAR LIKO-screw  
Tornillo IN-STAR LIKO

**4 × 50.002**  
Zyl.-Schraube  
Socket head cap screw  
Tornillo cabeza allen

6	1	Stk	Reparaturanleitung LDD	Austausch Gummidämpfer 127.0	142.219
5	1	Stk	Minigripbeutel	220×150×0,050	141.018
4	6	Stk	Gummidämpfer		127.032
3	3	Stk	IN-STAR LIKO-Schraube	M6×8-8.8-A3C-P80	65.003
2	6	Stk	Zyl.-Schraube	DIN 912-M8×22-8.8-A3C	50.099
1	4	Stk	Zyl.-Schraube	DIN 912-M5×8-8.8-A3C	50.002

Pos.	Menge	Einheit	Benennung	Sachnummer/Norm-Kurzbezeichnung	Bemerkung
1	2	3	4	5	6
LINNIG Markdorf			Für diese Zeichnung behalten wir uns alle Rechte nach DIN 34 vor		
Maßstab 1:1			DIN A4		
Werkst.:			Ersatzteilbaugruppe für LDD (außer LDD12)		
Gew.: 0,360 kg			EB0112		
Index			Erst.zg. EB0103/EB0112/EB01		
Änderungsnummer			Entst. aus EB0103		
Datum			Name		
27.02.2006			Meckes		
26.04.2006			Kre		
17.06.04			Bearb.		
27704			Gepr.		
			Freig.		



### Achtung:

Je nach Ausführung des Drehschwingungs-dämpfers können evtl. Schrauben bzw. Gummidämpfer übrig bleiben !



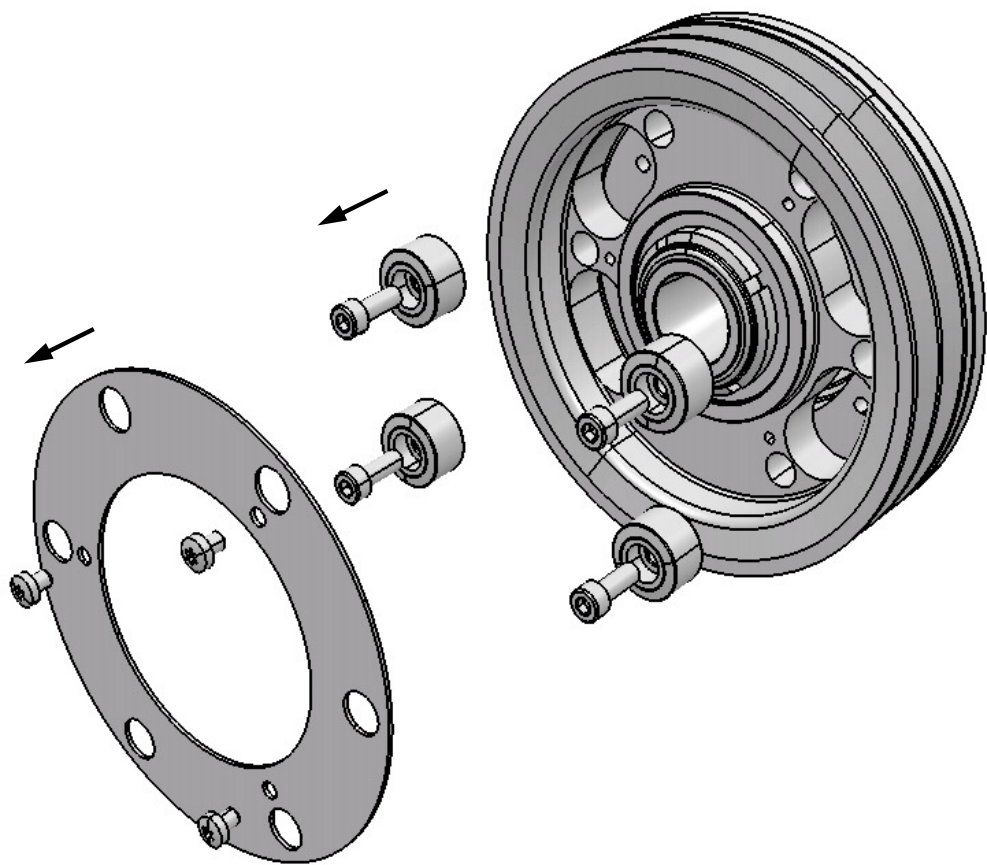
### Attention:

Beause of differnt versions of the torsional vibration damper, it is possible that some of the delivered screws and rubber damper are not be used !



### Atención:

Debido a las diferentes versiones de Poleas antivibratorias, es posible que algunos de los tornillos y amortiguadores de goma no se utilizen!



**1.**  
4 Zyl.-Schrauben M5  
bzw. 3 IN-STAR LIKO-  
Schrauben M6 am  
Deckel entfernen.

**1.**  
Remove 4 socket head  
cap screws M5 resp. 3  
IN-STAR LIKO-screws  
M6 on the cover.

**1.**  
Retire los 4 tornillos M5  
o 3 tornillos M6 IN-  
STAR LIKO de la tapa  
de la polea.

**2.**  
Deckel entfernen.

**2.**  
Remove cover.

**2.**  
Retire la tapa.

**3.**  
4 bzw. 6 Zyl.-Schrauben  
M8 der Gummidämpfer  
entfernen.

**3.**  
Remove 4 resp. 6 socket  
head cap screws M8 of  
the 4 resp. 6 rubber  
damper.

**3.**  
Retire los 4 o 6 tornillos  
M8 de los  
amortiguadores de goma  
de la polea.

**4.**  
4 bzw. 6 Gummidämpfer  
entfernen.

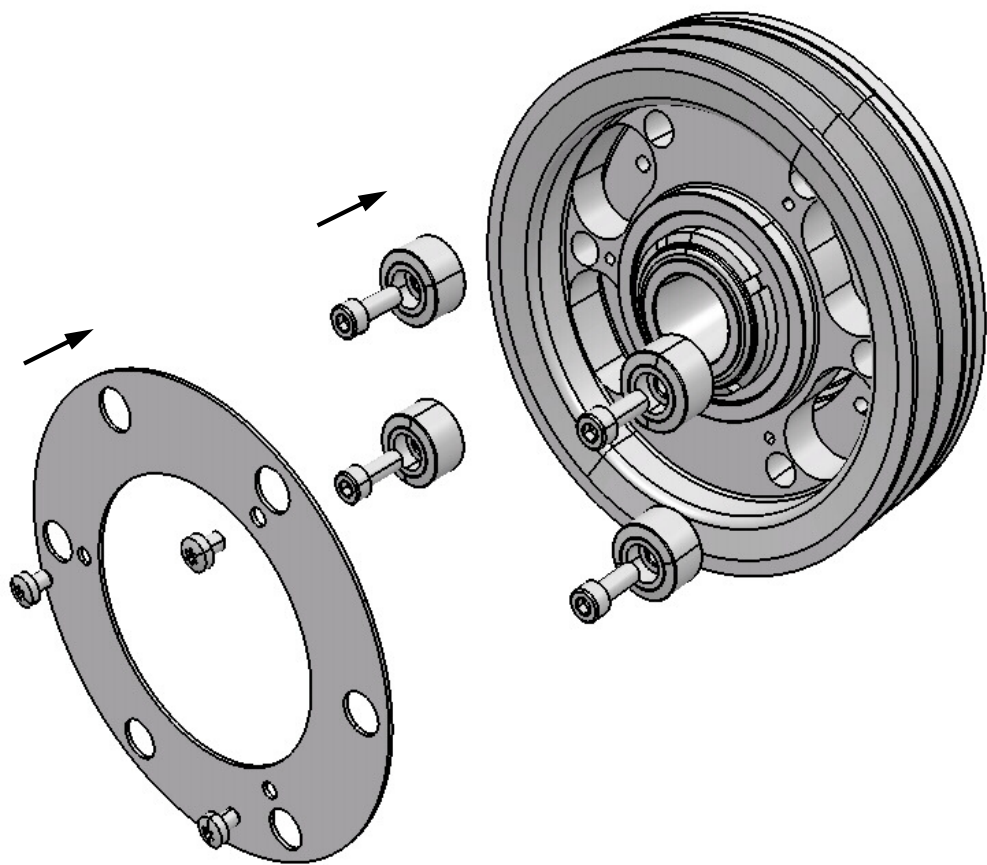
**4.**  
Remove 4 resp. 6 rubber  
damper.

**4.**  
Retire los 4 o 6  
amortiguadores de goma  
de la polea.

**5.**  
Nach Entfernen der  
Gummidämpfer alle 4  
bzw. 6 Gewinde M8  
reinigen.

**5.**  
After removing of the  
rubber damper clean all  
of the 4 resp. 6 threads.

**5.**  
Después de retirar los  
amortiguadores de goma  
de la polea, limpiar las 4  
o 6 roscas.



**6.**  
4 bzw. 6 neue Zyl.-  
Schrauben 50.099 mit  
Loctite 270 versehen und  
4 bzw. 6 neue  
Gummidämpfer 127.032  
an Nabe anschrauben.

Anzugsmoment  
***Ma = 25 Nm***

**6.**  
Protect 4 resp. 6 new  
socket head cap screws  
50.099 with Loctite 270  
and attach the 4 resp. 6  
new rubber damper on  
the hub.

Tightening torque  
***Ma = 25 Nm***  
***(18,5 lbs.ft)***

**6.**  
Aplicar Loctite 270  
o equivalente a los  
4 o 6 tornillos M8  
nuevos (50.099), y  
sujetar los 4 o 6 nuevos  
amortiguadores de goma  
a la polea.

Torque de apriete  
***Ma = 25 Nm***  
***(18,5 lbs.ft)***

**7.**  
Deckelmontage:  
Bei LK 4×90°:  
4 neue Zyl.-Schrauben  
50.002 (M5) mit Loctite  
270 versehen und Deckel  
an Riemenscheibe  
anschrauben.

Anzugsmoment  
***Ma = 6 Nm***

Bei LK 3×120°:  
Mit 3 neuen IN-STAR  
LIKO-Schrauben 65.003  
(M6) Deckel an  
Riemenscheibe  
anschrauben.

Anzugsmoment  
***Ma = 10 Nm***

**7.**  
Mounting the cover:  
Pitch circle 4×90°:  
Protect 4 new socket  
head cap screws 50.002  
with Loctite 270 and  
attach the cover on the  
pulley.

Tightening torque  
***Ma = 6 Nm***  
***(4,5 lbs.ft)***

Pitch circle 3×120°:  
Attach cover with 3 new  
IN-STAR LIKO-screws  
65.003 (M6) on the  
pulley.

Tighening torque  
***Ma = 10 Nm***  
***(7,5 lbs.ft)***

**7.**  
Montaja de la tapa:  
Tapa con 4 tornillos:  
Aplicar Loctite 270  
o equivalente a los  
tornillos M5 nuevos  
(50.002) y colocar la  
tapa de la polea.

Torque de apriete  
***Ma = 6 Nm***  
***(4,5 lbs.ft)***

Tapa con 3 tornillos:  
Con los 3 tornillos M6  
IN-STAR LIKO nuevos  
(65.003) colocar la tapa  
de la polea.

Torque de apriete  
***Ma = 10 Nm***  
***(7,5 lbs.ft)***



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### 1. GENERAL DESCRIPTION

This vehicle uses a dual voltage system to obtain two different voltages (12 and 24-volt) for various electrical controls and accessories. The main power source incorporates four maintenance-free "Delco" model 1150 batteries connected in a parallel-series configuration. 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.

- The Multiplexed Device Index,
- The Arrangement-Harness drawing showing the harnesses arrangement and harness number on the vehicle,
- Glossary,
- Circuit number listing,
- Circuit breaker code,
- Connector code,
- Diode number code,
- Resistor number code,
- Fuse code.

##### 1.1.1 Using Wiring Diagrams

Three methods are used to "*work*" with electric wiring diagrams.

**Situation:** You have identified the defective part (breaker, diode, relay, etc.), and you wish to locate its corresponding circuit.

**Problem:** Circuit breaker CB12 is released (open circuit) and you don't know which circuit is affected.

- a) Refer to wiring diagram index, and look for "*Circuit breaker code*", pages **F**.
- b) At item CB12, you will find the location, the Prevost number, the breaker function, the breaker ampere rating and the page on which to find the corresponding diagram.
- c) Refer to page 3.1.
- d) When you have located CB12, follow the wiring up to the end and find the diagram page number and function on which the circuit continues.

**Situation:** You have a problem with a specific system and you want to find the corresponding diagram.

**Problem:** The last three (3) speakers on the R.H. side of vehicle are inoperative and you must trace the electric circuit.

- a) Refer to wiring diagram index and look for "*Sound system*".
- b) You will find on page 35.1 & 35.2 the components as well as the electric wiring, thus providing you with a complete understanding of this circuit.

**Situation:** Using the message center display (MCD), you check on arrival if there are active errors in the vehicle electrical system. With the SYSTEM DIAGNOSTIC menu, highlight FAULT DIAGNOSTIC, highlight ELECTRICAL SYSTEM to request a diagnostic of the electrical system and then press the enter key. If applicable, the MCD shows the fault messages or fault codes recorded. When more than one fault is recorded, an arrow pointing down appears on the right of the display. Use the down to see all the fault messages.

**Problem:** MCD displays the fault "Elec. Horn SW61 SW62; shorted to ground" as being active.

- a) Refer to wiring diagram index, and look for "*Multiplexed Device Index*", pages B1-B8.

- b) In first column DEVICE ID, look for device SW61, SW62.
- c) At device SW61,SW62, find the fault message, the minimum condition to activate, other inputs involved in logic, the multiplex module related to switch 61 and switch 62, the connector and pin number on the module and the page on which to find the corresponding diagram.
- d) Once the problem corrected, the MCD still shows the fault as being active. You have to leave the FAULT DIAGNOSTIC menu, wait approximately 20 to 30 seconds and then return to FAULT DIAGNOSTIC to request a new diagnostic of the ELECTRICAL SYSTEM from the CECM. The MCD should display the fault as being inactive.

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
Black	110 V ac system (live)
White	110 V ac system (neutral)
Green	110 V ac system (ground)
Orange	speakers (+)
Brown	speakers (-)
Grey	spare wire

**NOTE**

*Wires are identified at each 2-4 inch (5-10 cm) intervals by a printed number.*

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. Refer to paragraph 4.2 PROBING VOLTAGE ON THE MULTIPLEX CIRCUITS.

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.

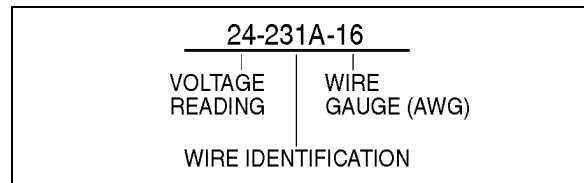


FIGURE 1: WIRE NUMBER

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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.

1.3 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 to serve as replacement wires if regular wires are damaged. Refer to page 8.1 "Spare wires" and page E "Circuit number listing" to determine the number and location of these wires.

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.

**⚠ 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.**

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:

## Section 06: ELECTRICAL

### NOTE

Spare wires are identified by the word "SPARE" followed by the wire identification number.

### 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.

### WARNING

**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 manually switchable circuit breakers. The main circuit breakers, as well as those protecting the A/C system, are located in the main power compartment, on R.H. side of the vehicle (Fig. 2).

This type of circuit breaker allows to de-energizes the circuit without disconnecting any wire. Simply push the red button on breaker to open the circuit, repair defective circuit, and afterwards lift the black tab of breaker to its original position to close the circuit.

CIRCUIT BREAKERS (VIP)			
CB1	Front distibution	24 VI	90 amps
CB2	Front distibution	12 VD	90 amps
CB3	HVAC - evaporator	24 VI	90 amps
CB4	Rear distribution	12 VD	70 amps
CB5	Rear distribution	24 VI	150 amps
CB6	Rear Distribution	24 VD	70 amps
CB7	HVAC - condenser	24 VI	70 amps
CB8	Rear Junction Box	12 VI	40 amps
CB9	Slide-out	24VI	40 amps
CB10	Front distribution	12 VI	70 amps
CB11	Slide-out	24 VI	35 amps
CB12	HVAC - condenser	12 VI	40 amps

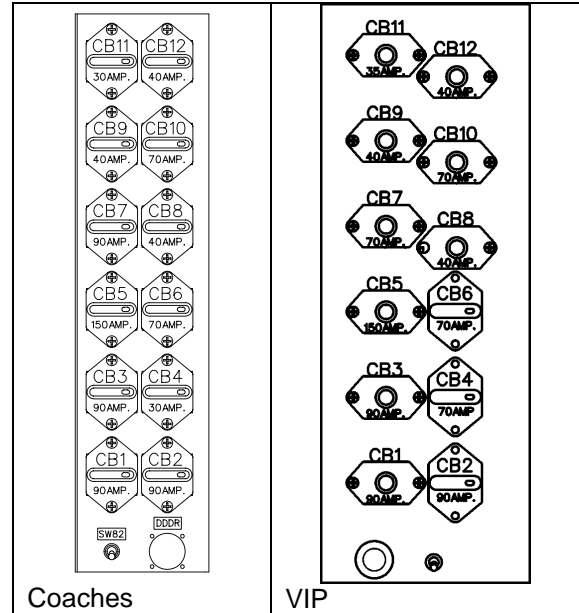


FIGURE 2: MAIN BREAKERS

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### CIRCUIT BREAKERS (coaches)

CB1	Front distribution	24 VI	90 amps
CB2	Distribution	12 VD	90 amps
CB3	HVAC - evaporator	24 VI	90 amps
CB4	Sound system	12 VD	30 amps
CB5	Rear distribution	24 VI	150 amps
CB6	Distribution	24 VD	70 amps
CB7	HVAC - condenser	24 VI	70 amps
CB8	Rear distribution	12 VI	40 amps
CB9	WCL or other options	24VD	40 amps
CB10	Front distribution	12 VI	70 amps
CB11	Sound system	24 VD	30 amps
CB12	HVAC - condenser	12 VI	40 amps

VD= volts direct. The electrical components connected to these circuit breakers are direct-connected to the battery.

VI= volts indirect. Electrical power is supplied via master relay R1 which engages when ignition key is in the ON or ACC position and battery master switch is set to ON.

### 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 de-energize 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 de-energize a given component. As the control current required for the coil is very low, the relay allows a remote station to control a high energy circuit without running great lengths of costly high capacity cable, and also eliminates the need for high amperage switches and heavy connectors.

**NOTE**

Each relay is identified with "12 V" or "24 V" 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

**WARNING**

Prior to working on a system inside vehicle, make sure to cut electrical power and air supply. A component could be supplied with electricity even if the ignition switch is set to the OFF position and/or a component could be pressurized even if air tanks are emptied. Always refer to the appropriate wiring and pneumatic diagrams prior to working on electrical and/or pneumatic systems.

**NOTE**

When the ignition switch is set to the OFF position, the electrical components are not energized except for the CECM (Chassis Electronic Control Module), engine MCM, transmission TCM, instrument cluster module, the battery equalizer, the preheater system, the wheelchair lift system and some Multiplex modules which are energized during 15 minutes after the ignition has been set to the OFF position. Prior to working on one of these electrical components, set the battery master switch in the main power compartment 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 the main circuit breakers located in the main power compartment to stop the small current drawn by the radio preset station memory, the CECM memory and the instrument cluster clock. Note that the radio station presets will be erased, same thing for the diagnostic codes history and the instrument cluster clock will have to be reset.

**CAUTION**

Prior to arc welding on the vehicle, refer to "Multiplex Modules Disconnection Procedure Prior To Welding" in section 00 GENERAL of this manual to avoid serious damage to the vehicle components.

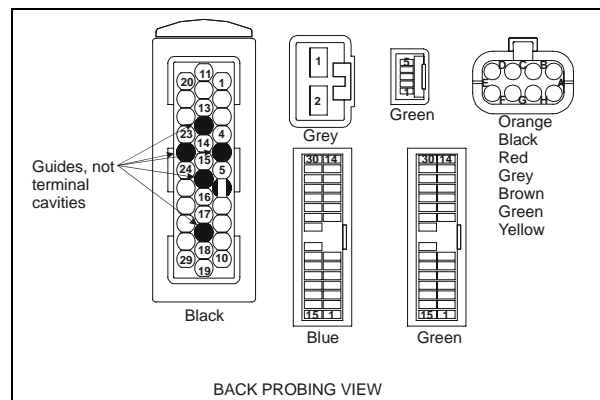
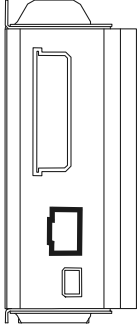
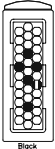
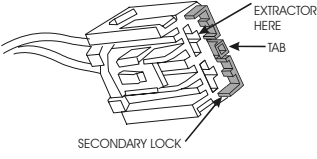
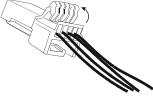
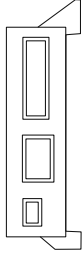
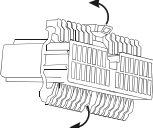
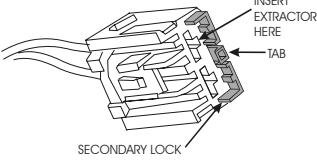
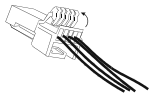
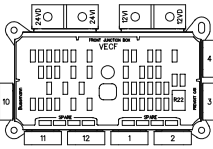
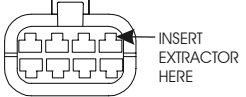


FIGURE 3: MULTIPLEX MODULE CONNECTORS PIN-OUT

**Section 06: ELECTRICAL**

Multiplex modules	Connector type	Terminal removal
 <p><b>IO-B</b></p>	 <p>Black <b>AMP</b></p>	<p>EXTRACTOR/TOOL: Prevost #683594</p> <p>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.</p>
	 <p>INSERT EXTRACTOR HERE TAB SECONDARY LOCK grey <b>YAZAKI</b></p>	<p>EXTRACTOR/TOOL: Packard #12094430 or small flat blade screwdriver</p> <p>Using a small flat blade screwdriver, pull up the secondary lock tab and then pull out the secondary lock partially. Insert the extractor over the terminal cavity to lift the connector housing plastic primary lock. Gently remove the terminal from the connector by pulling on the wire.</p>
	 <p>green <b>JAE</b></p>	<p>EXTRACTOR/TOOL: Prevost #683766</p> <p>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.</p>
 <p><b>IO-A</b></p>	 <p>green, blue (CECM) <b>JAE</b></p>	<p>EXTRACTOR/TOOL: Prevost #683766</p> <p>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.</p>
	 <p>INSERT EXTRACTOR HERE TAB SECONDARY LOCK grey <b>YAZAKI</b></p>	<p>See above</p>
	 <p>green <b>JAE</b></p>	<p>See above</p>
 <p><b>VECF</b></p>	 <p>INSERT EXTRACTOR HERE Orange Black Red Grey Brown Green Yellow <b>BUSSMAN</b></p>	<p>EXTRACTOR/TOOL: Prevost #682256 (Packard 12094429)</p> <p>Remove the terminal by disengaging the flexible lock tab on the terminal. Gently remove the terminal from the connector by pulling on the wire.</p>



## 2. H3 SERIES VEHICLES ELECTRICAL COMPARTMENTS

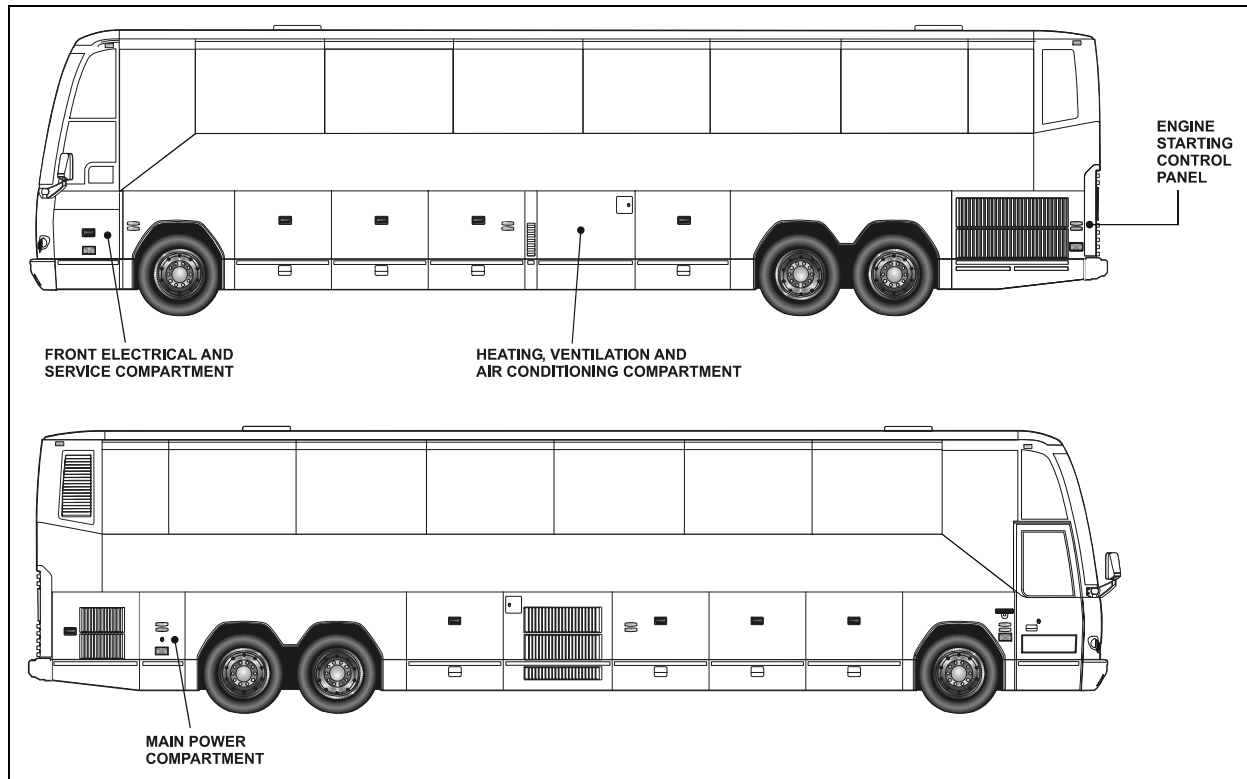


FIGURE 4: ELECTRICAL COMPARTMENTS

### 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.

**⚠ WARNING ⚠**

**Use VCI-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.**

**⚠ CAUTION ⚠**

**Never put grease, Cortec VCI-238 or other product on the multiplex modules connector terminals.**

### 2.2 MAIN POWER COMPARTMENT

The main power compartment is located on rear R.H. side of vehicle behind the rear

wheelhousing. This compartment contains the following components (Fig. 5 & 6):

- Four 12-volt batteries;
- Main circuit breakers for 12-volt and 24-volt electrical system;
- Voltage regulator (if applicable);
- Battery equalizer;
- Battery Charger (optional);
- Battery master relay (R1) & battery master switch;
- TCM (Transmission Control Module) for Allison Transmission or ZF-Astronic transmission ECU;
- Secondary circuit breakers;
- Relays;
- Rear fuse box known as VECR (Vehicle Electrical Center Rear);
- Multiplex modules: I/O-A, I/O-B;
- Electronic ground stud.

**Section 06: ELECTRICAL**

<b>Main Power Compartment (coaches)</b>			
<b>Multiplex Modules</b>			
A49	I/O-A	A52	I/O-B
A50	I/O-B	A53	I/O-B
A51	I/O-B		
<b>Relays</b>			
R1	Master relay	R14	Reading lamps
R3	12V IGN & A/C	R15	Option
R6	Fluorescent (direct lighting)	R17	12V Rr wake-up mode
R8	Service brakes	R21	Emergency cut-out
R13	Fluorescent (indirect lighting)	R25	Option
<b>Fuses</b>			
F50	Pre-heating	F69	Overhead storage compartment lighting RH & LH
F51	Pre-heating	F70	Free/customer
F52	Spare fuse	F71	Spare fuse
F53	A54 multiplex module	F72	A50 multiplex module
F54	Free/customer	F73	Spare fuse
F55	Center aisle fluorescent & emergency lighting	F74	MCM engine IGN
F56	Fluorescent (indirect lighting)	F75	ECU trans IGN
F57	Fluorescent (indirect lighting)	F76	Free/customer
F58	Fluorescent (direct lighting)	F77	ECU transmission wake-up
F59	Fluorescent (direct lighting)	F78	MCM engine wake-up
F60	Reading lamps RH	F79	MCM engine wake-up
F61	Reading lamps RH	F80	A51 multiplex module
F62	Lavatory night light	F81	Alternators excitation resistor
F63	Pre-heater	F85	Spare fuse
F64	Wheelchair lift	F86	Spare fuse
F65	Multiplex modules main power compartment	F87	Spare fuse
F66	Radiator fan clutch	F88	Spare fuse
F67	A54 multiplex module	F89	Spare fuse
F68	A54 multiplex module		
<b>Resistors</b>			
RES13	Excit. res. ALT-1	RES14	Excit. res. ALT-2
<b>Diodes</b>			
D6	Master relay	D31	A/C compressor clutch
D8	Passenger liquid valve	D33	Toilet flush pump
D15	Wake-up mode	D36	Radiator fan clutch 2
D28	A/C compressor unloader RH	D37	Radiator fan clutch 1
D29	A/C compressor unloader LH	DXX	Not used

<b>Main Power Compartment (VIP)</b>			
<b>Multiplex Modules</b>			
A49	I/O-A	A52	I/O-B
A50	I/O-B	A53	I/O-B
A51	I/O-B		
<b>Relays</b>			
R1	24V Master relay	R30	24V Door lock LH
R3	12V IGN & A/C	R31	24V Door lock RH
R17	12V Rr wake-up mode	R32	24V Door unlock LH
R21	24V Emergency cut-out	R33	24V Door unlock RH
R25	24V MCM ignition	CH57	Slide-out Trans inhibit
<b>Fuses</b>			
F50	Regulator	F69	Service brake relay
F51	Awning window Luggage doors lock relay	F70	Customer 24VI Battery cmpt lighting
F52	Refrigerant fill up valve	F71	PWR A50 multiplex module
F53	Customer 24VD	F72	Spare fuse
F54	Spare	F73	MCM engine IGN
F55	Spare	F74	ECU trans IGN
F56	Spare	F75	Ccustomer12VI
F57	Spare	F76	ECU transmission wake-up
F58	Spare	F77	MCM engine wake-up
F59	Luggage door locks	F78	MCM engine wake-up
F60	Luggage door locks	F79	PWR A51 multiplex module
F61	Spare	F80	Alternators excitation resistor
F62	Prime pump	F81	Spare fuse
F63	Spare	F85	Spare fuse
F64	PWR MUX modules main power cmpt	F86	Spare fuse
F65	Radiator fan clutch	F87	Trailer PWR
F66	PWR A54 multiplex module	F88	Backup camera
F67	PWR A54 multiplex module	F89	Spare fuse
F68			
<b>Resistors</b>			
RES13	Excit. res. ALT-1	RES14	Excit. res. ALT-2
<b>Diodes</b>			
D6	Master relay	D31	A/C compressor clutch
D15	Wake-up mode	D36	Radiator fan clutch 2
D28	A/C compressor unloader RH	D37	Radiator fan clutch 1
D29	A/C compressor unloader LH	D62	Engine door switch

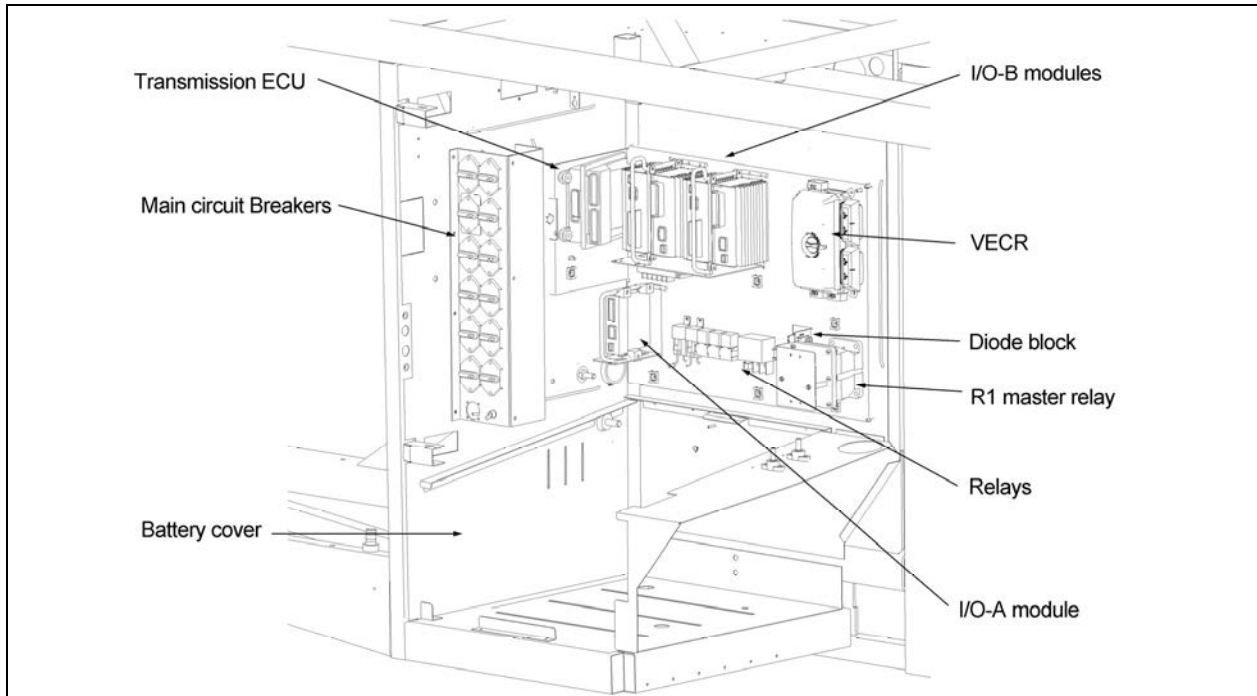


FIGURE 5: MAIN POWER COMPARTMENT (PARTIAL VIEW)

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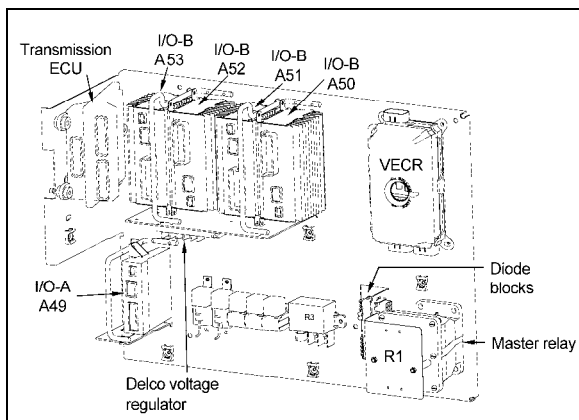


FIGURE 6 : MAIN POWER COMPARTMENT

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The front electrical and service compartment is located on front L.H. side of vehicle. It contains the front junction panel with the following components (Fig. 7).

- Resistors;
- ABS module;
- Fuses;
- Relays;
- Kneeling audible alarm;
- Front multiplex modules;
- Front fuse box known as VECF (Vehicle Electrical Center Front);
- Emergency door opening unlock valve (coaches only);
- Windshield washer reservoir;
- Reclining bumper opening handle;
- Accessories air tank purge valve;
- Accessories system fill valve;
- Spare wheel support and rail (coaches only);
- Keyless entry system module (VIP only).

### 2.2.1 Battery Charger Or In-Station Lighting Connector

The vehicle may be equipped with a battery charger or in-station lighting connector. When it is connected to an external 110-120 VAC power source, the in-station lighting circuit can be energized without depleting the batteries. The receptacle is usually located on the main power compartment door or engine compartment R.H. side door.

### 2.3 FRONT ELECTRICAL AND SERVICE COMPARTMENT

**Section 06: ELECTRICAL**

Front Electrical & Service Compartment (coaches)			
<b>Multiplex Modules</b>			
MASTER ID	Interface	A43	I/O-A
ABS-ECU	ABS system 12 volts	A44	I/O-B
CECM	Multiplex chassis electronic control module	A45	I/O-B
A41	I/O-A	A46	I/O-B
A42	I/O-A		
<b>Relays</b>			
R18	Wake-up mode	R22	Engine brake
R19	Wake-up mode	R24	Upper windshield wipers
<b>Fuses</b>			
F1	Multiplex CECM module	F23	Intercom
F2	Front start main switch	F24	Mirror
F3	Pre-heating & driver liquid solenoid valve	F25	Back-up camera
F4	Wireless microphone	F26	Spare fuse
F5	Wake-up mode relay 24 volts	F27	Free/customer
F6	Free/customer	F28	Driver power window
F7	ABS & pre-heating control	F29	Instrument cluster & data reader
F8	Air horn	F30	Cigarette lighter & 12-volt accessory outlet
F9	Spare fuse	F31	Keyless entry module
F10	Spare fuse	F32	Spare fuse
F11	Sun visor	F33	Wake-up mode relay 12 volts
F12	power A41 multiplex module	F34	Wake-up mode relay 12 volts
F13	power A41 multiplex module	F35	12-volt accessory outlet
F14	Free/customer	F36	HVAC & telltale panel
F15	ABS brake system	F37	Spare fuse
F16	Defroster unit	F38	Spare fuse
F17	Destination sign	F39	Spare fuse
F18	Upper windshield defroster	F40	Spare fuse
F19	Pro Driver	F41	Spare fuse
F20	Dashboard rocker switch red LED	F82	Lower windshield wipers
F21	A44 multiplex module	F83	Sound system
F22	ABS brake system	F84	Free/customer
<b>Diodes</b>			
D1	Accessories	D21	Service brake
D44	Ignition	D22	Service brake
DXX	Not used		

Front Electrical & Service Compartment (VIP)			
<b>Multiplex Modules</b>			
MASTER ID	Interface	A43	I/O-A
ABS-ECU	ABS system 12 volts	A44	I/O-B
CECM	Multiplex chassis electronic control module	A45	I/O-B
A41	I/O-A	A46	I/O-B
A42	I/O-A		
<b>Relays</b>			
R18	24V Wake-up mode	R22	Engine brake
R19	12V Wake-up mode	R24	Upper windshield wipers
<b>Fuses</b>			
F1	PWR CECM module	F23	ABS brake system
F2	Front start main switch	F24	Mirror
F3	Driver liquid solenoid valve	F25	Spare fuse
F4	Spare fuse	F26	Spare fuse
F5	Wake-up mode relay 24 volts	F27	Customer
F6	Customer	F28	Driver power window
F7	Spare fuse	F29	Instrument cluster & data reader
F8	Multi function switch	F30	Cigarette lighter & 12-volt accessory outlet
F9	Auxiliary unit fan	F31	Keyless entry module
F10	Pneumatic cut-out solenoid	F32	Driver seat
F11	Sun visor	F33	Wake-up mode relay 12 volts
F12	PWR MUX modules	F34	Wake-up mode relay 12 volts
F13	PWR MUX modules	F35	12-volt accessory outlet
F14	Customer	F36	HVAC module & telltale panel
F15	Engine brake relay R22	F37	Spare fuse
F16	Defroster unit	F38	Spare fuse
F17	Level low	F39	Spare fuse
F18	Upper windshield wiper	F40	Spare fuse
F19	Keyless module	F41	Spare fuse
F20	Dashboard rocker switch red LED	F82	Lower windshield wipers
F21	PWR A44 multiplex module	F83	Spare fuse
F22	ZF steering control	F84	Customer
<b>Diodes</b>			
D1	Accessories	D13	ABS
D2	Driver unit liquid solenoid valve	D22	Service brake
D12	Engine brake	D44	ignition

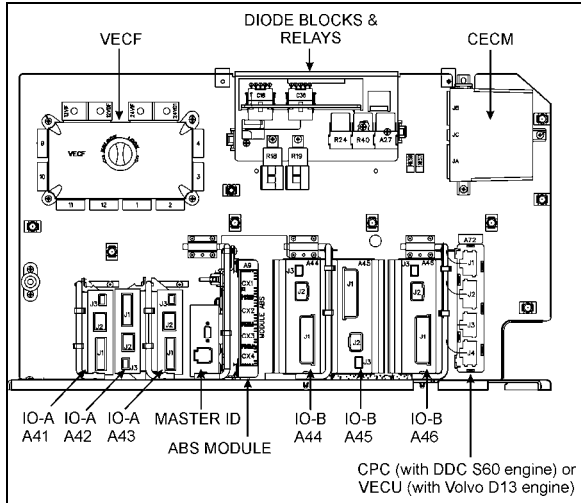


FIGURE 7: FRONT ELECT. & SERVICE COMPARTMENT  
06665

2.4 ENGINE REAR START PANEL

This control panel is located in the R.H. side of engine compartment near the engine oil reserve tank. This control panel includes the engine starter selector switch, as well as the rear start push button switch to start engine from engine compartment.

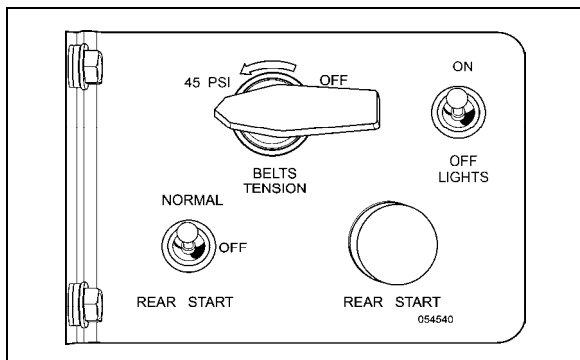


FIGURE 8: ENGINE REAR START PANEL  
01044

2.5 A/C AND HEATING CONTROLS

The following components are located in the main power compartment (Fig. 5).

Main Power Compartment			
Diodes (HVAC)			
D8	Passenger liquid valve (Central HVAC System)	D31	A/C compressor clutch (Central HVAC System)
D28	A/C compressor unloader R.H	D65	Small A/C compressor clutch (VIP)
D29	A/C compressor unloader L.H		

The following components are located in the front electrical and service compartment (Fig. 7).

Front Electrical & Service Compartment			
Fuses & Diode (HVAC)			
F3	Pre-heating driver solenoid valve	F18	Upper windshield defroster
F9	Auxiliary unit fan	F36	HVAC & telltale panel
F16	Defroster unit	D2	Driver unit liquid solenoid valve (VIP)

The following components are located in the Evaporator Compartment (HVAC). They are mounted on a panel located on the R.H. side wall when facing the compartment (Fig. 9).

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		

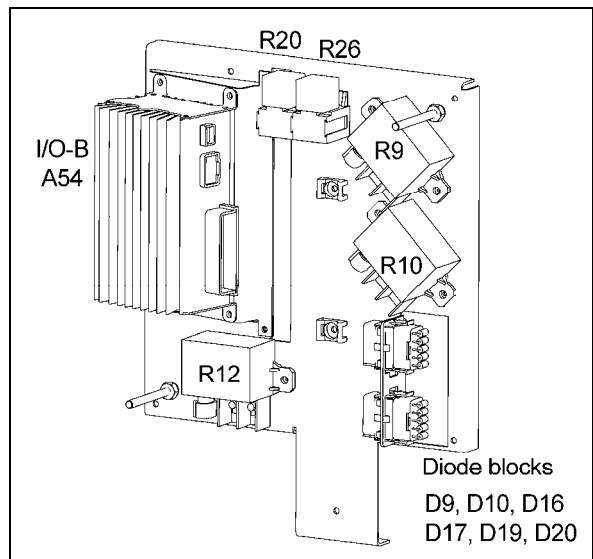


FIGURE 9: HVAC PANEL IN EVAPORATOR COMPARTMENT

06596

## Section 06: ELECTRICAL

Each relay or resistor is identified to facilitate its location (Fig. 9).

### NOTE

*It is important when checking the A/C and heating system to keep the condenser compartment door closed in order to avoid faulty readings.*

### 2.6 PNEUMATIC ACCESSORY PANEL

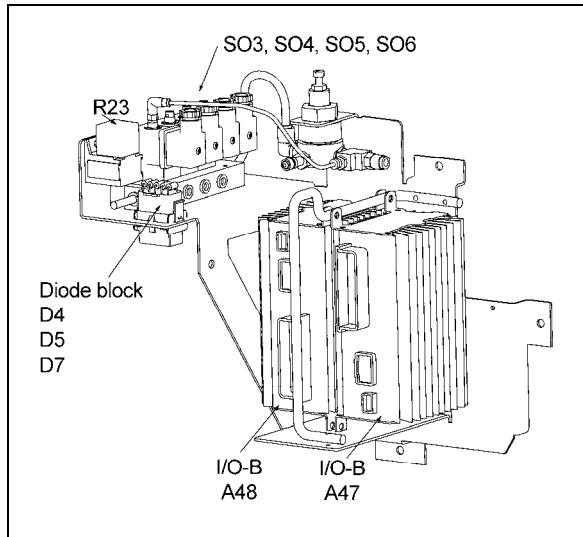


FIGURE 10 : PNEUMATIC ACCESSORY PANEL 06597

Pneumatic Accessory Panel Inside Right Console (coaches)			
Multiplex Modules			
A47	I/O-B	A48	I/O-B
Relays			
R23	Lower windshield wipers		
Solenoids			
SO3	Door unlock solenoid valve	SO5	Door opening solenoid valve (coaches)
SO4	Door unlock solenoid valve	SO6	Door closing solenoid valve (coaches)
Diodes			
D4	Lower windshield wipers speed 2	D56	Entrance door switch (VIP)
D5	Lower windshield wipers speed 1	D66	Water pump (VIP)
D7	Entrance door (coaches)	D73	Entrance door hinge switch

To access the pneumatic accessory panel of the right console, remove the panel under the larger utility compartment at the right of the dashboard.

### 3. BATTERIES

The vehicle is provided with four (4) maintenance-free 12-volt heavy-duty batteries connected in series-parallel (Fig. 11 & 12). 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.

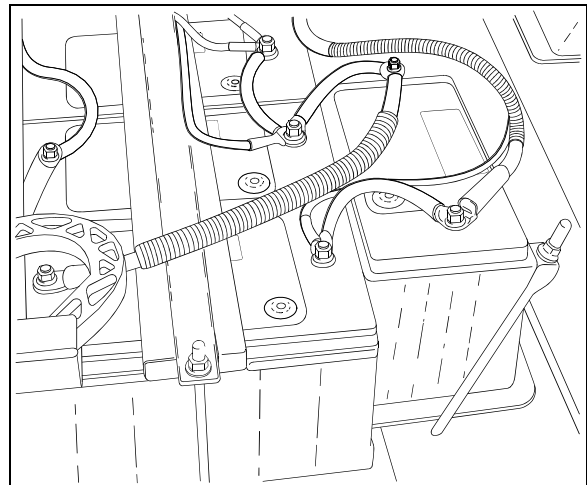


FIGURE 11: BATTERIES

06343

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.

**⚠ WARNING ⚠**

**All lead-acid batteries generate hydrogen gas, which is highly flammable. If ignited by a spark or flame, the gas may explode violently, causing spraying of acid, fragmentation of the battery, which may result in severe personal injuries. Wear safety glasses and do not smoke when working near batteries. In case of contact with acid, flush immediately with water.**

The battery has four (4) major functions:

1. Providing a source of current for starting the engine.
2. Stabilizing the voltage in the electrical system.
3. Supplying current for a limited time, when electrical demands of the equipment exceed the power output of the alternator.
4. Providing a limited source of power for connected accessories, when the engine is not running.

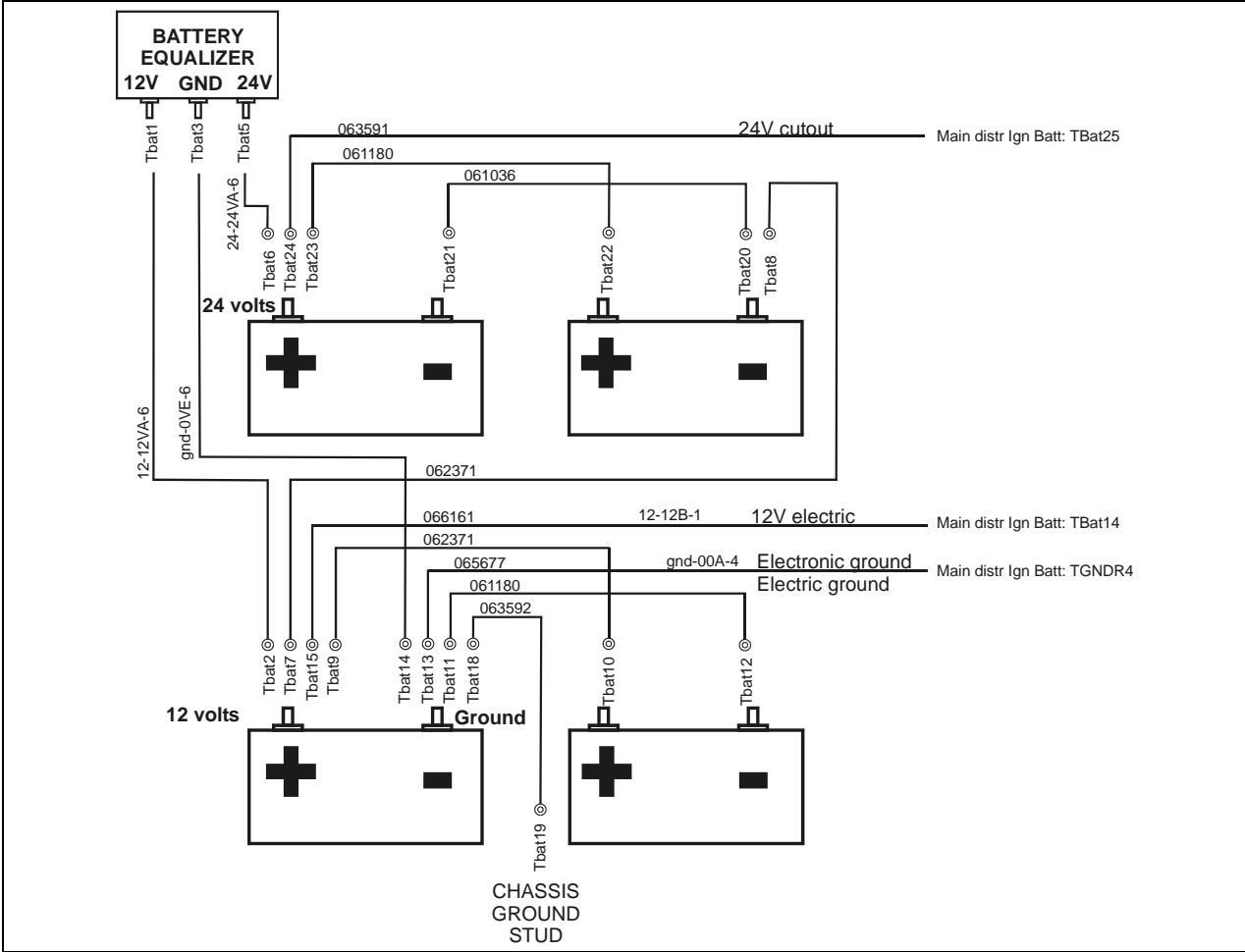


FIGURE 12: BATTERY CONNECTIONS

## Section 06: ELECTRICAL

### 3.1 BATTERY DISCHARGE PROTECTION

To prevent discharge of the batteries when the engine is not running, some functions are automatically switched off if the batteries voltage drops below 24 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 (12 V. and 24 V.) are provided for this vehicle. The relays are located in the main power compartment. The 24-volt battery relay engages when ignition key is in the ON or ACC position and battery master switch is flipped ON.

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;
- MCM;
- TCM power (Allison transmission);
- Preheater electronic timer;
- Preheater and water recirculating pump;
- Sedan entrance door;
- Radio memory;
- CECM;
- Cluster memory.

### 3.3 BATTERY REMOVAL AND INSTALLATION

1. Remove the two screws at the bottom of the plastic protective cover. Unscrew the two quarter turn nuts to remove the protective cover.
2. Remove supports. Unscrew terminal nuts of each defective battery.

#### NOTE

Main battery relays should be in the "Off" position before disconnecting cables from the batteries.

3. Remove battery cables from the 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.

4. Remove batteries.
5. 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.

#### NOTE

When reinstalling batteries, battery connections must be tightened to 10-15 lbf-ft (13-20 Nm) and the nut on top of sliding tray to 4 lbf-ft (5-6 Nm). A torque wrench is required to ensure an accurate tightening torque.

#### ⚠ CAUTION ⚠

Ensure that connections are not reversed when reinstalling batteries, since damage to electrical system components will result.

#### ⚠ CAUTION ⚠

After reinstalling battery terminals, apply protective coating (Nyogel grease). Do not use Cortec VCI-238.

#### ⚠ WARNING ⚠

To prevent possible electric shock or sparking, the main battery relays must be set to the "Off" position before tightening an electrical connection.

#### NOTE

A protective silicone free, coating should be applied on all power connections that have been disconnected. We recommend the use of Cortec VCI-238 (Prevost #682460) on all electrical connections.



### 3.4 BATTERY RATING

Each of the 12-volt batteries used on the vehicle has the following rating:

- Reserve capacity: 195 minutes
- Cold cranking (amps): 950 @ 0°F (-18°C)
- Cold cranking (amps): 745 @ -20°F (-29°C)
- Weight (filled): 59 lb (26,7 kg)

The reserve capacity is defined as the number of minutes a new, fully charged battery at 80°F (26,6°C) can be discharged at 25 amperes and maintain a minimum of 1.75 volts per cell (10.5 volts total for one 12-volt 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-volt 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. 13).

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.

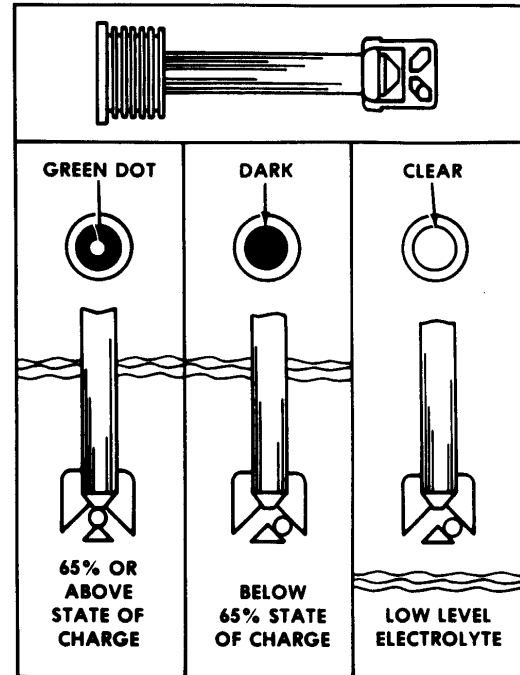


FIGURE 13: TEST INDICATOR

06096

#### Dark - Green Dot Not Visible

If there is difficulty cranking the engine, the battery should be tested as described in this section. On rare occasions, the test indicator may turn light yellow. In this case, the integral charging system should be checked. Normally, the battery is capable of further service; however, if difficult start has been reported, replace the battery. **DO NOT CHARGE, TEST, OR JUMP-START.**

#### 3.5.1 Visual Inspection

1. Check the outside of the battery for a broken or cracked cover or case that could permit loss of electrolyte. If obvious physical damage is noted, replace the battery.
2. Check for loose terminal posts, cable connections, damaged cables, and for evidence of corrosion. Correct conditions as required before proceeding with tests.

#### 3.5.2 Removing Surface Charge

Disconnect cables from the battery and attach alligator clamps to the contact lead pad on the battery as shown in figure 15. Connect a 300 ampere load across the terminal for 15 seconds to remove surface charge from the battery.



## Section 06: ELECTRICAL

### 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 13.

 <b>CAUTION</b> 
<p><b>Observe polarity of the meters and the battery when making connections, and select the correct meter range.</b></p>

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 70°F (21°C) and above. For temperatures below 70°F (21°C), refer to the following "Voltage and Temperature Chart".

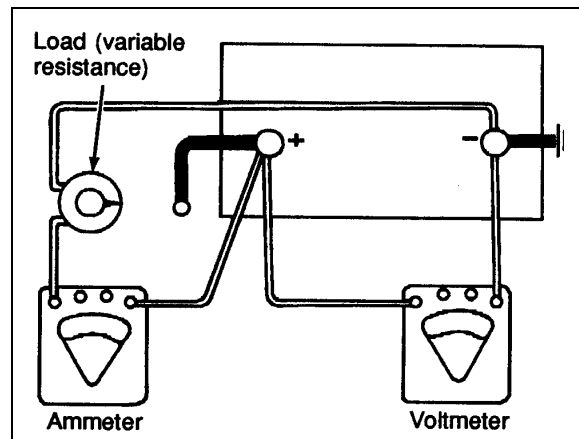


FIGURE 14: LOAD TEST

06064



<b>NOTE</b>
<p><i>The accuracy of this test procedure is dependent upon close adherence to the proper load, time and temperature specifications.</i></p>

### Voltage and Temperature Chart

Ambient Temperature	Minimum Voltage
70°F (21°C) and above	9.6
60°F (16°C)	9.5
50°F (10°C)	9.4
40°F (4°C)	9.3
30°F (-1°C)	9.1
20°F (-7°C)	8.9
10°F (-12°C)	8.7
0°F (-18°C)	8.5

### 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:

 <b>WARNING</b> 
<p><b>To prevent the engine from starting, remove fuses F78 &amp; F79 located in the VECR. Once these tests are completed, reinstall F78 &amp; F79.</b></p>

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 70°F (21°C), 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 starter motor is operated. If the reading is more than 2.5 volts, there is excessive resistance in this circuit.

<b>NOTE</b>
<p><i>If it is necessary to extend the voltmeter lead for this test, use a #16 (AWG) or larger wire.</i></p>

3. Check voltage drop between the starter housing and a good ground on the vehicle. The reading should be less than 0.2 volt.

**⚠ WARNING ⚠**

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

**⚠ WARNING ⚠**

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.

Do not smoke near a battery which is being charged or which has been recently charged.

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.

**⚠ CAUTION ⚠**

The electrical system on this vehicle is negative ground. Installing the batteries with the positive terminals grounded or incorrect use of the booster battery and jumper cables will result in serious damage to the alternator, batteries and battery cables.

The batteries used on this vehicle can be charged either on or off the vehicle; however, when they are removed from the vehicle, it is recommended that an adapter kit, which is available from any "A/C DELCO" dealer, be used in charging sealed-terminal batteries. Use the booster block to charge the batteries when they are left on vehicle and **make sure that the main battery disconnect switch is set to the "On" position.**

The alligator clamps of the tester or charger must be placed between the terminal nuts and the lead pads of the terminal studs (Fig. 15) after the vehicle cables are detached. The alligator clamps should make firm contact with the lead pads.

**Note:** *If this connection cannot be made because of the alligator clamp design, the load value for testing must be reduced from 290 to 260 amperes.*

On rare occasions, such as those that occur following prolonged cranking, the green dot in the test indicator may still be visible when the battery is obviously discharged. Should this occur, a boost charge of 20 amperes-hour is recommended. Under normal operating conditions, do not charge the battery if the green dot is visible. The battery should never be charged if the test indicator (hydrometer) is clear or light yellow. If this occurs, replace the battery.

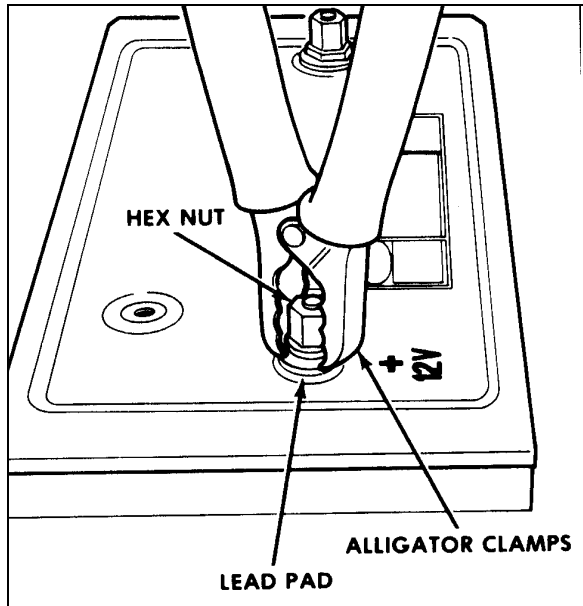


FIGURE 15: ALLIGATOR CLAMPS AND BATTERY 06065

A charge rate between 3 and 50 amperes is generally satisfactory for any maintenance-free battery as long as spewing out of electrolyte does not occur or the battery does not feel excessively hot (over 125°F (52°C)). If spewing out or violent gassing of electrolyte occurs or battery temperature exceeds 125°F (52°C), the charging rate must be reduced or temporarily stopped to allow cooling and to avoid damaging the battery.

Battery temperature can be estimated by touching or feeling the battery case. The battery is sufficiently charged when the green dot in the built-in hydrometer is visible. No further charging is required. Shake or tilt the battery at hourly intervals during charging to mix the electrolyte and see if the green dot appears.

**⚠ WARNING ⚠**

**Always turn off the charger before connecting or disconnecting to a battery.**

**NOTE**

*The charge rate must be doubled when the batteries are charged by the booster block, because of the series-parallel circuit.*

Battery charging consists of a charge current in amperes for a period of time in hours. Thus, a 25 ampere charging rate for 2 hours would be a 50 ampere-hour charge to the battery. Most batteries, whose load test values are greater than 200 amperes, will have the green dot visible after at least a 75 ampere-hour charge. In the

event that the green dot does not appear, replace the battery.

### 3.6.1 Battery Charging Guide

#### Fast Charging Rate

3-3/4 hours @ 20 amps

2-1/2 hours @ 30 amps

2 hours @ 40 amps

1-1/2 hours @ 50 amps

#### Slow Charging Rate

15 hours @ 5 amps

7-1/2 hours @ 10 amps

The time required for a charge will vary according to the following factors:

#### Size of Battery

For example, a completely discharged large heavy-duty battery requires more than twice the recharging time of a completely discharged small passenger car battery.

#### Temperature

For example, a longer time will be needed to charge any battery at 0°F (-18°C) than at 80°F (27°C). When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first, and then in time, the battery will accept a higher rate as it warms.

#### State of Charge

For example, a completely discharged battery requires more than twice as much charge than a half-charged battery. Since the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will likewise increase.

#### Charger Capacity

For example, a charger which can supply only 5 amperes will require a much longer period of charging than a charger that can supply 30 amperes or more.

### 3.6.2 Emergency Jump Starting With Auxiliary (Booster) Battery

**⚠ WARNING ⚠**

**Off-board battery charger with a start boost facility must not be used to jump start the vehicle. This could damage the electrical system. Do not jump start vehicles equipped with maintenance-free batteries if the test indicator is light yellow.**

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.

**⚠ WARNING ⚠**

**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.

**⚠ WARNING ⚠**

**Follow the procedure exactly as outlined hereafter. Avoid making sparks.**

Wear eye protection and remove rings, watches with metal bands and other metal jewelry.

Apply parking brake and place the transmission shift lever or push-button pads in Neutral (N) position in both vehicles. Turn off lights, heater and other electrical loads. Observe the charge indicator. If the indicator in the discharged battery is illuminated, replace the battery. **Do not** attempt jump starting when indicator is illuminated. If the test indicator is dark and has a green dot in the center, failure to start is not due to a discharged battery and the cranking system should be checked. If charge indicator is dark but the green dot does not appear in center, proceed as follows:

1. Connect one end of one red jumper cable to the positive (+) terminal of the booster power source and the other end to the positive (+) post of the booster power block, located in the engine R.H. side compartment.
2. Connect one end of the remaining negative jumper cable (black) to the negative (-) terminal of the booster power source, and the other end of the black jumper cable to the negative (-) post of the booster power block.
3. Make sure the clips from one cable do not inadvertently touch the clips on the other cable. Do not lean over the battery when making connections. The ground connection must provide good electrical conductivity and current carrying capacity.
4. Start the engine in the vehicle that is providing the jump start. Let the engine run for a few minutes, then start the engine in the vehicle that has the discharged batteries.
5. When removing the jumper cables, perform the above procedure exactly in reverse order, and replace protective caps on booster block terminals.

**⚠ WARNING ⚠**

**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

## Section 06: ELECTRICAL

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-volt 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 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 volts dc

- Check alternator output.
- Check voltage regulator.
- Check battery connections.
- Check battery cells.
- Check battery equalizer connections.

Voltmeter exceeds 30 volts dc

- Check alternator output.
- Check voltage regulator.
- Check battery connections.

Battery Balance

<b>NOTE</b>
<i>Allow at least 15 minutes to balance batteries after any corrective measure has been taken.</i>

1. Batteries out of balance (difference greater than 1.5 volts between the two battery banks).
  - Check battery equalizer connections.
  - Check equalizer cables for proper gauge.
  - Check battery connections.
2. Demand for 12-volt power exceeding rated amperage output of battery equalizers causing batteries to go out of balance.
  - 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.

<b>NOTE</b>
<i>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.).</i>
<i>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 CAN NETWORK LAYOUT AND TROUBLESHOOTING in this section.</i>

<b>NOTE</b>
<i>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.</i>

**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.

<b>NOTE</b>
<ul style="list-style-type: none"> <li>• Verify on the wiring diagram whether the voltage is 12V or 24V,</li> <li>• 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.</li> <li>• 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.</li> </ul>

**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 right-hand console. Connector C100 disconnects the modules from the evaporator compartment. Connector C3 (evaporator compartment) 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 the section 4.2.3 for more information.

**4.4 TEST MODE FOR SWITCHES AND SENSORS**

The switch/sensor test mode provides useful information to diagnose problems complimentary to the electrical system diagnosis.

To enter this mode, activate the dashboard "Telltale Light Test" switch 3 times within 4 seconds. To exit the switch/sensor test mode, reactivate the test switch 1 time or turn OFF the ignition.

**4.4.1 Information Available And Impact On The Functions In Switch/Sensor Test Mode**

Telltale panel audible alarm emits a *beep* each time an OFF/ON transition is detected on a multiplex input. This allows quick verifying if the switches and sensors are detected or seen by the multiplex modules. When the vehicle is parked, the back-up alarm also emits a sound that allows verification of the sensors at the rear of the vehicle.

Certain inputs are doubled (ex. turn signal switch on multi-function lever, door operating buttons) and also other inputs activate at the same time (ex. kneeling switch and Kneeling proximity sensor switch). For these inputs, 2 *beeps* are emitted. If only one *beep* is heard, one of the inputs is defective.

<b>SWITCHES AND SENSORS SUPPORTED BY THE SWITCH/SENSOR TEST MODE</b>
HVAC control unit driver's section ON/OFF
A/C door ajar open sensor
HVAC control unit driver recirculate switch
HVAC overhead compartment fan switch
HVAC control unit passenger's section ON/OFF
Engine ether start switch
Radiator fan clutch switch
Engine front start enable switch
Engine rear start enable switch



Engine ignition front switch
Engine ignition rear switch
Entrance door inside closing switch
Entrance door outside opening /closing switch
Entrance door electric window down switch
Entrance door electric window up switch
Electric horn button
Kneeling down switch
Kneeling up switch
Lavatory emergency switch
Interior lighting switch, 2 positions
Driver's area lighting switch
Reading lights switch
Multi-function lever LH turn signal
Multi-function lever RH turn signal
Fog lights switch
Hazard warning flashers switch
Multi-function lever courtesy blinkers switch
Headlights switch, 2 positions
Multi-function lever headlights beam toggle switch
Baggage compartment door lock/unlock switch
Tag axle signal
Wheelchair lift activation switch
Windshield lower wiper
Multi-function lever windshield wipers intermit.
Multi-function lever windshield wipers speed 1,2
Lower windshield wipers backup switch
Lower windshield washer switch
Upper windshield washer switch
Upper windshield wipers switch, 2 positions

The following inputs, either certain options or sensors which are difficult to activate, are not supported by the switch/sensor test:

- Low-Buoy switch,
- Starter Sensor,
- ABS Warning input,

- WCL switch,
- Driver's Power Window Switch (up & down),
- Fog Lights Switch,
- Alternator Sensors 1 & 2,
- Retarder Active Signal,
- Radiator fan speed 1 & 2 signals.

When in switch/sensor test mode, the A/C compressor HI and LO pressure values are displayed one after the other instead of the outside temperature in the telltale panel LCD display. This feature can be used when the vehicle is traveling to check the A/C compressor pressure values, but no *beep* can be heard.

In test mode, with the parking brake applied and the passenger set point set to a value higher than 64°F (18°C), the circulator pump is not set to OFF as it would normally do when the outside temperature gets above 50°F (10°C). This feature allows verification of the pump when inside a garage. This is also useful when working on the heating system to remove air pockets trapped in the system.



When performing an A/C cooling test and having the water pump shut off in switch/sensor test mode is required, just set the passenger set point temperature to the minimum 64°F (18°C) to shut off the pump.

**4.5 TEST MODE FOR ELECTRIC MOTORS**

The test mode allows testing the motors and electric contactors without the need to have the engine running. Note that while in test mode, the engine cannot be started.

Prerequisite conditions for the motor test mode:

- 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 volts,
- Engine not running,
- Parking brake applied,

 <b>WARNING</b> 
<b>Before starting the test sequence, make sure nobody is working in the evaporator or condenser compartment.</b>

<i><b>NOTE</b></i>
<i>A delay of 15 seconds during which the back-up alarm will sound is introduced prior the test start</i>

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*to advise people that may be working on the vehicle.*

### To enter this mode:

- Activate the dashboard Telltale Light Test switch 3 times within 4 seconds;
- Push the ON/OFF button on the driver's side HVAC control unit 5 times (that makes 3 transitions from OFF to ON),
- A *beep* can be heard indicating the motor test mode has started.

### Using the test mode:

During the entire test, the telltale panel audible alarm gives a signal each second to remind that the motor test mode is underway.

#### 4.5.1 Test Sequence – Coaches only

1. Go to the condenser compartment. The condenser fans start at speed 1, then after a short pause, speed 2 activates.
2. The passenger's unit refrigerant solenoid valve activates.

*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:

3. A/C compressor clutch activates 3 times.
4. Left compressor unloader activates 3 times.
5. Right compressor unloader activates 3 times.
6. Toilet fan motor starts.

### 5 beeps from the back-up alarm indicate to go to the radiator fan clutch.

7. Fan clutch is disengaged (fan can be turned freely by hand).
8. Fan clutch engages in speed 1 (fan can be turned by hand but with a certain resistance).
9. Fan clutch engages in speed 2 (cannot be turned but hand).

*5 beeps from the back-up alarm indicate to go to the evaporator compartment.*

### In the evaporator compartment:

10. Evaporator fan motor runs at speed 1 for 3 seconds then runs at speed 2 for 2 seconds.

11. Hot water pump starts running for 5 seconds and hot water pneumatic valve cycles 3 times.

*5 beeps from the back-up alarm indicate to go to the overhead storage compartment inside the vehicle.*

### Inside the vehicle:

12. The driver's HVAC unit refrigerant solenoid valve cycles 3 times and the hot water pneumatic valve cycles 3 times also.
13. Left and right overhead compartment fans start running one after the other for 5 seconds.
14. The upper windshield defroster (optional) starts running.

### This ends the test. Activate the dashboard Telltale Light Test switch one time to leave the motor test mode.

#### 4.5.2 Test Sequence – VIP With Central HVAC System

1. Driver's & passenger's unit fresh air damper opening. *[20 seconds delay]*
2. 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]*
3. The passenger's 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 and main power compartment.*

### In the engine compartment, the sequence is as follows:

4. The main power compartment door fan starts running for 3 seconds (will not run if door is open). *[10 seconds delay]*
5. A/C compressor clutch activates 3 times.
6. Left compressor unloader activates 3 times.
7. Right compressor unloader activates 3 times. *[5 seconds delay]*
8. Radiator fan clutch is disengaged (fan can be turned freely by hand). *[3 seconds delay]*
9. Fan clutch engages in speed 1 (fan can be turned by hand but with a certain resistance). *[3 seconds delay]*
10. 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:**

11. Evaporator fan motor runs at speed 1 for 3 seconds then runs at speed 2 for 2 seconds.
12. 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 spare wheel compartment behind the reclining bumper.*

**Inside the spare wheel compartment:**

13. Driver's unit refrigerant solenoid valve activates 3 times.
14. Driver's unit hot water pneumatic valve cycles 3 times.
15. 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.**

7. Auxiliary unit refrigerant solenoid valve activates 3 times. *[10 seconds delay]*
8. Hot water pump starts running for 5 seconds.
9. Driver's unit refrigerant solenoid valve activates 3 times.
10. Driver's unit hot water pneumatic valve cycles 3 times.
11. 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.**

**4.5.3 Test Sequence – VIP With Small HVAC System**

1. 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 and main power compartment.*

**In the engine compartment, the sequence is as follows:**

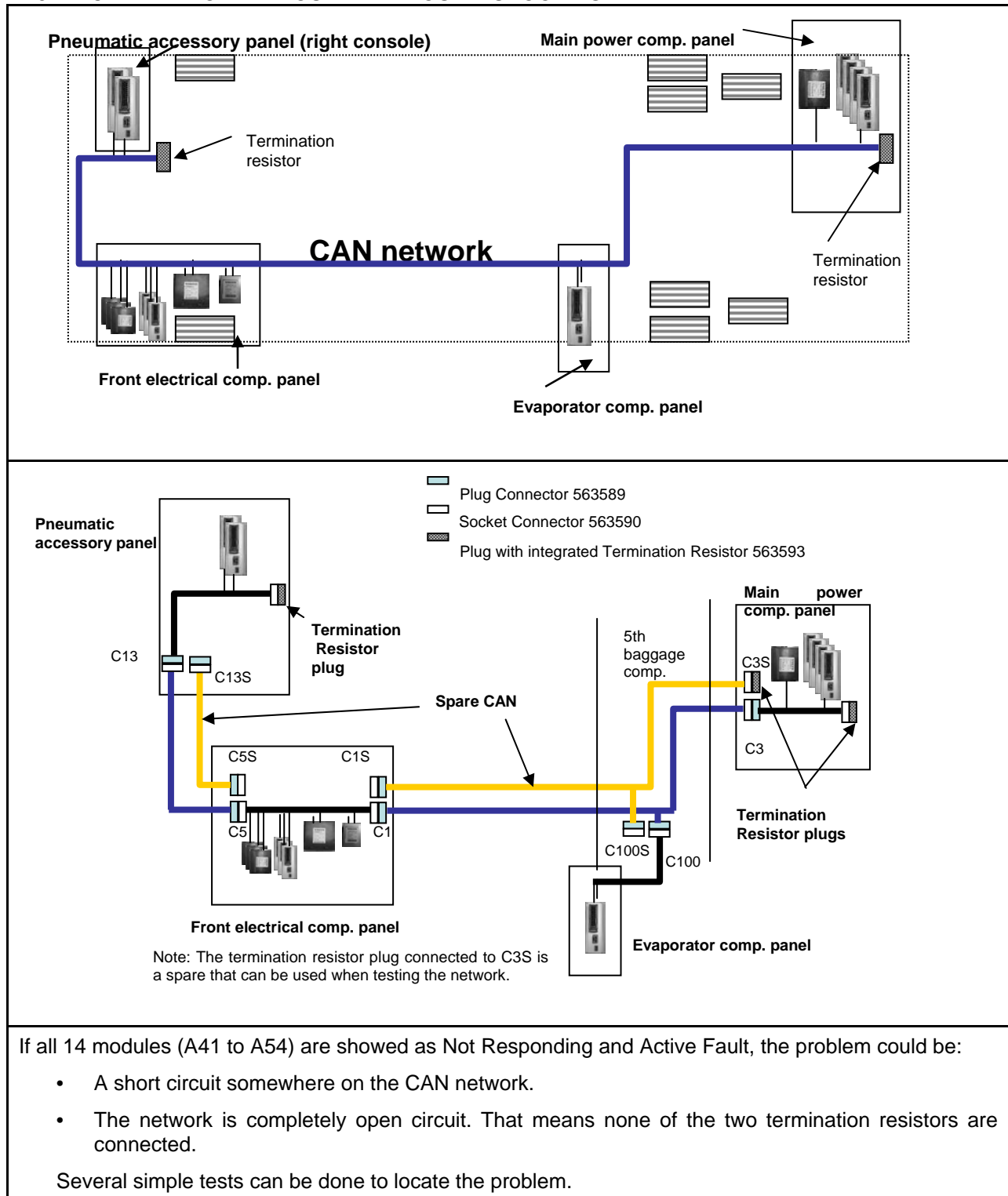
2. The main power compartment door fan starts running for 3 seconds (will not run if door is open). *[10 seconds delay]*
3. A/C compressor clutch activated 3 times. *[5 seconds delay]*
4. Radiator fan clutch is disengaged (fan can be turned freely by hand). *[3 seconds delay]*
5. Fan clutch engages in speed 1 (fan can be turned by hand but with a certain resistance). *[3 seconds delay]*
6. Fan clutch engages in speed 2 (cannot be turned but hand). *[10 seconds delay]*

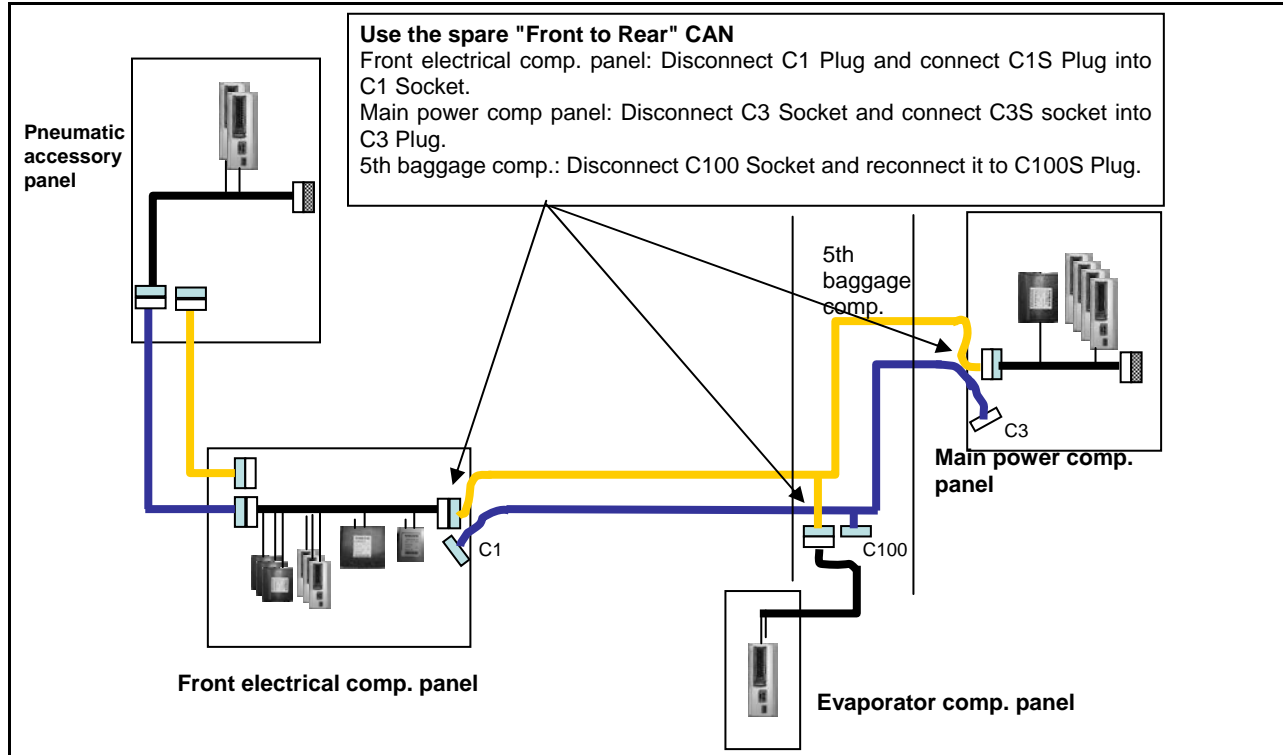
*5 beeps from the back-up alarm indicate to go to the spare wheel compartment behind the reclining bumper.*

**Inside the spare wheel compartment:**

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### 4.6 CAN NETWORK LAYOUT AND TROUBLESHOOTING





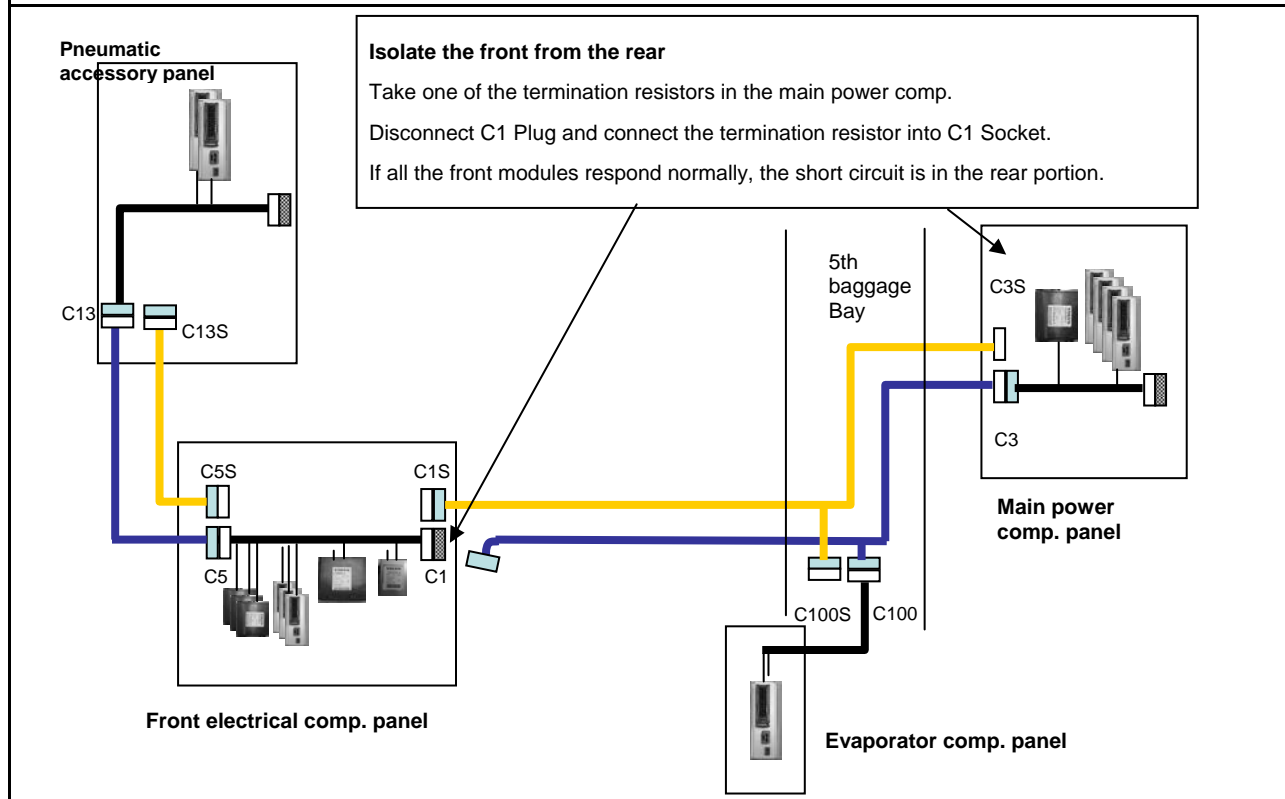
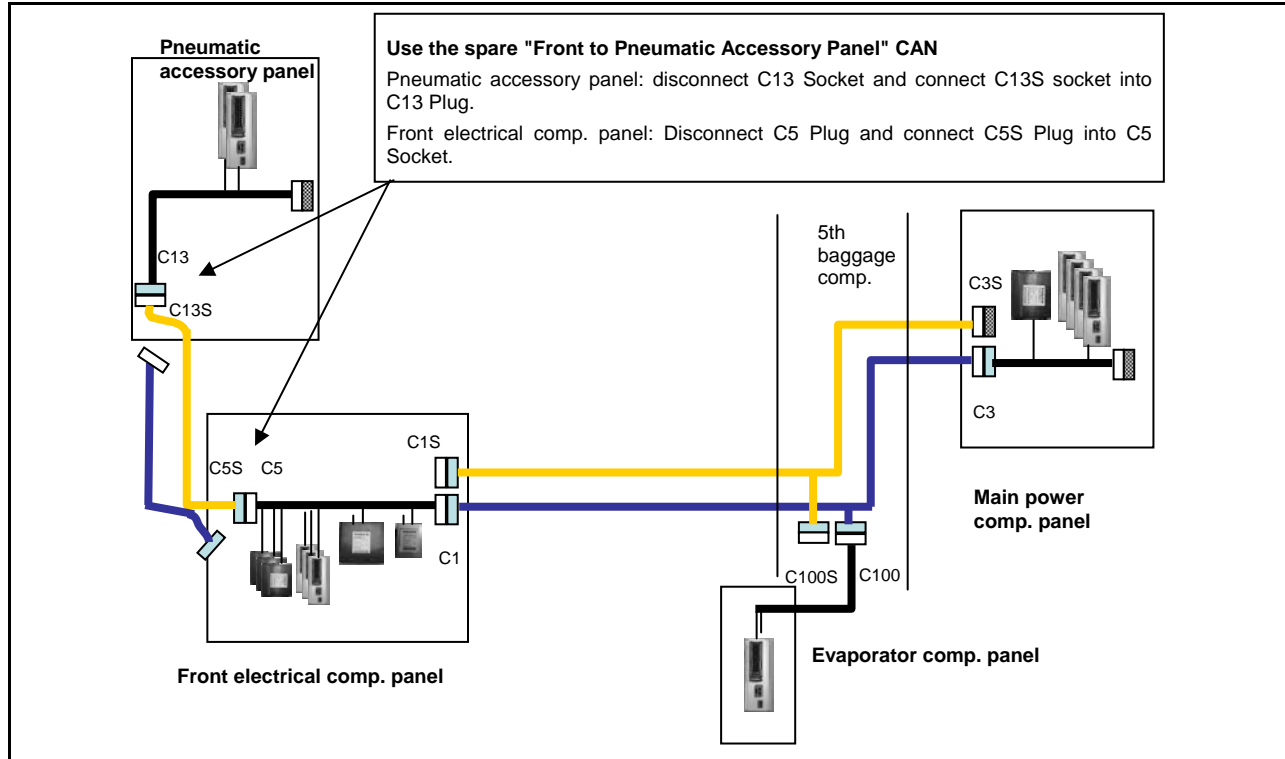
All modules including Wake-up modules and CECM have to be powered OFF prior to probe the CAN lines with an ohmmeter.

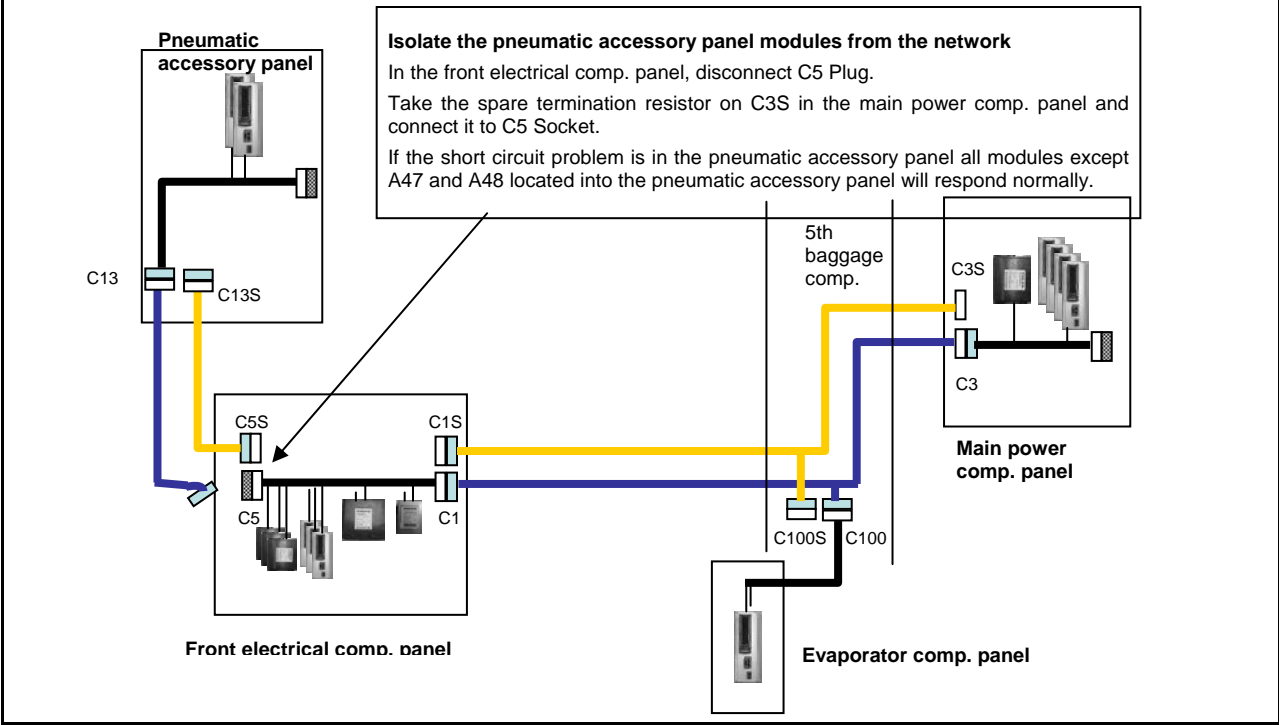
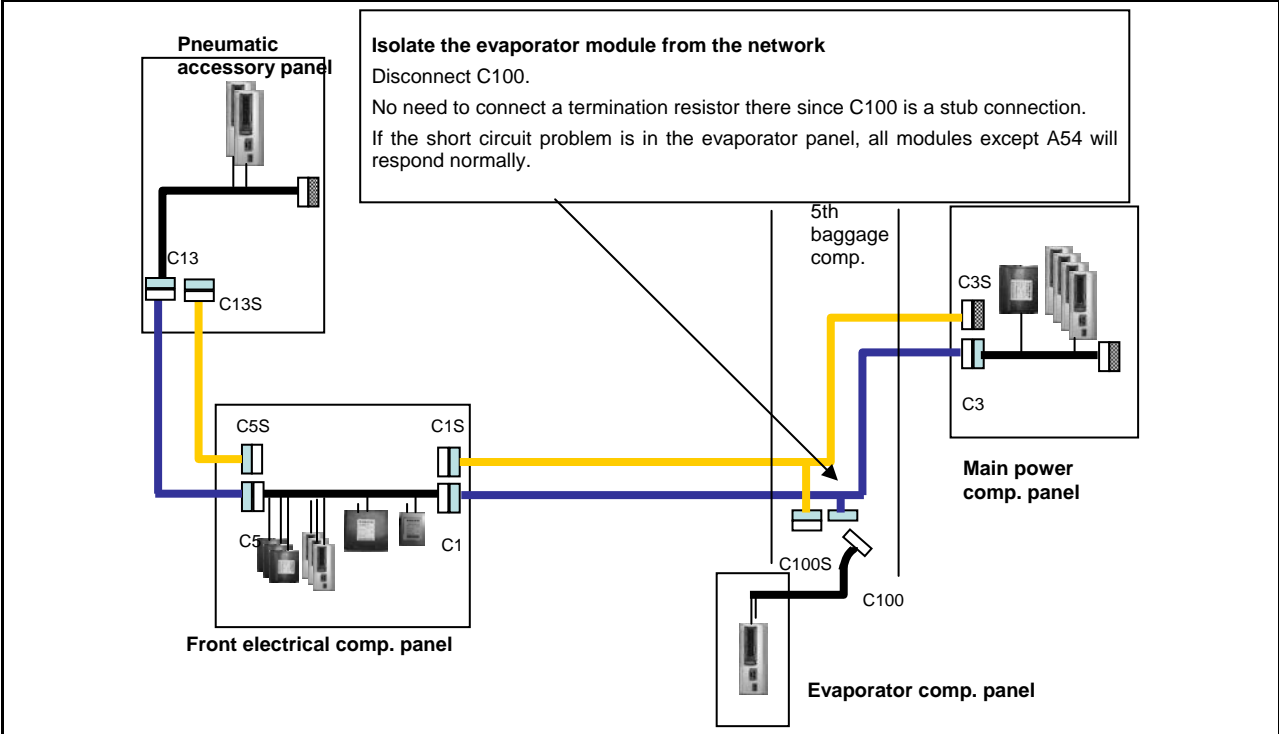
Probing the resistance between the CAN-H and CAN-L wire is a useful method to localise short circuits or open circuit on the CAN network. However, when doing so, make sure none of the modules connected to the CAN line are powered, including wake-up powered modules and battery direct supply module (CECM). Otherwise the measured value is invalid and will always show OL (Open Load). This is because the modules are applying a voltage on the CAN lines and this is fooling the ohmmeter.

**Proceed as follow when probing the CAN line with an ohmmeter in order to get a valid reading:**

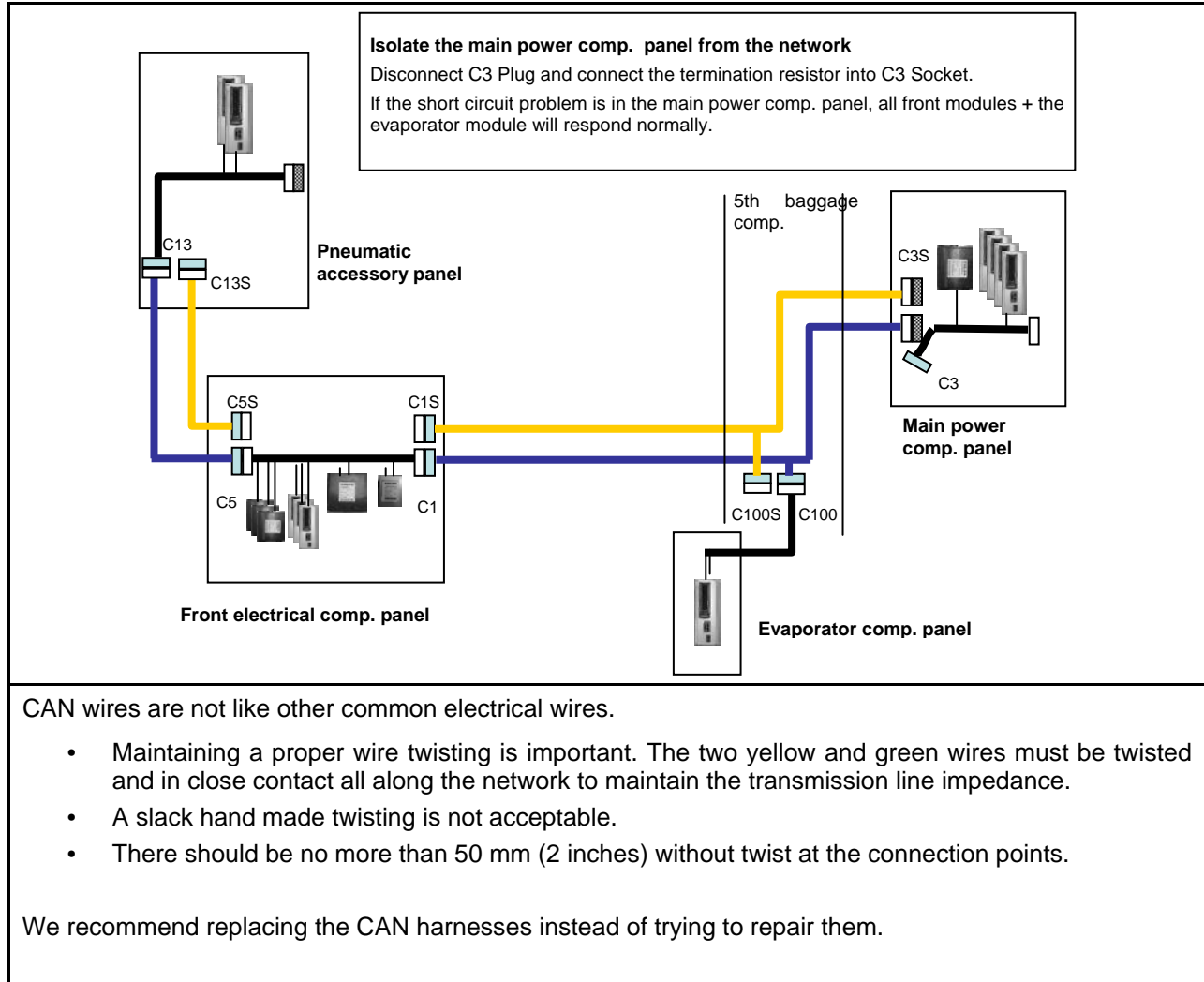
- Turn ignition key to the OFF position.
- Set the battery master switch to the OFF position to turn all Wake-up modules power to OFF.
- Trip circuit breakers CB2, CB4 and CB6 to remove direct battery power from the CECM.

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CAN wires are not like other common electrical wires.

- Maintaining a proper wire twisting is important. The two yellow and green wires must be twisted and in close contact all along the network to maintain the transmission line impedance.
- A slack hand made twisting is not acceptable.
- There should be no more than 50 mm (2 inches) without twist at the connection points.

We recommend replacing the CAN harnesses instead of trying to repair them.



## 4.7 ROADSIDE TROUBLESHOOTING

Problem/Symptom	Probable Causes	Actions
Vehicle does not Start	<p>Rear Start selector switch is not at the NORMAL position</p> <p>Battery master switch in the battery compartment is at the OFF position (down)</p> <hr/> <p>CAN network problem (Multiplex)</p> <p>Module A53 not powered or is defective</p> <p>Engine MCM does not receive the ignition signal</p> <p>Engine MCM is not powered</p>	<ol style="list-style-type: none"> <li>1. Check that the rear start selector switch is flipped up to NORMAL start position and battery master switch is flipped up to ON and retry cranking</li> <li>2. Flip the rear start selector switch to "Rear Start" and start the vehicle from the rear</li> </ol> <hr/> <p>If the vehicle does not start from the rear:</p> <ol style="list-style-type: none"> <li>1. Verify that module A53 is powered:               <ol style="list-style-type: none"> <li>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.</li> <li>b) Check / reset circuit breaker CB5</li> <li>c) Check / replace fuse F65</li> <li>d) Probe gray connector on module to see if it is powered.</li> </ol> </li> <li>2. Verify that the engine MCM is powered and get the ignition signal               <ol style="list-style-type: none"> <li>a) Check / reset circuit breaker CB8 Check / replace fuse F74</li> <li>b) Check / reset circuit breaker CB2 Check / replace fuse F78</li> </ol> </li> </ol>
<p>None of the Multiplexed functions are operating, including the basic limp-home functions (door opening, flashers, wipers in speed 1)</p> <p>Three dashes "---" appear in the telltale panel instead of the outside temperature</p> <p><i>Note: The sunshades are still functioning since these are not multiplexed</i></p>	<p>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</p>	<ol style="list-style-type: none"> <li>1. Engage the auto-programming of the I/O modules: Turn the ignition key to the OFF position, flip the battery master switch in the battery compartment to OFF and ON and then turn the ignition key ON. The letters CAN will appear in the telltale LCD panel for about 3 minutes Everything shall get back to normal once the letters CAN are replaced with outside temperature display</li> <li>2. Try disconnecting the green connector on the CECM and reconnect</li> <li>3. If step 1 and 2 are ineffective, try disconnecting the Master ID module completely and repeat step 1</li> <li>4. Try disconnecting the CECM completely, leave it disconnected and</li> </ol>

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Problem/Symptom	Probable Causes	Actions
		see if the limp-home functions (start of the vehicle from the engine compartment, wipers speed 1, flashers, etc ) are functioning
<p>Many secondary functions (not essential for driving) not functioning (interior lighting, driver's area lighting, wiper speed 2 and intermittent)</p> <p>Outside temperature display in the telltale LCD panel displays three dashes "---"</p> <p>Marker lights and clearance lights are turned ON when setting ignition to the ON position</p>	<p>The CECM module does not receive 24 V power</p> <p>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</p>	<ol style="list-style-type: none"> <li>1. Check / reset circuit breaker CB6 (4<sup>th</sup> from the top on the right side column) Check / replace fuse F1</li> <li>2. Operate in limp-home mode by starting the vehicle from the engine compartment (REAR START). All functions essential to drive are available</li> </ol> <p>To close and lock the door, pull the door manually up to its closed position and it will lock by itself. The door opening button is still functioning</p>
<p>No temperature control in the passenger area</p> <p>Passenger temperature display indicates two dashes "--"</p>	<p>Problem with the temperature sensor located in the evaporator compartment air intake or the sensor wiring</p>	<ol style="list-style-type: none"> <li>1. Instruct the driver to manually control the temperature by playing with the passenger set point. Set above 22°C (72°F) to heat and below 22° C (72°F) to cool</li> </ol>
<p>Entrance door does not open nor close using the control buttons</p> <p>Defroster fan not functioning</p> <p>Lower windshield wipers not functioning in speed 1 or intermittent</p>	<p>Module A47 is not powered or is faulty</p>	<ol style="list-style-type: none"> <li>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).</li> <li>2. Check / reset circuit breaker CB6</li> <li>3. Check / replace fuse F5</li> <li>4. Probe gray connector on module to see if it is powered.</li> <li>5. Use the air release valves near the entrance door and in the front service compartment to lock / unlock the door</li> </ol>
<p>Lower windshield wipers not functioning in speed 1 or intermittent</p>	<p>No power on R23</p>	<ol style="list-style-type: none"> <li>1. Check / replace fuse F82</li> </ol>
<p>HVAC condenser fans not functioning in speed 1</p>	<p>Circuit breaker CB12 was manually tripped and not reset</p>	<ol style="list-style-type: none"> <li>1. Check / reset circuit breaker CB12</li> </ol>

<b>Problem/Symptom</b>	<b>Probable Causes</b>	<b>Actions</b>
HVAC condenser fans not functioning in speed 2	Circuit breaker CB7 was manually tripped and not reset	1. Check / reset circuit breaker CB7
Lower and upper windshield washer not functioning  Upper windshield wiper not functioning  Defroster fan is functioning but no heat or cooling available in the driver area	Module A46 is not powered or is faulty	1. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message "No Response ModA46, Active" indicates a power problem on the module. (A CAN network problem would show the same message but doesn't produce these symptoms).  2. Check / reset circuit breaker CB1  3. Check / replace fuse F12  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 CB2  3. Check / replace fuse F33 and F34  4. Probe gray connector on module to see if it is powered.
Low beam headlights and flasher on right side not functioning	Module A48 is not powered or is faulty	1. Check the SYSTEM DIAGNOSTIC menu of 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 this symptom).  2. Check / reset circuit breaker CB2  3. Check / replace fuse F33 and F34  4. Probe gray connector on module to see if it is powered.
Rear flashers not functioning  Stoplights and high-mounted stoplight not	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

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Problem/Symptom	Probable Causes	Actions
functioning		<p>the module. (A CAN network problem would show the same message but doesn't produce this symptom).</p> <ol style="list-style-type: none"> <li>2. Check / reset circuit breaker CB2</li> <li>3. Check / replace fuse F80</li> <li>4. Probe gray connector on module to see if it is powered.</li> </ol>
<p>Engine is overheating and radiator fan clutch does not engage</p> <p>The A/C compressor clutch does not engage</p>	Module A52 is not powered or is faulty	<ol style="list-style-type: none"> <li>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).</li> <li>2. Check / reset circuit breaker CB5</li> <li>3. Check / replace fuse F65</li> <li>4. Probe gray connector on module to see if it is powered.</li> </ol>
Evaporator fan not functioning	<p>Circuit breaker CB3 tripped</p> <p>Module A54 is not powered or is faulty</p>	<ol style="list-style-type: none"> <li>1. Check / reset circuit breaker CB3</li> <li>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).</li> <li>3. Check / reset circuit breaker CB5</li> <li>4. Check / replace fuse F67 , F68</li> <li>5. Probe gray connector on module to see if it is powered.</li> </ol>
HVAC condenser fans not functioning in speed 1	Module A54 is not powered or is faulty	<ol style="list-style-type: none"> <li>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).</li> <li>2. Check / reset circuit breaker CB5</li> <li>3. Check / replace fuse F67 , F68</li> <li>4. Probe gray connector on module to see if it is powered.</li> </ol>

Problem/Symptom	Probable Causes	Actions
Sound system not functioning	Circuit breaker CB4 or CB11 was manually tripped and not reset	1. Check / reset circuit breaker CB4 or CB11
Fire alarm telltale light and audible alarm always ON and there is no fire or high temperature in the engine compartment	Short-circuited fire sensor or defective sensor	1. 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	1. 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	1. Turn the ignition key to the OFF position and turn to the ON position again. This resets all "soft-fuses"
No backlighting in the instrument cluster	Circuit breaker CB10 is tripped or fuse F20 blown	Check / reset circuit breaker CB10 Check / replace fuse F20
The radiator fan clutch does not function and the engine is overheating		1. Set the ignition key to the ON position. 2. Activate the dashboard Telltale Light Test switch 3 times within 4 seconds. 3. In the engine compartment, set the starter selector switch to REAR START and then start the engine from the rear.  While in this mode, the rear start push-button can be used to manually engage the fan clutch. The Multiplex system knows when the engine is already running, and it will not activate the starter.  4. Press the push-button one time to engage the clutch to 1 <sup>st</sup> speed, press a second time to engage to 2 <sup>nd</sup> speed, press a third time to stop the fan, press once again to return to 1 <sup>st</sup> 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

## Section 06: ELECTRICAL

Problem/Symptom	Probable Causes	Actions
		manual.

### 4.8 ESSENTIAL FUNCTIONS TO OPERATE THE VEHICLE

Even with a defective CECM (Chassis Electronic Control Module) or a CAN network problem, essential base functions are maintained to rear start the vehicle from the engine compartment and drive in a secure manner.

However, many secondary functions are lost. In this case, the following directives must be followed.

- Never connect a battery charger when the ignition is at the ON position on a vehicle with a CAN defective or certain functions will start up by themselves,
- Disconnect the charger before starting the vehicle, if not the default functions will not activate,
- If the default mode does not activate, try to turn the ignition OFF while ensuring that no charger is connected and then restart the vehicle.

#### 4.8.1 Available Functions

- Startup: Turn on the ignition in the driver's area and rear start the vehicle from the engine compartment,
- Opening the door: Functions normally,
- Closing the door: Manually pull on the door and it will lock automatically,
- Windshield wipers: Wipers functions at 1st speed only,
- Windshield washer fluid: Lower windshield washer only,
- Headlights: Low beams only,
- Directional signals: Rear and front only,
- Stoplights: 2 upper stoplights + high-mounted stoplight are functional,
- HVAC: Functional with set point fixed at 70°F (22°C), evaporator and condenser fixed at speed 1, defroster fixed at speed 4.

### 4.9 LOWER PRIORITY MODULES FOR BREAKDOWN SERVICE

Modules A43 (IO-A) and A44 (IO-B) affect lower priority functions. These modules can therefore be used as spare parts for breakdown service while on the road.

Functions lost if A43 is removed and used as spare part:

- High beams,
- Ability to turn on the parking lights only,
- « Watch your step » sign,
- Driver's area lighting,
- Tag axle activation,
- Courtesy lights.

Functions lost if A44 is removed and used as spare part:

- Fresh air damper mix trap control,
- Driver's area and entrance overhead light,
- Front clearance lights.

### 4.10 MULTIPLEX MODULES

#### 4.10.1 CECM

The CECM plays the role of interface between the engine MCM, the transmission 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.

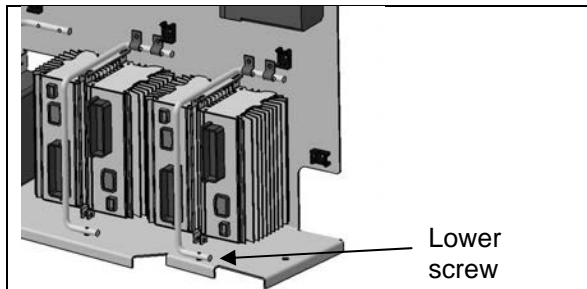


FIGURE 16: IO-B MODULE REMOVAL

## 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.
- Inside main power compartment, trip circuit breaker CB6.
- Replace the module (for IO-B modules, disconnect the green connector first, then the grey one and finish with the black connector. To disconnect the black connector, slide downwards the red latch. Remove the lower screw that holds the cable attachment rod onto the floor portion of the panel and flip the rod up, this will relieve the IO-B module, see Fig. 16).
- Reset circuit breaker CB6. This engages the automatic reprogramming.
- The telltale panel LCD display indicates "CAN" until the reprogramming is complete. Once completed, "CAN" disappears and the temperature reappears.
- Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. Verify the fault message to be certain the module is reprogrammed. If the module is not reprogrammed, the message « Axx Not Responding » appears where Axx is the module number (Ex: A41, A42...etc).


## 4.11.2 Replacing The CECM Module

- Set the ignition key to the ON position and leave it in that position at all time while performing this procedure.
- Inside main power compartment, trip circuit breaker CB6.
- Replace the module.
- Reset circuit breaker CB6. This engages the program transfer from the Master ID to the CECM module (the back-up program is inside the Master ID. The Master ID will identify the CECM as being new and will send the correct program to it). The telltale panel LCD display indicates "CAN" during 3 minutes approximately. "CAN" disappears and "---" is displayed alternately with "CAN" (during that sequence, "---" will be displayed up to 6 times and the audible alarm will ring). Wait until "CAN" is replaced by "---" that remains for more than 10 seconds. At this point the MasterID module has finished loading the program in the CECM.
- Go to the main power compartment and trip circuit breaker CB6 once again. Wait 1 second and reset it. This engages I/O's modules automatic reprogramming.
- The telltale panel LCD display indicates "CAN" until the reprogramming is completed. Once completed, "CAN" disappears and the temperature reappears. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. Check the error messages. All modules appear in error but are not active. If an active error appears for a module, this one was not reprogrammed. In this case, trip CB6 once again. Wait 1 second and reset CB6. Re-verify the error messages when "CAN" disappears from the telltale panel LCD display.
- 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.

## Section 06: ELECTRICAL

### 5. ALTERNATORS

BOSCH T1 24-volt 140 ampere or BOSCH HD10 24-volt 120 ampere, self regulated, belt driven, air-cooled alternators may be used in the 24-volt electrical system. An auxiliary BOSCH 12-volt 200 ampere may be installed also.

 <h2 style="margin: 0;">MAINTENANCE</h2>
<p><b>BOSCH T1 ALTERNATOR ONLY</b></p> <p>Change the brushes and the 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.</p> <p>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.</p> <p>Refer to Bosh T1 Alternator Maintenance Manual annexed at the end of this section.</p>

ALTERNATORS ARRANGEMENT	
<b>H3-41, H3-45 COACH</b>	
Whit DDC S60 engine	With Volvo D13 engine
2x Bosch HD10 24V-120Amp	2x Bosch T1 24V-140Amp
<b>VIP 45 with central HVAC system</b>	
2x Bosch T1 24V-140Amp	
2x Bosch T1 24V-140Amp + 1 auxiliary Bosch T1 24V-140Amp	
2x Bosch T1 24V-140Amp + 1 auxiliary Bosch 12V-200Amp	
<b>VIP 45 with small HVAC system</b>	
2x Bosch T1 24V-140Amp	
2x Bosch T1 24V-140Amp + 1 auxiliary Bosch T1 24V-140Amp	

#### 5.1 TWIN BOSCH T1 ALTERNATORS INSTALLATION WITH DDC SERIES 60 ENGINE (VIP MOTORHOMES)

If the alternators needed to be removed, reinstall as follows. Refer to figure 17 up to figure 20 for installation and tightening specifications:

1. Install alternator mounting bracket (1, figure 19) 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 upper alternator to the bracket using the 4 inch bolt at the top (2, fig 19) and two inch bolts at the lower mounting bosses (3 and 4, figure 19). Bolt the other alternator using the 6 inch bolt at the top (2a, fig 19) and two inch bolts at the lower mounting bosses (3a and 4a, figure 19);
3. On the drive shafts of both alternators, install key, pulley, spring washer and nut (5, figure 19);

#### *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 (fig. 20) using three flanged bolts. Do not tighten the adjustment bolts on the snubber until after final tightening;
5. Install the A/C compressor belt idler pulley (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. Install alternators belt (6, figure 19).

#### 5.1.1 Alternator Drive Belt

- Removal

1. Insert a ¾ inch socket drive into the automatic belt tensioner opening (fig. 19).
2. Twist the automatic belt tensioner to slacken belt.
3. Remove belt.

#### *NOTE*

*Belts specifications may vary. For proper belt selection, always consult your vehicle Coach Final Record.*


- Installation

Installation of the alternator drive belt is the reverse of removal.

#### 5.1.2 Adjustment

Correct belt tension is required to maximize belt life. The automatic belt tensioner maintains proper belt tension, no adjustment is required.





**MAINTENANCE**

Check for wear and proper tension every 6,250 miles (10 000 km) or twice a year, whichever comes first.

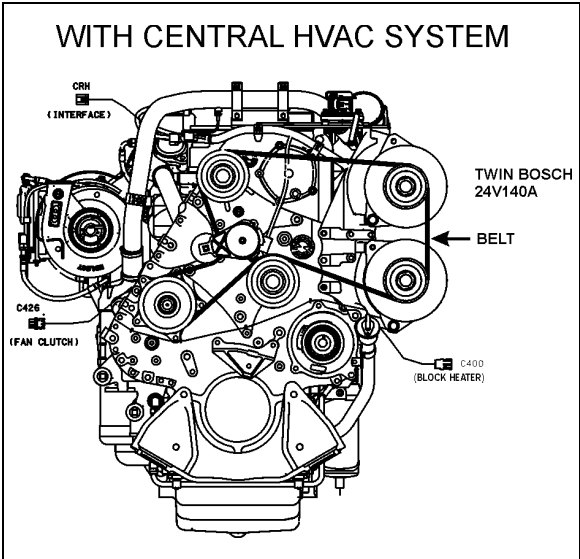


FIGURE 17: ALTERNATOR DRIVE BELT 01180

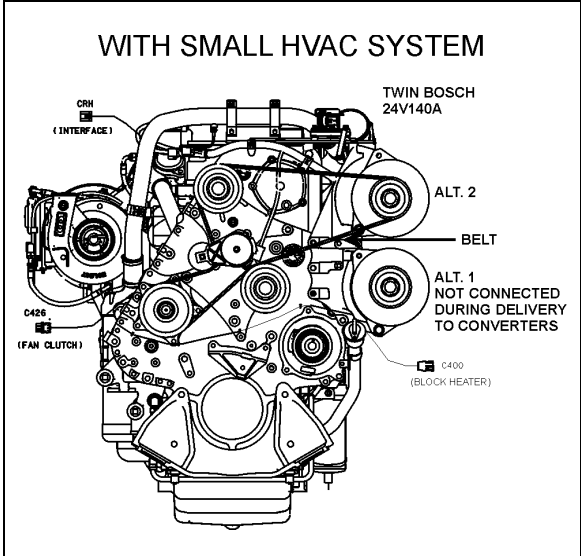


FIGURE 18: ALTERNATOR DRIVE BELT 01181

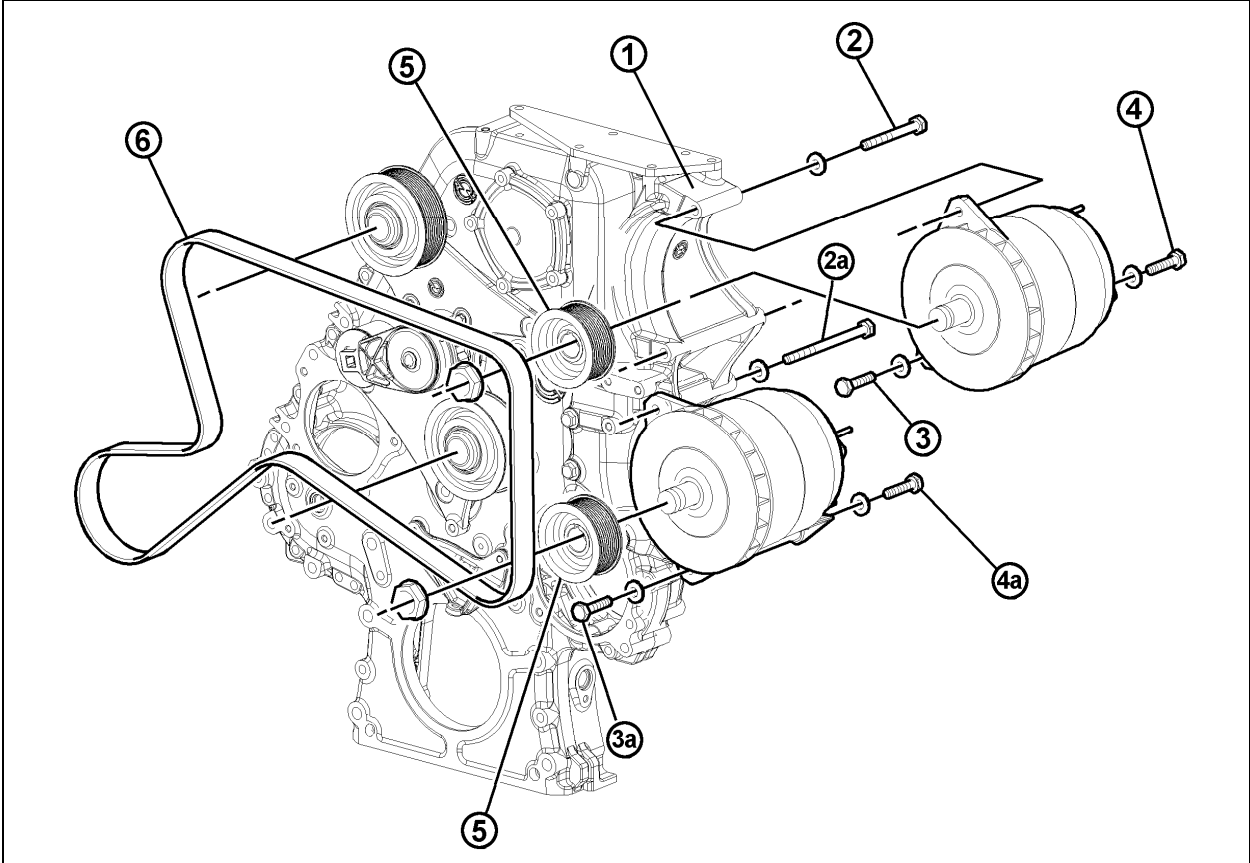


FIGURE 19: TWIN BOSCH ALTERNATORS INSTALLATION WITH DDC SERIES 60 ENGINE (VIP MOTORHOMES) 01077

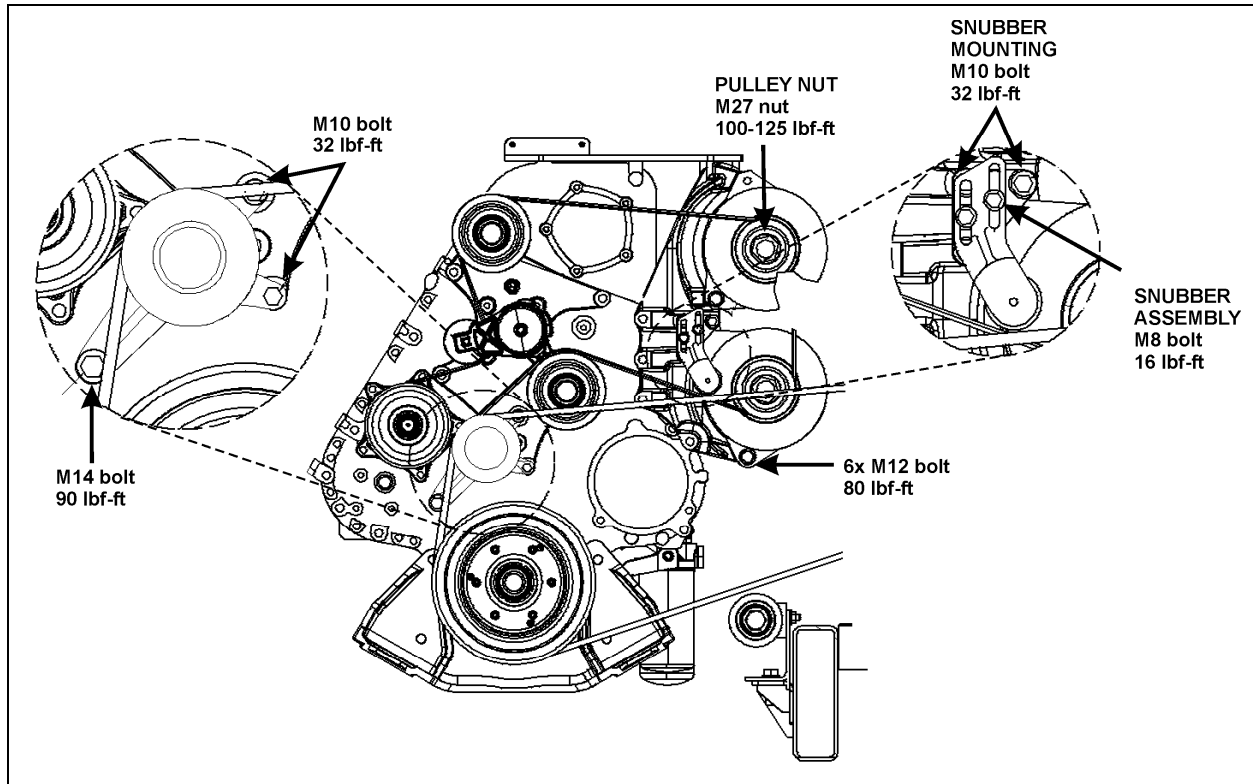


FIGURE 20: ALTERNATORS AND ACCESSORIES MOUNTING TORQUES

01182

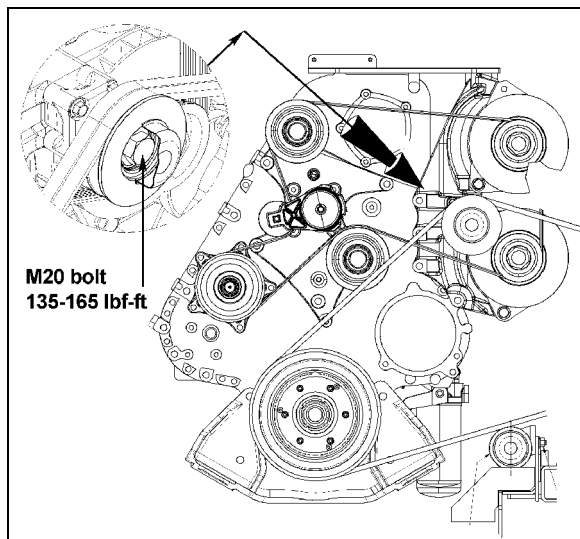


FIGURE 21: ALTERNATORS AND ACCESSORIES MOUNTING TORQUES (VIP WITH SMALL OR CENTRAL HVAC SYSTEM)

01183

**⚠ 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 ALTERNATOR WILL NOT REVERSE TO ACCEPT INVERSE POLARITY.** Also, do not ground or short across any of the alternator or regulator terminals.

## 5.2 TWIN BOSCH T1 ALTERNATORS INSTALLATION WITH VOLVO D13 ENGINE

If the alternators needed to be removed, reinstall as follows. Refer to figures 22 and 23 for installation and tightening specifications:

1. If not already done, mount the alternator brace to the engine and alternator support (figure 22).
2. Bolt the alternators to the bracket using one 3.5 inch bolt at the top and two 1¾ inch bolts at the lower mounting bosses (fig. 22).

- On the drive shafts of both alternators, install key, pulley, spring washer and nut;

**NOTE**  
*Final tightening of the pulleys can be performed once the belt is installed. This will help keep the pulley from turning when tightening.*

- Install the alternators belt, the coolant pump belt, the A/C compressor belt and then the radiator fan driving mechanism belt (figure 23).

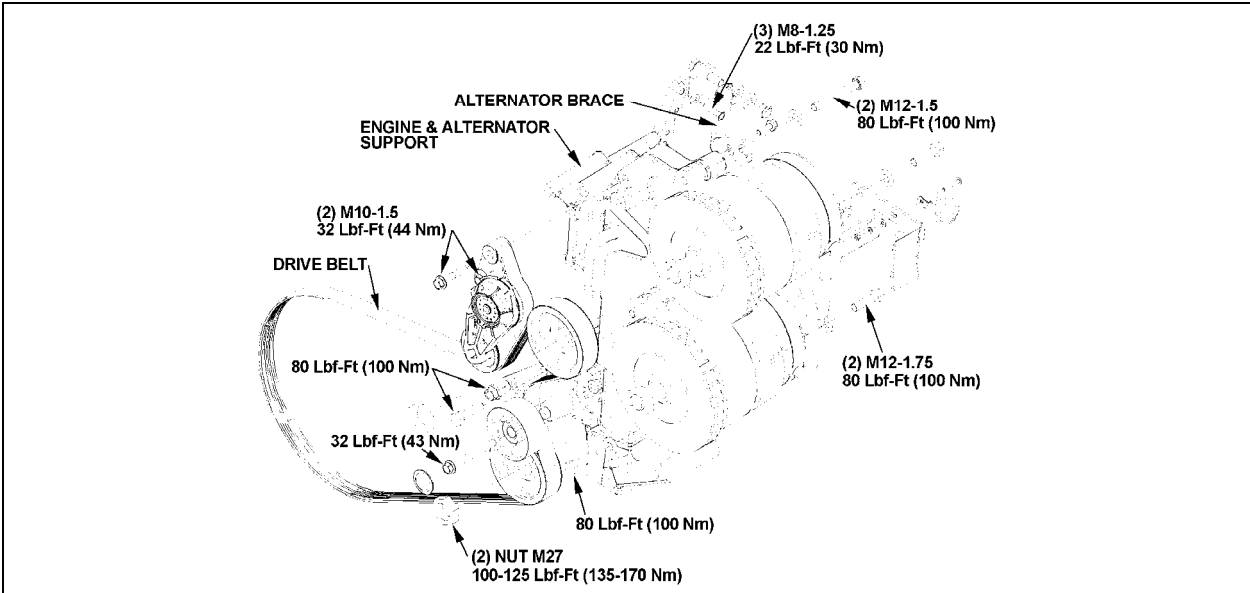


FIGURE 22: BOSCH ALTERNATORS MOUNTING TORQUES (VOLVO D13)

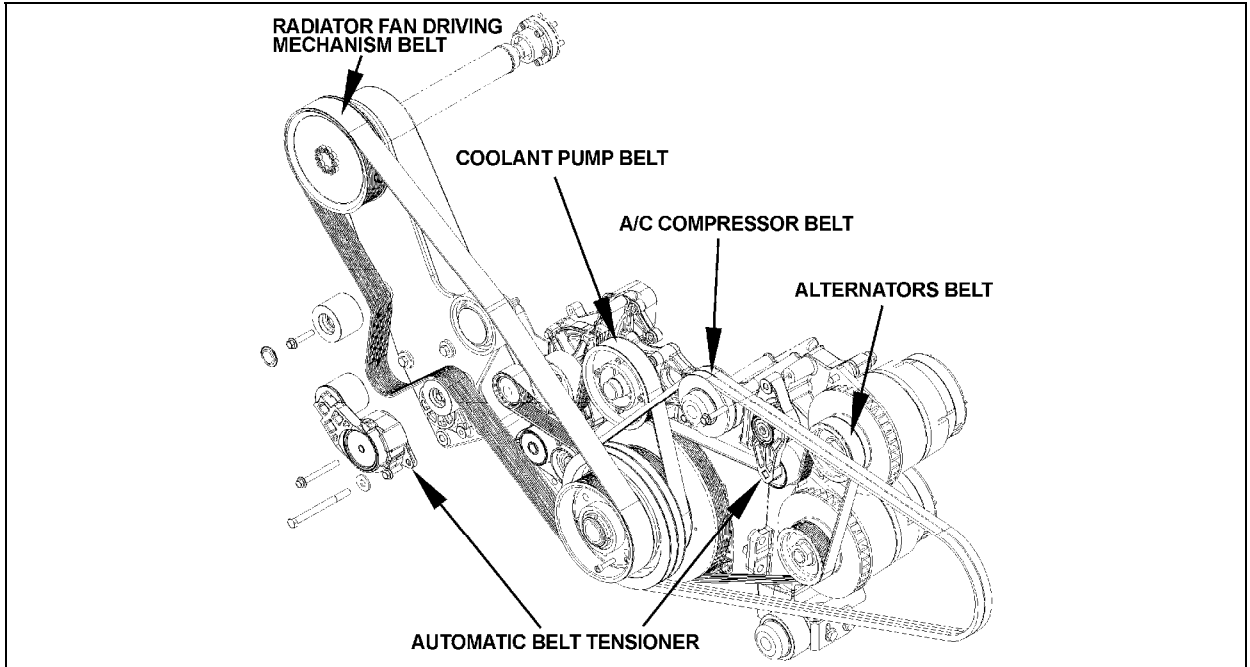


FIGURE 23: TWIN BOSCH ALTERNATORS INSTALLATION (VOLVO D13)

## Section 06: ELECTRICAL

### 5.2.1 Alternator Drive Belt

#### Removal

1. Remove the radiator fan driving mechanism belt, the A/C compressor belt, and then the coolant pump belt.
2. Insert a ¾" socket drive into the automatic belt tensioner opening (Fig. 22).
3. Twist the tensioning arm to slacken the alternator drive belt.
4. Remove belt.

#### **NOTE**

*Belts specifications may vary. For proper belt selection, always consult your vehicle Coach Final Record.*

#### Installation

Installation of the alternator drive belt is the reverse of removal.

### 5.2.2 Adjustment

Correct belt tension is required to maximize belt life. The tensioning arm maintains proper belt tension, no adjustment is required.



#### **MAINTENANCE**

Check for wear and proper tension every 6,250 miles (10 000 km) or twice a year, whichever comes first.

### 5.3 TWIN BOSCH HD10 ALTERNATORS INSTALLATION WITH DDC SERIES 60 ENGINE (H3 SERIES COACHES)

Two 24 volt 120Amp, self regulated, belt driven, air-cooled HD 10 BOSCH alternators are used in the 24 volt electrical system.

If the alternators needed to be removed, reinstall as follows. Refer to figure 24 and 25 for installation and to figure 26 for tightening specifications:

1. If necessary, reinstall protector (00, figure 25) to the alternator support assembly. Use the stud (0a, figure 19) and bolt (0b, figure 25) to fix the protector. Use some Loctite 262 red (688910) onto the threads.

2. If removed, reinstall ring bracket (1, figure 19) and L-shaped bracket (1.1, figure 25). Fix the ring bracket using bolt (1a, figure 25) and also bolt and nut (1b, figure 19) for the ring bracket and L-shaped bracket. Use some Loctite 262 red (688910) onto the threads.
3. Mount the upper alternator using bolt and nut (2a, figure 25), and also bolt and nut (2b, figure 25).
4. Mount the lower alternator using bolt and nut (3a, figure 25), and also bolt and nut (3b, figure 25). Fix the lower portion of the alternator using nut (3c, figure 25).
5. Mount the cable bracket (4, figure 25) and fix using bolts (4, figure 25).
6. Mount pulleys (5, figure 25) onto alternators.
7. Install alternators belt (6, figure 25).

#### **NOTE**

*Final tightening of the pulleys can be performed once the belt is installed. This will help keep the pulley from turning when tightening.*

### 5.3.1 Alternator Drive Belt

#### Removal

4. Insert a ¾" socket drive into the automatic belt tensioner opening (Fig. 25).
5. Twist the tensioning arm to slacken belt.
6. Remove belt.

#### **NOTE**


*Belts specifications may vary. For proper belt selection, always consult your vehicle Coach Final Record.*

#### Installation

Installation of the alternator drive belt is the reverse of removal.

### 5.3.2 Adjustment

Correct belt tension is required to maximize belt life. The tensioning arm maintains proper belt tension, no adjustment is required.

 **MAINTENANCE**

Check for wear and proper tension every 6,250 miles (10 000 km) or twice a year, whichever comes first.

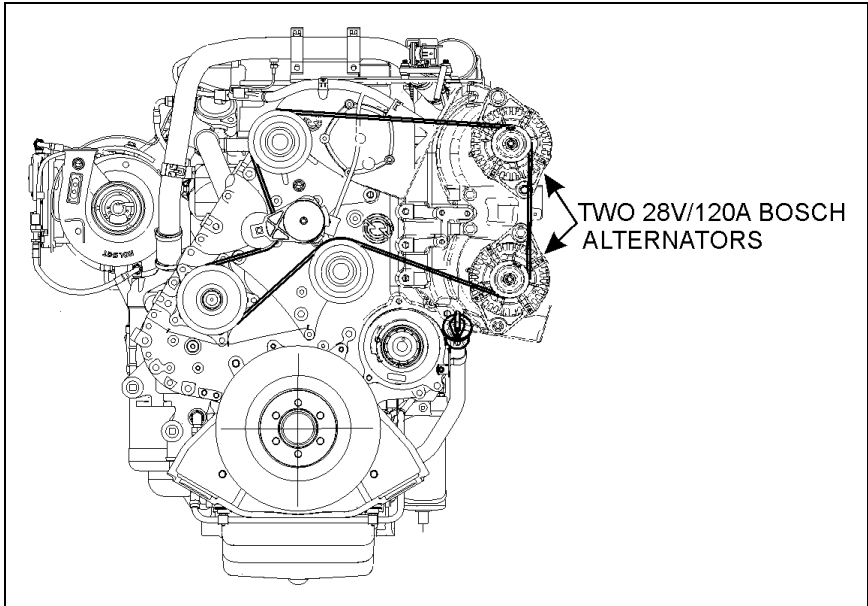


FIGURE 24: TWIN BOSCH HD10 ALTERNATOR

01180

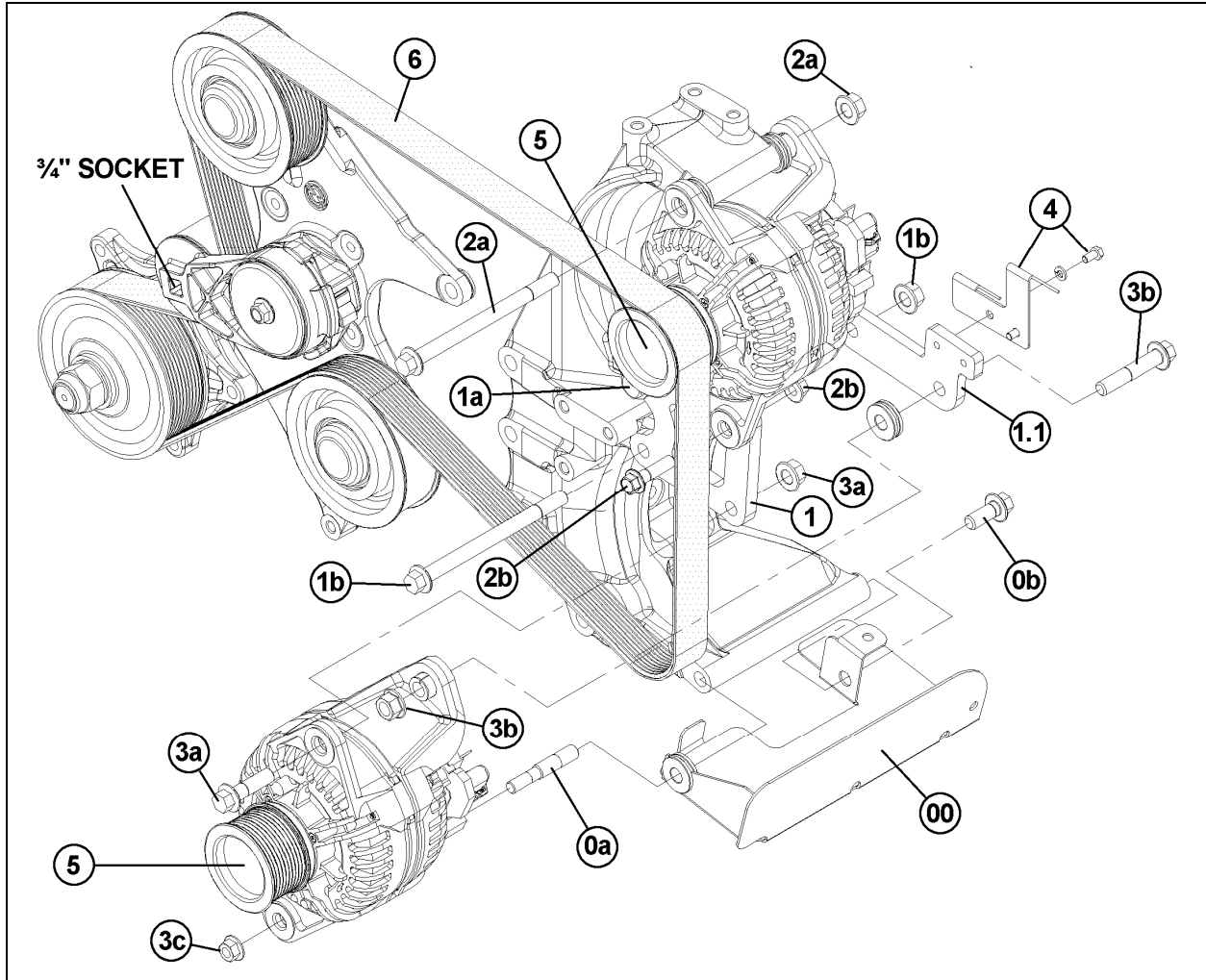


FIGURE 25: TWIN BOSCH HD10 ALTERNATORS INSTALLATION (H3 SERIES COACHES)

01077

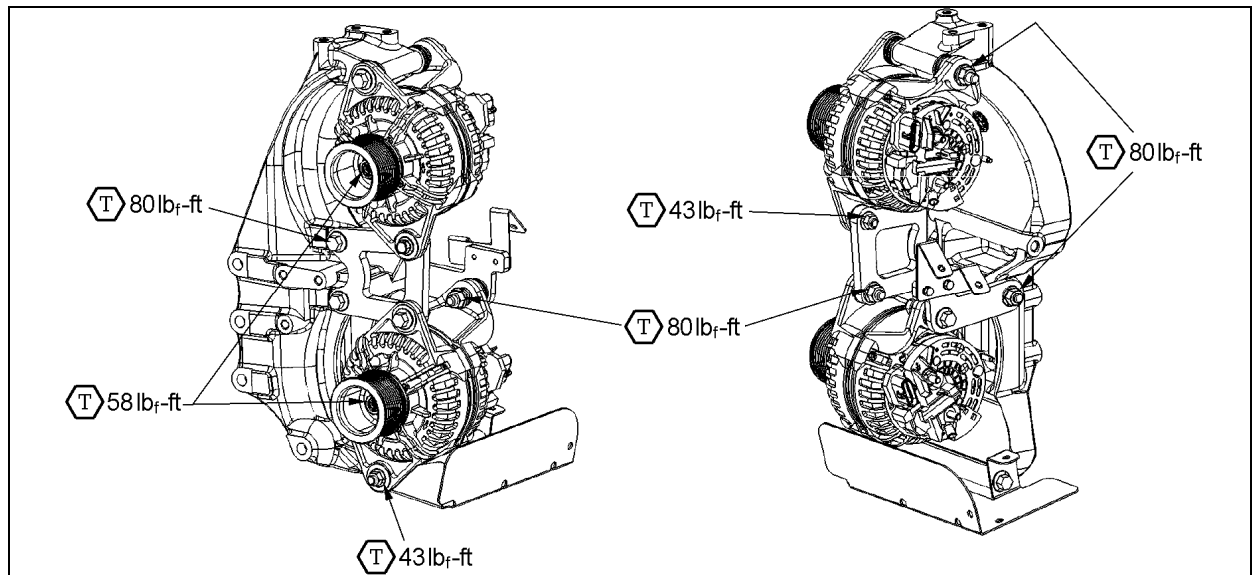


FIGURE 26: TWIN BOSCH HD10 ALTERNATORS AND ACCESSORIES MOUNTING TORQUES (H3 SERIES COACHES)

## 6. 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 located on the engine compartment door (Fig. 27) or on the engine compartment R.H. side door. To use it, connect the female plug of an electrical extension cord to the heater plug. Some converted vehicles may have the heater connected to the coach AC power system. 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.

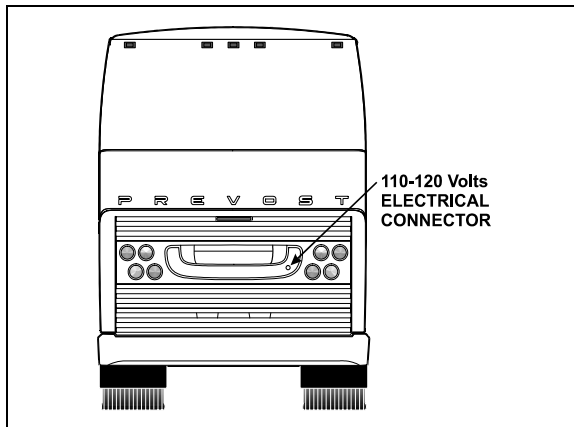


FIGURE 27: ENGINE BLOCK HEATER PLUG LOCATION

06481

### 6.1 MAINTENANCE

This heater is non-serviceable except for the cord, and if faulty, must be replaced as a unit.

## 7. 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.

### 7.1 HEADLIGHTS

Inner headlights are used for high beam and daytime running light while outer headlights are used for low beam. The inner or outer lamp uses the same single filament halogen bulb part number.

#### NOTE

If vehicle is equipped with optional Xenon headlights, refer to paragraph 6.1.6.

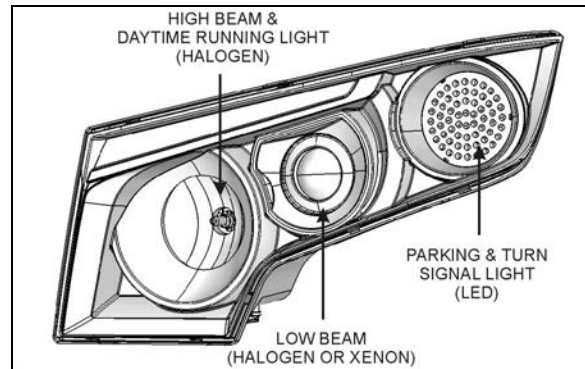


FIGURE 28: HEADLIGHT ASSEMBLY

06713

#### 7.1.1 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.

#### 7.1.2 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.

#### 7.1.3 Replacing headlight bulbs

The following illustrations show how to gain access to the bulbs. When replacing a bulb, make sure the ignition switch and light switch are off.

## Section 06: ELECTRICAL



### CAUTION

- To prevent burning yourself, do not replace the light bulbs while they are hot.
- Halogen bulbs have pressurized gas inside and require special handling. They can burst or shatter if scratched or dropped. Hold a bulb only by its plastic case. Do not touch the glass part of a bulb with bare hands.

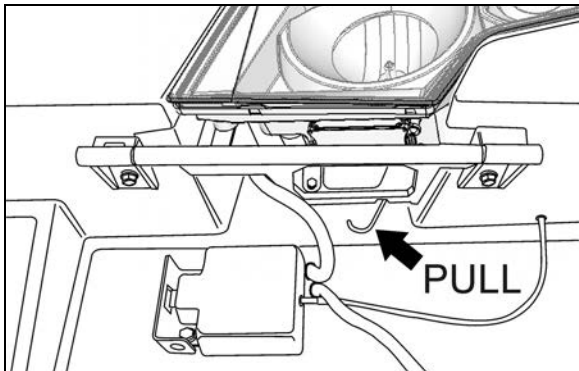


FIGURE 29: ROCKING THE HEADLIGHT ASSEMBLY 06714

1. First, make sure the ignition switch and light switch are off.
2. Pull on the reclining bumper opening handle located inside the front electrical and service compartment.
3. Pull on the rod shown on figure 29 to pivot the headlight assembly.
4. Unscrew the cap to gain access to the bulb connector.

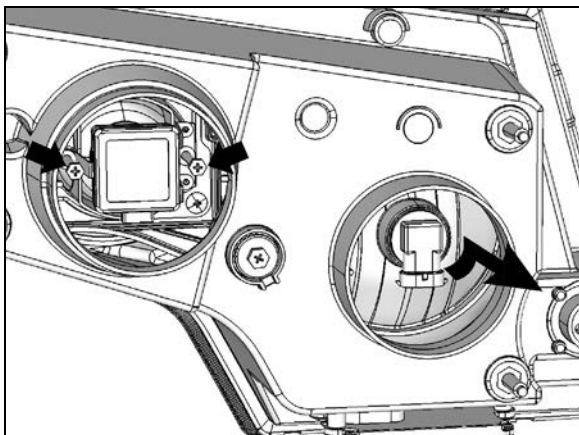


FIGURE 30: HEADLIGHT ASSEMBLY REAR VIEW 06715

5. HALOGEN: turn the bulb base counterclockwise. XENON: Unscrew the

Phillips head screws indicated by arrows, pull the retainer and bulb out (figure 30).



### CAUTION

During this step, avoid contacting the bulb with the fingers not to alter the bulb life.

6. Unplug the connector while depressing the lock release when applicable.
7. Replace bulb, connect to harness and install into mounting hole.

Aiming is not necessary after replacing the bulb. When aiming is necessary, refer to paragraph "HEADLIGHT AIMING".

#### 7.1.4 Replacing Front Turn Signal LED module

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. Rotate the cap to gain access to the LED module.
2. Disconnect the electrical harness connector from the LED module.
3. Unscrew the 3 mounting fasteners and replace LED module.
4. Install wiring connector on back of new turn signal module.

#### 7.1.5 Optional Xenon Headlamp (Low Beam)

The outer lamps of each headlight assembly may be equipped with the optional Xenon lamps. These lamps improve visibility and provide better lifespan.



### CAUTION

To avoid breaking the bulb, make sure the socket is in proper position against the stop.



### CAUTION

Never connect a voltmeter or V.O.M. to measure bulb voltage as instrument will be destroyed.

### NOTE

Do not disrupt headlight adjustment screws.



When switching on the Xenon headlamp using the rocker switch, a 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 30mA 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 stat ( $< 34$  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 1.58A after one minute for the 24V ballast.

#### 7.1.6 Aiming headlights

Headlights must be properly aimed to provide maximum allowable road illumination. Aiming

can be performed without opening headlight assembly. Vertical aiming of each module is provided by one adjusting screw that pivot the entire module in the housing for proper alignment (Fig. 31, 32). There is no adjustment for focus since the module is set for proper focus during manufacturing assembly.

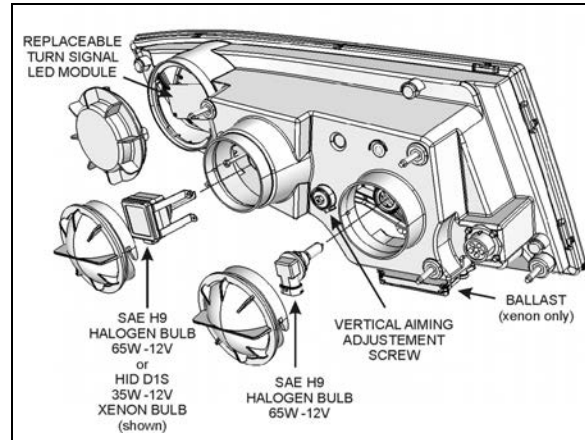


FIGURE 31: HEADLIGHT ASSEMBLY

06716

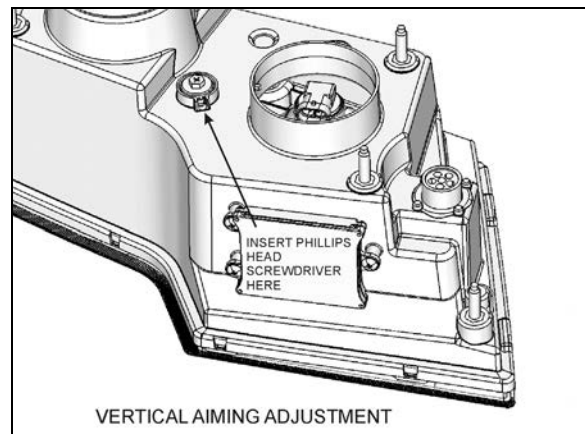


FIGURE 32: VERTICAL AIMING

06717

### 7.2 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, a high-mounted stoplight will illuminate simultaneously with the stoplights on the sides for increased safety.

The stop and tail lights are combined in the same 6-LED lamp. The directional signal and license plate lights consist of individual LED lights mounted on the engine rear door, and each light is serviced individually as a complete

## Section 06: ELECTRICAL

unit. The back-up light sealed unit 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.

### 7.2.1 Lamp Removal And Replacement

1. Open engine compartment rear door.
2. Unscrew 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.

### 7.2.2 High-Mounted Stop Light Removal And Replacement

This vehicle is equipped with a high-mounted stop light (LED). This light is a sealed unit 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.

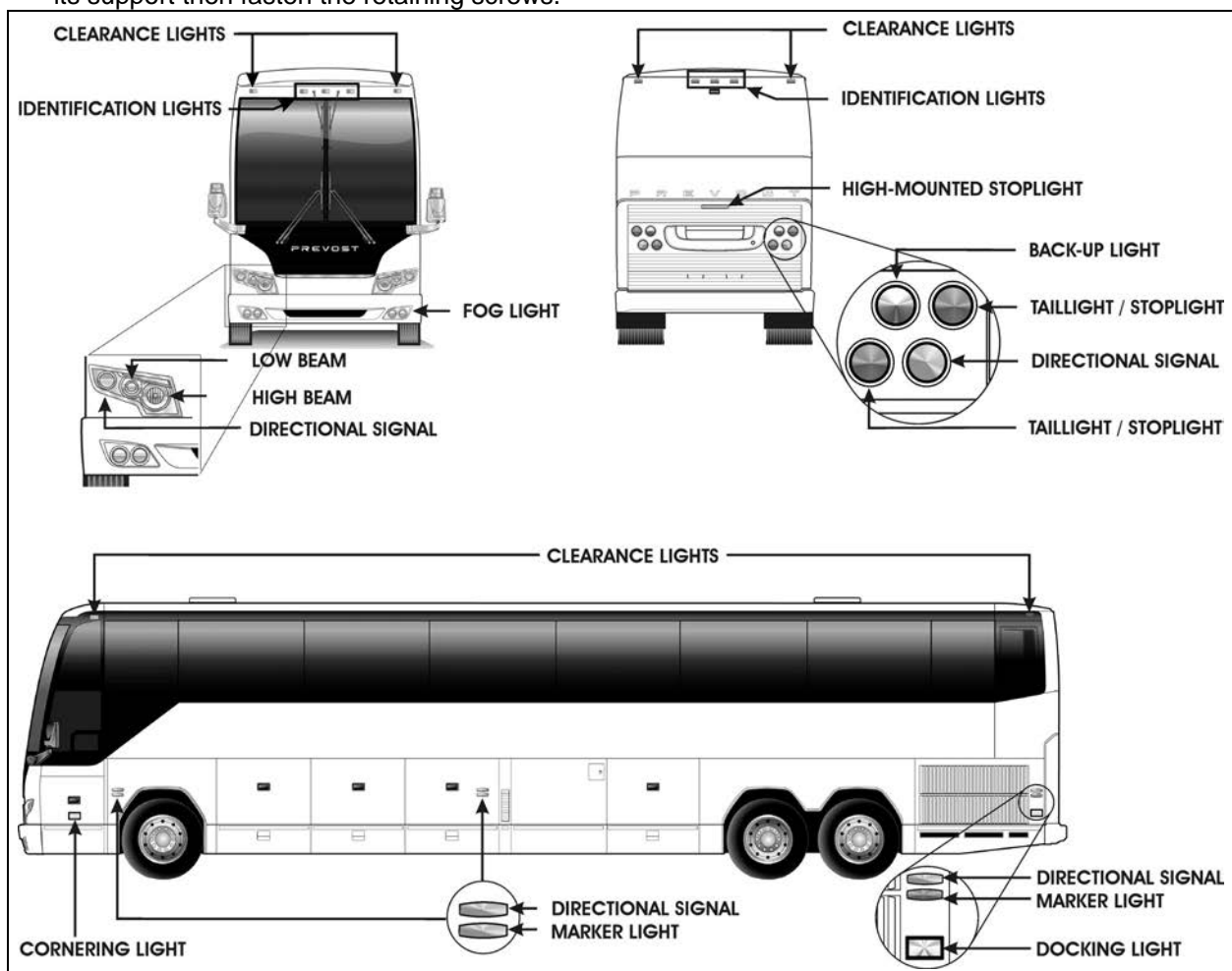


FIGURE 33: VARIOUS LIGHTS LOCATION

18588\_4

### 7.3 LICENCE 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.

**7.4 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.

**7.4.1 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, disconnect and remove the light assembly.
2. Connect and position the new light assembly and install the "Phillips" screws.

**7.4.2 Clearance And Identification Light Removal And Replacement**

The clearance and identification lights are sealed units (LED) and should be replaced as an assembly in accordance with the following procedure:

1. Unscrew both "Phillips" light screws, disconnect and remove the light assembly.
2. Connect and position the new light assembly, then install the "Phillips" screws.

**7.5 DOCKING AND CORNERING LIGHTS**

This vehicle is provided with two halogen sealed-beam units that serve as cornering lights. They are mounted on the front L.H. side service compartment door, while the other is located between the front wheel and 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. On the V.I.P. model, a dashboard-mounted rocker switch may be actuated to cancel this system in special situations.

Two additional halogen sealed-beam units are installed on rear electrical compartment door (R.H.) and radiator door. These lights are used as docking lights and both will illuminate

automatically when reverse range is selected to facilitate back-up or docking procedure.

On the V.I.P. model, these lights do not operate automatically when the reverse range is selected, but by means of a dashboard-mounted rocker switch. When actuated, the docking as well as the cornering lights illuminate. Furthermore, a "Low docking" switch, also located on dashboard, allows the use of the docking and cornering lights at a lower intensity when the docking switch is actuated.

**7.5.1 Lamp Removal And Replacement**

Both docking and cornering sealed-beam units can be changed in accordance with the following procedure:

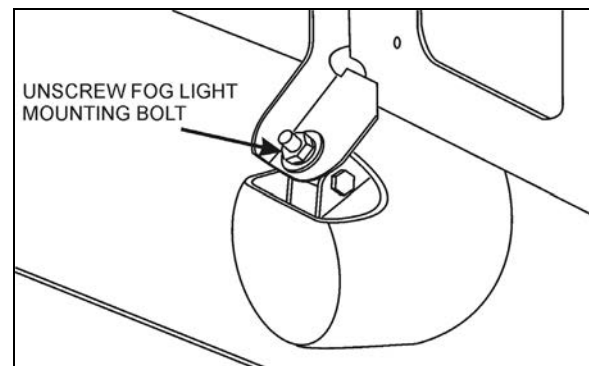
1. Remove the two "Phillips" screws attaching the retaining ring.
2. Disconnect the light unit connection.
3. Remove the lamp.
4. Position new lamp.
5. Connect and position the light unit.
6. Finally, install the retaining ring and screw.

**7.6 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.

**7.6.1 Bulb Removal And Replacement**

1. Pull on the release handle located in the front electrical and service compartment, near the door lower hinge. The bumper will lower gradually.



**FIGURE 34: FOG LIGHT MOUNTING BOLT**

2. From bumper inner side, unscrew the nut fixing the fog light and remove the entire fog light assembly from the bumper.

## Section 06: ELECTRICAL

3. Unscrew the outer ring. Disconnect the light unit connection and remove the bulb.

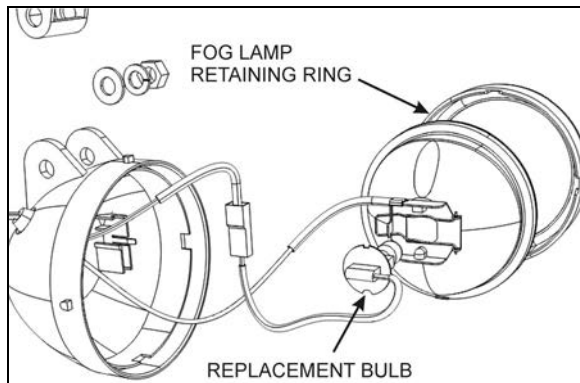


FIGURE 35: FOG LIGHT EXPLODED VIEW



### CAUTION

During this step, avoid contacting the bulb with your fingers. This could alter the bulb life.

4. Install the new bulb, reconnect the light unit and replace in its proper position.
5. Reinstall the outer ring, then return the fog light assemble to its proper location.
6. Fasten the fog light mounting nut and securely close the bumper.

## 8. INTERIOR LIGHTING EQUIPEMENT

### 8.1 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.

#### 8.1.1 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. 36).

### NOTE

Switches are lighted by the use of LED. When lighting on a switch fails, replace defective switch as a unit.

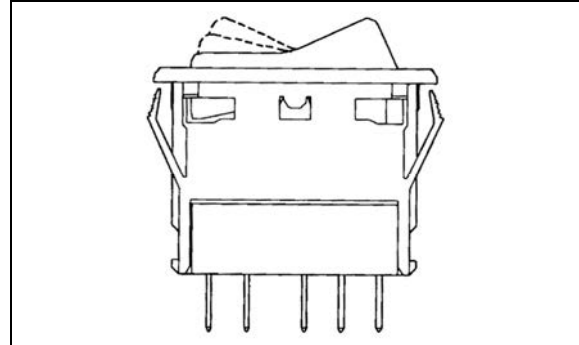


FIGURE 36: SWITCH

#### 8.1.2 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.

#### 8.1.3 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.

## 8.2 STEPWELL LIGHTS

### 8.2.1 Coach Entrance

The three stepwell lights are illuminated when the door opening system is activated (Fig. 37).

#### • Light Removal and Replacement

1. Unsnap the lamp outer ring with a flat head screwdriver and remove it.

2. Unfasten the three fixing screws, remove and disconnect LED light assembly.
3. Connect and install the new LED assembly in position.
4. Fasten the three fixing screws and replace the lamp outer ring by snapping it back in place.

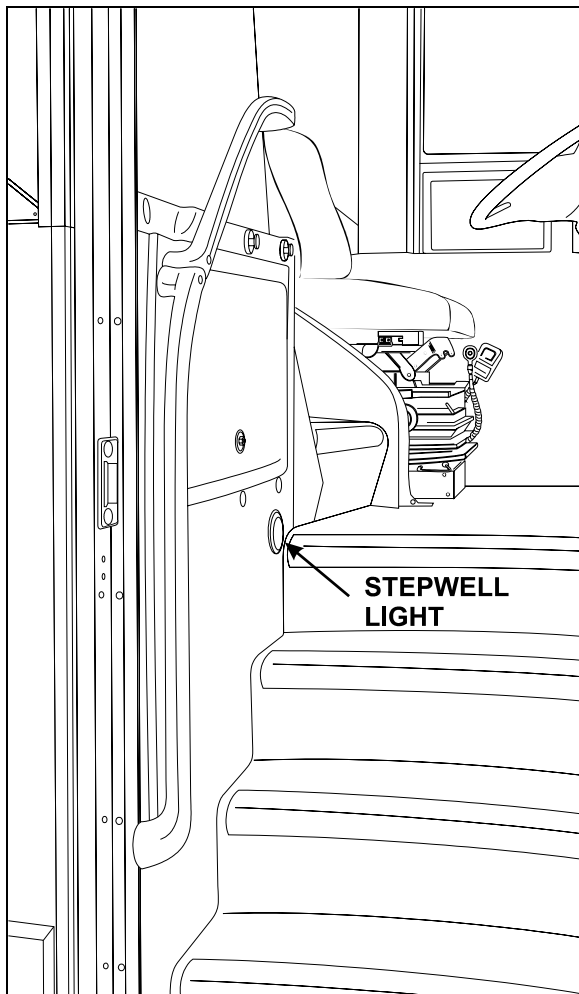
### 8.2.2 VIP Entrance And Bus Entrance Door

The stepwell light is illuminated when the door opening system is activated (Fig. 38).

### 8.2.3 Bulb Removal And Replacement

Proceed as follows to replace defective bulb:

1. Unscrew the two Phillips-head screws retaining the lens to the wall, and remove it.
2. With the light lens removed, pull bulb from the lamp while applying lateral pressure.
3. Install the new bulb into the lamp.
4. Position the light lens and install it.



**FIGURE 37: COACH ENTRANCE STEPWELL** 06492

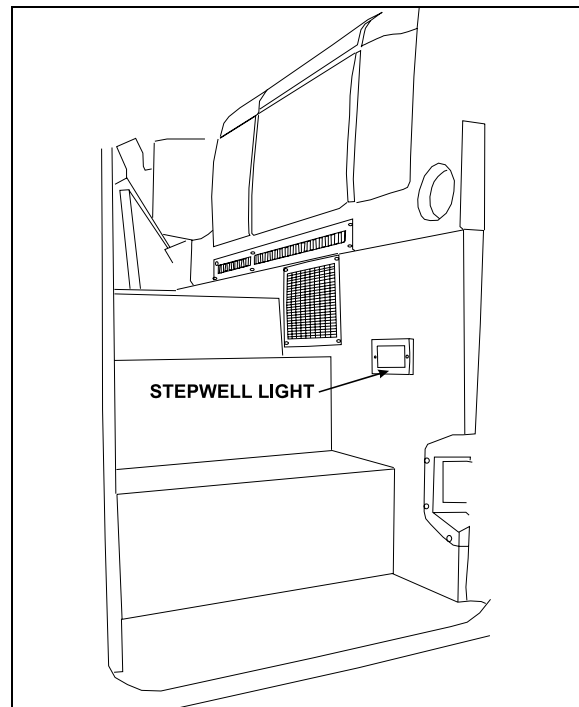
### 8.3 LAVATORY NIGHT-LIGHT

The lavatory night-light is illuminated as soon as the ignition switch is set to the "ON" position.

#### 8.3.1 Bulb Removal And Replacement

Proceed as follows to replace defective bulb:

1. Unscrew the two Phillips-head screws retaining the lens to the lavatory wall, and remove it.
2. With the light lens removed, pull bulb from the lamp while applying lateral pressure.
3. Install the new bulb into the lamp.
4. Position the light lens and install it.



**FIGURE 38: VIP ENTRANCE STEPWELL** 06507

### 8.4 DRIVER'S AREA LIGHTS

One halogen ceiling light is installed over the stepwell and another one over the driver's area. These lights are frequently used for nighttime operation when passengers board or leave coach.

#### 8.4.1 Bulb Removal And Replacement

1. Unsnap the lamp with a flat head screwdriver and remove it.

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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.



**Do not touch halogen bulbs with bare hands as natural oils on skin will shorten bulb life span.**

### 8.5 PASSENGER SECTION LIGHTING

The passenger section of coach is lit by two types of fluorescent tube lamps installed on the parcel racks.

The aisle or indirect lights are located on front of parcel racks, and provide soft, indirect cabin lighting and parcel rack interior lighting. More powerful lighting for general and in-station applications is provided by fluorescent tubes located under the parcel racks, close to the windows. A dual power system is available for this lighting either from the 24-volt vehicle power supply or from a 110-volt outlet supply. In order to save batteries during extended periods of in-station lighting, no current is drawn from the batteries as soon as the 110-volt circuit is connected.

Moreover, adjustable reading lamps are installed under the parcel racks for passenger accommodation.

#### 8.5.1 Fluorescent Tube Replacement

- Indirect Fluorescent Light
  1. Open the parcel rack access door, if so equipped, unscrew the two Phillips screws (one each end). Let the hinged cover down.
  2. Remove fluorescent tube from light socket and install a new fluorescent tube.
  3. Lift the hinged cover and replace the two retaining screws (Fig. 39).
- Parcel Rack Interior Lighting
  1. Open the parcel rack access door, if so equipped, unscrew the two Phillips screws (one each end). Pull the hinged cover down.
  2. Push on the bulb, turn and then, pull it from the socket.
  3. Install a new bulb.
  4. Lift the hinged cover and replace the two retaining screws.

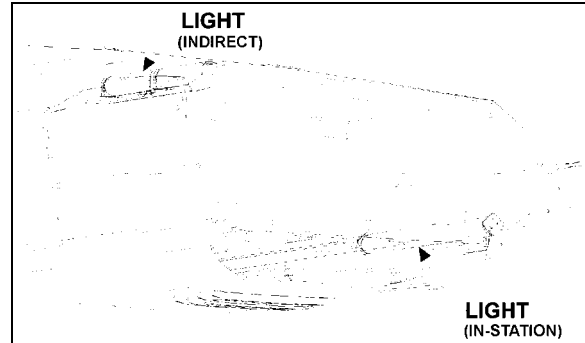


FIGURE 39: PARCEL RACK

06419

#### 8.5.2 Removal And Replacement Of In-Station Fluorescent Tubes

1. Start by pulling out the corner of the lens then delicately peeling it out of its seat.



**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.

#### 8.5.3 Removal And Replacement Of Reading Lamp Bulb

1. Engage the tool (#830164) over the lamp and turn one quarter turn counterclockwise. Then, remove the tool slowly.
2. Pull the bulb socket off the reading lamp unit.
3. Push and turn bulb counterclockwise, then pull it out of the socket.
4. Install new bulb in the socket, then push and turn clockwise to lock bulb in position.
5. Push the bulb socket in the reading lamp unit.
6. Position the reading lamp with the tool (#830164), turn one quarter turn clockwise.

### 8.6 ENGINE COMPARTMENT LIGHTING

Two lights illuminate the engine compartment upon opening of the engine door (Fig. 40).

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.

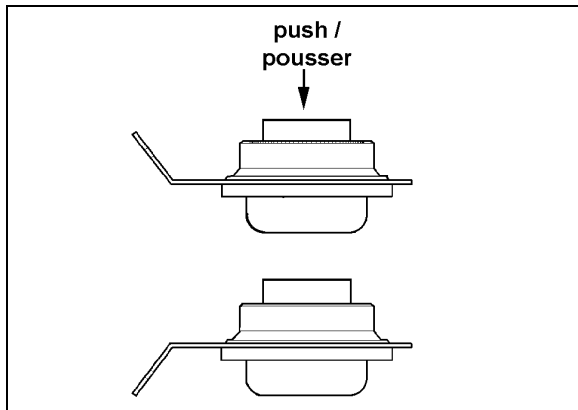


FIGURE 40: ENGINE COMPARTMENT LIGHT

### 8.7 LAVATORY LIGHT

The lavatory halogen lights are installed on ceiling. A microswitch, mounted in the door exterior frame, is activated by the door lock mechanism upon locking to energize the circuit. This switch is readily serviced by removing the two Phillips-head screws securing the mounting plate to the door exterior frame.

Proceed as follows to replace the bulb:

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.**

## Section 06: ELECTRICAL

### 9. LIGHT BULB DATA

When replacing a light bulb, special attention must be paid to the voltage rating (refer to light bulb data hereafter).

<i>NOTE</i>
<i>Exterior and interior lights can be 12 volts or 24 volts.</i>

Application	Prevost part no.	Trade or SAE number	Watts or Candle Power	Volts	Qty
<b>EXTERIOR LIGHTING</b>					
Hi-beam	563092	H9	65 W	12	2
Low-beam	563092	H9	65 W	12	2
Low-beam Xenon (optional)	564477	D1S	35 W	12	2
Docking & cornering	930319	H9415	37.5 W	12	4
Fog	930361	H3	55 W	12	2
License plate (sealed)	930368	Led	.05 A	12	2
Side marker (red)	930340	Led	.06 A	12	2
Side marker (amber)	930341	Led	.06 A	12	10
Identification (red)	930334	Led	0.10 A	12	3
Identification (amber)	930337	Led	0.10 A	12	3
Clearance (red)	930334	Led	0.10 A	12	4
Clearance (amber)	930337	Led	0.10 A	12	4
Front directional (hazard and marker)	930409	Led	0.75 / 0.10 A	12	2
Rear directional	930365	Led	0.55 A	12	2
Stop	930366	Led	0.3 A	12	4
Back-up	930367	Sealed Unit	2.1 A	12	2
Center stop (high-mounted)	930330	Led	---	12	1
Tail	930366	Led	0.03 A	12	4
Exterior compartment (except engine)	562278	6429 (78207)	10 W	24	A R
Engine compartment	930383	Sealed Unit	2.1 A	12	2
<b>INTERIOR LIGHTING</b>					
Speedometer	560145	2721 M OSRAM	1 cp	24	2
Tachometer	560145	2721 M	1 cp	24	2
Turbo boost	561167	2721 M	3 W	24	1
Other instruments (1/unit)	560144	2721 MFX OSRAM	1.6 cp	24	A R



**Section 06: ELECTRICAL**

<b>Application</b>	<b>Prevost part no.</b>	<b>Trade or SAE number</b>	<b>Watts or Candle Power</b>	<b>Volts</b>	<b>Qty</b>
Step (VIP)	562278	6429	10 W	24	1
Step (Coaches)	830173	LED	0.7 W	12	3
Lavatory	561009	6423	5 W	24	1
Parcel rack	561553	313	1.6 cp	24	A R
Driver's area	830176	Q20MR16	20 W	12	2
"EMERGENCY EXIT" decal	560601	456	2 cp	24	20
"LAVATORY OCCUPIED"	561166	1820	1.6 cp	24	2
"WATCH YOUR STEP"	561166	1820	1.6 cp	24	2
Aisle	563546	---	---	24	A R
Reading	563073	623	.37 A	24	A R
Fluorescent (In-Station)	830153	F32T8/SP41	32 W	---	A R
Lavatory	830176	Q20MR16	20 W	12	1
Destination sign fluorescent	830080	F30T8CW4	30 W	---	1
Fluorescent (Indirect)	830152	F13T5/CW	13 W	---	---

**10. SPECIFICATIONS**

**Battery**

Make..... Volvo  
Model..... 20359831  
Type ..... Maintenance-free  
Terminal type ..... Top Stud  
Group size..... 31  
Volts ..... 12  
Load test amperage ..... 290  
Reserve capacity (minutes) ..... 195  
Cold cranking (in amps)  
-At 0°F (-18°C).....950 (each battery)  
Maximum dimensions (inches/mm)  
-Length (including flange) ..... 13.0/330,2  
-Width..... 6.7/169,3  
-Height (including top posts) ..... 9.3/237,0  
-Approximate weight (lbs/kg) ..... 59/26,7

\* *Battery tester cable clamps should be between terminal nuts and lead pads of terminals. If not possible, load value should be 210 amperes.*

**Torque specifications**

Battery cable to post ..... 10-15 ft-lbf (13-20 N m)  
Battery cover ..... 45-50 ft-lbf (5-6 N m)

**Alternator**

Make..... BOSCH  
Series ..... T1  
Hot output  
-Amperes..... 140 at 25°C (AMBIENT)  
-Volts ..... 28  
-Approximate rpm..... 6000  
Ground ..... negative  
Prevost Number ..... 562752

**Alternator**

Make..... BOSCH  
Series ..... HD10  
Hot output

Amperes ..... 120 at 25°C (AMBIENT)  
Volts ..... 28.4  
Power output ..... 3 Kw  
Ground ..... negative  
Prevost Number ..... 564119

**Battery equalizer**

Make..... Vanner  
Model..... 60-100D  
Amperes ..... 100 amps  
Prevost Number ..... 562542

**Starter**

Make.....Mitsubishi Electric Corporation (MELCO)  
Model Number..... M009T82479  
Type ..... 105P70  
Voltage ..... 24  
Prevost Number ..... 510752

No-load test

-Volts ..... 23.5  
-Max. current draw ..... 125 amperes  
-Min. rpm ..... 3000 rpm

**Starter solenoid**

Make.....Mitsubishi Electric Corporation (MELCO)  
Model Number..... 1115557  
Pull In Voltage ..... 16 volts max.

**IO-A Volvo multiplex module**

Rated voltage ..... 24 or 12 VDC  
Operating voltage ..... 9-32 V  
Over voltage ..... 35 V  
Number of inputs ..... 15  
Number of outputs ..... 6  
Prevost number ..... 565864

**IO-B Volvo multiplex module**

Rated voltage ..... 24 or 12 VDC  
Operating voltage ..... 9-32 V

**Section 06: ELECTRICAL**

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Over voltage .....	35 V
Number of inputs .....	10
Number of outputs.....	6
Prevost number .....	565865

**CECM Volvo multiplex module**

Rated voltage .....	24 VDC
Operating voltage .....	8-24 V
Over voltage .....	35 V
Number of inputs.....	10
Analog inputs .....	1
Number of outputs.....	16
Prevost number .....	563274

**Master-ID Volvo multiplex module**

Rated voltage .....	24 VDC
Operating voltage .....	18-32 V
Over voltage .....	36 V
Prevost number .....	563295



# 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



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# 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 an 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 $\mu$ F (microfarad)
Load current less than/equal to 10A	27.6 ... 28.4 V (volts, regulated)
Damping Resistance	3.1 ... 3.5 k $\Omega$ (kilohms)
Stator Resistance	0.036 $\Omega$ (-0/+10%) T1 (RL) 28V70/140A
Rotor Resistance	7.5 $\Omega$ (-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

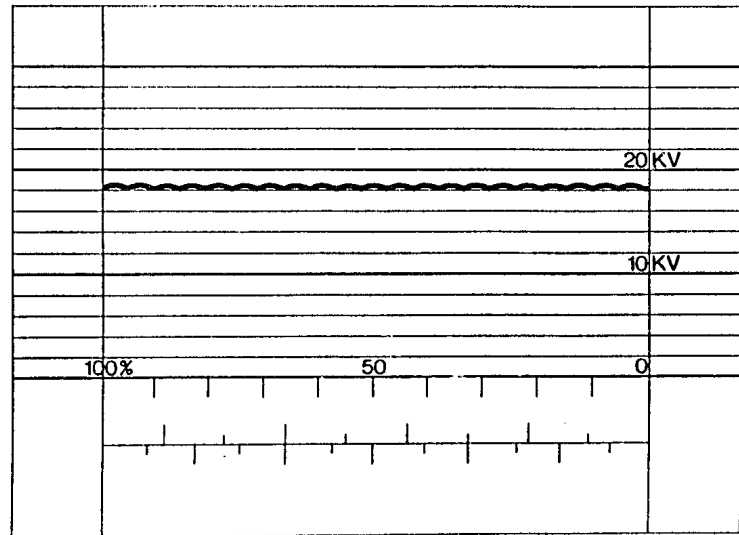
Following completion of the output test, allow alternator to run at 7000 rpm for one minute.

#### 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.



KME00052

**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.

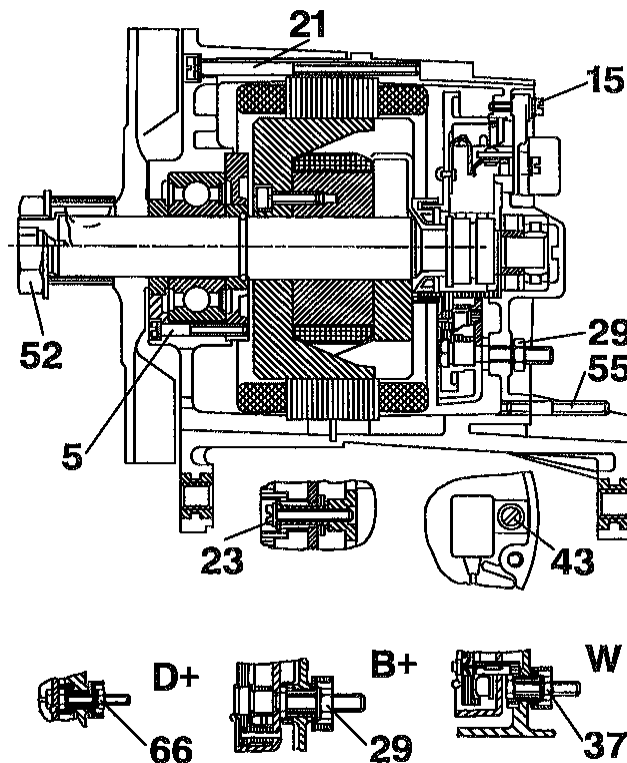
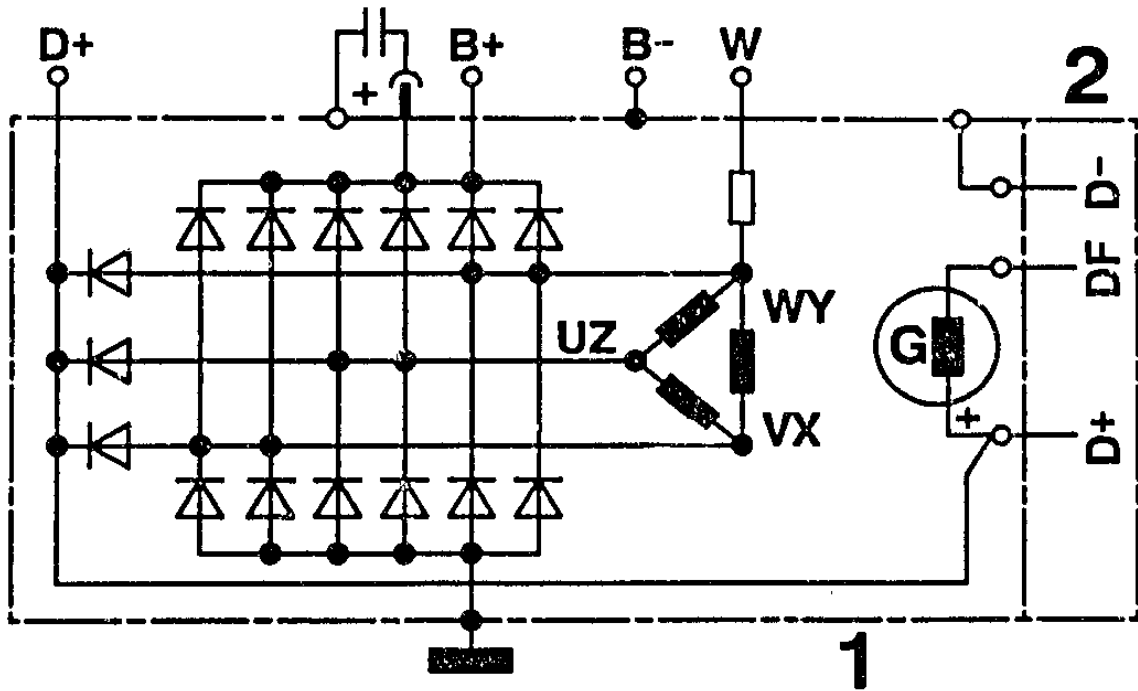


Figure 2 Fastener Torque Chart



### 4 Alternator Schematic



KME 00050

Figure 3 Alternator/Voltage Regulator Schematic

#### 1 Alternator

- B+ Battery Positive
- B- Battery Negative
- D+ Dynamo + (Warning Lamp Output)
- W Tachometer Output

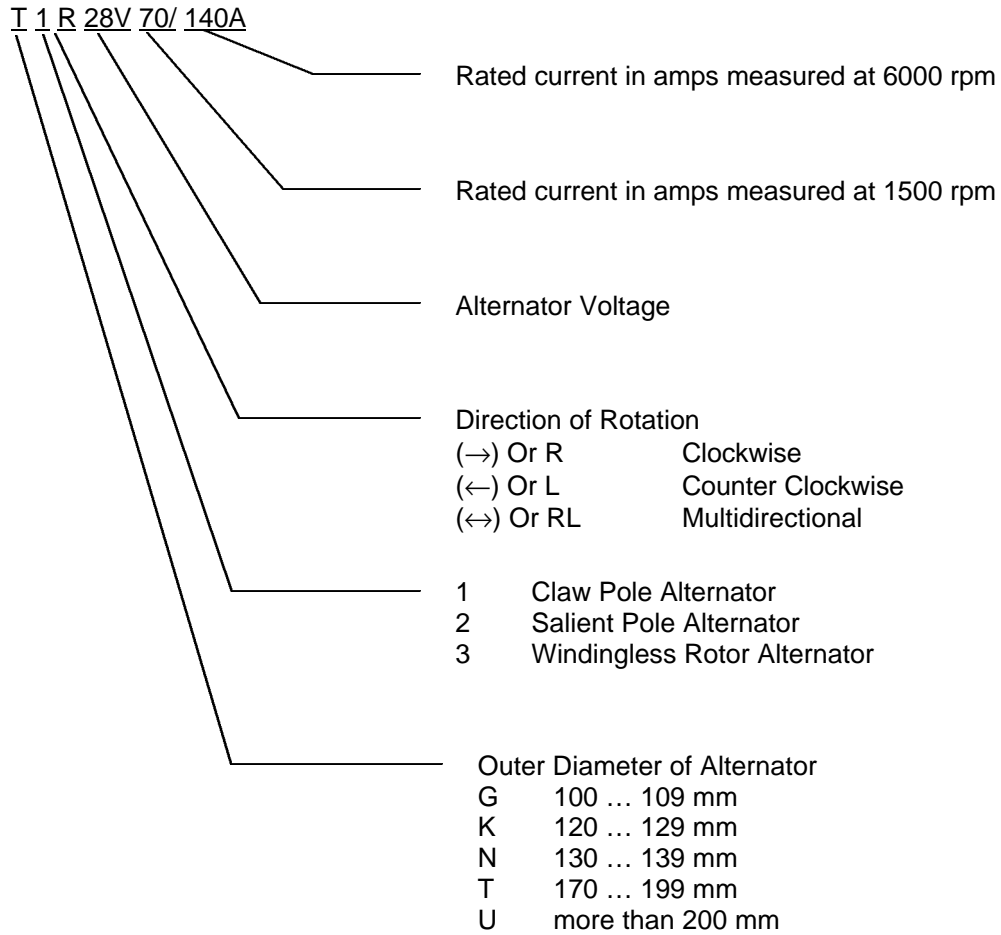
#### 2 Voltage Regulator

- D+ Dynamo + (Alternator Output)
- DF Dynamo Field
- D- Dynamo -



## 5 Alternator Coding

T 1 R 28V 70/ 140A





## 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 an 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 <i>Note: 2 Required</i>	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) <i>Note: 4 required</i>	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

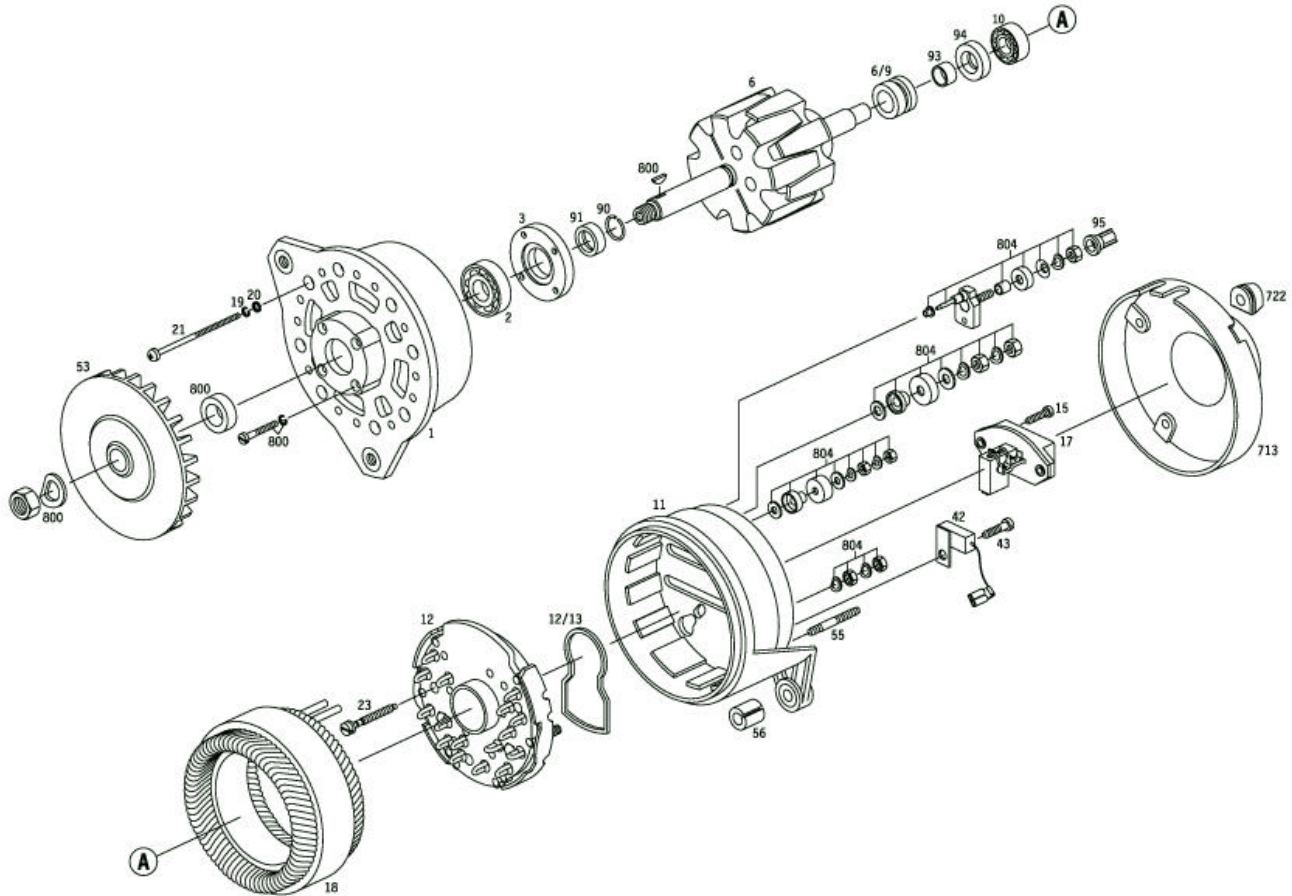
Description	Manufacturer Number	Bosch Number
Roller Bearing Grease	UNIREX N3	5 975 560 125
	Ft1 v 34	5 700 009 000
	VS 15164-Ft	5 975 560 000
Molycote Paste	Ft 70 v 1	5 700 040 000
Adhesive Dispersant	KK57v1	5 703 151 000
Silicon Paste	Ft2v4	5 700 083 005

#### 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**

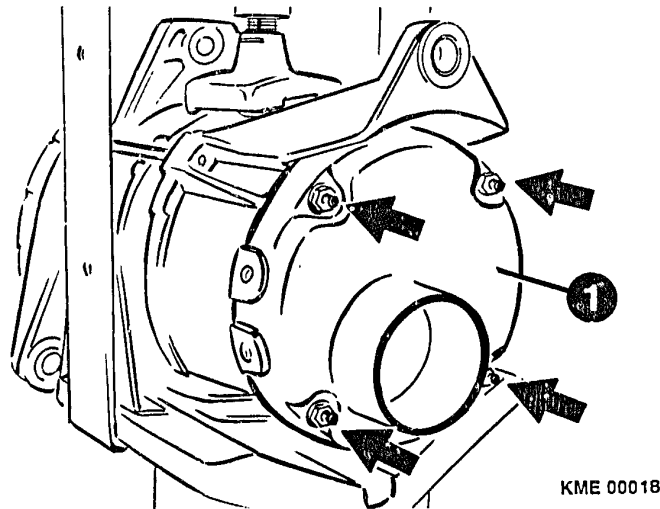
<u>Item</u>	<u>Designation</u>	<u>Item</u>	<u>Designation</u>
1	Drive End Shield	20	Plain Washer
2	Ball Bearing	21	Oval-Head Screw
3	Cover Plate	23	Washer & Screw Assembly
6	Rotor	42	Suppression Capacitor
6/9	Collector Ring	43	Oval-Head Screw
10	Roller Bearing	53	Fan
11	Collector-Ring End Shield	55	Stud
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)



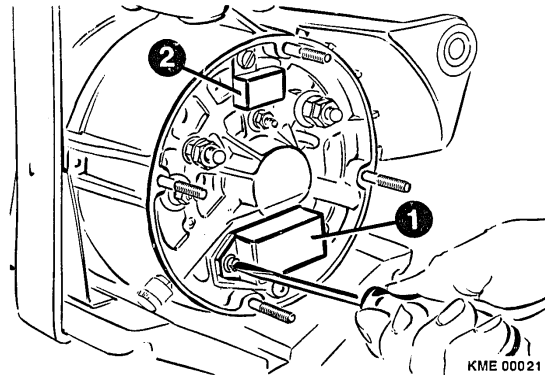
**Figure 5 Air Intake Cover Removal (1)**

*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.

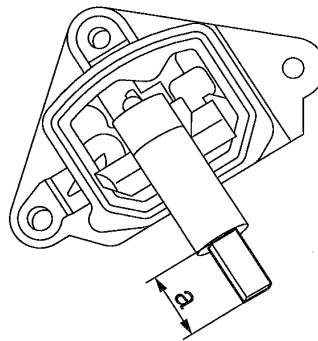
*Note: The brushes of the regulator will break if the regulator is not removed before any other disassembly of the alternator takes place.*



**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.*

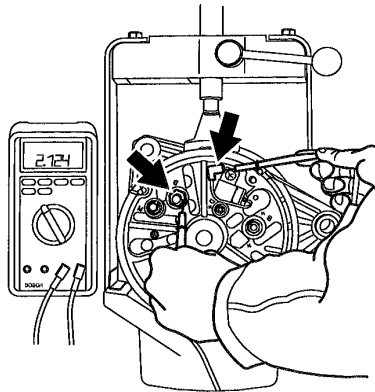
4. Check the brushes for freedom of movement after they are soldered.
5. Measure the exposed length of the new brushes. The exposed length should be 16 mm (0.630")

### 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**

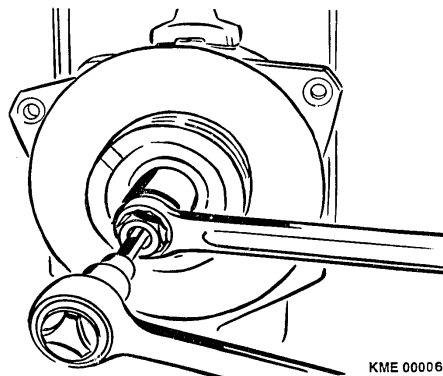
3. Measure the capacitance of the suppression capacitor. If the capacitance does not read between 1.8 and 2.6  $\mu\text{F}$  (microfarad), the capacitor must be replaced.
4. Remove the screw that secures the suppression capacitor and remove capacitor.

*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.

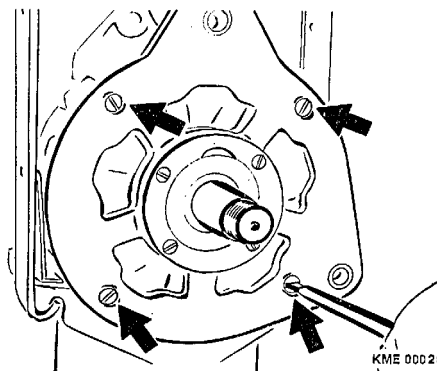
## 9.5 Separation of Drive Shield and Collector End Shield

*Note: With a scribe, mark the relationship between the drive end shield and the collector ring end shield. This will assist in the realignment 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)



- Slide the drive end shield and rotor out of the collector end shield.



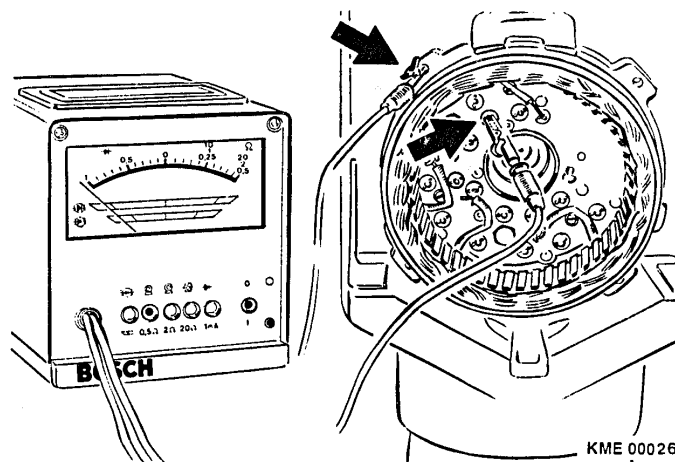
**Figure 10 Drive End Shield Removal**

## 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.*

- With the rectifier assembly still installed in the collector end shield, testing of the rectifier is to be performed.
  - Using tester WPG 012.00 (Bosch Number 0 684 201 200)** (Figure 11)
    - 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.
    - 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.
    - 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**

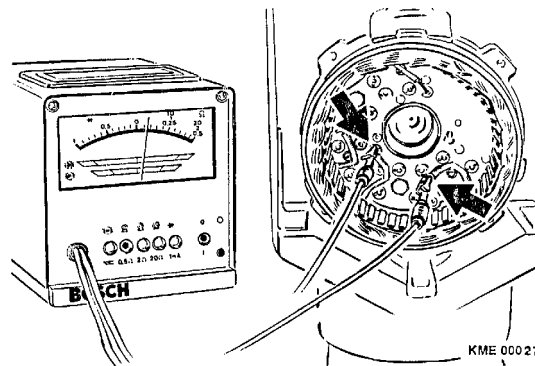
**b. Using a Diode Tester**

- 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  $\Omega$ , 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  $\Omega$  and 0.040  $\Omega$ . (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.

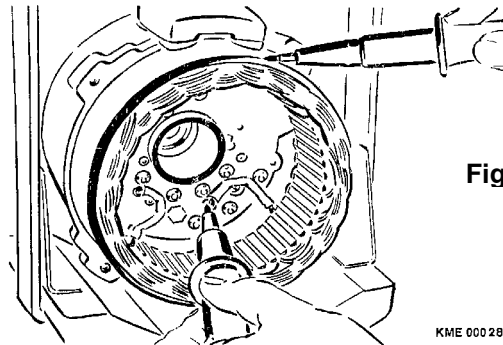


*Note: The insulation tester applies a voltage of 80 VAC to the stator. Voltages of 80V can be fatal. When performing this test, observe care is used in handling the stator and any component or surface that is exposed to the stator. Use insulated gloves and do not touch the work surface until all tests are completed.*



- 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)

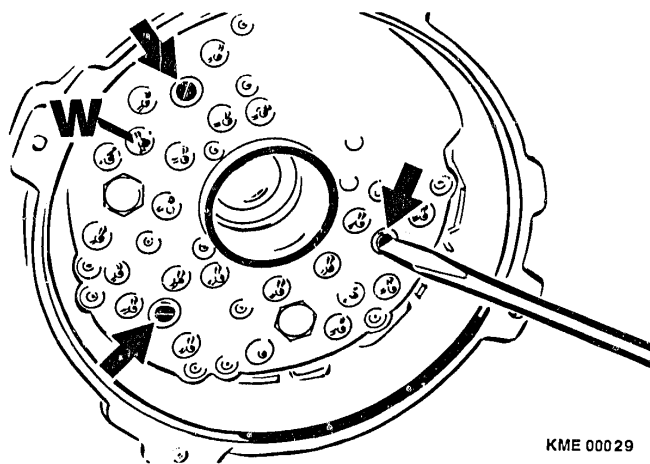
No continuity should be present. Any continuity between the stator phase leads and the exterior of the stator indicates a breakdown of the stator insulation and a short to ground. If continuity is present, the stator must be replaced.

**Figure 13 Stator Insulation Testing**

KME 000 28

## 9.8 Rectifier Assembly Removal

- Loosen and remove the three screws that hold the rectifier to the collector end shield. (Figure 14)
- Unsolder the W terminal from the rectifier assembly.



KME 000 29

**Figure 14 Rectifier Assembly Removal**

- 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.*

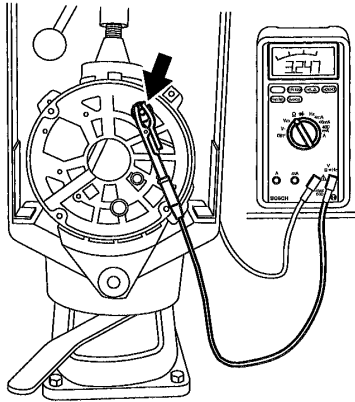
- Remove the rectifier assembly from the collector end shield.





## 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)

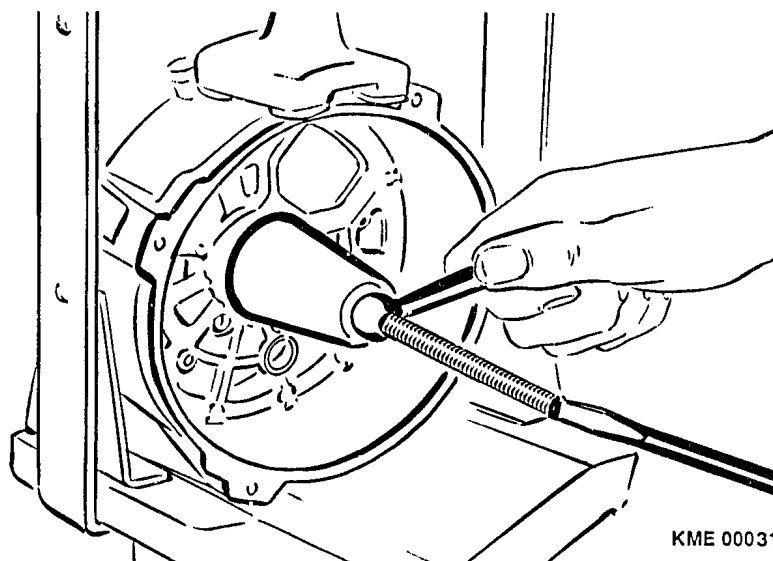


**Figure 15 Testing of W Terminal Dampening Resistor**

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)



KME 00031

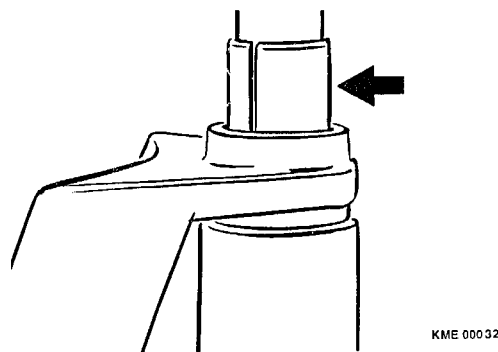
**Figure 16 Bearing and Seal Removal**



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.



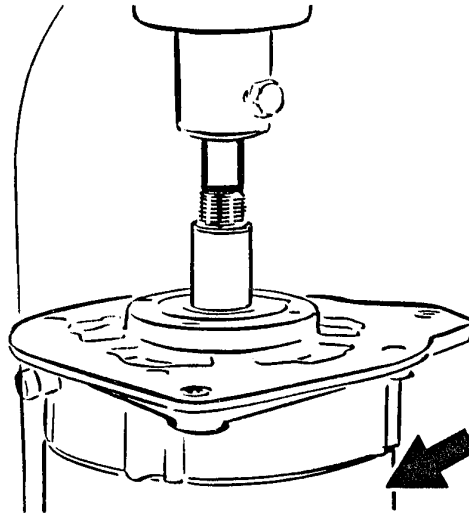
**Figure 17 Sliding Bushing Removal**

### 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.



KME 00033

**Figure 18 Pressing out Rotor**

4. Remove spacer ring from rotor shaft.

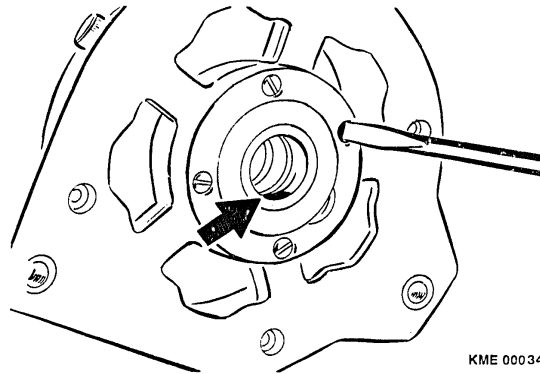
*Notes: Protect the threads of the rotor from damage prior to pressing. Always replace the drive end bearing if the rotor has been pressed out. Therefore, only remove the rotor if;*

- *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.



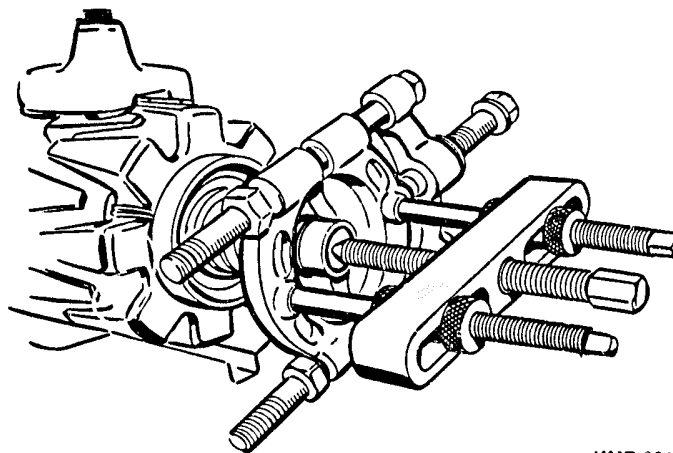
**Figure 19 Drive End Bearing Removal**

### 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.

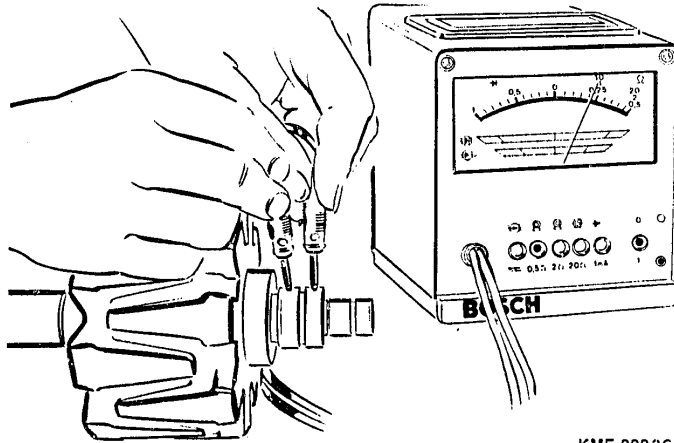


**Figure 20 Inner Bearing Race Removal**



## 9.15 Rotor Inspection

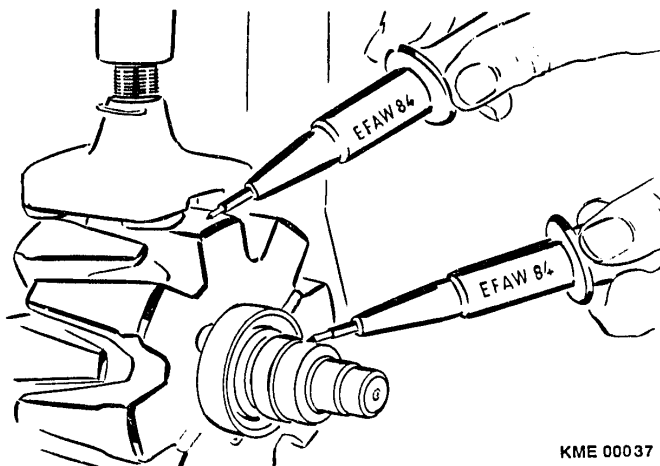
1. Using electric tester ETE 014.00 or Multimeter MMD 302, measure the resistance between the two collector rings of the rotor. The resistance measured should be between 7.5 and 8.3  $\Omega$ . (Figure 21)



**Figure 21 Rotor Resistance Testing**

KME 00036

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**

KME 00037

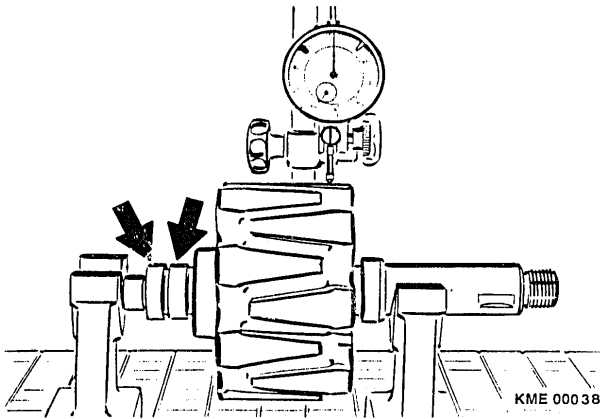


*Note: The insulation tester applies a voltage of 80 VAC to the rotor. Voltages of 80V can be fatal. When performing this test, observe care is used in handling the rotor and any component or surface that is exposed to the rotor. Use insulated gloves and do not touch the work surface until all tests are completed.*

3. Mount the rotor in a pair of V-Blocks at the rotor bearing points.



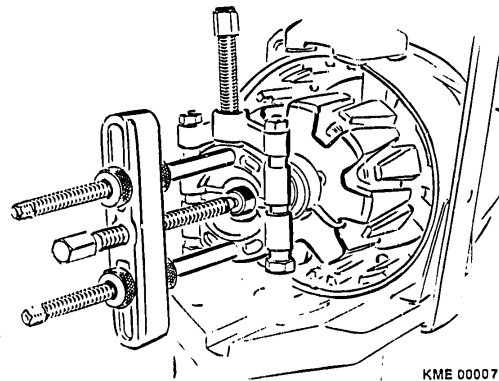
4. Position dial indicator (Magnetic Base T-M 1 (Bosch Number 4 851 601 124) and Dial Indicator EFAW 7 (Bosch Number 1 687 233 011)) to measure the concentricity of the rotor at: (Figure 23)
  - a. Outer diameter of rotor, maximum run-out 0.05 mm (0.002 in). If the run-out of the rotor exceeds the maximum, 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)

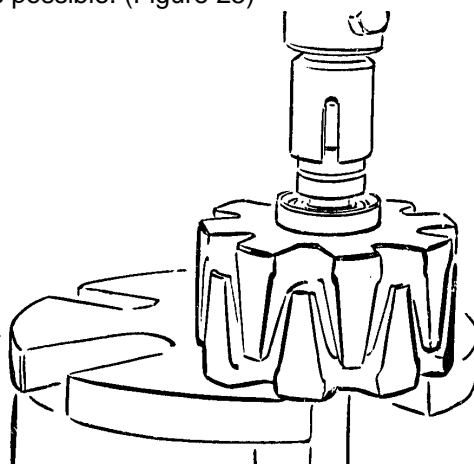
**Figure 24 Collector Ring Removal**



## 10 Alternator Assembly

### 10.1 Rotor Assembly

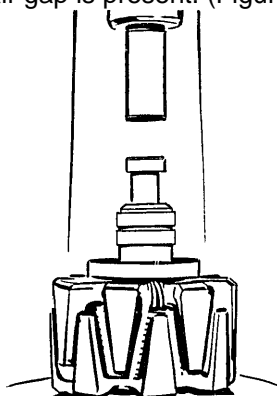
1. Position rotor in arbor press with the drive end pointing down.
2. Press the lead for the rotor winding into the slot of the rotor.
3. Slide the collector rings onto the rotor shaft as far as possible by hand. Make sure the lead for the rotor windings does not become damaged while sliding the collector 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)



KME 00040

**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)



KME 00008

**Figure 26 Spacer Ring**

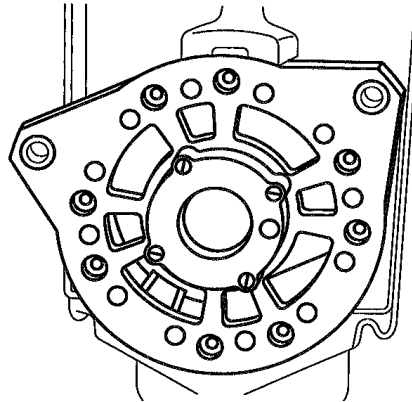


*Note: Do not allow the spacer ring to twist while pressing onto the rotor.*

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)

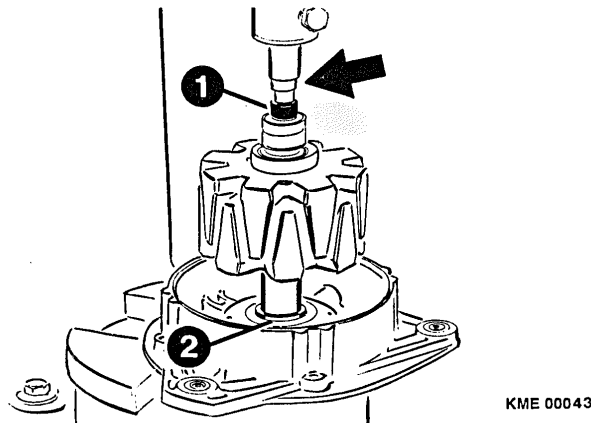
## 10.2 Drive End Shield Assembly

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**





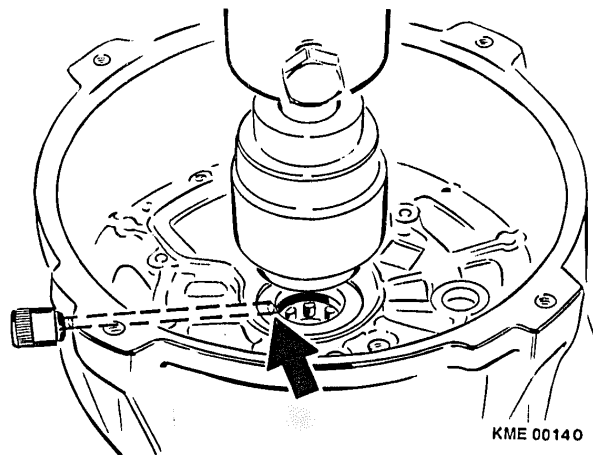
7. Place rotor into the drive end bearing.
8. Place tool KDLJ 6018 onto the end of the rotor and press the rotor into the drive end bearing until the bearing seats against the support ring.

### 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.*

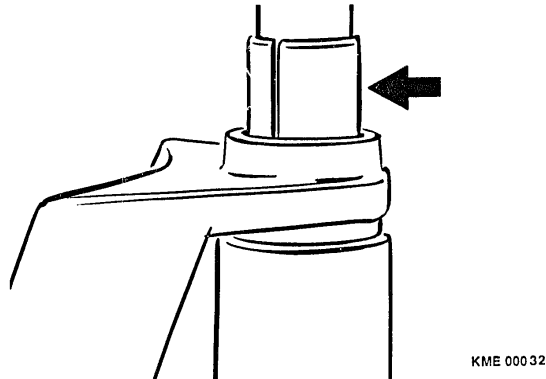


**Figure 29 Installation of Bearing and Seal**

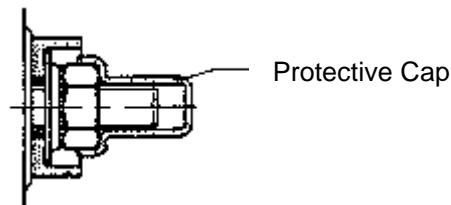
6. Place seal onto tool KDLJ 6011 and press the seal into the collector end shield. (Figure 29)
7. Place collector end shield in an arbor press, support mounting/pivot boss on tool KDLJ 6016. (Figure 30)
8. Coat the inside of the collector end shield bore with Molycote.
9. Place sliding bushing into 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)

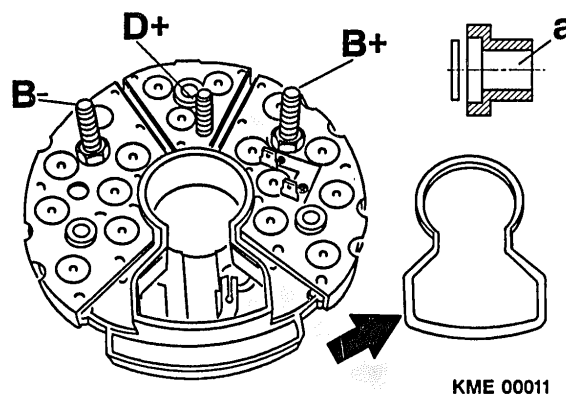
**Figure 30 Sliding Bushing Installation**

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**

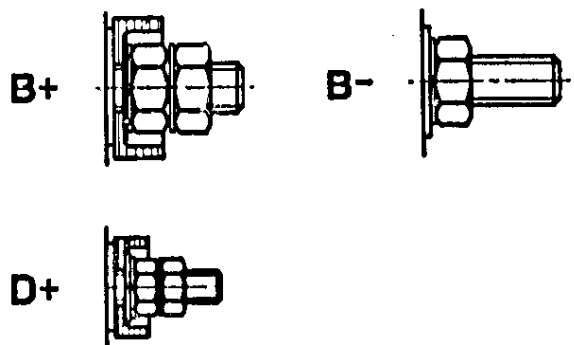
## 10.4 Rectifier Assembly

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**

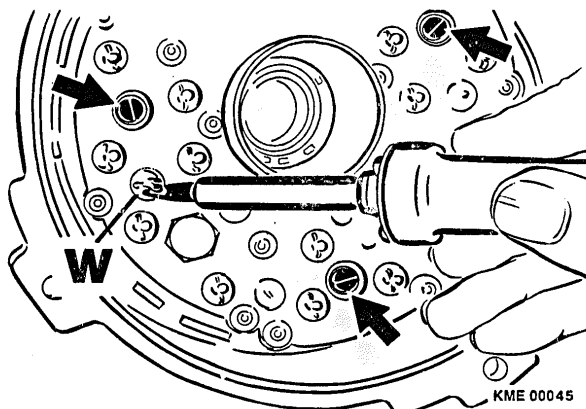


2. Coat the keyhole shaped surface of the rectifier with adhesive. (Figure 32)
3. Place the rectifier seal ring onto the keyhole shaped surface of the rectifier. Make sure the seal conforms to the shape of the keyhole.
4. Once the adhesive has cured, place the rectifier into the collector end shield. 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 )

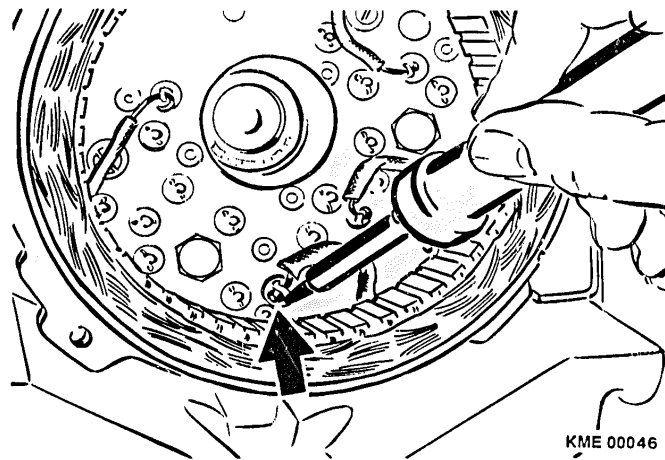


**Figure 34 Rectifier Mounting and Soldering of Terminal W**



## 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**

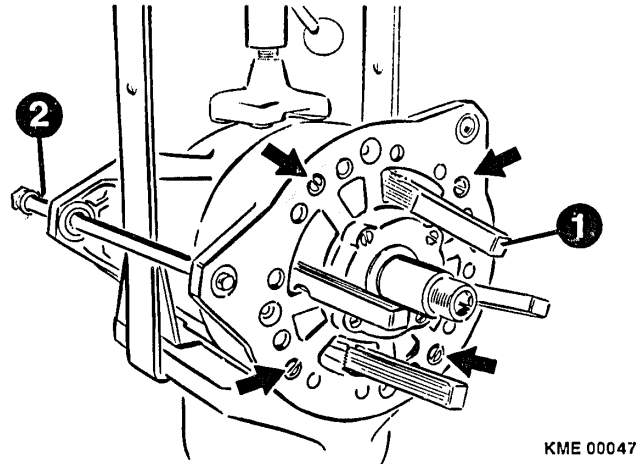
4. Solder each of the stator leads to the rectifier assembly with rosin core solder.

## 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.

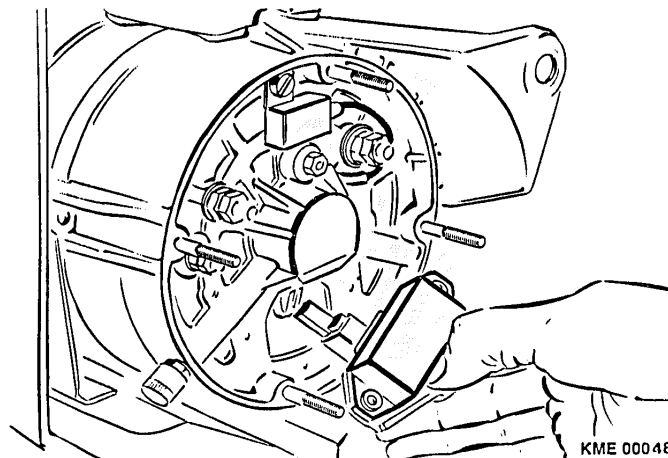


**Figure 36 Drive End Shield, Stator and Collector End Shield Assembly**  
(1) Feeler Gauge (2) Tool KDLJ 6015

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)



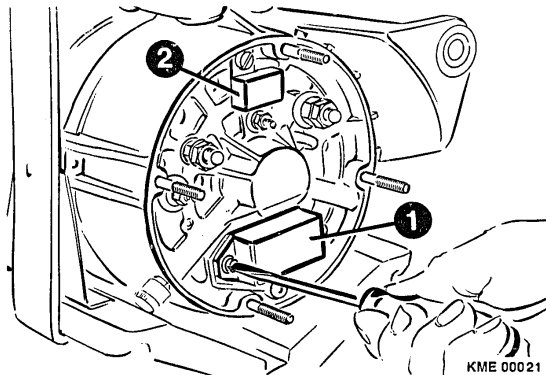
**Figure 37 Regulator Installation**



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.

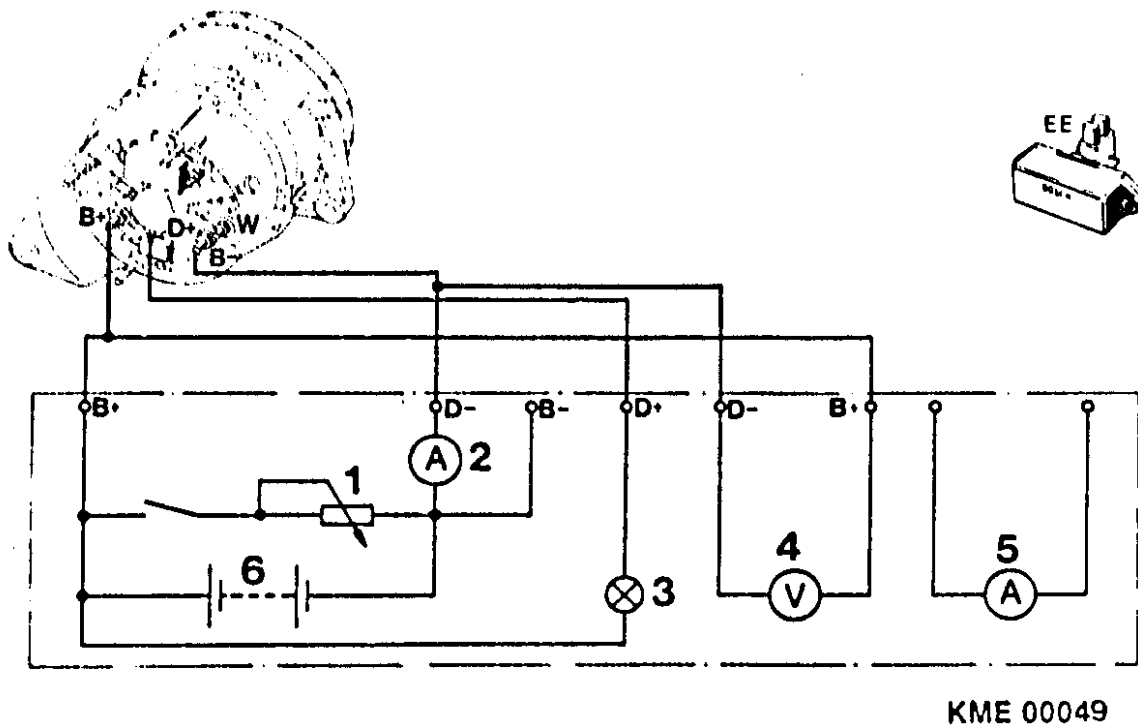
*Note: Only perform the power output tests with the fan pulley installed on the alternator. Failure to test the alternator with the correct fan installed can cause the alternator to overheat and damage the internal components of the alternator.*



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.

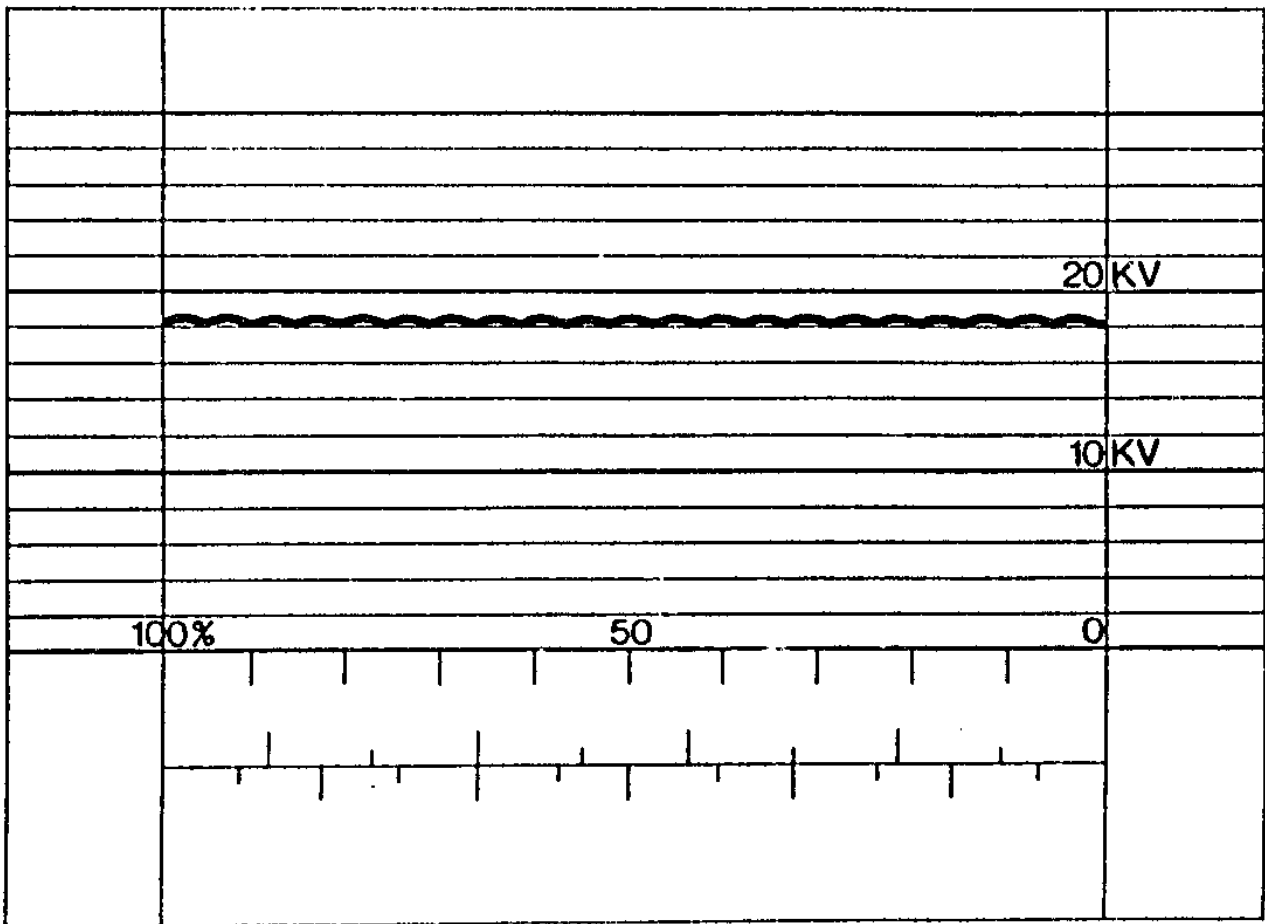


**11.3.2 Normal Pattern**

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.



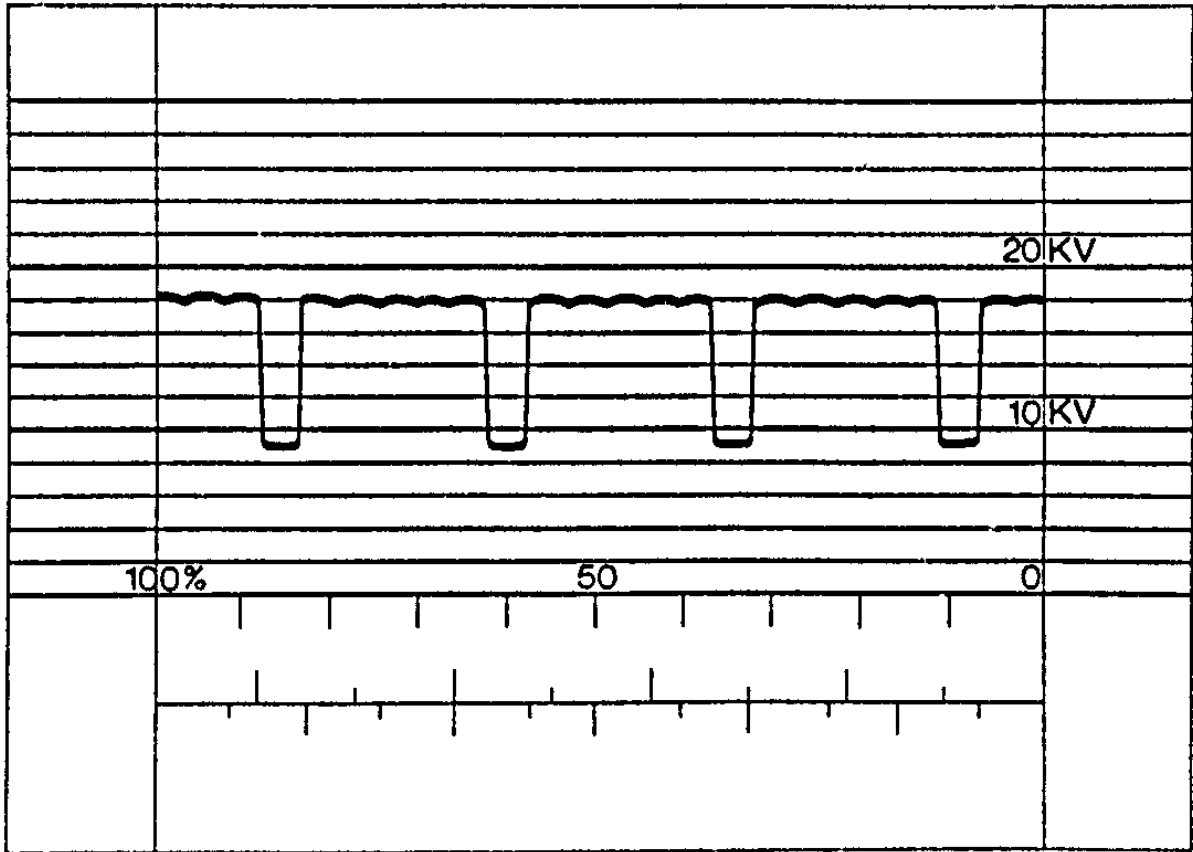
KME00052

**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.



KME00053

**Figure 41 Open Exciter Diode**

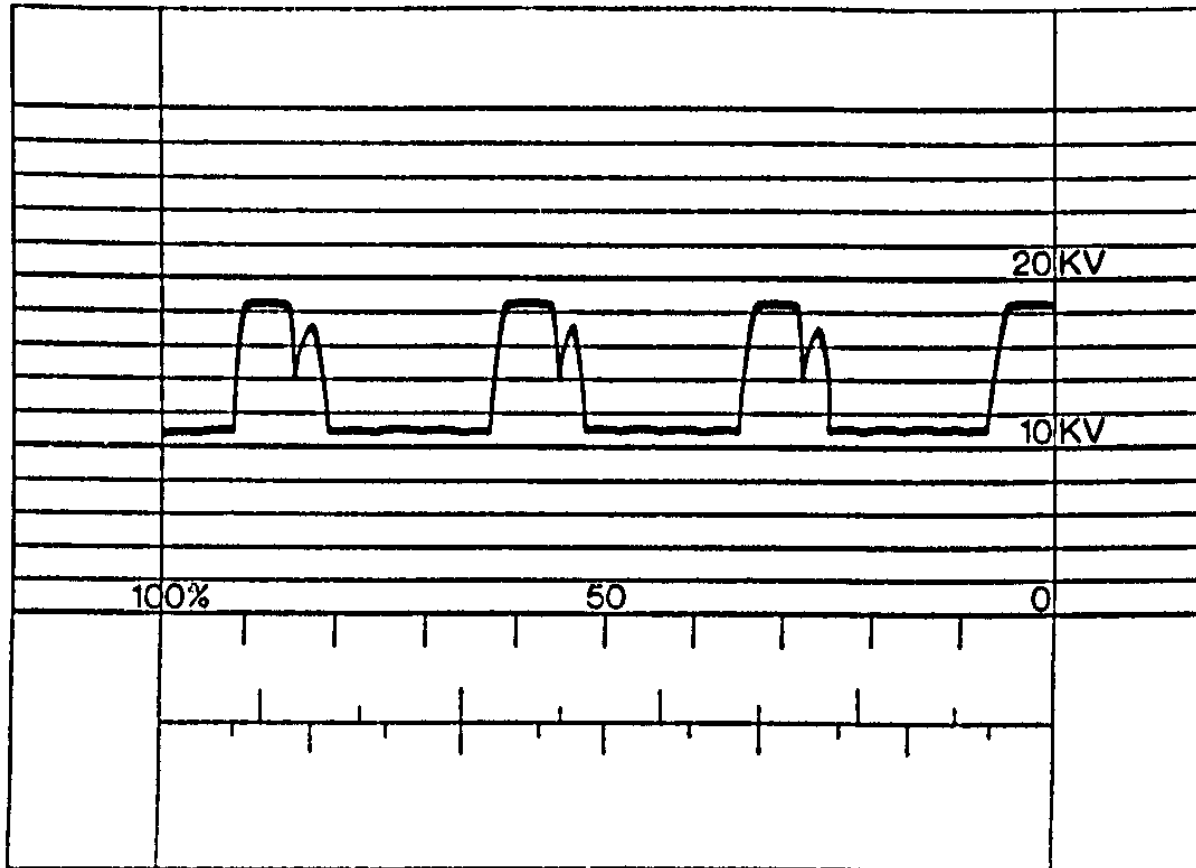


### 11.3.4 Open Positive Rectifier Diode

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.



KME00054

**Figure 42 Open Positive Rectifier Diode**

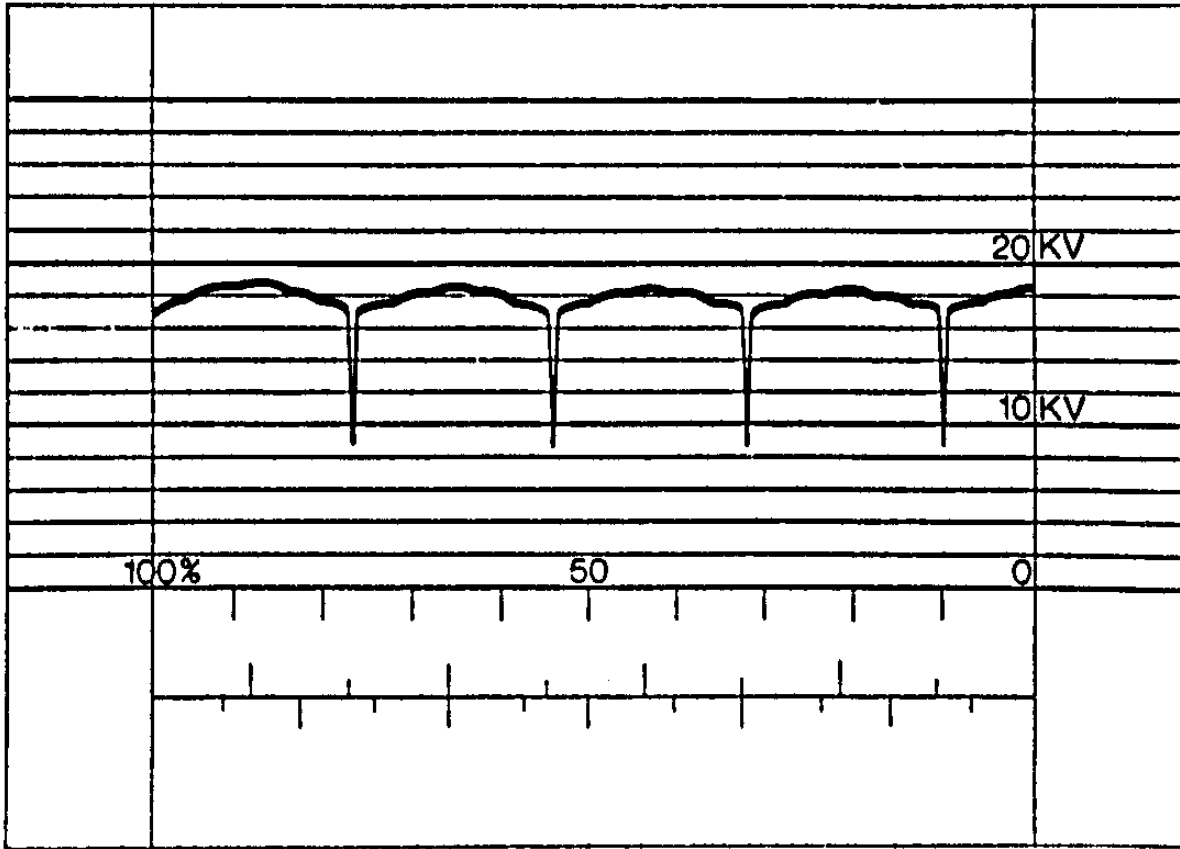


**11.3.5 Open Negative Rectifier Diode**

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.



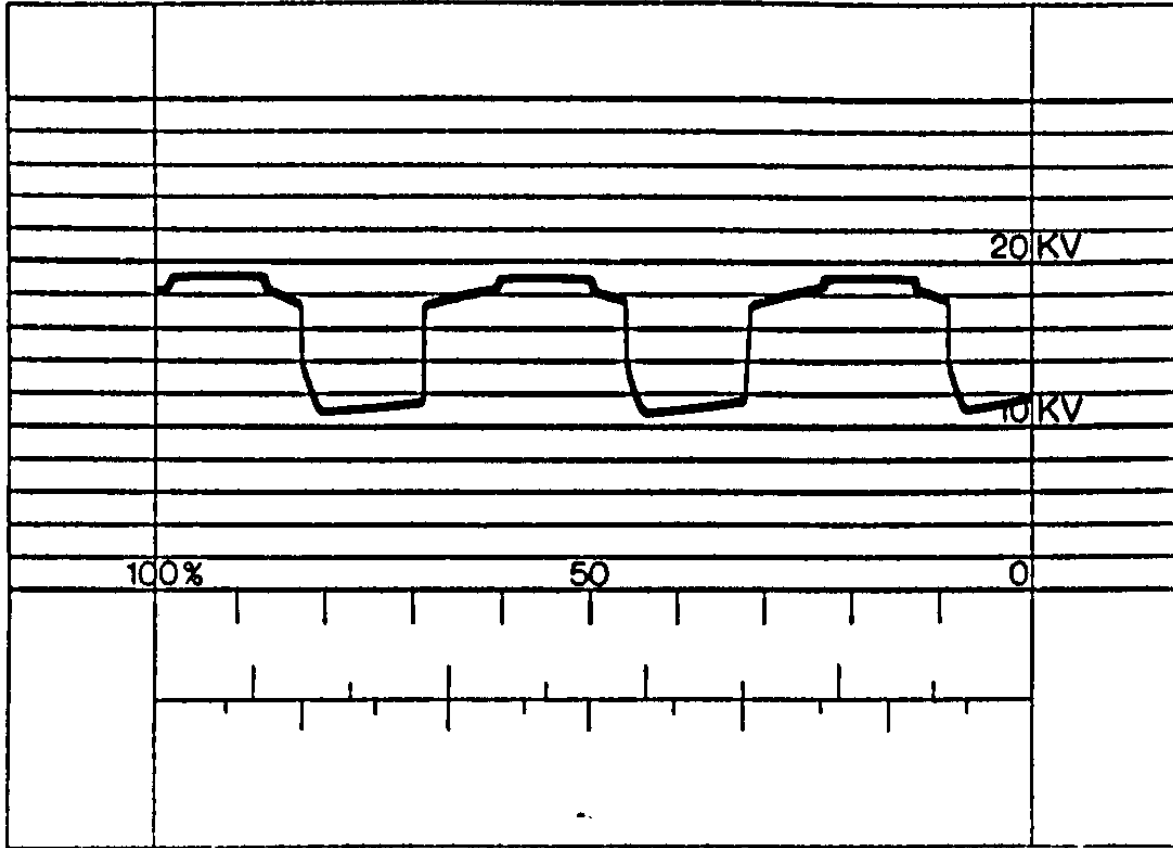
KME00055

**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.



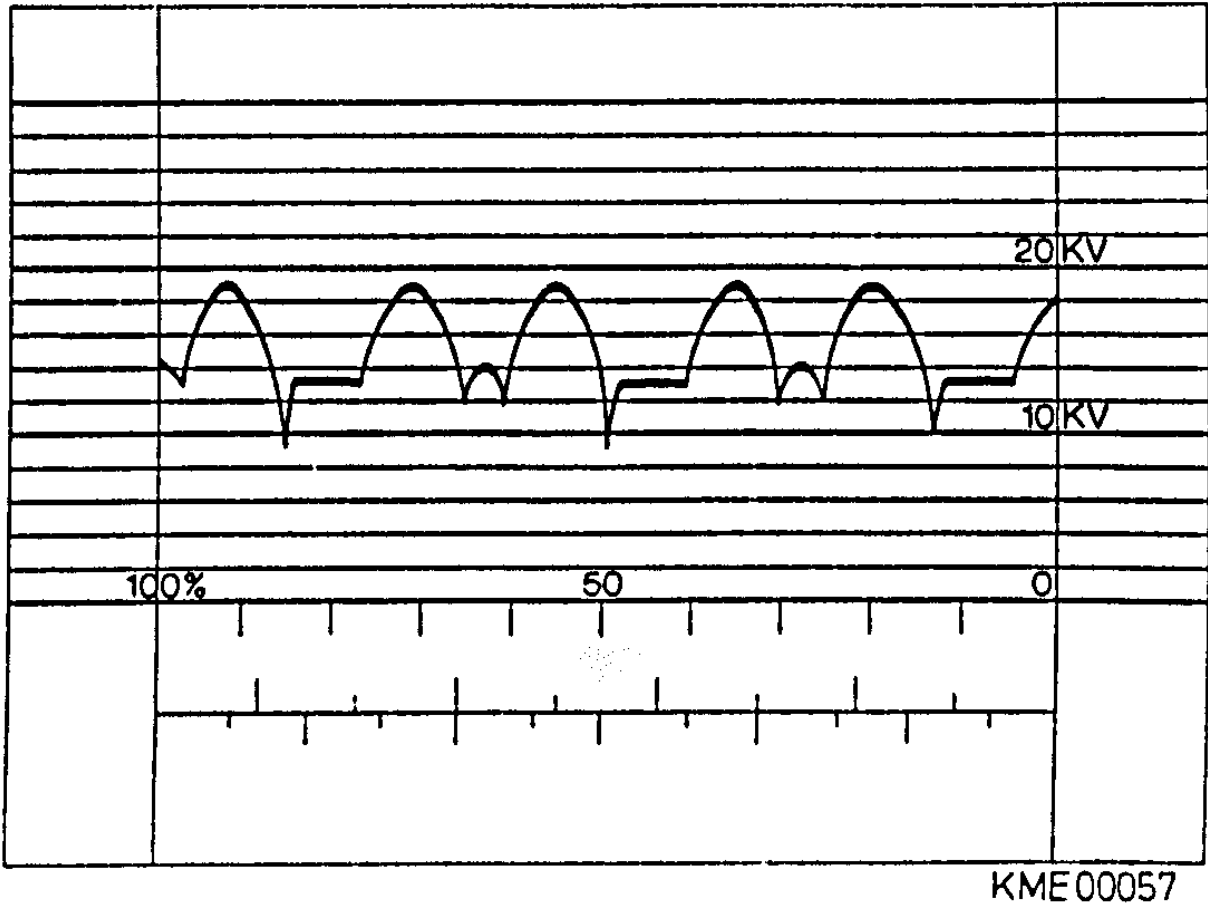
KME 00056

**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.

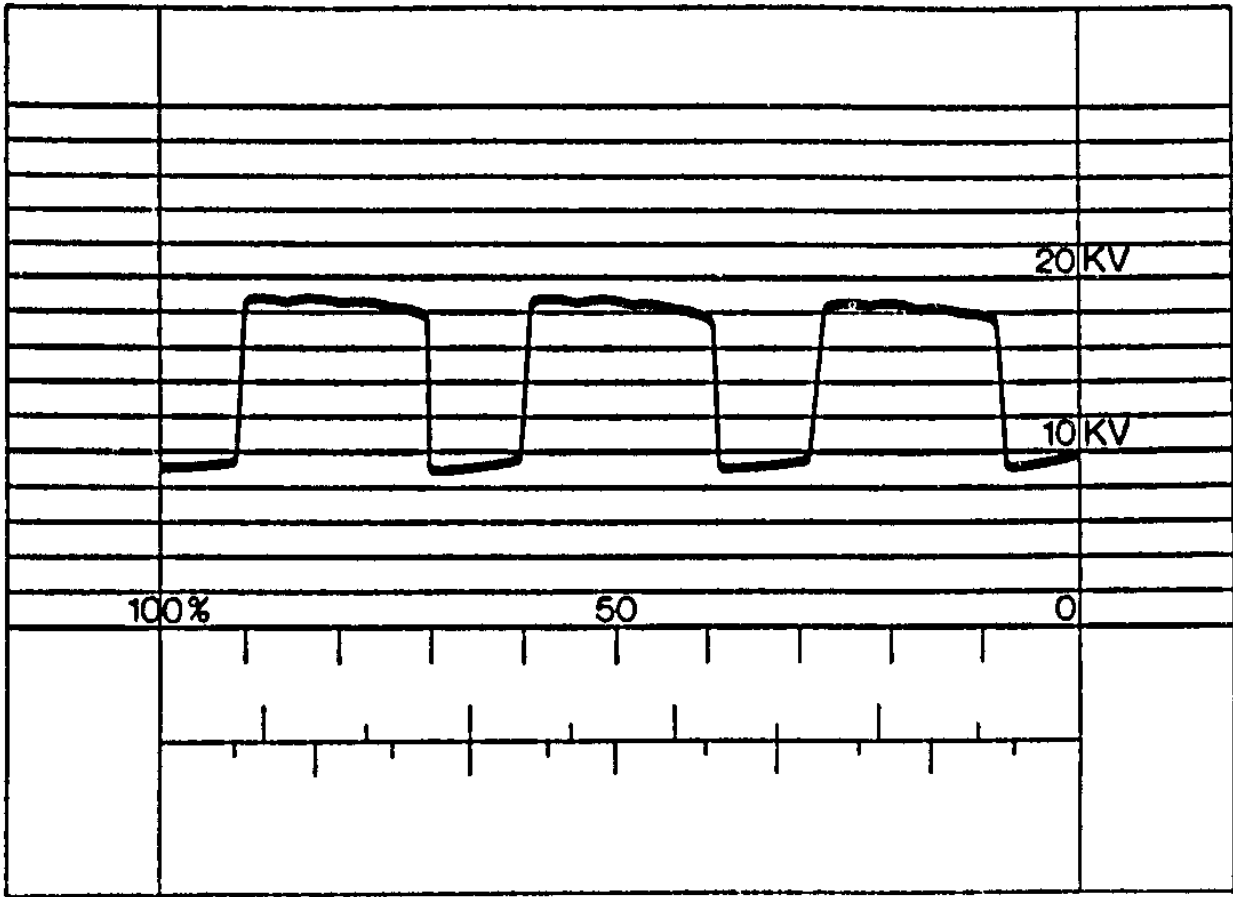


**Figure 45 Shorted Positive Rectifier Diode**



**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.



KME00058

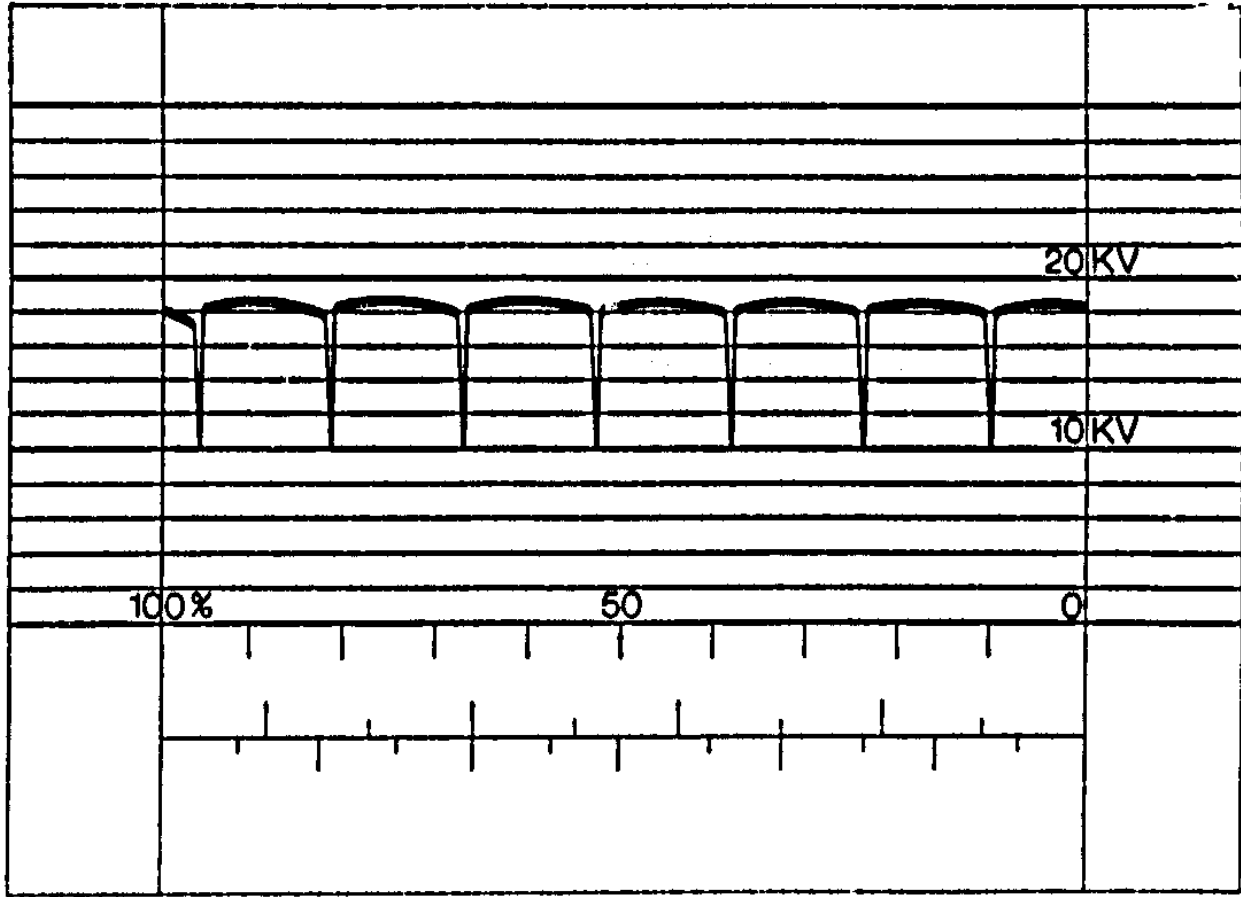
**Figure 46 Shorted Negative Rectifier Diode**





**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.



KME00059

**Figure 47 Open Stator Phase**



# Mitsubishi Electric Corporation (MELCO)

## STARTER MOTORS (105P70)

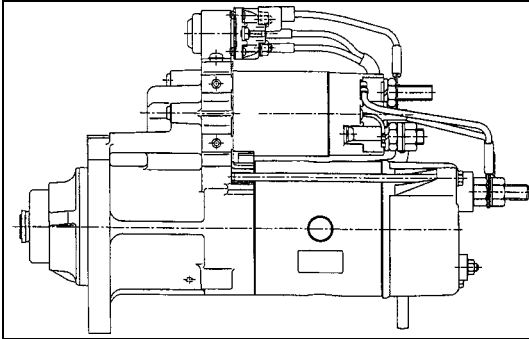


Figure 1 - 105P70 STARTER

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.

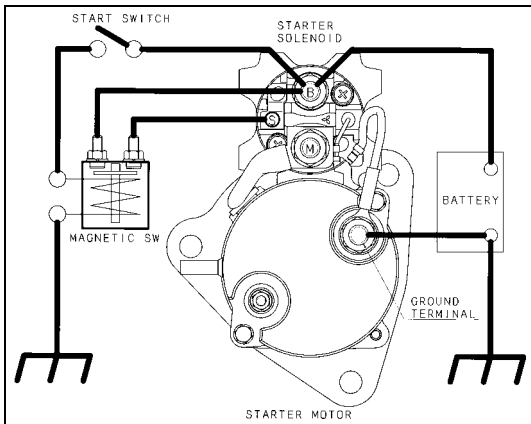


Figure 2 - BASIC STARTING CIRCUIT (GROUND-FLOAT TYPE)

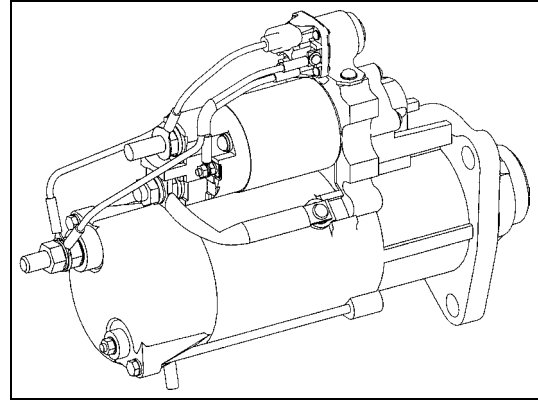


Figure 2 shows the circuit diagram for the 105P70 Ground-float type (sometimes referred to as Insulated or Isolated Ground).

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.

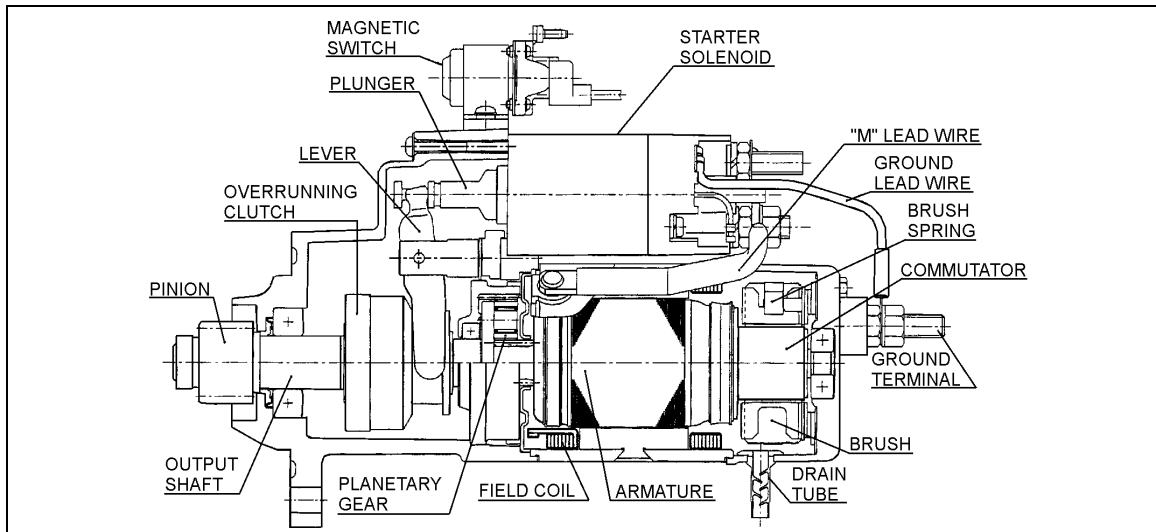


Figure 3 - CROSS-SECTIONAL VIEW (GROUND-FLOAT TYPE)

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-shortened, or the pinion sliding area may be clogged.

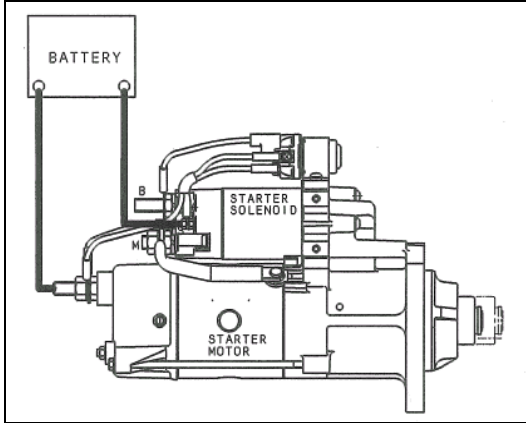


Figure 4 - TESTING PINION MOVEMENT AND PULL-IN WINDINGS (GROUND-FLOAT TYPE)

For the starter switch coils, refer to the switch circuit diagrams for the ground-wire type (ground-float type) shown in figures 5.

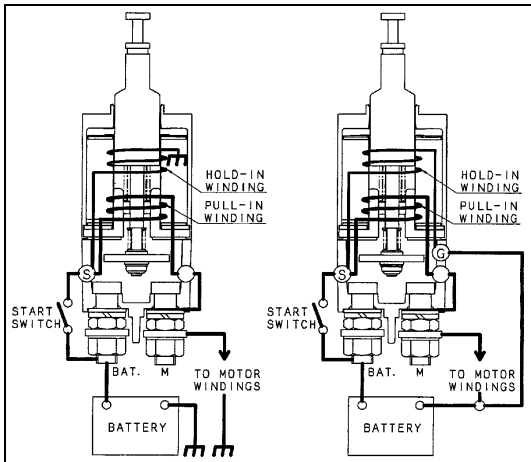


Figure 5 - SOLENOID CIRCUIT (GROUND-FLOAT TYPE)

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-short.

\* M-terminal nut tightening torque: 20 to 30 N·m

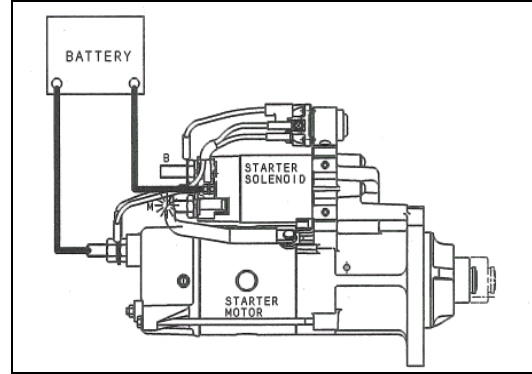


Figure 6 - TESTING HOLD-IN WINDINGS (GROUND-FLOAT TYPE)

Below are the resistance values for the P- and H-coils for reference.

Coil	Resistance (reference)
P-coil	0.072ohm at 68° F
H-coil	1.300 ohm at 68° F

### 2.5.2 No-load test

The no-load test makes it easy to inspect the starter for functional failure without disassembling. This test can also identify an open/short circuit that is difficult to check when disassembled.

As shown in figure 7, connect the starter, fully charged battery, ammeter, and voltmeter. If possible, connect a resistor suitable for voltage control in parallel with the battery. In addition, use an rpm indicator to measure the revolution speed of the output shaft.

**Note:** Attention should be given to the output shaft which advances forward to approximately 0.8" (20 mm) and rotates at that position when the starter is operated.

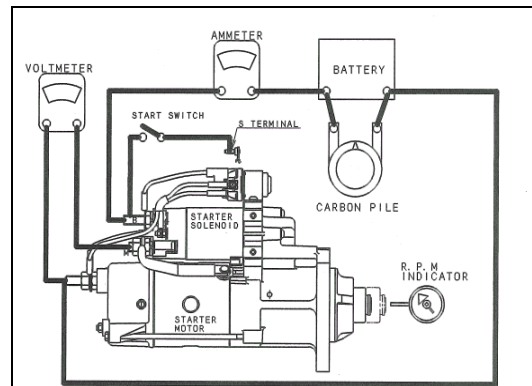


Figure 7 - NO-LOAD TEST CIRCUIT (BODY-GROUND TYPE)

- \* If the output shaft does not move, stop voltage application. If voltage continues to be applied, excessive heat will occur in the starter solenoid and give thermal damage to the coil, thereby making it unserviceable.

Inspect that the current and revolution speed satisfy the following standards when the start switch is closed.

Voltage	Current	Speed
23.5 V	125 A max.	3000 rpm min.

It is not necessary to adjust the voltage to the exact value of 23.5 V. If the voltage is slightly higher, the rpm will be proportionately higher, while if the voltage is lower, the rpm will be proportionately lower. The current is independent of the voltage, and can be judged using the above standard.

- \* Note that the starter solenoid will not operate unless the voltage between the S-terminal and the ground exceeds 16 V.

Test result and possible cause

1. Rated current draw and revolution speed indicate normal condition of the starter.
2. Low revolution speed and high current draw indicate:
  - a. Too much friction inside starter motor such as clogging, dirt, wearing, faulty bearings
  - b. Shorted circuit inside starter
3. No revolution of the output shaft indicates:
  - a. Grounded M-lead wire or field coils
  - b. Frozen bearings
4. No current draw indicates:
  - a. Open field coils
  - b. Open armature coils
  - c. Broken brush springs, worn brushes, or high insulation resistance between brushes and commutator
5. Extremely low revolution speed and low current draw indicate:

Poor connection between M-terminal and lead wire, or between bracket and brush holder screws (body-ground type only), damaged M-lead wire, damaged

brush pig tails, or poor contact between commutator and brushes

6. High revolution speed and high current draw indicate:

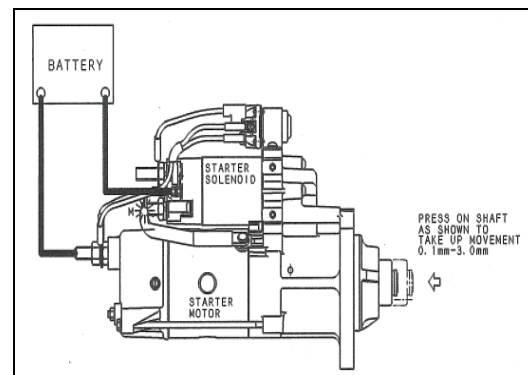
Shorted field coils

- \* In case of symptoms 2 to 6, replace the starter, because of the possible failures mentioned above.

2.5.3 Output shaft play

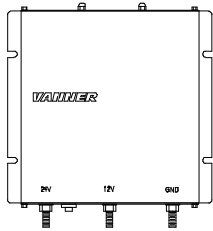
Before reinstalling the starter to the engine, follow the procedure below to inspect the output shaft clearance.

1. Remove the M-terminal nut and keep the lead wire end in contact with the M-terminal.
2. Apply voltage to between the S-terminal and the ground to let the pinion advance forward. Immediately after that, separate the lead wire from the M-terminal. The pinion stays in the advanced forward position until the battery is disconnected.
3. As described in figure 8, measure the distance between the shaft pressed-in and pulled-out positions. The play should be within 0.004" to 0.118" (0.1 to 3.0 mm). If the measured value does not satisfy the standard, replace the starter.

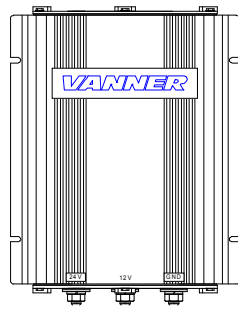


**Figure 8 - CHECKING OUTPUT SHAFT CLEARANCE (GROUND-FLOAT TYPE)**

# VoltMaster Battery Equalizer



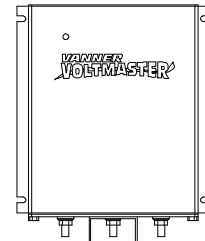
Family 1  
60-10B  
60-20A  
60-50A  
60-50E  
60-50M



Family 2  
60-100C  
60-100D  
60-100E



Family 3  
60-60  
60-60M  
60-80  
60-100



<u>Family 4</u>	<u>Family 5</u>
65-60	66-60
65-60M	66-80
65-80	66-100
65-100	

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## 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.



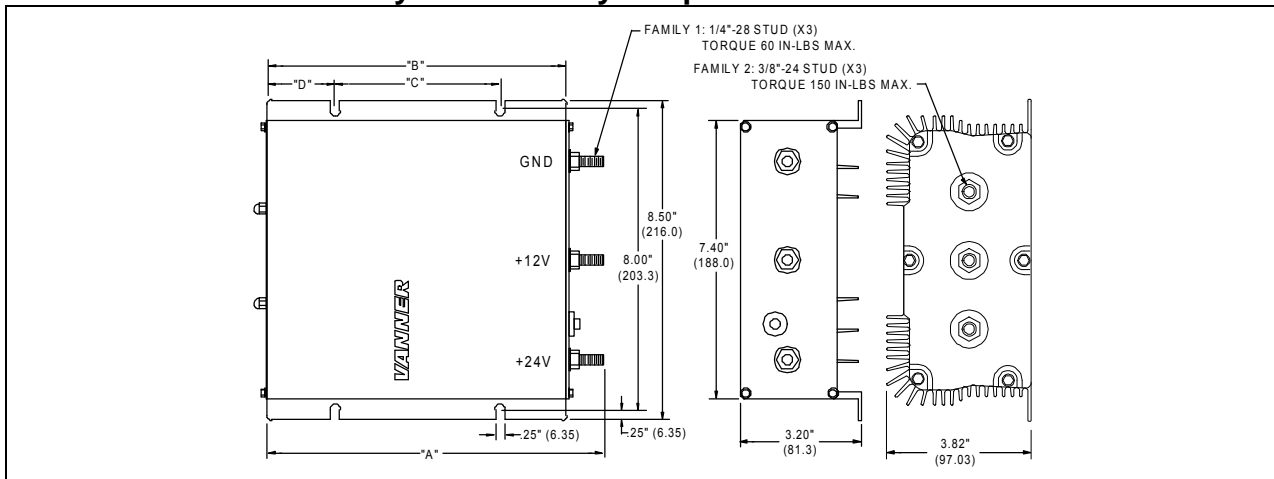
## Specifications

	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	Yes	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.

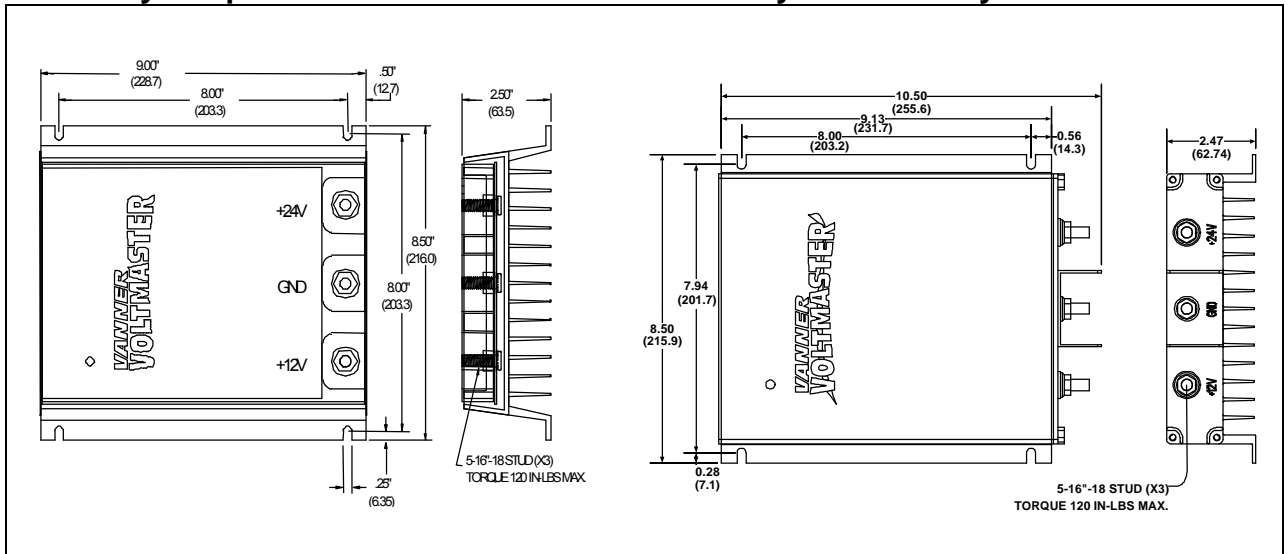
### Family 1 and Family 2 Equalizer Dimensions



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**

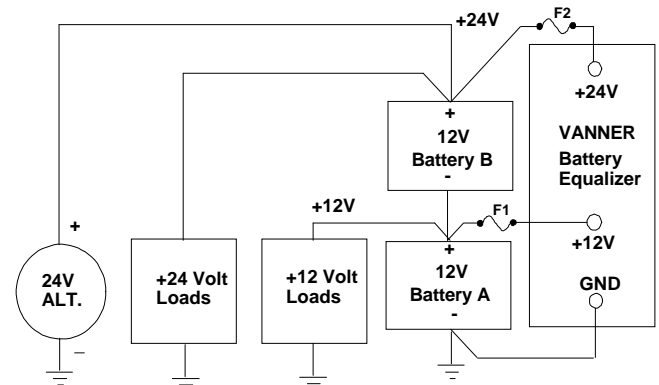
**Family 4 and Family 5 Dimensions**



**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 resettable 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.

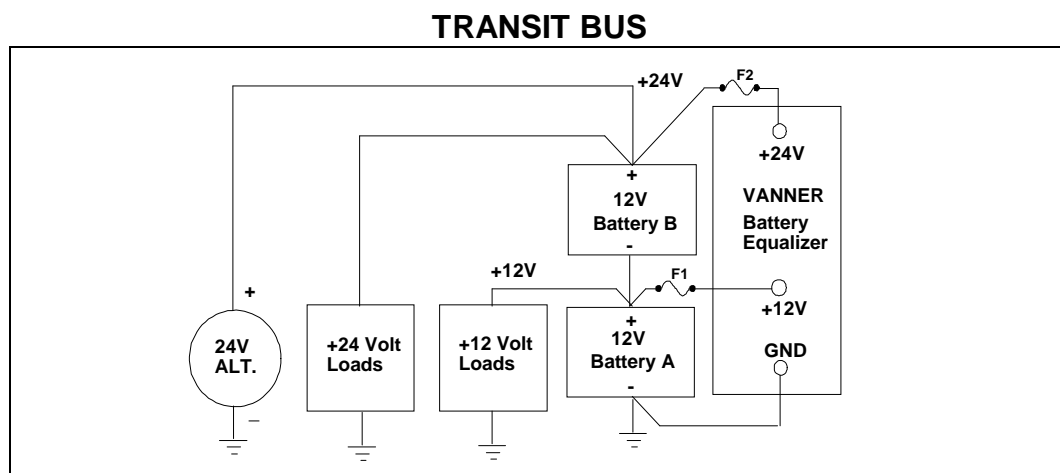
**Scenario #2 - Both 24 volt and 12 volt loads present, alternator is OFF.** The Battery Equalizer will insure that both batteries will discharge at the same rate even if different loads are present.

**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.

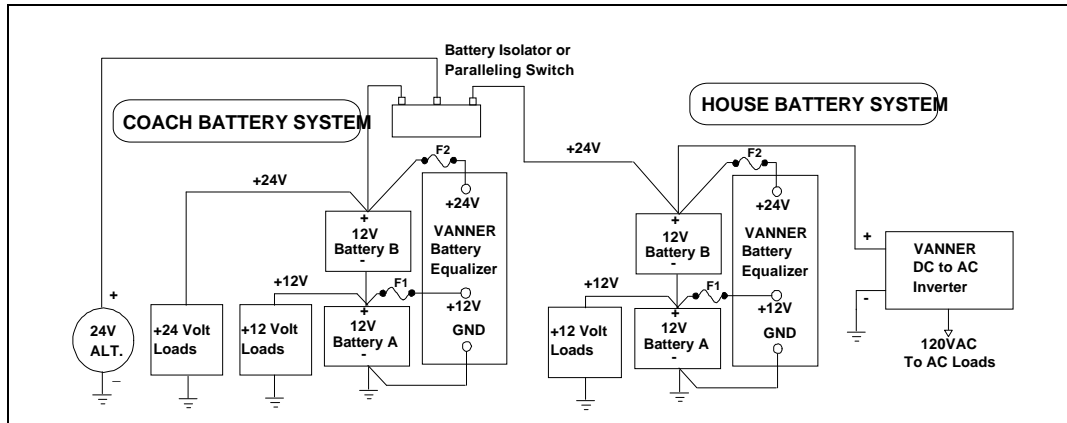
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## Typical Applications

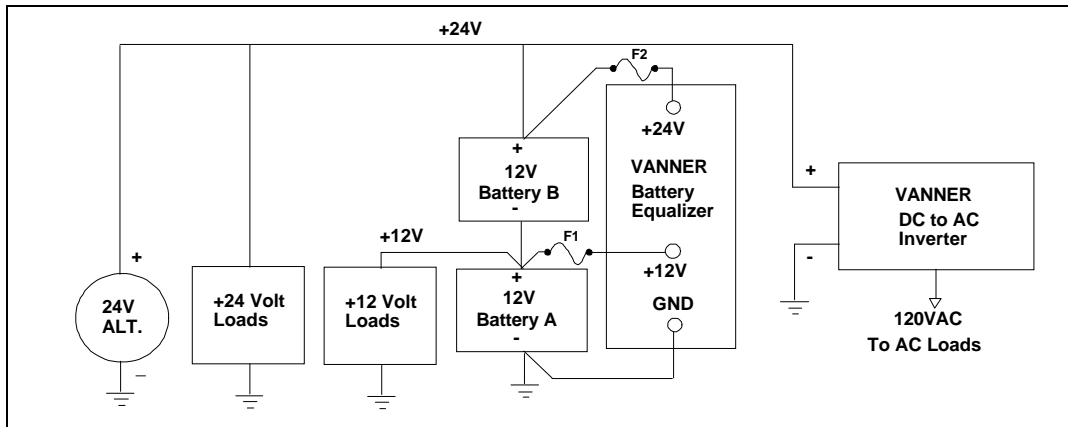
Vanner *VoltMaster* Battery Equalizer are used in many types of applications including transit and tour buses, private coaches, heavy trucks and off highway equipment, yachts, and alternative energy systems such as solar powered homes. In addition to Battery Equalizers, Vanner manufactures a wide range 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.



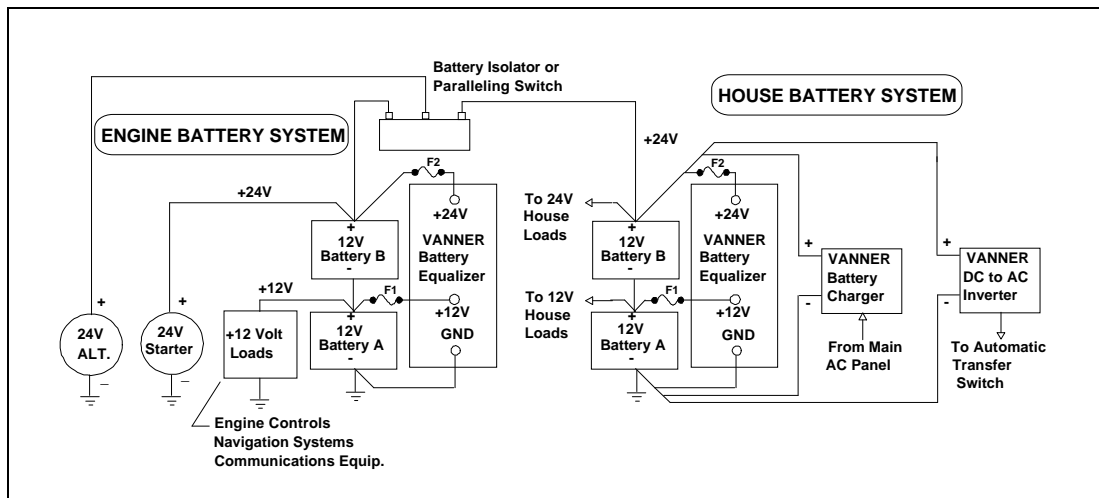
**PRIVATE COACH**



**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](mailto:pwrsales@vanner.com) if assistance is needed in sizing fault protection devices.

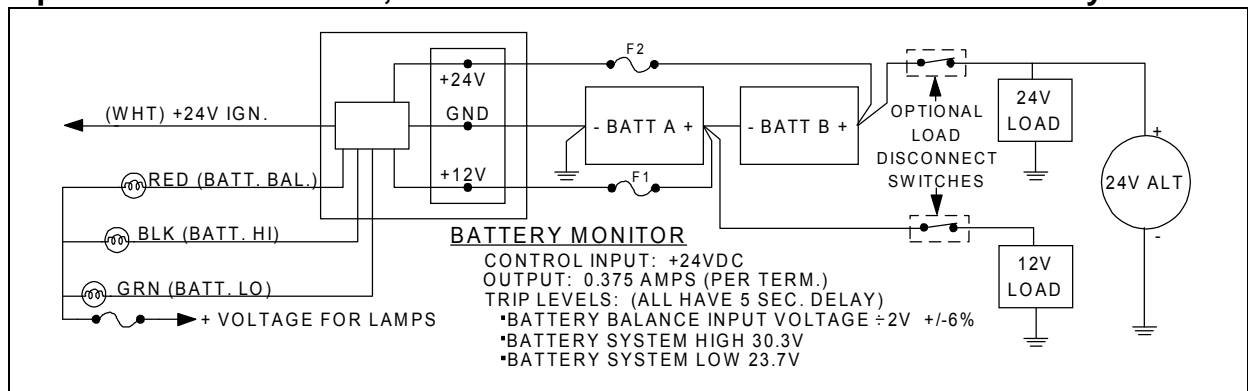
**Caution:** This equipment employs components that tend to produce arcs and sparks. To prevent fire or explosion, do not install in compartments containing batteries or flammable materials. Safety goggles should always be worn when working near batteries

**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.

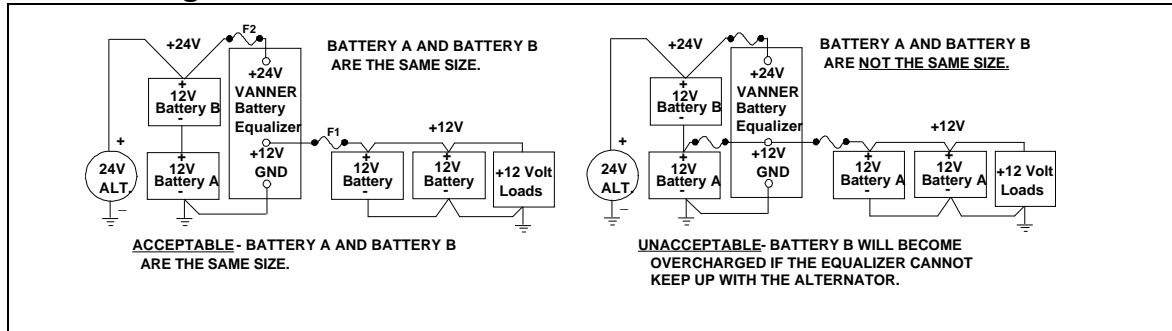
**Wiring Sequence**– To prevent reverse polarity damage on Family 1 and Family 2 models when connecting/disconnecting battery terminals: ALWAYS 1) Remove Equalizer ground terminal first, and 2) Replace Equalizer ground terminal last. The wiring sequence is not an issue with Family 3 or 4 models.

### 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.

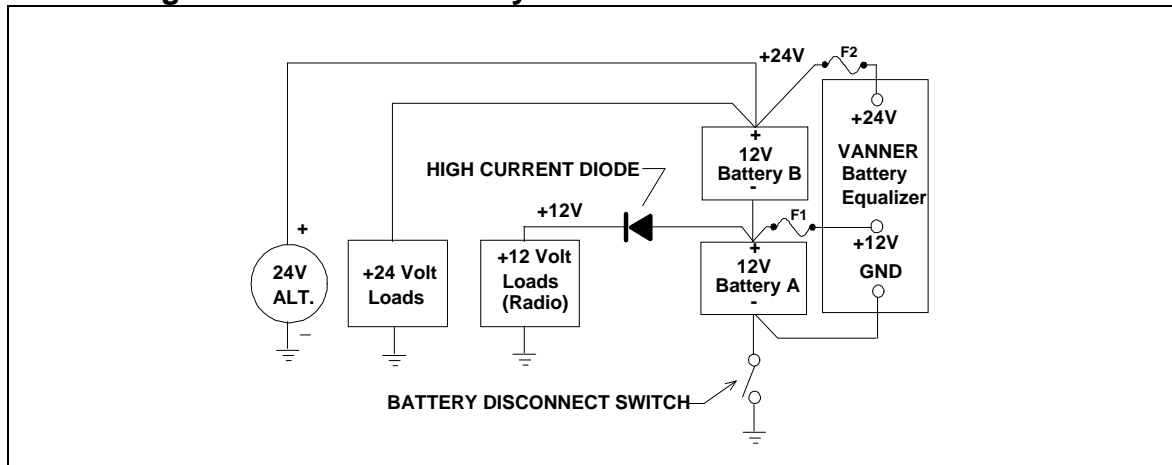
**Caution adding 12volt batteries**



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 sensitive 12 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 71° or 75° C, use wire rated at least 90° 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 80° C.						
		60-10	60-20	60-50	60-60	60-80	60-100	2 x 60-100
					65-60	65-80	65-100	2 X 65-100
#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.

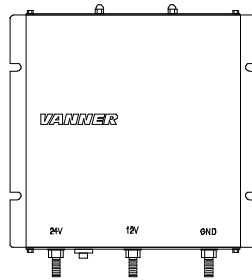
**Equipment Required**

- 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.

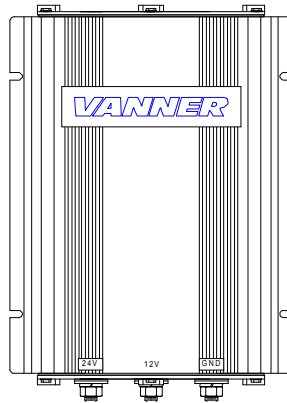
### Common Questions for Family 1 Battery Equalizers

- 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 breakers 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:

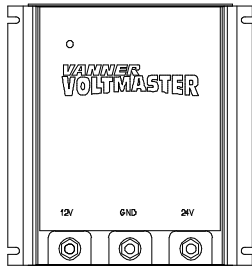
1. Remove Equalizer Ground terminal first.
2. Replace Equalizer Ground terminal last.

### Family 2 Battery Equalizer Test Procedure:

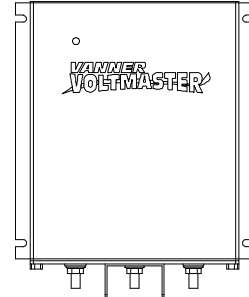
1. With the coach engine and vehicle loads OFF measure the voltage of Battery A. Replace or recharge Battery A if less than 11.5 volts.
2. Start the engine and turn ON a 12 volt load such as headlights.
3. Measure the input voltage between the +24 and GND posts of the equalizer. This voltage should be 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 <u>higher</u> 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.

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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.

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# **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 occurrence of incorrect information. We will however, update the manual as soon as we get new information and distribute revised versions to all parties concerned.



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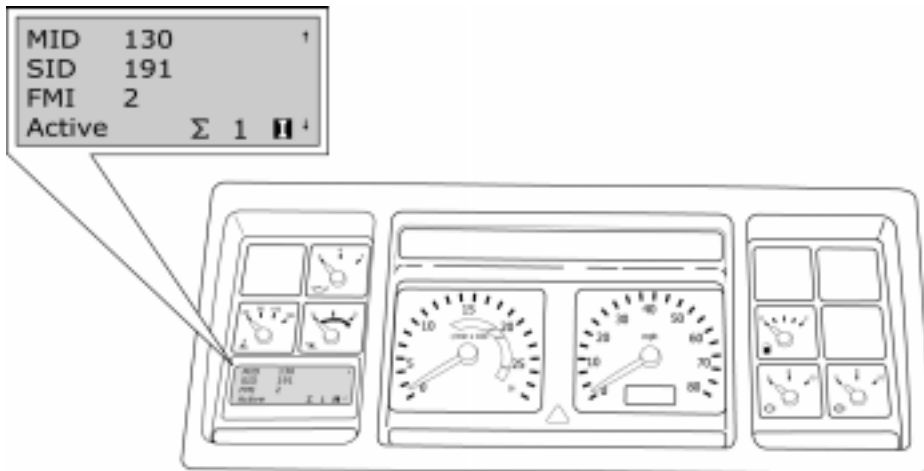
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**1. Bus Instrument Cluster (BIC)**

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.

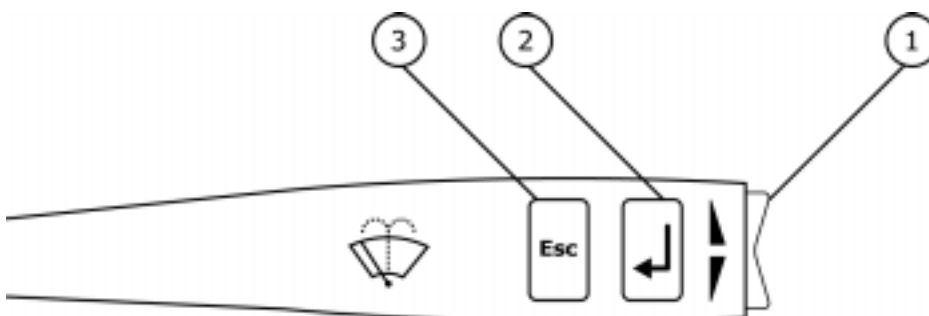
**2. The instrument display**

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**

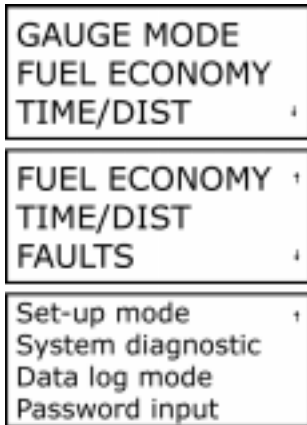
Using the the windscreen wiper handle at the right of the steeringwheel makes it possible to display the error at the lower left corner of the BIC. The errors can be displayed in numerical form and with help of the fault code table in this manual you can draw conclusions of what may have caused the errors.



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.

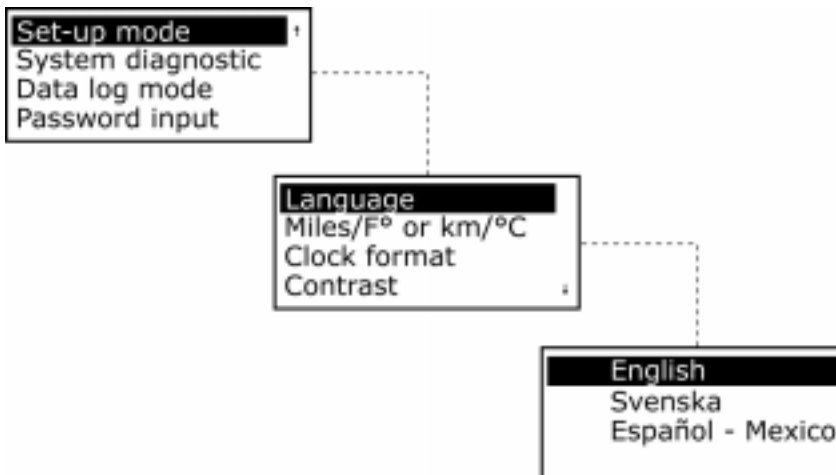
**4. Display menus**

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.



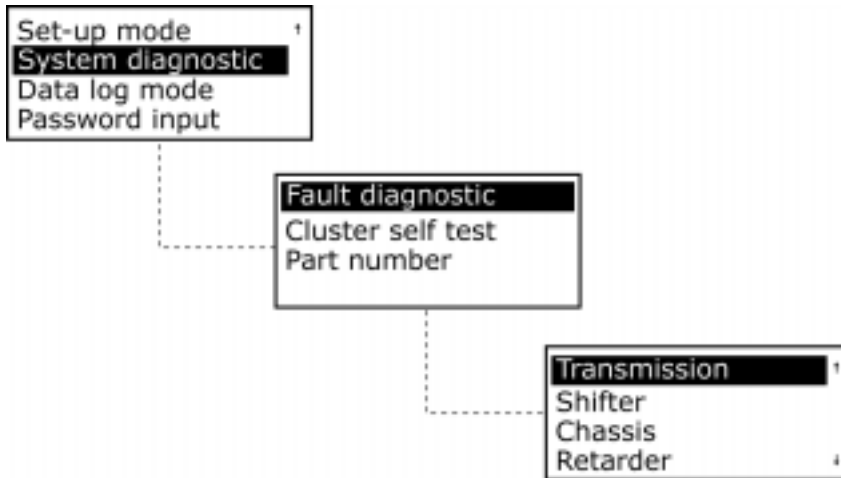
**5. Setting the display language**

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 already highlighted. Press the “Return” button again to enter the choices of languages, select “English” and press the “Return” button once more.



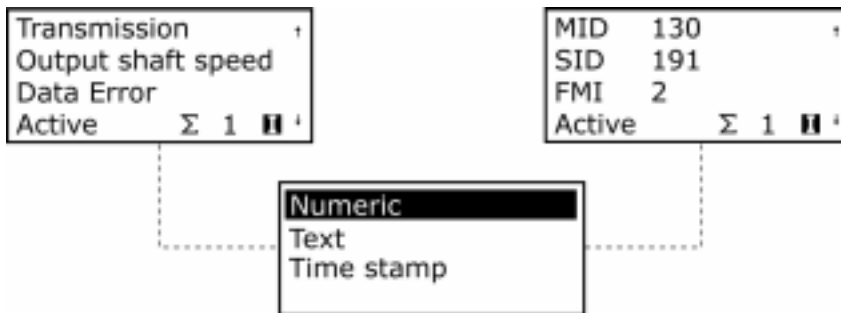
**6. Read fault codes from ECU**

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 display 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.
1	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.

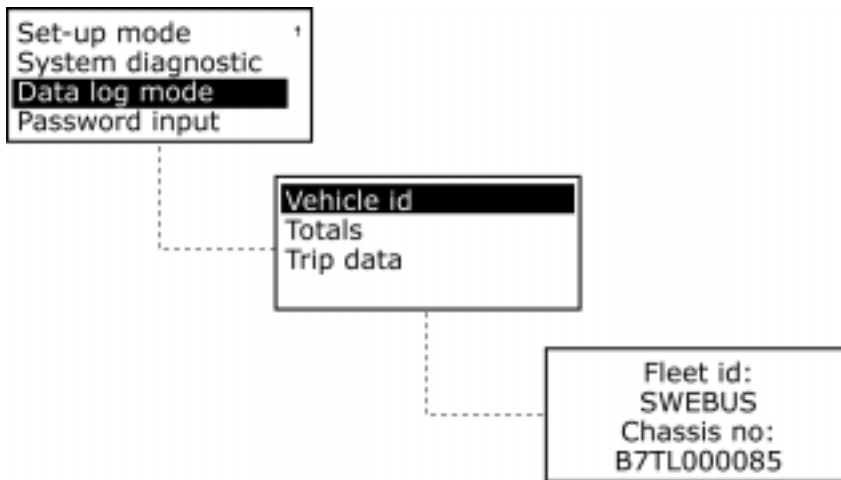
SAE-standard	
FMI	SAE-text
0	Data valid, but above normal operating range.
1	Data valid, but under normal operating range.
2	Intermittent or incorrect data.
3	Abnormally high voltage or short circuit to higher voltage.
4	Abnormally low voltage or short circuit to lower voltage.
5	Abnormally low current 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**

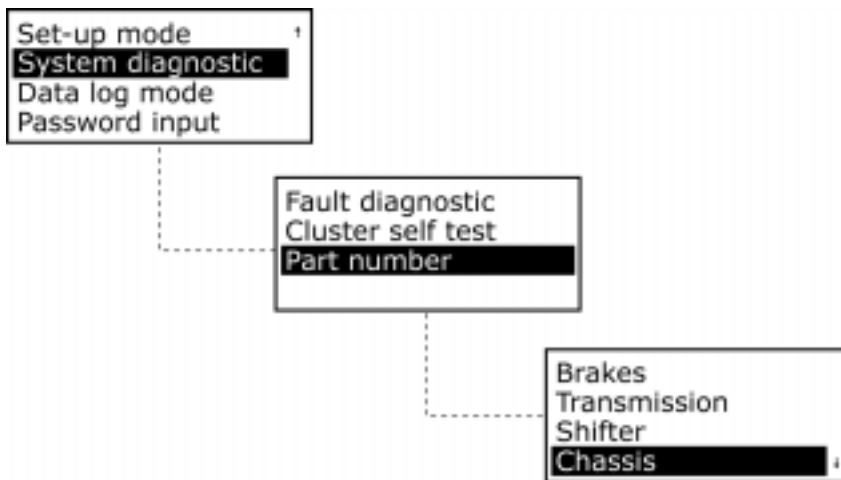
The VIC (Vehicle Identification Card) is a card that comes with every new bus that identifies the chassis number for the bus and the HW/SW id for each control unit.

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” button on the windscreen wiper handle. The fleet id and the chassis number should occur on the display.

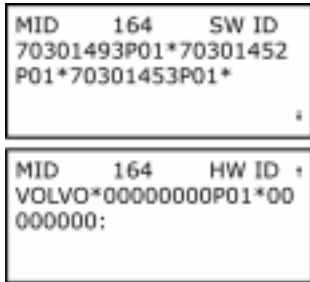


**8. Comparing HW/SW id with the VIC**

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	<b>Invalid data</b>
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	<b>Invalid data</b>
222	PID 1	4		U_Ret shorted ground	<b>Invalid data</b>
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

<b>Code</b>	<b>Description</b>
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)**

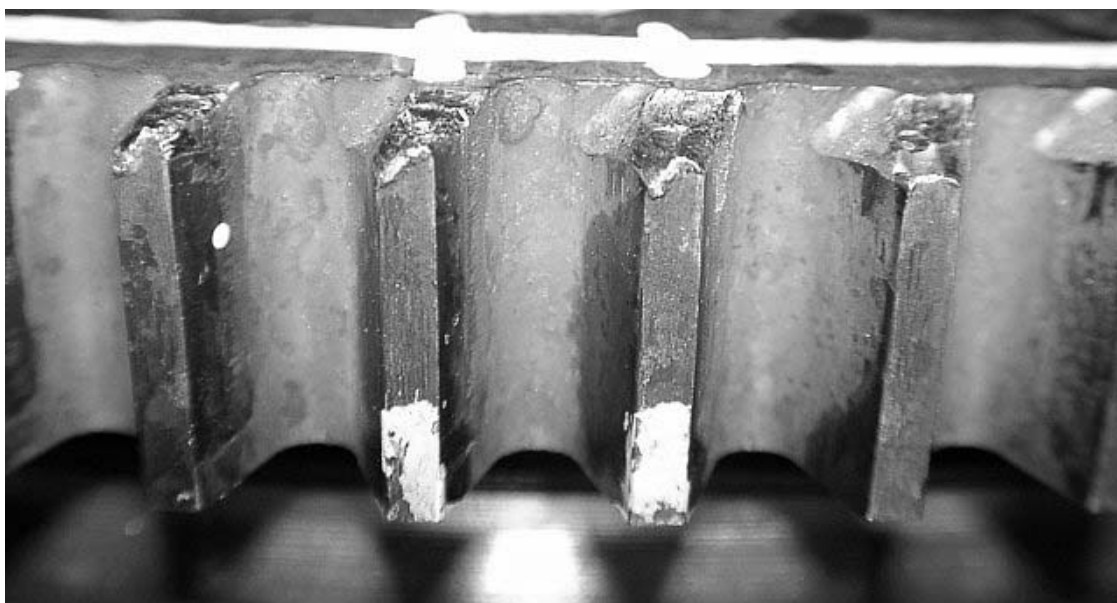
MID	(P)PID/SID	FMI	Seriousness	Component/Function	Display text
144	PID 29	3	Yellow lamp	Extra throttle, percentage mode	Second throttle
144	PID 29	4	Yellow lamp	Extra throttle, percentage mode	Second throttle
144	PID 46	1		Wet tank air pressure	Wet tank air press
144	PID 46	3	Yellow lamp	Wet tank air 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





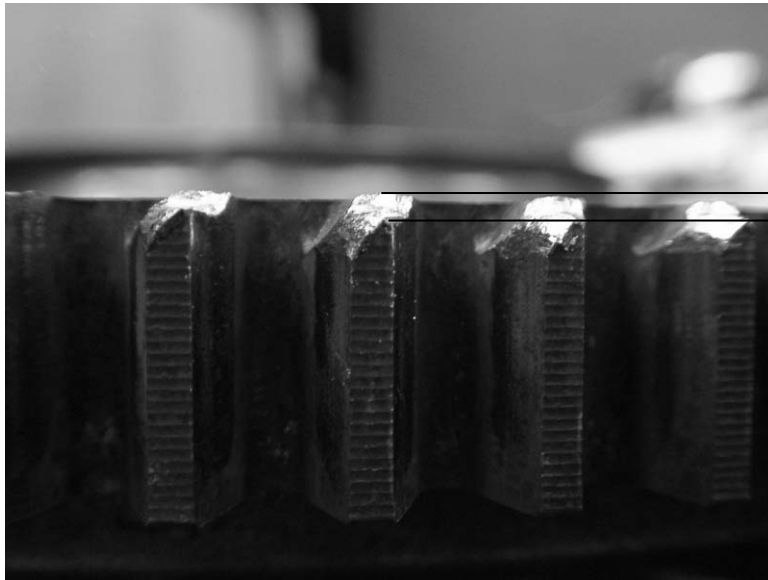
## Service Bulletin A1-M1N-1729EN - Flywheel Ring Gear Wear / Damage

(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

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## 1. DESCRIPTION

H3 Series vehicles may be provided with either an Allison automatic transmission or a ZF-Astronic transmission.

### NOTE

*Volvo D13 engines may only be provided with an Allison automatic transmission.*

### 1.1 ALLISON AUTOMATIC TRANSMISSION

The B500 and B500R (with retarder) 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.

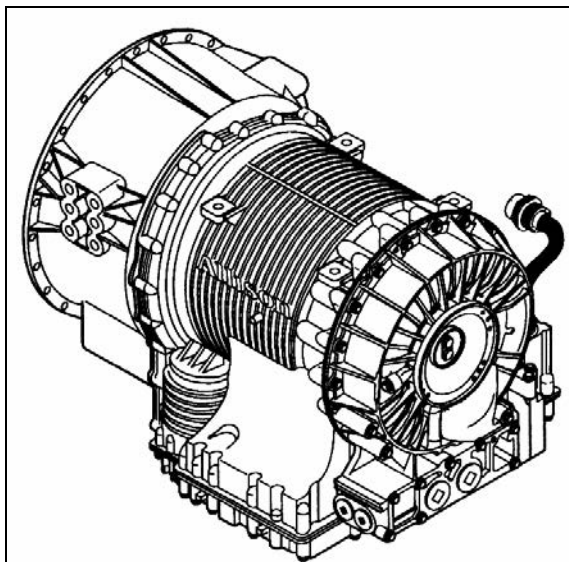


FIGURE 1: ALLISON TRANSMISSION

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Gear selection and torque converter modes are controlled by a microcomputer-based electronic transmission management system. It is fed information regarding throttle position, operator range selection, engine speed, turbine speed, transmission output speed and various system pressures from special electronic sensors.

With this information, it computes shift points and clutch pressures to meet immediate needs. Using closed loop adaptive logic, the electronic control looks at a number of parameters during the shift, and makes minute adjustments to match the shift to desired profile stored in its memory. It then looks at these adjustments and resets the parameters, which allow the transmission to quickly compensate for variations in load, terrain or environment and to adjust for clutch wear and engine power changes. A Diagnostic Data Reader can be connected to the electronic control unit to provide a self-check of all systems in the transmission. Five-digit trouble codes greatly reduce the time it takes to pinpoint potential problems. (Refer to paragraph "9. 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.

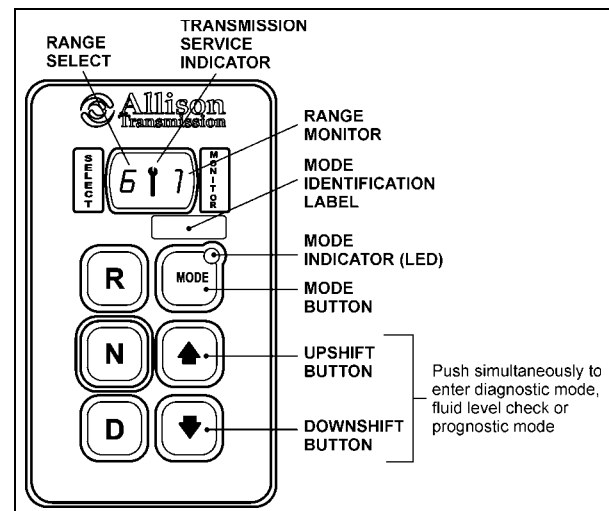


FIGURE 2: ALLISON PUSHBUTTON SHIFT SELECTOR

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When activated, fluid enters a cavity and provides resistance to the turning of rotor blades revolving with the output shaft. This effectively slows the vehicle to the point where the service brakes are needed only for final stopping. The retarder is fully modulated and is compatible with ABS.

### 1.2 ZF-ASTRONIC TRANSMISSION

The ASTRONIC gear shift system is a combination of an electro-pneumatically shifted

constant-mesh gearbox and an automated dry clutch.

If the ASTRONIC transmission system is to be used, the vehicle must have an electronic engine control unit as well as CAN communication. Since the clutch is automated (clutch pedal no longer fitted), the driver no longer has to activate the clutch.

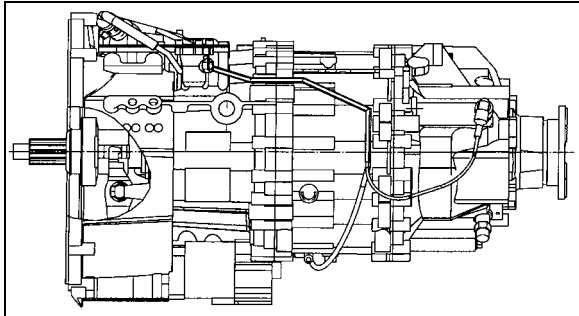


FIGURE 3: ZF-ASTRONIC TRANSMISSION 07078

The actual shift procedure is performed by the electronic transmission control unit. The driver has the option of driving the vehicle in both semi-automatic mode as well as fully automatically. When in semi-automatic mode, manual shifting with the range selector is made easier.

When in fully automatic mode, gears are selected and shifts made by the electronic control unit. The driver can still intervene if he wishes to. All system functions required are shown on the display, e.g. neutral, gear change, clutch overload and diagnosis information.

## 2. WELDING PROCEDURES

These procedures are intended only for vehicles equipped with transmission electronic controls. When frame or other welding is required on the vehicle, precautions are to be taken to protect the electronic control components. Refer to section 00: GENERAL INFORMATION, paragraph 3: "Precautions to be observed before welding" for complete procedure.

## 3. ALLISON TRANSMISSION MAINTENANCE

### 3.1 MANUAL FLUID LEVEL CHECK

To gain access to the dipstick, open the engine compartment rear doors; dipstick is located on the radiator side of the engine (Fig. 4).

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".



## WARNING

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.

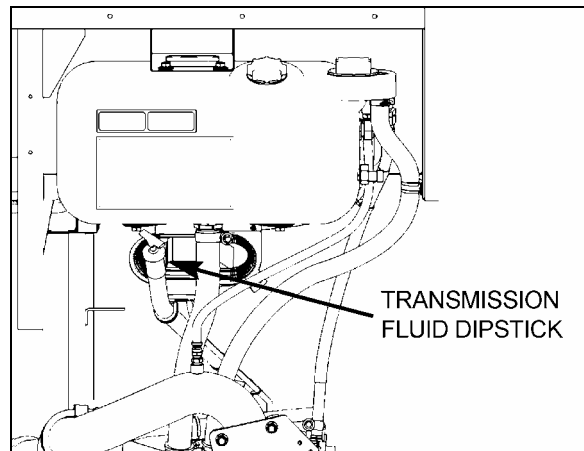


FIGURE 4: OIL LEVEL DIPSTICK (ALLISON) 01195

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.

### 3.1.1 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 «D» (Drive) and operate the engine for 30 seconds at 1000-1500 rpm; then shift to «R» (Reverse) 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 (Fig. 4). Insert the dipstick into the fill tube, pushing down until it stops.
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 160°F to 200°F (71°C to 93°C) is attained.

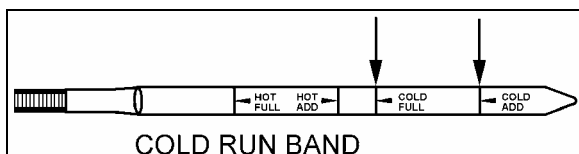


FIGURE 5: COLD CHECK

07050

**CAUTION**

**DO NOT** operate the transmission for extended periods of time until a **Hot Check** has verified proper fluid level. Transmission damage can

result from extended operation at improper fluid level conditions.

**CAUTION**

Obtain an accurate fluid level by imposing the following conditions:

- Engine is idling (500-800 rpm) in «N» (Neutral).
- Transmission fluid is at normal operating temperature.
- The vehicle is on a level surface.

## 3.1.2 Hot Check

**CAUTION**

The oil **must be hot** to obtain an accurate check because the fluid 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 (160°F to 200°F / 71°C to 93°C). 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 «N» (Neutral). 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.
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.

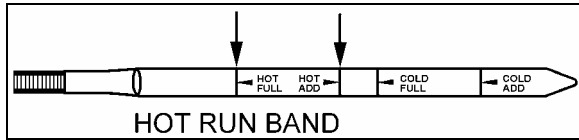


FIGURE 6: HOT CHECK

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**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.

3.2 FLUID LEVEL CHECK USING THE PUSHBUTTON SHIFT SELECTOR

Oil level codes are obtained as follows:

1. Park vehicle on a level surface, select «N» (neutral) on the pushbutton shift selector and apply parking brake.
2. Press simultaneously the ▲ (Up) and ▼ (Down) arrow buttons once.
3. Oil level codes are displayed in 2 minutes (e.g. display will flash and 8, 7, 6, 5, ...; countdown will occur during the 2 minutes) once the following parameters are met:
  - **Waiting time, vehicle must be stationary for at least 2 minutes to allow the oil to settle;**
  - **Engine at idle;**
  - **Oil at normal operating temperature, between 140°F (60°C) and 220°F (104°C);**
  - **Transmission in «N» (Neutral);**
  - **Transmission output shaft stopped;**
  - **Oil level sensor present and working.**

After 2 minutes, the display will flash one of the codes shown below:

DISPLAY	INTERPRETATION
O L...O K	Oil level is correct
O L...L O... 1	Oil Level is LOw 1 quart
O L...L O... 2	Oil Level is LOw 2 quart
O L...L O... 3	Oil Level is LOw 3 quarts
O L...L O... 4	Oil Level is LOw 4 or more quarts
O L...H I... 1	Oil Level is Hlgh 1 quart

DISPLAY	INTERPRETATION
O L...H I... 2	Oil Level is Hlgh 2 quarts
O L...H I... 3	Oil Level is Hlgh 3 or more quarts
O L... - (fc)	Oil Level is invalid. Source of invalid reading is defined by a two-character fault code (fc)

**NOTE**

Note that the quantities LO 4 and HI 3 are the largest values displayed and that the actual variation in oil level may exceed these numbers.

**NOTE**

Failure to meet one of the above parameters will stop the two minute countdown. One of the codes shown hereafter will indicate the cause of the countdown interruption. Once all parameters are met, the countdown will continue from where it left off.

If the fluid level check cannot be completed, an Invalid for Display fault is reported. This condition is reflected by the display of "OL", followed by "-", followed by one or two additional characters. The displayed characters define the cause of the fault, which may be either a system malfunction or an improper condition for conducting the check.

CODE	CAUSE OF FAULT CODE
OL...-...0X	Waiting period is not complete
OL...-...EL	Engine speed (rpm) too low
OL...-...EH	Engine speed (rpm) too high
OL...-...SN	N (neutral) must be selected
OL...-...TL	Sump oil temperature too low
OL...-...TH	Sump oil temperature too high
OL...-...SH	Output shaft rotation
OL...-...FL	Sensor failure

To exit the Oil Level Display Mode, press any range button: «R», «N» or «D» at any time.

3.2.1 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.

### 3.2.2 Keeping Fluid 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.

### 3.3 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®** and **DEXRON-VI®** fluids are recommended for on-highway applications.

- **TranSynd™** is a full synthetic transmission fluid developed by Allison Transmission and Castrol Ltd. This fluid meets Allison specifications for Severe Duty and Extended Drain Intervals. TranSynd™ is fully qualified to the Allison TES295 specifications and is available through Prevost Parts.

#### NOTE

*The prognostics package requires the use of TranSynd™ or an Allison approved TES-295 licensed fluid in the transmission and Allison High Capacity filters. If any other fluids or filters are used, Prognostic mode **must be disabled**. Prognostic information will not be accurate with any other fluids or filters and could result in missed maintenance activities resulting in transmission damage.*

- To be sure that a fluid is qualified for use in Allison transmission, check for the **DEXRON-III®** or **DEXRON-VI®** 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 non-TES 295 like Dexron-III®, Dexron-VI® or approved Schedule 1 TES-389 fluids.

The Transmission Fluid Operating Temperature Requirements table lists the minimum fluid temperatures at which the transmission may be safely operated without preheating. Preheat with auxiliary heating equipment or by running the equipment or vehicle with the transmission in «N» (Neutral) for a minimum of 20 minutes before attempting range operation.

#### Transmission Fluid Operating Temperature Requirements

Fluid type	Minimum operating temperature	
	Celsius	Fahrenheit
TranSynd™	-30	-22
DEXRON-VI®	-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 -25°F (-32°C). If a preheat kit is not available, the TCM will restrict full operation until the sump temperature is increased.*


### 3.3.1 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.

### 3.3.2 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.

	<h2>CAUTION</h2>
<p>If excessive metal contamination has occurred, replacement of the oil cooler and replacement of all bearings within the transmission is recommended.</p>	

### 3.3.3 Coolant Leakage


If engine coolant leaks into the transmission oil system, immediate action must be taken to prevent malfunction and possible serious damage. The transmission must be completely disassembled, inspected, and cleaned. All traces of the coolant contamination must be removed. Friction clutch plates contaminated with ethylene glycol must be replaced.

## 3.4 CONTROL SYSTEM PROGNOSTICS



The transmission control system includes the provision for the user to monitor various transmission operating parameters. Transmission operating parameters monitored by the prognostics feature are:

- Oil Life Monitor
- Filter Life Monitor
- Transmission Health Monitor

<p><b>NOTE</b></p>
<p><i>The prognostics package requires the use of TranSynd™ or an Allison approved TES-295 licensed fluid in the transmission and Allison High Capacity filters. If any other fluids or filters are used, Prognostic mode <b>must be disabled</b>. Prognostic information will not be accurate with any other fluids or filters and could result in missed maintenance activities resulting in transmission damage.</i></p> <p><i>Refer to TES 295 Approved Fluids list, found under the Service/Fluids heading on the home page of the Allison Transmission web site.</i></p> <p style="text-align: center;"><b><a href="http://www.allisontransmission.com">www.allisontransmission.com</a></b></p>

When a specified threshold is detected for any of the serviceable conditions, the TRANSMISSION SERVICE indicator  is illuminated to alert the operator. Failure to attend to the service condition and reset the TRANSMISSION SERVICE indicator within a defined operating period will result in illumination of the CHECK TRANS light on the dashboard telltale panel, indicating the increased probability


that the service condition will develop into a more serious condition.

To access the Prognostic Mode functions, simultaneously press the  (Up) and  (Down) arrow buttons repeatedly. See the reference table at the end of this section.

### 3.4.1 Oil Life Monitor

The display message denotes the calculated remaining life of the transmission fluid. This value is based on the established life for the required baseline fluid, and then is continuously adjusted for cumulative effects of such operating parameters as operating time, retarder operation, output shaft revolutions and shift frequency.

**Display:** The display is a two-digit number, denoting percentage of the fluid life which remains. New fluid is displayed as 99%.

The TRANSMISSION SERVICE indicator  will be illuminated, denoting a required change of transmission fluid, when the remaining fluid life reaches approximately 1–2 %. The indicator will be lit steadily upon each initialization of the TCM, and will remain on steady for approximately 1–2 minutes after the first selection of “D” (drive) range each time, until service is performed and the indicator is reset.

Failure to perform maintenance and reset the TRANSMISSION SERVICE indicator within a defined period will result in the illumination of the CHECK TRANS light on the dashboard telltale panel and diagnostic code P0897 Transmission Fluid at Limit will be set.


**Reset:** The TRANSMISSION SERVICE indicator can be reset by a message over the SAE J1939 communication interface, with the Allison DOC™ for PC diagnostic program, or by depressing and holding the MODE button for ten (10) seconds while the Oil Life Monitor function is displayed. It may also be reset by selecting N-D-N-D-N-R-N on the shift selector, pausing briefly (less than 3 seconds) between each selector movement, with the ignition on and the engine not running.

**CAUTION**


Required calendar-based oil & filter change intervals (based on month) still apply because Oil Life Monitor function cannot measure time while ignition power is OFF.

If the Oil Life Monitor function has not indicated the need for a fluid change before 60 month (five years) have passed, it will be necessary to change the fluid and filters per calendar requirements and reset the system.

### 3.4.2 Filter Life Monitor

The display message denotes operating status of the transmission main fluid filter, based on the measured pressure drop across the filter. The feature is not functional at transmission sump temperatures below 40 °C (105 °F). Both the main and lube filters **must be** changed when the TRANSMISSION SERVICE indicator  shows the main filter should be changed.

**Display:** An acceptable filter life status is displayed as "OK". An unacceptable filter life status is displayed as "LO".

Once the programmed threshold for maximum filter pressure drop has been observed and verified, the diagnostic code P088A Transmission Filter At/Over Limit will be recorded to indicate that the filter has reached the end of its designed life. At the next initialization of the TCM, the TRANSMISSION SERVICE indicator  will flash for approximately 1–2 minutes after the first selection of "D" (drive) range. Thereafter, the indicator will illuminate and flash upon each TCM initialization, continuing to flash for 1–2 minutes after the first selection of a drive range each time, until service is performed and the indicator is reset.

Failure to perform maintenance and reset the monitor after a calibration-defined number of warnings will result in the illumination of the CHECK TRANS light on the dashboard telltale panel and diagnostic code P088B will be recorded to indicate a highly deteriorated filter.

**Reset:** The feature will reset automatically when the main fluid filter has been changed and the pressure drop across the filter no longer exceeds the threshold value. A manual reset can be performed by depressing and holding the MODE button for ten (10) seconds while the Filter Life Monitor function is displayed. It may also be reset by selecting N-R-N-R-N-D-N on

the shift selector, pausing briefly (less than 3 seconds) between each selector movement, with the ignition on and the engine not running.

### 3.4.3 Transmission Health Monitor

The display message denotes clutch life status, as determined by monitored changes and the calculated running clearance of the transmission clutches C1, C2, C3, C4 & C5.

**Display:** An acceptable clutch life status is displayed as "OK". An unacceptable clutch life status is displayed as "LO". The specific clutch(es) for which the function indicates "LO" cannot be identified with the shift selector. Allison DOC™ for PC-Service Tool displays clutch condition as OK or NOT OK for each clutch, C1 through C5.

The TRANSMISSION SERVICE indicator will be illuminated, indicating the need for clutch maintenance, when the remaining clutch life reaches approximately 10%, or if the running clearance exceeds a maximum value which may indicate a non-wear-related issue. Thereafter, the indicator will be lit upon each initialization of the TCM, and will remain on steady during all vehicle operation until service is performed and the indicator is reset.

Failure to perform maintenance and reset the monitor after a number of warnings will result in the illumination of the CHECK TRANS light on the dashboard telltale panel and diagnostic code P2789 Clutch Adaptive learning at Limit will be set.

**Reset:** The feature will reset automatically upon elimination of the clutch clearance condition which initiated it. The indicator can also be manually reset using the Allison DOC™ for PC diagnostics program if necessary.

The following table illustrates how to access Oil Level Check, Prognostics & Diagnostic Troubleshooting Codes functions on the Allison pushbutton shift selector.

▲ (up) & ▼ (down) arrow buttons pressed simultaneously	Description	SELECT	MONITOR
1 <sup>st</sup> press	<b>Allison transmission oil level check</b> Other codes will be displayed	" _ "	" _ "
2 <sup>nd</sup> press	<b>Oil Life Monitor</b> Oil life remaining will range from 99% down to 00%	" O " Some number from 9 to 0	" M " Some number from 9 to 0
3 <sup>rd</sup> press	<b>Filter Life Monitor</b> Present life of filter is OK Present life of filter is low	" F " " O " " L "	" M " " K " " O "
4 <sup>th</sup> press	<b>Transmission Health Monitor</b> Shows "OK" until remaining life of one or more of the clutch(es) wear enough so that the programming changes One or more of the clutches C1 through C5 have worn enough to change the program	" O " " O " " L "	" K " " K " " O "
5 <sup>th</sup> press	<b>Display of diagnostic codes</b> Other codes will be displayed	" d "	" 1 "

### 3.5 OIL AND FILTER CHANGE INTERVAL

#### 3.5.1 Oil And Filter Change Interval With Prognostics Mode Disabled

Allison transmissions are factory fill with **Castrol TranSynd™** fluid. Oil change must be performed with the vehicle on a flat and level surface and with parking brake applied. Oil and oil filter change frequency is determined by the severity of service and operating conditions of the transmission and by the filter equipment installed. See "TABLE 1, TABLE 2 or TABLE 3" for oil and filter change intervals when PROGNOSTIC MODE is **disabled**. 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.*

TABLE 1

Recommended Fluid and Filter Change Intervals Using Dexron-III/ Dexron-VI/ Non-TranSynd™/ Non-TES 295 / Mixture							
Severe <sup>3</sup> Coaches or MTH equipped with retarder				General <sup>4</sup> Coaches or MTH without retarder			
Fluid	Filters			Fluid	Filters		
	Main	Internal	Lube/ Auxiliary		Main	Internal	Lube/ Auxiliary
12,000 Miles (20 000 km) 6 Months/ 500hrs	12,000 Miles (20 000 km) 6 Months/ 500hrs	Overhaul	12,000 Miles (20 000 km) 6 Months/ 500hrs	25,000 Miles 40 000 km 12 Months/ 1000hrs	25,000 Miles 40 000 km 12 Months/ 1000hrs	Overhaul	25,000 Miles (40 000 km) 12 Months/ 1000hrs

2 inch Control Module (1.75 approximately) – Requires High-Capacity Filter Kit Allison P/N 571709

TABLE 2

Recommended Fluid and Filter Change Intervals <sup>1</sup> Using 100% TranSynd™/TES 295 Approved Fluid <sup>2</sup>							
Severe <sup>3</sup> Coaches or MTH equipped with retarder				General <sup>4</sup> Coaches or MTH without retarder			
Fluid	Filters			Fluid	Filters		
	Main	Internal	Lube/ Auxiliary		Main	Internal	Lube/ Auxiliary
150,000 Miles (240 000 km) 48 Months/ 6000hrs	75,000 Miles (120 000 km) 36 Months/ 3000hrs	Overhaul	75,000 Miles (120 000 km) 36 Months/ 3000hrs	300,000 Miles (480 000 km) 48 Months/ 6000hrs	75,000 Miles (120 000 km) 36 Months/ 3000hrs	Overhaul	75,000 Miles (120 000 km) 36 Months/ 3000hrs

<sup>1</sup> Extended TranSynd™/TES 295 fluid and filter change intervals are only allowed with Allison High-Capacity filters.

<sup>2</sup> 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.

<sup>3</sup> Severe vocation= All retarder, On/Off highway, transit and intercity coach with duty cycle greater than one (1) stop per mile.

<sup>4</sup> General vocation= intercity coach with duty cycle less than or equal to one (1) stop per mile and all other vocations not listed in severe vocation.

TABLE 3

Recommended Fluid and Filter Change Intervals Using 100% TranSynd™/TES 295 Approved Fluid And Gold Series Filters							
Coaches or MTH equipped with retarder				Coaches or MTH without retarder			
Fluid	Filters			Fluid	Filters		
	Main Initial Break-in 5,000 miles (8,000 km) 200hrs	Internal	Lube/ Auxiliary		Main Initial Break-in 5,000 miles (8,000 km) 200hrs	Internal	Lube/ Auxiliary
50,000 Miles (80 000 km) 24 Months/ 2000hrs	50,000 Miles (80 000 km) 24 Months/ 2000hrs	Overhaul	50,000 Miles (80 000 km) 24 Months/ 2000hrs	150,000 Miles (240 000 km) 48 Months/ 4000hrs	50,000 Miles (80 000 km) 24 Months/ 2000hrs	Overhaul	50,000 Miles (80 000 km) 24 Months/ 2000hrs

3.5.2 Oil And Filter Change Interval With Prognostics Mode Enabled

Oil Life Monitor and Filter Life Monitor of the Prognostics mode provide indicators of required maintenance actions. They are designed to maximize fluid and filter utilization. **Prognostics enabled requires the use of 100% TranSynd™ or an Allison approved TES-295 transmission fluid and Allison High Capacity filters.** If any other fluids or filters are used, Prognostic mode **must be disabled**. Prognostic information will not be accurate with any other fluids or filters and could result in missed maintenance activities resulting in transmission damage.

**IMPORTANT NOTE**

The following schedule is to be used with Prognostics enabled.

100% concentration of TES-295 Allison approved fluids and Allison High Capacity Filters is **required**. Less than 100% concentration of TES-295 Allison approved fluids are considered a mixture and shall not be used with Prognostics mode or this change schedule. Utilization of previous Non-TES 295 fluid/filter change intervals (Table 1) is required.

	General or Severe Vocation
FLUIDS Prognostics enabled	Change fluid when indicated by TRANSMISSION SERVICE indicator or 60 month (five years) whichever occurs first. In addition, change filters with fluid.
FILTERS Prognostics enabled	Change filters (Main & Lube) when indicated by TRANSMISSION SERVICE indicator between fluid change or 60 month (five years) whichever occurs first.

3.5.3 Changing The Transmission Oil And Oil Filters

The procedure for changing the transmission oil and oil filters is as follows:

**Drain**

1. The transmission should be at an operating temperature of 160°F (71°C) to 200°F (93°C) when the oil is drained. This will ensure quicker and more complete fluid drainage.


**NOTE**

Remove transmission protective panel located underneath transmission for easier access.

2. Remove the drain plug from under the transmission (Fig. 7) and allow the oil to drain

into a suitable container. Check the condition of the oil as described previously.

3. To replace the integral filters, remove twelve bolts (6 on each cover), two filter covers, two O-rings, two square cut seals and the two filters from the bottom of the control module (Fig. 7).
4. To install filters, pre-lube and install the two O-rings, the two square cut seals followed by the filters (lube the O-ring in filter cartridge only) into the filter compartment. Index each filter/cover assembly to holes in channel plate/sump. Push the cover assembly in by hand to seat the seals.



**CAUTION**

Do not use bolts to draw the cover to sump. This can damage the cover, seal, or sump.

5. Install twelve bolts and both covers, and then tighten to 38-45 Ft-lbs (51-61 Nm).
6. Inspect the drain plug and O-ring. Replace if necessary. Reinstall the drain plug and tighten to 18-24 Ft-lbs (25-32 Nm).
7. Reinstall transmission protective panel.

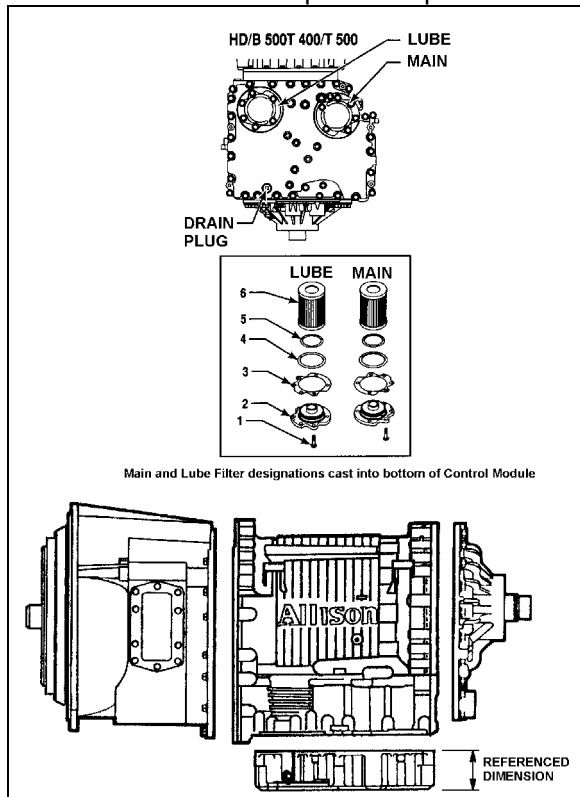


FIGURE 7: DRAIN PLUG AND FILTERS 07052

**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)

**Refill 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 below 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. ZF AS-TRONIC TRANSMISSION MAINTENANCE**

The information needed for the removal/installation or maintenance of the ZF transmission is included in the documents annexed at the end of this section.



**Use of electronic equipment in the proximity of the shifter may cause malfunction**

 **WARNING**

Do not use electronic equipment in the proximity of the ZF range selector keypad as this may cause improper operation and unwanted gear shifting.



#### 4.1 OIL CHANGE

Approximately 11 liters is needed for a complete oil change.

#### 4.2 ZF AS-TRONIC / SACHS CLUTCH

##### Installation Procedure

##### **Important Note:**

The clutch hub splines, input shaft, release bearing, clutch fork, and clutch push rod ends all come pre-lubed from the factory.

- Clean the flywheel, clutch disc, and pressure plate surfaces, removing any grease prior to assembly.
- Slide the clutch disk onto the transmission input shaft to check for smooth engagement. Remove clutch disk.
- Apply a very thin coating of Optimol Olista Longtime synthetic grease to the transmission input shaft. Slide the clutch disk along the full length of the input shaft to transfer grease to the clutch hub splines. Remove clutch disc, and remove any excess grease from the exterior of the clutch disc hub. **It is very important that no excess grease is left on the exterior of the clutch hub or clutch disk!**
- Install two temporary pilot studs (7/16-14, 3" long), placing them on the same diameter, 180° apart. These are used to aid in the alignment of the clutch pressure plate.
- Verify that the pilot bearing is seated properly in the flywheel. Insert a clutch alignment tool (SAE 2" DIA, 10 Spline) through the clutch disc and into the pilot bearing. PLEASE NOTE: the direction matters – the large side of the hub should face the clutch pressure plate. The clutch disc hub should be marked "flywheel side" – this side should face the flywheel.
- Use the clutch alignment tool to keep the clutch disc in the proper position and align the clutch cover with the two studs. Push the cover in place in the direction of the flywheel and start installing the clutch bolts. Use Lock-Tite for each bolt. Install, but do not torque, the 10 bolts. Remove the two pilot studs and in their place install the remaining 2 bolts.
- When the bolts are hand tight, be sure that the clutch cover fits into the flywheel centering ring. Tighten each bolt a little at a time, in a crisscross pattern, until the pressure plate cover contacts the flywheel face. Once the cover has touched the face of the flywheel, torque the clutch bolts to 55 ft-lbs, again in a crisscross fashion.
- Remove the clutch alignment tool. If the installation was successful, it should slide out smoothly.
- Ensure that the release bearing retaining clip (located on the "fingers" of the pressure plate) is closed. Refer to figure 8.
- Remove the Clutch Inspection Cover from the bottom of the transmission.
- The transmission should have been shipped in gear. This will allow the installer to rotate the output shaft in order to align the input shaft with the clutch disc hub. If the transmission is in neutral, a "strap wrench" (with a rubber or leather strap) can be used to align the input shaft. Do not use a wrench of the "chain" variety, as damage to the input shaft may result. When aligned, push the transmission towards the engine. Be sure that the bell housing contacts the flywheel housing.
- **Warning!** Insure that the transmission moves in a straight line. It can very easily go off center relative to the clutch disc and pilot bearing.
- Insure that the bell housing interfaces evenly with the flywheel housing. Even surface contact should be attained before tightening bolts.
- Do not try to correct relative position of the bell housing and flywheel housing by pulling the transmission into place with the bell housing bolts. The transmission bell housing should seat into the flywheel housing freely.
- When the bell housing and flywheel housing surfaces and bolt holes are aligned, install the transmission bolts. Only hardened steel flat washers should be used, **SERRATED LOCK WASHERS ARE NOT ALLOWED.** Torque the transmission bolts to 55 lbf-ft in a crisscross fashion.
- From underneath, push the clutch release bearing forward (in the direction of flywheel) using the release fork. Use force to snap the bearing into the retaining clip located on the "fingers" of the pressure plate. The installer should be able to both hear and feel the bearing seat into place. Refer to figure 8.

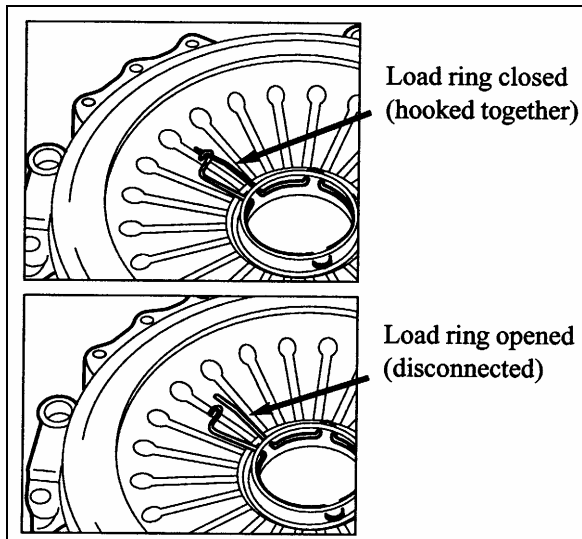


FIGURE 8: RELEASE BEARING RETAINING CLIP 07112

- Install the Clutch Actuator inspection cover.
- The clutch/transmission installation is now complete.

## 5. INSTALLATION OF ZF OR ALLISON TRANSMISSION BRACKETS

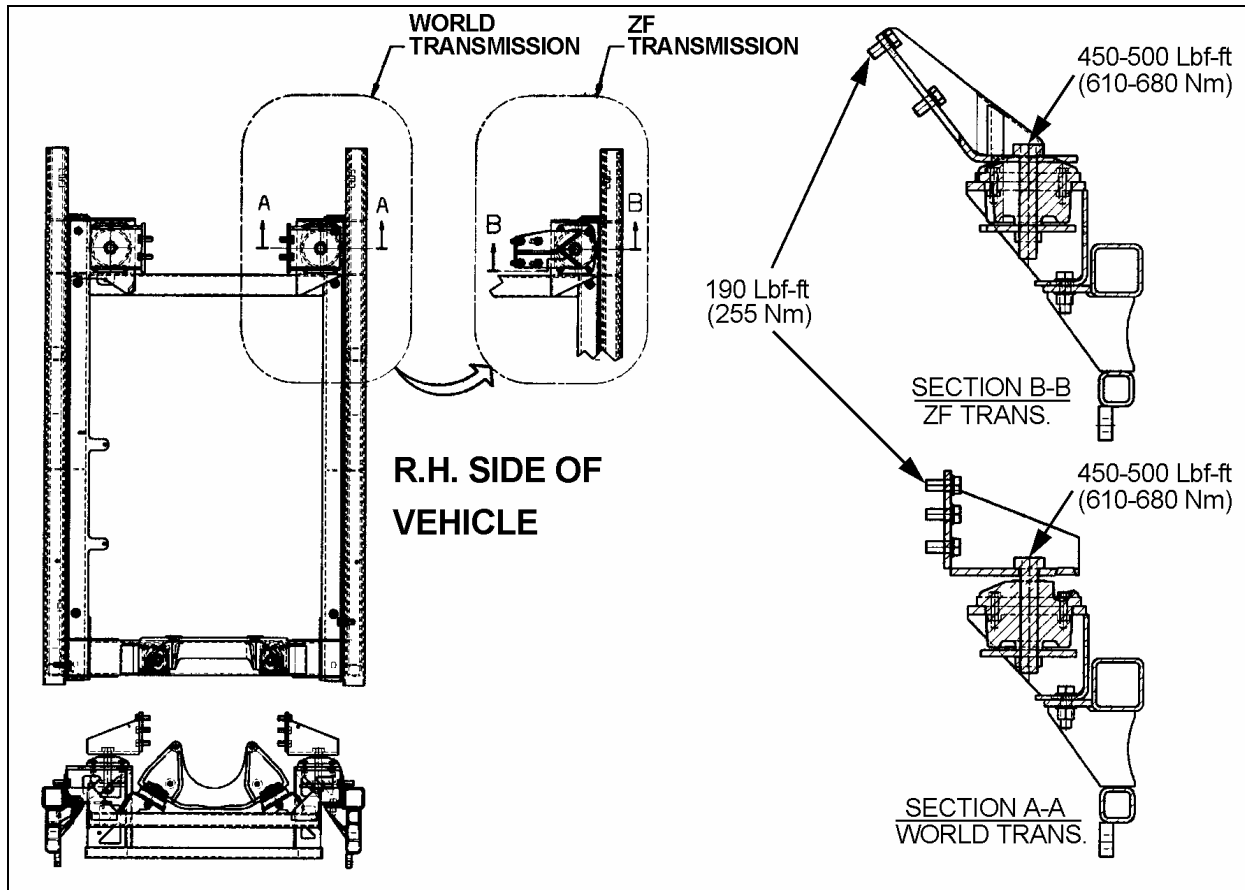


FIGURE 9: ZF OR ALLISON TRANSMISSION BRACKETS

07114

## 6. 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, and then set battery master switch to the "OFF" position.
2. Jack up vehicle, then place safety supports underneath body.



### CAUTION

Only the recommended jacking points must be used as outlined in Section 18, "BODY".

### NOTE

For more clearance between the tag axle and transmission, the tag axle may be unloaded and jacked up or retracted (if applicable).

3. Remove engine splash guards and protective panels surrounding transmission.
4. Remove cross member from under transmission.
5. Remove the transmission drain plug and allow oil to drain. Inspect the drain plug washer and replace it if necessary. Reinstall the drain plug and tighten to 33-41 Lbf-ft (45-56 Nm) (see "3.1.11 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.

 <b>WARNING</b>
<p>A significant amount of oil may drain from oil lines when they are disconnected.</p>

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.

• **Detroit Diesel Series 60 Engine Only**

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. 10).

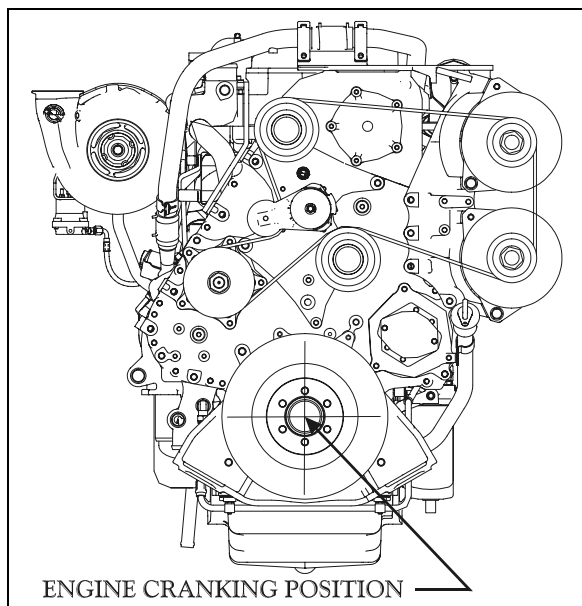


FIGURE 10: ENGINE CRANKING POSITION 01153

▪ **Volvo D13 Engine Only**

Remove starter motor located on engine L.H. side. Removing the starter motor will allow access

to unfasten the 12 converter-to-flexible plate attaching screws. Remove the plug located below starter motor and install cranking tool (88800014). Cranking the engine to gain access to the attaching screws may be done by turning the cranking tool using a suitable adapter (fig. 11).

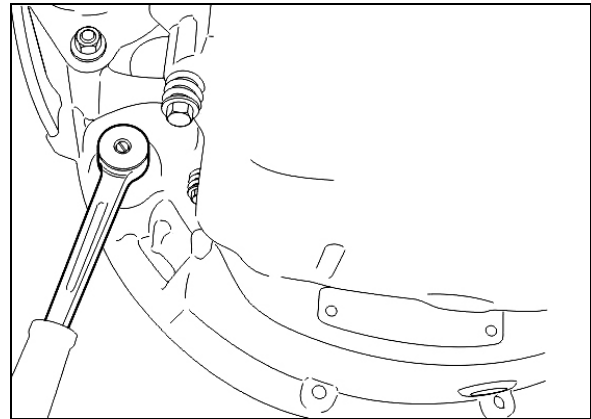




FIGURE 11: VOLVO ENGINE CRANKING POSITION

 <b>CAUTION</b>
<p>Do not rotate alternator shaft clockwise to avoid removing tension on belt.</p>

14. Remove the 12 screws retaining the torque converter housing to the flywheel housing.

 <b>CAUTION</b>
<p>Make sure transmission-to-engine alignment is maintained when removing screws to avoid damaging torque converter housing.</p>

15. Slowly pull transmission straight out to clear the engine.
16. Remove the transmission.

**7. TRANSMISSION OIL COOLER REMOVAL**

**7.1 TRANSMISSION WITHOUT RETARDER**

**7.1.1 Detroit Diesel Series 60**

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 (fig.12).

**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.

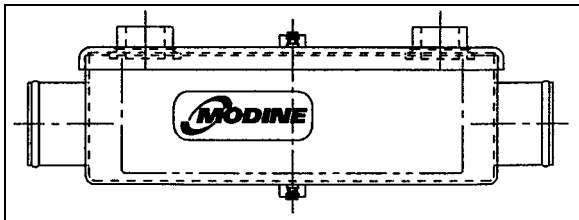


FIGURE 12: MODINE OIL COOLER

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.

## 7.1.2 Volvo D13 engine

Stop engine and allow engine to cool. Close both heater line shutoff valves (refer to Section 05 "Cooling").

To drain the cooling system, proceed as per Section 05 "Cooling", paragraph 5: Draining. If the cooling system is contaminated, flush system as per Section 05 "Cooling", paragraph 7: Flushing.

1. Remove the rear L.H. side tag axle wheel, then remove the rear L.H. side fender panel.
2. Disconnect the two transmission hoses from oil cooler. Cover hose ends and fittings to prevent fluid contamination (fig.12).

**WARNING**

A significant amount of oil may drain from oil lines when they are disconnected.

3. Unfasten the constant-torque hose clamps and remove the two hoses.
4. Unscrew the four holding nuts and remove the U-bolts, remove the oil cooler from engine compartment.
5. Reinstall transmission oil cooler by using reverse procedure.

## 7.2 TRANSMISSION WITH RETARDER

## 7.2.1 Detroit diesel series 60 engine

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.

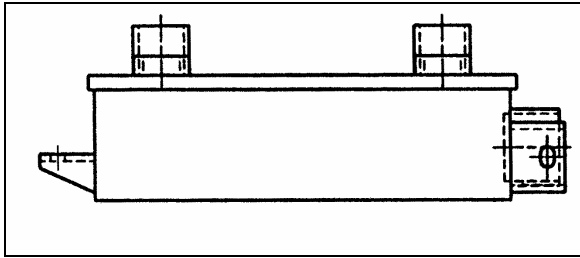



FIGURE 13: COOLER WITH RETARDER 07073

6. Reinstall transmission oil cooler by using reverse procedure.

### 7.2.2 Volvo D13 engine

Stop engine and allow engine to cool. Close both heater line shutoff valves (refer to Section 05 "Cooling").

1. To drain the cooling system, proceed as per Section 05 "Cooling", paragraph 5: Draining. If the cooling system is contaminated, flush system as per Section 05 "Cooling", paragraph 7: Flushing.
2. Remove the rear L.H. side tag axle wheel, then remove the rear L.H. side fender panel.
3. Disconnect the transmission hoses from oil cooler. Cover hose ends and fittings to prevent fluid contamination.

	<h2>WARNING</h2>
<p>A significant amount of oil may drain from oil lines when they are disconnected.</p>	


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.

## 8. CLEANING AND INSPECTION OF THE ALLISON 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.

	<h2>CAUTION</h2>
<p>DO NOT pressure wash the transmission electrical connectors. Water and detergent will cause the contacts to corrode or become faulty.</p>	

### 8.1 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.

## 9. ALLISON TRANSMISSION INSTALLATION

<h3>NOTE</h3>
<p><i>For more clearance between the tag axle and transmission, the tag axle may be unloaded and jacked up, or retracted (if applicable).</i></p>

### • Detroit Diesel Series 60 Engine Only

With the access plug removed, align one of the 12 attaching screw holes in the flexible plate with the access opening (starter side).

### • Volvo D13 Engine Only

With the starter motor removed, align one of the 12 attaching screw holes in the flexible plate with the access opening.

1. Place the transmission on a transmission jack.
2. Install a headless guide bolt into one of the 12 threaded holes for flexible plate attaching screws in the flywheel.

3. Lubricate the flywheel center pilot boss with molybdenum disulfide grease (Molycote G, or equivalent).
4. 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.

**WARNING**

Severe damages and/or personal injury can occur if transmission is not adequately supported.

5. Seat the transmission against the engine flywheel housing. **NO FORCE IS REQUIRED.** If interference is encountered, move the transmission away from engine, then investigate the cause.

**CAUTION**

The torque converter housing must be seated against the flywheel housing prior to tightening any screws. **DO NOT USE SCREWS TO SEAT THE HOUSING.**

6. Start all torque converter housing screws, and then tighten four of them gradually and in a criss-cross sequence around the housing. Tighten the 12 remaining screws. Recommended torque is between 42-50 Lbf-ft (57-68 Nm).
7. Remove the guide bolt through the access opening in the flywheel housing. Replace it with a self-locking screw, finger-tighten then start the remaining screws; tighten to 17-21 lbf-ft (23-28 Nm). Place a wrench on the crankshaft pulley attaching screw to turn the converter to gain access to the threaded holes.

- **Detroit Diesel Series 60 Engine Only**

*Place a wrench on the crankshaft pulley attaching screw to turn the converter to gain access to the threaded holes.*

*Reinstall the access plug.*

- **Volvo D13 Engine Only**

*Remove the plug located below starter motor and install cranking tool (88800014). Crank the engine to gain access to the threaded holes by turning the cranking tool using a suitable adapter (Refer to fig. 11).*

*Reinstall starter motor and connect cables.*

*Reinstall access plug below starter motor.*

8. Remove jack from under transmission.
9. Connect all sensors.
10. Connect the main wiring harness.
11. Connect the air supply line (steel-braided hose) to the retarder control valve (if applicable).
12. Connect the two transmission oil cooler hoses as they were previously.
13. Reinstall clamps and brackets, and replace locking ties previously removed during removal procedure.
14. Install propeller shaft and its safety guard. Refer to Section 09, "PROPELLER SHAFT".
15. Install transmission dipstick and filler tube.
16. Install cross member under transmission.
17. Install engine splash guards.
18. Adjust the retarder pressure to  $80 \pm 3$  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 at back of engine compartment, on R.H. side (Fig. 13) or in the R.H. side rear service compartment.
19. Make sure that the drain plug is in place, and then remove the transmission dipstick and pour approximately 24 US quarts (23 L) of automatic transmission fluid through the filler tube. Check and adjust oil level.

**CAUTION**

Do not overfill the transmission. Overfilling can cause oil aeration (milky appearance) and overheating. If overfilling occurs, drain oil as required to bring it to the proper level.

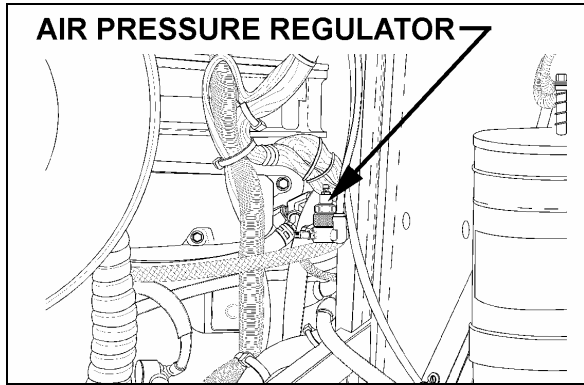


FIGURE 14: AIR PRESSURE REGULATOR (TYPICAL) 07037

## 10. ALLISON TRANSMISSION TROUBLESHOOTING

For complete information about Allison transmission troubleshooting, refer to "Allison 4<sup>th</sup> Generation Controls – Troubleshooting Manual: 3000 and 4000 Product families (TS3989)".

### 10.1 4<sup>TH</sup> GENERATION TRANSMISSION CONTROL MODULE

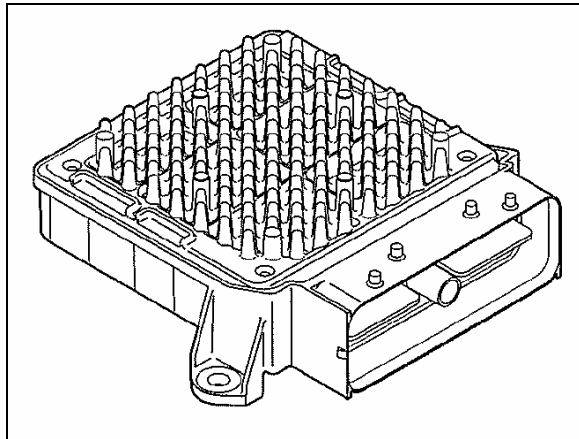


FIGURE 15: TRANSMISSION CONTROL MODULE 07140

The Allison transmission has a new Transmission Control Module (TCM) which involves specific diagnostic incident codes. The TCM unit is located in the coach main power compartment.

#### TCM Replacement

The TCM is a non-serviceable electronic device. When it fails, it must be replaced using the following procedure:

- Open the coach main power compartment in order to get access to the TCM;
- Remove the electrical cable connectors;
- Unscrew the TCM unit;

- Replace by reversing the procedure.



### CAUTION

Place the battery master switch to the "OFF" position.

### 10.2 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.

#### 10.2.1 Diagnostic Codes – Allison 4<sup>th</sup> 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.

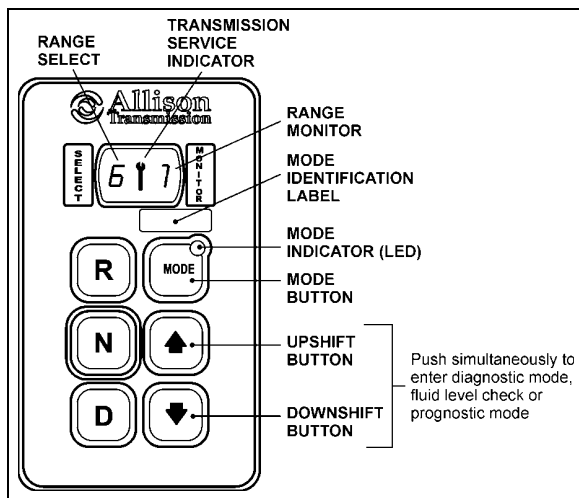


FIGURE 16: ALLISON PUSHBUTTON SHIFT SELECTOR

### 10.2.2 Diagnostic Code Display And Clearing Procedure – Allison 4<sup>th</sup> Generation Controls

Diagnostic codes can be read and cleared by two methods:

- Using an Allison DOC™ diagnostic tool. For specific instructions on how to use an Allison DOC™ diagnostic tool, refer to the User Guide.
- Using the pushbutton shift selector.

#### To begin the diagnostic process:

1. Bring the vehicle to a stop at a safe location.
2. Apply the parking brake.

#### To display stored codes:

1. Simultaneously press the ▲ (Up) and ▼ (Down) arrow buttons twice to access the Diagnostic Display Mode.

#### NOTE

To access the Oil Level Display Mode, simultaneously press the ▲ (Up) and ▼ (Down) arrow buttons once. Consult paragraph: « ALLISON TRANSMISSION OIL LEVEL CHECK USING THE PUSHBUTTON SHIFT SELECTOR » at the end of this section.

2. Observe the digital display for code (d1).
3. Press the MODE button to see the next code (d2) – repeat for subsequent codes (d3, d4 & d5).

#### NOTE

Be sure to record all codes displayed before they are cleared. This is essential for troubleshooting.

#### NOTE

The Diagnostic Display Mode can be entered for viewing codes at any speed. Codes can only be cleared when the output speed = 0 and no output speed sensor failure is active

Active indicators (MODE INDICATOR LED) and inactive codes can be cleared manually, while in the diagnostic display mode, after the condition causing the code is identified.

#### To clear active indicators and inactive codes:

1. While in Diagnostic Display Mode, press and hold the MODE button for 10 seconds to clear both active indicators and inactive codes.
2. Begin operating as normal. Have the transmission checked at the earliest opportunity by an Allison Transmission distributor or dealer.

#### NOTE

All active indicators are cleared at TCM power down.

Some codes will clear their active indicator when the condition causing the code is no longer detected by the TCM.

The Diagnostic Display Mode can be exited by any of the following methods:

- Press simultaneously the ▲ (Up) and ▼ (Down) arrow buttons at the same time on the pushbutton shift selector.
- Press any range button «D», «N» or «R» on the pushbutton shift selector (the shift will be commanded if it is not inhibited by an active code).
- Wait until the calibrated time (approximately 10 minutes) has passed. The system will automatically return to the normal operating mode.
- Turn off power to the TCM (shut off the engine using the ignition key).

**NOTE**

*If clearing a code while locked in a «D» (Drive) or «R» (Reverse) position (fail-to-range), the transmission will still be in «D» (Drive) or «R» (Reverse) when the clearing procedure is completed. «N» (Neutral) must be manually selected.*

### 10.2.3 Diagnostic Code Response

The following responses are used in the "Diagnostic Troubleshooting Code List and Inhibited Operation Description" table to command safe operation when diagnostic codes are sent.

#### **DNS - Do Not Shift Response**

- Release lock up clutch and inhibit lock up operation.
- Inhibit all shifts.
- Turn *ON* the CHECK TRANS light.
- Display the range attained.
- Ignore any range selection inputs from the shift selector.

#### **DNA - Do Not Adapt Response**

The TCM stops adaptive shift control while the code is active.

#### **SOL OFF - SOLenoid OFF Response**

All solenoids are commanded *OFF* (turning solenoids "A" and "B" off electrically cause them to be on hydraulically).

#### **RPR - Return to Previous Range Response**

When the speed sensor ratio or C3 pressure switch test associated with a shift not successful, the TCM commands the same range as commanded before the shift.

#### **NNC - Neutral No Clutches Response**

When certain speed sensor ratio or C3 pressure switch tests are not successful, the TCM commands a neutral condition with no clutches applied.

10.2.4 Diagnostic Troubleshooting Codes (DTC) List - Allison 4<sup>th</sup> Generation Controls

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
C1312	Retarder Request Sensor Failed Low	No	May inhibit retarder operation if not using J1939 datalink
C1313	Retarder Request Sensor Failed High	No	May inhibit retarder operation if not using J1939 datalink
P0122	Pedal Position Sensor Low Voltage	No	Use default throttle values. Freezes shift adapts.
P0123	Pedal Position Sensor High Voltage	No	Use default throttle values. Freezes shift adapts.
P0218	Transmission Fluid Over Temperature	No	Use hot mode shift schedule. Holds fourth range. TCC is inhibited. Freezes shift adapts.
P0561	System Voltage Performance		
P0562	System Voltage Low		
P0563	System Voltage High		
P0602	TCM Not Programmed	Yes	Lock in Neutral
P0610	TCM Vehicle Options (Trans ID) Error	Yes	Use TID A calibration
P0613	TCM Processor	No	All solenoids off
P0614	Torque Control Data Mismatch - ECM/TCM	Yes	Allows operation only in reverse and second range.
P0634	TCM Internal Temperature Too High	Yes	SOL OFF (hydraulic default)
P063E	Auto Configuration Throttle Input Not Present	Yes	Use default throttle values
P063F	Auto Configuration Engine Coolant Temp Input Not Present	No	None
P0658	Actuator Supply Voltage 1 (HSD1) Low	Yes	DNS, SOL OFF (hydraulic default)
P0659	Actuator Supply Voltage 1 (HSD1) High	Yes	DNS, SOL OFF (hydraulic default)
P0667	TCM Internal Temperature Sensor Circuit Range / Perform		
P0668	TCM Internal Temperature Sensor Circuit Low		
P0669	TCM Internal Temperature Sensor Circuit High		
P0701	Transmission Control System Performance		
P0702	Transmission Control System Electrical (TransID)	Yes	Use TID A calibration
P0703	Brake Switch Circuit Malfunction	No	No Neutral to Drive shifts for refuse packer. TCM inhibits retarder operation if a TPS code is also active.
P0708	Transmission Range Sensor Circuit High Input	Yes	Ignore defective strip selector inputs
P070C	Transmission Fluid Level Sensor Circuit – Low Input	No	None
P070D	Transmission Fluid Level Sensor Circuit – High Input	No	None
P0711	Transmission Fluid Temperature Sensor Circuit Performance	Yes	Use default sump temp
P0712	Transmission Fluid Temperature Sensor Circuit Low Input	Yes	Use default sump temp
P0713	Transmission Fluid Temperature Sensor Circuit High Input	Yes	Use default sump temp
P0716	Turbine Speed Sensor Circuit Performance	Yes	DNS, Lock in current range
P0717	Turbine Speed Sensor Circuit No Signal	Yes	DNS, Lock in current range
P0719	Brake Switch ABS Input Low	No	TCM assumes ABS is OFF
P071A	RELS Input Failed On	Yes	Inhibit RELS operation

**Section 07: TRANSMISSION**

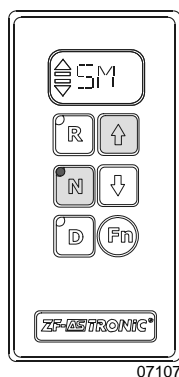
<b>DTC</b>	<b>Description</b>	<b>CHECK TRANS Light</b>	<b>Inhibited Operation Description</b>
P071D	General Purpose Input Fault	Yes	None
P0720	Output Speed Sensor Circuit		
P0721	Output Speed Sensor Circuit Performance	Yes	DNS, Lock in current range
P0722	Output Speed Sensor Circuit No Signal	Yes	DNS, Lock in current range
P0726	Engine Speed Sensor Circuit Performance	No	Default to turbine speed
P0727	Engine Speed Sensor Circuit No Signal	No	Default to turbine speed
P0729	Incorrect 6 <sup>th</sup> Gear Ratio	Yes	DNS, Attempt 5 <sup>th</sup> , then 3 <sup>rd</sup>
P0730	Incorrect Neutral Gear ratio		
P0731	Incorrect 1 <sup>st</sup> Gear ratio	Yes	DNS, Attempt 2 <sup>nd</sup> , then 5 <sup>th</sup>
P0732	Incorrect 2 <sup>nd</sup> Gear ratio	Yes	DNS, Attempt 3 <sup>rd</sup> , then 5 <sup>th</sup>
P0733	Incorrect 3 <sup>rd</sup> Gear ratio	Yes	DNS, Attempt 4 <sup>th</sup> , then 6 <sup>th</sup>
P0734	Incorrect 4 <sup>th</sup> Gear ratio	Yes	DNS, Attempt 5 <sup>th</sup> , then 3 <sup>rd</sup>
P0735	Incorrect 5 <sup>th</sup> Gear ratio	Yes	DNS, Attempt 6 <sup>th</sup> , then 3 <sup>rd</sup> , then 2 <sup>nd</sup>
P0736	Incorrect Reverse Gear ratio	Yes	DNS, Lock in Neutral
P0741	Torque Converter Clutch System Stuck Off	Yes	None
P0776	Pressure Control Solenoid 2 Stuck Off	Yes	DNS, RPR
P0777	Pressure Control Solenoid 2 Stuck On	Yes	DNS, RPR
P0796	Pressure Control Solenoid 3 Stuck Off	Yes	DNS, RPR
P0797	Pressure Control Solenoid 3 Stuck On	Yes	DNS, RPR
P0842	Transmission Pressure Switch 1 Circuit Low	Yes	DNS, Lock in current range
P0843	Transmission Pressure Switch 1 Circuit High	Yes	DNS, Lock in current range
P0847	Transmission Pressure Switch 2 Circuit Low		
P0848	Transmission Pressure Switch 2 Circuit High		
P088A	Transmission Fluid Filter Deteriorated		
P088B	Transmission Fluid Filter Very Deteriorated		
P0880	TCM Power Input Signal	No	None
P0881	TCM Power Input Signal Performance	No	None
P0882	TCM Power Input Signal Low	Yes	DNS, SOL OFF (hydraulic default)
P0883	TCM Power Input Signal High	No	None
P0894	Transmission Component Slipping	Yes	DNS, Lock in first
P0960	Pressure Control Solenoid Main Mod Control Circuit Open	Yes	None
P0961	Pressure Control Solenoid (PCS) MM System Performance		
P0962	Pressure Control Solenoid Main Mod Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P0963	Pressure Control Solenoid Main Mod Control Circuit High	Yes	None
P0964	Pressure Control Solenoid 2 (PCS2) Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P0965	Pressure Control Solenoid (PCS) 2 System Performance		
P0966	Pressure Control Solenoid 2 (PCS2) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P0967	Pressure Control Solenoid 2 (PCS2) Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P0968	Pressure Control Solenoid 3 (PCS3) Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P0969	Pressure Control Solenoid (PCS) 3 System Performance		
P0970	Pressure Control Solenoid 3 (PCS3) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
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)

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
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 2 <sup>nd</sup> and allow shifts 2 through 6, N, R
P1891	Throttle Position Sensor PWM Signal Low Input	No	Use default throttle values
P1892	Throttle Position Sensor PWM Signal High Input	No	Use default throttle values
P2184	Engine Coolant Temperature Sensor Circuit Low Input	No	Use default engine coolant values
P2185	Engine Coolant Temperature Sensor Circuit High Input	No	Use default engine coolant values
P2637	Torque Management Feedback Signal (SEM)	Yes	Inhibit SEM
P2641	Torque Management Feedback Signal (LRTP)	Yes	Inhibit LRTP
P2670	Actuator Supply Voltage 2 (HSD2) Low	Yes	DNS, SOL OFF (hydraulic default)
P2671	Actuator Supply Voltage 2 (HSD2) High	Yes	DNS, SOL OFF (hydraulic default)
P2685	Actuator Supply Voltage 3 (HSD3) Low	Yes	DNS, SOL OFF (hydraulic default)
P2686	Actuator Supply Voltage 3 (HSD3) High	Yes	DNS, SOL OFF (hydraulic default)
P2714	Pressure Control Solenoid 4 (PCS4) Stuck Off	Yes	DNS, RPR
P2715	Pressure Control Solenoid 4 (PCS4) Stuck On	Yes	DNS, SOL OFF (hydraulic default)
P2718	Pressure Control Solenoid 4 (PCS4) Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P2719	Pressure Control Solenoid (PCS) 4 System Performance		
P2720	Pressure Control Solenoid 4 (PCS4) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P2721	Pressure Control Solenoid 4 (PCS4) Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P2723	Pressure Control Solenoid 1 (PCS1) Stuck Off	Yes	DNS, RPR
P2724	Pressure Control Solenoid 1 (PCS1) Stuck On	Yes	DNS, RPR
P2727	Pressure Control Solenoid 1 (PCS1) Control Circuit Open	Yes	DNS, SOL OFF (hydraulic default)
P2728	Pressure Control Solenoid (PCS) 1 System Performance		
P2729	Pressure Control Solenoid 1 (PCS1) Control Circuit Low	Yes	DNS, SOL OFF (hydraulic default)
P2730	Pressure Control Solenoid 1 (PCS1) Control Circuit High	Yes	DNS, SOL OFF (hydraulic default)
P2736	Pressure Control Solenoid 5 (PCS5) Control Circuit Open	Yes	Inhibit retarder operation
P2737	Pressure Control Solenoid (PCS) 5 System Performance		
P2738	Pressure Control Solenoid 5 (PCS5) Control Circuit Low	Yes	Allow 2 through 6, N, R. Inhibit retarder and TCC operation
P2739	Pressure Control Solenoid 5 (PCS5) Control Circuit High	Yes	Inhibit retarder operation
P2740	Retarder Oil Temperature Hot	No	None
P2742	Retarder Oil Temperature Sensor Circuit – Low Input	No	Use default retarder temp values
P2743	Retarder Oil Temperature Sensor Circuit – High Input	No	Use default retarder temp values
P2761	TCC PCS Control Circuit Open	Yes	Inhibit TCC operation
P2762	TCC PCS Control Circuit Range / Performance		
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
P2772	Four Wheel Drive Low Switch Circuit Performance		

DTC	Description	CHECK TRANS Light	Inhibited Operation Description
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)
P2813	Pressure Control Solenoid (PCS) 6 System Performance		
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

## 11. ZF-ASTRONIC TRANSMISSION SYSTEM FAULTS AND ERROR MESSAGES

### 11.1 SYSTEM FAULTS (ERROR MESSAGES)



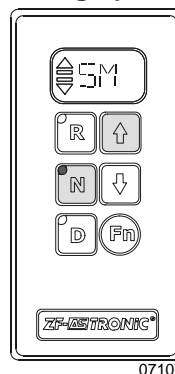
If the “SM” symbol appears in the display, a system error has occurred.

- Stop the vehicle
- Vehicle may no longer be driven

Error messages and the reactions resulting from these errors can be deleted with the vehicle at a standstill and the “Ignition OFF”. (Wait until the display goes out). If the display does not go out once the ignition has been turned “OFF”, set the battery master switch to the **OFF** position.

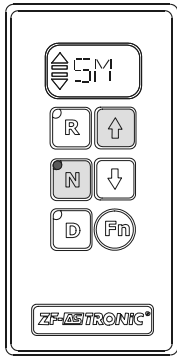
Switch the ignition back on. If the error message is still in place, the transmission has to be repaired. The transmission is inoperative. The vehicle will have to be taken to a service point. The error number(s) must be specified when the service point is contacted.

#### Calling up error numbers



- ☞ Switch on ignition
- ☞ Depress “N” key
- ☞ Hold down “↑” key
- ☞ One or more error numbers appear on the display. These correspond to the errors presently active in the system.

#### Calling up error numbers from the error memory:



- ☞ Switch on ignition
- ☞ Press “N” key and at the same time depress the foot-operated brake
- ☞ Hold down the foot-operated brake and depress and hold down “↑” key
- ☞ The errors stored in the transmission ECU are shown on the display one after another.

**ERROR CODES**

Remark to titles in table:

ZF fault number: defined by ZF.

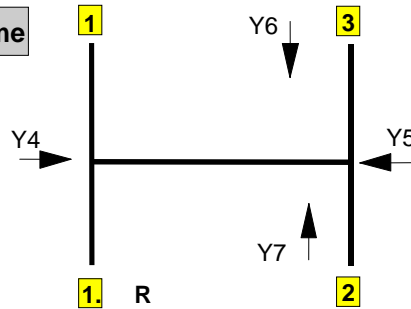
Display SM-Symbol : (0=NO, 1=YES) Display shows “SM”(severe failure)

Warning lamp : (0=NO, 1=YES) Telltale panel warning lamp “check trans”(less severe failure)

Shift schemes of transmissions:

**10/12-Gear Scheme**

- Y2 Splitter K2
- Y3 Splitter K1
- Y8 Range (GP) low
- Y9 Range (GP)



ON MESSAGES CENTER DISPLAY (MCD) SAE-J1587 Codes	ON SHIFT SELECTOR DISPLAY	ISO CODES WITH TESTMAN TOOL	DESCRIPTION
8, 7	8	161	Easy Start, Brake doesn't open completely
8, 14	8	162	Easy Start, Not Available
20,6	14	22	Short circuit to ground at output ACC (wakeup control signal for ZMTEC, keep alive signal for voltage doubler, and power signal for speed sensor #2)
20,5	14	54	Interruption at output ACC (wakeup control signal for ZMTEC, keep alive signal for voltage doubler, and power signal for speed sensor #2)
20,3	14	86	Short circuit to positive at output ACC (wakeup control signal for ZMTEC, keep alive signal for voltage doubler, and power signal for speed sensor #2)
21,2	15	127	Error on ECU temperature sensor signal
21,0	15	193	ECU temperature too high
31,3	1F	137	No range change group (GP) sensor signal (Short circuit to positive)
31,6	1F	138	No range change group (GP) sensor signal (Short circuit to ground)
31,5	1F	139	No range change group (GP) sensor signal (Interruption)
31,13	1F	140	Self adjustment error of range change group sensor in position fast
31,7	1F	159	Range-change group sensor signal leaves engaged position during driving
32,3	20	141	No splitter group (GV) sensor signal (Short circuit to positive)
32,6	20	142	No splitter group (GV) sensor signal (Short circuit to ground)
32,5	20	143	No splitter group (GV) sensor signal (Interruption)
32,13	20	144	Splitter group (GV) sensor self adjustment error
32,7	20	160	Splitter sensor signal leaves engaged position during driving



ON MESSAGES CENTER DISPLAY (MCD) SAE-J1587 Codes	ON SHIFT SELECTOR DISPLAY	ISO CODES WITH TESTMAN TOOL	DESCRIPTION
33,14	21	107	Stabilised voltage supply at output AU (clutch sensor supply) too high or too low
33,13	21	117	Error in clutch self-adjustment process
33,2	21	124	Error on clutch travel signal
34,7	22	120	Mechanical failure of small clutch disengagement valve
34,7	22	121	Mechanical failure of large clutch disengagement valve
34,7	22	122	Mechanical failure of small clutch engagement valve
34,7	22	123	Mechanical failure of large clutch engagement valve
34,6	22	18	Short circuit to ground at output stage to small disengagement clutch valve
34,6	22	19	Short circuit to ground at output stage to small engagement clutch valve
34,6	22	20	Short circuit to ground at output stage to large disengagement clutch valve
34,6	22	21	Short circuit to ground at output stage to large engagement clutch valve
34,5	22	50	Interruption at output stage to small disengagement clutch valve
34,5	22	51	Interruption at output stage to small engagement clutch valve
34,5	22	52	Interruption at output stage to large disengagement clutch valve
34,5	22	53	Interruption at output stage to large engagement clutch valve
34,3	22	82	Short circuit to positive at output stage to small disengagement clutch valve
34,3	22	83	Short circuit to positive at output stage to small engagement clutch valve
34,3	22	84	Short circuit to positive at output stage to large disengagement clutch valve
34,3	22	85	Short circuit to positive at output stage to large engagement clutch valve
35,5	23	41	Interruption at output stage to Y9 (Valve Range)
35,3	23	73	Short circuit to positive at output stage to Y9 (Valve range)
35,6	23	9	Short circuit to ground at output stage to Y9 (Valve Range)
36,5	24	40	Interruption at output stage to Y8 (Valve Range)
36,3	24	72	Short circuit to positive at output stage to Y8 (Valve range)
36,6	24	8	Short circuit to ground at output stage to Y8 (Valve Range)
37,6	25	2	Short circuit to ground at output stage to Y2 (Valve Splitter)
37,5	25	34	Interruption at output stage to Y2 (Valve Splitter)
37,3	25	66	Short circuit to positive at output stage to Y2 (Valve Splitter)
38,6	26	3	Short circuit to ground at output stage to Y3 (Valve Splitter)
38,5	26	35	Interruption at output stage to Y3 (Valve Splitter)
38,3	26	67	Short circuit to positive at output stage to Y3 (Valve Splitter)
39,5	27	36	Interruption at output stage to Y4 (Valve Select)
39,6	27	4	Short circuit to ground at output stage to Y4 (Valve Select)
39,3	27	68	Short circuit to positive at output stage to Y4 (Valve Select)

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ON MESSAGES CENTER DISPLAY (MCD) SAE-J1587 Codes	ON SHIFT SELECTOR DISPLAY	ISO CODES WITH TESTMAN TOOL	DESCRIPTION
40,5	28	38	Interruption at output stage to Y6 (Valve Shift)
40,6	28	6	Short circuit to ground at output stage to Y6 (Valve Shift)
40,3	28	70	Short circuit to positive at output stage to Y6 (Valve Shift)
43,2	2B	175	Error on "Ignition lock" signal (terminal 15)
48,3	30	129	No shift sensor signal (Short circuit to positive)
48,6	30	130	No shift sensor signal (Short circuit to ground)
48,5	30	131	No shift sensor signal (Interruption)
48,13	30	132	Self adjustment error of shift sensor
48,7	30	157	Selector sensor signal leaves position during driving
48,7	30	158	Engage sensor signal leaves engaged position during driving
50,5	32	37	Interruption at output stage to Y5 (Valve Select)
50,6	32	5	Short circuit to ground at output stage to Y5 (Valve Select)
50,3	32	69	Short circuit to positive at output stage to Y5 (Valve Select)
51,5	33	39	Interruption at output stage to Y7 (Valve Shift)
51,6	33	7	Short circuit to ground at output stage to Y7 (Valve Shift)
51,3	33	71	Short circuit to positive at output stage to Y7 (Valve Shift)
54,6	36	17	Short circuit to ground at output stage to Y1 (inertia brake valve)
54,5	36	49	Interruption at output stage to Y1 (inertia brake valve)
54,3	36	81	Short circuit to positive at output stage to Y1 (inertia brake valve)
55,7	37	114	Clutch engaged unintentionally at standstill, gear engaged
55,7	37	118	Clutch does not disengage
55,7	37	119	Clutch does not engage / does not transmit engine torque
56,7	38	145	Range change group (GP) disengagement error
56,7	38	146	Changeover error during range change group (GP) shifting
56,7	38	147	Range change group (GP) does not engage
57,2	39	108	Error in shift lever
57,14	39	110	ZF CAN timeout (can also means shift lever error through ZMP06400.hex)
58,7	3A	154	Main transmission gear does not disengage
58,7	3A	155	Main transmission gear does not engage
58,7	3A	156	Wrong gear shifting
59,7	3B	151	Selector cylinder does not disengage
59,7	3B	152	Change over error during gate selection procedure
59,7	3B	153	Selector cylinder does not engage
60,3	3C	133	No gate select sensor signal (Short circuit to positive)

ON MESSAGES CENTER DISPLAY (MCD) SAE-J1587 Codes	ON SHIFT SELECTOR DISPLAY	ISO CODES WITH TESTMAN TOOL	DESCRIPTION
60,6	3C	134	No gate select sensor signal (Short circuit to ground)
60,5	3C	135	No gate select sensor signal (Interruption)
60,13	3C	136	Gate select sensor self adjustment error
61,7	3D	148	Splitter (GV) does not disengage
61,7	3D	149	Change over error during splitter shifting
61,7	3D	150	Splitter (GV) does not engage
63,14	3F	100	Error on output speed signal 2
106,0	6A	125	Error on pressure reduction valve
106,1 4	6A	126	Error on pressure sensor signal
150,1 4	96	59	Acknowledge fault of PTO 1
150,1 4	96	60	Acknowledge fault of PTO 2
150,7	96	61	Disengagement fault of PTO 1
150,7	96	62	Disengagement fault of PTO 2
150,7	96	63	Engagement fault of PTO1
150,7	96	64	Engagement fault of PTO2
151,1 4	97	102	Plausibility error between transmission input speed and output speed
152,6	98	10	Short circuit to ground at output stage to Y10 (Main valve)
152,5	98	42	Interruption at output stage to Y10 (Main valve)
152,3	98	74	Short circuit to positive at output stage to Y10 (Main valve)
153,1 4	99	-	Error on ISO 14320 communications line
154,1 4	9A	101	Error on both output speed signals
161,1 4	A1	98	Error on transmission input speed signal
177,2	B1	128	Error on oil temperature sensor signal
191,1 4	BF	194	Both sources of vehicle speed are faulty
191,1 4	BF	99	Error on output speed signal 1
230,1 4	E6	166	Permanent idle signal
230,1	E6	168	No idle signal or error on "idle signal switch" signal (EEC2)

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ON MESSAGES CENTER DISPLAY (MCD) SAE-J1587 Codes	ON SHIFT SELECTOR DISPLAY	ISO CODES WITH TESTMAN TOOL	DESCRIPTION
4			
230,1 4	E7	103	Error on "Wheel-based vehicle speed" signal (CCV)
231,7	E7	163	Engine does not react on torque intervention
231,1 4	E7	164	Error on "Drivers demand engine percent torque" (EEC1)
231,1 4	E7	165	Error on "Accelerator pedal position" (EEC2)
231,1 4	E7	167	Error on "Percent load at current speed" signal (EEC2)
231,1 4	E7	171	Error on "Actual engine percent torque" signal (EEC1)
231,1 4	E7	172	Permanent engine brake request signal
231,1 4	E7	173	Error on "Brake switch" signal (CCVS)
231,1 4	E7	177	System-CAN Busoff error
231,1 1	E7	178	CAN error frames
231,1 1	E7	179	CAN queue overrun
231,1 4	E7	180	CAN EEC1 timeout
231,1 4	E7	181	CAN EEC2 timeout
231,1 4	E7	182	CAN CCVS timeout
231,1 4	E7	183	CAN ERC1_ER timeout
231,1 4	E7	197	Error on "Front axle speed" (WSI)
231,1 4	E7	198	Error on "Relative wheel speeds" (WSI)
231,1 4	E7	199	CAN WSI timeout
231,1 4	E7	26	CAN engine configuration timeout
231,1 4	E7	27	Error on "engine configuration message" (engine configuration)

ON MESSAGES CENTER DISPLAY (MCD) SAE-J1587 Codes	ON SHIFT SELECTOR DISPLAY	ISO CODES WITH TESTMAN TOOL	DESCRIPTION
231,1 4	E7	31	Error on "Actual engine retarder - percent torque" signal (ERC1_ER)
231,1 4	E7	32	Error on "Engine retarder configuration message" (Engine retarder configuration)
231,1 4	E7	33	CAN "Engine retarder configuration" timeout
231,1 4	E7	91	CAN EBC1 timeout
231,1 4	E7	92	Error on "ABS active" signal (EBC1)
231,1 4	E7	93	Error on "ASR engine control active" signal (EBC1)
231,1 4	E7	94	Error on "ASR brake control active" signal (EBC1)
231,1 4	E7	95	Error on "Cruise control active" signal (CCVS)
231,1 4	E7	96	Error on "Cruise control set speed" (CCVS)
231,1 4	E7	97	Error on "Engine speed" signal (EEC1)
-	EE	-	Communication error between GS3 and ZMTEC on display line
248,6	F8	25	Short circuit to ground at output SD to display
248,3	F8	89	Short circuit to positive at output SD to display

## 12. SPECIFICATIONS

### ALLISON AUTOMATIC TRANSMISSION WITH OR WITHOUT RETARDER

#### H3 Buses

Gross input power (maximum).....500 HP (335 kW)  
 Gross input torque (maximum) ..... 1525 Lbf-ft (2068 Nm)  
 Rated input speed (minimum-maximum) ..... 1600-2300 rpm

#### H3-45 VIP

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, DEXRON-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 (26.5 liters)

#### **Oil Filters:**

Make ..... Allison Transmission  
 Type ..... Disposable cartridge  
 Prevost part number (2-filters replacement kit) .....571709

# SECTION 09: PROPELLER SHAFT

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## 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 the full round end yoke with four needle bearings.

The other extremity (slip yoke assembly) is connected to the transmission by the 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".

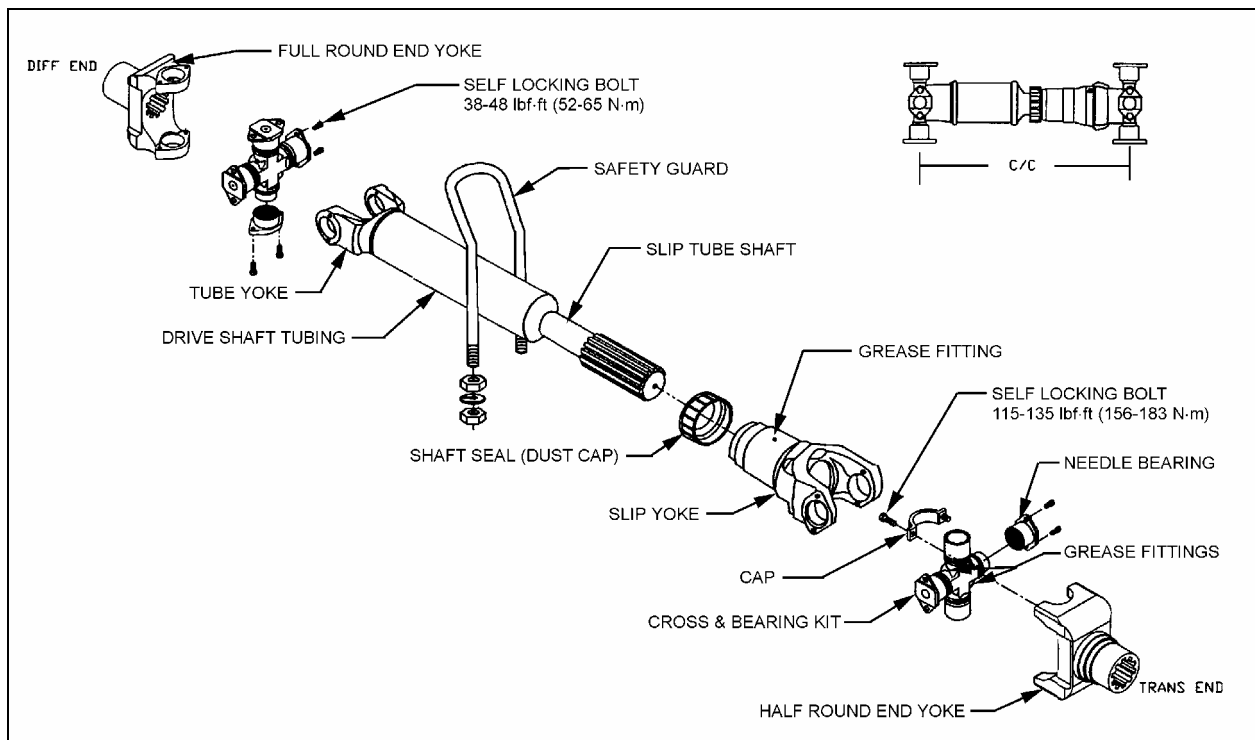


FIGURE 1: PROPELLER SHAFT ASSEMBLY

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### 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. Scoring:** 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 scoring), where no structural damage occurs, with actual scoring.

**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

#### H3 VEHICLES EQUIPPED WITH AN AUTOMATIC WORLD TRANSMISSION

Make ..... Hayes-Dana Inc.  
Series..... 1810  
Supplier number ..... 819325-1900  
Prevost number .....580069

#### H3 COACHES EQUIPPED WITH ZF TRANSMISSION

Make ..... Hayes-Dana Inc.  
Series..... 1810  
Supplier number ..... 816688-1400  
Prevost number .....580081

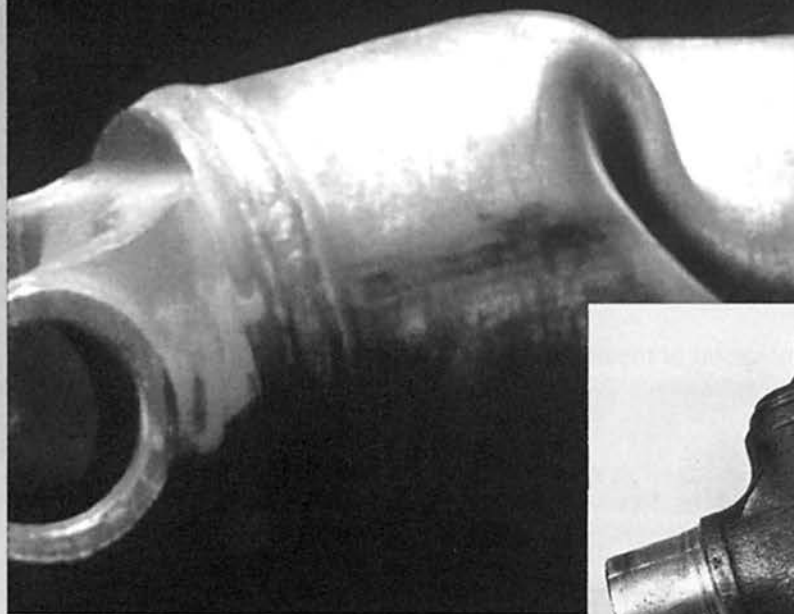
#### Repair kits

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

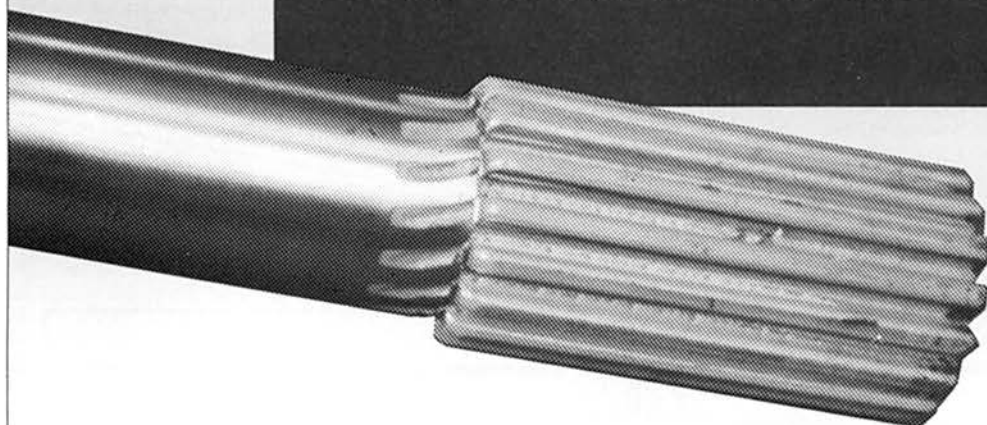
**Note:** *U-joint kits will come equipped with the serrated bolt and lock patch and will no longer contain a lock strap.*

# 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

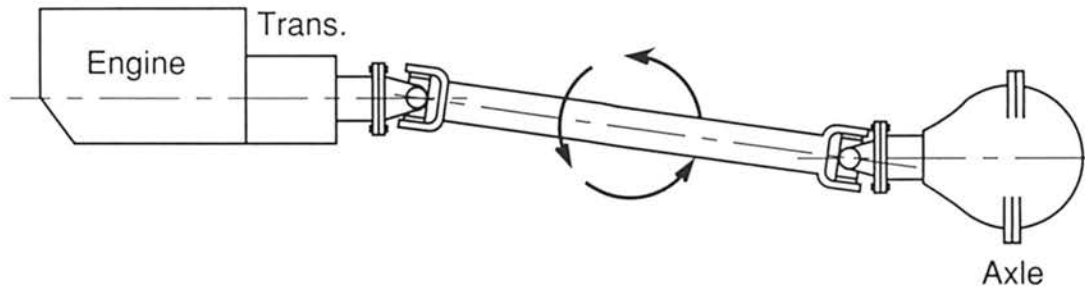
caused by a lack of lubricant, inadequate lube quality for the application, inadequate initial lubrication or failure to lubricate properly and often enough.

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:

$$\text{L.G.T.} = \text{N.E.T.} \times \text{Trans L.G.R.} \times .85 \text{ (efficiency factor)}$$

$$\text{D.L.T. (to Slip Wheels)} = \frac{W_R \times \text{C.O.F.} \times \text{R.R.}}{12 \times \text{A.R.}}$$

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.

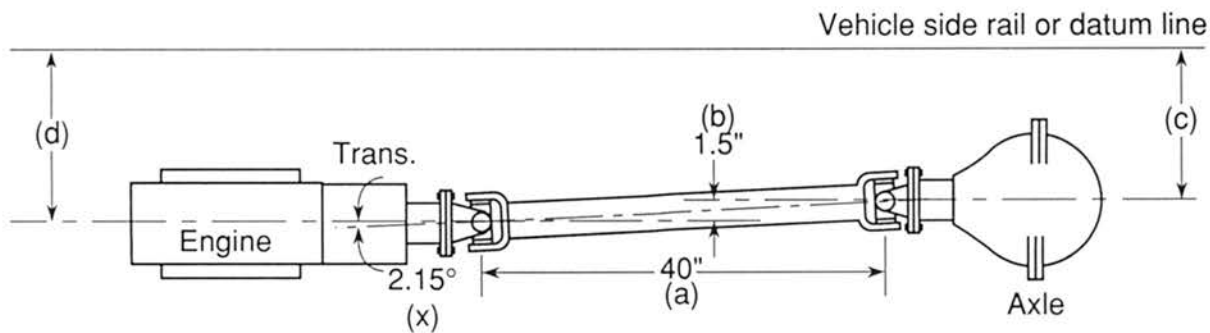
U-joint operating angles are probably the most common causes of driveline vibrations in vehicles that have been re-worked or in vehicles that have had auxiliary equipment installed.

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.

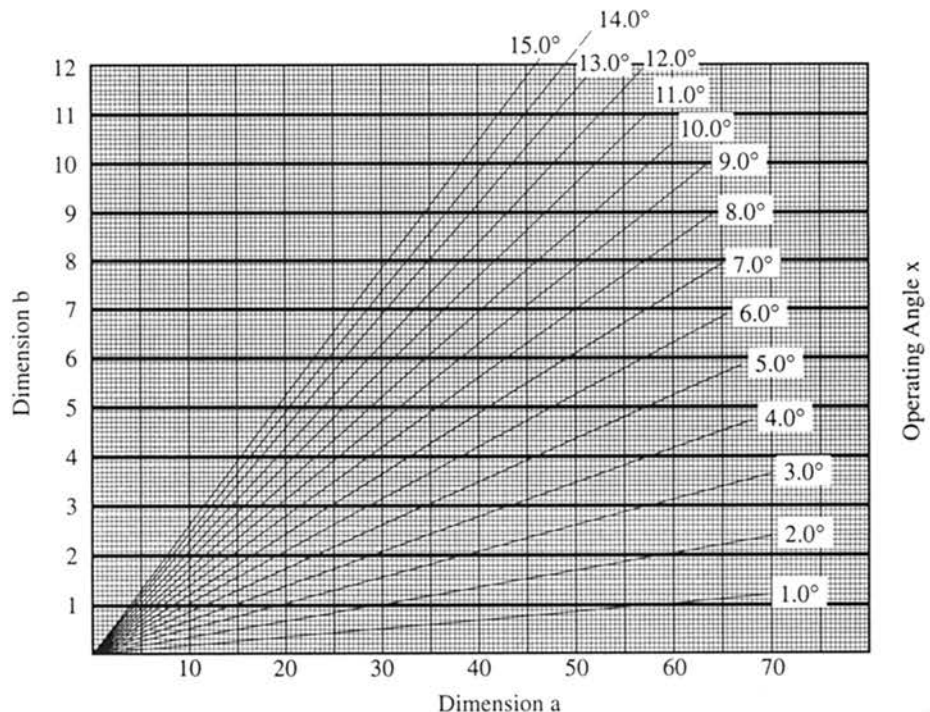
## I. TO DETERMINE OPERATING ANGLES IN TOP VIEW



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:

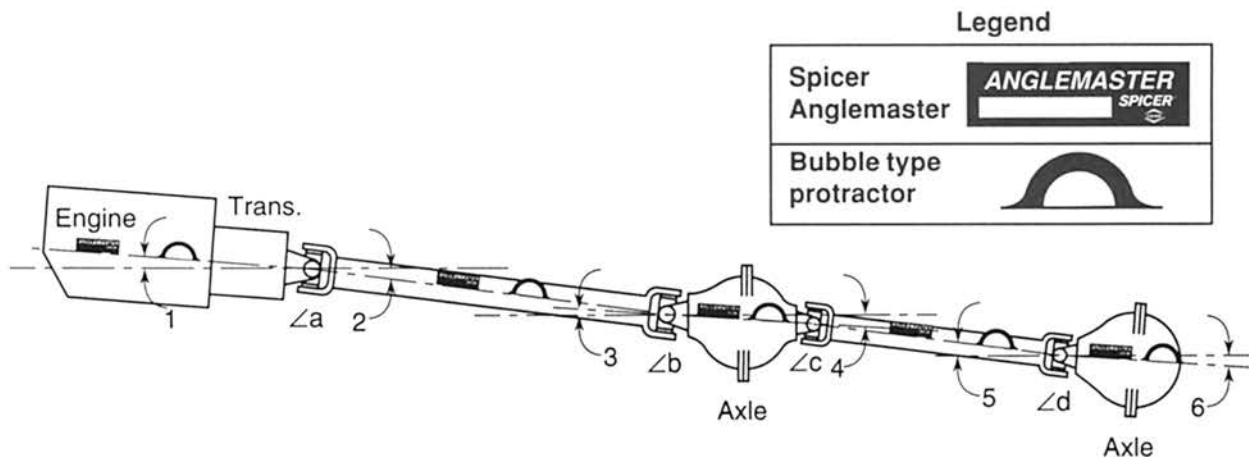
Where  $a = 40.0''$   
 $b = 1.5''$   
 $X = 2.15^\circ$  operating angle



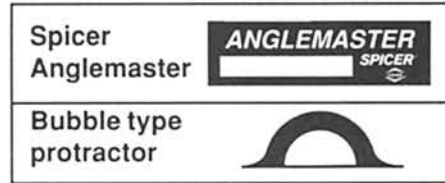


# U-JOINT OPERATING ANGLES

## II. TO DETERMINE OPERATING ANGLES IN SIDE VIEW



### Legend



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.

$$\angle a = (2) - (1) = 7^{\circ}00' - 4^{\circ}30' = 2^{\circ}30' (2.50^{\circ})$$

$$\angle b = (2) - (3) = 7^{\circ}00' - 4^{\circ}00' = 3^{\circ}00' (3.00^{\circ})$$

$$\angle c = (5) - (4) = 7^{\circ}00' - 4^{\circ}00' = 3^{\circ}00' (3.00^{\circ})$$

$$\angle d = (5) - (6) = 7^{\circ}00' - 4^{\circ}15' = 2^{\circ}45' (2.75^{\circ})$$

## III. CALCULATING THE TRUE U-JOINT OPERATING ANGLE

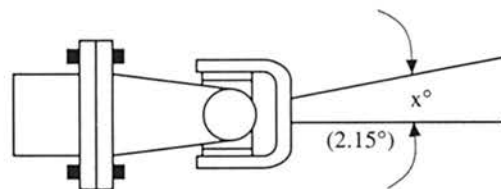
The true U-joint operating angle is the sum of the U-joint angles in both the top view and the side view. The true U-joint operating angle is calculated in the following manner:

$$\text{True operating angle} = \sqrt{x^{o2} + a^{o2}}$$

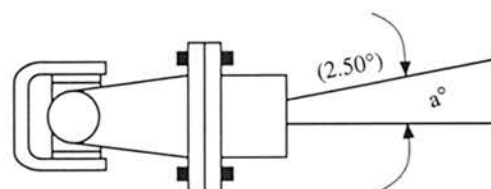
Where  $x = 2.15^{\circ}$  as determined by use of chart in Section I.

$a = 2.5^{\circ}$  as determined in Section II.

$$\begin{aligned} \text{True operating angle} &= \sqrt{2.15^2 + 2.5^2} \\ &= 3.297^{\circ} \text{ or } 3^{\circ}18' \end{aligned}$$



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

Complaint	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	Excessive Continuous Running Load	End Galling of Cross Trunnion and Bearing Cup	Contamination (Abrasion)	Lubricating Film Breakdown	Excessive Thrust Fit	Yoke Cross Hole Alignment	No U-Joint Operating Angle	Long Shaft with Loose U-Joint Thrust Fit and Unbalance	Roller Lock	Roller Skewing	Fretting Corrosion Due to Yoke Working Under Load	Galling (Adhesive Wear)	Slip Member Working In Extreme Extended	Excessive Loose O.D. Fit	Male Spline Head	Excessive
Low Mileage U-Joint Failure	1	1	1	1	2	4	5	14																
Repeat U-Joint Failure	1	1	1	1	2	4	5	14																
End Galling of Cross Trunnion and Bearing Cup										1	1	7	7	7										
Fretting (Also: False Brinelling, Wear Oxidation, Friction Oxidation, and Chaffing Fatigue)										1	1													
Bearing Race O.D. Seizure in Yoke Cross Holes																								
Slip Spline Seizures	1	1	1	1	1					8	1													
Slip Spline Galling										8	1													
Slip Spline O.D. Wear at Extremities and at 180°																								
Slip Spline Shaft or Tube Broken in Torsion																								
Shaft Broken in Bending																								
Tube Split in Longitudinal Seam Weld																								
Tube Circle Weld Failure																								
Yoke Broken in Hub																								
Yoke Broke at Ear Tip																								
Broken Cross or Cups																								
Needle Rollers Brinelled into Cups and Cross Trunnion																								
Shaft Support Brg. Failure	11	11																						
Shaft Support Rubber Insulator Failure	32																							
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.


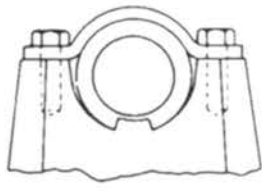

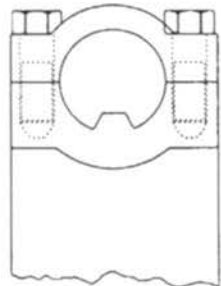


8. Check components. If serviceable...Clean and relubricate per lube specs. If not serviceable...Replace.
9. No immediate fix. Anti-seize lubricant on bearing O.D. will initially help.
10. Re-align for a minimum 1° running angle.
11. Replace.
12. Replace roller lock assembly.
13. Yoke deflections under 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.

Excessive Torque Load for U-Joints and Driveshaft Application  
 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  
 Excessive U-Bolt Torque on Retaining Nuts — Pinching Rollers  
 Inadequate Torque on Cap Screws Retaining Big 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  
 Secondary Couple Load Reaction at Shaft Support Brg.  
 Torsional Excitation  
 Inertial Excitation  
 Shaft Support Brg. Misaligned — Interference with Slinger  
 Improper Shaft Length and Slip

26																							
26																							
11	5	5	11																				
	17	19		18	4																		
			11																				
				11	11	11																	
				4		20																	
							11	4	27											28			
				11																29			
				32																			

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

<b>U-BOLT</b>				
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.	
<b>BEARING STRAP</b>				
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.	
	<b>WARNING:</b> Bearing Strap Retaining Bolts Should <b>NOT</b> Be Reused.			
<b>CAP &amp; BOLT</b>				
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.	
<b>BEARING PLATE</b>				
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.
<b>New part nos. for kits with lockstraps available after Spring, 1994</b>				
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.
	<b>WARNING:</b> Self Locking Bolts Should <b>NOT</b> Be Reused			

\* 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			Diameter, Thread, & Length Under Head	Recommended Torque
	Bolt	Washer	Nut		
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

3119-5 DSD 4/94

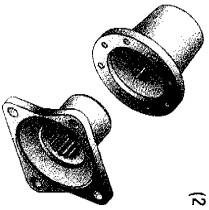
**SPICER®**



# SPICER LIFE™ DRIVELINE COMPONENTS

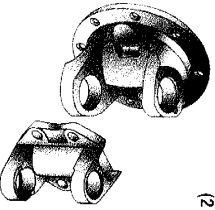
**COMPANION FLANGE (1)**

(2 STYLES)

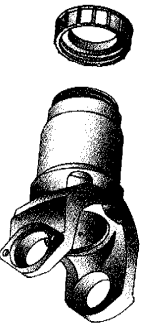


**FLANGE YOKE (2)**

(2 STYLES)



**SLIP YOKE ASSEMBLY (3)**

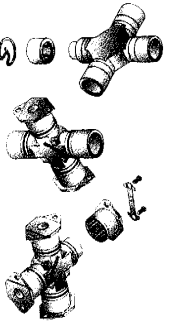


**END YOKE (4)**

(3 STYLES)

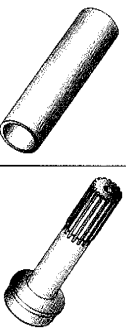


**JOURNAL & BEARING KIT**



**TUBING (30 or 32)**

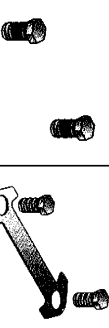
**TUBE SHAFT (40-42)**



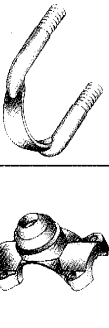
**MIDSHIP TUBE SHAFT (53-57)**



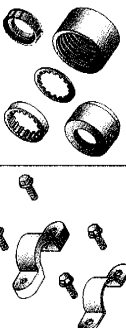
**SEPARATED BOLTS w/LOCK PATCH (73)**



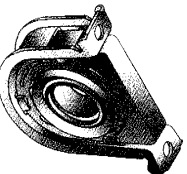
**U-BOLT ASSEMBLY (94)**



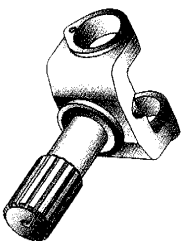
**DUST CAP & WASHER KIT (VARIABLE PART NO.)**



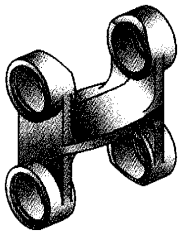
**STRAPS OR CARS & BOLT ASSEMBLY (70)**



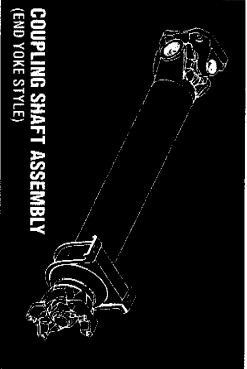
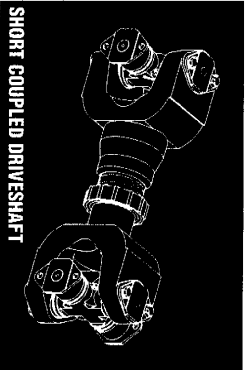
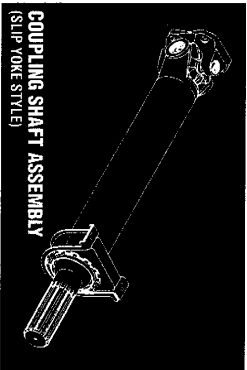
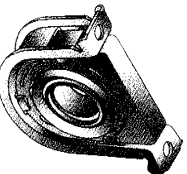
**YOKE SHAFT (82)**



**CENTER YOKE (26)**



**SHAFT SUPPORT BEARING ASSEMBLY**



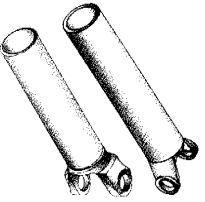
Warning: Hotting shafts can be dangerous. You can snag clothes, skin, hair, hands, etc. This can cause a serious injury or death. Do not work on a shaft (with or without a guard) when the engine is running.



Dana Corporation  
 Spicer Universal Joint Division  
 P.O. Box 955  
 Toledo, Ohio 43697-0955  
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 Dana  
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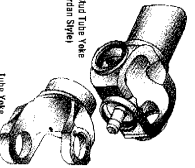
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**TUBE YOKE w/TUBE (27)**

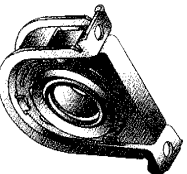


**TUBE YOKE (28)**

(2 STYLES)



**SHAFT SUPPORT BEARING ASSEMBLY**





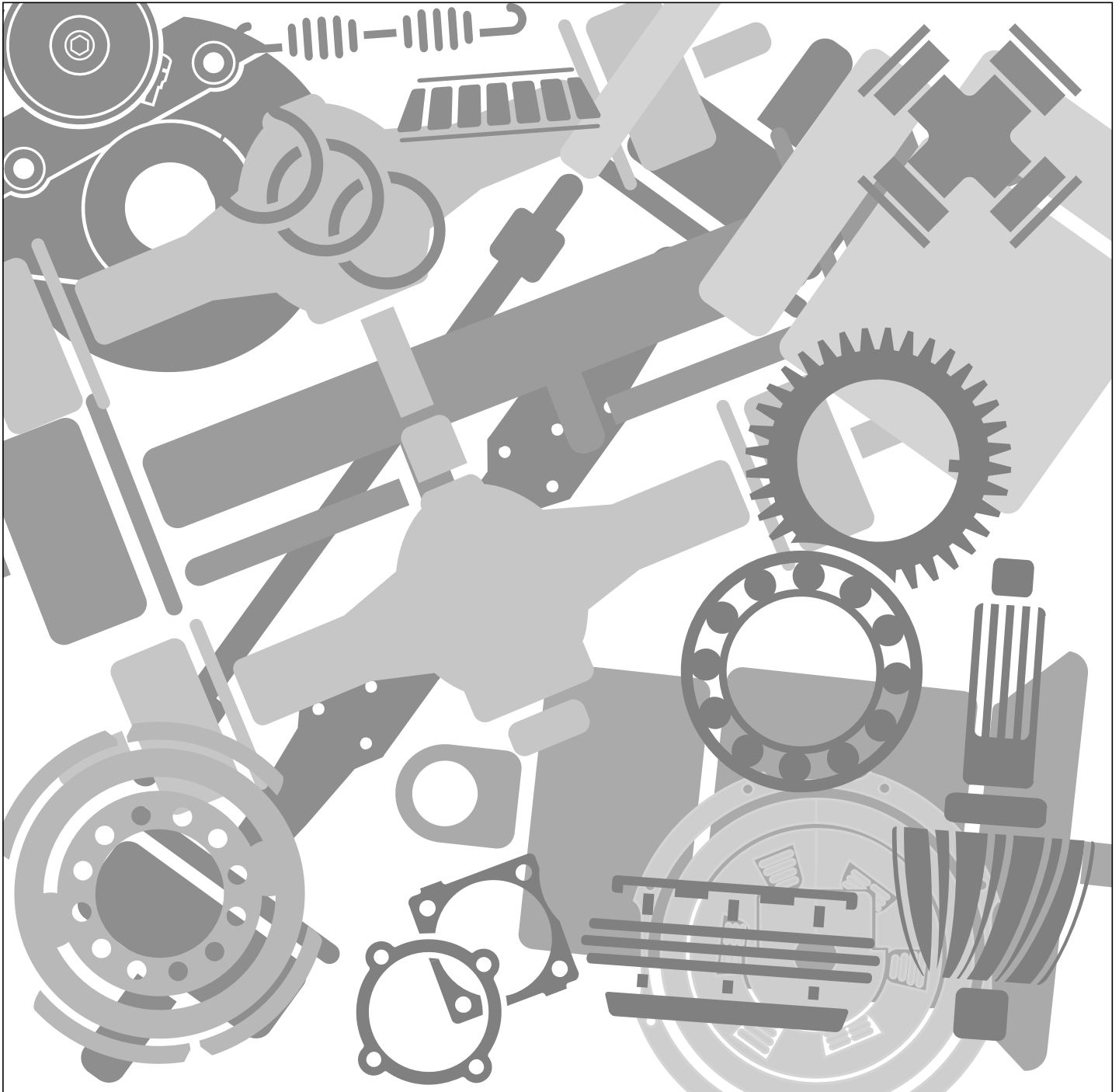
**SPICER**<sup>®</sup>  
DRIVETRAIN COMPONENTS

**Dana<sup>®</sup> Spicer<sup>®</sup> Driveshaft**

Universal Joints and Driveshafts  
1000-1880 Series



Service Manual DSSM3264 July 2006



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## Safety

**Note:** Spicer 10 Series™ Driveshafts are found on vehicles throughout the world. Therefore, this manual includes worldwide terminology.

