WASHINGTON METROPOLITAN AREA TRANSPORATION AUTHORITY

SERVICE MANUAL

XCELSIOR® CNG 40FT. TRANSIT BUS

This service manual is effective for only those coaches with the following Identification Numbers:

SR2107

Vehicle Identification Number	Unit Number
5FYC8FB1XJF053432	3100
5FYC8FB11JF053433	3101
5FYC8FB13JF053434	3102
5FYC8FB15JF053435	3103
5FYC8FB17JF053436	3104
5FYC8FB19JF053437	3105
5FYC8FB10JF053438	3106
5FYC8FB12JF053439	3107
5FYC8FB19JF053440	3108
5FYC8FB10JF053441	3109
5FYC8FB12JF053442	3110

SR2107 continued

Vehicle Identification Number	Unit Number
5FYC8FB14JF053443	3111
5FYC8FB16JF053444	3112
5FYC8FB18JF053445	3113
5FYC8FB1XJF053446	3114
5FYC8FB11JF053447	3115
5FYC8FB13JF053448	3116
5FYC8FB15JF053449	3117
5FYC8FB11JF053450	3118
5FYC8FB13JF053451	3119
5FYC8FB15JF053452	3120
5FYC8FB17JF053453	3121
5FYC8FB19JF053454	3122
5FYC8FB10JF053455	3123
5FYC8FB12JF053456	3124
5FYC8FB14JF053457	3125
5FYC8FB16JF053458	3126
5FYC8FB18JF053459	3127
5FYC8FB14JF053460	3128
5FYC8FB16JF053461	3129
5FYC8FB18JF053462	3130
5FYC8FB1XJF053463	3131
5FYC8FB11JF053464	3132
5FYC8FB13JF053465	3133
5FYC8FB15JF053466	3134
5FYC8FB17JF053467	3135
5FYC8FB19JF053468	3136
5FYC8FB10JF053469	3137
5FYC8FB17JF053470	3138
5FYC8FB19JF053471	3139
5FYC8FB10JF053472	3140
5FYC8FB12JF053473	3141
5FYC8FB14JF053474	3142
5FYC8FB16JF053475	3143
5FYC8FB18JF053476	3144
5FYC8FB1XJF053477	3145

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Vehicle Identification Number	Unit Number
5FYC8FB11JF053478	3146
5FYC8FB13JF053479	3147
5FYC8FB1XJF053480	3148
5FYC8FB11JF053481	3149
5FYC8FB13JF053482	3150
5FYC8FB15JF053483	3151
5FYC8FB17JF053484	3152
5FYC8FB19JF053485	3153
5FYC8FB10JF053486	3154
5FYC8FB12JF053487	3155
5FYC8FB14JF053488	3156
5FYC8FB16JF053489	3157
5FYC8FB12JF053490	3158
5FYC8FB14JF053491	3159
5FYC8FB16JF053492	3160
5FYC8FB18JF053493	3161
5FYC8FB1XJF053494	3162
5FYC8FB11JF053495	3163
5FYC8FB13JF053496	3164
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5FYC8FB19JF053504	3172
5FYC8FB10JF053505	3173
5FYC8FB12JF053506	3174
5FYC8FB14JF053507	3175
5FYC8FB16JF053508	3176
5FYC8FB18JF053509	3177
5FYC8FB14JF053510	3178
5FYC8FB16JF053511	3179
5FYC8FB18JF053512	3180

SR2107 continued

Vehicle Identification Number	Unit Number
5FYC8FB1XJF053513	3181
5FYC8FB11JF053514	3182
5FYC8FB13JF053515	3183
5FYC8FB15JF053516	3184
5FYC8FB17JF053517	3185
5FYC8FB19JF053518	3186
5FYC8FB10JF053519	3187
5FYC8FB17JF053520	3188
5FYC8FB19JF053521	3189
5FYC8FB10JF053522	3190
5FYC8FB12JF053523	3191
5FYC8FB14JF053524	3192
5FYC8FB16JF053525	3193
5FYC8FB18JF053526	3194
5FYC8FB1XJF053527	3195
5FYC8FB11JF053528	3196
5FYC8FB13JF053529	3197
5FYC8FB1XJF053530	3198
5FYC8FB11JF053531	3199

To Our Valued Customer,

New Flyer Industries Canada ULC is pleased to provide you and your property with this technical manual prepared specifically for your new order of buses.