### General Safety

The following **WARNINGS** and **CAUTIONS** should be read and understood before attempting any service or repair on the various components of the driveshaft assembly.

**CAUTION**

**Under no circumstances should individuals attempt to perform driveline service and/or maintenance procedures for which they have not been trained or do not have the proper tools or equipment.**

**WARNING**

**Failure to take common sense, precautionary measures when working on a vehicle or other machinery could result in property damage, serious personal injury, or death. To avoid property damage, serious personal injury, or death, please follow basic safety rules as noted below.**

1. **ALWAYS** wear safety glasses when performing maintenance or service. Failure to do so can result in personal injury and/or partial or complete vision loss.
2. **NEVER** perform service or maintenance tasks underneath a vehicle while the engine is running. Be sure the vehicle engine is off and the keys are removed from the ignition.
3. **NEVER** perform service or maintenance tasks underneath a vehicle that is not on a level or flat surface.
4. **NEVER** work on a driveshaft without blocking the vehicle wheels and releasing all parking brakes.
5. **ALWAYS** wear gloves when handling parts with sharp edges or abrasive surfaces.
6. **NEVER** lift a vehicle without the appropriate weight-rated vehicle-lift equipment. Always properly support the vehicle with appropriate weighted support equipment.
7. **NEVER** remove a driveshaft from a vehicle without keeping the transmission in neutral.

**CAUTION**

**Spicer 10 Series™ Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Be sure to use proper lifting techniques when handling Spicer 10 Series™ Driveshaft assemblies. More than one person may be needed when handling driveshaft assemblies.**

8. **ALWAYS** use support straps to prevent the driveshaft from falling out of the vehicle during the removal and installation process.

**Note:** This manual does not discuss the removal and installation of Spicer 10 Series™ Driveshaft assemblies from the vehicle. It only covers the disassembly and reassembly of component parts of the driveshaft assembly. Please refer to the original-equipment manufacturer's service documentation for removal and installation procedures.

9. **NEVER** heat components, and never use sledgehammers or floor jacks to remove the driveshaft from the vehicle.

**Note:** For driveshaft applications that have pillow blocks, dampers, parking brakes, or retarders, refer to these component manufacturers' or the original equipment manufacturer's service manuals for the proper procedures. **NEVER** perform any unauthorized procedures that will change the disconnected properties of Spicer products.



**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.

## Component Safety

### Driveline

**⚠ WARNING**

Failure to replace damaged driveline components can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

Reassembly of a driveline out of original phase can cause vibration and failure of the driveline and attaching components. Driveline failure can result in separation of the driveline from the vehicle, resulting in property damage, serious personal injury, or death.

Driveshaft assemblies can weigh in excess of 100 pounds (46 kilograms). Be sure to use proper lifting techniques when handling driveshafts. More than one person may be needed when handling driveshaft assemblies.

**⚠ CAUTION**

Never heat components, never use sledge hammers, and never use floor jacks to disassemble driveshafts. This can result in damaged, weakened, or bent components.

### End Fitting

**⚠ WARNING**

A loose end-fitting can result in driveline failure, which can in turn lead to separation of the driveline from the vehicle. A separated driveline can lead to property damage, serious personal injury, or death.

### Universal Joint

**⚠ WARNING**

Excessive looseness across the end of universal joint bearing cup assemblies can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline. A separated driveline can lead to property damage, serious personal injury, or death.

DO NOT reuse bolts or use inferior grade bolts. Reuse of bolts and/or use of inferior grade bolts can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

Failure to torque bolts to specification can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

**⚠ CAUTION**

Use a journal locator to avoid nicking journal cross trunnions or damaging oil seal slingers.

If a bearing assembly or journal cross is worn or damaged, the universal joint assembly must be replaced.

Be sure the snap rings are properly seated in the snap ring grooves.

### Slip Member

**⚠ WARNING**

Excessive radial looseness in the slip member assembly can cause imbalance or vibration in the driveshaft. Imbalance or vibration can cause components to wear, which in turn can result in separation of the driveline from the vehicle. A separated driveline can cause property damage, serious personal injury or death.

### Yoke (Includes Slip Yoke, Yoke Shaft, and Tube Yoke)

**⚠ WARNING**

A loose or damaged slip yoke seal allows contaminants to invade the slip member assembly. Invasion of contaminants into the slip member assembly can degrade the grease, and damage slip member components, which can result in driveline separation. A separated driveline can result in property damage, serious personal injury, or death.

DO NOT deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can be a cause of cross and bearing failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

Yoke shaft assemblies can weigh in excess of 50 pounds (23 kilograms). Be sure to use proper lifting techniques when handling yoke shafts.

### Tubing

**⚠ WARNING**

Bent or dented tubing can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

**⚠ CAUTION**

Do not bend or dent the tube when handling or servicing driveshaft.

### Midship Nut

**⚠ WARNING**

DO NOT reuse the midship nut. Reuse of the midship nut can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

DO NOT touch or disturb the micro-encapsulated adhesive found on the midship nut threads. Doing so may initiate the curing process and impair the installation of the nut. Premature curing of the micro-encapsulated adhesive will result in the improper installation of the midship nut. Improper installation of this nut can cause driveline failure, which can result in a separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

Failure to torque the midship nut to required specifications can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

A loose midship nut can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

### Center Bearing

**⚠ WARNING**

Loose center bearing bracket bolts can result in driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

Damaged center bearings or center bearing components can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

### Foreign Material

**⚠ WARNING**

Build-up of foreign material, excessive paint, or undercoating on a driveshaft can cause imbalance or vibration in the driveshaft assembly. Imbalance or vibration can cause component wear, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

A contaminated slip member can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

### Hardware

**⚠ WARNING**

Loose, missing, or damaged bearing retainers or stamped straps, retaining bolts, nuts, end fitting tangs, snap rings, or rotating bearing cups can result in driveline failure. A separated driveline can lead to property damage, serious personal injury, or death.

DO NOT reuse bolts, straps, nuts, or damaged bearing retainers, or use inferior grade bolts. Reuse of bolts, straps, nuts, or damaged bearing retainers, or use of inferior grade bolts, can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

**⚠ CAUTION**

If loosening or removing bolts, always install a new strap and bolts and torque bolts to specification.

## Lubrication (When Applicable)

### WARNING

A missing, loose, or fractured grease zerk (nipple) fitting or plug eliminates the ability to lubricate the universal joint. Improper or inadequate lubrication can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

Improper lubrication techniques can cause driveline failure, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

A missing, loose, damaged, or fractured plug or grease zerk (nipple) fitting can allow contaminants to invade the universal joint. Invasion of contaminants into the universal joint can degrade grease and cause universal joint damage, which can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

Incompatible greases that are applied to universal joints and/or slip members can result in driveline failure and can result in separation of the driveline from the vehicle. A separated driveline can result in property damage, serious personal injury, or death.

Hand tightening of grease zerk (nipple) fittings or plugs is NOT recommended. Failure to torque grease zerk (nipple) fittings to specifications can result in separation of the driveline from the vehicle. A separated driveline can cause property damage, serious personal injury, or death.

### CAUTION

In cold temperatures, be sure to drive the vehicle immediately after lubrication. This activates the slip spline and removes excess grease. Failure to do so could cause excess grease to stiffen in the cold weather and force the plug out. The end of the spline would then be open to collect contaminants and cause the spline to wear and/or seize.

All slip yoke and universal joint seals should be completely purged.

## Inspection

Spicer 10 Series™ Driveshafts should be carefully inspected at recommended original-equipment manufacturer's service intervals and/or at Spicer recommended lubrication intervals as shown in the Lubrication section on page 11.

### End Fitting Inspection

This information refers to axle, transmission, transfer case, and center bearing end fittings. Please refer to the End Fitting information in Component Safety on page 2.

1. Visually inspect all end-fitting retaining nuts or bolts for any gaps or looseness between mating surfaces. If gaps are present, consult transmission, axle, or transfer case original-equipment manufacturer's service and maintenance manual for proper fastener specifications. If looseness is evident between the nut, yoke, or center bearing, take the driveshaft to a qualified driveshaft facility for further inspection and repair.
2. Check all end fittings for looseness. Grasp the end fitting with both hands and try to move it vertically and horizontally to feel any looseness.



3. Grasp the end fitting with both hands and rotate left to right, feeling for play and backlash. There should not be any movement in the end fittings relative to the output or input shafts to which they are connected. If looseness is evident, consult transmission, axle, or transfer case original-equipment manufacturer's service and maintenance manuals for proper end fitting to shaft specifications.



4. Visually inspect for:
  - damaged half round bearing straps
  - loose bearing strap bolts
  - loose companion flange bolts and nuts
  - damaged or worn tangs on end fittings
  - damaged or missing snap rings
  - rotating bearing cups

If any of these conditions are present, component replacement is necessary. Refer to the original-equipment manufacturer's recommendations for removal instructions.

## Bearing Plate (Full Round) Yoke Inspection

Please refer to the End Fitting information in the Component Safety section on page 2.

1. Refer to original-equipment manufacturer for removal of the driveshaft from the vehicle.
2. Place the driveshaft in v-blocks to remove the cross and bearing assemblies. Completely remove the cross and bearings from the yokes at both ends of the driveshaft using a universal joint removal tool. Next, disassemble the bearing assemblies from the slip yoke (and flange yoke, where applicable), using a tool kit.



3. Clean the cross holes on the yoke, and inspect the cross hole surfaces for damage or raised metal. Raised metal or fretting can be removed from yoke cross holes with a fine-toothed file and/or emery cloth.



**⚠ WARNING**

**DO NOT deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can cause cross and bearing failure, which can result in separation of the driveline from the vehicle.**

4. Check the yoke lug cross holes with a No-Go Wear Gauge, and then use a Spicer Alignment Bar to inspect for damage by sliding through both cross holes simultaneously.



The alignment bar will identify yoke lugs that have taken a set because of excessive torque. The raised metal or distorted lugs can be a cause of premature cross and bearing problems.

5. If, after proper cleaning of the cross holes, the alignment bar will not pass through both cross holes simultaneously, the yoke lugs are distorted, and the yoke or yokes should be replaced.

## Quick Disconnect™ (Half Round) End Yoke Inspection

Please refer to the End Fitting information in the Component Safety section on page 2.

1. Remove the universal joint assembly from the end yoke, and clean the cross hole surfaces for inspection.
2. Inspect the cross hole surfaces for damaged or raised metal. Raised metal or fretting can be removed from yoke cross holes with a fine-toothed file and/or emery cloth.

**WARNING**

**DO NOT deform yoke cross holes by removing excessive metal. Raised metal or deformed yoke cross holes can cause cross and bearing failure, which can result in separation of the driveline from the vehicle.**

Inspect the bearing caps for any indication of rotation within the cross holes. If rotation is apparent, the yoke should be replaced.

3. Check the yoke for cross hole alignment using the Spicer alignment gauge. Place the correct bushing in each lug ear, allowing a .030" (.75 mm) to .060" (1.5 mm) clearance between the tang and the bushing.



4. Assemble bearing straps and bolts, tightening bolts a minimum of 30 lbs. ft. (41 N•m). Insert the alignment bar into one bushing. If the bar enters and passes through the opposite bushing, alignment is correct. If the alignment bar will not enter the opposite bushing, re-inspect for yoke seat burrs.



5. If, after proper cleaning, the alignment bar still does not pass through both bushings, the yoke lugs are distorted, and the yoke should be replaced.

## Universal Joint Inspection

Please refer to the Universal Joint information in the Component Safety section on page 2.

1. Check for excessive looseness between the ends of the universal joint bearing cup assemblies and trunnions.
2. Grasp the inboard yoke on the driveshaft with both hands and attempt to move the yoke horizontally and vertically. There should be less than .006" (.15 mm) movement in the universal joint relative to the inboard or outboard yokes. If looseness is greater than .006" (.15 mm) in either direction, the universal joint must be replaced. See Disassembly and Reassembly on page 16.



### Re-lubable Style Universal Joints

1. With re-lubable style universal joints, check for the presence of all grease zerk (nipple) fittings. Grease zerk (nipple) fittings should not be missing, loose, or fractured.



2. If a grease zerk (nipple) fitting is loose, tighten it to required specifications. See the Universal Joint Grease Zerk (Nipple) Fitting and Plug Torque table on page 26.
3. If a grease zerk (nipple) fitting is fractured or missing, the entire universal joint must be replaced. Refer to Disassembly and Reassembly on page 16 for removal and replacement instructions.

### Permanently Greased Plug Style Universal Joints

Please refer to the Universal Joint information in Component Safety on page 2.

1. Permanently greased plug style universal joints have a plug rather than grease zerk (nipple) fittings. Make sure the plug is not missing, loose, or fractured. If the plug is loose, tighten it to required specifications. See the Universal Joint Grease Zerk (Nipple) Fitting and Plug Torque table on page 26.
2. If a plug is missing or fractured, the entire universal joint must be replaced. Refer to recommendations in the Disassembly and Reassembly on page 16 for removal and replacement instructions.



## Slip Member Assembly

This information refers to slip yokes and tube shaft assemblies. Please refer to the Slip Member information in the Component Safety section on page 2.

1. Check all slip yoke assemblies to be sure the slip yoke plug is not loose, missing, or damaged. If any of these situations are evident, replacement of the yoke assembly is necessary.



2. Visually inspect for the presence of the grease zerk (nipple) fitting, if applicable, on the slip yoke. Grease zerk (nipple) fittings should not be missing, loose, or fractured.
3. If a grease zerk (nipple) fitting is loose, tighten it to required specifications. See the Universal Joint Grease Zerk (Nipple) Fitting and Plug Torque table on page 26.
4. If a grease zerk (nipple) fitting is missing or damaged, the slip member assembly must be replaced.
5. Check the slip yoke seals and dust caps. Make sure the seal is properly attached to the slip yoke and is not loose or damaged. If any of these situations are evident, replacement of the slip member and/or seal may be necessary.
6. For an inboard and outboard slip yoke assembly design, check to be sure the slip yoke welch plug is not loose, missing, or damaged.
7. If there is excessive looseness between the mating components, with the presence of vibration, all slip assembly components should be replaced.

## Tubing

Please refer to the Tubing information in the Component Safety section on page 2.

1. Check the driveshaft for bent or dented tubing or missing balance weights. If any of these conditions is evident, replacement of the complete driveshaft assembly or tube is necessary.
2. Make certain there is no build-up of foreign material on the driveshaft. If found, build-up should be removed carefully to avoid damaging the driveshaft.

**CAUTION**

**Do not allow solvents to come in contact with seals or greasable areas of the driveshaft assembly. If foreign material cannot be removed without complete assurance that the driveshaft will not be damaged, the complete driveshaft should be replaced with a new OEM driveshaft.**

## Center Bearings

Please refer to the Center Bearing information in the Component Safety section on page 2.

1. Inspect the center bearing bracket bolts for looseness. If looseness is evident, re-tighten the center bearing bracket bolts. Consult the vehicle manufacturer's documentation for proper bolt torque. Check the alignment of the bracket before tightening the bolt. Bracket should not be skewed more than 3° in relation to the centerline of the driveshaft.



2. Visually inspect the center bearing rubber cushion for damage. Make sure the slingers are not rubbing against the rubber cushion. Verify that the rubber cushion is properly seated in the metal bracket. If any of these conditions are evident, replacement of the center bearing assembly is necessary. Refer to recommendations in the Disassembly and Reassembly on page 16 for proper center bearing replacement procedures.

### Midship End Fitting

Please refer to the safety information in the General Safety section and the Midship Nut information in the Component Safety section on page 2.

1. Inspect the center bearing end fitting and bolt hole threads for damage. If the bolt hole threads are damaged, the end fitting must be replaced.



2. Check the center bearing end fitting and fitting nut washer for any looseness. Grasp the end fitting with both hands, and try to move it both vertically and horizontally to feel for looseness. There should NOT be any movement in the center bearing end fitting relative to the midship tube shaft to which it is connected. If any of these conditions are present, the center bearing end fitting and midship tube shaft must be replaced as a pair.
3. Refer to the End Fitting Inspection section on page 5 for proper procedures.

**Note:** Repeat the same inspection steps for all center bearings within the driveline.

## Lubrication

Lack of proper lubrication is among the most common causes of universal joint and slip member problems. Properly sized Spicer universal joints that are adequately lubricated at recommended intervals will normally meet or exceed vehicle operation requirements.

**Note:** Spicer 10 Series™ relube style universal joints contain only enough grease to provide needle roller bearing protection during storage and shipment. It is therefore necessary to completely lubricate each replacement universal joint after assembly into the end fitting.

Inadequate service intervals and failure to properly lubricate the universal joints will cause universal joint failures. Proper lubrication purges all universal joint seals, thus removing abrasive contaminants from the bearing assemblies. Slip members must also be adequately lubricated to prevent slip member failure.

## Spicer 10 Series™ Universal Joint and Slip

The Spicer 10 Series™ Driveshafts include 1310 through 1880.

City	Highway	Line Haul	On/Off Highway	Off-Highway and Industrial*
5,000/8,000 Miles (8,000/12,000Km) or 3 months (whichever comes first)	10,000/15,000 Miles (16,000/24,000Km) or 3 months (whichever comes first)	10,000/15,000 Miles (16,000/24,000Km) or 30 days (whichever comes first)	5,000/8,000 Miles (8,000/12,000Km) or 3 months (whichever comes first)	500/200 Hrs.

\*Grease cycles for off-highway and industrial uses vary depending on the application and operating conditions. In general, to obtain maximum life, lubrication should occur every 500 hours for normal service and every 200 hours for continuous service or severe environmental conditions.

Spicer Driveshaft recommends lubricating with a compatible grease meeting N.L.G.I. Grade 2 specifications with an operating range of +325° F to -10° F (163° C to -23° C). For more information on Spicer Driveshaft lubrication intervals, please refer to Form #3283-SDD.

- **City** is defined as all applications requiring a minimum of 90 percent of operation time within city limits.
- **Highway** is defined as all applications requiring less than 10 percent of operating time on gravel, dirt, or unpaved roads.
- **Line Haul** is defined as 100 percent of operating time on smooth concrete or asphalt.
- **On/Off Highway** is defined as all applications operating primarily on paved roads but requiring more than 10 percent of operating time on gravel, dirt, or unpaved roads.
- **Off-Highway and Industrial** is defined as 100 percent on gravel, dirt, or unpaved roads, or stationary applications.

## Members Lubrication Intervals

1. Carefully review the lubrication specifications found in this manual.
2. Be sure to lubricate at the recommended intervals. See the table below.
3. Be sure to use only recommended greases that meet the listed criteria. See “Lubrication for Universal Joints” on page 12.
4. Carefully follow driveshaft inspection procedures as outlined in this manual.

**Note:** It is essential that all bearing seals be completely purged of old grease and contaminants. If only fresh grease can be seen at all seals, the purging process is complete, and the universal joint is properly lubricated.

## Lubrication for Universal Joints

Spicer recommends the following requirements be met for any grease used to service most vehicular and industrial applications and all auxiliary driveshaft applications:

- Use a good quality E.P. (extreme pressure) grease (Timken Test Load - 50 lbs. / 23 kg. minimum), and that
- Meets N.L.G.I. (National Lubricating Grease Institute) Grade 2 specifications, and has an
- Operating range of +325° F to -10° F (163° C to -23° C), which is
- Compatible with commonly used multi-purpose greases. For information about grease compatibility, see the Grease Compatibility section below. Consult your local grease source for greases that meet these specifications.

**Note:** There are instances when special lubrication is required due to original-equipment manufacturer specifications or customer requests. The lubrication recommendations listed in this manual are authorized by Spicer Driveshaft engineering. Any alternate greases or lubrication procedures are the responsibility of the user.

### Grease Compatibility

To help reduce the effects of incompatible greases, be sure to thoroughly purge all four bearing seals on each universal joint with the new grease. Purge seals until the **fresh** grease is visible on the outside of all four bearing seals. **It is recommended that all purged grease be wiped clean to prevent discharge into the general environment. Contact your local grease supplier for grease compatibility information.**



### Lubrication Procedure for Universal Joints

Please refer to the Lubrication information in the Component Safety section.

#### Required Materials:

- N.L.G.I. Grade-2, E.P. Grease
- Grease gun

#### May Need If Bearing(s) Will Not Purge:

- C-Clamp
  - New straps
  - New bolts
1. Use the proper grease to purge all four seals of each universal joint. This flushes abrasive contaminants from each bearing assembly and assures all four bearings are filled. Purge the seals. Spicer seals are made to be purged. Make sure **fresh** grease is evident at all four universal joint bearing seals.
  2. If any of the seals fail to purge, try to push the drive-shaft away from the seal that will not purge, while applying grease gun pressure. There will occasionally be one or more bearing assemblies that will not purge.

**Quick Disconnect™ (Half Round) Universal Joints**

Series	Strap Kit Assemblies	Recommended Bolt Torque	N•m
1310	2-70-18X	13-18 lbs. ft.	17.6 - 24.4
1330	2-70-18X	13-18 lbs. ft.	17.6 - 24.4
1350	3-70-18X	30-35 lbs. ft.	40.7 - 46.5
1410	3-70-18X	30-35 lbs. ft.	40.7 - 46.5
1480	3-70-28X	45-60 lbs. ft.	61 - 81.3
1550	3-70-28X	45-60 lbs. ft.	61 - 81.3
1610	5-70-28X	45-60 lbs. ft.	61 - 81.3
1710	6.5-70-18X	115-135 lbs. ft.	162.7 - 183
1760	6.5-70-18X	115-135 lbs. ft.	162.7 - 183
1810	6.5-70-18X	115-135 lbs. ft.	162.7 - 183

The bolt torque specifications refer to Spicer bearing straps and bearing plates only. If using original-equipment bearing straps and bearing plates, refer to manufacturer's service manual for proper bolt torque specifications.

**Note:** Unless otherwise noted all recommended bolt torques are with dry threads.

1. If any of the bearing assemblies fail to purge removal of the driveshaft is necessary. See the original-equipment manufacturer for proper driveshaft removal procedures.
2. Place the driveshaft in v-blocks and apply a C-clamp across the half round bearings. Apply grease gun pressure. Completely purge both bearings.
3. If outboard bearings fail to purge, slightly loosen C-clamp and reapply grease gun pressure until both half round bearings purge.
4. After **all** four bearings purge fresh grease, re-tighten the C-clamp to squeeze out excess grease and wipe clean. This will ease installation of universal joint kit back into yoke. Install universal joint kit in the yoke using new straps and bolts, and torque bolts to the required specifications. Reference bolt torque specifications in the above table.
5. If the bearings still will not purge, complete removal of the universal joint kit is needed to determine the cause of blockage. Refer to original-equipment manufacturer's service manual for removal procedures.

## Bearing Plate (Full Round) Universal Joints

Series	Bolt Part Number	Recommended Bolt Torque	N•m
1610	5-73-709	26-35 lbs. ft.	35.3 - 47.5
1710	6-73-209	38-48 lbs. ft.	51.5 - 65.1
1760	6-73-209	38-48 lbs. ft.	51.5 - 65.1
1810	6-73-209	38-48 lbs. ft.	51.5 - 65.1
1880	7-73-315	60-70 lbs. ft.	81.3 - 94.9

The bolt torque specifications refer to Spicer bearing straps and bearing plates only. If using original-equipment bearing straps and bearing plates, refer to manufacturer's service manual for proper bolt torque specifications.

**Note:** Unless otherwise noted all recommended bolt torques are with dry threads.

1. There will occasionally be one or more bearing assembly seals that will not purge. Release seal tension by loosening the bolts holding the bearing assembly that does not purge. It may be necessary to loosen the bearing assembly approximately 1/16" minimum. If loosening it does not cause purging, remove the bearing assembly to determine the cause of blockage.

**Note:** It is essential that all seals be completely purged of old grease and contaminants. If fresh grease can be seen at these seals, the purging process is complete, and the universal joint is properly lubricated.

**Note:** Spalling and/or brinelling can be caused if contaminants (water, air, etc.) are left in the universal joint and/or the bearing seals. Purge old grease thoroughly.

2. Install new bolts, and torque to specifications in the above table.

## Snap Ring Universal Joints

1. There will occasionally be one or more bearing assembly seals that will not purge. If any of the seals will not purge, replacement of the universal joint kit is necessary. See the Reassembly - Inboard Slip Style under "Center Bearing Assembly" on page 20 for proper replacement procedures.

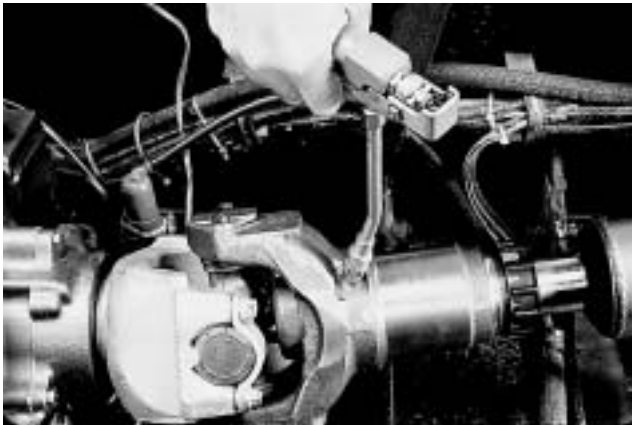
## Lubrication for Slip Members

Please refer to the Lubrication information in the Component Safety section on page 2.

The grease used for universal joints is satisfactory for slip members. Glidecote® and steel splines both use a high quality E.P. grease meeting N.L.G.I. Grade 2 specifications.

Grease splines at the intervals recommended in the Lubrication Intervals table page 11.

1. Apply grease gun pressure to the grease zerk (nipple) fitting until grease appears at the pressure relief hole in the plug.



2. Now cover the pressure relief hole with your finger and continue to apply pressure until grease appears at the slip yoke seal.

**Note:** Use caution to prevent seal damage when using high pressure lubrication systems.

## Lubrication of Center Bearing Assemblies

Spicer center bearings are lubricated for life. No attempt should be made to add to or change grease within the bearing itself.



**Note:** For pillow blocks, use original-component manufacturer's recommended greases and lubrication intervals.

## Disassembly and Reassembly

For procedures used in the removal and installation of Spicer Driveshafts from the vehicle, please consult the vehicle manufacturer's service manual. This manual concerns itself only with the disassembly and reassembly of driveshaft components.

### Universal Joint

#### Disassembly - Snap Ring Design

Please refer to the Universal Joint information in the Component Safety section on page 2.

With the driveshaft removed, the following procedure should be followed:

1. Using snap ring pliers, remove the snap rings from the yoke ears.



2. Set the yoke in the arbor press with a piece of tube stock beneath it. Position the yoke with the universal joint grease zerk (nipple) fitting pointing up to prevent interference during disassembly. Place an appropriate push rod on the upper bearing assembly, and press it through to release the lower bearing assembly.



**CAUTION**

**Do not distort yoke ears with excessive force while in the arbor press.**

3. If the bearing assembly will not pull out by hand after pressing, grip the bearing cup and pull from the yoke.
4. Place the yoke in the arbor press with the remaining bearing cup face down. Using an appropriate push rod, press on the end of the journal cross trunnion. Continue to press down on the journal cross trunnion until the shoulder of the journal cross makes contact with the inside of the yoke ear.
5. Repeat steps three and four on the remaining bearing assemblies to remove the cross from the yoke.
6. Inspect all yoke cross hole surfaces for damage. Raised metal or fretting can be removed from yoke cross holes with a fine-toothed file and/or emery cloth.



## Reassembly - Snap Ring Design

Please refer to the Universal Joint information in the Component Safety section on page 2.

1. Using a high quality N.L.G.I., grade 2 extreme pressure (E.P.) grease, apply adequate grease to each bearing cup assembly. Fill all the cavities between the needle rollers, and also apply a liberal coating of grease in the bottom of each bearing cup and on the lip of the seal. Be careful not to get grease on the outside machined surface of the bearing cup.
2. Position the journal cross in the yoke cross holes with the grease zerk (nipple) fitting inward toward the tubing. **Failure to properly position the universal joint may result in the inability to lubricate the universal joint.** If using an arbor press, proceed to Step 3. If using a universal joint installation tool, follow the tool manufacturer's instructions.



3. Move one end of the journal cross to cause a trunnion to project through the cross hole beyond the outer machined face of the yoke ear. Check the bearings for skewed or dropped needle rollers. Place the bearing cup assembly over the protruding trunnion diameter and align it to the yoke cross hole. Align the yoke in an arbor press with the bearing assembly resting on the base of the press. Cover the yoke ear with a metal plate that has .150" (6.4 mm) minimum thickness. Push the yoke onto the bearing cup assembly until it is flush with the cross hole face.



4. Place a push rod that is smaller than the diameter of the bearing cup assembly under the bearing cup assembly, and continue pressing into the yoke cross hole until a snap ring can be installed.
5. Remove the yoke from the arbor press. Install a snap ring using snap ring pliers.



6. Flip the yoke 180°. Check the bearings for skewed or dropped needle rollers. Place another bearing cup assembly over trunnion diameter, and align it to the yoke cross holes. Align the yoke in arbor press with previously installed bearing cup assembly resting on the base of the press. Place a push rod that is smaller than the bearing cup assembly on top of the bearing cup assembly. Press bearing cup assembly into the yoke cross hole until a snap ring can be installed.
7. Remove the yoke from the arbor press. Install a snap ring using snap ring pliers.



8. Ensure snap rings are seated into the snap ring grooves.
9. Flex the journal cross to make sure it moves freely by hand. Some resistance is acceptable. If it does not move freely, tap the yoke ear as shown.



### Disassembly - Bearing Plate Style

Please refer to the Universal Joint information in the Component Safety section on page 2.

With the driveshaft removed, see "Inspection" on page 5 for Bearing Plate (Full Round) Yoke Inspection disassembly procedures.

### Reassembly - Bearing Plate Style

Please refer to the Universal Joint information in the Component Safety section on page 2.

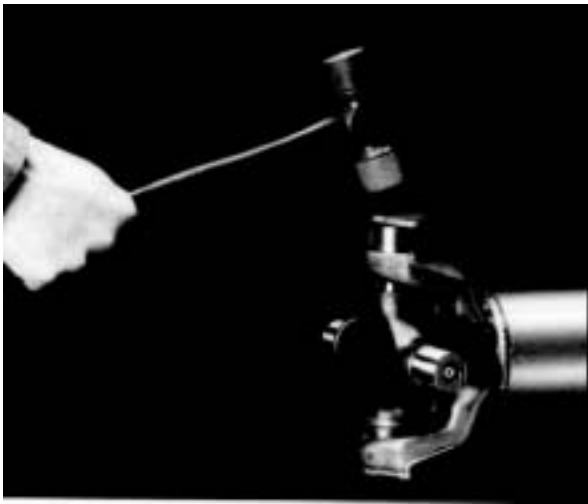
1. Remove the cross and bearings from the box and remove all four bearing assemblies. Rotate the cross to inspect for the presence of a positive purging valve in each grease hole of all four trunnions. Then position the cross into the end yoke with its grease fitting in line as near as possible with the slip spline grease fitting. Keep the grease fitting on the inboard side.
2. Using a high quality N.L.G.I., grade 2 extreme pressure (E.P.) grease, apply adequate grease to each bearing cup assembly. Fill all the cavities between the needle rollers, and also apply a liberal coating of grease in the bottom of each bearing cup and on the lip of the seal. Be careful not to get grease on the outside machined surface of the bearing cup.
3. Position one end of the cross to cause a trunnion to project through the hole beyond the outer machined face of the yoke lug.



4. Place a bearing assembly over the trunnion diameter and align it to the cross hole.



5. Holding the trunnion in alignment with the cross hole, install the bearing assembly by hand until it is flush with the face of the end yoke. If the universal joint bearing cap is pressed into place, the bearings and bearing surfaces could be damaged.
6. If the bearing assembly binds in the cross hole, tap it with a soft-faced hammer directly on the center bearing assembly. Do not tap the outer edges of the bearing assembly.



 CAUTION

**Exact fit of all driveline components is extremely important. The correct parts and clean mating services are essential for safe operation, long life, and good repair.**

7. When the bearing assembly is completely seated, put the lock plate tab (if used) in place and use the "Grade 8" cap screws furnished with the universal joint and insert them through the cap screw holes in both the lock strap and/or the bearing plate assembly. Thread by hand or with a wrench into the tapped holes in the yoke. Do not torque down the bolts.

**Note:** The self-locking bolt design for full round yokes uses serrated bolts with lock patch and does not require a lock strap. DO NOT reuse any retaining bolt. If loosening or removal of a bolt is necessary, replace it with a new one.



8. Move the cross laterally to the opposite side and through the cross hole, beyond the machined surface of the yoke lug. Place a bearing assembly over the cross trunnion and slide it into the cross hole, seating the plate to the face of the lug. Thread the bolts by hand or with a wrench into tapped holes in the yoke.

**Note:** Projecting the trunnion through a cross hole beyond the machined surface of the lug will provide a surface to help align the bearing assembly with the cross hole.

9. For flange yoke applications, install the flange yoke, bearing assemblies, and bolts at this time.

## Center Bearing Assembly



### Disassembly - Inboard Slip Style

Please refer to the Center Bearing information in the Component Safety section on page 2.

This information includes procedures for disassembling SAE, DIN, and T-Type Companion Flange / Flange Yoke, Quick Disconnect, and Bearing Plate Styles.

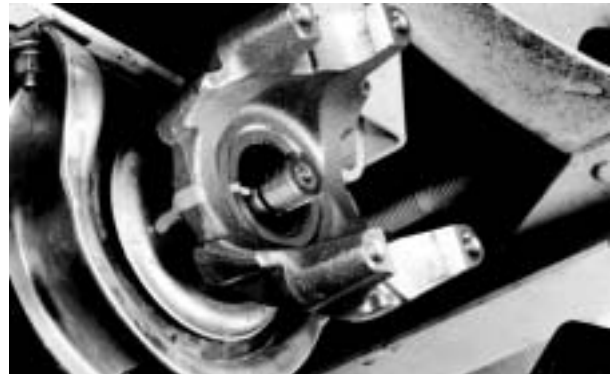
1. Remove the midship nut. Reference the midship nut specification in the Midship Nut Specifications table. Discard the nut. If the washer is damaged, discard and replace it. Otherwise, reuse the washer.

**Note:** The midship nut can be removed when the coupling shaft is still in the vehicle. For coupling shaft removal, please refer to original-equipment manufacturer's service document.



2. Remove driveshaft per original-equipment manufacturer's instructions, and then place the driveshaft in v-blocks.

3. Mark the counterbore of the coupling shaft end yoke to midship "nose" with a marking stick, paint marker or other legible marking device. This assures proper reassembly of the coupling shaft end yoke in its original phased position.



4. Using a puller, follow the tool manufacturer's instructions to remove the end fitting. The end fitting has a press fit and should NOT be removed with a hammer. If the end fitting is loose enough to be removed by hand, the entire coupling shaft must be replaced. Remove and discard the slinger from the yoke.



5. Visually inspect the splines of the center bearing end yoke. If the yoke splines are damaged, missing or twisted, the yoke must be replaced. If the yoke hub has cracked, the yoke must be replaced.
6. Visually inspect the midship splines and threads. If the splines or threads are damaged, missing or twisted, replacement of the entire coupling shaft is necessary.

7. On some Spicer center bearing assemblies, a metal retainer spans the outside center bearing bracket. If the metal retainer is present, remove it and discard.



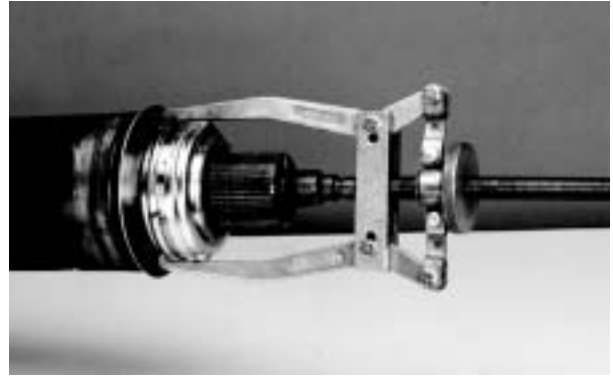
8. Remove and discard the center bearing bracket.



9. Remove and discard the rubber cushion.



10. Using a puller, follow the tool manufacturer's instructions to remove the bearing assembly from the midship. Discard the center bearing.



11. Inspect the midship for wear on the bearing diameter. If the midship is damaged from a seized bearing, replacement of the entire coupling shaft is necessary.



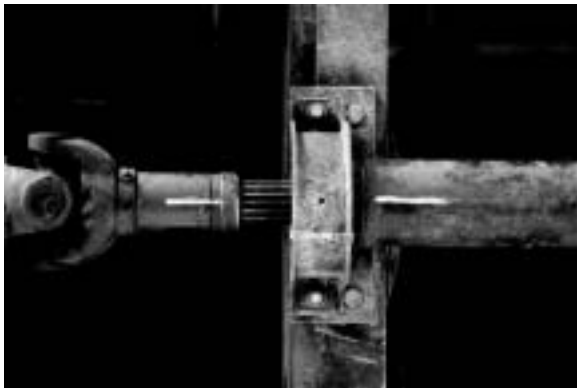
12. If no damage is apparent, remove the slinger, and proceed to the installation of the center bearing, described in the "Reassembly - Inboard Slip Style" section.

## Midship Nut Specifications Table

Series	Nut Part Number	Nut Catalog Color	Washer Part Number	Head Size	Nut Torque	
					N•m	lbs. ft.
1310	231781	cadmium plate & wax	230123-12 230123-14	15/16"	136-163	100-120
1310 (Toyota Only)	10-74-101	cadmium plate & wax	230123-12 230123-14	15/16"	136-163	100-120
1410	16-74-101	silver	230123-15	1-5/16"	373-440	275-325
1480	16-74-101	black	230123-15	1-5/16"	542-610	400-450
1480	16-74-101	silver	230123-15	1-5/16"	373-440	275-352
1550	231502	black	none	1-5/8"	644-712	475-530
1610	231502	black	none	1-5/8"	644-712	475-525
1710	20-74-91	black	230123-6	1-5/8"	644-712	475-525
1710	231502	black	none	1-5/8"	644-712	475-525
1760	20-74-91	black	230123-6	1-5/8"	644-712	475-525
1810	20-74-91	black	230123-6	1-5/8"	644-712	475-525

### Disassembly - Outboard Slip Style

1. Mark the slip yoke barrel and midship tube shaft with a marking stick, paint marker, or other legible marking device. This ensures proper reassembly of the mating components in their original phased position.



2. Refer to original-equipment manufacturer's instructions for removal of the coupling shaft.
3. Visually inspect midship tube shaft, looking for wear on spline surface. If splines are damaged, missing or twisted, or Glidecote® is missing, replacement of entire coupling shaft is necessary.
4. On some Spicer center bearing assemblies, a metal retainer spans the outside center bearing bracket. If the metal retainer is present, remove it and discard.

5. Remove and discard the center bearing bracket.



6. Remove and discard the rubber cushion.



- Using a puller, follow the tool manufacturer's instructions to remove the bearing assembly from the midship. Discard the center bearing.



- Inspect the midship for wear on the bearing diameter. If the midship is damaged from a seized bearing, replacement of the entire coupling shaft is necessary.



- If no damage is apparent, remove the slinger and proceed to the installation of the center bearing, described in the "Reassembly - Outboard Slip Style" section.

### Reassembly - Inboard Slip Style

Please refer to the Center Bearing information in the Component Safety section on page 2.

This information pertains to SAE, DIN, and T-Type Companion Flange/Flange Yoke, Quick Disconnect, and Bearing Plate styles.

- Wipe the bearing surface of the midship tube shaft with a fine emery cloth.
- Install a new slinger (included in the center bearing replacement parts kit) on the midship tube shaft. Use a section of tubing to avoid damaging the slinger. Make sure the slinger is completely seated against the midship tube shaft shoulder.
- Before installing the new center bearing assembly, be sure to fill the entire cavity around the bearing with a waterproof lubricant.

Enough lubricant must be applied to fill the cavity to the extreme edge of the slinger surrounding the bearing. Lubricants must be waterproof.



### Recommended Center Bearing Lubricants

<b>Lubricants</b>	<b>Source</b>
<i>Rykon Premium No. 3</i>	<i>Amoco Oil Company</i>
<i>Amolith 8516</i>	<i>Amoco Oil Company</i>
<i>Van Talgar No. 4</i>	<i>Exxon Company</i>

4. Carefully align the new center bearing assembly with the ground surface of the midship tube shaft. Install the center bearing onto the midship tube shaft. Minimal force should be necessary to push the center bearing onto the midship tube shaft, provided the shaft and bearing are in alignment.
5. Install the remaining slinger on the end yoke using a section of tubing to avoid damaging the slinger.



6. **Make sure that the phasing marks from driveshaft removal are aligned, and** using an installation tool, press the yoke onto the midship tube shaft. **Do not strike yoke with hammer or use midship nut to install yoke.**
7. Installation of the driveshaft onto the vehicle can now proceed. Refer to the vehicle manufacturer's documentation for installation procedures. See the Midship Nut information in the Component Safety section on page 2.

### Midship Nut Installation Procedure

Only work on components when they are cool to the touch. Installing the midship nut onto a threaded midship which is above the ambient temperature will cause the adhesive to cure too rapidly, and the midship nut may not install correctly.

Do not use the midship nut to pull the end fitting onto the midship. This may result in improper seating of the end fitting and will begin the curing of the midship nut adhesive. As a result, the midship nut may not install correctly.

1. Visually inspect the midship washer (if applicable) for flatness, corrosion, or cracks. If the washer is bent, corroded, or cracked, the washer must be replaced.



2. Thoroughly clean midship threads with mineral spirits. Wipe the midship threads dry with a clean, dry rag. **Do not use a wire brush to clean threads.** This may distort the midship threads and result in the midship not being able to properly retain the midship nut.
3. Thoroughly clean the midship washer (if applicable) and the inboard, machined face of the end fitting with mineral spirits. Wipe components with a clean, dry cloth.
4. Do not apply any additional compounds to midship threads, washer (if applicable), or nut. These compounds may interfere with the adhesive that is pre-applied to the midship nut and will be detrimental to its effectiveness. Unacceptable compounds include, but are not limited to:
  - thread lockers, such as Loctite.™
  - anti-seizing compounds, such as Never-Seez.™
  - lubricants, such as oil, grease, silicone, graphite, or soap.
5. Install the midship washer (if applicable) onto the midship and up against the machined surface of the end fitting.
6. By hand, start the midship nut onto the midship threads until it will no longer spin freely. Use a socket and a torque wrench with a suggested range of 600 lbs. ft. (800 N•m) or equivalent device capable of installing the midship nut to a final torque at a maximum rate of 120 rpm. (Refer to the Midship Nut Specifications table for proper socket size and torque specs.)



## Reassembly - Outboard Slip Style

1. Wipe the bearing surface of the midship tube shaft with a fine emery cloth.
2. Install a new slinger (included in the center bearing replacement parts kit) on the midship tube shaft, using a section of tubing to avoid damaging the slinger. Make sure the slinger is completely seated against the midship tube shaft shoulder.



3. When replacing a center bearing assembly, be sure to fill the entire cavity around the bearing with a waterproof lubricant. Enough lubricant must be applied to fill the cavity to the extreme edge of the slinger surrounding the bearing. Refer to the below table.

### Recommended Center Bearing Lubricants

<b>Lubricants</b>	<b>Source</b>
<i>Rykon Premium No. 3</i>	<i>Amoco Oil Company</i>
<i>Amolith 8516</i>	<i>Amoco Oil Company</i>
<i>Van Talgar No. 4</i>	<i>Exxon Company</i>

4. Carefully align the new center bearing assembly with the ground surface of the midship tube shaft. Physically push the center bearing onto the midship tube shaft. Minimal force should be necessary to push the center bearing onto the midship tube shaft provided the shaft and bearing are in alignment.
5. Press the remaining slinger on the midship tube shaft using a section of tubing to avoid damaging the slinger.
6. Installation of the driveshaft onto the vehicle can now proceed. Refer to the vehicle manufacturer's documentation for installation procedures. Ensure phasing marks are aligned on mating components.

## Grease Zerk (Nipple) Fittings or Plugs

For procedures used in the removal and installation of Spicer Driveshafts from the vehicle, please consult the vehicle manufacturer's service manual.

Once the driveshaft has been removed or the defective grease zerk (nipple) fitting or plug is accessible, follow the steps listed in the Disassembly - Universal Joint section on page 16 for replacement. Please refer to the Lubrication information in the Component Safety section page 2.

### Universal Joints and Slip Member Assembly

1. Tilt the universal joint or flange yoke and universal joint to allow access to the defective grease zerk (nipple) fitting or plug. Using pliers or an open-ended wrench, turn the grease zerk (nipple) fitting or plug counter-clockwise until it is removed from the journal cross or slip member assembly. Discard the grease zerk (nipple) fitting or plug.
2. Check the threads in the journal or slip member. If threads are damaged, replacement of the universal joint or slip member is necessary. See disassembly procedures for universal joints and slip member in the Disassembly and Reassembly section on page 16.
3. Thoroughly wipe the grease zerk (nipple) fitting or plug threaded hole.
4. Install the new grease zerk (nipple) fitting or plug. Tighten to a minimum 40-55 lbs. in. (4.5 - 6.2 N•m). Continue to turn only until the grease zerk (nipple) fitting is correctly positioned.

### Universal Joint Grease Zerk (Nipple) Fitting and Plug Torque

Part Number	Description	Minimum Zerk Torque	
		N•m	lbs. in.
500174-1	.250-28 NF Tapered Thread	4.5 - 6.2	40 - 55
500168-2	.125-27 PTF	4.5 - 6.2	40 - 55

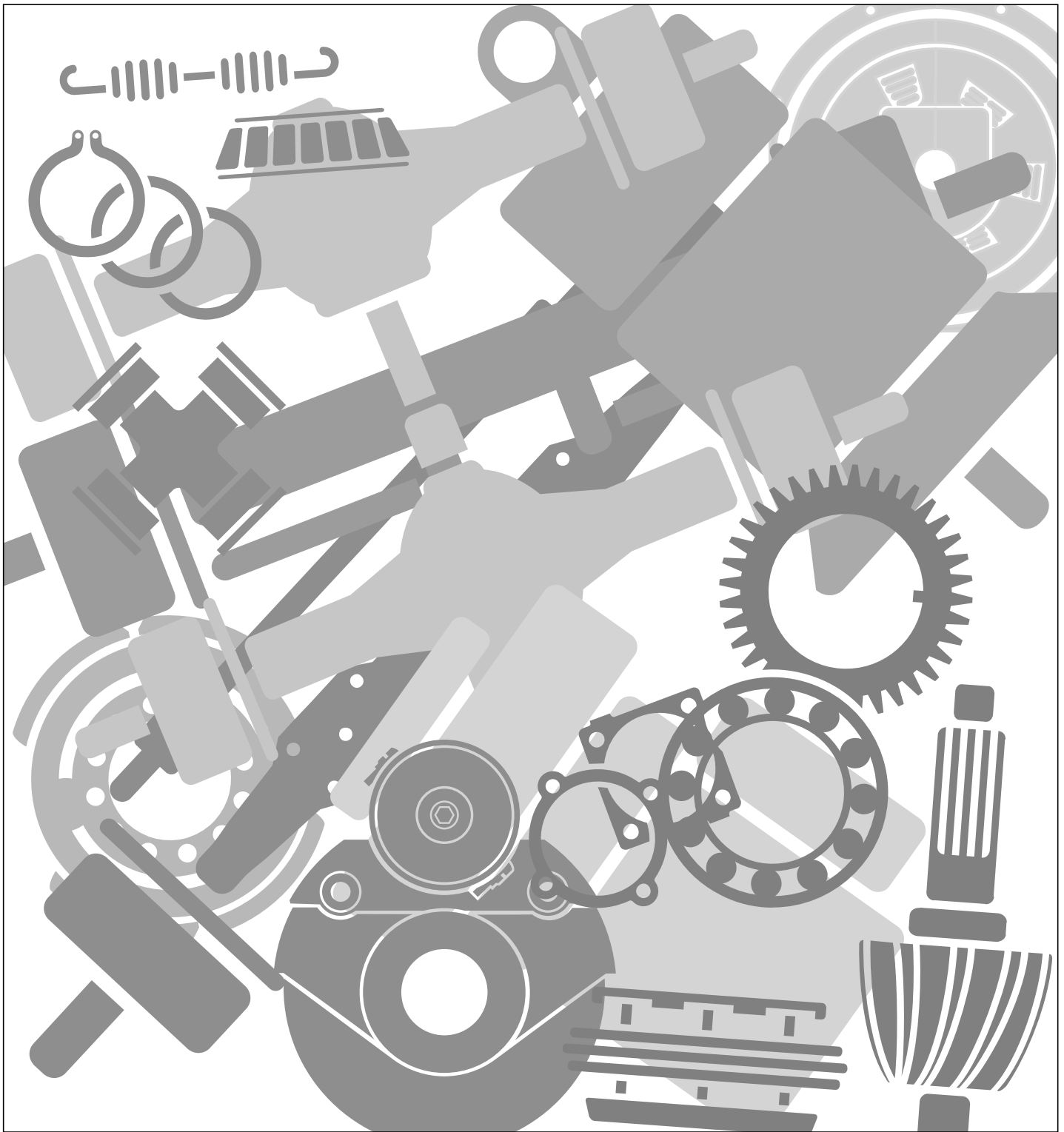
## Glossary

Alignment Bar	A device (gauge) used to check yoke cross hole alignment.
Ball Yoke	See Tube Yoke.
Bearing Cross Hole	See Cross Hole.
Bearing Cup Assembly	Consists of a bearing cup with needle rollers, generally held in place by a seal guard and bearing seal. Sometimes the assembly includes a thrust washer.
Bearing Cup	A cup-shaped member used as the bearing bore of a bearing cup assembly and for positioning a thrust end of a cross trunnion.
Bearing Seal	A flexible member of a bearing cup assembly that prevents the escape of grease from or entry of foreign matter into a bearing.
Bearing Strap	A narrow, stamped metal plate used to retain a bearing cup assembly in a half round end yoke or flange yoke design.
Center Bearing	Consists of a rolling element bearing isolated in rubber and a bracket configuration for attachment to the vehicle frame.
Companion Flange	A fixed flange member that attaches a driveshaft to another drivetrain component.
Coupling Shaft	The coupling member or members of a multiple-piece driveline, which consists of a universal joint, tube, center bearing, and a slip or fixed spline shaft.
Coupling Shaft Length (Centerline to Centerline)	The distance between the outermost universal joint centers on a driveshaft. On coupling shafts with fixed centers, it is the nominal dimension.
Cross	See Journal Cross.
Cross Hole	A through hole in each lug ear of a yoke used to locate a bearing assembly.
Deflector	See Slinger.
Driveline	An assembly of one or more coupling shafts and a driveshaft with provisions for axial movement, which transmits torque and/or rotary motion at a fixed or varying angular relationship from one drivetrain component to another.
Driveshaft	An assembly of one or two universal joints connected to a tubular shaft member, which accommodates axial movement.
Driveshaft Length (Centerline to Centerline)	The distance between the outermost universal joint centers on a driveshaft. On driveshafts with variable length centers, driveshaft length is usually measured in the compressed or installed lengths.
Ear	One of two projecting parts of a yoke symmetrically located with respect to the rotation axis of the yoke.
End Fitting	An end yoke or companion flange (including SAE, DIN, and T-Type styles) that attaches a driveshaft to another drivetrain component.
End Yoke	A half round yoke that attaches a driveshaft to another drivetrain component.
Flange Yoke	A full round or half round style yoke that attaches a driveshaft to a companion flange.
Flinger	See Slinger.
Glidecote®	The blue, nylon, wear-resistant coating on Spicer yoke shafts and tube shafts.
Grease Zerk (Nipple) Fitting	The fitting on the shoulder or center of a journal cross or on a greaseable slip spline that allows for lubrication.

## Glossary

Half Round Cross Hole	A semicircular hole located on the end of each lug ear of some end yoke and flange yoke designs used to locate a bearing cup assembly.
Inboard Bearing Assembly	Contained in inboard yoke.
Inboard Yokes	Yokes that make up the ends of a driveshaft or coupling shaft assembly, i.e. tube yokes, slip yokes, yoke shafts, and center bearing end yokes.
Journal Cross	The core component of a universal joint, which is an intermediate drive member with four equally spaced trunnions in the same plane.
Lug Ear	See Ear.
Midship Shaft	A machined element consisting of spline teeth, a pilot for a center bearing, and a piloting hub that attaches to the tube of a coupling shaft assembly.
Needle Rollers	One of the rolling elements of a bearing cup assembly.
Nib	See Tang.
Outboard Bearing Assembly	Contained in an outboard yoke.
Outboard Yokes	Yokes that are not a part of a driveshaft or coupling shaft assembly, i.e. transmission, axle, transfer case end yokes.
Phase Angle	The relative rotational position for each yoke on a driveshaft or driveline.
Pillow Block	Consists usually of a rolling element bearing and a bracket configuration for attachment.
Pressure Relief Hole	A hole in the welch plug of Spicer slip yokes that allows air to escape from the slip member assembly.
Purge	The act of flushing old grease and contaminants from universal joints and slip member assemblies with fresh grease.
Retaining Ring	See Snap Ring.
Retaining Ring Groove	See Snap Ring Groove.
Round Bearing Assembly	See Bearing Cup Assembly.
Seal Guard	A covering member used to protect a bearing seal on the bearing cup assembly.
Serrated Flange	See T-Flange.
Shaft Support Bearing	See Center Bearing.
Slinger	A stamped metal or non-metal ring, which prevents the entry of foreign matter into a center bearing, transmission, axle, or transfer case.
Slip	The total permissible length of axial travel.
Slip Yoke	A yoke that accommodates axial movement.
Slip Yoke Plug	See Weld Plug.
Slip Yoke Seal	Pop-on or threaded ring that contains a seal that protects the slip member assembly from environmental contaminants and retains grease.
Snap Ring	A removable member used as a shoulder to retain and position a bearing cup assembly in a yoke cross hole.
Snap Ring Groove	A groove used to locate a snap ring.
Spline	A machined element consisting of integral keys (spline teeth) or keyways (spaces) equally spaced around a circle or portion thereof.

Stub Shaft	See Tube Shaft.
Tang	A nib of metal found on half round end yoke and/or flange yoke style cross holes, used to locate a bearing cup assembly.
T-Flange	A companion flange and flange yoke design, which has a serrated flange face. Found most often in European applications.
T-Type Flange	See T-Flange.
Thrust Washer	A washer found in the bottom of a bearing cup assembly that reduces needle roller friction and bearing heat, and guards against end galling on the journal cross trunnions.
Tube	The tubular connecting member of a driveshaft. Pipe or piping is not an equivalent.
Tubing	See Tube.
Tube O.D.	The outside diameter (O.D.) of a tube.
Tube Yoke	An inboard yoke with a piloting hub for attachment to a tube or spline sleeve.
Tube Shaft	A machined element consisting of spline teeth and a piloting hub that attaches to the tube of a driveshaft assembly.
Trunnion(s)	Any of four projecting journals of a cross.
Universal Joint	A mechanical device that can transmit torque and/or rotary motion from one shaft to another at fixed or varying angles of intersection of the shaft axes. Usually consisting of a journal cross, grease zerk (nipple) fitting, and four bearing cup assemblies.
U-Joint	See Universal Joint.
Welch Plug	A plug in the slip yoke face that seals off one end of the spline opening. Also known as a slip yoke plug.
Weld Yoke	See Tube Yoke.
Yoke Lug Ear Cross Hole	See Cross Hole.
Yoke Shaft	A slip member yoke with a male machined spline used for axial movement.



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# SECTION 10: FRONT AXLE

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## 1. FRONT AXLE

### 1.1 DESCRIPTION

This front axle is of the "Reverse Elliot" type manufactured by Dana Spicer Europe. The front axle consists of a girder section axle bed or beam with stub axles. Each stub axle is carried on a taper king pin, with a plain phosphor bronze bushing at the top and at the bottom. The unitized hub bearings used on the NDS range of axles, are non-serviceable items. Bearings are pre-adjusted, lubricated and have seals fitted as part of the manufacturing process. The bearings are greased for life and there is no need or facility for re-lubrication. Brakes are manufactured by KNORR-BREMSE. Steering ball joints with hardened balls and rubbing pads incorporate compression springs which automatically take up any wear.

The tie rod simplifies toe-in adjustment. The maximum turning angle is set through stop screws installed on the inner side of the knuckle.

Steering stabilizer (damper) and steering drag link which are mounted on the front axle are described in Section 14; "Steering" of this manual.

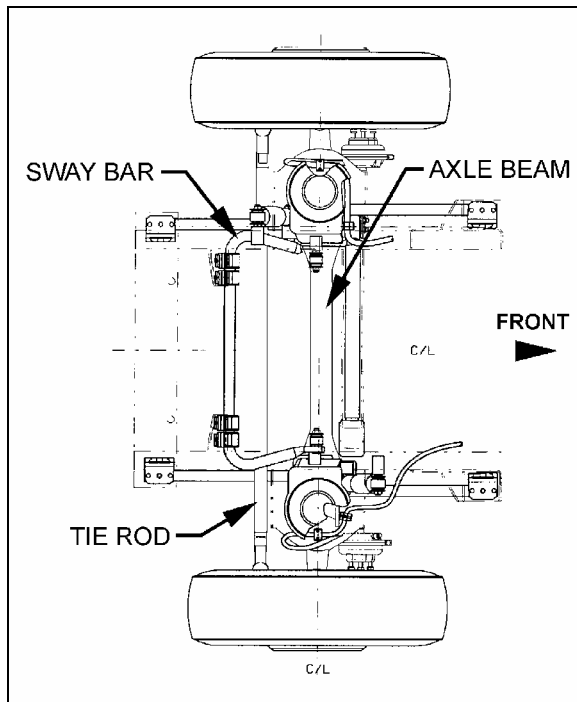


FIGURE 1: FRONT AXLE ASSEMBLY

10025

## 2. LUBRICATION

Pressure lubricate axle every 6 months or 30,000 miles (48 000 km) whichever comes first (Fig. 2). Tie rod ends and knuckle pins are provided with grease fittings for pressure lubrication. These grease fittings should be serviced every 6,250 miles (10 000 km) or twice a year whichever comes first. Good quality lithium-base roller bearing grease NLGI No.1 and 2 are recommended.

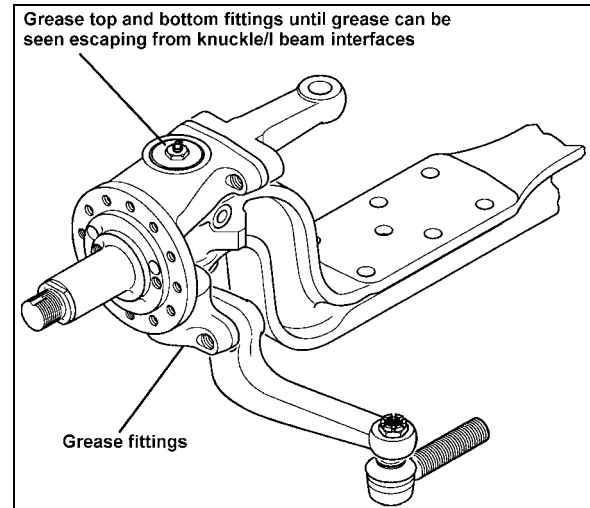


FIGURE 2: FRONT AXLE GREASING POINTS

## 3. MAINTENANCE

A periodic inspection of the front axle assembly should be made to check that all bolts are tight, and that no damage and distortion have taken place. Suspension support stud nuts, U-bolt nuts, tie rod arms, steering arm nuts and stop screws should be checked and tightened, as required, to the torque specifications given at the end of this section. Also check the condition of the steering knuckle pins and bushings. In case of excessive looseness, the bushings and pins should be replaced.

Any looseness in the steering linkage, under normal steering loads, is sufficient cause to immediately check all pivot points for wear, regardless of accumulated mileage. Steering linkage pivot points should be checked each time the front axle assembly is lubricated. Any looseness can be visually detected while rotating the steering wheel in both directions.

Steering knuckles, knuckle pins and bushings can be overhauled or replaced without removing the axle from the vehicle. However, if extensive overhaul work is necessary, the axle assembly should be removed.



**Caution:** Should removal of a locking device be required when undergoing repairs, disassembly or adjustments, always replace with a new one.

### 3.1 TIE ROD END PLAY ADJUSTMENT

If end play exceeds 0.047" (1.2 mm), readjustment is necessary.

Remove protective cap, using a suitable tool ie: a 1" x 1/8" x 9" long flat bar, tighten adjuster piece fully home (SOLID) locating thrust cup onto ball pin.

Still with tool located on adjuster piece, back off carefully (LEAST AMOUNT) until adjuster piece cotter pin is allowed to pass through body, then remove tool.

Reinstall protective cap.

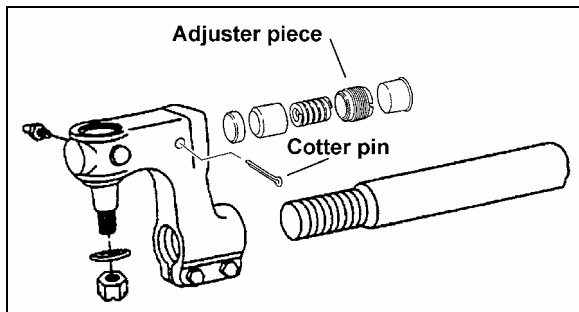


FIGURE 3: TIE-ROD END PLAY ADJUSTMENT 10029

## 4. REMOVAL AND REPLACEMENT

The following procedure deals with the removal of the front axle assembly. The method used to support the axle assembly and suspension components during removal and disassembly depends upon local conditions and available equipment.

### 4.1 REMOVAL

1. Raise the vehicle by its jacking points on the body (see Section 18, "Body" under heading 34; Vehicle Jacking Points) until vehicle body is approximately 20 inches (508 mm) from the floor. Place jack stands under frame. Remove the wheels (if required, refer to Section 13, "Wheels, Hubs and Tires").

**Caution :** Use only the recommended jacking points as outlined in section 18 "BODY".

2. Exhaust compressed air from the air supply system by opening the drain valve of each reservoir.

3. Install jacks under axle jacking points to support the axle weight.

**Warning :** To help prevent injury caused by the axle rolling off the jacks, these should be equipped with U-adapters, or similar precautions must be taken.

4. Disconnect the steering drag link from the steering arm.
5. Remove the ABS sensors from their location in hubs (if applicable).
6. Disconnect the height control valve link from its support on the axle.
7. Disconnect air lines from front brake chambers, and cover line ends and fittings to prevent the entry of foreign matter.

**Caution:** Position the air lines and electric wires so they will not be damaged while removing the front axle assembly.

8. Proceed with steps a, b and c, while referring to Section 16: "SUSPENSION".
  - a) Disconnect sway bar links from axle brackets.
  - b) Remove shock absorbers.
  - c) Disconnect five radius rods: one transversal and two longitudinal from subframe, and two upper rods from axle.
9. Remove the bolts and nuts fixing the axle to the left-hand and right-hand side air bellows mounting supports.
10. Using the jacks, slowly lower the axle assembly, and carefully pull away from underneath vehicle.

### 4.2 REPLACEMENT

Reverse front axle "Removal" procedure. Ensure cleanliness of air bellows support mounting plates.

**Note :** Refer to Section 16, "SUSPENSION", Section 14, "Steering" and to paragraph 8 "Specifications" at the end of this section for applicable checks and recommended tightening torques.

## 5. SERVICE INSTRUCTIONS FOR STEER AXLE

### 5.1 HUB BEARING INSPECTION

An inspection should be made at intervals of 30,000 miles (48 000 km).

- Apply parking brake, raise wheels off the ground and support axle on stands. When the wheels are raised, they should revolve quite freely without roughness.
- Place magnetic base of a dial indicator on brake caliper and position dial indicator stem against a convenient marked spot on face of hub flange.
- With dial indicator in position pull hard but steadily on hub flange and oscillate at same time until a steady reading is achieved.
- Without releasing the pressure, turn bearing so that dial indicator stem contacts marked spot and note reading on indicator.
- Push bearing flange hard and oscillate as before until a steady reading is achieved.
- Without releasing the pressure, turn bearing so that indicator stem again contacts the marked spot and note new reading on indicator.
- The difference between readings is the amount of mounted end play in bearing unit.
- The mounted end play figure should not exceed **0.050 mm (0.002")** for a new bearing and **0.20 mm (0.008")** for a bearing which has been in service.

#### **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.*

### 5.2 KING PIN INSPECTION

An inspection should be made at intervals of 30,000 miles (48 000 km).

Aspects to be considered are: Lateral slackness and Vertical slackness.

#### **NOTE**

*Before commencing checks, apply parking brake, raise wheels off ground and support axle on stands.*

#### 5.2.1 Checking Lateral Slackness

- While this is being carried out the brake must be applied.
- Place a set-square with its stock on ground and its blade against tire 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 outwards.
- Mark changed position of stock end.
- Maximum allowable stock displacement is given as follows: **for 22.5" wheels = 8mm (5/16")**.
- If displacement exceeds stated allowance then need for bush / bearing attention and possible renewal, is in evidence.

#### 5.2.2 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, while applying a lifting force, observe any movement on indicator dial.

**If vertical movement is evident and it exceeds 0.040" (1.02mm)** then readjustment of swivel is required by adjusting thickness of bearing adjusting washers.

Refer to "DANA SPICER Maintenance Manual Model NDS and Maintenance Manual NDS Axles" annexed at the end of this section.

## 6. FRONT WHEEL ALIGNMENT

Correct front wheel alignment must be maintained for steering comfort and satisfactory tire life. Road shocks and vibrations, as well as normal stress and strains on the front-end system can, under normal operating conditions, result in loss of front wheel alignment.

Check the front wheel alignment when the following occurs:

1. Every 200,000 miles (320 000 km) or 24 months (normal maintenance);
2. When the vehicle does not steer correctly; or
3. To correct a tire wear condition.

There are two types of front wheel alignment: **minor alignment** and **major alignment**.

### 6.1 MINOR FRONT WHEEL ALIGNMENT

Perform a minor front wheel alignment for all normal maintenance conditions.

Perform the minor front wheel alignment in the following sequence :

1. Inspect all the systems that affect the wheel alignment. See paragraph 6.3, *"Inspection Before Alignment"* in this section.
2. Check the hub bearings. See section 13, *"Wheels, hubs and Tires"* under heading 8: Front and Tag Axle Wheel Hubs.
3. Check and adjust the toe-in.

### 6.2 MAJOR FRONT WHEEL ALIGNMENT

Perform a major front wheel alignment to correct steering and tire wear conditions.

Perform the major front wheel alignment in the following sequence:

1. Inspect all systems affecting the wheel alignment. See paragraph 6.3, *"Inspection Before Alignment"* in this section.
2. Check the hub bearings. See section 13, *"Wheels, hubs and Tires"* under heading 8: Front and Tag Axle Wheel Hubs.

**Note:** *If steering angle stoppers are changed, a special procedure is required for readjusting gearbox steering limiter. See paragraph 6.5 "HYDRAULIC STOP" in this section.*

3. Check and adjust the turning angle adjustment.
4. Check the camber angle.
5. Check and adjust the caster angle.
6. Check and adjust the toe-in.

### 6.3 INSPECTION BEFORE ALIGNMENT

Check the following before doing a front wheel alignment:

1. Ensure that the vehicle is at normal riding height. See Section 16, *"Suspension"* under heading 7: *"Suspension Height Adjustment"*.
2. Ensure that front wheels are not the cause of the problem. See Section 13, *"Wheels, Hubs and Tires"*. Inspect the tires for wear

patterns indicating suspension damage or misalignment.

- a. Make sure the tires are inflated to the specified pressure.
  - b. Make sure the front tires are the same size and type.
  - c. Make sure the wheels are balanced.
  - d. Check wheel installation and straightness.
3. Check the wheel bearing adjustment. See Section 13, *"Wheels, Hubs and Tires"*.
  4. Check steering linkage for bending and pivot points for looseness.
  5. Check knuckle pins for evidence of excessive wear.
  6. Check radius rods for bending and rubber bushings for evidence of excessive wear.
  7. Make sure all fasteners are tightened to the specified torque. Use a torque wrench for verification. As soon as the fastener starts to move, record the torque. Correct if necessary. Replace any worn or damaged fasteners.

### 6.4 TURNING ANGLE ADJUSTMENT

The maximum turning angle is set through the two steering stop screws installed on the axle center. The turning angle is factory adjusted to accommodate the chassis design, and therefore, does not require adjustment on new vehicles. However, it should be checked and adjusted any time any component of the steering system is repaired, disassembled or adjusted.

Check if front tires rub against the frame or if the steering gear has been serviced.

Proceed with the following method to check the steering maximum turning angle :

#### 6.4.1 R.H. Turn Adjustment

**Caution :** *To prevent the steering damper from interfering with the adjustment of turning angles, make sure its fixing bracket is at the correct location on the axle center (refer to section 14 "STEERING").*

1. Turn steering wheel to the right until the boss on the axle center touches the right stop screw.
2. Verify the nearest point of contact of the ball socket body with the air bellows support

assembly. Measure the distance between those two points.

3. The distance between these two points should be approximately 1/8 inch (3 mm). If not, the steering stop screws must be readjusted.
4. Verify the nearest point of contact of the drag link with the tire. Measure the distance between those two points.
5. The distance should be 1 inch (25 mm) or more. If not, the steering stop screws must be readjusted.
6. This must be done for a full right turn.
7. If readjustment is required:
  - a. Remove the swivel stop screw.
  - b. Add to the stop screw the required number of washers to obtain the proper measure, tighten the stop screw afterwards. Two washers of different thickness are available: 1/16 inch and 3/16 inch.

#### 6.4.2 L.H. Turn Adjustment

1. Turn steering wheel to the left until the boss on the axle center touches the left stop screw.
2. Verify the nearest point of contact of the ball socket body with the air bellows support assembly. Measure the distance between those two points.
3. The distance between these two points should be approximately 1/8 inch (3 mm). If not, the steering stop screws must be readjusted.
4. Check the stroke of the steering stabilizer cylinder (damper). It should not exceed 12.59 inches (320 mm).
5. The steering stopper screw must be in contact before the steering stabilizer reaches the end of the stroke.
6. This must be done for a full left turn.
7. If readjustment is required:
  - a. Remove the swivel stop screw.
  - b. Add to the stop screw the required number of washers to obtain the proper measure, tighten the stop screw afterwards. Two washers of different thickness are available: 1/16 inch and 3/16 inch.

**Note :** If steering angle stoppers are changed, a special procedure is required for readjusting gearbox steering limiter. See paragraph 6.5 "HYDRAULIC STOP" in this section.

#### 6.5 HYDRAULIC STOP

**Note :** Before readjusting steering limiter, verify vehicle wheel alignment and ensure that oil level is checked and that air bleeding is done.

Refer to 'ZF-Servocom Repair Manual' annexed at the end of Section 14 "Steering" under heading 'Setting and Functional Test'.

#### 6.6 FRONT WHEEL CAMBER

Wheel camber is the number of degrees the top of the wheel tilts outward (positive) or inward (negative) from a vertical angle (Fig. 4).

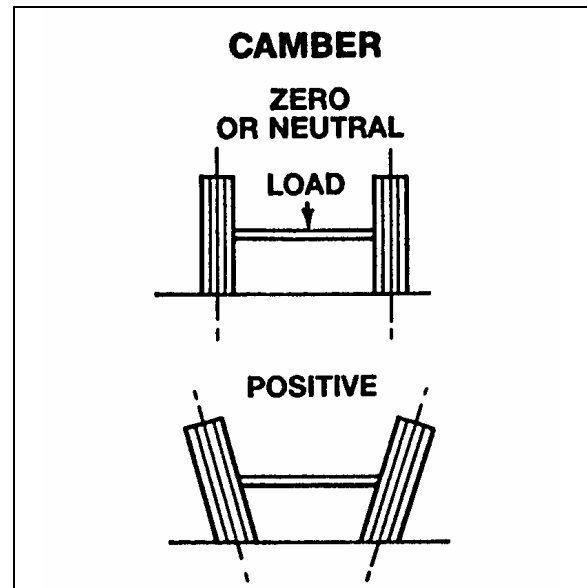


FIGURE 4: CAMBER

10006

The camber angle is not adjustable. Camber variations may be caused by wear at the wheel bearings, steering knuckle pins or by a bent knuckle or sagging axle center. Steering effort is affected by improper camber, and uneven tire wear will result. Excessive positive camber causes an irregular wear of tire at the outer shoulder and excessive negative camber causes wear at the inner shoulder.

##### 6.6.1 Camber Check

**For camber specifications, refer to paragraph 8: "SPECIFICATIONS" in this section**

**Note:** Camber angle varies with the axle loading. If the vehicle is not completely empty,

please refer to the camber angle curve in the specifications at the end of this section.

1. Use an alignment machine to check the camber angle.
2. If camber reading is not in the specifications, adjust the wheel bearings and repeat the check. If the reading is still not within specifications, verify the steering knuckle pins and axle center.
3. See instructions in "DANA SPICER Maintenance Manual Model NDS and Maintenance Manual NDS Axles" annexed at the end of this section.
4. Check the wheel lateral distortion as instructed in Section 13, "Wheels, Hubs and Tires" under heading, "Checking for Distorted Wheel on Vehicle". If distortion is excessive, straighten or replace wheel(s).

#### 6.7 FRONT AXLE CASTER

**For caster specifications, refer to paragraph 8: "SPECIFICATIONS" in this section.**

Positive caster is the rearward tilt from the vertical axis of the knuckle pin. Negative caster is the forward tilt from the vertical axis of the knuckle pin (Fig. 5). This vehicle is designed with a positive caster. The purpose of the caster angle is to give a trailing effect. This results in stabilized steering and a tendency for the wheels to return to the straight-ahead position after taking a turn.

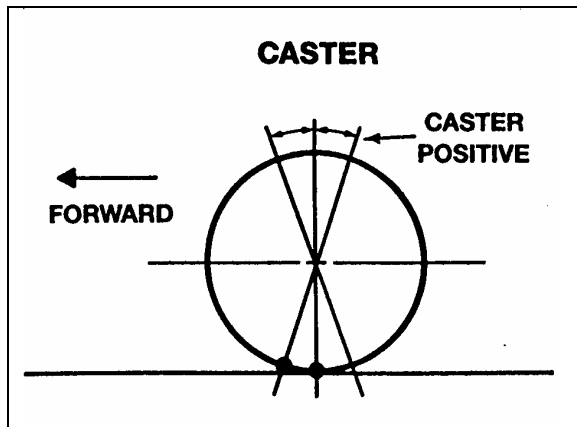


FIGURE 5: CASTER

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Excessive caster results in hard steering around corners. A shimmy may also develop when returning to the straight ahead position (pulling out of curves).

Insufficient caster will cause wandering and steering instability. Caster variations may be caused by a bent axle, tilting or distortion of the

side suspension supports, damaged radius rod bushings, or unequal tightening of the front and rear suspension support bolts. Incorrect caster must be corrected by replacing the damaged suspension parts. A precision instrument should be used to measure the caster.

**Note :** The caster of this vehicle is factory set and is not adjustable. However, if after replacing damaged parts or in case of improper caster due to irregular setting, the front axle caster needs adjustment; it can be adjusted by means of shims (Prévost #110663) on the left-hand side upper radius rod support in order to obtain minor adjustment.

#### 6.8 FRONT WHEEL TOE-IN

Wheel toe-in is the degree (usually expressed in fractions of an inch) to which the forward part of the vehicle front wheels are closer together than the rear part, measured at wheel centerline height with the wheels in the normal "straight-ahead" position of the steering gear.

Incorrect toe-in results in excessive tire wear caused by side slippage and also steering instability with a tendency to wander. Toe-in may be measured from the center of tire tread or from the inside of the tires. Take measurements at both front and rear of axle (see "A" and "B" in fig. 6).

When setting toe-in adjustment, the front suspension must be neutralized; that is, all component parts must be in the same relative position when marking the adjustment as they will be when in operation.

To neutralize the suspension, the vehicle must be rolled forward, approximately ten feet.

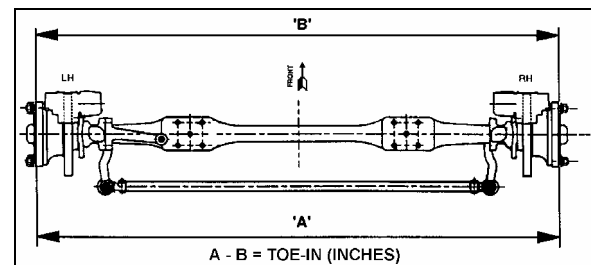


FIGURE 6: TOE-IN MEASUREMENT

10008B

For toe-in specifications, refer to paragraph 8 "Specifications" in this section.

By rolling the vehicle forward, all tolerances in the front suspension are taken up and the suspension is then in its normal operating position. Neutralizing the front suspension is

extremely important, especially if the vehicle has been jacked up in order to mark the tires. Otherwise, the front wheels will not return to their normal operating position due to the tires gripping the floor surface when the vehicle jack is lowered.

**Note:** *“Toe-in” measurements must be taken at the horizontal axis of the wheel centerline.*

#### 6.8.1 Inspection and Adjustment

Before checking front wheel toe-in, first check the camber angles and make the necessary corrections.

1. Measure the toe-in.
2. If the toe-in measurement is not within the specified tolerance, carry out the following procedure :
  - a. Loosen the pinch bolt nuts and bolts on each tie rod end.
  - b. Turn the tie rod until the specified toe-in measurement is obtained.
  - c. Tighten the pinch bolt nuts alternately and progressively to 65-75 lbf-ft (88-102 Nm), thus securing all tie rod joints.

## 7. TROUBLESHOOTING

CONDITION	CAUSE	CORRECTION
Tires wear out quickly or have uneven tire tread wear.	<ol style="list-style-type: none"> <li>1. Tires have incorrect air pressure.</li> <li>2. Tires out-of-balance.</li> <li>3. Incorrect tag axle alignment.</li> <li>4. Incorrect toe-in setting.</li> <li>5. Incorrect steering arm geometry.</li> </ol>	<ol style="list-style-type: none"> <li>1. Put specified air pressure in tires.</li> <li>2. Balance or replace tires.</li> <li>3. Align tag axle.</li> <li>4. Adjust toe-in specified setting.</li> <li>5. Service steering system as necessary.</li> </ol>
Vehicle is hard to steer.	<ol style="list-style-type: none"> <li>1. Low pressure in the power steering system.</li> <li>2. Steering gear not assembled correctly.</li> <li>3. Steering linkage needs lubrication.</li> <li>4. King pins binding.</li> <li>5. Incorrect steering arm geometry.</li> <li>6. Caster improperly adjusted.</li> <li>7. Tie rod ends hard to move.</li> <li>8. Worn thrust bearing.</li> </ol>	<ol style="list-style-type: none"> <li>1. Repair power steering system.</li> <li>2. Assemble steering gear correctly.</li> <li>3. Lubricate steering linkage.</li> <li>4. Replace king pins.</li> <li>5. Service steering system as necessary.</li> <li>6. Adjust caster as necessary.</li> <li>7. Replace tie rod ends.</li> <li>8. Replace thrust bearing.</li> </ol>
Bent or damaged steering arm, steering top lever or tie rod assembly.	<ol style="list-style-type: none"> <li>1. Too much pressure in the power steering system.</li> <li>2. Cut-off pressure of the power steering system improperly adjusted.</li> <li>3. Vehicle not powered on correctly.</li> <li>4. Power steering system not installed correctly.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace damaged part(s), adjust power steering system to specified pressure.</li> <li>2. Make sure vehicle is powered on correctly.</li> <li>3. Correctly install the power steering system.</li> <li>4. Correctly install the power steering system.</li> </ol>
Worn or damaged steering ball stud.	<ol style="list-style-type: none"> <li>1. Drag link fasteners tightened past specified torque.</li> <li>2. Lack of lubrication or incorrect lubricant.</li> <li>3. Power steering stops improperly adjusted.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace damaged part(s), tighten drag link fasteners to specified torque.</li> <li>2. Lubricate linkage with specified lubricant.</li> <li>3. Adjust stops to specified dimension.</li> </ol>
Worn king pins and knuckle bushings.	<ol style="list-style-type: none"> <li>1. Worn or missing seals and gaskets.</li> <li>2. Incorrect lubricant.</li> <li>3. Axle not lubricated at scheduled frequency.</li> <li>4. Incorrect lubrication procedures.</li> <li>5. Lubrication schedule does not match operating conditions.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace damaged part(s), replace seals and gaskets.</li> <li>2. Lubricate axle with specified lubricant.</li> <li>3. Lubricate axle at scheduled frequency.</li> <li>4. Use correct lubrication schedule to match operating conditions.</li> <li>5. Change lubrication schedule to match operating conditions.</li> </ol>
Vibration or shimmy of front axle during operation.	<ol style="list-style-type: none"> <li>1. Caster not adjusted properly.</li> <li>2. Wheels and/or tires out-of balance.</li> <li>3. Worn steering stabilizer cylinder.</li> </ol>	<ol style="list-style-type: none"> <li>1. Adjust caster.</li> <li>2. Balance or replace wheels and/or tires.</li> <li>3. Replace steering stabilizer cylinder.</li> </ol>

### 8. SPECIFICATIONS

#### Front Axle

Make ..... DANA SPICER EUROPE  
Model ..... NDS  
Front Track ..... 84.4 inches (2 145 mm)  
Rated load capacity ..... 16,500 lbs (7 500 kg)

#### Torque specifications

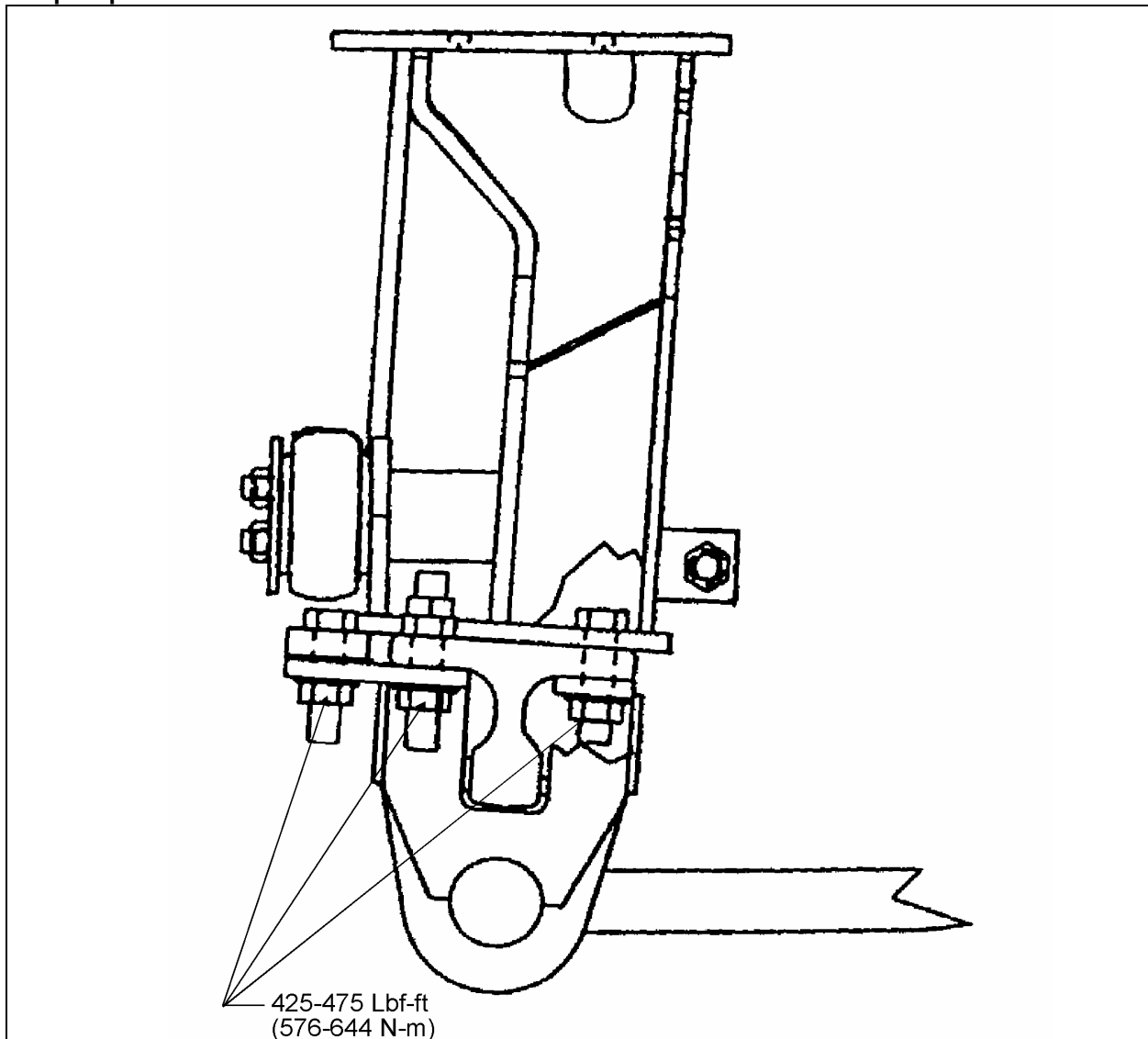


FIGURE 7: AIR BELLOWS MOUNTING SUPPORT AND AXLE

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For more torque specifications, see 'Dana Spicer Maintenance Manual NDS Axles and Maintenance Manual Model NDS' annexed at the end of this section.



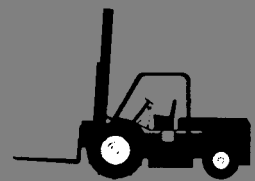
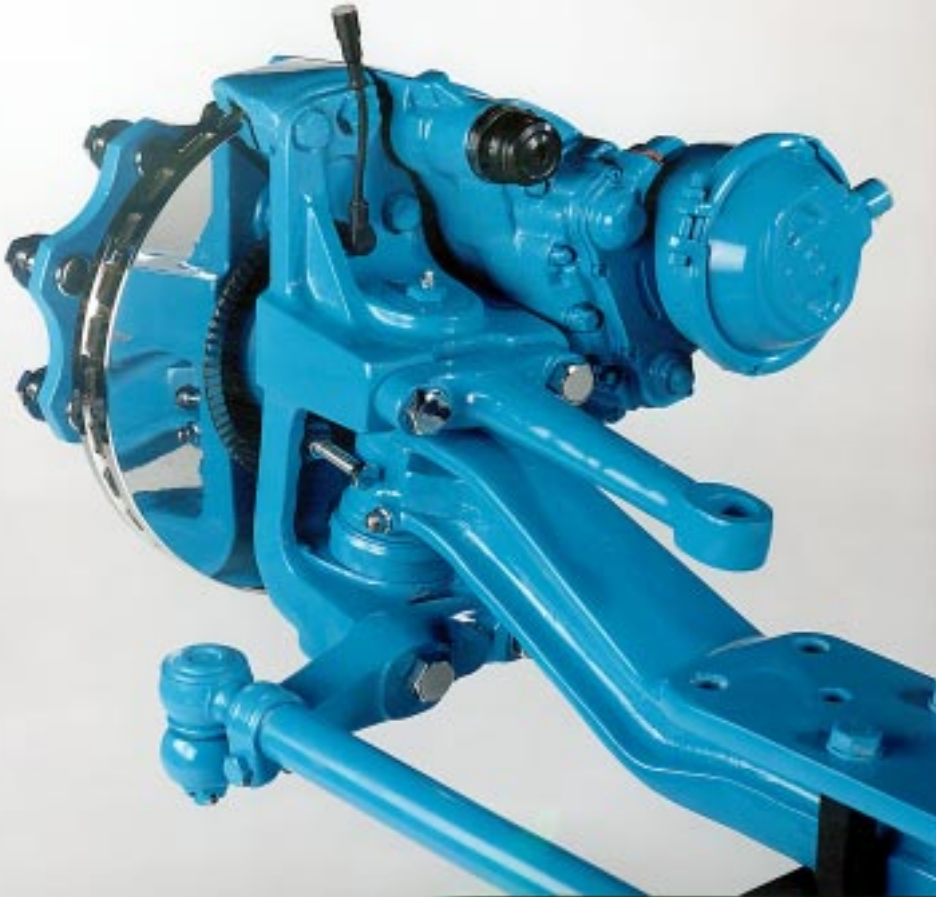
FRONT WHEEL ALIGNMENT SPECIFICATIONS			
Front Wheel Alignment	Minimal	Nominal	Maximal
Camber, (degrees) R.H. and L.H. *	-0.250	0.125	0.375
Caster, (degrees) R.H. and L.H.	2	2.75	3.5
Toe-in (A minus B), (degrees)	0.06	0.08	0.10

**NOTE**

*Camber angle changes with loading. The given numbers are for an empty vehicle.*



**SERVICE MANUAL**  
**GENERAL INFORMATION**  
NDS Axle range



**SPICER SPECIALITY AXLE DIVISION**



**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  
ABBAY 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 words require clarification; hence the following list:-

ENGLISH

SWIVEL  
COTTER PIN  
AXLE BED  
STEERING LEVER  
HUB NUT  
SWIVEL STOP SCREW  
TOP / BOTTOM CAP  
BUSHES  
LUBRICATOR

U.S.A

KNUCKLE  
DRAW KEY  
I BEAM  
TIE ROD ARM  
SPINDLE NUT  
STOP BOLT  
KING PIN CAP  
BUSHINGS  
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**

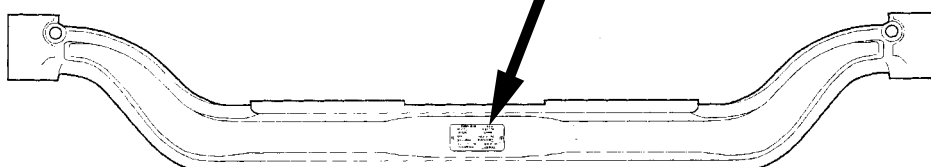
In order to assist our spares department when ordering spare parts for your NDS range axle, please have the following information to hand.

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*<sup>®</sup> SPARE PARTS!**





**APPLICATION POLICY**

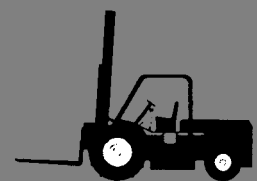
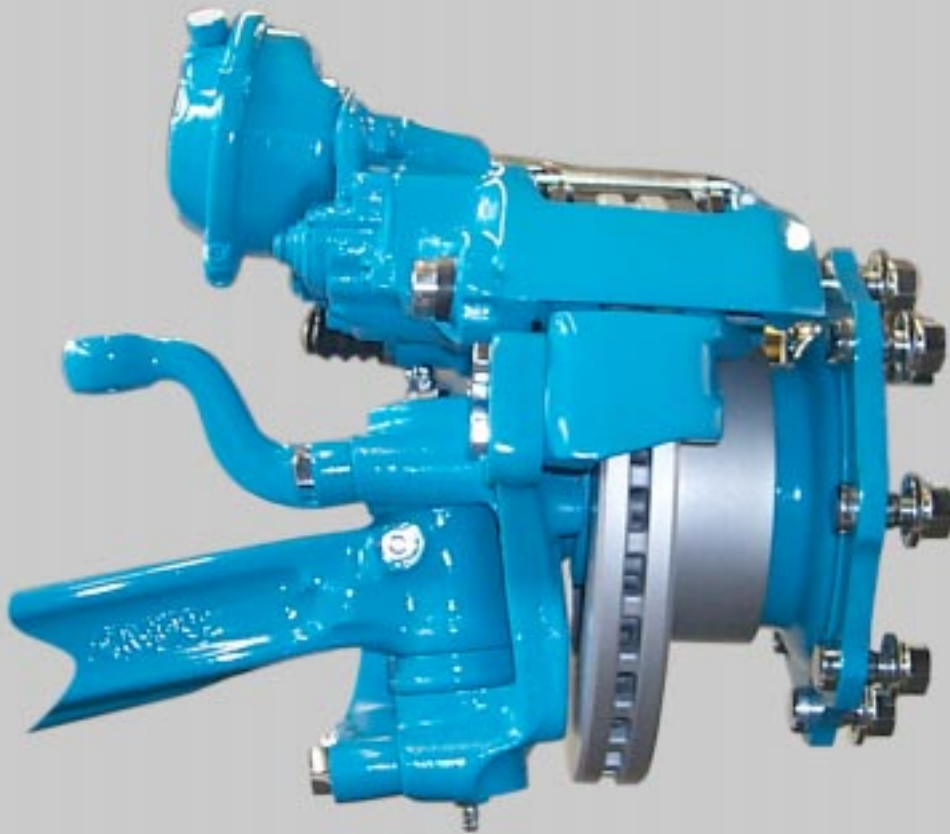
Capability ratings, features and specifications vary depending upon the model type of service. Applications approvals must be obtained from Spicer Speciality axle division. We reserve the right to change or modify our product specifications, configurations, or dimensions at any time without notice.



**SPICER SPECIALITY AXLE DIVISION  
ABBAY 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**





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**

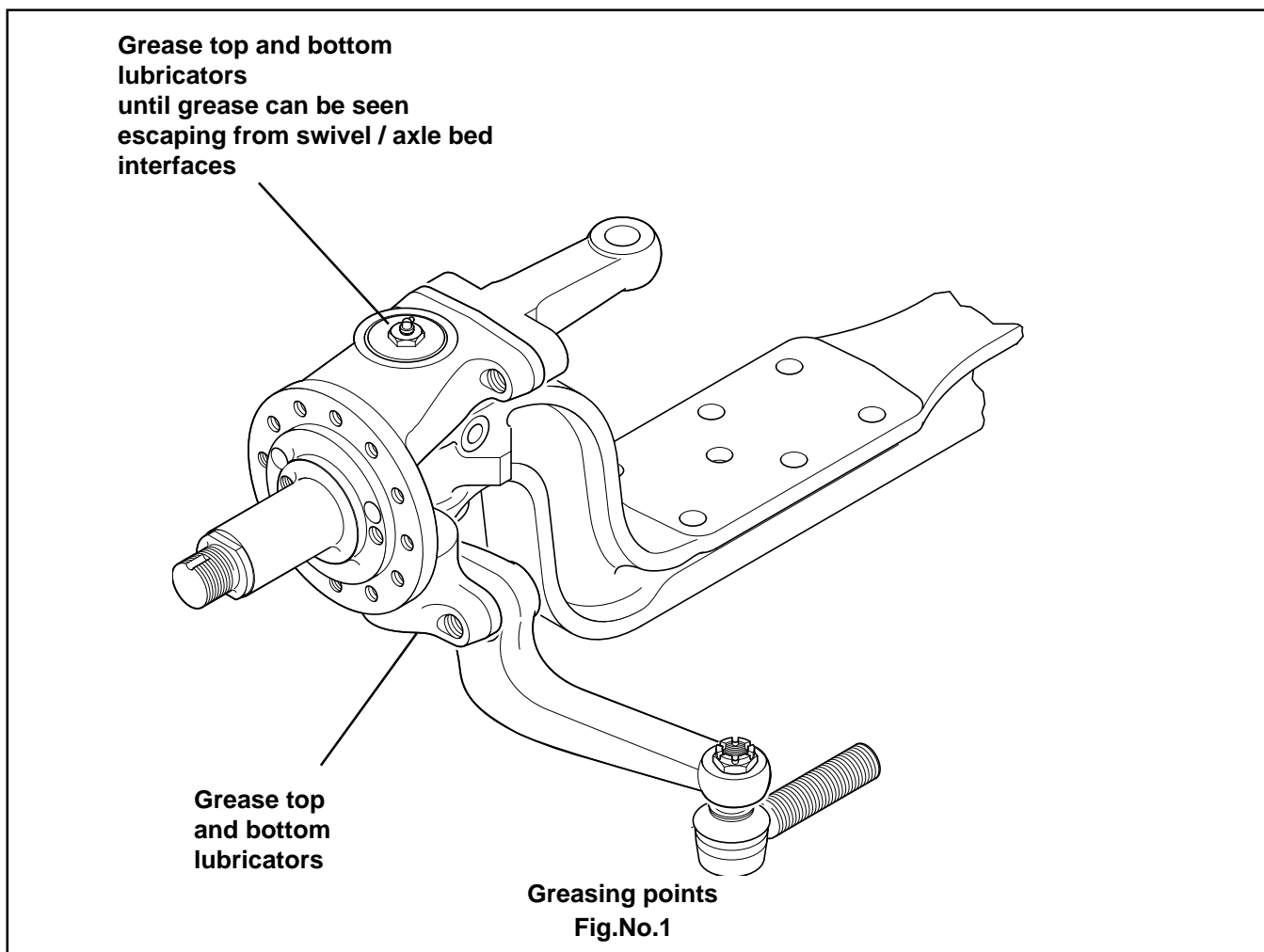
**1.1 GREASING PERIODS**

**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.**



**NOTE :- ALL OTHER COMPONENTS IN THE NDS RANGE OF AXLES ARE GREASED FOR LIFE AND REQUIRE NO FURTHER LUBRICATION DURING THE LIFE OF THE COMPONENT.**

**Recommended lubrication - LITHIUM BASE ROLLER BEARING GREASE NLGI NUMBER 2**

**1.2 Recommended Greases**

**Use greases to grade "F" in lubrication manual**

**SECTION 2 ROUTINE MAINTENANCE**

- 2.1 Hub bearing check should be carried out every 30000 miles (48000 km)
- a) Before commencing checks, apply parking brake, raise wheels off ground and support axle on stands. and remove brake drum (if fitted) .



**WARNING!**  
**NEVER WORK UNDER A VEHICLE SUPPORTED ONLY BY JACKS!**  
**ALWAYS USE SUITABLE AXSLE STANDS!**

- b) Place magnetic base of a dial indicator on brake shoe / caliper and position dial indicator stem against a convenient marked spot on face of Hub flange
- c) With dial indicator in position pull hard but steadily on Hub flange and oscillate at same time until a steady reading is achieved.
- d) Without releasing the pressure, turn bearing so that dial indicator stem contacts marked spot and note reading on indicator.
- e) Push bearing flange hard and oscillate as before until a steady reading is achieved.
- f) Without releasing the pressure, turn bearing so that indicator stem again contacts the marked spot and note new reading on indicator.
- g) The difference between readings is amount of mounted end play in bearing unit .
- h) The mounted end play figure should not exceed 0.050mm for a new bearing.

**NOTE:-**  
**IF ORIGINAL BEARING UNIT IS RE-FITTED, AND END FLOAT IS MEASURED AT 1MM, WITH HUB NUT FULLY TIGHTENED TO CORRECT TORQUE, THEN THE RETAINING CLIP WITHIN THE UNIT IS DAMAGED / DISPLACED AND A NEW UNIT MUST BE FITTED.**



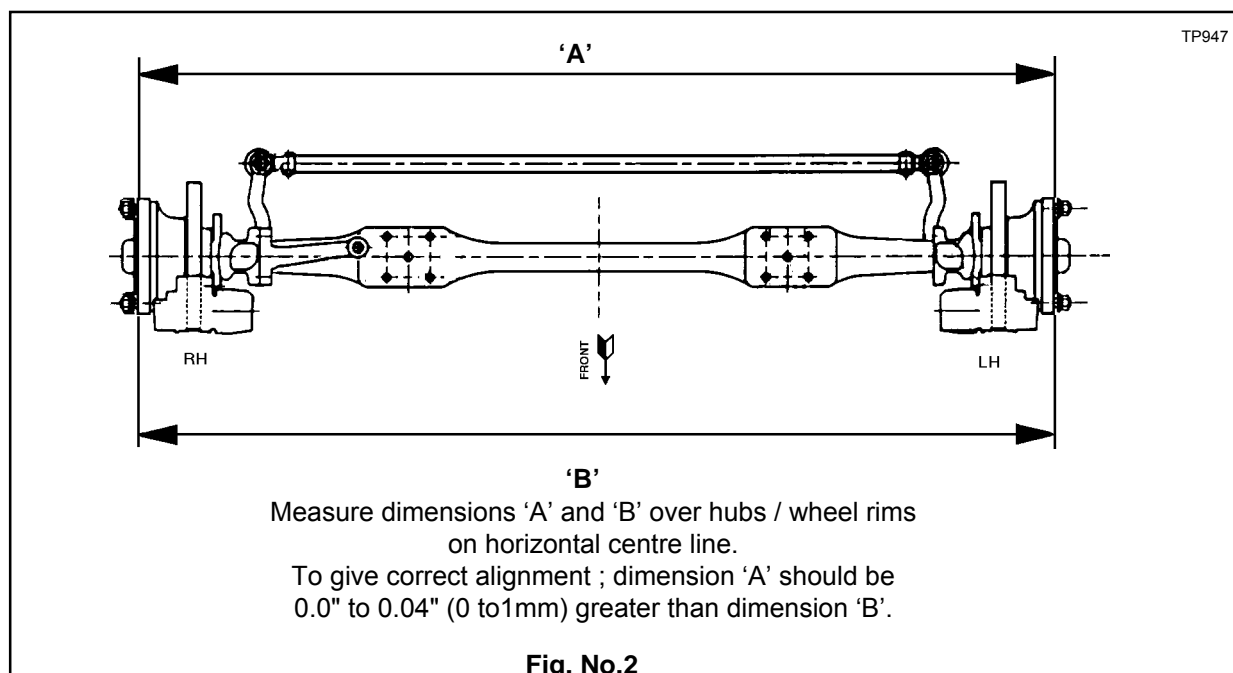
To check front wheel ' Toe In '

- a) To preserve correct steering and avoid excessive tyre wear, tracking (or alignment) of front wheels should be checked periodically, as follows :-  
 Set front wheels in straight ahead position and at points level with wheel centre, measure distance over hubs / wheel rims, both in front and behind axle centre.  
 For correct 'Toe In' front measurement 'B' should be 0" to 0.04" (0 to1mm) smaller than rear measurement 'A' .
- b) To allow for inaccuracies in wheels, same check should be made with vehicle moved an equivalent to half of a wheel revolution (180°). Any adjustment required can be effected by backing off clamp bolts in ball sockets and rotating tie (track) rod tube.  
 After adjustment, tighten clamp bolts to specified torque.

All steer axles supplied by Spicer Speciality Axle Division have their lockstops set to customer requirements.

It is important that when the power assisted steering is fitted, the steering gear is adjusted so that the hydraulic assistance cuts out just before the lockstops come into contact with the axle beam, to avoid excessive loads being transmitted through the steering linkages.

Incorrectly adjusted steering could lead to premature failure or shortened life of all steering components.



- 2.3 Check condition of brake pads as described in relevant brake manufacturers service manual.

**SECTION 2 ROUTINE MAINTENANCE Cont.**

2.4 Check permissible slackness in swivel (king) pins every 30000 miles (48000 km) as follows :-

Aspects to be considered are :-

- a) Lateral slackness.
- b) Vertical slackness.

Before commencing checks, apply parking brake, raise wheels off ground and support axle on stands.

**a) Checking lateral slackness**

Whilst this is being carried out the brake must be applied.

Place a set -square with its stock on ground and its blade against tyre wall.

Place a mark on ground to indicate position of stock end.

Insert a lever through bottom cut-out of wheel and lever it upwards thus moving set-square outboard.

Mark changed position of stock end.

Maximum allowable stock displacement is given as follows:-

for 17.5" wheels	=	6mm.
for 19.5" wheels	=	7mm.
for 22.5" wheels	=	8mm.
for 24.0" wheels	=	9mm.

If displacement exceeds stated allowance then need for bush / bearing attention and possible renewal, is in evidence.

**b) Checking vertical slackness**

This is measured by a dial indicator anchored to axle beam and having its pointer placed vertical against swivel top.

Place a jack against underside of swivel and, whilst applying a lifting force, observe any movement on indicator dial.

If vertical movement is evident and it exceeds 0.040" (1.02mm) then re-adjustment of swivel is required by adjusting thickness of bearing adjusting washers.

2.5 Every 6 months, check for movement in ball joints as follows :-



**NOTE :-**

**THIS TEST IS TO BE CARRIED OUT WITH VEHICLE IN LOADED CONDITION, DO NOT JACK UP VEHICLE**

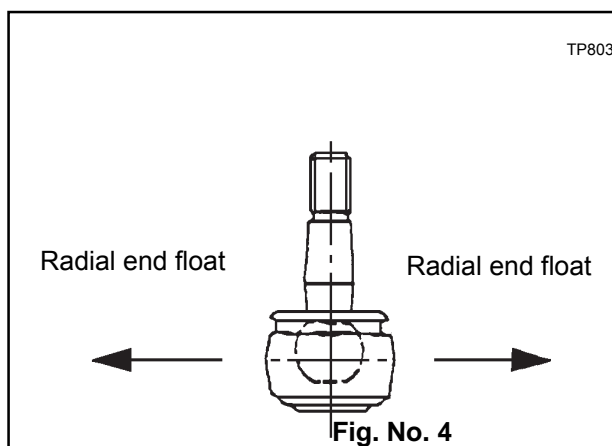
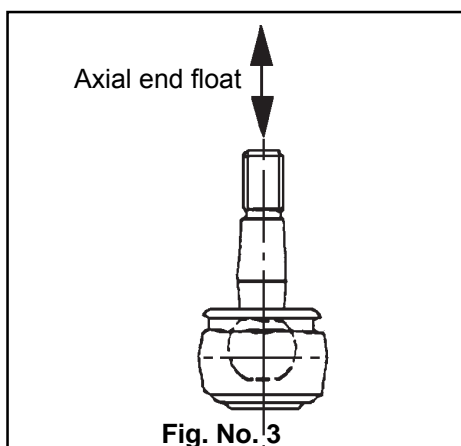
**a) Axial end float (axial travel)**

End float in direction of axis of ball pin, as shown in fig. no.3 should be within limits of 0.4mm to 2.0mm max. using a test force of 850N.

**b) Radial end float (radial travel)**

Radial end float at right angles to axis of ball pin as shown in fig. no. 4 should be within limits of 0.4mm to 0.8mm max. using a test force of 6000N.

Replace ball joints if outside limits given in a) and / or b).



## SECTION 2 ROUTINE MAINTENANCE Cont.

2.6 Every 6 months inspect ball joints for corrosion as follows :-

**NOTE:-**

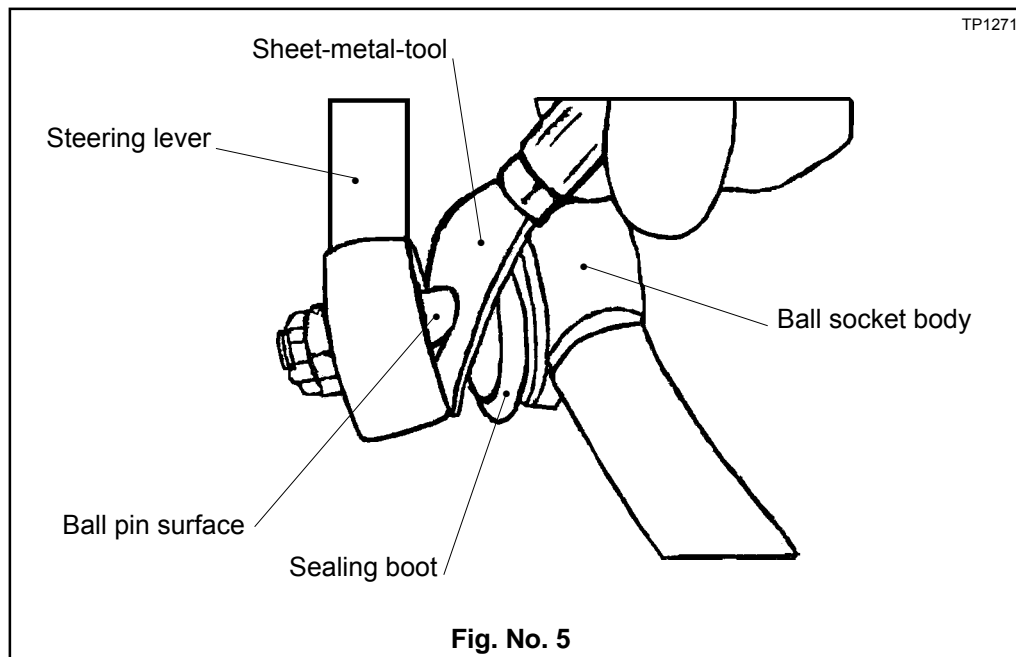
**INSPECTION OF BALL JOINTS IS IMPORTANT, ESPECIALLY THOSE IN OLDER VEHICLES. DAMAGED SEALING BOOTS, SALT ON ROADS IN WINTER AND CLIMATIC CONDITIONS CAN CAUSE LOSS OF THE CORROSION PROTECTION COATING APPLIED DURING MANUFACTURE.**

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.



If there is corrosion of the ball pin or the sealing boot has deteriorated through ageing or is damaged, replace the ball joint in question, or the complete tie rod or drag link as appropriate.

If there is corrosion of the steering lever area which is in contact with the sealing boot, clean and eliminate all surface irregularities.

If there is no corrosion or damage to the sealing boot, smear the steering lever surface with Lithium grease and push the sealing boot back into its properly seated position.

When dismantling tie rods, drag links or drop arms ensure that no damage is caused to the sealing boots or ball joint housings.



## SECTION 3 CARE OF WHEELS AND FIXING FACES (ALL AXLES WITH SPIGOT FIXING)

At approximately 100 miles after fitting wheels, wheel nut torque should be checked with wheel ends in " cold " condition ( ie not after prolonged braking.).

If any relaxation of original torque (**see specification**) has occurred, 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 occurring.

**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 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.

**NOTE :-**

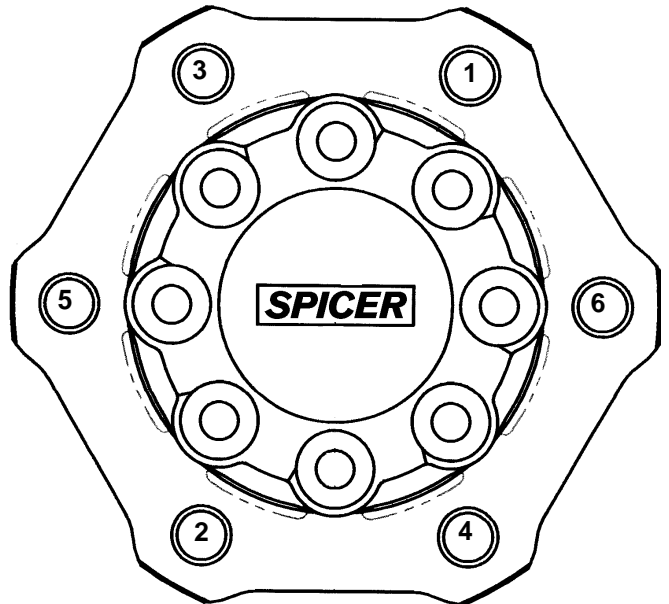
**FURTHER DETAILS ARE GIVEN IN BRITISH STANDARD CODE OF PRACTICE FOR THE SELECTION AND CARE OF TYRES AND WHEELS FOR COMMERCIAL VEHICLES:- BSAU50 : PART 2 : SECTION 7A : 1995**

**3.2 PROTECTION OF SPIGOT WHEEL FIXING DIAMETERS AND PRESSURE SURFACES.**

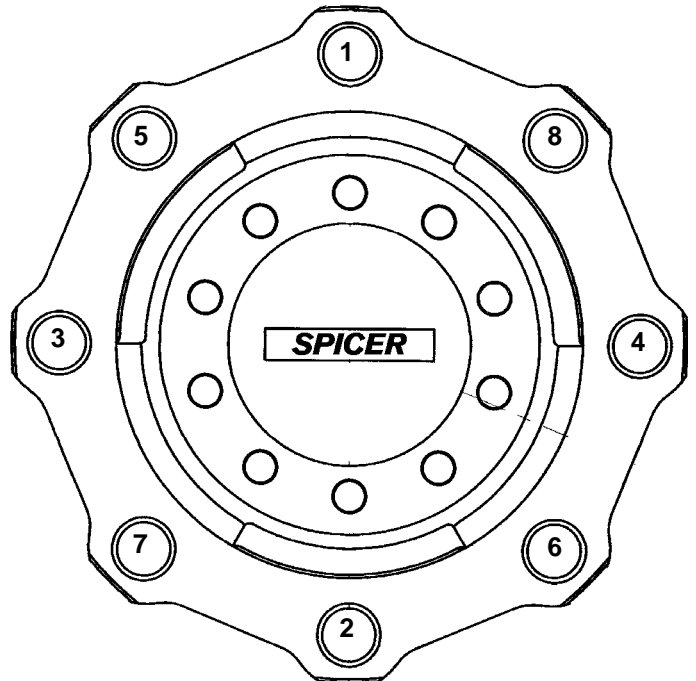
Although **Spicer Speciality Axles Division** apply an initial surface coating to wheel rim mating faces on spigot to stop rusting and facilitate easy removal of wheels. The application of P.B.C. grease such as 'Rocol Tufgear' or equivalent to wheel register is recommended.

**The above P.B.C. grease is available from Rocol Ltd., Rocol House, Wakefield Road, Swillington, Leeds, UK. Phone: 44 (113) 2322600. Fax: 44 (113) 2322740.**

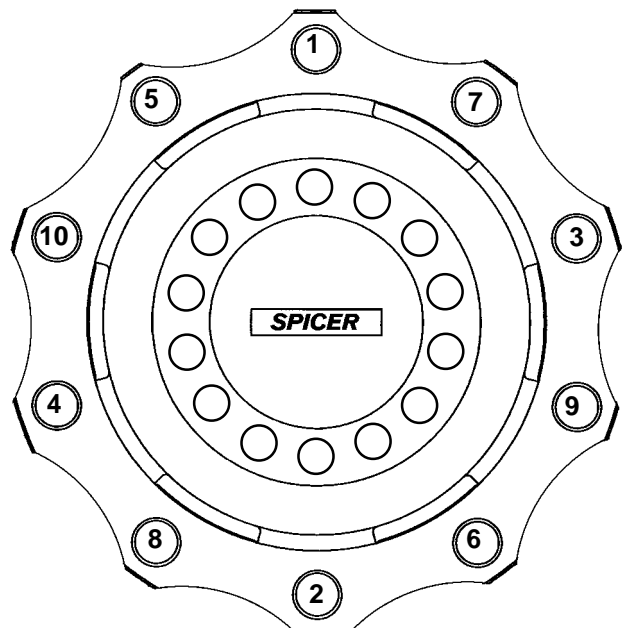
**WHEELNUT TIGHTENING  
TORQUE SEQUENCE  
6 - STUD FIXING**



**WHEELNUT TIGHTENING  
TORQUE SEQUENCE  
8 - STUD FIXING**



**WHEELNUT TIGHTENING  
TORQUE SEQUENCE  
10 - STUD FIXING**



**SECTION 4**      **Guidance standards for acceptable brake drum crazing (if fitted).**

Every 30000 miles (48000 km) or whenever brake drums are removed for axle maintenance purposes they should be checked for crazing.

Brake drums with crazing in excess of that shown in fig.6 below, and which are of Spicer Speciality axle division manufacture should not be re introduced into service.

Figs.7 & 8 show examples of unacceptable crazing.



fig.6



fig.7



fig.8

**EVALUATION OF BRAKE DISC SURFACE**

TP1627

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.**



Fig. 9



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.**

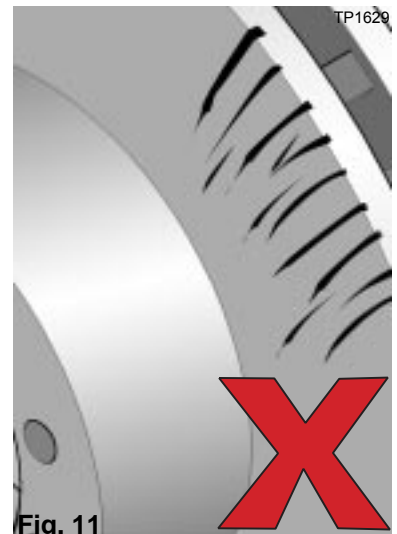


Fig. 11

If any **Through** cracks are found in the brake disc as shown in fig. 12. then the disc **must be replaced.**

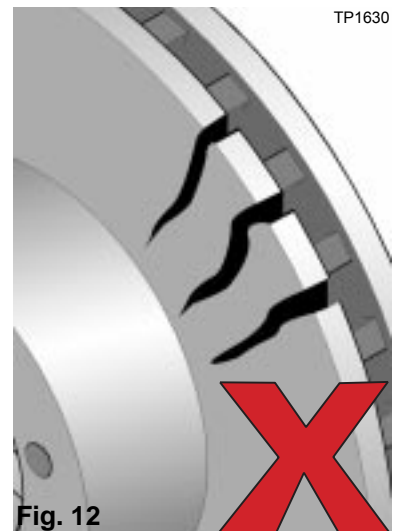


Fig. 12

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.

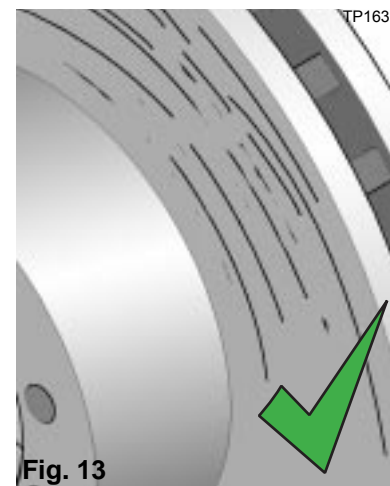


Fig. 13

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.

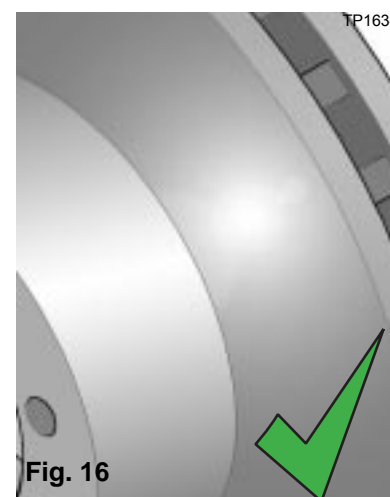


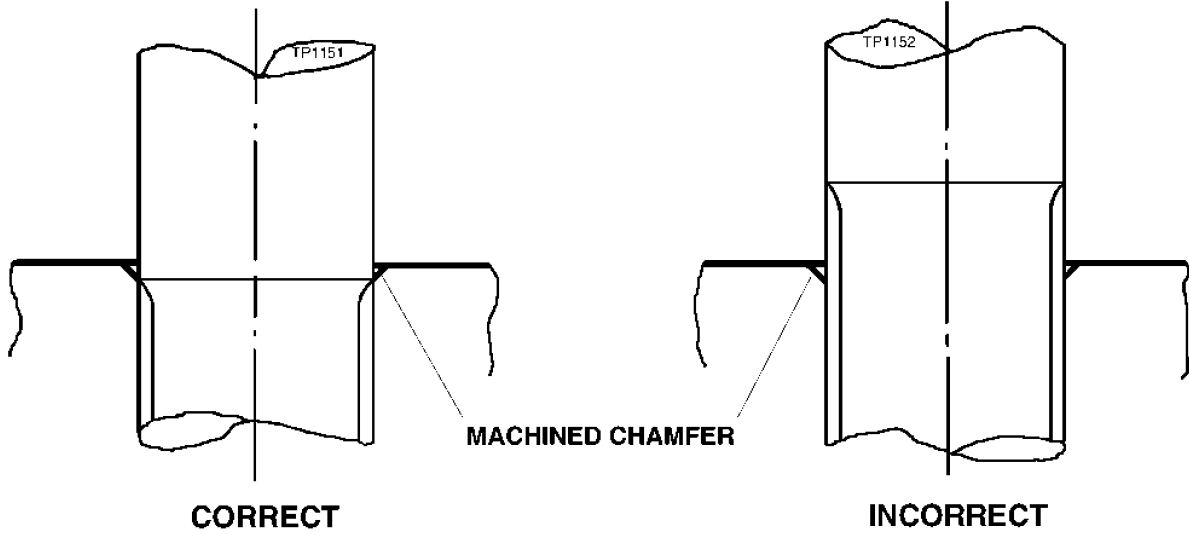
Fig. 16



**SPICER SPECIALITY AXLE DIVISION**

**STANDARD STUDS - FITTED INTO MACHINED CHAMFERED HOLES**

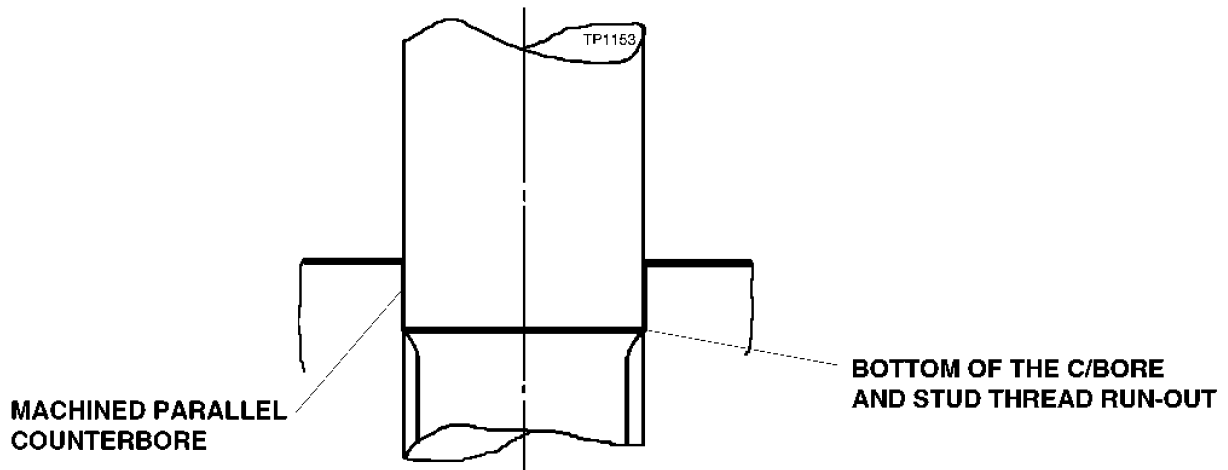
STUDS TO BE INSERTED UNTIL THREAD RUN-OUT LOCKS INTO PARENT METAL



**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									
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<p><b>DISTRIBUTION</b> Front Axle B.U. Drive Axle B. U. Production</p>	<p><b>STUD FITTING PROCEDURES</b></p>	<p><b>TD183/1</b> SHT 1 OF 1</p>
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SWIVEL / AXLE BED TIGHTENING TORQUES

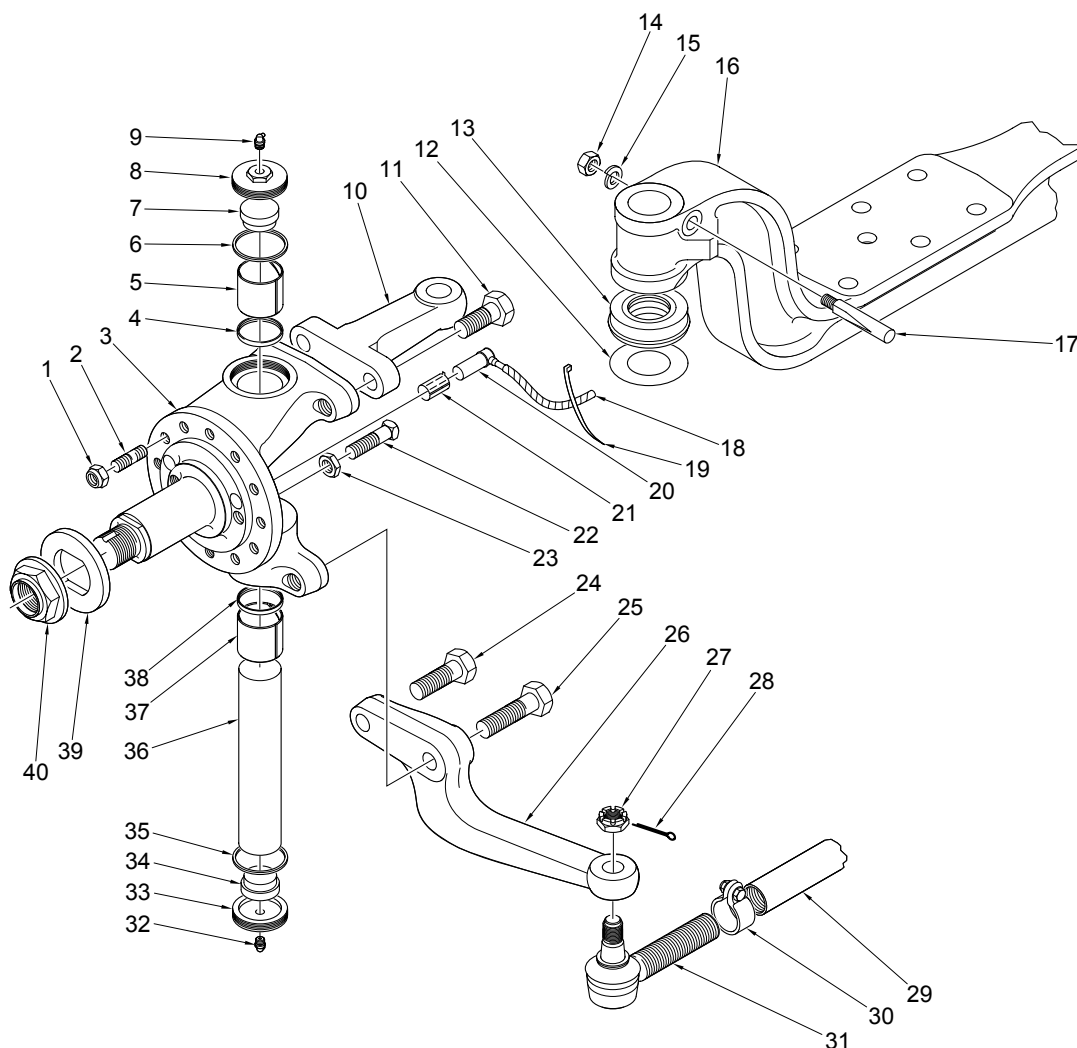


Fig.No.17

PART N° --- DESCRIPTION ----- TIGHTENING TORQUE

1	Brake backplate nut 1/2" UNF	85 - 103 lbs.ft	115 - 140 NM	(All axles)
2	Brake backplate stud 1/2" UNF	See TD 183/1		(All axles)
8	Swivel top cap	25 - 75 lbs.ft	34 - 102 NM	(All axles)
9	Swivel top cap lubricator	10 - 15 lbs.ft	14 - 20 NM	(All axles)
11	Top lever bolts M20 x 2.5 grade 10.9	433 - 479 lbs.ft	587 - 649 NM	(NDS 35/41/56)
	Top lever bolts M20 x 2.5 grade 12.9	520 - 575 lbs.ft	705 - 780NM	(NDS 56)
	Top lever bolts M24 x 3 grade 10.9	751 - 830 lbs.ft	1018 - 1125 NM	(NDS 80)
14	Cotter pin nut 1/2" UNF	51 - 61 lbs.ft	69 - 82 NM	(All axles)
23	Lockstop nut	90 - 120 lbs.ft	122 - 162 NM	(All axles)
24 & 25	Bottom lever bolts M20 x 2.5 grade 10.9	433 - 479 lbs.ft	587 - 649 NM	(NDS 35/41/56)
	Bottom lever bolts M20 x 2.5 grade 12.9	520 - 575 lbs.ft	705 - 780NM	(NDS 80)
	Bottom lever bolts M24 x 3 grade 10.9	751 - 830 lbs.ft	1018 - 1125 NM	(NDS 80)
27	Ball pin nut (F4845T assembly)	155 - 170 lbs.ft	210 - 230 NM	(All axles)
	Ball pin nut (F4109T assembly)	184 - 206 lbs.ft	249 - 279 NM	(All axles)
	Ball pin nut (F4779S assembly)	100 - 170 lbs.ft	135 - 230 NM	(All axles)
	Ball pin nut (F4897S assembly)	190 - 220 lbs.ft	257 - 298 NM	(All axles)
30	Socket pinch bolt (F4845T assembly)	33 - 37 lbs.ft	45 - 50 NM	(All axles)
	Socket pinch bolt (F4109T assembly)	52 - 59 lbs.ft	70 - 80 NM	(All axles)
	Socket pinch bolt (F4779S assembly)	65 - 75 lbs.ft	88 - 102 NM	(All axles)
	Socket pinch bolt (F4897S assembly)	118 - 155 lbs.ft	160 - 210 NM	(All axles)
33	Swivel bottom cap lubricator	10 - 15 lbs.ft	14 - 20 NM	(All axles)
34	Swivel bottom cap	25 - 75 lbs.ft	34 - 102 NM	(All axles)
41	Hub nut	350 - 400 lbs.ft	475 - 542 NM	(NDS 35/41/56)
	Hub nut	575 - 626 lbs.ft	778 - 849 NM	(NDS 80)



SWIVEL / AXLE BED TIGHTENING TORQUES

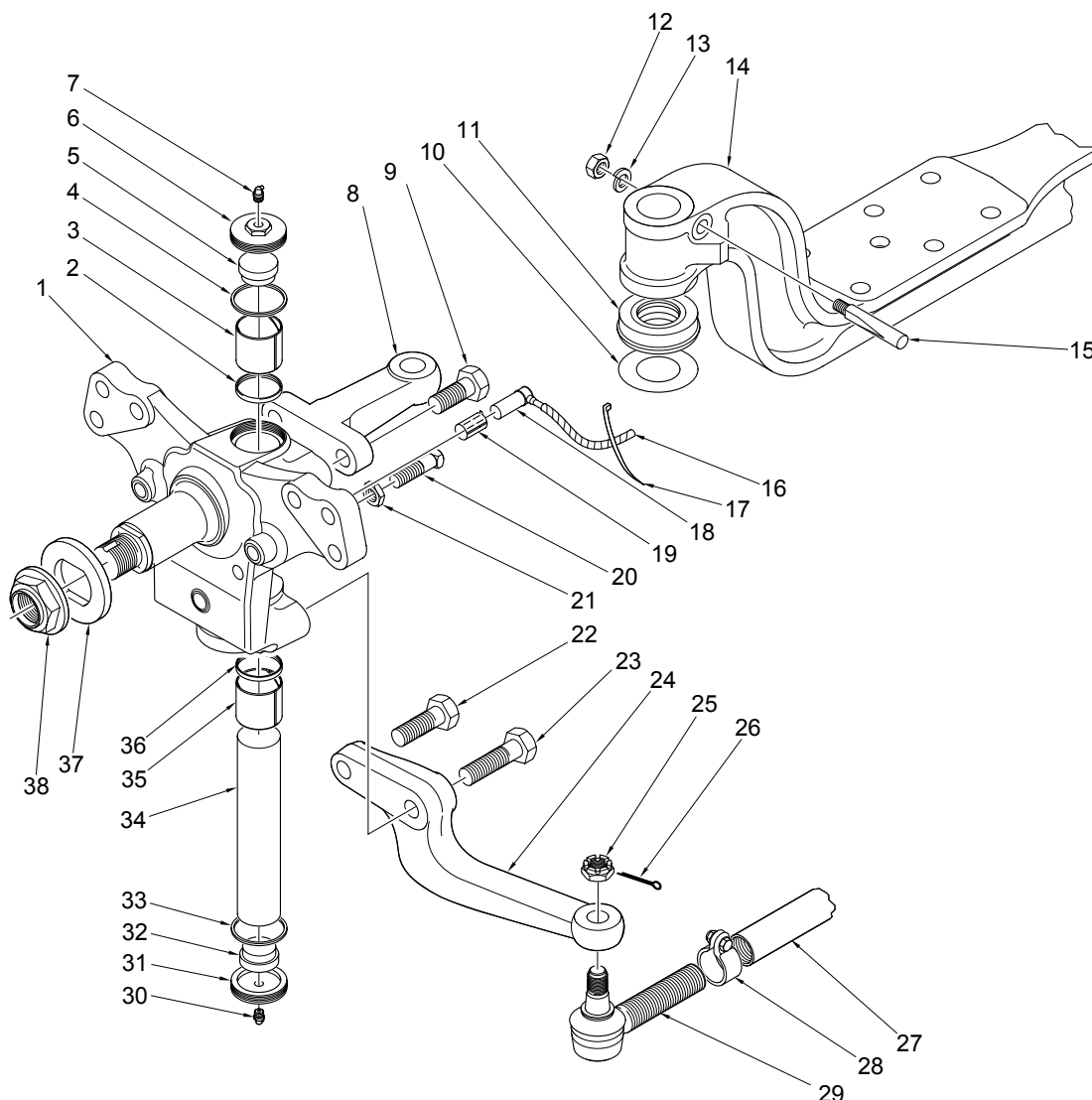


Fig.No.18

PART N° --- DESCRIPTION ----- TIGHTENING TORQUE

6	Swivel top cap	25 - 75 lbs.ft	34 - 102 NM	(All axles)
7	Swivel top cap lubricator	10 - 15 lbs.ft	14 - 20 NM	(All axles)
9	Top lever bolts M20 x 2.5 grade 10.9	433 - 479 lbs.ft	587 - 649 NM	(NDS 35/41/56)
	Top lever bolts M20 x 2.5 grade 12.9	520 - 575 lbs.ft	705 - 780NM	(NDS 56)
	Top lever bolts M24 x 3 grade 10.9	751 - 830 lbs.ft	1018 - 1125 NM	(NDS 80)
12	Cotter pin nut 1/2" UNF	51 - 61 lbs.ft	69 - 82 NM	(All axles)
21	Lockstop nut	90 - 120 lbs.ft	122 - 162 NM	(All axles)
22 & 23	Bottom lever bolts M20 x 2.5 grade 10.9	433 - 479 lbs.ft	587 - 649 NM	(NDS 35/41/56)
	Bottom lever bolts M20 x 2.5 grade 12.9	520 - 575 lbs.ft	705 - 780NM	(NDS 80)
	Bottom lever bolts M24 x 3 grade 10.9	751 - 830 lbs.ft	1018 - 1125 NM	(NDS 80)
25	Ball pin nut (F4845T assembly)	155 - 170 lbs.ft	210 - 230 NM	(All axles)
	Ball pin nut (F4109T assembly)	184 - 206 lbs.ft	249 - 279 NM	(All axles)
	Ball pin nut (F4779S assembly)	100 - 170 lbs.ft	135 - 230 NM	(All axles)
	Ball pin nut (F4897S assembly)	190 - 220 lbs.ft	257 - 298 NM	(All axles)
28	Socket pinch bolt (F4845T assembly)	33 - 37 lbs.ft	45 - 50 NM	(All axles)
	Socket pinch bolt (F4109T assembly)	52 - 59 lbs.ft	70 - 80 NM	(All axles)
	Socket pinch bolt (F4779S assembly)	65 - 75 lbs.ft	88 - 102 NM	(All axles)
	Socket pinch bolt (F4897S assembly)	118 - 155 lbs.ft	160 - 210 NM	(All axles)
30	Swivel bottom cap lubricator	10 - 15 lbs.ft	14 - 20 NM	(All axles)
31	Swivel bottom cap	25 - 75 lbs.ft	34 - 102 NM	(All axles)
38	Hub nut	350 - 400 lbs.ft	475 - 542 NM	(NDS 35/41/56)
	Hub nut	575 - 626 lbs.ft	778 - 849 NM	(NDS 80)



SWIVEL / HUB END TIGHTENING TORQUES

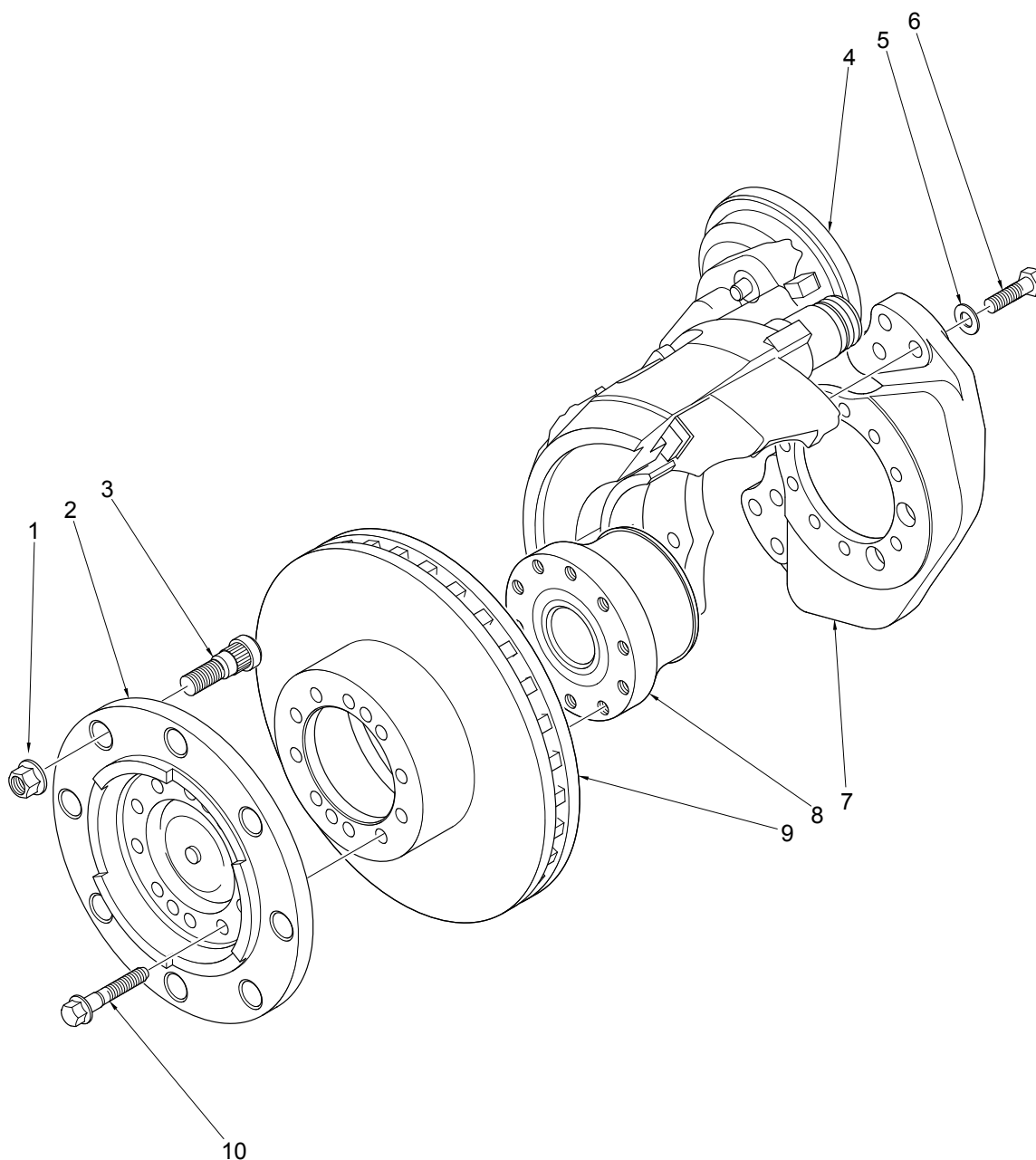


Fig.No.19

PART N°	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

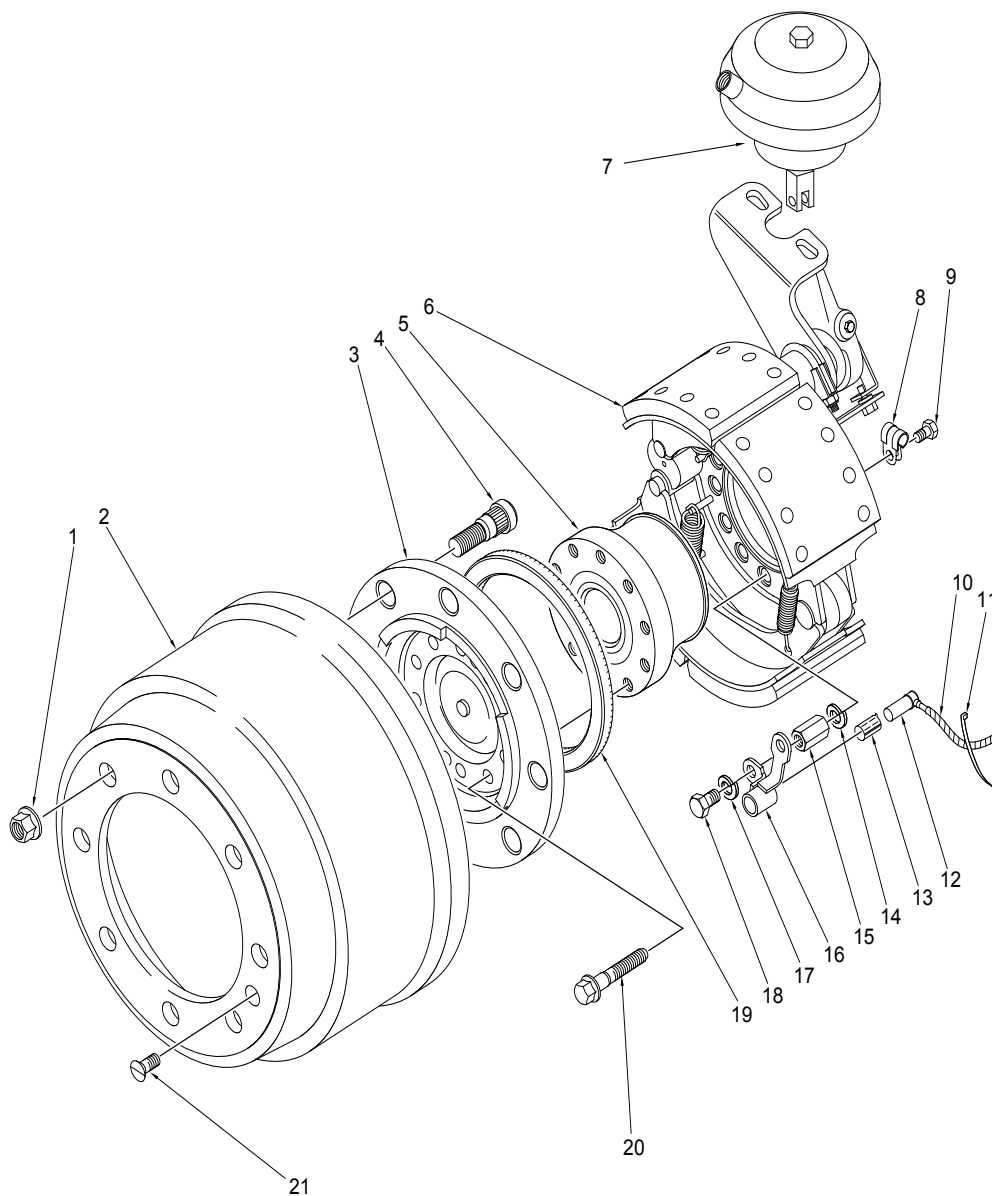


Fig.No.20

PART N°	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

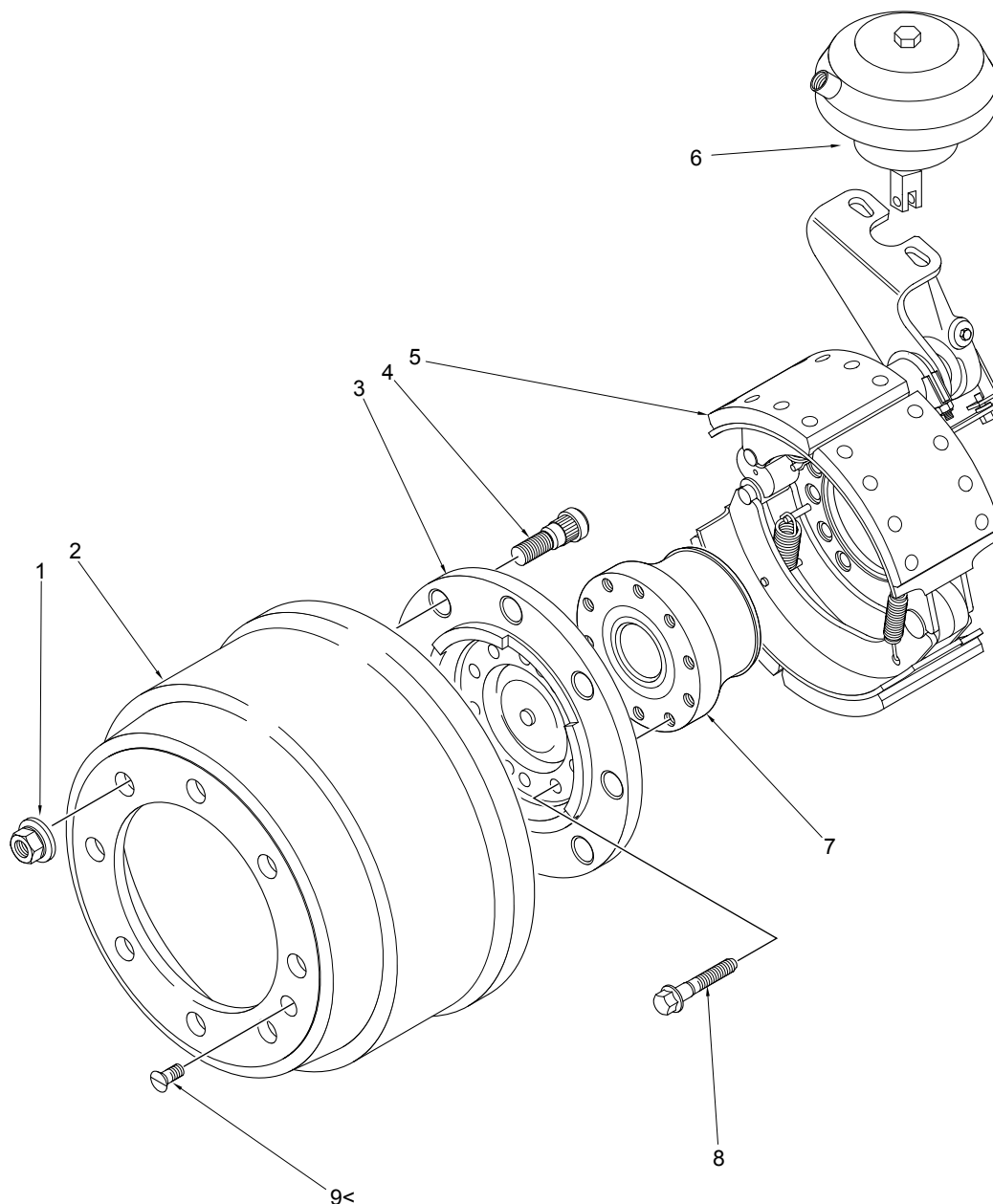


Fig.No.21

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

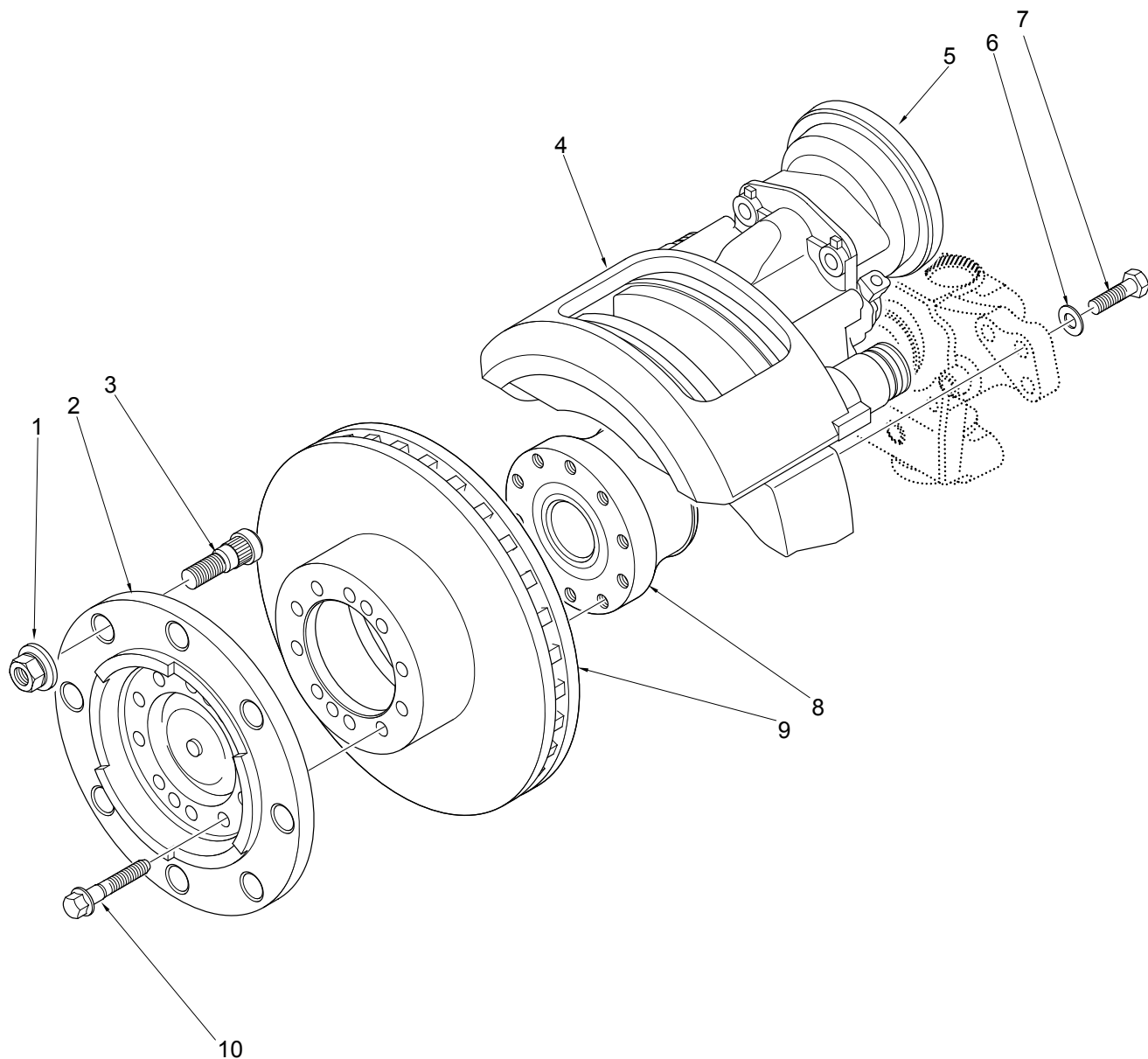


Fig.No.22

PART N <sup>o</sup>	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

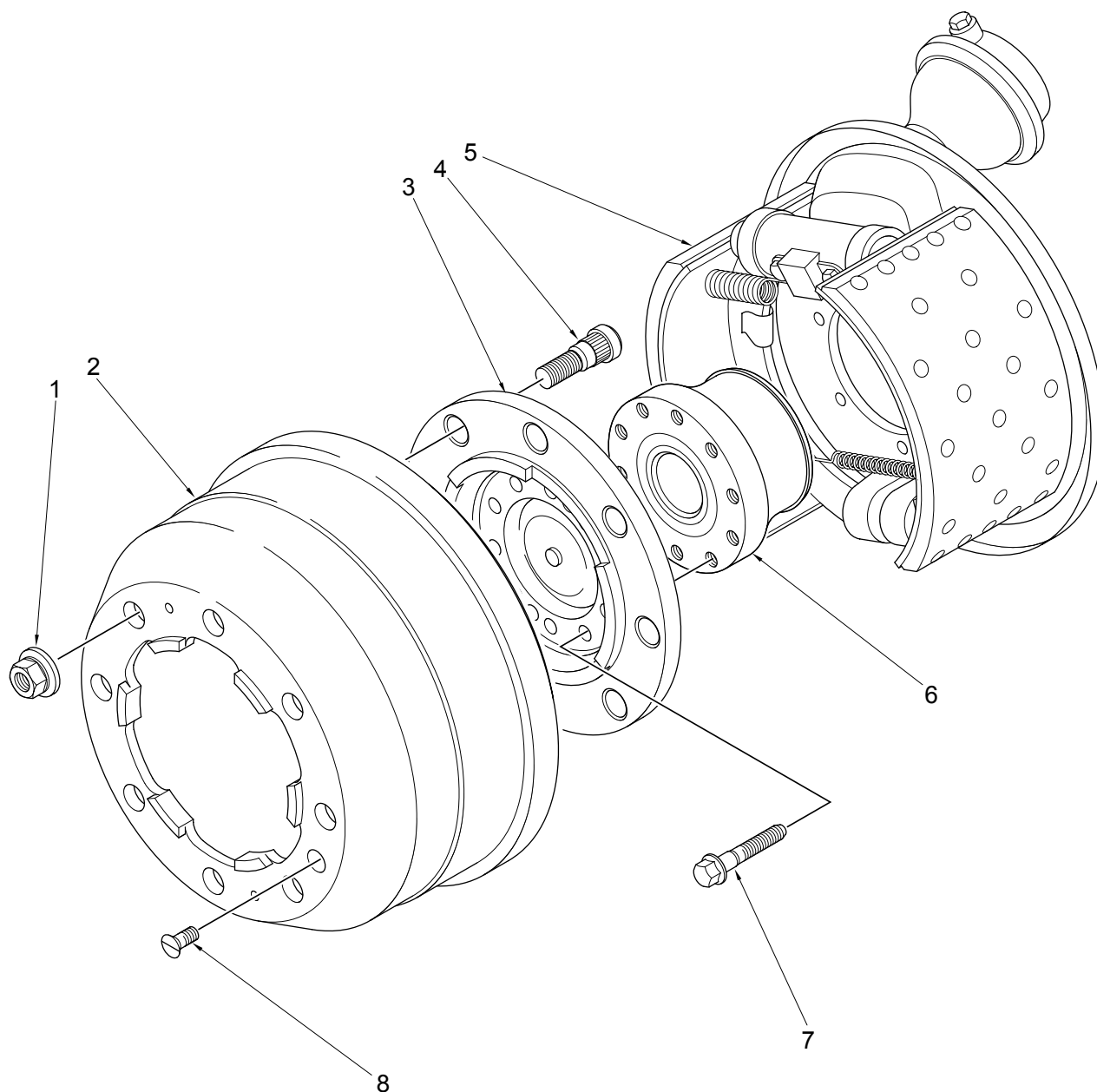


Fig.No.23

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**

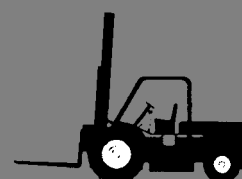
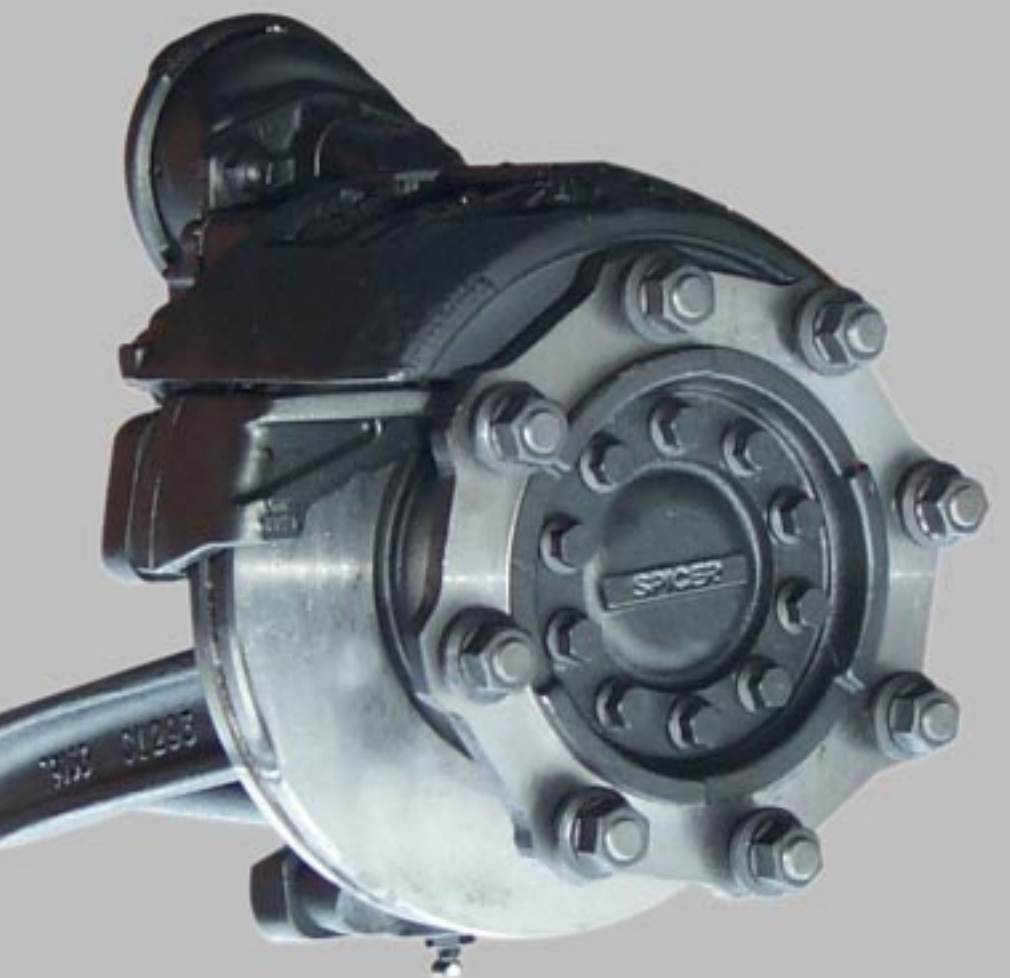
Abbey Road, Kirkstall

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 11 7	A B C	New Manual Page added all subsequent pages re numbered Optimol Paste Added	Brake disc checking added To prevent fretting ECN 8695	Mar.2000 Oct.2000 Aug.2002



## OVERHAUL PROCEDURES

### PREPARATION

Prepare for axle overhaul as follows:

1. Set parking brake and block drive wheels to prevent vehicle movement.
2. Raise vehicle until tyres are off the ground. support raised vehicle with safety stands.



#### **WARNING!**

**NEVER WORK UNDER A VEHICLE SUPPORTED ONLY BY A JACK. ALWAYS USE SAFETY STANDS.**

### HUB END DISASSEMBLY

1. Disconnect brake connections and ABS sensor from vehicle. Fit plugs to connections to prevent dirt ingress.
2. Loosen but do not remove, brake caliper retaining bolts
3. Using suitable lifting equipment, support the brake caliper.
4. Remove brake caliper retaining bolts and remove brake caliper from axle.



#### **WARNING!**

**BRAKE CALIPER IS HEAVY ENSURE WEIGHT IS FULLY SUPPORTED BEFORE REMOVING RETAINING BOLTS. TAKE CARE TO AVOID CALIPER SWINGING AND TRAPPING FINGERS.**

#### **NOTE:-**

**BRAKE CALIPERS ARE HANDED! SPICER SPECIALITY AXLE DIVISION RECOMMENDS MARKING CALIPERS WITH PAINT OR MARKER PEN TO FACILITATE CORRECT REFITTING**

**BRAKE AIR CYLINDERS SHOULD ONLY BE REMOVED IF REPLACEMENT OR REPAIR IS REQUIRED.**

**REFER TO THE BRAKE MANUFACTURERS MANUAL FOR DETAILS OF CALIPER OR AIR CYLINDER SERVICE.**



## OVERHAUL PROCEDURES

## HUB END DISASSEMBLY

5. Loosen but do not remove hub flange bolts.
6. Remove 2 diametrically opposed hub flange bolts.
7. Replace 2 diametrically opposed hub flange bolts with 2 studs (loosely fitted).



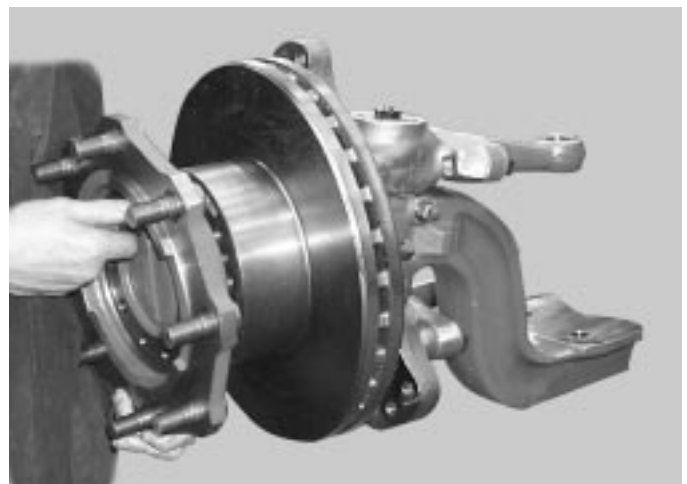
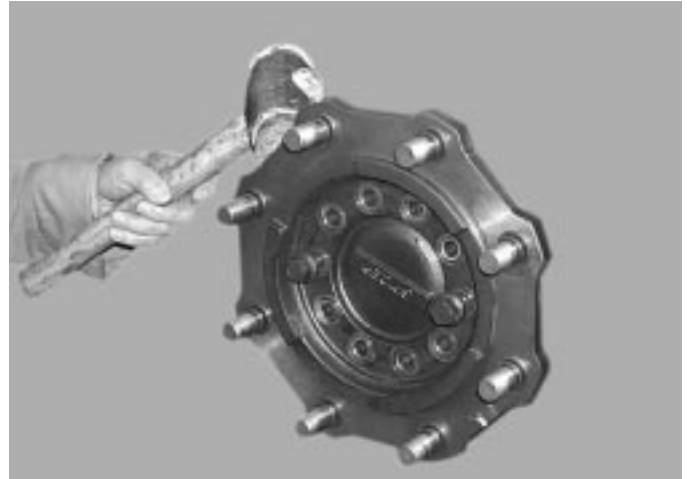
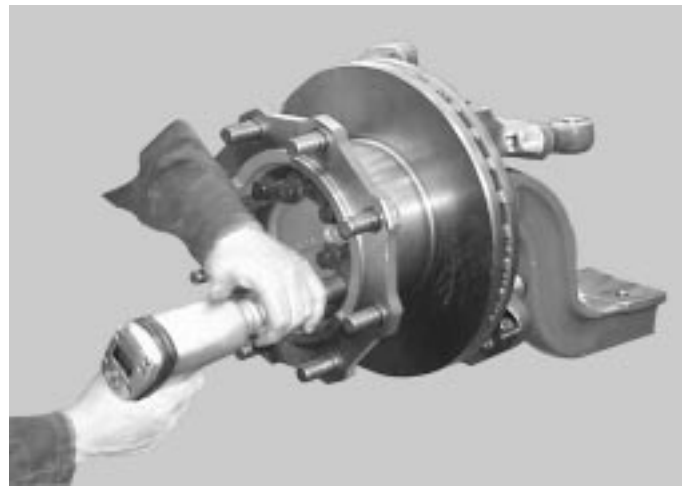
**NOTE!**  
**REPLACEMENT STUDS SHOULD PROTRUDE BEYOND FRONT FACE OF HUB FLANGE TO AID REMOVAL**

8. Gently tap hub flange outwards using a hide faced hammer.
9. Support weight of hub flange and remove hub flange retaining bolts.
10. Remove hub flange and place on a suitable workbench.



**WARNING!**  
**COMPONENT IS HEAVY ENSURE WEIGHT IS FULLY SUPPORTED BEFORE REMOVING RETAINING BOLTS.**

11. Inspect wheel studs and remove for replacement, any that are found to be defective.



**OVERHAUL PROCEDURES**

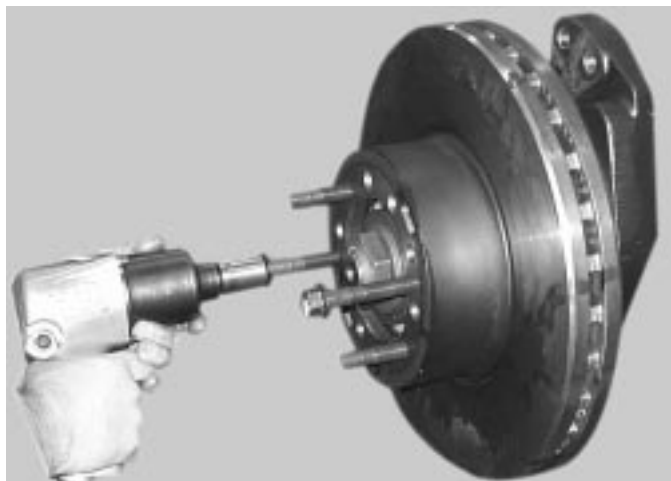
**HUB END DISASSEMBLY**

- 12. Once hub flange has been removed, insert two bolts into brake disc extraction holes
- 13. Tighten to free brake disc from hub bearing.
- 14. Support weight of brake disc and carefully slide along dummy studs to remove.

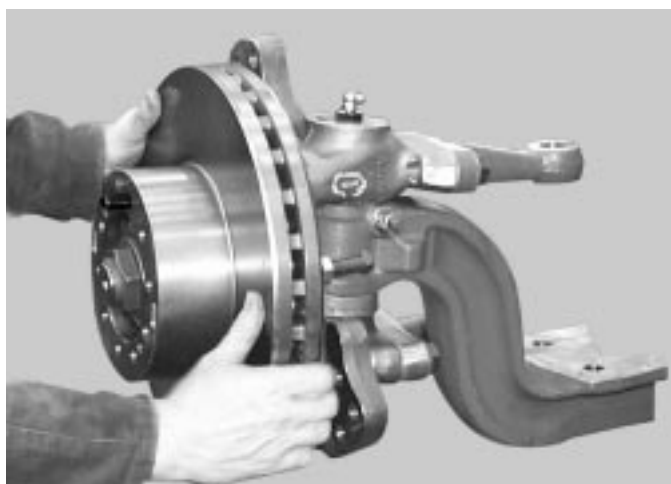


**WARNING!**  
**COMPONENT IS HEAVY**  
**ENSURE WEIGHT IS FULLY SUPPORTED**  
**BEFORE REMOVING .**

- 15. Place brake disc on a suitable work bench and inspect for cracks and defects, Replace if necessary.  
 (See Lubrication and maintenance section for details of typical defects and acceptability)  
 Check brake disc thickness is within manufacturers specifications.  
 Refer to table below for Acceptable dimensions:



**WARNING!**  
**DO NOT ALLOW BRAKE DISC TO WEAR**  
**BELOW MINIMUM THICKNESS!**



Brake disc type	Original thickness	Minimum thickness
SB5000	34MM	28MM
SB6000	45MM	37MM
SB7000	45MM	37MM

OVERHAUL PROCEDURES

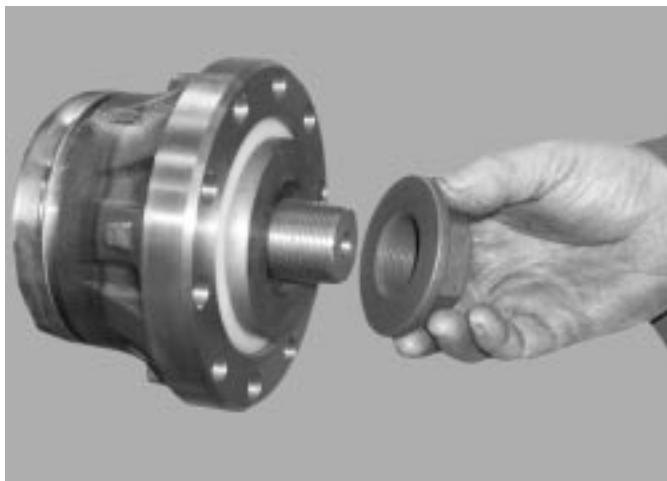
HUB END DISASSEMBLY

- 16. Using a small ended chisel, pry off the "staking" on the hub nut.
- 17. Remove hub nut and discard.
- 18. Remove bearing thrust washer.
- 19. Fit bearing guide sleeve onto swivel thread. (See chart at front of swivel assembly )
- 20. Carefully pull unitised hub bearing assembly towards end of swivel stub and remove.
- 21. Place on a suitable workbench and inspect for wear / damage, taking care not to damage the ABS exciter ring in the process.



**NOTE:-**  
**THE UNITISED BEARINGS USED ON THE NDS RANGE OF AXLES, ARE NON SERVICABLE ITEMS. BEARINGS ARE PRE ADJUSTED, LUBRICATED AND HAVE SEALS FITTED AS PART OF THE MANUFACTURING PROCESS. THE BEARINGS ARE GREASED FOR LIFE AND THERE IS NO NEED OR FACILITY FOR RE-LUBRICATION.**

- 22. Remove ABS sensor and sensor bush inspect for wear / damage and replace if necessary.
- Stripdown remainder of axle as described in swivel assembly removal and refitting instructions.

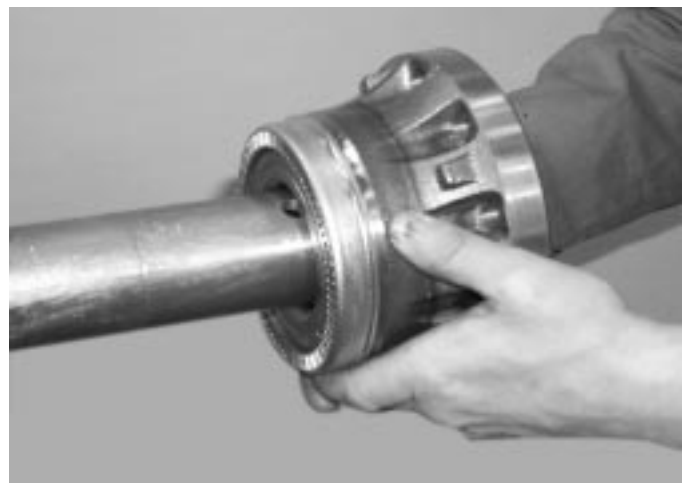


Place bearing this way up on bench to avoid damaging pole wheel.

**OVERHAUL PROCEDURES**

**HUB END REASSEMBLY**

1. Follow instructions contained in swivel / axle bed reassembly section, before attempting to reassemble hub end.
2. Fit Unitised hub bearing guide sleeve onto swivel stub .  
(see chart at front of swivel section)
3. Lightly smear the axle stub bearing journal with a thin layer of anti-fretting assembly paste, white i.e Optimol Paste White T (Castrol) or equivalent.
4. Offer new unitised bearing onto swivel stub.



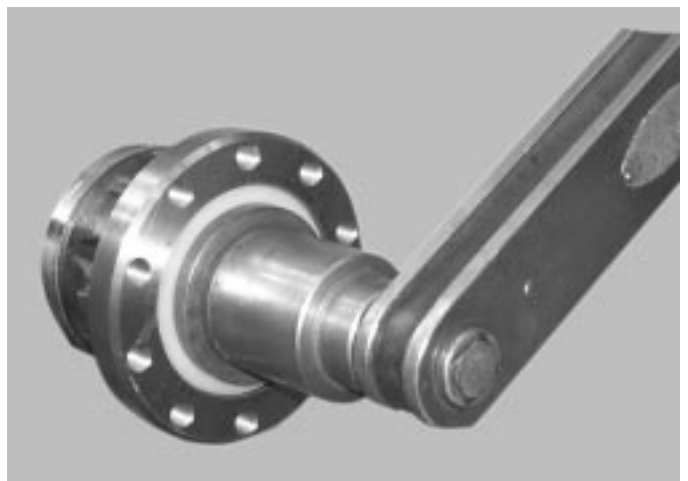
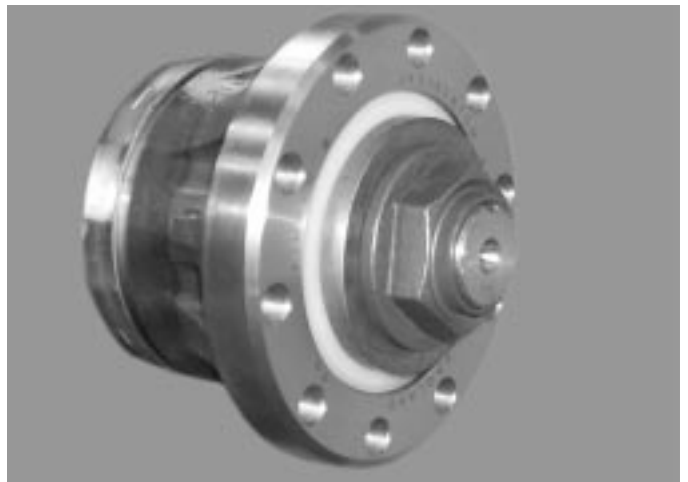
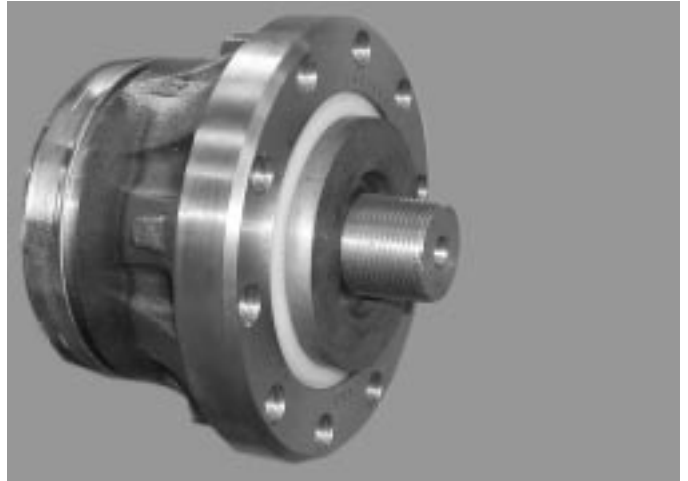
OVERHAUL PROCEDURES

HUB END REASSEMBLY CONTINUED

5. Place unitised hub bearing thrust washer onto axle stub.
6. Fit hub nut.
7. Tighten to specified torque.



**NOTE:-  
ROTATE UNITISED HUB BEARING  
WHILST TIGHTENING.**

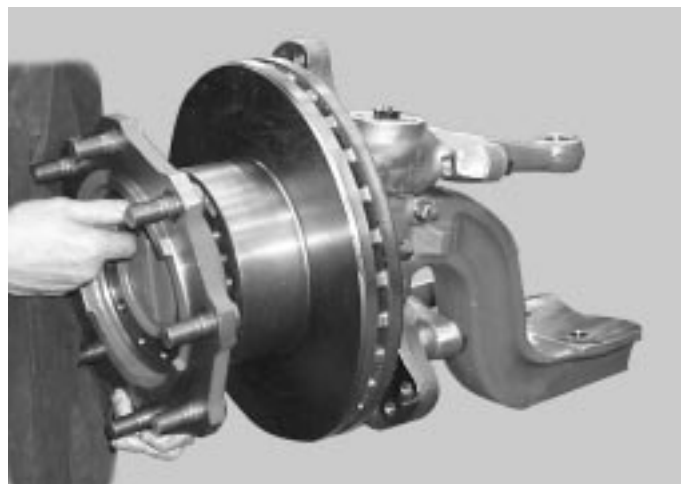
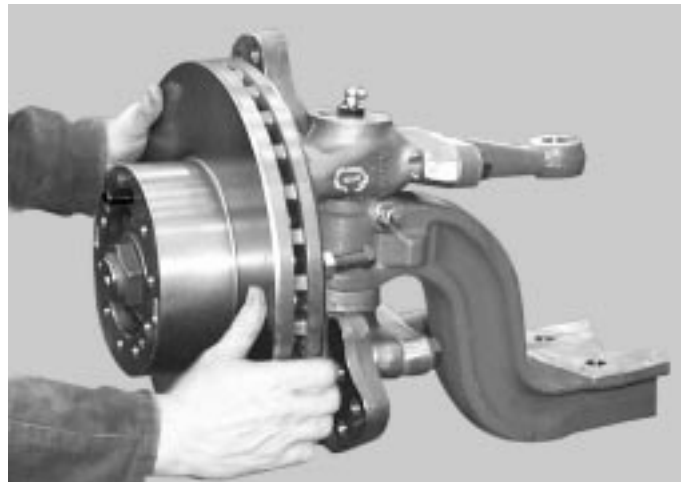
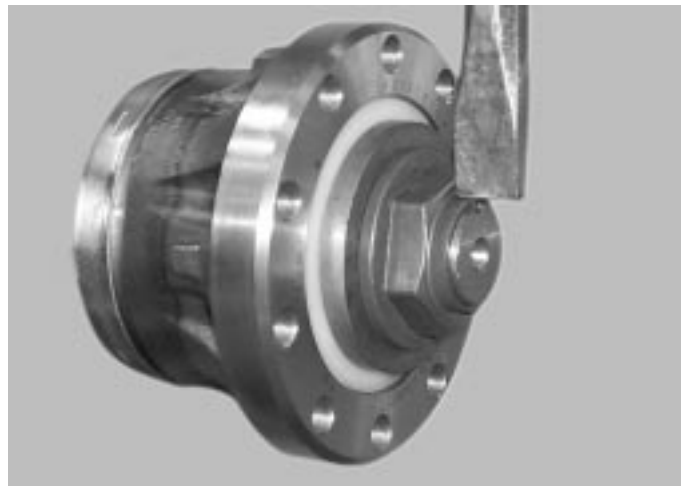




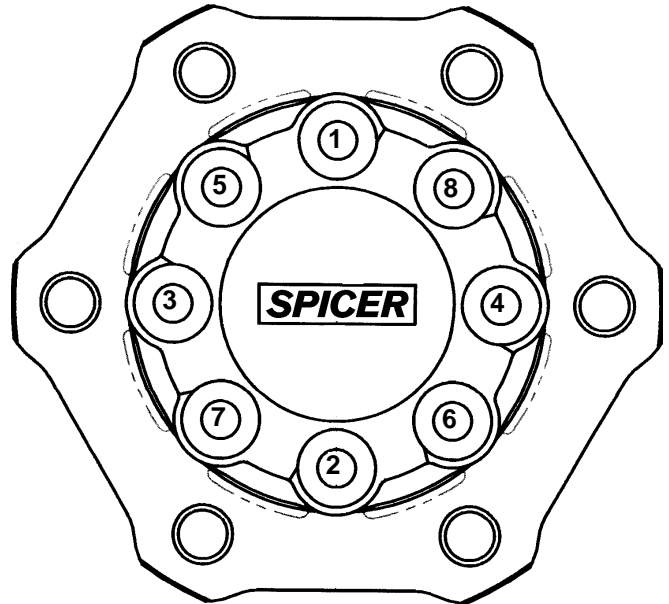
**OVERHAUL PROCEDURES**

**HUB END REASSEMBLY CONTINUED**

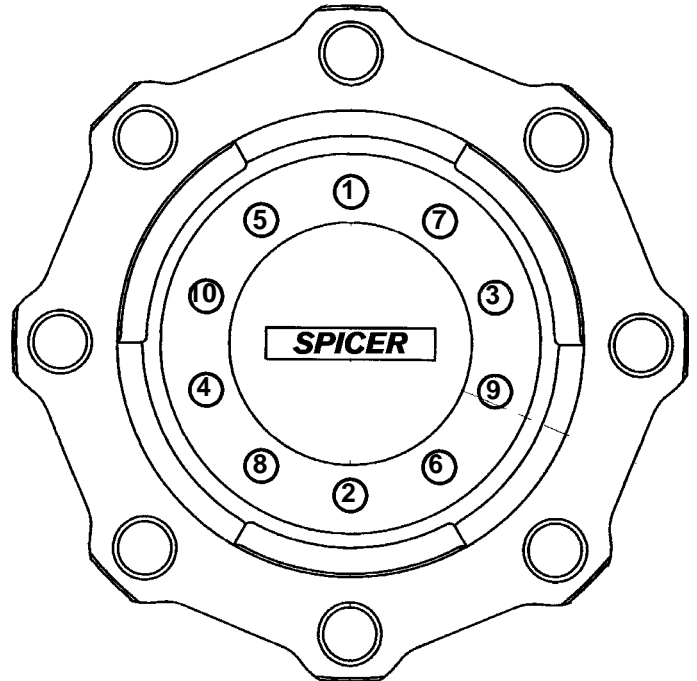
8. Stake the hub nut by deforming with a round nosed chisel.
9. Using a modified hub flange bolt as a guide, carefully position brake disc onto unitised hub bearing.
10. Tap securely home (using a hide faced hammer to avoid damaging the brake disc itself.)
11. Remove the modified hub flange bolt at this point.
12. Carefully offer hub flange up to brake disc / unitised hub bearing assembly and hold in position by inserting 1 - off hub flange bolt and tightening hand tight.
13. Insert remainder of hub flange bolts.
14. Tighten to correct torque using selection procedure as shown on following page.



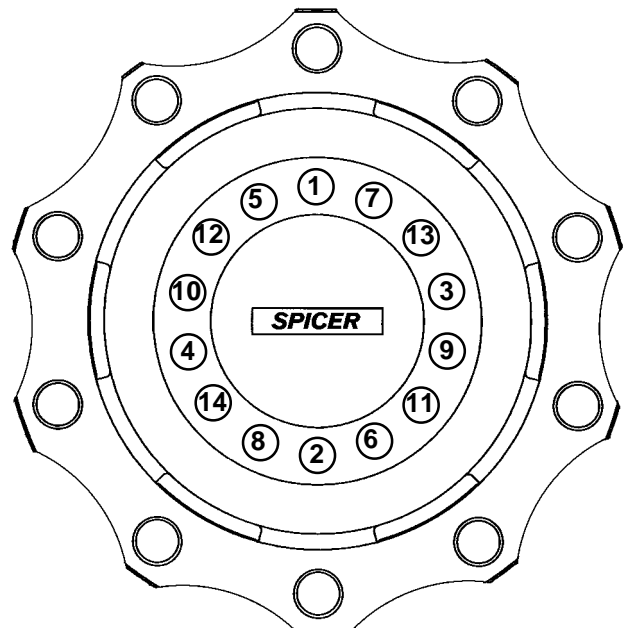
**HUB FLANGE BOLT  
TIGHTENING TORQUE SEQUENCE  
FOR 8 BOLT FIXING**



**HUB FLANGE BOLT  
TIGHTENING TORQUE SEQUENCE  
FOR 10 BOLT FIXING**



**HUB FLANGE BOLT  
TIGHTENING TORQUE SEQUENCE  
FOR 14 BOLT FIXING**





**OVERHAUL PROCEDURES****HUB END REASSEMBLY CONTINUED**

15. Once the hub flange has been correctly fitted; it is necessary to check the axial run out of the brake disc.
16. Position a metric dial test indicator onto axle in a suitable position as shown.



**NOTE:-  
POSITION MAY VARY DEPENDENT ON  
AXLE SPECIFICATION**

17. Position stylus of dial test indicator onto brake disc as shown.
18. Rotate the hub through 360° and note any movement of the dial test indicator.

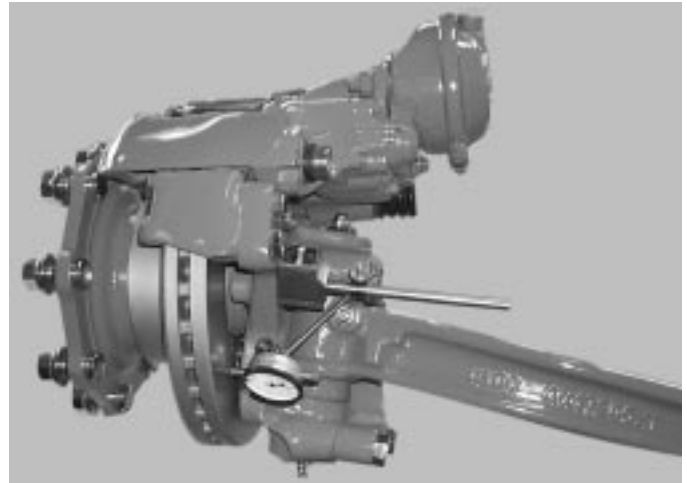


**NOTE:-  
MAXIMUM AXIAL RUNOUT IS 0.1mm**

19. Should axial runout exceed 0.1mm. the brake disc is out of specification .
20. Remove and check out of specification disc to ensure no damage has occurred to the mounting faces, or that no dirt is present.
21. Remove any dirt found on the mounting faces and refit and re check disc.

**NOTE:-  
DAMAGED DISCS SHOULD BE  
REPLACED AS A MATTER OF  
COURSE!**

22. Should it be found that a cleaned and refitted disc is still out of specification; it must be replaced.



## OVERHAUL PROCEDURES

## HUB END REASSEMBLY CONTINUED

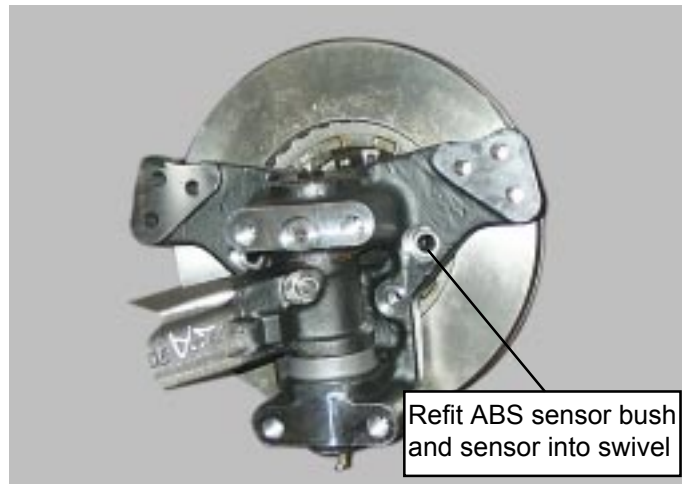
23. Refit ABS sensor bush and sensor into swivel



**NOTE:-  
A NEW SENSOR BUSH SHOULD BE  
FITTED WHENEVER A NEW SENSOR IS  
FITTED.  
IF FITTING A NEW SENSOR AND BUSH  
INTO AN ABS READY AXLE. SENSOR  
AND BUSH SHOULD BE SUPPLIED  
FROM THE SAME MANUFACTURER.**

24. Push sensor through bush until it comes into contact with polewheel on hub assembly.
25. Rotate hub bearing assembly through at least one revolution.

**THIS SERVES TO SET THE CORRECT  
GAP BETWEEN SENSOR AND  
POLEWHEEL.**



## OVERHAUL PROCEDURES

## HUB END REASSEMBLY CONTINUED

26. Check A.B.S. sensor performance as follows :-

**Before commencement of this check It is important that the number of teeth be checked and found to be the correct, on both LH and RH hubs.**

- a) Insert the probes from a volt-meter into the two plugs in the sensor connector.
- b) set the voltmeter to read mili-volts AC.
- c) Rotate the hub in any direction at a constant speed of 60Hz (7Kph).  
To determine this speed use the following calculation ;

$$\text{RPM} = \frac{60\text{Hz}}{z} \times 60 \text{ secs}$$

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.

$$\frac{V_{\max}}{V_{\min}} \leq 1.8$$

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.

$$\frac{V_{\max}}{V_{\min}} > 1.8$$

- e) The minimum reading must be greater than the voltage threshold (Vt) ie.

$$V_{\min.} > V_t$$

$$V_t = 60\text{mV}$$

If this is not the case, then the sensor 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.**



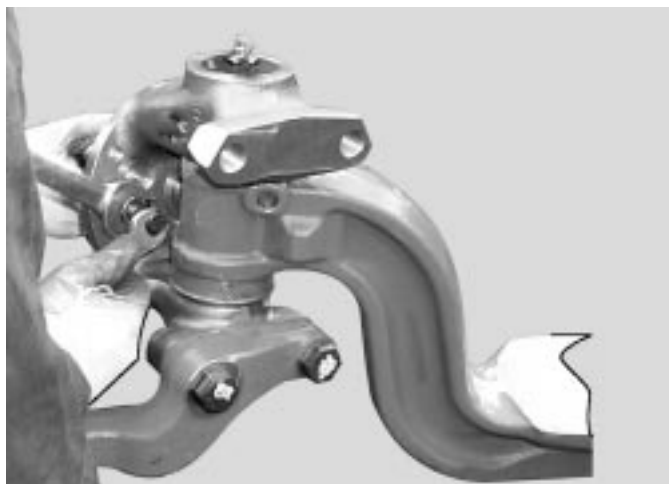
OVERHAUL PROCEDURES

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.

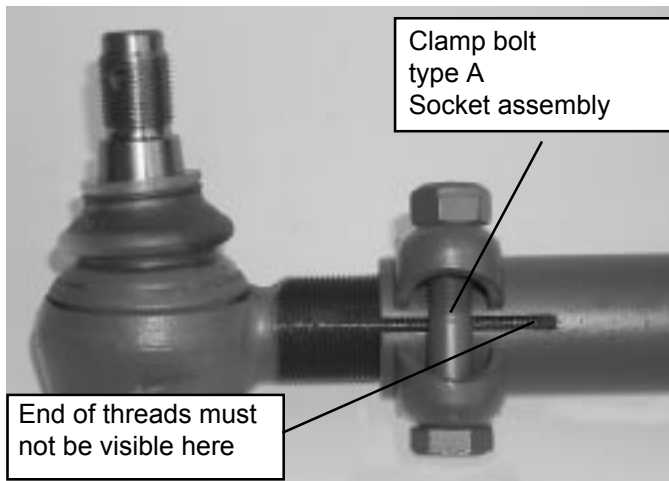


**NOTE:-  
DO NOT ALLOW LOCKSTOP THREADS  
TO PROTRUDE THROUGH FRONT FACE  
OF SWIVEL.**

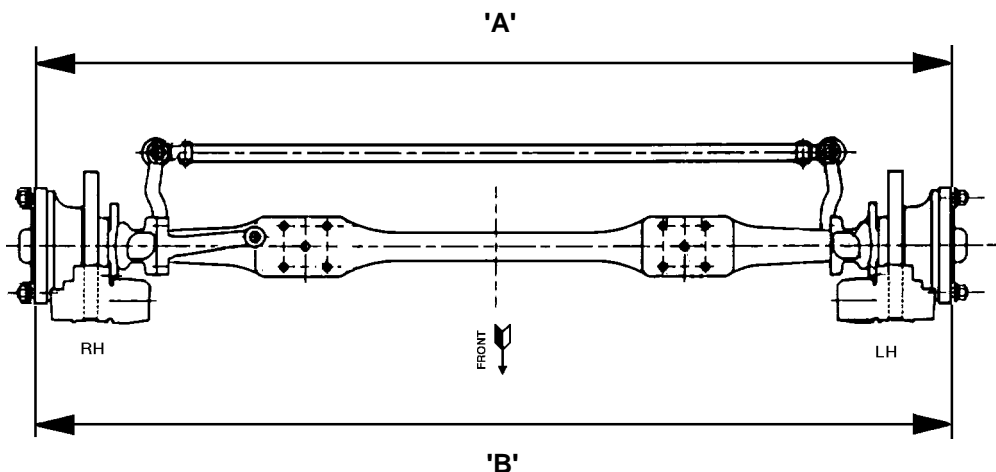
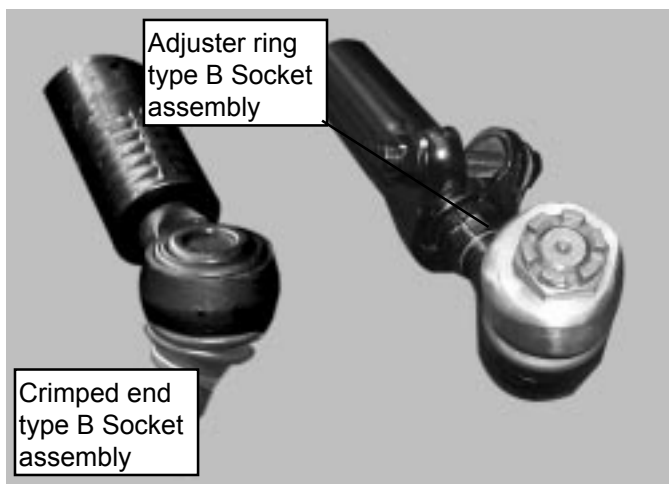


36. Check wheel alignment as follows :-

- 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

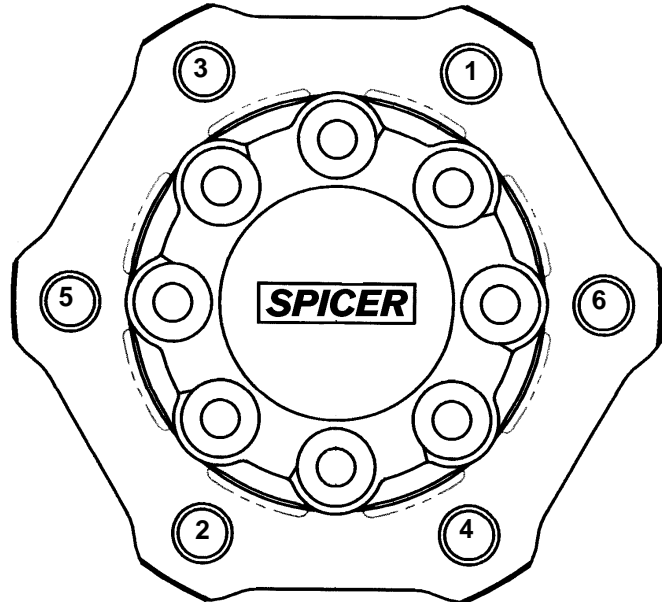
37. Re-connect brake to vehicle hydraulic system as recommended in brake manufacturer's manual.
38. Clean interfaces of wheelnuts, wheel rim & hub then re-fit road wheels securing with wheel nuts and tighten in correct sequence (as shown on following page) to specified torque.



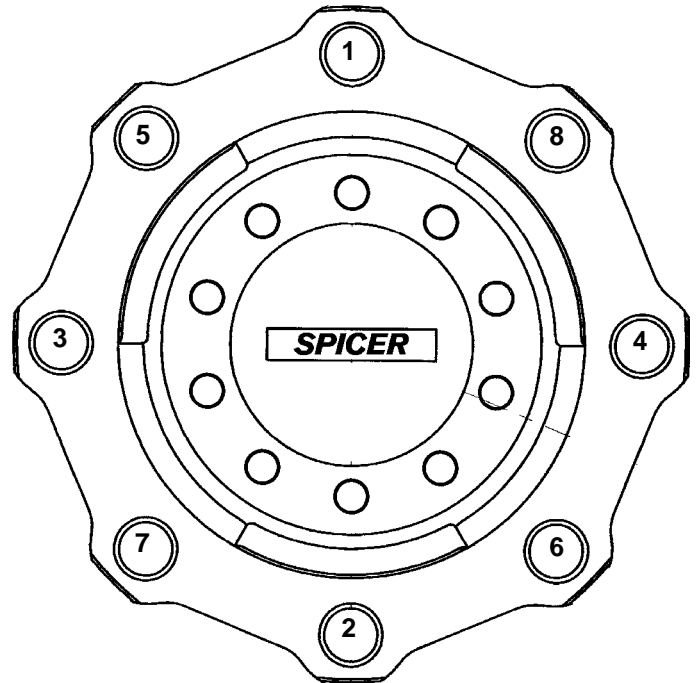
**NOTE:-  
INTERFACES MUST BE FREE FROM  
DIRT, INCLUDING BRAKE LINER  
MATERIAL DEBRIS, RUST AND PAINT.  
FAILURE TO KEEP INTERFACES  
CLEAN CAN AND WILL CAUSE WHEEL  
RIM TO DISTORT UPON TIGHTENING  
OF WHEEL NUTS  
FOR FURTHER DETAILS SEE  
BS AU50 : part 2 : section 7A : 1995**

39. Remove axle supports and lower vehicle to ground.

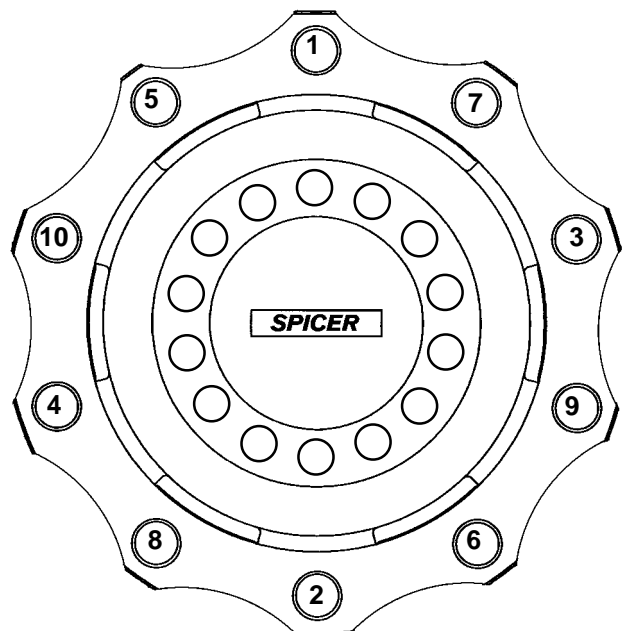
**WHEELNUT TIGHTENING  
TORQUE SEQUENCE  
FOR 6 STUD FIXING**



**WHEELNUT TIGHTENING  
TORQUE SEQUENCE  
FOR 8 STUD FIXING**



**WHEELNUT TIGHTENING  
TORQUE SEQUENCE  
FOR 10 STUD FIXING**



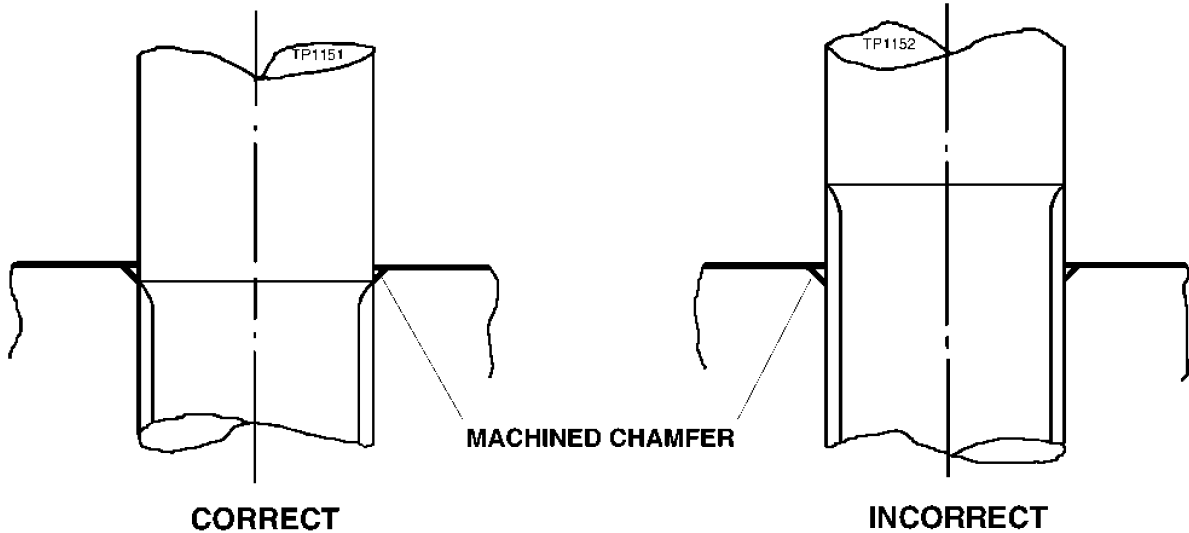


**SPICER SPECIALITY AXLE DIVISION**

TP1193

**STANDARD STUDS - FITTED INTO MACHINED CHAMFERED HOLES**

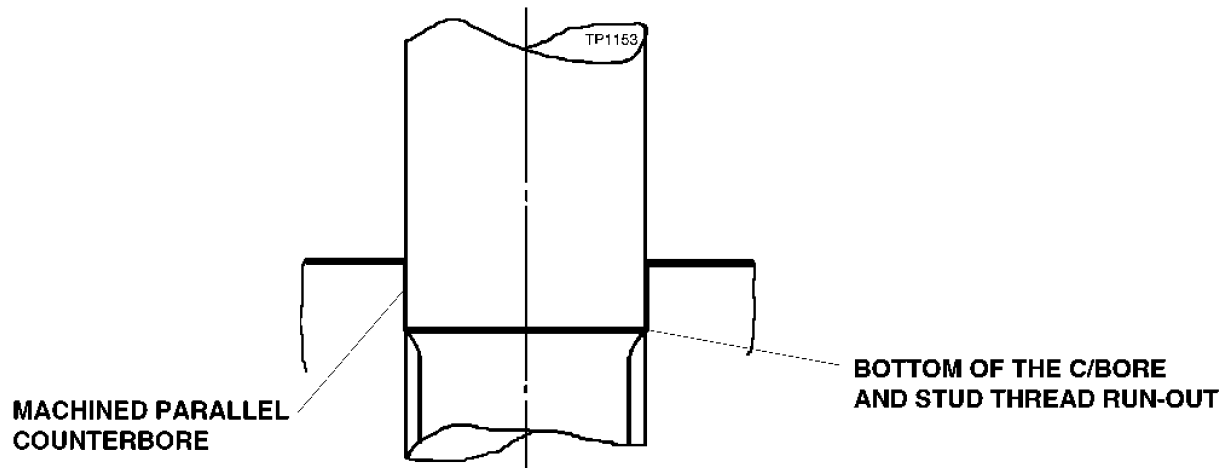
STUDS TO BE INSERTED UNTIL THREAD RUN-OUT LOCKS INTO PARENT METAL



**IMPORTANT :- THIS STUD FITTING PROCEDURE IS TO BE USED IN LIEU OF STATED TORQUE VALUES ON EXISTING ARRANGEMENTS. NEW ARRANGEMENTS WILL SPECIFY TD183/1 FROM THE DATE OF ISSUE.**

**SPECIAL STUDS - FITTED INTO MACHINED PARALLEL COUNTERBORE**

STUDS TO BE INSERTED UNTIL CORRECT TORQUE VALUE IS OBTAINED - AS SHOWN ON RELEVANT ARRANGEMENT DRAWING



**THIS SPECIFICATION IS FOR STUD FITTING ONLY ; NUTS & SETSCREWS MUST BE TORQUED TO VALUE SPECIFIED**

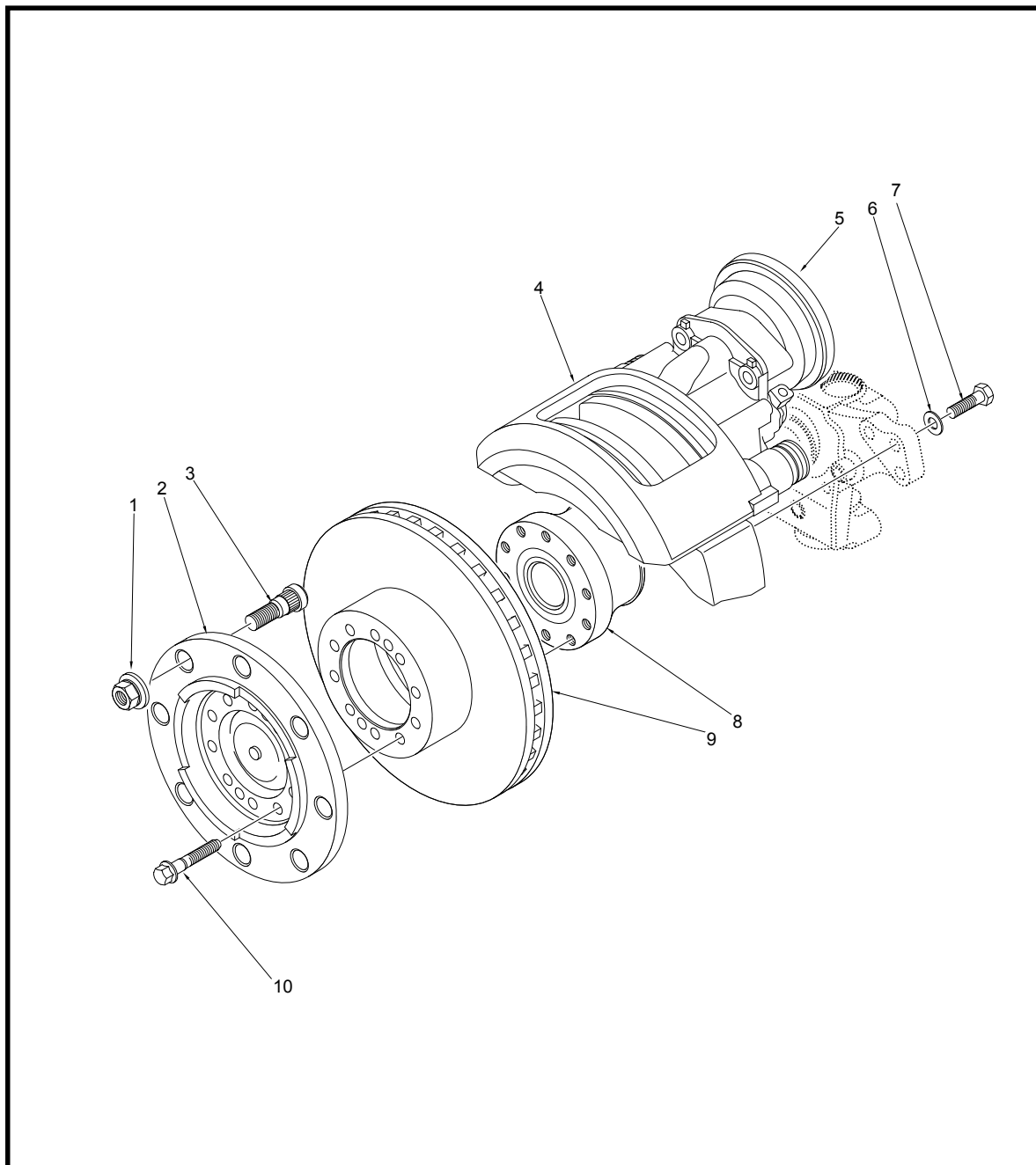
Alteration Numbers

ISSUE A									
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<p><b>DISTRIBUTION</b> Front Axle B.U. Drive Axle B. U. Production</p>	<p><b>STUD FITTING PROCEDURES</b></p>	<p><b>TD183/1</b> SHT 1 OF 1</p>
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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  
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# SECTION 11: REAR AXLES

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## 1. DRIVE AXLE

### 1.1 DESCRIPTION

The Meritor drive axle is equipped with a single reduction standard carrier mounted in front of the axle housing. The carrier consists of a hypoid drive pinion, a ring gear set and gears in the differential assembly.

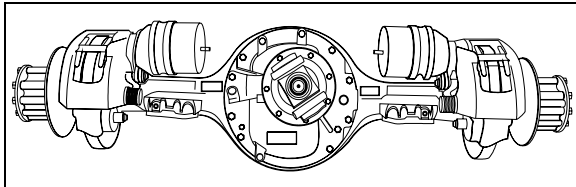


FIGURE 1: DRIVE AXLE

11019

A straight roller bearing (spigot) is mounted on the head of the drive pinion. All other bearings in the carrier are tapered roller bearings. When the carrier operates, there is a normal differential action between the wheels all the time.

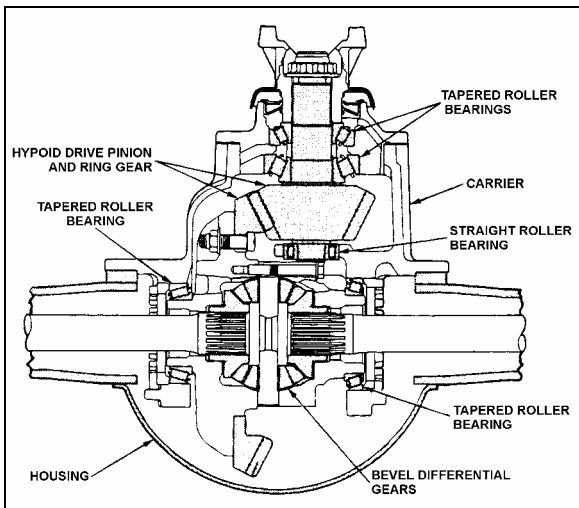


FIGURE 2: DIFFERENTIAL ASSEMBLY

11024

Several speed ratios are available for the drive axle. These ratios depend upon the motor and transmission. Also, special applications may suggest slightly different gear ratios.

### 1.2 DCDL (DRIVER-CONTROLLED MAIN DIFFERENTIAL LOCK)

Meritor Single-reduction carriers with driver-controlled main differential lock (DCDL) have the same type of gears and bearings as the standard-type carriers. The differential lock is operated by an air actuated shift assembly that is mounted on the carrier.

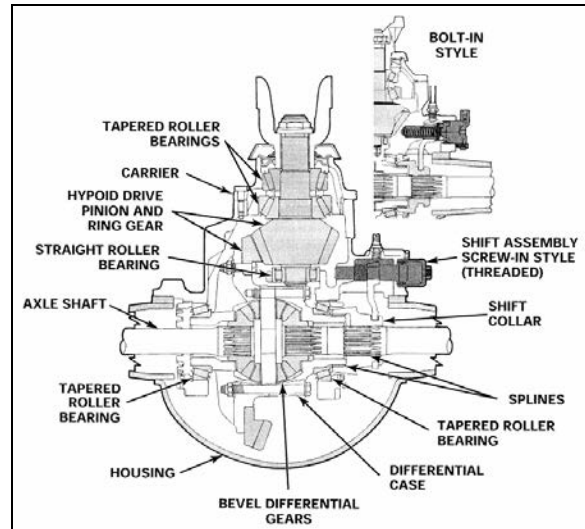


FIGURE 3: DRIVER-CONTROLLED DIFFERENTIAL LOCK

### 1.3 DRIVE AXLE LUBRICATION

Use Multigrade gear oil 85W/140 meeting MIL-PRF-2105-E, tested and approved to SAE J2360. If temperature drops below 10°F (-12°C), 80W/90 should be used, and below -15°F (-26°C), 75W/90 should be used. Additional lubrication information is covered in the Meritor Technical Bulletin "Approved Rear Drive Axle Lubricants" annexed to this section.

In extreme conditions, or for better performance, fill with synthetic gear oil.



### MAINTENANCE

Check oil level and add (if necessary) every 25,000 miles (40 000 km) or according to the fleet maintenance interval, whichever comes first (Fig. 4).



### MAINTENANCE

Change differential oil and clean the breathers, magnetic fill and drain plugs, every 100,000 miles (160 000 km) or once a year, whichever comes first.

If using full synthetic gear oil, change differential oil and clean the breathers, magnetic fill and drain plugs, every 250,000 miles (400 000 km) or every four years, whichever comes first.

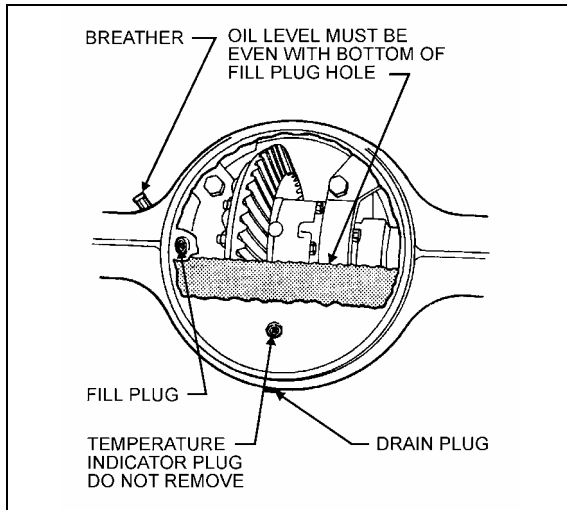


FIGURE 4: DIFFERENTIAL HOUSING BOWL 11007

## 1.4 MAINTENANCE

Proper vehicle operation begins with preventive maintenance, such as good differential use. The most common types of drive axle carrier failures are spinout, shock, fatigue, overheating and lubrication. Avoid neglecting these points since they would be the first steps to improper maintenance, expensive repairs, and excessive downtime.



### MAINTENANCE

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



### WARNING

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.



### CAUTION

Check the oil level when the axle is at room temperature. When hot, the oil temperature may be 190°F (88°C) 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



### WARNING

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 250°F (120°C).

6. Install and tighten the fill plug to 35-50 lbf-ft (48-67 Nm).

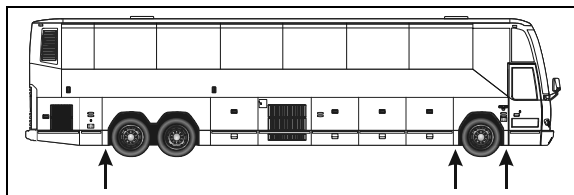
**1.4.3 Speed Sensors (Anti-Lock Brake system, ABS)**

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".



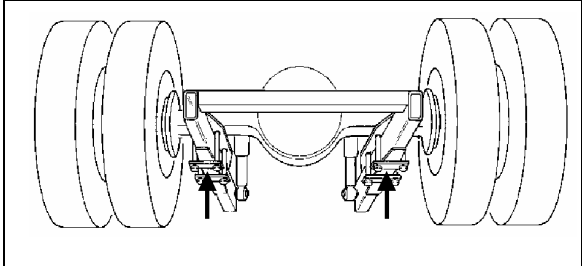
**FIGURE 5: JACKING POINTS ON FRAME** 18524

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 the 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.

**NOTE**  
Position the hoses so they will not be damaged when removing the axle.

7. Disconnect the brake chamber hoses.
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.

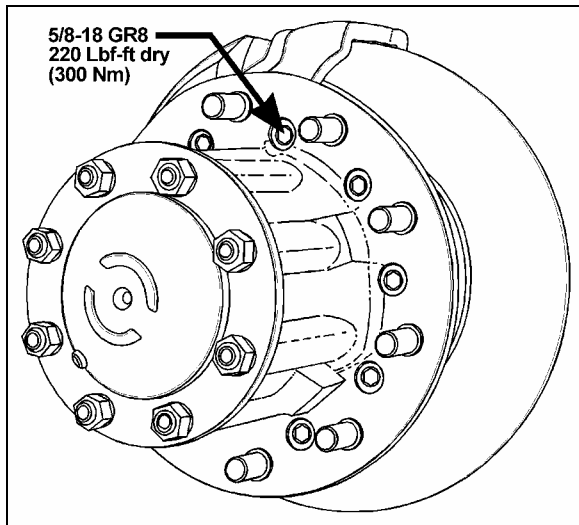


FIGURE 7: TORQUE SPECIFICATION

### 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 1/2 inch from ground. Secure in this position with safety stands, and release parking brake.
3. Install wheel mount sensors on front and drive axles (fig. 7). Adjust front axle according to appropriate specifications chart below.

**NOTE**

See reference numbers on wheel mount sensors (fig. 7).

**NOTE**

Select axle specifications in the appropriate chart.

### DRIVE AXLE ALIGNMENT

- With the system installed as for front axle 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-in

**TAG AXLE ALIGNMENT**

- Remove and reinstall all wheel mount sensors on the drive and tag axles (fig. 8);

**NOTE**  
For an accurate alignment, the tag axle must be aligned with the drive axle.

**NOTE**  
Reinstall wheel mount sensors as shown in figure 8. For example, the sensor from the right side of the front axle is mounted on the left side of the tag axle. For corresponding wheel mount sensor reference numbers, refer to figure 6.

- 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

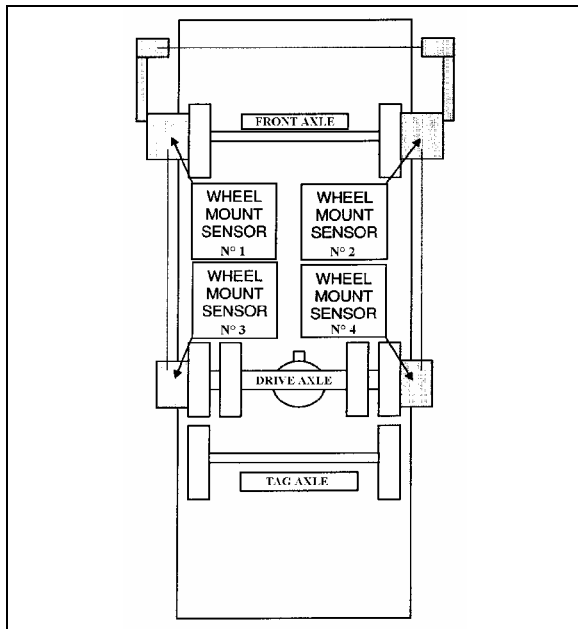


FIGURE 8: FRONT & DRIVE AXLE ALIGNMENT 11025

**NOTE**  
Refer to Section 16, "Suspension", for proper torque tightening of the longitudinal radius rod support nuts.

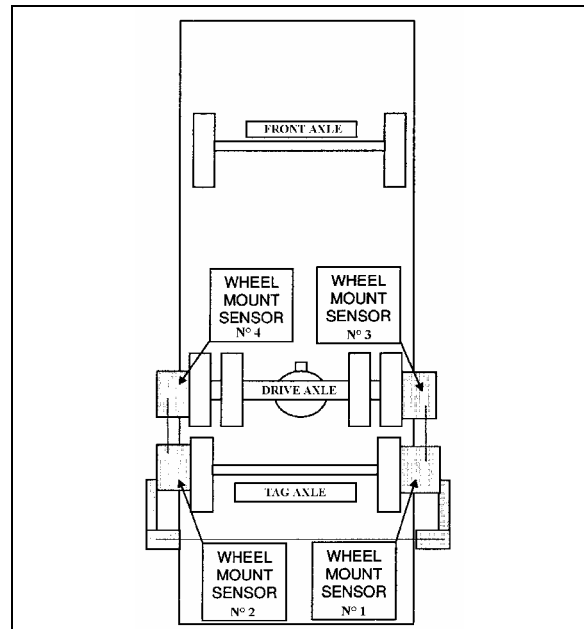


FIGURE 9: TAG AXLE ALIGNMENT 11026

**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:

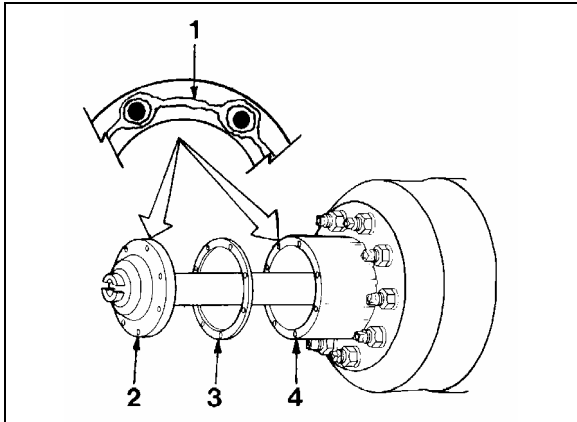



FIGURE 10: AXLE SHAFT INSTALLATION 11003

- 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\* (Prevost 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.

	<p><b>WARNING</b></p>
<p>Carefully read cautions and instructions on the tube of silicone sealant and its packing.</p>	

3. Assemble components immediately to permit the silicone sealant to compress evenly between parts.
  - a. Place a new gasket and then install the axle shaft into the wheel hub and differential carrier. The gasket and flange of the axle shaft must fit flat against the wheel hub.
  - b. Install the tapered dowels at each stud and into the flange of the axle shaft. Use a punch or drift and hammer if needed.

- c. Install the lock washers and nuts on the studs. Tighten nuts to the correct torque value.

<p><b>NOTE</b></p>
<p>Torque values are for fasteners that have a light application of oil on the threads (refer to Meritor Maintenance Manual).</p>


9/16-18 plain nut: 110 – 165 lbf-ft (149 – 224 Nm)

5/8-18 plain nut: 150 - 230 lbf-ft (203 - 312 Nm)

2. TAG AXLE

The tag axle is located behind the drive axle. It carries a single wheel and tire on each side. One optional system allows unloading of the tag axle air springs without raising the axle, while the other system enables unloading and raising of the tag axle (refer to the "OPERATOR'S MANUAL" for location of controls). Both of these systems have 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.

	<p><b>CAUTION</b></p>
<p>Do not use tag axle in raised position for an extended period. Raising tag axle increases load on the drive axle, suspension and tires.</p>	
<p>Do not drive vehicle with tag axle raised when speed is exceeding 9mph (15 km/h).</p>	
<p>In order to prevent damage to the suspension, always raise the tag axle before lifting the coach.</p>	

The tag axle service brakes operate only when the axle is in normal driving (loaded) position.


2.1 RETRACTING TAG AXLE FOR REPAIR PURPOSES

- Connect an external air pressure line to the emergency fill valve in the engine compartment.
- Lift the tag 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 recommended 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 sling over tag axle shock absorbers.

## 2.2 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.

 **MAINTENANCE**

Front and tag axle hub bearings need to be checked every 30,000 miles (48 000 km).


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 10.

## 2.3 REMOVAL AND REINSTALLATION

### 2.3.1 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.

### 2.3.2 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).

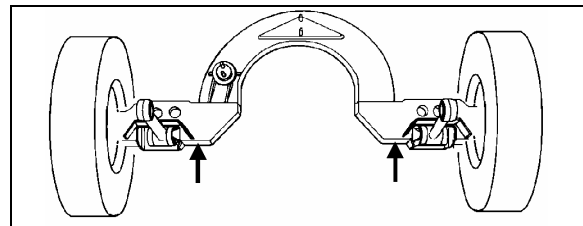



FIGURE 11: JACKING POINTS ON TAG AXLE 11023


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.

 <b>CAUTION</b>
<p><i>Position the hoses so they will not be damaged when removing axle.</i></p>

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.

 <b>CAUTION</b>
<p>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.</p>


14. Reverse removal procedure to reinstall tag axle.

<b>NOTE</b>
<p><i>Refer to Section 16, "Suspension", for proper torque tightening of suspension components.</i></p>

<b>NOTE</b>
<p><i>Refer to section 13 "Wheels, Hubs And Tires" for correct wheel bearing adjustment procedure.</i></p>

## 2.4 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 1.10). 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.

 <b>CAUTION</b>
<p>If this setting is altered significantly, it will cause excessive tire wear.</p>

<b>NOTE</b>
<p><i>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.</i></p>

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

Allison Transmission

- 4.88:1 Standard
- 4.56:1 Optional

**Section 11: REAR AXLES**

---

***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 .....Prevost  
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.*

MERITOR®

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Technical Bulletin

## Approved Rear Drive Axle Lubricants

**CAUTION**

**You must fill Meritor axles with Meritor-specified lubricants only. Do not fill an axle with non-approved lubricants, which will void Meritor’s warranty. Damage to axle components also can result.**

To avoid axle component damage, fill Meritor axles with approved lubricants only. Using non-approved lubricants also will void Meritor’s warranty.

For complete lubrication information, refer to Maintenance Manual 1, Preventive Maintenance and Lubrication. To obtain this publication, call ArvinMeritor’s Customer Service Center at 800-535-5560, or visit Literature on Demand on our website at meritorhvs.com.

**Table A: Oil Change Intervals and Specifications for All Rear Drive Axles**

Vocation or Vehicle Operation	Linehaul	Intercity Coach	City Delivery, School Bus, Fire Truck, Motorhome	Construction, Transit Bus, Refuse, Yard Tractor, Logging, Heavy Haul, Mining, Oil Field, Rescue
Initial Oil Change	Not required			
Check Oil Level <b>Add the correct type and amount of oil as required.</b>	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
<b>Petroleum-Based Oil</b> 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
<b>Synthetic Oil</b> 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](http://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**

	<b>Gear Oil Type</b>	<b>A.P.I. Specification</b>	<b>SAE Viscosity Grade</b>	<b>ArvinMeritor Specification</b>	<b>SAE Specification</b>	<b>Outside Temperature</b>
<b>Standard Drain Lubricants</b>	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)
<b>Extended-Drain Lubricants</b>	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**

<b>Name of Lubricant</b>	<b>Viscosity</b>	<b>Manufacturer</b>
Allied Mag Synthetic EP	75W/90, 80W/140	Allied Oil and Supply Incorporated
Altra Syntec GT-7	75W/90, 80W/140	Allegheny Petroleum Products
Amalie Synthetic Gear Lubricant	75W/90, 80W/140	Amalie Refining Company
Amoco Ultimate Multipurpose Gear Lube	75W/90, 80W/140	Amoco Oil Company
Archer Synthetic	75W/90, 80W/140	McCollister & Co.
Brad Penn Full Syn. Hypoid Gear Lube	75W/90, 80W/140	American Refining Group
Bulldog Syn Gear Lube	75W/90, 80W/140	Mack Truck Company
Chevron Delo Synthetic Gear Lubricant	75W/90	Chevron Global Lubricants
Chevron RPM Synthetic Gear Lubricant	75W/90, 80W/140	Chevron Global Lubricants
Citgo Synthetic Gear Lube	75W/90, 80W/140	Citgo Petroleum Corporation
Coastal HD	75W/90, 80W/140	Coastal Unilube Inc.
Dyna-Plex 21C Synzol	75W/90, 80W/140	Universal Lubricants
Dyno-Tech HD	75W/90, 80W/140	Chemtool Inc.
Emgard EP	75W/90, 80W/140	Cognis Corporation
Emgard FE Fuel Efficient Synthetic Gear Lubricant	75W/90	Cognis Corporation
Emgard Synthetic Gear Lubricant	75W/90, 80W/140	Cognis Corporation
Emgard 2986	75W/90	Cognis Corporation
Fleerite Synthetic	75W/90, 80W/140	International Truck & Engine Group
FS Synthetic	75W/90, 80W/140	Growmark
Gear Plus Super EW	75W/90, 80W/140	Pennzoil-Quaker State

**Table C: Extended-Drain-Approved Synthetic Axle Oil Suppliers – United States Distributors**

<b>Name of Lubricant</b>	<b>Viscosity</b>	<b>Manufacturer</b>
Gibraltar Syn-Gear	75W/90, 80W/140	David Weber Oil Company
Gulf Syngear	75W/90, 80W/140	Gulf Oil
Hi-Tek Synthetic	75W/90, 80W/140	Industrial Oils Limited
Imperial SGO	75W/90, 80W/140	IPAC
Lubemaster Syn EP	75W/90, 80W/140	Lubemaster (A Division of Certified Labs)
Maxtron GL	75W/90, 80W/140	Country Energy LLC
Mobil Delvac Synthetic Gear Oil	75W/90, 80W/140	ExxonMobil Corporation
Mobilube SHC	75W/90, 80W/140	ExxonMobil Corporation
Monarch Syngear Plus	75W/90, 80W/140	Royal Manufacturing Co. Inc.
Mystik Synguard SX-7000	75W/90, 80W/140	Cato Oil and Grease Company
NEO	75W/90, 80W/140	Neo Lubricants
Pennzoil Long-Life EW	75W/90, 80W/140	Shell Oil U.S.
Quaker State FCI Synthetic	75W/90, 80W/140	Shell Oil U.S.
Raloy Transintex Plus EP	75W/90, 80W/140	Raloy Lubricantes S. A. de C.V.
Roadranger FE Fuel Efficient Synthetic Gear Lubricant	75W/90	Eaton Corporation
Roadranger Synthetic Gear Lubricant	75W/90, 80W/140	Eaton Corporation
Schaeffer Synthetic EP	75W/90, 80W/140	Schaeffer Manufacturing Company
SHP Gear Lube	75W/90, 80W/140	Kendall Lubricants
Spirax S	75W/90, 80W/140	Shell Lubricants
SYN HD Gear Oil	75W/90, 80W/140	Lyondell Lubricants
Syn. Axle Lubricant 12345841	75W/90, 80W/140	General Motors Service Parts
Syncon HP Synthetic Gear Oil	75W/90, 80W/140	Conoco Lubricants
SYN-EP Gear Lubricant	75W/90, 80W/140	Black Bear Company Incorporated
Synergy Syn. Gear Lube EP	75W/90, 80W/140	Northland Products Company
Syn-Gear	75W/90, 80W/140	Castrol Heavy Duty Lubricants, Inc.
Syngear EP	75W/90, 80W/140	American AGIP
Synolec	75W/90, 80W/140	Lubrication Engineers Incorporated
Synpro	75W/90, 80W/140	Fina Oil and Chemical Company
Syn-Star GL	75W/90, 80W/140	Texaco Lubricants Company
Synsure Synthetic Lubricant	75W/90, 80W/140	D-A Lubricant Company Incorporated
Syn-Tech EP	75W/90, 80W/140	Benz Oil
Syntex 2700	75W/90, 80W/140	Texas Refinery Corporation
Texaco Syn-Star GL	75W/90, 80W/140	Chevron Global Lubricants
Traxon E Synthetic	75W/90, 80W/140	Petro-Canada Lubricants Centre
Triton Syn Lube EP	75W/90, 80W/140	76 Lubricants
United Syn	75W/90, 80W/140	McCullister & Co.
Valvoline HD Synthetic Gear Oil EP	75W/90, 80W/140	Valvoline Incorporated

## Table D: Additional Extended-Drain-Approved Axle Oil Suppliers

### CANADA:

Name of Lubricant	Viscosity	Manufacturer
HDH Synthetic	75W/90, 80W/140	Irving Oil Limited
NEMCO Syngear	75W/90, 80W/140	NemCo Resources Limited
Sonic MP Gear Oil	75W/90, 80W/140	Federated Cooperatives Limited
Titan Syndrive	75W/90, 80W/140	Fuchs Lubricants Canada Limited

### MEXICO:

Name of Lubricant	Viscosity	Manufacturer
Akron Axle Synthetic	75W/90, 80W/140	Mexicano de Lubricantes, S.A. de C.V.
Q.S. Synquest Gear	80W/140	Commercial Importada, S.A. de C.V.
Sun Gear Gold Syn	75W/90, 80W/140	Aceites Y Parafinas Industriales
Syn-Star GL	75W/90, 80W/140	Productos Texaco, S.A. de C.V.
Transintex Plus EP	75W/90, 80W/140	Raloy Lubricantes, S.A. de C.V.

### AUSTRALIA/NEW ZEALAND:

Name of Lubricant	Viscosity	Manufacturer
Synstar GL	75W/90, 80W/140	Caltex Oil Pty. Limited
Syntrax E	75W/90, 80W/140	Castrol Australia PTY Limited
TransGear S	80W/140	BP Oil Company
Tutela Truck FE Axle	80W/140	Fiat Lubrificanti

### Other Approved Extended-Drain Gear Oils

Name of Lubricant	Viscosity	Manufacturer
Delo Gear Lubricant ESI	80W/90, 85W/140	Chevron Global Lubricants
PED 6449	75W/90	Chevron Global Lubricants
Pennzoil Long-Life EW	75W/90, 80W/140	Shell Lubricants
SAF-AM	80W/90	Castrol Heavy Duty Lubricants
Shell Spirax EW	75W/90, 80W/140	Shell Lubricants
Synergyn Blended Synthetic	80W/90	Synergyn Racing Products
Texaco Star Gear Lubricant	80W/90, 85W/140	Chevron Global Lubricants
Triton Syn Lube LDO	75W/90, 80W/140	76 Lubricants
Super Three Star	75W/90, 80W/140	Kendall



## For Meritor R-170 Axles Equipped With Traction Equalizer®

Meritor's R-170 axles with Traction Equalizer normally operate with either standard petroleum, semi-synthetic or full-synthetic oils.

### When to Use "Limited Slip Friction Modifiers"

Occasionally the Traction Equalizer will "slip" or "stick." When this happens, you will hear intervals of shrill noises when the vehicle operates at low speed or when the vehicle makes sharp turns. You can correct this condition by adding "limited slip friction modifiers."

**NOTE:** "Limited slip friction modifiers" usually deteriorate more quickly than extreme pressure (EP) additives. Shorten the lubricant change schedule if you add a friction modifier.

- **At the initial lubricant change interval for an R-170 equipped with Traction Equalizer:** Replace the factory-installed lubricant with an approved lubricant and one of the additives specified in the following table.
- **After the initial change interval:** Change the lubricant and the additive at or before 50,000 miles (80 000 km).

### Specifications

For all GL-5 oils (petroleum oil or synthetic), add one of the following modifiers specified in the following table.

Manufacturer	Specification
DSL-178	Guardsman Products
Equa-Torque #2411 and #2414	Sta-Lube Corporation
Lubrizol #6178	Lubrizol Corporation

### Quantities for R-170 Axles With and Without Traction Equalizer

WITH Traction Equalizer	WITHOUT Traction Equalizer
40 pints oil (18.9 liters) + 3 pints additive (1.4 liters)	43 pints oil (20.3 liters)

## Lubrication Analysis Recommendations

Meritor recommends using a lubricant analysis program. Perform lubricant analysis at regularly-scheduled preventive maintenance intervals. Refer to Maintenance Manual 1, Preventive Maintenance and Lubrication, for drive axle differential oil analysis guidelines.

**ArvinMeritor**<sup>TM</sup>

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# Maintenance Manual Update

## Applying Loctite® Ultra Grey Flange Sealant 5699/Meritor Part Number 2297-Z-7098

### Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

#### **⚠ WARNING**

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

When you apply some silicone gasket materials, a small amount of acid vapor is present. To prevent serious personal injury, ensure that the work area is well-ventilated. Read the manufacturer's instructions before using a silicone gasket material, then carefully follow the instructions. If a silicone gasket material gets into your eyes, follow the manufacturer's emergency procedures. Have your eyes checked by a physician as soon as possible.

### Procedures

1. Remove all old gasket material from both the axle and the carrier surfaces. Figure 1.

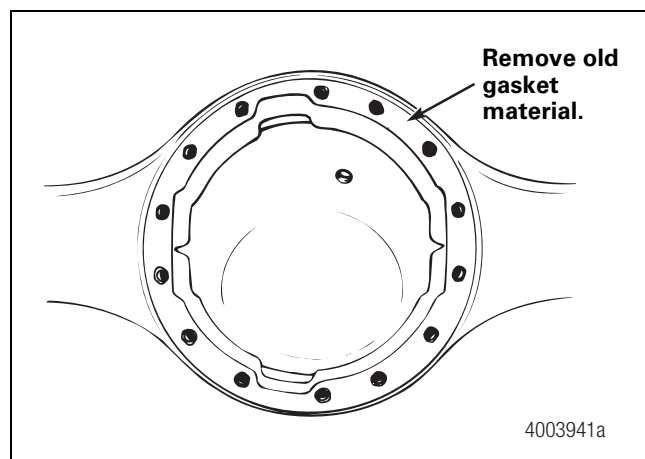


Figure 1

2. Clean the surfaces where you will apply the silicone gasket material. Remove all oil, grease, dirt and moisture. Figure 1.
3. Dry both surfaces.

#### **⚠ CAUTION**

The amount of silicone gasket material applied must not exceed a 0.125-inch (3 mm) diameter bead. Too much gasket material can block lubrication passages and result in damage to the carrier or axle components.

4. Apply a 0.125-inch (3 mm) diameter continuous bead of Loctite® Ultra Grey Flange Sealant 5699, Meritor part number 2297-Z-7098, around one surface. Also apply the gasket material around the edge of all fastener holes on that surface. Figure 2.

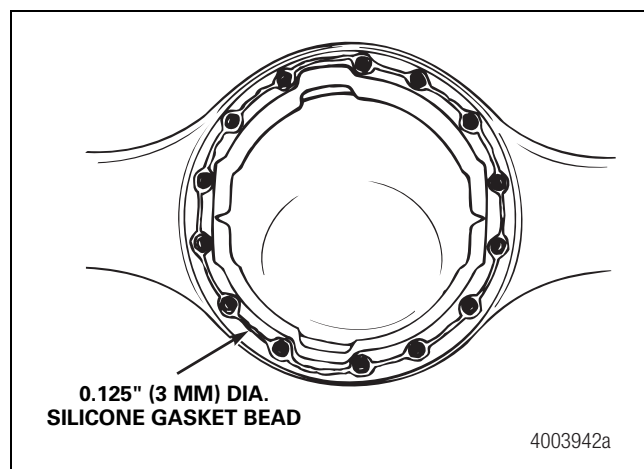


Figure 2

5. Assemble the components immediately to permit the silicone gasket material to compress evenly between the parts. Tighten the fasteners to the required torque value for that size fastener.
6. Wait 20 minutes before filling the assembly with lubricant.

## Maintenance Manuals

The information in this Technical Bulletin updates the following Maintenance Manuals.

<b>MM</b>	<b>Title</b>	<b>Date</b>
5B	Tandem Axle Forward Rear Drive Units	09-88
5J	Single-Reduction Hypoid Drive Unit	08-79
5P	Tandem Axle Forward Rear Drive Units	03-91
6C	Double-Reduction Differential Carriers	08-84
7A	Hypoid Planetary Two-Speed Differential Carriers	08-90
12	Heavy-Duty Front Drive Steer Axles	11-98

**ArvinMeritor™**

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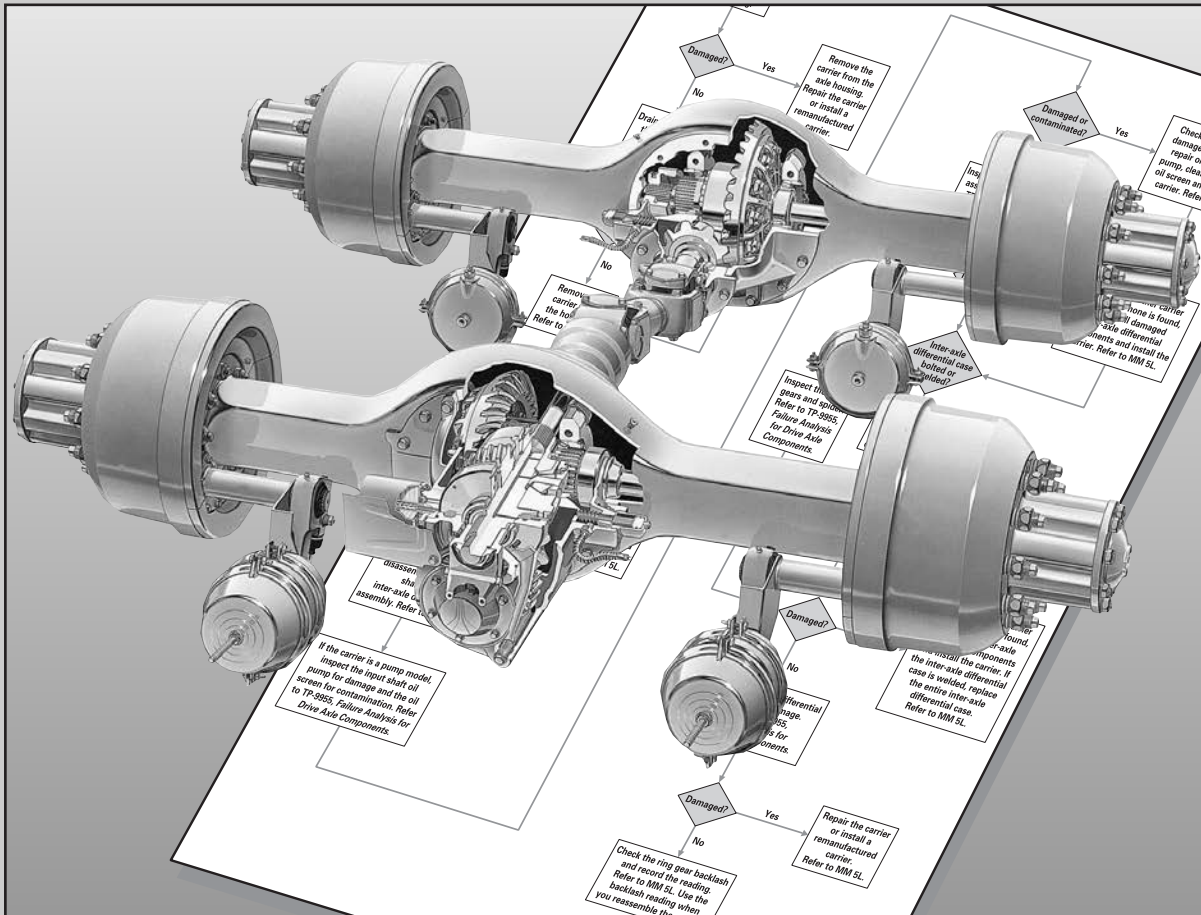
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TP-96105  
Revised 07-03  
(16579/24240)



# TECHNICAL BULLETIN

## Forward and Rear Axle Carrier Diagnostic Flowcharts



# Introduction

---

## How to Use This Publication

Refer to the following diagnostic flowcharts to help you determine the source of axle differential carrier complaints.

Before you use the flowcharts, investigate the axle carrier complaint and confirm that the problem involves the carrier.

To locate the correct flowchart, refer to the following tables.

### Forward Tandem Carrier

Flowchart	Page
Vehicle Will Not Move	2
Differential Making Noise	4
Oil Leak	6

### Rear Tandem or Single Carrier

Flowchart	Page
Vehicle Will Not Move	7
Differential Making Noise	8
Oil Leak	9

### All Rear Axles

Flowchart	Page
Contaminated Lubricant Found During Preventive Maintenance	10

## Performing the Diagnostic Procedures in This Bulletin

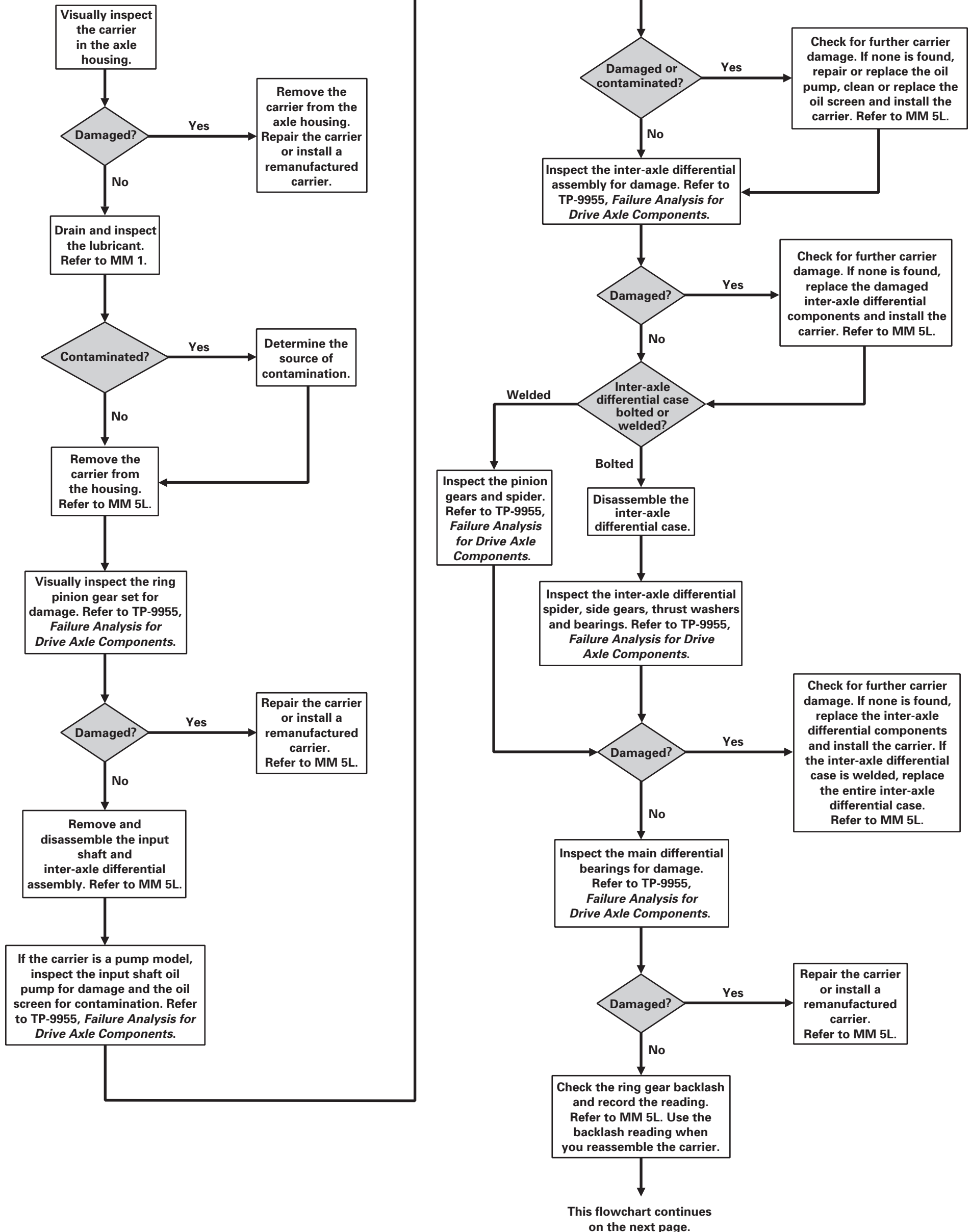
Refer to the following publications when you perform the diagnostic procedures in this bulletin.

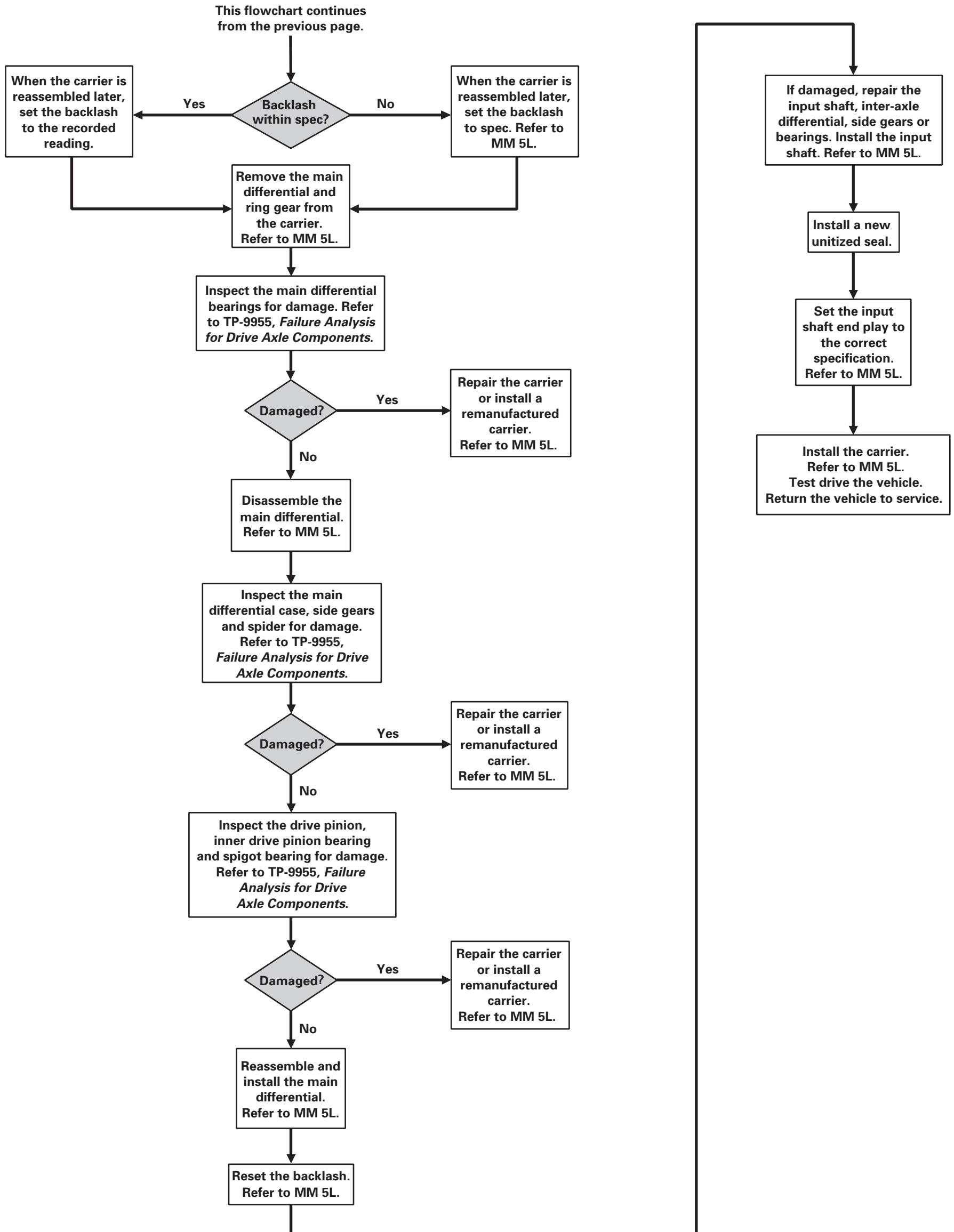
- *Lubrication*  
Maintenance Manual No. 1
- *Single Reduction Differential Carriers*  
Maintenance Manual No. 5
- *Single Reduction Rear Differential Carriers*  
Maintenance Manual No. 5A
- *Tandem Axle Forward Carriers and Single Axle Carriers* — Maintenance Manual No. 5E
- *Single Reduction Forward Differential Carriers on Tandem Axles* — Maintenance Manual No. 5L
- *Failure Analysis for Drive Axle Components*  
Manual No. TP-9955

To order copies of these publications or a CD version of the diagnostic flowcharts (TP-99113), call Meritor's Customer Service Center at 800-535-5560.

# Forward Tandem Carrier

## Vehicle Will Not Move

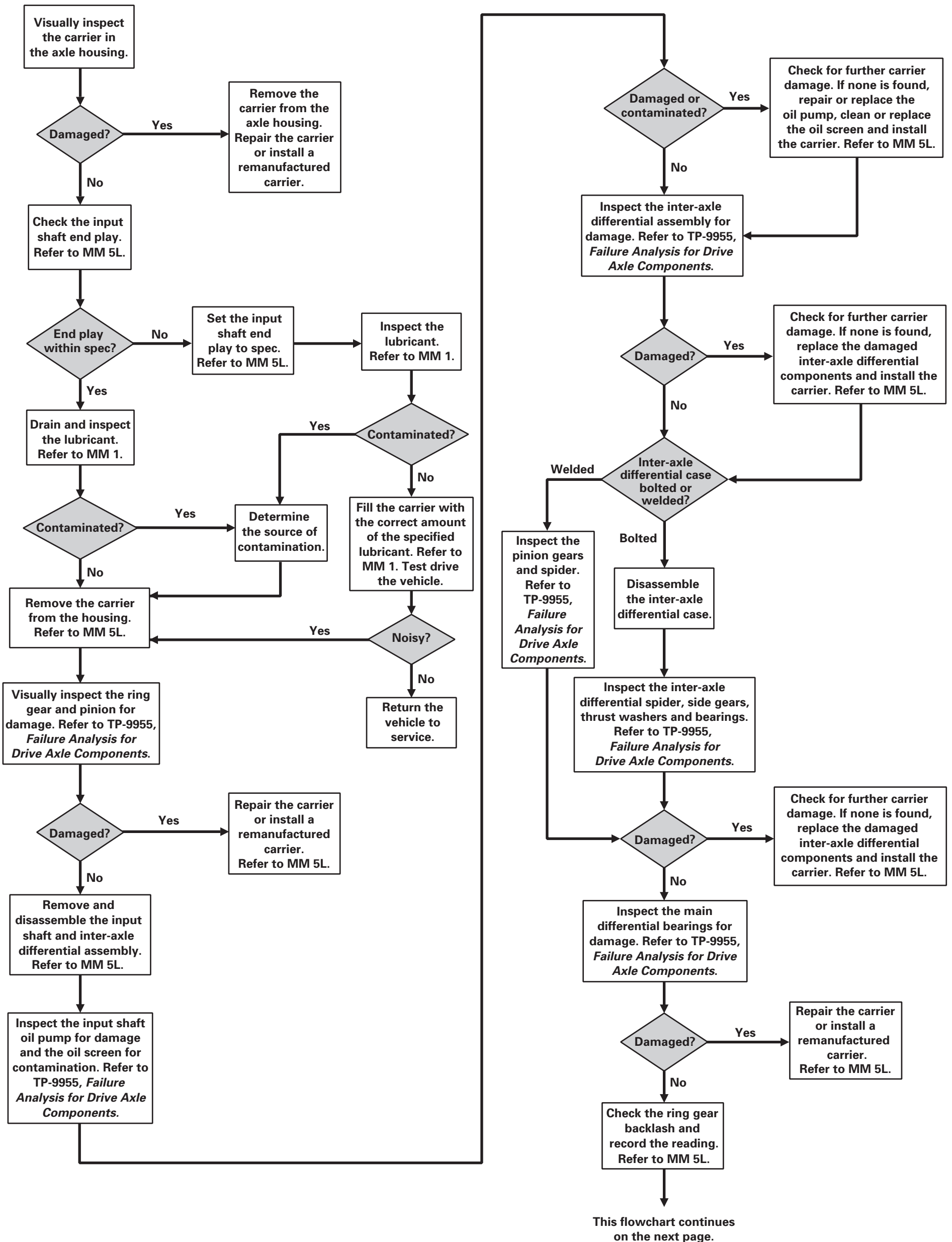


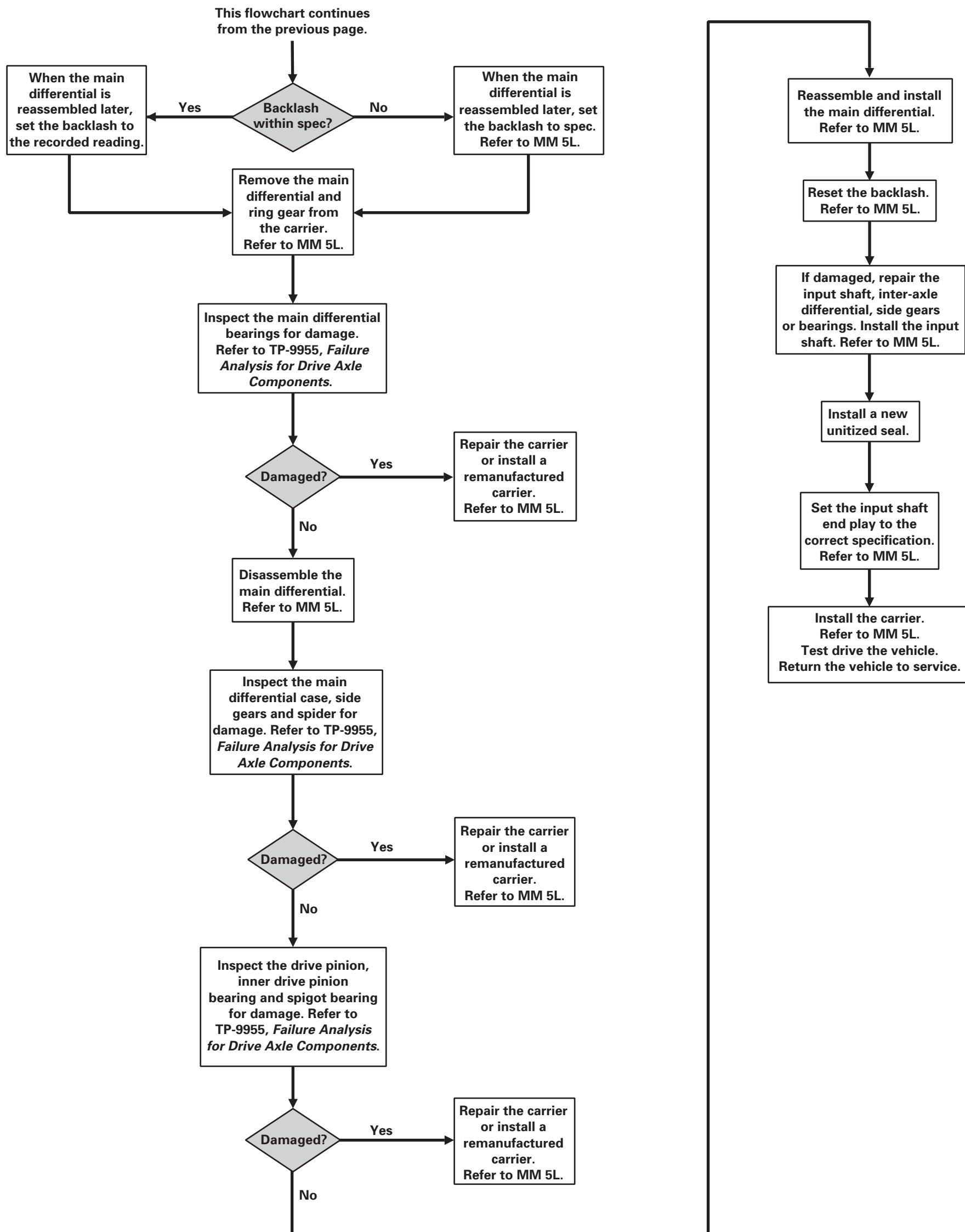




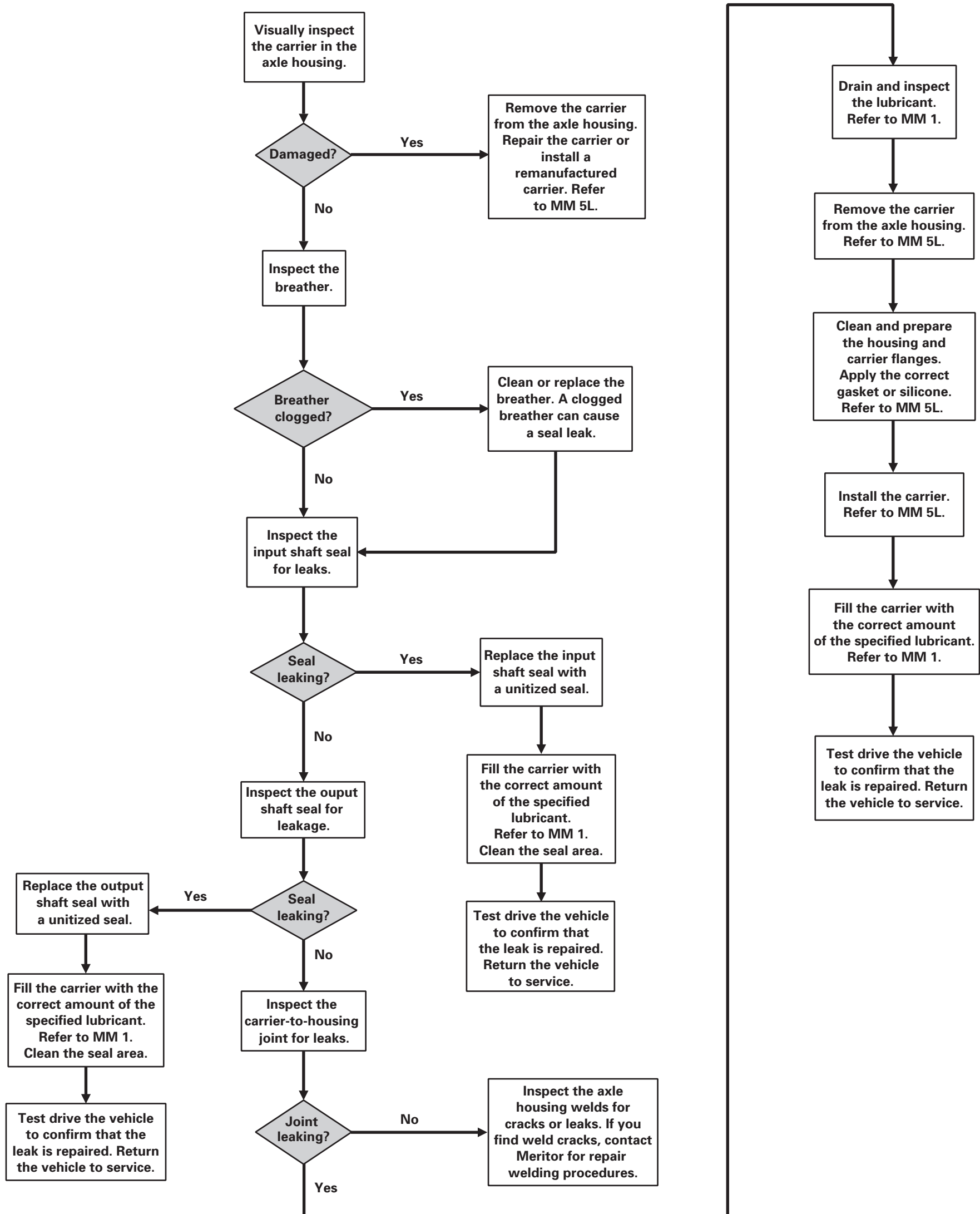
# Forward Tandem Carrier

## Differential Making Noise

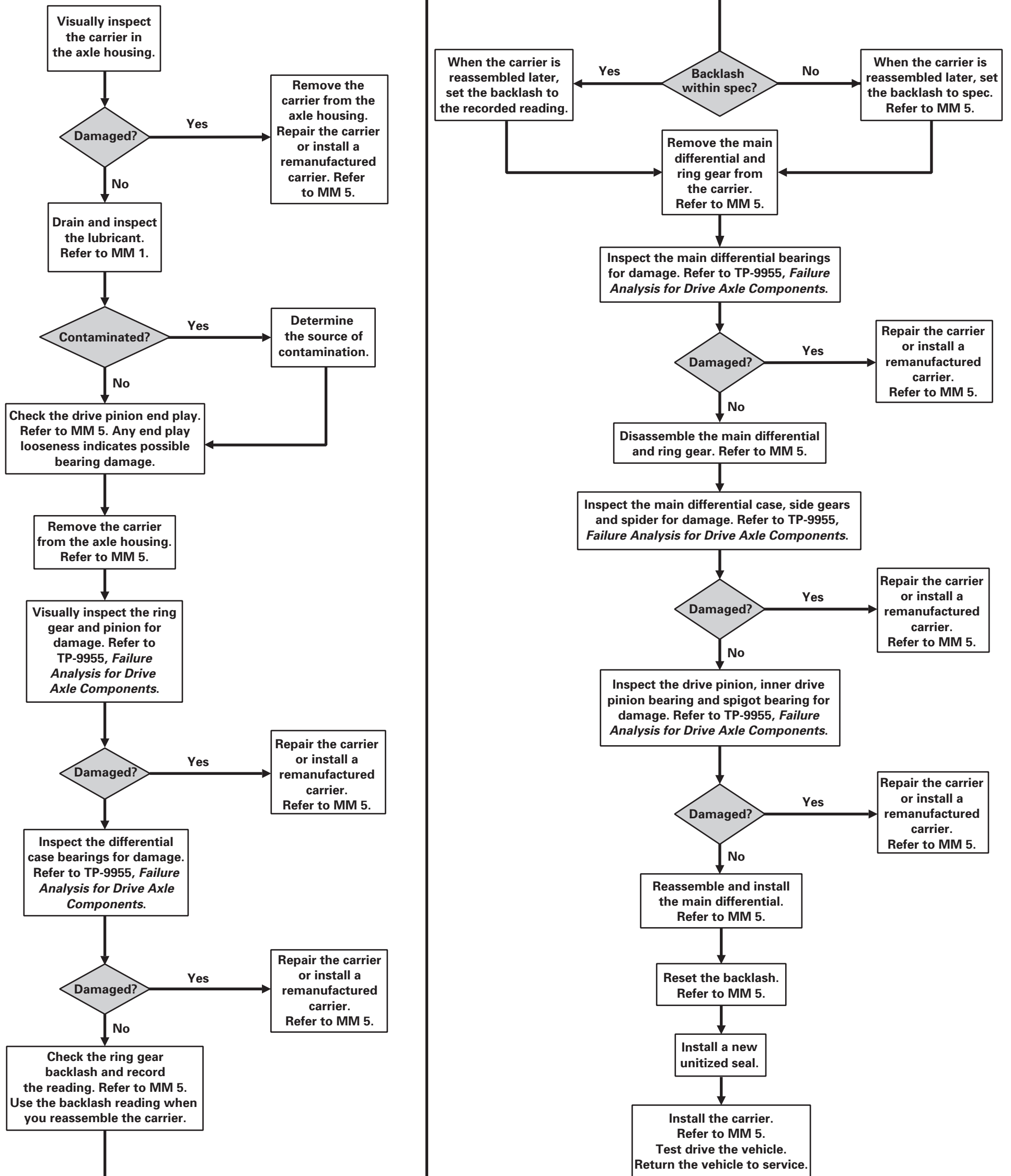




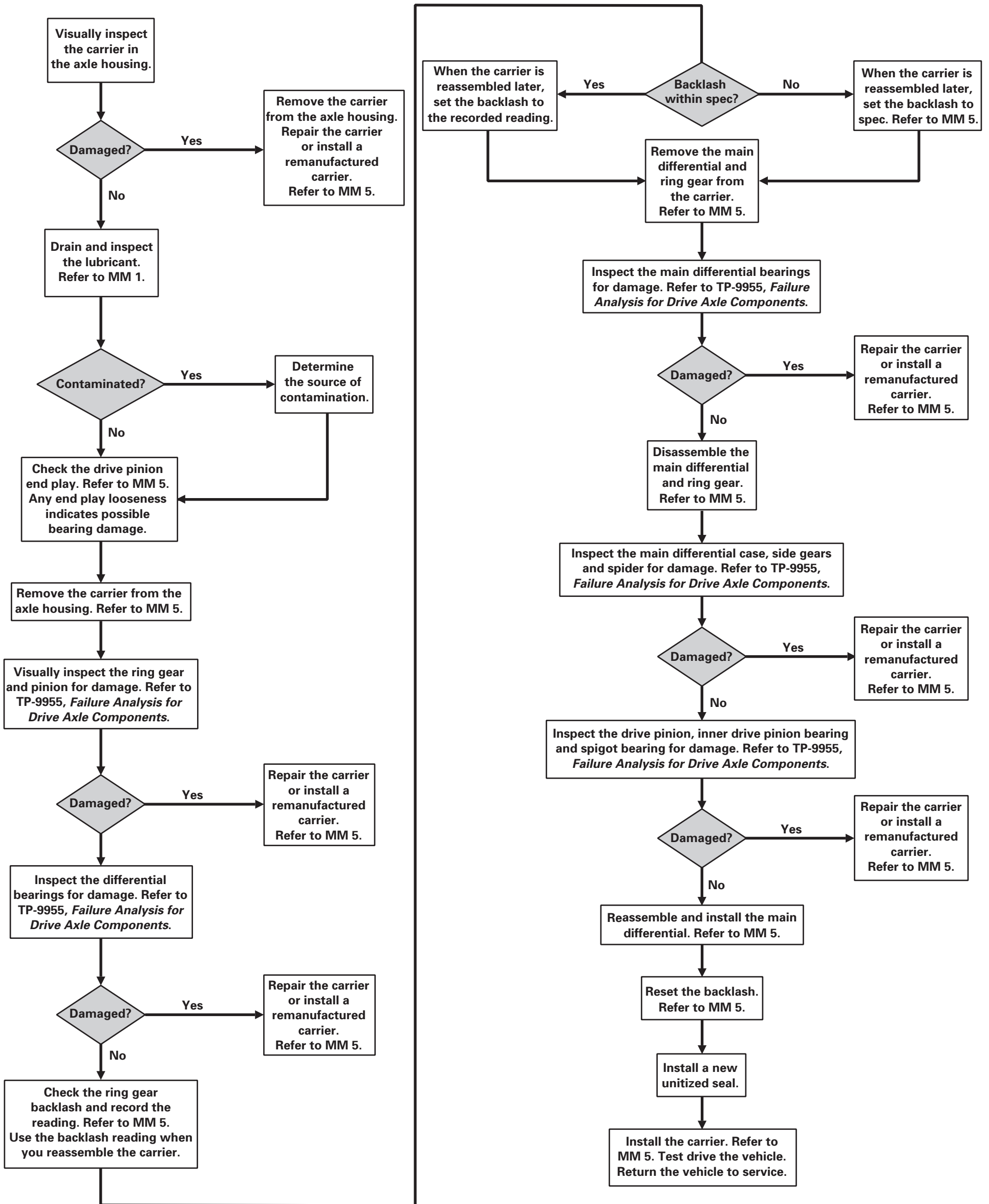
# Forward Tandem Carrier Oil Leak



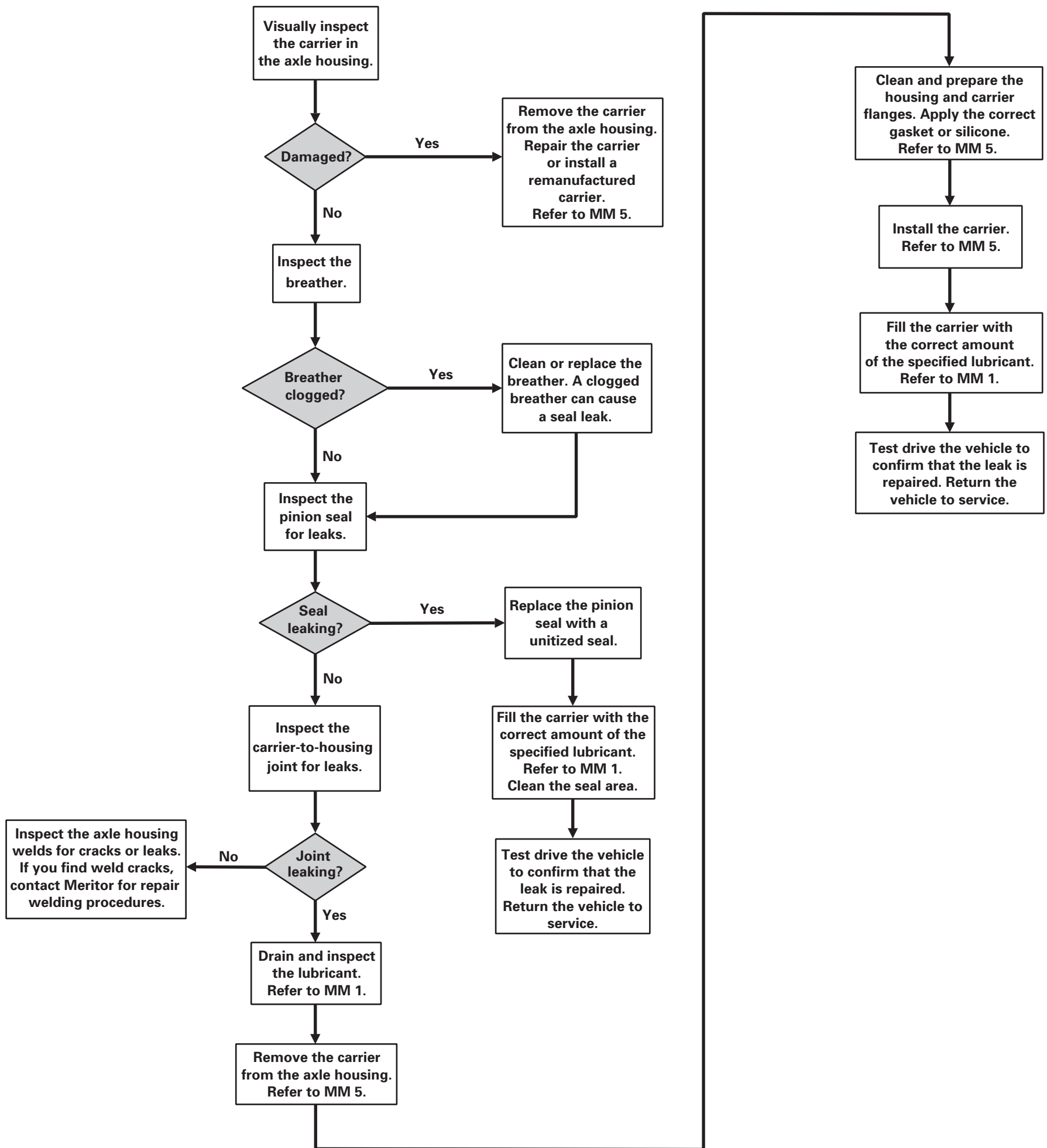
# Rear Tandem or Single Carrier Vehicle Will Not Move



# Rear Tandem or Single Carrier Differential Making Noise

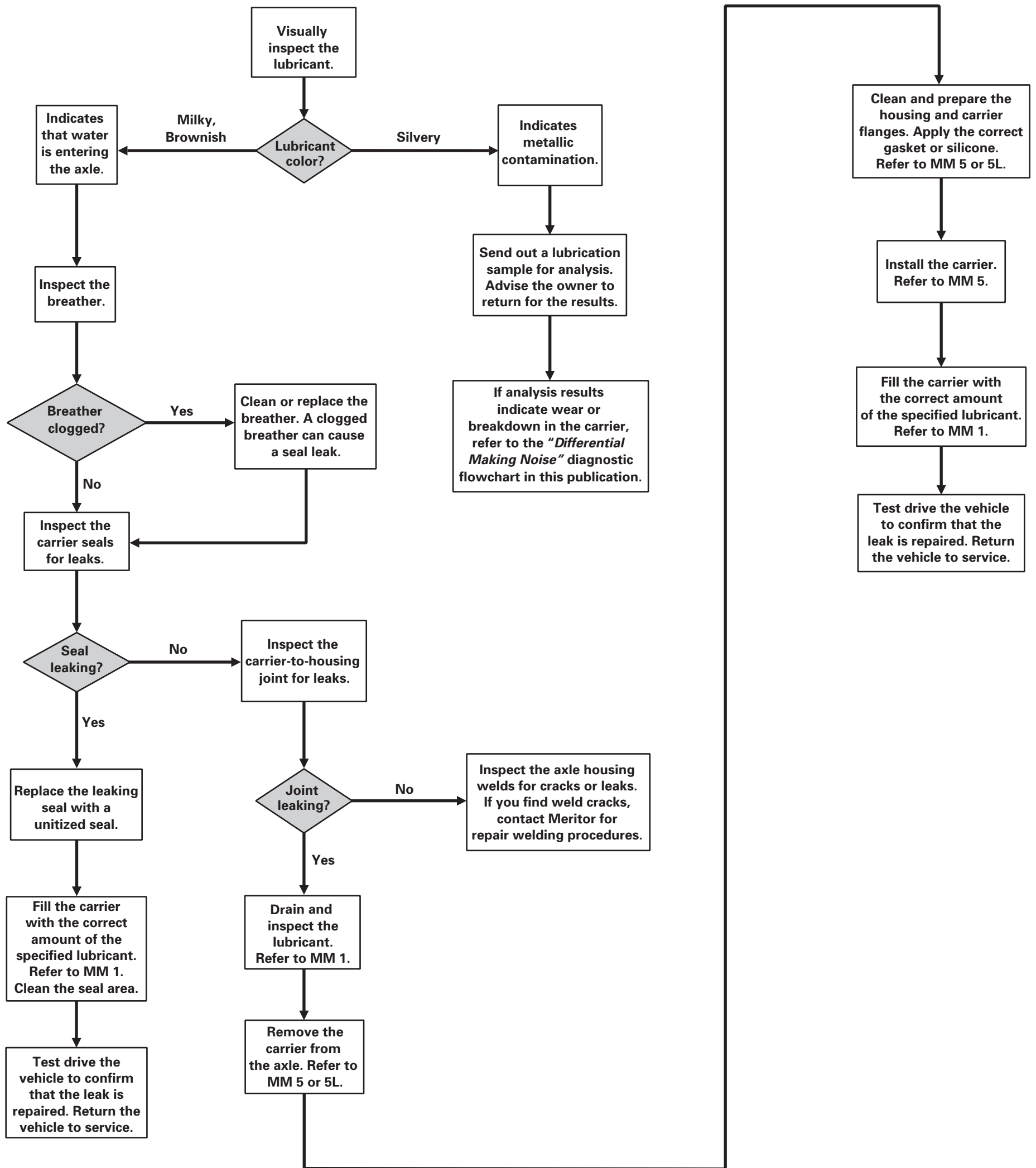


# Rear Tandem or Single Carrier Oil Leak



# All Rear Axles

## Contaminated Lubricant Found During Preventive Maintenance





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# SECTION 12: BRAKE AND AIR SYSTEM

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**1. AIR SYSTEM**

The basic air system consists of an air compressor, reservoirs, valves, filters and interconnecting lines and hoses. It provides a means for breaking, 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).*

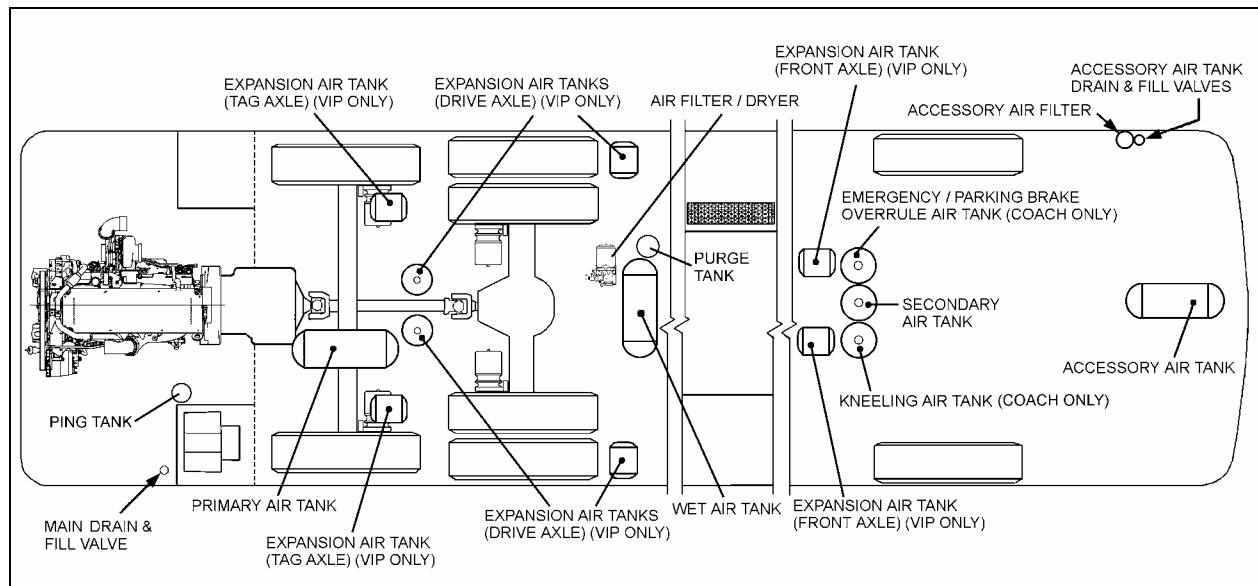
Furthermore, the brake application or release, which is speed up by pneumatic relay valves (R-12 & R-12DC), will start with the rear axles and will be followed by the front axle, thus providing uniform braking on a slippery road. The vehicle is also equipped with an Anti-Lock Braking System (ABS), which 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). The optional emergency/parking brake overrule system allows the driver to release spring brakes, and to move the vehicle to a safe parking place, such as in the case of a self-application of these brakes due to a drop in air pressure.

**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).

Two additional air reservoirs may be installed on the vehicle: the kneeling air tank and emergency/ parking brake overrule air tank.



**FIGURE 1: AIR RESERVOIRS LOCATION**

12196

**3.1 MAINTENANCE**

Ensure that both the accessories and the wet (main) air tanks are purged during pre-starting

inspection. In addition, it is good practice to purge these reservoirs at the end of every working day. The remaining reservoirs must be

## Section 12: BRAKE AND AIR SYSTEM

purged at every 12,000 miles (or 20 000 km) or once every year, whichever comes first.

### 3.1.1 Wet (Main) Air Tank

This reservoir, located in front and above the drive axle in the rear wheelhousing, is provided with a bottom drain valve. A recommended purge using the bottom drain valve should be done every 12,000 miles (20 000 km), or once a year, whichever comes first. Purge daily using the drain valve located in the engine compartment R.H. side (Fig. 2).

### 3.1.2 Primary Air Tank

This reservoir is located above the tag 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.

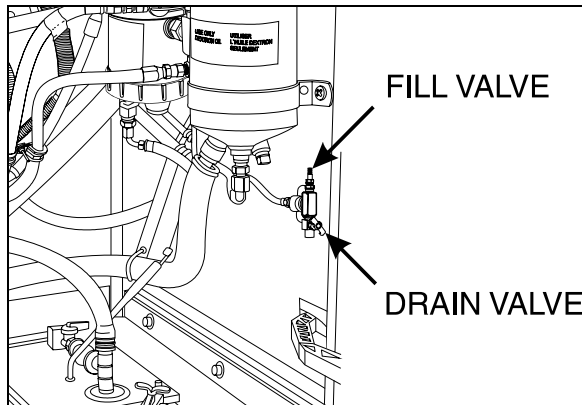


FIGURE 2: REAR VALVE LOCATION

12148

### 3.1.3 Accessory Air Tank

The accessory air tank is installed at the ceiling of spare wheel compartment and is provided with a bottom drain valve (Fig. 1). Purge daily using the remote drain valve located in the front service compartment (Fig. 3). Purge the reservoir by its drain valve every 12,500 miles (20 000 km) or once a year, whichever comes first.

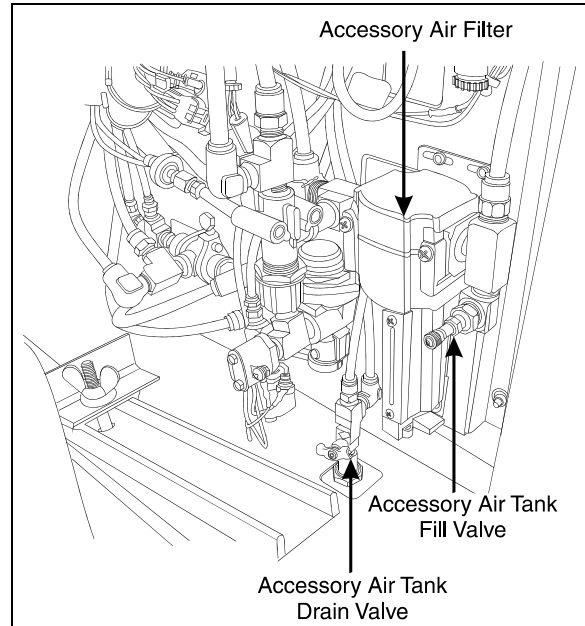


FIGURE 3: FRONT SERVICE COMPARTMENT

12130

### 3.1.4 Emergency/Parking Brake Override Air Tank

Installed on vehicles equipped with this option, this reservoir is located in the front wheelhousing (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.

### 3.1.5 Secondary Air Tank

Located in the front wheelhousing, this tank is set between the optional Emergency/Parking Brake override air tank and the Kneeling air tank (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.

### 3.1.6 Kneeling Air Tank


The kneeling air tank is installed on vehicles equipped with the Kneeling or Hi/Low-Buoy options. It is located in the front wheelhousing (Fig. 1), and 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.

#### 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 compartment R.H. side door (Fig 2.).

	<h3>CAUTION</h3>
<p>Maximum allowable air pressure is 140 psi (965 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.</p>	

The front valve is located in the front electrical and service compartment close to R.H. side of doorframe (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 to accessories only.

#### 5. ACCESSORY AIR FILTER

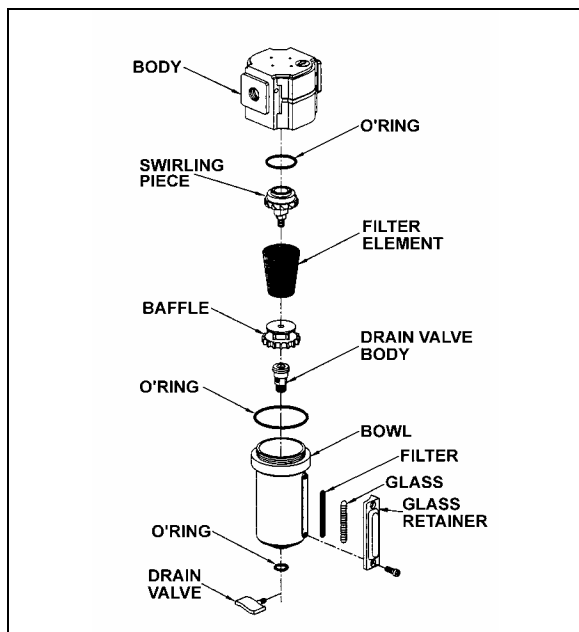


FIGURE 4: ACCESSORY AIR FILTER 12088

This filter is located inside the front electrical and 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 "Operator's Manual" or "Owner's Manual"), are connected to the DC-4 double check valve, located on the pneumatic accessories 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 publication box. 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

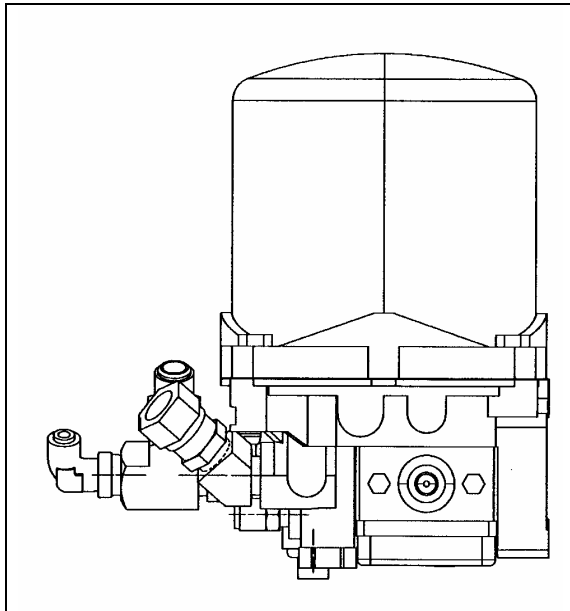


FIGURE 5: HALDEX AIR FILTER DRYER 12194

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 close to the door hinge (Fig. 2). The air filter/dryer has a built-in governor to maintain the system between 108 and 123 psig.

Maintenance and repair information is supplied in the applicable booklet 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, 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 or belt tensioner air cylinder hoses. Hose connections should be tested for leakage at least every 6,250 miles (10 000 km) or twice a year, whichever comes first and tightened or replaced if necessary. Any hose, which is chafed, worn or kinked, should be replaced.

Teflon-braided stainless steel hoses used in the engine compartment must be replaced only with similar hoses.

8.3 NYLON TUBING

Nylon tubing is used for air lines in areas where usage of this material is suitable. Nylon tubing is flexible, durable, and weather resistant. When replacing an air line, use nylon tubing only where it has been used previously.

Nylon air lines must never be routed in areas where temperature could exceed 200°F (93°C).





**CAUTION**

Nylon air lines should be used to replace existing nylon lines only, and must comply with the color identification code to ease pneumatic system troubleshooting.

**8.4 AIR LINE OPERATING TEST**

If any trouble symptom such as slow brake application or slow brake release indicates a restricted or clogged air line, disconnect the suspected tube or hose at both ends and blow through it to clear the passage.

Inspect tubing and hose for partial restriction that may be caused by dents or kinks. If such a condition is found, the tubing or hose should be replaced.

**8.5 AIR LINE LEAKAGE TEST**

With air system fully charged and the brakes applied, coat all tubing and hose connections with a soapy solution to check for air leakage. No leakage is permitted. Leakage can sometimes be corrected by tightening the connection. If this fails to correct the leakage, new fittings, nylon tubing, copper tubing, teflon-braided stainless steel and flexible hoses must be installed as applicable.

**8.6 MAINTENANCE**

Inspect all lines for cuts, swelling, kinks or other damage or deterioration. Check for lines being pinched by other components. Retaining clips and ties must be in place.

Any support or bracket should be in good condition and mounted firmly in position. Hose spring guards should be in usable condition and not distorted. Particular attention should be given to long lines. Any supporting component (clips, ties, grommets, etc.) must be secured to prevent against unnecessary vibration and eventual loosening of connection. Any detected leak should be repaired. Be sure nylon lines are not near areas of intense heat. Check for any missing grommets or loose material where chafing or cutting may occur. Replace with new material as required. In general, lines should be securely located in position and free from any binding condition, which would hinder air flow.

**9. PRESSURE REGULATING VALVES**

There is one pressure regulator for the belt tensioners, and an optional one installed on

vehicles equipped with the world transmission output retarder.

The belt tensioner pressure regulating valve is located in the engine compartment at the back of the engine starting control panel. It is used to limit the air pressure in belt tensioners to  $45 \pm 2$  psi ( $310 \pm 15$  kPa) (Fig. 7).

The optional regulator is located in the engine compartment and is accessible through the engine R.H. side door. It is used for transmission retarder and should be adjusted to  $80 \pm 3$  psi ( $550 \pm 20$  kPa).

	Air Pressure (psi)	Air Pressure (kPa)
Belt Tensioner	$45 \pm 2$	$310 \pm 15$
Retarder	$80 \pm 3$	$550 \pm 20$

**9.1 MAINTENANCE**

Every 100,000 miles (160 000 km) or once every two years, whichever comes first, disassemble the pressure 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.

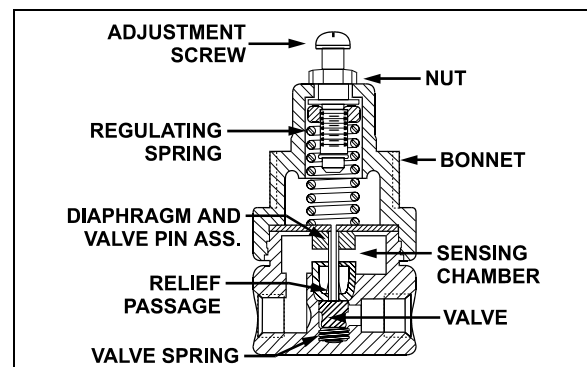


FIGURE 6: AIR PRESSURE REGULATING VALVE 12141A

**9.2 PRESSURE SETTING PROCEDURE**

Remove the dust cap from the pressure check port (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.

## Section 12: BRAKE AND AIR SYSTEM

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 pressure check port.

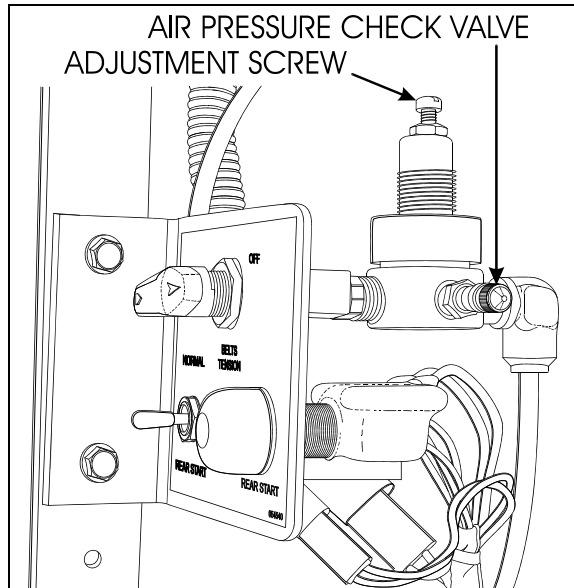


FIGURE 7: AIR PRESSURE REGULATOR 12143

### 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 (fuel pump 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.

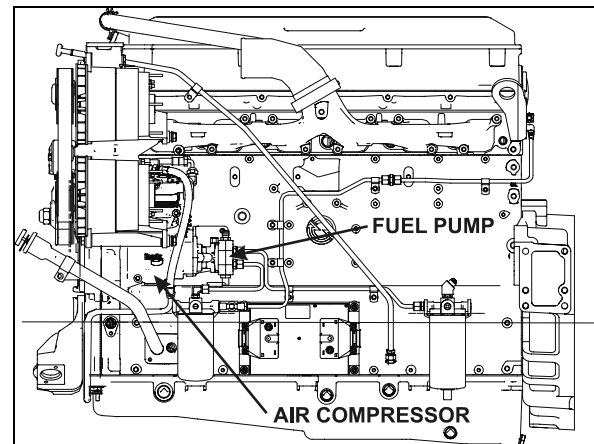


FIGURE 8: AIR COMPRESSOR INSTALLATION 03061

### 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.

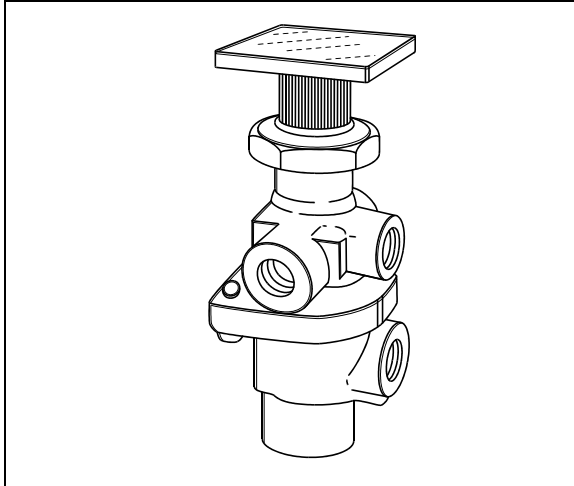


FIGURE 9: PP-1 12142

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. EMERGENCY / PARKING BRAKE OVERRULE CONTROL VALVE (RD-3)

A RD-3 control valve is used with the optional parking brake overrule system. In the case of self-application of spring brakes due to a pressure drop, the brakes can be released by holding down this control valve. Maintenance and repair information on this valve is supplied in the applicable booklet annexed to this section under reference number SD-03-3611.

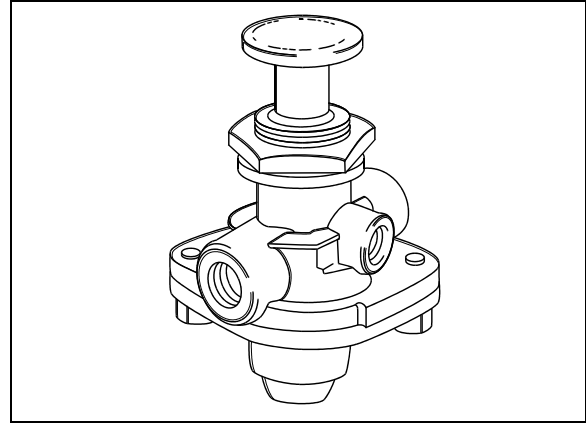


FIGURE 10: RD-3 12136

### 13. FLIP-FLOP CONTROL VALVE (TW-1)

A flip-flop control valve mounted on the L.H. lateral console is provided to unload tag axle air springs (and to lift tag axle if vehicle is so equipped). Another one controls the low-buoy system (coaches only). It is a manually operated "on-off" valve. Maintenance and repair information on this valve is supplied in the applicable booklet annexed to this section under reference number SD-03-3602.

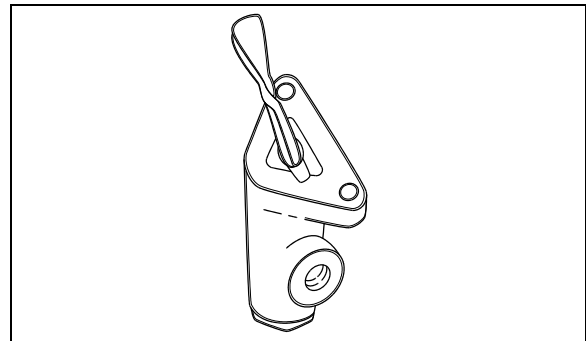


FIGURE 11: TW-1 12138

### 14. DUAL BRAKE APPLICATION VALVE (E-10P)

The E-10P dual brake valve is a floor mounted, foot-operated type brake valve with two separate supply and delivery circuits. This valve is located in the front service compartment (Fig. 12).

#### 14.1 BRAKE PEDAL ADJUSTMENT

After brake pedal replacement or repair, adjust the pedal to its proper position according to the following procedure:

1. Replace the linkage, loosen threaded rod lock nuts and screw or unscrew the threaded adjustment rod in order to obtain a 45° brake pedal inclination (Fig. 12).

## Section 12: BRAKE AND AIR SYSTEM

2. Tighten threaded rod lock nuts.

### 14.1.1 Maintenance

Maintenance and repair information on the E-10P dual brake application valve is supplied in the applicable booklet annexed to this section under reference number SD-03-830.

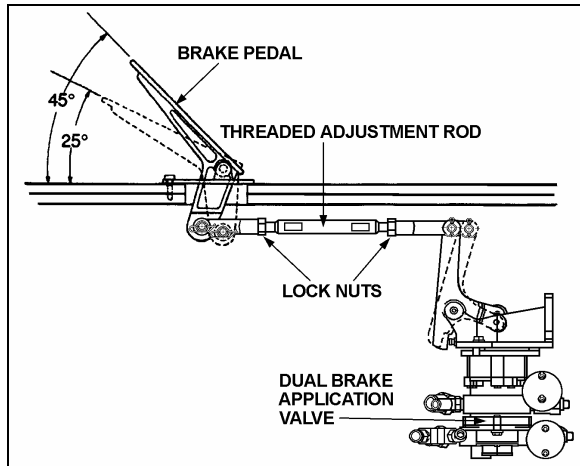


FIGURE 12: BRAKE PEDAL ADJUSTMENT 12208

### 15. STOPLIGHT SWITCHES

Two Electro-pneumatic stoplight switches are mounted on the dual brake application valve (E-10P). 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. 13), while the lower one (Bendix, SL-5) closes its contact at 4 psi (28 kPa) (Fig. 14). The switches are not serviceable items; if found defective, the complete unit must be replaced.

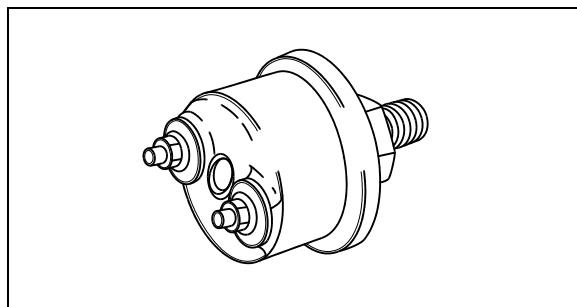


FIGURE 13: DELCO SWITCH 12139

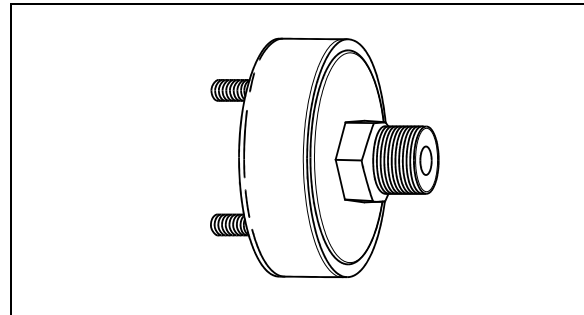


FIGURE 14: BENDIX SWITCH 12140

### 16. PARKING BRAKE ALARM SWITCH

Refer to the appropriate annexed booklet (Bendix, SL-5 Stop Light Switch; reference no. SD-06-2501).

The parking brake alarm uses the same switch as the stoplights. It is mounted on the spring brake valve and operates in conjunction with a NC relay to sound a warning alarm by completing the electrical circuit when the ignition key is turned OFF with parking brake released.

### 17. BRAKE RELAY VALVE (R-12 & R-14)

The primary air system includes three brake relay valves being supplied by the dual brake valve, and which function is to speed up the application and release of the service brakes.

One Wabco R-14 valve located above the drive axle 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 and Wabco Relay Valves.

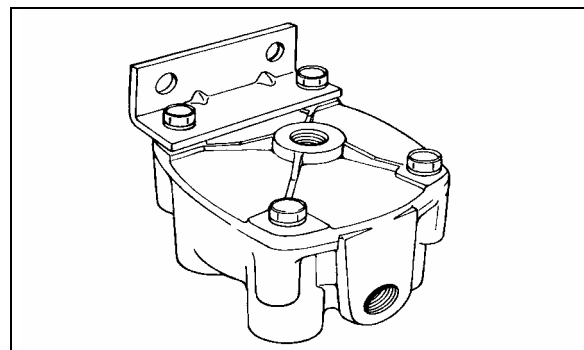


FIGURE 15: R-12 12074

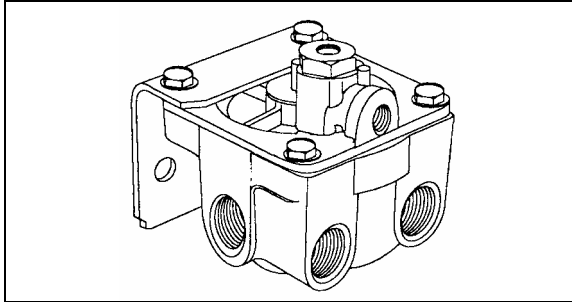


FIGURE 16: R-14 12207

**18. QUICK RELEASE VALVES (QR-1)**

One quick release valve is installed on this vehicle and is used on Low Buoy rear release system. It permits rapid exhaust of air pressure from brakes, thus decreasing the brake release time.

Maintenance and repair information on these valves is supplied in the applicable booklet annexed to this section under reference number SD-03-901.

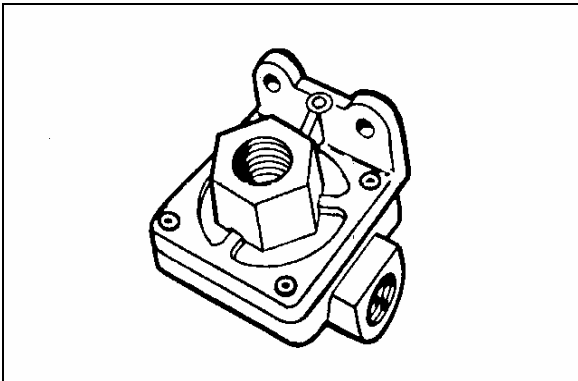


FIGURE 17: QR-1 12075

**19. SPRING BRAKE VALVE (SR-7)**

The spring brake valve is located above the drive axle. The SR-7 Modulating Valve is used in conjunction with a dual air brake system and spring brake actuator and performs the following functions:

- Provides a rapid application of the spring brake actuator when parking.
- Modulates the spring brake actuator application using the dual brake valve should a primary failure occur in the service brake system.
- Prevents compounding of service and spring forces.

Maintenance and repair information on the spring brake valve is supplied in the applicable booklet annexed to this section under reference number SD-03-9043.

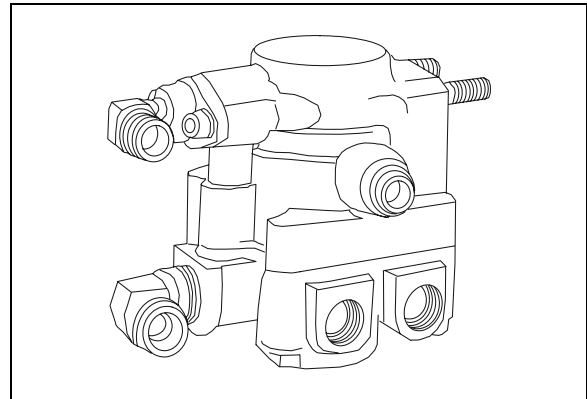


FIGURE 18: SR-7

**20. PRESSURE PROTECTION VALVE (PR-2 & 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. 19). One valve, the PR-2 is installed on the manifold block, and insures at all times a minimum pressure of 75 psi (517 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 besides the air filter.

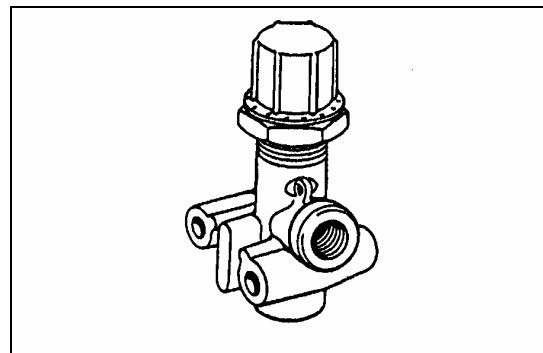


FIGURE 19: PR-2 & PR-4 12077

The other valve, the PR-4 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). The closing pressure of the PR-2 is

## Section 12: BRAKE AND AIR SYSTEM

externally adjustable while the PR-4 has a fixed setting.

### 21. LOW PRESSURE INDICATORS (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. One is located on the pneumatic accessories panel in the front service compartment. The remaining pressure switch is mounted on the spring brake valve, and monitors the parking brake pilot lamp. Its pressure setting is 30 psi (205 kPa).

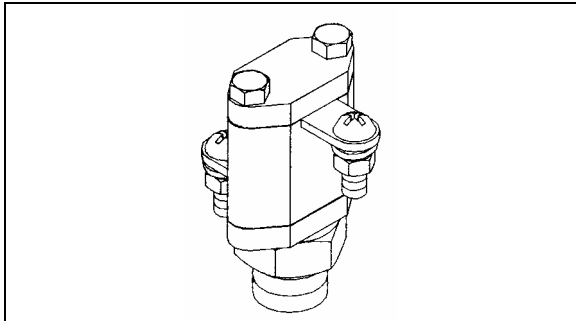


FIGURE 20: LP-3

12078

### 22. SHUTTLE-TYPE DOUBLE CHECK VALVE (DC-4)

Maintenance and repair information on the shuttle-type double check valve is supplied in the applicable booklet annexed to this section under reference number SD-03-2202.

The double check valve is located on the pneumatic accessories 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.

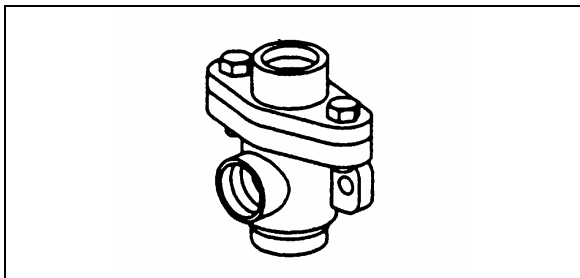


FIGURE 21: DC-4

12134

### 23. EMERGENCY DOOR OPENING VALVES

Two emergency door opening three-way valves are installed on coaches. One is in the front service compartment, readily accessible. The other one is on the R.H. side lateral console, close to the entrance door. When used, the valve releases pressure in the door locking cylinder, thus allowing the door to be manually opened.

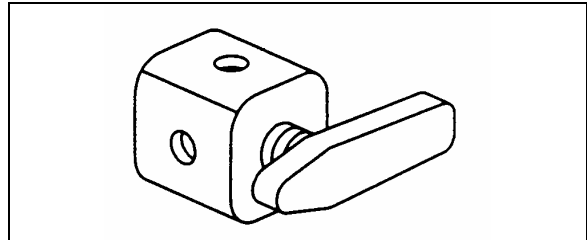


FIGURE 22: THREE WAY VALVE

12186

#### 23.1 INTERIOR VALVE MAINTENANCE

When needed, this valve can be changed according to the following procedure:

1. Unscrew the front R.H. decorative panel in order to access the valve.
2. Unscrew and remove the valve handle.
3. Unscrew and remove the valve retaining ring.
4. Push the valve inside the console.
5. Disconnect the air tubes.
6. Reverse the procedure to install a new valve.

### 24. AIR HORN VALVE

The air horn solenoid valve is located in the front service compartment. The air horn activating button is on the center of the steering wheel. Refer to section 23 "ACCESSORIES" for more information.

### 25. AIR SYSTEM TROUBLESHOOTING

The following list has been designed to help in troubleshooting some of the most common problems in the air system and main causes. For air brakes troubleshooting, refer to "Air Brakes Troubleshooting" in this section. For more troubleshooting information, refer to the manufacturer's brochures annexed to this section.

**Air pressure doesn't rise to, or doesn't maintain, a normal setting:**

- Defective air gauge (registering incorrectly).
- Excessive leaking in air system.
- Reservoir drain cock open.
- Air filter/dryer built-in governor poorly adjusted or defective.
- Defective compressor.
- Worn compressor or excessive wear on piston and/or ring.

### **Air pressure rises to normal setting too slowly:**

- Excessive leaking in air system.
- Clogged engine air cleaner.
- Worn compressor or excessive wear on piston and/or ring.
- Engine speed too low.

### **Air pressure rises above a normal setting:**

- Defective air gauge (registering incorrectly).
- Air filter/dryer built-in governor poorly adjusted or defective.

### **Air pressure drops quickly when engine is stopped:**

- Leaks in compressor discharge valve.
- Leaks in air lines.
- Leaks in air system valves.

## **26. BRAKE OPERATION**

The vehicle braking system uses both service and parking air-operated brakes. The air system is divided into two independent circuits to isolate the front axle brakes and the rear axle brakes (drive and tag), thus providing safe brake operation in the event that one circuit of the system fails. The primary circuit is connected to the drive and tag axle brakes, while the secondary circuit is connected to the front axle brakes. The tag axle service brakes operate only when the axle is in the normal driving (loaded) position. The spring-type emergency brakes are mounted on the drive and tag axles, and will apply automatically if primary system pressure falls below 40 psi (276 kPa). The optional parking brake override system can cancel the parking brakes, enabling the driver to move the vehicle to a safe parking place. To operate this system, push down and hold the control knob located on the R.H. side of the

driver's seat (see "Operator's Manual" for more details).

Furthermore, brake application or release, which is sped up by a pneumatic relay valve (R-12 & R-12DC), will start with the rear axles and be followed by the front axle, thus providing uniform braking on a slippery surface. The vehicle is also equipped with an Anti-lock Brake System (ABS), detailed later in this section.

Brake and air system maintenance consists of periodic inspections. Check all parts for damage and brake adjustment (refer to subsequent headings in this section for more details). Ensure all fasteners are tight (refer to "Specifications" for recommended tightening torques).

## **27. AIR BRAKES**

*Knorr-Bremse SN7000* disc brakes are used on all axles. The front and drive axle discs are actuated by 24 inch<sup>2</sup> effective area air brake chambers (22 inch<sup>2</sup> for front solid beam axle), while on tag axle, the brake chambers have a 14 inch<sup>2</sup> effective area for service brake and a 16 inch<sup>2</sup> 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.

### **27.1 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. 23). 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.

## Section 12: BRAKE AND AIR SYSTEM

### 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 Prevest 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-Prevest product notification annexed at the end of Section 12 of Maintenance Manual.

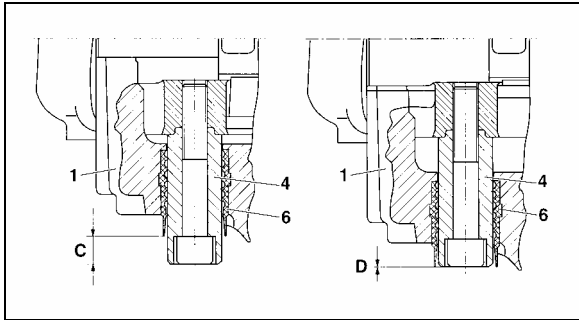


FIGURE 23: BRAKE PAD CHECK

12117

### 27.2 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. 24), push down retainer bar (11), pull out pin (44) and remove retainer bar. Push caliper toward actuator (center of vehicle) for maximum clearance.

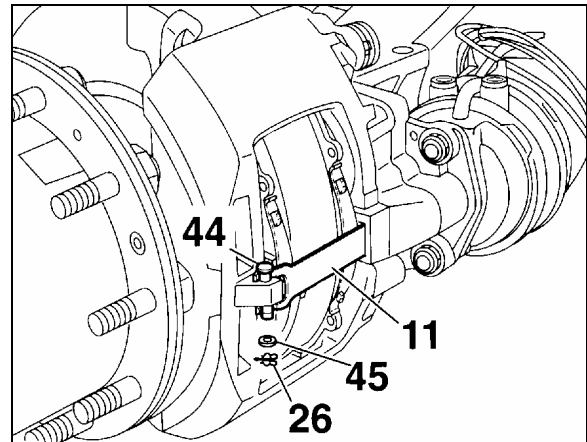


FIGURE 24: CLEARANCE INSPECTION

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).

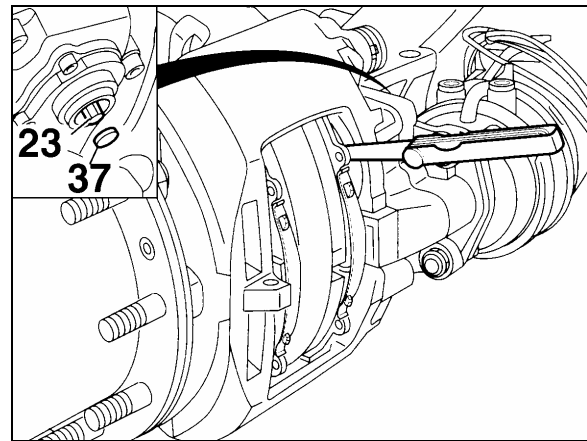


FIGURE 25: RUNNING CLEARANCE

12116

#### 4. Checking the adjuster





**CAUTION**

Use only a standard box wrench on the adjuster hexagonal pinion. Do not overtorque the pinion as overtightening will damage the pinion.

- a) Remove cap (37, Fig. 26).
- b) Using a box wrench (8 mm), turn the adjuster pinion (23, Fig. 26) 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. 26 and 27).

**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.

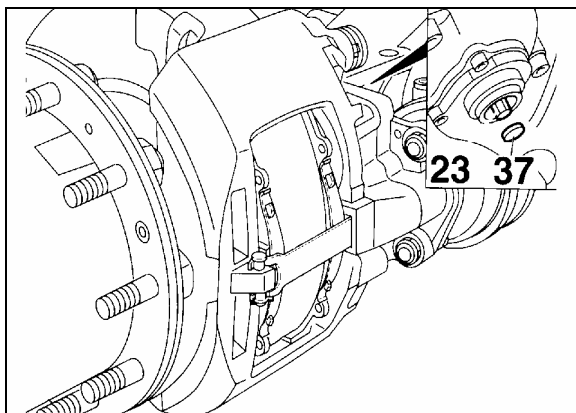


FIGURE 26: ADJUSTER PINION 12120

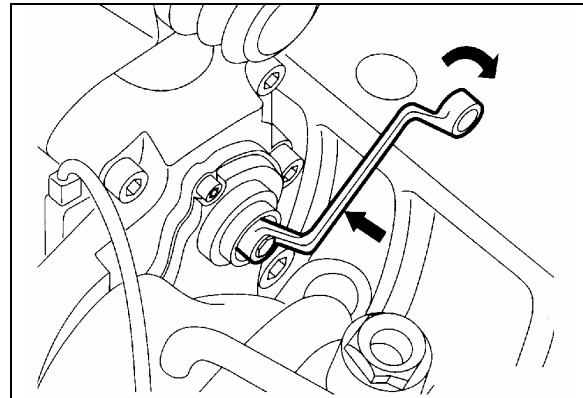


FIGURE 27: BOX WRENCH ON ADJUSTER PINION 12118

**27.3 ROADSIDE INSPECTION FOR KNORR-BREMSE 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-Bremse air disc brake is designed to move freely, with minimal force, in the axial direction on the two sliding pins as identified in figure 28. The movement in the axial direction should not exceed 2 mm (5/64").

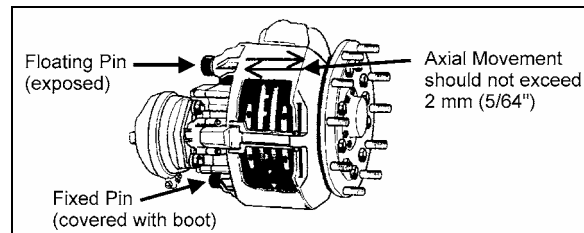


FIGURE 28: CALIPER AXIAL MOVEMENT 12132

The caliper flotation consists of two pins. One pin (fixed pin) floats and should have minimal movement in the radial direction. The other pin is floating in a rubber bushing. The maximum radial movement should not exceed 2.0 mm (0.080"). To check the radial movement, insert a pry tool between the caliper and carrier near the middle and then measure the relative movement as shown in figure 29.

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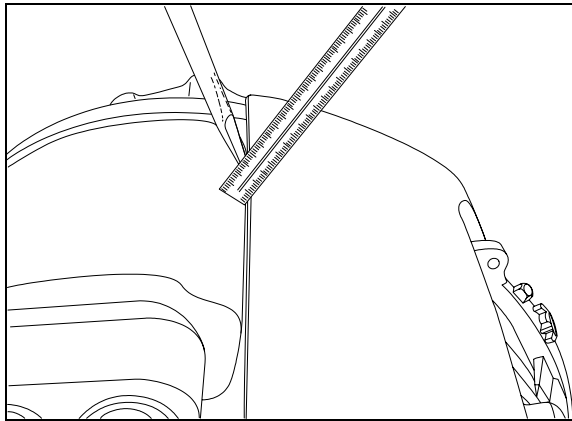


FIGURE 29: RADIAL MOVEMENT INSPECTION 12187

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 30. When pads are in new thickness condition, the pin will be exposed (C) 19 mm ( $\frac{3}{4}$ " ). When the pads are worn to replacement conditions, the pin will be nearly flush to the bushing (D) or within 1 mm ( $\frac{3}{64}$ " ) of the edge of the rubber bushing.

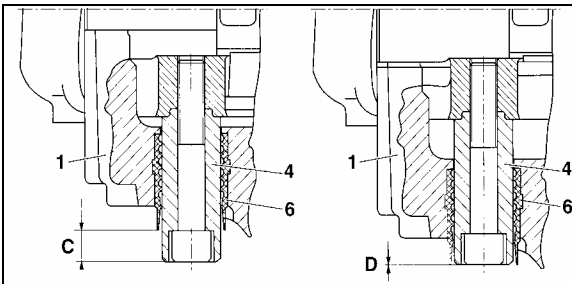


FIGURE 30: BRAKE PAD CHECK 12117

### 27.4 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.

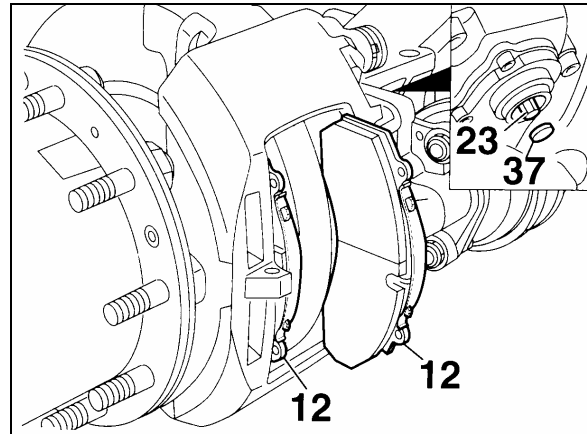


FIGURE 31: PAD REMOVAL 12111

### 27.5 CHECKING PAD WEAR

Minimum friction material thickness is 2 mm (A, Fig. 32)

New friction material has a thickness of 21 mm (B, Fig. 32)

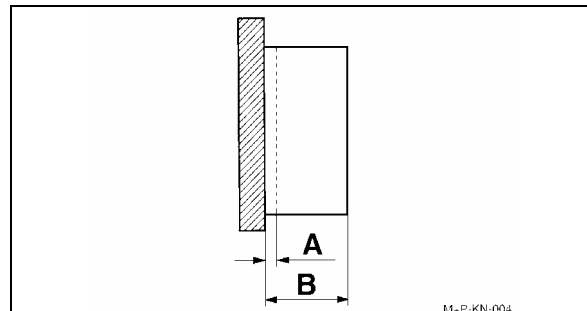


FIGURE 32: PAD WEAR 12112

### 27.6 IMPORTANT PAD AND ROTOR MEASUREMENTS

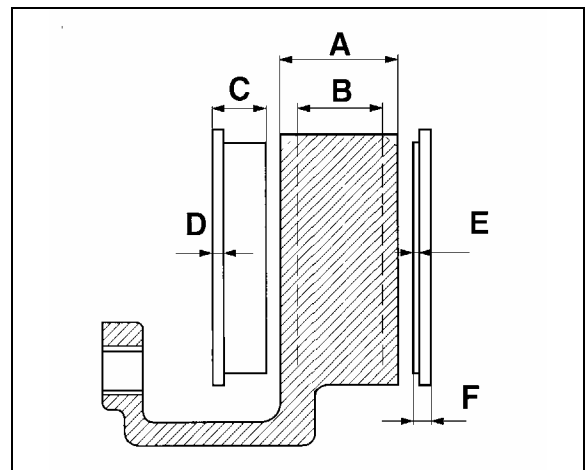


FIGURE 33: ROTOR AND PAD WEAR LIMITS 12113

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.**

**27.7 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. 34):

- 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 (Prevost #683344) to reassemble the slide pin into the bushing, white or yellow grease (Prevost #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.

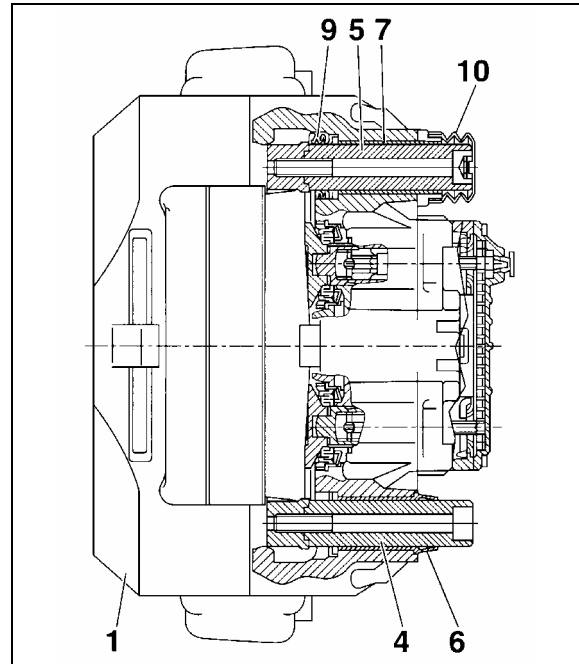


FIGURE 34: CALIPER GUIDANCE 12114

**27.8 CHECKING THE TAPPET BOOTS**

- a) The rubber boots (13, Fig. 35) should show no damage, check the attachment.

**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 (Prevost #611177).

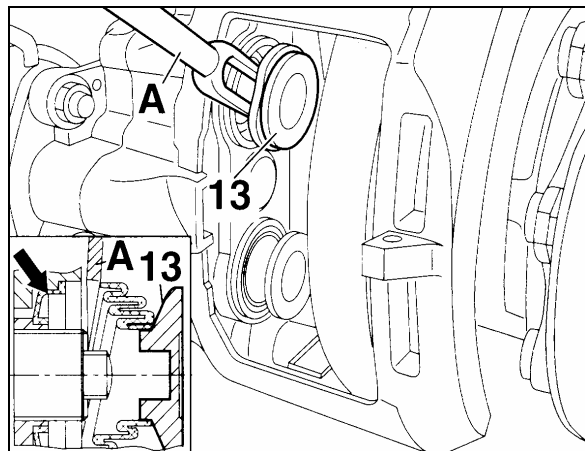


FIGURE 35: RUBBER BOOTS 12115

## Section 12: BRAKE AND AIR SYSTEM

### 27.9 PAD INSTALLATION

Turn adjuster pinion (23, Fig. 36) 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.

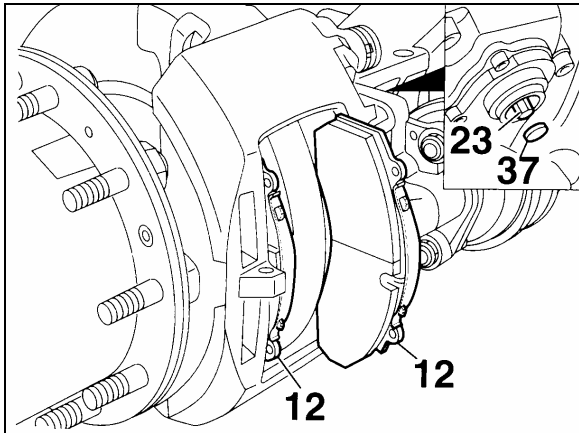


FIGURE 36: PAD INSTALLATION

12111

### 27.10 ADJUSTING THE RUNNING CLEARANCE

- Insert a feeler gauge 0.028 inch (0.7 mm thickness) between tappet and pad backplate (Fig. 37). Turn adjuster pinion clockwise until 0.028 inch (0.7 mm) clearance is achieved. Replace cap (37) (Prevost # 641313).
- 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. 37) 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.

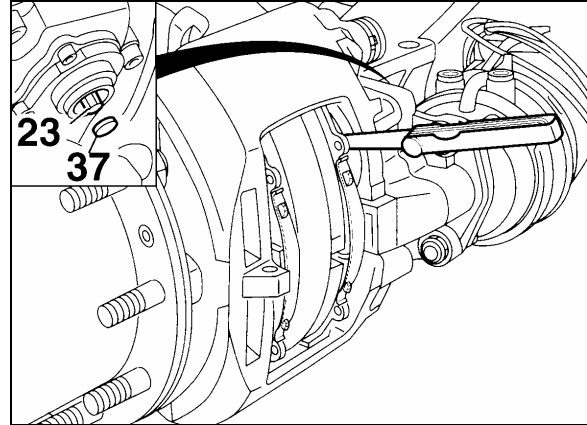


FIGURE 37: RUNNING CLEARANCE

12116

### 27.11 BRAKE TOOLS

Four brake tools are available from Prevost to facilitate disc brake maintenance:

- #641321, Tappet with boot (item 13).
- #641322, Caliper inner boot (item 9).
- #641323, Caliper bushing (item 7).
- #641435, Fork for boot tappet (item 13).

#### Maintenance tip

Using the following procedure, pad wear can be determined without removing the wheel.

### 27.12 TORQUE SPECIFICATIONS

For proper caliper maintenance, refer to the following figures.

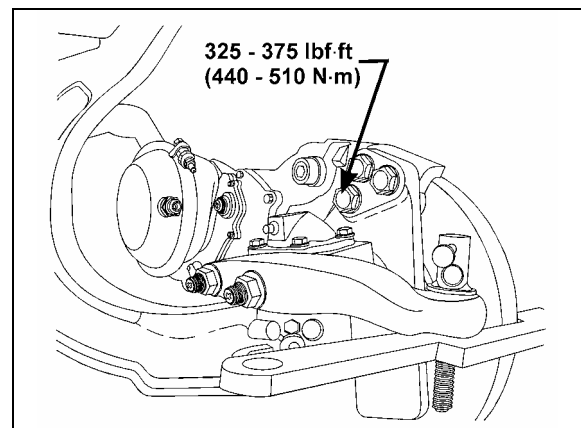


FIGURE 38: TORQUE SPECIFICATION

12145

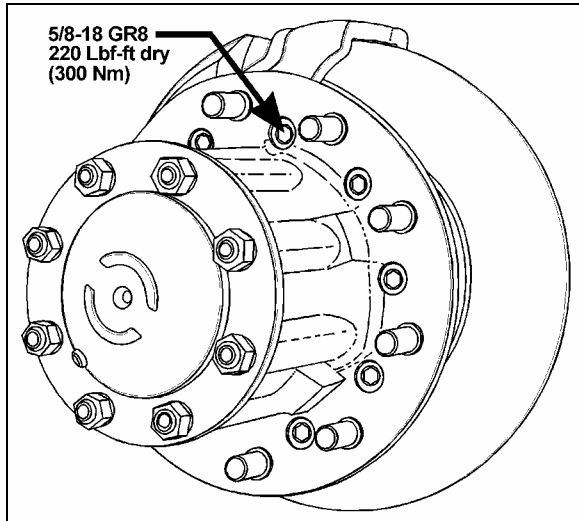


FIGURE 39: TORQUE SPECIFICATION

11030

## 28. SAFE SERVICE PROCEDURES

Most recently manufactured brake linings no longer contain asbestos fibers. Instead of asbestos, these linings contain a variety of ingredients, including glass fibers, mineral wool, aramid fibers, ceramic fibers, and carbon fibers. At present, OSHA (Occupational Safety and Health Administration) does not specifically regulate these non-asbestos fibers, except as nuisance dust. Medical experts do not agree about the potential long-term risks from working with and inhaling non-asbestos fibers. Nonetheless some experts think that long-term exposure to some non-asbestos fibers could cause diseases of the lung, including pneumoconiosis, fibrosis, and cancer. Therefore, lining suppliers recommend that workers use caution to avoid creating and breathing dust when working on brakes that contain non-asbestos fibers.



## WARNING

Whenever possible, work on brakes in a separate area away from other operations.

Always wear a respirator approved by NIOSH (National Institute of Occupational Safety and Health) or MSHA (Mine Safety and Health Administration) during all brake service procedures. Wear the respirator from removal of the wheels through assembly.

NEVER use compressed air or dry brushing to clean brake parts or assemblies. OSHA recommends that you use cylinders that enclose the brake. These cylinders have vacuums with high efficiency (HEPA (Health and Environment Protection Agency)) filters and workmans' arm sleeves. But, if such equipment is not available, carefully clean parts and assemblies in the open air.

Clean brake parts and assemblies in the open air. During disassembly, carefully place all parts on the floor to avoid getting dust into the air. Use an industrial vacuum cleaner with a HEPA filter system to clean dust from the brake drums, backing plates and other brake parts. After using the vacuum, remove any remaining dust with a rag soaked in water and wrung until nearly dry.

If you must grind or machine brake linings, take additional precautions because contact with fiber dust is higher during these operations. In addition to wearing an approved respirator, do such work in an area with exhaust ventilation.

When cleaning the work area, NEVER use compressed air or dry sweeping to clean the work area. Use an industrial vacuum with a HEPA filter and rags soaked in water and wrung until nearly dry. Dispose of used rags with care to avoid getting dust into the air. Use an approved respirator when emptying vacuum cleaners and handling used rags.

Wash your hands before eating, drinking or smoking. Do not wear your work clothes home. Vacuum your work clothes after use and then launder them separately, without shaking, to prevent fiber dust from getting into the air.

Material safety data sheets on this product, as required by OSHA, are available from Rockwell and Knorr-Bremse.

### 29. AIR BRAKE TROUBLESHOOTING

The following tests and check lists have been designed to identify the cause(s) of a sluggish performance and/or leaks in the system. These tests require very little time to perform, and give you a general idea of the system condition. Each test is provided with a corresponding check list which will guide you to the most common causes of problems.

Before performing any test, check all air lines for kinks or dents, and hoses for signs of wear, drying out or overheating.



#### **WARNING**

When working on or around 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.

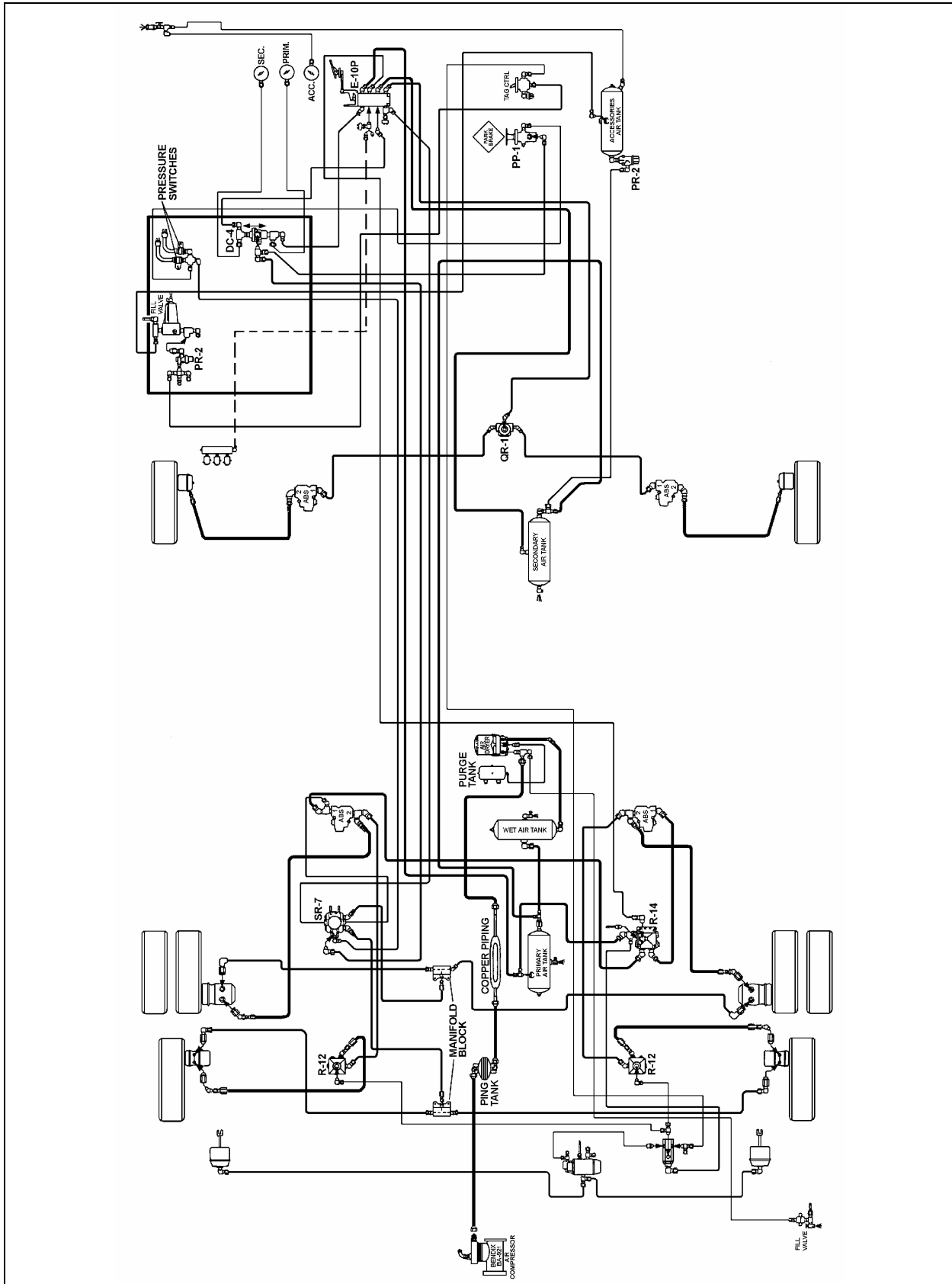


FIGURE 40: H3.COACHES AIR-OPERATED BRAKING SYSTEM

12197

Section 12: BRAKE AND AIR SYSTEM

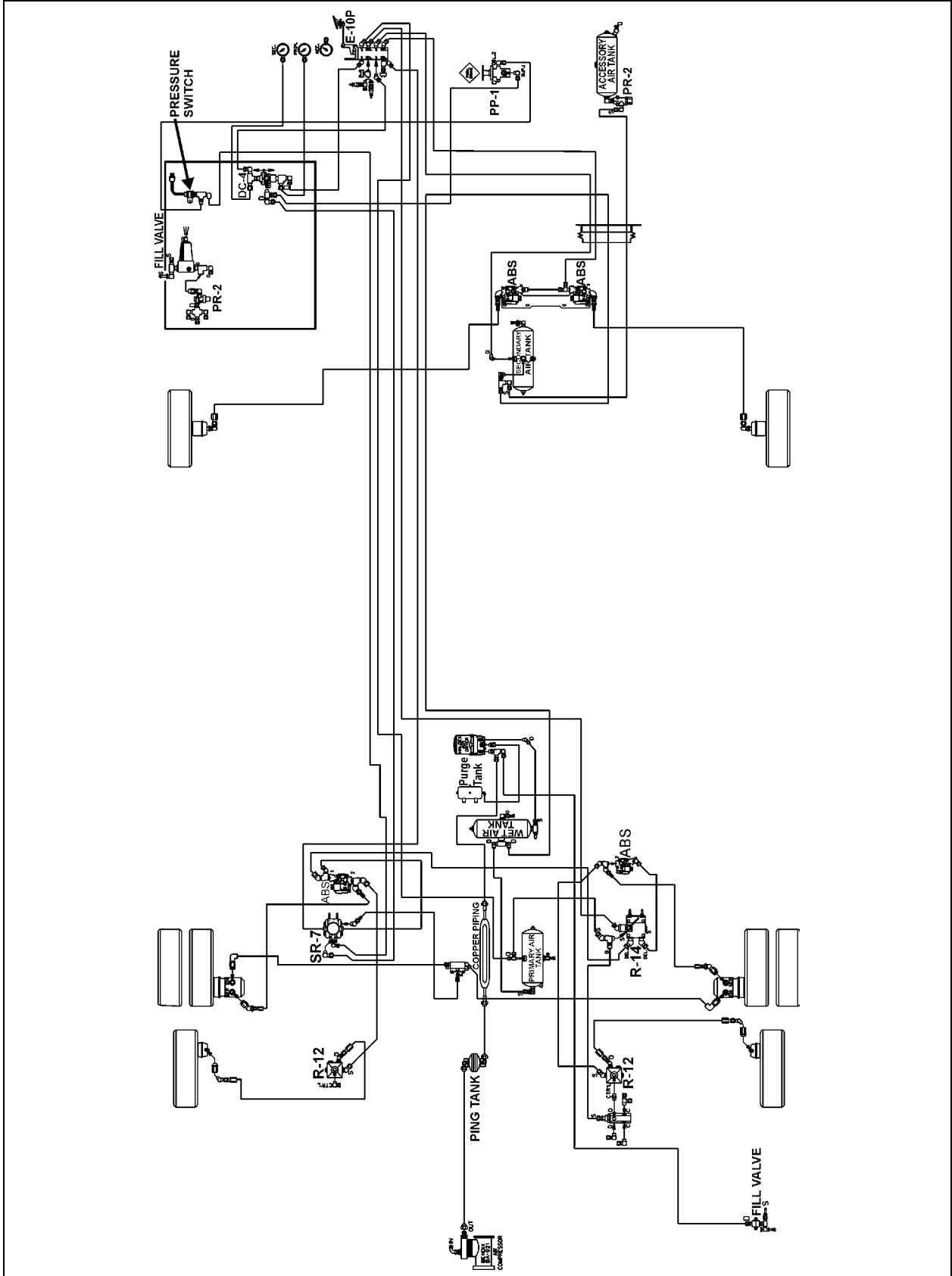


FIGURE 41: VIP-45 BASIC AIR-OPERATED BRAKING SYSTEM



### **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  $\pm$ 3 (847 $\pm$ 21 kPa).
7. Air filter/dryer built-in governor cut-in. Cuts in around 110 psi (758 kPa).

For common corrections, refer to the following check list:

#### **High or Low Warning Cutoff Point**

- Perform a telltale light and gauge test. Replace entire cluster if found defective.

#### **High or Low Air Filter/Dryer Built-in Governor Cutout Point**

- Perform a telltale light and gauge test. Replace entire cluster if found defective.

OR

- Repair or replace air filter/dryer as necessary after checking that compressor unloader mechanism operates correctly.

#### **More than 30 seconds to build-up pressure from 85 to 100 psi (585 - 690 kPa) at full engine RPM**

- Perform a telltale light and gauge test. Replace entire cluster if found defective.
- Check compressor strainer or inlet line. If restricted, clean or replace element or faulty line.
- Check compressor head or discharge line for carbonization or restriction. Clean or replace as necessary.

- If discharge valves leak, pull head and correct or replace cylinder head.
- If drive is slipping, replace gear.
- If inlet valves are stuck, open or leaking severely, replace unloader kit, inlet valves and/or seats as necessary.
- If drain cock is found open, close it.
- Listen for air leaks and repair.
- Redo list to check all items repaired or replaced.

#### **Air Supply Reservoir Leakage**

CONDITION: Full pressure, engine stopped, parking brake applied

1. Allow at least 1 minute for pressure to stabilize.
2. Stop engine, then check air pressure gauge for 2 minutes. Note any pressure drop.
3. Pressure should not drop by more than 3 psi (20 kPa) per minute.

For common corrections, refer to the following check list:

Excessive air loss:

- With the primary air system at normal operating pressure (95 - 125 psi (655 - 860 kPa)), coat all air line connections and pneumatic components with a water and soap solution. Bubbles will indicate an air leak, and none should be permissible. Repair or replace defective parts.
- Listen for leaks and correct as required.
- Redo test to check all items repaired or replaced.

#### **Brake System Air Leakage**

CONDITION: Full pressure, engine stopped, parking brake released.

1. Apply service (foot) brakes, allow at least 1 minute for pressure to stabilize.
2. Hold down foot valve for 2 minutes while observing air pressure gauge on the dash-board.
3. Pressure drop should not be more than 4 psi (27 kPa) per minute.

For common corrections, refer to the following check list.

## Section 12: BRAKE AND AIR SYSTEM

### 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.

### 30. BRAKE AIR CHAMBER

This vehicle uses “Knorr-Bremse” brake chambers on all axles. 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 42 and 43.

The front axle brake air chambers are used only for service brake duty (Fig. 42).

#### 30.1 MAINTENANCE

Every 6,250 Miles (10 000 km) or twice a year, whichever comes first depending on type of operation:

1. Insert a box wrench (8 mm) onto the adjuster pinion.
2. Apply brakes 5 – 10 times and observe that the pads move out promptly without binding and that box wrench turns clockwise in small increments.
3. Check tightness of mounting nuts. Check that cotter pins are in place.
4. Check all hoses and lines. They should be secure and in good condition.

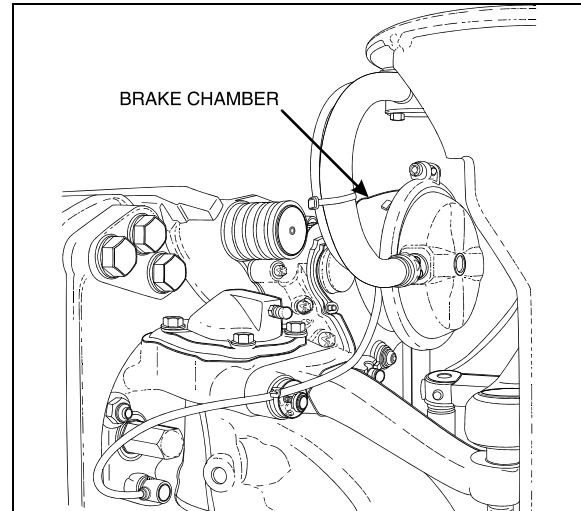


FIGURE 42: I-BEAM FRONT AXLE BRAKE AIR CHAMBER  
12158

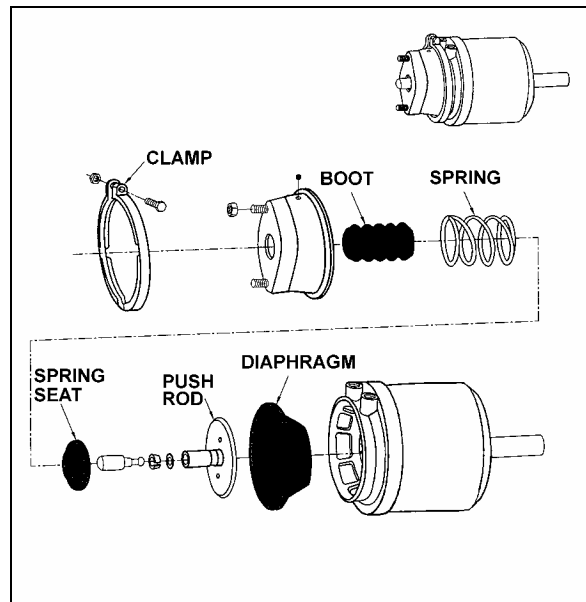


FIGURE 43: TAG AXLE OR DRIVE AXLE BRAKE AIR CHAMBER  
12126

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 airtightness 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 over-tighten** as this can distort sealing surface or clamping ring. Coat area around push rod hole (loosen boot if necessary). No leakage is permitted. If leakage is detected, the diaphragm must be replaced.

30.2 EMERGENCY/PARKING BRAKE  
MANUAL RELEASE



Never stand in the axis line of the spring brake chambers, especially when caging the spring.

**Drive Axle**

1. Block the wheels to prevent the vehicle from moving.
2. Remove the release stud tool from its storage place on drive axle brake air chamber.
3. Remove the access plug from the end of the spring chamber, and then insert the release stud through the opening. Turn the release stud 1/4 turn (clockwise) to anchor it into the spring plate. Install the flat washer and nut, and then turn the nut clockwise to cage the spring. Repeat on the opposite side.



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.

30.3 BRAKE CHAMBER REMOVAL



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.

30.4 BRAKE CHAMBER INSTALLATION

Reverse removal procedure, then check brake adjustment.



Always clean air lines and fittings, and coat pipe threads with Teflon pipe sealant before reconnecting air lines.

## Section 12: BRAKE AND AIR SYSTEM

### 30.5 BRAKE CHAMBER DISASSEMBLY



#### DANGER

Spring brake chambers, on drive and tag axles contain an extremely high compressive force spring, which can possibly cause serious injury if special precautions are not taken when working around this area.

To avoid such injury, the following recommendations must be applied:

- 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.

### 31. ANTI-LOCK BRAKING SYSTEM (ABS)

This device has been designed to ensure stability and permit steering control of vehicle during hard braking, and to minimize its stopping distance whatever the road conditions are. On slippery roads and generally in emergency situations, over-braking frequently induces wheel lock. The anti-lock braking system provides maximum braking performance while maintaining adequate steering control on slippery roads.

The ABS continuously monitors wheel behavior during braking. Sensors on each wheel of front and drive axles (tag axle is slave to drive axle) transmit data to a four channel electronic processor which senses when any wheel is about to lock. Modulator valves quickly adjust the brake pressure (up to 5 times per second) to prevent wheel locking. Each wheel is therefore controlled according to the grip available between its tire and the road.

With this device, the vehicle is brought to a halt in the shortest possible time, while remaining stable and under the driver's control.

Since the braking system has dual circuits, the ABS is also provided with a secondary system should a fault develop in the ABS. Anti-lock systems are a parallel system which does not hinder brake functioning in case of failure. Braking system functions in normal, non anti-lock controlled operation during ABS system failure.

The ABS system consists of two diagonally related circuits, only the half of the system which has sustained damage or other fault is switched off (i.e. wheels return to normal non-ABS braking). The other diagonal half remains under full ABS control.

#### NOTE

*ABS is active on service brake, transmission retarder, Jake brake, but is inactive on emergency/parking brake.*

**NOTE**

The ABS system is inoperative at speeds under 4 mph (6 Km/h). Illumination of ABS telltale indicator at these speeds is normal.



**CAUTION**

Disconnect the ECU or pull the ABS fuse before towing vehicle.

31.1 TROUBLESHOOTING AND TESTING

For troubleshooting and testing of the vehicle's anti-lock braking system, refer to Meritor Wabco Maintenance Manual MM-0112: "Anti-Lock Braking System (ABS) for Trucks, Tractors and Buses", at the end of this section, and to Bendix applicable booklet annexed to this section under reference number SD-134869. Use dashboard Message Center Display (MCD) Diagnostic Mode for troubleshooting and repair.

31.2 ABS COMPONENTS

The main components of the ABS system are listed hereafter. Refer to each component for its specific function in the system and for proper maintenance.

31.2.1 Electronic Control Unit (ECU)

This control unit is located in the first baggage compartment, on the driver's side of the vehicle (refer to figure 45 for location) or in the front electrical and service compartment. 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.

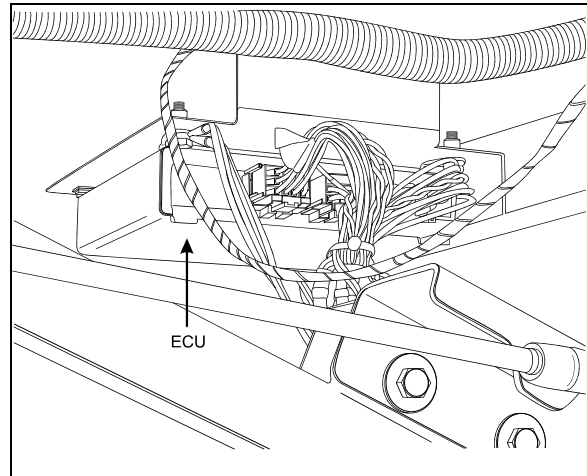


FIGURE 44: FIRST L.H. BAGGAGE COMPARTMENT 12198

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.



**CAUTION**

In order to protect the ABS electronic control unit from voltage surges, always disconnect before performing any welding procedure on vehicle.

31.2.2 Bendix® M-32QR™ Pressure Modulator Valves (PMV)

This ABS system is equipped with four modulator valves, located between the brake chamber and the relay valve (Fig. 46). 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).

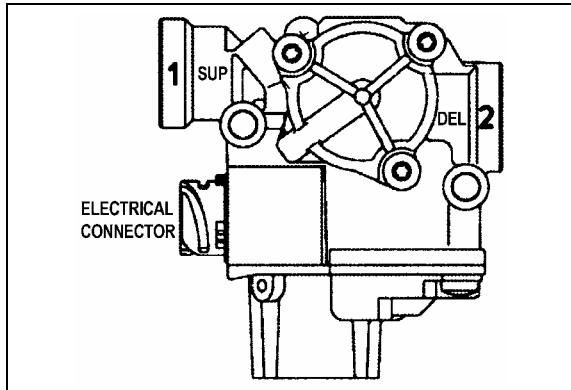


FIGURE 45: ABS MODULATOR VALVE 12084

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**

Maintenance and repair information on this valve is supplied in the applicable booklet annexed to this section under reference number SD-13-4870.

31.2.3 Sensors

The sensors are mounted on the front and drive axle wheel hubs (Fig. 47). 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.

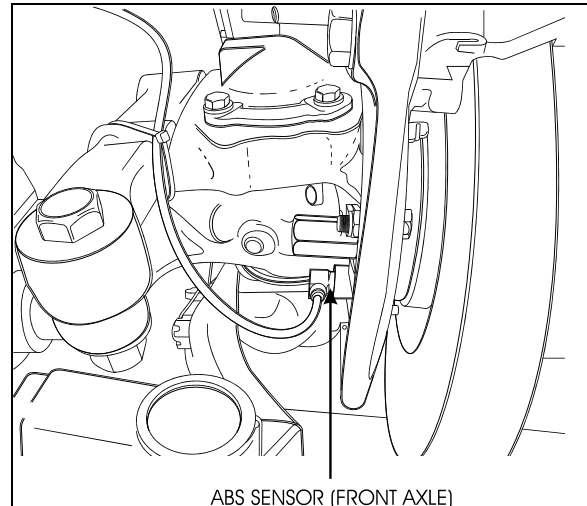


FIGURE 46: ABS SENSOR LOCATION 12153

**Maintenance**


No specific maintenance is required for sensors, except if the sensors have to be removed for axle servicing. In such a case, sensors should be lubricated with special grease (Prevost #680460) before reinstallation. Refer to paragraph "Sensor Installation" for details.

<p><b>NOTE</b></p> <p><i>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.</i></p>
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**Sensor Installation**

The following procedure deals with sensor installation on the axle wheel hubs. Read procedure carefully before reinstalling a sensor, as its installation must comply with operational tolerances and specifications.

1. Apply recommended lubricant (Prevost #680460) to spring clip and sensor.

<p> <b>CAUTION</b></p> <p>Use only this type of grease on the sensors.</p>
---

2. Insert spring clip in the holder on hub. Make sure the spring clip tabs are on the inboard side of the vehicle. Push in until the clip stops.

3. Push the sensor completely inside the spring clip until it is in contact with the tooth wheel. Ensure mounting is rigid, as it is an important criterion for adequate sensor operation.

**NOTE**

*This installation should be of the "press fit" type.*

31.2.4 Spring clip

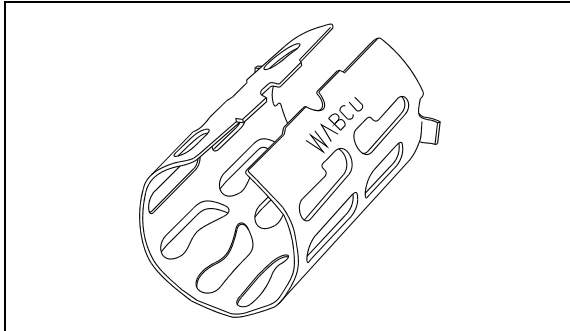


FIGURE 47: SPRING CLIP

12161

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. 48).

**Maintenance**

The spring clip requires no specific maintenance.

**32. AUTOMATIC TRACTION CONTROL (ATC) – ELECTRONIC STABILITY PROGRAM (ESP)**

In addition to the ABS function, advanced models of Bendix EC-60 controllers provide an **Automatic Traction Control (ATC)** feature. Bendix ATC can improve vehicle traction during acceleration, and lateral stability while accelerating through curves. ATC utilizes **Engine Torque Limiting (ETL)** where the ECU communicates with the engine's controller and/or **Differential Braking (DB)** where individual wheel brake applications are used to improve vehicle traction.

The EC-60 advanced model controller also provide ABS-based stability features referred to as **ESP® Electronic Stability Program**.

The Bendix ESP system is an ABS-based stability system that enhances vehicle stability by both reducing engine throttle and by applying vehicle braking based on actual vehicle dynamics. Accordingly, the ESP system is available only on specific approved vehicle platforms after vehicle application and development efforts and validation testing. Only certain limited variations of an approved vehicle platform are permitted without further validation of the ESP system application.

ESP stability system consists of Yaw Control (YC) and Roll Stability Program (RSP) features.



**CAUTION**

Even with ESP-equipped vehicles, the driver remains responsible for ensuring vehicle stability during operation.

32.1 COMPONENTS

32.1.1 The EC-60™ controller's ABS function utilizes the following components:

- Six (6) Bendix® WS-24™ wheel speed sensors. Each sensor is installed with a Bendix Sensor Clamping Sleeve;
- Five (5) Bendix® Pressure Modulator Valves (M-32QR™);
- Dash-mounted vehicle ABS Indicator Lamp;
- Service brake relay valve;
- Dash-mounted trailer ABS Indicator Lamp.

32.1.2 The EC-60™ controller's ATC function utilizes the following components:

- Drive axle traction control valve;
- Dash-mounted ATC status/indicator lamp;
- J1939 serial communication to engine control module.

32.1.3 The EC-60™ controller's ESP/RSP function utilizes the following components:

- Front Axle Traction Control Valve integral to the service brake relay valve;
- Dash-mounted ESP status/indicator lamp (also serves as the ATC status/indicator lamp);

## Section 12: BRAKE AND AIR SYSTEM

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- Bendix SAS-60™ Steering Angle Sensor (mounted to the steering column);
- Bendix YAS-60™ Yaw Rate/Lateral Acceleration Sensor (mounted to a cross member forward of the drive axle);
- Brake Demand Sensors (installed in the primary and secondary delivery circuits);
- Load Sensor (installed in the suspension air spring);
- An additional Modulator Valve (Bendix® M-32QR™ Pressure Modulator Valve) that controls pressure apply to the trailer brakes during system intervention.

### 32.1.4 Bendix® M-32QR™ Pressure Modulator Valves (PMV)

This Bendix® M-32QR™ Pressure Modulator Valves (PMV) is operated by the EC-60™ controller to modify driver applied air pressure to the service brakes during ABS, ATC, RSP or YC activation. The PMV is an electro pneumatic control valve and is the last valve that air passes through on its way to the brake chamber. The modulator hold and release solenoids are activated to “modulate” or “control” the brake pressure during an antilock braking event. The hold solenoid is normally open and the release solenoid is normally closed, such that the PMV nominally allows air to flow through. This design allows for air delivery to brake chambers in the event of electrical trouble.

The Advanced EC-60™ controller also utilizes an additional PMV for control of the trailer service brakes during stability interventions.

### 32.2 6S/5M CONFIGURATION

Prévost vehicles utilize a 6S/5M configuration, with the additional axle (rear tag axle) having two sensors, but only one Pressure Modulator Valve. In this case, the PMV controls both wheels on the additional axle. The additional axle wheels would receive equal brake pressure, based on the wheel that is currently experiencing the most wheel slip.

### 32.3 ADVANCED ABS WITH STABILITY CONTROL

#### Overview

ESP stability system reduces the risk of rollovers, jackknifing and other loss of control.

ESP features include Roll Stability Program (RSP) and Yaw Control. During operation, the ECU of the Bendix Advanced ABS system constantly compares performance models to the vehicle’s actual movement, using the wheel speed sensors of the ABS system, as well as lateral, yaw, and steering angle sensors. If the vehicle shows a tendency to leave an appropriate travel path, or if critical threshold values are approached, the system will intervene to assist the driver.

#### Roll Stability Program

Bendix RSP, an element of the overall ESP system, addresses rollover conditions. In the case of a potential roll event, the ECU will override the throttle and quickly apply pressure at all wheel ends to slow the vehicle combination. The level of braking application during an RSP event will be proportional to roll risk.

#### Yaw Stability

Yaw stability counteracts the tendency of a vehicle to spin about its vertical axis. During operation, if the friction between the road surface and the tires is not sufficient to oppose lateral (side) forces, one or more of the tires can slide, causing the vehicle to spin. These events are referred to as either an “under-steer” situation (where there is a lack of vehicle response to steering input due to the slide on the front axle) or an “over-steer” (where the vehicle’s rear end slides out due to tire slide on the rear axle) situation. Factors that influence yaw stability are: wheelbase, suspension, steering geometry, weight distribution front to rear, and vehicle track width.

#### Yaw Control

Yaw Control corresponds to a wide range of low to high friction surface scenarios including rollover, jackknife and loss of control. It is the recommended system for all power vehicles and especially critical for vehicles pulling trailers. In the case of vehicle slide (over-steer or under-steer situations), the system will reduce the throttle and then brake one or more of the “four corners” of the vehicle (in addition to potentially applying the trailer brakes), thus applying a counter-force to better align the vehicle with an appropriate path of travel.

For example, in an over-steer situation, the system applies the “outside” front brake; while in an under-steer condition, the “inside” rear brake is applied.



**DANGER**

**ESP may reduce the vehicle speed automatically.**

ESP can make the vehicle **decelerate automatically**. ESP can slow the vehicle with or **without the operator applying the brake**, and **even when the throttle is being applied**.

### 32.4 BENDIX® SAS-60™ STEERING ANGLE SENSOR

The Steering Angle Sensor (SAS) is used to provide driver steering input to the controller. It reports the steering wheel position to the controller utilizing a dedicated serial communications link that is shared with the YAS-60™ sensor. The controller supplies the power and ground inputs to the SAS-60™ sensor.

The SAS-60™ sensor installed on Prevost vehicles is the 90° connector.

#### 32.4.1 Removal of the steering angle sensor

##### Service Checks:

1. Check all wiring and connectors. Some installations also include an intermediate connector from the steering angle sensor to the main vehicle wire harness. Make sure all connections are free from visible damage.
2. Examine the sensor. Make sure the sensor, its mounting screws, and the interface between the hub and the steering column are not damaged.

##### Diagnostics:

The steering angle sensor is only operational in conjunction with an Advanced ECU. No independent diagnostics can be performed on the sensor.

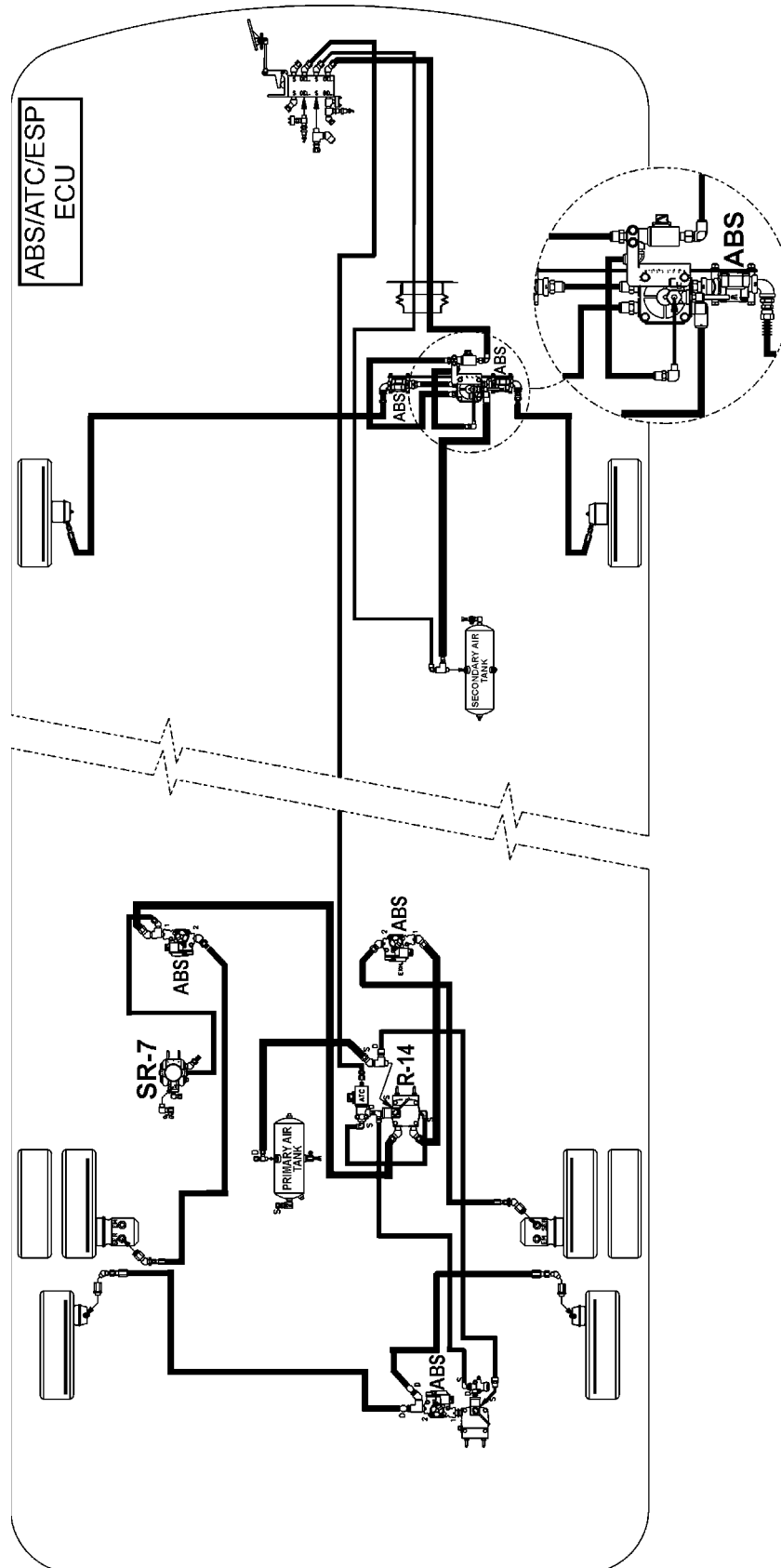


FIGURE 48: VIP-45 ABS 6S/5M CONFIGURATION

12190

**Removal:**

1. Remove steering column upper, middle and lower covers.
2. The steering angle sensor is located near the universal joint.
3. Unplug sensor cable assembly from body of sensor. Squeeze the mounting tabs and pull gently on connector until it disengages.
4. Disconnect steering column upper U-joint.
5. Unscrew all three of the mounting screws that hold the body of the sensor to the steering column body.
6. Slide the sensor over the column to remove. Take note if the sensor label is facing upward or downward.

**Installation:**

1. Obtain a new sensor. The sensor is not repairable in the field.
2. Slide the sensor over the column. The center hub of the sensor must be aligned with the corresponding notch in the column. The sensor label should be facing in the same direction as the removed sensor.
3. Reconnect the steering column U-joint.
4. Assemble the column non-moving plate with three self-locking screws.
5. Tighten screws to 48 lbf-ft (65 Nm) to 74 lbf-ft (100 Nm).
6. Reconnect the connector. Ensure that there will be no force applied to the sensor because the connector is pulling on the sensor body.
7. If the wire harness leading to the sensor is being replaced, ensure that it is adequately tie wrapped so that the full motion of the steering column can be achieved without pulling apart the connectors.
8. Reinstall the steering column covers. The sensor is not protected against dirt or water intrusion, so care must be taken not to introduce these elements during installation.


**Steering Angle Sensor Calibration**

The steering angle sensor calibration can only be achieved when the sensor is powered by the Advanced ABS ECU. No stand-alone sensor calibration can be carried out. The calibration procedure is performed using Bendix® ACom™

Diagnostic V4.0 or higher. See “Troubleshooting Diagnostic Trouble Codes: Steering Angle Sensor (SAS-60)” for the calibration procedure using this tool.

The sensor **must** be recalibrated after any of these situations:

- Replacement of the steering angle sensor;
- Any opening of the connector hub from the steering angle sensor to the column;
- Any maintenance or repair work on the steering linkage, steering gear or other related mechanism;
- Adjustment of the wheel alignment or wheel track;
- After an accident that may have led to damage of the steering angle sensor or assembly.

 **WARNING**

If the steering angle sensor is not properly recalibrated as needed, the yaw control system may not function properly, which can result in incidents leading to loss of vehicle control.

**33. FITTING TIGHTENING TORQUES**

**45° Flare and Inverted Flare:** Tighten assembly with a wrench until a solid feeling is encountered. From that point, tighten 1/6 turn (Fig. 49).

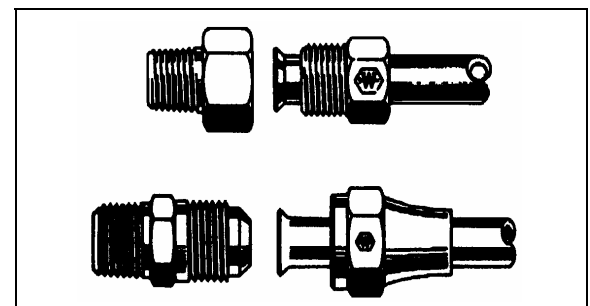


FIGURE 49: HOSE FITTINGS 12053

**Compression:** Tighten nut by hand (Fig. 50). 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 manual tightening
2	1/8	1 ¼
3	3/16	1 ¼

## Section 12: BRAKE AND AIR SYSTEM

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

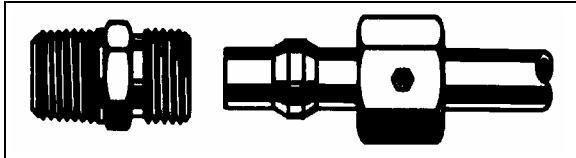


FIGURE 50: HOSE FITTING

12054

**NTA-Type Plastic Tubing:** Hand tighten nut (Fig. 51). From that point, tighten using a wrench the number of turns indicated in the following chart.

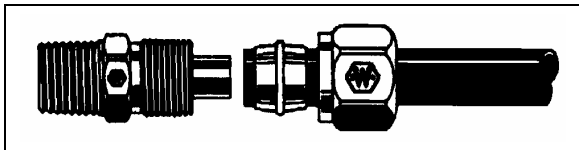


FIGURE 51: HOSE FITTING

12055

Tubing diameter (inch)	Number of additional turns required following manual tightening
1/4	3
3/8 to 1/2	4
5/8 to 3/4	3 ½

**34. SPECIFICATIONS**

Make..... Bendix Westinghouse  
 Model..... BA-921  
 Capacity (at 1250 rpm) ..... 15.7 cfm (0,445 m<sup>3</sup>/min.)  
 Prevost number ..... 641990

**BA-921 Service Kits**

ST-4 Safety Valve  
 Prevost number ..... 641989

Series 60 Seal Kit  
 Prevost number ..... 641988

Compressor Seal Kit  
 Prevost number ..... 641987

Cylinder Head Gasket Kit  
 Prevost number ..... 641986

**Air Dryer**

Make..... Haldex  
 Model..... AT-87192  
 Prevost number ..... 70303498  
 Desiccant cartridge Prevost number..... 3097369

**Flip-Flop Control Valve**

Make..... Bendix Westinghouse  
 Model..... TW-1  
 Type ..... On-Off  
 Prevost number ..... 640136

**Emergency/Parking Brake Control Valve**

Make..... Bendix Westinghouse  
 Model..... PP-1  
 Automatic release pressure ..... 40 psi (275 kPa) nominal  
 Prevost number ..... 641128

**Emergency/Parking Brake Overrule Control Valve**

Make..... Bendix Westinghouse  
 Model..... RD-3  
 Prevost number ..... 640472

**Dual Brake Application Valve**

Make..... Bendix Westinghouse  
 Model..... E-10P  
 Prevost number ..... 641856

**Stoplight Switches**

Make..... Bendix Westinghouse  
 Model..... SL-5  
 Contact close (ascending pressure) ..... 4 psi and more (28 kPa)  
 Prevost number ..... 641462

**Brake Relay Valves**

Make..... Bendix Westinghouse

## Section 12: BRAKE AND AIR SYSTEM

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Model.....R-12 & R-12DC  
Prevost number..... 641088

### Quick Release Valve

Make..... Bendix Westinghouse  
Model..... QR-1  
Prevost number..... 641429

### Spring Brake Valve

Make..... Bendix Westinghouse  
Model..... SR-1  
Prevost number..... 640870

### Pressure Protection Valve

Make..... Bendix Allied Signal  
Model..... PR-2 & PR-4  
Nominal closing pressure PR-2 ..... 75 psi (517 kPa)  
Prevost number PR-2..... 640439  
Nominal closing pressure PR-4 ..... 70 psi (482 kPa)  
Prevost number PR-4..... 641137

### Shuttle-Type Double Check Valve

Make..... Bendix Westinghouse  
Model..... DC-4  
Prevost number..... 641015

### Low Pressure Indicators

Make..... Bendix Westinghouse  
Model..... LP-3  
Contact close ..... 66 psi (455 kPa)  
Prevost number..... 640975  
Make..... Bendix Westinghouse  
Model..... LP-3  
Contact close ..... 30 psi (207 kPa)  
Prevost number..... 641174

### Air Pressure Regulator

Make..... Norgren  
Adjustable output range ..... 0-80/85 psi (0-552/586 kPa)  
Recommended pressure setting ..... 75 psi (517 kPa)  
Prevost number..... 641472

### Air Filter Element

Make..... Norgren  
Type ..... With manual drain  
Prevost number..... 641338

### Front Axle Brake Chambers

Make..... Knorr-Bremse  
Type ..... 22  
Prevost number (R.H.) ..... 641414  
Prevost number (L.H.)..... 641413

### Drive Axle Brake Chambers

Make..... Knorr-Bremse  
Type ..... 24 as service -24 as emergency  
Prevost number..... 641432

**Tag Axle Brake Chambers**

Make.....Knorr-Bremse  
Type ..... 14 as service – 16 as emergency  
Prevost number ..... 641308

**Brake Lining (All Axles)**

Make.....Knorr-Bremse  
Prevost number ..... 611049

**ABS ANTILOCK BRAKING SYSTEM (if applicable)**

**ABS Modulator Valve**

Make.....Meritor Wabco  
Voltage .....24 V  
Prevost number ..... 641097

**Sensor, Front Axle**

Prevost number ..... 641288

**Sensor, Drive Axle (In Carrier)**

Prevost number ..... 641341

**Sensor, Drive Axle (In Wheel End)**

Prevost number ..... 641095







Effective Date: 12/02/05

**Subject: Bendix Air Disc Brake Pad Replacement on Prevost Car Vehicles**

Prevost Car and Bendix Spicer Foundation Brake LLC are issuing this product notification about the potential brake performance degradation associated with use of non-approved, aftermarket replacement friction materials on Bendix® and Knorr-Bremse air disc brakes.

A compatible combination of disc pads and rotor material is essential for the safe and reliable performance of air disc brakes and also helps to extend the useful life of both parts.

Prevost Car and Bendix Spicer Foundation Brake worked together to optimize the disc pad and rotor material combination (“the friction couple”) for use with Bendix® air disc brakes. Prevost Car and Bendix offer service replacement parts that maintain the same quality and compatibility as the original equipment pads and rotors.

Recent benchmarking tests by Bendix Spicer Foundation Brake with two different non-approved aftermarket brake pad brands indicate that there is a significant risk of brake performance degradation when non-approved friction materials are used with Bendix or Knorr-Bremse air disc brakes. The aftermarket pads tested demonstrated the following shortcomings:

- At high operating temperatures the non-approved pads had approximately 20% lower friction level than the original equipment friction material.
- During fade testing, brake torque was 50% to 60% of original material levels.
- Significant brake torque reduction was experienced at increased temperatures.
- Tests to replicate stops on mountain roads and other severe service conditions showed significant performance reductions.
- Insufficient pad strength caused cracking across the friction material.

- Shear testing of the friction material adhesion resulted in the friction material completely separating from the backing plate in many instances.
- Pad wear was accelerated.
- Early rotor cracking symptoms were observed much earlier than for typical genuine parts.

Based on our tests, Prevost Car and Bendix Spicer Foundation Brake LLC strongly recommend against the use of non-approved aftermarket brake pads and service parts on Bendix and Knorr-Bremse air disc brakes. Brake performance, reliability and service life can be seriously degraded if non-approved aftermarket replacement parts are used in Bendix and Knorr-Bremse air disc brake systems.

To maintain your vehicle’s air disc brakes at their original performance standard, we strongly recommend use of only genuine, approved service replacement parts on Bendix and Knorr-Bremse air disc brake systems. If non-approved friction materials or replacement components are used, neither Prevost Car nor Bendix Spicer Foundation Brake LLC will accept any air disc brake-related warranty returns or claims.

**BRAKE DUST WARNING:  
AVOID CREATING DUST WHEN WORKING WITH  
BRAKE PADS DUE TO POSSIBLE CANCER AND  
LUNG DISEASE HAZARD.**

While Bendix Spicer Foundation Brake LLC does not offer asbestos-containing brake linings or disc pads, the long-term effects of certain non-asbestos fibers have not been determined. Current OSHA Regulations cover exposure levels to some, but not all, components of non-asbestos linings and pads. The following precautions should be used when handling these materials:

- Avoid creating dust. Compressed air or dry brushing must never be used to clean brake assemblies or the work area.

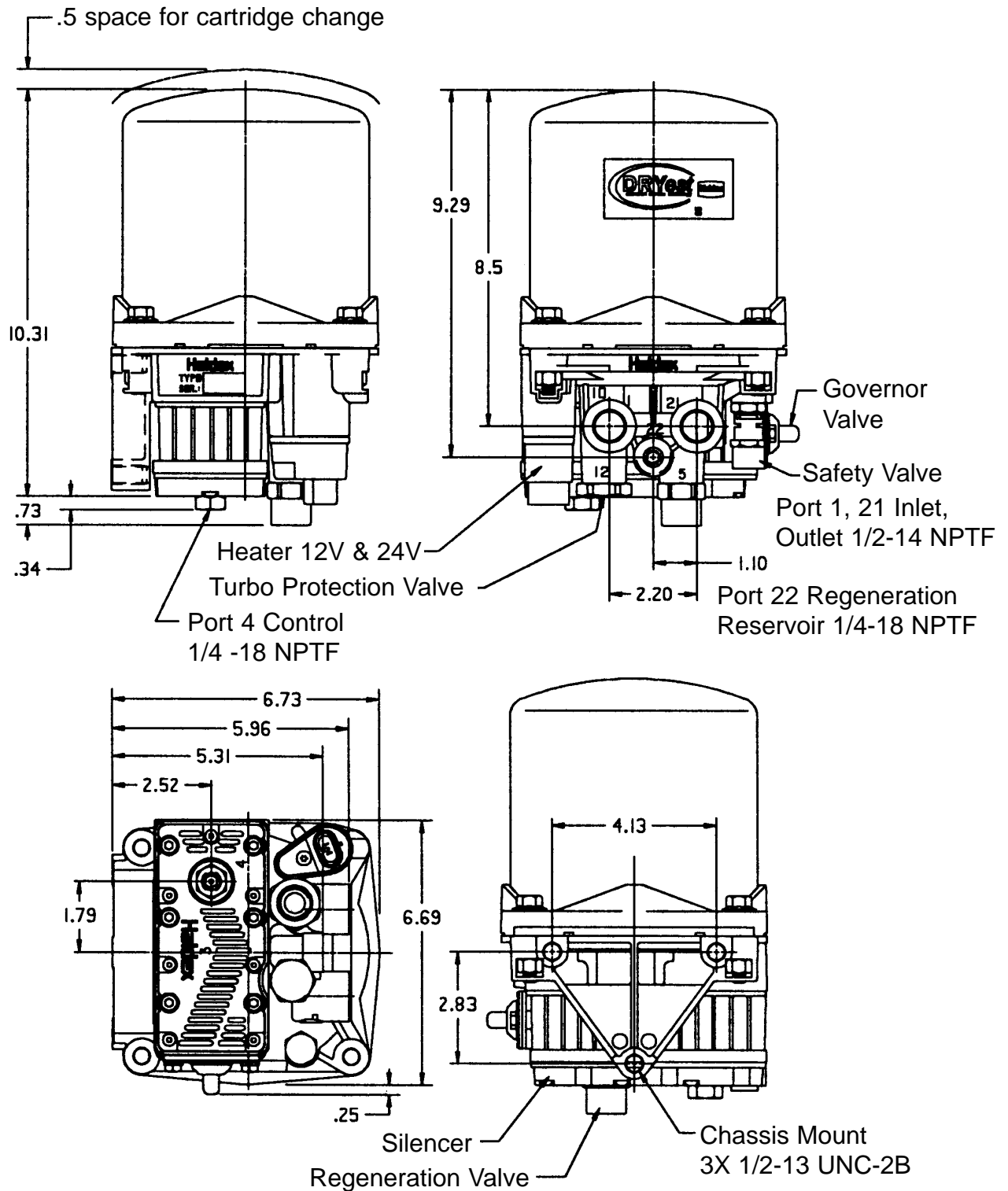
*(Continued over)*

- Brake workers must take steps to minimize their exposure to airborne brake lining particles. Procedures to reduce exposure include: working in a well-ventilated area, segregating areas where brake work is performed, using local filtered ventilation systems or enclosed cells with filtered vacuums for all brake work. Respirators approved by the Mine Safety and Health Administration (MSHA) or National Institute for Occupational Safety and Health (NIOSH) should be worn at all times during brake servicing.
- Workers must wash before eating or drinking, should not use tobacco products in any form, shower after working, and not wear work clothes home. Work clothes should be vacuumed using a high efficiency particulate filter (HEPA) vacuum and laundered separately without shaking.
- OSHA Regulations regarding testing, disposal of waste and methods of reducing exposure for asbestos are set forth in 29 Code of Federal Regulations §1910.001. These Regulations provide valuable information which can be utilized to reduce exposure to airborne particles.
- Material Safety Data Sheets on Bendix® air disc brake pads, as required by OSHA, are available from Bendix Spicer Foundation Brake LLC.





# DRYest Air Dryer Installation and Maintenance



The Haldex DRYest 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 DRYest are illustrated on the next page.

# Application Schematics

FIG. 2.A. Standard System Regeneration with Integrated Governor

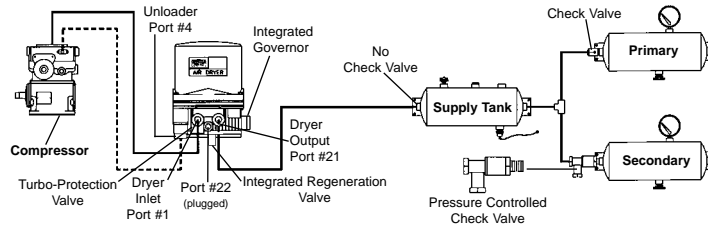


FIG. 2.B System Regeneration with External Governor

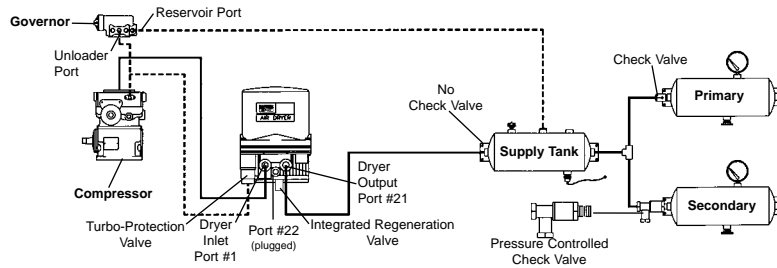


FIG. 2.C External Purge Tank Regeneration with Integrated Governor

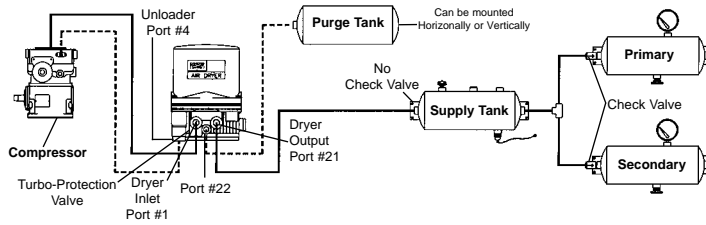


FIG. 2.D External Purge Tank Regeneration with External Governor

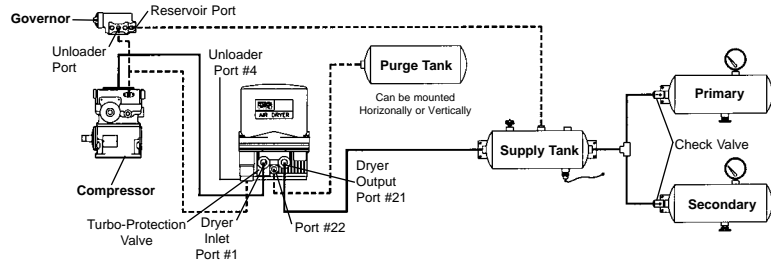


FIG. 2.E. Blow Thru: External Purge Tank with Integrated Governor

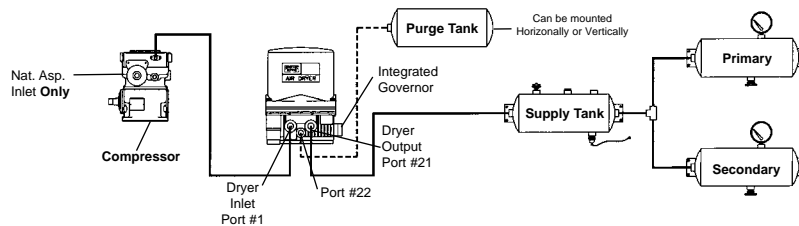
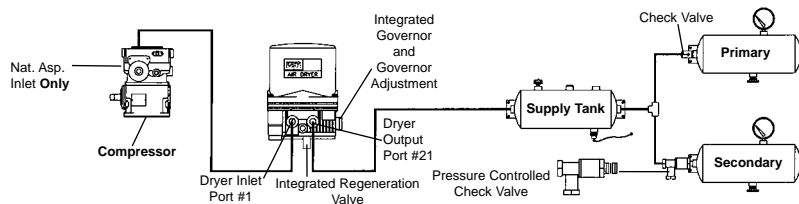


FIG. 2.F. Blow Thru: System Regeneration with Integrated Governor



# Installing the DRYest

## **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 DRYest 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 DRYest should have continuous downward slope and no dips.
8. 90° Fittings should be avoided.
9. Not to exceed 15° inclination.
10. Maintain a minimum of ½" above the dryer for access to the desiccant cartridge.
11. The dryer is equipped with an integrated mounting bracket. The enclosed template is to be used to drill three (3) 9/16" holes. If the dryer is to be bolted directly to the frame or support member, check vehicle manufacturer's recommendations.
12. A mounting bracket can be used if necessary.
13. Install the dryer using the enclosed ½" bolts. Tighten to 45-55 ft-lb.

## **Heater Connection**

1. Locate a circuit with the correct voltage that is "hot" when the ignition is "ON". The current draw is 8 amp@12V; 4amp@24V. A 10-15amp fuse is recommended in this line. Connect one heater lead to this wire.
2. Connect other lead to a good ground on vehicle chassis or electrical junction box.
3. For upgrade heater and connector information see " Service Information".

## Installing the DRYest (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 DRYest Air Dryer discharge contaminates away from vehicle components, it will be necessary to purchase an air dryer with special hose fitting option.

## Testing the DRYest

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

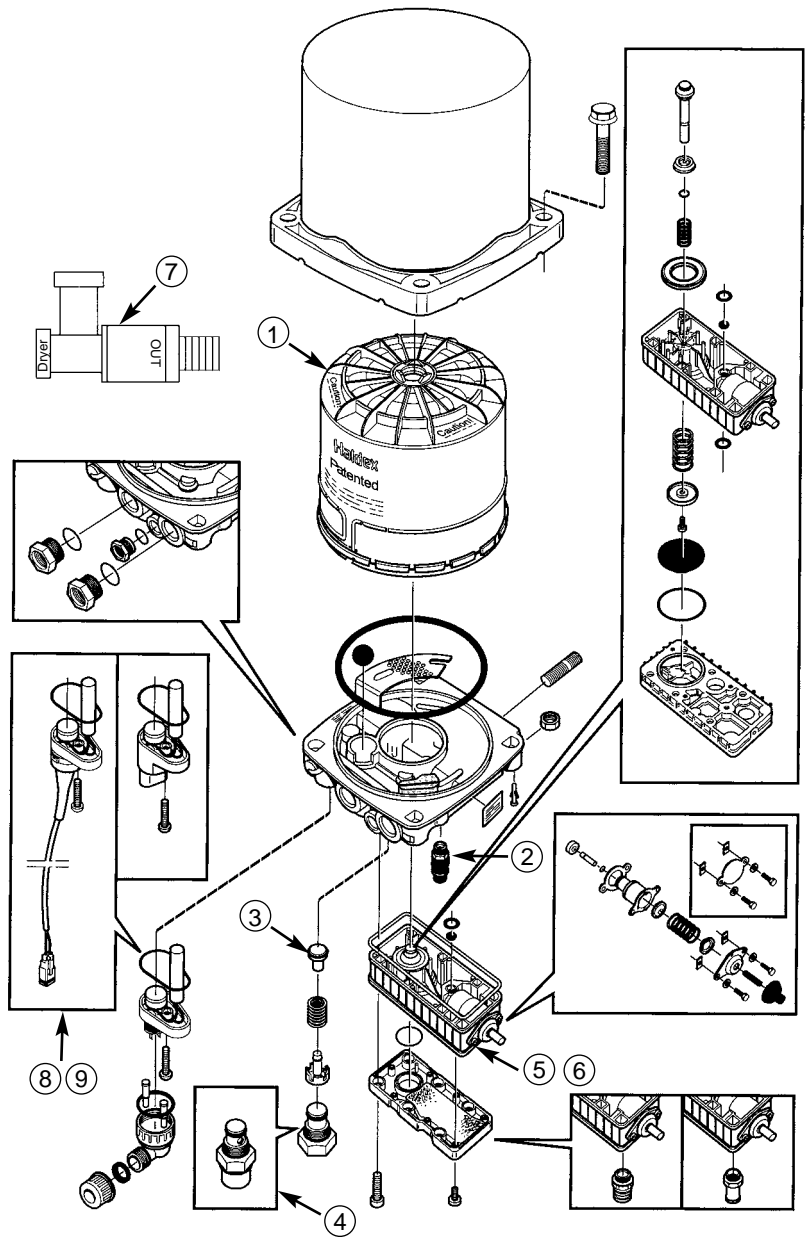
<b>Problem</b>	<b>Cause</b>	<b>Repair</b>
<b>Water in air system</b>	<ol style="list-style-type: none"> <li>1. Contaminants in desiccant.</li> <li>2. Leaks in air system.</li> </ol>	<ol style="list-style-type: none"> <li>1. Change desiccant cartridge. Check compressor for excessive oil passage.</li> <li>2. Tighten air connections, soap connection and recheck for leaks per Testing the <i>DRYest</i> section.</li> </ol>
<b>Constant exhaust of air at air dryer and not Blow-Thru Type</b>	<ol style="list-style-type: none"> <li>1. Defective dryer outlet check valve.</li> <li>2. Dryer unloading valve not closing.</li> </ol>	<ol style="list-style-type: none"> <li>1. Clean valve seat and replace check valve.</li> <li>2. At compressor cut-out there <b>must</b> be a slight blow of regenerated air from the purge tank for approximately 30 seconds. If air flow continues, replace valve pack.</li> </ol>
<b>Excessive compressor cycling</b>	<ol style="list-style-type: none"> <li>1. Excessive leaks in air system.</li> <li>2. Defective dryer outlet check valve.</li> <li>3. Undersize compressor, duty cycle of compressor should not exceed 25%.</li> </ol>	<ol style="list-style-type: none"> <li>1. Tighten air connections, soap connection and recheck for leaks.</li> <li>2. Clean valve seat and replace check valve.</li> <li>3. Reduce air demand or use greater output compressor.</li> </ol>
<b>Safety valve is open</b>	<ol style="list-style-type: none"> <li>1. Desiccant cartridge is plugged.</li> <li>2. Ice block in dryer.</li> <li>3. Excessive system pressure.</li> </ol>	<ol style="list-style-type: none"> <li>1. Excessive oil passage from compressor. Check for worn compressor. Replace desiccant cartridge.</li> <li>2. Check heater function.</li> <li>3. Repair or replace governor.</li> </ol>
<b>Short life of dryer or desiccant cartridge</b>	<ol style="list-style-type: none"> <li>1. Air at inlet of dryer exceeds 170°F.</li> <li>2. Duty cycle of compressor does not allow for sufficient time for desiccant regeneration.</li> </ol>	<ol style="list-style-type: none"> <li>1. Extend length of compressor discharge line; see Installing the <i>DRYest</i> section. The 170°F dryer inlet temperature can usually be accomplished with 12' to 15' of compressor discharge line.</li> <li>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.</li> </ol>
<b>Poor drying efficiency</b>	<ol style="list-style-type: none"> <li>1. Air at inlet of dryer exceeds 170°F.</li> </ol>	<ol style="list-style-type: none"> <li>1. Extend length of compressor discharge line; see Installing the <i>DRYest</i> section. The 170°F dryer inlet temperature can usually be accomplished with 12' to 15' of compressor discharge line.</li> </ol>

# 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)



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## BA-921 BENDIX AIR POWER COMPRESSOR

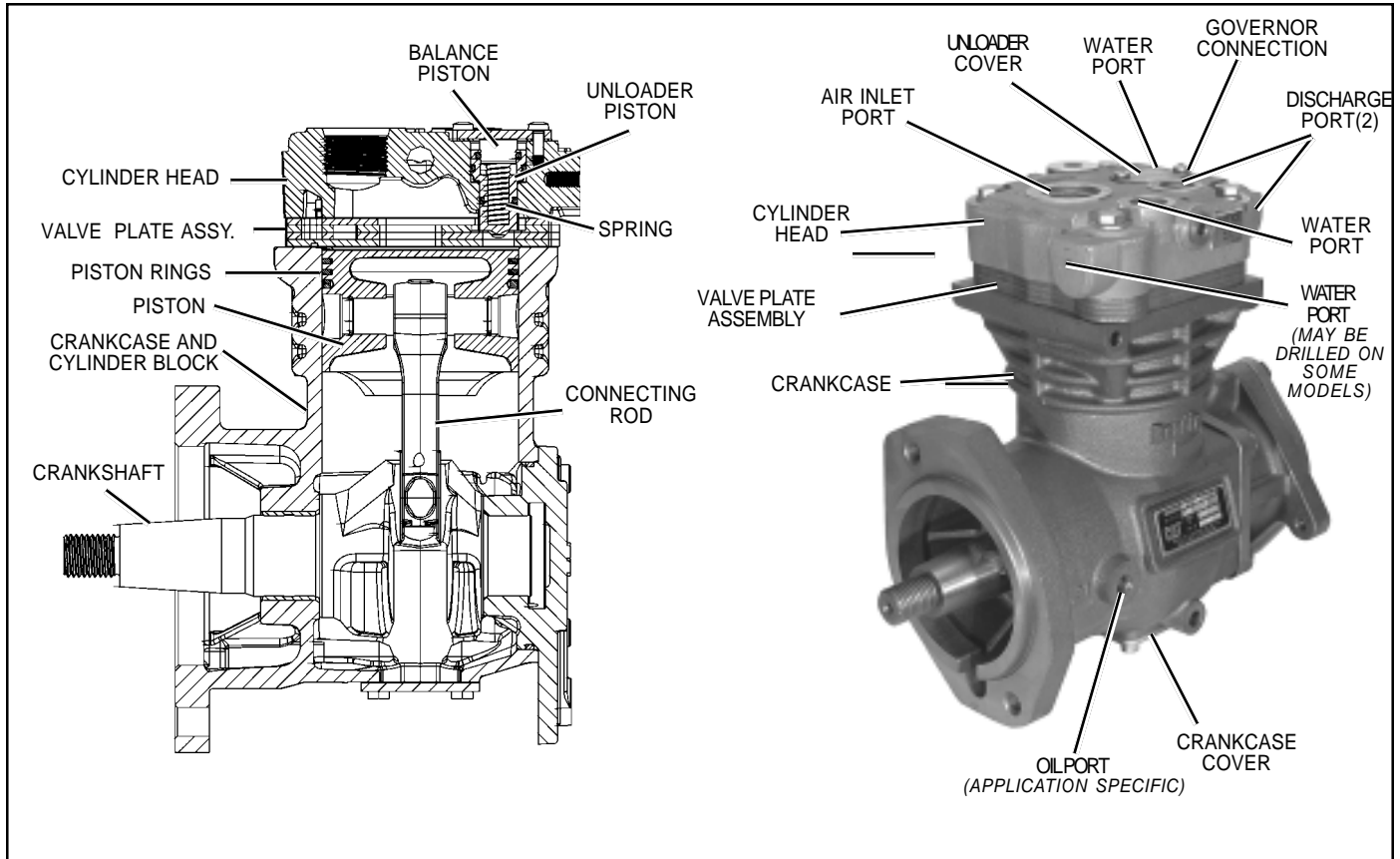


FIGURE 1 - BA-921 COMPRESSOR

### 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.

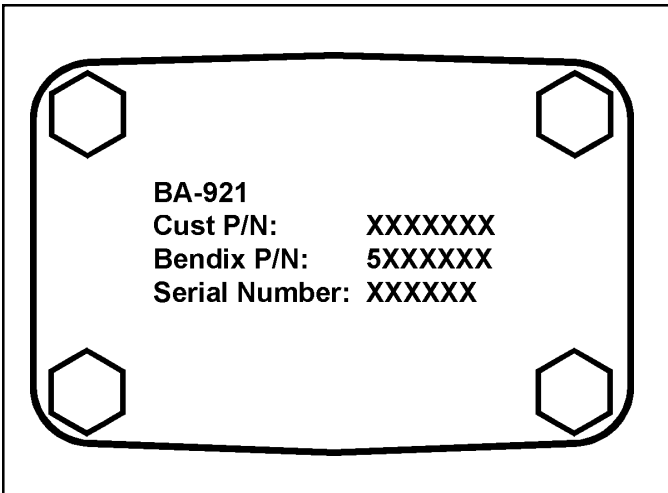


FIGURE 2 - BA-921 CRANKCASE COVER

## 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.

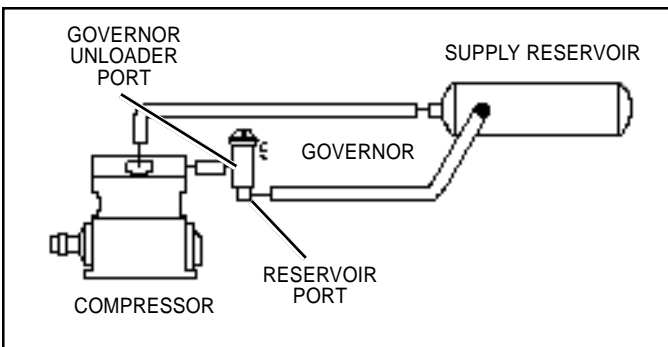


FIGURE 3 - BA-921 COMPRESSOR UNLOADER SYSTEM

### 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

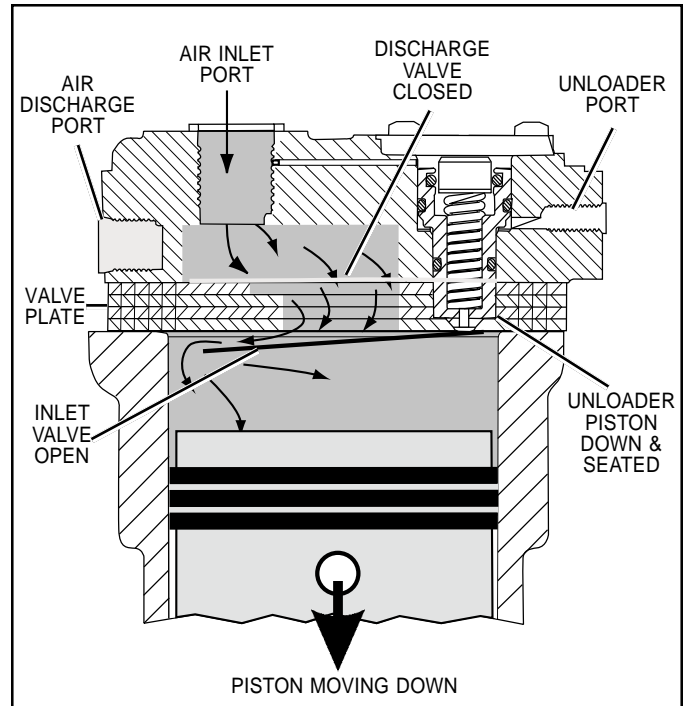


FIGURE 4 - OPERATIONAL-LOADED (INTAKE)

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.

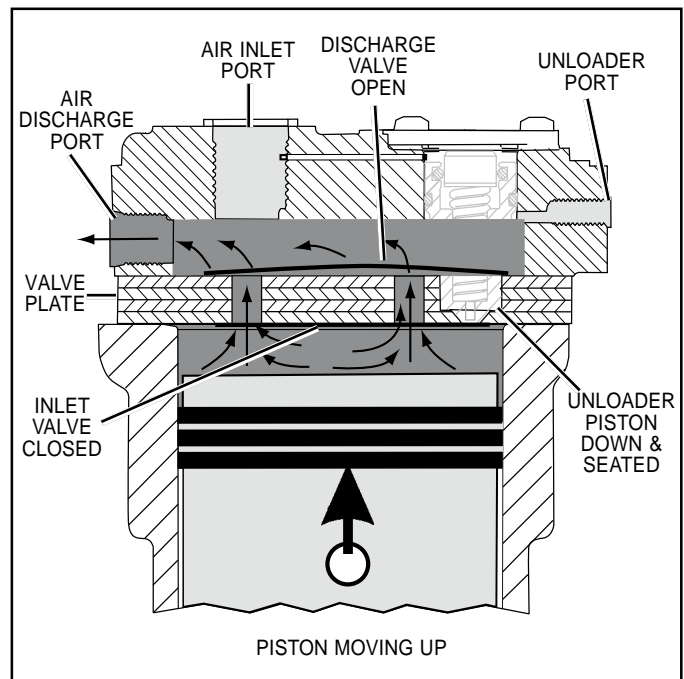


FIGURE 5 - OPERATIONAL-LOADED (COMPRESSION)

### 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

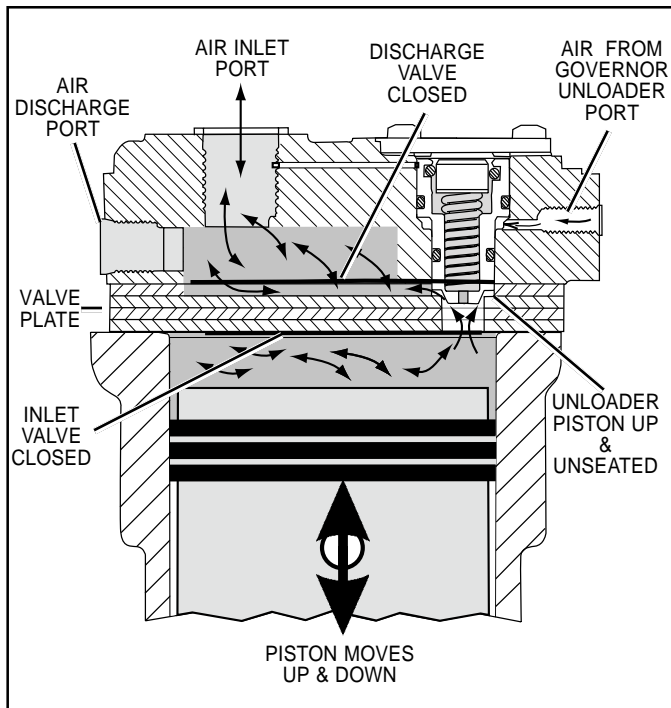


FIGURE 6 - OPERATIONAL-UNLOADED

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

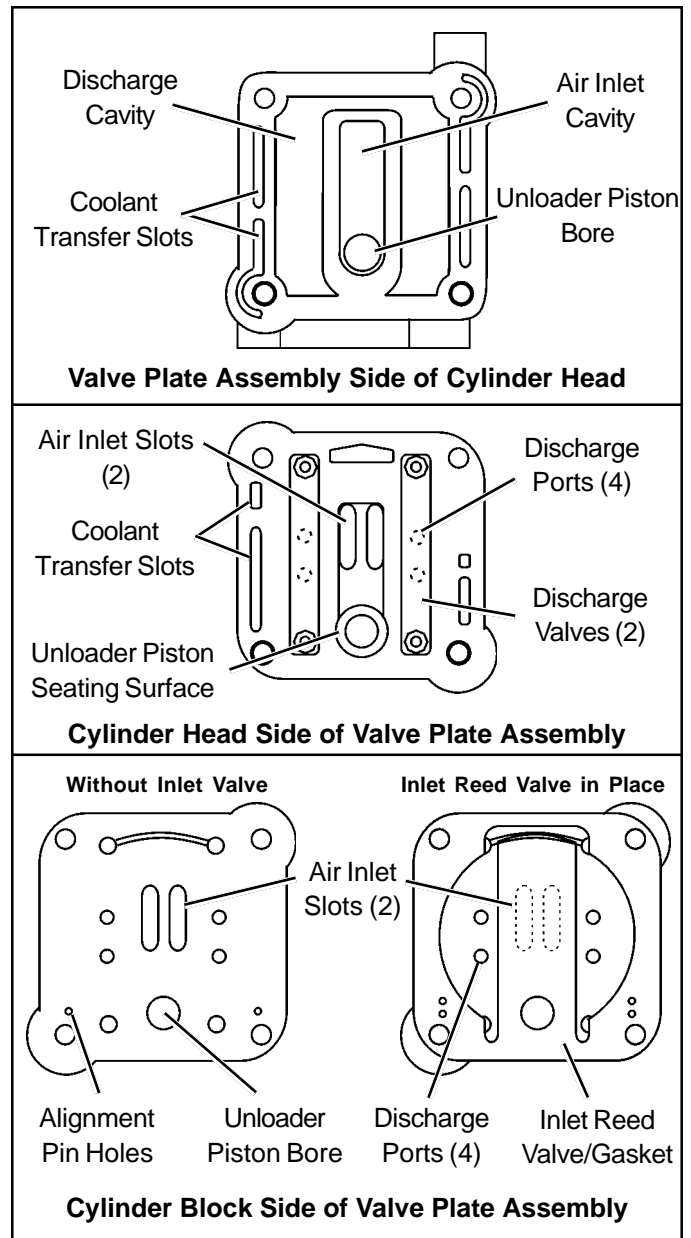


FIGURE 7 - CYLINDER HEAD AND VALVE PLATE ASSY.

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.**

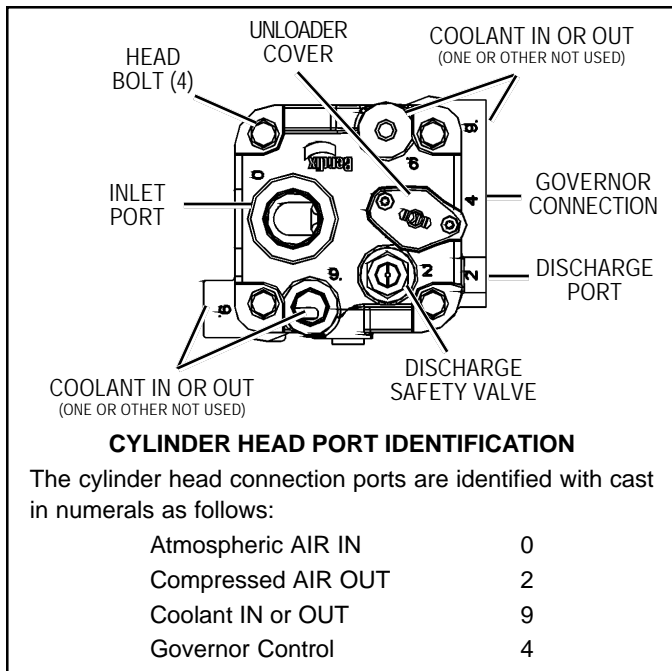


FIGURE 8- TYPICAL BA-921 CYLINDER HEAD

## 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 kinks 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 dryer, 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

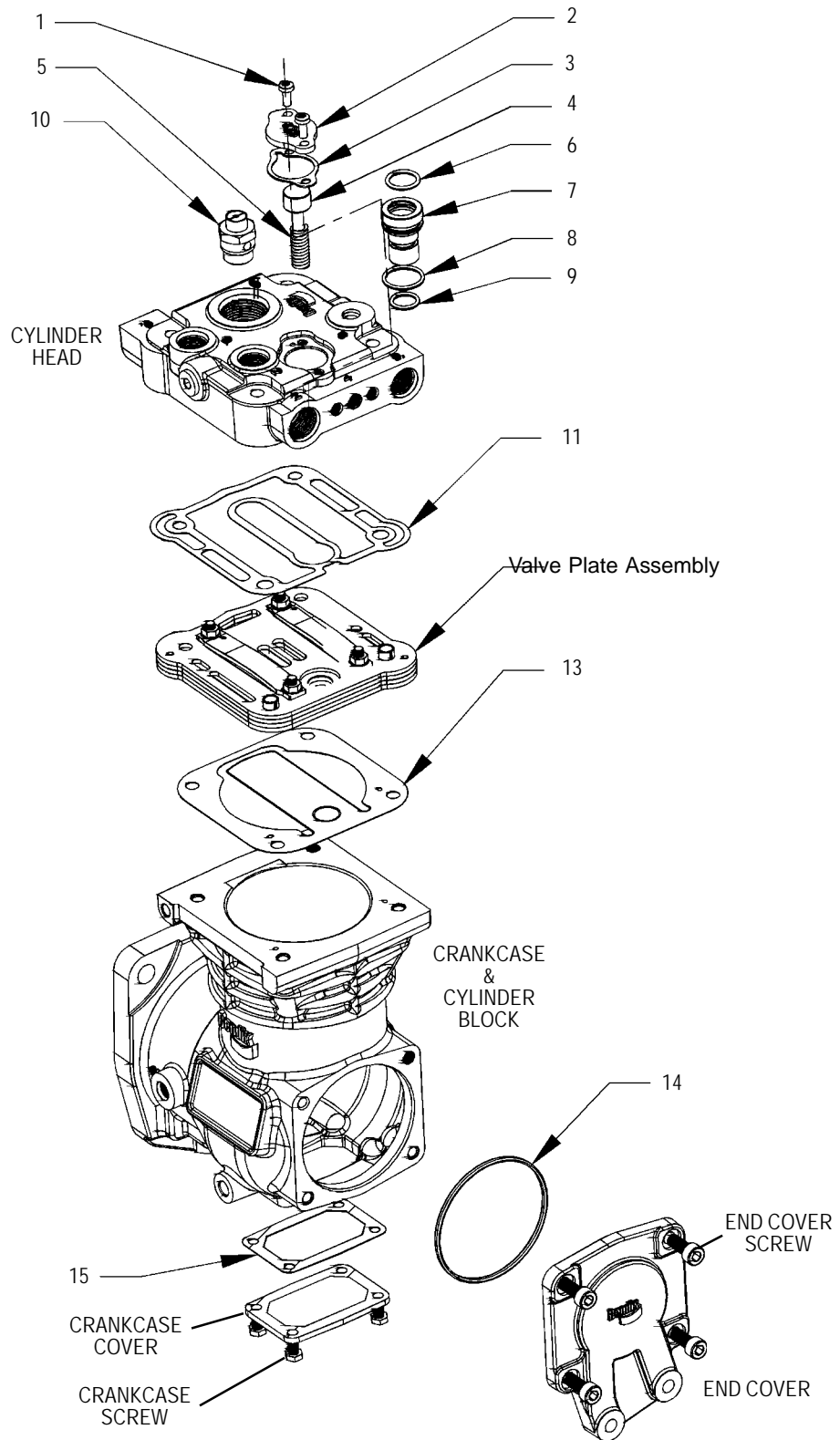
Remove the balance of road dirt and grease from the exterior of the compressor with a cleaning solvent. Mark the rear end cover or end cover adapter in relation to the crankcase. It is recommended but not specifically necessary to mark the relationship of the cylinder head to the valve plate assembly 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



- Remove the balance piston (4) and its spring (5) from the cylinder head.
- Remove the four hex head bolts and washers from the cylinder head.
- 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.
- Remove the metal reed valve/gasket (13).
- 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).
- 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

- 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

- Remove the four end cover cap screws that secure the rear end cover or end cover adapter to the crankcase.
- 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

- 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.
- 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.
- 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.
- Check the threads in all cylinder head ports for galling. Minor chasing is permitted.

- 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

- Carefully inspect the cylinder head gasket surfaces for deep gouges and nicks. If detected, the compressor must be replaced.
- 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.
- 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

- 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: 
$$12 \text{ Inch Pounds} = 1 \text{ Foot Pound}$$

### 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 <sup>1</sup>
Discharge Port Fittings	
7/8"-12 UNF .....	221 - 248
3/4"-14 NPT .....	2 - 3 TFFT <sup>1</sup>
Water Port Fittings	
3/4"-16 UNF .....	221 - 248
3/8"-18 NPT .....	2 - 3 TFFT <sup>1</sup>
Unloader Port Fittings	
1/8"-27 NPT .....	2 - 3 TFFT <sup>1</sup>
Safety Valve Port	
3/4"-16 UNF .....	221 - 248
1/2"-14 NPT .....	2 - 3 TFFT <sup>1</sup>
Oil Port 7/16"-16 UNF .....	177 - 204

<sup>1</sup>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: <ol style="list-style-type: none"> <li>1. Check for proper coolant line sizes. Minimum recommended size is 3/8" I.D. tubing.</li> <li>2. Check the coolant flow through the compressor. Minimum allowable flow is 2.5 gallons per minute at engine governed speed. If low coolant flow is detected, inspect the coolant lines and fittings for accumulated rust scale, kinks and restrictions.</li> <li>3. Water temperature should not exceed 200 degrees Fahrenheit.</li> <li>4. Optimum cooling is achieved when engine coolant flows, as shown in Figure 8 of this manual.</li> </ol>
	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 assure 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.

**Bendix™**

A thick, black, curved bar that starts under the 'B' and ends under the 'x', curving upwards at both ends.



## LOW PRESSURE INDICATORS

\*Formerly SD-06-2

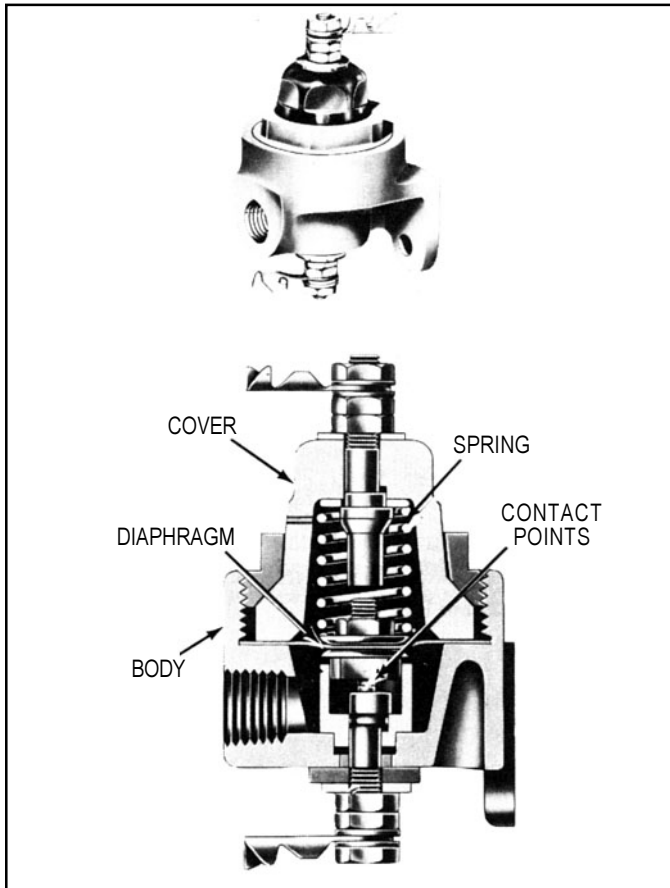


FIGURE 1 - LP-2

### 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

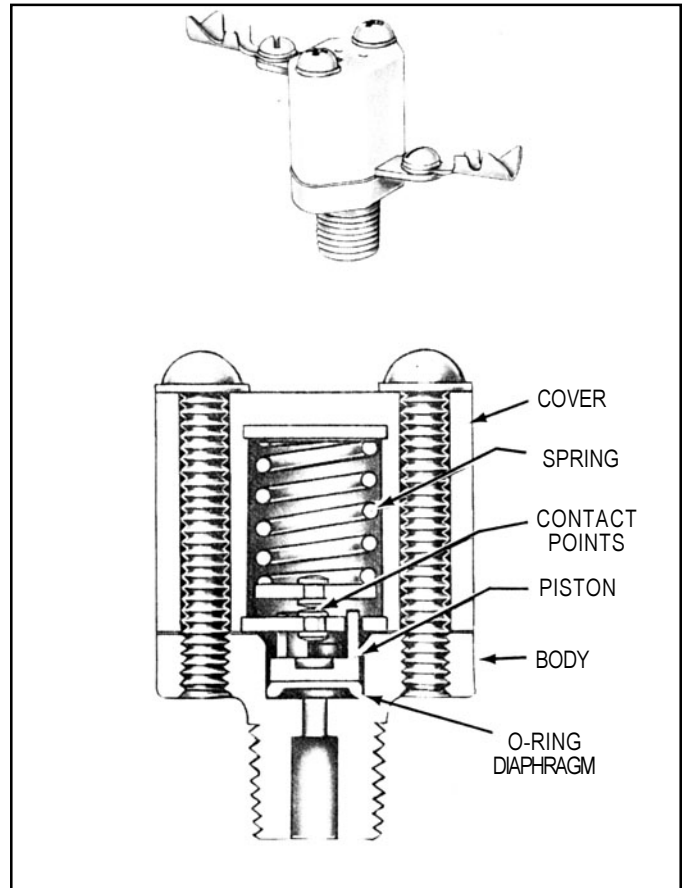


FIGURE 2 - LP-3

available with either one terminal or two. The single terminal unit utilizes a metallic gasket between body and case to ground the lower contact 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.



## PUSH-PULL TYPE CONTROL VALVES: PP-1, PP-2, PP-5, PP-8, & RD-3

\*FORMERLY SD-03-61

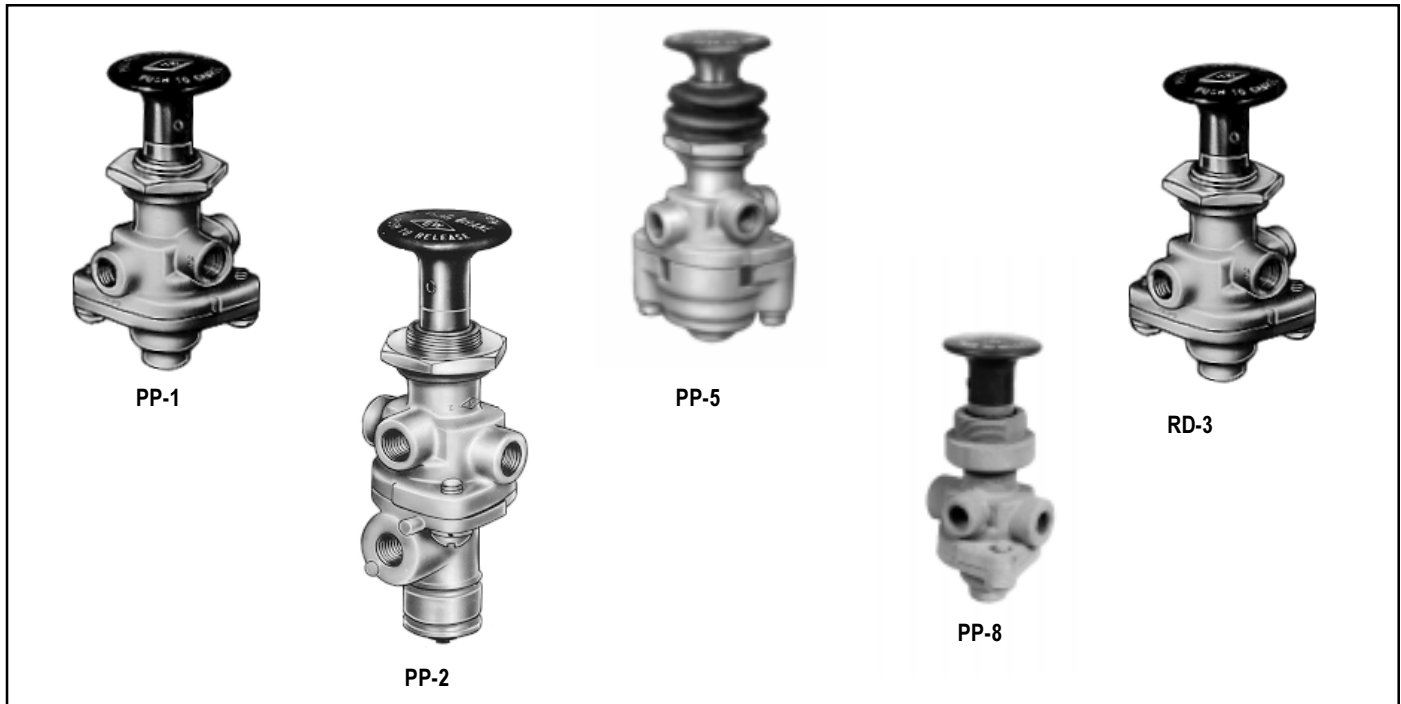


FIGURE 1 - PUSH-PULL TYPE CONTROL VALVES

### 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.**



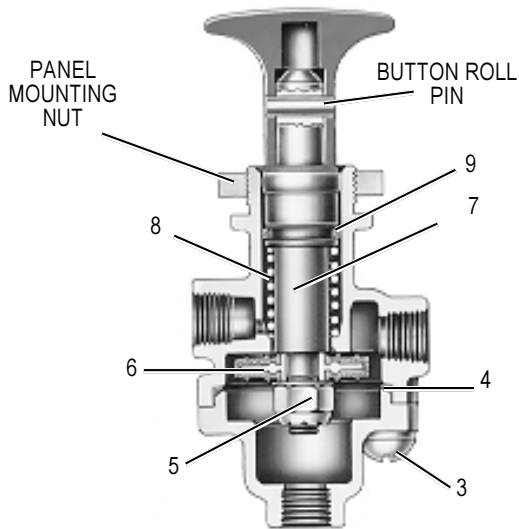


FIGURE 2 PP-1

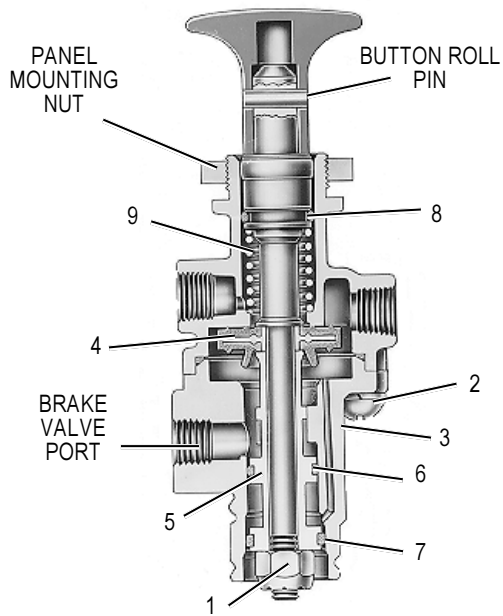


FIGURE 3 PP-2

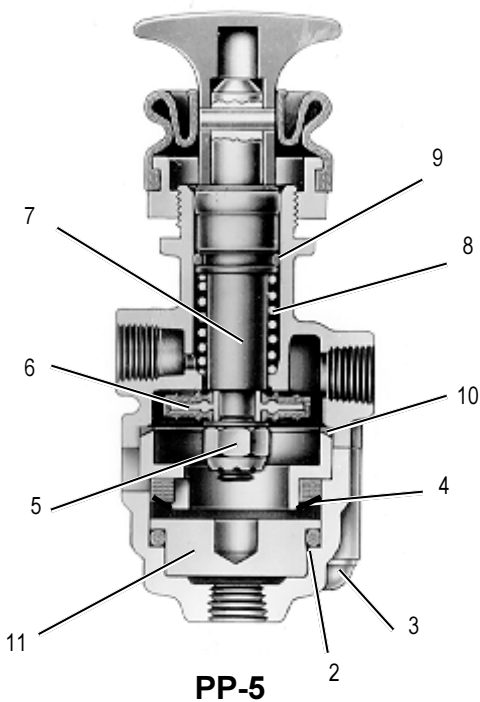


FIGURE 4

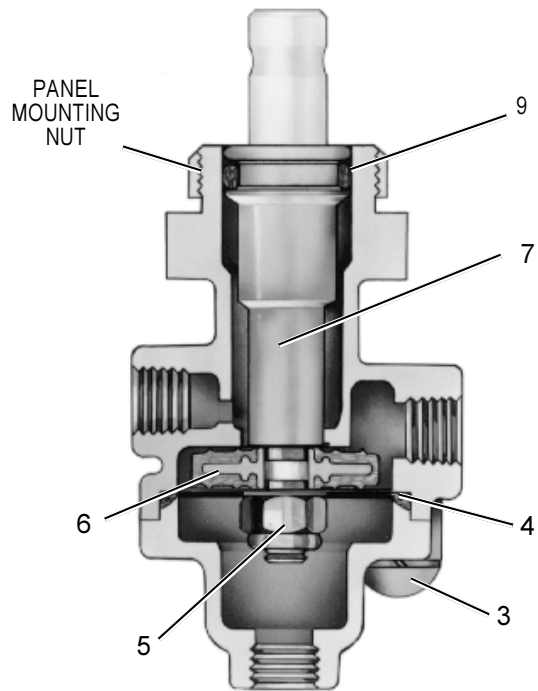
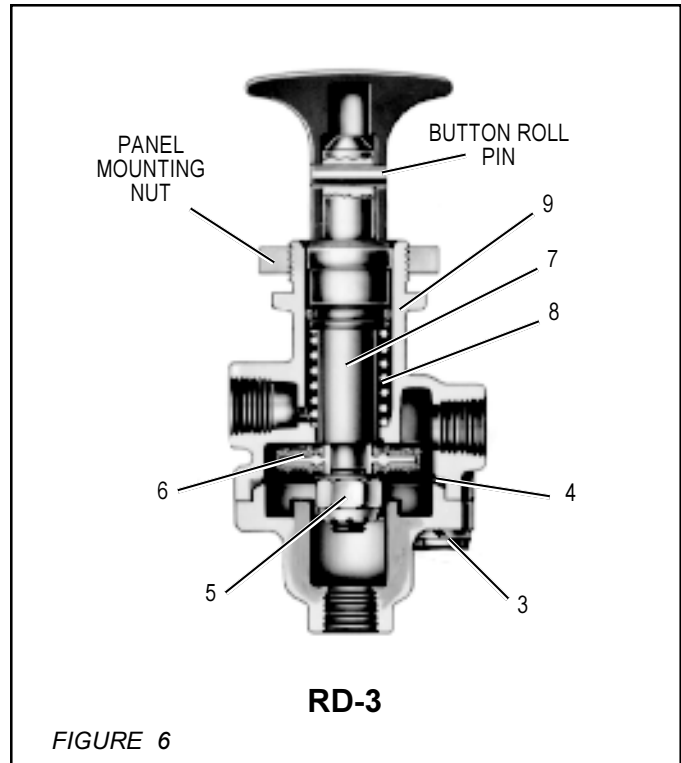


FIGURE 5

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.





## TW-1, TW-3, TW-4, TW-5 & TW-6 CONTROL VALVES

\*Formerly SD-03-64

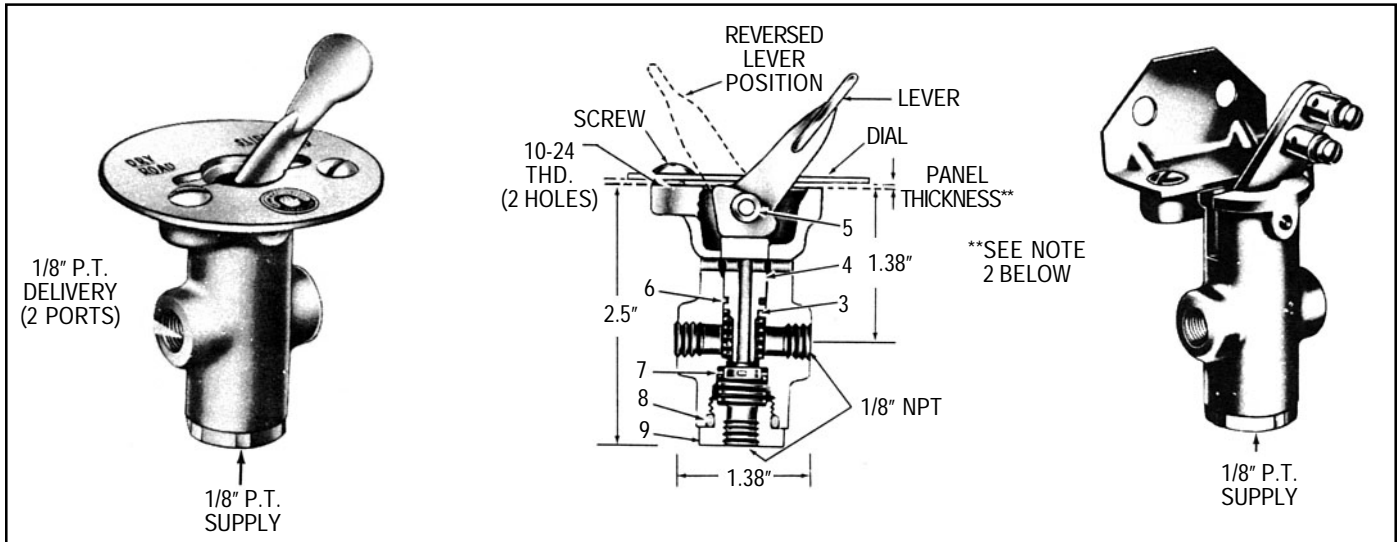


FIGURE 1 - TW-1

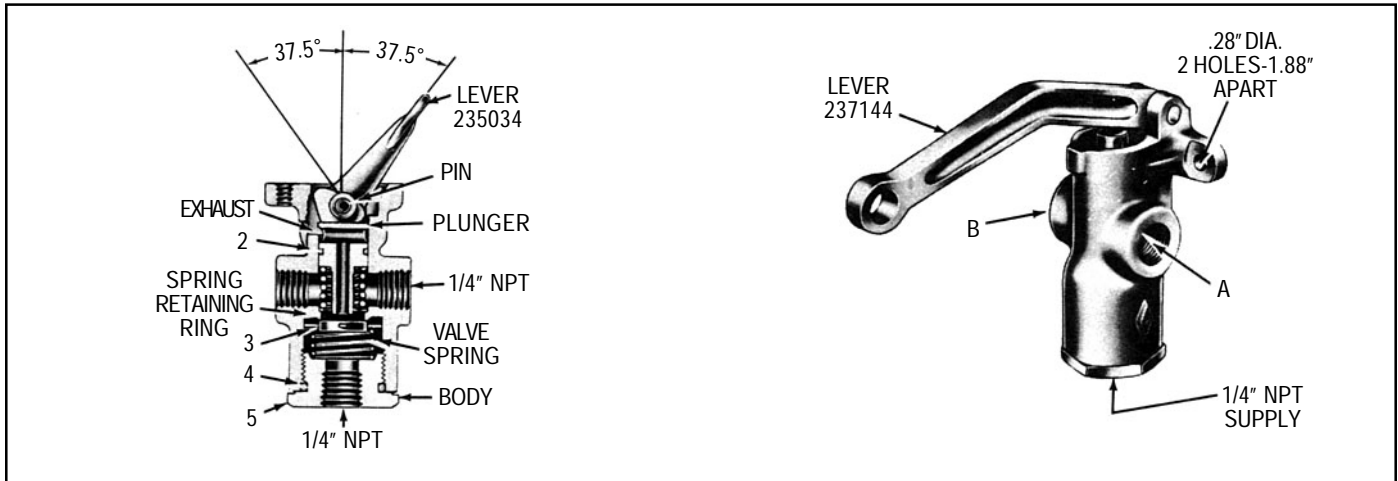


FIGURE 2 - TW-3

### 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.

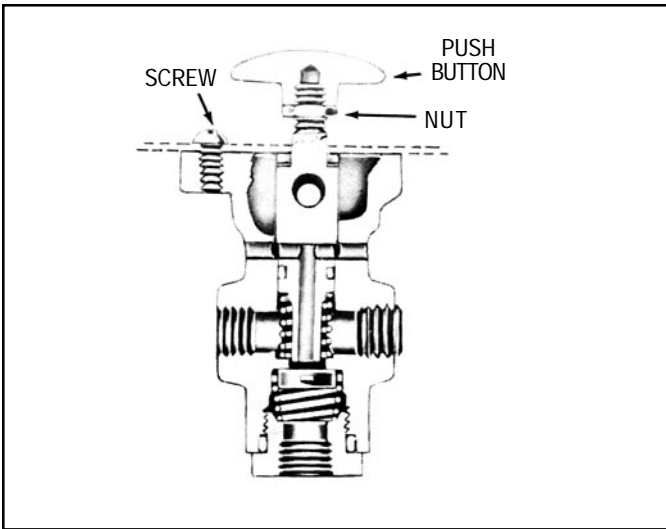


FIGURE 3 - TW-4

## OPERATION

With air pressure at 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.

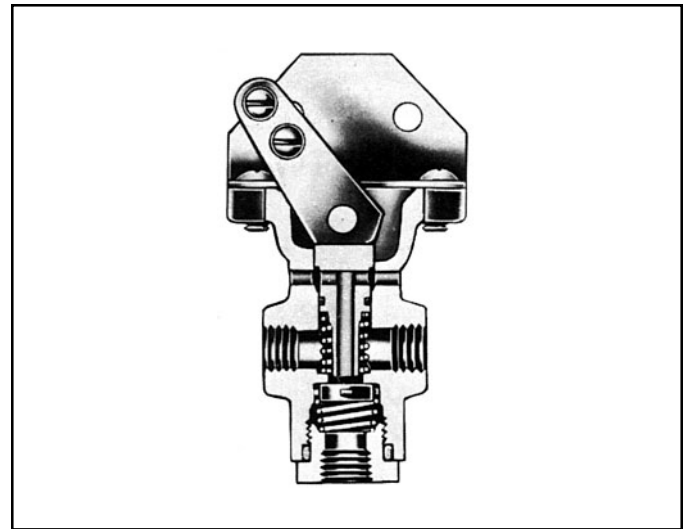


FIGURE 4 - TW-6

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 O-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.





## DOUBLE CHECK VALVES

\*FORMERLY SD-03-67

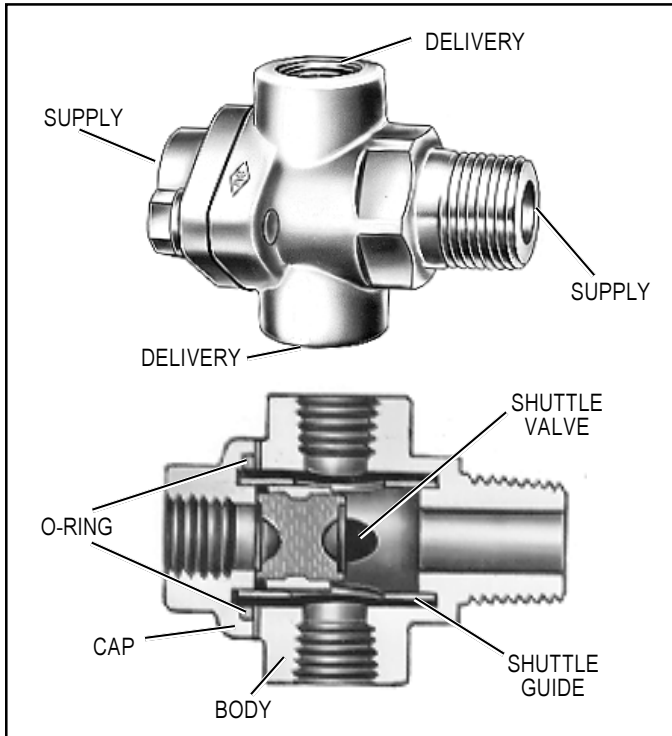


FIGURE 1 - DOUBLE CHECK VALVE (SHUTTLE TYPE)

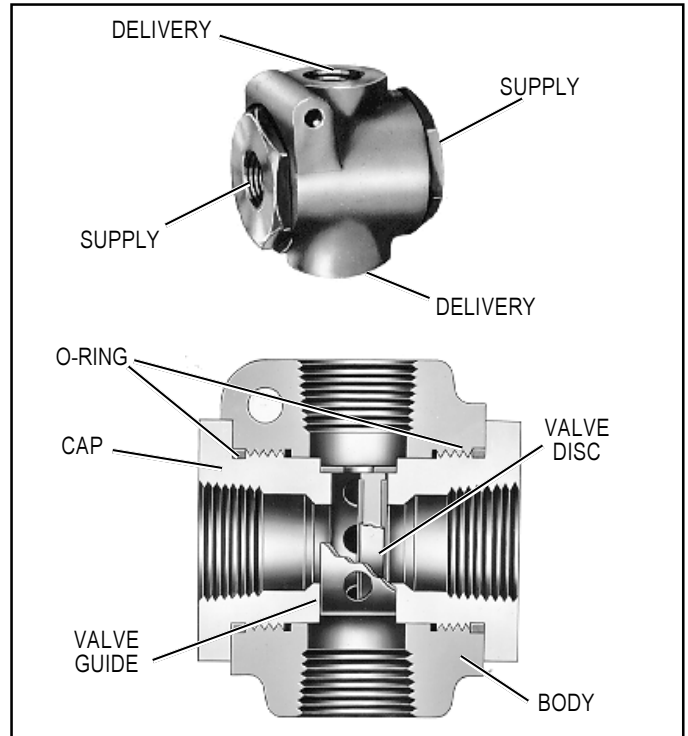


FIGURE 2 - DOUBLE CHECK VALVE (DISC TYPE)

### 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.

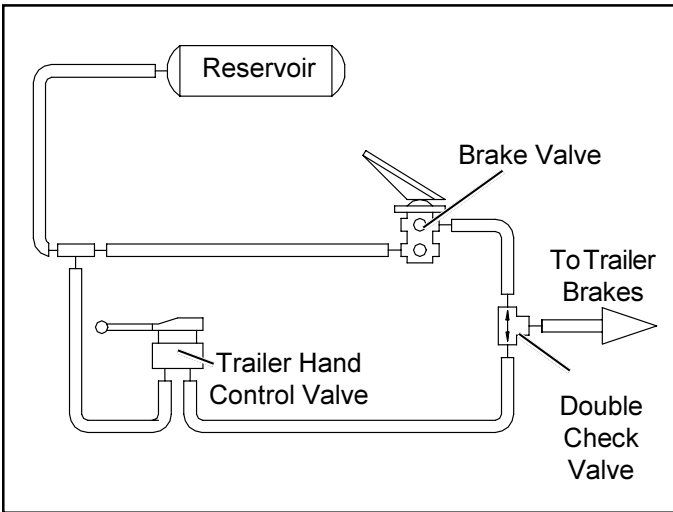


FIGURE 3 - DOUBLE CHECK VALVE: CONTROL OF SYSTEM FROM EITHER OF TWO CONTROL SOURCES

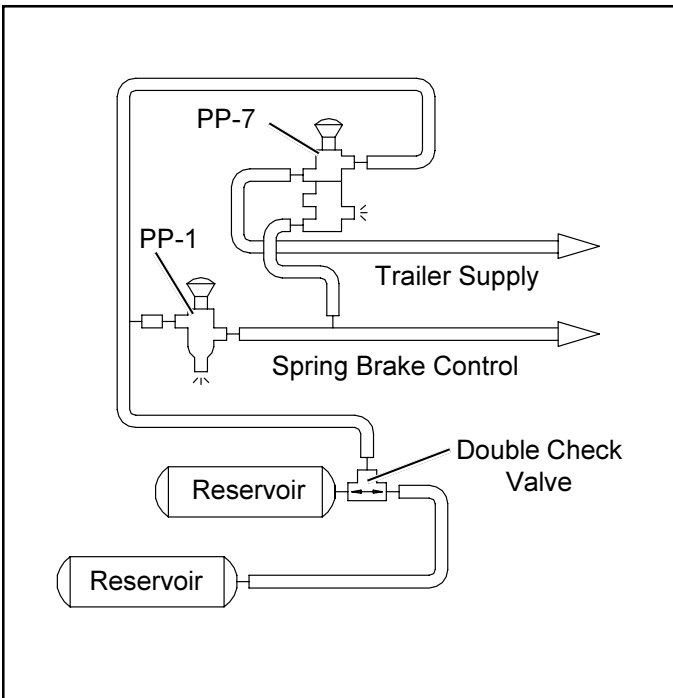


FIGURE 4 - DOUBLE CHECK VALVE: SYSTEM WITH TWO SUPPLY SOURCES

## 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.**







# Service Data

SD-03-2010\*

## PRESSURE PROTECTION VALVES

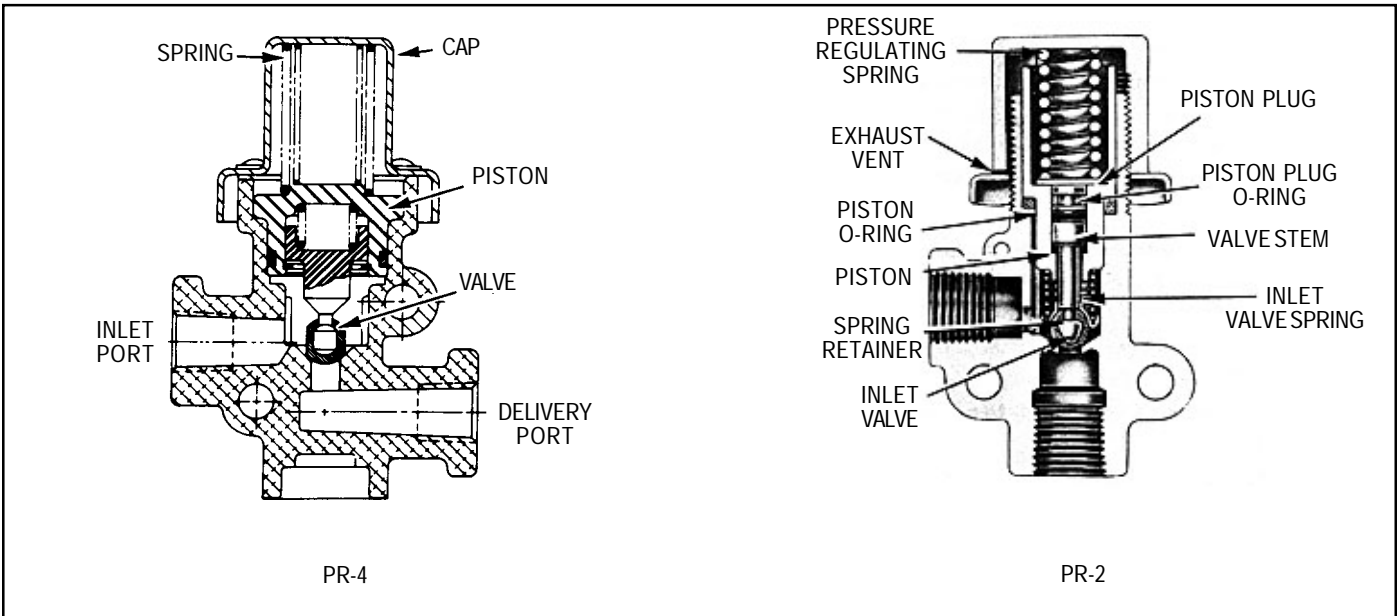
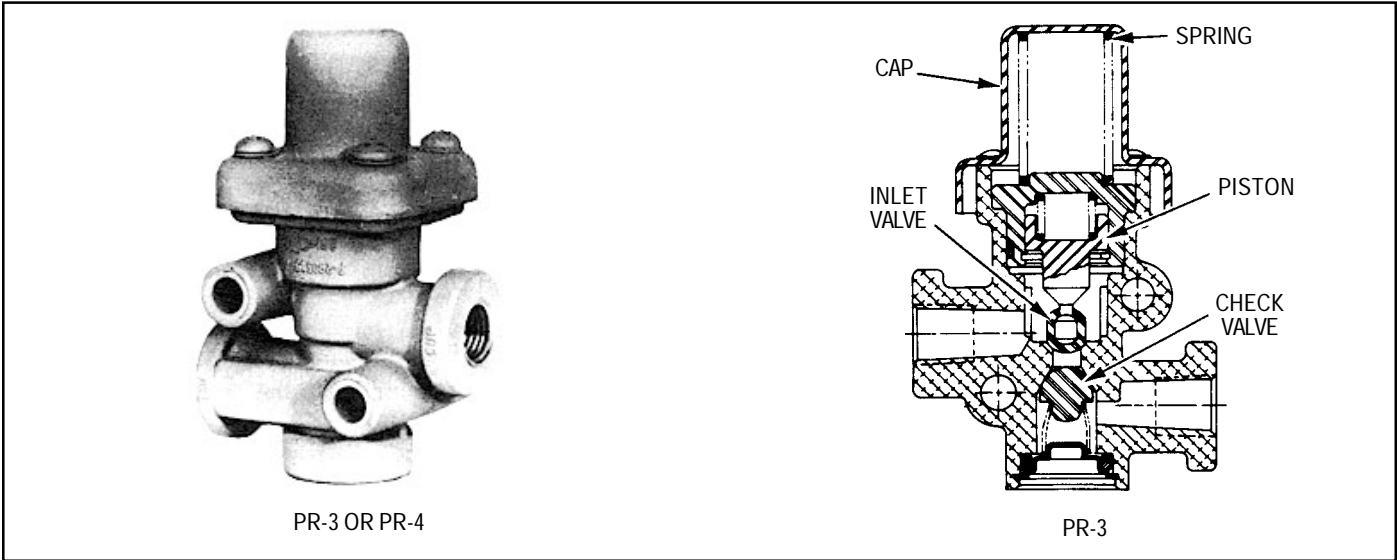
\*Formerly SD-03-55

### 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.



## 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 is 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 ( $\pm 5$  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 permissible 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.





## 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



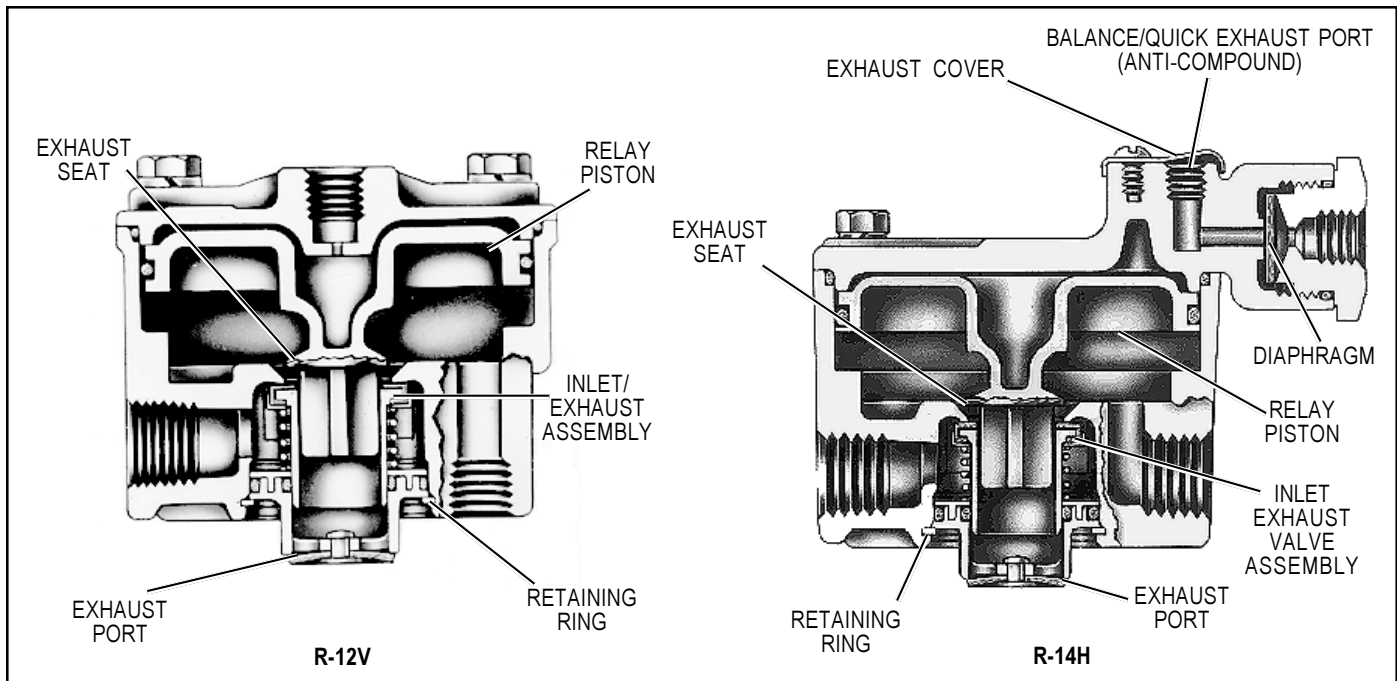


FIGURE 2 - SECTIONAL VIEWS

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.

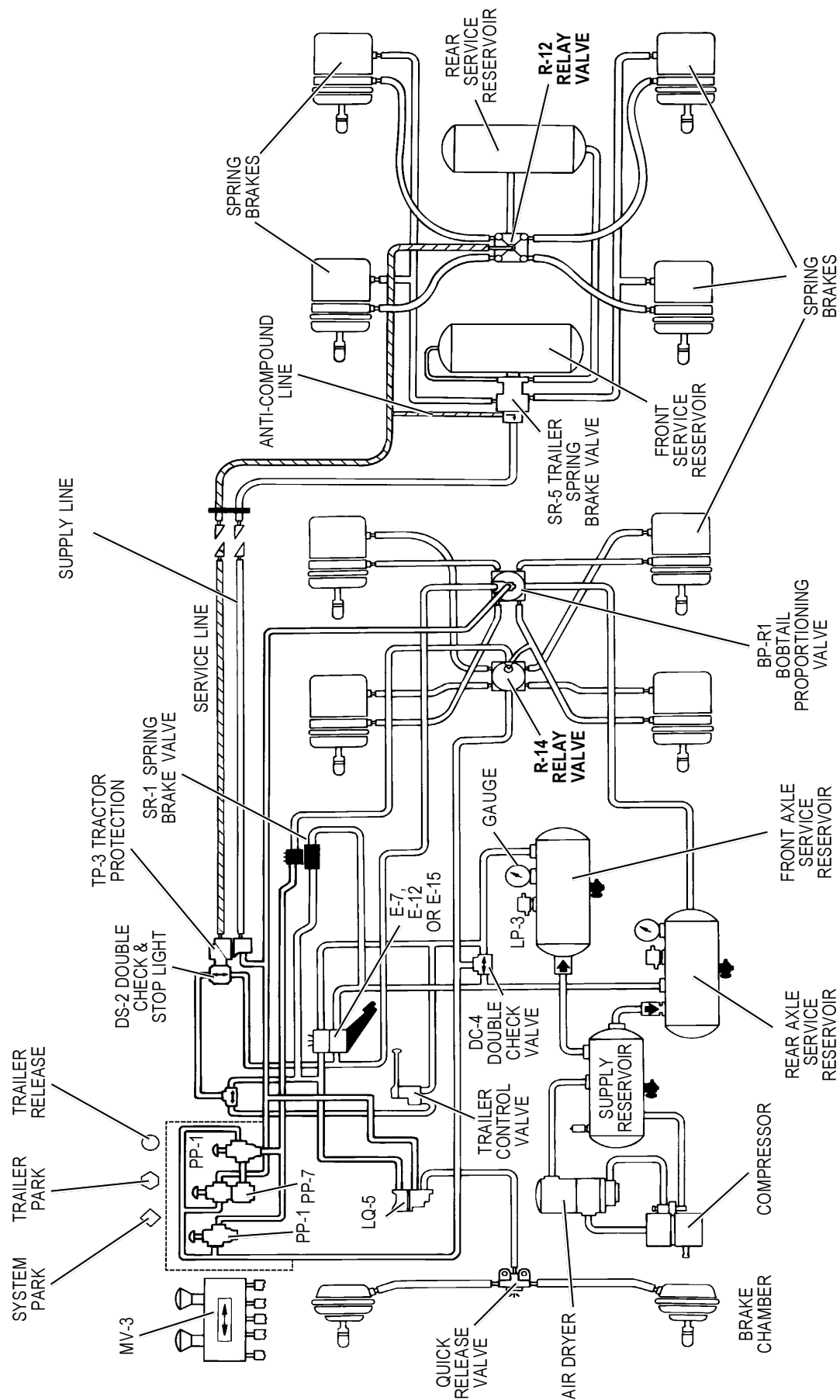


FIGURE 3 - TYPICAL PIPING SCHEMATIC



## 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 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.





## QR AND QR-1 QUICK RELEASE VALVES

\*Formerly SD-03-69

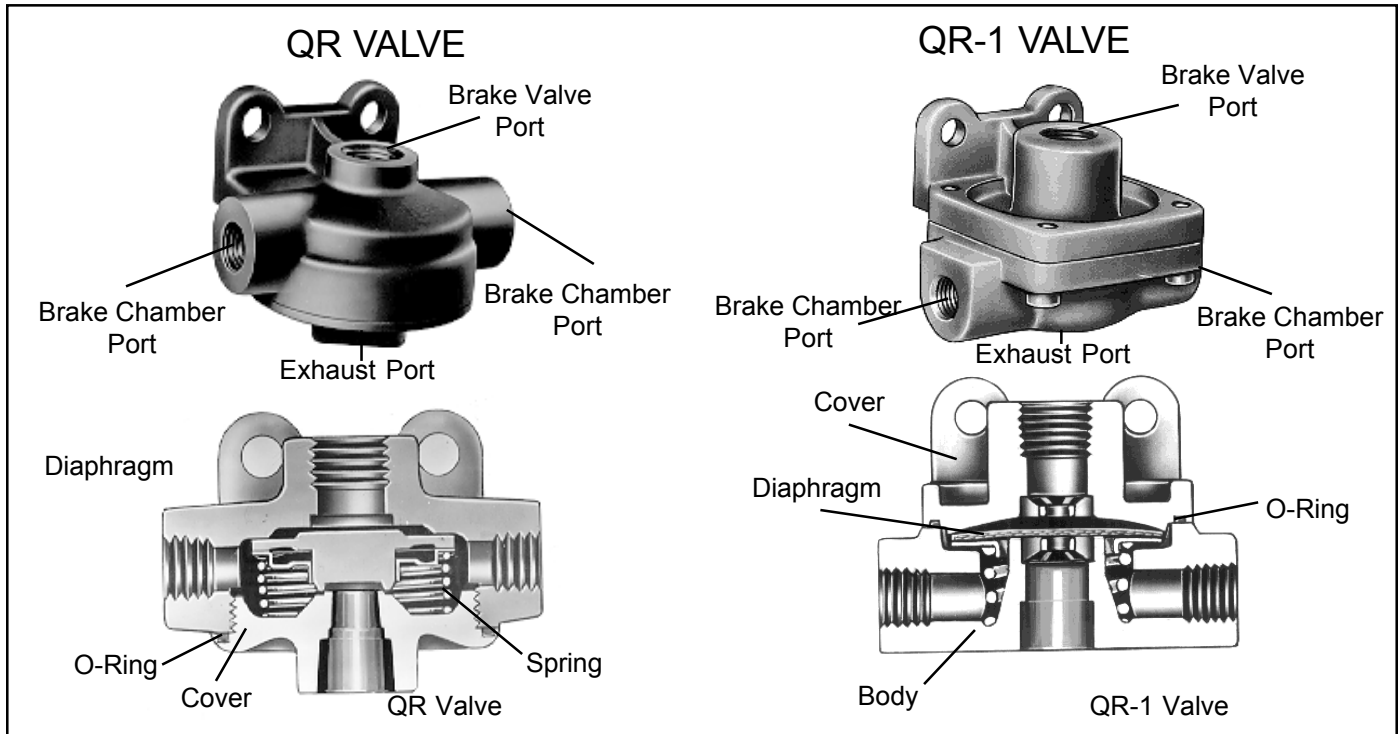


FIGURE 1

### 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.

- a. 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.

## E-8P & E-10P DUAL BRAKE VALVES

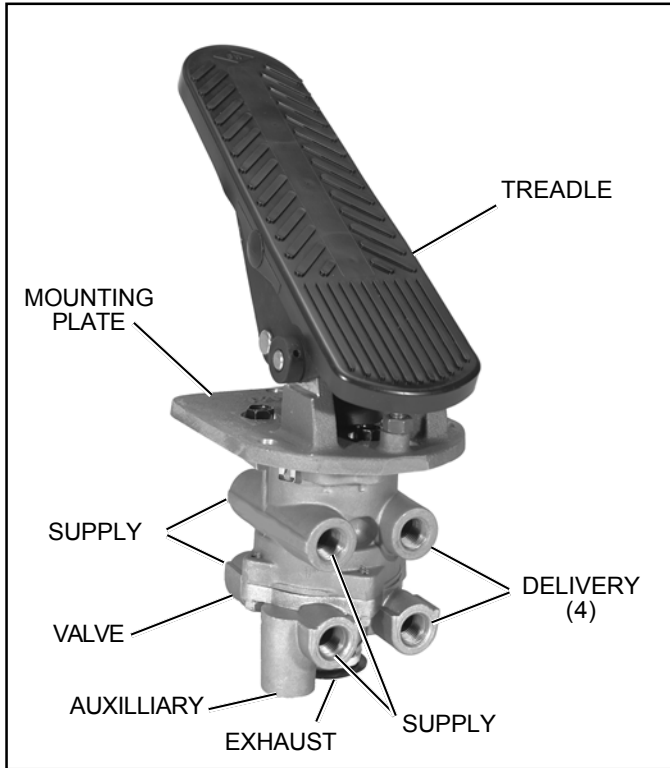


FIGURE 1 - E-8P

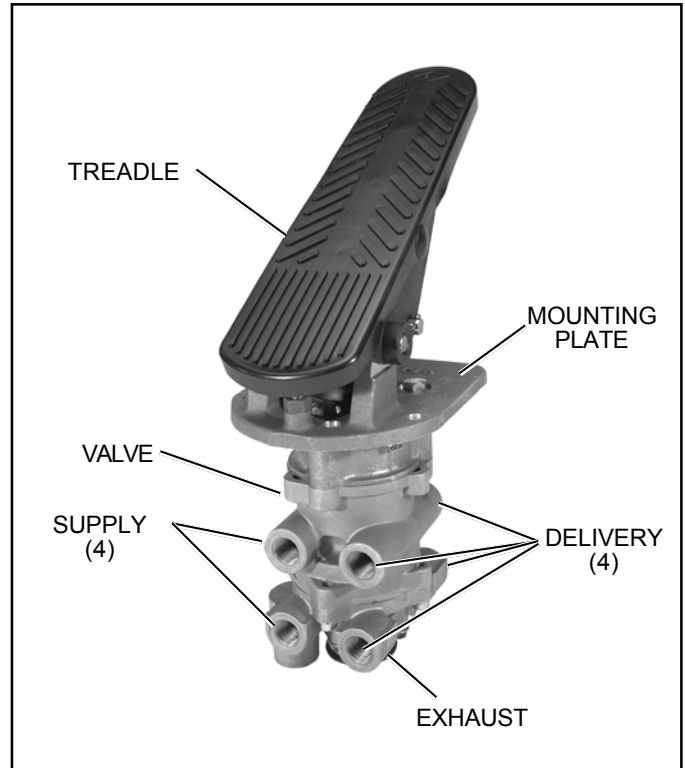


FIGURE 2 - E-10P

### DESCRIPTION

Refer to Figures 4, 5 and 6 for item numbers referenced in parenthesis.

The E-8P (Figure 1) and E-10P (Figure 2) Dual Brake Valves are floor mounted, treadle operated type brake valves with two separate supply and delivery circuits for service (primary and secondary) braking, which provides the driver with a graduated control for applying and releasing the vehicle brakes.

The E-10P Dual Brake Valve (Figure 2) is similar to the E-8P Dual Brake Valve except that a metal coil spring (5) housed in an upper body assembly replaces the rubber spring (27) used in the E-8P valve. The use of a metal coil spring (and the upper body assembly) provides greater treadle travel and, therefore, provides the driver with a less sensitive "feel" when making a brake application. The E-10P Dual Brake

Valve is generally used on busses, where smooth brake applications contribute to passenger comfort.

The circuits in the E-8P/E-10P Dual Brake Valves are identified as follows: The No. 1 or primary circuit is that portion of the valve between the spring seat which contacts the plunger and the relay piston; the No. 2 or secondary circuit is that portion between the relay piston and the exhaust cavity.

The primary circuit of the valve is similar in operation to a standard single circuit air brake valve and under normal operating conditions the secondary circuit is similar in operation to a relay valve.

Both primary and secondary circuits of the brake valve use a common exhaust protected by an exhaust diaphragm.



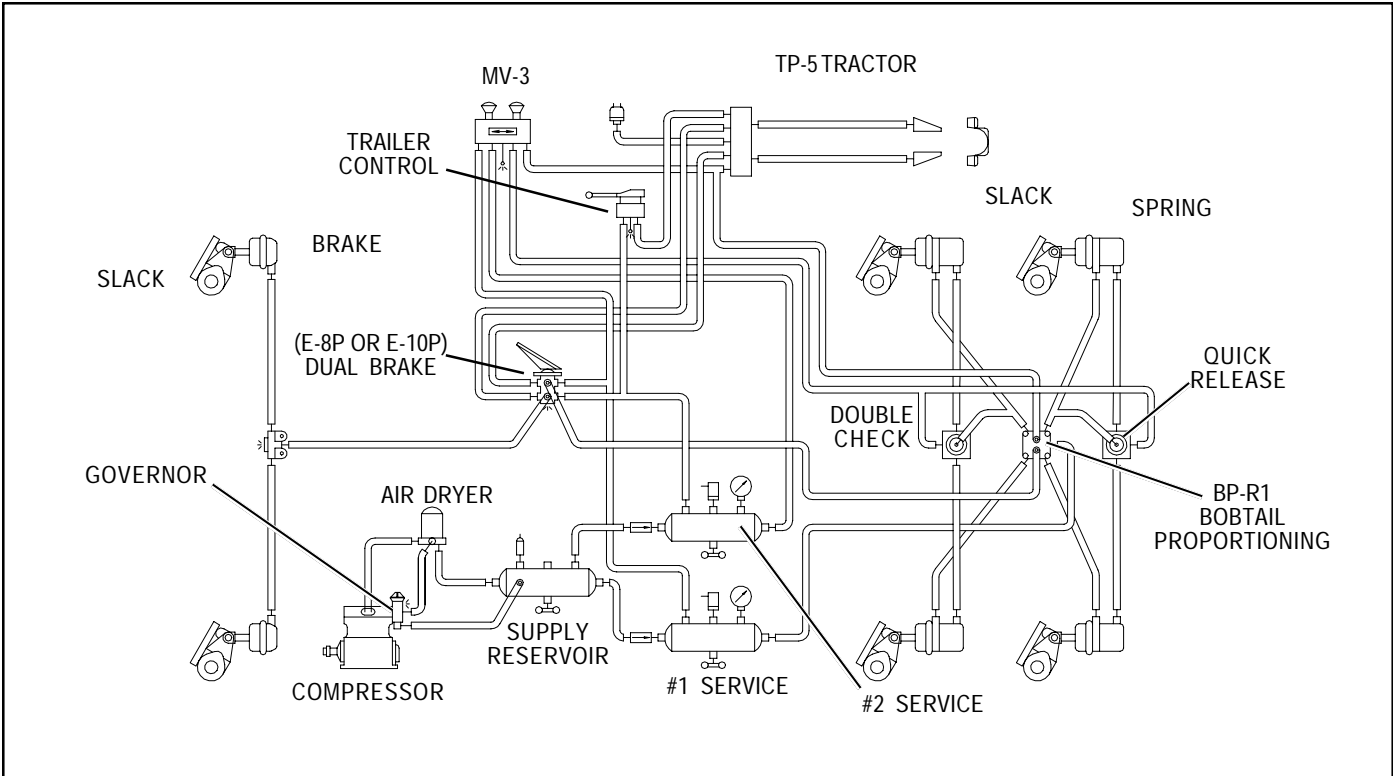


FIGURE 3 - TYPICAL PIPING SCHEMATIC

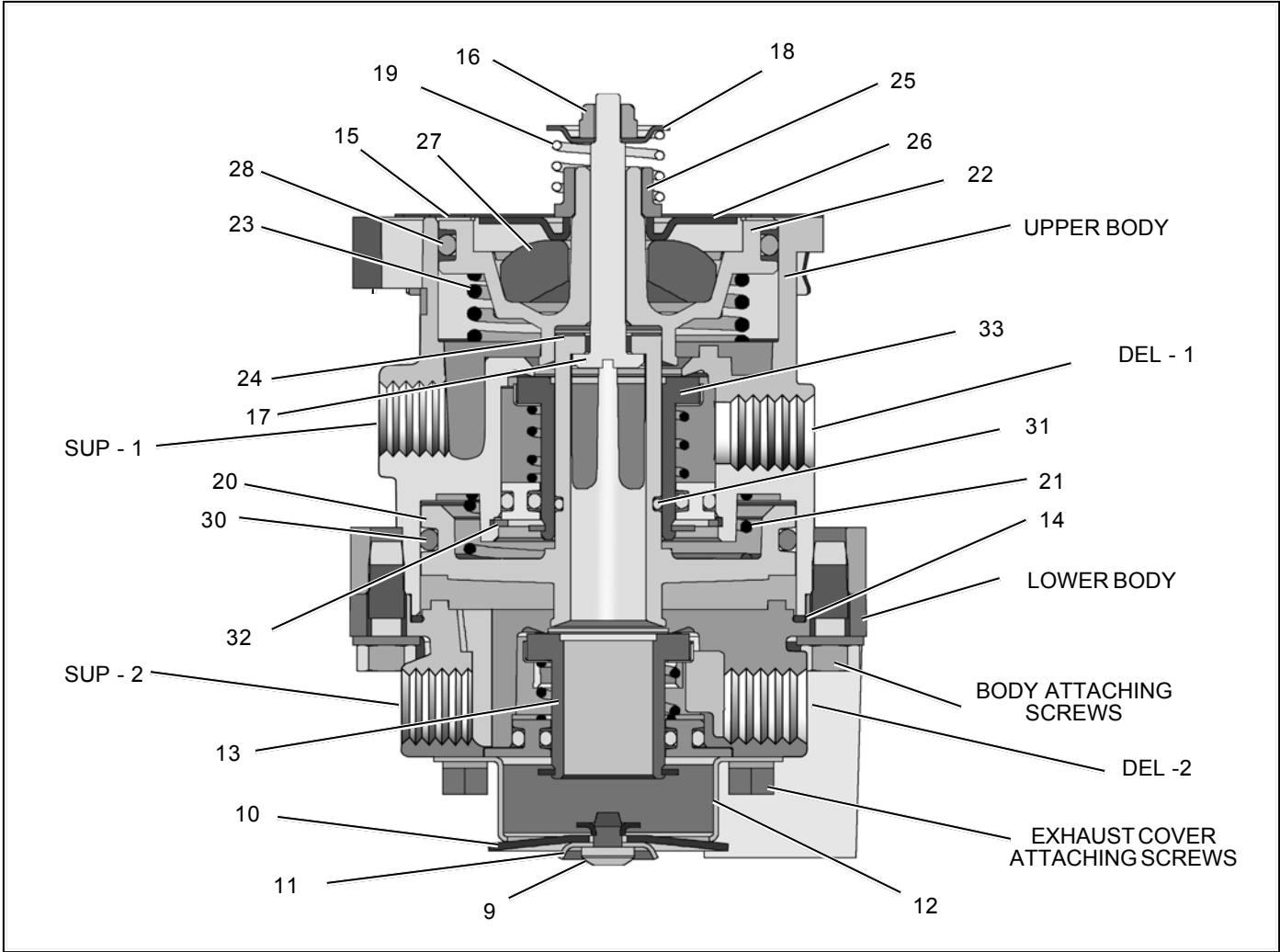


FIGURE 4 - E-8P SECTIONAL VIEW



## **OPERATION** - Refer to Figure 3

### **APPLYING: NORMAL OPERATION - NO. 1 OR PRIMARY CIRCUIT PORTION**

When the brake treadle is depressed, the plunger exerts force on the spring seat (26), graduating spring (23), and primary piston (22). The primary piston, which contains the exhaust valve seat, closes the primary exhaust valve. As the exhaust valve closes, the primary inlet valve is moved off its seat allowing primary air to flow out the No. 1 or primary delivery port.

### **APPLYING: NORMAL OPERATION - NO. 2 OR SECONDARY CIRCUIT**

When the primary inlet valve (33) is moved off its seat, air is permitted to pass through the bleed passage and enters the relay piston cavity. The air pressure moves the relay piston (20), which contains the exhaust seat, and closes the secondary exhaust valve. As the secondary exhaust valve closes, the inlet valve (13) is moved off its seat allowing the secondary air to flow out the delivery of the same circuit. Because of the small volume of air required to move the relay piston (20), action of the secondary circuit of the valve is almost simultaneous with the primary circuit portion.

### **APPLYING: LOSS OF AIR IN THE NO. 2 OR SECONDARY CIRCUIT**

Should air be lost in the No. 2 or secondary circuit, the No. 1 or primary circuit will continue to function as described above under *Normal Operation: No. 1 or Primary Circuit Portion*.

### **APPLYING: LOSS OF AIR IN THE NO. 1 OR PRIMARY CIRCUIT**

Should air be lost in the primary circuit, the function will be as follows: As the brake treadle is depressed and no air pressure is present in the primary circuit supply and delivery ports, the primary piston (22) will mechanically move the relay piston (20), allowing the piston to close the secondary exhaust valve and open the secondary inlet valve and allow air to flow out the secondary delivery port.

### **BALANCED: NO. 1 OR PRIMARY CIRCUIT**

When the primary delivery pressure acting on the primary piston (22) equals the mechanical force of the brake pedal application, the primary piston (22) will move and the primary inlet valve (33) will close, stopping further flow of air from the primary supply line through the valve. The exhaust valve remains closed preventing any escape of air through the exhaust port.

### **BALANCED: NO. 2 OR SECONDARY CIRCUIT**

When the air pressure on the delivery side of the relay piston (20) approaches that being delivered on the primary side of the relay piston, the relay piston moves closing the secondary inlet valve and stopping further flow of air from the supply line through the valve. The exhaust remains closed as the secondary delivery pressure balances the primary delivery pressure.

When applications in the graduating range are made, a balanced position in the primary circuit is reached as the air pressure on the delivery side of the primary piston (22) equals the effort exerted by the driver's foot on the treadle. A balanced position in the secondary portion is reached when air pressure on the secondary side of the relay piston (20) closely approaches the air pressure on the primary side of the relay piston.

When the brake treadle is fully depressed, both the primary and secondary inlet valves remain open and full reservoir pressure is delivered to the actuators.

### **RELEASING: NO. 1 OR PRIMARY CIRCUIT**

With the brake treadle released, mechanical force is removed from the spring seat (26), graduating spring (23), and primary piston (22). Air pressure and spring load moves the primary piston, opening the primary exhaust valve, allowing air pressure in the primary delivery line to exhaust out the exhaust port.

### **RELEASING: NO. 2 OR SECONDARY CIRCUIT**

With the brake treadle released, air is exhausted from the primary circuit side of the relay piston (20). Air pressure and spring load move the relay piston, opening the secondary exhaust valve, allowing air pressure in the secondary delivery line to exhaust out the exhaust port.

## **PREVENTIVE MAINTENANCE**

**Important:** Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period.

Because no two vehicles operate under identical conditions, maintenance and maintenance intervals will vary. Experience is a valuable guide in determining the best maintenance interval for any one particular operation.

Visually check for physical damage to the brake valve such as broken air lines and broken or missing parts.

### **Every 3 months, or 25,000 miles or 900 operating hours:**

Clean any accumulated dirt, gravel, or foreign material away from the heel of the treadle, plunger boot, and mounting plate.

Using light oil, lubricate the treadle roller, roller pin, and hinge pin.

Check the rubber plunger boot for cracks, holes or deterioration and replace if necessary. Also, check mounting plate and treadle for integrity.

Apply 2 to 4 drops of oil between plunger and mounting plate - **do not over oil!**

**Every year, or 100,000 miles, or 3,600 operating hours:**

Disassemble, clean parts with mineral spirits, replace all rubber parts, or any part worn or damaged. Check for proper operation before placing vehicle in service.

## SERVICE CHECKS

### OPERATING CHECK

Check the delivery pressure of both primary and secondary circuits using accurate test gauges. Depress the treadle to several positions between the fully released and fully applied positions, and check the delivered pressure on the test gauges to see that it varies equally and proportionately with the movement of the brake pedal.

After a full application is released, the reading on the test gauges should fall off to zero promptly. It should be noted that the primary circuit delivery pressure will be about 2 PSI greater than the secondary circuit delivery pressure with both supply reservoirs at the same pressure. This is normal for this valve.

**Important:** A change in vehicle braking characteristics or a low pressure warning may indicate a malfunction in one or the other brake circuit, and although the vehicle air brake system may continue to function, the vehicle should not be operated until the necessary repairs have been made and both braking circuits, including the pneumatic and mechanical devices, are operating normally. Always check the vehicle brake system for proper operation after performing brake work and before returning the vehicle to service.

### LEAKAGE CHECK

1. Make and hold a high pressure (80 psi) application.
2. Coat the exhaust port and body of the brake valve with a soap solution.
3. Leakage permitted is a one inch bubble in 3 seconds. If the brake valve does not function as described above or leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired with genuine Bendix parts available at authorized Bendix parts outlets.

Refer to figures 4, 5 and 6 for item numbers referenced in parenthesis.

### REMOVAL

1. Chock the vehicle wheels or park the vehicle by mechanical means. (Block and hold vehicle by means other than air brakes.) Drain all air system reservoirs.
2. Identify and disconnect all supply and delivery lines at the brake valve.
3. Remove the brake valve and treadle assembly from the vehicle by removing the three cap screws on the outer bolt circle of the mounting plate. The basic brake valve alone can be removed by removing the three cap screws on the inner bolt circle.

### DISASSEMBLY (Figures 4, 5 and 6)

1. If the entire brake valve and treadle assembly was removed from the vehicle, remove the three cap screws securing the treadle assembly to the basic brake valve.
2. Remove the screw (9) securing the exhaust diaphragm (10) and washer (11) to the exhaust cover (12).
3. Remove the four screws that secure the exhaust cover (12) to the lower body.
4. Remove the secondary inlet and exhaust valve assembly (13) from the lower body.
5. Remove the four hex head cap screws securing the lower body to the upper body and separate the body halves.
6. Remove the rubber seal ring (14) from the lower body.
7. **For E-8P only:** While applying thumb pressure to the primary piston (22), lift out and up on the three lock tabs of the primary piston retainer (15).
8. **For E-10P only:** While depressing spring seat (7), remove retaining ring (8). Remove spring seat (7) and coil spring (5).

**Caution:** Before proceeding with the disassembly, refer to Figures 3 and 4 and note that the lock nut (16) and stem (17) are used to contain the primary piston return spring (**for E-8P:** 23, **for E-10P:** 6), stem spring (19), and the relay piston spring (21). The combined force of these springs is approximately 50 pounds and care must be taken when removing the lock nut as the spring forces will be released. It is recommended that the primary piston and relay piston be manually or mechanically contained while the nut and stem are being removed.

9. Using a 3/8" wrench, hold the lock nut (16) on the threaded end of the stem (17). Insert a screwdriver to restrain the stem, remove the lock nut (16), spring seat, (18) and stem spring (19).
10. **For E-10P only:** Remove adapter (1) and o-ring (4). Remove the primary piston (2) from adapter (1) and o-ring (34) from the primary piston (2).

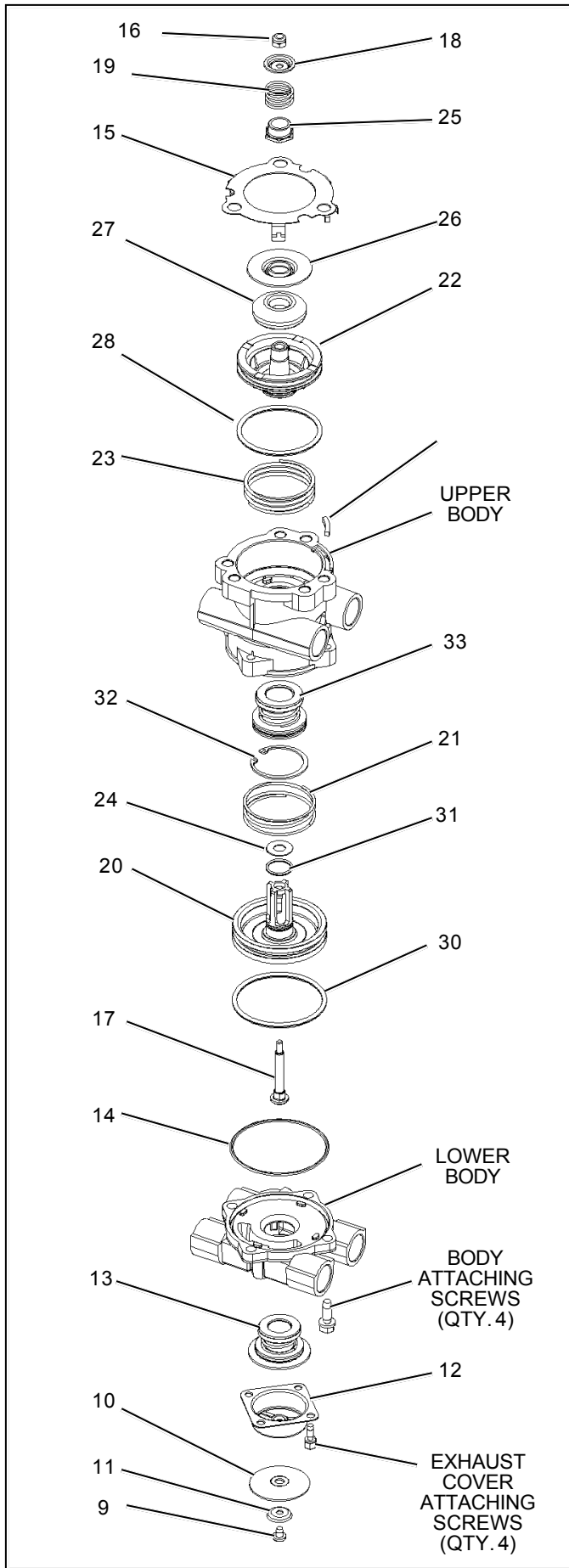


FIGURE 5 - E-8P BRAKE VALVE - EXPLODED VIEW

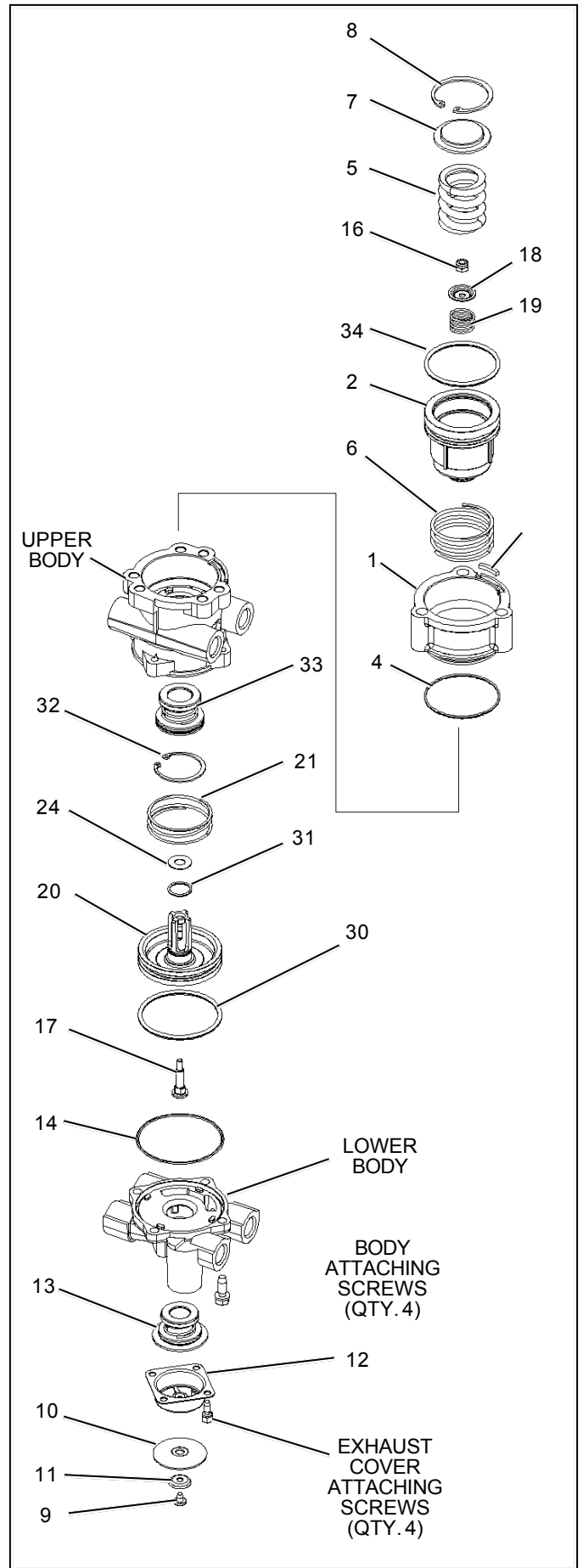


FIGURE 6 - E-10P BRAKE VALVE - EXPLODED VIEW

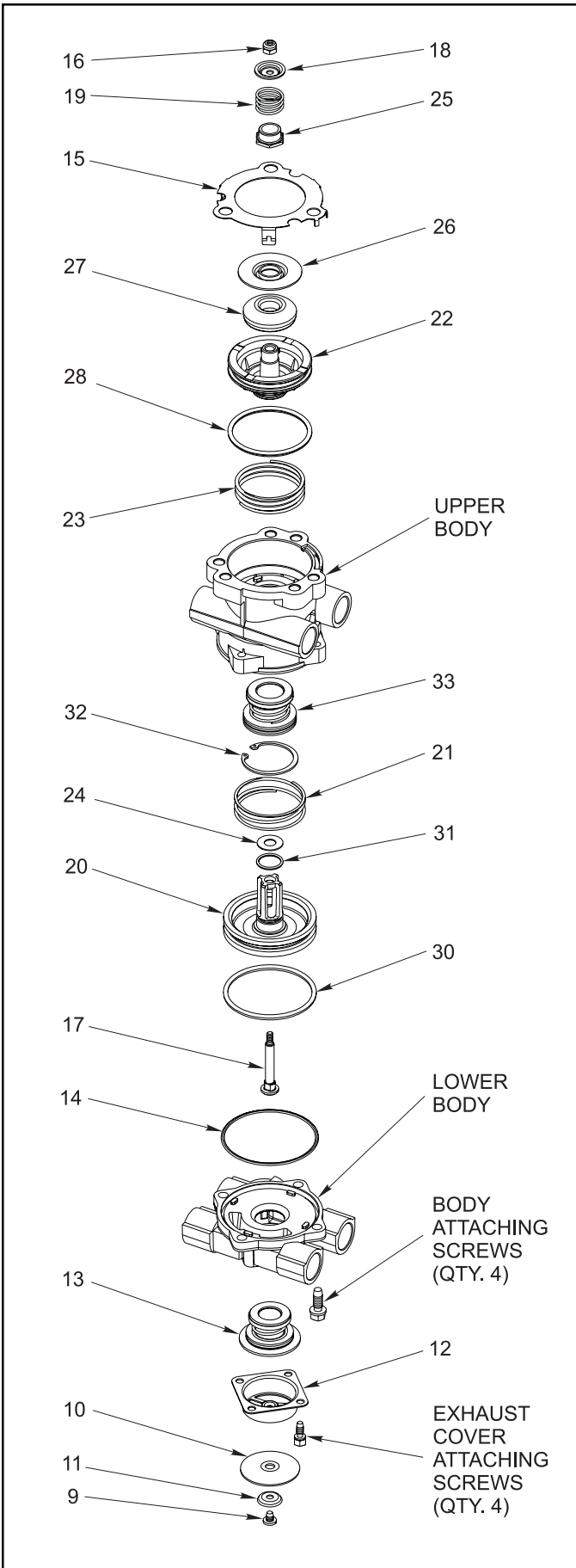


FIGURE 5 E-8P BRAKE VALVE EXPLODED VIEW

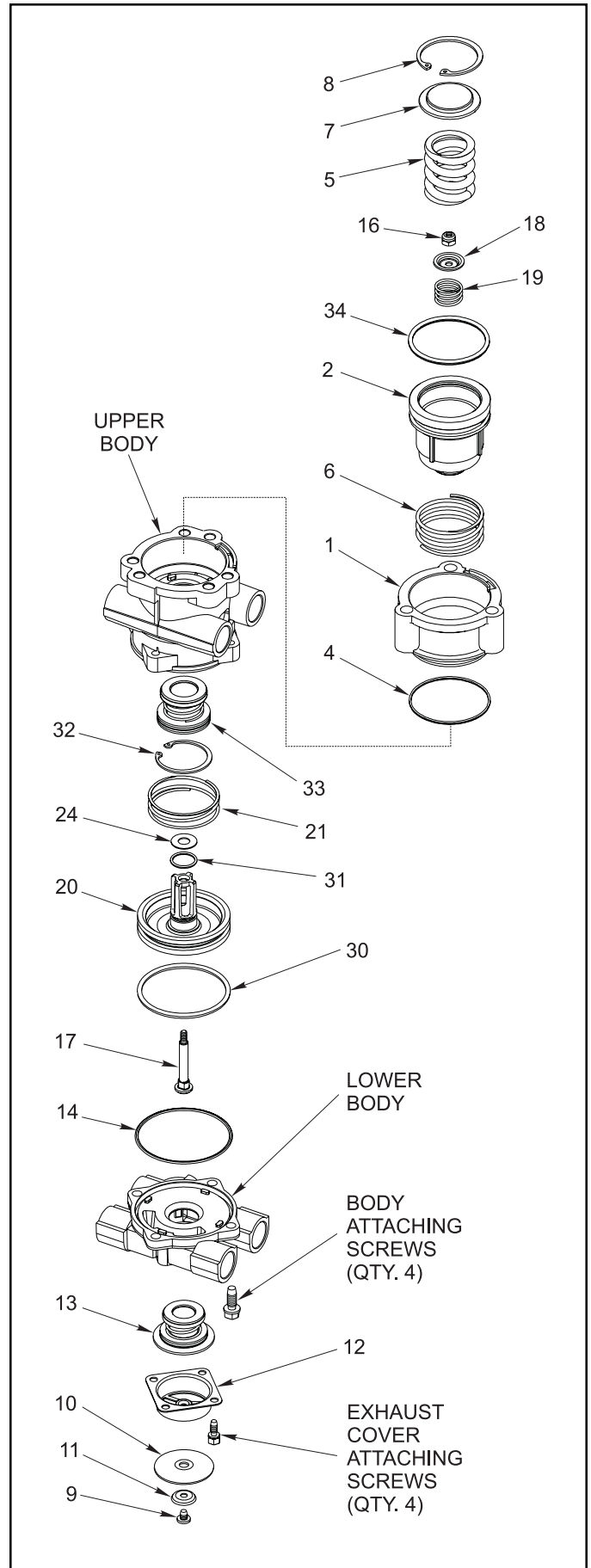


FIGURE 6 E-10P BRAKE VALVE EXPLODED VIEW

11. Remove the relay piston (20), relay piston spring (21), primary piston (**E-8P**: 22, **E-10P**: 2) and primary piston return spring (**E-8P**: 23, **E-10P**: 6) from the upper body. Use care so as not to nick seats.
12. A small washer (24) will be found in the cavity of the lower side of the primary piston (**for E-8P**: 22, **for E-10P**: 2).
13. **For E-8P only**: Disassemble the primary piston by rotating the spring seat nut (25) counterclockwise. Separate the spring seat nut, spring seat (26), and rubber spring (27) and remove the piston o-ring (28).
14. Remove the large and small o-rings (30 & 31) from the relay piston (20).
15. Remove the retaining ring (32) securing the primary inlet and exhaust valve assembly (33) in the upper body and remove the valve assembly.
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).

## 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.
12. Compress piston(s) (**For E-8P**: the relay piston (20), **for E-10P**: the primary and relay pistons (2 & 20)) and retaining ring into the upper body from either side and hold compressed, either manually or mechanically. **See the cautionary note under step 8 in the Disassembly section of this manual.**
13. Place the stem spring (19) (**E-8P**: place over the spring seat nut (25)), the spring seat (18) (concave side up) and lock nut (16) on the stem (17). Torque to 20 - 30 inch pounds.
14. **For E-8P only**: Install the primary piston retainer (15) over the piston, making certain all three lock tabs have engaged the outer lip of the body.
15. **For E-10P only**: Install coil spring (5), spring seat (7), and retaining ring (8) .
16. Replace the rubber seal ring (14) on the lower body.
17. Install the 4 hex head cap screws securing the lower body to the upper body. Torque to 30 - 60 inch pounds.
18. Install the secondary inlet and exhaust valve assembly (13) on the lower body.
19. Install the screws that secure the exhaust cover (12) to the lower body. Torque to 20 - 40 inch pounds.
20. Secure the screw (9) holding the exhaust diaphragm (10) and the diaphragm washer (11) to the exhaust cover (12). Torque to 5 - 10 inch pounds.
21. Install all air line fittings and plugs making certain thread sealant material does not enter valve.

## VALVE INSTALLATION

1. Install the assembled brake valve on the vehicle.



2. Reconnect all air lines to the valve using the identification made during VALVE REMOVAL step 1.
3. After installing the brake valve assembly, perform the "OPERATION AND LEAKAGE CHECKS" before placing the vehicle in service.

### **IMPORTANT: MAINTENANCE PRECAUTIONS**

When working on or around a vehicle, the following general precautions should be observed:

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels.
2. Stop the engine when working around the vehicle.
3. Drain the air pressure from all reservoirs before beginning ANY work on the vehicle.
4. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that removes all electrical power from the vehicle.
5. When working in the engine compartment the engine should be shut off. Where circumstances require that the engine be in operation, **EXTREME CAUTION** should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.
6. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
7. Never exceed recommended pressures and always wear safety glasses.
8. Do not attempt to install, remove, disassemble, or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
9. Use only genuine Bendix replacement parts, components, and kits. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.
10. Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted unless specifically approved and stated by the vehicle or component manufacturer.
11. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.







## SR-7 SPRING BRAKE MODULATING VALVE

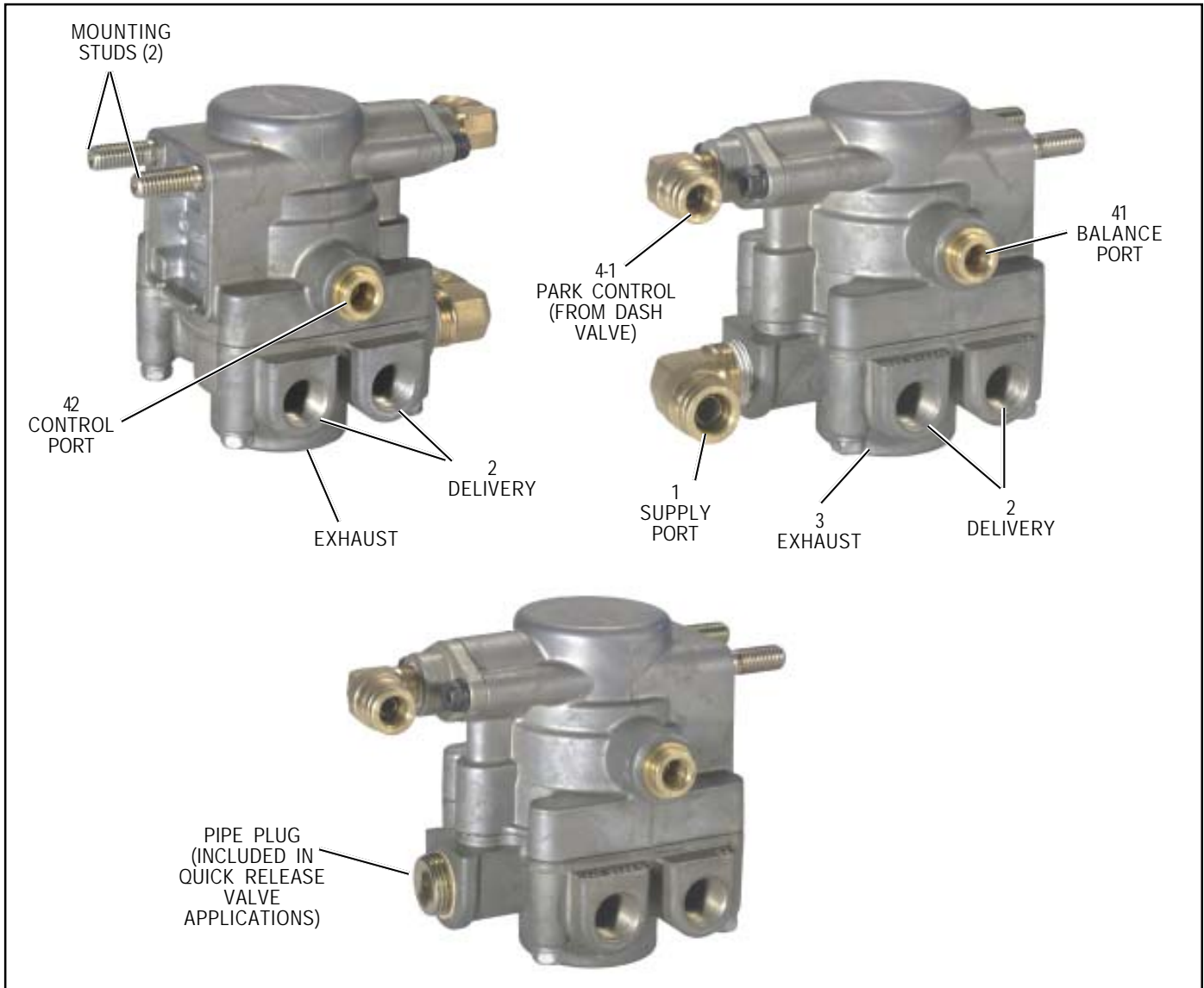


FIGURE 1 - EXTERIOR VIEW

### DESCRIPTION

The SR-7 Spring Brake Modulating Valve is used in conjunction with a dual air brake system and spring brake actuator and performs the following functions:

1. Provides a rapid application of the spring brake actuator when parking.
2. Modulates the spring brake actuator application using the dual brake valve should a primary failure occur in the service brake system.
3. Prevents compounding of service and spring forces.

The valve has one park control, one service control, one supply, one balance, four delivery NPTF ports, and an exhaust port protected by an exhaust diaphragm. The valve incorporates two mounting studs for mounting the valve to the frame rail or cross member (where applicable).

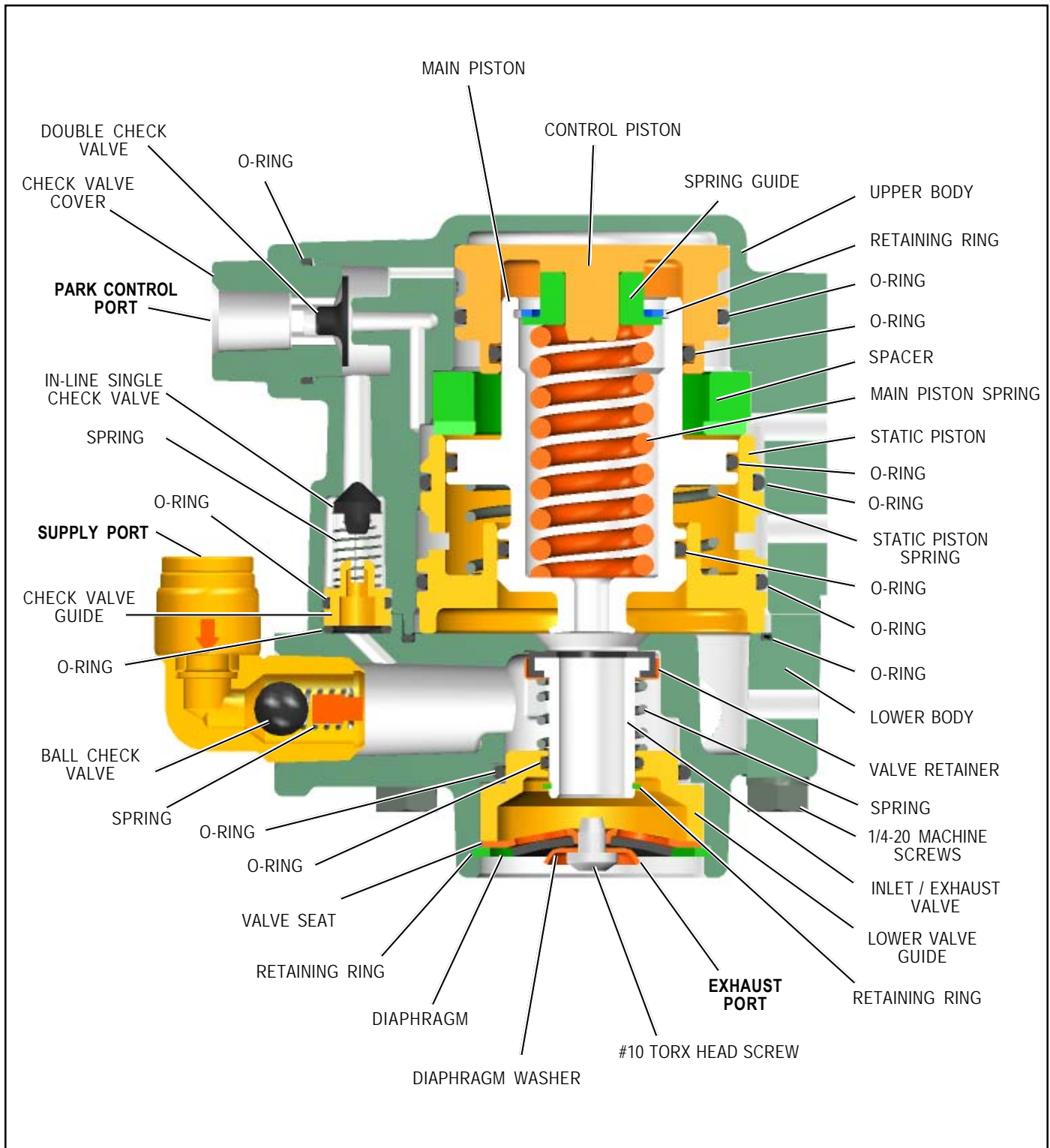


FIGURE 2 - SECTIONAL VIEW OF SR-7 USED IN RELAY VALVE APPLICATIONS

## OPERATION

The operation guidelines shown in this manual represent the relay valve based SR-7 (refer to system schematic shown in figure 3). A quick release based valve functions similarly to the relay valve based version with the exception that all

air delivered to spring brakes passes through the park control port through the in-line single check valve. The quick release style SR-7 can be easily identified by the pipe plug in the supply port of the valve.

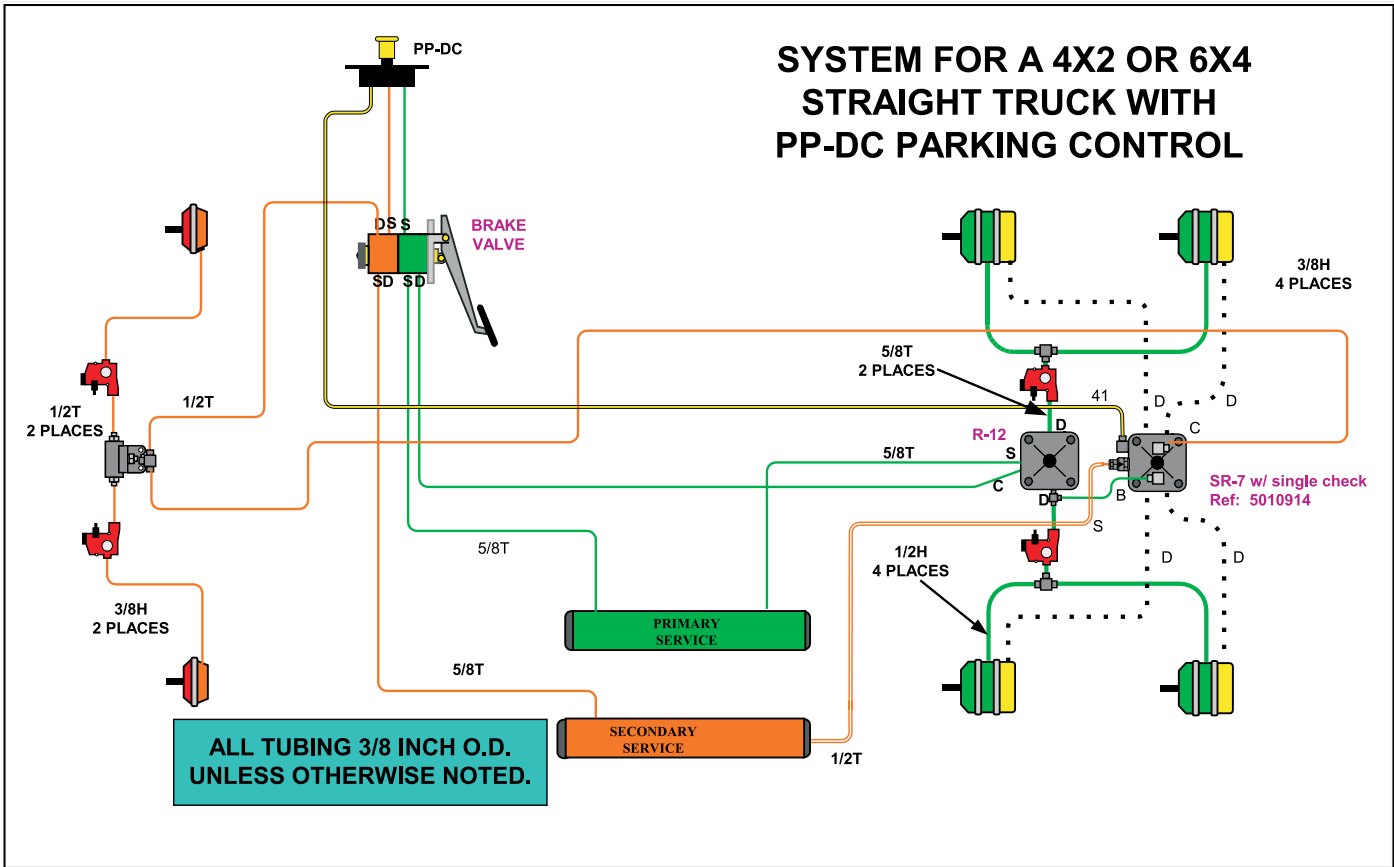


FIGURE 3 - SYSTEM SCHEMATIC WITH PP-DC PARK CONTROL

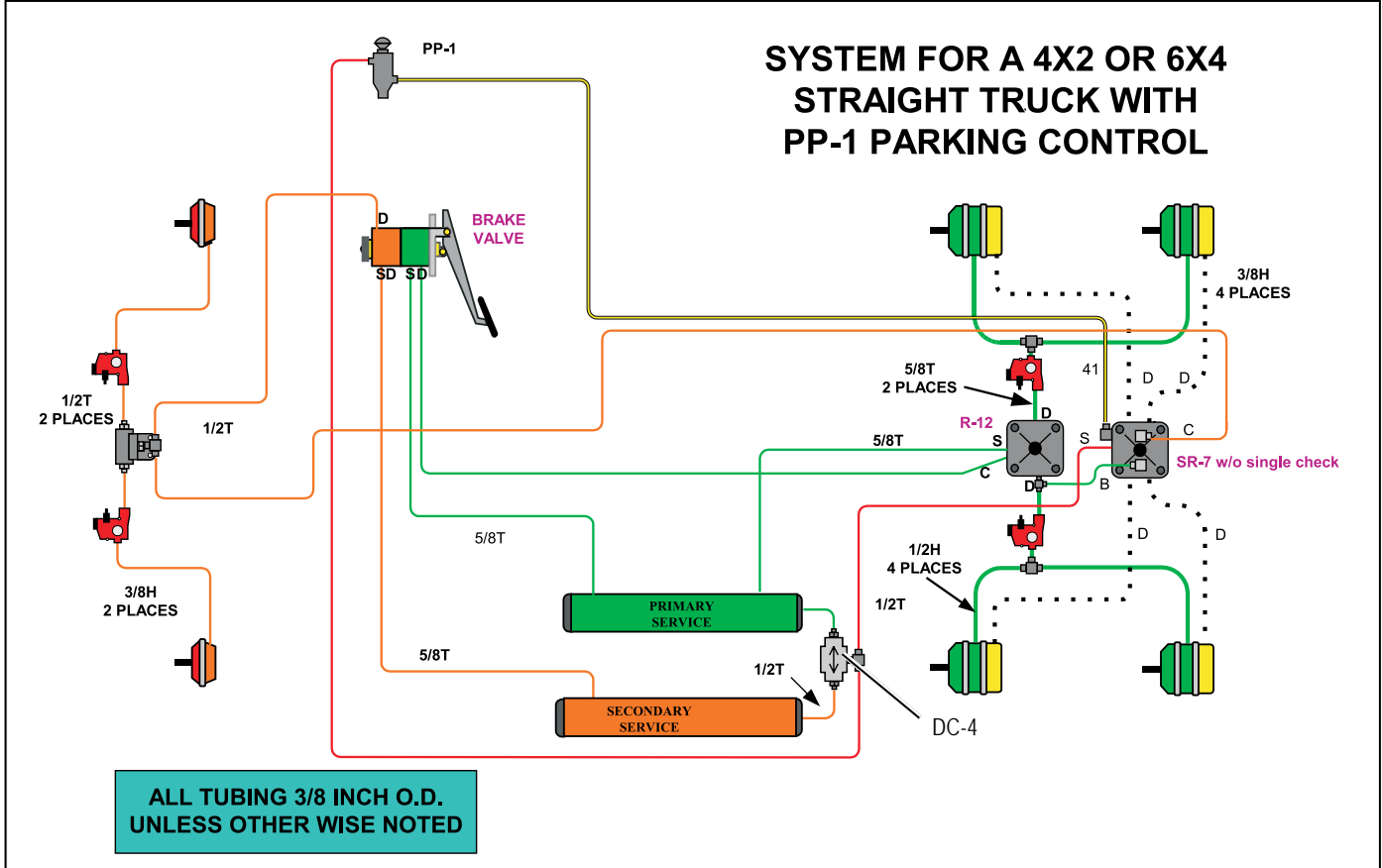


FIGURE 4 - SYSTEM SCHEMATIC WITH PP-1 PARK CONTROL AND DC-4 DOUBLE CHECK VALVE

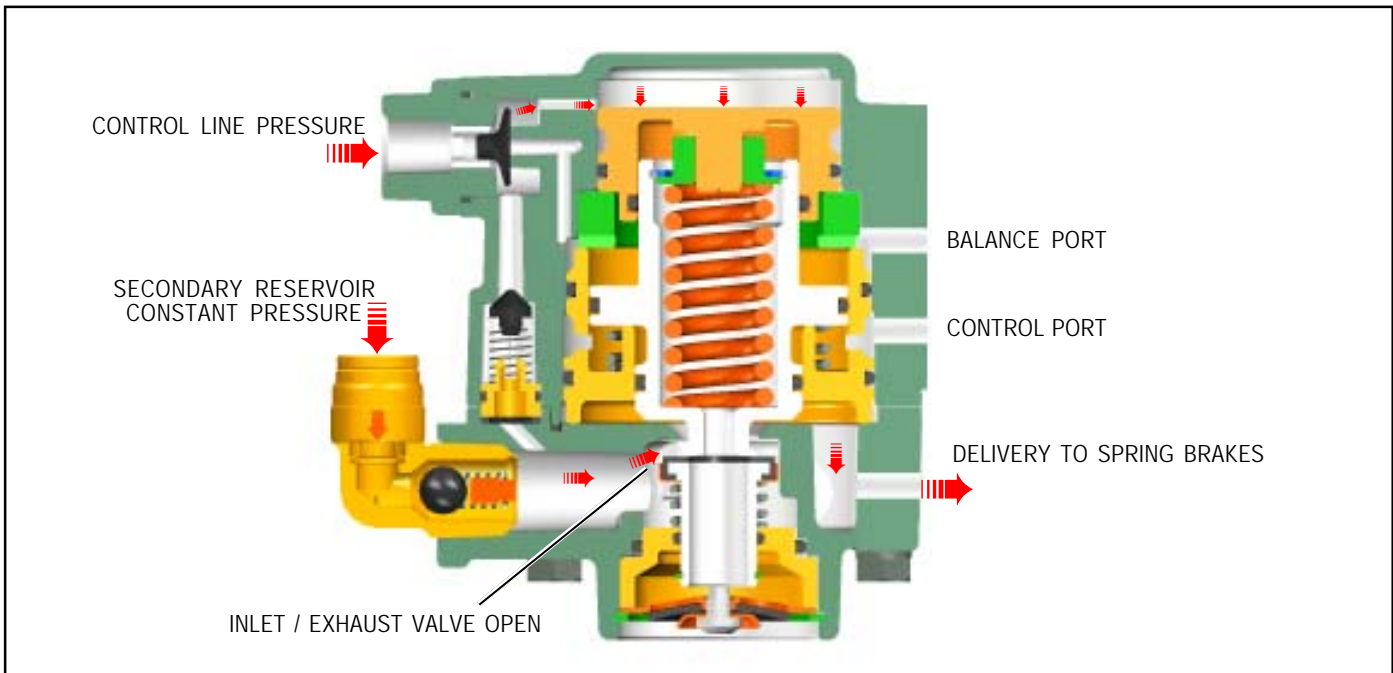


FIGURE 5 - CHARGING LESS THAN 107 PSI

**CHARGING SPRING BRAKE ACTUATORS BELOW 107 PSI (FIGURE 5)**

With the air brake system charged and the parking brakes released (by pushing the dash valve button in), air enters the park control port. This opens the SR-7 to supply air pressure to the spring brake chambers. As illustrated, air pressure in the chambers is below 107 psi (nominally).

**CHARGING SPRING BRAKE ACTUATORS ABOVE 107 PSI (FIGURE 6)**

Once the SR-7 valve delivery pressure reaches 107 psi (nominal), the inlet and exhaust are closed (valve lap position). This maintains the spring brake hold-off pressure at 107 psi (nominal).

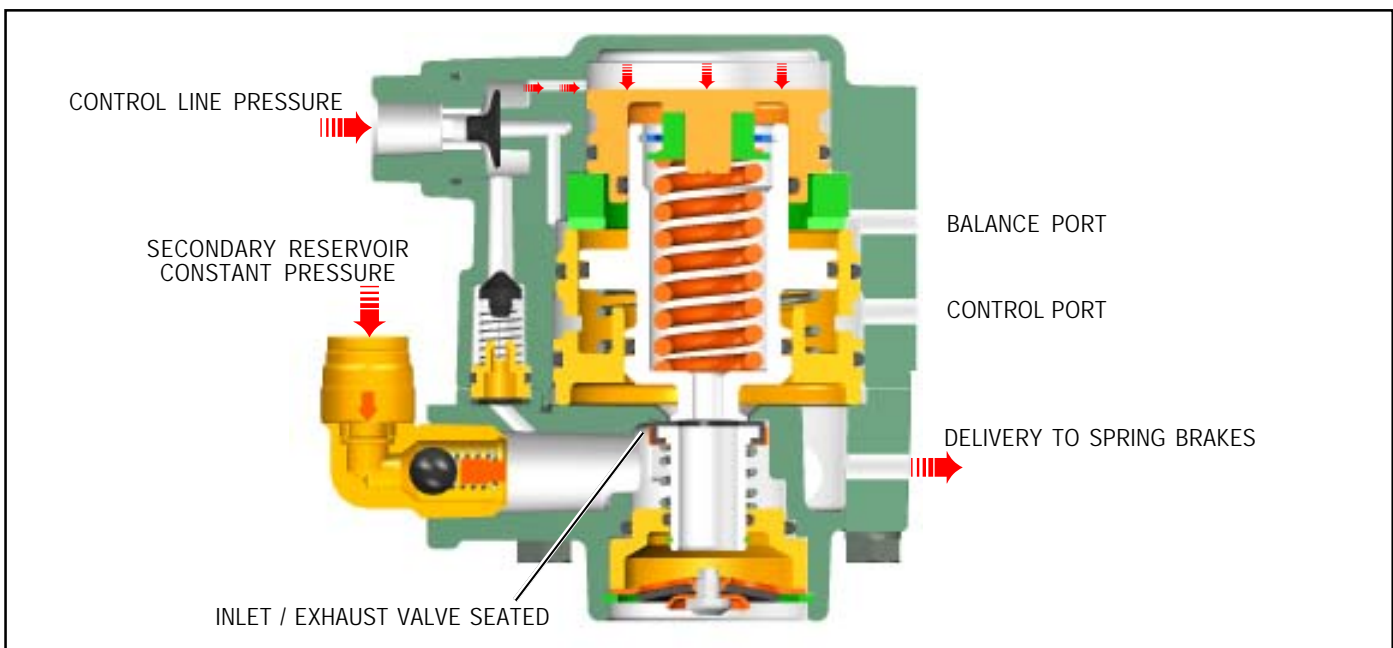


FIGURE 6 - CHARGING GREATER THAN 107 PSI

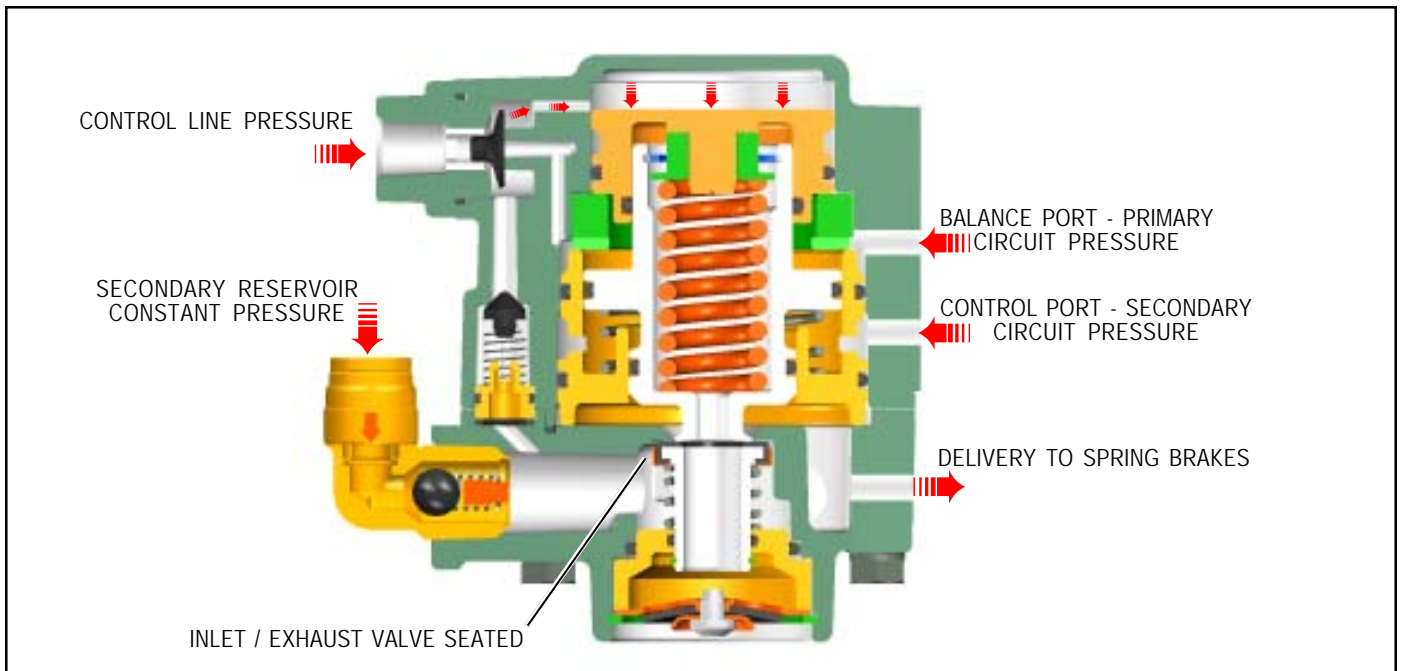


FIGURE 7 - NORMAL SERVICE APPLICATION

**NORMAL SERVICE APPLICATION (FIGURE 7)**

During a service brake application, the valve remains in the lap position. The SR-7 valve monitors the presence of air pressure in both primary and secondary delivery circuits.

**PARKING (FIGURE 8)**

Actuating the park brakes (by pulling the dash valve button out) exhausts spring brake air pressure through the SR-7 exhaust port.

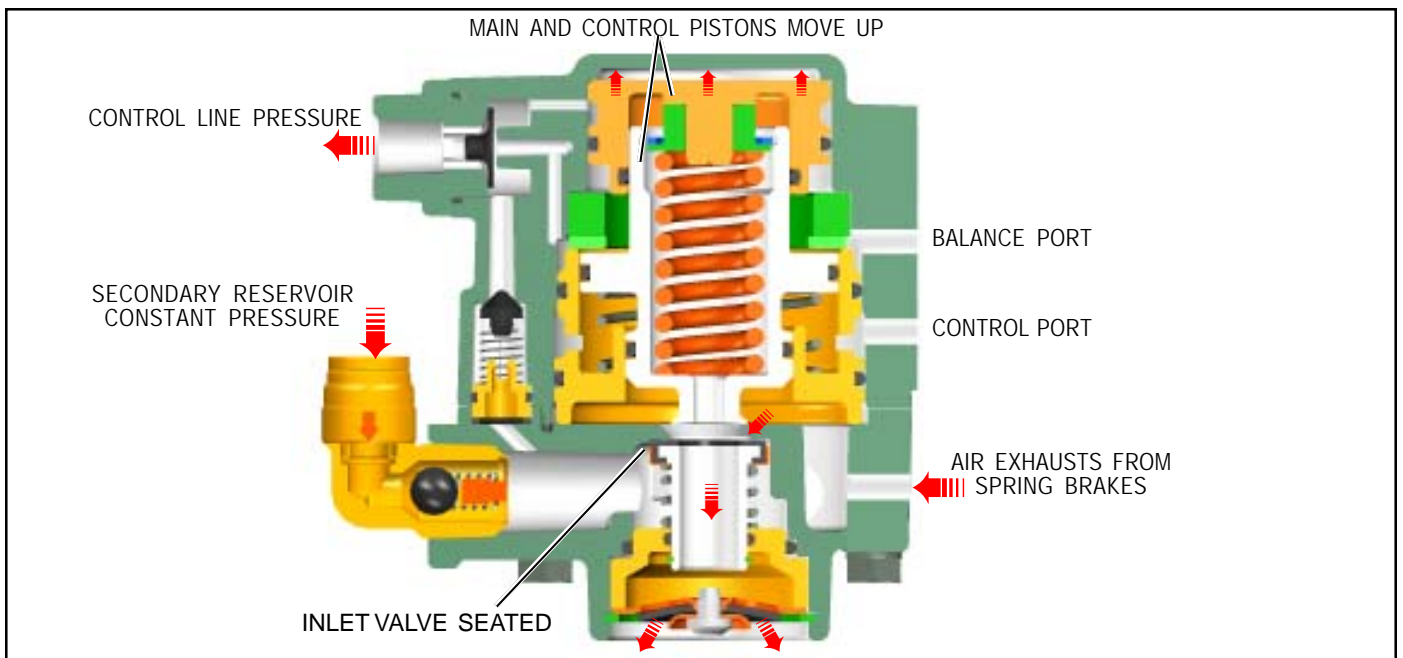


FIGURE 8 - PARKING



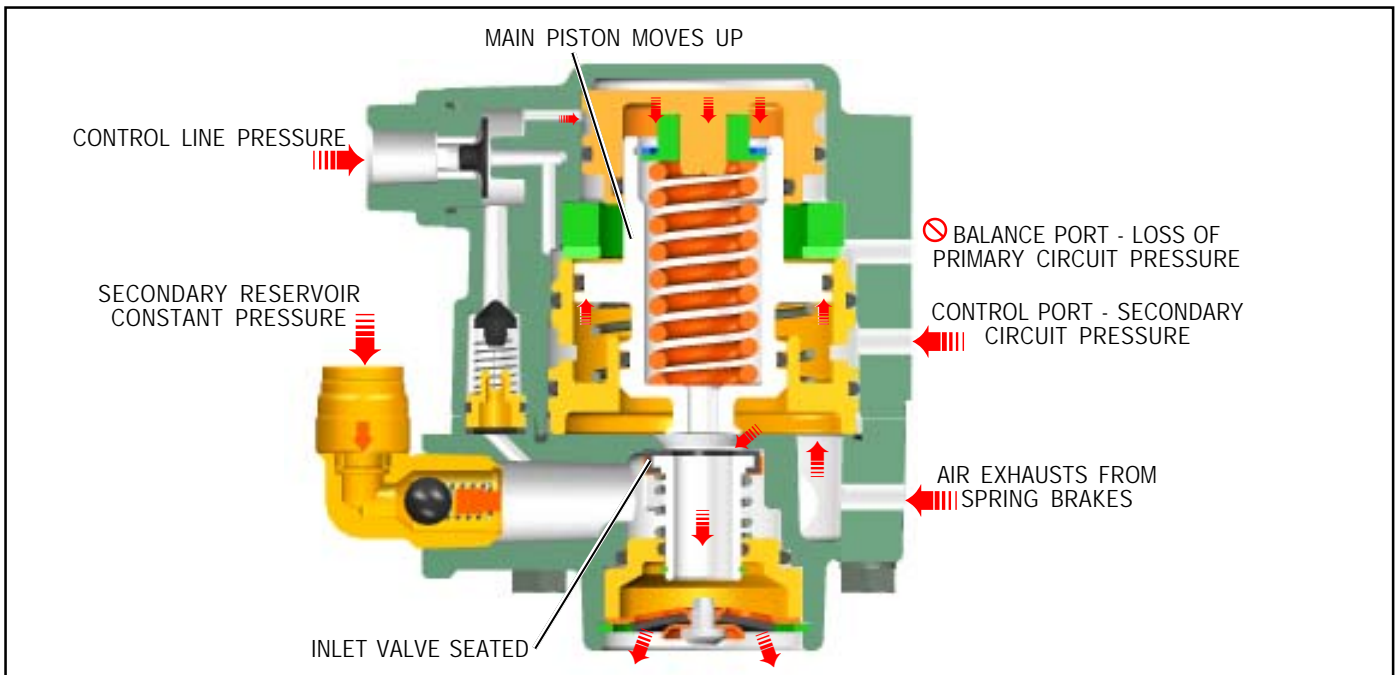


FIGURE 9 - SERVICE APPLICATION LOSS OF PRIMARY CIRCUIT

**SERVICE APPLICATION WITH LOSS OF AIR IN PRIMARY CIRCUIT (FIGURE 9)**

With the parking brakes released (dash valve button in) and the absence of air in the primary circuit delivery, a service brake application from the secondary circuit causes the pressure in the spring brakes to be exhausted proportionally to this application. This is known as spring brake modulation. A 30 psi service brake application will exhaust the spring brake pressure to approximately 60 psi.

**SERVICE APPLICATION WITH LOSS OF AIR IN SECONDARY CIRCUIT (FIGURE 10)**

With the parking brakes released (dash valve button in) and the absence of air in the secondary circuit reservoir, the external single check valve in the supply port seals to prevent air leakage to atmosphere from the SR-7 valve. The dash valve delivery air flows through the in-line single check valve and becomes SR-7 supply air. This air is delivered to maintain at least 107 psi (nominal) in the spring brake chambers.

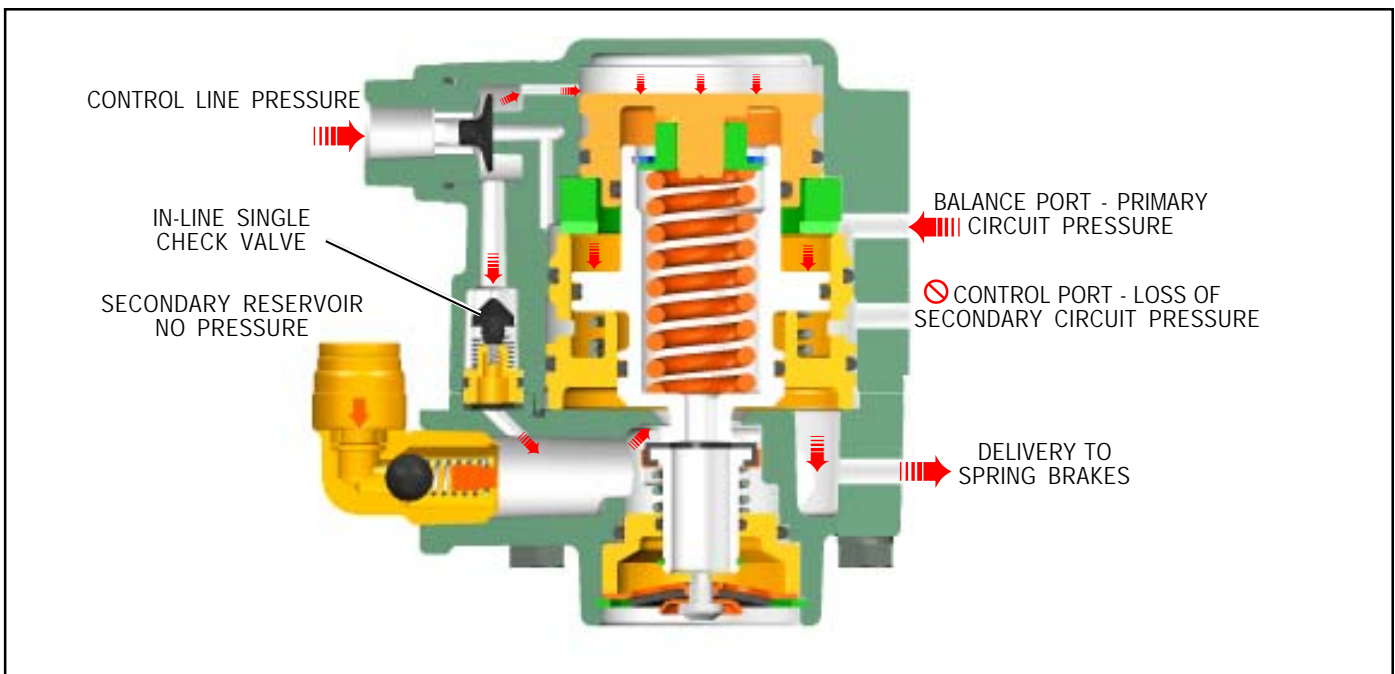


FIGURE 10 - SERVICE APPLICATION LOSS OF SECONDARY CIRCUIT

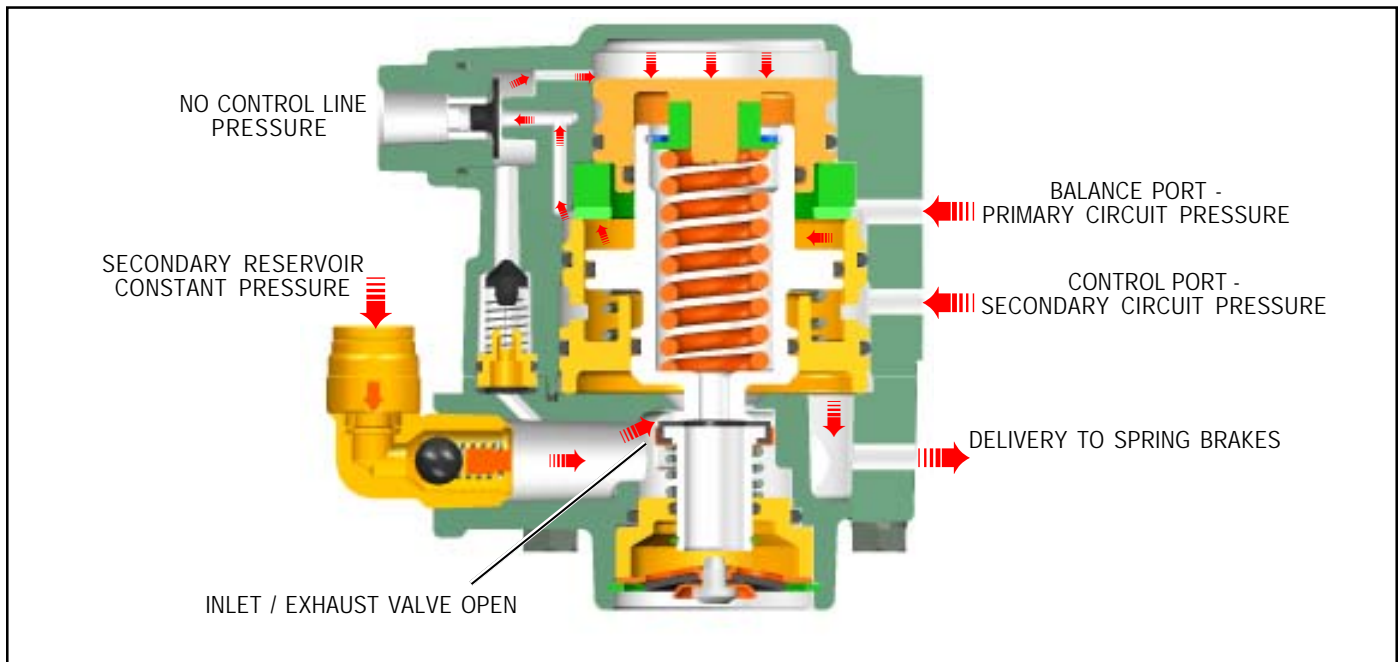


FIGURE 11 - ANTI-COMPOUNDING

## ANTI-COMPOUNDING (FIGURE 11)

The SR-7 provides anti-compounding of the service and spring brake forces. When the park brakes are actuated (by pulling the dash valve button out), a service brake application will cause the SR-7 to deliver air pressure to the spring brake chambers. Thus the vehicle is held stationary using a service brake application. When the service brake application is released, the delivery pressure is exhausted from the spring brake chambers and the vehicle remains parked using the spring brake actuators.

## PREVENTIVE MAINTENANCE

**Important:** Review the warranty policy before performing any intrusive maintenance procedures. An extended warranty may be voided if intrusive maintenance is performed during this period.

Because no two vehicles operate under identical conditions, maintenance intervals will vary. Experience is a valuable guide in determining the best maintenance interval for a vehicle.

## OPERATING TEST

Block vehicle and hold by means other than vehicle brakes. Charge air brake system to governor cut-out pressure.

1. Place parking control valve in "park" position. Observe that spring brake actuators apply promptly. Remove one line from delivery port of the SR-7 valve and install test gauge known to be accurate. Place parking control valve in "release" position. Observe that spring brake actuators release fully.

2. With parking control valve in "release" position, note gauge pressure reading. (Correct spring brake actuator hold-off pressure is 107 psi nominally.)
3. Place parking control valve in "park" position - gauge reading should drop to zero promptly. A lag (more than 3 seconds) in drop of pressure would indicate faulty operation.
4. With the parking control valve in the "park" position, gradually apply foot brake valve and note a pressure reading increase on the gauge installed in the SR-7 delivery port.
5. Place parking control valve in "release" position.
6. Drain the reservoir, which supplies the rear service brake circuit, apply the foot brake valve several times and note that pressure reading on gauge decreases each time foot brake valve is applied (spring brake modulation). After the foot brake valve has been applied several times, pressure on gauge will drop to the point where release of the spring brake actuators will no longer occur.

## LEAKAGE TEST

Place the park control valve in the "release" position; using a soap solution, coat all ports including the exhaust port. A 1 inch bubble in three seconds is permitted.

If the valve does not function as described, or if leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit available from a Bendix parts outlet. **DO NOT ATTEMPT TO DISASSEMBLE THE SR-7. THE VALVE CONTAINS HIGH SPRING FORCES THAT COULD RESULT IN PERSONAL INJURY IF DISASSEMBLY IS ATTEMPTED!**

## SERVICING THE SR-7

**IMPORTANT! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH.**

When working on or around a vehicle, the following general precautions should be observed at all times:

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels.
2. Stop the engine when working around the vehicle.
3. If the vehicle is equipped with air brakes, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle.
4. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that removes all electrical power from the vehicle.
5. When working in the engine compartment the engine should be shut off. Where circumstances require that the engine be in operation, **EXTREME CAUTION** should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.
6. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
7. Never exceed recommended pressures and always wear safety glasses.
8. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
9. Use only genuine Bendix replacement parts, components, and kits. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.

10. Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted unless specifically approved and stated by the vehicle or component manufacturer.

11. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.

### VALVE REMOVAL

1. Prior to removing the SR-7 apply the parking brakes and drain all the vehicle reservoirs.
2. Identify all air lines before disconnecting.
3. Remove the two mounting nuts that secure the valve to the frame rail and remove the valve.

### VALVE INSTALLATION

1. Align the mounting studs with the mounting holes on the vehicle frame rail. Tighten the mounting nuts to 180-220 in. lbs.
2. Install the valve onto the vehicle ensuring all ports are connected as marked during disassembly.

### TESTING THE REPLACEMENT SR-7 SPRING BRAKE MODULATING VALVE

Perform operating and leakage tests as outlined in "Operating Tests" section.





# Service Data

SD-13-4869

## Bendix® EC-60™ ABS / ATC Controllers (Advanced Models)

See SD-13-4863 for Standard and Premium Controllers



FIGURE 1 - EC-60™ ADVANCED CONTROLLER

### INTRODUCTION

The Bendix® EC-60™ advanced controller is a member of a family of electronic **Antilock Braking System (ABS)** devices designed to help improve the braking characteristics of air braked vehicles - including heavy and medium duty buses, trucks, and tractors. ABS controllers are also known as **Electronic Control Units (ECUs)**.

Bendix® ABS uses wheel speed sensors, ABS pressure modulator valves, and an ECU to control either four or six wheels of a vehicle. The EC-60™ controller monitors individual wheel turning motion during braking and adjusts or modulates the brake pressure at the wheel end. When excessive wheel slip, or wheel lock-up is detected, the EC-60™ controller will activate the pressure modulator valves to automatically reduce the brake pressure at one or more of the wheel ends. By these actions, the ABS system helps to maintain the vehicle's lateral stability and steerability during heavy brake applications and during braking on slippery surfaces.

In addition to the ABS function, advanced models of the EC-60™ controller provide an **Automatic Traction Control (ATC)** feature. Bendix ATC can improve vehicle traction during acceleration, and lateral stability while accelerating through curves. ATC utilizes **Engine Torque Limiting (ETL)** where the ECU communicates with the engine's controller and/or **Differential Braking (DB)** where individual wheel brake applications are used to improve vehicle traction.

Advanced EC-60™ controllers have a drag torque control feature which reduces driven-axle wheel slip (due to driveline inertia) by communicating with the engine's controller and increasing the engine torque.

The EC-60™ advanced model provides ABS-based stability features referred to as **ESP® Electronic Stability Program**. ESP® is a registered trademark of DaimlerChrysler and is used by BCVS under license from DaimlerChrysler.

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The Bendix ESP system is an ABS-based stability system that enhances vehicle stability by both reducing engine throttle and by applying vehicle braking based on actual vehicle dynamics. Accordingly, the ESP system is available only on specific approved vehicle platforms after vehicle application and development efforts and validation testing. Only certain limited variations of an approved vehicle platform are permitted without further validation of the ESP system application.

ESP stability system consists of Yaw Control (YC) and Roll Stability Program (RSP) features.

### CAUTION

Even with ESP-equipped vehicles, the driver remains responsible for ensuring vehicle stability during operation.

The ESP system only functions within the limits of physics.

ESP functionality mitigates potential vehicle stability incidents, but cannot prevent them in all cases. Other factors such as driving too fast for road, traffic or weather conditions, oversteering, an excessively high vehicle Center of Gravity (CG), or poor road conditions can cause vehicle instability that is beyond the capability of any stability system to mitigate. In addition, the effectiveness of ESP can be greatly reduced on vehicles towing multiple trailer combinations.

## CAUTION

The ESP stability system may only be used on vehicles tested and approved by Bendix engineering. ESP installations require on-vehicle testing and EC-60 parameter tuning. See "Advanced ABS with Stability Control" on page 9 for further details.

Accordingly, the EC-60 controller is provided with a corresponding parameter data set that is validated for a specific vehicle platform. Therefore, specific steps are necessary should a replacement ECU be required. See "Obtaining a New EC-60™ Controller" on page 13 for further details.

ESP-equipped vehicles should not be driven on high-banked roads – such as those found on high-speed test or race tracks. Test personnel must have ESP functionality disabled prior to operating an ESP vehicle on such tracks.

## YAW CONTROL (YC)

Advanced ECU can include Yaw Control (YC) functionality, which has the ability to apply brakes to individual wheel ends, as well as applying the trailer brakes to counteract trailer "push" that, during certain maneuvers, could lead to a loss of control or a jackknife incident. See "Yaw Stability" on page 9 for further details.

## ROLL STABILITY PROGRAM (RSP)

The Bendix Roll Stability Program (RSP), is an all-axle ABS solution that helps reduce vehicle speed by reducing the engine's throttle and applying all vehicle brakes as needed, reducing the vehicle's tendency to roll over. RSP focuses on reducing the vehicle's speed below the critical roll threshold during direction-changing maneuvers such as driving on curved highway exit ramps or obstacle avoidance maneuvers on dry, high friction surfaces. See "Advanced ABS with Stability Control" on page 9 for further details.

## WARNING

During an RSP system intervention, the vehicle **automatically decelerates**. RSP can slow the vehicle with or **without the operator applying the brake pedal**, and **even when the operator is applying the throttle**.

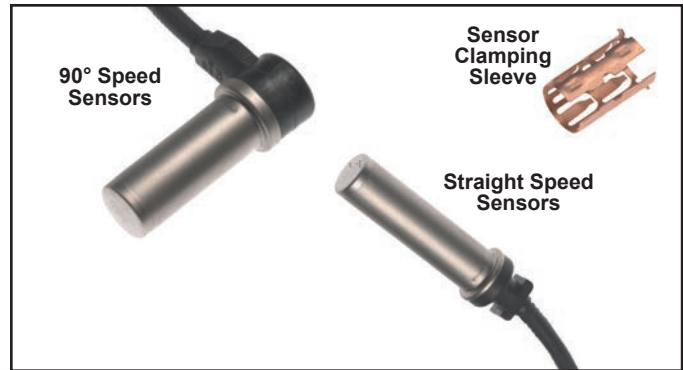


FIGURE 2 - BENDIX® WS-24™ WHEEL SPEED SENSORS

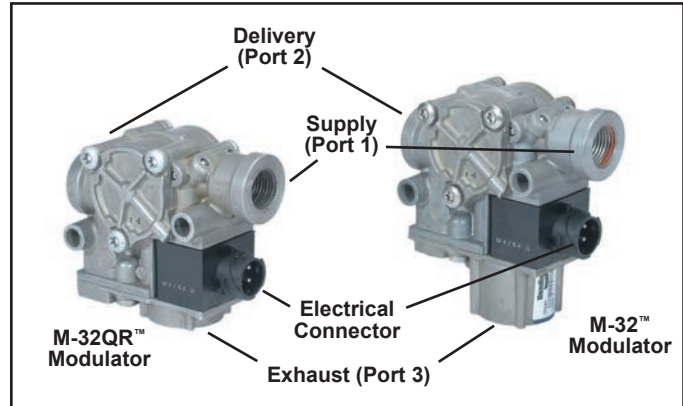


FIGURE 3 - M-32™ AND M-32QR™ MODULATORS

## COMPONENTS

The EC-60™ controller's ABS function utilizes the following components:

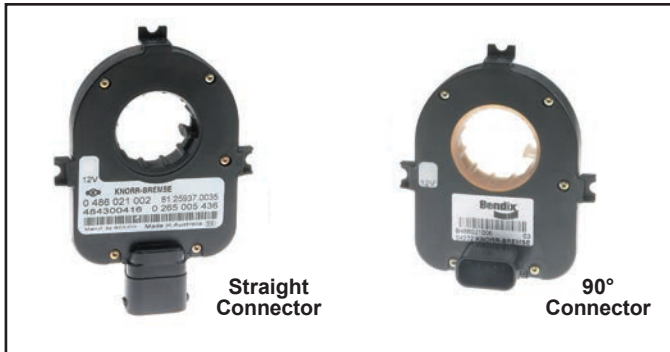
- Bendix® WS-24™ wheel speed sensors (4 or 6, depending on configuration). Each sensor is installed with a Bendix Sensor Clamping Sleeve
- Bendix® M-32™ or M-32QR™ Pressure Modulator Valves (4, 5, or 6 depending on configuration)
- Dash-mounted tractor ABS Indicator Lamp
- Service brake relay valve
- Dash-mounted trailer ABS Indicator Lamp
- Optional blink code activation switch
- Optional ABS off-road switch

The EC-60™ controller ATC function utilizes the following additional components:

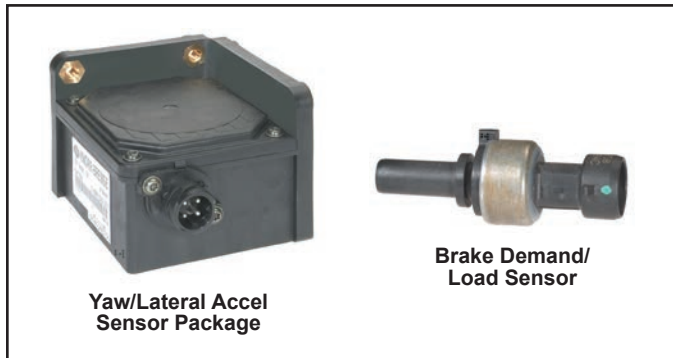
- Drive axle traction control valve (may be integral to the service brake relay valve or a stand-alone device)
- Dash-mounted ATC status/indicator lamp
- J1939 serial communication to engine control module
- Stop lamp switch input (may be provided using the ECU hardware input or J1939)
- Optional ATC mud/snow switch (sometimes referred to as an ATC off-road switch)

Input Voltage	Sensors	PMVs	ATC	ESP/RSP	Blink Codes	Serial Communication		PLC	ABS Off-Road	ATC Mud/Snow	Retarder Relay
						J1587	J1939				
12 VDC	4/6	4/5/6	✓	✓	✓	✓	✓	✓	✓	✓	✓

**CHART 1 - EC-60™ ADVANCED CONTROLLER FEATURES**



**FIGURE 4 - STEERING ANGLE SENSORS**



**FIGURE 5 - YAW AND BRAKE DEMAND/LOAD SENSORS**

The EC-60™ controller ESP/RSP function utilizes the following additional components:

- Steer Axle Traction Control Valve (may be integral to the service brake relay valve or a stand-alone device)
- Dash-mounted ESP status/indicator lamp (also serves as the ATC status/indicator lamp)
- Bendix SAS-60™ Steering Angle Sensor (mounted to the steering column)
- Bendix YAS-60™ Yaw Rate/Lateral Acceleration Sensor (typically mounted to a cross-member near the back of the vehicle cab)
- Brake Demand Sensors (installed in the primary and secondary delivery circuits)
- Load Sensor (typically installed in the suspension air bag)
- An additional Modulator Valve (Bendix® M-32™ or M-32QR™ Pressure Modulator Valve) that controls pressure apply to trailer brakes during system intervention

### ECU MOUNTING

The Bendix® EC-60™ advanced cab-mounted controller is not protected against moisture, and must be mounted in an environmentally protected area.

All wire harness connectors must be properly seated. The use of secondary locks is strongly recommended.

Cab ECUs utilize connectors from the AMP MCP 2.8 product family.

### HARDWARE CONFIGURATION

Advanced model EC-60™ controllers support applications up to six sensor/six modulator (6S/6M) installations with ATC and drag torque control. Available in 12 volt models, all advanced model EC-60™ controllers support PLC (See Chart 1).

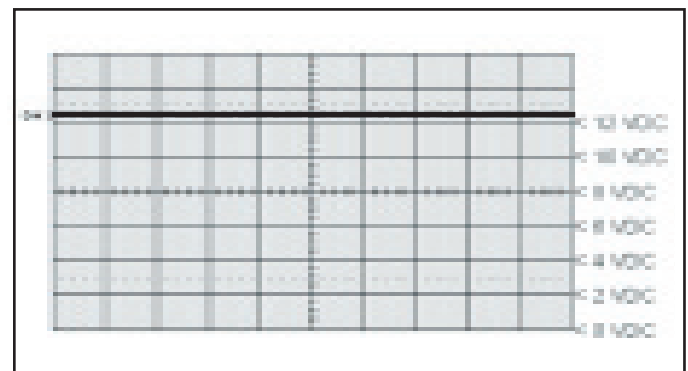
### ADVANCED EC-60™ CONTROLLERS USE POWER LINE CARRIER (PLC)

All new towing vehicles built since March 1, 2001 have had an in-cab trailer ABS Indicator Lamp installed.

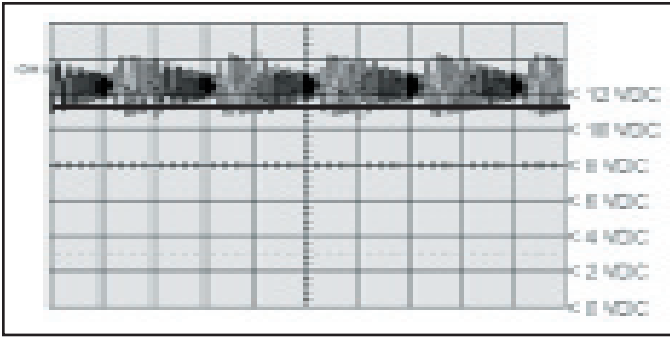
Trailers built since March 1, 2001 transmit the status of the trailer ABS over the power line (the blue wire of the J560 connector) to the tractor using a Power Line Carrier (PLC) signal. See Figures 6 and 7. Typically the signal is broadcast by the trailer ABS ECU.

The application of PLC technology for the heavy vehicle industry in North America is known as “PLC4Trucks.”

The Advanced EC-60™ controller supports PLC communications in accordance with SAE J2497.



**FIGURE 6 - POWER LINE WITHOUT PLC SIGNAL**



**FIGURE 7 - POWER LINE WITH PLC SIGNAL**

### PLC SIGNAL

An oscilloscope can be used to measure or identify the presence of a PLC signal on the power line. The PLC signal is an amplitude and frequency modulated signal. Depending on the filtering and load on the power line, the PLC signal amplitude can range from 5.0mVp-p to 7.0 Vp-p. Suggested oscilloscope settings are AC coupling, 1 volt/div, 100  $\mu$ sec/div. The signal should be measured at the ignition power input of the EC-60™ controller.

Note: An ABS trailer equipped with PLC, or a PLC diagnostic tool, must be connected to the vehicle in order to generate a PLC signal on the power line.

## EC-60™ CONTROLLER INPUTS

### Battery and Ignition Inputs

The ECU operates at a nominal supply voltage of 12 volts. The battery input is connected through a 30 amp fuse directly to the battery.

The ignition input is applied by the ignition switch circuit through a 5 amp fuse.

### Ground Input

The EC-60™ controller supports one ground input. See page 42 for a system schematic.

### ABS Indicator Lamp Ground Input

Advanced EC-60™ cab ECUs require a second ground input (X1-12) for the ABS indicator lamp. The X1 wire harness connector contains an ABS indicator lamp interlock (X1-15), which shorts the ABS indicator lamp circuit (X1-18) to ground if the connector is removed from the ECU.

### Bendix® WS-24™ Wheel Speed Sensors

Wheel speed data is provided to the EC-60™ controller from the WS-24™ wheel speed sensor (see Figure 2). Vehicles have an exciter ring (or “tone ring”) as part of the wheel assembly, and as the wheel turns, the teeth of the exciter ring pass the wheel speed sensor, generating an AC signal. The EC-60™ controller receives the AC signal, which varies in voltage and frequency as the wheel speed changes.

Vehicle axle configurations determine the number of WS-24™ wheel speed sensors that must be used. A vehicle with a single rear axle requires four wheel speed sensors. Vehicles with two rear axles can utilize six wheel speed sensors for optimal performance.

## Diagnostic Blink Code Switch

A momentary switch that grounds the ABS Indicator Lamp output is used to place the ECU into the diagnostic blink code mode and is typically located on the vehicle’s dash panel.

## Optional ABS Off-Road Switch and Indicator Lamp Operation

Advanced EC-60™ controllers use an optional dash-mounted switch for the operator to place the ECU into the ABS off-road mode. See “Optional ABS Off-Road Mode” on page 7 for further details. In some cases, ECUs may also be put into the ABS off-road mode by one of the other vehicle control modules, using a J1939 message to the EC-60™ controller.

(If you need to know if this EC-60™ controller uses a J1939 message to operate the lamp, e-mail [ABS@bendix.com](mailto:ABS@bendix.com), specifying the ECU part number, or call 1-800-AIR-BRAKE and speak to the Bendix TechTeam.)

**WARNING:** The ABS off-road mode should not be used on normal, paved road surfaces because vehicle stability and steerability may be affected. When the ECU is placed in the ABS off-road mode, the ABS Indicator Lamp will flash constantly (at a rate of once per 2.5 seconds) to notify the vehicle operator that the off-road mode is active.

## Optional ATC Mud/Snow (Off-Road) Switch and Indicator Lamp Operation (see also page 8.)

Advanced controllers use a dash-mounted switch for the operator to place the ECU into the ATC Mud/Snow mode.

## Stop Lamp Switch (SLS)

The Advanced EC-60™ controller monitors the vehicle stop lamp status. Certain vehicle functions, such as ATC and All-Wheel Drive (AWD), use the status of the stop lamp to determine when the driver makes a brake application. This can be provided to the ECU via J1939 communications, or hardware input.

## Brake Demand Sensors

The brake demand sensors provide the controller with an indication of driver-applied brake pressure. One is installed in the primary air brake circuit, and another is installed in the secondary air brake circuit.

## Load Sensor

The load sensor provides the controller with an indication of the vehicle load. It is typically installed in one of the suspension air bags.

## Bendix® SAS-60™ Steering Angle Sensor

The Steering Angle Sensor (SAS) is used to provide driver steering input to the controller. It reports the steering wheel position to the controller utilizing a dedicated serial communications link that is shared with the YAS-60™ sensor. The controller supplies the power and ground inputs to the SAS-60™ sensor.

The SAS-60 sensor is available with two different styles of wire harness connectors. (See Figure 4)



## **Bendix® YAS-60™ Yaw Rate/Lateral Acceleration Sensor**

The Yaw Rate/Lateral Acceleration Sensor is used to provide the controller an indication of vehicle lateral acceleration and rotation around the vertical axis. This information is provided to the controller utilizing a dedicated serial communications link that is shared with the SAS-60™ sensor. The controller supplies the power and ground inputs to the YAS-60™ sensor.

## **EC-60™ CONTROLLER OUTPUTS**

### **Bendix® M-32™ and M-32QR™ Pressure Modulator Valves (PMV)**

The Bendix® M-32™ and M-32QR™ pressure modulator valves (PMV) are operated by the EC-60™ controller to modify driver applied air pressure to the service brakes during ABS, ATC, RSP or YC activation (See pages 7-8). The PMV is an electropneumatic control valve and is the last valve that air passes through on its way to the brake chamber. The modulator hold and release solenoids are activated to "modulate" or "control" the brake pressure during an antilock braking event. The hold solenoid is normally open and the release solenoid is normally closed, such that the PMV nominally allows air to flow through. This design allows for air delivery to brake chambers in the event of electrical trouble.

The Advanced EC-60™ controller also utilizes an additional PMV for control of the trailer service brakes during stability interventions.

### **Traction Control Valve (TCV)**

Advanced EC-60™ controllers use two TCVs, one on the steer axle and one on the drive axle. The TCV may be a separate valve or integrated into the rear axle relay valve.

The controller will activate the drive axle TCV during differential braking ATC events.

During stability interventions, the ECU will activate both the steer axle and drive axle TCVs as required.

### **Stop Lamp Output**

The controller provides an output to control a relay that illuminates the vehicle stop lamps during stability interventions. This information is also available using the J1939 serial communications link.

### **ABS Indicator Lamp Control with Optional Diagnostic Blink Code Switch**

The Advanced EC-60™ controller has internal circuitry to control the ABS Indicator Lamp on the dash panel.

The ABS Lamp Illuminates:

1. During power up (e.g. when the vehicle is started) for approximately 3 seconds and turns off after the self test is completed, providing no **Diagnostic Trouble Codes (DTCs)** are present on the ECU.

2. When full ABS operation is not available due to presence of a DTC on the ECU.
3. If the ECU is unplugged or has no power.
4. When the ECU is placed into the ABS off-road mode (the lamp flashes steadily at a rate of once per 2.5 sec.).
5. To display blink codes for diagnostic purposes after the external diagnostic switch is activated.

The EC-60™ controller may communicate with other vehicle control modules to operate the ABS Indicator Lamp using serial communications. (If you need to know if this EC-60™ controller uses serial communications to operate the lamp, e-mail [ABS@bendix.com](mailto:ABS@bendix.com), specifying the ECU part number, or call 1-800-AIR-BRAKE and speak to the Bendix Tech Team.)

### **Indicator Lamp Control Using Serial Communications Links**

As mentioned above, depending on the vehicle manufacturer, the dash indicator lamps (ABS, ATC, ESP and trailer ABS) may be controlled using serial communications links. In these cases, the EC-60™ controller will send a serial communications message over the J1939 or J1587 links indicating the required status of the lamp(s). Another vehicle control module receives the message and controls the indicator lamp(s).

### **Retarder Relay Disable Output**

The retarder relay disable output may be used to control a retarder disable relay. When configured to use this output, the ECU will energize the retarder disable relay and inhibit the use of the retarder as needed.

### **SAE J1939 Serial Communications**

A Controller Area Network (CAN) data link (SAE J1939) is provided for communication. This link is used for various functions, such as:

- To disable retarding devices during ABS operation.
- To request torque converter lock-up during ABS operation.
- To share information such as wheel speed and ECU status with other vehicle control modules.

Advanced EC-60™ controllers utilize the J1939 data link for:

- ATC and drag torque control functions.
- Vehicle stability functions.

### **Trailer ABS Indicator Lamp Control**

The Advanced EC-60™ controller will activate a trailer ABS Indicator Lamp (located on the dash panel) that indicates the status of the trailer ABS unit on one, or more trailers, or dollies that are equipped with PLC functionality. Typically, the EC-60™ controller directly controls the trailer ABS Indicator Lamp based on the information it receives from the trailer ABS, via PLC.

Alternatively, some vehicles require the EC-60™ controller to activate the trailer ABS Indicator Lamp by communicating with other vehicle controllers using serial communications.

(If you need to know if this EC-60™ controller uses a serial communications message to operate the lamp, e-mail ABS@bendix.com, specifying the ECU part number, or call 1-800-AIR-BRAKE and speak to the Bendix TechTeam.)

**SAE J1708/J1587 Serial Communications**

An SAE J1708 data link, implemented according to SAE J1587 recommended practice, is available for diagnostic purposes, as well as ECU status messages.

**Interaxle Differential Lock Control (AWD Transfer Case)**

Advanced ECUs can control the interaxle differential lock (AWD transfer case). This is recommended on AWD vehicles, but the ECU must be specially configured to provide this feature. E-mail to ABS@bendix.com for more details.

**POWER-UP SEQUENCE**

**NOTICE:** The vehicle operator should verify proper operation of all installed indicator lamps (ABS, ATC/ESP, and trailer ABS) when applying ignition power and during vehicle operation. Lamps that do not illuminate as required when ignition power is applied, or remain illuminated after ignition power is applied, indicate the need for maintenance.

**ABS Indicator Lamp Operation (Bulb Check)**

The ECU will illuminate the ABS Indicator Lamp for approximately three seconds when ignition power is applied, after which the lamp will extinguish if no diagnostic trouble codes are detected.

The ECU will illuminate the ABS Indicator Lamp whenever full ABS operation is not available due to a diagnostic trouble code. In most cases, partial ABS is still available.

**ATC/ESP Status/Indicator Lamp Operation**

The ECU will illuminate the ATC/ESP lamp for approximately 2.5 seconds when ignition power is applied, after which the lamp will extinguish, if no diagnostic trouble codes are detected. The ECU will continuously illuminate the ATC/ESP Indicator Lamp whenever ESP or ATC is disabled due to a diagnostic trouble code.

During an ESP or ATC intervention, the lamp will flash rapidly (2.5 times per second). When the ECU is placed in the ATC Mud/Snow (off-road) mode, the lamp will flash slowly at a rate of once every 2.5 seconds

**Trailer ABS Indicator Lamp Operation**

The ECU will control the Trailer ABS Indicator Lamp when a PLC signal (SAE J2497) from a trailer ABS ECU is detected.

**ECU Configuration Test**

Within two seconds of the application of ignition power, the ECU will perform a test to detect system configuration with regards to the number of wheel speed sensors and PMVs. This can be audibly detected by a rapid cycling of the PMVs.

(Note: The ECU will not perform the configuration test when wheel speed sensors show that the vehicle is in motion.)

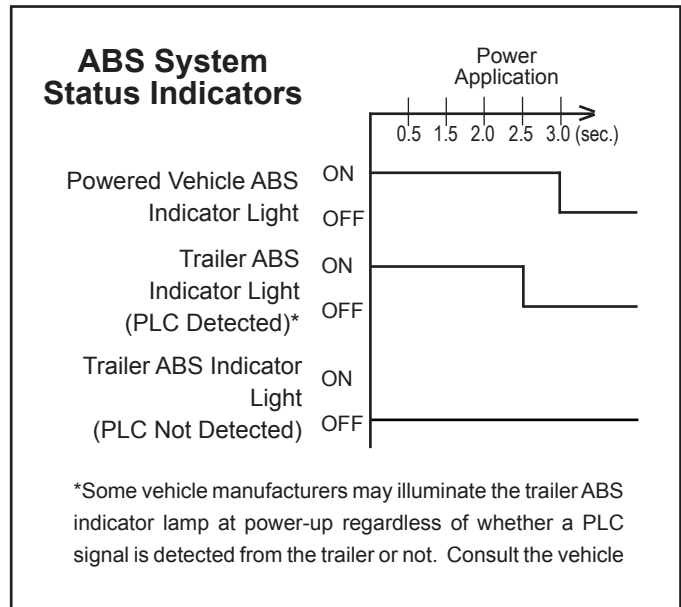


FIGURE 8 - ABS DASH LIGHTS START UP SEQUENCE

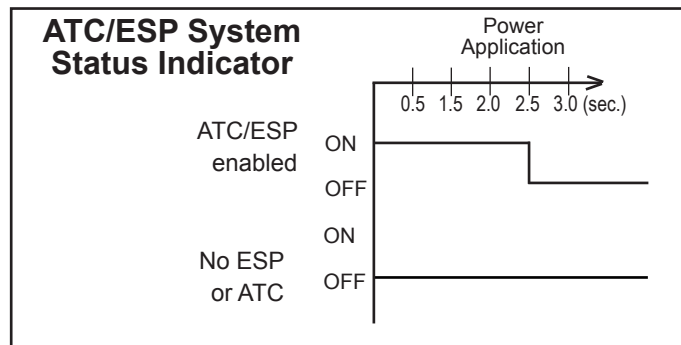


FIGURE 9 - ATC INDICATOR LIGHT START UP SEQUENCE

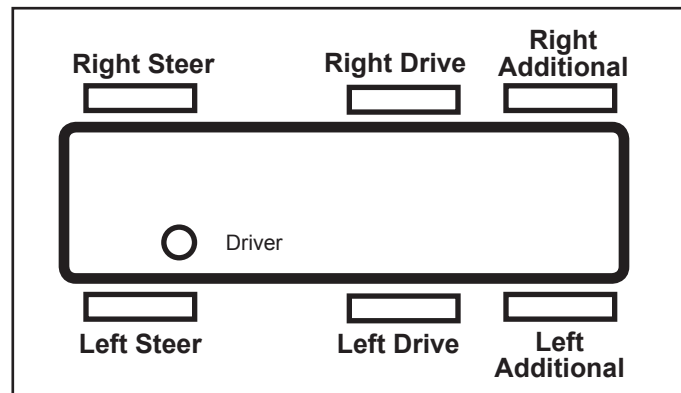


FIGURE 10 - VEHICLE ORIENTATION (TYPICAL)

**Pressure Modulator Valve and Traction Control Valve Chuff Test**

After the performance of the configuration test, the EC-60™ controller will perform a Bendix-patented PMV and TCV Chuff Test. The Chuff Test is an electrical and pneumatic PMV test that can assist maintenance personnel in verifying proper PMV wiring and installation.

With brake pressure applied, a properly installed PMV will perform one sharp audible exhaust of air by activating the hold solenoid twice and the release solenoid once. If the PMV is wired incorrectly, it will produce two exhausts of air or none at all.

The EC-60™ controller will perform a PMV chuff test on all installed modulators in the following order:

- Steer Axle Right PMV
- Steer Axle Left PMV
- Drive Axle Right PMV
- Drive Axle Left PMV
- Additional Axle Right PMV
- Additional Axle Left PMV
- Drive Axle TCV

The pattern will then repeat itself.

With the EC-60 advanced controller, at the completion of the second round of PMV & TCV chuff tests, the controller (if configured to do so) will perform a test to cross-check the trailer PMV operation with the vehicle stop lamps. If the trailer PMV circuit is mis-wired (including the steer axle TCV), the PMV will exhaust a large amount of air, or none at all.

**NOTICE:** If there are any active Diagnostic Trouble Codes, stop lamp cross-check portion of the chuff test will not be carried out until all DTCs are fully diagnosed and corresponding repairs are successfully conducted. The ESP/ATC dash indicator will also be illuminated when there are active ABS, ATC or ESP DTCs.

The ECU will not perform the PMV Chuff Test when wheel speed sensors show that the vehicle is in motion.

---

## ABS OPERATION

Bendix® ABS uses wheel speed sensors, ABS pressure modulator valves, and an ECU to control either four or six wheels of a vehicle. The EC-60™ controller monitors individual wheel turning motion during braking and adjusts or modulates the brake pressure at the wheel end. When excessive wheel slip, or wheel lock-up is detected, the EC-60™ controller will activate the pressure modulator valves to automatically reduce the brake pressure at one or more of the wheel ends. By these actions, the ABS system helps to maintain the vehicle's lateral stability and steerability during heavy brake applications and during braking on slippery surfaces.

### Steer Axle Control

Although both wheels of the steer axle have their own wheel speed sensor and pressure modulator valve, the EC-60™ controller blends the applied braking force between the two steering axle brakes. This Bendix patented brake application control, called Modified Individual Regulation (MIR), is designed to help reduce steering wheel pull during an ABS event on road surfaces with poor traction (or areas of poor traction, e.g. asphalt road surfaces with patches of ice).

### Single Drive Axle Control (4x2 Vehicle)

For vehicles with a single rear drive axle (4x2), the brakes are operated independently by the EC-60™ controller, based on the individual wheel behavior.

### Dual Drive Axle Control (4S/4M Configuration)

For vehicles with dual drive axles (6x4) using a 4S/4M configuration, one ABS modulator controls both right-side rear wheels and the other modulator controls both left-side rear wheels. Both wheels on each side receive equal brake pressure during an ABS stop. The rear wheel speed sensors must be installed on the axle with the lightest load.

### Dual Rear Axle Control (6S/6M Configuration)

For vehicles with dual rear axles (6x4, 6x2) using a 6S/6M configuration, the rear wheels are controlled independently. Therefore, brake application pressure at each wheel is adjusted according to the individual wheel behavior on the road surface.

## 6x2 Vehicles with 6S/5M Configuration

6x2 vehicles can utilize a 6S/5M configuration, with the additional axle (a non-driven rear axle) having two sensors, but only one Pressure Modulator Valve. In this case, the PMV controls both wheels on the additional axle. The additional axle wheels would receive equal brake pressure, based on the wheel that is currently experiencing the most wheel slip.

### Normal Braking

During normal braking, brake pressure is delivered through the ABS PMV and into the brake chamber. If the ECU does not detect excessive wheel slip, it will not activate ABS control, and normal vehicle service braking is applied.

### Retarder Brake System Control

On surfaces with low traction, application of the retarder can lead to high levels of wheel slip at the drive axle wheels, which can adversely affect vehicle stability.

To prevent this, the EC-60™ controller switches off the retarder as soon as a lock-up is detected at one (or more) of the drive axle wheels.

When the ECU is placed in the ABS off-road mode (on vehicles equipped with this optional feature), it will switch off the retarder only when ABS is active on a steer axle wheel and a drive axle wheel.

### Optional ABS Off-Road Mode

On some road conditions, particularly when the driving surface is soft, the stopping distance with conventional ABS may be longer than without ABS. This can occur when a locked wheel on soft ground or loose gravel plows up the road surface in front of the tire, changing the rolling friction value. Although vehicle stopping distance with a locked wheel (in the absence of ABS) may be shorter than corresponding stopping distance with conventional ABS control, vehicle steerability and stability would be reduced.

Advanced EC-60™ controllers have an optional dash switch initiated modified ABS control mode (know as "offroad ABS) that more effectively accommodates these soft road conditions to shorten stopping distance while maintaining optimal vehicle steerability and stability.



**WARNING: The ABS off-road mode should not be used on normal, paved road surfaces because vehicle stability and steerability may be reduced. The ABS Indicator Lamp will flash slowly to indicate to the driver that the ABS off-road mode is engaged.**

**CAUTION: When ABS off-road mode is engaged, stability functions are disabled at speeds below approximately 25 mph. The ATC/ESP dash lamp will illuminate to indicate to the driver that the stability system is disabled.**

The vehicle manufacturer should provide the optional ABS off-road function only for vehicles that operate on unpaved surfaces or that are used in off-road applications, and is responsible for insuring that vehicles equipped with the ABS off-road function meet all FMVSS-121 requirements and have adequate operator indicators and instructions.

The vehicle operator activates the off-road function with a switch on the dash panel. A flashing ABS Indicator Lamp indicates to the driver that the ABS off-road function is engaged. To exit the ABS off-road mode, depress and release the switch. A new ignition cycle will also cause the ECU to exit the ABS off-road mode.

### **All-Wheel Drive (AWD) Vehicles**

AWD vehicles with an engaged interaxle differential (steer axle to rear axle)/AWD transfer case may have negative effects on ABS performance. Optimum ABS performance is achieved when the lockable differentials are disengaged, allowing individual wheel control.

Advanced EC-60™ controllers can be programmed specifically for this configuration to control the differential lock/unlock solenoid in the AWD transfer case. When programmed to do so, the ECU will disengage the locked interaxle/AWD transfer case during an ABS event and reengage it once the ABS event has ended.

## **ATC OPERATION**

### **ATC Functional Overview**

Just as ABS improves vehicle stability during braking, ATC improves vehicle stability and traction during vehicle acceleration. The EC-60™ controller ATC function uses the same wheel speed information and modulator control as the ABS function. The EC-60™ controller detects excessive drive wheel speed, compares the speed to the front, nondriven wheels, and reacts to help bring the wheel spin under control. The controller can be configured to use engine torque limiting and/or differential braking to control wheel spin. For optimal ATC performance, both methods are recommended.

### **ATC/ESP Lamp Output/ATC Mud/Snow Switch Input**

Advanced ECUs control the ATC/ESP dash lamp as follows.

The ATC/ESP dash lamp illuminates:

1. During power up (e.g. when the vehicle is started) for approximately 2.5 seconds and turns off after the self test is completed, providing no diagnostic trouble codes are present.
2. When ESP or ATC is disabled for any reason.
3. During an ESP or ATC event (the lamp will flash rapidly at a rate of 2.5 per second).
4. When the ECU is placed in the ATC off-road mode (the lamp will flash steadily at a rate of once per 2.5 seconds). This notifies the vehicle operator that the ATC Mud/Snow mode is active.
5. When the ECU is placed in the ABS off-road mode. When in this mode, ESP will be disabled below 25 mph and its inactive status will be indicated by a steadily illuminated ATC/ESP lamp.

### **Differential Braking**

Differential braking within ATC is automatically activated when drive wheel(s) on one side of the vehicle are spinning excessively, which typically occurs on road surfaces with patches of ice. The traction system will then lightly apply the brake to the drive wheel(s) that are spinning excessively. The vehicle differential will then drive the wheels on the other side of the vehicle.

Differential braking as part of ATC functionality is available at vehicle speeds up to 25 MPH.

### **Disabling ATC Differential Braking**

ATC differential braking is disabled under the following conditions:

1. During power up (e.g. when the vehicle is started), until the ECU detects a service brake application.
2. If the ECU receives a J1939 message indicating that the vehicle is parked.
3. When the dynamometer test mode is active. The dynamometer test mode is entered using the diagnostic blink code switch or by using a diagnostic tool (such as Bendix® ACom™ Diagnostics).
4. In response to a serial communications request from a diagnostic tool.
5. If "ATC Differential Braking" function is activated for a long time period to avoid overheating of the brakes, it would take approximately 3 continuous minutes of activation for the timeout to occur. Once timed out, approximately 2 minutes of "cool off" time would be required before ATC Differential Braking can be used again.
6. When certain diagnostic trouble code conditions are detected.

### **Engine Torque Limiting with Smart ATC™ Traction Control**

The EC-60™ controller uses Engine Torque Limiting to control drive axle wheel slip. This is communicated to the engine control module (using J1939), and is available at all vehicle speeds.



## Bendix® Smart ATC™ Traction Control

The EC-60™ controller has an additional feature known as Smart ATC™ traction control. Smart ATC™ traction control monitors the accelerator pedal position (using J1939) to help provide optimum traction and vehicle stability. By determining the driver's throttle input and adapting the target slip of the drive wheels to the driving situation, the Smart ATC™ traction control allows higher wheel slip when the accelerator pedal is applied above a preset level.

The wheel slip allowed by Smart ATC™ is decreased when driving through a curve for improved stability.

## Disabling ATC Engine Control and Smart ATC™ Traction Control

ATC Engine Control and Smart ATC™ traction control will be disabled under the following conditions:

1. In response to a serial communications request from an off-board tool.
2. At power-up until the ECU detects a service brake application.
3. If the ECU receives a J1939 message indicating that the vehicle is parked.
4. If the dynamometer test mode is active. This may be accomplished via an off-board tool or the diagnostic blink code switch.

5. When certain diagnostic trouble code conditions are detected.

## Optional ATC Mud/Snow (Off-Road) Mode

In some road conditions, the vehicle operator may desire additional drive wheel slip when ATC is active. The Advanced EC-60™ controller has an optional control mode to permit this desired performance.

The vehicle operator can activate the Mud/Snow function with a switch on the dash panel. Alternately, a J1939 message may be used to place the vehicle in this mode. The ATC/ESP Indicator Lamp will flash steadily at a rate of once every 2.5 seconds to confirm that the ATC mud/snow mode is engaged.

To exit the ATC Mud/Snow mode, depress and release the ATC Mud/Snow switch.

## Drag Torque Control Functional Overview

Advanced EC-60™ controllers have a feature referred to as drag torque control which reduces wheel slip on a driven axle due to driveline inertia. This condition is addressed by increasing the engine torque to overcome the inertia.

Drag torque control increases vehicle stability on low-traction road surfaces during down-shifting or retarder braking.

## ADVANCED ABS WITH STABILITY CONTROL

### Overview

ESP stability system reduces the risk of rollovers, jackknifing and other loss of control. ESP features include Roll Stability Program (RSP) and Yaw Control. During operation, the ECU of the Bendix Advanced ABS system constantly compares performance models to the vehicle's actual movement, using the wheel speed sensors of the ABS system, as well as lateral, yaw, and steering angle sensors. If the vehicle shows a tendency to leave an appropriate travel path, or if critical threshold values are approached, the system will intervene to assist the driver.

### Roll Stability Program

Bendix RSP, an element of the overall ESP system, addresses rollover conditions. In the case of a potential roll event, the ECU will override the throttle and quickly apply brake pressure at all wheel ends to slow the vehicle combination. The level of braking application during an RSP event will be proportional to roll risk.

See Figure 11.

### Yaw Stability

Yaw stability counteracts the tendency of a vehicle to spin about its vertical axis. During operation, if the friction between the road surface and the tires is not sufficient to oppose lateral (side) forces, one or more of the tires can slide, causing the truck/tractor to spin. These events

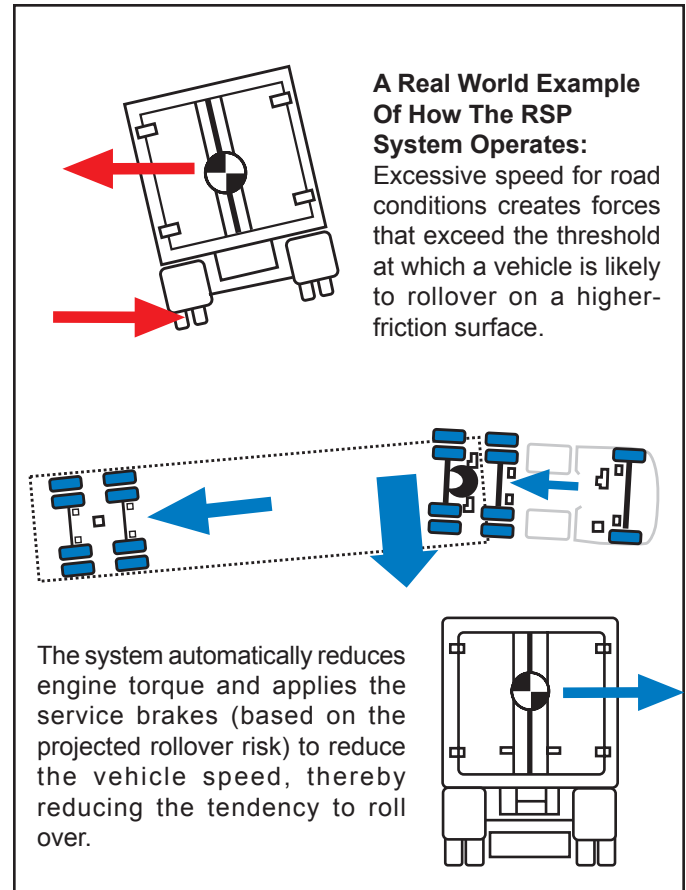
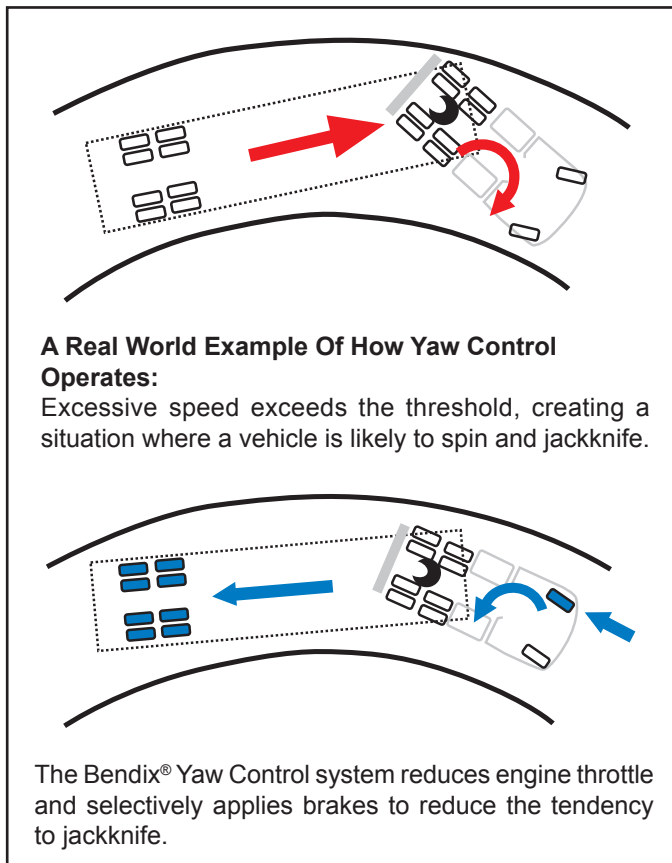


FIGURE 11 - RSP EXAMPLE



**FIGURE 12 - YAW CONTROL EXAMPLE**

are referred to as either an "under-steer" situation (where there is a lack of vehicle response to steering input due to tire slide on the steer axle) or an "over-steer" (where the tractor's rear end slides out due to tire slide on the rear axle) situation. Generally, shorter wheelbase vehicles (tractors, for instance) have less natural yaw stability, while longer wheelbase vehicles (straight trucks, for instance) have greater natural yaw stability. Factors that influence yaw stability are: wheelbase, suspension, steering geometry, weight distribution front to rear, and vehicle track width.

### Yaw Control

Yaw Control responds to a wide range of low- to high-friction surface scenarios including rollover, jackknife and loss of control. It is the recommended system for all power vehicles and especially critical for tractors pulling trailers. In the case of vehicle slide (over-steer or under-steer situations), the system will reduce the throttle and then brake one or more of the "four corners" of the vehicle (in addition to potentially applying the trailer brakes), thus applying a counter-force to better align the vehicle with an appropriate path of travel.

For example, in an over-steer situation, the system applies the "outside" front brake; while in an under-steer condition, the "inside" rear brake is applied. (See Figure 12)

## IMPORTANT SAFETY INFORMATION ABOUT THE BENDIX® ESP® STABILITY SYSTEM

### ESP May Reduce The Vehicle Speed Automatically

ESP can make the vehicle **decelerate automatically**. ESP can slow the vehicle with or **without the operator applying the brake**, and **even when the throttle is being applied**.

To minimize unexpected deceleration and reduce the risk of a collision the operator must:

- Avoid aggressive driving maneuvers, such as sharp turns or abrupt lane changes at high speeds, which might trigger the stability system.
- Always operate the vehicle safely, drive defensively, anticipate obstacles and pay attention to road, weather and traffic conditions. ABS, ATC and ESP stability systems are no substitute for prudent, careful driving.

### Towing Doubles Or Triples May Reduce The Effectiveness Of Stability Systems

ESP is designed and optimized for trucks and for tractors that tow single trailers. If a tractor equipped with ESP is used to power multiple trailer combinations (known as "doubles" or "triples") **the effectiveness of the ESP system may be greatly reduced**. Extremely careful driving is always required when towing doubles or triples. Excessive speed and aggressive maneuvers, such as sharp turns, sudden steering inputs or abrupt lane changes should be avoided.

### Limitations Of Stability Systems

The ESP stability system's effectiveness may be greatly reduced if:

- The load shifts due to improper retention, accident damage or the inherently mobile nature of some loads (for example, hanging meat, live animals or partially laden tankers),
- The vehicle has an unusually high or off-set center of gravity (CG),
- One side of the vehicle drops off the pavement at an angle that is too large to be counteracted by a reduction in speed,
- The vehicle is used to haul double or triple trailer combinations,
- If very rapidly winding steering inputs are inputted at high speeds,
- There are mechanical problems with suspension leveling of the tractor or trailer resulting in uneven loads,
- The vehicle is maneuvering on a high banked road creating either additional side forces due to the weight (mass) of the vehicle or a deviation between expected & actual yaw rates,
- Gusty winds are strong enough to cause significant side forces on the vehicle and any towed vehicles.

## To Maximize The Effectiveness Of ESP:

- Loads must be properly secured at all times.
- Drivers need to exercise extreme caution at all times, and avoid sharp turns, sudden steering inputs or abrupt lane changes at high speeds, particularly if:
  - › the vehicle hauls loads that could shift,
  - › the vehicle or load has a high or off-set center of gravity (CG) when loaded, or
  - › the vehicle tows doubles or triples.

## Truck Chassis Modifications

If the vehicle's chassis components are altered (for example, a wheel base extension or reduction, tag axle addition or removal, a major body change such as conversion of a tractor into a truck, or an axle, suspension, or steering system component modification) the Bendix® ESP® system must be disabled. Have a qualified mechanic replace the Advanced EC-60 ECU with a Premium EC-60 ECU and secure the X4 connector which will no longer be used. The ATC/ESP indicator lamp would continue to function as an ATC indicator lamp, and should be designated as ATC only.

**WARNING: If a modified vehicle does not have the ESP system disabled, serious vehicle braking and performance issues could result, including unnecessary ESP system interventions. This can lead to a loss of control of the vehicle. In addition, remove all cab signage (e.g. visor labels, etc.) used to show that Bendix ESP was installed and make any necessary notations in the vehicle manual(s), so that drivers do not misunderstand which ABS options are installed on the vehicle.**

## Sensor Location Modifications

The location and orientation of the Steering Angle Sensor and Yaw Rate Sensor must not be altered. When servicing, an identical component must be used in the same orientation (using OEM brackets & torque requirements). During installation follow the OEM leveling guidelines.

## Steering Angle Sensor Re-Calibration

Whenever maintenance or repair work is performed to the steering mechanism, linkage, steering gear, adjustment of the wheel track, or if the steering angle sensor is replaced, a recalibration of the Steering Angle Sensor must be performed.

**WARNING! If the Steering Angle Sensor is not recalibrated, the yaw control system may not function properly, which can result in incidents leading to loss of vehicle control. See page 14 of this document for more details on this procedure.**

## Dynamometer Test Mode

**CAUTION:** ATC and ESP must be disabled prior to conducting any dynamometer testing. When the Dynamometer Test Mode is engaged, ATC brake control and engine control along with drag torque control and ESP are turned off. This test mode is used to avoid torque reduction or torque increase and brake control activation when the vehicle is operated on a dynamometer for testing purpose.

The Dynamometer Test Mode may be activated by pressing and releasing the diagnostic blink code switch five times or by using a hand-held or PC-based diagnostic tool.

Advanced EC-60™ Contollers will remain engaged in the Dynamometer Test Mode even if power to the ECU is removed and re-applied. To exit the test mode, press and release the blink code switch three times, or use a hand-held or PC-based diagnostic tool.

## Automatic Tire Size Calibration

The ECU requires a precise rolling circumference ratio between steer axle and drive axle tires in order for ABS, ATC, and ESP to perform in an optimal manner. For this reason, a continuously monitoring process takes place in which the precise ratio is calculated. This calculated value is stored in the ECU memory provided the following conditions are met:

1. Rolling-circumference ratio is within the permissible range.
2. Vehicle speed is greater than approximately 12 MPH.
3. No acceleration or deceleration is taking place.
4. There are no active speed sensor diagnostic trouble codes.

The ECU is provided with a ratio value of 1.00 as a default setting. If the automatic tire size alignment calculates a different value, this is used to overwrite the original figure in the memory. This process adapts the ABS and ATC function to the vehicle.

## Acceptable Tire Sizes

The speed calculation for an exciter ring with 100 teeth is based on a default tire size of 510 revolutions per mile. This figure is based on the actual rolling circumference of the tires, which varies with tire size, tire wear, tire pressure, vehicle loading, etc.

The ABS response sensitivity is reduced when the actual rolling circumference is excessive on all wheels. For a 100 tooth exciter ring, the minimum number of tire revolutions per mile is 426, and the maximum is 567. The ECU will set diagnostic trouble codes if the number of revolutions is out of this range.

In addition, the size of the steer axle tires compared to the drive axle tires also has to be within the ABS system design. To avoid diagnostic trouble codes, the ratio of the effective rolling circumference of the steer axle, divided by the effective rolling circumference of the drive axle, must be between 0.85 to 1.15.

**CAUTION: The ESP system effectiveness relies on the accuracy of vehicle speed. If a major change on the tire sizes occurs such that odometer setting needs to be changed, the Advanced ABS controller's setting of tire sizes must be reprogrammed to new values at the same time by a certified mechanic.**

## SYSTEM IMPACT DURING ACTIVE TROUBLE CODES

### ABS PARTIAL SHUTDOWN

Depending on which component the trouble code is detected, the ABS, ATC, and ESP functions may be fully or partially disabled. Even with the ABS indicator lamp illuminated, the EC-60™ controller may still provide ABS function on wheels that are not affected. The ABS system controller should be serviced as soon as possible.

#### Steer Axle ABS Modulator Diagnostic Trouble Code

ABS on the affected wheel is disabled. ABS and ATC on all other wheels remains active. ESP is disabled.

#### Drive Axle/Additional Axle ABS Modulator Diagnostic Trouble Code

ATC is disabled. ABS on the affected wheel is disabled. ABS on all other wheels remains active. ESP is disabled.

#### Steer Axle Wheel Speed Sensor Diagnostic Trouble Code

The wheel with the diagnostic trouble code is still controlled by using input from the remaining wheel speed sensor on the steer axle. ABS remains active on the rear wheels. ATC and ESP are disabled.

#### Drive Axle/Additional Axle Wheel Speed Sensor Diagnostic Trouble Code

ATC and ESP are disabled. In a four sensor system, ABS on the affected wheel is disabled, but ABS on all other wheels remains active.

In a six sensor system, ABS remains active by using input from the remaining rear wheel speed sensor on the same side.

#### ATC Modulator Diagnostic Trouble Code

ATC and ESP are disabled. ABS remains active.

#### J1939 Communication Diagnostic Trouble Code

ATC and ESP are disabled. ABS remains active.

#### ECU Diagnostic Trouble Code

ABS, ATC, and ESP are disabled. The system reverts to normal braking.

#### Voltage Diagnostic Trouble Code

While voltage is out of range, ABS, ATC, and ESP are disabled. The system reverts to normal braking. When the correct voltage level is restored, full ABS and ATC function is available. Operating voltage range is 9.0 to 17.0 VDC.

#### Steering Angle Sensor Diagnostic Trouble Code

ESP is disabled. ABS and ATC remain active.

#### Yaw Rate/Lateral Acceleration Sensor Diagnostic Trouble Code

ESP is disabled. ABS and ATC remain active.

### Brake Demand Pressure Sensor Diagnostic Trouble Code

ESP is disabled. ABS and ATC remain active.

### Load Sensor Diagnostic Trouble Code

ESP is disabled. ABS and ATC remain active.

### Steer Axle TCV Diagnostic Trouble Code

ESP is disabled. ABS and ATC remain active.

### Trailer PMV Diagnostic Trouble Code

ESP is disabled. ABS and ATC remain active.

## SYSTEM CONFIGURATION

The EC-60™ controller is designed to allow the technician to change the default system settings (chosen by the vehicle OEM) to provide additional or customized features.

Depending on the model, the customizable features include ABS control settings, engine module communication etc. Many of these settings can be reconfigured using a hand held or PC-based software, such as the Bendix® ACom™ Diagnostics program.

## ECU RECONFIGURATION

Reconfiguring an EC-60™ controller may be carried out by using the Blink Code Switch or by using a hand-held or PC-based diagnostic tool.

Note: During the reconfiguration process, and independently from any reconfiguration being carried out by the technician, the ECU will automatically check the J1939 serial link and communicate with other vehicle modules. In particular, if the serial link shows that the vehicle has a retarder device present, the ECU will configure itself to communicate with the retarder device for improved ABS performance. For example, if the ECU detects the presence of a retarder disable relay during a reconfiguration, it will configure itself to control the relay to disable the retarding device as needed.

### 6S/5M Configuration

Advanced EC-60™ controllers will configure for 6S/5M operation when a reconfiguration event is initiated and the ECU detects that an additional axle PMV is wired as follows:

PMV Connector	ECU Connector
Hold	Right Additional Axle Hold
Release	Left Additional Axle Release
Common	Right Additional Axle Common

### Reconfiguration Using the Blink Code Switch

With ignition power removed from the EC-60™ controller, depress the blink code switch. After the ignition power is activated, depress and release the switch seven times to initiate a reconfiguration event.

### Diagnostic Tool

A reconfiguration event may be initiated using a hand-held or PC-based diagnostic tool to communicate with the ECU over the SAE J1587 diagnostic link.



# Troubleshooting: General

## SAFE MAINTENANCE PRACTICES

### **WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:**

When working on or around a vehicle, the following general precautions should be observed at all times:

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.
2. Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, **EXTREME CAUTION** should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.
3. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
4. If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning **ANY** work on the vehicle. If the vehicle is equipped with an AD-IS™ air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.
5. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
6. Never exceed manufacturer's recommended pressures.
7. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
8. Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
9. Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
10. Prior to returning the vehicle to service, make

certain all components and systems are restored to their proper operating condition.

11. For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.

## REMOVING THE EC-60™ CONTROLLER ASSEMBLY

1. Turn vehicle ignition off.
2. Remove as much contamination as possible prior to disconnecting electrical connections.
3. Note the EC-60™ controller assembly mounting position on the vehicle.
4. Disconnect the electrical connectors from the EC-60™ controller.
5. Remove and retain the mounting bolts that secure the EC-60™ controller.

## CAUTION

The VIN of the vehicle is stored in the ECU internal memory, and is cross-checked by the ECU using information obtained from other vehicle controllers. If the VIN stored in the ECU does not match the VIN obtained from the other vehicle controller, the ECU will generate an ECU Internal VIN Mismatch DTC.

Accordingly, do not switch Advanced controllers from one vehicle to another.

## OBTAINING A NEW EC-60™ ADVANCED CONTROLLER

Should the Advanced EC-60™ controller require replacement, certain steps must be followed:

1. Record the vehicle model, VIN, model year and date of manufacture from the vehicle.
2. Record the part number of the EC-60™ Advanced Controller.
3. Provide this information to your local OEM vehicle service department to obtain a new ECU. The OEM service department will install the same parameter set in the new controller that was loaded into the original ECU at the vehicle OEM assembly facility.

## INSTALLING A NEW EC-60™ CONTROLLER

**CAUTION!** When replacing the EC-60™ controller, verify with the OEM service department that the unit you are installing has the correct parameter set. Failure to do so could result in a loss of features or degraded ESP performance.

For further information, contact either the vehicle manufacturer, Bendix or your local authorized Bendix dealer.

1. Position and secure the EC-60™ controller in the original mounting orientation using the mounting bolts retained during removal. Use no more torque than is necessary to firmly secure the ECU into position. Over-tightening the mounting hardware can cause damage to the EC-60™ controller.
2. Reconnect the electrical connectors to the EC-60™ controller.
3. Apply power and monitor the EC-60™ controller power-up sequence to verify proper system operation.

See Troubleshooting: Wiring section beginning on page 38 for more information on wire harnesses.

**WARNING:** Bendix ESP stability system is validated with specific Bendix® components. Always use Bendix® replacement parts to prevent compromising system performance. Bendix is not able to validate the safe and reliable use of substitute or alternate components that may be available from other manufacturers. Further, suppliers of a non-Bendix® ABS component may implement design changes in their component (without the knowledge or approval of Bendix) which could negatively affect antilock system reliability and braking performance issues.

## REMOVAL OF THE STEERING ANGLE SENSOR

### Service Checks:

1. Check all wiring and connectors. Some installations also include an intermediate connector from the steering angle sensor to the main vehicle wire harness. Make sure all connections are free from visible damage.
2. Examine the sensor. Make sure the sensor, its mounting screws, and the interface between the hub and the steering column are not damaged.

### Diagnostics:

The steering angle sensor is only operational in conjunction with an Advanced ABS ECU. No independent diagnostics can be performed on the sensor.

### Removal:

1. Remove steering column sheathing.
2. Depending upon manufacturer, the steering angle sensor could be located either near the steering wheel, necessitating the removal of the steering wheel, or near the joint to the vehicle steering mechanism, necessitating the disconnection of this linkage.
3. Unplug sensor cable assembly from body of sensor. Squeeze the mounting tabs and pull gently on connector until it disengages.
4. Unscrew all three of the mounting screws that hold the body of the sensor to the steering column body.
5. Slide the sensor over the column to remove. Take note if the sensor label is facing upward or downward.

### Installation:

1. Obtain a new sensor. The sensor is not repairable in the field.
2. Slide the sensor over the column. The center hub of the sensor must be aligned with the corresponding notch in the column. Different column manufacturers may implement this hub alignment in different ways. The sensor label should be facing in the same direction as the removed sensor.
3. Assemble to column non-moving plate with three self-locking screws.
4. Tighten screws to 65N to 100N.
5. Reconnect the connector. Ensure that there will be no force applied to the sensor because the connector is pulling on the sensor body.
6. If the wire harness leading to the sensor is being replaced, ensure that it is adequately tie wrapped so that the full motion of the steering column can be achieved without pulling apart the connectors.
7. Reinstall the column sheathing. The sensor is not protected against dirt or water intrusion, so care must be taken not to introduce these elements during installation.

### Steering Angle Sensor Calibration

The steering angle sensor calibration can only be achieved when the sensor is powered by the Advanced ABS ECU. No stand-alone sensor calibration can be carried out. The calibration procedure is performed using Bendix® ACom™ Diagnostic V4.0 or higher. See “Troubleshooting Diagnostic Trouble Codes: Steering Angle Sensor (SAS-60)” for the calibration procedure using this tool. The sensor must be recalibrated after any of these situations:

- Replacement of the steering angle sensor
- Any opening of the connector hub from the steering angle sensor to the column
- Any maintenance or repair work on the steering linkage, steering gear or other related mechanism
- Adjustment of the wheel alignment or wheel track
- After an accident that may have led to damage of the steering angle sensor or assembly

**WARNING: If the steering angle sensor is not properly recalibrated as needed, the yaw control system may not function properly, which can result in a loss of vehicle control.**

## REMOVAL OF THE YAW RATE/LATERAL ACCELERATION SENSOR

### Service Checks:

1. Check all wiring and connectors. Make sure all connections are free from visible damage.
2. Examine the sensor. Make sure the sensor, its mounting bolts, and the mounting bracket are not damaged.
3. Check vent hole in underbody of sensor housing. Vent hold should remain free from paint and debris at all times.

### **Diagnostics:**

The yaw rate sensor is only operational in conjunction with an Advanced ABS ECU. No independent diagnostics can be performed on the sensor.

### **Removal:**

1. Unplug sensor cable assembly from body of sensor. The connector must be twisted and pulled gently to release.
2. In some mounting configurations, the sensor can be removed independently from its mounting bracket. Otherwise, remove entire assembly, then remove sensor from bracket.
3. Take note of the direction in which the connector is pointed.

### **Installation:**

1. Obtain a new sensor. The sensor is not repairable in the field. **WARNING:** Only Bendix-approved replacement sensors must be used to prevent negatively affecting antilock system reliability and braking performance issues.
2. Assemble yaw rate sensor housing to mounting bracket. The bracket must be the same design as used on the original vehicle configuration.
3. Using three M8 size bolts, the fixing torque should be between 18 and 22N. The connector should be facing in the same direction as the removed sensor. The unit must not be installed upside-down where there is a pressure-balancing hole.
4. The sensor should be as level as possible and parallel to the road surface when installed on the vehicle.
5. Reconnect the connector. Ensure that there will be no force applied to the sensor because the connector is pulling on the sensor body.

**CAUTION: When removing or installing the sensor, care must be used to prevent damage. Do not strike or pry the sensor. Do not use an impact tool to install the mounting hardware.**

### **Sensor Location Modifications**

The location and orientation of the Yaw Rate Sensor must not be altered. When servicing, an identical component must be used in the same orientation (using OEM brackets & torque requirements). During installation follow the OEM leveling guidelines.

### **Yaw Rate Sensor Calibration:**

The yaw rate sensor calibration can only be achieved via the Advanced ABS ECU. The sensor must be recalibrated after any of these situations:

- Replacement of the sensor
- After an accident that may have led to damage of the yaw rate sensor

The calibration procedure is performed using Bendix® ACom™ Diagnostics V4.0 or higher.

See “Troubleshooting Diagnostic Trouble Codes: Yaw Rate Sensor” for the calibration procedure.

### **BRAKE DEMAND SENSOR CALIBRATION**

Calibration must be performed under the following conditions:

- After servicing any pressure sensor related DTCs
- Replacement of any sensor

The calibration procedure is performed using Bendix® ACom™ Diagnostics V4.0 or newer versions.

See “Troubleshooting Diagnostic Trouble Codes: Brake Demand Sensor/Load Sensor” for the calibration procedure.

### **PRESSURE SENSOR INSTALLATION REQUIREMENTS**

#### **Service Checks:**

1. Check all wiring and connectors. Make sure all connections are free from visible damage.
2. Examine the sensor. Make sure the sensor and its interface to the pressure location are not damaged.

#### **Diagnostics:**

The pressure sensor can be independently diagnosed when supplied with a five volt voltage supply to the B location and ground to the A location. Signal output on the C location should read approximately 0.5V if there is no pressure applied. The signal output should increase proportionately as pressure is applied, up to a maximum of 4.5V at 150 psi.

#### **Removal:**

1. Unplug sensor cable assembly from body of sensor. Pull gently on the mounting tab and connector until it disengages.
2. Remove sensor from its pressure mounting using approved air brake push in fitting tools.

#### **Installation:**

1. Obtain a new sensor. The sensor is not repairable in the field.
2. Insert sensor into pressure fitting using approved tools.
3. Reconnect the connector. Ensure that there will be no force applied to the sensor because the connector is pulling on the sensor body.
4. If the wire harness leading to the sensor is being replaced, ensure that it is adequately tie wrapped.

#### **Pressure Sensor Calibration:**

There is no need for pressure sensor calibration as long as the part replaced its identical to the part removed and a component approved for use with the Bendix Advanced ABS system. However, replacement of brake demand sensors or clearing of demand pressure sensor related DTCs require the following:

1. Use of ACom V4 or newer to clear the active p-sensor fault.
2. Carrying out the demand p-sensor initialization procedure which involves applying service brakes of 90 psi or greater for 3 sec (while stationary).

Once this procedure is carried out successfully, if there are no other active DTCs, ATC/ESP indicator will no longer illuminate.

# Troubleshooting: Blink Codes and Diagnostic Modes

## ECU DIAGNOSTICS

The EC-60™ controller contains self-testing diagnostic circuitry that continuously checks for the normal operation of internal components and circuitry, as well as external ABS components and wiring.

### Active Diagnostic Trouble Codes

When an erroneous system condition is detected, the EC-60™ controller:

1. Illuminates the appropriate indicator lamp(s) and disengages part or all of the ABS, ATC and ESP functions. (See ABS Partial Shutdown, on page 12.)
2. Places the appropriate trouble code information in the ECU memory.
3. Communicates the appropriate trouble code information over the serial communications diagnostic link as required. Hand-held or PC-based diagnostic tools attach to the vehicle diagnostic connector, typically located on or under the dash (see Figure 13).

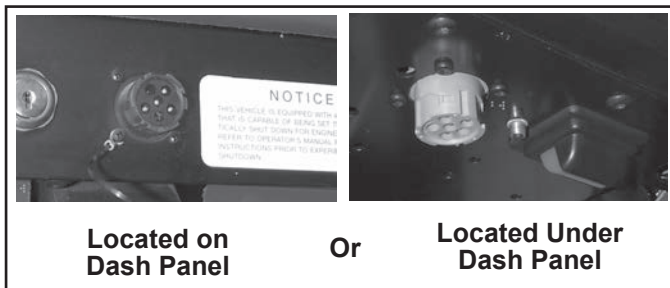


FIGURE 13 - TYPICAL VEHICLE DIAGNOSTIC CONNECTOR LOCATIONS (J1708/J1587, J1939)

## BLINK CODES

Blink codes allow a technician to troubleshoot ABS problems without using a hand-held or PC-based diagnostic tool. Instead, information about the ABS system is communicated by the ECU using the ABS indicator lamp to display sequences of blinks.

Note: The ECU will not enter the diagnostic blink code mode if the wheel speed sensors show that the vehicle is in motion. If the ECU is in the diagnostic blink code mode and then detects vehicle motion, it will exit the blink code mode.

In addition, by operating the blink code switch as described below, one of several diagnostic modes can be entered. See Diagnostic Modes below.

### Blink Code Switch Activation

When activating the blink code switch:

1. Wait at least two seconds after "ignition on." (Except when entering Reconfiguration Mode - see Reconfiguration section on page 12)
2. For the ECU to recognize that the switch is activated "on," the technician must press for at least 0.1 seconds, but less than 5 seconds. (If the switch is held for more than 5 seconds, the ECU will register a malfunctioning switch.)
3. Pauses between pressing the switch when a sequence is required, (e.g. when changing mode) must not be longer than 2 seconds.
4. After a pause of 3.5 seconds, the ECU will begin responding with output information blinks. See Figure 14 for an example.

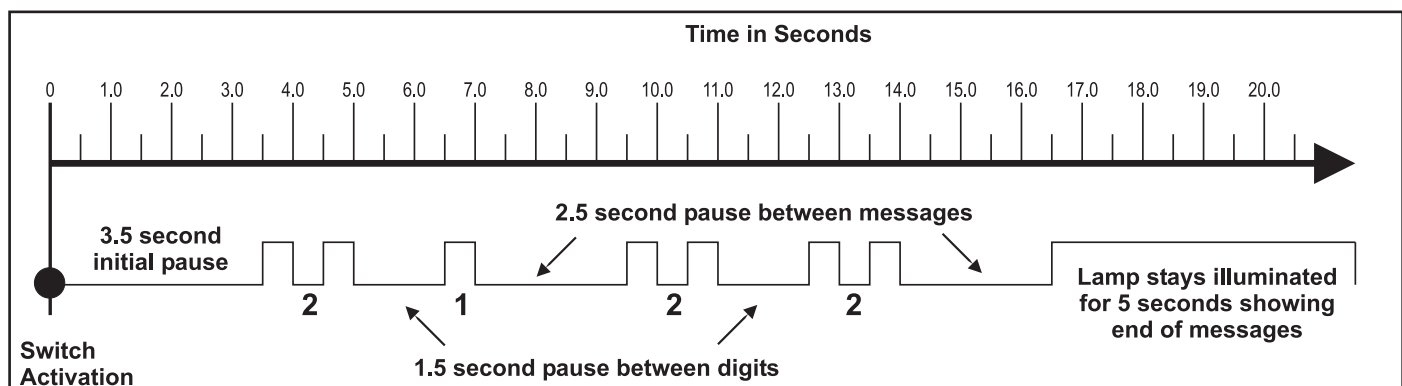


FIGURE 14 - EXAMPLE OF BLINK CODE MESSAGE



## Blink Code Timing

The ECU responds with a sequence of blink codes. The overall blink code response from the ECU is called a “message.” Each message includes, depending on the mode selected by the technician, a sequence of one or more groups of blinks. Simply record the number of blinks for each sequence and then use the troubleshooting index on page 21 for active or inactive trouble codes and you will be directed to the page that provides troubleshooting information.

### NOTE:

1. Sequences of blinks illuminate the ABS indicator lamp for half a second, with half-second pauses between them.
2. Pauses between blink code digits are 1.5 seconds.
3. Pauses between blink code messages are 2.5 seconds.
4. The lamp remains on for 5 seconds at the end of messages.

Once the ABS indicator lamp begins displaying a sequence of codes, it continues until all blink code messages have been displayed and then returns to the normal operating mode. During this time, the ECU will ignore any additional blink code switch activation.

All trouble codes, with the exception of voltage and J1939 trouble codes, will remain in an active state for the remainder of the power cycle.

Voltage trouble codes will clear automatically when the voltage returns within the required limits. All ABS functions will be re-engaged.

J1939 trouble codes will clear automatically when communications are re-established.

## DIAGNOSTIC MODES

In order to communicate with the ECU, the controller has several modes that the technician can select, allowing information to be retrieved, or other ECU functions to be accessed.

### Diagnostic Modes

To enter the various diagnostic modes:

No. of Times to Press the Blink Code Switch	System Mode Entered
1	Active diagnostic trouble code retrieval
2	Inactive diagnostic trouble code retrieval
3	Clear active diagnostic trouble codes
4	System configuration check
5	Dynamometer Test Mode
7*	Reconfigure ECU

\* To enter the Reconfiguration Mode, the switch must be held in before the application of ignition power. Once the power is supplied, the switch is released and then pressed seven times.

**CHART 2 - DIAGNOSTIC MODES**

### Active Diagnostic Trouble Code Mode

For troubleshooting, typically the Active and Inactive Diagnostic Trouble Retrieval Modes are used. The technician presses the blink code switch once and the ABS indicator lamp flashes a first group of two codes, and if there are more trouble codes recorded, this is followed by a second set of codes, etc. (See page 21 for a directory of these codes.) All active trouble codes may also be retrieved using a hand-held or PC-based diagnostic tool, such as the Bendix® ACom™ Diagnostics software.

To clear active diagnostic trouble codes (as problems are fixed), simply clear (or “self-heal”) by removing and re-applying ignition power. The only exception is for wheel speed sensor trouble codes, which clear when power is removed, re-applied, and the ECU detects valid wheel speed from all wheel speed sensors. Alternately, codes may be cleared by pressing the diagnostic blink code switch 3 times (to enter the Clear Active Diagnostic Trouble Code Mode) or by using a hand-held or PC-based diagnostic tool. Hand-held or PC-based diagnostic tools are able to clear wheel speed sensor trouble codes without the vehicle being driven.

### Inactive Diagnostic Trouble Code Mode

The ECU stores past trouble codes and comments (such as configuration changes) in its memory. This record is commonly referred to as “event history.” When an active trouble code is cleared, the ECU stores it in the event history memory as an inactive trouble code.

Using blink codes, the technician may review all inactive trouble codes stored on the ECU. The ABS indicator lamp will display inactive diagnostic blink codes when the diagnostic blink code switch is depressed and released two times. See page 20 for the index showing trouble codes and the troubleshooting guide page to read for help.

Inactive trouble codes, and event history, may be retrieved and cleared by using a hand-held or PC-based diagnostic tool, such as the Bendix® ACom™ Diagnostics software.

### Clearing Active Diagnostic Trouble Codes

The ECU will clear active trouble codes when the diagnostic blink code switch is depressed and released three times.

### System Configuration Check Mode

The ABS indicator lamp will display system configuration information when the diagnostic blink code switch is depressed and released four times. The lamp will blink out configuration information codes using the following patterns. (See Chart 3). In this mode the ECU tells the technician, by means of a series of seven blink codes, the type of ABS system that the ECU has been set up to expect. For example, if the fourth blink code is a two, the technician knows that a 6S/4M sensor/modulator configuration has been set.

### Dynamometer Test Mode

The Dynamometer Test Mode is used to disable ESP & ATC when needed (e.g. when performing any vehicle maintenance where the wheels are lifted off the ground and moving, including dyno testing). **For Advanced ABS controllers this mode will remain engaged even if power to the ECU is removed and re-applied.**

To exit the Dynamometer Test Mode, press and release the blink code switch three times, or use a hand-held or PC-based diagnostic tool.

### Reconfigure ECU Mode

Controller reconfiguration is carried out by using the Reconfigure ECU Mode. (See page 11.)

Note: To enter the Reconfiguration Mode, the blink code switch must be held in before the application of ignition power. Once the power is supplied, the switch is released and then pressed seven times.

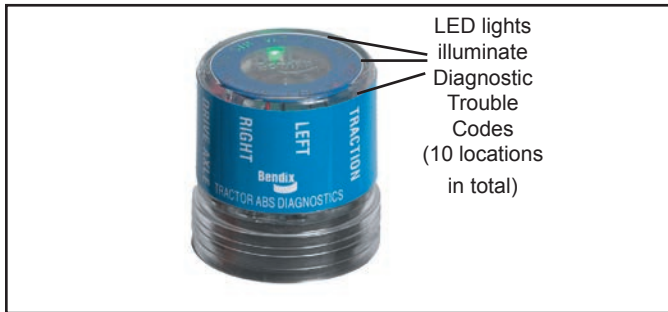
<b>1st Number</b>	<b>System Power</b>
1	12 Volts
<b>2nd Number</b>	<b>Wheel Speed Sensors</b>
4	4 Sensors
6	6 Sensors
<b>3rd Number</b>	<b>Pressure Modulator Valves</b>
4	4 Modulators
5	5 Modulators
6	6 Modulators
<b>4th Number</b>	<b>ABS Configuration</b>
1	4S/4M or 6S/6M
2	6S/4M
3	6S/5M
<b>5th Number</b>	<b>Traction Control Configuration</b>
2	No ATC
3	ATC Engine Control Only
4	ATC Brake Control Only
5	Full ATC (Engine Control & Brake Control)
<b>6th Number</b>	<b>Retarder Configuration</b>
1	No Retarder
2	J1939 Retarder
3	Retarder Relay
4	J1939 Retarder, Retarder Relay
<b>7th Number</b>	<b>Stability Configuration</b>
1	No Stability Program
2	Electronic Stability Program (ESP), which includes RSP
3	Roll Stability Program (RSP) Only

**CHART 3 - SYSTEM CONFIGURATION CHECK**

# Troubleshooting: Using Hand-Held or PC-Based Diagnostic Tools

## USING HAND-HELD OR PC-BASED DIAGNOSTICS

Troubleshooting and diagnostic trouble code clearing (as well as reconfiguration) may also be carried out using hand-held or PC-based diagnostic tools such as the Bendix® Remote Diagnostic Unit (RDU™), Bendix® ACom™ Diagnostics software, or the ProLink tool.



**FIGURE 15 - THE BENDIX® REMOTE DIAGNOSTIC UNIT**

### Bendix® RDU™ (Remote Diagnostic Unit)

The Bendix® RDU™ tool provides the technician with a visual indication of Antilock Braking System (ABS) component **Diagnostic Trouble Code (DTC)** information. The RDU™ tool is specifically designed for use with Bendix® ABS systems and Bendix makes no claims for its operation and/or usability with other brands of ABS systems.

### Features of the Bendix® RDU™ Tool

The RDU™ tool attaches to the 9 pin diagnostic connector in the cab of the vehicle. An adapter cable (Bendix part number 801872) is available to connect the RDU to vehicles with a 6-pin diagnostic connector.

The RDU™ tool allows the technician to:

- Troubleshoot ABS system component problems using Diagnostic Trouble Code reporting via LEDs.
- Reset Diagnostic Trouble Codes on Bendix® ABS ECUs by holding a magnet over the reset in center of RDU™ tool for less than 6 seconds.
- Enter the Self-Configuration Mode used by Bendix® ABS ECUs by holding a magnet over the reset area for greater than 6 seconds but less than 30 seconds.

### How the Bendix® RDU™ Operates

See Figure 9 for typical vehicle connector locations.

When the RDU™ tool is plugged into the diagnostic connector, all the LEDs will illuminate, and the green LED will flash 4 times to indicate communications have been established.

If the ABS ECU has no active Diagnostic Trouble Codes, only the green LED will remain illuminated.

If the ABS ECU has at least one active Diagnostic Trouble Code the RDU™ tool displays the first diagnostic trouble code by illuminating the red LEDs, indicating the malfunctioning ABS component and its location on the

vehicle. (See Figure 15.) If there are multiple diagnostic trouble codes on the ABS system, the RDU™ tool will display one diagnostic trouble code first, then once that Diagnostic Trouble Code has been repaired and cleared, the next code will be displayed.

- MOD red LED illuminated, shows the "Common" connection of one or more modulators is shorted to battery or ground
- VLT (Flashing indicates either over- or under-voltage condition)

Typical Combination Diagnostic Trouble Codes are:

- Right steer sensor
- Left steer sensor
- Right drive sensor
- Left drive sensor
- Right additional sensor
- Left additional sensor
- Right steer modulator
- Left steer modulator
- Right drive modulator
- Left drive modulator
- Right additional modulator
- Left additional modulator
- Rear Axle Traction modulator
- ECU
- Engine serial communication

To pinpoint the root cause and to ensure the system diagnostic trouble code is properly corrected the first time, additional troubleshooting may be necessary. Note: The RDU is not capable of diagnosing ESP-specific diagnostic trouble codes including additional sensors: steering angle sensors, yaw sensors, pressure sensors, or modulator valves (trailer pressure modulating valves or front axle traction control valves.)

### Bendix® RDU™ Reset Function

The magnetic reset switch is located in the center top of the RDU™ tool. Activation requires a magnet with 30 gauss minimum.

The reset operations are:

1. If the magnet is held over the switch for less than 6 seconds the "clear current diagnostic trouble codes" command is sent.
2. If the magnet is held over the switch for more than 6 seconds, but less than 30 seconds, the Bendix® ABS "self-configuration command" is sent.

Additionally, it is recommended at the end of any inspection that the user switches off and restores the power to the ABS ECU, then check the ABS Indicator Lamp operation and RDU™ tool to see if they indicate any remaining Diagnostic Trouble Codes.

### Bendix® RDU™ Communication Problems

If the ABS ECU does not respond to the RDU™ tool's request for diagnostic trouble codes, the RDU™ tool will

### LED Diagnostic Trouble Codes

LFT - Left	ECU - ABS Controller
RHT - Right	SEN - Wheel Speed Sensor
DRV - Drive Axle	MOD - Pressure Modulator Valve
ADD - Additional	TRC - Traction Control
STR - Steer Axle	
VLT - Power	

Example: If the Diagnostic Trouble Code is "Right Steer Axle Sensor", the RDU™ unit will display one green and three red



LEDs  
Green  
VLT  
Red  
SEN  
STR

**FIGURE 16 - DIAGNOSTIC TROUBLE CODES**

illuminate each red LED in a clockwise pattern. This pattern indicates the loss of communication and will continue until the ABS ECU responds and communication has been established.

Possible sources of communication problems are:

1. A problem with the J1587 link at the in-cab off-board diagnostic connector (9 or 6 Pin).
2. The ECU does not support PID194.
3. No power is being supplied to the ECU and/or the diagnostic connector.
4. The J1587 bus is overloaded with information and the RDU can not arbitrate access.
5. A malfunctioning RDU™ tool.

### Nexiq Bendix Application Card

Nexiq provides a Bendix application card for use with the ProLink tool. It can also be used to diagnose the EC-30™, EC-17™, Gen 4™, Gen 5™, and MC-30™ ABS Controllers.

For more information on the Bendix application card visit [www.bendix.com](http://www.bendix.com), Nexiq at [www.nexiq.com](http://www.nexiq.com), or your local authorized Bendix parts outlet.

### Bendix® ACom™ Diagnostics V4.0 Software

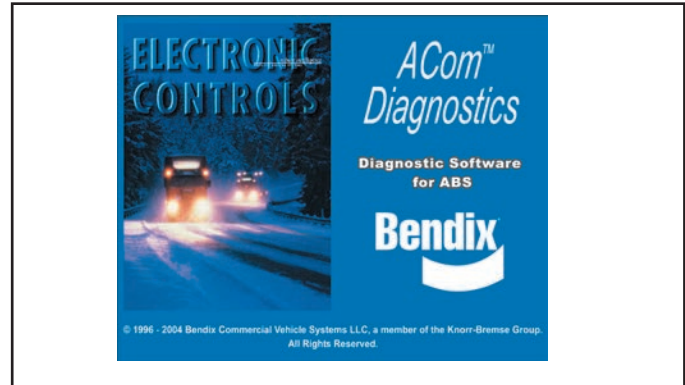
Bendix® ACom™ Diagnostics V4.0 is a PC-based software program and is designed to meet RP-1210 industry standards developed by the Truck Maintenance Council (TMC). This software provides the technician with access to all the available ECU diagnostic information and configuration capability, including:

- ECU information
- Diagnostic trouble codes and repair information
- Configuration (ABS, ATC, and more)
- Wheel speed information
- Perform component tests
- Save and print information

ACom™ Diagnostics V4.0 software is required to calibrate the Steering Angle Sensor, the Yaw Rate/Lateral Acceleration Sensor, the Brake Demand Sensors and the Load Sensor.



**FIGURE 17 - NEXIQ (MPSI) PRO-LINK TOOL**



**FIGURE 18 - BENDIX® ACOM™ DIAGNOSTICS**

When using ACom™ Diagnostics V4.0 software to diagnose the EC-60™ ABS ECU, the computer's serial or parallel port needs to be connected to the vehicle's diagnostic connector.

For more information on ACom™ Diagnostics software or RP1210 compliant tools, go to [www.bendix.com](http://www.bendix.com) or visit your local authorized Bendix parts outlet.

See Page 44 for Appendix A: J1587 SID and FMI codes and their Bendix blink code equivalents.

### www.bendix.com

Visit Bendix online for the latest information, and ways to find the Bendix contacts you need. Contact technical support, service engineers, Bendix account managers, and more — [www.bendix.com](http://www.bendix.com) is your complete Bendix resource.

### Bendix Technical Assistance Team

For direct telephone technical support, call the Bendix technical assistance team at:

**1-800-AIR-BRAKE (1-800-247-2725),**

Monday through Friday, 8:00 A.M. to 6:00 P.M. EST, and follow the instructions in the recorded message.

Or, you may e-mail the Bendix technical assistance team at: [tbs.techteam@bendix.com](mailto:tbs.techteam@bendix.com).

# Active or Inactive Diagnostic Trouble Codes:

## INDEX

How to interpret the first digit of messages received when Active or Inactive Diagnostic Trouble Code Mode

1st Blink Code Number	Go Here for Troubleshooting Tests
1	No faults (1,1)
2	Wheel Speed Sensors - page 22
3	Wheel Speed Sensors - page 22
4	Wheel Speed Sensors - page 22
5	Wheel Speed Sensors - page 22
6	Power Supply - page 27
7	Pressure Modulator Valves - page 24
8	Pressure Modulator Valves - page 24
9	Pressure Modulator Valves - page 24
10	Pressure Modulator Valves - page 24
11	J1939 - page 28
12	Miscellaneous - pages 30-31
13	ECU - page 29
14	Wheel Speed Sensors - page 22
15	Wheel Speed Sensors - page 22
16	Pressure Modulator Valves - page 24
17	Pressure Modulator Valves - page 24
18	Drive Axle Traction Control Valve - page 26
19	Steer Axle Traction Control Valve - page 26
20	Trailer Pressure Modulator Valve - page 24
21	Steering Angle Sensor - pages 33-33
22	Yaw Rate Sensor - pages 34-35
23	Lateral Acceleration Sensor - page 36
24	Brake Demand/Load Sensors - page 37

Example: For a message sequence of:

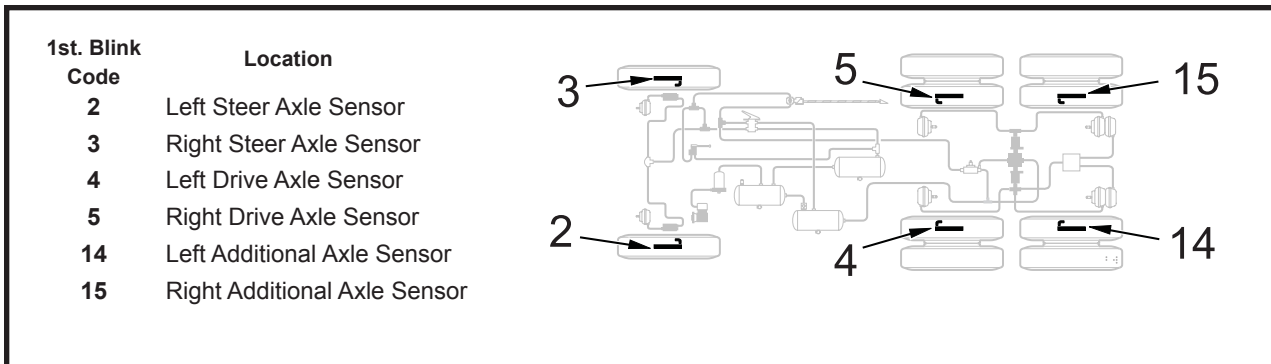
**3, 2 12, 4**

For the first sequence go to page 22 and for the second sequence go to page 30.

See Page 43 for Appendix A: J1587 SID and FMI Codes and Their Bendix Blink Code Equivalents



# Troubleshooting Diagnostic Trouble Codes: Wheel Speed Sensors



2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	Excessive Air Gap	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping.
2	Output Low at Drive-off	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping.
3	Open or Shorted	Verify 1500 – 2500 ohms across sensor leads. Verify no continuity between sensor leads and ground or voltage. Verify no continuity between sensor leads and other sensors. Check for corroded/damaged wiring or connectors between the ECU and the wheel speed sensor.
4	Loss of Sensor Signal	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping. Check for corroded/damaged wiring or connectors between the ECU and the wheel speed sensor.
5	Wheel End	Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping. Check mechanical function of brake. Check for kinked or restricted air lines.
6	Erratic Sensor Signal	Adjust sensor to contact exciter ring. Rotate wheel and verify a minimum of 0.25 VAC sensor output at ~ 0.5 RPS. Verify condition of sensor head. Verify mounting of exciter ring and condition of teeth. Verify proper bearing end-play. Verify condition and retention of clamping sleeve. Verify sensor lead routing and clamping. Check for corroded/damaged wiring or connectors between the ECU and the wheel speed sensor.
7	Tire Size Calibration	Verify correct tire size as desired. Verify proper tire inflation. Verify correct number of exciter ring teeth.
10	Configuration Error	ECU is configured for four sensors, but has detected the presence of additional sensors. Verify sensor wiring and ECU configuration.

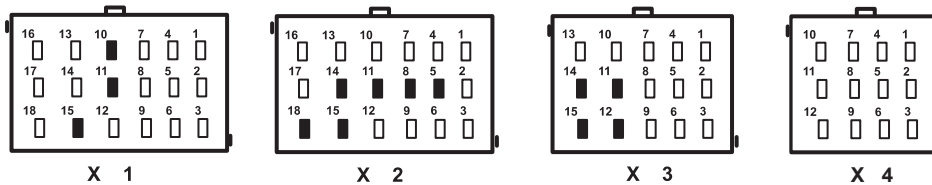
## Speed Sensor Repair Tests:

1. Take all measurements at ECU harness connector pins in order to check wire harness and sensor.  
Probe the connector carefully so that the terminals are not damaged.
2. Wheel speed sensor measurements should read:

Location	Measurement
Sensor	1500 - 2500 Ohms
Sensor to voltage or ground	Open Circuit (no continuity)
Sensor output voltage	>0.25 of VAC sensor output at ~ 0.5 revs/sec.

3. Clear DTC after issue is corrected. The sensor DTC will remain until the power is cycled to the ABS ECU and vehicle is driven above 15 MPH or DTC was cleared using either the diagnostic blink code switch or diagnostic tool.

### Cab-mount ECU: Looking into wire harness connector

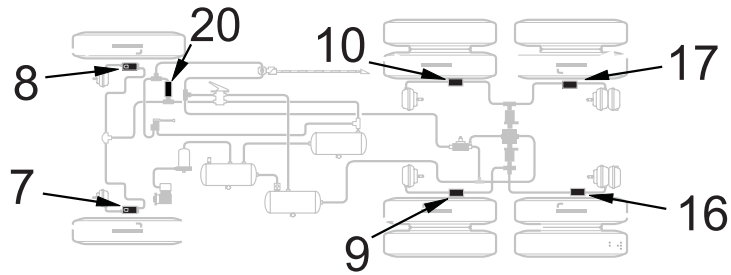


Connector	Pin	Wheel Speed Sensor Location
X1 18 Way	10	Right Drive Axle (+)
	11	Right Drive Axle (-)
X2 18 Way	5	Left Steer Axle (+)
	8	Left Steer Axle (-)
	11	Right Steer Axle (+)
	14	Right Steer Axle (-)
X3 15 Way (if ECU is configured for 6 sensors)	15	Left Drive Axle (+)
	18	Left Drive Axle (-)
	11	Left Additional Axle (+)
	14	Left Additional Axle (-)
	12	Right Additional Axle (+)
	15	Right Additional Axle (-)

# Troubleshooting Diagnostic Trouble Codes: Pressure Modulator Valves

## 1st. Blink Code

1st. Blink Code	Location
7	Left Steer Axle
8	Right Steer Axle
9	Left Drive Axle
10	Right Drive Axle
16	Left Additional Axle
17	Right Additional Axle
20	Trailer PMV



## 2nd. Diagnostic Blink Code Description

## Repair Information

1	Release Solenoid Shorted to Ground	Verify no continuity between PMV leads and ground. Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
2	Release Solenoid Shorted to Voltage	Verify no continuity between PMV leads and voltage. Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
3	Release Solenoid Open Circuit	Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
4	Hold Solenoid Shorted to Ground	Verify no continuity between PMV leads and ground. Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
5	Hold Solenoid Shorted to Voltage	Verify no continuity between PMV leads and voltage. Verify 4.9 to 5.5 ohms from REL to CMN & HLD CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between ECU and PMV.
6	Hold Solenoid Open Circuit	Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between the ECU and PMV.
7	CMN Open Circuit	Verify 4.9 to 5.5 ohms from REL to CMN & HLD to CMN, and 9.8 to 11 ohms from REL to HLD. Check for corroded/damaged wiring or connectors between the ECU and PMV.
8	Configuration Error	A mis-match exists between the ECU configuration and the modulator installation and wiring. Verify PMV wiring and installation. Verify ECU configuration.



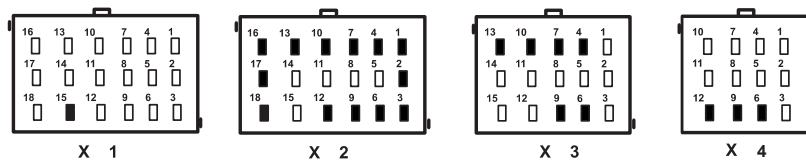
## Pressure Modulator Valve Repair Tests:

1. Take all measurements at ECU harness connector pins in order to check wire harness and PMV. Probe the connector carefully so that the terminals are not damaged.
2. Pressure modulator resistance should read:

Location	Measurement
Release to Common	4.9 to 5.5 Ohms
Hold to Common	4.9 to 5.5 Ohms
Release to Hold	9.8 to 11.0 Ohms
Release, Hold, Common to Voltage or Ground	Open Circuit (no continuity)

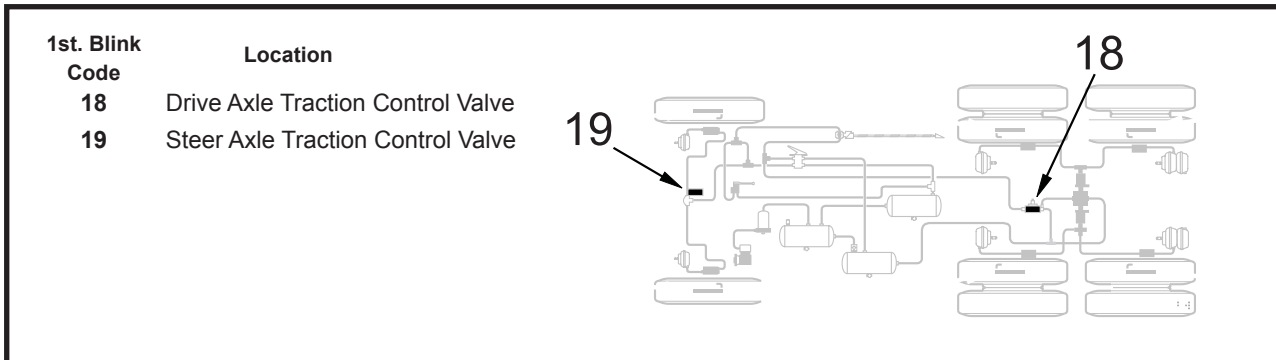
**Caution:** When troubleshooting modulator trouble codes, check inactive trouble codes and event history for over-voltage or excessive noise trouble codes. If one of these is found, troubleshoot these trouble codes first before the PMV.

### Cab-mount ECU: Looking into wire harness connector



Connector	Pin	PMV Location	
X2 18 Way	1	Left Steer Axle Hold	
	2	Left Steer Axle Release	
	3	Left Steer Axle Common	
	4	Right Steer Axle Hold	
	6	Right Steer Axle Common	
	7	Right Steer Axle Release	
	9	Right Drive Axle Common	
	10	Right Drive Axle Hold	
	13	Right Drive Axle Release	
	12	Left Drive Axle Common	
	16	Left Drive Axle Hold	
	17	Left Drive Axle Release	
	4	Left Additional Axle Hold	
	X3 15 Way (if ECU is configured for 6 modulators)	6	Left Additional Axle Common
		7	Left Additional Axle Release
		9	Right Additional Axle Common
		10	Right Additional Axle Hold
X4 12 Way	13	Right Additional Axle Release	
	6	Trailer PMV Hold	
	9	Trailer PMV Release	
	12	Trailer PMV Common	

# Troubleshooting Diagnostic Trouble Codes: Traction Control Valves



2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	TCV Solenoid Shorted to Ground	Verify 7 to 19 ohms between TCV and TCV common. Verify no continuity between TCV leads and ground. Check for corroded/damaged wiring or connectors between ECU and TCV.
2	TCV Solenoid Shorted to Voltage	Verify 7 to 19 ohms between TCV and TCV common. Verify no continuity between TCV leads and voltage. Check for corroded/damaged wiring or connectors between ECU and TCV.
3	TCV Solenoid Open Circuit	Verify 7 to 19 ohms between TCV and TCV common. Check for corroded/damaged wiring or connectors between ECU and TCV.
4	TCV Configuration Error	The ECU is not configured for ESP or ATC, but has detected the presence of a TCV. Verify TCV wiring. Inspect for the presence of a TCV. Verify ECU configuration.

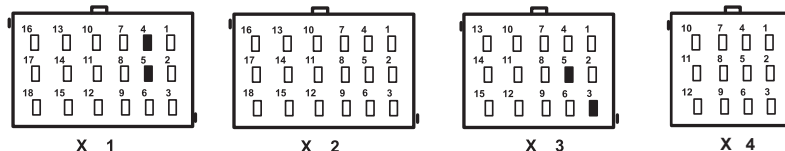
## Traction Control Valve Repair Tests:

1. Take all measurements at ECU harness connector pins in order to check wire harness and traction control valve. Probe the connector carefully so that the terminals are not damaged.

Location	Measurement
TCV to TCV Common	7 to 19 Ohms
Release, Hold, Common to Voltage or Ground	Open Circuit (no continuity)

## Cab-mount ECU:

### Looking into wire harness connector



Connector	Pin	Traction Control Test
X1	4	Drive Axle Traction Control Valve Common
18 Way	5	Drive Axle Traction Control Valve

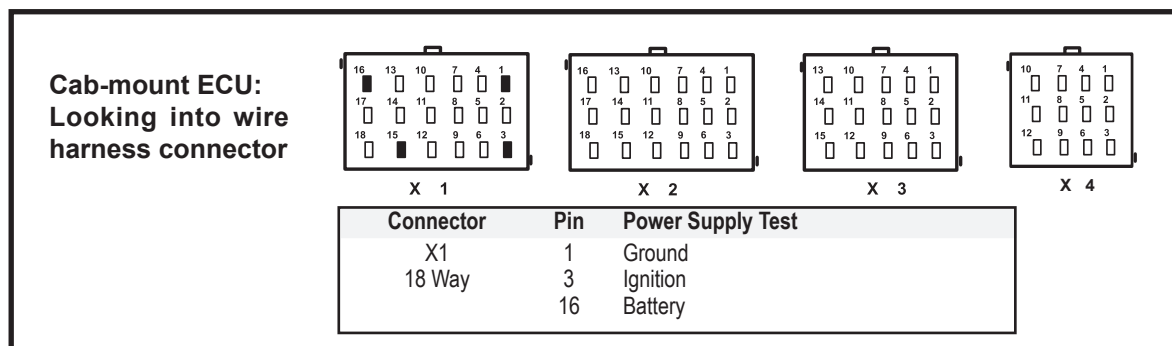
Connector	Pin	Traction Control Test
X3	3	Steer Axle Traction Control Valve Common
15 Way	5	Steer Axle Traction Control Valve

# Troubleshooting Diagnostic Trouble Codes: Power Supply

1st. Blink Code	Location	2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
6	Power Supply			
1	Battery Voltage Too Low			Measure battery voltage under load. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
2	Battery Voltage Too High			Measure battery voltage under load. Ensure that battery voltage is correct for the model of ECU. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
3	Battery Voltage Too Low During ABS			Measure battery voltage under load. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
4	Battery Voltage Open Circuit			Measure battery voltage under load. Check condition of fuse. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
5	Ignition Voltage Too Low			Measure ignition voltage under load. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections. Check condition of fuse.
6	Ignition Voltage Too High			Measure ignition voltage. Ensure that ignition voltage is correct for the model of ECU. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
7	Ignition Voltage Too Low During ABS			Measure ignition voltage under load. Check vehicle battery and associated components. Check for damaged wiring. Check for damaged or corroded connectors and connections.
8	Input Voltage Has Excessive Noise (Temporary)			Check alternator output for excessive noise. Check for other devices causing excessive noise.
9	Input Voltage Has Excessive Noise			Check alternator output for excessive noise. Check for other devices causing excessive noise.

## Power Supply Tests:

- Take all measurements at ECU harness connector.
- Place a load (e.g. an 1157 stop lamp) across battery or ignition and ground connection, measure ignition and battery voltage with the load. Ignition to Ground should measure between 9 to 17 VDC. Battery to Ground should also measure between 9 to 17 VDC.
- Check for damaged wiring, damaged or corroded connectors and connections.
- Check condition of vehicle battery and associated components, ground connection good and tight.
- Check alternator output for excessive noise.



# Troubleshooting Diagnostic Trouble Codes: J1939 Serial Communications

1st. Blink Code	Location		
11	J1939		
2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information	
1	J1939 Serial Link	Loss of communications between the EC-60™ controller and other devices connected to the J1939 link. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify ECU Configuration. Check for other devices inhibiting J1939 communications.	
2	J1939 Retarder	Loss of communications between the EC-60™ controller and other devices connected to the J1939 link. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify presence of retarder on the J1939 link. Verify ECU Configuration. Check for other devices inhibiting J1939 communications.	
3	J1939 Engine Communications	Loss of communications between the EC-60™ controller and the engine ECU over the J1939 link. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors. Verify presence of engine ECU on the J1939 link. Verify ECU Configuration. Check for other devices inhibiting J1939 communications.	
4	J1939 Invalid Data (Engine Retarder)	Invalid data received from the engine or retarder. Check for damaged or reversed J1939 wiring. Check for damaged or corroded connectors. Verify presence of engine and/or retarder on J1939. Verify proper programming of engine and/or retarder. Check for other devices inhibiting J1939 communications.	
5	J1939 Supply Pressure	Invalid pressure signals received from a vehicle controller. Verify proper operation of brake demand sensors. Check wiring between brake demand sensors and the vehicle controller. Verify proper programming of vehicle controller. Check for damaged or reversed J1939 wiring. Check for damaged or corroded connectors. Check for other devices inhibiting J1939 communications.	
6	J1939 ESP Messages Invalid Data	Invalid ESP messages on the J1939 link. Check for damaged or reversed J1939 wiring. Check for damaged or corroded connectors. Verify presence of engine and/or retarder on J1939. Verify proper programming of engine and/or retarder. Check for other devices inhibiting J1939 communications.	

## J1939 Troubleshooting Tests:

1. Take all measurements at ECU harness connector
2. Check for damaged or reversed J1939 wiring
3. Check for corroded or damaged wiring connector problems such as (opens or shorts to voltage or ground)
4. Check for other J1939 devices which may be loading down (inhibiting) J1939 communication

**Cab-mount ECU:**  
**Looking into wire harness connector**

Connector	Pin	J1939
X1	7	J1939 Low
18 Way	8	J1939 High

# Troubleshooting Diagnostic Trouble Codes: ECU

<b>1st. Blink Code</b>	<b>Location</b>
13	ECU

<b>2nd. Blink Code</b>	<b>Diagnostic Trouble Code Description</b>	<b>Repair Information</b>
------------------------	--	---------------------------

1	ECU (02)	
2	ECU (10)	
3	ECU (11)	
4	ECU (12)	
5	ECU (13)	
6	ECU (14)	
7	ECU (15)	
8	ECU (16)	
9	ECU (17)	
10	ECU (18)	
11	ECU (1A)	
12	ECU (1B)	
13	ECU (80)	
14	ECU (04)	
15	ECU (06)	
16	ECU (0E)	
17	ECU (0D)	
18	ECU (19)	
19	ECU (1C)	
20	ECU (27)	
21	ECU (1D)	
22	ECU (1E)	
23	ECU (28)	
24	ECU (37)	
25	ECU Internal VIN Mismatch - The ECU internally-stored VIN does not match the VIN of the vehicle. Ensure that the ECU is installed on the correct vehicle. Verify ECU programming. Verify engine programming.	

2-24: Check for damaged or corroded connectors. Check for damaged wiring. Clear trouble codes. If diagnostic trouble codes return, replace the ECU.

# Troubleshooting Diagnostic Trouble Codes: Miscellaneous

1st. Blink Code	Location	
12	Miscellaneous	
2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	Stop Lamp Switch Not Detected	ECU has not detected the presence of the stop lamp switch since ignition power was applied (note that stop lamp switch input may be applied to the EC-60™ controller using either hardwire input or J1939). Apply and release service brake. Check for brake switch input into ECU (see system wiring schematic). With service brake released, check for presence of the stop lamp bulb. With service brake applied, verify system voltage is now present at the stop lamp switch input to the ECU. Check for damaged wiring between ECU, stop lamp switch and bulb. Check for corroded or damaged connectors. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors on J1939 link. Verify presence of engine ECU on the J1939 link. Verify ECU configuration.
2	Stop Lamp Switch Defective	Apply and release service brake. Check for brake switch input into ECU (see system wiring schematic). With service brake released, check for presence of the stop lamp bulb. With service brake applied, verify system voltage is now present at the stop lamp switch input to the ECU. Check for damaged wiring between ECU, stop lamp switch and bulb. Check for corroded or damaged connectors. Check for damaged or reversed J1939 wiring. Check for corroded or damaged connectors on J1939 link. Verify presence of engine ECU on the J1939 link. Verify ECU configuration.
3	Dynamometer Test Mode	ECU has been placed in the Dynamometer Test Mode by either the diagnostic blink code switch or a hand-held or PC-based diagnostic tool. ATC is disabled.
4	Retarder Relay Open Circuit or Shorted to Ground	Verify vehicle contains a retarder relay. Verify ECU configuration. Check wiring between ECU and retarder relay. Verify no continuity between retarder disable output of EC-60™ controller and ground. Verify condition and wiring of the retarder relay.
5	Retarder Relay Circuit Shorted to Voltage	Check wiring between ECU and retarder relay. Verify no continuity between retarder disable output of EC-60™ controller and voltage. Verify condition and wiring of the retarder relay.
6	ABS Indicator Lamp Circuit DTC	Check operation of diagnostic blink code switch. Check wiring of diagnostic blink code switch and ABS WL. Verify ABS WL ground input.
7	PMV Common Shorted to Ground	Verify no continuity between the CMN of all PMVs, TCV, and Diff Lock Solenoid and ground. Check for corroded/damaged wiring or connectors between the ECU and CMN of all PMVs, TCV, and Diff Lock Solenoid.
8	PMV Common Shorted to Voltage	Verify no continuity between the CMN of all PMVs, TCV, and Diff Lock Solenoid and voltage. Check for corroded/damaged wiring or connectors between the ECU and CMN of all PMVs, TCV, and Diff Lock Solenoid.
9	ATC Disabled to Prevent Brake Fade	ATC is temporarily disabled to prevent excessive heating of the foundation brakes.
10	Tire Size Out of Range (Front to Rear)	Verify correct tire size as desired. Verify proper tire inflation. Verify correct number of exciter ring teeth. Verify that the ECU has the proper tire size settings.
11	Wheel Speed Sensors Reversed on an Axle	Sensors are reversed (left to right) on one of the axles. Verify proper installation, connection, and wiring of the sensors.
12	Diff. Lock Solenoid Shorted to Ground or Open Circuit	Verify no continuity between the Diff Lock Solenoid and ground. Check for corroded/damaged wiring or connectors between the ECU and Diff Lock Solenoid.
13	Diff. Lock Solenoid Shorted to Voltage	Verify no continuity between the Diff Lock Solenoid and voltage. Check for corroded/damaged wiring or connectors between the ECU and Diff Lock Solenoid.
14	Sensor CAN Supply Voltage Error	Incorrect supply voltage for the SAS-60 and the YAS-60. Verify proper voltage at sensor connectors. Verify wiring between the ECU and the sensors. Verify proper output voltage from ECU.
15 - 21	Reserved	
22	ESP Sensor Voltage Out of Range	Incorrect supply voltage for the SAS-60 and the YAS-60. Verify proper voltage at sensor connectors. Verify wiring

# Miscellaneous Troubleshooting (continued)

For all tests below, take all measurements at ECU harness connector pins in order to check wire harness and sensor. Probe the connector carefully so that the terminals are not damaged.

## Stop Lamp Switch Test

Test	Measurement
Stop Lamp Switch to Ground	9 to 17 VDC

- Apply and release service brake, does lamp extinguish?
- Verify brake lamp switch is connected to ECU via hard wire or J1939.

## Dynamometer Test Mode (ATC/ESP Indicator Lamp Continuously Illuminated)

- Clear the dynamometer test mode by depressing and releasing the blink code switch three times (or use an off-board diagnostic tool).

## ABS Indicator Lamp

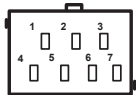
- Verify diagnostic blink code switch is open when not activated.

## Steering Angle Sensor and Yaw Rate/Lateral Acceleration Sensor

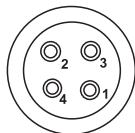
- Measure resistance between input voltage and ground at the sensor wiring harness connector.

Test	Measurement
Power and Ground Input	8 to 16 volts

### Looking into wire harness connector



SAS Connector



Yaw Connector

Connector	Pin	PMV Location
SAS	2	Voltage Input
	1	Ground Input
YAS	1	Voltage Input
	2	Ground Input

## Retarder Relay

- Measure resistance between retarder disable output of EC-60™ controller and voltage / ground.

Test	Measurement
Retarder disable to Voltage or Ground	Open Circuit (no continuity)

- Verify vehicle has retarder relay.
- Verify proper wiring from ECU to retarder relay.

## PMV Commons

- Measure resistance between any common (PMV, TCV, and Diff.) and voltage or ground.

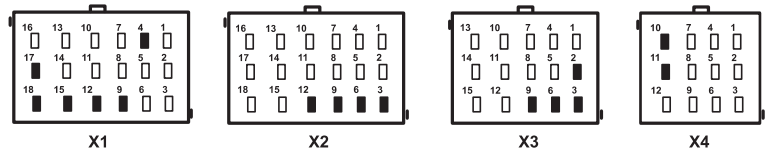
Test	Measurement
Any PMV, TCV, or Diff. Common to Voltage or Ground	Open Circuit (no continuity)

## Differential Lock Solenoid

- Measure resistance between Diff lock solenoid and voltage or ground.

Test	Measurement
Diff. Lock Solenoid to Voltage or Ground	Open Circuit (no continuity)

## Cab-mount ECU: Looking into wire harness connector



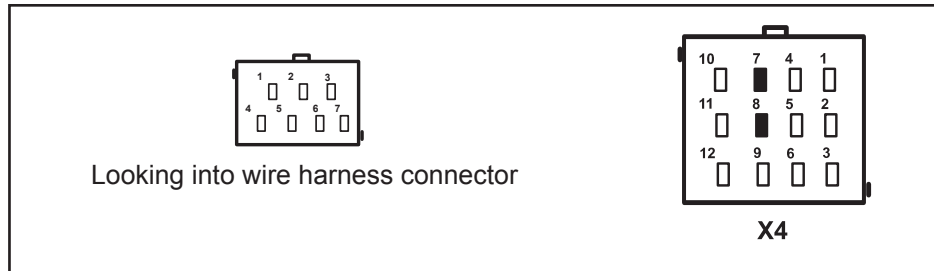
Connector	Pin	PMV Location
X1 18 Way	4	TCV Common
	9	Stop Lamp Switch
	12	ABS WL Ground
	15	ABS WL Interlock
	17	Retarder
X2 18 Way	18	ABS WL
	3	PMV Left Steer Axle Common
X3 15 Way	6	PMV Right Steer Axle Common
	9	PMV Right Drive Axle Common
	12	PMV Left Drive Axle Common
X4 12 Way	2	Diff Lock Solenoid
	3	Diff Lock Solenoid Common
X4 12 Way	6	PMV Left Additional Axle Common
	9	PMV Right Additional Axle Common
X4 12 Way	11	SAS-60/YAS-60 Voltage Input
	10	SAS-60/YAS-60 Ground Input

# Troubleshooting Diagnostic Trouble Codes: Steering Angle Sensor (SAS-60™ sensor)

1st. Blink Code	Location	
21	Steering Angle Sensor	
2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	SAS Not Calibrated	SAS has not been calibrated. Perform SAS calibration procedure.
2	SAS Calibration in Progress	SAS calibration procedure is underway.
3	SAS Static Signal	SAS signal incorrect. Verify proper installation of the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output.
4	SAS Signal Out of Range	SAS signal incorrect. Verify proper installation of the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output. Perform SAS calibration procedure.
5	SAS Signal Reversed	SAS signal is reversed. Verify proper installation of the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output.
6	SAS Invalid Signal	SAS signal is invalid. Verify proper installation of the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output. Verify that correct SAS is being used.
7	SAS Gradient Error	SAS signal is invalid. Verify proper installation of the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output. Verify that correct SAS is being used.
8	SAS CAN Timeout	Loss of CAN communications between the ECU and the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output.
9	SAS Long Term Calibration Error	SAS calibration error. Verify proper installation of the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output. Verify that correct SAS is being used. Verify proper ECU programming. Perform SAS calibration procedure.
10	SAS Plausibility Check	ECU has detected incorrect SAS signal as compared to the YAS-60 signal. Verify proper installation of the SAS. Verify proper wiring between the ECU and the SAS. Check SAS output. Verify that correct SAS is being used. Verify proper ECU programming. Perform SAS calibration procedure.



# Troubleshooting Diagnostic Trouble Codes: Steering Angle Sensor (SAS-60™ sensor) (continued)



## Steering Angle Sensor Tests

1. Measure resistance between input voltage and ground at the sensor wiring harness connector.

Test	Measurement
Power and Ground Input	8 to 16 volts
2 = Power Input	
1 = Ground Input	

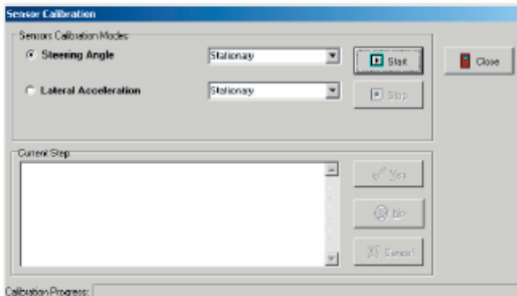
2. Verify wiring between the Steering Angle Sensor and the ECU.

SAS Wire Harness Terminal	ECU Wire Harness Terminal	Measurement
4	7	Verify Continuity
3	8	Verify Continuity

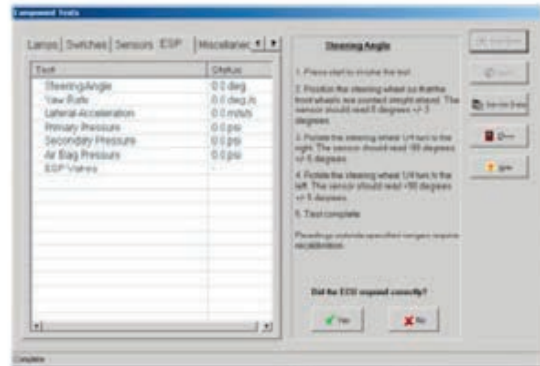
3. Verify wiring between the Steering Angle Sensor and power/ground.

SAS Wire Harness Terminal	Measurement
4 to Voltage & Ground	Verify open circuit (no continuity)
3 to Voltage & Ground	Verify open circuit (no continuity)

4. To perform a calibration procedure of the Steering Angle Sensor, ACom™ Diagnostics V4.0 is required. Using the program, select the “Configuration” option, followed by the “Calibrate” option. The following screen should be displayed.



5. Follow the prompts to perform a calibration of the Steering Angle Sensor.
6. To test the Steering Angle Sensor, ACom V4.0 is required. Using Bendix ACom V4.0, select the “Component Test” option, followed by the “ESP Test” option. The following screen should be displayed.



7. Follow the prompts to perform a test of the Steering Angle Sensor.

# Troubleshooting Diagnostic Trouble Codes: Yaw Rate Sensor (YRS)

1st. Blink Code	Location	
22	Yaw Rate Sensor	
2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	YRS Signal Out of Range	YRS signal incorrect. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Perform YRS calibration procedure.
2	YRS Sensor Reversed Signal	YRS signal is reversed. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output.
3	YRS Invalid Signal	YRS signal is invalid. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used.
4	YRS Gradient Error	YRS signal is invalid. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used.
5	YRS CAN Timeout	Loss of CAN communications between the ECU and the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output.
6	YRS Static BITE Error	YRS signal fails static self-test. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
7	YRS Dynamic BITE Error	YRS signal fails self-test conducted while vehicle is in motion. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
8	YRS Fast Calibration Error	YRS calibration error. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
9	YRS Static Calibration Error	YRS calibration error. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
10	YRS Normal Calibration Error	YRS calibration error. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
11	YRS Sensitivity Calibration Error	YRS calibration error. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
12	YRS Plausibility Check (Ref Yaw Rate)	ECU has detected an incorrect YRS signal. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
13	YRS Plausibility Error (Inside Model Based Limits)	ECU has detected an incorrect YRS signal. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
14	YRS Plausibility Error (Outside Model Based Limits)	ECU has detected an incorrect YRS signal. Verify proper installation of the YRS. Verify proper wiring between the ECU and the YRS. Check YRS output. Verify that correct YRS is being used. Verify proper ECU programming. Perform YRS calibration procedure.
15	YRS - SAS Signal Cross-check Incomplete	ECU (if configured) must confirm that YRS and SAS signals match. The vehicle must be exposed to an S-shaped driving maneuver for this DTC to automatically clear. If the DTC does not clear even after the S-shaped driving maneuver, check and correct the orientation of the YRS and repeat maneuver.

# Troubleshooting Diagnostic Trouble Codes: Yaw Rate Sensor (YRS) (continued)



## Yaw Rate Sensor Tests

1. Measure resistance between input voltage and ground at the sensor wiring harness connector.

Test	Measurement
Power and Ground Input	8 to 16 volts
1 = Power Input	
2 = Ground Input	

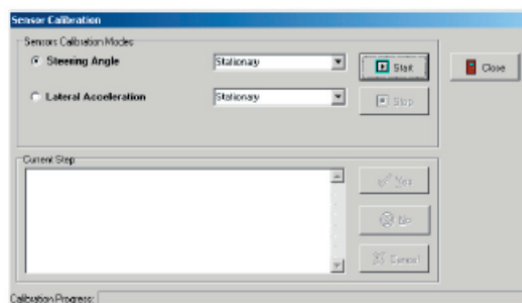
2. Verify wiring between the Yaw Rate Sensor and the ECU.

SAS Wire Harness Terminal	ECU Wire Harness Terminal	Measurement
4	7	Verify Continuity
3	8	Verify Continuity

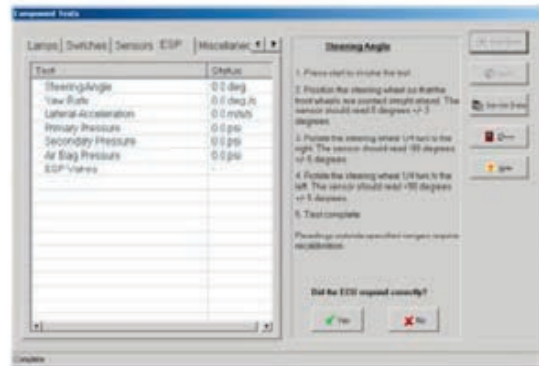
3. Verify wiring between the Yaw Rate Sensor and power/ground.

SAS Wire Harness Terminal	Measurement
4 to Voltage & Ground	Verify open circuit (no continuity)
3 to Voltage & Ground	Verify open circuit (no continuity)

4. To perform a calibration procedure of the Yaw Rate Sensor, ACom™ Diagnostics V4.0 is required. Using the program, select the “Configuration” option, followed by the “Calibrate” option. The following screen should be displayed.



5. Follow the prompts to perform a calibration of the Yaw Rate Sensor.
6. To test the Yaw Rate Sensor, ACom V4.0 is required. Using Bendix ACom V4.0, select the “Component Test” option, followed by the “ESP Test” option. The following screen should be displayed.



7. Follow the prompts to perform a test of the Yaw Rate Sensor.

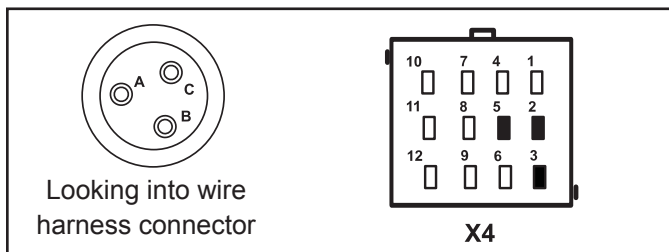
# Troubleshooting Diagnostic Trouble Codes: Lateral Acceleration Sensor (LAS)

1st. Blink Code	Location	
23	Lateral Acceleration Sensor	
2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
1	LAS Signal Out of Range	LAS signal incorrect. Verify proper installation of the YRS/LAS. Verify proper wiring between the ECU and the YRS/LAS. Check YRS/LAS output. Perform LAS calibration procedure.
2	LAS Calibration in Progress	LAS calibration procedure is underway.
3	LAS Static Calibration Error	LAS calibration error. Verify proper installation of the YRS/LAS. Verify proper wiring between the ECU and the YRS/LAS. Check YRS/LAS output. Verify that correct YRS/LAS is being used. Verify proper ECU programming. Perform LAS calibration procedure.
4	LAS Long Term Calibration Error	LAS calibration error. Verify proper installation of the YRS/LAS. Verify proper wiring between the ECU and the YRS/LAS. Check YRS/LAS output. Verify that correct YRS/LAS is being used. Verify proper ECU programming. Perform LAS calibration procedure.
5	LAS Plausibility Error (Inside Model Based Limits)	ECU has detected an incorrect LAS signal. Verify proper installation of the YRS/LAS. Verify proper wiring between the ECU and the YRS/LAS. Check YRS/LAS output. Verify that correct YRS/LAS is being used. Verify proper ECU programming. Perform LAS calibration procedure.
6	LAS Plausibility Error (Outside Model Based Limits)	ECU has detected an incorrect LAS signal. Verify proper installation of the YRS/LAS. Verify proper wiring between the ECU and the YRS/LAS. Check YRS/LAS output. Verify that correct YRS/LAS is being used. Verify proper ECU programming. Perform LAS calibration procedure.
7	Erratic ESP Sensor Signal	ECU has detected an erratic signal. Verify proper installation of the YRS/LAS. Verify proper wiring between the ECU and the YRS/LAS. Check YRS/LAS output. Verify that correct YRS/LAS is being used. Verify proper ECU programming. Perform LAS calibration procedure.

1. Follow the steps shown in the Yaw Rate Sensor troubleshooting section for calibration and troubleshooting of the Lateral Acceleration Sensors.

# Troubleshooting Diagnostic Trouble Codes Brake Demand/Load Sensors

1st. Blink Code	Location	2nd. Blink Code	Diagnostic Trouble Code Description	Repair Information
24	Brake Demand/Load Sensors			
1		PS1	Open or Shorted	Check wiring between Brake Demand Sensor (primary brake circuit) and ECU. Verify operation of pressure sensor.
2		PS2	Open or Shorted	Check wiring between Brake Demand Sensor (secondary brake circuit) and ECU. Verify operation of pressure sensor.
3		PS3	Open or Shorted	Check wiring between Load Sensor and ECU. Verify operation of pressure sensor.
4		PS1/2	Plausibility Error	ECU has detected an invalid pressure sensor signal from one of the Brake Demand Sensors.
5		PS	Supply Voltage Error	Incorrect supply voltage for the sensors. Verify proper voltage at sensor connectors. Verify wiring between the ECU and the sensors. Verify proper output voltage from the ECU.
6		PS	Not Calibrated	Perform static sensor calibration procedure.



## Brake Demand/Load Sensor Tests

1. Measure resistance between input voltage and ground at the sensor wiring harness connector.

Test	Measurement
Power and Ground Input	4.75 to 5.25 volts
B = Power Input	
A = Ground Input	

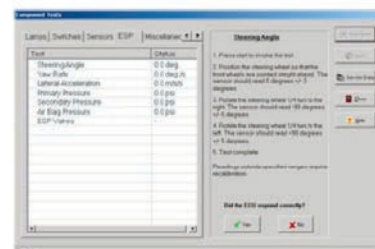
2. Verify wiring between the Load Sensor and the ECU.

Load Sensor Wire Harness Terminal	ECU Wire Harness Terminal	Measurement
C	X4 - 2 Brake Demand Sensor (primary brake circuit)	Verify Continuity
	X4 - 5 Brake Demand Sensor (secondary brake circuit)	Verify Continuity
	X4 - 3 Load Sensor	Verify Continuity

3. Verify wiring between the Load Sensor and power/ground.

Load Sensor Harness Terminal	Measurement
C to Voltage & Ground	Verify open circuit (no continuity)

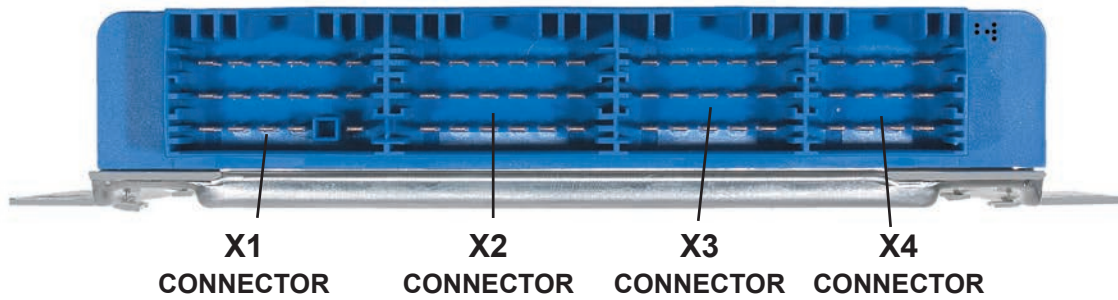
4. To perform a calibration procedure of the Brake Demand Sensor(s), ensure that the air system is fully charged. Apply ignition power, and wait 30 seconds. Perform a full application of the service brake and hold for 5 seconds. Release the service brake.
5. To test the Brake Demand Sensor and/or the Load Sensor, ACom V4.0 is required. Using the program, select the "Component Test" option, followed by the "ESP Test" option. The following screen should be displayed.



6. Follow the prompts to test of the Brake Demand Sensor(s) and/or the Load Sensor.

## EC-60™ Controller Wire Harness Connector Part Numbers and Pin Assignments:

### ADVANCED CAB



### Advanced Cab Model EC-60™ Controller

Advanced cab models utilize four AMP connectors for wire harness connections.



#### X1 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	Ground	7	J1939 Low	13	J1587 (B)
2	Trailer ABS Indicator	8	J1939 High	14	J1587 (A)
3	Ignition	9	SLS Input	15	ABS Indicator Interlock
4	TCV CMN (DA)	10	WSS DA Right (+)	16	Battery
5	TCV (DA)	11	WSS DA Right (-)	17	Retarder
6	ATC/ESP Indicator and ATC ORS	12	ABS Indicator Ground	18	ABS Dash Indicator

#### X2 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	PMV SA Left HLD	7	PMV SA Right REL	13	PMV DA Right REL
2	PMV SA Left REL	8	WSS SA Left (-)	14	WSS SA Right (-)
3	PMV SA Left CMN	9	PMV DA Right CMN	15	WSS DA Left (+)
4	PMV SA Right HLD	10	PMV DA Right HLD	16	PMV DA Left HLD
5	WSS SA Left (+)	11	WSS SA Right (+)	17	PMV DA Left REL
6	PMV SA Right CMN	12	PMV DA Left CMN	18	WSS DA Left (-)

#### X3 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	ABS ORS	6	PMV AA Left CMN	11	WSS AA Left (+)
2	Diff. Lock SOL <sup>1</sup>	7	PMV AA Left REL	12	WSS AA Right (+)
3	TCV CMN (SA)	8	Stop Lamp Output	13	PMV AA Right REL
4	PMV AA Left HLD	9	PMV AA Right CMN	14	WSS AA Left (-)
5	TCV (SA)	10	PMV AA Right HLD	15	WSS AA Right (-)

#### X4 Connector Pin Assignments

Pin	Designation	Pin	Designation	Pin	Designation
1	Pressure Sensor CMN	5	Brake Demand Secondary CKT Signal	9	PMV Trailer REL
2	Brake Demand Primary CKT Signal	6	PMV Trailer HLD	10	Sensor CAN Common
3	Load Sensor Signal	7	Sensor CAN Low	11	Sensor CAN Supply
4	Pressure Sensor Supply	8	Sensor CAN High	12	PMV Trailer CMN

<sup>1</sup>AWD vehicles only. (AWD Transfer Case)



# Troubleshooting: Wiring

## ABS/ATC WIRING

### ECU Wiring Harness Connectors

The Advanced EC-60™ controller is designed to interface with AMP MCP 2.8 connectors as referenced in Chart 4. Follow all AMP requirements for the repair of wire harnesses.

All wire harness connectors must be properly seated. The use of secondary locks is strongly advised.

**CAUTION:** All unused ECU connectors must be covered and receive proper environmental protection.

### ABS Wiring Requirements

As a matter of good practice and to ensure maximum system robustness, always use the maximum size wire supported by the wire harness connectors for battery, ignition, ground, PMV, TCV, Interaxle Differential Lock and indicator lamp circuits.

All sensor and serial communications circuits (J1587 and J1939) must use twisted pair wiring (one to two twists per inch). See the appropriate SAE document for additional details.

**WARNING:** All wires must be carefully routed to avoid contact with rotating elements. Wiring must be properly secured approximately every 6 to 12 inches using UV stabilized, non-metallic hose clamps or bow-tie cable ties to prevent pinching, binding or fraying.

It is recommended that wires be routed straight out of a connector for a minimum of three inches before the wire is allowed to bend.




















Battery and ground wires should be kept to a minimum length.

If convoluted tubing is used, its I.D. must match the size of the wire bundle as closely as possible.

**CAUTION:** Wire harness lengths must be carefully selected for the vehicle. Excess lengths of wire are **not** to be wound to form coils, instead re-route, repair or replace wire harness to avoid the possibility of electrical interference and wire damage. Do not attempt to stretch harnesses that are too short, since mechanical strain can result in wire breakage.

### SAS-60™ Sensors/YAS-60™ Sensor Wiring

If it is necessary to replace the wiring that connects the SAS-60 or the YAS-60 to the ECU, it is important to use the same wiring as that utilized by the vehicle OEM.

ABS Component	Connector	Wire Terminal	Wire Seal/ Plug	Terminal Lock	Terminal Crimp Tool
Controller Harness 17-Way AMP MCP 2.8 (X1)	 1718091-1	 927768-9 1 - 2.5 mm <sup>2</sup> X1-12 & 18	N/A	 967634	 539723-2
Controller Harness 18-Way AMP MCP 2.8 (X2)	 8-968974-1	 968874 2.5 - 4 mm <sup>2</sup>	N/A	N/A	
Controller Harness 15-Way AMP MCP 2.8 (X3)	 8-968973-1	 968873 1.0 - 2.5 mm <sup>2</sup>	N/A	N/A	
Controller Harness 12-Way AMP MCP 2.8 (X4)	 8-968972-1		N/A	N/A	
ABS Modulator Harness AMP Twist-Lock (Bayonet)	 1-967325-2	 929975-1	N/A	N/A	 539635-1
ATC Modulator Harness AMP Twist-Lock (Bayonet)	 1-967325-3	 929975-1	N/A	N/A	
ABS Modulator Harness 3-pin Packard Metri-Pack 280 Series	 12040977	 12077411	 12015323	 12034145	 12155975

WS-24™ Wheel Speed Sensor Connectors



Packard GT  
150 series



Packard Metripack  
150.2 series



Deutsch DTM06  
series



Packard Metripack  
280 series (female)



Packard Metripack  
280 series (male)



Deutsch DT04  
series



Standard round  
two pin

**Not Shown:**

SAS-60™ Sensor Connectors:

Straight Connector (4 contact, DIN 72575) (Schlemmer) part number 9800 351

90 degree Connector (4 contact, DIN 72575) (Schlemmer) part number 9800 331

Contact Pins (Schlemmer) part number 7814 125

YAS-60™ Wire Harness Connectors:

(Robert Bosch) part number 1 928 404 025

YAS-60™ Wire Harness Terminals:

(Robert Bosch) part number 1 928 498 001

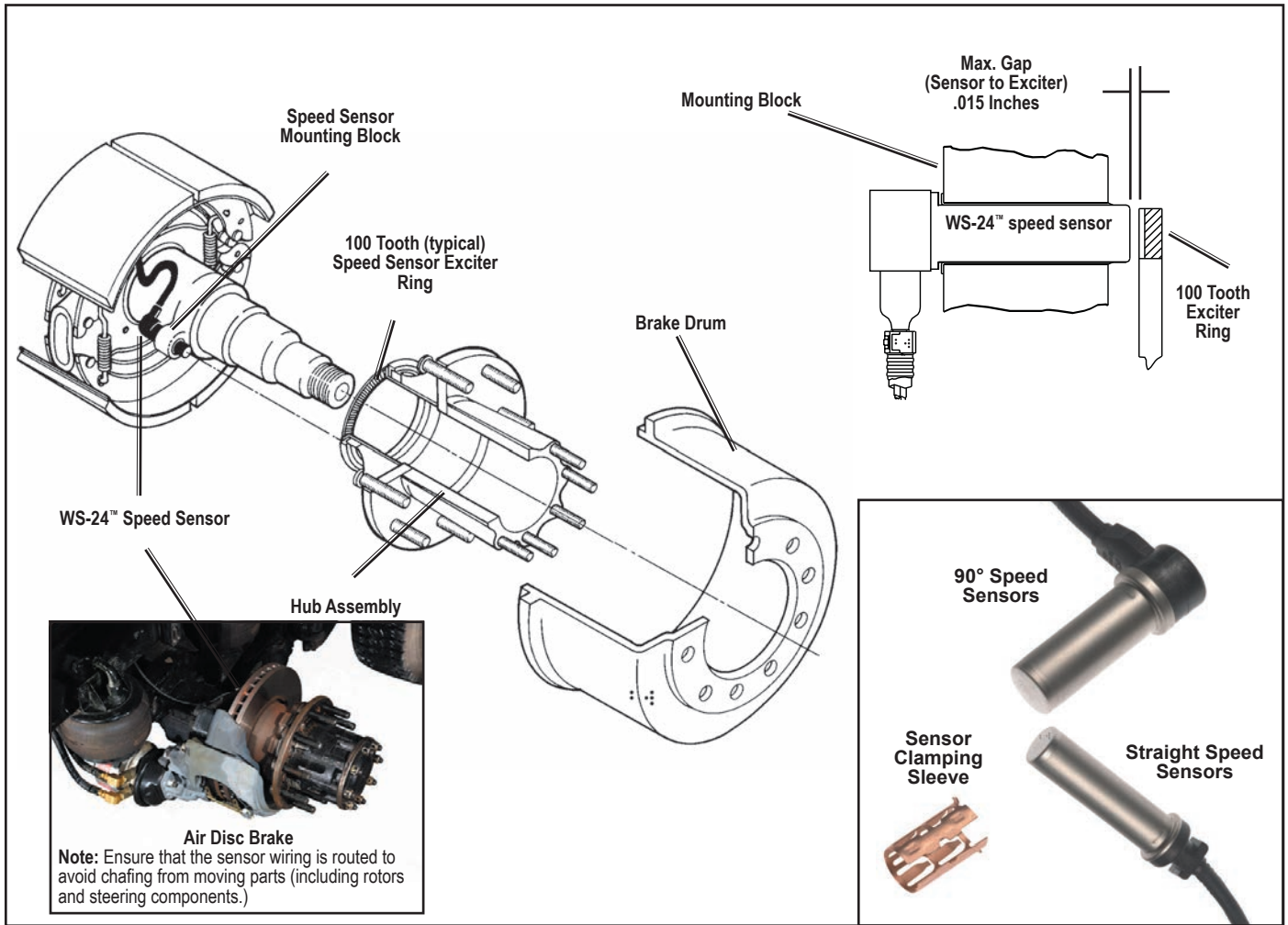
Brake Demand Sensor/Load Sensor Wire Harness Connectors:

Metri-Pack Connector (Packard) part number 1206 5287

Contact Pins (Packard) part number 1210 3881



# Troubleshooting: Wiring (Continued)



**FIGURE 19 - WS-24™ WHEEL SPEED SENSOR INSTALLATION (S-CAM AND AIR DISC BRAKE)**

## Wheel Speed Sensor Wiring

Route sensor wiring coming out of the wheel ends away from moving brake components. Sensor wiring needs to be secured to the axle to prevent excess cable length and wiring damage. It is required that cable ties be installed to the sensor wire within 3 inches (76.2 mm) of the sensor head to provide strain relief.

Following the axle, the sensor wires must be attached along the length of the service brake hoses using cable ties with ultraviolet protection and secured every 6 to 8 inches (152 to 203 mm). Sufficient – but not excessive – cable length must be provided to permit full suspension travel and steering axle movement. Install wires so that they cannot touch rotating elements such as wheels, brake discs or drive shafts. Radiation protection may be necessary in the area of brake discs.

Bendix does not recommend using standard tie-wraps to secure wiring harnesses directly to rubber air lines. This may cause premature wiring failure from the pressure exerted on the wiring when air pressure is applied through the air line. Non-metallic hose clamps or bow-tie tie-wraps are preferred.

The use of grommets or other suitable protection is required whenever the cable must pass through metallic frame members.

All sensor wiring must utilize twisted pair wire, with approximately one to two twists per inch.

It is recommended that wires be routed straight out of a connector for a minimum of three inches before the wire is allowed to bend.



## Glossary

**ABS** — Antilock Brake System.

**ABS Event** — Impending wheel lock situation that causes the ABS controller to activate the modulator valve(s).

**ABS Indicator Lamp** — An amber lamp which indicates the operating status of an antilock system. When the indicator lamp is on, ABS is disabled and the vehicle reverts to normal brake operation.

**Air Gap** — Distance between the Sensor and tone ring.

**ASR** — Automatic Slip Regulation. Another name for traction control.

**ATC** — Automatic Traction Control. An additional ABS function in which engine torque is controlled and brakes are applied differentially to enhance vehicle traction.

**ATC/ESP Lamp** — A lamp that indicates when stability functions, including traction control, roll stability program or yaw control are operating.

**Channel** — A controlled wheel site.

**CAN** — Controller Area Network. J1939 is an SAE version of the CAN link.

**Clear Codes** — System to erase historical diagnostic trouble codes from the ECU, from either the Diagnostic Switch or from a hand-held diagnostic tool (only repaired diagnostic trouble codes may be cleared).

**Configuration** — The primary objective is to identify a “normal” set of sensors and modulators for the Electronic Control Unit, so that it will identify future missing sensors and modulators.

**Diagnostic Connector** — Diagnostic receptacle in vehicle cab for connection of J1587 hand-held or PC based test equipment. The tester can initiate test sequences, and can also read system parameters.

**Diagnostic Switch** — A switch used to activate blinks codes.

**Differential Braking** — Application of brake force to a spinning wheel so that torque can be applied to wheels which are not slipping.

**ECU** — Electronic Control Unit.

**ESP** — Electronic Stability Program. Full stability function that includes RSP & YC subfunctions.

**Diagnostic Trouble Code** — A condition that interferes with the generation or transmission of response or control signals in the vehicle's ABS system that could lead to the functionality of the ABS system becoming inoperable in whole or in part.

**FMVSS-121** — Federal Motor Vehicle Safety Standard which regulates air brake systems.

**IR** — Independent Regulation. A control method in which a wheel is controlled at optimum slip, a point where retardation and stability are maximized. The brake pressure that is best for the wheel in question is directed individually into each brake chamber.

**J1587** — The SAE heavy duty standard diagnostic data link.

**J1708** — An SAE standard which defines the hardware and software protocol for implementing 9600 baud heavy vehicle data links. J1587 version of a J1708 data link.

**J1939** — A high speed 250,000 baud data link used for communications between the ABS ECU engine, transmission and retarders.

**LAS** — Lateral Acceleration Sensor.

**MIR** — Modified Independent Regulation. A method of controlling the opposite sides of a steer axle during ABS operation so that torque steer and stopping distance are minimized.

**PLC** — Power Line Carrier. The serial communication protocol used to communicate with the trailer over the blue full time power wire.

**PMV** — Pressure Modulator Valve. An air valve which is used to vent or block air to the brake chambers to limit or reduce brake torque.

**QR** — Quick Release. Quick release valves allow faster release of air from the brake chamber after a brake application. To balance the system, quick release valves have hold off springs that produce higher crack pressures (when the valves open).

**Relay Valve** — Increases the application speed of the service brake. Installed near brakes with larger air chambers (type 24 or 30). The treadle valve activates the relay valve with an air signal. The relay valve then connects its supply port to its delivery ports. Equal length air hose must connect the delivery ports of the relay valve to the brake chambers.

**Retarder Relay** — A relay which is used to disable a retarder when ABS is triggered.

**RSP** — Roll Stability Program. An all-axle ABS solution that helps reduce vehicle speed by applying all vehicle brakes as needed, reducing the tendency to roll over.

**SAS** — Steering Angle Sensor.

**Sensor Clamping Sleeve** — A beryllium copper sleeve which has fingers cut into it. It is pressed between an ABS sensor and mounting hole to hold the sensor in place.

**Stored Diagnostic Trouble Codes** — A diagnostic trouble code that occurred.

**TCS** — Traction Control System, another name for ATC or ASR.

**Tone Ring** — A ring that is usually pressed into a wheel hub that has a series of teeth (usually 100) and provides actuation for the speed sensor. Note maximum run out is .008.

**YC** — Yaw Control. Helps stabilize rotational dynamics of vehicle.

**YRS** — Yaw Rate Sensor.

## Appendix A: J1587 SID and FMI Codes and Their Bendix Blink Code Equivalents

SID (J1587)	FMI (J1587)	General	Bendix Blink Code Equivalent(s)		Diagnostic Trouble Code Description
			(1st Digit)	(2nd Digit)	
-	-	No DTCs	1	1	No DTCs
1	1	Wheel Speed Sensor DTCs	2	1	SA Left WSS Excessive Air Gap
2	1	Wheel Speed Sensor DTCs	3	1	SA Right WSS Excessive Air Gap
3	1	Wheel Speed Sensor DTCs	4	1	DA Left WSS Excessive Air Gap
4	1	Wheel Speed Sensor DTCs	5	1	DA Right WSS Excessive Air Gap
5	1	Wheel Speed Sensor DTCs	14	1	AA Left WSS Excessive Air Gap
6	1	Wheel Speed Sensor DTCs	15	1	AA Right WSS Excessive Air Gap
1	14	Wheel Speed Sensor DTCs	2	2	SA Left WSS Output Low @ Drive-Off
2	14	Wheel Speed Sensor DTCs	3	2	SA Right WSS Output Low @ Drive-Off
3	14	Wheel Speed Sensor DTCs	4	2	DA Left WSS Output Low @ Drive-Off
4	14	Wheel Speed Sensor DTCs	5	2	DA Right WSS Output Low @ Drive-Off
5	14	Wheel Speed Sensor DTCs	14	2	AA Left WSS Output Low @ Drive-Off
6	14	Wheel Speed Sensor DTCs	15	2	AA Right WSS Output Low @ Drive-Off
1	2	Wheel Speed Sensor DTCs	2	3	SA Left WSS Open or Shorted
2	2	Wheel Speed Sensor DTCs	3	3	SA Right WSS Open or Shorted
3	2	Wheel Speed Sensor DTCs	4	3	DA Left WSS Open or Shorted
4	2	Wheel Speed Sensor DTCs	5	3	DA Right WSS Open or Shorted
5	2	Wheel Speed Sensor DTCs	14	3	AA Left WSS Open or Shorted
6	2	Wheel Speed Sensor DTCs	15	3	AA Right WSS Open or Shorted
1	10	Wheel Speed Sensor DTCs	2	4	SA Left WSS Loss of Sensor Signal
2	10	Wheel Speed Sensor DTCs	3	4	SA Right WSS Loss of Sensor Signal
3	10	Wheel Speed Sensor DTCs	4	4	DA Left WSS Loss of Sensor Signal
4	10	Wheel Speed Sensor DTCs	5	4	DA Right WSS Loss of Sensor Signal
5	10	Wheel Speed Sensor DTCs	14	4	AA Left WSS Loss of Sensor Signal
6	10	Wheel Speed Sensor DTCs	15	4	AA Right WSS Loss of Sensor Signal
1	7	Wheel Speed Sensor DTCs	2	5	SA Left WSS Wheel End
2	7	Wheel Speed Sensor DTCs	3	5	SA Right WSS Wheel End
3	7	Wheel Speed Sensor DTCs	4	5	DA Left WSS Wheel End
4	7	Wheel Speed Sensor DTCs	5	5	DA Right WSS Wheel End
5	7	Wheel Speed Sensor DTCs	14	5	AA Left WSS Wheel End
6	7	Wheel Speed Sensor DTCs	15	5	AA Right WSS Wheel End
1	8	Wheel Speed Sensor DTCs	2	6	SA Left WSS Erratic Sensor Signal
2	8	Wheel Speed Sensor DTCs	3	6	SA Right WSS Erratic Sensor Signal
3	8	Wheel Speed Sensor DTCs	4	6	DA Left WSS Erratic Sensor Signal
4	8	Wheel Speed Sensor DTCs	5	6	DA Right WSS Erratic Sensor Signal
5	8	Wheel Speed Sensor DTCs	14	6	AA Left WSS Erratic Sensor Signal
6	8	Wheel Speed Sensor DTCs	15	6	AA Right WSS Erratic Sensor Signal
1	13	Wheel Speed Sensor DTCs	2	7	SA Left WSS Tire Size Calibration
2	13	Wheel Speed Sensor DTCs	3	7	SA Right WSS Tire Size Calibration
3	13	Wheel Speed Sensor DTCs	4	7	DA Left WSS Tire Size Calibration
4	13	Wheel Speed Sensor DTCs	5	7	DA Right WSS Tire Size Calibration
5	13	Wheel Speed Sensor DTCs	14	7	AA Left WSS Tire Size Calibration
6	13	Wheel Speed Sensor DTCs	15	7	AA Right WSS Tire Size Calibration
1	9	Wheel Speed Sensor DTCs	2	9	SA Left WSS (RESERVED)
2	9	Wheel Speed Sensor DTCs	3	9	SA Right WSS (RESERVED)
3	9	Wheel Speed Sensor DTCs	4	9	DA Left WSS (RESERVED)
4	9	Wheel Speed Sensor DTCs	5	9	DA Right WSS (RESERVED)
5	9	Wheel Speed Sensor DTCs	14	9	AA Left WSS (RESERVED)
6	9	Wheel Speed Sensor DTCs	15	9	AA Right WSS (RESERVED)
5	13	Wheel Speed Sensor DTCs	14	10	AA Left WSS Configuration Error
6	13	Wheel Speed Sensor DTCs	15	10	AA Right WSS Configuration Error
251	4	Power Supply DTCs	6	1	Battery Voltage Too Low
251	3	Power Supply DTCs	6	2	Battery Voltage Too High
251	4	Power Supply DTCs	6	3	Battery Voltage Too Low During ABS
251	5	Power Supply DTCs	6	4	Battery Voltage Input Open Circuit
251	4	Power Supply DTCs	6	5	Ignition Voltage Too Low
251	3	Power Supply DTCs	6	6	Ignition Voltage Too High
251	4	Power Supply DTCs	6	7	Ignition Voltage Too Low During ABS
251	2	Power Supply DTCs	6	8	Input Voltage Excessive Noise (Temp.)
251	14	Power Supply DTCs	6	9	Input Voltage Excessive Noise (Latched)
48	4	Pressure Modulator Valve DTCs	7	1	SA Left PMV REL Solenoid Shorted to Ground
49	4	Pressure Modulator Valve DTCs	8	1	SA Right PMV REL Solenoid Shorted to Ground
50	4	Pressure Modulator Valve DTCs	9	1	DA Left PMV REL Solenoid Shorted to Ground
51	4	Pressure Modulator Valve DTCs	10	1	DA Right PMV REL Solenoid Shorted to Ground
52	4	Pressure Modulator Valve DTCs	16	1	AA Left PMV REL Solenoid Shorted to Ground



SID (J1587)	FMI (J1587)	General	Bendix Blink Code Equivalent(s)		Diagnostic Trouble Code Description
			(1st Digit)	(2nd Digit)	
53	4	Pressure Modulator Valve DTCs	17	1	AA Right PMV REL Solenoid Shorted to Ground
66	4	Pressure Modulator Valve DTCs	20	1	Trailer PMV REL Solenoid Shorted to Ground
48	3	Pressure Modulator Valve DTCs	7	2	SA Left PMV REL Solenoid Shorted to Voltage
49	3	Pressure Modulator Valve DTCs	8	2	SA Right PMV REL Solenoid Shorted to Voltage
50	3	Pressure Modulator Valve DTCs	9	2	DA Left PMV REL Solenoid Shorted to Voltage
51	3	Pressure Modulator Valve DTCs	10	2	DA Right PMV REL Solenoid Shorted to Voltage
52	3	Pressure Modulator Valve DTCs	16	2	AA Left PMV REL Solenoid Shorted to Voltage
53	3	Pressure Modulator Valve DTCs	17	2	AA Right PMV REL Solenoid Shorted to Voltage
66	3	Pressure Modulator Valve DTCs	20	2	Trailer PMV REL Solenoid Shorted to Voltage
48	5	Pressure Modulator Valve DTCs	7	3	SA Left PMV REL Solenoid Open Circuit
49	5	Pressure Modulator Valve DTCs	8	3	SA Right PMV REL Solenoid Open Circuit
50	5	Pressure Modulator Valve DTCs	9	3	DA Left PMV REL Solenoid Open Circuit
51	5	Pressure Modulator Valve DTCs	10	3	DA Right PMV REL Solenoid Open Circuit
52	5	Pressure Modulator Valve DTCs	16	3	AA Left PMV REL Solenoid Open Circuit
53	5	Pressure Modulator Valve DTCs	17	3	AA Right PMV REL Solenoid Open Circuit
66	5	Pressure Modulator Valve DTCs	20	3	Trailer PMV REL Solenoid Open Circuit
42	4	Pressure Modulator Valve DTCs	7	4	SA Left PMV HLD Solenoid Shorted to Ground
43	4	Pressure Modulator Valve DTCs	8	4	SA Right PMV HLD Solenoid Shorted to Ground
44	4	Pressure Modulator Valve DTCs	9	4	DA Left PMV HLD Solenoid Shorted to Ground
45	4	Pressure Modulator Valve DTCs	10	4	DA Right PMV HLD Solenoid Shorted to Ground
46	4	Pressure Modulator Valve DTCs	16	4	AA Left PMV HLD Solenoid Shorted to Ground
47	4	Pressure Modulator Valve DTCs	17	4	AA Right PMV HLD Solenoid Shorted to Ground
66	4	Pressure Modulator Valve DTCs	20	4	Trailer PMV HLD Solenoid Shorted to Ground
42	3	Pressure Modulator Valve DTCs	7	5	SA Left PMV HLD Solenoid Shorted to Voltage
43	3	Pressure Modulator Valve DTCs	8	5	SA Right PMV HLD Solenoid Shorted to Voltage
44	3	Pressure Modulator Valve DTCs	9	5	DA Left PMV HLD Solenoid Shorted to Voltage
45	3	Pressure Modulator Valve DTCs	10	5	DA Right PMV HLD Solenoid Shorted to Voltage
46	3	Pressure Modulator Valve DTCs	16	5	AA Left PMV HLD Solenoid Shorted to Voltage
47	3	Pressure Modulator Valve DTCs	17	5	AA Right PMV HLD Solenoid Shorted to Voltage
66	3	Pressure Modulator Valve DTCs	20	5	Trailer PMV HLD Solenoid Shorted to Voltage
42	5	Pressure Modulator Valve DTCs	7	6	SA Left PMV HLD Solenoid Open Circuit
43	5	Pressure Modulator Valve DTCs	8	6	SA Right PMV HLD Solenoid Open Circuit
44	5	Pressure Modulator Valve DTCs	9	6	DA Left PMV HLD Solenoid Open Circuit
45	5	Pressure Modulator Valve DTCs	10	6	DA Right PMV HLD Solenoid Open Circuit
46	5	Pressure Modulator Valve DTCs	16	6	AA Left PMV HLD Solenoid Open Circuit
47	5	Pressure Modulator Valve DTCs	17	6	AA Right PMV HLD Solenoid Open Circuit
66	5	Pressure Modulator Valve DTCs	20	6	Trailer PMV HLD Solenoid Open Circuit
7	5	Pressure Modulator Valve DTCs	7	7	SA Left PMV CMN Open Circuit
8	5	Pressure Modulator Valve DTCs	8	7	SA Right PMV CMN Open Circuit
9	5	Pressure Modulator Valve DTCs	9	7	DA Left PMV CMN Open Circuit
10	5	Pressure Modulator Valve DTCs	10	7	DA Right PMV CMN Open Circuit
11	5	Pressure Modulator Valve DTCs	16	7	AA Left PMV CMN Open Circuit
12	5	Pressure Modulator Valve DTCs	17	7	AA Right PMV CMN Open Circuit
66	5	Pressure Modulator Valve DTCs	20	7	Trailer PMV CMN Open Circuit
7	13	Pressure Modulator Valve DTCs	7	8	SA Left PMV Configuration Error
8	13	Pressure Modulator Valve DTCs	8	8	SA Right PMV Configuration Error
9	13	Pressure Modulator Valve DTCs	9	8	DA Left PMV Configuration Error
10	13	Pressure Modulator Valve DTCs	10	8	DA Right PMV Configuration Error
11	13	Pressure Modulator Valve DTCs	16	8	AA Left PMV Configuration Error
12	13	Pressure Modulator Valve DTCs	17	8	AA Right PMV Configuration Error
231	12	J1939 DTCs	11	1	J1939 Serial Link
231	14	J1939 DTCs	11	2	J1939 Retarder
231	2	J1939 DTCs	11	3	J1939 Engine Communications
231	2	J1939 DTCs	11	10	Invalid Data From Transmission
231	2	J1939 DTCs	11	4	J1939 Invalid Data (Engine/Retarder)
231	2	J1939 DTCs	11	5	J1939 Supply Pressure
231	2	J1939 DTCs	11	6	J1939 ESP Messages Invalid Data
55	7	Miscellaneous DTCs	12	1	Stop Lamp Switch Not Detected
55	2	Miscellaneous DTCs	12	2	Stop Lamp Switch Defective
17	14	Miscellaneous DTCs	12	3	Dynamometer Test Mode
13	2	Miscellaneous DTCs	12	4	Retarder Relay Open Circuit or Shorted to Ground
13	3	Miscellaneous DTCs	12	5	Retarder Relay Circuit Shorted to Voltage
23	2	Miscellaneous DTCs	12	6	ABS Dash Indicator Circuit DTC
93	4	Miscellaneous DTCs	12	7	PMV Common Shorted to Ground
93	3	Miscellaneous DTCs	12	8	PMV Common Shorted to Voltage
17	14	Miscellaneous DTCs	12	9	ATC Disabled to Prevent Brake Fade
79	13	Miscellaneous DTCs	12	10	Tire Size Out of Range (Front to Rear)

SID (J1587)	FMI (J1587)	General	Bendix Blink Code Equivalent(s) (1st Digit) (2nd Digit)		Diagnostic Trouble Code Description
22	7	Miscellaneous DTCs	12	11	Wheel Speed Sensors Reversed on an Axle
102	5	Miscellaneous DTCs	12	12	Diff Lock Solenoid Shorted to Ground or Open Circuit
102	3	Miscellaneous DTCs	12	13	Diff Lock Solenoid Shorted to Voltage
103	2	Miscellaneous DTCs	12	14	Sensor CAN Supply Voltage Error
N/A	N/A	Miscellaneous DTCs	12	15	Reserved
"	"	Miscellaneous DTCs	12	16	Reserved
"	"	Miscellaneous DTCs	12	17	Reserved
"	"	Miscellaneous DTCs	12	18	Reserved
"	"	Miscellaneous DTCs	12	19	Reserved
"	"	Miscellaneous DTCs	12	20	Reserved
"	"	Miscellaneous DTCs	12	21	Reserved
103	2	Miscellaneous DTCs	12	22	ESP Sensor Voltage Out of Range
254	12	ECU DTCs	13	1	ECU (02)
254	12	ECU DTCs	13	2	ECU (10)
254	12	ECU DTCs	13	3	ECU (11)
254	2	ECU DTCs	13	4	ECU (12)
254	2	ECU DTCs	13	5	ECU (13)
254	12	ECU DTCs	13	6	ECU (14)
254	2	ECU DTCs	13	7	ECU (15)
254	13	ECU DTCs	13	8	ECU (16)
254	13	ECU DTCs	13	9	ECU (17)
254	12	ECU DTCs	13	10	ECU (18)
254	12	ECU DTCs	13	11	ECU (1A)
254	12	ECU DTCs	13	12	ECU (1B)
254	12	ECU DTCs	13	13	ECU (80)
254	12	ECU DTCs	13	14	ECU (04)
254	12	ECU DTCs	13	15	ECU (06)
254	12	ECU DTCs	13	16	ECU (0E)
254	2	ECU DTCs	13	17	ECU (0D)
254	2	ECU DTCs	13	18	ECU (19)
253	12	ECU DTCs	13	19	ECU (1C)
253	12	ECU DTCs	13	20	ECU (27)
253	13	ECU DTCs	13	21	ECU (1D)
253	13	ECU DTCs	13	22	ECU (1E)
253	13	ECU DTCs	13	23	ECU (28)
254	12	ECU DTCs	13	24	ECU (37)
254	12	ECU DTCs	13	25	ECU Internal VIN Mismatch
18	4	TCV DTCs	18	1	TCV DA Solenoid Shorted to Ground
18	3	TCV DTCs	18	2	TCV DA Solenoid Shorted to Voltage
18	5	TCV DTCs	18	3	TCV DA Solenoid Open Circuit
18	13	TCV DTCs	18	4	TCV DA Configuration Error
19	4	TCV DTCs	19	1	TCV SA Solenoid Shorted to Ground
19	3	TCV DTCs	19	2	TCV SA Solenoid Shorted to Voltage
19	5	TCV DTCs	19	3	TCV SA Solenoid Open Circuit
19	13	TCV DTCs	19	4	TCV SA Configuration Error
89	13	Steering Angle Sensor DTCs	21	1	SAS Not Calibrated
89	13	Steering Angle Sensor DTCs	22	15	YRS Sign Check Not Finished
89	13	Steering Angle Sensor DTCs	21	2	SAS Calibration in Progress
89	2	Steering Angle Sensor DTCs	21	3	SAS Static Signal
89	2	Steering Angle Sensor DTCs	21	4	SAS Signal Out of Range
89	2	Steering Angle Sensor DTCs	21	5	SAS Signal Reversed
89	12	Steering Angle Sensor DTCs	21	6	SAS Invalid Signal
89	2	Steering Angle Sensor DTCs	21	7	SAS Gradient Error
89	9	Steering Angle Sensor DTCs	21	8	SAS CAN Timeout
89	2	Steering Angle Sensor DTCs	21	9	SAS Long Term Calibration Error
89	2	Steering Angle Sensor DTCs	21	10	SAS Plausibility Check (Ref Yaw Rate)
103	2	Yaw Rate Sensor DTCs	22	1	YRS Signal Out of Range
103	2	Yaw Rate Sensor DTCs	22	2	YRS Sensor Reversed Signal
103	2	Yaw Rate Sensor DTCs	22	3	YRS Invalid Signal
103	2	Yaw Rate Sensor DTCs	22	4	YRS Gradient Error
103	9	Yaw Rate Sensor DTCs	22	5	YRS CAN Timeout
103	2	Yaw Rate Sensor DTCs	22	6	YRS Static BITE Error
103	2	Yaw Rate Sensor DTCs	22	7	YRS Dynamic BITE Error
103	2	Yaw Rate Sensor DTCs	22	8	YRS Fast Calibration Error
103	2	Yaw Rate Sensor DTCs	22	9	YRS Static Calibration Error
103	2	Yaw Rate Sensor DTCs	22	10	YRS Normal Calibration Error
103	2	Yaw Rate Sensor DTCs	22	11	YRS Sensitivity Calibration Error

SID (J1587)	FMI (J1587)	General	Bendix Blink Code Equivalent(s) (1st Digit) (2nd Digit)	Diagnostic Trouble Code Description
103	2	Yaw Rate Sensor DTCs	22 12	YRS Plausibility Check (Ref Yaw Rate)
103	2	Yaw Rate Sensor DTCs	22 13	YRS Plausibility Error (Inside Model Based Limits)
103	2	Yaw Rate Sensor DTCs	22 14	YRS Plausibility Error (Outside Model Based Limits)
99	2	Lateral Acceleration Sensor DTCs	23 1	LAS Signal Out of Range
99	13	Lateral Acceleration Sensor DTCs	23 2	LAS Calibration in Progress
99	2	Lateral Acceleration Sensor DTCs	23 3	LAS Static Calibration Error
99	2	Lateral Acceleration Sensor DTCs	23 4	LAS Long Term Calibration Error
99	12	Lateral Acceleration Sensor DTCs	23 5	LAS Plausibility Error (Inside Model Based Limits)
99	12	Lateral Acceleration Sensor DTCs	23 6	LAS Plausibility Error (Outside Model Based Limits)
99	14	Lateral Acceleration Sensor DTCs	23 7	Erratic ESP Sensor Signal
77	2	Brake Demand/Load Sensor DTCs	24 1	Shorted Brake Demand Sensor (Primary CKT) Open
78	2	Brake Demand/Load Sensor DTCs	24 2	Shorted Brake Demand Sensor (Secondary CKT) Open
69	2	Brake Demand/Load Sensor DTCs	24 3	Open or Shorted Load Sensor
77	11	Brake Demand/Load Sensor DTCs	24 4	Plausibility Error Brake Demand Sensor
77	2	Brake Demand/Load Sensor DTCs	24 5	PS Supply Voltage Error
77	7	Brake Demand/Load Sensor DTCs	24 6	PS Not Calibrated
89	13	Yaw Rate Sensor	22 15	Check Incomplete







# Service Data

SD-13-4870

## Bendix® M-32™ and M-32QR™ AntiLock Modulators

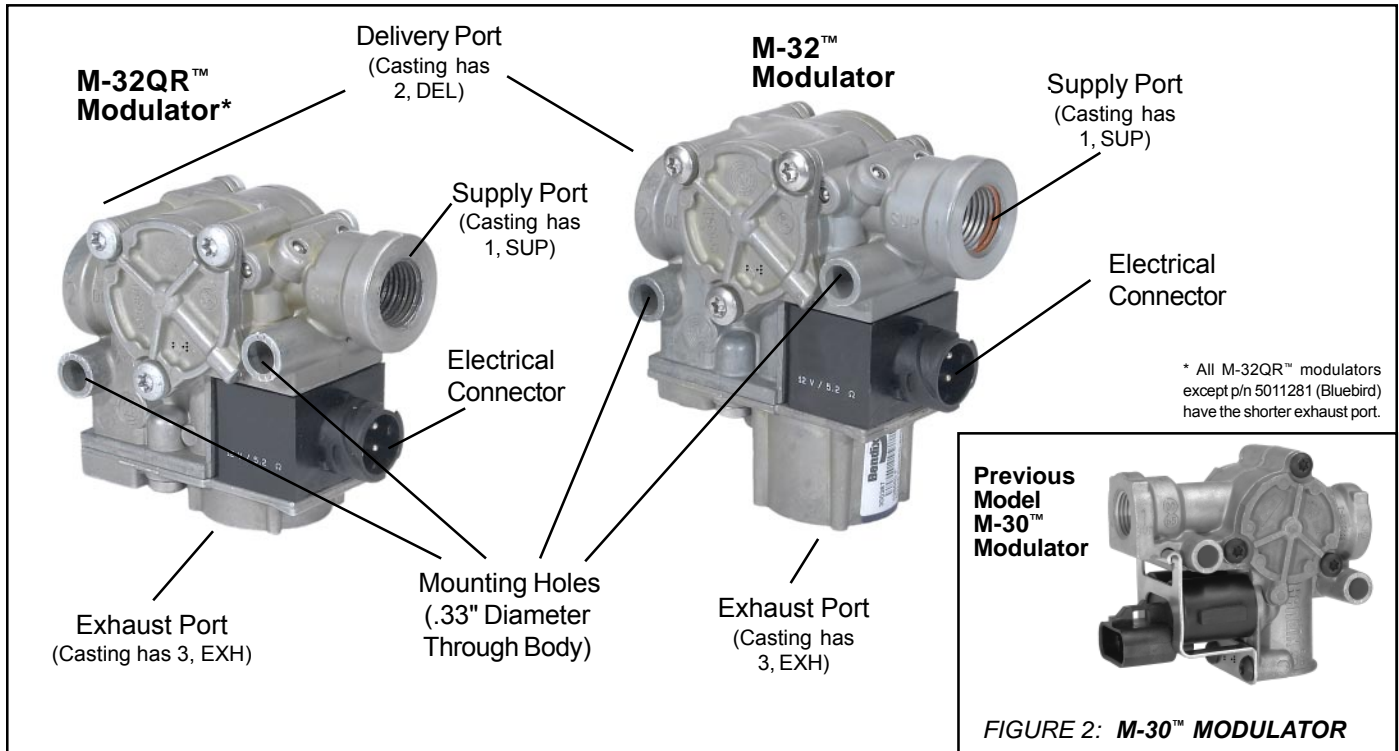


FIGURE 1: M-32™ AND M-32QR™ MODULATORS

### DESCRIPTION

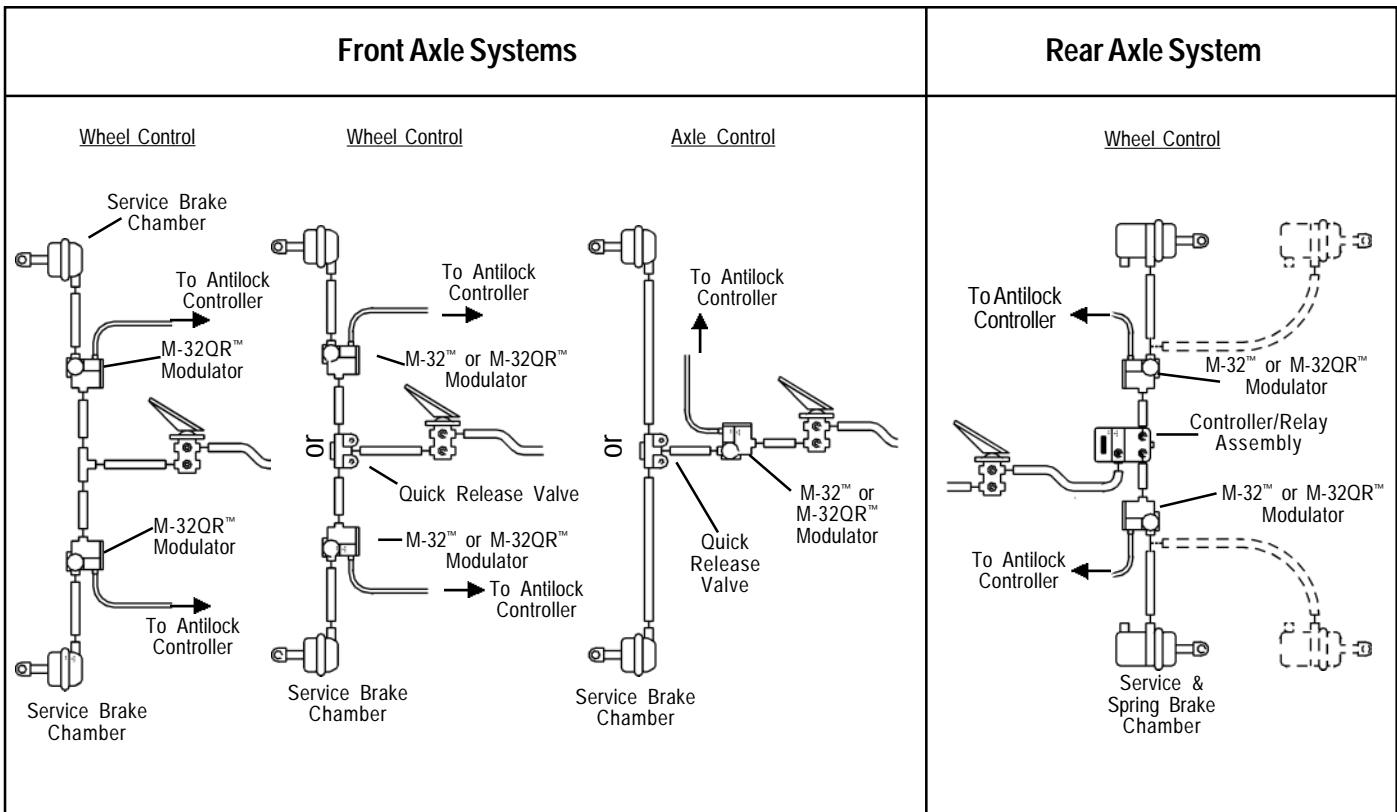
The M-32™ and M-32QR™ (quick release) antilock system modulators (Figure 1) are high capacity, on/off air valves that incorporate a pair of electrical solenoids for control. The solenoids provide the electro-pneumatic interface between the antilock controller electronics and the air brake system. The modulator is used to control the braking function on individual or dual service actuators during antilock activity.

The M-32QR™ modulator is the direct replacement for the M-30™ (Figure 2) modulator in all applications. The M-32QR™ modulator includes a bias valve to provide an internal quick release function. In applications using an M-32™ modulator, an external quick release valve may be required, depending on the system design (see Figure 3 for typical system schematics). When used to control both service chambers on an axle or two chambers on the same side of a tandem axle, the modulator is sometimes mounted ahead of a quick release valve, which provides quick exhaust of service applications during normal braking. In the case of individual wheel control applications, the modulator is always the last control valve through which air passes on its way to the service brake actuator.

The modulator consists of a die cast aluminum body and a solenoid assembly which contains one normally open solenoid, one normally closed solenoid, and an inlet and exhaust diaphragm valve. A three pin, weather resistant electrical connector is an integral part of the modulator solenoid assembly and serves to carry control commands from the antilock controller to the modulator. Two mounting holes are provided for frame or cross member mounting of the valve.

The supply, delivery and exhaust ports on the M-32™ modulator are identified with a cast, embossed numeral for positive identification.

Identification	Air Line Connection
1, SUP (incoming air from foot, relay or quick release valve)	Supply
2, DEL (air delivery to service actuators)	Delivery
3, EXH	Exhaust



**FIGURE 3: TYPICAL WHEEL AND AXLE CONTROL SYSTEMS**

**NOTE:** use of a quick release valve is not typically required with the M-32QR™ modulator. Refer to vehicle specifications for recommended configuration.

## FUNCTIONAL CHECK

A wiring harness connects the vehicle modulators to the controller. The ABS controller is able to simultaneously and independently control the individual modulators. When vehicle power is supplied to the ABS ECU, a modulator "chuff" test is performed. When the brake pedal is depressed and the ignition turned on, the modulator "chuff" test can be heard. This test will verify if the modulator is functioning pneumatically correct. The modulators will exhaust air in the sequence of right front, left front, right rear, left rear. If they do not follow this sequence, proceed with modulator troubleshooting.

## OPERATION

### NON-ANTILOCK BRAKE APPLICATION (Figure 4)

During normal, non antilock braking, both solenoids are de-energized (no electrical power). Brake application air enters the Supply port of the modulator and flows to the exhaust diaphragm. Air pressure, along with spring force, seats the exhaust diaphragm on the exhaust passage, thus preventing the escape of service air. Simultaneously, application air flows to the supply diaphragm and forces it away from its seat. Air flows past the open supply port and out the modulator delivery port to the service brake chambers.

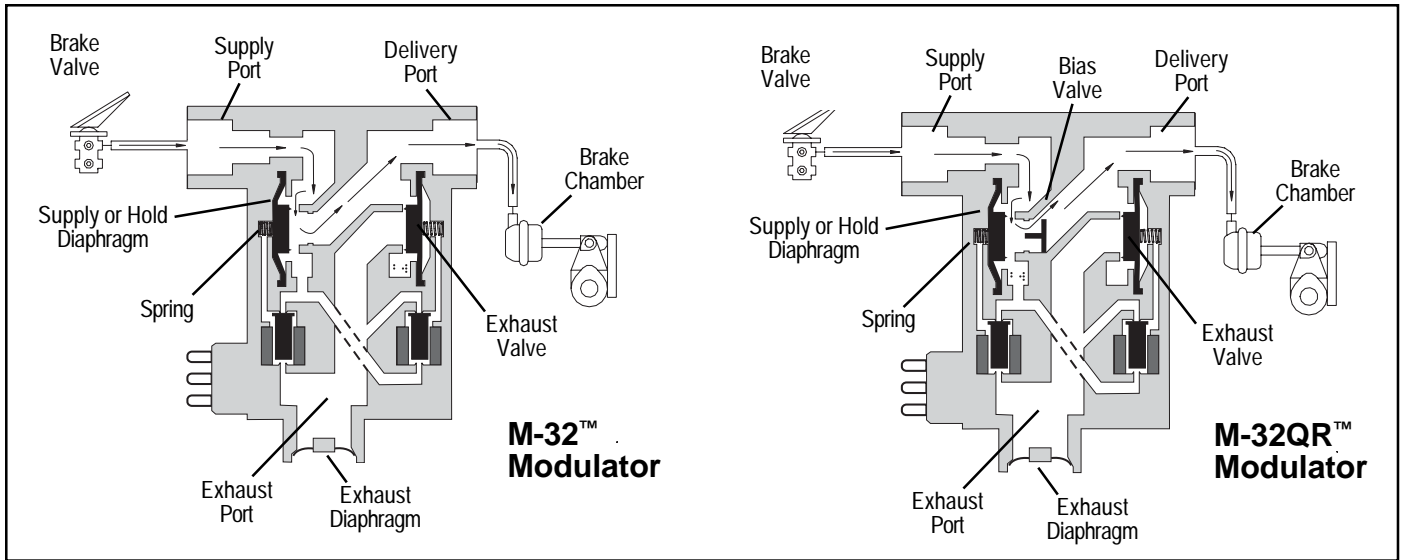
### NON-ANTILOCK HOLD (Figure 5)

When the desired air pressure is attained in the service brake chambers, the brake system is in the Holding position. In the Holding position, both solenoids in the modulator remain de-energized and the balance of the internal components remain in the same position as they assumed during application.

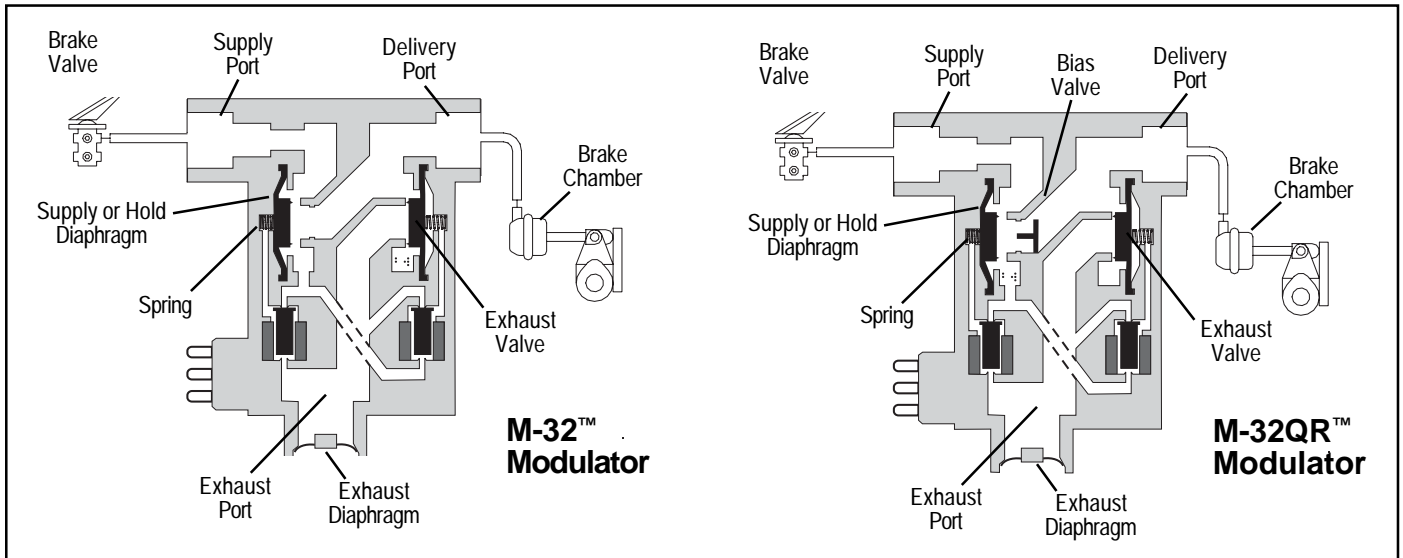
### NON-ANTILOCK EXHAUST

The manner in which air exhausts through the modulator differs depends upon how rapidly the brake application is released by the driver.

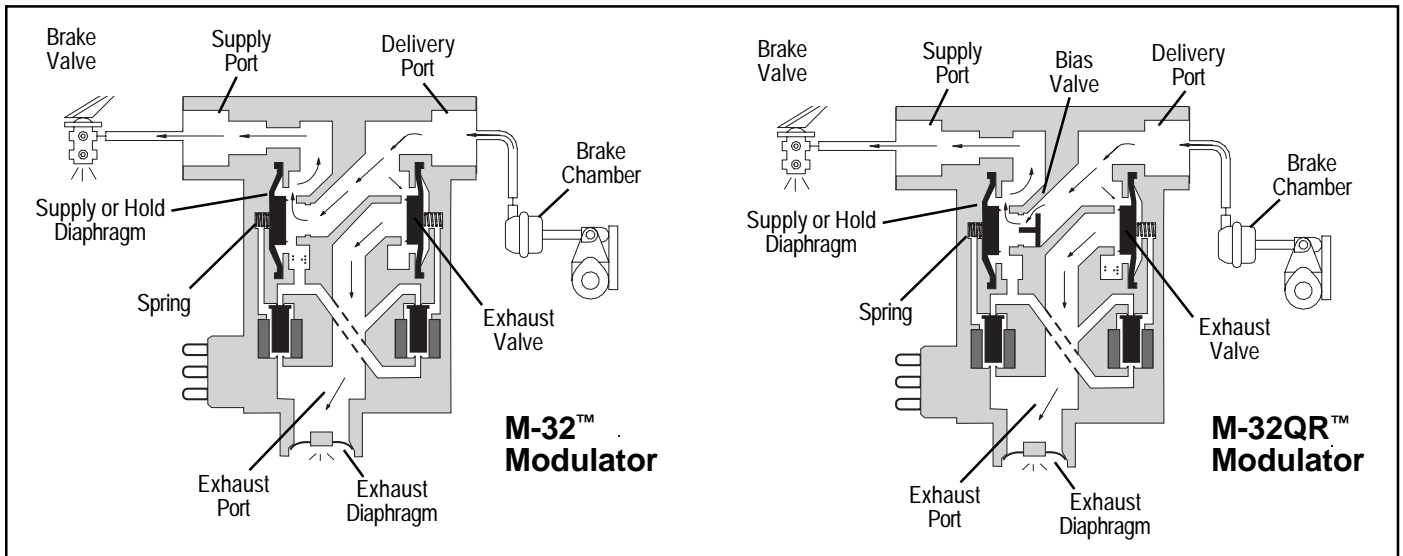
**Normal Exhaust (Figure 6)** - During a normal, relatively "slow" brake release, air moves back through the modulator in the reverse direction as it flowed during application. The internal components of the modulator will remain in the same position as they assumed during application until air pressure decreases to approximately one half psi, at which time the supply diaphragm will seat on the supply passage. A relatively small amount of air will generally be expelled from the modulator exhaust port during "slow" brake release.



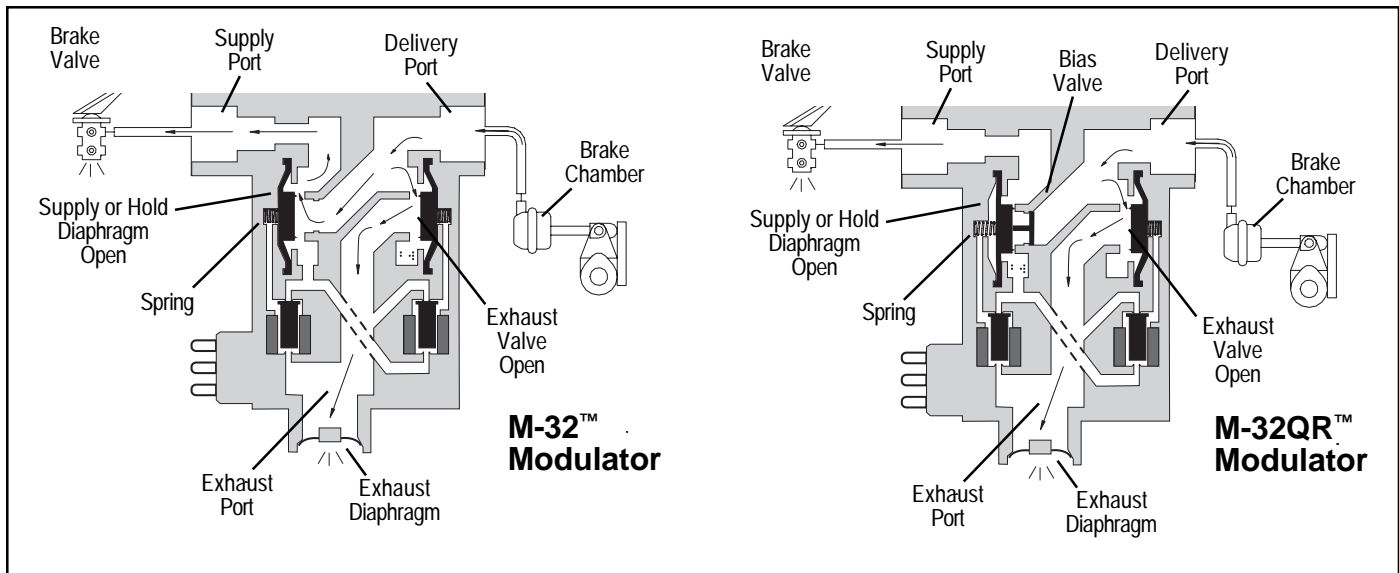
**FIGURE 4: M-32™ AND M-32QR™ MODULATORS NON-ANTILOCK APPLICATION OF SERVICE BRAKES**



**FIGURE 5: M-32™ AND M-32QR™ MODULATORS NON-ANTILOCK BRAKE APPLICATION HELD POSITION**



**FIGURE 6: M-32™ and M-32QR™ MODULATORS "SLOW" NON-ANTILOCK EXHAUST OF SERVICE BRAKES**



**FIGURE 7: M-32™ AND M-32QR™ MODULATORS RAPID NON-ANTILOCK EXHAUST OF SERVICE BRAKES**

**Rapid Exhaust** (Figure 7) - The Rapid Exhaust operation described in the following text occurs when the modulator is controlling service chamber(s). During a rapid brake release the quick release modulator will exhaust air differently to a “slow” brake release.

An example of this would be the case if the driver made a severe brake application then lifted his foot from the foot valve. During a rapid brake release, the air previously delivered to the brake chamber is vented through the M-32™ modulators as follows:

**For the M-32QR™ Modulator:** The bias valve moves to its closed position, closing the air return route to the brake valve’s exhaust. Air pressure against the exhaust valve within the M-32™ modulator overcomes the spring force and allows air to exhaust through the M-32QR™ modulator exhaust port. Residual air pressure between the bias valve and the brake pedal flows back to the brake valve exhaust.

**For the M-32™ Modulator:** As in the “slow” brake release, air pressure travels back to the brake valve’s exhaust, but also the air pressure against the exhaust valve within the M-32™ modulator overcomes the spring force and allows air to exhaust through the M-32™ modulator exhaust port.

## ANTILOCK OPERATION

### GENERAL

If a service brake application is made and the antilock system detects an impending wheel lockup, the antilock controller will make a controlled brake application using the modulator.

In order to control the brake application, the coils of the two solenoid valves contained in the modulator are energized or de-energized in a preprogrammed sequence by the antilock controller. When a solenoid coil is energized, and depending whether the exhaust or hold solenoid is energized, it either

opens or closes, thereby causing the exhaust or reapplication of air pressure to the brake actuator. The solenoids in the modulator are controlled independently by the antilock controller (ECU).

An experienced driver (of a vehicle without ABS) who encounters wheel lock-up may sometimes “pump the brakes” in order to attempt to prevent wheel lock-up and maintain vehicle control. In the case of an ABS braking system, the driver does not need to “pump the brakes” since the antilock controller is able to apply and release the brakes using the modulators, with far greater speed and accuracy. Depending on the number of modulators used, some systems are able to apply braking power to wheels independently (see page 2).

### ANTILOCK EXHAUST (Figure 8)

When wheel lock is detected or imminent, the antilock controller energizes the supply and exhaust solenoids in the modulator.

Energizing the supply solenoid allows application air to flow to the control side of the supply diaphragm. Air pressure acting on the supply diaphragm, along with the spring force, enables the diaphragm to prevent further delivery of air to the brake chamber.

Energizing the exhaust solenoid shuts off the air normally applied to the control side of the exhaust diaphragm to keep it closed. Air pressure acting on the exhaust diaphragm, overcomes the spring force, and allows air to exhaust through the exhaust port.

### ANTILOCK HOLD MODE (Figure 9)

The antilock controller will place the modulator in the Hold position when it senses that the correct wheel speed (braking force) has been attained. The antilock controller will also

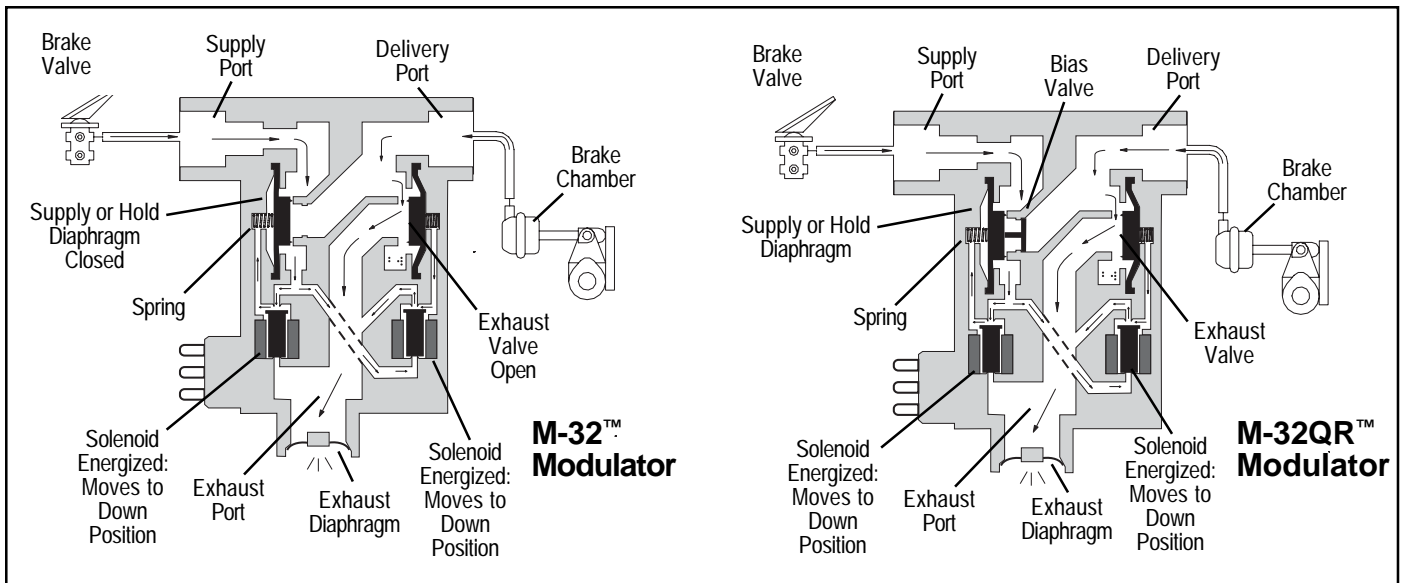


FIGURE 8: M-32™ MODULATOR ANTILOCK EXHAUST OF BRAKES

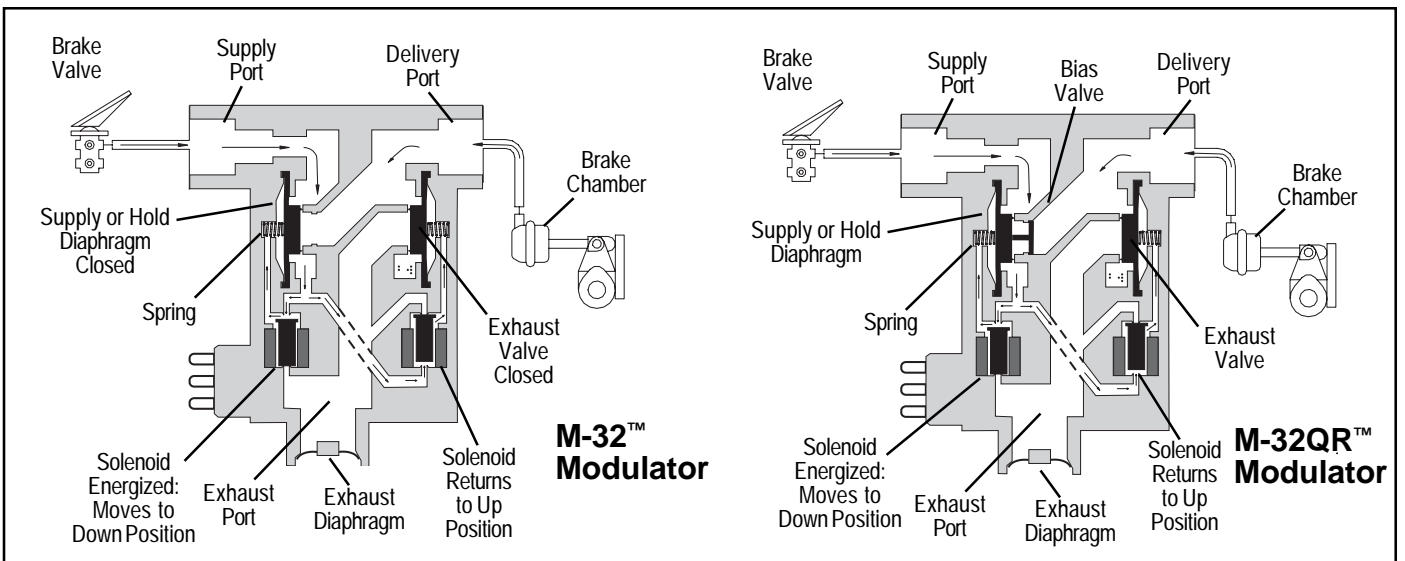


FIGURE 9: M-32™ AND M-32QR™ MODULATORS ANTILOCK APPLICATION HELD POSITION

place the modulator in the hold position, prior to entering the reapply mode, when it detects recovery from a locked wheel condition. In this mode of operation, the modulator supply/hold solenoid remains energized while the exhaust solenoid returns to its normal position. The exhaust solenoid allows application air to flow to the control side of the exhaust diaphragm, which then seals the exhaust passage. With the exhaust diaphragm seated, further exhaust of brake chamber air pressure is prevented. Because the supply solenoid remains energized, the supply diaphragm remains seated, thus preventing application air from flowing to the delivery port and out to the brake chamber. The modulator can enter both the antilock exhaust or reapply mode from the antilock hold mode depending on the needs of the antilock controller.

### ANTILOCK “REAPPLY” MODE

If the antilock controller senses that wheel speed has increased sufficiently enough to allow re-application of braking pressure, without further wheel lock-up, it de-energizes the supply solenoid. With both solenoids de-energized, the modulator re-applies air to the brakes in the same manner it did during a non-antilock event.

## PREVENTIVE MAINTENANCE

### GENERAL

Perform the tests and inspections presented at the prescribed intervals. If the modulator fails to function as described, or leakage is excessive, it should be replaced with a new Bendix unit, available at any authorized parts outlet.

### EVERY MONTH, 10,000 MILES OR 350 OPERATING HOURS

1. Remove any accumulated contaminants and visually inspect the exterior for excessive corrosion and physical damage.
2. Inspect all air lines and wire harnesses connected to the modulator for signs of wear or physical damage. Replace as necessary.
3. Test air line fittings for leakage and tighten or replace as necessary.
4. Perform the ROUTINE OPERATION AND LEAKAGE TESTING described in this manual.

### OPERATION & LEAKAGE TESTS

#### LEAKAGE TEST

1. Park the vehicle on a level surface and block or chock the wheels. Release the parking brakes and build the air system to full pressure.
2. Turn the engine OFF and make 4 or 5 brake applications and note that the service brakes apply and release promptly.
3. Build system pressure to governor cut-out and turn the engine OFF.
4. After determining the pressure loss with the brakes released (2 PSI/minute allowed), make and hold a full service brake application. Allow the pressure to stabilize for one minute.
5. Begin timing pressure loss for two minutes while watching the dash gauges for a pressure drop. The leakage rate for the service reservoirs should not exceed 3 PSI/minute.
6. If either circuit exceeds the recommended two PSI/minute, apply soap solution to the exhaust port of the modulator and any other components in the respective circuit.
7. The leakage at the exhaust port of most Bendix components, including M-32™ modulators, should not exceed a one-inch bubble in three seconds. If leakage at the modulator is determined to exceed the maximum limits, replace the modulator.

## OPERATION TEST

To properly test the function of the modulator will require two (2) service technicians.

1. Park the vehicle on a level surface and block or chock the wheels. Release the parking brakes and build the air system to governor cut out.
2. Turn the engine ignition key to the OFF position then make and hold a full brake application.
3. With the brake application held and one (1) service technician posted at one (1) of the modulators, turn the vehicle ignition key to the ON position. ONE OR TWO SHORT bursts of air pressure should be noted at the modulator exhaust. Repeat the test for each modulator on the vehicle. If at least a single burst of exhaust is not noted or the exhaust of air is prolonged and not short, sharp and well defined, perform the Electrical Tests.

### ELECTRICAL TESTS

1. Before testing the solenoid assembly of a suspect modulator, its location on the vehicle should be confirmed using the Trouble Shooting or Start Up procedure for the specific antilock controller in use. (See the Service Data Sheet for the antilock controller for this procedure.)
2. Proceed to the modulator in question and inspect its wiring connector. Disconnect the connector and test the resistance between the pins ON THE MODULATOR. Refer to Figures 10 and 11.
  - A. HOLD TO SOURCE (41-42): Read 4.9 to 5.5 Ohms.
  - B. EXHAUST TO SOURCE (43-41): Read 4.9 to 5.5 Ohms.
  - C. EXHAUST TO HOLD (43-42): Read 9.8 to 11.0 Ohms.
  - D. Individually test the resistance of each pin to vehicle ground and note there is NO CONTINUITY.

If the resistance readings are as shown, the wire harness leading to the modulator may require repair or replacement. Before attempting repair or replacement of the wire harness, refer to the test procedures specified for the antilock controller in use for possible further testing that may be required to substantiate the wire harness problem. If the resistance values are NOT AS STATED, replace the modulator.

### **WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:**

**When working on or around a vehicle, the following general precautions should be observed at all times.**

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses.**

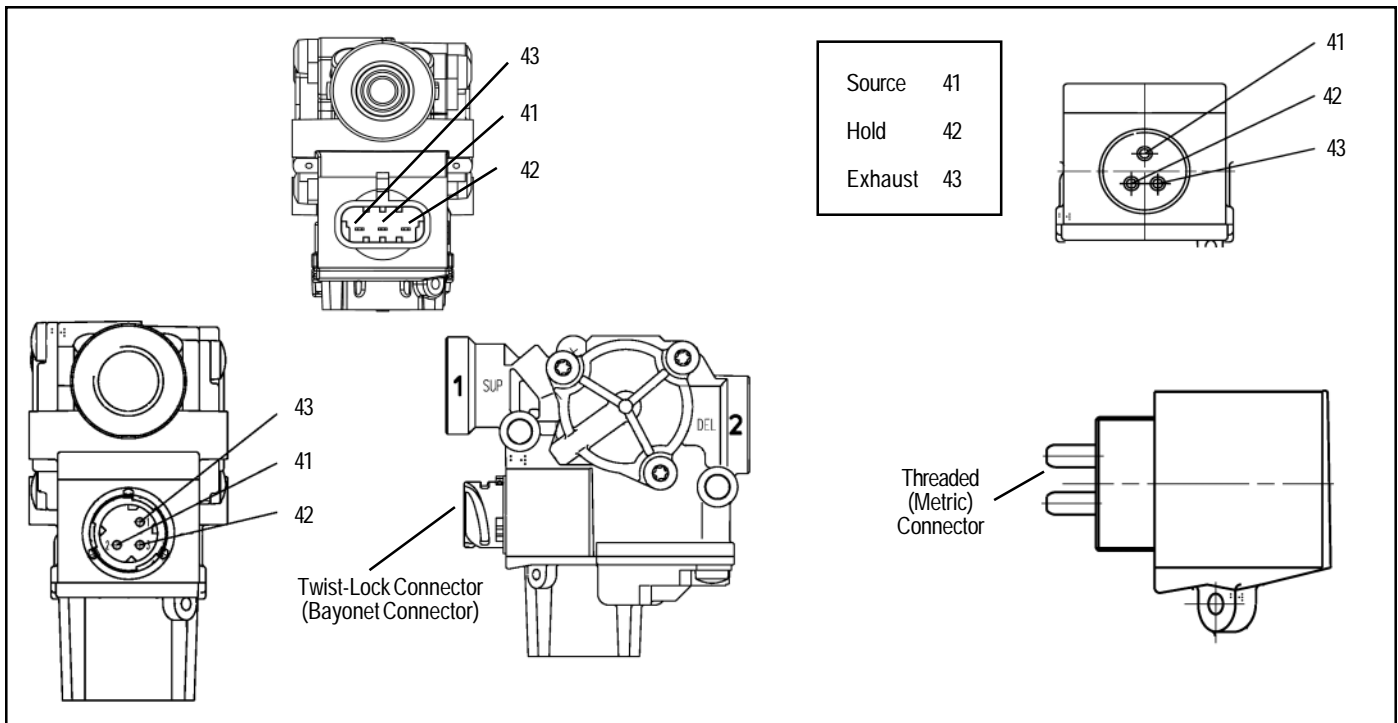


FIGURE 10: M-32™ AND M-32QR™ MODULATORS CONNECTOR VIEWS

2. Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, **EXTREME CAUTION** should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.
3. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
4. If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning **ANY** work on the vehicle. If the vehicle is equipped with an AD-IS™ air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.
5. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
6. Never exceed manufacturer's recommended pressures.
7. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
8. Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent

size, type and strength as original equipment and be designed specifically for such applications and systems.

9. Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
10. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
11. For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.

#### MODULATOR REMOVAL

1. Locate the modulator that will be replaced and clean the exterior.
2. Identify and mark or label all air lines and their respective connections on the valve to facilitate ease of installation.
3. Disconnect both air lines and the electrical connector.
4. Remove the modulator from the vehicle.
5. Remove all air line fittings and plugs. **These fittings will be re-used in the replacement modulator.**



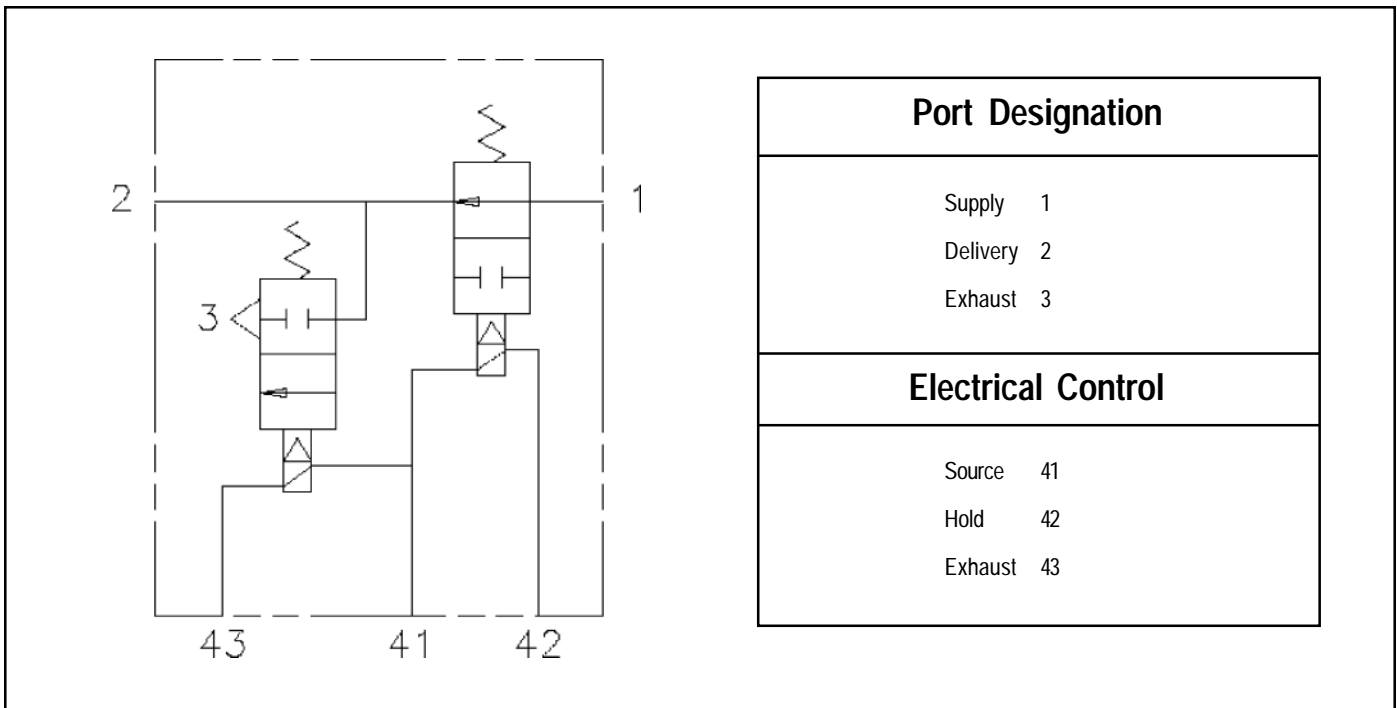


FIGURE 11: M-32™ AND M-32QR™ MODULATORS DIN SYMBOL

### MODULATOR INSTALLATION

1. Install all air line fittings and plugs, making certain thread sealing material does not enter the valve.
2. Install the assembled valve on the vehicle.
3. Reconnect both air lines to the valve using the identification made during VALVE REMOVAL step 5.
4. Reconnect the electrical connector to the modulator.
5. After installing the valve, test all air fittings for excessive leakage and tighten as needed.

### TECHNICAL INFORMATION

- Porting**
- 1 Supply Port (from brake, relay or quick release valve) - 1/2" NPT
  - 1 Delivery Port (brake actuator) - 1/2" NPT
- Optional:**
- 1 Push-to-connect for 1/2" tubing
  - 2 NPT supply, PTC delivery
- Solenoid Voltage:** 12 Volts DC Nominal, optional 24 Volt available.
- Weight:** 1.7 pounds
- Maximum Operating Pressure:** 150 psi Gauge
- Operating Temperature Range:** -40 to 185 degrees Fahrenheit
- Pressure Differential:** 1 psi maximum (supply to delivery)
- Mounting Hole Sizes:** 0.33" diameter through body





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**MERITOR WABCO**

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**System Saver 636 Twin  
Cylinder Air Compressor  
for Mack E-Tech™ Engines**

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**Maintenance Manual MM-0204  
Issued 08-02**

## Bendix® ADB 22X™, ADB 225™, SN6™, SN7™, SK7™ Air Disc Brakes

### DESCRIPTION

Bendix® Air Disc Brakes use a floating caliper design to provide foundation braking on all axles of heavy commercial vehicles, buses and trailers. Bendix Air Disc Brakes provide safety and performance, as well as ease of service. Available in models with or without a combination spring brake unit, these brakes may also include optional wear sensors and/or wear diagnostic equipment.

### OPERATION

Bendix Air Disc Brakes convert air pressure into braking force. (See Figure 2.) When the vehicle brakes are applied, air enters the service brake chamber through the supply port, applying pressure within the diaphragm. The pressure expands the diaphragm, applying force to, and moving the pressure plate and pushrod forward. The pushrod acts against a cup in the internal lever which pivots on an eccentric bearing moving the bridge. Moving against a return spring, the bridge transfers the motion to two threaded tubes and tappets, which move the inner brake pad. The inner brake pad (from its normal position of having a running clearance between it and the rotor) moves into contact with the brake rotor. Further movement of the bridge forces the caliper, sliding on two stationary guide pins, away from the rotor, which pulls the outer brake pad into the rotor. The clamping action of the brake pads on the rotor applies braking force to the wheel.

### Brake Release and Adjustment

When the vehicle brakes are released, the air pressure in the service brake chamber is exhausted and the return springs in the chamber and the bridge return the air disc brake to a neutral, non-braked position. To maintain the running clearance gap between the rotor and the brake pads over time, the non-braked position is mechanically adjusted by a mechanism in the caliper. The adjustment mechanism operates automatically whenever the brakes are activated, to compensate for rotor and brake pad wear and to keep the running clearance constant. During pad or rotor maintenance, the technician manually sets the system's initial non-braked position. The total running clearance (sum of clearances on both sides of the rotor) should be between 0.024 to 0.043 in. (0.6 and 1.1 mm).



FIGURE 1 - BENDIX® ADB 22X™ AIR DISC BRAKE

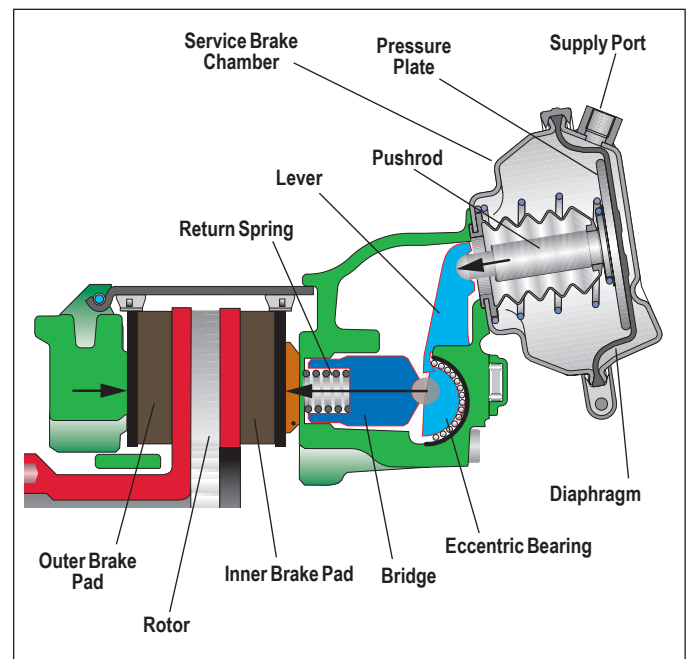


FIGURE 2 - CROSS-SECTION VIEW SHOWING BRAKE OPERATION

## SAFE MAINTENANCE PRACTICES

### **WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:**

When working on or around a vehicle, the following general precautions should be observed at all times:

1. Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear safety glasses. Where specifically directed, the parking brakes may have to be released, and/or spring brakes caged, and this will require that the vehicle be prevented from moving by other means for the duration of these tests/procedures.
2. Stop the engine and remove ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, **EXTREME CAUTION** should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated or electrically charged components.
3. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
4. If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning **ANY** work on the vehicle. If the vehicle is equipped with an AD-IS® air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.
5. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
6. Never exceed manufacturer's recommended pressures.
7. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
8. Use only genuine Bendix® replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
9. Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
10. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.

11. For vehicles with Antilock Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.

**WARNING:** Not all wheels and valve stems are compatible with Bendix Air Disc Brakes. Use only wheels and valve stems approved by the vehicle manufacturer to avoid the risk of valve stem shear and other compatibility issues.

### **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.
- 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.

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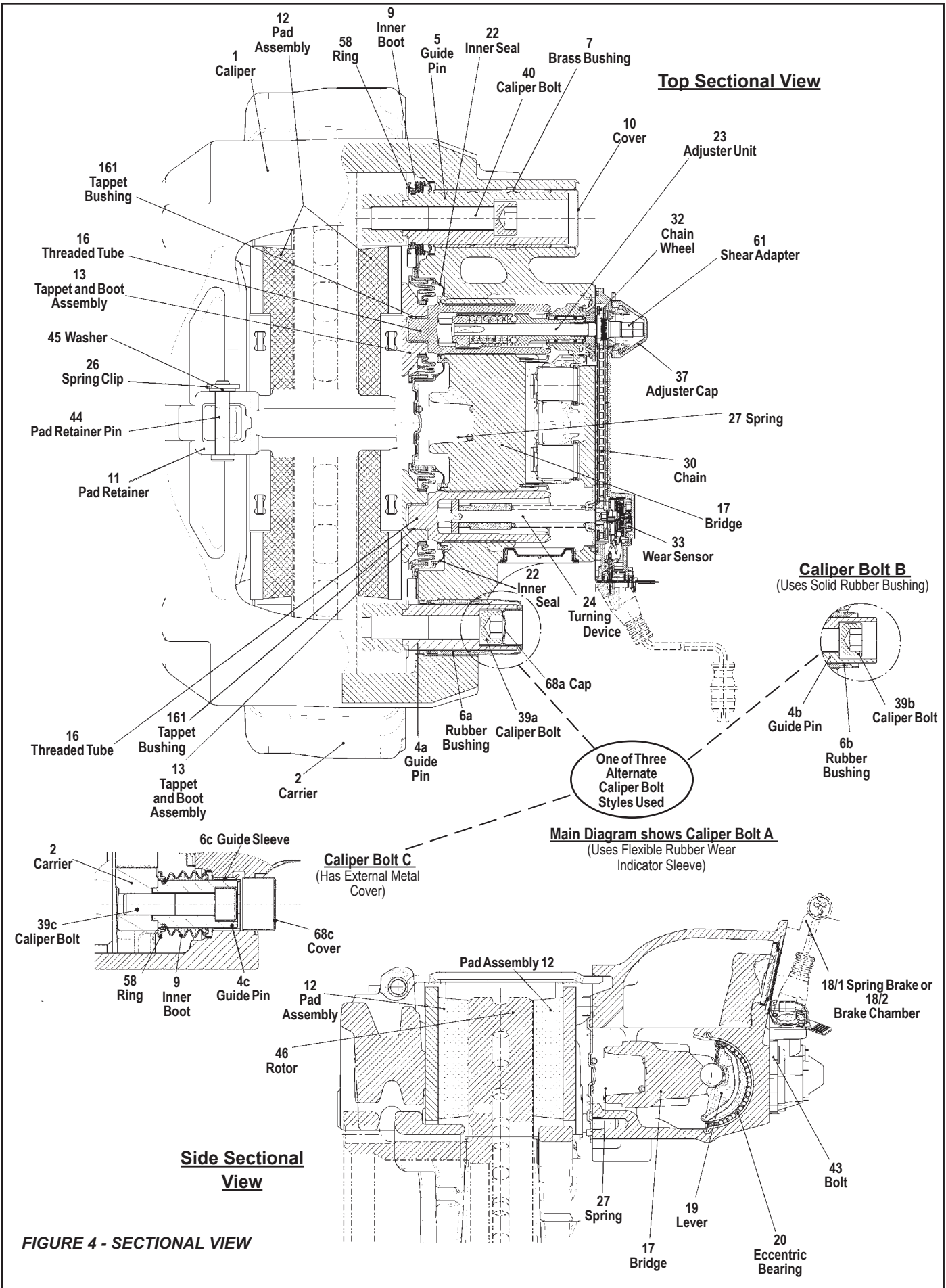
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### Inspections

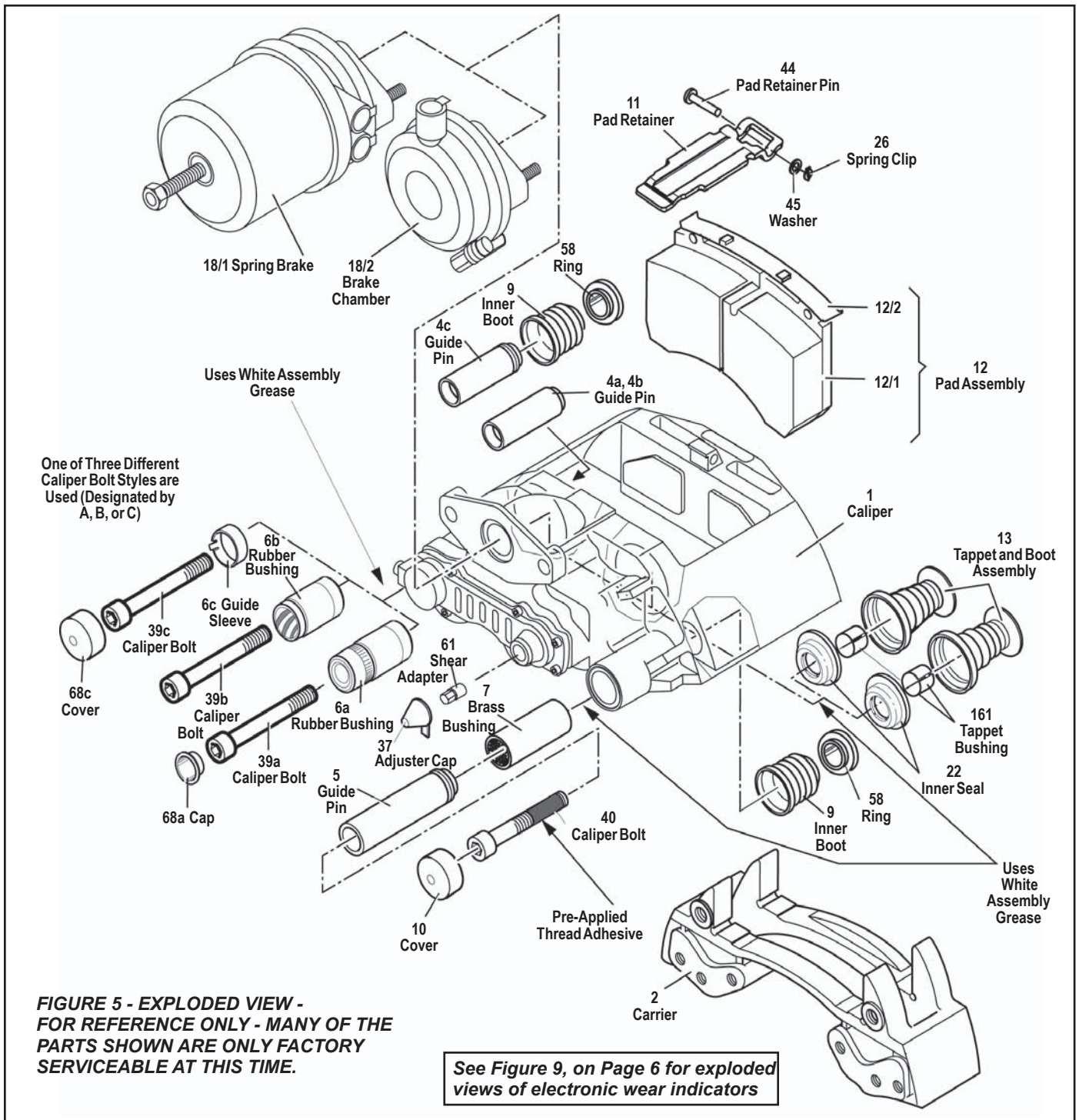
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Cap.....	68a
Guide Pin .....	4a
Rubber Bushing .....	6a

<b>Caliper Bolt B</b>	
Caliper Bolt.....	39b
Guide Pin .....	4b
Rubber Bushing .....	6b

<b>Caliper Bolt C</b>	
Caliper Bolt.....	39c
Guide Pin .....	4c
Cover .....	68c

## AIR DISC BRAKE IDENTIFICATION

To determine which version of the Bendix air disc brake is installed, locate the identification label near the guide pin housing. See below for examples of the different styles of label you may find.

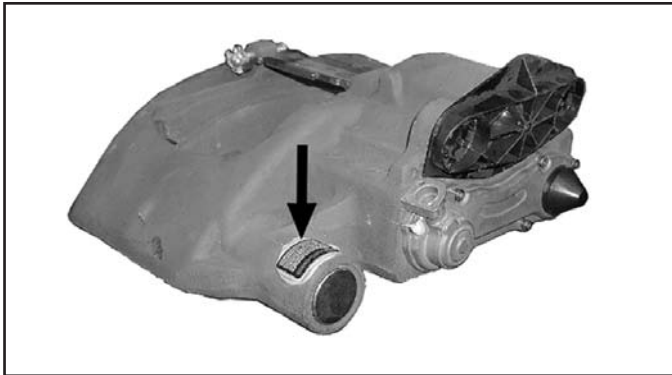


FIGURE 6 - PART NUMBER LABEL LOCATION

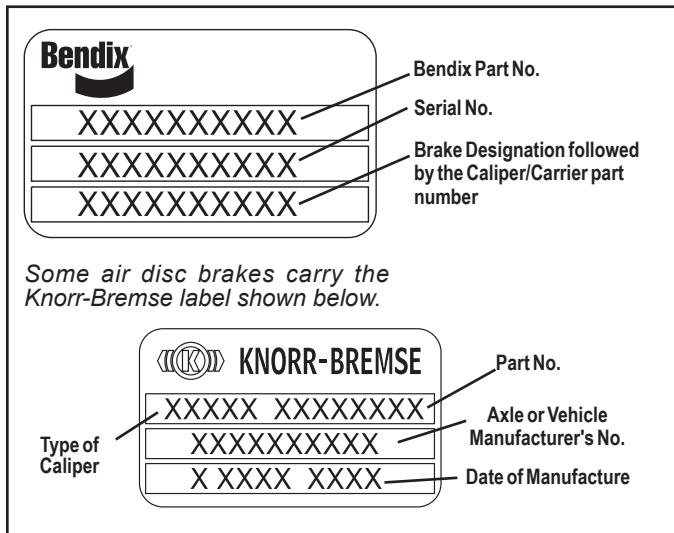


FIGURE 7 - PART NUMBER LABEL FIELDS

## ROTOR IDENTIFICATION

Certain maintenance inspection procedures depend on the type of rotor installed (See Page 13). See below for examples of the different styles of rotor in use.

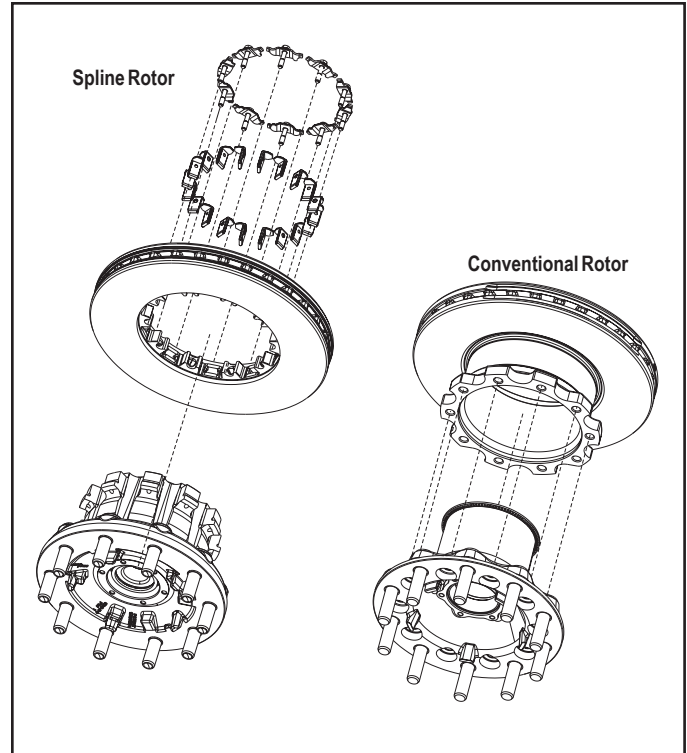


FIGURE 8 - ROTOR IDENTIFICATION

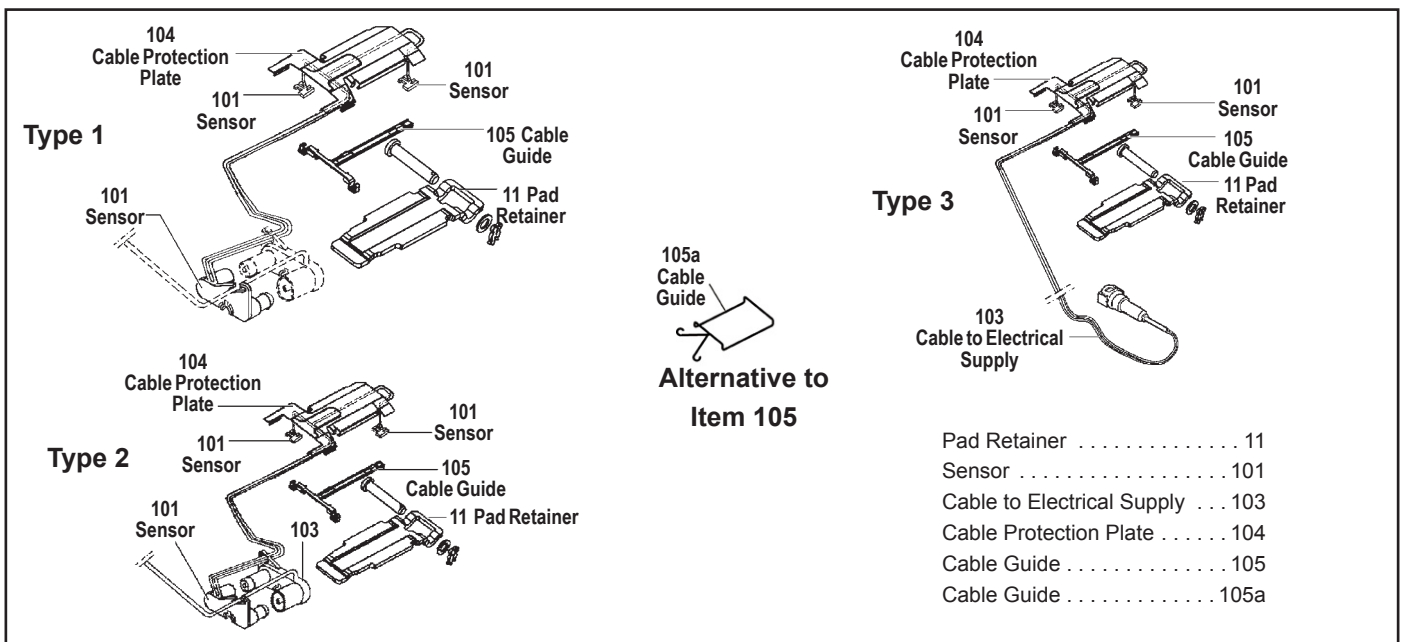


FIGURE 9 - ELECTRONIC WEAR INDICATOR COMPONENTS


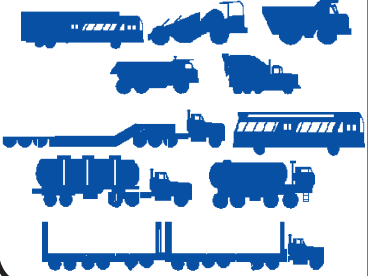
## PREVENTIVE MAINTENANCE

Regular inspection and maintenance of air disc brake components is an important part of vehicle maintenance.

The maintenance practices outlined here are recommended in addition to all standard industry practices (including e.g. daily pre-trip inspections, etc.) Also, see the vehicle's manual for recommendations.

**Use the table below for a guide to maintenance interval planning**, however, depending on the vehicle use, more frequent checks of the components may be necessary.

**Keep track of the results of your maintenance inspections to assist you determine the ideal maintenance interval for the vehicle.**

Vehicle Used for:	Basic Inspection Program	
	Pad & Rotor Wear, Running Clearance <i>(Inspection with the wheel mounted)</i>	At Least Once Annually and at Every Pad Replacement <i>(Inspection with wheel removed)</i>
<p><b>Over the Road</b></p> <p>e.g. Line haul, RV, Open Highway Coach.</p> 	<ul style="list-style-type: none"> <li>For vehicles with electronic wear indicators, use the dash indicator(s) and/or the hand-held diagnostic tool to regularly monitor the pad wear.</li> <li>In all cases, <b>visually inspect the wear indicator</b> (see Pages 8-9) <b>every four months</b> (or keep track of the results of maintenance inspections to schedule checks 4 to 5 times during the pad lifetime). <b>At the same time, conduct the Running Clearance Inspection</b> (see below).</li> <li>A visual check of the mechanical wear indicator every time the tire pressures are checked is recommended. Be alert for any rotor cracks, etc. visible (See Page 13 for criteria.)</li> </ul>	<p><b>Inspect:</b></p> <ul style="list-style-type: none"> <li>The rotor for cracks, etc. (see Page 13 for criteria)</li> <li>The running clearance and adjuster function (see Page 15)</li> <li>The caliper travel (see Pages 16-17)</li> <li>The tappet and boot assemblies (see Page 14)</li> <li>All covers, caps, hoses, and brake exterior for damage etc.</li> </ul>
<p><b>Higher Duty Use</b></p> <p>e.g. Pick-Up &amp; Delivery, Off-Highway, Construction, Loggers, Concrete Mixer, Dump Truck, City Transit Bus, Refuse, Urban Region Coach, School Bus.</p> 	<ul style="list-style-type: none"> <li>For vehicles with electronic wear indicators, use the dash indicator(s) and/or the hand-held diagnostic tool to regularly monitor the pad wear.</li> <li>In all cases, <b>visually inspect the wear indicator</b> (see Pages 8-9) <b>every three months</b> (or keep track of the results of maintenance inspections to schedule checks 4 to 5 times during the pad lifetime). <b>At the same time, conduct the Running Clearance Inspection</b> (see below).</li> <li>A visual check of the mechanical wear indicator every time the tire pressures are checked is recommended. Be alert for any rotor cracks, etc. visible (See Page 13 for criteria.)</li> </ul>	

### Air Disc Brake Running Clearance Inspection.

Follow all industry safety guidelines, including those listed on Page 2. On level ground, with the wheels chocked and the parking brake temporarily released, check for movement of the brake caliper. This small movement, less than 0.80" (2 mm) - approximately the thickness of a nickel - in the inboard/outboard direction indicates that the brake is moving properly on its guide pins. If the caliper has no movement or appears to move greater than the distances above, a full wheel-removed inspection will be necessary. See Page 16.

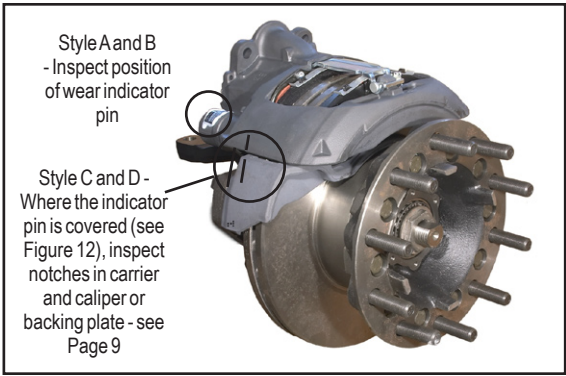


# MECHANICAL BRAKE PAD AND ROTOR WEAR INDICATORS

A preliminary visual check of the condition of the brake pad/rotor wear can be made without removing the wheels. See below for the inspection to make for each of the three guide pin styles in use for Bendix air disc brakes.

**Note:** These inspections provide an indication of when to schedule a full wheel-removed inspection of the brake pads and rotor. The thicknesses of both the pad and rotor will affect the wear indicator position at which maintenance is actually needed.

**These inspections do not constitute "out-of-service" criteria.**



## Style A: Rolling Boot Style Wear Indicator

Inspect the position of the guide pin flexible rubber bushing. See Figure 10. When the guide pin has moved in so that the ribbed section of the flexible rubber bushing reaches the point where it folds back in, it is time to schedule a full wheel-removed inspection of the pads and rotor. Note: This is only an indication that the pads and rotor are ready for inspection, and does not necessarily mean that maintenance is required.

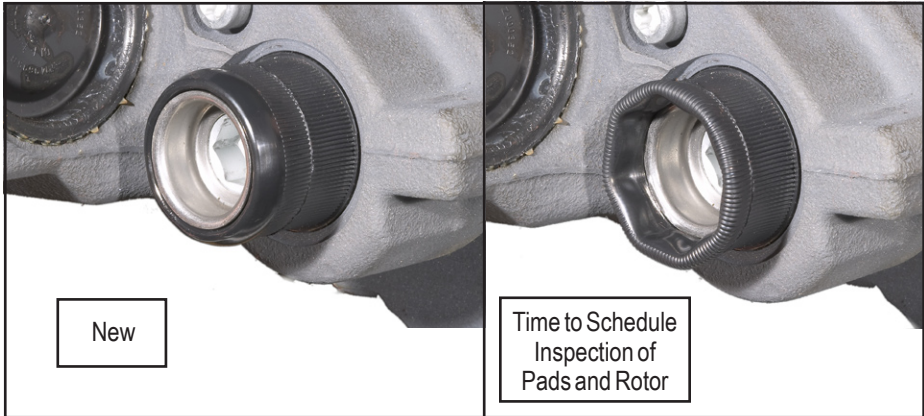


FIGURE 10 - ROLLING BOOT-STYLE WEAR INDICATOR INSPECTION

## Style B: Solid Rubber Bushing Style Wear Indicator

Inspect the position of the guide pin compared to the solid rubber bushing. See Figure 11. When the guide pin is aligned with the bushing, it is time to schedule a full wheel-removed inspection of the pads and rotor. Note: This is only an indication that the pads and rotor are ready for inspection, and does not necessarily mean that maintenance is required.

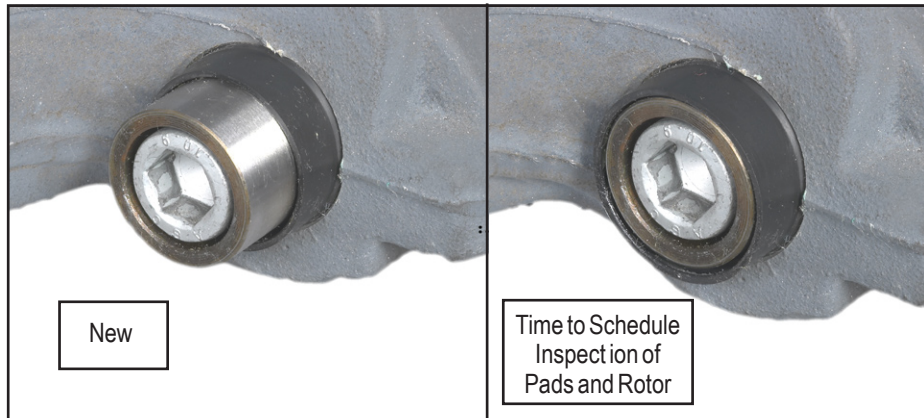


FIGURE 11 - SOLID RUBBER BUSHING-STYLE WEAR INDICATOR INSPECTION

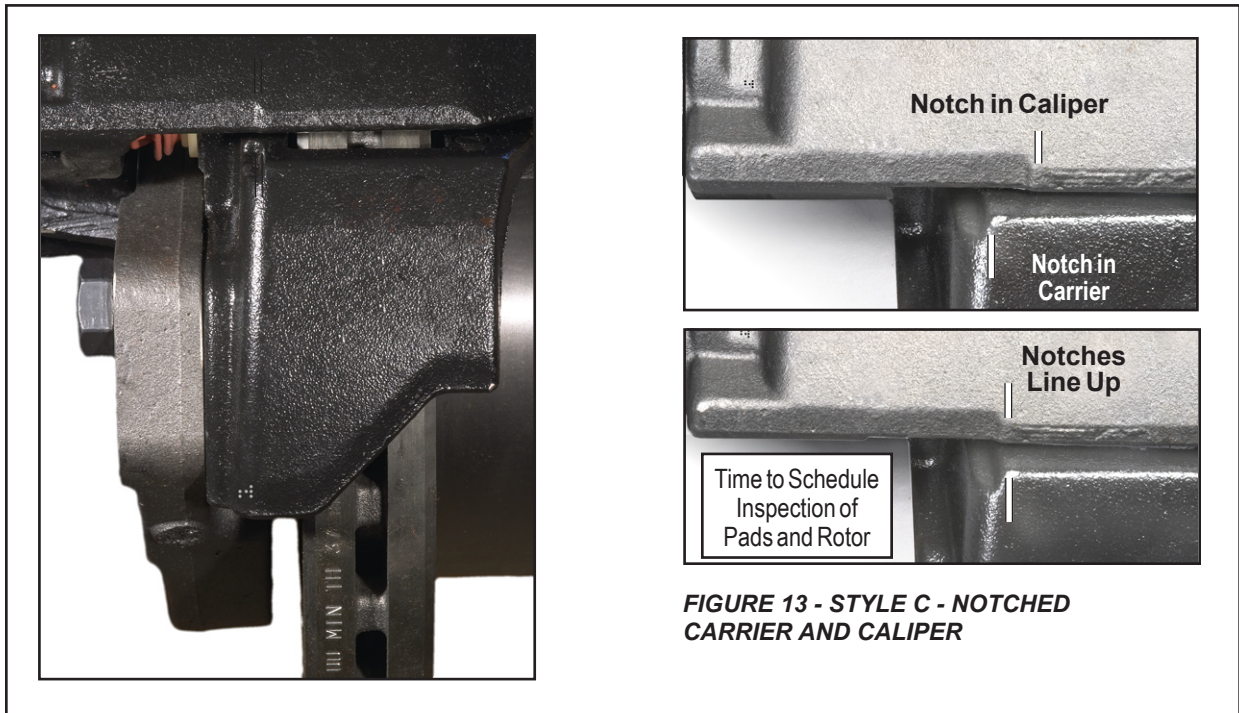
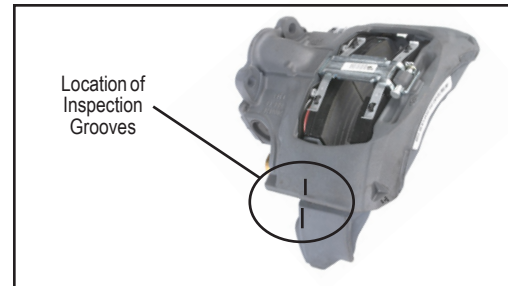


FIGURE 12 - PIN COVER

## MECHANICAL BRAKE PAD AND ROTOR WEAR INDICATORS (continued)

### Style C: Where Both the Carrier and Caliper Have an Indicator Notch

Compare the relative position of two notches cast into the Carrier and Caliper. See Figure 13. When the two notches align, it is time to schedule a full wheel-removed inspection of the pads and rotor. Note: This is only an indication that the pads and rotor are ready for inspection, and does not necessarily mean that maintenance is required.

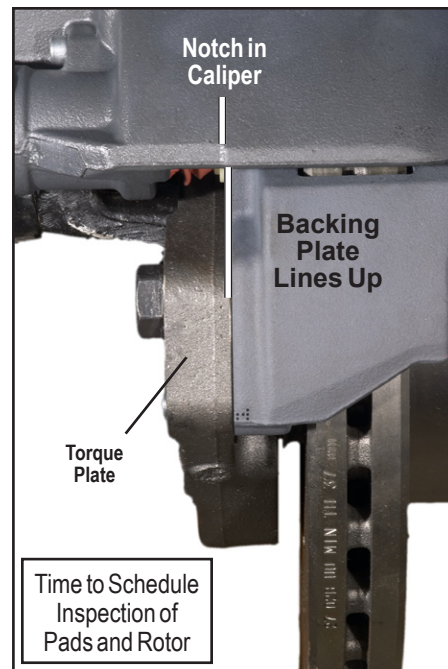


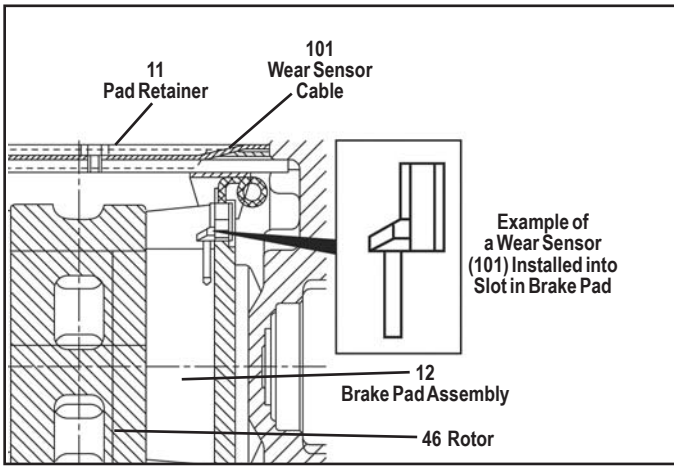
**FIGURE 13 - STYLE C - NOTCHED CARRIER AND CALIPER**

### Style D: Where Only the Caliper has an Indicator Notch

When the notch in the Carrier aligns with the front edge of the torque plate, it is time to schedule a full wheel-removed inspection of the pads and rotor. Note: This is only an indication that the pads and rotor are ready for inspection, and does not necessarily mean that maintenance is required.

**FIGURE 14 - CARRIER WEAR INDICATOR NOTCH AND BACKING PLATE ALIGNMENT**





**FIGURE 15 - EXAMPLE OF NORMALLY OPEN OR CLOSED WEAR SENSOR**

## ELECTRONIC BRAKE PAD WEAR INDICATORS

The electronic monitoring system uses sensors installed in a pre-formed slot in the brake pad to allow the status of the pad wear to be monitored. When the pad wears away through use, the point is reached when the indicator itself comes into contact with the rotor.

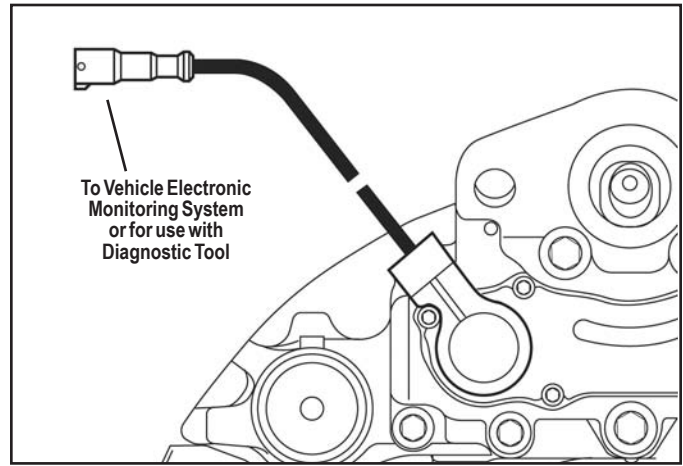
For **in-pad Normally-Closed Indicators**, when the point is reached when the indicator itself is worn through, the circuit flowing through it is broken and the vehicle operator is alerted.

For **in-pad Normally-Open Indicators**, when the point is reached when the indicator itself is worn through, the circuit is completed by the rotor touching the contacts and the vehicle operator is again alerted.

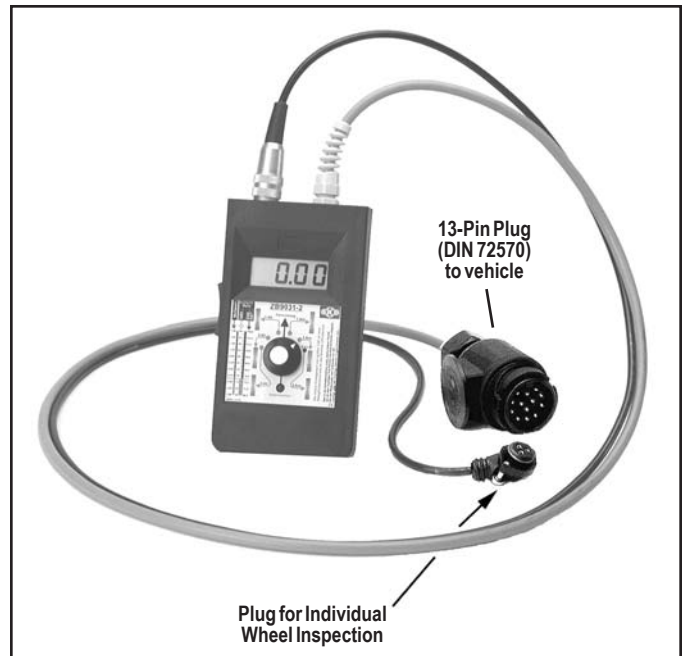
On some vehicles, the electronic system is fully integrated into the vehicle monitoring system and uses a buzzer or indicator lamp to alert the driver. Alternate vehicle arrangements permit a hand-held diagnostic tool to be used to test individual wheel connectors, or where installed, attach to a DIN socket in the dash, and allow up to six brakes to be checked from that location. The system provides feedback on the pad wear and can also conduct a test of the Wear Indicator Potentiometer.

Even when using wear indicators, always follow the standard preventive maintenance schedule outlined on page 7.

Refer to the vehicle manual and/or the diagnostic tool manual for specific device operating instructions.



**FIGURE 16 - EXAMPLE OF POTENTIOMETER WEAR SENSOR**



**FIGURE 17 - HAND HELD DIAGNOSTIC TOOL**



# GENERAL TROUBLESHOOTING PROCEDURE FLOWCHART

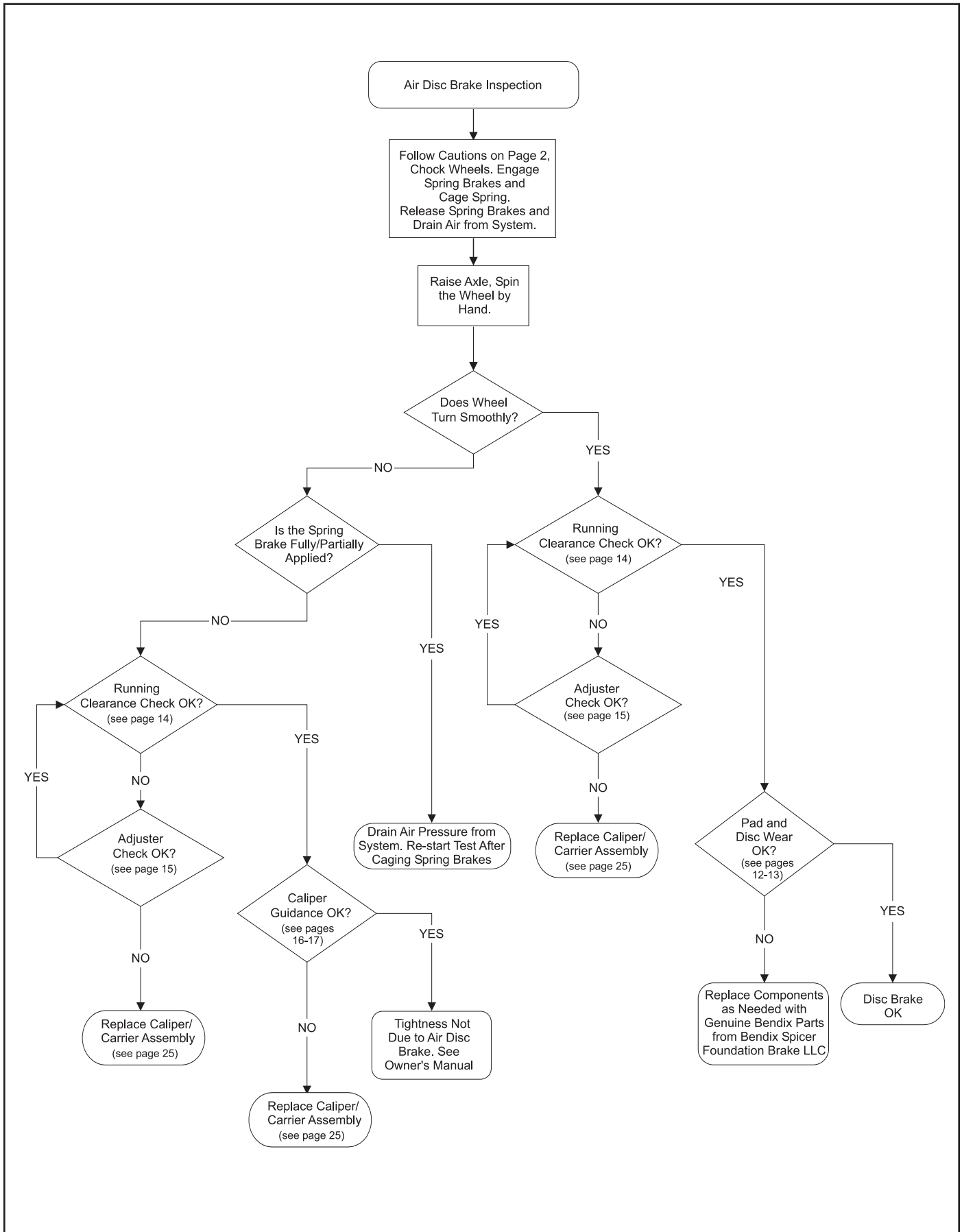


FIGURE 18 - TROUBLESHOOTING BENDIX AIR DISC BRAKES

## INSPECTIONS

Follow all standard safety procedures including, but not limited to, those on page 2 of this service manual.

### BRAKE PADS AND ROTORS

Bendix Air Disc Brakes are precision-engineered braking mechanisms. The “friction couple” braking characteristics have been carefully optimized and the rotor design and materials have been matched with special formulation brake pads for optimal performance.

**CAUTION:** When replacing brake pads, Bendix strongly recommends using only replacement pads and replacement rotors approved by the OEM. Use of non-approved rotors or non-approved replacement disc pads can cause excess wear to brake components, and can increase the risks of rotor cracking, etc. Note that two thicknesses of backing plate are generally available, so to maintain the vehicle within spec's only use brake pads with the type of backing plate and lining material originally supplied by the vehicle manufacturer. See the manual supplied with the vehicle for further information.

### INSPECT BRAKE PADS

Regular inspection of the brake pads (even for vehicles that use a wear indicator) is an important part of vehicle maintenance.

See Figure 16. If the thickness of the friction material (M2) is less than 0.079 in. (2 mm) the pads must be replaced.

Bendix® ADB 22X™, ADB 225™, SN6™, SN7™ (and some SK7™) air disc brakes use 0.35 in. (9 mm) backing plates, so P2 (the combined pad and backing plate thickness) must be a minimum of 0.43 in. (11 mm).

Note that for some Bendix® SK7™ air disc brakes, a 0.28 in. (7 mm) backing plate is used, so P2 (the combined pad and backing plate thickness) must be a minimum of 0.35 in. (9 mm).

If the pad thickness is within the acceptable range, inspect the pad surface. Minor damage at the edges is permitted (see Figure 20), but replace the pads if major damage on the surface of the pad is found (see Figure 21).

When replacing brake pads, Bendix strongly recommends that all the brake pads on an axle be replaced at one time. See pages 18-19 for the pad replacement procedure. Also see the vehicle manual recommendations.

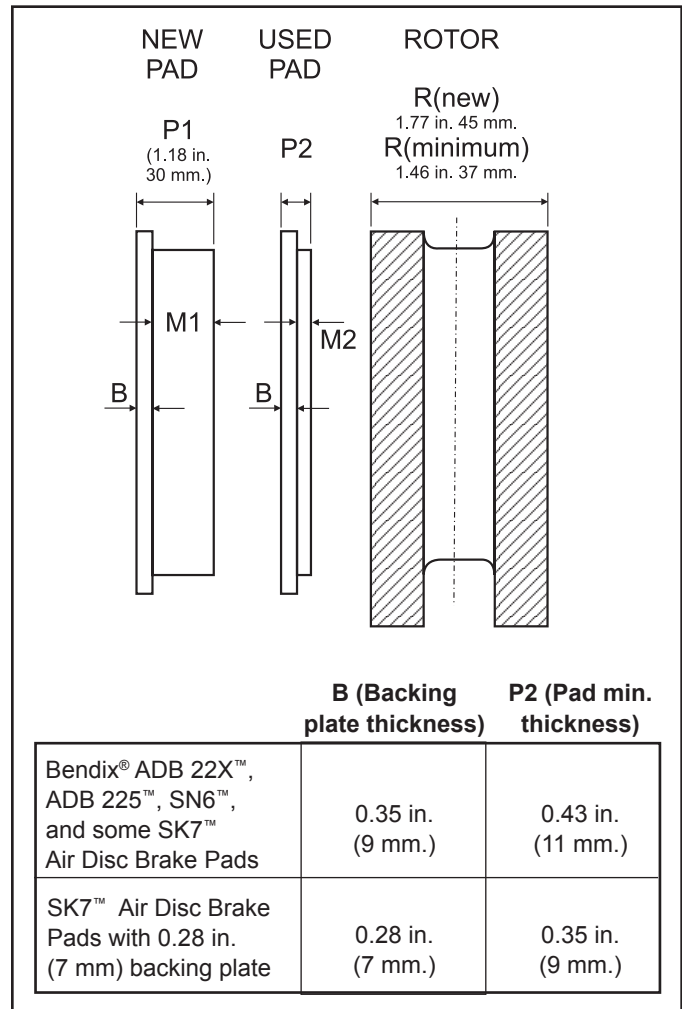
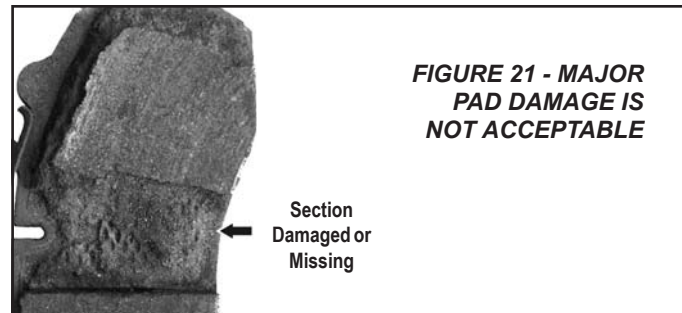
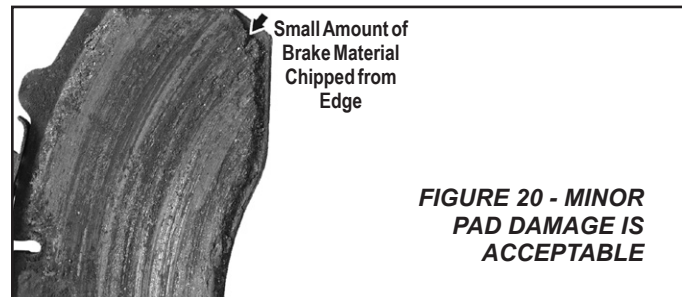


FIGURE 19 - PAD AND ROTOR DIMENSIONS



## INSPECT ROTORS

Identify if the rotor is a conventional or a splined assembly (see Page 6).

Examine the rotor and measure the thickness at thinnest point. Avoid measuring near the edge of the rotor as minor burrs may be present.

Replace Bendix rotors when the minimum thickness of 1.46 in. (37 mm) is reached or as instructed by vehicle manufacturer. When replacing Rotors, please refer to the instructions of the Vehicle Manufacturer. It is recommended to install Bendix Brake Rotors, available from your local Bendix Spicer Foundation Brake parts outlet, and it is also recommended that the pads should be replaced at the same time.

**Non-Bendix rotors.** If a non-Bendix rotor is used, refer to the vehicle manual and rotor manufacturer's recommendations. **CAUTION: The use of non-approved brake rotors may reduce levels of safety and invalidate warranty.**

## Rotor Surface Inspection

Inspect the rotor at each change of pads for grooves and cracks. The action to take depends on the type of rotor, and also the size, depth and direction of the imperfections, see Figure 22.

## Rotor Turning (Grinding)

Bendix rotors are normally service-free.

Turning of Bendix spline rotors is not permitted.

Conventional rotors may be turned when changing pads, but is not normally necessary. In the case of severe grooving of the entire friction surface, however, turning could be useful, and may increase the load-bearing surface of the pads. To meet Bendix recommendations, the minimum rotor thickness after turning must be greater than 1.53 in. (39 mm).

**CAUTION:** Always maintain air disc brake pads and rotors within specifications. Excessive pad or rotor wear will degrade optimum performance. When replacing Rotors, be sure to adhere to the vehicle manufacturer's recommended bolt tightening torques.

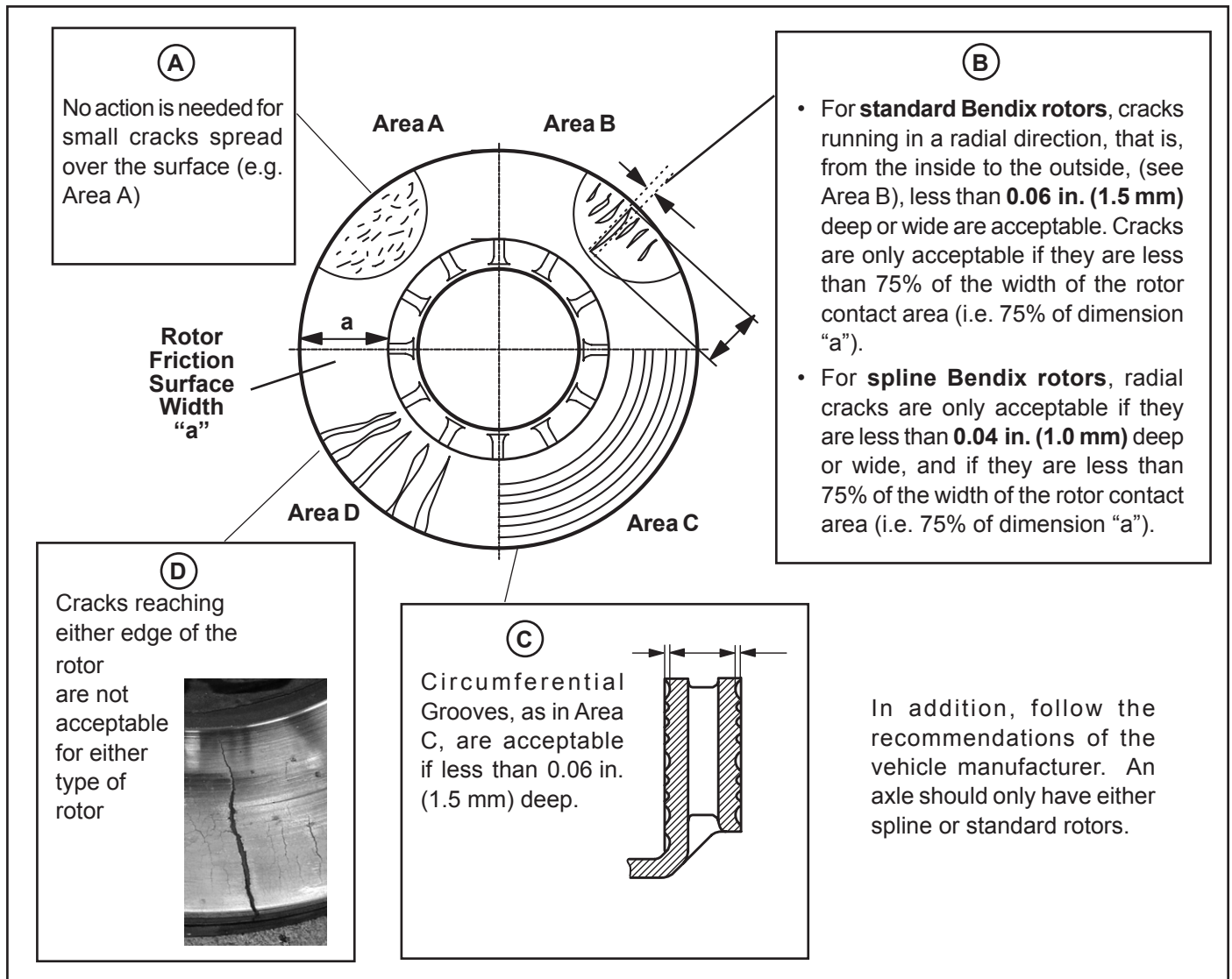


FIGURE 22 - EXAMPLES OF ACCEPTABLE AND NON-ACCEPTABLE ROTOR CRACKS AND GROOVES

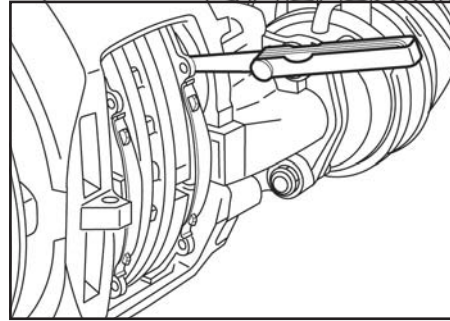
## 2. CALIPER RUNNING CLEARANCE

**CAUTION:** Follow all standard safety procedures including, but not limited to, those on page 2 of this service manual. See the vehicle manufacturer's recommendations. When working on foundation brakes, be sure that the vehicle is on level ground, that the vehicle is parked by other means than the foundation brakes, and that the wheels are chocked.

### CALIPER MOVEMENT TEST

Remove the wheel. With the spring brakes caged, push the caliper assembly inboard on its guide pins. Using a suitable tool, press the inboard pad (12) away from the tappets and check the gap between the tappet and the inboard pad backplate - it should be between 0.024 in. (0.6 mm) & 0.043 in. (1.1 mm). **If the movement is within the range there is no need to inspect further.**

**CAUTION:** If the clearance is too wide, there is a danger of brake failure. If the clearance is too small, there is a danger of overheating. That may lead to consequential damage.



**FIGURE 23 -  
MEASURING  
THE RUNNING  
CLEARANCE**

If there is no movement at all, go to pages 16-17 for the "Guide Pin Inspection Procedure."

If instead, there is movement, but the running clearance is too small or too large, the adjuster may not be functioning correctly and should be checked. See "Inspect Adjuster Mechanism" on Page 15.

### CONTACTING BENDIX

[www.foundationbrakes.com](http://www.foundationbrakes.com)

Bendix on-line information is available 24/7. In the on-line contacts directory, you can find: technical support contacts; service engineers; Bendix account managers; international contacts and more. [www.foundationbrakes.com](http://www.foundationbrakes.com) is your complete Bendix resource.

#### **Bendix Technical Assistance Team**

For direct personal technical support, call the Bendix technical assistance team at:

**1-800-AIR-BRAKE** (1-800-247-2725),

Monday through Friday, 8:00 A.M. to 6:00 P.M. EST, and follow the instructions in the recorded message.

Alternatively, you may e-mail the Bendix technical assistance team at: [techteam@bendix.com](mailto:techteam@bendix.com).

**To better serve you, please record the following information before you call the Bendix Tech Team, or include this information in your e-mail:**

- Bendix product model number, part number and configuration.
- Vehicle make and model.
- Vehicle configuration. (Number of axles, tire size, etc.)
- System performance symptoms: When do they occur?
- What troubleshooting/measurements have been performed?
- What Bendix service data literature do you have or need?

### 3. INSPECT ADJUSTER MECHANISM

**CAUTION:** Follow all standard safety procedures including, but not limited to, those on page 2 of this service manual. See the vehicle manufacturer's recommendations. When working on foundation brakes, be sure that the vehicle is on level ground, that the vehicle is parked by other means than the foundation brakes, and that the wheels are chocked.

Aside from the normal maintenance schedule, this Adjuster Check is also carried out when the Caliper Movement Test (see Page 14) finds that the running clearance is too small or too large.

The adjuster should then be checked as follows:

With the spring brake released (or caged), remove the adjuster cap (37) using the tab, taking care not to move the shear adapter (61). Note: One of two styles of adjuster cover (stamped metal or plastic) may be used.

Although exploded view (Figure 25) shows the adjuster (23) and shear adapter (61) separated, only turn the adjuster with the shear adapter installed on the adjuster. Using a box-end wrench or socket, turn the Shear Adapter (61) **counter-clockwise** and listen for the sound of 2 or 3 clicks as the mechanism increases the running clearance. Note: Do not use an open-ended wrench as this may damage the adapter.

**CAUTION:** Never turn the adjuster (23) without the shear adapter (61) installed. The shear adapter is a safety feature and is designed to prevent an excess of torque being applied to the adjuster. The shear adapter will fail (by breaking loose) if too much torque is applied.

If the shear adapter fails, you may attempt a second time with a new (unused) shear adapter. A second failure of the shear adapter confirms that the adjustment mechanism is seized and the caliper must be replaced.

With a box-end wrench (or socket) positioned so that it can turn freely without coming into contact with parts of the vehicle (See Figure 27) on the shear adapter, make five to ten moderate applications of the brakes [at about 30 psi (2 Bar)]. For a normally functioning Bendix air disc brake, the box-end wrench or socket should turn clockwise in small increments. NOTE: As the number of applications increases, the turning movement will decrease (as the brake reaches its normal calibration point).

If the box-end wrench or socket does not: (a) turn at all, or (b) turns only with the first application, or (c) turns forward and backward with every application, the automatic adjuster has failed and the caliper/carrier assembly must be replaced.

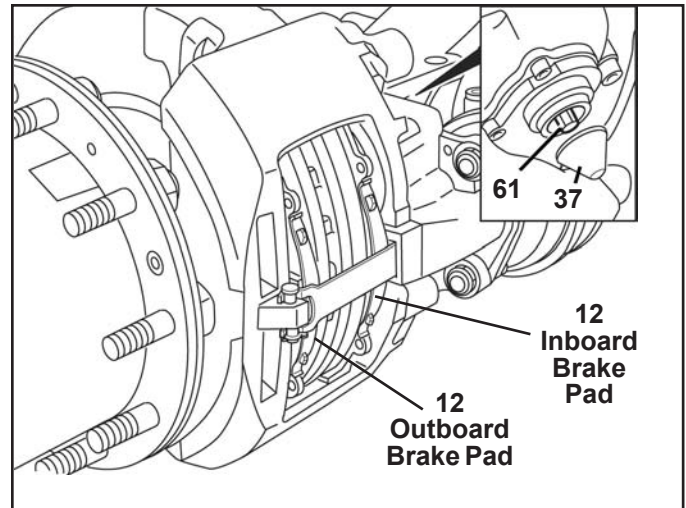


FIGURE 24 - COVER REMOVAL

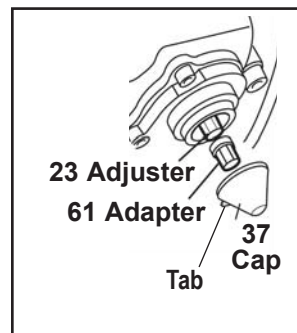


FIGURE 25 - EXPLODED VIEW OF ADJUSTER AND ADAPTER

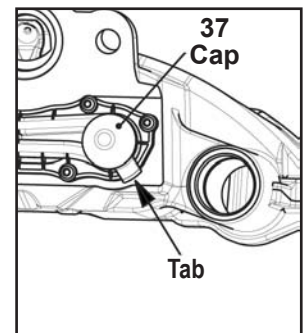


FIGURE 26 - TAB POSITION

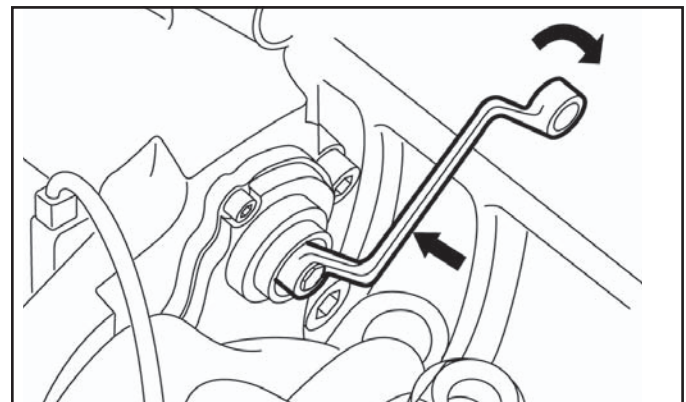


FIGURE 27 - ADJUSTMENT MECHANISM TEST

Bendix recommends installing a new adjuster cap (lightly greased using white lithium-based grease) when returning the air brake to service. Ensure that the tab is in the position shown in Figure 26.



## GUIDE PINS

**CAUTION:** Follow all standard safety procedures including, but not limited to, those on page 2 of this service manual. See the vehicle manufacturer's recommendations. When working on foundation brakes, be sure that the vehicle is on level ground, that the vehicle is parked by other means than the foundation brakes, and that the wheels are chocked.

Note: If the steps below lead the technician to a step where the wheel needs to be removed, inspect first to see that there is no contact between the caliper and axle, vehicle, chassis sections or carrier, etc. that may be impeding the caliper movement. When removing wheels, refer to the vehicle manufacturer's recommendations.

This guide pin inspection should be carried out if the result of the Caliper Movement Test (see Page 13) is that the technician cannot move the caliper.

## GUIDE PIN BEARING INSPECTION

Use the following procedure to check caliper movement along the guide pins:

Remove the Pads (see Page 18).

One of the three different styles of guide pin (A, B, or C) may be present (See Figure 28). The bearings for styles A and B use a rubber bushing, and style C uses a guide sleeve. Clean dirt, road grime, etc. from the guide pin or cover.

Using hand pressure only (no tools), the Caliper (1) should slide freely along the whole length of the Guide Pin arrangement. With the pads removed, this movement should be at least 0.8 inch (20mm). If the movement is less than this amount, replace the caliper/carrier assembly.

**To measure the clearance from the rubber bushing (6a, 6b) or guide sleeve (6c) to the guide pin:**

See Figures 29 and 30. Remove the wheel. Remove the pad retainer (11), but leave the pads (12) in position. Attach a magnetic dial-gauge holder to the carrier (2) on the short bearing side of the caliper (1).

Use the measuring point on the caliper (1) - see the arrow in Figure 28. Press the caliper in the direction of carrier (2) and set the dial-gauge to zero.

Place a suitable tool (e.g. screwdriver) between Carrier (2) and Caliper (1) forcing them in opposite directions, and read the maximum value on the dial-gauge.

For styles A and B guide pins, if the value is greater than 0.079 in. (2.0 mm), or for style C guide pins, if the value is greater than 0.039 in. (1.0 mm), the caliper/carrier assembly must be replaced.

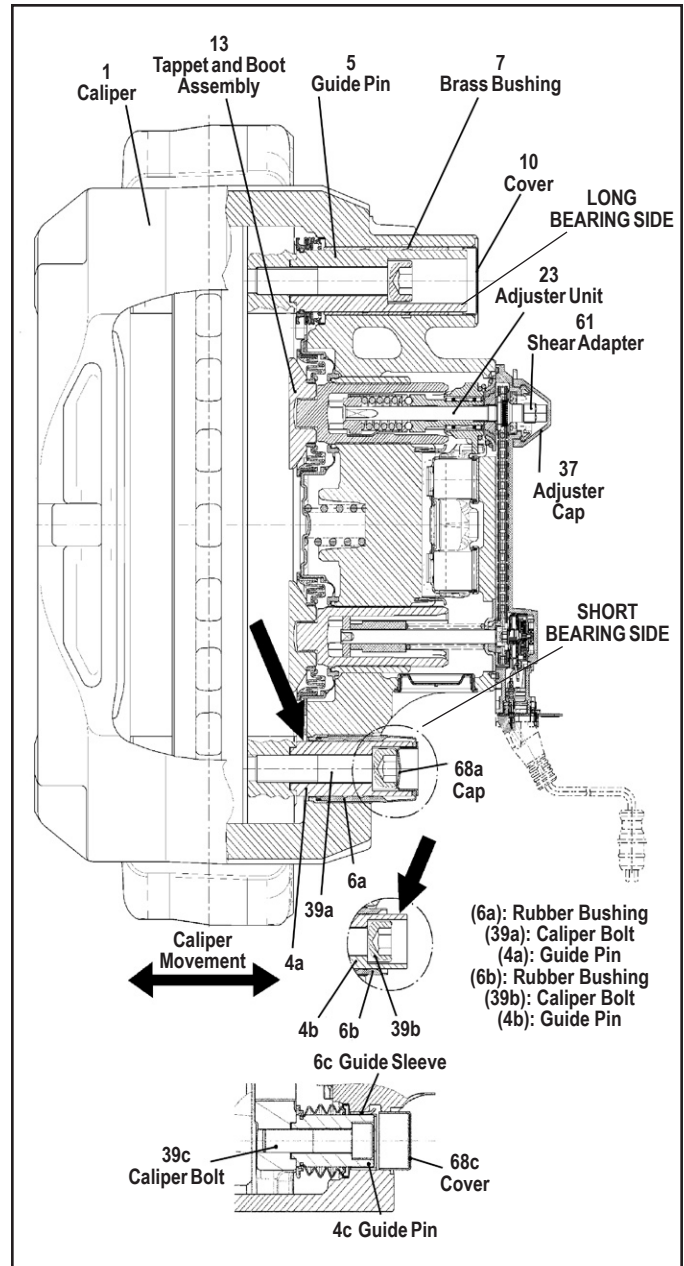


FIGURE 28 - GUIDE PINS

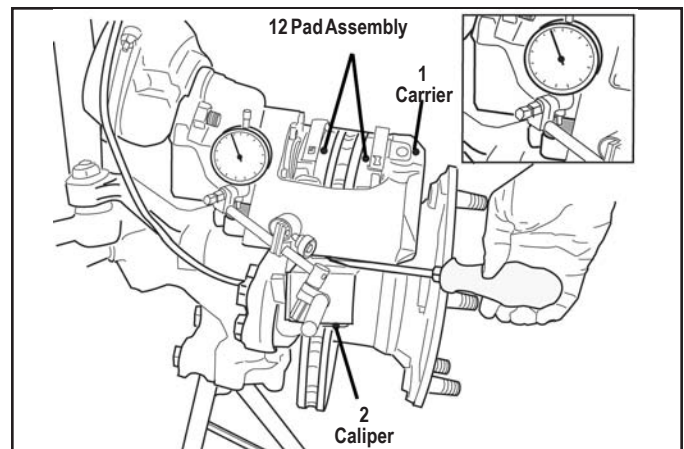


FIGURE 29 - MAGNETIC DIAL-GAUGE

## GUIDE PIN SEAL INSPECTION

### Caliper Guide Pin Seals

The long bearing side guide pin (5) is sealed with the cover (10) and with the inner boot (9). See Figure 28. Note: It may be necessary to remove the pads to inspect the inner boots (9) if pad wear is minimal. The guide pin (4a, 4b, or 4c, depending on the style) is also sealed with an inner boot (9) and a cover (style C), or a flexible rubber wear indicator in the case of style A guide pins.