Our goal is to provide our customer with comprehensive, accurate and easy to use technical manuals that are designed to present information in a clear and concise manner. The information contained in this manual is not generic and is derived from your bus build specifications only.

Throughout the preparation of this manual, we have applied rigid technical publications specifications to ensure that you receive a high quality product that will serve you well for many years to come. Every effort has been expended to ensure that the information and data within are accurate and technically correct. All illustrations have been drawn to represent easy-to-view, comprehensive and clear assemblies and sub-assemblies.

If you discover any omissions or have any suggestions for changes or improvements, please do not hesitate to write or fax us your information on the tear-away sheet provided at the back of this manual.

It is our sincerest hope and intent that you find this manual useful and a reliable source of information.

Yours truly,

M. Monsigneur

Mike Monsigneur
Director
NF Publications

nfi.parts™

MCI NEW FLYER

The information contained in this manual is updated periodically. While great care is taken in compiling the information contained in this manual, New Flyer Industries Canada ULC cannot assume liability for losses of any nature arising from any errors and/or omissions.
The information and specifications contained throughout this manual are up to date at the time of publication. New Flyer Industries Canada ULC reserves the right to change the content of this manual at anytime without notice.

Printed in Canada

☞**NOTE:**

The National Highway Traffic Safety Administration (NHTSA) has requested that the following statement be provided for your information.

If the property believes that its vehicle has a defect which could cause a crash or could cause injury or death, inform the National Highway Traffic Safety Administration (NHTSA) in addition to notifying New Flyer Industries Canada ULC.

If NHTSA receives similar complaints, it may open an investigation, and if it finds that a safety defect exists in a group of vehicles, it may order a recall and remedy campaign. However, NHTSA cannot become involved in individual problems between you and New Flyer Industries Canada ULC.

To contact NHTSA, either call the Vehicle Safety Hotline toll-free at 1-888-327-4236 (TTY: 1-800-424-9153); go to http://www.safercar.gov and download the SaferCar mobile application or write to: Administrator, NHTSA,1200 New Jersey Ave. SE, Washington, DC 20590. Other information about motor vehicle safety can be obtained from http://www.safercar.gov.

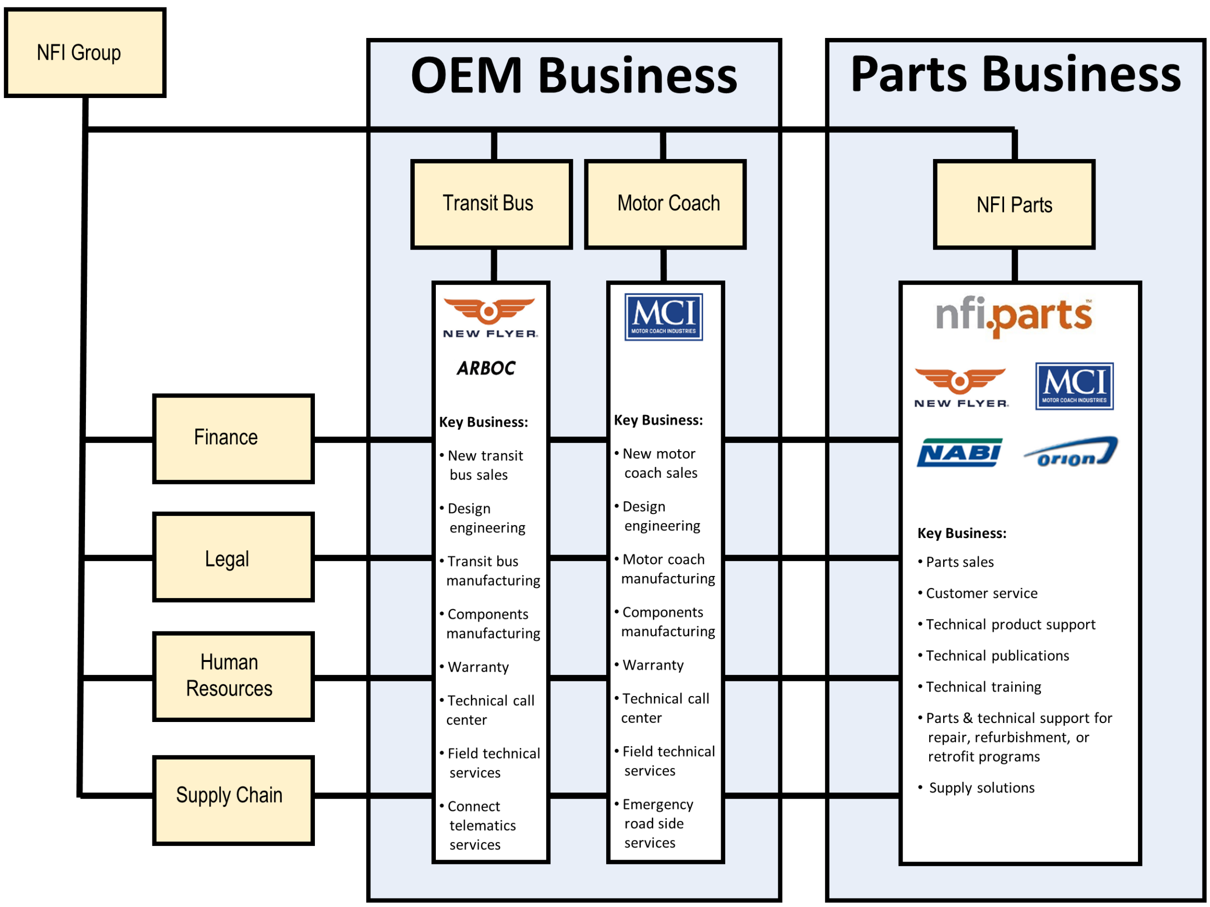
Vehicle Patent Information

This New Flyer product and its components, and methods of manufacturing thereof, may be protected by one or more of the following patents, design registrations and patent applications. In addition, such products, components, and/or methods may be protected by one or more patent and design applications which may have not been published as of the date of this manual, in the United States, Canada, and elsewhere. Please direct all inquiries to our Corporate Offices. For a current listing of applicable patents, please refer to our Legal Notice at our corporate website, http://www.newflyer.com.

New Flyer Products	Patents, Patent Applications, Design Registrations & Design Applications
Xcelsior® Bus[1]	U.S.: 6,343,908; 6,397,965; 6,416,094; 6,556,899; 6,611,739; 6,681,174; 6,695,366; 8,109,551; 8,548,669; D637520; D639712; D660761; D678818; D680670; D687593; D692360; published applications 2012/0161469; 2013/0181679 Canada: 2,317,237; 2,455,153; 2,652,352; 2,794,822; 2,825,732; design registrations 129599; 132413; 132414; 132415; 132416; 132417; 133389; 133391; 133392; 133598; 133599; 133600; 133645; 133646; 133647; 133648; 133649; 133650; 133651; 136,266; 139456; 139757
MiDi® Bus[1]	U.S.: 6,343,908; 6,556,899; 6,611,739; 6,681,174; 6,556,899; 6,611,739; 6,681,174; 8,548,669 Canada: 2,306,413; 2,689,744
Invero® Bus[1]	U.S.: 6,257,652; 6,340,202; 6,343,908; 6,375,249; 6,397,965; 6,416,094; 6,416,116; 6,556,899; 6,611,739; 6,681,174; 6,695,366; 6,726,271; 8,548,669 Canada: 2,297,618; 2,297,623; 2,297,625; 2,297,719; 2,306,413; 2,317,237; 2,455,153
High Floor Bus[1]	U.S.: 6,343,908; 6,397,965; 6,416,094; 6,556,899; 6,611,739; 6,681,174; 6,695,366; 8,548,669 Canada: 2,317,237; 2,455,153
Low Floor Bus[1]	U.S.: 6,343,908; 6,397,965; 6,416,094; 6,556,899; 6,611,739; 6,681,174; 6,695,366; 8,548,669 Canada: 2,317,237; 2,455,153

New Flyer Products	Patents, Patent Applications, Design Registrations & Design Applications
Electric Bus	U.S.: published application 2013/0181679 Canada: 2,794,822
Passenger Ramps	U.S.: 6,343,908 Canada: 2,306,413
Energy Absorbing Bumpers	U.S.: 6,416,094; 6,695,366 Canada: 2,455,153
Engine Mounts	U.S.: 6,397,965 Canada: 2,317,237
New Flyer Connect™ Products & Services	U.S.: 6,556,899; 6,611,739; 6,681,174; 6,556,899; 6,611,739; 6,681,174; 8,548,669 Canada: 2,689,744
Note 1: Not all buses have features covered by all patents. Contact Legal@newflyer.com for further information.	