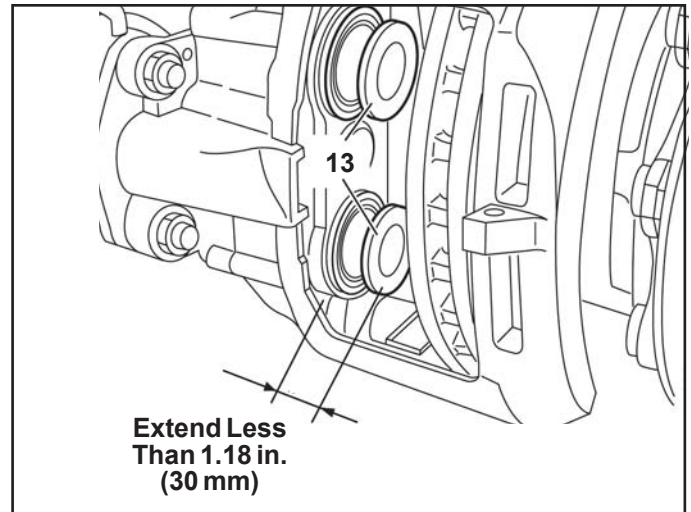
Inspect the above components, and if damage is found, replace the caliper/carrier assembly. No kits are available at this time for Guide Pin Seals.

## TAPPET AND BOOT ASSEMBLY INSPECTION

In order to inspect the tappet and boot assembly, it may be necessary to remove the pads (12) (see Page 18) and advance the shear adapter (61) clockwise (see Page 15) until the boots are clearly visible.

**CAUTION: NEVER EXTEND THE TAPPET MORE THAN 1.18 in. (30 mm). Over-extending the tappet will result in the tappet losing engagement with the threads of the synchronizing mechanism. Since the mechanism can only be set at the manufacturing plant, the CALIPER/CARRIER ASSEMBLY MUST BE REPLACED if this happens.**

Inspect the tappet and boot assemblies (13) for evidence of damage, corrosion, etc. The penetration of dirt and moisture into the brake can lead to corrosion and impair the function of the air disc brake. Replace as necessary (see Pages 22-24).



**FIGURE 30 - TAPPET EXTENSION LIMIT**

After re-installing a wheel according to the vehicle manufacturer's recommendations, please ensure that there is sufficient clearance between the tire inflation valve stem, the caliper and the wheel rim, to avoid damage.

**WARNING: Not all wheels and valve stems are compatible with Bendix Air Disc Brakes. Use only wheels and valve stems approved by the vehicle manufacturer to avoid risk of valve stem shear and other compatibility issues.**

# MAINTENANCE PROCEDURES

## PAD REPLACEMENT

**CAUTION:** Follow all standard safety procedures including, but not limited to, those on page 2 of this service manual. See the vehicle manufacturer's recommendations. When working on foundation brakes, be sure that the vehicle is on level ground, that the vehicle is parked by other means than the foundation brakes, and that the wheels are chocked. When installing pads, where appropriate use heavy duty gloves and always keep fingers away from potential pinch hazard areas.

As noted earlier, Bendix Air Disc Brakes are precision-engineered braking mechanisms. The "friction couple" braking characteristics have been carefully optimized and the rotor design and materials have been matched with special formulation brake pads for optimal performance.

## PAD REMOVAL

Bendix strongly recommends that when replacing brake pads, pads are replaced as an axle set.

Release or cage spring brakes and remove the wheel (refer to the vehicle manufacturer's recommendations).

Note: Before removing the brake pads it is strongly recommended that the adjuster mechanism be checked for correct operation (see Page 15).

Remove the clip (26) and washer (45), depress the pad retainer (11) and remove the pad retainer pin (44). Discard these four items - replacements are included in the service kits. As necessary remove any in-pad wear sensor components and discard.

Pull off the adjuster cap (37) using the tab, taking care to keep the shear adapter (61) in position on the adjuster (23).

Using a box-end wrench or socket, fully wind back the tappet and boot assemblies (13) by rotating the shear adapter (61) in an counter-clockwise direction (see Page 15). Note: Do not use an open-ended wrench as this may damage the adapter.

**CAUTION:** Never turn the adjuster (23) without the shear adapter (61) installed. The shear adapter is a safety feature and is designed to prevent an excess of torque being applied to the adjuster. The shear adapter will fail (by breaking loose) if too much torque is applied.

If the shear adapter fails, you may attempt a second time with a new (unused) shear adapter. A second failure of the shear adapter confirms that the adjustment mechanism is seized and the caliper/carrier assembly must be replaced.

To remove the outboard brake pad (12), slide the caliper

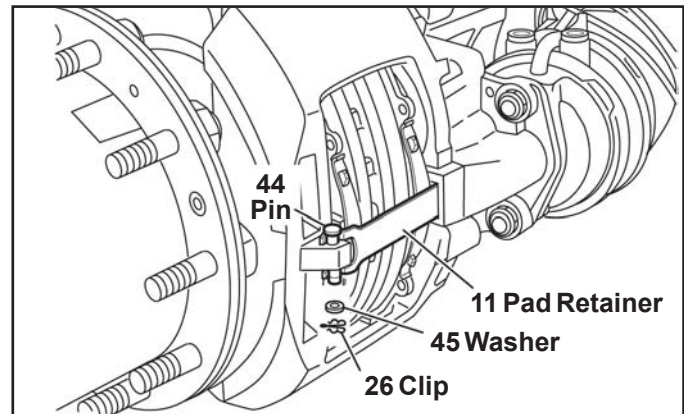


FIGURE 31 - BRAKE PAD REMOVAL

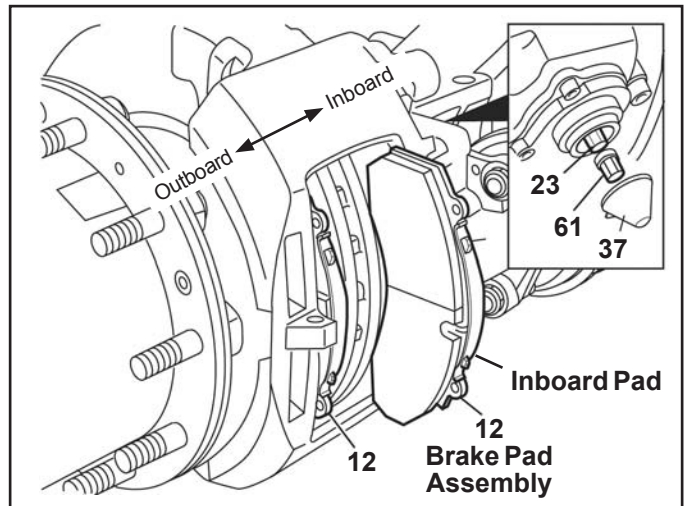


FIGURE 32 - BRAKE PAD REMOVAL

(1) fully to the outboard position first. Similarly, to remove the inboard pad, first move the caliper fully to the inboard position, and then remove the pad. See Figure 32.

**Inspect the rotor.** See Page 13 for full information.

## PAD INSTALLATION

**CAUTION:** When replacing brake pads take care to always use the correct replacement pads. For example, note that two thicknesses of backing plate are generally available - to maintain vehicle within spec's only use brake pads with the type of backing plate and lining material originally supplied by the vehicle manufacturer. See the manual supplied with the vehicle for further information.

As noted above, Bendix strongly recommends that when replacing brake pads, pads are replaced as an axle set. **Use only pads which are permitted by the vehicle manufacturer, axle manufacturer and/or disc brake manufacturer. Failure to comply with this may invalidate the vehicle manufacturer's warranty.**



Check that the tappet and boot assemblies have been fully retracted, as outlined above. Clean the brake as needed - see the vehicle manufacturer's recommendations.

To install the outboard brake pad (12), slide the caliper (1) fully to the outboard position before inserting the pad (with the brake lining material facing the rotor). Similarly, to install the inboard pad, move the caliper fully to the inboard position, and then install the brake pad (with the lining material facing the rotor). See Figure 30.

Install new in-pad wear indicator kit, if appropriate (see Pages 20-21).

Using a box-end wrench or socket, turn the shear adapter (61) clockwise until the pads come into contact with the rotor. Then turn back the shear adapter counter-clockwise two clicks to set the initial running clearance.

Note: Use only pads with the same backing plate thickness as originally specified for the vehicle's brakes.

Note: The Bendix air disc brakes covered by this service manual use more than one pad retainer design. Be sure to install the correct part number for the vehicle.

After installing the pad retainer (11) supplied with the kit, into the groove of the caliper (1), it must be depressed to enable the insertion of the pad retainer pin (44).

Install the supplied washer (45) and spring clip (26) to the pad retainer pin (44). It is recommended that the pad retainer pin (44) be installed pointing downwards (see Figure 35).

Apply and release the brake and then check that the hub turns easily by hand.

Lightly grease and install a new adjuster cap (37) using white lithium-based grease. Note: The tab of the adjuster cap should be positioned as shown by the arrow in Figure 34 for ease of access.

Re-install the wheel according to the vehicle manufacturer's recommendations. **Note: Not all wheels (and or valve stems) are compatible with Bendix Air Disc Brakes. Use only wheels and valve stems approved by the vehicle manufacturer.**

CAUTION: Bendix recommends that after every air brake service, if available, the technician checks the brake performance and the system behavior on a dynamometer.

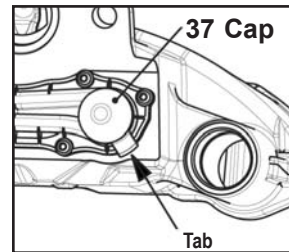
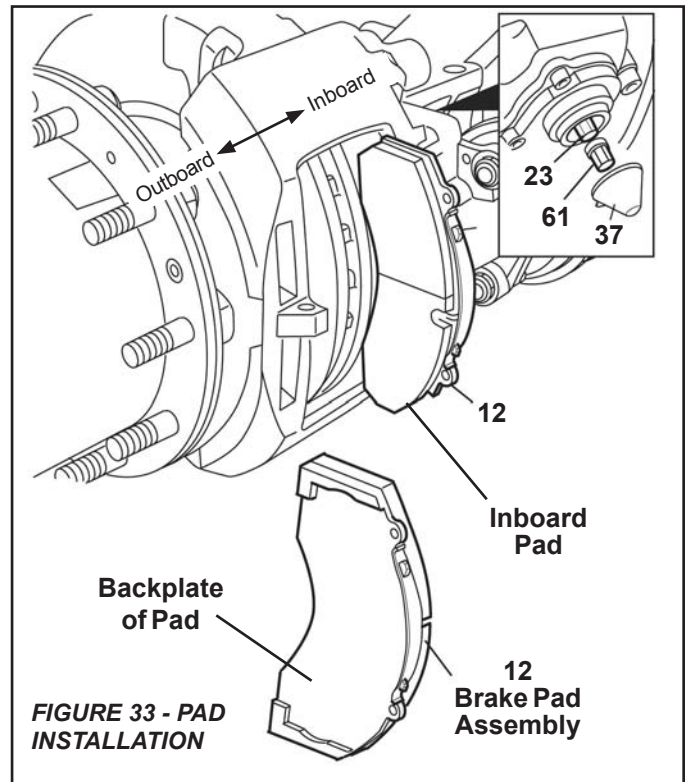


FIGURE 34 - TAB POSITION

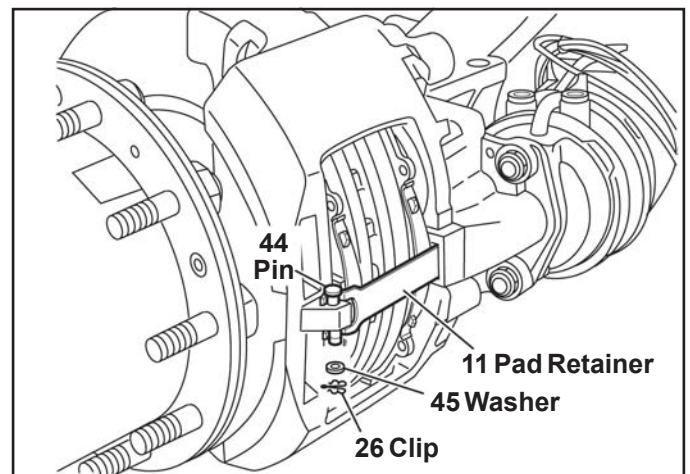


FIGURE 35 - BRAKE PAD INSTALLATION

## ELECTRONIC WEAR INDICATOR REPLACEMENT

(Normally-Closed or Normally-Open Type) See page 10.

New wear indicators are normally installed whenever brake pads are replaced. Please see Brake Pad Installation on Page 18 for cautions and procedures. The wear indicator is installed after the new brake pads are installed into the brake, but before the retainer hardware.

Remove and retain the pad holder springs.

See page 6 for typical contents of wear indicator kits.

Installation: The longer branch of the wear indicator cable (see arrow) must be installed in the outboard pad. Insert the Wear Indicator Cables (101) into the pre-cut slot in the pads. The wear indicators snap into place.

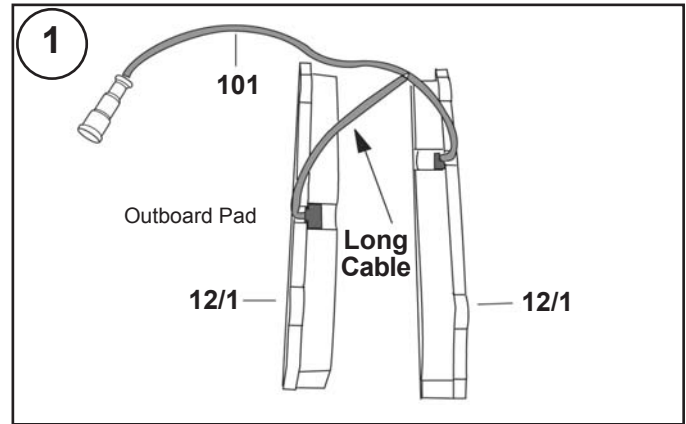
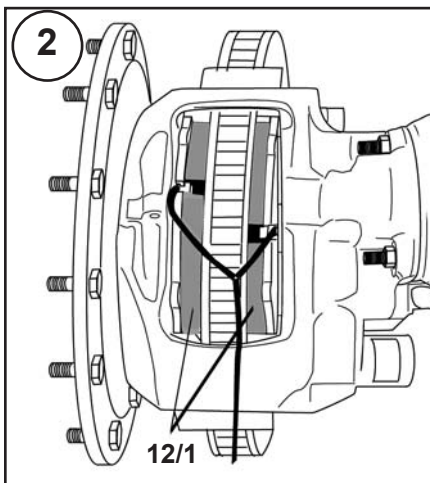
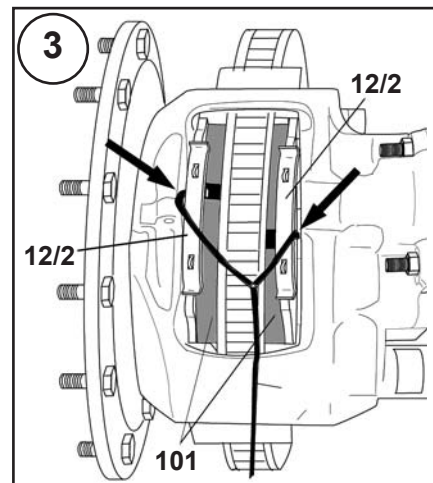


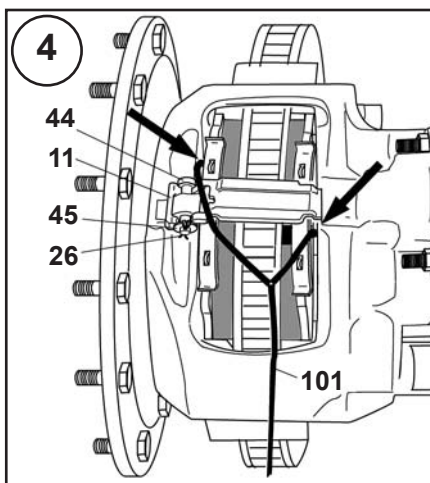
FIGURE 36 - WEAR INDICATOR CABLE



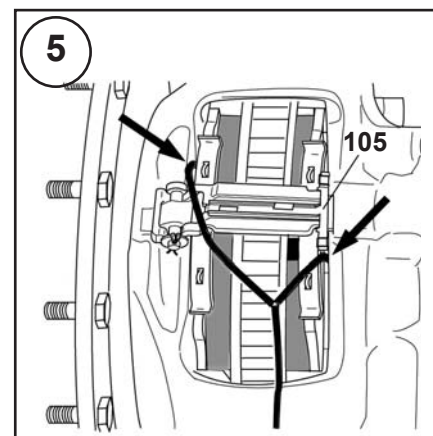
2. Insert wear indicator sensors into the pads.



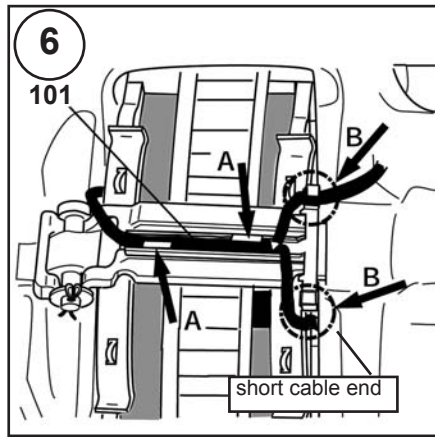
3. Install the pad holder springs (12/2) onto the pads (12/1) with the wear indicator cable (101) as shown.



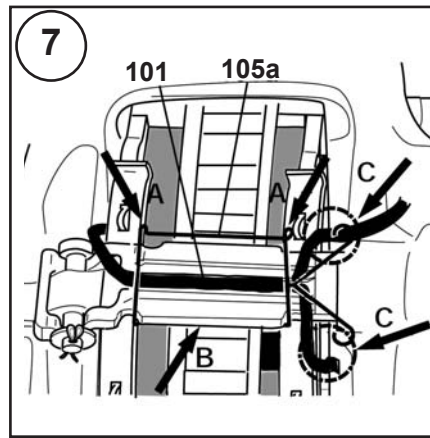
4. Install the pad retainer (11), pad retainer pin (44), washer (45) and spring clip (26) with the wear indicator cable (101) as shown.



5. Install the cable guide (105) onto the pad retainer (11). The cable guide (105) snaps into place when pressing lightly onto the pad retainer (11).

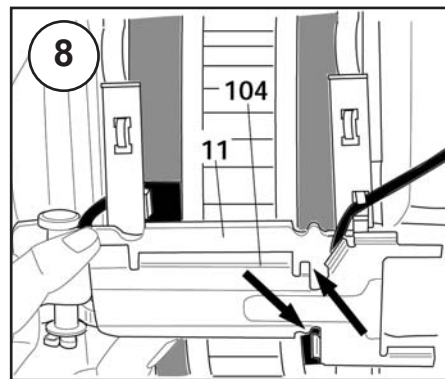


6. Press the wear indicator cable (101) into the locating tabs of the cable guide (105) (see arrows A). The short cable end of the wear indicator cable (101) must not be secured by locating tabs of the cable guide (105). According to vehicle type, install the cable that leads to the electrical supply of the vehicle, in one of the two locating tabs (see arrows B).



7. Install the indicator cable (101) in the middle of the pad retainer (11). Insert the cable guide (105a) at one side of the pad retainer (11) (see arrow B). Slightly press in on the other side of the pad retainer (11) (see arrows A). The cable guide (105a) snaps into place.

According to vehicle type, install the cable that leads to the electric supply of the vehicle, in one of the wire loop (see arrows C). The short end of the wear indicator cable (101) must not be secured by a wire loop of the cable guide (105a) (see arrows C).



8. Carefully install the cable protection plate (104) with attention to the correct position of the cable protection plate's catch (see arrows).

The cable protection plate (104) will snap into place.



## TAPPET AND BOOT ASSEMBLIES REPLACEMENT

**CAUTION:** Follow all standard safety procedures including, but not limited to, those on page 2 of this service manual. See the vehicle manufacturer's recommendations. When working on foundation brakes, be sure that the vehicle is on level ground, that the vehicle is parked by other means than the foundation brakes, and that the wheels are chocked. When installing pads, where appropriate use heavy duty gloves and always keep fingers away from potential pinch hazard areas. Cage spring brakes before beginning procedure.

Note: In some cases, the technician may find it easier to remove the caliper from the vehicle before making the replacement (see Page 25 for instructions on caliper/carrier removal).

## REMOVAL OF TAPPET AND BOOT ASSEMBLIES (13)

Follow the procedure for removing brake pads (12) on Page 18.

**CAUTION:** Never turn the adjuster (23) without the shear adapter (61) installed. The shear adapter is a safety feature and is designed to prevent an excess of torque being applied to the adjuster. The shear adapter will fail (by breaking loose) if too much torque is applied.

**CAUTION:** NEVER EXTEND THE TAPPET MORE THAN 1.18 in. (30 mm). Over-extending the tappet will result in the tappet losing engagement with the threads of the synchronizing mechanism. Since the mechanism can only be set at the manufacturing plant THE CALIPER/CARRIER ASSEMBLY MUST BE REPLACED if this happens.

Removal of the tappet and boot assembly (13) requires the use of the wedge fork (A). See Figure 39. Extend the tappets less than 1.18 in. (30 mm) by turning the shear adapter (61) clockwise until there is sufficient access to the boots to remove the tappet boot from the caliper bore. A screwdriver (B) should be used to move the boot location ring - see Figure 40 and allow the wedge fork (A) to be inserted. **CAUTION:** Take care not to damage the inner sealing face (see arrow "X" in Figure 40). Gouges or grooves that would prevent a good seal necessitate caliper replacement.

The tappet and boot assemblies (13) can then be removed from the threaded tubes (16) by using the wedge fork (A).

Remove the old tappet bushing(s) (161). Inspect the inner sealing face (see arrow "X") for damage. If damage is found to the inner seal the caliper/carrier assembly must be replaced.

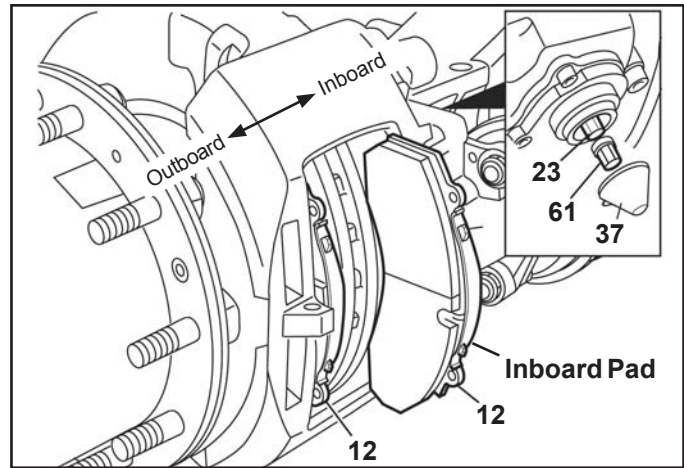


FIGURE 37 - BRAKE PAD REMOVAL

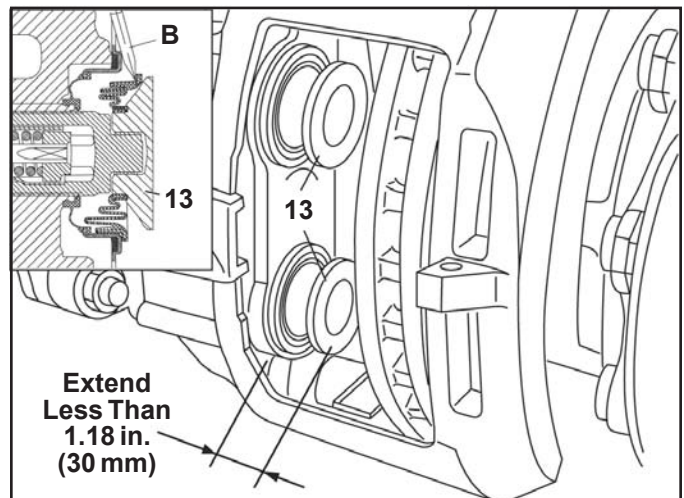


FIGURE 38 - TAPPET EXTENSION

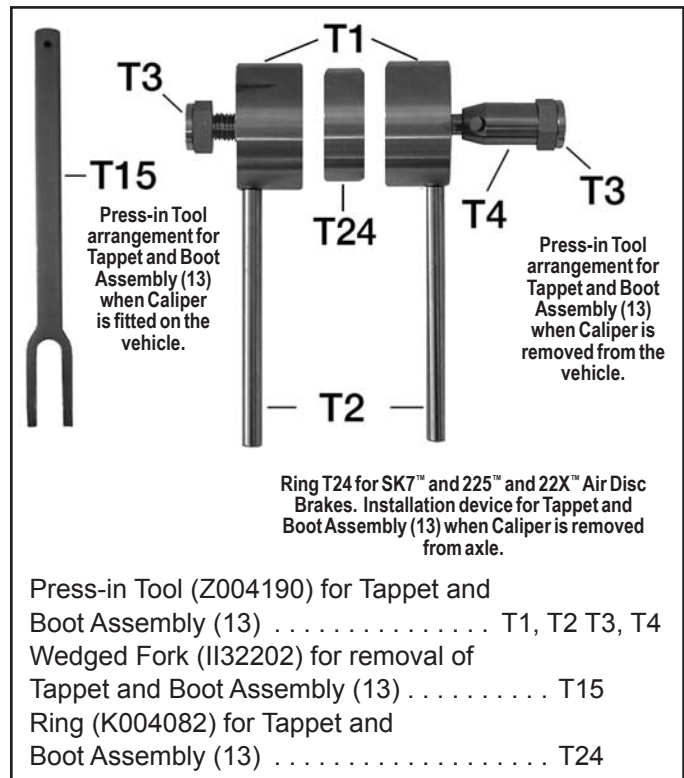
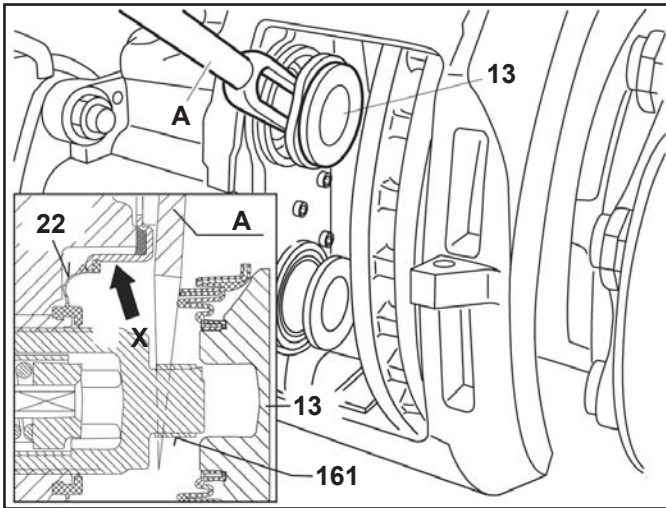
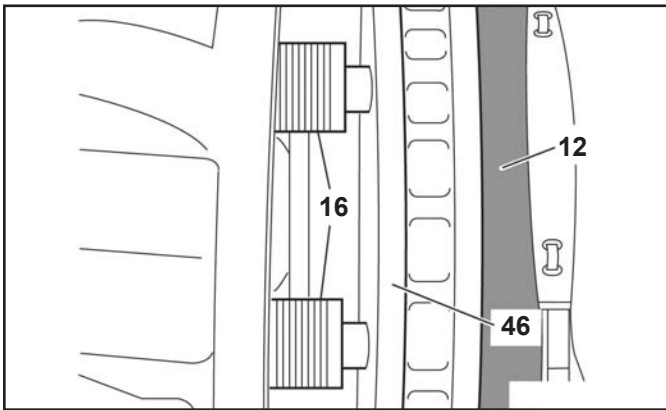


FIGURE 39 - TAPPET REMOVAL TOOL



**FIGURE 40 - WEDGE TOOL USE**



**FIGURE 41 - USE OF A NEW BRAKE PAD AS A SPACER**

### INSPECT THE THREADED TUBES (16)

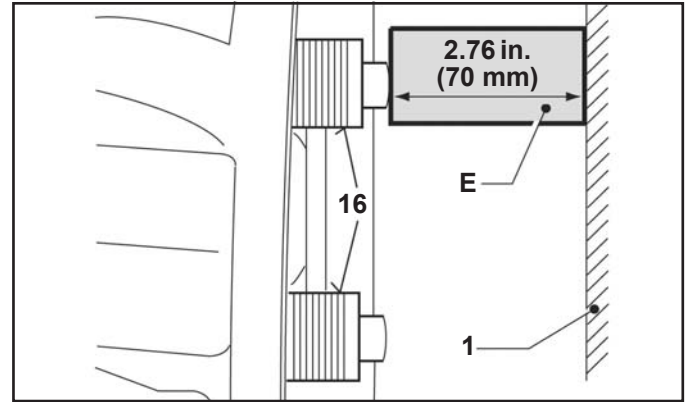
For the inspection of the threads, the tubes must be extended, but by less than 1.18 in. (30mm), by turning the shear adapter (61) clockwise. If working with the caliper on the vehicle, the technician may place a new brake pad (12) into the outboard gap to help avoid the loss of thread engagement of the threaded tubes. If the work is being carried out at a workbench, the technician may insert a 2.76 in. (70 mm) spacer (E) into the caliper (1) to help avoid the loss of thread engagement. See CAUTION on Page 22.

Check the threads for rust, corrosion, or damage etc. If there is evidence of damage to the threads, rust or corrosion, the caliper/carrier assembly must be replaced (see Page 25).

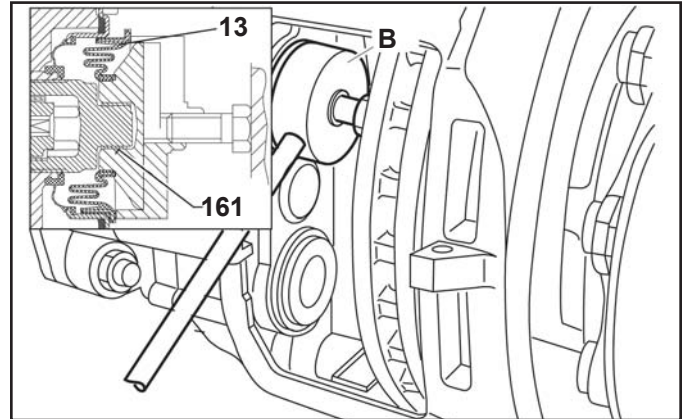
If the threads are in good condition, fully wind back the threaded tubes (16) by turning the shear adapter (61) counter-clockwise.

### INSTALLING THE TAPPET AND BOOT ASSEMBLIES (13)

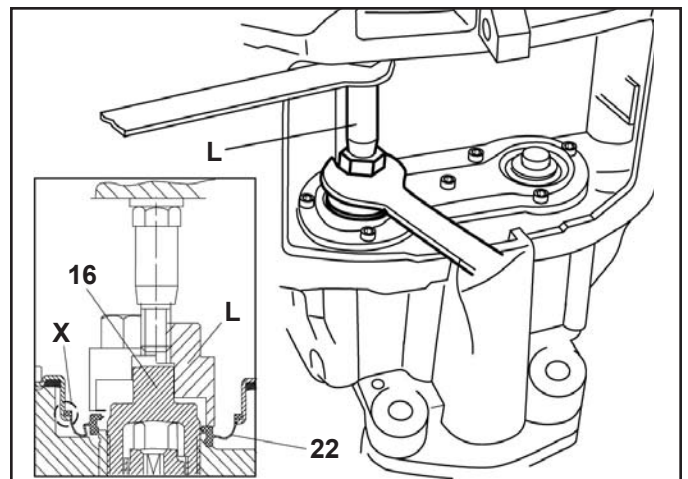
Grease threads with white grease (Part No. II14525 or II32868).



**FIGURE 42 - USE OF A SPACER (OFF VEHICLE USE)**



**FIGURE 43 - ON VEHICLE BOOT INSTALLATION**



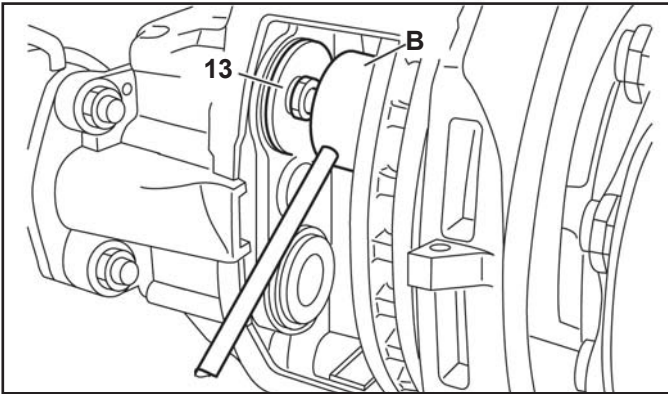
**FIGURE 44 - INNER SEAL INSTALLATION**

Screw back the threaded tubes (16), by turning the shear adapter (61) counter-clockwise (see Cautions earlier in these instructions).

The sealing seat in the caliper for tappet and boot assemblies (13) must be clean and free of grease. See Figure 44.

Fit a new tappet bushing (161) onto the center post of each threaded tube (16).





**FIGURE 45 - ON VEHICLE TAPPET INSTALLATION**

**Technicians working with the caliper installed on vehicle:**

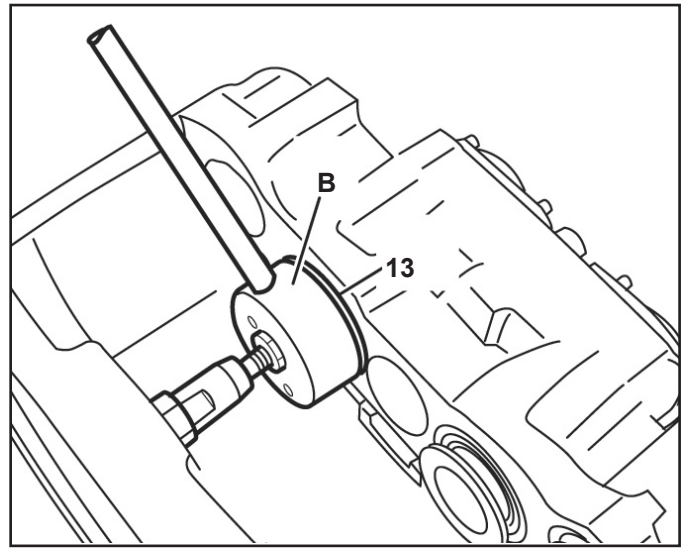
- Install the boots using the press-in tool (B) with the short press-in extension (T3) for positioning and pressing into place - see Figure 43.
- Position a tappet assembly (13) onto each tappet bushing. Using press-in tool (B) in a reversed orientation with the press-in extension (T3) towards the threaded tube, install each tappet onto its tappet bushing - see Figure 45.

**Technicians working with the caliper not installed on vehicle:**

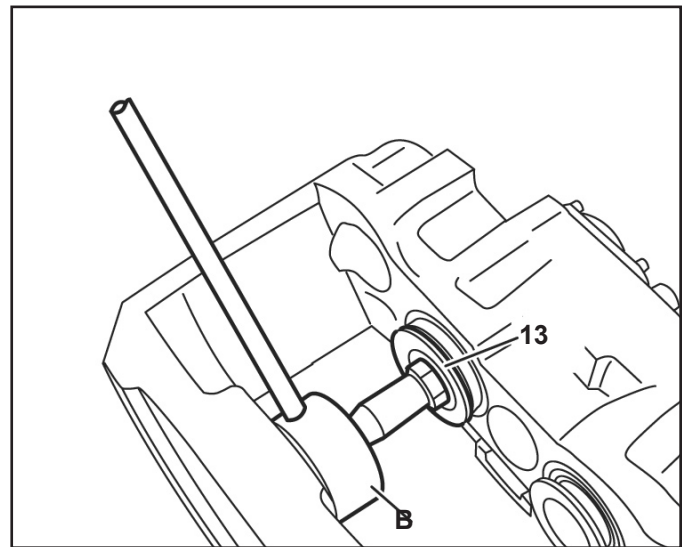
- Install the boots using the press-in tool (B) with the long press-in extension (T3 + T4) for positioning and pressing into place - see Figure 43.
- Position a tappet (13) onto each tappet bushing. Using press-in tool (B) in a reversed orientation with the press-in extension (T3 + T4) towards the threaded tube, install each tappet onto its tappet bushing - see Figure 45.

After assembly, check that the tappet (13) is free to turn in both directions.

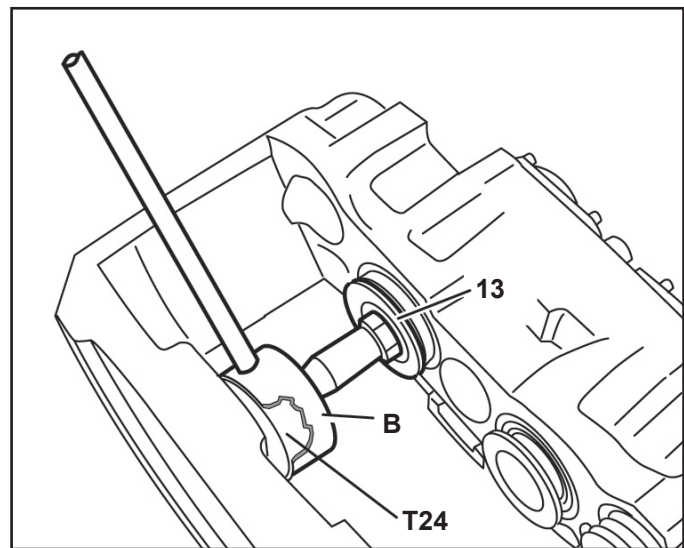
Note: When installing the tappet for Bendix® ADB 22X™, ADB 225™, and SK7™ disc brakes, use the supplemental ring (T24), inserted into the tool (T2) - see Figure 48 - to assist the installation, since the caliper's back plate is too thin using only Tool (B) to achieve the correct position.



**FIGURE 46 - OFF VEHICLE BOOT INSTALLATION**



**FIGURE 47 - OFF VEHICLE TAPPET INSTALLATION**



**FIGURE 48 - OFF VEHICLE - USE OF EXTRA TOOL FOR SOME STYLES**

## CALIPER/CARRIER ASSEMBLY REPLACEMENT

**CAUTION:** Follow all standard safety procedures including, but not limited to, those on page 2 of this service manual. See the vehicle manufacturer's recommendations. When working on foundation brakes, be sure that the vehicle is on level ground, that the vehicle is parked by other means than the foundation brakes, and that the wheels are chocked.

With the caliper/carrier assembly securely supported, remove and discard the six bolts attaching the carrier to the axle.

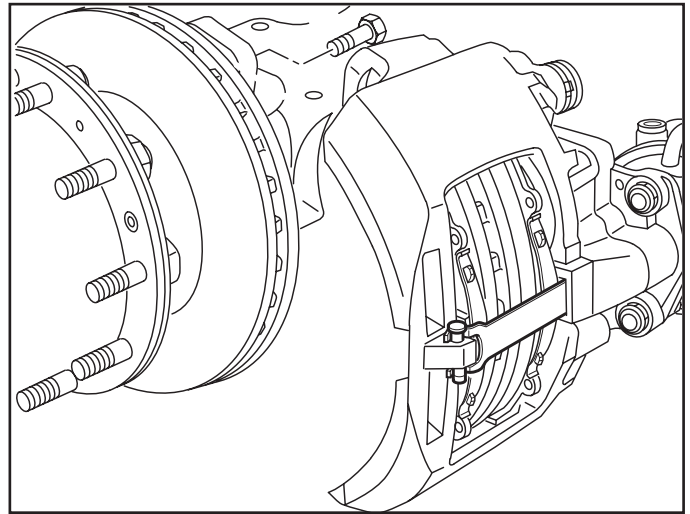
**CAUTION:** Do not attempt to use the pad retainer (11) to attach any lifting device to the brake. The pad retainer is not suitable for this purpose, and damage to the brake and/or unsafe conditions may result.

Clean and inspect the axle contact area. See axle or vehicle manual for instructions if damage is found.

## CALIPER/CARRIER ASSEMBLY INSTALLATION

The correct choice of caliper/carrier must be ensured by using the air disc brake part number on the identification label when ordering replacement parts. See Page 6.

Replacement caliper/carrier assemblies may be delivered with a plastic cap, adhesive tape, or a breakthrough diaphragm in the area of the actuator attachment. Remove the cap or tape only after installing the replacement caliper on the vehicle. If the replacement caliper has the breakthrough diaphragm, it should be left in place.



**FIGURE 49 - CALIPER/CARRIER ASSEMBLY REPLACEMENT**

If the replacement caliper/carrier assembly is equipped with a potentiometer for wear indication, then the connection must be made using the appropriate mating plug – refer to the vehicle manufacturer's recommendations.

**CAUTION:** See the cautions in this document with regard to possible pinch hazard, and the restriction against using the pad retainer (11) as a place to secure lifting devices.

With the replacement carrier/caliper assembly held in position, install with new bolts. Note: Replacement bolts are not supplied by Bendix - use only those of a grade and type specified by the vehicle manufacturer. Consult the vehicle manual for required torques.

## BRAKE ACTUATOR AND SPRING BRAKE REPLACEMENT

**CAUTION:** Replace actuator and spring brakes only with the same as originally installed on the vehicle. Replacement with alternate equipment (without written authorization from Bendix and the vehicle manufacturer) could compromise brake performance.

**CAUTION:** Follow all standard safety procedures including, but not limited to, those on page 2 of this service manual. See the vehicle manufacturer's recommendations. When working on foundation brakes, be sure that the vehicle is on level ground, that the vehicle is parked by other means than the foundation brakes, and that the wheels are chocked.

### Brake Chamber Removal

With all air pressure drained from the air brake system, disconnect the air hose from the brake chamber (18/2).

Remove and discard brake chamber mounting nuts (see Figure 50, arrows B).

### Brake Chamber Installation

Note: New brake chambers (18/2) have drain plugs installed (see Figure 50, arrows A). After installation, remove whichever plug is at the lowest position. Be sure that all other drain holes remain plugged. The drain hole must be aligned downwards (or within  $\pm 30^\circ$ ) when installed on the vehicle.

Before installing the new brake chamber, the actuator flange (see Figure 51, arrow C) must be cleaned, and inspected. Consult the vehicle manual. The spherical cup in the lever (19) must be greased with white grease (Part No. II14525 or II32868).

**CAUTION:** Do not use grease containing molybdenum disulfate.

See Figure 52. The seal, as well as the pushrod area must be clean and dry.

**CAUTION:** Do not use brake chambers with seals with a thickness less than 0.12 in. (3 mm). Use only actuators which are recommended by the vehicle manufacturer.

Install the brake chamber using new self-locking nuts (EN ISO 10513). Tighten alternately both the nuts step by step up to a final torque of  $133 \pm 7$  ft. lbs ( $180 \pm 10$  Nm).

Re-connect the air hose and be sure that the hose is not twisted or in contact with moving vehicle components. The air hose routing must allow for full caliper travel. Test for leakage and check the brake operation and effectiveness before returning vehicle to service.

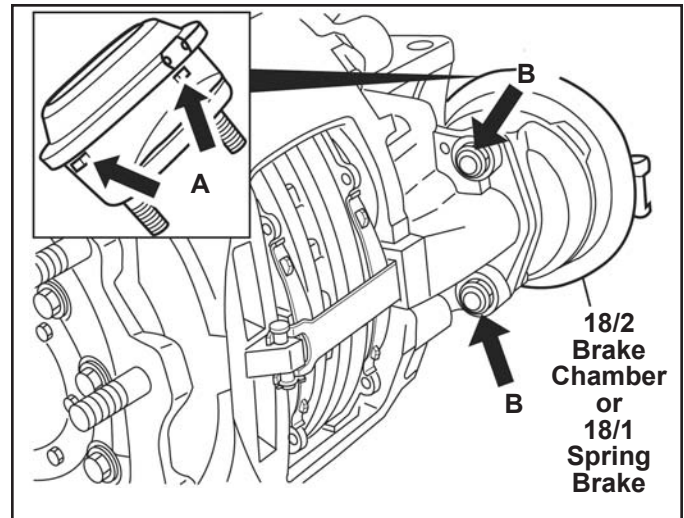


FIGURE 50 - ACTUATOR INSTALLATION

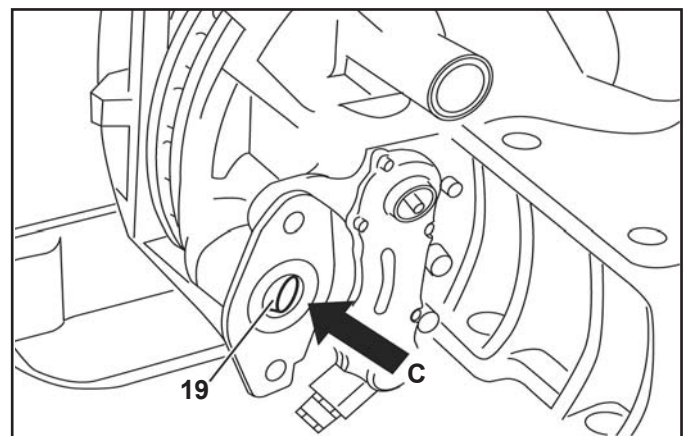


FIGURE 51 - ACTUATOR FLANGE

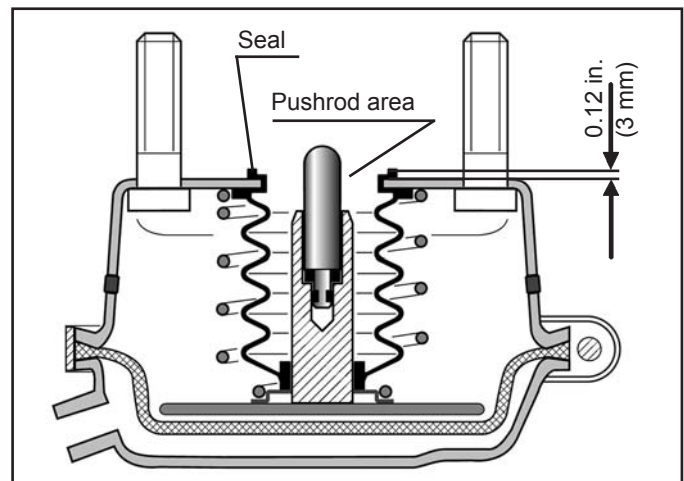


FIGURE 52 - CAP INSTALLATION

## Spring Brake Removal

CAUTION: Follow all standard safety procedures - see note above. Be familiar with the spring brake manufacturer's recommended safety practices.

With all air pressure drained from the air brake system, disconnect the air hose from the brake chamber (18/1).

Back out the release bolt (Figure 53, arrow D) using a maximum torque of 26 ft. lbs. (35 Nm) to release spring force on the pushrod. Refer to the spring brake and vehicle manufacturer's recommendations - in some cases it may be permissible to cage the spring brake while the spring brake is engaged. While supporting the spring brake in position, remove and discard brake chamber mounting nuts (see Figure 53, arrows B). Remove the spring brake.

## Spring Brake Chamber Installation

Note: New spring brake chambers (18/1) have drain plugs installed (see Figure 53, arrows A). After installation, remove whichever plug is at the lowest position. Be sure that all other drain holes remain plugged. The drain hole must be aligned downwards (or within  $\pm 30^\circ$ ) when installed on the vehicle.

Before installing the new brake chamber, the actuator flange (see Figure 51, arrow C) must be cleaned, and inspected. Consult the vehicle manual. The spherical cup in the lever (19) must be greased with white grease (Part No. II14525 or II32868).

CAUTION: Do not use grease containing molybdenum disulfate.

See Figure 54. The seal, as well as the pushrod area must be clean and dry.

CAUTION: Do not use brake chambers with seals with a thickness less than 0.12 in. (3 mm). Use only actuators which are recommended by the vehicle manufacturer.

Install the brake chamber using new self-locking nuts (EN ISO 10513). Tighten alternately both the nuts step by step up to a final torque of  $133 \pm 7$  ft. lbs ( $180 \pm 10$  Nm).

Re-connect the air hose and be sure that the hose is not twisted or in contact with moving vehicle components. The air hose routing must allow for full caliper travel. Test for leakage and check the brake operation and effectiveness before returning vehicle to service.

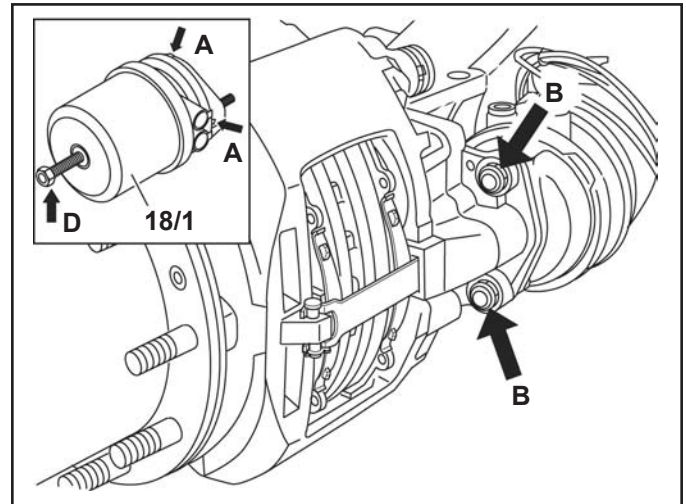


FIGURE 53 - SPRING BRAKE INSTALLATION

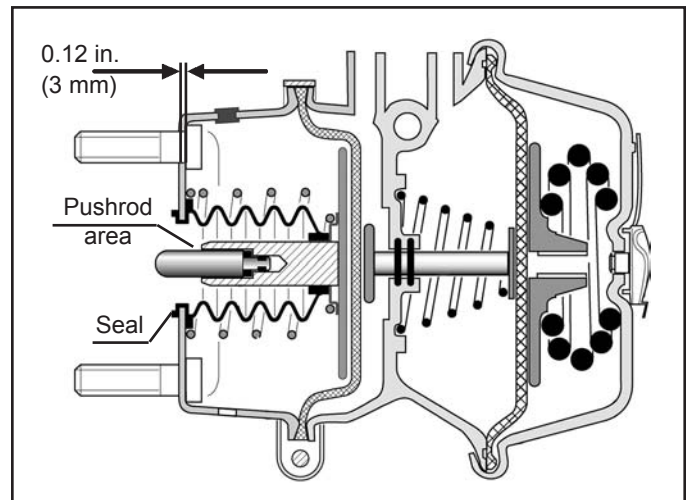


FIGURE 54 - CAP INSTALLATION



# Bendix Spicer Foundation Brake LLC

*A Bendix Commercial Vehicle Systems  
and Dana Corporation Joint Venture*








## Before You Begin

This manual provides service and repair procedures for the Meritor WABCO System Saver 636 twin cylinder air compressor for Mack E-Tech™ engines. Before you begin procedures:

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Caution and Warning safety alerts that precede instructions or procedures you will perform. These alerts help to avoid damage to components, serious personal injury, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

## Safety Alerts, Torque Symbol and Notes

 <b>WARNING</b>	A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury.
 <b>CAUTION</b>	A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components.
	A torque symbol alerts you to tighten fasteners to a specified torque value.
<b>NOTE</b>	A Note provides information or suggestions that help you correctly service a component.

## Access Product and Service Information on Our Website

Enter [meritorwabco.com](http://meritorwabco.com) in your browser's address box for quick access to our website. At our home page, click on literature to access our publications.

[meritorwabco.com](http://meritorwabco.com)

## To Order Information by Phone

Call ArvinMeritor's Customer Service Center at 800-535-5560 to order the following item.

- Drivetrain Plus™ by ArvinMeritor Technical Electronic Library on CD. Features product and service information on most Meritor, ZF Meritor and Meritor WABCO products. \$20. Order TP-9853.

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**Section 3: Compressor Replacement**

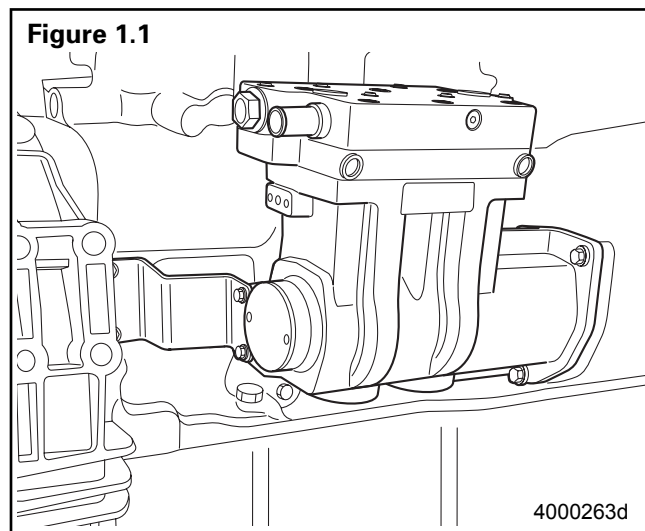
Compressor Replacement Information .....9  
Compressor Removal  
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Air System Leakage Test



## Application

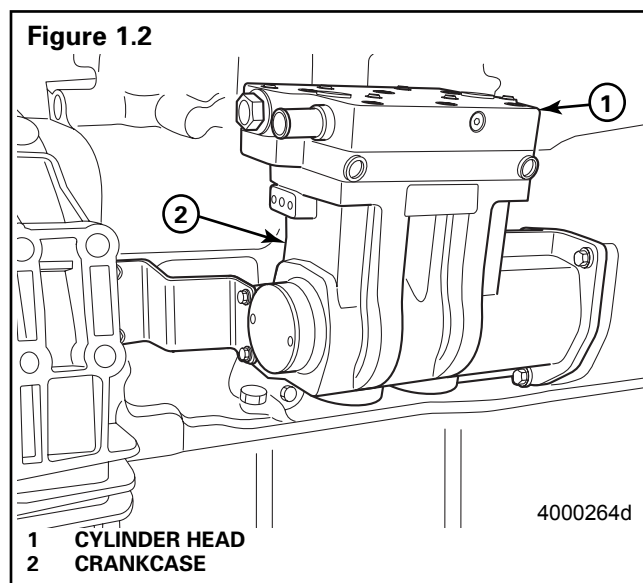
- Used on Mack engines. **Figure 1.1.**
- Swept volume displacement: 37.4 cubic feet per minute.
- Flange mounted to the engine.
  - Coupling driven through the auxiliary shaft.
  - Inlet air, oil lubrication and coolant supplied from the engine.
- Pneumatic pressure signal from the governor controls compression:
  - Integrated pressure relief valve protects the compressor and engine if discharge or governor lines become blocked, or if compressor cannot unload. The valve prevents the compressor from pumping more than 250 psi in the event of a blocked discharge line or other malfunction.

**NOTE:** This compressor has NO through drive capabilities for hydraulic power steering pumps.



## Description

The Meritor WABCO System Saver 636 twin cylinder air compressor provides and maintains air under pressure to operate devices in the air brake and auxiliary air systems of a vehicle. It consists of two major subassemblies: Cylinder head and crankcase. **Figure 1.2.**



The **cylinder head** contains the inlet, discharge and unloader valving, as well as an integral relief valve. There are two water ports, marked Port 9, an air discharge port, marked Port 2, and an inlet port, marked Port 0, cast into the cylinder head to accommodate a hose connection. The cylinder head is mounted on the crankcase.

The **crankcase** contains the cylinder bores, pistons, bearings, crankshaft, governor port and connecting rods.

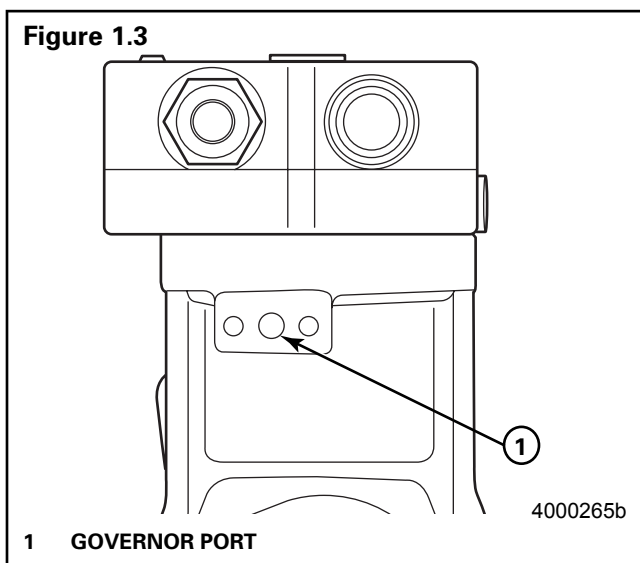
# Section 1 Introduction

**MERITOR WABCO**

## Operation

The compressor is driven by the engine. The compressor's crankshaft turns continuously while the engine is running. Compression of air is controlled by the **governor** and by the **compressor's unloading mechanisms**.

The **governor** maintains the brake system air pressure at preset maximum and minimum levels. The governor is mounted apart from the compressor, either horizontally or vertically. The governor port is located on the crankcase of the compressor. **Figure 1.3**.

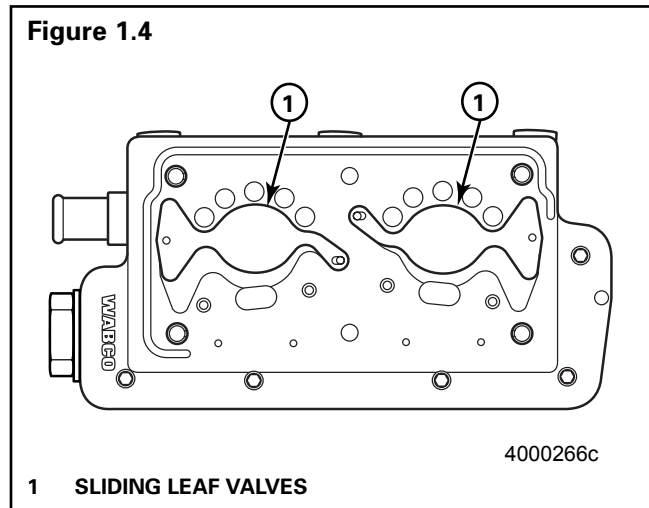


The **unloader mechanisms** control the air compression cycle; an air compression cycle has three phases:

1. **Induction:** Air flows from the engine to the compressor, opening the inlet valves in the cylinder head of the compressor.
2. **Compression:** Air pressure is increased, causing the compressor's discharge valves to open.
3. **Unloading:** Air passes from the cylinders to the inlet chambers of the cylinder head via a port controlled by sliding leaf valves.

When system cut-in pressure is reached, air is exhausted from the unloader ports.

4. After unloading, the unloader pistons return the sliding leaf valves to the loaded position. This seals the unloader ports and compression resumes. **Figure 1.4**.



## Maintenance Intervals

The Meritor WABCO System Saver 636 twin cylinder air compressor receives inlet air, oil and coolant from the engine, so it is important to follow the engine manufacturer's recommendations and maintenance schedules regarding fluid levels, air filter and recommended change intervals.

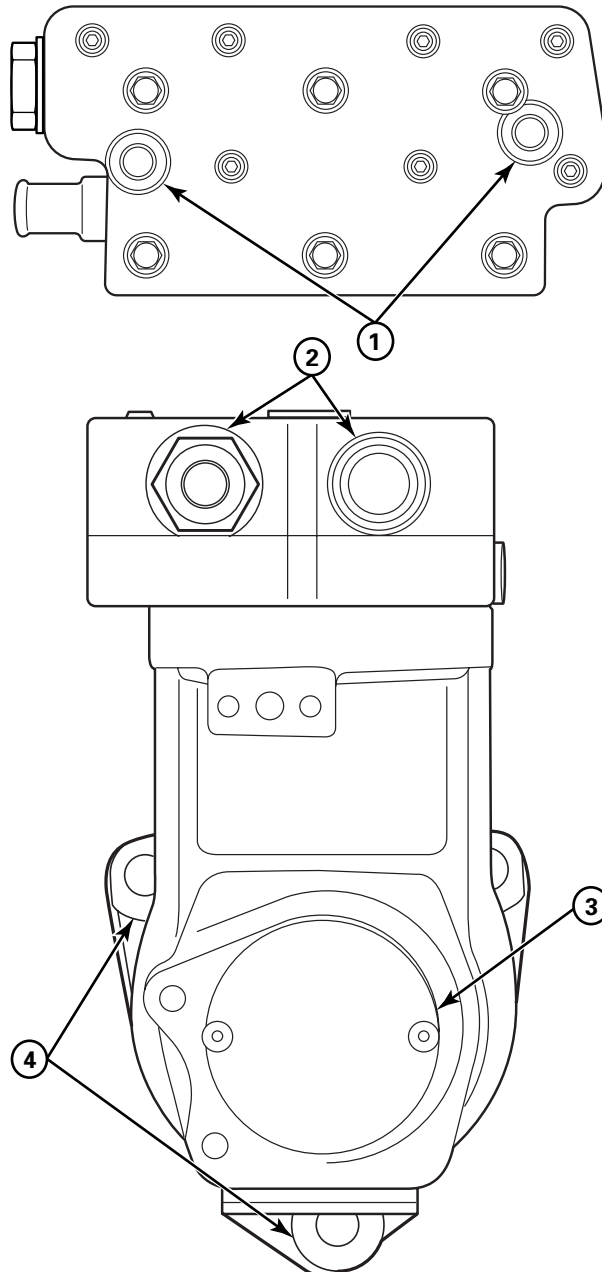
## Cylinder Head

Remove carbon deposits from the discharge cavity and rust and scale from the cooling passages of the cylinder head.

Clean carbon and dirt from the inlet and unloader passages.

**Visual Inspection**

A visual check of the compressor can detect minor problems (see legend for examples of these problems). This check should be part of the vehicle preventive maintenance program. **Figure 1.5.**

**Figure 1.5**

- 1 Check water ports for leakage.**
- 2 Check air inlet and discharge ports for leakage.**
- 3 Check around end cover for oil leakage.**
- 4 Check flanges for cracks or breaks.**

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Use the following chart to troubleshoot the Meritor WABCO System Saver 636 twin cylinder air compressor.

**NOTE:** If you have any questions or need additional information, please contact the Meritor WABCO Customer Service Center at 866-668-7221.

**Table A: Compressor Troubleshooting Guide**

Condition	Possible Cause	Solution
<b>Compressor passes excessive oil</b> (for example, the presence of oil at exhaust air brake system valves, oil in air dryer dessicant, etc.)	Blocked or restricted oil return	Clean oil drain passages in the compressor and on the engine surface. Verify proper passage alignment.
	Contaminated inlet air or oil	Replace damaged, defective or dirty engine air filter. Repair any leaking, damaged or defective compressor air intake components. Change engine lubricating oil.  <b>NOTE:</b> To avoid this condition, make sure vehicle manufacturer's oil and filter maintenance schedules are followed.
	Restricted air inlet or excessive vacuum present at compressor inlet	Verify engine air cleaner is functioning properly. Replace if necessary. Repair compressor air inlet kinks or excessive bends. Check vehicle specifications to ensure air and coolant lines meet all requirements.
	Excessive engine crankcase pressure	Verify engine crankcase venting is to manufacturer's specification.
	Compressor duty cycle too high	Check system for leaks. Make necessary repairs.
	None of the above, but condition persists	Replace the compressor.
<b>Compressor leaks oil</b>	Physical damage or internal problems with compressor	Replace the compressor.
<b>Compressor continuously cycles</b>	Compressor unloader piston leaking	With compressor unloaded check for air leakage. If leaking, replace the cylinder head.
	Governor air leak	Refer to the manufacturer's manual for governor maintenance and troubleshooting procedures.
	Dryer purge valve air leakage	Check for air dryer malfunction. Refer to air dryer manufacturer's service instructions.
	Air leak at governor-compressor attachment.	Inspect connection for physical damage. Inspect and repair connection.
	Air leak at alcohol injector	Clear line of any obstructions. Inspect and repair connection.
	Excessive reservoir contamination	Drain reservoirs.
None of the above, but condition persists	Replace the compressor.	

## Section 2 Troubleshooting

**Table A: Compressor Troubleshooting Guide (Continued)**

Condition	Possible Cause	Solution
<b>No air delivery</b> <b>Low air delivery</b> <b>Low air pressure</b>	Discharge line blockage	Check for freeze up in the discharge line. Check low spots and eliminate any traps in the discharge line. Inspect and repair compressor discharge port and clear any line restrictions. Replace damaged lines as necessary. Check for carbon build-up. If carbon has built up, make sure cooling lines are not kinked or restricted. If carbon has built up in the discharge line, replace the line.
	Inlet line kinked or restricted	Inspect the compressor air induction line for kinks and restrictions. Repair or replace as necessary.
	Governor malfunction or misadjustment	Check for proper loader/unloader cycles of compressor. Refer to vehicle manufacturer's manual for governor maintenance and troubleshooting procedures.
	External contamination	Replace broken, defective or dirty air filters. Clean contaminants from surface of compressor.
	Air dryer purge valve stuck open or leaking	Check for air dryer malfunction. Refer to air dryer manufacturer's service instructions.
	Chafed or worn discharge line	Replace faulty sections of discharge line.
	Loose or leaking air line connections	Verify all connections are secure. Tighten to vehicle specifications where necessary. Inspect port threads for damage. If damage is extensive, replace cylinder head.
	Damage to compressor valves and/or valve seats	Replace the cylinder head.
	Leaking or malfunctioning internal pressure relief valve	Replace the cylinder head.
<b>Noisy air compressor</b>	Loose drive hub Loose accessory drive coupling	Check fit of drive coupling. Ensure hub is completely seated and crankshaft nut is tight. Inspect crankshaft for damage — replace compressor if crankshaft is damaged.
	None of the above, but condition persists	Replace the compressor.
	<b>Broken connecting rod or crankshaft</b>	Oil starvation to crank pin or front main bearing
Failed power steering pump		Verify power steering pump is in proper operating order. Refer to the component manufacturer's service instructions.
All of the above		Replace compressor.

**Table A: Compressor Troubleshooting Guide (Continued)**

<b>Condition</b>	<b>Possible Cause</b>	<b>Solution</b>
<b>Compressor leaks engine coolant</b>	Loose fitting	Check fittings at compressor and engine for leaks and verify fittings are properly torqued.
	Cracked coolant port	Replace cylinder head.
	Porosity in cylinder head	Replace cylinder head.
	Leaking of gasket internal to the cylinder head	Verify cylinder head bolts are properly torqued. Make necessary adjustments. Inspect gasket for cracks or signs of wear. Replace if necessary. Replace cylinder head.
	None of the above, but condition persists	Replace compressor.
<b>Compressor pressurizes coolant system or coolant leakage to compressor inlet</b>	Leaking of gasket internal to the cylinder head	Inspect gasket. Replace if necessary.
	Cavitation or corrosion in cylinder head	Replace cylinder head.
	Porosity in cylinder head or cylinder head cracked	Replace cylinder head.
	None of above, but condition persists	Replace the compressor.
<b>Unloader leakage</b>	Possible internal damage, including worn or damaged unloader piston O-ring, porosity in unloader piston bore, loose or leaking seal at unloader piston bore	Replace compressor cylinder head assembly.
<b>Compressor head gasket failure</b>	Discharge line blocked due to freezing or carbon build-up	Check for trap (low spots) in lines. Make necessary repairs. Clear discharge line. Replace line if necessary. Check for carbon build-up. If carbon build-up is present, replace the discharge line.
	Frozen or blocked line to governor	Clear blocked line. Replace line if necessary. Check for air dryer malfunction. Repair or replace as required. Refer to the air dryer manufacturer's maintenance manual for service information.
	Governor malfunction	Repair or replace the governor. Refer to governor manufacturer's maintenance manual for service information.
	Improper cylinder head bolt torque, machining defect on cylinder head or block, defective cylinder head gasket	Inspect gasket. Replace if necessary. Verify all bolts are properly torqued. If problem persists, replace cylinder head.
	None of the above, but condition persists	Replace compressor cylinder head assembly.





The cylinder head portion of the compressor is replaceable. The crankcase is not replaceable. If the crankcase is damaged or malfunctioning, replace the complete compressor.

**WARNING**

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Remove all pressure from the air system before you disconnect any component. Pressurized air can cause serious personal injury.

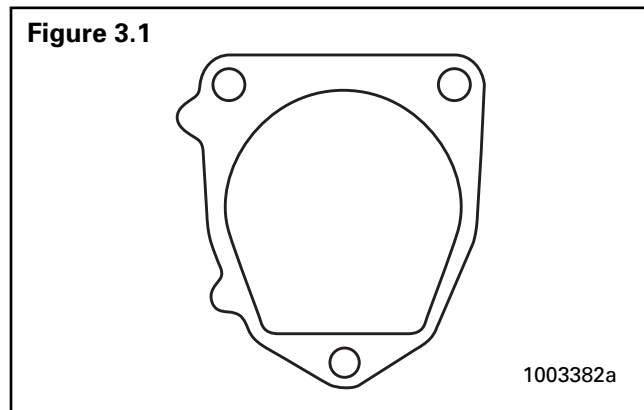
Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

**Compressor Replacement Information****CAUTION**

The removal instructions given in this manual are general. Depending on the type of vehicle involved, additional steps may be required. Refer to the vehicle manufacturer's manual for additional information.

The front of the Meritor WABCO System Saver 636 air compressor is mounted to the engine.

Before you remove the compressor, make sure you have a replacement gasket to install with the new compressor (Mack Part Number 590GB2159). Figure 3.1.

**Compressor Removal**

1. Set the spring (parking) brakes and block the wheels of the vehicle.
2. Drain the air pressure from the air system.
3. Drain the engine cooling system and the cylinder head of the compressor.
4. Disconnect all air and water lines leading to the compressor.
5. Remove the discharge and coolant fittings. Note fitting locations to aid in reassembly.

**NOTE:** The discharge fitting consists of a fitting and a bushing. The bushing should remain in the cylinder head.

6. Loosen and remove the four bracket mounting bolts: Two bolts that hold the rear support bracket to the back of the compressor and two bolts that hold the bracket to the engine block. Retain the bolts for re-assembly.

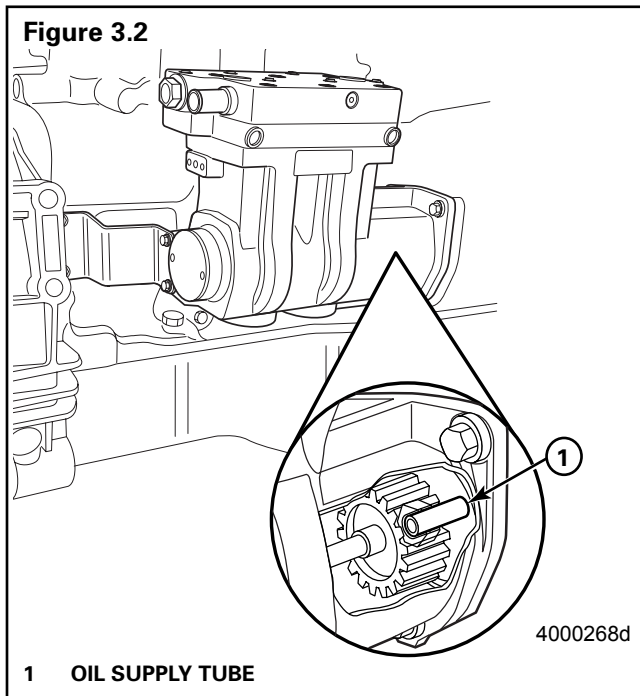
**NOTE:** This bracket supports the weight of the compressor.

7. Loosen the three flange mounting bolts that hold the compressor to the engine.
8. Remove the compressor from the engine.




**Remove and retain the oil supply tube that runs between the compressor and the engine. Figure 3.2.**

## Section 3 Compressor Replacement

**MERITOR WABCO**



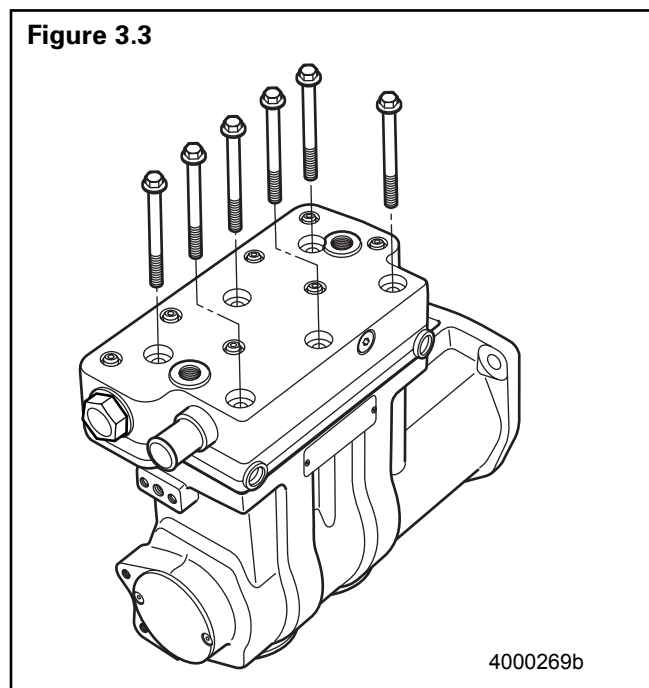
### Compressor Installation

1. Reinstall the oil supply tube.
  2. Install a new compressor gasket.
  3. Position the compressor on the engine.
  4. Install the three flange mounting bolts. Tighten to 15 lb-ft (20 N•m) +90° rotation. 
  5. Install the two bolts that hold the bracket to the compressor and the two bolts that hold the bracket to the engine block. Run the bolts down finger tight at both ends of the bracket (engine and compressor). The bracket should be in contact with both surfaces; engine block and compressor rear support face. Tighten bolts to 18 lb-ft (25 N•m) maximum at compressor side. Tighten bolts at engine side per Mack specification. 
  6. Attach the discharge and coolant fittings. Finger-tighten fittings and rotate 2 to 3 turns to position fitting. 
  7. Connect all air and water lines leading to the compressor. Tighten per Mack specifications.
  8. Add engine coolant to the cooling system. Use the coolant recommended by the engine manufacturer. Visually inspect the engine and compressor for leaks.
9. Start the engine and allow air system to build to governor cutout. Stop the engine. Use a soap and water solution at connection points to check for air leaks. Make any necessary repairs.
  10. Remove the wheel blocks and release the spring (parking) brakes.

### Cylinder Head Replacement

#### Removal

1. Follow the steps listed in Compressor Removal to remove the compressor from the engine. Take care not to damage the crankcase, since it will not be replaced.
2. Use a cleaning solvent to remove road dirt and grease from the exterior of the compressor.
3. Remove and discard the six hex head bolts that attach the cylinder head to the crankcase and remove the cylinder head valves and gaskets. **Figure 3.3.**



4. Use a mild cleaning solvent to clean the top of the crankcase.

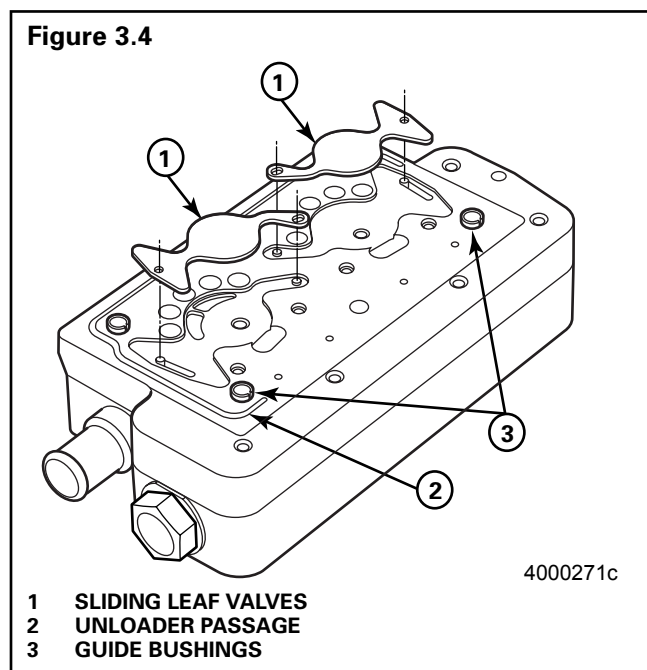
**Installation**

**NOTE:** A Torx® tool is required for this procedure.

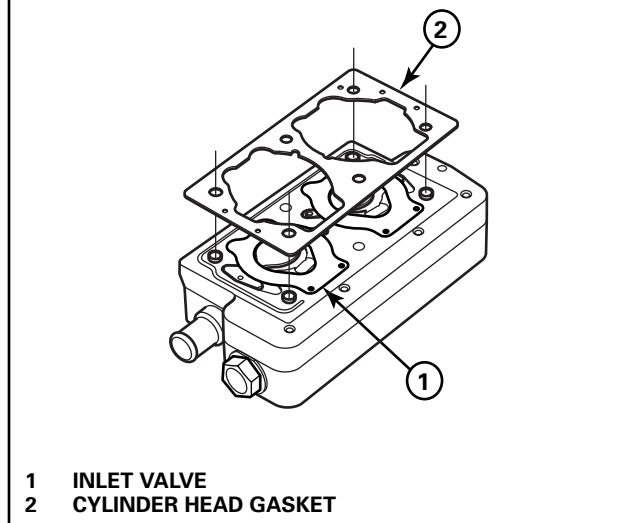
Cylinder head valve components **MUST** be aligned in the proper position in order for the compressor to function.

1. Install the sliding leaves. The two holes in each sliding leaf must be installed over the two pins on the base of the cylinder head. **Figure 3.4.**

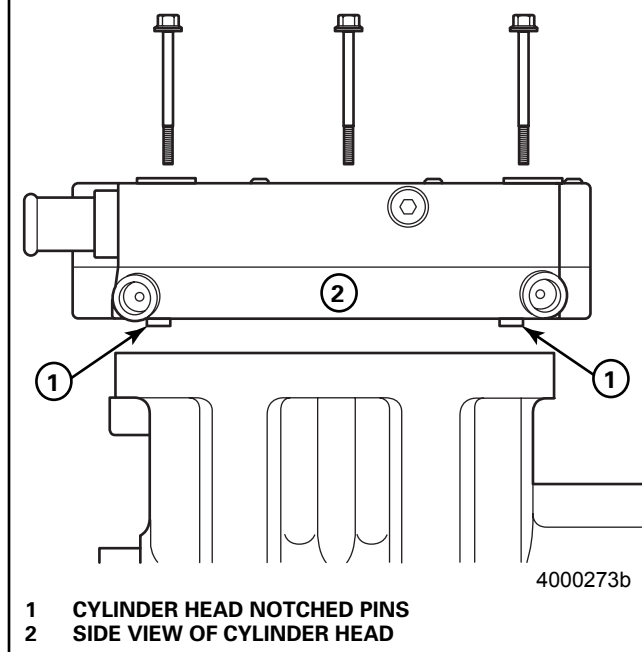
**NOTE:** A light application of engine oil will hold the sliding leaves to the inlet valves.  
**Figure 3.4.**



2. Lay the new cylinder head gasket in place, ensuring that it fits over the guide bushings and that the unloader hole allows air pressure communication from the cylinder head to the crankcase. **Figure 3.5.**
3. Place the inlet valves over the guide pins provided, ensuring that the pads are up and the valves will lie flat against the head openings. A small amount of Lubriplate grease can be used to ensure they remain in place for the remainder of the assembly. **Figure 3.5.**

**Figure 3.5**

4. Position the cylinder head on top of the compressor. Ensure the notched pins on the cylinder head align with the recesses in the block. Only four of the six bolt holes have notched pins. **Figure 3.6.**

**Figure 3.6**

# Section 3 Compressor Replacement

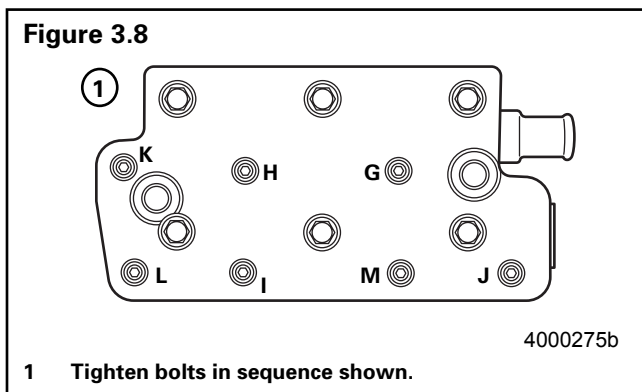
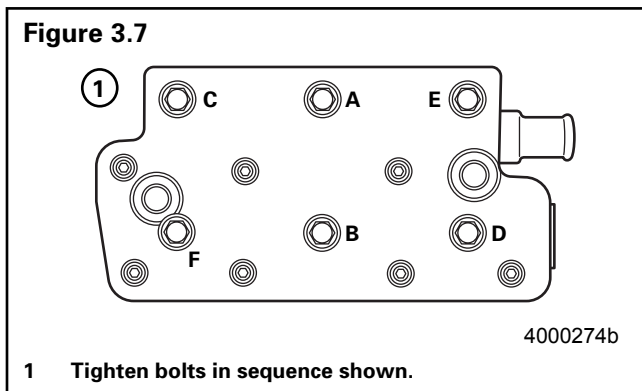
5. Install the six hex head mounting bolts that hold the cylinder head in place. Tighten the mounting bolts in sequence per Table B, following Steps 1-12. **Figure 3.7.**
6. Use a Torx® tool to tighten the seven Torx® head screws in sequence per Table B, following Steps 13-26. **Figure 3.8.**

**CAUTION**

Use the proper tools to perform this torque-turn bolt tightening sequence exactly as shown in Table B. Accuracy is CRITICAL to your field service success!

**Table B: Bolt Tightening Sequence**

Step	Bolt	Torque		Rotation (Degrees)
		(N·m)	lb-ft	
1	A	25 <sup>+0</sup> <sub>-.5</sub>	18.5 <sup>+0</sup> <sub>-3.7</sub>	
2	B	25 <sup>+0</sup> <sub>-.5</sub>	18.5 <sup>+0</sup> <sub>-3.7</sub>	
3	C	25 <sup>+0</sup> <sub>-.5</sub>	18.5 <sup>+0</sup> <sub>-3.7</sub>	
4	D	25 <sup>+0</sup> <sub>-.5</sub>	18.5 <sup>+0</sup> <sub>-3.7</sub>	
5	E	25 <sup>+0</sup> <sub>-.5</sub>	18.5 <sup>+0</sup> <sub>-3.7</sub>	
6	F	25 <sup>+0</sup> <sub>-.5</sub>	18.5 <sup>+0</sup> <sub>-3.7</sub>	
7	A			150° <sup>+15</sup> <sub>-.5</sub>
8	B			150° <sup>+15</sup> <sub>-.5</sub>
9	C			120° <sup>+15</sup> <sub>-.5</sub>
10	D			120° <sup>+15</sup> <sub>-.5</sub>
11	E			120° <sup>+15</sup> <sub>-.5</sub>
12	F			120° <sup>+15</sup> <sub>-.5</sub>
13	G	6 <sup>+6</sup> <sub>-.6</sub>	4.4 <sup>+4.4</sup> <sub>-4.4</sub>	
14	H	6 <sup>+6</sup> <sub>-.6</sub>	4.4 <sup>+4.4</sup> <sub>-4.4</sub>	
15	I	6 <sup>+6</sup> <sub>-.6</sub>	4.4 <sup>+4.4</sup> <sub>-4.4</sub>	
16	J	6 <sup>+6</sup> <sub>-.6</sub>	4.4 <sup>+4.4</sup> <sub>-4.4</sub>	
17	K	6 <sup>+6</sup> <sub>-.6</sub>	4.4 <sup>+4.4</sup> <sub>-4.4</sub>	
18	L	6 <sup>+6</sup> <sub>-.6</sub>	4.4 <sup>+4.4</sup> <sub>-4.4</sub>	
19	M	6 <sup>+6</sup> <sub>-.6</sub>	4.4 <sup>+4.4</sup> <sub>-4.4</sub>	
20	G			135° <sup>+15</sup> <sub>-.5</sub>
21	H			135° <sup>+15</sup> <sub>-.5</sub>
22	I			135° <sup>+15</sup> <sub>-.5</sub>
23	J			135° <sup>+15</sup> <sub>-.5</sub>
24	K			135° <sup>+15</sup> <sub>-.5</sub>
25	L			135° <sup>+15</sup> <sub>-.5</sub>
26	M			135° <sup>+15</sup> <sub>-.5</sub>



7. Follow the steps listed in Compressor Installation to reinstall the compressor and test for leaks.

## Performance Testing

Test the vehicle air system as follows:

1. Bleed the vehicle air system reservoir gauges down (apply brakes several times) to approximately 85 psig.
2. With the engine running at full governed speed (no load, no air accessories being used), the compressor should reach governor cutout pressure, then unload.

If the compressor does not reach governor cutout pressure, check for air leaks in the system. If reservoir volume and engine RPM are per original vehicle manufacturer's specifications, system plumbing leakage must be checked and, if necessary, repaired. See air system leakage test procedures which follow.

If the compressor fails to unload, verify proper governor operation.

## Air System Leakage Test

*(Conforms to North American Uniform Roadside Inspection Criteria)*

1. Park the vehicle on a level surface. Apply the parking brakes. Disconnect any attached or towed vehicles (semi-trailer, full trailer, dolly, etc.). Leave engine on.
2. Chock the tires.
3. Release the parking brakes.
4. With the compressor in pumping mode, engine at idle and service brakes fully applied gauge must stay between 80-90 psi or gradually rise.

If pressure is not maintained (pressure drops) there is an air leak in the system.

Listen for air leaks. Soapy water or high frequency acoustic detectors may be used to detect any leaks. Make the necessary repairs.

**ArvinMeritor**<sup>TM</sup>  
Commercial Vehicle Systems

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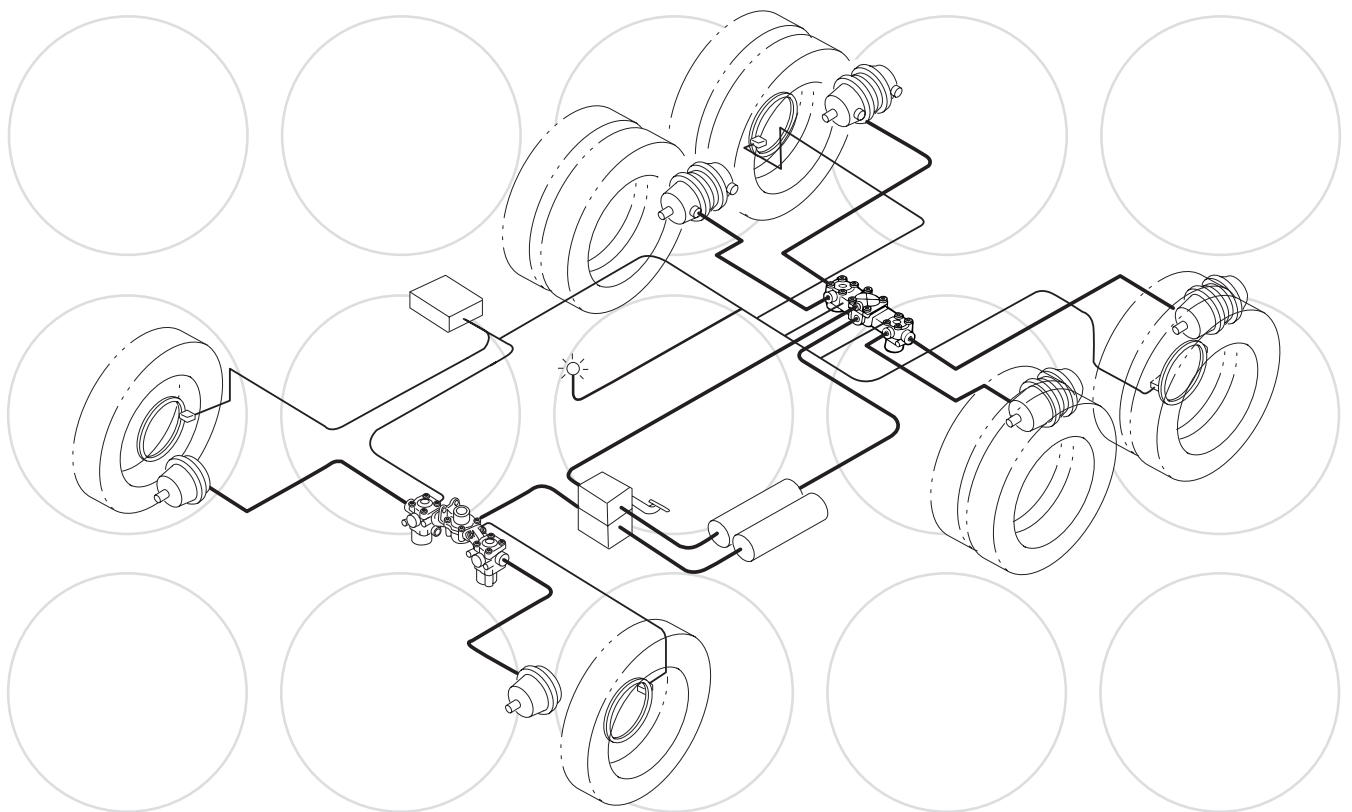
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Maintenance Manual MM-0112

# Anti-Lock Braking System (ABS) for Trucks, Tractors and Buses

Revised 07-05



For E Version ECUs  
12-Volt Systems

# Service Notes

## About This Manual

This manual contains maintenance procedures for Meritor WABCO's Anti-Lock Braking System (ABS) for trucks, tractors and buses.

## Before You Begin

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.
3. Follow your company's maintenance and service, installation and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.


## Hazard Alert Messages and Torque Symbols

### WARNING

A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.

### CAUTION

A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components.

 This symbol alerts you to tighten fasteners to a specified torque value.

## How to Obtain Additional Maintenance and Service Information

### On the Web

Visit the [meritorwabco.com](http://meritorwabco.com) website to easily access product and service information. The website also offers an interactive and printable Literature Order Form.

## ArvinMeritor's Customer Service Center

Call ArvinMeritor's Customer Service Center at 800-535-5560.

## Technical Electronic Library on CD

The DriveTrain Plus™ by ArvinMeritor Technical Electronic Library on CD contains product and service information for most Meritor and Meritor WABCO products. \$20. Specify TP-9853.

## How to Obtain Tools and Supplies Specified in This Manual

Call ArvinMeritor's Commercial Vehicle Aftermarket at 888-725-9355 to obtain Meritor tools and supplies.

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## ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from ArvinMeritor.

### Hazard Summary

Because some brake linings contain asbestos, workers who service brakes must understand the potential hazards of asbestos and precautions for reducing risks. Exposure to airborne asbestos dust can cause serious and possibly fatal diseases, including asbestosis (a chronic lung disease) and cancer, principally lung cancer and mesothelioma (a cancer of the lining of the chest or abdominal cavities). Some studies show that the risk of lung cancer among persons who smoke and who are exposed to asbestos is much greater than the risk for non-smokers. Symptoms of these diseases may not become apparent for 15, 20 or more years after the first exposure to asbestos.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to asbestos dust follow. Consult your employer for more details.

### Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons. OSHA has set a maximum allowable level of exposure for asbestos of 0.1 f/cc as an 8-hour time-weighted average and 1.0 f/cc averaged over a 30-minute period. Scientists disagree, however, to what extent adherence to the maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling asbestos dust. OSHA requires that the following sign be posted at the entrance to areas where exposures exceed either of the maximum allowable levels:

DANGER: ASBESTOS  
CANCER AND LUNG DISEASE HAZARD  
AUTHORIZED PERSONNEL ONLY  
RESPIRATORS AND PROTECTIVE CLOTHING  
ARE REQUIRED IN THIS AREA.

2. Respiratory Protection. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA for use with asbestos at all times when servicing brakes, beginning with the removal of the wheels.
3. Procedures for Servicing Brakes.
  - a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.
  - b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.
  - c. If an enclosed vacuum system or brake washing equipment is not available, employers may adopt their own written procedures for servicing brakes, provided that the exposure levels associated with the employer's procedures do not exceed the levels associated with the enclosed vacuum system or brake washing equipment. Consult OSHA regulations for more details.
  - d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.
  - e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.
4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.
5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.
6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

### Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.



## NON-ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to non-asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from ArvinMeritor.

### Hazard Summary

Most recently manufactured brake linings do not contain asbestos fibers. These brake linings may contain one or more of a variety of ingredients, including glass fibers, mineral wool, aramid fibers, ceramic fibers and silica that can present health risks if inhaled. Scientists disagree on the extent of the risks from exposure to these substances. Nonetheless, exposure to silica dust can cause silicosis, a non-cancerous lung disease. Silicosis gradually reduces lung capacity and efficiency and can result in serious breathing difficulty. Some scientists believe other types of non-asbestos fibers, when inhaled, can cause similar diseases of the lung. In addition, silica dust and ceramic fiber dust are known to the State of California to cause lung cancer. U.S. and international agencies have also determined that dust from mineral wool, ceramic fibers and silica are potential causes of cancer.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to non-asbestos dust follow. Consult your employer for more details.

### Recommended Work Practices

1. Separate Work Areas. Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons.
2. Respiratory Protection. OSHA has set a maximum allowable level of exposure for silica of 0.1 mg/m<sup>3</sup> as an 8-hour time-weighted average. Some manufacturers of non-asbestos brake linings recommend that exposures to other ingredients found in non-asbestos brake linings be kept below 1.0 f/cc as an 8-hour time-weighted average. Scientists disagree, however, to what extent adherence to these maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling non-asbestos dust.

Therefore, wear respiratory protection at all times during brake servicing, beginning with the removal of the wheels. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA, if the exposure levels may exceed OSHA or manufacturers' recommended maximum levels. Even when exposures are expected to be within the maximum allowable levels, wearing such a respirator at all times during brake servicing will help minimize exposure.

3. Procedures for Servicing Brakes.
  - a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.
  - b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.
  - c. If an enclosed vacuum system or brake washing equipment is not available, carefully clean the brake parts in the open air. Wet the parts with a solution applied with a pump-spray bottle that creates a fine mist. Use a solution containing water, and, if available, a biodegradable, non-phosphate, water-based detergent. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.
  - d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.
  - e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.
4. Cleaning Work Areas. Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA, to minimize exposure. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.
5. Worker Clean-Up. After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.
6. Waste Disposal. Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

### Regulatory Guidance

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## Contents

This manual contains service information for E version Meritor WABCO Anti-Lock Braking System (ABS) and ABS with Automatic Traction Control (ATC) for trucks, tractors and buses. E version ABS incorporates Power Line Carrier Communication (PLC), an optional feature that allows tractor/trailer communication. For the driver, this means that a trailer ABS indicator lamp located on the vehicle dash will come on if a trailer ABS fault occurs on a trailer equipped with PLC.

**NOTE:** For diagnostic and testing procedures for systems with C version ECUs, use Maintenance Manual 28, Anti-Lock Braking Systems (ABS) for Trucks, Tractors and Buses. For D version ECUs, use Maintenance Manual 30, Anti-Lock Braking Systems (ABS) for Trucks, Tractors and Buses. The ABS version is marked on the ECU. Figure 1.1. If you cannot identify the ECU version installed on your vehicle, contact ArvinMeritor's Customer Service Center at 800-535-5560.

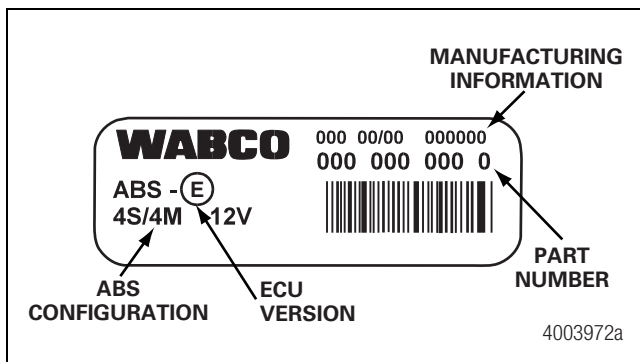


Figure 1.1

## Description

### How ABS Works

Meritor WABCO ABS is an electronic system that monitors and controls wheel speed during braking. The system works with standard air brake systems.

ABS monitors wheel speeds at all times and controls braking during wheel lock situations. The system improves vehicle stability and control by reducing wheel lock during braking.

The ECU receives and processes signals from the wheel speed sensors. When the ECU detects a wheel lockup, the unit activates the appropriate modulator valve, and air pressure is controlled.

In the event of a malfunction in the system, the ABS in the affected wheel(s) is disabled; that wheel still has normal brakes. The other wheels keep the ABS function.

Two ABS indicator lamps, one for tractor and one for trailer, let drivers know the status of the system. The tractor ABS lamp is also used to display tractor blink code diagnostics. Figure 1.2. The location of the ABS indicator lamps varies depending on the make and model of the vehicle.

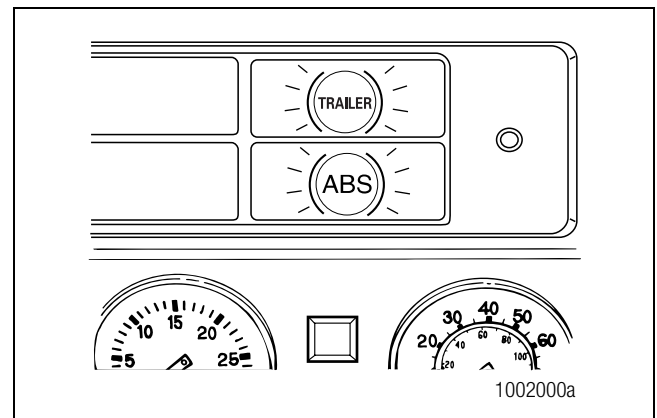


Figure 1.2

Do not open the ECU. Opening the ECU to gain access to the internal components will void the warranty.

If the vehicle is equipped with optional Automatic Traction Control (ATC), or with ATC and Roll Stability Control (RSC), the ATC indicator lamp is used to indicate both ATC and RSC. Refer to Section 2.

Blink code diagnostics information for **trailer** ABS is not included in this manual. Refer to Maintenance Manual 33, Easy-Stop™ Trailer ABS, or Maintenance Manual MM-0180, Enhanced Easy-Stop™ Trailer ABS with PLC, for trailer diagnostics.

# 1 Introduction

## ABS Configuration

With the E Basic ECU, 4S/4M is the only configuration used.  
Figure 1.3.

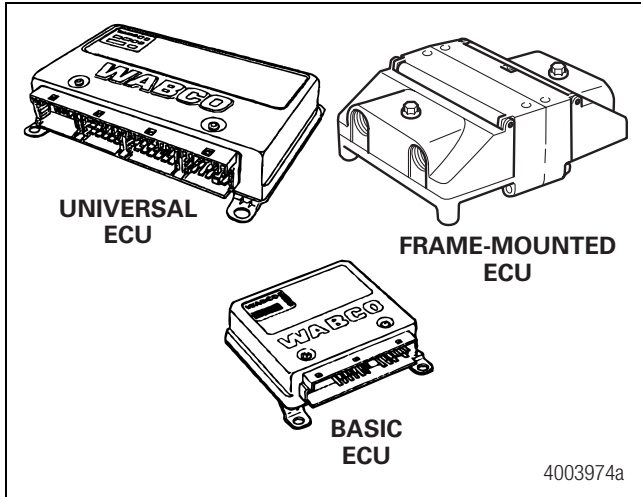


Figure 1.3

The ABS configuration is defined by the number of wheel-end sensors and modulator valves. There are three common ABS configurations used with E version ECUs.

- 4S/4M (4 wheel speed sensors, 4 modulator valves).  
Figure 1.4.
- 6S/4M (6 wheel speed sensors, 4 modulator valves)
- 6S/6M (6 wheel speed sensors, 6 modulator valves)

Typical illustrations in this manual use the 4S/4M configuration as a sample. Layouts for 4S/4M, 6S/4M and 6S/6M configurations are included in Appendix I.

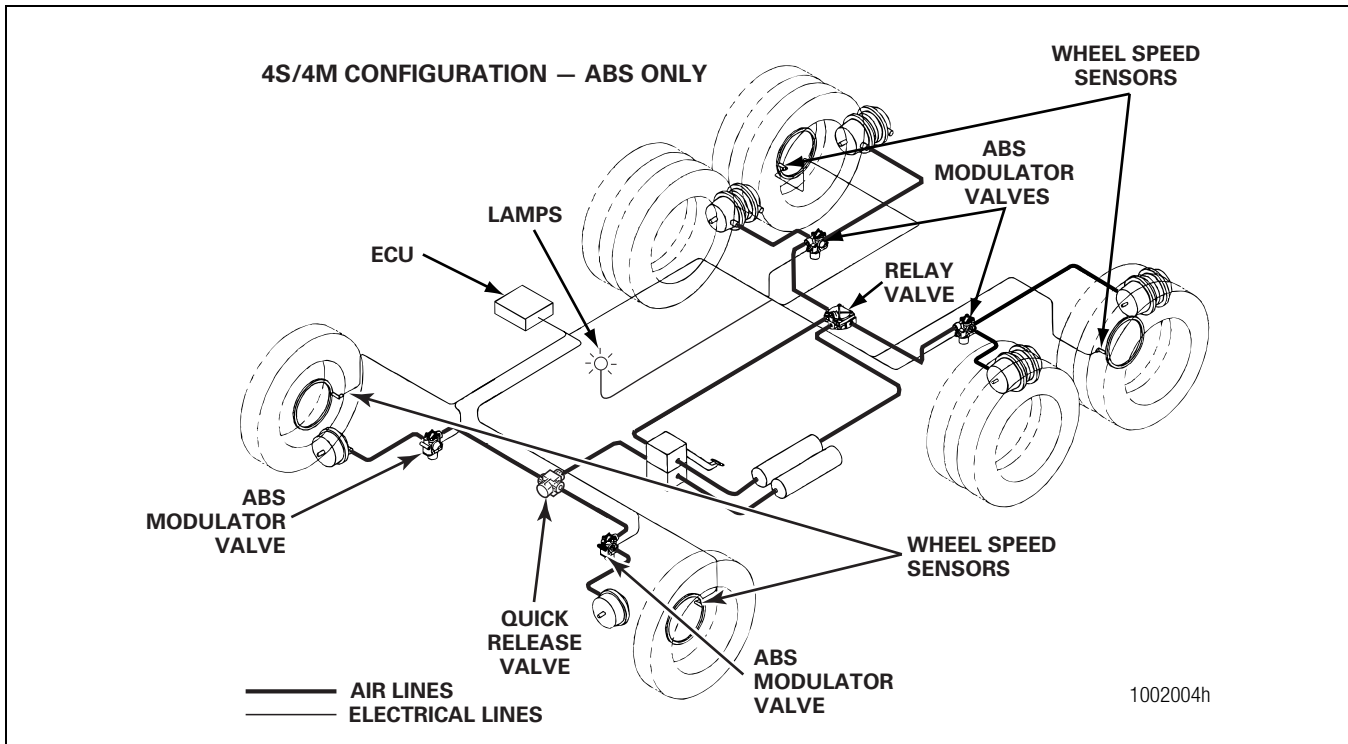
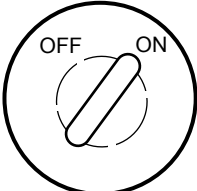


Figure 1.4

## ABS Indicator Lamp

The ABS indicator lamp works as follows:

Ignition ON	Normal Operation	ABS lamp comes on at ignition momentarily for a bulb check, then goes out.	System is OK.
	After servicing ABS	ABS lamp does not go out at ignition.	When vehicle is driven at speeds above 4 mph (6 km/h), lamp goes out. System is OK.
1002005a	Off-road ABS operation. Refer to the off-road ABS information in this section.	ABS lamp flashes during vehicle operation.	The vehicle's normal ABS function is being modified due to road conditions.
	Existing Fault	ABS lamp does not go out at ignition.	Lamp does not go out at speeds above 4 mph (6 km/h) — a fault exists in the ABS system.

**NOTE:** If the ECU senses a tractor ABS fault during normal vehicle operation, the ABS indicator lamp will come on and stay on.

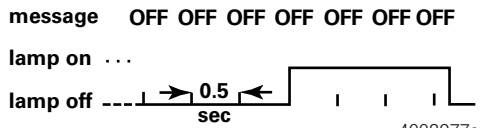
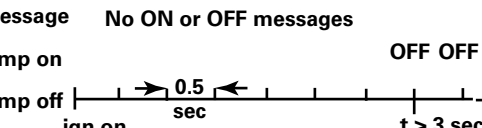
## Trailer ABS Indicator Lamp

The trailer ABS indicator lamp on the vehicle dash applies to Trailer ABS only. The lamp is controlled by a signal to the tractor ECU, sent over the power line (PLC function). When a trailer ABS fault is detected, an ON message is sent; when no fault is detected, the ECU receives an OFF message. Table A illustrates trailer ABS lamp operation at power-up, or ignition on. Table B depicts lamp responses that occur during operation.

Lamp turn ON and OFF messages do not turn the lamp ON or OFF instantly. The delay between the receipt of the message and the lamp response time is intentional. It prevents erratic lamp activity.

**NOTE:** For doubles or triples, the lamp does not distinguish between trailers. A system fault in any of the trailers will activate the trailer ABS indicator lamp.

**Table A: Dash-mounted Trailer ABS Indicator Lamp Operation — Bulb Check (Information for Drivers)**

Signal from Trailer to Tractor ECU	Status of Trailer ABS Lamp on Vehicle Dash	Explanation
<p>Single or Multiple Trailers</p> <p>message OFF OFF OFF OFF OFF OFF OFF</p> <p>lamp on ...</p> <p>lamp off --- 0.5 sec</p>  <p>4003977a</p>	<p>Trailer ABS lamp comes on at ignition, OFF message is detected within three seconds of ignition, Trailer ABS lamp goes out.</p>	<p>Bulb Check performed AND Trailer ABS system is OK. In this case, the lamp is ON for a Bulb Check only.</p>
<p>Single or Multiple Trailers</p> <p>message No ON or OFF messages</p> <p>lamp on OFF OFF ..</p> <p>lamp off   0.5 sec   t &gt; 3 sec</p>  <p>4003978a</p>	<p>Trailer ABS lamp does not come on within three seconds of ignition.</p>	<p>No Bulb Check, trailer added after initial power-up, system OK. There was no trailer PLC message for at least three seconds following ignition ON.</p>

ON = Turn ON message to the “trailer ABS” lamp

OFF = Turn OFF message to the “trailer ABS” lamp

# 1 Introduction

Removing a trailer with a fault will cause the ABS lamp to turn off. Remember to have the trailer with the fault repaired as soon as possible before returning it to service.

**Table B: Dash-mounted Trailer ABS Indicator Lamp Operation (Information for Service Technicians)**

Signal from Trailer to Tractor ECU	Status of Trailer ABS Lamp on Vehicle Dash	Explanation	Action
<p>Single or Multiple Trailers</p> <p><b>message</b> No ON or OFF messages</p> <p><b>lamp on</b> [Blank]</p> <p><b>lamp off</b> [Blank]</p> <p style="text-align: right;">4003979a</p>	Trailer ABS lamp does not come on within three seconds of ignition.	Not using the PLC system (no trailer connected) or trailer not equipped with PLC or fault in PLC system.	Use lamp on side of trailer to identify fault. Make necessary repairs.
<p>Single Trailer</p> <p><b>message</b> OFF OFF OFF ON ON ON ON ON</p> <p><b>lamp on</b> ... [Blank]</p> <p><b>lamp off</b> [Blank]</p> <p style="text-align: right;">4003980a</p>	Trailer ABS lamp comes on.	Trailer ABS fault(s) occurred during operation and still exists.	
<p>Multiple Trailers/Dollies</p> <p><b>message</b> OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF OFF ON ON ON ON</p> <p><b>lamp on</b> ... [Blank]</p> <p><b>lamp off</b> [Blank]</p> <p style="text-align: right;">4003981a</p>			
<p>Single Trailer</p> <p><b>message</b> ON ON OFF OFF OFF OFF OFF OFF OFF</p> <p><b>lamp on</b> ... [Blank]</p> <p><b>lamp off</b> [Blank]</p> <p style="text-align: right;">4003982a</p>	Trailer ABS lamp comes on but goes out after 2.5 seconds after fault is detected.	Trailer ABS fault occurred during operation and the fault was corrected.	None
<p>Multiple Trailers/Dollies</p> <p><b>message</b> OFF OFF OFF OFF OFF OFF OFF OFF ON ON OFF OFF OFF OFF OFF OFF</p> <p><b>lamp on</b> ... [Blank]</p> <p><b>lamp off</b> [Blank]</p> <p style="text-align: right;">4003983a</p>			
<p>Single Trailer</p> <p><b>message</b> ON ON ON No ON or OFF messages</p> <p><b>lamp on</b> ... [Blank]</p> <p><b>lamp off</b> [Blank]</p> <p style="text-align: right;">4003984a</p>	ABS lamp is off, comes on, then goes off, 10 seconds after loss of messages.	ABS fault existed, then signal was lost because trailer disconnected or PLC fault.	Use lamp on side of trailer to identify fault. Make necessary repairs.
<p>Multiple Trailers/Dollies</p> <p><b>message</b> OFF OFF OFF OFF OFF OFF OFF OFF ON ON</p> <p><b>lamp on</b> ... [Blank]</p> <p><b>lamp off</b> [Blank]</p> <p style="text-align: right;">4003985a</p>		ABS fault existed, then trailer with fault lost signal because trailer was disconnected or PLC fault.	

Table B: Dash-mounted Trailer ABS Indicator Lamp Operation (Information for Service Technicians)

Signal from Trailer to Tractor ECU	Status of Trailer ABS Lamp on Vehicle Dash	Explanation	Action
<p>Single Trailer to Multiples</p> <p>message    OFF OFF OFF</p> <p>lamp on    ON ON ON ON ON ON</p> <p>lamp off         → 0.5 sec ←                 </p> <p style="text-align: right; margin-right: 50px;">4003986a</p>	<p>ABS lamp is on and stays on when a new trailer with no new fault is added.</p>	<p>There was a fault in existence before the new trailer was added AND the ignition was not turned off before the trailer was added.</p>	<p>Use lamp on side of trailer to identify fault. Make necessary repairs.</p>
<p>Single Trailer to Multiples</p> <p>message    ON ON ON ON ON ON</p> <p>lamp on    ON ON ON</p> <p>lamp off         → 0.5 sec ←            </p> <p style="text-align: right; margin-right: 50px;">4003987a</p>	<p>ABS lamp is on and stays on when a new trailer with a new fault is added.</p>	<p>ABS fault was in existence before the new trailer was added AND the ignition was not turned off before the trailer was added AND the new trailer has an ABS fault.</p>	

ON = Turn ON message to the "trailer ABS" lamp  
 OFF = Turn OFF message to the "trailer ABS" lamp

Removing a trailer with a fault will cause the ABS lamp to turn off. Remember to have the trailer with the fault repaired as soon as possible before returning it to service.

### ABS Modulator Valves

Modulator valves control the air pressure to each affected brake during an ABS function.

### Valve Arrangement Option

In Figure 1.4, the modulator valves on the rear axle are mounted separately and a relay valve is used to deliver air pressure to the modulator valves. There is also an optional valve package available from Meritor WABCO, the ABS valve package, which may be found on certain vehicle models. The **ABS valve package** may be used on all D and E version units, including D and E Basic, and is available for front or rear axle installation.

# 1 Introduction

## Easy Listening Tip!

To ensure the ABS valves are working — just listen! Figure 1.5.

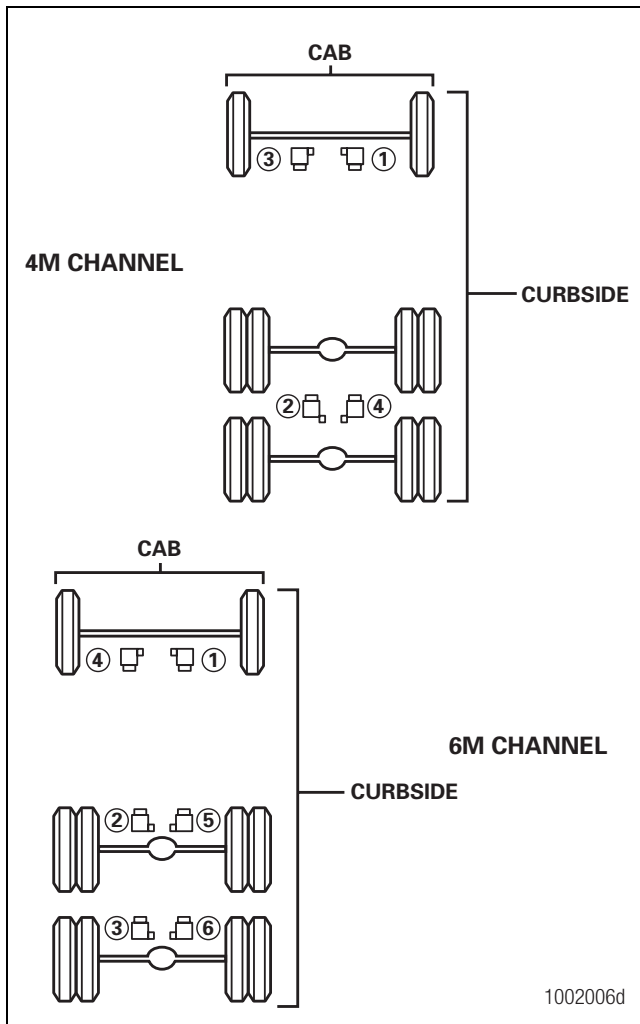


Figure 1.5

1. Apply the brakes.
2. Turn on the ignition.
3. Wait for the ABS indicator lamp to come on.

**NOTE:** In previous versions of ABS, the valves are cycled diagonally. Diagonal cycling does not occur with E version ABS.

4. Listen to the valves cycle one by one, then together diagonally, as follows:
  - 4M (channel) valve cycle order:  
1 – 2 – 3 – 4
  - 6M (channel) valve cycle order:  
1 – 2 – 3 – 4 – 5 – 6

## ABS Valve Packages

The front ABS valve package combines a quick release valve with two ABS modulator valves and is mounted in the front of the vehicle. The rear ABS valve package combines a service brake relay valve with two ABS modulator valves and is mounted in the rear of the vehicle. The valve package, front or rear, must be mounted near the brake chambers it serves. Figure 1.6.



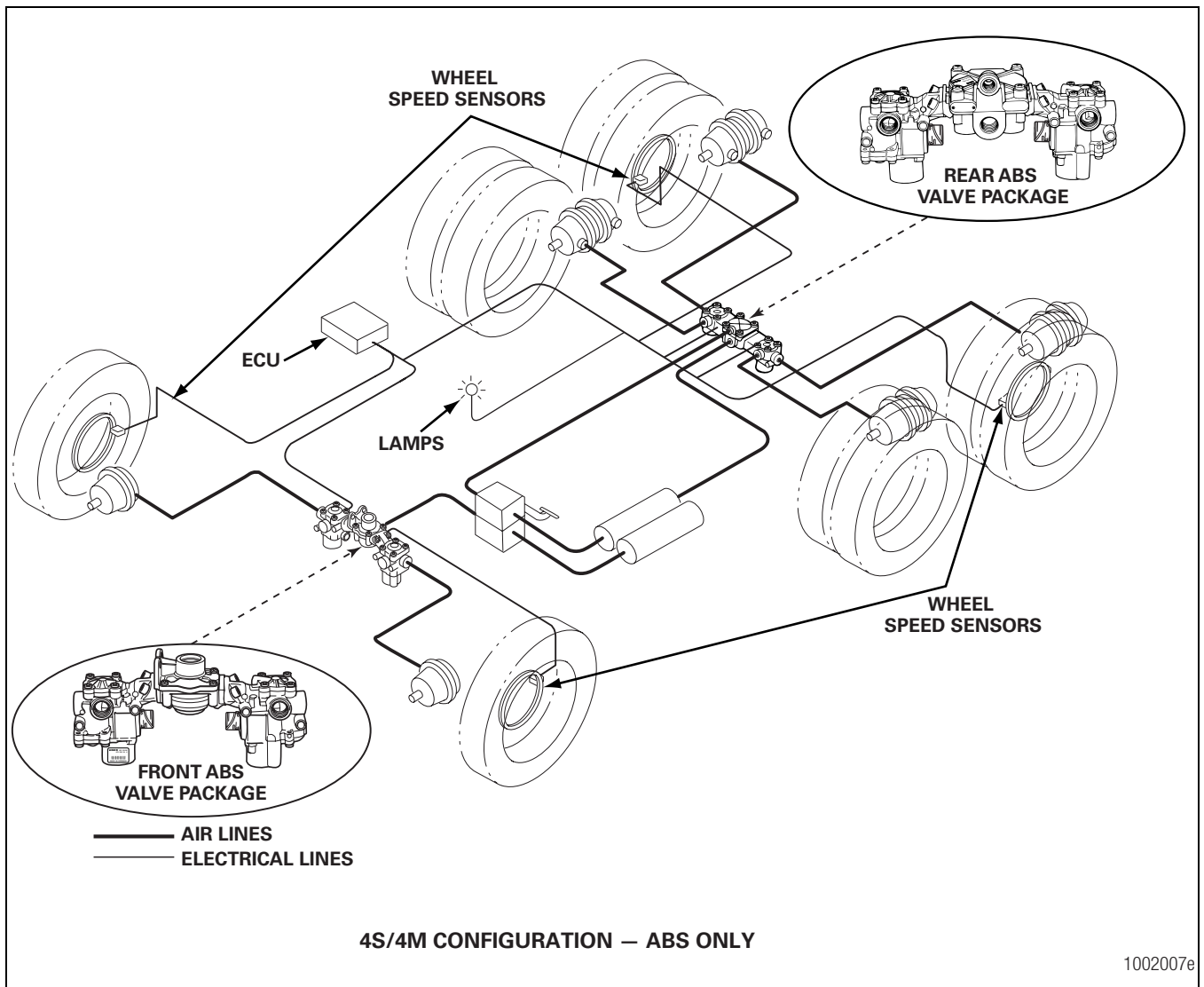


Figure 1.6

## ABS Sensors

ABS sensor systems consist of a tooth wheel mounted on the hub of each monitored wheel and a sensor installed so that its end is against the tooth wheel. The sensor continuously sends wheel speed information to the ECU. A sensor clip holds the sensor in place at the tooth wheel.

The type of axle determines sensor mounting location.

- Steering axle sensors are installed in the steering knuckle or in a bolted-on bracket.
- Drive axle sensors are mounted in a block attached to the axle housing or in a bolted-on bracket.

Check the wheel speed sensors for correct alignment and apply lubricant to the sensor and sensor clip whenever wheel-end maintenance is performed. Refer to Section 3 and Section 4.

# 1 Introduction

## Off-Road ABS

On some vehicles, an off-road ABS function may be selected. Off-road ABS improves vehicle control and helps reduce stopping distances in off-road conditions or on poor traction surfaces such as loose gravel, sand and dirt. **This option is not available on 4S/4M frame-mounted ECUs.**

**NOTE:** On vehicles equipped with an off-road switch, the off-road ABS mode is manually selected by the driver. On some vehicles, the off-road mode may be fully automatic. Refer to the vehicle specifications for information about the off-road ABS feature.

The ABS indicator lamp on the dash will flash while the vehicle is in the off-road mode. This alerts the driver that the vehicle's normal ABS function is being modified.

## Automatic Traction Control (ATC)

ATC is an option with Basic and frame-mounted E version ECUs and is available with all Universal ECUs. ATC can be used with individual valves, or with an integrated ABS/ATC valve package. Universal and frame-mounted 4S/4M E version ECUs with ATC may have roll stability control. Basic ECUs with ATC do not have RSC. Section 2 describes ATC and RSC in detail.

## System Components

The **ECU** is the brain of the ABS system. It receives information from the sensors and sends signals to the ABS valves. ECUs are available for cab- or frame-mounted applications. Basic and universal ECUs are cab-mounted. Universal and frame-mounted 4S/4M E version ECUs with ATC may have roll stability control. Basic ECUs with ATC do not have RSC. Figure 1.7.

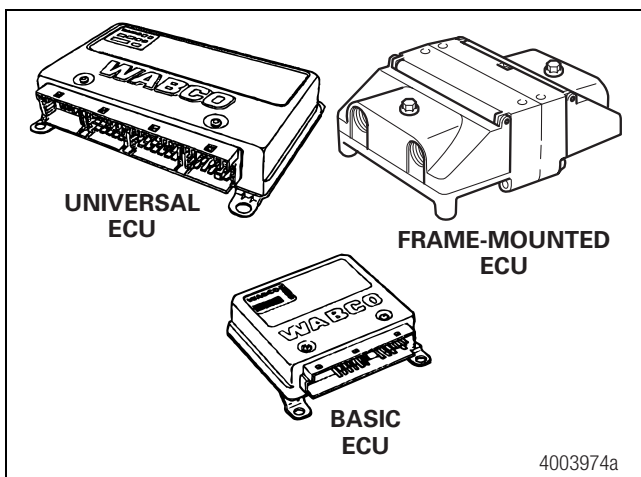


Figure 1.7

A **tooth wheel** is mounted at, or cast in, the hub of each sensed wheel, with a sensor installed so that its end is against the tooth wheel. A sensor clip holds the sensor in place at the tooth wheel. Figure 1.8.

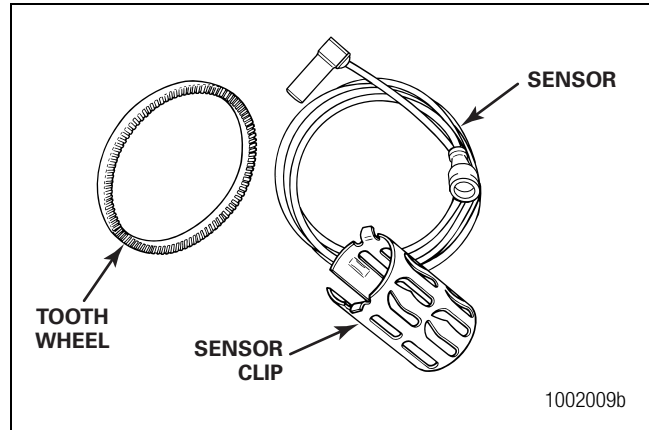


Figure 1.8

**NOTE:** The sensor and clip must be greased with Meritor WABCO-recommended lubricant whenever wheel-end maintenance is performed. Refer to Section 4 for lubrication specifications.

An **ABS modulator valve** controls air pressure to each affected brake during an ABS event. The modulator valve is usually located on a frame rail or cross member near the brake chamber. The modulator valve is available in bayonet-style, Figure 1.9, or open-style connector.

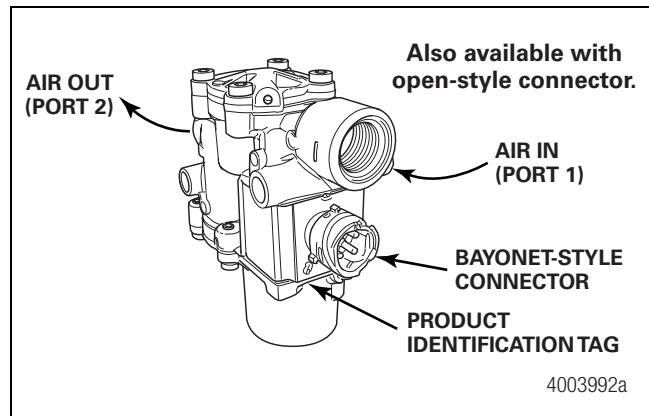
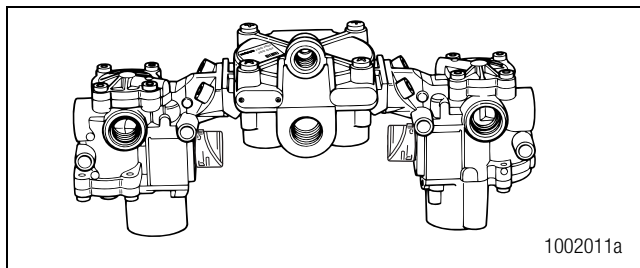


Figure 1.9

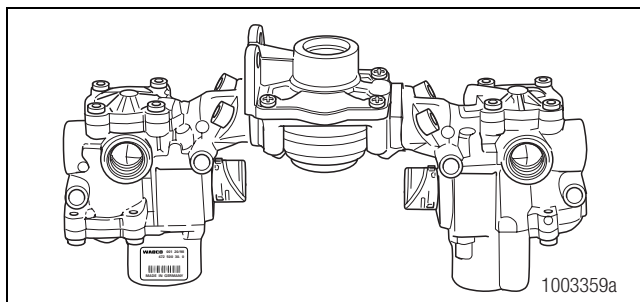
The **ABS valve package** is an alternative to individual valves.

The **rear ABS valve package** combines two modulator valves and one service relay valve. Figure 1.10.



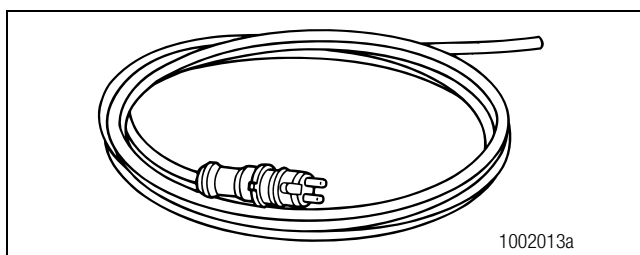
**Figure 1.10**

The **front ABS valve package** combines two modulator valves and a quick release valve. Figure 1.11.



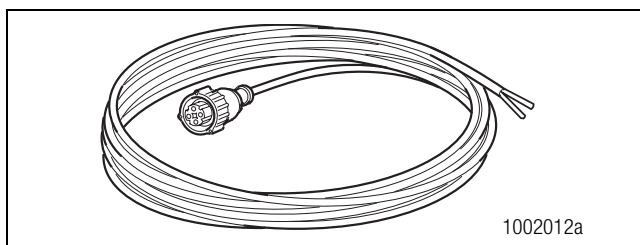
**Figure 1.11**

**Sensor cables** connect the sensor to the ECU. Figure 1.12.



**Figure 1.12**

**ABS modulator valve cables** connect the modulator valve to the ECU. Figure 1.13.

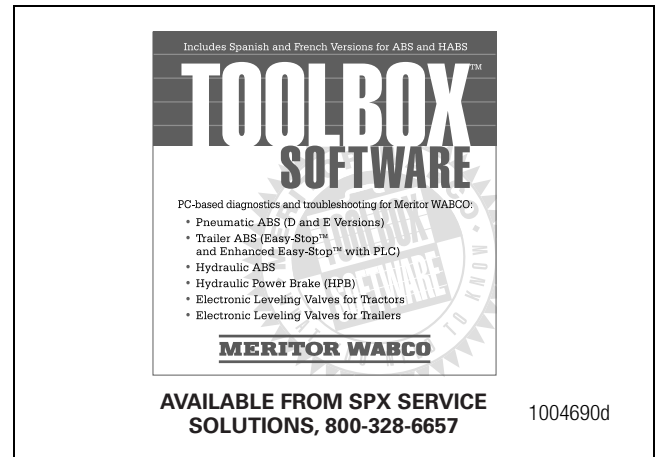


**Figure 1.13**

**TOOLBOX™ Software** is a PC-based diagnostics program that can display wheel speed data, test individual components, verify installation wiring and more. Runs in Windows® 98\*, Me, 2000 or XP\*\*. Internet Explorer version 3.02 or higher must be installed. RS232 to J1708 convertor box is required. Figure 1.14.

\* Not recommended

\*\* Approved for use with TOOLBOX™ as of July 2005



**Figure 1.14**

The **MPSI Pro-Link® Plus** with a multiple protocol cartridge (MPC) and Meritor WABCO applications card, version 2.0 or higher, provides diagnostic and testing capabilities for the E version ABS. Figure 1.15.



**Figure 1.15**

**NOTE:** The RSC functions of E version ABS cannot be tested with the Pro-Link® Plus.

## 2 Automatic Traction Control (ATC), Deep Snow and Mud Switch and Roll Stability Control (RSC)

### ATC

Automatic traction control is available as an option on all E version ABS ECUs and is standard on most. ATC can be used with individual valves, or with an integrated ABS/ATC valve package. ATC helps improve traction when vehicles are on slippery surfaces by reducing drive wheel overspin. ATC works automatically in two different ways.

- A. If a drive wheel starts to spin, ATC applies air pressure to brake the wheel. This transfers engine torque to the wheels with better traction.
- B. If all drive wheels spin, ATC reduces engine torque to provide improved traction.

If ATC turns itself on and off, drivers do not have to select this feature. If drive wheels spin during acceleration, the ATC indicator lamp comes on, indicating ATC is active. It goes out when the drive wheels stop spinning. Figure 2.1.

**NOTE:** Some vehicle manufacturers may refer to ATC as Anti-Spin Regulation (ASR).

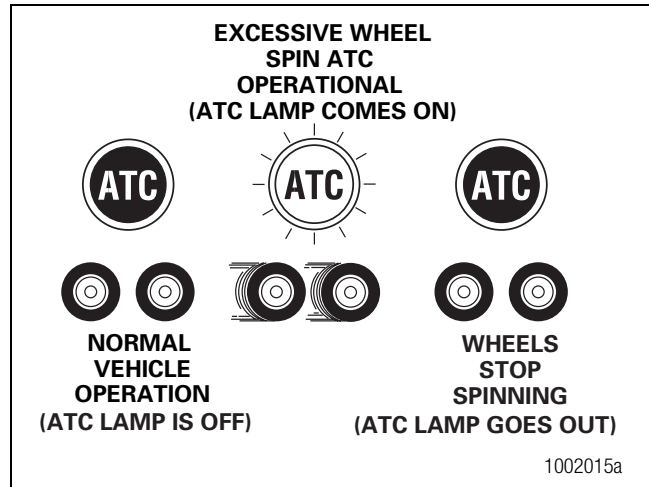


Figure 2.1

If ATC is installed, there will be an indicator lamp on the vehicle dash or instrument panel marked ATC or ASR.

If the ATC lamp goes out before the ABS lamp, there is no ATC.

An ATC installation may use an individually mounted valve, or the valve may be part of the ABS valve package. Figure 2.2.

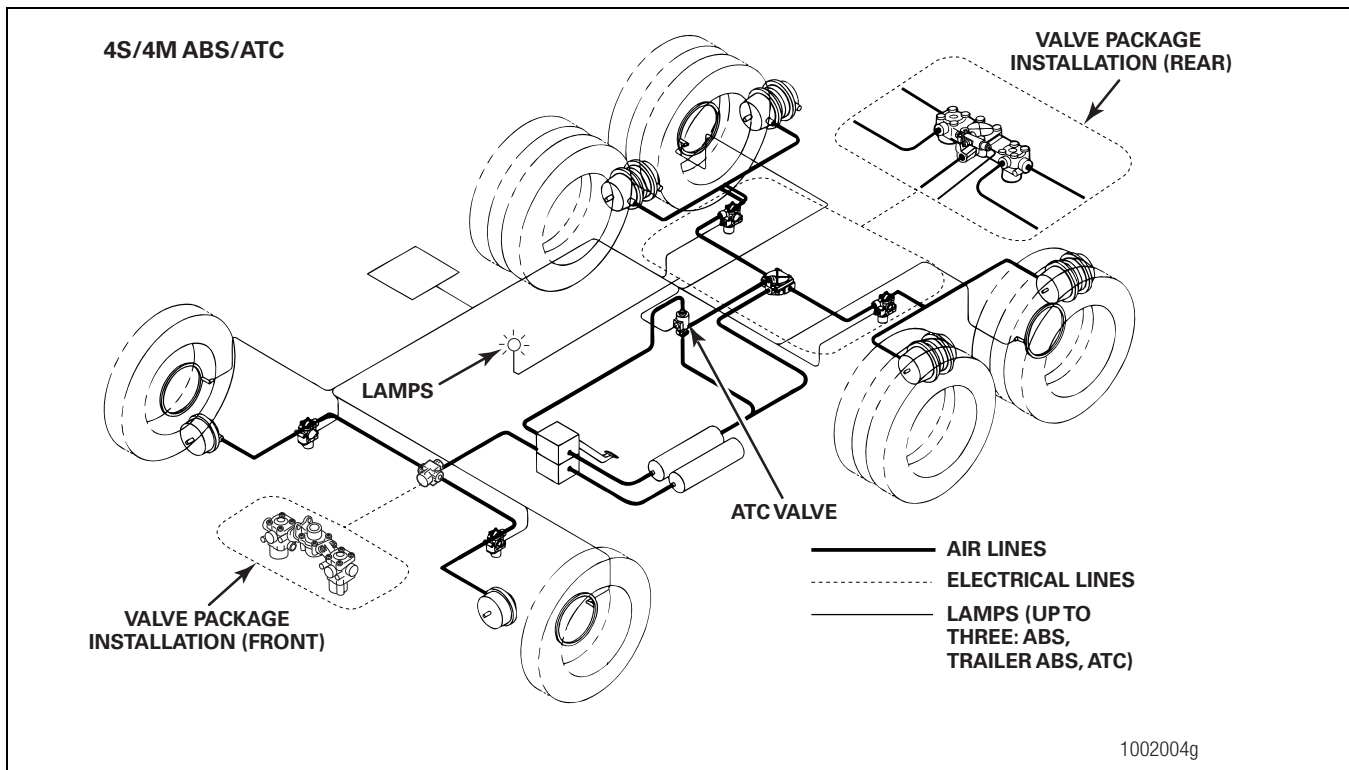


Figure 2.2

## 2 Automatic Traction Control (ATC), Deep Snow and Mud Switch and Roll Stability Control (RSC)

### ATC Components

ATC may be used with individual ABS modulator valves, or installed with the ABS valve package.

When installed with individual ABS modulator valves, an ATC solenoid valve is mounted on the frame or cross member, near the rear of the vehicle.

When it is part of the ABS valve package, an ATC valve is attached to the relay valve.

A cable connects the ECU to the ATC valve.

ATC components are illustrated in Figure 2.3.

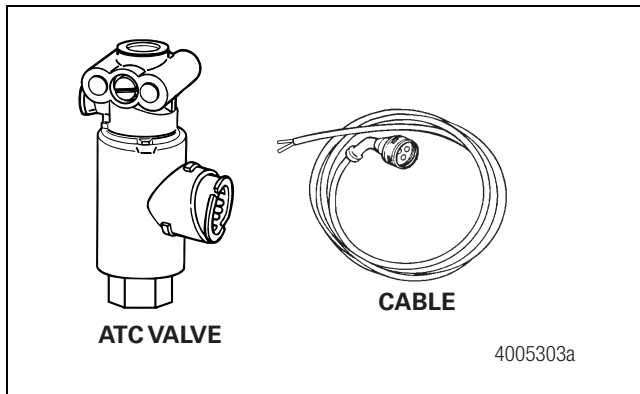


Figure 2.3

### Deep Snow and Mud Switch

A deep snow and mud option switch is included with ATC. This function increases available traction on extra soft surfaces like snow, mud or gravel, by slightly increasing the permissible wheel spin.

Drivers use a deep snow and mud switch to select this feature. When this function is in use, the ATC indicator lamp blinks continuously. Figure 2.4.

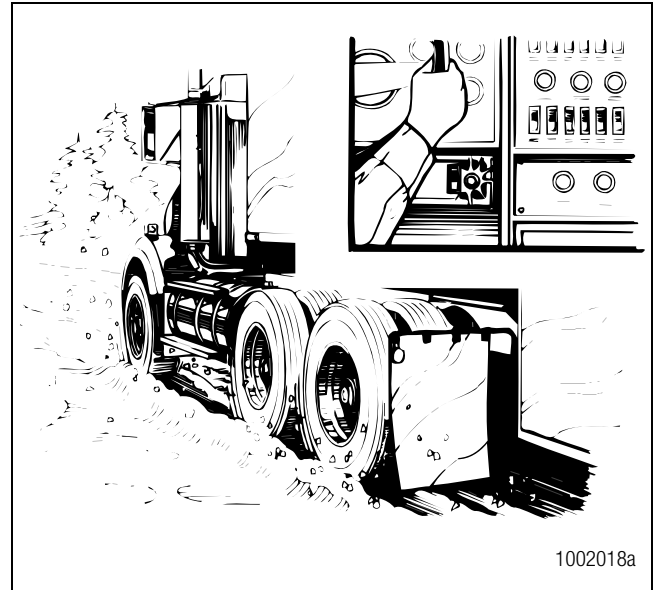


Figure 2.4

Switch and lamp locations will vary, depending on the vehicle make and model.

Here's how the deep snow and mud feature works.

Driver Action	System Response	Function	
		Active	Not Active
Press deep snow and mud switch	ATC lamp blinks continuously	X	
Press switch again	ATC lamp stops blinking		X

**NOTE:** Turning off the ignition will also deactivate the deep snow and mud feature.

## 2 Automatic Traction Control (ATC), Deep Snow and Mud Switch and Roll Stability Control (RSC)

### RSC

Roll stability control is an option designed to assist drivers in managing the conditions that result in commercial vehicle rollovers. When RSC senses conditions that may result in a rollover, it reduces engine torque, engages the engine retarder, applies enough pressure to the drive axle brakes and may modulate the trailer brakes to slow the vehicle down. Like ATC, RSC works automatically. The driver does not have to select this feature.

RSC uses many of the same components used by ABS and ATC. A second solenoid valve, the RSC valve, controls the trailer service brakes during an RSC event. This is a stand-alone valve that is not available as part of the ABS/ATC valve package. Figure 2.5.

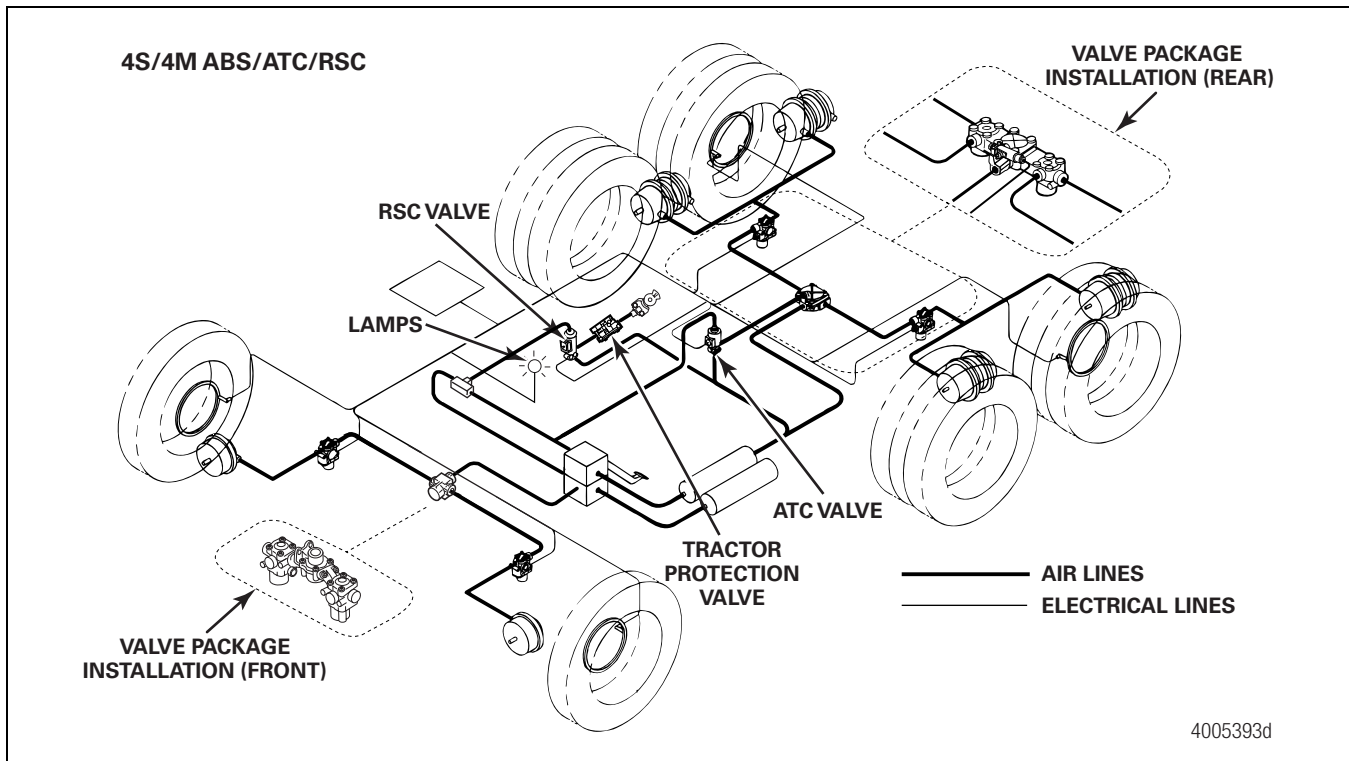


Figure 2.5

## 2 Automatic Traction Control (ATC), Deep Snow and Mud Switch and Roll Stability Control (RSC)

Because ATC and RSC functions share the same dash indicator lamp, understanding how the ABS and ATC/RSC lamps work is very important.

- If the vehicle is equipped with ATC, but not RSC, when the ignition is turned to the ON position, the ABS and ATC lamps will light for approximately three seconds, then both lamps will turn off simultaneously. Figure 2.6.
- If the vehicle is equipped with ATC and RSC, when the ignition is turned to the ON position, the ABS and ATC/RSC will both light . . . but the ATC/RSC lamp will stay lit briefly after the ABS lamp goes out. Figure 2.6.

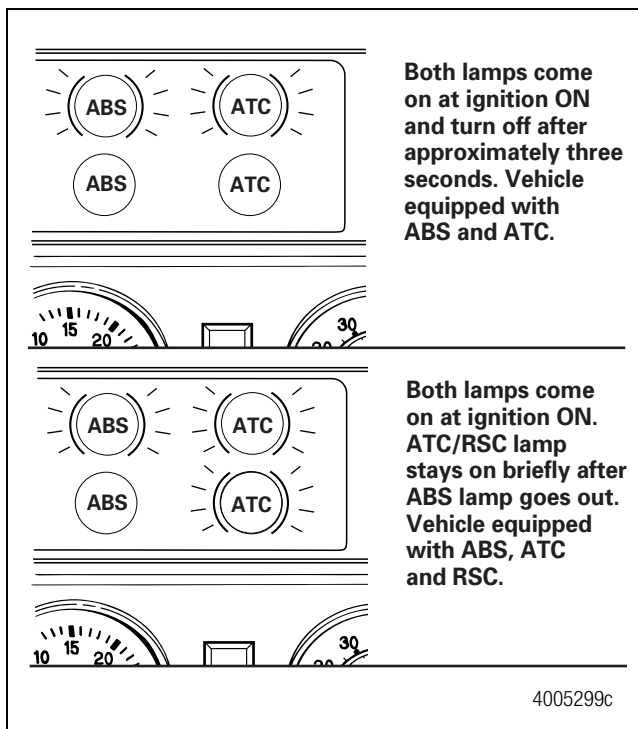


Figure 2.6

**NOTE:** Active mode means RSC is installed and will become active if it is needed.

TOOLBOX™ Software can also be used to determine if RSC is active. Refer to Section 3.

### RSC Components

An additional solenoid valve is needed for RSC. The RSC valve controls the trailer service brakes during an RSC event. The RSC valve is a stand-alone valve. The valve is not part of an ABS valve package. Figure 2.7.

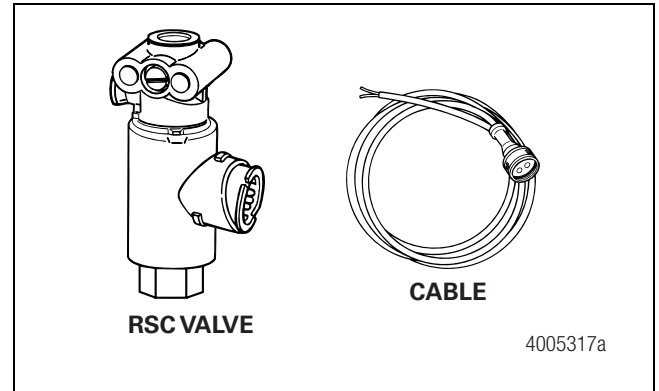


Figure 2.7



## 3 Diagnostics, Troubleshooting and Testing

### General

### Maintenance Information

There is no regularly scheduled maintenance required for the Meritor WABCO ABS or ABS/ATC. However, ABS does not change current vehicle maintenance requirements.

- **Lamp Check:** To ensure the ABS tractor lamp is operating, drivers should check the lamp every time the vehicle is started. When the vehicle is started, the ABS lamp should come on momentarily. If it does not come on, it could mean a burned-out bulb.
- **ABS Wheel Speed Sensors:** Check the wheel speed sensor adjustment and lubricate the sensor and sensor clip whenever wheel-end maintenance is performed. Use only Meritor WABCO-recommended lubricant, as specified in Section 4.

### Diagnostics

Use any of the following methods to diagnose E version ABS:

- TOOLBOX™ Software, a PC-based ABS diagnostic and testing program that runs in Windows® 98\*, Me, 2000 or XP\*\*. Internet Explorer version 3.02 or higher must be installed. Refer to the information in this section.
- Blink Codes. Refer to the information in this section.
- MPSI Pro-Link® Plus with MPC and Meritor WABCO applications card, version 2.0 or higher. Refer to the information in this section.
- OEM Diagnostic Displays. Refer to the vehicle operator's manual.

Information about TOOLBOX™ Software, MPSI Pro-Link® Plus and blink codes follows. If you have any questions about system diagnostics, please contact ArvinMeritor's Customer Service Center at 800-535-5560.

\* Not recommended

\*\* Approved for TOOLBOX™ as of July 2005

### TOOLBOX™ Software Diagnostics

**NOTE:** For complete instructions for using TOOLBOX™ Software, refer to the User's Manual. The manual is posted on [meritorwabco.com/TOOLBOX](http://meritorwabco.com/TOOLBOX).

If you have TOOLBOX™ Software installed on your computer, use it to identify system faults. Then, follow the on-screen repair information to make the necessary repairs or replacements.

To display E version ABS faults:

1. Connect the computer to the vehicle:
  - Attach the cable from your computer to the J1708 to RS232 converter box.
  - Attach the diagnostic cable (Deutsch) to the vehicle.Figure 3.1.

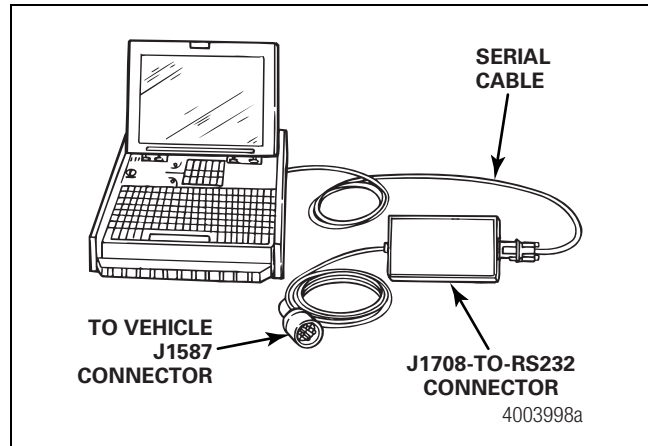


Figure 3.1

2. Select TOOLBOX™ Software from the Desktop or from the Windows Start Menu to display the TOOLBOX™ Main Menu. From the **Main Menu**, select **Tractor ABS**. The **ABS Main Screen** will appear. Figure 3.2.

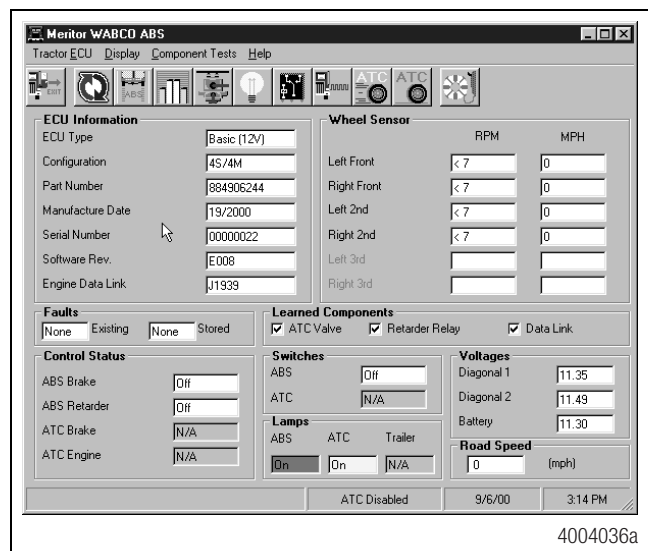


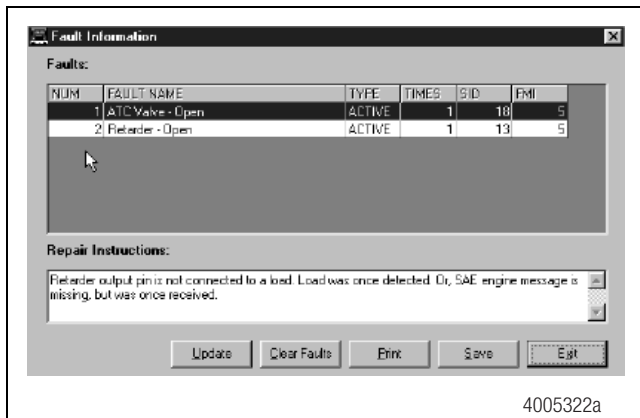
Figure 3.2

3. Select **Display** for a pull-down menu.



### 3 Diagnostics, Troubleshooting and Testing

- From the pull-down menu, select **Faults** to bring up the Fault Information screen. Figure 3.3.



**Figure 3.3**

- A description of the fault, the number of times the fault occurred, the system identifier (SID) and the failure mode (FMI) are all displayed in the fault information window. Basic repair instructions for each fault are also provided. Figure 3.3.

For detailed repair instructions, click on the fault to display a troubleshooting information sheet. **Bookmark** and **Thumbnail** tabs at the side of the troubleshooting information sheet provide additional information. A sample troubleshooting information sheet appears in the Appendix. This screen also provides a link to the appropriate system schematic.

Faults that may occur after the screen is displayed will not appear until a screen update is requested. Use the **update** button to refresh the fault information table.

After making the necessary repairs, use the **clear faults** button to clear the fault. Use the **update** button to refresh the fault information table and display the new list of faults.

Use the **Save** or **Print** button to save or print the fault information data.

### Blink Code Diagnostics (Tractor ABS Only)

#### Definitions

Before using blink code diagnostics, you should be familiar with a few basic terms. If you used previous versions of Meritor WABCO's blink code diagnostics, review these definitions to identify major changes.

**ABS Indicator Lamp:** This lamp serves two purposes: it alerts drivers to an ABS tractor fault and it is used during diagnostics to display the blink code.

**Blink Code:** A series of blinks or flashes that describe a particular ABS system fault or condition.

**Blink Code Cycle:** Two sets of flashes with each set separated by a one-and-one-half second pause. Blink codes are defined in the blink code identification information in this section.

**Blink Code Switch:** A momentary switch that activates blink code diagnostic capabilities. Switch types and locations vary, depending on the make and model of the vehicle.

**Clear:** The process of erasing faults from the ECU.

**Diagnostics:** The process of using blink codes to determine ABS system faults.

**Fault:** An ABS malfunction detected and stored in memory by the Meritor WABCO ECU. System faults may be Active or Stored.

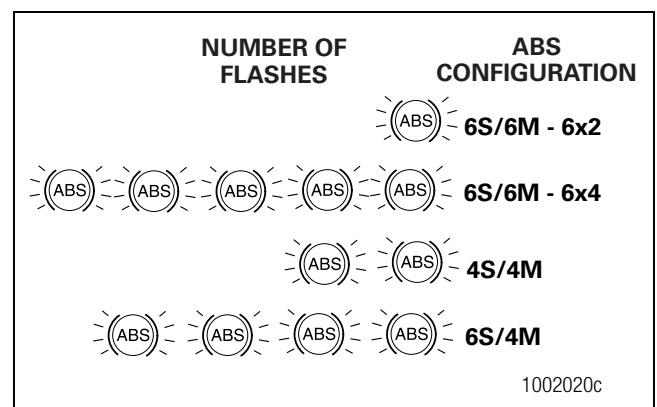
**Active Fault:** A condition that **currently exists** in the ABS system; for example, a sensor circuit malfunction on the left front steering axle. An active fault must be repaired before it can be cleared from memory — and before you can display additional blink code faults.

**Stored Fault:** There are two types of stored faults:

- A repaired active fault that **has not been cleared** from the ECU.
- A fault that occurred but **no longer exists**. For example, a loose wire that makes intermittent contact. Because stored faults are not currently active, they do not have to be repaired before they can be cleared from memory.

Meritor WABCO recommends you keep a record of these faults for future reference.

**System Configuration Code:** One digit code displayed during the clear mode. Blink codes for common ABS system configurations are shown in Figure 3.4.



**Figure 3.4**

### 3 Diagnostics, Troubleshooting and Testing

#### Diagnostic Mode

To enter the diagnostic mode, press and hold the blink code switch for one second, then release.

#### Clear Mode

To erase faults from the ECU, you must be in the clear mode. To enter the clear mode, press and hold the blink code switch for at least three seconds, then release.

If the system displays eight quick flashes followed by a system configuration code, the clear was successful. Stored ABS faults have been cleared from memory.

If you do not receive eight flashes, there are still active faults that must be repaired before they can be cleared.

**NOTE:** The clear mode is also used to disable the ATC function.

**Table C: Troubleshooting with Blink Code Diagnostics**

Procedure	System Response	Action
<b>Diagnostics Mode</b>		
<b>Step I.</b> <b>Turn ignition ON.</b>	Possible responses:  ABS indicator lamp comes on momentarily then goes out, indicating System OK.  ABS indicator lamp does not light, indicating possible wiring fault or burned-out bulb.  ABS indicator lamp stays on, indicating: <ul style="list-style-type: none"> <li>• Fault, or faults, in the system.</li> <li>• Sensor fault during last operation.</li> <li>• Faults cleared from ECU, but vehicle not driven.</li> <li>• ECU disconnected.</li> </ul>	No recognizable active faults in the ABS. No action required.  Inspect wiring. Inspect bulb. Make necessary repairs.  Continue with blink code diagnostics. <b>(Go to Step II.)</b> Continue with blink code diagnostics. <b>(Go to Step II.)</b> Drive vehicle — lamp will go out when vehicle reaches 4 mph (6 km/h). Connect ECU.
<b>Step II.</b> <b>Press and hold Blink Code Switch for one second, then release.</b>	ABS indicator lamp begins flashing two digit blink code(s).	Determine if fault is active or stored:  <b>Active Fault:</b> Lamp will repeatedly display one code. <b>Stored Fault:</b> Lamp will display code for each stored fault then stop blinking. Faults will be displayed <b>one time only.</b>
<b>Step III.</b> <b>Count the flashes to determine the blink code.</b>	First Digit: 1-8 flashes, Pause (1-1/2 seconds) Second Digit: 1-6 flashes, Pause (4 seconds)	Find definition for blink code on blink code chart.
<b>Step IV.</b> <b>Turn ignition OFF.</b> <b>Repair and record faults.</b>	Active Fault  Stored Fault	Make the necessary repairs. Repeat Step 1, Step II and Step III until System OK, code (1-1) received.  Record for future reference.  <b>NOTE:</b> Last fault stored is first fault displayed.
<b>Clear Mode</b>		
<b>Step V.</b> <b>Turn ignition ON.</b> <b>Clear Faults from memory: Press and hold blink code switch for at least three seconds, then release.</b>	ABS indicator lamp flashes eight times.  Eight flashes not received.	All stored faults successfully cleared. Turn ignition OFF.  Active faults still exist, repeat Step I through Step V.

Blink Code Illustrations

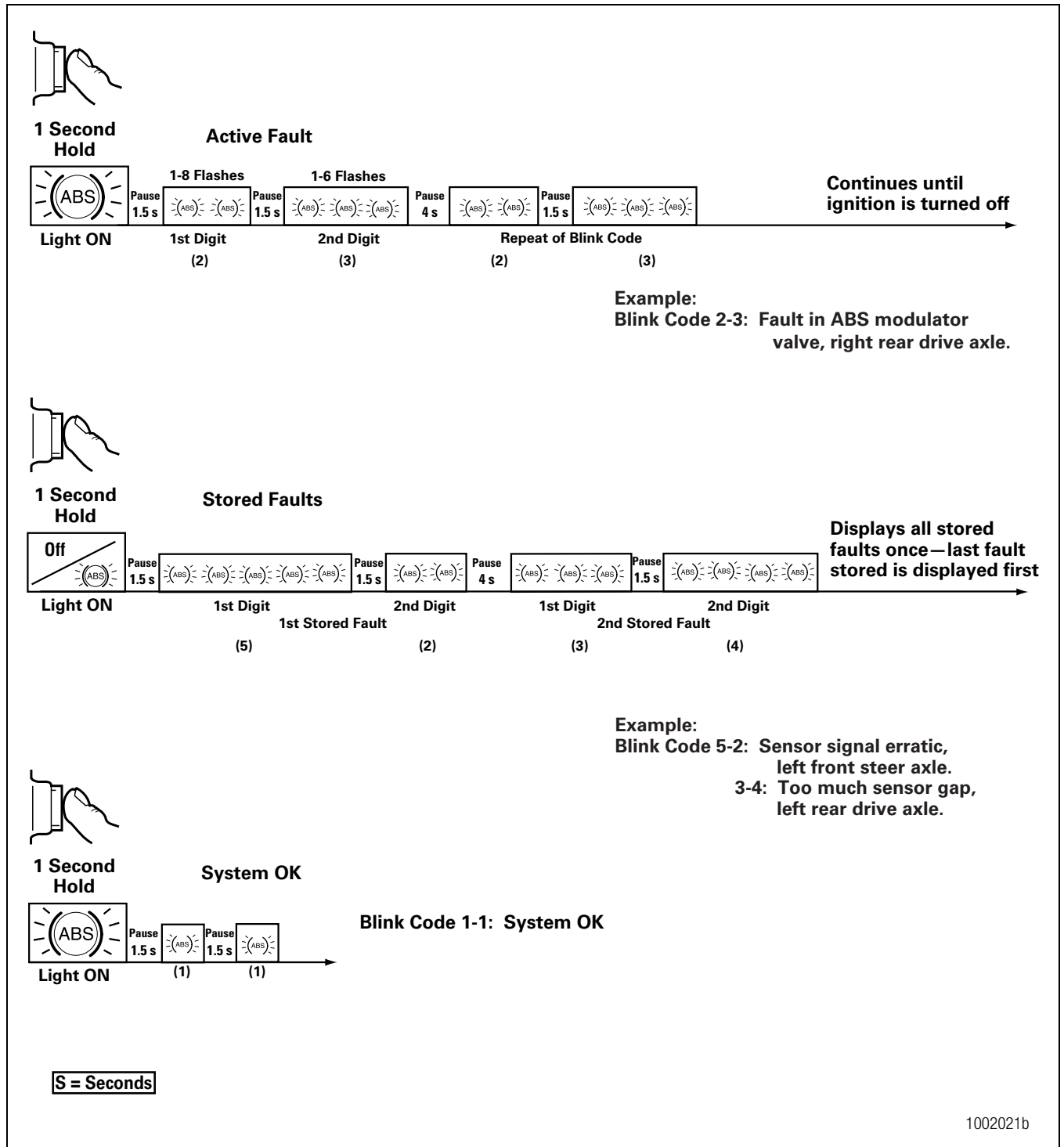


Figure 3.5

### 3 Diagnostics, Troubleshooting and Testing

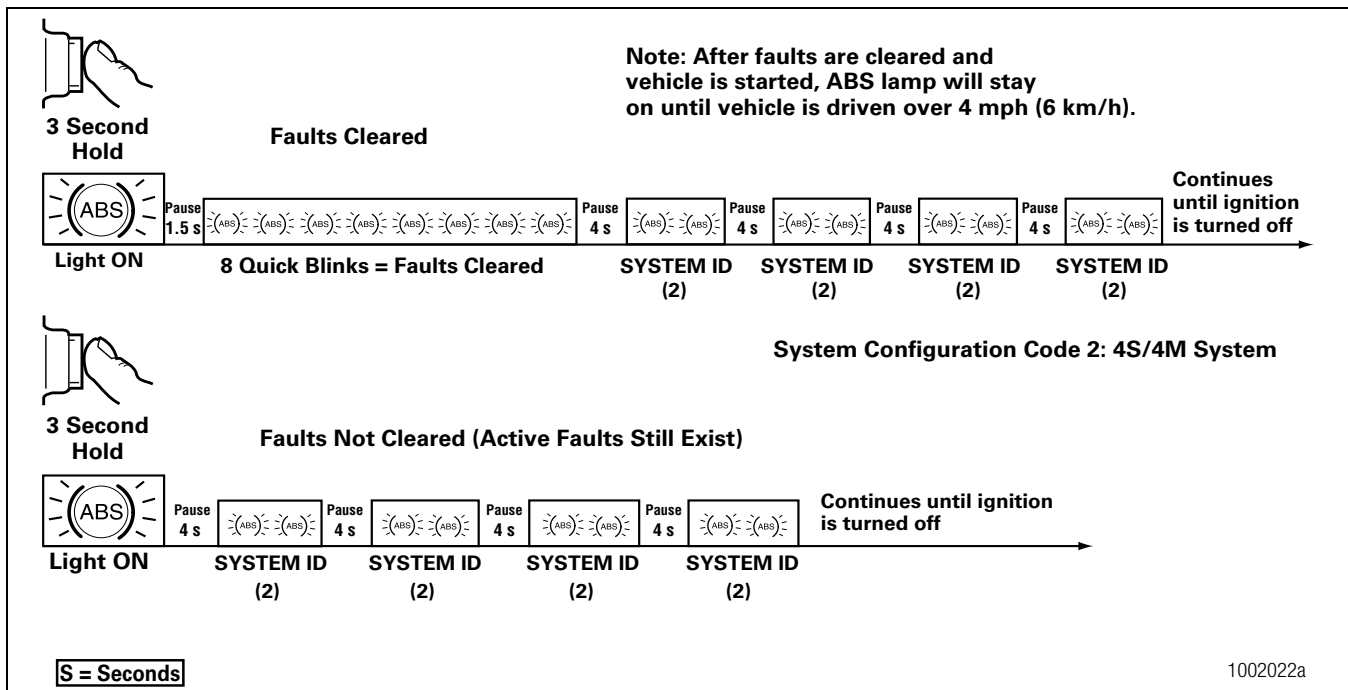


Figure 3.6

#### Blink Code Conditions

When using blink code diagnostics, the following conditions could occur:

Table D: Blink Code Conditions

Condition	Reason	Action
ABS indicator lamp does not come on at ignition.	Loose or burned-out bulb.	Check bulb. Check connections. Make necessary repairs.
	Voltage not within acceptable range (9.5-14.0 volts).	Check connections. Measure voltage. Make necessary repairs.
Can't use blink code diagnostics. ABS indicator lamp will not go off when blink code is activated.	Switch not held for correct length of time: 1 Second — Diagnostics Mode 3 Seconds — Clear All Mode	Repeat procedure, hold switch for correct length of time.
	Incorrect or faulty wiring.	Inspect and repair wiring.
	Fault not erased from ECU after report.	Repeat procedure until System O.K. code received.
Eight flashes not received after blink code switch pressed for at least three seconds, then released.	Active faults still exist.	Identify active faults, then make necessary repairs. Turn ignition OFF, then repeat Blink Code Diagnostics.

#### Blink Code Identification

Use the following information to identify the blink code:

First Digit (Type of Fault)	Second Digit — Specific Location of Fault
1 No faults	1 No faults
2 ABS modulator valve	1 Right front steer axle (curb side)
3 Too much sensor gap	2 Left front steer axle (driver's side)
4 Sensor short or open	3 Right rear drive axle (curb side)
5 Sensor signal erratic/tire size	4 Left rear drive axle (driver's side)
6 Tooth wheel	5 Right rear/additional axle (curb side) <sup>1</sup>
	6 Left rear/additional axle (driver's side) <sup>1</sup>
7 System function <sup>2</sup>	1 J1939 datalink
	2 ATC valve
	3 Retarder relay (third brake)
	4 ABS indicator lamp
	5 ATC configuration
	6 RSC valve
8 ECU	1 Low power supply
	2 High power supply
	3 Internal fault
	4 System configuration error
	5 Ground
	6 RSC accelerometer

<sup>1</sup> Tandem, lift, tag or pusher axle depending upon the type of suspension

<sup>2</sup> If this code continues after all repairs have been made — or if you receive a code for a component that is not installed on the vehicle — it may be necessary to reconfigure the ECU. Refer to Appendix III. TOOLBOX™ Software may also be used to reconfigure the ECU (refer to Appendix III). Contact ArvinMeritor's Customer Service Center at 800-535-5560 for reconfiguration information.

### 3 Diagnostics, Troubleshooting and Testing

#### Blink Code Troubleshooting and Repair

Blink Code	Action Required	Reference
2-1, 2-4 2-2, 2-5 2-3, 2-6	Check ABS modulator valve, valve cable and connectors. Verify 4.0-9.0 ohms resistance (ABS modulator valve).	Refer to Valve Tests in this section.
3-1, 3-4 3-2, 3-5 3-3, 3-6	Adjust wheel sensor to touch tooth wheel. Check sensor gap. Check for loose wheel bearings or excessive hub runout. Verify minimum 0.2 volts AC output @ 30 rpm.	Refer to Testing Components in this section.
4-1, 4-4 4-2, 4-5 4-3, 4-6	Check sensor, sensor cable and connectors. Verify 900-2000 ohms resistance.	Repair or replace as needed.
5-1, 5-4 5-2, 5-5 5-3, 5-6	Check for tire size mismatch or tooth wheel difference. Check sensor, sensor cable, and connector for intermittent contact.	Refer to Tire Size Range in this section.
6-1, 6-4 6-2, 6-5 6-3, 6-6	Check for damaged tooth wheel.	Repair or replace as needed.
7-1*	Check for correct J1939 data link connection. Verify correct sensor adjustment. Refer to the sensor adjustment information in this section.	Refer to the wiring diagram in Appendix II.
7-2*	Check ATC valve, valve cables and connectors. Verify 7.0-14.0 ohms resistance.	Refer to Valve Tests in this section.
7-3*	Check retarder (third brake) connections.	Refer to the wiring diagram in Appendix II.
7-4*	Check ABS indicator lamp connections. Verify blink code switch was activated longer than 16 seconds.	
7-5*	Verify correct ATC set-up.	
7-6*	Check RSC valve. Verify 7.0-14.0 ohms resistance.	Refer to Valve Tests in this section.
8-1	Check for low voltage. Check vehicle voltage, fuse and supply to ECU (9.5-14.0 volts).	Refer to the wiring diagram in Appendix II and Voltage Check in this section.
8-2	Check for high voltage. Check for vehicle voltage (9.5-14.0 volts). Verify accuracy of blink code and clear from ECU memory.	Refer to Voltage Check and Blink Code Diagnostics (Tractor ABS Only) in this section.
8-3	Verify accuracy of blink code and clear from ECU memory.	Refer to Blink Code Diagnostics (Tractor ABS Only) and Clear Mode information in this section.
8-4	Verify all ECU connectors are in place. Verify accuracy of blink code and clear from ECU memory. <i>If code does not clear, it may be necessary to replace the ECU.</i>	Contact ArvinMeritor's Customer Service Center at 800-535-5560.
8-5	Check all ABS, ECU, ATC and RSC valve grounds.	Refer to the wiring diagram in Appendix II.
8-6	Verify accuracy of blink code and clear from ECU memory.	Contact ArvinMeritor's Customer Service Center at 800-535-5560.

\* If this code continues after all repairs have been made — or if you receive a code for a component that is not installed on the vehicle — it may be necessary to reconfigure the ECU. Refer to the Appendix III. TOOLBOX™ Software may also be used to reconfigure the ECU (refer to Appendix III). Contact ArvinMeritor's Customer Service Center at 800-535-5560 for additional information or assistance.

### Pro-Link<sup>®</sup> Plus Diagnostics

**NOTE:** You must use the Multiple Protocol Cartridge (MPC) and Meritor WABCO applications card, version 2.0 or higher, with E version ECUs. **The PLC functions of E version ABS cannot be tested with the Pro-Link<sup>®</sup> Plus.**

The Pro-Link<sup>®</sup> Plus may be used in place of blink code diagnostic procedures.

The Pro-Link<sup>®</sup> Plus screens illustrated appear with E version ECUs. Refer to Maintenance Manual 28, Anti-Lock Braking Systems (ABS) for Trucks, Tractors and Buses, if you are using the Pro-Link<sup>®</sup> Plus with C version ECUs or Maintenance Manual 30, Anti-Lock Braking Systems (ABS) for Trucks, Tractors and Buses, if you are using the Pro-Link<sup>®</sup> Plus with D version ABS.

#### Diagnostic Procedure

1. Slide the MPC into the Pro-Link<sup>®</sup> Plus keypad until the connection is tight. Then, insert the Meritor WABCO applications card into the cartridge.
2. Block the wheels, apply the parking brake, and verify that the ignition power is off.
3. Locate the 6-pin diagnostic receptacle in the vehicle cab. Insert the 6-pin connector from the Pro-Link<sup>®</sup> Plus into the receptacle.
4. Turn the ignition to the ON/RUN position. The Pro-Link<sup>®</sup> Plus screen should power up.

If the Pro-Link<sup>®</sup> Plus does not power up, or if the screen indicates NO DATA RECEIVED:

- Check connections.
  - Verify that the cartridge is correctly connected to the Pro-Link<sup>®</sup> Plus keypad.
  - Verify 9.5-14.0 volts DC power and ground at the connector and ABS ECU.
  - Check the fuse panel for a blown fuse.
  - Check for correct wiring in the diagnostic connector.
5. Refer to the Pro-Link<sup>™</sup> Plus manual for complete diagnostic instructions.

**The Pro-Link<sup>®</sup> Plus is available from SPX, 800-328-6657.**

#### Pro-Link<sup>®</sup> Plus Screens

This information provides basic screen explanations for the Pro-Link<sup>®</sup> Plus with an MPC and Meritor WABCO application card. For complete operating instructions and test information, refer to the Pro-Link<sup>®</sup> Plus manual.

#### Fault Information Screens

**Existing Faults:** Use these screens to identify existing faults. The Pro-Link<sup>®</sup> Plus screen displays a written description of the fault, including the location on the vehicle where each exists. As long as there is an active (existing) fault in the system, the Pro-Link<sup>®</sup> Plus will not let you clear faults.

**Stored Faults:** Use these screens to identify faults stored in the ECU memory. Stored faults may be existing faults that have been repaired, or faults that existed for a short time, then corrected themselves. After displaying the stored faults, the Pro-Link<sup>™</sup> Plus lets you erase them from memory. All stored faults are cleared at one time.

#### Pro-Link<sup>®</sup> Plus Display

Depending upon the ECU being tested, the Pro-Link<sup>®</sup> Plus screen will display certain options or components only when recognized by the ECU. These include:

- ATC, ATC Indicator Lamps, Trailer ABS Indicator Lamp, ATC Valve
- Engine Datalink
- Retarder Relay
- Retarder Datalink

#### Component Test Screens (Pro-Link<sup>®</sup> Plus)

These screens help you test ABS components. Select this function from the Tractor ABS/ATC menu.

ABS VALVES

ATC

ABS INDICATOR LAMP

ABS TRAILER INDICATOR LAMP

ATC INDICATOR LAMP

ABS/ATC SWITCHES

SENSORS

ENGINE DATALINK

RETARDER RELAY

RETARDER DATALINK



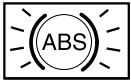
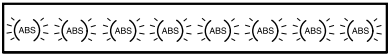






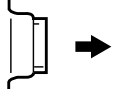


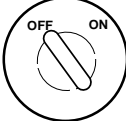
VEHICLE VOLTAGES

Select the appropriate function. Each screen has instructions to guide you through the test. Refer to the Pro-Link<sup>®</sup> Plus Manual for complete instructions.

### 3 Diagnostics, Troubleshooting and Testing

#### J1939 Datalink Verification — Pro-Link® Plus

The Pro-Link® Plus diagnostic tool may be used to verify J1939 datalink connection. If you do not have a Pro-Link® Plus, you can use the blink code switch to verify this connection.

<p>1. Turn ignition ON. Press blink code switch — hold for three seconds.</p> <p>A. ATC indicator lamp will come on and stay on for the entire test. <i>If the vehicle is not equipped with ATC, the ATC indicator lamp will not come on.</i></p> <p>B. ABS indicator lamp will come on and blink eight times. <i>If the lamp does not blink eight times, there are faults that must be cleared before you continue with this test.</i></p> <p>C. The eight quick flashes will be followed by the system configuration code. A 4S/4M (two blinks) system is identified here. <i>The system configuration code will continue during the entire test.</i></p> <p>2. Activate the J1939 engine torque reduction code, as follows:</p> <p>A. Step on the accelerator. Bring the engine to 1000 rpm. <i>Leave your foot on the accelerator during the entire test.</i></p> <p>B. While the engine is at 1000 rpm, press the blink code switch twice, as follows: Press for one second Release for one second Press for one second Release for one second</p> <p>C. The engine will go to idle for approximately 10 seconds and then return to 1000 rpm.</p> <p>3. Turn ignition OFF. <b>Test complete, engine torque reduction command verified.</b></p>	<p>1.</p> <p> → <b>IGNITION ON</b> 3 Second Hold</p> <p>A. </p> <p>B.   <b>8 Quick Blinks = Faults Cleared</b></p> <p>C.  Pause 4 s  Pause 4 s  <b>Continues During Test</b></p> <p>2.</p> <p>A.  </p> <p>B.  Pause  Pause</p> <p>C.  </p> <p>3. </p>
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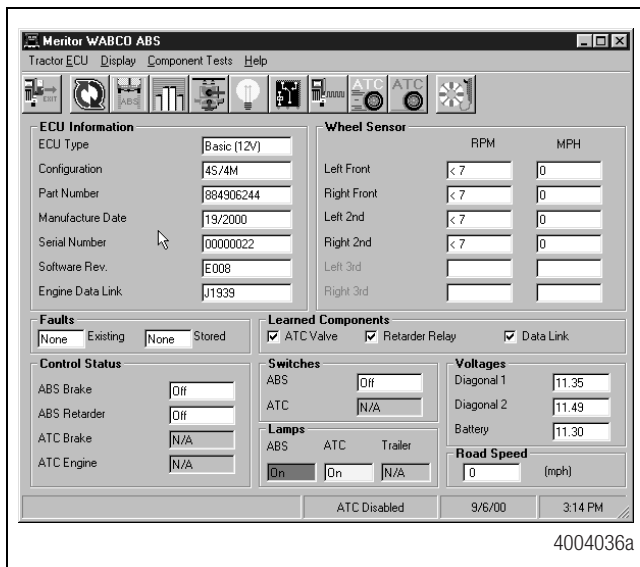


## System Information

### TOOLBOX™ Software Display

**NOTE:** Refer to the procedure in this section for TOOLBOX™ Software instructions, or refer to the Software Owner's Manual, TP-99102, for complete operating instructions.

The quickest method of verifying system information is the TOOLBOX™ Software **ABS Main Screen**. Figure 3.7.



**Figure 3.7**

This screen provides information about the current state of Meritor WABCO ABS. ECU information is read once from the ECU and does not change. All other information (e.g., wheel sensors, control status, voltages, faults and road speed) is read and updated continuously.

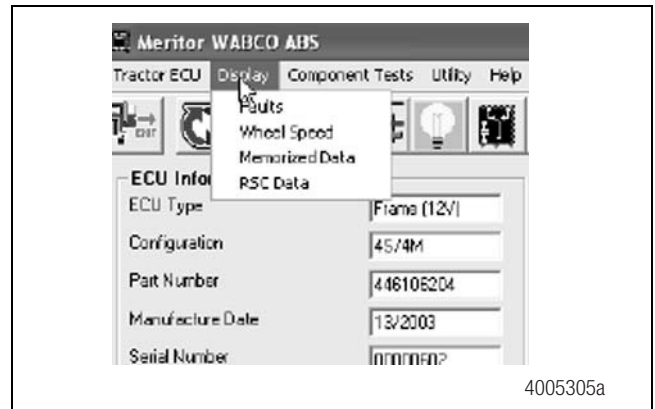
The status of ABS switches and lamps, as well as other data, may also be observed from this screen.

## TOOLBOX™ Software

### Display

Select **Display** from the Tractor **ABS Main Screen**. A pull down menu will appear.

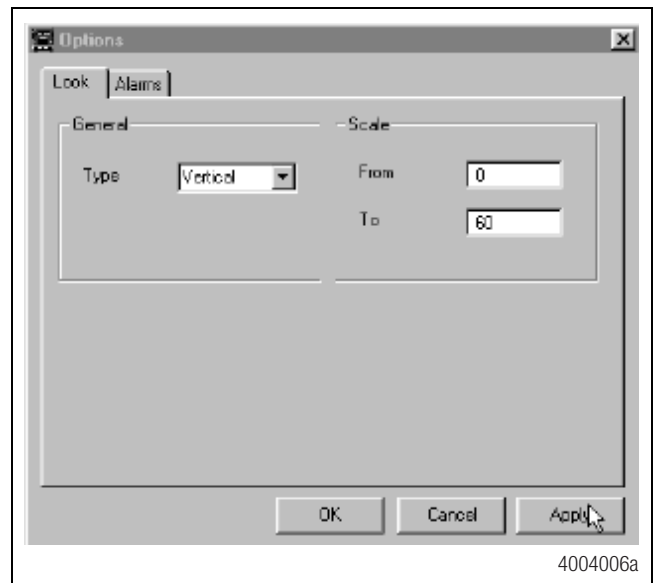
In addition to fault identification and repair information, the display option on the Tractor Main Screen provides Wheel Speed, Memorized Data and RSC Data. Figure 3.8.



**Figure 3.8**

### Wheel Speed

Select the wheel speed icon or use the Display menu from the ABS Main Screen to display wheel speed data in both numeric and graphical form. This data may be shown in RPM or MPH format, Figure 3.9, and in vertical or horizontal graphs, Figure 3.10 and Figure 3.11. Select the appearance and style from the options menu.



**Figure 3.9**

### 3 Diagnostics, Troubleshooting and Testing

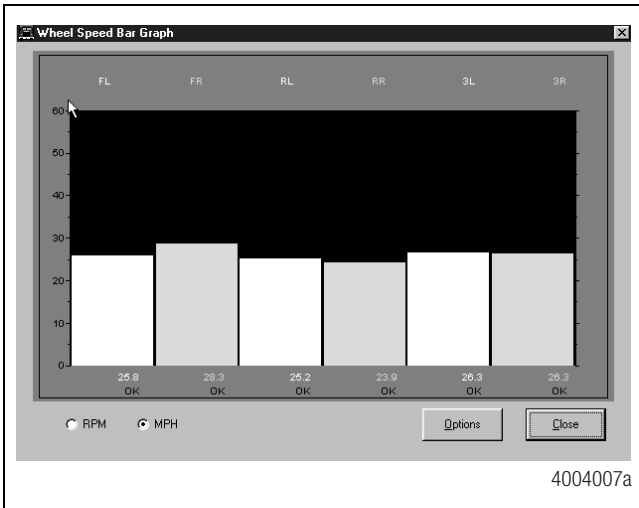


Figure 3.10

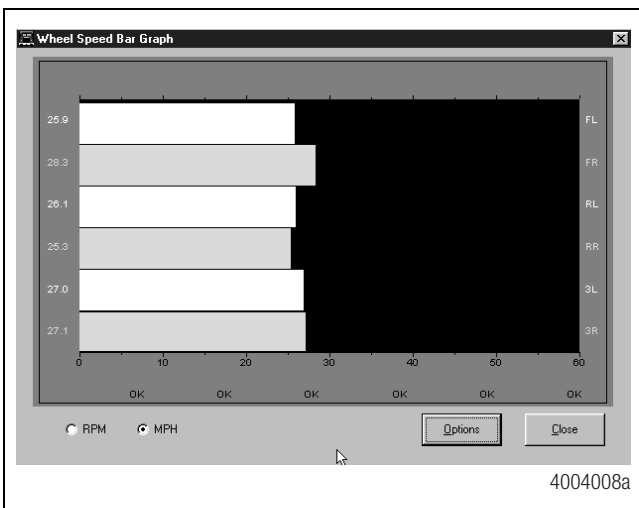


Figure 3.11

#### Memorized Data

Select **Memorized Components** from the Display menu.

**NOTE:** Use Display/Memorized Components to **view** data. Figure 3.12. To **clear** a memorized component, use the Memorized Components function that appears on the Component Tests Menu.

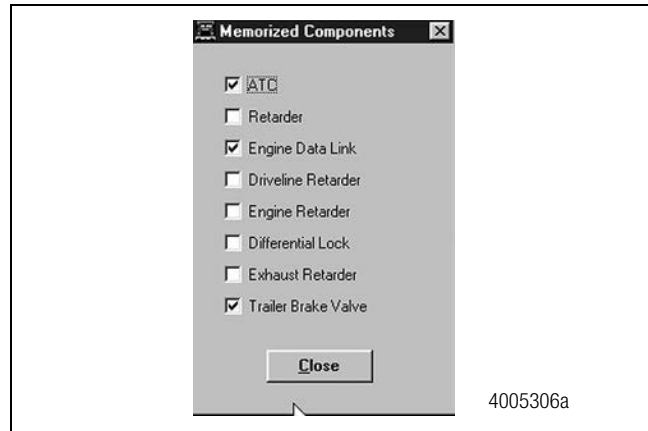


Figure 3.12

**NOTE:** Trailer Brake Valve = RSC Valve

#### RSC Data

Select **RSC Data** from the pull down menu for RSC status information. Figure 3.13.

For RSC Control Status:

NA — RSC is not an option

OFF — RSC is installed but is not currently active

For Accelerometer sensor:

Acceptable range is 2.21-2.78 volts.

A **red** background in this field indicates voltage is outside of the acceptable range.

A **green** background in this field indicates voltage is within the acceptable range.

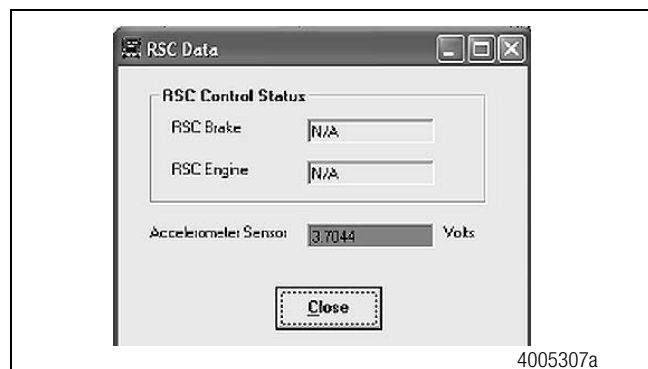


Figure 3.13

**NOTE:** Trailer Brake Valve = RSC Valve

#### Component Tests

Select **Component Tests** from the Tractor **ABS Main Screen**. A pull down menu will appear. Figure 3.14.

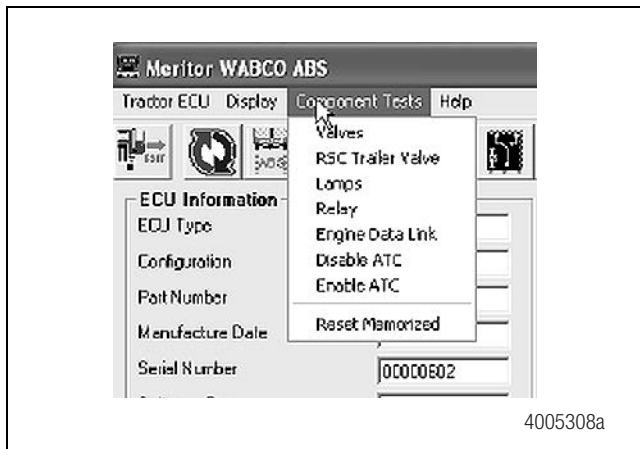


Figure 3.14

**NOTE:** Components for test may also be selected from the icons on the Tractor ABS Main Screen.

Select **Valves** from the pull down menu to select and cycle individual ABS modulator valves. Then, listen to ensure the correct valve is cycling. This is also helpful in verifying correct operation, installation and wiring. Figure 3.15.

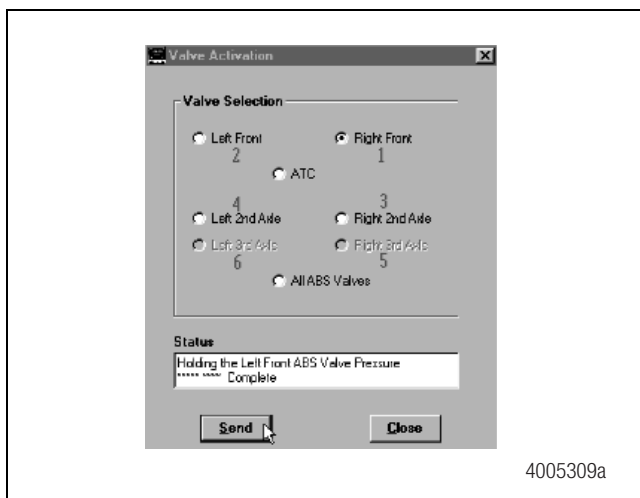


Figure 3.15

Select **all valves** from the menu to cycle all available ABS valves in the order shown below.

Verification of the ATC valve is also available from this menu.

#### RSC Trailer Valve

Select **RSC Trailer Valve** from the pull down menu to cycle the RSC trailer valve.

**Do not activate the service brake while testing the RSC trailer valve.** Figure 3.16.

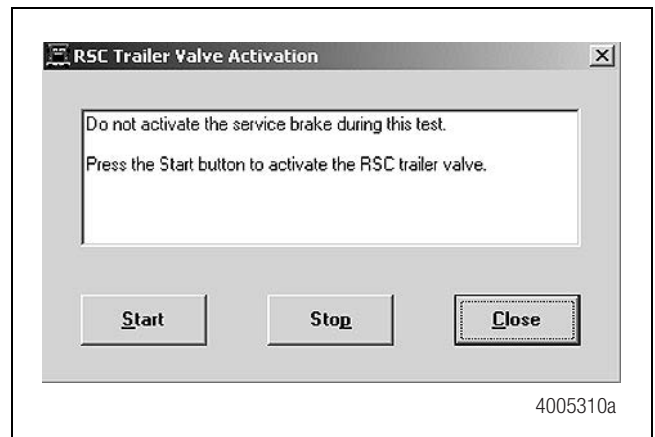


Figure 3.16

Press **Start** to begin the test. Figure 3.17.

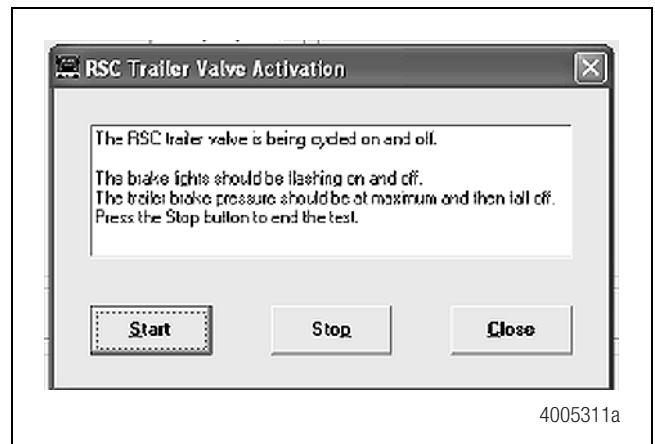


Figure 3.17

### 3 Diagnostics, Troubleshooting and Testing

#### Lamps

Select **Lamps** from the pull down menu to turn the tractor ABS, trailer ABS or ATC (wheel spin) indicator lamps on or off. Figure 3.18.

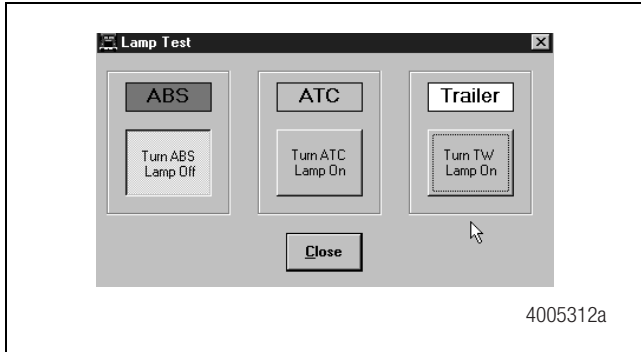


Figure 3.18

This is helpful in verifying correct operation, installation and wiring of the lamps to the ECU.

#### Relay

Select **Relay** from the pull down menu to turn the Retarder Relay on or off. Figure 3.19.

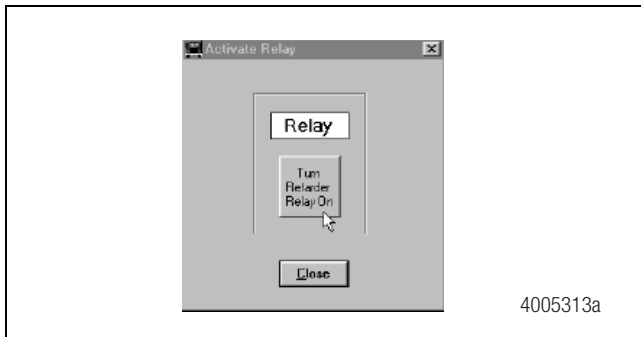


Figure 3.19

This is helpful in verifying correct operation, installation and wiring of the unit under test.

Select **Engine Data Link** from the pull down menu to send a “limit engine torque” command to the engine or a “disable retarder” command to the retarder. Figure 3.20.

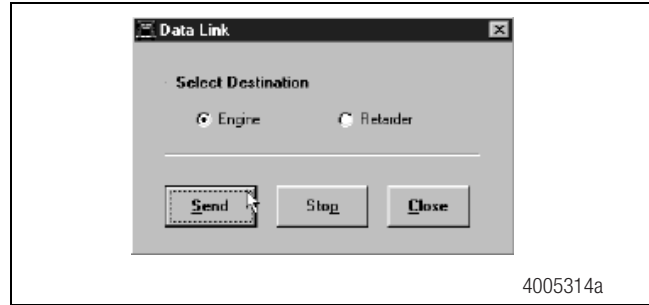


Figure 3.20

Select **Disable ATC** from the pull down menu to send a command to the ECU to disable automatic traction control. ATC will remain disabled until the enable command is sent or the vehicle ignition is cycled. The status bar on the Main Screen reflects the current state of the ATC function, either Enabled, Disabled or N/A (not available).

Using the **Disable ATC** command is useful and essential for dynamometer testing. Figure 3.21.

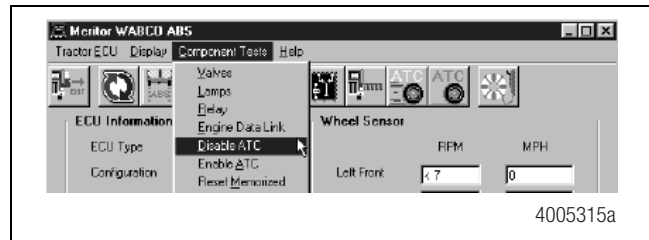


Figure 3.21

#### Enable ATC

Select **Enable ATC** from the pull down menu to send a command to the ECU to enable automatic traction control. This is the normal state of the ECU. The status bar on the Main Screen reflects the current state of the ATC function, either Enabled, Disabled or N/A (not available). Figure 3.22.

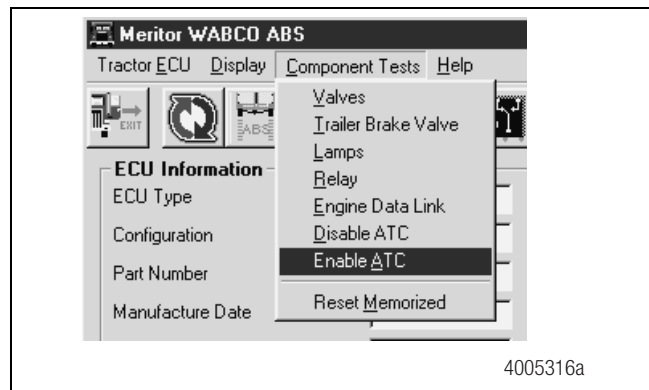


Figure 3.22

### 3 Diagnostics, Troubleshooting and Testing

#### Reset Memorized

Select **Reset Memorized** from the pull down menu to tell the ECU to reset the memorized or “learned” components.

The ECU has the ability to learn the following components: ATC valve, engine datalink and retarder relay. Once any of these have been detected, the ECU expects to see them each time the ECU is powered on. If they are not seen, the ECU records a fault.

Because there are times when an ECU is moved to another vehicle — or during diagnostic testing — you may want the ECU to disregard these learned components. Use the **Reset Memorized** command for this purpose.

#### Pro-Link® Plus Display

With some ECUs, the Pro-Link® Plus will display system information — components or options supported by the ECU. Access these screens through System Setup (main ABS menu).

The following screens illustrate:

- A 4S/4M ABS/ATC system
- Where the ECU has not recognized a retarder relay
- Where the ECU has recognized a J1939 datalink
- The ECU is capable of supporting ABS and ATC switches.

**NOTE:** **Yes** indicates the ECU is capable of supporting these options. These may or may not be installed on the vehicle.

<b>TRACTOR ABS/ATC</b>	
<b>SYSTEM INFORMATION</b>	
<b>SENSORS</b>	<b>4</b>
<b>MODULATORS</b>	<b>4</b>

ATC VALVE	YES
RETARDER RELAY	NO
J1939	YES
ABS SWITCH	YES
ATC SWITCH	YES

#### Component Test Screens

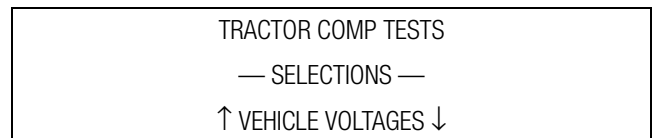
These screens help you test ABS components. Select this function from the Tractor ABS/ATC menu.

- ABS VALVES
- ATC
- ABS INDICATOR LAMP
- ATC INDICATOR LAMP
- ABS/ATC SWITCHES
- SENSORS
- ENGINE DATALINK
- RETARDER RELAY
- RETARDER DATALINK
- VEHICLE VOLTAGES

Select the appropriate function. Each screen has instructions to guide you through the test. Refer to the Pro-Link® Plus Manual for complete instructions.

#### Component Tests and Functions (Pro-Link® Plus)

These screens help you test ABS components. Select this function from the Tractor ABS/ATC menu.



Select the appropriate function. Each screen has instructions to guide you through the test. Refer to the Pro-Link® Plus Manual for complete instructions.

### 3 Diagnostics, Troubleshooting and Testing

The following definitions explain the function of each test.

**Table E: Definitions**

<b>Component Test</b>	<b>Function</b>
Vehicle Voltages	Monitors the voltage signals powering the ECU.
ABS Valves	Cycles the valves, one at a time. With brake pedal applied, you should hear four short air exhausts, then one long air pressure hold. A menu selection lets you choose from four or six valves. This test is used to verify valve locations and correct wiring.  <b>NOTE:</b> The treadle must be applied to pressurize the brake chambers.
ATC	Checks the ATC valve. You will hear a click as the valve cycles.  <b>NOTE:</b> TOOLBOX™ Software or the Pro-Link® Plus may be used to shut off ATC for dynamometer testing.
ABS Tractor Lamp	Monitors the commanded (on/off) states of the ABS tractor lamp. Follow the screen prompts (1 On, 2 Off) to change the status of the lamp on the instrument panel.
ABS Trailer Lamp	Monitors the commanded (on/off) states of the ABS trailer lamp. Follow the screen prompts (1 On, 2 Off) to change the status of the lamp on the instrument panel.
ATC Tractor Lamp	Monitors the commanded (on/off) states of the ATC tractor lamp. Follow the screen prompts (1 On, 2 Off) to change the status of the lamp on the instrument panel.
ABS/ATC Switches	Checks the status of ABS and ATC/Deep Snow and Mud switches on the instrument panel.
Sensors	Monitors the input to the ECU from the wheel. Vehicle must be stationary and wheels must be rotated during this test.
Engine Datalink	Checks wiring connections and response between the engine and the ECU.
Retarder Relay	Activates the relay to verify function (a click will be heard). This test also checks wiring connections.
Retarder Datalink	Checks wiring connections and retarder response between the retarder and the ECU.

## Tire Size Range

### ABS

For correct ABS/ATC operation with the standard ECU, front and rear tire sizes must be within  $\pm 14\%$  of each other. When this tire size range is exceeded without electronically modifying the ECU, the system performance can be affected and the indicator lamp can illuminate.

Calculate the tire size with the following equation:

$$\% \text{ Difference} = \left\{ \frac{\text{RPM Steer}}{\text{RPM Drive}} - 1 \right\} \times 100$$

RPM — tire revolutions per mile

### RSC

RSC requires that the steer axle tire size range be no more than 4% of a pre-set value.

Call Meritor WABCO at 800-535-5560 if you plan a tire size range greater than those specified.

## Testing Components

### ⚠ CAUTION

When troubleshooting and testing the ABS system, do not damage the connector terminals.

### Voltage Check

Measure voltage at the pins indicated in Table F.

- Voltage must be between 9.5 and 14.0 volts.
- The ignition must be turned ON for this test.

Table F: Voltage Check Pins

ECU	Connector	Pins
Universal	14-Pin	4 and 9
		9 and 4
Basic	14-Pin	7 and 4
		8 and 9
Frame-mounted	X1-Grey	1 and 12
		2 and 11

**NOTE:** Pin locations are illustrated in Figure 3.23 (Frame) and Figure 3.24 (Basic and Universal).

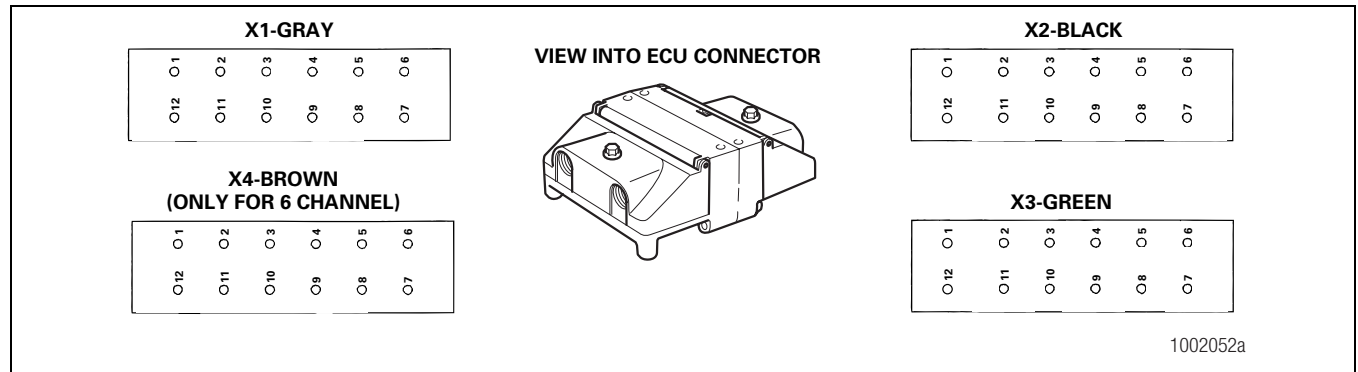


Figure 3.23

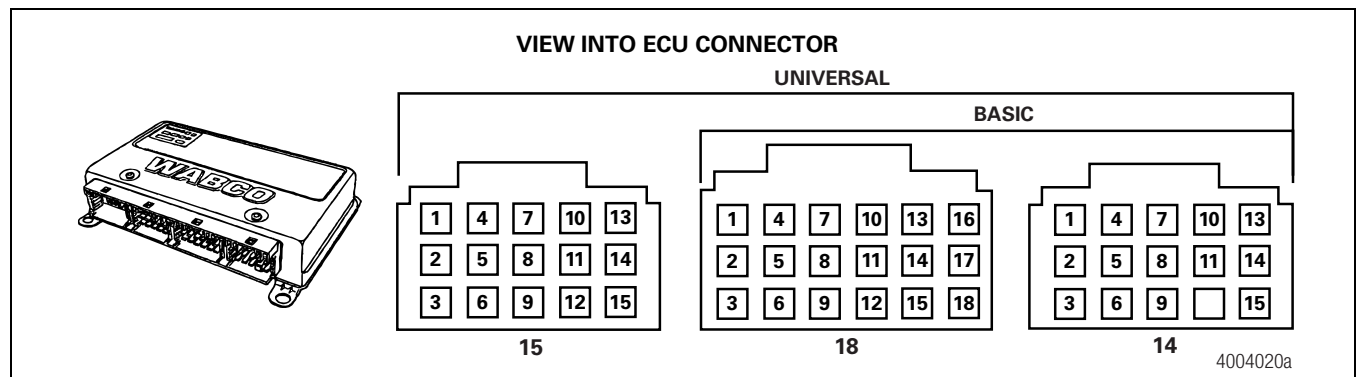


Figure 3.24

### 3 Diagnostics, Troubleshooting and Testing

#### Location of Sensors

On steering axles, the sensor is accessible on the in-board side of the steering knuckle.

On drive axles, the drum assembly may have to be pulled to gain access to the sensor.

#### Sensor Adjustment

- Push the sensor in until it contacts the tooth wheel.
- Do not pry or push sensors with sharp objects.
- Sensors will self-adjust during wheel rotation.

#### Sensor Output Voltage Test

Voltage must be at least 0.2 volts AC at 30 rpm.

1. Turn ignition OFF.
2. Disconnect the appropriate connector from the ECU (refer to Appendix II).
3. Rotate the wheel by hand at 30 rpm (1/2 revolution per second).
4. Measure the voltage at the pins indicated in Table G.
  - **If the minimum output voltage is less than 0.2:** Push the corresponding sensor toward the tooth wheel, then repeat the measurement.

**Table G: Sensor Check Pins**

ECU	Sensor	Connector	Pins
Universal	LF	18-Pin	12 and 15
	RF	18-Pin	10 and 13
	LR	18-Pin	11 and 14
	RR	18-Pin	17 and 18
6S/6M	LR (3rd Axle)	15-Pin	2 and 5
6S/6M	RR (3rd Axle)	15-Pin	11 and 14
Basic	LF	18-Pin	12 and 15
	RF	18-Pin	10 and 13
	LR	18-Pin	11 and 14
	RR	18-Pin	17 and 18
Frame-mounted	LF	X2 — Black	7 and 8
	RF	X2 — Black	5 and 6
	LR	X3 — Green	1 and 2
	RR	X3 — Green	3 and 4
	LR (3rd Axle)	X4 — Brown	3 and 4
	RR (3rd Axle)	X4 — Brown	5 and 6

#### Sensor Resistance

The sensor circuit resistance must be between 900 and 2000 ohms. Resistance can be measured at the sensor connector, or at the pins on the ECU connector. To measure resistance:

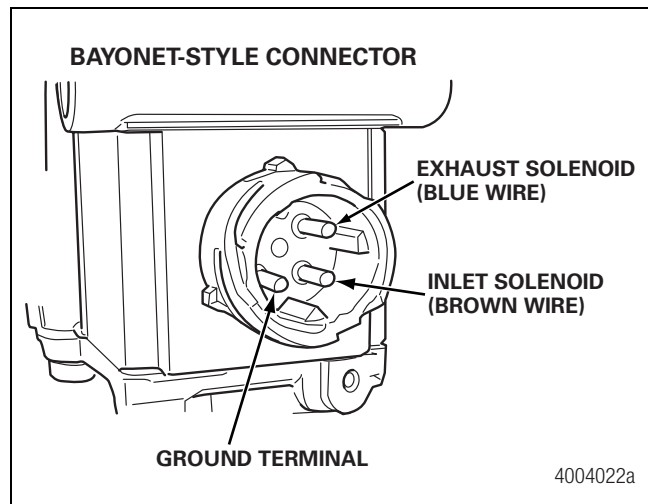
1. Turn ignition OFF.
2. To measure resistance at the sensor connector, disconnect the ECU connector from the ECU. To measure resistance at the sensor connector, disconnect the sensor from the sensor extension cable.
3. Measure output at the pins indicated in Table G.

#### Valve Tests

##### ABS Modulator Valve

Measure resistance across each valve solenoid coil terminal and ground on the ABS valve to ensure 4.0 to 9.0 ohms. Figure 3.25 and Figure 3.26.

- If the resistance is greater than 9.0 ohms, clean the electrical contacts in the solenoid. Check the resistance again.
- To check the cable and the ABS valve as one unit, measure resistance across the pins on the ECU connector of the harness. Check the diagram of the system you are testing for pin numbers. (Refer to Appendix II.)



**Figure 3.25**



### 3 Diagnostics, Troubleshooting and Testing

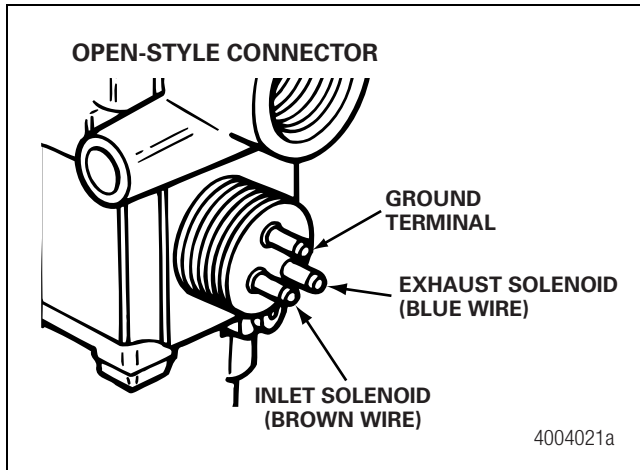


Figure 3.26

#### ATC Valve

Measure resistance across the two electrical terminals on the ATC valve to ensure 7.0 to 14.0 ohms. Figure 3.27.

- If the resistance is greater than 14.0 ohms, clean the electrical contacts on the solenoid. Check the resistance again.
- To check the cable and ATC valve as one unit, measure resistance across the pins on the ECU connector of the harness. Check the diagram of the system you are testing for pin numbers. (Refer to Appendix II.)

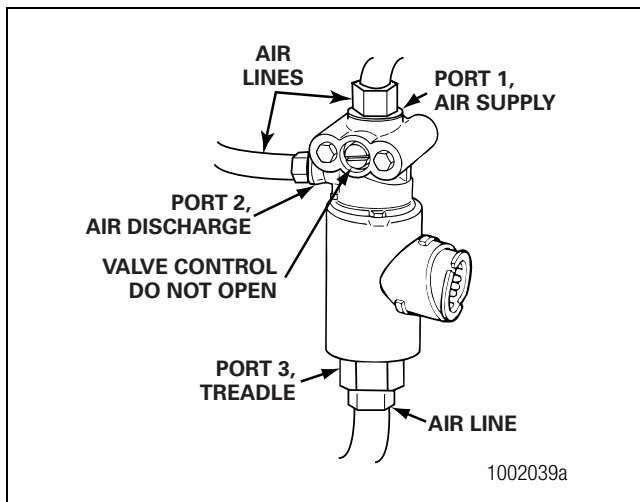


Figure 3.27

Refer to Meritor WABCO ABS Valve Package in Appendix III for ABS Valve Package Troubleshooting information.

#### RSC Valve

Measure resistance across the two electrical terminals on the RSC valve to ensure 7.0 to 14.0 ohms. Figure 3.28.

- If the resistance is greater than 14.0 ohms, clean the electrical contacts on the solenoid. Check the resistance again.
- To check the cable and RSC valve as one unit, measure resistance across the pins on the ECU connector of the harness. Check the diagram of the system you are testing for pin numbers. (Refer to Appendix II.)

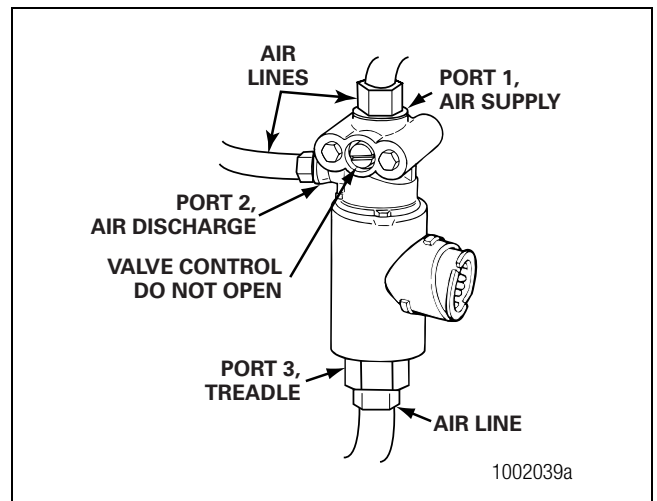


Figure 3.28

## 3 Diagnostics, Troubleshooting and Testing

### Dynamometer Testing Vehicles with ATC

#### WARNING

The automatic traction control (ATC) function must be disabled before any type of dynamometer testing is conducted on the vehicle. If the ATC is not disabled, the vehicle ATC may actuate and cause the vehicle to move forward without warning to the operator. If the vehicle moves forward unexpectedly, the vehicle may cause damage or injuries to individuals who are in the path of the vehicle.

#### CAUTION

Do not cycle the vehicle ignition while the vehicle is on a dynamometer. Cycling the vehicle ignition will enable the ATC.

Vehicles with ATC must have the ATC disabled to test the vehicle on a dynamometer. To disable the ATC, use one of the following methods:

#### 1. **Blink Code Switch**

Press and hold the blink code switch for at least three seconds. Refer to the blink code diagnostics information in this section for a description of how the blink code display will appear.

- Once the system configuration code begins, ATC has been disabled.
- The ATC lamp comes on and stays on while ATC is disabled.
- ATC will remain disabled until the vehicle ignition is cycled.
- After testing, ATC will automatically reactivate the first time the vehicle ignition is cycled.

#### 2. **Remove Power**

Remove the ABS circuit breaker/fuse or remove the ECU power connector to disable the ABS and ATC.

- After testing, re-install the circuit breaker/fuse and the ATC will automatically reactivate the first time the vehicle power is applied to the ECU.

#### 3. **TOOLBOX™ Software**

At the ABS Main Menu, select the **Disable ATC** icon or use the pull down menu to send the command to the ECU to disable the ATC. Refer to the TOOLBOX™ Software Owner's Manual for complete instructions for using TOOLBOX™.

- ATC will remain disabled until the enable command is sent or the vehicle ignition is cycled.
- After testing, ATC will automatically reactivate the first time the vehicle ignition is cycled.

#### 4. **MPSI Pro-Link® Plus**

Refer to the MPSI Pro-Link® Plus Owner's Manual for instructions.

- ATC will remain disabled until the enable command is sent or the vehicle ignition is cycled.
- After testing, ATC will automatically reactivate the first time the vehicle ignition is cycled.

### Hazard Alert Messages

Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.

#### **⚠ WARNING**

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Release all air from the air systems before you remove any components. Pressurized air can cause serious personal injury.

### Component Removal and Installation

#### Valves

- ABS Modulator Valves
- ATC Valve
- RSC Valve
- ABS Valve Package (Front or Rear)
  - Modulator Valves
  - Relay Valve or Quick Disconnect Valve
  - ATC Valve

#### Sensor Lubricant Specification

Meritor WABCO specifications call for a sensor lubricant with the following characteristics:

Lubricant must be mineral oil-based and contain molydisulfide. It should have excellent anti-corrosion and adhesion characteristics, and be capable of continuous function in a temperature range of  $-40^{\circ}$  to  $300^{\circ}\text{F}$  ( $-40^{\circ}$  to  $150^{\circ}\text{C}$ ).

Lubricants approved for use on Meritor WABCO sensors and spring clips are as follows. Figure 4.1.

- Mobilith SHC-220 (Mobil)
- TEK 662 (Roy Dean Products)
- Staburags NBU 30 PTM (Kluber Lubrication)
- Valvoline EP 633

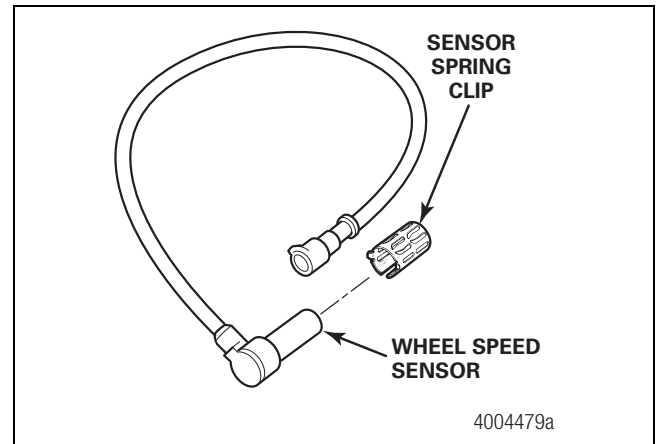


Figure 4.1

#### **⚠ CAUTION**

Use the following procedures to avoid damage to the electrical system and ABS/ATC components.

When welding on an ABS- or ABS/ATC-equipped vehicle is necessary, disconnect the power connector from the ECU.

#### Sensors

**NOTE:** When replacing the wheel speed sensor, the sensor spring clip must also be replaced.

#### Wheel Speed Sensor Removal — Front Axle

To remove the sensor from the front axle:

#### **⚠ WARNING**

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

1. Place blocks under the rear tires to stop the vehicle from moving. Apply the parking brake.
2. If necessary, raise the front tires off the ground. Place safety stands under the axle.
3. Disconnect the fasteners that hold the sensor cable to other components.
4. Disconnect the sensor cable from the chassis harness.

## 4 Component Replacement

5. Remove the sensor from the sensor holder. Use a twisting motion if necessary. **Do not pull on the cable.** Figure 4.2.

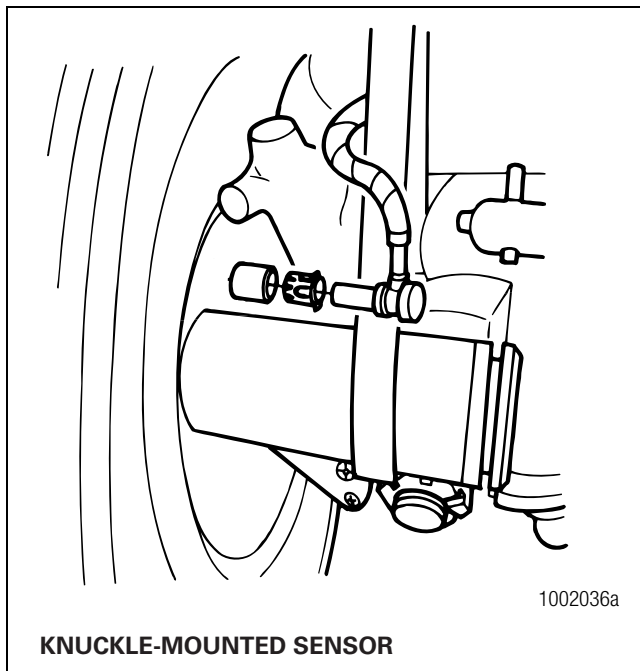


Figure 4.2

6. Remove the sensor spring clip.

### Wheel Speed Sensor Installation — Front Axle

To replace the sensor in the front axle:

1. Connect the sensor cable to the chassis harness.
2. Install the fasteners used to hold the sensor cable in place.
3. Apply a Meritor WABCO recommended lubricant to the sensor spring clip and sensor.
4. Install the sensor spring clip. Make sure the spring clip tabs are on the inboard side of the vehicle.
5. Push the sensor spring clip into the bushing in the steering knuckle until the clip stops.
6. Push the sensor completely into the sensor spring clip until it contacts the tooth wheel.

**NOTE:** After installation, there should be no gap between the sensor and the tooth wheel. During normal operation, a gap of up to 0.04-inch (1.016 mm) is allowable.

7. Remove the blocks and safety stands.

### Wheel Speed Sensor Removal — Rear Axle

**NOTE:** When replacing the wheel speed sensor, the sensor spring clip must also be replaced.

To remove the sensor from the rear axle:

#### **⚠ WARNING**

**Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.**

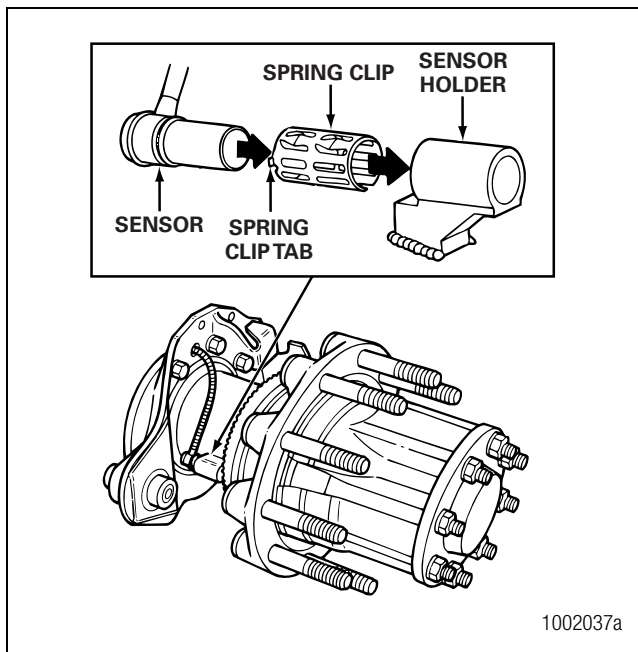
1. Place blocks under the front tires to stop the vehicle from moving.
2. Raise the rear tire off the ground. Place safety stands under the axle.
3. Release the parking brake and back off the slack adjuster to release the brake shoes.
4. Remove the wheel and tire assembly from the axle.
5. Remove the brake drum.
6. Remove the sensor from the mounting block in the axle housing. Use a twisting motion if necessary. **Do not pull on the cable.**
7. Remove the sensor spring clip from the mounting block.
8. Disconnect the fasteners that hold the sensor cable and the hose clamp to other components.
9. Disconnect the sensor cable from the chassis harness.

### Wheel Speed Sensor Installation — Rear Axle

1. Apply a Meritor WABCO recommended lubricant to the sensor spring clip and sensor.
2. Install the sensor spring clip. Verify that the spring clip tabs are on the inboard side of the vehicle.
3. Push the sensor spring clip into the mounting block until it stops.

**NOTE:** After installation, there should be no gap between the sensor and the tooth wheel. During normal operation, a gap of up to 0.04-inch (1.016 mm) is allowable.

4. Push the sensor completely into the sensor spring clip until it contacts the tooth wheel. Figure 4.3.



**Figure 4.3**

5. Insert the sensor cable through the hole in the spider and axle housing flange. Route the cable to the frame rail. Be sure to route the cable in a way that will prevent pinching or chafing and will allow sufficient movement for suspension travel.
6. Connect the sensor cable to the chassis harness.
7. Install the fasteners that hold the sensor cable in place.
8. Install the brake drum on the wheel hub.
9. Complete the installation per the vehicle manufacturer's manual.

### ABS Modulator Valve

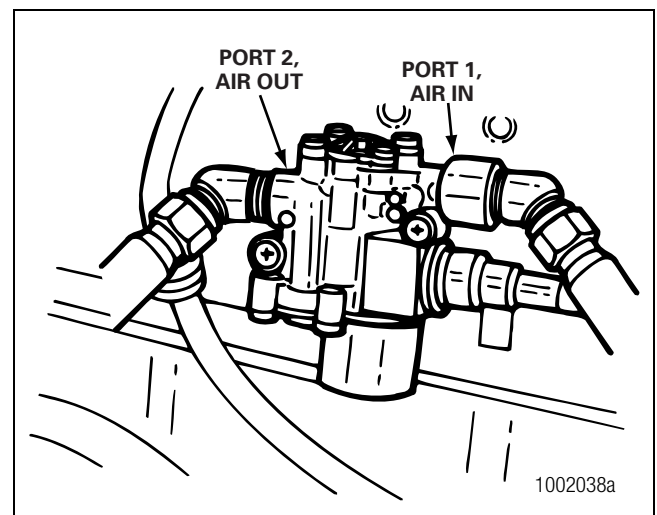
#### Removal

1. Turn the ignition switch to the OFF position. Apply the parking brake.

#### **⚠ WARNING**

**Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.**

2. Place blocks under the front and rear tires to stop the vehicle from moving.
3. If necessary, raise the vehicle off the ground and place safety stands under the axle.
4. Disconnect the wiring connector from the ABS valve.
5. Disconnect the air lines from Ports 1 (air supply) and 2 (air discharge) of the ABS valve. Figure 4.4.



**Figure 4.4**

6. Remove the two mounting capscrews and nuts.
7. Remove the ABS valve.

## 4 Component Replacement

### Installation

#### **⚠ CAUTION**

Moisture can affect the performance of all ABS/ATC systems, as well as the standard braking system. Moisture in air lines can cause air lines to freeze in cold weather.

1. Install the ABS valve with two mounting capscrews and nuts. Tighten the capscrews per the manufacturer's recommendation.
2. Connect the line to the brake chambers to Port 2 of the ABS valve. Connect the air supply line to Port 1 of the ABS valve.
3. Connect the wiring connector to the ABS valve. Hand tighten only.
4. Remove the blocks and stands.
5. Test the installation.

### Checking the Installation

1. Apply the brakes. Listen for leaks at the modulator valve.
2. Turn the ignition on and listen to the modulator valve cycle. If the valve fails to cycle, check the electrical cable connection. Make repairs as needed.
3. Drive the vehicle. Verify that the ABS indicator lamp operates correctly.

### ATC Valve

#### Removal

1. Turn the ignition switch to the OFF position. Apply the parking brake.

#### **⚠ WARNING**

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

2. Place blocks under the front and rear tires to stop the vehicle from moving.

3. If necessary, raise the vehicle off the ground. Place safety stands under the axle.
4. **Relieve line pressure by bleeding the air from the appropriate supply tank.**
5. Disconnect the wiring from the ATC valve.
6. Disconnect the air lines from Port 1 (air supply), Port 2 (air discharge) and Port 3 (treadle) of the ATC valve. Figure 4.5.

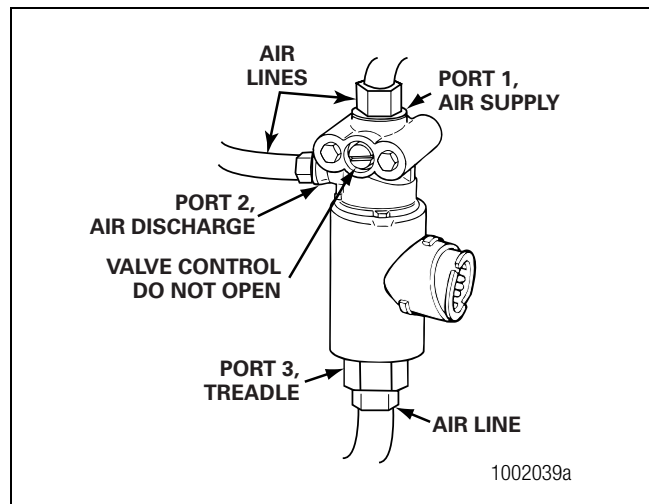


Figure 4.5

7. Remove the two mounting capscrews and nuts. Remove the ATC valve.

### Installation

1. Install the ATC valve with two mounting capscrews and nuts. Tighten the capscrews per the manufacturer's recommendation.
2. Connect the air supply, discharge and treadle lines to Ports 1, 2 and 3 of the ATC valve.
3. Connect the harness connector to the ATC valve. Hand tighten only.
4. Remove the blocks and stands.
5. Test the installation.

### Checking the Installation

To test the ATC valve:

1. Start the vehicle.
2. Fully charge the reservoirs with air. Shut off the vehicle.
3. Apply the brakes.
4. Listen for air leaks at the ATC valve.
5. Release the brakes.
6. Activate the ATC valve using the MPSI tool.
7. Disconnect the MPSI tool.
8. Drive the vehicle. Verify that the ATC indicator lamp operates correctly.

### RSC Valve

#### Removal

1. Turn the ignition switch to the OFF position. Apply the parking brake.
2. Place blocks under the front and rear tires to stop the vehicle from moving.
3. If necessary, raise the vehicle off the ground. Place safety stands under the axle.
4. **Relieve line pressure by bleeding the air from the appropriate supply tank.**
5. Disconnect the wiring from the RSC valve.
6. Disconnect the air lines from Port 1 (air supply), Port 2 (air discharge) and Port 3 (treadle) of the RSC valve. Figure 4.6.

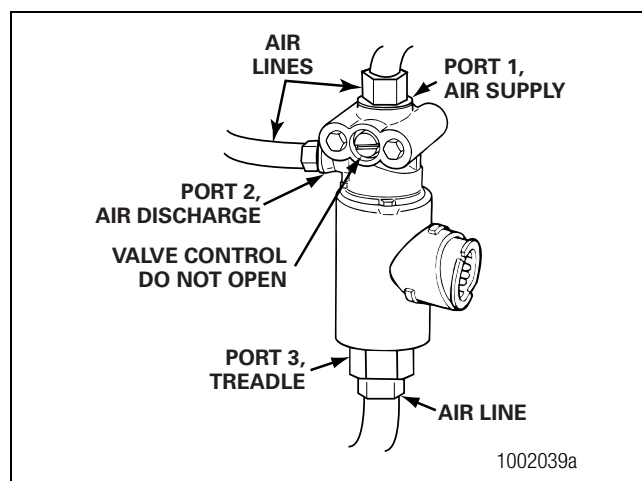


Figure 4.6

7. Remove the two mounting capscrews and nuts. Remove the RSC valve.

#### Installation

1. Install the RSC valve with two mounting capscrews and nuts. Tighten the capscrews per the manufacturer's recommendation.
2. Connect the air supply, discharge and treadle lines to Ports 1, 2 and 3 of the RSC valve.
3. Connect the harness connector to the RSC valve. Hand tighten only.
4. Remove the blocks and stands.
5. Test the installation.

#### Checking the Installation

To test the RSC valve:

1. Connect the blue glad hand to a 50 cu. in. (819 cu. cm) air tank.
2. Start the vehicle.
3. Fully charge the reservoirs with air. Shut off the vehicle.
4. Activate the RSC valve using TOOLBOX™ Software.
5. Listen for air leaks at the RSC valve.
6. Make necessary repairs.
7. Turn the ignition on. Verify that the ATC/RSC indicator lamp operates correctly.

## 4 Component Replacement

### Front or Rear ABS Valve Package

#### Removal and Installation — Complete Package

1. Place blocks under tires to stop the vehicle from moving.
2. If necessary, raise the tires off the ground.
3. Drain the air from all system air tanks.
4. Remove all the air lines and connections from the ABS valve package. Figure 4.7 and Figure 4.8.

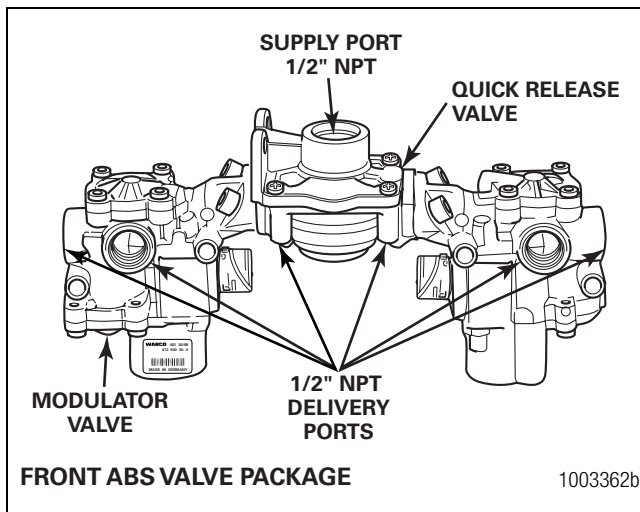


Figure 4.7

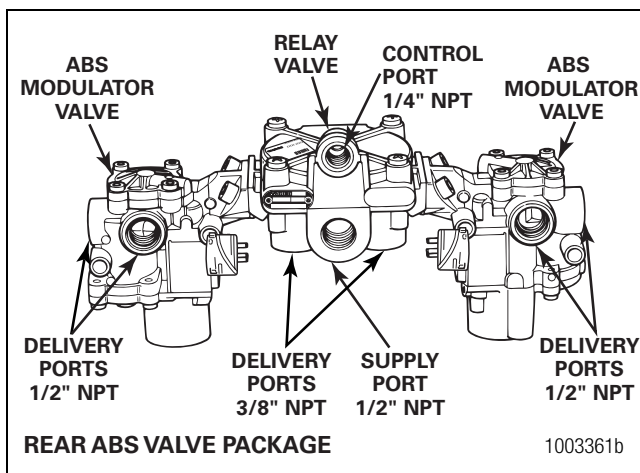


Figure 4.8

5. Remove the mounting bolts from the valve package. Remove the valve package from the vehicle.

6. **Replace the ABS valve package:** Tighten the bolts to the vehicle manufacturer's recommendation. Remove the blocks and safety stands as necessary.
7. Test the installation.

#### Removal and Installation — Component Valves

1. Remove the ABS valve package from the vehicle. Figure 4.9.

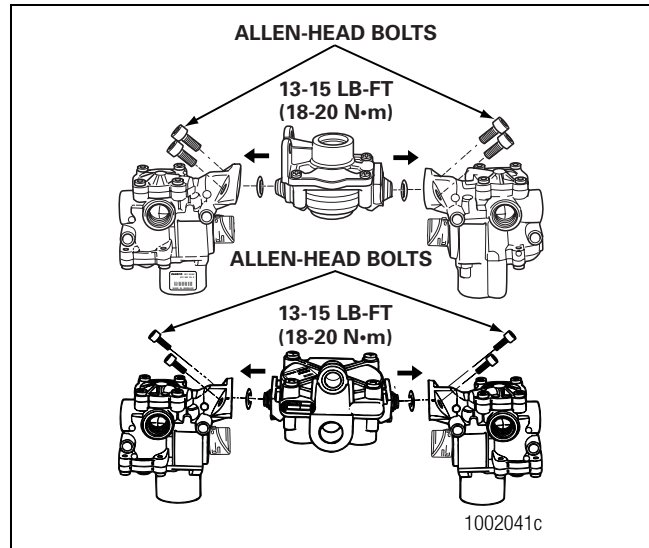



Figure 4.9

2. Use a 6 mm Allen wrench to loosen and remove the Allen-head bolts.
3. Carefully separate the ABS modulator valve(s) from the relay or quick release valve.
4. Remove and discard old O-rings. Lubricate replacement O-rings with the grease provided.
5. Plug any unused ports on the replacement valve(s).
6. Attach the ABS modulator valve(s) to the relay or quick release valve. Use a 6 mm Allen wrench to tighten the Allen-head bolts to 13-15 lb-ft (18-20 N·m). 
7. **Replace the ABS valve package:** Tighten the bolts to the vehicle manufacturer's recommendation. Remove the blocks and safety stands as necessary.
8. Check the valves for leaks:
  - Modulator valve(s). Refer to the procedure for checking the modulator valve installation in this section.
  - Relay or quick release valve. Refer to the procedure for checking the quick release or relay valve installation in this section.



### ATC Valve on the Rear ABS Valve Package

#### Removal

**NOTE:** If there is enough room to work, it is not necessary to remove the valve package from the vehicle before replacing the ATC valve. If the valve package must be removed, follow the instructions for removing and replacing the ABS Valve Package that appear in this section of the manual.

When installing the new ATC valve on the valve package, you must use the new O-rings, seals, mounting bolts and lubricant included with the replacement kit.

1. Turn the ignition switch to the OFF position. Apply the parking brake.
2. Place blocks under the front and rear tires to stop the vehicle from moving.
3. If necessary, raise the vehicle off the ground. Place safety stands under the axle.
4. **Relieve line pressure by bleeding the air from the appropriate supply tank.**
5. Disconnect the wiring from the ATC valve.
6. Disconnect the supply air line from the adapter and the treadle air line from the ATC valve.
7. Use a 5 mm Allen wrench to remove the two screws that hold the adapter piece to the relay valve portion of the valve package.

Use a 6 mm Allen wrench to remove the two mounting bolts that hold the ATC valve to the adapter piece. Remove the ATC valve from the adapter piece. Remove the ATC valve.

Remove the adapter piece, seal and O-rings from the valve package. Figure 4.10.

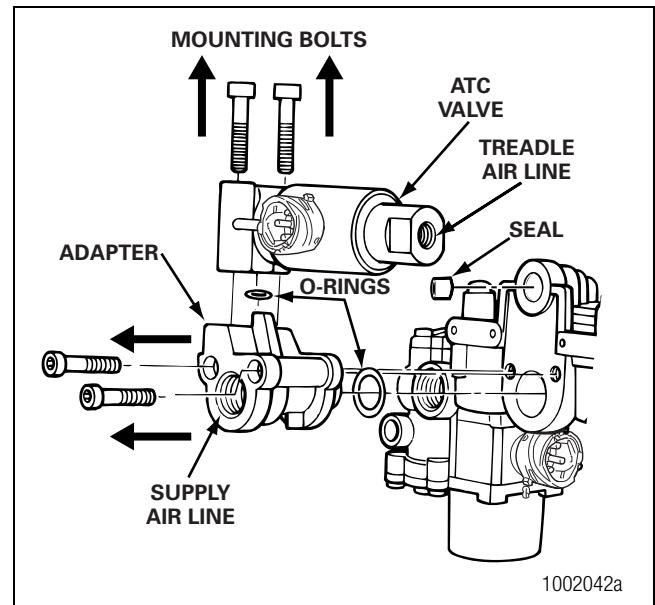


Figure 4.10

#### Installation

1. Clean and lubricate the small adapter piece O-ring. Install the O-ring on the adapter piece.

Use the two new M8 Allen-head bolts to attach the ATC valve to the adapter piece. Use a 6 mm Allen-head tool to tighten to 13-15 lb-ft (18-20 N•m). Figure 4.11. **ⓘ**

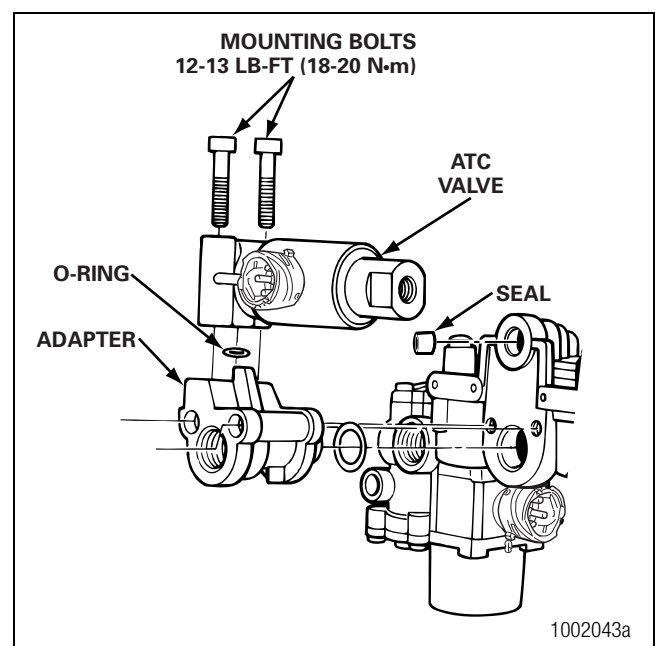


Figure 4.11

## 4 Component Replacement

2. Lubricate the replacement seal and install it in Port 2 of the ATC valve.

Lubricate the large replacement O-ring and install it in the groove of the relay valve supply port. Figure 4.12.

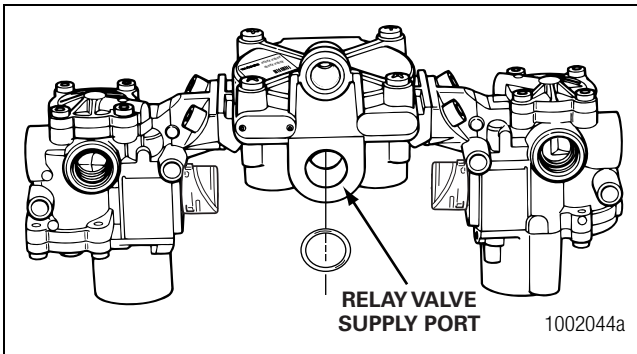


Figure 4.12

**NOTE:** Use Meritor WABCO-recommended lubricant.

3. Use the two M6 Allen-head bolts to attach the adapter to the relay valve. Use a 5 mm Allen-head tool to tighten to 4-5 lb-ft (6-8 N•m). Figure 4.13. 

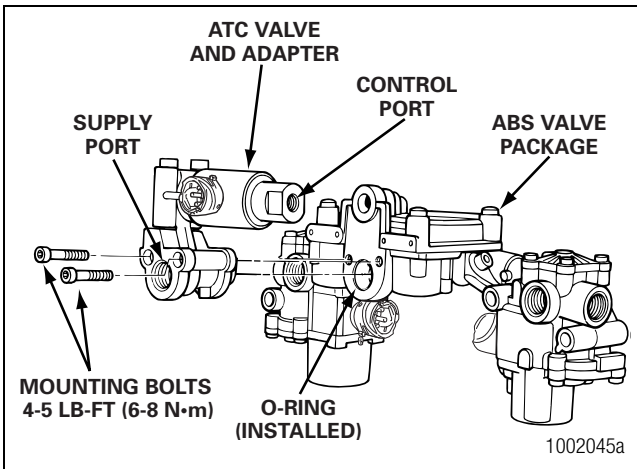


Figure 4.13

4. Connect the supply air line to the supply port on the adapter. Connect the treadle air line to the control port on the ATC valve.
5. Attach the wiring connector to the ATC valve. Hand tighten only.
6. Remove the blocks and stands.
7. Test the installation.

### Checking the Installation

1. Start the vehicle.
2. Fully charge the reservoirs with air. Shut off the vehicle.
3. Apply the brakes.
4. Listen for air leaks at all valves.
5. Drive the vehicle. Verify that the ABS indicator lamp operates correctly.

## ABS Configurations

Refer to Figure 5.1, Figure 5.2, Figure 5.3, Figure 5.4, Figure 5.5, Figure 5.6 and Figure 5.7 for system configuration layouts.

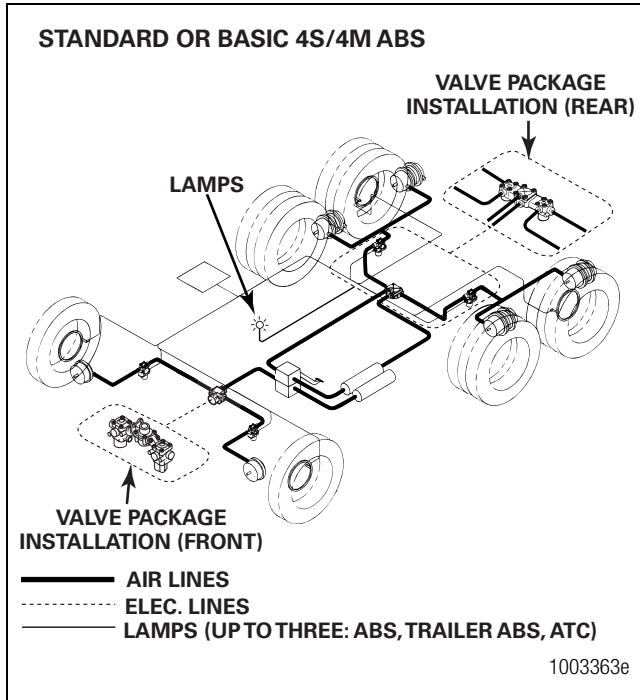


Figure 5.1

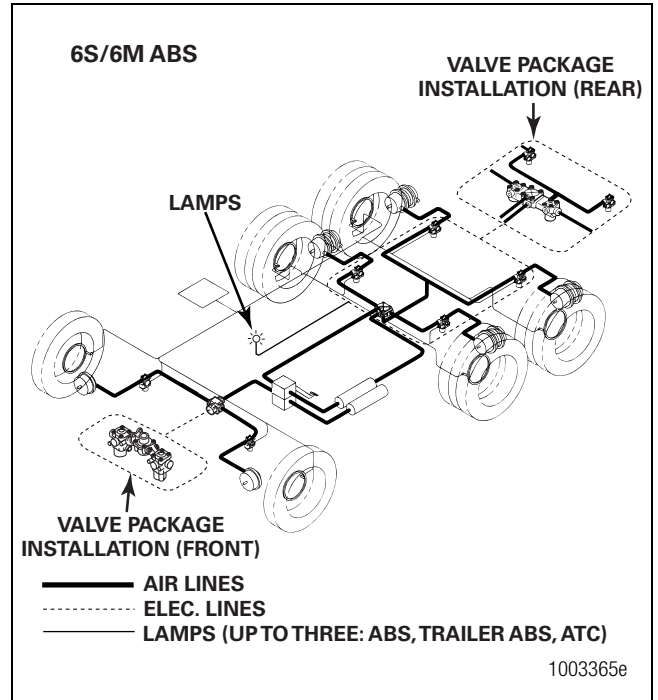


Figure 5.3

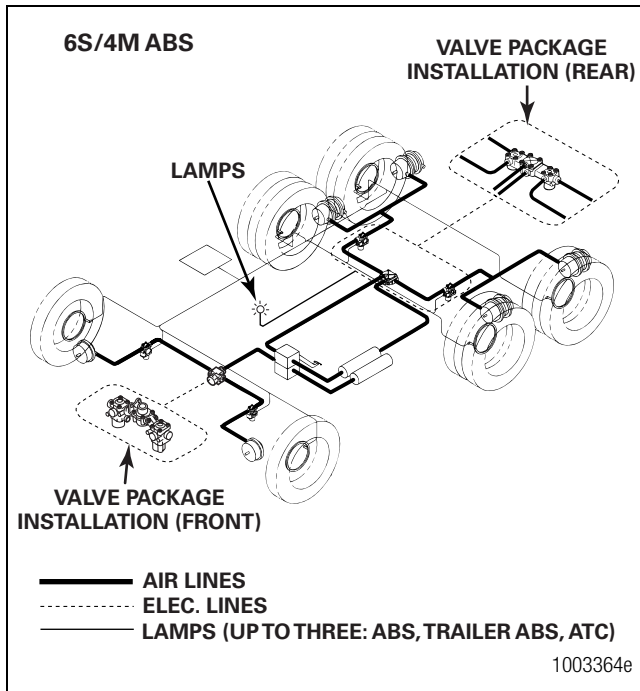


Figure 5.2

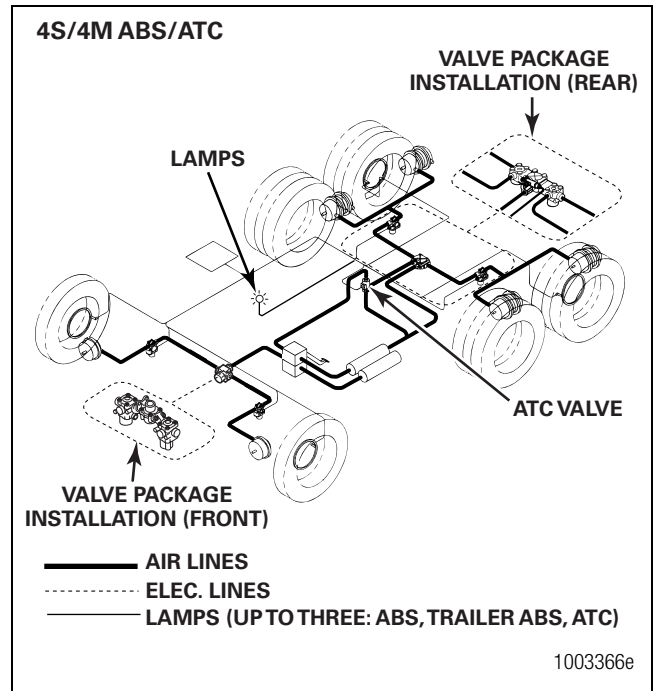


Figure 5.4

## 5 Appendix I — System Configuration Layouts

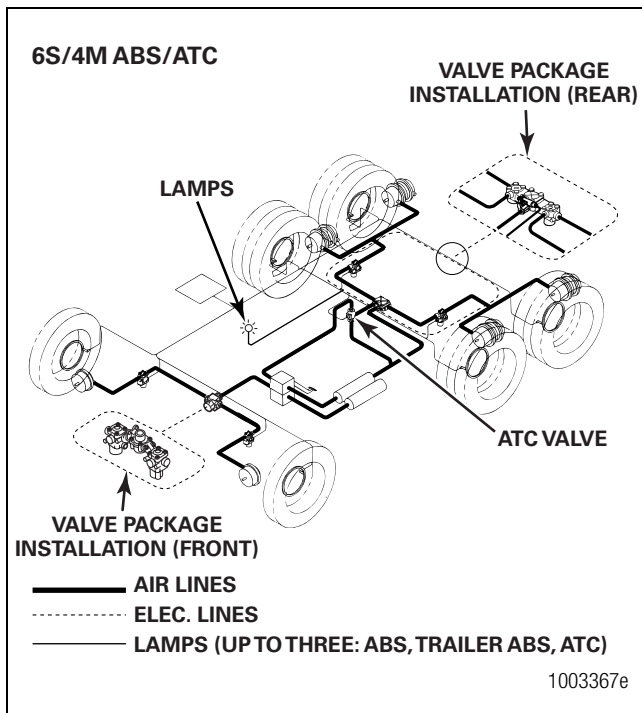


Figure 5.5

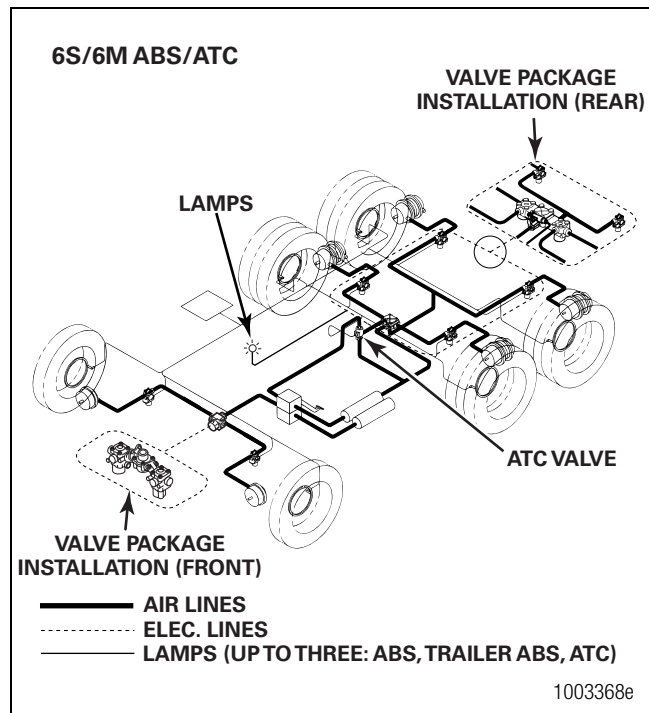


Figure 5.7

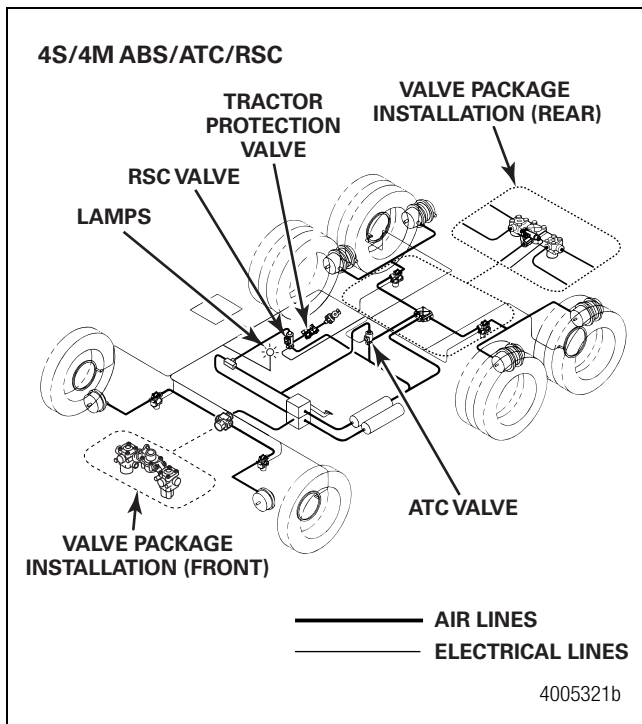


Figure 5.6

## ECU Connector Pin Assignments

Refer to Figure 6.1, Figure 6.2, Figure 6.3, Figure 6.4, Figure 6.5, Figure 6.6 and Figure 6.7 for ECU wiring diagrams.

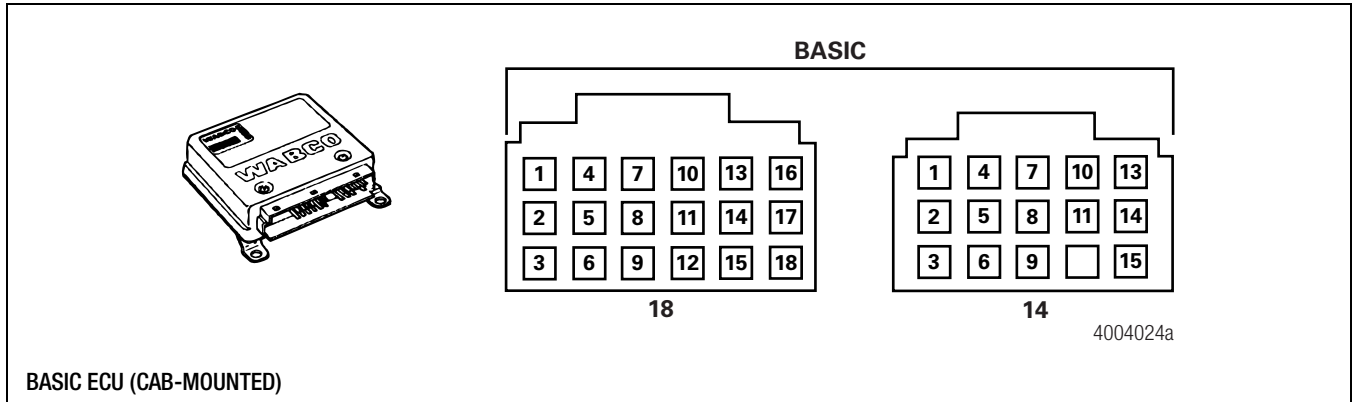


Figure 6.1

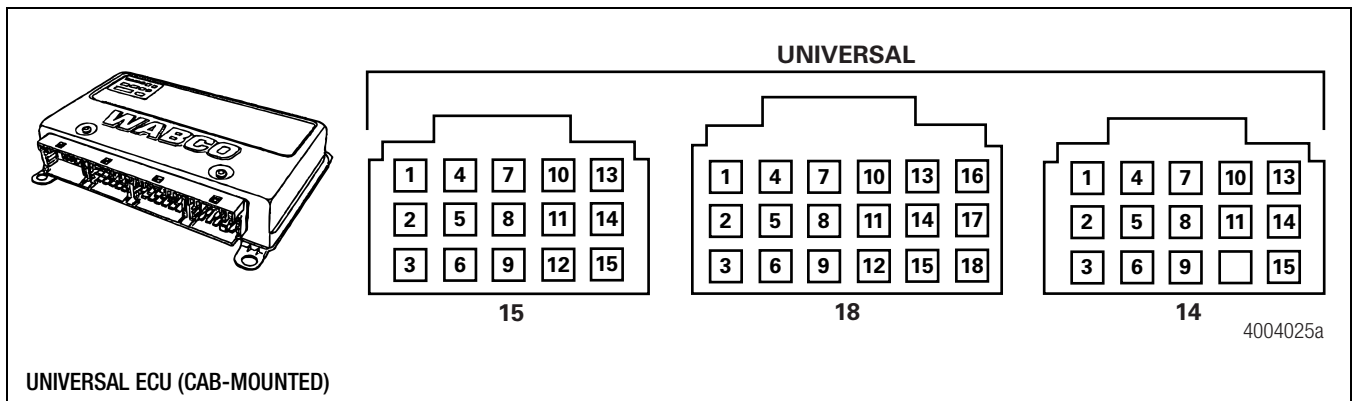


Figure 6.2

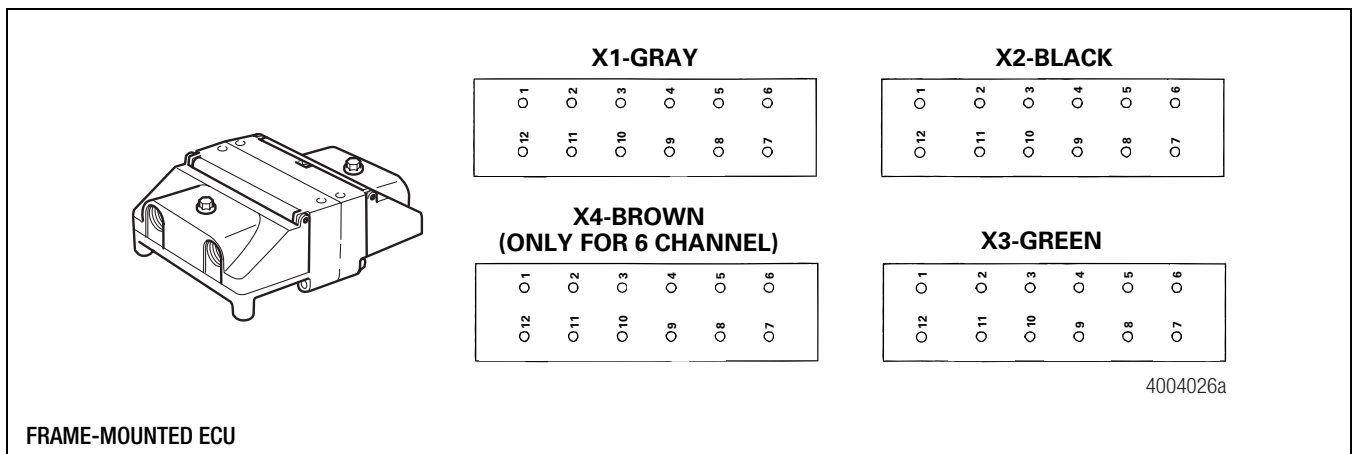


Figure 6.3

# 6 Appendix II — Wiring Diagrams

## Basic ECU (Cab-mounted)

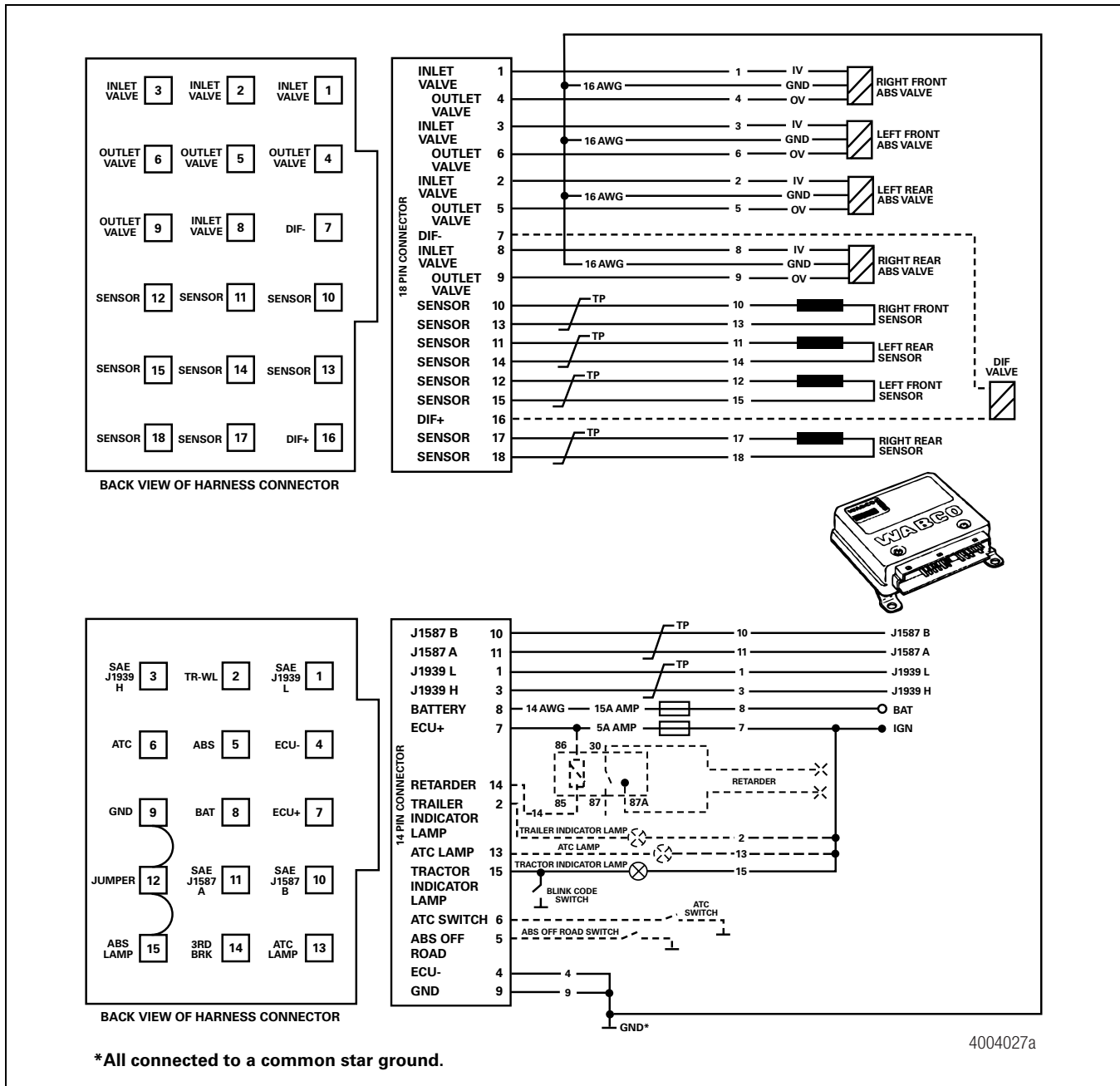


Figure 6.4

6S/6M Universal ECU (Cab-mounted)

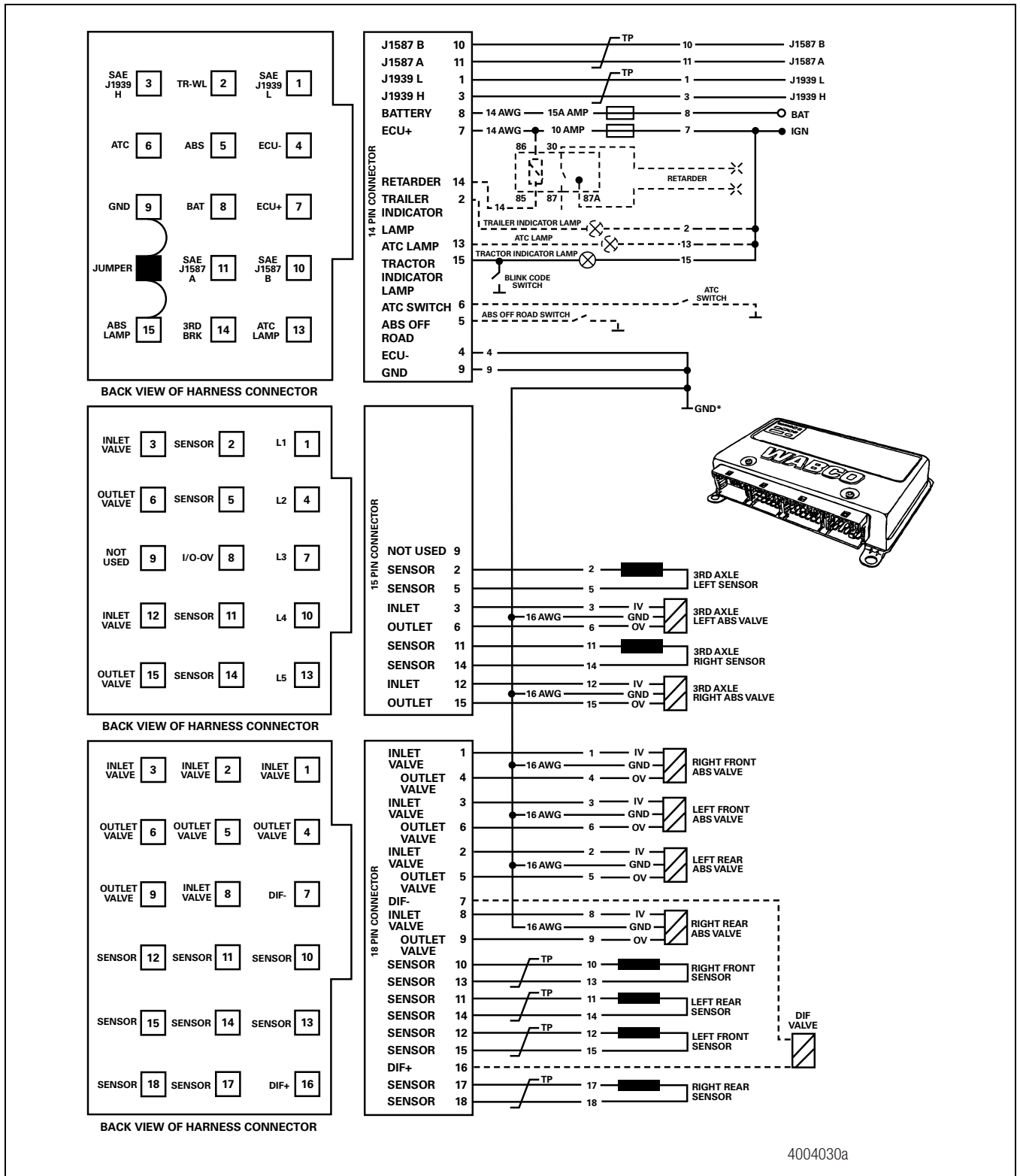


Figure 6.5

4004030a

# 6 Appendix II — Wiring Diagrams

## 4S/4M Universal ECU (Cab-mounted) with RSC

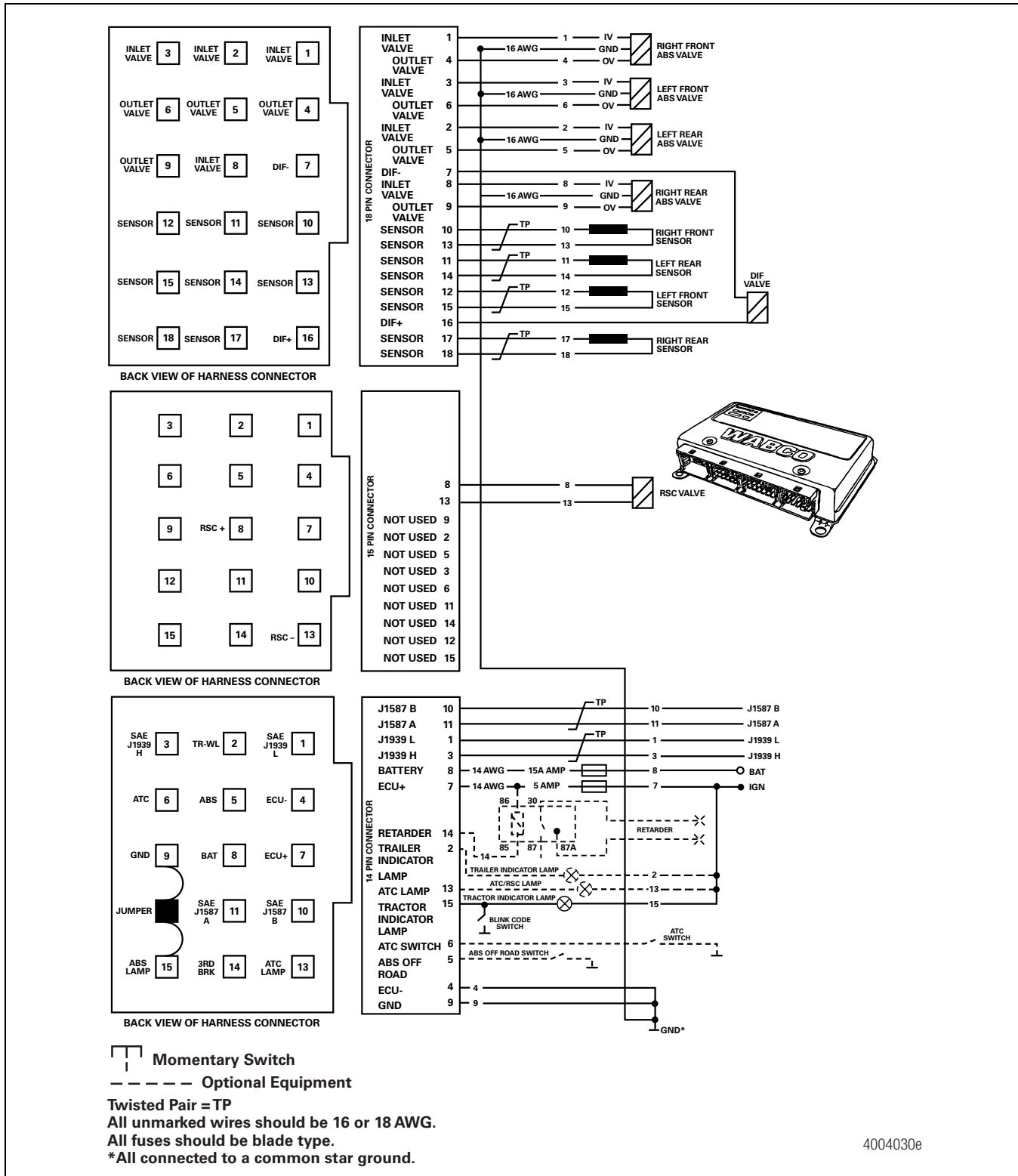


Figure 6.6



Frame-mounted ECU

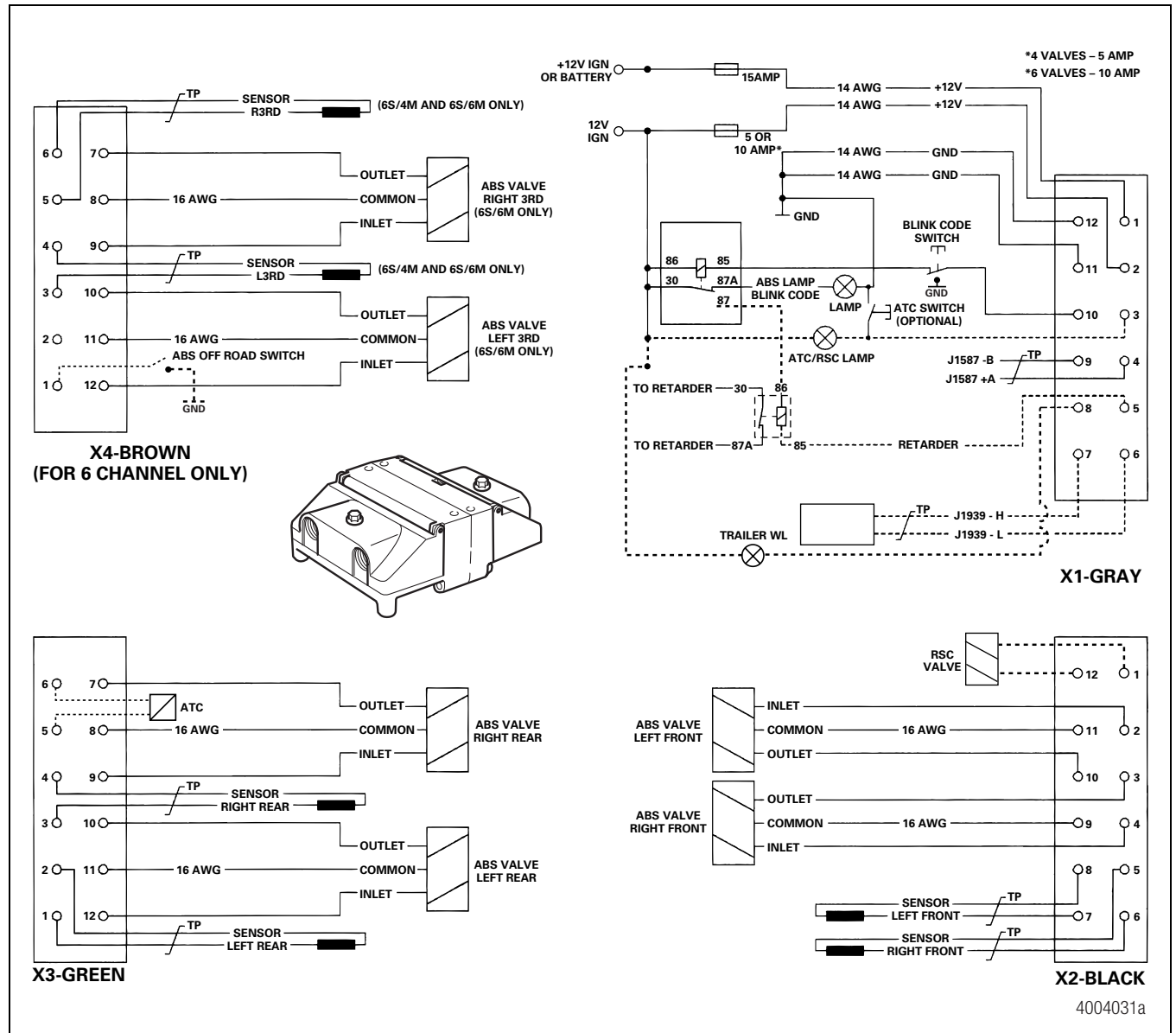


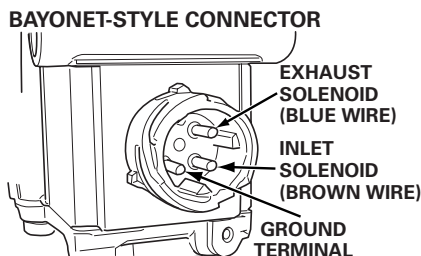
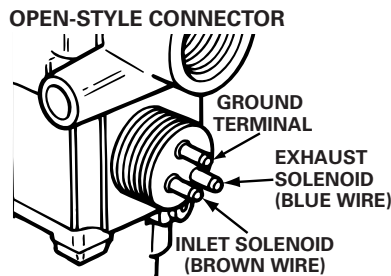
Figure 6.7

## Troubleshooting

### Meritor WABCO ABS Valve Package

This troubleshooting information is a reference tool to help identify possible malfunctions of the ABS modulator or relay valves. It does not take the place of diagnostic tests or other service instructions.

Condition	Possible Cause	Recommended Action
Air constantly leaks from exhaust port of relay valve.	Internal relay valve problem.	Replace the relay valve.
Air leaks from exhaust port of ABS modulator valve or relay valve when parking brake is released.	Parking brake problem. OR Anti-compound 2-way check valve problem.	Service the appropriate component. <ul style="list-style-type: none"> <li>Refer to manufacturer's service manual for instructions.</li> </ul>
Rear service brakes releasing slowly (brakes dragging).	Kinked air line. Dirt buildup inside relay valve.	Inspect/repair lines, brakes. If the condition is not corrected: <ul style="list-style-type: none"> <li>Replace the relay valve.</li> </ul>
Valves don't cycle at power-up. OR Indicator lamp comes on (blink code or diagnostic tool indicates electrical problem with ABS valve).	Broken wire. OR Loose or broken terminal connection. Corroded connector pins. OR Problem with solenoid.	Check the wires and connections. <ul style="list-style-type: none"> <li>Make repairs as needed.</li> </ul> <p><b>If condition is not corrected:</b> Measure resistance across each valve solenoid coil terminal and ground on the ABS modulator valve to ensure 4.0 to 8.0 ohms.</p> <ul style="list-style-type: none"> <li>If <b>greater than 8.0 ohms</b>, clean the valve and repeat the measurement. — If cleaning does not solve the problem, replace the ABS modulator valve.</li> <li>If <b>less than 4.0 ohms</b>, replace the ABS modulator valve.</li> </ul>
ABS valve package damaged.	Road hazards. OR Vehicle damage.	Replace the complete ABS valve package or individual component as required.



## Reconfiguration Procedure

### How to Reconfigure an ECU (E Version)

Before reconfiguring the ECU, contact ArvinMeritor's Customer Service Center at 800-535-5560 for additional information.

E version ECUs memorize the following components if they are connected at power-up:

- ATC valve
- Retarder relay
- Datalink SAE J1939

**NOTE:** The ATC valve and Datalink SAE J1939 are required for RSC. The RSC ECUs cannot be reconfigured to remove these components. Only the retarder relay is memorized or cleared.

Once these components have been memorized, the ECU will look for them at each power-up. If a memorized component is not present, the ECU will record a fault. For example, if an ATC valve is memorized, but is not present at the next power-up, the ECU records a fault. This can occur if an ECU is moved from one truck to another and one or more of the memorized components are not available on the new truck. If this occurs, use TOOLBOX™ Software to reconfigure the ECU. If you do not have TOOLBOX™ Software, follow the manual reconfiguration instructions in this section.

### TOOLBOX™ Software

**NOTE:** For complete instructions for using TOOLBOX™ Software, refer to the TOOLBOX™ User's Manual, TP-99102.

To reconfigure the ECU with TOOLBOX™ Software, use the **Reset Memorized** command.

Select **Reset Memorized** from the pull down menu to tell the ECU to reset the memorized or "learned" components. Figure 7.1 and Figure 7.2.

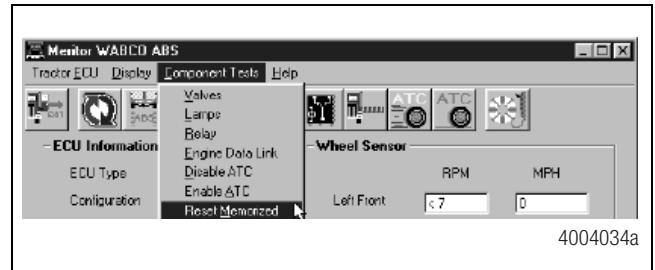


Figure 7.1



Figure 7.2

## 7 Appendix III — Additional ABS Information

### Manual Reconfiguration

Refer to Table H and Figure 7.3 for information on manual reconfiguration.

Table H

Action	Result	Reason
<p>1. <b>Turn the ignition ON.</b></p> <p>2. <b>Press and hold the blink switch for at least three seconds.</b></p> <p><b>NOTE:</b> Do not hold this switch longer than seven seconds.</p>	<p>The ABS lamp displays the ABS system configuration code:</p> <ul style="list-style-type: none"><li>• One blink: 6S/6M</li><li>• Two blinks: 4S/4M</li><li>• Four blinks: 6S/4M</li></ul> <p><b>NOTE:</b> The ABS lamp may display eight quick flashes before the system configuration code begins.</p>	<p>Stored faults cleared, no active faults present. Continue with reconfiguration.</p> <p><b>NOTE:</b> The reconfiguration procedure cannot be conducted if there are active faults present. These must be repaired before proceeding with the reconfiguration.</p>
<p><b>Observe the ABS and ATC lamps.</b></p>	<p>The ATC lamp comes on and stays on.</p> <p>The ABS lamp will continuously blink the system configuration code.</p>	<p>A complete ATC system — including an ATC lamp — is installed. If not, the ATC lamp will not come on.</p> <p>ECU reconfiguring the system.</p> <p>The ECU checks the following components and reprograms itself based on the new system:</p> <ul style="list-style-type: none"><li>• ATC valve</li><li>AND/OR</li><li>• Retarder relay</li><li>AND/OR</li><li>• Datalink J1939</li></ul>
<p><b>While the configuration code is flashing, press the blink code switch three times (one second each, with a one second pause between each).</b></p> <p><b>Turn the ignition OFF.</b></p>	<p>The ABS lamp displays <b>four quick flashes</b>, followed by a continuous display of the system configuration code.</p> <p><b>NOTE:</b> The system configuration code continues until ignition is turned OFF.</p>	<p>Successfully reconfigured.</p>

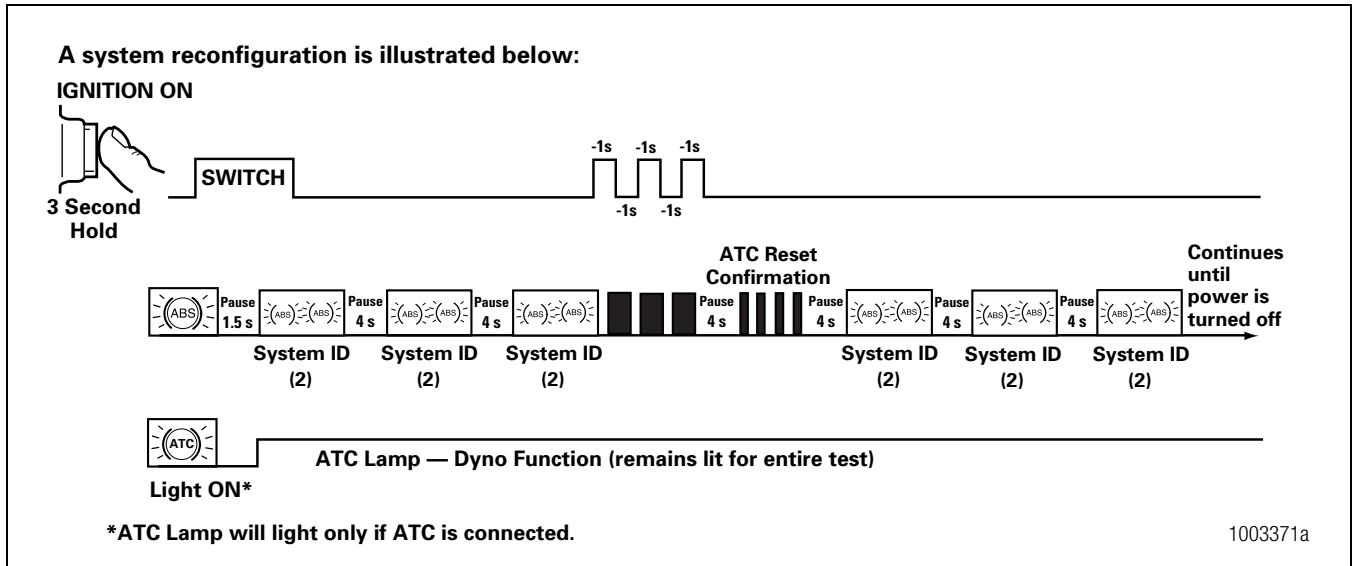


Figure 7.3



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**MERITOR WABCO**

# MERITOR WABCO

## Technical Bulletin

### Engine Torque Reduction Diagnostics (J1922 Datalink Verification) for D-Version Meritor WABCO Pneumatic ECUs with Date Codes of 25/00 or Higher

#### WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

The information in this technical bulletin explains the procedure for J1922 datalink verification for all D-version Meritor WABCO pneumatic ABS Electronic Control Units (ECUs) with date codes of 25/00 or higher. These ECUs require the ABS blink code be activated using **both** the vehicle ABS blink code switch **AND** a diagnostic tool — either TOOLBOX™ Software or the MPSI Pro-Link. Do not use the instructions in Maintenance Manual 30 for datalink verification if your ECU has a date code of 25/00 or higher.

**NOTE:** The date code appears on the ECU identification label, as illustrated. The date code is also displayed on the Main Screen of TOOLBOX™ Software and on the Program ID screen of the Pro-Link.



There are two ways to perform J1922 datalink verification, one using TOOLBOX™ Software and the other using the MPSI Pro-Link. Both methods require the use of the vehicle ABS blink code switch.

#### Using TOOLBOX™ Software for J1922 Datalink Verification

1. With TOOLBOX™ Software connected to the vehicle, turn the ignition ON.
  - A. Press the ABS blink code switch. Hold for 3 seconds. The ATC lamp will come on and stay on for the entire test. If vehicle is not equipped with ATC, the ATC lamp will not come on.

- B. The ABS lamp will come on and blink eight times. If the lamp does not blink eight times, there are faults that must be cleared **before** you continue with this test. The eight quick flashes will be followed by the system identification code. The system identification code will continue during the entire test.
2. Click on the Datalink Activation menu icon, or from the Component Tests pull down menu click on Engine Data Link.



3. Click on Engine.
4. Click on Send.

**NOTE:** TOOLBOX™ Software sends the engine torque reduction command continuously until you click on the Stop button.



5. Send the Blink Code J1922 engine torque reduction command, as follows:
  - A. Step on the accelerator. Bring the engine to 1000 RPM. Leave your foot on the accelerator during the entire test.
  - B. While the engine is at 1000 RPM, press the blink code switch twice, as follows:
    - Press and hold for one second.
    - Release for one second.
    - Press and hold for one second.
    - Release for one second.

The engine will alternate between 1000 RPM and idle indefinitely. Click the Stop button on the TOOLBOX™ screen. This stops the test and returns the RPM to accelerator control.

**NOTE:** To retest, begin at Step 4.

6. Click the Close button to exit the screen.
7. Take your foot off the accelerator. Turn the ignition OFF.

Engine torque reduction command verified.

## Using the Pro-Link for J1922 Datalink Verification

1. With the Pro-Link connected to the vehicle, turn ignition ON.
  - A. Press the ABS blink code switch — hold for 3 seconds. The ATC lamp will come on and stay on for the entire test. If vehicle is not equipped with ATC, the ATC lamp will not come on.
  - B. ABS lamp will come on and blink eight times. If the lamp does not blink eight times, there are faults that must be cleared **before** you continue with this test. The eight quick flashes will be followed by the system identification code. This indicates the ECU is in the Datalink Verification mode. The system identification code will continue during the entire test.

2. Select the Pro-Link Engine Datalink choice, as follows:
  - A. Press the arrow key(s) to find the Component Test choice.
  - B. Press the Enter key to enter Component Test.
  - C. Press the arrow key(s) to find the Engine Datalink choice.
3. Prepare the Pro-Link Engine Datalink command, as follows:
  - A. Press the Enter key once to enter the first stage of the Datalink setup. The Pro-Link screen will display the following message: “run engine 1000 RPM/engine torque will change during test/[ENTER] to continue.”
  - B. **DO NOT** press Enter at this time.
4. Prepare the Blink Code J1922 Engine Datalink command, as follows:
  - A. Step on the accelerator.
  - B. Bring the engine to 1000 RPM. Leave your foot on the accelerator during the entire test.
  - C. While engine is at 1000 RPM, press the blink code switch twice, as follows:
    - Press and hold for one second.
    - Release for one second.
    - Press and hold for one second.
    - Release for one second.

**This mode remains active for 10 seconds, which means you must start Step 5 within 10 seconds.**

5. Send the Pro-Link J1922 engine torque reduction, as follows:

Press the Enter key on the Pro-Link. The engine will alternate between 1000 RPM and idle for approximately 10 seconds, then return to 1000 RPM.

**NOTE:** To repeat the test, start with Step 3.

6. Take your foot off the accelerator. Turn ignition OFF.

Engine torque reduction command verified.

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# SECTION 13: WHEELS, HUBS & TIRES

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## 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. Either steel wheels or optional aluminum-polished wheels may be installed on the vehicle. Both are mounted with radial tubeless tires.

Except for customer special request, all wheel dimensions are 22.50 X 9.0 inches (571.5 X 228.6 mm) for 315/80 R 22.5 "L" tires.

**Note:** Wheel dimensions 22.50 X 10.5 (571.5 X 266.7 mm) for 365/70 R 22.5 tires are standard on VIP front and tag axle.

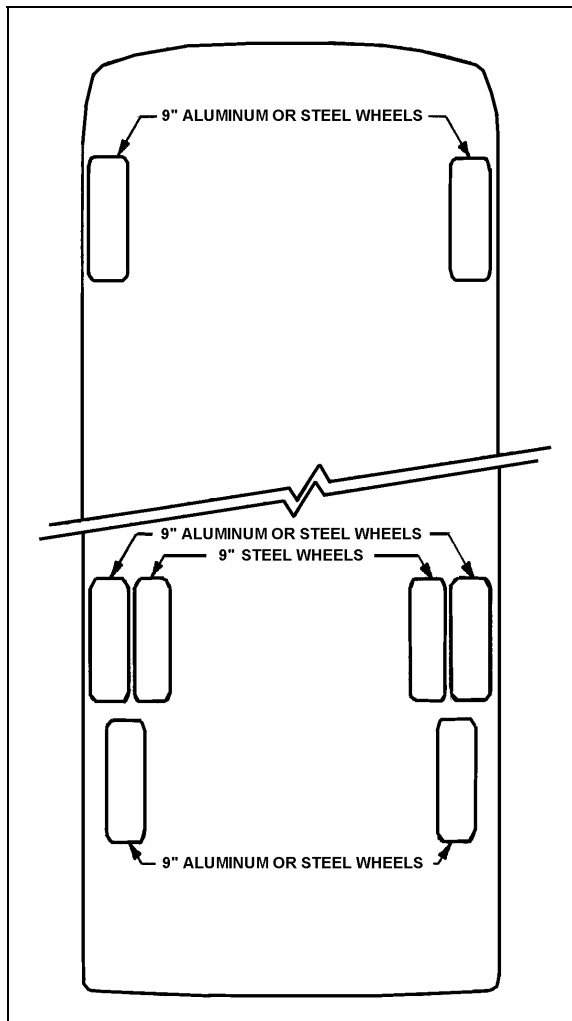


FIGURE 1: ALUM/STEEL WHEEL ARRANGEMENT 13001

## 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 as well as steel wheels.

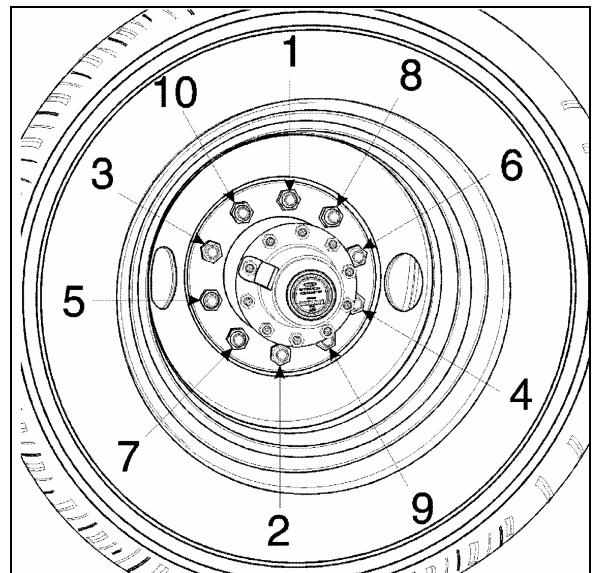


FIGURE 2: TIGHTENING SEQUENCE 13018

### 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 as well as steel wheel.

**Caution:** Insufficient mounting-torque can result in damage to parts. Excessive mounting torque can cause studs to break and the wheel to crack in stud hole area.

## 3. DUAL WHEELS

### 3.1 OUTER WHEEL REMOVAL

Same as described in "Single Wheel Removal" procedure described previously.

### 3.2 INNER WHEEL

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. 4), 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 as well as steel wheel.

**Caution:** Insufficient mounting-torque can result in damage to parts. Excessive mounting torque can cause studs to break and the wheel to crack in stud hole area.

### 3.4 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 180° 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 3/4-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 wrench-**

**ing. 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 (Prevost #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 (Prevost #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 (Prevost #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;

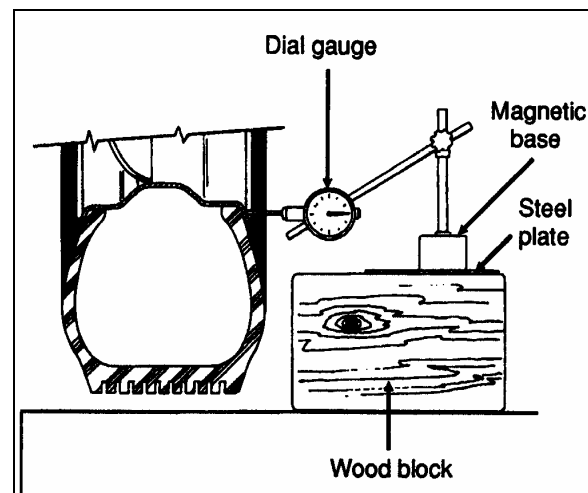


FIGURE 3: DIAL GAUGE INSTALLATION

13008

**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.

If doubt exists whether wheel or hub is distorted, hub may be checked as follows:

- Replace the existing wheel with a wheel known to be correct;
- Check wheel lateral runout as outlined in step 2;
- If, within specifications, the hub is correct but the suspected wheel must be replaced.

**Warning:** NEVER STRAIGHTEN ALUMINUM WHEELS. Never heat aluminum wheels to repair damages incurred after hitting a curb or resulting from other causes. The special alloy in wheels has been heat treated, and any uncontrolled heating could alter wheel structure. Furthermore, never weld aluminum-forged wheels for any reason whatsoever.

## 6. WHEEL STUDS

Stripped threads may be the result of excessive torquing or may have been damaged during wheel installation when placing the wheel over the studs. A stud having damaged threads must be replaced. Broken studs are a direct result of operating with loose stud nuts or improperly seated wheels. When a broken stud is replaced, the adjacent studs, on each side of the broken one must also be replaced since they could have been subjected to excessive strain and may be fatigued.

When installing wheel studs to hubs, check nuts retaining the wheel stud to wheel hub and replace if they are deformed, damaged or severely corroded. Install nut (and washer where applicable) to new stud. Torque to 450 - 500 lbf-ft (610 - 680 Nm).

**Note:** For stud-mounted wheels, turn nuts counterclockwise on R.H. side of vehicle and clockwise on L.H. side. For hub-mounted wheels, turn nuts counterclockwise on both sides of vehicle.

### 6.1 DRIVE AXLE STUDS

Stud-mounted wheels are mounted on the drive axle with  $\frac{3}{4}$ "-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.

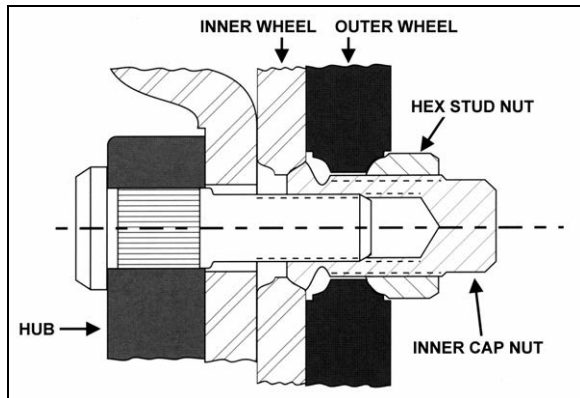


FIGURE 4: STUD-MOUNTED WHEELS

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.

**Caution:** 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.

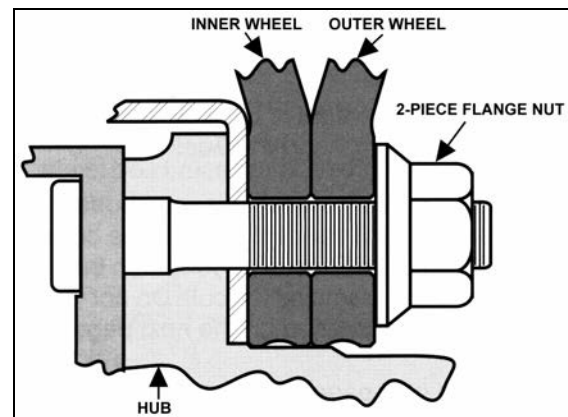


FIGURE 5: HUB-MOUNTED WHEELS

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).

- Apply parking brake, raise wheels off the ground and support axle on stands. When the wheels are raised, they should revolve quite freely without roughness.
- Place magnetic base of a dial indicator on brake caliper and position dial indicator stem against a convenient marked spot on face of hub flange.
- With dial indicator in position pull hard but steadily on hub flange and oscillate at same time until a steady reading is achieved.
- Without releasing the pressure, turn bearing so that dial indicator stem contacts marked spot and note reading on indicator.
- Push bearing flange hard and oscillate as before until a steady reading is achieved.
- Without releasing the pressure, turn bearing so that indicator stem again contacts the marked spot and note new reading on indicator.
- The difference between readings is the amount of mounted end play in bearing unit.
- The mounted end play figure should not exceed 0.050 mm (0.002") for a new bearing and 0.20 mm (0.008") for a bearing which has been in service.

**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 10.

**Note:** For vehicles equipped with Independent Front Suspension, refer 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:** Always mark position of the wheel on the axle before removal, to replace wheel at the same location, 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. Assemble axle flange to axle using a new gasket. Apply sealant in stud area. After both wheels have been assembled according to above procedure, fill the differential with the recommended lubricant to the proper factory recommended level.

**Note:** During regular inspection, do not forget to check lubricant level in differential. Clean thoroughly or replace vent as required.

### 10. SPARE WHEEL (IF APPLICABLE)

Tire failure is a rare event if tires are properly cared for. In case of a flat tire, move vehicle a safe distance away from traffic and apply parking brake. Remember to use the hazard flashers and according to the Highway Code regulations, set up the triangular reflectors (see "Emergency Warning Reflectors" in the Operator's Manual) at an adequate distance, to warn incoming motorists.

The spare wheel is stored in a dedicated compartment behind the front bumper. To access, pull the release handle located in the front electrical and service compartment. Although the bumper is heavy, sprung hinges permit one person operation.

When closing bumper compartment, make sure bumper is securely installed.

**Note:** Converted vehicles contain no spare wheel. Access to compartment is also obtained by pulling the release handle located in the front service compartment.

**Warning:** This compartment has not been designed for storage. Never leave loose objects in this area since they may interfere with steering linkage mechanism. Make sure bumper is safely locked in place after closing the compartment.

#### 10.1 PULLING OUT SPARE WHEEL

To pull out spare wheel, open reclining bumper according to the previous instructions. Loosen and turn the holding chain buckle to release the wheel and dolly assembly. Open the front service compartment, unscrew the wing nut retaining the support and rail extension assembly, and then pull out. Fasten by matching its two holes to the corresponding mounting pins located in front center of spare wheel compartment. Pull out wheel using the strap, and then remove tire covering. Separate wheel from dolly by unscrewing the two mounting wing nuts.



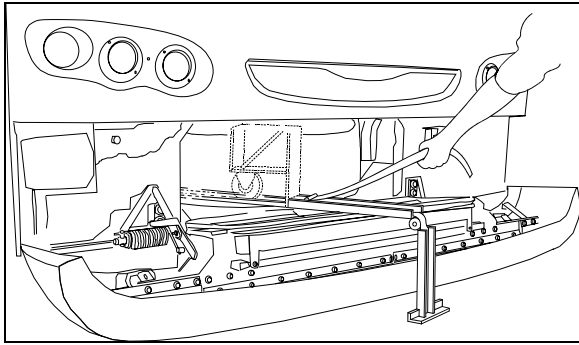


FIGURE 6: SPARE WHEEL COMPARTMENT 13024

**Note:** Reinstall support and rail extension assemblies then secure wheel with holding chain before moving vehicle.

**Note:** The jack and wheelnut wrench are stored at right in forward R.H. baggage compartment.

The jack/tools kit stowed in the forward R.H. baggage compartment contains a:

1. 30 ton bottle jack;
2. Wheel nut wrench and lever;
3. Triangular reflectors kit.

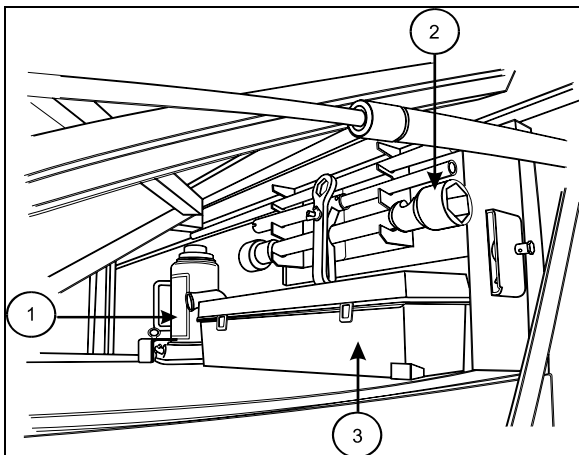


FIGURE 7: FORWARD R.H. SIDE COMPARTMENT 13015

**Note:** Check the inflation pressure of the spare tire periodically to keep it ready for use. Inflate spare tire to the pressure of the tire, which has the highest pressure on the vehicle. When installing, deflate to correct pressure if necessary.

## 10.2 CHANGING A FLAT

In case of flat tire, refer to appropriate procedure under "Wheel Maintenance" heading in this section.

**Note:** For hydraulic jack placement, refer to Section 18 "Body", under heading "Vehicle Jacking Points".

**Warning:** Place jack on stable and level ground; if necessary, place a board under the jack. Do not raise the vehicle until you are sure the jack is securely engaged.

**Warning:** To prevent personal injury and/or equipment damage, use only the recommended jacking points. Passengers must not remain inside vehicle while wheel is being replaced.

**Caution:** Adjust tire pressure according to the appropriate cold tire inflation-pressure.

**Note:** Store damaged wheel in spare tire compartment. Repair and balance the flat tire as soon as possible.

## 10.3 SPARE WHEEL MAINTENANCE

Maintenance of the spare wheel and tire consists in ensuring that tire inflation pressure is the same as the tire on the coach that has the highest inflation pressure (refer to "Specifications" in this section for the recommended tire inflation pressure). Inspect rim to ensure that there is no important corrosion. In addition, check if spare wheel covering is in good condition and check that spare tire is securely fastened in compartment.

## 11. TIRE MAINTENANCE

The most critical factor in tire maintenance is proper inflation (Fig. 8). 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

#### 11.1.1 Vehicles equipped with BERU TPMS

On vehicles equipped with the BERU Tire Pressure Monitoring System (TPMS), it is better to use the TPMS display as the primary reference to judge when tire pressure need adjustment.

The TPMS presents pressure readings of each tire as a +/- deviation from the wanted target.

If a tire reads within +/- 3 PSI no adjustment is needed.

If a tire reads -4 PSI and below, re-inflate by the marked amount.

If a tire reads +4 PSI and above, deflate by the marked amount.

Relying on the TPMS system is better than relying on a hand gage since the TPMS is temperature compensated, so it provides pressure reading which are not influenced by normal tire temperature increase when riding.

Tires take up to 3 hours to get down to ambient temperature after a ride. A common mistake consist of checking and adjusting pressure while the tires have not fully cooled down which leads into under-inflated tires once cooled. Relying on the TPMS eliminate this mistake.

Running tires at optimal pressure reduce tire wear, improve safety and fuel economy.

<b>NOTE</b>
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<i>It is more accurate to use the TPMS display to set the tire pressures than a pressure gauge.</i>
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The TPMS target pressure are factory set to equal the prevailing tire pressure at delivery time.

When tire pressure are increased to account for higher vehicle weight, the TPMS set point need to be increased accordingly.

#### 11.1.2 Vehicles not equipped with BERU TPMS

The condition and pressure of the tires can greatly affect both useful tire life and road safety.

At regular intervals, verify the tire pressures. Use an accurate tire pressure gauge when checking inflation pressures. Never exceed the maximum inflation pressure specified on each tire.

**Note:** Inflation pressure should be checked when tires are cold. Cold tire inflation pressure can be measured when a vehicle has not been driven for at least 3 hours or less than 1 mile (1.6 km). Driving, even for a short distance, causes tires to heat up and air pressure to increase. Check inflation pressure on all tires (including the spare tire) using an accurate tire gauge.

**Note:** The recommended tire inflation pressures are given in the applicable documents supplied with the vehicle. In addition, cold tire inflation pressures are listed on the Department of Transport's certification plate, affixed on the panel behind the driver's seat. For special tire selection, a "PREVOST 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"

**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 Prevost 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.

**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.

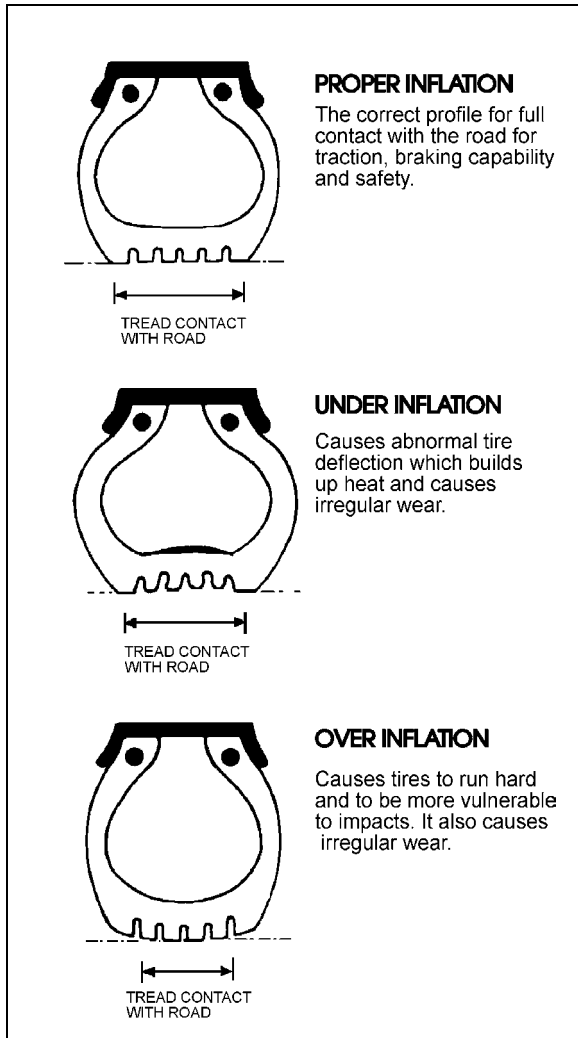


FIGURE 8: TIRE INFLATION 13009

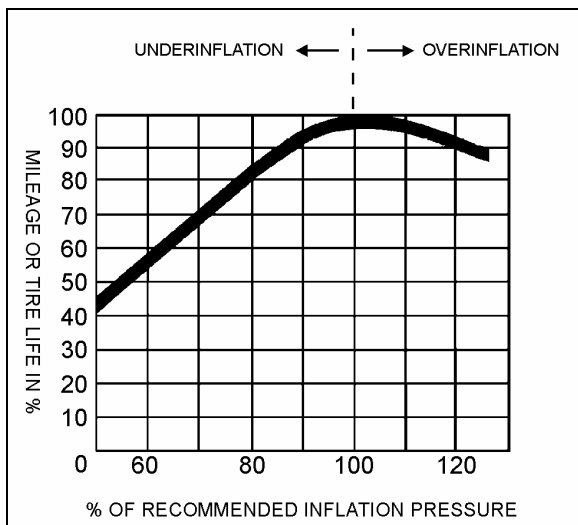


FIGURE 9: TIRE LIFE / INFLATION PRESSURE 13010

### 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.

## Section 13: WHEELS, HUBS & TIRES

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### 12. SPECIFICATIONS

#### STEEL WHEELS (including inner drive axle)

Wheel size.....	9.0" X 22.5"
Wheel nut torque.....	450 - 500 lbf-ft (610 - 680 Nm)
Tire size.....	.315/80 R 22.5 load range "L"

#### ALUMINUM WHEELS (except inner drive axle wheel on coaches)

Wheel size.....	9" X 22.5"
Wheel nut torque.....	450 - 500 lbf-ft (610 - 680 Nm)
Tire size.....	.315/80 R 22.5 load range "L"

#### WHEELS ON VIP (Front & Tag axle)

Wheel size.....	10.5" X 22.5"
Wheel nut torque.....	450 - 500 lbf-ft (610 - 680 Nm)
Tire size.....	365/70 R 22.5

#### OPTIONAL WHEELS ON VIP (Drive axle)

Wheel size.....	14" X 22.5" hub mounted wheel
Wheel nut torque.....	450 - 500 lbf-ft (610 - 680 Nm)
Tire size.....	455/55 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:** In the case of a converted vehicle, weigh fully loaded and pressurize 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) .....	Prevost #683529
Aluminum Wheel Polish (16 Oz bottle) .....	Prevost #683528
Aluminum Wheel Sealer (13 Oz bottle) .....	Prevost #683527

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**



Dura-Bright® is a federally registered trademark of Alcoa Inc.



# 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 <sup>1</sup> in pounds	Wheel wt. lbs.	Outset inches <sup>2</sup>	Inset inches	Maximum inflation PSI – cold	Valve stem	Part number <sup>2</sup>	DiscMate™	Stabilizer	Front outer cap nuts	Rear inner cap nuts A/AI	Rear inner cap nuts A/StI	Rear outer cap nuts	Lug nut covers	Hub cover system kits front/rear
<b>10-hole, stud located ball seat mounting – 11.25 in. bolt circle, 8.73 in. hub bore, 1.219 in. bolt hole diameter</b>															
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
<b>10-hole, hub piloted mounting – 285.75mm bolt circle, 220.1mm hub bore, 26.75mm bolt hole diameter (use two-piece flange nuts)</b>															
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†
<b>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)</b>															
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 <sup>1</sup> in lbs. (kgs)	Wheel wt. lbs. (kgs)	Outset inches <sup>2</sup> (mm)	Inset inches (mm)	Maximum inflation PSI-cold (Kpa)	Valve stem	Part number <sup>2</sup>	DiscMate™	Stabilizer	Front outer cap nuts	Rear inner cap nuts A/AI	Rear inner cap nuts A/StI	Rear outer cap nuts	Lug nut covers	Hub cover system kits front/rear
<b>10-hole, hub piloted mounting – 335mm bolt circle, 281.2mm hub bore, 26.75mm bolt hole diameter (use two-piece flange nuts)</b>															
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	—
<b>10-hole, hub piloted mounting – 335mm bolt circle, 281.2mm hub bore, 32.87mm bolt hole diameter (use two-piece flange nuts)</b>															
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.

- <sup>1</sup> 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.
- <sup>2</sup> 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.
- <sup>3</sup> 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



www.alcoawheels.com

Alcoa Inter-America, Inc.  
115-A Matheson Blvd. West, Suite 207  
Mississauga, Ontario L5R 3L1  
800.668.1150

# 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 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 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.

## 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.



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## Rim flange wear

Irregular wear on the surface 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.

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## 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

TR 509

TR 510

TR 511

### 7 to 11 foot-pounds for part numbers

TR 542 Series

TR 543 Series

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.

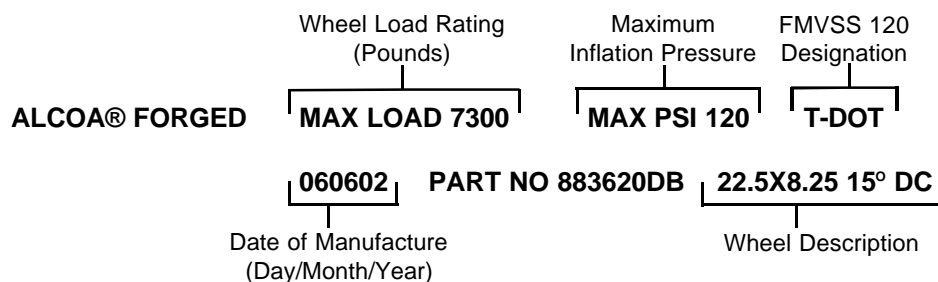
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## Identification

### Alcoa wheel identification

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Since 1977, all Alcoa aluminum disc wheels have been identified with a stamp that shows the wheel load rating, maximum inflation pressure, date of manufacture, part number, wheel description and DOT marking designation (shown below).



Prior to June 1996, all Alcoa heavy duty truck wheels has the Alcoa identification symbol  $\Sigma$  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.

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## 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.

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## 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.

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## 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.

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## 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.

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## **Limited Warranty FOR HEAVY DUTY TRUCKS, TRUCK TRAILERS AND BUSES**

**Dura-Bright wheels  
denoted by Alcoa part  
numbers ending with  
a “4” and “7” with bead  
seat diameters measured  
in 0.5-inch increments**

Alcoa Inc. warrants to the original purchaser from Alcoa or its authorized distributor that a new Alcoa Dura-Bright® aluminum disc heavy duty truck, truck trailer or bus wheel is free from defects in material and workmanship. Alcoa agrees, without charge, to repair or replace a Dura-Bright® wheel that fails in normal use and service because of defects in material or workmanship. Wheels are structurally warranted for 60 months from the date of manufacture, and the Dura-Bright® surface treatment is also warranted for 60 months from the date of manufacture. Alcoa bus mount wheels (10-hole, 11.25-inch bolt circle, 8.670-inch hub bore with 1.22-inch diameter bolt holes) and other wheels used in transit bus service are structurally warranted for 120 months from the date of manufacture, and the Dura-Bright® surface treatment is warranted for 60 months from the date of manufacture. In all cases, the date of manufacture is shown on the wheel. Alcoa does not warrant and will not repair, replace or make adjustments with respect to normal wear or for any wheel that has been damaged or subjected to misuse or abuse including, without limitation, the following:

- (a) Using a tire that is improperly sized according to standards recommended by Alcoa or the Tire and Rim Association, Inc.;
- (b) Loading beyond the applicable maximum wheel load as specified by Alcoa;
- (c) Inflating the tire beyond the applicable maximum as specified by Alcoa;
- (d) Changing the original condition of the wheel by alteration or by subjecting it to processing, such as heating, welding, straightening or machining;
- (e) Accidents, road conditions, abnormal or severe operating conditions;
- (f) Failure to follow instructions and recommended maintenance on the wheel as set forth in the Alcoa Wheel Service Manual, Alcoa Technical Bulletins and other Alcoa literature. Recommended maintenance includes, without limitation, periodic cleaning with standard non-abrasive wheel and/or car wash cleaners/detergents, valve replacement and rim flange wear inspections and procedures.

This limited warranty in regards to the Dura-Bright® wheel finish (denoted by Alcoa part numbers ending in “4” and “7”) does not cover corrosion or other damage associated with the conditions addressed above or associated with the following: damage in areas of the mounting surfaces (such as lug holes, hubs, drums and against other wheels in dual position), damage due to cleaning with abrasives, abrasive brushes, steel wool, scouring pads or strong chemicals (such as acids or lye-based products), and removal/damage of the Dura-Bright® wheel finish, including chipping, by contact with road obstacles such as stones, gravel, concrete curbs, metallic barriers, signs, etc. Alcoa recommends cleaning the wheels with mild soap and water. For detailed recommended use and maintenance instructions, see the Alcoa Wheel Service Manual and the Alcoa Dura-Bright® Wheel Finish Care and Maintenance instructions.

Do not exceed maximum wheel load. Customer must compare OEM vehicle load 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.

**THERE IS NO WARRANTY THAT THE WHEEL IS MERCHANTABLE OR SATISFACTORY FOR ANY PARTICULAR PURPOSE. NOR IS THERE ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, ON THE WHEEL.**

**ALCOA WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR ANY BREACH OF WARRANTY, ITS LIABILITY AND THE PURCHASER'S EXCLUSIVE REMEDY BEING EXPRESSLY LIMITED TO REPAIR OR REPLACEMENT OF THE WHEEL.**

Repair or replacement will be handled by any authorized Alcoa wheel distributor or by any Alcoa wheel representative under Alcoa's return policy. This warranty gives you specific legal rights. You may also have other rights under other applicable laws.

To obtain a copy of the Alcoa Wheel Service Manual, the Alcoa Dura-Bright® Wheel Finish Care and Maintenance instructions, or other product and specification literature, contact Alcoa Wheel Products at 800-242-9898 or at 1600 Harvard Avenue, Cleveland, Ohio 44105. For additional information on our warranty or to submit a warranty claim, contact the Alcoa Wheel Service Center at 800-242-9898 (option 2) or 888-279-3055.





# ALCOA



## WHEEL SERVICE MANUAL

HEAVY DUTY TRUCK  
| TRAILER | BUS |  
MOTOR HOME

IMPORTANT SAFETY PRECAUTIONS FOR TRUCK RIMS AND WHEELS

JANUARY 2009  
(SUPERSEDES JANUARY 2007)

**IMPORTANT:** Federal OSHA Regulations require all employers to make sure their employees who service rims/wheels understand the safety information contained in this manual. Do not let your employees service rims/wheels unless they are thoroughly trained and completely understand this safety information.

If you are a service technician do not service rims/wheels unless you are thoroughly trained and completely understand this safety information.

# LIMITED WARRANTY

FOR HEAVY DUTY TRUCKS, TRUCK TRAILERS,  
BUSES, RV and MOTORHOME WHEELS

(Wheels with bead seat diameters measured in .5 inch increments and Alcoa tube type wheels)

Alcoa warrants to the original purchaser, from Alcoa or its authorized distributor, that a new Alcoa aluminum disc heavy duty truck, truck trailer, bus, 19.5-inch and 22.5-inch RV or motorhome wheel is free from defects in material and workmanship. Alcoa agrees, without charge, to repair or replace a wheel that fails in normal use and service because of defects in material and workmanship. Truck, truck trailer, Dura-Flange<sup>®</sup> and the Dura-Bright<sup>™</sup> 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<sup>™</sup> 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<sup>™</sup> 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<sup>™</sup> rim flange treatment is warranted for 24 months against sharp edges. Satin finish, polished and Dura-Bright<sup>™</sup> surface treatment 19.5-inch and 22.5-inch RV and motorhome wheels are warranted for 120 months from the date of manufacture as shown on the wheel. Alcoa does not warrant and will not repair or replace or make adjustment with respect to any wheel that has been subjected to misuse or abuse including the following:

- (a) Using a tire that is oversized according to standards recommended by the Tire and Rim Association, Inc. or other recognized tire and rim agencies such as ETRTO (Europe) or others;
- (b) Loading the wheel beyond the applicable maximum wheel load as specified by Alcoa;
- (c) Inflating beyond the applicable maximum as specified by Alcoa;
- (d) Changing the original condition of the wheel by alteration or by subjecting it to any processing such as welding or straightening.
- (e) Accidents, abnormal or severe operating conditions including without limitation tire fires, brake fires, severe brake system drags or seizures or running with a flat tire; or
- (f) Failure to follow maintenance and other instructions and warnings set forth in the Alcoa Wheel Service Manual, Alcoa Technical Bulletins and other Alcoa literature. Recommended maintenance includes, without limitation, using proper torque, periodic cleaning, polishing, valve replacement, periodic inspection for damage, loose lug nuts and rim flange wear inspections and procedures.
- (g) Nicks, scratches and other surface blemishes resulting from improper maintenance, cleaning, road debris, curbing, accident or operation are not warrantable.
- (h) Rim flange wear (other than Dura-Flange<sup>™</sup>) is not warrantable.
- (i) Damage due to cleaning with abrasives, abrasive brushes, steel wool, scouring pads, or strong chemicals (acids or alkaline).

Dura-Bright<sup>™</sup> 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<sup>™</sup> 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<sup>™</sup> 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<sup>™</sup> surface treatment. The Dura-Bright<sup>™</sup> 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<sup>™</sup> 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<sup>™</sup> Wheel Finish Care and Maintenance Manual. The Wheel Service Manual contains important safety information and warnings, and failure to read and understand this information may result in serious injury or death. The limited warranty is included with the Wheel Service Manual, but may appear elsewhere. If you do not have copies of the Wheel Service Manual you may obtain copies free of charge from Alcoa Wheel Products, 1600 Harvard Avenue, Cleveland, Ohio 44105, (800) 242-9898 and on the web at [www.alcoawheels.com](http://www.alcoawheels.com).



**WARNING** Wheels that are not properly installed or maintained may not be safe.

Failure to follow proper wheel installation or maintenance practices may result in injury or death.

Follow the proper wheel installation and maintenance practices as contained in this Alcoa Wheel Service Manual. For additional copies of the manual and other useful items listed below, available free of charge, or for the most recent updates, contact Alcoa Wheel Products at 1-800-242-9898 or on the web at [www.alcoawheels.com](http://www.alcoawheels.com).

To obtain information on free training on proper installation and maintenance procedures, contact Alcoa Wheel Products at (800) 242-9898 or on the web at [www.alcoawheels.com](http://www.alcoawheels.com).

Important information available free from Alcoa

Alcoa Wheel Service Manual

Videos/CD

- Safe Wheel and Tire Changing Practices for Heavy Duty Trucks and Buses
- Maintaining Your Edge Rim Flange Maintenance
- Simple Facts about Hub-Piloted Wheel System Maintenance
- Disc Wheel Inspection CD published by the TIA

Maintenance Charts

- Zipper Rupture Published by RMA
- Tire Information Service Bulletin Published by RMA
- Heavy & Medium Truck & Trailer Torque Specifications Published by WRIS
- Demounting & Mounting Procedures for Truck/Bus Tires Published by RMA
- Multipiece Rim Matching Chart Published by OSHA
- Mounting/Demounting Instructions for Alcoa Aluminum 19.5" RW Published by Alcoa Wheel Products
- Wheels and Steel Disc 19.5" Wheels Published by Alcoa Wheel Products

Alcoa Rim Flange Safety Material

- Maintaining Alcoa Aluminum Wheels Rim Flange Wear Instructions
- Rim Flange Wear Gauge

Technical Bulletins available on Alcoa web at [www.alcoawheels.com](http://www.alcoawheels.com).

- Welding Rim Flange or otherwise heating Alcoa Aluminum Wheels
- Altering Alcoa Wheels from original design and use of adaptor plates
- Tire Balancers/Sealants
- Wheel balancing weights
- Mounting/demounting tires on Alcoa 22.5 non-symmetrical wide base wheels
- Rim Flange Wear

# Table of Contents

## 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 Section 3-1). These numbers are cross references to other sections of the manual. The numbers (3-1) refer to section 3, subtopic 1. You will find the section number and subtopic number under the heading in each section.

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# 1 Safety

1

Safe service practices are a matter of life and death.



**WARNING** An inflated wheel and tire assembly contains enough air pressure to cause an explosive separation.

Unsafe handling or failure to follow approved mounting and demounting procedures can lead to serious injury or death.

Study, understand and follow the procedures contained in this manual.

## 1-1

Safety is serious business. All tire shops must know and follow OSHA work regulations... no matter how small the shop. Under U.S. federal law any individual handling tire/wheel assemblies must be trained in OSHA regulations as mentioned in section 7.

Safety is everybody's business. Do not attempt to service any wheel assembly without proper training.

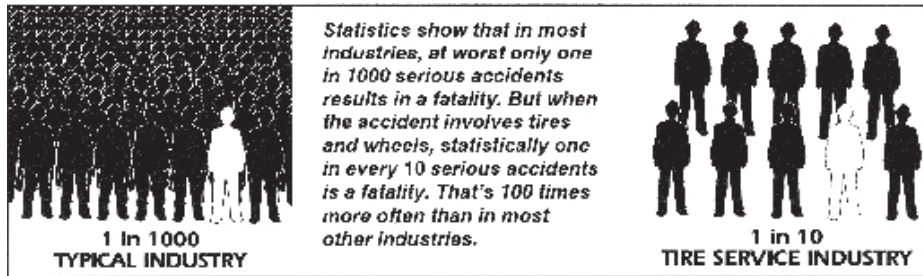
Proper equipment is important. Be sure you have the recommended tools and equipment on hand and use them according to manufacturer's instructions.

Tubeless wheels and tires require the same equal care. Even though tubeless assemblies have fewer parts than multi-piece wheels, they still require respect and proper handling.

Pay particular attention during crucial steps:

- Removal of tire and wheel assemblies from vehicles
- Demounting tire from wheel
- Wheel inspections
- Inflation of tire
- Handling and storing of inflated assembly

Safety and service information is readily available. Wheel, tire and service equipment manufacturers offer service manuals and other training materials. Stay up to date on proper procedures and keep current instructional materials handy in the shop. Study safety and service information and use it on the job.





# 2 Wheel Specifications

Alcoa aluminum disc wheel mounting dimensions are consistent with SAE Recommended Practice J694 June 2007. Part numbers listed for all sizes are brushed finish (the last digit of the six-digit numerical part number is "0"). Polished finishes are indicated by changing the last digit of the part number listed to one of the following: For polished outside only, part number should end in "1." For polished inside only, part number should end in "2." For polished both sides, part number should end in "3." Only for item numbers marked with a single asterisk (\*), part numbers ending in "9" are inset position wheels brushed finished (see footnote).

Dura-Bright® Wheels with XBR™ Technology are identified by using the regular numerical part number and the addition of "DB" at the end. Finishes are indicated by changing the last numerical digit of the part number to one of the following. For brushed both sides, the number is "0." For polished outside only, the number is "1." For polished inside only, the number is "2." For polished both sides, the number is "3." Only the wheel part numbers with available surface finishes having the "DB" suffix are available with the Dura-Bright® with XBR™ Technology option. Dura-Flange® Wear Protection wheels are identified by using the regular numerical part number and the addition of "DF" at the end. Only the wheel part numbers with available surface finishes having the "DF" suffix are available with the Dura-Flange® option. The Dura-Bright® with XBR™ Technology surface treatment and the Dura-Flange® Wear Protection options are currently available together on the same wheel, indicated by the "DD" suffix.

## TUBELESS WHEELS (round hand holes) ENGLISH UNITS

Item no.	Wheel description	Maximum wheel load <sup>1</sup> in lbs.	Ap-prox. Wheel wt. lbs.	Outset inches <sup>3</sup>	Inset inches	Maxi-mum inflation PSI—cold	Valve stem*** (Alcoa Part No.)	Part number <sup>2</sup>	Available finishes <sup>4</sup>	Stabi-lizer	Front outer cap nuts	Rear inner cap nuts Al/Al	Rear in-ner cap nuts Al/Stl	Rear outer cap nuts
Six-hole, stud located, ball seat mounting—8.750 in. bolt circle, 6.495 in. hub bore, 1.219 in. bolt hole diameter Lug nut covers: 150, Hub covers: N/A														
1	17.5x6.75-15°DC	5070	32	5.55	4.72	125	TR553C (005533)	663170	0, 2	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	5996 L&R
10-hole, stud located, ball seat mounting—8.750 in. bolt circle, 6.495 in. hub bore, 1.219 in. bolt hole diameter Lug nut covers: 150, Hub covers: N/A														
2	17.5x6.75-15°DC	5070	31	5.55	4.72	125	TR553C (005533)	663070	0, 2	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	5996 L&R
10-hole, stud located, ball seat mounting—11.25 in. bolt circle, 8.73 in. hub bore, 1.219 in. bolt hole diameter Lug nut covers: 150, Hub covers: Front - 076015, Rear - 077015														
3	22.5x8.25-15°DC	7200	52	6.66	5.68	120	TR555D (005554)	883110	0, 1, 2, 0DB**, 1DB**, 2DB**	2225	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R
4	22.5x9.00-15°DC	9000	60	6.94	5.94	130	TR553C (005533)	893000	0, 1, 2	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R
5	22.5x12.25-15°DC	11,400	62	.56 Revers-ible	—	130	TR553E (005535)	823000	0	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	-	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R
*6	22.5x12.25-15°DC	11,400	66	3.88	2.76	130	TR553E outset (005535) TR555E inset (005555)	823050	0, 1, 2**, 9	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	--	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R
7	22.5x12.25-15°DC	11,000	71	5.84	4.68	130	TR555E (005555)	823060A	0, 1	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	-	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R
††8	22.5x14.00-15°DC	12,800	71	2.0	—	130	TR553E outset (005535)	841100	0, 2**	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	-	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R
9	24.5x8.25-15°DC	7200	59	6.6	5.59	120	TR555D (005554)	983120	0, 1, 2	-	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R	5988 L&R	7896 L&R	3/4" Stud 5995 L&R, 1-1/8" Stud 5996 L&R
Eight-hole, hub piloted mounting—275mm bolt circle, 221.1mm hub bore, 26.75mm bolt hole diameter (use two-piece flange nuts) Lug nut covers: 181 Hub covers: N/A Hub Cover Kits: 082122 (Front 33mm), 082133 (Rear 33mm), 082012 (30mm) 140233A (Stainless Front 33mm), 109176A (Stainless Rear 33mm)														
10	22.5x7.50-15°DC	7300	53	6.28	5.44	120	TR555D (005554)	873400	0**, 1, 2	2225	39874	-	-	39874
11	22.5x8.25-15°DC	7400	50	6.66	5.82	130	TR5554D (005544)	883440	0, 1**, 2, 0DF, 1DF**, 2DF	8864	39874	-	-	39874
††12	22.5x14.00-15°DC	12,800	71	2.0	—	130	TR553E outset (005535)	841400	0**, 2**	-	39874	-	-	39874

This Specifications guide is not inclusive of all applicable Alcoa part numbers. If a part number is not on this list call 1-800-242-9898 for further information.

**TUBELESS WHEELS (round hand holes) ENGLISH UNITS — continued**

Item no.	Wheel description	Maximum wheel load <sup>1</sup> in lbs.	Approx. Wheel wt. lbs.	Outset inches <sup>3</sup>	Inset inches	Maximum inflation PSI—cold	Valve stem*** (Alcoa Part No.)	Part number <sup>2</sup>	Available finishes <sup>4</sup>	Stabilizer	Front outer cap nuts	Rear inner cap nuts Al/Al	Rear inner cap nuts Al/Stl	Rear outer cap nuts
<b>10-hole, hub piloted mounting—285.75mm bolt circle, 220.1mm hub bore, 26.75mm bolt hole diameter (use two-piece flange nuts) Lug nut covers: 181 Hub covers: Front - 076018 or 076085‡ Rear - 077018 or 077085‡ One-Piece hub cover system: Front - 086100S, Rear - 087100S</b>														
14	22.5x7.50-15°DC	7300	53	6.28	5.44	120	TR555D (005554)	873600	0, 1, 2, 0DB**, 1DB**, 2DB**	2225	39874	-	-	39874
15	22.5x8.25-15°DC	7400	47	6.66	5.81	130	TR554D (005544)	883640	0, 1, 2, 3, 0DB, 1DB, 2DB, 3DB, 0DF, 1DF, 2DF, 0DD, 1DD, 2DD	8864	39874	-	-	39874
§16	22.5x8.25-15°DC	8000	55	6.66	5.69	130	TR553C (005533)	885600	0, 1, 2, 0DF, 1DF, 2DF	-	39874	-	-	39874
17	22.5x9.00-15°DC	9000	59	6.94	6.04	130	TR554D (005544)	893640	0, 1, 2, 3, 0DB, 1DB, 2DB, 3DB, 0DF, 1DF, 2DF, 3DF, 0DD, 1DD, 2DD, 3DD	8964	39874	-	-	39874
18	22.5x9.00-15°DC	10,000	53	—	3.12	130	TR555E (005555)	893630	0, 1, 0DB**, 1DB	-	39874	-	-	39874
19	22.5x10.50-15°DC	10,500	68	6.61	5.5	130	TR553 (005530)	803600	1, 1DB**	-	39874	-	-	-
20	22.5x12.25-15°DC	12,300	63	.56 Reversible	-	130	TR553E (005535)	823600	0, 2	-	39874	-	-	39874
*21	22.5x12.25-15°DC	11,400	66	3.88	2.75	130	TR553E outset (005535) TR555E inset (005555)	823650	0, 1, 2, 9, 0DB, 1DB, 2DB, 9DB, 0DF, 1DF, 2DF, 9DF	-	39874	-	-	39874
22	22.5x12.25-15°DC	11,000	68	5.8	4.68	130	TR552 (005520)	823640	0, 1, 0DB, 1DB, 0DF, 1DF	-	39874	-	-	39874
*23	22.5x13.00-15°DC	12,300	70	3.5	2.38	130	TR553E outset (005535) TR555E inset (005555)	833650	0, 1, 2, 9	-	39874	-	-	39874
24	22.5x13.00-15°DC	11,000	74	6.42	5.3	130	TR552 (005520)	833640	0, 1	-	39874	-	-	39874
†125	22.5x14.00-15°DC	12,800	68	2.0	—	130	TR553E outset (005535)	841600	0, 2, 0DB, 2DB	-	39874	-	-	39874
†126	22.5x14.00-15°DC	12,800	71	1.13	0	130	TR555E outset (005555) TR553E inset (005535)	841610	0, 1, 2, 9, 0DB, 1DB, 2DB, 9DB	-	39874	-	-	39874
27	24.5x8.25-15°DC	7400	56	6.6	5.73	130	TR555D (005554)	983640	0, 1, 2, 3, 0DB, 1DB, 2DB, 3DB, 0DF, 1DF, 2DF, 3DF	8864	39874	-	-	39874
§28	24.5x8.25-15°DC	8000	65	6.6	5.63	130	TR555D (005554)	985600	0, 1, 2, 0DF, 1DF, 2DF	-	39874	-	-	39874
<b>10-hole, hub piloted bus mounting—11.25 in. bolt circle, 8.670 in. hub bore, 1.219 in. bolt hole diameter (use two-piece flange nuts) Lug nut cover: 182 Hub covers: N/A</b>														
29	22.5x8.25-15°DC	7300	53	6.66	5.82	120	TR555D (005554)	883610	0, 3, 0DB, 3DB, 0DF, 3DF, 0DD, 3DD	-	-	-	-	-
30	24.5x8.25-15°DC	7300	62	6.6	5.77	120	TR555D (005554)	983610	0**, 3**, 0DB**, 3DB**	2245	-	-	-	-

Specifications are subject to change without notice. To request a copy of the current Alcoa Specifications Data brochure for aluminum wheels for trucks, trailers and buses, call toll-free 800-242-9898. To view online, go to [www.alcoawheels.com](http://www.alcoawheels.com). The Spec Data brochure contains current part number availability and complete specifications such as wheel dimensions, load rating, wheel weight, outset and inset, inflation pressure and accessory part numbers.

Alcoa provides training, live or on video, on proper wheel installation and maintenance practices free of charge. Contact Alcoa Wheel and Forged Products at 800-242-9898.

Note: Dura-Bright® wheels produced after November 2002 have Alcoa wheel part numbers ending with “DB” (earlier wheels have part numbers ending in a 4 or 7). Not all Alcoa wheels are available with the Dura-Bright® surface treatment.

2

**TUBELESS WHEELS (round hand holes) ENGLISH UNITS (METRIC UNITS)**

Item no.	Wheel description	Maximum wheel load <sup>1</sup> in lbs. (kilograms)	Approx. Wheel wt. lbs. (kilograms)	Outset inches <sup>3</sup> (mm)	Inset inches (mm)	Maximum inflation PSI—cold (KPa)	Valve stem*** (Alcoa Part No.)	Part number <sup>2</sup>	Available finishes <sup>4</sup>	Stabilizer	Front outer cap nuts	Rear inner cap nuts Al/Al	Rear inner cap nuts Al/Stl	Rear outer cap nuts
<b>Eight-hole, hub piloted mounting—275mm bolt circle, 221.1mm hub bore, 24.75mm bolt hole diameter (use two-piece flange nuts) Lug nut covers: 181 Hub covers: N/A Hub Cover Kits: 082122 (Front 33mm), 082133 (Rear 33mm), 082012 (30mm) 140233A (Stainless Front 33mm), 109176A (Stainless Rear 33mm)</b>														
31	17.5x6.75-15°DC	5515 (2500)	29.5 (13.4)	5.55 (141)	4.72 (120)	142 (978)	TR553C (005533)	663470	0, 2	-	39874	-	-	39874
32	19.5x6.75RW-15°DC	5515 (2500)	36.4 (16.5)	5.55 (141)	4.72 (120)	142 (978)	TR553C (005533)	764490	0, 1, 2	-	39874	-	-	39874
33	19.5x7.50RW-15°DC	6615 (3000)	37.7 (17.1)	6.10 (155)	5.28 (134)	142 (978)	TR553C (005533)	773400	0**, 1, 2	-	39874	-	-	39874
<b>10-hole, hub piloted mounting—285.75mm bolt circle, 220.1mm hub bore, 26.75mm bolt hole diameter (use two-piece flange nuts) Lug nut covers: 181 Hub covers: Front - 076018 or 076085‡ Rear - 077018 or 077085‡ One-Piece hub cover system: Front - 086100S, Rear - 087100</b>														
34	19.5x7.50RW-15°DC	6615 (3000)	37.7 (17.1)	6.10 (155)	5.28 (134)	142 (978)	TR553C (005533)	773600	0, 1, 2, 3	-	39874	-	-	-
<b>10-hole, hub piloted mounting—335mm bolt circle, 281.2mm hub bore, 26.75mm bolt hole diameter (use two-piece flange nuts), Lug nut covers: 181 Hub covers: 5811 polished with view port for P/N 833580 only, all others: N/A</b>														
†35	22.5x8.25-15°DC	8047 (3650)	50.6 (23.0)	6.57 (167)	5.70 (145)	138 (952)	70MS7 (007007)	886520	0, 3, 0DB, 3DB, 0DF, 3DF, 0DD, 3DD	-	39874	-	-	39874
†36	22.5x9.00-15°DC	9094 (4125)	51.5 (23.4)	6.89 (175)	6.02 (153)	142 (978)	70MS7 (007007)	896520	0, 3, 0DB, 3DB, 0DF, 3DF	-	39874	-	-	39874
‡37	22.5x13.00-15°DC	12,800 (5806)	76.0 (34.5)	—	6.12 (155)	130 (896)	TR553 (005530)	833580	0, 1	-	39874	-	-	39874
38	24.5x8.25-15°DC	8500 (3855)	64.0 (29.0)	6.79 (172.5)	5.81 (147.5)	120 (827)	TR554D (005544)	983500	0, 3	-	39874	-	-	39874
<b>Ten-hole, hub piloted mounting—335mm bolt circle, 281.2mm hub bore, 32.87mm bolt hole diameter (use two-piece flange nuts), Lug nut covers: N/A Hub covers: N/A</b>														
†39	22.5x8.25-15°DC (32mm bolt hole)	8047 (3650)	50.3 (22.8)	6.57 (167)	5.70 (145)	138 (952)	70MS7 (007007)	886510	0, 3, 0DB, 3DB, 0DF, 3DF, 0DD, 3DD	-	4306.32	-	-	4307.32
†40	22.5x9.00-15°DC (32mm bolt hole)	9094 (4125)	51.2 (23.2)	6.89 (175)	6.02 (153)	142 (978)	70MS7 (007007)	896510	0, 3, 0DB, 3DB, 0DF, 3DF	-	4306.32	-	-	4307.32
<b>Six-hole, hub piloted mounting—205mm bolt circle, 160.2mm hub bore, 21.5mm bolt hole diameter (use two-piece flange nuts) Lug nut covers: N/A Hub covers: N/A</b>														
41	17.5x6.00-15°DC	4000 (1814)	27.0 (12.2)	5.0 (127)	4.25 (108)	130 (896)	TR554C	664800	0,1	-	-	-	-	-

Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating. Do not overinflate. Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire, perform a wheel fitment check to ensure proper clearance from any obstructions.

- Capacity ratings as dual or single in highway service — bias-ply or radial. Load ratings in lbs. for items 31 through 41 rounded to nearest multiple of 5.
  - Part numbers listed for all sizes are brushed finish (the last digit of the six-digit numerical part number is "0"). Polished finishes are indicated by changing the "0" with any of the suffixes in the adjacent column (Available Finishes). Some wheels may bear part numbers not shown in this manual. Before servicing these wheels, contact your Alcoa wheel representative for proper load, inflation and part compatibility information.
  - Outset (positive)/inset (negative) — The distance from the rim centerline to the mounting face of the wheel. Inset (negative) places the rim centerline inboard of the wheel mounting face and outset (positive) places the rim centerline outboard of the wheel mounting face (½ dual spacing = offset).
  - The Dura-Bright® surface treatment and the Dura-Flange® options are currently available together on the same wheel, indicated by the "DD" suffix.
- \* Part numbers should end in "1" or "9" when used in an inset position and "0" or "2" when used in an outset position.  
 \*\* This finish is only available under the non-stock policy.  
 \*\*\* TR55XX Valve stems are the standard rim valves with a rubber grommet. TR54XX are an acceptable option with "O" rings.  
 † Indicates European New Generation Wheels.  
 †† Check with vehicle manufacturer or axle manufacturer before retrofitting to outset wide base wheels to ensure compatibility with axle and wheel end components. P/Ns 841100, 841400, and 841600 are not recommended for use on "N" spindle trailer axles.  
 ‡ Hub cover system kits P/N 076085 (front) and P/N 077085 (rear) contain screw-on Hug-a-lug® nut covers and require a minimum of four threads of the stud to extend above the tightened cap nut for use.  
 ‡‡ The minimum stud standout required for P/N 833580 is 2.375 inches (60.3mm) when using wheel nut P/N 39874. Taller nuts will require more stud standout.  
 § P/Ns 885600 and 985600 are Alcoa Severe Service™ Wheels.

Dura-Bright® wheels with XBR™ Technology surface treatment option shine without polishing. Just wash with soap and water, do not polish or clean with abrasives.

For more information call 800-242-9898 or visit [www.alcoawheels.com/durabrightxbr](http://www.alcoawheels.com/durabrightxbr).

# 3 Inspection and Maintenance

## Inspect thoroughly and frequently

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.

### 3-1

It is not always possible to predict the useful life of a wheel. Wheels will eventually wear out. Generally, older wheels and wheels operating in extreme conditions should be examined more frequently for obvious signs that they should be removed from service.

Examine all exposed areas frequently. Clean wheels and look for cracks or other damage. Also check the inner dualed wheel when the outer wheel is removed.

During tire changes, thoroughly examine the entire wheel. Pay particular attention to the rim contour and the surfaces of the rim.

#### Hidden damage

Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

Do not overinflate. Use the tire manufacturer's recommended pressure, but under no circumstances exceed cold tire pressures listed in Section 2 Specifications of this manual. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

Some forms of wheel damage can be hidden beneath the tire, so whenever a tire is removed, thoroughly examine the complete wheel. Remove all grease and road dirt. Use a wire brush or steel wool to remove rubber from the bead seats.

Check mounting holes for the enlargement and elongation which can occur if the cap nuts are not kept tight (see Section 3-8). Dirt streaks radiating from stud holes may indicate loose cap nuts.

## Wheel alteration

Alcoa does not approve any form of alteration to wheels except minor cosmetic buffing for appearance purposes or sanding in the rim flange area (see Section 3-12).

### 3-2

Wheels should not be altered by welding, brazing or other heat application in an attempt to repair or straighten a wheel. Use of adapter plates or bead-locks are not approved on Alcoa wheels.

Wheels should not be painted or otherwise coated in any way that may interfere with the mounting surfaces.

Any wheels that shows signs of alteration should be removed from service and scrapped.



**WARNING**

**WARNING** Welding, brazing or otherwise heating any area of an Alcoa aluminum wheel will weaken the wheel. Weakened or damaged wheels can lead to an explosive separation of tires and wheels or wheel failure on the vehicle.

Explosive separations of tires and wheels or wheel failure on the vehicle could cause serious injuries or death.

Never attempt to weld, braze or heat any surface of an Alcoa aluminum wheel.

# Heat damage

## 3-3



**WARNING** Excessive heat from fire, brake malfunction, wheel bearing failure, tire failure or other sources may weaken the metal and cause the wheel/tire assembly to separate explosively.

Exploding wheel/tire assembly can cause serious injury or death.

Immediately and permanently remove from service any wheel that has been exposed to excessive heat.

Inspect for exposure to excessive heat. A wheel that has been subjected to excessive heat may appear charred or burned. A wheel that has been exposed to excessive heat may appear to be in good condition if it has been cleaned. Do not use any wheel that has been overheated regardless of appearance. Even if a wheel does not appear to be obviously burned, labels, tire bead, brake drum and Disc Mate for evidence of charring, melting, blistering or burning.

A wheel may discolor from excessive heat. It can appear a dull grayish color and will not polish to a bright finish as a typical wheel would.

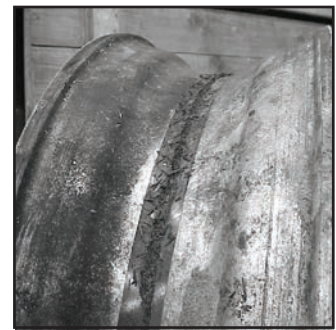
Any wheel run with a flat tire longer than the time necessary to immediately pull off the road should be checked for excessive heat damage.



Charred Sticker (prior to 2009)

After January 2009 the new Alcoa Logo may not show heat damage

A blistered, charred, blackened or cracked-looking logo decal on an Alcoa wheel may indicate that the wheel has been exposed to excessive heat as shown in picture to the left, or discoloration of the wheel as shown in picture to the right

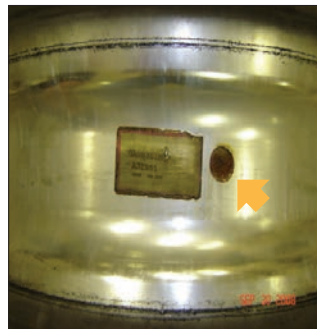


Discoloration of Wheel



Charred Discmate

Inspect all axle end components for signs of exposure to excessive heat. Pay particular attention to brake drums (or discs), Disc Mate wheel liners and tire beads. If these components show signs of over heating, the entire assembly, including the wheel, should be replaced.



Charred Heat Indicator Drop Center (2009 and after)

Wheels manufactured starting in January 2009 will have a 1 inch clear round heat indicator located next to the roll stamp on the inside shown on the left and right, along with the same 1 inch clear round heat indicator located on the tire side drop well as shown in the photo above.

If either of these round labels show signs of blistering, charred, blackened, or cracked look, this may indicate that the wheel has been exposed to excessive heat.



Charred Rubber



Charred Heat Indicator (2009 and after)



Charred Heat Indicator (2009 and after)

**IF ANY OF THE ABOVE CONDITIONS ARE SEEN, REMOVE THE WHEEL FROM SERVICE IMMEDIATELY. THIS INCLUDES ANY HEAT DAMAGE TO THE TIRE, DISCOLORATION TO THE WHEEL, AND OR BRAKE DRUM, AND ANY BURNT OR CHARRED LABELS.**



## Dimension checks

3-4

### Open side circumference check



**WARNING**

**WARNING** Wheels that have been subjected to high pressure tire and rim separation or excessive heat damage may no longer have sufficient dimension and contour to retain the tire bead while under pressure.

Exploding wheel/tire assembly can cause serious injury or death.

Immediately and permanently remove from service any wheel that has been exposed to high pressure tire and rim separation or excessive heat.



**WARNING**

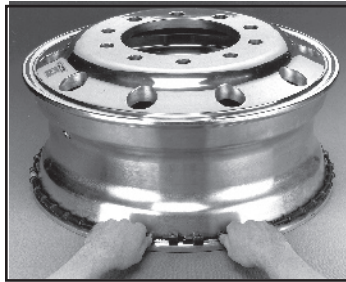
**WARNING** Wheels that have been run flat or have other physical damage may no longer have sufficient dimension and contour to retain the tire bead while under pressure.

Rims that lack proper dimension and contour can lead to explosive separation of the tire and rim, causing serious injury or death.

Any wheel that has been in service must be inspected prior to mounting. Follow dimension check procedures described in this section during each wheel inspection.

#### Best Inspection Method

Photo to the right shows the TRA Ball Tape



Measure the circumference of the bead seat on the open side (see illustration to left) with a ball tape.

The circumference of the bead seat on the open side of the wheel should be checked at each tire change. The open side is the side opposite the disc face. In the case of center flange wide base wheels, or wheels with insets less than 3 inches, both rim flanges should be checked. Any wheel should be inspected prior to mounting. If the circumference of the bead seat does not match the required dimension as indicated by the TRA certified ball tape, immediately and permanently remove the wheel from service.

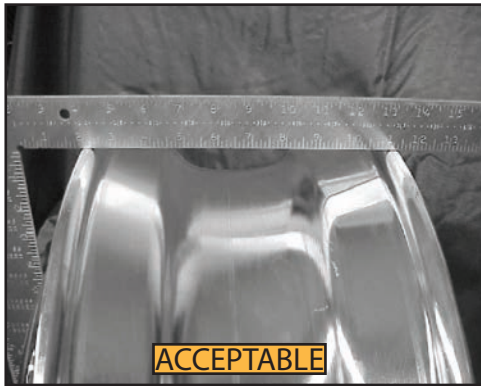
Ball tapes used for measuring wheel circumference can be purchased from the Tire and Rim Association, Inc., 175 Montrose West Avenue, Copley, Ohio 44321. (330) 666-8121 or at [www.rma.org](http://www.rma.org). For instructions on proper use of ball tape, reference the current Tire and Rim Association yearbook.

#### 2nd Best Inspection Method

If a ball tape is unavailable



Dual wheel



**ACCEPTABLE**

Photo above shows carpenter square even on both bead seats.



**UNACCEPTABLE**

Photo above shows an undersized wheel that you can clearly place a credit card (approximately .030 in. or .76mm) between the square and the wheel.

**THIS INSPECTION TECHNIQUE ONLY APPLIES TO DUAL OR DISC FACED WHEELS**

Check all wheels at each tire change for proper contour of the open side of the rim. Place the long leg of a carpenter's square across the center of the disc side of the wheel. Extend the short leg across both rim flanges of the wheel as shown above. Repeat this process at four equidistant points around the wheel.

The short leg should touch both rim flanges at each point. If a distance greater than the thickness of a credit card (or .030 in. or .76mm feeler gauge) appears between the short leg and the rim flange, the wheel should be removed from service and scrapped.

#### 3rd Best Inspection Method

Rolling wheel as described on this page.

If a ball tape or carpenter's square is unavailable, roll the unmounted wheel, without a tire, a minimum of 10 feet over a smooth, flat, level, clean surface such as asphalt or concrete pavement. Any deviation from rolling in a straight line is an indication of a potential lack of proper dimension and contour. Remove the wheel from service until it can be properly checked with a ball tape.

**IF YOU DO NOT FULLY UNDERSTAND ANY OF THESE INSPECTION METHODS AS DESCRIBED IN THIS SECTION CONTACT ALCOA AT 800-242-9898 FOR CLARIFICATION.**

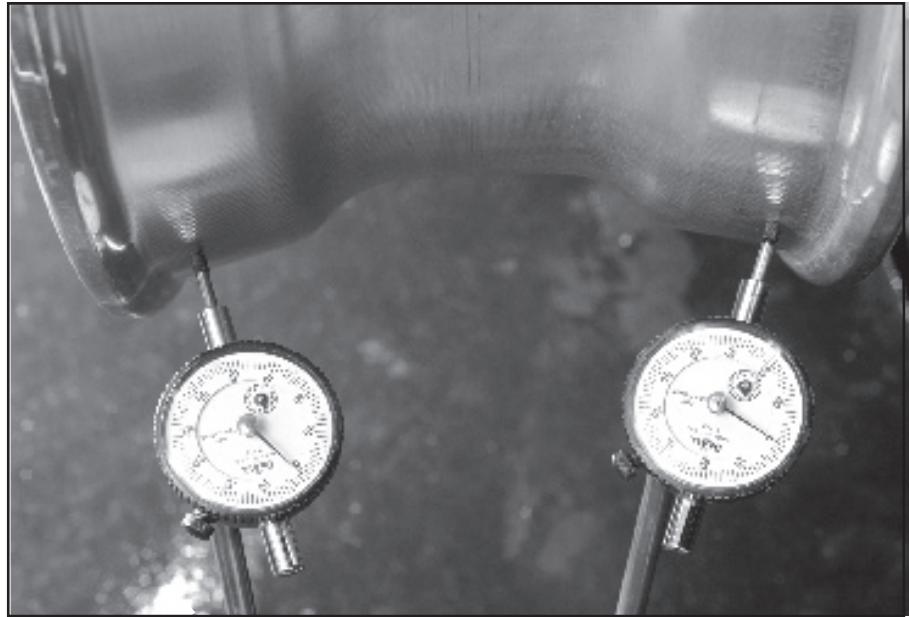
3

## Dimension checks (continued)

### Tire wear or ride problems

If you experience tire wear or ride problems it may be helpful to check radial run out. Remove the wheel from the vehicle, deflate and remove the tire (see Section 4-5, for recommendations and instructions for demounting tubeless tires).

Remount the wheel on the vehicle without the tire. Be sure to follow proper mounting procedures to assure the wheel is well centered on the hub. Place a dial indicator as illustrated below to trace the bead seats of the wheel. Rotate the wheel noting the amount of variation shown on the dial indicator. Note: Alcoa aluminum wheels should be tested for radial run out only at the bead seat surface. A total indicator reading of .040 inches or less is acceptable.



Tire wear can also be caused by improperly seated tires. Inspect the tire for proper seating on the wheel. The tire beads may not be seated properly. If so, remove the wheel from the vehicle, deflate and break the bead seats (see Section 4-5 for recommendations and instructions for demounting tubeless tires). Adequately lubricate the bead seats and properly reseal the tire beads. Reinflate the wheel in a safety cage or other suitable restraint (refer to OSHA rule 1910.177, paragraph b, see Section 7).

## Cracked or damaged wheel checks

### 3-5



**WARNING**

**WARNING** Cracked or damaged wheels may fail or come off the vehicle.

Wheels that fail or come off the vehicle while it is moving can cause serious injury or death.

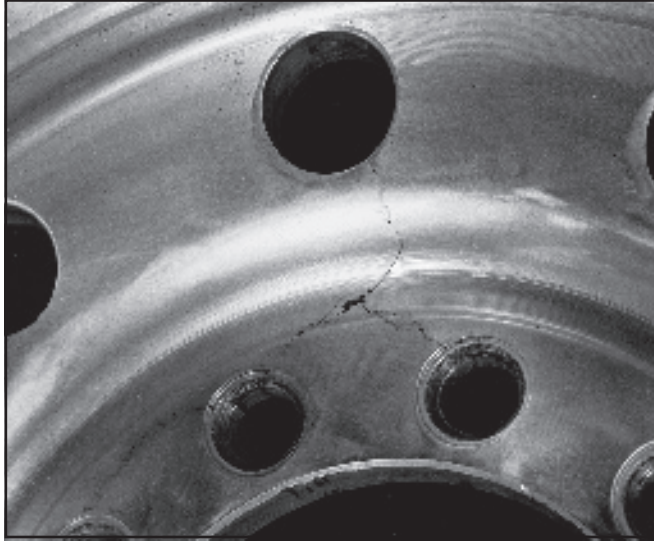
Immediately and permanently remove cracked or damaged wheels from service.

Visually inspect wheels for cracks or damage. Remove wheels from service with known or suspected damage.

## Mounting area

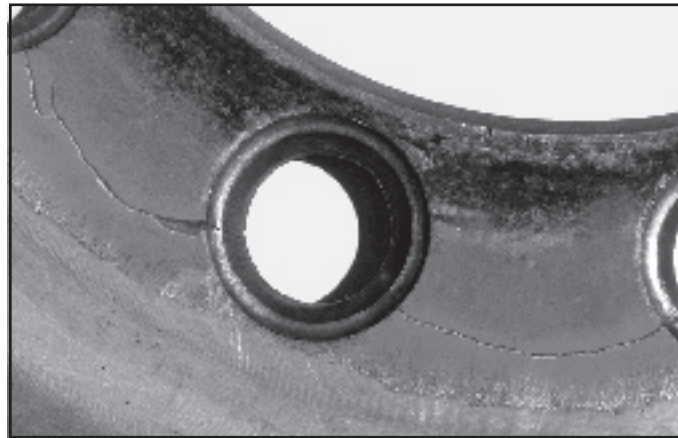
Stud hole cracks are usually caused by improper torquing (see Sections 5-8, and 6-2), excessive loading or insufficient mounting flange support by the hub or brake drum. Remove wheel from service.

### 3-6



Shown below are stud hole cracks emanating from bolt hole to bolt hole. Causes are: undersized diameter of wheel support surface (see specifications on next page), support surface not flat, incorrect attachment parts (see Section 5-2) and insufficient torque (see Sections 5-8, 5-11, 6-2). Remove wheel from service.

Support surface should be flat to the diameter recommended on the chart on the following page.



Inspect the hub/drum contact area thoroughly for cracks or other damage.



## Mounting area (continued)

## Support surface diameters

Support surface should be flat to the diameter recommended per SAE J694:

Number of Bolts	Bolt Circle	Mounting Type	Backup Diameter	Thread Size
10	11.25 inch	U.S. Stud pilot	13.2-13.5 in.	.750/1.125 in.
10	285.75mm	Hub pilot	13.2-13.4 in.	22mm
10	335mm	Hub pilot	15.0-15.2 in.	22mm
8	275mm	U.S. Stud pilot	13.2-13.5 in.	22mm
8	275mm	ISO Hub pilot	12.4-12.6 in.	20mm

## Corrosion

Certain environments can lead to corrosion. Some of the more common corrosives are: salt, magnesium chloride and calcium chloride compounds used for snow removal and highly alkaline materials. If the air used to fill tubeless tires, or the tire itself, is not dry, the areas of the wheel under the tire can corrode severely.

### 3-7

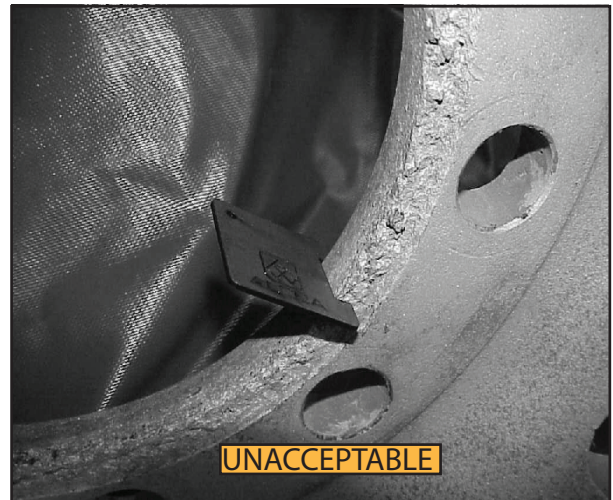


Bead seat and valve stem corrosion often are caused by entrapped moisture. Mild corrosion should be removed thoroughly by wire brush and the rim protected with non-water-based tire lubricant (see Section 4-1). Remove any severely corroded wheel from service.



**ACCEPTABLE**

Hub bore gauge does not fit.



**UNACCEPTABLE**

Hub bore gauge with severe corrosion. Remove any severely corroded wheel from service



CAUTION

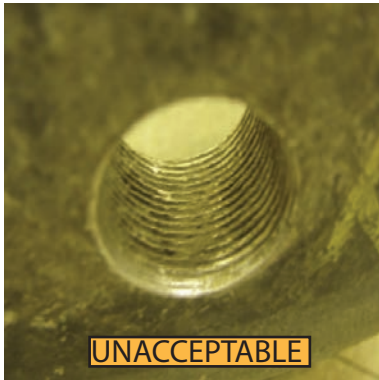
**CAUTION** The use of liquid tire balancers or sealants in Alcoa wheels may cause extremely rapid corrosion of the wheel rim surface.

Severely corroded wheels are unsuitable for service. Alcoa wheels corroded by the use of liquid tire balancers or sealants will not be replaced under the Alcoa limited warranty.

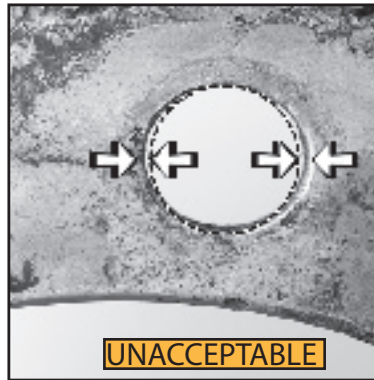
## Bolt holes

If wheels are run loose, both stud located wheels and hub piloted wheels can be damaged. Look for wallowed out or elongated ball seats on stud located wheels. On hub piloted wheels look for elongated stud holes. Over torquing can lead to damaged ball seats on stud located wheels and can damage the disc surface of hub piloted wheels. Remove damaged wheels from service.

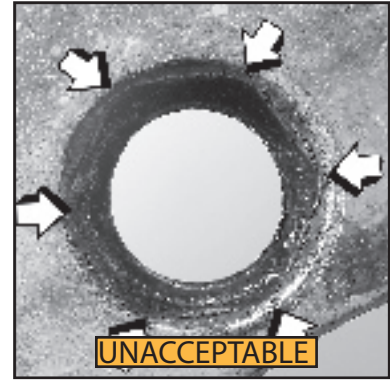
3-8



For hub piloted - normally if you see thread marks on the inside diameter of the bolt holes, this would indicate the wheel ran loose.



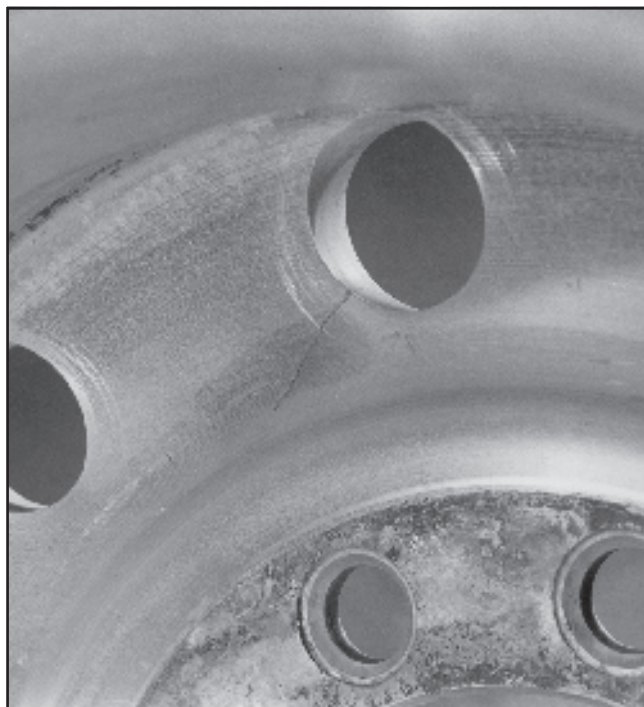
For hub piloted - normally if you see a wallowed out bolt hole, this would indicate the wheel ran loose.



Damaged ball seat contact area. Pounding of nut on ball seat contact area identified by arrows.

## Disc area

3-9



Inspect both sides of disc area for hand hole cracks. If cracks are found, remove the wheel from service.

## Rim area

Check the entire rim area for nicks, gouges and cracks. Loss of air may be caused by cracks in areas around the valve stem hole. Remove the wheel from service.

### 3-10



Drop center crack



Valve hole crack

## Bead Seat area

Loss of air may be caused by cracks in the bead seat areas around the rim. Remove the wheel from service if damaged.

### 3-11



Bead seat cracks are normally caused by overloading of the wheels. If you have this type of wheel breakage it would be recommended to use SEVERE SERVICE WHEELS.



## Rim flange wear

3-12

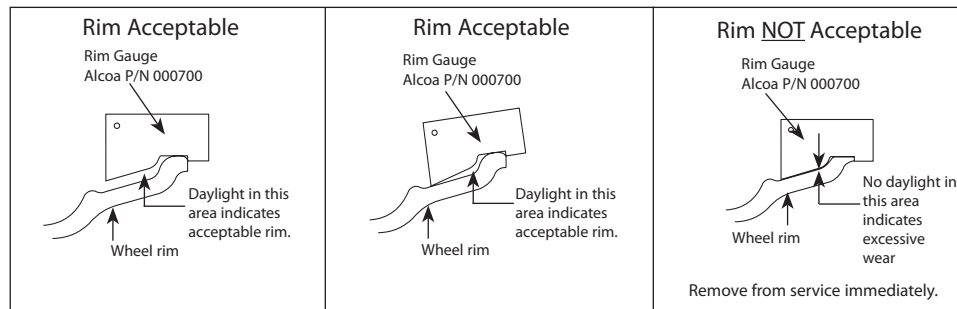
Rim Flange wear is not a warrantable issue. Only Dura-Flange® wheels have a warranty on rim flange wear against sharp edges for the 24 month warranty period.



Irregular wear on the surface of the rim flange is caused by abrasion from the tire chafer and sidewall. Rim flange wear happens most often in applications with heavy or shifting loads. If you are experiencing excessive rim flange wear in your operation, consider using Alcoa Dura-Flange® aluminum wheels. These wheels have been specially treated to significantly reduce rim flange wear. Remove wheels from service when rim flange wear is excessive. Excessive wear can be determined using an Alcoa approved wear gauge and procedures detailed below. If rim flange wear becomes sharp and/or cuts the tire, contact Alcoa for recommended maintenance procedures.

### Alcoa Rim Flange Wear Gauge Instructions

THESE GAUGES ARE TO BE USED FOR RIM FLANGE WEAR ONLY. THEY ARE NOT A BEAD SEAT ANGLE OR DIAMETER TOOL



To obtain a gauge(s) at no charge and information on free training on proper installation and maintenance procedures, contact Alcoa Wheel Products at (800) 242-9898 or on the web at [www.alcoawheels.com](http://www.alcoawheels.com).

### Determining Rim Flange Wear

STEP 1. Remove the wheel/tire assembly from the vehicle. Remove the valve core to deflate the tire completely. Remove the tire from the wheel according to OSHA regulations, TMC recommended practices for tire and rim safety procedures and/or the Alcoa Wheel Service Manual.



## Rim flange wear (continued)

STEP 2. After the wheel is separated from the tire, verify the circumference of the bead seat on the open side is acceptable (see Section 3-4). Check the wheel flange with the Alcoa Rim Flange Wear Gauge to determine if the wheels must be removed from service for excessive rim flange wear (photo 1 on previous page).

See Rim Flange Wear Gauge Instructions on the illustrations on previous page to make this determination. If you do not have an Alcoa Rim Flange Wear Gauge, contact Alcoa Wheel Products to obtain a gauge(s) at no charge by calling (800) 242-9898 or on the web at [www.alcoawheels.com](http://www.alcoawheels.com).

STEP 3. If the wheel is deemed to be serviceable by the rim flange gauge, examine the wheel flange edge for sharpness by using a rubber sharpness gauge. These gauges are constructed by having a section of tire side wall or a suitable piece of rubber attached to a block of wood (photo 2). By running the sharpness indicator gauge along the wheel in the area of the wear, determine if the wear is sharp enough to cut or damage the rubber on the sharpness indicator (photo 3). If the rubber is cut, then follow the edge removal instructions below.

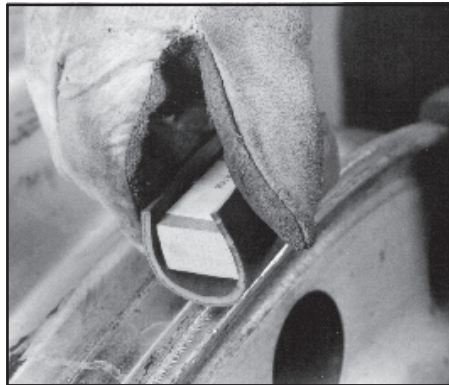


Photo 2. A rubber sharpness gauge or a suitable piece of rubber attached to a block of wood.

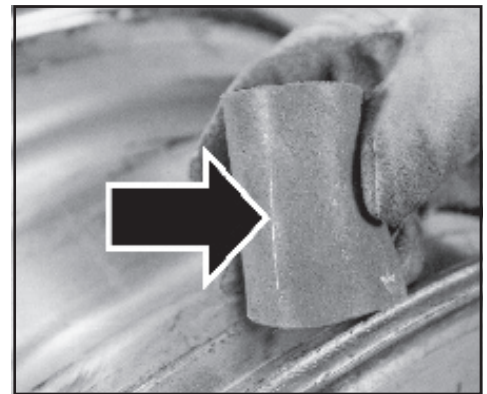


Photo 3. Run the sharpness indicator gauge along the wheel in the area of the wear to determine if the wear is sharp enough to cut or damage the rubber on the sharpness indicator.

NOTICE: Examine the tire for cuts in the bead area and side wall. If no damage occurred to these areas, return the tire to service. Cut tires should be removed from service. The tire should be inspected at this time for any other damage and be treated per normal tire procedures recommended by the tire manufacturer.

NOTICE: Check the wheel at every tire change or ONCE PER YEAR for rim flange wear and any sharp edges. If you follow this practice, you will significantly reduce the possibility of a rim flange cutting into the tire.

If the flange cuts or appears close to being sharp enough to cut the rubber on the sharpness indicator gauge, the edge can be removed per the edge removal procedures below. If the rubber is not cut, then the wheel can be returned to service without further work for rim flange wear.



**CAUTION** Do not run unprotected hands or fingers across worn rim flange areas of used wheels.

Worn rim flange areas are sharp and can cut hands or fingers. Cuts can lead to infection.

Always wear gloves when handling used wheels or when testing for edge sharpness.

## Rim flange wear (continued)

### Edge Removal Procedures

There are many tools available to remove the sharp edge on the wheel caused by rim flange wear. Here are some examples of commonly used tools:

File. A file can be used very effectively to remove the edge (photo 4).

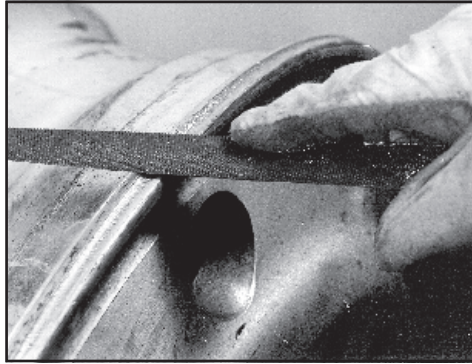


Photo 4. Removing sharp edge by hand with a metal file.

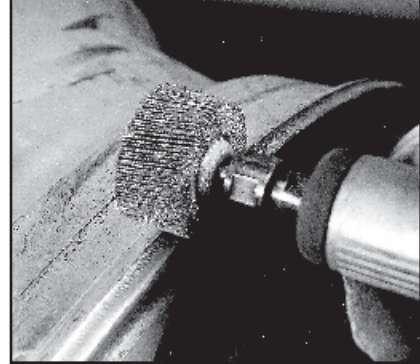


Photo 5. Air or electric power sander.

Air or Electric Powered Sander. This provides a very quick and effective method of removing the edge. Operators should use all care to keep a uniform edge when using these tools (photo 5).

Air or Electric Grinder. Another quick and effective method of removing the sharp edge caused by rim flange wear. Be careful as grinding pads may “gum up” from the aluminum that is removed (photo 6). Care must be used to avoid gouging the wheel.

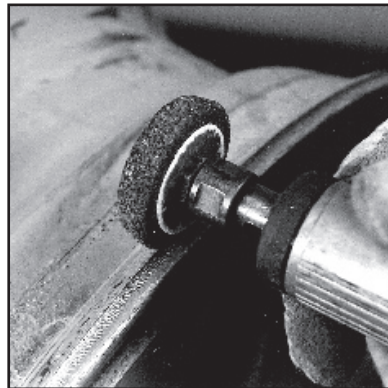


Photo 6. Air or electric grinder

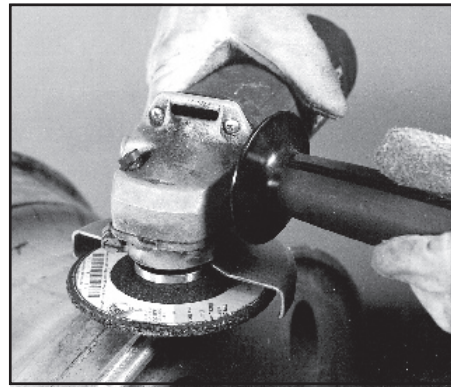


Photo 7. Die grinder.

## Rim flange wear (continued)

Die Grinder. Used with a sanding wheel, cutting stone or grinding tool, this is a version of an electric grinder. This tool is very quick and effective as well, and care must be taken to remove metal as uniformly as possible and not to gouge the wheel (photo 7 on previous page).



**CAUTION** Removing sharp edges with hand or power tools produces metal filings and sparks. Many power tools have edges that are sharp or may become hot during use. Some power tools produce excessive noise when used.

Metal filings can be sharp and, when projected by the action of power tools, can cause serious skin or eye damage. Excessive noise from power tools can harm hearing. Sharp edges can produce cuts and hot surfaces can cause burns. Cuts and burns can lead to infection.

Always wear appropriate safety gear such as protective eye wear, gloves, protective clothing and hearing protection when using hand or power tools.



Photo 8. Severe rim flange wear.

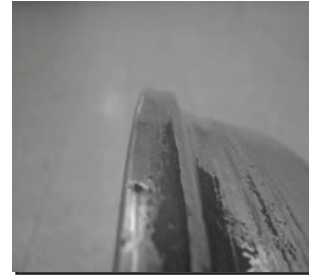


Photo 9. Sharp edge removed.

STEP 4. These photographs show the process of removing the edge. Using whatever tool is selected, work the tool around the wheel's circumference removing only enough material to eliminate the sharp edge. This should only be a small amount of metal. Perform this work on both flanges if there is evidence of sharpness.

Regardless of the method which you choose, the objective is to remove only the sharp edge (photo 9). Remove just enough metal to smooth the edge. Take care to make sure the edge removal is as uniform as possible. Avoid gouging the wheel.

## Rim flange wear (continued)

STEP 5. After the edge is removed, run the sharpness indicator gauge along the area of edge removal to check for any remaining sharpness. If the rubber is still cut, perform the steps again to remove the sharp edge. Always remove the minimum amount of material necessary to eliminate the sharp edge.

STEP 6. Check the rim flange height with the Alcoa Rim Flange Wear gauge to make sure there is adequate height remaining to safely support the tire. The photograph again shows how this gauge is used (photo 1). Be sure to move the gauge all around the wheel's circumference and make sure that no area of the flange is below what the gauge indicates is acceptable. If the entire wheel flange is within the limits of the rim flange wear gauge, the wheel may be returned to service.

STEP 7. Always inspect the wheel for any other conditions that would warrant removal from service. Consult the Alcoa Wheel Service Manual or the TMC User's Guide to Wheels and Rims.



**WARNING**

**WARNING** Welding or brazing the rim flange or any area of an Alcoa aluminum wheel will weaken the wheel. Weakened or damaged wheels can lead to an explosive separation of tires and wheels or wheel failure on the vehicle.

Explosive separations of tires and wheels or wheel failure on the vehicle could cause serious injury or death.

Never attempt to weld or braze any surface of an Alcoa aluminum wheel.



**WARNING**

**WARNING** Returning wheels to service with inadequate flange height as determined by the Alcoa Rim Flange Wear Gauge can lead to an explosive separation of tires and wheels.

Explosive separation can cause serious injury or death.

Wheels with flange height that falls below the Alcoa gauge have inadequate rim flange height to support the tire on the rim. Immediately and permanently remove any wheel from service that has inadequate rim flange height.



**WARNING**

**WARNING** Excessive heat from fire, brake malfunction, wheel bearing failure, tire failure or other sources may weaken the metal and cause the wheel/tire assembly to separate explosively.

Exploding wheel/tire assembly can cause serious injury or death.

Immediately and permanently remove from service any wheel that has been exposed to excessive heat.

Always follow safe mounting procedures as recommended using OSHA approved tire inflation cages. See the Alcoa Wheel Service Manual or OSHA safety wall charts and procedures.



## Dura-Flange<sup>®</sup> maintenance

### 3-13

1. Dura-Flange<sup>®</sup> has a 24 month warranty against wear which creates a sharp edge that would require maintenance per section 3-12.
2. Minor wear or minor pitting is not a warrantable condition.
3. Edge re-conditioning cannot be performed on Dura-Flange<sup>®</sup> wheels including those described in Section 3-12.

## Maintenance against corrosion<sup>®</sup> (non-Dura-Bright<sup>®</sup> surface treated wheels)

### 3-14

The following information is for standard Alcoa forged aluminum wheels without the Dura-Bright<sup>®</sup> surface treatment. See Section 3-15 for specific instructions on the care and cleaning of Alcoa Dura-Bright<sup>®</sup> surface treated wheels.

1. Clean frequently with high pressure water from a hose. The use of a mild detergent will speed the cleaning process. Use no strong cleaners.
2. When tires are removed the entire wheel must be cleaned and inspected. (See Section 3). With a wire brush, remove any foreign products from the tire side of the rim. Do not use a wire brush to remove dirt and corrosion products from the appearance surface of the wheel. Generously coat the entire air chamber surface with an approved surface protectant and lubricant each time the tire is removed (see Section 4-1).
3. To maintain the original appearance of your Alcoa wheels, the following procedures are recommended:
  - a. After installing new wheels and prior to operating your vehicle, use a sponge, cloth or soft fiber brush to wash exposed wheel surfaces with a mild detergent and warm water solution.
  - b. Rinse thoroughly with clean water.
  - c. Wipe dry to avoid water spots.
  - d. Wax the cleaned surface with Alcoa Advanced Aluminum Care System Polish or any automotive polish equivalent.
  - e. Clean your Alcoa truck wheels as frequently as required to maintain their appearance.

## Dura-Bright<sup>®</sup> surface treated wheels cleaning and maintenance

### 3-15

1. The Dura-Bright<sup>®</sup> surface treatment is designed to be easy to clean and generally only requires water. If soils attached to the surface do not come off with cold water, try warm water and wipe with a soft towel or chamois material. If soils remain, use warm water and a mild detergent (with assistance of a commercial high pressure power washer, if available). Always dilute the detergent according to the manufacturer's recommendation; never use the detergent straight without diluting with water. In the mixed, diluted state the cleaner acidity should be at pH equal or greater than 5; avoid cleaners that contain any hydrofluoric acid. In the mixed, diluted state the cleaner alkalinity (basicity) should be at pH equal or lower than 9.
2. When tires are removed, the entire rim must be cleaned and inspected (see Section 3). With a soft brush, remove any foreign products from the rim (portion of the wheel that supports the tire). Generously coat the entire air chamber surface with an approved surface protectant and lubricate each time the tire is removed (see Section 4-1).
3. Once in service, Dura-Bright<sup>®</sup> wheels can become nicked or scratched by road debris and/or mechanical damage. If this occurs, continue to follow the normal washing and cleaning instructions provided above.
4. Even as durable as Dura-Bright<sup>®</sup> wheels are, the mounting area can become scratched, marred or discolored when mounted against another wheel, hub or drum. The use of a wheel mounting surface guard, such as Disc Mates, are highly recommended.
  - Note: pH value can be found in chemical MSDS (Material Safety Data Sheet). If the cleaner is in concentrated form, contact your cleaning chemical supplier to determine pH

Only Alcoa's Warranty Center can authorize warranty claims and determine justified warranty returns. Dura-Bright<sup>®</sup> and Dura-Flange<sup>®</sup> claims can only be authorized and determined by Alcoa's Warranty Center.

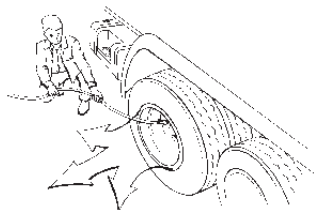
# 4 Mounting Alcoa wheels with Tubeless Tires

## Recommendations for mounting tubeless tires

### 4-1

NOTICE: For complete information on tube type wheels, contact Alcoa at (800) 242-9898.

NOTICE: Alcoa aluminum non-symmetrical wheels require special tire mounting techniques, see Section 4-3.



WARNING

**WARNING** Damaged tires or wheels can lead to an explosive separation of tires and wheels.

Explosive separation can cause serious injury or death.

Inspect tires and wheels for damage before removing from vehicle. If damage is found, the tire must be completely deflated before loosening cap nuts. Immediately and permanently remove damaged tires or wheels from service.



WARNING

**WARNING** Use of inner tubes in tubeless wheels will hide slow leaks. Slow leaks may indicate cracked (see Section 3-10, 3-11) or damaged wheels which lead to wheel failures.

Wheel failures can cause accidents which may result in serious injury or death.

Never use an inner tube on an Alcoa tubeless wheel. Immediately and permanently remove cracked or damaged wheels from service.

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<sup>®</sup> surface treated wheels since minor nicks and scratches cannot be polished out (see Section 3-15, pages 19 for specific cautions, care and maintenance procedures). Disc Mate wheel spacers are recommended for use with Alcoa Dura-Bright<sup>®</sup> surface treated wheels to protect the wheel contact surfaces from marring.
2. Always use a rubber, leather-faced or plastic mallet.
3. Inspect the wheel for damage. Do not use a damaged or severely corroded wheel (see Section 3).
4. Clean the wheel face with mild detergent and the tire bead seat areas with a wire brush. Be sure the wheel is dry before applying tire lubricant.
5. Inspect the tire for damage. Be sure the inside of the tire is dry before it is mounted.
6. Use of a non-water-based lubricant is recommended as a rim surface protectant and tire mounting lubricant. Coat the entire rim surface (see Section 4-2).
7. Lubricate the rim and tire bead immediately before mounting the tire. Do not use any lubricant which contains water. Water-based lubricants can promote corrosion attack on the rim surface. The use of non-water-based lubricants is especially important when mounting tubeless tires as the air in the tire is contained by the seal between the bead and tire rim.
8. Never lubricate the rim or tire bead with a flammable solution. This can lead to an explosion during airing of the tire or in subsequent operation of the vehicle (see Warning on next page).
9. If using a tire mounting/demounting machine on aluminum wheels, care should be taken to prevent gouging the wheel.
10. Use only dry air for tire inflation. The use of moisture traps in the air compressor feed line is recommended.
11. Do not overinflate. Use the tire manufacturer's recommended pressure, but under no circumstances exceed cold tire pressures listed in Section 2 Specifications of this manual (see page 3).
12. When inflating a tire always use a clip-on air chuck or threaded straight chuck and a remote valve with pressure gauge.

## Recommendations for mounting tubeless tires (continued)



**WARNING**

**WARNING** Never use a volatile or flammable material, such as ether or gasoline, as an aid to seating the tire beads on the wheel can lead to an uncontrolled pressure build-up in the tire and may result in an explosion.

Explosive separation of the tire and wheel can occur while seating beads in this manner, while adding air to the tire on or off the vehicle, or later on the road. Loss of vehicle control can result, which can cause serious injury or death.

Only use approved mechanical or pneumatic bead seating devices.



**WARNING**

**WARNING** A pressurized tire/wheel assembly can explode and separate violently.

This violent separation can cause serious injury or death.

Always contain the tire/wheel assembly in an inflation cage during inflation.

## Mounting tubeless tires

### 4-2

**NOTICE:** Not all tire mounting/demounting machines work alike. Be sure to read the operating or instruction manual for your particular machine before attempting to mount or demount tires.

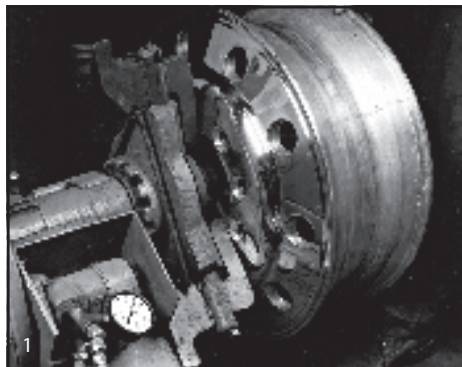
**NOTICE:** Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

**NOTICE:** When match mounting tires on Alcoa wheels locate valve stem adjacent to low point mark on the tire.

**NOTICE:** Alcoa aluminum 19.5" non-symmetrical wheels require tires to be mounted and demounted over the disc side of the wheel only.

**NOTICE:** Refer to tire manufacturer's recommendation for proper tire pressure.



1 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.



2 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.



3 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.



4 Place tire/wheel assembly inside safety cage or other suitable restraint (refer to OSHA rule 1910.177, paragraph b, see Section 7). Refer to tire manufacturer's recommendation for proper tire pressure. Using a clip-on air chuck or a self-locking straight chuck with remote valve and pressure gauge, inflate the tire/wheel assembly to proper pressure. If air escapes, roll tire or use bead expander to force tire beads against rim. Be sure to stay out of the path of potential exploding parts or air blasts.

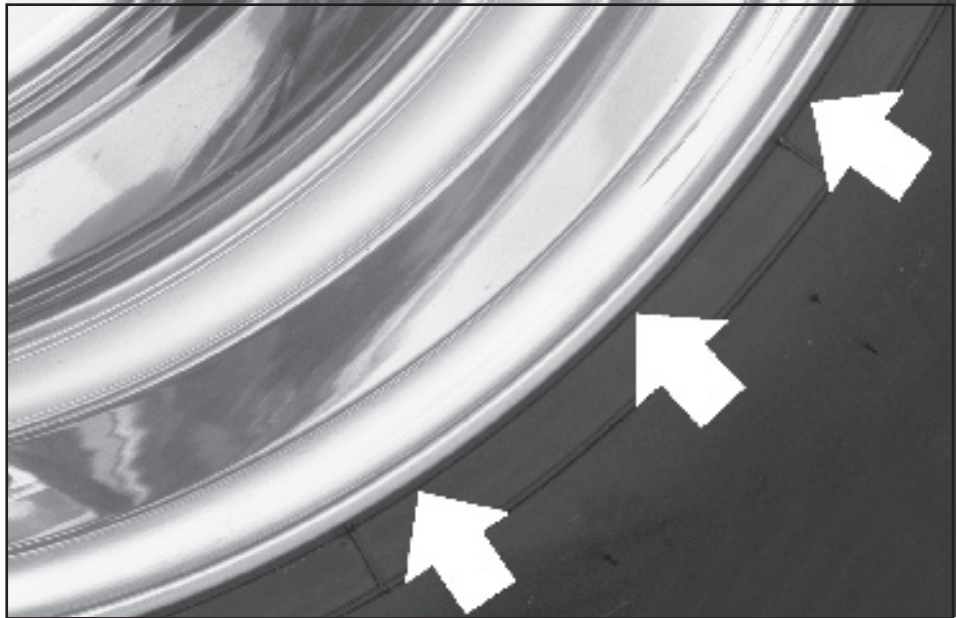
## Mounting tubeless tires (continued)



CAUTION

CAUTION The use of liquid tire balancers or sealants in Alcoa wheels may cause extremely rapid corrosion of the wheel rim surface.

Severely corroded wheels are unsuitable for service. Alcoa wheels corroded by the use of liquid tire balancers or sealants will not be replaced under the Alcoa limited warranty.



Heavy duty truck tires have a "guide rib" molded into the sidewall next to the tire bead. When the tire is inflated this ring should be evenly spaced from the wheel rim all the way around the wheel. Check the position of the ring before removing the assembly from the inflation cage. If the ring and wheel are not concentric, deflate the assembly in the cage and remount the tire.

## Mounting tires on non-symmetrical drop well wheels

Alcoa wheels often contain a symmetrical drop well with a narrow ledge on both sides of the rim. This feature allows mounting of the tire from either side of the wheel. However, some Alcoa wheels are non-symmetrical and contain a narrow ledge on only one side of the wheel. Reduced well wheels as well as some other wheel designs feature an increased underwell diameter and also have a non-symmetrical sloping rim profile which provides additional brake clearance.

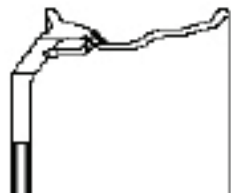
In order to minimize the possibility of tire bead damage, all mounting and dismounting of the tire should be performed only from the narrow ledge side of the wheel in accordance with OSHA regulation.

Tires should be mounted/demounted only across the disc side of the wheel.

4-3



Mount from this side



Do not mount from this side



Mount from this side



Do not mount from this side

## Rim width to tire matching

4-4

## Rim to tire matching chart for medium and heavy trucks.

Tire Size (for both radial and bias tires)	Approved Rim Widths	Tire Size (for both radial and bias tires)	Approved Rim Widths
8R17.5	5.25, 6.00	8R22.5	5.25, 6.00, 6.75
9R17.5	6.00, 6.75	9R22.5	6.00, 6.75, 7.50
10R17.5	6.75, 7.50	235/80R22.5	6.75, 7.50
11R17.5	7.50, 8.25	245/75R22.5	6.75, 7.50
		10R22.5	6.75, 7.50, 8.25
		255/70R22.5	7.50, 8.25
		255/80R22.5	7.50, 8.25
		275/80R22.5	7.50, 8.25
		11R22.5	7.50, 8.25
		265/75R22.5	7.50, 8.25
		12R22.5	8.25, 9.00
		295/60R22.5	8.25, 9.00
		295/75R22.5	8.25, 9.00
		305/75R22.5	8.25, 9.00
		305/85R22.5	8.25, 9.00
		315/80R22.5	9.00, 9.75
		335/65R22.5	9.00, 9.75, 10.5
		15R22.5	11.75, 12.25
		385/65R22.5	11.75, 12.25
		425/65R22.5	11.75, 12.25, 13.00
		16.5R22.5	12.25, 13.00
		18R22.5	13.00, 14.00
		445/50R22.5	14.00
		445/55R22.5	14.00
		445/65R22.5	13.00, 14.00
8R19.5	5.25, 6.00, 6.75	1124.5	7.50, 8.25
225/70R19.5	6.00, 6.75	275/80R24.5	7.50, 8.25
245/70R19.5	6.75, 7.50,	285/75R24.5	8.25
265/70R19.5	7.50, 8.25	12R24.5	8.25, 9.00
445/65R19.5	13.00, 14.00		

There may be additional rim to tire matches not shown above. Contact the tire manufacturer or your Alcoa wheel representative for additional information.

## Recommendations for demounting tubeless tires

4-5



**WARNING**

**WARNING** An aluminum wheel can be structurally weakened by excessive heat.

Tire/wheel assemblies using wheels that have been exposed to excessive heat may experience a sudden and unpredictable tire/wheel separation causing serious injury or death.

Immediately and permanently remove any wheel from service that has been subjected to excessive heat (such as a tire fire, wheel bearing failure or braking system drag/seize) or a high pressure tire/wheel separation.



**WARNING**

**WARNING** Damaged tires or wheels can lead to an explosive separation of tires and wheels.

Explosive separation can cause serious injury or death.

Inspect tires and wheels for damage before removing from vehicle. If damage is found, tire must be completely deflated before loosening cap nuts. Immediately and permanently remove damaged tires or wheels from service.

4



## Recommendations for demounting tubeless tires (continued)

1. When hand demounting tires from wheels, placing aluminum wheels on a clean wooden floor or rubber mat is recommended. Remove valve core/air from tire wheel assembly prior to removal from vehicle. Additional care should be used when demounting Alcoa Dura-Bright<sup>®</sup> surface treated wheels since minor nicks and scratches can not be polished out (see Section 3-15, for specific cautions, care and maintenance procedures).
2. Always use a rubber, leather-faced or plastic mallet.
3. Keep tire tools smooth. Use them with care. Rim gouges or nicks may cause cracks.
4. If using a tire mounting/demounting machine on aluminum wheels, care should be taken to prevent gouging the wheel.

# 4

## Demounting of tubeless tires

### 4-6

**NOTICE:** Not all tire mounting/demounting machines work alike. Be sure to read the operating or instruction manual for your particular machine before attempting to mount or demount tires.



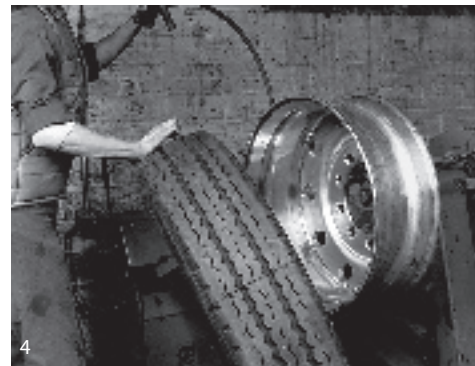
Remove the valve core from the valve stem to ensure complete deflation. Place wheel on machine and position tool so flat end can be driven between tire bead and rim flange. Straighten tool to a vertical position until bead is separated from wheel.



Repeat procedure at intervals until bead is totally separated from wheel. Repeat procedure on other side of tire. Tire is now ready for demounting. Lubricate the tire bead.



Insert curved end of tire tools between tire and wheel, approximately 10 inches apart. Pull one tool toward center of wheel, then pull second tool in the same manner. To free bead, leave one tool in position, take out and reinsert the other tool, curved end between bead and flange, a short distance from the spanned area. Pry bead free of rim, repeating process until entire bead is free from wheel.



Insert straight end of tire tool between beads and both rim flanges, hooking stop on the tool over second flange. Position inserted tool at 90° angle to tire assembly at top of wheel and lubricate bead areas on both sides of tool. Lean tire assembly toward tool and rock or bounce to pry off the tire.

# 5 Wheel Installation

## Recommendations for proper installation of wheels

### 5-1

**NOTICE:** Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

**NOTICE:** Check for and replace bent, broken, cracked or damaged studs. When replacing broken studs, always replace the studs on each side of the broken stud. If two or more studs are broken, replace all the studs for that wheel position. Check with the stud manufacturer for regular maintenance and stud replacement practices. All wheel fastener hardware should be grade 8 or metric conversion 10.9. Follow the hardware manufacturer's recommendations when replacing studs.

1. Make sure all wheel cap nuts are properly torqued — check them often (see Section 5-8). If the wheel is loose, the holes will pound out (deform). If some cap nuts are tight and others are loose, the wheel may develop cracks or studs may break. This condition may cause wheel to loosen and disengage from the vehicle. Dirt streaks or rust radiating from stud holes can indicate loose nuts (see Section 3).
2. Be sure the end of the wheel wrench is smooth or cover the wheel mounting surface with a protective shield prior to tightening the cap nuts. The wrench end will mar the wheel around the cap nuts if it is not smooth.
3. Keep all component contact surfaces smooth and clean. Dirt or projections on mounting surfaces may lead to loose wheels. Remove all projections resulting from burrs, nicks, etc. Be sure that loose dirt does not fall onto mounting surface during assembly.
4. Do not introduce any foreign objects such as spacers or top hats into the contact surface areas of the mounting system unless approved by Alcoa. Do not paint Alcoa forged aluminum wheels.
5. Additional care should be used when mounting Alcoa Dura-Bright<sup>®</sup> surface treated wheels since minor nicks and scratches cannot be polished out (see Section 3-15, for specific cautions, care and maintenance procedures).
6. Disc Mates are a protection gasket designed to be placed between the wheels and also the brake drum/wheel contact surfaces (see Sections 5-2, 5-6, 5-7, 5-9). Disc Mates are recommended to be replaced when the tire/wheel assemblies are removed and reinstalled.



**WARNING** Wheels that are not properly installed or maintained may not be safe.

Failure to follow proper wheel installation or maintenance practices may result in serious injury or death.

Follow the proper wheel installation and maintenance practices as contained in this Alcoa Wheel Service Manual. For training on proper installation and maintenance, available free of charge from Alcoa, or for the most recent updates, contact Alcoa Wheel Products at 1-800-242-9898 or on the web at [www.alcoawheels.com](http://www.alcoawheels.com).

# Wheel cap nuts

## 5-2



WARNING

**WARNING** Use of chrome-plated cap nuts which have chrome plating on the surfaces which contact the wheel can cause reduced and inconsistent wheel clamping.

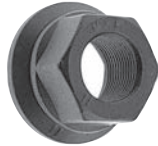
This condition can cause wheels to loosen and disengage from the vehicle, causing serious injury or death.

Never use cap nuts with chrome-plated contact surfaces. Use only recommended hardware on Alcoa aluminum wheels.

There are many types of nuts and studs in use, and their design and specifications are not standardized. The “R” and “L” on cap nut part numbers indicate right and left-hand threads respectively. Alcoa recommends the following cap nuts for use with Alcoa aluminum truck wheels:

### Cap Nuts

NOTICE: One-piece flange nuts are not approved for use on any Alcoa wheel application.



2-piece 33mm hex head flange nut. Mounts single and dual wheels to wheel centering hubs. Right hand threads used on both sides of vehicle. Single wheels require 2" (50.8 mm) stud stand-out. Dual wheels require 2-13/16 (71.44 mm) stud stand-out. P/N 39874 (supersedes P/Ns 39701 and 39691); M22-1.5 RH threads.



2 piece 1-1/16" hex head flange nut. Mounts single and dual wheels to wheel centering hubs. Right hand threads used in both sides of vehicle. P/N 39946; 5/8"x18 RH threads



2-piece 30mm hex head flange nut. Mounts single and dual 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 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.



2-piece 33mm hex head flange nut. Mounts dual 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.



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 stand-out. P/N 7896R, 7896L (Grade 8).



1-1/8" cap nut. Mounts standard single wheels and wide base wheels to 1-1/8" studs. Also mounts outer dual wheel to 1-1/8" inner cap nut. P/N 5996R, 5996L (replaces P/N 5552R, 5552L).



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 stand-out. Full internal and external threads. P/N 5978R, 5978L (Grade 8). For studs without exposed shoulders. Do not use with steel inner dual wheel.



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).



Inner cap nut 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 stand-out. 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 dual wheel.

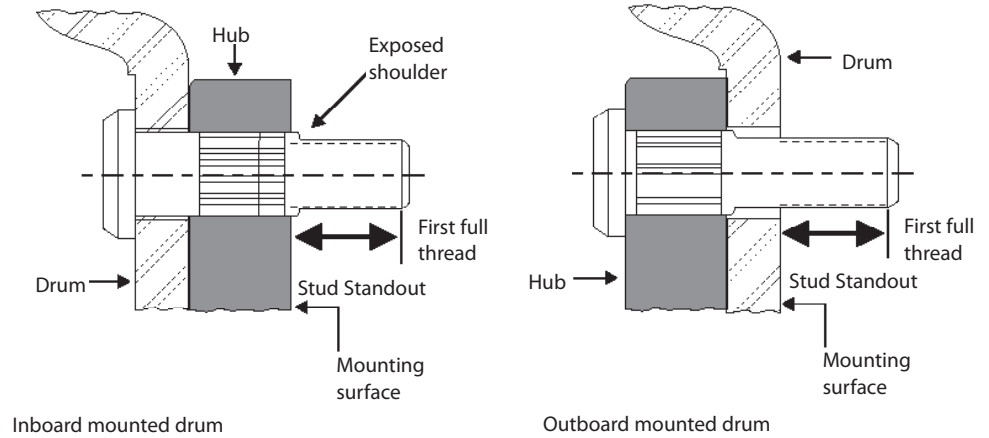
5



## How to measure stud standoff

Stud standoff is measured from the axle end mounting surface (the hub, for inboard mounted drums, and the drum, for outboard mounted drums) to the first complete thread at the outside end of the stud.

### 5-3



## Stud located ball seats are spherical

The nut seat for the stud located ball seat mounting system is a precision-machined spherical surface. Cap nuts must be properly manufactured to assure correct seating. Never use one or two-piece flange nuts on a wheel designed with ball seats (see Section 5-11). Ball seat cap nuts may be obtained from your Alcoa Wheel Distributor.

### 5-4

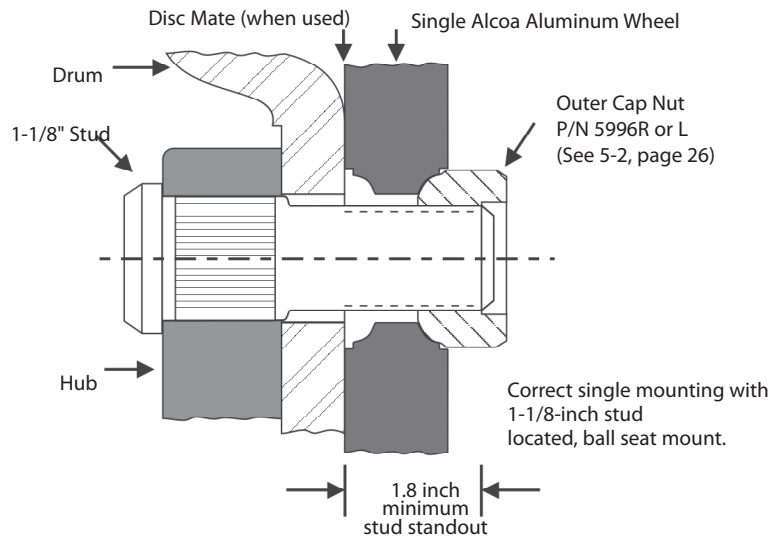


## Single and wide base wheel, stud located, ball seat mounting

Front wheels are mounted as singles and require 1.8" (45.7mm) minimum stud standoff. Most vehicles have 1-1/8-inch studs on the front hubs. Alcoa single cap nuts, Part Nos. 5996R and 5996L, or equivalents, should be used. Some front hubs have 3/4-inch studs. On these hubs, use Alcoa single cap nuts, Part Nos. 5995R and 5995L or equivalents.

Disc Mate wheel spacers are recommended for use with Alcoa Dura-Bright<sup>®</sup> surface treated wheels to protect the wheel contact surfaces from marring. Disc Mate wheel spacers are placed between the contact surfaces of the Dura-Bright<sup>®</sup> wheel and the brake drum as shown below and on the next page.

### 5-5



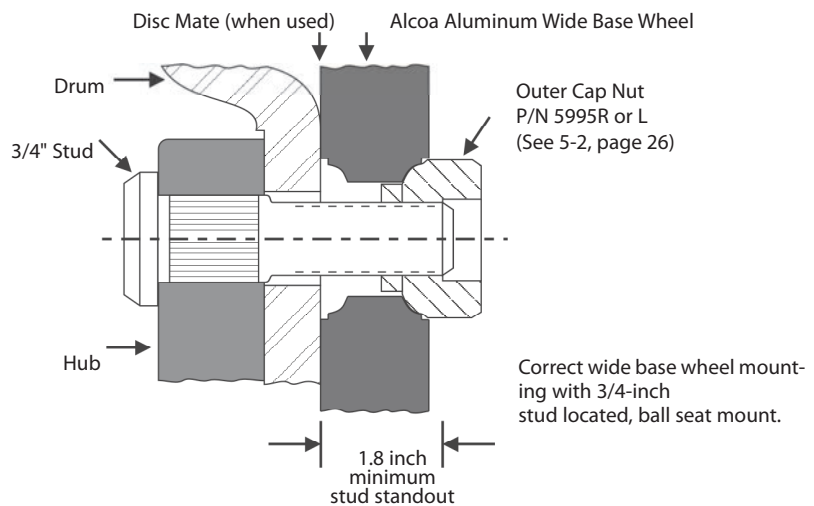
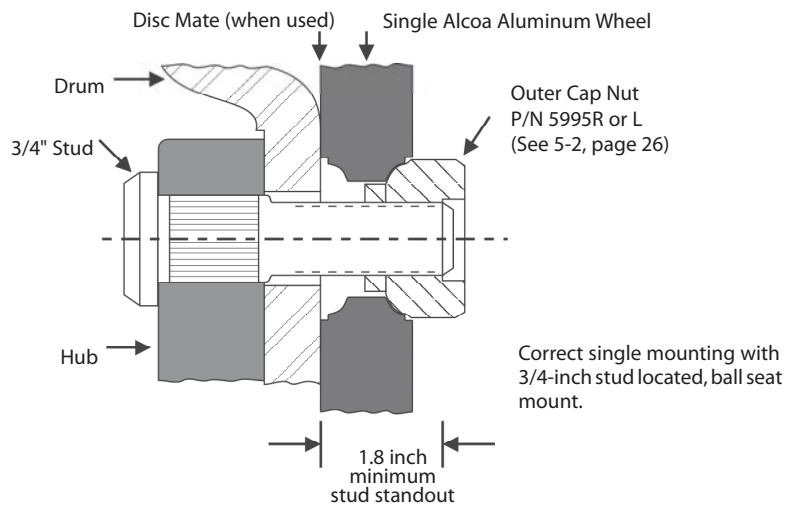
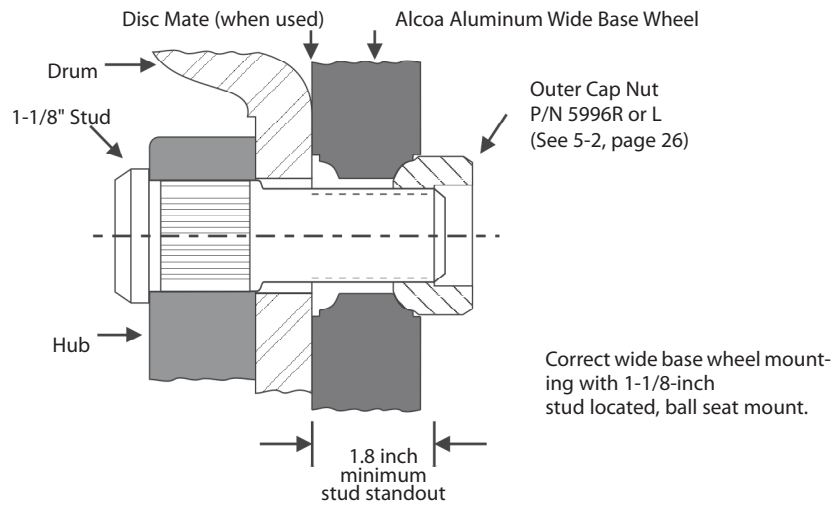
Continued on the next page

## Single and wide base wheel, stud located, ball seat mounting (continued)

NOTICE: Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

NOTICE: Check for and replace bent, broken, cracked or damaged studs. When replacing broken studs, always replace the studs on each side of the broken stud. If two or more studs are broken, replace all the studs for that wheel position. Check with the stud manufacturer for regular maintenance and stud replacement practices. All wheel fastener hardware should be grade 8 or metric conversion 10.9. Follow the hardware manufacturer's recommendations when replacing studs.