New Flyer Industries Inc. ("NFI Group")



Introduction to NFI Group

New Flyer Industries, Inc. and its subsidiaries, ("**NFI Group**"), is the largest transit bus and motor coach manufacturer and parts distributor in North America, with fabrication, manufacturing, distribution, and service centers across Canada and the United States. NFI Group provides a comprehensive suite of mass transportation solutions through its operating divisions: Transit Bus OEM (**New Flyer** and **ARBOC**), Motor Coach OEM (**MCI**), and Parts Sales and Support (**NFI Parts™**).

Within NFI Group's Transit Bus OEM division, **New Flyer** is North America's heavy-duty transit bus leader. New Flyer offers the most advanced transit bus product line under the Xcelsior® and Xcelsior CHARGE™ brands, incorporating the broadest range of drive systems available, including: clean diesel, natural gas, diesel-electric hybrid, trolley-electric, and battery-electric. New Flyer actively supports over 44,000 heavy-duty transit buses (New Flyer, NABI, and Orion) currently in service, of which 6,400 are powered by electric and battery propulsion.

Also within NFI Group's Transit Bus OEM division, **ARBOC** is North America's low-floor, body-on-chassis ("cutaway") bus leader serving transit, paratransit, and shuttle applications. With more than 2,500 buses in service, ARBOC provides unsurpassed passenger accessibility and comfort over traditional high-floor cutaway vehicles. ARBOC also offers a medium-duty bus for transit and shuttle applications. ARBOC bus sales, parts, and service is provided through a dealer network.

NFI Group's motor coach OEM division, **Motor Coach Industries (MCI)**, is North America's motor coach leader, offering the MCI J-Series, the industry's best-selling intercity coach since 2006, and the MCI D-Series, the industry's best-selling motor coach line in North American history. MCI actively supports over 28,000 coaches currently in service.

NFI Group's parts division, **NFI Parts™**, is North America's most comprehensive parts organization, providing parts, technical publications, training, and support for NFI Group bus and coach fleets in service. NFI Parts™ supports current and legacy OEM product lines, including New Flyer, NABI, and Orion transit buses, and MCI motor coaches. NFI Parts™ brings together over 85 years of parts experience and supports a combined fleet of over 72,000 active transit buses and motor coaches. NFI Parts™ has grown to serve over 17,000 customers from 15 parts distribution centers throughout North America.

Further information is available on NFI Group websites at www.newflyer.com, www.arbocsv.com, www.mcicoach.com, and www.nfi.parts.

Service Manual Explanations

Purpose

The purpose of this Service Manual is to present information and procedures required to properly service and maintain your New Flyer vehicles.

Service Personnel Responsibilities

All personnel involved in the service of the vehicle should be acquainted with this manual.

Organization of the Service Manual

This manual is divided into major sections. A tab on the first page of each major section indicates the section number and title. The first page following the tab page is the section table of contents.

This manual and any manufacturers/vendors manuals should be referred to when servicing or maintaining the vehicles with the Vehicle Identification Numbers listed.

Additional Manuals & Publications

New Flyer urges service technicians to read this publication carefully, as well as obtain other manuals dealing with components of the vehicle. In the sections dealing with the vehicle specifics the suggested manuals for reading and referencing have been recommended.

Liability Disclaimer

In the preparation of this manual, New Flyer Industries Canada ULC has incorporated and/or compiled service information and maintenance procedures/instructions sourced from manufacturers/vendors of parts and components used in the manufacturing of this vehicle. Therefore, New Flyer Industries Canada ULC shall not be liable for omissions/missing data.

It is not the intention of this manual to instruct service technicians in using common sense, basic skills and rules of service/repair. The information and specifications throughout this manual are up to date at time of publication. New Flyer reserves the right to change the content of this manual at anytime without notice.

Safety

Danger, Warnings, Cautions & Notes

Four types of headings are used in this manual to attract your attention. They appear in the text as follows:

⚠DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠WARNING

Used when an operating procedure or practice, if not correctly followed, could result in personal injury or loss of life.