## Dualed wheels, stud located, ball seat mounting

Rear wheels are most frequently mounted as duals. Each inner aluminum wheel is attached by 10 inner cap nuts. Alcoa recommends use of inner cap nuts 5978R, 5978L, or 5988R, 5988L (see 5-2, page 26).

Cap nuts recommended by Alcoa are compatible with Alcoa wheels. Hardware of equal dimensions and strength may be used.

Continued on next page.

5-6

## Dualed wheels, stud located, ball seat mounting (continued)

**NOTICE:** Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

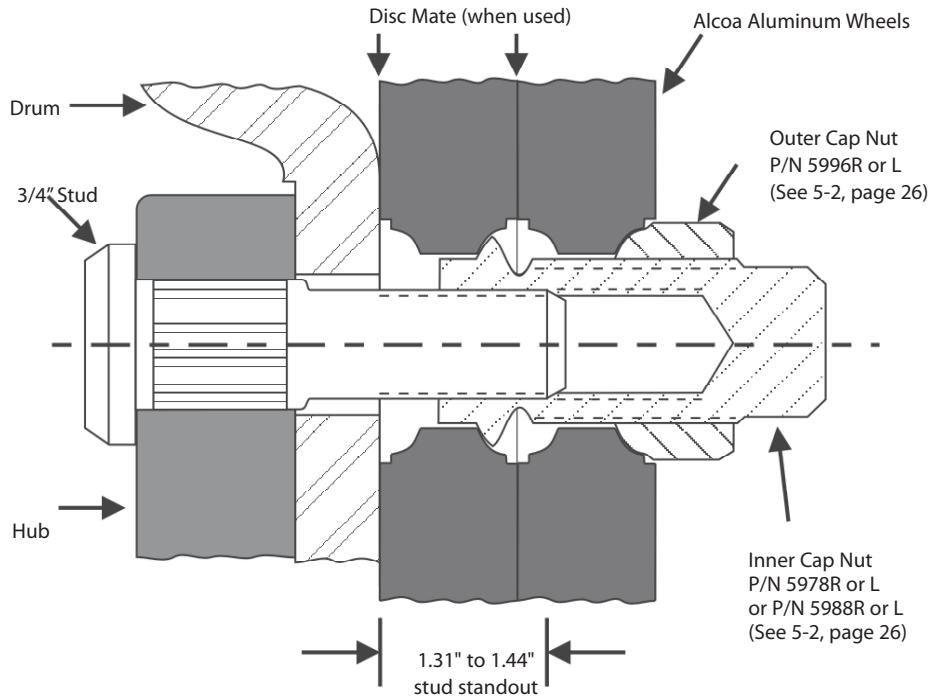
**NOTICE:** Check for and replace bent, broken, cracked or damaged studs. When replacing broken studs, always replace the studs on each side of the broken stud. If two or more studs are broken, replace all the studs for that wheel position. Check with the stud manufacturer for regular maintenance and stud replacement practices. All wheel fastener hardware should be grade 8 or metric conversion 10.9. Follow the hardware manufacturer's recommendations when replacing studs.

Most vehicles have standard length studs (1.31" [1-5/16"] to 1.44" [1-7/16"] stud standout). Some vehicles use studs longer than standard (up to 1.88" [1-7/8"] standout).

When changing types of brake drums be sure to check for excessive stud standout (greater than 1.88" [1-7/8"]). All states and provinces have their own standards for fastener engagement. Most of these consist of at least 1 to 2 threads past full thread engagement. Excessive stud standout may cause the inner cap nut to bottom out on the longer stud preventing proper seating of the wheel.

Each outer dual wheel is attached by 10 single cap nuts which thread on the inner cap nuts. Use Alcoa outer cap nuts, Part Nos. 5996R, 5996L or equivalents. Match mounted dual wheels should be put on the vehicles with the valve stems 180° apart.

Disc Mate wheel spacers are recommended for use with Alcoa Dura-Bright® surface treated wheels to protect the wheel contact surfaces from marring. Disc Mate wheel spacers are placed between the contact surfaces of the Dura-Bright® wheel and the brake drum and between the dual aluminum



Correct mounting for dual aluminum, stud located / ball seat mount wheels.



**WARNING** Incorrect inner cap nuts used with dualed aluminum wheels can bottom out on the unthreaded portion of the stud before the wheels are properly seated.

Improperly seated wheels can run loose, cause stud breakage and disengage from the vehicle which can cause serious injury or death. Loose running wheels can lead to stud breakage.

Use only cap nut 5978R or L, 5988R or L, or their equivalent when mounting dual aluminum wheels.

On occasion Alcoa aluminum truck wheels are operated dualed with a steel inner wheel. When this application occurs it is recommended to use a Disc Mate, because of corrosion issues. In the event a steel inner wheel is used, extreme care must be exercised to properly seat it to the hub or drum prior to mounting the outer aluminum wheel. Selection of an inner cap nut capable of fixing the steel inner wheel and providing adequate external thread length to secure the outer aluminum dualed wheel is critical to a safe assembly. Alcoa recommends the use of inner cap nuts 7896R and L (Grade 8), or equivalent, for this purpose.

## Dualed wheels, steel inner / aluminum outer stud located ball seat mounting (continued)

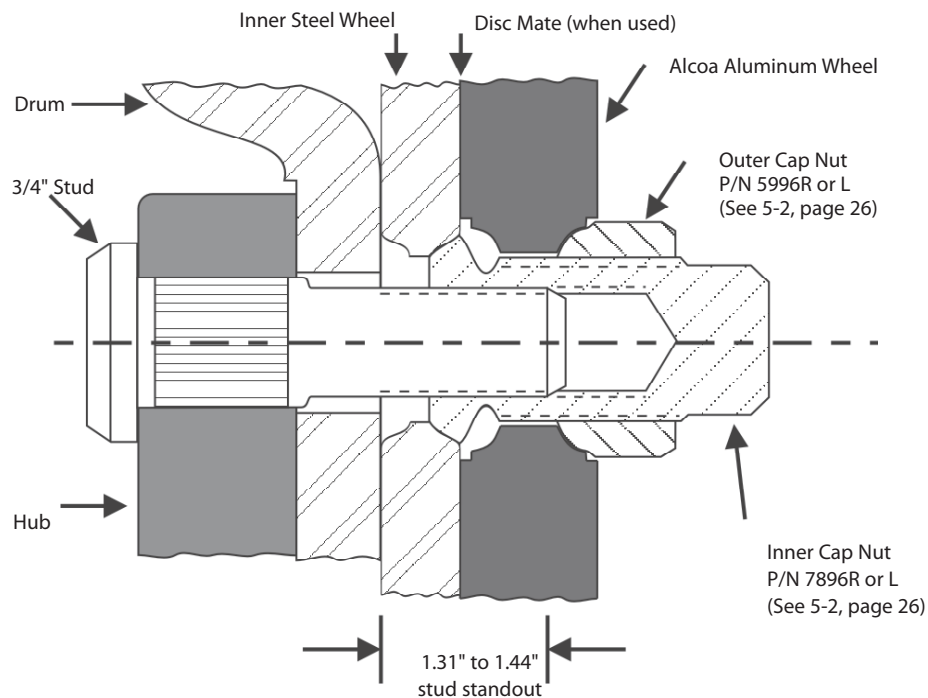
### 5-7

**NOTICE:** Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

**NOTICE:** Check for and replace bent, broken, cracked or damaged studs. When replacing broken studs, always replace the studs on each side of the broken stud. If two or more studs are broken, replace all the studs for that wheel position. Check with the stud manufacturer for regular maintenance and stud replacement practices. All wheel fastener hardware should be grade 8 or metric conversion 10.9. Follow the hardware manufacturer's recommendations when replacing studs.

Disc Mate wheel spacers are recommended for use with Alcoa Dura-Bright<sup>®</sup> surface treated wheels to protect the wheel contact surfaces from marring. Disc Mate wheel spacers are placed between the contact surfaces of the Dura-Bright<sup>®</sup> wheel and the brake drum and between the steel and aluminum wheels as shown below.



Correct dual mounting for steel inner/aluminum outer stud located ball seat mount.



**WARNING**

**WARNING** Incorrect inner cap nuts used with steel wheels can bottom out on the unthreaded portion of the stud before the wheels are properly seated.

Improperly seated wheels can run loose, cause stud breakage and disengage from the vehicle which can lead to serious injury or death. Loose running wheels can lead to stud breakage.

Use only cap nut 7896R or L or its equivalent when mounting steel inner duals.



**WARNING**

**WARNING** Inadequate wheel support surface can lead to stud hole-to-stud hole fracture resulting in separation of the outer disc and rim from the vehicle.

Separation of the wheel from the vehicle can cause serious injury or death.

Alcoa aluminum wheels with 11-1/4" diameter bolt circle require a support surface at least 13-3/16" in diameter. Check the outer support surface of the inner steel wheel for flatness and adequate diameter before installing the outer wheel. When the wheels are serviced, check the mounting surfaces of both wheels for stud hole to stud hole cracks. If cracks are found, immediately and permanently remove the wheel from service. For the support surface diameter required by other bolt circle sizes, ask your Alcoa representative.



**WARNING**

**WARNING** Use of two-piece flange nuts on ball seat wheels or ball seat cap nuts on hub piloted wheels is dangerous.

Using the wrong cap nuts can cause loss of torque, broken studs and cracked wheels, conditions which can lead to serious injury or death.

Use only hardware designed specifically for each wheel type. See Section 5-2 pg. 26 for proper hardware assemblies.

# Tightening stud located, ball seat cap nuts

## 5-8

Cap nuts must be kept tight, and studs and nuts should be checked frequently. Nuts should be retorqued if necessary. At tire changes, nuts and studs should be inspected for cracks and stripped or damaged threads. After each wheel mounting, cap nut torque should be checked with a torque wrench.

Impact wrenches, if used, should be carefully adjusted to apply torques within the limits recommended. Torquing of cap nuts should be done in recommended sequences.

Some states have laws which dictate full thread engagement or thread engagement past the nut body. Make sure you know the laws for the states in which you operate and comply.



**WARNING**

**WARNING** Lubricants should not be applied to the cap nut seat or to the cap nut-to-wheel contact surface.

Oiled seats can lead to over-torquing which can stretch studs causing failure of studs. Failed studs can cause the wheel to disengage from the vehicle, causing serious injury or death.

Lubricants must be completely removed from the cap nut seats and contact surfaces if applied accidentally.



**WARNING**

**WARNING** Undertorqued cap nuts allow wheels to run loose, pounding out (deforming) the ball seats, fatiguing studs or losing nuts. Overtorquing can stretch studs causing them to fail.

Both under and overtorquing can lead to wheels coming off, causing serious injury or death.

Check all parts, including wheels, studs and cap nuts. Check mounting faces of wheels, hubs and drums. Check for dirt, corrosion or damage. Remove dirt and rust; replace damaged parts. Follow correct tightening sequences and torque levels.

Continued on next page

# Tightening stud located, ball seat cap nuts (continued)

## Stud located, ball seat mounting system.

It is recommended to torque to between 450 and 500 foot-pounds. If lubricated with SAE 30W oil torque should be between 350 and 400 foot-pounds. Note: when dualing steel wheels with Alcoa aluminum wheels, follow the steel wheel manufacturer's recommendations regarding the proper torque and use of thread lubricants to mount the wheel.

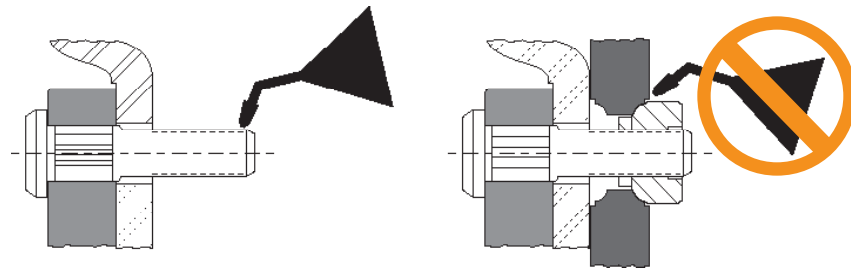


**WARNING**

**WARNING** Application of lubricant to the ball seats can cause excessive torque. Over torque can stretch studs causing them to fail.

Overtorquing can lead to wheel disengagement causing serious injury or death.

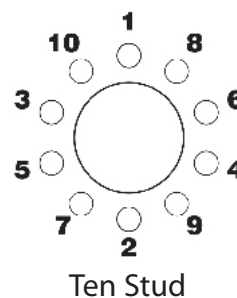
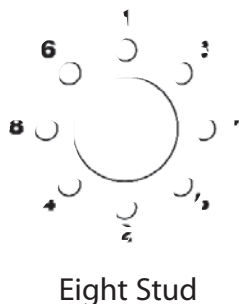
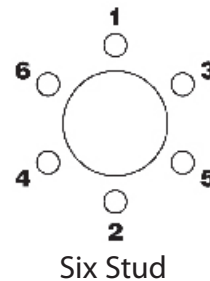
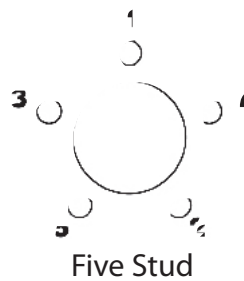
Do not allow oil to contact ball seats or mounting surfaces of the wheel, hub or drum. Do not use aerosol cans for lubrication of stud threads.



On vehicles equipped to accept wheels manufactured for use with the stud located ball seat mounting system, wheel studs on the right side of the vehicle have right-hand threads and those on the left have left-hand threads. The "R" and "L" on the studs and nuts indicate right and left-hand threads respectively (see Section 5-2).

After mounting a wheel over the studs, snug up the cap nuts in the order shown in the illustrations that follow. After all the cap nuts have been snugged, tighten the cap nuts to the recommended torques, following the same tightening sequence.

**NOTICE:** In service, stud dimensions and condition may change over time due to environmental conditions, multiple re-installations, improper torquing and other factors. Consult with your hub and stud manufacturer for maintenance and replacement recommendations.



Continued on the next page

## Tightening stud located, ball seat cap nuts (continued)

After 5-50 miles of operation, torque should be rechecked, unless your documented fleet practices determine otherwise. Loosen outer cap nuts on every other stud to check the torque on inner cap nuts, then retorque outer cap nuts. Repeat steps on remaining studs. Check torque frequently from then on. If nuts require frequent tightening, studs break frequently, or wheel nut seats are pounding out, hardware and mounting practices should be reviewed. Note: whenever the outer cap nut is loosened ALWAYS retorque the inner cap nut before retorquing the outer cap nut.

## Single, dualed and wide base wheels, hub piloted mounting, two-piece flange nuts

Most U.S. manufacturers of highway trucks, tractors and trailers which incorporate the hub piloted wheel mounting system require wheel studs and cap nuts with metric threads. Most frequently these are M22x1.5.

Generally the same diameter stud is used to mount either single or dualed wheels.

Studs on both sides of the vehicle are right-hand threads thereby eliminating the need for flange nuts peculiar to either the right or left side of the vehicle. The same flange nut is used to mount dualed or single wheels. Proper stud standout for single wheels is 2.36-inch (60mm) minimum, dualed wheels require 3.346-inch (85mm) minimum and single wide base wheels require 2.36-inch (60mm).

Some states have laws which dictate full thread engagement or thread engagement past the nut body. Make sure you know the laws for the states in which you operate and comply.

Disc Mate wheel spacers are recommended for use with Alcoa Dura-Bright<sup>®</sup> surface treated wheels to protect the wheel contact surfaces from marring. Disc Mate wheel spacers are placed between the contact surfaces of the Dura-Bright wheel and the brake drum and between the dual wheels as shown below.

Note: Some stud located ball seat wheels have the same number of holes and bolt circle diameter as hub piloted wheels. They should not be mixed.

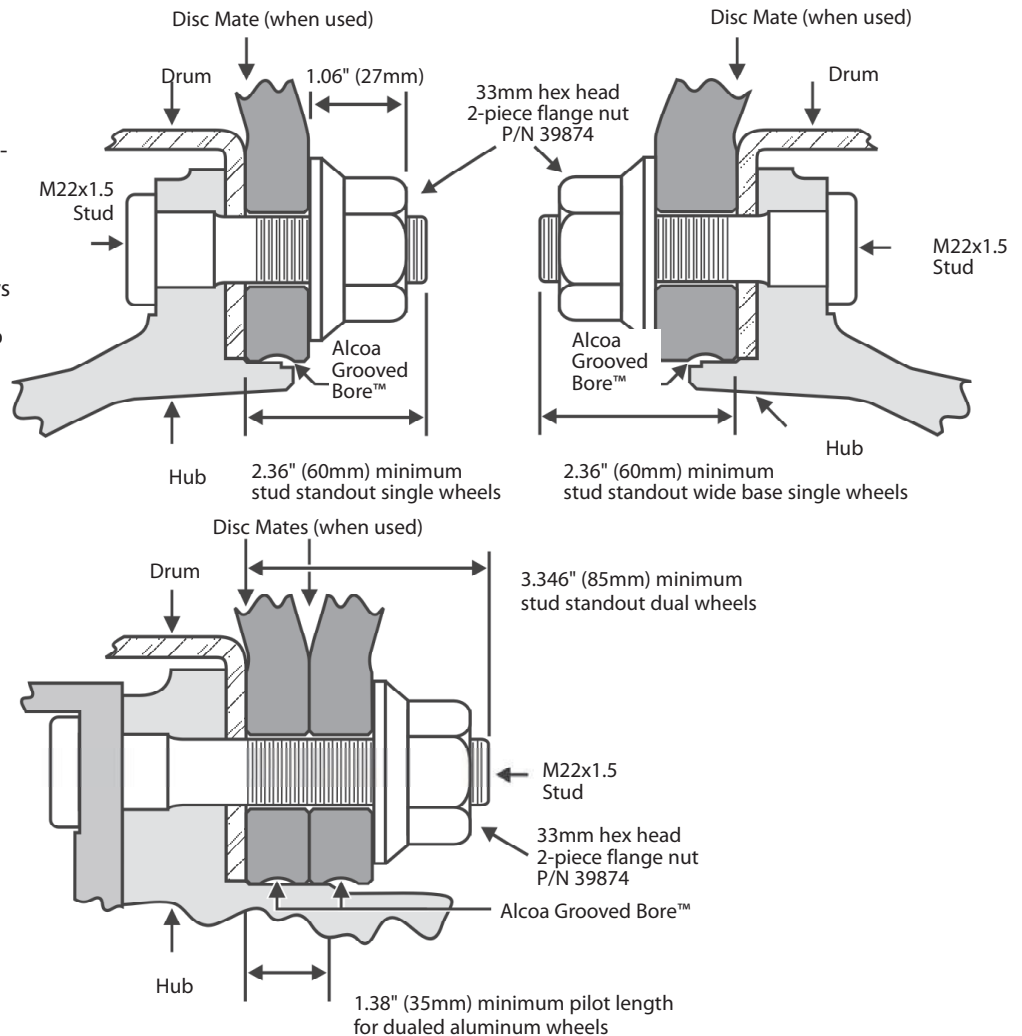
## 5-9

**NOTICE:** Do not exceed maximum wheel load. Customer must compare OEM vehicle load rating to maximum wheel load rating.

Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

**NOTICE:** Check for and replace bent, broken, cracked or damaged studs. When replacing broken studs, always replace the studs on each side of the broken stud. If two or more studs are broken, replace all the studs for that wheel position. Check with the stud manufacturer for regular maintenance and stud replacement practices.

All wheel fastener hardware should be grade 8 or metric conversion 10.9. Follow the hardware manufacturer's recommendations when replacing studs.



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, dually 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 dually aluminum wheels. Pay close attention to pilot length, particularly when converting from steel to aluminum duals. Measure the hub pilot to make sure the hub has a minimum pilot length of 1.38-inch or (35mm) for dually wheels.

When mounting painted steel inner dual wheels with outer aluminum wheels, be cautious of excessive paint build-up on the inner steel wheel. Excessive paint can reduce the clamping force and allow the wheels to become loose.

## Tightening hubpiloted mounting, two-piece flange nuts

Flange nuts must be kept tight, and studs and nuts should be checked frequently. At tire changes, nuts and studs should be inspected to be sure they are in good condition. If nuts require frequent tightening or studs break frequently, hardware and mounting practices should be reviewed.

Impact wrenches, if used, should be carefully adjusted to apply torques within the limits recommended. Torquing of flange nuts should be done in recommended sequences.

## 5-10



**WARNING**

**WARNING** Under or Over torqued flange nuts allow wheels to run loose and fatigue studs or lose nuts. Overtorquing can stretch studs causing them to fail with loss to torque and may cause pre-mature fatigue.

Both under and overtightening can lead to wheel disengagement causing serious injury or death.

Check all parts including wheels, studs and flange nuts. Check mounting faces of wheels, hubs and drums. Check for dirt, corrosion or damage. Remove dirt and rust; replace damaged parts. Follow correct tightening sequences and torque levels.

Two-piece flange nuts with a 33mm hex head design (see Section 5-2), used with hub piloted wheels should be tightened to a torque of 450 to 500 foot-pounds. Two-piece flange nuts with 1-1/2-inch hex head design and other designs have different torque requirements. Inquire of the manufacturer for the proper torque values. See section 6-2.

Wheel studs on both the right and left side hubs of vehicles utilizing the hub piloted wheel system have right-hand threads.

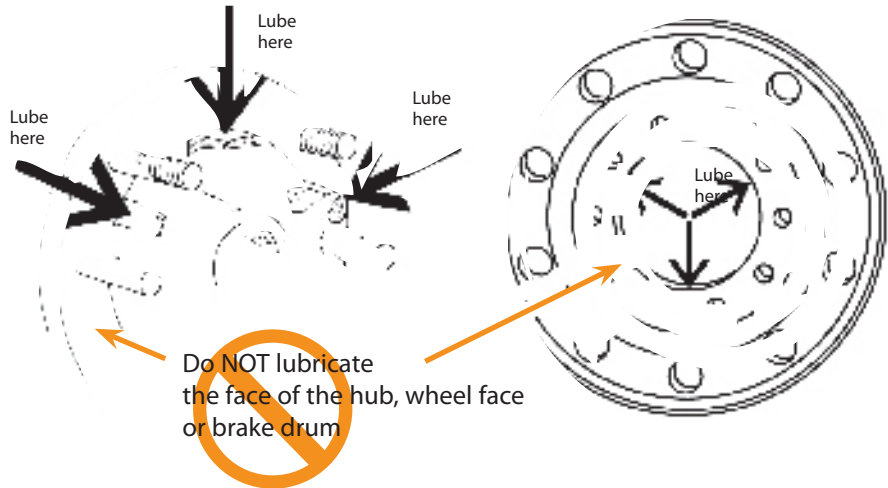
Prior to mounting hub piloted wheels, generously coat the wheel pilot or hub pads with a non-water-based lubricant to minimize corrosion product build-up between the wheel and hub pilot. Excessive corrosion build-up between the wheel and hub pilots can make wheel removal difficult. Do not lubricate the face of the wheel, hub or brake drum (see illustration on the next page).

Continued on the next page.

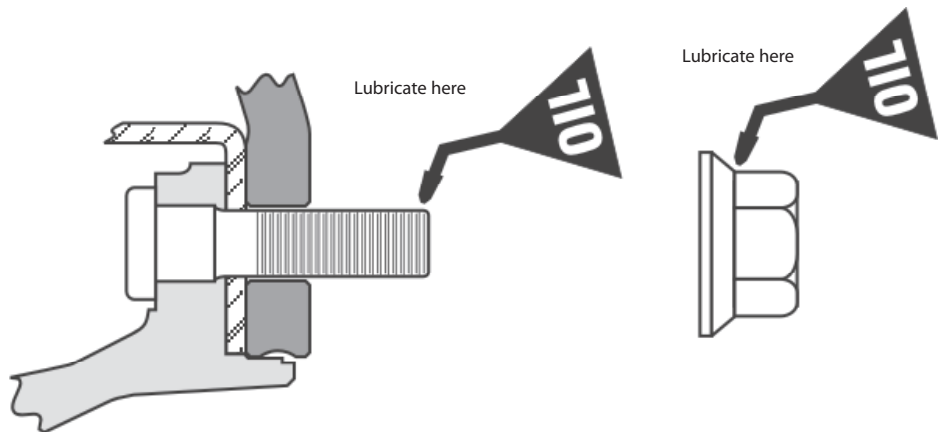


# Tightening hub-piloted mounting, two-piece flange nuts (continued)

Lubricate the hub pads or the wheel hub bore generously with a non-water-based lubricant.

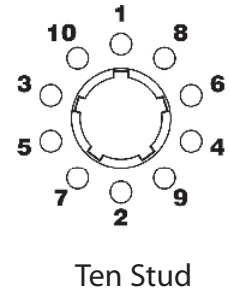
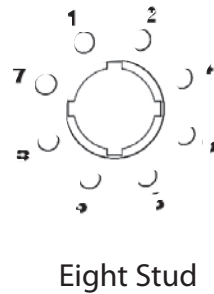
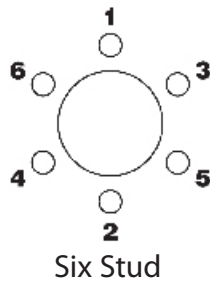


Before installing two-piece flange nuts, lightly lubricate the stud threads and the contact surfaces between the cap nut and the washer as illustrated below with an SAE 30W oil. This will minimize corrosion between the mating surfaces. Lubrication is not necessary with new hardware.



Position one of the hub's pilot pads at the twelve o'clock position. After positioning wheels on the pilot pads, hand tighten all two-piece flange nuts, then tighten to the recommended torque following the proper sequence shown below for your type wheel. After 5-50 miles of operation torque should be rechecked, unless your documented fleet practices determine otherwise. Check torque frequently from then on. If nuts require frequent tightening, studs break frequently, or wheel bolt holes are pounding out, hardware and mounting practices should be reviewed.

NOTICE: In service, stud dimensions and condition may change over time due to environmental conditions, multiple re-installations, improper torquing and other factors. Consult with your hub and stud manufacturer for maintenance and replacement recommendations.



## Incorrect assemblies

# 5-11



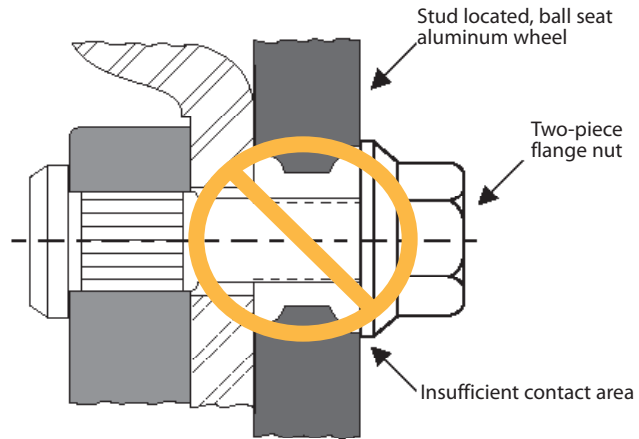
WARNING

**WARNING** Use of two-piece flange nuts on ball seat wheels, ball seat cap nuts on hub piloted wheels or single-piece flange nuts in place of 2-piece flange nuts is dangerous.

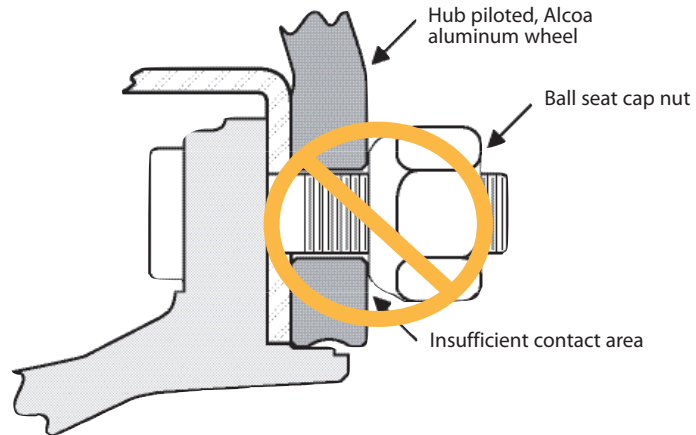
Using the wrong wheel nuts can cause loss of torque, broken studs and cracked wheels, conditions which can lead to serious injury or death.

Use only hardware designed specifically for each wheel type. See Section 5-2 pg. 26 for proper hardware assemblies.

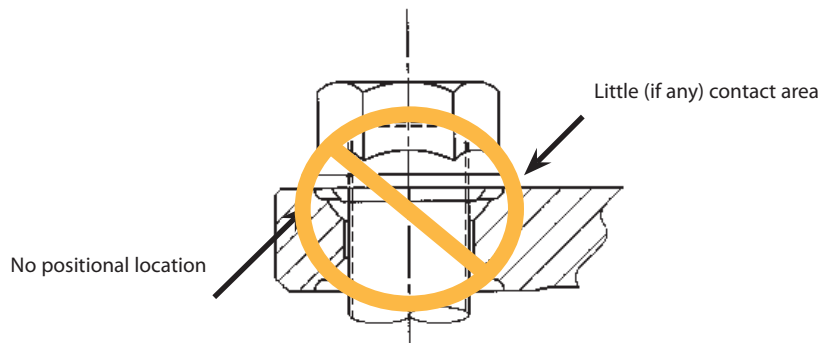
The following are examples of incorrect wheel assemblies.



Do not use two-piece flange nuts with stud located ball seat wheels.



Incorrect use of ball seat cap nut on hub piloted system.  
Do not use ball seat cap nuts with hub piloted wheels.



Incorrect use of flange nut positioned on Alcoa ball seat wheel.  
Do not use any flange nut on Alcoa aluminum ball seat wheels.

# 6

## Proper Torque, Wheel Identification and Valves

### Avoid abuse

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.

### 6-1

Do not overinflate. Use the tire manufacturer's recommended pressure, but under no circumstances exceed cold inflation pressures listed in Section 2 Specifications of this manual. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

Refer to tire manufacturer's recommendation for proper tire pressure. Before mounting the tire perform a wheel fitment check to insure proper clearance from any obstructions.

### Keep wheel nuts tight

### 6-2

Wheel cap nuts must be kept tight (see Section 5-8). When checking the cap nuts on dual disc wheels utilizing the stud located ball seat mounting system, loosen every other outer cap nut and then check the torque of the inner cap nuts. Retorque the loosened outer cap nuts. Repeat procedure with the rest of the nuts. Check all cap nuts for proper torque after the first use or any removal. Inspect wheels and check wheel nuts during service stops (see Section 3). Dirt streaks from cap nuts may indicate looseness.

Flange nuts must be kept tight, and studs and nuts should be checked frequently. At tire changes nuts and studs should be inspected to be sure they are in good condition. If nuts require frequent tightening or studs break frequently, hardware and mounting practices should be reviewed.

For proper nut torque, refer to the chart below:

Mount Type	Nut Thread	Torque Level Ft-Lb Lubricated*	Torque Level Ft-Lb Dry*
Hub piloted using two-piece flange nut	11/16" - 16	300-400	
	7/8 - 14	350-400	
	M20 x 1.5	280-330	
	M22 x 1.5	450-500	
Stud piloted, double cap nut standard type (7/8" radius)	3/4" - 16		450-500
	1-1/8" - 16		450-500
Stud piloted, double cap nut heavy duty type (1-3/16" radius)	15/16" - 12		750-900
	1-1/8" - 16		750-900
	1-5/16" - 12		750-900

\*For nuts used on hub piloted wheels, apply two drops of oil to the point between the nut and flange and two drops to the first two or three threads at the tip of each stud (see Section 5-10).

For nuts used on stud piloted wheels, apply two drops of oil to the first two or three threads at the tip of each stud only (see Sections 5-8).

#### NOTE:

1. If using specialty fasteners (cap nuts), consult the manufacturer for recommended torque values.
2. Tightening wheel nuts to their specified torque is extremely important. Undertightening which results in loose wheels can damage wheels, studs and hubs, and can result in wheel loss. Overtightening can damage studs, nuts and wheels and results in loose wheels as well.
3. All torque wrenches, air wrenches and any other tools should be calibrated periodically to ensure the proper torque is applied.

### Balance weights (clip-on)

### 6-3

Balance weights for Alcoa wheels are available from your Alcoa Wheel Distributor. With radial tires it may be necessary to temporarily reduce the tire pressure when installing clip-on weights to allow clearance of the weight clamp over the rim flange. Use of coated balance weights is recommended to avoid staining and corrosion of the aluminum wheel surface.

Excessive rim flange wear (see Section 3-12) could dictate the use of “stick-on” or adhesive wheel weights if there is inadequate rim to properly hold a clip-on style weight.

Improperly installed weights could “fly off” during use and damage the vehicle or cause personal injury. Always follow the recommended procedures in this manual or the wheel weight manufacturer. Adhesive weights should be applied only to a clean surface on the brake side of the wheel rim. These weights should be installed only in a location where they will not contact the brake components during vehicle operation.

### Owner/in-service identification

### 6-4

Some fleets wish to specially identify wheels as to OWNERSHIP and IN-SERVICE dates. Alcoa recommends that fleets and owner-operators adopt the practice of permanently stamping wheels with the date they are first placed into service.

1. Use “Lo-Stress” stamps or equivalent.
2. Location of stamped areas on outside disc should be in space outward from a line between hand hole centers and a minimum of one inch from the periphery of any hand hole.
3. Location of stamped identification on inside of wheel should be as close to the factory identification stamping as possible.

Note: Use of an impression stamp on Dura-Bright<sup>®</sup> surface treated wheels can affect the appearance and performance of the Dura-Bright<sup>®</sup> surface treatment local to the stamp.

### Valves

### 6-5

Alcoa drop center wheels for tubeless tires come from the factory with air valves installed. If it becomes necessary to replace an air valve, install it using 9 to 11 foot-pounds of torque.

Replacement valves may be obtained from your authorized Alcoa Wheel Distributor. Always use silicone or EPDM O-rings or grommets – not rubber – when reinstalling valve stems. Metal valve stem caps are recommended instead of plastic. It is recommended that valve stems with O-rings or grommets be replaced at every tire change.

When replacing valve stems, it is recommended to lubricate the threads and O-ring with a non-water based tire lubricant.


When valve stem extensions are used, it is recommended that valve stem stabilizers be used.

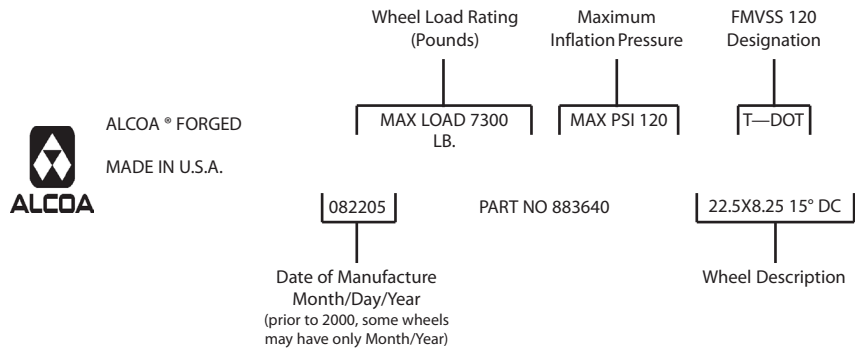
# Identification

## Alcoa wheel identification

### 6-6

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<sup>®</sup> surface treated wheels are designated by the letters “DB” following the part number such as 883640DB.

Note: Dura-Bright<sup>®</sup> 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<sup>®</sup> surface treatment.

All Dura-Flange<sup>®</sup> wheels are designated by the letters “DF” following the part number such as 883640DF.

All Dura-Bright<sup>®</sup> / Dura-Flange<sup>®</sup> wheels are designated by the letters “DD” following the part number such as 883640DD.

If you cannot identify the size or load rating of the wheel it should not be used.

As of January 2009 Alcoa introduced a new logo label.

# 7 OSHA Regulations

## OSHA Regulations

Sec. 1910.177 Servicing multi-piece and single piece rim wheels.

### 7-1

#### (a) Scope

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- (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:

## OSHA Regulations (continued)

- (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,



## OSHA Regulations (continued)

- or
- (ii) When there is obvious or suspected damage to the tire or wheel components.
  - (3) Rubber lubricant shall be applied to bead and rim mating surfaces during assembly of the wheel and inflation of the tire, unless the tire or wheel manufacturer recommends against it.
  - (4) If a tire on a vehicle is underinflated but has more than 80% of the recommended pressure, the tire may be inflated while the rim wheel is on the vehicle provided remote control inflation equipment is used, and no employees remain in the trajectory during inflation.
  - (5) Tires shall be inflated outside a restraining device only to a pressure sufficient to force the tire bead onto the rim ledge and create an airtight seal with the tire and bead.
  - (6) Whenever a rim wheel is in a restraining device the employee shall not rest or lean any part of his body or equipment on or against the restraining device.
  - (7) After tire inflation, the tire and wheel components shall be inspected while still within the restraining device to make sure that they are properly seated and locked. If further adjustment to the tire or wheel components is necessary, the tire shall be deflated by removal of the valve core before the adjustment is made.
  - (8) No attempt shall be made to correct the seating of side and lock rings by hammering, striking or forcing the components while the tire is pressurized.
  - (9) Cracked, broken, bent or otherwise damaged rim components shall not be reworked, welded, brazed, or otherwise heated.
  - (10) Whenever multi-piece rim wheels are being handled, employees shall stay out of the trajectory unless the employer can demonstrate that performance of the servicing makes the employee's presence in the trajectory necessary.
  - (11) No heat shall be applied to a multi-piece wheel or wheel component.

### (g) Safe operating procedure - single piece rim wheels.

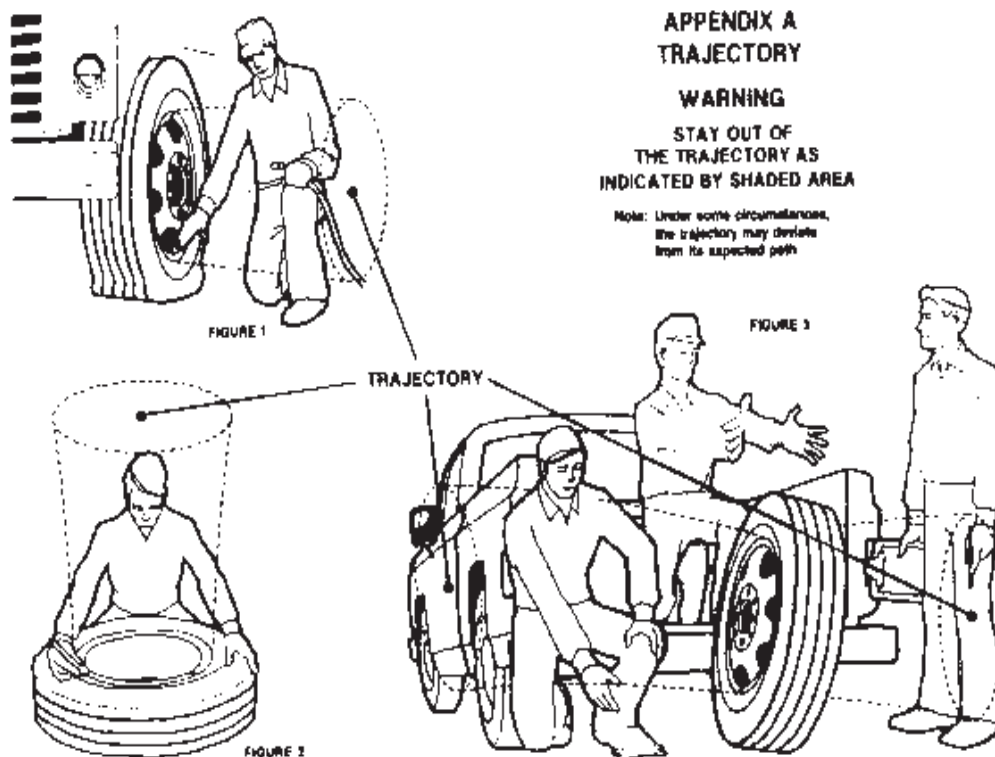
The employer shall establish a safe operating procedure for servicing single piece rim wheels and shall assure that employees are instructed in and follow that procedure.

The procedure shall include at least the following elements:

- (1) Tires shall be completely deflated by removal of the valve core before demounting.
- (2) Mounting and demounting of the tire shall be done only from the narrow ledge side of the wheel. Care shall be taken to avoid damaging the tire beads while mounting tires on wheels. Tires shall be mounted only on compatible wheels of matching bead diameter and width.
- (3) Nonflammable rubber lubricant shall be applied to bead and wheel mating surfaces before assembly of the rim wheel, unless the tire or wheel manufacturer recommends against the use of any rubber lubricant.
- (4) If a tire changing machine is used, the tire shall be inflated only to the minimum pressure necessary to force the tire bead onto the rim ledge while on the tire changing machine.
- (5) If a bead expander is used, it shall be removed before the valve core is installed and as soon as the rim wheel becomes airtight (the tire bead slips onto the bead seat).
- (6) Tires may be inflated only when contained within a restraining device, positioned behind a barrier or bolted on the vehicle with the lug nuts fully tightened.
- (7) Tires shall not be inflated when any flat, solid surface is in the trajectory and within one foot of the sidewall.
- (8) Employees shall stay out of the trajectory when inflating a tire.
- (9) Tires shall not be inflated to more than the inflation pressure stamped in the sidewall unless a higher pressure is recommended by the manufacturer.
- (10) Tires shall not be inflated above the maximum pressure recommended by the manufacturer to seat the tire bead firmly against the rim flange.
- (11) No heat shall be applied to a single piece wheel.
- (12) Cracked, broken, bent, or otherwise damaged wheels shall not be reworked, welded, brazed, or otherwise heated.

[39 FR 23502, June 27, 1974, as amended at 52 FR 36026, Sept. 25, 1987; 53 FR 34736, Sept. 8, 1988]

## Appendix A - Trajectory



## Appendix B - Ordering Information for NHTSA Charts

OSHA has printed two charts entitled "Demounting and Mounting Procedures for Truck/Bus Tires" and "Multi-piece Rim Matching Chart," as part of a continuing campaign to reduce accidents among employees who service large vehicle rim wheels.

Reprints of the charts are available through the Occupational Safety and Health Administration (OSHA) Area and Regional Offices. The address and telephone number of the nearest OSHA office can be obtained by looking in the local telephone directory under U.S. Government, U.S. Department of Labor, Occupational Safety and Health Administration.

Single copies are available without charge.

Individuals, establishments and other organizations desiring single or multiple copies of these charts may order them from the OSHA Publications Office, U.S. Department of Labor, Room N-3101, Washington, DC 20210, Telephone (202) 219-4667.

[49 FR 4350, Feb. 3, 1984, as amended at 52 FR 36026, Sept. 25, 1987; 53 FR 34737, Sept. 8, 1988; 61 FR 9227, Mar. 7, 1996]

# 8

# Glossary of Common Terms

## Glossary of Common Terms

### 8-1

1/2 DUAL SPACING - One half the distance between the two center lines of dual wheels. The dimension is the same as the OUTSET dimension.

1-PIECE FLANGE NUT - A one-piece washer and nut combination not recommended for use on any Alcoa wheel application.

2-PIECE FLANGE NUT - A two-piece washer and nut combination used to secure hub piloted wheels.

AIR CHAMBER - The space enclosed by a tire and wheel rim or inner tube.

BEAD SEAT - The area along the outer edges of the rim where the mounted tire and rim are in contact.

BOLT CIRCLE - The circle defined by the centers of the bolt holes (stud holes) of a wheel, dimensions stated in diameter inches or millimeters.

BOLT HOLE - Hole found in the disc of the wheel through which the bolt (stud) passes.

BORE - See "HUB BORE."

CENTER BORE - See "HUB BORE."

CONE LOCK CAP NUT - See "2-PIECE FLANGE NUT."

DC - Abbreviation for drop center.

DISC AREA - The vertical wheel face which supports the rim.

DISC MATE - (wheel gasket) A nylon 6-6 gasket that goes between the brake drum and wheel and/or between two wheels to protect against corrosion.

DISC WHEEL - A one-piece (forged) or two-piece (welded) assembly of a disc and a rim.

DROP CENTER - The well or center portion of the wheel rim.

DUAL WHEEL - Any wheel that can be mated disc side to disc side with another wheel resulting in an inner and outer dual wheel assembly.

FLAT BASE WHEEL - A multi-piece wheel with a removable side ring.

FOOT-POUNDS - The measure of the amount of torque applied to a cap nut or other part. May be measured with a torque wrench.

GUTTER FLANGE - A groove which supports the removable portion of a multi-piece wheel.

HUB BORE - The center hole of a disc wheel, dimensions stated in inches or millimeters.

HUB PILOTED MOUNTING - A wheel mounting system which uses the hub to center the wheel and two-piece flange nuts to secure it.

in. - Abbreviation for inches.

INNER CAP NUT - Cap nut used to mount the inner wheel in a dual stud located wheel system.

INSET - The distance from the wheel mounting surface to the rim centerline when the centerline is placed inboard of the mounting surface.

kg - Abbreviation for kilogram (weight measurement), equal to 1000 grams.

kPa - Abbreviation for kilo Pascals (pressure measurement).

## Glossary of Common Terms (continued)

**LOCK RING** - The third piece of a three piece rim assembly which positions and supports the side ring to the rim base.

**MAXIMUM INFLATION** - The highest amount of air pressure allowed, measured at normal ambient temperatures.

mm - Abbreviation for millimeters.

**MULTI-PIECE WHEEL** - A wheel assembly in which the rim portion of the wheel consists of two or more separate parts.

N-m - Abbreviation for Newton meters

**OFFSET** - See "OUTSET."

**OPEN SIDE** - The side of the wheel opposite the disc face.

**OSHA** - Abbreviation for the U.S. Department of Labor, Occupational Safety and Health Administration.

**OUTER CAP NUT** - A cap nut used to secure the outer stud located wheel in a dual wheel pair and threaded onto the inner cap nut.

**OUTSET** - The distance from the mounting surface of the wheel to the rim centerline when the rim centerline is mounted outboard of the hub face. This dimension is the same as the 1/2 DUAL SPACING dimension.

**PILOT PAD** - The raised surfaces on a hub used to center a hub piloted wheel.

PSI - Abbreviation for pounds per square inch.

**REVERSIBLE** - Term applied to a disc wheel which can be reversed on the hub without changing the position of the tire centerline.

**RIM CENTERLINE** - A line to the radial axis of the wheel running through the mid point between the rim flanges.

**RIM FLANGE** - That portion of the rim which extends above the rim surface which retains the tire bead.

**RIM** - That portion of the wheel which supports the tire.

**SIDE RING** - A removable piece of a multi-piece wheel assembly which provides lateral support for one tire bead.

**SINGLE CAP NUT** - A cap nut used to secure single wheels or outer dual wheels.

**STUD** - A threaded bolt extending from the hub surface to which the wheels are secured by the cap nuts.

**STUD LOCATED, BALL SEAT MOUNTING** - A wheel mounting system which uses the studs and spherical ball seat cap nuts to center and secure the wheel.

**TIRE BEAD** - That surface of the tire which contacts the angled surface of the wheel rim.

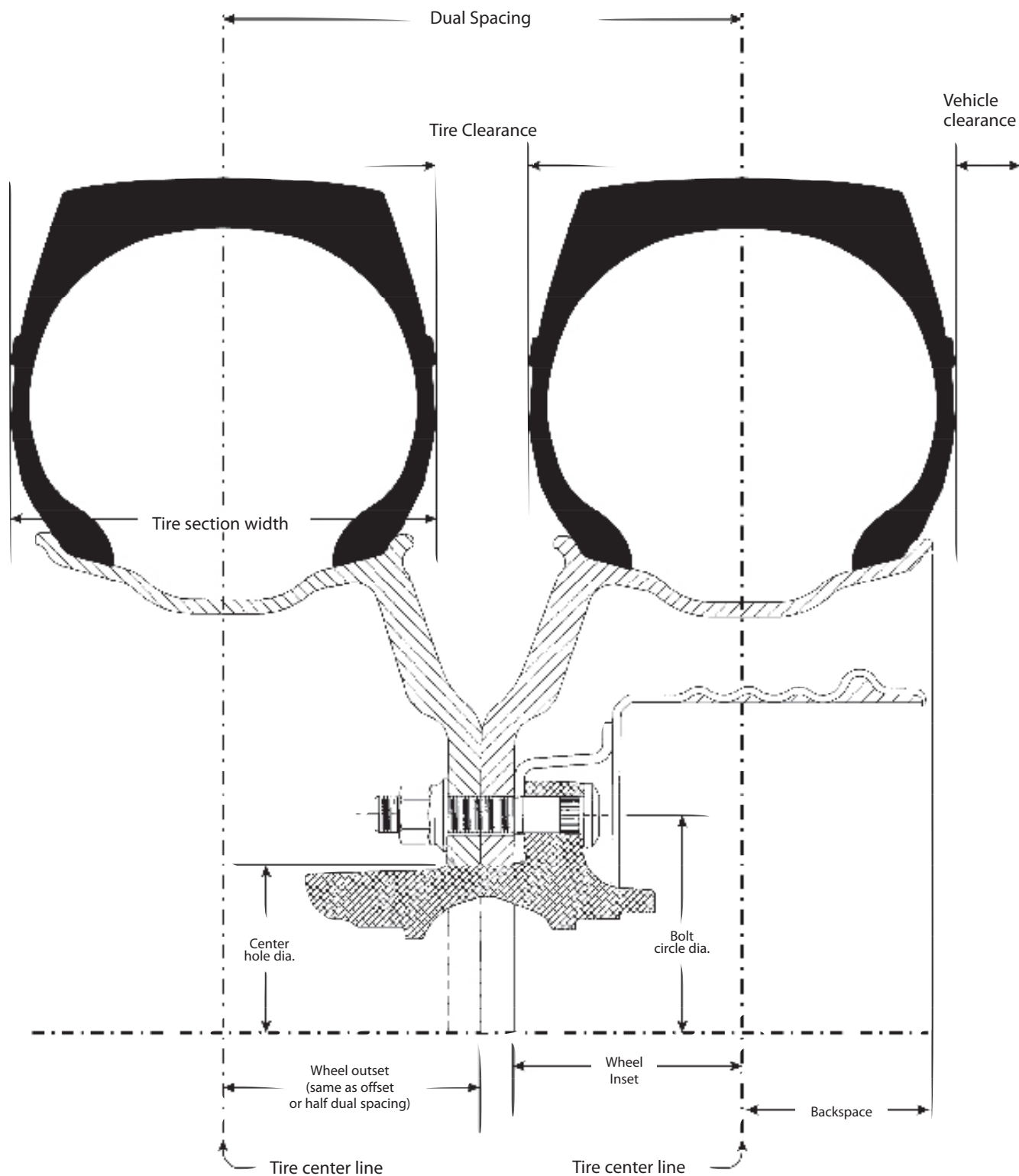
**TORQUE** - The amount of force used to tighten cap nuts. Usually stated in foot-pounds or kilograms and measured with a torque wrench.

**WHEEL MOUNTING FACE** - That portion of the wheel face which contacts the hub or brake drum.

wt. - Abbreviation for weight.

8-2

Minimum dual spacing measurement is determined by the tire manufacturer and may be obtained from the tire manufacturer's handbook. To determine if the Alcoa aluminum dual wheel assembly has adequate minimum dual spacing for the selected tires, double the wheel outset measurement of the Alcoa wheel used. If the doubled outset measurement is equal to or greater than the tire manufacturer's recommendation, there will be sufficient minimum dual spacing. Wheel inset and outset is given for each Alcoa wheel on pages 2 and 3. Both inset and outset wheels are measured from the mounting surface of the wheel to the center line of the rim. Maintaining proper tire inflation and load ratings are essential to maintaining proper minimum dual spacing.



# 9 Conversion Tables

Inch Fraction,  
Decimal and  
Millimeter  
Equivalents  
Chart  
(Up to 1 inch)

9-1

Inches	Decimals	Millimeters
1/64	0.0156	0.3969
1/32	0.0313	0.7938
3/64	0.0469	01.1906
1/16	0.0625	1.5875
5/64	0.0781	1.9844
3/32	0.0938	2.3813
7/64	0.1094	2.7781
<b>1/8</b>	<b>0.1250</b>	<b>3.1750</b>
9/64	0.1406	3.5719
5/32	0.1563	3.9688
11/64	0.1719	4.3656
3/16	0.1875	4.7625
13/64	0.2031	5.1594
7/32	0.2188	5.5563
15/64	0.2344	5.9531
<b>1/4</b>	<b>0.2500</b>	<b>6.3500</b>
17/64	0.2656	6.7469
9/32	0.2813	7.1438
19/64	0.2969	7.5406
5/16	0.3125	7.9375
21/64	0.3281	8.3344
11/32	0.3438	8.7313
23/64	0.3594	9.1281
<b>3/8</b>	<b>0.3750</b>	<b>9.5250</b>
25/64	0.3906	9.9219
13/32	0.4063	10.3188
27/64	0.4219	10.7156
7/16	0.4375	11.1125
29/64	0.4531	11.5094
15/32	0.4688	11.9063
31/64	0.4844	12.3031
<b>1/2</b>	<b>0.5000</b>	<b>12.7000</b>

Inches	Decimals	Millimeters
33/64	0.5156	13.0969
17/32	0.5313	13.4938
35/64	0.5469	13.8906
9/16	0.5625	14.2875
37/64	0.5781	14.6844
19/32	0.5938	15.0813
39/64	0.6094	15.4781
<b>5/8</b>	<b>0.6250</b>	<b>15.8750</b>
41/64	0.6406	16.2719
21/32	0.6563	16.6688
43/64	0.6719	17.0656
11/16	0.6875	17.4625
45/64	0.7031	17.8594
23/32	0.7188	18.2563
47/64	0.7344	18.6531
<b>3/4</b>	<b>0.7500</b>	<b>19.0500</b>
49/64	0.7656	19.4469
25/32	0.7813	19.8438
51/64	0.7969	20.2406
13/16	0.8125	20.6375
53/64	0.8281	21.0344
27/32	0.8438	21.4313
55/64	0.8594	21.8281
<b>7/8</b>	<b>0.8750</b>	<b>22.2250</b>
57/64	0.8906	22.6219
29/32	0.9063	23.0188
59/64	0.9219	23.4156
15/16	0.9375	23.8125
61/64	0.9531	24.2094
31/32	0.9688	24.6063
63/64	0.9844	25.0031
<b>1</b>	<b>1.000</b>	<b>25.4000</b>

## Conversion Factors

### 9-2

#### Inches to Millimeters

---

$$\text{Inches} \times 25.4 = \text{Millimeters}$$

#### Millimeters to Inches

---

$$\text{Millimeters} \times 0.03937 = \text{Inches}$$

#### PSI to kPa

---

$$\text{PSI} \times 6.8948 = \text{kPa}$$

#### kPa to PSI

---

$$\text{kPa} \times 0.145 = \text{PSI}$$

#### Pounds to Kilograms

---

$$\text{Pounds} \times 0.4536 = \text{kg}$$

#### Kilograms to Pounds

---

$$\text{kg} \times 2.2046 = \text{Pounds}$$

#### Foot-pounds to Newton Meters

---

$$\text{Ft-lbs} \times 1.35582 = \text{N-m}$$

#### Newton Meters to Foot-pounds

---

$$\text{N-m} \times .737561 = \text{Ft-lbs}$$

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# SECTION 14: STEERING

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## 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, linkage and steering damper (Fig. 1). The steering linkage includes the pitman arm, drag link, steering arm, tie rod arms and tie rod.

Hydraulic components are added to transmit, increase and regulate steering control forces.

These elements are:

1. Steering stabilizer (damper);
2. A vane type hydraulic pump; and
3. Hydraulic reservoir and hoses.

The steering stabilizer reduces road shocks and vibrations in the system. The steering gearbox is self powered and provides movement with power assistance to the left wheel.

Steering stability and tire wear are influenced by wheels, hubs, tires, air suspension, brakes, front suspension and front end alignment which are all covered in their respective sections in this manual.

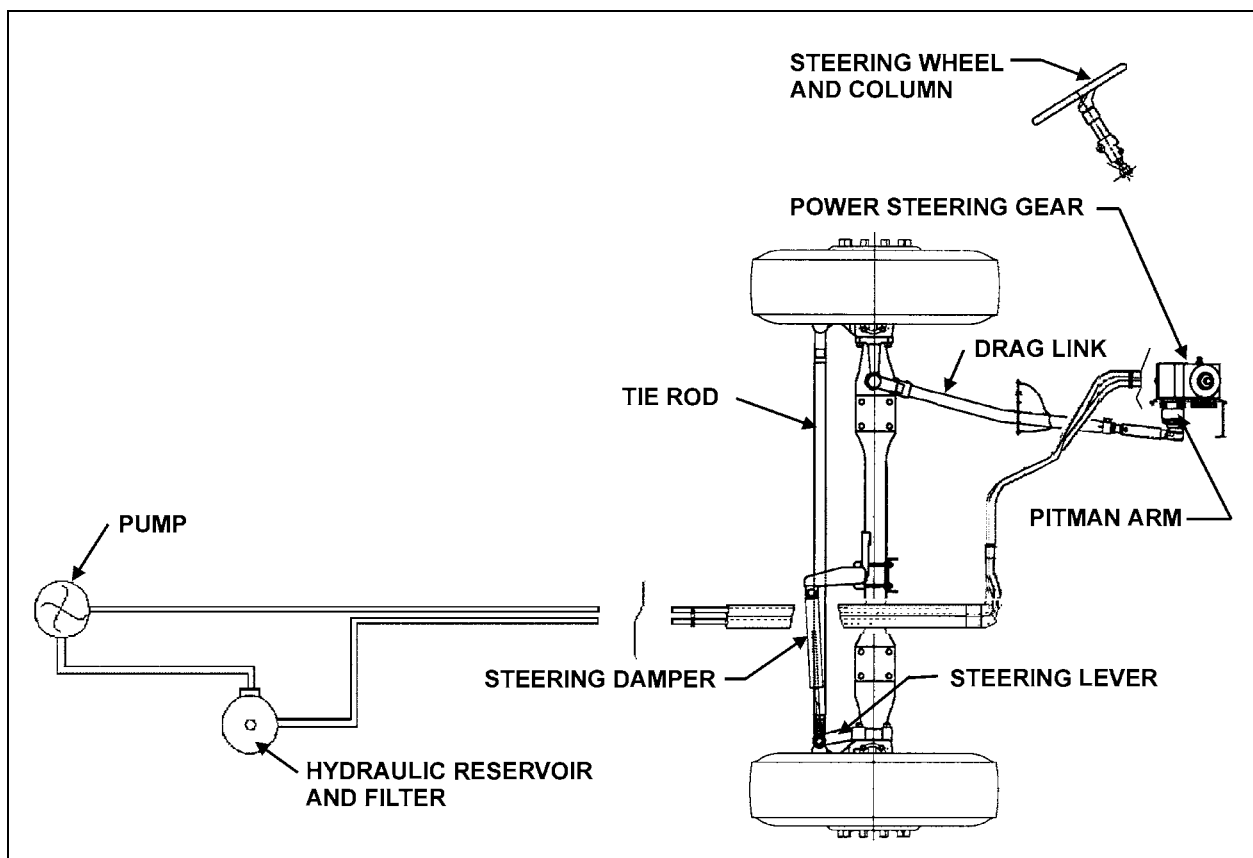


FIGURE 1: STEERING SYSTEM AXLE SETUP

14041

### 1.2 INDEPENDENT FRONT SUSPENSION STEERING SYSTEM DESCRIPTION

The steering system consists of the steering wheel and column assembly, a vane-type hydraulic pump, reservoir, filter, interconnecting system lines and hoses, integral power steering gear and linkage (Fig. 2).

## Section 14: STEERING

The steering linkage consists of tie rods connected to the bell crank and the steering arm at the left side of the coach, and to the idler arm and steering arm at the right side of the coach. The bell crank and idler arm are connected by a relay rod. A drag link connected to the bell crank and the pitman arm, which is mounted to the steering gear, transfers the turning motion of the steering wheel to the steering arms.

Hydraulic components are added to transmit, increase and regulate steering control forces.

These elements are:

1. A vane type hydraulic pump; and
2. Hydraulic reservoir and hoses.

The steering gearbox is self powered and provides movement with power assistance to the left wheel.

Steering stability and tire wear are influenced by wheels, hubs, tires, air suspension, brakes, front suspension and front end alignment which are all covered in their respective sections in this manual.

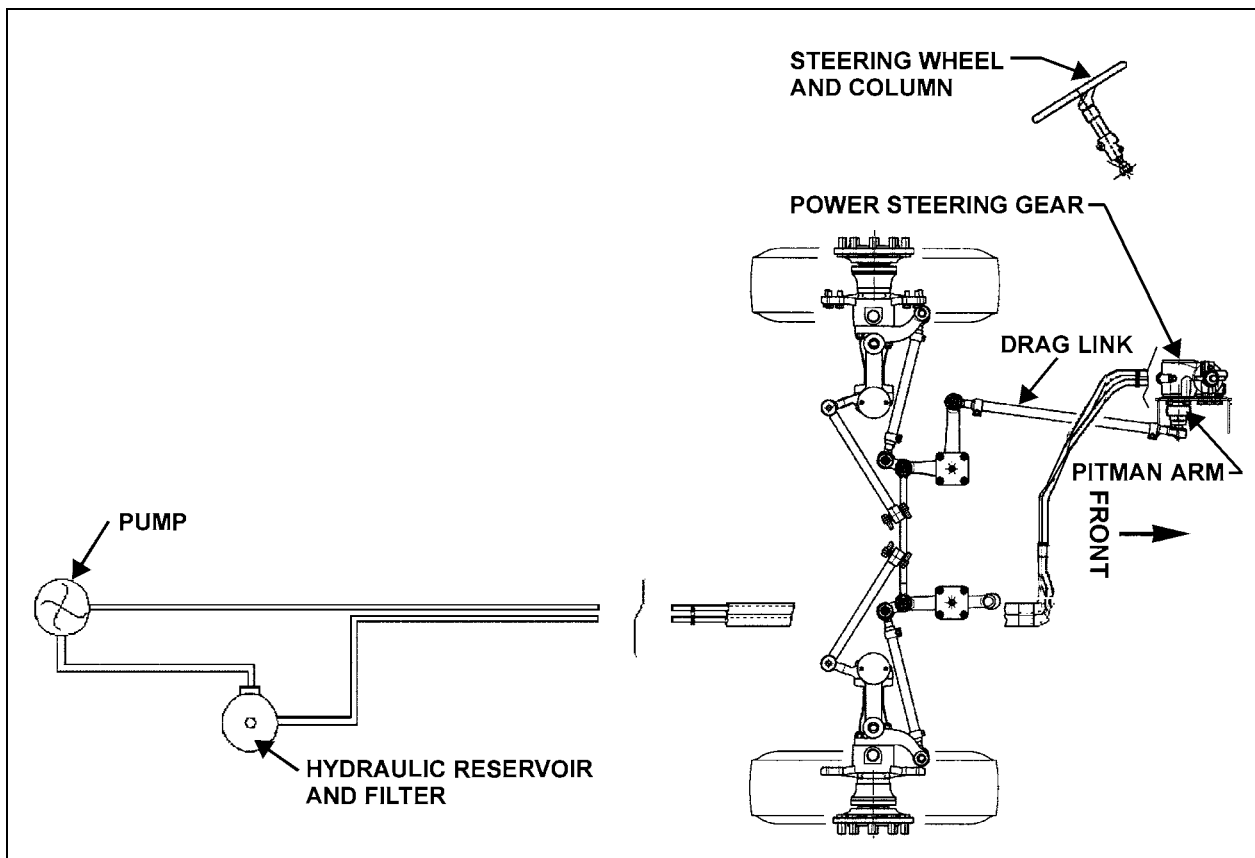


FIGURE 2: IFS STEERING SYSTEM SETUP

14060

## 2. POWER STEERING GEAR

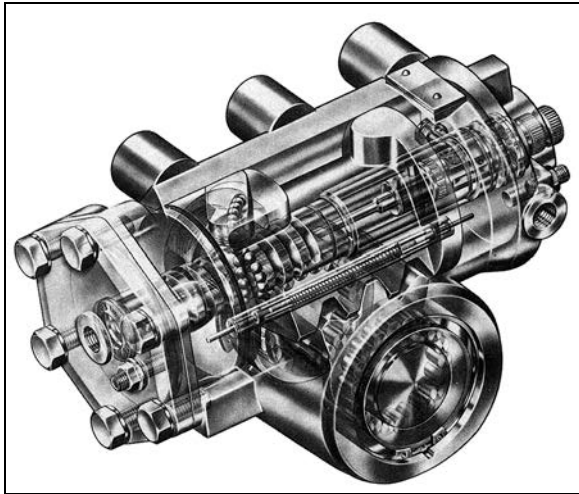


FIGURE 3: POWER STEERING GEAR

14035

### 2.1 DESCRIPTION

The power steering gear is located in the lower part of front service compartment (Figs. 3 & 4). The housing of the ZF-Servocom contains a control valve, working cylinder and a complete mechanical steering gear. The pressure oil for the steering is delivered by a motor-driven oil pump which is supplied with oil from an oil tank.

The housing is designed as a cylinder for the piston, which converts the rotation of the steering shaft and the worm into an axial movement and transfers this to the steering worm sector shaft. The serration of the sector shaft is straight-cut with a high surface quality in such a way that it is only possible to set a unique setting without play on installation in the straight-ahead driving area by means of the two eccentrically designed lateral housing covers.

The piston and worm are connected via a ball chain. When the worm is turned, the balls are collected by a circulating pipe at one end of the chain and fed in again at the other end, thus producing an endless ball chain.

The control valve consists of the valve slide in a needle bearing in the worm, with six control grooves on the circumference and the control sleeve on the worm, which also has six control grooves. The valve slide, designed with steering shaft connection, turns together with the worm as the steering wheel is turned.

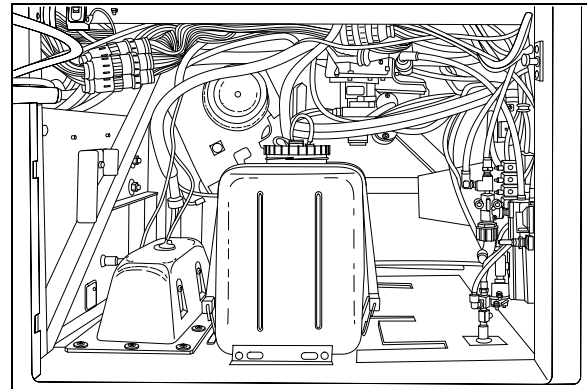


FIGURE 4: FRONT SERVICE COMPARTMENT

14050

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 maneuvering.

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 WITH DDC SERIES 60 ENGINE

#### 6.1.1 Description

The TRW PS Series 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.

#### 6.1.2 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 (Prevost P/N 510488).
2. Bleed air from the system as per step 3, "Bleeding Power Steering Hydraulic System".

#### 6.1.3 Maintenance

Refer to the "ZF-SERVOCOM Repair Manual" and the "TRW - Power Steering Pump Service Manual" annexed to this section.

## 6.2 WITH VOLVO D13 ENGINE

## 6.2.1 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, at the flywheel end and is also used for driving the fuel pump.

## 6.2.2 Removal And Installation

The pump is accessible through the engine compartment R.H. access door.

To remove the pump, proceed as follows:

1. You must first remove the fuel feed pump.
2. Clean around the fuel pump and fuel lines. Position a container to catch any fuel that might drain from the pump or lines.
3. Remove the fuel pump.

**NOTE**

Only unfasten the bolts marked with arrows.

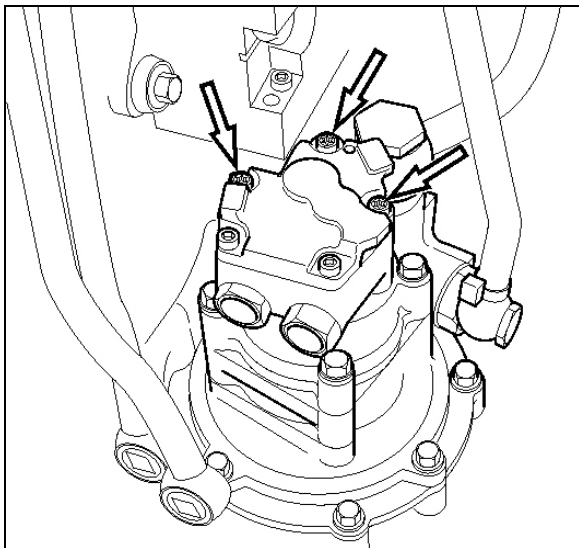


FIGURE 5: FUEL PUMP REMOVAL

**CAUTION**

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

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

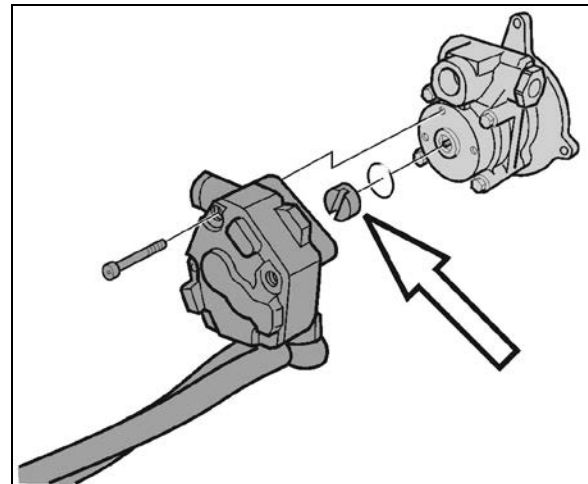


FIGURE 6: FUEL PUMP DRIVE AXLE

5. Set the fuel pump aside.
6. Clean around the power steering pump and loosen the steering lines. Position a container to catch any hydraulic fluid that might drain from the pump or lines.
7. Unfasten the power steering pump bolts.

**NOTE**

Only unfasten the bolts marked with arrows.

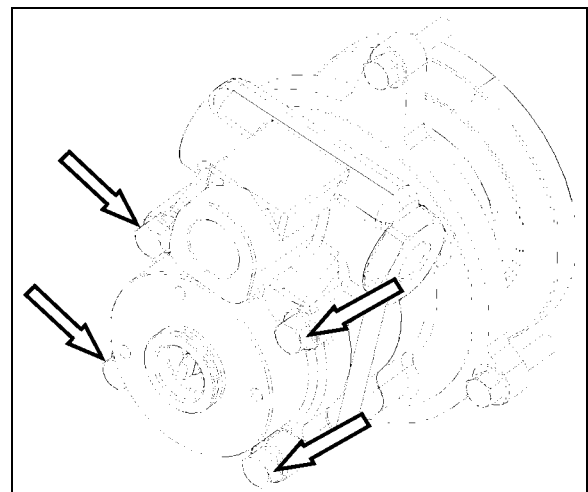


FIGURE 7: POWER STEERING PUMP REMOVAL

8. Install the new power steering pump. Torque-tighten bolts to specification.

**NOTE**

Use a new gasket.

9. Connect the hydraulic lines to the power steering pump.
10. Install the fuel pump. Torque-tighten bolts to specification.

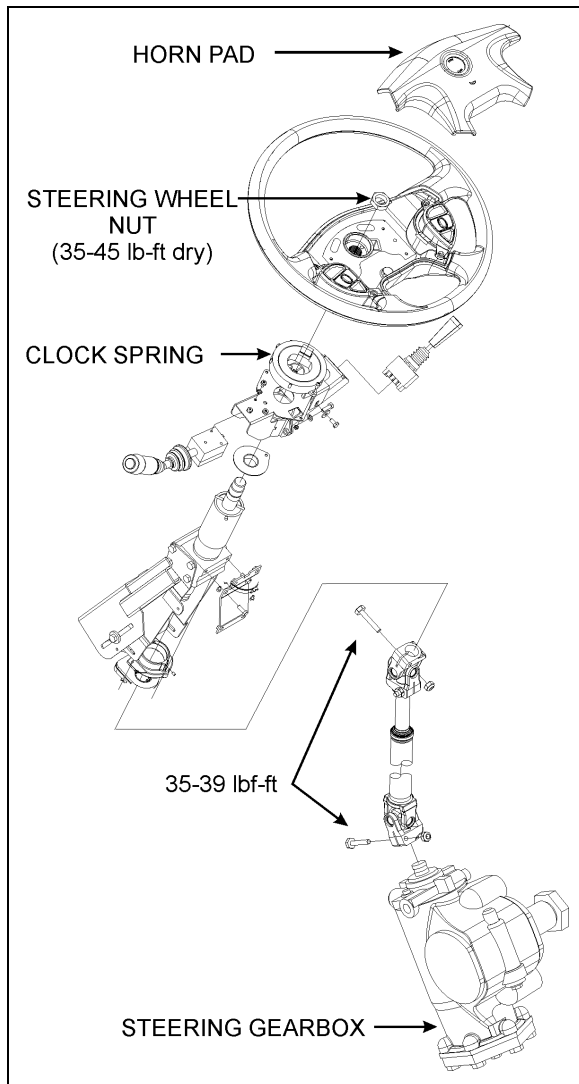
**NOTE**

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

Start the engine and let run for 5 minutes. Make sure that there are no leaks.

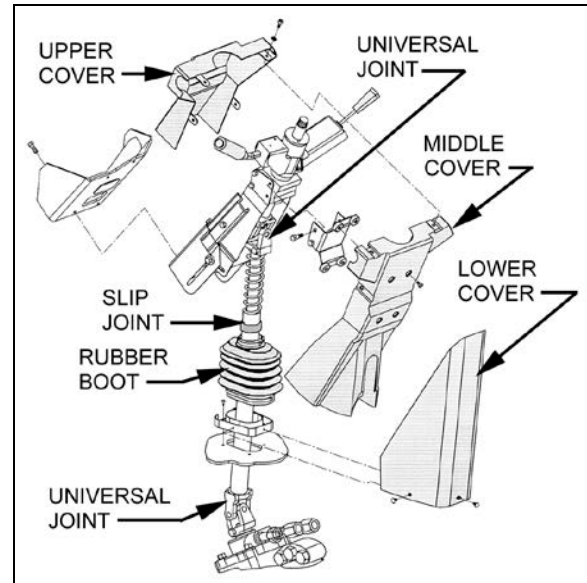
**7. STEERING COLUMN**

**7.1 REMOVAL**



**FIGURE 8: STEERING COLUMN**

To disassemble the steering column from system, refer to figure 8 & 9. The steering column has no lubrication points. The lower steering column U-joint is easily accessible through the front service compartment. The upper steering column U-joint and the steering slip joint are accessible from the front driver's area. To access these joints, proceed as follows:



**FIGURE 9: STEERING COLUMN COVERS** 14040

1. From the front driver's compartment area, remove the three plastic fasteners on steering column lower cover. Remove the lower cover (Fig. 9).
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.

**8. STEERING WHEEL**

**8.1 REMOVAL**

**NOTE**

Before undertaking the steering wheel removal, assure that the front wheels are pointing straight ahead, aligned with the vehicle.

1. Set the battery master switch located in the R.H. side rear service compartment to the "OFF" position.
2. Pull the horn pad straight up gently to detach it from the steering wheel (Fig. 10).
3. Disconnect the horn wire (white) connected to the horn pad and the steering wheel harness 4-pin connector.



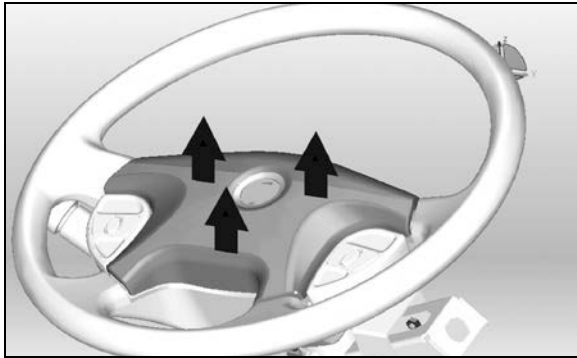


FIGURE 10: REMOVING THE HORN PAD

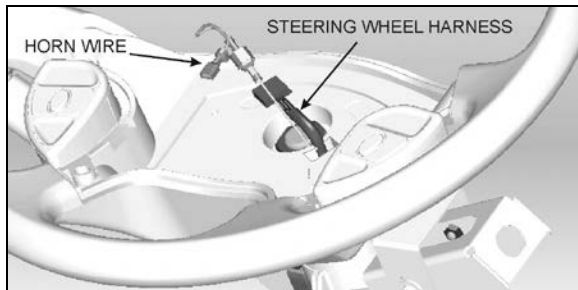


FIGURE 11: STEERING HARNESS &amp; HORN WIRE

4. Unscrew the steering wheel nut. To simplify installation and ensure steering wheel alignment, mark the relationship of the spline shaft to the steering wheel hub (if marks don't already exist or don't line up).
5. Using an appropriate puller, separate the steering wheel from the spline shaft.
6. From behind the steering wheel, pull gently on the electrical wires passing through the rectangular opening in the steering wheel to finish removal of the steering wheel.

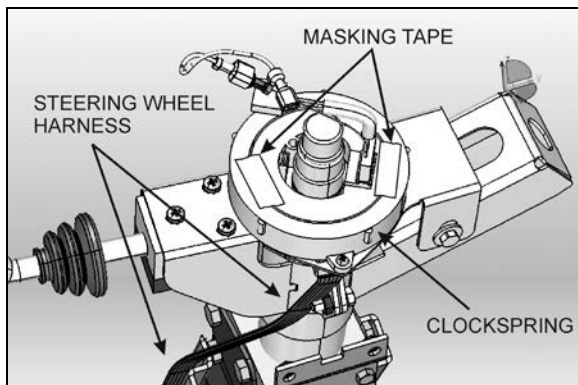


FIGURE 12: LOCKING THE CLOCKSPRING IN PLACE

7. Once the steering wheel is removed, it is important to block any rotating movement of the clockspring in order to prevent it from

losing its neutral position. Use two pieces of masking tape to lock it in place (Fig. 12).

**NOTE**

*The clockspring mechanism permits a certain number of turns in each direction. At the moment of reinstalling the steering wheel, if the clockspring is not at its neutral position, the number of available turns will be reduced. That may damage the clockspring if the steering wheel is turned to its maximum amplitude.*

**8.2 INSTALLATION**

1. Route the white horn wire and the 4-pin connector through the opening on the steering wheel.
2. Align the mark on the steering wheel hub with the mark on the spline shaft and slide the wheel onto the shaft.
3. Tighten wheel retaining nut to a torque of 35-45 lbf·ft.
4. Plug the 4-pin connector and connect the white horn wire to the center pad.
5. Reinstall the center pad and test for proper horn functioning.

**8.3 CLOCKSRRING REPLACEMENT**

1. Remove the steering wheel.
2. Remove the 2 clockspring mounting screws and then remove the clockspring. You will have to disconnect the clockspring harness connector located lower along the steering wheel column. If necessary, remove the steering column covers (Fig. 9).
3. Route the new clockspring harness through the opening in the clockspring support (Fig. 13). Plug the connector at the base of the steering wheel column and fix harness along the steering wheel column.

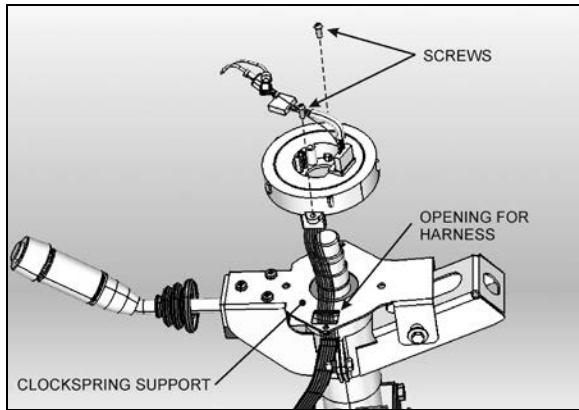


FIGURE 13: CLOCKSPRING INSTALLATION

4. Mount the clockspring in place with 2 screws.
5. Break the paper seal and rotate the center part of the clockspring about 50° clockwise (Fig. 14). This step is necessary for the installation of the steering wheel.

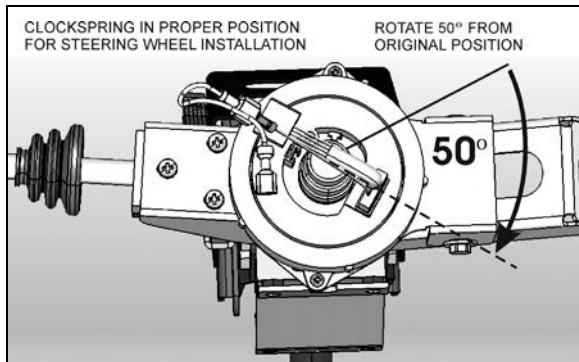


FIGURE 14: PROPER CLOCKSPRING POSITION

6. Reinstall the steering wheel.

### 9. TURNING ANGLE ADJUSTMENT

The maximum turning angle is set through two (2) steering stop screws installed on the axle center. Steering stop screws are factory adjusted to accommodate the chassis design, and therefore, do not require adjustment on new vehicles. However, these should be checked and adjusted if necessary, any time a steering system component is repaired, disassembled or adjusted. Refer to section 10 "FRONT AXLE" under heading "6.4 TURNING ANGLE ADJUSTMENT".

**Caution:** To prevent the steering damper from interfering with the adjustment of turning angles, make sure its fixing bracket is at correct location on the axle (refer to "12.2 Steering Stabilizer Cylinder (Damper)").

### Hydraulic Stop

**Caution:** Reduce or shut off the power steering hydraulic pressure before the boss on the axle touches the stop screw. If not, the components of the front axle will be damaged (refer to "ZF-SERVOCOM REPAIR MANUAL" and "ZF-SERVOCOM Operating, Servicing/Maintenance and Inspection Instructions" annexed to this section, under heading "SETTING THE STEERING LIMITER").

**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 includes the pitman arm, drag link, steering arm, tie rod arms and tie rod.

Perform lubrication according to "DANA SPICER NDS Axles Lubrication and Maintenance" annexed to section 10 "FRONT AXLE".



### MAINTENANCE

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 10 "FRONT AXLE" under heading 6. "FRONT WHEEL 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.

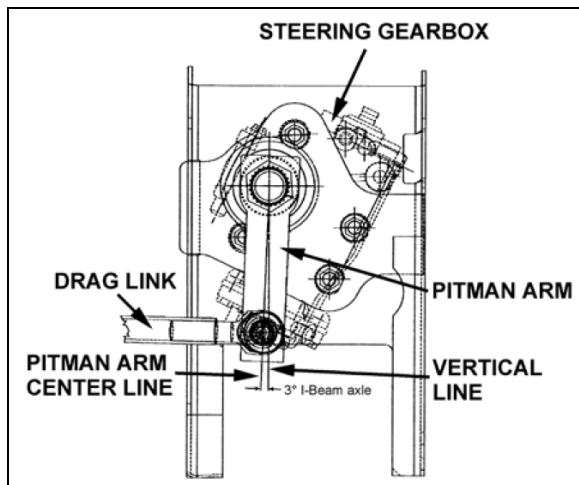


FIGURE 15: PITMAN ARM ADJUSTMENT 14052

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.
8. 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 (Prevost #661050). Tighten as per "Torque Specifications" in this section.

**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 16).

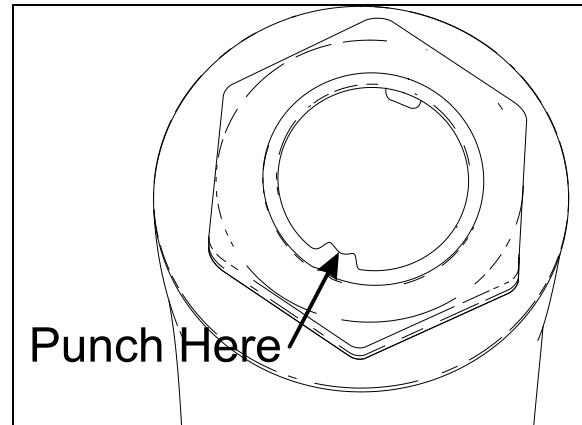


FIGURE 16: FIXING NUT PUNCH MARK 16098

4. Connect drag link to pitman arm while ensuring that rubber stabilizer is in place on the rod end. Install washers. Tighten as per "Torque Specifications" in this section. 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. 15 for details).
3. The pitman arm should be adjusted to an angle of 3° (I-Beam axle) or 2° (Independent Front Suspension) in relation with the vertical axis (towards rear 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 Tighten as per "Torque Specifications" in this section.

## 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-IIIE, Dexron-III or Dexron-VI" 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".

**Warning:** Do not operate the pump without fluid in the power steering fluid reservoir.

If the steering linkage between the steering gear and the two front wheels is not properly adjusted, or if it is bent, twisted or worn, the steering of the vehicle will be seriously impaired. Whenever a steering linkage part is repaired, replaced or adjusted, steering geometry and front wheel alignment must be checked and necessary corrections made. Refer to section 10 "FRONT AXLE" under heading 6: "FRONT WHEEL ALIGNMENT".

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, on front wall and accessible through the engine compartment R.H. side door. (Fig. 17).



## MAINTENANCE

At regular intervals, fluid level should be checked in the reservoir and filter assembly. Furthermore, the oil filter cartridge element in the power steering reservoir should be replaced every 50,000 miles (80 000 km) or once a year, whichever comes first.

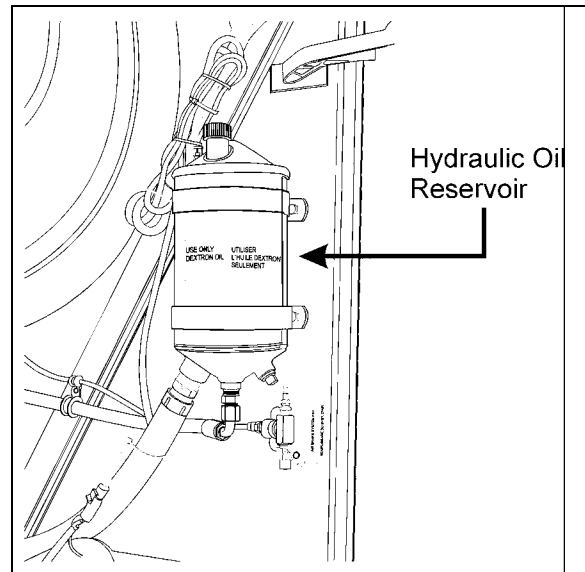


FIGURE 17: HYDRAULIC FLUID RESERVOIR LOCATION  
14043

#### 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.
3. Insert dipstick in reservoir. Remove it again to check fluid level (Fig. 18).
4. Adjust level to "FULL" mark using proper dipstick side depending on fluid temperature, use "Dexron-IIIE, Dexron-III or Dexron-VI" 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.

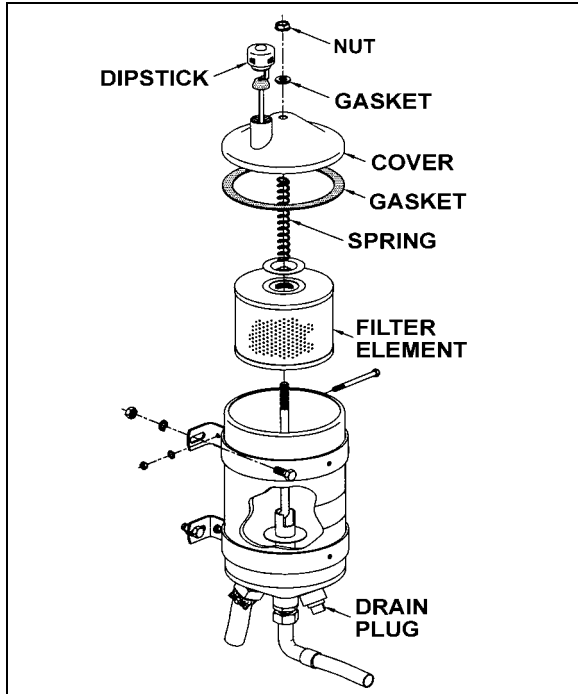



FIGURE 18: POWER STEERING FLUID RESERVOIR<sup>14018A</sup>

### 12.2 STEERING STABILIZER CYLINDER (DAMPER)

The steering damper is located on R.H. side, at back of front axle (Fig.19).

The cylinder is nonadjustable and non-repairable. Check for oil leaks or lack of resistance. Disconnect the cylinder from axle, then carefully attempt to extend and collapse it manually.



### MAINTENANCE

The rod end (ball joint) is provided with a grease fitting. Under normal conditions, it should be serviced 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"). Check the ball joint for wear, and replace if necessary.

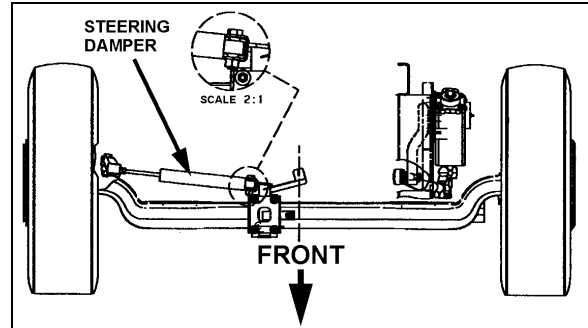
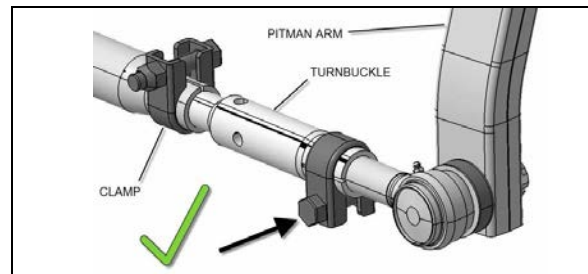


FIGURE 19: STEERING STABILIZER (DAMPER) 14053


### 12.3 DRAG LINK

Particular attention must be awarded to draglink turnbuckle clamp orientation at part removal and replacement.

Proper clamp position is shown here and should be maintained at all times.



Note horizontal orientation of clamp bolt and bolt insertion direction.



### MAINTENANCE

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").

### 12.4 POWER STEERING HYDRAULIC PUMP

For maintenance of the TRW power steering hydraulic pump (DDC S60 engine), 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.

### 14. TORQUE SPECIFICATIONS

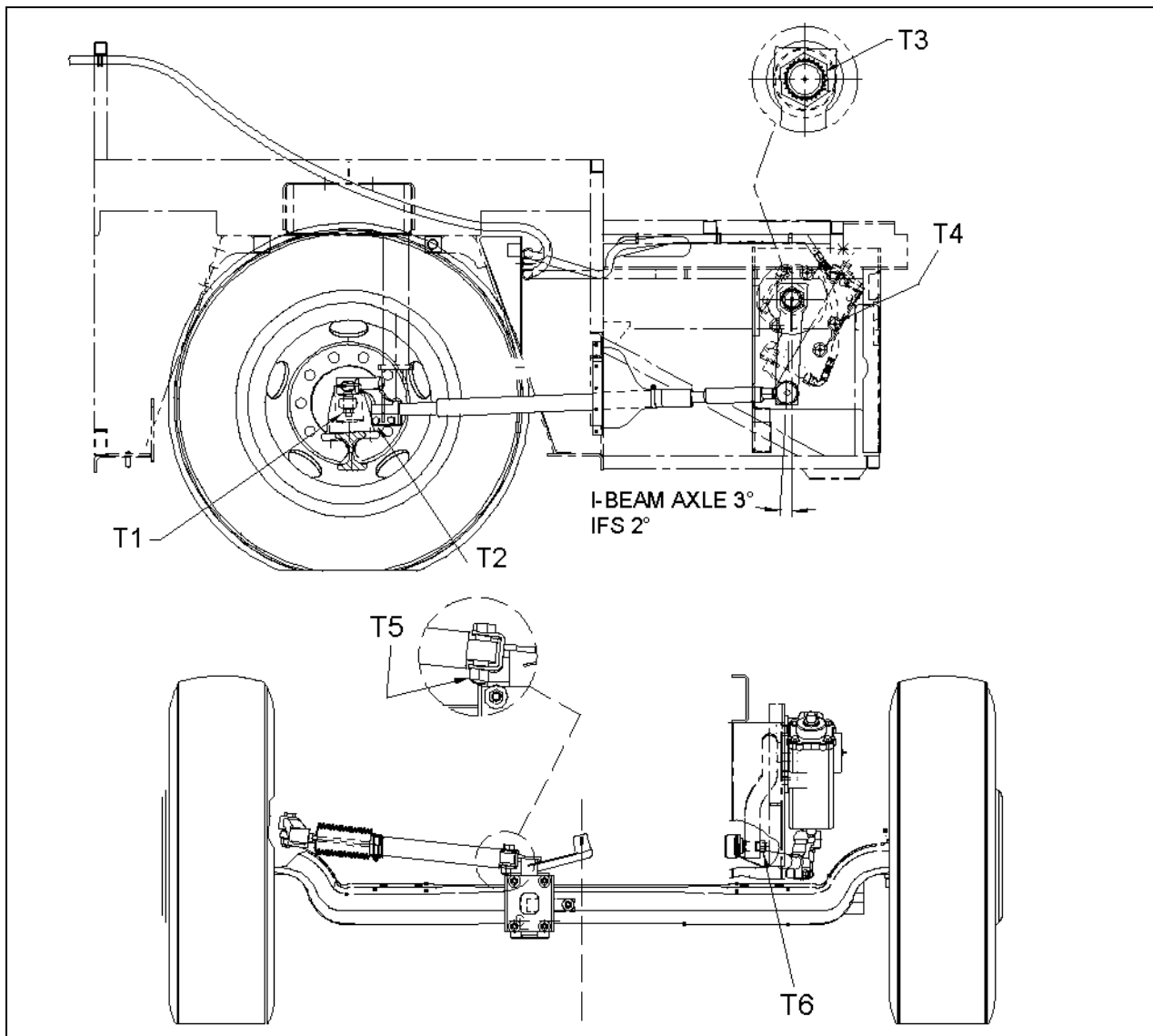


FIGURE 20: DRAG LINK COMPONENTS

14054

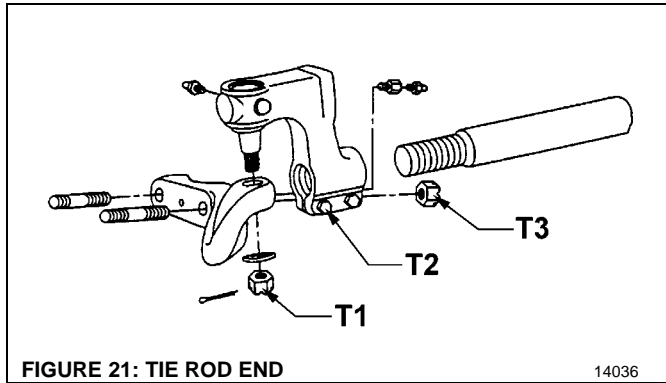


FIGURE 21: TIE ROD END

14036

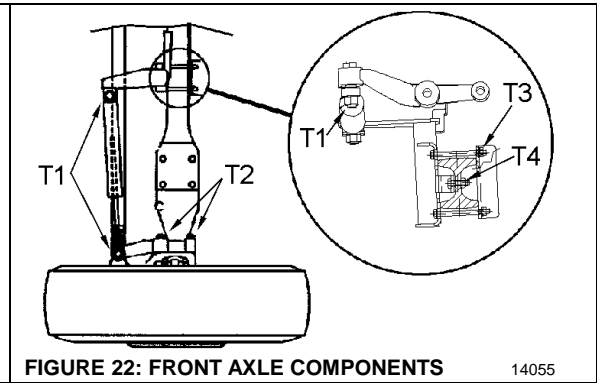


FIGURE 22: FRONT AXLE COMPONENTS

14055

TORQUES			
Description	Reference	Lbf-ft dry	Nm dry
Drag Link End Stud Nut (on steering arm)	Fig. 20, T1	150-200	203-271
Drag Link End Pinch Bolt Nuts	Fig. 20, T2	65-75	88- 101
Pitman Arm Fixing Nut	Fig. 20, T3	470-570	637-773
Steering Gear Fixing Bolts (5)	Fig. 20, T4	365-405	495-550
Steering Stabilizer (damper) Fixing Nuts	Fig. 20, T5	100-120	135-165
Drag Link End Stud Nut (on pitman arm)	Fig. 20, T6	150-200	203-271
Tie Rod End Screw Pin Nut	Fig. 20, T1	100-175	135-240
Tie Rod End Pinch bolt Nuts	Fig. 20, T2	65-75	90-100
Lower Lever Stud Nuts	Fig.20, T3	190-275	260-375
Steering Stabilizer (damper) Fixing Nuts	Fig. 21, T1	100-120	135-165
Steering Top Lever Nuts	Fig. 21, T2	285-315	386- 427
Steering Damper Mounting Support Nuts	Fig. 21, T3	30-36	40-49
Steering Damper Mounting Support Nuts	Fig. 21, T4	54-66	73-89

**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 – With Detroit Diesel Series 60 Engine**

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 ..... 661070  
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

**Steering Stabilizer Cylinder (Damper)**

Make ..... Arvin  
Extended length..... 32.73±0.12"  
Collapsed length ..... 20.26±0.12"  
Stroke..... 12.47±0.12"  
Supplier number ..... 651535  
Prevost number ..... 660979  
Dust cap - Prevost number ..... 660980





## MAINTENANCE INFORMATION

### MI13-16

DATE :	MARCH 2013	SECTION :	14 - Steering
SUBJECT :	DRAGLINK TURNBUCKLE CLAMPS ORIENTATION - ALL MODELS		

### ***IMPORTANT NOTICE***

*This Maintenance Information supersedes the info contained in your maintenance manual. This modification is recommended by PrevoSt to increase your vehicle's performance. Note that no reimbursement will be awarded for carrying out this modification.*

### **APPLICATION**

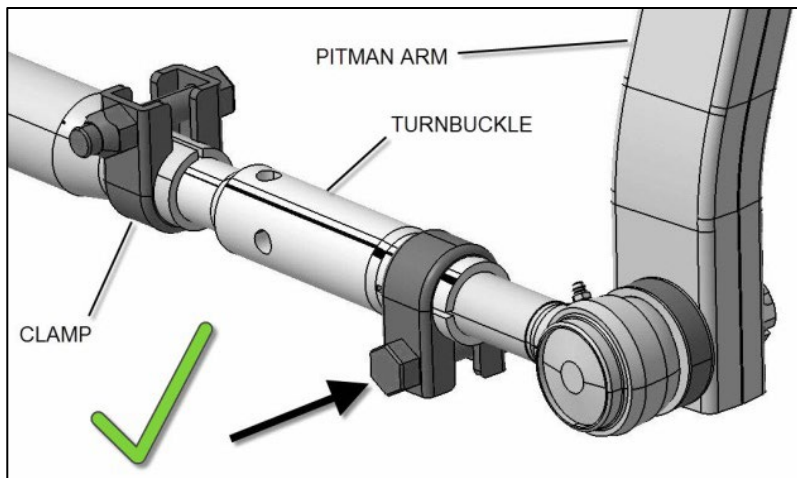
<b>Model</b>
All models with I-beam front axle and turnbuckle draglink. Model Year : 1994 up to 2013

### **DESCRIPTION**

This Maintenance Information supersedes the info contained in your maintenance manual. Add this bulletin to the steering section of the pertaining maintenance manuals.

On all models starting with model year 1994, particular attention must be awarded to draglink turnbuckle clamp orientation at part removal and replacement.

Proper clamp position is shown here and should be maintained at all times.



*Note horizontal orientation of clamp bolt and bolt insertion direction.  
Prescribed torque for clamp bolt (arrow) is between 50 and 60 lbf-ft. Applies to both clamps.*

If replacement is required, order the following parts:

Part No.	Description	Qty
160932	Turnbuckle	1
661133	Clamp	2

**NOTE**

Material can be obtained through regular channels.

## PROCEDURE

The scope of this procedure is to inspect the steering draglink turnbuckle clamp orientation on vehicles with an I-beam front axle.

If required the procedure details how to perform the replacement of the turnbuckle and clamps without undergoing a vehicle alignment.



### DANGER

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

#### 1. Setting-up for the procedure

Drive the vehicle in the service bay, making sure to leave the steering wheel as straight as possible.

Mark steering wheel position with a pair of masking tape. Align the tapes by placing one piece on the dashboard and the other on the steering wheel.

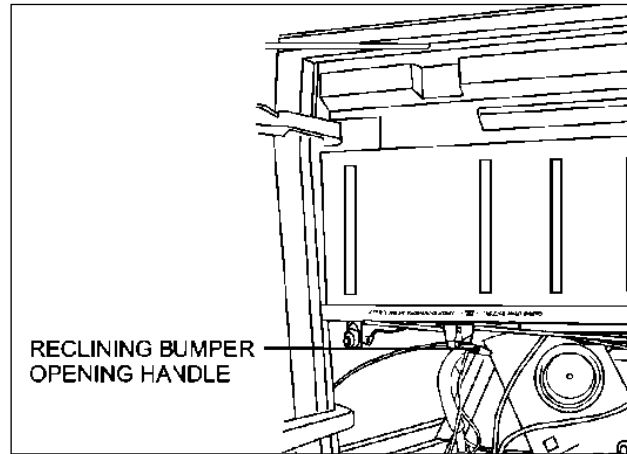
This will be your reference to restore the steering to its original state if any part replacement is required.

Note that on vehicles having a substantial steering wheel indexation or offset, the vehicle wheels may not be straight ahead when starting procedure. This does not affect the procedure in itself.

Leave vehicle on the ground to make sure the wheels will not move.



Recline the front bumper and remove spare tire.



Locate the steering gear pitman arm on the driver's side of the spare tire compartment.



## 2. Steering operation inspection

Turn wheels all the way left.

No contact should occur between pitman arm and bolt.

If contact occurs, replace both clamps and turnbuckle.

Refer to Catbase parts manual to select appropriate parts for your vehicle.

Follow replacement procedure below.



### 3. Pitman arm and bolt shank inspection

If no contact occurs in the above inspection, visually inspect the fore clamp bolt shank and pitman arm surface for previous contact marks.

Typical signs of contact may be a circular rust spot (1) on the pitman arm and/or flattened threads on bolt shank end (2).

If any one of these contact marks is visible, replace clamps and turnbuckle following procedure below.

If there is no contact evidence, proceed to clamp inspection.



### 4. Clamp inspection

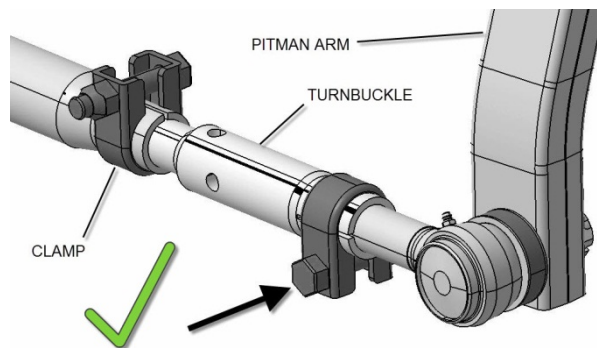
Proper draglink clamp orientation is shown here.

*Note horizontal orientation of clamp bolt and bolt insertion direction.*

Clamps should not be bent or squeezed by the bolt. If this is the case, they have been over torqued and should be replaced. Refer to replacement procedure below.

If clamps are in good condition but are not properly oriented, rotate the clamps as shown.

If clamps are properly oriented and in good condition, proceed to interference inspection.



*Clamp is bent. Replace clamp.*

## 5. Turnbuckle replacement procedure

Apply this procedure to change the turnbuckle without undergoing a vehicle alignment.

Mark center of ball joint.

Measure distance **(A)** between center of ball joint on pitman arm and draglink end.

**A** : \_\_\_\_\_

Unfasten clamps.

Release the clamps.

Rotate turnbuckle by inserting a tool like a round nose chisel in the turnbuckle holes.

Install the new clamps on the new turnbuckle. Make sure bolts are inserted as shown on the clamps.

Apply a small amount of anti-seize compound to the turnbuckle threads.

Engage the turnbuckle female threads two or three turns on the ball joint end.

➤ **Two people are required for next steps.**

Align turnbuckle and draglink. Have a partner turn the steering wheel to position the turnbuckle male threads ready to engage in the draglink.

Engage by turning the turnbuckle in the draglink while applying a light tension on the steering wheel to help thread insertion.

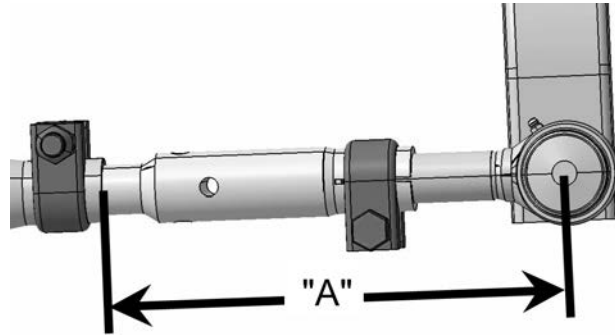
Adjust the turnbuckle until you reach measure **(A)** noted earlier.

At this point, make sure threads are visible the entire length of the slots on the draglink and turnbuckle female ends.

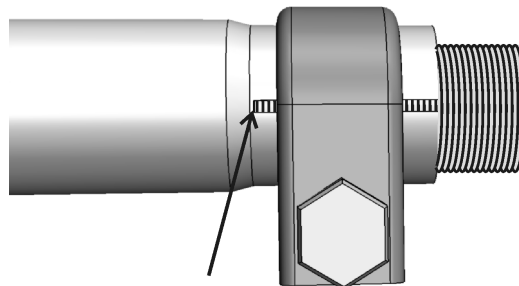
Finish by making fine adjustments to align the tape marks on the steering wheel.

This will return the steering to its original state.

Make sure the ball joints at each end of the draglink assembly are in neutral



THREADS MUST BE VISIBLE  
THE ENTIRE LENGTH OF THE SLOT

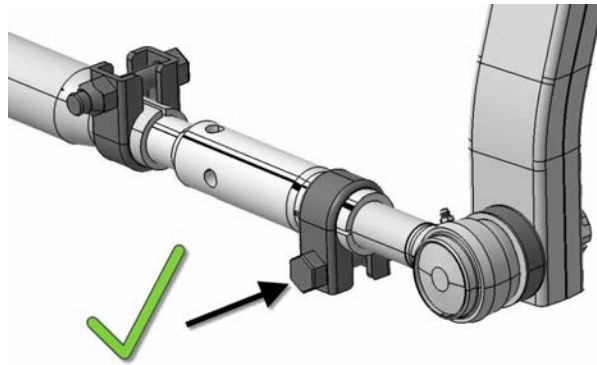


position (centered) before final clamp tightening.

Clamp bolts should be installed horizontal with bolt head as shown. Tighten clamp bolts to 50-60 lbf-ft.

Mark bolt head with torque seal.

Remove rust and restore the paint finish on the pitman arm to mask any contact marks. This way any future contact will be revealed.



## 6. Interference inspection

➤ **Two people are required for next steps.**

Turn the wheels fully in both directions while another person inspects the linkage for interference with surrounding structural parts and components.

Minimum acceptable clearance is 3/8".

### Waste disposal:

Discard according to applicable environmental regulations (Municipal/State[Prov.]/ Federal)

Access all our Service Bulletins on  
<http://prevostparts.volvo.com/technicalpublicatios/en/pub.asp>  
 Or scan the QR-Code with your smart phone.

E-mail us at [technicalpublications\\_prev@volvo.com](mailto:technicalpublications_prev@volvo.com) and type "ADD" in the subject to receive our warranty bulletins by e-mail.







# **ZF-Servocomtronic<sup>®</sup>**

**Supplement to the Repair Manual ZF-Servocom**

**ZF FRIEDRICHSHAFEN AG  
GESCHÄFTSBEREICH LENKUNGSTECHNIK**

**D - 73522 Schwäbisch Gmünd**

Telephone: (07171) 31-0

Telefax: (07171) 31-4396



## Important general information

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- The present Manual aims to help the user properly to execute the necessary maintenance and repair work on the ZF product.
- Read the Manual before starting any inspection and repair work.
- On completion of the maintenance and repair work, the specialist personnel must make certain that the product is once more operating flawlessly.

→ ***Please note that the ZF product must be repaired only in workshops that***

- ☞ ***employ trained personnel***
- ☞ ***have the prescribed equipment, including a test rig, crack detector and special tools***
- ☞ ***use ZF genuine spare parts.***

- This Manual is only for foremen and fitters who have undergone practical and theoretical training in our Customer Service School. Together with service information bulletins, it is intended to supplement their knowledge.
- All work carried out on ZF products must be executed with extreme care and diligence. This applies in particular to products and transmission components from vehicles damaged in accidents.
- The manufacturer does not, of course, accept any liability for damage and its consequences arising from incorrectly or inexpertly executed repairs.
- This Manual draws attention to notes on safety as follows:

**Note:** Where incorrect and careless work can cause damage to the product.



**Attention:** Where incorrect and careless work can lead to personal injury and endanger life.

- This Manual is not part of the updating service.
  - The contents of the additional service information bulletins must also be observed.
-





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I. Disassembly .....	2
II. Examining the individual parts .....	4
III. Assembly .....	4
IV. Setting and functional test .....	6
V. Troubleshooting .....	8
VI. Special tools .....	12
VII. Key to numbers in figures and exploded drawing .....	12

**Notes:**

- The processes necessary for the repair of a ZF-Servocomtronic have mostly been described in the Repair Manual ZF-Servocom.
- Any deviating or additional process will be described in the following.



## I. Disassembly

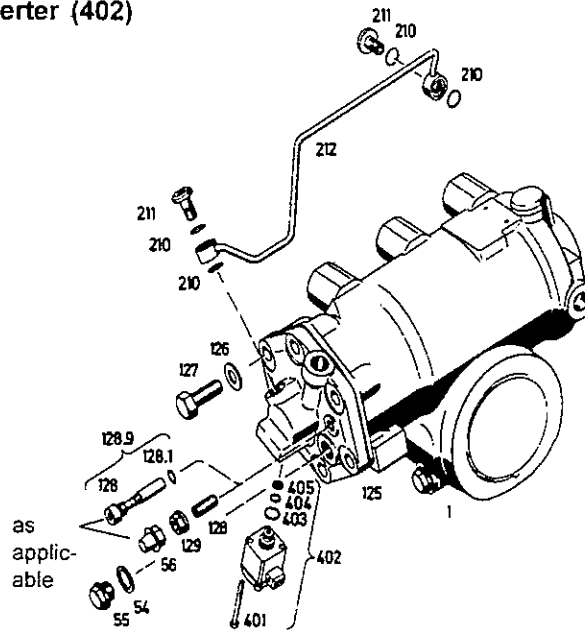
### 1 Removal of pipe (212) and converter (402)

Screw out union screws (211) and remove pipe (212) with O-rings (210).

Mark position of converter (402).

Turn out two cap screws (401) provided with an internal hexagon.

Remove converter (402) and dismantle O-rings (403 and 404) as well as oil screen (405).



Unscrew hexagon screws (127) with washers (126).

Drive piston (101) back towards bottom of housing so that the valve tappet of valve insert (109) is not damaged when turning the cylinder cover (125).

Remove screw (128) with O-ring (128.1) and set them aside for later use (required for functional tests, chapter IV.).

**or:**

Remove set screw (128) and collar nut (129).

Unscrew screw plug (55) with sealing ring (54).

Put steering drop arm onto sector shaft (80).



## Disassembly

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).

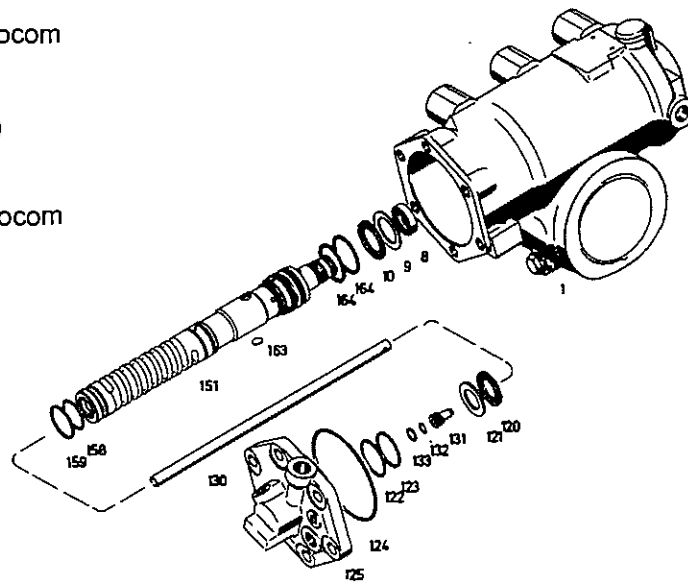
Pull pipe (130) together with reaction piston (131) out of worm (151).

### 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)

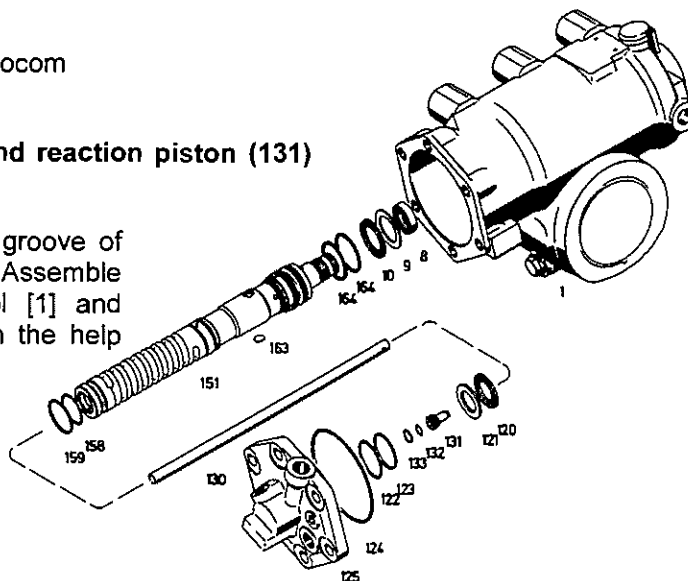
See Repair Manual ZF-Servocom

### 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).



## Assembly

### 4 Installation of cylinder cover (125)

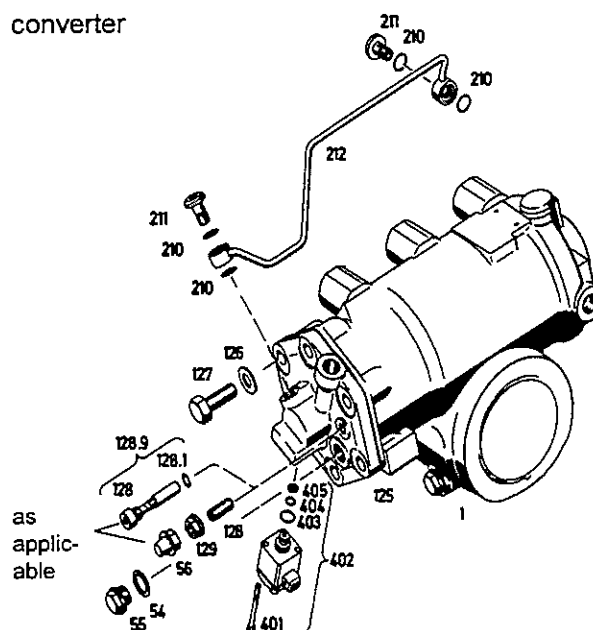
See Repair Manual ZF-Servocom

### 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:  $20 \pm 2$  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] (Servotronicstest) 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

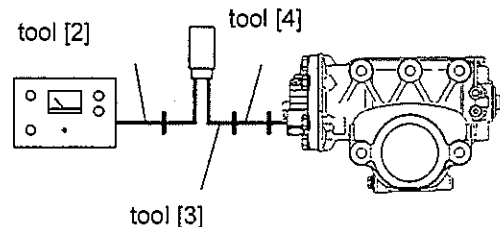
#### Note:

Before using the Servotronicstest 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 Servotronicstest (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 Servotronicstest to position "0" .
- Note on the Servotronicstest 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 Servotronic test 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 Servotronic 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 Servotronic test 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 Servotronic 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.

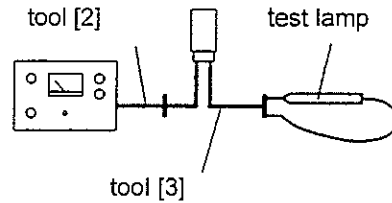
## 2.2 Functional test of the control unit:

→ Connect the Servotronic test 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 Servotronic test to position "0".

→ Connect tool [3] to Servotronic test (tool [2]).

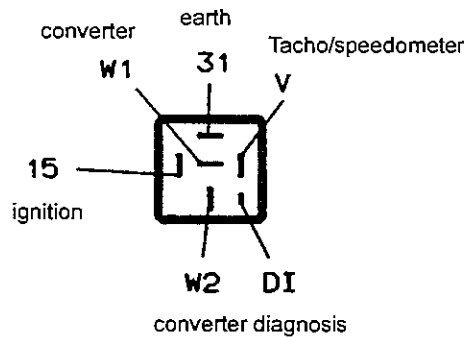
→ Connect the test lamp directly to the control unit or to the cable leading to the converter as accessibility allows.



- 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 <sup>1</sup>
		→ replace speedometer signal <sup>1</sup>
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 <sup>1</sup>
	→ cable connection to converter in contact with on-board voltage	→ check and replace, if necessary –remove control unit –measure at the socket <sup>2</sup> voltage from pin W1 to 31 nom. value: 0V resistance from pin W2 to 31 nom. value: ∞Ω i.e. no connection

<sup>1</sup> see vehicle manufacturer's manual

<sup>2</sup> **Attention!** Any measurement between V and 31 must be performed only with a voltmeter. Otherwise the speed signal sensor will be destroyed.

## Troubleshooting



Trouble	Cause	Remedy
	→ wrong control unit	→ check → replace
	→ defect in cable tree	→ check <sup>1</sup> → replace
Alternate heavy and easy steering during travelling	→ wrong speedometer signal	→ check speedometer signal <sup>1</sup> → replace speed signal sensor <sup>1</sup>
	→ 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

<sup>1</sup> see vehicle manufacturer's manual

<sup>2</sup> **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-Servocontronic on the basis of which the entire manual has been compiled.

Other tools may consequently be required for the particular ZF-Servocontronic unit to be repaired.

**Tool [1].**

Guide bush



**Part-No.**

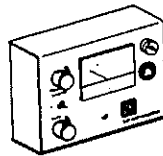
8098 798 004

Mounting ring

8098 798 655

**Tool [2]**

Servotronic test



7418 798 545

Power supply unit

7418 798 546

**Tool [3]**

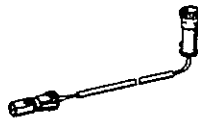
Adapter



7038 340 201

**Tool [4]**

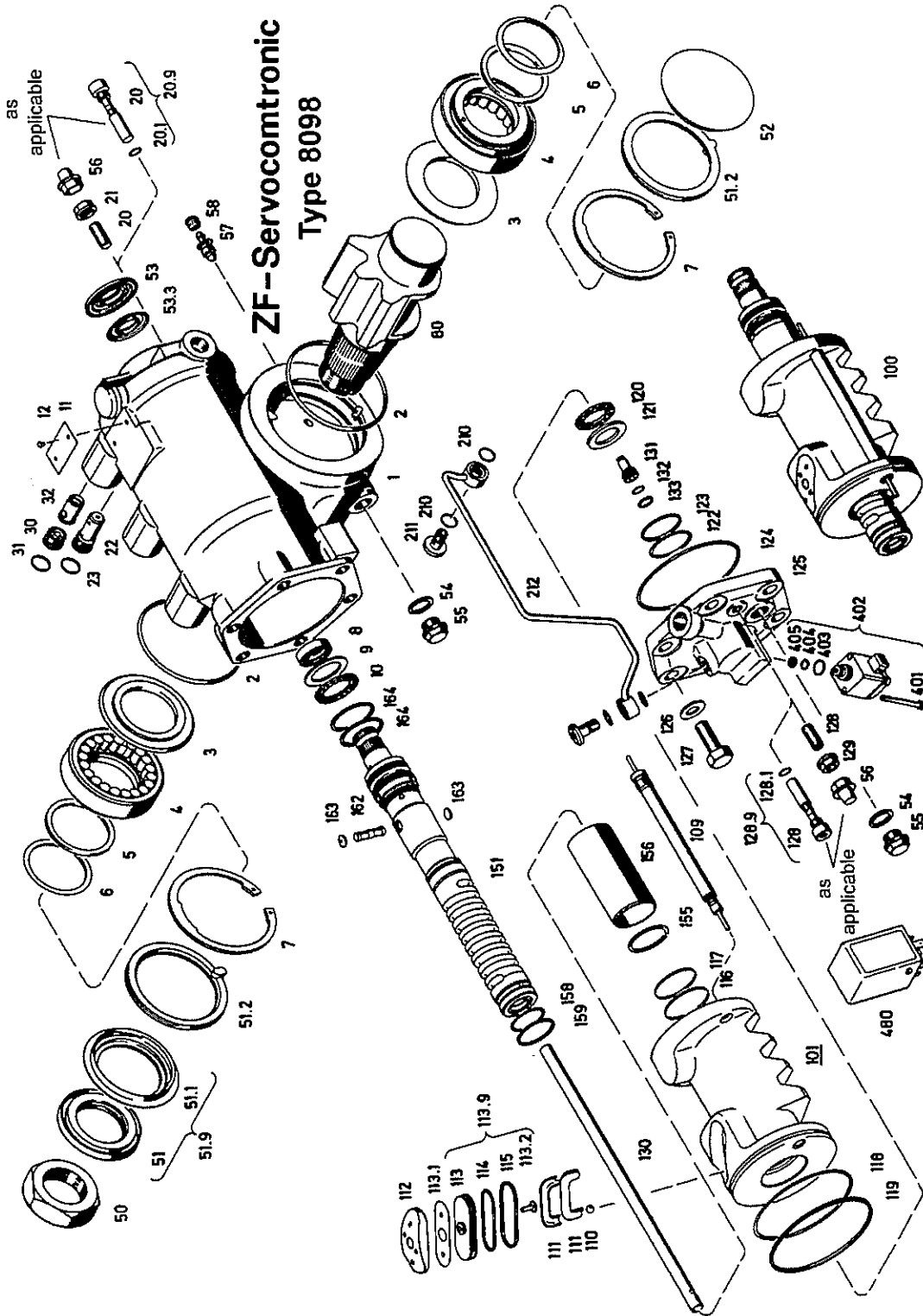
Adapter cable



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





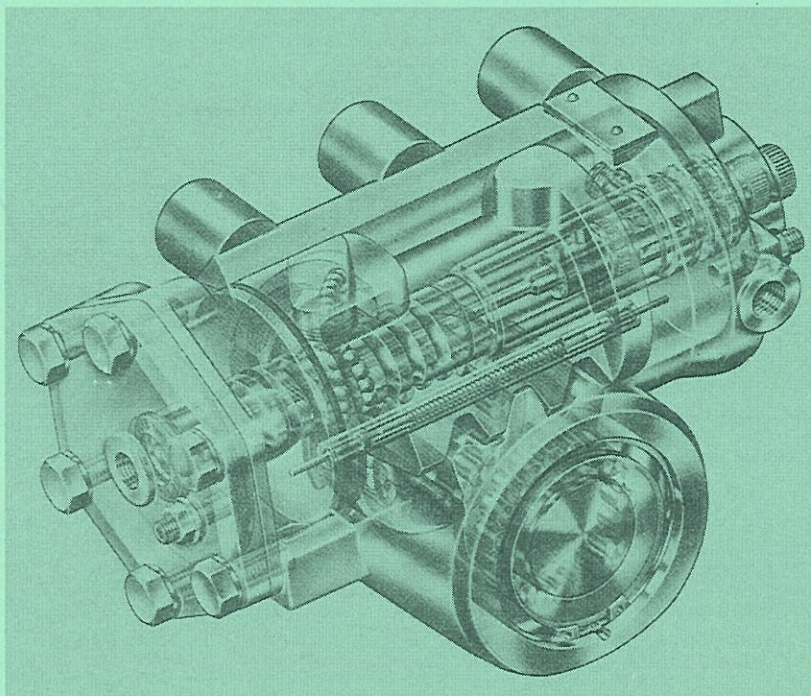




# ZF-Servocom

**Types 8090 - 8099  
(Single and dual-circuit versions)**

## Repair Manual



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## Important general information

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- The present Manual aims to help the user properly to execute the necessary maintenance and repair work on the ZF product.
- Read the Manual before starting any inspection and repair work.
- On completion of the maintenance and repair work, the specialist personnel must make certain that the product is once more operating flawlessly.

→ ***Please note that the ZF product must be repaired only in workshops that***

- ☞ ***employ trained personnel***
- ☞ ***have the prescribed equipment, including a test rig, crack detector and special tools***
- ☞ ***use ZF genuine spare parts.***

- This Manual is only for foremen and fitters who have undergone practical and theoretical training in our Customer Service School. Together with service information bulletins, it is intended to supplement their knowledge.
- All work carried out on ZF products must be executed with extreme care and diligence. This applies in particular to products and transmission components from vehicles damaged in accidents.
- The manufacturer does not, of course, accept any liability for damage and its consequences arising from incorrectly or inexpertly executed repairs.
- This Manual draws attention to notes on safety as follows:

**Note:** Where incorrect and careless work can cause damage to the product.



**Attention:** Where incorrect and careless work can lead to personal injury and endanger life.

- This Manual is not part of the updating service.
  - The contents of the additional service information bulletins must also be observed.
-





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## I. Disassembly



### Attention:

Utmost cleanliness must be maintained when disassembling and storing the parts in order to ensure that the steering operates reliably. Force must never be used when disassembling parts, as this may damage the sealing ring seats, sealing faces, etc. The resultant damage may lead to partial or total failure of the steering.

### Notes:

- The figures in round brackets, e.g. (348), refer to the part numbers used in Chapter VIII and the list of spare parts.
- The figures in square brackets, e.g. [1], refer to the special tools listed in Chapter VII.

### 1 Preparing the steering for disassembly

Clamp steering in tool [1] or between the soft jaws of a standard vice.

Turn the steering through from end to end and note the total number of turns (reference value for function tests).

Set the steering to straight-ahead position (half the total number of turns) and check or restore the markings for straight-ahead.

### 2 Removal and disassembly of the bevel box

#### 2.1 Versions with cross disc (348)

##### 2.1.1 Remove bevel box

Mark position of bevel box and intermediate flange (335).

Unscrew cap screws / hexagon screws (352) with washers (350) (*Fig.1*).

Remove complete bevel box.

Remove shim plate (330) and O-ring (333).

##### 2.1.2 Disassembly of intermediate flange (335)

Unscrew cap screws (334).

Remove intermediate flange (335) with cross disc (348) and ball bearing (343).

Remove O-ring (341).

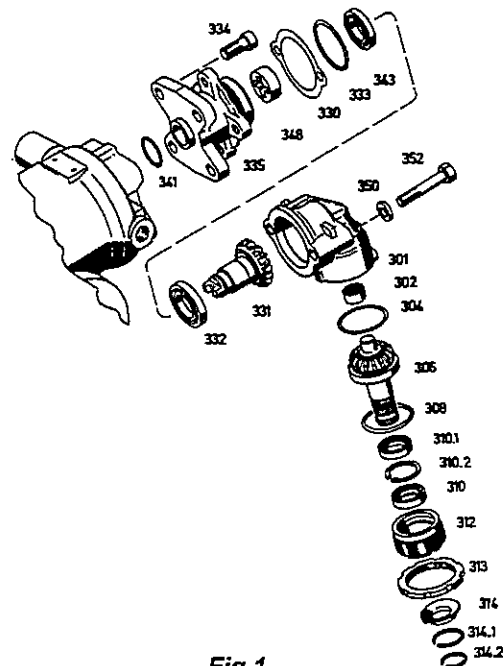


Fig.1

## 2.1.3 Disassembly of bevel box

**Note:**

The bevel gear (306) must not be forced off in order to replace the ball bearing, as it cannot be ensured that the notched gearing locks securely when the bevel gear (306) is pressed into position a second time.

Remove snap ring (314.1 and 314.2) and draw dust seal (314) off steering shaft stub.

Unscrew slotted nut (313) and unscrew adjusting screw (312) from housing with tool [25].

Remove O-ring (308). Remove shaft seal (310), retaining ring (310.2) and shaft seal (310.1).

Draw bevel gear (306) out of housing with ball bearing. Remove washer (304).

**Note:**

Needle sleeve (302) should only be removed if the bearing journal of the bevel gear assembly is found to be damaged. If necessary, needle sleeve (302) can be drawn out with tools [26] and [27].

Dismantle ball bearing (332) and remove bevel gear (331).

## 2.2 Versions with coupling sleeve (349)

### 2.2.1 Remove bevel box

Mark position of bevel box in relation to housing (1).

Unscrew hexagon screw (352) and remove complete bevel box (see Fig.4).

Remove coupling sleeve (349), centering ring (346) and O-ring (333).

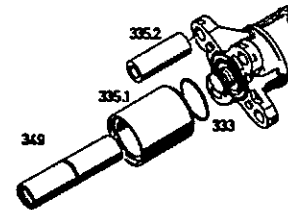


Fig.2

### 2.2.2 Remove pipes

Remove pipes (335.1 and 335.2). Dismantle O-ring (333) (Fig.2).

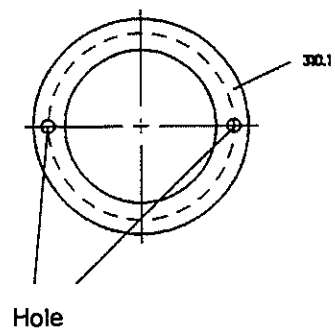


Fig.3

### 2.2.3 Disassembly of bevel box

Remove protecting cap (314) and draw off shaft seal (310) with tool [33] (see Fig.4).

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).

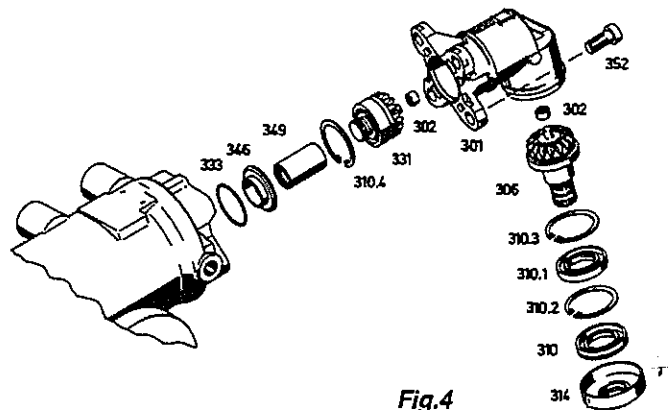


Fig.4

### 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).

**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).

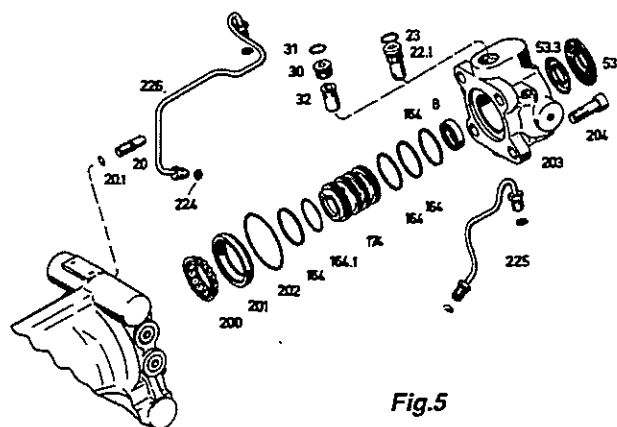


Fig.5

### 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*).

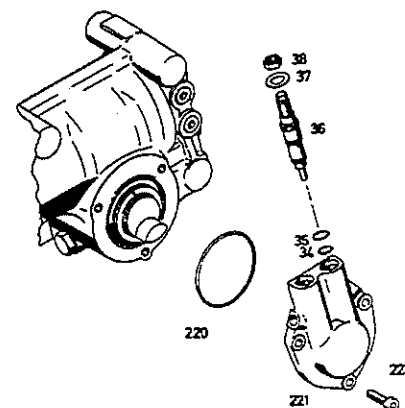


Fig.6

# Disassembly

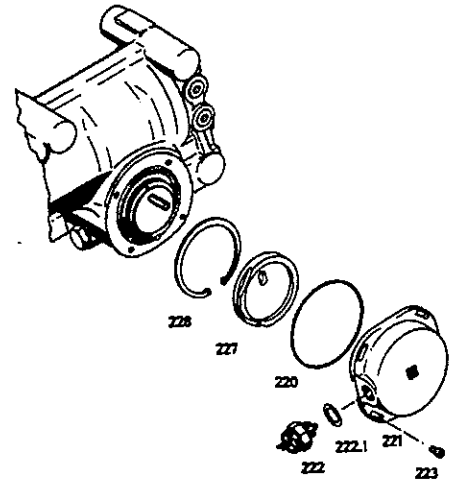
Unscrew valves (36) and remove O-rings (34 and 35). Remove cap screws (223) and lift off housing cover (221).

## 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).

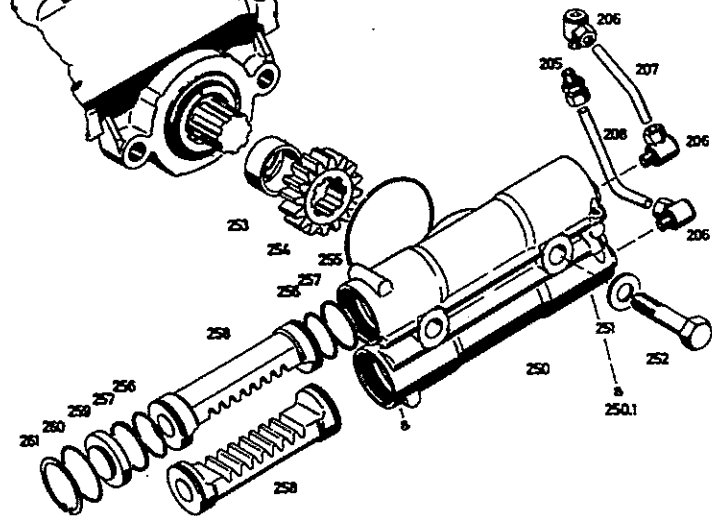
Unscrew hexagon screws (252) with washers (251) and remove add-on cylinder (250) (*Fig.8*).

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**

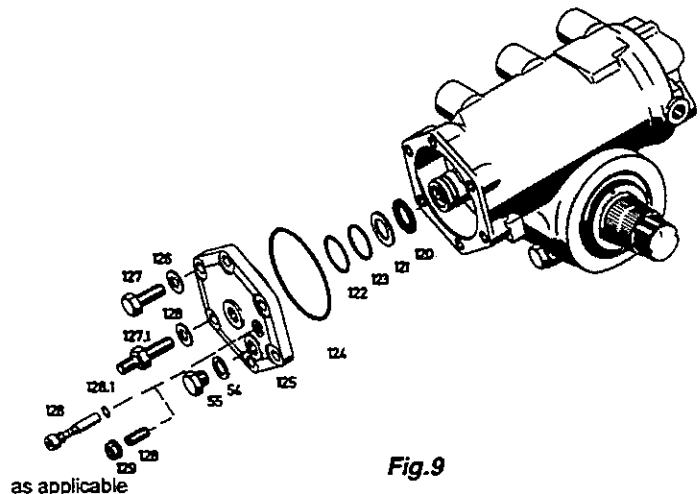
## 6 Removal and disassembly of cylinder cover (125)

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**

# Disassembly

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**).



### Attention:

The tappet of the valve insert (109) (*see Fig. 13*) installed in piston (101) must not be damaged.

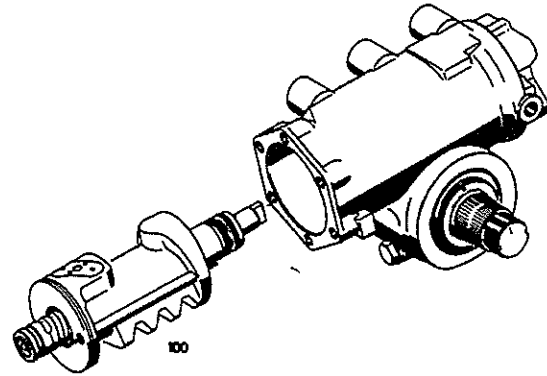


Fig.10

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**).

Turn worm (151) to release the balls (110) and carefully set them aside for later use.

Remove sealing elements (116, 117, 118 and 119).

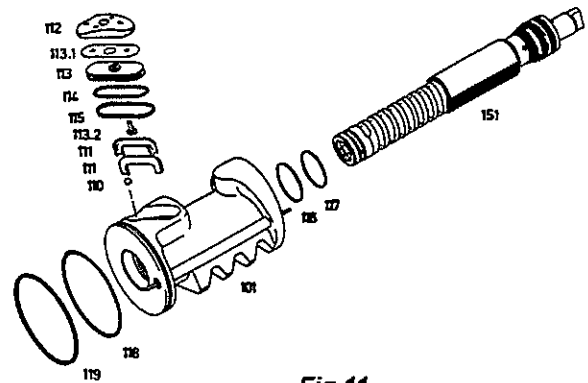


Fig.11

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**).

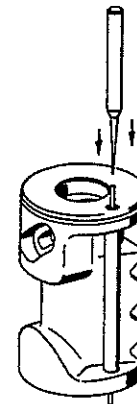


Fig.12

## Disassembly

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

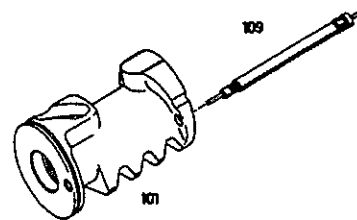


Fig.13

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).

Remove plug (163) and pin (162).

Remove sealing elements (158, 159, 164).

Further disassembly of the worm (151) is not permitted, since the hydraulic centre is then no longer set correctly.

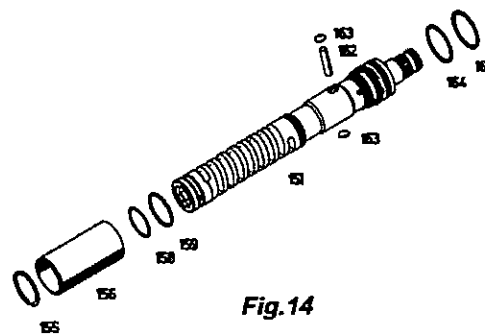


Fig.14

### 8.2 Exception:

Sealing ring (170) may be replaced by specially trained personnel:

Mark position of valve slide (168) and worm (161) (Fig.15).

Remove caulking from worm (161).

Drive out pin (160).

Pull valve slide (168) out of worm (161) together with torsion bar (165).

Remove O-ring (169) and sealing ring (170).

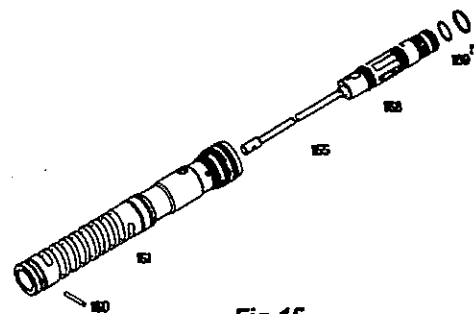


Fig.15

## 8.3 Additionally required for dual-circuit versions:

Remove sealing elements (172 and 173) (Fig.16).

Remove sealing rings (164) and O-ring (164.1) from control sleeve (174).

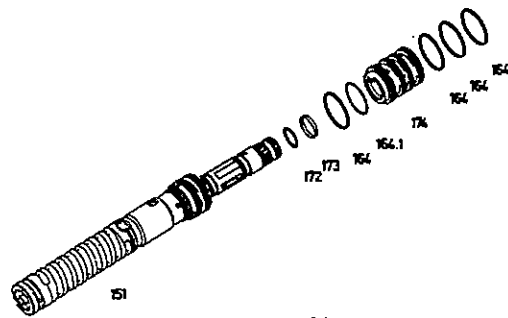


Fig.16

## 9 Removal of sector shaft (80)

Remove dust seal (51), stop-ring (51.1), gasket (51.2) and plug (52) on both sides (Fig.17).

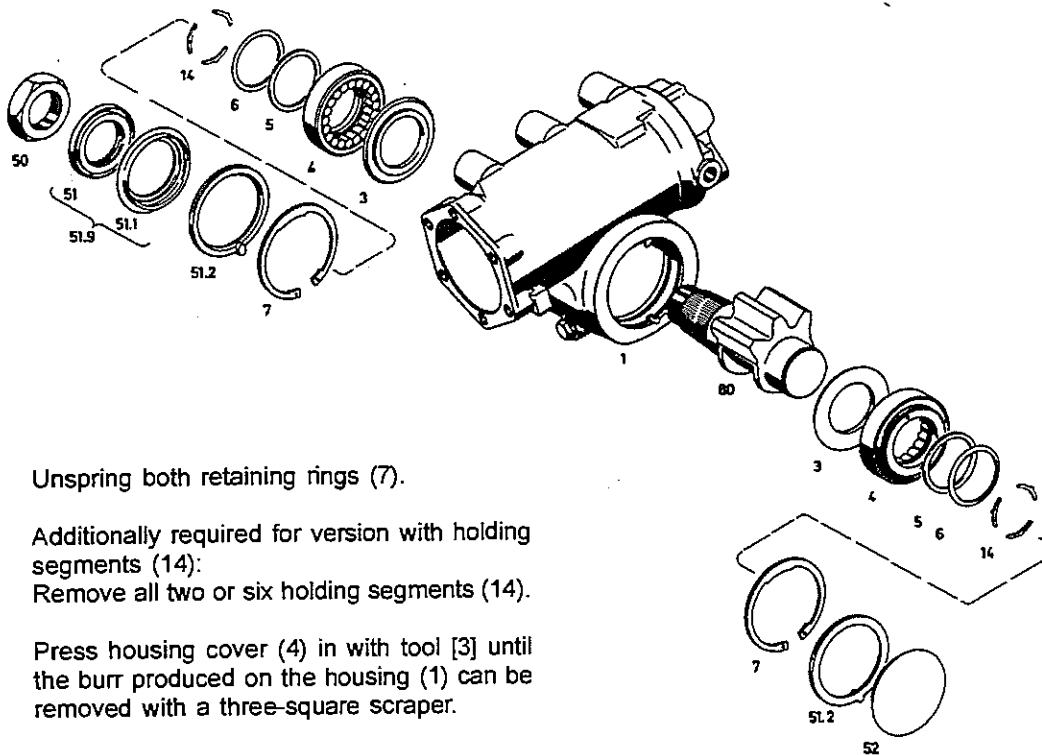


Fig.17

Unspring both retaining rings (7).

Additionally required for version with holding segments (14):  
Remove all two or six holding segments (14).

Press housing cover (4) in with tool [3] until the burr produced on the housing (1) can be removed with a three-square scraper.

Remove chips.

Draw housing cover (4) out with tool [4].

### Note:

The spindle of tool [4] must not be inserted in the centering bore of the sector shaft (80), otherwise the sector shaft (80) may tilt due to eccentricity.

Draw support rings (6) and gaskets (5) out of the grooves.



# Disassembly

## 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).

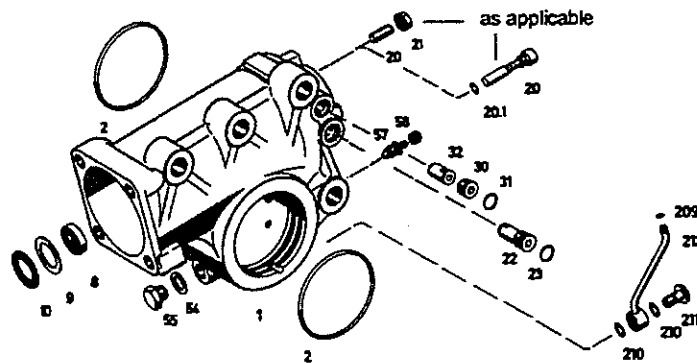
## 10 Disassembly of housing (1)

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).



## Examining the individual parts

---

### 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).



## Examining the individual parts

---

- 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 (151) 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



## Examining the individual parts

---

- 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



## Examining the individual parts

---

### 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)

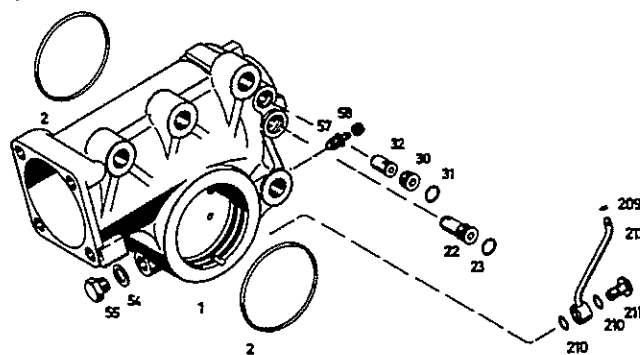
- 1.1 Screw in valve insert (22) - pressure limiting valve - with preassembled O-ring (23) (tightening torque: 30+10 Nm) (**Fig.19**).

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.

## Assembly

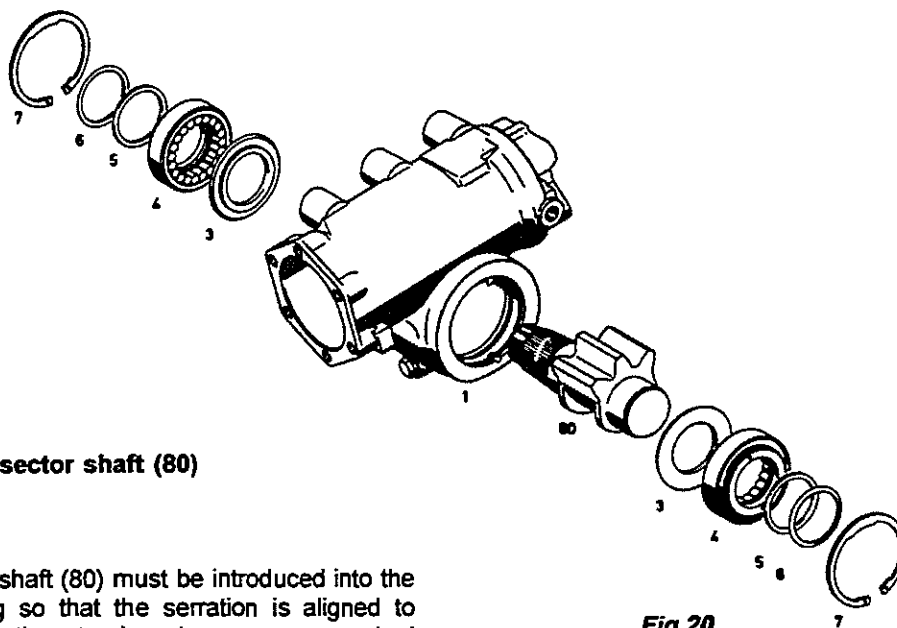
### 2 Preassembly of housing cover (4)

**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).

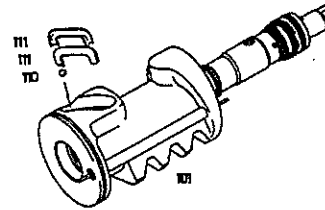


Fig.21



**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.



# Assembly

## □ 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.**

→ 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.

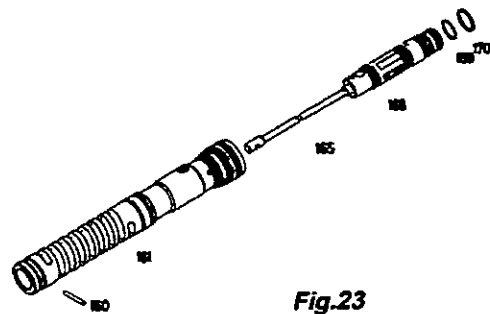
4.3 If a higher friction torque is obtained, the balls (110) must be removed and replaced with balls from a smaller tolerance group.

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**

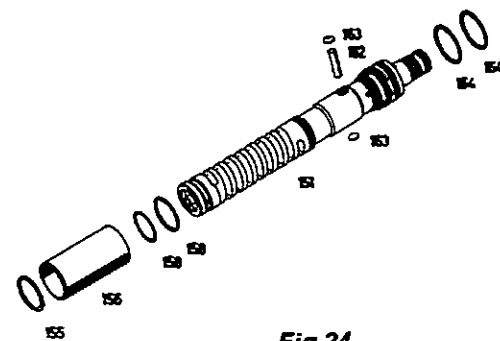
5.2 Place O-ring (158) in radial groove and slip on sealing ring (159) (**Fig.24**).

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**

Measurement of friction torque



Measurement of tilting clearance



**Fig.22**

### 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).

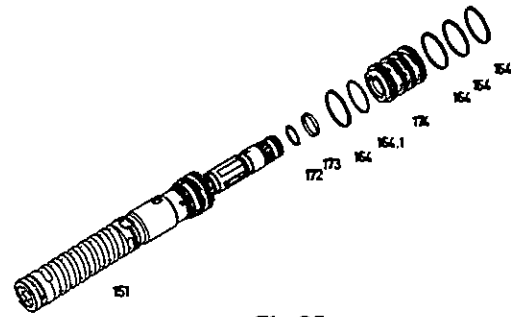


Fig.25

## 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).

At the same time, ensure that valve tappet protruding beyond the piston is introduced into the bore in tool [6].

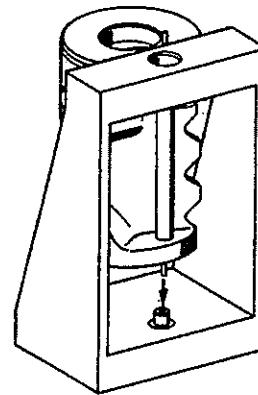


Fig.26

Adjust the supporting screw of tool [6] so that a gap of 0.1 - 0.2 mm is obtained between the fixture and piston when the latter has been fitted (Fig.27).

Screw caulking die of tool [6] onto a pressure pickup and insert it in the upper bore of tool [6].

Caulk the metal edge of the valve insert with a press applying a force of 7000 N + 800 N without backlash.



### Attention:

Correct operation of the steering may be impaired if the caulking force is too high or too low.

Check that the valve insert (109) is seated securely.

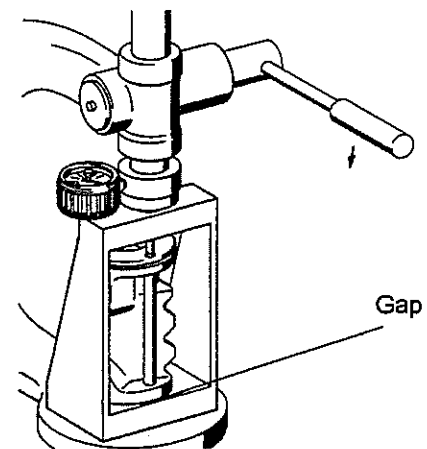
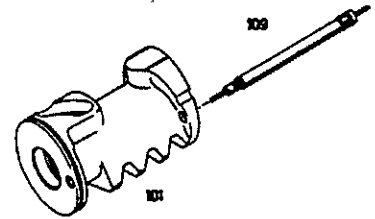


Fig.27

# Assembly

## 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:  $15 \pm 1$  Nm).



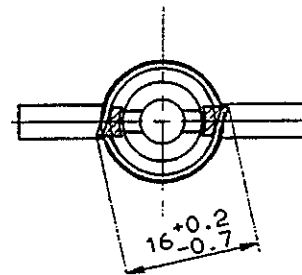
**Fig.28**

**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*).

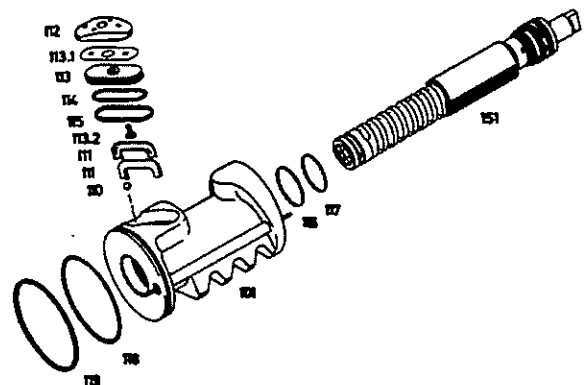
Fit O-ring (118) and then slip on gasket (119).

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).



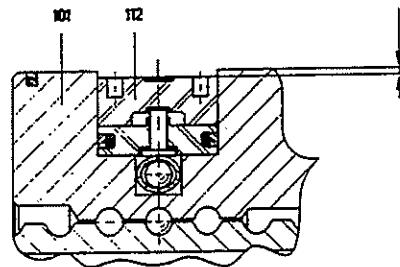
**Fig.30**



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



Max. permissible clearance

**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

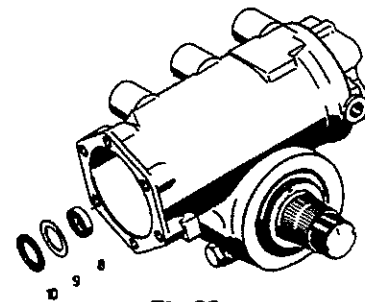
### 8.1 For 1-circuit versions and versions with bevel box

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).



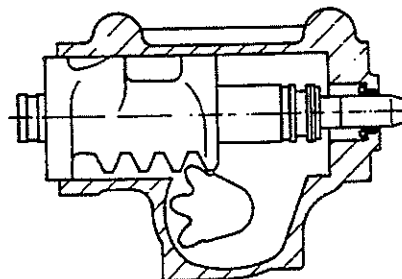
**Fig.32**

### 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**

# Assembly

## 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*).

**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.

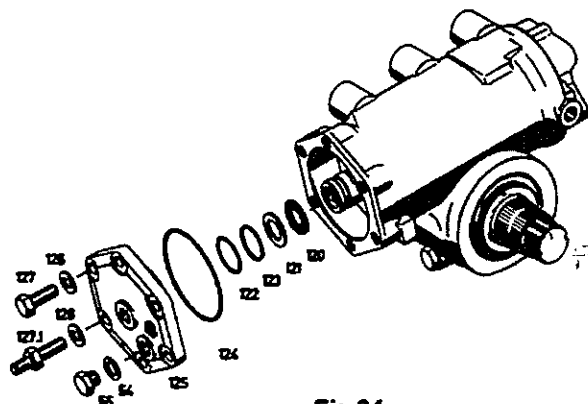


Fig.34



**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).

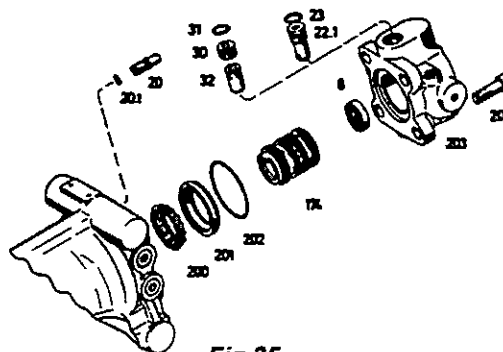


Fig.35



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).

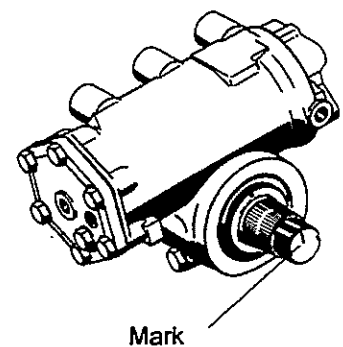


Fig.36

## 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].

## Assembly

Secure tools [16] and [17] on the steering shaft stub (**Fig.37**).

Turn sector shaft (80) until worm (151) axially comes to rest on one side. Set dial gauge to "zero".

Turn sector shaft (80) until worm (151) axially comes to rest on the opposite side without tool [16] being radially entrained and check the permissible axial backlash.

Required values:

Type 8090:	0.005 - 0.025 mm
Types 8095/8096:	0.010 - 0.030 mm
Type 8097:	0.015 - 0.035 mm
Types 8098/8099:	0.020 - 0.040 mm

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.

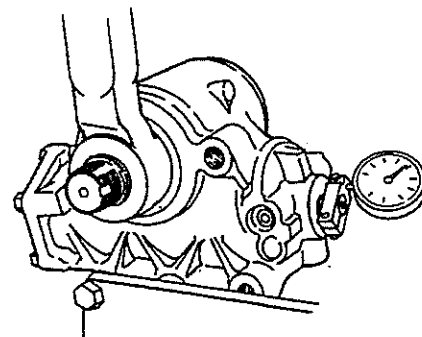
Measure the friction torque required to turn the steering outside the straight-ahead range (approx. half a turn short of the limit position).

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.

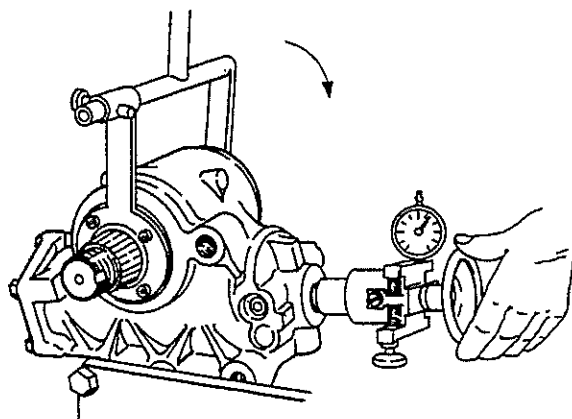
Required increase in friction torque:

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.37**



**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:**

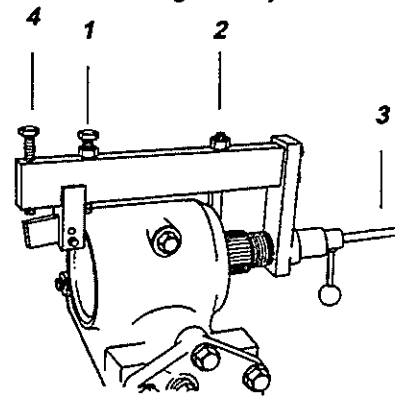
The max. permissible friction torque should be set if possible when making this adjustment.

**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

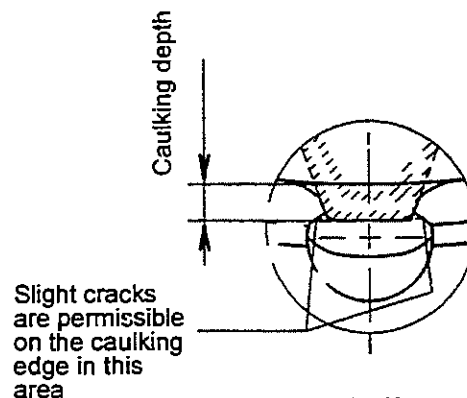
Remove fixture and check caulked area.

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**



## Assembly

Additionally required for versions with holding segments (14):

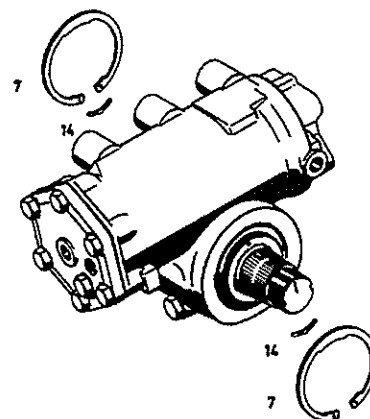
Holding segments (14) must be pressed in until flush (**Fig.41**).

Fit retaining ring (7) so that the gap is located at the caulking point opposite the piston (100).



**Attention:**

Check that retaining ring (7) is seated securely.



**Fig.41**

14.1.2 Repeat the complete procedure for the other side as described in section 14.1.1.

### 14.2 Versions with three-fold caulking

14.2.1 Carry out single caulking on both sides as described in section 14.1.

Remove retaining ring (7) and insert tool [22] (without caulking tool) in the caulking grooves of the housing with the three pilot pins.

Turn tool [22] through 60° in the groove of the retaining ring until one of the two caulking points is reached. Secure tool [22] with a stop pin to prevent it twisting and fit the caulking tool.

Proceed as described in section 14.1. Remove caulking tool. Release stop pin and turn fixture through 120° until the third caulking point is reached.

Proceed as described in section 14.1 for the third caulk.

Dismount tool [22] from the steering and check the caulked area as described in section 14.1.1.

Additionally required for versions with holding segments (14):

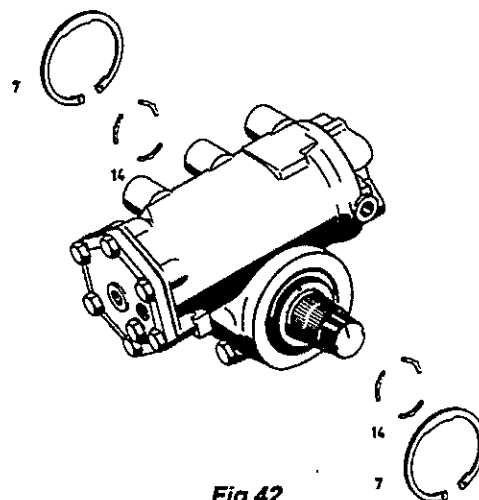
Press holding segments (14) in until flush (**Fig.42**).

Fit retaining ring (7) so that the gap is located on the caulking point opposite the piston (100).



**Attention:**

Check that retaining ring (7) is seated securely.



**Fig.42**

14.2.2 Repeat the complete procedure for the other side as described in section 14.1.1.

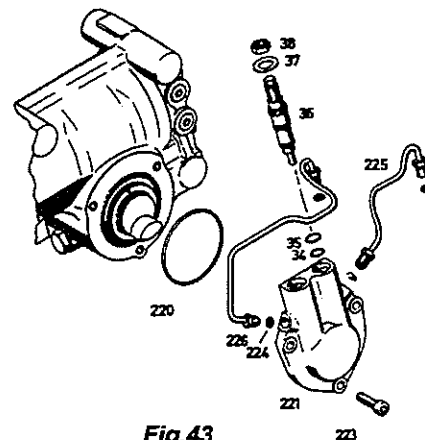
# Assembly

## 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.

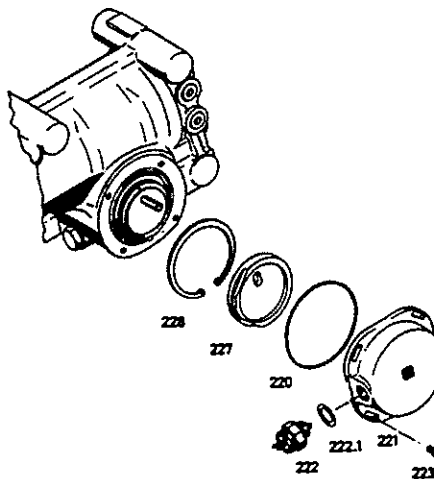
### 15.2 Versions with switch (222)

**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<sup>3</sup> oil (oil sort see List of Lubricants TE-ML 09).

Screw in switch (222) with washer (222.1) (tightening torque: 50 Nm).

## 16 Assembly and installation of add-on cylinder (250)

Set steering to straight-ahead position.

Slide bush (253) and gear (254) as far as possible onto sector shaft (80) (Fig.45).

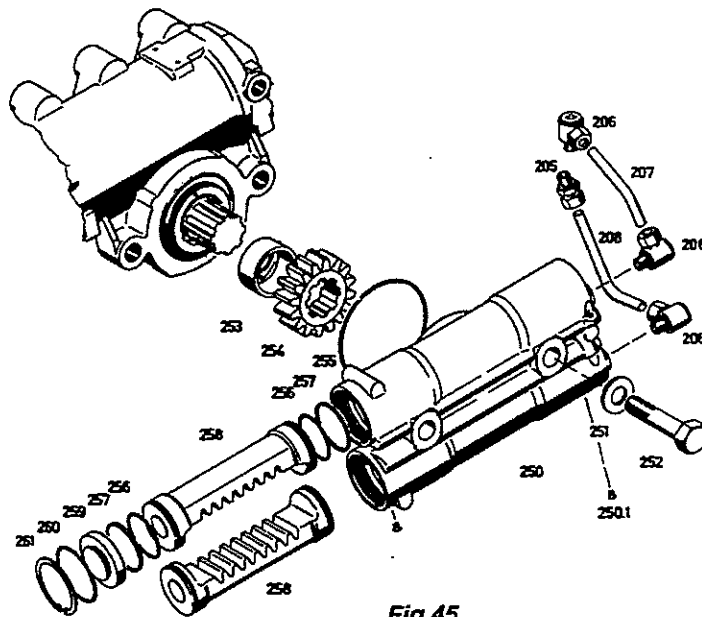


Fig.45

Slip two O-rings (256) and two gaskets (257) onto each piston (258).

Slide both pistons (258) into add-on cylinder (250) up to the middle position (installed value 60.7 ±0.2 mm) (Fig.46).

**Notes:**

- The middle tooth of both pistons (258) is marked on both face ends.
- The centered bore (with installed breather valve) in pistons (258) must point towards the closed end of add-on cylinder (250).

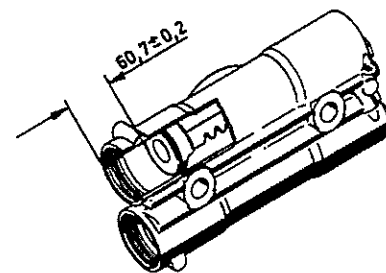


Fig.46

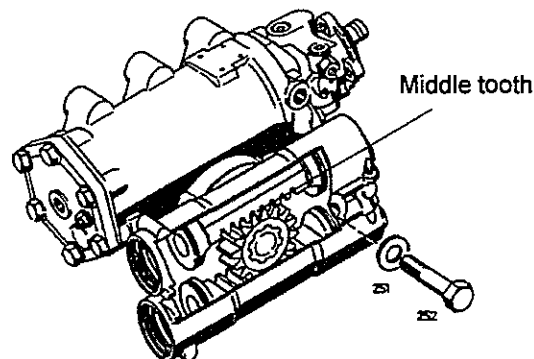
## Assembly

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  $60.7 \pm 0.2$  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)

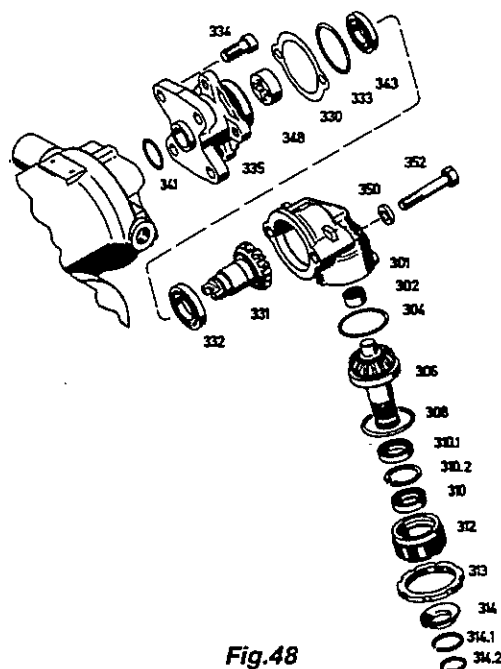
Slip O-ring (341) onto intermediate flange (335). Press cross disc (348) and ball bearing (343) onto intermediate flange (335) (**Fig.48**). Use tool [28] for this purpose.

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).

# Assembly

Unscrew adjusting screw (312) from housing (301).

Place a greased O-ring (308) in the radial groove of housing (301), behind the threaded bore.

Fill space between sealing lip and dust lip of shaft seal (310 and 310.1) with grease, see note in chapter III.

Mount tool [32] on bevel gear (306).

Fit retaining ring (310.2) in adjusting screw (312).

Press inner shaft seal (310.1) in as far as possible with tool [31].

Fit outer shaft seal (310) in adjusting screw (312) flush with face end.

Screw adjusting screw (312) into housing (301) with tool [25] and a torque of 50 Nm.

Tighten slotted nut (313) to a torque of 50 Nm.

Depress cast edge of housing to secure slotted nut (313) and prevent it twisting.

Check set friction value again (required value: max. 80 Ncm).

## 17.2 Versions with coupling sleeve (349)

### 17.2.1 Preassembly of bevel box

Press needle sleeves (302) in as far as possible with tool [36]. Install bevel gear (306) (*Fig.49*).

Select a retaining ring (310.3) leaving the bevel gear (306) with a max. backlash of 0.06 mm.

Install bevel gear (331).

Choose a retaining ring (310.4) ensuring zero backlash over the largest possible angle of rotation while simultaneously allowing the bevel box to run as smoothly as possible.

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).

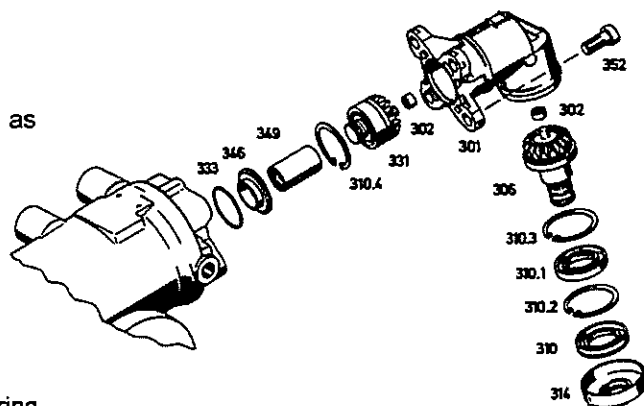


Fig.49

## Assembly

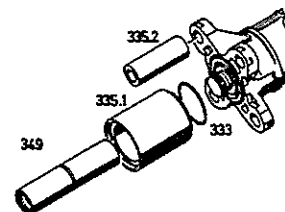
Turn to find a zero-backlash area and fit protecting cap (314) with the mark pointing towards the steering gear. Remove former straight-ahead marking.

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**

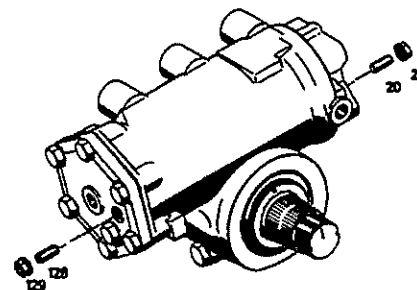
### 17.2.2 Fit pipes

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**).

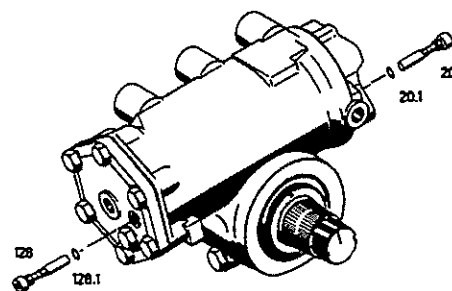
### 18.2 Versions with screws (20 and 128)

Refit the screws (20 and 128) which were removed during disassembly (tightening torque: 12+3 Nm) (**Fig.52**).



**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.



**Fig.52**



## 19 Final assembly of steering gear

### Note:

The final assembly described here must not be undertaken until the setting and functional tests (chapter IV.) have been completed on the test bench.

### 19.1 Fit plug (52)

#### 19.1.1 Versions with gasket (51.2)

Oil or grease the inner groove of dust seal (51), the outer circumference of gasket (51.2) and the mating face of gasket (51.2) on housing (1) (see note in chapter III. with regard to type of grease) (Fig.53).

Insert stop-ring (51.1) in the groove of dust seal (51) and place gaskets (51.2) on the inside of stop-ring (51.1) or plug (52) so that the protruding nose points away from plug (52) and stop-ring (51.1).

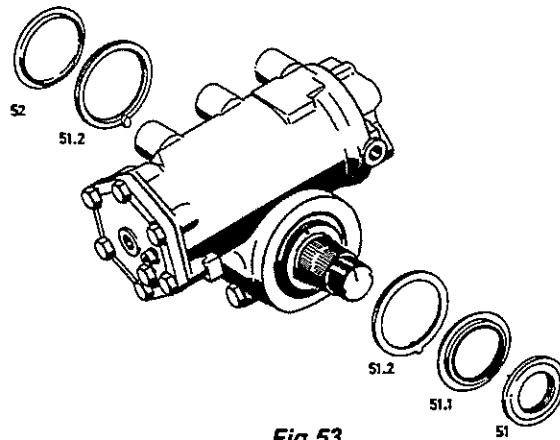


Fig.53

Slide the assembled dust seal (51) over the serration of sector shaft (80) by hand (the sector shaft must be kept as free of grease as possible) and press it into housing (1) until stop-ring (51.1) is flush with housing (1).

When fitting dust seal (51), ensure that the nose on gasket (51.2) fits exactly in the groove in housing (1).

On the opposite side of the serration on the sector shaft, press the preassembled plug (52) into housing (1) by hand until it is flush with housing (1).

When fitting plug (52), ensure that the nose on gasket (51.2) fits exactly in the groove in the housing.

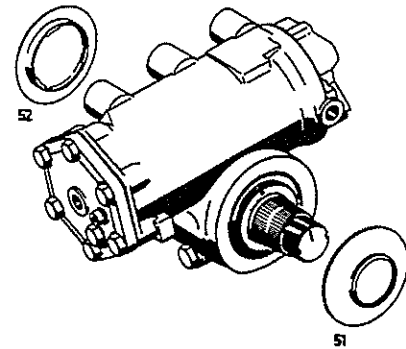
### Note:

Plug (52) may arch outwards due to air trapped under it during installation. For this reason, insert a small screwdriver between gasket (51.2) and housing (1) so that the trapped air can escape.



## 19.1.2 Versions without gasket (51.2)

Slip dust seal (51) and plug (52) onto sector shaft (80) after ensuring that the space between the dust lip and housing (1) is filled with grease (see note in chapter III. with regard to the type of grease) (*Fig.54*).



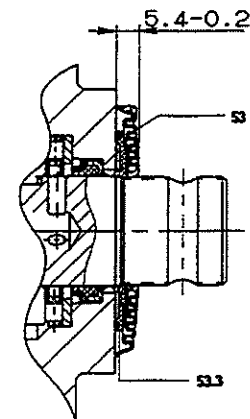
*Fig.54*

## 19.2 Fit protecting cap (53)

### 19.2.1 Versions with gasket (53.3)

Fit gasket (53.3) on the worm stub so that it fits exactly into the recess (*Fig.55*).

Press protecting cap (53) on as far as possible with tool [24]. Check assembly value of 5.4-0.2 mm (see illustration).



*Fig.55*

### 19.2.2 Versions without gasket (53.3)

Fit protecting cap (53) on the worm stub as far as possible with tool [24] after ensuring that the gap between dust lip and housing (1) is filled with grease (see note in chapter III. with regard to the type of grease).

### 19.2.3 Versions with retaining ring (53.1)

Slip protecting cap (53) onto the worm stub and fit retaining ring (53.1) (*Fig.56*).

## 19.3 Fit dust seal (314)

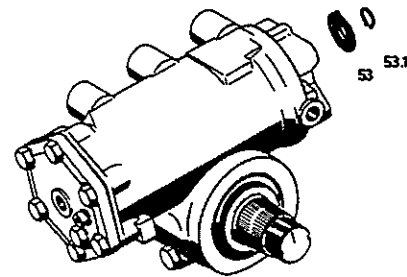
### 19.3.1 Bevel box versions with cross disc (348)

Fit dust seal (314) on bevel gear (306) after ensuring that the gap between adjusting screw (312) and dust lip is filled with grease (see note in chapter III. with regard to the type of grease) (*see Fig.48*).

Fit snap rings (314.1 and 314.2).

### 19.3.2 Angular gear versions with coupling sleeve (349)

Fit dust seal (314) on bevel gear (306) (*see Fig.49*).



*Fig.56*

## Assembly

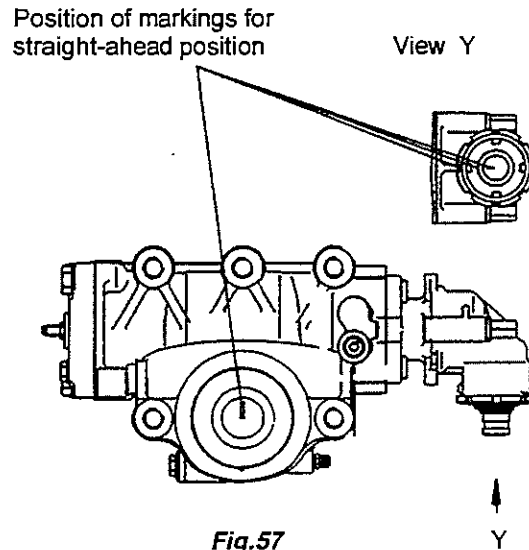
- 19.3.3 Check that the markings for the straight-ahead position are present as shown in *Fig.57*.

**Exception:**

The markings may be in a different position in special versions. This is then indicated on the technical cover sheet of the spare parts list.

- 19.4 Versions with automatically adjusted steering limiter

Fit new screws (20 and 128) with new O-rings (20.1 and 128.1) (tightening torque: 12+3 Nm) (*Fig.58*).



*Fig.57*



**Attention:**

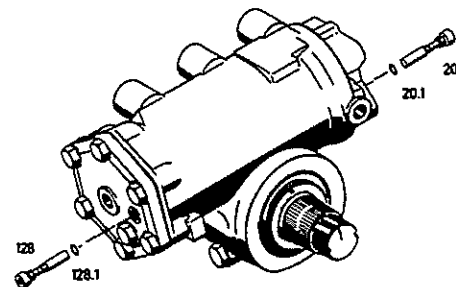
The steering must not subsequently be turned to either limit position, otherwise the sliding sleeves of screws (20 and 128) are displaced into their limit position.

This then makes it impossible to adjust the hydraulic steering limiter in the vehicle as specified.

- 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.



*Fig.58*



## Setting and functional test

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### 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).



## Setting and functional test

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### 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.



## Setting and functional test

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### 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.



## Setting and functional test

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### 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.

## Setting and functional test

---



### 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<sup>3</sup>/min (1 cm<sup>3</sup>/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.



## Setting and functional test / Troubleshooting

### 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
- Internal fault → Replace
- Valve insert (22) defective → Replace

For dual-circuit versions also:

- Working cylinder defective → Repair
- Working cylinder defective → 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
- Internal fault → Replace

For dual-circuit versions also:

- Valves (36) defective/ wrongly set → Repair
- Valves (36) defective/ wrongly set → Replace
- Valves (36) defective/ wrongly set → 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

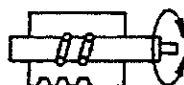


## VI. Friction torques, adjustment values and tightening torques

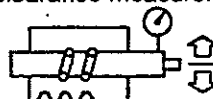
### Friction torques:

#### 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. $i_1, i_2 \dots$ ) and variable (e.g. $iv_1, iv_2 \dots$ )	Friction torque [Ncm]	
	without bevel box	with bevel box
<b>8090</b>		
$i_1 = 15.2 : 1$	max. 160	max. 240
$iv_1 = 16.6 : 1 / 14.0 : 1$		
$i_2 = 18.0 : 1$	max. 140	max. 220
$iv_2 = 19.6 : 1 / 16.6 : 1$		



		<b>8095</b>			
$i_1$	=	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		
		<b>8097</b>			
$i_1$	=	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		
		<b>8098</b>			
$i_1$	=	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. $i_1, i_2 \dots$ ) and variable (e.g. $iv_1, iv_2 \dots$ )		Friction torque [Ncm]			
		without bevel box - add-on cylinder	+ add-on cylinder	with bevel box - add-on cylinder	+ add-on cylinder
<b>8096</b>					
$i_1$	=	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			
<b>8099</b>					
$i_1$	=	18.3 : 1	max. 250	max. 320	max. 330
$iv_1$	=	20.1 : 1 / 17.0:1			max. 400
$i_2$	=	20.7 : 1	max. 230	max. 300	max. 310
$iv_2$	=	22.6 : 1 / 19.2:1			max. 380
$i_3$	=	23.9 : 1	max. 210	max. 280	max. 290
$iv_3$	=	26.1 : 1 / 22.2:1			max. 360



**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

# Friction torques, adjustment values and tightening torques



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



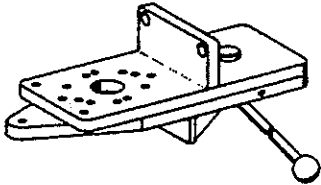
## VII. Special tools

**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.

**Tool [1]**

Assembly vice



**Tool [2]**

Insert for screw-out and screw-in the valve insert (109)



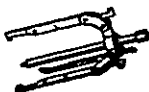
**Tool [3]**

Sleeve for pressing the housing covers (4)



**Tool [4]**

Puller for housing cover (4)



8090	8095	8096	8097	8098	8099
7418 798 654					
8098 798 151					
8090 798 006	8095 798 002	8097 798 002	8098 798 002		
8090 798 201					

# Special tools



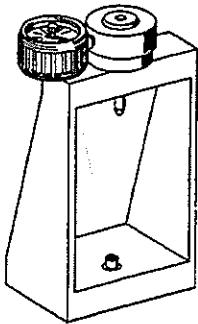
**Tool [5]**

Guide bush for housing cover (4)



**Tool [6]**

Peening fixture for valve insert (109)



**Tool [7]**

Punch for screwed valve insert (109)



**Tool [8]**

Insert for tool [9]



8090	8095	8096	8097	8098	8099
	8043 798 001				
8090 798 655					
8098 798 654					
serration					
1x54	7/8"x48	1x79	1x75	7/8x48	1x79
8052 798 552	8043 798 551	7419 798 551	7418 798 553	8043 798 551	7419 798 551
serration					
	1x79	A6x23x26	1x79	1x79	A6x23x26
	7419 798 551	8065 798 552	7419 798 551	7419 798 551	8065 798 552

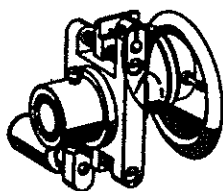




8090	8095	8096	8097	8098	8099
			Valve slide		
			ø25	ø25,99	
			7421 798 551	8097 798 554	
			Valve slide serration		
			ø25,99	24/48x22	
			8097 798 554	8038 798 551	
7470 798 703					
7470 798 706					
8090 798 004	8090 798 001				
		8090 798 005			8090 798 005

**Tool [9]**

Torque measuring device



**Tool [10]**

Dial gauge: Graduation 0.01 mm



**Tool [11]**

Guide bush for sealing rings (164)



for dual-circuit version



**Tool [12]**

Pliers for pressing on the sealing rings (164)



**Tool [13]**

Sleeve for mounting the O-ring (172) and the sealing ring (173)



**Tool [14]**

Mandrel for shaft seal (8)



**Tool [15]**

Guide bush for shaft seal (8)



	8090	8095	8096	8097	8098	8099
8090 798 652	8090 798 651					
			8096 798 001			8096 798 001
8090 798 052	8090 798 051					
8090 798 002	8090 798 003					



**Tool [16]**

Dial gauge holder for adjustment of axial play-worm



8090	8095	8096	8097	8098	8099
serration					
1x54	7/8"x48	1x79	1x75	7/8x48	1x79
8090 798 101	8095 798 102	8095 798 101	8097 798 101	8095 798 102	8095 798 101
serration					
	1x79	A6x23x26	1x79	1x79	A6x23x26
	8095 798 101	8097 798 102	8095 798 101	8095 798 101	8097 798 102
Valve slide					
			ø25	serration 24/48x22	
			8095 798 101	8097 798 101	
Valve slide					
			ø25,99		
			8097 798 102		
7016 798 704					

**Tool [17]**

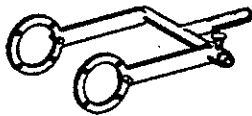
Dial gauge graduation 0.001 mm for tool [16]





**Tool [18]**

Adjusting device for pressure point setting



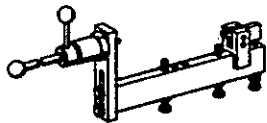
**Tool [19]**

Insert for tool [18]  
(2 pieces are required)



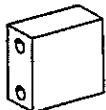
**Tool [20]**

Assembly tool for prying over of housing covers (4)



**Tool [21]**

Extension for tool [20]  
for steerings with C-mass >137 mm

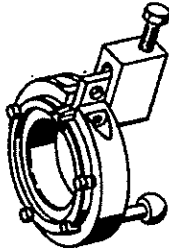


8090	8095	8096	8097	8098	8099
8090 798 151					
8090 798 551	8095 798 551		8097 798 551	8098 798 551	
8090 798 654					
				8090 798 656	



**Tool [22]**

Assembly tool for threefold prying



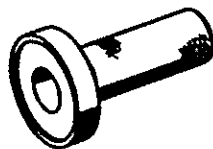
**Tool [23]**

Insert for torx screw (250.1)



**Tool [24]**

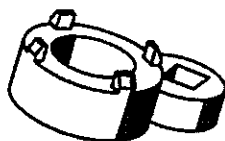
Mandrel for pressing the protecting cap (53)



**Bevel box with cross disc (348)**

**Tool [25]**

Grooved nut wrench for adjusting screw (312)



8090	8095	8096	8097	8098	8099
		8096 798 651		8098 798 651	
					7016 798 152
8090 798 053	8095 798 051				

8096	8097	8098	8099
1249 898 151			



**Tool [26]**

Puller for needle sleeve (302)



**Tool [27]**

Counter for tool [26]  
and [34]



**Tool [28]**

Mandrel for ball bearing (343)



**Tool [29]**

Mandrel for needle sleeve (302)



**Tool [30]**

Press-in sleeve for  
ball bearing (332)



8096	8097	8098	8099
7421 798 201			
7421 798 351			
7421 798 051			
7677 798 051			
7330 798 053			



**Tool [31]**

Mandrel for shaft seal  
(310 and 310.1)



**Tool [32]**

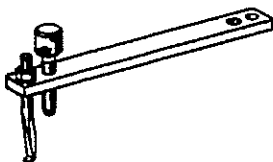
Guide bush for shaft seal  
(310 und 310.1)



**Bevel box with coupling sleeve (349)**

**Tool [33]**

Puller for shaft seal (310)



**Tool [34]**

Puller for needle sleeve (302)



**Tool [35]**

Extension for tool [34]



8096	8097	8098	8099
7418 798 051			
8090 798 003			
8052 798 201			
8098 798 201			
8098 798 202			



**Tool [36]**

Mandrel for needle sleeve (302)



**Tool [37]**

Sleeve for shaft seal (310.1)



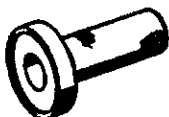
**Tool [38]**

Guide bush for shaft seal (310)



**Tool [39]**

Mandrel for shaft seal (310)



8096	8097	8098	8099
8098 798 052			
8090 798 006			
8098 798 003			
8098 798 051			





**VIII. Key to numbers in figures, sectional drawings and exploded drawings**

1.0	Housing	58.0	Protecting cap
2.0	O-ring	63.0	Stick-on label
3.0	Washer	80.0	Sector shaft
4.0	Housing cover	100.0	Piston
5.0	Gasket	101.0	Piston
6.0	Support ring	109.0	Valve insert
7.0	Retaining ring	110.0	Ball set
8.0	Shaft seal	111.0	Recirculating half tube
9.0	Axial-, washer	112.0	Gasket/Plug
10.0	Needle cage	113.0	Gasket
11.0	Type plate	113.1	Compensating plate
12.0	Grooved stud	113.2	Pin
14.0	Holding segment	114.0	O-ring
20.0	Set screw / Adjusting screw / Screw	115.0	Sealing ring
20.1	O-ring	116.0	Sealing ring
21.0	Collar nut	117.0	Sealing ring
22.0	Valve insert	118.0	O-ring
22.1	Valve insert	119.0	Gasket
23.0	O-ring	120.0	Needle cage
30.0	Screw	121.0	Washer
31.0	O-ring	122.0	O-ring
32.0	Valve insert	123.0	Sealing ring
34.0	O-ring	124.0	O-ring
35.0	O-ring	125.0	Cylinder cover
36.0	Valve	126.0	Washer
37.0	Washer	127.0	Hexagon screw
38.0	Hex nut	127.1	Screw
50.0	Locking nut	128.0	Set screw / Screw
51.0	Dust seal	128.1	O-ring
51.1	Stop-ring	129.0	Collar nut
51.2	Gasket	150.0	Worm
51.9	Dust seal	151.0	Worm
52.0	Plug	155.0	Snap ring
53.0	Protecting cap	156.0	Sliding tube
53.1	Retaining ring	157.0	Bush
53.3	Gasket	158.0	O-ring
54.0	Sealing ring	159.0	Sealing ring
55.0	Screw plug	160.0	Pin
56.0	Protecting sleeve	161.0	Worm
57.0	Breather	162.0	Pin

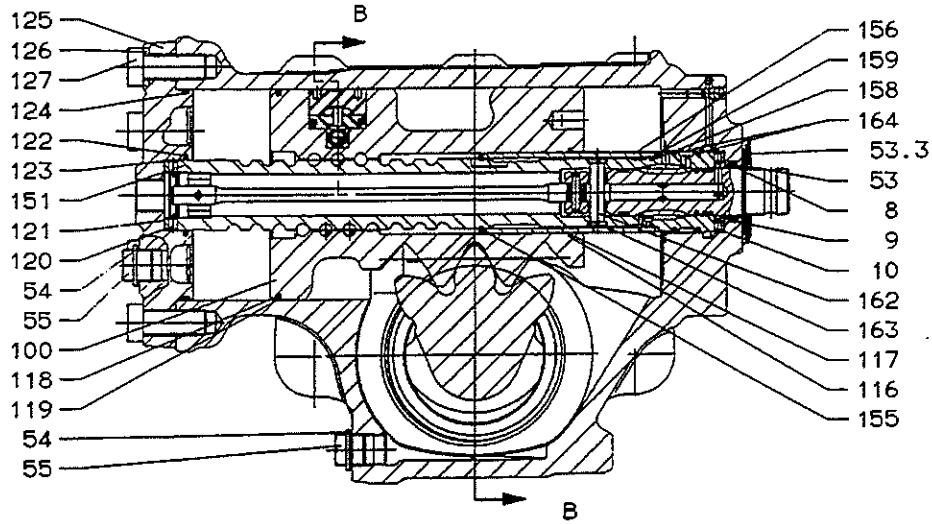


163.0	Plug	253.0	Bush
164.0	Sealing ring	254.0	Gear
164.1	O-ring	255.0	O-ring
165.0	Torsion bar	256.0	O-ring
166.0	Needle cage	257.0	Gasket
166.1	Snap ring	258.0	Piston
167.0	Pin	259.0	Cylinder cover
168.0	Valve slide	260.0	O-ring
169.0	O-ring	261.0	Retaining ring
170.0	Sealing ring	301.0	Housing
171.0	Needle cage	302.0	Needle sleeve
172.0	O-ring	304.0	Washer
173.0	Sealing ring	306.0	Bevel gear
174.0	Control sleeve	308.0	O-ring
200.0	Ball cage	310.0	Shaft seal
201.0	Bearing ring	310.1	Shaft seal
202.0	O-ring	310.2	Retaining ring
203.0	Valve housing	310.3	Retaining ring
204.0	Cap screw	310.4	Retaining ring
205.0	Pipe union	312.0	Adjusting screw
206.0	Pipe union	313.0	Slotted nut
207.0	Pipe	314.0	Dust seal / Protecting cap
208.0	Pipe	314.1	Snap ring
209.0	O-ring	314.2	Snap ring
210.0	O-ring	330.0	Shim plate
211.0	Union screw	331.0	Bevel gear
212.0	Pipe	332.0	Ball bearing
220.0	O-ring	333.0	O-ring
221.0	Housing cover / Cover	334.0	Cap screw
222.0	Steering limiter kit / Switch	335.0	Intermediate flange
222.1	Washer	335.1	Pipe
223.0	Cap screw	335.2	Pipe
224.0	O-ring	341.0	O-ring
225.0	Pipe	343.0	Ball bearing
226.0	Pipe	346.0	Centering ring
227.0	Cam disc	348.0	Cross disc
228.0	Retaining ring	349.0	Coupling sleeve
250.0	Add-on cylinder	350.0	Washer
250.1	Torx screw	352.0	Hexagon screw/Screw/ Cap screw
251.0	Washer		
252.0	Hexagon screw		

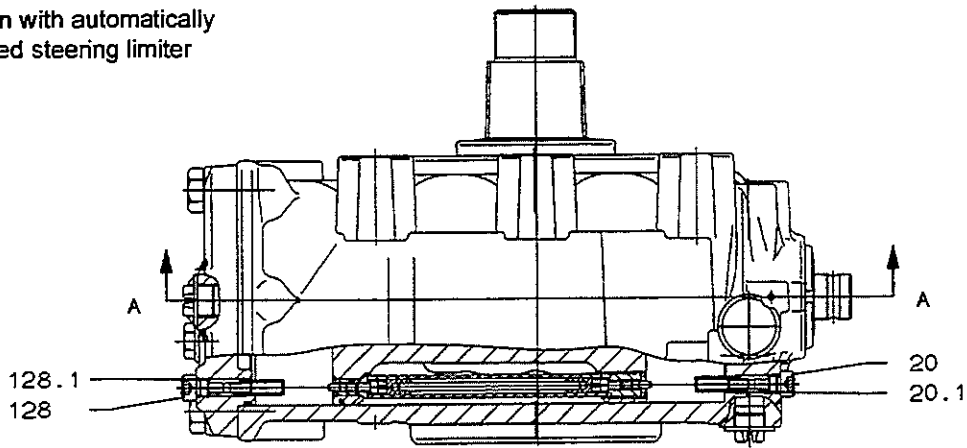


Types 8090 - 8099

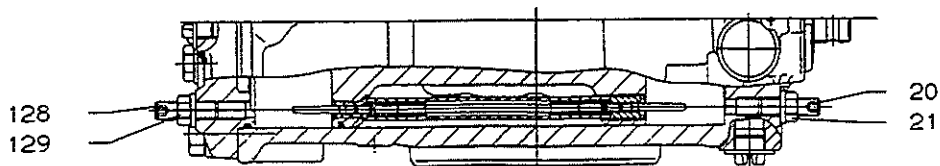
Section A-A



Version with automatically adjusted steering limiter

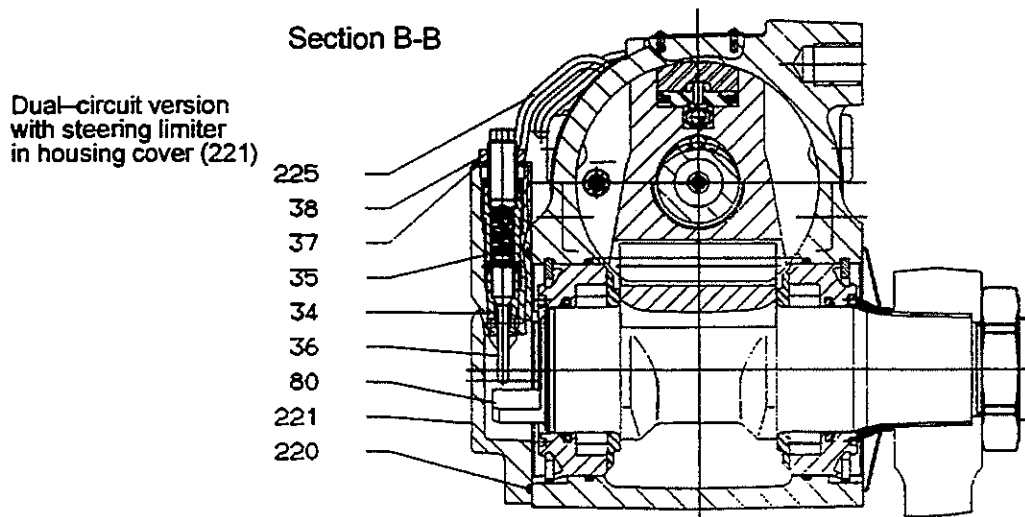
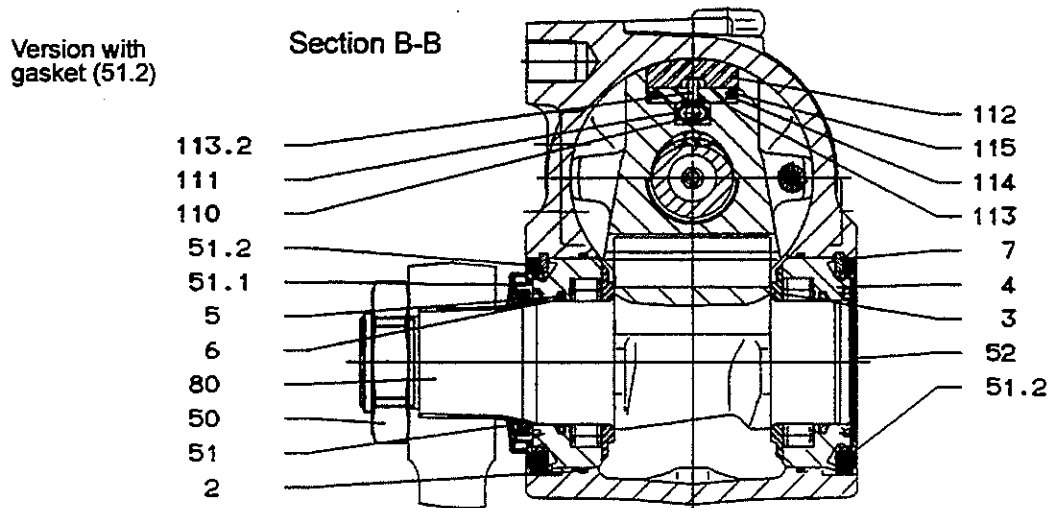
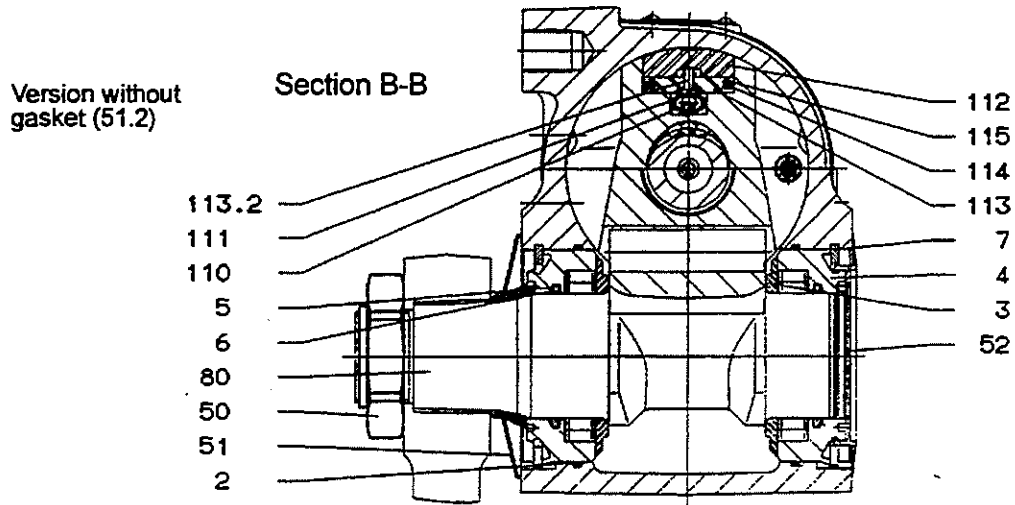


Version with manually adjusted steering limiter





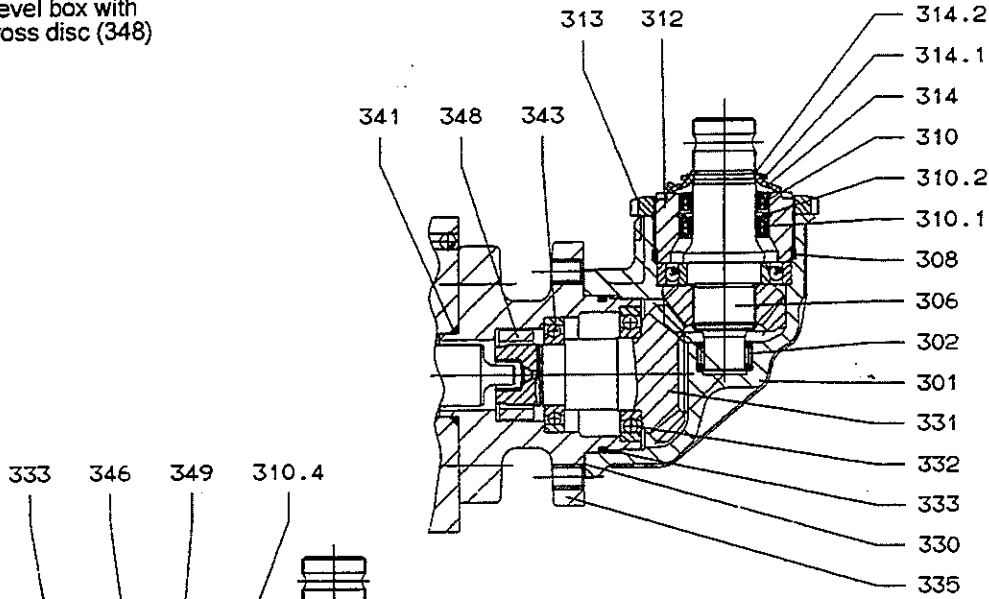
# Key to numbers in figures, sectional drawings and exploded drawings



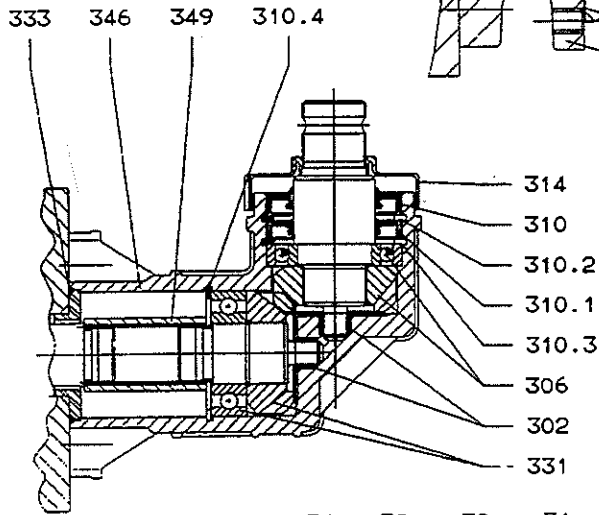


Key to numbers in figures, sectional drawings and exploded drawings

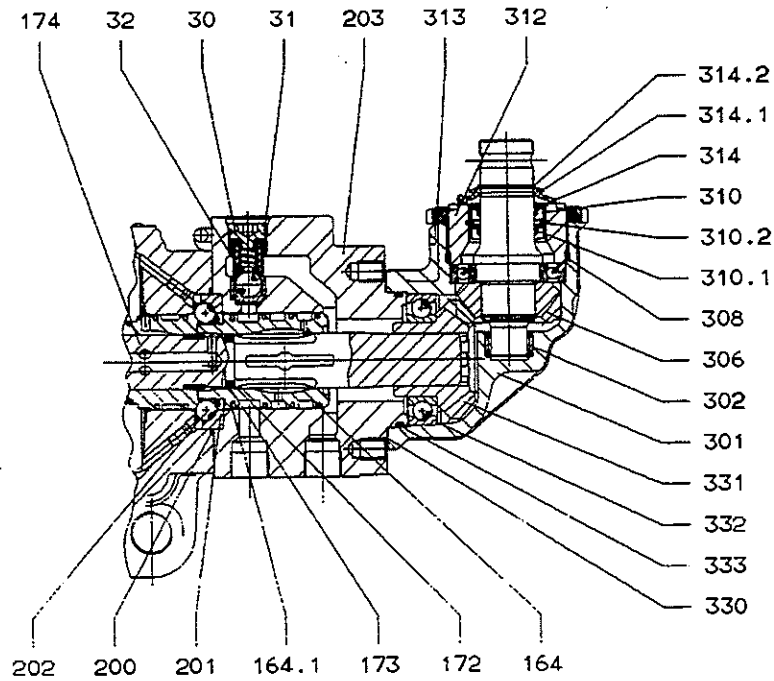
Bevel box with cross disc (348)

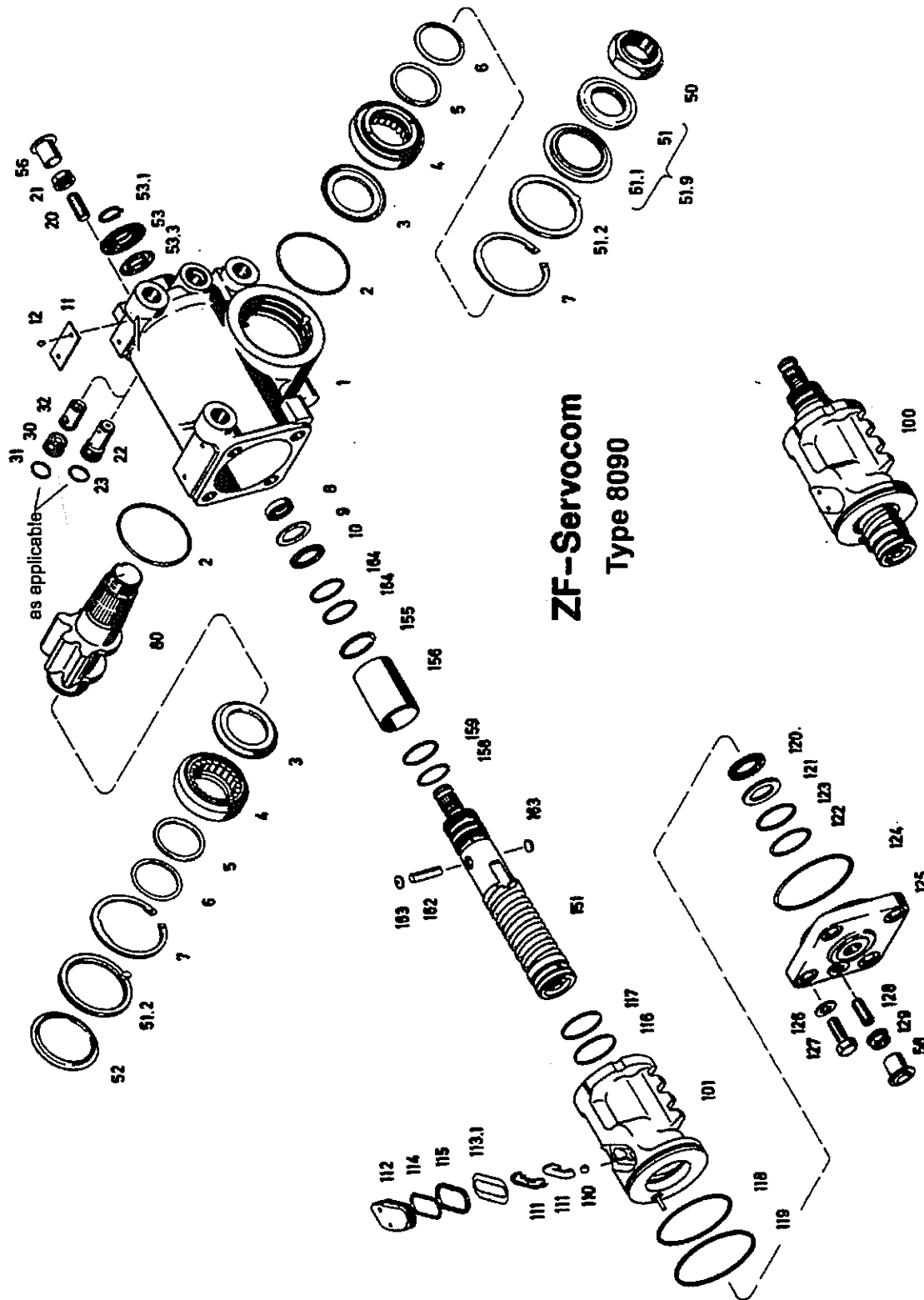


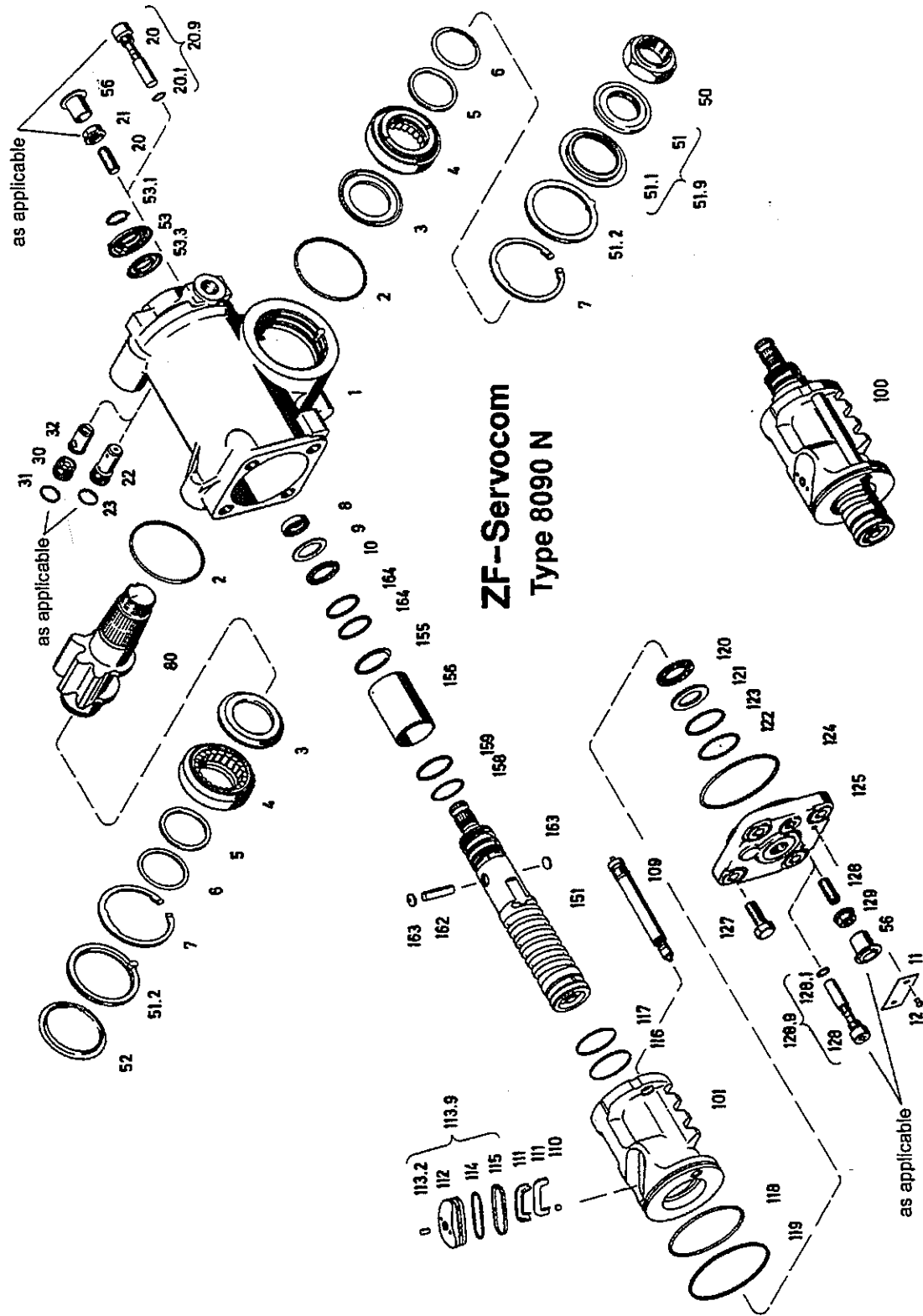
Bevel box with coupling sleeve (349)

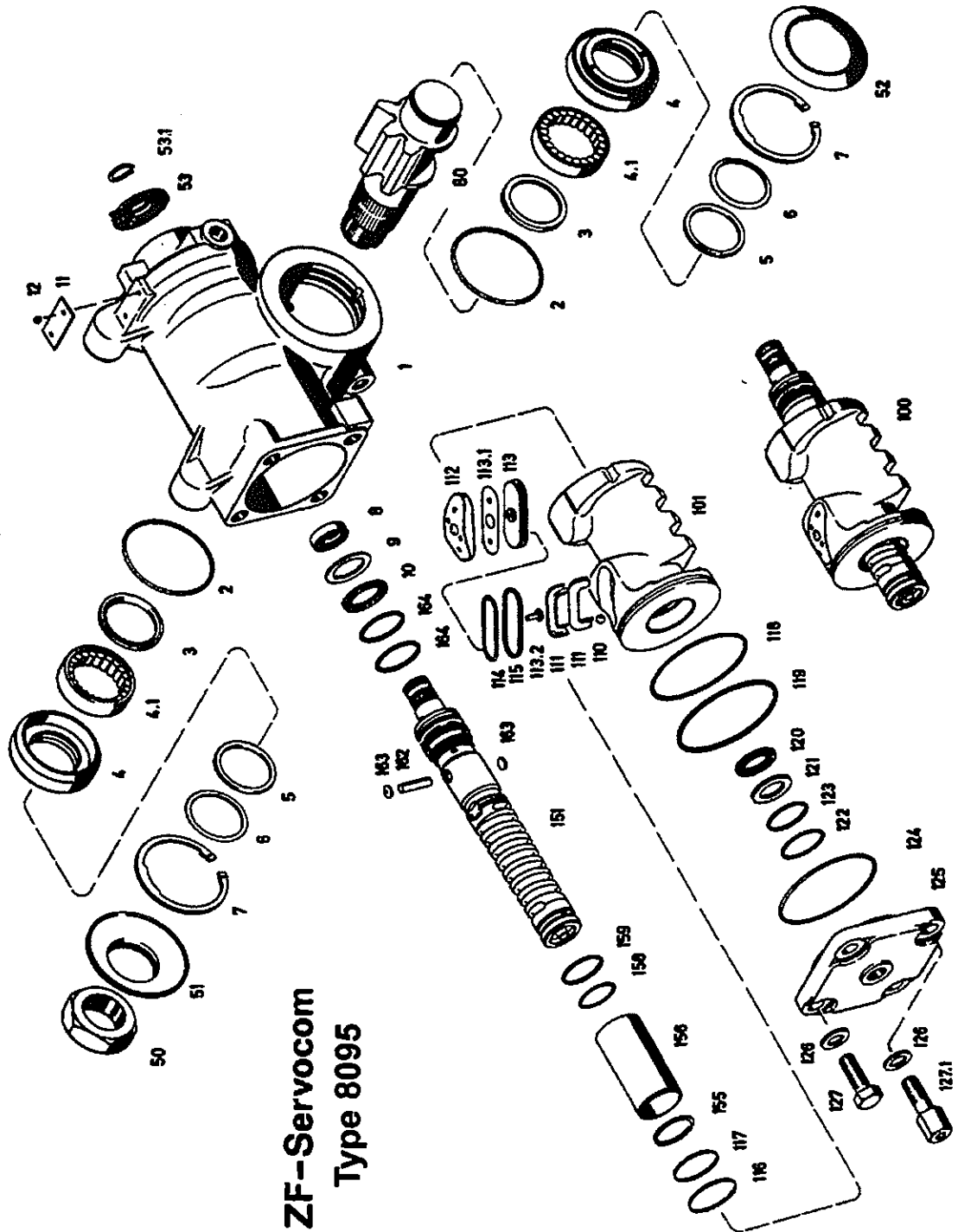


Dual-circuit version with bevel box



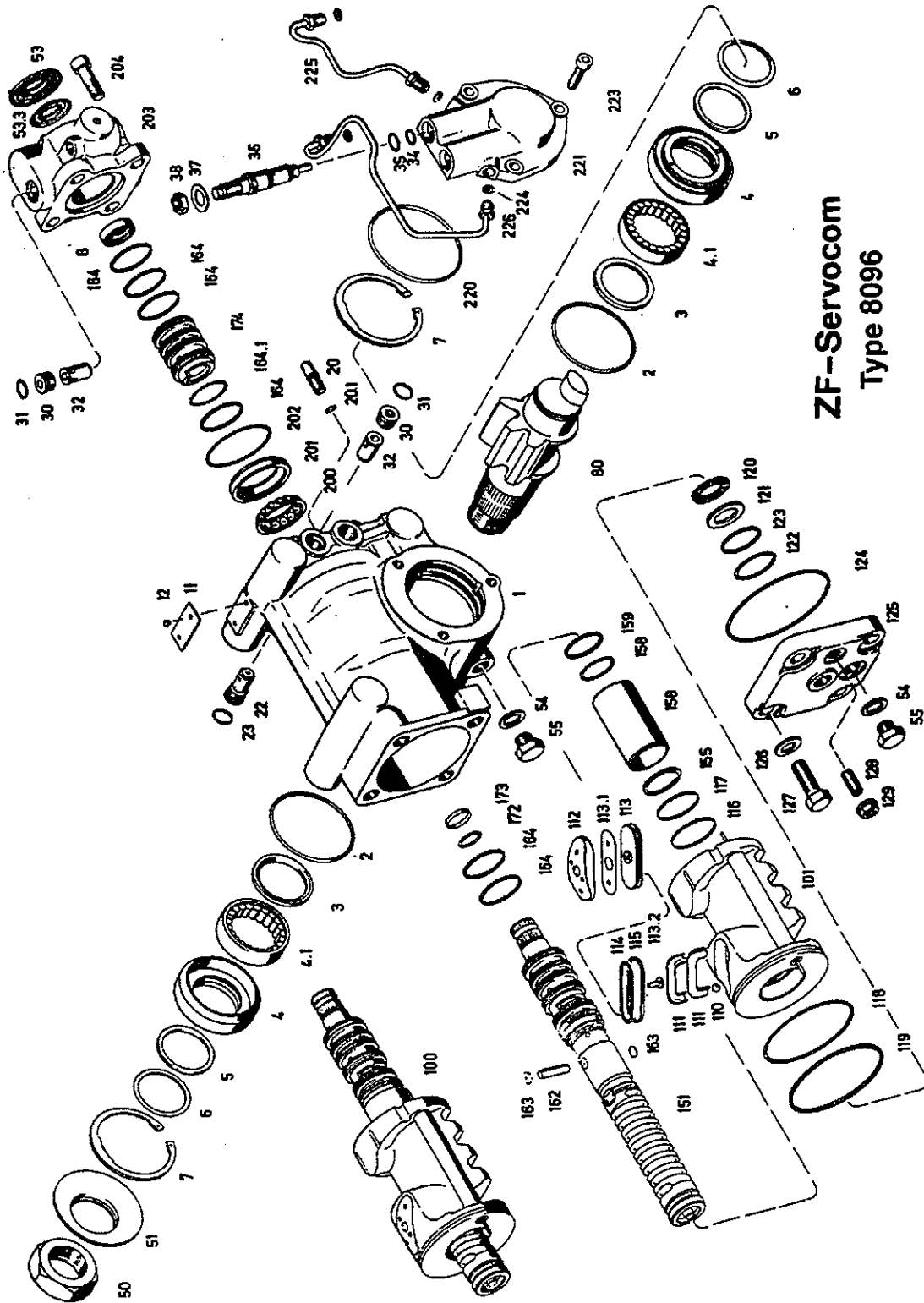




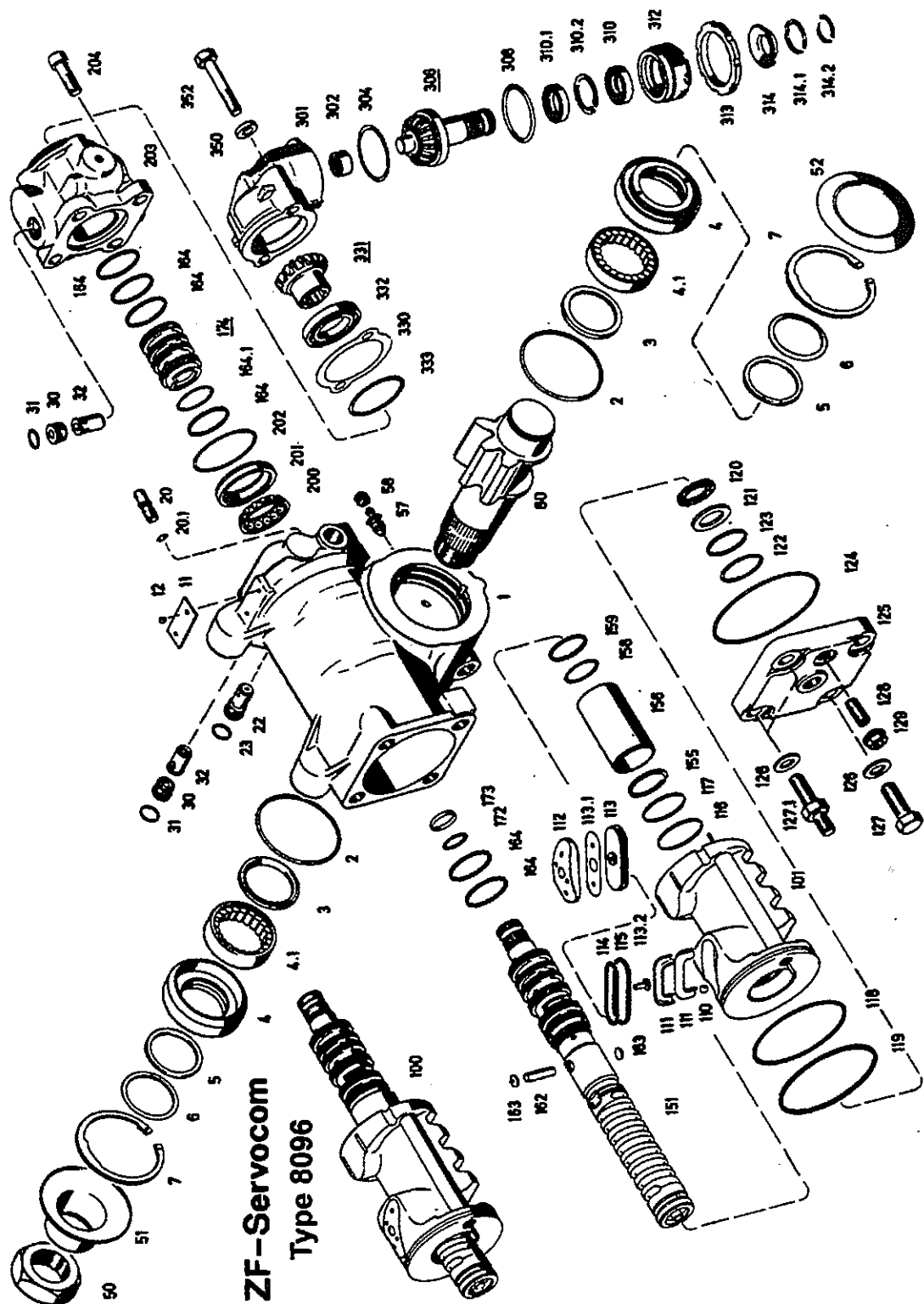


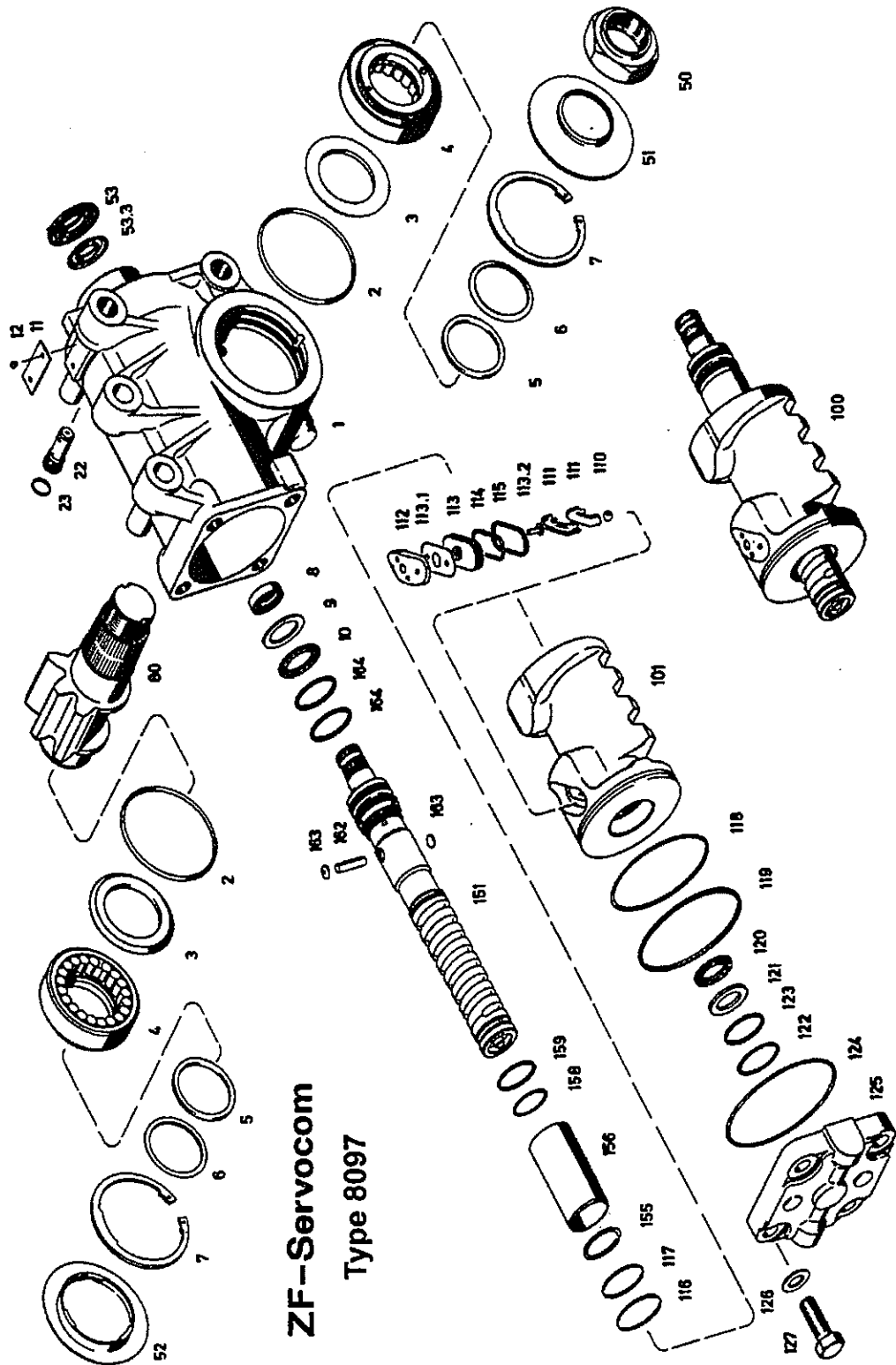
ZF-Servocom  
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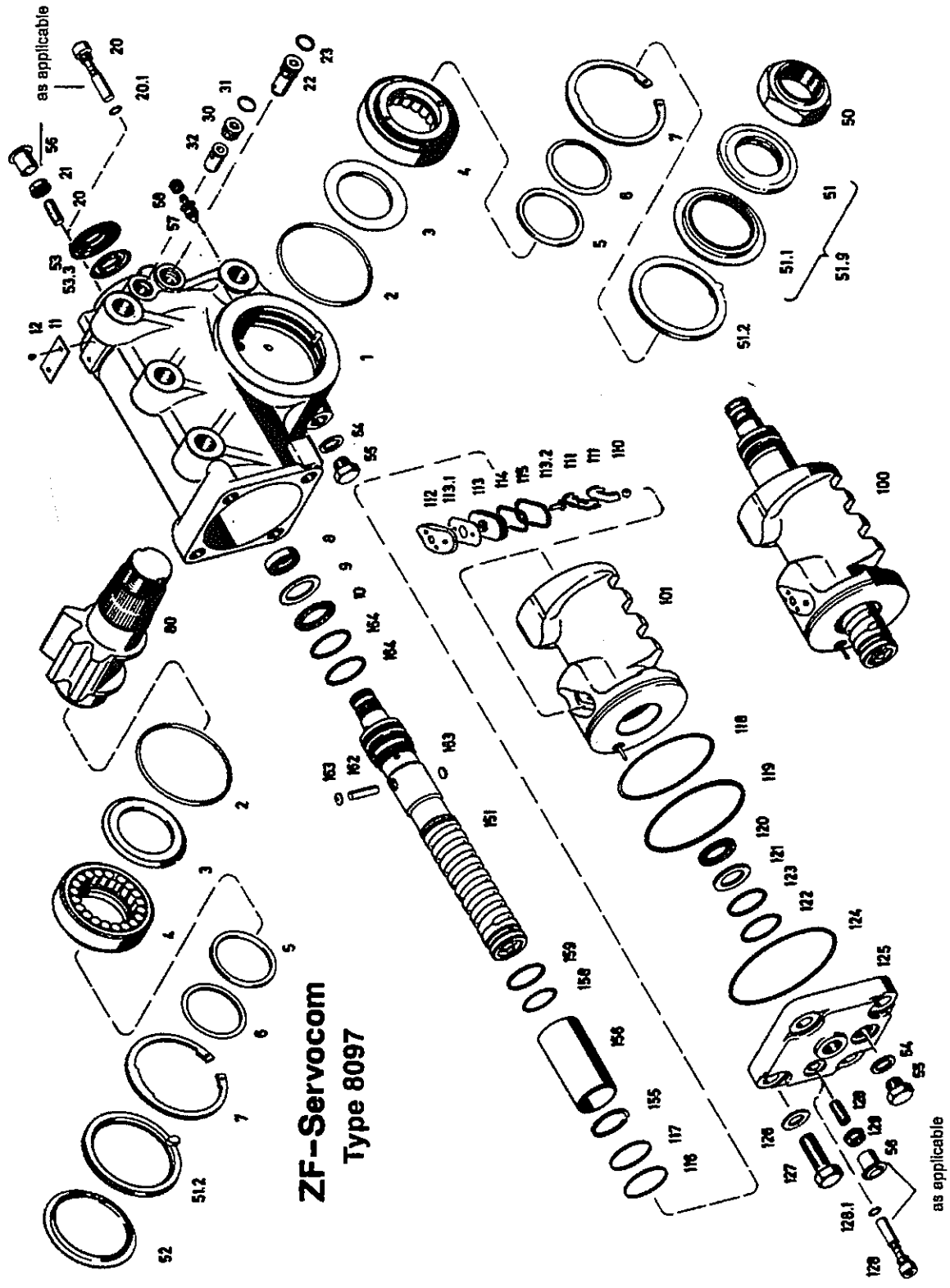




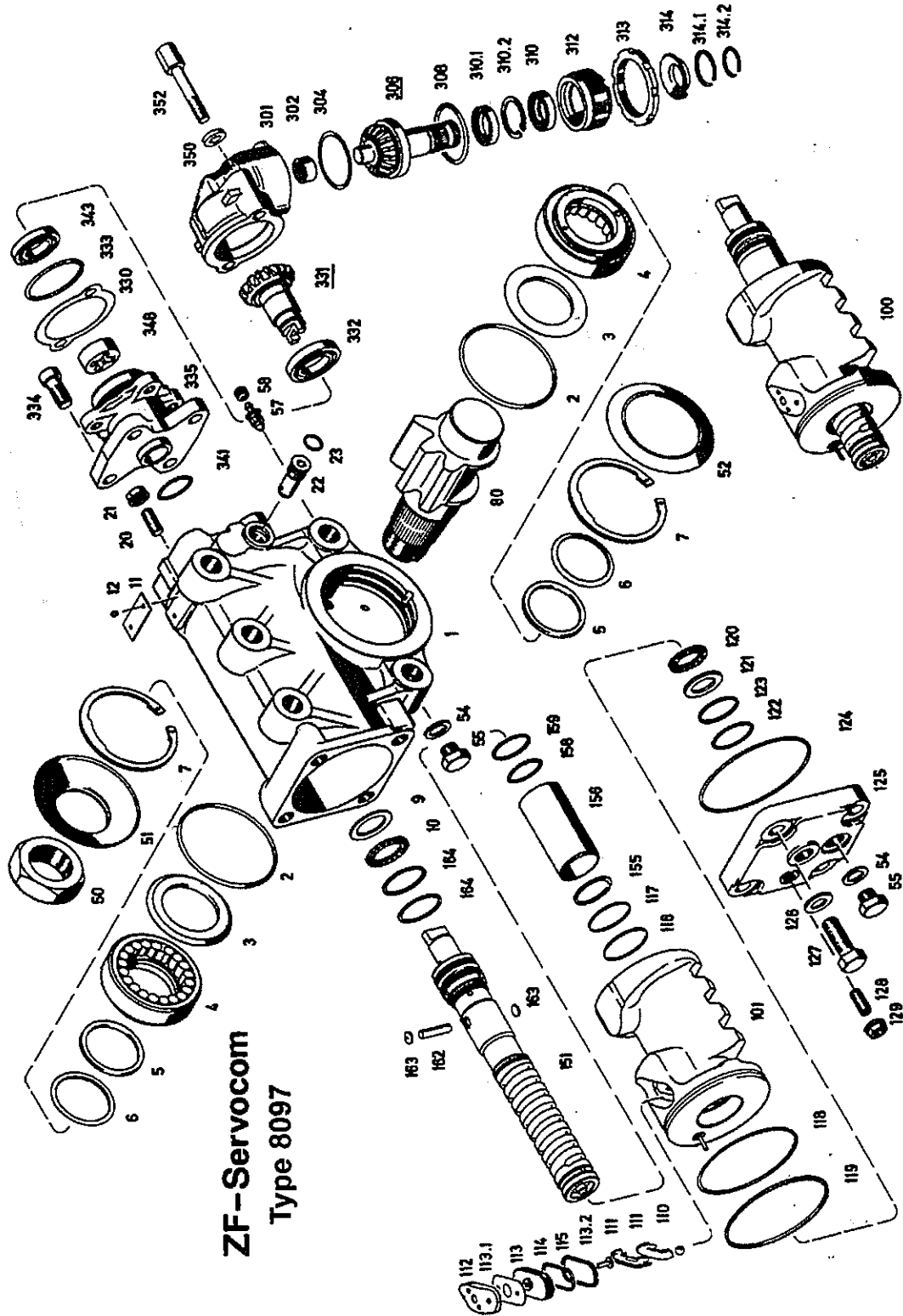
ZF-Servocom  
Type 8096



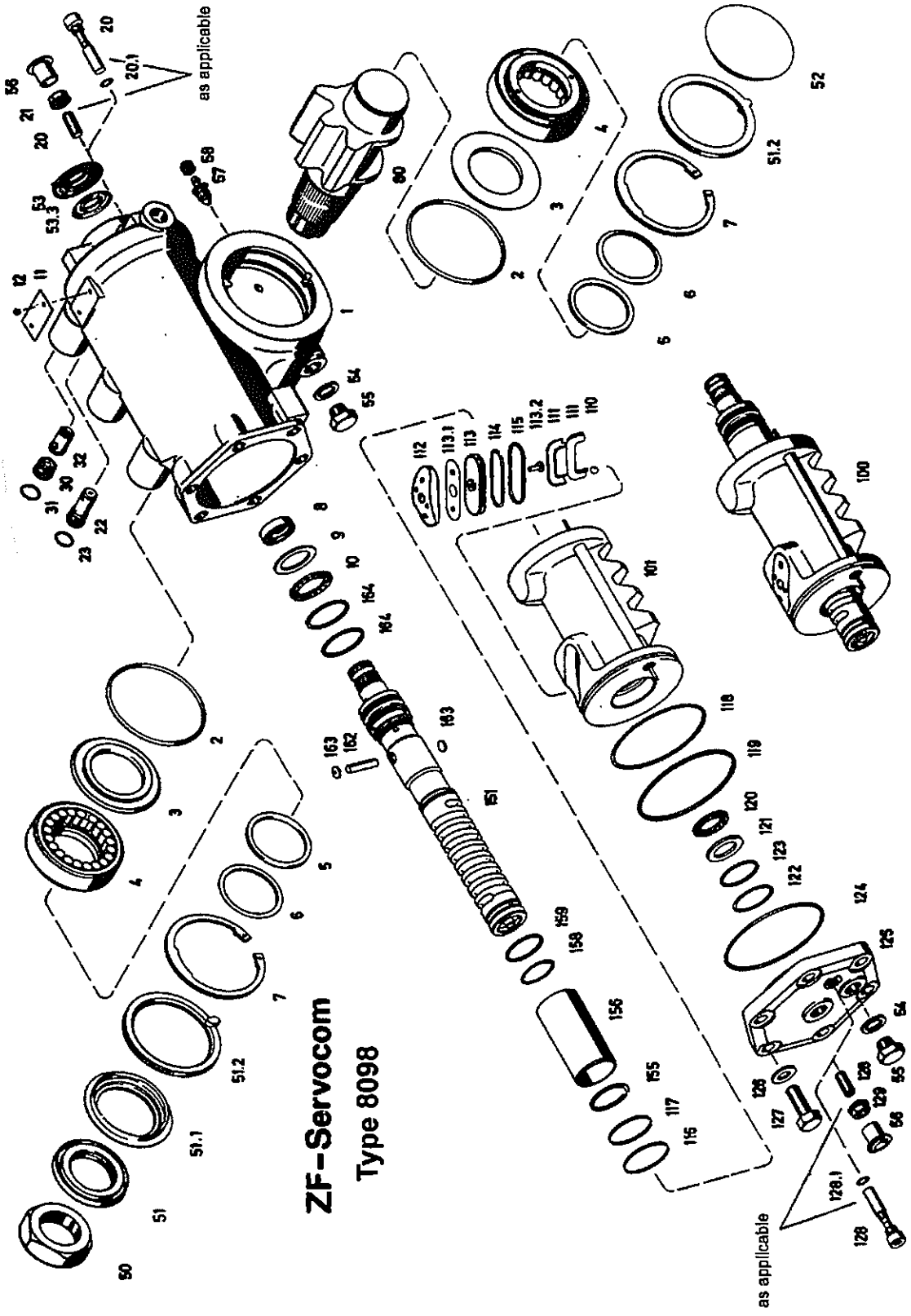




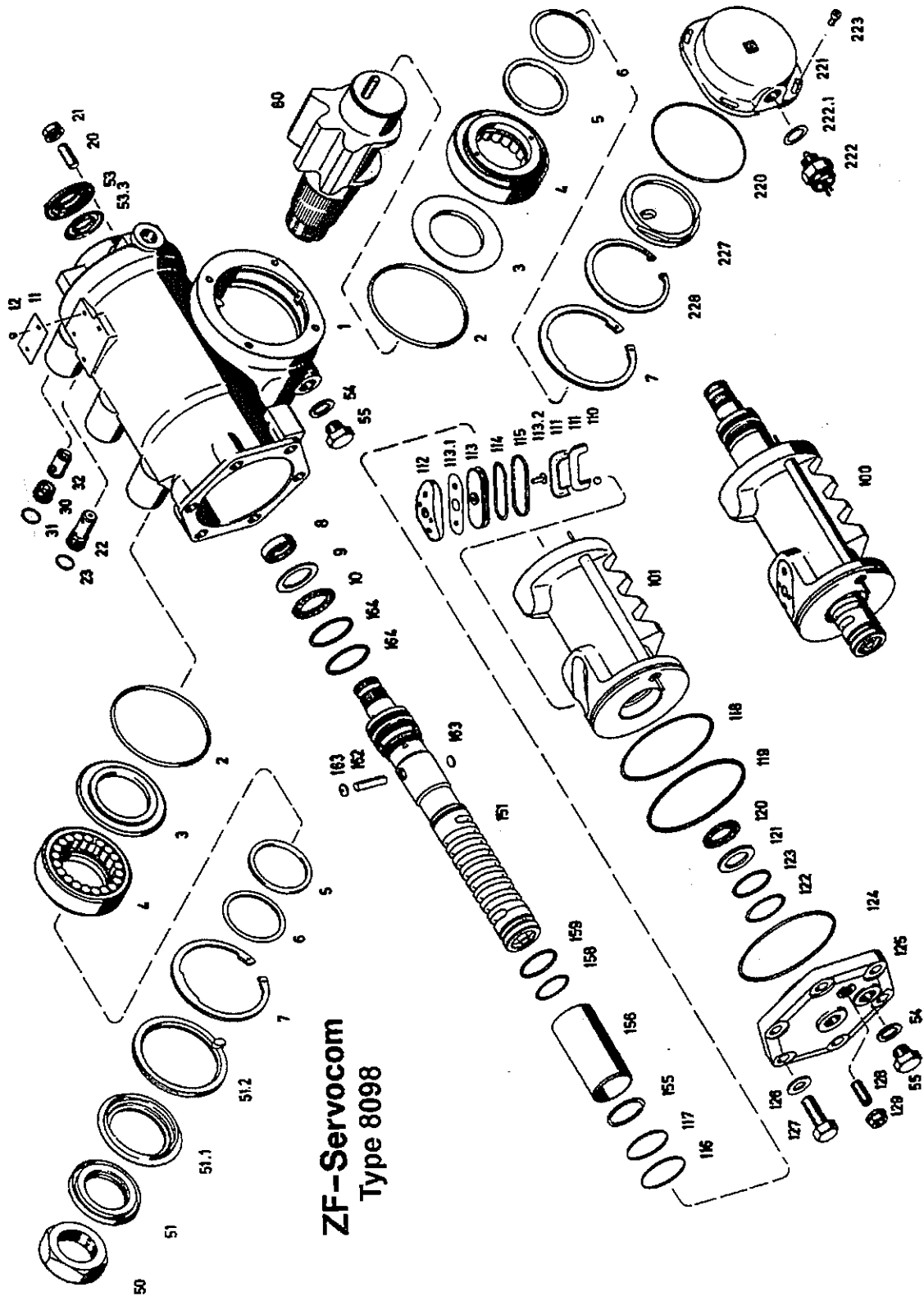
ZF-Servocom  
Type 8097



ZF-Servocom  
Type 8097

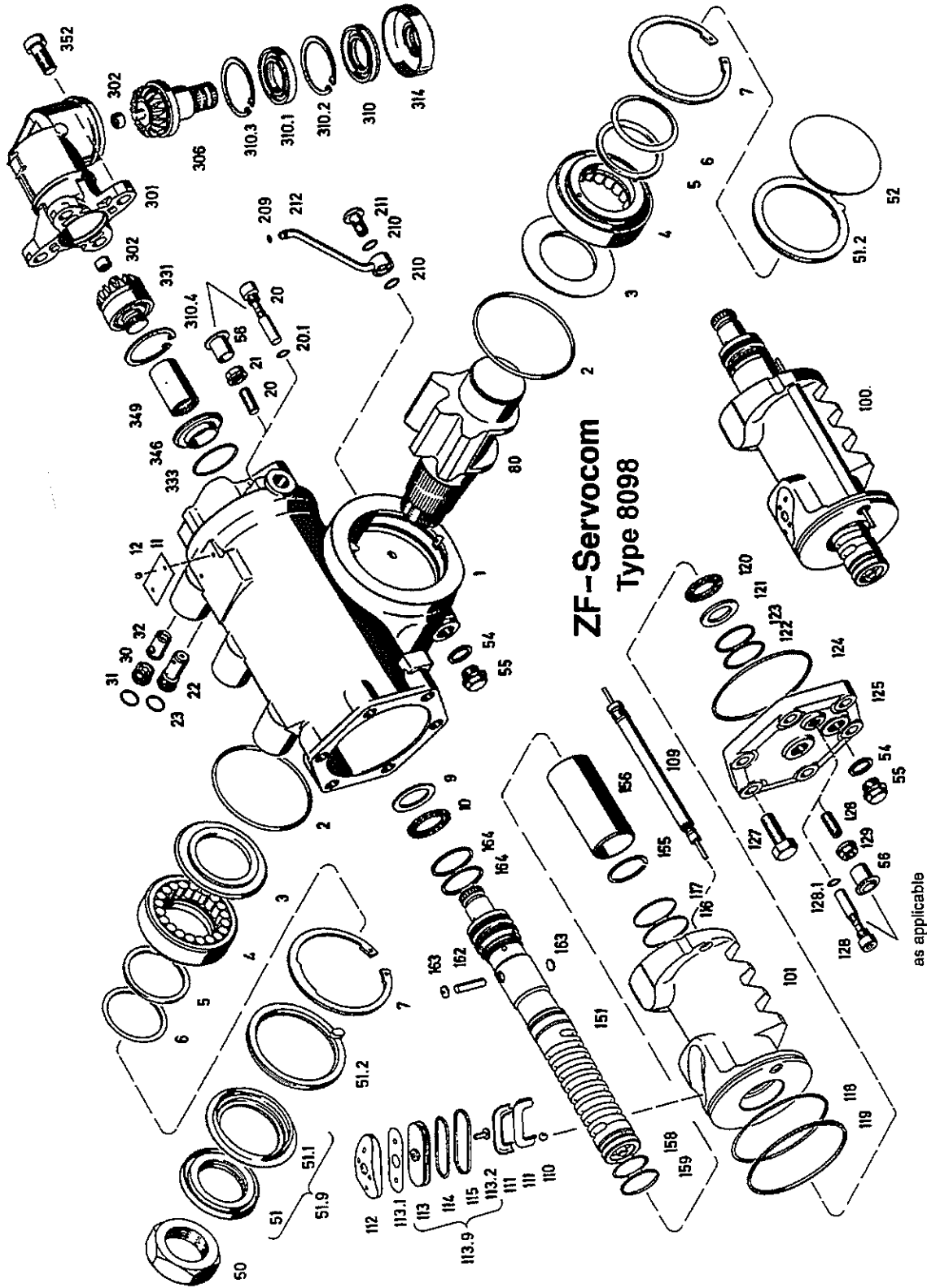


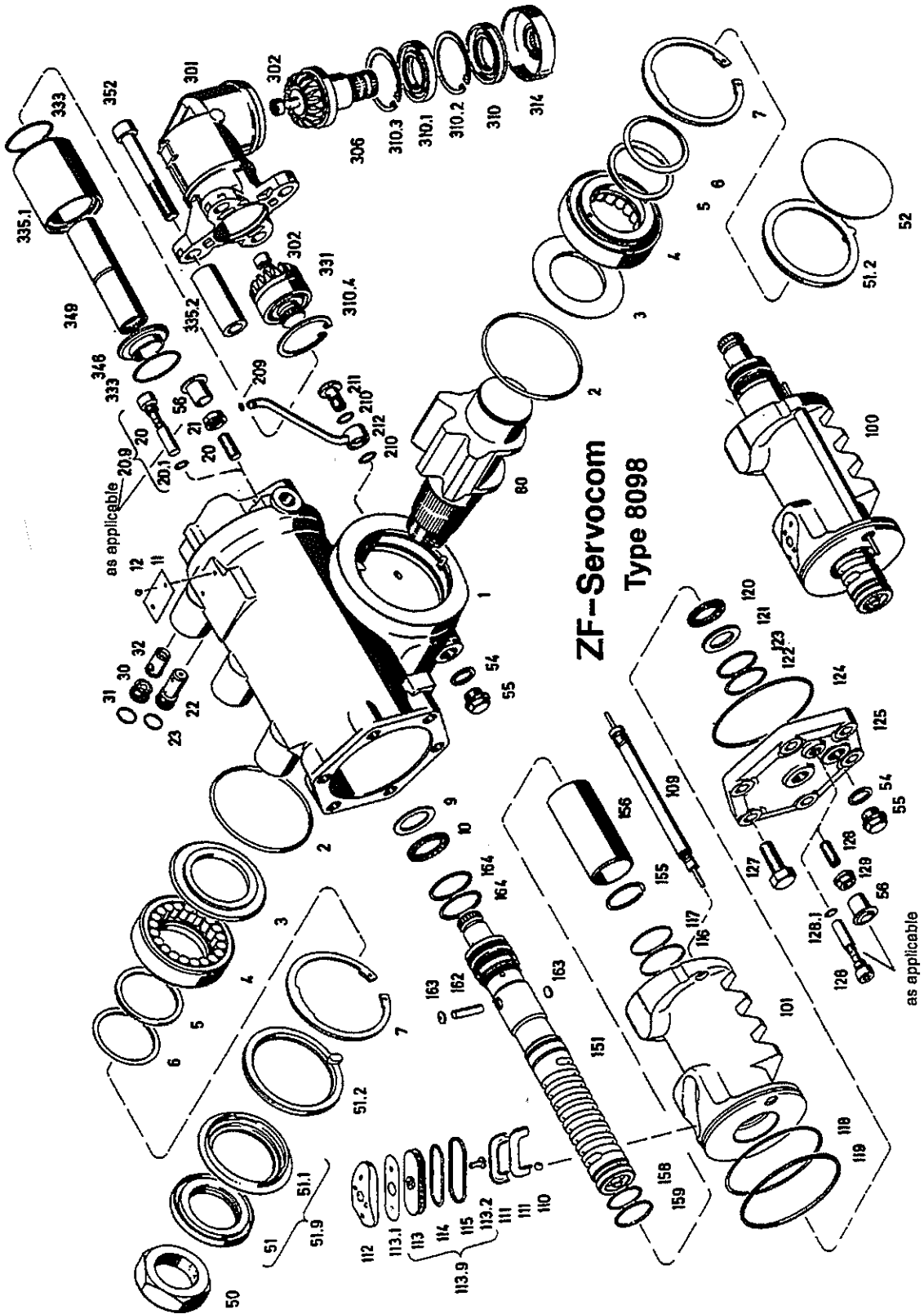
**ZF-Servocom**  
**Type 8098**

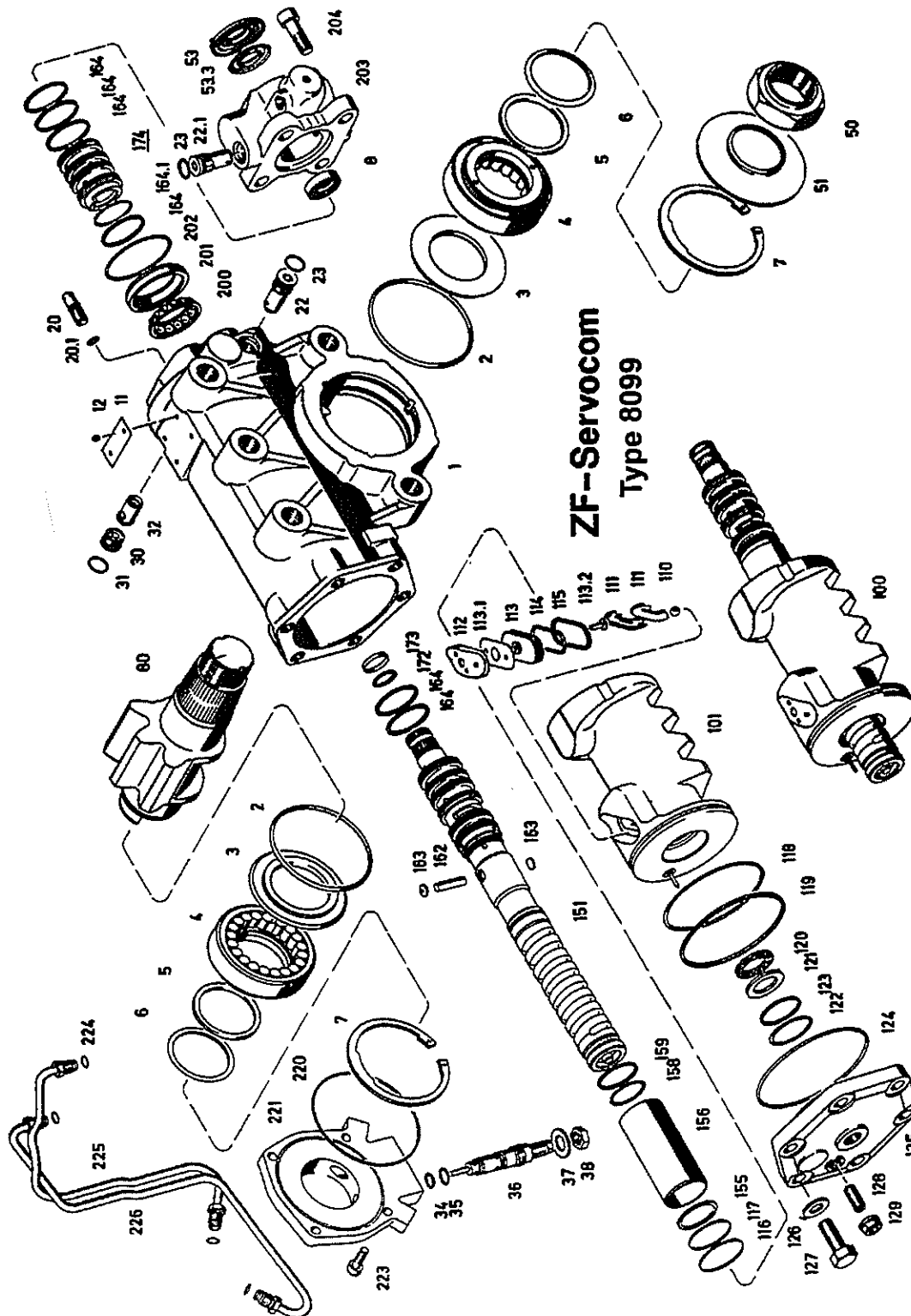


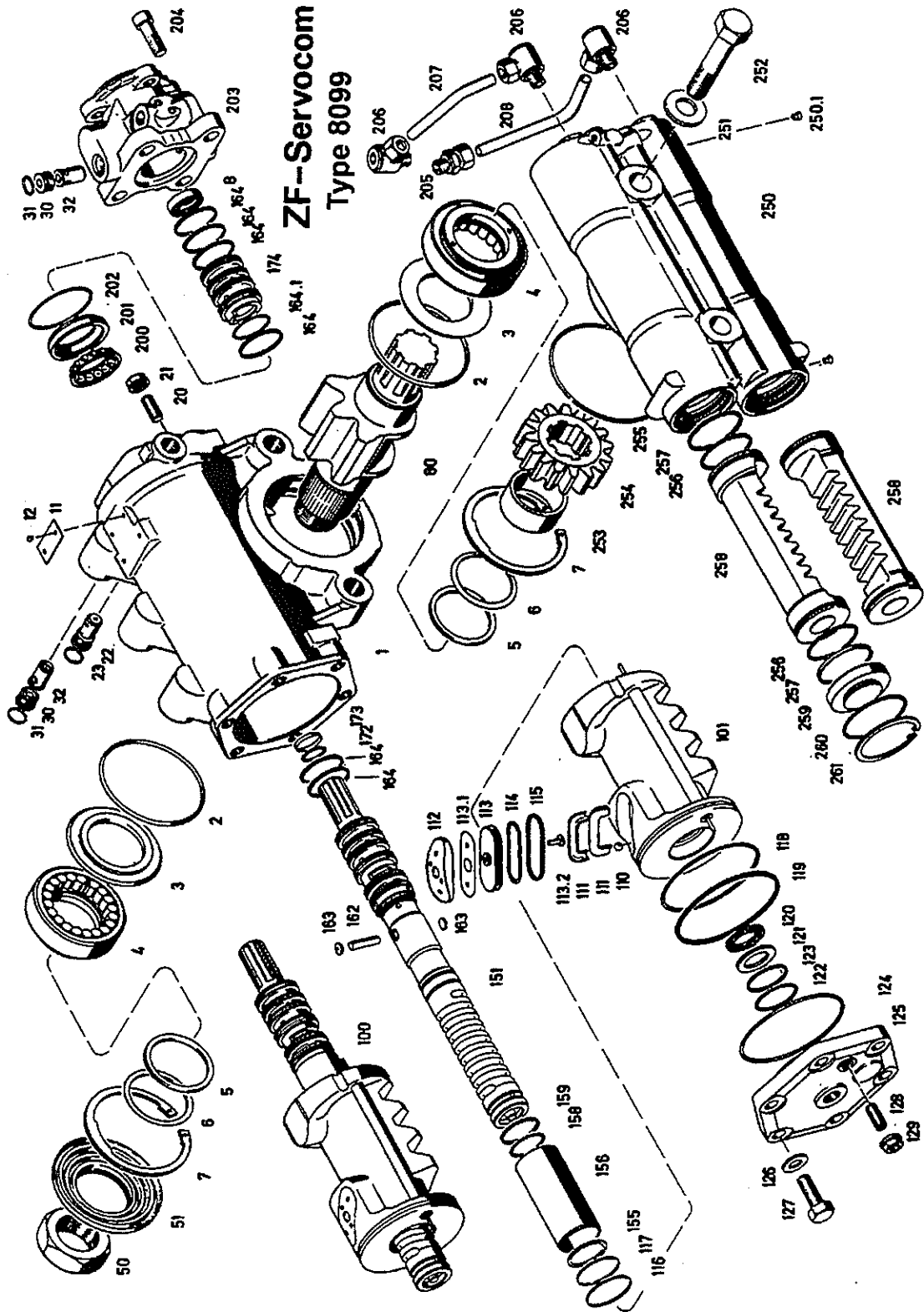










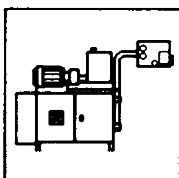
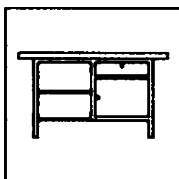
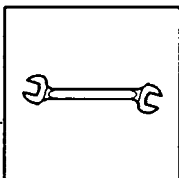








Service



ZF Lenksysteme

Design

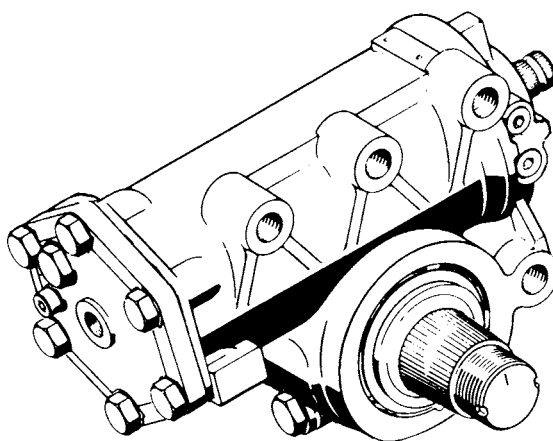
Operation

Maintenance

Inspection

# ZF Servocom<sup>®</sup>

Types 8090, 8095, 8097 and 8098



ZF Lenksysteme GmbH

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## I. Safety note



### **Attention: Important safety note for the driver and the workshop personnel, respectively**

If the steering system is in a perfect working order, the steering efforts the driver has to exert on the steering wheel are low (e.g., 30 N corresponding to approx. 3 kg).

In the event of a failure of the hydraulic assistance (for example owing to lack of oil) the effort needed to carry out a steering motion will increase considerably (for example to 450 N corresponding to approx. 45 kg).

As this happens very seldom and unexpectedly, the driver may be led to believe, erroneously, that the steering system cannot be moved at all any longer.

However, even in the event of a failure of the hydraulic assistance, there is always a mechanical connection between the steering wheel and the road wheel ensuring that manual steering at increased steering efforts can take place.

To avoid damages inside the steering gear and damages to the steering column, the steering effort at the steering wheel rim must not exceed 700 N (approx. 70 kg) when steering motions are carried out without hydraulic assistance and at vehicle standstill.



## II. Design and operation

### 1 Design

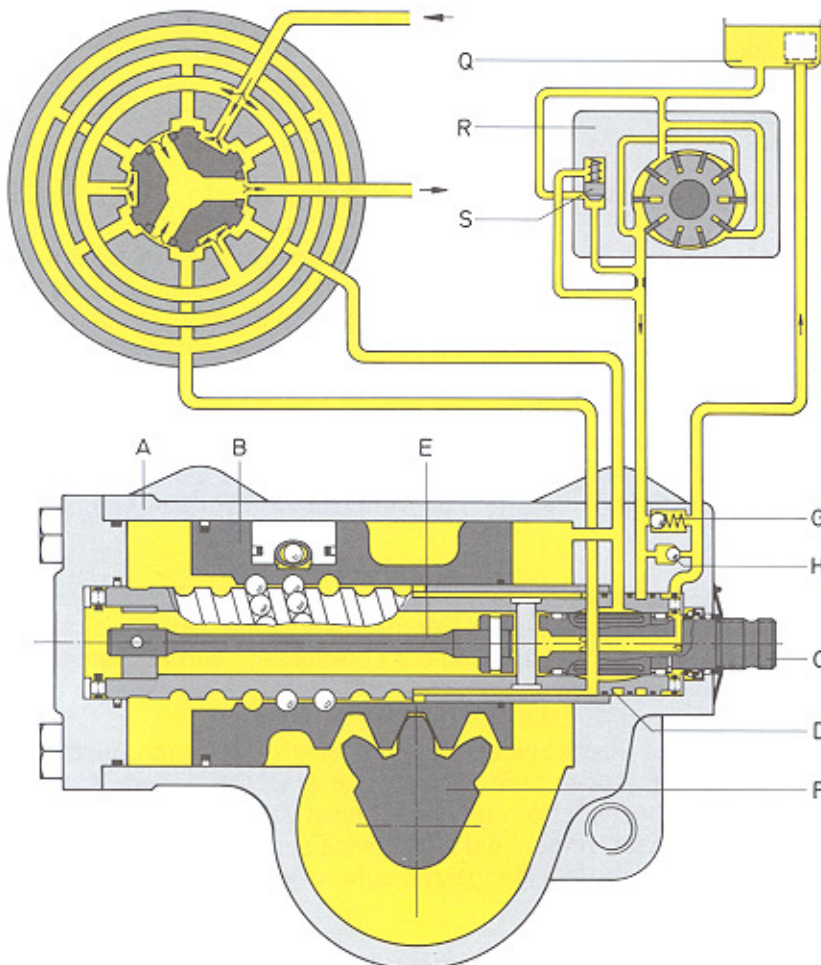
The housing of the ZF Servocom steering gear houses the steering valve, the steering cylinder and a complete manual steering gear.

The oil flow and the pressure required by the steering gear is supplied by an engine-driven pump. To achieve this, the oil is taken in from the oil tank and fed back to the tank via the pump and the steering gear.

The housing (A) - see **Fig. 1** - and the piston (B) have the function of a cylinder. The piston transforms the rotation of the steering input shaft (C) and of the worm (D) into an axial motion which it transmits to the sector shaft (F).

The piston (B) and the worm (C) are positively connected with each other by means of a ball chain. As the worm rotates, the balls at one end of the chain are taken up by a recirculation tube and fed back to the other end so that an endless ball chain is formed.

The teeth of the piston (B) and of the sector shaft (F) cause the sector shaft to rotate when the piston is displaced.



**Fig. 1**  
Valve rotor in mid-position

- A Housing
- B Piston
- C Valve rotor/steering input shaft
- D Valve sleeve/worm
- E Torsion bar
- F Sector shaft
- G Pressure relief valve
- H Replenishment valve
- Q Oil tank
- R Vane pump
- S Flow limiting valve

 Return line pressure

The steering valve consists of the valve rotor (C) which is carried in a needle bearing in the worm and is provided with six control grooves on the circumference, and of the valve sleeve (D) on the worm.

A torsion bar (E) pinned to the valve rotor (C) and the worm (D) keeps the steering valve in mid-position as long as no effort is exerted on the steering wheel.

A pressure relief valve (G) limiting the maximum pressure within the steering system may be integrated in the steering gear housing.

In addition, a replenishment valve (H) sucking oil from the return oil line when a steering motion without hydraulic assistance takes place can be fitted to the housing or to the steering valve.

In comparison with constant ratio steering gears, variable ratio steering gears are more direct around centre than outside the mid-position area, which has a favourable effect on the steering performance during straight ahead driving as minor steering corrections only, if any, are required.

At the same time, in the static parking range requiring a wider steering wheel turning angle a higher hydraulic torque is available at the sector shaft owing to the more indirect steering ratio.

In the event of a failure of the hydraulic assistance the steering efforts at the steering wheel rim are lower in this range than they would be for a constant ratio steering gear.

The 3 functional drawings to **Figs. 1 to 3** give a simplified representation of the steering valve and the oil flow. In addition, these figures give a cross-sectional view of the steering valve in order to schematically represent the connections from the steering valve to the cylinder chambers and the mode of operation of the valve.

## 2 Operation

When a torque is transmitted from the steering input shaft to the worm or vice-versa, the torsion bar is subjected to a deformation in the elastic area of its length, causing a torsion to occur between the valve rotor and the valve sleeve and, thus, to move the control grooves of the valve rotor away from the mid-position as compared with the position of the valve sleeve control grooves.

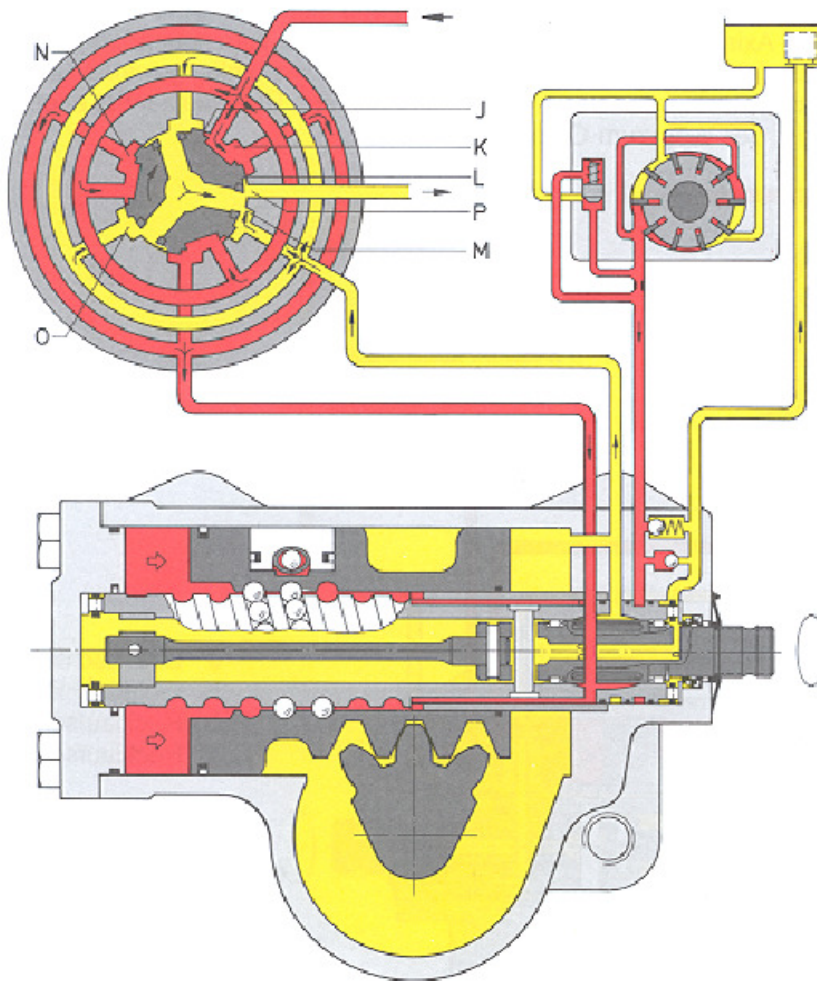
When the steering wheel is released, the action of the torsion bar will make the steering valve return to the neutral (mid) position.

Through the bore in the housing, the oil flows into the annular groove of the valve sleeve and is fed to the arcuate control grooves of the inner valve rotor through three symmetrically-arranged radial bores.

The position of the control grooves in the valve rotor and the valve sleeve is such that, in the mid-position of the steering valve, the oil can flow through the inlet slots (J and K) to the axial grooves (N and O) of the valve sleeve, which are also arcuate. From there, the oil can freely flow through radial bores to the cylinder chambers.

As long as the steering valve is in the mid-position, the oil can flow to both cylinder chambers, and via the three return grooves (P) in the valve rotor it can also flow off to the oil tank.

## 2.1 Forward steering motion to the right (piston with right-handed thread)



**Fig. 2**  
Valve rotor in  
operating position  
Steering wheel turned  
clockwise

- J Inlet slot
- K Inlet slot
- L Return slot
- M Return slot
- N Axial groove
- O Axial groove
- P Return groove

- Operating pressure
- Return line pressure

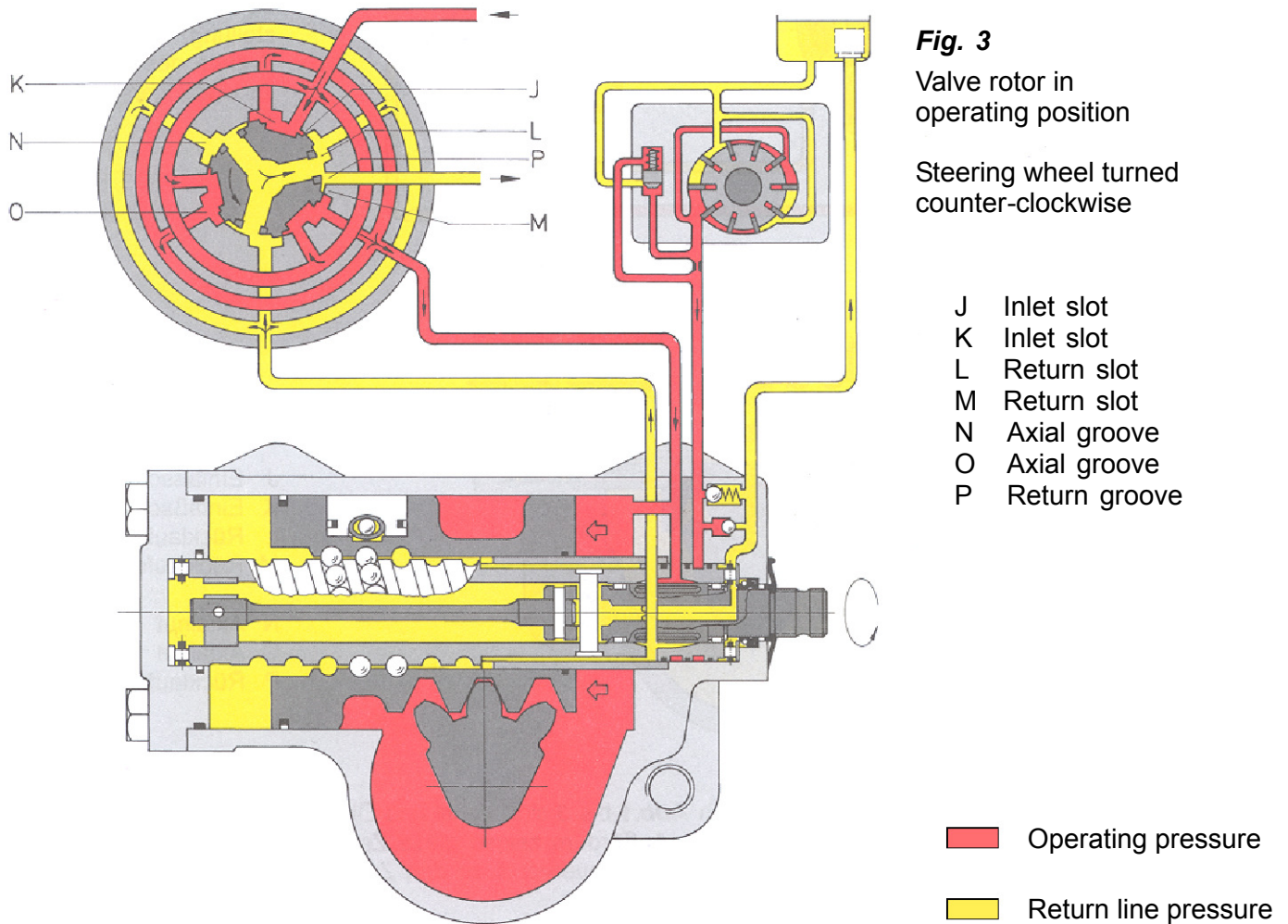
When the steering wheel is turned to the right, the piston will shift to the right (**Fig. 2**). A pressure will now build up in the left-hand cylinder chamber which is a function of the steering effort required.

To achieve this, the control grooves of the valve rotor are displaced clockwise and the inlet slots (K) are opened wider to admit the oil, while the inlet slots (J) are closed to the same extent and thus obstruct the feeding of oil to the axial grooves (O) of the valve sleeve.

The oil will now flow through the inlet slots (K) to the axial grooves (N) of the valve sleeve and, from there, will pass through the ball screw thread and flow to the left-hand cylinder chamber. The closed inlet slots (J) prevent the oil from flowing off to the tank and, thus, cause a pressure to build up.

The oil from the right-hand cylinder chamber is displaced. Via the opened return slots (M), it flows to the return grooves (P) of the valve rotor. From there, it can at any time flow through the central oil bore in the valve rotor and the worm and off to the oil tank.

## 2.2 Forward steering motion to the left (piston with right-handed thread)



When the steering wheel is turned to the left, the piston will shift to the left (**Fig. 3**). Therefore, pressure build-up now takes place in the right-hand cylinder chamber.

The control grooves of the valve rotor are displaced counter-clockwise and allow the oil to flow through the opened inlet slots (J) to the axial grooves (O) from where there is a connection to the right-hand cylinder chamber.

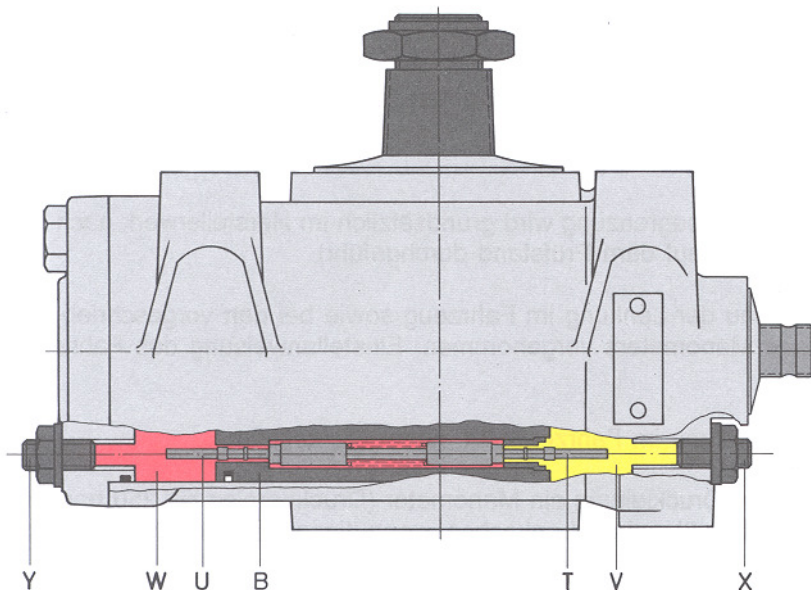
The oil from the left-hand cylinder chamber flows to the return grooves (P) of the valve rotor, via the ball screw thread and the opened return slots (L), and can then freely flow off to the oil tank through the central bore in the valve rotor and the worm.



### 3 Operation of the hydraulic steering limitation

The hydraulic steering limitation prevents a steering to the lock stops at full hydraulic pressure. It, thus, protects the pump and the steering linkage and prevents high oil temperatures.

A double-acting steering limiting valve with spring-loaded valve pins (T and U) is arranged in the longitudinal direction in the piston (B). The valve pins project over the right-hand and the left-hand front faces of the piston (**Fig. 4**).



**Fig. 4** Steering limiting valve closed

T Right-hand valve pin of steering limiting valve

U Left-hand valve pin of steering limiting valve


V Right-hand cylinder chamber

W Left-hand cylinder chamber

X Right-hand adjusting screw

Y Left-hand adjusting screw

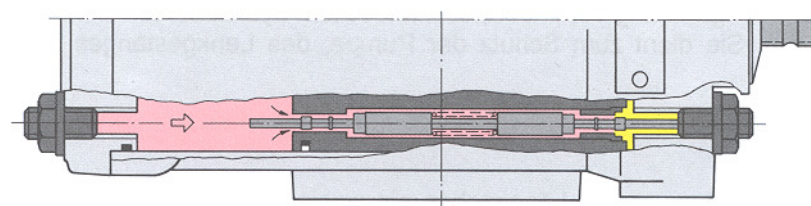
 Operating pressure


 Return line pressure


If the piston is shifted to the right or to the left towards the lock stop, the valve pins (T and U) are actuated by the adjusting screws (X and Y) fastened in the housing and the cylinder cover, respectively. The steering limiting valve remains closed until one of the valve pins hits against an adjusting screw.

If for instance the piston is displaced to the right (**Fig. 5**), the right-hand valve pin will hit against the adjusting screw (X) before the piston end position is reached. Valve pin (U) is displaced by the oil pressure so that the oil can flow away from cylinder chamber (W) to cylinder chamber (V) and from there to the return line. When the piston is displaced to the left, the same sequence of operations as described above will take place by analogy.

**Fig. 5** Piston displacement to the right. Right-hand valve pin open. Oil pressure greatly reduced.



 Reduced operating pressure

 Return line pressure

As soon as the steering limiting valve is open, the steering gear can be turned forward further at an increased steering effort and with greatly reduced hydraulic assistance until the lock stop is reached.

## III. Servicing work

### 1 Hints

In a number of countries a safety inspection (Sicherheitsprüfung = SP) is prescribed by law for vehicles with more than 8 passenger seats or a gross vehicle weight rating in excess of 7.5 t.



#### Attention:

On vehicles not subject to the safety inspection (SP), the work detailed in Chapter III. Servicing work, para.s 3.5...3.10, has to be carried out in addition.

Following a **test drive** and a subsequent visual inspection of the complete steering system (steering column, bevel box, steering gear, drag links, pump, and hydraulic lines) we recommend to carry out the following work.

Within the scope of **maintenance** the proper functioning of the steering system is checked by a test drive and a visual inspection.

During an **inspection**, safety-critical characteristics are tested.

## 2 Maintenance

### Maintenance intervals:

We recommend to carry out the following work within the scope of the general maintenance work. <sup>[1]</sup>

### 2.1 Test driving

During the test drive, in particular look out for the following characteristics:

- return to neutral
- sticking
- increased friction
- play

### 2.2 Checking and inspecting for external leakproofness/damages

Check the steering gear (with bellows), the protecting caps, the pumps (engine-driven and ground-driven), the valves and the steering cylinders, the lines and the screwed connections for leakproofness and damages. The piston rod of the steering cylinder may be covered by a thin oil film but there must not be any oil drops.

#### Note:

When cleaning with a high pressure cleaning machine, make sure not to direct the water jet directly towards the sealing elements of the steering system. Ingressing water and impurities can cause malfunctions.

### 2.3 Checking the oil level

Oil grade required: please refer to List of Lubricants TE-ML 09

Prior to pulling out the oil dipstick, thoroughly clean the oil tank and its immediate vicinity to protect the hydraulic oil from being soiled by impurities.



#### Attention:

Too low an oil level may cause malfunctions which can entail a failure of the hydraulic assistance of the steering system.

<sup>[1]</sup> see vehicle manufacturer's instructions

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## For vehicles with ZF Servocom RAS (Rear Axle Steering System)

Check the oil level in the straight ahead driving position.

If the oil level is above the top mark, there may be a leakage in the master cylinder of the ZF Servocom RAS steering.

Check the ZF Servocom RAS as specified in the Instructions for the Functional Check, Maintenance and Inspection of ZF Servocom RAS steering gears.

- **Oil level check with the engine stopped:**

The oil must be topped up to the upper mark of the oil dipstick.


- **Oil level check with the engine running:**

When the engine is running, the oil level must be between the lower and the upper marks.

When the engine is stopped, the oil level may rise by 1...2 cm (depending on the capacity of the steering system)

If the oil level rises by more than 2 cm, the steering system has to be bled

Start the engine.

For vehicles equipped with an additional ground-driven emergency steering pump: jack up the drive axle of the emergency steering pump  and engage a gear.

 see vehicle manufacturer's instructions



## 3 Inspection



### Attention:

The inspection intervals depend on how the vehicle is used.

Therefore, the table below distinguishes between different kinds of use which may, though, be overlapping.

For the sake of increased traffic safety, we recommend to inspect the steering system in accordance with the inspection intervals listed below.

Minor variations in inspection intervals are permissible if it is desirable to adjust these intervals to the vehicle-specific inspection intervals.

### Note:

The work listed below also includes work that has to be carried out within the scope of the safety inspection (SP).

Such work is marked “(part of SP)”. Therefore, inspection steps bearing this mark can be omitted when vehicles subject to safety inspection (SP) are checked within the scope of the normal inspection.

In addition, the safety inspection (SP) rules applying in the country of registration of the vehicle being inspected have to be complied with.

### 3.1 Inspection intervals

#### up to date of manufacture 12/93

Kind of use	Ist inspection Inspection on the vehicle	IIInd inspection Inspection on the vehicle	IIIrd inspection
Long-distance vehicles	100 000 km 60 000 miles	200 000 km 120 000 miles	300 000 km 180 000 miles
Vehicles in long and short distance use	100 000 km 60 000 miles	175 000 km 105 000 miles	250 000 km 150 000 miles
Construction site vehicles and vehicles in off-road use	80 000 km 50 000 miles 2 500 op.hrs	150 000 km 90 000 miles 4 500 op.hrs	200 000 km 120 000 miles 6 000 op.hrs

Additionally, at the time of the IIIrd inspection, the mechanical transmission elements of the ZF Servocom steering gear have to be inspected.

To this effect, dismantle the steering gear and visually inspect and crack test all transmission elements (see Repair Instructions).

starting from date of manufacture/repair 1/94

Kind of use	Ist inspection Inspection on the vehicle	Further inspections Inspection on the vehicle
Long-distance vehicles Coaches with high mileages	600 000 km	after a further 300 000 km, ea.
Buses Construction site vehicles Vehicles in short-distance use Vehicles subject to extreme loads	300 000 km 7 500 op.hrs	every 300 000 km 7 500 op.hrs

### 3.2 Test driving

During test driving, in particular look out for the following characteristics:

- return to neutral
- sticking
- increased friction
- play

### 3.3 Visual inspection

- Check the screws of the complete steering system (steering column, bevel box, steering gear, drag links and steering cylinder) for correct fastening.
- Check whether the locking plate and the split pin are still perfectly secured.
- By turning the steering wheel to both sides or by applying a load to it, check whether the fit of the drop arm on the sector shaft is still tight.
- Check the steering column, bevel box, steering gear, axle stops, drag links and tie rods for damages, cracks and corrosion.
- With the engine running, check the complete steering system for external leakproofness.

### 3.4 Replacing the oil filter



#### Attention:

Before taking off the oil tank cover, thoroughly clean the oil tank and its immediate vicinity to prevent the ingress of impurities into the hydraulic fluid.

Pull the filter insert out of the oil tank.

Avoid any dripping of oil from the insert into the tank.

If heavily soiled, clean the oil tank.

Fit a new filter insert.



## Attention:

Below is a list of all work that has to be carried out on the steering gear within the scope of the safety inspection (SP).

This list represents the currently valid status and is not subject to the Updating Service.

### 3.5 Steering gear play (part of SP)

- Start the engine
- Rotate the steering gear to the straight ahead driving position.
- Slowly turn the steering wheel and, simultaneously, watch the front wheel to see how far the steering wheel has to be turned to make the front wheel move.  
perm. total displacement (stg. wheel  $\varnothing$  500 mm): max. 50 mm  
max. 55 mm for version with bevel box

### 3.6 Hydraulic steering limitation (part of SP)

The hydraulic steering limitation causes the pressure to drop in the area of the steering stop, thus protecting the steering pump and the steering linkage and preventing increased temperatures.

- For a check of the setting please refer to Chapter III., para. 5.

### 3.7 Light operation of the steering gear (part of SP)

If the steering system has a hydraulic defect, this is indicated by increased steering efforts.

- Start the engine.
- At vehicle standstill, quickly rotate the steering gear twice from lock to lock and look out for stiff operation of the steering.

### 3.8 Points of stiff operation (part of SP)

Defective transmission elements (steering column, universal joints, ...) may cause a temporarily stiff operation of the steering gear.

- Relieve the front axle (conform to vehicle manufacturer's instructions)
- With the engine cut off, rotate the steering gear from lock to lock and look out for points of stiff operation.

### 3.9 Automatic return to neutral (part of SP)

The axle geometry ensures automatic return to neutral during driving.

- Test drive the vehicle on a cordoned-off ground.
- During the test drive, rotate the steering gear to full lock.
- Release the steering wheel and find out whether the steering gear automatically returns to mid-position.

### 3.10 Steering wheel (part of SP)

- Check whether the steering wheel is properly fastened.
- Check the steering wheel for damages.

## 4 Oil change and bleeding

### 4.1 Oil change

#### 4.1.1 Draining the oil

**Note:**

An oil change is only required if steering gear units were repaired or replaced.

Do not use any drained oil to refill the system. Avoid any blending of oils.

#### 4.1.2 Draining the steering system

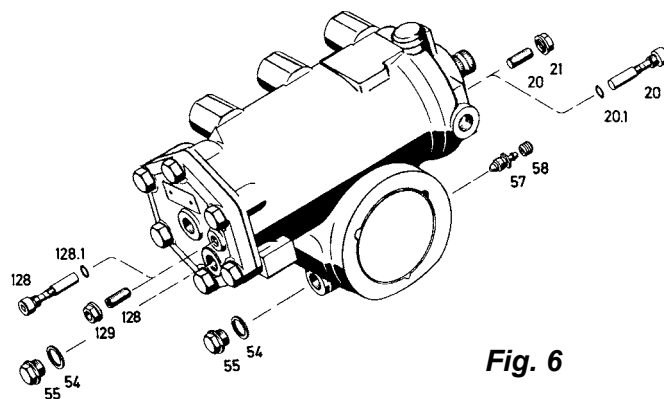
Jack the steered axle up. <sup>1</sup>

Unscrew the pressure and return lines from the steering gear.

Then have the engine run for a short time (maximum 10 seconds) to allow the oil to be sucked from the pump and the oil tank. Collect any escaping oil in a pan.

Screw in again all components unscrewed earlier.

#### 4.1.3 Draining the steering gear



**Fig. 6**

If existing on the version inspected, unscrew

- the screw plugs (55) from the cylinder cover or the housing
- the set screw or the collar nut (20 or 128)
- the screw (20 or 128)
- the bleeder (57)

**(Fig. 6).**

<sup>1</sup> see vehicle manufacturer's instructions

To achieve a quick draining, open the one among the components referred to above which is lowest in the installed position.

Rotate the steering gear manually from lock to lock until no more oil is draining.

Unscrewed components must be screwed in again at the following tightening torques:

Screw plug (55):	40 Nm (M16x1.5)
	50 Nm (M18x1.5)
Collar nut (21 and 129):	20+10 Nm
Screw (20 and 128):	12+3 Nm
Bleeder (57):	30 Nm

**Note:**

Even after unscrewing all components mentioned above, a residual oil quantity may be left over in the steering gear.

A complete draining of the steering gear may be necessary depending on the amount of impurities in the oil. To this effect the steering gear has to be removed from the vehicle and opened at a ZF Service Centre.

## 4.2 Oil filling



**Attention:**

When the steering system is filled with oil, there is a risk of impurities getting into the steering oil circuit. To avoid malfunctions caused by foreign bodies in the system, maximum cleanliness is of paramount importance both at initial fill and when topping up with oil.

For admitted oil grades, refer to the List of Lubricants TE-ML 09.

Fill the tank with oil to the rim.

Start the engine and have it run at idling speed to fill the steering system with oil.

During this operation, the oil level in the tank will quickly drop.

Therefore, to avoid any suction of air, the oil tank has to be topped up constantly.

In addition, for vehicles equipped with a ground-driven emergency steering pump:

Jack up the drive axle. <sup>1</sup>

Select a gear and have the engine run at idling speed.

To avoid any suction of air, constantly top up with oil.

<sup>1</sup> see vehicle manufacturer's instructions

## 4.3 Bleeding

- For steering gear versions with automatic bleeding:

Steering gear versions with automatic bleeding do not have any bleed screws. These steering gears automatically bleed any air remaining within the steering system.

**Note:**

Automatic bleed valves operate in the idle pressure range only; therefore, any unnecessary pressure build-up should be avoided.

When the steering system is filled to an extent preventing the oil level from dropping below the upper mark of the oil dipstick:

Have the engine run at low speed for 2...3 minutes.

Rotate the steering wheel several times from lock to lock and, while doing so, watch the oil level.

Top up with oil if required.

- In addition, for vehicles equipped with a ground-driven emergency steering pump:

Jack up the drive axle. <sup>[1]</sup>

With a gear selected and the engine running, bleed the emergency steering pump.

2...3 minutes later rotate the steering wheel several times from lock to lock.

**Note:**

In the end positions, do not pull heavier at the steering wheel than is necessary to rotate the steering gear.

Top up with oil if required.

- Versions with additional steering cylinder:

The line connections of the steering cylinder must point upward to allow for an escaping of the air in the cylinder.

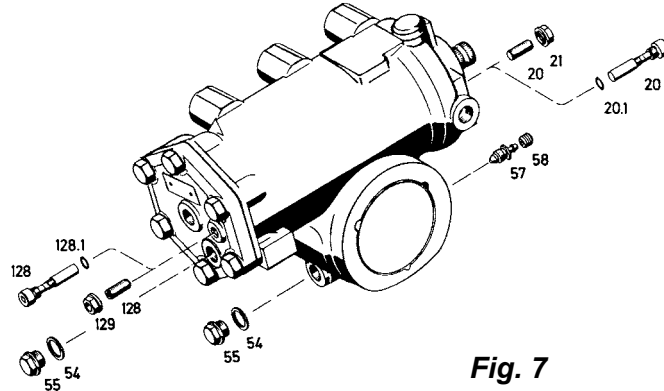
If required turn the steering cylinder to a suitable position and mount it again in its original position after air bleeding.

<sup>[1]</sup> see vehicle manufacturer's instructions

- Versions with bleeder (57):

With the engine running, open the bleeder (57) until nothing but oil is coming out (**Fig. 7**). Afterwards, close the bleeder again until it is oil-tight.

On versions without automatic bleeding (installed position horizontal, steering output shaft in the bottom position) the topmost screw/set screw (20 and 128, respectively) can be used for bleeding.



**Fig. 7**

- Versions with screw (20 and 128):

Open the topmost screw (20 and 128, respectively) until nothing but oil is coming out. Re-tighten the screw (20 or 128) using a torque of 12+3 Nm.

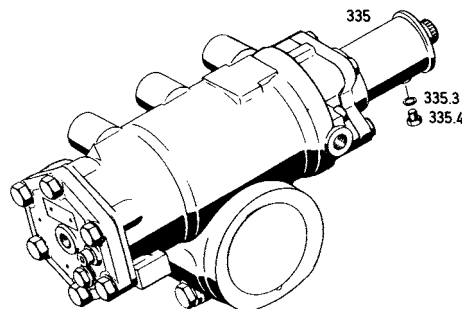
- Versions with set screw (20 and 128):

Slacken the collar nut (21 or 129) of the topmost set screw (20 or 128) until nothing but oil is coming out.

Re-tighten the collar nut (21 and 129) using a torque of 20+10 Nm.

The hydraulic steering limitation must be checked after bleeding.

- For versions with flange (335), in addition:



**Fig. 8**

Open the screw plug (335.4) until nothing but oil is coming out (**Fig. 8**).

Then close the screw plug again.

Tightening torque: 8+1 Nm (M8x1)

- If bleeding was done correctly, the oil level in the tank must not rise by more than 1 to 2 cm when the engine is stopped.  
Turn the engine off and lower the jacked-up steered axle or drive axle to the ground.

## 5 Setting the hydraulic steering limitation

A setting of the steering limitation is necessary if or when

- a new or repaired steering gear is fitted or
- new screws (20 and 128) were fitted to the automatically adjusting steering limitation or
- alterations to or adjustments of the front axle were carried out.

### 5.1 Hydraulic steering limitation with manual setting (Fig. 9)

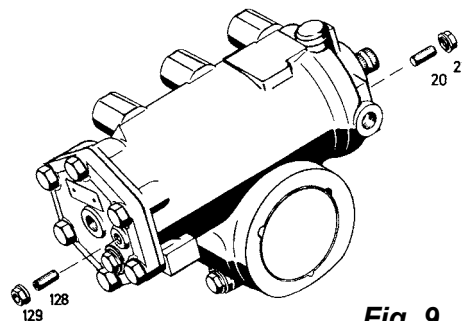


Fig. 9

Fit a pressure gauge (pressure range up to 250 bar) or tool [1] (ZF Servotest power steering tester) to the pressure line between the pump and the steering gear (see Fig. 10).

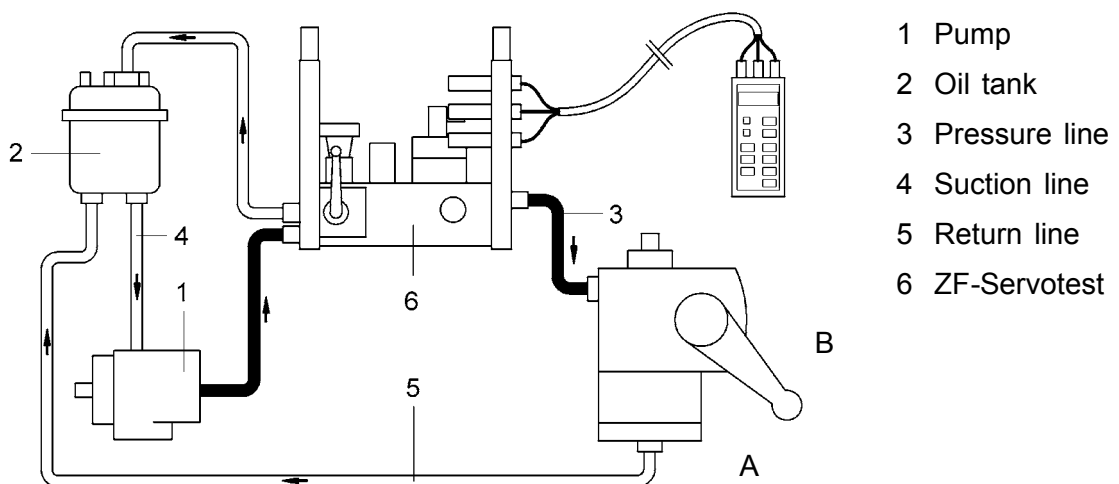


Fig. 10

If the setting takes place at set screw (128) the drop arm will be caused to move in direction “B” (Fig. 10).

If the setting takes place at set screw (20) the drop arm will be caused to move in direction “A”.



Test temperature: 50° C ±10°

- Rigid axle:

Relieve the axle by jacking it up or place it on swivel plates. <sup>[1]</sup>

- Single-wheel suspension:

Place the steered wheels on swivel plates.

- With the engine running at **idling speed**, rotate the steering gear to the lock stop.

Upon reaching the lock stop, overcome the return force of the steering valve by rotating the steering wheel further for a short time (5 sec. maximum) until a positive steering stop is reached.

Read the pressure at the pressure gauge or at tool [1] (ZF Servotest power steering tester).

Specified values:	Steering systems	up to 16 dm <sup>3</sup> /min:	40...50 bar
		up to 20 dm <sup>3</sup> /min:	50...60 bar
		above 20 dm <sup>3</sup> /min:	70...80 bar

To correct, slacken the corresponding collar nut (21 or 129) and screw the set screw (20 or 128) **Fig. 14** in or out.

**If a higher pressure is measured**, the corresponding set screw must be **screwed in** further.

**If a lower pressure is measured**, the corresponding set screw must be **screwed out** further.

While doing so, release the steering wheel so that idle pressure only can build up during this work.

Then tighten the collar nut (21 or 129) using a torque of 20+10 Nm.



### Attention:

During the setting operation as well as in the built in condition, the set screws (20 and 128) must be screwed in at least 3 threads deep for otherwise, because of insufficient thread overlap, they would run the risk of being ejected when maximum pressure is built up in the steering gear.

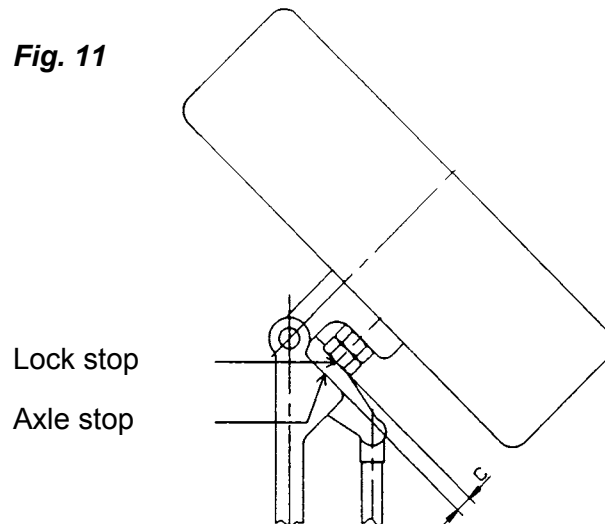
<sup>[1]</sup> see vehicle manufacturer's instructions

Proceed as described above for the setting of the second lock stop.

**Note:**

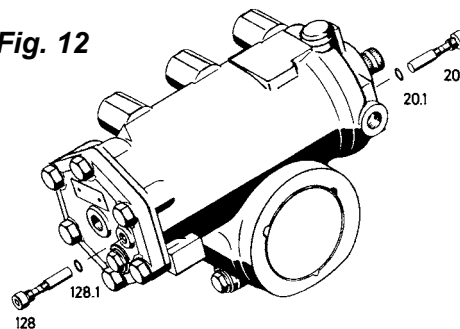
At variance with the setting described above, the vehicle manufacturer may specify a different way of adjustment, e.g. by inserting a spacer to ensure that, when the steering limitation responds, a distance dimension "C" can be kept (**Fig. 11**).

**Fig. 11**



## 5.2 Automatically adjusting hydraulic steering limitation (**Fig. 12**)

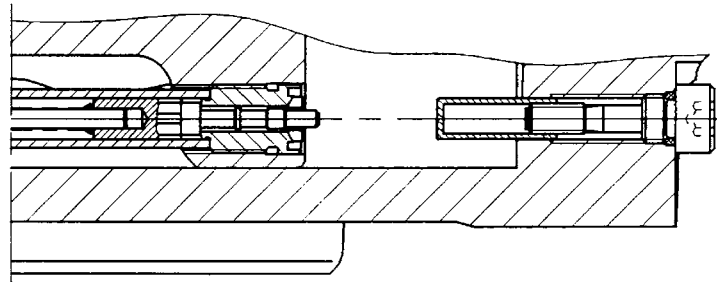
**Fig. 12**



**Attention:**

Steering gears with automatically adjusting steering limitations must not be rotated manually to the end positions when the steering linkage is removed or when the steering gear is removed from the vehicle, for the sliding bushes of the screws (20 and 128, respectively) would, thereby, be shifted to the cut-off position that is at maximum possible, and an automatic adjustment on the vehicle would only be possible with **new** screws (20 and 128) (**Fig. 12**). The screws (20 and 128) and the set screws (20 and 128) are **not** interchangeable.

**Fig. 13** Initial position  
Sliding bushes not yet adjusted



## 5.2.1 Operating mode of the automatically adjusting steering limitation

In the end positions, the valve piston tappets run up against the sliding bushes (20 and 128, respectively) and open the steering limiter valves (U and T, respectively).

The opening of the steering limiter valve is determined by the position of the sliding bushes on the screws (20 and 128).

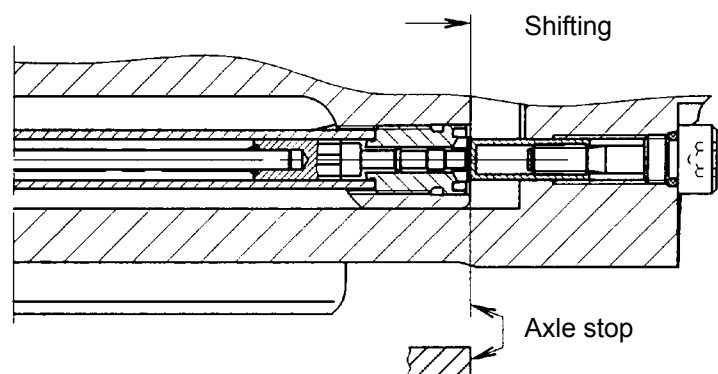
## 5.2.2 Setting

**Note:**

This setting (**Fig. 14**) can only be carried out after the steering gear was fitted to the vehicle. To enable the setting, the steering linkage and the axle stops must be installed and set.

**Fig. 14** Setting operation

Positioning of the sliding bushes



- For vehicles with a rigid axle:

Relieve the steered axle by jacking it up (there must, however, still be a load on the steered axle) or place it on swivel plates. <sup>1</sup>

<sup>1</sup> see vehicle manufacturer's instructions

- For vehicles with single-wheel suspension:  
Place the wheels on swivel plates.
- Rotate the steering wheel, with and without hydraulic assistance, to the maximum lock stop.  
This will cause the piston to push the sliding bush on the screw (20 and 128) up to the required cut-off position (**Fig. 15**).

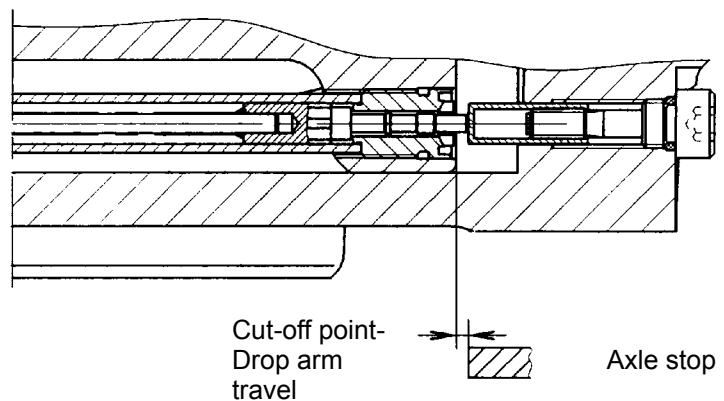
**Note:**

During this setting operation the steering limiter valve is constantly open which means that, with as well as without hydraulic assistance, the steering wheel can only be rotated further at an increased effort.

Repeat the setting operation for the other direction of rotation.

**Fig. 15**

Left-hand steering limiter valve open, oil pressure highly reduced



### 5.2.3 Correcting the drop arm travel

**Increasing the drop arm travel:**

Carry out the setting as described above.

**Reducing the drop arm travel:**

Fit new screws (20 and 128, respectively).

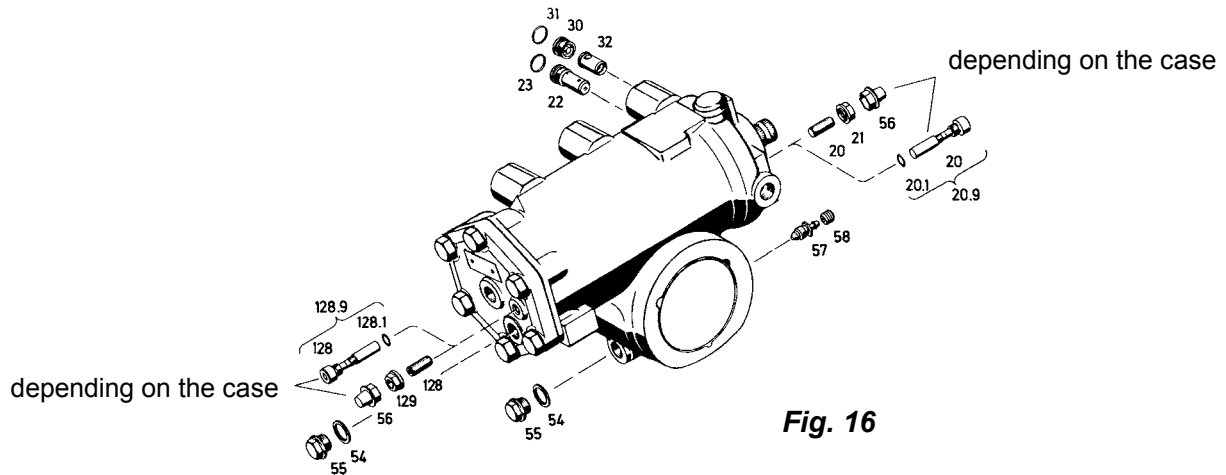


**Attention:**

The sliding bushes on the screws (20 and 128) may not be pulled back.

Tightening torque for the screws (20 and 128, respectively): 12+3 Nm

## IV. Repair of external leakages



**Fig. 16**

- 1 Valve insert (22) - Pressure relief valve**  
 Unscrew the valve insert (22) from the housing (**Fig. 16**) and remove O ring rests. If the pressure does not conform to the specified value or if there is any leakage, replace the complete valve insert (22).  
 Fit a new greased O ring (23) to the valve insert (22) and screw it in again.  
 Tightening torque: 30+10 Nm
- 2 Valve insert (32) - Replenishment valve**  
 Unscrew the screw (30) and the valve insert (32).  
 Put the valve insert (32) into the housing bore. Remove o ring rests.  
 Fit a new greased O ring (31) to the screw (30) and screw it in again.  
 Tightening torque: 30+10 Nm
- 3 Screws (20 and 128)**  
 Screw in new screws (20 and 128)  
 Tightening torque: 12+3 Nm  
 Setting the steering limitation - please refer to Chapter III., para. 5.
- 4 Collar nuts (21 and 129)**  
 Screw in new collar nuts (21 and 129).  
 Tightening torque: 20+10 Nm  
 Setting the steering limitation - please refer to Chapter III., para. 5.
- 5 Screw plug (55)**  
 Unscrew the screw plug (55), fit a new sealing ring (54) and screw it in again.  
 Tightening torque:           40 Nm   (M16x1.5)  
                                       50 Nm   (M18x1.5)
- 6 Bleeder (57)**  
 Screw in a new bleeder (57).  
 Tightening torque: 30 Nm



**Attention:**

Apart from the work detailed above, no further repair work may be carried out. Any repair work exceeding the extent described above has to be done by a ZF Service Centre.

## V. Replacing and setting the switch (222) and the potentiometer (232)

### 1 Replacing the switch (222)

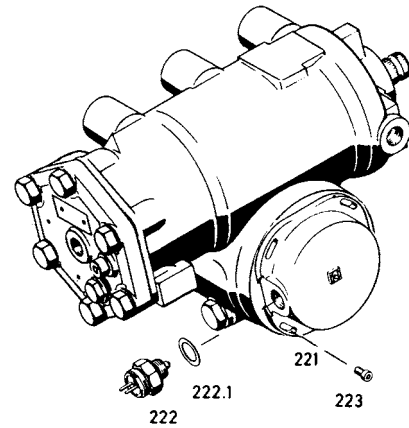
Unscrew the switch (222) and replace it by a new one (tightening torque: 50 Nm).

Starting from mid-position, rotate the steering gear to the left and to the right. The contact of the switch (222) must open after drop arm travels of  $5^\circ (\pm 10\%)$ , each ( $110^\circ \pm 10\%$  drop arm travel corresponding to 0.3 steering wheel turns) (**Fig. 17**). Make sure that the steer angles to the left and to the right are uniform. If required, correct the symmetry of the switching range by rotating the cover (221).

Tightening torque:

Cap screws (223): 5.5 Nm

Testing tool: Multimeter



**Fig. 17**

#### Note:

The switching range is set by varying the screw-in depth of the switch (222). Washers (222.1) of different thicknesses are available to enable this setting.

Do not use more than 3 washers (222.1) for the setting operation. (A washer thickness of approx. 0.25 mm corresponds to a drop arm travel of  $1^\circ - 22^\circ$  at the steering wheel). The cover (221) must be filled with 50 cm<sup>3</sup> of oil (see list of lubricants TE-ML 09).

### 2 Replacing the potentiometer

#### 2.1 Removing the potentiometer (232)

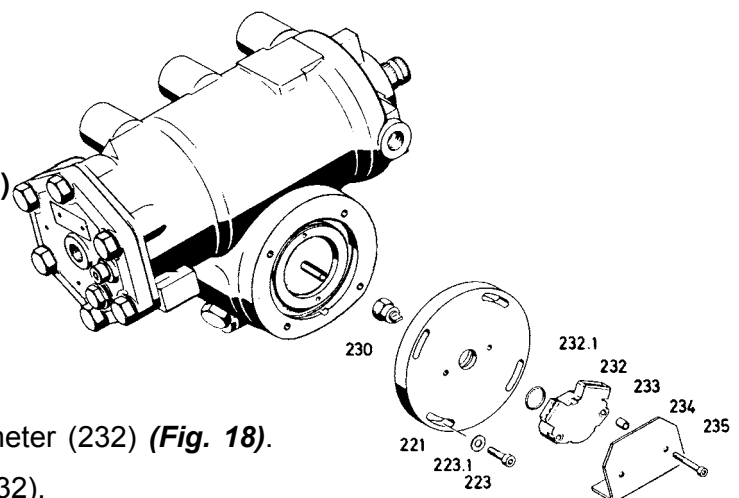
Rotate the steering gear to mid-position.

Clean the area surrounding the potentiometer (232) (**Fig. 18**).

Mark the position of the potentiometer (232).

Unscrew the cap screws (235).

Remove the potentiometer (232) along with the screening plate (234), the spacing sleeves (233) and the O ring (232).



**Fig. 18**

## 2.2 Fitting the potentiometer (232) again

Check whether the steering gear is in mid-position.

Fit an O ring (232.1) to the potentiometer (232).

Place the deep groove of the potentiometer (232) drive on the carrier (230).

### Note:

The slider of the potentiometer (232) being spring-loaded, it will return to its initial position when disassembled.

Therefore, check whether the potentiometer (232) can be turned through 50° minimum to either side when the steering gear is in mid-position.

Fasten the potentiometer (232) along with the spacing sleeves (233), the screening plate (234) and the cap screws (235).

Tightening torque: 2.8 Nm

Check:

The installed position of the potentiometer (232) must be identical with the position as marked during disassembly.

## 2.3 Setting the potentiometer (232)



### Attention:

A maximum value of 6 V must not be exceeded for otherwise the potentiometer (232) would be destroyed.

The tumbler switch of the Servotronic test tester (tool [7]) must not be switched to speedo position as otherwise the potentiometer would be destroyed.

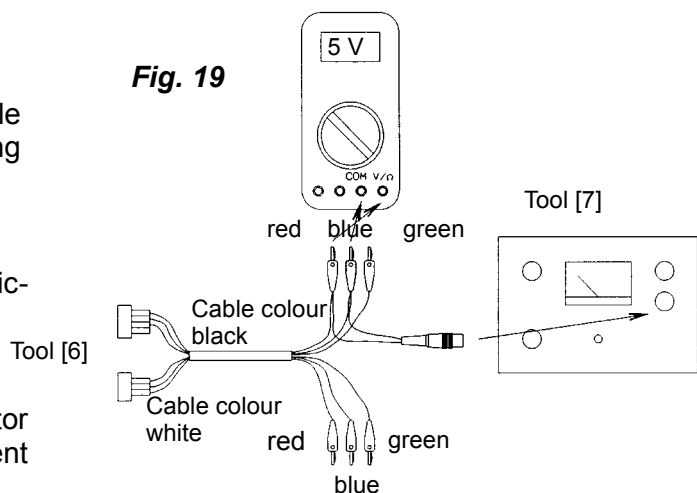
Rotate the steering gear to mid-position (dividing the total number of steering wheel turns in two).

### • Setting a voltage of 5V

Connect tools [6] and [7] (or use a suitable transformer) and the Multimeter measuring instrument as shown in **Fig. 19** .

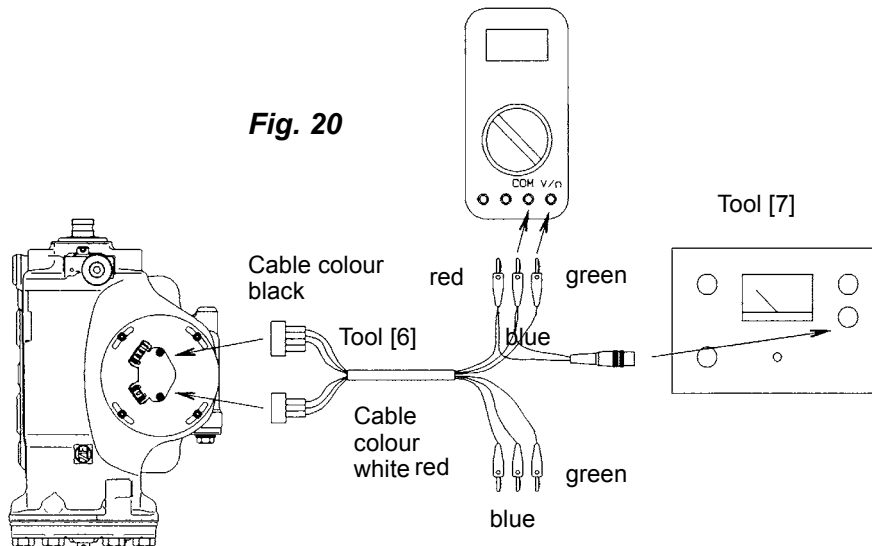
Switch the tumbler switch of the Servotronic test tester (tool [7]) to transducer position.

Continue adjusting the transducer regulator until the Multimeter measuring instrument reads 5V.



- **Setting the potentiometer (232) to steering gear mid-position**

Connect tools [6] and [7] and the Multimeter measuring instrument as shown in **Fig. 20**.



Rotate the potentiometer (232) together with the cover (221) until the Multimeter measuring instrument reads half the voltage applied, namely  $2.5\text{ V} + 0.03\text{ V}$ .

In this position, tighten the cap screws (223) (tightening torque:  $4+1.5\text{ Nm}$ ).

## Instructions on measurements, paths 1 and 2

### Measurement, path 2:

See **Fig. 20**

### Measurement, path 1:

See **Fig. 20**

**Additionally:**

- Plug in a jumper from blue to blue
- Plug in a jumper from red to red
- Unplug the green cable of path 2

**At variance:** Plug the green cable of path 1 in the Multimeter

Rotate the potentiometer (232) along with the cover (221) until the same voltage (specified value:  $2.3\text{...}2.7\text{ V}$ ) is indicated for both paths.

In this position, tighten the cap screws (223) (tightening torque  $4 + 1.5\text{ Nm}$ ).

Rotate the steering gear to the right-hand lock and measure the voltages of paths 1 and 2 (specified value:  $0.122\text{ V...}4.88\text{ V}$ ).

Rotate the steering gear to the left-hand lock and, again, measure the voltages of paths 1 and 2 (specified value:  $0.122\text{ V...}4.88\text{ V}$ ).

### Note:

If the specified values are not attained, a new potentiometer has to be used.



## VI. Removal and re-installation of the steering gear

### 1 Removing the steering gear

- 1.1 Thoroughly clean the steering gear and its immediate surroundings, in particular the pipe connections.

Drain the oil as described in Chapter III..

Take a note of the pressure and return lines' position.

Unscrew the pressure and return lines.

Obturate all oil pipes (danger of soiling).

- 1.2 Check whether the marks on the sector shaft and the drop arm coincide.

**Note:**

If the marks are offset from each other, prior to fitting the drop arm inquire with the vehicle manufacturer whether differing assembly instructions exist.

Screw out the locking screw (50).

Pull the drop arm off, using tool [5].



**Attention:**

Heating up the drop arm or driving in a wedge between the housing and the drop arm or removing the drop arm by means of hammer blows is not permitted as such action may cause changes to the material and/or inner damages to the steering gear.

- 1.3 Additionally, for vehicles with adjustable steering column:

- Adjust the driver's workplace to the topmost position to relieve the ball-track relay shaft as much as possible.
- By means of a suitable tool, for instance a ratchet belt, relieve the ball-track relay shaft in such a way that no thrust force can act towards the steering gear.

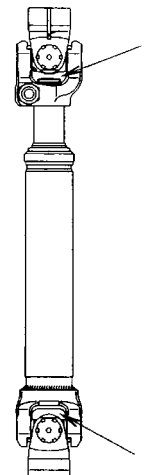
When a ratchet belt is used, pass the belt through the yoke spaces if possible (see arrows in **Fig. 21**). Tension the belt to an extent avoiding any damage to the sealing elements or the steering gear protection cap caused by a dislocation of the universal joints at the moment the clamping screws are unscrewed.

- 1.4 Unscrew the universal joint or the elastic coupling between the steering gear and the steering column or the separately mounted bevel box.

Unscrew the mounting screws and remove the steering gear.

**Note:**

If a fitting bolt was used, write its position down.



**Fig. 21**

## 2 Re-installing the steering gear



### Attention:

To guarantee a safe operation of the steering system, maximum cleanliness is an absolute must when re-installing all units that are part of the system.

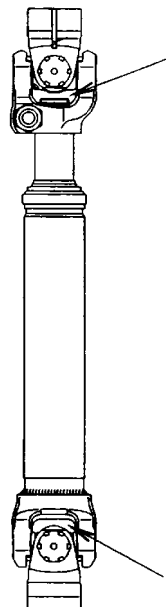
### Note:

To avoid malfunctions caused by foreign bodies or impurities in the oil circuit of the steering gear, the plugs in the ports of the steering gear, the oil pump, the steering cylinder, the valves etc. ... should only be removed at the moment the lines are connected. Remove protecting sleeves in the installed position, only, if this is possible. Connecting lines and screwed connections must be thoroughly cleaned and deburred.

2.1 Rotate the steering wheel to the straight ahead driving position.

Clean the locating surfaces of the mounting bracket and the steering gear.

2.2 Additionally, for vehicles with adjustable driver's workplace:

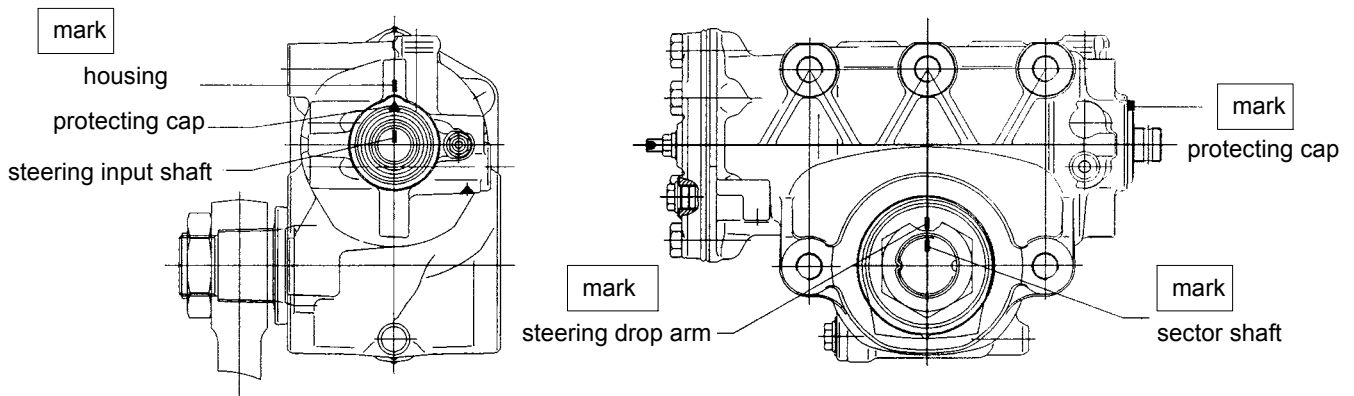


**Fig. 22**

Using a suitable tool, for example a ratchet belt, constrict the ball-track relay shaft until there is sufficient space for the steering gear to be built in without constricting the ball-track relay shaft any further. (**Fig. 22**).

2.3 Rotate the steering gear to mid-position by dividing the total number of steering wheel turns in two. Then continue to rotate until the marks (see **Fig. 23**) on the input shaft, the protection cap and the housing coincide.

**Fig. 23**



2.4 Place the steering gear into the mounting bracket and fasten it with screws.

**Note:**

Make sure that the position of the fitting bolt is correct.  
For the tightening torque, please refer to the technical cover sheet of the spare parts list.  
If no data is given in the list, the values below shall apply.

Depending on the vehicle type, space restrictions may require a previous fitment of the drop arm.

Tightening torque:

Thread	Screw grade	Tightening torque
M18x1.5	10.9	410+10% Nm
M20x1.5	10.9	520+10% Nm



**Attention:**

Conform to vehicle manufacturer's instructions.

2.5 Fit the universal joint or the elastic coupling between the steering column and the steering gear.

**Note:**

The clamping slot in the universal joint must point towards the mark on the cover cap or on the input shaft.

2.6 Additionally, for vehicles with adjustable driver's workplace:

Put the universal joint on without damaging the steering gear seal.

Tighten the clamping screw (M10x1,25) applying a torque of 48+5 Nm.

Relieve the tool, e.g. the ratchet belt (see **Fig. 22**), **cautiously** and remove it.

2.7 Move the steered wheels of the vehicle to the straight ahead driving position.

This position is reached when the steered wheels are in line with or parallel to, respectively, the second pair of road wheels (place a graduated ruler against the front and rear wheels).

2.8 Put the drop arm on the serration, making sure that the marks on the drop arm and on the sector shaft coincide (**see Fig. 23**).

Screw the locking nut (50) on and tighten it, applying the torques specified below.

- For versions with tapered serration:

**Note:**  
For the tightening torque, please refer to the technical data sheet of the spare parts list. If no data is given in the list, the following values shall apply:

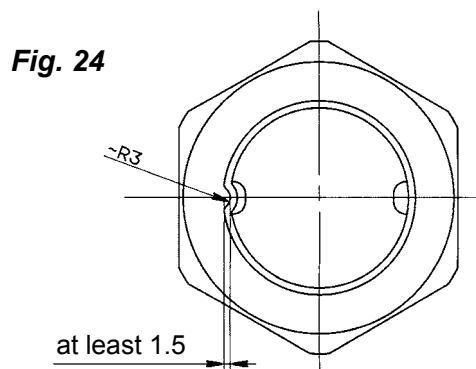
Thread	Serration	Tightening torque	Exception
M30x1.5	1 3/8"x36	250 Nm +10%	
M30x1.5	1 1/2"x36	300 Nm +10%	
M30x1.5	1 5/8"x36	330 Nm +10%	
M35x1.5		400 Nm +10%	
M42x1.5		500 Nm +10%	
M45x1.5		550 Nm +10%	MAN: 850 Nm+10%

If the vehicle manufacturer specifies different values, manufacturer's values shall apply.

- For versions with cylindrical serration and/or clamping screws:

Apply the tightening torque specified by the vehicle manufacturer.

2.9 Peen the locking nut (50) as shown in **Fig. 24**. 1



Put the drag link or the tie rod into place and tighten it. 1

Rotate the steering gear to the left until reaching the stop.

Take off the drag link or the tie rod.

2.10 Additionally, for versions with automatically adjusting steering limitation:

Unscrew the screws (20 and 128).

2.11 Check at the steering wheel whether any further movement to the left is possible.

If the steering gear cannot be rotated any further to the left, the lock stop and the axle stop, respectively, must be re-set.

 **Attention:**

It must be guaranteed that the steering angle limitation takes place at the lock stops and the axle stops, respectively, and is not done by the steering gear.

Mount the drag link or the tie rod. 1

Repeat the check for the right-hand side and, if required, re-set the lock stop and the axle stop, respectively.

2.12 Additionally, for versions with automatically adjusting steering limitation:

Screw in the screws (20 and 128). Tightening torque: 12+3 Nm

2.13 Mount the drag link or the tie rod. 1

1 see vehicle manufacturer's instructions

2.14 Connect the pressure and return lines between the pump, the steering gear and the steering cylinder according to the notes taken on the removal.

Fill the steering system with oil and bleed it.

See Chapter III.

2.15 Set the hydraulic steering limitation

See Chapter III.

2.16 Check the oil level

Before pulling out the oil dipstick, thoroughly clean the oil tank and its immediate vicinity to prevent dirt from getting into the hydraulic fluid.



**Attention:**

If the oil level is too low, it can entail malfunctions which, in turn, may cause a failure of the hydraulic steering assistance.

**Additionally, for vehicles equipped with a ZF Servocom RAS (rear axle steering system):**

Check the oil level in the straight ahead driving position.

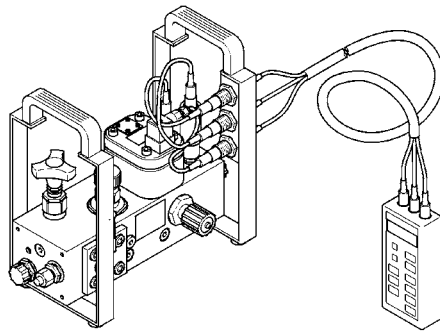
If the oil level is above the upper mark, there may be a leakage in the master cylinder of the ZF Servocom RAS.

## VII. Special tools

**Note:**

The tools described below are universal tools. For special applications, special tools recommended by the vehicle manufacturer may therefore be necessary.

**Tool [1]**  
ZF Servotest 600 tester



**Ordering ref. No.**

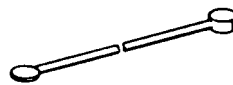
7418 798 600

**Tool [2]**  
Dial with pointer



7418 798 452

**Tool [3]**  
Thrust pad



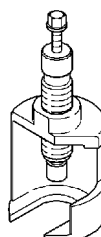
7418 798 556

**Tool [4]**  
1 pair of expanders



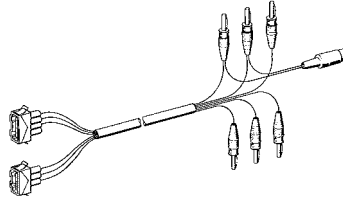
7418 798 653

**Tool [5]**  
Extracting device



7418 798 219

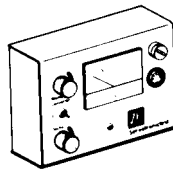
**Tool [6]**  
Adapter cable



**Ordering ref. No.**

7418 798 567

**Tool [7]**  
Servotronic test tester



7418 798 545



## VIII. Troubleshooting

### 1 Troubleshooting on the steering system, incl. checking the hydraulic functions

#### 1.1 Checking the play of the input shaft bearing in the steering column

By moving (shaking) the steering wheel sideward to and fro, check whether there is any play. If so, replace or repair the steering column/the bearing.

#### 1.2 Checking the universal joint, the telescopic shaft and the bevel box for angular play or stiff operation

If play (can be identified by the noticeable rattling noise occurring when the steering wheel is turned to and fro) or stiff operation are ascertained, replace the defective components.

#### 1.3 Checking for leakage

- Start the engine.
- Check whether all screwed connections, lines and sealing elements of the complete steering system (bevel box, steering gear, pump and steering cylinder) are leakproof.
- Check all hoses and lines, protecting caps and bellows for possible traces of chafing and embrittlement cracks.
- Switch the engine off.



#### **Attention:**

When you replace hose lines or parts with externally visible damages such as for instance cracks, only use spare parts that are pressure-tested and released by the vehicle manufacturer.

## 1.4 Checking the straight ahead driving position of the steering gear and the vehicle

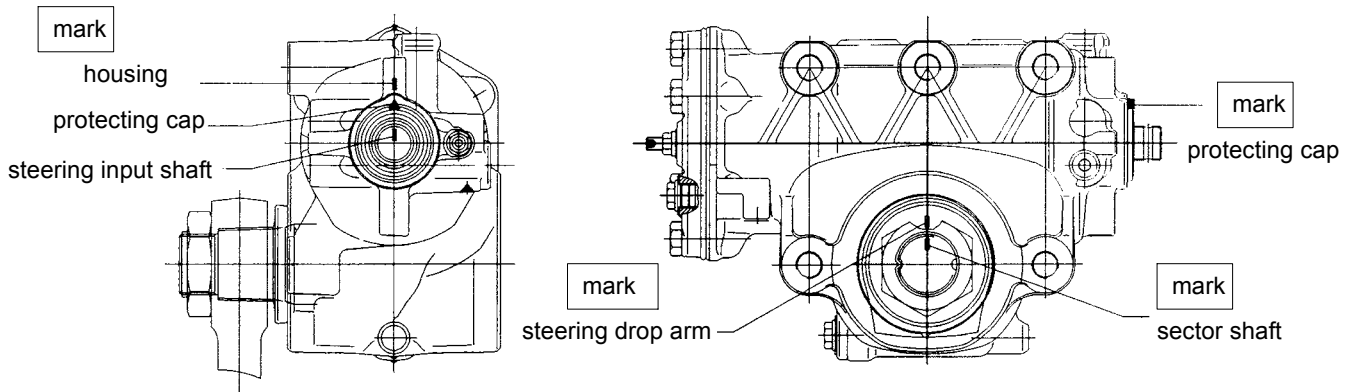


### Attention:

Steering gears equipped with an automatically adjusting hydraulic steering limitation must not be rotated to the end positions if the steering linkage had been removed previously.

- Vehicles with single-wheel suspension:  
Place the wheels of the steered axle on swivel plates.
- Vehicles with a rigid axle:  
Jack the steered axle up. <sup>1</sup>
- Move the steering gear to mid-position by rotating it half the total number of steering wheel turns. Then rotate it further until the marks (*see Fig. 25*) coincide.

**Fig. 25**



Now turn the steered wheels to the straight ahead driving position.

Corrections can be made by screwing the ball joint on the drag link further in or out.



### Attention:

If the steering wheel position is not correct or if a length correction of the steering linkage turns out to be necessary, it may well be that this necessity originates in a preceding accident-like event. We, therefore, recommend to check whether the serration of the sector shaft (30) is twisted (to do so, pull the drop arm off), whether the input shaft is installed in a twisted position and whether some or all further transmission elements are bent or have cracks. In addition, check the play as detailed in Chapter III., para. 3. Deformed components may not be re-bent to shape but must be replaced.

Additionally, for versions with automatically adjusting hydraulic steering limitation:

If required, fit new screws (20 and 128, respectively) and reset the steering limitation - see Chapter III., para. 5.

<sup>1</sup> see vehicle manufacturer's instructions

## 1.5 Checking the belt tension of the pump drive

Check the tension of the drive belt. <sup>1</sup>

Even at maximum pump pressure, the drive belt must transmit the power without any slip.

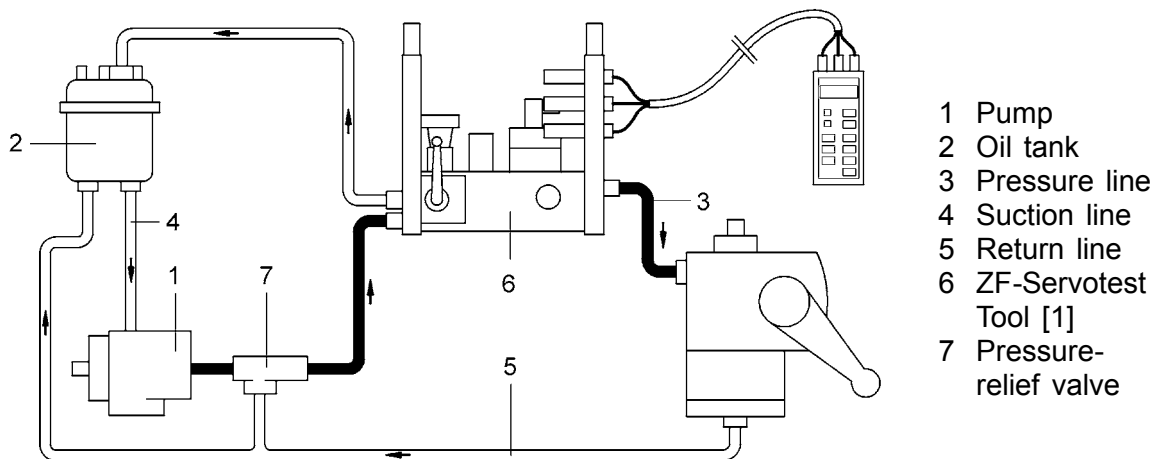
## 1.6 Checking the hydraulic functioning of pump and steering gear

### 1.6.1 Installing tool [1] (ZF Servotest tester)

For the implementation of the pressure and leakage oil tests described below, it is necessary to distinguish 2 kinds (variants ① and ②) of steering systems.

#### Variant ①

Steering systems with the **pressure relief valve arranged in the pump or in the pressure line between the pump and tool [1] (ZF Servotest power steering tester) (Fig. 26)**. This means that pressure relief takes place ahead of built-in tool [1]. On steering systems of this type the nameplate of the pump or of the pressure relief valve will indicate the maximum pressure, e.g. 130 bar.



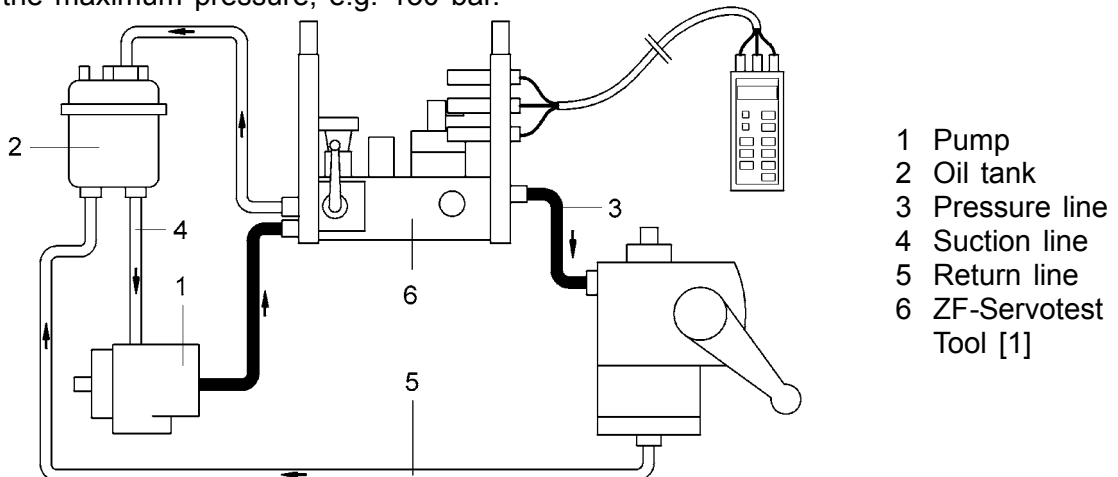
- 1 Pump
- 2 Oil tank
- 3 Pressure line
- 4 Suction line
- 5 Return line
- 6 ZF-Servotest Tool [1]
- 7 Pressure-relief valve

#### Variant ②

**Fig. 26**

Steering systems with the **pressure relief valve arranged in the steering gear or in the pressure line between tool [1] (ZF Servotest power steering tester) and the steering gear (Fig. 27)**.

On steering systems of this type the nameplate of the steering gear or of the pressure relief valve will indicate the maximum pressure, e.g. 130 bar.



- 1 Pump
- 2 Oil tank
- 3 Pressure line
- 4 Suction line
- 5 Return line
- 6 ZF-Servotest Tool [1]

<sup>1</sup> see vehicle manufacturer's instructions

**Fig. 27**

Fit tool [1] (ZF Servotest) to variants ① or ② in such a way that the readings can be seen from the driver's seat.

Check the oil level and bleed the steering system - see Chapter III.

Test conditions: oil temperature 50°C

## 1.6.2 Checking the maximum pressure of the ZF pump

Read the maximum permissible pressure from the nameplate of the steering gear/the pump or of the separately arranged pressure relief valve. Start the engine.

Set the pressure relief of tool [1] (ZF Servotest) to a value excluding any damages to the steering system during the tests described below.

### 1.6.2.1 For steering systems with pressure relief **ahead of** tool [1]: **Variant ①**

Have the engine run at idling speed.

Close the shut-off valve of tool [1] (ZF Servotest) and read the maximum pressure.



#### **Attention:**

Admit maximum pressure for a short time only (10 seconds maximum) to avoid an excessive heating-up of the inner parts of the pump and, in consequence, a premature wear of these parts.

Specified value: maximum pressure (see nameplate) +10 %

Open the shut-off valve again.

Wird der Sollwert nicht erreicht Pumpe ersetzen bzw. reparieren.

### 1.6.2.2 For steering systems with pressure relief **aft of** tool [1]: **Variant ②**



#### **Attention:**

If tool [1] is installed to variant ② make absolutely sure that during the entire period of pressure testing the engine is running at idling speed, only. An increase in engine speed would entail an immediate and sharp rise in system pressure which could cause a damage to the pressure line/the pump.

Have the engine run at idling speed.

While watching the pressure gauge of tool [1], slowly close the shut-off valve until the maximum pressure indicated is reached.

Do not close the shut-off valve any further. Admit maximum pressure for a short time only (maximum 10 seconds) to avoid an excessive heating of the inner parts of the pump.

Have the shut-off valve return to its initial position.

If maximum pressure is not reached during this measurement, the pump has to be replaced or repaired.

## 1.6.3 Checking the flow rate of the ZF pump

**Note:**

Specified values for flow rate, test pressure and test speed: see table below. Designations and operation of tool [1] (ZF Servotest power steering tester 6..): see separate operating instructions for ZF Servotest 6.. .

- **Checking the controlled flow rate**

Raise the engine speed until the pump flow rate remains constant despite a further increase in speed (approx. 1300 r.p.m.)

The pump is now in the flow setting range.

Specified value: see spare parts list

- **Checking the minimum flow rate**

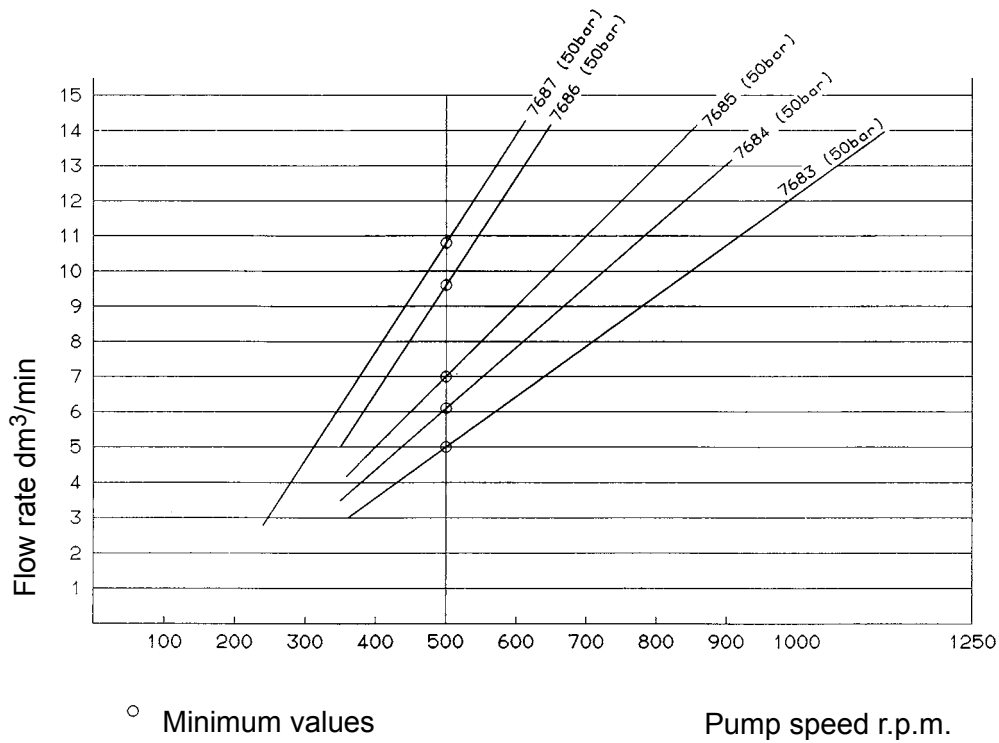
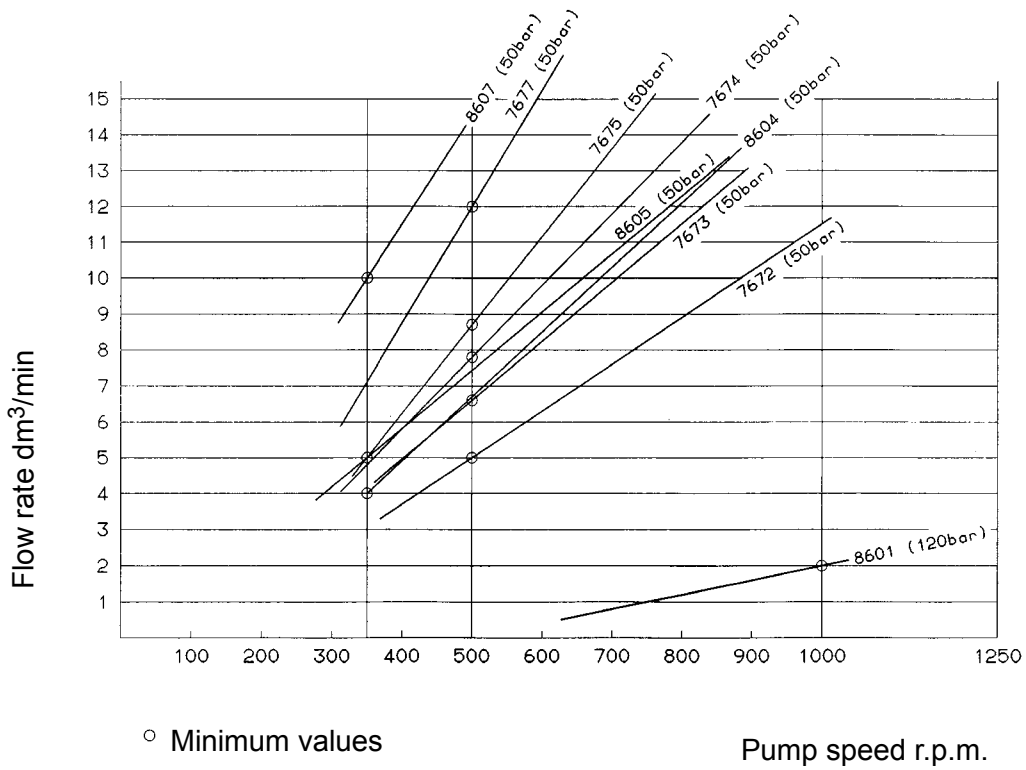
With the engine running at idling speed, progressively close the shut-off valve until the test pressure specified for the pump type in question is built up.

Read the flow rate.

Make sure the engine speed/pump speed ratio is correct.

Pump Type	Test Speed [r.p.m.]	Test Pressure [bar]	Minimum Flow Rate [dm <sup>3</sup> /min]
7672	500	50	5.0
7673	500	50	6.6
7674	500	50	7.8
7675	500	50	8.7
7677	500	50	12
7683	500	50	5.0
7684	500	50	6.1
7685	500	50	7.0
7686	500	50	9.6
7687	500	50	10.8
8601	1000	120	2.0
8604	350	50	4.0
8605	350	50	5.0
8607	350	50	5.0

Graphs see next page.



## 1.6.4 Checking the hydraulic steering limitation

### 1.6.4.1 Manually adjustable hydraulic steering limitation

- Vehicles with a rigid axle:  
Jack the steered axle up. <sup>1</sup>
- Vehicles with single-wheel suspension:  
Place the wheels of the steered axle on swivel plates.
- Rotate the steering wheel clockwise. When the axle stop and the lock stop, respectively, are reached, continue to rotate the steering wheel until a positive stop is reached.

In this position read the pressure at the pressure gauge:

Specified values: Steering systems	up to 16 dm <sup>3</sup> /min:	40...50 bar
	up to 20 dm <sup>3</sup> /min:	50...60 bar
	above 20 dm <sup>3</sup> /min:	70...80 bar

Repeat this test for the other direction of rotation.

Setting the steering limitation: see Chapter III., para. 5.

### 1.6.4.2 Automatically adjusting hydraulic steering limitation

Carry out the test as described in para. 1.6.4.1.

If there is no more space left at the lock stop components or if the oil pressure does not drop to the specified value, fit new screws (20) and (128), respectively, and reset the steering limitation as specified in Chapter III., para. 5.

Specified values: Steering systems	up to 16 dm <sup>3</sup> /min:	40...50 bar
	up to 20 dm <sup>3</sup> /min:	50...60 bar
	above 20 dm <sup>3</sup> /min:	70...80 bar

If there is too much space available at the lock stop components and if the oil pressure does not drop to the specified value, reset the steering limitation as specified in Chapter III., para. 5.

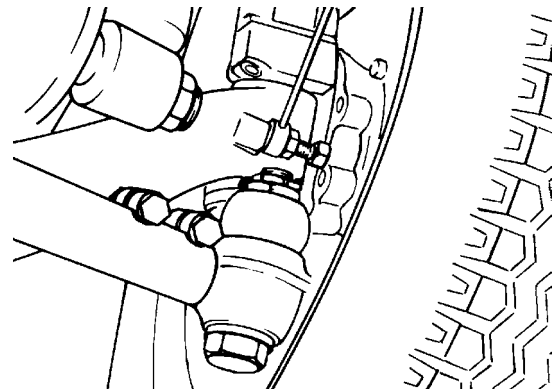
Repeat this test for the other direction of rotation.

<sup>1</sup> see vehicle manufacturer's instructions

## 1.6.5 Checking the maximum pressure and the leakage oil of the steering gear

### For steering systems with pressure relief ahead of tool [1]: Variant ①

Between the lock stops, insert tool [3] or approx. 15 mm thick thrust pads (**Fig. 28**) ensuring that the steering motion is stopped 1/2 to 3/4 steering wheel turn before reaching the axle stop/lock stop. The restriction of the steering motion must take place at tool [3] or at the said thrust pads and must not be done by the piston in the steering gear.



**Fig. 28**



### Attention:

A tool under pressure may be ejected - avoid any direct visual contact with the tool. Danger of accidents by squeezing.

Use the special tool specified by the vehicle manufacturer for the axle version in question.

At engine idling speed, rotate the steering wheel to the stop and continue to turn for abt. 5 seconds with an effort of 100...200 N at the steering wheel. Read the maximum pressure and the leakage oil.

Repeat this test in the opposite direction of rotation.

Maximum permissible leakage oil values:	Type 8090:	2.0 dm <sup>3</sup> /min
	Types 8095...8098:	2.5 dm <sup>3</sup> /min

Checking the leakage oil at a reduced flow rate:

Set tool [1] (ZF Servotest) 6.. to a flow rate which is 0.5 dm<sup>3</sup>/min higher than the maximum permissible leakage oil value.

Repeat the leakage oil test as described above. The leakage oil value measured in this repetition test must not exceed the value measured previously - see above.

Cause of insufficient maximum pressure/too much leakage oil:

- Pressure relief valve and/or replenishment valve defective.
- Pressure cut-off of steering limitation valve comes too early - refer to Chapter III., para. 5 for setting.
- Seals in the steering gear defective.

### For steering systems with pressure relief aft of tool [1]: Variant ②

The shut-off valve (4) must be closed completely and the throttle valve (5) must be closed progressively until a pressure is achieved that is 30 bar lower than maximum pressure. Re-open the shut-off valve (4).

Repeat this test as described above.

## 1.6.6 Checking the return to neutral of the valve

### Note:

Make sure the steering column has sufficient clearance (floor carpets, coverings).

By rotating the steering wheel, close the steering valve, thus causing maximum pressure to build up. Then rotate the steering wheel back until idle pressure is available. Next, raise the pressure to idle pressure +10 bar.

Release the steering wheel and watch the pressure which must drop to idle pressure (at maximum 0.5 bar higher) within 1 second.

Example: Idle pressure: 4.0 bar Maximum permissible value: 4.5 bar



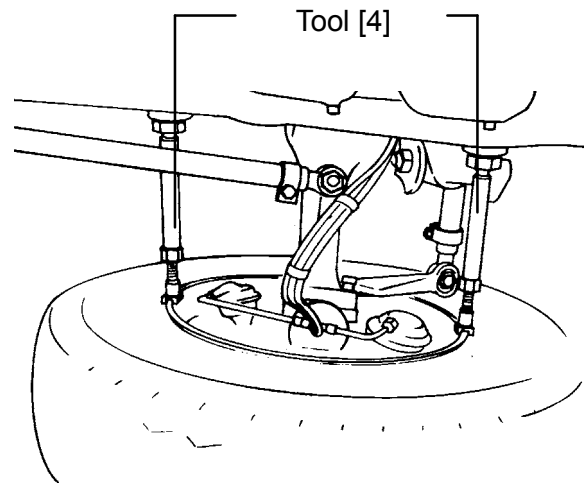
## 1.6.7 Checking the steering gear play

Prerequisite for the test described below:

The transmission parts between the steering wheel and the road wheel must be free from play.

- Versions with leaf spring:

Lock the LH front wheel (the RH front wheel if the vehicle is RH steered) in the straight ahead driving position by fitting tool [4] between the wheel rim (rear and front) and the front spring (**Fig. 29**).



**Fig. 29**

### Attention:

Do not exert any pressures in excess of those mentioned below on the tools and the wheel rim in order to avoid damages to the wheel rim.

- Versions with single-wheel suspension:

Lock the LH front wheel (the RH front wheel if the vehicle is RH steered) as per vehicle manufacturer's instructions.

- Put tool [2] on the steering wheel and attach the pointer to the dashboard or to the wind-screen (**Fig. 30**).

Raise the engine speed to approx. 1000 r.p.m..

Read the idle pressure at tool [1] (ZF Servotest/pressure gauge).

Rotate the steering wheel to the left until a pressure of 1 bar above idle pressure is indicated.

On tool [2] read the dial value.

Rotate the steering wheel to the right until a pressure of 1 bar above idle pressure is indicated.

On tool [2] read the dial value.

Calculate the total travel covered.

Specified value: max. 50 mm (steering wheel Ø 500 mm)

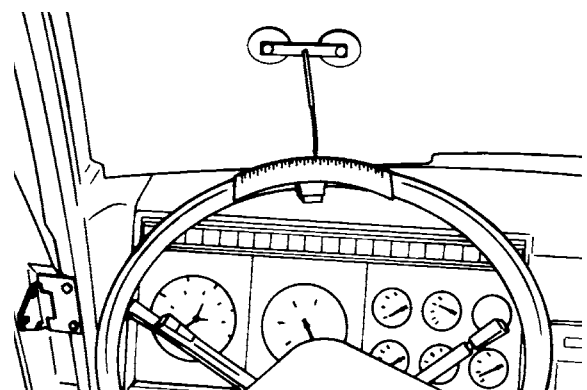
For versions with bevel box:

Specified value: max. 55 mm (steering wheel Ø 500 mm)

If the maximum value is exceeded, check the play of the steering column and, if required, repair or replace the steering gear.

Remove tool [1] (ZF Servotest)/the pressure gauge.

Check the oil level and bleed the steering system - see Chapter III.



**Fig. 30**

## 2 Troubleshooting aid

Fault	Cause	Remedial action
Noise	Air in the oil Oil level too low	Bleed steering system <sup>3</sup> Top up with oil
	Pump defective	Repair <sup>2</sup> Replace <sup>2</sup>
Stiff operation to either side	Oil level too low	Repair leakage Top up with oil <sup>3</sup>
	Steering system is sucking in air (Suction area)	Repair leakage Top up with oil <sup>3</sup> Bleed steering system <sup>4</sup>
	Universal joints/steering column Stiff operation	Check Replace <sup>1</sup>
	Oil filter soiled	Replace <sup>3</sup>
	Steering gear defective	Repair <sup>2</sup> Replace <sup>2</sup>
	Pump defective	Repair <sup>2</sup> Replace <sup>2</sup>
Stiff operation in one direction	Incorrect setting of steering limitation	Set <sup>3</sup>
	Steering gear defective	Repair <sup>2</sup> Replace
Stiff operation during fast steering motion	Steering system is sucking in air (Suction area)	Repair leakage Top up with oil Bleed steering system <sup>3</sup>
	Pump defective or wrong version	Replace pump <sup>2</sup>

<sup>1</sup> see vehicle manufacturer's instructions

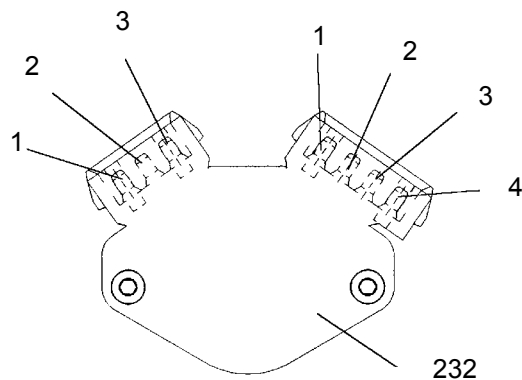
<sup>2</sup> approach ZF Service Centre

<sup>3</sup> see Chapter III.

Fault	Cause	Remedial action
Self-centring hampered	Stiff operation of axle/ axle guide components	Repair [1]
	Steering gear/steering column fitted in twisted position	Eliminate twisting [1]
	Stiff operation of steering column	Eliminate stiff operation [1]
	Steering gear defective	Repair [2] Replace [2]
Exact straight ahead driving impossible	Oil level too low	Repair leakage Top up with oil [3] Bleed steering system [3]
	Axle/axle guide components/ steering column not play-free	Check [1] Replace [1]
	Steering gear not play-free	Check [3] Replace [2]

Additionally, for versions with potentiometer (232):

Pin assign-  
ment at poten-  
tiometer and  
plug, respec-  
tively (vehicle  
electrical sys-  
tem)



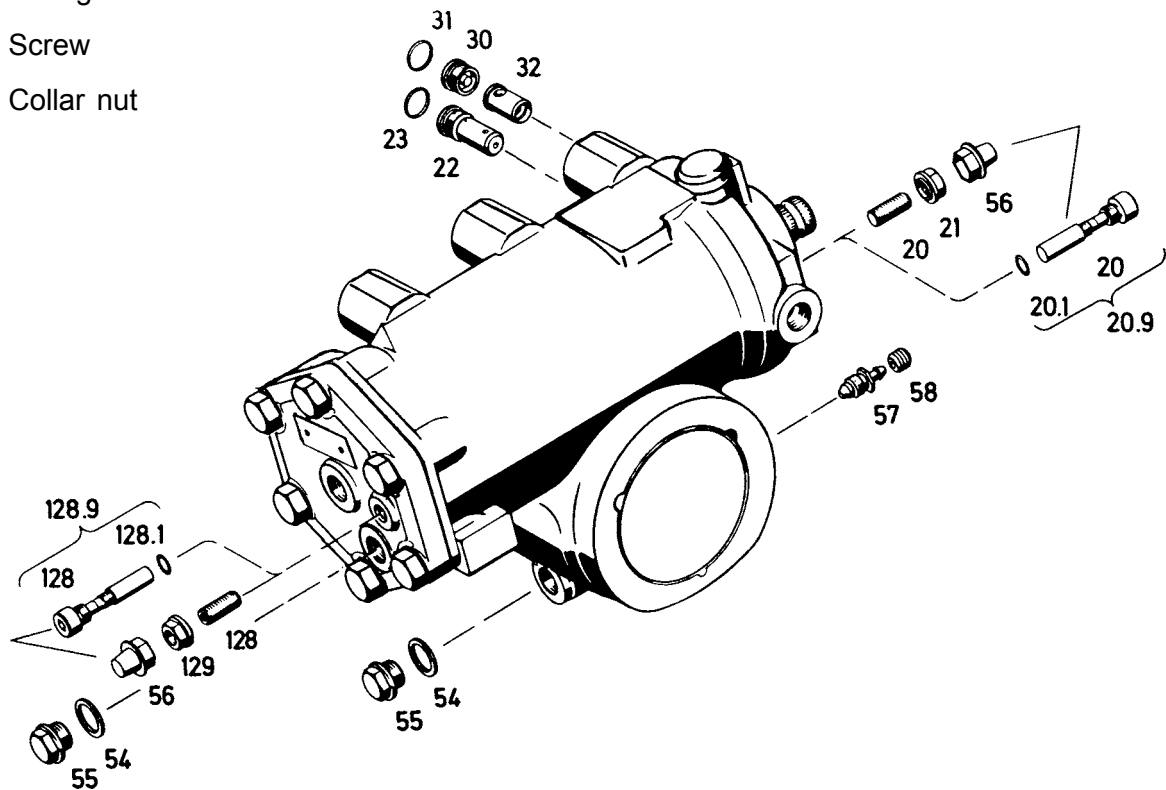
Potentiometer (232) does not work	No operating voltage	At plug (vehicle electrical sys- tem) measure between pins 1-3 Specified value: operating volt- age [1]
	Contact problems	Remove dirt and/or corrosion

Fault	Cause	Remedial action
	Internal malfunction	Check potentiometer (see below)
	No tripping of potentiometer (232)	Replace steering gear <sup>2</sup>
Wrong operation of potentiometer (232)	Wrong setting	Set potentiometer <sup>4</sup>
	Wrong cabling	Check cabling <sup>4</sup>
	Cap screws (223 and 235) loose	Check and tighten <sup>4</sup>
	Potentiometer (232) mounted incorrectly	Check <sup>4</sup>

- <sup>1</sup> see vehicle manufacturer's instructions
- <sup>2</sup> approach ZF Service Centre
- <sup>3</sup> see Chapter III.
- <sup>4</sup> see Chapter V.

## IX. Key to numbers in figures and exploded drawing

- 20 Set screw/screw
- 20.1 O ring
- 20.9 Screw
- 21 Collar nut
- 22 Valve insert
- 23 O ring
- 30 Screw
- 31 O ring
- 32 Valve insert
- 54 Sealing ring
- 55 Screw plug
- 57 Bleeder
- 128 Set screw/screw
- 128.1 O ring
- 128.9 Screw
- 129 Collar nut



# Maintenance Report for ZF Servocom Steering Gears

Original for duplicating



Customer: ..... Steering gear version: .....

Vehicle manufacturer: ..... Pump manufacturer: .....

Vehicle type (or model): ..... Pump version: .....

Mileage: ..... Emergency steering pump: .....

**1 Test drive carried out**  yes  no

Complaints: .....

**2 Tested or checked for external leakproofness / damages**  yes  no

Complaints: .....

**3 Oil level checked**  yes  no

Remarks: .....  
.....

Checked by (name): .....

Date: .....

# Inspection Report for ZF Servocom Steering Gears

Original for duplicating



Customer: ..... Steering gear version: .....

Vehicle manufacturer: ..... Pump manufacturer: .....

Vehicle type (or model): ..... Pump version: .....

Mileage: ..... Emergency steering pump: .....

## 1 Inspection intervals (see Chapter III.)

2 Test drive carried out  yes  no

Complaints: .....

3 Visual inspection carried out  yes  no

Complaints: .....

4 Oil filter replaced  yes  no

5 Steering gear play checked  yes  no

Specified value: Measured value: ..... mm

max. 50 mm

max. 55 mm (for versions with bevel box)

6 Safety inspection (SP) checks carried out  yes  no

Remarks: .....

Checked by (name): .....

Date: .....





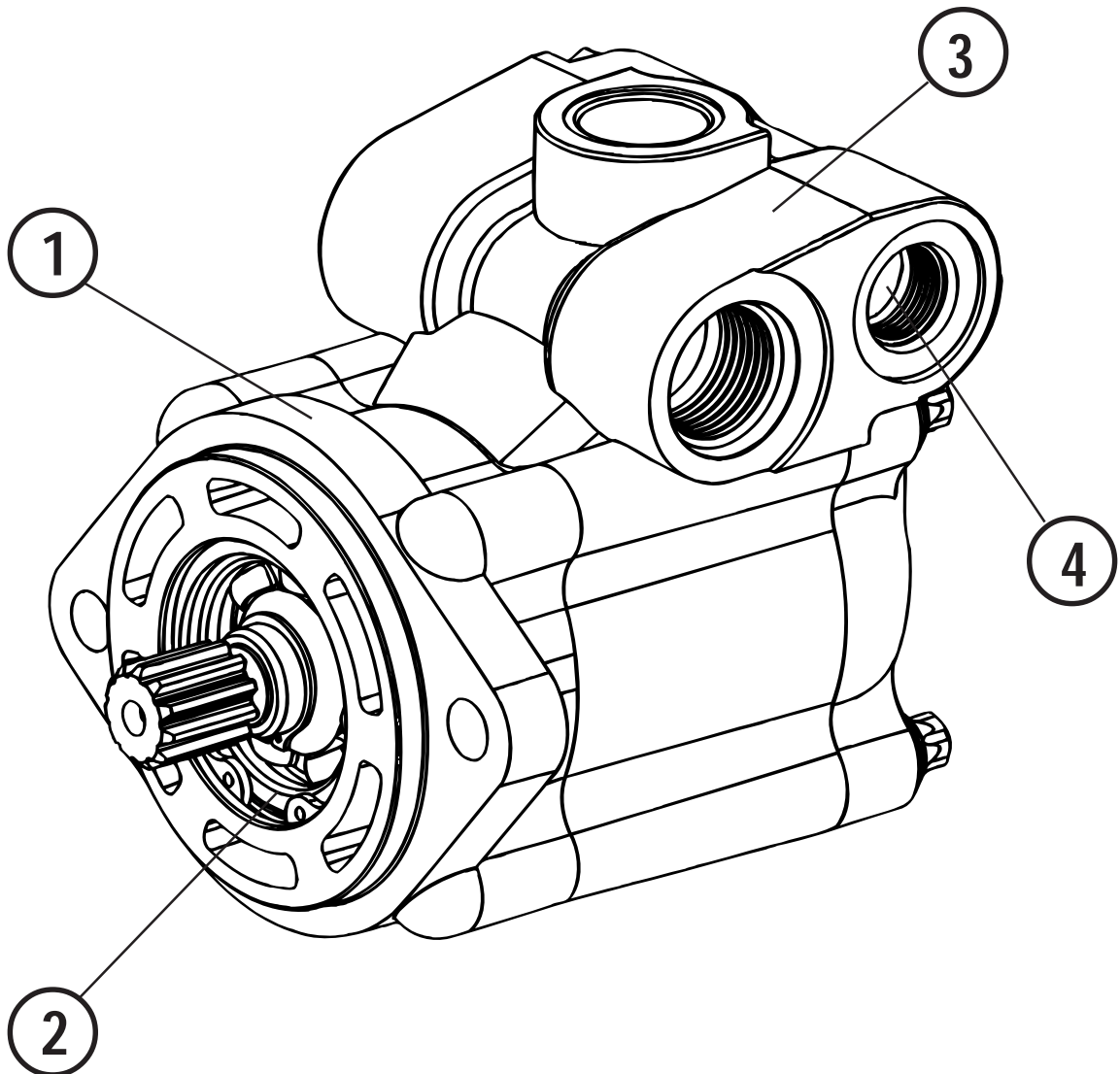
# Power Steering Pump Service Manual

PS SERIES





# Design Features

- ① Cover rotatable in 90 degree increments
  - ② Heavy duty bearing package
  - ③ Lightweight aluminum housing (overall weight approx. 7.2 lbs.)
  - ④ Flow control valve compatible with TAS steering gear
- Made in the USA
  - Three inlet port locations
  - Two outlet port locations
  - Three displacements available in a single housing size
  - Only two housing castings needed
  - Short pump overall length
  - Seals are all high temperature capable (not to exceed 250° F.)



# Hazard Warning Definitions

 <b>WARNING</b>	A warning describes hazards or unsafe practices which could result in severe personal injury or death.
 <b>CAUTION</b>	A caution describes hazards or unsafe practices which could result in personal injury or product or property damage.
<b>NOTE</b>	A note gives key information to make following a procedure easier or quicker.

## Disclaimer

This Service Manual has been prepared by TRW Commercial Steering Division for reference and use by mechanics who have been trained to repair and service steering components and systems on heavy commercial vehicles. TRW Commercial Steering Division has exercised reasonable care and diligence to present accurate, clear and complete information and instructions regarding the TRW Commercial Steering PS Series Power Steering Pumps. Since this is a general Service Manual, the photographs and illustrations may not look exactly like the pump being serviced. The procedures, therefore, must be carefully read and understood before servicing.

If inspection or testing reveals evidence of abnormal wear or damage to the PS pump or if you encounter circumstances not covered in the Manual, STOP - CONSULT THE VEHICLE MANUFACTURER'S SERVICE MANUAL AND WARRANTY. DO NOT TRY TO REPAIR OR SERVICE A PS POWER STEERING PUMP WHICH HAS BEEN DAMAGED OR INCLUDES ANY PART THAT SHOWS EXCESSIVE WEAR UNLESS THE DAMAGED AND WORN PARTS ARE REPLACED WITH ORIGINAL TRW REPLACEMENT AND SERVICE PARTS AND THE UNIT IS RESTORED TO TRW'S SPECIFICATIONS FOR THE PS POWER STEERING PUMP.


It is the responsibility of the mechanic performing the maintenance, repairs or service on a particular PS power steering pump to (a) inspect the pump for abnormal wear and damage, (b) choose a repair procedure which will not endanger his/her safety, the safety of others, the vehicle, or the safe operation of the vehicle, and (c) fully inspect and test the PS pump and the vehicle steering system to ensure that the repair or service of the pump has been properly performed and that the pump and system will function properly.

## Patents

TRW Commercial Steering Division PS Power Steering Pumps are covered by several United States and foreign patents, either issued or pending.

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 <b>WARNING</b>	All steering mechanisms are safety critical items. As such, it is imperative that the instructions in this booklet be followed to the letter. Failure to observe the procedures set forth in this pamphlet may result in a loss of steering.
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## Section 1

## General Information

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# Introduction

The three-column format used in the Service Manual will help make it easy for you to service a power steering pump. Column 1 illustrates the procedure with photographs, column 2 gives a brief key as well as tools to be used for each procedure, and column 3 explains in detail the procedure you should follow. **Pay special attention to the notes, cautions and warnings.**

The exploded view is on a fold-out page so you can see it while reading through the procedures. Item numbers on the exploded view correspond with item numbers used throughout the Service Manual.

As you gain experience in servicing PS power steering pumps, you may find that some information in this Service Manual could be clearer and more complete. If so, let us know about it. Don't try to second-guess the Service Manual; if you do not understand a procedure, or are stuck, contact our Field Service Department at 1-800-TRW-0899. Servicing PS power steering pumps should be safe and productive.

# General Design

## Description of the TRW Commercial Steering Division Power Steering Pump

The PS power steering pump is a balanced, positive displacement, sliding vane type, two line pump with an internal pilot operated flow control and relief valve. The components of this description are broken down and explained below:

### Balanced

The pumping element has two pumping pockets opposed 180° from each other which balance the internal forces due to the pressure generated by the pumping action.

### Positive Displacement

The pump will output a fixed volume for each revolution of the input shaft. This fixed volume is determined by the internal contour of the cam ring.

### Sliding Vane Type

This describes the type of pumping element. The PS pumping element consists of three components.

- 1 The rotor that holds the vanes and is driven by the engine with the pump input shaft.
- 2 The vanes that slide back and forth in slots in the rotor while following the internal contour of the cam ring as the rotor is being turned, thus a sliding vane.

- 3 The cam ring that contains the internal contour that defines the amount of fluid that is output with each revolution of the rotor.

### Two Line

The PS pump requires an inlet line to supply oil to the pump and an outlet line to take the oil supplied by the pump to the steering gear. All excess, (bypass), oil is diverted internally in the pump housing back to the inlet of the pumping element. Other systems may have a third line which takes this excess oil back to the reservoir.

### Internal Flow Control Valve

The pump has a pilot operated valve built into the pump housing that will control the amount of oil that is output to the steering gear. This allows the output flow to remain within specification for almost any input speed variation.

### Relief Valve

The pump has a pilot operated relief valve built into the flow control valve spool which will limit the maximum pressure the pump can produce. When the pressure limit has been reached, the relief section will cause the flow control to bypass more oil internal to the pump, limiting the outlet pressure.

# General Operation

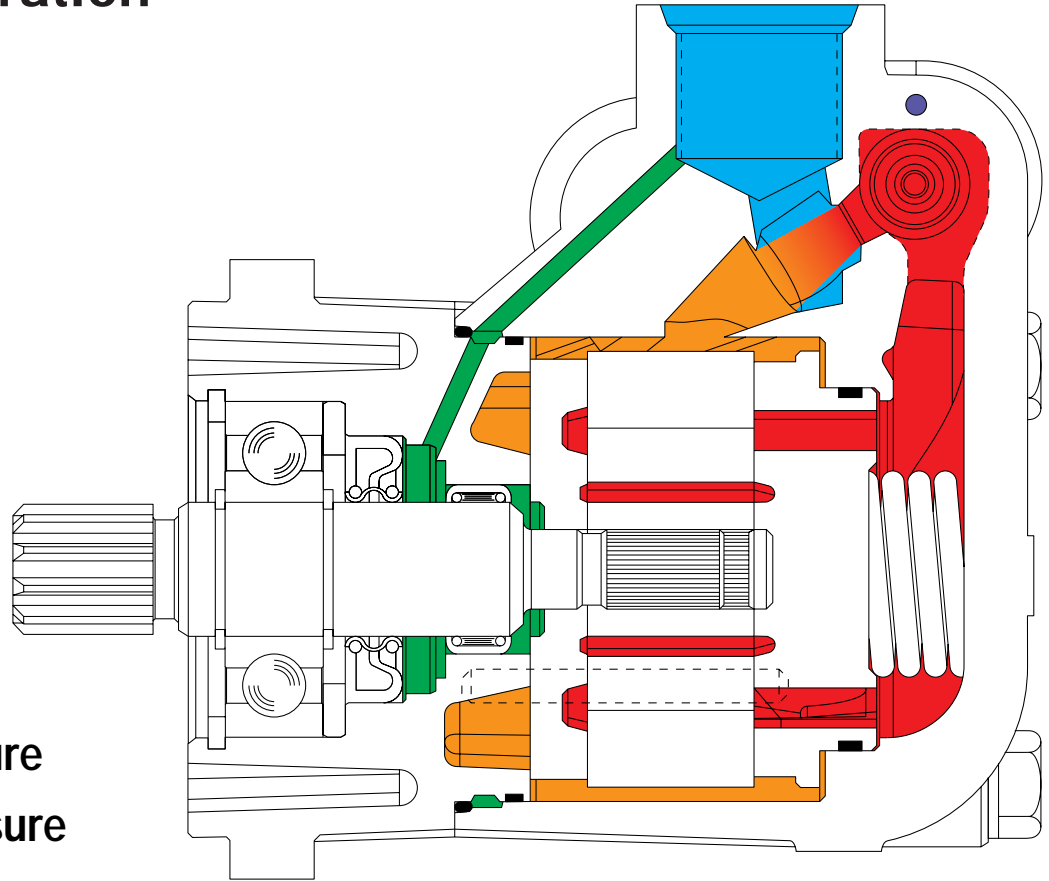
## What is a Power Steering Pump?

The pump is the heart of the hydraulic steering system. It converts the rotational energy supplied by the engine into hydraulic energy, flow and pressure, for use by the steering gear.

## Theory of Operation

All pumps function by creating a partial vacuum at the inlet, which causes atmospheric pressure to force fluid into the pump from the reservoir. The pump then pushes this fluid into the system for use. The fluid is used to power the steering gear. Pump output flow relates to steering gear speed and pump output pressure relates to steering gear force (work).

# Oil Flow Illustration



- Inlet Pressure
- Boost Pressure
- Outlet Pressure
- Seal Drain
- Pilot Pressure

## Approved Hydraulic Fluids

Automatic Transmission Fluid Dexron II  
Automatic Transmission Fluid Type "E" or "F"  
Chevron 10W-40  
Chevron Custom 10W-40 Motor Oil  
Chevron Torque 5 Fluid  
Exxon Nuto H32 Hydraulic Fluid  
Fleetrite PSF (Can #990625C2)  
Ford Spec. M2C138CJ

Mack EO-K2 Engine Oil  
Mobil ATF 210  
Mobil Super 10W-40 Motor Oil  
Texaco 10W-40  
Texaco TL-1833 Power Steering Fluid  
Union 10W-40  
Union 15W-40  
Unocal Guardon 15W-40 Motor Oil

The steering system should be kept filled with one of the above fluids.

**⚠ WARNING** Completely flush the steering system with one of the recommended fluids above only. Do not mix oil types. Any mixture or any unapproved oil could lead to seal deterioration and leaks. A leak could ultimately cause the loss of fluid, which could result in a loss of power steering assist.

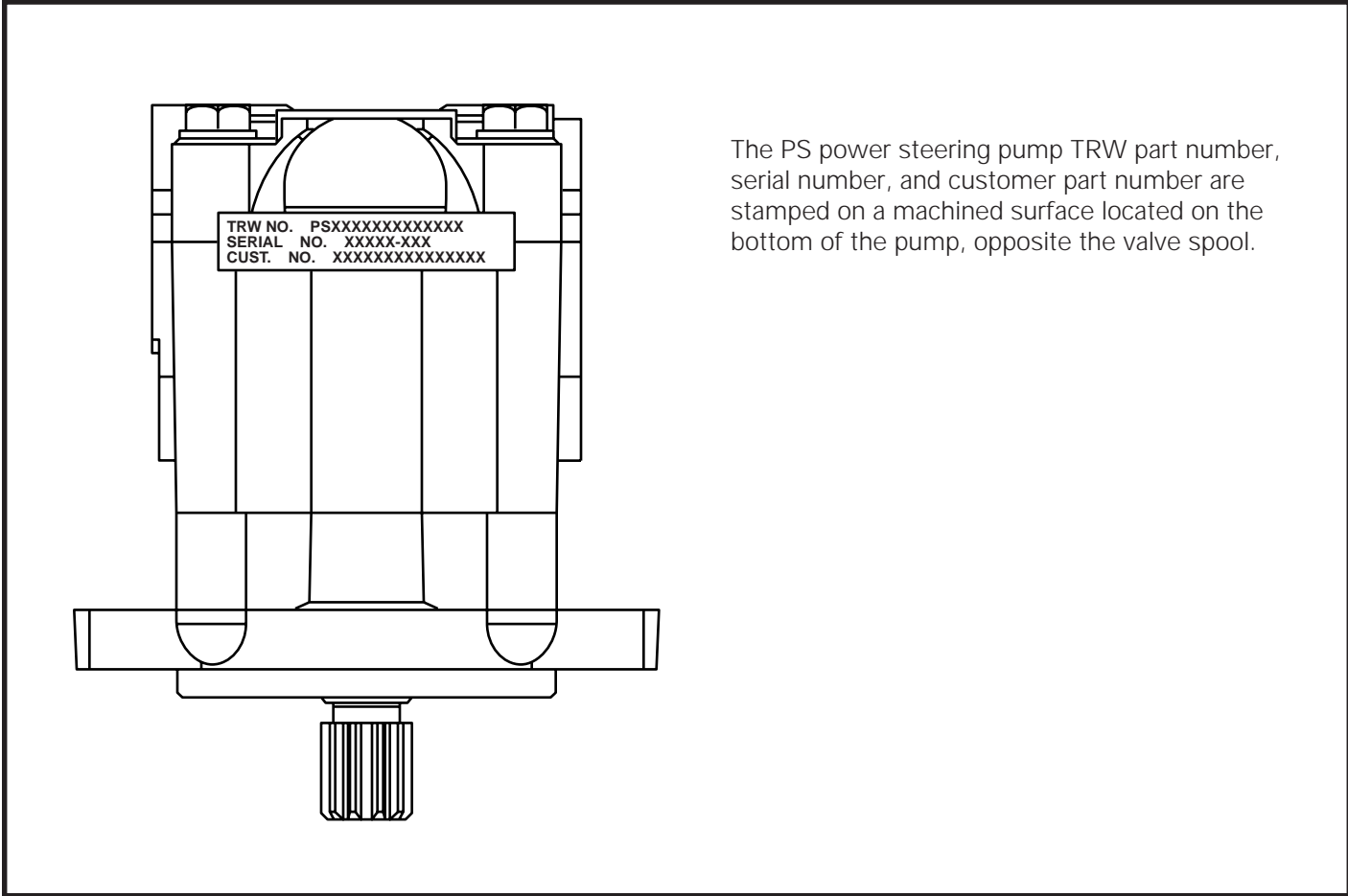


# Torque Chart

Part Name	Item #	Torque Range Dry	Torque Range Lubricated
Bolts (4)	4	20-30 lbf•ft (27-41 N•M)	15-25 lbf•ft (20-34 N•M)
Relief valve seat assembly	6E	7-15 lbf•ft (9-20 N•M)	
Plug	9		
Pressure port (outlet)		37 lbf•ft maximum (50 N•M)	
Suction port (inlet)		74 lbf•ft maximum (100 N•M)	

Item numbers referenced are shown on the exploded view, pages 7A & 7B.

# Specification Numbers

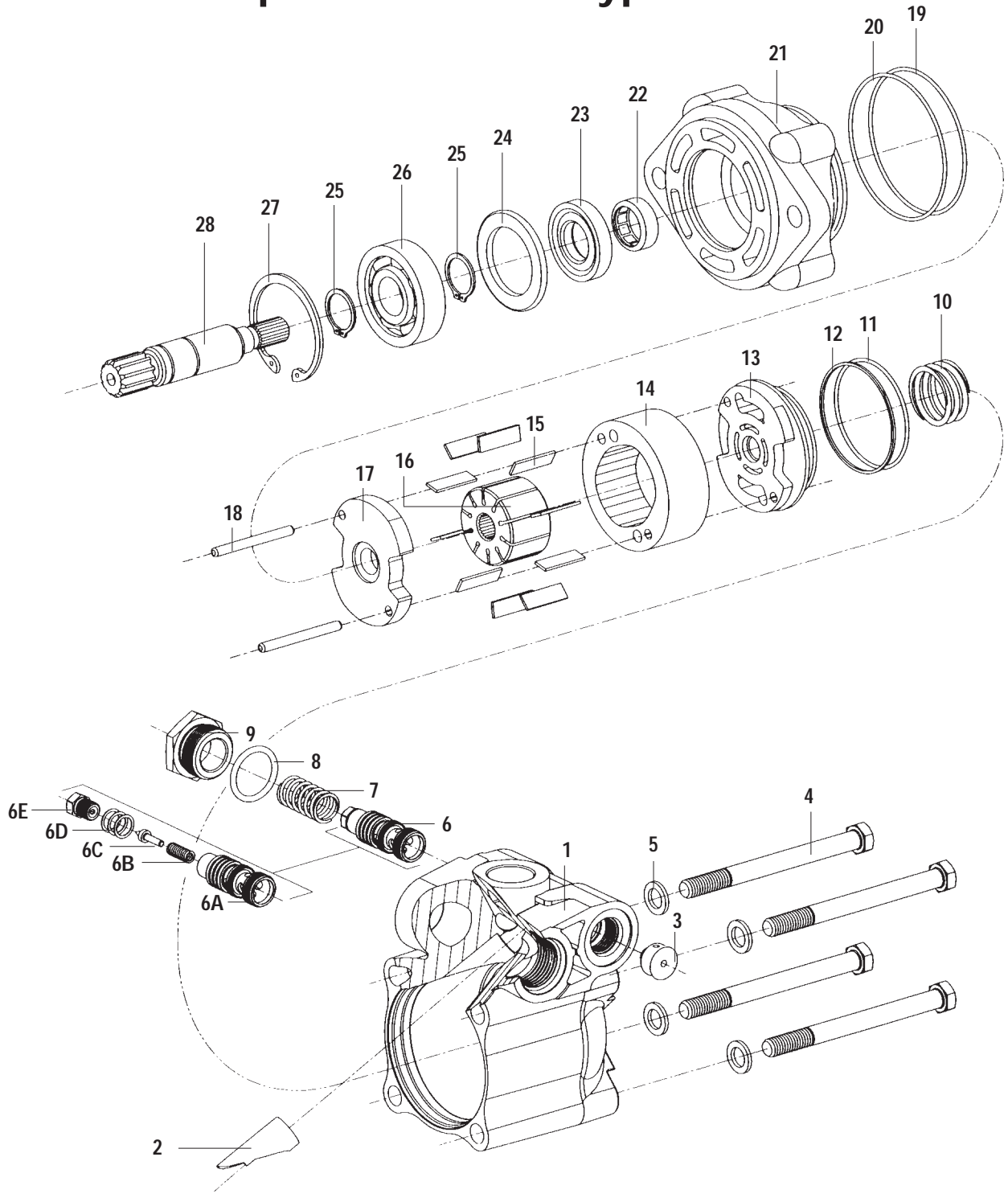


The PS power steering pump TRW part number, serial number, and customer part number are stamped on a machined surface located on the bottom of the pump, opposite the valve spool.

# Service Parts List

<u>Item</u>	<u>Description</u>	<u>Part Number</u>
28	Input shaft (11 tooth)	086128
28	Input shaft (woodruff key)	086129
Seal Kit (includes following parts)		SK000131
8	O-ring	032845
11	O-ring	032844
12	Backup ring	032846
19	O-ring	032843
20	O-ring	032842
23	Shaft seal	032847
	Shaft seal grease	

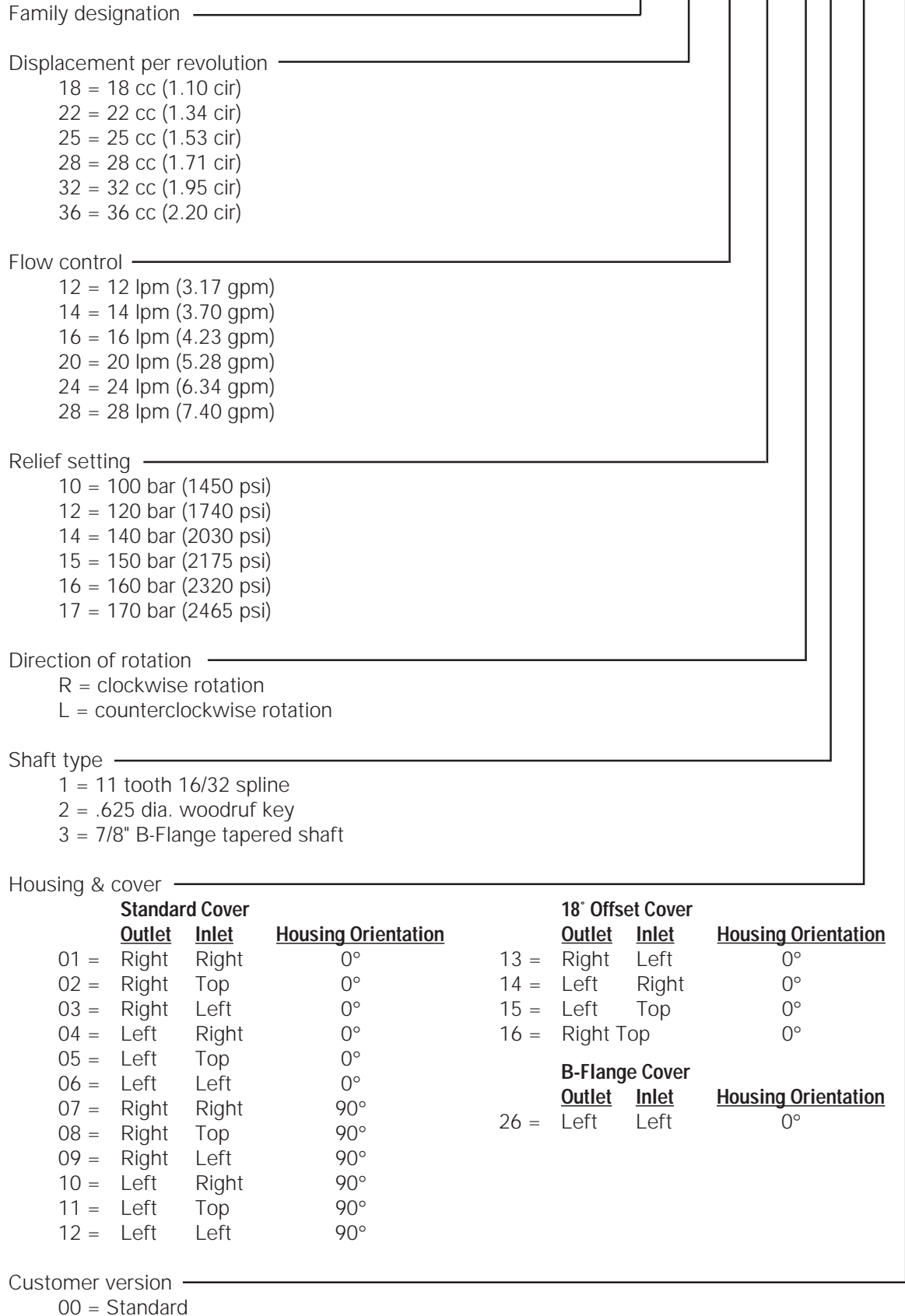
# PS Series Exploded View -- Typical



- |    |                            |    |              |    |                    |
|----|----------------------------|----|--------------|----|--------------------|
| 1  | Housing                    | 7  | Spring       | 18 | Locating pins      |
| 2  | Boost tube                 | 8  | O-ring       | 19 | O-ring             |
| 3  | Orifice                    | 9  | Plug         | 20 | O-ring             |
| 4  | Bolts                      | 10 | Spring       | 21 | Cover              |
| 5  | Washers                    | 11 | O-ring       | 22 | Needle bearing     |
| 6  | Valve spool assembly       | 12 | Backup ring  | 23 | Shaft seal         |
| 6A | Spool                      | 13 | Top plate    | 24 | Spacer             |
| 6B | Spring                     | 14 | Cam ring     | 25 | Retaining ring (2) |
| 6C | Poppet                     | 15 | Vanes        | 26 | Ball bearing       |
| 6D | Shims                      | 16 | Rotor        | 27 | Retaining ring     |
| 6E | Relief valve seat assembly | 17 | Bottom plate | 28 | Input shaft        |

# Part Number

**PS 18 12 15 R 1 01 00**



**Section 2**

**Initial Installation**

Installation ..... 14

Maintenance Tips ..... 15

# Initial PS Installation

1. Install fittings to input and output ports, if fittings for this application can be preinstalled.
2. Install a gear on the input shaft, if required for this application.
3. Install the retaining nut, if required for this application, and torque to the manufacturer's specification.
4. Position either a gasket or o-ring, dependent on the application, which will seal the pump face to the mounting surface.
5. Engage the input shaft.
6. Tighten the mounting bolts to manufacturer's specifications.
7. Connect the input and output lines.
8. Fill the reservoir.
9. Start the vehicle to purge the system.
10. Turn off the vehicle and check the fluid level in the reservoir. Add fluid as necessary.
11. Bleed the system if necessary using instructions on page 36.

# Maintenance Tips

**Never high-pressure wash or steam clean a power steering pump while off the vehicle. Doing so could force contaminants inside the pump and cause it to malfunction.**

Always **clean off around the reservoir filler cap** before you remove it. Prevent dirt or other foreign matter from entering the hydraulic system.

**Regularly check the fluid** and the fluid level in the power steering reservoir.

**Investigate and correct any external leaks**, no matter how minor.

**Encourage drivers to report any malfunctions or accidents** which could have damaged steering components.

**Replace reservoir filters** according to requirements.

**Do not attempt to weld any broken steering component.** Replace the component with original equipment only.

If you feel the vehicle is developing excessively **high hydraulic fluid temperatures**, consult with your vehicle manufacturer for recommendations.

**Do not cold-straighten, hot straighten, or bend any steering system component.**

## Section 3

## Reseal & Repair

Disassembly .....	17
Inspection .....	23
Assembly .....	25
Internal Damage Repair (by reference)	
Input Shaft Replacement .....	31
Needle Bearing Removal .....	32



# Disassembly Preparation


Stop the vehicle with wheels pointed straight ahead.

Clean off all outside dirt from around fittings and hose connections before you remove the pump.


Remove the pump from the vehicle and take it to a clean work surface.

Clean and dry the pump before you start to disassemble it.

As you disassemble the pump, clean all parts in clean, OSHA approved solvent, and air blow-dry them only.

 <b>WARNING</b>	Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.
--	---

 <b>WARNING</b>	Wear eye protection and be sure to comply with OSHA or other maximum air pressure requirements.
--	---

 <b>CAUTION</b>	Never steam clean or high-pressure wash hydraulic steering components. Do not force or abuse closely fitted parts. Use care that bearing and sealing surfaces are not damaged by the assembly and disassembly procedures.
--	---

Keep each part separate to avoid nicks and burrs.

# Disassembly

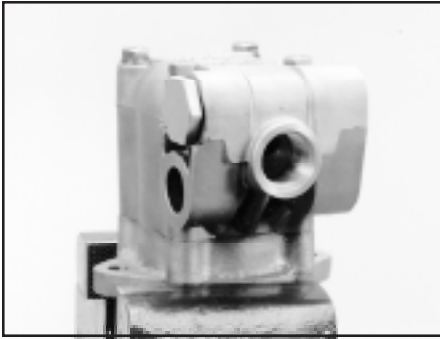
## Tools Required

Hammer  
Press  
Ratchet  
Retaining Ring Pliers  
Screwdriver  
Sockets: 1 1/4", 9/16", 7/16"

Vise

## Materials Required

Marker, solvent-proof  
Small Rod (1/8" dia. or less)



**Position pump in vise**

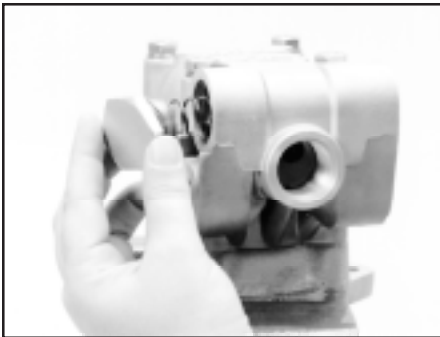
Vise

1. Place the pump in a vise, clamping firmly on the cover. Do not deform the cover with excessive clamping force.



**CAUTION**

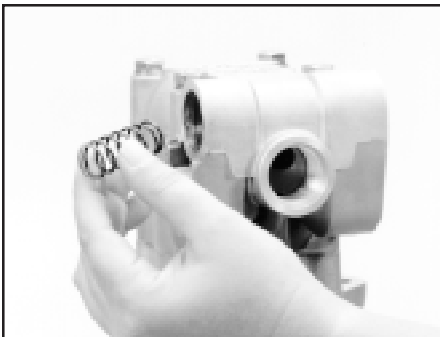
**Clamp on the cover only. Clamping on the housing may cause damage requiring pump replacement.**



**Remove plug**

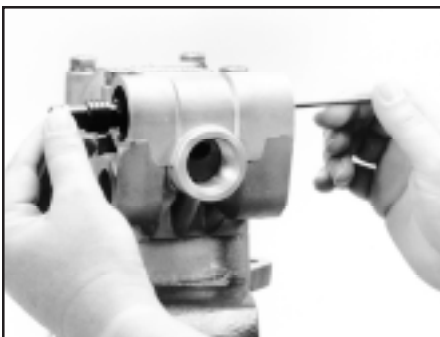
1 1/4" Socket

2. Prepare for fluid drainage and remove the hydraulic plug (9) and o-ring (8). Discard the o-ring.



**Remove spring**

3. Remove the spring (7), if it didn't come out with the plug.

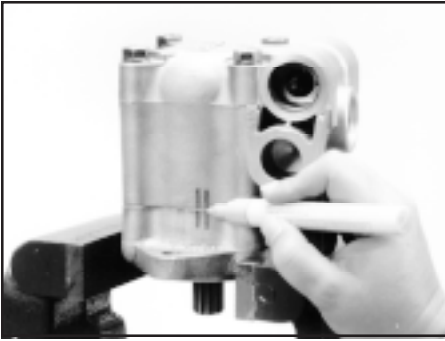


**Remove valve spool assembly**

Small rod, 1/8" dia. or less

4. Remove the valve spool assembly (6) by hand, or by pushing with a small rod through the orifice (3) on the opposite end of the spool cavity. Don't push on the small screen located in the relief valve seat assembly (6E).

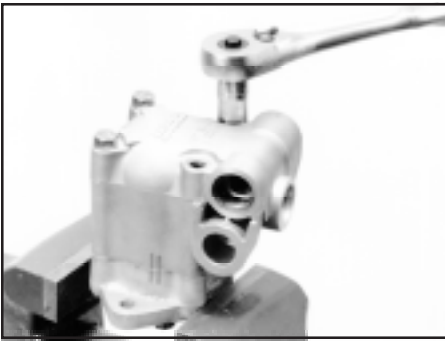
Note whether or not the valve spool assembly slides freely in the housing.



**Mark cover orientation**

Marker, solvent proof

5. Make a mark across the housing (1) and cover (21) to make reassembly easier.



**Remove bolts**

9/16" Socket

6. Prepare for fluid drainage and remove 4 bolts (4), and washers (5).



**Remove housing**

7. Separate the housing (1) from the cover (21) using a twisting motion.

**CAUTION**

Wear eye protection. The spring (10) will make the housing jump, and may fly out. Make sure you hold the housing tightly when removing.



**Remove spring**

8. Remove the spring (10).



**Mark internal components**

Marker, solvent proof

9. Make a line across remaining internal components to make reassembly easier.



**Remove top plate, O-ring and backup ring**

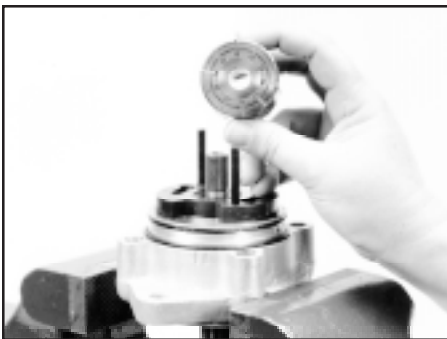
10. Hold the cam ring (14) in place, and remove the top plate (13).

Remove the o-ring (11) and Teflon backup ring (12) from the top plate. Discard the o-ring and Teflon backup ring.



**Remove cam ring, locate dots**

11. Hold the bottom plate (17) in place, and remove the cam ring (14). Note and record whether the dots near the locating pin holes on the cam ring are up or down.



**Remove rotor and vanes**

12. Look for wear on the outside (radiused) edge of the vanes. Note and record the direction of the wear for reinstallation. Remove the rotor (16) and vanes (15) carefully, being prepared for the vanes to slip from their slots in the rotor.



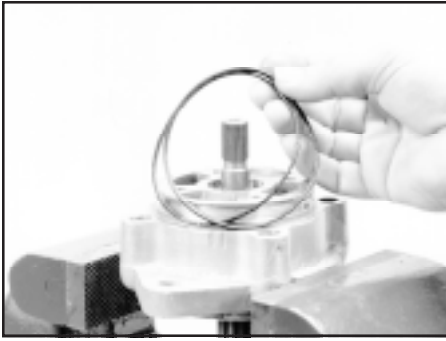
**Remove locating pins**

13. Remove the locating pins (18). Make marks on the outside of the cover (not on the sealing surface) to remind you from which holes the locating pins were removed.



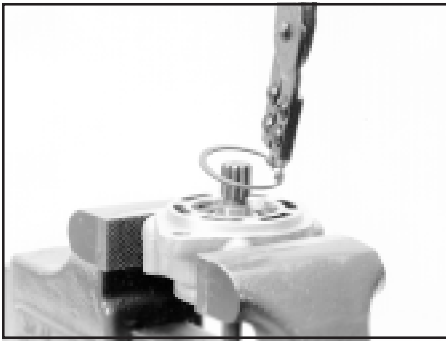
**Remove bottom plate**

14. Remove the bottom plate (17).



**Remove o-rings**

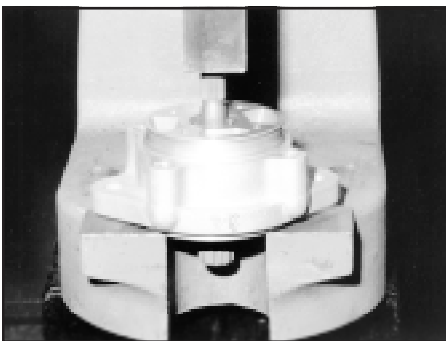
15. Remove o-rings (19 & 20) from the cover, and discard the o-rings.



**Remove retaining ring**

Retaining ring pliers

16. Turn the cover over and remove the large retaining ring (27). Don't deform the cover with excessive clamping force.



**Press out shaft & bearing**

Press

17. Press out the input shaft (28) and ball bearing assembly (26).



**Inspect input shaft/ ball bearing subassembly**

18. Check the input shaft (28) for damaged splines and unusual wear around the shaft seal area. Check retaining rings (25) for damage. The ball bearing (26) should exhibit free-rolling operation. If replacement is required, go to **Input Shaft Replacement** section on page 31. Otherwise, proceed to step 19.

**NOTE**

TRW recommends the ball bearing not be removed from the input shaft unless replacement of shaft is necessary.



**Remove spacer**

19. Remove the spacer (24) from the cover.



**Remove shaft seal**

Hammer  
Screwdriver

20. Remove the shaft seal (23) being careful not to damage the bore. Discard the shaft seal.

**CAUTION** Damage to the bore could cause leakage.



**Inspect needle bearing**

21. Make sure all needles roll freely in the needle bearing (22). If removal is necessary, go to **Needle Bearing Removal** section on page 32. Otherwise, proceed to step 22.

**NOTE** TRW recommends the needle bearing not be removed from the cover.



**Remove relief valve seat assembly**

22. Remove the relief valve seat assembly (6E) from the valve spool assembly (6) by placing the spool in a collet if necessary.

**CAUTION** Take care not to deform the spool nor make nicks or burrs on the surface. If the spool is damaged, both the spool and housing must be replaced.



**Remove spool assembly components**

7/16" Socket

23. Remove the shims (6D) (make sure to count them), poppet (6C) and spring (6B) from the spool (6A).

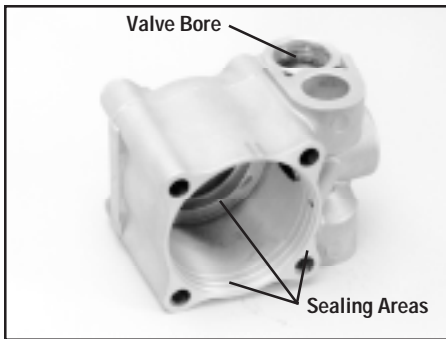
# Inspection

Make sure all sealing surfaces and seal cavities are free from nicks and corrosion. Any nicked or corroded surface requires part replacement to ensure proper sealing.

Wash all parts in clean, OSHA approved solvent. Air blow them dry only.

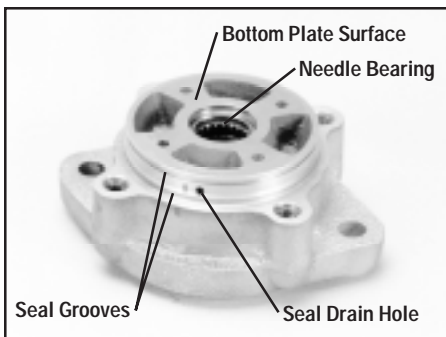
**⚠ WARNING** Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.

**⚠ WARNING** Wear eye protection and be sure to comply with OSHA or other maximum air pressure requirements.



## Inspect housing

1. Inspect the housing (1) for cracks, stripped threads, damaged valve bore and damaged sealing areas.



## Inspect cover

2. Inspect the cover (21) for nicks in o-ring seal grooves. Make sure the seal drain hole is open, and the seal bore is free of nicks and other damage.

Make sure the surface on which the bottom plate rests is flat and free of nicks and other damage.

Make sure all needles roll freely in the needle bearing (22).



## Inspect top plate

3. Inspect the top plate (13) for seal area nicks, and abnormal wear or erosion. A polished pattern from the rotor and vanes is normal, grooves you can feel with your fingernail are not normal.



## Inspect cam ring

4. Look for obvious damage on the inside of the cam ring (14) like abnormal wear, erosion or surface imperfections.



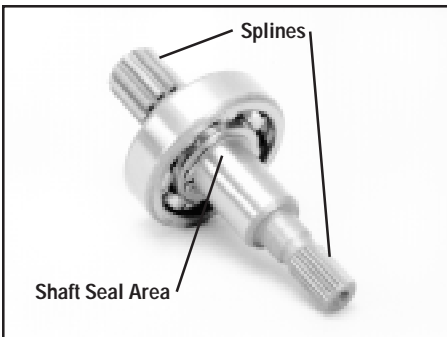
**Inspect rotor and vanes**

5. Inspect the rotor (16) and vanes (15) for abnormal wear or damage. There will be normal polish marks on both the top and bottom. The vanes need to be free to slide both up and down and in and out. If vanes are removed for inspection, make sure to reinstall them with the rounded edge out.



**Inspect bottom plate**

6. Check the bottom plate (17) for abnormal wear patterns.



**Inspect input shaft/ Ball Bearing**

7. Check the input shaft (28) for damaged splines and unusual wear or grooves around the shaft seal area. Grooves you can detect with your fingernail necessitate replacement of the input shaft.

The ball bearing (26) should exhibit free-rolling operation.



**Inspect spool components**

8. Inspect spool components as follows: Check all components for damage. Check the relief valve seat assembly (6E) for wear or chipping. Back flush with air and solvent if necessary. Check the spool for nicks or burrs.



# Assembly Preparation

Wash all parts in clean, OSHA approved solvent. Air blow-dry them only.

**⚠ WARNING** Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.

**⚠ WARNING** Wear eye protection and be sure to comply with OSHA or other maximum air pressure requirements.

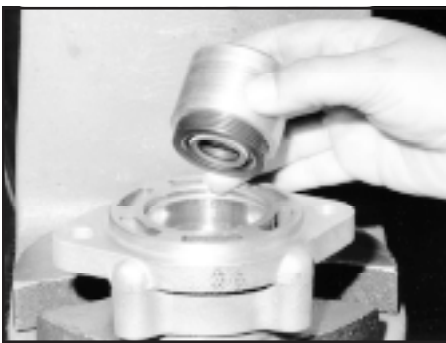
## Assembly

### Tools Required

Lbf•ft Torque wrench  
Press  
Ratchet  
Retaining ring pliers  
Sockets: 1 1/4", 9/16", 7/8" deep well  
Vise

### Materials Required

Grease (petroleum base chassis lube)

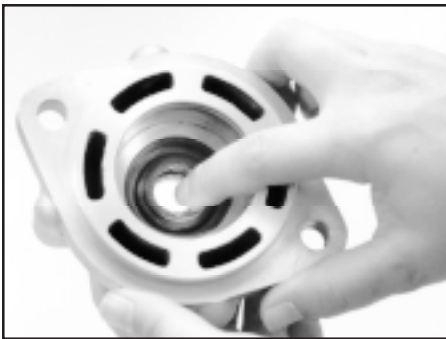


#### Press in shaft seal

Press  
Suitable size  
tool or socket

1. Grease the outside diameter of the shaft seal (23) with the special grease provided, and press it into the cover, with the lettered side facing toward the needle bearing. The installed seal should be flush with or just below the sealing surface on the cover.

**⚠ CAUTION** Make sure the press is clean and free of debris so as not to damage the face of the cover on which the bottom plate rests. If damage occurs to the cover, the pump will not function properly.



#### Grease shaft seal

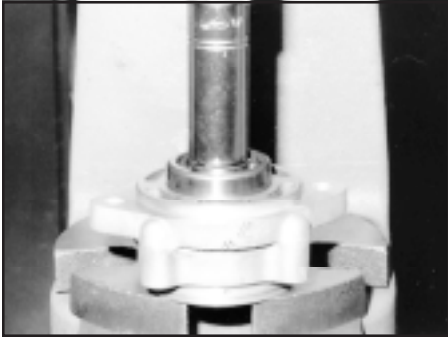
Grease

2. Grease the inside diameter of the shaft seal (23) with the special grease provided.



#### Install spacer

3. Install the spacer (24). Make sure it lays flat. There is no up or down for the spacer.



**Insert input shaft into cover**

Press  
7/8" Deep well  
socket

4. Insert the input shaft (28), small splined end first, into the cover. Don't allow the splines to contact the shaft seal (23). Engage the shaft into the seal by hand until the ball bearing contacts the cover.

Use a 7/8" socket or other appropriate tool to press the shaft and bearing into the cover until it bottoms.

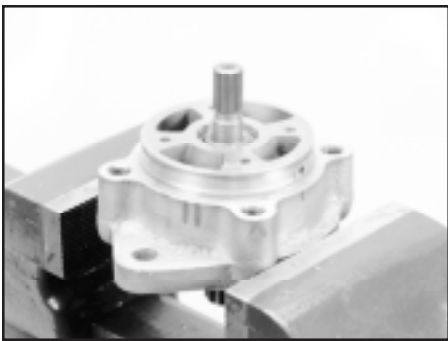
**CAUTION** If splines contact the shaft seal, the seal can be damaged. Take great care to not allow contact. Tape splines if desired.



**Install large retaining ring**

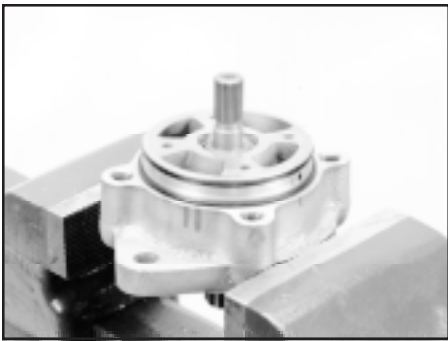
Retaining ring  
pliers

5. Place the cover in a vice and install the large retaining ring (27) with the sheared edge out. Don't deform the cover with excessive clamping force.



**Reverse the cover assembly**

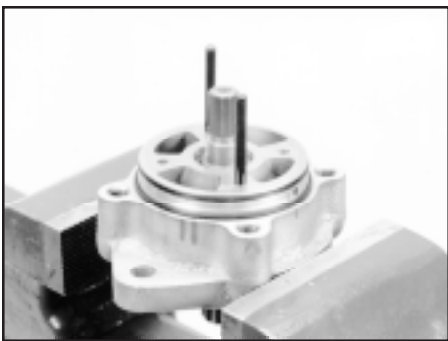
6. Reverse the cover assembly in the vice. Don't deform the cover with excessive clamping force.



**Install o-rings**

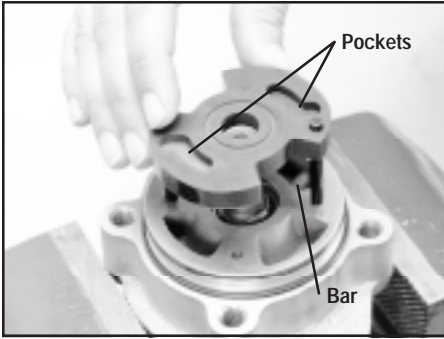
7. Install a new large o-ring (20), onto the cover without rolling it. Make sure it is properly seated on the cover sealing surface.

Install a new small o-ring (19) onto the cover without rolling it. Make sure it is properly seated in its groove.



**Install locating pins**

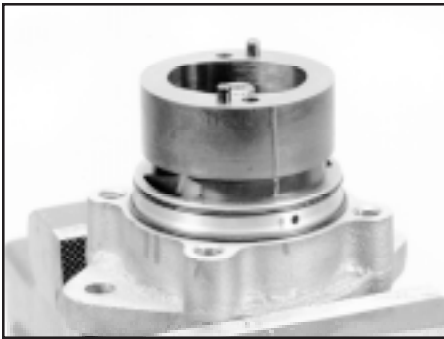
8. Install the locating pins (18) according to the marks you made on the outside of the housing during disassembly.



### Install bottom plate

9. Notice there is a bar in one of the four cutouts in the cover. This bar should be covered by the bottom plate when it is installed. Install the bottom plate (17) with the pockets facing up. The bottom plate is installed correctly if the:

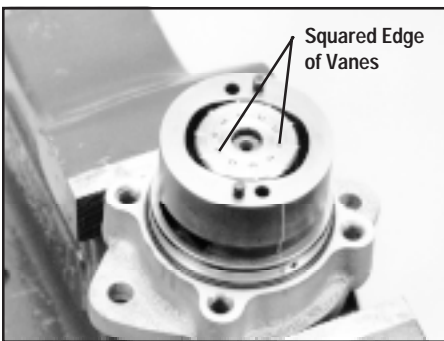
- bar is covered,
- pockets face up,
- outermost edges are fairly symmetrical with the mounting surface,
- marks made for internal components align.



### Install cam ring

10. Install the cam ring (14) with the dots facing up or down as noted during disassembly. Locating pins go into the smaller holes, the cam ring will only fit properly one way.

The installed cam ring should be fairly flush with the bottom plate at the large outside diameter. Alignment marks made during disassembly should be aligned.



### Install rotor and vanes

11. Install the rotor (16) and vanes (15) in the same orientation as removed and noted. If vanes are separate from the rotor, install the rotor first, then install the vanes.

Make sure all vanes are installed with the squared edge toward the center of the rotor.

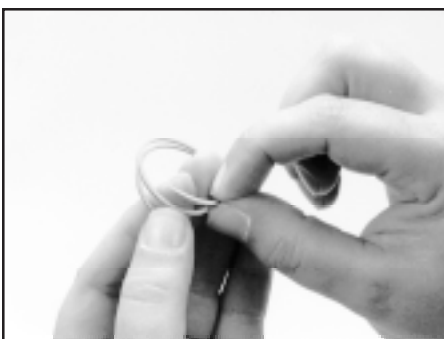
**CAUTION** If vanes are installed with the square edge out, they could cause premature wear to components.



### Install top plate

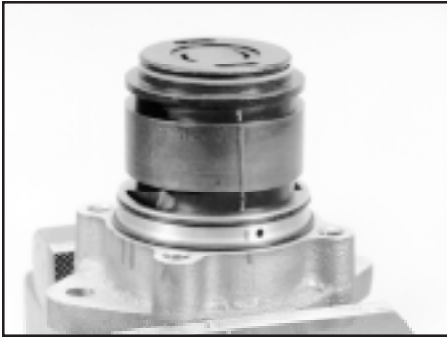
12. Install the top plate (13) with the pin holes down. The locating pins (18) must be engaged in the pin holes, not the pockets.

The top plate should be fairly flush with the cam after installation. Alignment marks made during disassembly should align.



### Prepare backup ring

13. To make the new Teflon backup ring (12) hold more tightly to the top plate, wrap the backup ring, without twisting, loosely around two fingers, and then allow it to unwrap.



**Install backup ring**

14. Install the backup ring (12) on the top plate. Seat it at the bottom of the groove.



**Install o-ring**

15. Install a new o-ring (11) on the top plate without allowing it to roll. Seat it at the top of the groove.




**Grease o-ring and back-up ring**

16. Grease the o-ring (11) and back-up ring (12).



**Grease housing sealing areas**

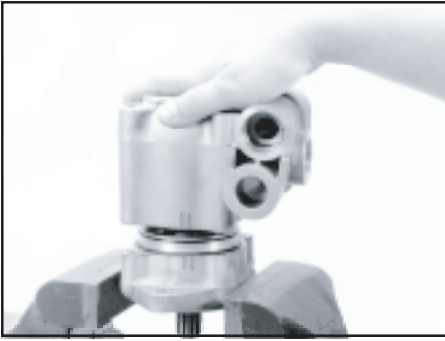
17. Grease the sealing areas of the housing (1).

 <b>CAUTION</b>	The housing may have sharp edges. Be careful not to cut your finger when applying grease.
--	---



**Position spring**

18. Place the spring (10) on the top plate (13).



### Install housing

- Place the housing (1) over the cover assembly. Make sure the orientation is correct by matching the original markings made on the housing and cover during disassembly.

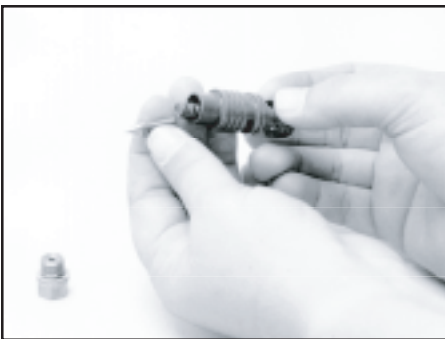


### Install bolts and washers

9/16" Socket Torque wrench

- Install the bolts (4) and washers (5). Thread all four bolts into the cover evenly, and **torque alternately to 25 lbf•ft. (35 N•M)**

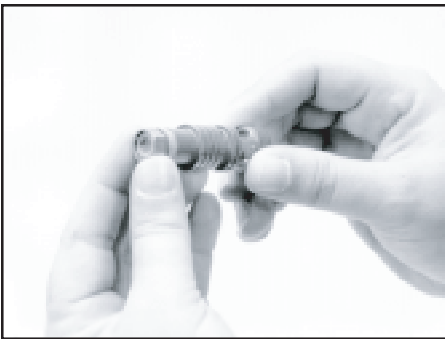
**CAUTION** Failure to thread the bolts into the cover evenly could result in damage to the seals, top plate or housing.



### Assembly valve spool assembly

- Assemble valve spool components: Insert spring (6B), and poppet (6C) (blunt end first) into the spool (6A). Install shims (6D) onto the relief valve seat assembly (6E).

Make sure to install the same number of shims as were removed.

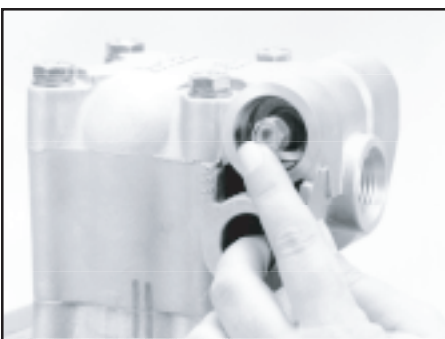


### Install relief valve seat assembly

7/16" Socket Torque wrench

- Screw the relief valve seat assembly into the spool and **torque to 11 lbf•ft. (15 N•M)**. Placing the spool in a collet will facilitate torquing.

**CAUTION** Take care not to deform the spool nor make nicks or burrs on the surface. If the spool is damaged, both the spool and housing must be replaced.



### Install valve spool assembly

- Insert the valve spool assembly (6), screen end last, into the housing. Make sure the spool slides freely in the housing.

**WARNING** Do not install the valve spool backwards; doing so disables the pressure relief function of the pump. Serious personal injury may occur if hydraulic components burst due to over-pressurizing the power steering system.



**Install spring**

24. Install the spring (7).



**Install o-ring**

25. Install a new o-ring (8) onto the plug (9).



**Install plug & o-ring**

26. Lightly grease the o-ring (8) and plug (9) threads. Install into housing, and **torque to 20 lbf·ft. (27 N·M)**

1 1/4" Socket  
Torque wrench

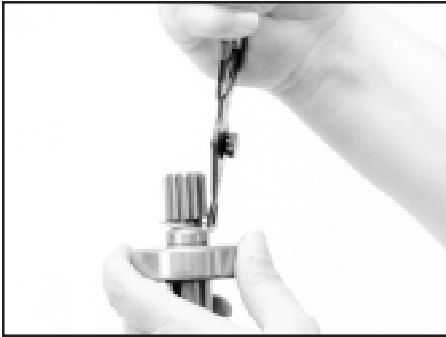
**Install woodruff key if removed**

27. Install the woodruff key into the new input shaft, if removed during input shaft replacement.

# Input Shaft Replacement

## Tools Required

Press  
Retaining ring pliers  
7/8" Deep well socket

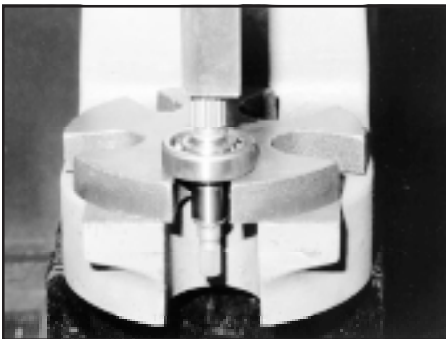


**Remove retaining ring**

Retaining ring pliers

1. Remove the retaining ring (25), nearest the engine drive end, from the shaft.

Remove woodruff key, if equipped.

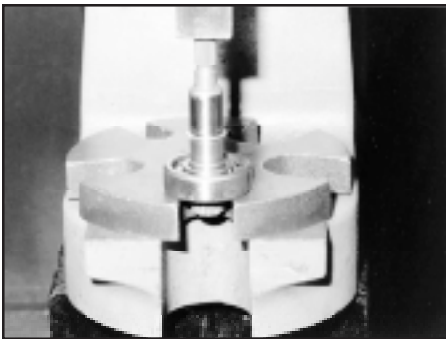


**Press shaft from bearing**

Press

2. Press the input shaft (28) from the ball bearing (26) applying pressure to the engine drive end of the input shaft.

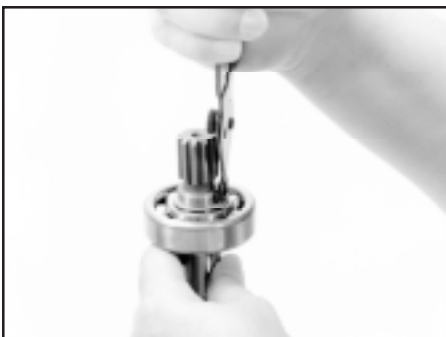
Remove the second retaining ring (25) and replace it in the same groove in the new input shaft, sheared edge out.



**Press ball bearing onto input shaft**

7/8" Deep well socket  
Press

3. Press the new input shaft (28) into the ball bearing (26) from the small splined end, until it bottoms on the retaining ring.



**Install retaining ring**

Retaining ring pliers

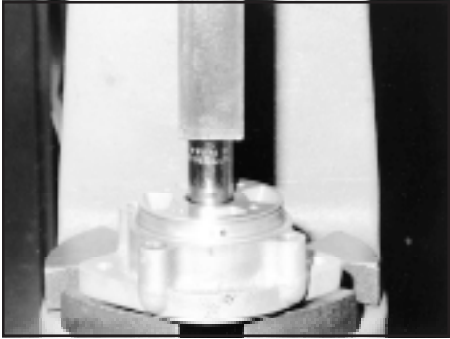
4. Install the retaining ring (25) onto the input shaft with the sheared edge away from the bearing. Make sure it is properly seated in its groove.



# Needle Bearing Removal

## Tools Required

Press  
11/16" and 7/8" Deep well sockets



**Press out needle bearing**

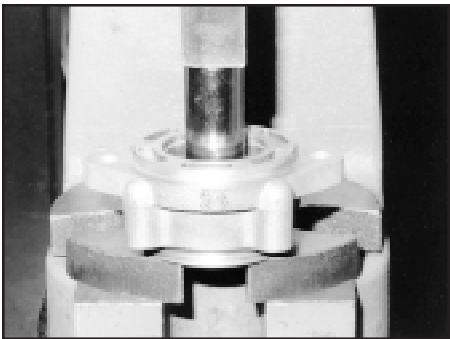
Press  
11/16" Socket  
or other  
suitable tool

1. Place the cover in a press with the flange side down. Press the needle bearing (22) out of the cover.



**Inspect needle bearing**

2. Make sure all needles roll freely in the needle bearing (22).



**Press in needle bearing**

Press  
7/8" Deep well  
socket, or  
other suitable  
tool

3. Put the cover in a clean press with the flange side up. Press the needle bearing (22) into the cover, lettered side toward the pressing tool, until flush with the inside surface.

### **CAUTION**

**Make sure the press is clean and free of debris so as not to damage the face of the cover on which the bottom plate rests. If damage occurs the cover will have to be replaced for the pump to function properly.**



## Section 4      **Reinstallation**

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# Reinstallation

1. Reinstall any fittings removed prior to disassembly.
2. Reinstall the gear on the input shaft if one was removed prior to disassembly.
3. Reinstall the retaining nut, if one was removed prior to disassembly, and torque to manufacturer's specification.
4. Position the new gasket or o-ring (whichever was removed) which will seal the pump face to the mounting surface.
5. Engage the input shaft.
6. Tighten the mounting bolts to manufacturer's specifications.
7. Unplug and reconnect the input and output lines.
8. Fill the reservoir.
9. Start the vehicle to purge the system.
10. Turn off the vehicle and check the fluid level in the reservoir. Add fluid as necessary.
11. Bleed the system if necessary using instructions on the following page.

# Filling & Air Bleeding the TRW System (TAS Gear)

Tools Required	Materials Required
$\frac{5}{16}$ " Socket Lbf•in. Torque wrench	Hydraulic fluid

**CAUTION** Make sure poppets are set correctly before beginning this procedure.

**Run engine for 10 seconds, turn off and fill reservoir**

1. Fill the reservoir nearly full. Do not steer. Start and run the engine for 10 seconds, then shut it off. Check and refill the reservoir. Repeat at least three times, checking the reservoir each time.

Hydraulic fluid

**CAUTION** Do not allow the fluid level to drop significantly or run out of the reservoir. This may induce air into the system.

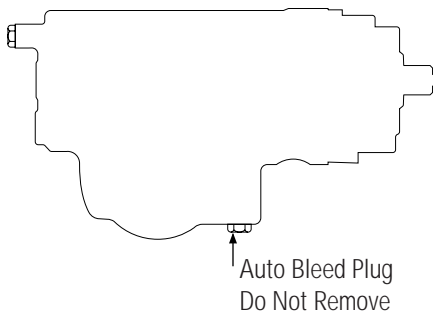
**Run engine for 2 minutes, turn off and fill reservoir**

2. Start the engine and let it idle for 2 minutes. Do not steer. Shut off the engine and check the fluid level in the reservoir. Refill as required.

Hydraulic fluid

**Steer vehicle**

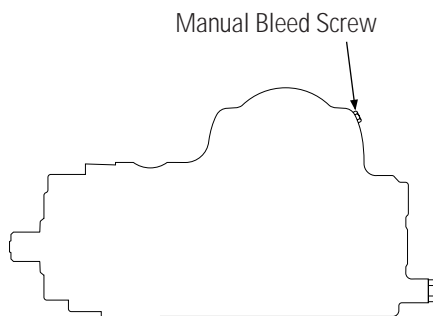
3. Start the engine again. Steer the vehicle from full left to full right several times. Add fluid, as necessary, to the full line on the dip stick.



Automatic bleed systems should now be free from trapped air. **Manual bleed systems continue with step 4.**

**Allow air to bleed out from bleed screw**

4. With engine idling, steer from full left turn to full right turn several times. Stop steering, with the wheels pointed straight ahead, and loosen the manual bleed screw about one turn. Allow air and aerated fluid to "bleed out" until only clear fluid is seen. Close the bleed screw, refill the reservoir if required.



Lbf•in. Torque wrench  
 $\frac{5}{16}$ " Socket

Repeat step 4 three to four times until all the air is discharged. Torque manual bleed screw to **30 lbf•in.**

**CAUTION** Do not turn steering wheel with bleed screw loosened.

# Maintenance Tips

**Never high-pressure wash or steam clean a power steering pump while off the vehicle. Doing so could force contaminants inside the pump and cause it to malfunction.**

Always **clean off around the reservoir filler cap** before you remove it. Prevent dirt or other foreign matter from entering the hydraulic system.

**Regularly check the fluid** and the fluid level in the power steering reservoir.

**Investigate and correct any external leaks**, no matter how minor.

**Encourage drivers to report any malfunctions or accidents** which could have damaged steering components.

**Replace reservoir filters** according to requirements.

**Do not attempt to weld any broken steering component.** Replace the component with original equipment only.

If you feel the vehicle is developing excessively **high hydraulic fluid temperatures**, consult with your vehicle manufacturer for recommendations.

**Do not cold-straighten, hot straighten, or bend any steering system component.**

**Section 5**

**Glossary**

Glossary ..... 39

# Glossary

## Abnormal Wear

Any wear other than normal "polish marks" made by the spinning motion of the rotor and vanes. Abnormal wear would include nicks, chips, cracks and grooves.

## Burrs

Rough edges or ridges left on metal by cutting or drilling.

## Corrosion

Gradual wearing away by rust or chemical action.

## Cracks

breaks or splits in the surface.

## Damaged Splines

Cracked, broken or chipped splines on the input shaft.

## Displacement

Volume of output fluid transferred through the pump.

## Drain Hole

Excess fluid from lubricating the seal is diverted internally in the pump housing back to the inlet of the pumping element via the drain holes located in the cover and housing.

## Erosion

Gradual wearing away or deteriorating.

## Full Turn

Axle contacts axle stop

## Grooves

A long, narrow furrow cut in a surface.

## Input Port

Opening in the pump through which fluid is received from the reservoir. (Suction port).

## Manual Bleed Systems

Gears are mounted in such a way that an air pocket could form in one end of the steering gear. The bleed screw is positioned so trapped air can be forced out when loosened.

## Nicks

Small cuts, indentations or chips on the edge or surface.

## OSHA

Occupational Safety and Health Administration

## Output Port

Opening in the pump through which fluid is forced to the steering gear. (Pressure port).

## Relief Valve

Limits maximum supply pressure

## Subassembly

An assembled unit that fits into a larger unit

## Stripped Threads

Broken or damaged threads.

## Surface Imperfections

Blemish on a machined surface.

**TRW Automotive**  
Commercial Steering Systems  
800 Heath Street  
Lafayette, IN 47904  
Tel 765.423.5377  
Fax 765.429.1868  
[www.trucksteering.com](http://www.trucksteering.com)







# SECTION 16: SUSPENSION

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## 1 DESCRIPTION

The vehicle is provided with an air suspension system. The system consists of air springs, height control valves, radius rods, sway bars, tripod and shock absorbers (Fig. 1, 2, 3 and 4). The system operation is fully automatic and maintains a constant vehicle height regardless of load, or load distribution.

The vehicle can also be equipped with systems such as:

- Front Kneeling (w/ Front High-Buoy);
- Front Kneeling (w/ Full High-Buoy);
- Front Kneeling (w/ Front High-Buoy) and Low-Buoy Combination;
- Front Kneeling (w/ Full High-Buoy) and Low-Buoy Combination;

For a description of each of these systems, refer to the appropriate heading in this section.

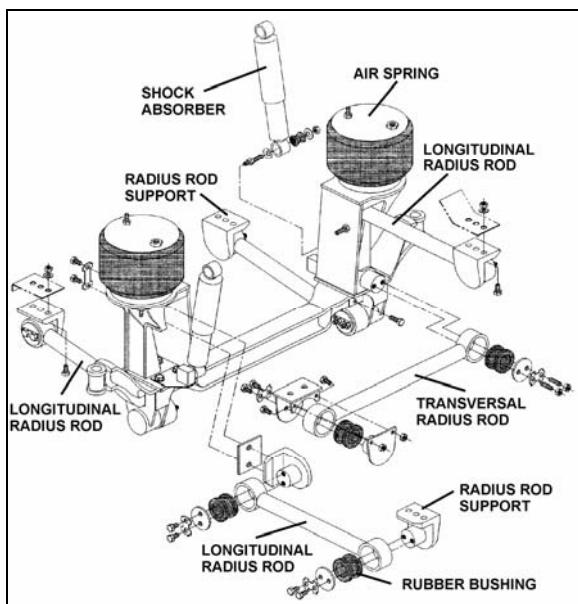


FIGURE 1: FRONT I-BEAM AXLE SUSPENSION 16105

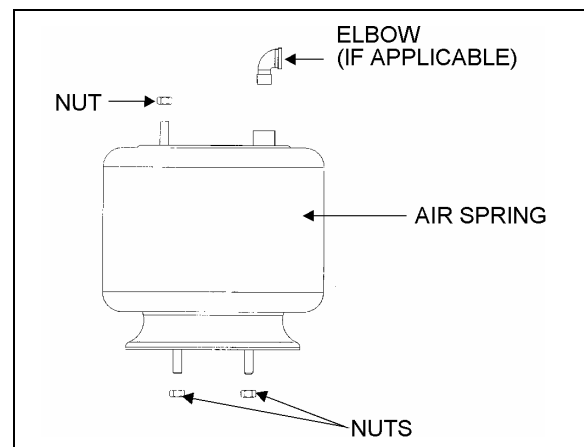


FIGURE 3: AIR SPRING

16052

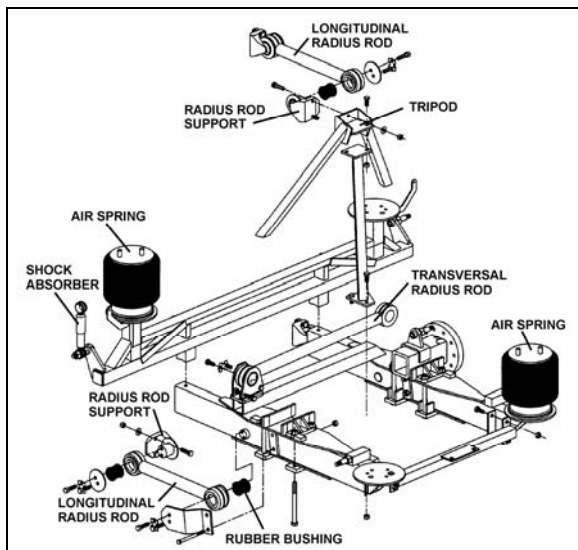


FIGURE 2: DETAILS OF REAR SUSPENSION 16106

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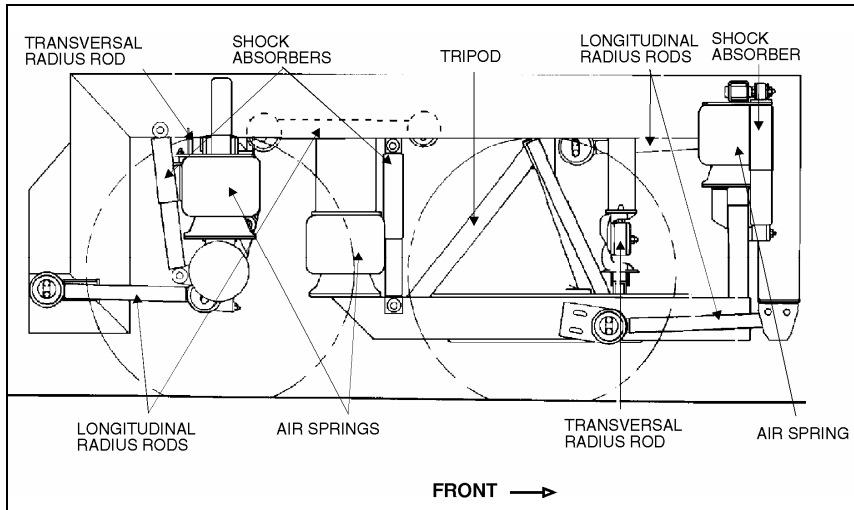


FIGURE 4: REAR SUSPENSION COMPONENTS 16003

## 2 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 three axles is provided with air springs that are attached to the subframe and to the axles (Fig. 4).

### 2.1 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) air pressure with the air spring not mounted.

### 2.2 REMOVAL

**Note:** Suspension air springs (front, 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 points.
- c) Remove wheel.

2. Exhaust compressed air from accessory air tank by opening drain cock under reservoir.
3. Disconnect the height control valve link and pull down the overtravel lever to ensure all air is exhausted from air springs.

**Note:** While performing this step, do not change the height control valve overtravel lever adjustment.

4. Disconnect air line from air spring, remove elbow (if applicable), and cover both the line end and fitting to prevent the entry of foreign matter.
5. Remove the air spring upper nut, and then the two lower nuts. Remove air spring.

### 2.3 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 according to Torque Table under heading Torque Specifications.
3. Thread the remaining upper nut (large nut) and tighten according to Torque Table under heading Torque Specifications in this section.
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,

## Section 16: SUSPENSION

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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.

### 3 SHOCK ABSORBERS

Double-action, telescoping-type shock absorbers ensure a smooth ride and enhance vehicle stability on the road. All shock absorbers are eye-type mountings. The front and tag axles are each provided with two shock absorbers while the drive axle is provided with four of them (Fig. 1, 2 & 3).

Shock absorbers are non-adjustable and non-repairable. Maintenance requirements involve replacement of the rubber mounting bushings, and tightening of all shock absorber pins according to Torque Table under heading Torque Specifications 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.

#### 3.1 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 (Refer to the SACHS document "Guideline To Evaluate Warranty Claims" annexed at the end of this section before replacing a shock). 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.

#### 3.2 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 5 for details.
2. Remove the shock absorber assembly from pins.
3. Remove the two inner bushings from the shock absorber and discard them.



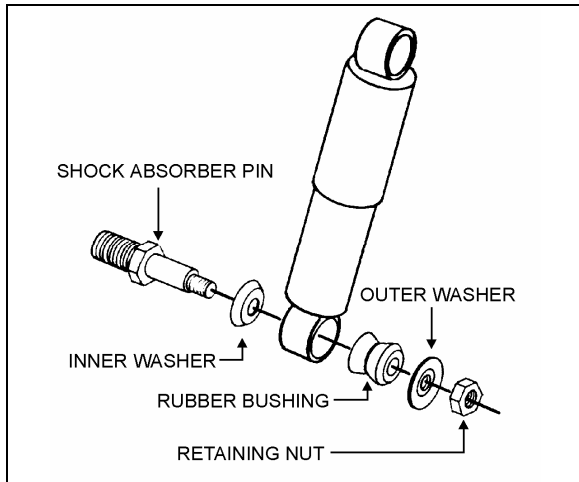


FIGURE 5: SHOCK ABSORBER

16008

### 3.3 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. 6).

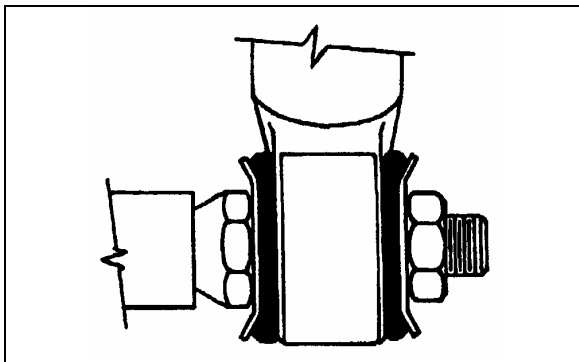


FIGURE 6: TYPICAL SHOCK ABSORBER SETUP

16009

4. Install the shock absorber eyes over the mounting pins, then the outer washers (with washer convex side facing the shock absorber rubber bushing) on each shock absorber extremity.

**Note:** If shock absorber pins are removed, they must be reinstalled using "Loctite 242".

5. Place the lower and upper mounting pin stud nuts and torque according to paragraph 13 Torque Specifications.

## 4 RADIUS RODS

Radius rods are used to secure the axles in the proper transversal and longitudinal positions. Four radius rods are provided on the front I-beam axle suspension (three longitudinal and one transversal), four 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 1, 2, 3 and 4 for details. These rods transmit both braking and driving forces from the axles to the vehicle body.

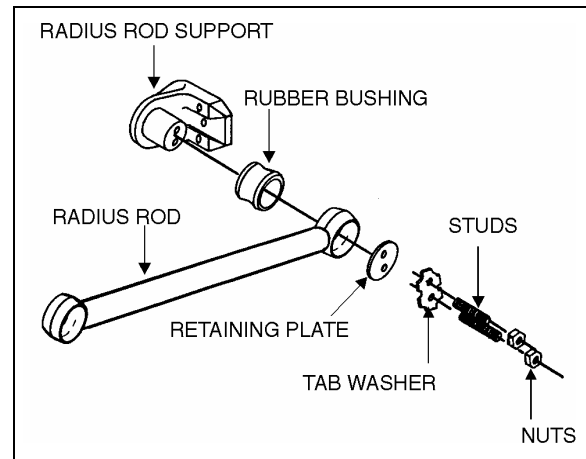


FIGURE 7: TYPICAL RADIUS ROD SETUP

16010

### 4.1 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.

### 4.2 REMOVAL

1. Flatten the tab washer which secures the two retaining nuts (or bolts), and then unscrew the nuts (or bolts) at each extremity of the radius rod (Fig. 7).

## Section 16: SUSPENSION

2. Remove the tab washer and the retaining plates and radius rod ends from anchor pins, and then remove the radius rod.

### 4.3 BUSHING REMOVAL

1. Safely support the radius rod as shown in figure 8.

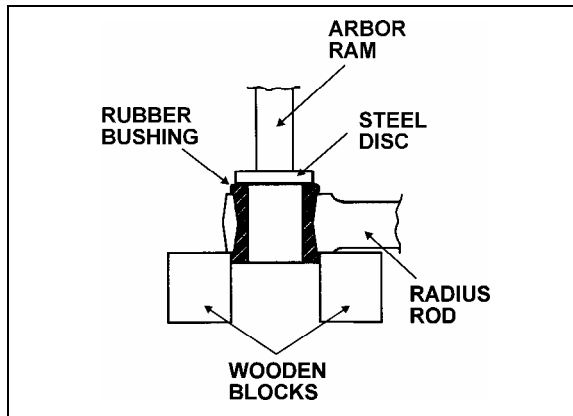


FIGURE 8: RADIUS ROD BUSHING REMOVAL 16011

2. Place a flat steel disc, slightly smaller than the outside diameter of the bushing (Fig. 8).
3. Using an arbor press or a suitable driving tool, press or drive the old bushing out of the rod and discard the bushing.

### 4.4 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. 9).
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.

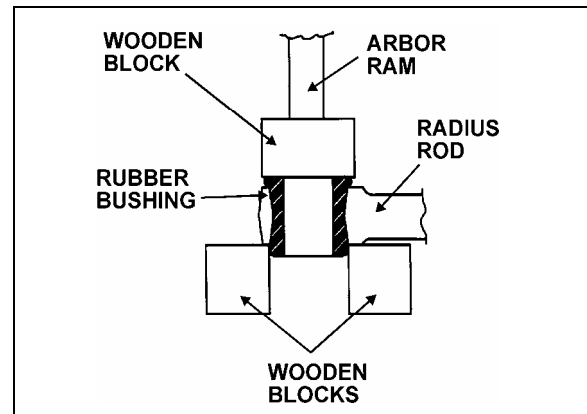


FIGURE 9: RADIUS ROD BUSHING INSTALLATION 16012

### 4.5 INSTALLATION

1. Lightly spray the radius rod support with water. Place the radius rod end over the radius rod support (Fig. 10).
2. Put 3 drops of Loctite243 (Prevost #680038) in each radius rod support tapped blind holes and a line of Loctite on bolts.
3. Position the retaining plate. Install the tab washer and nuts (or bolts).

**Caution:** Always use new tab washers at installation.

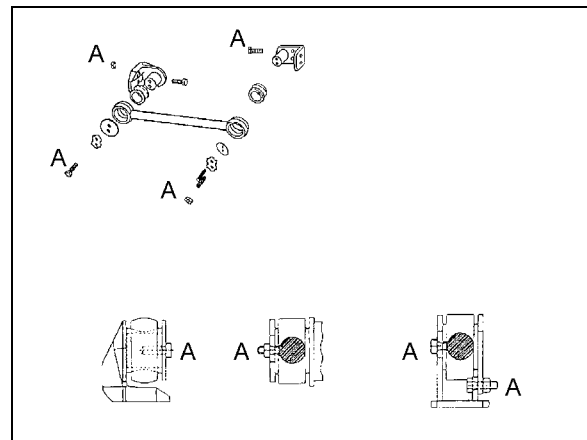


FIGURE 10: RADIUS ROD INSTALLATION 16028

4. Tighten the nuts (or bolts) lightly, and repeat at the other end.
5. Refer to heading "SUSPENSION HEIGHT ADJUSTMENT" later in this section, and set the vehicle to normal ride height.
6. With the vehicle at normal ride height, apply corrosion-protective oil Prevost #680064 on threads and tighten all radius rod anchor pin nuts or bolts according Torque Table under heading Torque Specifications.

**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.

## 5 SWAY BAR

A sway bar is provided on the front and drive axles to increase vehicle stability. It controls lateral motion (swaying movement) of vehicle (Fig. 11).

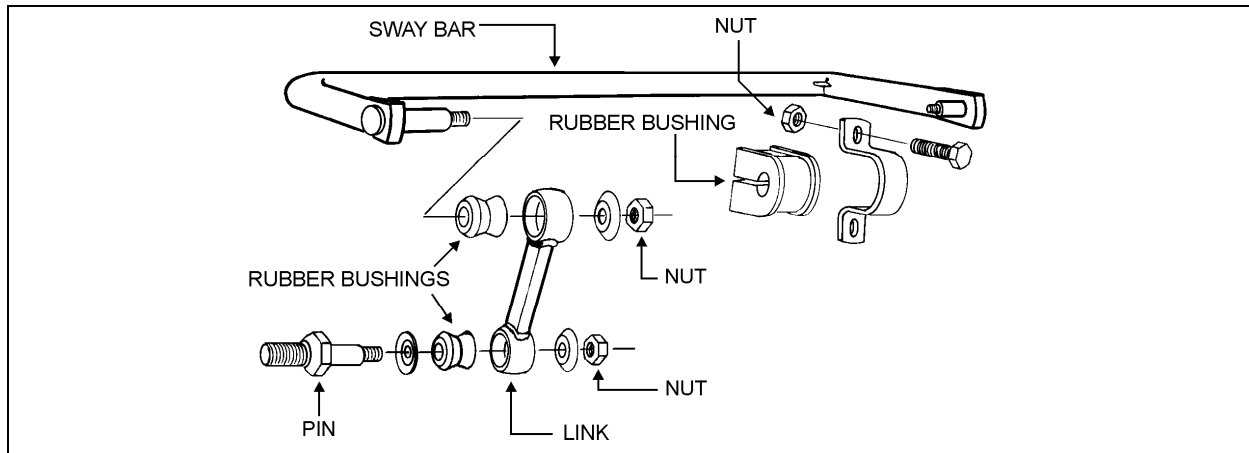


FIGURE 11: FRONT & DRIVE AXLE SWAY BAR

16144

### 5.1 REMOVAL

1. Disconnect the two links from sway bar.
2. Safely support the sway bar. Unbolt the four bushing collars from subframe.
3. Remove sway bar.

**Note:** Sway bar bushings are slotted to ease their removal.

### 5.2 INSTALLATION

1. Loosely install the sway bar.
2. Tighten the eight bushing collar nuts according to Torque Table under heading Torque Specifications (Fig. 11).
3. Tighten sway bar link upper nuts and lower nuts according to Torque Table under heading Torque Specifications (Fig. 11).

## 6 INDEPENDENT FRONT SUSPENSION (IFS)

This section contains service procedures and specifications unique to the independent front suspension (IFS).

### 6.1 STEERING LINKAGE

Turning motion of the steering wheel is transferred by the steering gear and steering linkage to the steering arms at the right and left front wheels. The steering linkage consists of tie rods connected to the bell crank and the steering arm at the left side of the coach, and to the idler arm and steering arm at the right side of the coach. The bell crank and idler arm are connected by a relay rod. A drag link connected to the bell crank and the pitman arm, which is mounted to the steering gear, transfers the turning motion of the steering wheel to the steering arms. On VIP series, a 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. 12).

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 coach will be seriously

## Section 16: SUSPENSION

affected. Any time steering linkage components are replaced or adjusted, steering geometry and front wheel alignment must be checked as explained in this section.

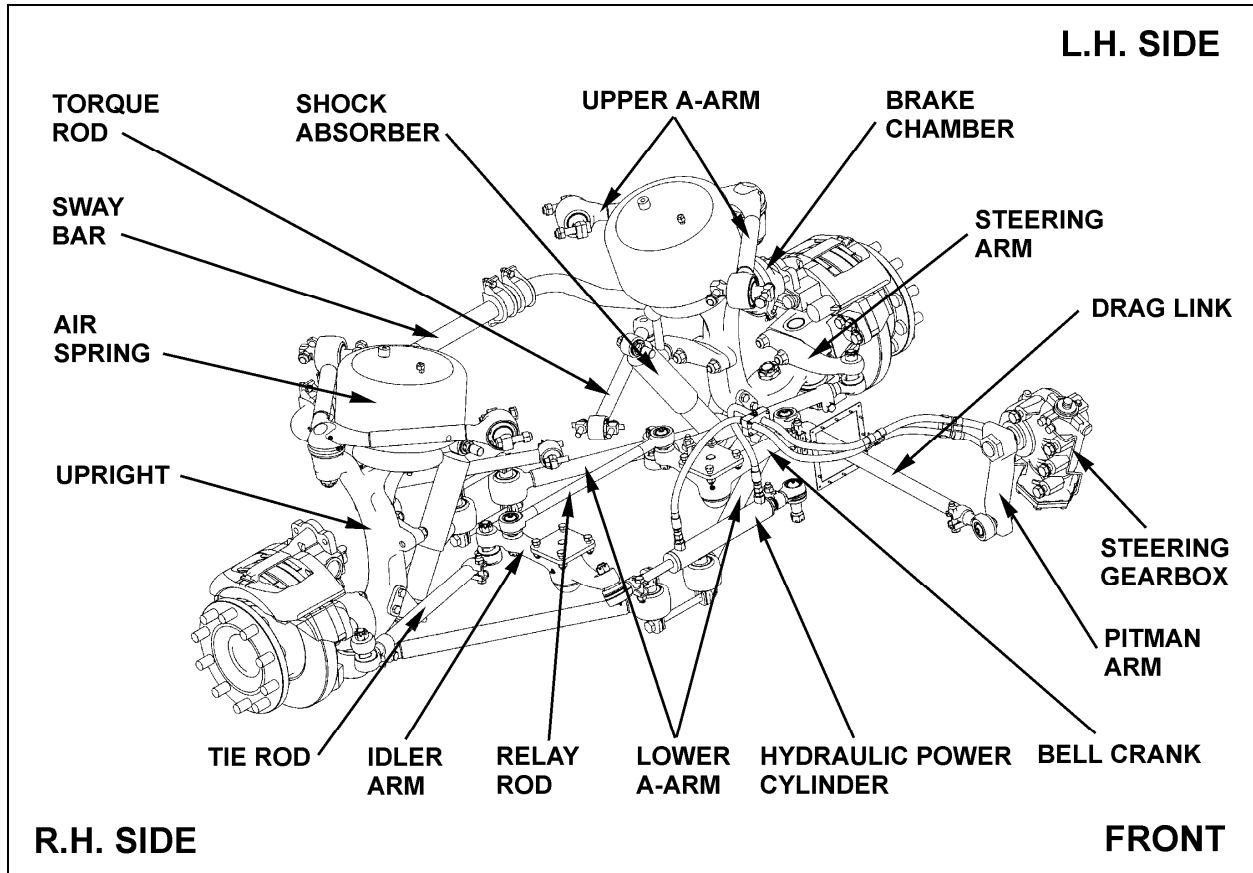


FIGURE 12: INDEPENDENT FRONT SUSPENSION AND STEERING LINKAGE

16124

### Turning Angle

The maximum turning angle is set mechanically through the two steering stop screws installed on the swivel assembly. The turning angle ( $56^{\circ} + 0^{\circ} - 1^{\circ}$ ) 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 6.11 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 13 to 19 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".

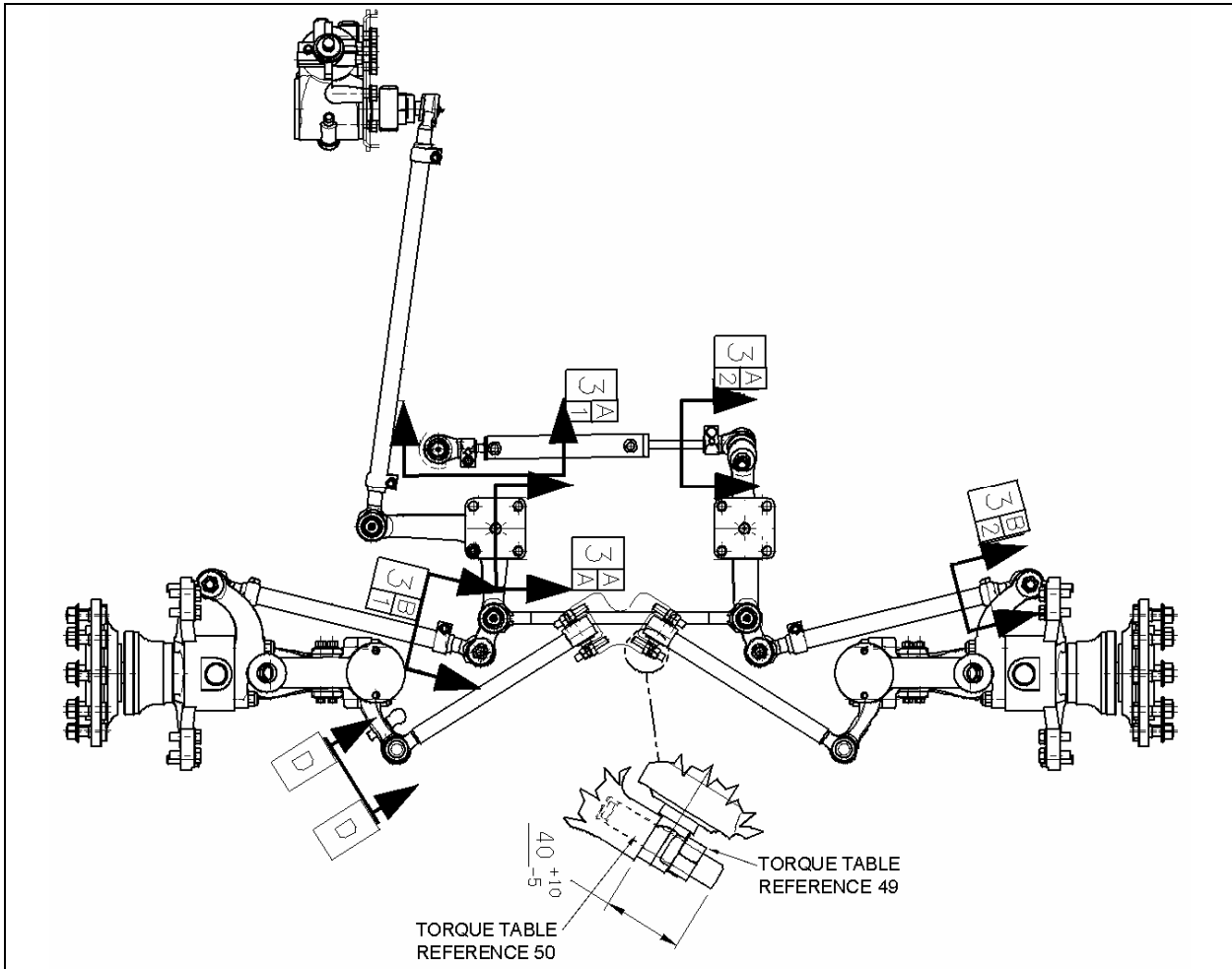


FIGURE 13: LOCATION OF CLAMPS

16147

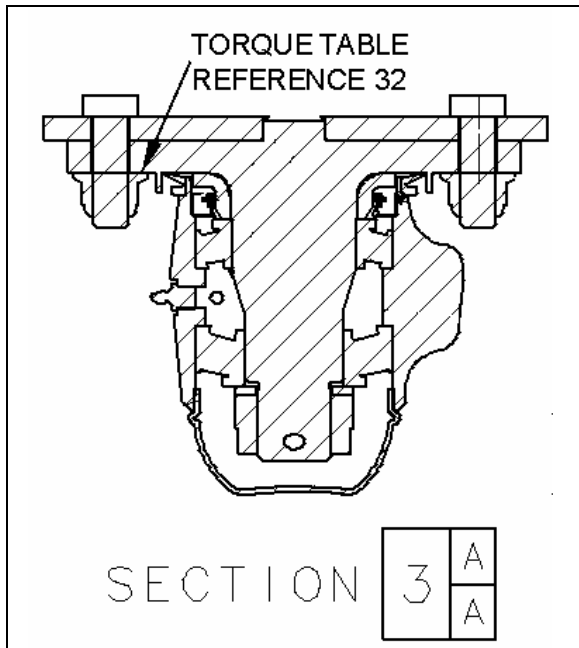


FIGURE 14: TORQUE SPECIFICATIONS 16148

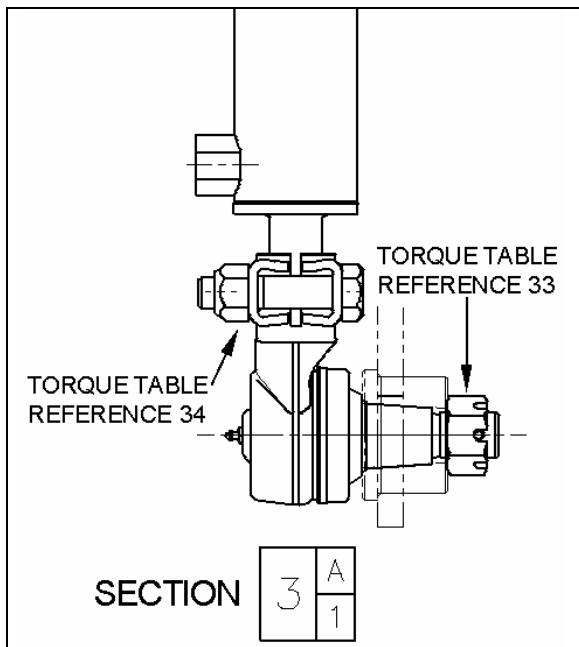


FIGURE 15: TORQUE SPECIFICATIONS 16152

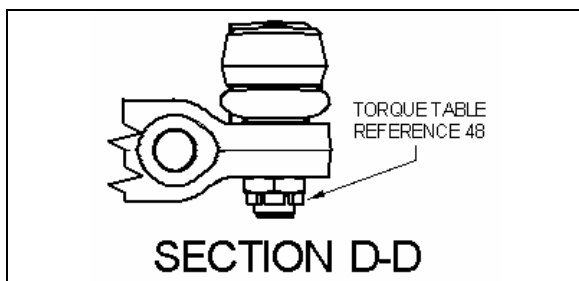


FIGURE 16: TORQUE SPECIFICATIONS 16156

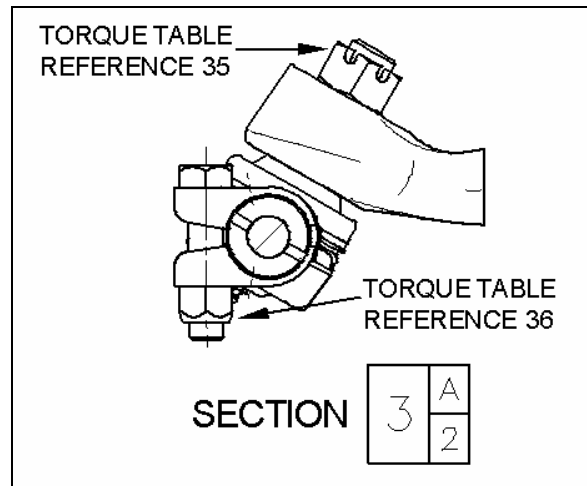


FIGURE 17: TORQUE SPECIFICATIONS 16149

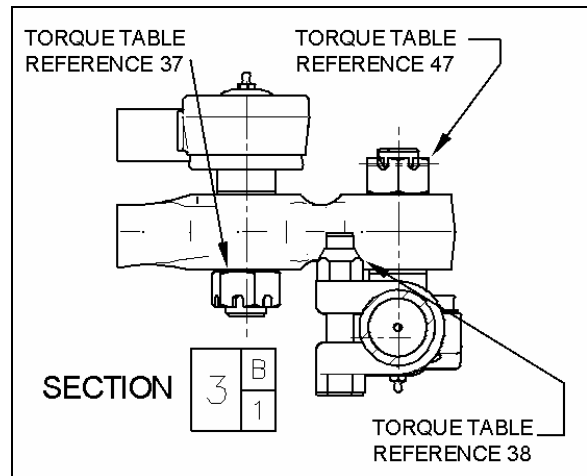


FIGURE 18: CLAMP POSITIONING 16150

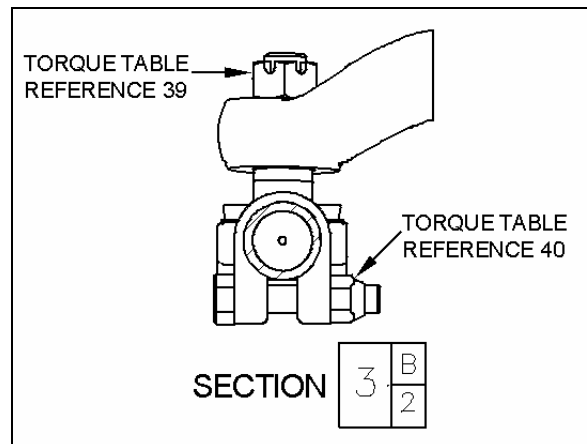


FIGURE 19: TORQUE SPECIFICATIONS 16151

6.1.1 Power Steering Hydraulic Pump

Refer to the "TRW Power Steering Pump Service Manual" annexed at the end of Section 14.

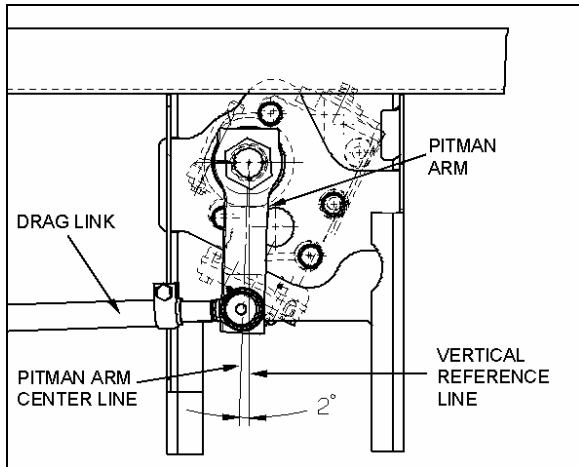


FIGURE 20: PITMAN ARM ALIGNMENT 14056

6.1.2 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. See Torque Table under heading Torque in this section.

1. First, align the input shaft marks.
2. Afterwards, the pitman arm should be adjusted with reference mark aligned or to an angle of 2° in relation with the vertical axis (Fig. 20).
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 then adjust toe-in as described in "Front End Alignment" in this section.

6.1.3 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.

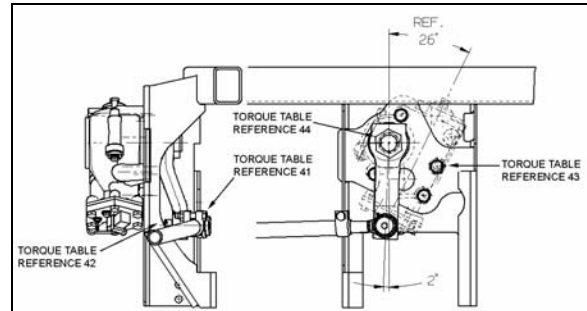


FIGURE 21: TORQUE SPECIFICATIONS 16154

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.

6.1.4 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 dry (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 22).

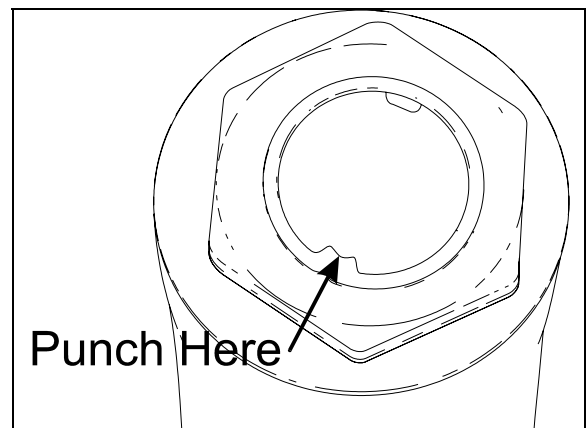


FIGURE 22: FIXING NUT PUNCH MARK 16098

3. Connect drag link to pitman arm. Install washers. Tighten nut to 150-200 lbf-ft dry (203-271 Nm). Advance nut to next

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alignment cotter pin slot and install a new cotter pin.

### 6.1.5 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.

#### 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 "6.12 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 dry (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 dry (54-82 Nm), then test the adjustment. Front wheels should turn from right to left extremities without noticeable binding at drag link ends.

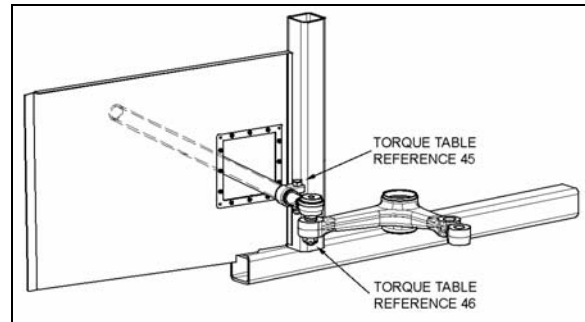


FIGURE 23: TORQUE SPECIFICATIONS

16155

## 6.2 BELL CRANK AND IDLER ARM

Bell crank and idler arm are equipped with one lubrication fitting and should be lubricated as directed in "Lubrication Fittings" in this section.

### 6.2.1 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.

### 6.2.2 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. 24).
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. 24).

### 6.2.3 Bell Crank or Idler Arm Ball Joint Reassembly

**Note:** For bearing installation use tool Prevost # 110684.

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. 24).

**Note:** Install grease retainer according to figure 13. Grease must be able to exit the bell crank or idler arm mechanism. For grease retainer installation use tool Prevost # 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. 25).

**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. 26).

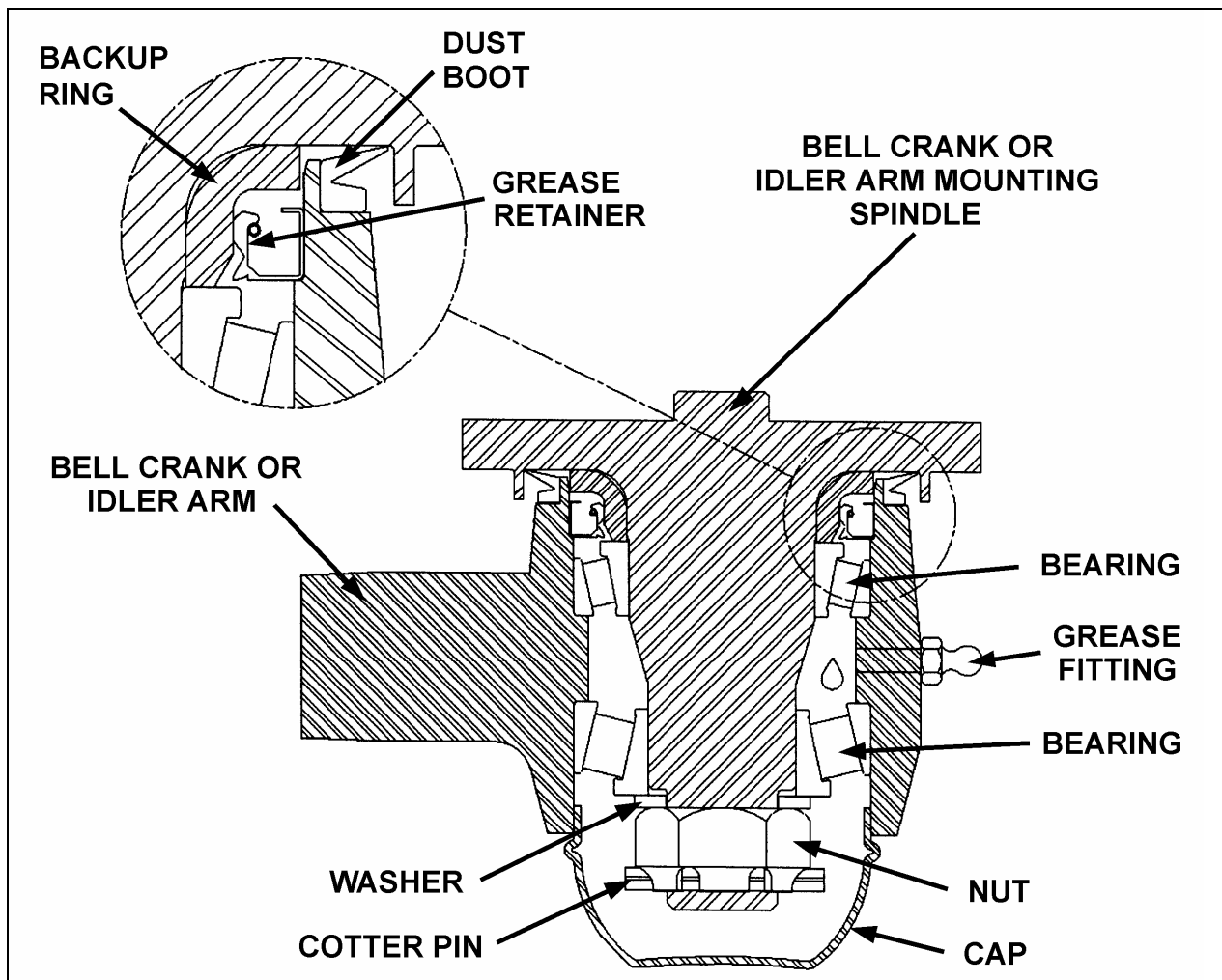


FIGURE 24: BELL CRANK AND IDLER ARM

16109

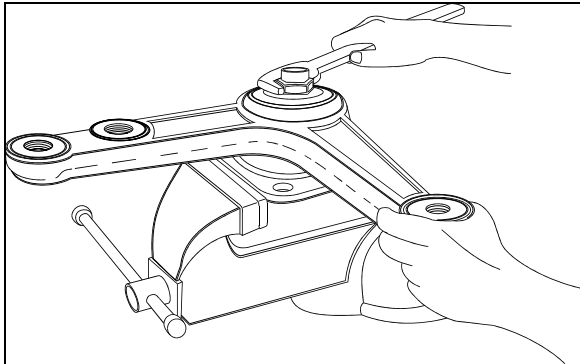


FIGURE 25: BELL CRANK 16044

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.

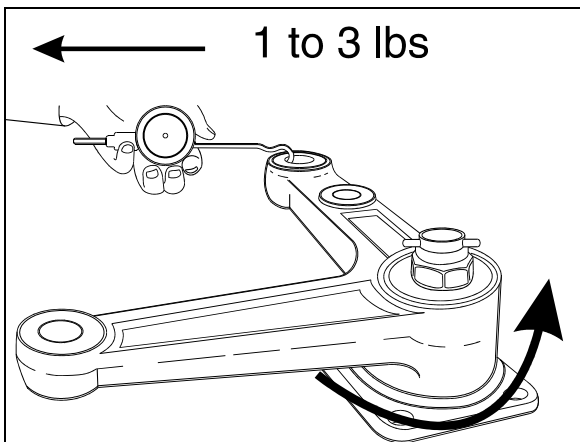


FIGURE 26: BELL CRANK 16045

6. Align nut with cotter pin slot (tighten) and install a new cotter pin.

**Note:** Bend cotter pin around the nut (Fig. 24). 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 under heading "Front End Alignment".

### 6.3 RELAY ROD

Relay rod ends are equipped with lubrication fittings and should be lubricated as directed in paragraph "6.6 Lubrication Fittings".

**Note:** The relay rod is crimped in place and it is not possible to remove the ball joints.

#### 6.3.1 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 lb-ft dry (203-271 Nm) torque. Align cotter pin slot (tighten) and install a new cotter pin.

### 6.4 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 "6.6 Lubrication Fittings" in this section.

6.4.1 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.*

6.4.2 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 dry (203-271 Nm). Align cotter pin slot (tighten) and install a new cotter pin.

**Note:** *Adjust toe-in as directed under heading "Toe-In Adjustment".*

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.*

6.5 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.

6.5.1 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.


6.5.2 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 "Installation" of the maintenance manual.

6.6 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. 27) shows approximate location of steering lubrication fittings.

	<h2>MAINTENANCE</h2>
<ol style="list-style-type: none"> <li>1. <b>Drag Link Ends:</b> 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).</li> <li>2. <b>Relay Rod Ends:</b> 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).</li> </ol>	

## Section 16: SUSPENSION

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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 10.
5. **Idler Arm and Crank bell:** Lubricate at two fittings, one on the idler arm and the other on the crank bell, every 6,250 miles (10 000 km) with good quality lithium-base grease NLGI No. 2 (Shell Retinax LX or equivalent). Apply grease gun pressure to the fitting until lubricant appears at the top seal.
6. **Upper A-Arm Central Ball Joint:** Lubricate at fitting until you see some grease on the relief valve nearby, every 6,250 miles (10 000 km) with good quality lithium-base grease NLGI No. 2 (Shell Retinax LX or equivalent).

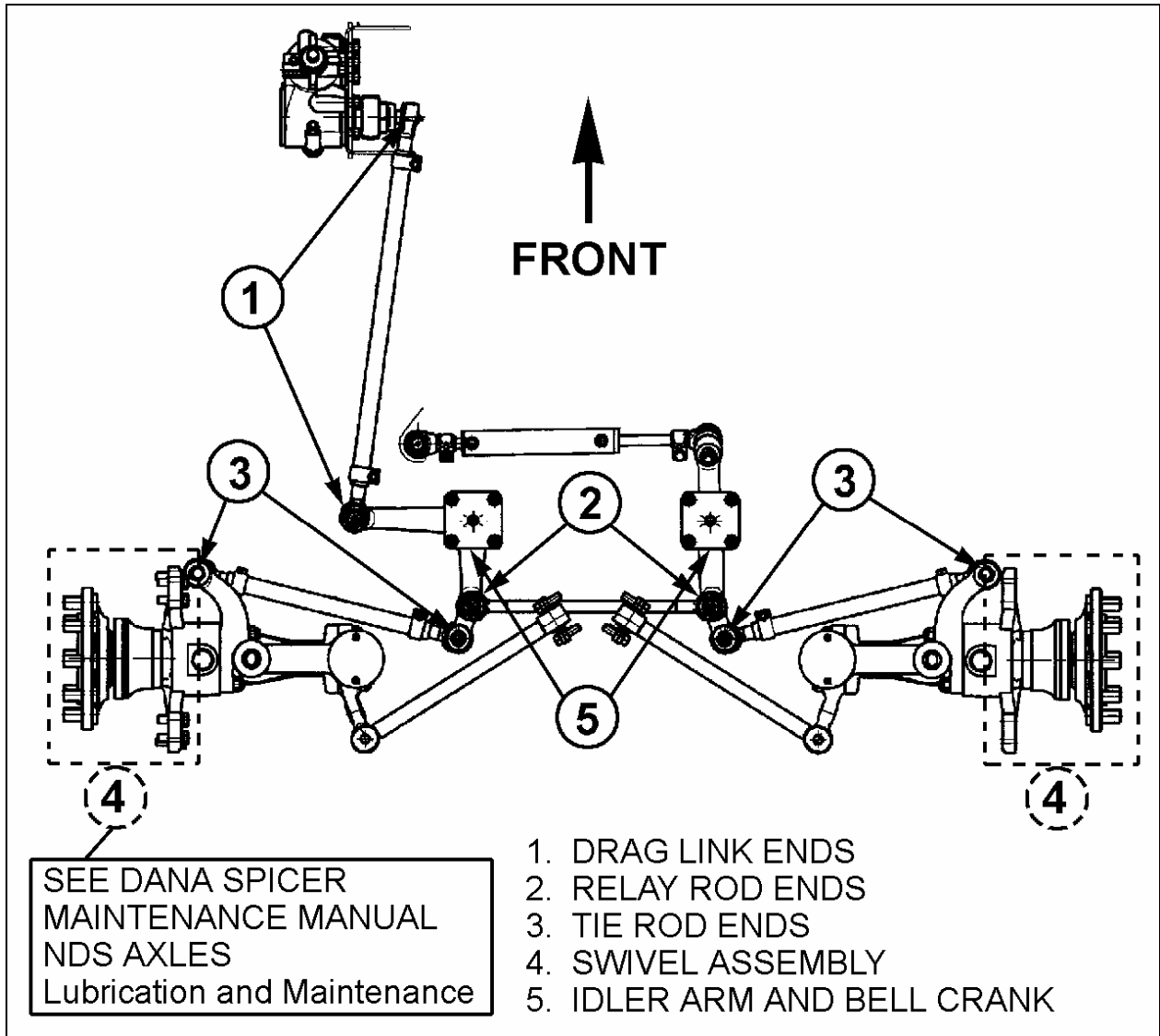


FIGURE 27: LUBRICATION FITTINGS LOCATION DIAGRAM

16046

6.7 BALL JOINTS

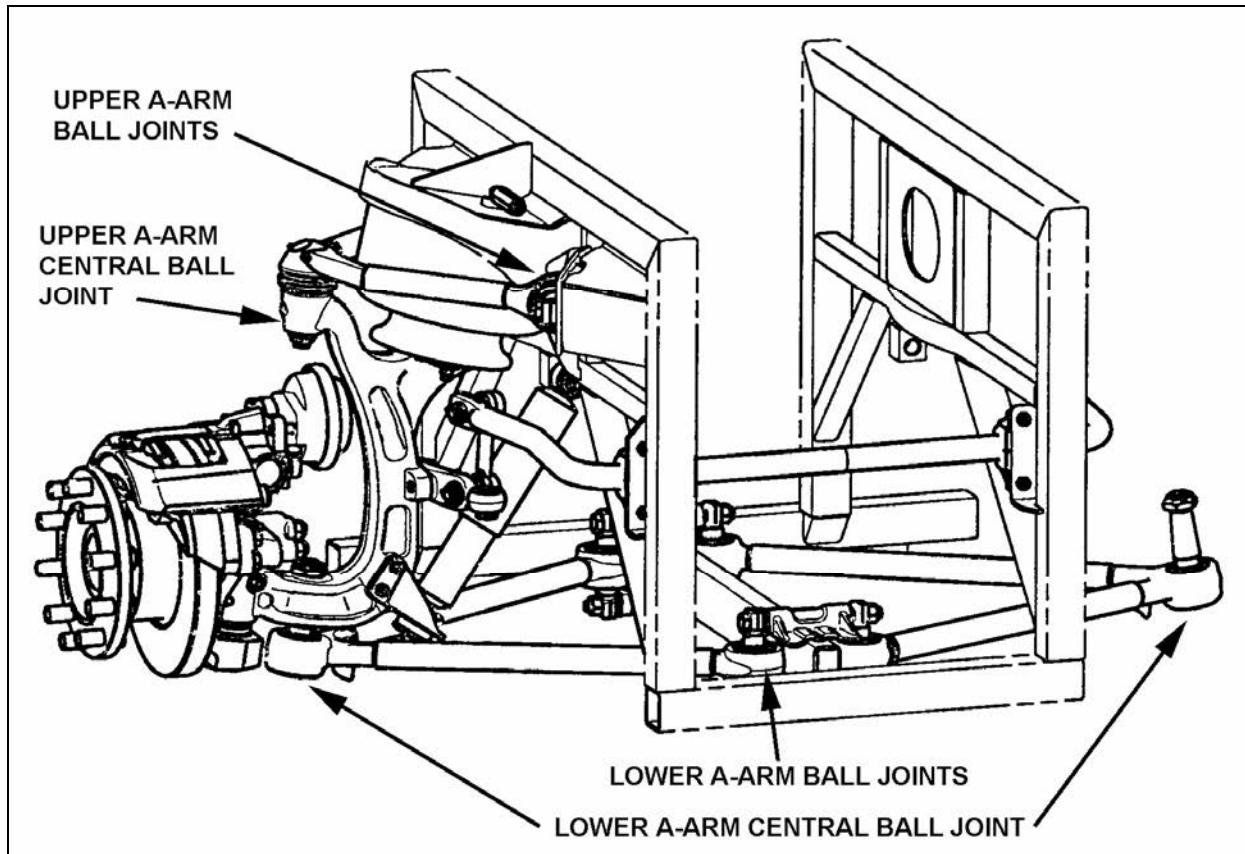


FIGURE 28: BALL JOINTS LOCATION

6.8 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.

6.8.1 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 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.

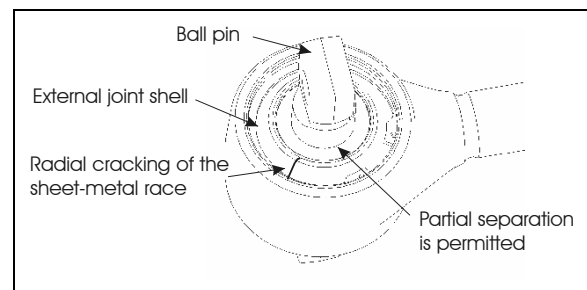


FIGURE 29: A-ARM BALL JOINT

6.8.2 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.

6.8.3 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 (Prevost # 611114).

2. Insert ball pin/bushing assembly. In case of the two-bolt type, ensure that the bolt bores are in the correct position in relation to the axis of the tube.
3. Place joint in receiving fixture and mount annular assembly tool on the housing. Then locate annular spacer and retaining ring in the housing using axial load with the aid of assembly matrix. If the ends of the annular spacer are not in contact with each other, the thus formed opening must be located at 180° to the opening of the retaining ring. Pay attention during assembly to ensure that the retaining ring eyelets are located at each side of the housing shaft axis (retaining ring eyelet lug points to tube), and that retaining ring is properly engaged in the groove of the housing.
4. When repairing defective ball pin assemblies, the necked down-bolt must regularly be replaced with a new one.

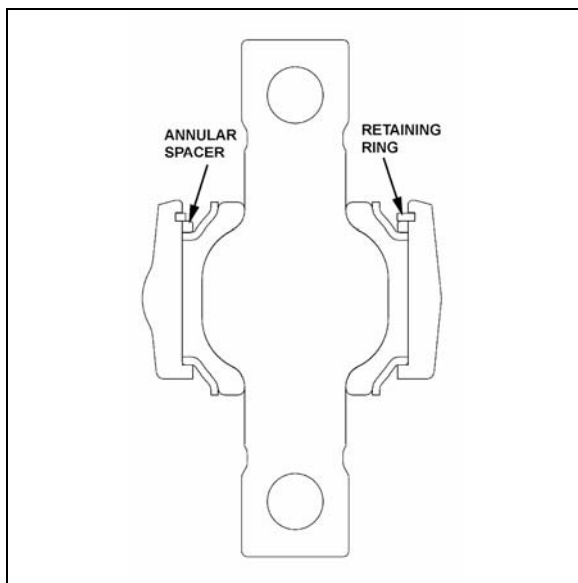


FIGURE 30: LOWER A-ARM BALL JOINTS 16047

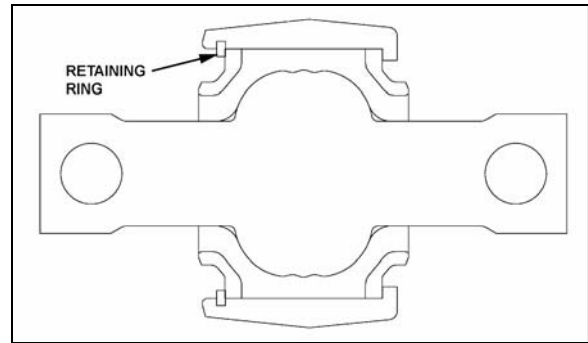


FIGURE 31: UPPER A-ARM BALL JOINTS

## 6.9 LOWER A- ARM CENTRAL BALL JOINT

### 6.9.1 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.

### 6.9.2 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

### 6.9.3 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

## Section 16: SUSPENSION

that the retaining ring eyelets are located at each side of the housing shaft axis (retaining ring eyelet lug points to tube), and that retaining ring is properly engaged in the groove of the housing.

3. Faultlessly apply grease by mechanical means to bracket-outer core and ball-inner cone. Insert bracket outer cone in fixture with distance ring and then use press tool to apply pressure to press mount with ball-inner cone.

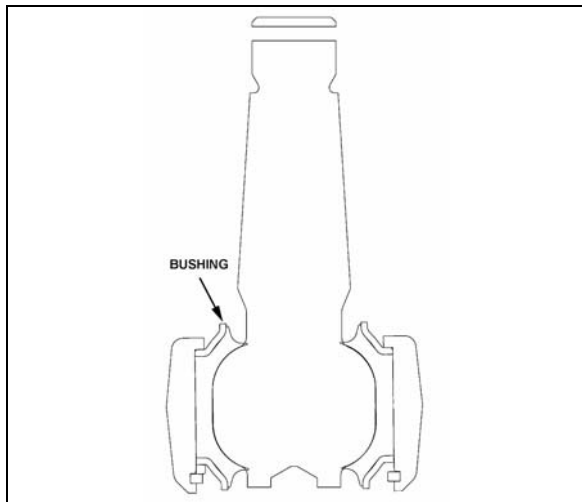


FIGURE 32: LOWER A-ARM CENTRAL BALL JOINT

### 6.10 UPPER A-ARM CENTRAL BALL JOINT

#### 6.10.1 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.

#### 6.10.2 Play Measurement

1. Raise the vehicle and support through axle jacking points.
2. Using a caliper, measure dimension A on figure 33.
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. Measure dimension A again. If the difference between the two dimensions is greater than 0.060" (1.5mm), then the ball joint should be replaced.

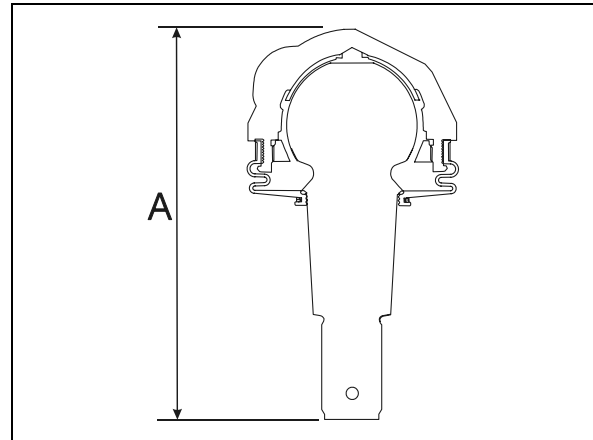


FIGURE 33: UPPER A-ARM CENTRAL BALL JOINT 16116

### 6.11 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-arm of the IFS suspension. After performing alignment, make sure that the following is done:

- a) Installing a new lock nut after all shims are finalized.
- b) Torque replaced nuts as per Torque Table under heading Torque Specifications.



c) Installing a longer bolt if less than 2 threads are remaining after the nut.

d) Using a torque mark on the nut for future visual inspection.

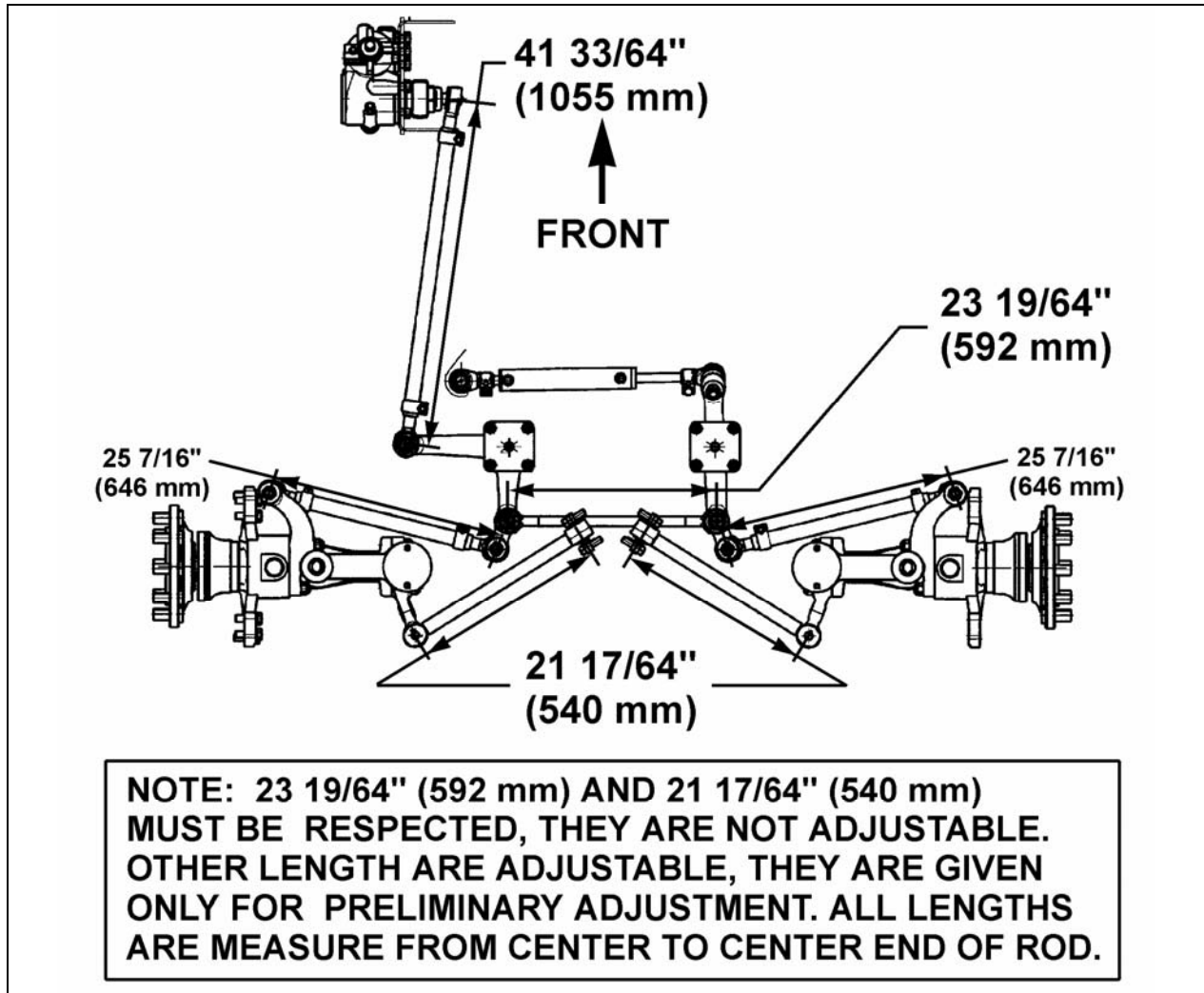


FIGURE 34: STEERING LINKAGE MEASURE

16050

### 6.11.1 Alignment Terminology

#### Wheel Camber

The amount the wheels are inclined from the vertical plane (A, Fig. 35).

#### 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. 35).

#### 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. 35).

#### Front Axle Caster

The inclination of the king pin from vertical in the fore and aft direction (C, Fig. 35).

### 6.11.2 Front End Inspection

Before checking front end alignment, make the following inspection:

1. Check that the vehicle is at normal ride height (see paragraph "8. Suspension Height Adjustment").
2. Check the tires for proper inflation.
3. Check wheel installation and run-out.

## Section 16: SUSPENSION

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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 rod is 21 17/64" (540 mm) (Fig. 34). Check if the length of the relay rod is 23 19/64" (592 mm)

### 6.11.3 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 locking 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.*

### 6.11.4 Front Wheel Toe-In

Toe-in is measured from the center of the tire treads. Measurements at the front and rear of the tires must be made at the same height from

the floor. Incorrect toe-in results in excessive tire wear and steering instability with a tendency to wander.

### Toe-In Check

1. Check the camber adjustment and adjust if necessary.
2. Hoist the front of the vehicle and spin the wheels marking the centerline of the tire treads.
3. Place the wheels in the straight ahead position and lower the vehicle to rest on the floor.
4. Roll the vehicle ahead several feet. This removes any slack caused by looseness in the wheel bearings or steering connections.
5. Check the distance between the tire centerlines at the front and rear of the front tires. These two measurements must be made at the same height above the floor. The front measurement must be  $3/32 \pm 1/32$  of an inch less than the rear measurement.

### Toe-In Adjustment

1. Loosen the tie rod clamp bolts.
2. Using a pipe wrench, turn the tie rod tubes to obtain the toe-in measurement specified in step 5 under paragraph "Toe-in Check".
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 20.

**Note:** *Use only tie rods to adjust toe-in.*

### 6.11.5 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 A-arm, lower suspension A-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.

Variations from the specified caster will affect steering stability, cause wandering, wheel shimmy, and reduce returnability when pulling out of curves.

<b>NOTE</b>
<i>On Independent Front Suspension, caster on right wheel must be equal or greater than caster on left wheel, without exceeding 0.3°.</i>

6.11.6 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 "Front End Alignment".

6.11.7 Alignment Specifications

See figure 35.

<b>NOTE</b>
<i>On Independent Front Suspension, caster on right wheel must be equal or greater than caster on left wheel, with a maximum difference of 0.3°.</i>

VIP INDEPENDENT FRONT SUSPENSION						
Load	Minimum value		Nominal value		Maximum value	
	Non-converted	Converted	Non-converted	Converted	Non-converted	Converted
Right camber	0.2°	-0.150	0.35°	0°	0.55°	0.200°
Left camber	0.2°	-0.150	0.35°	0°	0.55°	0.200°
Right caster	2.55°		2.8°		3.05°	
Left caster	2.55°		2.8°		3.05°	
Total toe-in	0.08°		0.10°		0.12°	

H3-45 Coaches WITH INDEPENDENT FRONT SUSPENSION			
	Minimum value	Nominal value	Maximum value
Right camber	0.0°	0.150°	0.35°
Left camber	0.0°	0.150°	0.35°
Right caster	2.35°	2.6°	2.85°
Left caster	2.35°	2.6°	2.85°
Total toe-in	0.06°	0.08°	0.10°

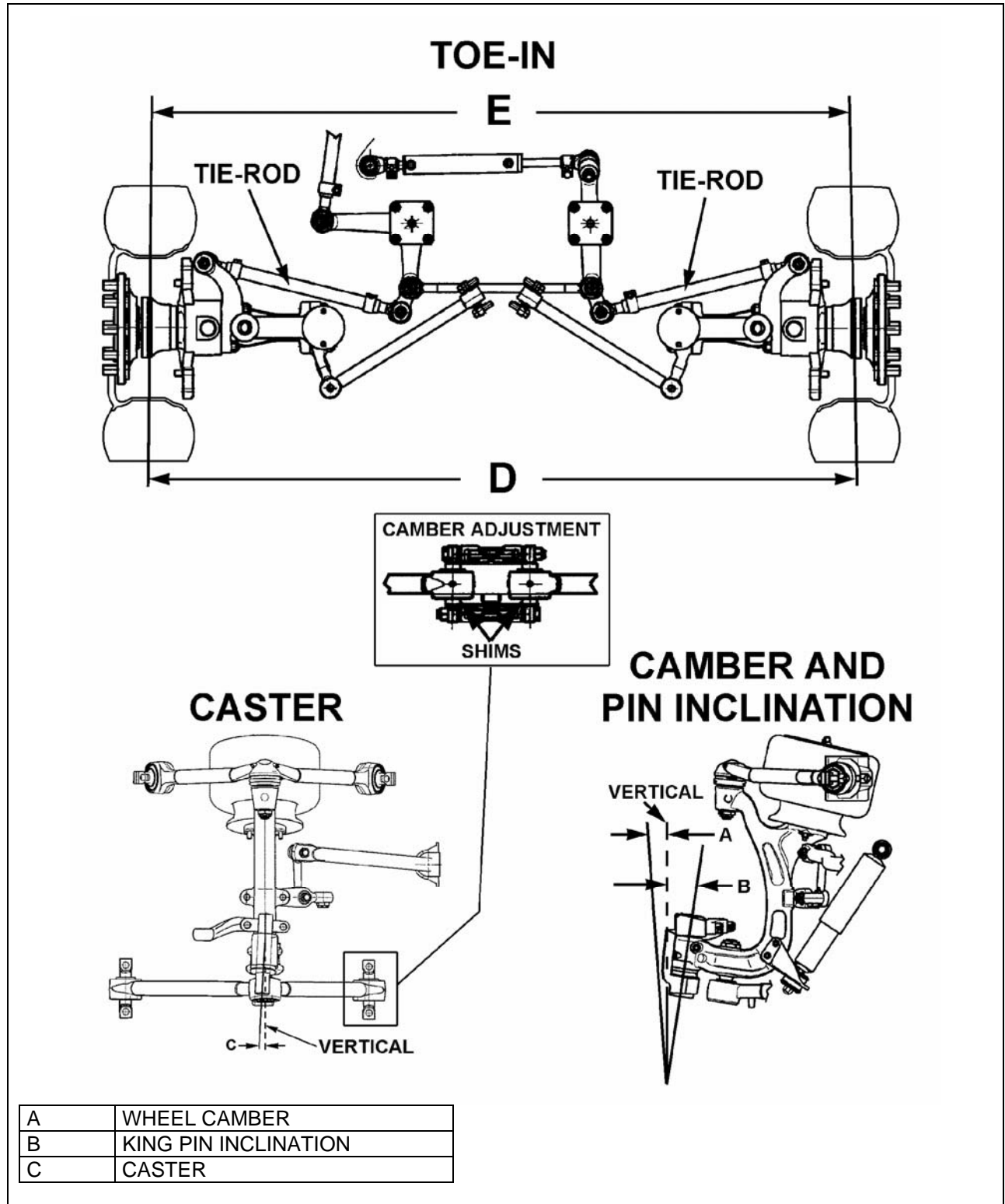


FIGURE 35: FRONT END ALIGNMENT DIAGRAM

16051

## 6.12 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.

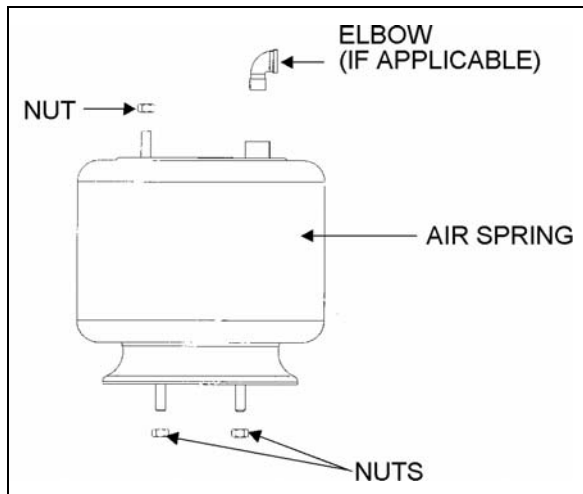


FIGURE 36: AIR SPRINGS

16052

### 6.12.1 Inspection

Refer to paragraph 2.1.

### 6.12.2 Removal

Refer to paragraph 2.2.

### 6.12.3 Installation

Refer to paragraph 2.1.3.

**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.

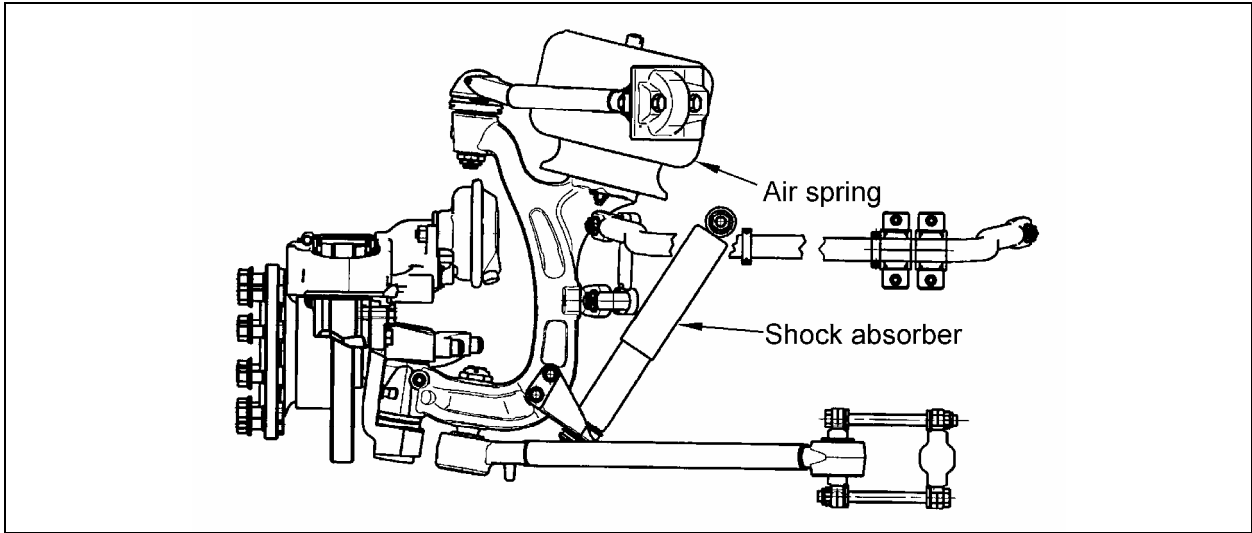


FIGURE 37: AIR SPRING AND SHOCK ABSORBER

16145

### 6.13 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 (Refer to the SACHS document "Guideline To Evaluate Warranty Claims" annexed at the end of this section before replacing a shock).

#### 6.13.1 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 38 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.

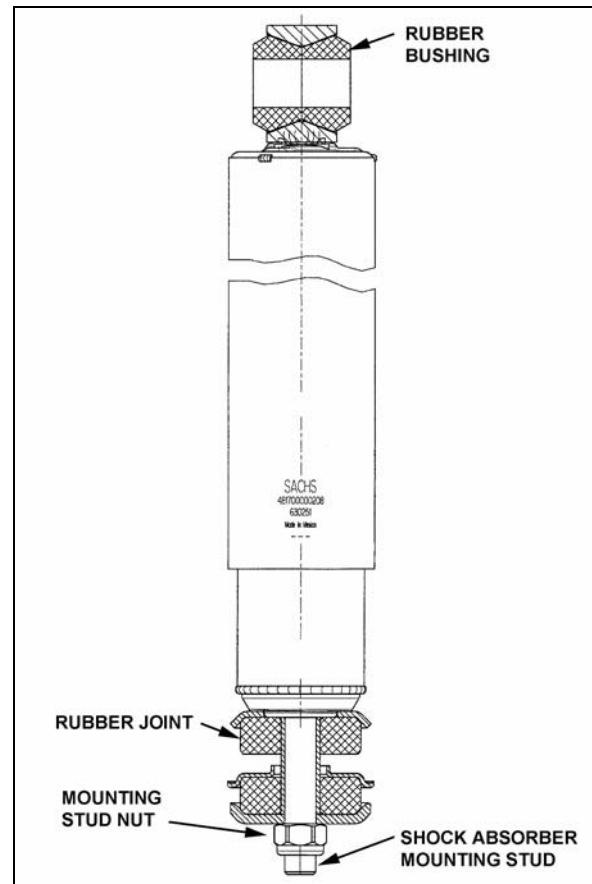


FIGURE 38: SHOCK ABSORBER

161124

#### 6.13.2 Shock Absorber Installation

1. Check that the shock absorber mounting pin is proper torque [350-400 lbf-ft dry (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. 38).
4. Install washer and rubber joint on shock absorber mounting stud (lower side).
5. Install the shock absorber as shown in figure 35 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 dry (81-102 Nm).
7. Place the upper mounting pin stud nut and torque to 70-85 lbf-ft dry (95-116 Nm).

## Section 16: SUSPENSION

### 6.14 SWAY BAR

A sway bar is provided on the IFS to increase vehicle stability. It controls lateral motion (swaying movement) of vehicle.

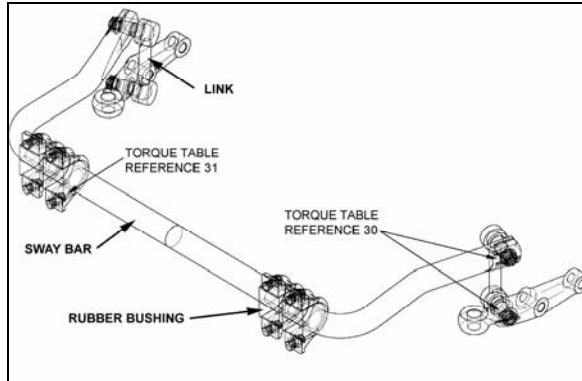


FIGURE 39: SWAY BAR (INDEPENDENT FRONT SUSPENSION)

16138\_C

#### 6.14.1 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.

#### 6.14.2 Installation

1. Loosely install the sway bar.
2. Torque bushing collar nuts to 80-100 lbf-ft dry (108-136 Nm).
3. Torque sway bar link upper nuts to 165-200 lbf-ft dry (224-271 Nm) on front suspension and to 100-120 Lbf-ft (136-163 Nm) on rear suspension.
4. Torque sway bar link lower nuts to 165-200 lbf-ft dry (224-271 Nm) on front suspension and to 70-80 lbf-ft (95-110 Nm) on rear suspension.

### 6.15 INDEPENDENT FRONT SUSPENSION ADJUSTMENT

VIP coach 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 air springs. To improve road comfort, an expansion air tank is installed in series with each air spring.

**Note:** Only for preliminary adjustment, refer to figure 34. 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.

#### 6.16 IFS HEIGHT ADJUSTMENT

The flow of pressurized air from the accessory air tank to the air springs is controlled by three height control valves. The two rear valves are mounted to the subframe and connected to the rear axles through an arm and link connection. The front valve is mounted to the subframe and connected to the front air tank support (Fig. 40). These connections allow the valves to apportion air pressure in the springs to the vehicle load, maintaining normal ride height.

Immediate response height control valves increase or decrease the air pressure in the suspension system as required. One height control valve is located **at center of front sway bar**, and regulates air to front suspension air springs in order to maintain the vehicle at the required height. Two are located at the drive axle, one on each inner side of rear wheelhousing.



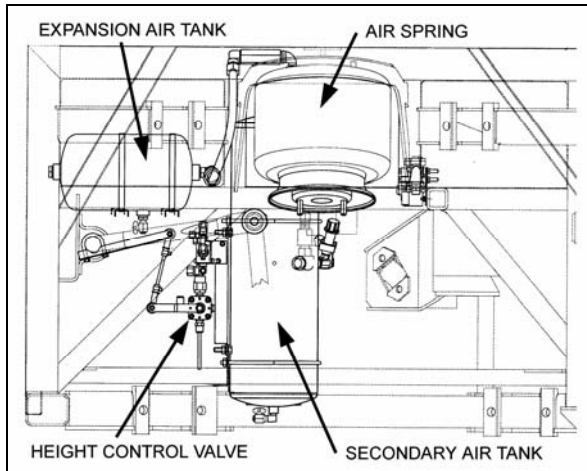


FIGURE 40: HEIGHT CONTROL VALVE LOCATION 16057

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  $11 \pm \frac{1}{4}$ " (279  $\pm$  6 mm). Refer to figure 41 to identify the correct area to take measurement. The rear air springs clearance should be  $11 \frac{1}{2} \pm \frac{1}{4}$ " (292  $\pm$  6 mm) (refer to paragraph "8.0 Suspension Height Adjustment" for rear height control valves' adjustment). 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.

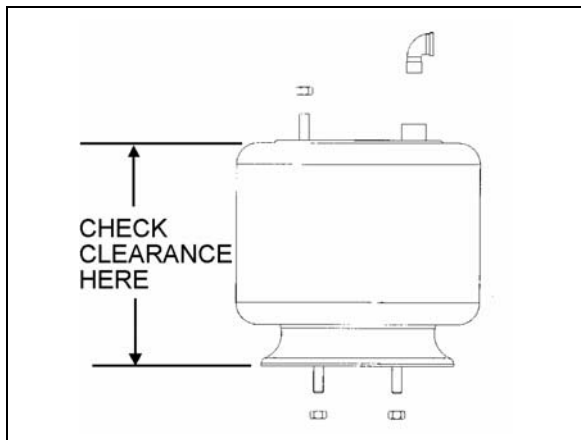


FIGURE 41: TYPICAL AIR SPRING CLEARANCE 16058

**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.

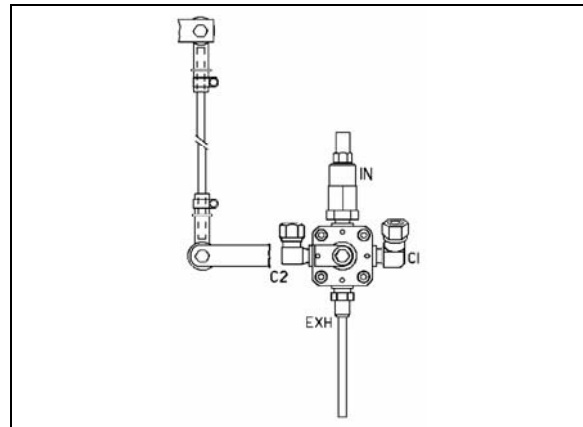


FIGURE 42: FRONT HEIGHT CONTROL VALVE 16100

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  $11 \pm \frac{1}{4}$ " (279  $\pm$  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 41 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. 32).

**Note:** Allow suspension to stabilize before taking reading.

When the desired height is obtained, tighten clamp.

**Rear air springs clearance**

Refer to paragraph "8.0 Suspension Height Adjustment".

6.17 "LEVEL-LOW" LEVELING SYSTEM – VIP SERIES OPTION ONLY

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.

### 6.17.1 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.

### 6.17.2 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".

## 7 SUSPENSION AIR SYSTEM

The suspension air system has its own air reservoir (accessory tank) which is located in the reclining bumper compartment. Pressurized air from the main tank (wet tank) flows through a pressure protection valve (PR-2), to the accessory air tank and through an air filter which is located in front service compartment.

The pressure protection valve (PR-2) is mounted to the supply port of the tank. This valve controls the pressure at which compressed air is delivered to the accessory air tank. The valve remains closed until a preset pressure is reached (approximately 70 psi (485 kPa)). It then opens and passes air out the delivery port.

The main use for this valve is to protect the main air system by ensuring at all times a sufficient air pressure in the main system (i.e. air delivered to the accessories will be shut off in case of a decrease in pressure). Maintenance and repair information on the pressure protection valve is supplied in the applicable booklet, annexed to Section 12, "Brakes and Air System" under reference number SD-03-2010.

**Warning:** Depressurize parts prior to removal.

### 7.1 INSPECTION

The following inspection should be performed at established service inspection periods. Performing these procedures will allow substandard performance to be discovered before the condition becomes bad enough to cause operator complaints and failure on a run.

1. Visually inspect the suspension air lines for evidence of chafing on metal parts or other damage.
2. Visually inspect the air springs for cracks, abrasion or other damage.
3. Replace any parts found to be damaged.

### 7.2 AIR LINE TEST

With the main air system at normal operating pressure, coat all suspension air line connections and air spring mountings with a solution of soap and water. Air leakage will produce soap bubbles. Any leak found must be corrected as no air leakage is permissible.

### 7.3 AIR TANK MAINTENANCE

Refer to Section 12, "Brakes and Air System" under "MAINTENANCE" for complete instructions on air tank maintenance.

## 8 SUSPENSION HEIGHT ADJUSTMENT

The flow of pressurized air from the accessory air tank to the air springs is controlled by three height control valves. These valves are mounted to the subframe and connected to the axles through an arm and link connection. This connection allows the valves to apportion air pressure in the springs to the vehicle load, maintaining normal ride height.

Immediate response height control valves increase or decrease the air pressure in the suspension system as required. One height control valve is located at center of front axle, and regulates air to front axle air springs in order to maintain the vehicle at the required height. Two are located at the drive axle, one on each inner side of rear wheelhouse. Refer to figure 3.

The appropriate vehicle body height is obtained by measuring the clearance of all the air springs installed on the front and drive axles. The clearance should be  $12 \pm \frac{1}{4}$ " ( $305 \pm 6$  mm) for the air springs installed on the front I-beam axle and  $11\frac{1}{2} \pm \frac{1}{4}$ " ( $292 \pm 6$  mm) for those installed on the drive axle. Refer to figure 41 to identify the correct location where the measure has to be taken. 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 the height of vehicle and down to lower it. Check that main air pressure is at normal operating pressure and raise the vehicle to the specified height.

**Caution:** Because of the "deadband", 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 through fill cycle.

To adjust suspension height, proceed as follows:

1. With the vehicle at normal operating air pressure, check the air spring clearance as illustrated in figure 43. This clearance should be  $12 \pm \frac{1}{4}$ " ( $305 \pm 6$  mm) for the front

I-beam axle air springs and  $11\frac{1}{2} \pm \frac{1}{4}$ " ( $292 \pm 6$  mm) for those on the drive axle.

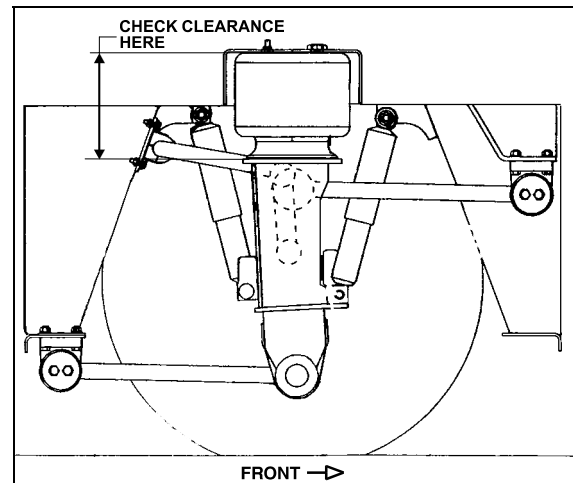


FIGURE 43: TYPICAL AIR SPRING CLEARANCE, FRONT I-BEAM AXLE 16108

**Note:** The measure should be taken from under the upper air spring support on subframe to top of the lower air spring support on axle (refer to figure 41 for more details). If adjustment is required, begin with the drive axle.

2. Loosen the adjusting nuts on the connecting rod of height control valve to raise or lower the overtravel lever until the desired clearance is reached.
3. If there is not enough play on adjusting nuts, it is possible to make further adjustments by loosening the clamp on the rubber coupling and bringing it up or down.

**Note:** Allow suspension to stabilize before taking reading.

4. When the desired height is obtained, tighten adjusting nuts and clamp.

## 9 HEIGHT CONTROL VALVES

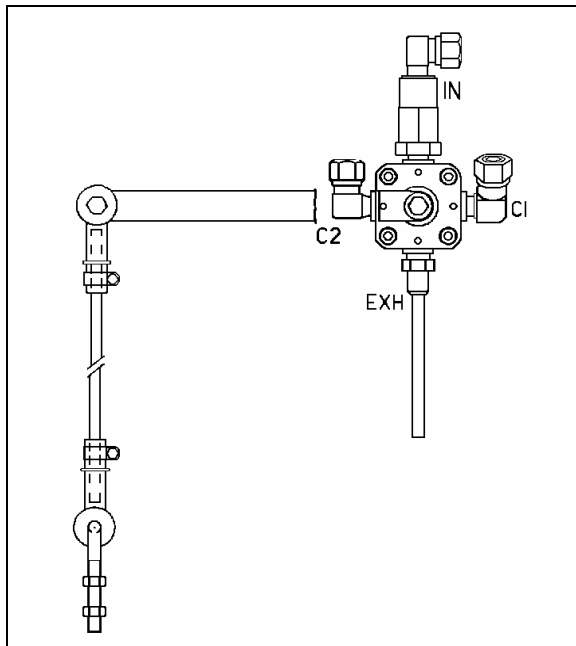


FIGURE 44: HEIGHT CONTROL VALVE

16093

The height control valves automatically add air to, or release air from air springs to maintain constant suspension height regardless of load, or load distribution. Each valve adjusts independently according to the following conditions:

### Loading position

As the load increases and lowers the vehicle body, the overtravel lever commands the height control valve to add air to air springs.

### Neutral position

When vehicle body reaches the normal ride height, the height control valve overtravel lever reaches the "neutral" position and keeps both the supply and exhaust ports closed to ensure normal ride height is maintained. This condition remains static until the vehicle load is altered.

### Unloading position

As the load decreases and raises the vehicle body, the overtravel lever commands the height control valve to release air from air springs.

## 9.1 MAINTENANCE

The height control valve requires no periodic maintenance. Height control valve linkage operates on rubber bushings and no lubrication should be attempted at this point. Inspect the valve for loose joints, air leaks and worn bushings.

### 9.1.1 Removal and installation

Before disconnecting any height control valve air lines, securely support the vehicle by its jacking points on the body, and place safety support underneath body. Refer to "VEHICLE JACKING POINTS" in Section 18, "Body".

1. Exhaust air from air system by opening the drain cock on accessory air reservoir. 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 ends of the lines 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.

### 9.1.2 Air leakage test

**Note:** The following procedure applies when valve assembly has been removed from vehicle.

1. Clean the exterior of valve assembly.
2. Connect air pressure line to air inlet port, then allow air pressure build-up (70- 100 psi (480 - 690 kPa)).
3. Dip the valve assembly in a container of water, and watch for air bubbles when the overtravel lever is in the center position. No air should escape from any point of the valve assembly.
4. If bubbles appear from the air spring port, this is an indication that the air inlet valve assembly is defective and must be replaced.
5. Remove air pressure line from air inlet fitting and connect it to the air spring port. If bubbles appear at the air inlet check valve port, this is an indication that check valve unit is defective and must be replaced.
6. If bubbles appear at the exhaust port, this is an indication that the exhaust valve assembly is defective and must be replaced.
7. If bubbles appear around edge of valve cover plate, the cover plate gasket must be replaced.

8. If no leaks are found, remove valve assembly from water, then with air pressure still connected to the air spring port, actuate overtravel lever to remove any excess water which may have entered exhaust valve chamber. Remove air line, connect it to the air inlet port, and repeat operation to remove water from the air inlet valve chamber.

## 10 FRONT KNEELING SYSTEM

The kneeling system is used to lower front of vehicle. This allows passengers to board the vehicle with greater ease. The kneeling action is achieved by exhausting air from the front air springs (bellows). This system bypasses the height control valve to provide a fast up and down movement of the front suspension. Only seven seconds are required to lower vehicle from normal level to the lowered position, and approximately the same time to raise the vehicle back to normal level. The quick response is achieved by the kneeling air tank installed beside the secondary air reservoir (for exact position, refer to Section 12, *“Brake and Air System”*).

This tank provides sufficient air supply to the kneeling system for some successive operations. On I-beam axle, a second kneeling air tank is available as an option. This second kneeling air tank is standard on coaches with Independent Front Suspension (IFS).

The system is provided with two safety features; first, a speed switch will enable the kneeling system to work only below 5 mph (8 km/h). Secondly, the parking brake is automatically applied, and a limit switch will keep it applied as long as the vehicle has not returned to a certain height where the driver will be able to manually remove the parking brake.

The purpose of the front axle hi-buoy function in this system is to raise the front end of the vehicle to allow an extra ground clearance for particular situations. In driving condition, the height control valve is in operation and only the hi-buoy can be operated.

### 10.1 PRINCIPLE OF OPERATION

Refer to the air system schematic diagram annexed at the end of Section 12, *“Brake and Air System”*.

DOWN (FRONT KNEELING):

Both the air spring control and air spring exhaust solenoid valves are energized, so the air control valves release air from front air springs. The height control valve is bypassed to ensure no air is forwarded to air springs while lowering the front suspension.

UP (FRONT HIGH-BUOY):

Only the air spring control solenoid valve is energized, so the air coming from the kneeling air tank is routed through air control valves, and up to front air springs.

The height control valve is bypassed until the kneeling proximity switch signals the kneeling module to cut off the air spring control solenoid valve, about 1" (25 mm) below normal ride height. The final height adjustment is achieved by the height control valve.

## 10.2 MAINTENANCE

Since the kneeling action is issued from both the air system and electrical system, refer to Section: 12, *“Brake and Air System”* and Section 06, *“Electrical System”*.

For diagnosis and understanding of the system, refer to wiring diagrams, and to the appropriate air system schematic diagram annexed to Section 12, *“Brake and Air System”*.

### 10.3 AIR SPRING CONTROL SOLENOID VALVES

#### 10.3.1 Removal and installation

1. On the rear side of steering compartment, locate both the air spring control and air spring exhaust solenoid valves.
2. Identify hoses and wires to ease reinstallation. Disconnect solenoid wires and the three flexible black hoses from solenoid valves.
3. Unscrew and remove the control solenoid valve and exhaust solenoid valve assembly. Place on a clean working place.

Reverse removal procedure to reinstall.

**Caution:** Any cable tie that has been cut during removal procedure should be replaced with a new one.

## 11 HIGH-BUOY SYSTEM

The purpose of the full high-buoy system is to raise the entire vehicle body about 4" (100 mm) in order to increase ground clearance to board a ferryboat, to jump a curb, etc. This system can be put into service during normal vehicle operation.

### 11.1 PRINCIPLES OF OPERATION

The rear high-buoy system is added over the front kneeling (with front high-buoy). The front end uses the same valves as the front kneeling (with front high-buoy). A solenoid valve is added to send air to the double shuttle valves for the rear end. It uses the same dash switch as the kneeling.

UP:

The air coming from the control valve, flows through double shuttle valves, to supply air springs. The double shuttle valves prevent height control valves from releasing air from air springs.

DOWN:

The control valve, on the dashboard, cuts off air supply, so the double shuttle valves allow height control valves to accomplish their function. Height control valves release air from air springs until suspension returns to its normal position.

### 11.2 MAINTENANCE

Refer to the air system schematic diagram "OPT. FRONT KNEELING WITH REAR HIGH-BUOY COMBINATION".

### 11.3 HIGH-BUOY – PRESSURE REGULATOR

The pressure regulator is located on ceiling of the spare wheel and tire compartment and is accessible through the reclining bumper. This valve should be adjusted to 90 psi (621 kPa).

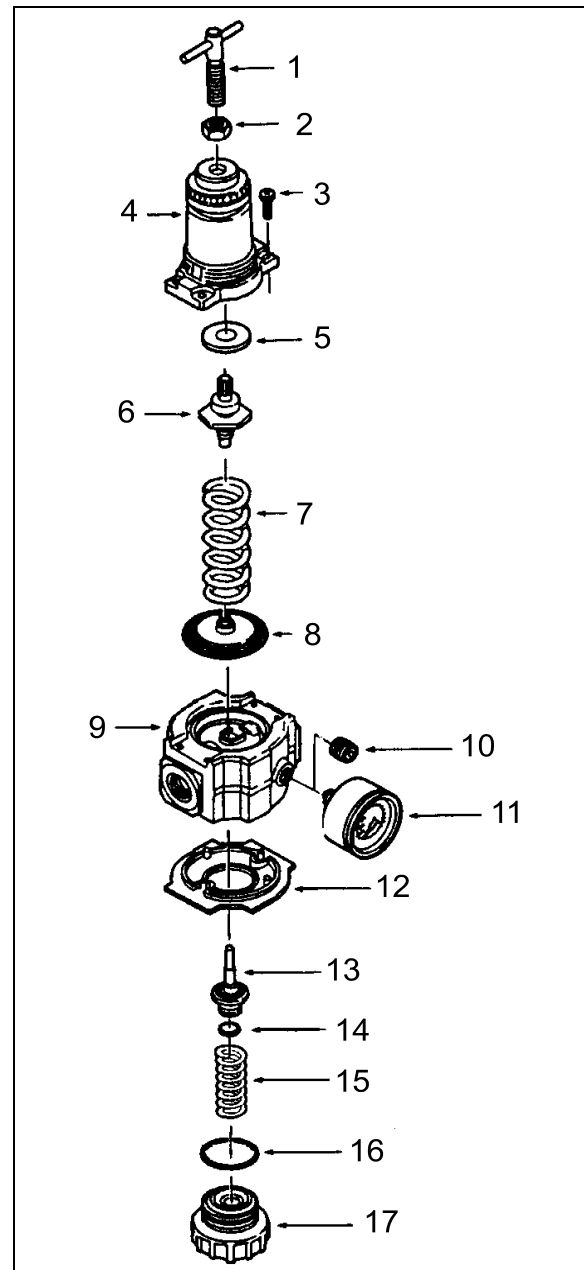


FIGURE 45: AIR PRESSURE REGULATOR

16035

#### 11.3.1 Adjustment

1. Before turning on system air pressure, release jam nut (2, Fig. 45) then turn regulator adjustment handle counter-clockwise until all load is removed from the regulating spring.
2. Turn on system pressure.
3. Turn regulator adjustment handle clockwise until the desired outlet pressure is reached.
4. To avoid minor readjustment after making a change in pressure setting, always

approach the desired pressure from a lower pressure. When reducing from a higher to a lower setting, first reduce the pressure at a lower pressure, and then increase it to the desired level of pressure.

5. Tighten jam nut (2, Fig. 45) to lock pressure setting.

### 11.3.2 Disassembly

1. Shut off inlet pressure and reduce pressure in inlet and outlet lines to zero. Turn regulator adjustment handle (1, Fig. 45) counterclockwise until all load is removed from regulating spring. Regulator can be disassembled without removal from air line.
2. Disassemble regulator in accordance with the item numbers on the exploded view.

### 11.3.3 Cleaning

1. Clean parts with warm water and soap. Dry parts and blow out internal passages in body using clean, dry compressed air.
2. Inspect parts. Replace those found to be damaged.

### 11.3.4 Reassembly

1. Lubricate O-ring (14 and 16, Fig. 45), valve stem (13, Fig. 45), tip of adjusting screw (1, Fig. 45), and the outer circumference and both sides of the thrust washer (8, Fig. 45) with a light coat of good quality O-ring grease.
2. Assemble the regulator as shown on the exploded view.

Torque Table	
Item	Torque in Lbf-inch (Nm)
3 (Screw)	25-35 (2.8-3.9)
17 (Bottom plug)	20-25 (2.3-2.8)

## 12 LOW-BUOY SYSTEM

The purpose of the low-buoy system is to lower the whole suspension by about 4" (100 mm) in order to reduce the overall height for low clearances. This system can be put into service during normal vehicle operation.

## 12.1 PRINCIPLES OF OPERATION

On H3-41 and H3-45 coaches, the rear low-buoy is added over the front kneeling system. The control valve on the left console panel sends an electric signal from its pressure switch to control the front suspension as if kneeling. It also removes air from a relay valve that exhausts air supply to all leveling valves and the quick release in the rear section. Air from the rear suspension can then be depleted through the check valve-quick release assembly.

### DOWN:

The control valve, on the L.H. control panel, cuts off air supply, so air is released from air springs. A relay valve prevents height control valves from supplying air springs.

### UP:

The control valve, on the L.H. control panel, supplies air to close the passage between both the delivery and supply ports. A relay valve opens and provides air springs until the suspension reaches the normal ride height.

## 12.2 MAINTENANCE

Refer to the air system schematic diagram "OPT. FRONT KNEELING WITH REAR LOW-BUOY COMBINATION".

## 13 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.

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. 46).

In addition, an expansion air tank is installed in series with each air spring.

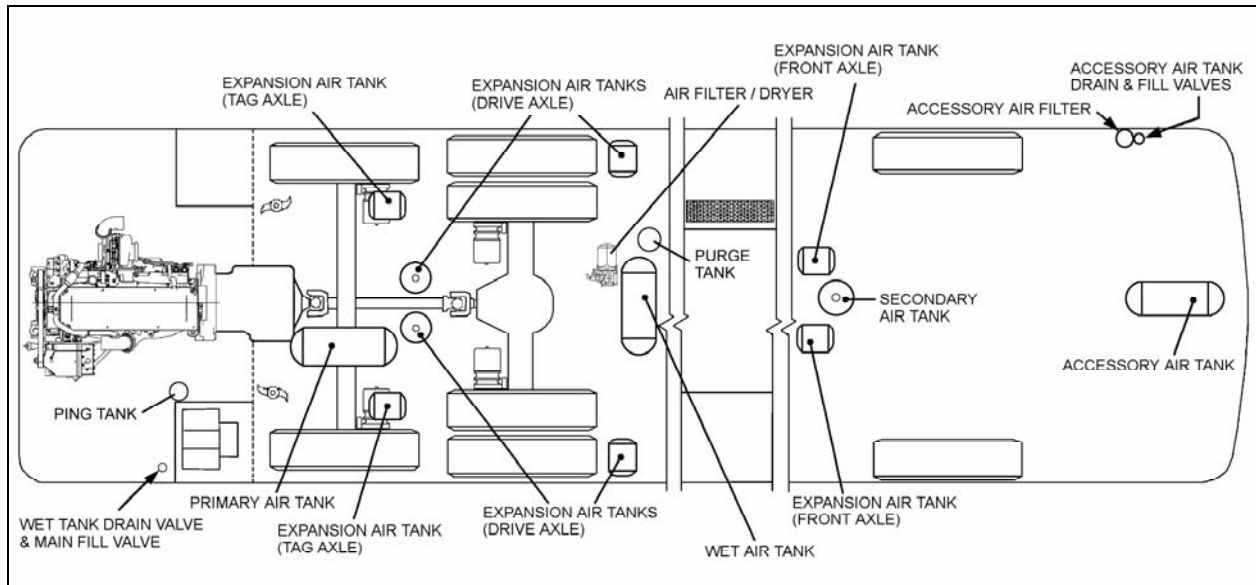


FIGURE 46: LOCATION OF AIR TANKS

12195

### 13.1 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. 48).

Moreover, purge all tanks by their bottom drain valves at specified intervals.

#### 13.1.1 Wet Air Tank

This tank is installed in front of and above drive axle in the rear wheelhousing 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 **purge daily** (Fig. 47).

#### 13.1.2 Primary Air Tank

The primary air tank is located above tag axle.

This tank is also provided with a bottom drain valve. It is recommended to purge the tank by its bottom drain valve every 12,500 miles (20 000 km), or once a year, whichever comes first.

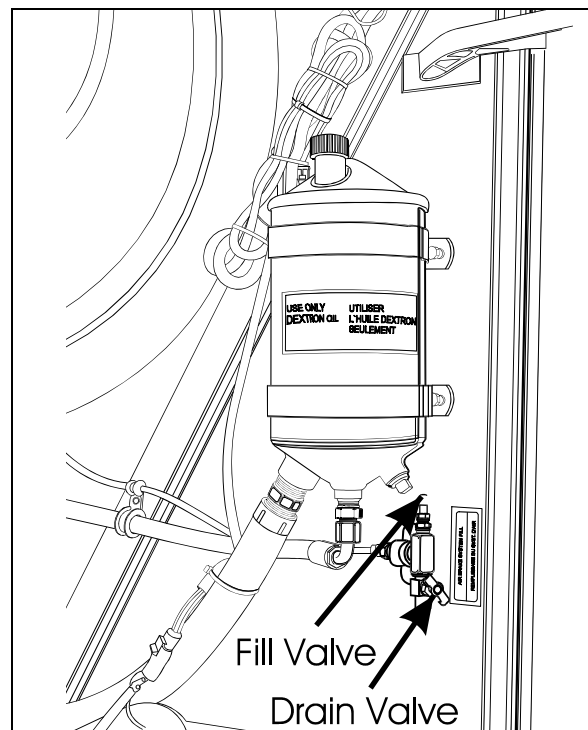


FIGURE 47: REAR VALVE LOCATION

12162

#### 13.1.3 Secondary Air Tank

This tank is located in front wheelhousing. The tank is installed vertically and is provided with a bottom drain valve (Fig. 46).

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.



### 13.1.4 Accessory Air Tank

The accessory air tank is installed at the ceiling of spare wheel compartment. The tank is provided with a bottom drain valve (Fig. 46).

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. 35) underneath the accessory air filter. Refer to Section 12, paragraph "4. Accessory Air Filter" of the maintenance manual for daily purge procedure.

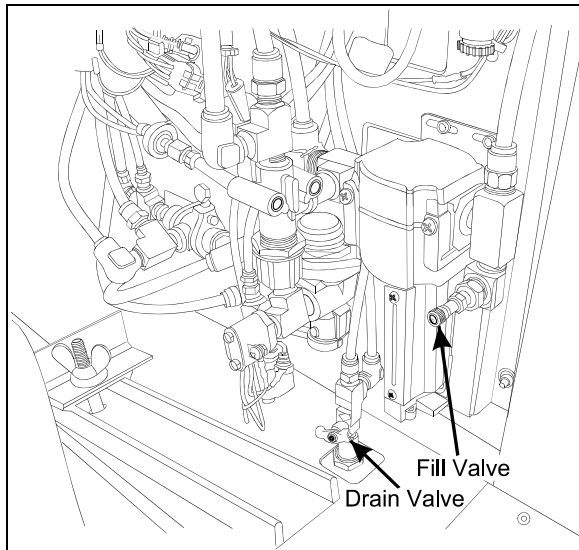


FIGURE 48: FRONT VALVE LOCATION  
12144

### 13.1.5 Expansion Air Tank

Two expansion tanks are located in front wheelhousing. These air tanks are located behind secondary air tank. Also, six expansion tanks are located near rear air springs (Fig. 46). 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.

## 13.2 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. 47).

**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. 48).

These two air valves are fitted with the same valve stems as standard tires, and can be filled by any standard external air supply line.

The rear valve will supply air for all systems (brakes, suspension and accessories) while the front valve will supply air for accessories only.

**Caution:** Air filled through these two points will pass through the standard air filtering system provided by Prevost. Do not fill air through any other points.

## 14 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 10 "Front Axle".

15 TORQUE SPECIFICATIONS

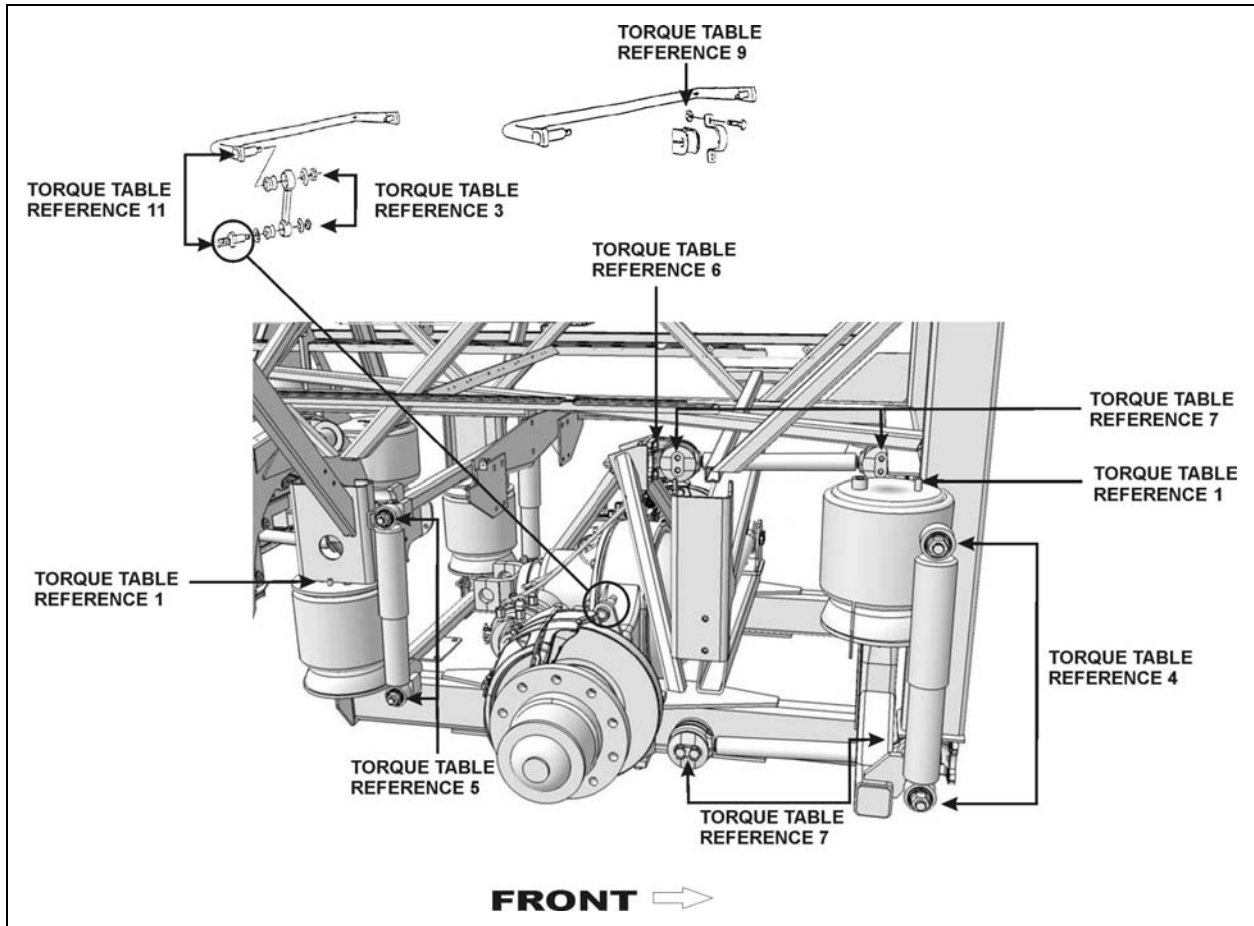


FIGURE 49: TORQUE SPECIFICATIONS – DRIVE AXLE

16158

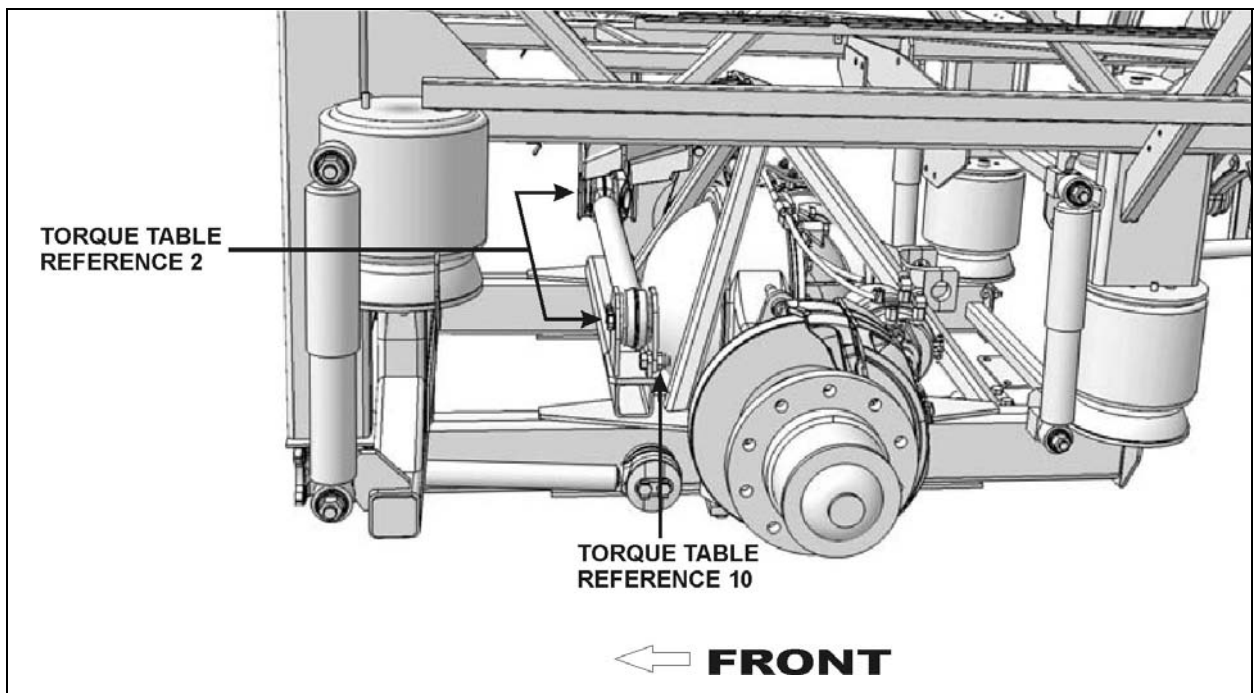


FIGURE 50: TORQUE SPECIFICATIONS – DRIVE AXLE

16159

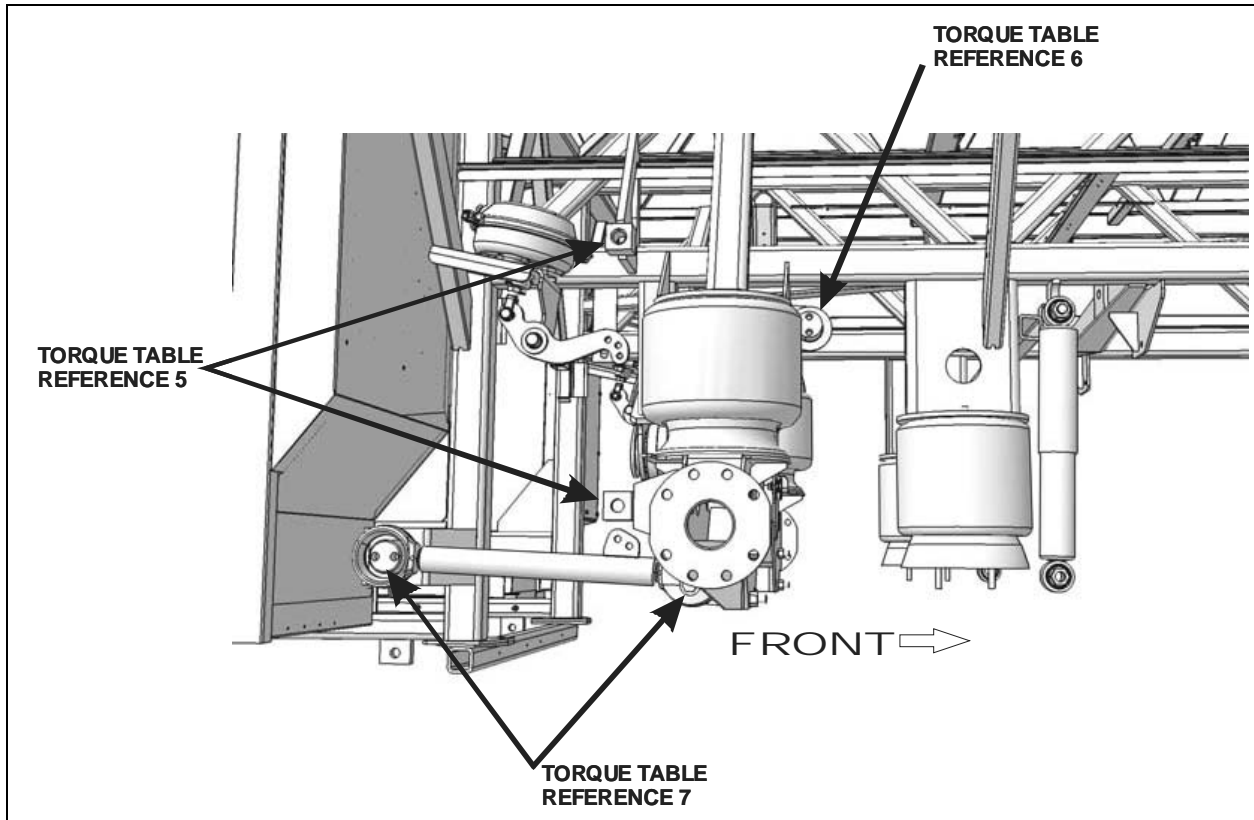


FIGURE 51: TORQUE SPECIFICATIONS – TAG AXLE

16160

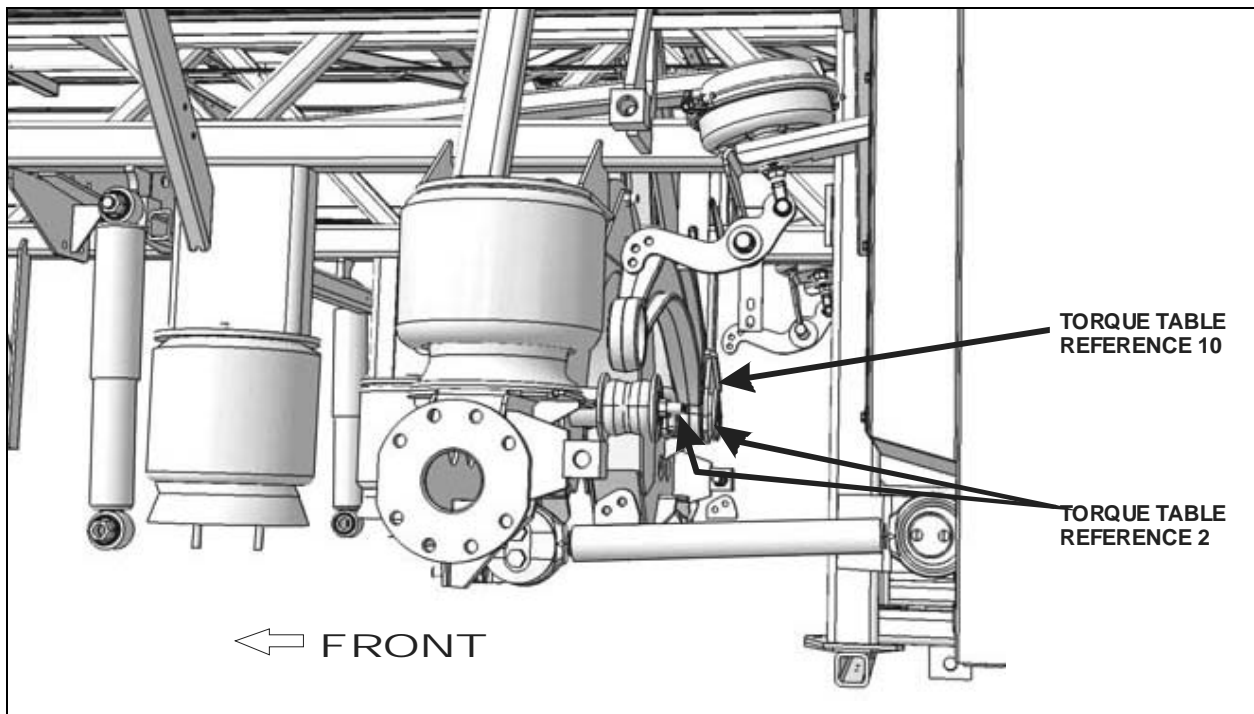


FIGURE 52: TORQUE SPECIFICATIONS – TAG AXLE

16161

Section 16: SUSPENSION

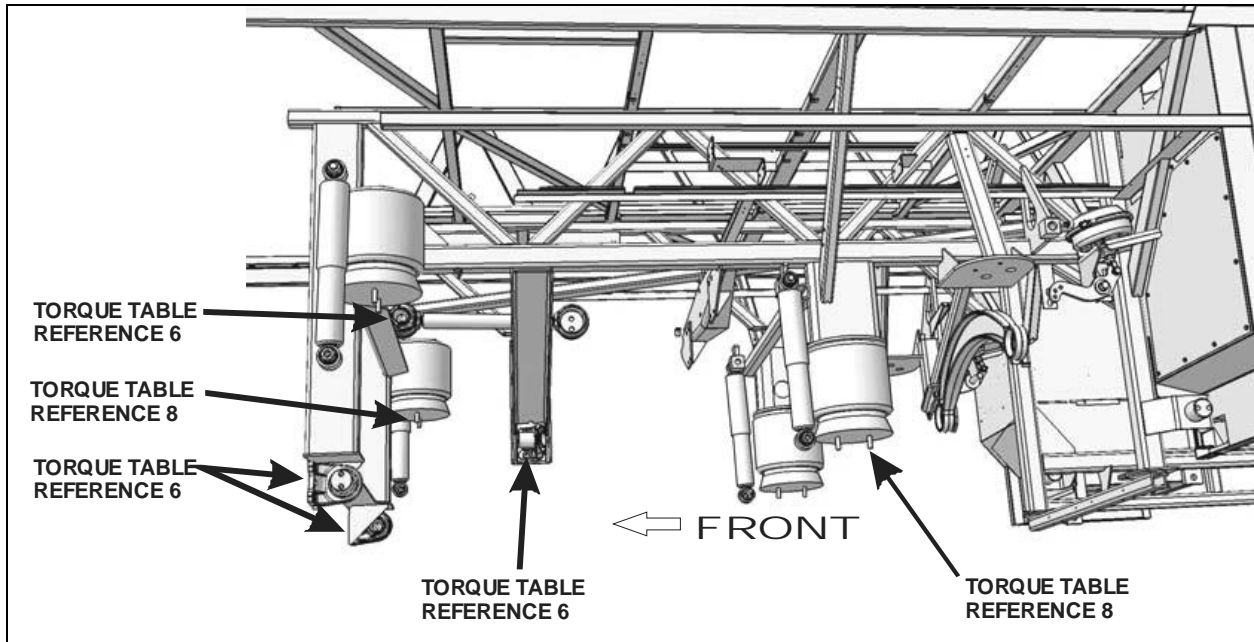


FIGURE 53: TORQUE SPECIFICATIONS – REAR SUBFRAME

16162

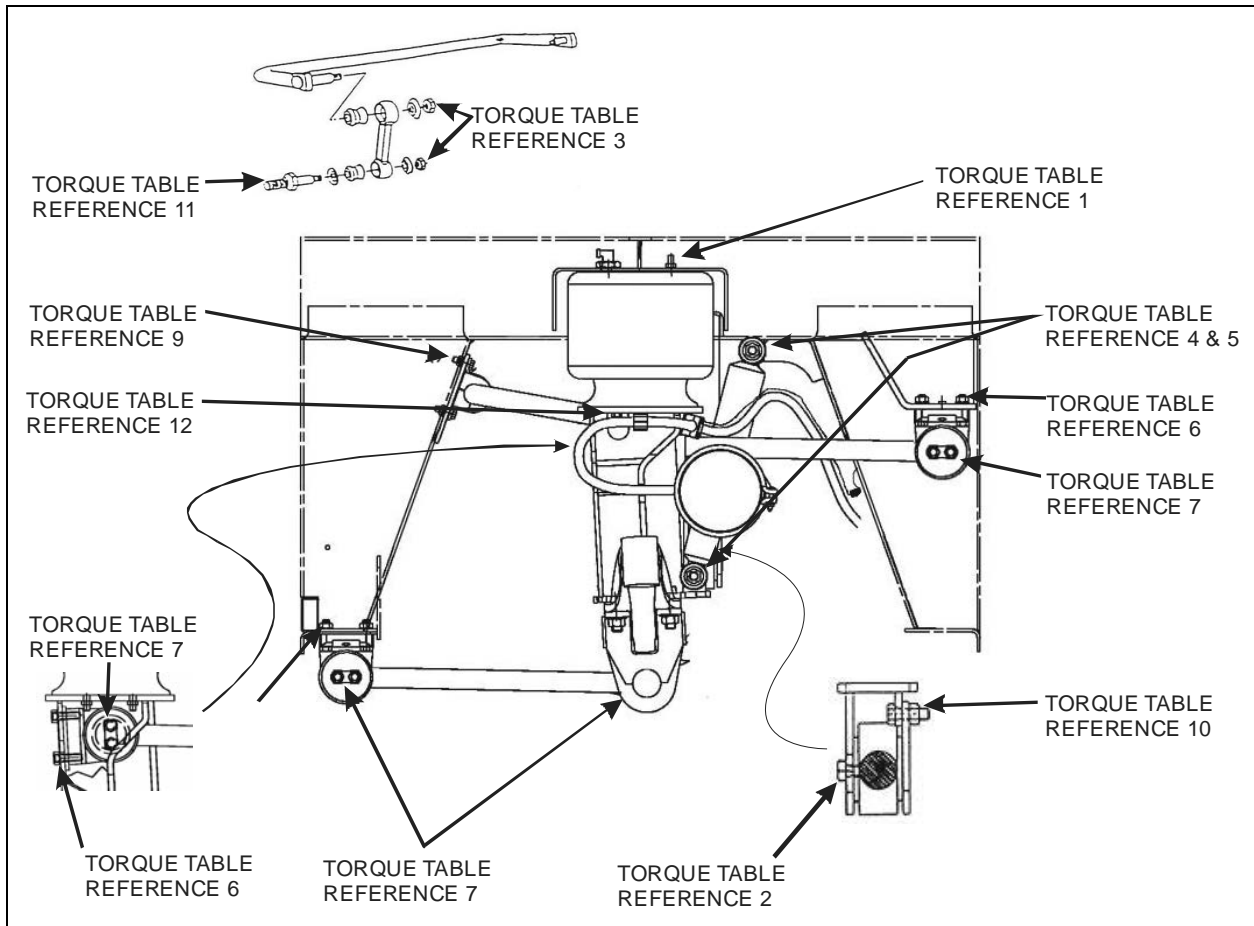


FIGURE 54: TORQUE SPECIFICATIONS – FRONT I-BEAM AXLE

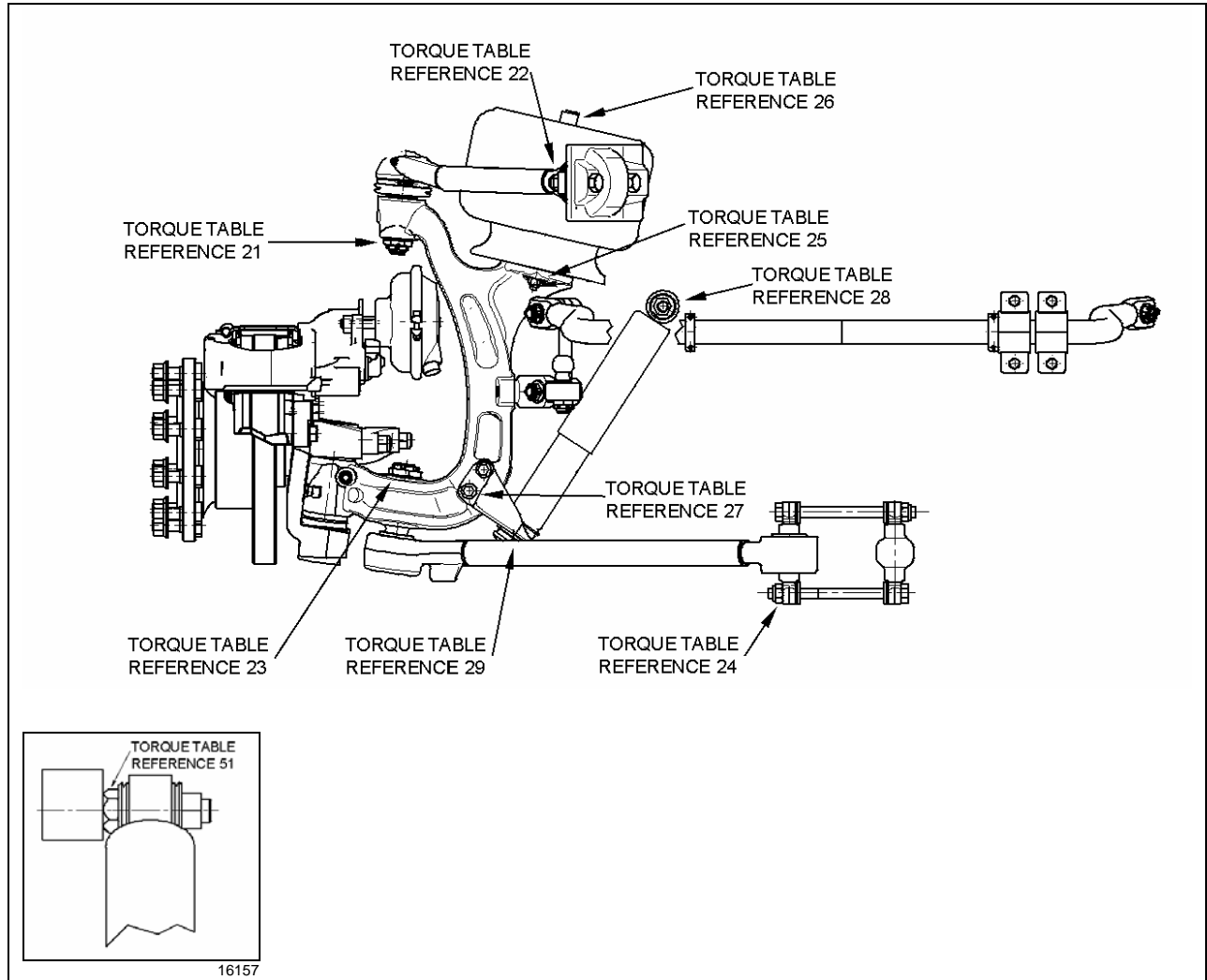


FIGURE 55: TORQUE SPECIFICATIONS

16146

## Section 16: SUSPENSION

TORQUE TABLE				
DESCRIPTION	QTY	REFERENCE	TORQUE DRY (lbf-ft / Nm)	
Air Spring Upper Stud Nut (8 air springs)	-	1	20-25	27-34
Transversal Radius Rod Retaining Bolts (Tag, drive & front axle)	-	2	140-155	190-210
Sway Bar Link Upper & Lower Nut	-	3	70-85	95-115
Shock Absorber Pin Nut (6 shock absorbers)	-	4	70-85	95-115
Shock Absorber Pin (8 shock absorbers) <sup>1</sup>	-	5	350-400	475-545
Radius Rod Support Nut/bolt (13 supports)	-	6	200-220	271-298
Radius Rod Retaining Bolts (10 longitudinal radius rods)	-	7	140-155	190-210
Air Spring Lower Stud Nut (6 air springs)	-	8	31-38	42- 51
Sway Bar Bushing Collar Bolt	-	9	80-100	108-136
Transversal Radius Rod Support Nut (Tag, drive & front axle)	-	10	250-280	339-380
Sway Bar Link Pin Stud	-	11	350-400	475-545
Air Spring Lower Stud Nut (2 front axle air springs)	-	12	20-25	27-34
Upper A-Arm Central Ball Joint (Castellated Hex Nut)*	2	21	210-250	284-339
Upper A-Arm Ball Joint	8	22	230-255	312- 346
Lower A-Arm Central Ball Joint (Castellated Nut)*	2	23	490-540	664- 732
Lower A-Arm Ball Joint	8	24	270-300	366-407
Air Spring Lower Nut (Front Suspension)	4	25	20-25	27-34
Air Spring Upper Nut (Front Suspension)	2	26	20-25	27-34
Shock Absorber Support	4	27	145-165	196-224
Shock Absorber Upper Mounting Pin Stud Nut	2	28	70-85	95-115
Shock Absorber Lower Mounting Pin Stud Nut	2	29	60-75	81-102
Sway Bar Link Upper and Lower Nuts (Front Suspension)	4	30	165-200	224-271
Sway Bar Bushing Collar (Front Suspension)	8	31	80-100	108-136
Idler Arm and Bell Crank Mounting Spindle Nut	8	32	90-105	122-142
Hydraulic power cylinder to bracket Stud Nut*	1	33	150-200	203-271
Hydraulic Power Cylinder End Clamp Bolt Nut	1	34 & 36	40-60	54-81
Hydraulic power cylinder to Idler Arm Stud Nut*	1	35	150-200	203-271
Relay Rod To Bell Crank Stud Nut*	1	37	150-200	203-271
Relay Rod to Idler Arm Stud Nut*	1	similar to 37	150-200	203-271
Tie Rod End Clamp Bolt Nut	4	38 & 40	50-60	68-81
Tie Rod to Steering Arm Stud Nut <sup>1</sup> *	2	39	150-200	203-271
Drag Link Socket End Clamp Bolt Nut	2	41 & 45	40-60	54-81
Drag Link to Pitman Arm Stud Nut*	1	42	150-200	203-271
Steering Gear to Mounting Bracket Bolt	5	43	365-405	495-549
Pitman Arm to Steering Gear Fixing Nut	1	44	470-570	637-773
Drag Link to Bell crank Stud Nut*	1	46	150-200	203-271
Tie Rod to Bell crank Stud Nut*	1	47	150-200	203-271
Tie Rod to Idler Arm Stud Nut*	1	similar to 47	150-200	203-271
Torque Rod Stud Nut	2	48	150-200	203-271
Torque Rod Mounting Bracket Nut	4	49	140-155	190-210
Torque Rod Mounting Bracket Stud	4	50	90-110	122-150
Shock Absorber Pin	2	51	350-400	475-545
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
Sway Bar Link Upper Nuts (Rear Suspension)	2	-	100-120	135-160
Sway Bar Link Lower Nuts (Rear Suspension)	2	-	70-80	95-110

\* Tighten nut to specified torque, then advance to next aligning cotter pin slot and install a new cotter pin.

### NOTE

Apply corrosion-protective compound on exposed threads.

**16 TROUBLESHOOTING**

Condition	Cause	Correction
Air springs deflate over time	<ol style="list-style-type: none"> <li>1. Defective check valve assembly.</li> <li>2. Defective exhaust valve assembly.</li> <li>3. Leak in air line and/or air springs.</li> <li>4. Defective valve cover, rubber O-rings or gasket.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace check valve assembly.</li> <li>2. Replace exhaust valve assembly.</li> <li>3. Replace air line or air springs.</li> <li>4. Replace valve cover, O-rings or gasket.</li> </ol>
Air springs raise to full height and fail to exhaust air pressure	<ol style="list-style-type: none"> <li>1. A clogged exhaust screen in height control valve assembly.</li> <li>2. A combination clogged exhaust screen and defective air inlet valve assembly.</li> </ol>	<ol style="list-style-type: none"> <li>1. Remove and clean screen.</li> <li>2. Clean exhaust screen and replace air inlet valve assembly.</li> </ol>
Erratic valve action	<ol style="list-style-type: none"> <li>1. Dirt or foreign matter in the air valve lever chamber.</li> <li>2. Defectives valves.</li> </ol>	<ol style="list-style-type: none"> <li>1. Remove valve cover and blow out dirt. Install cover using new gasket.</li> <li>2. Overhaul height control valve assembly</li> </ol>
Vehicle body fails to level to satisfactory ride height	<ol style="list-style-type: none"> <li>1. Improper height control valve overtravel lever adjustment</li> </ol>	<ol style="list-style-type: none"> <li>1. Adjust lever as directed.</li> </ol>

**17 SPECIFICATIONS**

**Independent Front Suspension - Front Axle Air Springs (VIP)**

Make.....Goodyear Tire and Rubber  
 Diameter..... 14.5 inches  
 Air Inlet ..... 1/2"-14 NPTF AIR INLET  
 Prevost number .....630239

**Independent Front Suspension - Front Axle Air Springs (H3-45)**

Make.....Goodyear Tire and Rubber  
 Diameter..... 12 inches  
 Air Inlet ..... 1/2"-14 NPTF AIR INLET  
 Prevost number .....630262

**Front I-Beam axle air springs and tag axle air springs**

Make.....Goodyear Tire and Rubber  
 Model..... 1200  
 Type .....Mae West  
 Nominal diameter ..... 12" (304 mm)  
 Prevost number ..... 630258

**Drive axle air springs**

Make.....Goodyear Tire and Rubber  
 Model..... 1100  
 Type ..... Double Flare  
 Nominal diameter ..... 11" (279 mm)  
 Prevost number ..... 630260

**Independent Front Suspension - Shock Absorbers**

## Section 16: SUSPENSION

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Collapsed length ..... 366±3 mm  
Extended Length ..... 576±3 mm  
Prevost number ..... 630251

### Independent Front Suspension - Shock Absorbers (H3-45)

Collapsed length ..... 366±3 mm  
Extended Length ..... 576±3 mm  
Prevost number ..... 630136

### Shim (Camber Adjustment)

Thickness ..... 3.175 mm  
Prevost number ..... 160993  
Thickness ..... 6.35 mm  
Prevost number ..... 160992  
Thickness ..... 4.76 mm  
Prevost number ..... 661094  
Thickness ..... 1.52 mm  
Prevost number ..... 661101

### Front I-Beam axle shock absorbers

Make ..... Sachs  
Color ..... Black  
Type ..... N45X225HA  
Ext. Diam. .... 75 mm  
Collapsed length ..... 15.51" (394 mm)  
Extended length ..... 24.37" (619 mm)  
Prevost number ..... 630252

### Drive and tag axle shock absorbers

Make ..... Sachs  
Color ..... Black  
Type ..... N45X225HA  
Ext. Diam. .... 75 mm  
Collapsed length ..... 15.51" (394 mm)  
Extended length ..... 24.37" (619 mm)  
Prevost number ..... 630253

### Height control valve (IFS)

Make ..... Barksdale  
Quantity used ..... 1  
Prevost number ..... 630157

### Height control valve (coach, all axles & VIP, rear only)

Make ..... Barksdale  
Quantity ..... 2 or 3  
Prevost number ..... 630156

### Bellows control and exhaust solenoid valve assembly

Make ..... Norgren



**Solenoid valve manifold**

Prevost number ..... 641130

**Coil**

Voltage ..... 24 V DC

Current draw ..... 29 amperes

Prevost number ..... 641144

**Valve (3 way, 2 positions)**

Type ..... N/C

Supplier number ..... 411-C-456235W

Prevost number ..... 641357

Type ..... N/O

Prevost number ..... 641356

**Radius rod bushing**

Make ..... Prevost

Prevost number ..... 630021

**Loctite**

Make ..... Loctite

Prevost number ..... 680039

**Sway bar bushing (Independent Front Suspension (H3-45))**

Make ..... Prevost

Prevost number ..... 630020

**Sway bar bushing (Front Axle)**

Make ..... Prevost

Prevost number ..... 131355

**Sway bar bushing (Drive Axle)**

Make ..... Prevost

Prevost number ..... 130953

**Sway bar link bushings**

Prevost number ..... 506678

**Shock absorber bushings**

Make ..... Monroe

Prevost number ..... 630062

**Section 16: SUSPENSION**

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**High-Buoy Pressure regulator**

Make..... Norgren  
Recommended pressure setting ..... 90 psi (621 kPa)  
Prevost number ..... 641352

## Guideline to Evaluate Warranty Claims Heavy-duty Shock Absorbers

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### Index:

- 1) Inspection
- 2) Misting
- 3) Leakage
- 4) Noise – Rubber Bushings
- 5) Noise – Scratching Metal Dust Cover
- 6) Damping Performance

### 1) Inspection

It is recommended to inspect Sachs shocks visually during regular maintenance schedules, however at least:

- linehaul applications: every 100,000 miles
- vocational applications: every 50,000 miles

The visual inspection should include

- the shock itself (leakage, any irregularities)
- shock bushings
- tires (tire cupping)

The most common failures and their possible causes are compiled in this document. By understanding the cause you may be able to correct the problem, avoid future failures and ensure ride safety.

### For further assistance please contact:

Sachs Automotive of America

(859) 647 – 84 47      Ivan Botello  
or (248) 458 – 36 88      Jim C. King

## Guideline to Evaluate Warranty Claims Heavy-duty Shock Absorbers

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### 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

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### 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

## Guideline to Evaluate Warranty Claims Heavy-duty Shock Absorbers

---

### 4) Noise - Rubber Bushings

Noise emitted during operation is not necessarily caused by defective shocks.

Therefore in case of noise issues:

Check all relevant suspension and axle components, e.g. rubber mounts, springs, jounce stops, bushings, steering.



#### Rubber bushing „worn“ or „deformed“

##### OBSERVATION:

- rubber bushing is visibly deformed or damaged
- eye (or „loop“) is eccentrically deformed
- sleeve is not centered within bushing

##### CAUSE:

- extensive use of rebound stop, incorrect ride height, shock may be too short for application
- extremely high conical angles, not suitable for this design

##### EFFECT:

noise, increased wear of shock and suspension

##### ACTION:

- verify ride height
- verify that shock is suitable for this application
- replace defective shock absorber



## Guideline to Evaluate Warranty Claims Heavy-duty Shock Absorbers

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### 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



## Guideline to Evaluate Warranty Claims Heavy-duty Shock Absorbers

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### 6) Degradation of Damping Performance

It is impossible to verify the correct damping characteristic of a shock absorber without a dynamometer. In the field, the following, more practical test can help to identify a shock, which is suspected to have failed:

- 1) Conduct test few minutes after operating the vehicle
- 2) Touch a metal element of the chassis to determine a reference temperature
- 3) Carefully touch the shock reservoir tube (lower tube, smaller diameter) on either side of the same axle to measure temperature of shock absorbers
- 4) Both shocks should be
  - warmer than the original reference point
  - similar in temperature
- 5) A cool or significantly colder shock absorber likely is a failure and needs to be replaced
- 6) After removal from the vehicle, the following may hint to the cause of failure:
  - Manually stroke shock several times in vertical position: no or delayed resistance would indicate a loss of damping force.
  - Shake shock upside down: rattling would indicate a broken internal component
- 7) A final determination can only be made by the manufacturer, using a dynamometer

#### **Other indicators of damping force degradation include:**

- a) ride deterioration
- b) deteriorated rubber attachments
- c) uneven tire wear („tire cupping“)
- d) excessive vibrations and premature wear on other vehicle components

**EFFECT:** Reduced ride control, comfort and safety

**ACTION:** Replace shock absorber



# SECTION 18: BODY

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1. VEHICLE EXTERIOR

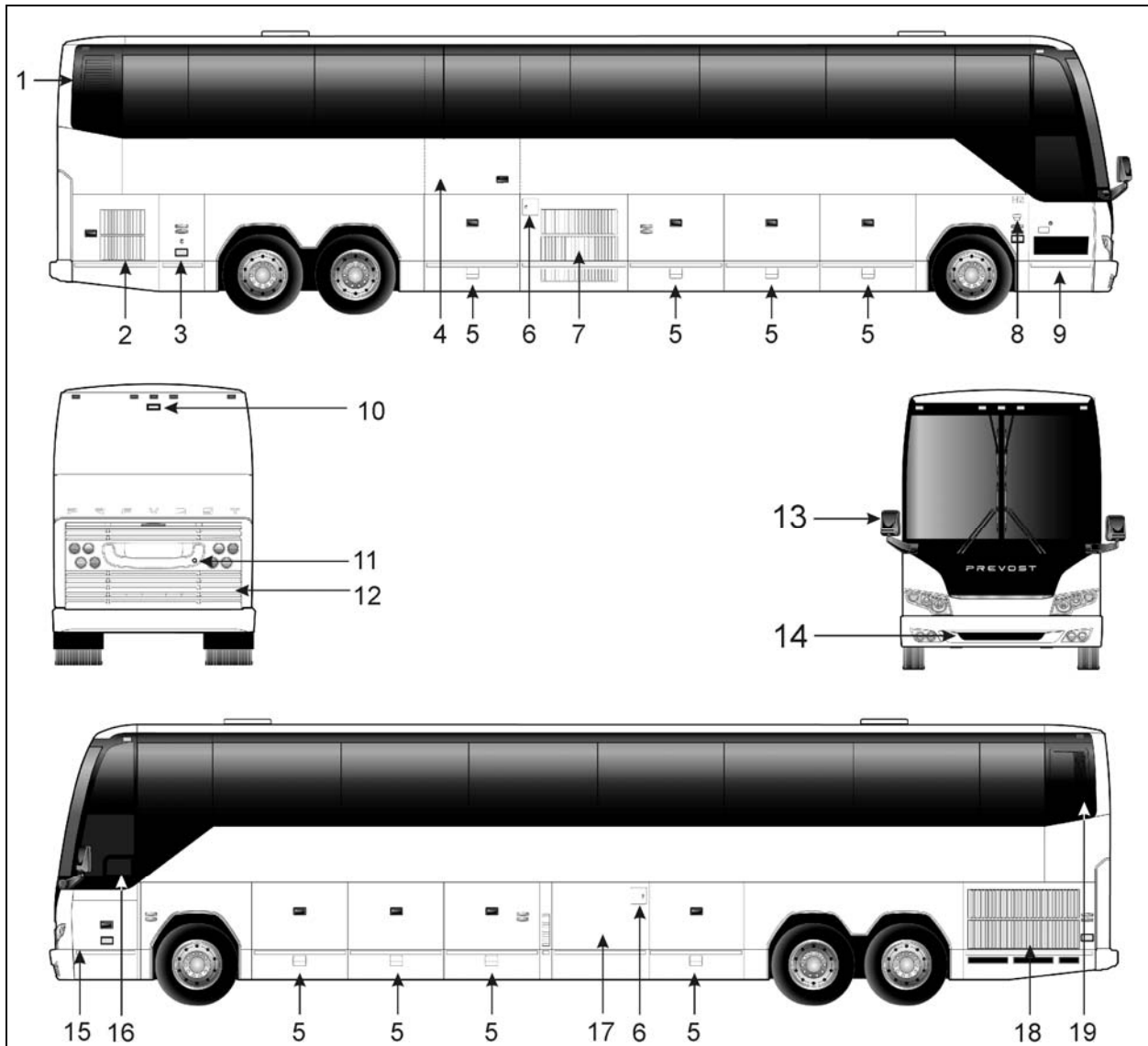


FIGURE 1: H3-45 (TYPICAL)

18681

- |   |   |
|---|---|
| 1. Engine air intake                            | 11. 120-volt connector for engine block heater              |
| 2. Engine compartment curb-side door            | 12. Engine compartment rear door                            |
| 3. Main power compartment (battery compartment) | 13. Rear-view mirror  |
| 4. Wheelchair access door (optional Ricon lift) | 14. Spare wheel compartment                                 |
| 5. Baggage compartment                          | 15. Front electrical and service compartment                |
| 6. Fuel filler door                             | 16. Driver's power window                                   |
| 7. Condenser compartment                        | 17. Evaporator compartment                                  |
| 8. Entrance door control switch                 | 18. Radiator door   |
| 9. Entrance door                                | 19. Diesel Particulate Filter (DPF) compartment access door |
| 10. Back up camera (optional)                   |   |

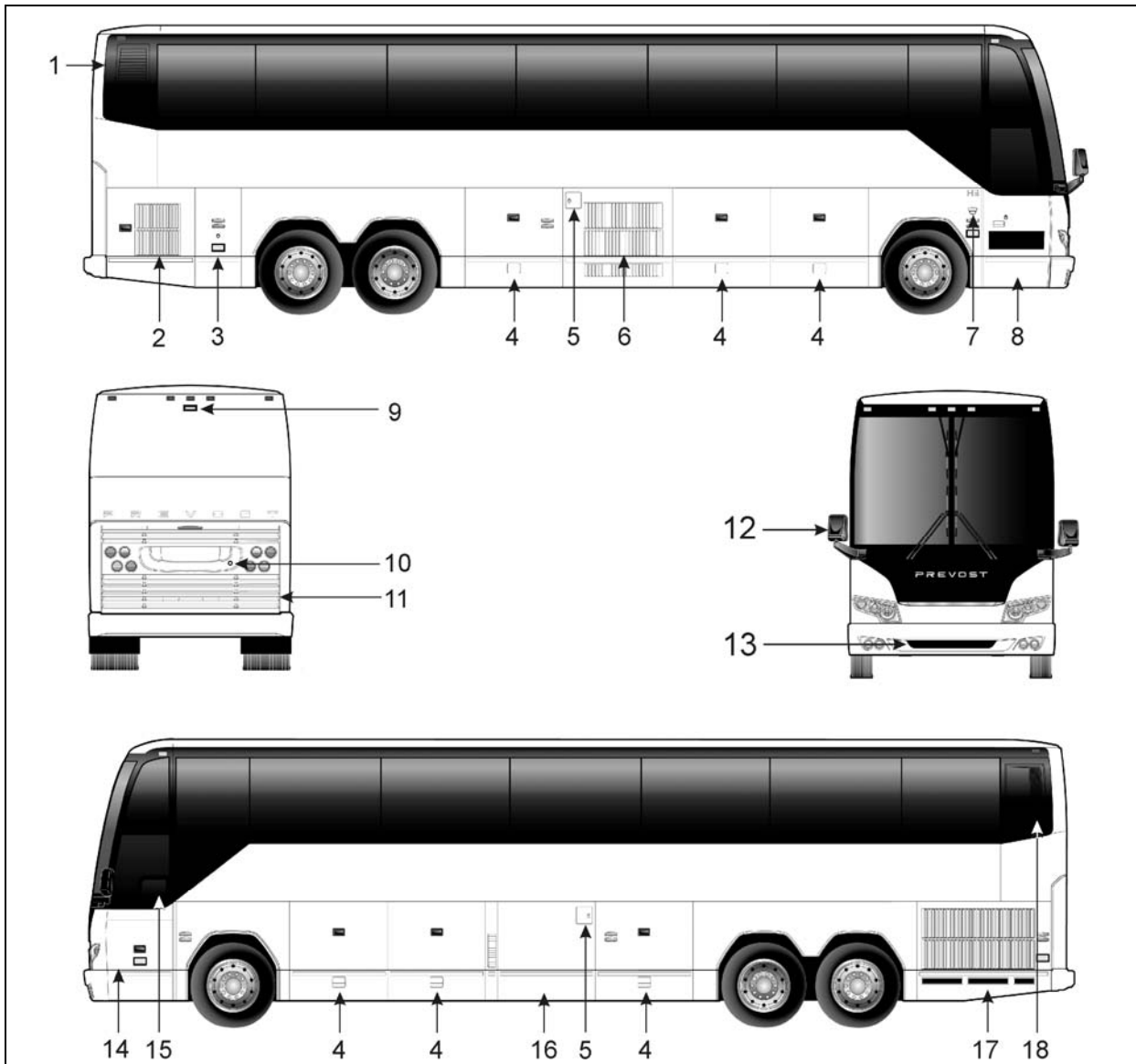


FIGURE 2: H3-41 (TYPICAL)

18682

- |   |   |
|---|---|
| 1. Engine air intake                            | 10. 120-volt connector for block heater                     |
| 2. Engine compartment curb-side door            | 11. Engine compartment rear door                            |
| 3. Main power compartment (battery compartment) | 12. Rear-view mirror  |
| 4. Baggage compartment                          | 13. Spare wheel compartment                                 |
| 5. Fuel filler door                             | 14. Front electrical and service compartment                |
| 6. Condenser compartment                        | 15. Driver's power window                                   |
| 7. Entrance door control switch                 | 16. Evaporator compartment                                  |
| 8. Entrance door                                | 17. Radiator door   |
| 9. Back up camera (optional)                    | 18. Diesel Particulate Filter (DPF) compartment access door |

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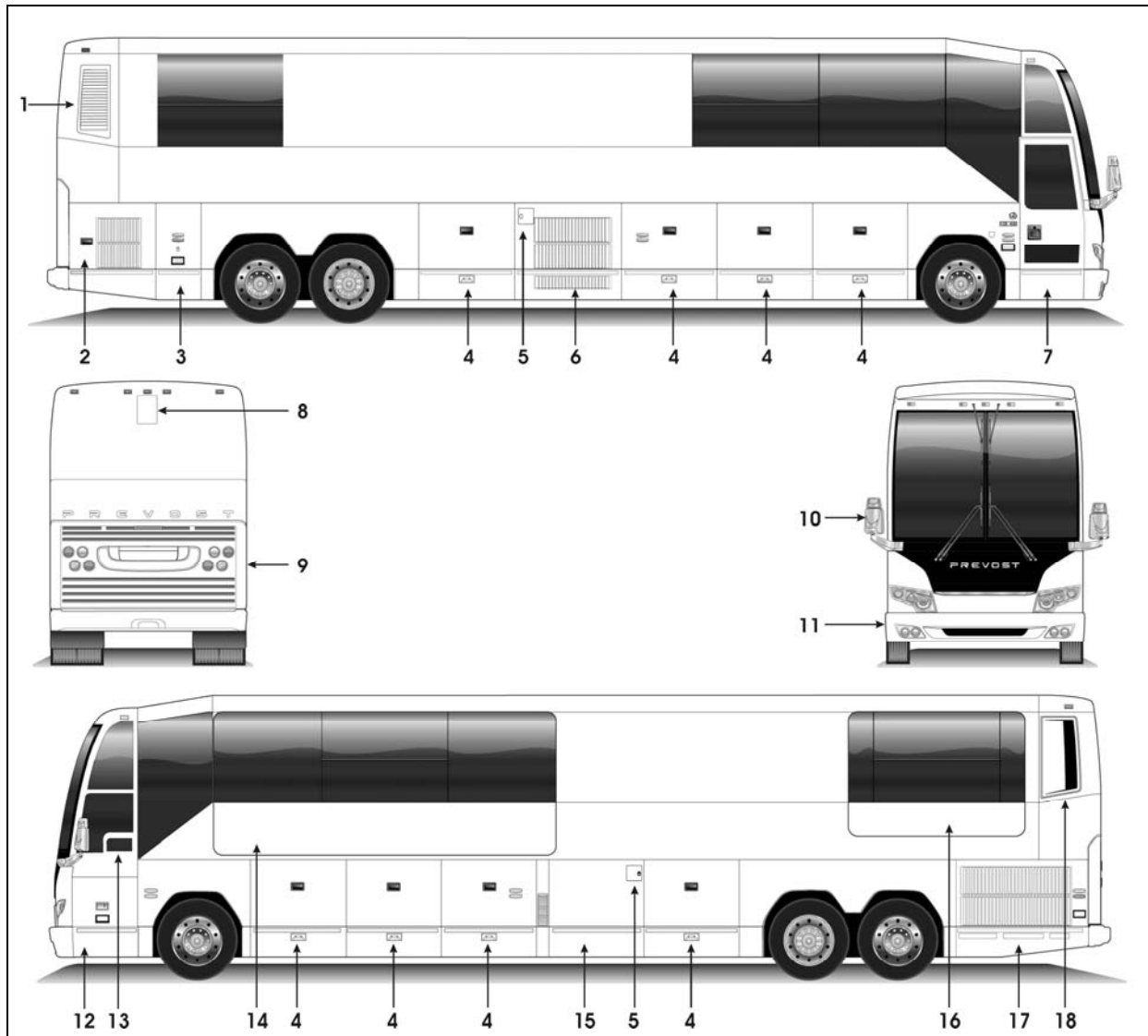


FIGURE 3: H3-45 VIP EXTERIOR VIEW

18677

- |   |   |
|---|---|
| 1. Engine air intake                                | 12. Front electrical and service compartment  |
| 2. Engine R.H. side access door                     | 13. Driver's power window   |
| 3. Main power compartment                           | 14. Front Slide-out   |
| 4. Baggage compartment                              | 15. Heating, ventilating and air conditioning compartment (HVAC) or baggage compartment |
| 5. Fuel filler door                                 | 16. Rear Slide-out  |
| 6. A/C condenser compartment or baggage compartment | 17. Engine radiator door  |
| 7. Entrance door                                    | 18. Diesel Particulate Filter (DPF) compartment access door                             |
| 8. Retractable back up camera (optional)            |   |
| 9. Engine compartment rear door                     |   |
| 10. Rear-view mirrors                               |   |
| 11. Reclining bumper compartment                    |   |



## 2. STRUCTURE

The body of the H3-41, H3-45 and VIP vehicles is an integral structure made of 14, 16 and 18 gauge welded and braced high tensile steel and stainless steel members. The roof arches are made with cold rolled, electrically welded (CREW) steel tubes, 1 ½" x 2" x 14 gauge. The inside is filled with urethane foam and the exterior is primed. The front subframe is made of open sections of high-strength steel alloy. These open sections permit a better application of primer and undercoating, and does not trap moisture. The rear subframe is made of closed sections of high tensile steel sealed at both ends.

### 2.1 WELDING

Since welding is a procedure that may be carried out either as specific instructions from Prevost or by an independent decision of the owner, the following information pertaining to welding should be read before beginning any welding procedure. The prohibitions and requirements outlined below must be followed during welding procedure:

1. Welding must be done only by a qualified and experienced person.
2. Adequate ground contacts and shields must be positioned as required to protect components from damage due to heat, contact by weld splatter, arcing, or other potentially damaging events associated with welding.
3. The following precautions are to be taken to protect the electronic control components. Refer to Section 00, paragraph 3, "PRECAUTIONS TO BE OBSERVED BEFORE WELDING" in this manual.
4. Always wear the appropriate safety equipment.

Weld in clean and well ventilated area, and always have an appropriate fire extinguisher within your reach

## 3. EXTERIOR MAINTENANCE

Regular washing to remove dust and dirt is recommended. See "Operator'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 underbody 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 understructure, 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.

## Section 18: BODY

### 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 UNDERSTRUCTURE AND VISUALLY INSPECT FOR CALCIUM DEPOSIT, CORROSION OR ANY DIRT ACCUMULATED ONTO EXPOSED SURFACES. VISUALLY INSPECT SEALING BEADS CONDITION.  VISUALLY INSPECT IF UNDERFLOOR IS PEELING. 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		



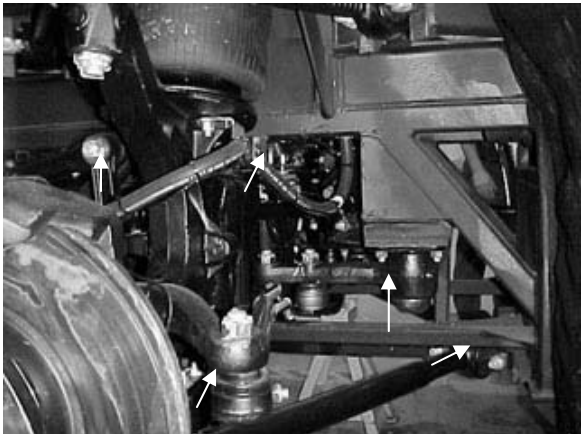
**WARNING: Failure to follow this preventive maintenance schedule will result in warranty void.**

### 3.3 RUST INHIBITOR APPLICATION

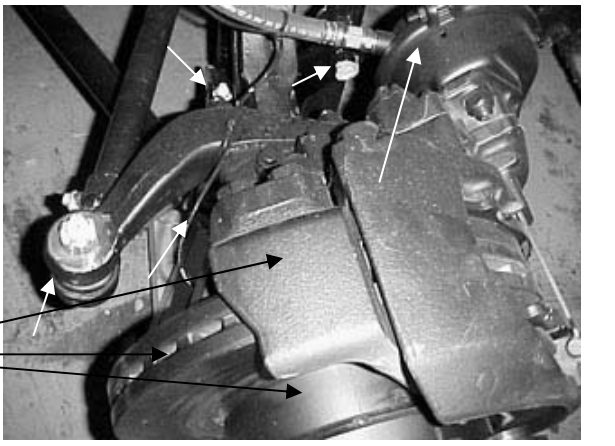
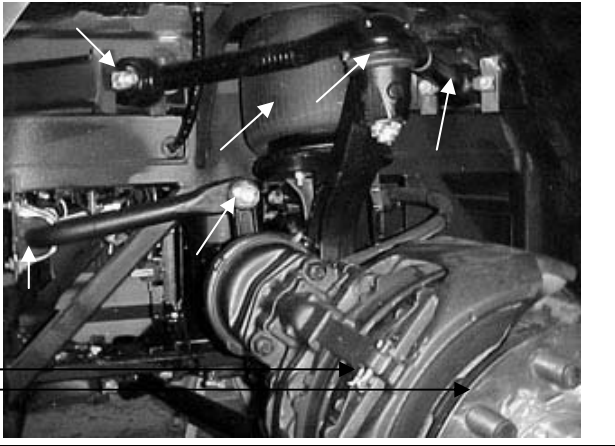
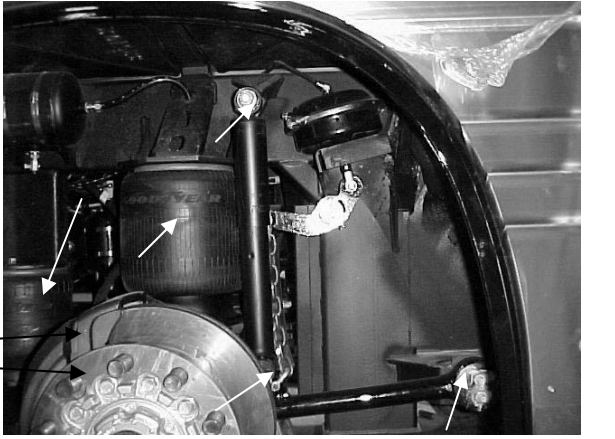
Material: Tectyl 185 GW  
R1KG21

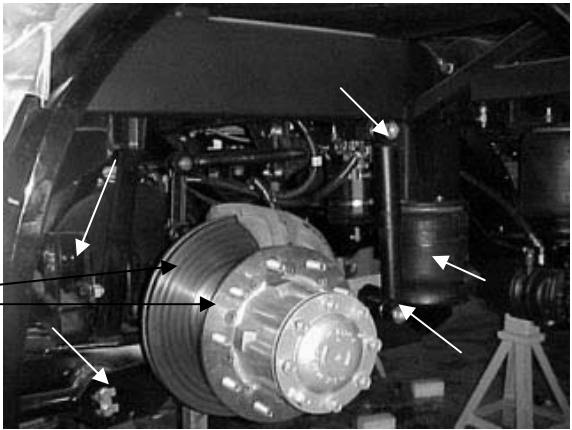
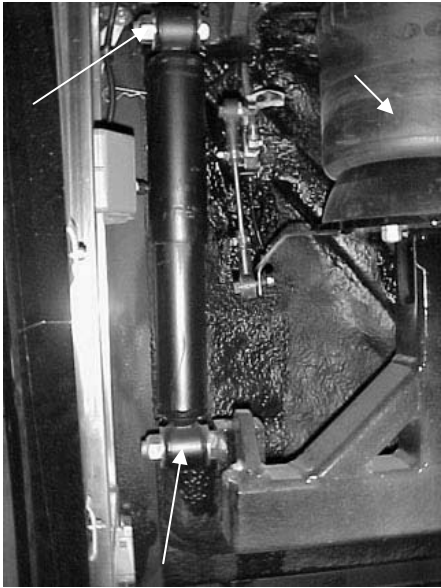
Safety Rules: Use safety glasses  
Supplied air hood  
Solvent-resistant rubber gloves

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.
---	---

<p>2.0 Dry all water sprayed parts. Surface temperature and dew point must be respected before applying rust inhibitor.</p>	<p>Air pressure system may be used, refer to annex 1 for surface temperature and dew point.</p>
<p><b>3.0 Front wheelhousing</b>  a) Mask all rubber joints. Braking system must also be protected (refer to arrows). Commercial aluminum foil may be used for masking.</p>	
<p><b>3.1 Front wheelhousing</b>  Front view</p>	
<p><b>3.2 Front wheelhousing</b></p>	

**Section 18: BODY**

<p><b>3.3 Front wheelhousing</b></p> <p>(Entire braking system)</p>	 <p>A black and white photograph showing the front wheelhousing assembly. Several white arrows point to various components, including the brake master cylinder, brake lines, and suspension parts. A black arrow from the text '(Entire braking system)' points to the main brake assembly area.</p>
<p><b>4.0 Rear wheelhousing</b></p> <p>a) Mask all rubber joints. Braking system must also be protected (refer to arrows). Commercial aluminum foil may be used for masking</p> <p>(Entire braking system)</p>	 <p>A black and white photograph showing the rear wheelhousing assembly. Several white arrows point to various components, including the brake master cylinder, brake lines, and suspension parts. A black arrow from the text '(Entire braking system)' points to the main brake assembly area.</p>
<p><b>4.1 Rear wheelhousing</b></p> <p>(Entire braking system)</p>	 <p>A black and white photograph showing the rear wheelhousing assembly. Several white arrows point to various components, including the brake master cylinder, brake lines, and suspension parts. A black arrow from the text '(Entire braking system)' points to the main brake assembly area.</p>

<p>4.2 Rear wheelhousing</p> <p>(Entire braking system)</p>	
<p>4.3 Rear wheelhousing</p>	
<p>5.0 Close off wheelhousing using masking paper.</p>	<p>Prevent rust inhibitor from coming in contact with paint. To close off wheelhousing, a polythene sheet may be used.</p>
<p>6.0 Apply TECTYL 185 GW black rust inhibitor onto wheelhousing mechanical parts.</p>	<p>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. <b>Minimum required thickness is 10 mils wet or 5 mils dry.</b></p>
<p>7.0 Remove all masking material 30 minutes after application.</p>	

**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.

**Section 18: BODY**

	<b>DEW POINT</b>									
	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. FIBERGLASS REPAIR

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 °F (21-24 °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 °F (60 °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 with 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 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.

## Section 18: BODY

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).

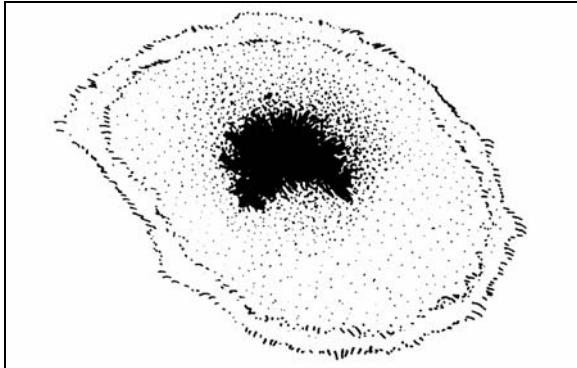


FIGURE 4: FIBERGLASS REPAIR

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).

**Note:** Remove all air between surfaces being joined. Allow area to harden and sand surface to remove any wax.

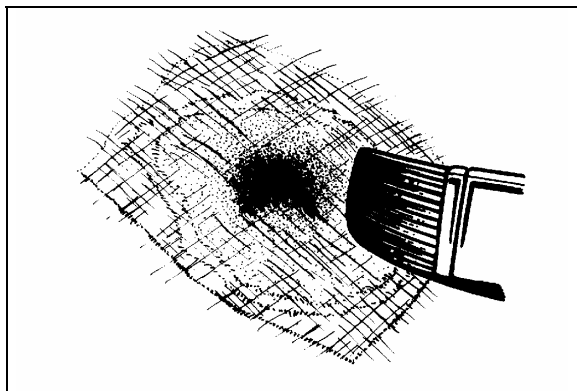


FIGURE 5: FIBERGLASS REPAIR

18090

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).

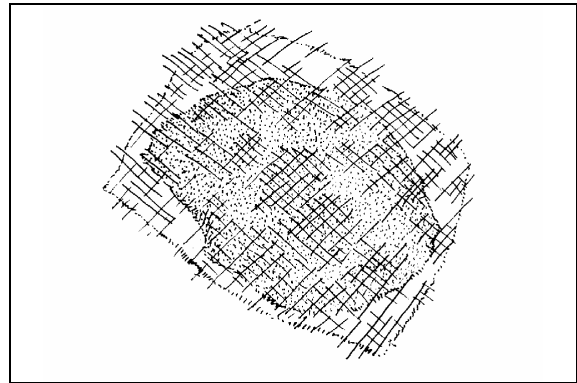


FIGURE 6: FIBERGLASS REPAIR

18091

Allow area to harden and contour the area with coarse sandpaper #100 (Fig. 7).

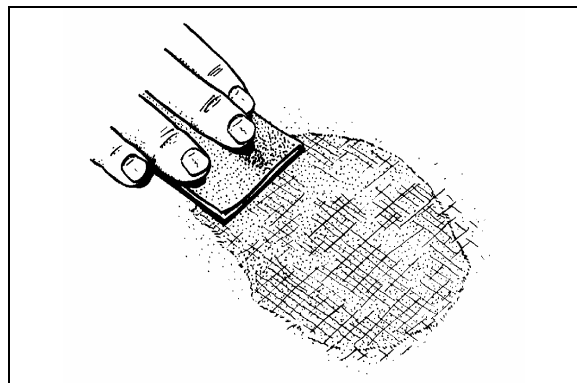


FIGURE 7: FIBERGLASS REPAIR

18092

Cover the area with a layer of resin putty and allow drying for approximately 15 to 20 minutes (Fig. 8).

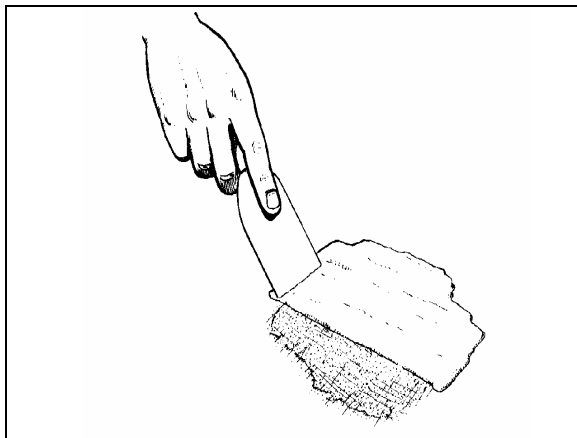


FIGURE 8: FIBERGLASS REPAIR

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. PAINTING

### 5.1 NEW PAINT CARE

Our paint supplier recommends that you follow these simple precautions the first months of your new vehicle's life.

**Caution:** *Apply these recommendations after repainting vehicle.*

#### During the first 30 days:

- Do not use a commercial bus wash. Stiff brushes or sponges could mar the finish and damage the surface. Wash the vehicle by hand only and with cool water and a very mild bus wash solution. Be careful to use only a soft cloth or sponge;
- Wash vehicle in the shade, never in direct sunlight;
- Do not "dry wipe" vehicle –always use clean water. Dry wiping could scratch the finish;
- Avoid extreme heat and cold. Park vehicle in the shade whenever possible;
- Do not park under trees which drop sap or near factories with heavy smoke fallout. Tree sap and industrial fallout may mar or spot a freshly painted surface;
- Trees are also likely to attract birds. Bird droppings are highly acidic and will damage a freshly painted surface. Bird droppings, tree sap and industrial fallout should be washed off as soon as possible;
- Do not spill oil, gasoline, antifreeze, transmission fluid or windshield solvent on new finish. IMMEDIATELY rinse off any such spill with clean water, DO NOT WIPE;
- Do not drive on gravel roads. Paint finish easily chips during the first 30 days;
- Do not scrape ice or snow from the surface. A snow scraper can act like a paint scraper if the finish is new. Brush off loose material with a soft snow brush.

#### During the first 90 days:

- Do not wax or polish the vehicle. This will allow the finish to dry and harden completely.

### 5.2 PAINT TOUCHUP

When paint touchup or partial repainting is necessary, refer to the vehicle's paint scheme for color codes and paint brand.

Prevost recommends using the original paint brand to ease color matching.

In the event you sand through to the gelcoat surface you should prime the area with Standox "Non Stop Fill Primer (ST-11000)".

If you sand through to metal surface, first prime with Standox "Etch Primer (ST-11858)" then with Standox "Non Stop Fill Primer (ST-11000)".

**Caution:** *Be sure to heed all paint manufacturer's recommendations, especially concerning paint dilution and application.*

### 5.3 PAINTING

The standard paint used on the exterior of the vehicle is Standox Basislack. It is a high gloss polyurethane enamel finish designed for exposure to extreme conditions. Other types of paint may be called for as options by owner but are not dealt with in this section.

#### 5.3.1 Safety

Care should be exercised in storing, handling, mixing, and applying paint and chemicals listed in this manual. The topcoat, primer, solvent, catalysts, accelerators, and cleaners are highly volatile and/or toxic if not properly used. Observe all safety instructions marked on the different packagings, 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.

## Section 18: BODY

### 5.3.2 Surface Preparation and Paint Application

	Aluminum and / or Stainless Steel	Fiberglass	Comments
<b>Surface Preparation</b>	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.
<b>Cleaning</b>	STANDOX silicone remover ST-11654 (68-2989)		
<b>Priming</b>	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
<b>Basecoat</b>	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
<b>Clearcoat</b>	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

## 5.4 FRONT AND REAR BUMPERS

### 5.4.1 Paint touchup and surface preparation for vehicles equipped with urethane bumpers

	COMMENTS	VIP	COACHES
<b>Cleaning</b>	Clean using red wool and Standoflex 11100 (ST-11425) thinner	YES	YES
	Clean again twice using Standoflex 11100 (ST-11425) thinner	YES	YES
<b>Priming</b>	Apply Non-Stop primer (ST-13320) with flexible agent dilution 2:1 10% in 2 or 3 coats, 15 min. flash/off between coats	YES	YES
<b>Sanding</b>	Sand Non-Stop primer using P-320 grit sandpaper	YES	YES
	Use a tack cloth	YES	YES
<b>Basecoat</b>	Apply basecoat. Wait 30 minutes.	YES	YES
<b>Varnish dilution</b>	Dilution without flexible agent	YES	YES
<b>Varnishing</b>	Apply varnish	YES	YES

If assistance or technical information on STANDOX products is needed, please dial: 1 (800) 551-9296

## 6. FRONT AND REAR BUMPERS

### 6.1 FRONT BUMPER REMOVAL AND INSTALLATION

The front bumper is hinged to give access to the spare wheel compartment. Bumper must first be tilted down before its removal. Two people are required to remove and install the front bumper.

**Warning:** Front bumper weighs approximately 180 lbs. (80 kg). Use proper lifting equipment to support the bumper during the removal and installation operations to avoid personal injury.

Pull on the release handle located in the front electrical and service compartment. The bumper assembly will lower gradually.

#### 6.1.1 Front Bumper Removal

Loosen 12 attaching bolts from inside the bumper, 6 over and 6 under the bumper beam

(Fig. 9). Let the bumper rest face down on the lifting equipment platform.

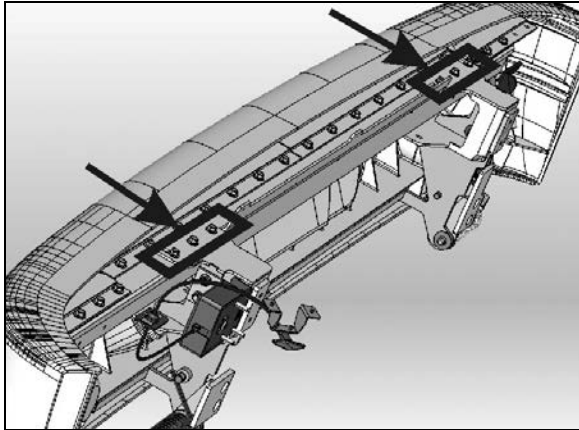


FIGURE 9: BUMPER ATTACHING BOLTS 18498

To reinstall the front bumper, reverse the procedure.

### 6.1.2 Front Bumper Skin Removal

The bumper skin is pinched to the bumper beam by the use of aluminum extrusions bolted over and under the beam. First, remove the front bumper as per “Front Bumper Removal”. Let the bumper rest face down on the lifting equipment platform. Loosen the aluminum extrusion bolts as required and then detach the skin from the beam (Fig. 10).

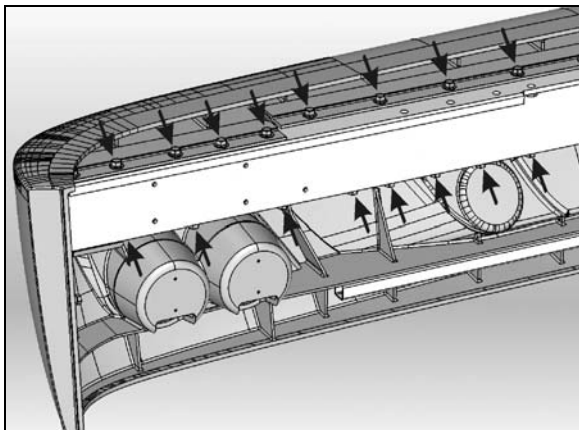


FIGURE 10: ALUMINUM EXTRUSIONS - BUMPER SKIN REMOVAL

### 6.1.3 Front Bumper Assembly Removal including spare wheel compartment door.

1. Ask assistant to relieve spring tension with assistant proper tool, and relieve spring tension on one locking pin and remove it. Slowly release spring tension and remove the second locking pin. The spring is free. Repeat procedure for the other spring.

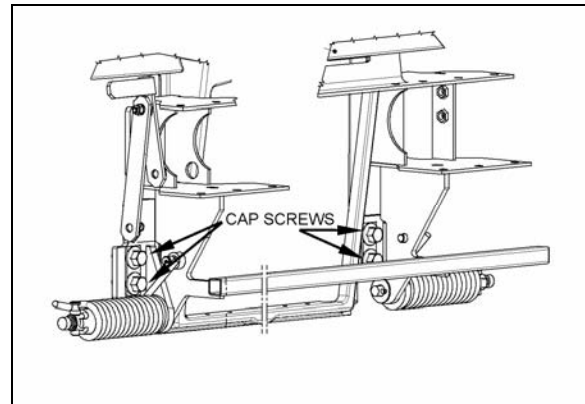


FIGURE 11: FRONT BUMPER ASSEMBLY

**Note:** A special tool kit is available from Prevostr Car Inc: Kit # 410671 including tool #410708.

2. Remove 4 cap screws holding bumper to vehicle and remove bumper (Fig. 11).
3. To install bumper, reverse the removal procedure.

### 6.2 FRONT BUMPER LICENSE PLATE SUPPORT INSTALLATION

License plate supports are stored in the first baggage compartment. Install supports as per figure 12.

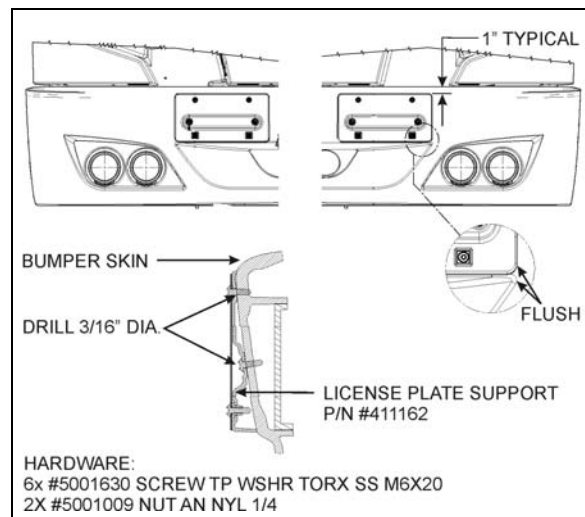


FIGURE 12: LICENSE PLATE SUPPORTS 18500A

### 6.3 REAR BUMPER REMOVAL AND INSTALLATION

**Warning:** Rear bumper weighs approximately 180 lbs. (80 kg). Use proper lifting equipment to support the bumper during the removal and installation operations to avoid personal injury.

## Section 18: BODY

1. Remove 6 nuts (3 on each side) holding bumper assembly to vehicle and remove bumper (Fig. 13).
2. Let the bumper rest face down on the lifting equipment platform.
3. To install bumper, reverse the procedure.

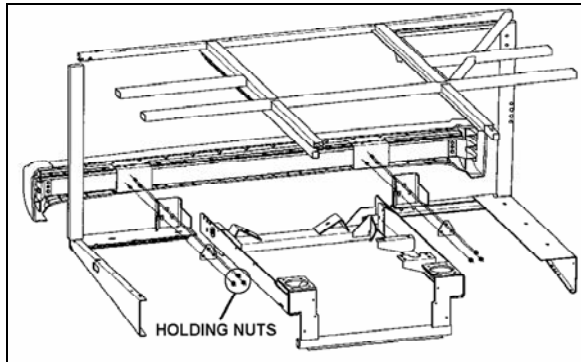


FIGURE 13: REAR BUMPER ASSEMBLY

18501

### 7. COACH ENTRANCE DOOR

An air operated “sedan type” entrance door, with an air door cylinder and damper assembly are installed under the right hand dash. The opening and closing door speed cycle is adjustable by a damper mounted in parallel with the door cylinder on the door hinge (Fig. 16). Door activation is controlled by a relay panel, located near the defroster and wiper motors. The accessory air reservoir supplies air to this system.

The door is held in the closed position during coach operation by two air cylinder locking mechanisms (Fig. 17). Air cylinders with return spring in the cylinder body are used. Air cylinders are controlled by an electrically operated solenoid valve energized by a rocker switch located under the right hand dashboard.

To open the door, initial movement of the rocker switch de-energizes the air lock solenoid valve, venting the door locking cylinders. The return locking spring pulls the door lock away from the latch, unlocking the door. Door movement starts only when pressure in the central air door lock is below 10 psi. The “air cylinder open solenoid valve” opens and allows air to flow to the door cylinder, “the air cylinder close solenoid valve” exhausts air from the rod side of the cylinder.

To close the door, initial movement of the switch energizes the “air cylinder close solenoid valve” and air flows to the cylinder by its rod side port. The “air cylinder open solenoid valve” exhausts

air from cylinder. When entrance door latch is grounded with the door frame, the air lock solenoid valve is de-energized and loads the door lock cylinders. The cylinder moves the door lock in a position which engages a latch on the entrance door, holding the door positively closed.

Emergency exit valves, which open the air valve circuit, should be used only in emergencies, or when the door control system does not function properly.

Refer to the air system schematic diagram annexed at the end of section 12, “Brakes” and to page 22 of the wiring diagram.

#### 7.1 OPERATION

The air-operated door is controlled from inside the coach by two push-button switches located on the R.H. dashboard.

Opening and closing of the door from outside the coach is accomplished by a momentary toggle switch located behind the coach model nameplate (Fig. 14).

To close the door, the switch must be pushed towards the rear of the coach and held in position until the door has completed its movement.

To open the door, the switch must be pushed towards the front of the coach and held in position. When the door reaches the fully opened position, the system will keep pressure in the cylinder locking the door in that position. The door can be stopped in any position by releasing the switch. The door is not locked in position when not fully opened or closed.

If the door has been locked with the key, a lever on the door can be moved to unlock.

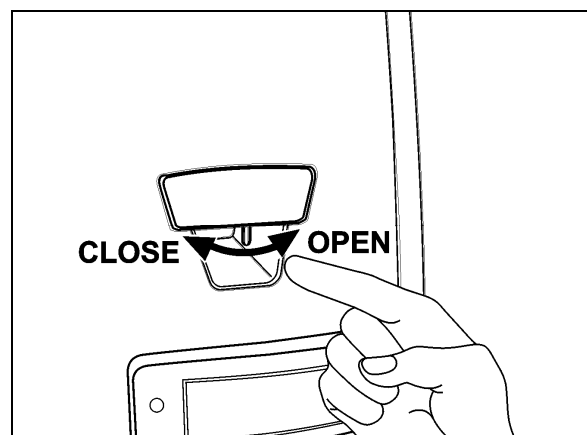


FIGURE 14: DOOR OPERATING SWITCH

18316

## 7.2 EMERGENCY EXIT VALVES

From inside the vehicle, an emergency exit valve located near the door on the dash panel, releases the pressure from the lock cylinders. From the exterior, an emergency exit valve located in the front service compartment, also releases the air from the lock cylinders.

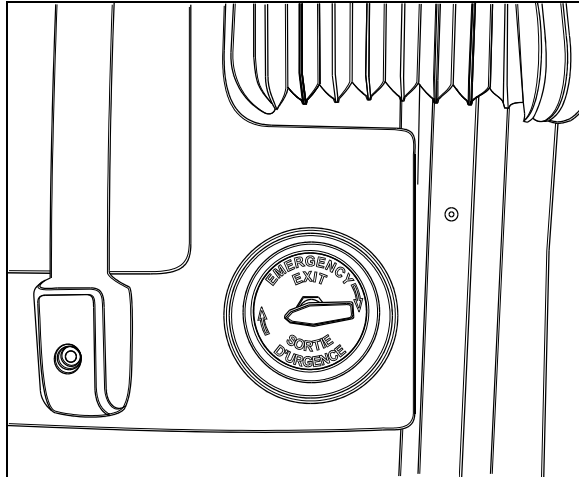


FIGURE 15: EMERGENCY EXIT VALVE 18321

### 7.2.1 Without Air and/or Without Electricity

If the air pressure drops while coach has or hasn't any electricity, the spring loaded cylinders will unlatch the door. In such a case, unlock the door by moving the lever on the door or by using the key, then open the door manually.

### 7.2.2 With Air but Without Electricity

From inside the vehicle, turn the emergency exit valve to the "UNLOCK" position. Move the lever. From the exterior, turn the emergency exit valve to the "UNLOCK" position. Open the door. Close it, lock with the key and reset the outside emergency exit valve to the "NORMAL" position.

## 7.3 DOOR CYCLE SPEED ADJUSTMENT

To do any adjustment, remove the two panels located next to the door hinge, as well as the door's upper hinge control.

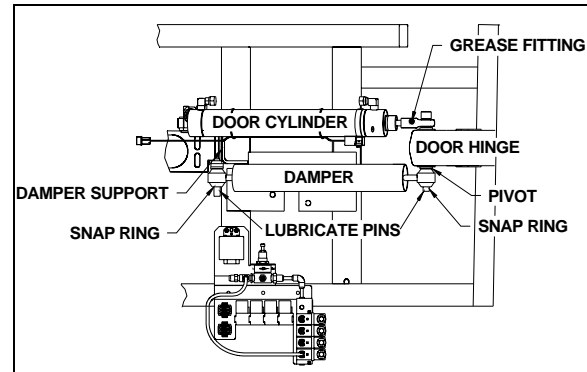


FIGURE 16: DOOR CYLINDER AND DAMPER 18161

**Caution:** It is important to make sure that damper does not reach end of stroke when door is completely closed or opened. The door cylinder must stop the door on opening. Screw or unscrew rod end to adjust if necessary.

To adjust opening and closing cycle speed on damper (Fig. 16):

1. Remove the damper from the vehicle and hold it vertically with the lower eye or pin attachment in a vice. Use clamp plates to prevent damage.
2. Fully close the damper while turning the dust cap or piston rod slowly CCW until it is felt that the cams of the adjusting nut engage in the recesses of the foot valve assembly (Fig. 18).

**Note:** In figure 18, if there is an indentation (B) in the dust cap (C) and the cover shows two holes (A), the damper is fitted with a bump rubber (D). If so, fully extend the damper and insert a round bar or screwdriver through the holes. Push the bump rubber down and remove. Remove the split plastic collar (E) (if fitted) from the piston rod.

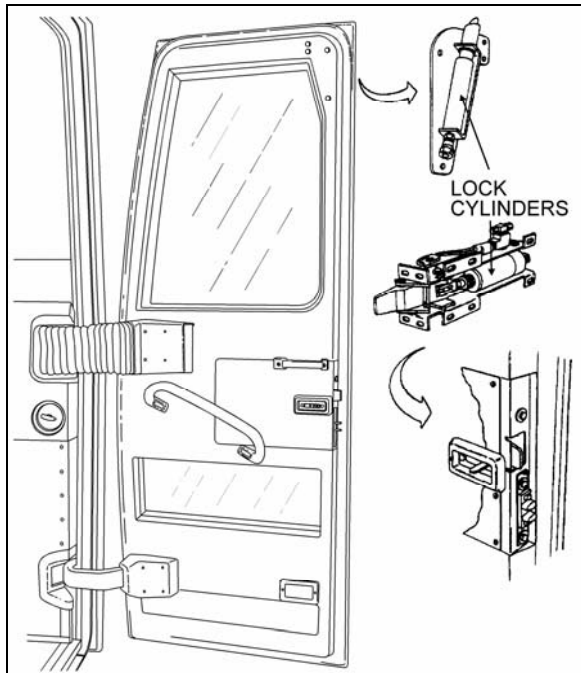


FIGURE 17: COACH ENTRANCE DOOR

18439

3. The damper may have already been adjusted. Therefore check whether the damper is adjusted or not by keeping it closed and gently turning further CCW, counting at the same time the half-turns until a stop is felt. Stop turning and do not force.
4. While keeping the damper closed, make two CW half-turns. In case of prior adjustment, add the number of half-turns previously counted. The total range is about five half-turns.
5. Pull the damper out vertically without turning for at least 3/8" (1cm) to disengage the adjusting mechanism. The dust cap or piston rod may now be turned freely.

**Note:** Where a bump rubber was installed, refit same inside the dust cap and by fully closing the damper, the rubber will seat again at top of the dust cap. Refit the split plastic collar E (Fig. 18)

6. The damper can now be refitted in the vehicle.
7. Reinstall panels and entrance door hinge cover.

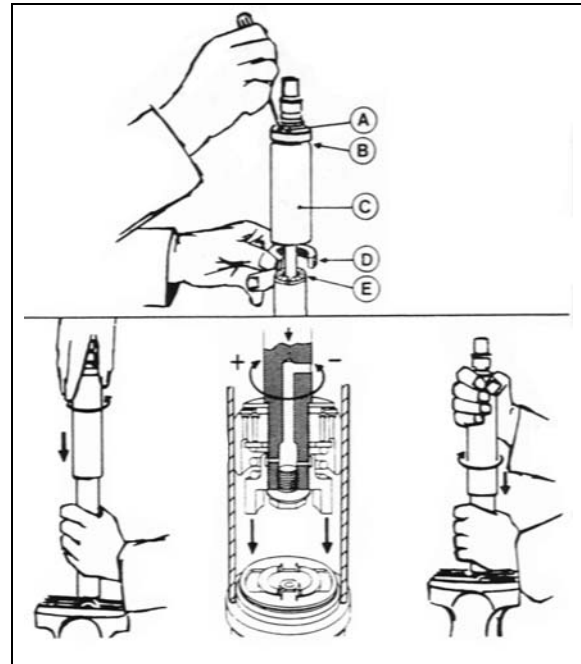


FIGURE 18: DAMPER

#### 7.4 HORIZONTAL AND VERTICAL ADJUSTMENT

Before attempting to correct any door operating problem by adjusting any part of the air cylinder assembly, first perform the following mechanical checks and procedure.

Check around the perimeter of the door for binding. If any binding is found, adjust as follows:

1. Remove the screws and the plastic molding covering each of the hinges.

**Note:** Ask an assistant to help you to perform the following adjustments.

2. Remove the Allen button head screw and the washer retaining the rod end with bearing to the upper hinge. See figure 19.
3. Support the door with a wooden block and a hydraulic jack.
4. Loosen the horizontal bolts retaining the door to the hinges. Adjust the door horizontally and vertically with the jack. Tighten the bolts to 30-36 Lbf-ft (40-50 Nm). Remove the jack and the wooden block.

**Caution:** Make sure the entrance door does not interfere with the exterior panel.

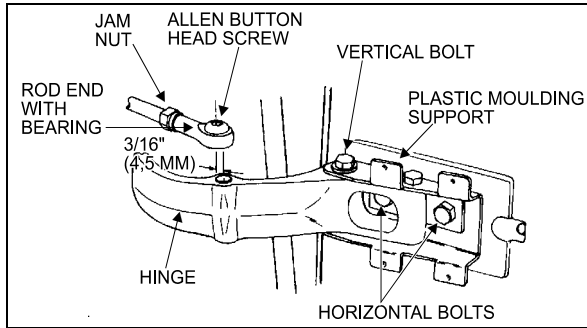


FIGURE 19: UPPER DOOR HINGE (COACH) 18058

5. Pull and fasten the rod end to the hinge with the washer and the button screw.
6. Screw the plastic moldings covering the hinges.

### 7.5 DEPTH ADJUSTMENT

1. Turn the emergency exit valve to the "UNLOCK" position.
2. Remove the screws and the plastic molding covering each of the hinges.

**Note:** Ask an assistant to help you to perform the following adjustments.

3. Remove the Allen button head screw and the washer retaining the ball and socket rod to the upper hinge. See figure 19.
4. Loosen the vertical bolts on the hinges for the front section, and for the rear section, move the central door catch on the door frame.
5. To adjust the male dovetail on L.H. side of the door, remove the two screws and loosen the two bolts. Slide the male dovetail toward the interior and loosely tighten the two bolts. Close the door slowly but firmly, then slowly open it and tighten the two bolts. Attach dovetail to the door with screws. See figure 20.

**Note:** The frame dovetail is not adjustable.

6. Pull and fasten the rod end to the hinge with the washer and the button screw.
7. Using the screws, attach the plastic moldings covering the hinges.
8. Reset the emergency exit valve to the normal position.

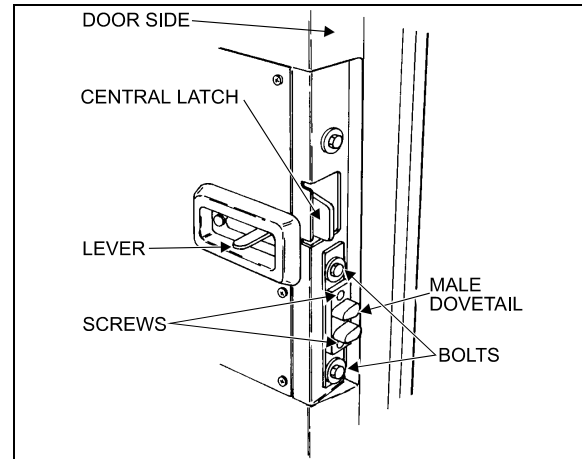


FIGURE 20: DOOR LATCH (COACH) 18059

### 7.6 ROD END ADJUSTMENT

1. Turn the emergency exit valve to the "UNLOCK" position.
2. Remove the screws and the plastic moldings covering the upper and lower hinges.
3. Remove the Allen button head screw and the washer retaining the rod end with bearing to upper hinge. See figure 19.
4. Loosen the jam nut locking the door cylinder rod end. Close the door firmly, adjust the rod end center hole in order to be 3/16" (4,5 mm) eccentric toward the left with the hinge hole center. Tighten the jam nut.
5. Pull and fasten the rod end to the hinge with the washer and the button screw.
6. Using the screws, attach the plastic moldings covering the hinges.
7. Reset the emergency exit valve to the normal position.

### 7.7 LUBRICATION

Part	Lubricant	Frequency
Latches Upper door catch Door cylinder rod end with bearing grease fitting (Fig. 16)	Low temperature grease	Every six months
Door locking mechanism	White grease	Every six months
Key hole Damper pins (Fig. 16) Hinges	Low viscosity oil	Every six months

**Section 18: BODY**

7.8 TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
DOOR WILL NOT OPEN FROM EXTERIOR SWITCH.	Manual door locks engaged.	Release manual door locks.
	Upper and lower solenoid locks do not disengage.	Check voltage at solenoid locks when door is open. If the voltage is 24 volts then replace solenoid #641217. Else, check circuit power.
	Relay module do not receive current.	Reset breaker "ON" or check batteries power supply.
	Opening solenoid door does not receive current.	Check voltage at opening solenoid door. If the voltage is 24 volts then replace it. Else replace control relay.
	Switch malfunction.	Replace switch.
DOOR WILL NOT CLOSE FROM EXTERIOR SWITCH.	Switch malfunction.	Replace switch.
	Solenoid failure.	Check voltage at solenoid. If the voltage is 24 volts then replace solenoid. Else replace control relay.
DOOR WILL NOT OPEN FROM INTERIOR SWITCH.	Manual door locks engaged.	Release manual door locks (open position) from vehicle exterior.
	Upper and lower solenoid locks do not disengage.	Check voltage at solenoid locks when door is open. If the voltage is 24 volts then replace solenoid #641217. Else, check circuit power and replace control relay.
	Module relay does not receive electric current.	Reset breaker "ON" or check batteries power supply.
	Door opening solenoid does not receive current.	Check voltage at door opening solenoid. If the voltage is 24 volts then replace it. Else replace control relay.
	Switch malfunction.	Replace switch.
	Upper lock stays engaged.	Lubricate upper lock assembly. Check wear and replace parts if necessary.
DOOR WILL NOT CLOSE FROM INTERIOR SWITCH.	Switch malfunction.	Replace switch.
	Door closing solenoid does not receive electric current.	Check voltage at door closing solenoid. If the voltage is 24 volts then replace it. Else replace control relay.
DOOR WILL NOT OPEN AFTER DRAINING AIR FROM SYSTEM BY EMERGENCY VALVE(S).	Manual door locks engaged.	Release manual door locks (open position) from vehicle exterior.
	Damper cylinder blocks the door.	Adjust or replace damper cylinder.
	The upper lock blocks the door	Adjust lower lock. Lubricate upper latch bolt. Adjust upper latch height.
DOOR LOCKS STAY ENGAGED WHEN DOOR IS OPEN.	Power supply is cut at solenoid.	Place switch in open position.
	Solenoid lock does not disengage.	Check voltage at solenoid locks when door is OPEN. If the voltage is 24 volts then replace solenoid #641217. Else, check circuit power and replace control relay.
DOOR DO NOT LOCK WHEN DOOR IS CLOSED.	Emergency valve is open.	Close emergency valve.
	Lock solenoid stays electrified.	Check latch bolt ground on door frame. If needed clean locks for better contact. Check ground circuit.
	Lock solenoid works in reverse.	Reverse air hoses at solenoid locks.
	Relay does not function.	Replace relay.



## 8. ENTRANCE DOOR (V.I.P)

There are three ways of unlocking the entrance door from the inside of vehicle. The two first consist in actuating the rocker switch on the dashboard, but this last operation will also unlock the baggage compartments. Finally, you can unlock the door by sliding its lock lever to the left. If the orange tab on the door lock lever is visible, the door is unlocked.

You may lock/unlock the entrance door from the outside with the lock key provided with the vehicle. Turn key CCW to lock and CW to unlock the entrance door.

### 8.1 KEYLESS ENTRY SYSTEM

With this system, you can lock or unlock the entrance door as well as the baggage and service compartment doors. The keyboard is located below the entrance door handle. The module is pre-programmed by the manufacturer and this code can not be deleted. Moreover, you can program your own entry code. Refer to the "VIP Owner's Manual" for instructions on how to program your own entry code.

When you use the keyless entry system, the keyboard and stepwell lights illuminate. Do not push the buttons with a key, pencil or any other hard object as it could damage the buttons.

Although each button is provided with two digits separated by a vertical line, there is only one contact per button. Always press the center of the button (between the two digits, on the vertical line).

If you let more than five seconds pass between each button press, the system shuts down, and you have to enter your code again. If the keyless entry system does not work properly, use the key to lock or unlock entrance or compartment doors. To know more about the keyless system, refer to the "VIP Owner's Manual".

**Note:** You must unlock the entrance door before you unlock with the appropriate key any baggage or service compartment doors.

### 8.2 DOOR ADJUSTMENT

Check around the perimeter of the door for binding. If any binding is found, adjust as follows:

#### 8.2.1 Horizontal and Vertical Adjustments

1. Remove the screws and the plastic molding covering each of the hinges.

**Note:** Ask an assistant to help you to perform the following adjustments.

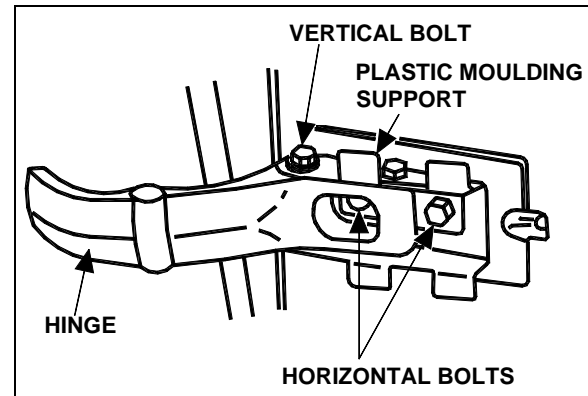


FIGURE 21: ENTRANCE DOOR (VIP)

18058VIP

2. Support the door with a wooden block and a hydraulic jack.
3. Loosen the horizontal bolts retaining the door to the hinges. Adjust the door horizontally and vertically with the jack. Tighten the bolts to 30-36 Ft-lbs (40-50 Nm). Remove the jack and the wooden block.
4. Check door fit.
5. Using the screws, fasten the plastic trim to cover the hinges.

#### 8.3 DEPTH ADJUSTMENT

**To adjust door depth on the hinged side:**

1. Remove the screws and the trim covering each of the hinges.

**Note:** Ask an assistant to help you to perform the following adjustments.

2. Slightly loosen, but not completely the vertical bolts on both door hinges.
3. Ask your assistant to press the door from the exterior, until it will adjust with the vehicle structure. Then, tighten the vertical bolts.
4. Repeat step 3 until depth is corrected to satisfaction.
5. Using the screws, install the trim hiding the hinges.

## Section 18: BODY

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### To adjust door depth on lock side:

Depth adjustment is done by moving the two door strikers.

1. Slightly loosen the door strikers.
2. Ask your assistant to press the door from the exterior, until it will adjust with the vehicle structure. Then tighten the striker pin.
3. Repeat until the door depth is corrected to satisfaction.

### 8.4 DOOR LOWER SECTION

When a plastic door lower section replacement is needed, proceed the following way:

1. Remove the reflective stripe at the top edge of the door's lower section. Unscrew the retaining screws located under the reflective stripe.
2. Remove the lower section.
3. With a sharp edge knife, scrape as much tape as possible and compound left on the fiberglass door surface. Note where adhesive tape and sealing compound was applied.
4. Sand the surface or the door where new adhesive tape will be applied with 240 grit sandpaper.

**Note:** *Tape adheres best to smooth surfaces such as glass or gelcoat finishes. Be careful surface is as smooth as possible before applying tape.*

5. Clean contact surfaces with alcohol.
6. Clean the fiberglass door and the new plastic lower section with a "tack cloth". Make only one pass on the surface and never come back on a previously cleaned surface.

**Caution:** *Wear rubber gloves and do not smoke when cleaning.*

7. Prepare the door lower section with Sika #205 and a clean rag. Make only one pass on the surface and never come back on a previously cleaned surface.

**Note:** *Never use Sika #205 directly from the container to avoid contamination of the product.*

8. Wait at least 5 minutes before proceeding the next step to allow complete evaporation of the product.

9. Put new adhesive tape where it was previously applied. Pass a 1" (25mm) roller on it to get a good adhesion on the fiberglass.

10. Apply Sika #252 (Prevost #682462) compound where it was previously applied.

11. Remove protective paper from the adhesive tape and install the door lower section. Apply pressure with a roller where the lower door section touches the fiberglass door.

12. Replace the retaining screws.

### 8.5 REFLECTOR STRIPE INSTALLATION

1. Clean contact surfaces with alcohol.
2. Prepare surface of reflector stripe and door lower section with Sika #205.
3. Put two rows of adhesive tape on the lower door section.
4. Apply Sika #252 (Prevost #682462) compound between parallel tape stripes.
5. Remove protective paper from the adhesive tape and press the reflective stripe in place.

### 8.6 DOOR SEAL REPLACEMENT

1. Inspect the seal; if cracked or torn, it must be replaced:
2. Remove the old seal and with a sharp edge knife, scrape tape left on the fiberglass door surface.
3. Sand the surface of the door where a new seal will be applied with 240 grit sandpaper.
4. Clean the surface with alcohol.

**Caution:** *Wear rubber gloves and do not smoke when cleaning.*

5. Peel of protective paper from the seal. Position the seal in order to leave 1/4" (6 mm) from the upper molded edge of the door and 3/16" (4,5 mm) from the sides and lower molded edges of the door.
6. Progress slowly all around the door.
7. Cut the seal and glue both ends with LOCTITE 414 glue.
8. To assure bonding, press a small roller on top of the new seal.

## 8.7 DOOR LUBRICATION

Part	Lubricant	Frequency
Latches Upper door catch	Low temperature grease	Every six months
Door locking mechanism	White grease	Every six months
Key hole Hinges	Low viscosity oil	Every six months

## 8.8 DOOR LATCH MECHANISM

Generally, when the latch mechanism malfunctions, a number of causes may be responsible for this situation. No single procedure will correct this situation. It is best to remove the protective cover and to look for binding, used or bent parts. Operate the latch mechanism and try to find where any binding occurs. Replacing a part or slightly bending a rod should be enough. Remember, having a global understanding of the mechanical activity will generally lead you to the cause of the problem, and ultimately to an easy repair.

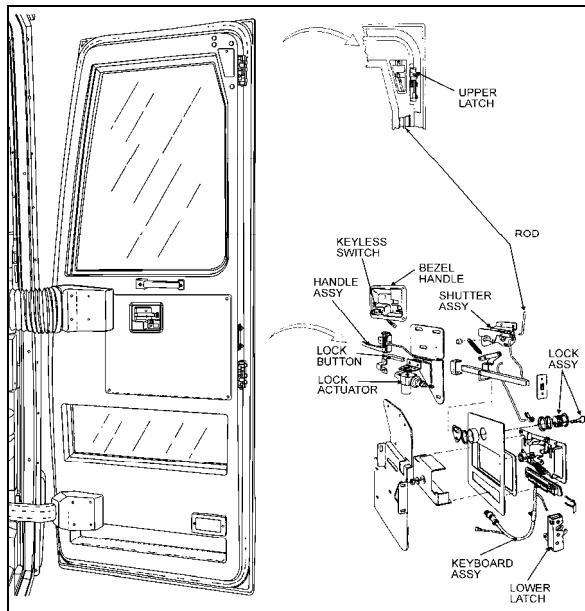


FIGURE 22: ENTRANCE DOOR (VIP, TYPICAL) 18440

## 9. DRIVER'S POWER WINDOW

To replace window or motor, the whole assembly must be removed. The following instructions refer to figure 23.

## 9.1 POWER WINDOW REMOVAL

1. Raise the driver's power window.
2. Set the battery master switch to the OFF position.
3. The window must be held in upper position. To do so, use duct tape to hold it in place.
4. Gain access to the power window mechanism. Dismount the driver's area lateral control panel and left interior trim. It may be required to remove the driver's seat and dashboard panel.
5. Unfasten bolts (item 1) fixing the window to the lifting mechanism (actuator).
6. Remove the three bolts (item 2) holding the motor support and actuator assembly in place.
7. Detach the plastic water protection shield and remove the assembly by slipping it under the vehicle structural members.
8. Dismount the window support and lower the window completely to release it from its guides.
9. Detach the motor and actuator guide from the support and plastic shield. Replace parts as required.

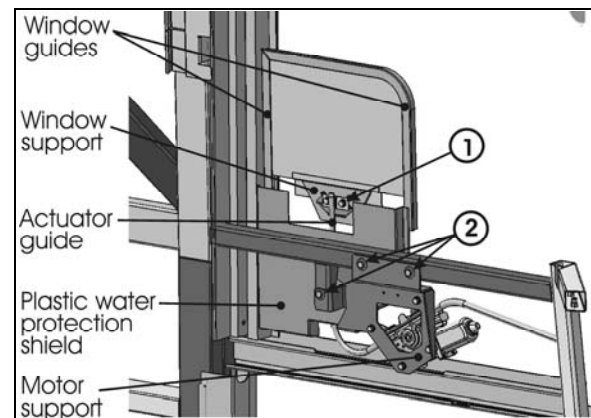


FIGURE 23: DRIVER'S WINDOW

23358

## 9.2 POWER WINDOW INSTALLATION

1. Energize the motor and position the actuator to its full extended position.
2. Using alcohol, a sharp knife or 240-grit sandpaper, clean off the butyl strip from the shield and frame. Install new butyl strip on plastic shield.
3. Install new window in opening. Use duct tape to hold it in upper position. Fix the

## Section 18: BODY

window support using bolts recovered from disassembly. Use Loctite on threads.

4. Fasten window support to actuator using the recovered bolts (item 1). Use Loctite on threads.
5. Expose the other sticky side of the butyl strip. Install motor support and actuator assembly using recovered bolts (item 2). Stick plastic shield in place.

### 10. ROOF ESCAPE HATCH

The vehicle can be equipped with one or two escape hatches. The escape hatch is designed to provide years of reliable service with a minimum of maintenance. All components are rust proof, and moving parts are Teflon coated to eliminate need for lubrication. Should water infiltrate the vehicle from the escape hatch, refer to the heading "Sealing" in this section for procedures on how to seal this area.

**Caution:** Use of lubricants, paints, or other coatings such as graffiti deterring sprays are not recommended.

Suggested maintenance includes periodic inspection of fasteners for evidence of loosening due to tampering, and regular cleaning with mild soap and water.

Although there are other cleaning solutions available, some contain solvents and other chemicals that can attack the high strength materials used in the production of the escape hatch.

**Caution:** Ensure that cleaning solutions are compatible with the materials used on the escape hatch.

Graffiti removing cleaners often contain acetone, ether, lacquer thinner or other solvents known to destroy the high strength properties of many plastics. Use of these cleaners must be avoided.

Graffiti-resisting coatings often leave a sticky residue that interferes with smooth up/down movement of the hatch mechanism. Some of these coatings also contain solvents that will reduce the strength of certain components.

**Caution:** Use of these coatings is at considerable risk and should be avoided.

#### 10.1 REPAIR

All components used in the production of the escape hatch are available as service parts,

except for one hinge that represents a possible hazard when improperly reattached to a hidden tapping plate, itself often damaged whenever the hinge is damaged. The tapping plate is permanently laminated between the inner and outer cover assemblies, and it cannot be inspected or replaced. It is therefore necessary to replace the entire assembly following damage to the hinge. See figures 24 and 25.

**Caution:** Hinge assembly is critical and hinge should never be removed from cover assembly. Fasteners used in this assembly are special and have critical torque requirements and tamper-resistant heads to discourage tampering.

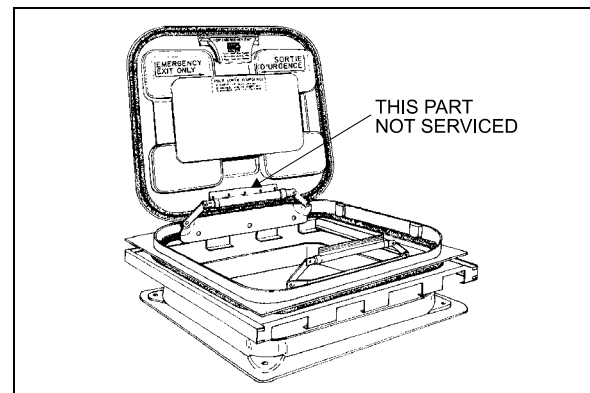


FIGURE 24: ESCAPE HATCH

18104

#### 10.2 SEALING

1. Open and tilt up the escape hatch cover.
2. Join the 2 ends of the rubber seal.

**Caution:** Seal joint should be toward rear of vehicle.

3. Apply rubber adhesive CA-40 (Prevost # 681285) in the gap between the seal ends.
4. Apply Sikaflex 221 sealant (Prevost # 680532) along the outline of the escape hatch on the roof of vehicle.

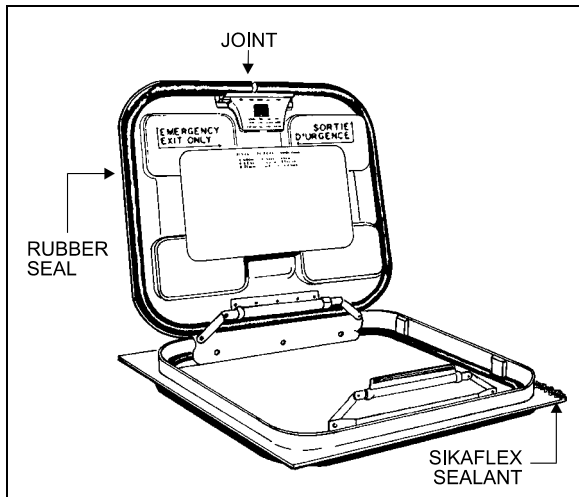


FIGURE 25: ESCAPE HATCH

18105

8. Install the frame in place and fix it with rivets.
9. Remove excess adhesive and clean all around.

### 10.3 ESCAPE HATCH PANEL ASSEMBLY

The frame of the escape hatch is riveted to the roof of the vehicle. The escape hatch panel assembly can be replaced as a unit and a new panel assembly installed in the existing frame. To remove the panel assembly, remove the 4 bolts fastening the 2 hinges to the escape hatch frame and retain the 4 flat washers. Reinstall the panel assembly by fastening the 2 hinges with the 4 bolts and flat washers removed earlier.

**Caution:** When installing, roof escape hatch's hinge must be toward the front of vehicle, to prevent the hatch from being ripped out if accidentally opened while vehicle is running.

### 10.4 ESCAPE HATCH FRAME

When necessary, the escape hatch frame can be removed and replaced in the following way:

1. Support the frame from inside the vehicle.
2. Remove rivets.
3. Cut the rubber seal with a sharp edge knife and remove the hatch frame.
4. On vehicle top, using the knife, remove as much as possible the remaining rubber seal.
5. Drill holes (if needed) in the new metal frame.
6. Clean both vehicle top and new hatch frame with SIKA 205.
7. Apply rubber adhesive SIKA 221 under the hatch frame surface.

**11. REPAIR OR REPLACEMENT OF “TARABUS” FLOOR COVERING**

“Tarabus” covering installed in H3 coaches may be replaced or repaired. The purpose of this paragraph is to explain the steps to be followed to ensure the best results and adherence.

**MATERIAL**

<b>Part No</b>	<b>Description</b>	<b>Qty</b>
680028	Adhesive, Tarabus Floor Covering (White)	A/R
684655	Adhesive, Contact (3M)	3.8L
684654	Adhesive, Contact (3M)	18.9L
680532	Sikaflex 221 Gray	A/R

**Note :** *Material can be obtained through regular channels.*

1. Remove number of passenger seats required to perform repair.
2. Cut and remove damaged section of floor covering.

**Note:** *It would be preferable to cut under two rows of seats so that repair is not as noticeable.*

3. Clean plywood using a scraper.

**Note:** *Make sure that no staples are sticking out beyond surface. Adjacent plywood sheets must be leveled.*

4. Fill up holes and imperfections using MAPI PRP 110 then sand.
5. Remove dirt and adhesive residue.

**Caution:** *Do not leave floor covering folded down except temporarily during installation.*

6. Apply floor covering adhesive (680028) onto plywood using a serrated spreader with 1/8-inch serration. If required, apply contact adhesive (3M) (684654 or 684655) onto aluminum molding and also onto section of floor covering, which will be in contact with molding (refer to figure 26).

**Note:** *Allow adhesive to dry (3 to 5 minutes).*

7. Compress floor covering using a roller so as to remove any trapped air bubble.
8. Apply Sikaflex 221 gray sealant (680532) alongside passenger seat fixing tracks (refer to figure 27).

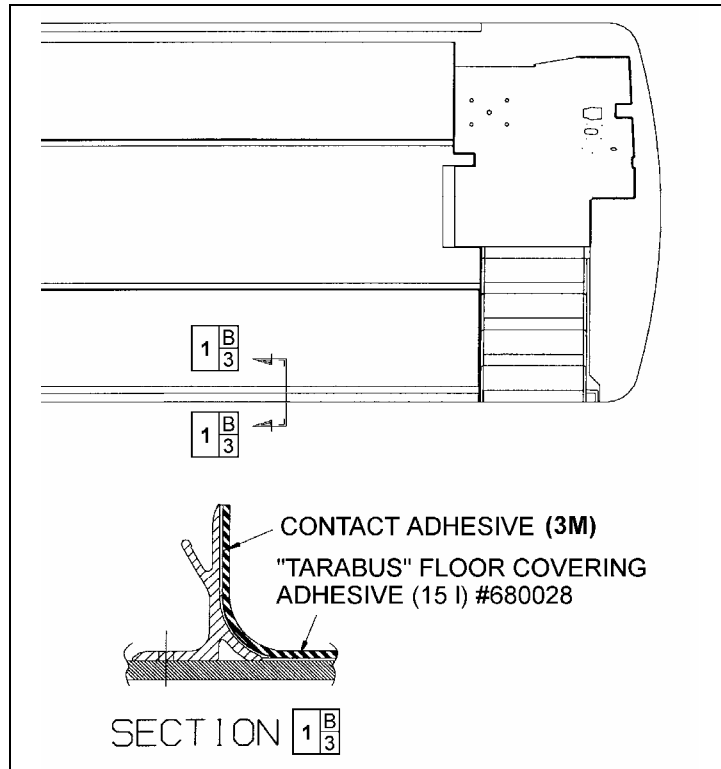


FIGURE 26: TARABUS FLOOR COVERING ADHESIVE APPLICATION

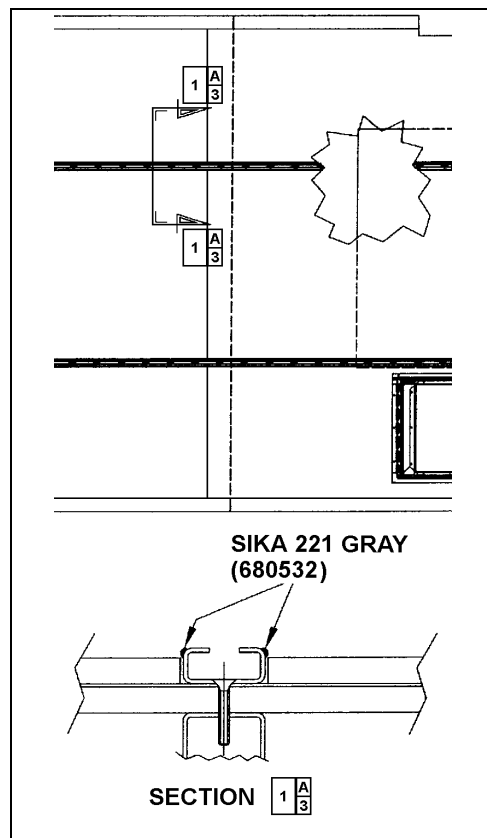


FIGURE 27: APPLICATION OF SIKA 221 GRAY

## Section 18: BODY

### 11.1 FRONT STEPS REPLACEMENT PROCEDURE

#### MATERIAL

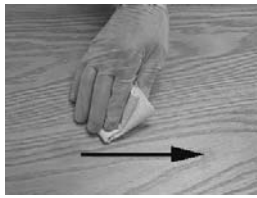
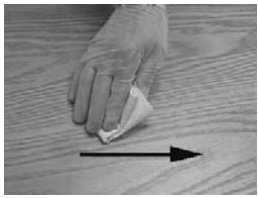
Part No	Description	Qty
682989	Anti-silicone	A/R
683097	Sika 205 (1 liter)	A/R
685101	Sika Remover 208	A/R
683916	Sika 215 (1 liter)	A/R
684654	Adhesive, Contact (3M)	3.8L
684655	Adhesive, Contact (3M)	18.9L
684517	Sealant, gray	A/R

1. Cut and remove damaged step(s).
2. Remove dirt and adhesive residue.

**Note:** In wintertime, condensation and cold temperature may greatly influence bonding parameters. Working area must be at a temperature sufficient to prevent reaching condensation point. Mechanically preheat working area (heat lamp or heat gun) or wait until vehicle reaches room temperature.

#### PREPARATION OF "TARABUS" FLOOR COVERING

1. Sand under step using "Scotchbrite".
2. Clean using anti-silicone (refer to Section A).

<b>Section A Alcohol or Anti-silicone</b>	
	<p><b>1. Apply</b></p> <p><b>CHIX cloth</b></p>
	<p><b>2. Dry immediately</b></p> <p><b>Blue cloth</b></p>
<b>3. Allow drying</b>	
<b>Mandatory</b>	<b>Minimum time : Wait for product to evaporate</b>
	<b>After 2 hours: Start cleaning operation again</b>
<b>Before applying any other product</b>	If surface seems dusty, greasy or with finger marks, start cleaning operation again.

3. Apply Sika Primer 215 (refer to Section D).



## Section D Sika Primer 215



1. Shake bottle to mix product
2. Apply a thin layer

CHIX cloth

### 3. Allow drying

<b>Mandatory</b>	<b>215</b>	<b>Minimum time : 20 minutes</b>
		<b>After 2 hours : Remove dust using damp cloth (pure water)</b>
<b>Before applying any other product</b>		If surface seems dusty, dust using damp cloth.
		If surface seems greasy or with finger marks, reactivate with Aktivator.

### PREPARATION OF FIBERGLASS

1. Clean using anti-silicone (refer to Section A).
2. Apply Sika 205 (refer to Section B).

## Section B Sika 205



1. Apply

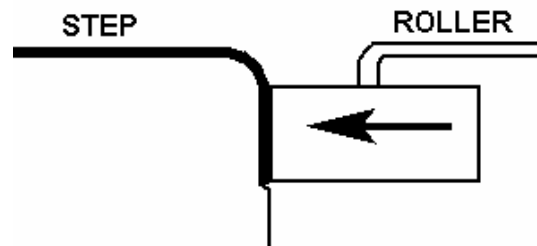
CHIX cloth

### 2. Allow drying

<b>Mandatory</b>	<b>Minimum time</b>	- For a smooth surface (aluminum, stainless, steel, fiberglass (gelcoat side), etc.):	<b>2 minutes</b>
		- For a porous surface (fiberglass (non gelcoat side), etc.)	<b>10 minutes</b>
<b>After 2 hours : Reactivate surface with Sika 205</b>			
<b>Before applying any other product</b>		If surface seems dusty, greasy or with finger marks, start operation again.	

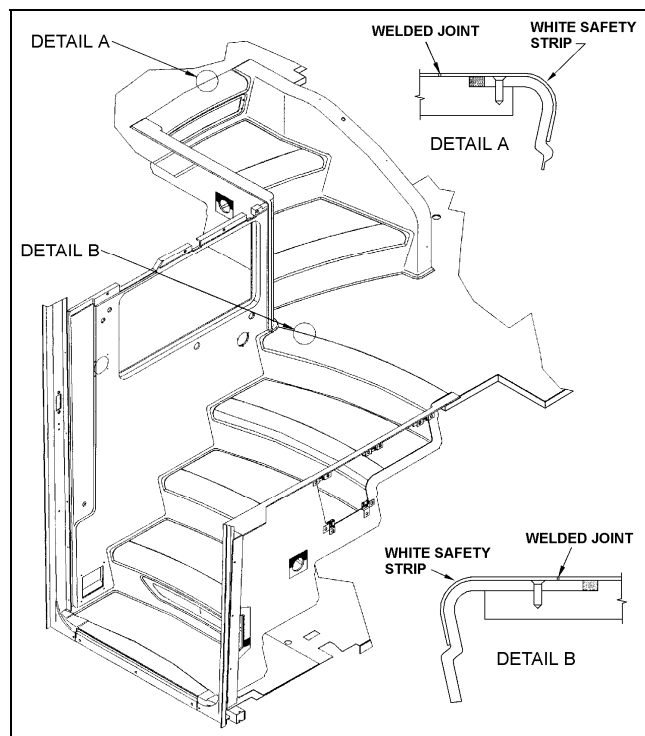
### H3 VEHICLE FRONT STEPS GLUING

1. Remove adhesive tape from underneath step.
2. Apply a thin and even layer of contact adhesive (3M) (684655 or 684654) onto fiberglass and step surfaces. Allow drying for 3 to 5 minutes.
3. Install step beginning with the back and finishing with step nosing. Compress step covering using a roller paying particular attention to corners, edges and front of step.
4. Apply a bead of sealant (684517) around the perimeter of steps. Smooth out the joints.



### GLUING OF WHITE SAFETY STRIP BETWEEN STEP AND “TARABUS” FLOOR COVERING

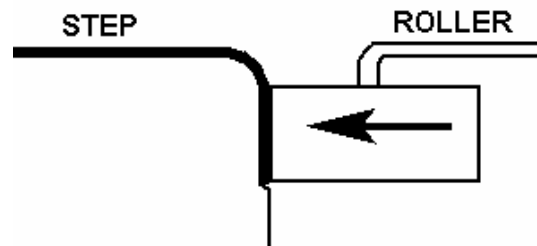
1. Sand fiberglass using “Scotchbrite”.
2. Clean using tack cloth.
3. Clean twice using anti-silicone (refer to Section A).
4. Protect surfaces around the step with masking tape.



5. Apply contact adhesive (3M) (684655 or 684654) onto both surfaces to glue (fiberglass and back of white safety strip). Drying time: 4 to 5 minutes.

**Note:** There should be no floor covering adhesive (680028) onto plywood before applying contact adhesive, otherwise the two surfaces won't stick.

6. Position white safety strip with reference to “Tarabus” step covering finishing with step nosing. Compress step covering using a roller paying particular attention to corners, edges and front of step.



**Note:** Keep a gap of 1 to 1.5 mm between “Tarabus” covering and white safety strip.

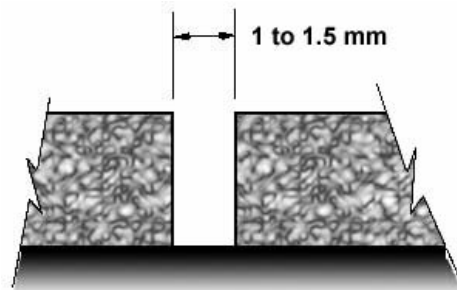
7. Remove masking tape.

## 11.2 WELDING OF JOINT BETWEEN WHITE SAFETY STRIP AND “TARABUS” FLOOR COVERING

1. Pre-heat welding torch;

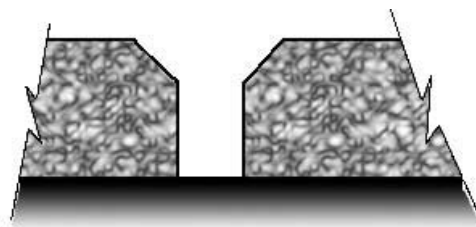
Set welding torch to position #4.5 (temperature of 500 °C),  
Heating time: 5 minutes.

2. Before welding, visually ensure that a 1 to 1.5 mm gap exists between white safety strip and “Tarabus” floor covering. Use a knife if this is not the case.



**Note:** There should be no excess of adhesive on top of surfaces, clean if required using “All-Sol”.

3. Chamfer the joint.



**Note:** The chamfer width must always be less than the filler bead diameter (between 2.5 and 3 mm).

4. Use chamfer knife. **Be careful not to overcut or to cut to the side to prevent damaging “Tarabus” covering.**

## Section 18: BODY

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5. Add (about 6 inches) some length to the required length of filler bead to make the joint then cut.
6. Take position with welding torch. The proper position is with a slight slope to the rear.



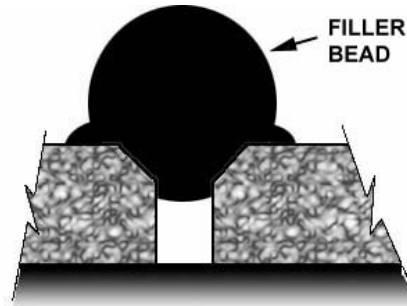
7. Once the welding torch is ready, insert the filler bead into the nozzle and immediately start welding. Move in a regular manner while pressing slightly with torch.



8. The heel of the fast nozzle must not lean against "Tarabus" covering (always parallel to the surface).

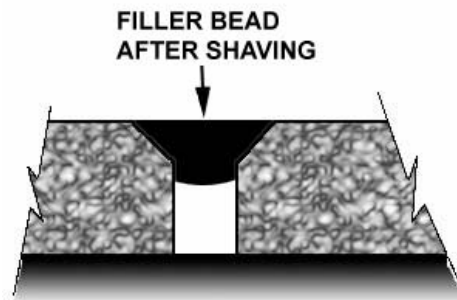


9. Allow cooling down of filler bead (about 5 minutes).



10. Shave filler bead to make it level to the floor. Use supplied knife designed for that purpose.

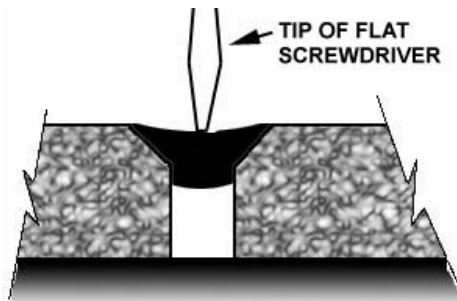
**Note:** To facilitate the cut, you can spray some soapy water onto the joint.



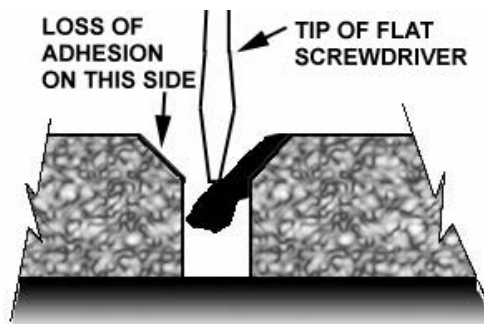
**Caution:** The procedure for turning the torch off must absolutely be followed. If this step is not taken, the element may burn.

11. Set temperature potentiometer to "0" position. Fan will evacuate residual heat. Leave the torch in operation as it is for 3 minutes.

12. Perform adhesion test using the tip of a flat screwdriver; apply a slight pressure on the joint.



13. If welding was not performed properly, there will be a loss of adhesion on one side. If this is the case, repair the joint.



## Section 18: BODY

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### 11.3 REPAIR OF A WELDED JOINT

**Note:** In wintertime, condensation and cold temperature may greatly influence bonding parameters. Working area must be at a temperature sufficient to prevent reaching condensation point. Mechanically preheat working area (heat lamp or heat gun) or wait until vehicle reaches room temperature.

1. Using a knife, remove portion of joint to be repaired.

**Note:** Loss of adhesion may be local. If this is the case, repair may also be local.

2. Chamfer the joint again as indicated in paragraph 3, Section: WELDING OF JOINT BETWEEN WHITE SAFETY STRIP AND "TARABUS" FLOOR COVERING.
3. Re-weld the joint as indicated in paragraphs 6, 7 and 8. Use your thumb to hold the filler bead end.

**Warning:** Nozzle is hot.



4. Always add an extra inch of filler bead at the beginning and at the end of repair.
5. Perform steps indicated in paragraphs 9, 10 and 11.

## 12. PASSENGER SEATS

H3-41 and H3-45 coaches can be equipped with any of 2 basic seat models and installed in a variety of seating arrangements:

1. The "Tourismo 2" seat is the base model and is available in heights of 40" (102 cm) and 42" (107 cm). Seating arrangement includes 2 card tables which can be folded and removed, and pivoting seats ahead of each card table. Each pair of seats is built on a welded steel frame fastened to the side wall and on a track-mounted pedestal. Standard seating capacity is 48 in H3-41 and 56 in H3-45.
2. The "V.I.P." seat model is an optional seat. "V.I.P." seats are mounted on one row of paired seats built on a common frame on one side of the vehicle, and a row of single seats on the other side of the vehicle with an off-center aisle. Each "V.I.P." seat has its own set of armrests.

Each seat has a easily removable bottom cushion. Upholstery is clipped on the cushion frame for cleaning or replacement. To remove the fabric, simply unclip from the frame. The

"Tourismo 2" seats have 3 armrests. The aisle and center armrests can be folded up and down manually, while the window armrest is fixed.

### 12.1 ROTATING SEATS

1. Remove 1 wing nut holding each seat bottom cushion from under the seat frame.
2. Lift front part of cushions and remove cushions.
3. Remove 4 wing screws fastening seat assembly to seat frame.
4. Pull seat toward aisle and rotate.
5. Align mounting holes and reinstall 4 wing screws.
6. Reinstall seat bottom cushions with wing nuts.

### 12.2 REMOVING FIXED SEATS

**Note:** Seats on one row are not interchangeable with seats of the other row.

To remove fixed seats, proceed as follows:

1. Remove 1 nut holding each seat bottom cushion from under the front part of the seat frame.
2. Lift front part of cushions and remove cushions.
3. Remove 4 finishing screws holding plastic cover between side wall and seat frame.
4. Remove 2 cap screws, nuts, and washers holding seat frame to side wall and retain the 2 holding brackets. See figures 28 and 29.

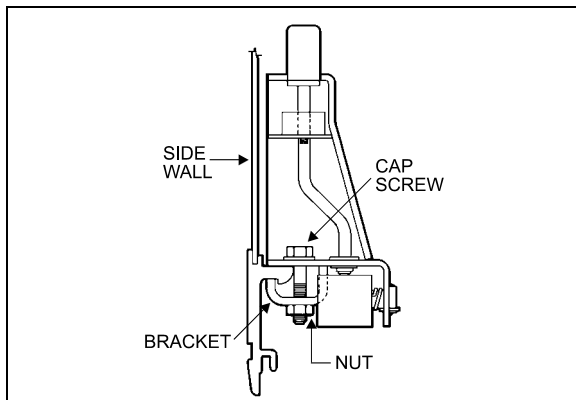


FIGURE 28: ARMREST

18106

5. Remove 2 nuts and washers holding seat frame to pedestal rods.

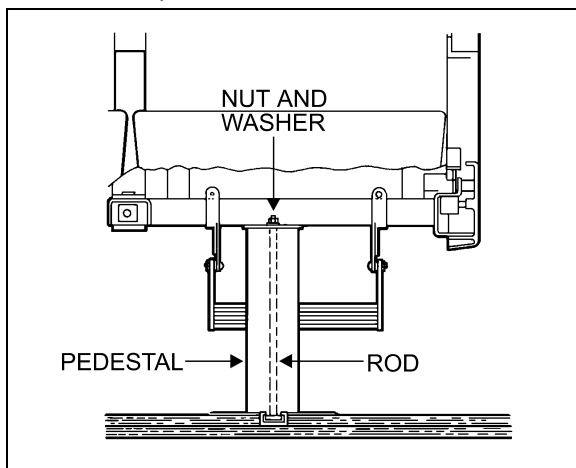


FIGURE 29: SEAT PEDESTAL ASSEMBLY

18107

**Note:** Bottom end of rod is coated with Loctite and threaded in a steel block which slides in the floor track. Removal of rod is possible if loosened from block. Otherwise, slide rod and block assembly to the front end of track after removing all seats located in front.

6. Remove seat assembly.
7. Reverse the above procedure to install seat assembly.

**Note:** On newer vehicles, the rod consists of a carriage bolt inserted in a square plate sliding in the floor track. Removal is possible only by the front or rear end of track.

### 12.3 UPHOLSTERY MAINTENANCE

Coach seats are lightweight, with foam-padded backs and cushions. For both appearance and wearability, best results are obtained if upholstery is cleaned at regular intervals before dirt, dust and grit have been ground into the fabric. Seat fabric is made of 50% wool, 33% cotton, 9% nylon, and 8% acrylic.

#### 12.3.1 Routine Cleaning

All that is required to remove the dirt is a gentle beating with the hand or the back of a brush. This will bring the dirt to the surface where it is easily removed with a vacuum or brush in the direction of the pile which can easily be recognized by running a hand lightly over the pile. If the fabric become excessively dirty, particles of grit will cause gradual wear, reducing the life span of the fabric.

#### 12.3.2 Dry Cleaning

If covers are to be removed for cleaning, dry cleaning is recommended since washing might cause some shrinkage, preventing the covers from being reapplied to the seats without damage. Other than spot cleaning the covers while they are in place, dry cleaning is not recommended, since the resulting fumes could be hazardous in the confines of the coach and the solvent could be detrimental to the foam padding of the seats.

#### 12.3.3 Cleaning With Covers in Place

The most effective and economical method to clean the fabric seat covers is by washing with either an approved foam upholstery cleaner or with a mild household detergent.

Thoroughly vacuum the upholstery. Remove any spots or stains before the seats are washed to avoid a cleaning ring.

Dilute household detergent or liquid foam cleaner according to directions on the container. Pour a small quantity into a flat pan and work into a thick foam with a sponge or brush.

Apply only the foam to the fabric with a sponge or brush. Clean a small area of the fabric at a time with the foam. DO NOT SOAK. Rub vigorously.

## Section 18: BODY

Sponge the suds from the fabric with a clean sponge or cloth moistened with water. Rinse the sponge or cloth often and change the water when it becomes dirty.

Allow the upholstery to dry completely before the coach goes back into service. To speed up drying, excess moisture can be blown off the fabric with compressed air.

**Caution:** Oil in the air line will soil the fabric. Blow the line clear and test air discharge against a plain white piece of paper. It is also effective to press the edge of a flat hardwood stick down on the cushion and slowly draw it across the fabric.

Even very soiled areas can be returned to their original appearance by a thorough cleaning, but a regular schedule of cleaning that keeps the upholstery reasonably clean at all times will greatly enhance the life span of upholstery.

### 13. COACH SIDE WINDOWS

Seven passenger side windows are provided on each side on H3-41, while the H3-45 has eight. They are made of fixed, single or double-glazed, heat absorbing AS-3 glass. Windows are mounted in painted aluminum extrusions, which hold the glass in place from the top rail of the coach. The extrusion also serves as a hinge to allow the window to swing open when needed. The single-glazed windows are made of tinted tempered safety glass, while the double-glazed windows are made of tinted tempered safety glass outside and clear tempered glass inside.

The two trapezoidal windows are also mounted on an aluminum extrusion (except for H3-45 VIP, where they're mounted with adhesives. Refer to "Adhesive Mounted Windows" in this section, for more information on this type of installation). The trapezoidal windows are made of fixed, double glazed, heat absorbing AS-3 tempered safety glass inside and tempered glass outside.

#### 13.1 EMERGENCY EXIT WINDOWS

Three of the windows on each side serve as emergency exits on the H3-41, while there are three of them on curb side of the H3-45, and four on driver's side. See figures 30 and 31.

Except for the window upper edge, the three other glass edges are unprotected, which causes the workers to be exceptionally careful when manipulating or installing such windows.

In addition, when it becomes necessary to lay down the unprotected edges of the glass window, never use a steel or concrete floor support. It is recommended to use a wooden support, even better, a padded surface.

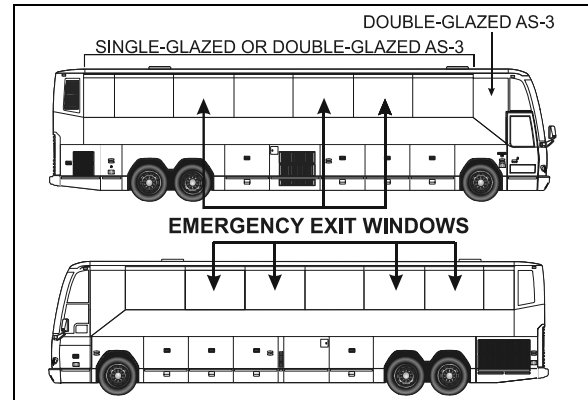


FIGURE 30: H3-45 COACH

18519

An emergency exit window can be opened by pulling the lower part of the release bar to disengage the safety latches, and then by pushing out the window frame (Fig. 32).

Emergency operating instruction decals are affixed under each emergency exit window. To close the window, pull back the window and push down the release bar.

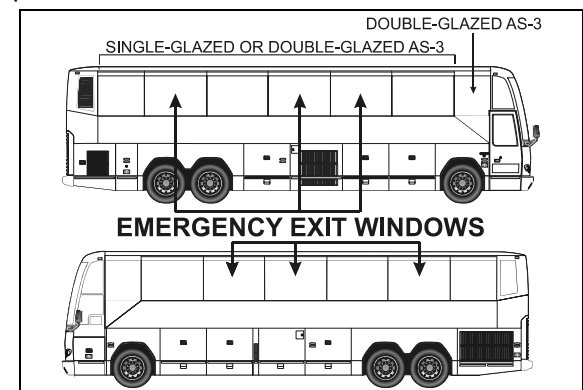


FIGURE 31: H3-41 COACH

18520

#### 13.2 EMERGENCY EXIT RELEASE BAR

The emergency exit release bar system is generally maintenance free.

It has been designed to answer the twenty pound resistance criteria for opening the emergency window. If this handle should be replaced:

1. Remove the screws and bolts securing it to the emergency exit window;
2. To install a new release bar, reverse the procedure.



**Note:** Check the legal twenty pound maximum resistance to be sure to comply with regulations.

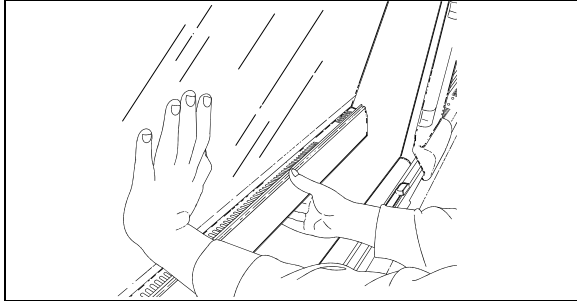


FIGURE 32: EMERGENCY EXIT WINDOW 18391

### 13.2.1 Emergency Exit Window Adjustment

Emergency exit windows should be checked periodically for easy opening and closing. Pulling the lower part of the release bar with both hands placed near the safety latches should disengage both locks on the window simultaneously. The tension required to release the window should not exceed twenty pounds (9 kg) of force.

The release bar mechanism itself has been designed such as no adjustments are necessary.

If too much effort is required to disengage the locks when pulling the release bar or if the window doesn't close tightly or rattles, check for interference by foreign objects or nearby parts into mechanism, such as the microswitch, rubber seal, wires, etc. Correct situation immediately.

**Note:** Tangs on the lock must be in a horizontal position.

### 13.3 FIXED WINDOW REPLACEMENT

When it becomes necessary to replace the glass of a fixed-type window, follow this procedure:

1. Unscrew the decorative plate and the bottom window bar in order to get access to the window retaining devices.
2. Remove the window bottom retaining bolts.
3. Push the glass window out ninety degrees (90°).

**Warning:** The window may fall out.

4. The window is free and can be unhooked.
5. Reverse procedure to install a new one.

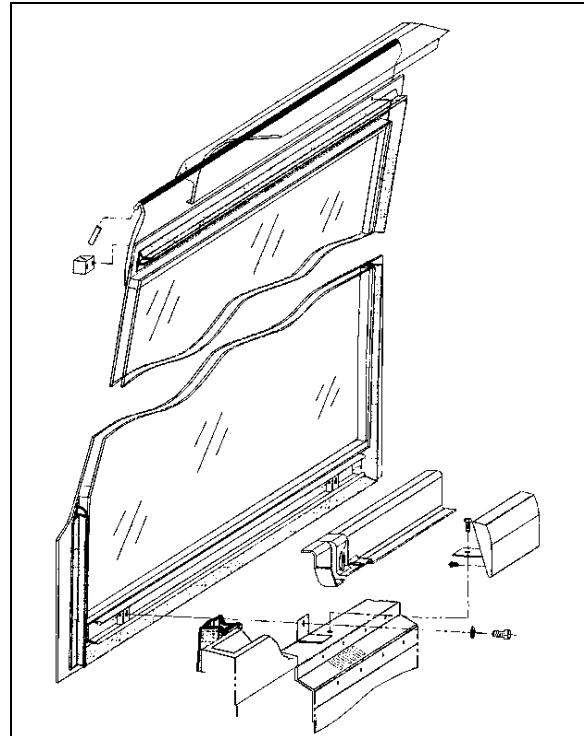


FIGURE 33: FIXED WINDOW 18434

**Note:** For all window replacement, it is extremely important to center the top side between the window dividing posts with great precision in order to be able to attach the bottom of window and the structural posts.

### 13.4 EMERGENCY EXIT WINDOW REPLACEMENT

1. Lift the bar release system and follow the same procedure mentioned above for fixed windows.
2. Remove the stop blocks from the top exterior of the window.
3. Reverse the procedure to install a new emergency exit window.

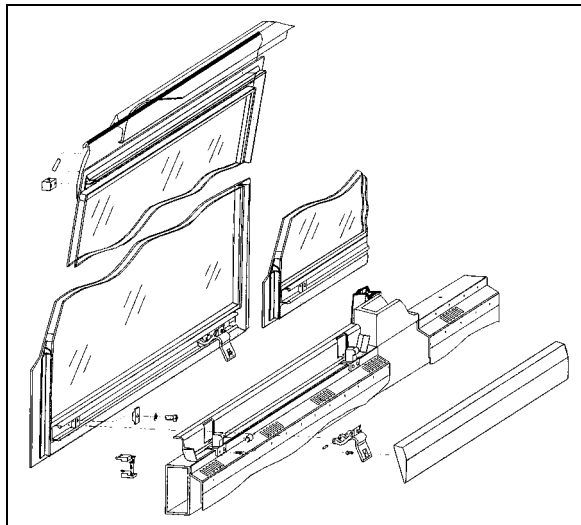


FIGURE 34: EMERGENCY WINDOW 18435

### 13.5 TRAPEZOIDAL WINDOW REPLACEMENT

Apply procedure for fixed window replacement described in this section but with these variations:

- The angle at which the window will detach is considerably smaller (about 45°);
- These windows are also glued to the structure at certain areas on their perimeter. Note where adhesives are used and apply gluing techniques at these areas to complete replacement of these windows.

### 13.6 SMALL REAR WINDOWS REPLACEMENT

These small windows are located at the vehicle's rear end, just forward of the lavatory.

Apply procedure for fixed window replacement described in this section but with these variations:

- The angle at which the window will detach is considerably smaller (about 45°);
- These windows are also glued to the structure at certain areas on their perimeter. Note where adhesives are used and apply gluing techniques at these areas to complete replacement of these windows.

Both the trapezoidal windows and the small rear window are fixed in place with adhesives. They are not serviceable, in the event that they may need replacement.

### 13.7 ADHESIVE-MOUNTED WINDOWS

These windows are located in the vehicle's front and rear caps (Fig. 35).

The adhesive-mounted windows are fixed, double-glazed, heat absorbing AS-2 or AS-3 glass mounted in their opening with polyurethane windshield adhesive. The double-glazed windows are tempered safety glass outside and inside.

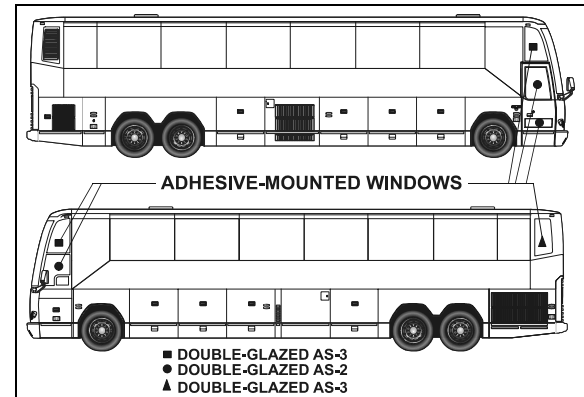


FIGURE 35: ADHESIVE-MOUNTED WINDOWS 18494

#### 13.7.1 Glass Window Replacement

##### Items Needed:

- Scraper with new blade;
- Masking tape;
- Tremshield tape (Prevost #681089);
- Chix cloths (Prevost #682384);
- Isopropyl alcohol or enamel reducer or NAPA 6383 surface cleaner;
- Sika 205 cleaner;
- Sika 255 F.C. adhesive;
- Disposable vinyl gloves;

**Warning:** Wear disposable vinyl gloves during this procedure. Do not smoke. Dispose of unused toxic material properly. Heed all warnings on product containers.

1. Remove old window glass and scrape off remaining material up to 1/16" to 1/8" (2 to 3 mm) thick.

**Note:** Hardened adhesive will not remove easily. A new blade works best to remove all adhesive residue using care not to damage the fiber structure.

2. Place the new window glass in the opening and center it to leave an even gap top and bottom, and from side to side.

**Note:** Use small shims to raise the glass in proper position. Shims can be cut from the tremshield tape (Fig. 36).

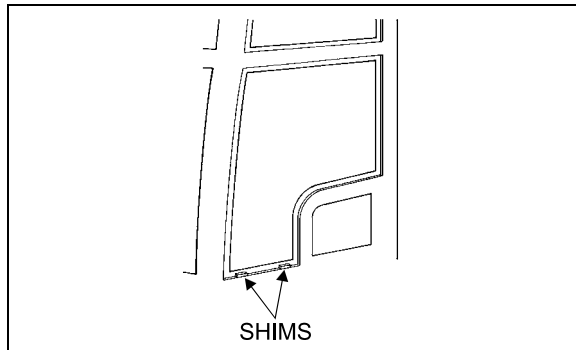


FIGURE 36: ADHESIVE-MOUNTED WINDOW 18079

3. Hold the window glass centered and have an assistant mark the inside contour of the opening on the glass with a china pencil. Remove glass and place it on a table with the pencil mark facing up.
4. Place masking tape on the inside surface of the glass to just cover the china pencil mark, leaving the outer surface exposed for the adhesive. This will make cleanup much easier. For ease of removal, do not overlap the tape at corners.

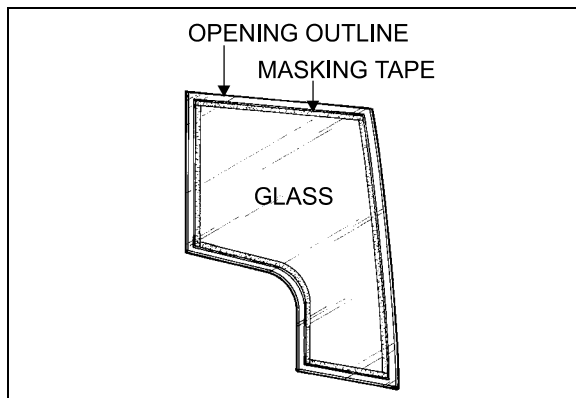


FIGURE 37: ADHESIVE-MOUNTED WINDOW 18080

5. Clean all around the window opening and the window glass edge with Sikaflex 205 (shake well before applying). Let dry 5-6 minutes minimum but no more than 8 hours.

**Caution:** There must be absolutely no silicone on glass or channel or Sikaflex 255 FC will not stick.

6. Put masking tape on the inner and outer contour of the window opening on the structure, approximately 1/16" (1,5 mm) from the edges of the contour.

7. Install Tremshield tape around the sealing surface of the window opening.

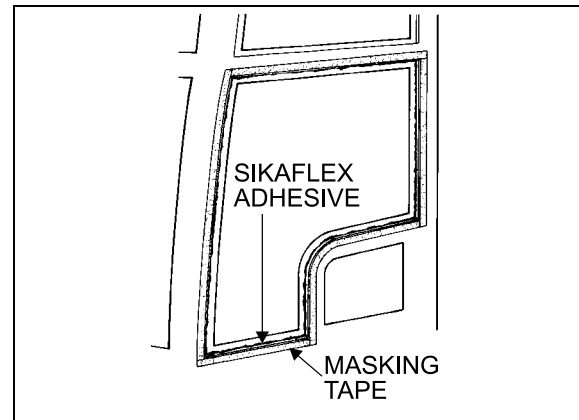


FIGURE 38: ADHESIVE-MOUNTED WINDOW 18081

8. Apply a generous bead of Sikaflex-255 FC polyurethane adhesive on the sealing surface around the window opening from outside the vehicle.

**Note:** To ease applying of Sikaflex 255 FC, it may be heated to 86° F (30°C).

**Note:** Bead should touch the side surface of the window opening.

9. Place shims correctly, and position window glass in the opening. Press firmly and evenly. Excess adhesive should flow out from behind glass.

**Note:** Add adhesive in areas where overflow is minimal or if air bubbles are present.

10. Smooth the adhesive joint using your finger (wear vinyl gloves). Remove excess material around both sides of the window as soon as possible before adhesive dries.

**Note:** Remove most of the adhesive from the scraper or trowel with a rag, and then dip tool in heavy hydrotreated naphta (vanishing oil) after each use for cleaning.

**Caution:** Never use solvents to clean excess adhesive.

11. Remove masking tape at once, clamp window glass suitably and let dry overnight or at least 8 hours.
12. Spraying pure water on the joint will accelerate the drying process.

#### 14. ELECTRIC AWNING WINDOW

The electric awning windows are connected directly on the batteries 24 V DC terminal block.

## Section 18: BODY

As a result, they can be operated regardless of the state open or close of the master switch. However, the circuit is protected with fuse F41 (10A) located in the front service compartment.

### 14.1 OPERATION

Opening sequence: switch is set to the OPEN position. Window latch solenoid SOL1-A and SOL1-B are turned on along with M1 window motor. Once the latch is open, proximity switch PROX1 is de-activated, turning sol1-A and SOL1-B off.

Closing sequence: switch is set to the CLOSE position, turning on relay R1 which turns on M1 in reverse polarity, closing the window. Once the window is closed, PROX1 is activated, turning on SOL1-A and SOL1-B in reverse polarity latching the window closed.

### 14.2 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 connector C7 & C9. Dismount the gas spring from the window.
4. Loosen the set screws #5 (figure 40)(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.

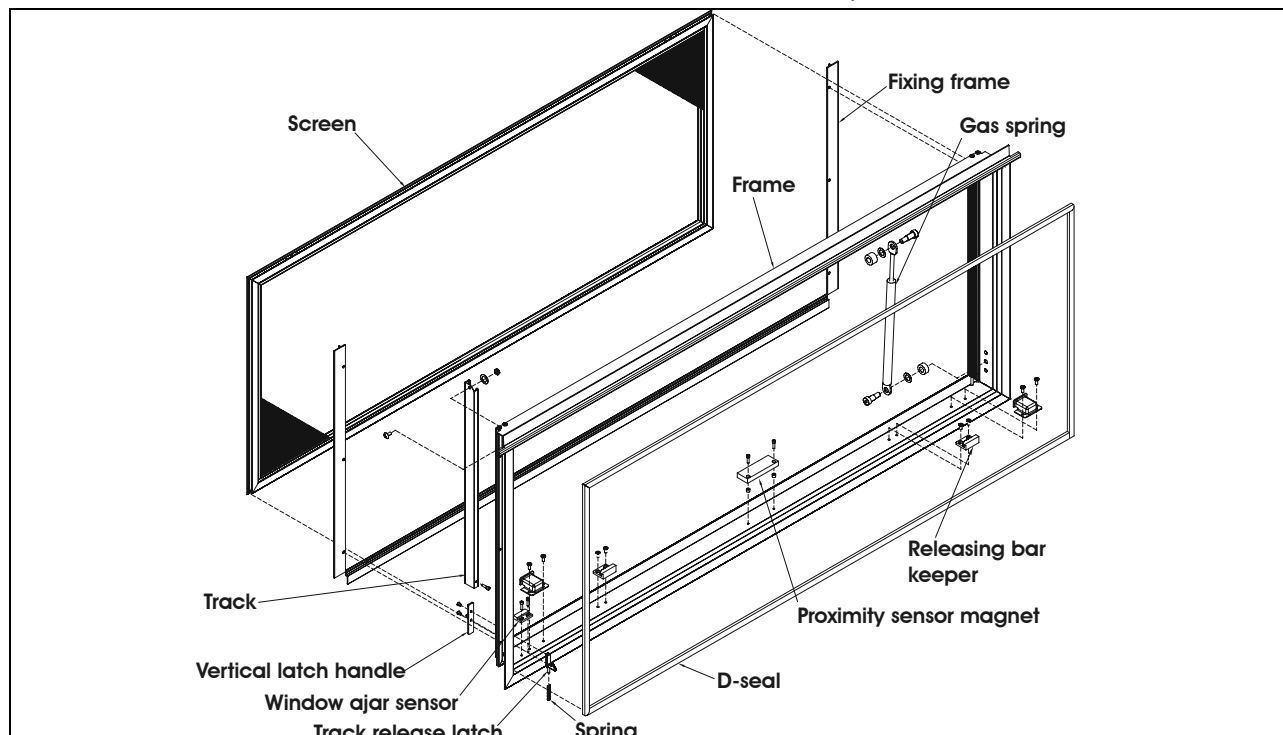


FIGURE 39: ELECTRIC AWNING WINDOW EXPLODED VIEW (FRAME)

18586

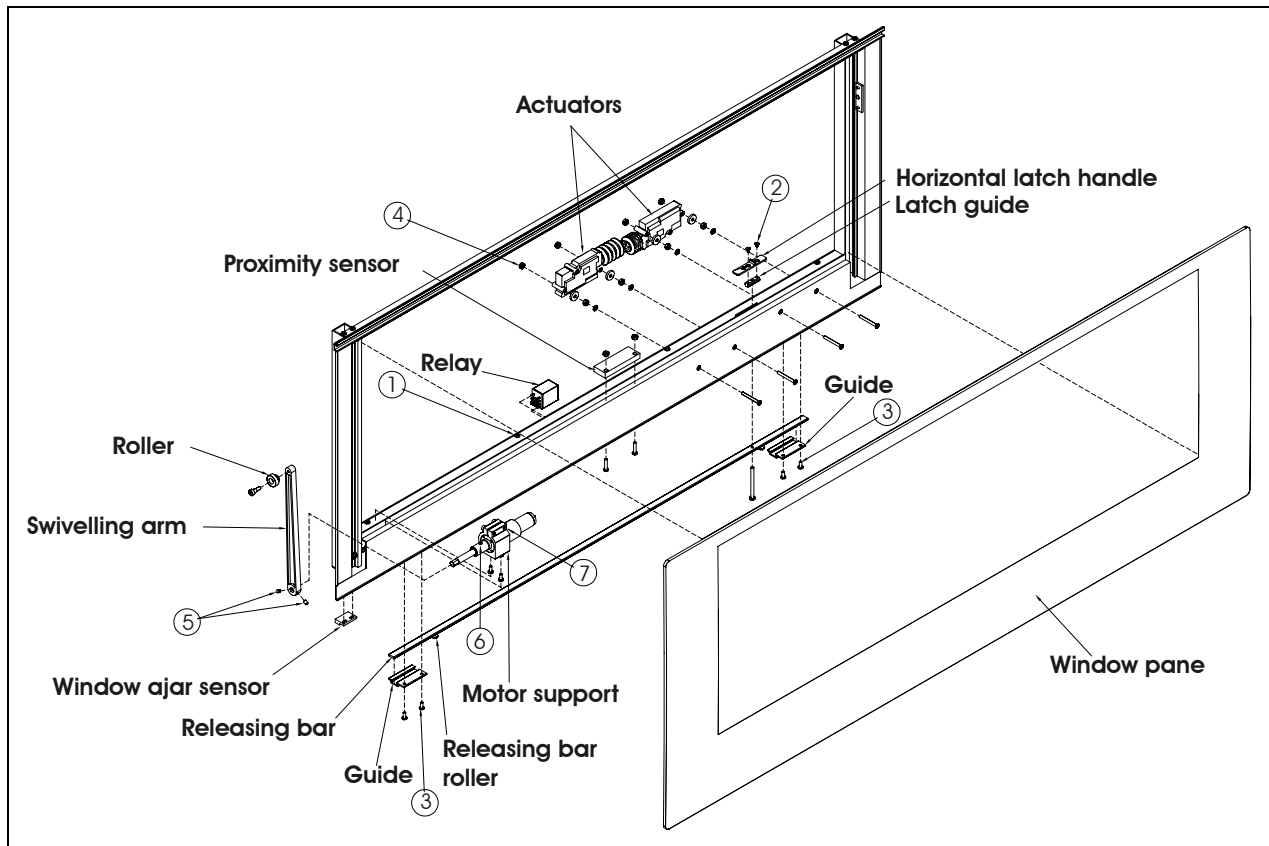


FIGURE 40: ELECTRIC AWNING WINDOW EXPLODED VIEW (SASH)

18583

### 14.3 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 connector C3 or C4 from problem actuator, unscrew nuts #4 (2x) and remove the actuator.
6. Reverse operations for reinstallation.
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 C2 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.
7. Reverse operations for reinstallation.

### 14.4 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.

**Section 18: BODY**

<b>ELECTRIC AWNING WINDOW – CONVERTER CHECKLIST</b>	
<p>Check the electrical circuit &amp; proximity sensor</p>	<p>A: The latching system will not operate without power.</p> <p>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.</p> <p>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).</p> <p>Is the proximity sensor switching when the window is closed?</p>
<p>Check the release force required to operate the horizontal latch handle</p>	<p>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.</p> <p>What is the force required to release the handle? Check using a force gauge (same test done by manufacturer).</p>
<p>Check Installation</p>	<p>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.</p> <p>Was the window installed correctly?</p> <p>Was the correct sequence (see below) used when tightening the clamping frame screws?</p> <div style="text-align: center;"> </div> <p>B: Removing the shipping blocks before the window is installed can create major problems.</p> <p>Were the shipping blocks in place during installation?</p> <p>C: Failure to remove the shipping blocks after installation can create interference between sash and frame.</p> <p>Have the shipping blocks been removed after installation?</p> <p>D: The window is misaligned or not installed squarely.</p> <p>Is there interference with any coach parts?</p> <p>Is there proper clearance between the bottom of the outer glass and the belt-line trim / seal?</p>
<p>Check for missing parts or misaligned parts</p>	<p>A: The frame and sash are misaligned.</p> <p>Is there any interference between the sash and frame?</p> <p>Is there clearance between the sash and the rocker switch covers?</p> <p>B: Releasing bar guides are missing.</p> <p>Check that the releasing bar guides are installed. There should be 4 installed on H windows, and 3 installed on XL2 windows.</p>

## 15. ELECTRIC SLIDING WINDOW

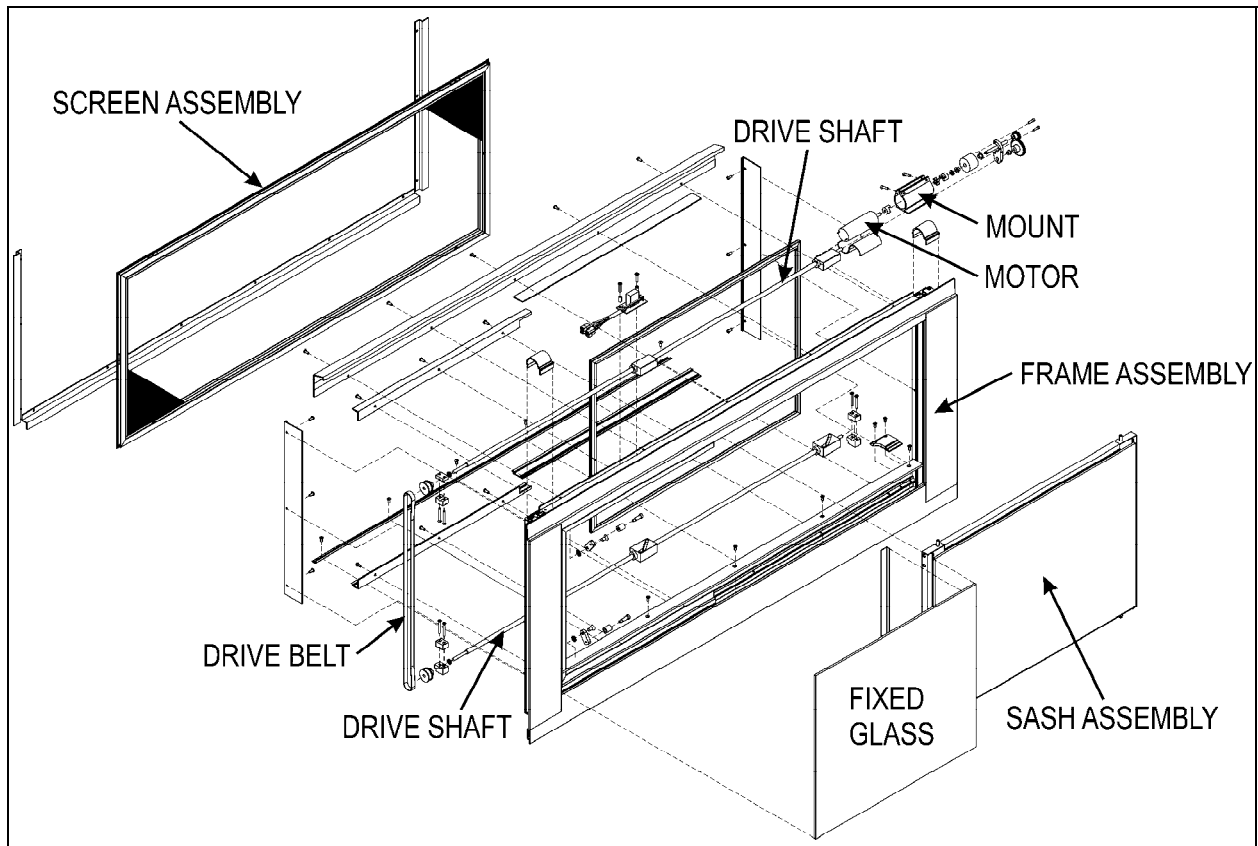


FIGURE 41: ELECTRIC SLIDING WINDOW EXPLODED VIEW

**Sash Removal**

1. Remove the Screen Assembly
2. Pull down on both release latches simultaneously and rotate the sash inwards approximately 10 degrees.(Figure 43)



FIGURE 42: REMOVING THE SASH

3. Lift the sash up and out to disengage the bottom of the sash from the window frame. (Figure 42)

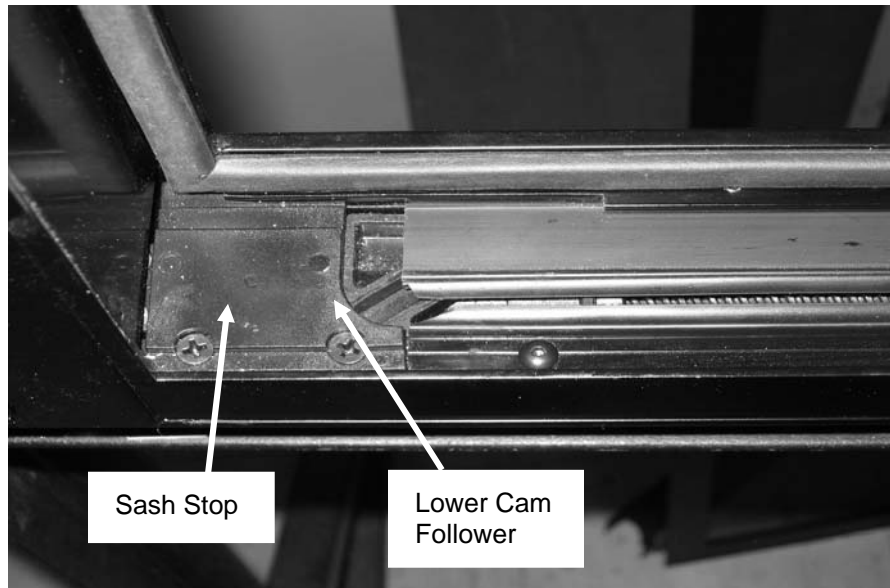


FIGURE 43: DISENGAGING THE BOTTOM OF THE SASH

### Installation

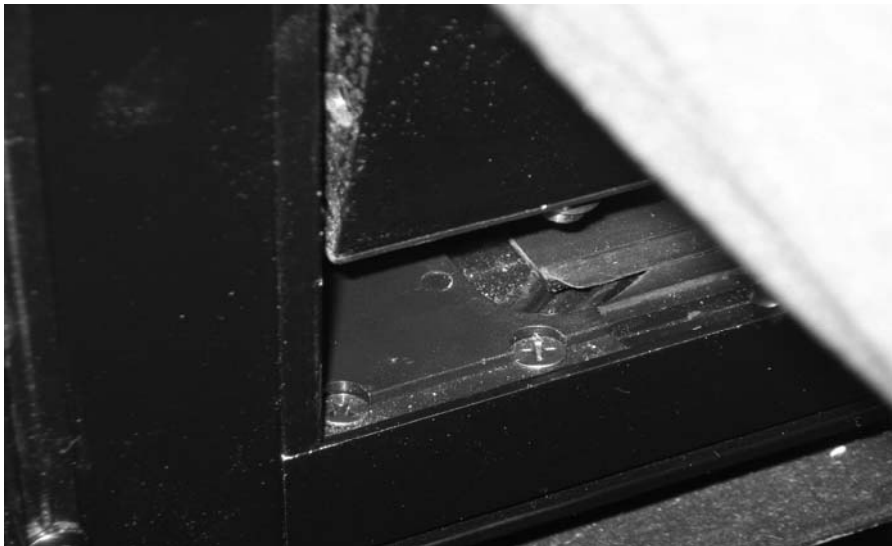
1. Align the leading edge of the slot on the lower cam follower block with the sash stop. Use the power toggle switch to obtain the correct alignment. (Figure 44)





**FIGURE 44: PROPER ALIGNMENT**

2. Position the left hand lower corner of the sash over the front cam follower block (Figure 45)



**FIGURE 45: 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 46)

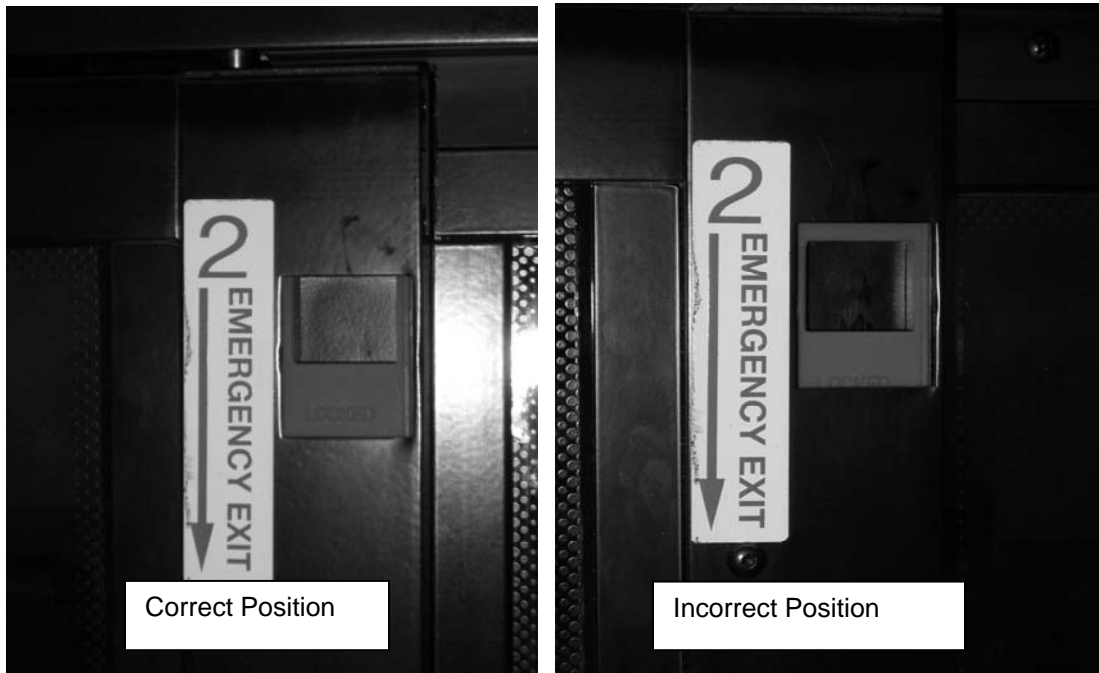


FIGURE 46: RELEASE LATCH PROPER POSITION

7. \* Failure to confirm this step may lead to the sash becoming disengaged with the frame and could result in personal injury.
  8. Operate the window to confirm that it opens and closes properly.
- Install the screen assembly.

## 16. WINDSHIELD

The windshield is single-glazed AS-1 laminated safety glass. Each windshield side is laced to a flange around an opening in the front structure by means of a one-piece black rubber extrusion and locked with two filler strips. Proper installation of the windshield is necessary to ensure watertightness. Since glass varies in fit depending on the supplier, we recommend installing a replacement windshield obtained from Prevost Parts to ensure proper fit. Windshields obtained from other sources should be checked for proper size and curvature.

**Note:** For more information on windshield removal or installation, a video is available from Prevost Parts Inc.

### 16.1 REMOVAL

**Warning:** Windshield removal and installation must be performed by more than one person. To avoid personal injury, wear protective gloves when handling the windshield glass.

1. Remove the wiper arms of the affected windshield.
2. To ease damaged windshield removal, remove the two top rubber filler strips from the rubber extrusion, then the two rubber filler strips on each side. Finally, remove the rubber filler strip located on top of rubber extrusion bottom section. Leave the bottom filler strip in place.

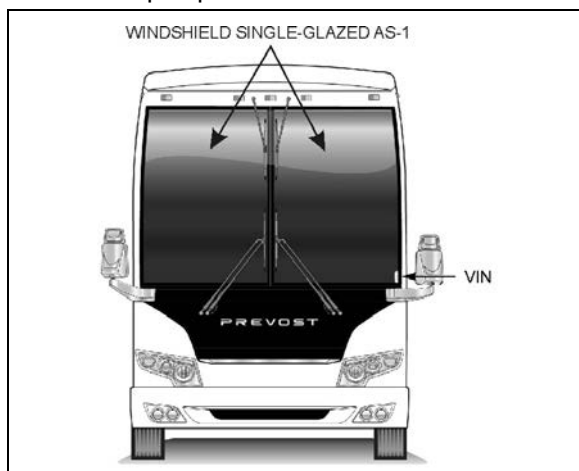


FIGURE 47: WINDSHIELD

18495A

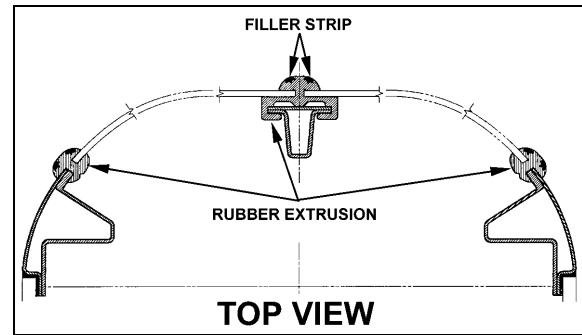


FIGURE 48: WINDSHIELD INSTALLATION TOP VIEW<sup>18098</sup>

3. 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.

4. At the same time, another person gradually lifts the rubber lip from the vehicle exterior using a plastic spatula from top to bottom.
5. Remove the entire damaged windshield and broken glass if applicable.
6. Clean the rubber extrusion channel with Sika 205. Refer to heading "Windshield Installation Only" in this section for instructions on how to reinstall windshield.

**Note:** If the rubber extrusion is damaged, remove and discard it, then clean the windshield opening with Sika 205. Refer to heading "Installation of Rubber Extrusion and Windshield" in this section for complete instructions.

### 16.2 WINDSHIELD INSTALLATION ONLY

1. Spray rubber extrusion with soapy water to ease windshield insertion.
2. Insert rope into rubber extrusion leaving enough length at each corner to make a loop. Spray soapy water onto rope and rubber extrusion (Fig. 48).
3. Slide windshield into rubber extrusion groove starting with the bottom curved side edge. Using a plastic spatula, move the rubber extrusion lip aside to gradually insert the windshield into the groove.

**Note:** Spray lubricant on a regular basis to ease windshield insertion.

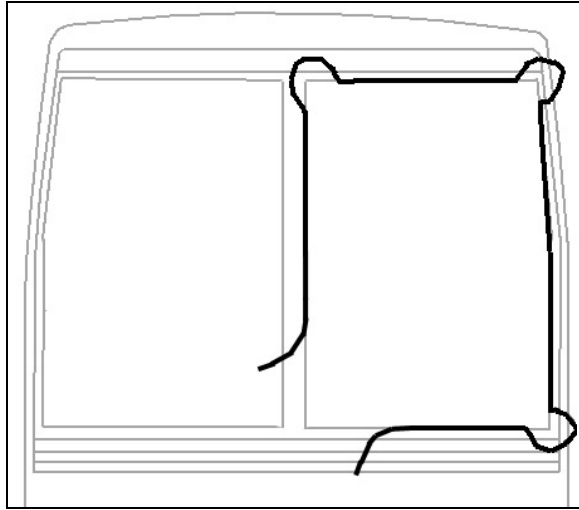


FIGURE 49: WINDSHIELD INSTALLATION USING ROPE

- Using the same type of plastic spatula, repeat the same operation from inside of vehicle, gradually inserting the windshield into the groove.

**Note:** Make sure windshield bottom edge is well inserted into the rubber extrusion groove before proceeding with the sides.

- Then, working from both sides of windshield bottom to top, gradually move the rubber extrusion lip aside to insert the windshield into the groove. Use also lubricant on the inside of vehicle to insert the windshield into the rubber extrusion groove.

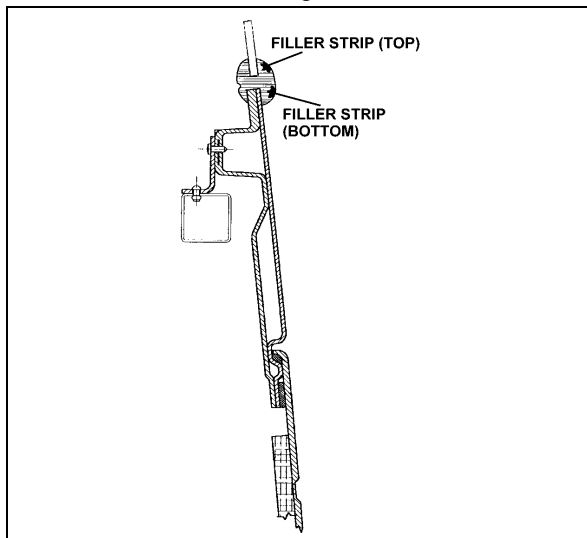


FIGURE 50: WINDSHIELD INSTALLATION SIDE VIEW 8099

- 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. 51).

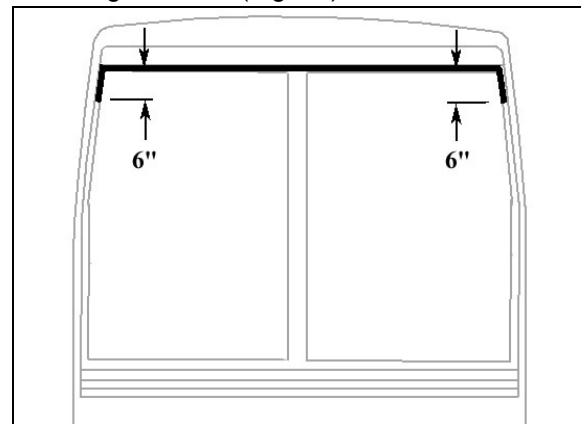


FIGURE 51: APPLICATION OF SIKA 221 BLACK

- Apply Sika 221 black between fiberglass and rubber extrusion.
- Spray filler strip and rubber extrusion groove generously with lubricant.

**Note:** Filler strips retract with time. Install ends of filler strips as tight as possible in the V-channel.

- Using the special filler insertion tool, insert the filler into the bottom rubber extrusion groove. Gradually insert filler 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 at a 45° angle leaving ¼" of excess length to thwart filler contraction over time then insert filler into groove.
- Continue with side filler strips and finish with top ones.
- Reinstall windshield wiper and destination sign if applicable.

### 16.3 INSTALLATION OF RUBBER EXTRUSION AND WINDSHIELD

**Caution:** The black rubber extrusion securing the windshield in the opening fits correctly in only one position. Find the correct position of the rubber extrusion now, and make reference marks with a china marker to avoid searching for the correct position later in the procedure.

1. Clean the windshield opening sealing surfaces with Sika 205 and let dry 1 to 2 minutes.
2. Clean the rubber extrusion with wiping towels soaked with Sika 205 and let dry 1 to 2 minutes.

**Note:** Force the soaked towels in the channels for good cleaning in these critical areas.

3. Find the reference marks made earlier and install the rubber extrusion in the windshield opening.
4. Install windshield as per paragraph 10.2: "Windshield Installation Only".

## 17. BODY PANELS AND DOORS

Each of the doors should be checked for proper operation. This includes latching. Also, inspect each of the doors for damage, missing, or loose parts. Repair or replace those parts as needed.

Unless otherwise noted, body panels and doors should be aligned and centered with surrounding panels. In general, a gap of  $\frac{1}{4}$  inch (6 mm) is desirable between panels. Refer to figure 46 for specified gaps.

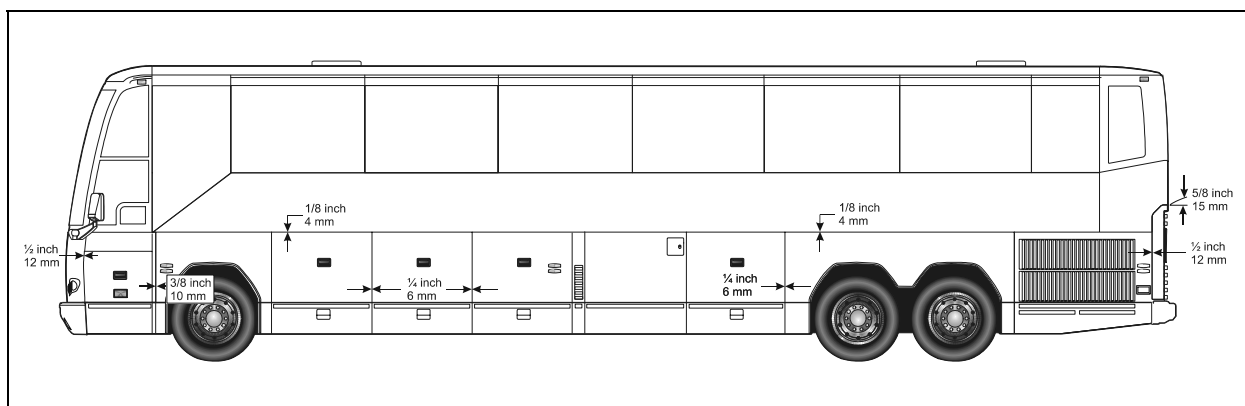


FIGURE 52: BODY PANEL SPACING

18496

## 18. WHEELCHAIR LIFT ACCESS DOOR

### 18.1 INSTALLATION

**Caution:** Install the sliding door onto a suitable lifting device that will allow proper lifting and positioning.

1. Lift and move the sliding door near the opening.
2. Push the door into the opening making sure the positioning lugs are properly inserted into their housing then pivot the main hinge and secure the door using 4 bolts. Do not fully tighten the bolts yet.
3. Remove the lifting device from the sliding door.

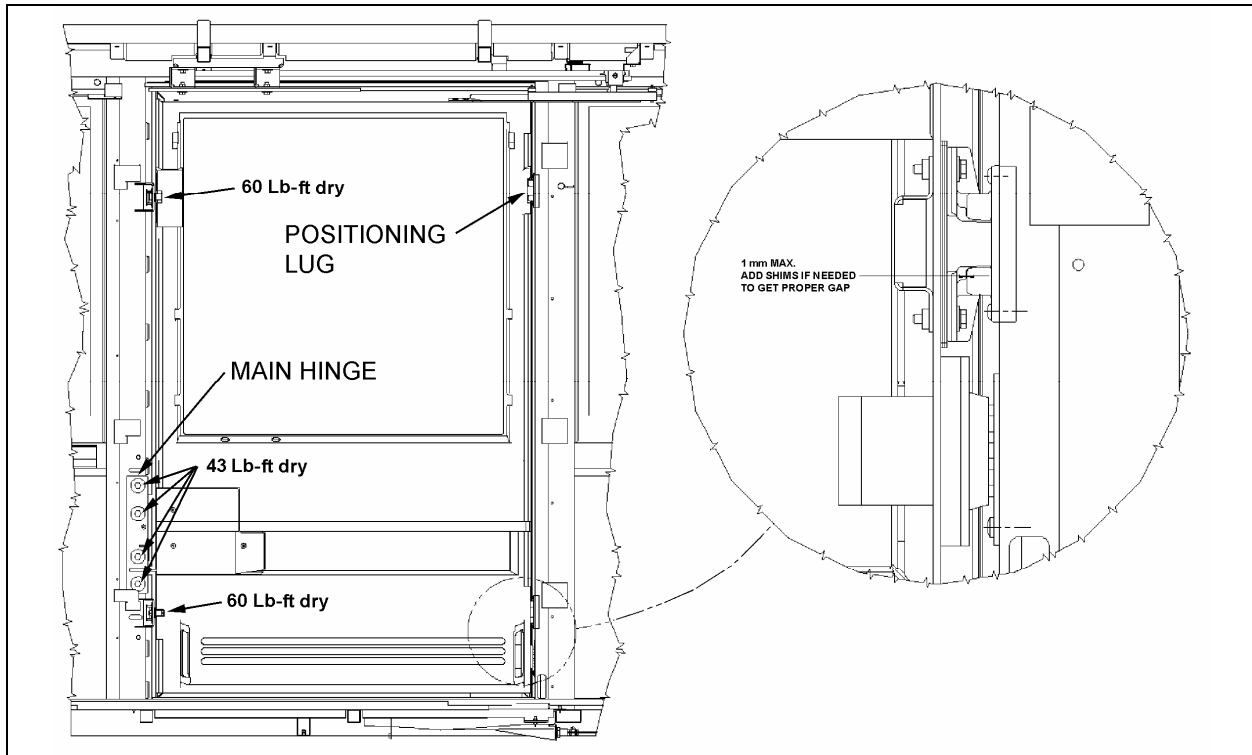


FIGURE 53: WCL SLIDING DOOR INSTALLATION

## 18.2 ADJUSTMENT

1. Adjust sliding door height with reference to the side panels and windows.
2. Slide the top rail into the upper arm then bolt the rail to the structure. Do not fully tighten (Refer to fig. 54).

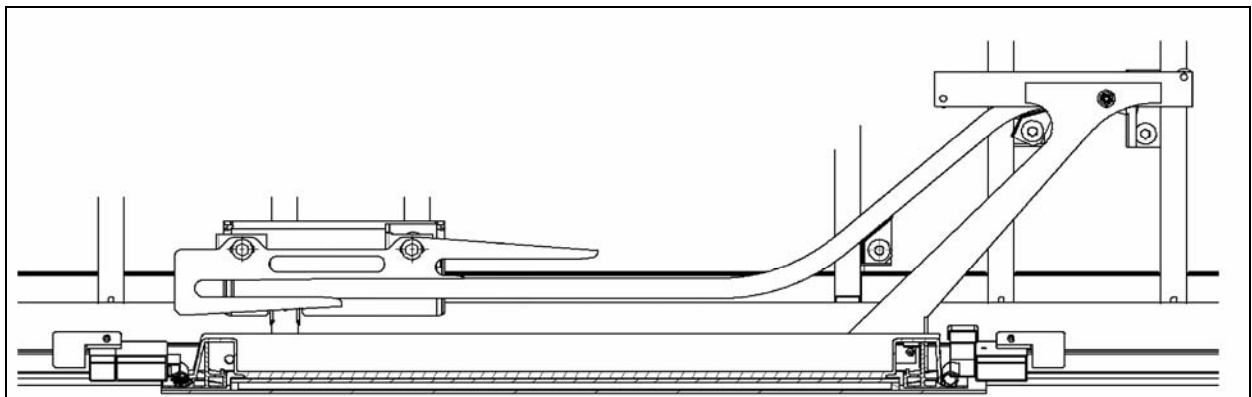


FIGURE 54: WCL UPPER ARM AND RAIL

3. Pull the door in or push from the outside to adjust the door with reference to the vehicle outside surface.
4.
  - Unfasten the upper arm bolt located on the door side.
  - Position the top rail at 3mm from the ceiling bracket.
  - Force the upper arm down then tighten the upper arm fixing bolt.
  - Pull the upper rail towards the inside in order to remove the play between the roller and the upper rail then tighten the rail fixing bolt at the back.

- Push the lower rail towards the outside in order to remove the play between the roller and the lower rail then tighten the rail fixing bolt at the back.

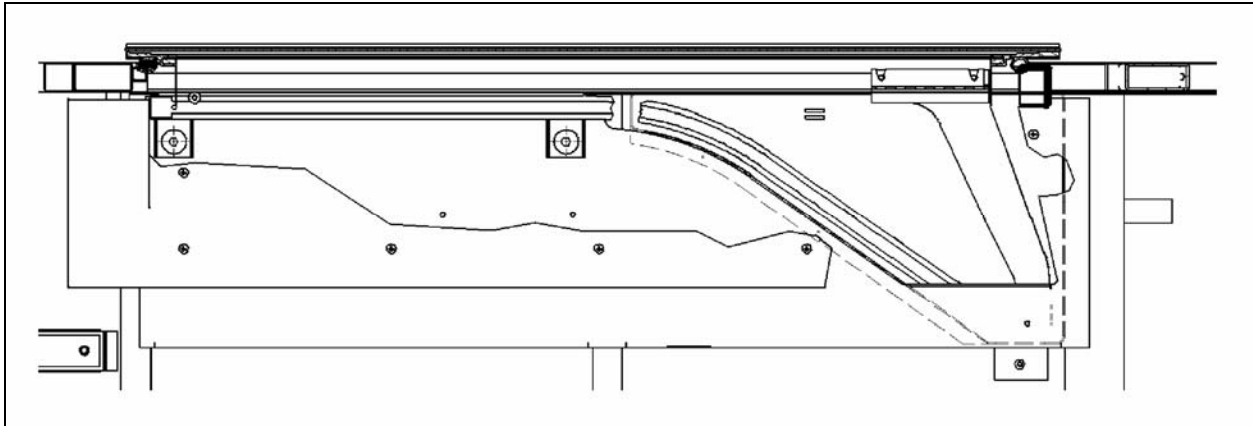


FIGURE 55: WCL LOWER RAIL INSTALLATION

- Adjust the gap between the positioning lugs and their housing, required gap: 0.5 – 1.5mm. Add shims underneath the lugs to get the proper adjustment.
- Take away the plays from the upper arm assembly by lifting the main hinge using a crowbar. Tighten the main hinge bolts to 43 Lb-ft.

**Note:** Do not exert too much force to lift the door.

- Open WCL sliding door completely.
- Pull the upper rail towards the inside in order to remove the play between the roller and rail then bolt the rail at front and center. Add some shims if necessary between the rail and the structure before tightening the bolts.
  - Push the lower rail towards the outside of the vehicle in order to remove the play between the roller and rail then bolt the rail at front and center. Make sure the rollers stay in contact with the support when starting to close the door.
- Adjust the distance between the bottom of the guide and the roller when the door is completely open. Required distance: 2 – 3mm. Make sure the roller stay in contact with the guide.

- Install and adjust strikers. Torque to 60 Lb-ft (Refer to figure 53).

**Note:** Make sure that a 2mm gap exists between the door structure and the striker.

- Adjust latches releasing, the two latches must open simultaneously.

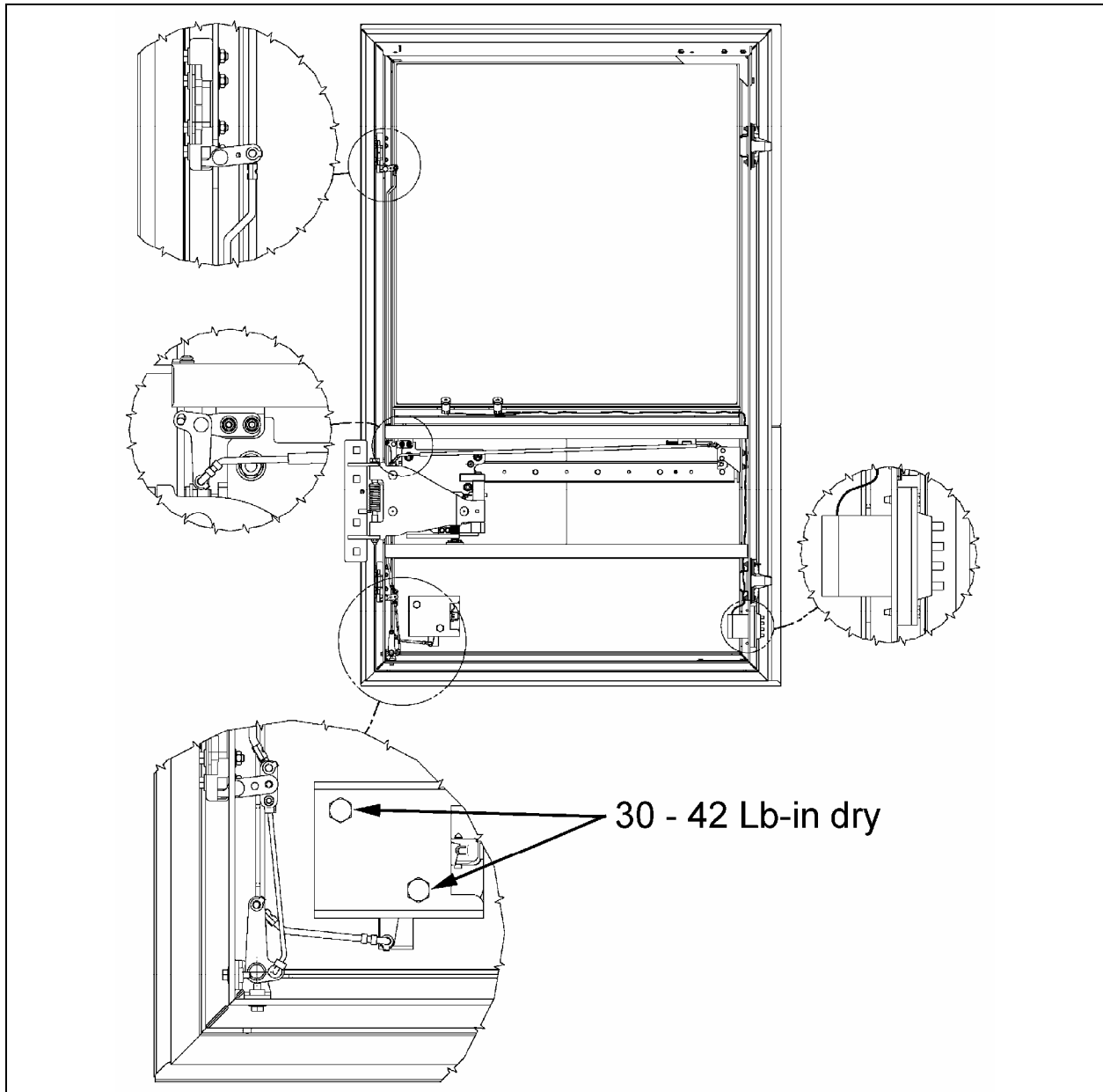


FIGURE 56: WCL SLIDING DOOR OPENING MECHANISM



## 19. BAGGAGE COMPARTMENT DOORS

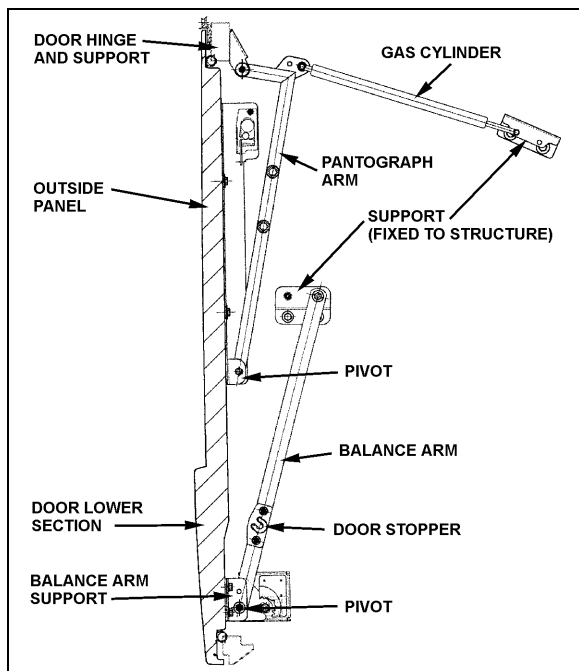


FIGURE 57: BAGGAGE COMPARTMENT DOOR 18061

There are 6 pantograph doors serving as baggage compartment doors on the H3-41, while there are 8 on the H3-45 and the V.I.P (depending on options, VIP model may have even more pantograph doors). Each of these doors is of identical design. A centrally mounted, key-lockable door handle unlatches the door which can then be pulled out and raised up in a path parallel to the side of the vehicle. The door is held in open position by two fully extended gas-charged cylinders, giving clear access to the opening of the baggage compartment.

From its fully open position, the door can be closed by pulling down on the door panel, and letting go when you sense the door will close on its own. The door will easily hinge its way back in the contour of the compartment opening and will be held closed by two latches. Each door can be opened by lifting the centrally mounted handle to unlatch the door and lifting it all the way up. If the door does not remain in the fully open position, one or both gas cylinders on that door is (are) defective. To test the cylinders, first support the door in the fully open position with proper equipment. Disconnect the rod end of one cylinder and try to retract the rod. If strong resistance is felt, the gas 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. Test the other cylinder on that door the same way.

**Note:** In case of malfunctioning or in specific situations, use door stoppers to secure the door in the open position.

### 19.1 PANTOGRAPH ADJUSTMENT

**Warning:** Park vehicle safely, apply parking brake, stop engine and set batteries master switches to the "OFF" position prior to working on the vehicle.

**For more information concerning baggage compartment door adjustment, refer to the following procedures. You will find these procedures at the end of this section.**

- SAV00589
- SAV00590

**Note:** Refer, if needed, to figure 57 for identification of door components.

If the door bends when opening or if pantograph does not function properly, it is probably because the pantograph arms are misadjusted.

Measure distance between a pantograph arm end and a straight edge resting on structure. Repeat procedure for the other arm. The distance on each side should be equal. If not, bend appropriate arm until desired measure is obtained. (Fig. 59 and 60).

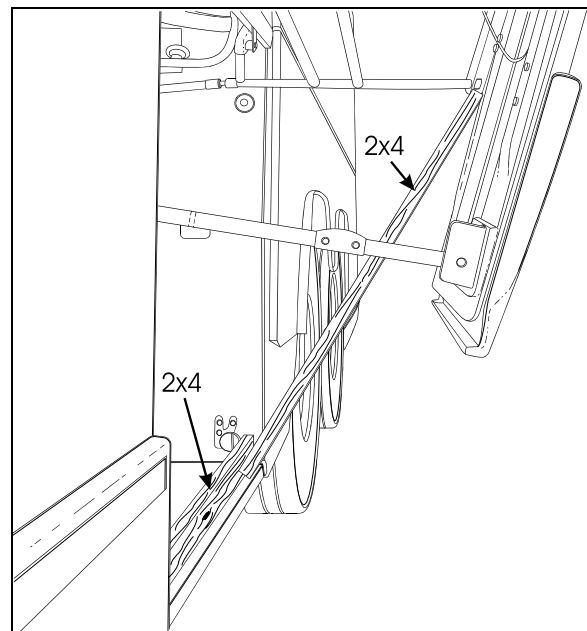


FIGURE 58: PANTOGRAPH ADJUSTMENT 18319

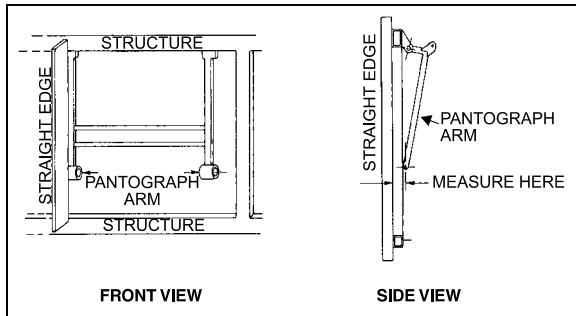


FIGURE 59: PANTOGRAPH DOOR ADJUSTMENT 18062

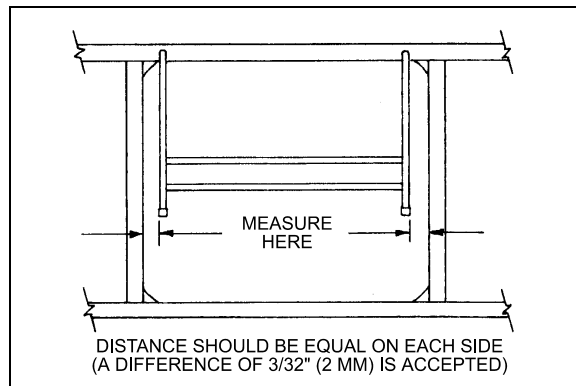


FIGURE 60: PANTOGRAPH DOOR ADJUSTMENT 18063

Doors can be adjusted by bending the arms as follows:

1. Open the door halfway up.
2. Install a piece of wood (a 2x4 will do) along the bottom of the baggage compartment. Arrange so it rests against the striker pins and is prevented from sliding further in the compartment.
3. Install another piece of 2x4 between the first piece and the bottom of the pivot of the lowest (or shortest) pantograph arm, (Fig. 58).
4. Pull down on the opposite side of the door to bend the door around the pantograph arm pivot (prevented from moving by the 2x4).
5. When the door is straight, remove the 2x4's and check door operation and fit. A difference of 3/32" (2mm) between both sides is accepted (Fig. 60).
6. Repeat as necessary.

## 20. DOOR HANDLES

Compartment door handles are non serviceable. When a door handle has to be removed, proceed as follows:

1. Unscrew the four (4) retaining screws;

2. Remove the two (2) wires connecting the handle to the door latch locking mechanisms.
3. To install a new handle, reverse the procedure.

## 21. ENGINE COMPARTMENT DOOR

The engine compartment rear door (Fig. 61) rises in the same way as the baggage compartment doors and is held open by three gas-charged cylinders (Prevost # 980024). The engine compartment opens by lifting a handle accessed from the R.H. side of the engine compartment.

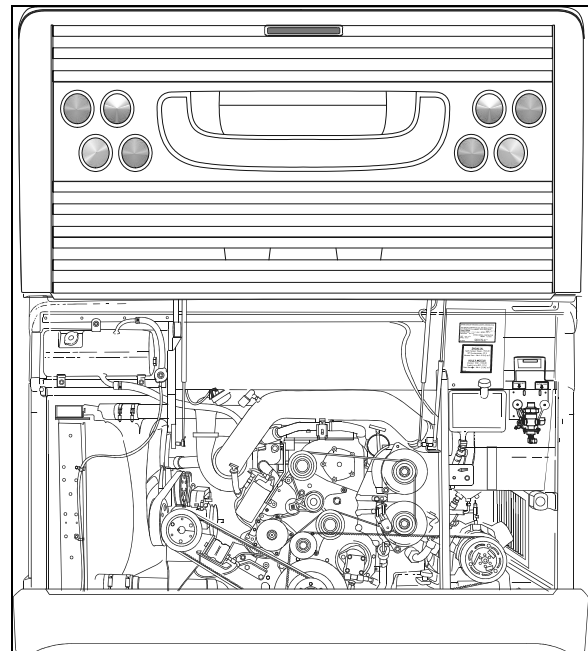


FIGURE 61: ENGINE COMPARTMENT DOOR 18497

When pushed up, the handle pulls on two steel wires, each steel wire connected to its respective door latch locking the rear door. Both steel wires are looped at the release handle and can be adjusted to proper length to ensure positive release of both catches when the handle is raised.

### 21.1 ENGINE DOOR ADJUSTMENT

As indicated above, the engine door mechanism is similar to the baggage door mechanism using a pantograph and 3 gas cylinders to move the door up and down.

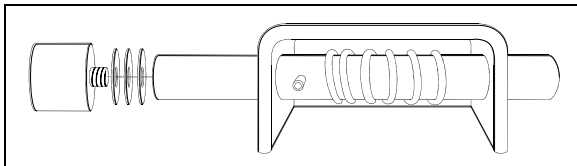
For a minor horizontal or vertical adjustment:

1. Open the door mid-height;

2. With the help of an assistant, pull down one side of door while holding up the other side to bend the pantograph arms in the desired position;
3. Close the door and check the top edge parallelism between the door and the vehicle end cap structure. The space may be somewhere between 10 and 15 mm;
4. Repeat until satisfied.

### 21.2 MINOR TOP EDGE DEPTH ADJUSTMENT

Two rubber spring loaded stops may be adjusted. They are located near the top edge on each side of the rear door.



**FIGURE 62: DOOR STOP**

18324

To adjust:

1. Open door.
2. Unscrew rubber stop.
3. Add or remove washers as needed.
4. Firmly screw back rubber stop.

### 21.3 MINOR LOWER EDGE DEPTH ADJUSTMENT:

1. Open door.
2. Slightly loosen the striker pins on each side of door.
3. Using a hammer, strike striker pin gently in the desired direction (in or out).
4. Close the door slowly and check fit.
5. Repeat 3 and 4 to adjust the other striker pin.
6. When door depth is completed on the four corners, both vertical door sides should be parallel to the vehicle body structure.
7. Firmly tighten the striker pins (2) to lock them in position.

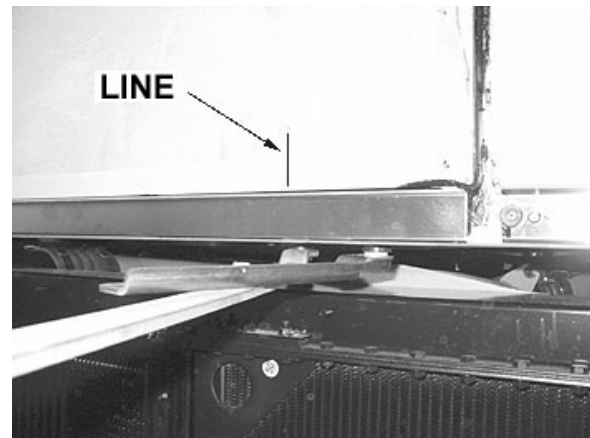
## 22. ENGINE AIR INTAKE GRILL

When needed, the engine air intake grill can be changed:

1. Cut the seal around the grill with a sharp edged knife.
2. Remove the grill from the vehicle.
3. On the vehicle grill opening, using the knife, remove as much adhesive as possible.
4. Sand the new grill backing edge to remove the glossy surface.
5. Clean with alcohol, wipe dry.
6. Apply SIKA 205 primer to the grill opening and the grill edges. Allow to dry at least 2 minutes for chemical evaporation.
7. Apply SIKA 255 FC adhesive on the grill edge.
8. Install the grill on the vehicle, adjust and fasten with masking tape. Allow 8 hours setting period.

## 23. RADIATOR DOOR ADJUSTMENT

### 23.1 DOOR HEIGHT ADJUSTMENT



**FIGURE 63: REFERENCE LINE**

1. Using a pencil, draw a line onto the lateral panel in line with the balance arm.
2. Using a rubber mallet, adjust the lower part of pantograph arm in order to get  $4 \pm 1$  mm between lateral panel and engine door (Refer to figures 64 and 66).



FIGURE 64: PANTOGRAPH ARM ADJUSTMENT

3. Tighten the bolt.

### 23.2 DOOR LATERAL ADJUSTMENT



FIGURE 65: DOOR LATERAL ADJUSTMENT

1. Using a rubber mallet, adjust radiator door positioning with reference to pantograph arm so that the door is parallel to the lateral panel and to the engine door.
2. Tighten the two bolts.

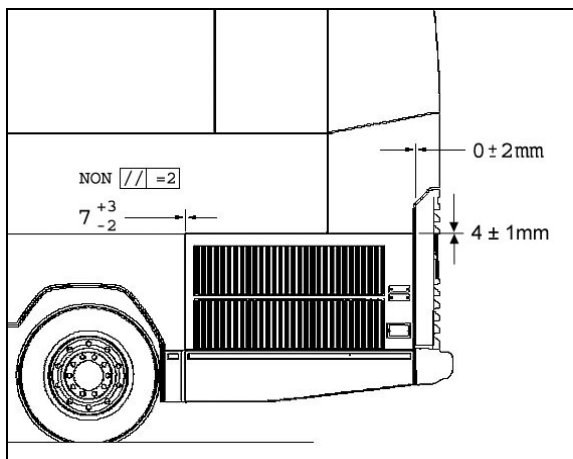


FIGURE 66: PROPER DOOR POSITIONING

### 23.3 DOOR DEPTH ADJUSTMENT

1. Close radiator door.
2. Check parallelism between radiator door and rear fender (max.  $0 \pm 2$  mm).

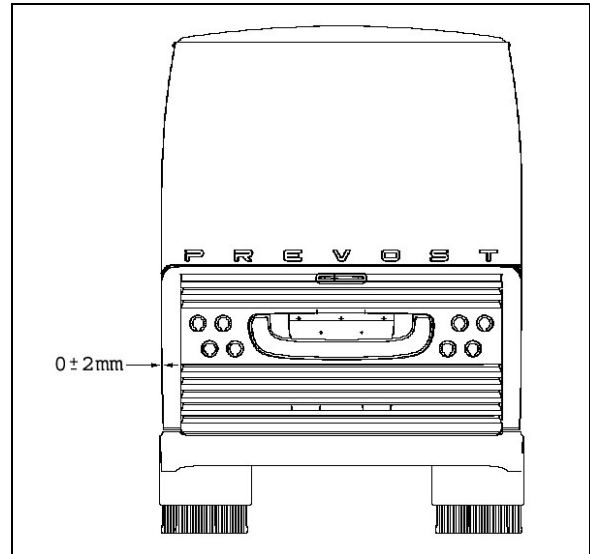


FIGURE 67: DOOR DEPTH ADJUSTMENT

3. If the door is too far inside, adjust using a rubber mallet (Refer to figure 68).
4. Tighten the bolt.
5. Close the radiator door in order to verify that latches adjustment is proper. If the gap is too small or too big, adjust latch positioning.
6. Make sure that latch striker pin engages behind the strike plate at least 10 mm. Add or remove spacers if needed. Check door fit and operation. Tighten the latches bolts.



FIGURE 68: DEPTH ADJUSTMENT

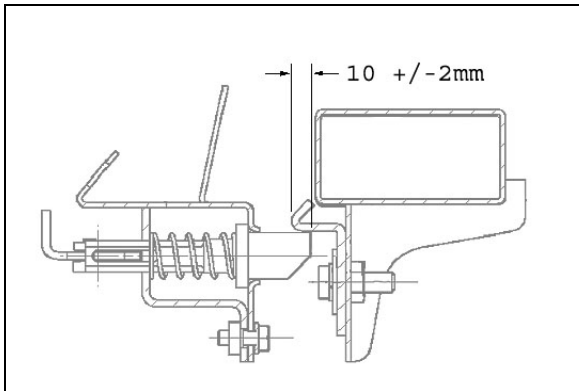


FIGURE 69: DOOR LATCHES ADJUSTMENT

## 24. CONDENSER DOOR ADJUSTMENT

1. Open the condenser door.
2. Loosen the nuts (1, Fig. 70) holding the hinge (3, Fig. 70) to hinge attachment (4, Fig. 77). Loosening nuts (1, Fig. 70) allows the condenser assembly to be shifted "LEFT or RIGHT" and "UP or DOWN".
3. Adjust condenser assembly position at the hinge.
4. Tighten the nuts.
5. Loosen bracket nuts holding the panel to condenser. Panel (6, Fig. 70) may be shifted "IN or OUT", "LEFT or RIGHT" and "UP or DOWN".
6. Adjust condenser panel at brackets (2, Fig. 70) and (5, Fig. 70).
7. Tighten the nuts.
8. Respect the required gap between exterior finishing panels (Fig. 52).
9. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

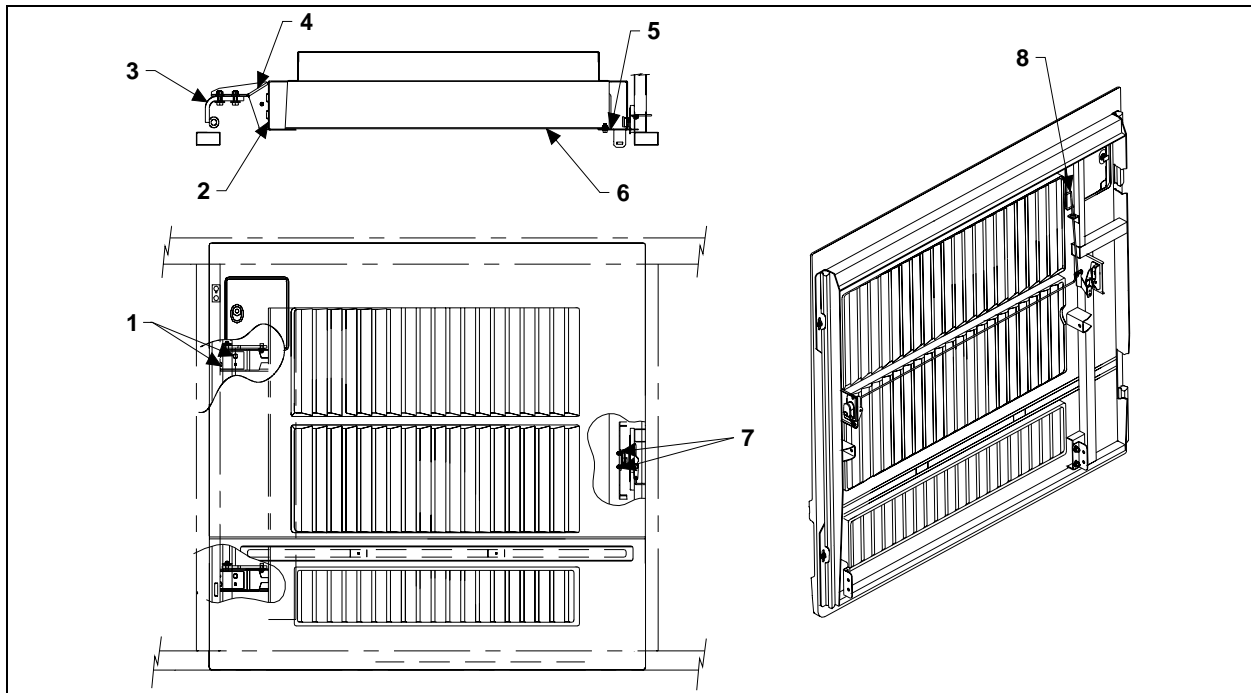


FIGURE 70: CONDENSER DOOR

D280201

## 25. FUEL FILLER DOOR

1. Open the fuel filler door (1, Fig. 71).
2. Loosen the screws (3, Fig. 71) holding the panel to hinge (2, Fig. 71) assembly.
3. Adjust the fuel filler door position according to distance required between exterior finishing parts (Fig. 52).
4. Tighten the nuts.
5. Check that the door swings freely and closes properly.

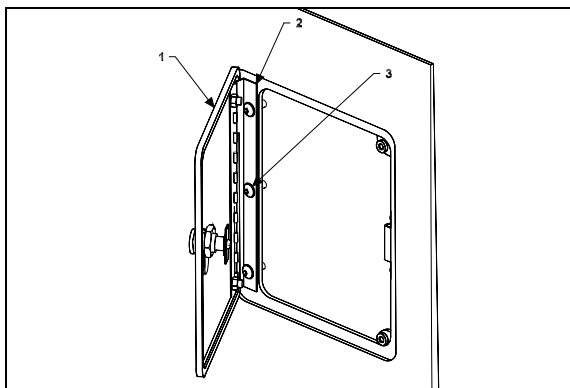


FIGURE 71: FUEL FILLER DOOR

1875003D

## 26. FRONT SERVICE COMPARTMENT

Adjustment of the front service compartment door can be done by following these steps:

1. Open the door.
2. Loosen nut (2, Fig. 72).
3. Move part (1, Fig. 72), as close as possible to exterior of coach, so as to have enough clearance for proper door opening.
4. Tighten nut (2, Fig. 72).
5. Loosen nut (3, Fig. 72). Hinge allows the door to be shifted "IN or OUT".
6. Adjust door panel to have the same gap space as neighboring panels or refer to figure 52 for specified gap space. Only if necessary, use the adjustment allowed by moving part 1, Fig. 72.

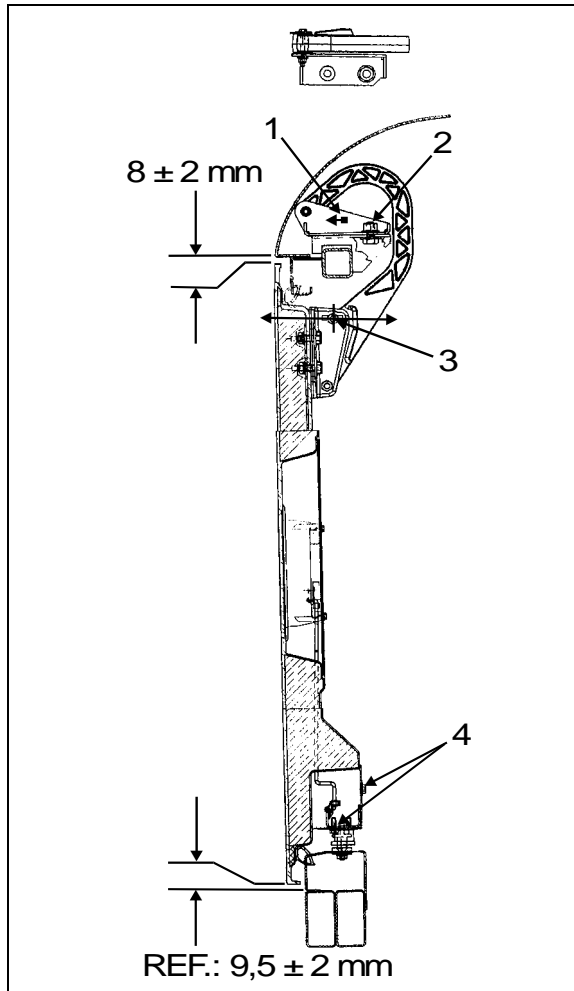


FIGURE 72: DOOR HINGE

18194

7. Loosen screws (5, Fig. 73) to allow the door to be shifted "UP or DOWN".
8. Adjust the door position.
9. Tighten the screws.
10. Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

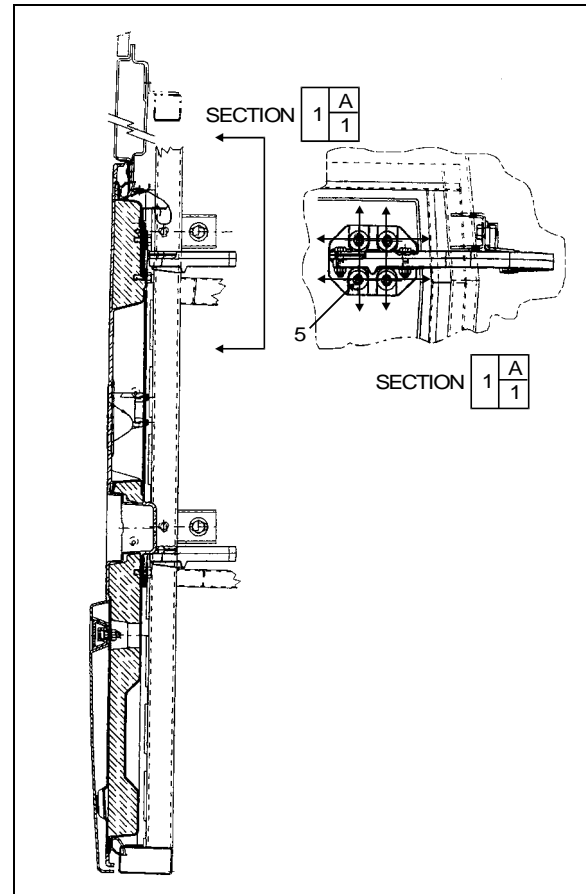


FIGURE 73: FRONT SERVICE DOOR

18195

### 26.1 LATCH MECHANISM ADJUSTMENT

To adjust the latch mechanism and the striker pin, open the door to access the striker pin. Slightly loosen the striker pin. Using a hammer, adjust the striker pin to center it in the door latch mechanism. Tighten the striker pin. Check door fit and operation.

### 27. ENGINE COMPARTMENT R.H. SIDE DOOR

The engine compartment R.H side door can be adjusted by following these steps:

1. Open the door.
2. Loosen nut (1, Fig. 74).
3. Move part (3, Fig. 74) as shown in figure for "LEFT or RIGHT" adjustment.
4. Tighten nut (1, Fig. 74).
5. Loosen nut (2, Fig. 74).
6. Hinge allows the door to be shifted "IN or OUT".

## Section 18: BODY

7. Adjust the door in accordance with the required distance between exterior finishing parts (Fig. 52).
8. Loosen screws (4, Fig. 75).
9. Screws allow the door to be shifted "UP or DOWN".
10. Adjust the door position according to the distance required between exterior finishing parts (Fig. 52).
11. Tighten the screws.

Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

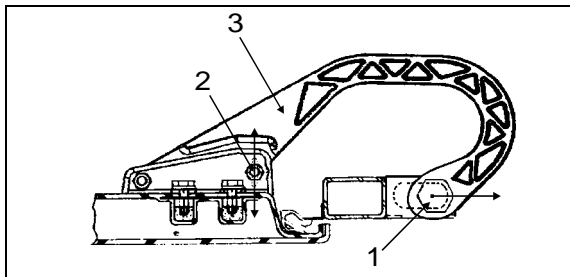


FIGURE 74: DOOR HINGE

18196

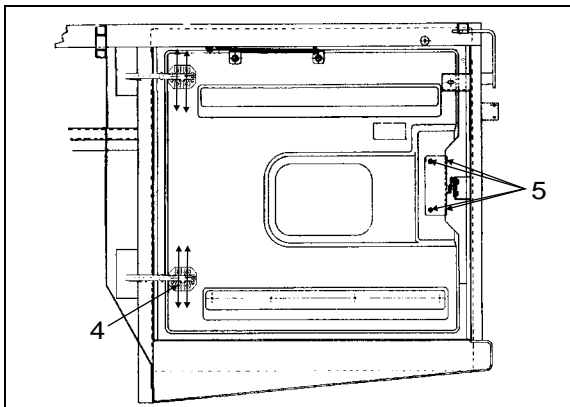


FIGURE 75: ENGINE COMPARTMENT R.H. DOOR

18197

3. Move part as shown in figure for "LEFT or RIGHT" adjustment.
4. Tighten nut (1, Fig. 76).
5. Loosen nut (2, Fig. 76). Hinge allows the door to be shifted "IN or OUT".
6. Adjust the door in accordance with the required distance between exterior finishing parts (Fig. 75).
7. Loosen screws (3, Fig. 74). Screws allow the door to be shifted "UP or DOWN".
8. Adjust the door position according to the distance required between exterior finishing parts (Fig. 75).
9. Tighten the screws.

Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

### 28.1 LATCH MECHANISM ADJUSTMENT

1. To adjust the latch mechanism and the striker pin:
2. Open the door to access the striker pin.
3. Loosen slightly the striker pin.
4. Using a hammer, adjust the striker pin to center it in the door latch mechanism.
5. Tighten the striker pin. Check door fit and operation.

### 27.1 LATCH MECHANISM ADJUSTMENT

To adjust the latch mechanism and the striker pin, open the door to access the striker pin. Slightly loosen the striker pin. Using a hammer, adjust the striker pin to center it in the door latch mechanism. Tighten the striker pin. Check door fit and operation.

## 28. EVAPORATOR DOOR ADJUSTMENT

1. Open the door.
2. Loosen nut (1, Fig. 76).



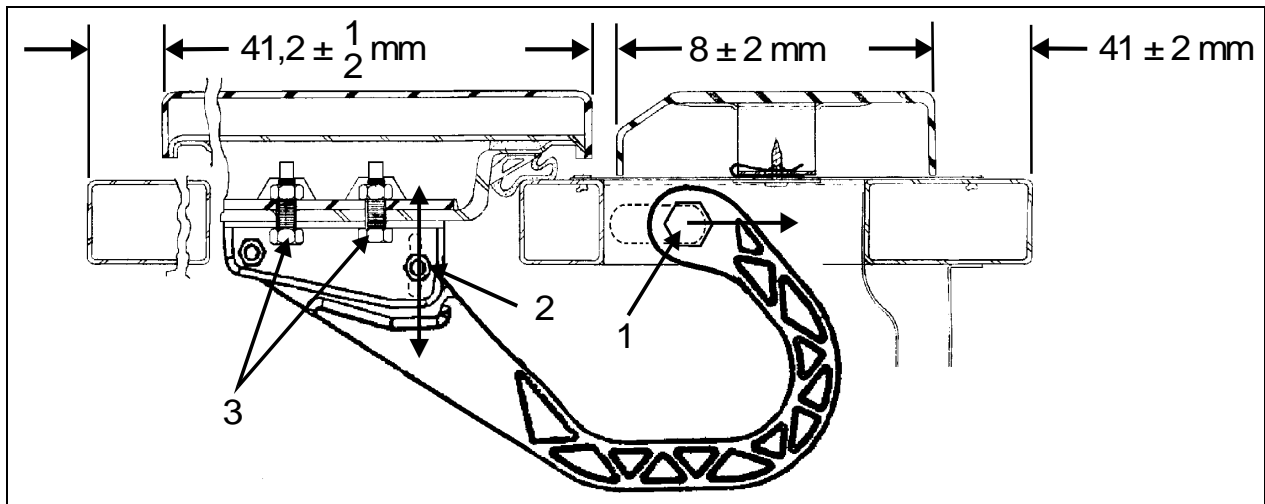


FIGURE 76: EVAPORATOR DOOR

18198

## 29. MAIN POWER COMPARTMENT

To adjust the main power compartment door:

1. Loosen nut (1, Fig. 77).

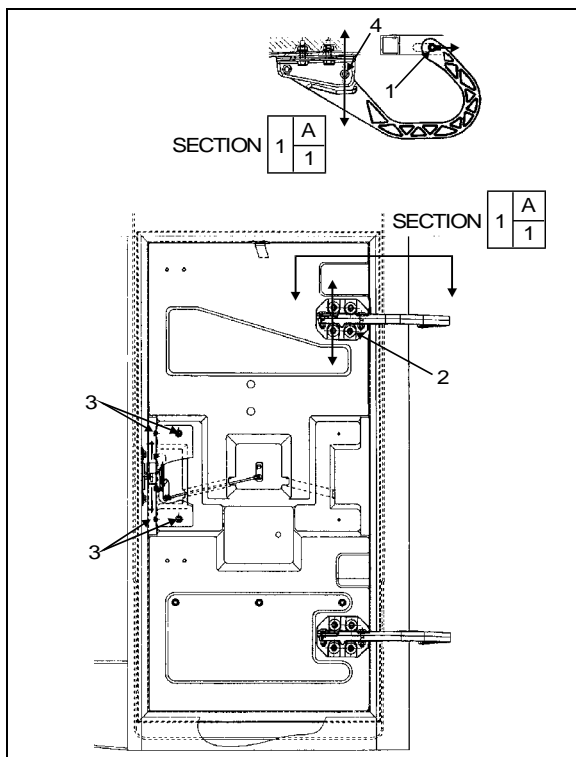


FIGURE 77: MAIN POWER COMP. DOOR

18199

2. Move part as shown in figure for "LEFT or RIGHT" adjustment.
3. Tighten nut (1, Fig. 77).
4. Loosen nut (4, Fig. 77).

5. Hinge allows the door to be shifted "IN or OUT".
6. Adjust door panel to have the same gap space as neighboring panels or refer to figure 45 for specified gap space
7. Loosen screws (2, Fig. 77). Screws allow the door to be shifted "UP or DOWN".
8. Adjust the door position.  
Tighten the screws.

Check that the door swings freely and closes properly. It may be necessary to adjust the door latch to get proper fit and operation.

### 29.1 LATCH MECHANISM ADJUSTMENT

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.

Check door fit and operation.

## 30. FENDERS

On the "H" series vehicle, all fenders are easily removable for maintenance on brakes and suspension. Each rear fender has three mechanical spring-loaded holding devices fixing it to the vehicle's structure.

## Section 18: BODY

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### 30.1 REAR FENDER REMOVAL

1. Push the spring type rod sideways so that the lock disengages.
2. Support or have somebody hold the fender up.
3. As in 1, repeat to release both remaining holding devices.
4. Holding the fender firmly, pull it down until the top edge disengages from the holding plates.

To reinstall, reverse the procedure.

### 30.2 FRONT FENDER REMOVAL

1. At the bottom of fender, remove the retaining screws on one side of the fender.
2. Support or have someone hold the fender up.
3. Remove the screw on the other side of the fender.
4. Pull the fender down until the top edge disengages from the holding plates.

To reinstall, reverse the procedure.

### 31. REAR CAP

The fiberglass rear cap does not need any maintenance except painting as needed. For minor damages, refer to section 4 "Fiberglass Repair" and section 5 "Painting". If the rear cap ever has to be replaced:

1. Remove all accessories.
2. Drill out the retaining pop rivets.
3. With a sharp edge blade, cut the seal joint and remove the rear cap.
4. With the sharp edge blade, remove as much of the remaining seal pieces as possible.
5. Sand with #120 or #150 sandpaper.
6. Wipe clean with alcohol
7. Prepare surface with SIKA #205 and let dry for a minimum of 2 minutes.
8. Install a new seal using LOCTITE 414 glue.
9. Install the rear cap and fasten with pop rivets.

**Caution:** Do not attempt this procedure unless you are qualified and equipped to handle this job.

### 32. FRONT CAP

The front cap windshield frame does not need any maintenance. It is held in place with bolts and nuts. If it ever it has to be replaced, make an appointment at a Prevost service center near you.

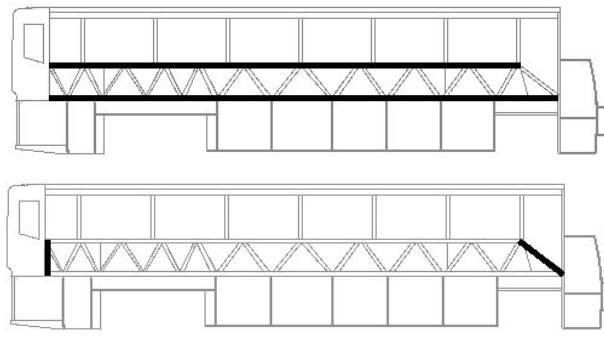
**33. SIDE PANEL INSTALLATION PROCEDURE FOR COACHES AND VIP**



**Material:**

		<b>Scotchbrite gray (680226)</b>	√	<b>Sika 206 G+P 1 liter (683446)</b>	√
<b>Anti-silicone (682989)</b>	√				
<b>Tack cloth</b>	√				
<b>CHIX cloth (682384)</b>	√				
<b>Blue cloth (682383)</b>	√			<b>Sika 252 black</b>	√
<b>Pure water</b>	√	<b>Masking tape</b>	√		

**Equipment:**


<b>Glue gun</b>	√	
<b>Compression roller</b>	√	

<b>SECTION #1 SIDE PANEL INSTALLATION</b>		
1.00	<b>SS Body structure preparation</b>	<p>A) Clean using anti-silicone. See SAV000001 section A. Use Scotchbrite to sand structure. Use 1 side of Scotchbrite for 1 side of vehicle.</p>
		

<b>SAV000001 Section A Alcohol or Anti-silicone</b>	
 <p><b>1. Apply</b></p> <p style="background-color: yellow; border: 1px dashed black; display: inline-block; padding: 2px;">CHIX cloth</p>	 <p><b>2. Dry immediately</b></p> <p style="background-color: blue; border: 1px dashed black; display: inline-block; padding: 2px;">Blue cloth</p>
<b>3. Allow to dry</b>	
<b>Mandatory</b>	<b>Minimum time : Wait for product to evaporate</b>
	<b>After 2 hours: Start cleaning operation again</b>
<b>Before applying any other product</b>	If surface seems dusty, greasy or with finger marks, start cleaning operation again.

1.05	<b>Fiberglass panel preparation (fiber side)</b>
------	--

**Section 18: BODY**

A)	Clean using tack cloth. Repeat if surface seems dusty.	
B)	Clean using anti-silicone See SAV000001 section A.	
C)	Apply primer 206 G+P. See SAV000001 section D.	

**PR000001 Section D Sika Primer 206 G+P**



**3. Shake bottle to mix product**

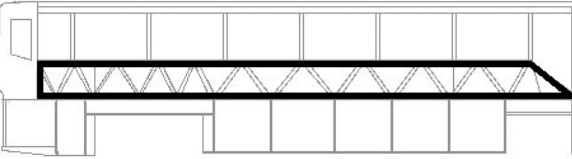
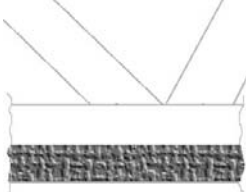
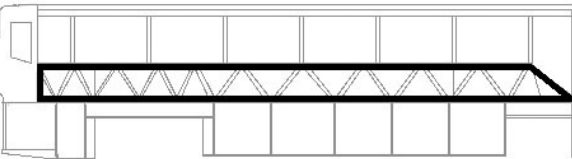
**4. Apply a thin layer**

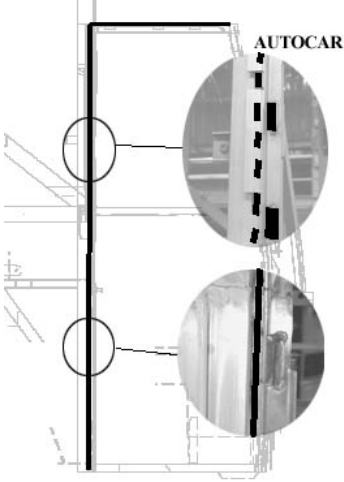

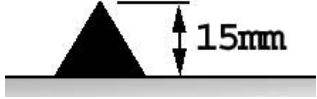

**CHIX cloth**

**3. Allow to dry**

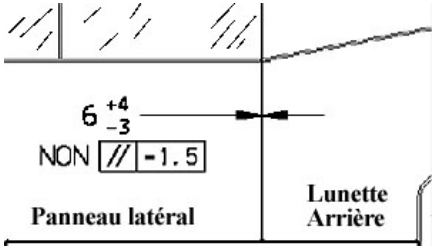
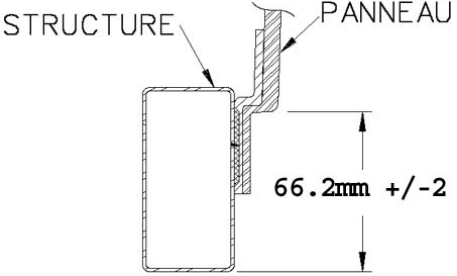

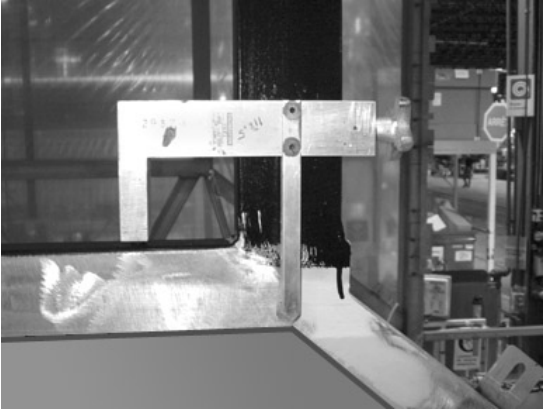

<b>Mandatory</b>	<b>206 G+P</b>	<b>Minimum time : 10 minutes</b>
		<b>After 2 hours: Remove dust using damp cloth (pure water)</b>
		<b>After 8 days : Reactivate with Aktivator as per section "C"</b>


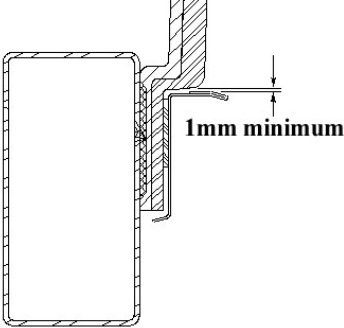
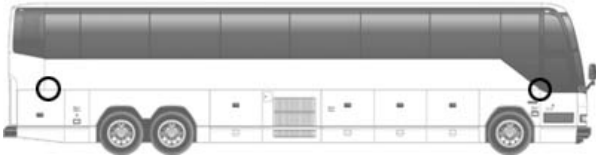
<b>Before applying any other product</b>	If surface seems dusty, dust using damp cloth. If surface seems greasy or with finger marks, reactivate with Aktivator.
--	--

1.10	<b>SS Body structure preparation</b>	
A)	Clean using anti-silicone. Clean structure at least twice. Repeat is necessary until cloth comes clean. See SAV000001 section A.	
B)	Apply 1 ¼" protective tape along bottom structural tubing.	
C)	Apply 206 G+P onto structure.  See SAV000001 section D.	

1.15	<p>Seal entrance door perimeter using Sika 252 black,  Smooth down the excess.</p>	
1.20	<p>Install lateral panel supports onto bottom structural tubing. Install lateral panel onto supports to verify proper positioning.</p>	
1.25	<p style="text-align: center;"><b>Glue application</b></p> <p>A) Set (timer) or record time.   <b>No more than 45 minutes should elapse between beginning of glue application and panel installation.</b></p> <p>B) Apply Sika 252 black onto structure  </p>	
1.30 *	<p>A) Install lateral panel onto supports and clamp panel in place using "C" clamps and square tubing to even out the pressure.  <b>Note: A maximum of clamps should be used (every 6 inches) to ensure proper bonding. Do not tighten too much.</b></p>	
	<p>B) At the rear, adjust panel height so that it is level with rear cap</p>	

**Section 18: BODY**

	<p>C) Gap between lateral panel and rear cap must be 6mm +4/-3 and panels must be aligned within 1.5mm.</p>	
	<p>D) Using a ruler, adjust front of lateral panel.</p>	
	<p>E)  Verify if panel upper corner is in the middle of window post.</p>	
<p>1.55</p>	<p>Remove excess of glue using a spatula.</p> <p>Apply a bead of Sika 252 at the top of panel</p> <p>Spray pure water onto all the joints to speed up drying process</p>	
<p>1.60</p>	<p>Remove protective tape (installed at step 1.10b).</p>	
<p>1.70</p>	<p><b>Do not move the vehicle for 48 hours</b></p> <p><b>Make sure room temperature is superior to 20°C (68°F) before gluing</b></p> <p><b>Perform a visual inspection before installing side windows</b></p>	

<b>SECTION #2 DRIP MOLDING INSTALLATION</b>			
2.00 *	A)	Clean using Anti-silicone See SAV000001 section A.	
	B)	Apply Sika 206 G+P See SAV000001 section D.	
2.05	Remove blue paper from drip molding. Remove protective tape from double-face self adhesive tape		
2.10	Glue drip molding. Allow a gap of 1mm minimum between top of drip molding and panel.		
2.15	Compress drip molding using the compression roller to increase adherence.		
2.20	Round off rear and front drip molding corners.		

<b>SECTION #3 REPAIR</b>			
4.00	Remove fiberglass from structure using a screwdriver. Use wedges if necessary to hold down panel during the work.		
4.05	Remove as much glue as possible. If primer is removed, apply primer 206 G+P locally. If primer is OK, reactivate as per SAV000001 section D.		
4.10	Apply Ultrafast 2 glue (heated).		
4.15	Compress panel using clamps and a metal flat bar (for an even compression). Only use screws as a last resort to compress.		
4.20	<b>Vehicle must not move for the next 12 hours.</b>		

### 34. REAR VIEW MIRRORS (RAMCO)

Your vehicle is equipped with two exterior mirrors.

The mirrors may be equipped with an optional electric heating system which serves to minimize ice and condensation on the mirror glass in extreme weather conditions. Integral thermostats are installed in both mirrors to avoid continuous heating. Use the appropriate switch on the dashboard to activate the defroster system on both mirrors simultaneously. The mirrors can easily be adjusted by using the remote controls located on the L.H. side control panel. The mirrors have easy to replace glass in case of breakage. Remote control motors can also be replaced.

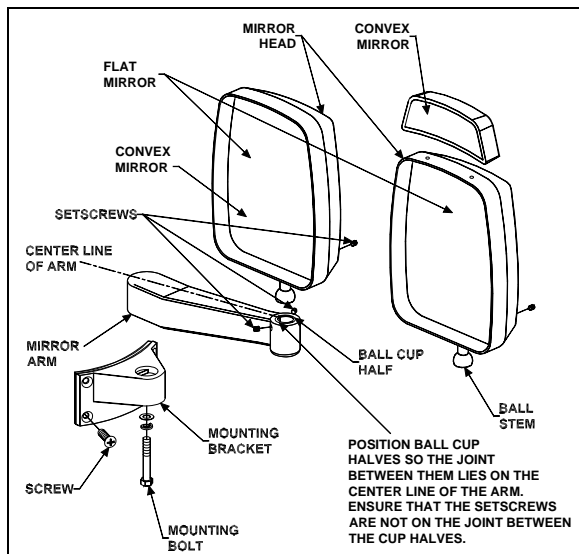


FIGURE 78: REAR-VIEW MIRROR (RAMCO) 18201

#### 34.1 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.

#### 34.2 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.

#### 34.3 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.

#### 34.4 REPLACEMENT OF MIRROR GLASS

Remove the broken glass.

Position new glass in mirror head and press to lock the Velcro in place.

#### 34.5 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.

##### 34.5.1 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.

#### 34.5.2 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.

#### 34.5.3 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.

#### 34.5.4 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.

### 35. VEHICLE JACKING POINTS

The vehicle can be lifted by applying pressure under body jacking points or front and drive axle jacking points (from fig. 79 up to 86). 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 79 up to 86.

**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".

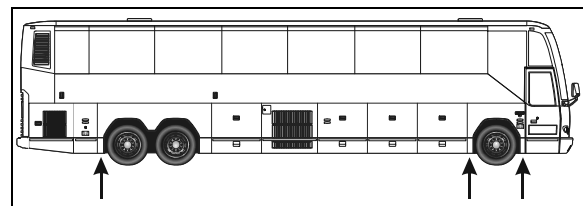


FIGURE 79: JACKING POINTS ON STRUCTURE 18480

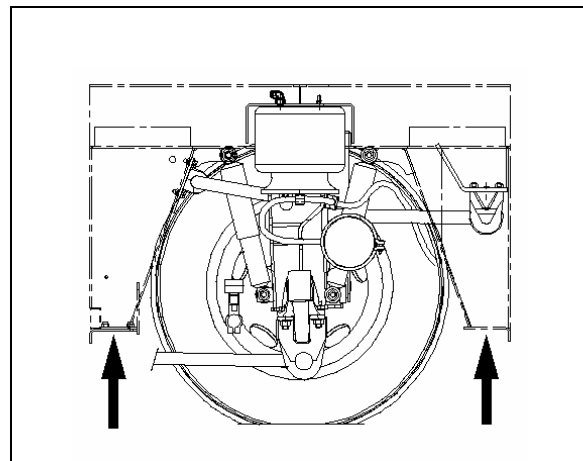


FIGURE 80: JACKING POINTS ON FRONT UNDERFRAME - I BEAM AXLE

16183

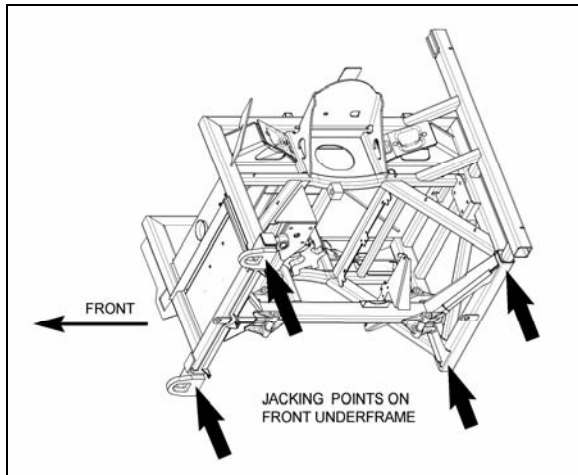


FIGURE 81: JACKING POINTS ON FRONT UNDERFRAME – IFS 18530

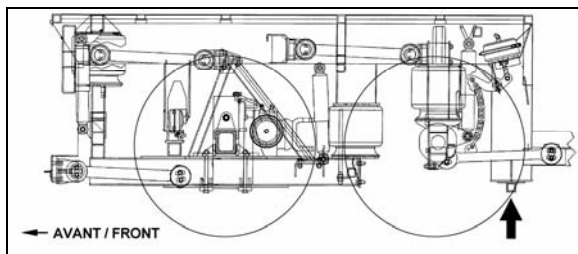


FIGURE 82: JACKING POINTS ON REAR FRAME

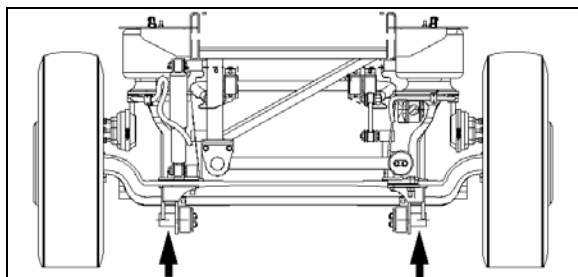


FIGURE 83: JACKING POINTS ON FRONT AXLE – I BEAM AXLE 10000

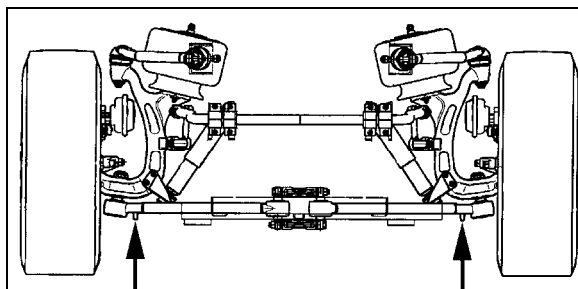


FIGURE 84: JACKING POINTS ON IND. SUSPENSION

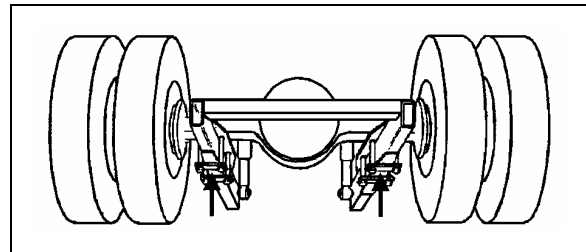


FIGURE 85: JACKING POINTS ON DRIVE AXLE 18085

**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.

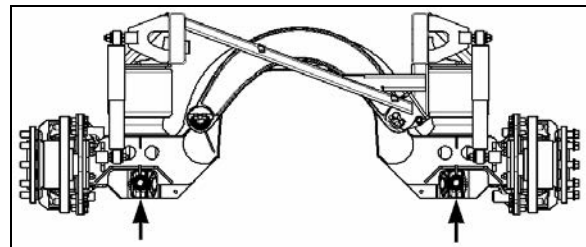


FIGURE 86: JACKING POINTS ON TAG AXLE 11029

**Caution:** The jacking points on the tag axle must be used for raising the tag axle only.

### 36. 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.

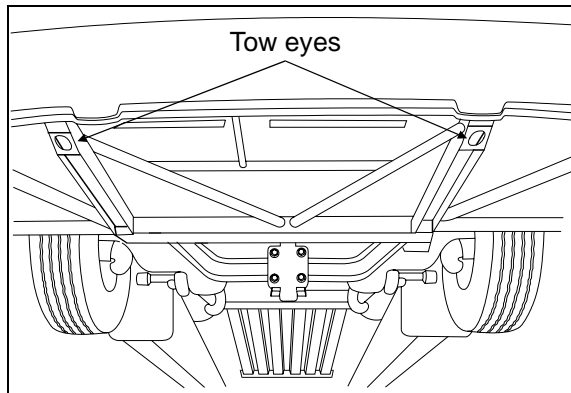


FIGURE 87: TOW EYES UNDER VEHICLE

18401

### 36.1 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. With either automatic, semi-automatic or manual transmission, 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.

**Caution:** 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. Lift the vehicle from under the front axle, and adequately secure the underside to the tow vehicle lifting attachment with chains.
4. Observe safety precautions when towing.

### 36.2 TOWING WITHOUT LIFTING

**Caution:** 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. With automatic, semi-automatic or manual transmission, 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.

**Caution:** 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.

## **Section 18: BODY**

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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.

**37. SPECIFICATIONS****Door cylinder**

Manufacturer .....Bimba  
 Type ..... Pneumatic  
 I.D. .... 1½" ( mm)  
 Stroke..... 8" ( mm)  
 Prevost number..... 780595

**Damper**

Manufacturer .....Koni  
 Prevost number..... 780565

**Lock cylinder (upper)**

Manufacturer .....Bimba  
 Type ..... Air, single action, 1/8 NPT, hexagonal rod  
 I.D. .... 7/8" (22 mm)  
 Stroke..... 1" (25 mm)  
 Prevost number..... 641392

**Lock cylinder (central)**

Manufacturer .....Bimba  
 Type ..... Air, single action, ¼ NPT  
 I.D. .... 1¾" (45 mm)  
 Stroke..... 1" (25 mm)  
 Prevost number..... 641209

**Manifold solenoid**

Manufacturer .....Norgren  
 Type ..... 4 ports, 1/8 NPT  
 Voltage..... 24 VDC  
 Power consumption.....6 watts  
 Maximum pressure..... 150 psi (1035 kPa)  
 Prevost number..... 641448

**Solenoid valve (Latching valve)**

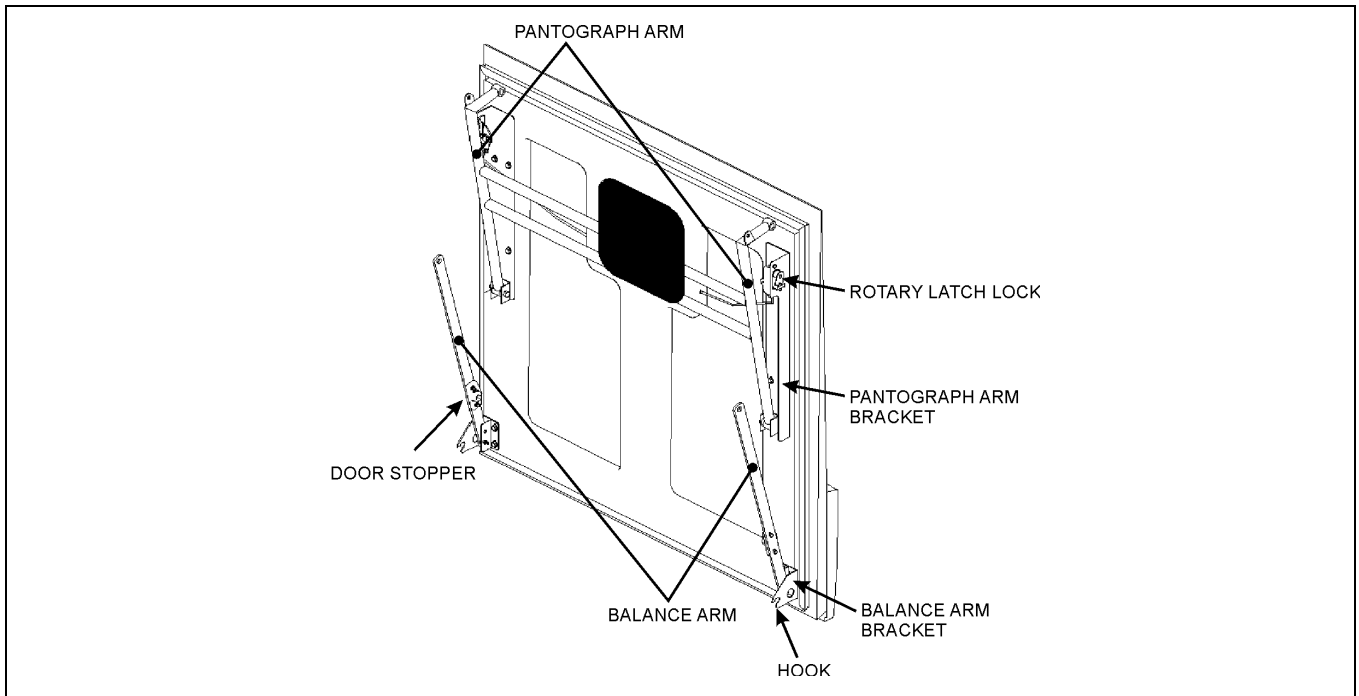
Manufacturer ..... Humphrey  
 Model ..... 310  
 Operating range ..... 0 to 125 psi (0 to 860 kPa)  
 Voltage..... 24 VDC  
 Voltage tolerance ..... +10%, -15% of rated voltage  
 Power consumption.....4 watts  
 Leak rate (max allowed) ..... 0.245 in<sup>3</sup>/min @ 100 psi (4cc/min @ 690 kPa)  
 Type of operation ..... Direct solenoid  
 Lubrication..... Not required (factory pre-lubed)  
 Filtration ..... 40 micron recommended  
 Prevost number..... 641412

**Pressure switch assembly**

Prevost number..... 452831

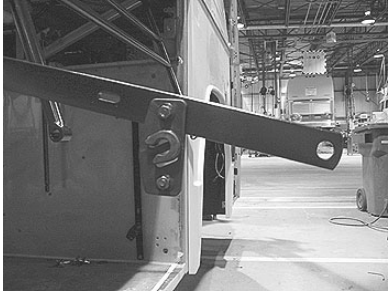
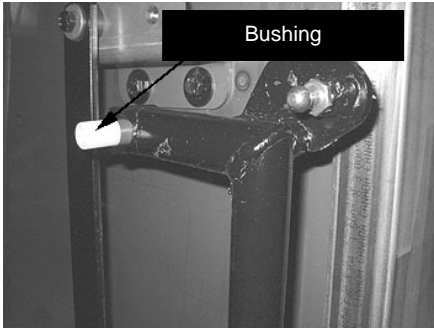
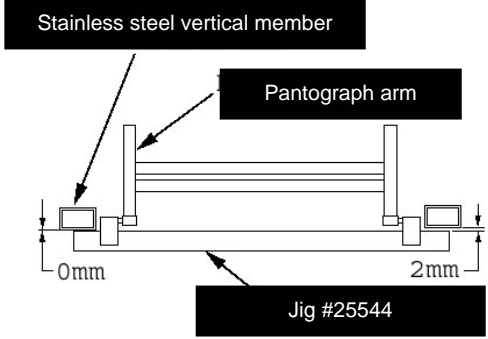
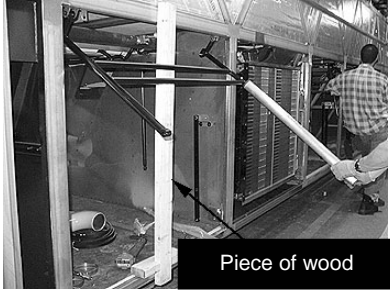


<b>SAV00589</b>	<b>PANTOGRAPH BAGGAGE COMPARTMENT DOOR - MECHANICAL COMPONENTS INSTALLATION</b>	<b>PREVOST</b>	
		<b>Effective :</b>	<b>REVISION 00</b>
		<b>2007-02-12</b>	

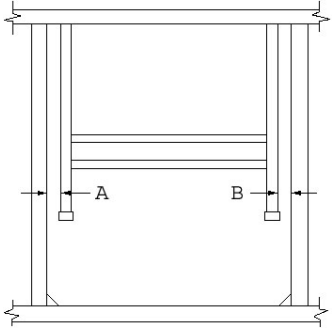
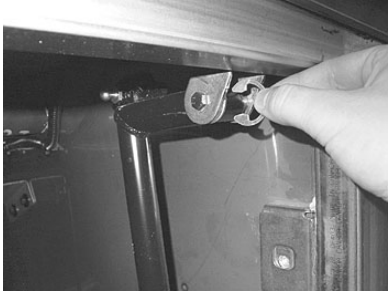

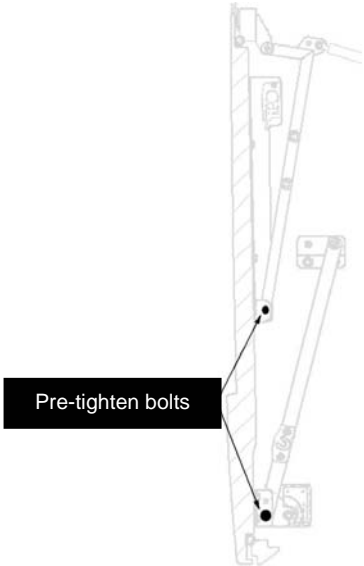


1.00	<p>Install gas cylinder support (2x) and tighten mounting bolts.</p> <p>Install gas cylinders (2x). Connect the rod end to the support.</p>	
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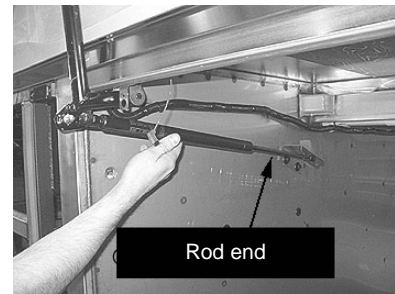
1.05	A)	Install the balance arms (2x).	
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	<p>B) Pretighten the door stopper onto the balance arm (2x).</p>	
<p>1.10</p>	<p>A) Spray grease #680343 onto pantograph arm holes prior installation of the bushings (4 bushings).</p> <p>B) Insert all 4 bushings on the pantograph arms. (2 bushings per arm)</p>	
<p>1.15</p>	<p>Install pantograph arms.</p>	
<p>1.20</p>	<p>Using jig #25544 (or a straight edge), measure distance between pantograph arm end and the straight edge. Repeat procedure for the other arm. The distance on each side should be equal. If not, bend appropriate arm until desired measure is obtained. Use a piece of wood as support.</p> <p>A difference of <b>2mm max. (3/32" max.)</b> is accepted.</p>	 

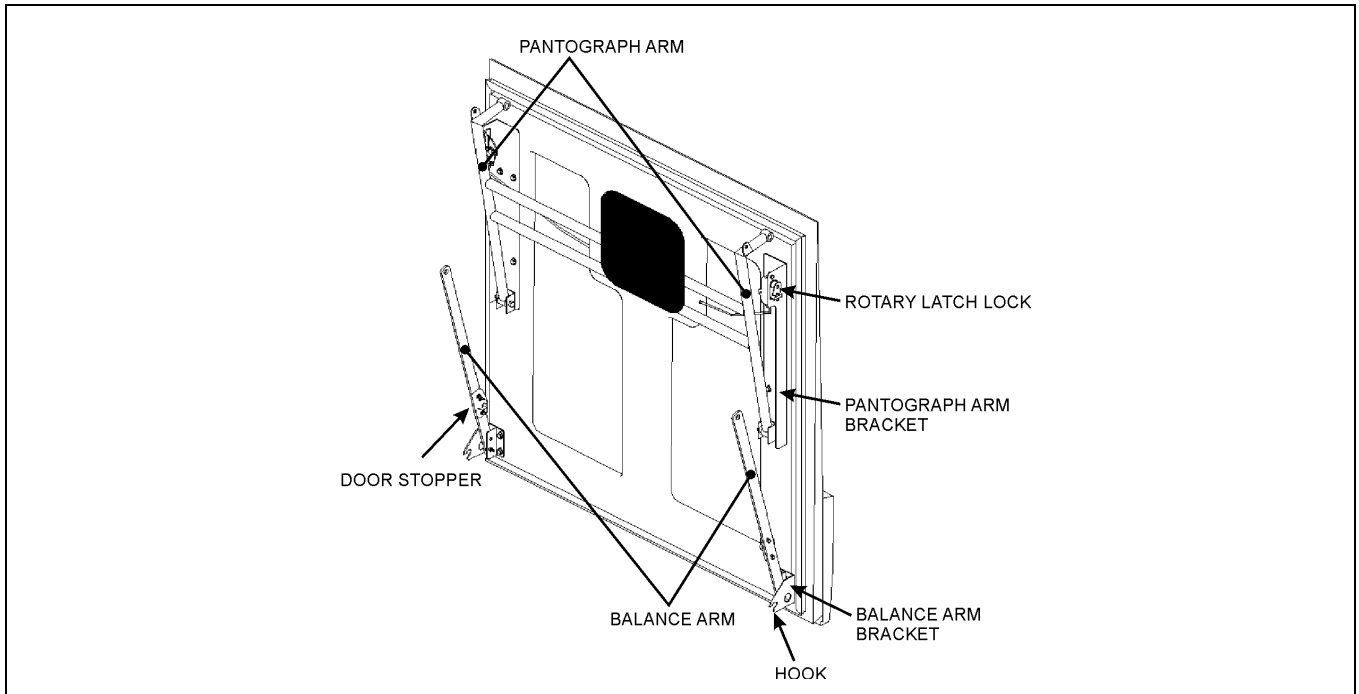


<p>1.25</p>	<p>A) Check if pantograph arm assembly is centered within the baggage compartment. Measurement A &amp; B should be equal on each side. A difference of 2mm (3/32") is accepted.</p>	
	<p>B) Center the pantograph arm assembly using shims #504660 as required. This will prevent the arm from moving freely.</p>	
<p>1.30</p>	<p>A) On the baggage compartment door, widen the brackets that will receive the pantograph arms about 1mm (1/32").</p>	
<p>1.35</p>	<p>A) Install the door onto pantograph arms and balance arms. Pretighten the mounting bolts where indicated. Final tightening will be done after door adjustment.</p>	

1.40 Connect gas cylinders to pantograph arms.



<b>SAV00590</b>	<b>BAGGAGE COMPARTMENT DOOR H &amp; VIP ADJUSTMENT</b>	<b>PREVOST</b>	
		<b>Effective :</b>	<b>REVISION 00</b>
		<b>2007-02-12</b>	



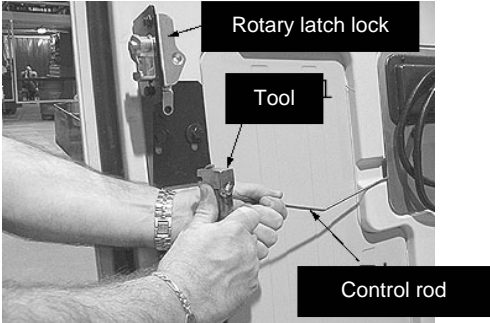
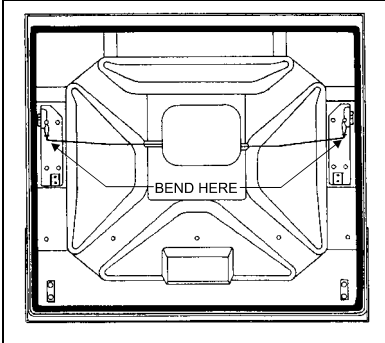

**Two different open positions**


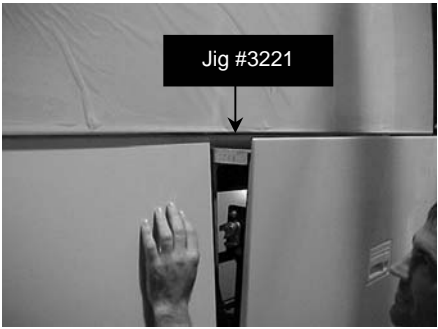

**Standard position**






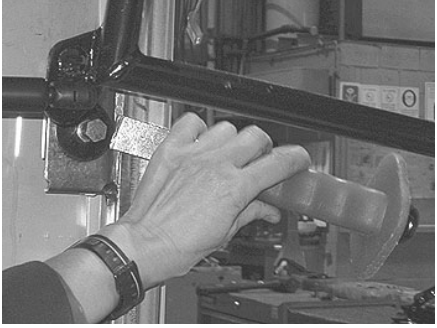
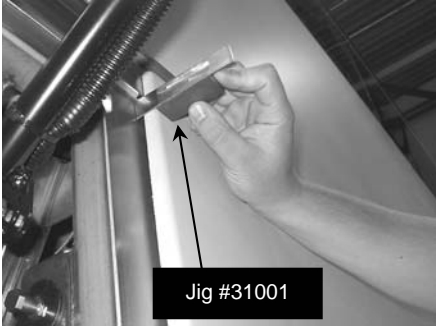
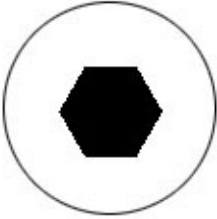
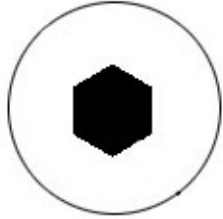
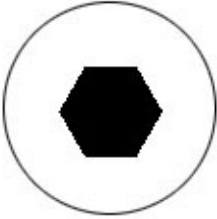
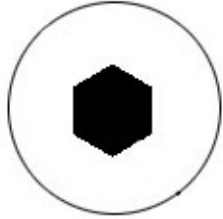
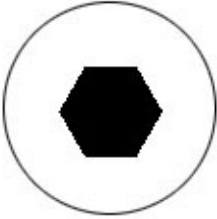
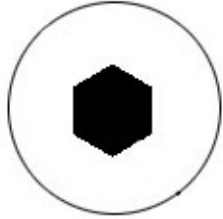
**VIP with awning windows**






<p>1.00</p>	<p>A) Open the door and then close the two rotary latch locks. Pull gently on the door handle to check that both latches unlatch simultaneously (you will hear them as they release).</p>	
	<p>B) If they do not unlatch simultaneously, gently bend the appropriate latch control rod until proper timing is achieved.</p>	
<p>1.20</p>	<p style="text-align: center;"><b>Door height adjustment – top</b></p> <p>A) First, make sure that the mounting bolts securing the brackets (4x) on the inner side of the door are loose, so the brackets can move (2 balance arm brackets &amp; 2 pantograph arm).</p> <p>With door closed, lift and adjust height so there is a gap of <b>4±1 mm (5/32±1/32")</b> between the top of the door and the angle along the side panel. Instead of measuring, you can use jig #3221 for proper gap.</p> <p>In addition, the top of the door should be flush with the adjacent doors.</p> <p>The difference in height measurement of the doors should not exceed <b>1.5 mm (1/16")</b>.</p>	

	<p>B) Pretighten the pantograph brackets.</p>	
<p>1.25</p>	<p style="text-align: center;"><b>Door adjustment - bottom</b></p> <p>A) Slightly open the door, position it to obtain a gap of <b>100mm (4")</b> between structure and door panel upper lip. To ease this operation, use jig <b>#3244</b>. Maintain door in this position while pressing the bottom of the door against the structure with you knee.</p> <p>B) Have an assistant to complete tightening of the two bolts retaining door to each balance arm brackets (2 lower brackets).</p> <p>Do so on both sides of the door.</p>	
<p>1.30</p>	<p style="text-align: center;"><b>Gas cylinder adjustment</b></p> <p>A) Fully open the door, loosen the two bolts retaining each gas cylinder support bracket to structure.</p> <p>B) Using a hammer, move the support bracket to the maximum towards the outside of the vehicle. You should see the support bracket slotted holes.</p> <p>C) Tighten cylinder support bolts.</p>	

<p>1.35</p>	<p><b>Door stopper adjustment</b></p>		
	<p>A)</p>	<p>Loosen the door stoppers mounting bolts. Adjust door stoppers position so that the pin rest against the bottom of the stopper.</p>	
	<p>B)</p>	<p>Pretighten door stoppers mounting bolts.</p>	
	<p>C)</p>	<p>With door fully open and pins engaged in the door stoppers, check if the lower lip of the door is flush with the adjacent doors (fully open). If not, pull the door to disengage the door stopper and using a hammer, move the door stoppers in order to shorten the stroke as necessary.</p>	
		<p>In open position, the lower lip of the doors must be even in height within <b>6mm (1/4")</b></p>	
	<p>D)</p>	<p>Tighten door stoppers.</p>	
<p>1.40</p>	<p><b>Striker pins adjustment</b></p>		
	<p>A)</p>	<p>First, mark the position of striker pins on structure to avoid upsetting the vertical adjustment of the pin.</p>	

<p>B)</p>	<p>Loosen the striker pins just enough to allow them to be moved with a hammer and chisel.</p> <p>Close the door. Make sure the rotary latch locks are fully engaged, i.e up to the second lock position. You should hear two “clicks”.</p> <p>Working from inside compartment and with the door closed (lower catches engaged); hit the pin washers to horizontally move the pins and consequently the door.</p> <p>Moving the pins inwardly will bring the door closer to the stainless steel structural members but, this will compress more the rubber seal, which is not necessarily required.</p> <p>The door panel surface must be flush with the adjacent doors. A difference of <b>2mm (3/32“)</b> is accepted. <b>3mm (1/8“)</b> is accepted for the bottom of the doors.</p>					
<p>C)</p>	<p>Using jig #31001, check for proper rubber seal compression at the <u>top</u> of the door panel. Use jig end identified H.</p> <p>Note 1: Distance between door panel surface and the SS structural member should not exceed <b>19 mm (3/4“)</b>.</p> <p>Note 2: If a vertical extrusion is fixed on the SS vertical member, use jig #31002.</p>					
<p>D)</p>	<p>Striker pin position.</p> <p><i>Note: Pay attention to the final orientation of the striker pin. If the striker pin hexagonal head is not properly oriented, it will interfere with the rotary latch, preventing proper functioning of the locking mechanism.</i></p>	<table border="0"> <tr> <td> <p>Good</p> </td> <td> <p>Wrong</p> </td> </tr> <tr> <td>  </td> <td>  </td> </tr> </table>	<p>Good</p>	<p>Wrong</p>		
<p>Good</p>	<p>Wrong</p>					
						

<p>1.45</p>	<p style="text-align: center;"><b>Door adjustment - bottom</b></p> <p>Using jig #31001, check for proper rubber seal compression at the <u>bottom</u> of the door panel. Use jig end identified B.</p> <p>Note 1: Distance between door panel surface (at the bottom) and the SS structural member should not exceed <b>24 mm (15/16")</b>.</p> <p>Note 2: If a vertical extrusion is fixed on the SS vertical member, use jig #31002.</p> <p>Door bottom adjustment is done by moving the balance arms bracket at the door, up or down. Lower the brackets to bring to door panel closer to the structure.</p> <p>Tighten the bolts from inside the compartment.</p>	
<p>1.50</p>	<p style="text-align: center;"><b>Door horizontal adjustment</b></p> <p>Position the door horizontally in order to have an equal gap between each door. Center the door panel using shims #504660 as required.</p> <p>Refer to the diagram at the end of this document for proper gap. Dimensions on the diagram are in millimeter.</p> <p>4±1mm is about 5/32±1/32"</p> <p>6.2±2mm is about 1/4±3/32"</p> <p>7.2±2mm is about 9/32±3/32"</p> <p>8±2mm is about 5/16±3/32"</p>	
<p>1.55</p>	<p style="text-align: center;"><b>Lower striker pins adjustment</b></p> <p>A) Loosen the lower striker pins just enough to allow them to be moved with a hammer and a chisel.</p> <p>Close the door. Make sure the rotary latch locks are fully engaged, i.e up to the second lock position. You should hear two "clicks".</p>	



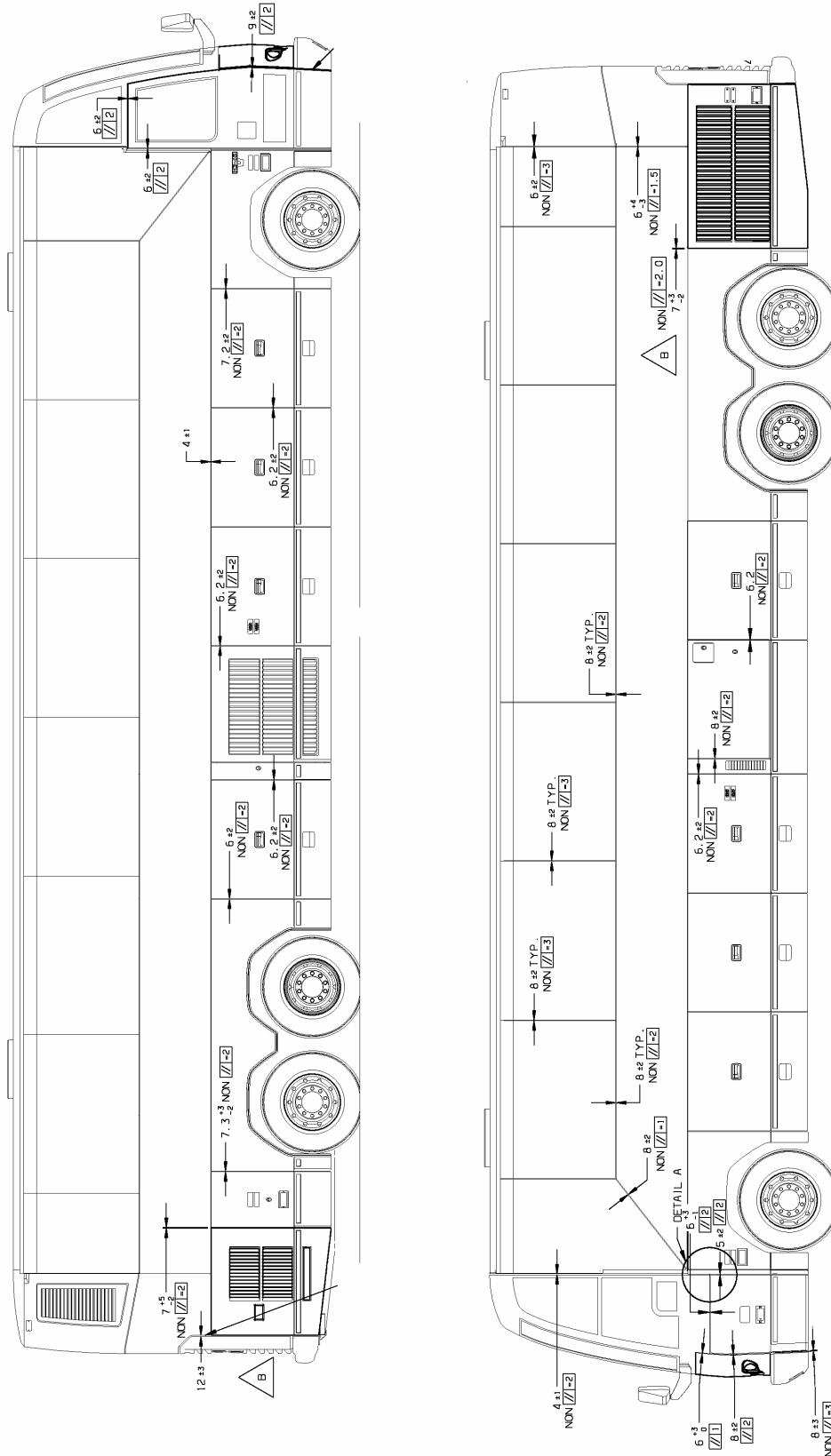
	<p>B) Working from inside compartment, move the striker pins in order to have a gap of <b>1/16"</b> to <b>1/8"</b> between the striker pin and door hook.</p>	
	<p>C) Tighten striker pins.</p>	
<p>1.60</p>	<p>Proceed to a final tightening of all the bolts.</p>	

<p>1.65</p>	<p>A) Once the door is properly adjusted and positioned, drill <b>Ø11/64"</b> diameter hole between the two bolts on the pantograph arm brackets.</p>	
	<p>B) Insert a crew <b>#5001017</b> to keep the door adjustment permanent.</p>	

<p>1.70</p>	<p>Using rivets, install the lower striker pin guard.</p>	
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1.75 Using nylon ties, fix all electrical harness to the pantograph arms.





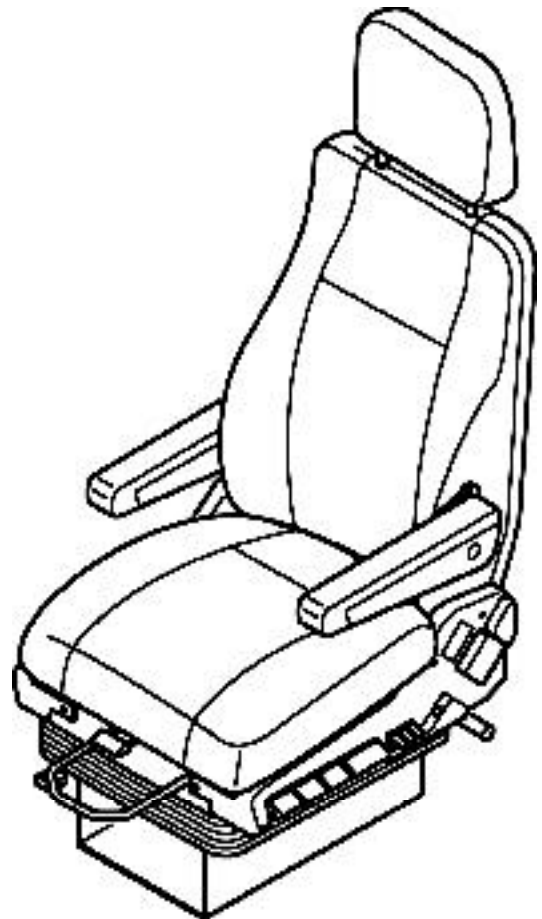


**Isringhausen**

Seat Model 6800/338 Bus  
Seat Model 6800/338 Premium LX

# Service Manual

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**Read and understand this manual before servicing this seat.**



# INTRODUCTION

**MODEL 6800/338 BUS  
MODEL 6800/338 PREMIUM LX**

## **SERVICE AND REPAIR**

Proper service and repair are important to the safe, reliable operation of this seat. Service and repair should be performed only by responsible persons who have been properly instructed and authorized to do so. The procedures recommend in this manual are safe effective methods for performing service and repair operations.

We could not possibly know, evaluate, and advise the service trade of all conceivable ways in which service can be done or of the possible hazardous consequences of each way. If you use a service procedure which is not recommended, be sure that personal safety and equipment safety will not be jeopardized.

It is the responsibility of the mechanic performing the service and repair to:

- inspect for abnormal wear and damage
- choose a repair procedure that will ensure your safety, the safety of others, and the safe operation of the equipment
- fully inspect and test the equipment to ensure that the repair or service has been properly performed and the equipment will function properly.

This manual describes the correct service procedures for Model 6800/348 Premium seats. The information in this manual was current at the time of printing and is subject to change without notice or liability.

## **READ AND UNDERSTAND THIS MANUAL AND THE OPERATOR'S MANUAL**

Learn how to service Model 6800/348 Premium seats. Failure to do so could result in personal injury or equipment damage. Consult your dealer if you do not understand the instructions in this manual and/or need additional information.

## **KEEP THIS MANUAL**

This manual should be considered a permanent part of the seat and be available for reference when servicing the seat.