⚠CAUTION

Used when an operating procedure or practice, if not strictly observed, could result in damage to or destruction of equipment.

☞**NOTE:**
Is used to provide additional information that requires special attention by the operator.

IT IS YOUR RESPONSIBILITY to be completely familiar with the warnings and cautions described in this service manual.

These warnings and cautions advise against the use of specific troubleshooting methods that can result in personal injury, damage to the equipment or cause the equipment to be unsafe. It is, however, important to understand that these warnings and cautions are not exhaustive.

New Flyer Industries could not possibly know, evaluate and advise service technicians of all conceivable ways in which service/maintenance/troubleshooting might be done or of the possible hazardous consequences of each way. Consequently, New Flyer Industries has not undertaken any such broad evaluation.

Accordingly, ANYONE WHO USES A SERVICE/MAINTENANCE/TROUBLESHOOTING PROCEDURE OR TOOLS NOT RECOMMENDED BY New Flyer Industries CANADA ULC MUST first be thoroughly satisfied that neither personal safety nor equipment safety will be jeopardized by the troubleshooting procedures selected.

Proper service and repair are important to the safe, reliable operation of the equipment. The service/maintenance/troubleshooting procedures recommended by New Flyer Industries and described in this manual are effective methods for carrying out service procedures. Some of these troubleshooting procedures require the use of special tools. The special tools should be used when and as recommended.

Special Tools

Special tools and equipment mentioned throughout the text are specifically designed to perform certain repair requirements beyond the scope of normal tools.

Contact New Flyer Parts if these special tools are not able to be obtained locally.

Vehicle Identification

To aid New Flyer personnel that is serving you, please have the appropriate V.I.N. (vehicle identification number) information. This information can be obtained from the V.I.N. sticker normally located in the front upper portion of the driver's compartment.

Abbreviations

The following is an explanation of the different abbreviations which are used.

A/R	As Required
ABS	Anti-lock Braking System
AC	alternating current
AC	Air Conditioning
ACTM	Alternating Current Traction Motor
AF	Auxiliary Functions
AGA	American Gas Association
AGC	Automatic Gain Control
AMDT	Advanced Mobile Data Terminal
amp	ampere
ANSI	American National Standards Institute
APC	Automatic Passenger Counter
APS	Auxiliary Power System
ASTM	American Society for Testing and Materials
ATC	Automatic Traction Control
AVA	Automatic Vehicle Annunciation (Voice Annunciator)
AVL	Automatic Vehicle Locator
BLK	Black
BRV	Brake Release Valve
BTU	British Thermal Unit
CAC	Charge Air Cooler
CAN	Controller Area Network
CB	Circuit Breaker
CC	Climate Control
CCA	Cold Cranking Amps
ccw	counter clockwise
cfm	cubic feet per minute
CGA	Compressed Gas Association
CLASS™	Contact-Less Acoustic Sensing System
cm	centimeter
CNG	Compressed Natural Gas
CONT	Control Port (Air Schematic)
CONT	Control
CP	Communication Provision
CS	Curbside
CSK	Countersunk
CV	Check Valve
CVSA	Commercial Vehicle Safety Alliance
cw	clockwise
D	Delivery Port (Air Schematic)
Db	Decibel
DC	direct current
DC	Double Check Valve (Air Schematic)
DC	Door Control
DE	Diesel Electric
DEF	Diesel Exhaust Fluid
DEL	Delivery
DOT	Department of Transport
DPDT	Double Pole Double Throw
DPF	Diesel Particulate Filter
DPIM	Dual Power Inverter Module
DPST	Double Pole Single Throw
DPTT	Double Pole Triple Throw
DS	Driver's Signal (Electrical Schematic)
DS	Driver's Seat (Air Schematic)
DV	Drain Valve
DVM	Digital Volt Meter
DVR	Digital Video Recorder
EAS	Electric Alternator System
EBR	Emergency Brake Release Valve
ECM	Electronic Control Module
ECP	Electronics Cooling Package (BAE Hybrid Buses)
ECU	Electronic Control Unit
EL	Exterior Lighting
ENG	Engine
EPROM	Electronic Programmable Read Only Memory
EPU	Emergency Power Unit
ES	Electrical Schematic
ESS	Energy Storage System
EVAP	Evaporator
EXH	Exhaust Port (Air Schematic)
FAP	Fuel Absolute Pressure
FET	Field Effect Transistor
FPT	Female Pipe Thread

FRT .... Fuel Regulated Temperature
FRT .... Front (Air Schematic)
FS....... Fire Suppression
FSS .... Fire Suppression System
ft-lb. .... foot pound
ft. .... foot or feet
GEN .... Generator
GI .... General Information
GND .... Ground
GOV .... Governor
GPS....... Global Positioning System
HF .... High Floor
HT .... High Temperature
HV .... High Voltage
HVAC....... Heating Ventilation & Air Conditioning
HYB....... Hybrid
HYD....... Hydraulic
Hz....... Hertz, cycles per second
I/O .... Input/Output
ID....... Inside Diameter
IDS .... Information Display System
IGN....... Ignition
IL .... Interior Lighting
in-lb. .... inch pound
IN. .... inch or inches
ISG .... Integrated Starter Generator (BAE Hybrid Buses)
ISO .... International Standards Organization
IVLU .... Integrated Vehicle Logic Unit
IVS .... Integrated Voice System
IWC .... Intermittent Wiper Control
JB .... Junction Block
Kg....... Kilogram
km .... Kilometer
kP .... Kilopascal
kW....... Kilowatt
kWh....... Kilowatt hour
L/B....... Local Buy
LCD .... Liquid Crystal Display
LED .... Light Emitting Diode
LEL....... Lower Explosive Limit
LH....... Left-Hand
LK .... Lift & Kneeling
LNG .... Liquefied Natural Gas
Ltd. .... Limited
LV....... Low Voltage
LV....... Leveling Valve (Air Schematic)
m .... meter
M/B .... Minimum Buy
mA .... Milliamp
MAP .... Manifold Absolute Pressure
MAWP....... Maximum Allowable Working Pressure
max. .... maximum
MDS....... Methane Detection System
MDT .... Mobile Data Terminal
min .... minimum
mm .... millimeter
MODV .... Modulating Valve (ABS)
MPT .... Male Pipe Thread
MSDS .... Material Safety Data Sheet
NFPA....... National Fire Protection Association
NGV .... Natural Gas Vehicle
NHTSA....... National Highway Traffic Safety Administration
NLGI .... National Lubricating Grease Institute
Nm .... Newton Meter
NOX .... Nitrous Oxide
NPT....... National Pipe Thread
NPTF .... National Pipe Thread Fine
NSS .... Not Sold Separately
OCU .... Operator Control Unit
ODK .... Operator's Display Keyboard
OEM....... Original Equipment Manufacturer
ORB .... O-Ring Boss
ORFS....... O-Ring Face Seal
OTS....... Oil Temperature Sensor
P .... Pressure Port (Air Schematic)
PA .... Public Address
PAL .... Push to Talk Logic Module
PBSS .... Push Button Shift Selector
PC....... Personal Computer
PCS .... Propulsion Control System (BAE Hybrid Buses)
PGM....... Pocket Gateway Module
PH....... Phillips Head

PMB .... Parts Manual Bulletin
PN .... Primary Network
PPM .... Parts Per Million
ppm .... parts per million
PPV .... Parking Brake Control Valve
PR .... Pressure Reducing Valve
PRD .... Pressure Relief Device
PRV .... Pressure Relief Valve
PS .... Power & Starting (Electrical Schematic)
psi .... pounds per square inch
psig .... pounds per square inch, gauge
PUR .... Purge
QR .... Quick Release
R .... Reservoir Port (Air Schematic)
RAD .... Radiator
RDV .... Rotary Dump Valve
REGEN .... Regeneration
RH .... Right-Hand
ROM .... Read Only Memory
RPM .... Revolutions per Minute
S .... Supply Port (Air Schematic)
SAE .... Society of Automotive Engineers
SBCV .... Spring Brake Control Valve
SCF .... Standard Cubic Feet
SCFH .... Standard Cubic Feet per Hour
SCFM .... Standard Cubic Feet per Minute
SCR .... Selective Catalytic Reduction
SCU .... Speedometer Control Unit
SCU .... System Control Unit (BAE Hybrid Buses)
SMB .... Service Manual Bulletin
SPDT .... Single Pole Double Throw
SPST .... Single Pole Single Throw
SPTT .... Single Pole Triple Throw
SRAM .... Static Random Access Memory
SS .... Streetside
SV .... Safety Valve
SWG .... Standard Wire Gauge
TCM .... Traction Control Module
Tpg. .... Tapping
Transv. .... Transverse
TRNSDCR .... Transducer
UHF .... Ultra High Frequency
UNC .... Unified National Coarse (thread)
UNF .... Unified National Fine (thread)
UNLDR .... Unload (Air Schematic)
VAC .... Volt Alternating Current
VCM .... Vehicle Control Module
VDC .... Volt Direct Current
VIN .... Vehicle Identification Number
VMM .... Vansco Multiplexing Module
W/C .... Wheelchair
WCLH .... Windshield Wiper Control Left-Hand (Air Schematic)
WCRH .... Windshield Wiper Control Right-Hand (Air Schematic)
WD .... Wiring Diagram
WIF .... Water in Fuel
WLAN .... Wireless Local Area Network