## **WARRANTY**

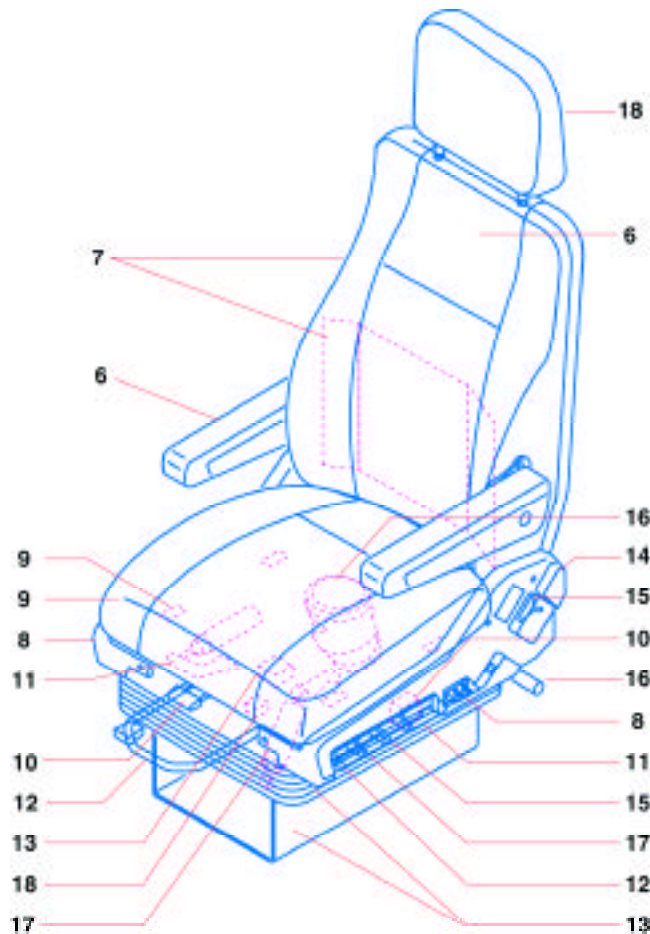
Warranty is provided as part of Isringhausen's support program for customers who operate and maintain their seat as shown in this manual. See the warranty for details.

**MODEL 6800/338 BUS  
MODEL 6800/338 PREMIUM LX**

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**REMOVAL AND INSTALLATION PAGE NUMBERS**



# GENERAL SAFETY

MODEL 6800/338 BUS  
MODEL 6800/338 PREMIUM LX

In this manual safety messages will alert persons to a specific hazard, the degree or level of hazard seriousness, the probable consequences of involvement with the hazard, and how the hazard can be avoided. Safety messages will include the safety alert symbol, a signal word, and a word message.

## SAFETY ALERT SYMBOL



Indicates a potential personal safety hazard.

## SIGNAL WORDS

**DANGER:** Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

**WARNING:** Indicates an potentially hazardous situation which, if not avoided, could result in death or serious injury.

**CAUTION:** Indicates an potentially hazardous situation which, if not avoided, may result in minor or serious injury.

## WORD MESSAGE

The word message will identify the hazard, indicate how to avoid the hazard, and advise of probable consequence of not avoiding the hazard.



<b>Problem</b>	<b>Cause</b>	<b>Solution</b>	<b>Page</b>
Armrest will not stay in position.	Armrest control is defective.	Replace armrest.	6
Backrest will not adjust and/or stay adjusted.	Teeth on backrest are defective.	Replace backrest.	6
	Backrest seat latch is defective.	Replace backrest seat latch.	14
Lumbar/Bolster will not inflate.	No air supply to seat.	90 to 145 psi req'd.	5
	Air lines leak.	Replace air lines.	7
	Valve is defective.	Replace valve.	8
	Air bags leak.	Replace air bags.	7
Height will not adjust and/or stay adjusted.	Height adj. cam is defective.	Replace height adj. cam.	11
	Height adj. cylinder is defective.	Replace height adj. cylinder.	11
	Height adj. valve is defective.	Replace height adj. valve.	10
Horizontal slide will not adjust and/or stay adjusted.	Horizontal slide is defective.	Replace horizontal slide.	12
Seat pan assem. will not adjust and/or stay adjusted.	Seat pan lever is defective.	Replace seat pan lever.	10
	Seat pan glides are defective.	Replace seat pan glides.	9
Quick air release will not function.	No air supply to seat.	90 to 145 psi req'd.	5
	Valve is defective.	Replace valve.	12
Adjustable shock absorber will not adjust.	Shock absorber is defective.	Replace shock absorber.	17
	Shock absorber cable is defective.	Replace shock absorber cable.	17
Suspension will not function properly.	Suspension is defective.	Replace suspension.	13

# INSPECTION

MODEL 6800/338 BUS  
MODEL 6800/338 PREMIUM LX



## CAUTION

**Avoid the risk of injury.**  
Vehicle must be in a safe parked position before inspecting seat.

Visually inspect the seat. Look for damaged or worn upholstery and parts. The seat should be clean and free of dirt and debris. Check all the seat functions they should work properly and be in good condition.

### 1. Adjustable armrest

Should move up freely, the adjustment knob should be easy to use, the armrest must stay in the adjusted position.

### 2. Backrest adjustment

The control should be easy to release then the backrest should move freely. The backrest must stay in the adjusted position.

### 3. Backrest side bolster

The control should be easy to move to the inflate or deflate position and must return to neutral when released. Each side bolster should inflate and deflate evenly and stay at the adjusted firmness.

### 4. Height adjustment

Control should be easy to move and hold the seat in the adjusted position when released.

### 5. Horizontal adjustment

Control should be easy to move and hold the seat in the adjusted position when released.

### 6. Seat tilt adjustment

Control should be easy to move and hold the seat in the adjusted position when released.

### 7. Lower and upper lumbar support

The controls should be easy to move to the inflate or deflate position and must return to neutral when released. Each lumbar support must stay at the adjusted firmness.

### 8. Cushion length adjustment

Control should be easy to move and hold the seat cushion in the adjusted position when released.

### 9. Adjustable shock absorber

Control should be easy to move and stay in position when released.

### 10. Quick air release

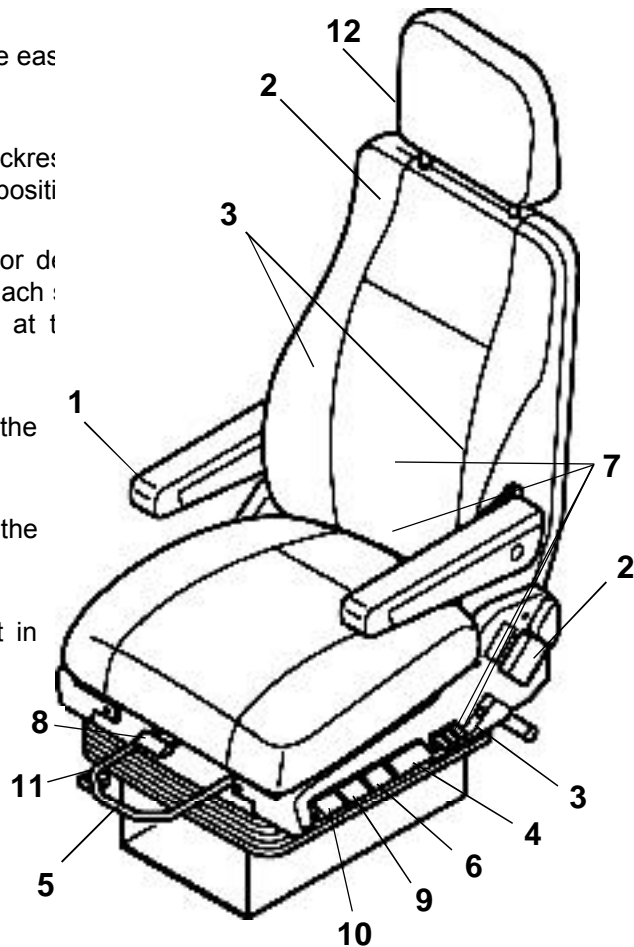
Control should be easy to move and hold seat in the adjusted position when released.

### 11. Horizontal isolator

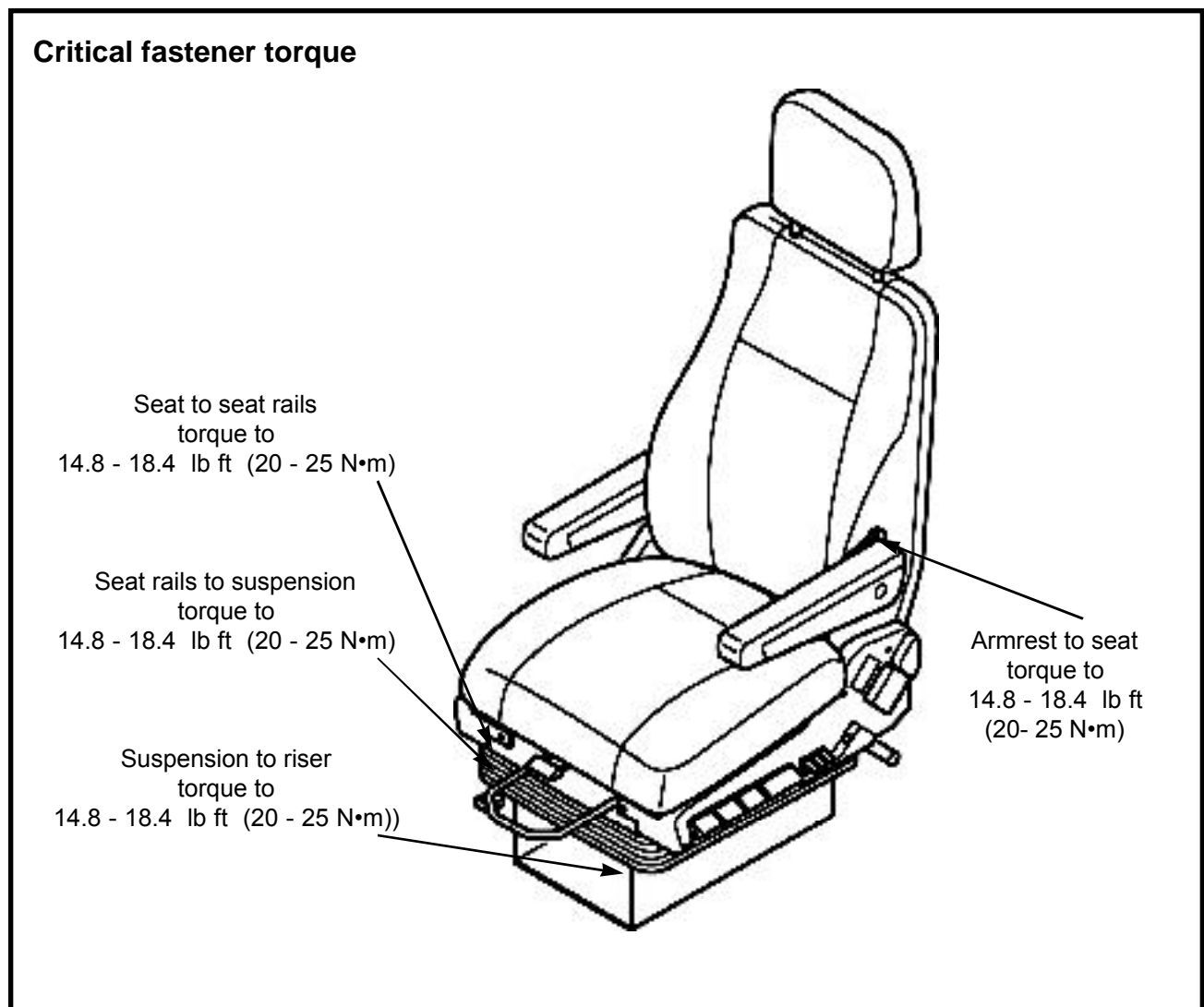
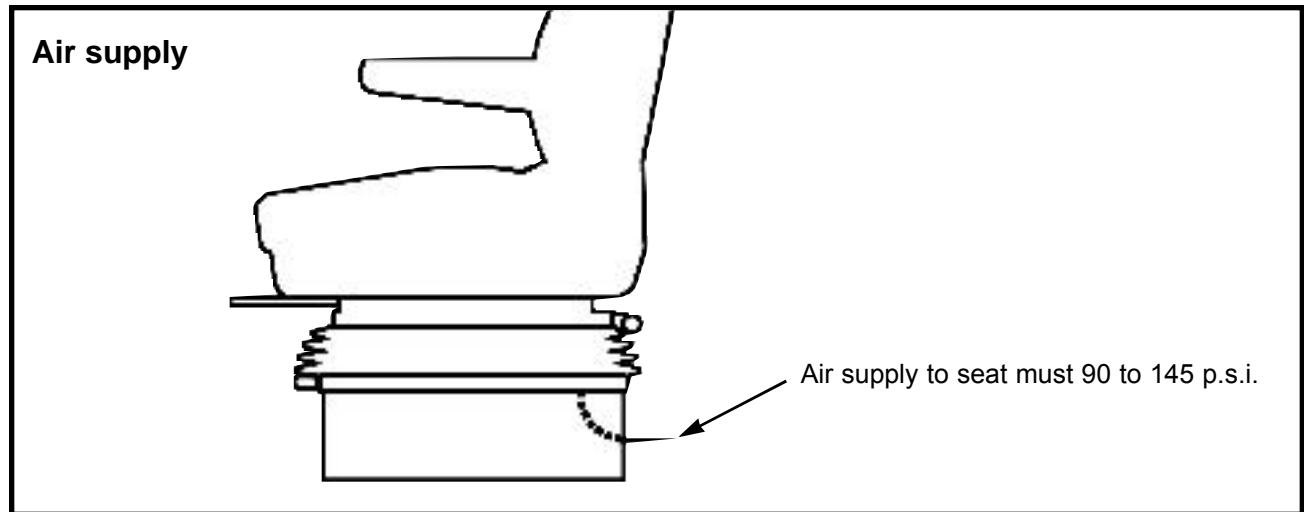
Control should be easy to move and stay in position when released.

### 12. Headrest

Should be easy to move up and down and stay in position. Headrest should tilt forward and backward freely.



If the seat is not functioning properly take it out of service until it can be repaired.



# REMOVAL and INSTALLATION

MODEL 6800/338 BUS  
MODEL 6800/338 PREMIUM LX



**Avoid the risk of injury.** Vehicle must be in a safe parked position before working on the seat.

## NOTICE

To remove seat from vehicle follow vehicle manufacturer's instructions.

### Armrest

#### Set up

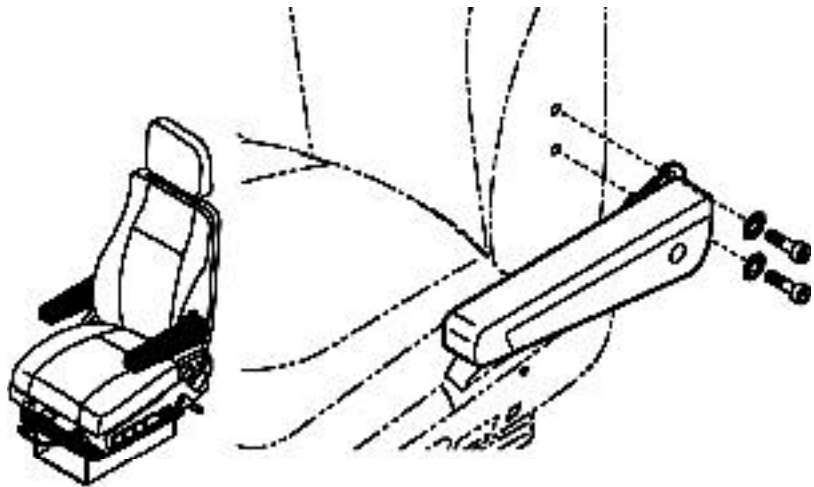
- Vehicle must be in a safe parked position or seat removed from vehicle.

#### Removal

- Remove fasteners
- Remove armrest

#### Installation

- Fasten armrest to seat with screws and lockwashers.
- Torque screws to 14.8 - 18.4 lb ft (20 - 25 N•m)



### Backrest

#### Set up

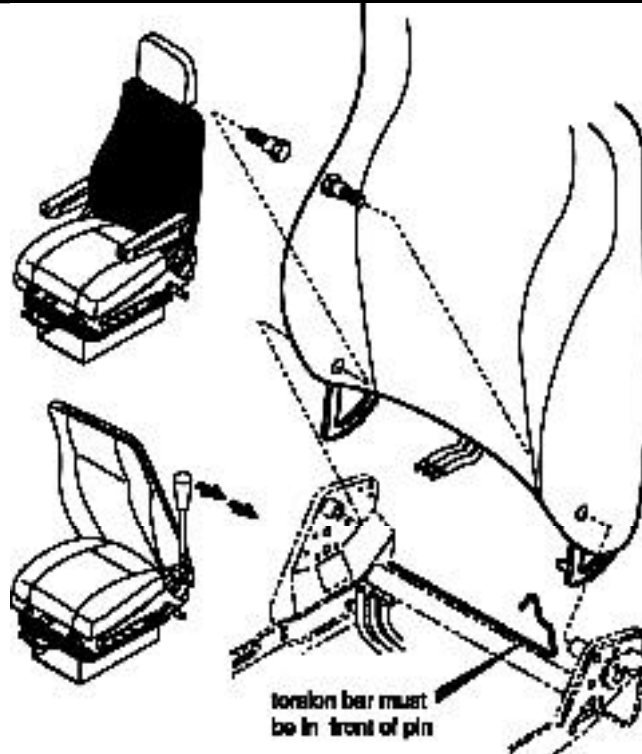
- Vehicle must be in a safe parked position or seat removed from vehicle.

#### Removal

- Mark and disconnect air lines
- Remove fasteners
- Pry one side of seat frame away from backrest
- Remove backrest

#### Installation

- Put one side of backrest in place
- Pry other side of seat frame away and put backrest in place
- Fasten backrest to seat frame with shoulder bolts
- Torque shoulder bolts to 22 - 25.5 lb ft (30 - 35 N•m)
- Connect air lines



**Backrest assembly**

**Set up**

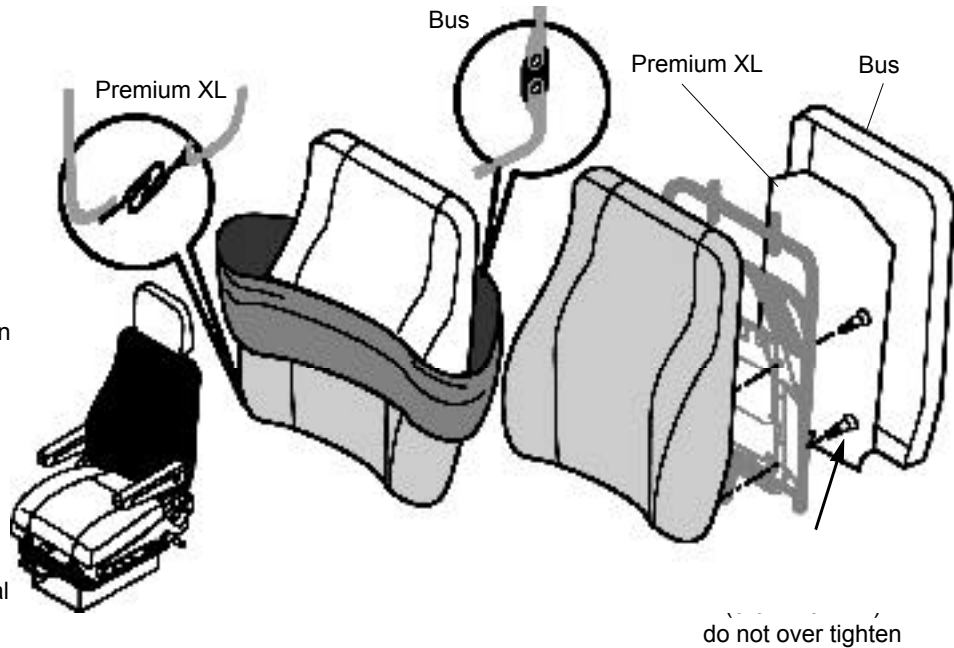
- Backrest must be removed from seat (see **Backrest**)

**Removal**

- Premium XL - remove upholstery and backrest liner
- Bus - remove cover, hog rings and wires.-- remove upholstery
- Remove backrest cushion fasteners -- remove cushion

**Installation**

- Fasten backrest cushion to backrest frame with screws
- Premium XL - install backrest liner and upholstery
- Bus - install upholstery, hog rings and wires.-- instal cover



**Lumbar and bolster air bags**

**Set up**

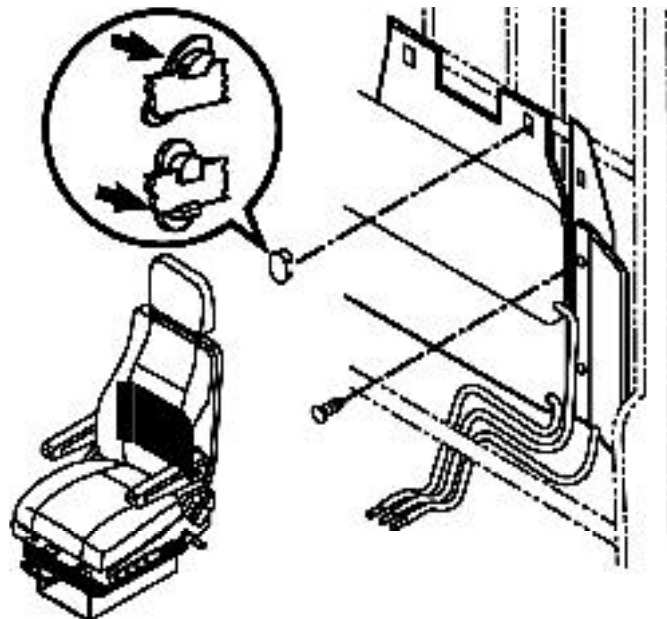
- Remove backrest components (see **Backrest assembly**)

**Removal**

- Remove air bag clips, push fasteners and cable ties
- Remove air bags

**Installation**

- Fasten air bags to backrest frame with clips - put long clip arm over bar and snap bottom of clip in place
- Install push fasteners and cable ties



# REMOVAL and INSTALLATION

MODEL 6800/338 BUS  
MODEL 6800/338 PREMIUM LX

## Lumbar and bolster valve

### Set up

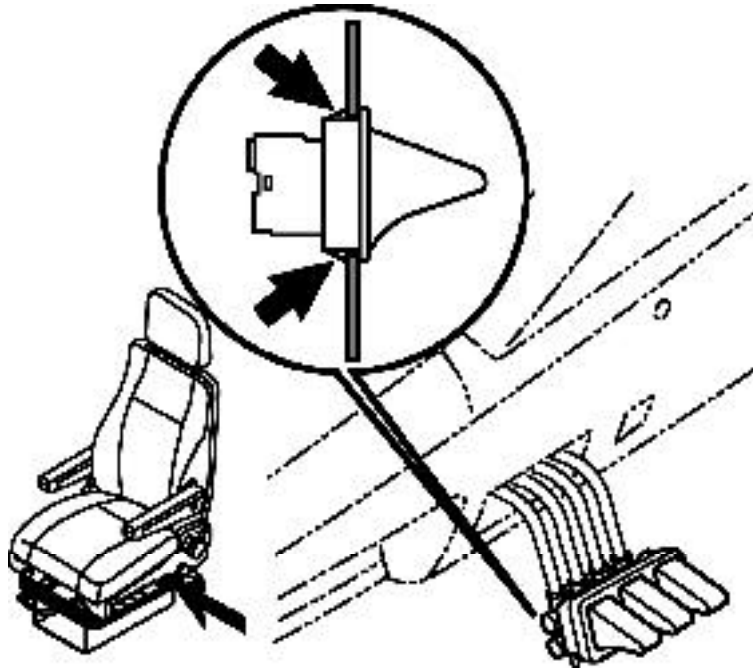
- Cover must be removed from seat (see **Covers front, LH and RH**)

### Removal

- Mark air line and remove them from valve
- Press valve clips in and remove valve from cover

### Installation

- Snap valve into cover
- Connect air lines



## Covers, LH and RH

### Set up

- Vehicle must be in a safe parked position or seat removed from vehicle.

### Removal

#### Control cover

- Remove backrest adjustment handle
- Remove tilt adjustment handle - for fastener access
- Remove fasteners and cover

#### Non control cover

- Remove fasteners and cover

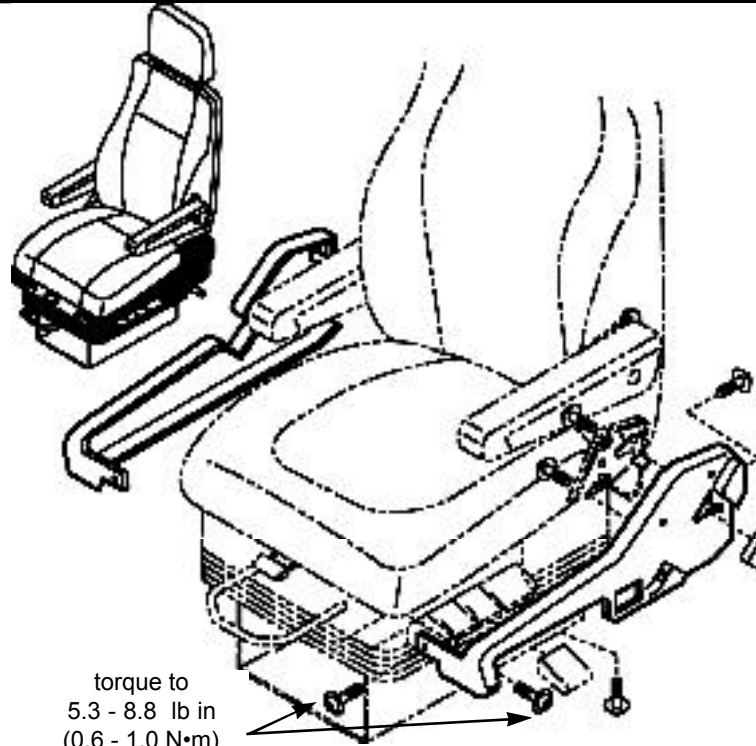
### Installation

#### Control cover

- Fasten cover to seat frame with screws
- Install backrest adjustment handle
- Install tilt adjustment handle - removed for fastener access

#### Non control cover

- Fasten cover to seat frame with screws



torque to  
5.3 - 8.8 lb in  
(0.6 - 1.0 N•m)  
do not over tighten

## Seat pan assembly

### Set up

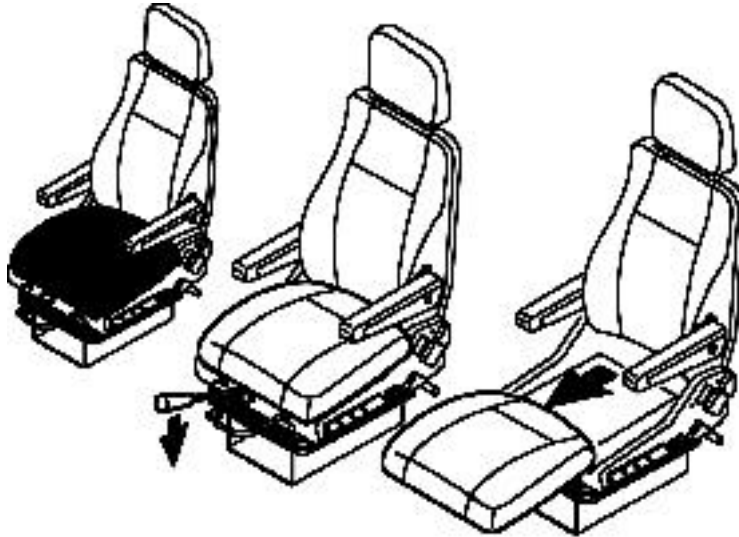
- Vehicle must be in a safe parked position or seat removed from vehicle.

### Removal

- Slide cushion assembly forward
- Pry lever handle up to release cushion stop -- lift cushion off of glides

### Installation

- Put seat cushion assembly on glides and slide back



## Glides - seat pan

### Set up

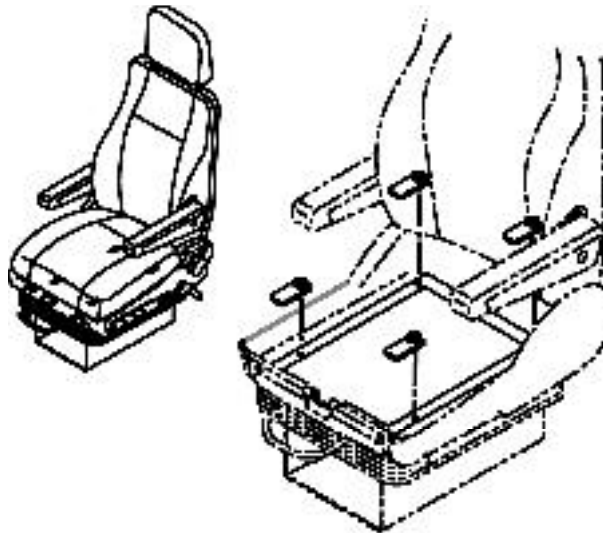
- Seat cushion must be removed from seat (see **Cushion seat pan**)

### Removal

- Remove cushion glides

### Installation

- Install cushion glides to seat frame



# REMOVAL and INSTALLATION

MODEL 6800/338 BUS  
MODEL 6800/338 PREMIUM LX

## Seat pan assembly, lever and handle

### Set up

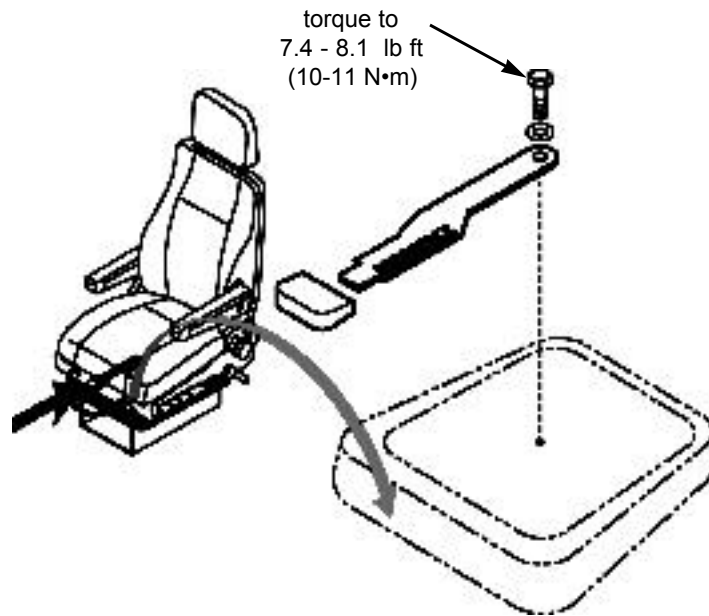
- Seat cushion must be removed from seat (see **Cushion seat pan**)

### Removal

- Pull handle off
- Remove lever fasteners and remove lever

### Installation

- Align locator button of lever with hole in seat pan
- Fasten lever to seat pan with screw and washer
- Push handle on



## Height adjustment valve

### Set up

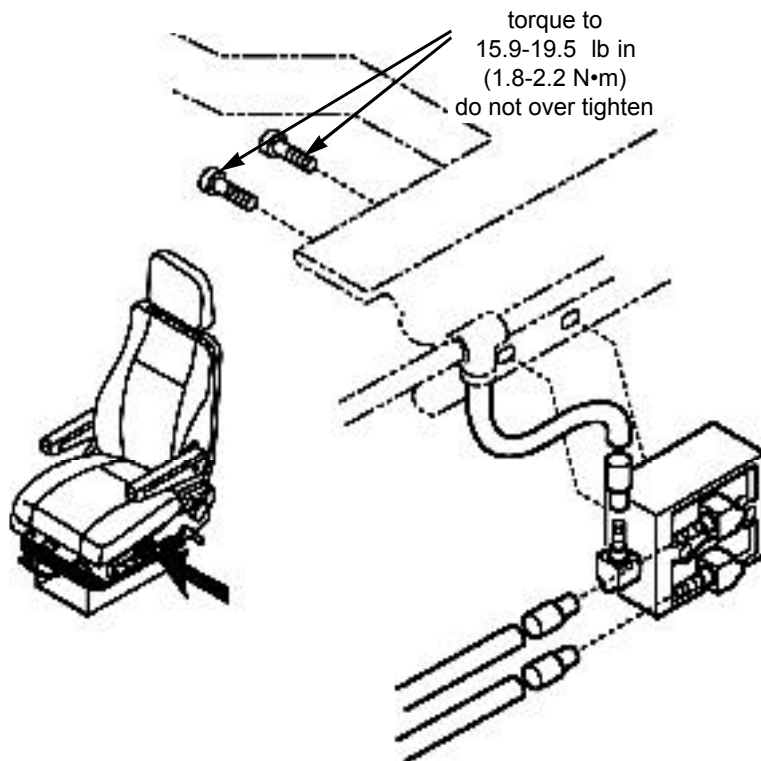
- Seat cushion must be removed from seat (see **Cushion seat pan**)

### Removal

- Mark and remove air lines from valve
- Remove valve fasteners
- \* Remove valve

### Installation

- Fasten valve to seat frame with screw
- Connect air lines





### Height adjustment handle

#### Set up

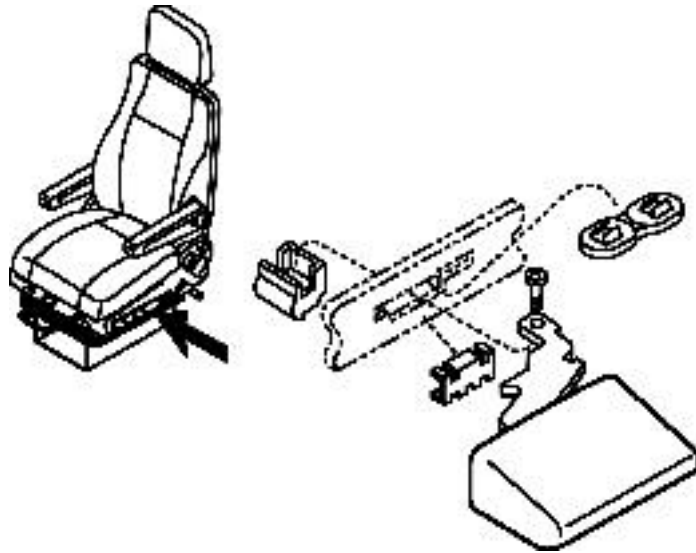
- Vehicle must be in a safe parked position or seat removed from vehicle
- Control cover must be removed (see Covers front, LH and RH)

#### Removal

- Remove screw and cam
- Pull handle and lever out
- Remove retainers

#### Installation

- Put upper retainers in place
- Put lever in place
- Put lower retainers in place - be sure it snaps in place
- Install cam and screw
- Install handle



### Height adjustment cylinder and cam

#### Set up

- Vehicle must be in a safe parked position or seat removed from vehicle
- Seat cushion must be removed from seat (see Cushion seat pan)

#### Removal

##### Air cylinder

- Remove base end pin and retainer washer - remove rod end fastener, air line, and remove cylinder

##### Cam

- Remove rod end fastener
- Remove E ring and mounting pin
- Remove cam

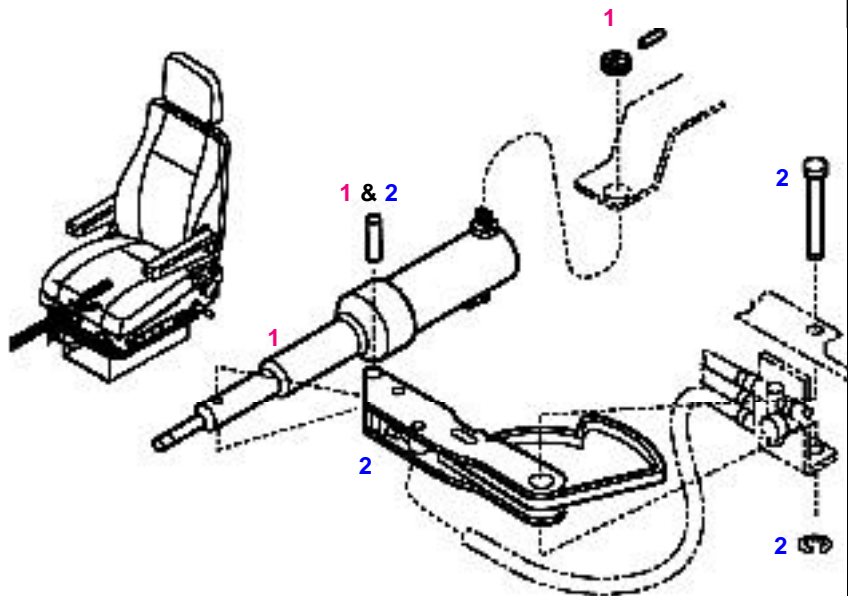
#### Installation

##### Air cylinder

- Put cylinder in place and install base end pin and retainer washer - install rod end fastener, connect air line

##### Cam

- Put cam in place and install pin and E ring



1 = Cylinder kit  
2 = Cam kit

# REMOVAL and INSTALLATION

MODEL 6800/338 BUS  
MODEL 6800/338 PREMIUM LX

## Horizontal adjustment slide set

### Set up

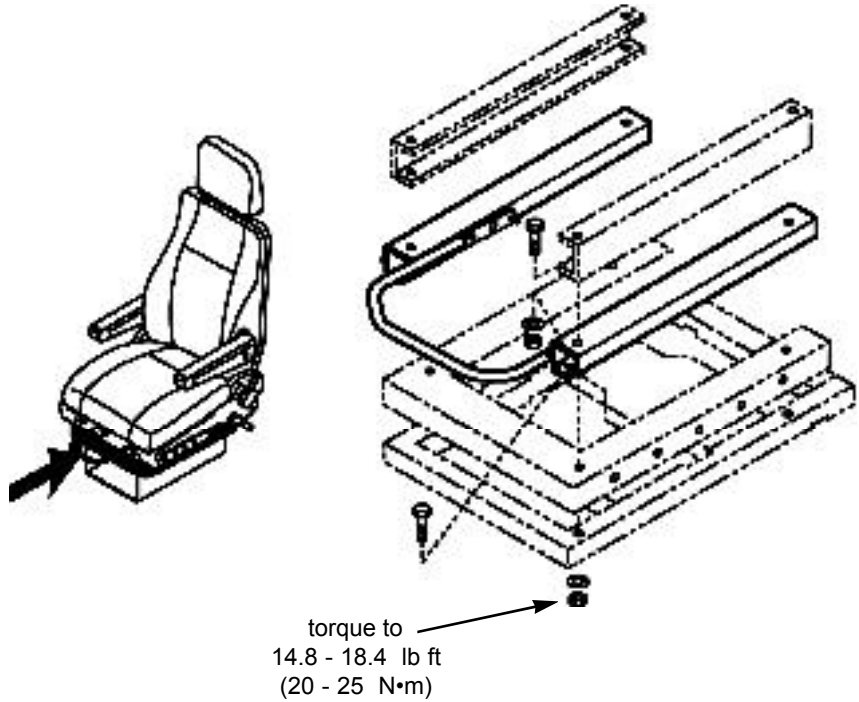
- Seat frame must be removed (see **Seat frame**)

### Removal

- Move horizontal adjustment forward or back to allow access to fasteners
- Remove mounting fasteners

### Installation

- Move horizontal adjustment forward or back to allow access to fasteners
- Install mounting fasteners



## Quick air release - valve and handle LH and RH

### Set up

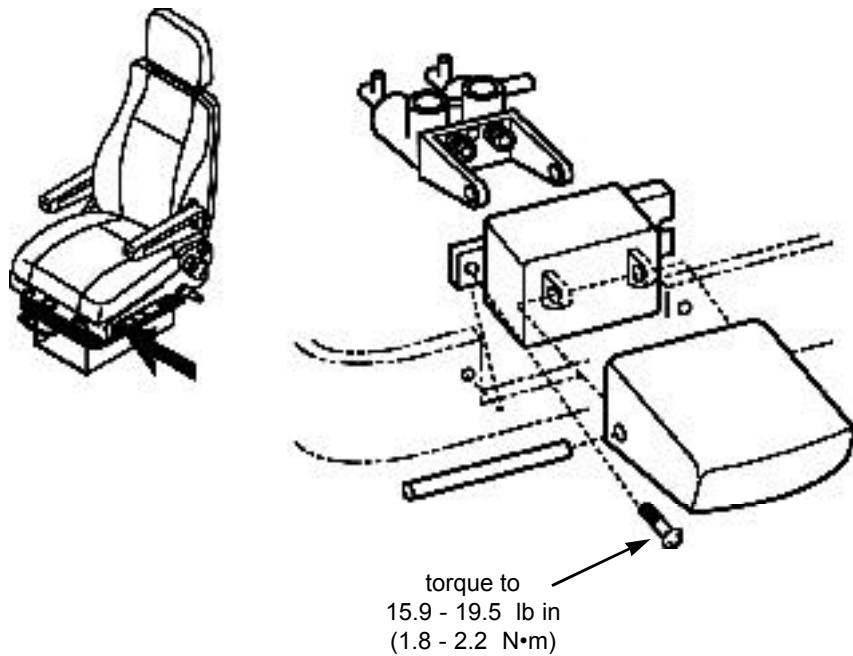
- Seat cushion must be removed from seat (see **Cushion seat pan**)

### Removal

- Mark and remove air lines from valve
- Remove valve fasteners
- Remove valve
- Remove valve handle pin and valve handle

### Installation

- Fasten valve handle to valve with pin
- Fasten valve to seat frame with screw
- Connect air lines



## Quick air release valve - suspension

### Set up

- Seat cushion must be removed from seat (see **Cushion seat pan**)

### Removal

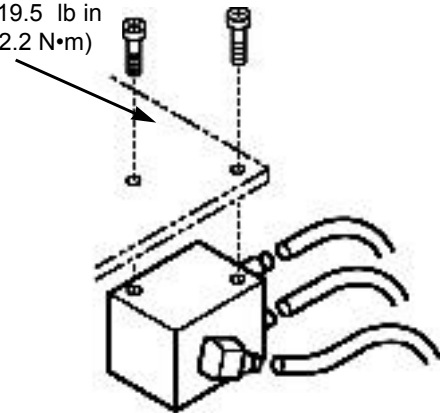
- Mark and remove air lines from valve
- Remove valve fasteners and remove valve

### Installation

- Fasten valve to suspension with screws
- Connect air lines



torque to  
15.9 - 19.5 lb in  
(1.8 - 2.2 N•m)



## Riser and Suspension

### Set up - riser and suspension

- Vehicle must be in a safe parked position or seat removed from vehicle.

### Set up - suspension

- Boot, Boot adapter plate, ICP bar, and tethers must be removed (see **Boot, Boot adapter plate, ICP bar, and tethers**)

### Removal - suspension

- Remove air line
- Remove suspension to riser fasteners and remove suspension

### Installation - suspension

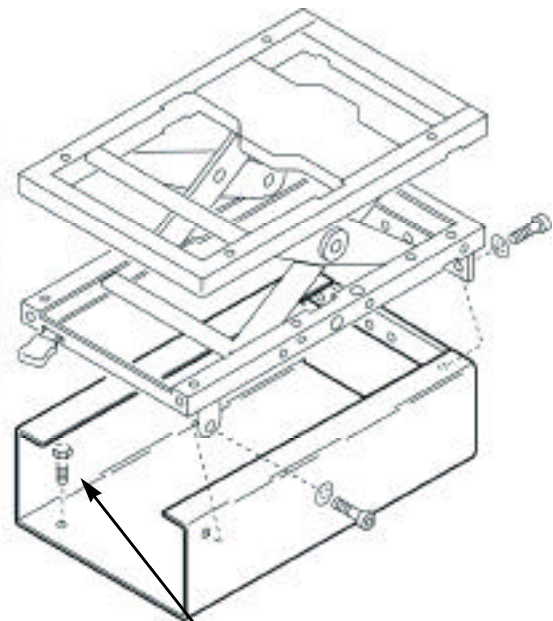
- Put suspension in place
- Install fasteners and torque to 14.8 - 18.4 lb ft (20 - 25 N•m)
- Connect air line

### Removal - riser

- Remove riser to floor fasteners and remove riser

### Installation - riser

- Put riser in place and install fasteners, torque to manufactures specification



torque to  
manufactures  
recommendation

# REMOVAL and INSTALLATION

MODEL 6800/338 BUS  
MODEL 6800/338 PREMIUM LX

## Seat frame

### Set up

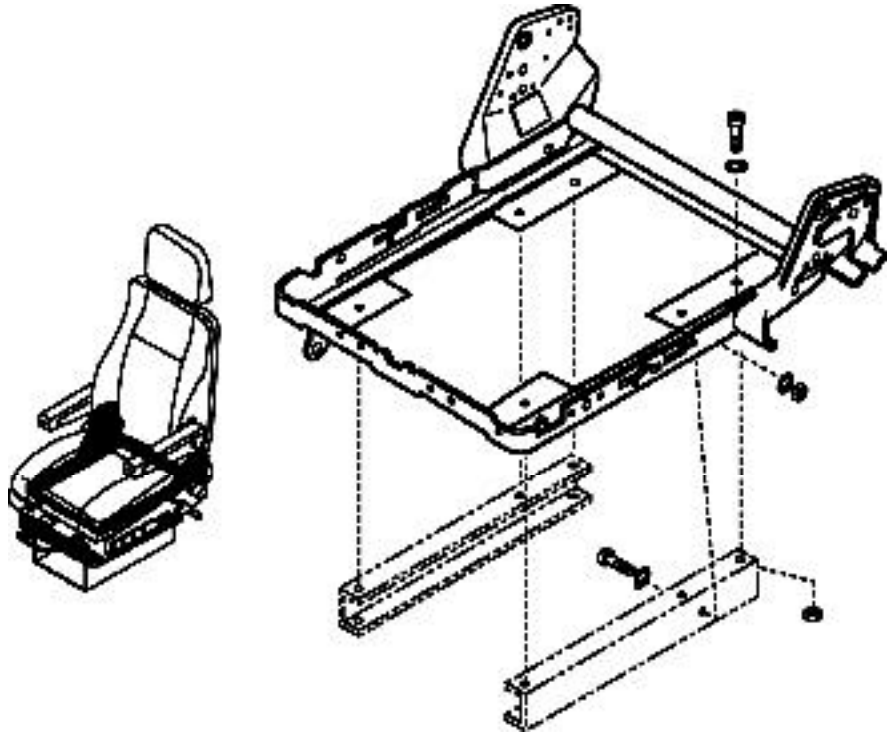
- Seat cushion and backrest must be removed from seat (see **Cushion seat pan and Backrest**)
- Shock absorber handle and cable must be removed. (see **Adjustable shock absorber handle and cable - handle end**)

### Removal

- Mark and remove air lines
- Remove fasteners
- Remove seat frame

### Installation

- Fasten seat frame to static spacer rails with bolts and nuts
- Torque fasteners to 14.8 - 18.4 lb ft (20 - 25 N•m)
- Connect air lines



## Seat frame tooth plate

### Set up

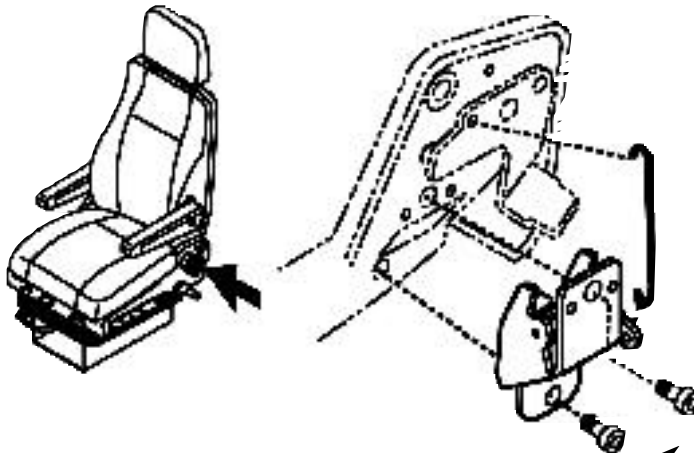
- Backrest and covers must be removed from seat (see **Backrest and Covers front, LH and RH**)

### Removal

- Remove seat latch fasteners
- Remove seat latch
- Remove connecting link

### Installation

- Install connecting link
- Fasten seat latch to seat frame with screws



torque to  
14.8 - 18.4 lb ft  
(20 - 25 N•m)

## Backrest adjustment handle

### Set up

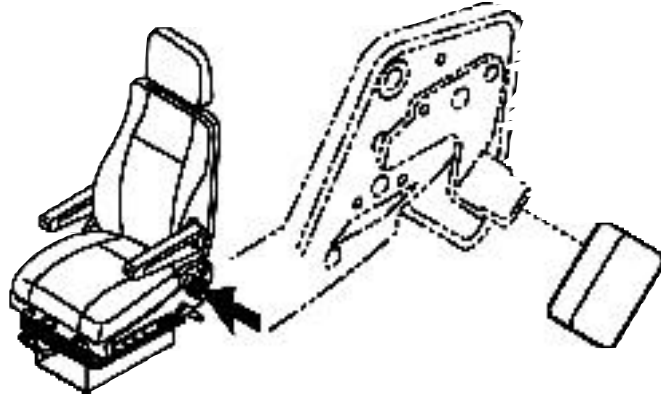
- Vehicle must be in a safe parked position or seat removed from vehicle.

### Removal

- Pull handle off

### Installation

- Push handle on



## Tilt handle

### Set up

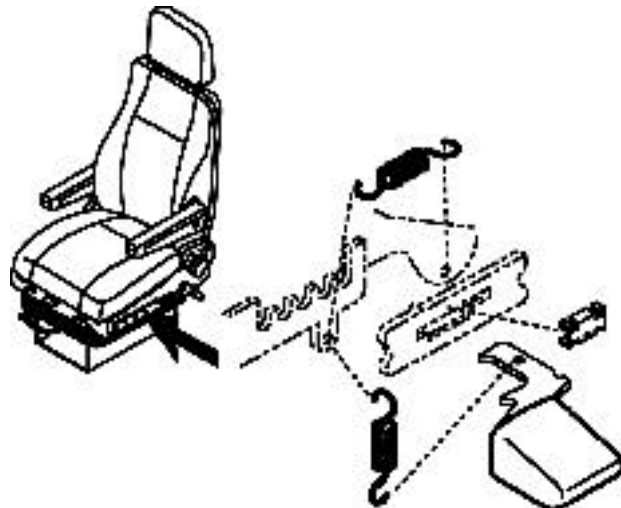
- Vehicle must be in a safe parked position or seat removed from vehicle.

### Removal

- Remove springs
- Pull handle and lever out
- Remove retainer

### Installation

- Put lever in place
- Install retainer, be sure it snaps in place
- Install springs
- Install handle



# REMOVAL and INSTALLATION

MODEL 6800/338 BUS  
MODEL 6800/338 PREMIUM LX

## Air spring

### Set up

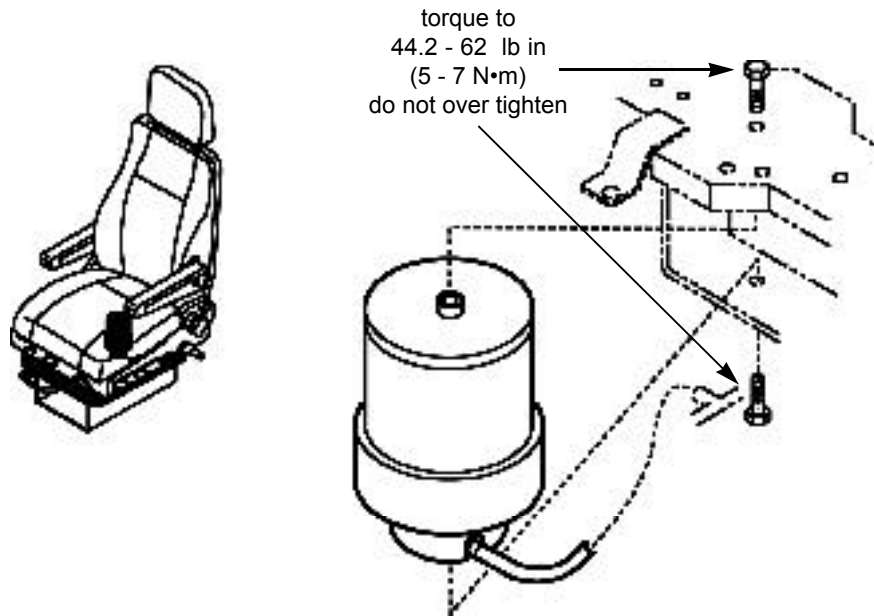
- Seat must be removed from vehicle
- Seat cushion must be removed from seat (see **Cushion seat pan**)

### Removal

- Mark and disconnect air line
- Remove top and bottom mounting fasteners
- Remove air spring

### Installation

- Put air spring in place
- Install top and bottom mounting fasteners
- Connect air line



## Boot, Boot adapter plate ICP bar, and tethers

### Set up

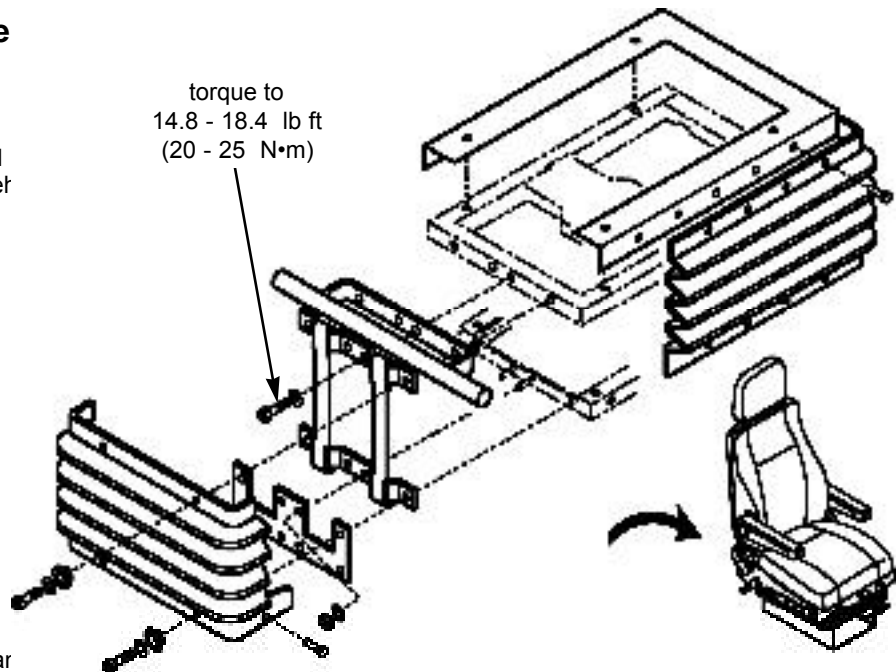
- Vehicle must be in a safe parked position or seat removed from vehicle
- Horizontal adjustment must be removed (see **Horizontal adjustment**)

### Removal

- Remove belts from ICP bar
- Remove boot fasteners, remove boot, and boot adapter plate
- Remove fasteners, tether plate, tether brackets, tethers, and ICP bar

### Installation

- Install fasteners, tether plate, tether brackets, tethers, and ICP bar
- Install boot adapter plate, boot, and fasteners
- Install belts to ICP bar



## Adjustable shock absorber handle and cable (handle end)

### Set up

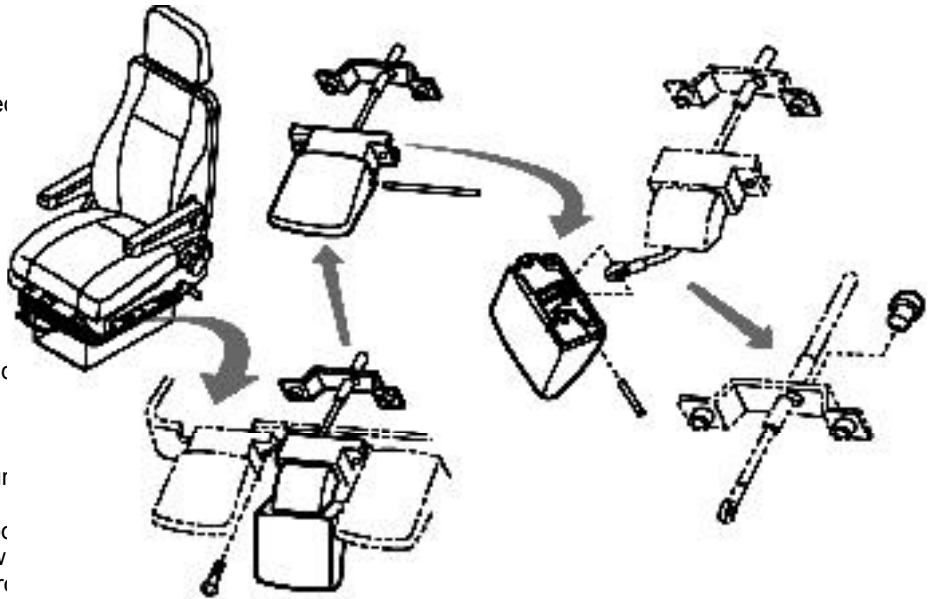
- Seat cushion must be removed from seat (see **Cushion seat pan**)

### Removal

- Remove fasteners and move control, bracket, and cable up away from seat frame
- Remove control handle pin and control handle
- Remove cable pin and cable
- Remove plug from bracket and remove cable

### Installation

- Put cable in bracket and secure plug
- Route cable through control bracket and fasten to control handle with pin
- Fasten control handle to control bracket with pin
- Fasten control and bracket to frame with screws



## Adjustable shock absorber and cable (shock absorber end)

### Set up

- Vehicle must be in a safe parked position or seat removed from vehicle
- Seat cushion must be removed from seat (see **Cushion seat pan**)

### Removal

#### Adjustable shock absorber

- Remove retaining rings
- Remove shock absorber

#### Adjustable shock absorber cable

- Remove retaining ring
- Remove cable

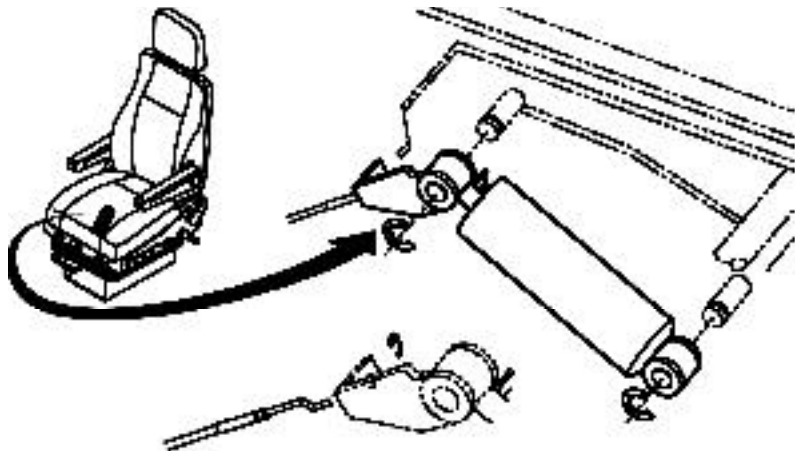
### Installation

#### Adjustable shock absorber cable

- Put cable in place
- Install retaining ring

#### Adjustable shock absorber

- Put shock absorber in place
- Install retaining rings



# REMOVAL and INSTALLATION

MODEL 6800/338 BUS  
MODEL 6800/338 PREMIUM LX

## Distribution valve

### Set up

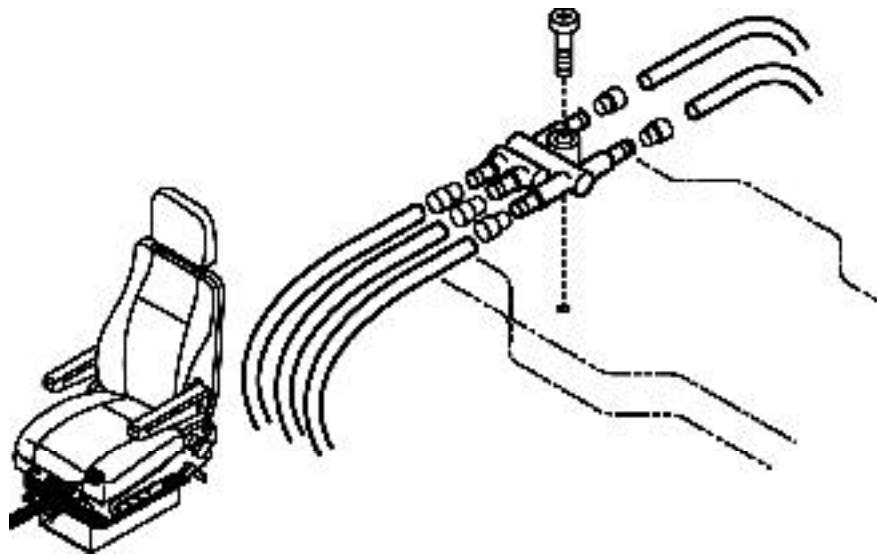
- Seat cushion must be removed from seat (see **Cushion seat pan**)

### Removal

- Mark and remove air lines from valve
- Remove valve fastener and remove valve

### Installation

- Fasten valve to frame with screw
- Connect air lines



## Headrest

### Set up

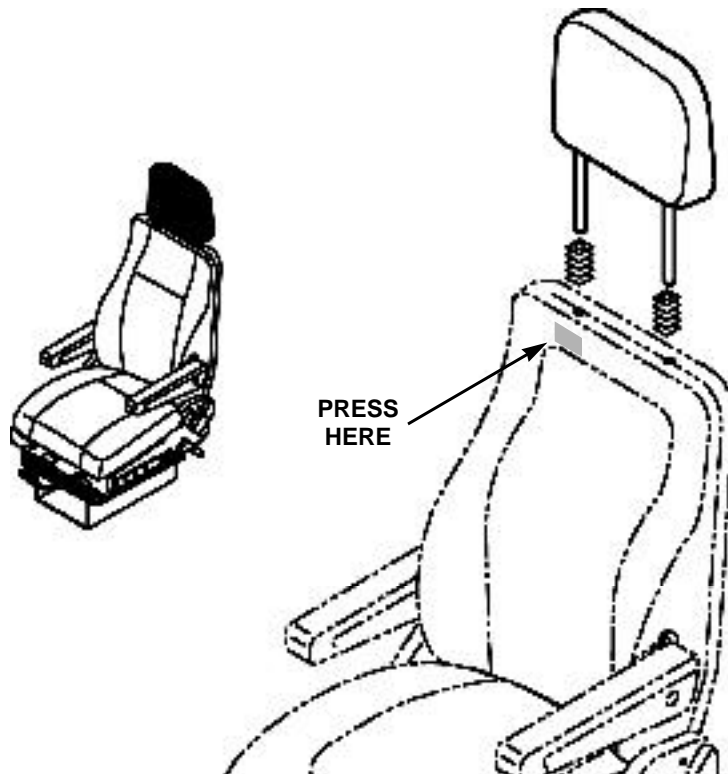
- Vehicle must be in a safe parked position or seat removed from vehicle

### Removal

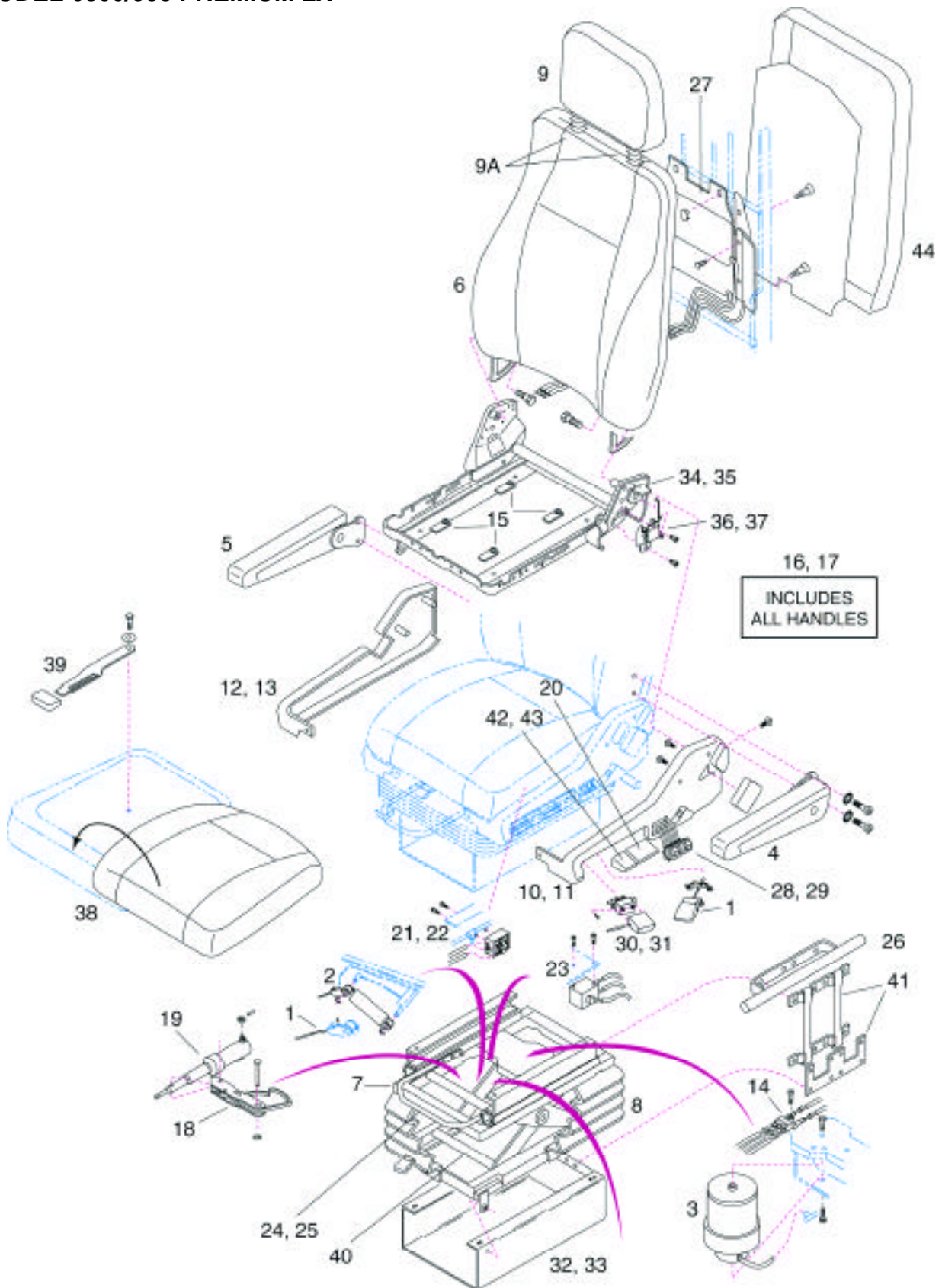
- Pull headrest to upper locking position
- Press foam, as shown, to release locking clip from detent on headrest and pull up

### Installation

- Guide headrest bars into position
- Press down to engage locking clip







# REMOVAL and INSTALLATION

MODEL 6800/338 BUS  
MODEL 6800/338 PREMIUM LX

item	part number	description
1	910353-09	ADJUSTABLE SHOCK ABSORBER CABLE KIT
2	98889-06	ADJUSTABLE SHOCK ABSORBER KIT
3	98872-15	AIR SPRING KIT
4	924473-32	ARMREST KIT - LH
5	924474-32	ARMREST KIT - RH
6	03003-00	BACKRESTASSEMBLY - NUDE
7	111776P02	BOOTADAPTER PLATE
8	926513-01	BOOT KIT
9	110922-00	HEADRESTASSEMBLY - NUDE
9A	47541	HEADREST BOOT (2 PCS)
10	920260-04	COVER KIT CONTROL - LH
10	927399-01	COVER KIT CONTROL - LH (W/O LOGO)
11	920263-04	COVER KIT CONTROL - RH
11	927398-01	COVER KIT CONTROL - RH (W/O LOGO)
12	920262-01	COVER KIT NON-CONTROL - LH
12	927397-01	COVER KIT NON-CONTROL - LH (BELT TO FRAME W/ LOGO)
12	927397-02	COVER KIT NON-CONTROL - LH (BELT TO FRAME W/O LOGO)
13	920261-01	COVER KIT NON-CONTROL - RH
13	927396-01	COVER KIT NON-CONTROL - RH (BELT TO FRAME W/ LOGO)
13	927396-02	COVER KIT NON-CONTROL - RH (BELT TO FRAME W/O LOGO)
14	915105-03	DISTRIBUTION VALVE KIT
15	914516-04	GLIDE KIT - SEAT PAN
16	920264-03	HANDLE KIT - SEAT FRAME - LH
17	920264-04	HANDLE KIT - SEAT FRAME - RH
18	33487	HEIGHTADJUSTMENT CAM KIT
19	95486-03	HEIGHTADJUSTMENT CYLINDER KIT
20	920266-05	HEIGHTADJUSTMENT HANDLE KIT - LH
20	920266-06	HEIGHTADJUSTMENT HANDLE KIT - RH
21	98976-07	HEIGHTADJUSTMENT VALVE KIT - LH
22	98875-07	HEIGHTADJUSTMENT VALVE KIT - RH
23	98873	HEIGHTADJUSTMENT VALVE KIT - SUSPENSION
24	24569F	HORIZONTALADJUSTMENT SLIDE HANDLE
25	18755-02	HORIZONTALADJUSTMENT SLIDE SET
26	111973P02	ICP BAR - TRUCK (NOT USED W/ BELT TO FRAME)
26	111895P01	ICP BAR - BUS (FOR BELT TO ICP BAR ONLY)
27	920272-01	LUMBAR/BOLSTER KIT
28	36571-01	LUMBAR/BOLSTER VALVE - LH
29	36572-01	LUMBAR/BOLSTER VALVE - RH
30	914514-24	QUICK AIR RELEASE VALVE AND HANDLE KIT - LH
31	914514-25	QUICK AIR RELEASE VALVE AND HANDLE KIT - RH
32	03007P	RISER - 127 MM (MCI 'D-SERIES' COACH)
33	03463P	RISER - 127 MM (STD, NEOPLAN, ORION VI, NEW FLYER)
33	03013P	RISER - 156 MM (MCI 'E-SERIES' COACH)
33	03468	RISER KIT - 76 MM (PREVOST COACH)
33	111779P03	RISER - 127 MM (KW O W900 & T2000, MACK, NAVISTAR)
33	112256P02	RISER - 110 MM (PB - 379)
34	03307-01	SEAT FRAME - LH
35	03308-01	SEAT FRAME - RH
36	914500-23	SEAT FRAME TOOTH PLATE KIT - LH
37	914500-24	SEAT FRAME TOOTH PLATE KIT - RH
38	03002-00	SEAT PAN ASSEMBLY - NUDE
39	921845-02	SEAT PAN ASSEMBLY LEVER AND HANDLE KIT
40	111833-01	SUSPENSION
41	924464-01	TETHER AND TETHER PLATE KIT
42	920267-05	TILT HANDLE KIT - LH
43	920267-06	TILT HANDLE KIT - RH
44	01955-03	BACKREST PANEL (BUS ONLY)



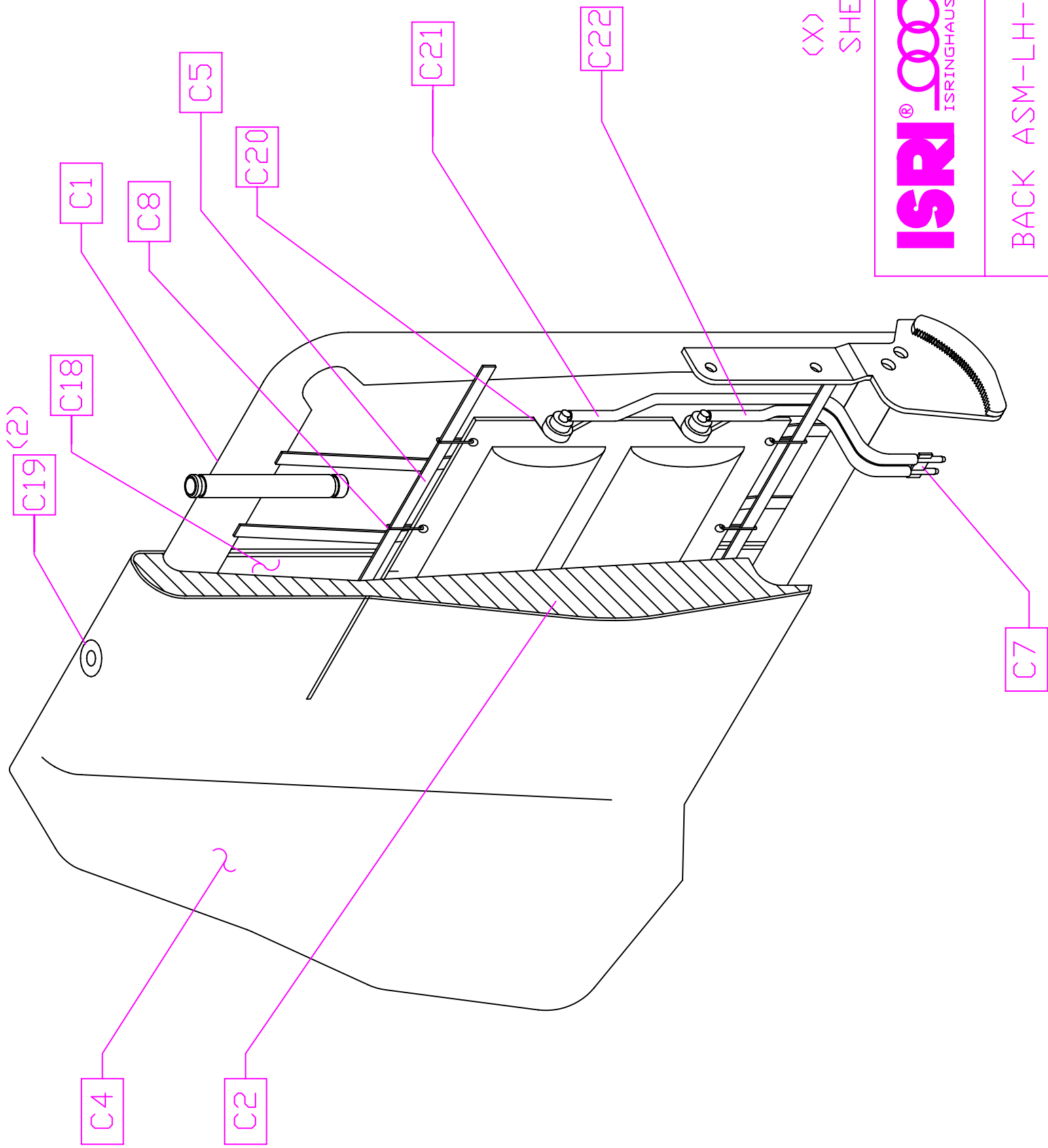


**SERVICE PARTS LIST**

ISRI P/N: 17518-00 Description: Backrest-517-LH-AL  
 ISRI Illus. No.: C-024  
 Customer: Prevost Car Customer P/N: 860739  
 Specification: LH controls, Air lumbar, Poly foam

<b>ILLUS NO.</b>	<b>DESCRIPTION</b>	<b>ISRI P/N</b>	<b>CUSTOMER P/N</b>
C1	Backrest Frame	17734D01	860740
C2	Backrest Foam	00849	864741
C3	Kit – Air Lumbar Bag	95622-01	860494
C4	Uph – Backrest	-----	
C5	Uph Rod – Long	See C27	
C7	Fitting	* 47278	
C8	Clip – Lumbar Bag Attach	See C3	
C18	Filler Foam – Back	13797	
C20	Air Lumbar Bag	See C24	
C21	Hose – Upper	See C24	
C22	Hose – Lower	See C24	
C23	Sew Strip	See C25	
C24	Air Lumbar Bag Asm	See C3	
C25	Uph Hdw Kit – Back – Nude	914413	
C27	Uph Hdw Kit – Back – Retro	-----	
C42	Hog Ring	See C25	
C47	Rub Strip	See C49	
C48	Screw (Rub Strip)	See C49	
C49	Rub Strip Kit	914439	

\* PART OF KIT



(X) = QUANTITY  
 SHEET 1 OF 2

 <p><b>ISRI</b><sup>®</sup>      ISRINGHAUSEN</p>	<p>05/92        (REV 5/22/01)        C-024</p>
<p>BACK ASM-LH-AL</p>	

KIT #	P/N	ITEM NO. IN KIT	ITEM
1	C3	C8, C24	AIR LUMBAR BAG – KIT
2	C24	C7, C20, C21, C22	AIR LUMBAR BAG – ASM
3	C25	C5, C18, C23	UPH HDW KIT–BACK–NUDE
4	C27	C5, C18	UPH HDW KIT–BACK–RETRO

SHEET 2 OF 2



05/92  
(REV 5/22/01)

KIT DESCRIPTION

C-024

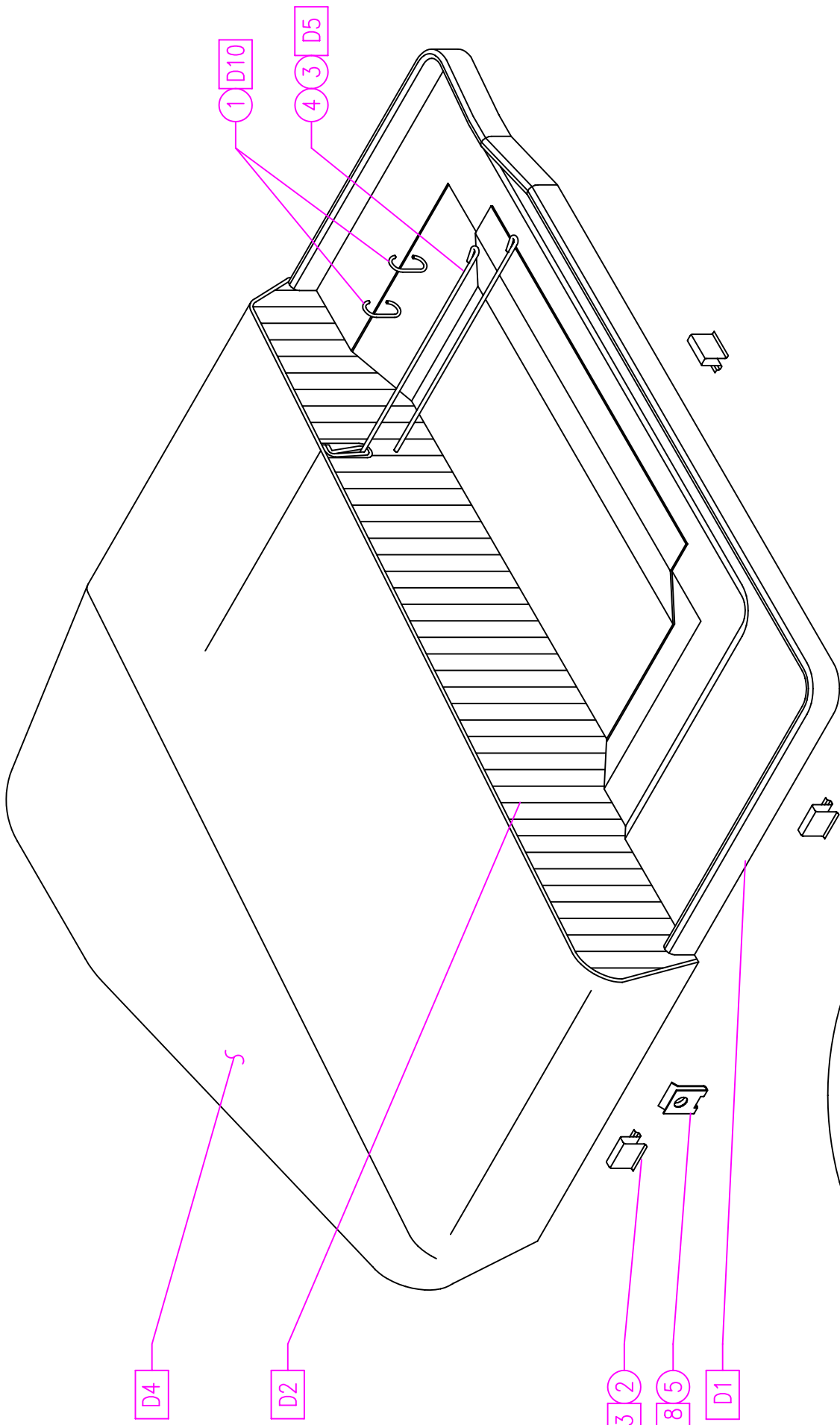


**SERVICE PARTS LIST**

ISRI P/N: 14663-04 Description: Seat Pan-515  
 ISRI Illus. No.: D-008  
 Customer: Prevost Car Customer P/N: 860742  
 Specification: Poly foam, w/o upholstery

ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
D1	Seat Pan	17832P	860743
D2	Seat Foam	00425	860744
D3	Uph Clip	See D15	
D5	Uph Rod – Long	See D16	
D10	Hog Ring	See D16	
D11	Sew Strip – Front	See D16	
D12	Sew Strip – Side	See D16	
D13	Sew Strip – Rear	See D16	
D14	Hog Ring Kit	* 912040	
D15	Uph Clip Kit	* 912039	
D16	Uph Hdw Kit – Seat – Nude	96728	861104
D18	Nut – Clip	See D19	
D19	Hdw Kit – Nut Clip	914257	

**\* PART OF KIT**



D4

D2

D3 2

D18 5

D1

D12 3

D11 3

3 D13

1 D10

4 3 D5

(X) = KIT #

SHEET 1 OF 2

**ISRI**<sup>®</sup>  
ISRINGHAUSEN

04/91

SEAT PAN ASM-LOW PROFILE D-008



KIT #	P/N	ITEM NO. IN KIT	ITEM
1	D14	D10	HOG RING KIT
2	D15	D3	UPH CLIP KIT
3	D16	D5,D11,D12,D13,D14,D15	UPH HDW KIT – NUDE
4	D17	D5, D14, D15	UPH HDW KIT – RETRO
5	D19	D18	SEAT PAN CLIP KIT

SHEET 2 OF 2



04/91

KIT DESCRIPTION

D-008



## SERVICE PARTS LIST

ISRI P/N: 02371-02 Description: Seat Frame-515-LH-AL/MV(RH)  
 ISRI Illus. No.: E-059  
 Customer: Prevost Car Customer P/N: 861099

Specification: LH controls, double swivel bolt, controls – black w/symbol,  
 Air lumbar/Manual valve-RH (IPS 5)

ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
E1	Side Plate Kit	95733-03	860487
E3	Valve Kit – Air Lumbar/MV	917471-04	861096
E4	Valve Asm – Air Lumbar/MV	* 35270-01	
E5	Torsion Bar Kit	95739-01	861091
E7	Spring Kit – Height/Slope	95619-04	860755
E8	Bushing Kit – Height/Slope	95773-01	860753
E9	Bushing / Hdw Kit – H/S	95847-01	860754
E13	Tooth Plate Kit	914209-05	
E14	Swivel Bolt / Clip Kit	914204-02	860757
E50	Cover – Seat Frame – Rear	See E1	
E51	Hose–Lumbar Upper-Rubber	See E4	
E52	Cover – Side Plate – RH	See E1	
E54	Handle – H/S – Front	* 47270-02	
E55	Cap – Side Plate	See E1	
E56	Handle – Backrest	* 43537-02	
E57	Cover – Side Plate – LH	See E1	
E58	Hose-Lumbar Supply-PU3	See E4	
E59	Cap – Torsion Bar	See E5	
E60	Bar – Torsion	See E5	
E61	Lock – Torsion Bar	See E5	
E62	Pad – Felt	* 42258	
E63	Seat Frame w/o Covers	917673D	
E65	Screw – Hose Guide	See E3	
E66	Hose Guide	See E3	
E67	Hose-Lumbar Lower-Rubber	See E4	
E70	Nut – Tee	See E3	
E73	Bushing	See E8 or E9	
E74	Link-Pivot-H/S-Opp Control	See E63	
E75	Ring – Retaining	See E14	
E76	Bolt – Swivel	See E14	

**\* PART OF KIT**



## SERVICE PARTS LIST

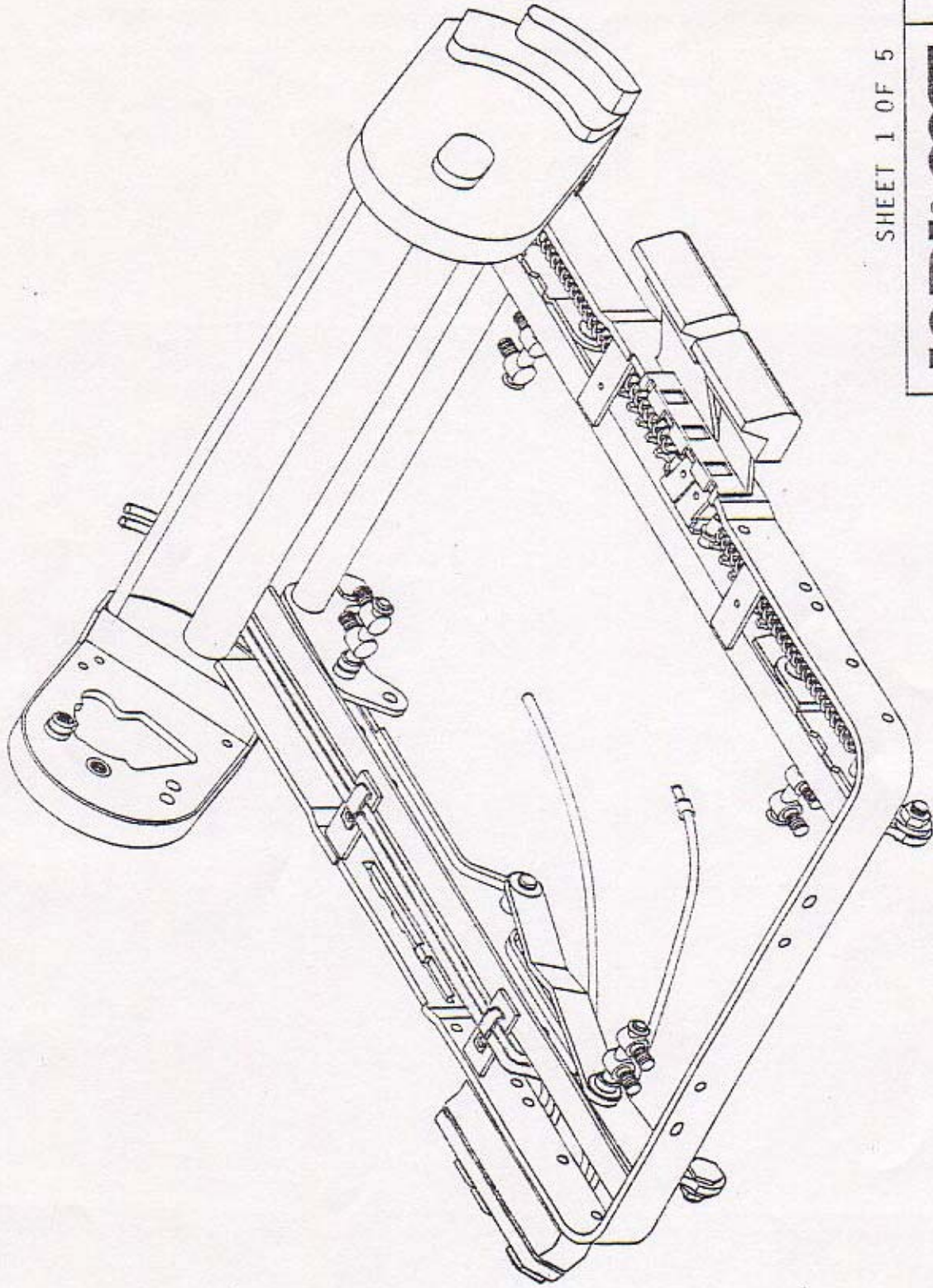
ISRI P/N: 02371-02 Description: Seat Frame-515-LH-AL/MV(RH)  
 ISRI Illus. No.: E-059  
 Customer: Prevost Car Customer P/N: 861099

Specification: LH controls, double swivel bolt, controls – black w/symbol,  
 Air lumbar/Manual valve-RH (IPS 5)

ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
E77	Bolt – Shoulder – M8	See E9	
E78	Bushing	See E8 or E9	
E79	Link-Pivot-H/S-Control	See E63	
E80	Lever – Backrest Adjust	41509D	
E81	Ring – Retaining	See E1	
E82	Spring – Tension – Backrest	41552D	860751
E83	Plate – Latch – H/S – Rear	35865J	
E84	Pin – Pivot – Latch	40647N	
E85	Ring – Retaining	60020	
E86	Guide – H/S	42962	
E88	Spring – Tension	See E7	
E89	Lever – H/S – Front	43012D	860588
E90	Spring – Tension	See E7	
E91	Spring – Tension	See E7	
E92	Plate – Latch – H/S – Front	47275D	860756
E93	Ring – Retaining	60020	
E94	Nut – Hex – Crimp Lock – M8	See E9	
E95	Linkage – H/S – Rear – DS	See E63	
E96	Ring – Retaining	60047	
E97	Link	See E63	
E98	Plate – Tooth – Seat Frame	See E13	
E99	Ring – Retaining	See E13	
E100	Ring – Retaining	60020	
E102	Bushing	See E8	
E103	Ring – Retaining	60020	
E104	Clip – U	60186	
E105	Linkage – H/S – Front – DS	See E63	
E138	Hose-PU3 (MV/Air Spring)	See E3	
E139	Housing – AL/MV	* 24111-02	
E140	Screw-Mtg-AL/MV Housing	See E3	
E141	Cover – Rocker – AL – Lower	* 45480-24	861094

**\* PART OF KIT**





SHEET 1 OF 5

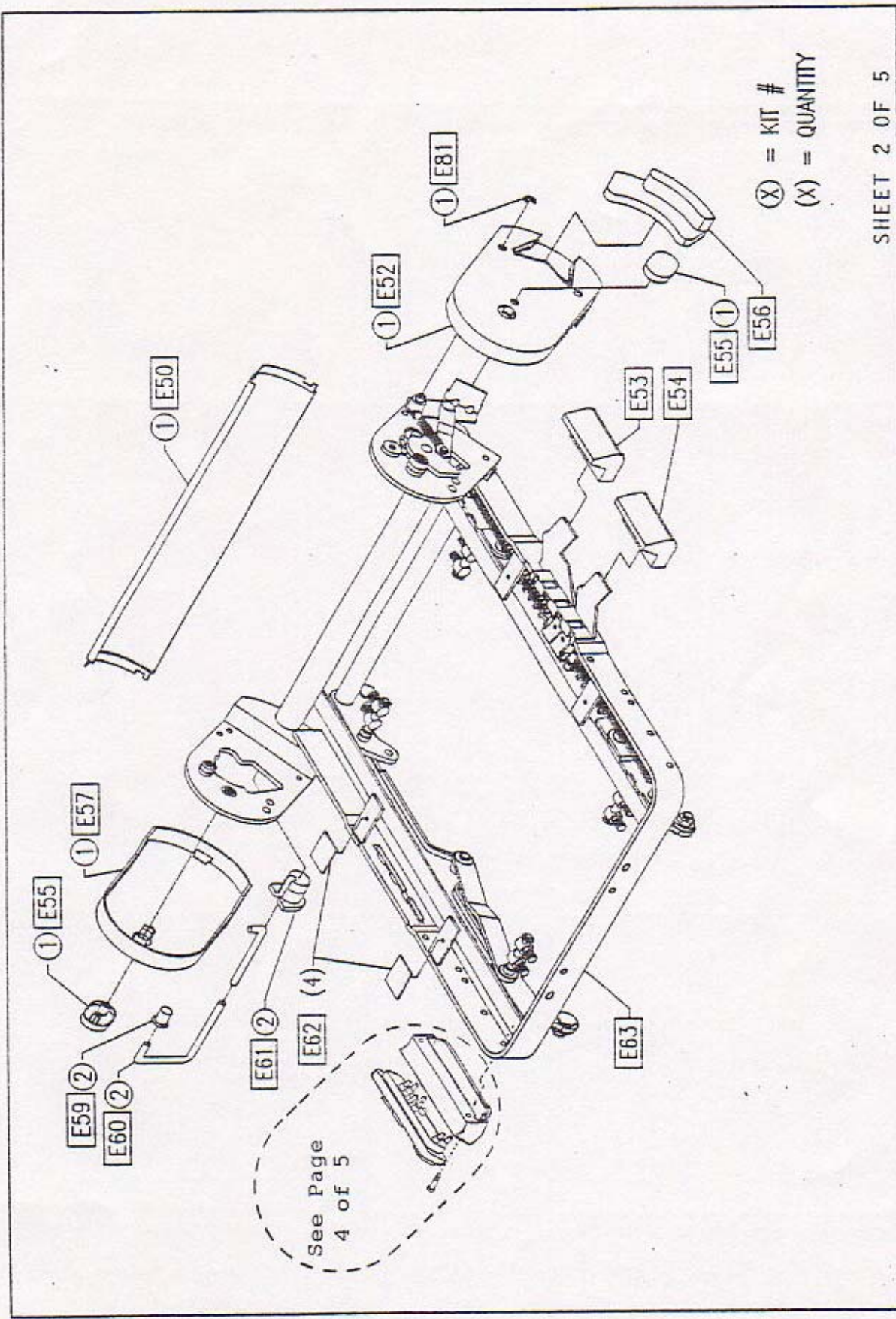
**ISRI**<sup>®</sup>  
ISRINGHAUSEN

12/95

SEAT FRAME-515-LH

E-059



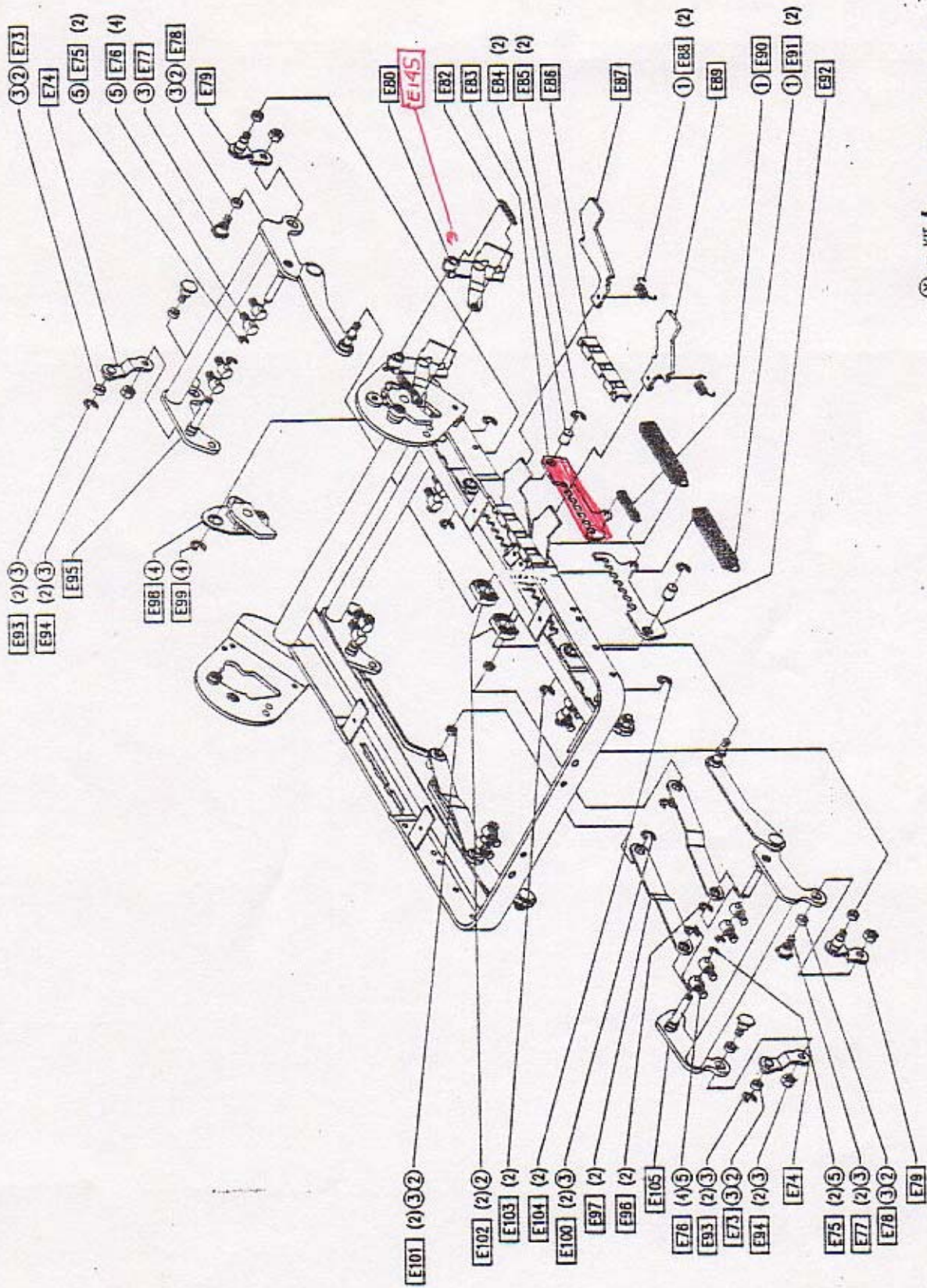


SHEET 2 OF 5

<b>ISRI</b> ESRIDIGHAUSEN		12/95
SEAT FRAME - 515-LH		E-059

KIT #	P/N	ITEM NO. IN KIT	ITEM
1	E1	E50, E52, E55, E57, E81	SIDE PLATE KIT
2	E5	E59, E60, E61	TORSION BAR KIT





⊗ = KIT  
 (X) = QUANTITY

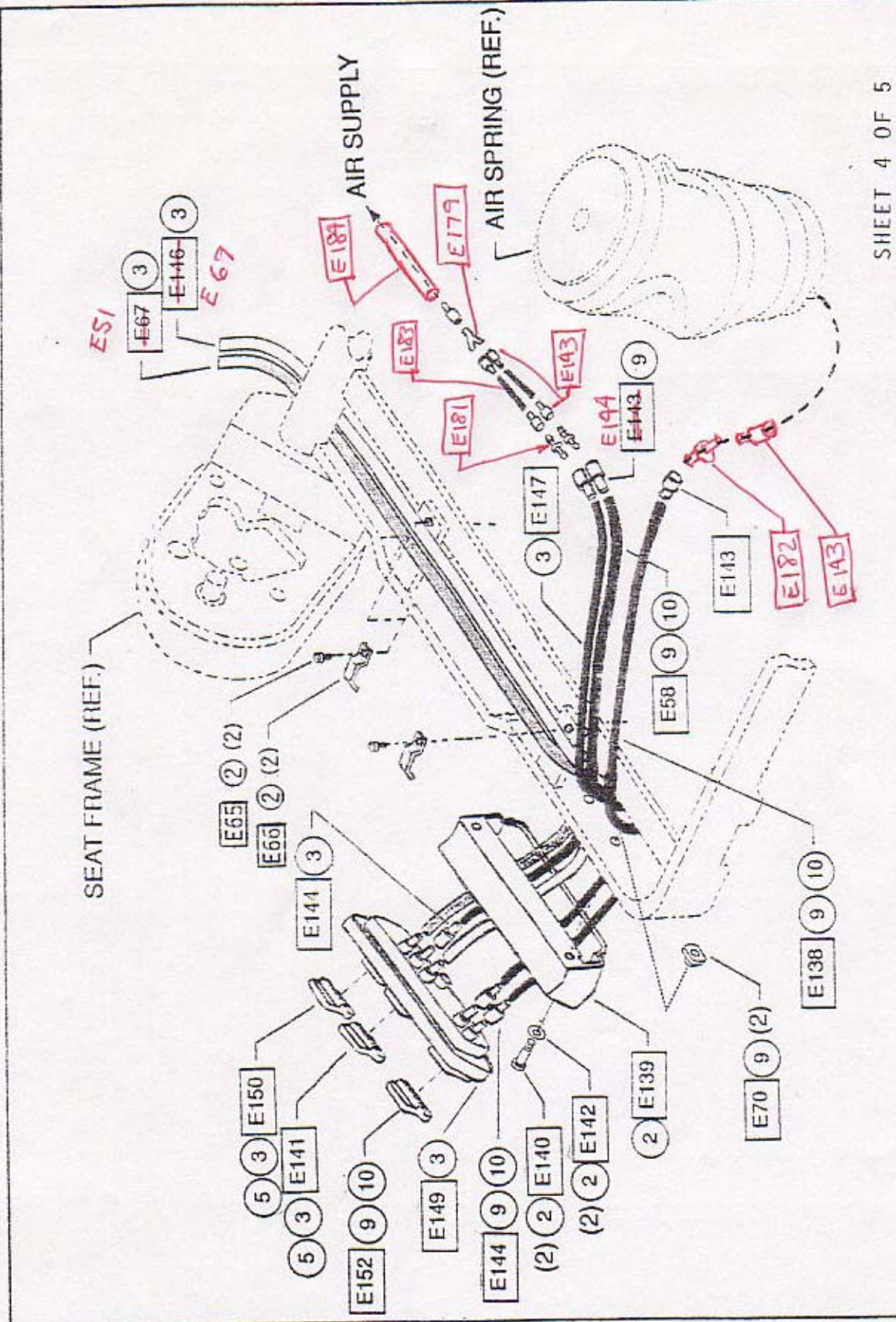
SHEET 3 OF 5

**ISRI** INDUSTRIAL SEATING

12/95

SEAT FRAME-515-LH E-059





SHEET 4 OF 5

 <b>ISRI</b> <small>ISRINGHAUSEN</small>	12/95
	E-059

○ = KIT #  
 ( ) = QUANTITY

SEAT FRAME-515-LH



KIT #	P/N	ITEM NO. IN KIT	ITEM
1	E1	E50, E52, E55, E57, E81	SIDE PLATE KIT
2	E3	E4, E70, E139, E140, E142, E143	VALVE KIT-AL/MV
3	E4	E51, E67, E141, E144, E146, E147, E149, E150	VALVE ASM-AL/MV
4	E5	E59, E60, E61	TORSION BAR KIT
5	E6	E54, E56, E141, E150, E152	HANDLE KIT-SF-AL/MV
6	E7	E88, E90, E91	SPRING KIT-H/S
7	E8	E73, E78, E102	BUSHING KIT-H/S
8	E9	E73, E77, E78, E93, E94, E100	BUSHING/HDW KIT-H/S
9	E13	E98, E99	TOOTHPLATE KIT
10	E14	E75, E76	SWIVEL BOLT/CLIP KIT

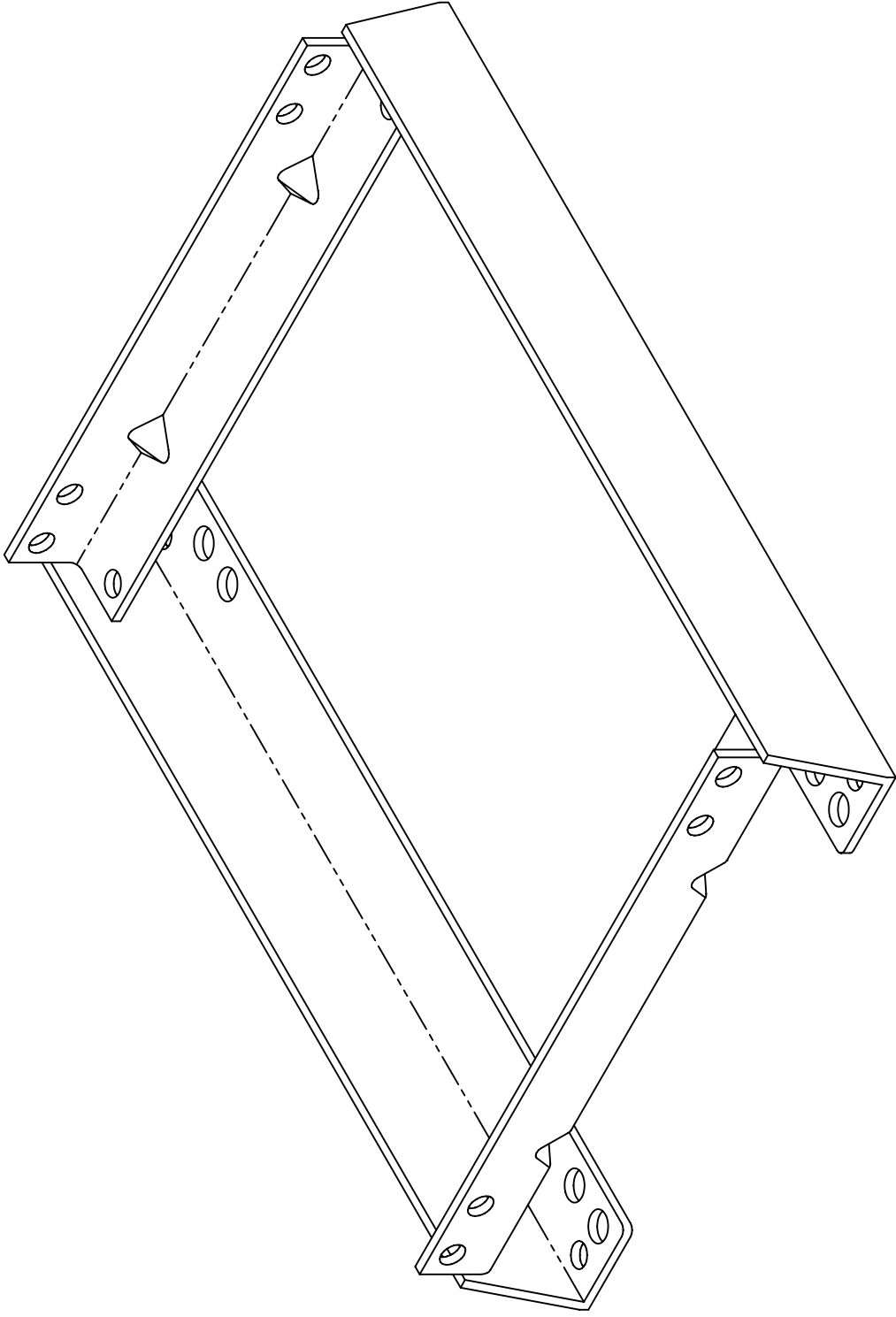
SHEET 5 OF 5

**ISRI**®   
ISRINGHAUSEN

12/95

KIT LIST

E-059

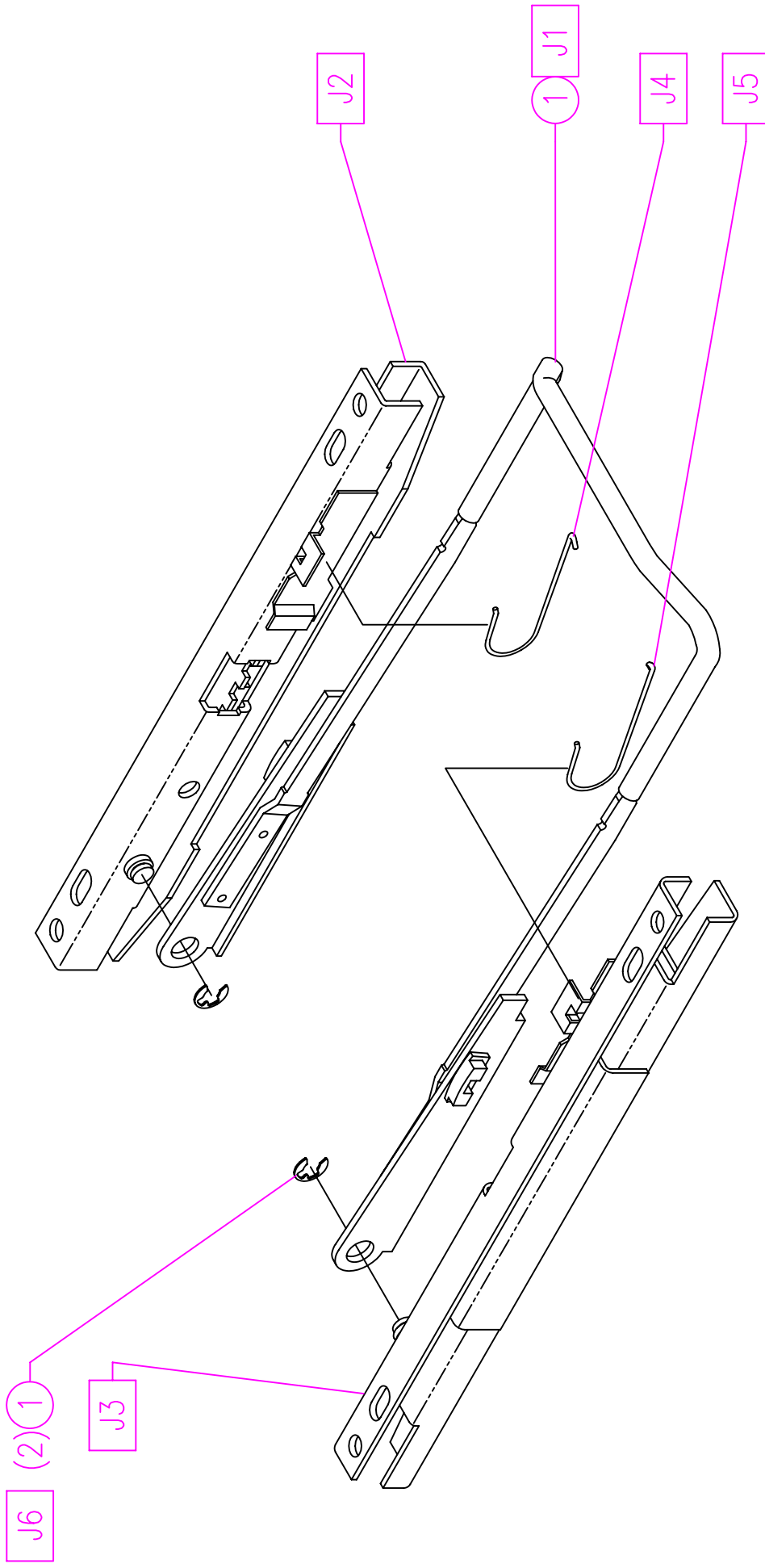




**SERVICE PARTS LIST**

ISRI P/N: 17491 Description: Slide Set – “B” Style  
ISRI Illus. No.: J-006  
Customer: Prevost Car Customer P/N: 860758  
  
Specification: 90/60 slide stroke, double locking, bar handle up

ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
J1	Handle – Slide	See J8	
J2	Slide – Slave – LH	23908	
J3	Slide – Master – RH	23907	
J4	Spring – Handle Return – LH	43284C	
J5	Spring – Handle Return – RH	43283C	
J6	Ring – Retaining	See J8	
J8	Handle/Clip Kit	914212-04	



KIT #	P/N	ITEM NO. IN KIT	ITEM
1	J8	J1, J6	HANDLE KIT



## SERVICE PARTS LIST

ISRI P/N: 17259-01 Description: Susp–Air  
 ISRI Illus. No.: K-019  
 Customer: Prevost Car Customer P/N:  
 Specification: Manual air, 100 mm stroke, Adjustable shock

ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
K2	Suspension Hdw Kit	95477-03	860770
K3	Bumper / Bracket Asm	See K12	
K5	Shock Kit	914410	860766
K6	Air Spring Kit	95474-02	
K12	Bumper Kit	913934-05	860769
K19	Shock Cable Kit	914411	860767
K20	Shock Handle Kit	914412-01	861105
K50	Nut – Hex – M8	See K12	
K51	Washer – Split Lock – B8	See K12	
K53	Bumper – Cone Shape	See K12	
K56	Bushing – Flange	See K2	
K59	Nut–Hex–Crimp Lock-M10	See K2	
K61	Spring – Air	See K6	
K66	Washer – Flat – A6.4	See K6	
K67	Screw – Air Spring Mtg - Lwr	See K6	
K69	Bracket – Bumper Stop	See K3	
K70	Bumper – Up Stop	See K3	
K72	Bolt – Shock Mtg - Lower	See K5	
K73	Hose–MV / Air Spring	See K16	
K75	Bolt – Shoulder – M10	See K2	
K78	Roller	See K2	
K83	Bushing – Shock - Lower	See K5	
K84	Shock Absorber	See K5	
K106	Frame – Upper	N/A Separate	
K108	Frame – Lower	N/A Separate	
K109	Scissor – Outer	N/A Separate	
K110	Scissor – Inner	N/A Separate	
K125	Cable Tie	See K5 or K9	
K152	Spacer Block	See K2	
K153	Bearing Block	See K2	
K154	Bolt – Air Spring Mtg – Upr	See K6	

**\*PART OF KIT**



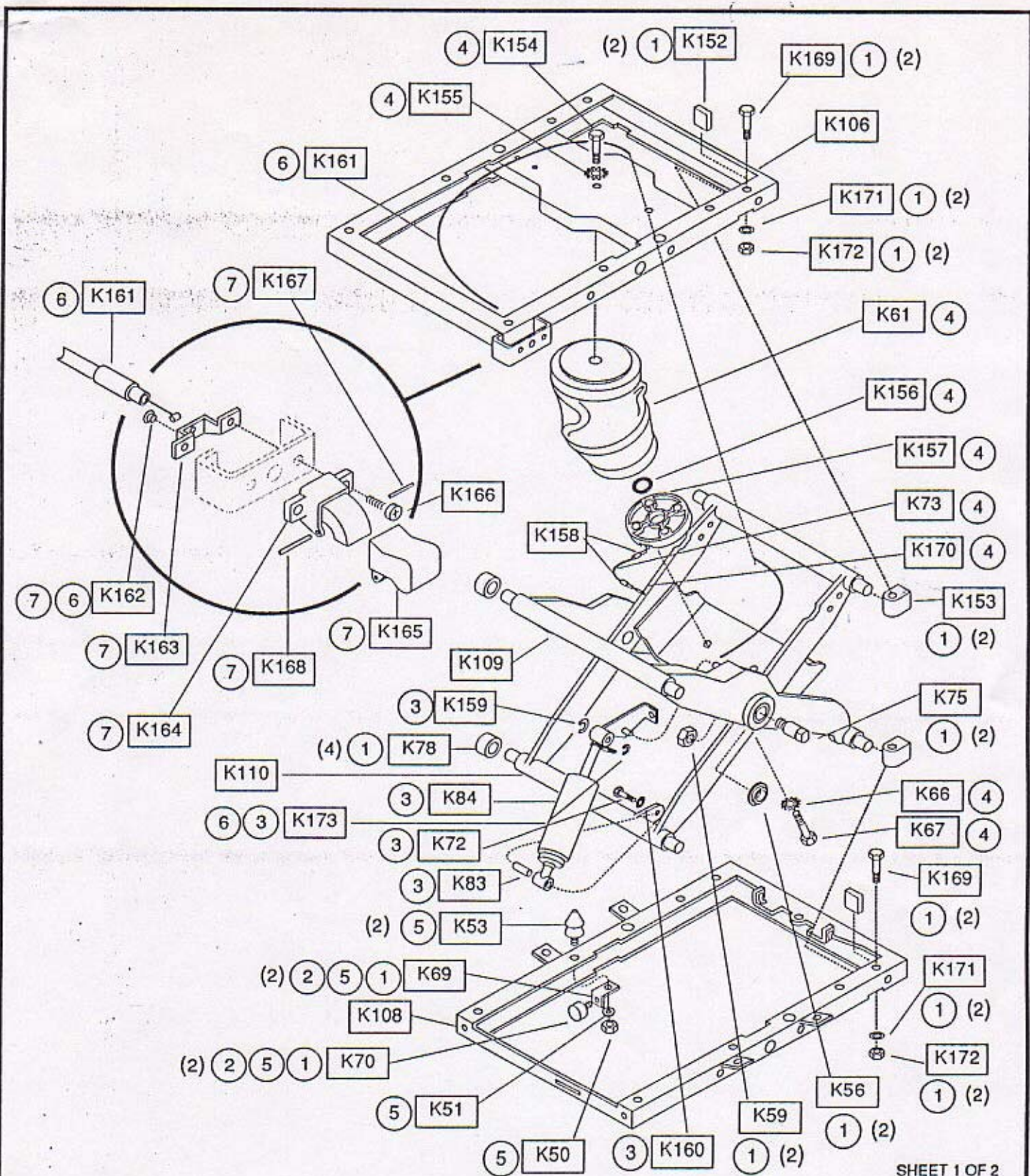
## SERVICE PARTS LIST

ISRI P/N: 17259-01 Description: Susp-Air  
ISRI Illus. No.: K-019  
Customer: Prevost Car Customer P/N:  
Specification: Manual air, 100 mm stroke, Adjustable shock

ILLUS NO.	DESCRIPTION	ISRI P/N	CUSTOMER P/N
K155	Washer-Air Spring Mtg-Upr	See K6	
K156	O-Ring (Air Spring)	See K6	
K158	Sleeve - Push on - PU3	* 44713-01	
K159	Ring-Retaining-Shock-Upr	See K5	
K160	Washer-Shock-Lwr	See K5	
K161	Cable - Adjustable Shock	See K19	
K162	Plug	See K19 or K20	
K163	Bracket - Cable/Handle Mtg	See K20	
K164	Housing - Adjustable Shock	See K20	
K165	Handle - Adjustable Shock	See K20	
K166	Screw (Adj Shock Housing)	See K20	
K167	Pin-Long (Shock Hdl Pivot)	See K20	
K168	Pin-short (Shock Cable)	See K20	
K169	Bolt - Bearing Block	See K2	
K170	Conn-Reducer-PU4/PU3	* 44436	
K171	Washer-Bearing Block	See K2	
K172	Nut-Bearing Block	See K2	
K173	Ring-Retaining (Shk Cable)	See K19	

\* PART OF KIT





SHEET 1 OF 2

 <b>ISRI</b> <sup>®</sup> ISRINGHAUSEN	5/92
	Susp Asm - Air    K-019

○ = KIT #  
 ( ) = QUANTITY



Kit No.	P/N	Item No. In Kit	Description
1	K2	K12, K56, K59, K75, K78, K152, K153, K169, K171, K172	Susp. HDW Kit
2	K3	K69, K70	Bumper/Bracket Assembly
3	K5	K72, K83, K84, K159, K160, K173	Shock Kit
4	K6	K61, K66, K67, K73, K154, K155, K156, K157, K170	Air Spring Kit
5	K12	K50, K51, K53	Bumper Kit

SHEET 2 OF 2

**ISRI**®   
 ISRINGHAUSEN

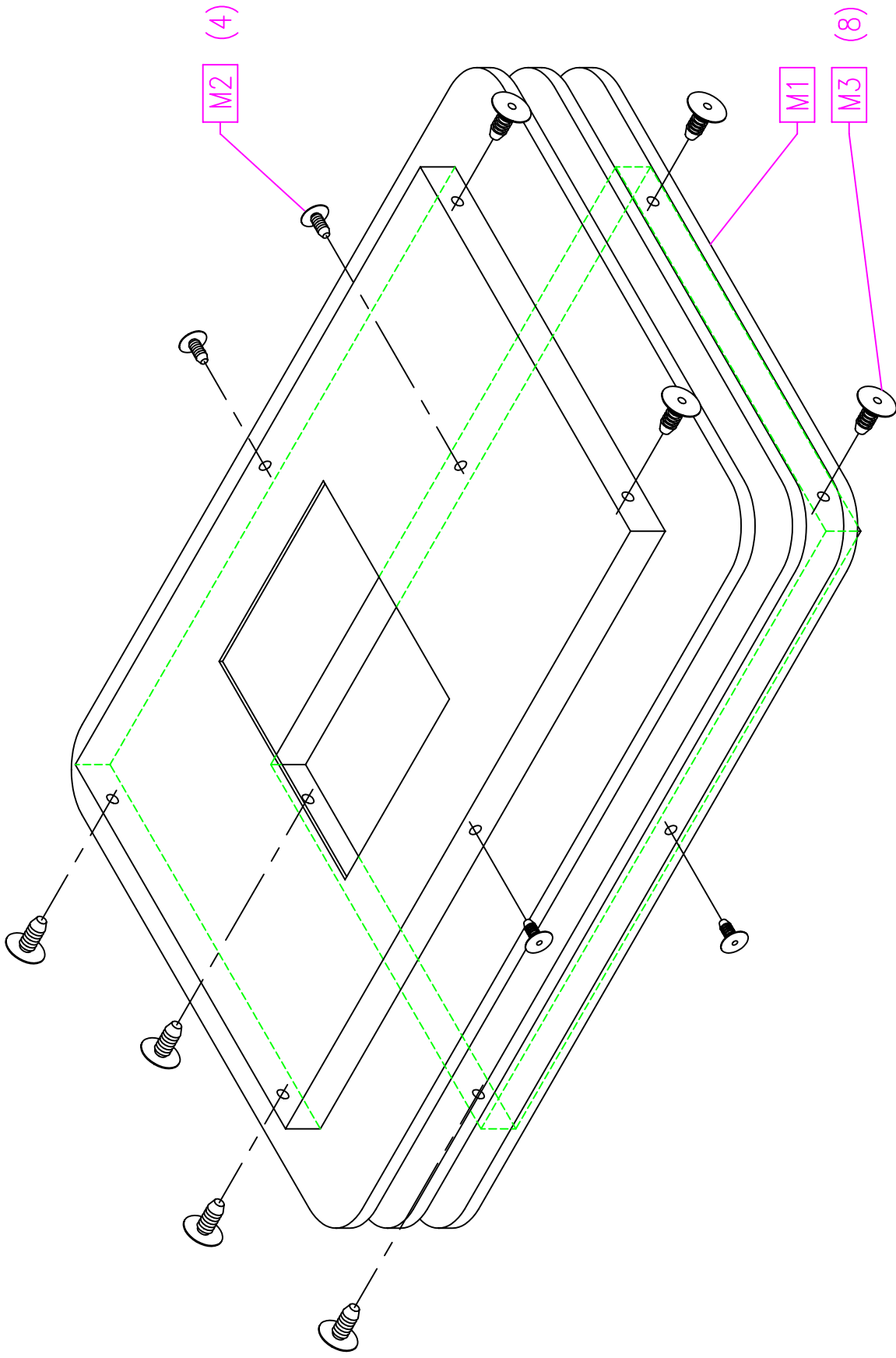
7/92

Susp Asm - Air

K-019







(X) = QUANTITY

**ISRI**<sup>®</sup>   
ISRINGHAUSEN

10/90

M-001

AIR SUSP BOOT KIT

# Sheffield Plastics Inc.

A  Bayer MaterialScience Company

119 Salisbury Road  
Sheffield, Massachusetts 01257  
TEL: 413.229.8711  
FAX: 413.229.8717  
www.sheffieldplastics.com

## Makrolon Cleaning Instructions

The Following techniques for cleaning Makrolon polycarbonate sheet are based on standard industry practice. To ensure acceptability of the results, always test a sample of the material with the cleaner and technique to be used.

### **Guidelines:**

**Do** rinse the sheet with warm water prior to cleaning process.

**Don't** use abrasives or high alkaline cleaners.

**Don't** leave cleaners on sheet for long periods, wash immediately.

**Don't** apply cleaners in direct sunlight or at elevated temperatures.

**Don't** use scrapers, squeegees or razors.

**Don't** clean with gasoline.

**Do** follow the application with a lukewarm water rinse.

### **Compatible Cleaners and Detergents:**

Formula 409<sup>1</sup>, Joy<sup>2</sup>, Windex with Ammonia D<sup>3</sup>, Palmolive<sup>4</sup>, Naphtha VM&P Grade, Isopropyl Alcohol

### **To Minimize Fine or Hairline Scratches:**

Plastic Polishes applied and removed per manufacturer instructions.

### **Suggested Polishes:**

Mirror Glaze Clear Plastic Polish, Cleaner & Detailer (by Meguiars 800-347-5700 or Meguiars.com)

Novus Plastics Polish #1, #2 (by Novus Inc. 800-NOVUS60 or noscratch.com)

Plexus Plastic Cleaner and Polish (by BTI Chemical Co. PlexusPlasticCleaner.com)

### **To Remove Masking Adhesive and Glazing Compound:**

Apply Naphtha VM&P grade, Kerosene or Isopropyl Alcohol with clean soft cloth. Wash immediately with soap and lukewarm water and rinse with thoroughly with clean water.

### **To Remove Graffiti:**

Naphtha VM&P grade, Isopropyl Alcohol or Butyl Cellosolve removes paint, marker ink. (Do not use in direct sunlight).

Isopropyl Alcohol, Naphtha VM&P grade or Kerosene will help lift stickers and other adhesive backed labels. Wash immediately with soap and lukewarm water and rinse with thoroughly with clean water.

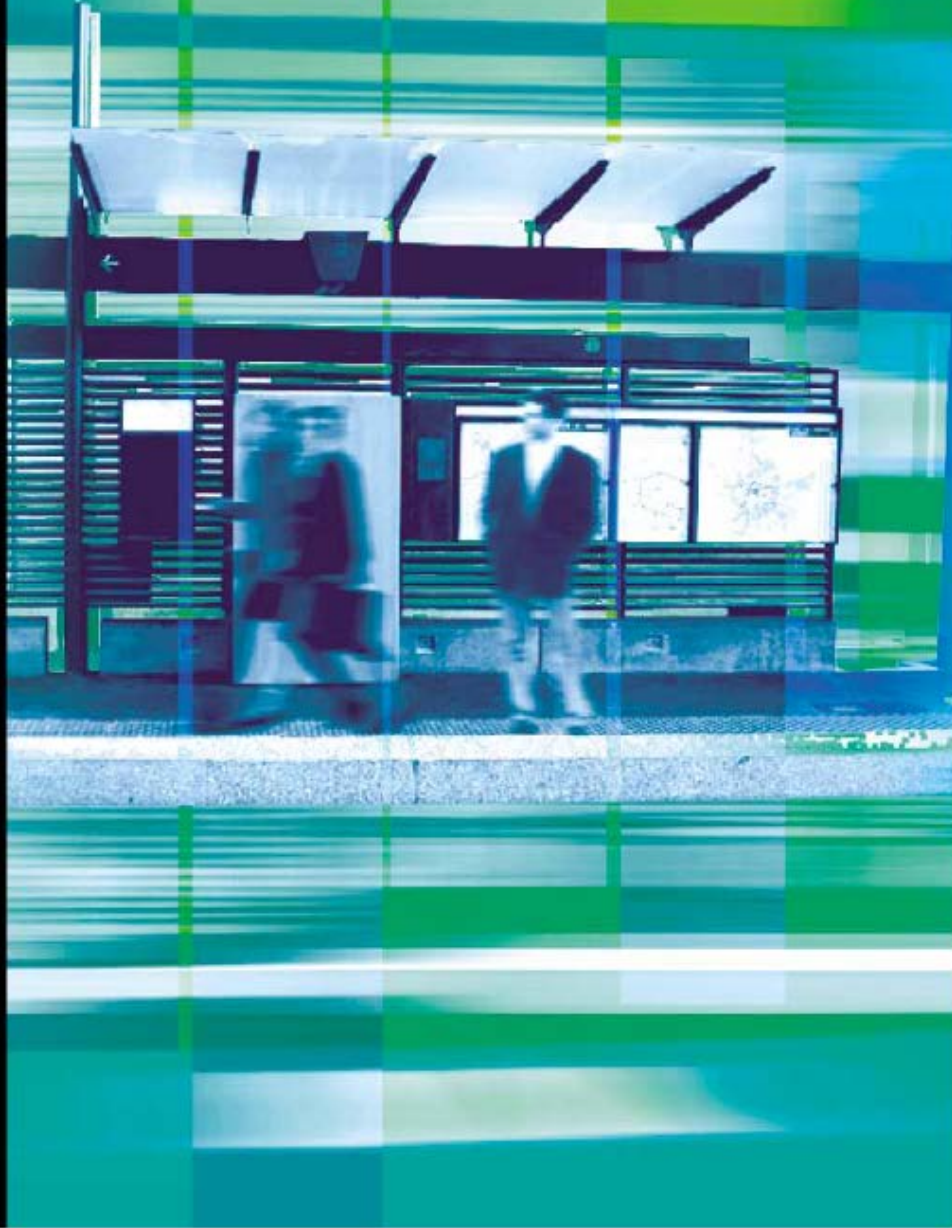
© Registered Trademarks of <sup>1</sup>Clorox, <sup>2</sup>Proctor&Gamble, <sup>3</sup>Drackett Products, <sup>4</sup>Colgate Palmolive

MAK\_Cleaning\_5-05



# TARABUS

CLEANING GUIDE



**Gerflor**  
Transport Floorings

TARABUS floor coverings are specifically designed to meet the requirements of the coach and transit bus industry such as durability, slip resistance, ease of cleaning and resistance to aggressive agents.

In common with all heavy duty floorings, they require correct and regular maintenance.

A cleaning procedure to meet your special needs is essential to ensure the optimum life span of the floor covering.



*TARABUS floor coverings are ideally suited to the specific constraints of the Transport sector and have been tested in thousands of vehicles all over the world !*



## REGULAR MAINTENANCE

- 1 Equipment :**
  - Broom or industrial vacuum cleaner
  - Damp mop
- 2 Procedure :**
  - Remove dust and loose debris with an industrial cleaner.
  - Mop the floor using clean water with 2 to 5% neutral detergent.
  - With a thoroughly rinsed mop, remop the floor using only clean water to remove all detergent residues
- 3 Frequency :**

daily or several times a week depending on the traffic.

## INTENSIVE MAINTENANCE

- 1 Equipment :**
  - Broom or industrial vacuum cleaner
  - Damp mop
  - Medium stiff bristled brush or broom
- 2 Procedure :**
  - Remove dust and loose debris with an industrial vacuum cleaner.
  - In case of grease/oil spots on the flooring, scrub the floor using a medium stiff bristled hand brush, a broom or an electric scrubber with alkaline detergent if required.
  - Detergent's dilution should be done according to manufacturer's instructions
  - Rinse with copious amounts of clean water to remove all detergent residues
  - Dry with a mop or a liquid vacuum cleaner.
- 3 Frequency :**

A minimum of once a month or more frequently



## DO NOT !

- 1 Use an electric scrubber with abrasive discs.
- 2 Use solvents.
- 3 Use industrial stain removers without first testing them on a small hidden area to prevent any damage.
- 4 Leave a detergent residue on the floor.
- 5 Apply a surface treatment.  
Wax or surface treatments **are not suitable** for bus floors as this will be detrimental to anti-slip properties.
- 6 Use a high pressure water jet.



*TARABUS is the easiest vinyl flooring on the market to clean !*

## DO !

- 1 TARABUS products are resistant to diluted acids and bases, with the obvious exception of PVC solvents
- 2 To remove stains, only use alcohol, "C oil" or recommended industrial spot removers such as :  
"Write Off" from Certified Laboratories\* or  
"Grafforange Bio" from MC2 CHIMIE-DERCAM\*.
- 3 Thoroughly rinse the floor with clean water.  
Remaining cleaning agents might affect the slip resistance properties of the floor.

\* List of local distributor available upon request.  
Please contact the local TARABUS sales representative.



## SPECIAL POINTS

- 1 **Chewing gum** can only be mechanically scraped off after chilling with a compressed nitrogen spray unit or specific orange oil gum remover
- 2 **Glue** can generally be removed with Mineral Spirit. Rinse immediately after with diluted detergent.
- 3 **Oil/grease** spots can be taken away by using an alkaline detergent, as can food stains such as **ketchup or sodas**.

## MANUFACTURERS

Colgate Palmolive Institutional Product Division	Diversey Lever Taski	Henkel Ecolab Ecolab
Toll free number : 800-432-8226 www.colpalipd.com	Toll free number : 800-831-9890 www.taski.com	Toll free number : 800-451-7191 www.ecolab.com

MAINTENANCE	pH
-------------	----

Stripping	Stripper	$\geq 12$
	Stripper(dry)	$> 10$

Cleaning	Spray Cleaner	8
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Detergent	Neutral Cleaning Agent	8.5 - 9
	Alkaline Cleaning Agent	$\geq 9$
	Cleaning Agent (removing rubber marks)	$\geq 12$
	Desinfectant/Detergent	10
	Cleaning Agent (heavy traffic)	4.5



# SECTION 22: HEATING AND AIR CONDITIONING

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**1. HEATING AND AIR CONDITIONING**

The coach's interior is pressurized by its Heating, Ventilation, and Air Conditioning (HVAC) system. Air flow and controls divide the vehicle in two areas: driver's area and passenger's (cabin) area. The interior of vehicle should always be slightly pressurized to prevent dust and moisture from entering vehicle. Each section has its own fresh air, returning air and discharge air ducting. The exhaust is mainly done through the lavatory ventilator and through normal air-tightness losses.

**2. AIR CIRCULATION WITH CENTRAL HVAC SYSTEM**

**2.1 DRIVER'S AREA**

Fresh air is taken from behind the R.H. side headlights assembly and enters the mixing box through an ON/OFF damper. Return 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 Operator's manual or Owner's manual).

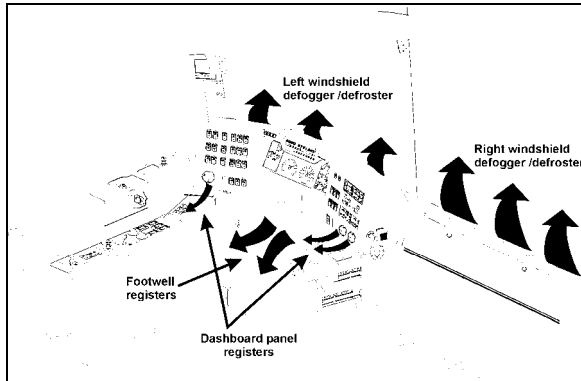


FIGURE 1: DRIVER'S UNIT AIR CIRCULATION 22291

**2.1.1 Coaches only**

Two additional air outlets are located in the front area but supplied by the passenger's (cabin) unit ducting system. One is located in the stepwell for step de-icing (Figure 2). The air flow outlet comes from the left side and is drawn from the first step riser. The other air outlet is located behind the driver, on his L.H. side. The air outlets can be rotated to direct Air flow.

Optionally, the coach may be equipped with a defogger/defroster system in the windshield upper-section, refer to paragraph: "Central Heating System" for more information.

**2.1.2 VIP only**

VIP vehicles equipped with the Central HVAC System have two additional registers called Navigator's registers located near the entrance door, at bottom of first lateral window.

**2.2 PASSENGER'S (CABIN) AREA**

Fresh air is taken from the left side of vehicle through a two-position damper located at the left of the evaporator compartment. The thermal control damper can be fully opened for normal operation or partially closed for extreme weather or highly polluted areas. The recirculation REC button is located on the HVAC control unit. Press down the button to partially close the fresh air damper.

***NOTE***

*Opening the entrance door also partially closes the fresh air damper.*

Return air is drawn through the first entrance step riser (coaches only), last entrance step riser and from the lower section of the floor ducts in two locations: one in the rear section of vehicle and the other in the front section of vehicle on the L.H. side (figure 2).

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 (upper section) along the walls, and finally exhausts it at the bottom of the windows.

On coaches, the Central HVAC system includes an overhead compartment ventilation system equipped with adjustable registers in the passenger's overhead console to control air flow for the passenger seats. Direct air flow by pointing or rotating register. Open or close register to adjust air flow (figure 3). Also on coaches, the lavatory ventilator acts as the main exhaust for the whole vehicle, eliminates odors, and finally heats or cools the lavatory with the vehicle's ambient air.

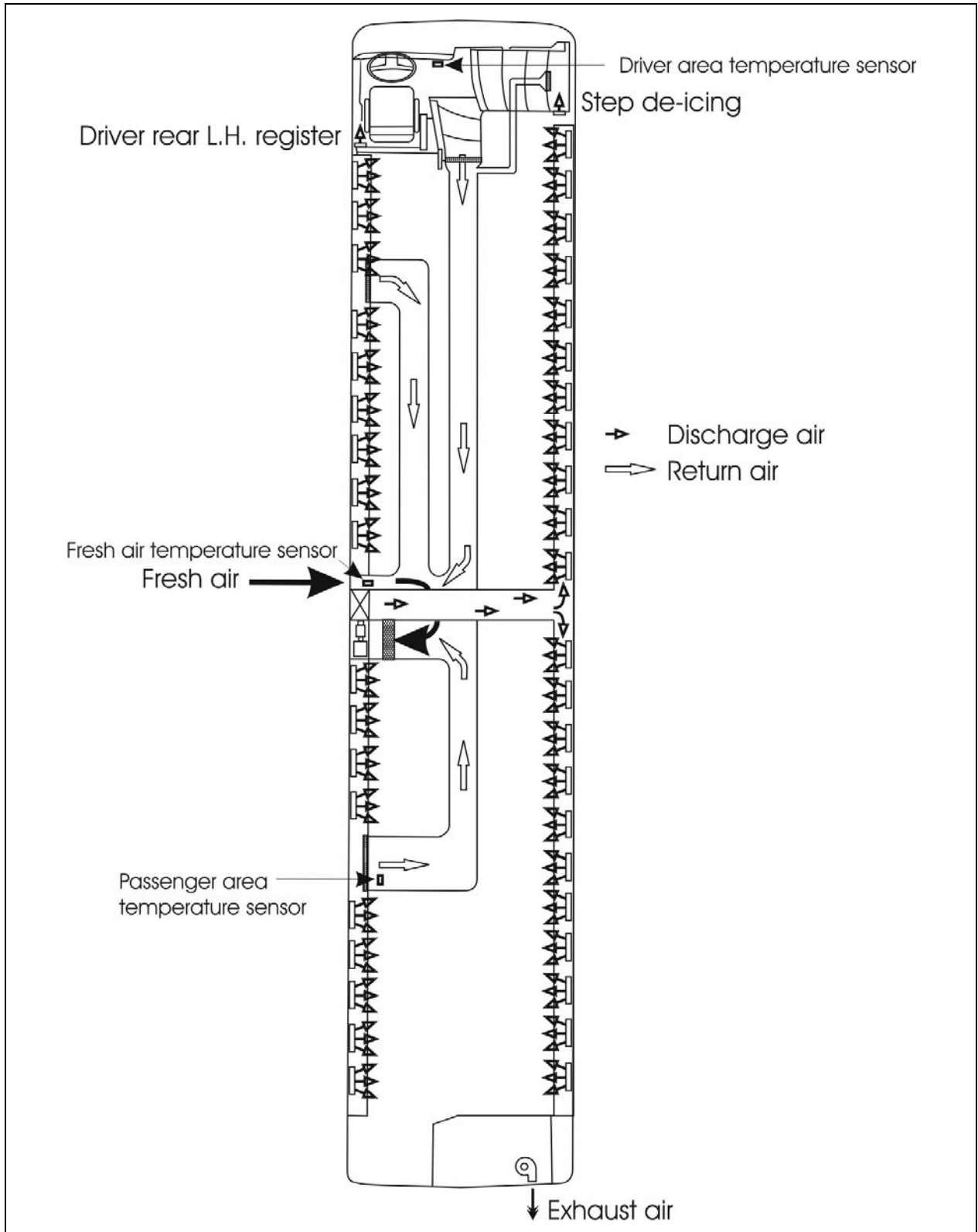


FIGURE 2: CENTRAL HVAC SYSTEM – PASSENGER'S UNIT AIR CIRCULATION (COACH)

22264

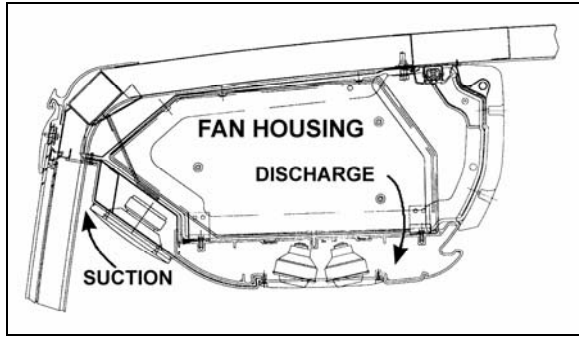


FIGURE 3: OVERHEAD COMPARTMENT VENTILATION SYSTEM 22211

### 3. AIR CIRCULATION WITH SMALL HVAC SYSTEM

Fresh air is taken from behind the R.H. side headlights assembly and enters the mixing box through an adjustable damper. Returning air is taken through the right console into the mixing box. The recirculation REC button is located on the HVAC control unit (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).

#### 3.1 AUXILIARY UNIT

VIP vehicles with small HVAC system are equipped with an auxiliary system that provides five additional registers. Three are located behind the driver's seat and the other two are located near the entrance door, at bottom of first lateral window. The auxiliary unit comes with cooling and heating coils, fan and discharge ducts.

### 4. SMALL HVAC SYSTEM OPERATION

#### 4.1 DRIVER'S UNIT OPERATION

The temperature control in the driver's area is provided directly by the HVAC control unit mounted on the dashboard R.H. side.

Using the Up/Down type switch sets the fan speed and the speed chosen is displayed on the HVAC control unit.

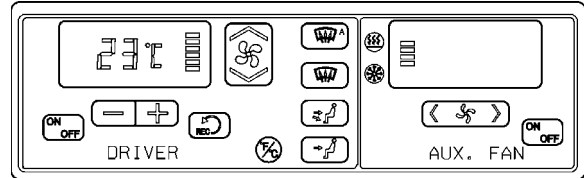


FIGURE 4: CONTROL UNIT - SMALL HVAC SYST. 22286

#### 4.2 AUXILIARY UNIT OPERATION

The temperature control is provided by the small system HVAC control unit. The R.H. portion of the HVAC control unit enables to actuate the Auxiliary Unit and to regulate the fan speed. Using the < > type switch sets the fan speed and the speed chosen is illustrated on the window display.

### 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

The temperature control in the driver's area is provided directly by the L.H. portion of the HVAC control unit.

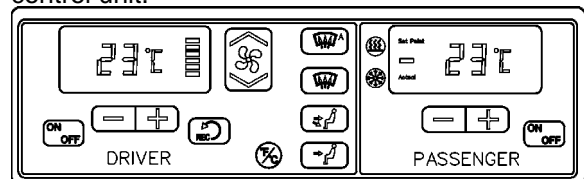


FIGURE 5: CONTROL UNIT - CENTRAL HVAC SYST 22276

The driver's unit piping is paralleled with the passenger's 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 passenger's unit to engage the A/C compressor magnetic clutch; consequently, the driver's unit cannot be operated alone in the air conditioning mode.

**NOTE**

*The driver's HVAC section turns on automatically at starting of the engine and uses the settings that were kept in memory before turning off of the system.*

The A/C compressor starts automatically when the two following conditions are satisfied:

## Section 22: HEATING AND AIR CONDITIONING

1. The outside temperature is above 32°F (0°C).
2. The passenger's area temperature has reached 7°F (4°C) under the set point.

### NOTE

Upon starting, if the outside temperature is above 32°F (0°C) and then drops below 32°F (0°C), the compressor will keep running up to a temperature of 15°F (-9°C) to prevent condensation from forming on the windows.

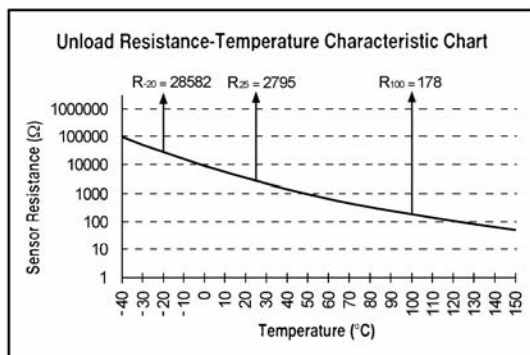
### NOTE

To perform a test of the driver's section windshield defroster, it is possible to run the system without running the engine.

The following table and 2% error chart can be used to troubleshoot the driver's area air temperature sensor and the two other temperature sensors (passenger's area and fresh air).

### NOTE

VIP vehicles equipped with Small HVAC System have two air temperature sensors; the driver's area temperature sensor (same place as coaches) and the exterior temperature sensor located behind the reclining bumper.



TEMPERATURE SENSOR		
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

Using the Up/Down type switch sets the fan speed and the speed chosen is illustrated on the window display.

## 5.2 PASSENGER'S UNIT

The passenger section of the HVAC control unit enables the selection of the temperature in the passenger's section (Refer to the VIP Owner's manual or H3 Operator's Manual for details).

Temperature control is provided in conjunction with a thermistor sensor located inside return duct, on L.H. side of vehicle (figure 2).

The flow of water to the passenger's unit heater core is controlled by a pneumatic water valve which varies the cycling rate depending on selected temperature. A red LED indicator, located on the HVAC control unit, illuminates when the heating mode is one. A green LED indicator illuminates when compressor clutch is in operation.

The evaporator motor is located in the evaporator compartment on the L.H. side of vehicle is protected by a 90 amp, with manual-reset (CB3) circuit breaker mounted in the main power compartment (refer to Section 06, "Electrical System" in this manual for details).



The condenser coil mounted on the opposite side of the evaporator is ventilated by four brushless axial fans. The fan motors are protected by a manual-reset 70 amp circuit breaker (CB 7) mounted in the main power compartment on rear R.H. side of vehicle (figure 6). Furthermore, the following relays, diodes and multiplex modules are located in the evaporator compartment (figure 7). They are mounted on the HVAC components panel located on the R.H. side wall when facing the compartment.

Multiplex Module (evaporator compartment)	
A54	I/O-B
Relays (evaporator compartment)	
R10	24V Condenser fans
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

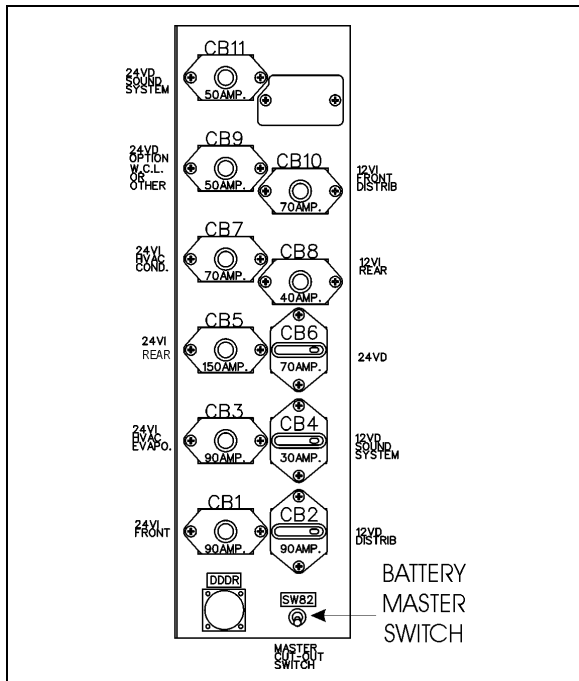


FIGURE 6: MAIN BREAKERS – SEATED COACH 06582A

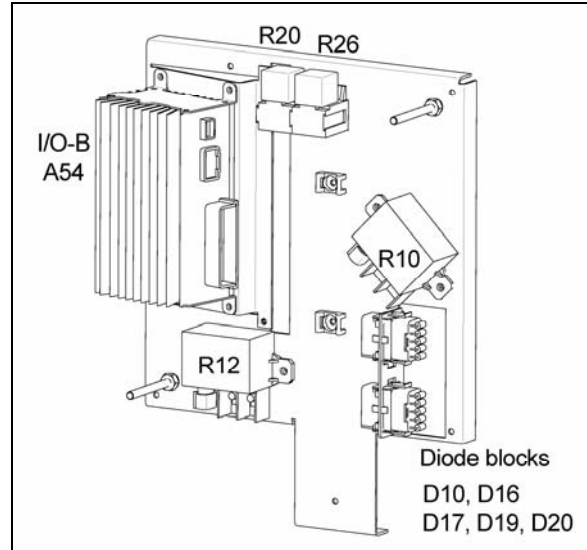


FIGURE 7: HVAC CONTROL PANEL 06596

### 5.3 OVERHEAD COMPARTMENT UNIT (H3 COACHES)

Optional evaporator coils may be added to both overhead compartment air systems. This air conditioning unit permits a wider temperature range in the passenger's area.

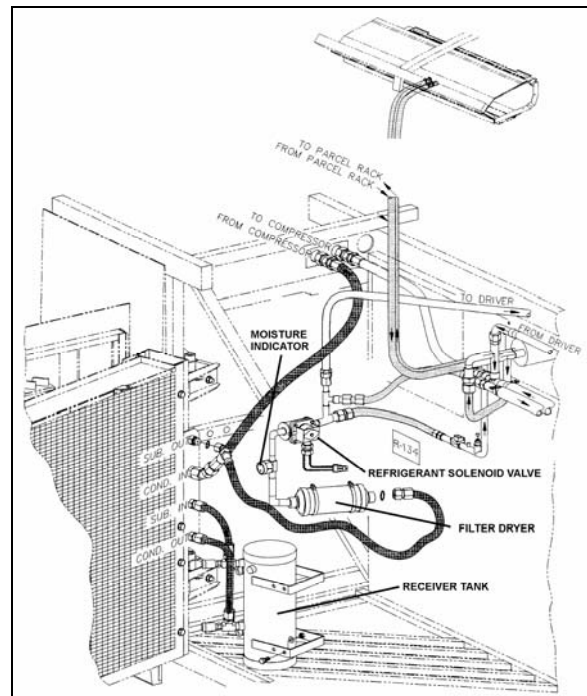


FIGURE 8: PASSENGER'S OVERHEAD COMPARTMENT UNIT 22221

### 6. HVAC UNIT MAINTENANCE

No special maintenance is required on the passenger's and driver's units, with the

## Section 22: HEATING AND AIR CONDITIONING

exception of cleaning their respective coil air filters.

### NOTE

*Squeeze rubber hose located under the concerned compartment, to eliminate 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 evaporator coil from inside (figure 14).

For the optional windshield upper section defogger/defroster, remove the bottom access panel, remove the six bolts fixing the blower motor assembly. Use low air pressure to clean the coil.



### MAINTENANCE

For the passenger's unit evaporator coil, back flush the coil (figure 9) every 12,500 miles (20 000 km) or once a year whichever comes first and for the condenser, back flush the coil (figure 11) every 6,250 miles (10 000 km) or twice a year, whichever comes first.

Use a water jet or water mixed with low air pressure to clean the coil.

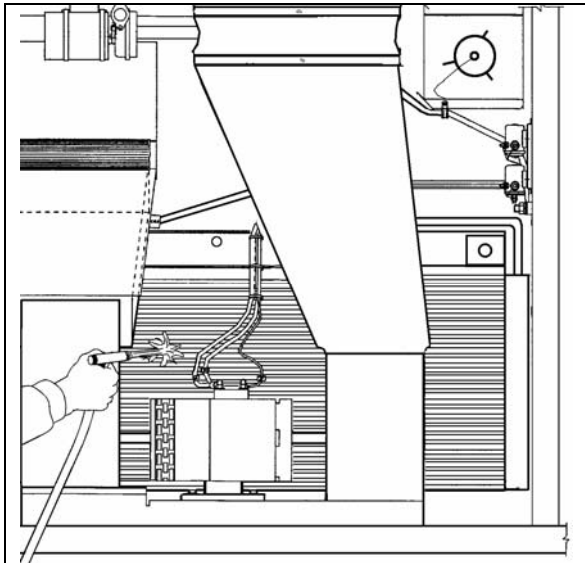


FIGURE 9: PASSENGER'S UNIT EVAPORATOR COIL 22226

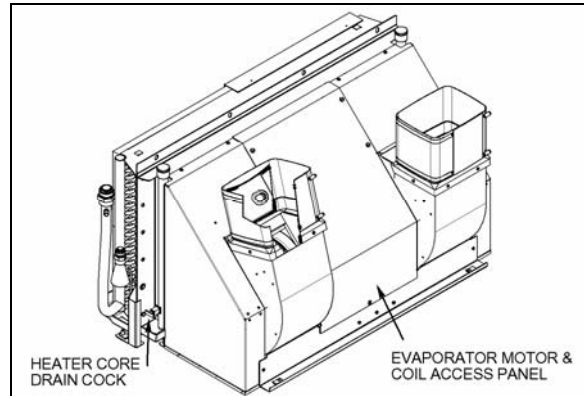


FIGURE 10: PASSENGER'S UNIT EVAPORATOR COIL (VIP WITH CENTRAL HVAC SYSTEM ONLY) 22332

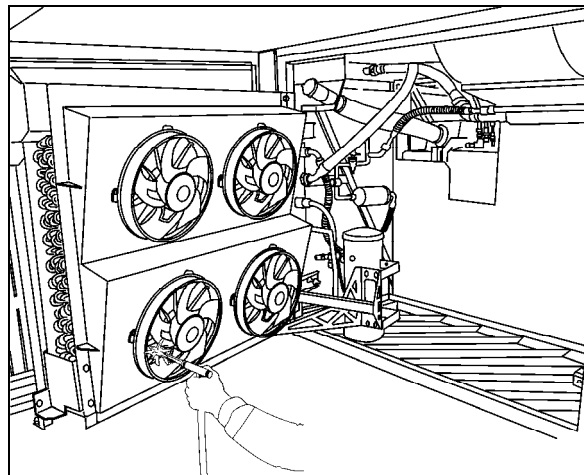


FIGURE 11: PASSENGER'S UNIT CONDENSER COIL 22362

### 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 AIR FILTERS

The driver's unit is located behind the R.H. console panel. To gain access to the air filters, unscrew the R.H. console's grill located in the entrance stepwell. Slide out the recirculating air filter.



### MAINTENANCE

To clean filter back flush with water, then dry with air, every 12,500 miles (20 000 km) or once a year, whichever comes first (Figure 12 to Figure 14).

The fresh air intake is located behind the R.H. side headlights assembly. Clean the steel wire screen as required.

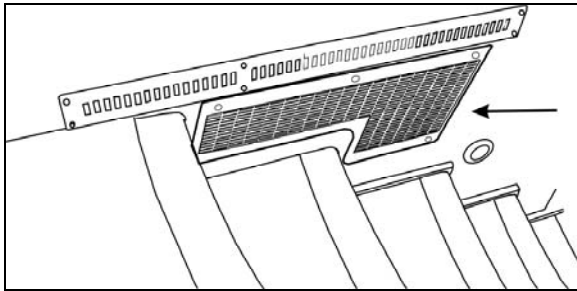


FIGURE 12: R.H CONSOLE AIR FILTER ACCESS GRILL (COACHES) 18505

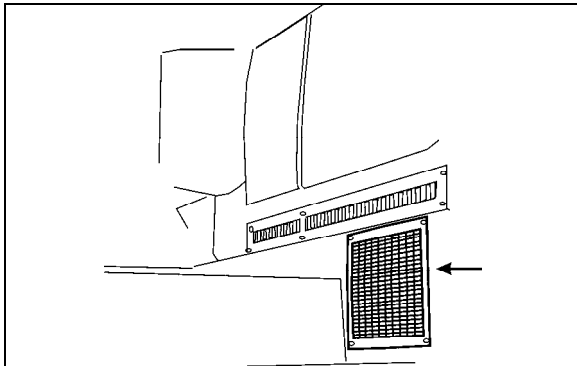


FIGURE 13: R.H. CONSOLE AIR FILTER ACCESS GRILL (VIP) 22232

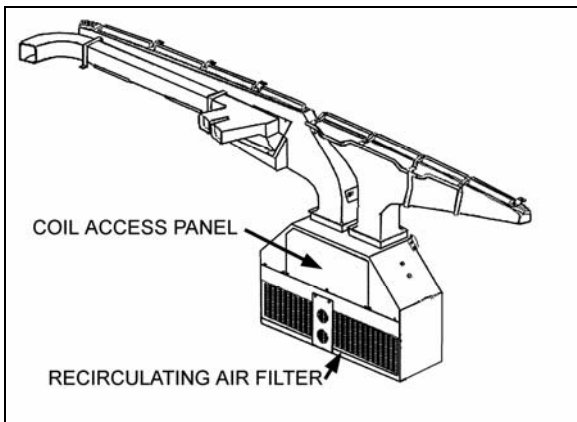


FIGURE 14: DRIVER'S UNIT AIR FILTERS 22171

### 6.3 PASSENGER'S UNIT AIR FILTER

The passenger's unit 2-part air filter is located in the evaporator compartment (figure 15). To access the filter, locate the access panel in the baggage compartment at the left of the evaporator compartment. Open panels by turning the three screws of either panel ¼ of a turn, unsnap both fasteners on top of filter, and slide out filter.



## MAINTENANCE

To clean filter, back flush with water or soapy water, then dry with air every 12,500 miles (20 000 km) or once a year, whichever comes first.

### ⚠ CAUTION ⚠

Do not use high pressure water jet to avoid damaging filter.

### ⚠ CAUTION ⚠

Be sure not to reverse filter upon installation.

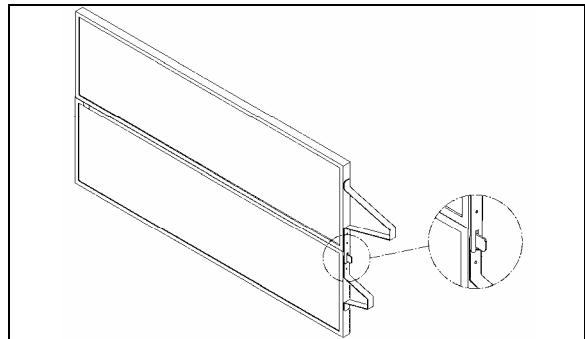


FIGURE 15: PASSENGER'S UNIT 2-PART AIR FILTER

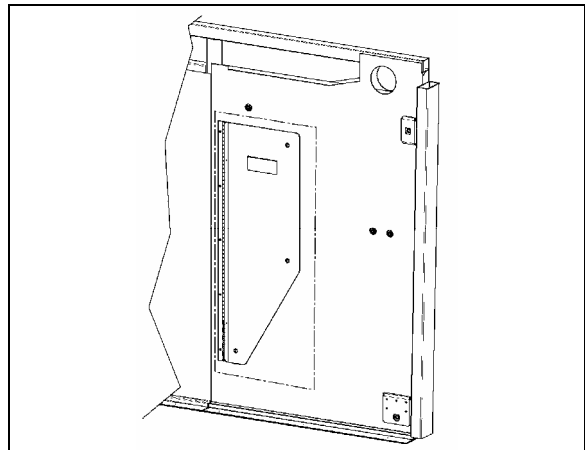

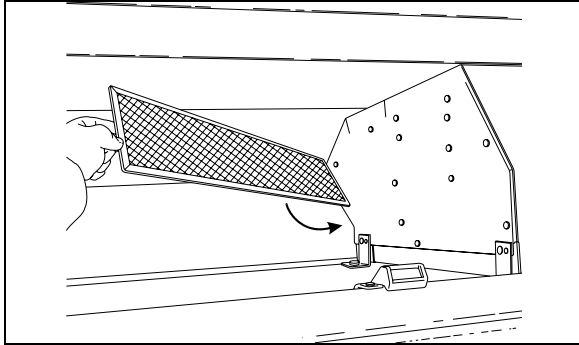


FIGURE 16: PASSENGER'S UNIT 2-PART AIR FILTER ACCESS PANEL

### 6.4 OVERHEAD COMPARTMENTS FAN AIR FILTER

Air conditioning evaporator coils may be installed in both overhead compartment air systems. Only the air filters are serviceable. The air filters are accessible from inside the overhead compartments (figure 17).

 <p><b>MAINTENANCE</b></p>
<p>Slide out the filters, then back flush with water, dry with air and replace. This procedure should be done every 12,500 miles (20,000 km) or once a year, whichever come first.</p>



**FIGURE 17: PARCEL RACK FAN AIR FILTER** 22201

For air conditioning unit, ball valves are added on supply and return lines in the condenser compartment. They have service port to evacuate the A/C parcel rack circuit. When work has to be done on an evaporator coil unit, it will be easier to remove it and repair it on a bench.

**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.

<i><b>NOTE</b></i>
<p><i>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.</i></p>

In test mode, with the parking brake applied and the passenger set point set to a value higher than 64°F (18°C), the hot water circulating pump is not set to OFF as it would normally do when the outside temperature gets above 50°F (10°C). This feature allows verification of the pump when inside a garage. This is also useful when working on the heating system to remove air pockets trapped in the system.

When performing an A/C cooling test and having the water pump shut off in switch/sensor test mode is required, just set the passenger set point temperature to the minimum 64°F (18°C) to shut off the pump.

**7.2 HVAC SYSTEM AND TEST MODE FOR ELECTRIC MOTORS**

The test mode allows testing the motors and electric contactors without the need to have the engine running (see Section 06: ELECTRICAL under "TEST MODE FOR ELECTRICAL MOTORS" for complete information).

Use this test mode for testing of the condenser motors, the A/C compressor clutch activation, left and right unloaders, evaporator motor, water pump, hot water solenoid valve and overhead compartment air register fans.

7.3 PARTICULARITIES

<p>Conditions for engaging the 2<sup>nd</sup> speed on the evaporator motor (cooling demand).</p>	<p>The 2<sup>nd</sup> speed engages if the passenger's area temperature is 1 degree above the set point and it revert to speed 1 if the temperature gets equal or below the set point.</p>
<p>Conditions for hot water recirculating pump activation (heating demand).</p>	<p>The pump turns to OFF if the outside temperature is above 50°F (10°C), when there is less demand for heating.</p> <p>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 5.2 HVAC SYSTEM AND TEST MODE FOR SWITCHES AND SENSORS.</p>
<p>The compressor unloaders are working based on pressure and also on the difference between the passenger's area temperature and the set point.</p>	<p><b>2 left compressor cylinders:</b></p> <p>Stop if: Passenger's area temperature is at less than 0.4°C degree above the set point or if the compressor output is above 280 psi, or if the compressor input is below 26 psi.</p> <p>Restart if: Passenger's area temperature is 0.9°C or more above the set point and the compressor pressure output is less than 220 psi and the compressor pressure input is above 34 psi.</p> <p><b>2 right compressor cylinders:</b></p> <p>Stop if: Passenger's area temperature is at less than 0.2°C above the set point or if the compressor input falls below 23 psi.</p> <p>Restart if: Passenger's area temperature is 0.7°C or more above the set point and the compressor input pressure is above 32 psi.</p>
<p>The A/C deactivation pressure is 320 psi.</p>	<p>In case of high pressure, the analog pressure sensor connected to the Multiplex module deactivates the compressor.</p> <p>There is also a « Pressure switch » adjusted to 350 PSI that acts to stop the compressor in the instance that the Multiplex module fails.</p>

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### 7.4 HVAC SYSTEM TROUBLESHOOTING

Problem/Symptom	Probable Causes	Actions
No temperature control in the passenger area  Passenger temperature display indicates two dashes "--"	Problem with the temperature sensor located in the passenger's area return air duct or the sensor wiring	1. Instruct the driver to manually control the temperature by playing with the passenger set point. Set above 22°C (72°F) to heat and below 22° C (72°F) to cool
Defroster fan not functioning	Module A47 is not powered or is faulty	1. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message "Voltage Module A47, Value too Low, Active" confirms a power problem on the module  2. Check / reset circuit breaker CB6  3. Check / replace fuse F5  4. Use the air release valves near the entrance door and in the front service compartment to lock / unlock the door
HVAC condenser fans not functioning in speed 1	Circuit breaker CB7 was manually tripped and not reset  Seized bearing  Bad wiring	1. Check / reset circuit breaker CB7
HVAC condenser fans not functioning in speed 1	Circuit breaker CB7 was manually tripped and not reset  Module A53 is faulty	1. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message "Voltage Module A53, Value too Low, Active" confirms a power problem on the module  2. Check / reset circuit breaker CB7
HVAC condenser fans not functioning in speed 2	Circuit breaker CB7 was manually tripped and not reset  Module A53 is not powered or is faulty  Seized bearing  Bad wiring	1. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message "Voltage Module A53, Value too Low, Active" confirms a power problem on the module  2. Check / reset circuit breaker CB7
Defroster fan is functioning but no heat or cooling available in the driver area	Module A46 is not powered or is faulty  Faulty speed control  Bad wiring	1. Check the SYSTEM DIAGNOSTIC menu of the message center display (MCD). Select FAULT DIAGNOSTIC and ELECTRICAL SYSTEM. The message "Voltage Module A46, Value too Low, Active" confirms a power problem on the module  2. Check / reset circuit breaker CB1  3. Check / replace fuse F12

Problem/Symptom	Probable Causes	Actions
The A/C compressor clutch does not engage	Module A52 is not powered or is faulty	<ol style="list-style-type: none"> <li>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</li> <li>2. Check / reset circuit breaker CB5</li> <li>3. Check / replace fuse F65</li> </ol>
Evaporator fan not functioning	Circuit breaker CB3 tripped  Module A54 is not powered or is faulty  Brush problem	<ol style="list-style-type: none"> <li>1. Check / reset circuit breaker CB3</li> <li>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</li> <li>3. Check / reset circuit breaker CB5</li> <li>4. Check / replace fuse F67 , F68</li> </ol>

## 8. CENTRAL HVAC SYSTEM - AIR CONDITIONING

The schematic of figure 18 shows the central A/C system and its components. The central system is equipped with a 6 cylinder, 05G Twin Port-134A Carrier compressor with an air conditioning capacity of 9 tons. The receiver tank and filter dryer are mounted inside the condenser compartment.

### NOTE

*For opening of the A/C condenser door, open the baggage compartment door at the right of the A/C condenser compartment door. The condenser compartment door must be unbolted to fully swing open.*

### 8.1 A/C CYCLE

Refrigeration may be defined as "the transfer of heat from a place where it is not wanted to a place where it is unobjectionable". Components required for a closed circuit refrigeration system are shown in Figure 18.

The air conditioning system used in the H3 series vehicle is the "Closed" type using R134a refrigerant.

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 passenger's and driver's unit evaporator coils which absorb 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<sup>2</sup> (5162 mm<sup>2</sup>) 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 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.

#### **WARNING**

**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 25 pounds (11,4 kg) are used in the central 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.

All refrigerant cylinders are shipped with a heavy metal screw cap. The purpose of the cap is to protect the valve and safety plug from damage.

It is a good practice to replace the cap after each use of the cylinder for the same reason. If the cylinder is exposed to the sun's radiant heat pressure increase resulting may cause release of the safety plug or the cylinder may burst.

For the same reason, the refrigerant cylinder should never be subjected to excessive temperature when charging a system. The refrigerant cylinder should be heated for charging purposes by placing it in 125°F (52°C) water. Never heat above 125°F (52°C) or use a blowtorch, radiator, or stove to heat the cylinder.

Welding or steam cleaning on or near any refrigerant line or components of the A/C system could build up dangerous and damaging pressures in the system.

If a small cylinder is ever filled from a large one, never fill the cylinder completely. Space should always be allowed above the liquid for expansion. Weighing cylinders before and during the transfer will determine the fullness of the cylinders.

#### **WARNING**

**One of the most important precautions when handling refrigerant consists in protecting the eyes. Any liquid refrigerant which may accidentally escape is approximately -40°F (-40°C). If refrigerant comes in contact with the eyes, serious injury could result. Always wear goggles to protect the eyes when opening refrigerant connections.**

#### 8.2.3 Treatment in Case of Injury

If liquid refrigerant comes in contact with the skin, treat the injury as if the skin was frost-bitten or frozen. If liquid refrigerant comes in contact with the eyes, consult an eye specialist or doctor immediately. Give the following first aid treatment:

1. Do not rub the eyes. Splash eyes with cold water to gradually bring the temperature above the freezing point.
2. Apply drops of sterile mineral oil (obtainable at any drugstore) in the eyes to reduce the possibility of infection. The mineral oil will also help in absorbing the refrigerant.



### 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.
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 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 cleanout procedures mentioned.

#### 8.3.1 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.

#### 8.3.2 Clean-out after Minor Compressor Failure

1. Be sure to correct the problem which caused the failure.
2. Change liquid line filter dryer.

## Section 22: HEATING AND AIR CONDITIONING

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.

### 8.3.3 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 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.

### 8.4 PUMPING DOWN

This procedure is intended to reduce refrigerant loss 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.*

#### **△ WARNING △**

**When air conditioning system must be opened, refer to previous paragraph "Precautions In Handling Refrigerant" to prevent any injury.**

#### *NOTE*

*To ease purging and refilling of refrigerant, it is possible to open the passenger's and overhead compartment system liquid solenoid valves. To do so, connect both male and female connector housing of C24 together for the passenger's area (located in evaporator compartment). During normal use, both male and female housings of connector C24 are kept unplugged. They are connected only for refrigerant refilling and pumping down procedure.*

### Procedure

1. Open the solenoid valves by connecting both male and female connector housing of C24 together.
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).
4. Start the engine, press the "Passenger ON/OFF" switch then the A/C switch, and adjust "A/C Temperature" control to maximum A/C.
5. Run the compressor until pressure reaches 1-2 psi (7-14 kPa).

<i>NOTE</i>
<i>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.</i>

- |   |
|---|
| <i>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.</i> |
|---|
5. Stop engine, and close compressor outlet valve by turning it clockwise until valve is properly seated.
  6. Close compressor suction valve by turning it clockwise until it is properly seated.
  7. 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. Connect the "Low Pressure Switch" connector and disconnect C24.

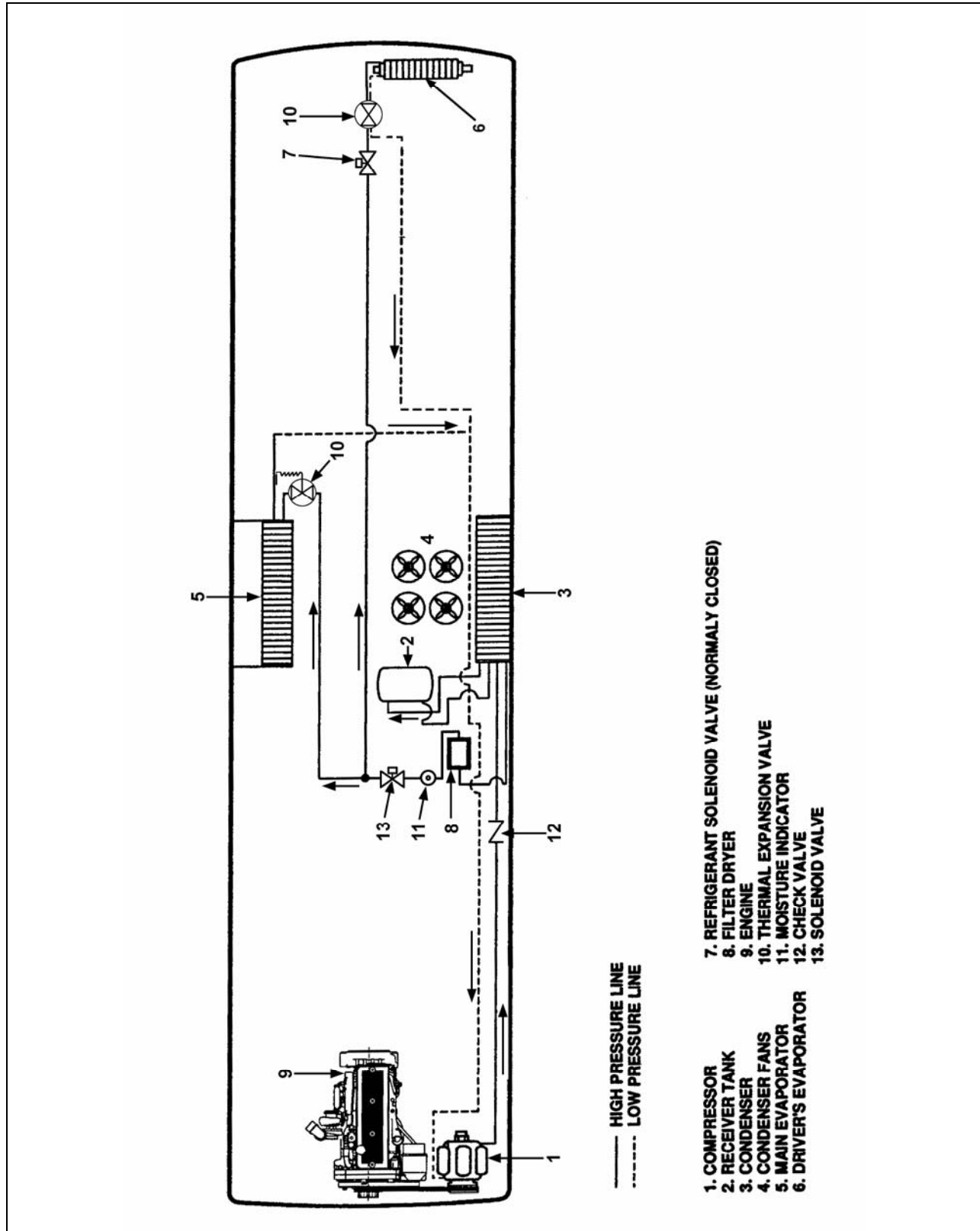


FIGURE 18: CENTRAL HVAC SYSTEM – AIR CONDITIONING

22220

8.5 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. Fill liquid refrigerant at the receiver tank and completely charge, if necessary, using previous procedure.

8.6 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 valves by connecting together both male and female connector housing of C24 (located in evaporator compartment) and C44 (located on the ceiling of the spare wheel compartment).
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.

8.6.1 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 Twin Port 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.*

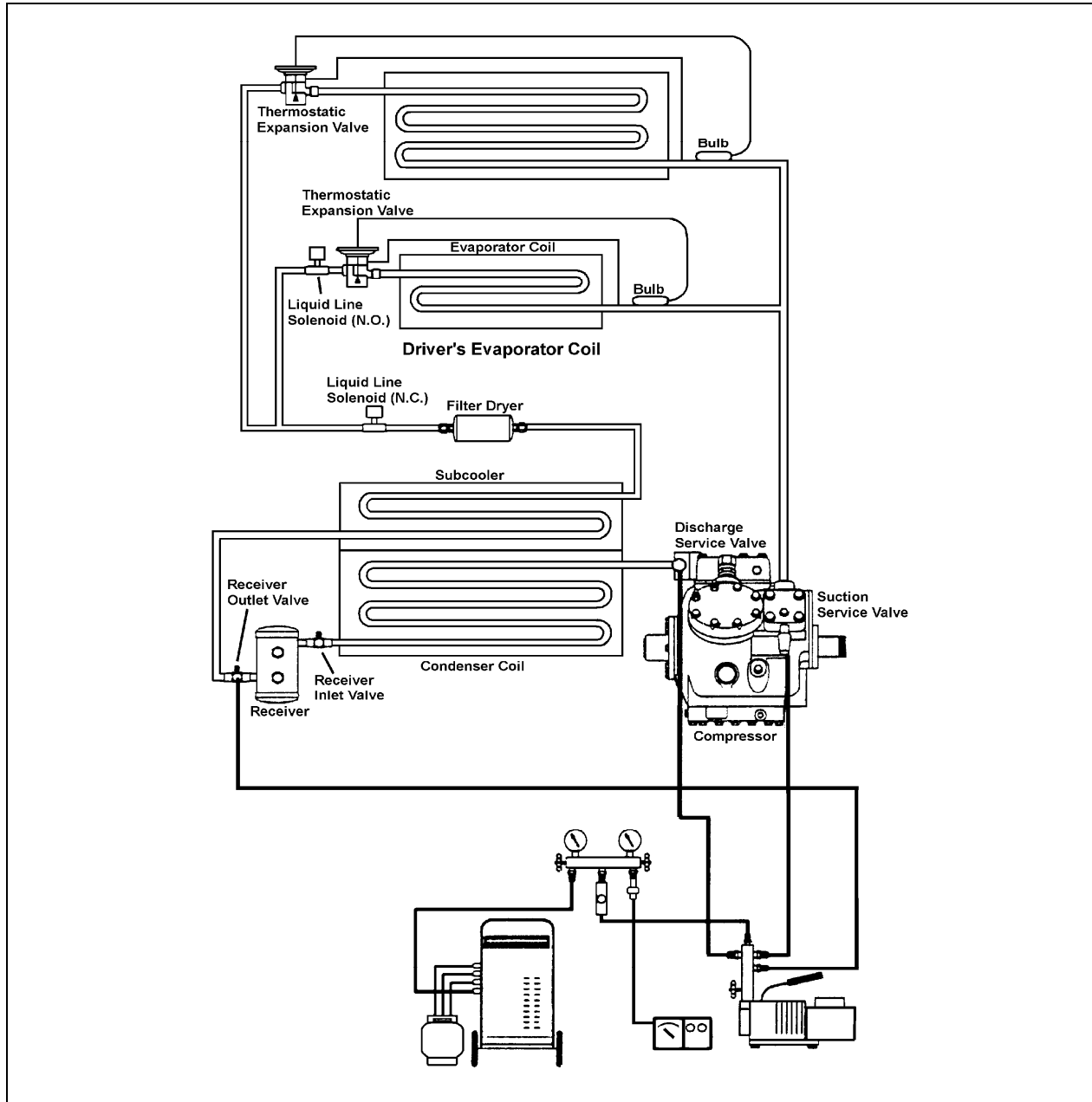


FIGURE 19: DOUBLE SWEEP EVACUATION SET-UP

### 8.7 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.

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.

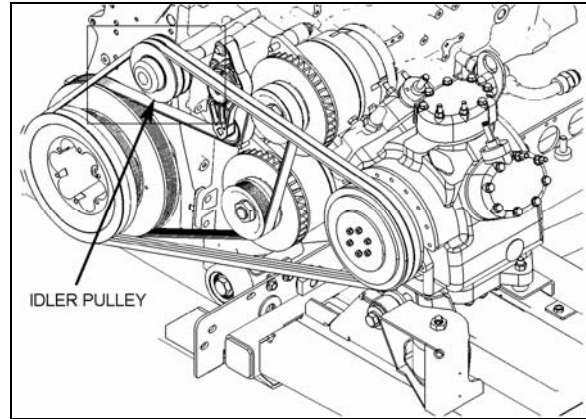


FIGURE 21: BELT LAYOUT WITH VOLVO D13

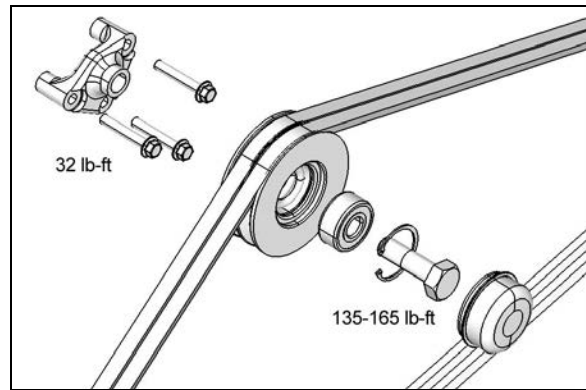


FIGURE 22: IDLER PULLEY ON VOLVO D13 INSTALLATION

**⚠ CAUTION ⚠**

The evacuation of the system must be made by authorized and qualified personnel only. Refer to local laws for R-134a recuperation.

**⚠ WARNING ⚠**

Set the main battery disconnect switch to the "Off" position. For greater safety, set the engine starter selector switch in engine compartment to the "Off" position.

## 9. CENTRAL HVAC SYSTEM – AIR CONDITIONING COMPONENTS

### 9.1 COMPRESSOR

#### 9.1.1 Belt Replacement

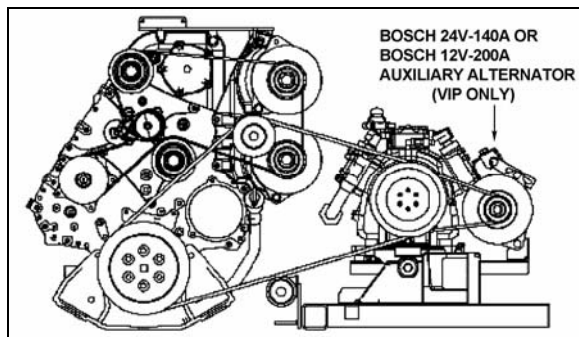


FIGURE 20: BELT LAYOUT (VIP WITH DDC S60 ENGINE SHOWN)  
22342

1. Open engine compartment rear doors and locate the belt tensioner two-way control valve (figure 23), mounted above the A/C compressor, then turn handle counterclockwise in order to release pressure and tension on belts.
2. Remove the radiator fan drive belt (refer to Section 05 COOLING).
3. Slip the old compressor belts off and the new ones on.
4. Reset belt tensioning pressure control valve (figure 23). Pressure is factory set to 45 psi (310 kPa), periodically check proper pressure.

### NOTE

Both belts must always be replaced simultaneously to ensure an equal distribution of load on each of them.

### NOTE

Belts specifications may vary. For proper belt selection, always consult your vehicle Coach Final Record.

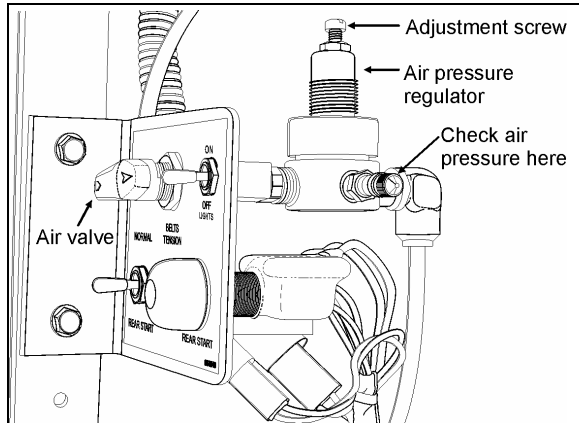


FIGURE 23: TENSIONING VALVE

01058

### 9.1.2 Belt Play

After belt replacement or during normal maintenance, belt play between idlers and belt must be checked to ensure proper operation. Refer to figure 25 for proper plays.

### 9.1.3 Pulley Alignment

In order to avoid skipping, disengagement and a premature wear of compressor belt, it is necessary to align compressor pulley with the crankshaft pulley. Before performing the following procedure, release air from belt tensioner bellows by means of the two-way control valve. After completing these procedures, reset belt tensioning pressure control valve to 45 psi (310 kPa).

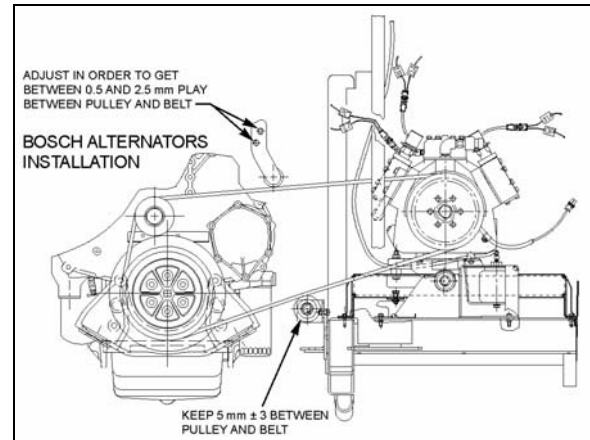


FIGURE 24: BELT PLAY (H3 COACH SHOWN)

### 9.1.4 Longitudinal Compressor Alignment

1. Rest an extremity of a straight edge of approximately 46 inches (117 cm) against the upper part of the outer face of crankshaft pulley, positioning the other end close to the compressor clutch pulley (figure 25 & 26).
2. Check the distance between each extremity of straight edge (1, figure 25) and the first drive belt. If they are different, loosen the compressor support bolts and with a hammer, knock support to slide it in order to obtain the same distance; then tighten bolts.

### 9.1.5 Horizontal Compressor Alignment

1. Rest an extremity of the straight edge against the upper part of the outer face of compressor pulley, positioning the other end close to the crankshaft pulley.
2. Check the distance between each extremity of straight edge (1, figure 25) 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.

### 9.1.6 Vertical Compressor Alignment

Rest a short "angle and level indicator" on the outer side face of the crankshaft pulley, adjust the level indicator inclination at 0° and check if the compressor pulley is at same angle (figure 25 & figure 26). If it is not the same, shim under the appropriate pillow block in order to obtain the correct angle.



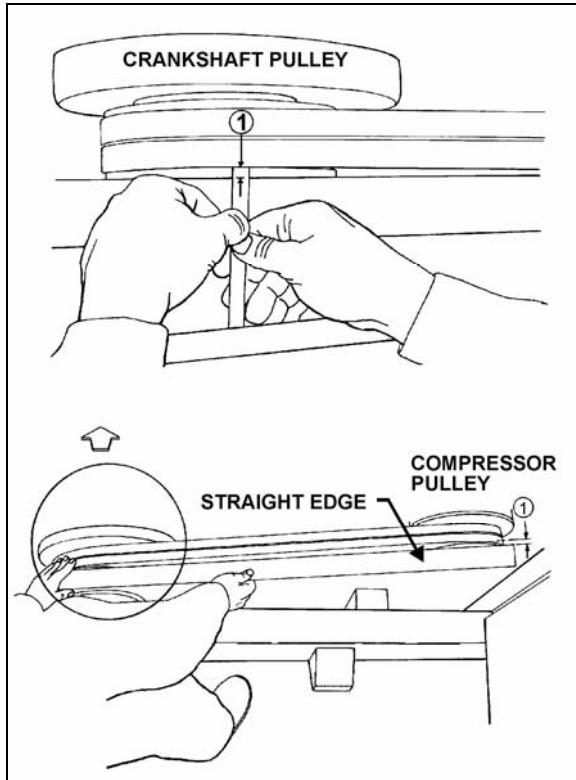


FIGURE 25: COMPRESSOR ALIGNMENT 22040

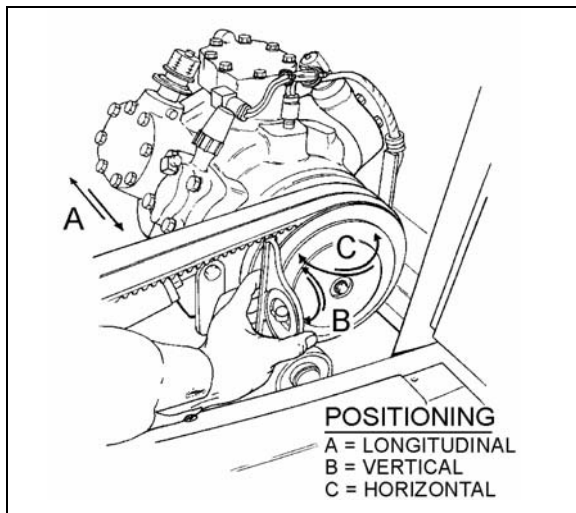


FIGURE 26: COMPRESSOR ALIGNMENT 22072

9.1.7 Compressor Maintenance

For the maintenance of the A/C compressor, see the “Carrier Compressor Operation and Service Manual” included at the end of this section.

**⚠ CAUTION ⚠**

**Use only Castrol SW 68 (POE) oils with refrigerant 134a.**

9.1.8 Troubleshooting Guide

A preliminary check may be made by simply feeling the cylinder heads with the unit in operation at ambient temperatures of 35 °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.


#### 9.2.1 HVAC Control Unit and Clutch Operation


The A/C compressor starts automatically when the two following conditions are satisfied:

1. The outside temperature is above 30°F (-1°C).
2. The passenger's area temperature has reached 7°F (4°C) under the set point.

#### NOTE

*Upon starting, if the outside temperature is above 30°F (-1°C) and then drops below 30°F (-1°C), the compressor will keep running up to a temperature of 15°F (-9°C) to prevent condensation from forming on the windows.*

When A/C compressor clutch engages, the corresponding A/C ON indicator LED  turns on.

The A/C ON indicator LED  will also turn off and the clutch will disengage if a low pressure (5 psi cut-out, 30 psi cut-in) or a high pressure (350 psi cut-out, 245 psi cut-in) condition is present.

### 9.3 BRUSHLESS EVAPORATOR MOTOR

The brushless evaporator motor is installed in the evaporator compartment (L.H. side of vehicle) (figure 27). It is a 27.5 volt, 2HP (1,5 kW) motor which activates a double blower fan unit.

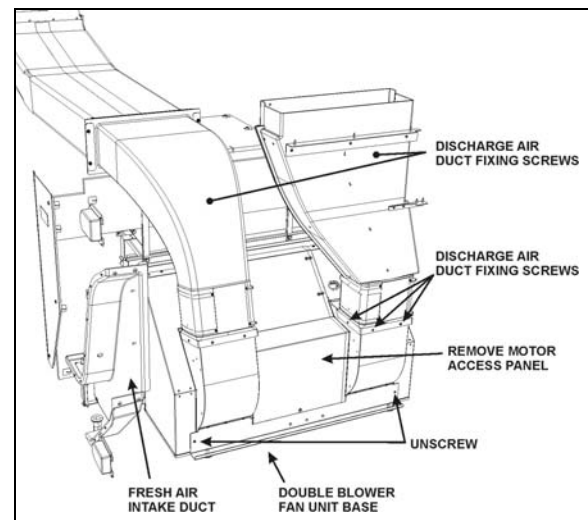


FIGURE 27: EVAPORATOR COMPARTMENT

#### 9.3.1 Removal

1. Set the battery safety switch to the "OFF" position.
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. Identify the discharge ducts inside compartment and remove the Phillips head screws fixing the air duct to blower fan unit.

4. Remove the motor access panel.
5. Disconnect electrical motor speed control wire (white wire, circuit 2F), power cable and ground cable from motor terminals.
6. From under the vehicle, remove the eight bolts fixing the double blower fan unit base. Remove the complete unit from the evaporator compartment (figure 28).

**⚠ CAUTION ⚠**

**Never support evaporator motor assembly by its output shafts while moving it. Always use double blower fan unit base.**

7. Install the complete unit on a work bench, unfasten the fan square head set screws, the Phillips head screws retaining cages to base and slide out the assemblies from the evaporator motor output shaft.
8. Remove motor from double blower fan unit base.

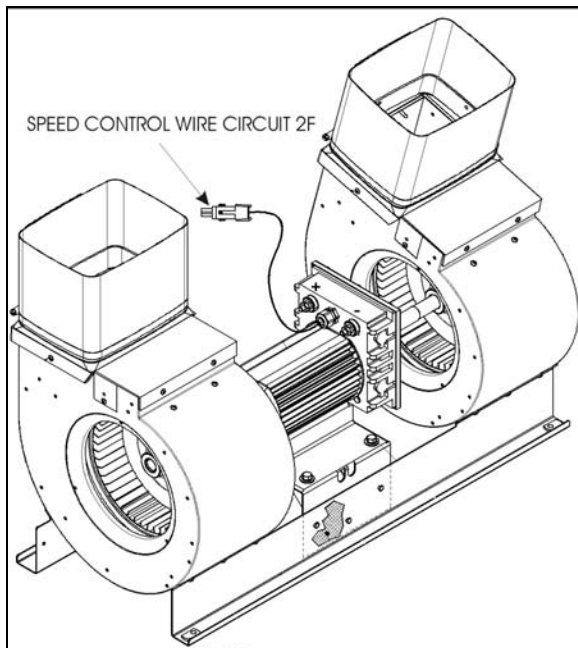


FIGURE 28: EVAPORATOR MOTOR ASSEMBLY

### 9.3.2 Installation

To reinstall the evaporator motor, reverse "Evaporator Motor Removal" procedure.

## 9.4 CONDENSER

The central A/C system condenser coil is hinge mounted on the R.H. side of the vehicle on the condenser compartment door. Since condenser's purpose is to dissipate heat from

the hot refrigerant, it is important to keep the cooling coils and fins clean. A clogged coil will cause high discharge pressure and insufficient cooling.

### 9.4.1 Condenser Fan Motors

Four brushless fan motors are installed in condenser compartment on R.H. side of vehicle in order to ventilate the condenser coil. The fans pull outside air through the condenser coil and discharge it through an opening at bottom of compartment. Depending on pressure in receiver tank (figure 31), the fan motors may be operated at full speed, half speed or not operated at all. With low pressure in receiver tank, fan motors operate at half speed and, with a high pressure in receiver tank, fan motors operate at full speed. Removing 24-volt applied to terminal 5-LOW will reduce fan speed to half speed, applying 24-volt to terminal 5-LOW engages full speed. For details about electrical wiring, refer to "A/C and Heat system" in the master wiring diagram.

**NOTE**

During normal conditions, fan motors function according to the following specifications:

Half speed: 3100cfm, 5.8A at 28 VDC

Full speed: 6200cfm, 37A at 28 VDC

Fan motor speed: 2950 rpm at full speed

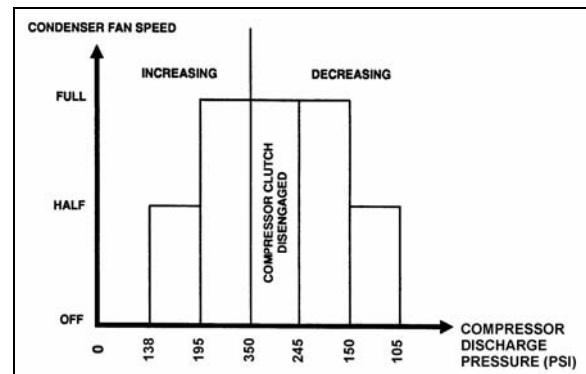


FIGURE 29: CONDENSER FAN SPEED IN RELATION WITH HIGH SIDE PRESSURE

22041

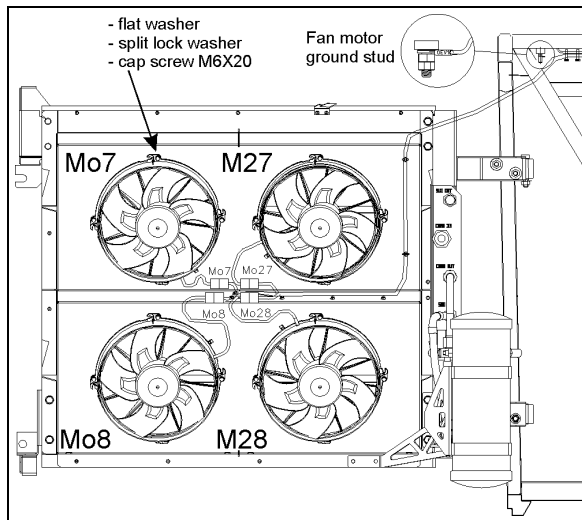


FIGURE 30: CONDENSER FANS

22363

### 9.4.2 Condenser Fan Motor Removal

1. Set the main battery disconnect switch to the "Off" position.
2. Unplug the fan motor harness connector.
3. Remove the four hexagonal head cap screws retaining the fan motor assembly to the shroud.
4. Remove the motor.

### 9.5 RECEIVER TANK

The receiver tank is located in the condenser compartment (figure 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.

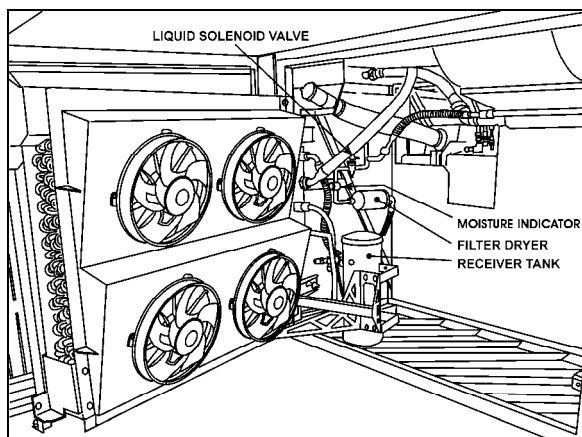


FIGURE 31: A/C CONDENSER COMPARTMENT

22362A

In case of extreme pressure there will be a rise in the liquid receiver tank. A pressure relief valve will break at 450 psi (3103 kPa) and relieve the receiver tank pressure.

The receiver tank incorporates an inlet valve on the inlet side (upper section) which allows the tank to be isolated or serviced. An outlet valve on the outlet side (lower section) permits complete isolation from the rest of the system.

### 9.6 FILTER DRYER

A filter dryer, also located in the A/C condenser compartment, is installed on the liquid refrigerant line (near 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 to prolonged exposure as shown by the moisture indicator sight glass.

A filter dryer, located in the engine compartment near the radiator is installed on vehicles equipped with a small HVAC system only. Its function is similar to that of filter used on main systems. Replace only when system is opened or a problem occurs.

#### 9.6.1 Replacement

The filter is of the disposable type. When replacement is required, remove and discard the complete unit and replace with a new unit of the same type according to this procedure:

1. Isolate the refrigerant in the receiver tank by following the "Pumping Down" procedure explained in this section
2. Change the filter dryer as a unit.
3. Add a small quantity of refrigerant R-134a to the low side of the system. Check for leaks. Return the system to normal operation.

#### ⚠ CAUTION ⚠

**Do not use carbon tetrachloride or similar solvents to clean parts. Do not use steam gun. Use mineral spirits or naphtha. All parts should be thoroughly cleaned. Use a stiff brush to wash dirt from grooves, holes, etc.**

#### ⚠ WARNING ⚠

**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 yellow to green and vice versa as the moisture content in the refrigerant changes. Yellow indicates a wet refrigerant, yellow green (caution) and green indicates a dry refrigerant.

Since temperature changes affect the solubility, color change will also vary with the refrigerant temperature. The following table shows the color change for R-134a at various moisture levels and liquid line refrigerant temperatures.

COLOR INDICATOR			
Temperature	BLUE (ppm)	LIGHT VIOLET (ppm)	PINK (ppm)
75°F (24°C)	Below 5	5-15	Above 15
100°F (38°C)	Below 10	10-30	Above 30
125°F (52°C)	Below 15	15-45	Above 45
p.p.m.= parts per million (moisture content)			

A moisture level of less than 15 p.p.m. for R-134a indicated in the blue color range of the above table is generally considered dry and safe. A color indication of light blue to light violet indicates the caution range of moisture level. For positive protection, the drying of the system should be continued until the color of the element turns to deep blue.

The liquid refrigerant is readily visible through the center opening of the moisture element where the presence of bubbles indicates a shortage of refrigerant or restriction in line.

Moisture is one of the main causes of chemical instability or contamination in air conditioning systems. If moisture is present, it can corrode the valves, condenser and evaporator coils, compressor and other components causing a malfunction and eventually failure of the system. Uncontrolled moisture in the system can result in 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.

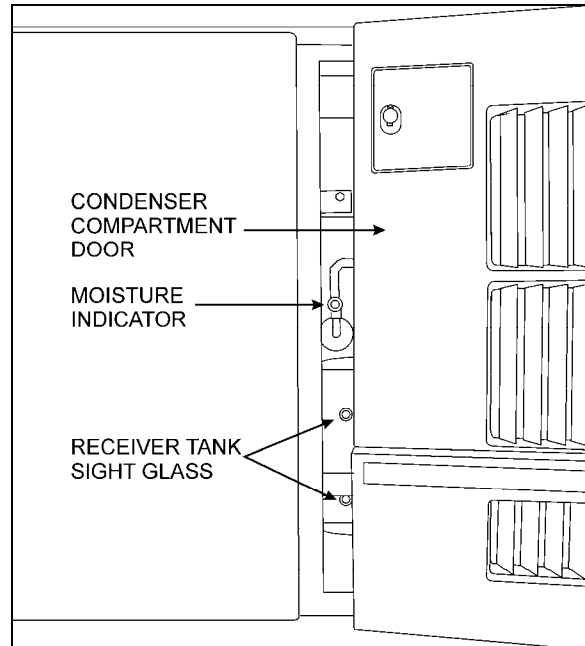


FIGURE 32: A QUICK CHECK OF THE MOISTURE INDICATOR AND THE RECEIVER TANK SIGHT GLASS  
06364

### 9.7 LIQUID REFRIGERANT SOLENOID VALVE

The flow of liquid refrigerant to both driver's and passenger's evaporators is controlled by a normally-closed solenoid valve. The driver's solenoid valve is located on the ceiling of the spare wheel compartment and is accessible through the reclining bumper while the central HVAC system solenoid valve is located in the condenser compartment.

#### 9.7.1 Manual Bypass

To ease purging, pumping down and refilling of refrigerant, it is possible to open the driver's, passenger's and overhead compartment system liquid solenoid valves. To do so, connect either male and female connector housing of C24 together for the passenger's area (located in evaporator compartment) or C44 for the driver's area (located on the ceiling of the spare wheel compartment). During normal use, both male and female housings of connector C24 & C44 are kept unplugged.

#### 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.

## Section 22: HEATING AND AIR CONDITIONING

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 (figure 33).
4. Carefully lift off the bonnet assembly (upper part of the valve) so that plunger will not fall out. The diaphragm can now be lifted out.

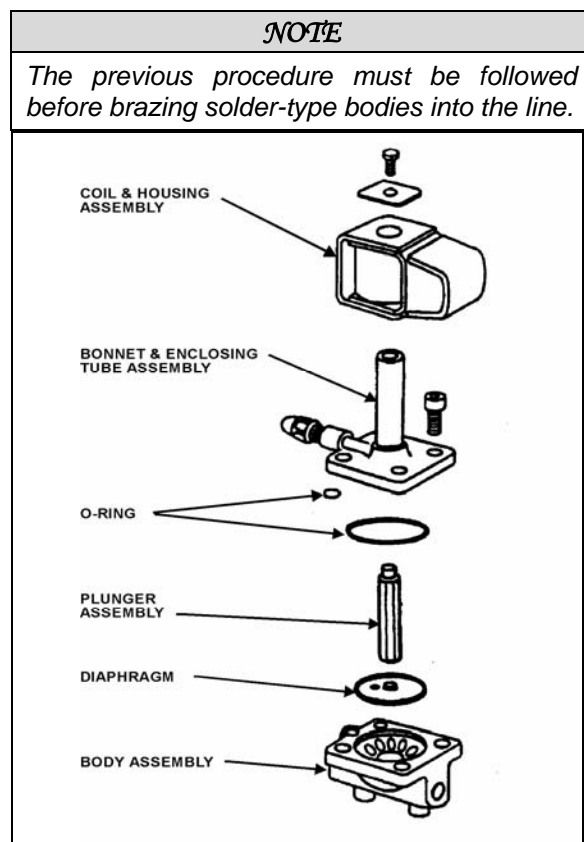


FIGURE 33: REFRIGERANT SOLENOID VALVE 22044

### ⚠ 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.

## 9.8 EXPANSION VALVE

### 9.8.1 Central system

The expansion valve for the main system is a thermo-sensitive valve with a remote control bulb head attached to the evaporator outlet line and is accessible by the evaporator filter access door. 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.

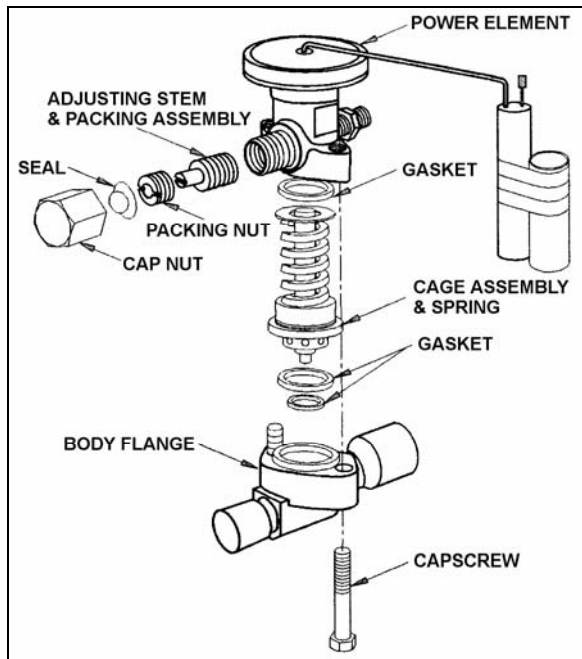


FIGURE 34: EXPANSION VALVE

22215

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° F (-11.1 to -8.8 ° C) of superheat at the evaporator outlet. This ensures that the refrigerant leaving the evaporator is in a completely gaseous state when drawn into the suction side of the compressor. Liquid would damage the compressor valve, piston and heads if allowed to return in the suction line.

A vapor is said to be superheated when its temperature is higher than the saturation temperature corresponding to its pressure. The amount of the superheat is, of course, the temperature increase above the saturation temperature at the existing pressure.

As the refrigerant moves along in the evaporator, the liquid boils off into a vapor and the amount of liquid decreases until all the liquid has evaporated due to the absorption of a quantity of heat from the surrounding atmosphere equal to the latent heat of vaporization of the refrigerant. The gas continues along in the evaporator and remains at the same pressure. However, its temperature increases due to the continued absorption of heat from the surrounding atmosphere. The degree to which the gas refrigerant is superheated is related to the amount of refrigerant being fed to the evaporator and the load to which the evaporator is exposed.

### Superheat Adjustment

The easiest method of adjusting the superheat is to unscrew completely the main evaporator expansion valve adjusting screw, and screw in 13 turns clockwise for 134A (figure 35). If this method does not provide an accurate superheat, the following procedure should be followed:

1. Operate coach for at least one-half hour at fast idle with temperature control set at 82°F (27,7°C), Then set temperature to minimum to keep the compressor on 6 cylinders.

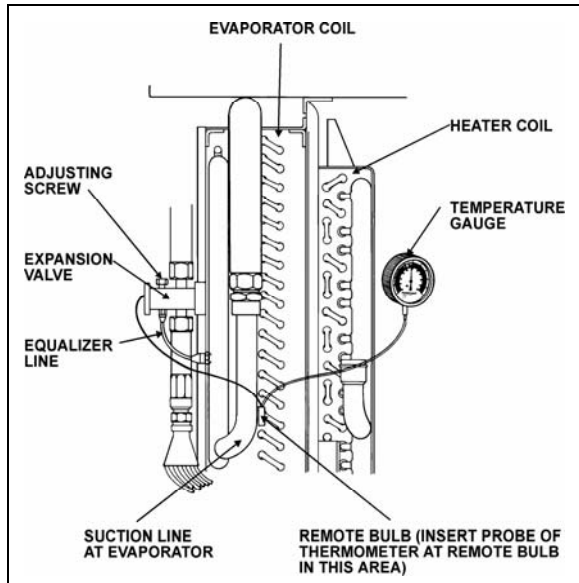


FIGURE 35: SUPERHEAT ADJUST. INSTALLATION 22046

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 (figure 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 vapor-pressure table (page 36). 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 figure 36).

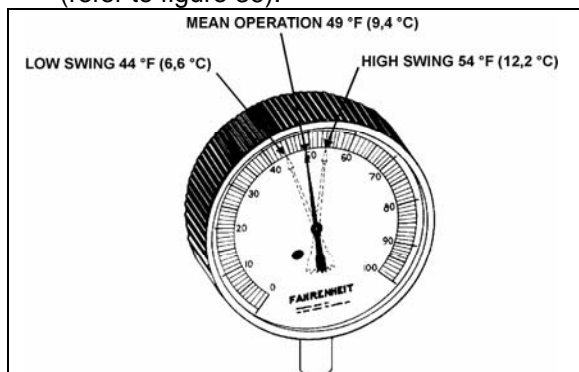


FIGURE 36: HIGH & LOW SWING TEMPERATURE AT REMOTE BULB 22047

Example of readings taken at **Erreur ! Source du renvoi introuvable.**:

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 12 to 16°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.*

7. 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 with the expansion valve adjustment, check for restriction on suction side for plugged filter dryer and partially open valves. These conditions will give a high superheat.**

**Maintenance**

1. Pump down the system as previously indicated in this section.



2. Disconnect the external equalizer line from the under side of the power head, and unclamp the remote control bulb from the evaporator coil outlet line.
3. Remove the two cap screws holding the power assembly to the valve body flange. Lift off the power assembly and remove the cage assembly.
4. When reassembling, replace with the new gaskets in proper location. Make sure the two lugs on the cage assembly fit into grooves provided in the power assembly. Do not force the valves together. The cage must fit properly before tightening the body flange. Tighten bolts evenly.
5. Check for leaks.

**Safety Instructions**

1. Make sure the valve is installed with the flow arrow on the valve body corresponding to the flow direction through the piping system.
2. Before opening any system, make sure the pressure in the system is brought to and remains at the atmospheric pressure. Failure to comply may result in system damage and/or personal injury.

9.8.2 Driver's System

The function and operation of the expansion valve for the driver" system are similar to the central system, but no superheat adjustment is required (see figure 34).

9.9 TORCH BRAZING

Use electrode containing 35% silver.

**NOTE**

*A 3.5% silver low temperature brazing electrode can be used on low side pressure and liquid high side.*

**⚠ CAUTION ⚠**

**When using heat near a valve, wrap with water saturated rag to prevent overheating of vital parts.**

**⚠ WARNING ⚠**

**Before welding any part of refrigeration system, make sure the area is well ventilated.**

## Section 22: HEATING AND AIR CONDITIONING

### 9.10 TROUBLESHOOTING

#### 9.10.1 Expansion Valve

PROBABLE CAUSE	PROBABLE REMEDY
<b>LOW SUCTION PRESSURE-HIGH SUPERHEAT</b>	
EXPANSION VALVE LIMITING FLOW:	
Gas in liquid line due to pressure drop in the line or insufficient refrigerant charge.	Locate cause of line flash and correct by use of any of the following methods. Add R-134a. Replace or clean filter dryer.
Inlet pressure too low from excessive low condensing temperature. Resulting pressure difference across valve too small.	Increase head pressure. Verify pressure switch for fan speed control.
Superheat adjustment too high.	Adjust superheat as outlined under "Superheat Adjustment".
Power assembly failure or partial loss of charge.	Replace power assembly or replace valve.
Air filter screen clogged.	Clean or replace air filter screen.
Plugged lines.	Clean, repair or replace lines.
<b>LOW SUCTION PRESSURE-LOW SUPERHEAT</b>	
Uneven or inadequate evaporator loading due to poor air distribution or liquid flow.	Balance evaporator load distribution by providing correct air or liquid distribution.
<b>HIGH SUCTION PRESSURE-HIGH SUPERHEAT</b>	
Compressor discharge valve leaking.	Replace or repair valve.
<b>HIGH SUCTION PRESSURE-LOW SUPERHEAT (DEFECTIVE UNLOADER)</b>	
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.
<b>FLUCTUATING DISCHARGE PRESSURE</b>	
Insufficient charge.	Add R-134a to system.
<b>HIGH DISCHARGE PRESSURE</b>	
Air or non-condensable gases in condenser.	Purge and recharge system.
Overcharge or refrigerant.	Bleed to proper charge.
Condenser dirty.	Clean condenser.

9.10.2 A/C Compressor

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  Superheat too high.	Clogged filter. Obstructed or defective expansion valve.  Reset superheat adjustment. Check for clogged external equalizer line, or filter dryer.
Reduced air flow: a. Dirty or clogged air filter; b. Evaporator motor inoperative; or c. Plugged return air ducts.	Dirty or iced evaporator coil. Clean air filter screen. Check return ducts for obstructions. Check blower motor.
Frequent startings and stoppings 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.)

**Section 22: HEATING AND AIR CONDITIONING**

TROUBLE	CAUSE
	<p>An evaporator just does a proper cooling job without sufficient air. Shortage of air can be caused by the following:</p> <ul style="list-style-type: none"> <li>○ Dirty filters; or</li> <li>○ Dirty coils.</li> </ul>
<p>Testing condenser pressure.</p> <p>Note: R-134A pressure is function of the temperature variation.</p> <p>Example, for an exterior temperature of 100°F.            Exterior temperature (100°F) + 40°F = 140°F. Refer to paragraph "9.11 Temperatures &amp; Pressures".            Note the corresponding pressure for a temperature of 140°F., 230.5 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, then 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 air cooled condenser pressure may be too high. Most frequent causes are:</p> <p>Reduced air quantity. This may be due to:</p> <ul style="list-style-type: none"> <li>○ Non-condensable in system;</li> <li>○ Dirt on the coil;</li> <li>○ Restricted air inlet or outlet;</li> <li>○ Dirty fan blades;</li> <li>○ Incorrect rotation of fan;</li> <li>○ Fan speed too low;</li> <li>○ Fan motor going out on overload; or</li> <li>○ Prevailing winds.</li> <li>○ Too much refrigerant in system. Remove refrigerant if necessary.</li> </ul>	

## 9.11 TEMPERATURES &amp; PRESSURES

VAPOR-PRESSURE			
TEMPERATURE		PRESSURE	
°F	°C	psi	kPa
-100	-73.3	27.8	191.7
-90	-67.8	26.9	185.5
-80	-62.2	25.6	176.5
-70	-56.7	23.8	164.1
-60	-51.1	21.5	148.2
-50	-45.6	18.5	127.6
-40	-40.0	14.7	101.4
-30	-34.4	9.8	67.6
-20	-29	3.8	26.2
-10	-23	1.8	12.4
0	-18	6.3	43.4
10	-12	11.6	80
20	-7	18.0	124.1
30	-1	25.6	176.5
40	4	34.5	237.9
50	10	44.9	309.6
60	16	56.9	392.3
70	21.1	70.7	487.5
80	27	86.4	595.7
90	32.2	104.2	718.5
100	38	124.3	857.0
110	43.3	146.8	1012.2
120	49	171.9	1185.3
130	54.4	199.8	1377.6
140	60	230.5	1589.3
150	65.6	264.4	1823.0
160	71	301.5	2078.8
170	76.7	342.0	2358.1
180	82.2	385.9	2660.8
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:

**⚠ WARNING ⚠**

**Do not inhale fumes from leak detector.**

The flow of acetylene to the burner causes a depression 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 specific 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**

**10.1 COMPRESSOR**

Consult the ICE Compressor Service Manual included at the end of this section.

**⚠ WARNING ⚠**

Read the cautionary information in the ICE Compressor Service Manual included at the end of this section.

**10.2 COMPRESSOR REMOVAL**

10.2.1 When the compressor is operational

- Perform the "OIL RETURN OPERATION" (Refer to paragraph 10.5).

10.2.2 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.

For complete system recovery, any of the High and Low service ports can be used (Refer to figure 18 & 19). Energize liquid 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.

**NOTE**

*Belts specifications may vary. For proper belt selection, always consult your vehicle Coach Final Record.*

10.2.3 When the compressor is inoperable

- Perform the "Refrigerant Recovery" operation (paragraph 10.2.2).
- Slacken bolts A (figure 37).
- Remove bolts B & C.
- Remove the compressor.

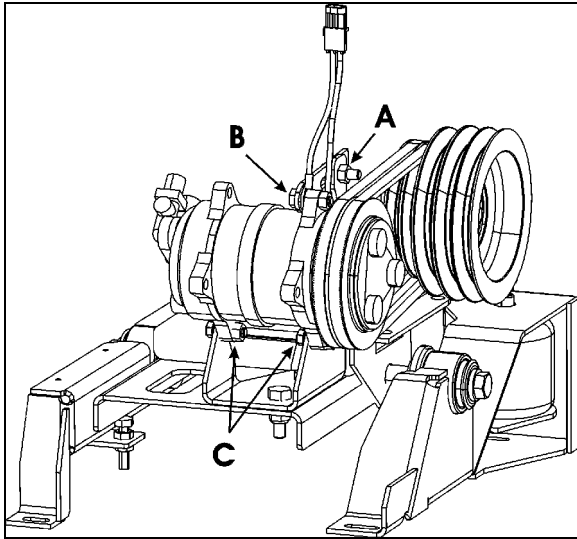


FIGURE 37: COMPRESSOR REMOVAL/ INSTALLATION  
22346

#### 10.2.4 Evacuating System prior Addition of Refrigerant (Driver's or Auxiliary System)

When a system has been opened for repairs, change the filter dryer and evacuate the system. VIPs equipped with a driver's system must use high-pressure service port located on the other side of check valve and low-pressure port located alongside rear truss (figure 38). It would be good practice to open the solenoid valve.

1. Connect two hoses equipped with a micron gauge between the high-pressure service port, the low-pressure service port and the vacuum pump.
2. With the unit service valves open and the vacuum pump valves open, start the pump and draw the manifold and hoses into a very deep vacuum (700 microns).
3. Close manifold valve
4. Shut down the vacuum pump.
5. Check to insure that vacuum holds. (If the pressure continues to rise, it indicates a leak or moisture in the system).
6. Charge the system with the proper amount of refrigerant through the service port near the check valve using recommended charging procedures.
7. Remove the hoses.

#### 10.3 OIL ADDITION

The chart below shows the approximate amount of oil to be added to the system when replacing a component.

Component replaced	Typical amount of oil
Evaporator	50 cm <sup>3</sup> (1.7 ozs)
Condenser	30 cm <sup>3</sup> (1.0 ozs)
Filter-Dryer	10 cm <sup>3</sup> (0.3 ozs)

The amount of oil recovered with the refrigerant recovery should be added at the same time.

#### 10.4 COMPRESSOR OIL CONTAMINATION

Unlike engine oil, no cleaning agent is added to the compressor oil. Even if the compressor is run for a long time, the oil never becomes turbid as long as there is nothing wrong with the compressor or its method of use. Inspect the extracted oil for any of the following conditions:

- Dirt in the oil.
- Change to a varnish color.
- Presence of foreign substance, metal shavings, etc. in the oil. When the oil extracted from the compressor is as described above, replace the oil as follows:
  1. Clean the interior of the system with approved method.
  2. Replace the filter-dryer.
  3. Supply with new oil as specified in paragraph 11.6: "COMPRESSOR OIL CHANGE".

#### 10.5 OIL RETURN OPERATION

There is a close affinity between oil and refrigerant. During normal operation, part of the oil recirculates with the refrigerant in the system. Therefore, when checking the amount of oil in the system or replacing any system component, the compressor must be run in advance to ensure return. This procedure is as follows:

- If the amount of refrigerant in the system has decreased, charge to the proper amount.
- Start the engine and select fast idle.
- Set the fan speed to full air/full A/C and let run for 20 minutes.

Section 22: HEATING AND AIR CONDITIONING

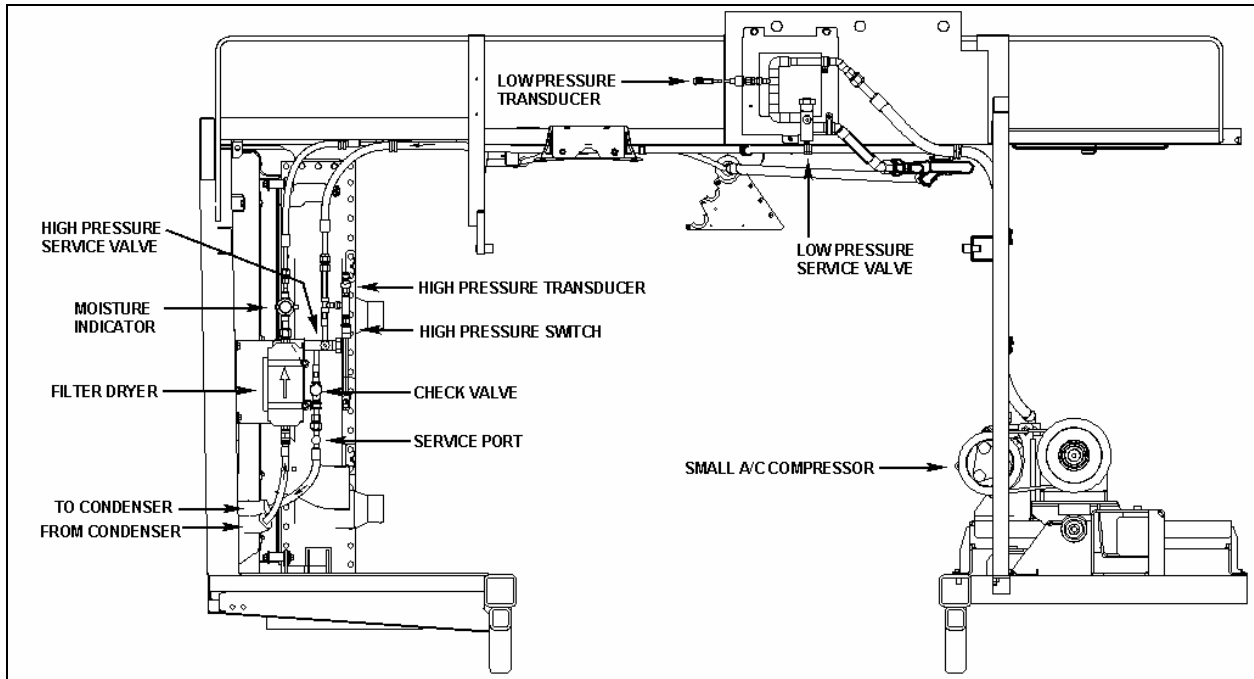


FIGURE 38: SMALL HVAC SYSTEM - AIR CONDITIONING

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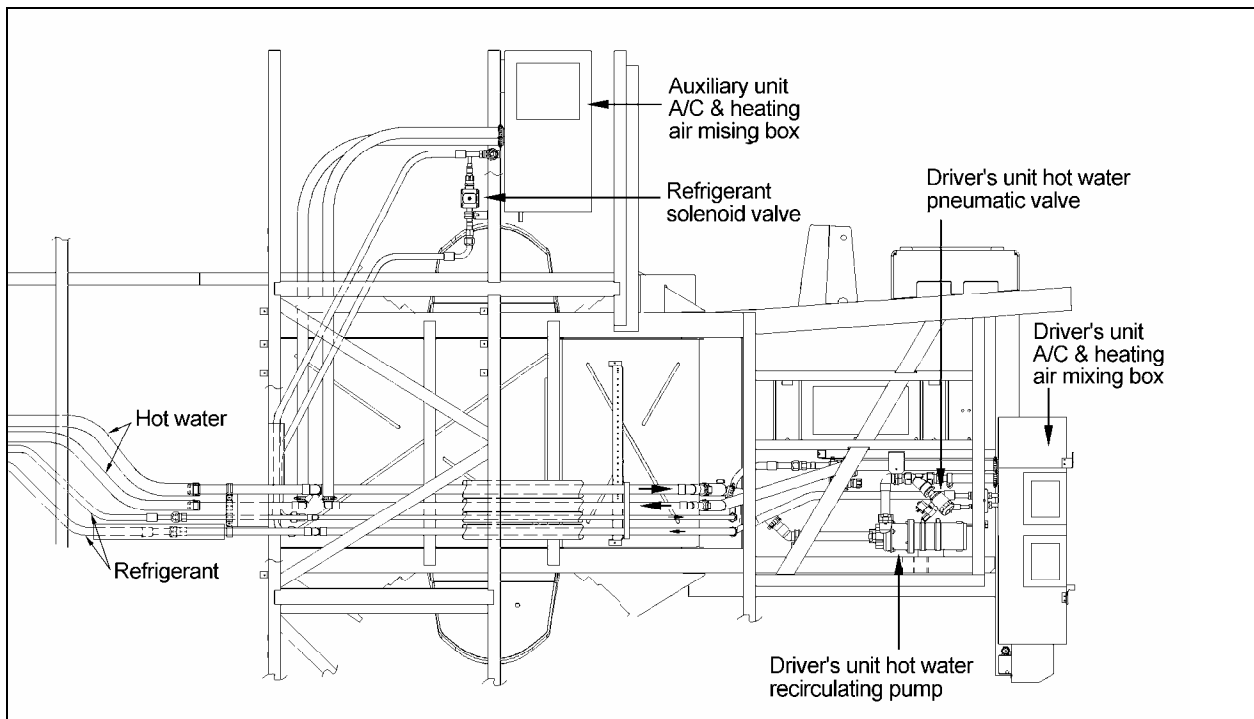


FIGURE 39: SMALL HVAC SYSTEM - DRIVER'S AND AUXILIARY UNIT

22290



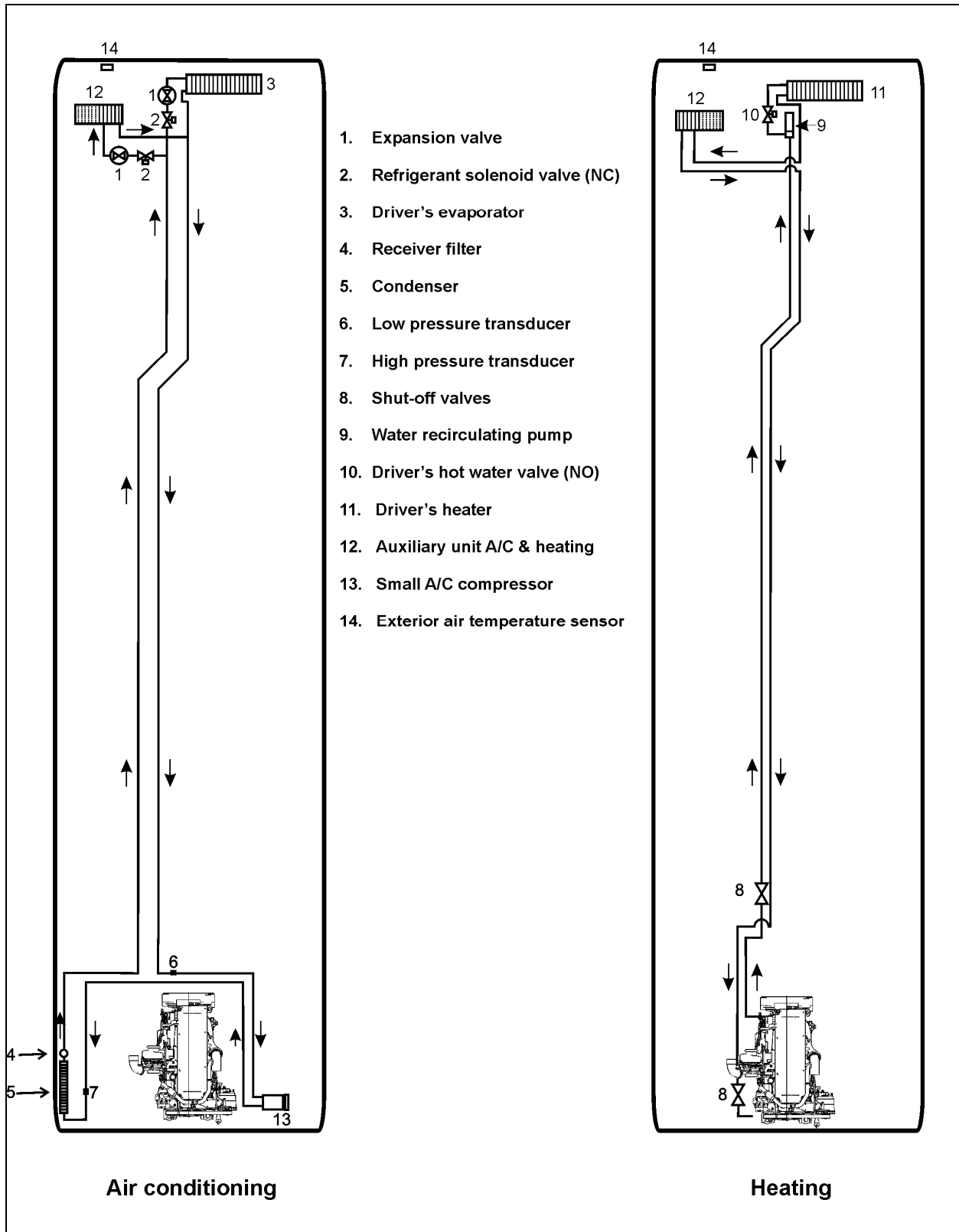


FIGURE 40: SMALL HVAC SYSTEM

22345

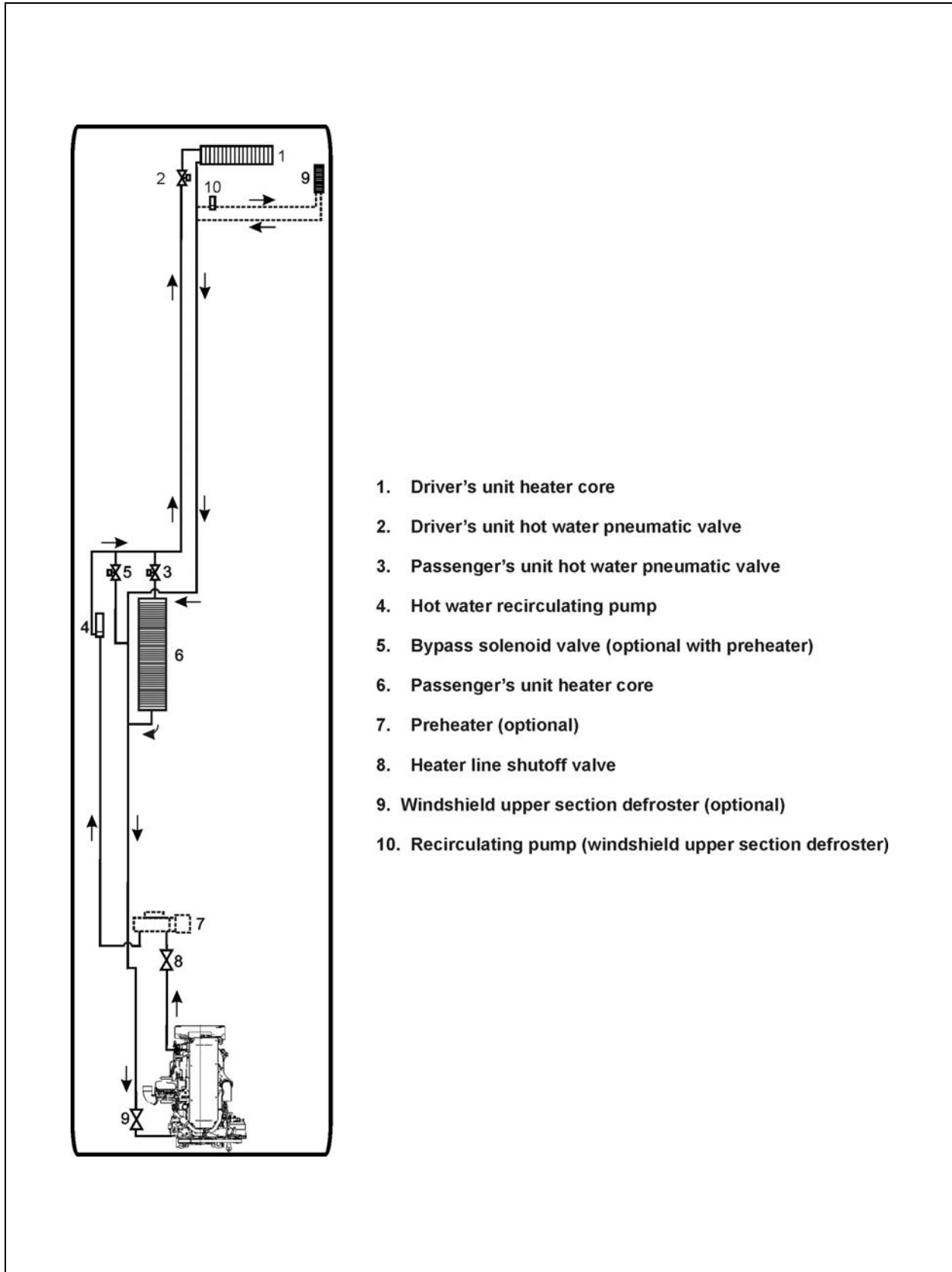


FIGURE 41: CENTRAL HVAC SYSTEM – HEATING

22262

## 11. HEATING SYSTEM

The schematics of figure 40 & 41 show respectively, the small HVAC system heating and air conditioning arrangement and the central HVAC system heating arrangement.

In addition to the normal heating provided by the engine, a preheating system (104,000 Btu/hr) (optional on coaches only) may have been installed in the vehicle.

### 11.1 SMALL HVAC SYSTEM

The small HVAC system driver's unit is similar to the driver's unit of the central HVAC system, except that the recirculating pump is located on the ceiling of the spare wheel compartment (figure 51).

Furthermore, an auxiliary unit is added in series on the return line of the small system, it increases the whole system heating capacity and gives the driver more options.

### 11.2 CENTRAL HVAC SYSTEM

The schematic of figure 40 shows the central HVAC system heating arrangement.

On coaches only, in addition to the normal heating provided by the engine, an optional preheating system (104,000 Btu/hr) may have been installed above the rear wheelhousing on the L.H. side.

### 11.3 DRAINING HEATING SYSTEM

To drain the entire system, refer to Section 05, "Cooling". If only the driver's unit heater core or passenger's unit heater core must be drained, refer to the following instructions.

#### 11.3.1 Draining Driver's Unit Heater Core

1. Stop engine and allow engine coolant to cool.
2. Locate the normally open hot water pneumatic valve on the ceiling of the spare wheel compartment (figure 39), disconnect its wiring connector, and then connect a 24-volt external power source, using jumper cables, to close valve.

**⚠ WARNING ⚠**

**Before proceeding with the following steps, check that coolant has cooled down.**

3. Loosen hose clamp, install an appropriate container to recover coolant, and disconnect

silicone hose from hot water pneumatic valve.

4. From inside of vehicle, remove the grill and the access panels. Open the purge valve located inside the driver's unit (figure 42) to ensure an efficient draining.

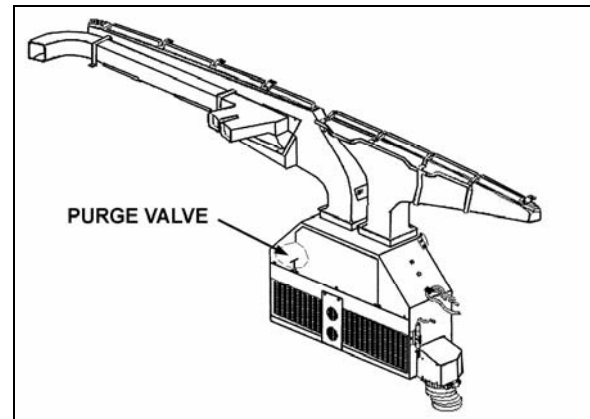


FIGURE 42: DRIVER'S UNIT AIR MIXING BOX 22171PV

#### 11.3.2 Draining Passenger's Unit Heater Core

1. Stop engine and allow engine coolant to cool.
2. Close both heater line shutoff valves (figure 45 & 46). One is located in the engine compartment under the radiator fan gearbox, while the other one is located behind the L.H. hinged rear fender near the preheater. Refer to "Preheater System" in this section to gain access to the heater line shutoff valve.
3. Open the last L.H. side baggage compartment door and then pull the black release button located on the L.H. side in order to unlock and open the evaporator compartment door.

**⚠ WARNING ⚠**

**Before proceeding with the following step, check that coolant has cooled down.**

4. Open drain cock in bottom of heater core, then open purge valve located on top of heater core (figure 43) in order to allow air to enter while draining.

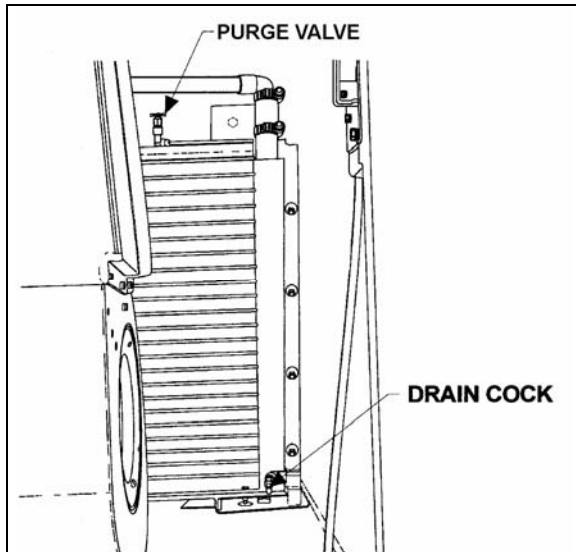


FIGURE 43: PASSENGER'S UNIT HEATER CORE (H3 COACHES) 22229

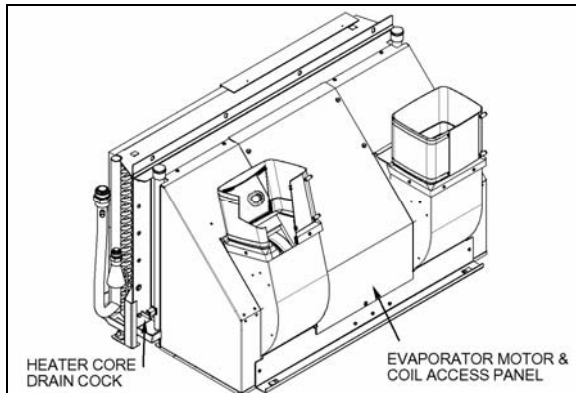


FIGURE 44: HEATER CORE INSIDE EVAPORATOR COMPARTMENT (H3 COACHES) 22332

#### 11.4 FILLING HEATING SYSTEM

1. Ensure that the drain hose is reconnected and the purge valves 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 unit, both driver and passenger sections, and set temperature to their maximum positions in order to request the heating mode in each of these sections.
4. When coolant level drops below the surge tank filler neck, slowly fill the system to level of filler neck.

5. If vehicle is equipped with a windshield upper section defroster, open front baggage compartment R.H. side door. Locate recirculating pump on top of front wheelhousing, momentarily pinch the hose located between the recirculating pump suction and the defroster outlet connector to ensure windshield upper section defroster complete filling.
6. Once the level has been stabilized, replace cap.

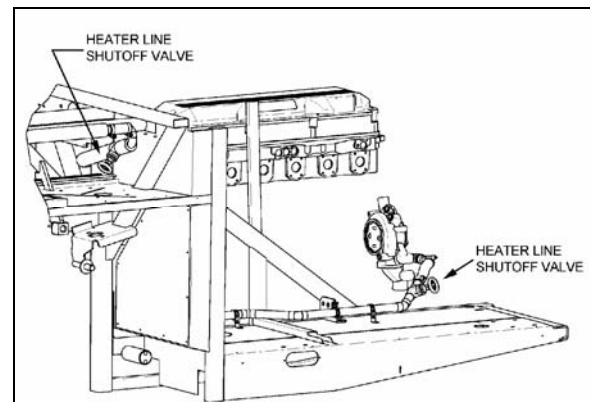


FIGURE 45: HEATER LINE SHUTOFF VALVES (CENTRAL HVAC SYSTEM)

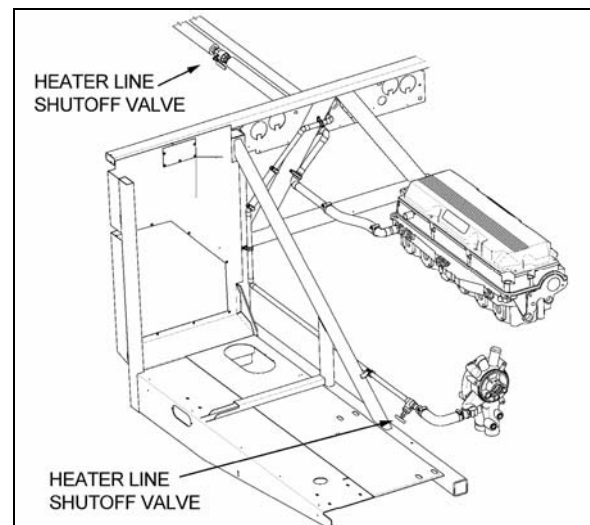


FIGURE 46: HEATER LINE SHUTOFF VALVES (SMALL HVAC SYSTEM)

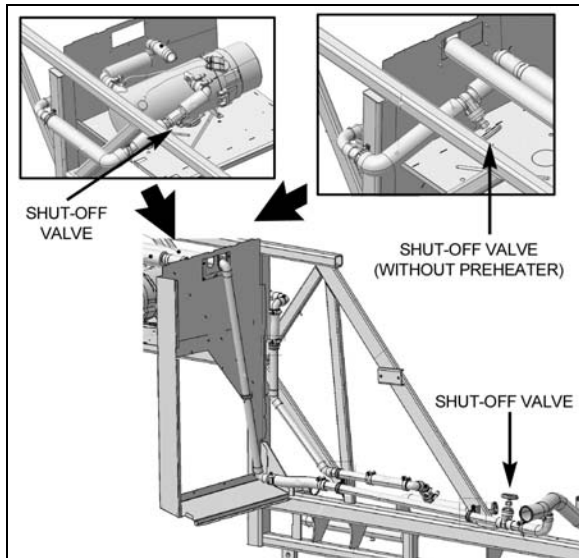


FIGURE 47: HEATER LINE SHUTOFF VALVES (WITH VOLVO D13 ENGINE) 05144

### 11.5 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 purge valve illustrated in figure 42 & 43, and open them momentarily until no air escapes from the lines.

**NOTE**

*In test mode (see paragraph 7.1 HVAC SYSTEM AND TEST MODE FOR SWITCHES AND SENSORS), 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 is useful when working on the heating system to remove air pockets trapped in the system.*

### 11.6 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 rag saturated of water to prevent overheating of vital parts.

### 11.7 DRIVER'S UNIT HOT WATER PNEUMATIC VALVE

The flow of hot water to the driver's unit heater core is controlled by a pneumatic valve like the passenger's unit hot water pneumatic valve. It is mounted on the coolant inlet line of the driver's heater core, and is accessible through the spare wheel compartment (see figure 40, 41 & 51). For more information, refer to paragraph 11.8.

### 11.8 PASSENGER'S UNIT HOT WATER PNEUMATIC VALVE ASSEMBLY

#### 11.8.1 Description

The flow of hot water to the vehicle's central heater core is controlled by a NO pneumatic water valve assembly (figure 48). 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 opening or closing the valve.

When the vehicle is operating with no current to the pilot solenoid valve, no air pressure is admitted to the actuator casing, the cylinder spring pushes up against the cylinder, thereby keeping the water valve open.

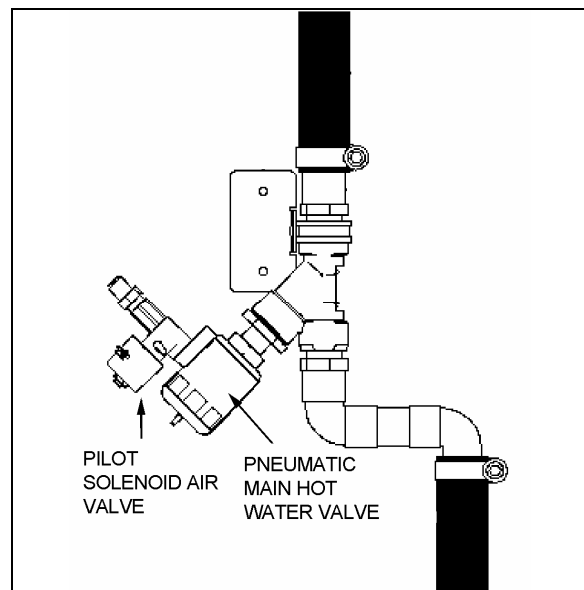


FIGURE 48: PASSENGER'S UNIT HOT WATER PNEUMATIC VALVE ASSEMBLY 22240

The passenger's unit 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

## Section 22: HEATING AND AIR CONDITIONING

maintenance is needed unless a malfunction occurs.

### 11.8.2 Hot Water Pneumatic Valve Disassembly

1. Assemble Shut off air supply pressure and electrical current to the pilot solenoid valve. Disconnect wires.
2. The water valve need not be removed from the line. Unscrew nipple, the actuator casing, tube, spindle and closure member can be removed (figure 49).
3. Remove the snap ring using a pair of pliers.
4. You can now access all seals for replacement.

Pneumatic water valve replacement seal kits:

- Water Side: 871311
- Actuator Side: 871312

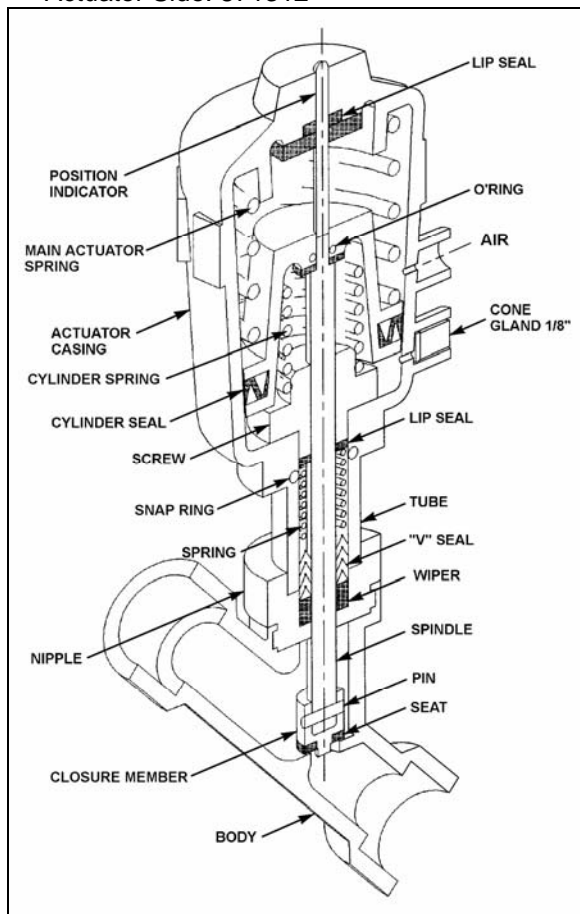


FIGURE 49: PASSENGER'S UNIT HOT WATER PNEUMATIC VALVE

22241

### 11.8.3 Hot Water Pneumatic Valve Reassembly

1. Assemble the actuator casing, tube, nipple, spindle and closure member.
2. Tighten the nipple in place in the body cavity as per Figure 49. Fasten pilot solenoid valve to the pneumatic water valve. Reconnect air supply pressure and electrical current to the pilot solenoid valve.
3. Check for proper operation.

### 11.8.4 Pilot Solenoid Valve

1. No maintenance is needed unless a malfunction occurs.
2. A pilot solenoid valve replacement seal kit is available: 871311.

### 11.8.5 Valve Troubleshooting

PROBLEM	PROCEDURE
Valve fails to close	<ol style="list-style-type: none"> <li>1. Check electrical supply with a voltmeter. It should agree with nameplate rating.</li> <li>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.</li> </ol>
Valve fails to open	<ol style="list-style-type: none"> <li>1. Check that the closure member assembly, and that main actuator and cylinder springs are free to travel.</li> <li>2. Check that there is no restriction to the air escaping from the actuator casing.</li> <li>3. Make sure that pilot solenoid valve operates properly.</li> </ol>

### 11.9 HOT WATER RECIRCULATING PUMP

This vehicle is provided with a water recirculating pump which is located in the evaporator compartment (figure 50) or on the ceiling of the spare wheel compartment for vehicles equipped with a small HVAC (figure 51). The water recirculating pump consists of a centrifugal pump and an electric motor which are mounted in a compact assembly.

The motor is equipped with pre-lubricated sealed ball bearings which require no maintenance. The 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 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 impellor failure or motor failure.

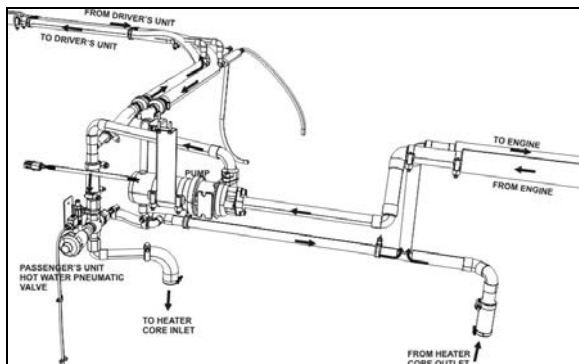


FIGURE 50: HOT WATER RECIRCULATING PUMP INSTALLATION (CENTRAL HVAC SYSTEM)

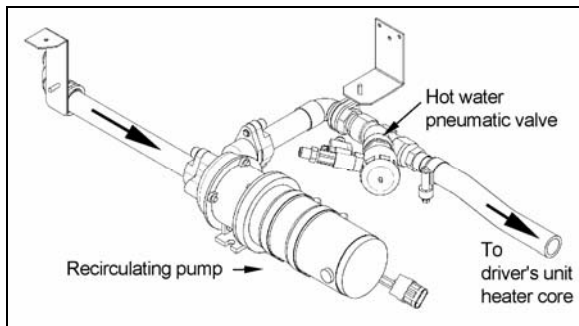


FIGURE 51: HOT WATER RECIRCULATING PUMP INSTALLATION (SMALL HVAC SYSTEM)

22292

#### 11.9.1 Removal

1. Stop engine and allow engine coolant to cool.

2. Close shutoff valves on the heater line. Refer to "Preheater System" in this section to gain access to the heater line shutoff valve.
3. Disconnect the electrical wiring from the motor.

#### ⚠ WARNING ⚠

**Before proceeding with the following steps, check that coolant has cooled down.**

4. Disconnect water lines from the pump at the flange connections.
5. Remove the two clamps holding the pump motor to its mounting bracket. Remove the pump with the motor as an assembly.

#### 11.9.2 Disassembly

Refer to figure 52.

1. Separate the housing from the adapter by first removing the 4 capscrews. Remove housing carefully to prevent damaging the O-ring.
2. Remove rotor assembly, washers and shaft from the adapter.

#### ⚠ CAUTION ⚠

**Do not scratch or mark the sealing surface of this seat, as its sealing feature will be affected, thus resulting in continuous leakage.**

#### Inspection

Components removed from the recirculating pump and motor assembly should be compared with new parts to determine the degree of wear.

#### 11.9.3 Brushes

- 1) When removing brushes, note the position of the brush in the tube. Brush life is shortened if the brushes are not replaced properly.
- 2) Examine brushes for the following:
  - a) Wear

Replace the brushes if less than 25% of the usable brush is left (less than 0.300 inch (8 mm)).

- b) Chipped edges

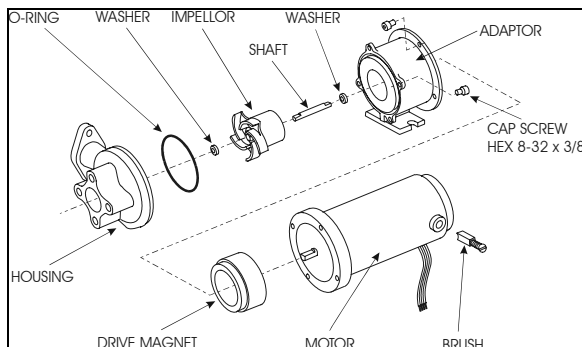
Chips can be caused by improper handling or installation. Badly chipped brushes should be replaced regardless of their length.

c) Annealed brush spring

This can be detected by noting the resiliency of the spring. Annealing is caused by failing to tighten the brush caps properly, thus not providing a good low resistance contact between the terminal and the brush tube. Replace brushes showing evidence of annealed springs.

d) Frayed or broken pigtail

An improperly installed brush may have the pigtail (shunt) pinched under the terminal or between the coils of the spring. If the pigtail is badly frayed or broken, replace the brush.



**FIGURE 52: HOT WATER RECIRCULATING PUMP**

3) Observe the following factors when replacing brushes

- The face of a new brush is carefully cut to cause proper seating during the "wear-in" period.
- Improper installation can harm both the brush and the commutator.
- Replacement brushes should be of the proper grade.
- 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.

### 11.9.4 Assembly

Refer to figure 52.

- Install washer, shaft and rotor assembly into adapter.

- Install O-ring into housing and assemble housing to the adapter.

- Secure housing to adapter using 4 cap screws.

### 11.9.5 Installation

- Apply gasket cement to the pump body line adapter and to the line flanges, put the two gaskets in place, and connect water lines from 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.

- Connect electrical wiring to the pump motor.

- Open both shutoff valves. Refer to "Preheater System" in this section to gain access to the heater line shutoff valves.

- Fill the cooling system as previously instructed in this section under "Filling Heating System" and then bleed the system as previously instructed in this section under "Bleeding Heating System".

### 11.10 BYPASS SOLENOID WATER VALVE (OPTIONAL)

This valve is optional and is installed on the vehicle equipped with a preheater. The valve is located in the evaporator compartment (Figure 50). Refer to figure 54 for part names.

#### 11.10.1 Improper Operation

- Faulty control circuit: Check the electric system by energizing the solenoid. A metallic clicking noise indicates that the solenoid is operating. Absence of clicking indicates a loss of power or a defective solenoid. Check for open breaker, open-circuited or grounded coil, broken lead wires.

- Burned-out coil: Check for open-circuited coil. Replace coil if necessary.

- Low voltage: Check voltage across the coil leads. Voltage must be at least 85% of nameplate rating.

- Excessive leakage: Disassemble valve and clean all parts. Replace worn or damaged parts with a complete repair kit for best results.



11.10.2 To Remove or Change the Coil

- Stop engine and allow engine coolant to cool.
- Close shutoff valve on the line located in the rear electric compartment. Refer to "Preheater System" in this section to gain access to the heater line shutoff valve.

To remove the solenoid coil:

First take out the retaining screw at the top of the coil housing. The entire coil assembly can be lifted off the enclosing tube.

To reassemble:

Make sure that the parts are placed on the enclosing tube in the following order:

Be sure to change electrical data plate according to coil specifications change.

1. Place coil and yoke assembly on the enclosing tube. Lay data identification plate in place.
2. Insert the coil retaining screw, rotate housing to proper position and tighten screw securely.

11.10.3 Valve disassembly and Reassembly

Disassembly:

This valve may be taken apart by removing the socket head screws which hold the body and bonnet together. After removing the screws, carefully lift off the bonnet assembly (upper part of the valve). Don't drop the plunger. The diaphragm can now be lifted out. Be careful not to damage the machined faces while the valve is apart.

**NOTE**

*The above procedure must be followed before brazing solder type bodies into the line.*

Reassembly:

Place the diaphragm in the body with the pilot port extension up. Hold the plunger with the synthetic seat against the pilot port. Make sure the bonnet O-rings are in place, the bonnet assembly over the plunger, and that the locating sleeve in the bonnet enters the mating hole in the body. Insert body screws and tighten uniformly.

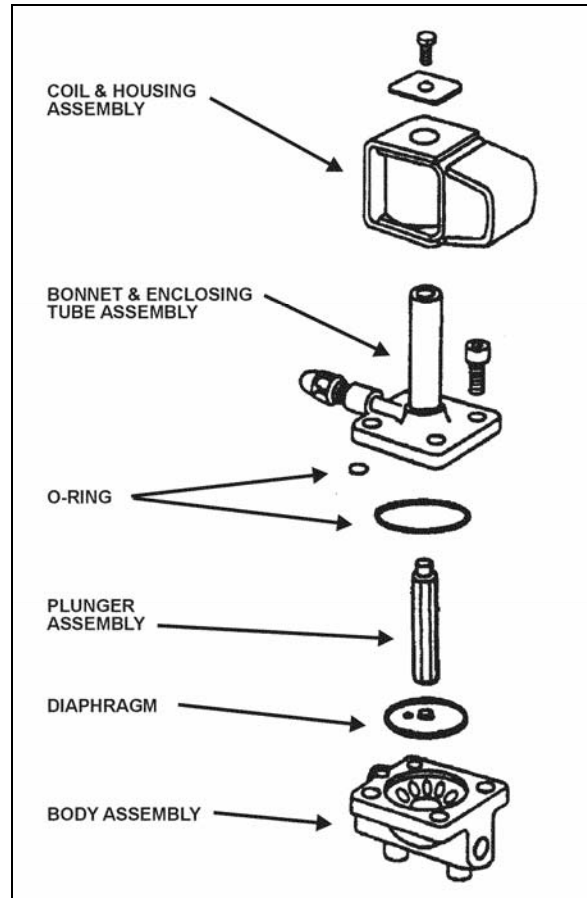


FIGURE 53: BYPASS HOT WATER SOLENOID VALVE 22044

**12. PREHEATING SYSTEM (OPTIONAL ON COACHES ONLY)**

The preheater is located over the rear wheelhousing, behind the vehicle's L.H. side rear fender.

To gain access to the preheater and the heater line shutoff valve next to it (figure 45), remove the L.H side rear fender.

This Auxiliary Preheating System is used for preheating and retaining the heat of water-cooled engines. It can be used before starting the engine to ease its starting and to provide immediate inside heat upon operation of the heating system. It can also be used with engine running to maintain coolant heat and maintain the set temperature inside vehicle.

The heater operates independently from the vehicle engine. It is connected to the cooling and heating circuits, the fuel system and the electrical system of the vehicle.

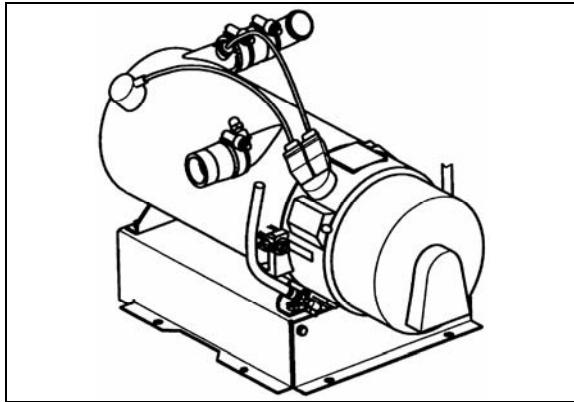


FIGURE 54: WEBASTO PREHEATER (104,000 BTU) 22224

The pilot lamp turns on when the heater is switched on. Combustion air flows in to flush out the combustion chamber and the water circulation pump is put into operation. The fuel metering pump conveys fuel in precise doses to the combustion chamber where fuel and combustion air form a combustible mixture which is ignited by the glow plug.

Once the flame sensor has signaled to the control unit that combustion has taken place correctly, the glow spark plug and ignition coil are switched off.

The hot combustion gases are diverted at the end of the flame pipe, then pass through the indirect heating surfaces of the heat exchanger and transmit their heat to the water passing through the heat exchanger.

The heat is thermostatically controlled and operates intermittently, i.e. the switched-on times of the burner vary depending on the heat requirement. The water temperature depends on the setting of the built-in water thermostat.

The water circulation pump remains in operation as long as the heater is operating, even in the regulation intervals and during the delayed cutout of the switched-off heater. The pump can also be operated independently from the heater by means of an appropriate circuit. The heater can be switched on at any time, even during the delayed cutout period. Ignition takes place once this delay time is over.

When the heater is switched off, the fuel supply is interrupted. The flame goes out, and at the same time a delayed cutout of some 2.5 minutes begins. The combustion air still flowing flushes the remaining combustion gases out of the chamber and cools off the hot parts on the exhaust side of the heat exchanger, while the water circulation pump, still running, transmits the heat present in the heat exchanger, thus

preventing local overheats. Once the delayed cutout time is over, both the combustion air blower and the water circulation pump switch off automatically.

A cutout will take place in case of any failure of the preheater.

### 12.1 OPERATION

Switch on the heater. The operation indicator lamp comes on and the heater motor and circulating pump begin to run. After about 10-25 seconds the solenoid valve opens and fuel is sprayed into the combustion chamber. At the same time, the electronic ignition unit produces high voltage (8000 V) and the mixture of fuel and air in the combustion chamber is ignited by the spark on the ignition electrodes. The flame is indicated by the flame detector, then the electronic ignition unit stops producing high voltage and combustion continues by itself (spark on electrodes is required only to ignite the flame). At this moment, the heater is working and producing heat.

If the heater is switched off by the on/off switch, the solenoid valve interrupts fuel supply, combustion stops and indicator lamp turns off. Combustion air fan still blows air, cleaning the combustion chamber of any fumes and cooling down the combustion chamber. Coolant circulation pumps coolant, making a purge cycle for approximately 2-3 minutes, thus protecting the heater against overheating.

If the heater is not switched off by the on/off switch, the control thermostat will switch off the heater when coolant temperature reaches  $165^{\circ} \pm 6^{\circ}\text{F}$  ( $75^{\circ} \pm 3^{\circ}\text{C}$ ) and turns it on at  $154^{\circ} \pm 9^{\circ}\text{F}$  ( $68^{\circ} \pm 5^{\circ}\text{C}$ ). During this time, the heater (combustion) is off and the indication lamp and coolant pump are on. Combustion air fan blows air for 2-3 minutes and then turns off.

### 12.2 PREHEATING SYSTEM TIMER

The timer, located on L.H. lateral console is used to program the starting and stopping time of the preheating system. The system indicator light, located on the timer, illuminates when the system is functional.



**The preheating system should not operate for more than one hour before starting engine as this could discharge batteries.**

**⚠ WARNING ⚠**

**Preheating system must not operate when vehicle is parked inside or during fuel fill stops.**

**NOTE**

*Preheating system uses the same fuel as the engine.*

*In case of failure:*

1. Shut off and turn on again.
2. Check main circuit breaker and overheat fuse.
3. Have system repaired in a specialized shop.

12.2.1 Timer operating instructions (Webasto)

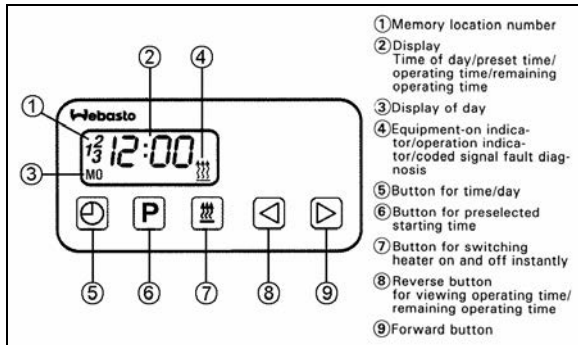


FIGURE 55: WEBASTO

22223

These instructions refer to the timer illustrated in Figure 55. They are the same instructions provided in the Webasto instruction booklet, provided with your vehicle.

**Remaining Operating Time**

The remaining operating time refers to the period of time the heater still continues to remain in operation. It may be changed while the heater is in operation.

**Setting the Digital Timer**

After the power has been connected, all symbols on the digital display are flashing. The time of the day and the day of the week must be set.

All flashing symbols of the timer can be set by means of the Forward (9) or Reverse (8) buttons.

When buttons (8) and (9) are pressed for more than 2 seconds, the quick digit advance mode is activated.

**Setting the Time and Day of the Week**

1. Press button (5) for more than 2 seconds (time display flashes).
2. Press (8) or (9) button to set the time of day.
3. Wait 5 seconds. The time of day is stored (time of week flashes).
4. Press (8) or (9) button to set the correct day of week.
5. Wait 5 seconds. The day of week is stored.

**Viewing the Time (Ignition ON)**

Continuous display of current time and day of the week.

**Viewing the Time (Ignition OFF)**

Briefly press button (5) to display current time and day for 5 seconds.

**Switching Heater ON (Instant Heating)**

**With Ignition ON:**

Press button (7). Heater is switched on (continuous operation) and continues to operate until button (7) is pressed again or ignition is switched off.

**NOTE**

*If the ignition is switched off while heater is in operation, the remaining operating time of 5 minutes flashes on the display and the heater will continue to operate for this period of time.*

**With Ignition OFF:**

Press button (7). Heater is switched on for preset operating time (the factory-set heater operating duration is 60 minutes).

**Switching Heater OFF**

Press button (7). The heater starts its after-run cycle and switches off thereafter.

**Presetting Operating Duration**

1. Press button (6). Memory location number flashes.

**NOTE**

*By repeatedly pressing button (6), starting time 2 or 3 can be preset.*

2. Press button (8) or (9) until correct startup time is set.
3. Wait 5 seconds. Preset starting time is stored and day of week flashes.

4. Press button (8) or (9) to select the correct startup day of week.
5. Wait 5 seconds. The startup day of week is stored.

The number of memory location remains on the display. The timer is now in the programmed mode and will switch the heater in a the preset time.

### NOTE

*We recommend that memory locations 1 and 2 be used for presetting times within 24 hours of setting the timer. Memory location 3 can be used for a starting time within the next 7 days of setting the timer.*

### Recalling Preset Times

Press (6) repeatedly until the desired memory location number and preset time are displayed.

### Canceling Preset Time

Press button (6) repeatedly until no more memory location number is visible on the display.

### Setting Operating Time

1. With heater off, press button (8). Operating time flashes.
2. Press button (8) or (9) to set the operating time (between 1 and 120 minutes).
3. Wait 5 seconds. Operating time is stored.

The heater remains in operation for the preset time (except for continuous operation).

### Setting the Remaining Operating Time

1. With heater in operation, press button (8). Remaining operating time flashes.
2. Set remaining time with button (8) or (9).
3. Wait 5 seconds. Remaining operating time is stored.

### Operational Failure Symptoms via Fault/Flash code

On heaters equipped with a fault diagnosis system using coded light signals, the equipment-on indicator/operation indicator flashes. Refer to the following table.

## 12.3 TROUBLESHOOTING AND MAINTENANCE

Refer to the Webasto manual for more information.

### NOTE

If there are no heater faults, the heater will go through a normal start cycle and regulate based on thermostat setting.

### NOTE

Switch on the preheating system briefly about once a month, even during the warm season.

### CAUTION

**When welding on the vehicle, disconnect the preheater module connector in order to protect this system from voltage surges.**

### CAUTION

**To avoid running down the batteries, do not turn on the preheating system for more than one hour before starting the engine.**

### WARNING

**The preheating system uses the same fuel as the engine. Do not operate in a building or while refueling. Operate only in a well-ventilated area.**

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Failure Symptom	Probable Cause	Check and Correct
<b>1X Flash (F 01)</b> No combustion after completion of start up sequence.	- Fuel system  - Combustion air - Electronic ignition	- Fuel level - Type of fuel being used - Fuel filter - Fuel line connections (air bubbles in fuel lines) - Fuel nozzle plugged - Air intake or exhaust, restricted or plugged - Incorrect electrode gap
<b>2X Flashes (F 02)</b> Flame out during burner operation no restart possible	- Fuel supply (shortage of fuel)	- Restriction in the fuel system - Fuel filter - Fuel line connections (air bubbles in fuel lines) - Type of fuel being used
<b>3X Flashes (F 03)</b> Low voltage for more than 20 seconds	- Electrical system	- Load test batteries - Corrosion at connections - Loose connections
<b>4X Flashes (F 04)</b> Flame detector recognizes false flame signal during pre-start or shut-down cycle	- Defective flame detector	- Replace flame detector
<b>5X Flashes (F 05)</b> Flame detector	- Wiring - Defective flame detector	- Damaged wiring, open or short circuit - Replace flame detector
<b>6X Flashes (F 06)</b> Temperature sensor	- Wiring - Defective temperature sensor	- Damaged wiring, open or short circuit - Replace temperature sensor
<b>7X Flashes (F 07)</b> Fuel solenoid valve	- Wiring - Defective solenoid valve	- Damaged or corroded wiring, open or short circuit - Replace solenoid valve
<b>8X Flashes (F 08)</b> Combustion air fan motor	- Wiring - Wrong RPM - Defective combustion air fan motor	- Damaged wiring, open or short circuit - Replace combustion air fan - Replace combustion air fan
<b>9X Flashes (F 09)</b> Circulation pump motor	- Wiring - Defective circulation pump motor	- Damaged wiring, open or short circuit - Replace circulation pump motor
<b>10X Flashes (F 10)</b> Temperature limiter	- Overheat condition - Coolant flow  - Wiring - Defective temperature limiter	- Reset temperature limiter - Coolant level or flow restriction - Air trapped in coolant circuit - Damaged or corroded wiring, open or short circuit - Replace temperature limiter
<b>11X Flashes (F 11)</b> Electronic ignition coil	- Wiring - Defective electronic ignition coil	- Damaged wiring, open or short circuit - Replace electronic ignition coil
<b>12X Flashes (F 12)</b> Heater lock out	- 3 repeated faults/flame-outs or 5 repeated start attempts	- Reinitialize control unit by switching heater on and disconnecting power.

**13. SPECIFICATIONS**

**Passenger's unit evaporator motor**

Make..... AMETEK ROTRON  
Type ..... BRUSHLESS DC MICROPROCESSOR CONTROLLED  
Voltage ..... 27.6 V DC  
Current draw ..... 68 amps  
Horsepower..... 2  
Revolution ..... 1400 & 1700 rpm  
Insulation ..... Class F  
Motor Prevost number..... 563586

**Passenger's unit condenser fan motors**

Make..... EBMPAPST  
Type ..... 12" AXIAL BRUSHLESS  
Voltage ..... 24 V DC  
Qty..... 4  
Prevost number..... 563461

**Passenger's unit evaporator air filter**

Make..... Permatron Corp.  
Type ..... Washable 1" X 23 3/8" X 43 1/2" Polypropylene filter  
Prevost number..... 871383

**Driver's unit evaporator motors**

Make..... MCC  
Voltage ..... 24 V DC  
Quantity ..... 2  
Prevost number..... 871135

**Driver's unit evaporator air filter**

Make..... MCC  
TYPE ..... Recirculating air 6-1/4" 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 (with A/C unities Parcel Rack) ..... 26 lbs (11.82 Kg)

**Compressor (Central HVAC system)**

Make..... Carrier Transicold  
 Capacity ..... 41 CFM  
 Model..... 05G Twin Port-134A  
 No. of cylinders ..... 6  
 Bore..... 2" (50,8 mm)  
 Operating speed..... 400 to 2200 rpm (1750 rpm. Nominal)  
 Minimum speed (for lubrication) ..... 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)

**A/C Compressor (Small HVAC system)**

Make..... Sanden  
 Model..... SD7H  
 Prevost number ..... 950436  
Approved oil ..... Sanden SP-20 (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

## Section 22: HEATING AND AIR CONDITIONING

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Voltage ..... 24 V DC  
Coil resistance at 68 °F (20 °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

Make..... Carrier Transicold  
Aluminium  
Prevost number ..... 452968  
Copper  
Prevost number ..... 453013

### Receiver tank (with sight glasses)

Make..... HENRY or PARKER  
Maximum pressure..... 450 psig  
Prevost number ..... 950261

### Filter Dryer assembly

Make..... ALCO  
Prevost number ..... 950332

### Moisture indicator

Make..... ALCO  
Prevost number ..... 950333

### 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 & passenger's hot water pneumatic valve**

Make.....BURKERT  
Type ..... Normally open  
Voltage ..... 24 V DC  
Pressure range..... 0 to 230 psi  
Max. temperature .....356°F  
Prevost number ..... 871252

**Hot Water recirculating pump**

Make.....M.P. pumps  
Voltage ..... 24 V DC  
Prevost number ..... 871342

**Driver's expansion valve**

Prevost number ..... 950221

**Main expansion valve**

Make.....CARRIER  
Prevost number ..... 950316

**Bypass solenoid water valve**

Make.....Parker Hannifin  
Bypass Prevost number ..... 870886  
Coil Prevost number..... 870886  
Repair kit Prevost number ..... 870980

**Preheating system**

Make.....WEBASTO  
Model..... THERMO 300  
Capacity ..... 104 000 Btu/h (30 kW)  
Heating medium ..... Coolant  
Rated voltage ..... 24 V DC  
Operating voltage..... 20-28 V DC  
Electric power consumption (without coolant recirc. pump) ..... 110 watts

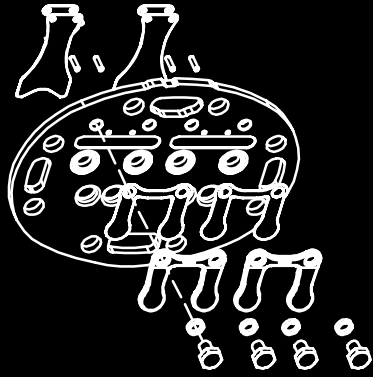
**Section 22: HEATING AND AIR CONDITIONING**

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Fuel consumption..... 1,2 US gallons/hr (4,5 liters/hr)  
Prevost number..... 871202



Compressor



WORKSHOP MANUAL  
for  
**MODEL 05G TWIN PORT  
COMPRESSOR**



**TRANSICOLD**

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# **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** - warns against an immediate hazard which **WILL** result in severe personal injury or death.



**WARNING** - warns against hazards or unsafe conditions which **COULD** result in severe personal injury or death.



**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	<b>05G-37CFM</b>	<b>05G-41CFM</b>
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)	
<b>SPEED (RPM) FOR OIL PUMP</b>		
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**

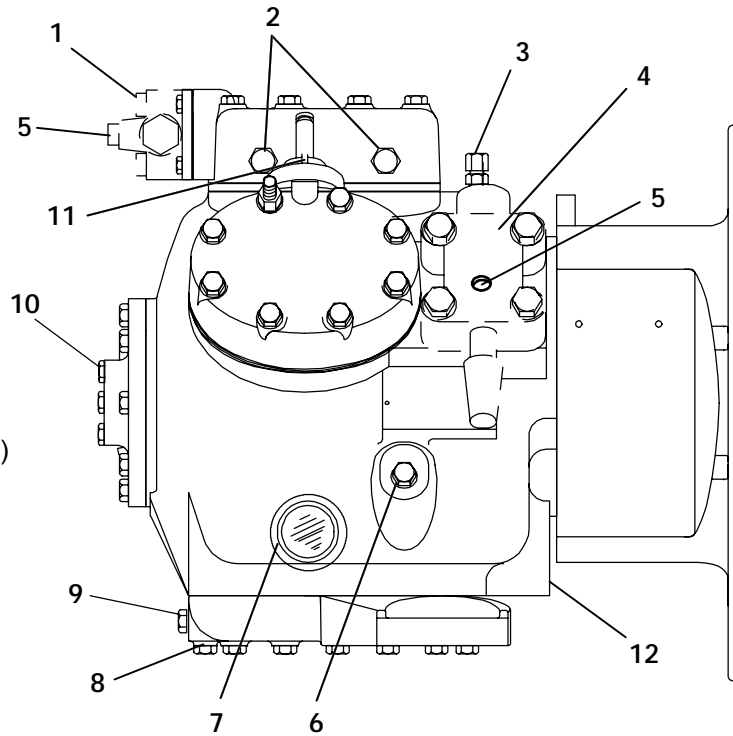
<b>Approved Oil for REFRIGERATION USE (TRAILER)</b>	
Refrigerant	Oil
R-12, R-22, R-500 or R-502	Alkyl Benzene (Synthetic) P/N 07-00274-00
R-404A	Polyolester (POE) P/N 07-00317-00PK6

<b>Approved Oil for AIR CONDITIONING USE (BUS AND RAIL)</b>	
Refrigerant	Oil
R-12, R-22, R-500 or R-502	Mineral (150 Viscosity) P/N 07-00275-00
R-12, R-22, R-502	Mineral (300 Viscosity) P/N 07-00377-00
R-22	Alkyl Benzene (Synthetic) P/N 07-00430-00
R-134a	Polyolester (POE) P/N 07-00317-00PK6

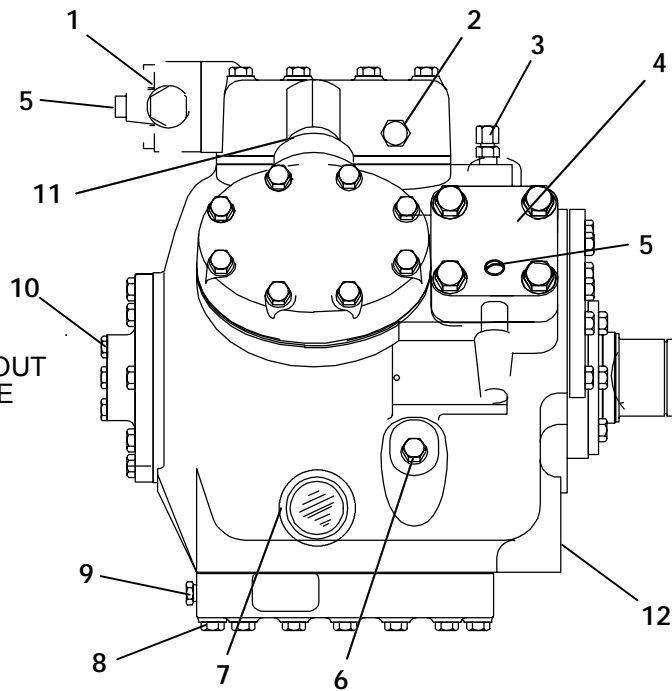
#### NOTE

Proper use and storage of Polyester (POE) type oil used with HFC refrigerants is critical. This type of oil is extremely hygroscopic, meaning that if allowed to become exposed to the atmosphere, it can collect moisture that leads to the formation of acids that will damage refrigeration components. Some refrigeration assemblies such as o-ring assemblies, compressor shaft seals and most solenoid valves require that refrigerant oil be applied to some of the parts during the assembly process. When this is needed, always use alkylated benzene oil CTD P/N 07-00274 (Zerol 150) even for R134a or R404A systems. All refrigerant oils must be stored in a sealed, airtight container.

COMPRESSOR WITH  
MOUNTING FLANGE  
(ULTRA TYPE SHOWN)



COMPRESSOR WITHOUT  
MOUNTING FLANGE



- |                             |                               |
|-----------------------------|-------------------------------|
| 1. Discharge Service Valve  | 7. Oil Level Sight Glass      |
| 2. High Pressure Connection | 8. Bottom Plate               |
| 3. Low Pressure Connection  | 9. Oil Drain Plug             |
| 4. Suction Service Valve    | 10. Oil Pump (See Figure 1-3) |
| 5. Gauge Connection         | 11. Unloader                  |
| 6. Oil Fill Plug            | 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 its temperature and pressure. The compressed gas is prevented from re-entering the cylinder on its next downstroke by the compressor discharge valve. (See Figure 1-2)

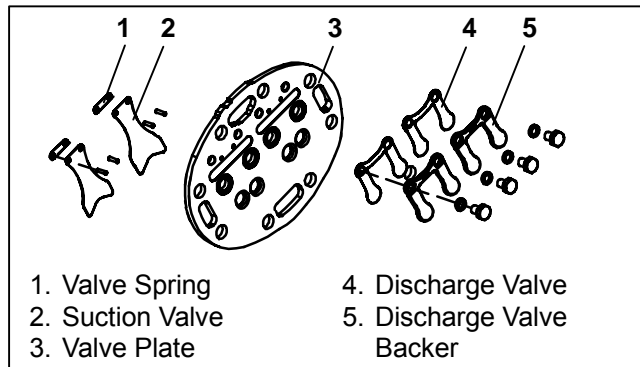


Figure 1-2. Suction & Discharge Valve

### 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.

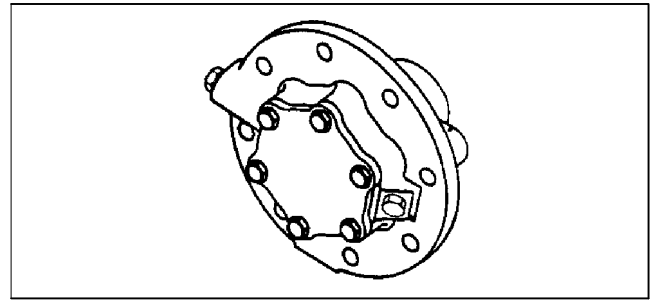


Figure 1-3. Oil Pump

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

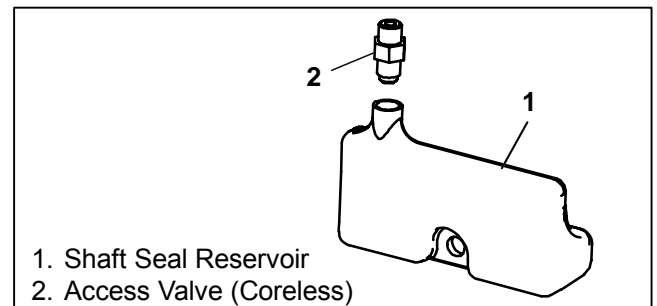


Figure 1-4. Shaft Seal Reservoir

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.

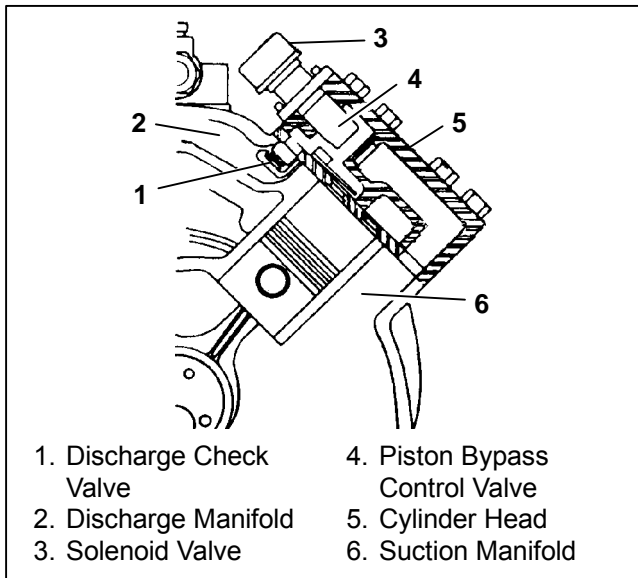


Figure 1-5. Compressor Unloader

#### 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.

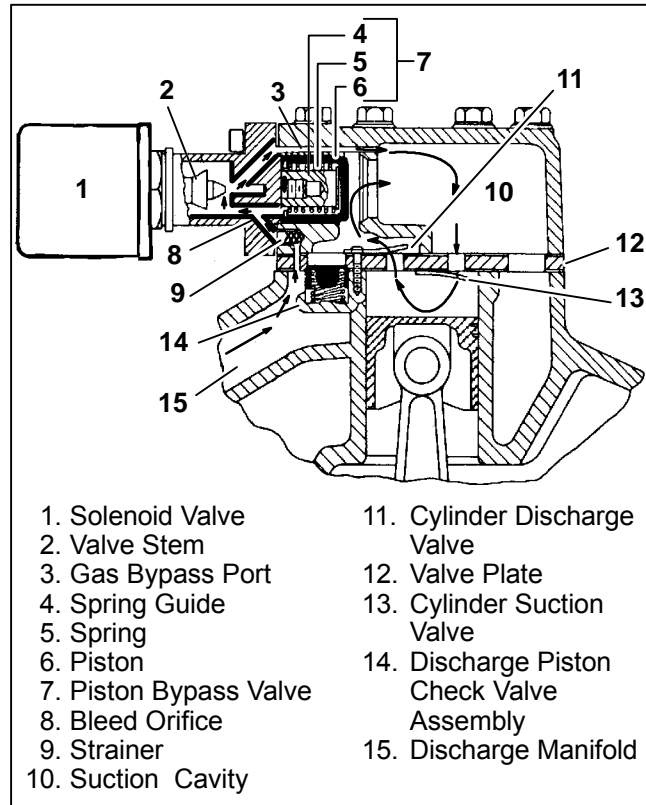


Figure 1-6. Electric-Operated Unloader- Unloaded Operation

#### c. Loaded Operation

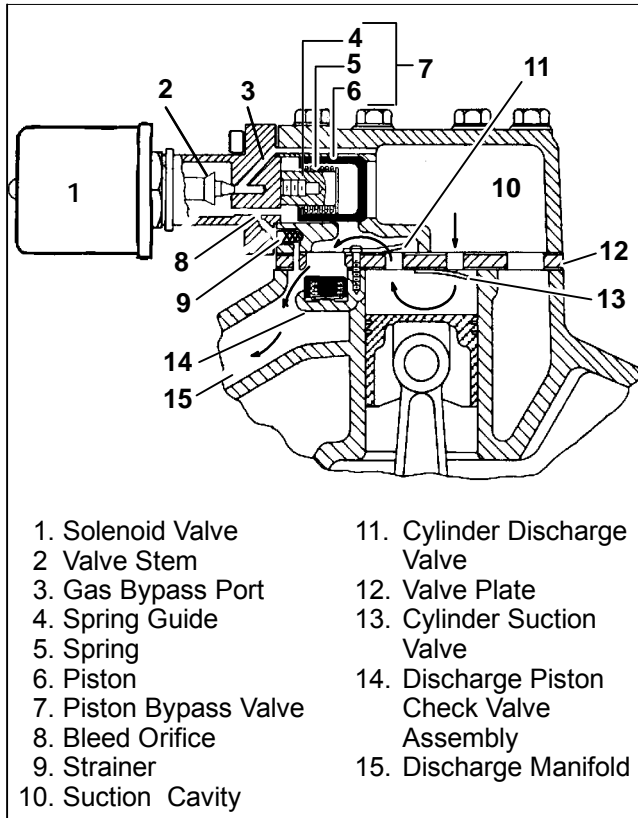
Discharge pressure bleeds from the discharge manifold (Figure 1-7, item 15) through the strainer (9) and bleed orifice (8) to the solenoid valve stem (2) chamber and the back of the piston bypass valve (7).

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.



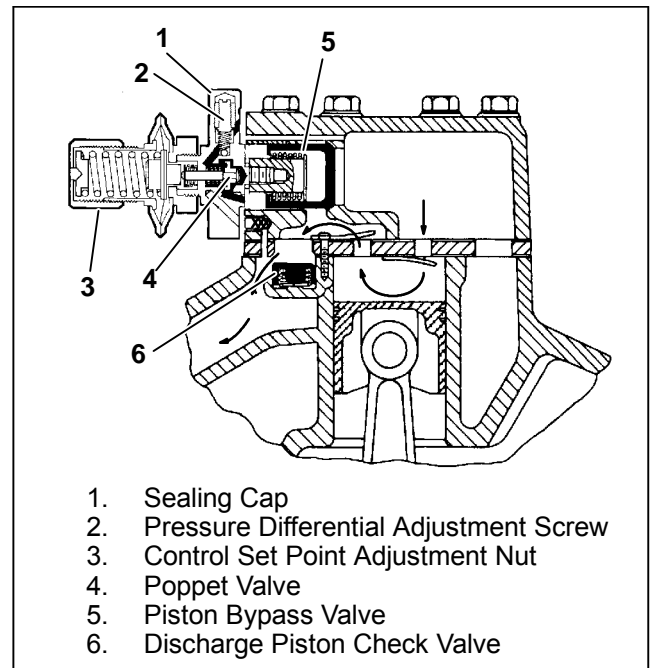
**Figure 1-7. Electric-Operated Unloader - Loaded Operation**

### 1.5.2 Pressure-Operated Unloaders

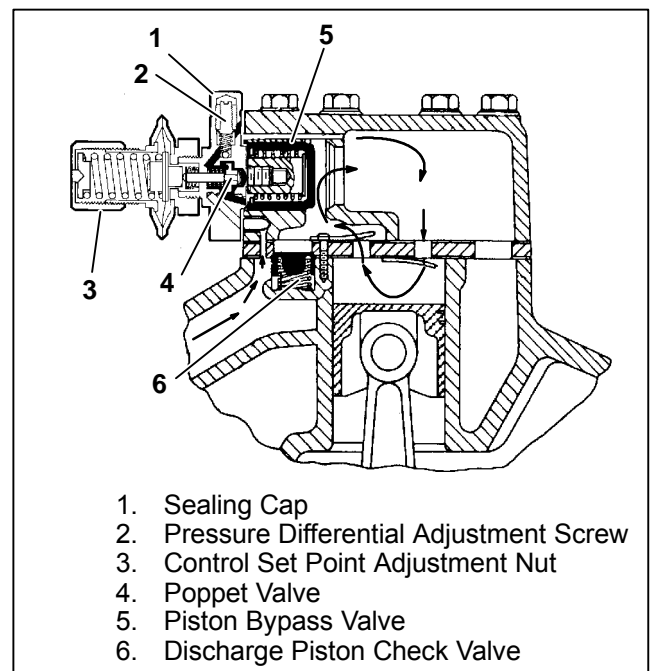
The pressure-operated unloaders are controlled by suction pressure and actuated by discharge pressure. The unloader valve controls two cylinders. On startup, controlled cylinders do not load up until differential between suction and discharge pressure is 10 psi (0.68 bar).

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.



**Figure 1-8. Pressure-Operated Unloader Loaded Operation**



**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.

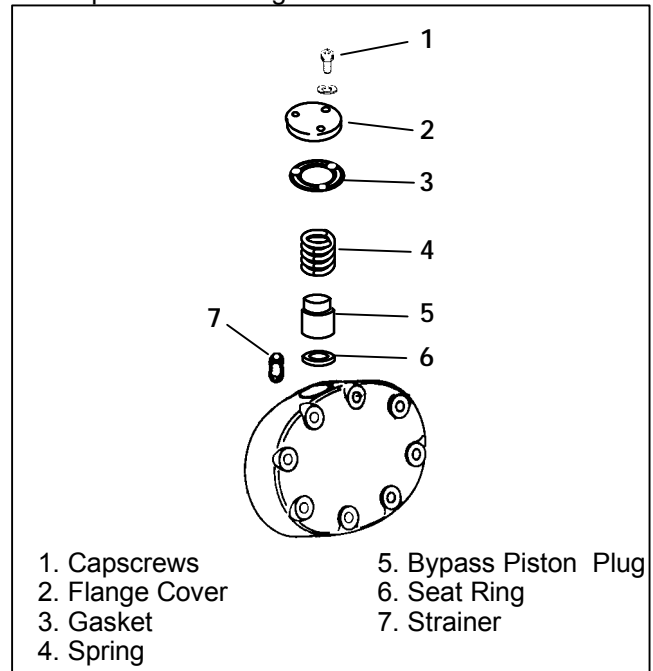
Service replacement compressors are furnished without suction and discharge service valves and unloader valves. The service valves are normally retained on the unit to isolate the refrigerant lines during compressor replacement. Blank-off pads are installed on the service replacement compressor valve 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.



**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.

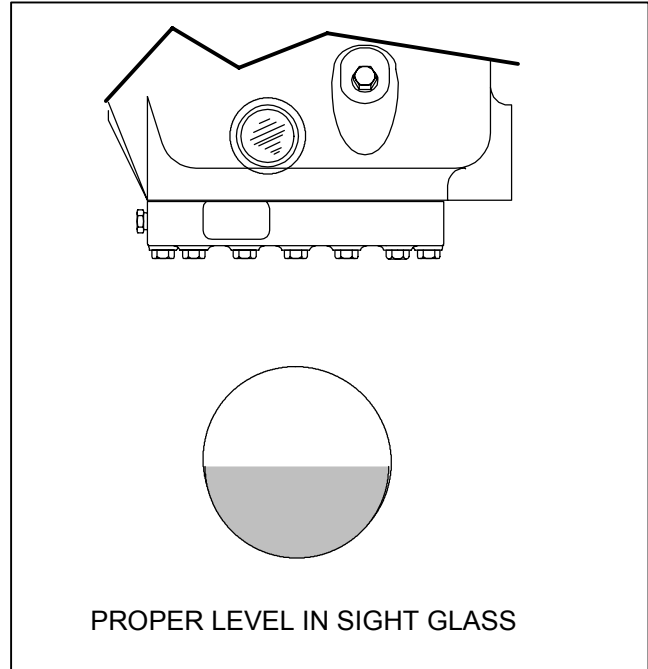
### **CAUTION**

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.

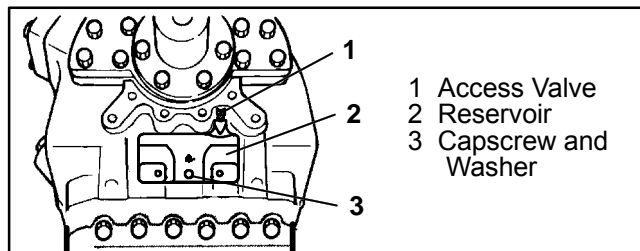


Figure 3-1. Shaft Seal Reservoir

#### NOTE

Do not return this oil to the compressor. 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



**Do not unscrew capscrews all the way before breaking seal. Entrapped pressure could result in injury.**

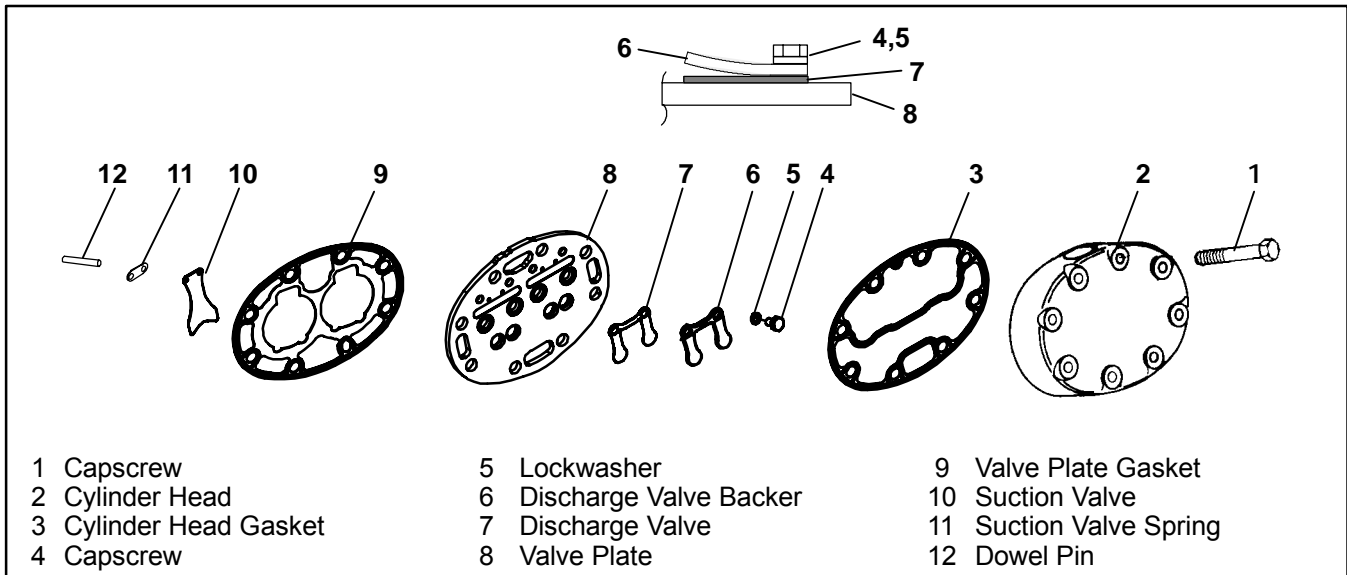
- a. Loosen cylinder head capscrews. If the head is stuck, tap it lightly with a wooden or lead mallet to free it. Be careful not to drop the head or damage the gasket sealing surface. Remove cylinder head capscrews and gasket. (See Figure 3-2)
- b. Remove the discharge valve capscrews, lock washers, 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

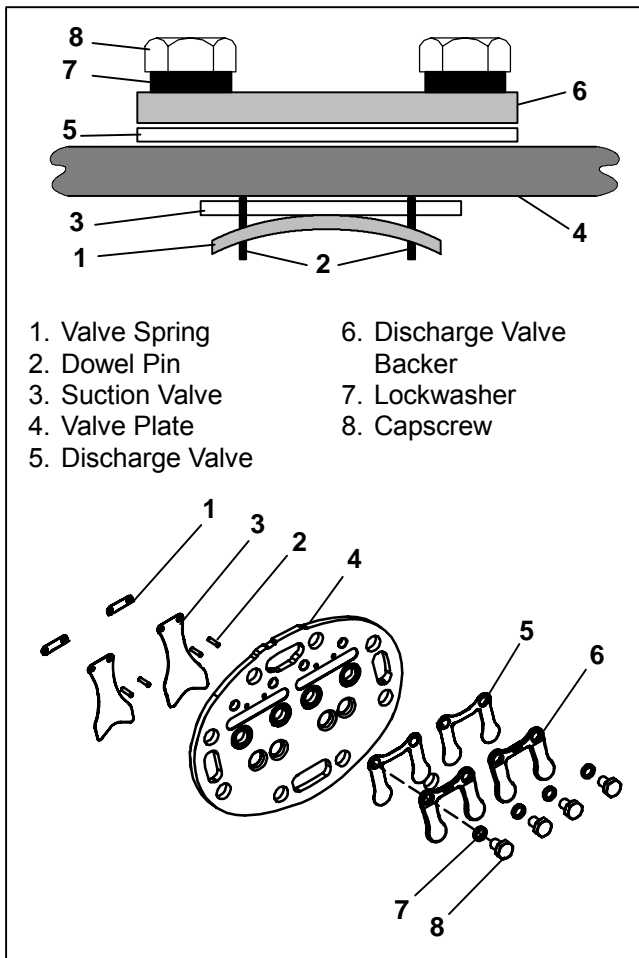
Install only new valves and gaskets, do not interchange valves.

- 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)



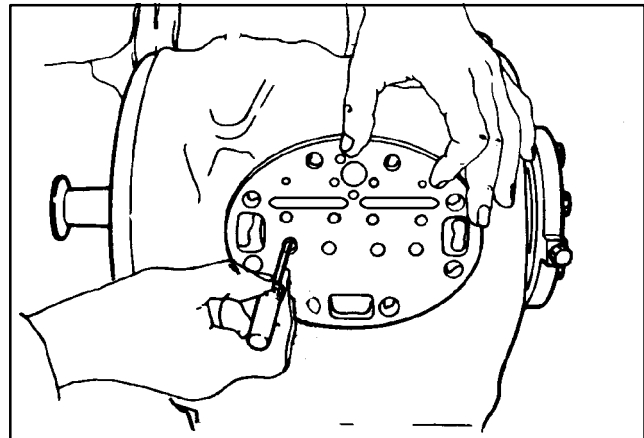


**Figure 3-2. Cylinder Head & Valve Plate**



**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 cap screws, 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 cap screws, in a diagonal pattern, to a value shown in Table 3-1.



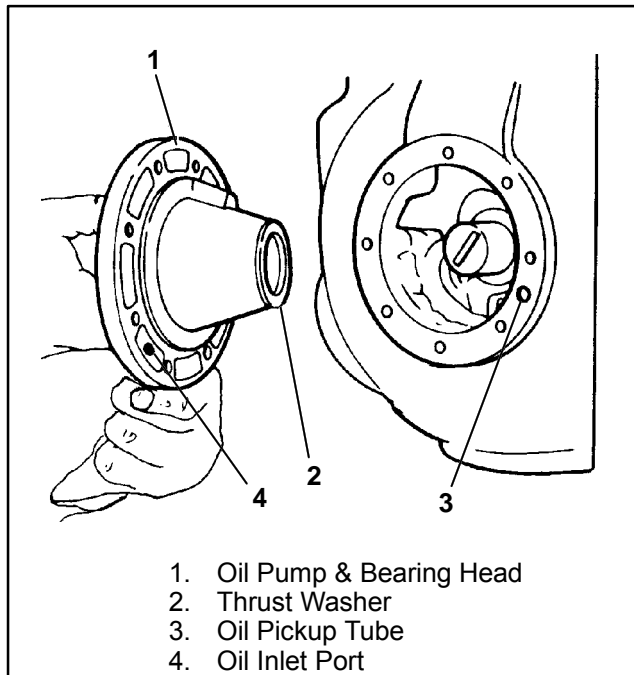
**Figure 3-4. Checking Suction Valve**

### 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.)

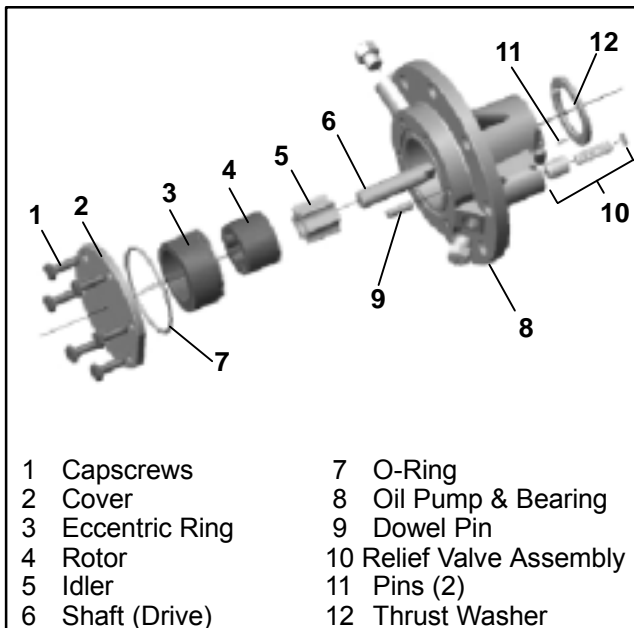


1. Oil Pump & Bearing Head
2. Thrust Washer
3. Oil Pickup Tube
4. Oil Inlet Port

**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.)



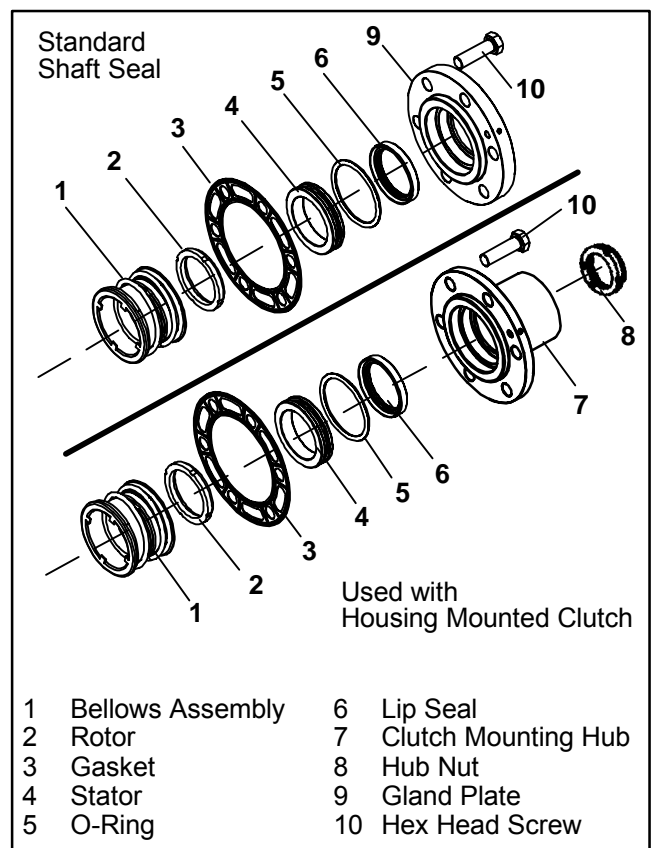
**Ensure that thrust washer does not fall off dowel pins while installing oil pump.**

- 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

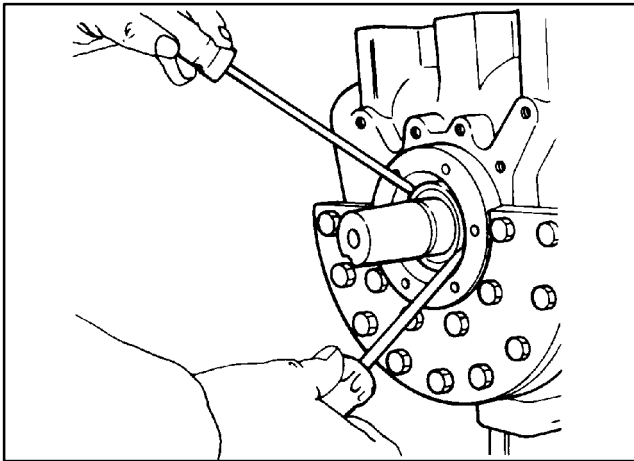
- a. Remove 6 capscrews, remove the shaft gland plate or clutch mounting hub. Remove rotor from top of bellows assembly. (See Figure 3-7)



- |                    |                       |
|--------------------|-----------------------|
| 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 lip seal 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

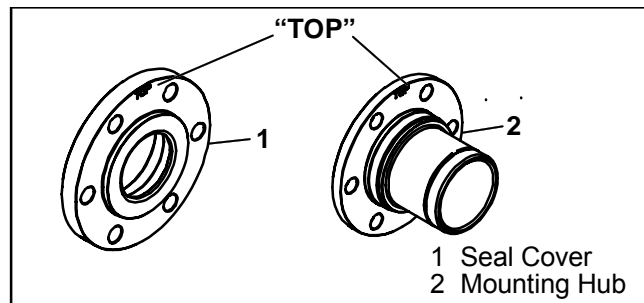
Do not touch the sealing surfaces with your fingers. If the sealing surfaces become contaminated, clean with isopropyl alcohol and a clean dry lint-free cloth.

- 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 assemblies, 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.

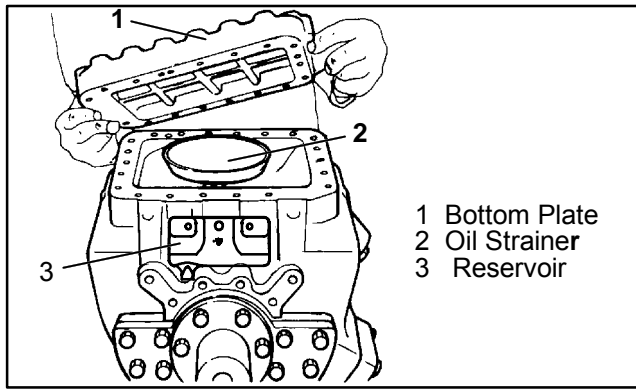


Figure 3-10. Bottom Plate Removal

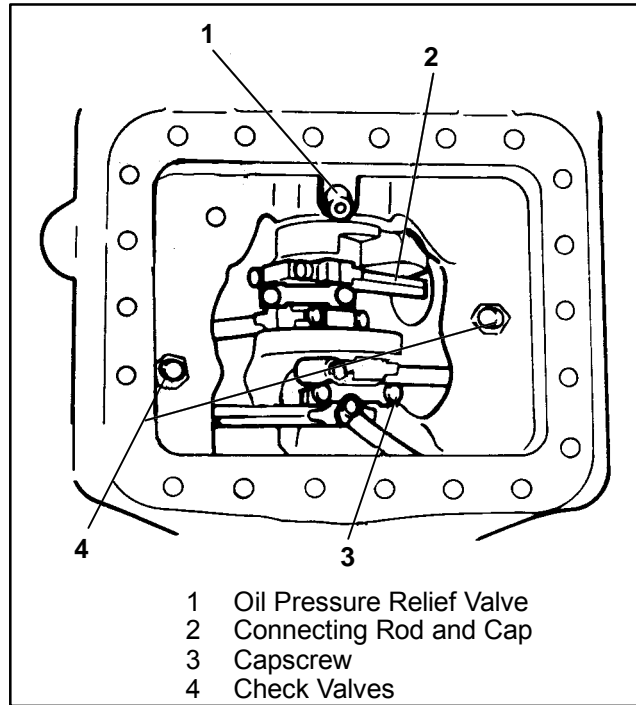


Figure 3-11. Bottom Plate and Oil Strainer Removed

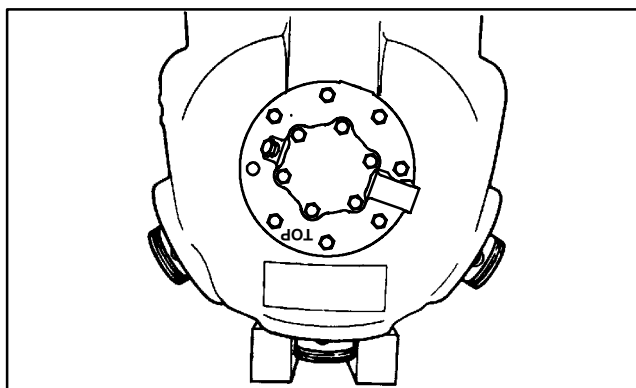


Figure 3-12. Piston Rings Removed

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



**Do not allow crankshaft to drop on connecting rods inside the crankcase when removing the crankshaft.**

- Push piston rod assemblies out of the way and remove crankshaft and seal end thrust washer.
- 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.
- 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.
- Remove piston rod assemblies.

### 3.7.3 Pistons, Rods, and Rings

- 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.
- Match mark and disassemble pistons, pins, connecting rods, and caps. (See Figure 3-13)

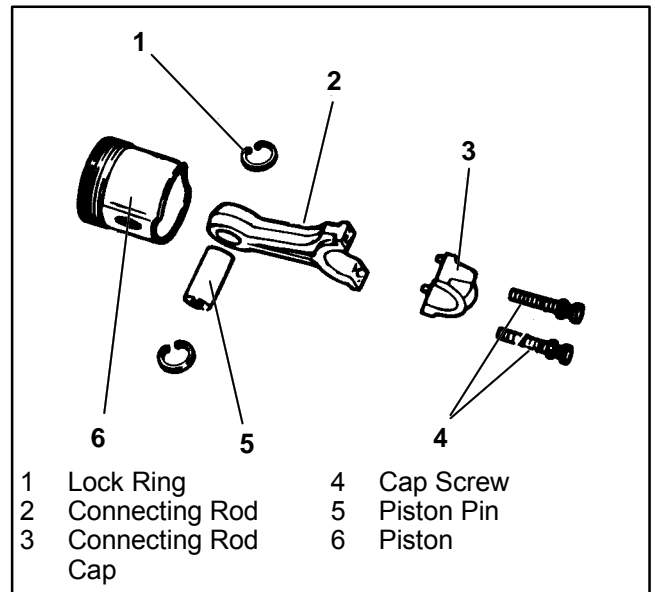


Figure 3-13. Connecting Rod, Piston, and Pin

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 .

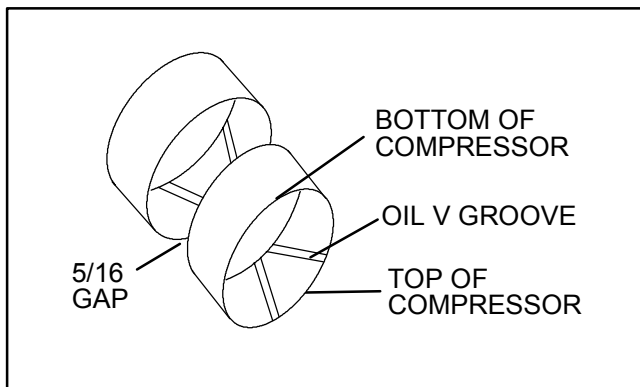
**3.7.4 Seal End Main Bearings**

- 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**

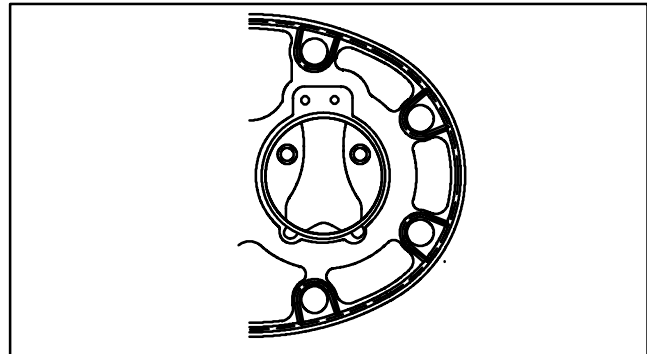
Prior to installing new piston rings, it is necessary to break the hard glazed surface of the cylinder in order to reduce the wearing-in period of the new rings. Break the glaze by honing lightly in an up and down rotating motion. Clean thoroughly after breaking glaze.

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.



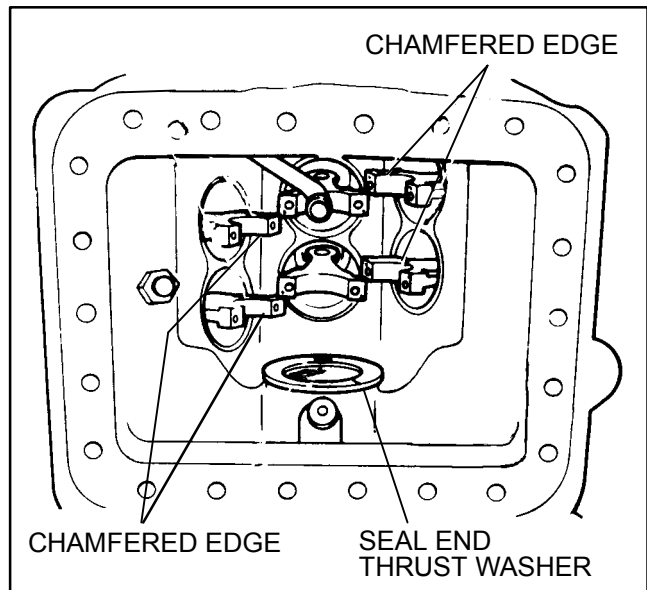
**Figure 3-15. Piston**

- 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.



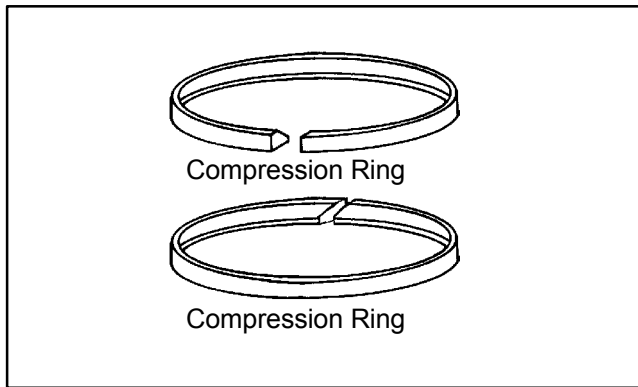
**Figure 3-16. Correct Piston in Cylinder Orientation**

- 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

- 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).
- 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.



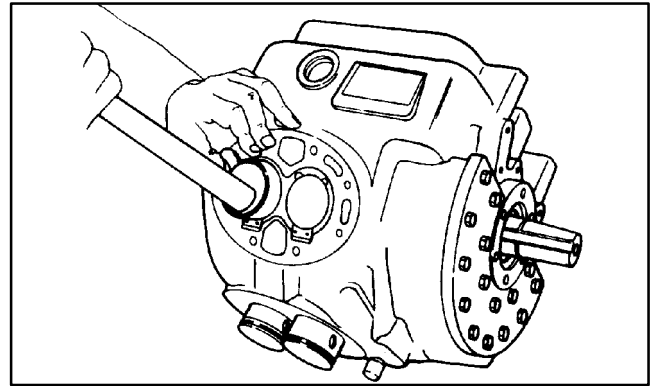
## CAUTION

**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

- 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.
- 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.
- 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**

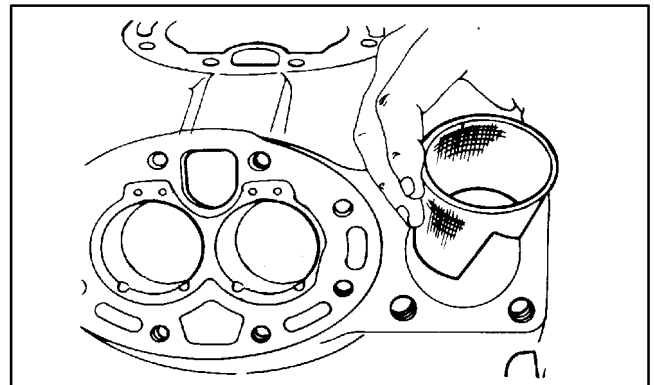
- Clean and reinstall the oil strainer.
- Using a new gasket, install the bottom cover plate. See figure 1-1 for relative location of compressor mounting flanges. Torque cover capscrews, in a diagonal pattern, to the torque value shown in Table 3-1.
- Reassemble the cylinder head, oil pump and shaft 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.

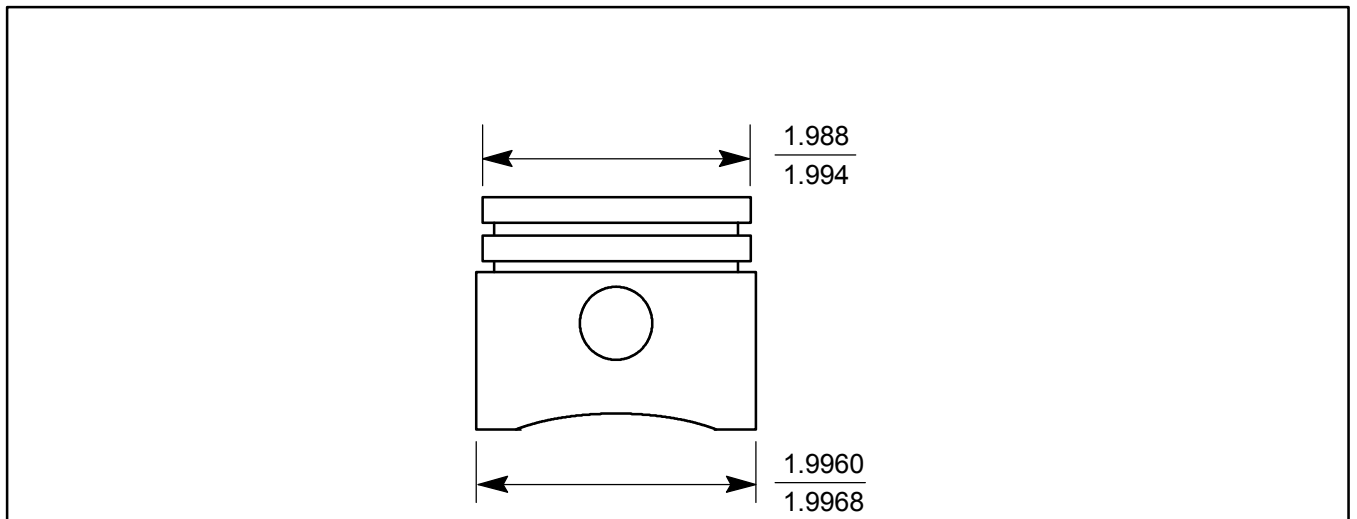
**Table 3-1. Torque Values**

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
<b>SEAL END</b>						
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
<b>PUMP END</b>						
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
<b>CONNECTING ROD</b>						
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
<b>CRANKSHAFT</b>						
Crankpin Diameter	1.3740	34.8996	1.3735	34.8869	.0025	0.0635
Throw - Height <b>(37 CFM)</b>	0.9698	24.6329	0.9678	24.5821	-	-
Throw - Height <b>(41 CFM)</b>	1.072	27.2288	1.070	27.1780	-	-
<b>THRUST WASHER (Thickness)</b>						
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
<b>CYLINDERS and PISTONS</b>						
Bore	2.001	50.8254	2.000	50.800	.002	0.051
Piston (Diameter)	-	-	See Figure 3-21		.002	0.051
Piston Pin (Diameter)	0.6882	17.4803	0.6877	17.4676	.001	0.025
Piston Ring Gap	0.013	0.3302	0.005	0.127	.025	0.635
Piston Ring Side Clearance	0.002	0.051	0.001	0.0254	.002	0.051



**Figure 3-21. Piston Dimension (Wear Limits)**



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# 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

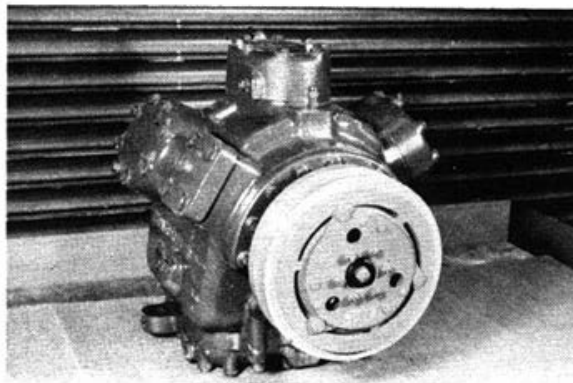
<u>DESCRIPTION</u>	<u>CTC PART NO.</u> <u>(WHERE APPLICABLE)</u>
Spanner Wrench	07-00240-01
Rotor Installation Tool	07-00241
Socket Bearing Retaining Nut-Large	07-00242-01
Socket Bearing Retaining Nut-Small	07-00242-02
3/8" Socket Set	
Torque Wrench	
3 Leg Puller w/ 3 1/4-20 UNC Cap Screws	
1 - Bolt 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.

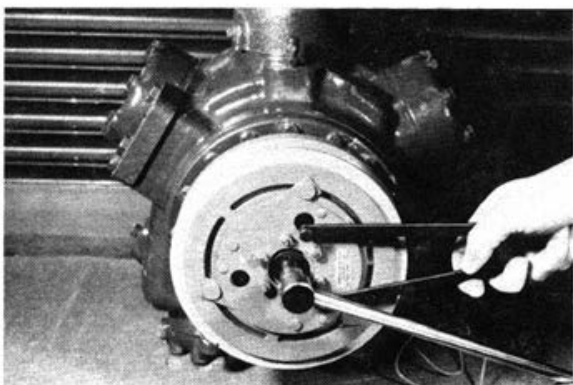
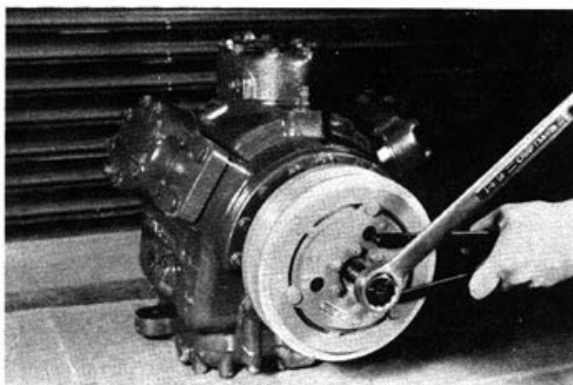
### Housing-Mounted Clutch Removal



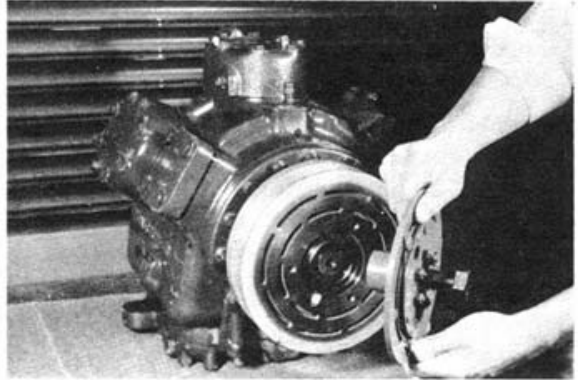
**CAUTION:** Remove drive belt before attempting to remove clutch.

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.

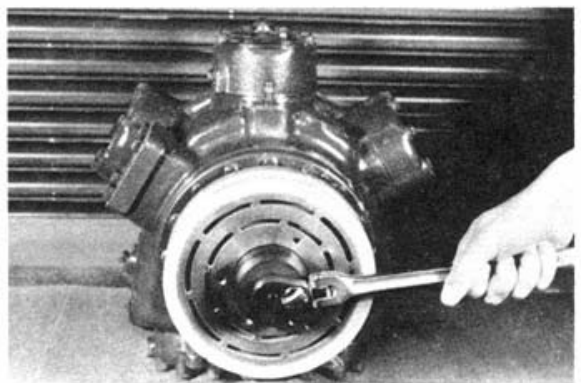
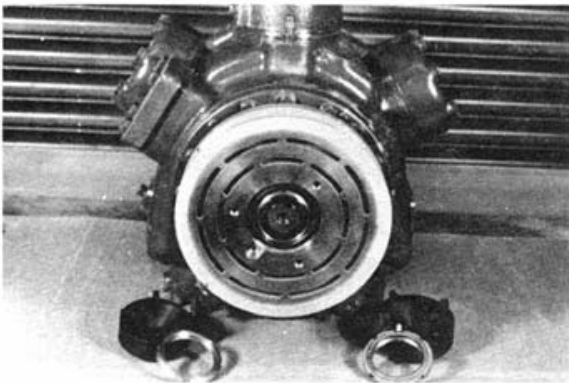
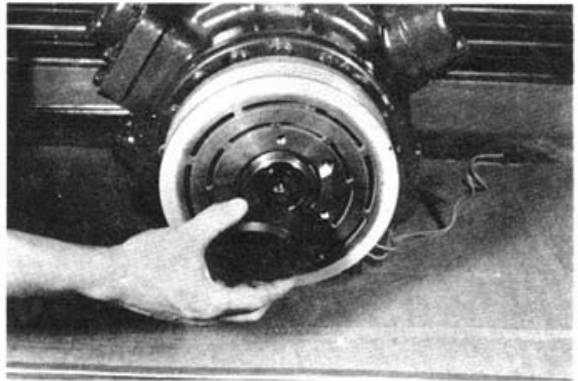
**Note:** Do not use a puller or pry against the armature hub or bumper plate, as this could cause damage to these parts.



3. Remove the clutch armature assembly from the compressor crankshaft as a complete assembly, as shown.

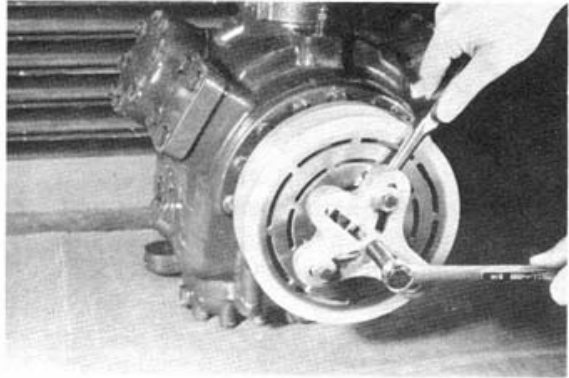


4. Remove the rotor retaining nut with special CTD tool P/N 07-00242-01.

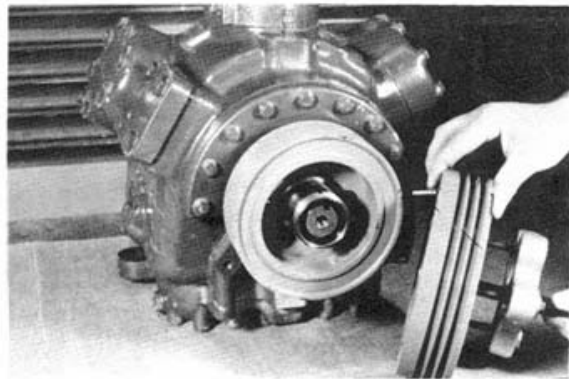


5. Install a flange-type gear puller into the three 5/16-18 tapped holes in the clutch rotor assembly, as shown.

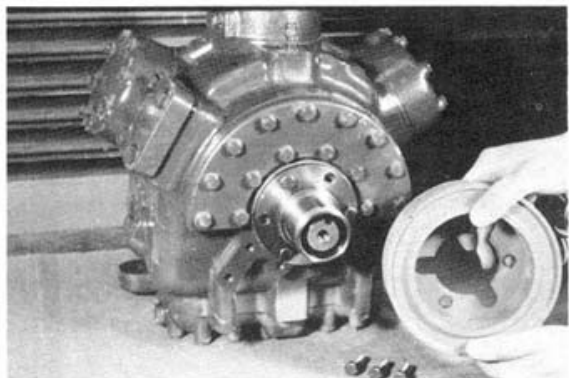
**CAUTION:** Use a washer or other protective device to prevent damage to crankshaft and threaded hole in the crankshaft by the puller. Never use a puller in the belt grooves, as damage to the rotor may result. Use a pry bar as shown to prevent rotation of the clutch rotor.



6. Once the rotor has been pulled from the clutch bearing mounting hub, carefully lift the rotor assembly away from the compressor, as shown.

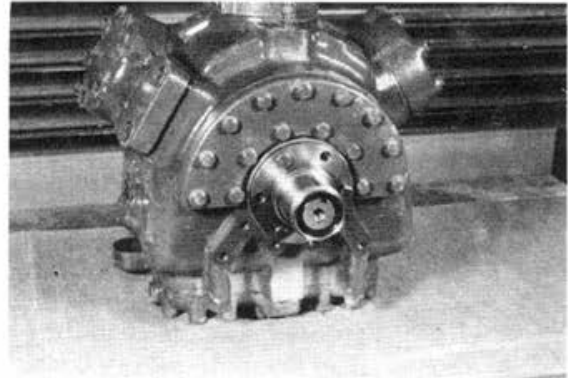


7. To remove the clutch coil, disconnect the coil's electrical cable from the wiring harness. Then remove only the three 3/8-16 capscrews holding the coil to the flange of the clutch bearing mounting hub, and carefully remove the coil, pulling straight out from the flange. Do not pry coil off, as it 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.



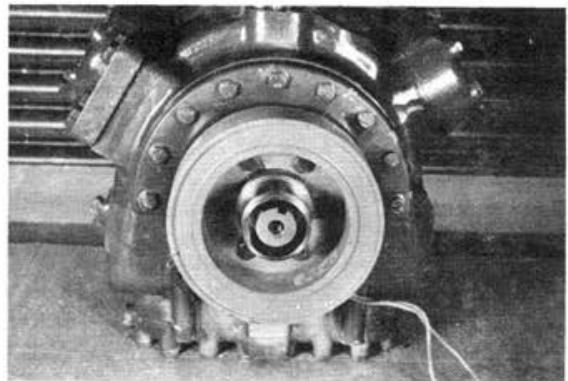
2. Inspect coil for damaged power leads, bent or cracked mounting plate, or burned or cracked potting material.

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).

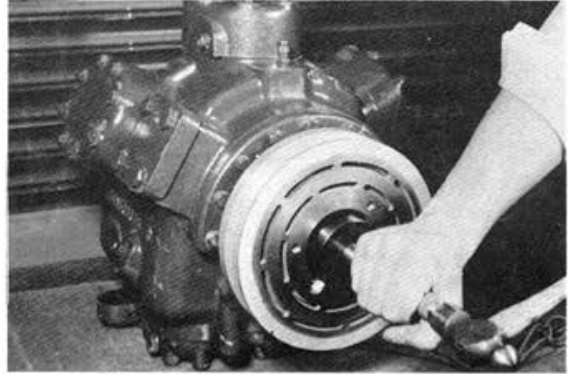
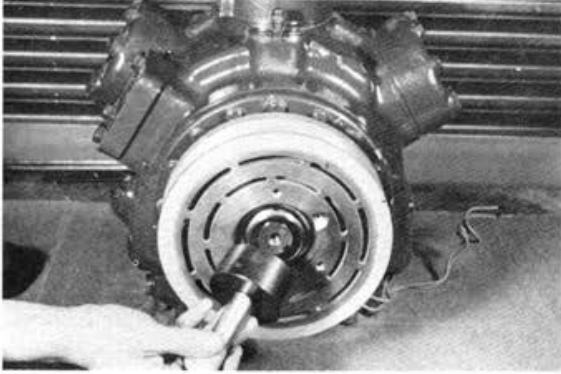
**CAUTION:** Do not draw coil onto the clutch bearing mounting hub flange with the capscrews, as this may distort the coil.

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.



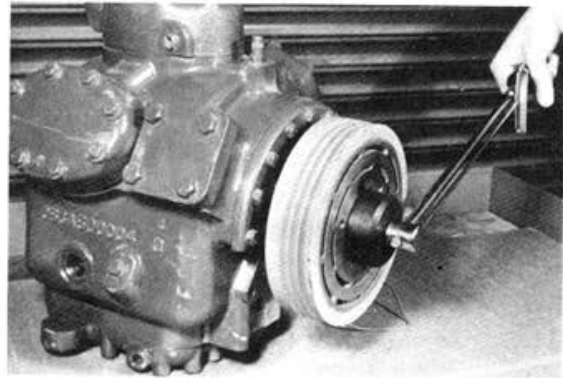
7. After preheating bearing, slide rotor assembly onto clutch bearing mounting hub. To facilitate seating of the bearing on the hub, place CTD tool P/N 07-00241 against the inner race of the bearing and tap gently with a hammer, as shown.



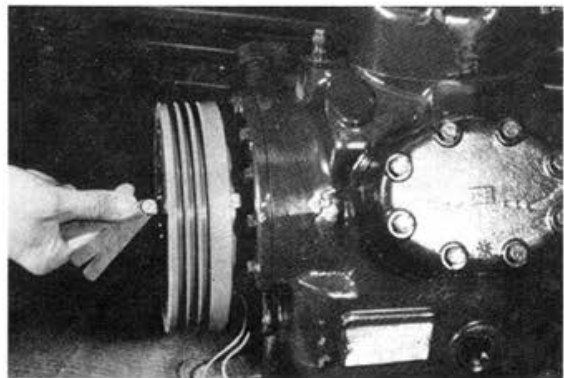
8. Install bearing retaining nut on clutch mounting hub and use torque wrench to tighten.

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.

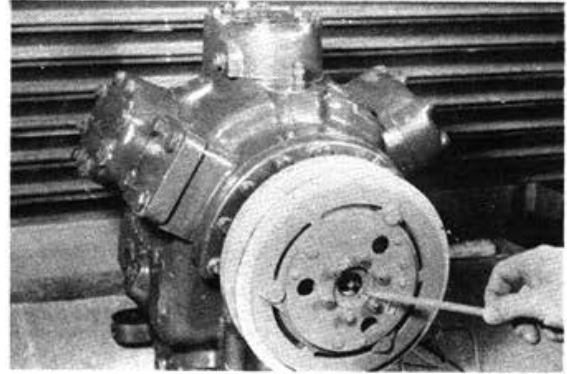
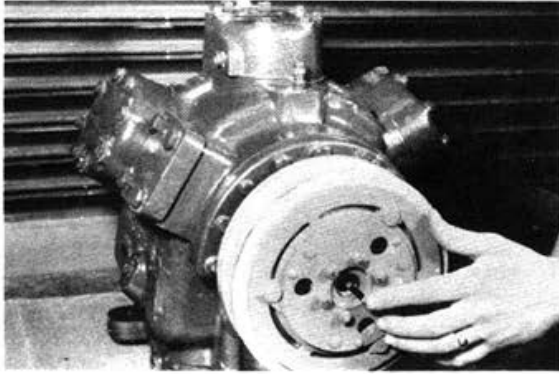
If the larger nut with the grease fitting is used, torque the nut with CTD tool P/N 07-00242-01. Due to the self-locking feature of the nut, the installation torque may vary. When installing the nut, observe the torque required to turn the nut onto the hub. After the nut seats the bearing against the 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.



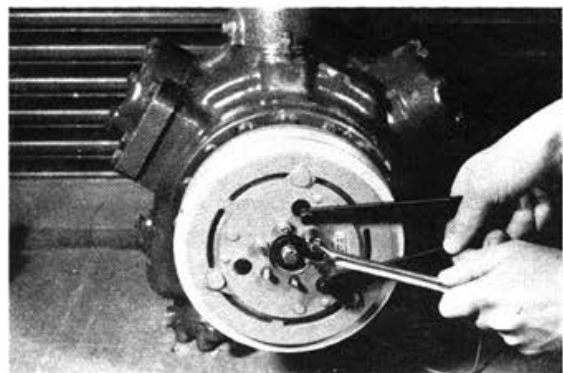
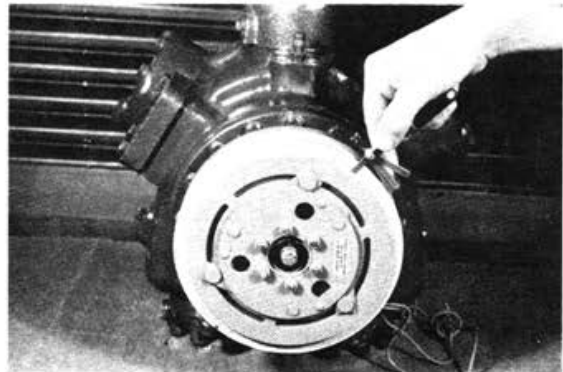
10. Place armature and hub assembly onto the compressor crankshaft and insure the hub seats on the crankshaft properly.
11. Insert the special key CTD P/N 68G2-9072 (1.75 x .250 x .199) in the keyway until outer end of key is flush with the hub's counter bore, as shown.



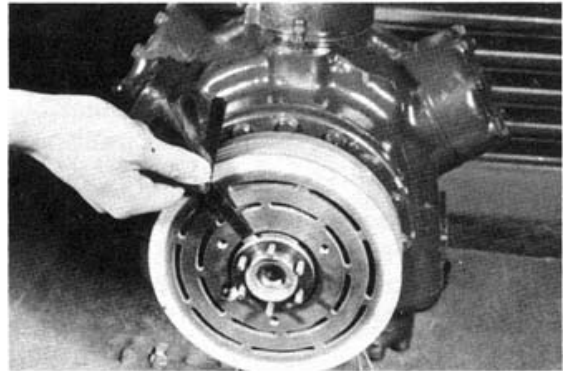
12. Secure armature assembly to crankshaft with the 3/8 special flat washer, lock washer, and 3/8-24 x 1-1/4" lg. capscrew removed in Step 1 of Clutch Removal. Torque capscrew to 16-20 ft-lb using CTD tool P/N 07-00240-01 to prevent crank shaft rotation.

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.

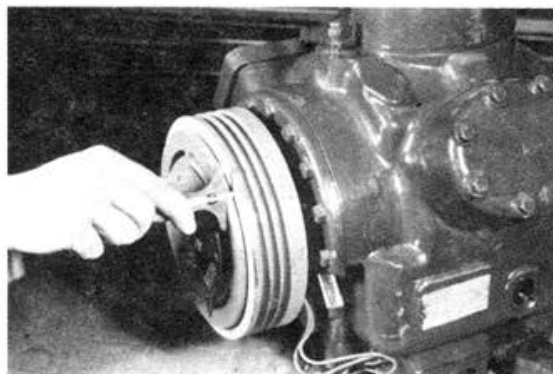
After adding grease to the bearing, wipe all grease spillage from clutch faces, retaining nut, and hubs. If you can see it, wipe it up.

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.

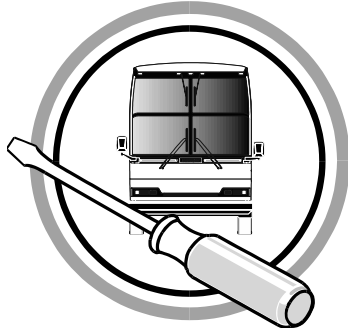
**NOTE:** Do not attempt to readjust the armature travel by removing shims. A catastrophic clutch failure may result. After initial (new) air gap adjustment the shim stack should never be changed.

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 be replaced.

C) If raised ribs on friction face are worn flat or nearly flat, replace armature and rotor assemblies.





**PREVOST**

ENREGISTRÉ - REGISTERED  
ISO 9001 & ISO 14001

**MAINTENANCE INFORMATION** Mi00-24



DATE : October 2000	SECTION : 22 - HVAC
SUBJECT : HEATING, VENTILATION AND AIR CONDITIONING (HVAC) SYSTEM MAINTENANCE	

**Important Notice:** This maintenance is recommended by Prévost Car to increase your vehicle's performance. Note that no reimbursement will be awarded for carrying out maintenance.

**APPLICATION**

Model
H3 series Coaches & Bus Shells Model Year : 1998 up
XL series Coaches & Bus Shells Model Year : 1998 up
XLII series Coaches & Bus Shells Model Year : 1999 up

**DESCRIPTION**

This is a reminder about the maintenance required for the heating, ventilation and air conditioning system. For more details on the system and its components, consult the operator's or the owner's manuals (care and maintenance) plus the maintenance manual (section 22).

**HVAC SYSTEM MAINTENANCE SCHEDULE**

Service every 6,250 miles (10 000 Km) or twice a year, whichever comes first.

DESCRIPTION	REMARKS	LUBRICANT &/OR PART <small>(depending on options, specifications may change. Consult your maintenance manual)</small>
Refrigerant Moisture Indicator	Replace filter dryer unit according to moisture indicator (as needed)	<b>Filter : #950262</b> <i>Coaches:</i> H3, XL-40, XL-45, XLII-40, XLII-45 <i>Bus Shells:</i> XL-40, XL-45E, XLII-40, XLII-45E  <b>Filter : #950231</b> <i>Bus Shells:</i> XL-45, XLII-45  <b>Filter : #950220</b> (auxiliary A/C system)

A/C Compressor	Check oil level, add if necessary	Polyolester Oil, HFC 134a compatible: Castrol SW-68 (POE) or equivalent
A/C Receiver Tank	Check refrigerant level, add if necessary	HFC 134a
Condenser coil	Clean with water	-----
A/C And Heating Air Filters	Replace elements (twice a year), clean every month	<p><b>XLII +H3</b>  Driver's : #871144 (<i>fresh air</i>)  #871147 (<i>return air</i>)  Passenger's : #871051</p> <p><b>XL Coaches</b>  Driver's : #871049  Passenger's : #871069</p> <p><b>XL Bus Shells</b>  Driver's : #871049  Passenger's : #871034</p>

**Service every 12,500 miles (20 000 Km) or once a year, whichever comes first.**

DESCRIPTION	REMARKS	LUBRICANT &/OR PART (depending on options, specifications may change. Consult your maintenance manual)
Parcel rack fan air filter	Clean	#871159
Evaporator coil	Clean with water	-----
Driver's evaporator coil	Clean with air	-----

**Service every 50,000miles (80 000 Km) or once a year, whichever comes first.**

DESCRIPTION	REMARKS	LUBRICANT &/OR PART
Flexible hoses	Inspect flexible hoses regularly	-----

**Miscellaneous Service**

DESCRIPTION	REMARKS	LUBRICANT &/OR PART (depending on options, specifications may change. Consult your maintenance manual)
Discharge Tubes*	<p>Every three months:  Check 2 condenser's discharge tubes  Check 6 evaporator's discharge tubes  Check 2 front discharge tubes</p> <p>* Discharge tubes are rubber tubes located under vehicle.</p>	-----
A/C system compressor drive belts	Check the drive belts conditions	Gates BX100 (Bosch Alternator) #506864 (set of 2) (mainly XLII Coaches, H3 Coaches from X2901)

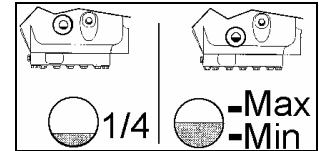


DESCRIPTION	REMARKS	LUBRICANT &/OR PART (depending on options, specifications may change. Consult your maintenance manual)
		Gates BX97 (Delco Alternator) #506664 (set of 2) (mainly XLII Bus Shells, XL coaches & Bus Shells, H3 VIP, H3 Coaches up to X2900)

## HVAC SYSTEM MAINTENANCE

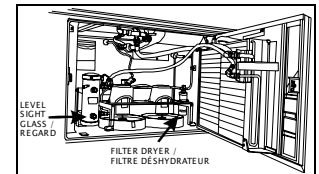
### A/C COMPRESSOR OIL LEVEL

Using the level sight glass, check the oil level. Depending on the sight glass location, oil level should be approximately at the first quarter or the mid-point. The oil fill plug is located on R.H. side of sight glass.



### RECEIVER TANK

The receiver tank is located in the condenser compartment. 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.

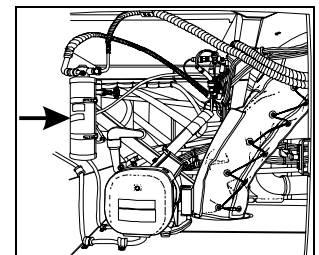
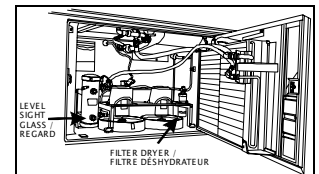


### FILTER DRYER

A filter dryer is located in the condenser compartment. The filter should be replaced if the system has been opened or after a prolonged exposure, when the moisture indicator sight glass turns to yellow.

A receiver-filter, located close to engine compartment L.H. side rear door, is installed on vehicles equipped with an auxiliary A/C system or a driver's system only. Its function is similar to that of filter and receiver used on main systems. Replace only when system is opened or a problem occurs.

**Note:** On XL2-45 vehicles, the receiver-filter is installed on wheel housing, inside L.H. side rear service compartment.



RECEIVER-FILTER LOCATION (XL2-45)

### A/C And Heating System Air Filters

For maximum air conditioning and heating system efficiency, air filters should be inspected and cleaned as required in maintenance schedule to ensure proper ventilation of the evaporator and heating radiator cores. To clean filters, back flush with water, then dry with air.

**Caution:** Do not use high pressure water jet to avoid damaging filter.

**Caution:** Be sure not to reverse filter upon installation.

### Driver's HVAC Unit Air Filter (XL, XLII, H3)

The driver HVAC system is located behind the dashboard's R.H. side lateral plastic panel. To gain access to the A/C filters, unscrew the R.H. lateral console's grill located at the top step of the entrance door steps. Slide out the R/A and F/A filters. Remove the filters for cleaning or replacement.

### Cabin Air Filter (XL & XLII coaches)

The central HVAC system's uses two air filters. They 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 screws is located in the wall separating the baggage compartment from the evaporator compartment. Slide out the upper filter first, then slide out the lower filter.

### Cabin System Air (H3 coaches + bus shells)

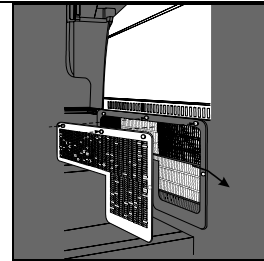
The central HVAC system's air filter is located in the A/C and heating compartment on L.H. side of the vehicle. To gain access, locate access panel in one of the baggage compartment adjacent to the A/C and heating compartment. Open panel by unscrewing ( $\frac{1}{4}$  turn) the three screws of either panel, unsnap both fasteners on top of filter and slide out the filter for cleaning.

### Main HVAC Unit Air Filters (XL & XLII bus shells)

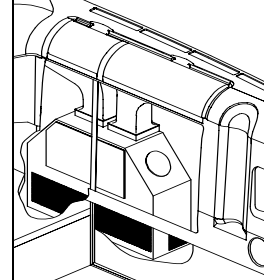
The main or cabin air filters are located in the evaporator compartment. To gain access, open evaporator compartment door. Remove filter panel by unscrewing the six fixing screws. Slide out the filters for cleaning or replacement.

### Parcel Rack fan Air Filter

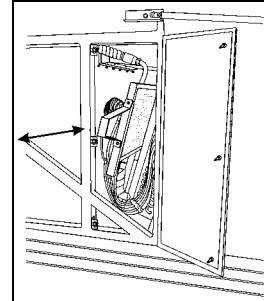
A/C condenser coils may be installed in both parcel rack air systems. Only the air filters are serviceable. The air filters are accessible from inside the parcel racks. Slide out the filters for cleaning or replacement.



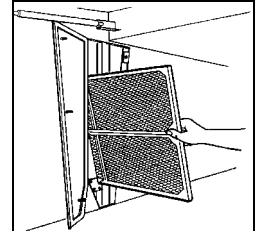
DRIVER'S AREA AIR FILTERS



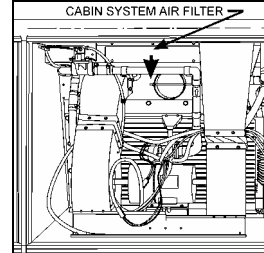
DRIVER'S AREA AIR FILTER (H3)



CABIN SYSTEM AIR FILTER (XL & XLII COACHES)



CABIN SYSTEM AIR FILTER (H3 COACHES & BUS SHELLS)



CABIN SYSTEM AIR FILTER REMOVAL (XL & XLII BUS SHELLS)

## COIL CLEANING

**Caution:** Use a water jet or water mixed with low air pressure to clean the coil.

**Caution:** Direct the pressure straight through the coil to prevent bending of fins and do not use extremely high pressure. Do not use hot water, steam or caustic soap.

### Central A/C system evaporator coil

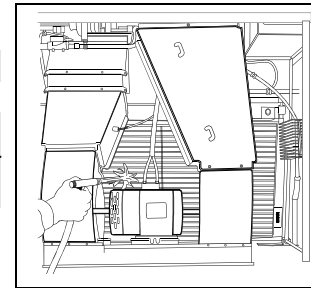
To gain access to the evaporator coil, open evaporator compartment door on L.H. side of vehicle. Check the external surface of the coil at regular intervals for dirt or any foreign matter. Clean with water jet.

### Central A/C system condenser coil

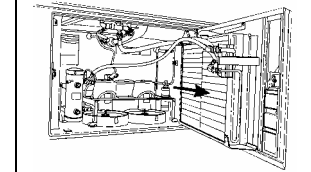
To gain access to the condenser coil, open condenser compartment door on R.H. side of vehicle. Check the external surface of the coil at regular intervals for dirt or any foreign matter. Clean with water jet.

### Driver's A/C system evaporator coil

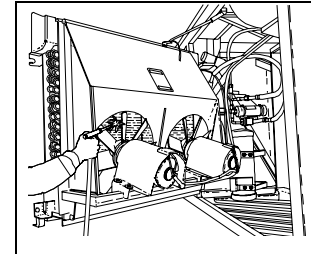
If necessary, clean with air.



EVAPORATOR COIL CLEANING



CONDENSER COIL CLEANING



CONDENSER COIL CLEANING (H3)

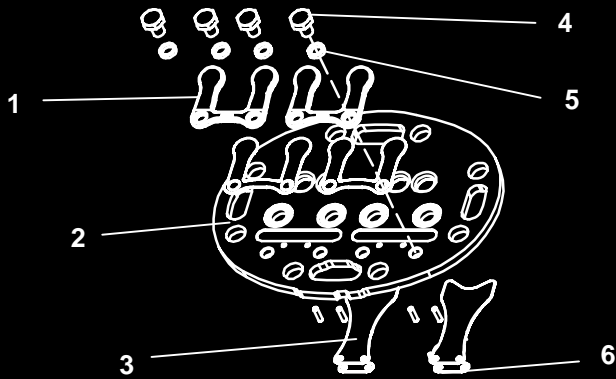
## Waste disposal :

Discard according to applicable environmental regulations (Municipal/State[Prov.]/ Federal)





Compressor



SERVICE PARTS LIST  
for  
**MODEL 05G TWIN PORT  
COMPRESSOR**



**TRANSICOLD**

## Service Parts List

# Model 05G Twin Port Compressor

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## INTRODUCTION

This parts list identifies service replacement parts for the 05G Twin Port Compressors listed in the Model Chart below. To find replacement parts, determine the major group in which the replacement parts are located (refer to the Table of Contents) and turn to the appropriate page for the illustrated parts breakdown of the replacement parts. A detailed list of the tools needed to service the 05G Twin Port Compressor may be found in the Service Tool List catalog 62-03213.

## MODEL CHART

<b>New Twin Port 05G Compressor Part Number</b>	<b>Carlyle/CSM Manufacturer's Number</b>	<b>Replaces This Part Number Of The Previous Design Three Port 05G Compressor</b>	<b>Compressor Configuration</b>	<b>Application</b>
18-00091-103	6GDG009UA0313A	18-00059-126RM	Ultra Bottom Cover, <b>37 CFM</b> , Contoured Pistons, Ultra Flange, 2 Electric Unloaders, No Oil	Trailer
18-00091-104	6GDG00BUA0313A	18-00059-128RM	Ultra Bottom Cover, <b>37 CFM</b> , Contoured Pistons, Ultra Flange With Clutch Hub, 2 Electric Unloaders, No Oil	Trailer With Standby
18-00091-105	6GDJ009UA0313A	18-00059-72RM	Ultra Bottom Cover, <b>41 CFM</b> , Contoured Pistons, Ultra Flange, 2 Electric Unloaders, No Oil	Trailer
18-00091-106	6GCG008WB03131	18-00059-130RM	Standard Bottom Cover, <b>37 CFM</b> , Contoured Pistons, Star Flange, 1 Electric Unloader, No Oil	Truck (Supra 9XX)
18-00091-150	6GCF00ATA03031	18-00059-169	Standard Bottom Cover, <b>37 CFM</b> , 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, <b>41 CFM</b> , Flat Pistons, Half Moon Flange With Hub, 2 Electric Unloaders, <b>5.8 Pints POE Oil</b>	Bus (R-134a)
18-00091-180	6GCF00A3A03031	18-00059-169	Standard Bottom Cover, <b>37 CFM</b> , 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

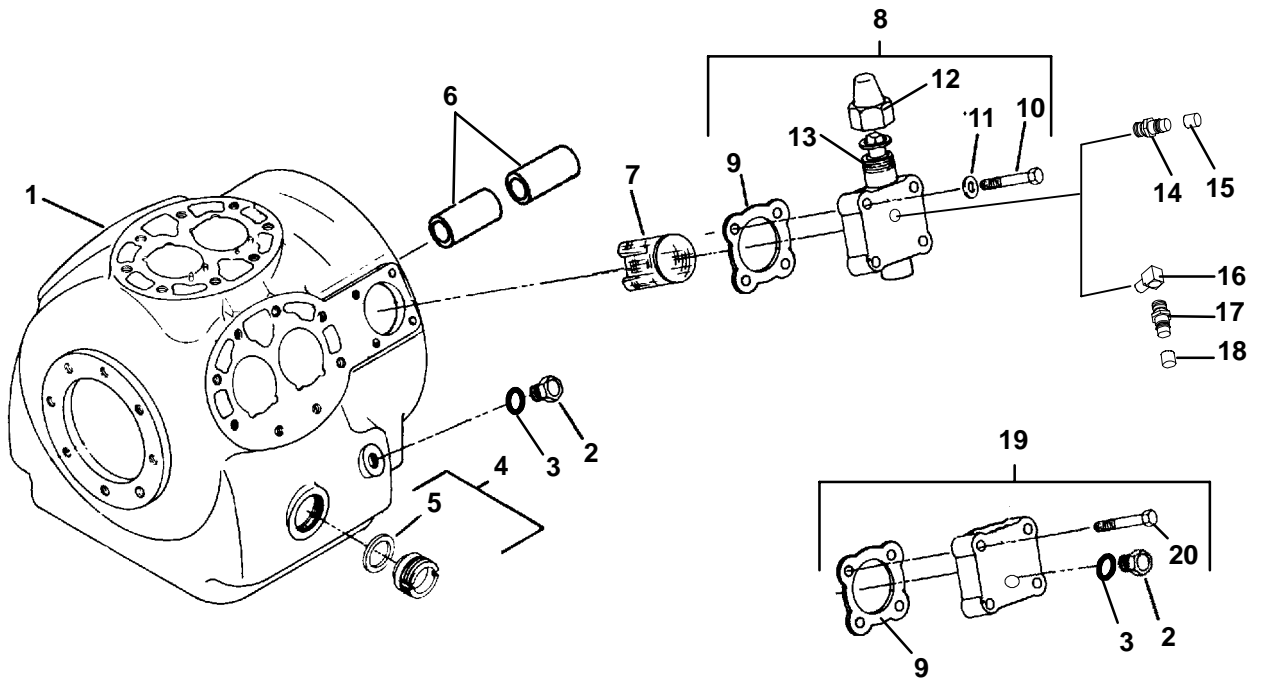
Part Number	Oil Type	Viscosity	Refrigerants	Application	Packaging
07-00275-00	Mineral	150	R-12, R-22, R-500, R-502	Large Bus	1 Gallon x 6
07-00377-00	Mineral	300	R-12, R-22, R-500	Large Bus	1 Gallon x 6
07-00430-00	Alkyl Benzene (A/B)	68	R-22	Large Bus	1 Gallon x 6
07-00274-00	Alkyl Benzene (A/B)	150	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.

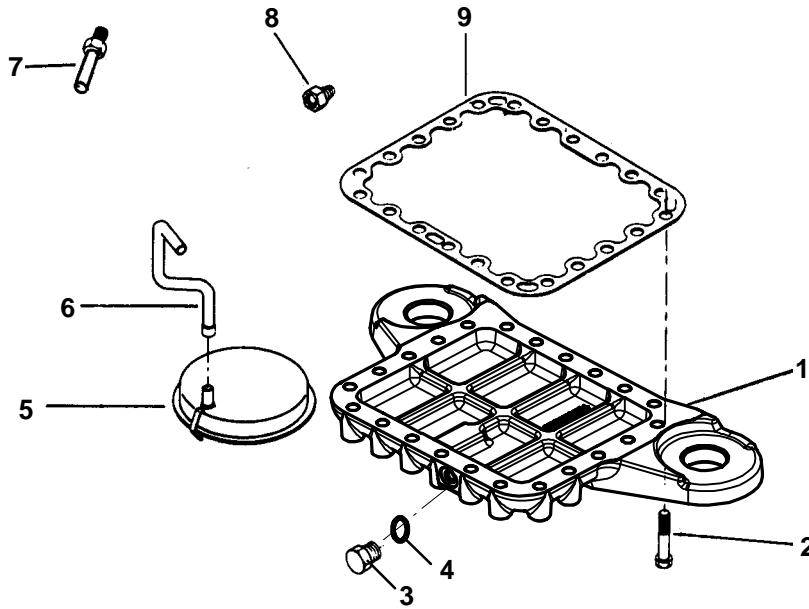


# 1 CRANKCASE AND SUCTION SERVICE VALVE



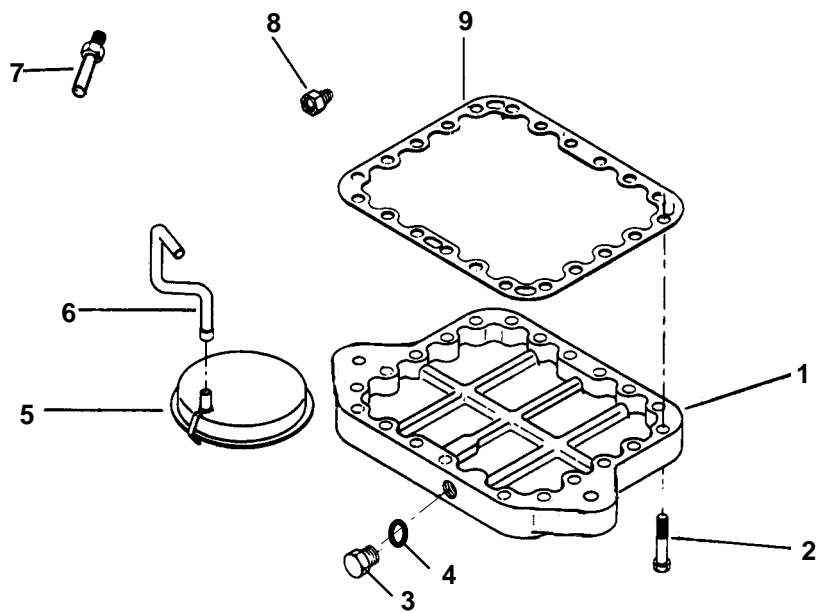
Item	Part Number	Description	Qty
1	NSA	Crankcase	1
2	17-44037-00	Plug, O-Ring, 7/16-20 - Includes:	1
3	42-00243-07	O-Ring	1
4	17-10218-00	Sight Glass, Oil Level - Includes:	2
5	17-10218-02	Gasket (Fiber)	1
	17-44021-00	Gasket (Metal)	1
6	17-44015-00	Bearing, Main Seal End (Requires Line Boring)	2
7	17-44005-00	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:	1
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)	1
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



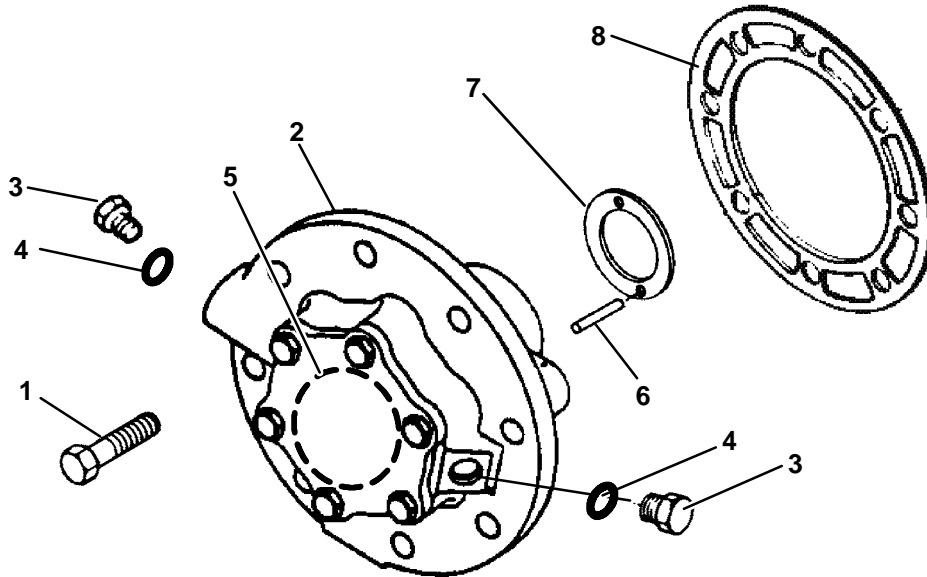
Item	Part Number	Description	Qty
1	17-44026-00	Plate, Bottom, Aluminum, (Ultra Style Compressors)	1
2	17-44117-00	Capscrew, Hex Head, 3/8-16 x 2-1/4 Inches Long - SAE Grade 8	22
3	17-44037-00	Plug, O-Ring, 7/16-20 - Includes:	1
4	42-00243-07	O-Ring	1
5	17-40020-00	Oil Filter Screen Assembly	1
6	17-40021-00	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



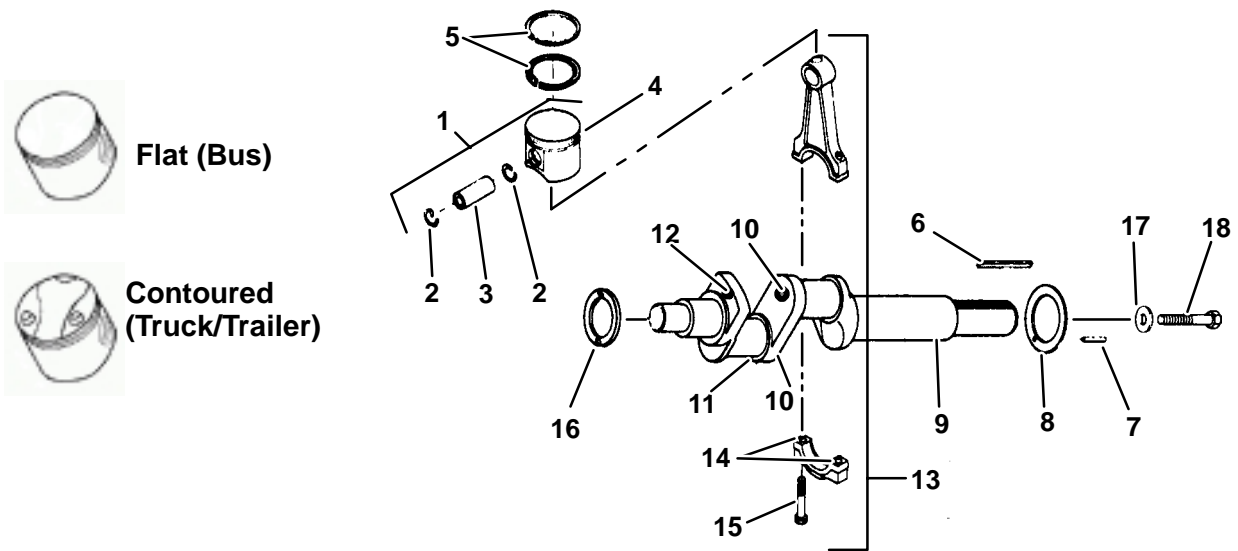
Item	Part Number	Description	Qty
1	17-44035-00	Plate, Bottom, Aluminum, (Non-Ultra Style Compressors)	1
2	17-44117-00	Capscrew, Hex Head, 3/8-16 x 2-1/4 Inches Long - SAE Grade 8	22
3	17-44037-00	Plug, O-Ring, 7/16-20 - Includes:	1
4	42-00243-07	O-Ring	1
5	17-40020-00	Oil Filter Screen Assembly	1
6	17-40021-00	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



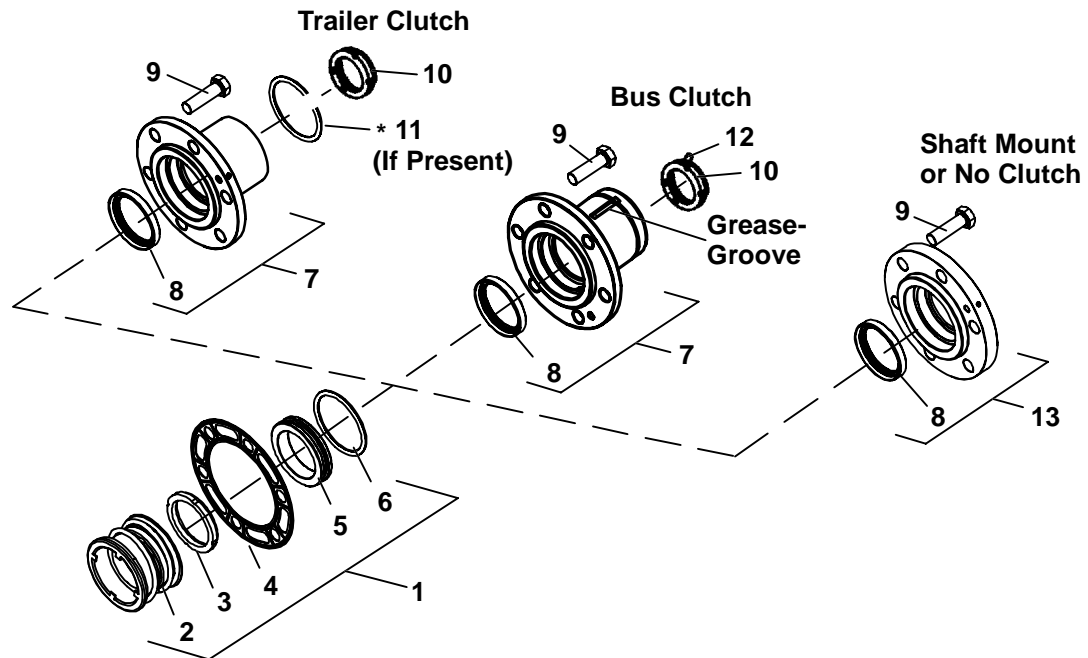
Item	Part Number	Description	Qty
1	17-10308-00	Capscrew, Hex Head, 3/8-16 x 1-1/4 Inches Long - SAE Grade 5	8
2	17-44137-00	Oil Pump and Bearing Head - Includes:	1
3	17-44037-00	Plug, O-Ring, 7/16-20 - Includes:	2
4	42-00243-07	O-Ring	2
5	17-44139-00	O-Ring, Pump Cover Plate	1
6	17-40204-00	Pin, Roll, 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)	1

## 5 CRANKSHAFT, ROD AND PISTON GROUP



Item	Part Number	Description	Qty
1	17-44045-01	Piston, 05G37 CFM, <b>Flat</b> , Standard - Includes:	6
	17-44045-03	Piston, 05G37 CFM, <b>Flat</b> , .020 Inch Oversize - Includes:	6
	17-44121-01	Piston, 05G41 CFM, <b>Flat</b> , Standard - Includes:	6
	17-44122-01	Piston, 05G41 CFM, <b>Flat</b> , .020 Inch Oversize - Includes:	6
1	17-44070-00	Piston, 05G37 CFM, <b>Contoured</b> , Standard - Includes:	6
	17-44071-00	Piston, 05G37 CFM, <b>Contoured</b> , .020 Inch Oversize - Includes:	6
	17-44072-00	Piston, 05G41 CFM, <b>Contoured</b> , Standard - Includes:	6
	17-44073-00	Piston, 05G41 CFM, <b>Contoured</b> , .020 Inch Oversize - Includes:	6
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)	1
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:	1
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

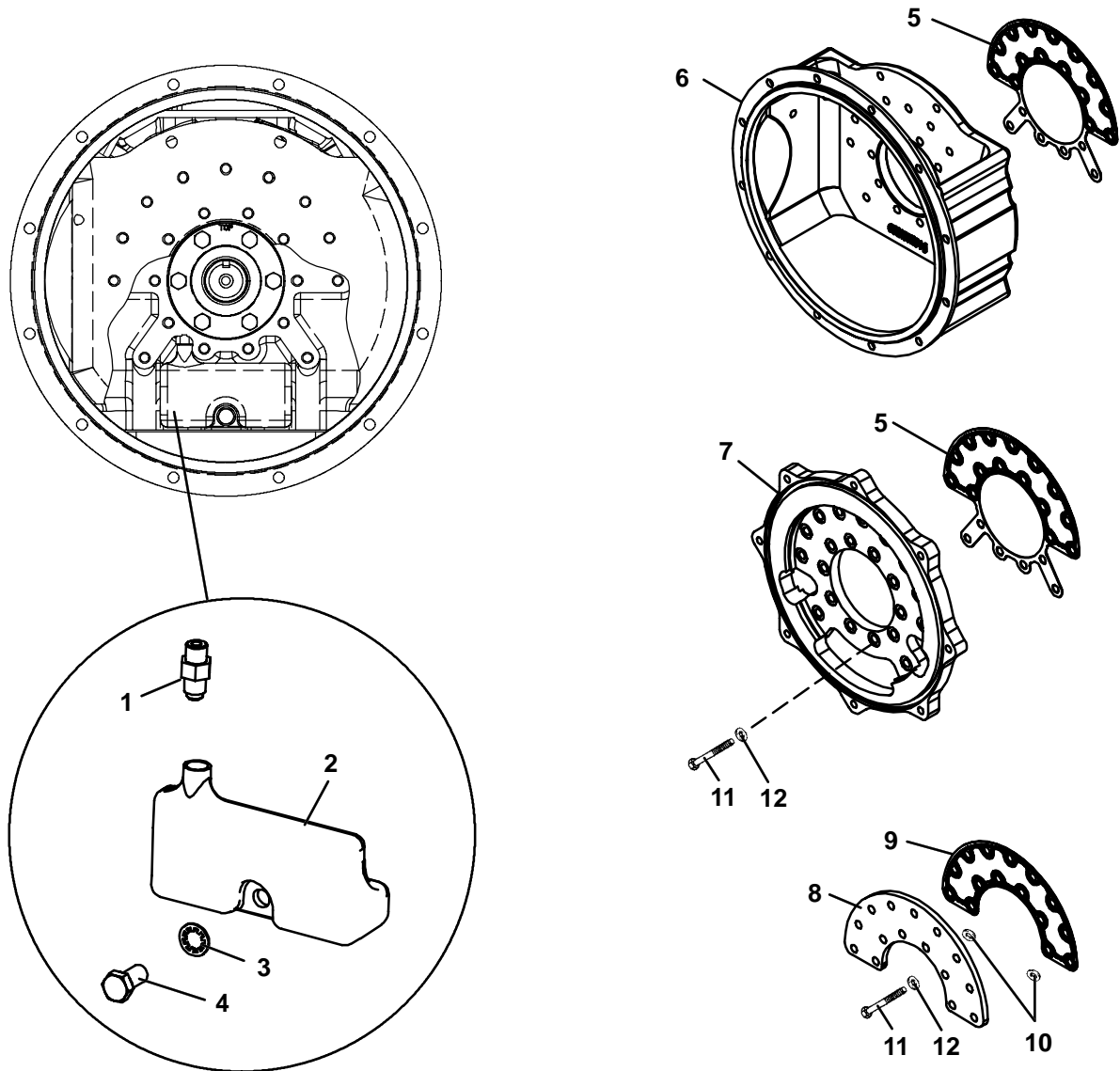
## 6 SHAFT END GROUP



\*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).

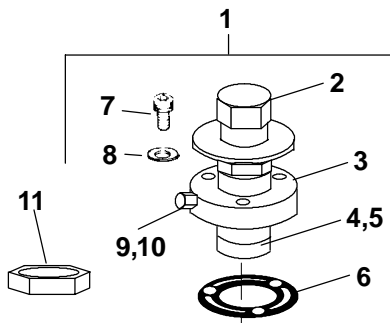
Item	Part Number	Description	Qty
1	17-44770-00	Seal Assembly (Shaft) - Includes:	1
2	NSS	Spring And Bellows Assembly, Shaft Seal	1
3	17-44768-00	Rotor, Seal	1
4	17-44004-06	Gasket, Seal Cover - (Metal)	1
5	NSS	Stator, Seal, (Wear Ring)	1
6	17-44773-00	O-Ring, Stator	1
7	17-44766-00	Hub Assembly, Housing Mounted Clutch, Threaded, No Groove - <b>Trailer</b> - Includes:	1
	17-44767-00	Hub Assembly, Housing Mounted Clutch, Threaded, W/Grease Groove - <b>Bus</b> - Includes:	1
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 ( <b>Trailer Only</b> )	1
	34-06083-00	Nut, Hub, Without Grease Fitting Port - <b>Bus</b>	1
	34-01161-00	Nut, Hub, With Grease Fitting Port - ( <b>Fitting Not Included</b> ) <b>Bus</b>	1
11	50-00221-30	Ring, Snap (If Applicable)	1
12	40-01132-00	Fitting, Grease, 1/4-28 NPT- <b>Bus</b>	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

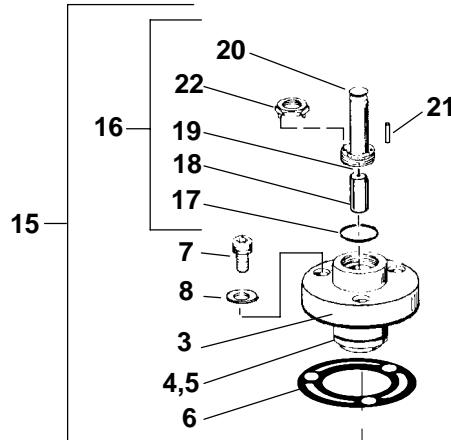


Item	Part Number	Description	Qty
1	05GA503-724	Access Valve, <b>Coreless</b> , 7/16-20, With O-Ring	1
2	17-44771-00	Reservoir, Shaft Seal	1
3	05GA503-734	Washer, Internal Tooth, 3/8 Inch, Plated	1
4	AA06GS228	Cap Screw, Hex Head, 3/8-16 X 0.75 Inch Long, Grade 8	1
5	17-44119-00	Gasket, End Flange, Ultra 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

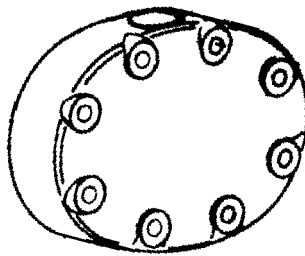
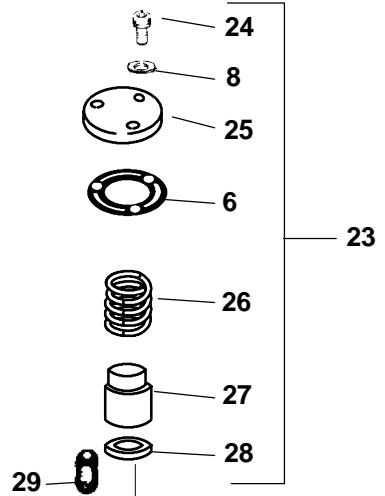
Pressure Valve



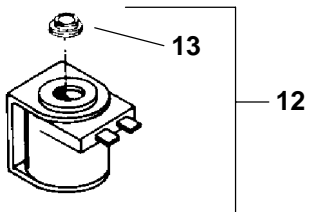
Electric Valve



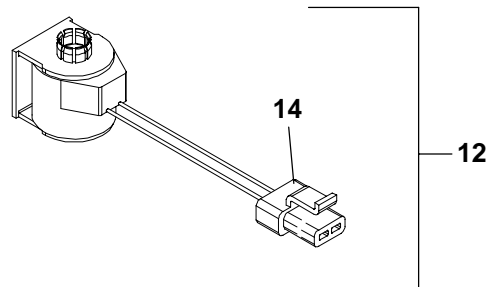
Valve Plug



COILS



OR

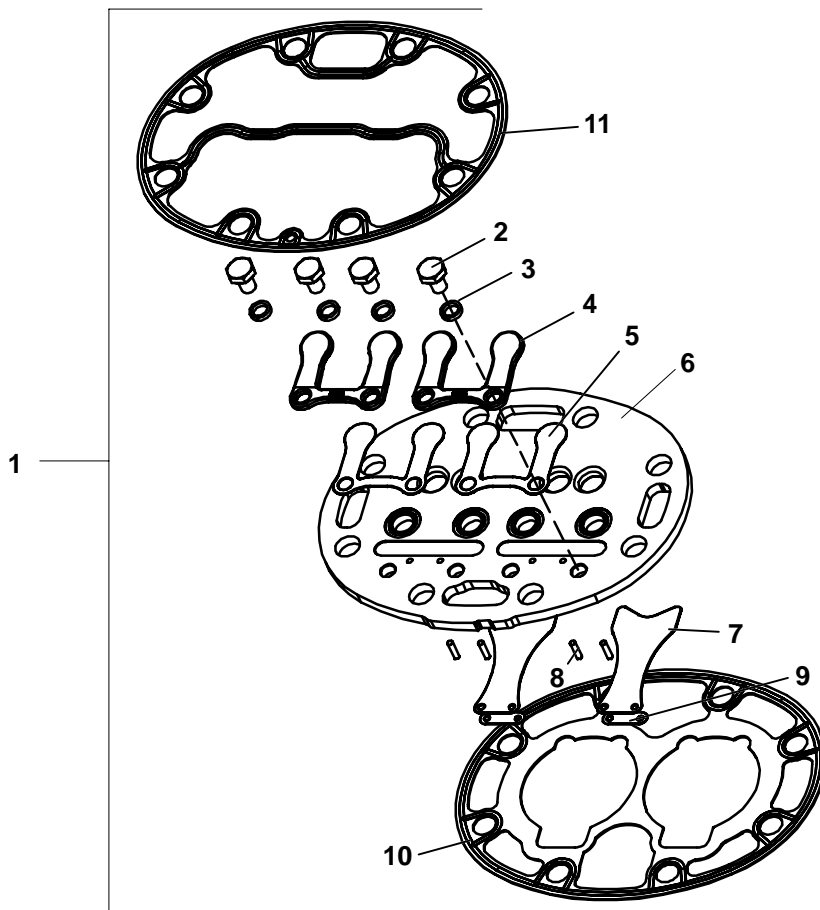




**8 UNLOADERS (Continued)**

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 ( <b>Truck/Trailer</b> ) - Includes:	A/R
	22-02567-00	Coil, Valve, 12 VDC With Spade Terminal - Includes:	A/R
	14-00143-07	Coil, Valve, 12 VDC With 6 inch wire leads - Includes:	A/R
	22-50030-00	Coil, Valve, 24 VDC With 42 inch wire leads - Includes:	A/R
	22-02567-01	Coil, Valve, 24 VAC With Spade Terminal - Includes:	A/R
	16-00149-00	Coil, Valve, 115 VAC With 42 inch Wire Leads - Includes:	A/R
	17-10829-00	Coil, Valve, 230 VAC With 42 inch Wire Leads - Includes:	A/R
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	17-55022-00	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

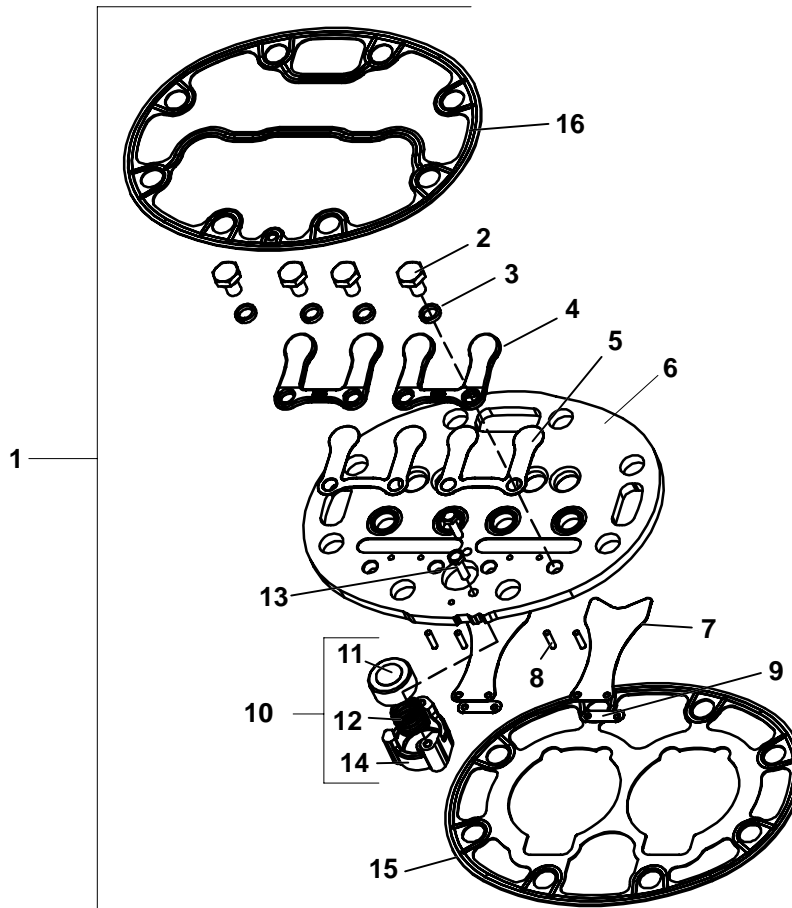
## 9 VALVE PLATE ASSEMBLY



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, <b>Center or Side Bank With No Unloader</b> - Includes:	1
2	17-44113-00	Capscrew, HexHead, 1/4-28 x 3/8 Inch Long	4
3	17-10715-00	Lockwasher, 1/4 Inch	4
4	17-44750-00	Backer, Discharge Valve	2
5	17-44749-00	Valve, Discharge	2
6	NSS	Valve Plate	1
7	17-44748-00	Valve, Suction	2
8	17-40057-00	Dowel, Pin Suction Valve	4
9	17-44751-00	Spring, Suction Valve	2
10	17-44746-00	Gasket, Valve Plate, Center or Side Banks	1
11	17-44747-00	Gasket, Cylinder Head, Center or Side Banks	1

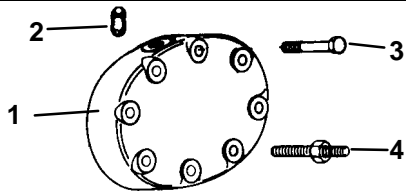
## 10 UNLOADER VALVE PLATE ASSEMBLY



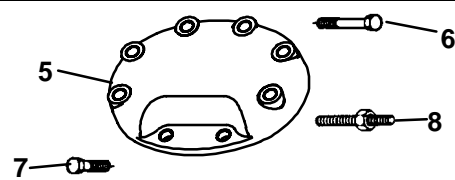
CAUTION: The above valve plate can only be used on the Twin Port 05G compressor.  
**It will not function in** the previous design (3 port) 05G compressor.

Item	Part Number	Description	Qty
1	17-44744-00	Valve Plate Assembly, <b>Side Bank With Unloader</b> - 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)



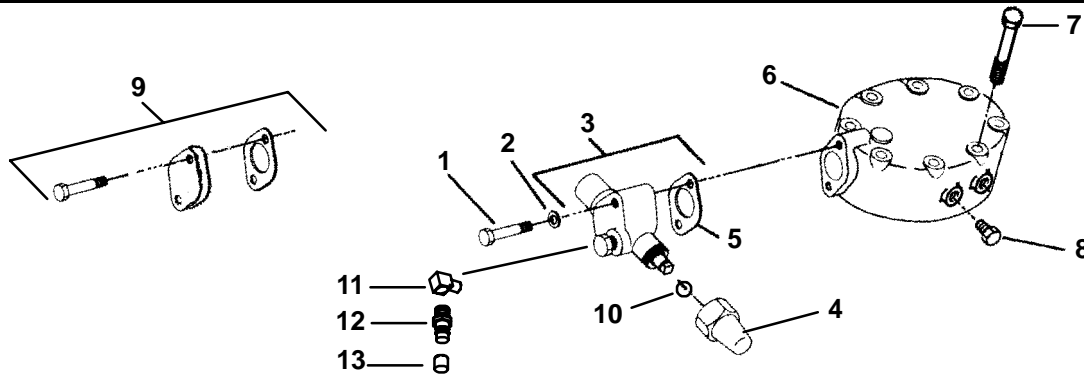
UNLOADER CYLINDER HEAD



STANDARD SHAVED CYLINDER HEAD

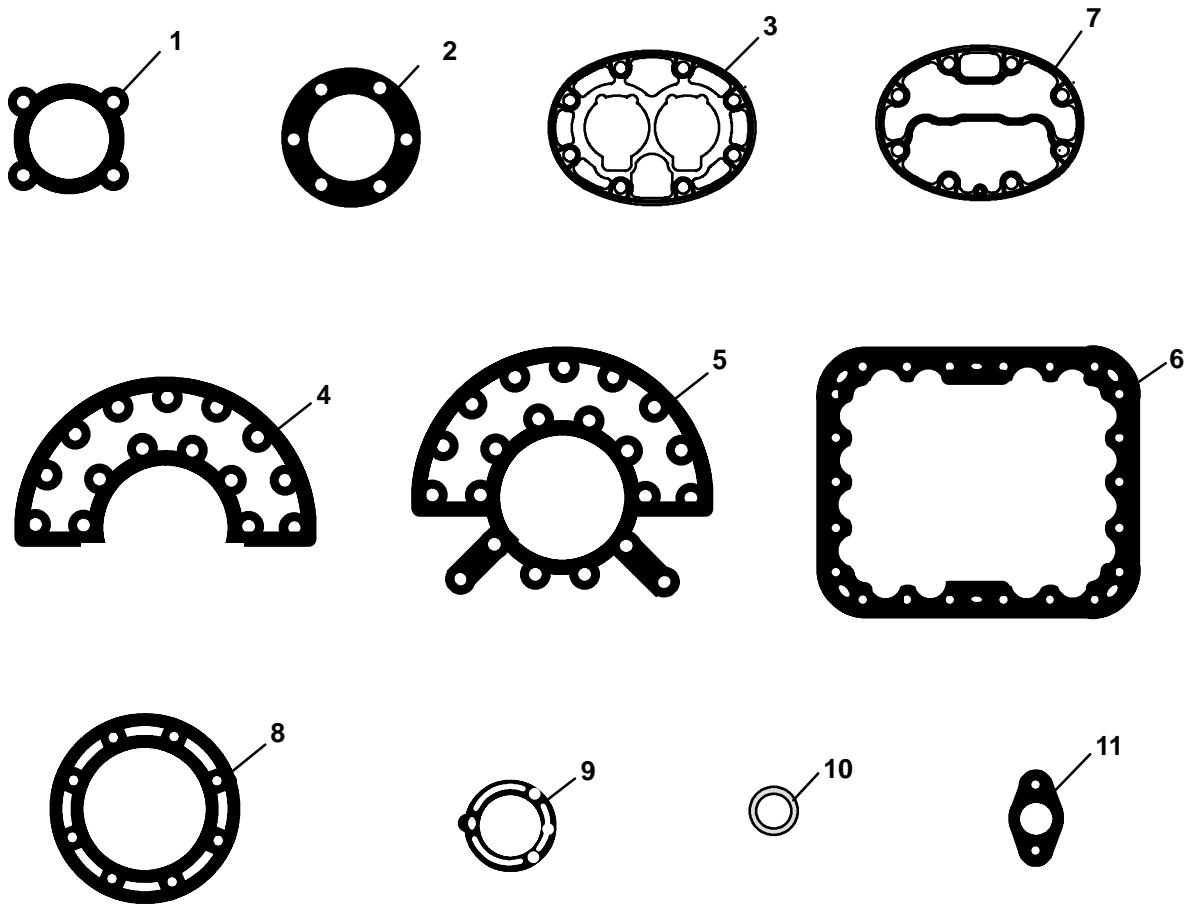
Item	Part Number	Description	Qty
1	17-44743-00	Cylinder Head, Unloader - Side Banks	2
2	17-40108-00	Strainer	1
3	17-10224-05	Capscrew, Hex Head, 3/8 -16 x 3-1/4 Inches Long - SAE Grade 8	8
4	17-44017-00	Stud, Cylinder Head (Unloader or Center), 3/8 -16 x 4-1/4 Inches Long	A/R
5	17-44753-00	Cylinder Head - 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 UNLOADER KITS, BUS - PRESSURE TO ELECTRIC



14 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

<b>14 UNLOADER KIT - PRESSURE TO ELECTRIC - R-22 ONLY - 24 VDC</b>			
<b>Item</b>	<b>Part Number</b>	<b>Description</b>	<b>Qty</b>
	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
<b>14 UNLOADER KIT - PRESSURE TO ELECTRIC - R-134a ONLY - 36 VDC</b>			
	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
<b>14 UNLOADER KIT - PRESSURE TO ELECTRIC - R-22 ONLY - 36 VDC</b>			
	74-50111-03	Kit, Convert Pressure Hot Gas Bypass to Electric Unloader (36 VDC), Includes:	2
1	17-40417-02	Unloader Valve	2
2	14-50086-00	Solenoid Coil - 36 VDC	2
3	12-00334-00	Switch, Pressure (UPS2) - R-22	1
4	12-00334-01	Switch, Pressure (UPS1) - R-22	1
5	40-00249-01	Fitting, Tee, Male Branch, 1/4 FPT x 1/4 FPT x 1/4 MPT	1
6	40-00243-01	Fitting, Tee, Street, 1/4 MPT x 1/4 x 1/4 FPT	1
7	06DA403-844	Valve, Access (1/4 Flare, Schrader)	3
8	40-00528-02	Connector, 1/4 FPT x 7/16-20 Straight Thread With O-Ring - Includes:	1
9	42-00243-07	O-Ring	1
10	DD19CA061	Cap, 1/4 Flare, Schrader	1
11	22-50222-00	Wire Harness	1

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# SECTION 23: ACCESSORIES

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1. AUDIO AND VIDEO SYSTEM DESCRIPTION

The rack mounted components are gathered on the audio-video panel which is located in the first driver's side overhead compartment (Fig. 1). In addition to the power amplifier, options for AM/FM radio, satellite radio, karaoke, wireless microphone, DVD, scenic view and back-up camera system and GPS Navigation System module may be featured.

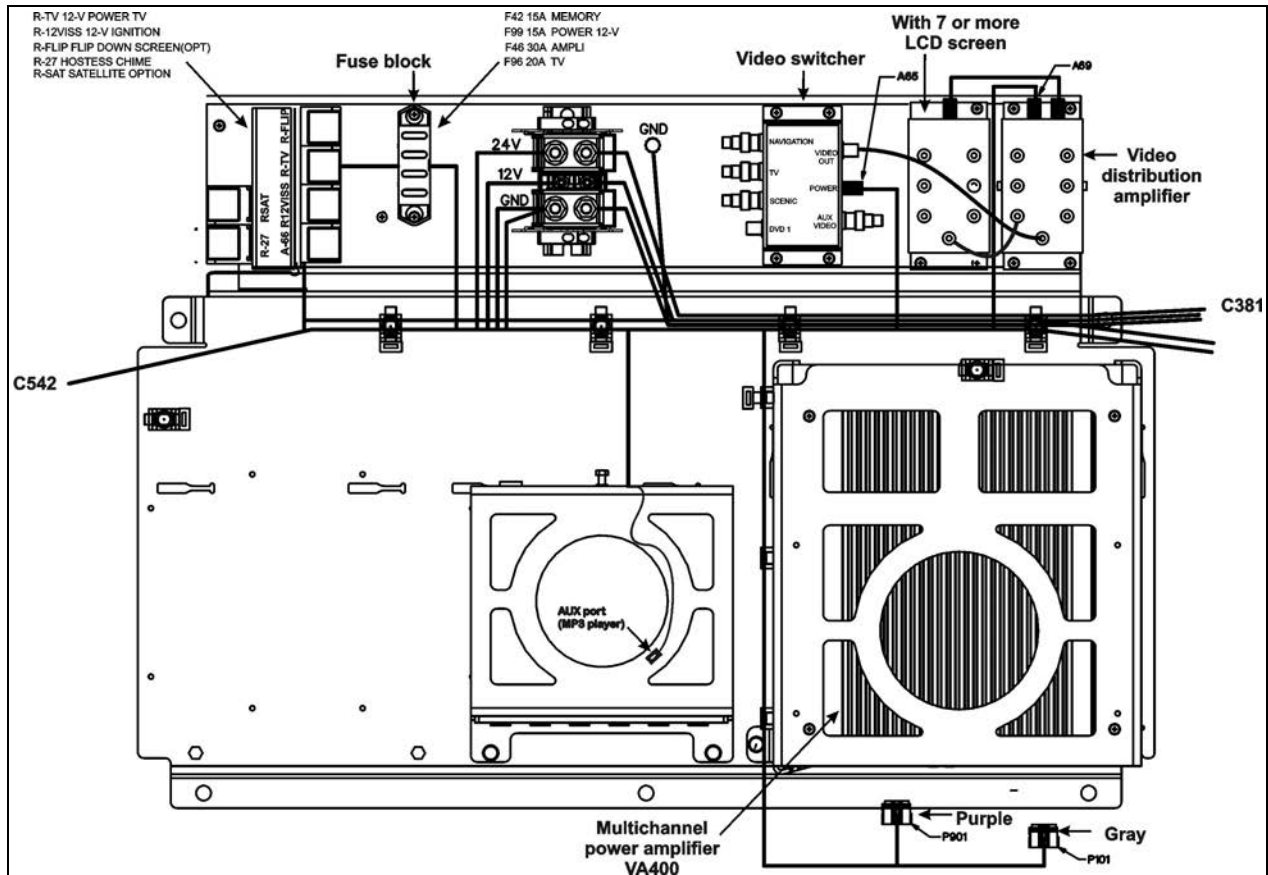
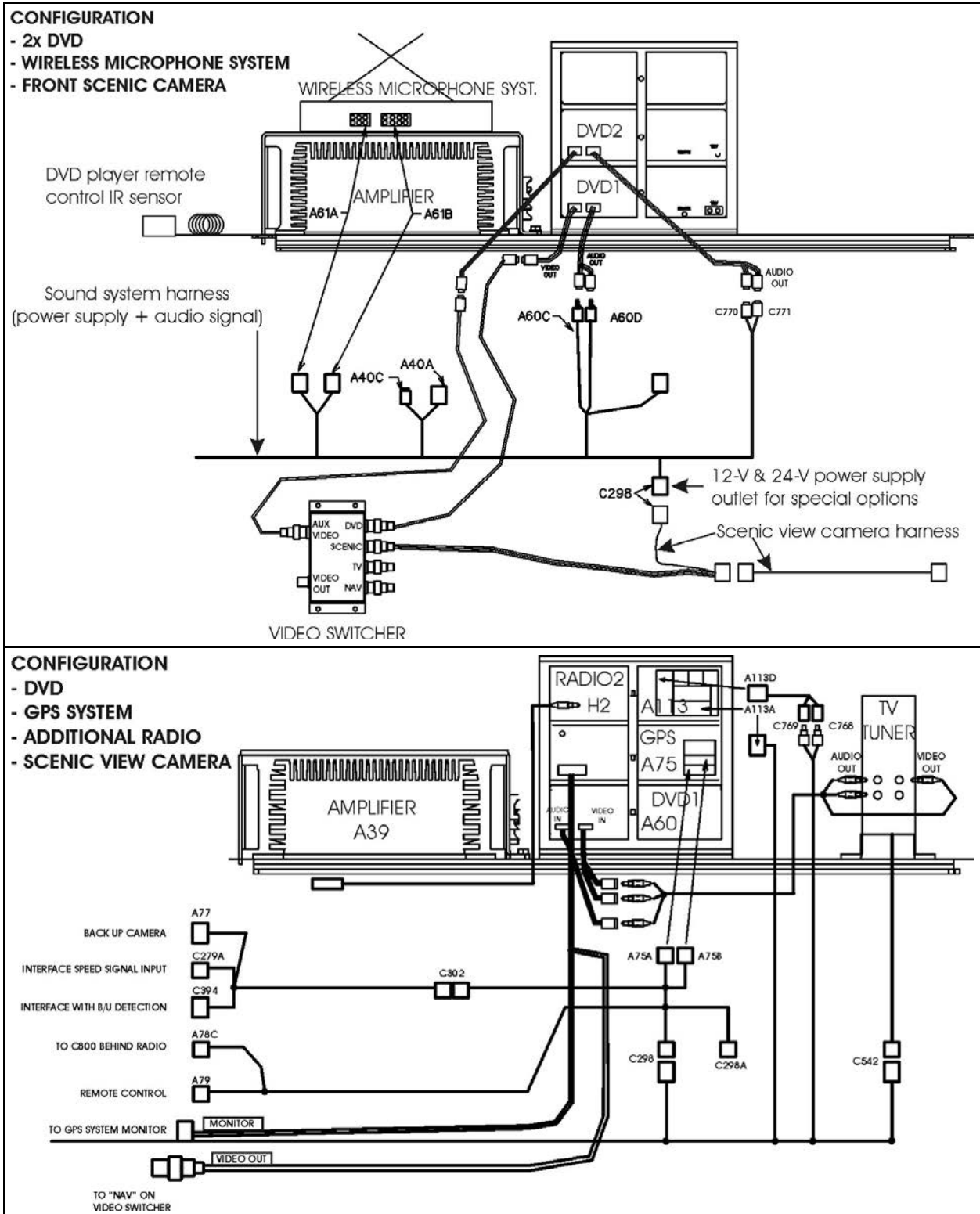


FIGURE 1: AUDIO-VIDEO PANEL

Each service module mounted to the underside of the parcel racks contains a 40-watt speaker. The speakers in the passenger section (twelve in H3-41 or sixteen in H3-45) are wired in stereo and are powered by the amplifier. A microphone outlet mounted in the driver's area is provided as standard equipment.



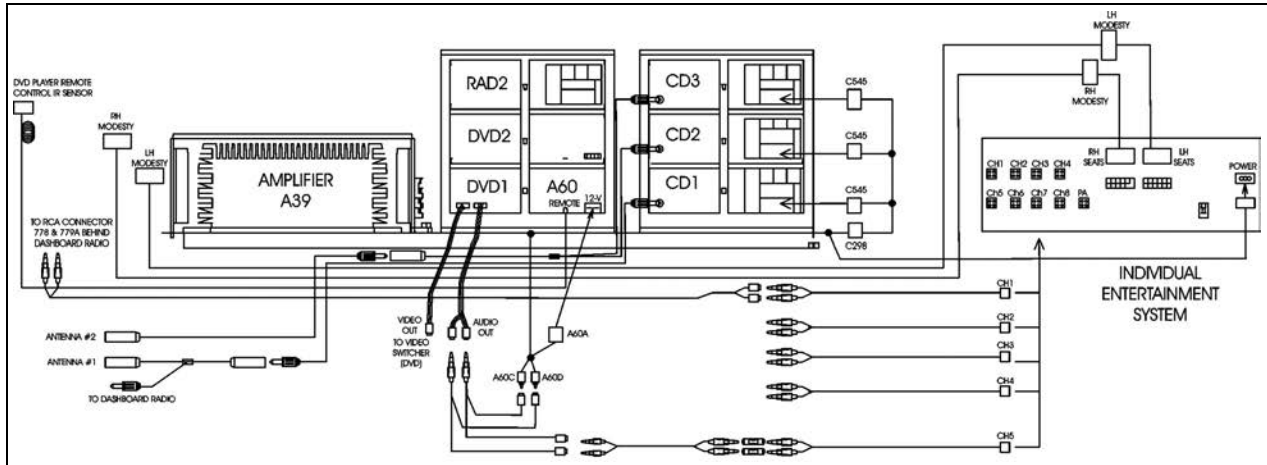


FIGURE 3: AUDIO-VIDEO CONNECTIONS

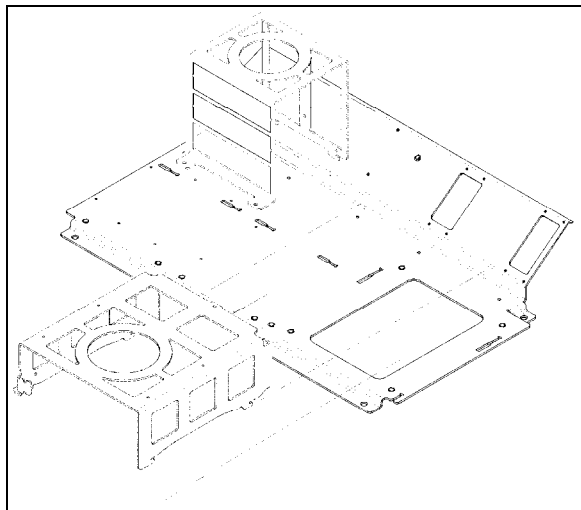


FIGURE 4: RACKS ON AUDIO-VIDEO PANEL

### 1.1 DASHBOARD RADIO



FIGURE 5: DASHBOARD RADIO

**NOTE**

*Before attempting to solve an electrical problem on the sound system, refer to the wiring diagrams.*

The radio operating instructions manual is included at the end of this.

#### 1.1.1 Removal/Installation

To remove the radio from its location, proceed as follows:

1. Place the ignition switch in the "OFF" position.
2. Remove the dashboard cover.
3. Unplug the connectors from the radio and unfasten back plate securing nuts/screws.
4. On the front side of the unit, insert the removal tool #20584494 in the holes found each side in order to separate the unit from the support.
5. From behind, push the unit through the front dashboard panel.
6. Installation of a new unit is the same as removal but in reverse order.

### 1.2 VSS-05 SOUND SELECTOR



FIGURE 6: VSS-05 SOUND SELECTOR

#### 1.2.1 Removal/Installation

To remove the Sound Selector from its location, proceed as follows:

4. Place the ignition switch in the "OFF" position.
5. Remove the dashboard cover.
6. Unplug the connectors from the radio and unfasten back plate securing nuts/screws.
4. On the front side of the unit, insert the removal tool #20584494 in the holes found each side in order to separate the unit from the support.



5. From behind, push the unit through the front dashboard panel.
6. Installation of a new unit is the same as removal but in reverse order.

The operating instructions are included in the Operator's Manual.

### 1.3 VD-404 MOBILE DVD PLAYER



FIGURE 7: VD-404 MOBILE DVD PLAYER

The MOBILE DVD PLAYER is located in the first parcel compartment on the driver's side. Instructions for proper use of this unit are included at the end of this section.