Indexes

- **REVISION INDEX**

This index is supplied only with an update package. It lists all pages which have been revised. Insert this index as a first page of the Index Section.

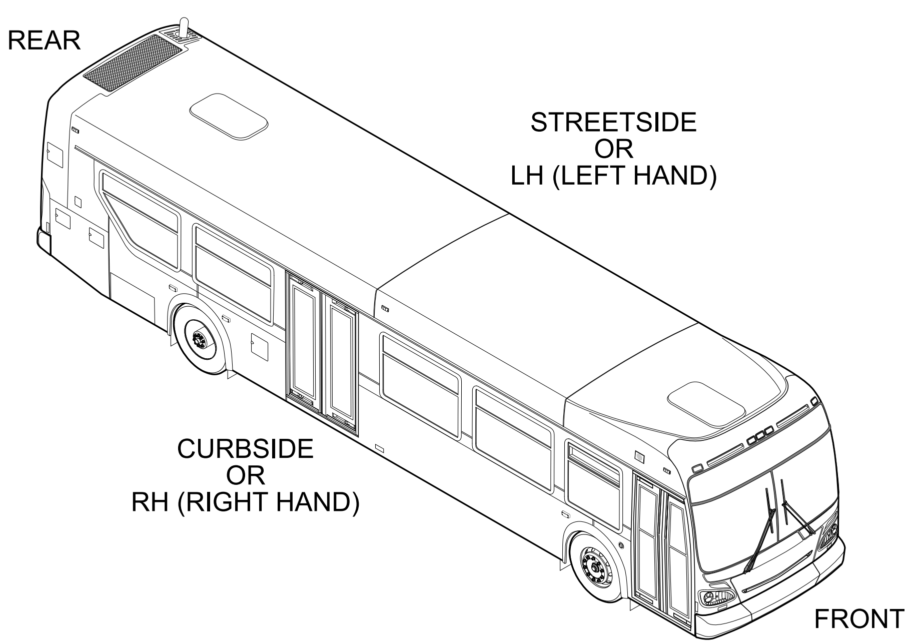
- **SECTION INDEX**

This index is located in the Index Section. It lists all sections and their corresponding section numbers.

- **ALPHABETICAL INDEX**

This is located after the Section Index. This index of subjects is alphabetically sorted for ease of use.

Vehicle Orientation



busorientationview.svg

Revision Index

Property: Washington Metropolitan Area Transit Authority

SR2107

Publication Type: Service Manual

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Current Revision Indicated by:

Current Revision Print Date: Jul 20 2020

Rev	Section/Pages Affected	Date
B	Section PM, Pages: TOC, 10 (2.5 Preventive Maintenance Guide), 64 (2.11.37 Driver's Door)	Jul 20 2020
B	Section 04, Pages: 40 (2.10.4 Installation, step2 NOTE & 3), 41 (fig. 4-24) Fire Suppression & Gas Detection Control Panel	Sep 11 2018
B	Section 07, Pages: 8 (fig. 7-1) CNG Tank Assembly	Jul 20 2020
B	Section 07, Pages: TOC, 82...83 (7. Gas Detection System), 82 (fig. 7-34) Fire Suppression & Gas Detection Control Panel	Sep 11 2018
C	Section 09, Pages: 103...106 (15.3 E-Stroke Troubleshooting)	Jul 20 2020
B	Section 09, Pages: 78, 80...83 (8.1 Headlights), 79 (fig. 9-49, list), 80 (fig. 9-50) Headlight Removal & Installation, 83 (fig. 9-52) Low Beam Center Location	Jul 20 2020
B	Section 09, Pages: 105...108 (15.3 E-Stroke Troubleshooting)	Sep 11 2018
B	Section 16, Pages: 25 (2.6.2 Door Panel Height Adjustment, step4), 38 (3.4.1 Door Panel Adjustments, step8)	Sep 11 2018
B	Section 17, Pages: TOC, 19...24 (5. Driver's Door) includes all illustrations	Jul 20 2020