Features:

- POWER  
Operating voltage: 12-volt DC
- COMPATIBILITY  
This DVD player can play the following disc formats:  
DVD, CD, VCD, DVCD, MP3, CD-R, CD-RW
- SYSTEM FUNCTIONS  
Video output system: system MULTI, NTSC or PAL switchable.
  - 1 L/R audio output
  - 1 L/R audio input
  - 1 AUX video output
  - 1 rear camera video input
  - 3 video outputs with one dedicated self switching rear view monitor
- ADDITIONAL VIDEO FEATURES  
Multi-angle, multi-view, multi-audio function, multi-level forward and backward motion, play position memory, resume stop and repeat function.

### 1.4 MULTICHANNEL POWER AMPLIFIER VA400.8

This 400-watt, 6-channels brings an added dimension to your stereo equipment and increases the total output of the system.

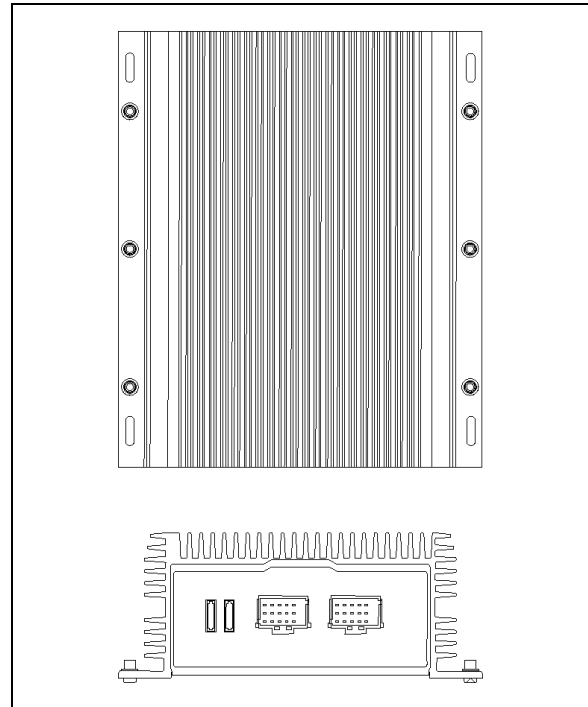


FIGURE 8: MULTICHANNEL POWER AMPLIFIER VA400.8

For optimum sound quality, adjust the subwoofer crossover filter as shown on figure 9. This adjustment is necessary to balance the subwoofers volume in respect to the other speakers and also to cut high frequencies for a better sound quality.

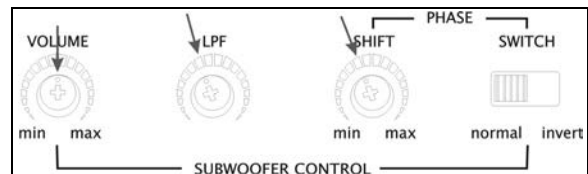


FIGURE 9: CROSSOVER ADJUSTMENT

### 1.5 SPEAKERS

Each passenger's overhead console mounted to the underside of the parcel racks contains a 20-watt coaxial 10cm speaker. The speakers (24 in H3-41 or 28 in H3-45) in the passenger's section, wired in stereo and arranged in a delta configuration are powered by the amplifier.



FIGURE 10: 10CM COAXIAL SPEAKER

The vehicle may be equipped with two additional Hi-Fi speakers in the driver's area, mounted one on each side. This arrangement provides the driver with clear stereo sound. Controls for the driver's audio are performed through the dashboard radio.

Two specially designed subwoofers are fixed under a passenger seat with anti-vibration supports.

#### 1.6 BOOM-TYPE MICROPHONE

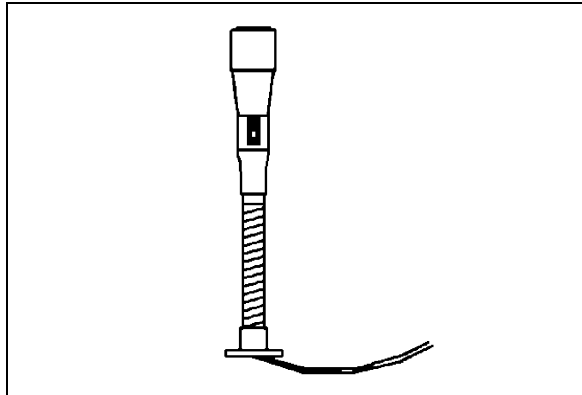


FIGURE 11: BOOM-TYPE MICROPHONE 23083

##### 1.6.1 Removal

1. Place the ignition switch in the "OFF" position.
2. Remove the mounting screws at mounting flange.
3. Disconnect wiring.

##### 1.6.2 Installation

1. Reconnect wiring.
2. Align mounting flange with holes and install screws.
3. Remove spacer block mounting screws.

4. Insert spacer block and install mounting screws.
5. Place the battery master switch in the "ON" position.

#### 1.7 HANDHELD PRIORITY MICROPHONE

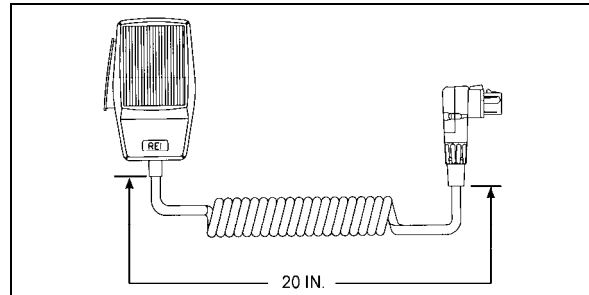


FIGURE 12: HANDHELD PRIORITY MICROPHONE 23216

#### 1.8 WIRELESS MICROPHONE

The System 2000 16 channel wireless microphone, Receiver and Charging Cradle are custom designed units that allow for wireless PA communication from anywhere on the coach. The unit consists of a receiver mounted in the parcel area directly behind the driver, and a rechargeable hand-held microphone and charging unit. Instructions for proper use of the microphone are included in the "REI Operating Manual" which is provided in the technical publications box delivered with the vehicle.

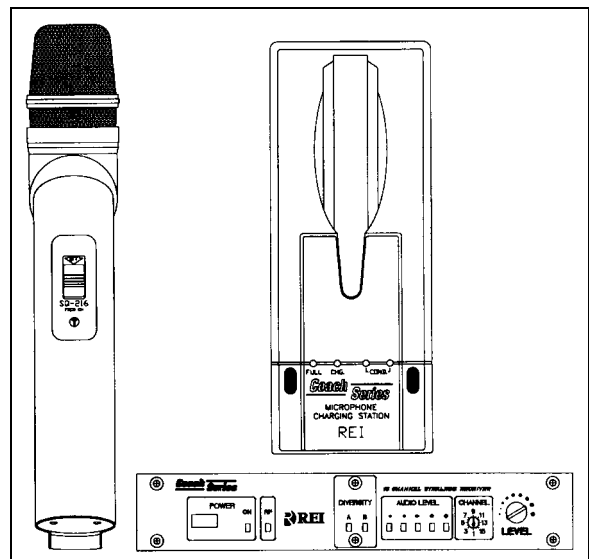


FIGURE 13: WIRELESS MICROPHONE

### 1.9 TV TUNER

For TV tuner control descriptions, refer to fig. 14.

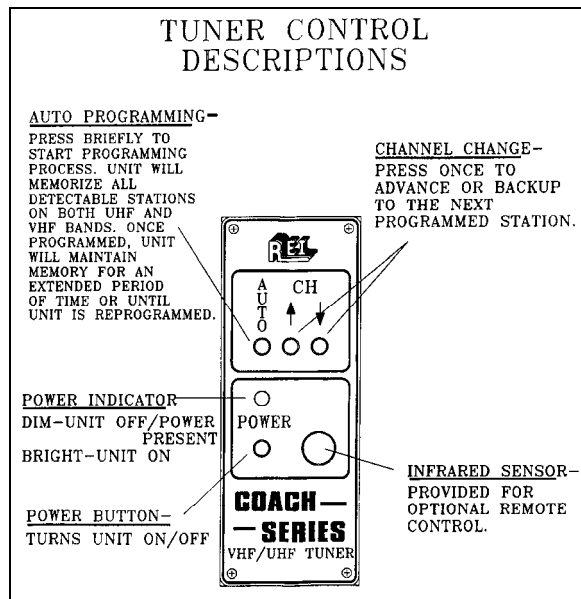


FIGURE 14: TUNER CONTROLS DESCRIPTION

### 1.10 KARAOKE

The modified Panasonic DVD Player powers up automatically when the video system is activated. The unit can be controlled with the plug-in remote control, or the control head, which has access to the PLAY and STOP commands.

If so equipped, instructions for proper use of the Karaoke system are included in the "Operating Manual" that is provided in the technical publications box delivered with the vehicle.

#### 1.10.1 Karaoke Panasonic Sound System – MOBILE DVD PLAYER DV1500

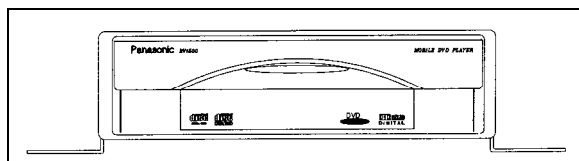


FIGURE 15: PANASONIC DV1500

### 1.11 DRIVER'S SPEAKERS

The driver's speakers are mounted one on each side. This arrangement provides the driver with clear stereo sound. Controls for the driver's audio allow selection between the radio and the auxiliary audio (independent of the passenger's speakers) or muting the speakers.

### 1.12 MONITOR

1. Place the ignition switch in the "OFF" position.
2. Unfasten the retaining screw located on the monitor R.H. side.
3. Slide the monitor to the right to release it from the mounting bracket.

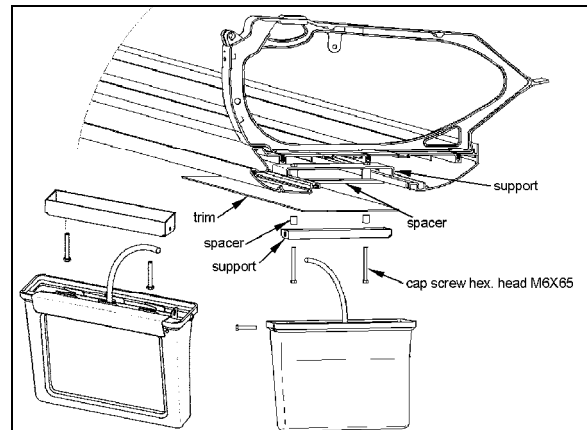


FIGURE 16: MONITOR MOUNTING

23221

### 1.13 SCENIC VIEWING SYSTEM

The scenic viewing system enables the passengers to view the road ahead of the vehicle.



FIGURE 17: SCENIC VIEW CAMERA

### 1.14 ROOF ANTENNA INSTALLATION

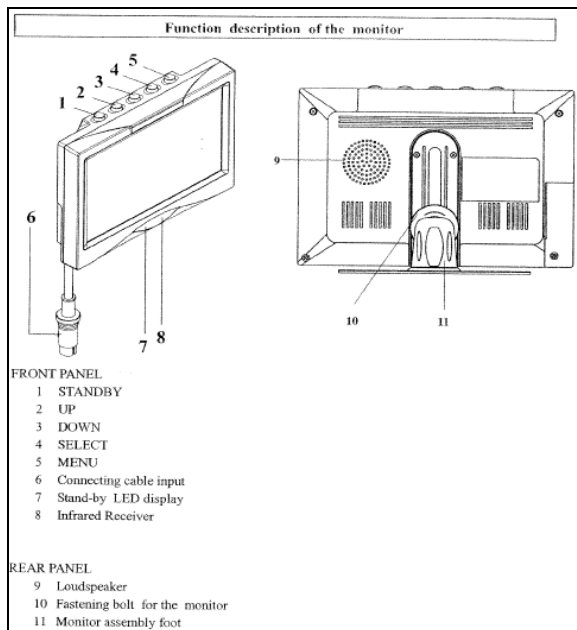
1. Find the desire location and drill a hole according to specification.
2. To remove dirt and grease, wash hole edge with alcohol.
3. If so equipped, remove foam padding ring from antenna to free the metal surface (foam can produce air bulbs in new rubber seal).

## Section 23: ACCESSORIES

4. With SIKA 205, wash the vehicle hole edge and the antenna base surface, wait at least two (2) minutes for chemical evaporation.
5. Apply new seal SIKA 221 on both, vehicle hole edge and antenna base.
6. Fix the antenna in place.
7. Remove excess seal and complete a finishing joint all around the antenna base.

### 2. BACK-UP CAMERA AND MONITOR

An optional back-up camera is available which provides the driver with visual assistance when backing-up. The camera is automatically activated when the transmission is put in reverse gear and the ignition switch is "ON".



#### BUTTON DESCRIPTION

- 1) **STANDBY** On/Off switch
- 2) **UP** This key has 3 functions
  - Increase of the volume during normal operation;
  - Modification of the setting within a function e.g. contrast (after calling up the menu);
  - By pressing this key when putting in the reverse gear, the distance markings move upwards;
- 3) **DOWN** This key has 3 functions
  - Decrease of the volume during normal operation;
  - Modification of the setting within a function e.g. contrast (after calling up the menu);
  - By pressing this key when putting in the reverse gear, the distance markings move downwards;
- 4) **SELECT** This key has 3 functions

- Selection of the video sources (CA1 → CA2 → AV → CA1). Press less than 1.5 seconds;
- Selection of the functions e.g. picture setting (after calling up the menu);
- Deleting and calling OSD letters of title & time (press longer than 1.5 seconds) during normal operation;

#### 5) MENU This key has 2 functions

- Activation of the dimmer function (press less than 1.5 seconds) during normal operation;
- Calling up the menu (press longer than 1.5 seconds, four menus can be called up). Press the key once again to call up the individual menus;
  - a) PICTURE= Functions for the image setting;
  - b) USER= Selection of the system function;
  - c) TIME= Setting time and date;
  - d) INSTALL= Setting the camera function (e.g. mirror function);

#### 6) BUSH FOR THE MONITOR CABLE OF THE CONNECTION BOX

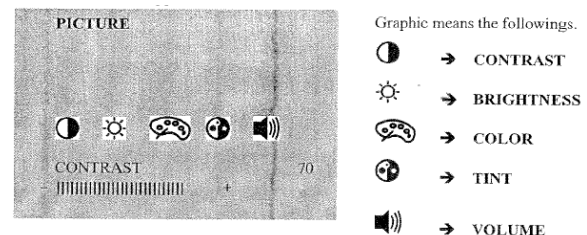
#### 7) STANDBY DISPLAY

#### 8) INFRARED RECEIVER

#### MONITOR MENU DISPLAY

The monitor (RV59 HD) is equipped with an On-Screen Display (OSD) function which displays date, camera, channel, mirror mode and distance markings. These functions can be selected on MENU. To calling up the menu, press longer than 1.5 seconds. Four menus can be called up. Press the key once again to call up the individual menus.

For calling up the menu PICTURE press the key **MENU** longer than 1.5 seconds. The menu PICTURE appears.



Select the function (e.g. contrast) by pressing the key **SELECT** repeatedly. The setting within the function can be modified with the keys **UP** and **DOWN**.

For calling up the menu USER press the key **MENU** once again. The menu USER appears. Select the function (e.g. SELECTION) by pressing the key **SELECT** repeatedly as necessary. The setting within the function can be modified with the keys **UP** and **DOWN**.

USER	POSSIBLE SETTINGS:
LANGUE ENG	LANGUAGE: ENGLISH/GERMAN (ENG/DEUT)
SCREEN WIDE	SCREEN FORMAT: NOR 4:3, picture format 4:3 WIDE, picture format 16:9 FULL, picture format 16:9 middle enlarge
TITLE ON	TITLE: CAMERA TITLE DISPLAY ON/OFF
TIME ON	TIME: TIME DISPLAY ON/OFF

For calling up the menu TIME press the key **MENU** once again. The menu TIME appears. Select the function (e.g. DATE) by pressing the key **SELECT** repeatedly as necessary. The setting within the function can be modified with the keys **UP** and **DOWN**.

<b>TIME</b>		- Hour-Month adjustable by UP BUTTON
TIME	08:25	- Minute/Date adjustable by DOWN BUTTON
DATE	MAY01	- Year adjustable by UP/DOWN BUTTON
YEAR	2005	

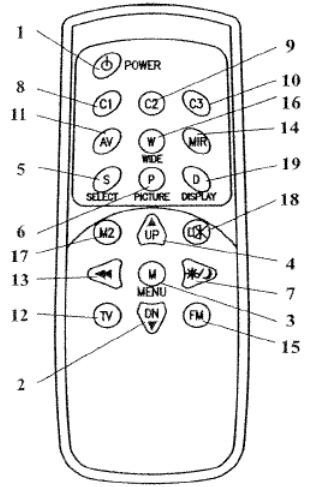
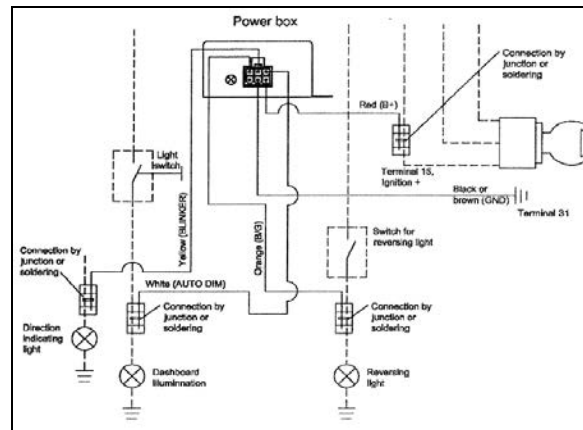
For calling up the menu INSTALL press the key **MENU** once again. The menu TIME appears. Select the function (e.g. SELECTION) by pressing the key **SELECT** repeatedly as necessary. The setting within the function can be modified with the keys **UP** and **DOWN**.

<b>INSTALL</b>		POSSIBLE SETTINGS:
REAR CAM1		REAR: Selection of priority camera (CAM1 or CAM2) which is triggered by rear gear.
CAM1	MIR	CAM1: Selection of real picture or mirrored picture for camera 1
CAM2	NOR	CAM2: Selection of real picture or mirrored picture for camera 2
	NOTE 1	The distance mark will appear on the picture of camera which set as MIR (mirrored).
	NOTE 2	Engaging the reverse gear, only distance mark will appear on the mirrored camera picture without any OSD. At the moment, no keys are available except UP/DOWN key for moving distance bar.

**BACK-UP CAMERA MODULE (Power box)**

The connection line consists of 6 branch lines as below:

RED	Voltage supply 12-volt to 24-volt (max. 32-volt)
BLACK/BROWN	Earth cable
WHITE	Control wire for switching on the dimmer function (night operation)
YELLOW	Control wire for switching on the side camera. The connection is to be made at the INDICATOR
ORANGE	Control wire for switching on the reversing camera. The connection is to be made at the reversing light



No	Key	Description
1	STANDBY	On/Off switch
2	DOWN ▼	This key has 3 functions. - Decrease of the volume during normal operation. - Modification of the setting within a function e. g. brightness (after calling up the menu). - By pressing this key when putting in the reverse gear the distance markings move downwards.
3	MENU	Calling up the menu on the screen. Three menus can be called up : a: PICTURE = Functions for the image setting b: USER = Selection of the system function c: TIME = Setting time and date d: INSTALL = Setting the camera function (e.g. mirror function)
4	UP ▲	This key has 3 functions. - Increase the volume during normal operation - Modification of the settings within a function e. g. contrast (after calling up the menu) - By pressing this key when putting in the reverse gear the distance markings move upwards.
5	SELECT	This key has 2 functions Selection of the video sources (CA1→CA2→AV) Selection of the functions e.g. picture setting (after calling up the menu)
6	PICTURER	Calls up the functions CONTRAST, BRIGHTNESS etc. directly for the picture setting. Carry out the setting with the key UP or DOWN.
7	DIMMER	Regulates the brightness to night operation temporarily
8	C1	Selection of the camera 1
9	C2	Selection of the camera 2
10	C3	Selection of the camera 3 (camera input 3 is not available)
11	AV	Selection of the video input (RCA)
12	TV	Not available
13	SEARCH	Not available
14	MIRROR	Reversing left and right of picture temporarily
15	FM	Not available
16	WIDE	Setting of the screen format NOR/NOR: 4:3, picture format 4:3 WIDE/WEIT, picture format 16:9 FULL/BREIT, picture format 16:9 middle enlarged
17	MONITOR2	Not available
18	MUTE	Switches off the tone temporarily
19	DISPLAY	This key has 2 functions - Deleting or calling OSD letters of Tile & Time temporarily - Leaving the menu

### 3. HUBODOMETER

#### 3.1 DESCRIPTION

An optional wheel hubodometer (Fig. 18) may have been installed on the R.H. side of the drive axle. It indicates the total distance in miles or kilometers covered by the coach since it has left the factory, including road testing.

##### 3.1.1 REMOVAL

To remove the unit, remove the two lock nuts and washers securing it to the wheel hub, and pull the unit off the studs.

##### 3.1.2 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).

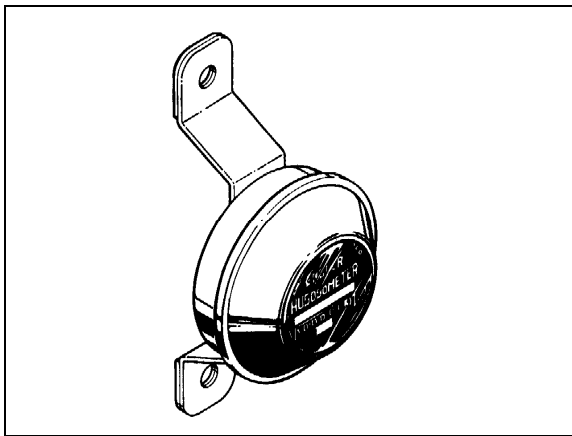


FIGURE 18: HUBODOMETER 23027

#### 3.2 OPERATION

The hubodometer is calibrated for a specific wheel size (diameter). Wheel rotation causes a mechanism inside the hubodometer to record distance after a predetermined number of rotations. The unit should be serviced at a competent speedometer repair facility.

**Note:** Do not use paint, solvent or thinner on hubodometer face or on plastic hubcaps. Do not weld on hubodometer.

### 4. COLD STARTING AID (ETHER)

If the vehicle is equipped with a DDC Series 60 engine an electrically-operated type ether cold starting aid designed to ease engine starting

when temperature is below 35°F (2°C) may be installed.

On vehicles equipped with cold starting aid, the system consists of the main following parts:

- Ether starting aid switch
- Ether cylinder
- Solenoid valve (24 V)
- Thermal cutout valve
- 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)). An atomizer is installed on top of the air intake duct (Fig. 19).

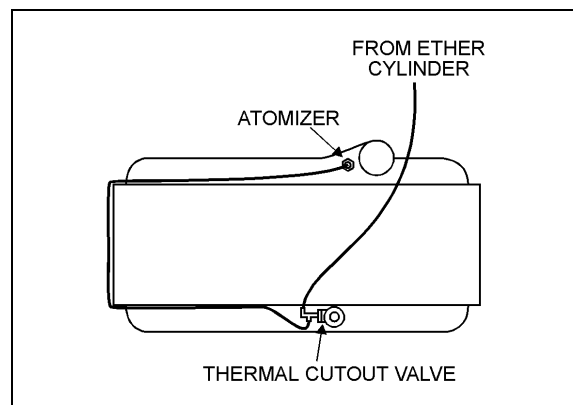


FIGURE 19: ENGINE 23032

#### 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)

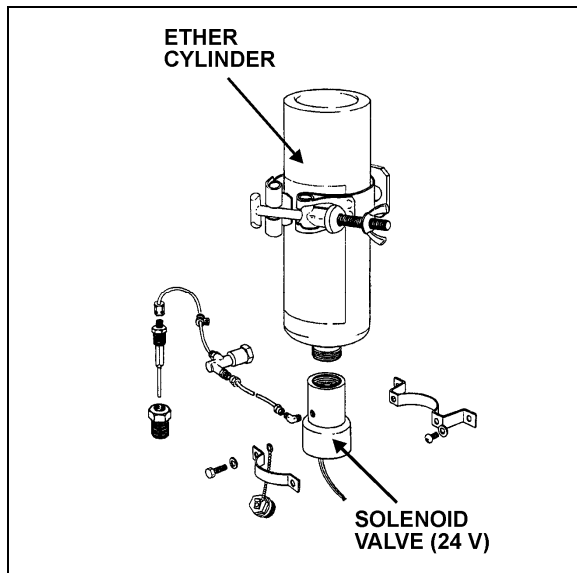


FIGURE 20: COLD STARTING AID

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**Warning:** 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.

1. Check cylinder for hand tightness and fuel supply (Fig. 20). 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).
  - 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.
  - 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.
    - If fuel is not discharged from tube, remove tube and blow out or replace.
    - If fuel is discharged, connect tube to thermal cutout valve, and disconnect other tube.
  4. Actuate the solenoid valve.
    - 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.
- If fuel is discharged, connect tube to thermal cutout valve, and disconnect tube from atomizer.
  5. Actuate the solenoid valve.
    - If fuel is not discharged from tube, fuel line is clogged. Remove tube and blow out or replace.
    - If fuel is discharged, replace the atomizer.

#### 4.3 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.

**Warning:** 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. DESTINATION SIGN

### 5.1 DESCRIPTION

The destination sign is located at upper front of the vehicle.

#### ELECTRONIC DESTINATION SIGN (Optional)

To change the destination, depress the selecting switches until the desired destination appears in the LCD display.

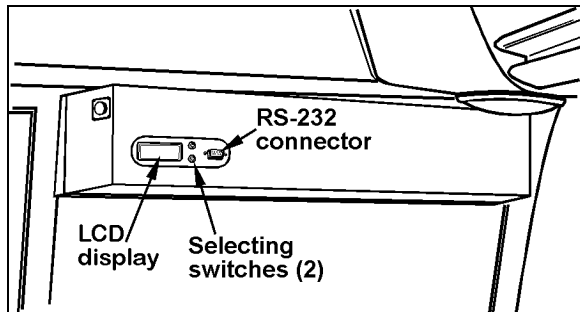


FIGURE 21: DESTINATION SIGN – ELECTRONIC 23123

**Note:** The destination sign must be programmed with a computer connected to the RS-232 connector prior to first use. Follow the instructions on the computer disk to install and run the software.

**Note:** All destination sign models are equipped with lights (bulb light or fluorescent) which illuminates automatically when the headlight or fog light switch is activated.

## 6. WINDSHIELD SUNSHADES

Two electrically-operated sunshades are installed behind the windshields. Two rocker switches on the dashboard operate each shade individually. Refer to Operator's Manual: "Controls and Instruments" chapter for more information.

**Caution:** The electric sunshades should only be operated electrically. Pulling down manually may damage the mechanism.

### 6.1 ADJUSTMENT

The sunshades are pre-adjusted, under no circumstances try to operate by hand. In case adjustments have to be made, proceed as follows:

1. Push the two (black and yellow) buttons into lock position. This cancels the pre-adjusted stop positions.
2. Move the sunshade into the requested upper limit position by using the electric motor (do not operate by hand). Press the button which is shaped like an arrow showing upwards. The upper position is now adjusted.
3. Now move the sunshade into the requested lower limit position by using the electric motor (do not operate by hand). Press the button shaped like an arrow showing downwards. The lower stop position is now adjusted.

## 7. LAVATORY

### 7.1 DESCRIPTION

The lavatory is located in the rear R.H. corner of the coach. It is equipped with a chemical flush toilet, bathroom tissue dispenser, washbasin, towel dispenser, waste container, mirror, ashtray, and a cleaning cabinet. A liquid soap dispenser and moist towel dispenser are optional.

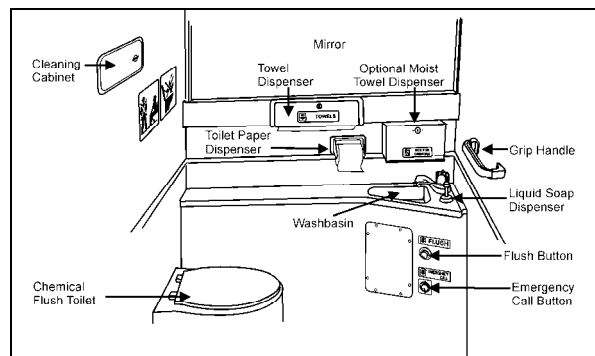


FIGURE 22: LAVATORY

Locking the lavatory door from the inside will illuminate a fluorescent light in the lavatory and two outside signs to indicate occupation. One sign is located on the outer wall of the lavatory and another sign is located over the windshield. An indicator light on the dashboard will illuminate to inform the driver when the lavatory is occupied. A night-light is permanently lit in the lavatory when the ignition switch is in the ON position.



## 7.2 MAINTENANCE

The servicing procedure for the lavatory is described in the "Operator's Manual" included in the technical publications box delivered with the vehicle.

## 7.3 VENTILATION FAN

### 7.3.1 Description

The lavatory ventilation fan, mounted in engine compartment over the oil reserve tank (Fig. 23), serves two purposes. It exhausts objectionable odors and provides a constant air circulation in the lavatory compartment by heating or cooling the lavatory with the vehicle ambient air. Air flows in the lavatory compartment through a vent grill located in the upper section of the lavatory door and exhausts through a grill located next to the toilet.

**Note:** This fan runs constantly when the ignition switch located on the dashboard is in the "ON" position.

### 7.3.2 Maintenance

The frequency of preventive maintenance should be determined according to vehicle mileage and operating conditions. However, it is recommended to check this item every 50,000 miles (80 000 km) or once a year, whichever comes first.

Remove fan and motor assembly. Check for fan housing wheel and motor free operation. When defective motor occurs, new motor must be installed.

### 7.3.3 Removal and Installation

1. With the engine compartment rear door opened, remove hose clamp securing duct to ventilation fan inlet, and disconnect duct.
2. Disconnect the ventilation motor wiring connector.
3. Remove the two bolts retaining the ventilation fan housing support to the square tubing. Remove the ventilation fan assembly from its location.
4. The unit can now be disassembled and motor replaced.
5. Reverse previous steps to reinstall ventilation fan assembly on vehicle.

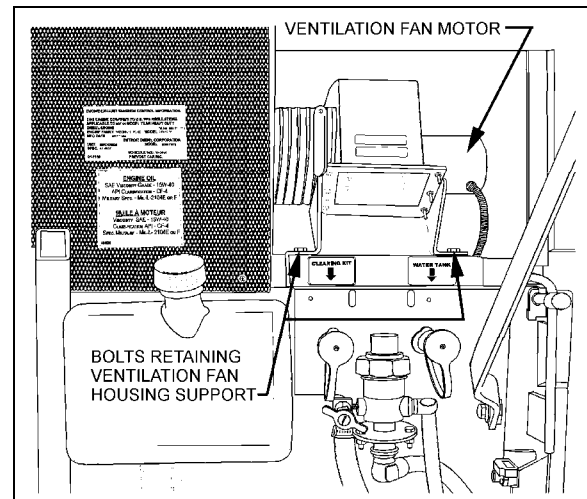


FIGURE 23: VENTILATION FAN INSTALLATION

## 7.4 DOOR LOCK

Lavatory door lock has inside and outside handles, as well as an inside latch to lock door from inside the compartment. If the lock fails to release, the door can be opened from the outside using a special key which is supplied to the driver. Lock assembly can be removed from the door, and then readily disassembled and parts replaced, if necessary. A thin coat of lubricant on all moving parts will ensure trouble-free operation.

## 7.5 LAVATORY LIGHT WITH MOTION SENSOR

The lavatory light, when dimmed, serves as a night-light and is illuminated as soon as the ignition switch is set to the "ON" position. A motion sensor will activate full light intensity whenever motion is detected in the lavatory compartment. The motion sensor will dim the light after a delay of 8 seconds when no additional motion is detected.

### NOTE

The lavatory light motion sensor has a warm-up period of approximately 2 minutes after the ignition switch is set to the "ON". During that warm-up period, the motion sensor will not detect motion and will not activate the lavatory light to full intensity.

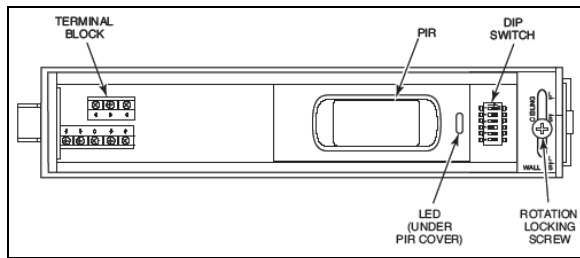


FIGURE 24: LAVATORY LIGHT MOTION SENSOR

### 7.5.1 Removal and Installation

1. Open the sensor housing by pressing on the latch with a screwdriver. The latch is located on the side of the sensor nearest the lens. Pull the cover up away from the sensor's base.
2. Loosen rotation locking screw two (2) turns (do not remove). Then, remove PCB assembly from the backplate of the sensor.
3. Insert the wiring into one of the wire channels on the sensor's backplate.
4. Securely affix the sensor's backplate to the wall using #6X3/4 screws.
5. Reinstall the PCB assembly and then, tighten rotation locking screw.

### 7.5.2 Dip Switch Settings

Adjust DIP switches as follows:

1=off	2=off	3=off
4=on	5=off	6=off

## 7.6 EMERGENCY BUZZER

The lavatory emergency buzzer is mounted on the alarm junction box in the front service compartment and sounds when the emergency call push-button switch in the lavatory compartment is activated. For specific wiring information, refer to wiring diagrams. To remove the emergency call push-button switch, proceed as follows:

1. Remove both Phillips-head screws retaining pushbutton switch plate to wall.
2. Remove steel plate located on L.H. side of pushbutton switch.
3. Remove switch through this opening, taking care to disconnect electric wires.

## 7.7 FRESH WATER TANK

The fresh water tank located at rear of lavatory

wall (over cleaning cabinet), supplies water to the washbasin by gravity. Two tubes are connected in the upper section of tank (Fig. 27). One serves as overflow as well as vent tube and runs along the wall to the underside of the lavatory close to the engine air filter housing, while the other tube is connected to the fresh water fill valve which is mounted besides the engine oil reserve tank.

A third tube connected in the lower section of fresh water tank is provided with a T-connector and allows fresh water to flow to the washbasin faucet and to the low temperature water safety valve for automatic or manual draining. An access panel, located at rear of last R.H. side row of seats and secured in place using 6 Phillips-head screws, allow access to the cleaning cabinet and fresh water tank tubing, fresh water tank heater and different wiring connectors.

### 7.7.1 Fresh Water Tank Heater (Optional)

75 watts, 110 volts AC immersion-type water heater may have been installed in the bottom of the fresh water tank. The heated portion of element must be immersed at all times to ensure proper heater life. The 110-120 volts in-station connector mounted on the engine compartment rear door provides the water heater power source.

### 7.7.2 Fresh Water Tank Draining

The fresh water tank can be drained by simply opening the fresh water drain cock (Fig. 27). Don't forget to close cock when draining is done.

**Caution:** If fresh water tank heater is inoperative or not installed on your vehicle, water should be drained from reservoir under cold weather conditions since it might freeze and damage both reservoir and connecting links.

### 7.7.3 Fresh Water Tank Filling

Plug the fresh water supply hose to the fresh water tank fill connection (Fig. 27); fill the tank until the overflow tube leaks, signaling that tank is full.

**Warning:** Never put antifreeze in fresh water tank; antifreeze is toxic.

**Warning:** If tank has not been drained for an extended period of time, draining and filling operations must be repeated three (3) times in order to clean tank and eliminate contaminated water.

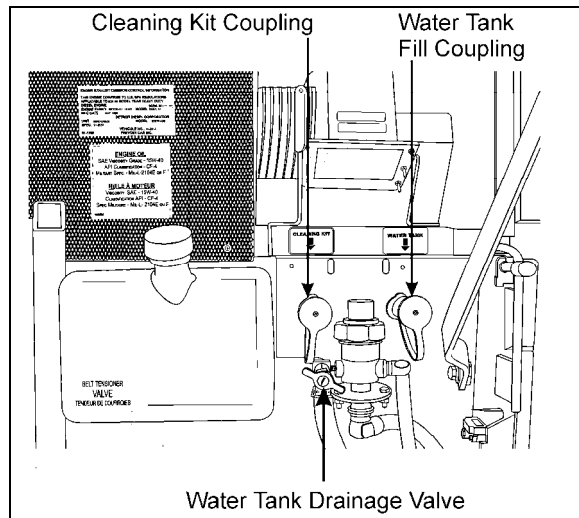


FIGURE 25: FRESH WATER TANK SERVICE VALVES

### 7.8 LIQUID SOAP DISPENSER

A liquid soap dispenser may have been installed as optional equipment. To refill dispenser, proceed as follows:

1. Turn cover slightly clockwise until it stops.
2. Insert projection at end of "BOBRICK" key into rectangular hole in cover (Fig. 28). Push straight in. While holding "BOBRICK" key in, turn cover counterclockwise about 1/8 turn.

**Caution:** Do not use "BOBRICK" key to turn cover.

3. Lift out piston and spout, cover and supply tube.
4. Fill dispenser with soap. This model can dispense vegetable oil soaps, synthetic detergents, and lotion soaps.

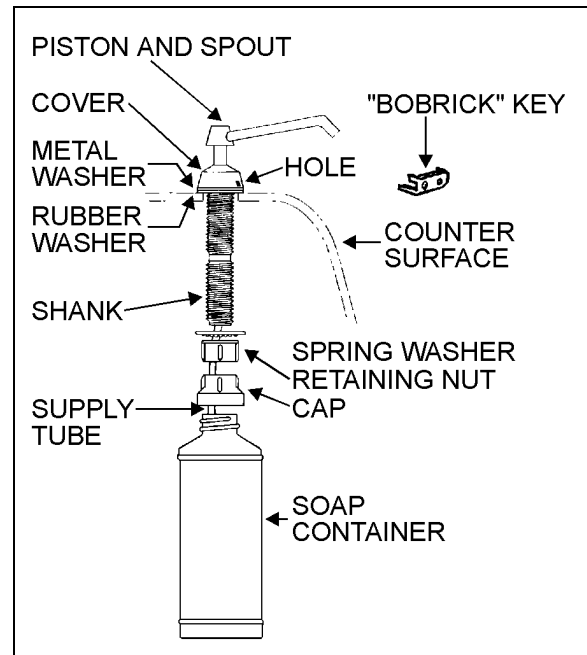


FIGURE 26: LIQUID SOAP DISPENSER

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**Caution:** Never use abrasive cleaners.

5. Replace supply tube, piston, and spout mechanism reversing the steps above.
6. Secure the cover by turning clockwise until lock snaps into position.

**Note:** The dispenser requires priming when extremely viscous lotion soaps are used. Remove piston and spout, cover and supply tube assembly. Pump water into assembly, then replace into dispenser.

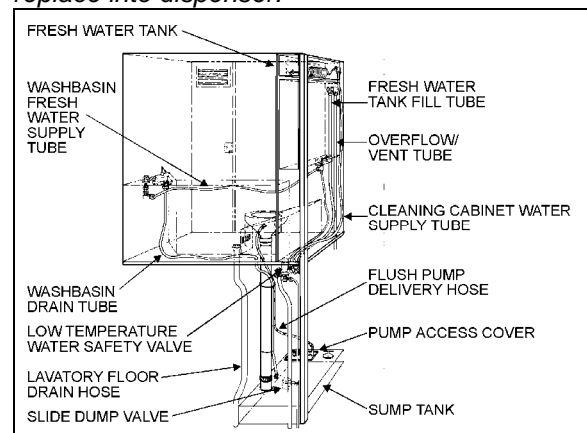


FIGURE 27: FUNCTIONING OF LAVATOR

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### 7.9 FLUSH PUSH-BUTTON

The green flush push-button is located near the toilet. Press on push-button to actuate a pneumatic timer located on the other side of wall.

## Section 23: ACCESSORIES

This timer allows an electric current flow during a preset time to a pump into the sump tank.

### 7.9.1 Pneumatic Timer Removal and Installation

1. Unscrew and remove the flush push-button locking ring.
2. Remove steel plate located on L.H. side of pushbutton switch.
3. Remove pneumatic timer through this opening, taking care to disconnect electric wires.

**Note:** Care must be taken to avoid losing the spacers installed on the mounting sleeve.

4. Reverse the above procedure to reinstall timer. The recommended torque for the lock nut is 15 Lbf-ft (21 Nm).

### 7.9.2 Timer Adjustment

Timer can be adjusted from 0.2 second to 3 minutes by turning the time adjustment screw clockwise to increase time, and counterclockwise to decrease time. To gain access to the time adjustment screw, repeat steps 1, 2 and 3 in the previous paragraph "6.10.1 Pneumatic Timer Removal and Installation".

### 7.10 FLUSH PUMP

The submersible-type flush pump is mounted inside an enclosure in the sump tank (Fig. 30). The enclosure is provided with a screened side which, serves as a strainer to prevent solid matters from entering the pump.

The pump requires no periodic maintenance other than cleaning of the strainer side using a water jet introduced through the circular cap opening, once the sump tank is completely drained. The pump can run dry periodically without damage. However, for maximum seal life, the run dry periods should be kept to a minimum.

**Caution:** If vehicle is stored for an extended period of time, make sure to clean the strainer as solid matter will tend to pack, and will necessitate replacement of strainer.

#### 7.10.1 Flush Pump Pressure Adjustment

The flush pump is provided with a manually-adjustable control valve mounted on the flush pump enclosure cover and serves to limit the flush pump output pressure. To adjust, ask an

assistant to activate the flush pushbutton and check the liquid projection while you manually adjust the control valve

### 7.11 SUMP TANK

#### 7.11.1 Sump Tank Draining

To drain sump tank, unscrew cap a few turns then turn drain valve handle CCW. Flush tank and pump cage with clean water. Close drain valve by turning handle CW.

**Caution:** The lavatory should be serviced by maintenance personnel after emergency draining. Lavatory tanks should be serviced only at suitably equipped stations.

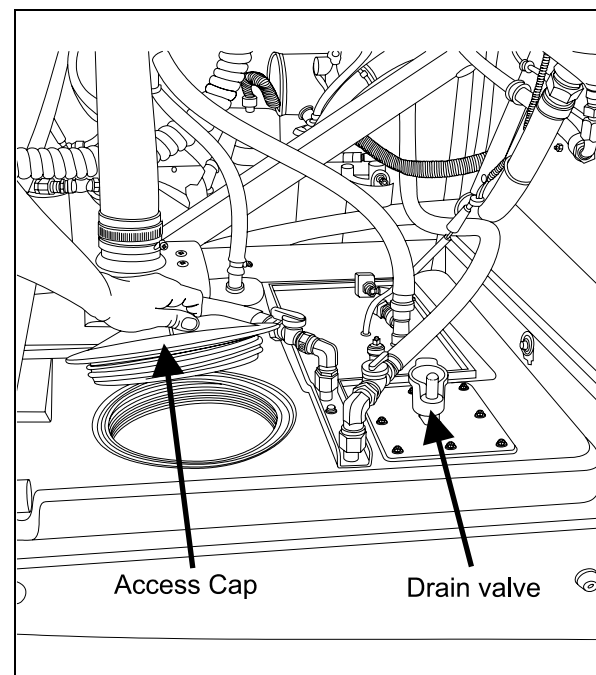


FIGURE 28: SUMP TANK

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#### 7.11.2 Sump Tank Filling

Remove cap on sump tank. Fill Tank with 2 gallons (9 liters) of antifreeze and two gallons of water.

**Caution:** Do not overfill sump tank.

**Note:** The antifreeze solution in the sump tank will be diluted by fresh water coming from the lavatory sink. Regular maintenance of the sump tank is required to prevent freezing.

## 7.12 CLEANING CABINET

A coiled hose located in the cleaning cabinet above the toilet can be used during lavatory cleaning. To use, connect a fresh water supply to the "Hansen" quick-release coupling, identified as "Cleaning Kit", located besides the engine oil reserve tank (Fig. 27). To prevent freezing during cold weather, drain the hose after every use. To drain the hose, uncoil and open the nozzle near the lavatory floor drain. Have an assistant push on the spring ball of the quick-release coupling to allow air into the system.

## 8. 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.

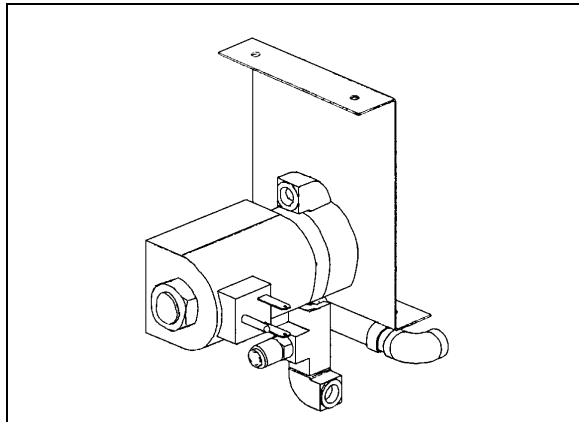


FIGURE 29: AIR HORN VALVE

23230

### 8.1 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.

## 9. HEADLIGHTS CLEANING SYSTEM

### 9.1 GENERAL DESCRIPTION

**Note:** When inspecting the headlights cleaning system, check the washer fluid hoses, fittings and connectors to be sure they are properly connected and seal with no restriction to the flow of washer fluid. Check that the washer nozzles are properly aimed.

The headlights cleaning system is independent from the windshield washer system and has its own washer fluid reservoir located in the front electrical and service compartment. However, this system shares the same switch than the upper windshield washer (refer to Operator or Owner's manual for operation). Each pressing of this switch produces 2 successive 0.7 seconds jets.

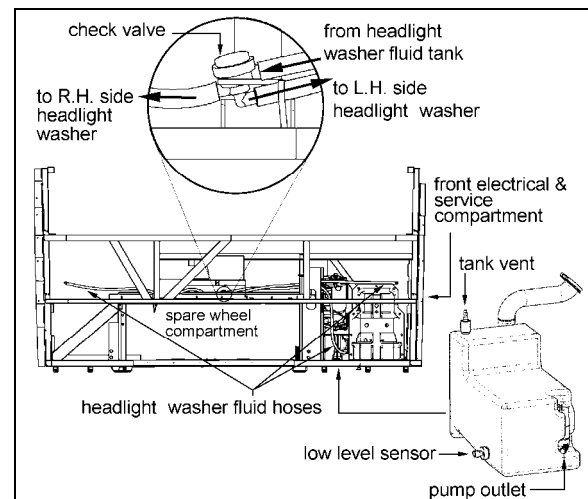
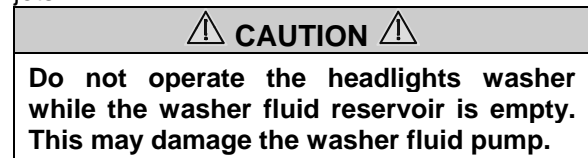


FIGURE 30: HEADLIGHT CLEANING SYSTEM

23361

### 9.2 WASHER FLUID REFILLING

Open the filler neck cap and add 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.

### 9.3 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 31. Align the jet adjustment tool #800377 with the reference line shown on the front view detail. As seen on the side view, position the adjustment tool vertically for proper aiming.

**⚠ CAUTION ⚠**

Because they are made of plastic, firmly tighten nozzle and bulkhead fittings by hand only.

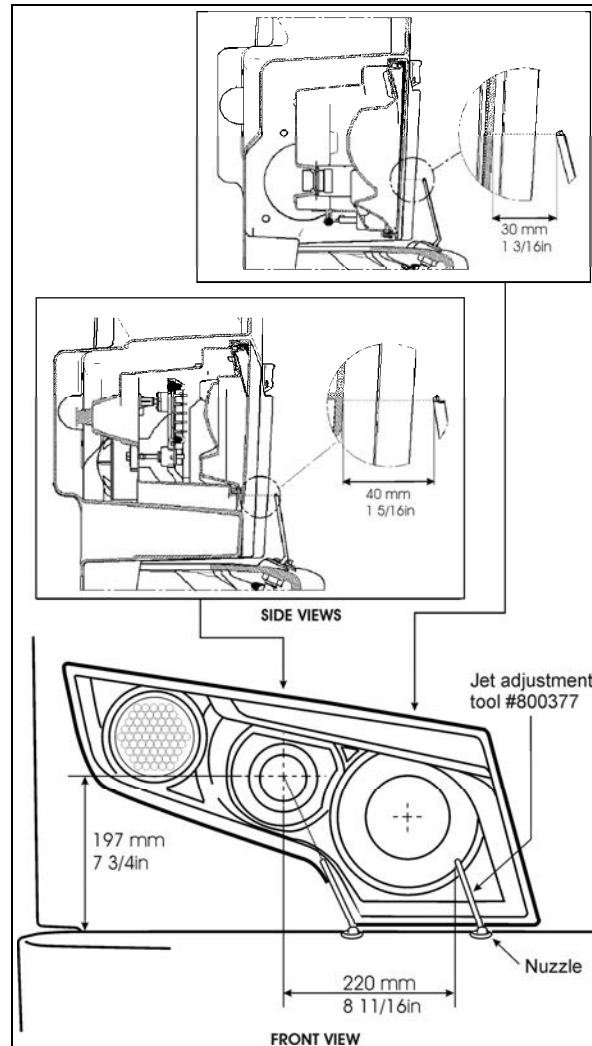


FIGURE 31: WASHER NOZZLES ADJUSTMENT 23386

## 10. WINDSHIELD WIPERS AND WASHERS

### 10.1 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 two electric wiper motors that are accessible for maintenance after raising the appropriate access panel at the front of the coach (refer to figure 32).

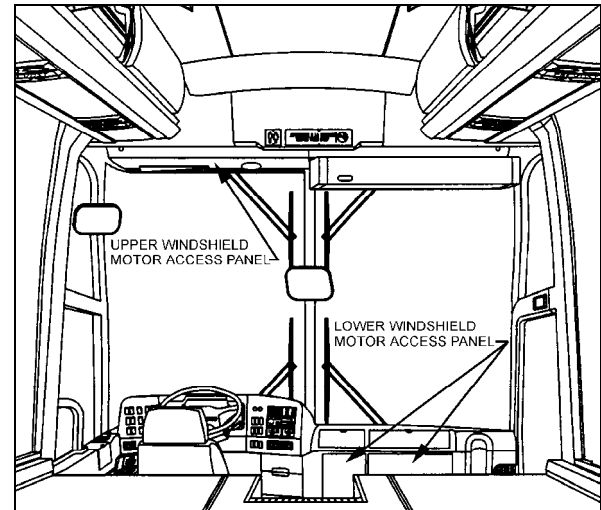


FIGURE 32: WIPER MOTORS LOCATION 23319

Each wiper motor is independently operated:

Depress the upper windshield wiper switch located on the dashboard L.H. side to the first position for intermittent wiping, and to the second position for continuous wiping (item 1, fig. 34).

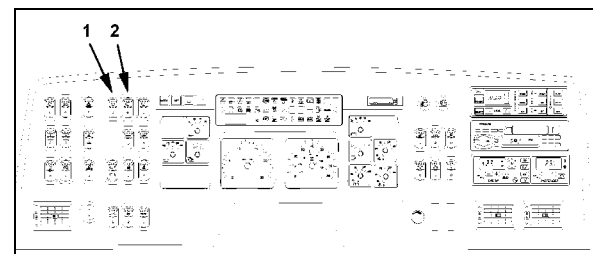


FIGURE 33: DASHBOARD

Turn the multifunction lever forward to activate lower windshield wipers (item 2, fig. 34). 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.

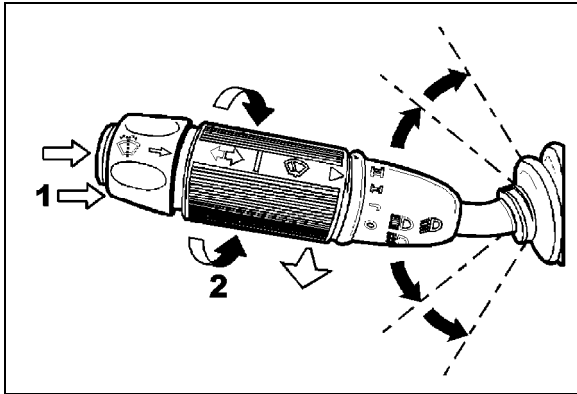


FIGURE 34: MULTIFUNCTION LEVER

23133

Each windshield washer pump is independently operated:

To activate the upper windshield washer pump, depress and hold the rocker switch on dashboard L.H. side (item 2, fig. 34). The upper wipers will come on automatically and will shut off a few seconds after releasing the rocker switch. The lower windshield washer pump is electrically operated and is controlled by a washer control ring on the multifunction lever (item 1, fig. 34).

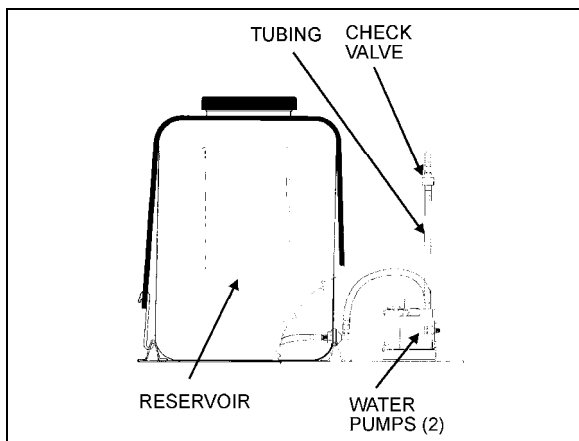


FIGURE 35: WINDSHIELD WASHER RESERVOIR

23085

The windshield washer reservoir is located in the front service compartment (Fig. 35). This unit pumps the washer liquid to the spray nozzles where it is dispersed across the windshield. Adjust nozzles with a flat tip screwdriver as needed to get proper spray coverage.

## 10.2 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.

### 10.2.1 Sweep Adjustment

On a dry windshield, to avoid possible damage to the arm assembly or wiper motors, hold the wiper arms away from the windshield by inserting a small nail, or other such object, through the holes at the base of each wiper arm specially drilled for this purpose.

Sweep adjustment is a rough adjustment. It must be followed by lower and upper linkage adjustment. See paragraph 10.3 and 10.4.

In order to obtain the sweep adjustment, it may be necessary to remove and reposition the wiper arms, proceed as follows:

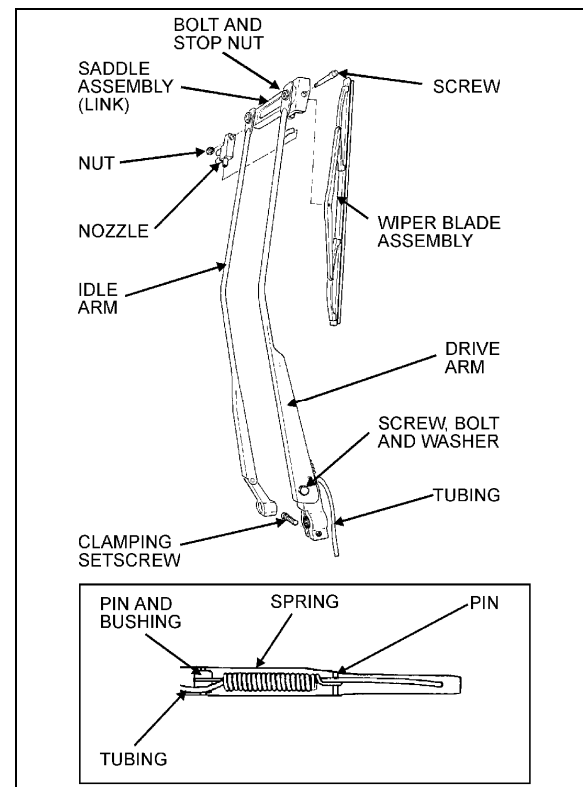


FIGURE 36: LOWER WINDSHIELD WIPER

23086

1. Remove the cap nuts from the wiper arm pivot shafts (Fig. 36 and 37);
2. Disconnect the windshield washer tubing at the base of the wiper arm;
3. Lower windshield wiper: loosen the clamping set screw securing the drive arm to the knurled arm pivot shaft;

## Section 23: ACCESSORIES

4. Remove the drive and idler arms or arm assembly;
5. Relocate the drive arm or arm assembly on its knurled pivot shaft to obtain the desired position;
6. Lower windshield wiper. Tighten the clamping set screw to secure the drive arm to the knurled shaft. Fit the idler arm onto the idler pivot shaft.
7. Install the cap nut pivot shafts.
8. Connect the windshield washer tubing at the base of the wiper arm;
9. Check the adjustment on a wet windshield.

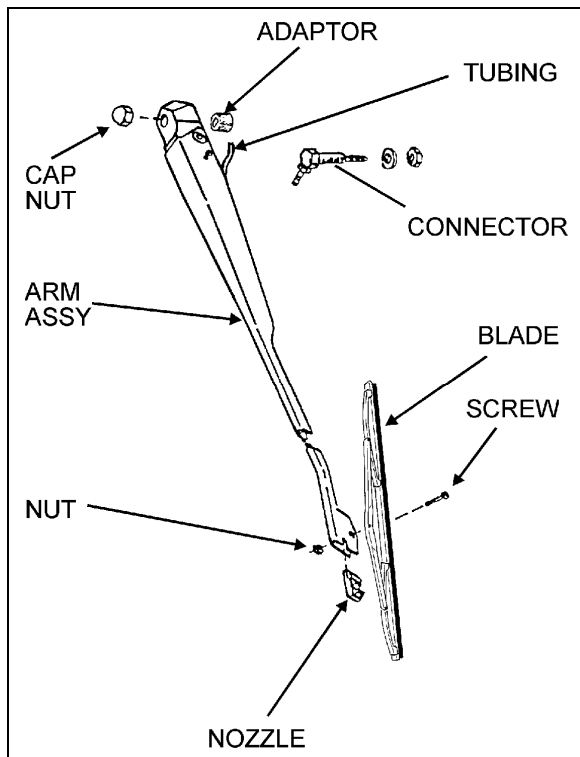


FIGURE 37: UPPER WINDSHIELD WIPER

23087

### 10.2.2 Removal

1. Remove the cap nuts from;
2. Disconnect the windshield washer tubing at the base of the wiper arm;
3. Mark the relationship of the arm head to the end of the knurled drive shaft to ensure the original position if the arm is to be reinstalled;
4. Lower windshield wiper: loosen the clamping set screw on the base of the drive arm;
5. Remove the wiper arm assembly.

### 10.2.3 Installation

1. Make sure the wiper motor is in the stop position. Lower windshield wiper: position the wiper arm on the knurled drive shaft and idler arm on the pivot shaft. Upper windshield wiper: position the wiper arm assembly on the knurled drive shaft;
2. If the original arm is reinstalled, align the marks made during removal;
3. Operate the wipers on a wet windshield to check the wiper blade sweep and angle. Readjust as necessary;
4. Lower windshield wiper: Tighten clamping nut onto the drive arm. Install cap nuts onto the arm shafts;
5. Connect the windshield washer tubing at the base of the wiper arm;
6. Check the adjustment on a wet windshield.

### 10.3 LOWER LINKAGE ADJUSTMENT

1. Make sure the wiper motor is in the stop position prior to working on the linkage.
2. Adjust the two pivot shafts vertically.
3. Adjust the rod length of the connecting pivot shafts. During rod length adjustment, maintain the pivot shafts in the vertical position.
4. Adjust the rod located between right pivot shaft and motor to a  $40.5^\circ$  angle (fig. 38). The motor lever must be on the same axis as the rod.
5. Install the right wiper arm in its normal position (in the middle of the windshield). Refer to paragraph "Sweep Adjustment".
6. The right wiper arm final adjustment is made by adjusting the smallest rod length.
7. Install the left wiper arm in its normal position (in the middle of the windshield). Refer to paragraph "Sweep Adjustment".
8. The left wiper arm final adjustment is made by adjusting the longest rod length.
9. Check the adjustment on a wet windshield.

### 10.4 UPPER LINKAGE ADJUSTMENT

1. Make sure the wiper motor is in the stop position prior to working on the linkage.
2. Adjust rods length.



3. Install the left wiper arm in its normal position (in the middle of the windshield). Refer to paragraph "Sweep Adjustment".
4. The left wiper arm final adjustment is made by adjusting the rod length to 8.46 inches (215 mm).
5. Install the right wiper arm in its normal position (in the middle of the windshield). Refer to paragraph "Sweep Adjustment".
6. The right wiper arm final adjustment is made by adjusting the rod length to 23.54 inches (598 mm).
7. Check the adjustment on a wet windshield

## 10.5 WINDSHIELD WIPER MOTORS

### 10.5.1 Lower Windshield Wiper Motor Replacement

The lower windshield wiper motor is located at lower front of the vehicle, behind the defroster panel. Refer to figure 32 for motor location.

**Warning:** Park vehicle safely, apply parking brake, stop engine and set battery master switch to the "OFF" position prior to working on the vehicle.

1. Remove the two Phillips-head screws retaining the defroster panel, and remove panel.
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 #800304), reverse removal procedure to reinstall.

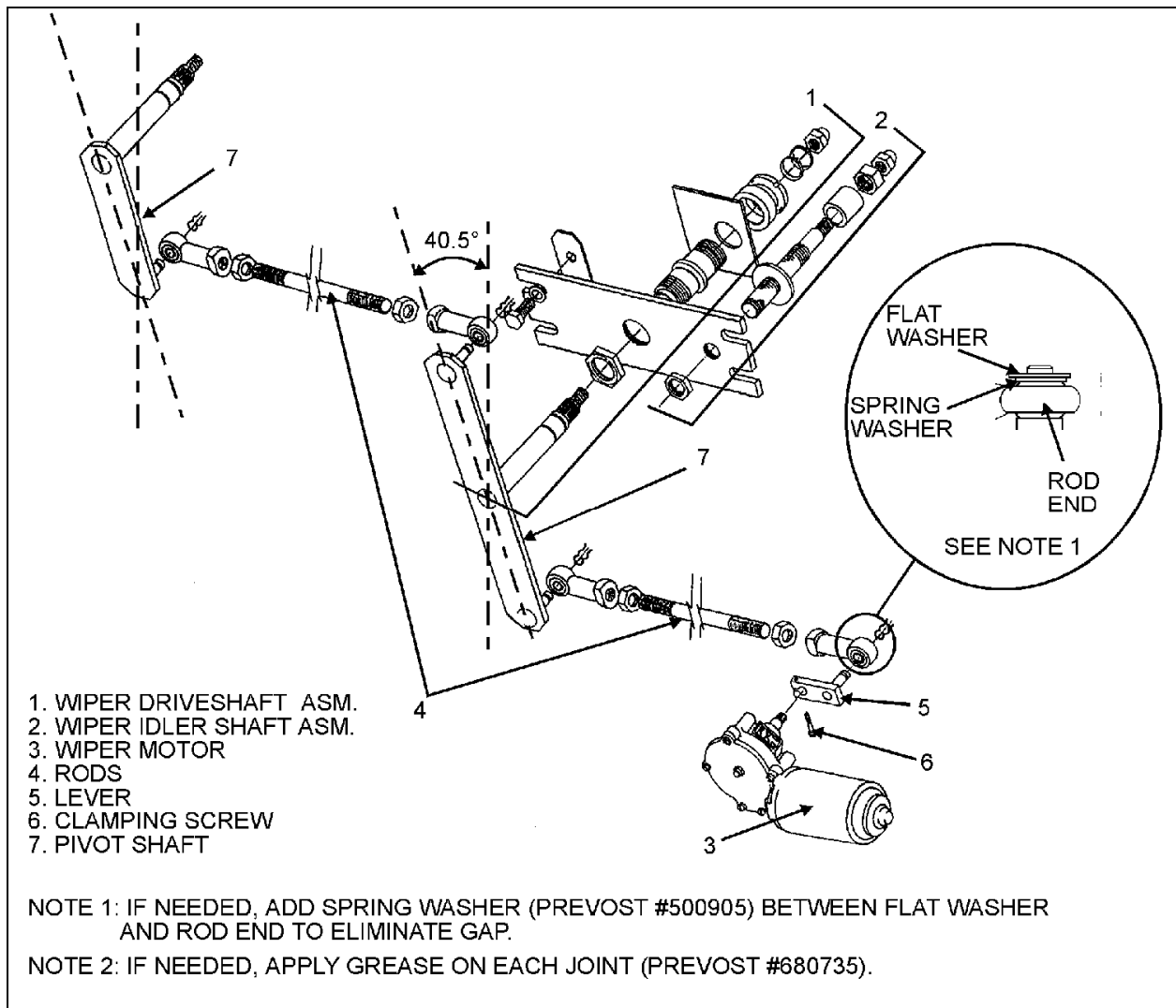


FIGURE 38: LOWER WINDSHIELD WIPER INSTALLATION

23088

### 10.5.2 Upper Windshield Wiper Motor Replacement

The upper windshield wiper motor is located above L.H. upper windshield panel. To remove the motor, it is necessary to remove left sun visor and upper windshield panel.

**Warning:** Park vehicle safely, apply parking brake, stop engine and set battery master switch to the "OFF" position prior to working on the vehicle.

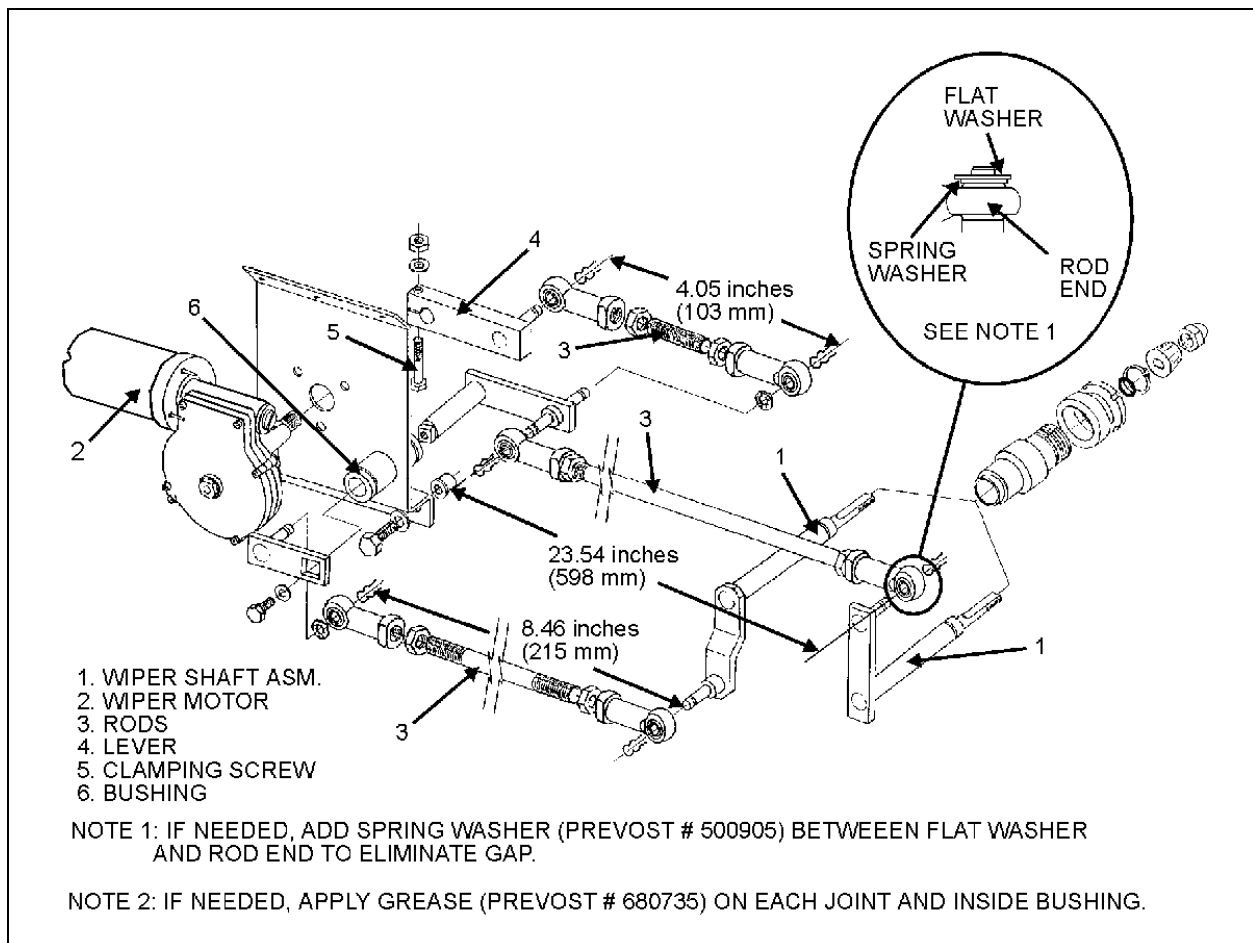


FIGURE 39: UPPER WINDSHIELD WIPER INSTALLATION

23089

1. Pull out the wiring connector (black and red wires) located on sun visor L.H. side and disconnect.
2. Remove the two Phillips-head screws at the bottom end of the sun visor arms.
3. Remove the two Phillips-head screws on each roller side, pull out the sun visor.
4. Remove the Phillips-head screws retaining the upper windshield panel.
5. If equipped with blower defroster, loosen hose clamp to remove air duct from hose.
6. Disconnect wiring connector from the windshield wiper motor.
7. Loosen the bolt retaining the lever at the end of the motor driving shaft (Fig. 37).
8. Remove the three bolts holding the motor to the steel plate.
9. Remove the windshield wiper motor (Prevost #800304), reverse removal procedure to reinstall.

### **11. AUTOMATIC FIRE SUPPRESSION SYSTEM (AFSS) (OPTIONAL)**

This optional system is used to shut down the engine and to extinguish a fire in the engine compartment or in the vicinity of the preheating system if so equipped.

The system operation is fully automatic and does not require assistance from the operator, however if required, the system can be manually activated by the operator at any time.

Refer to Prevost Operator's Manual or Owner's Manual for system operation and operational sequence (fire).

If more information is needed on the system, please refer to Kidde Dual Spectrum "Operation & Maintenance Manual annexed at the end of this section.

#### **11.1 PERIODIC MAINTENANCE**

##### **PRE-TRIP**

- Verify that the Protection Panel "SYSTEM OK" lamp is on solid green.

**EVERY 3000 MILES OR MONTHLY** (whichever comes first)

##### **General**

- Verify that neither the protected equipment nor the hazard has changed.
- Verify that no obvious physical damage or condition exists that might prevent system operation.

##### **Protection Panel**

- Verify that all warning lamps and the audible alarm are operational by pressing the "TEST/RESET" button.

##### **Manual Activation Switch**

- Verify that the tamper seal is intact and access to the switch is unobstructed.

##### **Fire Detectors**

- Optical
  - Verify that the status lamp on the detector face is on solid green.
  - Verify that nothing is blocking the detector's field of view.
  - Verify that the windows on the face of the detector are free of excess contamination (dirt, oil, grease, etc.) – if necessary, clean using a water soaked non-abrasive towel.
- Linear Thermal
  - Verify that there is no obvious physical damage and that the unit is free of excess contamination (dirt, oil, grease, etc) – if necessary, clean using a water soaked non-abrasive towel.
  - Verify that mounting is secure and taught.

##### **Electrical Harness**

- Verify that electrical connectors and electrical wiring have no visible damage and all connectors are securely seated.

##### **Extinguisher & Distribution System**

- Verify that the extinguisher pressure gauge pointer is in the green arc at room temperature.
- Verify that distribution piping and nozzles are intact and unobstructed and that nozzle blow-off caps are in place.

**EVERY 18000 MILES OR SEMI-ANNUALLY**  
(whichever comes first)

- Perform a comprehensive fire system test using a Kidde Dual Spectrum System Test Set (Optical Test Kit P/N 420871-2).
- Service the extinguisher in accordance with KDS Document 160296, "KDS Pre-Engineered Fire Suppression System: Installation, Operation and Maintenance Manual".

**EVERY SIX YEARS**

- Have the fire extinguisher rebuilt by a qualified fire protection equipment company familiar with Kidde Dual Spectrum equipment and in accordance with KDS Document 160296, "KDS Pre-Engineered Fire Suppression System: Installation, Operation and Maintenance Manual". Rebuilt shall include actuator, o-ring seals and dry chemical replacement.

**EVERY TWELVE YEARS**

- Have the Extinguisher cylinder hydrostatically tested by a qualified fire protection equipment company familiar with Kidde Dual Spectrum equipment and in accordance with KDS Document 160296, "KDS Pre-Engineered Fire Suppression System: Installation, Operation and Maintenance Manual".

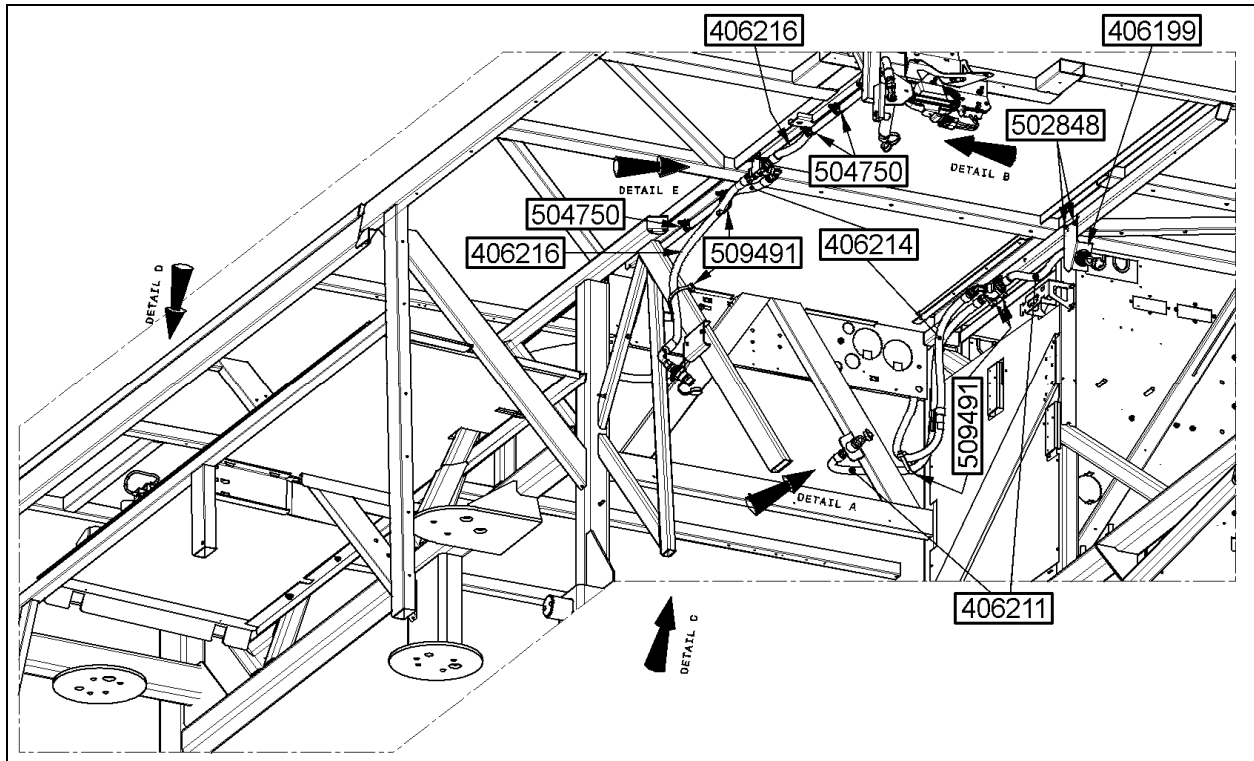


FIGURE 40: VIP AUTOMATIC FIRE SUPPRESSION SYSTEM (AFSS) INSTALLATION

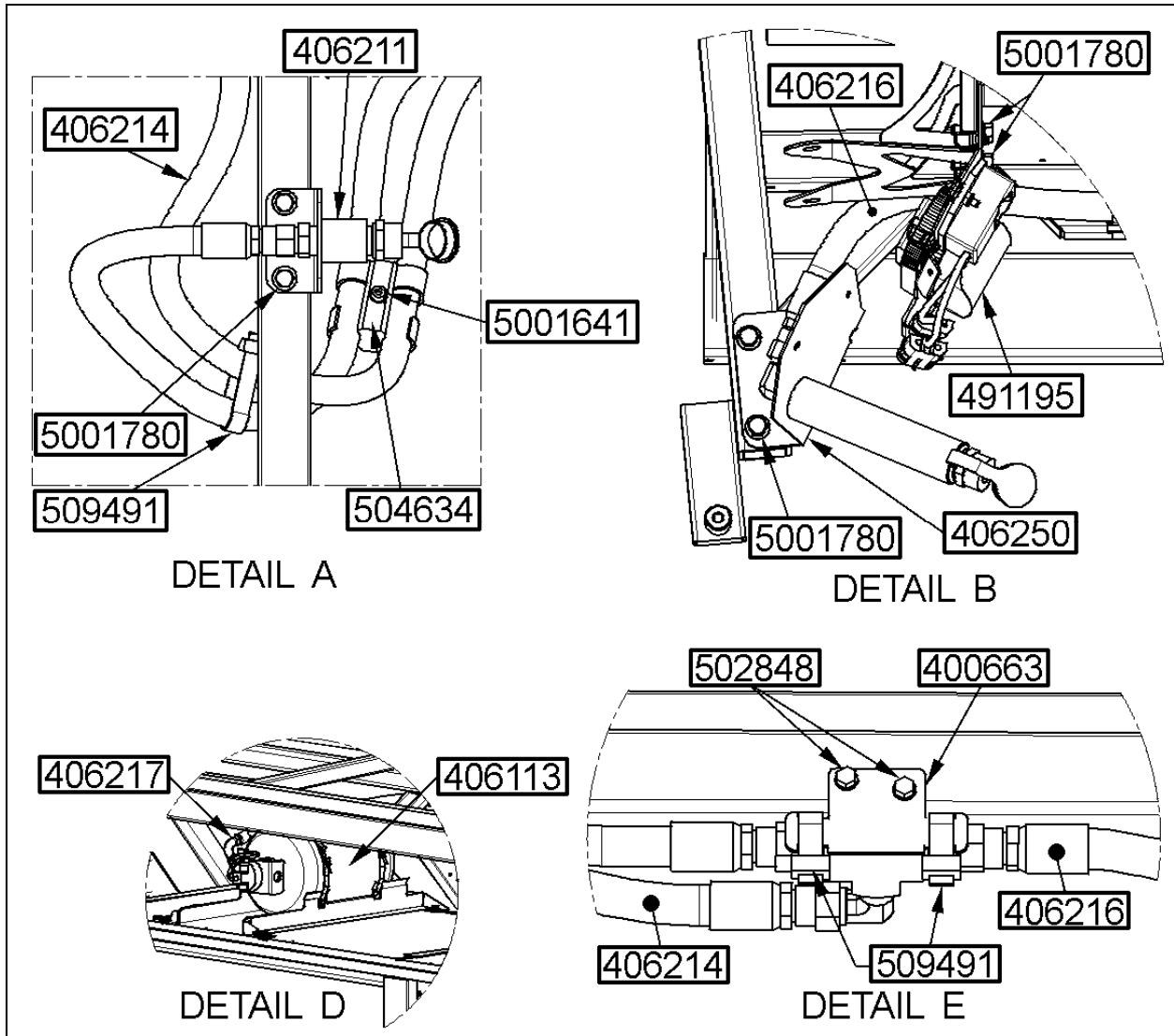


FIGURE 41: VIP NOZZLE BRACKETS AND COMPONENTS IDENTIFICATION AND INSTALLATION

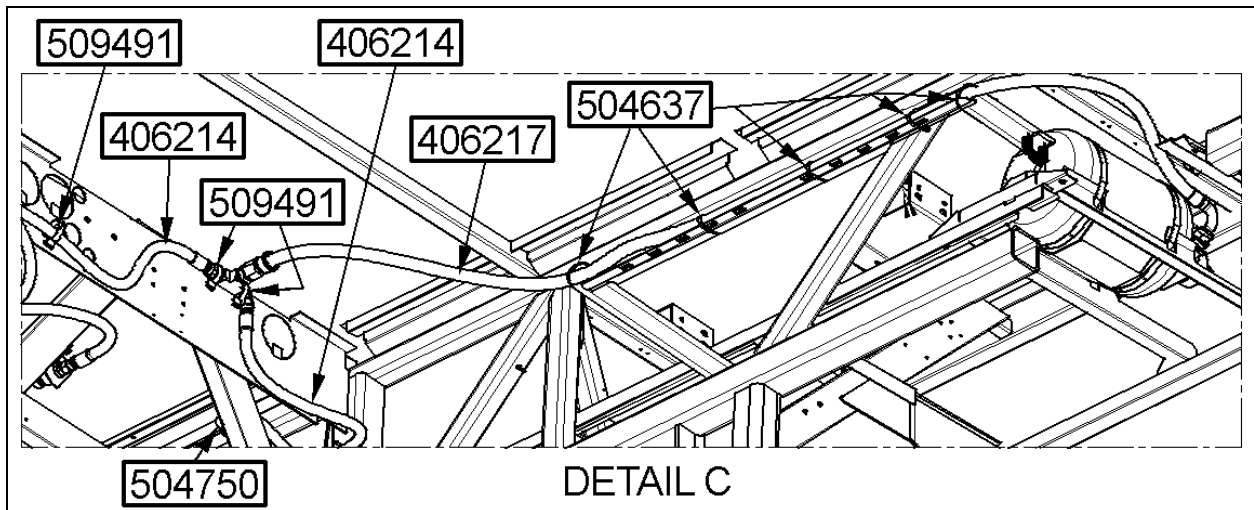


FIGURE 42: VIP NOZZLE BRACKETS AND COMPONENTS IDENTIFICATION AND INSTALLATION

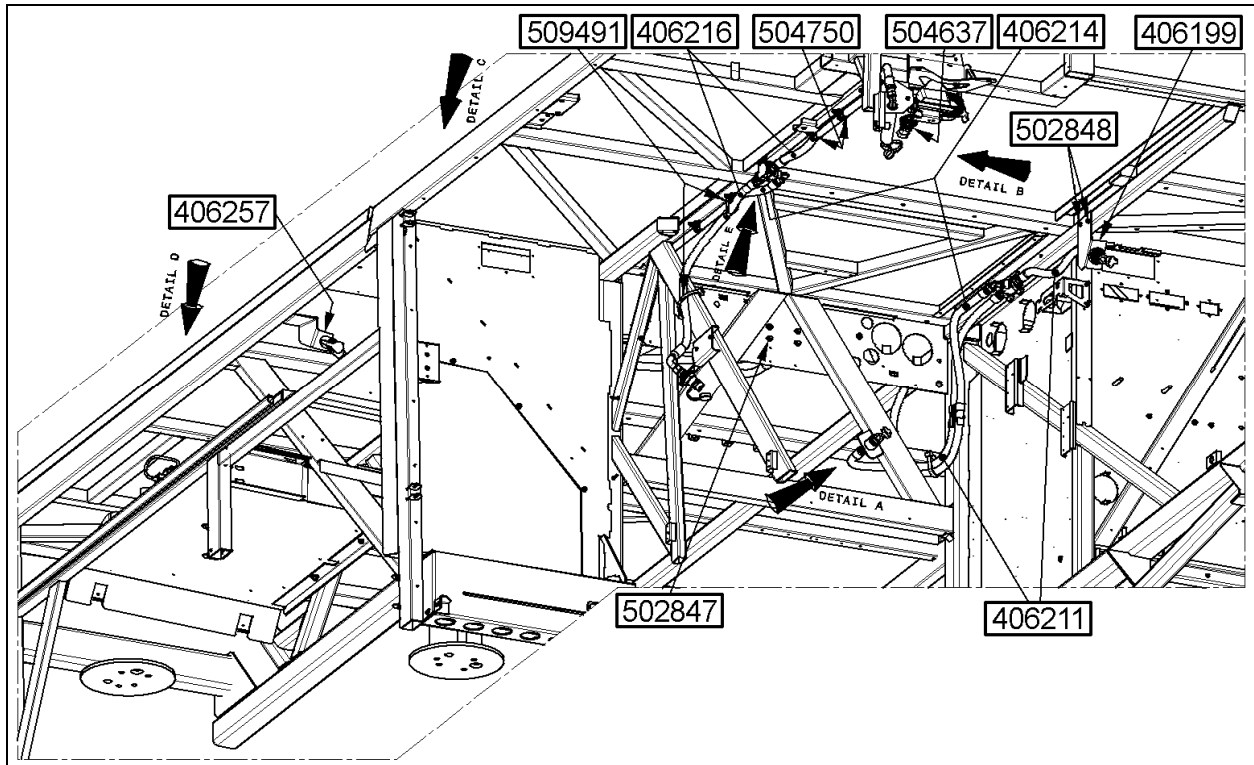


FIGURE 43: H3 COACHES AUTOMATIC FIRE SUPPRESSION SYSTEM (AFSS) INSTALLATION

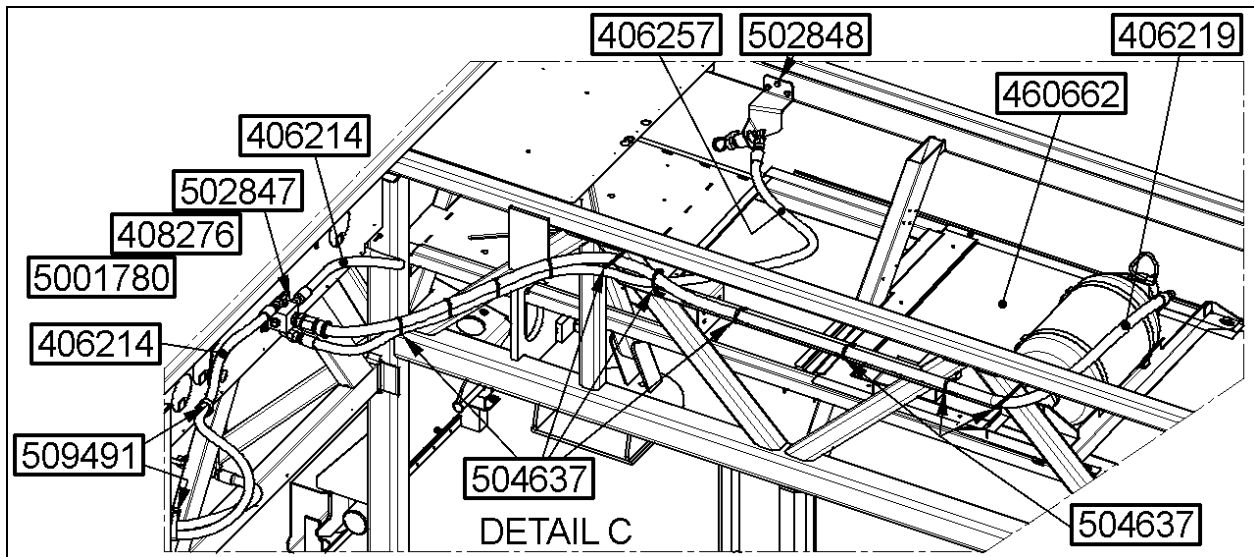


FIGURE 44: H3 COACHES NOZZLE BRACKETS AND COMPONENTS IDENTIFICATION AND INSTALLATION



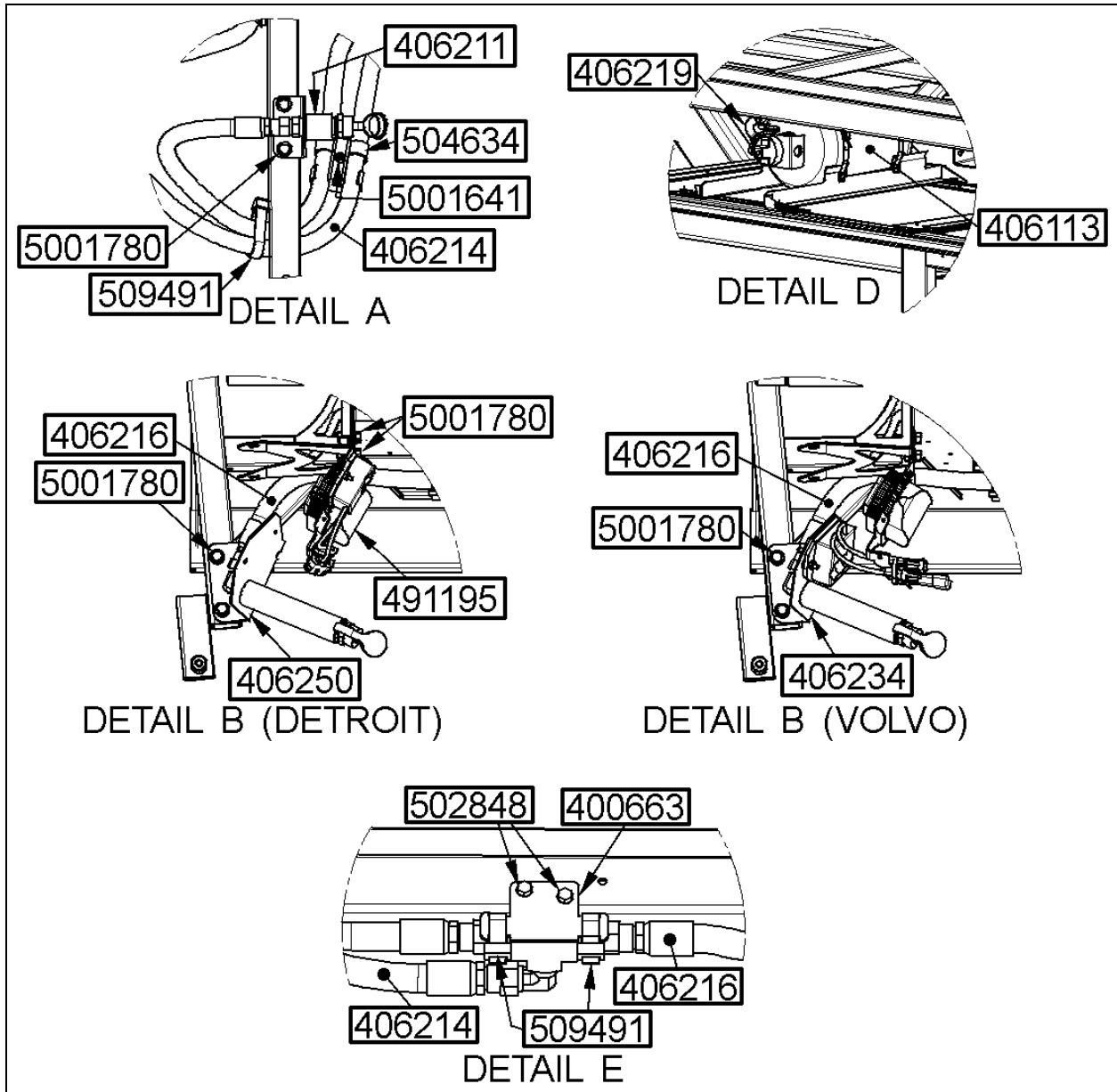


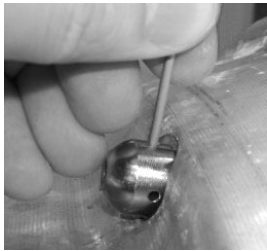



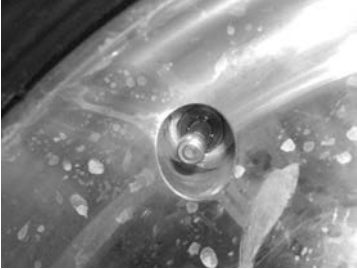

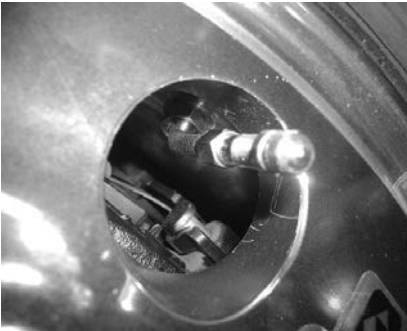
FIGURE 45: H3 COACHES NOZZLE BRACKETS AND COMPONENTS IDENTIFICATION AND INSTALLATION

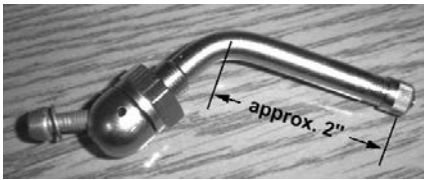

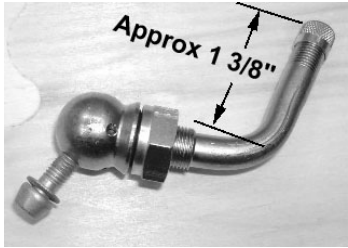



## 12. TIRE PRESSURE MONITORING SYSTEM (TPMS)

The optional active tire pressure and temperature monitoring system is a sensing device designed to identify and display tire operating data and activate an alert or warning when pressure or temperature irregularities are detected.

For more information on the operation and troubleshooting of the system, refer to the Operator's Manual, chapters "Controls and Instruments", "Safety Features and Equipment" and also "Appendix G".

### 12.1 TIRE VALVE INSTALLATION

<p><b>Use as required a small rod to hold the valve in place when tightening.</b></p>			
<p><b>Steel Wheels</b></p>	<p><b><u>All wheels</u></b>                      a) Install Beru valve                      Torque valve to 44.5lb-in +/- 9.5                      b) no extension piece</p>	 #Prevost 681083	
	<p><b><u>Front axle and tag axle wheels with 365 tires</u></b>                      a) Remove Alcoa valve                      b) Install Beru valve                      Torque valve to 102lb-in +/- 22                      c) No extension piece</p>	 #Prevost 651080	
<p><b>Aluminum Wheels (new Hub-Mounted wheels)</b></p>	<p><b><u>Front axle and tag axle wheels with 315 tires</u></b>                      a) Remove Alcoa valve                      b) Install Beru valve                      Torque valve to 102lb-po +/- 22                      c) Small extension piece (approx 50mm)</p>	 #Prevost 651081	

Aluminum wheels (new Hub-Mounted wheels)	<p><b><u>Drive axle inner and outer wheels with 315 tires-</u></b></p> <p>a) Remove Alco valve                  b) Install Beru valve                  Torque valve to 102lb-in +/- 22                  c) no extension piece</p>	 <p>#Prevost 651081</p>	
	<p><b><u>"Super Single" Tires</u></b></p> <p>a) Remove Alcoa valve                  b) Install Beru valve                  Torque valve to 102lb-in +/- 22                  c) no extension piece</p>	 <p>#Prevost 651079</p>	
Aluminum wheels (former Stud-Mounted wheels)	<p><b><u>All wheels</u></b></p> <p>a) Remove Alcoa valve                  b) Install Beru valve                  Torque valve to 102lb-in +/- 22                  c) no extension piece</p>	 <p>#Prevost 651082</p>	



**CAUTION**

When replacing Alcoa valve stems, it is recommended to lubricate the threads and O-ring with a non-water based tire lubricant.

When valve stem extensions are used, it is recommended that valve stem stabilizers be used.

12.2 BERU SENSORS INSTALLATION

**IMPORTANT NOTE**

*Beru sensors have a limited lifespan (5 years on average)*

Install sensor onto valve. Torx screw T-20. Torque to 35lb-in (4Nm) (supplier specification for the screw).

Make sure sensor rests against rim flange.

**IMPORTANT**

Use the screw only once. This screw uses a thread lock. Replacement screw #651084.



Note bar code and tie it up using wheel holes. Use supplied removable tie-rop.



**Decal**

Glue decal facing the valve.

#651091 ENGLISH #651090 BILINGUAL

**13. SPECIFICATIONS****AMPLIFIER**

Model..... VA400-8  
 Output..... 400 watts, 6 channel RMS at 4 ohm @ 0.5 T.H.D.  
 Prevost number ..... 901191

**SOUND SELECTOR**

Model..... VSS-05  
 Power source ..... 12 volts  
 Prevost number ..... 21116371

**DASHBOARD RADIO (standard)**

Power source ..... 12 volts  
 Prevost number ..... 901315

**DASHBOARD RADIO (SIRIUS)**

Power source ..... 12 volts  
 Prevost number ..... 901317

**DASHBOARD RADIO (XM)**

Power source ..... 12 volts  
 Prevost number ..... 901316

**MOBILE DVD PLAYER**

Power source ..... 12 volts  
 Prevost number ..... 901198

**SPEAKER (standard)**

Model..... Dual Cone  
 Impedance ..... 4 ohms  
 Prevost number ..... 901194

**SPEAKER (optional)**

Model..... Coaxial  
 Impedance ..... 4 ohms  
 Prevost number ..... 901195

**SUBWOOFERS (optional)**

Model..... J Drive VB170  
 Impedance ..... 4 ohms  
 Prevost number ..... 901193

**VIDEO SWITCHER**

Model..... V-3000  
 Prevost number ..... 901030

**BOOM-TYPE MICROPHONE**

Prevost number ..... 900763

**HANDHELD PRIORITY MICROPHONE**

Prevost number ..... 900808

**RUBBER COATED MICROPHONE**

Prevost number ..... 900745

**16 CHANNEL WIRELESS MICROPHONE**

Make..... R.E.I.  
Prevost number ..... 900954

**16 CHANNEL WIRELESS MICROPHONE CHARGING STATION**

Make..... R.E.I.  
Prevost number ..... 900953

**16 CHANNEL WIRELESS MICROPHONE RECEIVER**

Make..... R.E.I.  
Prevost number ..... 900952

**KARAOKE**

Make..... Panasonic  
Model..... MOBILE DVD PLAYER DV1500  
Prevost number ..... 901033

**TV RECEIVER**

Power source .....24V  
Prevost number ..... 901054

**VIDEO DISTRIBUTION AMPLIFIER**

Power source .....24V  
Prevost number ..... 901117

**TV MONITOR**

Type .....10.4" LCD  
Power source .....24V  
Prevost number ..... 901130

**HUBODOMETER (US model: miles)**

Make..... Stemco  
Prevost number ..... 650002

**HUBODOMETER (Canada model: km)**

Make..... Stemco  
Prevost number ..... 650117

**ELECTRIC DESTINATION SIGN (FLUORESCENT TUBE)**

Make..... General Electric  
Length ..... 30" (76 cm)  
Outside diameter ..... 1" (25 mm)  
Wattage ..... 20  
Color..... Cool white  
Quantity ..... 1  
Prevost number ..... 830120

**ELECTRONIC DESTINATION SIGN**

Make..... Pocatec  
Prevost number ..... 940050

**LAVATORY VENTILATION FAN MOTOR**

Make..... Aurora  
Type ..... RG500EF  
Voltage ..... 24 volts DC  
Rotation ..... R.H.

Prevost number ..... 870844

**EMERGENCY BUZZER SWITCH (PUSH BUTTON)**

Make..... Cole Hersee Co.  
 Voltage ..... 24 V  
 Prevost number ..... 562117

**FRESH WATER TANK**

Make..... Prevost  
 Capacity ..... 18 US gal (68 liters)  
 Prevost number ..... 403030

**FRESH WATER TANK HEATER**

Make..... Hot Watt  
 Wattage ..... 75 watts  
 Voltage ..... 115 volts AC  
 Prevost number ..... 562018

**FLUSH PUSH BUTTON PNEUMATIC TIMER**

Make..... McGill  
 Type ..... Resettable  
 Time ..... 0,2 to 180 seconds  
 Timer ..... 563327

**FLUSH PUMP**

Make..... Jabsco  
 Model number ..... 30240-1024 24 V  
 Power source ..... 24 volts DC  
 Capacity ..... 1452 GPH  
 Prevost number ..... 900496

**AIR HORN**

Make..... Allied Signal Inc.  
 Prevost number ..... 640093

**AIR HORN VALVE**

Make..... Allied Signal Inc.  
 Prevost number ..... 640128

**WINDSHIELD WIPER MOTOR**

Make..... SWF  
 Prevost number ..... 800304

**LOWER WIPER (BLADE)**

Make..... Sprague device inc.  
 Prevost number ..... 800284

**UPPER WIPER (BLADE)**

Make..... Sprague device inc.  
 Prevost number ..... 800234





# **OPERATION & MAINTENANCE MANUAL FOR PREVOST H345 TRIAL SYSTEM**

**Manual Number 160339  
Revision 09SEPT04**

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## INTRODUCTION

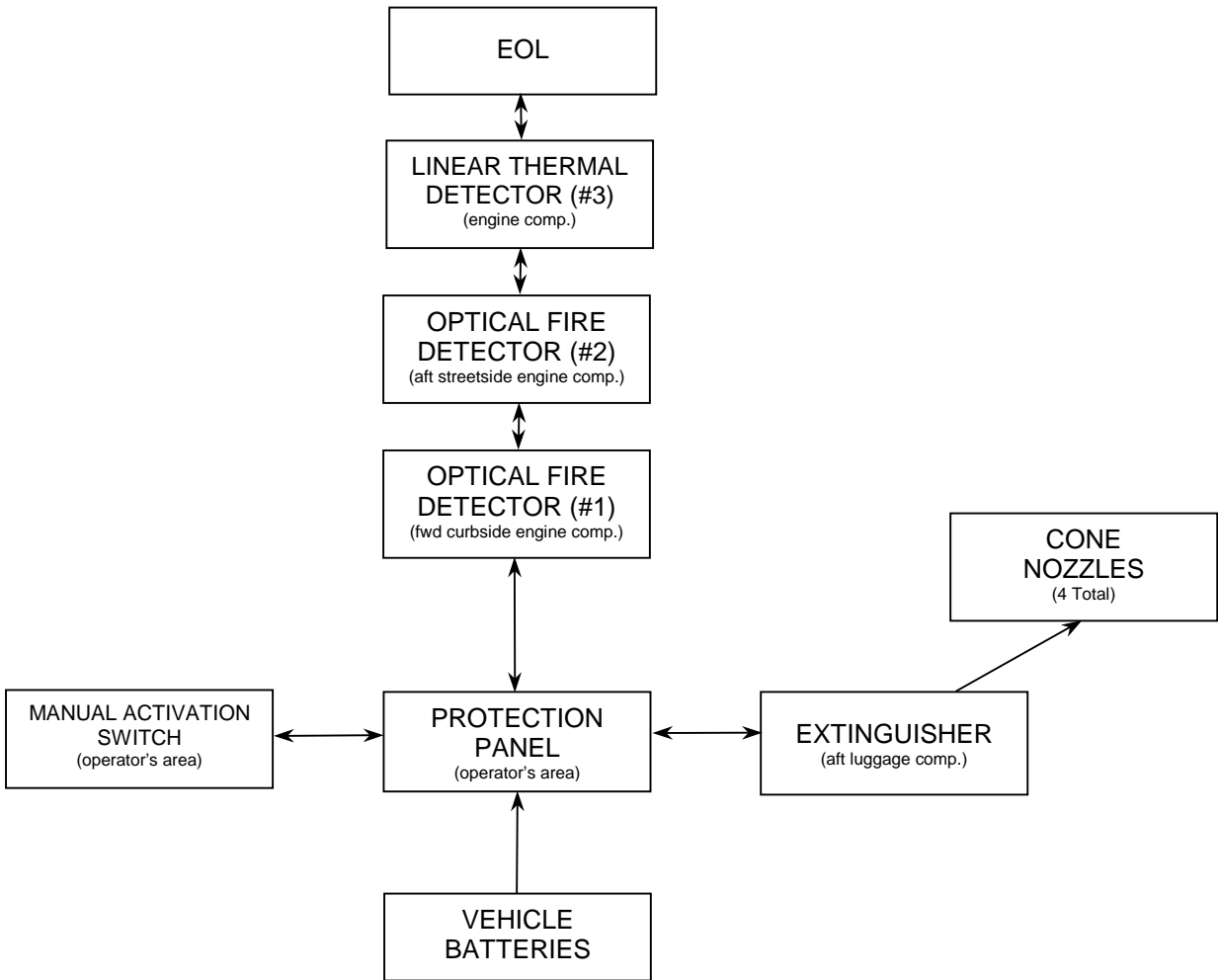
This manual describes the operation and maintenance of the Kidde Dual Spectrum® Automatic Fire Detection and Suppression System (AFSS) as installed for trial purposes on one Prevost H345 bus (#1304) at Prevost Car Inc, Sainte-Claire, QC, Canada.

## SYSTEM OPERATION

When a fire is detected inside the engine compartment, the system sends a fire alarm signal to the Protection Panel located in the operator's area. The Protection Panel immediately turns on the fire "ALARM" lamp and sounds the audio alarm. After a 15-second time delay the engine is automatically shut down. The Fire Extinguisher is discharged simultaneously with engine shutdown. The Manual Activation Switch is used when immediate discharge of the Fire Extinguisher and engine shutdown are desired.

The Protection Panel continuously monitors system integrity and displays the information via the "SYSTEM OK" and fire "TROUBLE" indicators.

A system block diagram is shown in Figure 1.



**FIGURE 1 - SYSTEM BLOCK DIAGRAM**

## OPERATIONAL SEQUENCE (FIRE)

### FIRE:

1. An Optical Fire Detector or Liner Thermal Detector detects a fire in the engine compartment and sends a signal to the Protection Panel in the operator's area.
2. The fire "ALARM" lamp on the Protection Panel will illuminate solid red and an audible alarm will sound.
3. The operator shall bring the vehicle to a safe stop.
4. The system automatically shuts down the vehicle engine and discharges the Extinguisher into the engine compartment 15 seconds after the fire alarm starts unless advanced or delayed by the operator.
  - If the operator presses the Manual Activation Switch, all delays will terminate and the engine shutdown and extinguisher discharge will occur immediately.
  - If the operator presses and releases the 'DELAY ENGINE STOP' switch once, the engine shutdown and extinguisher discharge will be delayed by an *additional* 15 seconds.

**WARNING**

**THE ENGINE WILL STOP 15 SECONDS AFTER THE FIRE ALARM STARTS. THE OPERATOR MUST BE PREPARED TO BRING THE VEHICLE TO A SAFE STOP AS SOON AS THE ALARM SOUNDS. STEERING MAY BECOME DIFFICULT AFTER ENGINE SHUTDOWN. IF MORE TIME IS REQUIRED, THE "DELAY ENGINE STOP" SWITCH MAY BE PRESSED AND RELEASED FOR AN ADDITIONAL 15 SECOND DELAY.**

**WARNING**

**THE EXTINGUISHER DISCHARGE MAY CAUSE AN OBSCURING CLOUD BEHIND AND NEAR THE VEHICLE**

5. The red Fire "ALARM" lamp and audible alarm will stay on. The yellow fire "TROUBLE" lamp will also be on indicating a discharged Extinguisher.
6. The system must be reset and the Fire Extinguisher removed and replaced in accordance with the 'SYSTEM RESET' portion of this manual.

## COMPONENT DESCRIPTIONS

### PROTECTION PANEL

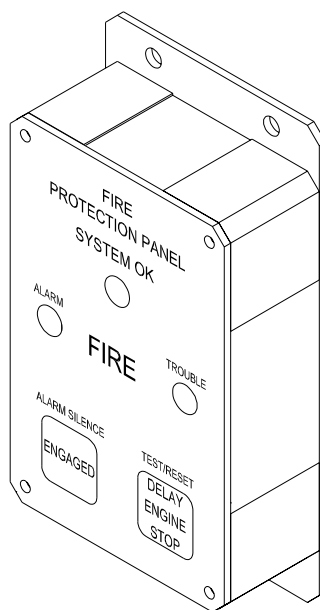
The Protection Panel is located in the operator's area and displays the current system status. The Protection Panel contains "SYSTEM OK", fire "ALARM" and "TROUBLE" lamps, the audio alarm, the "TEST/RESET" switch, and the "ALARM SILENCE" switch.

The "SYSTEM OK" lamp indicates power is on to the system and that there are no trouble conditions present. The "TROUBLE" lamp blinks if there is a fault in the detection circuitry and illuminates solid if there is a fault in the extinguishing circuitry. When the "TROUBLE" lamp is on, the "SYSTEM OK" lamp will be off and the audible alarm will sound intermittently. The "SYSTEM OK" lamp will flash when the system is low on battery power. Depressing the "TEST/RESET" switch tests the Protection Panel's lamps and audio alarm. The "ALARM SILENCE" switch will disable the audio alarm.

When a fire detector automatically detects a fire, the fire "ALARM" lamp and audio alarm activate. When the Manual Activation Switch is activated, the fire "ALARM" lamp blinks and the audio alarm activates. The lamp will remain blinking until power is cycled to the system.

The engine shutdown output is a normally open contact (1 Amp maximum) which shorts to ground 15 seconds after fire and/or significant gas leak detection. The "DELAY ENGINE STOP" will be illuminated immediately following detection. Pressing the "DELAY ENGINE STOP" will delay engine shutdown (and extinguisher discharge with fire detection only) an extra 15 seconds. The additional delay will be indicated by a flashing "DELAY ENGINE STOP".

The Protection Panel also has other features which can be enabled via internal configuration switches.



**FIGURE 2 - PROTECTION PANEL**

## OPTICAL FIRE DETECTOR

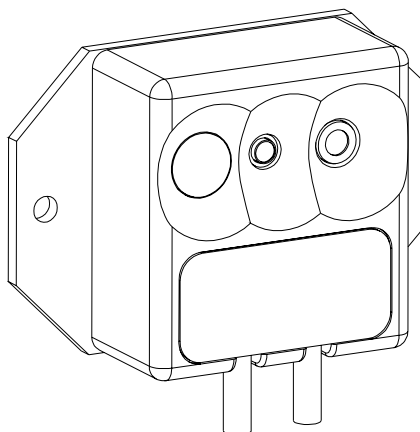
The Kidde Dual Spectrum® model PM-3M fire sensor operates by sensing two separate bands of infrared energy. A fire signal is generated when the sensors see a fire fueled by gasoline, diesel, CNG, LNG, LPG, methanol, oils, lubricants, and other types of hydrocarbons.

The fire sensor has a 100° solid cone field-of-view. It has a response time to explosive fires of one half of a second maximum. The PM-3M has a detection threshold of 42 inches for a one square foot pan fire fueled by diesel.

The fire sensor is immune to false alarms from sunlight, flashlights, lightning, vehicle headlights, incandescent lights (100W at 2 inches), and welding arcs (30 inches).

Each fire sensor has a green status light in the center of its front surface. The status light is illuminated when the fire sensor has electrical power. The status light will blink after the sensor has responded to a fire. The blinking will not stop with system reset, but is cleared when power has been cycled to the sensor. This feature can be used to help pinpoint the source of the fire.

The temperature operating range of the fire sensor is -40°F to 257°F (-40°C to 125°C). Input current is 5 mA quiescent.



**FIGURE 3 – OPTICAL FIRE DETECTOR**

### **LINEAR THERMAL DETECTOR (LTD)**

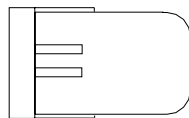
The Linear Thermal Detector (LTD) is a twin conductor cable with temperature-sensitive insulation protected by an outer sheath. It operates by short-circuiting in a fire or overheat condition. The LTD provides economical detection in vehicle engine bays, fuel storage tanks and any other location where the threat of fire exists. The LTD is capable of detecting a fire at any point along its length and will react to a fire situation within 20 seconds. The cable is not resettable however. If the wire alarms to a fire, the wire must be replaced or the damaged section cut out and a new section added prior to returning the system to service. The added section can be ordered as 420413-x where x indicates the length in feet required. Interface connectors must be added to the original LTD. LTD's are shock and vibration resistant.



**FIGURE 4 – LINEAR THERMAL DETECTOR**

### **END-OF-LINE DEVICE**

The End-of-Line device is required for supervision of the fire detection circuits. It consists of a resistor installed into a connector and is environmentally sealed with potting compound. The End-of-Line device is installed on the last detector in each series of detectors.

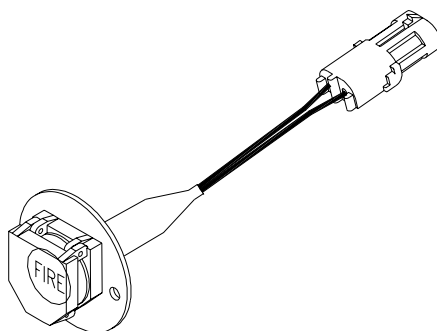


**FIGURE 5 – END-OF-LINE DEVICE**



## MANUAL ACTIVATION SWITCH

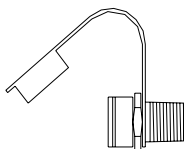
The Manual Activation Switch allows immediate system activation (extinguisher discharge and engine shutdown) by the vehicle operator at any time. Activation of the switch is accomplished by twisting and pulling the tamper seal (not shown) to remove, lifting the cover and pressing the red “FIRE” button for more than half a second. After the Manual Activation Switch has been activated, the Protection Panel will blink the fire “ALARM” indicator until power has been cycled to the system.



**FIGURE 6 – MANUAL ACTIVATION SWITCH (DEPICTED WITHOUT TAMPER SEAL)**

## CONE NOZZLE

The Cone Nozzle is constructed of plated steel and contains a 45° steel cone, causing the nozzle to disperse a cone shaped spray of dry chemical. The nozzle has a silicone rubber protective cap that is blown off by the dry chemical discharge.



**FIGURE 7 – CONE NOZZLE**

## FIRE EXTINGUISHER

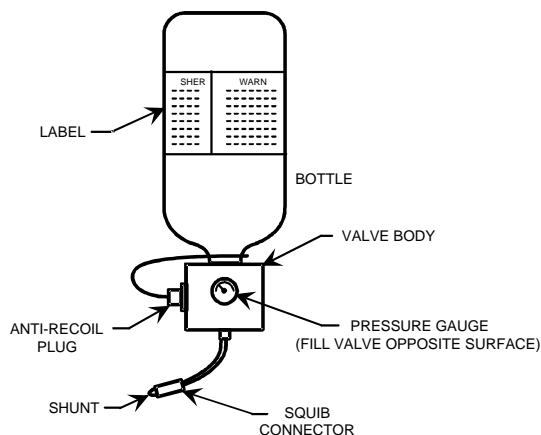
The Fire Extinguisher is an electrically operated, stored pressure type extinguisher that contains 22 pounds of BC rated 'Purple K' dry chemical extinguishing agent pressurized with nitrogen. A fast opening valve is mounted on a DOT certified cylinder. The Extinguisher is installed vertically in the bottle-mounting bracket.

### **CAUTION**

**THE EXTINGUISHER WILL NOT FUNCTION AS INTENDED IF ORIENTED INCORRECTLY**

### **WARNING**

**THE ANTI-RECOIL PLUG SHALL BE INSTALLED ON THE VALVE OUTLET PORT AT ALL TIMES EXCEPT WHEN THE EXTINGUISHER IS CONNECTED TO THE DISTRIBUTION PIPING OR WHILE THE EXTINGUISHER IS BEING FILLED.**










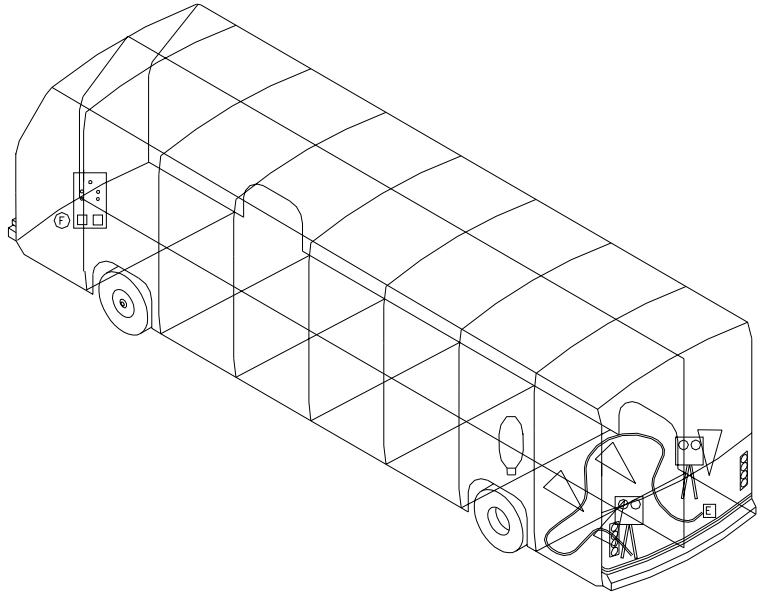
**FIGURE 8 – FIRE EXTINGUISHER**

## COMPONENT LOCATIONS

The major system components consist of a Protection Panel, 2 Optical Fire Detectors, 1 Linear Thermal Detector, 1 End-of-Line Device, a Manual Activation Switch, a Fire Extinguisher and 4 Cone Nozzles. See figure 9.

KEY:

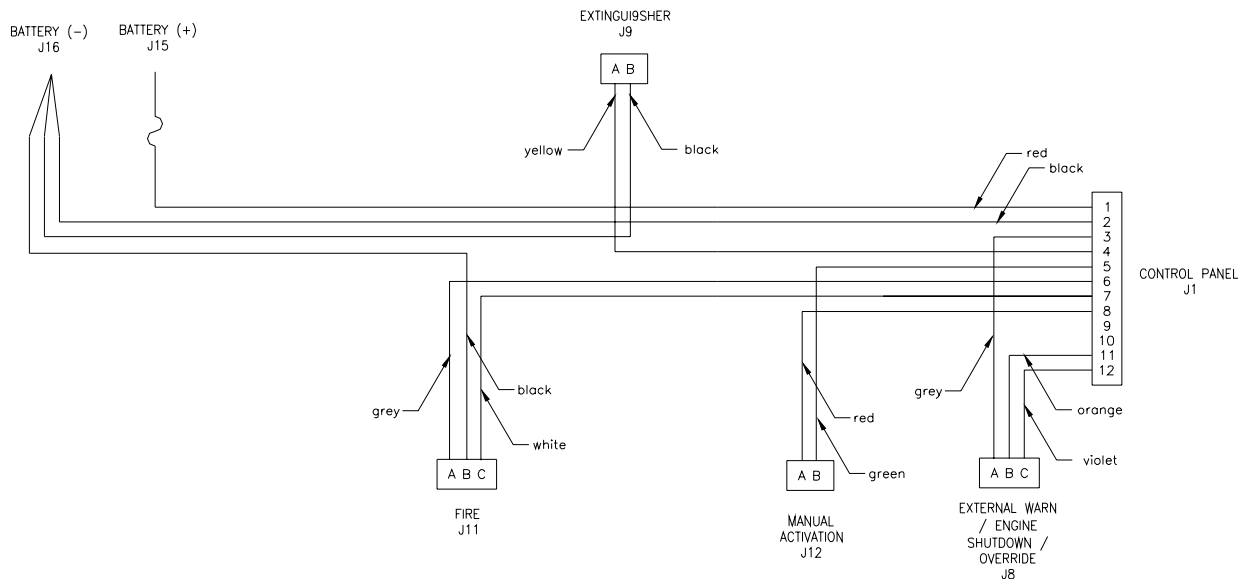
-  PROTECTION PANEL
-  MANUAL DISCHARGE SWITCH
-  OPTICAL FIRE DETECTOR
-  LINEAR THERMAL DETECTOR
-  END-OF-LINE DEVICE
-  EXTINGUISHER
-  NOZZLE



**FIGURE 9 – MAJOR SYSTEM COMPONENTS**

## ELECTRICAL INTERCONNECTIONS

The vehicle harness connects directly to the vehicle batteries, Protection Panel, Manual Activation Switch, Extinguisher, and first Optical Fire Detector. Additional Optical Fire Detectors and Linear Thermal Detector are connected to the preceding detector using interconnect harness. The vehicle harness also connects the Protection Panel's 'Engine Shutdown' output to the vehicle's multiplex system. See figure 10.



**FIGURE 10 - VEHICLE HARNESS**

## SYSTEM RESET

### FIRE:

After a fire in the engine compartment, the system is restored to operational status as follows:

1. Disconnect system power by removing system fuse located in battery compartment.
2. Repair and/or replace any damaged detection devices and/or electrical harnessing.
3. Remove the Fire Extinguisher:
  - a) Disconnect the electrical connector on the extinguisher valve from the vehicle harness.
  - b) Install a shorting plug to the electrical connector on the extinguisher valve.
  - c) Remove the distribution piping from the valve outlet port and install the anti-recoil plug.

**WARNING**

**THE ANTI-RECOIL PLUG SHALL BE INSTALLED ON THE VALVE OUTLET PORT AT ALL TIMES EXCEPT WHEN THE EXTINGUISHER IS CONNECTED TO THE DISTRIBUTION PIPING OR WHILE THE EXTINGUISHER IS BEING FILLED.**

- 
- 
- 
- d) Loosen the mounting clamps and remove the extinguisher.

**CAUTION**

**DO NOT ATTEMPT TO REBUILD THE EXTINGUISHER. HAVE THE FIRE EXTINGUISHER REBUILT BY A QUALIFIED FIRE PROTECTION EQUIPMENT COMPANY FAMILIAR WITH KIDDE DUAL SPECTRUM EQUIPMENT. REBUILD SHALL INCLUDE SQUIB, VALVE SEALS AND DRY CHEMICAL REPLACEMENT.**

- 
- 
- 
4. Remove the dry chemical nozzles from the distribution tubing for inspection and cleaning.
5. Blow out the distribution tubing with dry compressed air to insure the tubing is dry and free of debris and/or residual agent.
6. Reinstall the dry chemical nozzles wrench tight. NOTE: Do NOT use pipe dope or Teflon tape on the threads.
7. Replace the Fire Extinguisher:

- a) Inspect the new extinguisher; verify it is the correct part number to ensure it is the correct configuration for the application and verify the anti-recoil plug and the shorting plug are installed.
- b) Install the extinguisher in the mounting bracket and oriented per the instructions on the extinguisher nameplate. Tighten the mounting clamps. Do NOT connect the electrical connector at this time.

**CAUTION**

**THE EXTINGUISHER WILL NOT FUNCTION AS INTENDED IF ORIENTED INCORRECTLY**

- c) Remove the anti-recoil plug and immediately connect the distribution piping.
- d) Connect system power by replacing the system fuse located in the battery compartment and verify the red fire 'ALARM' lamp on the Protection Panel is NOT on. NOTE: The fire 'TROUBLE' lamp will be on because the electrical connector on the extinguisher valve is not connected.

**CAUTION**

**IF THE PROTECTION PANEL IS IN ALARM CONDITION, THE EXTINGUISHER MAY DISCHARGE IF IT IS CONNECTED TO THE SYSTEM. BE SURE THE RED FIRE 'ALARM' LAMP ON THE PROTECTION PANEL IS NOT ILLUMINATED BEFORE PROCEEDING FURTHER.**

- e) Remove the shorting plug from the electrical connector on the extinguisher valve.
  - f) Attach the vehicle harness to the electrical connector on the extinguisher valve.
7. Verify the green 'SYSTEM OK' lamp on the Protection Panel and green status lamp on each Optical Fire Detector is on solid.

## PERIODIC MAINTENANCE

### PRE-TRIP

- Verify the Protection Panel 'SYSTEM OK' lamp is on solid green

### EVERY 3000 MILES OR MONTHLY (whichever occurs first)

#### General

- Verify neither the protected equipment nor the hazard has changed
- Verify no obvious physical damage or condition exists that might prevent system operation

#### Protection Panel

- Verify all warning lamps and the audible alarm are operational by pressing the 'TEST/RESET' button

#### Manual Activation Switch

- Verify tamper seal is intact and access to switch is unobstructed

#### Fire Detectors

- Optical
  - Verify status lamp on the detector face is on solid green
  - Verify nothing is blocking the detector's field of view
  - Verify the windows on the face of the detector are free of excess contamination (dirt, oil, grease, etc) - if necessary, clean using water soaked non-abrasive towel
- Linear Thermal
  - Verify there is no obvious physical damage and that unit is free of excess contamination (dirt, oil, grease, etc) - if necessary, clean using water soaked non-abrasive towel
  - Verify mounting is secure and taught

#### Electrical Harness

- Verify electrical connectors and electrical wiring have no visible damage and all connectors are securely seated

#### Extinguisher & Distribution System

- Verify the extinguisher pressure gauge pointer is in the green arc at room temperature
- Verify distribution piping and nozzles are intact and unobstructed and that nozzle blow-off caps are in place

**EVERY 18000 MILES OR SEMI-ANNUALLY** (whichever occurs first)

- Perform a comprehensive fire system test using a Kidde Dual Spectrum System Test Set (Optical Test Kit P/N 420871-2)

**EVERY SIX YEARS**

- Have the fire extinguisher rebuilt by a qualified fire protection equipment company familiar with Kidde Dual Spectrum equipment. Rebuild shall include squib, valve seals and dry chemical replacement.
- At time of rebuild, if 12 or more years have passed since last hydrostatic test of the fire extinguisher cylinder; have the cylinder hydrostatically tested by a qualified fire protection equipment company familiar with Kidde Dual Spectrum equipment.



## TROUBLE SHOOTING GUIDE

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
All Protection Panel lamps off.	No power to system	<p>Check connections to &amp; voltage of vehicle batteries.</p> <p>Check system fuse (15A).</p> <p>Below 9 volts the system will not function</p>
Protection Panel green "SYSTEM OK" lamp blinking.	Low battery voltage	<p>Check connections to &amp; voltage of vehicle batteries.</p> <p>Below 22 volts the system will provide low voltage indication.</p>
Protection Panel green "SYSTEM OK" lamp off, yellow fire "TROUBLE" lamp on, red fire "ALARM" lamp on solid and audible alarm on.	System automatically discharged	Correct the cause of the fire and reset the system as described in the system reset portion of this manual
Protection Panel green "SYSTEM OK" lamp off, yellow fire "TROUBLE" lamp on, red fire "ALARM" lamp on blinking and audible alarm on.	System manually discharged	Correct the cause of the fire and reset the system as described in the system reset portion of this manual
Protection Panel green "SYSTEM OK" lamp off, yellow fire "TROUBLE" lamp on solid and audible alarm beeping.	Component not connected or damaged harness in the extinguisher circuit	<p>Check harness connections at extinguisher</p> <p>Check electrical interconnections (Figure 10)</p>
Protection Panel green "SYSTEM OK" lamp off, yellow fire "TROUBLE" lamp on blinking and audible alarm beeping.	Component not connected or damaged harness in the fire detection circuit	<p>Check harness connections at fire sensors</p> <p>Check connection at EOL</p> <p>Check electrical interconnections (Figure 10)</p>

<p>Bus will not start, Protection Panel red fire "ALARM" lamp on solid and audible alarm on</p>	<p>System not reset after fire</p>	<p>Correct the cause of the fire and reset the system as described in the system reset portion of this manual</p>
<p>Extinguisher pressure gauge reading is low</p>	<p>Extinguisher cold</p>	<p>Let extinguishers warm up to room temperature (about 70°F) and recheck the gauge. If the pointer is then within the green arc no corrective action is required</p>
	<p>Extinguisher leaking or discharged</p>	<p>Have the fire extinguisher serviced by a fire protection equipment company familiar with KDS equipment</p>

**REPLACEMENT PARTS LIST**

Protection Panel, P/N 413410-146

Manual Activation Switch Kit, P/N 421317

Manual Activation Switch Tamper Seal, P/N 421317-2

Optical Fire Detector, P/N 420010

Linear Thermal Detector (LTD), 20ft, P/N 420413-20

End-of-Line Device (EOL), P/N 420241

Vertical Fire Extinguisher, 22lb, BC, Gauge Right, P/N 408876-1232

Extinguisher Bracket Assembly, P/N 409475

Nozzle, Dry Chemical, P/N 408878-1

Wiring Harness, P/N 421410

Interconnect Harness, 13ft, P/N 420373-13

Optical Fire System Test Kit, P/N 420871-2





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**MATERIAL SAFETY DATA SHEET**  
**PURPLE "K" DRY CHEMICAL – POLVO QUÍMICO SECO PURPLE "K"**

**SECTION 1 – CHEMICAL PRODUCT AND COMPANY IDENTIFICATION**

<b>Trade Name / Label Name:</b>	PURPLE "K" DRY CHEMICAL
<b>CAS Number:</b>	N/A
<b>Chemical Name / Family</b>	N/A It is a mixture
<b>Synonyms:</b>	Purple K dry chemical powder Siliconized potassium bicarbonate
<b>Manufacturer's Name:</b>	KIDDE DE MEXICO, S. A. DE C. V.
<b>Address:</b>	Av. División del Golfo 3308 Nte. 87019 Cd. Victoria, Tamaulipas, MÉXICO
<b>Business phone / Fax:</b>	+52 (834) 313-03-03 / +52 (834) 313-03-01
<b>Date of preparation:</b>	February 25, 2004

**SECTION 2 – COMPOSITION AND INFORMATION ON INGREDIENTS**

CHEMICAL NAME	CAS N°	% w/w	OSHA PEL mg/m <sup>3</sup>	ACGIH TLV mg/m <sup>3</sup>	TOXICITY DATA
Potassium bicarbonate	298-14-8	78 – 82	NONE	15	NONE
Sodium bicarbonate	144-55-8	12 – 15	NONE	NONE	NONE
Mica	12001-26-2	1 – 3	3	3	NONE
Attapulguite clay	8031-18-3	1 – 3	NONE	NONE	NONE
Amorphous silica	7631-86-9	0.2 – 1.0	6	10	NONE
Methyl Hydrogen Polysiloxane	63148-57-2	0.2 – 1.0	NONE	NONE	NONE

**SECTION 3 – PHYSICAL AND CHEMICAL CHARACTERISTICS**

<b>Boiling point, °C:</b>	N/A	<b>Specific gravity (H<sub>2</sub>O=1)</b>	ABOUT 2.2	<b>Viscosity @ 20°C:</b>	N/A
<b>Vapor pressure, mm Hg:</b>	N/A	<b>Percent volatile by volume:</b>	N/A	<b>Melting point, °C:</b>	NDA
<b>Vapor density (Air=1):</b>	N/A	<b>Evaporation rate (Butyl acetate=1)</b>	N/A	<b>Solubility in water:</b>	NDA
<b>Reactivity in water:</b>	Unreactive	<b>Appearance and odor:</b>	Odorless, purple colored fine powder		

### SECTION 4 – FIRE AND EXPLOSION HAZARD DATA

<b>Flash point:</b>	N/A	<b>Flammable limits in air, % by volume</b>	N/A	<b>Auto-ignition temperature:</b>	N/A
<b>Extinguishing media:</b>	N/A – The product is a fire extinguishing agent				
<b>Unusual fire and explosion hazards:</b>	NONE				
<b>Special fire fighting procedures:</b>	The material is a fire extinguishing agent and will not burn. However, if other materials are involved, use standard chemical fire fighting procedures and consider the hazards of those materials. In enclosed areas, fire fighters must wear self-contained breathing apparatus and full protective equipment.				

### SECTION 5 – REACTIVITY DATA

<b>Stability:</b>	Stable	<b>Conditions to avoid:</b>	Extreme heat	<b>Hazardous polymerization:</b>	Will not occur
<b>Incompatibility (materials to avoid):</b>	Strong acids. Do not mix with ABC type dry chemical extinguishing agents.				
<b>Hazardous decomposition products:</b>	Carbon dioxide.				

### SECTION 6 – HEALTH HAZARD DATA

<b>Threshold limit value:</b>	ACGIH TLV for particulates not otherwise classified: 10 mg/m <sup>3</sup> OSHA PEL for nuisance dust limit total: 15 mg/m <sup>3</sup>				
<b>Routes of entry:</b>	<b>Inhalation:</b> YES; may be irritant to the respiratory tract. <b>Eye contact:</b> YES; mildly irritant for a short period. <b>Skin contact:</b> YES; may be mildly irritating. <b>Ingestion:</b> NOT an expected route of entry.				
<b>Signs and symptoms of overexposure:</b>	<b>Acute:</b> Transient cough, shortness of breath, irritation of airways. <b>Chronic:</b> This product is not known to cause chronic illness.				
<b>Medical conditions generally aggravated by exposure:</b>	Asthma, emphysema, bronchitis or other respiratory illness.				
<b>Chemical listed as carcinogen or potential:</b>	NTP program: No	IARC monographs: No	OSHA: No		
<b>Emergency and first aid procedures:</b>	<b>Eye contact:</b> Flush with large amounts of water for at least 15 minutes. If irritation persists, seek medical attention. <b>Skin contact:</b> Wash with soap and water. If irritation persists, seek medical attention. <b>Inhalation:</b> Move victim to fresh air. Seek medical attention if discomfort continues. <b>Ingestion:</b> Rinse mouth, drink large amounts of water and induce vomiting. Seek medical help.				

### SECTION 7 – SPECIAL PRECAUTIONS AND SPILL / LEAK PROCEDURES

<b>Precautions to be taken in handling and storage:</b>	Should be stored in original containers. Store in dry, cool, well-ventilated place away from acidic compounds. Wash after handling. Do not cut, grind, weld or drill on or near product containers. Treat empty containers as if they were full.
<b>Other precautions:</b>	Do not mix with acidic materials.
<b>Steps to be taken in case materials is released or spilled:</b>	Sweep up or vacuum. Store in covered containers. Do not reuse. In case of large spills, use rubber gloves, chemically resistant suit and boots, hard hat and air purifying respirator.
<b>Waste disposal method:</b>	Dispose of in compliance with local, state and federal regulations. Components are non hazardous, sanitary landfill disposal may be acceptable

### SECTION 8 – SPECIAL PROTECTION INFORMATION

<b>Respiratory protection:</b>	Dust mask where dustiness is prevalent or TLV exceeded. Mechanical filter respirator if exposure is prolonged.
<b>Ventilation:</b>	Use adequate ventilation. Use fan or vent to outside.
<b>Protective gloves:</b>	Wear rubber gloves for routine industrial use.
<b>Eye protection:</b>	Recommended as mechanical barrier for prolonged exposure. Safety glasses or chemical type goggles.
<b>Other protective equipment:</b>	If irritation occurs, long sleeves and impervious gloves should be worn.
<b>Work / Hygienic practices:</b>	Use good personal hygiene and good housekeeping practices. Avoid breathing of dust. Wash with soap and water.

### SECTION 9 – REGULATORY INFORMATION

<b>U.S. OSHA HAZARD COMMUNICATION STANDARD</b>	Product assessed in accordance with OSHA 29 CFR 1910.1200 and determined not to be hazardous.
<b>RCRA INFORMATION</b>	The unused product, in our opinion, is not specifically listed by the EPA as hazardous waste (40 CFR, Part 261D), nor is it formulated to contain materials which are listed hazardous wastes. It does not exhibit the hazardous characteristics of ignitability, corrosivity or reactivity, and is not formulated with contaminants as determined by the toxicity characteristics leaching procedure (TCLP). However, used product may be regulated.
<b>SARA Reporting Requirements</b>	No component of this product is subject to the reporting requirements of Sections 302, 304 and 313 of Title III of the Superfund Amendments and Reauthorization Act.
<b>TSCA Inventory status</b>	Kidde de México certifies that the product described herein complies with all applicable rules or orders under TSCA and no chemical substance for entry in violation under TSCA or any applicable rule or order thereunder TSCA is being offered.

### HAZARDOUS MATERIAL IDENTIFICATION SYSTEM RATINGS

<b>HEALTH:</b> 1	<b>FLAMMABILITY:</b> 0	<b>REACTIVITY:</b> 0
------------------	------------------------	----------------------

**HAZARD INDEX:**

- 0 Minimal hazard
- 1 Slight hazard
- 2 Moderate hazard
- 3 Serious hazard
- 4 Severe hazard

**GENERAL KEYS:**

- N/A: Not applicable.
- NDA: No data available.

The information herein is given in good faith. It is based on available data and is believed to be true and accurate, but no warranty, expressed or implied, is made. Therefore, *KIDDE DE MEXICO* assumes NO responsibility for damage or injury from the use of the product described herein.





**PREVOST.**



# DASHBOARD RADIO OPERATING INSTRUCTIONS

Beginning with vehicle A-1493, February 2009



# MANUEL D'UTILISATION DE LA RADIO DU TABLEAU DE BORD

Débutant avec le véhicule A-1493, Février 2009

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# Safety Information

**IMPORTANT:** Before driving this vehicle, be certain that you have read and that you fully understand each and every step of the driving and handling information in this manual. Be certain that you fully understand and follow all safety warnings.

IT IS IMPORTANT THAT THE FOLLOWING INFORMATION BE READ, UNDERSTOOD AND ALWAYS FOLLOWED.

The following types of advisories are used throughout this manual:



## DANGER

Danger indicates an unsafe practice that could result in serious personal injury or death. A danger advisory banner is in **white** type on a **black** background with a **black** border.



## WARNING

Warning indicates an unsafe practice that could result in personal injury. A warning advisory banner is in **black** type on a **gray** background with a **black** border.



## CAUTION

Caution indicates an unsafe practice that could result in damage to the product. A caution advisory is in **black** type on a **white** background with a **black** border.

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

## Safe Operation of the Radio

The driving conditions today require that the driver pays full attention to the road at all times. It is advised that when using this radio while driving the driver maintain full concentration on the road. Therefore it is strongly advised to do the following:

- Never Change a CD or read CD labels while driving.
- Always Ensure the Volume of the Audio System is set so that outside acoustics can also be heard.
- When possible use the Steering wheel controls. It is a feature to make it both easy and safe to handle the radio while driving

## Introduction

The following instructions explain the general functions and operations of Volvo Radio Models.

Radio information is displayed through the LCD display on the radio.

The radio is commanded by the Faceplate, shown in Fig 1.

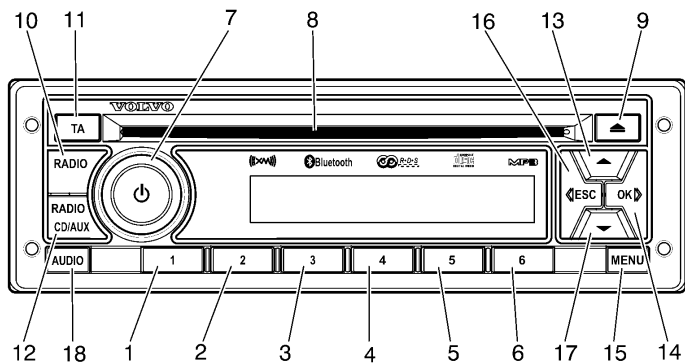
Some functions can be commanded by the Steering Wheel Control, shown in Fig 2; or by the Remote Control, shown in Fig 3.

### **The main functions of the audio unit are:**

- CD (supporting mp3 and WMA)
- USB (supporting mp3 and WMA)
- iPod
- Auxiliary audio input
- Hands free (Bluetooth Phone Operation)

### General Overview

### Radio / CD Controls Quick Reference Guide



W3007746

Fig. 1

#### 1. "Preset #1" Button:

- **Radio:** Push and release: Recall Preset Station
- **Radio:** Push and hold: Store Preset Station

#### 2. "Preset #2" Button:

- **Radio:** Push and release: Recall Preset Station
- **Radio:** Push and hold: Store Preset Station

#### 3. "Preset #3" Button:

- **Radio:** Push and release: Recall Preset Station
- **Radio:** Push and hold: Store Preset Station

#### 4. "Preset #4" Button:

- **Radio:** Push and release: Recall Preset Station
- **Radio:** Push and hold: Store Preset Station

#### 5. "Preset #5" Button:

- **Radio:** Push and release: Recall Preset Station
- **Radio:** Push and hold: Store Preset Station

6. **"Preset #6" Button:**
  - **Radio:** Push and release: Recall Preset Station
  - **Radio:** Push and hold: Store Preset Station
7. **"Rotary Knob/PWR" Button:**
  - **Push:** Power On and Off
  - **Turn:** Volume Adjust & Audio Value Update
8. **CD Slot:**
  - **CD:** Insert / Remove CD
9. **"Eject CD" Button:**
  - **CD:** Eject CD
10. **Radio Select Mode:**
  - **Radio:** Choose from FM1, FM2, FM3 (Mid radio only), AM, Weather band, and Satellite radio (Mid radio only)
11. **Information (Traffic / News):**
  - **Radio:** Switch Traffic on or off
  - **Radio:** Cancel ongoing Traffic or News message
12. **CD/Aux Mode Select:**
  - **CD/USB:** Switch between sources other than radio
13. **Up Button:**
  - **Radio:** Manual tuning up
14. **(Fast) Forward >> Button:**
  - **Radio:** Seek
  - **CD/USB:** Push and release: Select Next Track
  - **CD/USB:** Push and hold: Fast Forward
  - **Bluetooth Phone:** Accept incoming call
15. **Menu Button:**
  - **Radio:** Push and release: Menu Access
16. **(Fast) Reverse << Button:**
  - **Radio:** Seek
  - **CD/USB:** Push and release: Select previous Track
  - **CD/USB:** Push and hold: Fast Reverse
  - **Bluetooth Phone:** Reject incoming call or hang up
  - **iPod :** Push and hold: Enter iPod menu (Mid radio only)
17. **Down Button:**
  - **Radio:** Manual tuning down
18. **Audio Button:**
  - **General:** Audio Settings

## 4 English

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### Steering Wheel Controls Quick Reference Guide

#### 20. "Next" Button:

- **Radio:** Push and release: Seek
- **Radio:** Push and hold: Manual tune up
- **CD/USB:** Push and release: Select next track
- **CD/USB:** Push and hold: Fast forward

#### 21. "Previous" Button:

- **Radio:** Push and release: Seek
- **Radio:** Push and hold: Manual tune down
- **CD/USB:** Push and release: Select previous track
- **CD/USB:** Push and hold: Fast reverse

#### 22. "YES" Button:

- **Bluetooth Phone:** Accept incoming call (optional)

#### 23. "NO" Button:

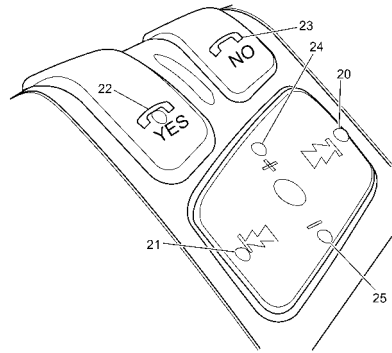
- **Bluetooth Phone:** Reject incoming call or hang up (optional)

#### 24. "Vol +" Button:

- **General :** Increase Sound Volume

#### 25. "Vol — " Button:

- **General :** Decrease Sound Volume



W3007856

Fig. 2

## Remote Control Quick Reference Guide

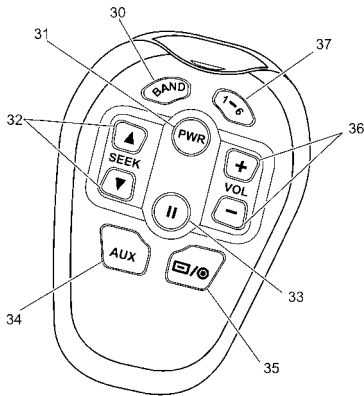


Fig. 3

W3007748

30. **"Band" Button:**

- **Radio:** Select between FM1, FM2, FM3 (Mid radio only), AM, Weather band, and Satellite radio (Mid radio only)

31. **"PWR" Button:**

- **General:** Turns the Radio On and Off

32. **"Seek" Buttons:**

- **Radio:** Seek
- **CD/USB :** Next or previous track

33. **"Mute / Pause" Button:**

- **General:** Mute or Pause the source of audio

34. **"Aux" Button:**

- Not used for Base radio functions
- **Source:** Select between USB, iPod, Aux.

35. **"CD Select" Button:**

- **CD:** Select CD

36. **"Vol + / Vol ?" Button:**

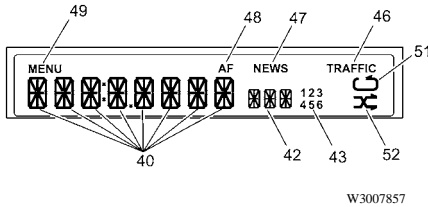
- Adjust the volume up and down

37. **Preset 1 to 6:**

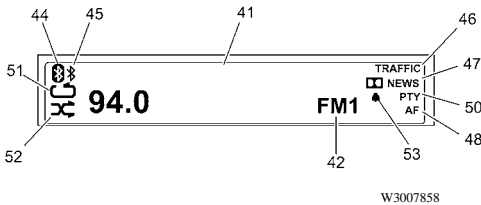
- **Radio:** Select a Preset Station

## Display Quick Reference Guide

### Radio LCD Display



Base Radio Display (Fig. 4)



Mid Radio Display — Optional  
(Fig. 5)

#### 40. Base Radio Text Display:

- **Radio:** Displays radio frequency and station name
- **CD:** Displays track, time and music info when available

#### 41. Mid Radio Text Display

- **Radio:** Displays radio band (FM/AM) and frequency
- **CD/USB:** Displays track, time and music info when available

#### 42. Source Display

- **Radio:** Displays radio band (FM1, FM2, FM3 (Mid radio only) AM, WX, or SAT (Mid radio only))
- **CD/USB:** Displays other source than radio

#### 43. Preset Number

- **Radio:** Displays preset number

#### 44. Phone Connected

- **General:** Indicates that the phone is connected

#### 45. Bluetooth On

- **General:** Indicates that the Bluetooth function is on

#### 46. Traffic Info

- **General:** Indicates that the traffic function is on

#### 47. News Info

- **General:** Indicates that the news function is on

#### 48. AF

- **General:** Indicates that the AF (Alternative frequency) function is on

#### 49. Menu

- **General:** Displayed when in Menu

#### 50. PTY

- **General:** Indicates that the PTY (Program type) function is on

#### 51. Repeat

- **CD/USB:** Display when Repeat is on

#### 52. Random

- **CD/USB:** Displayed when Random is on Menu

#### 53. Alarm

- **General:** Indicates that the Alarm clock function is on



## Main Functions

Many functions are controlled or adjusted through the radio Menu. If the Menu screen is open and the radio experiences no activity for a 10 second period, the radio will cancel

any incomplete actions, close the Menu screen and return to normal operation. The radio will save all completed changes.

## Power

### Switching On & Off, Mute and Pause of the Audio System

The audio system is switched on or off by pressing the **Volume Knob** (7).

If the driver wants to quickly mute the audio system sound, press the **Volume Knob** (7).

## Radio Mode

### Band Selection (FM and AM)

To select the radio as the play mode, turn the radio on and press the **RADIO** (10) button .

To switch between the bands (AM/FM1/FM2) use the **RADIO** (10) button .

The radio will then be active on the last used radio band (AM, FM etc).

## Seek in Radio Mode

There are two ways to seek for a radio station:

- 1 Use the Seek buttons **ESC** (16) or **OK** (14) to seek up or down respectively on the radio. Once a station is found the seek function will stop.

OR

- 2 Use the Seek buttons of the Steering Wheel Control << (21) or >> (20) to seek up or down respectively on the radio. Once a station is found the seek function will stop.

## Manual Tuning

Manual Tuning can be performed in two ways:

- 1 Push **UP** (13) or **DOWN** (17) buttons to tune up or down respectively.

OR

- 2 Push and hold button << (21) or >> (20) on the steering wheel, to tune up or down respectively.

### Presets (Storing Radio Stations)

Up to 12 FM and 6 AM radio stations can be stored for fast access. There are two sets of FM radio preset bands, which are FM1 and FM2, and one AM radio preset band. Each preset band can store 6 stations on buttons 1 thru 6.

To store a specific station into a preset button, do the following:

- 1 Push **RADIO** (10) button until the required frequency band is active (AM,

FM1, FM2, FM3 (Mid radio only), Weather, or Satellite radio (Mid radio only)).

- 2 Tune the radio to the desired station.
- 3 Push and hold the desired preset button **1 thru 6**.
- 4 There will be a short as the station is stored. When audio returns the process is completed.

### Presets (Selecting a Stored Radio Station)

To select one of the preset stations, perform the following:

- 1 Push the **RADIO** (10) button to select the required band (AM, FM1, FM2, FM3 (Mid radio only), Weather, or Satellite radio (Mid radio only)).

- 2 Push and release the required preset button **1 thru 6** to activate the desired station.

### Scan Mode

The scan feature allows the user to perform a radio station search without having to toggle manually through the stations. When in scan mode, each station found will play for 10 seconds to give the user a chance to sample the station program or music. The scan will then continue on to the next available station unless the user chooses to stop the scan and stay at the present station.

To enter scan mode, perform the following:

- 1 Push **MENU** (15) button.

- 2 Select "SCAN" by pushing **OK** (14) button.

To exit scan mode and stay at the present station perform:

- 1 Push the **RADIO** (10) button.

OR

- 2 Push steering wheel button << (21) or >> (20).

## Using the Weather Band

NOAA Weather Radio is a service of the National Weather Service. It provides continuous broadcasts of the latest weather information directly from the National Weather Service offices. Taped weather messages are repeated every four to six minutes and are revised every one to three hours or more frequently if needed. Most of the stations operate 24 hours a day. The weather for the area you are in can be found on one of 7 stations.

When in the Weatherband mode, the display will show the "WX" icon and "CH" plus the channel number. The channel can be changed using the **UP** (13) or **DOWN** (17) buttons and can also be preset to the pushbuttons.

The frequency associated with each channel is as follows:

1	162.550 MHz
2	162.400 MHz
3	162.475 MHz
4	162.425 MHz
5	162.450 MHz
6	162.500 MHz
7	162.525 MHz

The National Weather Service operates approximately 372 stations. Close to 90 percent of the nation's population is within listening range of a NOAA Weather Radio broadcast.

## Satellite Radio Service — (Optional Feature)

When the XM<sup>1</sup> or SIRIUS<sup>2</sup> logo appears on your radio, it is satellite radio compatible. XM and Sirius are satellite radio services that offer more than 100 channels of digital quality audio programming and can be heard uninterrupted across the contiguous United States. A service fee is required to receive satellite broadcasts. For more information, contact XM at [www.xmradio.com](http://www.xmradio.com) or by phone at 1-800-852-XXXM (9696) or Sirius at <http://activate.siriusradio.com> or by phone at 1-888-539-7474.

To activate the integrated satellite receiver, you must furnish your satellite radio provider with the satellite receiver's Electronic Serial Number. To find the electronic serial number complete the following instructions:

If your satellite radio provider is XM Satellite Radio:

- 1 With the ignition and the radio ON, press the **RADIO** (10) button and select XM1 or XM2.
- 2 Tune your radio to channel 0 and the 8-digit serial number will appear.

If your satellite radio provider is Sirius Satellite Radio:

- 1 With the ignition and radio ON, press the **RADIO** (10) button and select SR1 or SR2.
- 2 Tune your radio to channel 0 and the 12-digit serial number will appear.

**Note:** Satellite radio reception may be degraded by satellite signal obstruction.

<sup>1</sup>XM is a registered trademark of XM Satellite Radio Holdings Inc.

<sup>2</sup>SIRIUS is a registered trademark of SIRIUS Satellite Radio Inc.

## CD Mode

The radio is designed to work with standard CD format and MP3 and WMA files. The

CD player will accept CD-R as well as CD-RW discs.

## Switching to CD Mode

There are two ways to switch to the CD mode:

OR

- 2 Insert a CD into the CD slot (8).

- 1 Push the **CD/AUX** (12) button until “CD ” shows on display.

## Eject a CD

To eject a CD press the **EJECT** (9) button. When CD is ejected the radio will play the previous audio source. If the CD is not removed from the CD slot, it will automatically reload after 15 seconds.

## Changing a Track on a CD

There are two ways to change a track on a CD:

OR

- 1 Push and release the **ESC** (16) or **OK** (14) button to move to the next or previous track respectively.

- 2 Using the steering wheel controls: Push and release the << (21) or >> (20) button to move to the previous or next track respectively.

## Fast Reverse or Fast Forward of a CD

Fast forwarding or reversing a CD can be performed in one of two ways:

OR

- 1 Push and hold the **ESC** (16 ) or **OK** (14) button on the radio to fast forward or fast reverse respectively.

- 2 Using the steering wheel controls: Push and release the << (21) or >> (20) button to move to fast reverse or fast forward respectively.

## Play Tracks on a CD in Random Order

There are two possible Random settings for a CD: Random All and Random Folder (If the content of the CD is stored in folders). To play tracks in random order, do the following:

- 1 Push **MENU** (15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “RANDOM” is displayed.

- 3 Push **OK** (14) button to enter the random sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons to choose between All and Folder.
- 5 Push **OK** (14) button to enter the desired random mode.

## Repeating Tracks on a CD — (Optional Feature)

There are three possible Repeat settings for a CD: Repeat All, Repeat track and Repeat Folder (If the content of the CD is stored in folders). By default, Repeat All is active. To change the repeat setting, do the following:

1 Push **MENU**(15) button.

- 2 Push **UP** (13) or **DOWN** (17) buttons until “REPEAT” is displayed.
- 3 Push **OK** (14) button to enter the repeat sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons to choose between All and Folder.
- 5 Push **OK** (14) button to enter the desired repeat mode.

## Changing to Another Folder on a CD — (Optional Feature)

If the content of the CD is stored in folders, it is possible to change folders directly. To do this, push either the **UP** (13) or **DOWN** (17) button to move to the next or previous album/folder respectively.

## Scan a CD

When CD is scanned, the first 10 seconds of each track is played.

To activate Scan, do the following:

- 1 Push **MENU** (15) button.
- 2 Select “SCAN” by pushing **OK** (14) button.

Scanning will stop if:

- 1 The face plate buttons **ESC** (16 ) or **OK** (14).
- OR
- 2 All tracks are browsed through.

### External Audio Input — (Optional Feature)

There are three possible external audio input modes, USB, iPod and Aux. A USB and an AUX device can be connected and accessible

at the same time. However, if an iPod is connected the USB and the AUX devices will be disabled as an available source.

### USB Mode — (Optional Feature)

The radio is designed to work with USB devices formatted with the USB Mass Storage Device Class standard. Other USB devices may still work with the radio though. If a USB device doesn't work properly, try reconnecting the device which may solve the problem in some cases.

**Note:** A USB device must be connected prior to operating in this mode.

### Switching to USB Mode

There are two ways to switch to USB mode.

- 1 Push the **CD/AUX** (12) button until "USB" shows on the display.

OR

- 2 Connect a USB device.

### Disconnecting a USB Device

No special preparations are needed to disconnect the USB device. When USB

device is removed the radio will play the previous audio source.

### Changing a Track on USB Device

There are two ways to change a track on a USB:

- 1 Push and hold the **ESC** (16) or **OK** (14) button on the radio to fast forward or fast reverse respectively.

OR

- 2 Using the steering wheel controls: Push and release the << (21) or >> (20) button to move to fast reverse or fast forward respectively.

### Fast Reverse or Fast Forward on a USB Device

Fast reversing or forwarding can be performed in one of two ways:

- 1 Push and hold the **ESC** (16) or **OK** (14) button to fast forward or fast reverse respectively.

OR

- 2 Using the steering wheel controls: Push and release the << (21) or >> (20) button to move to fast reverse or fast forward respectively.

Please note that Push and hold the button will enter the iPod menu

## Playing Tracks on a USB Device in Random Order

There are two possible Random settings for a USB device: Random All and Random Folder (If the content of the USB device is stored in folders).

To play tracks in random order, do the following:

- 1 Push **MENU**(15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “RANDOM” is displayed.
- 3 Push **OK** (14) button to enter the random sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons to choose between All and Folder.
- 5 Push **OK** (14) button to enter the desired random mode.

## Repeating Tracks on a USB Device

There are three possible Repeat settings for a USB device: Repeat All, Repeat track and Repeat Folder (If the content of the USB device is stored in folders). By default, Repeat All is active.

To change the repeat setting, do the following:

- 1 Push **MENU**(15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “REPEAT” is displayed.
- 3 Push **OK** (14) button to enter the repeat sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons to choose between All, Track and Folder.
- 5 Push **OK** (14) button to enter the desired repeat mode.

## Changing to Another Folder on a USB

If the content of the CD is stored in folders, it is possible to change folders directly. To do this, push either the **UP** (13) or **DOWN** (17) button to move to the next or previous album/folder respectively.

## Scan a USB

When USB is scanned, the first 10 seconds of each track is played.

To activate Scan, do the following:

- 1 Push **MENU** (15) button.
  - 2 Select “SCAN” by pushing **OK** (14) button.
- Scanning will stop if:
- 1 The face plate buttons **ESC** (16) or **OK** (14).
- OR
- 2 All tracks are browsed through.

### iPod Mode — (Optional Feature)

The radio supports iPod Classic, iPod Video, and iPod nano. The iPod settings, e.g. Shuffle or Repeat, used prior to connecting the iPod to the radio will be used by the radio.

**Note:** An iPod device must be connected prior to operating in this mode.

### Connecting an iPod

Connecting the iPod can be done with two different cable sets.

- 1 A split cable from the iPod 30-pin connector to a USB connector and a 3.5 mm audio connector
- 2 A separate iPod/USB cable plus a 3.5 mm male/male stereo audio cable connected to the iPod earphone output

The iPod volume should in this case be set to maximum prior to connecting to the radio. When the iPod is connected to the radio, the iPod's controls will lock. All control of the iPod is done by the radio buttons. When in this state, the iPod will display a Volvo logotype.

### Switching to iPod Mode

There are two ways to switch to iPod mode:

- 1 Push the **CD/AUX** (12) button until "iPod" shows on the display.

OR

- 2 Connect an iPod device.

### Disconnecting an iPod Device

No special preparations are needed to disconnect the iPod device. When the iPod

device is removed the radio will play the previous audio source.

### iPod Menu

When iPod is connected and source, the user can Push and hold the **ESC** (16) button to enter the iPod Menu. This Menu contains some of the most common functions used in the iPod. E.g. the user can search for Artists and Albums, as well as starting a Playlist.

Push and hold the **ESC** (16) button for 1 second to enter the iPod Menu at last used level.

Push and hold the **ESC** (16) button for 2 seconds to enter the iPod Menu at top level.

### Changing a Track on an iPod

There are two ways to change a track:

- 1 Push and release the **ESC** (16) or **OK** (14) button on the radio to move to the next or previous track respectively.

OR

- 2 Using the steering wheel controls: Push and release the << (21) or >> (20) button to move to the previous or next track respectively.



## Fast Reverse or Fast Forward on an iPod

Fast forwarding or reversing a CD can be performed in one of two ways:

- 1 Push and hold the **ESC** (16) or **OK** (14) button to fast forward or fast reverse respectively.

OR

- 2 Using the steering wheel controls: Push and release the << (21) or >> (20) button to move to fast reverse or fast forward respectively.

## Play Tracks on an iPod in Random Order

There are two possible Random settings for iPod: Random Album and Random All.

To play songs in random order, do the following:

- 1 Push **MENU**(15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until "RANDOM" is displayed.

- 3 Push **OK** (14) button to enter the random sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons to choose between All and Folder.
- 5 Push **OK** (14) button to enter the desired random mode.

## Repeat a Track on an iPod

There are two possible Repeat settings for iPod: Repeat One, and Repeat All.

To change the repeat setting, do the following:

- 1 Push **MENU**(15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until "REPEAT" is displayed.

- 3 Push **OK** (14) button to enter the repeat sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons to choose between All, Track and Folder.
- 5 Push **OK** (14) button to enter the desired repeat mode.

## Scan iPod

When iPod is scanned, the first 10 seconds of each track is played.

To activate Scan, do the following:

- 1 Push **MENU** (15) button.
- 2 Select "SCAN" by pushing **OK** (14) button.

Scanning will stop if:

- 1 The face plate buttons **ESC** (16) or **OK** (14).

OR

- 2 All tracks are browsed through.

## AUX Mode — (Optional Feature)

To select an auxiliary audio input:

Push the **CD/AUX** (12) button until Aux shows on the display.

An auxiliary audio input may be selected except when in iPod mode.

The output volume of the Aux device should be set to maximum.

**Note:** Please note that for an Aux device, changing tracks, fast forwarding etc., must be done directly on the Aux device.

## Audio Settings

### Adjusting Volume Up and Down

The audio systems volume can be adjusted up by turning the **Volume Knob** (7) in a clockwise direction and adjusted down by turning the **Volume Knob** (7) in a counter-clockwise direction.

It can also be adjusted up and down by using the + (24) and - (25) buttons on the steering wheel controls respectively.

### Adjusting Bass Up and Down

The audio systems bass can be adjusted by pressing the **AUDIO** (18) button until “BASS” shows on the display.

The bass is then adjusted up by turning the **Volume Knob** (7) in a clockwise direction

and adjusted down by turning the **Volume Knob** (7) in a counter-clockwise direction.

It can also be adjusted up and down by using **ESC** (16 ) or **OK** (14) buttons respectively.

### Adjusting Treble Up and Down

The audio systems treble can be adjusted by pressing the **AUDIO** (18) button until “TREBLE” shows on the display.

The treble is then adjusted up by turning the **Volume Knob** (7) in a clockwise direction

and adjusted down by turning the **Volume Knob** (7) in a counter-clockwise direction.

It can also be adjusted up and down by using **ESC** (16 ) or **OK** (14) buttons respectively.

### Adjusting Balance Left and Right

The audio systems balance can be adjusted by pressing the **AUDIO** (18) button until “BALANCE” shows on the display.

The balance is then adjusted up by turning the **Volume Knob** (7) in a clockwise

direction and adjusted down by turning the **Volume Knob** (7) in a counter-clockwise direction.

It can also be adjusted up and down by using **ESC** (16 ) or **OK** (14) buttons respectively.

### Adjusting Fader Front and Back

The audio systems fader can be adjusted by pressing the **AUDIO** (18) button until “FADER” shows on the display.

The fader is then adjusted up by turning the **Volume Knob** (7) in a clockwise direction

and adjusted down by turning the **Volume Knob** (7) in a counter-clockwise direction.

It can also be adjusted up and down by using **ESC** (16 ) or **OK** (14) buttons respectively.

## Adjusting Mid (Medium Frequency Range) Up and Down — (Optional Feature)

The audio systems mid can be adjusted by pressing the **AUDIO** (18) button until “MID” shows on the display.

The mid is then adjusted up by turning the **Volume Knob** (7) in a clockwise direction

and adjusted down by turning the **Volume Knob** (7) in a counter-clockwise direction.

It can also be adjusted up and down by using **ESC** (16) or **OK** (14) buttons respectively.

## Speakers Selection

The audio system can be adjusted to 4 or 2 speaker mode by performing the following:

- 1 Push **MENU** (15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “ADVANCED” is displayed.
- 3 Push **OK** (14) button to enter the advanced sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons until “SPEAKERS” is displayed.
- 5 Push **OK** (14) button to change between 2CH and 4CH.

## Activate Speed Dependant Volume (ASC) — (Optional Feature)

The audio systems volume can be set to increase with the speed of the vehicle. This is sometimes preferred to compensate for road and engine sounds. The feature can be set to three levels of sensitivity, LOW, MID and HIGH.

To activate ASC, perform the following:

- 1 Push **MENU** (15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “ADVANCED” is displayed.
- 3 Push **OK** (14) button to enter the advanced sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons until “ASC” is displayed.
- 5 Push **OK** (14) button to enter the ASC sub menu.
- 6 Push **UP** (13) or **DOWN** (17) buttons to choose between LOW, MID and HIGH.
- 7 Push **OK** (14) button to enter the desired ASC setting.

## Bluetooth Hands Free Phone Mode — (Optional Feature)

The radio is designed to work with mobile phones that support the Bluetooth Hands Free Profile 1.5. Other Bluetooth capable mobile phones may still work with the radio though.

To connect a mobile phone to the radio through Bluetooth, the following steps must be completed on the radio:

### Bluetooth Activation

The purpose of this process is to make a Bluetooth connection possible.

- 1 Push **MENU** (15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “HANDS FREE” is displayed.
- 3 Push **OK** (14) button to enter the hands free sub menu.

### Adding a Phone

The purpose of this process is to make a connection between the radio and a phone as well as to add a phone to the radio phone list.

- 1 Push **MENU** (15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “HANDS FREE” is displayed.
- 3 Push **OK** (14) button to enter the hands free sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons until “ADD PHONE” is displayed.
- 5 Push **OK** (14) button to initiate the phone connection.

### Activating Another Phone

The purpose of this process is to disconnect a present bluetooth phone and establish a connection to another phone in the phone list.

- 1 Push **MENU** (15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “HANDS FREE” is displayed.
- 3 Push **OK** (14) button to enter the hands free sub menu.

- 1 Activate the Bluetooth function.
- 2 Add the Phone.

**Note:** Please note that corresponding steps have to be taken on the mobile phone.

An added phone will be stored in a list for quick access when connecting at another time.

- 4 Push **OK** (14) button to activate Bluetooth.

When Bluetooth is active, the display shows the icon (45).

The radio will now do a search for a bluetooth phone. This is indicated by the icon (45) blinking.

**Note:** Note that the phone must be in a corresponding connecting state during this process.

When a connection is established, the user will be prompted to enter a code on the phone. Enter code 0000 to verify connection.

- 4 Push **UP** (13) or **DOWN** (17) buttons until “ChangePhName” is displayed.
- 5 Push **OK** (14) button to enter the change phone sub menu.
- 6 Push **UP** (13) or **DOWN** (17) buttons until phone name that is to be connected is displayed.
- 7 Push **OK** (14) button to connect to the other phone.

## Deleting a Phone

The purpose of this process is to delete a specific phone from the phone list in the radio.

- 1 Push **MENU** (15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “HANDS FREE” is displayed.
- 3 Push **OK** (14) button to enter the hands free sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons until “EDIT PHONE” is displayed.
- 5 Push **OK** (14) button to enter the edit phone sub menu.
- 6 Push **UP** (13) or **DOWN** (17) buttons until phone name that is to be deleted is displayed.
- 7 Push **OK** (14) button to delete the other phone.
- 8 The display will show “Delete?”. Push **OK** (14) to verify.

## Deleting all Phones

The purpose of this process is to delete all phones from the phone list in the radio.

- 1 Push **MENU** (15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “HANDS FREE” is displayed.
- 3 Push **OK** (14) button to enter the hands free sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons until “EDIT PHONE” is displayed.
- 5 Push **OK** (14) button to enter the edit phone sub menu.
- 6 Push **UP** (13) or **DOWN** (17) buttons until “DELETE ALL” is displayed.
- 7 Push **OK** (14) button to delete all the phones.
- 8 The display will show “Are U sure?”. Push **OK** (14) to verify.

## Switching Phone Calls Between the Vehicle and an Active Phone

The purpose of this process is to allow switching of phone calls from being received and heard through the radio to being received and heard through a active phone.

- 1 To switch a call from the vehicle to an active phone, press the **AUDIO** button.
- 2 To switch a call from an active phone to the vehicle, press the **AUDIO** button.

## Clock

### Displaying the Time

By default, the time of day is displayed only when the ignition is ON and the radio is OFF. The Clock can be set to show the time also when radio is ON, by doing the following:

- 1 Push **MENU** (15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “CLOCK” is displayed.

### 12- or 24-Hour Format

The clock can be set to 12-hour or 24-hour mode. The 12-hour mode distinguishes between AM and PM.

To change the time format, do the following:

- 1 Push **MENU** (15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “CLOCK” is displayed.

### Setting the Clock

Normally the time is set automatically by the trucks system. The option to manually set the time will then not be available.

To set the clock manually, do the following:

- 1 Push **MENU** (15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “CLOCK” is displayed.
- 3 Push **OK** (14) button to enter the clock sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons until “SET TIME” is displayed.

- 3 Push **OK** (14) button to enter the clock sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons until “VISIBLE” is displayed.
- 5 Push **OK** (14) button to change between ON/OFF status.

- 3 Push **OK** (14) button to enter the clock sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons until “12/24 HR” is displayed.
- 5 Push **OK** (14) button to change between 12H or 24H options.

- 5 Push **OK** (14) button to enter the set time sub menu.
- 6 Push **UP** (13) or **DOWN** (17) buttons to adjust the hours up or down respectively.
- 7 Push **OK** (14) button to set the hour and toggle to the minute adjustment.
- 8 Push **UP** (13) or **DOWN** (17) buttons to adjust the minutes up or down respectively.
- 9 Push **OK** (14) button to save the time and finish the process.

### Turning the Alarm ON or OFF — (Optional Feature)

To set turn On or Off the Alarm time, do the following:

- 1 Push **MENU** (15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “WAKE UP ALARM” is displayed.

- 3 Push **OK** (14) button to enter the wake up alarm sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons “On/Off” is displayed.
- 5 Push **OK** (14) button to change the alarm status.

## Setting the Alarm — (Optional Feature)

To set the Alarm time, do the following:

- 1 Push **MENU** (15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “WAKE UP ALARM” is displayed.
- 3 Push **OK** (14) button to enter the wake up alarm sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons until “SET TIME” is displayed.
- 5 Push **OK** (14) button to enter the set time sub menu.
- 6 Push **UP** (13) or **DOWN** (17) buttons to adjust the hours up or down respectively.
- 7 Push **OK** (14) button to set the hour and toggle to the minute adjustment.
- 8 Push **UP** (13) or **DOWN** (17) buttons to adjust the minutes up or down respectively.
- 9 Push **OK** (14) button to save the time and finish the process.

## Anti Theft Code (Guard)

The radio unit is set to function with only one vehicle. The Guard feature prohibits operation of the radio anywhere else. The Guard is automatic and no manual handling is normally needed.

## In Case of Malfunction

If, by some reason, the radio fails in detecting the required vehicle, the user will be prompted to enter the Anti Theft Code (sticker found in Drivers Handbook). The display will then show “CODE 0000”.

**Note:** Please note that this is a malfunction and should be checked at an authorized workshop.

To enter the code, do the following:

- 1 For the current (blinking) digit, turn the **Volume Knob** (7) until the right number is shown.
- 2 Press the power button to enter the digit. The next digit will start to blink.
- 3 Repeat step 1 and 2 until all four digits has been entered.

The user has three tries to enter the code. If these are unsuccessful the radio will be locked for 60 minutes until three new tries are allowed.

### Deactivating Guard

It is possible to deactivate Guard, but not recommended.

To deactivate the Guard function, do the following:

- 1 Push **MENU** (15) button.
- 2 Push **UP** (13) or **DOWN** (17) buttons until “ADVANCED” is displayed.
- 3 Push **OK** (14) button to enter the advanced sub menu.
- 4 Push **UP** (13) or **DOWN** (17) buttons until “GUARD” is displayed.
- 5 Push **OK** (14) button to enter.
- 6 Push **OK** (14) button to set Guard On or Off.

The user will be requested for the Anti Theft Code to deactivate or activate Guard. The

display will then show “CODE 0000” with the first digit blinking.

To enter the code, do the following:

- 1 For the current (blinking) digit, turn the **Volume Knob** (7) until the right number is shown.
- 2 Press the power button to enter the digit. The next digit will start to blink.
- 3 Repeat step 1 and 2 until all four digits has been entered.

The user has three tries to enter the code. If these are unsuccessful the radio will be locked for 60 minutes until three new tries are allowed.



## Tips and Tricks

### USB and MP3

The radio is designed to work with USB devices that support the USB Mass Storage Device Class Standard.

**Note:** Other USB devices may still work with the radio.

If a USB device does not work together with the radio, please try to re-connect the USB device which in some cases solves the problem. Some USB devices come with extra software installed which makes them not compatible with the USB Mass Storage

Device Class Standard. If this is the case, formatting the USB device can sometimes solve the problem.

**Note:** Formatting the unit will erase all data on the USB device, so be sure to back-up of the data before trying this.

- WMA and MP3 are the only formats readable by the device.
- Playlist must be in .PLS or .M3U format.

### Bluetooth

The radio is designed to work with Bluetooth capable cellular phones that support the Bluetooth Hands-Free Profile 1.5.

**Note:** Some Bluetooth capable cellular phones that do not support this standard may still work

To see if your phone supports BlueTooth Hands-Free Profile 1.5, visit the BlueTooth organization homepage at <https://www.bluetooth.org/tpg/listings.cfm>

and search for the detailed specifications of your phone.

**Note:** The link above could change if the structure of the BlueTooth homepage is updated. You can also try contacting your cellular supplier, to get the details directly from them.

- Compatible with standard 1.5.
- More information at [www.bluetooth.org](http://www.bluetooth.org).

### iPod

The radio is designed to support the following iPod models;

- iPod nano — 1st, 2nd and 3rd generation
- iPod classic — 5th and 6th generation

**Note:** Both older and newer generations of these iPods may also work.

- An iPod adapter can be purchased through Volvo as part number 21259125.
- Other adapters may also be found at [www.sendstation.com](http://www.sendstation.com).
- For best performance, the iPod firmware should be recently updated [www.apple.com](http://www.apple.com).

### CD, MP3, and WMA

- A CD with MP3 or WMA will take several seconds to read before it starts playing.
- For best performance, an MP3/WMA CD should not contain other file types than MP3, WMA, M3U and PLS.

### Sécurité et utilisation de la radio

De nos jours, les conditions de conduite sont telles que le conducteur doit garder à tout moment sa concentration sur la route. Il est conseillé, lors de l'utilisation de cette radio tout en conduisant, que le conducteur reste concentré sur la conduite. Il est par conséquent vivement conseillé de :

- Ne jamais changer un CD ni lire une étiquette de CD lorsqu'on est au volant.
- Toujours s'assurer que le volume du système audio permette d'entendre les bruits extérieurs.
- Utiliser si possible les commandes situées sur le volant. Cette caractéristique rend la conduite plus sécuritaire et facilite la commande de la radio.

### Introduction

Les instructions suivantes expliquent le fonctionnement des modèles de radio Volvo. Les renseignements sur la radio paraissent sur l'afficheur LCD.

Les commandes de la radio sont accessibles sur sa façade, figure 1.

Certaines fonctions, illustrées à la figure 2, sont commandées au volant; ou à la télécommande, illustrée à la figure 3 (en option).

Les fonctions principales de la radio sont le mode radio et lecteur de CD.

#### Les fonctions principales en option de la radio sont :

- CD en format mp3 et WM
- USB (format mp3 et WMA)
- iPod (baladeur à disque dur)
- Entrée audio auxiliaire
- Mains libres (utilisation du téléphone à l'aide de Bluetooth)

## Vue d'ensemble

### Guide de référence rapide des commandes de la radio/du lecteur de CD

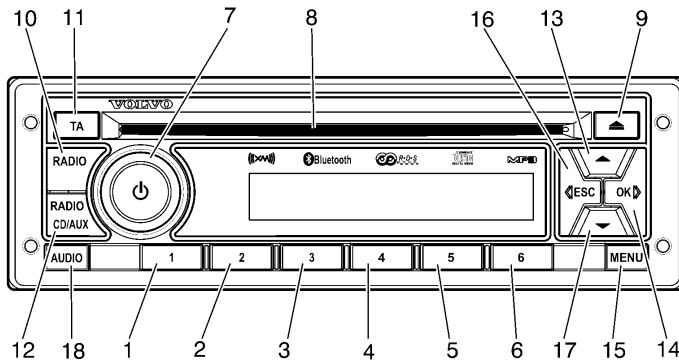


Fig. 1

W3007746

#### 1. Bouton « Préréglage n° 1 » :

- **Radio** : Appuyer et relâcher : Rappel de la station préréglée
- **Radio** : Appuyer et maintenir enfoncé : Mémorisation de la station préréglée

#### 2. Bouton « Préréglage n° 2 » :

- **Radio** : Appuyer et relâcher : Rappel de la station préréglée
- **Radio** : Appuyer et maintenir enfoncé : Mémorisation de la station préréglée

#### 3. Bouton « Préréglage n° 3 » :

- **Radio** : Appuyer et relâcher : Rappel de la station préréglée
- **Radio** : Appuyer et maintenir enfoncé : Mémorisation de la station préréglée

#### 4. Bouton « Préréglage n° 4 » :

- **Radio** : Appuyer et relâcher : Rappel de la station préréglée
- **Radio** : Appuyer et maintenir enfoncé : Mémorisation de la station préréglée

### 5. Bouton « Préréglage n° 5 » :

- **Radio:** Appuyer et relâcher : Rappel de la station préréglée
- **Radio:** Appuyer et maintenir enfoncé : Mémorisation de la station préréglée

### 6. Bouton « Préréglage n° 6 » :

- **Radio:** Appuyer et relâcher : Rappel de la station préréglée
- **Radio:** Appuyer et maintenir enfoncé : Mémorisation de la station préréglée

### 7. Bouton de mise en marche à pousser/rotatif :

- **Pousser :** Mise en marche et arrêt
- **Tourner :** Réglage du volume et mise à jour des valeurs audio

### 8. Fente pour CD :

- **CD:** Insertion/Extraction du CD

### 9. Bouton d'éjection du CD :

- **CD:** Éjection du CD

### 10. Mode de sélection radio :

- **Radio:** Choisir : FM1, FM2, FM3 (en option), AM, météo ou radio par satellite (en option)

### 11. Information (Trafic / Nouvelles) :

- **Radio:** Trafic en marche ou à l'arrêt
- **Radio:** Annule message continu de Trafic ou Nouvelles

### 12. Mode CD/Aux :

- **CD/USB:** Choisir entre les sources non radio

### 13. Bouton vers le haut :

- **Radio:** Syntonisation manuelle vers le haut

### 14. Bouton d'avance (rapide) >> :

- **Radio:** Recherche
- **CD/USB:** Appuyer et relâcher : Choisir prochaine plage
- **CD/USB:** Appuyer et maintenir enfoncé : Avance rapide
- **Bluetooth Phone:** Acceptation des appels (en option)

### 15. Bouton du menu :

- **Radio:** Appuyer et relâcher : Accès au menu

### 16. Bouton de recul (rapide) << :

- **Radio:** Recherche
- **CD/USB:** Appuyer et relâcher : Choisir plage précédente
- **CD/USB:** Appuyer et maintenir enfoncé : Recul rapide
- **Bluetooth Phone:** Refus d'appel ou raccrochage (en option)
- **iPod :** Appuyer et maintenir enfoncé : Entrer le menu iPod (en option)

### 17. Bouton vers le bas :

- **Radio:** Syntonisation manuelle vers le bas

### 18. Bouton audio :

- **Généralités :** Réglages audio

## Guide de référence rapide des commandes au volant

### 20. Bouton « suivant » :

- **Radio:** Appuyer et relâcher : Recherche
- **Radio:** Appuyer et maintenir enfoncé : Syntonisation manuelle vers le haut
- **CD/USB:** Appuyer et relâcher : Choisir prochaine plage
- **CD/USB:** Appuyer et maintenir enfoncé : Avance rapide

### 21. Bouton « précédent » :

- **Radio:** Appuyer et relâcher : Recherche
- **Radio:** Appuyer et maintenir enfoncé : Syntonisation manuelle vers le bas
- **CD/USB:** Appuyer et relâcher : Choisir plage précédente
- **CD/USB:** Appuyer et maintenir enfoncé : Recul rapide

### 22. Bouton « OUI » :

- **Téléphone Bluetooth :** Acceptation d'appel (en option)

### 23. Bouton « NON » :

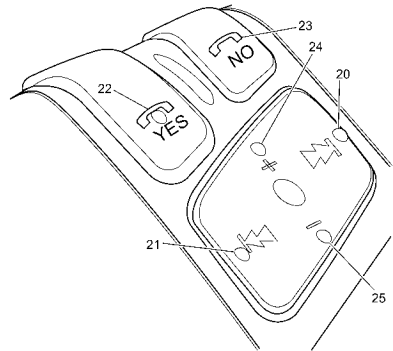
- **Téléphone Bluetooth :** Refus d'appel ou raccrochage (en option)

### 24. Bouton « volume + » :

- **Généralités :** Augmente le volume

### 25. Bouton « volume ? » :

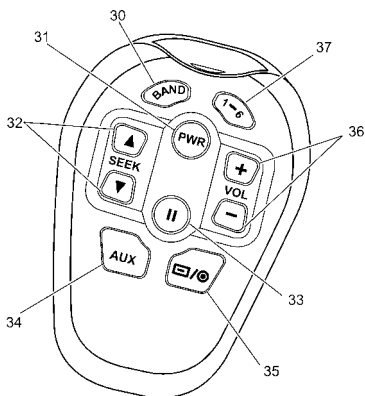
- **Généralités :** Baisse le volume



W3007856

Fig. 2

## Guide de référence rapide de la télécommande



W3007748

Fig. 3

### 30. Bouton « BAND » (bande) :

- **Radio:** Choisir : FM1, FM2, FM3 (en option), AM, météo ou radio par satellite (en option)

### 31. Bouton « PWR » (mise en marche) :

- **Généralités :** Mise en marche et arrêt de la radio

### 32. Boutons « SEEK » (recherche) :

- **Radio:** Recherche
- **CD/USB :** Plage suivante ou précédente

### 33. Bouton « sourdine / pause » :

- **Généralités :** Sourdine ou pause de la source audio

### 34. Bouton « AUX » :

- Fonction en option
- **Source:** Choisir entre : USB, iPod et Aux

### 35. Bouton « sélection CD » :

- **CD:** Choisir CD

### 36. Bouton « volume + / volume ? » :

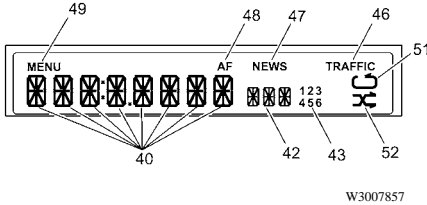
- Ajuster le volume vers le haut ou vers le bas

### 37. Préréglage 1 à 6 :

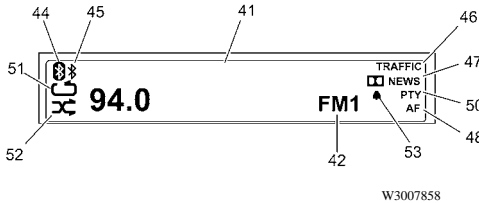
- **Radio:** Choisir une station préréglée

## Guide de référence rapide de l'afficheur

### Affichage à cristaux liquides de la radio



Affichage LCD de la radio (Fig. 4)



Affichage LCD de la radio (en option) — Optional (Fig. 5)

#### 40. Affichage texte de la radio :

- **Radio:** Radiofréquence et nom de station
- **CD:** Plage, heure et information musicale fournie.

#### 41. Affichage texte de la radio :

- **Radio:** Bande radio (FM/AM) et fréquence
- **CD/USB:** Plage, heure et information musicale fournie.

#### 42. Affichage de la source

- **Radio:** Bande radio (FM1, FM2, FM3 (en option) AM, WX ou SAT (en option))
- **CD/USB:** Autres sources que la radio

#### 43. Nombre préréglé

- **Radio:** Nombre préréglé

#### 44. Téléphone connecté

- **Généralités:** Indique qu'un téléphone Bluetooth est connecté

#### 45. Bluetooth en marche

- **Généralités:** Indique que la fonction Bluetooth est activée

#### 46. Information sur la circulation

- **Généralités:** Indique que la fonction circulation est activée

#### 47. Bulletin d'information

- **Généralités:** Indique que la fonction Bulletin d'information est activée

#### 48. AF

- **Généralités:** Indique que la fonction AF (Alternative Frequency) est activée

#### 49. Menu

- **Généralités :** Affiché si intégré au menu

#### 50. PTY

- **Généralités :** Indique que la fonction PTY (Program type) est activée

#### 51. Répétition

- **CD/USB :** Affiché lorsque la fonction Répétition est activée

#### 52. Aléatoire

- **CD/USB :** Affiché si la fonction Aléatoire est activée dans le menu

#### 53. Alarme

- **Généralités :** Indique que la fonction Alarme est activée

## Fonctions principales

Un grand nombre de fonctions se commandent ou s'ajustent en passant par le menu de la radio. Si le menu est affiché à l'écran et qu'aucune activité ne se présente pendant 10 secondes au niveau de la radio,

toute action incomplète sera alors annulée, l'écran avec menu sera fermé et la radio reviendra à son fonctionnement normal. Tous les changements réalisés seront mémorisés par la radio.

## Alimentation

### Mise en marche, mise à l'arrêt, sourdine et pause du système audio

Appuyer sur le bouton (7) pour allumer ou éteindre le système audio.

Si le conducteur souhaite une activation rapide du mode de discrétion, appuyer sur le bouton (7).

## Mode radio

### Sélection de bandes (FM et AM)

Pour choisir le mode radio, allumer la radio et appuyer sur le bouton **RADIO** (10).

La bande de fréquence de la radio sera alors la dernière utilisée (AM, FM, etc.).

Pour passer d'une bande à une autre (AM/FM1/FM2), utiliser le bouton **RADIO** (10).

### Recherche en mode radio

There are two ways to seek for a radio station:

- 1 Utiliser le bouton de recherche **ESC** (16) ou le **OK** (14) pour rechercher une station radio vers le haut ou le bas. Une fois que la station voulue est obtenue, la fonction de recherche s'arrête.

OU

- 2 Utiliser les boutons de recherche au volant, le << (21) ou le >> (20) pour rechercher une station radio vers le haut ou le bas. Une fois que la station voulue est obtenue, la fonction de recherche s'arrête.

### Syntonisation manuelle

La syntonisation manuelle s'exécute de deux façons :

- 1 Appuyer sur le bouton (13) ou le (17) pour un réglage vers le haut ou le bas.

OR

- 2 Maintenir enfoncé le bouton << (21) ou le >> (20) au volant, pour un réglage vers le haut ou le bas.



## Préréglages (mémorisation) des stations radio

Jusqu'à 12 stations FM et 6 AM peuvent être préréglées pour un accès rapide. Il existe deux bandes de fréquence préréglées pour la radio FM, la FM1 et la FM2, et une pour la radio AM. Chaque bande préréglée peut comporter 6 stations sur les boutons allant de 1 à 6. Et en plus, une bande FM ainsi qu'une bande satellite sont en option.

Pour enregistrer une station particulière sur un bouton de préréglage, il faut :

- 1 Appuyer sur le bouton **RADIO** (10) jusqu'à l'activation de la bande de

fréquence nécessaire (AM, FM1, FM2, FM3 [en option], météo, ou radio satellite [en option]).

- 2 Rechercher la station souhaitée.
- 3 Maintenir enfoncé le bouton de préréglage voulu (1) (2) (3) (4) (5) (6).
- 4 Lors de la mémorisation de la station, la radio n'émet aucun son. Le processus est terminé au retour de l'audio.

## Préréglages (sélection d'une station radio mémorisée)

Pour choisir l'une des stations préréglées, il faut :

- 1 Appuyer sur le bouton **RADIO** (10) pour choisir la bande nécessaire (AM, FM1, FM2, FM3 [en option], météo ou radio par satellite [en option]).

- 2 Appuyer momentanément sur le bouton de préréglage nécessaire (1) (2) (3) (4) (5) (6) pour activer la station souhaitée.

## Mode balayage

Le balayage permet à l'utilisateur de rechercher une station sans avoir à manuellement passer d'une station à une autre. En mode balayage, chaque station détectée diffuse pendant 10 secondes pour donner à l'utilisateur une idée du programme ou de la musique. Le balayage continue alors jusqu'à la station suivante à moins que l'utilisateur décide d'arrêter le balayage sur la station qu'il vient d'entendre.

Pour obtenir le mode balayage, il faut :

- 1 Appuyer sur le bouton **MENU** (15) de la radio.
- 2 Choisir <<SCAN>> (balayage) en appuyant sur **OK** (14).

Pour sortir du mode balayage et rester sur la station actuelle, il faut :

- 1 Appuyer sur le bouton **RADIO** (10).
- OU
- 2 Appuyer sur le bouton << (21) ou le >> (20).

### Utilisation de la bande radiométéo

La radiométéo NOAA est un service de National Weather Service. Cette radiodiffusion transmet en continu les dernières informations météorologiques directement des bureaux du National Weather Service. Des messages enregistrés sur les conditions météorologiques sont répétés toutes les quatre à six minutes et revus toutes les une à trois heures et même plus souvent dans certaines circonstances. La majorité des stations émettent 24 heures sur 24. La météo de votre région est retransmise par une des 7 stations disponibles.

En mode de bande radiométéo, l'afficheur donne l'icône « WX » et « CH » plus le numéro du canal. Il est possible de changer de canal avec le bouton (13) or (17) et le

canal peut également être préréglé avec les touches.

La fréquence associée avec chacun des canaux est la suivante :

- |   |             |
|---|-------------|
| 1 | 162.550 MHz |
| 2 | 162.400 MHz |
| 3 | 162.475 MHz |
| 4 | 162.425 MHz |
| 5 | 162.450 MHz |
| 6 | 162.500 MHz |
| 7 | 162.525 MHz |

Le National Weather Service exploite environ 372 stations. Près de 90% de la population se trouve dans la zone de radiodiffusion de la météo de la NOAA.

### Service de radio par satellite — (Caractéristiques en option)

Si votre radio comporte un logo XM<sup>3</sup> ou SIRIUS,<sup>4</sup> elle est donc compatible pour la radio par satellite. XM et Sirius sont des services de radio par satellite offrant plus de 100 canaux de programmation audio de qualité numérique. La transmission est sans interruption aux États-Unis continentaux. Le service de radiodiffusion par satellite est disponible moyennant une cotisation. Pour obtenir de plus amples renseignements, prendre contact avec XM à [www.xmradio.com](http://www.xmradio.com) ou par téléphone au 1-800-852-XXXM (9696) ou avec Sirius à <http://activate.siriusradio.com> ou par téléphone au 1-888-539-7474. Pour activer le récepteur de signaux de satellite intégré, il faut donner au fournisseur de la radiodiffusion par satellite le numéro de série électronique du récepteur. Voici les instructions qui permettent de trouver le numéro de série électronique :

Si votre fournisseur de radiodiffusion par satellite est XM Satellite Radio :

- 1 La clé de contact étant tournée et la radio ALLUMÉE, appuyer sur le bouton **RADIO** (10) et choisir XM1 ou XM2.
- 2 Syntoniser la radio sur le canal 0 et le numéro de série à 8 chiffres paraîtra.

Si votre fournisseur de radiodiffusion par satellite est Sirius Satellite Radio :

- 1 La clé de contact étant tournée et la radio ALLUMÉE, appuyer sur le bouton **RADIO** (10) et choisir SR1 ou SR2.
- 2 Syntoniser la radio sur le canal 0 et le numéro de série à 12 chiffres paraîtra.

La réception de la radiodiffusion par satellite peut être perturbée s'il y a des obstructions au niveau des signaux.

<sup>3</sup>XM est une marque déposée de XM Satellite Radio Holdings Inc.

<sup>4</sup>SIRIUS est une marque déposée de SIRIUS Satellite Radio Inc.

## Mode CD

La radio est conçue pour fonctionner avec des CD de format standard (fichiers MP3 et

WMA en option). Le lecteur de CD accepte les disques CD-R ainsi que les CD-RW.

## Sélection du mode CD

Il existe deux façons de passer au mode CD :

- 1 Appuyer sur le bouton **CD/AUX** (**12**) jusqu'à ce que **CD** s'affiche.

OU

- 2 Introduire un CD dans la fente pour CD (**8**).

## Éjection d'un CD

Pour éjecter un CD, appuyer sur le bouton **EJECT** (**9**). Une fois le CD extrait, la radio se remet en marche sur la dernière station

utilisée. Si le CD n'est pas extrait de son logement, il se remettra en marche dans les 15 secondes.

## Changement de la plage du CD

Il existe deux façons pour changer la plage d'un CD :

- 1 Enfoncer et relâcher le bouton **ESC** (**16**) ou le **OK** (**14**) de la radio pour passer à la plage précédente ou à la suivante.

- 2 Utilisation des commandes situées sur le volant (en option) : Enfoncer et relâcher le bouton << (**21**) or >> (**20**) pour passer à la plage précédente ou à la suivante.

OU

## Recul rapide ou avance rapide d'un CD

Le recul ou l'avance rapide se réalise de deux manières avec un CD :

- 1 Maintenir enfoncé le bouton **ESC** (**16**) ou le **OK** (**14**) de la radio pour une avance rapide ou un recul rapide.

OU

- 2 Utilisation des commandes situées sur le volant (en option) : Enfoncer et relâcher le bouton << (**21**) ou le >> (**20**) pour passer au recul rapide ou à l'avance rapide.

## Activation des plages d'un CD dans un ordre aléatoire

Il existe deux modes de réglage aléatoire pour un CD : Ordre aléatoire total ou ordre aléatoire de fichiers (si le contenu du CD est enregistré sous forme de fichiers).

Pour lire les plages en ordre aléatoire, il faut :

- 1 Appuyer sur le bouton **MENU** (**15**).
- 2 Appuyer sur le bouton (**13**) ou le (**17**) jusqu'à ce que « REPEAT » (répétition) s'affiche.

- 3 Entrer le sous-menu du réglage aléatoire en appuyant sur le bouton **OK** (**14**).
- 4 Appuyer sur le bouton (**13**) ou le (**17**) pour choisir entre « All » (tous), « Track » (plage) et « Folder » (fichier).
- 5 Appuyer sur le bouton **OK** (**14**) pour activer le mode de répétition souhaité.

### Répétition de plage sur un CD — (Caractéristiques en option)

Il existe trois modes de réglage de répétition pour un CD : Répétition pour tous, répétition de plage ou répétition de fichier (si le contenu du CD est enregistré sous forme de fichiers). Par défaut, « Repeat All » (répétition pour tous) est activé. Pour changer le réglage de répétition, il faut :

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « REPEAT » (répétition) s'affiche.
- 3 Entrer le sous-menu du réglage aléatoire en appuyant sur le bouton **OK** (14).
- 4 Appuyer sur le bouton (13) ou le (17) pour choisir entre « All » (tous), « Track » (plage) et « Folder » (fichier).
- 5 Appuyer sur le bouton **OK** (14) pour activer le mode de répétition souhaité.

### Changement de fichier sur un CD — (Caractéristiques en option)

Si le contenu du CD est mémorisé dans des fichiers, il est alors possible de changer directement de fichiers. Pour cela, appuyer sur le bouton (13) ou le (17) pour passer au suivant ou au précédent album/fichier.

### Balayage d'un CD

Lors du balayage d'un CD, on entend les 10 premières secondes de l'enregistrement de chaque plage.

Pour activer le balayage, il faut :

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Choisir « SCAN » (balayage) en appuyant sur le bouton **OK** (14).

Le balayage s'arrête si :

- 1 Le bouton **ESC** (16) ou le **OK** (14) de la façade est activé..

OU

- 2 Si toutes les plages sont explorées.

## Entrée audio externe — (Caractéristiques en option)

Il existe trois modes d'entrée externe, USB, iPod et Aux. Un appareil USB et un appareil auxiliaire peuvent être branchés et être

accessibles simultanément. Cependant, si un iPod est connecté, la source des appareils USB et AUX est désactivée.

## Mode USB — (Caractéristiques en option)

La radio est conçue pour fonctionner avec des dispositifs USB formatés selon la norme pour support mémoire de masse USB. Les autres appareils USB pourraient encore fonctionner avec la radio.

Si un appareil USB ne fonctionne pas correctement, essayer de le rebrancher. Ceci peut résoudre le problème dans certains cas.

**Note:** L'appareil USB doit être connecté avant d'utiliser ce mode.

## Sélection du mode USB

Il existe deux façons de passer au mode USB

- 1 Appuyer sur le bouton **CD/AUX** (12) jusqu'à ce que USB s'affiche.

- OU
- 2 connecter un appareil USB.

## Déconnexion d'un appareil USB

Aucune préparation spéciale n'est nécessaire pour débrancher un appareil USB. Une fois

l'appareil USB déconnecté, la radio se remet en marche sur la dernière station utilisée.

## Changement de la plage d'un appareil USB

Il existe deux façons pour changer la plage d'un USB :

- 1 Maintenir enfoncé le bouton **ESC** (16) ou le **OK** (14) de la radio pour une avance rapide ou un recul rapide.

- OU
- 2 Utilisation des commandes situées sur le volant (en option) : Enfoncer et relâcher le bouton << (21) ou le >> (20) pour passer au recul rapide ou à l'avance rapide.

## Recul rapide ou avance rapide sur un appareil USB

Le recul ou l'avance rapide se réalise de deux manières:

- 1 Maintenir enfoncé le bouton **ESC** (16) ou le **OK** (14) de la radio pour une avance rapide ou un recul rapide.

- OU
- 2 Utilisation des commandes situées sur le volant (en option) : Enfoncer et relâcher le bouton << (21) or >> (20) pour passer au recul rapide ou à l'avance rapide.

### Activation des plages d'un appareil USB dans un ordre aléatoire

Il existe deux modes de réglage aléatoire pour un appareil USB : Ordre aléatoire total ou ordre aléatoire de fichiers (si le contenu de l'USB est enregistré dans des fichiers).

Pour activer les plages dans un ordre aléatoire, il faut :

- 1 Appuyer sur le bouton **MENU**(15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « **RANDOM** » s'affiche.

- 3 Entrer le sous-menu du réglage aléatoire en appuyant sur le bouton **OK** (14).
- 4 Appuyer sur le bouton (13) ou le (17) pour choisir entre « **All** » (tous) et « **Folder** » (fichier).
- 5 Appuyer sur le bouton **OK** (14) pour activer le mode aléatoire souhaité.

### Répétition de plages sur un appareil USB

Il existe trois modes de réglage de répétition pour un appareil USB : Répétition pour tous, répétition de plage ou répétition de fichier (si le contenu du dispositif USB est enregistré dans des fichiers). Par défaut, « **Repeat All** » (répétition pour tous) est activé.

Pour changer le réglage de répétition, il faut :

- 1 Appuyer sur le bouton **MENU**(15).

- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « **REPEAT** » s'affiche.
- 3 Entrer le sous-menu du réglage aléatoire en appuyant sur le bouton **OK** (14).
- 4 Appuyer sur le bouton (13) ou le (17) pour choisir entre « **All** » (tous), « **Track** » (plage) et « **Folder** » (fichier).
- 5 Appuyer sur le bouton **OK** (14) pour activer le mode de répétition souhaité.

### Changement de fichier sur un USB

Si le contenu de l'USB est mémorisé dans des fichiers, il est alors possible de changer directement de fichiers. Pour cela, appuyer sur le bouton (13) or (17) pour passer au suivant ou au précédent album/fichier.

### Balayage d'un USB

Lors du balayage d'un USB, on entend les 10 premières secondes de l'enregistrement de chaque plage.

Pour activer le balayage, il faut :

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Choisir « **SCAN** » (balayage) en appuyant sur **OK** (14) button.

Le balayage s'arrête si

- 1 Le bouton **ESC** (16) ou le **OK** (14) de la façade est activé.

OU

- 2 Si toutes les plages sont explorées.

## Mode iPod — (Caractéristiques en option)

La radio est compatible avec iPod Classic, iPod Vidéo et iPod nano. Les réglages du iPod, par ex. « Shuffle » (réarrangement) ou « Repeat » (répétition), utilisés avant de connecter le iPod à la radio seront utilisés par la radio.

**Note:** Un appareil iPod doit être connecté avant d'utiliser ce mode.

### Connexion d'un iPod

Le branchement du iPod est possible avec deux ensembles de câble différents.

- 1 Un câble divisé du connecteur iPod à 30 broches au connecteur USB et un connecteur audio de 3,5 mm.
- 2 Un câble séparé iPod/USB plus un câble stéréo audio mâle/mâle de 3,5 mm connecté à la sortie pour écouteur du

iPod. Dans ce cas, le volume du iPod doit être réglé au maximum avant de le brancher sur la radio.

Une fois le iPod connecté à la radio, ses commandes se retrouvent verrouillées.

Une fois le iPod connecté à la radio, ses commandes se retrouvent verrouillées.

### Sélection du mode iPod

Il existe deux façons de passer au mode iPod :

- 1 Appuyer sur le bouton **CD/AUX** (12) jusqu'à ce que iPod s'affiche.

OU

- 2 Connecter un appareil iPod.

### Déconnexion de l'appareil iPod

Aucune préparation spéciale n'est nécessaire pour débrancher l'appareil iPod. Une fois

l'appareil iPod déconnecté, la radio se remet en marche sur la dernière station utilisée.

### Menu iPod

Une fois le iPod connecté et identifié, l'utilisateur peut maintenir enfoncé le bouton **ESC** (16) pour entrer le menu iPod. Ce menu contient certaines des fonctionnalités les plus courantes utilisées sur le iPod. Par exemple, l'utilisateur peut rechercher des artistes ou des albums, et commencer une liste de diffusion.

Maintenir enfoncé le bouton **ESC** (16) pendant 1 seconde pour entrer le menu iPod au dernier niveau utilisé.

Maintenir enfoncé le bouton **ESC** (16) pendant 2 secondes pour entrer le menu iPod au niveau supérieur.

## Changement de plage sur le iPod

Le recul ou l'avance rapide se réalise de deux manières :

- 1 Maintenir enfoncé le bouton **ESC** (16) ou le **OK** (14) pour une avance rapide.

OU

- 2 Utilisation des commandes situées sur le volant (en option) : Enfoncer et relâcher le bouton << (21) ou le >> (20) pour passer au recul rapide ou à l'avance rapide.

## Recul rapide ou avance rapide sur un iPod

Le recul ou l'avance rapide se réalise de deux manières :

- 1 Maintenir enfoncé le bouton **OK** (14) pour une avance rapide.

- 2 Utilisation des commandes situées sur le volant (en option) : Enfoncer et relâcher le bouton << (21) or >> (20) pour passer au recul rapide ou à l'avance rapide.

OU

Remarquer qu'en maintenant enfoncé le bouton **ESC** (16) on entre le menu iPod.

## Activation des plages d'un iPod dans un ordre aléatoire

Il existe deux modes de réglage aléatoire pour un iPod : Ordre aléatoire pour album et ordre aléatoire pour tous.

Pour activer des chansons dans un ordre aléatoire, il faut :

- 1 Appuyer sur le bouton **MENU**(15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « **RANDOM** » s'affiche.

- 3 Entrer le sous-menu du réglage aléatoire en appuyant sur le bouton **OK** (14).
- 4 Appuyer sur le bouton (13) ou le (17) pour choisir entre « **All** » (tous) et « **Folder** » (fichier).
- 5 Appuyer sur le bouton **OK** (14) pour activer le mode aléatoire souhaité.

## Répétition de plage sur le iPod

Il existe deux modes de réglage aléatoire pour un iPod : Répéter Un, répéter Tous.

Pour changer le réglage de répétition, il faut :

- 1 Appuyer sur le bouton **MENU**(15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « **REPEAT** » s'affiche.

- 3 Entrer le sous-menu du réglage aléatoire en appuyant sur le bouton **OK** (14).
- 4 Appuyer sur le bouton (13) ou le (17) pour choisir entre « **All** » (tous), « **Track** » (plage) et « **Folder** » (fichier).
- 5 Appuyer sur le bouton **OK** (14) pour activer le mode de répétition souhaité.

## Balayage sur le iPod

Lors du balayage d'un iPod, on entend les 10 premières secondes de l'enregistrement de chaque plage.

Pour activer le balayage, il faut :

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Choisir « **SCAN** » (balayage) en appuyant sur **OK** (14).

Le balayage s'arrête si

- 1 Le bouton **ESC** (16) ou le **OK** (14) de la façade est activé.

OU

- 2 si toutes les plages sont explorées.



## Mode AUX — (Caractéristiques en option)

Pour choisir une entrée audio auxiliaire :

Appuyer sur le bouton **CD/AUX** (12) jusqu'à ce que Aux s'affiche.

Une entrée audio auxiliaire peut être sélectionnée sauf en mode iPod.

Le volume de l'appareil auxiliaire doit être réglé au maximum.

Noter que pour un appareil auxiliaire, le changement de plage, l'avance rapide etc. doit être exécuté directement sur l'appareil aux.

## Réglages audio

### Réglage du volume vers le haut et vers le bas

Le volume du système audio peut être monté en tournant le bouton (7) dans le sens horaire et baissé en tournant le (7) dans le sens antihoraire.

Il peut également être monté et baissé avec les commandes + (24) et - (25) situées sur le volant (en option).

### Réglage des graves vers le haut et vers le bas

Pour ajuster les graves sur le système audio, appuyer sur le bouton **AUDIO** (18) jusqu'à ce que «BASS» s'affiche.

sens horaire et baissé en tournant le bouton (7) dans le sens antihoraire.

Le niveau des graves du système audio peut être monté en tournant le bouton (7) dans le

Il est aussi possible d'ajuster les graves avec **ESC** (16) ou **OK** (14) sur la radio.

### Réglage des aigus vers le haut et vers le bas

Pour ajuster les aigus sur le système audio, appuyer sur le bouton **AUDIO** (18) jusqu'à ce que «TREBLE» s'affiche.

sens horaire et baissé en tournant le bouton (7) dans le sens antihoraire.

Le niveau des aigus du système audio peut être monté en tournant le bouton (7) dans le

Il est aussi possible d'ajuster les aigus avec **ESC** (16) ou **OK** (14) sur la radio.

### Réglage à gauche et à droite de l'équilibre

Pour ajuster l'équilibre sur le système audio, appuyer sur le bouton **AUDIO** (18) jusqu'à ce que «BALANCE» (équilibre) s'affiche.

en tournant le bouton (7) dans le sens antihoraire.

Le réglage de l'équilibre vers la droite s'obtient en tournant le bouton (7) dans le sens horaire et le réglage vers la gauche

Il est aussi possible de l'ajuster vers la gauche et vers la droite avec **ESC** (16) ou **OK** (14) sur la radio.

## Équilibreur avant-arrière

Pour ajuster l'équilibreur sur le système audio, appuyer sur le bouton **AUDIO** (18) jusqu'à ce que « FADE » (équilibrer) s'affiche.

L'équilibreur se règle alors vers l'avant en tournant le bouton (7) dans le sens horaire et

vers l'arrière en tournant le bouton (7) dans le sens antihoraire.

Il est possible de l'ajuster aussi vers la gauche et vers la droite avec **ESC** (16) ou **OK** (14) sur la radio.

## Réglage Mid (Plage des moyennes fréquences) vers le haut et vers le bas — (Caractéristiques en option)

Pour ajuster les moyennes fréquences sur le système audio, appuyer sur le bouton **AUDIO** (18) jusqu'à ce que MID s'affiche.

Le niveau des moyennes fréquences du système audio peut être monté en tournant le bouton (7) dans le sens horaire et baissé

en tournant le bouton (7) dans le sens antihoraire.

Il est aussi possible d'ajuster les moyennes fréquences avec **ESC** (16) ou **OK** (14) sur la radio.

## Sélection de haut-parleurs

Pour le réglage du système audio en mode de 2 ou de 4 haut-parleurs, il faut

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « ADVANCE » s'affiche.
- 3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu « ADVANCE ».

- 4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « SPEAKERS » s'affiche.
- 5 Passer de 2CH à 4CH en appuyant sur le bouton **OK** (14).

## Activation de la commande automatique de sensibilité (CAS) — (Caractéristiques en option)

Le volume du système audio se règle afin que celui-ci augmente avec la vitesse du véhicule. Ce réglage permet de compenser pour les bruits de la route et du moteur. Cette fonctionnalité comporte trois niveaux de sensibilité « LOW, MID et HIGH » (BAS, MOYEN et HAUT).

Pour activer la CAS, il faut :

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « ADVANCE » s'affiche.

- 3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu « ADVANCE ».
- 4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « ASC » s'affiche.
- 5 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu ASC.
- 6 Appuyer sur le bouton (13) ou le (17) pour choisir entre « LOW, MID et HIGH » (BAS, MOYEN et HAUT).
- 7 Appuyer sur le bouton **OK** (14) pour entrer le réglage CAS souhaité.

## Mode Téléphone mains libres Bluetooth — (Caractéristiques en option)

La radio est conçue afin de fonctionner avec un téléphone cellulaire compatible avec Bluetooth mains libres Profile 1.5. D'autres téléphones cellulaires avec Bluetooth pourraient aussi fonctionner avec la radio. Pour brancher un téléphone cellulaire sur la radio par l'intermédiaire de Bluetooth, il est nécessaire de passer par les étapes suivantes au niveau de la radio.

- 1 Activer la fonction Bluetooth.
- 2 Ajouter le téléphone.

Noter que les étapes correspondantes doivent être prises sur le téléphone cellulaire.

Un téléphone ajouté sera mémorisé dans une liste pour donner un accès facile lors de la prochaine connexion.

### Activation Bluetooth

Le but de ce processus est de réaliser une connexion Bluetooth.

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Hands Free » (mains libres) s'affiche.

- 3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Mains libres.
- 4 Appuyer sur le bouton **OK** (14) pour activer Bluetooth.

Lorsque Bluetooth est actif, l'icône (45) s'affiche.

### Addition d'un téléphone

Le but de ce processus est d'obtenir une connexion entre la radio et un téléphone et d'ajouter un téléphone à la liste de téléphones de la radio.

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Hands Free » (mains libres) s'affiche.
- 3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Mains libres.
- 4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Add phone » (ajouter téléphone) s'affiche.

- 5 Appuyer sur le bouton **OK** (14) pour lancer la connexion téléphonique.

La radio recherche alors un téléphone Bluetooth. L'icône (45) se met à clignoter pour indiquer que la recherche est en cours.

Remarquer que les paramètres de connexion du téléphone doivent correspondre entre eux pendant ce processus.

Une fois la connexion établie, l'utilisateur devra entrer un code sur le téléphone. Entrer le code 0000 pour vérifier la connexion.

### Activation d'un autre téléphone

Le but de ce processus est de déconnecter un téléphone Bluetooth et établir une connexion à un autre téléphone se trouvant sur la liste de téléphones.

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Hands Free » (mains libres) s'affiche.
- 3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Mains libres.
- 4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « ChangePhName » («

PhName » étant le nom du téléphone actuellement connecté) s'affiche.

- 5 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Changement de téléphone.
- 6 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que le nom du téléphone à connecter s'affiche.
- 7 Appuyer sur le bouton **OK** (14) pour connecter l'autre téléphone.

### Suppression d'un téléphone

Le but de ce processus est d'éliminer un téléphone spécifique de la liste de téléphones de la radio.

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Hands Free » (mains libres) s'affiche.
- 3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Mains libres.
- 4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Edit Phone » (modification de téléphone) s'affiche.

- 5 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Modification de téléphone.
- 6 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que le nom du téléphone à éliminer s'affiche.
- 7 Appuyer sur le bouton **OK** (14) pour éliminer le téléphone.
- 8 « Delete? » (Éliminer?) s'affiche. Appuyer sur le bouton **OK** (14) pour effectuer une vérification.

### Suppression de tous les téléphones

Le but de ce processus est d'éliminer tous les téléphones de la liste de téléphones de la radio.

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Hands Free » (mains libres) s'affiche.
- 3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Mains libres.
- 4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Edit Phone » (modification de téléphone) s'affiche.

- 5 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Modification de téléphone.
- 6 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « Delete All » (éliminer tous) s'affiche.
- 7 Appuyer sur le bouton **OK** (14) pour éliminer tous les téléphones.
- 8 The display will show "Delete?". Push **OK** (14) to verify.
- 9 « Are U sure? » (Valider?) s'affiche. Appuyer sur le bouton **OK** (14) pour effectuer une vérification.

## Transférer les appels téléphoniques du véhicule à un téléphone actif

Le but de cette opération est de permettre de transférer les appels téléphoniques afin de les recevoir et de les entendre par le truchement d'un téléphone actif au lieu de par la radio.

- 1 Pour transférer un appel du véhicule à un téléphone actif, appuyer sur la touche **AUDIO**.
- 2 Pour transférer un appel d'un téléphone actif au véhicule, appuyer sur la touche **AUDIO**.

## Horloge

### Affichage de l'heure

Par défaut, l'heure n'est affichée que si la clé de contact est ACTIVÉE ou que si la radio est ÉTEINTE. Pour programmer l'horloge afin de pouvoir voir l'heure lorsque la radio est allumée, il faut :

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « CLOCK » (horloge) s'affiche.

### Format 12- ou 24- heures

Le mode de 12 heures et celui de 24 heures sont programmables sur cette horloge.

Le mode de 12 heures permet de faire la distinction entre AM et PM.

Pour changer la base horaire, il faut :

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « CLOCK » (horloge) s'affiche.

### Réglage de l'horloge

Normalement l'heure est automatiquement programmée par le système du camion. L'option de programmation manuelle n'est alors pas disponible.

Pour manuellement programmer l'horloge, il faut :

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « CLOCK » (horloge) s'affiche.
- 3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Horloge.
- 4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « SET TIME » (programmation de l'heure) s'affiche.

- 3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Horloge.
- 4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « VISIBLE » s'affiche.
- 5 Appuyer sur le bouton **OK** (14) pour passer de « ON » (marche) à « OFF » (arrêt).

- 3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Horloge.
- 4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « 12/24 HR » s'affiche.
- 5 Appuyer sur le bouton **OK** (14) pour passer à l'une de ces options 12H ou 24H.

- 5 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Programmation de l'heure.
- 6 Appuyer sur le bouton (13) ou le (17) pour changer l'heure dans un sens ou dans l'autre.
- 7 Appuyer sur le bouton **OK** (14) pour obtenir l'heure et appuyer en alternance pour obtenir le réglage des minutes.
- 8 Appuyer sur le bouton (13) ou le (17) pour changer les minutes dans un sens ou dans l'autre.
- 9 Appuyer sur le bouton **OK** (14) pour gagner du temps et terminer le processus.

## Mise en marche et arrêt de l'alarme — (Caractéristiques en option)

Pour mettre l'alarme ou l'éteindre, il faut :

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « WAKE UP ALARM » (réveil par alarme) s'affiche.
- 3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Réveil par alarme.
- 4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « ON/OFF » (marche/arrêt) s'affiche.
- 5 Appuyer sur le bouton **OK** (14) pour changer le réglage de l'alarme.

## Programmation de l'alarme — (Caractéristiques en option)

Pour programmer l'heure de réveil, il faut :

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « WAKE UP ALARM » (réveil par alarme) s'affiche.
- 3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Réveil par alarme.
- 4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « SET TIME » (programmation de l'heure) s'affiche.
- 5 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Programmation de l'heure.
- 6 Appuyer sur le bouton (13) ou le (17) pour changer l'heure dans un sens ou dans l'autre.
- 7 Appuyer sur le bouton **OK** (14) pour obtenir l'heure et appuyer en alternance pour obtenir le réglage des minutes.
- 8 Appuyer sur le bouton (13) ou le (17) pour changer les minutes dans un sens ou dans l'autre.
- 9 Appuyer sur le bouton **OK** (14) pour gagner du temps et terminer le processus.

## Code antivol

La radio est programmée pour qu'elle ne fonctionne que sur un seul véhicule. La caractéristique antivol empêche la radio de fonctionner partout ailleurs. L'antivol

fonctionne automatiquement et normalement il ne nécessite aucune manipulation manuelle.

## En cas de dysfonctionnement

Si, pour une raison quelconque, la radio ne détecte pas le bon véhicule, l'utilisateur devra entrer le code antivol (étiquette située dans le guide du conducteur). Le code « CODE 0000 » s'affiche alors.

Remarquer que cela est une défaillance et que celle-ci doit être vérifiée dans un atelier agréé.

Pour entrer le code, il faut :

- 1 Changer le chiffre (clignotant), en tournant le bouton du volume (7) jusqu'à obtention du bon chiffre.

- 2 Appuyer sur le bouton de mise en marche pour entrer le chiffre. Le prochain chiffre se mettra à clignoter.
- 3 Répéter les étapes 1 et 2 jusqu'au dernier chiffre.

Trois essais sont possibles pour entrer le code. Si ces trois essais sont manqués, la radio sera alors verrouillée pendant 60 minutes avant de pouvoir faire trois nouveaux essais.

## Désactivation de l'antivol

Il est possible de désactiver l'antivol, mais cela est vivement déconseillé.

Pour désactiver la fonction antivol, il faut :

- 1 Appuyer sur le bouton **MENU** (15).
- 2 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « ADVANCE » (avancement) s'affiche.
- 3 Appuyer sur le bouton **OK** (14) pour entrer le sous-menu Avancement.
- 4 Appuyer sur le bouton (13) ou le (17) jusqu'à ce que « GUARD » (antivol) s'affiche.
- 5 Appuyer sur le bouton **OK** (14) pour valider.
- 6 Appuyer sur le bouton **OK** (14) pour programmer l'antivol sur « ON » (marche) ou sur « OFF » (arrêt).

CODE 0000 » s'affichera alors et le premier chiffre clignotera.

Pour entrer le code, il faut :

- 1 Changer le chiffre (clignotant), en tournant le bouton du volume (7) jusqu'à obtention du bon chiffre.
- 2 Appuyer sur le bouton de mise en marche pour entrer le chiffre. Le prochain chiffre se mettra à clignoter.
- 3 Répéter les étapes 1 et 2 jusqu'au quatrième chiffre.

Trois essais sont possibles pour entrer le code. Si ces trois essais sont manqués, la radio sera alors verrouillée pendant 60 minutes avant de pouvoir faire trois nouveaux essais.

L'utilisateur devra alors fournir le code antivol pour activer ou désactiver l'antivol. «



## Conseils et astuces

### USB et MP3

La radio est conçue pour fonctionner avec des dispositifs USB compatibles avec le support mémoire de masse USB régulier.

**Remarque:** D'autres appareils USB peuvent fonctionner avec la radio. Si un appareil USB ne fonctionne pas avec la radio, essayer de le rebrancher, ceci résout, dans certains cas, le problème. Certains appareils USB sont livrés avec des logiciels installés ce qui les rend incompatibles avec le support mémoire de masse USB régulier. Dans ce

cas, le formatage d'un appareil USB peut parfois résoudre le problème.

**Remarque:** Le formatage de l'appareil efface toutes les données sur le dispositif USB, il est préférable de sauvegarder toutes les données avant de procéder.

- WMA et MP3 sont les seuls formats qui sont lisibles par cet appareil.
- La liste de diffusion doit être en version .PLS ou .M3U.

### Bluetooth

La radio est conçue afin de fonctionner avec un téléphone cellulaire compatible avec Bluetooth mains libres Profile 1.5.

**Remarque:** Certains téléphones cellulaires compatibles Bluetooth n'étant pas compatibles avec cette norme peuvent fonctionner malgré tout. Pour savoir si votre téléphone est compatible avec le profil Mains-libres Bluetooth 1,5, veuillez consulter la page d'accueil Bluetooth, <https://www.bluetooth.org/tpg/listings.cfm> et

trouver les spécifications correspondantes à votre téléphone.

**Remarque:** Si la structure de la page d'accueil Bluetooth est mise à jour, le lien ci-dessus pourrait changer. Vous pouvez également prendre contact avec votre fournisseur de téléphone cellulaire afin d'obtenir directement les détails.

- Compatible avec la norme 1.5.
- De plus amples renseignements sur [www.bluetooth.org](http://www.bluetooth.org).

### iPod

La radio est conçue afin d'être compatible avec les modèles iPod suivants:

- iPod nano – 1e, 2e et 3e génération
- iPod classic – 5e et 6e génération

**Remarque:** Les anciennes et les nouvelles générations de ces iPod peuvent également fonctionner.

- Un adaptateur iPod peut être acheté par Volvo sous le numéro de référence 21259125.
- D'autres adaptateurs se trouvent aussi sur le site [www.sendstation.com](http://www.sendstation.com).
- Pour obtenir les meilleures performances possibles, le micrologiciel iPod doit être à jour en allant [www.apple.com](http://www.apple.com).

### CD, MP3, et WMA

- Au début d'un CD avec MP3 ou WMA, les quelques premières secondes de lecture ne produisent pas de son.
- Pour obtenir les meilleures performances possibles, un CD MP3/WMA ne doit pas contenir des fichiers de types autres que MP3, WMA, M3U et PLS.





Radio Engineering Industries, Inc.

# Mobile DVD Player

## DVD/VCD/CD/MP3

# Instruction Manual



DVD

P/N 640364

## **AUDIO SYSTEMS**

Congratulations to your purchase of the REI DVD Player. This product has been designed and built to deliver the highest quality video reproduction with CD sound.

We are sure you'll enjoy watching your favorite movies with this system as a part of your multimedia. For best results, please consult a professional mobile electronics installer for application advice or troubleshooting.

To guarantee top performance, we recommend to using The Link installation accessories such as RCA interconnects, power cables, and speaker wire. Thank you for choosing REI products for your mobile entertainment system.

## **FEATURES**

Compatible with PAL-DVD (Video CD) and NTSC DVD (Video CD).

This player can play discs recorded in either PAL or NTSC format.

- A single LSI chip now integrates all major DVD playback circuit functions including MPEG2 decoder, video D/A converter, and audio decoders.
- L/R stereo analog audio outputs for connection to existing head unit aux inputs.
- Video output is composite video.
- Supplied remote handles multi-function software (multi-language audio-track/subtitle, multi-angle, multi-story, etc), plus all basic functions.
- Last position memory

## **USE THIS PRODUCT SAFELY**

### **When Driving**

Keep the volume level low enough to be aware of road and traffic conditions.

### **Moisture**

Do not expose the product to water or excessive moisture. This could cause electrical shorts, fire or other damage.

### **When Parked**

Parking in direct sunlight can produce very high temperatures inside your vehicle. Give the interior a chance to cool down before starting playback.

### **Use the proper Power Supply**

This product is designed to operate with a 10-30 volt DC.

### **Protect the Disc Mechanism**

Avoid inserting any foreign objects into the slot of this player.

Failure to observe this may cause malfunction due to the precise mechanism of this unit.

### **Use Authorized Service Centres**

Do not attempt to disassemble or adjust this precision product, please refer to the Service Centre near by for service assistance.

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## **Safety information**

### **Caution:**

Mobile DVD player is a class A laser product. However this mobile DVD player uses a visible /invisible laser beam which could cause hazardous radiation exposure if directed. Be sure to operate the mobile DVD player correctly as instructed. Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure. Do not open covers and do not repair by yourself, refer servicing to qualified person.

### **Warning:**

- to reduce the risk of fire or electric shock, do not expose this equipment to rain or moisture.
- to reduce the risk of fire of electric shock, and annoying interference, use only the recommended accessories.

This product incorporates copyright protection technology that is protected by method claims of certain US. Patents and other intellectual property rights owned by Macrovision Corporation, and is intended for home and other limited viewing uses only unless otherwise authorized by Macrovision Corporation. Reverse engineering or disassembly is prohibited.

Manufactured under license from Dolby Laboratories.  
"Dolby" and the double-D symbol are trademarks of Dolby Laboratories .

## **Region Management Information:**

This Mobile DVD Player is designed and manufactured to respond to the Region Management Information that is recorded on a DVD disc. If the Region number described on the DVD disc does not correspond to the Region number of this Mobile DVD Player cannot play this disc.

### **Disc formats supported by this player(12 & 8 cm disc)**

- **CD:** CD-DA, CD-R/RW, CD-ROM, MP3
- **VCD:** VCD, SVCD
- **DVD:** DVD5, DVD9, DVD10, DVD18

### **Discs which cannot be played with this player**

- DVD-ROM
- DVD-RAM
- CDV
- CD-G

### **Handling and cleaning**

- Dirt, dust, scratches and warping disc will cause mis-operation.
- Do not place stickers or make scratches on discs.
- Do not warp discs.
- A disc should be kept in its case when not in use to prevent damage.
- Do not place discs in following place:
  1. Direct sunlight
  2. Dirty, dusty and damp areas
  3. Near car heaters
  4. On the seats or dashboard

## Disc Cleaning

Use a dry soft cloth to wipe the surface. If the disc is quite dirty, use a soft cloth slightly moistened with isopropyl (rubbing) alcohol. Never use solvents such as benzene, thinner or conventional record cleaners as they may mar the surface of the disc.

### Note:

A disc may become somewhat scratched (although not enough to make it unplayable) depending on how it is handled and the conditions of exposure. Note these scratches are not an indication of any problem with the Player.

Label side up



Do not touch the underside of the disc

Do not bend

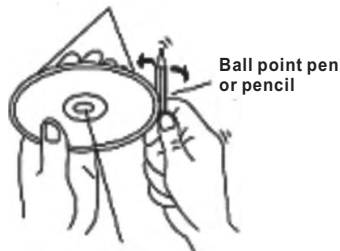


Wipe the disc from center  
Toward the outside edge

## Preparing New Discs with Rough Spots

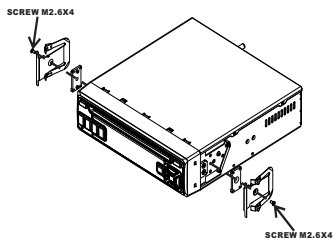
A new disc may have rough edges on its inside and outside edges. If a disc with rough edges is used, the proper setting will not be performed and the player will not play the disc. Therefore, remove the rough edges in advance by using a ball point pen or pencil as shown below. To remove the rough edges, press the side of the pen or pencil against the inside and outside edges of the disc.

Rough spots on  
outside edge



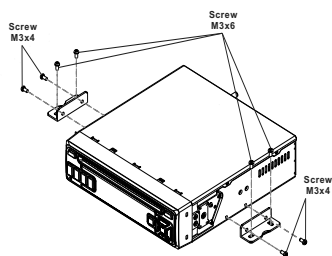
Rough spots  
on inside edge

## Installation



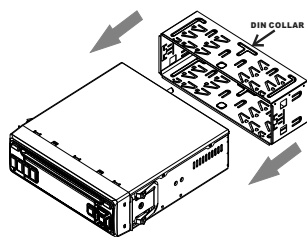
### Step1:

Attach 2 side brackets by the supplied screws



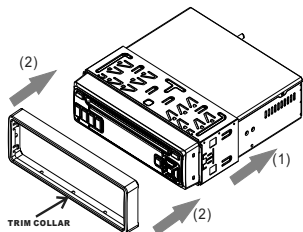
### Note:

(1) Attach the L-form brackets of the player using the supplied screws (M3x4).



### Step2:

Slide the DIN collar into DVD player from back



### Step3:

(1) Slide the DVD player into in-dash slot  
(2) Attach Trim collar into front panel.

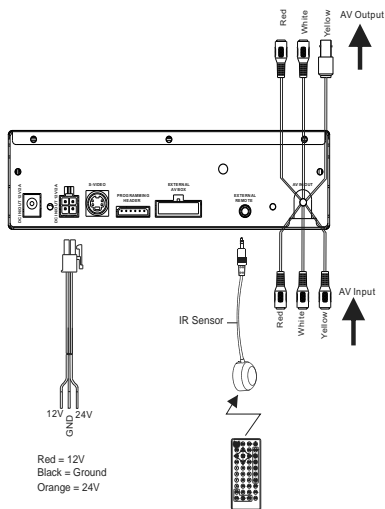


Figure: Electrical Connections1

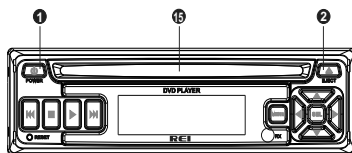
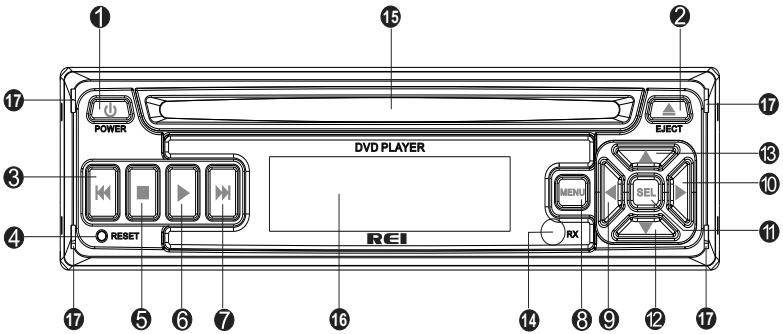


Figure: Electrical Connections2

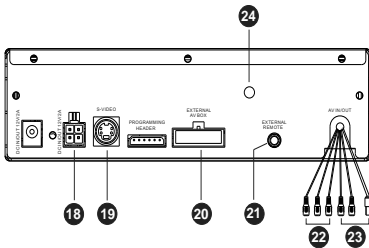


## Front Panel:



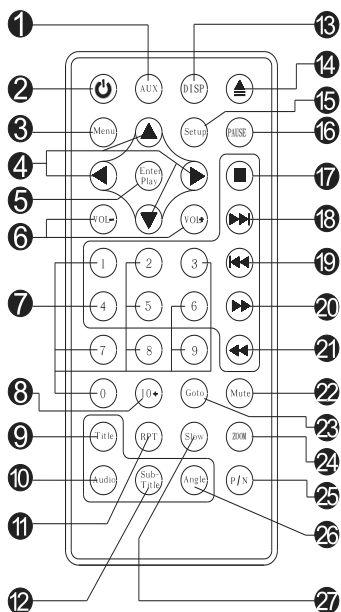
1. Press POWER to turn the unit ON or OFF
2. Eject button
3. Press to skip back one track/title/chapter
4. Press [ RESET ] button will make hardware reset to circuits built in the player.
5. Press to stop playback
6. Begin playback and display
7. Press to skip to the next title/chapter/track
8. Display the root menu that is stored on the DVD disc. Selects between PBC ON and PBC OFF on a VCD
9. In MENU mode, this button move the cursor to the left
10. In MENU mode, this button move the cursor to the right
11. Confirm the Track/Chapter selected with the number key or selected with the cursor buttons on the monitor, or return to playback
12. In MENU mode, this button moves the cursor to the down.
13. In MENU mode, this button moves the cursor up.
14. IR Sensor
15. Disc Slot
16. LCD Panel (Anti-glare)
17. DIN Collar Release Holes

## Back Panel:



18. 4-pin Power IN: +12VDC/+24VDC/GND
19. S-Video OUT
20. Control Interface
21. External IR IN
22. A/V IN: 3 \* RCA  
Yellow: Video/CVBS  
Red/White: Audio-R/Audio-L
23. A/V OUT: 2 \* RCA + BNC  
Yellow(BNC): Video/VBS  
Red/White(RCA): Audio-R/Audio-L
24. Mounting Stud

## Remote Control:



1. Change the video/audio to mode AV1 or DVD.
2. Press POWER to turn the unit ON or OFF.
3. Display the root menu that is stored on the DVD disc. Select between PBC ON and PBC OFF on a VCD.
4. In MENU mode, these buttons move the cursor to the up or down.  
In MENU mode, these buttons move the cursor to the left or right.
5. Confirm the Track/Chapter selected with the number key or selected with the cursor button to monitor, or return to playback.
6. Increase or decrease the sound volume.
7. Numeric buttons
8. Press to increase 10
9. Display the TITLE menu that is stored in DVD disc.

10. Changes the AUDIO soundtrack on multi-audio soundtrack DVD disc. Changes the sound output mode of the VCD/CD disc.
11. Switch the repeat mode of DVD/VCD/CD/MP3 disc.
12. Changes the SUBTITLE language on multi-subtitle language DVD disc.
13. Display statistical disc information during playback.
14. Eject button
15. Display the SETUP menu.
16. Press to pause playback.
17. Press to stop playback.
18. Press to skip to the next track or chapter.
19. Press to skip back one track or chapter.
20. Press to play forward rapidly.
21. Press to play reverse rapidly.
22. Mute the sound.
23. Disc search button, used in conjunction with numeric button
24. Zoom in by 2X, 3X, 4X, 1/2, 1/3 or 1/4.
25. Select playing discs in one of PAL, NTSC, and Multi(recorded in disc) signal formats.
26. Changes the view angle on multi-angle DVD disc.
27. Selects forward slow motion playback at the normal speed of 1/2, 1/4, 1/8 or 1/16.

## Preparing the Remote Control

### Inserting the Battery

1. Open the battery compartment cover.
2. Insert 2 new batteries ( 1.5V AAA ).  
Make sure that the positive and negative terminals of the battery are oriented Indicated.
3. Close the cover




## Using the Remote Control

Point the remote control toward the front of the player (at the remote receiver "eye")  
Operation angle: About  $\pm 30$  degree in each  
Direction of the front of the IR mark.

**To prevent damage to the unit, be sure to follow the connection diagram (page 5).**




## Loading a DVD/VCD/CD Disc (Figure: Electrical Connections 2)

1. Turn the ignition to the Accessory (ACC) position.
2. Press the  POWER button (1).
3. Insert the disc into the disc slot (15) with the label side of the disc facing up.
4. The player starts playback automatically.



## Ejecting a disc







Press  (EJECT) button (2) to eject the disc.

## Stopping play





1. Press the  (Stop) button to stop playback. Press the  (play) button for playback.
2. Press the  (Stop) button twice. It will stop the playback and go back to initial Track/Chapter.

## Rapid Forward/Reverse

Press FF  & REW  during play. Each time the button is pressed the speed changes (depending on the disc format) as follows:  
DVD/VCD/CD/MP3:

Normal  2X  4X  8X  16X  32X 






## Skipping Track

Press  /  on the remote handset or on the front panel during playback. Press  to skip to next track, and  to back one track.

## Slow Motion Playback

Press the slow button at playback. Each time, the button is pressed the playback changes

(depending) on the disc format) as follows:  
DVD/VCD:

Normal  1/2  1/4  1/8  1/16 

## Pause (still picture)





Pressing PAUSE (II) button during playback, it will stop playing temporarily.  
Press the PAUSE button the second time for playback.

## Repeat

Press the REPEAT (RPT) button to select repeat mode as follows:

DVD:

Press the REPEAT (RPT) button to select repeat mode as follows.

Chapter  Title  ALL  OFF 







SVCD/VCD/CD-DA:

Press the REPEAT (RPT) button to select repeat mode as follows.

Track  ALL  OFF 

1. Repeat Track mode continuously repeats the current track/song.
2. in Repeat ALL mode, all tracks /songs on the disc are repeated.

MP3:

Folder  Shuffle  Random  Single   
Repeat Folder  Repeat One 

## ZOOM

If the ZOOM button is pressed, picture will enlarge each time by 2X, 3X, 4X, 1/2, 1/3, 1/4.  
But some DVD discs pictures can not be zoomed.

## TITLE

Press TITLE button when DVD is in playback, it will come back to TITLE menu to play.

## GOTO

Press GOTO button to start searching function.

### (1) CD/MP3/JPEG

Press GOTO button, it will start searching file/ elapsed time or track. Press MENU button to exit from this function.

### (2) VCD/SVCD

Press GOTO button, "GOTO" menu will appear

for users to adjust some parameters during disc playing, such as playing track, and modes for Repeat/display.

### (3) DVD

Press GOTO button, "GOTO" menu will appear for users to adjust some parameters during disc playing such as playing title/chapter, language used for audio/subtitle, shot angle, and repeat /display modes.

### Mute Function

Press MUTE button on the remote control to cut down the sound output.

Press it again or VOL+/VOL- to resume to previous volume Level.

### VOL+ / VOL-

Volume Control:

Press VOL+ on the card remote control to increase the sound level and press VOL- to decrease the sound level.

### Remote Sensor(IR)

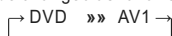
Point the remote handset to the remote sensor. Receive the signal from remote handset.

### Turning the player on/off

Press the POWER button on front of panel or press POWER button on remote control to turn the player on or off.

### Audio/Video Mode

Whenever you press AUX button, input source is to be changed as follows.



### AUDIO/VIDEO IN

The unit can accept an auxiliary(AUX) signal from external equipment.

1. Connect the equipment and the unit with A/V cables. the AUDIO OUT of the external equipment is connected to the AUDIO IN jack on the back of the unit , the VIDEO OUT of the external equipment is connected to the VIDEO IN Jack of the unit.
2. Turn on the external equipment and the unit.
3. Select input source by pressing the AUX button on the remote control. Select the AV1 input from extern AV signal.
4. The signals are also routed through the video output jack and the audio output jack of the DVD unit.

### On-Screen Display Function

Press the DISP button during playback to show the timing contents of the current disc on the upper-left corner of screen.

#### (1) DVD:

```
Title Elapsed
TT 01/03 CH 02/31      00:01:36
TT 01/03: current title/total titles,
CH 02/31: current chapter/total chapters under
current title
Title Elapsed: one of 5 display modes.
```

Available display modes are as follows:

Title Elapsed → Title Remain → Chapter Elapsed  
← Display off ← Chapter Remain ←

00:01:36: Show elapsed or remaining time based on the selected display mode

#### (2) SVCD/VCD:

```
Single Remain
Track 01/01          47:01
Track 01/01: current track/total tracks
Single Remain: one of 3 display modes.
```

Available display modes are as follows:

Single Elapsed → Single Remain → Display Off  
↑

47:01: Show elapsed or remaining time based on the selected display mode

#### (3) CD:

```
Total Elapsed
Track 01/18          10:06
Track 01/018: current track/total tracks
Single Remain: one of 4 display modes.
```

Available display modes are as follows:

Single Elapsed → Single Remain →  
↑ Total Remain ← Total Elapsed ←

10:06: Show elapsed or remaining time based on the selected display mode

#### (4) MP3/JPEG:

```
00:05 04:20 Folder Key +00
002/013 RepeatFolder Off
```

Based on the item highlighted by the cursor in orange, elapsed/total time/ordinal number for this item and total items in this folder will be shown. By pressing DISP button first time, "Folder", "Key +00", "Off", and current repeat Mode ("Repeat Folder") will be shown. For clearing display messages, press DISP button second time.

## Multi-audio Language Function

### (1) DVD:

Press AUDIO button during playback. Each time the button is pressed, number of the audio soundtrack language is changed in a sequential order.

#### Notes:

The language number is different according to the disc. Some disc only contain one language soundtrack. When no different language soundtrack is available, 0 will be displayed in the top left corner of the screen.

### (2) VCD/CD:

Press AUDIO during playback.

It is possible to switch the sound between monaural and stereo sound.

Stereo → Mono Left → Mono Right → Mix-Mono  
↑

## MENU Function

### (1) DVD:

Press MENU button while the disc is playing and the disc menu will be displayed. You can navigate with the remote control navigation keys and select a feature with the ENTER key. Press MENU twice, it will go back to the previous place.

### (2) VCD:

Press MENU button while the disc is playing, you can switch between "PBC ON" and "PBC OFF" mode.

## Title Menu Function (For DVD only)

If the DVD has multiple titles recorded on the disc. It can select preferred title from the title menu to start playback.

1. Press TITLE during playback. The title menu is display.
2. Press the cursor button shown on the monitor, select preferred title by the cursor button and confirm by ENTER key.

## Multi- subtitle Language Function

### (For DVD only)

Press SUBTITLE during playback.

Each time the button is pressed, number of the subtitle language is changed in a sequential order.

#### Notes:

The language number is different according to the disc.

Some discs only contain one language soundtrack. When no different language soundtrack are recorded, 0 will be display at screen left top corner.

## Multi-angle Function (For DVD only)

Press ANGLE during playback.

Each time the button is pressed, number of the angle changes in sequential order.

#### Notes:

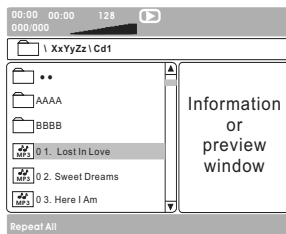
The angle number is different according to the disc.

The function only works for discs having scenes recorded at different angles.

When no different angles are available, 0 will display in the top left corner of the screen.

## MP3 /MPEG/JPG Disc PLAY

MP3 disc is playing as the format of FOLDER shown below. For example:

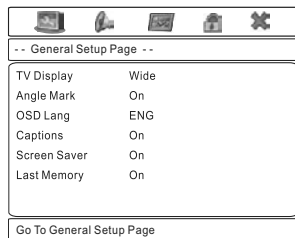


1. Use ▲ ▼ ◀ ▶ to select the item or folder, then press ENTER button.
2. Pressing REPEAT button repeatedly can select six kinds of repeat play mode.
3. During the playback, use ⏮ / ⏭ to skip an item ahead or back.
4. Use ▲ ▼ buttons and move yellow cursor to the folder [ ] ● . Press ENTER, and go back to previous folder window.

Note: Press MENU button to return FOLDER window when playing JPEG items.

## INITIAL SETUP

### SETUP MENU---MAIN PAGE



1. Press SETUP in the stop mode.
2. The initial SETUP menu is displayed.
3. Select the preferred item by using the ◀ / ▶ buttons.

There are four setup pages available:

#### a. General Setup

This setup page includes all the items of system and external TV display features. Please refer to *GENERAL SETUP* menu.

#### b. Audio Setup

This setup page includes all the items for audio effect features. Please refer to *AUDIO SETUP* menu.

#### c. Preference

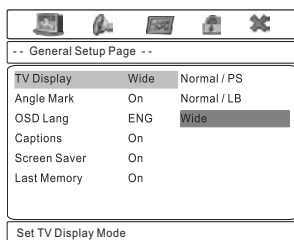
This setup page includes all the system features for disc playing. Please refer to *PREFERENCE* menu.

#### d. Password Setup

This setup page includes password features. Please refer to *PASSWORD SETUP* menu.

4. Press ENTER button to start navigating the selected page.
5. By pressing ▼ or ▲ buttons, move the yellow cursor to the item that users want to adjust.

## GENERAL SETUP



### TV Display

This is to select the appropriate aspect (4:3 or 16:9) according to the connected monitor.

#### (1) Normal / PS (For 4:3 TV)

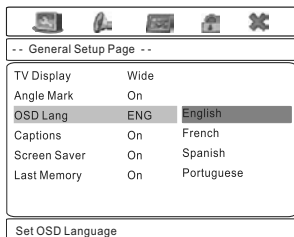
Play back in the PAN & SCAN style. (If wide screen monitor is connected, the left and right edges are cut off)

#### (2) Normal / LB (For 4:3 TV)

Play back in letterbox style. (If wide screen is connected, black bands appear at bottom and top of the screen.)

#### (2) Wide (For 16:9 TV)

Select when a wide-screen monitor set is connected.



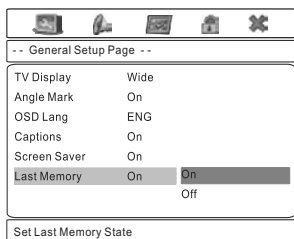
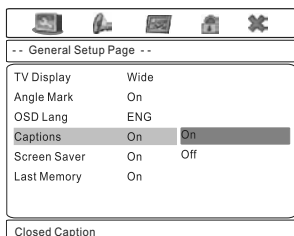
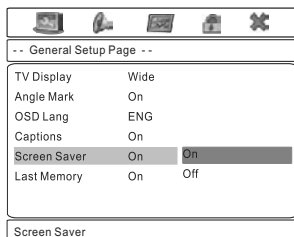
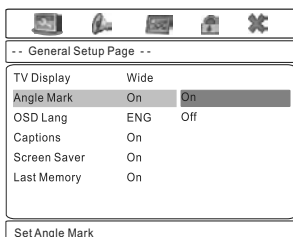
### OSD Lang

This item is to select the appropriate language for any on-screen-display (OSD) messages.

Once the cursor is moved to item "OSD Lang", press ENTER, and then ▼ or ▲ to locate an option. There are 4 languages available:

- (1) English,
- (2) French,
- (3) Spanish,
- (4) Portuguese.

Press ENTER to select.



## Angle Mark

This is to enable (On) or disable (Off) the ability for system to display a "video camera" mark on the upper-right corner of the screen to notify users that contents in the disc have scenes recorded at different angles.

### Note:

Video camera mark



## Captions

This is to enable (On) or disable (Off) the ability for system to display the subtitle language on the screen.

## Screen Saver

This is to enable (On) or disable (Off) the ability for system to play screen saver.

When DVD is in the stop or pause mode, or there is no disc in the slot the screen saver will be played after 3 minutes that no activities such as

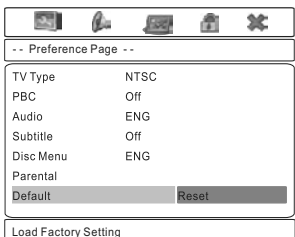
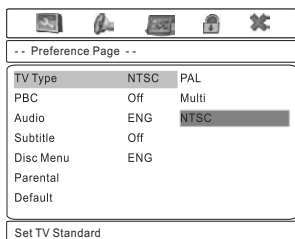
- (1) pressing keys on the front panel or remote
- (2) disc loading.

## Last Memory

This is to enable(On) or disable (Off) the ability to memorize the last playing position of the disc when system is powered off.

As long as this function is enable, system will automatically play disc from the last position when DVD is powered off.

## PREFERENCE



### TV Type

This player can play discs whose contents are recorded in either PAL or NTSC format.

Select NTSC format, when you connected to NTSC monitor.

Select PAL format, when you connected to PAL monitor.

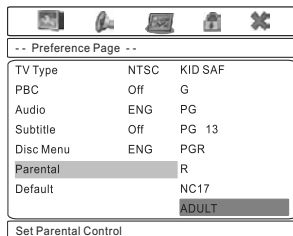
Select Multi format, the player's monitor output format will follow the content format in the disc.

### Default

Navigate to the "Preference Page" in the DVD player's SETUP menu, and then select item "Default".

Press the ENTER button to restore the initial factory settings except

- (1) password,
- (2) setting of password mode
- (3) parental rating level



### Parental

Press ENTER button for changing the preferred rating level between the following 8 level:

- (1) KID SAF
- (2) G
- (3) PG
- (4) PG 13
- (5) PGR
- (6) R
- (7) NC17
- (8) ADULT

By pressing ▲ ▼ buttons, move yellow cursor to the desired level. Press ENTER to select. After that, the following OSD will show and ask users for password. If users input the correct one, the selected rating level is accepted and activated.



### Subtitle

Select the preferred SUBTITLE language by using the cursor buttons and confirm by pressing ENTER.

### Audio

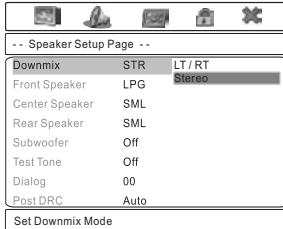
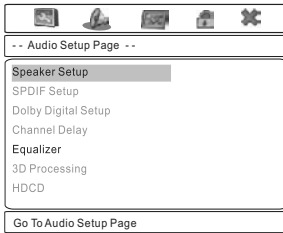
Select the preferred AUDIO soundtrack by using the cursor buttons and confirm by pressing ENTER.

### Disc Menu

DVD Menu selects the preferred DISC MENU language by using the cursor buttons and confirm by pressing ENTER.



## AUDIO SETUP



### Speaker Setup → Downmix

This is to allow users selecting the sound effect mode for 2-channel audio output.

After navigating the yellow cursor to the item "Speaker Setup" in the "Audio Setup" page, then press ENTER to open this page as shown in the 2nd picture above.

Press ENTER again, now users can navigate the yellow cursor by buttons ▲▼ to one of those two modes that are **LT/RT** and **Stereo**. Press ENTER to select.

### Notes: (Audio Downmix Mode)

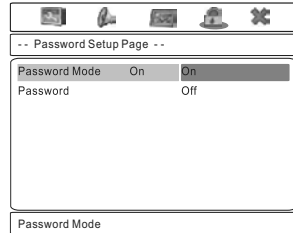
#### 1. LT/RT mode

- (Left channel)  
mix the signals from center/rear-left/front-left positions.
- (Right channel)  
mix the signals from center/rear-right/front-right positions.

#### 2. Stereo mode

- (Left channel)  
mix the signals from center/rear-left/front-left/rear-right positions.
- (Right channel)  
mix the signals from center/rear-right/front-right/rear-left positions.

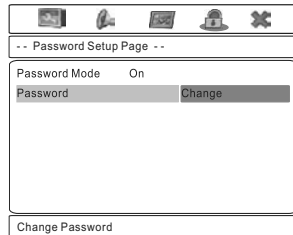
## PASSWORD SETUP



### Password Mode

This is to enable (On) or disable (Off) the ability for system to check password when rating level of parental control is being changed.

During users' changing this mode, System will ask users for password.

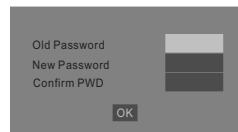


### Password

This is to allow users to replace the password with new appropriate one.

After navigating the yellow cursor to the item "Password" in the "Password Setup" page as shown on the above picture, then press ENTER to open the change process.

Press ENTER again, the following OSD menu will appear for users to change old password.



## ***Additional Information***

### **Notes**

To avoid shorts in the electrical system, be sure to disconnect the power cable before beginning installation.

Never feed power to other equipment by cutting the insulation of the power supply lead of the unit and tapping into the lead. The current capacity of the lead will be exceeded, causing overheating.

When replacing fuse, be sure to use only fuse of the same rating prescribed on this unit.

With DVD-R/DVD-RW discs, only recordings made in the video format ( Video mode ) can be played back. DVD - RW discs recorded in the Video Recording format (VR mode ) cannot be played back.

Even with DVD-R/DVD-RW discs featuring recordings made in the Video format ( Video mode ), playback may not be possible with this unit due to disc characteristics or scratches or dirt on the disc. Dirt or condensation on the lens inside this unit may also prevent playback.

Playback of discs recorded with a PC using the correct format is possible but depending on the application software, environmental settings and other factors playback may not be possible ( For details, inquire at the store or dealer where you purchased the application Software.)

CD - Extra discs can be played back as music CDs.

Normal playbackable discs are CD-R/CD-RW other than those recorded with a music CD Recorder.

Playback of music CD-R/CD-RW discs even than those recorded with a music CD recorder, may not be possible with this unit due to disc characteristics or dirt on the disc. Dirt or condensation on the lens inside this unit may also prevent playback.

Titles and other text information recorded on a CD-R/CD-RW discs can not be displayed by this unit.

If you insert a CD-RW disc into this unit to playback, it will take a bit longer time than when you do with a conventional CD or CD-R disc.

Read the precautions with the CD-R/CD-RW discs before using.

### **Restore Default**

Navigate to the "Preference Page" in the DVD player's SETUP menu, and then select item "Default" by pressing ENTER button.

Press the ENTER button again to restore the initial factory settings.

**Default Tables**

General Setup	TV Display	Wide
	Angle Mark	On
	OSD Lang	ENG
	Captions	On
	Screen Saver	On
	Last Memory	On
Preference	TV Type	NTSC
	PBC	Off
	Audio	ENG
	Subtitle	Off
	Disc Menu	ENG
	Parental	ADULT (un-resettable)
Audio Setup	Speaker Setup	Downmix --> LT/RT
Password Setup	Password Mode	On (un-resettable)

**Note:**

The default password is "136900".

The password will not be restored to default one after operating the "**Restore Default**" mentioned above.

## Technical Specifications

Supply Voltage:	10-30VDC, negative ground
Environment temperature:	0°C ~ 60°C
Chassis Dimensions:	187x178x50(mm)
Current Consumption:	Less than 1A @ 12VDC Quiescent $\leq$ 90mA
Video system	NTSC/PAL/AUTO
Discs Played:	(1) DVD-VIDEO, DVD-R/W, DVD+R/RW ■ (12 & 8 cm) single-sided, single-layer ■ (12 & 8 cm) single-sided, double-layer (2) Compact Disc(CD-DA, VIDEO CD, CD-R/RW, MP3) ■ (12 & 8 cm) disc
Audio Output Level:	2ch, 8.0 $\pm$ 0.5 Vp-p (10K $\Omega$ )
Video Output Level:	1 $\pm$ 0.2V(75 $\Omega$ )
Characteristic	(1)Frequency Response 20Hz~20KHz ( $\pm$ 2dB) (2)S/N Ratio 70dB(JIS) (1KHz) (3)Channel separation $\geq$ 55dB (1KHz)

### Note:

Specifications and design are subject to modification, without notice, due to improvements in technology.

# SECTION 24: LUBRICATION

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**1 GENERAL RECOMMENDATIONS**

The efficiency and life expectancy of mechanical equipment is largely dependent on proper lubrication and servicing. All mechanical components rely on a lubricating film between moving parts to reduce friction, prevent wear and oxidation. Proper lubrication also helps cool the parts and keep dirt particles away from mating surfaces. Efficient lubrication depends upon using the right type of lubricant, at specified intervals and by filling to correct capacities. Past experience shows that many service problems can be traced to an improper lubricant or to incorrect lubrication procedures.

A comprehensive maintenance and lubrication program is important to ensure the long service life this vehicle was designed for and to avoid costly repairs and associated downtime caused by premature part failure.

A lubrication schedule is included in this section to give the location of key service points on the vehicle as well as the lubricant specifications for each component to be serviced. Specific instructions on how to check and service different components are covered in their respective sections in this maintenance manual.


The recommended lubrication intervals are based on normal operating conditions and mileage accumulation.

Shorten the intervals if your vehicle operates in more severe conditions. Severe conditions include heavy towing, high vehicle weight or operation in mountainous areas. Some parts and equipment referred to in this section may not be installed on your vehicle. Check your vehicle's "Coach Final Record" for equipment list.


Dispose of used lubricants and filters in an environmentally safe manner, according to federal and/or local recommendations.

- Understand basic principles of vehicle operation;
- Always maintain the vehicle in good running condition;
- Do not drive with low fuel. If the fuel tank runs dry, the engine will not start until the air is bled from the fuel system. Refer to "Maintenance Manual" for more information;

- Allow engine to run for at least two minutes at slow idle before shutting *OFF*;
- Engine should be at idle when shifting from neutral (N) to forward (D) or from neutral (N) to reverse (R);

 <b>CAUTION</b>
Fast idle should always be turned off before releasing the parking brake and putting the coach in gear. Driveline damage can result if the fast idle switch is always left on.

- The automatic transmission does not have a park (P) position. Place transmission in neutral (N) position and apply parking brake when the vehicle is stopped. A warning buzzer will sound if the engine is stopped and the parking brake has not been applied when foot pressure is removed from the brake pedal;
- Always follow the procedures described in this manual;
- Unless stated otherwise, shut off the engine before performing all servicing, lubrication and maintenance tasks;
- Do not attempt to push or pull-start the coach;
- Damage may result if towed with the axle shafts or driveshaft connected;
- Two chemical fire extinguishers are under the first row of passenger seats. In case of fire, immediately evacuate all occupants. Occupant safety is the first priority. Do not attempt to extinguish the fire if there is immediate danger or risk for personal injury;
- When driving on ice and snow, accelerate and decelerate gradually;

 <b>WARNING</b>
Report all problems affecting passenger or driver safety to a Prevost service center or an authorized service center. Have problems corrected immediately.

1.1 FIRST SERVICE ON NEW VEHICLE

1.1.1 Hot Water Filter (H3 Coaches Only)

The hot water filter (located in the evaporator compartment) is designed to recover the soldering residues trapped inside the coolant lines during their initial assembly; perform initial cleaning (refer to Section 22: Heating And Air Conditioning) 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).*

2 OTHER VERIFICATIONS


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 HOSE INSPECTIONS

2.1.1 Hose Inspection

Inspect hoses for leaks regularly to ensure efficient, economical and safe operation of the engine and related equipment. Carefully inspect all fittings, clamps and ties. To prevent chafing, make sure hoses are not touching shafts, couplings, heated surfaces, sharp edges or other parts. Since hose clamps and ties can vibrate loose or fail over time, inspect frequently and tighten or replace as necessary.

Correct leaking hoses immediately. Failure to correct leaks can cause severe damage to the equipment, as well as increase operating costs due to lost fluids. Treat fuel and oil leaks as an immediate fire hazard.

	<p><b>WARNING</b></p>
<p>Personal injury and property damage may result from fire caused by leaking flammable fluids.</p>	

2.1.2 Hose Service Life

Hoses have a limited service life. Thoroughly inspect hoses annually. Look for surface damage or indications of twisted, worn, crimped, cracked or leaking lines. Replace damaged hoses immediately.

Hoses should be replaced during major overhaul or after a maximum of seven years service. Be certain replacement hoses match the original equipment manufacturer's specifications.

2.2 LUBRICATION


Grease all lubrication points during scheduled maintenance. For heavy loads or extended use, lubricate more often. Refer to the Maintenance Manual, section 24 for information on lubrication.

2.3 WHEELS AND TIRES

Check for loose wheel nuts. Inspect all types of rims for cracks. Cracks can appear in many places but typically radiate out from where a load is applied. Both aluminum alloy and steel wheel nuts should be tightened to 450 to 500 foot-pounds (610 to 680 N.m) torque.

Keep the tires inflated to the recommended inflation pressure to prolong tire life and for safety.

<p><b>NOTE</b></p>
<p><i>Recommended tire inflation pressures are given in the "Coach Final Record", placed in the technical publications package supplied with the vehicle. The cold tire inflation pressures are on the Department of Transport certification plate located on the L.H. console besides the driver's seat. When special tires are installed by Prevost on a new vehicle, a special tire inflation chart is added next to the certification plate.</i></p>

	<p><b>WARNING</b></p>
<p>Do not exceed maximum inflation pressure. Incorrect tire pressure increases tire wear and could lead to loss of driving control because of reduced road handling. Check tire pressure regularly.</p>	

## SECTION 24: LUBRICATION

### 2.4 WHEEL BEARINGS

Check wheel bearing cover for overheating (especially after using the service brakes) during fuel stops by touching the wheel bearing cover.



#### WARNING

If replacement tires are different from those described on the certification plate, pressure must be adjusted as requested in the Tire and Rim Association Manual.

### 2.5 SERVICE BRAKE TEST

Check for correct pressure build-up. Stop engine and check pressure gauge. Pressure loss should be imperceptible with engine stopped and without brake pedal applied. Air loss should not exceed 3 psi/minute (21 kPa/minute) with engine stopped and brake pedal fully applied.

### 2.6 PARKING BRAKE TEST

Release parking/emergency brake. Pump service brake pedal until air pressure drops to 65 psi (448 kPa). Make sure the warning buzzer operates and that the emergency brakes apply (the control valve knob lifts up). Allow air pressure to reach 95 psi (655 kPa) before releasing parking brake.

Driving the vehicle while the parking brake is applied should not be possible.

### 2.7 EXTERIOR LIGHTING VERIFICATION

#### 2.7.1 Exterior Lighting Test Mode

This useful function allows quick verification of the vehicle exterior lights.

#### Activating the test mode:

When the vehicle is stationary (parking brake applied), pull up the multi-function lever 3 times within 3 seconds to activate the test mode. This test can be done when the engine is not running providing that the battery charge is sufficient (above 24.0 volts).

The telltale panel alarm emits a sound each second to remind that the test mode is in progress.

#### Stopping the test mode:

To stop the test mode, pull up the multi-function lever once or turn the ignition OFF or remove the parking brake.

#### NOTE

*The test mode is useful to check the functioning of the multiplex outputs and the exterior lights. It doesn't test the functionality of the commands related to the exterior lighting. For a complete testing, the directional signal commands, the headlights commands and the brake pedal have to be checked before. Once these commands tested, activate the test mode to check the exterior lighting.*

#### Using the test mode:

First, test the functionality of the commands related to the exterior lighting:

- Activate the right directional signal and check that the corresponding telltale light illuminates.
- Activate the left directional signal and check that the corresponding telltale light illuminates.
- Press on the brake pedal and check that the STOP telltale light illuminates.

Once these commands tested, activate the test mode to check the exterior lighting by pulling up the multi-function lever 3 times within 3 seconds.

Go to the front of the vehicle and check the lights:

- First the left and right directional signals.
- Identification lights and clearance lights.
- Low beams.
- High beams.

Go to the left side of the vehicle:

- Directional signals.
- Marker lights.
- Directional signals.
- Marker lights.

Go to the rear of the vehicle:

- Directional signals.
- Identification lights and clearance lights.



- Stoplights and taillights.
- Back-up lights and back-up alarm (option).

**NOTE**

To check the back-up lights and back-up alarm, you must flip the starter selector switch to REAR START position. (If the vehicle is running, do this quick enough so that the engine does not stop).

Go to the right side of the vehicle (same sequence as left side).

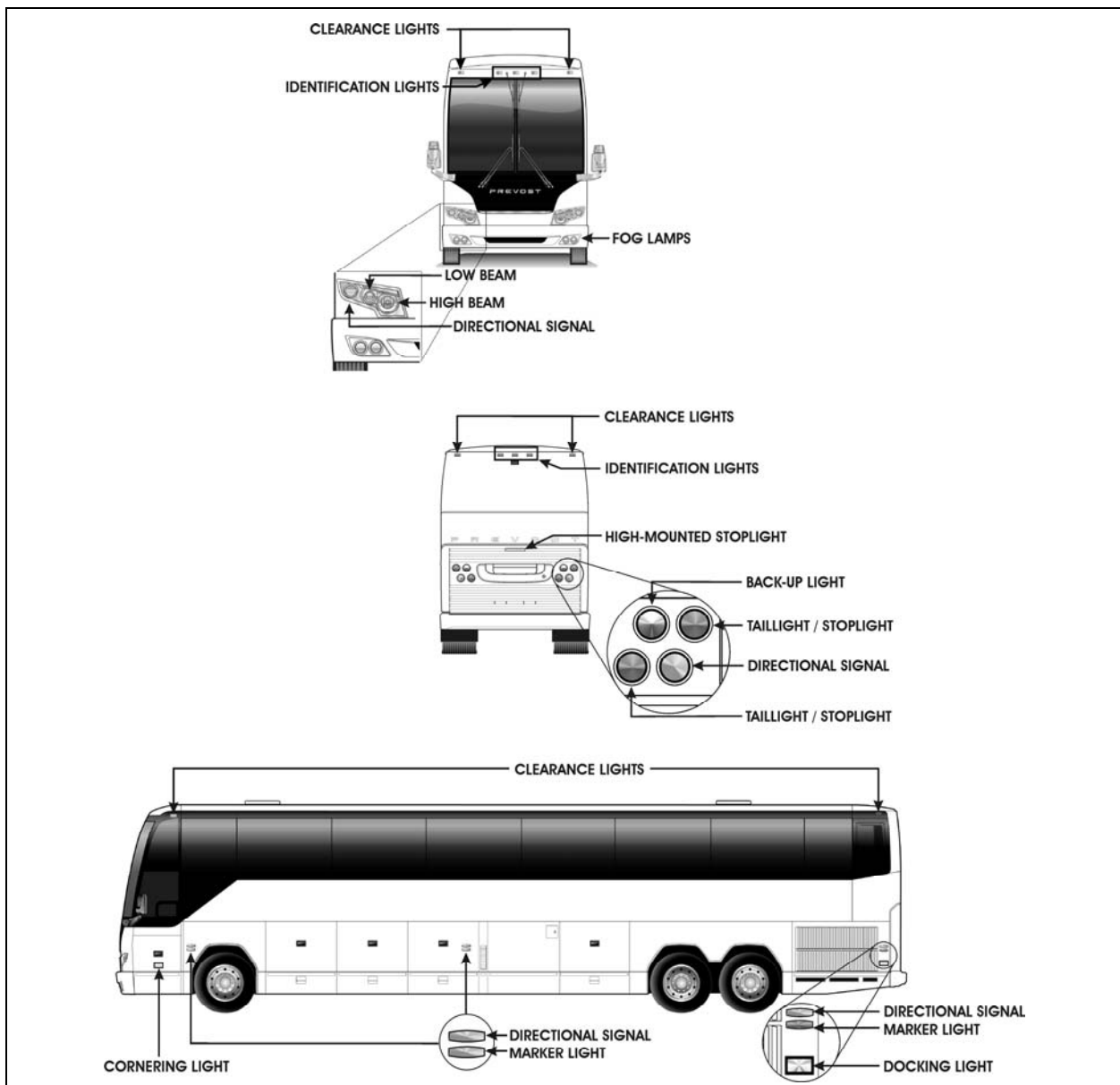


FIGURE 1: EXTERIOR LIGHTING IDENTIFICATION

### 3 WALK-AROUND INSPECTION (BEFORE EVERY TRIP)

It is good practice to make a visual inspection of key areas on the vehicle every day (or before every trip for private coaches) and to correct any problem found.

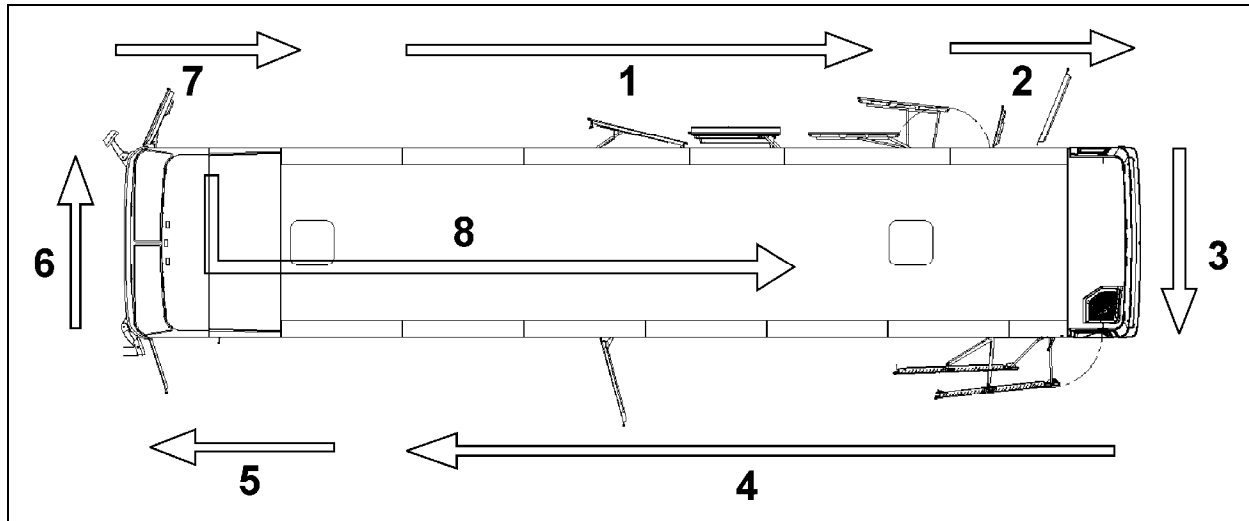


FIGURE 2: WALK-AROUND INSPECTION

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**NOTE**

*Inspect the coach in a circular manner as shown in the illustration.*

#### Approaching the Coach

- Check under the coach for oil, fuel or coolant leaks or other signs of damage.
- Check exterior body surfaces for signs of breaks or damage.

- Check condition of tires: properly inflated, no serious cuts, bulges, tread wear or any signs of misalignment; valve stems not touching wheels or rims; valve caps in place and no objects stuck between the wheels.

#### Preparation

- Start the engine and let the air pressure build up to normal. Stop engine.
- Switch on hazard warning flashers.
- Make sure parking brakes are applied.

#### Step 1: Right Side of the Coach

- Check that the vehicle is equipped with a wheel nut wrench, spare door keys, spare belts, reflectors and jack.
- Check that baggage doors and service compartment doors close properly. Check for good tightness and fit.
- Check condition of wheels and rims. Especially look for cracks, missing nuts, bent or broken studs.

#### Step 2: Engine Compartment Right Side Area

- Drain wet air tank by opening drain cock. Close drain cock when completed.
- Check engine and surrounding areas for coolant, oil and fuel leaks.
- Check primary fuel filter/water separator and drain if necessary. Close drain valve after draining.
- Check power steering reservoir fluid level, add if necessary.
- Check wiring harness for signs of damage.

#### Step 3: Engine Compartment

- Check engine and surrounding areas for coolant, oil and fuel leaks.

- Check wiring harness for signs of damage.
- Check for loose, worn or broken belts.
- Check belts tension adjustment.
- Check engine crankcase oil level, add if necessary.
- Check Allison transmission fluid level (can also be checked from push-button shift selector), add if necessary.
- Check coolant surge tank fluid level, add if necessary.
- Check air cleaner restriction indicator, replace air cleaner when red signal locks in full view.
- Check stop light, tail light, directional signal light and back-up light assembly, they should be clean.

#### **Step 4: Rear Left Side of the Coach**

- Check condition of wheels and rims. Especially look for cracks, missing nuts, bent or broken studs.
- Check that baggage doors and service compartment doors close properly. check for good tightness and fit.
- Check condition of tires: properly inflated, no serious cuts, bulges, tread wear or any signs of misalignment; valve stems not touching wheels or rims; valve caps in place and no objects stuck between the wheels.

#### **Step 5: Front Left Side of the Coach**

- Check condition of wheel rim. Especially look for cracks, missing nuts, bent or broken studs.
- Check condition of tire: properly inflated, no serious cuts, bulges, tread wear or any signs of misalignment; valve stem not touching wheel or rim; valve cap in place.
- Check windshield and headlights washer reservoir fluid level and add if necessary.
- Drain accessory air tank by opening drain cock. Close drain cock when completed.

#### **Step 6: Front of the Coach**

- Check for damage and clean if dirty.
- Check windshield wiper arms for proper spring tension.
- Check wiper blades for any damage, “dead” rubber and attachment to arm.
- Check clearance and identification lights, they should be clean.
- Check high and low beams, they should be clean. If equipped, check fog lights.
- Check left and right directional signals, they should be clean.

#### **Step 7: Front Right Side of the Coach**

- Check condition of wheel rim. Especially look for cracks, missing nuts, bent or broken studs.
- Check condition of tire: properly inflated, no serious cuts, bulges, tread wear or any signs of misalignment; valve stem not touching wheel or rim; valve cap in place.

#### **Step 8: Inside the Coach**

- Check for proper operation of the entrance door.
- Check steps; clean them if there is any substance that makes them slippery, which makes coach entry/exit hazardous.
- Adjust and clean mirrors for adequate rear view vision.
- Verify proper operation of windshield wiper/ washer.
- Check for fire extinguishers to make sure they are ready for operation.
- Check that emergency exit windows and roof escape hatches can be opened then close all windows and hatches securely

#### **With engine running**

- Start engine and check for proper operation of all gauges. Perform a telltale light test (see “CONTROLS AND INSTRUMENTS” chapter). Indicator lights

## SECTION 24: LUBRICATION

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and buzzers should all be OFF before driving.

- Using the message center display, perform a system diagnostic to check if error codes and anomalies were recorded in the vehicle electronic modules.
- Check for proper operation of electric and air horns and back-up alarm.
- Check automatic transmission oil level, using the pushbutton shift selector (see APPENDIX C).
- Check that there is enough fuel in the tank.
- Perform a parking brake test. Check both primary and secondary pressure gauges. Refer to “Other Verifications” in this chapter.
- Perform the exterior lighting verification using the test mode. Refer to “Other Verifications” in this chapter.
- Walk around the vehicle and listen for air leaks.
- Check for leaks and listen for unusual sounds coming from the turbocharger

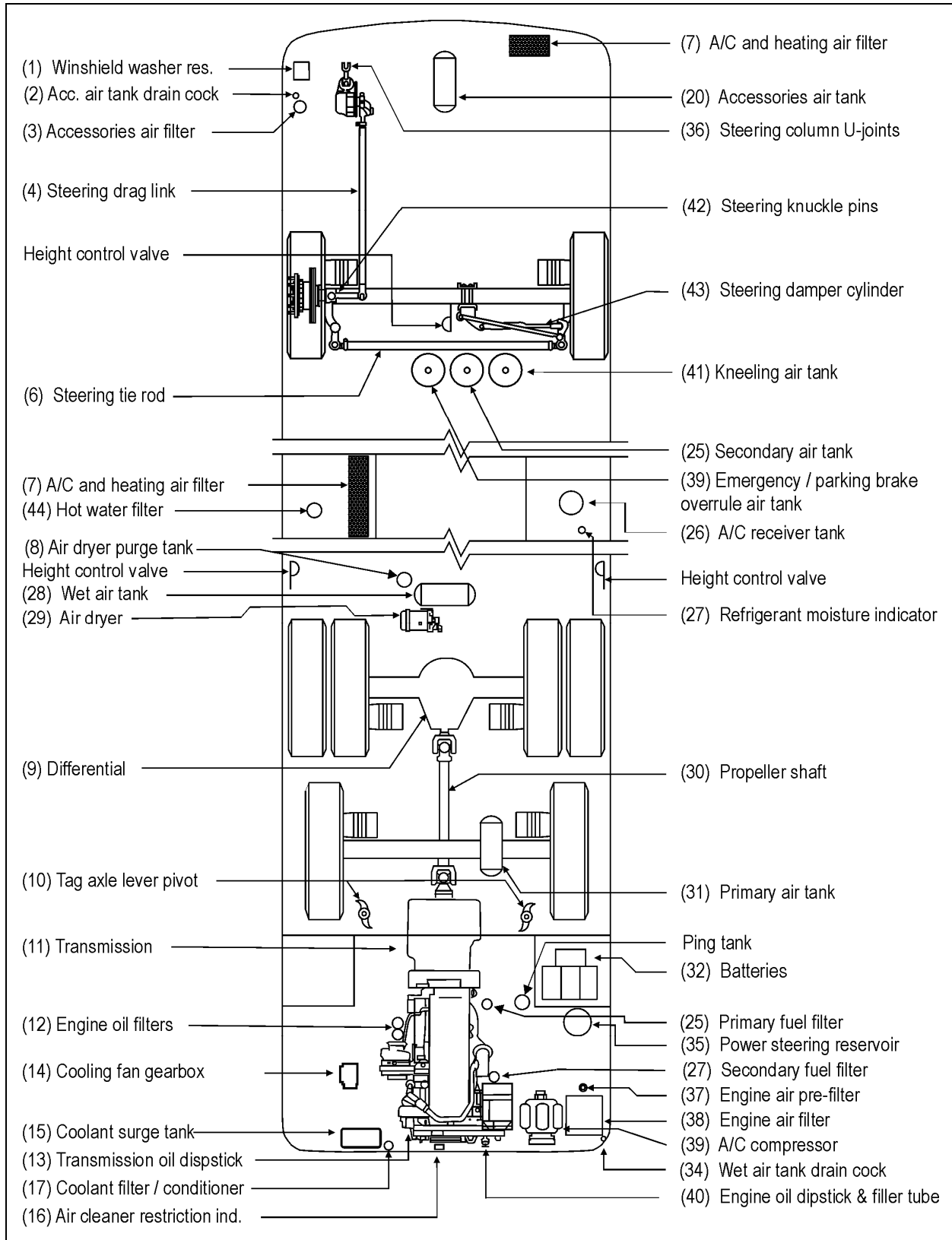
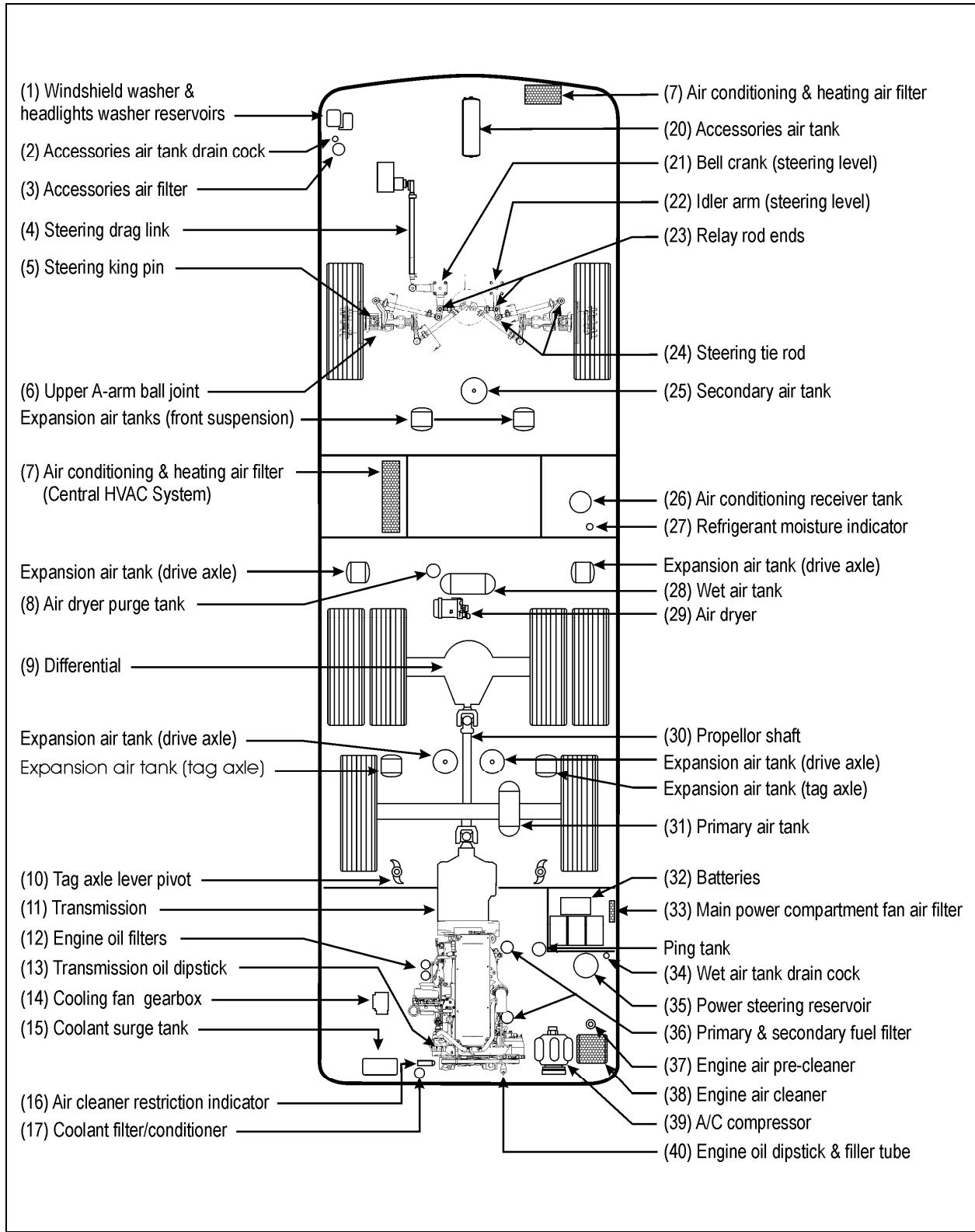


FIGURE 3: LUBRICATION AND SERVICING POINTS ON I-BEAM FRONT SUSPENSION VEHICLES (TYPICAL)

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**SECTION 24: LUBRICATION**



**FIGURE 4: LUBRICATION AND SERVICING POINTS ON INDEPENDENT FRONT SUSPENSION VEHICLES (TYPICAL)**

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## 4 FLUIDS AND LUBRICANTS SPECIFICATIONS

FLUIDS & LUBRICANTS		
REF	DESCRIPTION	SPECIFICATIONS
A	Engine Oil	DETROIT DIESEL SERIES 60 SAE Viscosity Grade: 15W-40 API Classification: CJ-4
		VOLVO D13 SAE Viscosity Grade: 15W-40 API Classification CJ-4 meeting Volvo specification VDS-4
B	Power Steering Oil	Automatic Transmission Oil, Dexron-III
C	Engine Coolant	DETROIT DIESEL SERIES 60 Low silicate, ethylene glycol coolant 50% antifreeze/water solution is normally used Antifreeze concentration should be between 30% and 67%
		VOLVO D13 Texaco or Chevron Extended Life Coolant (ELC) 50% antifreeze/water solution is normally used
D	A/C Compressor Oil	Central HVAC system: Polyolester oil, HFC 134a compatible; Castrol SW-68 (POE) or equivalent  Small HVAC system: PAG oil
E	Differential Oil	Multigrade gear oil meeting MIL-L-2105-D: 85W140. If temperature drops below 10°F (-12°C), 80W90 should be used. Below -15°F (-26°C), 75W90 should be used. (In extreme conditions or for better performance, full synthetic gear oil can be used)
F	Differential Oil (Full Synthetic)	Multigrade gear oil meeting MIL-L-2105-D: 85W140. If temperature drops below 10°F (-12°C), 80W90 should be used. Below -15°F (-26°C), 75W90 should be used.
G	Cooling Fan Gearbox Oil	Synthetic gear lubricant 75W-90
H	Allison Automatic Transmission Oil	Castrol TranSynd™ Synthetic Transmission Fluid for Allison or TES 295 approved equivalent
I	Allison Automatic Transmission Oil	Dexron-VI® or approved equivalent 1 Schedule 1 TES-389 fluids;
J	ZF-ASTronic Transmission Oil	Castrol Syntrans Grade SAE 75W-85 (Synthetic)
K	Multi Purpose Grease	Good quality lithium-base grease: NLGI No.2 Grade is suitable for most temperatures NLGI No.1 Grade is suitable for extremely low temperatures
L	Multi Purpose Grease	Molykote longterm 2/78 grease

**SECTION 24: LUBRICATION****5 PART NUMBER SPECIFICATIONS**

REF	DESCRIPTION	PREVOST NO
P1	Engine oil filters - DDC Series 60	#510458
P2	Engine oil filters - Volvo D13	#510938 (one by-pass) (Volvo #477556) #478736 (two full-flow)
P3	Power steering oil reservoir filter element	#660987
P4	Engine air filter	#530197
P5	Refrigerant filter dryer unit	#950332 Central A/C syst. #950370 Small A/C syst.
P6	Primary fuel filter/water separator - DDC Series 60	#032700 #541407
P7	Racor primary fuel filter and water separator (optional) - DDC Series 60	#531390
P8	Secondary fuel filter - DDC Series 60	#510794
P9	Primary fuel filter cartridge (used with water separation bowl) - Volvo D13	#20879806
P10	Secondary fuel filter - Volvo D13	#20405160
P11	Engine coolant precharge element filter - DDC Series 60	#550629
P12	Engine coolant maintenance element filter - DDC Series 60	#550630
P13	Engine coolant filter cartridge - Volvo D13	#20458771
P14	HVAC driver's air filter	#871147-871144
P15	HVAC cabin air filter	#871051 coaches #871383 VIP
P16	Allison transmission High Capacity fluid filter kit	#571709
P17	Hot water filter	#871029
P18	Accessories air filter element	#641340
P19	Air dryer cartridge	#3097369
P20	Fuel Pro 382 filter element	#510795
P21	Overhead compartment fan air filters	#871159
P22	Engine coolant	#685125
P23	Bosch T1 alternators, voltage regulator	#562981
P24	Bosch T1 alternators, brush set	#562983
P25	Bosch T1 alternators, ball bearing	#562972
P26	Bosch T1 alternators, roller bearing	#562976



**6 LUBRICATION AND SERVICING SCHEDULE**

For lubrication and servicing schedule, refer to table A.

***IMPORTANT NOTE***

*Refer to the manufacturers documentation included in this maintenance manual for specific manufacturer's maintenance requirements.*











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# 1 SLIDE-OUT

## 1.1 INNER STOPPER

The front slide-out is equipped with six inner stoppers laid out in the following way: two stoppers on the top horizontal member of the slide-out, and two stoppers on each vertical upright, while the rear slide-out is equipped with only three stoppers (FIGURE 1 and figure 2). The upper inner stoppers are used to provide a support to position the slide-out perpendicularly 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).

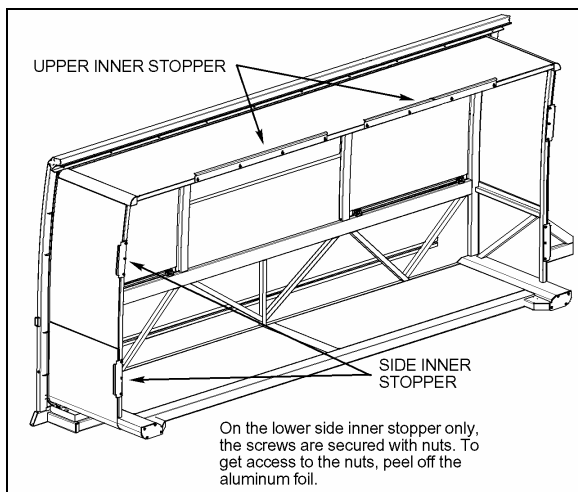


FIGURE 1 : FRONT SLIDE-OUT

### 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 inner stoppers according to FIGURE 4 with the seal deflated. When inflating, the seal presses the roof structure upward and at that moment, the upper inner

stopper comes into contact with the structure key.

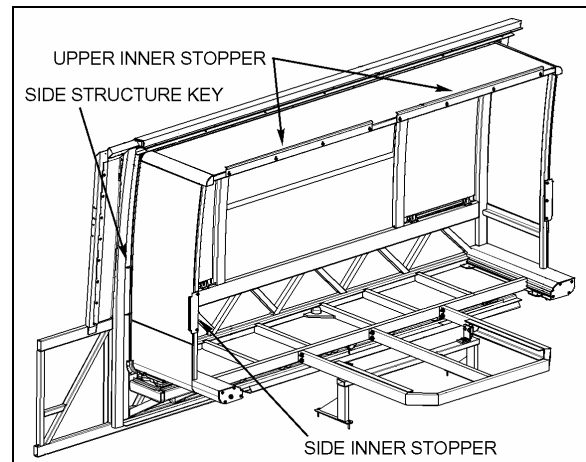


FIGURE 2 : REAR SLIDE-OUT

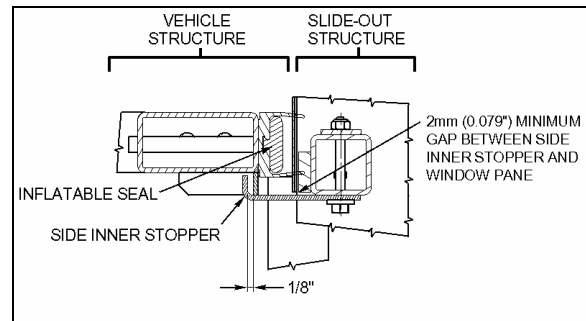


FIGURE 3 : SIDE INNER STOPPER ADJUSTMENT

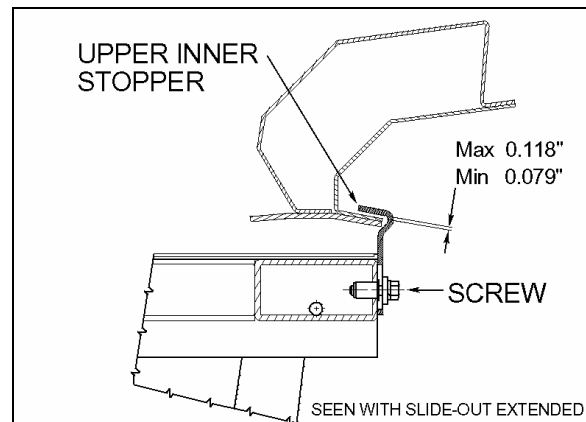


FIGURE 4: UPPER INNER STOPPERS ADJUSTMENT

## 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 its 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 (paragraph 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.

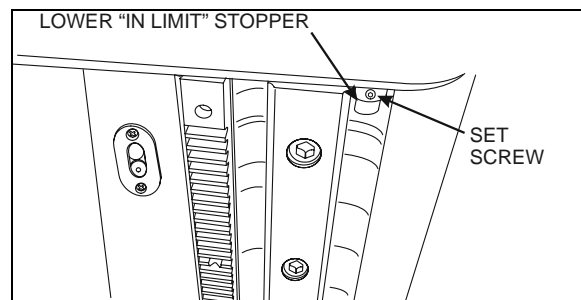


FIGURE 5: LOWER "IN LIMIT" STOPPER

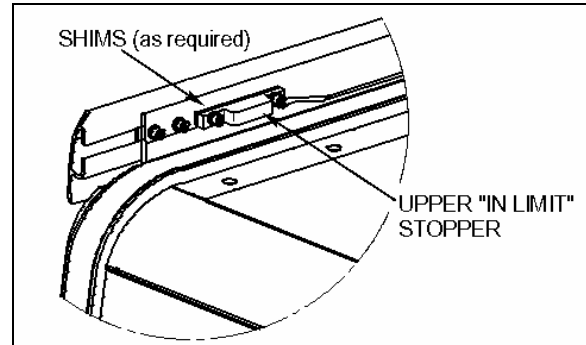


FIGURE 6: UPPER "IN LIMIT" STOPPER

**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.*

### 1.3 EXTERIOR EXTRUSION

The exterior extrusion assembly function is to provide a leaning surface for the inflatable seal. When inflating, the seal presses against the extrusion support (angle), lifting the roof structure upward until it rests on the inner side of the extrusion support.

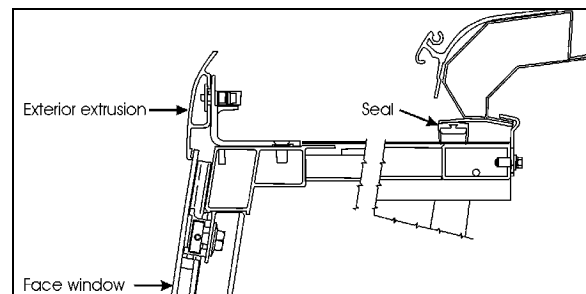


FIGURE 7 : EXTERIOR EXTRUSION

#### 1.3.1 Maintenance

Inspect the exterior extrusion & support 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.

#### 1.3.2 Removal

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.

## 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.

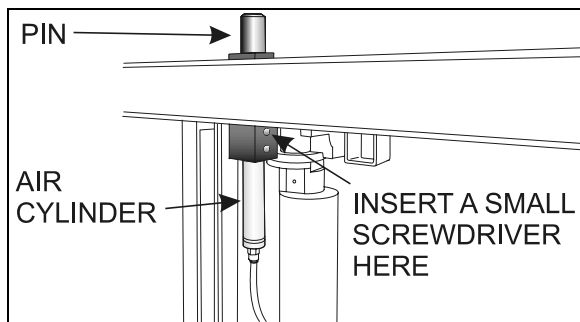


FIGURE 8: SECURITY PIN AIR CYLINDER REMOVAL

### 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 so, 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 module (FIGURE 30, item 11).

### 2.2 AIR CYLINDER REPLACEMENT

1. Assure the parking brake is applied.
2. Disconnect the cylinder air tubing from the 2<sup>nd</sup> 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 and then, unscrew the cylinder rod from the pin.
5. Transfer the fitting on the new cylinder. Place Teflon on threads.
6. Cylinder installation is the same as removal but in reverse order.

## 3 ROOF REINFORCING ROD

The roof reinforcing rod is located near the upper horizontal member of the front slide-out opening and is welded on the roof arches (figure 9).

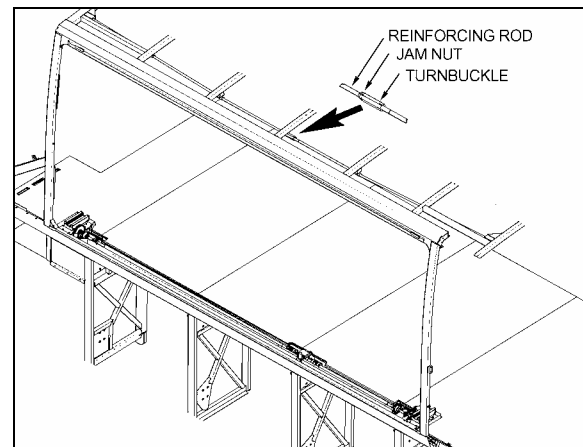


FIGURE 9 : FRONT SLIDE-OUT ROOF REINFORCING ROD

### ⚠ CAUTION ⚠

The maximum allowed upward shifting is 0.118" (3mm). To prevent permanent warping of the roof arches, never exceed that measurement.

The roof reinforcing rod may have already been adjusted up to the maximum shifting limit at the factory, do not attempt to move the roof any further. If an adjustment is required after a load variation inside the vehicle or on top of the vehicle, it must be done under supervision of a Prevest service representative.

## 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.

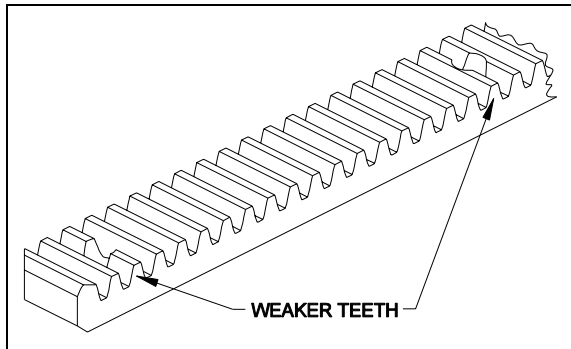


FIGURE 10 : RACK

### 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 2 screws located at each ends first and then the other screws to a maximum torque of 2 ft-lbs. Use Loctite™ 242 or equivalent product on threads. The clearance between rack and rail can be verified with jig #30710.



**CAUTION**

**The counterborings required for recessed screw heads reduce plastic thickness. Do not torque higher than specified.**

4. Reinstall the front slide-out inside the vehicle.

### 4.3 REAR SLIDE-OUT RACK REPLACEMENT

1. Using the slide-out handheld control or the manual override procedure (paragraph 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 (paragraph 18) only, retract the slide-out to its fully closed position.
4. Loosen the pinion keyless bushing of the rack to be changed.
5. From under the slide-out, unscrew all the rack screws and remove the rack.
6. Install a new rack between the slide out structural rack seat and the pinion. Tighten the screws to a maximum torque of 2 ft-lbs. Use Loctite™ 242 or equivalent product.





**CAUTION**

**The counterborings required for recessed screw heads reduce plastic thickness. Do not torque higher than specified.**

7. Tighten the pinion keyless bushing as described in paragraph 5.4.
8. Using the slide-out manual override procedure only, extend the slide-out about one foot.
9. Tighten the two remaining crews to a maximum torque of 2 ft-lbs. Use Loctite™ 242 or equivalent product.
10. Using the slide-out handheld control switch or the manual override procedure, retract the slide-out to its fully closed position.
11. Re-inflate the air seal at 10 psi.

## 5 PINION

 <b>CAUTION</b> 
<p>Make sure all keyless bushings are tightened to 125 lb-ft before moving the slide-out. Refer to paragraph 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.</p>

### 5.1 PINION AND KEYLESS BUSHING POSITIONING

For proper functioning, respect the positioning shown on the following figure.

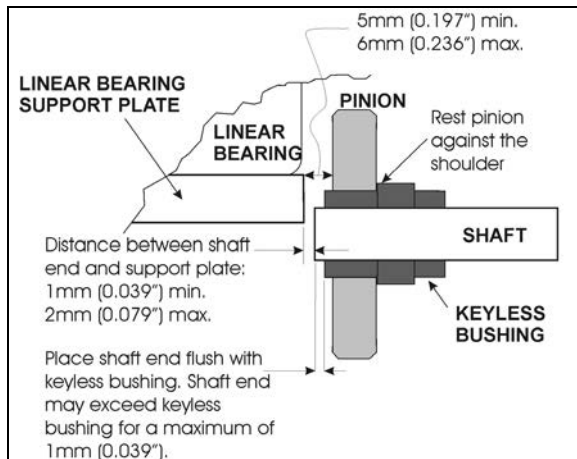


FIGURE 11: PINION AND KEYLESS BUSHING POSITIONING

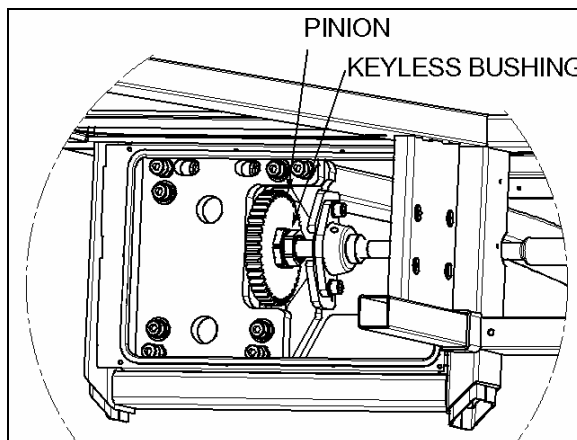




FIGURE 12: PINION AND KEYLESS BUSHING (BOTTOM VIEW)

### 5.2 FRONT SLIDE-OUT SHAFT PINION REPLACEMENT

 <b>CAUTION</b> 
<p>Before reinstalling the pinion, clean the following surfaces with alcohol to prevent slippage.</p> <ul style="list-style-type: none"> <li>○ Pinion bore;</li> <li>○ Keyless bushing I.D. and O.D.;</li> <li>○ Shaft.</li> </ul>

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 paragraph 7.2);

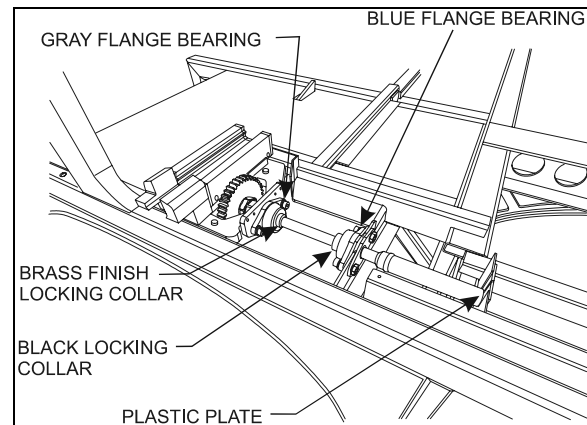


FIGURE 13: MECHANICAL COMPONENTS (TYPICAL)

1. Loosen the keyless bushing (see paragraph 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.

<p><b>NOTE</b></p> <p><i>If necessary, loosen the blue and gray flange bearing to move the pinion away from the rack.</i></p>
---

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 paragraph 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 paragraph 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 paragraph 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 1/2";
- torque wrench;
- combination wrench 1 3/4";
- pipe wrench;
- drive extension 5";
- socket 1 1/2".

#### 5.4.1 Installation

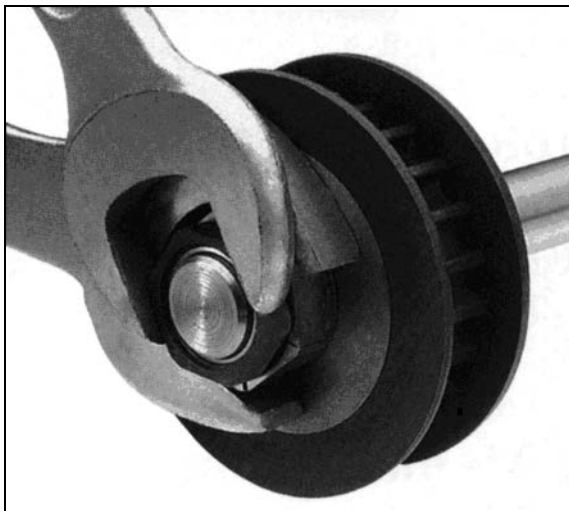


FIGURE 14 : KEYLESS BUSHING TIGHTENING

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.

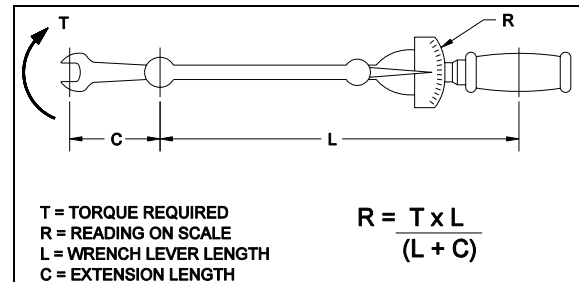


FIGURE 15 : TORQUE WRENCH FORMULA

**⚠ 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**

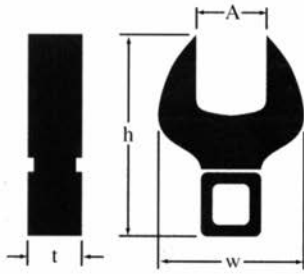
*On the front slide-out, the driver side keyless bushing is not accessible for tightening or removal unless you remove the front left wheel. If the slide-out has been removed, this keyless bushing should be tightened before reinstalling the slide-out.*



**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**



**Style C  
Installation Nut**

Shaft Size	Part Number	Wrench Style	Dimensions (inches)			
			A	h	w	t
13/16 to 1	6202990024	C	1-1/2	3.44	2.75	0.75

## INSTALLATION INSTRUCTIONS

A Trantorque GT Keyless Bushing offers flexible and easy installation while providing exceptional holding power. To ensure a Trantorque GT unit performs as specified, it must be installed properly.

**Warning: Use no lubricants in this installation.**

1. Shaft and component bore must be within  $\pm 0.003"$  ( $\pm 0.08\text{mm}$ ) [ $\pm 0.0015"$  ( $\pm 0.04\text{mm}$ ) 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.**

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  $\pm 0.075"$  ( $\pm 1.9\text{mm}$ ) [ $\pm 0.045"$  ( $\pm 1.1\text{mm}$ ) 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.**

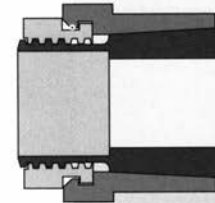


Figure 1

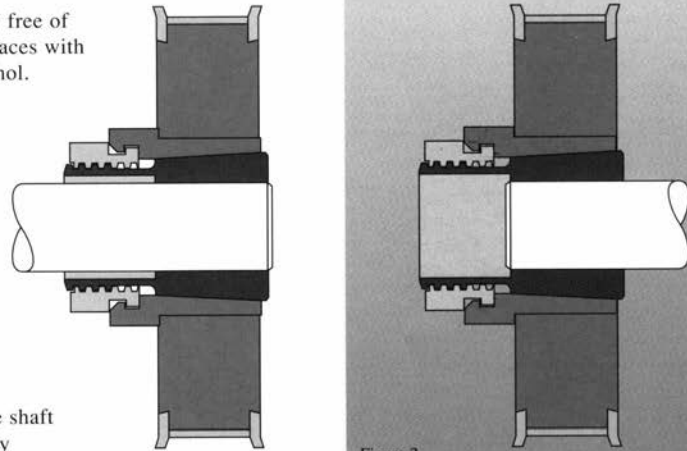


Figure 2

### Installation Torque on Nut

	Inch Pound System		Metric System	
	Shaft Size	In. Lbs.	Shaft size	N-m
<b>MINI SERIES</b>	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
<b>STANDARD SERIES</b>	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
<b>LARGE SERIES</b>	1-13/16-2	4900	45-50mm	554
	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 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 paragraph 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 for 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.

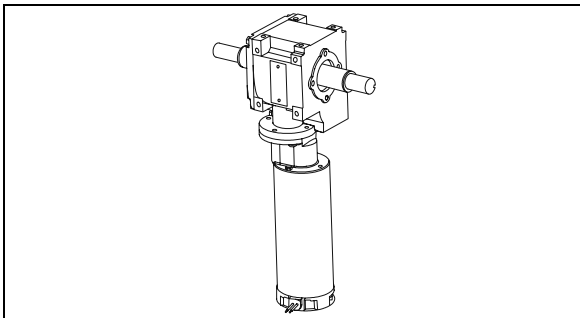


FIGURE 17: ELECTRIC MOTOR AND SPEED REDUCTION GEARBOX

3. Remove the motor from the gearbox.
4. Fasten the new motor to the gearbox using screws.
5. 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 for 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 paragraph 8: JAW COUPLING).
3. Remove the 4 cap screws securing the 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  $18 \pm 2$  lbf-ft in a criss-cross pattern.

### ⚠ CAUTION ⚠

**To prevent damaging threads, use your fingers to drive the bolts into the aluminum gearbox housing mounting holes.**

6. Reinstall the jaw couplings.

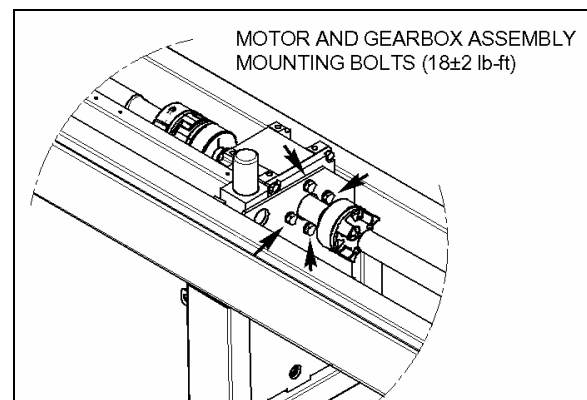


FIGURE 18: MOTOR/GEARBOX ASSEMBLY MOUNTING BOLTS

## 8 JAW COUPLING

### 8.1 MAINTENANCE

Inspect the jaw couplings for 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 (paragraph 18) to get to the clamping screws.
3. Separate both clamping hubs.

<b>NOTE</b>
<i>It may be necessary to loosen the blue flange bearings to move the shaft out of the way.</i>

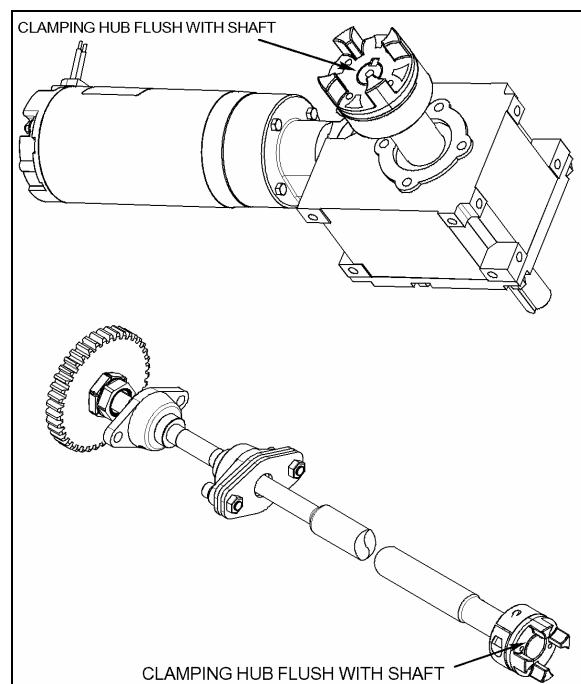


FIGURE 19: CLAMPING HUB POSITION ON SHAFTS

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 (see 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).
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 output shaft to align the keyways.
9. Tighten clamping screws to a torque of 18 lbf-ft dry.

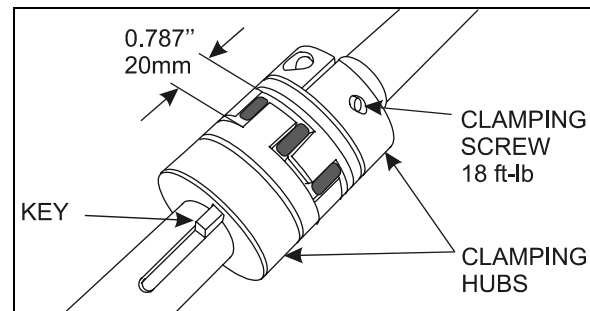


FIGURE 20: JAW COUPLING

## 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/Installation Procedure. Ask to your Prevost service representative).
2. Disconnect the jaw coupling on the side of the linear bearing being replaced (refer to paragraph 8).
3. Dismount the blue flange bearing.
4. From the mechanism access panel, remove the retaining screws A, B, C & D (see FIGURE 23).
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 dry.
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 23). When

proper level is attained, the retaining screws A, B, C & D maintain the support plate seated on the leveling screws. Also, the retaining screws prevent the slide-out from tipping inside the vehicle when it is retracted.

The slide-out is slightly tilted. When retracting, the upper "in limit" stoppers touch first the vehicle structure, followed by the lower "in limit" stoppers. Tilt adjustment is done by changing the linear bearing support plate inclination using the leveling screws 1 & 2 as pivot and 3 to adjust the angle (figure 23).

#### 11.3.1 Procedure

##### *NOTE*

For the **front slide-out**, the front linear bearing leveling screws are accessible from the access located over the front wheel (remove the front fender first) while the rear linear bearing leveling screws are accessible from the access panel in the evaporator compartment. For the **rear slide-out**, gain access to 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.**

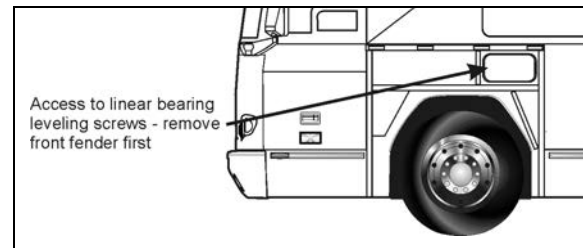


FIGURE 21: ACCESS LINEAR BEARING LEVELING SCREWS

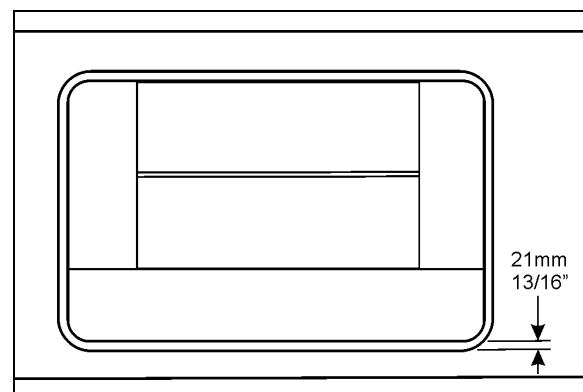


FIGURE 22: SLIDE-OUT LEVEL ADJUSTMENT

## Section 26: VIP SLIDE-OUT

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 paragraph 1.2).
1. Loosen the blue flange bearings mounting screws (FIGURE 13).
  2. For front slide-out only, loosen the two plastic plates mounting screws along the shafts (FIGURE 13).
  3. With the lower edge of the slide-out outer panel flush with the vehicle body, adjust the slide-out level. The distance between the top of the horizontal member under the slide-out and the slide-out under panel must be 21mm (13/16” approximately).



**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 24).
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±5 ft-lb dry.
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”).

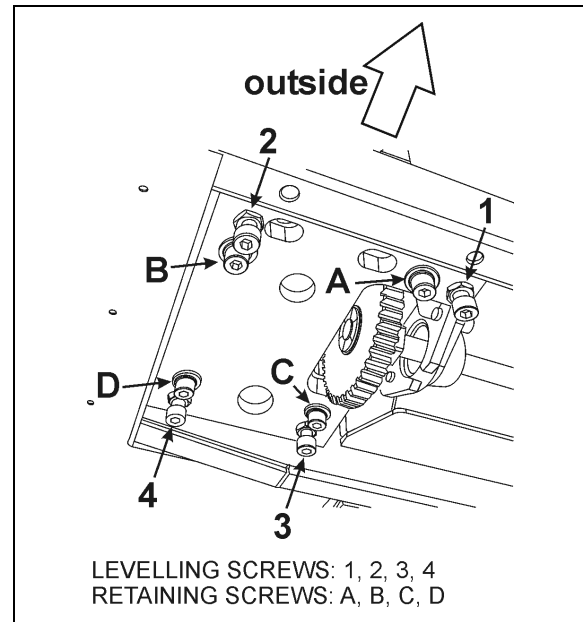


FIGURE 23 : SLIDE-OUT LEVELING

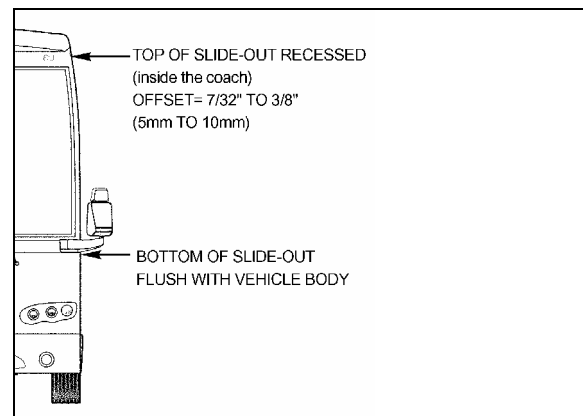


FIGURE 24: TILT ADJUSTMENT

## 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 film treatment is performed to the rail. Do not strike the rail with metal tools and avoid cleaning the rail surface with solvent, 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 rubber mallet. 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/Installation 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 25).

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 as per FIGURE 25. For each rail, make sure the gap is the same both side of the rail.

### NOTE

Jig #30534 (2 required) can be used to properly position the rail.

9. Tighten bolts according to the following order: 1<sup>st</sup>, 6<sup>th</sup>, 2<sup>nd</sup>, 5<sup>th</sup>, 3<sup>rd</sup> and 4<sup>th</sup>. Use blue Loctite™ on threads.

10. Cap the bolt holes.

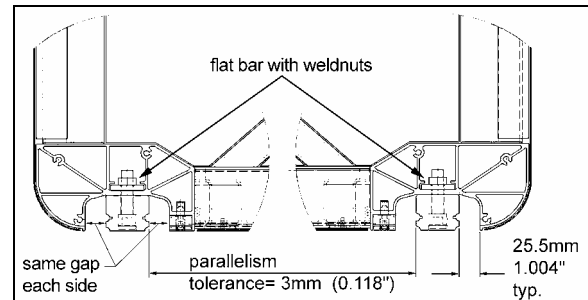


FIGURE 25 : RAIL POSITIONING

## 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.

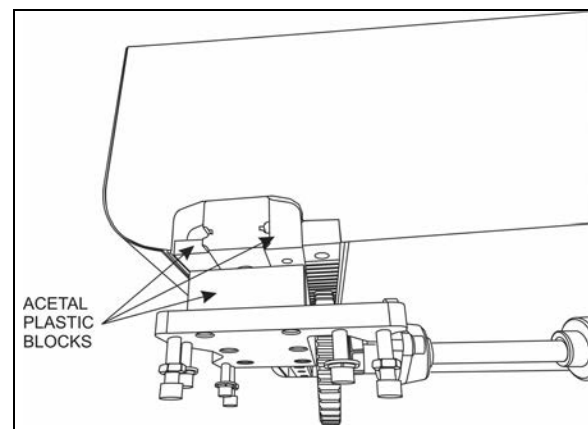


FIGURE 26: ACETAL PLASTIC BLOCKS

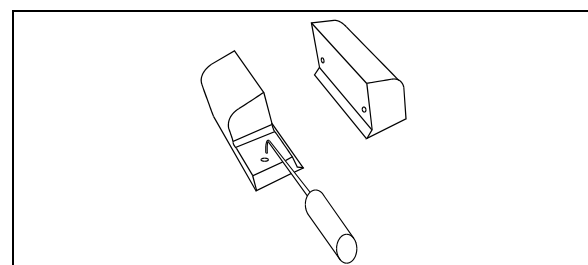


FIGURE 27: REMOVE THE UPPER ACETAL PLASTIC BLOCKS WITH A PICKING TOOL

### 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 23).
3. Extend the slide-out just enough to gain access to the about acetal plastic blocks.
4. Remove the 2 upper acetal plastic blocks. They have holes so they can be removed with a picking tool (FIGURE 27) 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.
5. 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.
6. Installation is the same as removal but in reverse order. When reinstalling the upper acetal plastic blocks, fold the wiper seal toward the outside with a flat tool to ease installation (FIGURE 28). Before tightening, make sure the acetal plastic blocks are leaning against the rail and the linear bearing. Tighten the mounting screws to a torque of 7 ft-lb.

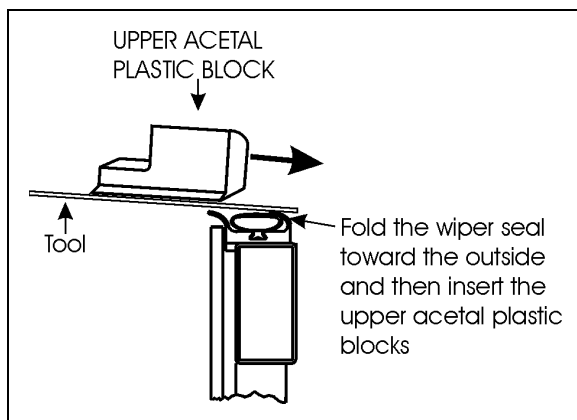


FIGURE 28: LOWER ACETAL PLASTIC BLOCK INSERTION

## 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 certain slide-out components and safety operations.

### 14.1 DESCRIPTION

#### AIR PRESSURE DELIVERY VALVE

The slide-out air pressure comes from the air pressure delivery valve on the pneumatic panel in the front service compartment (figure 29).

#### INFLATABLE SEAL VALVE

The inflation and the deflation of a seal are done with a 5-port 2-position valve with two solenoids. One solenoid is used for inflating of the seal and the other for deflating of the seal. When one solenoid is activated (seal deflating valve for example), the valve keeps 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 supplies the slide-out is not empty.

#### VACUUM GENERATOR

A vacuum generator using Venturi principle is controlled by a 5-port 2-position 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 a 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.*



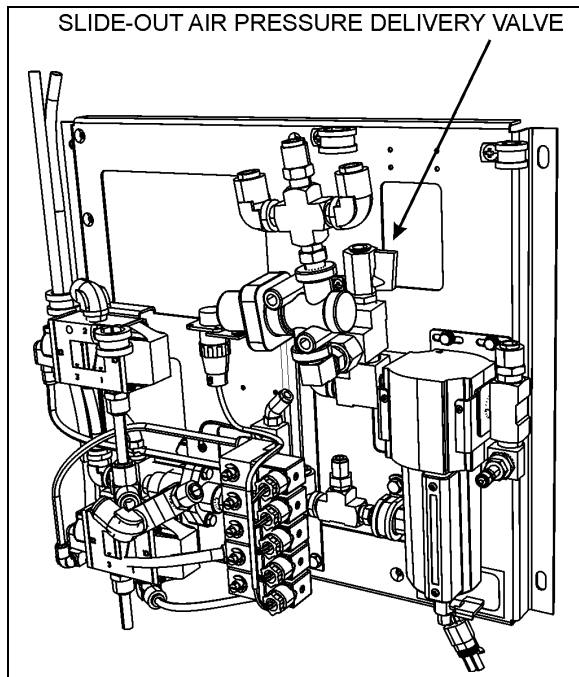


FIGURE 29 : FRONT SERVICE COMPARTMENT 12220

## 14.2 MAINTENANCE

### COMPRESSED AIR LINE

Inspect all compressed air line tubing for cut, swelling, and 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 required maintenance is described in Section 12 of this 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.

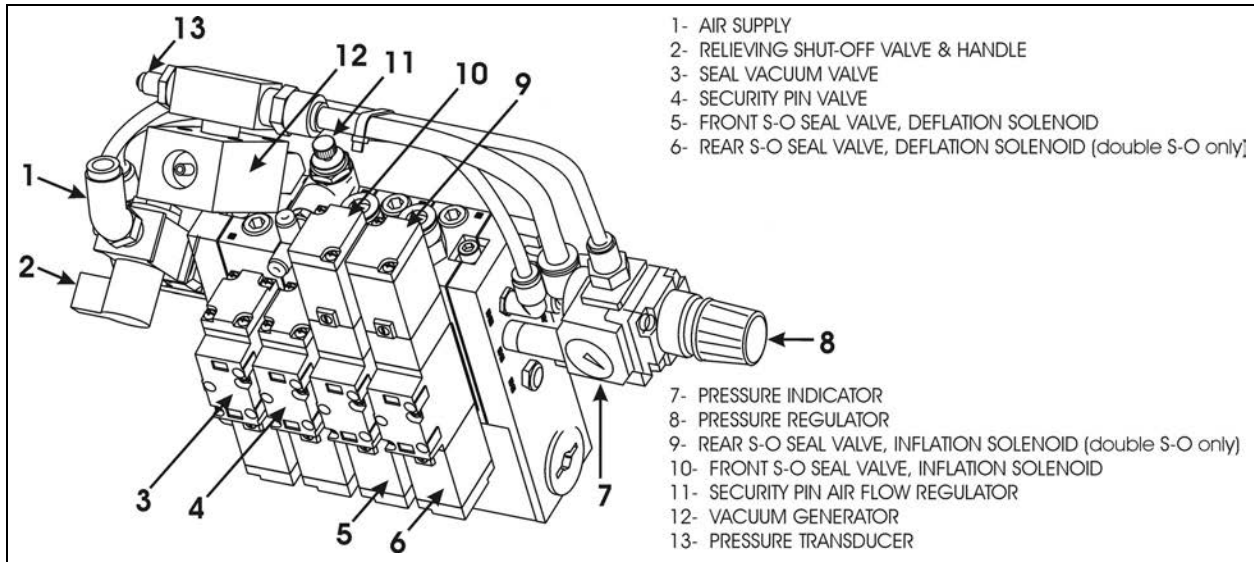


FIGURE 30: PNEUMATIC CONTROL UNIT

### 14.3 SEAL

**NOTE**

Refer to the Prevest parts manual for description of sealant and adhesives used.

The slide-out sealing device is used to prevent any type of infiltration that may occur between the body structure 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.

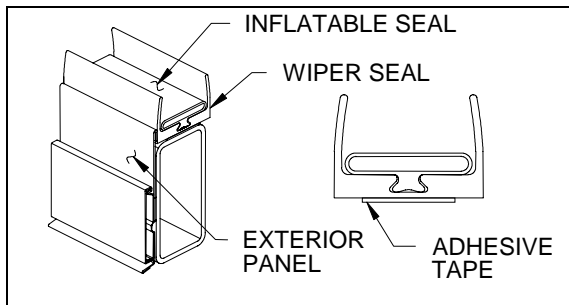


FIGURE 31 : SEAL ASSEMBLY

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 inflate the seal.

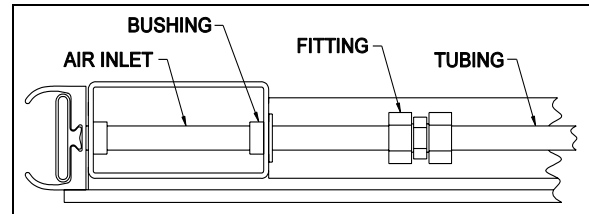


FIGURE 32: REAR SLIDE-OUT INFLATABLE SEAL AIR INLET

**CAUTION**

Make sure the inflatable seal is deflated when moving the slide-out manually during service maintenance. Deflate both inflatable seals completely by turning the relief shut-off valve handle clockwise (see FIGURE 30, item 2).

**CAUTION**

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

**⚠ WARNING ⚠**

**Always wear the appropriate safety equipment. Maintain adequate ventilation at all time.**

1. Retract the slide-out 2" inside the vehicle (paragraph 14.3.4).
2. Unplug the tubing from the inflatable seal air inlet (FIGURE 32). Keep the bushing.
3. Unstick and remove the wiper seal from the structure.
4. Scrape remaining tape from the structure and remove old sealant if applicable.

### 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**

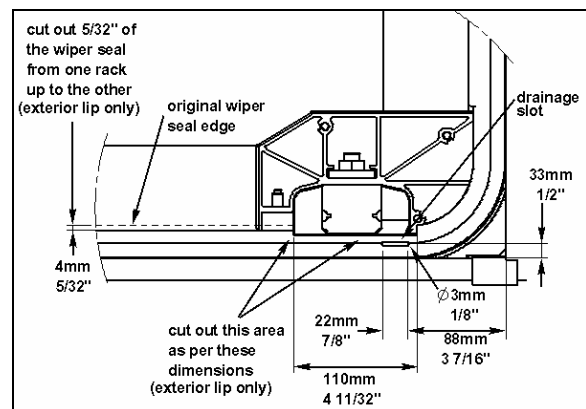
*Refer to procedure PR00001 in Section 18: BODY for primer, cleaner, adhesive specifications & application.*

**NOTE**

*Refer to the product specification for drying time.*

1. Retract the slide-out 2" inside the vehicle (paragraph 14.3.4).
2. Clean the area where the inflatable seal will be placed with anti-silicone. Make sure that the surface is perfectly smooth.
3. Rub the area a Scotch Brite (or equivalent product) (see PR00001paragraphe G).

4. Clean the area with anti-silicone once again.
5. Apply Sika 206 G+P on the area (see PR000001paragraphe D).
6. Insert inflatable seal air inlet tube through the hole on the frame vertical member.
7. Remove the inflatable seal adhesive tape protection in the lower corners area.
8. Press the lower corners on the frame and hold them in place for 90 to 120 seconds. Place the seal as close as possible from the exterior side of the frame.
9. Remove the inflatable seal adhesive tape protection on the rest of the lower frame area.
10. Press the seal on the frame and hold it in place for 90 to 120 seconds. Align the wiper seal drainage holes with the drainage holes on the frame. Place the seal as close as possible from the exterior side of the frame.
11. Remove the inflatable seal adhesive tape protection in the upper corners area and press the upper corners on the frame and hold them in place for 90 to 120 seconds. Place the seal as close as possible from the exterior side of the frame.
12. Install the rest of the straight upper area in the same way. Place the seal as close as possible from the exterior side of the frame.
13. Install the remaining straight inflatable seal sections on the frame. Place the seal as close as possible from the exterior side of the frame. Press for at least 15 seconds. Use a small roller to ensure a good adhesive contact on the structure.



**FIGURE 33: WIPER SEAL CUT-OUT**

14. Cut out the exterior lip of the wiper seal as per FIGURE 33.

15. Replace the bushing and plug the pneumatic tubing on the inflatable seal air inlet (FIGURE 32).

#### 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 27 (refer to paragraph 13).
2. Extend the slide-out a few inches so the exterior extrusion assembly screws located on the top of the slide-out are accessible from outside (figure 7).
3. Using a knife, cut the sealant between the extrusion's support and the roof (figure 7).
4. Unscrew and remove the exterior extrusion and support.
5. Using the handheld control, retract the slide-out up to its normal "IN" position.
6. Manually deflate the seal completely by turning the relieving shut-off valve clockwise (FIGURE 30). Make sure the pressure indicator reading is "0 psi".
7. Set the ignition to the off position.
8. Using the manual override procedure (paragraph 18), move the slide-out 2" inside the vehicle, so the seal is accessible from outside (FIGURE 34).

**⚠ CAUTION ⚠**

**Do not use the slide-out handheld control to move the slide-out 2" inside the vehicle, because the stroke limits are not recognized over the closed position. The slide-out would not stop and damage may occur.**

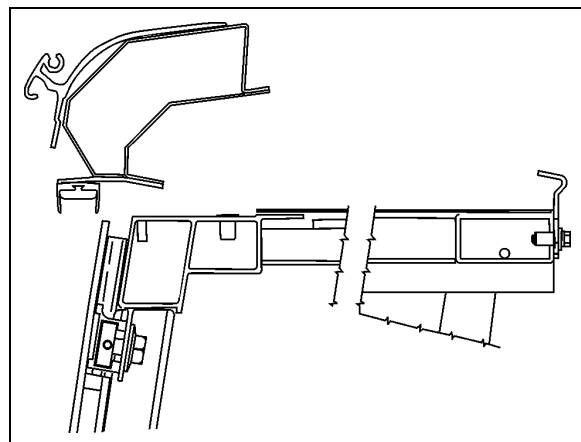


FIGURE 34: SLIDE-OUT 2" INSIDE – UPPER PART

9. 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.
10. Reinstall the acetal plastics blocks.
11. 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

**⚠ WARNING ⚠**

**Never modify the slide-out electrical wiring without the Prevest Car approval. Any modifications may cause an unexpected slide-out action and could result in personal injuries.**

Multiplexed slide-out electrical system is mainly composed of the current vehicle's Master ID module, CECM module and VEC module plus slide-out dedicated 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 related to slide-outs are:

- Dashboard telltale light;
- Transmission inhibit;

**⚠ WARNING ⚠**

**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 and 12-volts circuit breakers (FIGURE 36) in the main power 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 35) 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.

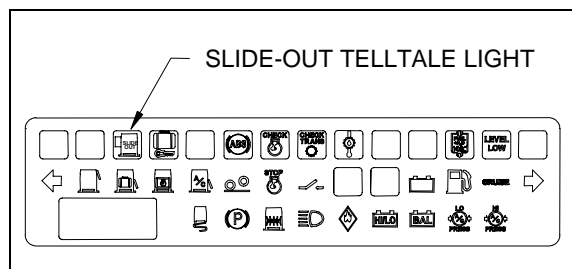


FIGURE 35 : DASHBOARD SLIDE-OUT TELLTALE LIGHT

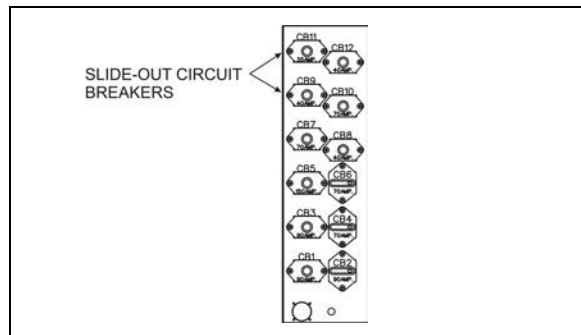


FIGURE 36: MAIN BREAKER IN MAIN POWER COMPARTMENT 26091

### 15.2 SLIDE-OUT BREAKERS

The 24-volts and 12-volts breakers are located in the main power compartment. Other electrical components are found on the slide-out control panel located in the first baggage compartment on the driver's side (figure 37).

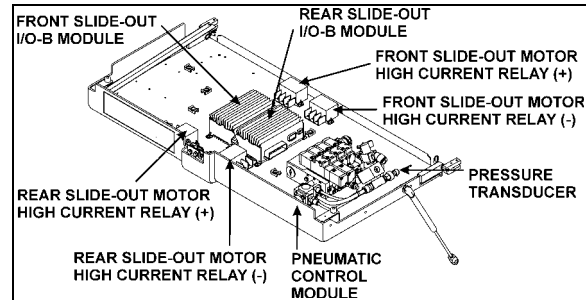


FIGURE 37 : SLIDE-OUT CONTROL PANEL

### 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 an intermediate voltage (ex. 12V, 4V, or 8V) this must be interpreted as if the input or the output is inactive.*

**⚠ CAUTION ⚠**

**Never put grease, Cortec VCI-238 or other product on the multiplex modules connector terminals.**

### 15.4 MODULE REPLACEMENT

I/O-B multiplex modules can be replaced and reprogrammed as described in Section 6: Electrical of this manual.

### 15.5 SLIDE-OUT LIMIT SENSORS

Two Hall-effect sensors are used on each slide-out to define stroke 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 3<sup>rd</sup> 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 paragraph 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.

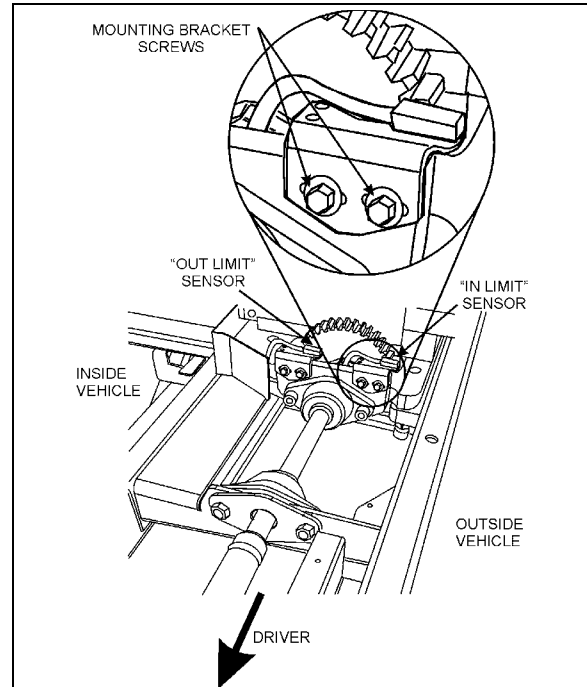


FIGURE 38: FRONT SLIDE-OUT SENSORS

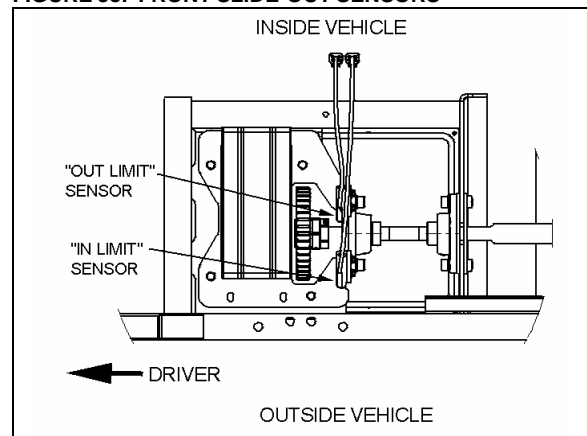


FIGURE 39: REAR SLIDE-OUT SENSORS

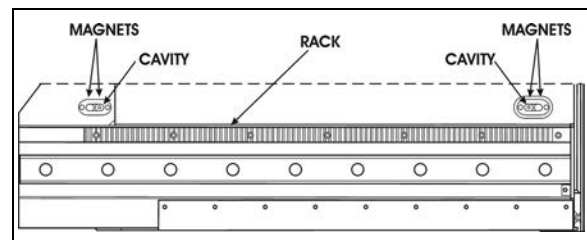


FIGURE 40 : MAGNETS ON SLIDE-OUT UNDERBODY  
26097

#### To adjust the "out limit" sensors:

Prior to adjust the "out limit" sensors, assure that the inner stoppers are perfectly adjusted (see paragraph 1.1).

1. The slide-out is slightly tilted except when it is in its full "IN" or "OUT" position. Extend the slide-out near its full "OUT" position.

When the slide-out straitens up and that it is perpendicular with the vehicle body, stop the slide-out.

2. Loosen the “out limit” sensor mounting bracket screws and move back the sensor completely (toward the inside of the vehicle).
3. Bring slowly the sensor toward the outside of the vehicle until the light emitting diode (LED) turns on. When it does, tighten the mounting bracket screws.

**NOTE**

*When the “out limit” sensors are properly adjusted, the slide-out extension stops before the side inner stoppers reach the vehicle structure.*

## 16 SLIDE-OUT EXTERIOR FINISHING PANELS & WINDOWS

**NOTE**

*The removal and installation procedures are all based on standard service methods described in section 18: BODY. Refer to this manual for procedures, tools, cleaner, adhesives and other product needed.*

### 16.1 FACE PANEL REMOVAL

Use the same procedure as described in section 18: BODY for side panel removal, and:

- Keep the slide-out retracted;
- 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 thickness. Use tape with same width and thickness when installing new panels.

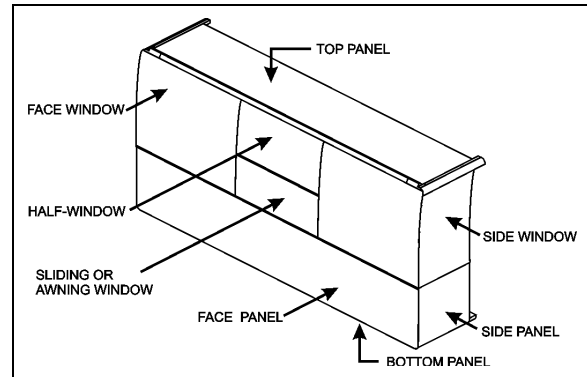


FIGURE 41 : SLIDE-OUT PANELS AND WINDOWS

### 16.2 FACE PANEL INSTALLATION

For surface cleaning, and preparation, panel installation and products needed, use the same procedure as the H3 or VIP “side panel installation” procedure 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 panel and bottom panel.

### 16.3 SIDE PANEL REMOVAL

**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. Drill through the rivets located at the bottom of the panel. Be careful not to let aluminum or stainless steel filings enter the corner extrusion. If necessary, remove the corner extrusion end cap to remove trapped filings.
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.

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6. Check the tape width and thickness. Use tape with same width and thickness 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.

**Warning:** Because of the adhesive toxicity, never use a buffer or other sanding method to remove it.

### 16.4 SIDE PANEL INSTALLATION

#### NOTE

The side panels are made of aluminum or 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 "side panel installation" procedure described in section 18: BODY.

1. Protect adjacent surfaces with appropriate material;
2. Refer to figure 42 for 1/4X1 (#5060038) and 3/16X1 (#506207) double face adhesive tape location on diagonal member of front slide-out only. Do not remove the tape blue protective layer;

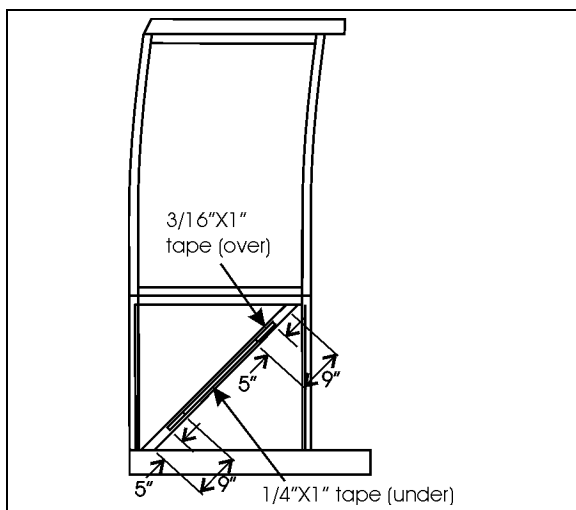


FIGURE 42 : SIDE PANEL INSTALLATION – DOUBLE FACE ADHESIVE TAPE APPLICATION ON THE SLIDE-OUT STRUCTURE (FRONT SLIDE-OUT ONLY)

#### NOTE

Do not remove the tape blue protective layer. The purpose of the tape is to maintain a certain gap and not to hold the panel in place.

3. Refer to figure 43 for 1/16x1/4 double face adhesive tape location on structure Do not remove the tape blue protective layer [7mm≈9/32"] [5mm≈6/32"];
4. Inspect the Sika bead at the intersection of the corner vertical member and the flat bar as shown in FIGURE 44. if it is damaged, remove adhesive residue and apply a new 3mm diameter bead of Sika 221;
5. Inspect the Sika bead shown in FIGURE 45. If it is damaged, remove adhesive residue and apply a new 5mm diameter bead of Sika 221 or 252;
6. Clean panel with anti-silicone. Sand surface using a Scotchbrite. Clean sanded surface with anti-silicone;
7. Apply Sika 206 G+P on side panel as shown in figure 46;
8. Apply a 5mm diameter bead of Sika 221 or 252 on side panel as shown on FIGURE 47;



Apply Sika Tack+Booster (triangular bead: 9mm width X 6mm high [11/32"x1/4"]) as shown in Figure 48 and glue panel in place as shown in FIGURE 49. Do not remove the tape blue protective layer;

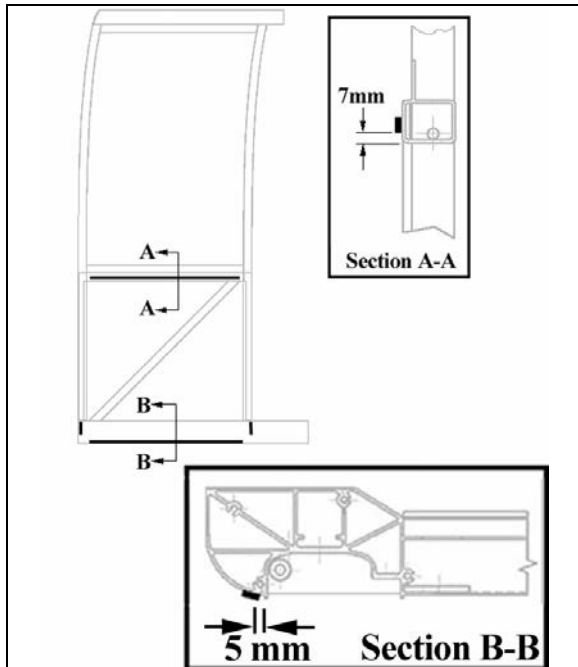


FIGURE 43 : SIDE PANEL INSTALLATION – DOUBLE FACE ADHESIVE TAPE APPLICATION ON THE SLIDE-OUT STRUCTURE

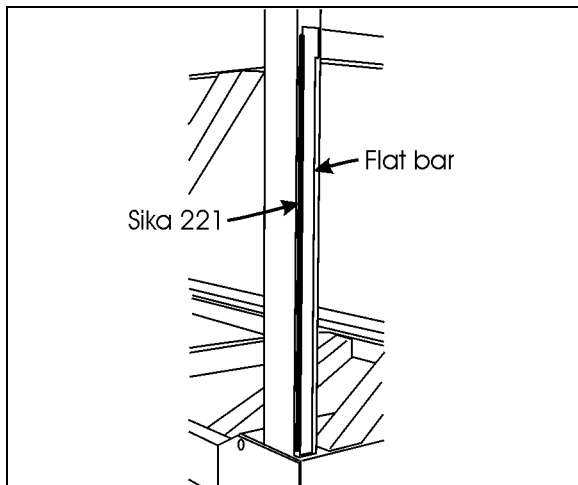


FIGURE 44 : SIDE PANEL INSTALLATION – SIKA 221 APPLICATION ON STRUCTURE

9. Exert pressure and let dry for at least 90 minutes;
10. Smooth down the joint and remove glue in excess;
11. Install rivets as per instruction sheet IS-06028 (ask to your Prevost service representative);

12. After drying, apply Sika 252 as a finishing joint. Refer to paragraph 16.12 for the finishing joint application procedure;

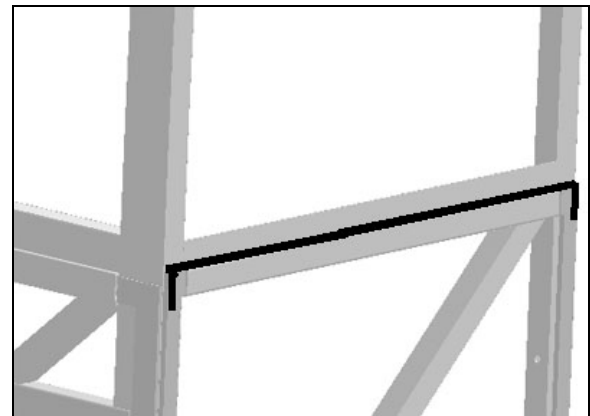


FIGURE 45 : SIDE PANEL INSTALLATION – SIKA 221 OR 252 APPLICATION ON STRUCTURE

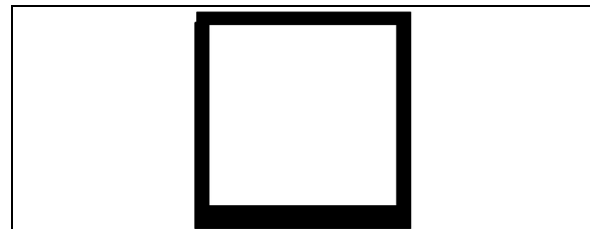


FIGURE 46 : SIDE PANEL INSTALLATION – SIKA 206 G+P APPLICATION

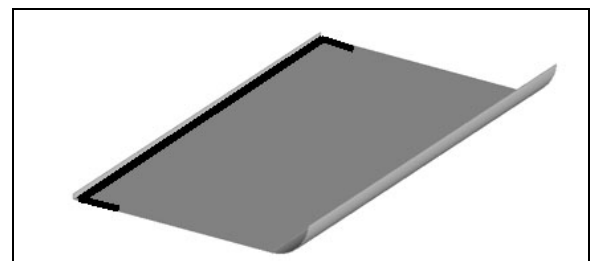


FIGURE 47 : SIDE PANEL INSTALLATION – SIKA 221 OR 252 APPLICATION ON SIDE PANEL

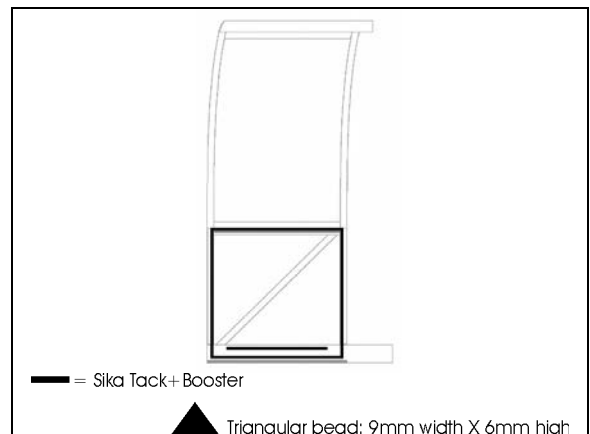


FIGURE 48 : SIDE PANEL INSTALLATION – SIKA TACK+BOOSTER APPLICATION

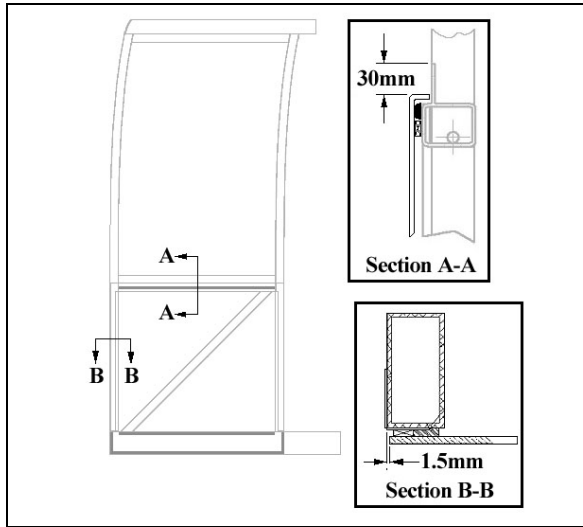


FIGURE 49 : SIDE PANEL INSTALLATION

### 16.5 TOP AND BOTTOM PANEL REMOVAL

**NOTE**

*The top and bottom panels are made of aluminum sheets.*

1. Remove the slide-out (as per the Slide-Out Removal/Installation 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 thickness. Use tape with same width and thickness when installing new panels.
6. Use a heat gun and putty knife to remove the dried off adhesive and tape residue from the structure.

**Warning:** 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 side panel installation procedure described in section 18: BODY.

1. Protect adjacent surfaces with appropriate material.
2. Refer to FIGURE 50 for 1/16x1/4 double face adhesive tape location on structure [5mm≈6/32”];

**NOTE**

*Do not remove the tape blue protective layer. The purpose of the tape is to maintain a certain gap and not to hold the panel in place.*

3. Clean panel with anti-silicone. Sand surface using a Scotchbrite. Clean sanded surface with anti-silicone;
4. Apply Sika 206 G+P on panel as shown in FIGURE 51;
5. Apply Sika Tack+Booster (triangular bead: 9mm width X 6mm high) has shown in FIGURE 52 and glue panel in place as shown in figure 53 & figure 54 ;
6. Exert pressure and let dry for at least 90 minutes;
7. Smooth down the joint and remove glue in excess;
8. After drying, apply Sika 252 as a finishing joint. Refer to paragraph 16.12 for the finishing joint application procedure.

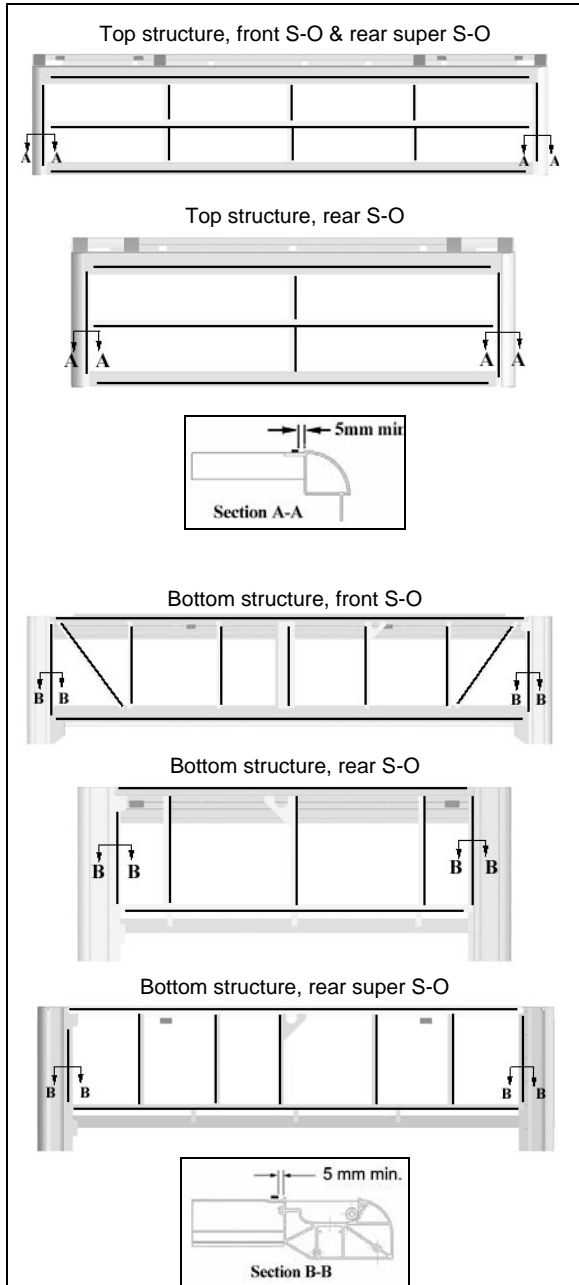


FIGURE 50 : TOP AND BOTTOM PANEL INSTALLATION - DOUBLE FACE ADHESIVE TAPE APPLICATION

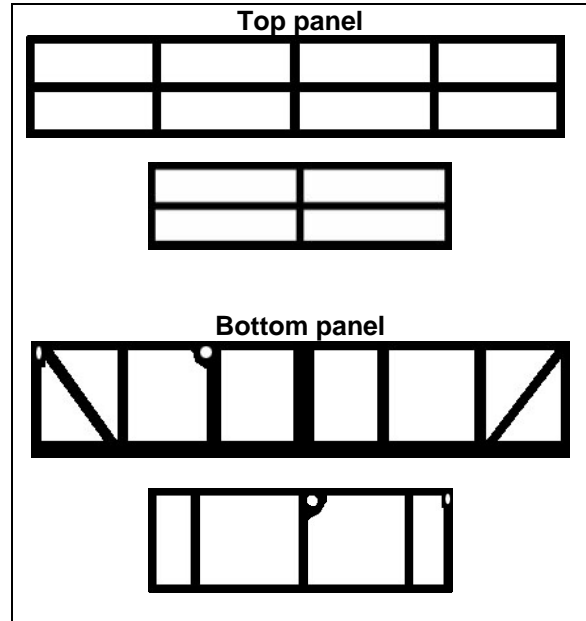


FIGURE 51 TOP AND BOTTOM PANEL INSTALLATION - SIKA 206 G+P APPLICATION

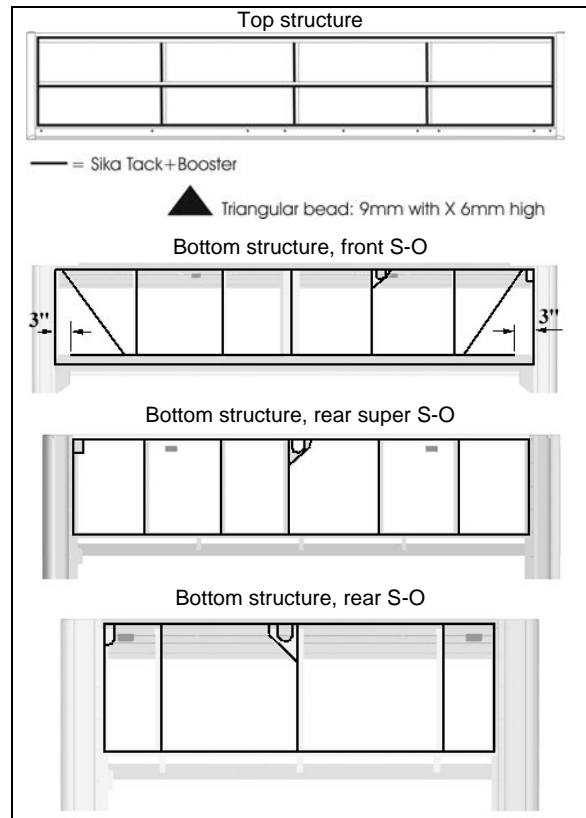


FIGURE 52 : TOP AND BOTTOM PANEL INSTALLATION - SIKA TACK+BOOSTER APPLICATION

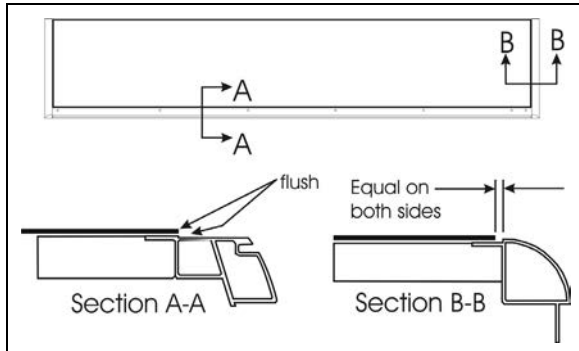


FIGURE 53 : TOP PANEL INSTALLATION

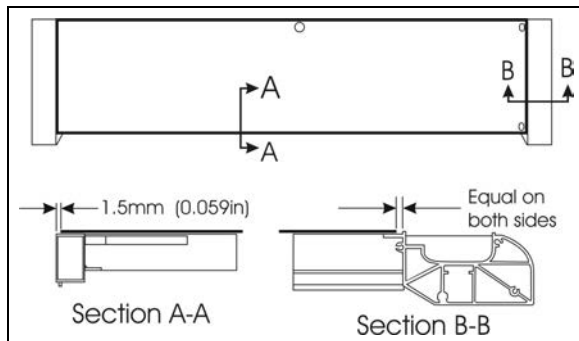


FIGURE 54 : BOTTOM PANEL INSTALLATION

**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.

**Warning:** Always wear safety equipment when working with glass and chemical adhesives.

**16.7 SIDE WINDOW & HALF-WINDOW REMOVAL**

1. Remove the slide-out (for side window removal only).
2. If needed, remove the exterior extrusion as described in paragraph 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 where applicable. Make sure not to damage the rubber seal between the windows.
4. With a helper, remove the window from the slide-out.

**16.8 HALF-WINDOW & SIDE WINDOW INSTALLATION**

Refer to procedures described in section 18: BODY of the maintenance manual for details.

1. Clean and prepare window and slide-out structure surface with appropriate cleaner, abrasives and primers [48mm≈1 7/8" ];
2. If necessary, install rubber seals as per FIGURE 55. Press the seal against the structure with a roller;
3. Apply ¼" X ½" double face self adhesive tape on the slide-out structure for side fixed window (see FIGURE 56) [10mm≈3/8" ] [15mm≈19/32" ];

**NOTE**

Do not remove the tape blue protective layer. The purpose of the tape is to maintain a certain gap and not to hold the panel in place.

4. Clean window with appropriate window cleaner;
5. Apply Sika Aktivator on the window pane as per FIGURE 57 (half-window) or FIGURE 58 (side window);
6. **HALF-WINDOW ONLY:** clean the sliding or awning window frame with anti-silicone and then, apply Sika Aktivator as shown on FIGURE 59;
7. **HALF-WINDOW ONLY:** place masking tape on awning or sliding window frame to protect it from smudge (see FIGURE 60);
8. **HALF-WINDOW ONLY:** On awning window, place 3 shims #790392 on frame, one at the center and the 2 other at each edge. On sliding window, place 3 shims #790392 on frame, one at the center and the 2 other at each edge in order to have a gap of 10mm between both windows (see FIGURE 60);
9. **HALF-WINDOW ONLY:** insert anchoring blocks in window extrusion (see FIGURE 64);
10. Apply Sika Tack+Booster (triangular bead: 20mm width X 15mm high) as per FIGURE 61 (side window) or FIGURE 62 (half-window) [20mm≈13/16" ] [15mm≈19/32" ];
11. Install side window on the slide-out structure as per FIGURE 63;
12. Install half-window centered with the awning or sliding window;

13. Press the jigs on the windows and wait for the adhesive to dry (90 minutes minimum).
14. Smooth down the joint and remove glue in excess. Clean excess adhesive with Sika 208.
15. Refer to paragraph 16.12 for the finishing joint application procedure.

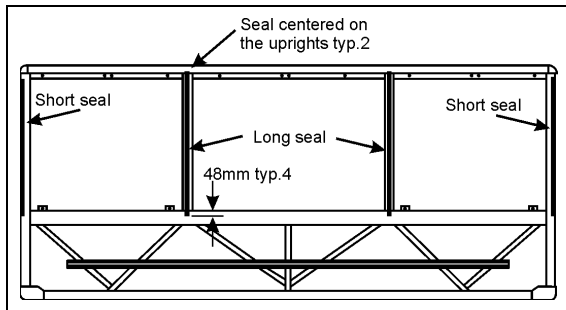


FIGURE 55 : FACE WINDOW - RUBBER SEAL INSTALLATION

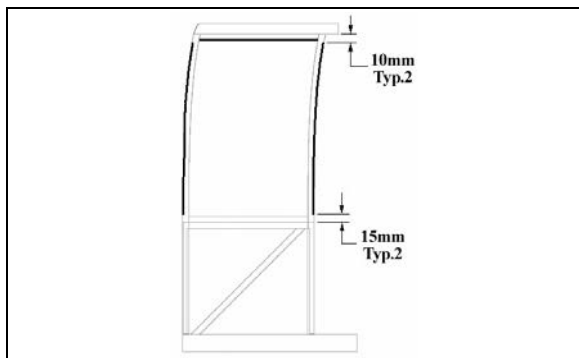


FIGURE 56 : SIDE WINDOW – ¼ X ½ DOUBLE FACE ADHESIVE TAPE INSTALLATION

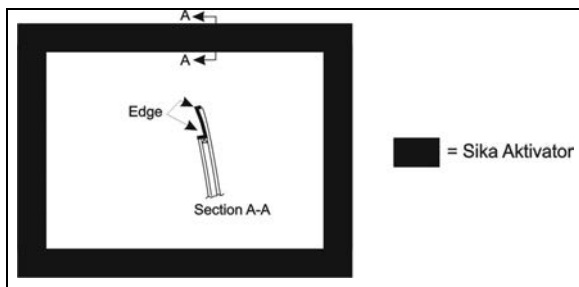


FIGURE 57 : HALF-WINDOW – SIKA AKTIVATOR

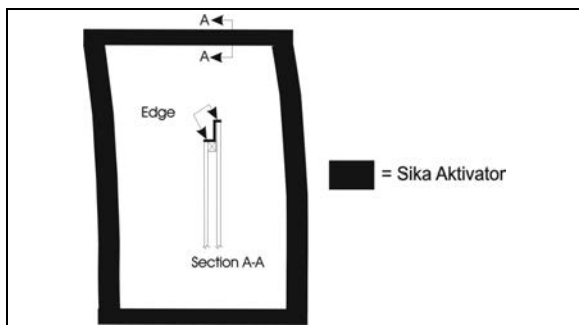


FIGURE 58 : SIDE WINDOW – SIKA AKTIVATOR

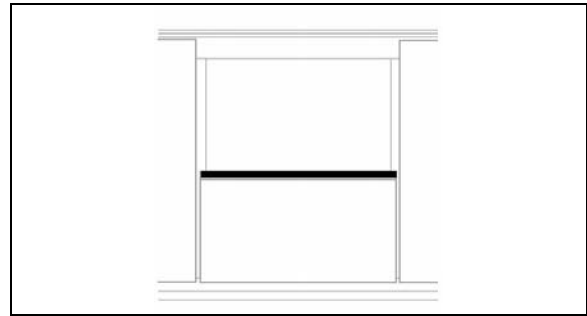


FIGURE 59 : HALF-WINDOW INSTALLATION – SIKA AKTIVATOR

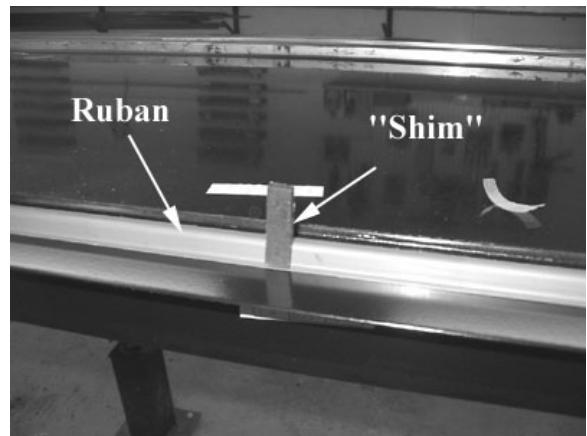


FIGURE 60 : HALF-WINDOW INSTALLATION

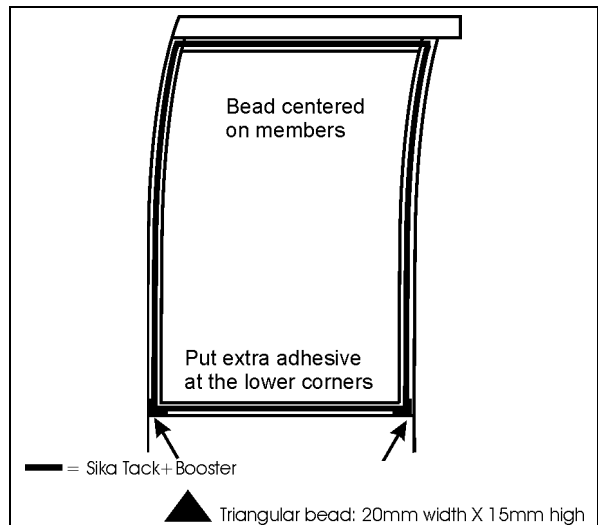


FIGURE 61 : SIDE WINDOW – SIKA TACK + BOOSTER

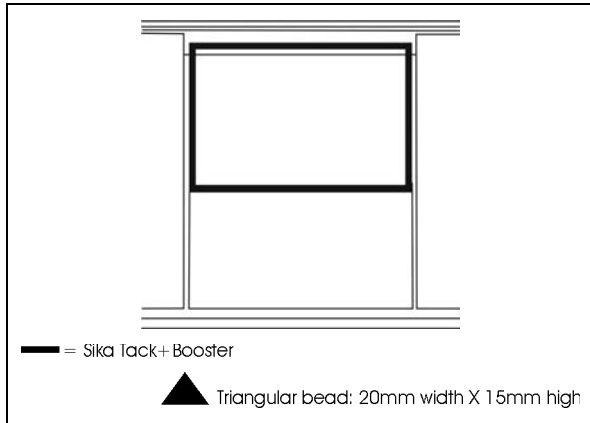


FIGURE 62 : HALF-WINDOW INSTALLATION – SIKA TACK+BOOSTER

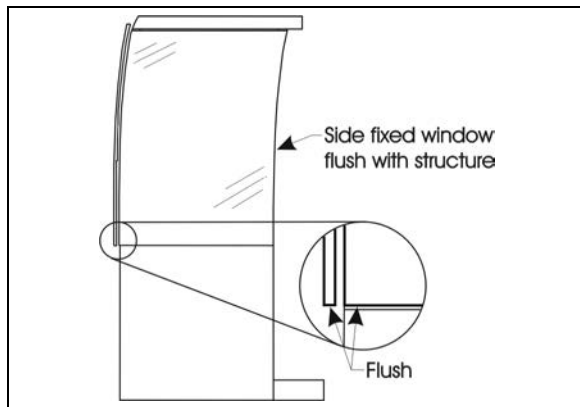


FIGURE 63 : SIDE WINDOW

## 16.9 FACE WINDOW INSTALLATION

Refer to procedures described in section 18: BODY of the maintenance manual for details.

1. If necessary, install the rubber seals as per FIGURE 55. Press the seal against the structure with a roller;
2. Insert anchoring blocks in window extrusion (see FIGURE 64) and install window with the lower edge flush with the sliding or awning window (see FIGURE 65);
3. Leave a gap between the face window and the sliding/awning window according to the slide-out overall length (see FIGURE 65);

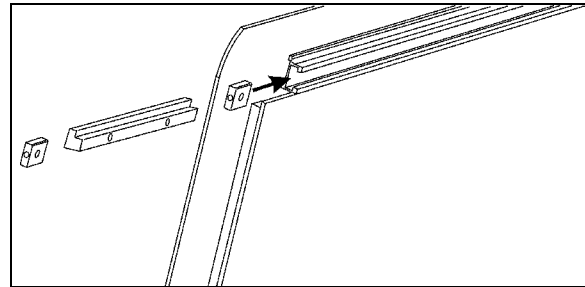


FIGURE 64 : FACE WINDOW INSTALLATION - ANCHORING BLOCKS

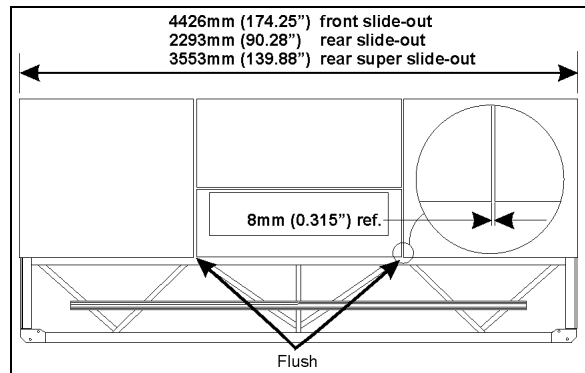


FIGURE 65 : FACE WINDOW INSTALLATION

## 16.10 AWNING WINDOW INSTALLATION

1. Clean and prepare window and slide-out structure surface with appropriate cleaner, abrasives and primers;
2. Glue 6 rubber bumpers (#790602) on the awning window frame as per FIGURE 66;

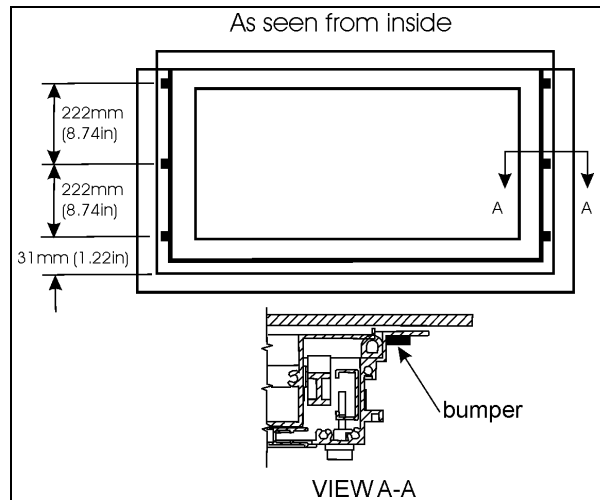


FIGURE 66: SIDE BUMPERS

3. Apply Sika 255 (or 252) at the upper and lower frame corner as per FIGURE 67.

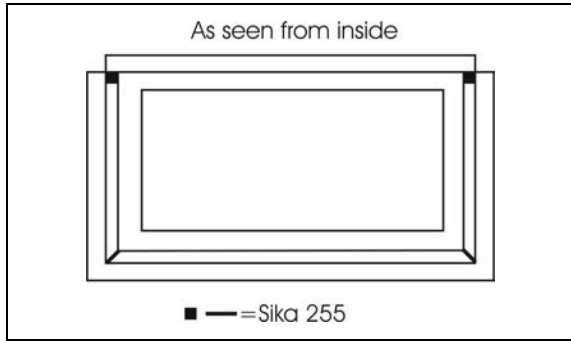


FIGURE 67: SIKA 255 APPLICATION

- Place masking tape on the inside of the window pane as per FIGURE 68 to protect it from smudge;

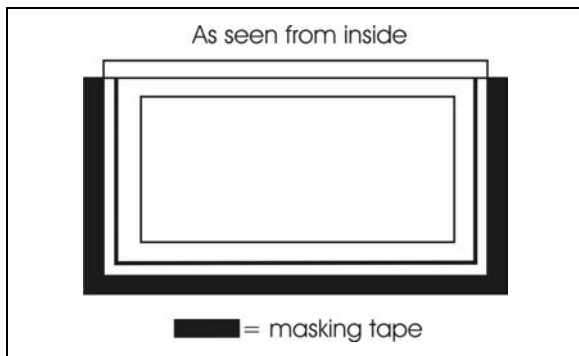


FIGURE 68: MASKING TAPE APPLICATION

- Previously clean surface with anti-silicone and then apply Sika Aktivator as per FIGURE 69;

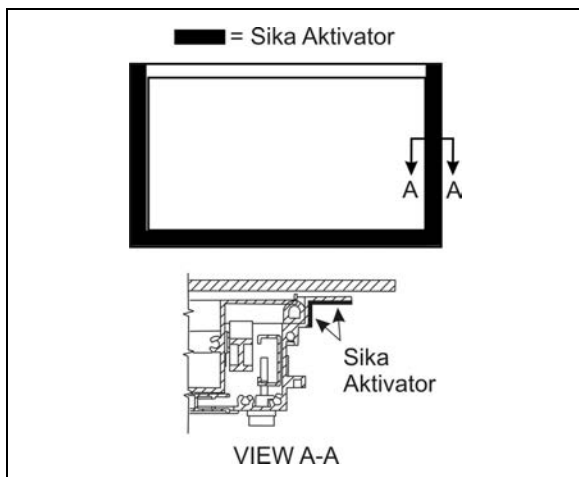


FIGURE 69 : AWNING WINDOW – SIKA AKTIVATOR

- Glue on the structure horizontal member, 3 rubber bumpers (#790597) (see FIGURE 70) [50mm≈2”].

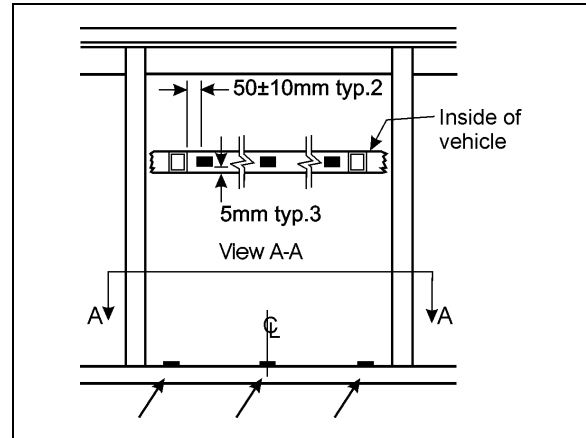


FIGURE 70: AWNING WINDOW - RUBBER BUMPER INSTALLATION

- Apply Sika 252 as per FIGURE 71 (triangular bead: 10mm width X 10mm high) [10mm≈3/8”];

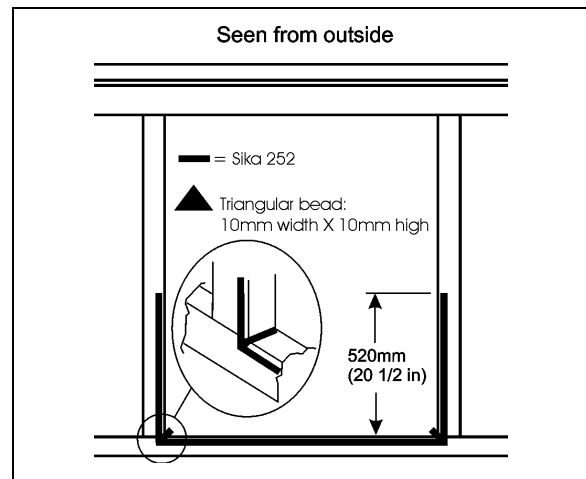


FIGURE 71: AWNING WINDOW – SIKA 252 APPLICATION

- Install the awning window centered in the opening.
- 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 72;

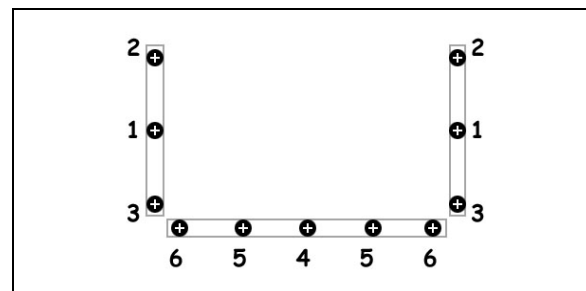


FIGURE 72 : CORRECT TIGHTENING SEQUENCE

10. Open the awning window manually and smooth down the joint (FIGURE 73) and remove glue in excess with Sika 208;

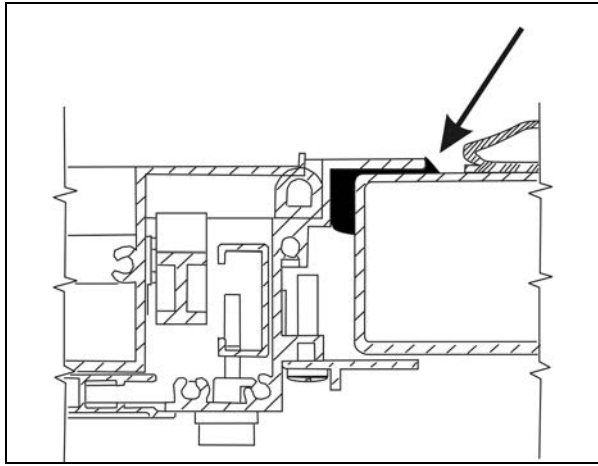


FIGURE 73 : SMOOTH DOWN THE JOINT

11. Using Sika 252 or 255, seal the upper corner of the awning window, both side (FIGURE 74);
12. Smooth down the joint from inside the vehicle;
13. Using Sika 252 or 255, seal the chink between the structure vertical member and the awning window, both side (FIGURE 75);

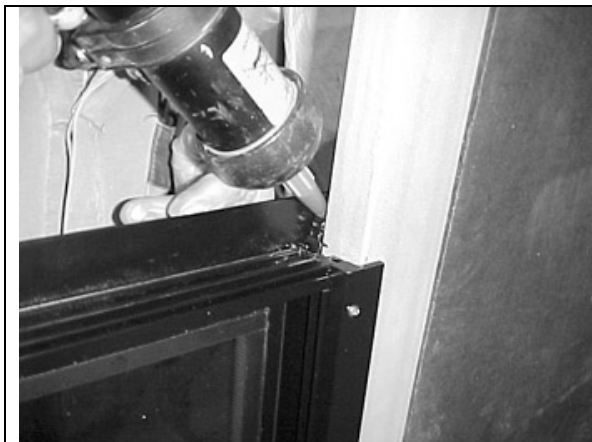


FIGURE 74 : AWNING WINDOW – SEAL THE UPPER CORNERS



FIGURE 75 : AWNING WINDOW – SEAL THE CHINK

### 16.11 SLIDING WINDOW INSTALLATION

1. Clean and prepare window and slide-out structure surface with appropriate cleaner, abrasives and primers. Clean surfaces with anti-silicone;
2. Clean sliding window frame with anti-silicone and then apply Sika Aktivator as per FIGURE 76;
3. Check for presence of 1 rubber bushing at each interior corner (see FIGURE 77) and 2 other bushings under the sliding window;
4. Apply Sika 252 as per FIGURE 78 (triangular bead: 20mm width X 10mm high [13/16"X 3/8"]).
5. Install the sliding window centered in the opening;
6. While a helper is pressing on the window from outside, install the sliding window clamping frame and tighten screws according to the sequence shown in FIGURE 79;
7. Using Sika 252 or 255, seal the inside upper corner of the sliding window, both side (FIGURE 80);
8. Remove glue in excess and clean with Sika 208.



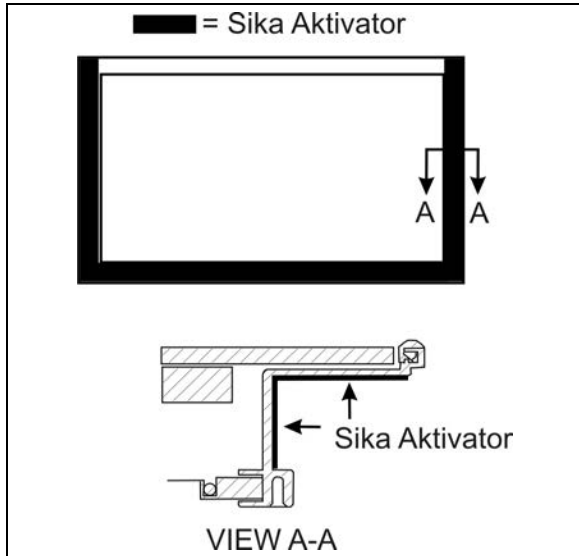


FIGURE 76 : SLIDING WINDOW - SIKa AKTIVATOR

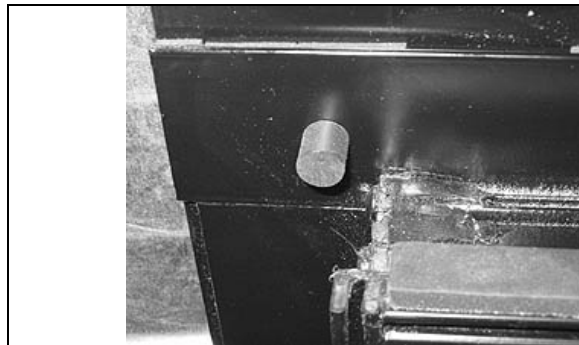


FIGURE 77 : SLIDING WINDOW - RUBBER BUSHING

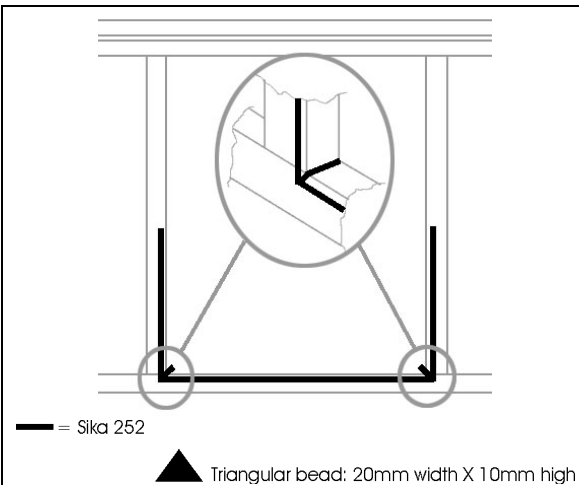


FIGURE 78 : SLIDING WINDOW - SIKa 252 APPLICATION

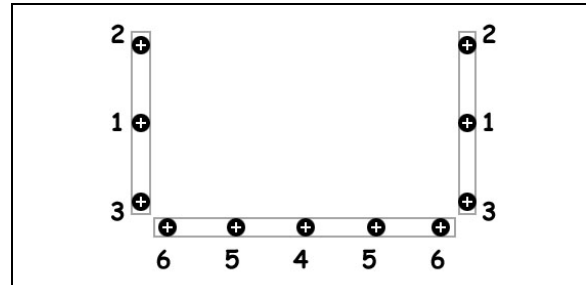


FIGURE 79 : CORRECT TIGHTENING SEQUENCE

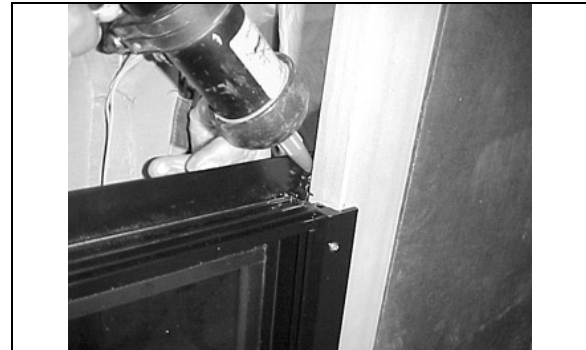


FIGURE 80 : SLIDING WINDOW – SEAL THE UPPER CORNERS

### 16.12 FINISHING JOINT

For surface cleaning and preparation, tools, cleaner, adhesives and other product needed, refer to the “side panel installation” procedure described in section 18: BODY.

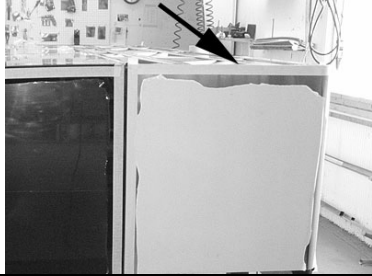
1. Place masking tape to protect surfaces from smudge.
2. Apply Sika Aktivator and then apply Sika 252 as per the following pictures.
3. Remove Sika 252 in excess. Using soapy water, smooth down the joint with your finger (wear vinyl gloves).

## Section 26: VIP SLIDE-OUT

Apply Sika Aktivator and then apply Sika 252 (black) between:

- 1- face panel & vertical structural member at the corner;
- 2- side panel & vertical structural member at the corner;

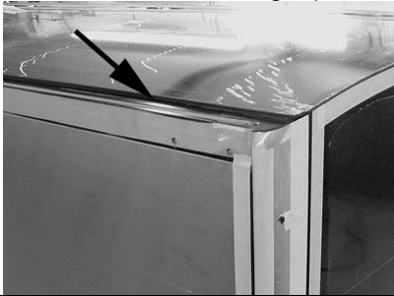
Note: as seen on the picture, protect the adjacent surface with masking tape.



Apply Sika Aktivator and then apply Sika 252 (black) between:

- 1- top of face window & upper horizontal structural member
- 2- top of half-window & upper horizontal structural member

Note: as seen on the picture, protect the adjacent surface with masking tape



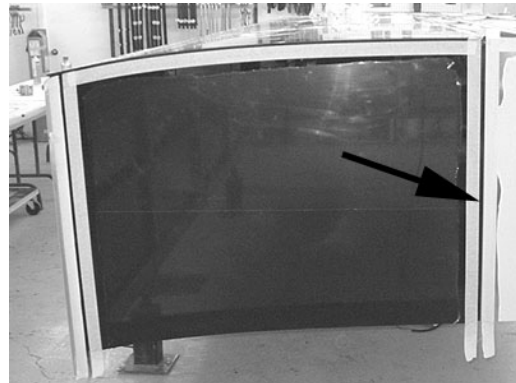
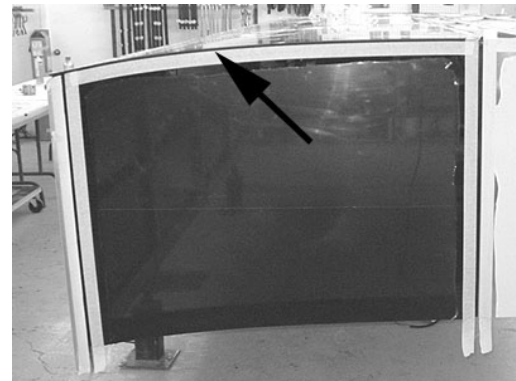
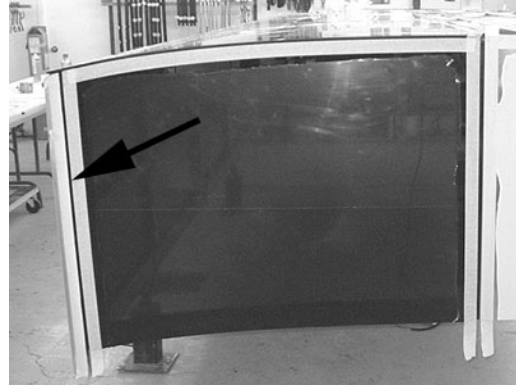
Apply Sika Aktivator and then apply Sika 252 between edge of bottom panel and structural member

Bead must overlap both surfaces about 2mm



Apply Sika Aktivator and then apply Sika 252 between side window and structural member

Bead must overlap both surfaces about 2mm



Apply Sika Aktivator and then apply Sika 252 between R.H. side edge of top panel and structural member

Apply Sika Aktivator and then apply Sika 252 between L.H. side edge of top panel and structural member

Bead must overlap both surfaces about 2mm

Note: as seen on the picture, protect the adjacent surface with masking tape



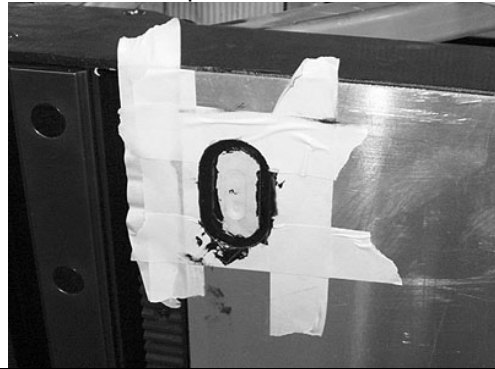
Apply Sika Aktivator and then apply Sika 252 around the security pin cavity

Bead must overlap both surfaces about 2mm



Apply Sika Aktivator and then apply Sika252 between the bottom panel and the magnets

Bead must overlap both surfaces about 2mm



## 17 WELDING PRECAUTION



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 socket.

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 procedure, make sure that the problem cannot be solved by one of the following simple checks:

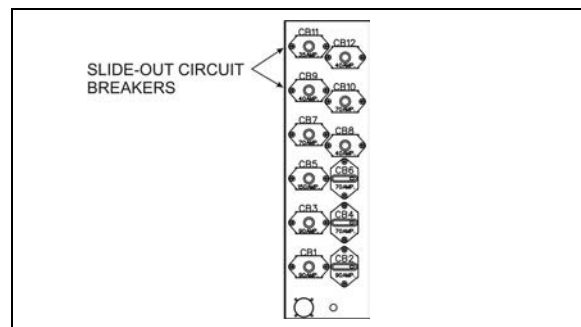
- Make sure that none of the breakers are tripped (slide-out circuit breakers CB9 & CB11 are located inside the main power compartment on the breaker panel).

## Section 26: VIP SLIDE-OUT

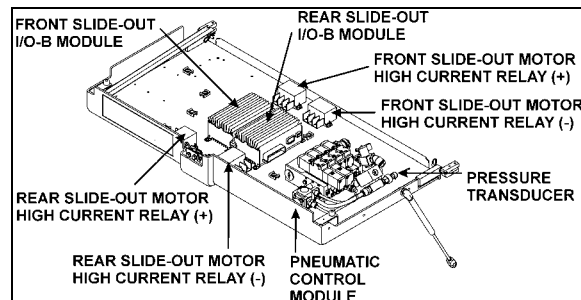
- Make sure the parking brake is applied and that transmission is in the "NEUTRAL" position.
- Make sure the voltage is high enough by running the engine at fast idle or having a battery charger connected.

**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 81 : SLIDE-OUT CIRCUIT BREAKERS CB9 & CB11 IN MAIN POWER COMPARTMENT**



**FIGURE 82 : SLIDE-OUT CONTROL PANEL IN FIRST BAGGAGE COMPARTMENT** 26107

### 18.1.1 Manual retracting procedure – Front and rear slide-out

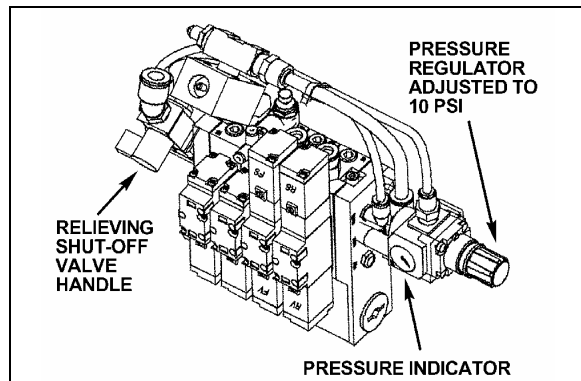
1. Turn the ignition switch to the "OFF" position, and remove the ignition key for more safety.
2. Deflate the inflatable seal by using the relieving shut-off valve located on the slide-out control panel. Turn the handle clockwise to deflate the seal. Make sure the pressure indicator reading is "0 psi".

**CAUTION**

The pressure in the inflatable seal must be completely relieved to prevent any damage to the seal. Also, check that the security pin is retracted so it does not stop slide-out movement.

**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.



**FIGURE 83 : INFLATABLE SEAL RELIEVING SHUT-OFF VALVE** 26098

3. To move the slide-out, use a cordless power drill with a 3/8" hexagonal socket on the shaft extension of the slide-out motor.
4. Rotate the slide-out motor shaft extension with the cordless power drill until the slide-out comes to its closed position.
5. Once the slide-out room is lined up to its closed position, remove the tool from the motor.

**NOTE**

The **front slide-out motor** is located inside the 2<sup>nd</sup> baggage compartment while the **rear slide-out motor** is accessible from inside the vehicle, under the bed structure.

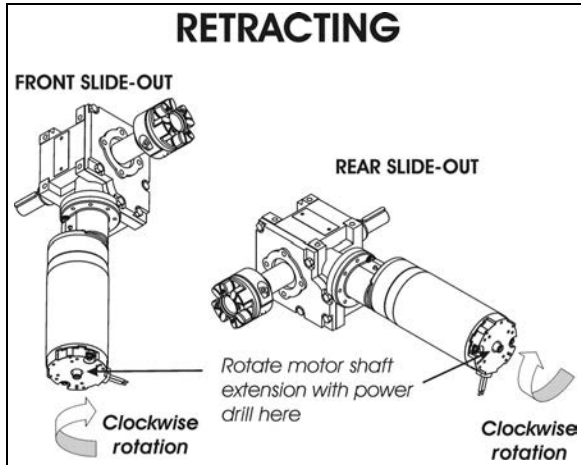


FIGURE 84 : SLIDE-OUT MOTOR ROTATION 26038

**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 cordless power drill rotating movement. Not doing so could overload the drive mechanism and cause damage to the reduction gearbox.

- 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.

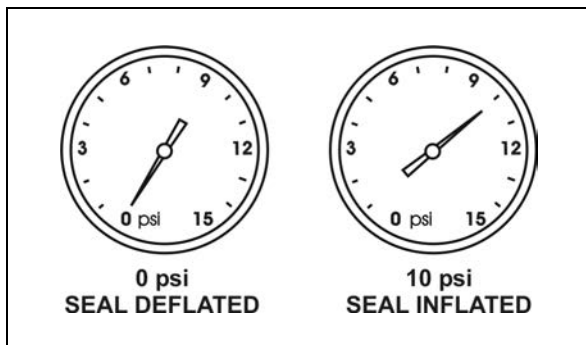


FIGURE 85 : INFLATABLE SEAL PRESSURE GAGE 26108

**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

- Apply parking brake to disengage the security pin from the receptacle.
- Turn the ignition switch to the "OFF" position, and remove the ignition key for more safety.
- Deflate the inflatable seal by using the relieving shut-off valve located in the slide-out control panel. 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. Also, check that the security pin is disengaged from the receptacle so it does not stop slide-out movement.

**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.

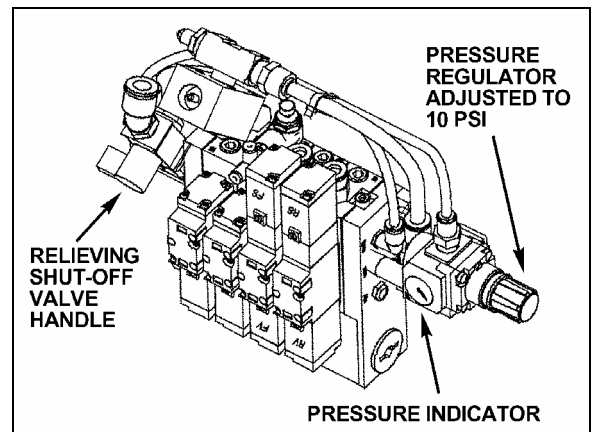
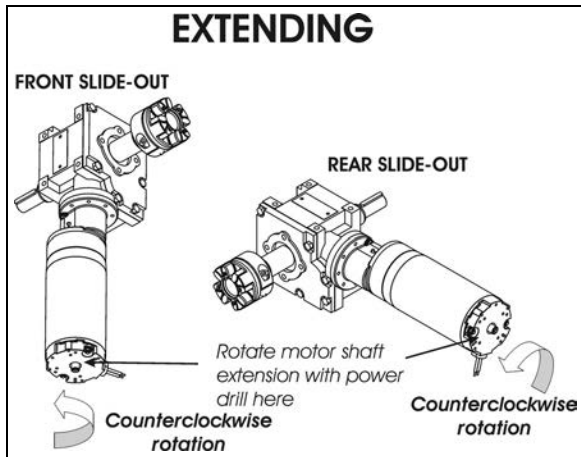


FIGURE 86 : INFLATABLE SEAL RELIEVING SHUT-OFF VALVE 26098

- To move the slide-out, use a cordless power drill with a 3/8" hexagonal socket on the shaft extension of the slide-out motor.
- Rotate the slide-out motor shaft extension with the cordless power drill until the slide-out comes to its opened position.

**Section 26: VIP SLIDE-OUT**

- Once the slide-out is lined up to its opened position, remove the tool from the motor.

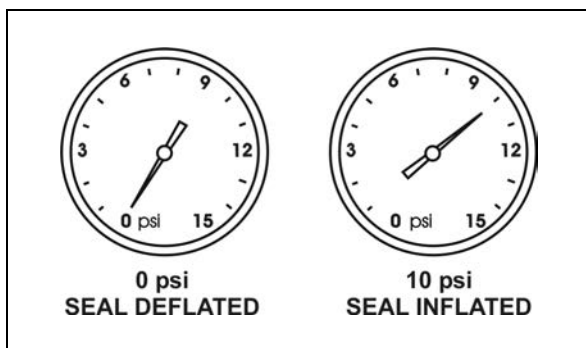


**FIGURE 87 : SLIDE-OUT MOTOR ROTATION** 26037

**NOTE**  
 The **front slide-out motor** is located inside the 2<sup>nd</sup> 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 cordless power drill rotating movement. Not doing so could overload the drive mechanism and cause damage to the reduction gearbox.

- 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 88 : INFLATABLE SEAL PRESSURE GAGE** 26108

**NOTE**

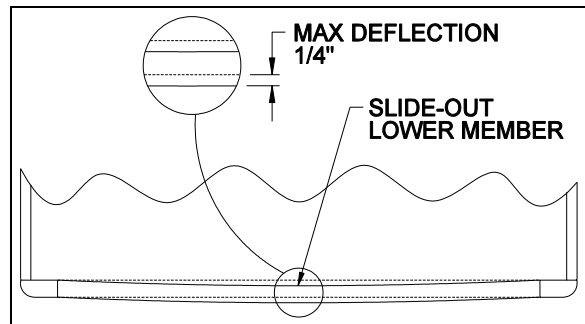
*The slide-out control system inhibits transmission range selection to prevent the vehicle from moving if the slide-out is not in its full "IN" position.*

**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<sup>1</sup>

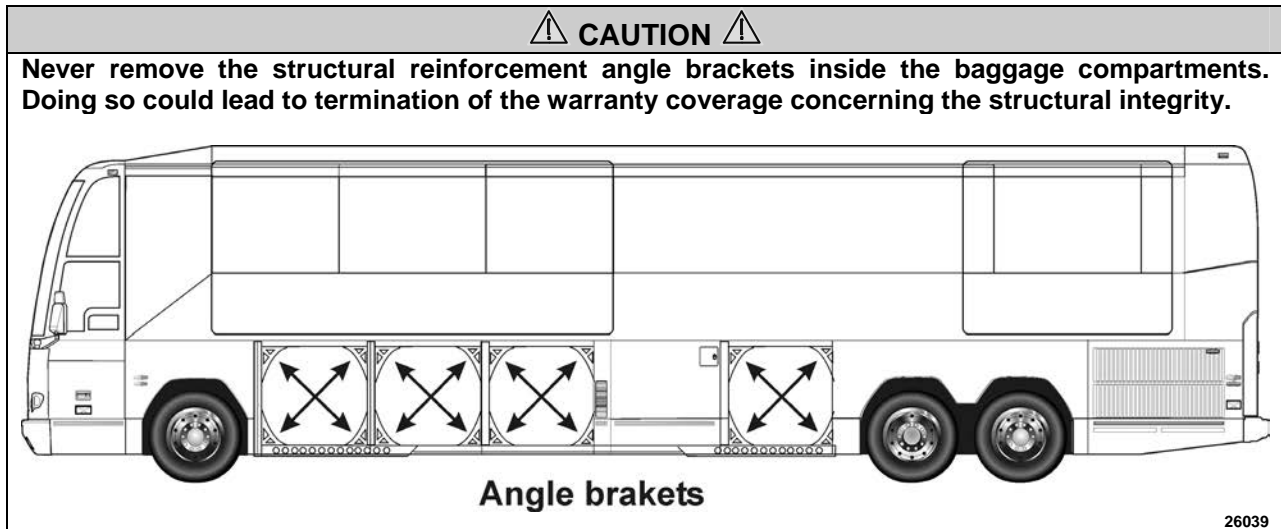
**Rear slide-out:**  
 Maximum load with vehicle at stand still (retracted or extended) .....1500 lb  
 Maximum load with vehicle moving or slide-out moving .....1000 lb<sup>1</sup>

**NOTE**  
 Maximum load includes people weight and equipment added by the converters in the slide-out



**FIGURE 89 : FRONT SLIDE-OUT DEFLECTION**

<sup>1</sup> With load distributed in the slide-out, to prevent a deflection of the inside lower member greater than 1/4" that could damage the seal.



## 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 upper inner stoppers.
3. Check if the vehicle upper member is parallel with the front slide-out structure. If not, an adjustment of the roof reinforcing rod may be required. This may be affected by the loading on the roof. See section 3 and contact your Prevest service representative.
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 proper 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.

## 21 TROUBLESHOOTING

### 21.1 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.

### 21.2 TROUBLESHOOTING – OPERATING CONDITIONS & CONTROL

PROBLEM	CAUSE	CORRECTIVE ACTION
The slide-out functions normally but the handheld control green indicator light blinks	<p>Something is defective and may eventually create an issue if not repaired. The problem may be:</p> <ul style="list-style-type: none"> <li>A. Faulty limit sensor causing the slide-out to stop in overcurrent;</li> <li>B. CAN network problem causing the transmission inhibit safety to be non-operational;</li> <li>C. Vacuum pressure transducer disconnected or damaged (vacuum is applied for a fixed time of 7 seconds);</li> <li>D. Seal inflating valve solenoid open circuit (the seal is not re-inflated and water can penetrate in the vehicle);</li> <li>E. Security pin valve solenoid open circuit (the security pin is not extended while vehicle is riding).</li> </ul>	Request a diagnostic from the electrical system using the MCD SYSTEM DIAGNOSTIC menu and refer to the Fault Message list in paragraph 21.4.



PROBLEM	CAUSE	CORRECTIVE ACTION
The slide-out does not extend	<p>A. The parking brake is not seen by the controller as being applied;</p> <p>B. Not enough air pressure in the accessory air tank to permit proper operation of the vacuum generator;</p> <p>C. Faulty vacuum generator, connection to the vacuum generator open, seal deflating valve solenoid open circuit;</p> <p>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;</p>	<p>A. Make sure the parking brake is applied. Confirm parking brake application with the parking brake light on the telltale panel.</p> <p>B. Run the engine at fast idle a few minutes to increase air pressure in the accessory air tank and try again.</p> <p>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;</p> <p>D. Operate the slide-out with the manual override procedures.</p>
The slide-out does not retract	<p>A. Not enough air pressure in the accessory air tank to permit proper operation of the vacuum generator;</p> <p>B. Faulty vacuum generator, connection to the vacuum generator open, seal deflating valve solenoid open circuit;</p> <p>C. I/O-B module output defective, "in limit" sensor shorted to ground, connection to the motor positive relay solenoid open circuit;</p>	<p>A. Run the engine at fast idle a few minutes to increase air pressure in the accessory air tank and try again.</p> <p>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;</p> <p>C. Operate the slide-out with the manual override procedures.</p>
When extending, the slide-out stops after having extended by 1 inch	<p>A. The security pin valve solenoid circuit is shorted to (+) 24-volt and the pin remains engaged;</p>	<p>A. Disconnect air supply from the safety pin cylinder;</p>
Transmission DRIVE range or REVERSE cannot be selected (the slide-out telltale light is illuminating).	<p>A. Slide-out not in full "in" position;</p> <p>B. Faulty "in limit" sensor. The slide-out is retracted but the controller doesn't see it as retracted.</p>	<p>A. Retract slide-out.</p> <p>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.</p>

**21.3 TROUBLESHOOTING - MECHANICAL COMPONENTS**

<b>PROBLEM</b>	<b>CAUSE</b>	<b>CORRECTIVE ACTION</b>
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").
Top of slide-out moves sideways when vehicle is	A. Roof reinforcing rod misadjusted;	A. Readjust as per procedure.

PROBLEM	CAUSE	CORRECTIVE ACTION
moving		
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.
Knocking sound when parking brake is released	A. Security pin retracts too rapidly;	A. Adjust security pin air flow regulator.
Inflatable seal damaged or	A. Slide-out has been retracted or extended	A. Always deflate the seal when

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<b>PROBLEM</b>	<b>CAUSE</b>	<b>CORRECTIVE ACTION</b>
removed, or wiper seal unstuck from the structure.	<p>with the manual procedure with the inflatable seal not deflated;</p> <p>B. Pressure transducer malfunction;</p> <p>C. Faulty roof reinforcing rod adjustment;</p> <p>D. Seal valve malfunction;</p> <p>E. Excessive load in the slide-out;</p> <p>F. Slide-out not centered in the structure opening;</p>	<p>manually retracting or extending the slide-out.</p> <p>B. Check the pressure transducer condition, replace if necessary.</p> <p>C. Readjust the roof reinforcing rod.</p> <p>D. Check the seal valve condition.</p> <p>E. Reduce load or distribute load evenly in order to respect the deflection criterion and slide-out load capacity.</p> <p>F. Readjust the slide-out height and center horizontally in opening.</p>
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.

**21.4 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.
		Shorted High	Wire between parking brake	Fix wiring harness.

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SID #	FAULT MESSAGE	TEXT	PROBABLE CAUSE	CORRECTIVE ACTION
			switch and CECM is shorted to 12v or 24v.	
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
		Open Circuit	Relay coil is broken or open.	Check / fix relay coil or

SID #	FAULT MESSAGE	TEXT	PROBABLE CAUSE	CORRECTIVE ACTION
			Bad connection on relay. Wiring harness is cut.	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.