Section Index

TITLE **SECTION**

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Numerical References

General Information

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❒ open flame
- ❒ excessive heat
- ❒ production of sparks
- ❒ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Maintenance Safety Procedures

This section of the service manual contains safety information which must be read and understood before attempting any service work on the vehicle. All safety procedures must be followed to ensure the safety of personnel working on or around the vehicle and to prevent any damage to equipment.

You are responsible for becoming completely familiar with the warning and cautions described in this section. These warnings and cautions advise against the use of specific service methods that can result in personal injury or damage to the equipment, or cause the equipment to be made unsafe. Anyone who uses a service procedure or tool which is not recommended by New Flyer Industries or the OEM must first be thoroughly satisfied that neither personal safety nor equipment safety will be jeopardized by the service methods selected.

Some service operations require the use of tools specifically designed for the purpose The special tools should be used when and as recommended.

1.2.1. General Safety

DANGER

During component removal or installation, ensure that the Master Run switch is set to the STOP-ENGINE position and that the Battery Disconnect switch is set to the OFF position. Failure to follow this procedure may result in personal injury or component damage.

WARNING

DO NOT perform any maintenance on roof-mounted components unless equipment is in place to prevent fall hazards. Ensure maintenance personnel use approved lift platforms or scaffolding and wear approved safety harness when working on the roof of the vehicle.

WARNING

NEVER connect or disconnect a hose or line containing pressure; it may whip. Ensure all system pressure has been depleted before removing a component or line.

WARNING

NEVER exceed recommended system operating pressures.

WARNING

ALWAYS wear safety glasses.

⚠ CAUTION

DO NOT attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understood the recommended procedures. Use only the proper tools and observe all safety precautions pertaining to use of those tools.

⚠ CAUTION

Ensure replacement hardware, tubing, hose, fittings and so forth, are of equivalent size, type, and strength as original equipment and they are designed specifically for such application and systems.

⚠ CAUTION

Repairs requiring machining or welding are not to be attempted unless specifically approved and stated by the vehicle or component manufacturer.

⚠ CAUTION

Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.

⚠ CAUTION

When working on or around a vehicle, the following safety steps should be undertaken:

- ❒ **Park the vehicle on a level surface, apply the parking brakes and always block the wheels.**
- ❒ **Cordon off, mark or use a clearly defined area to work on the vehicle. The purpose of this is to warn personnel that maintenance is being carried out on the vehicle.**
- ❒ **DO NOT run the engine unless it is necessary to perform maintenance on the vehicle.**

⚠ CAUTION

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.

1.2.2. Hoisting/Lifting & Jacking Safety

Refer to the General Information Section of this manual for recommended types of hoists, lifting equipment, and jackstands.

⚠ DANGER

Certain procedures may require the vehicle be operated in an elevated position in order to accurately troubleshoot and diagnose a problem. If the vehicle must be running while elevated, become familiar with the repair area prior to starting the engine. Take special care in noting areas which will become hot, electrically energized, and areas where moving and rotating components are located. Limit the work in these areas as personal and equipment safety is at risk.

⚠ WARNING

ALWAYS ensure that the vehicle is appropriately hoisted and blocked for procedures which require elevating the vehicle. Be aware of the limitations of the blocking equipment, and always ensure that the jarring and shaking created by component removal and installation procedures does not overload the blocks, or cause the vehicle to become unstable.

1.2.3. Air System Safety

WARNING

ALWAYS drain the air pressure from ALL reservoirs before beginning work on any air system component.

WARNING

Ensure air lines are safely depressurized prior to disconnecting. Wear safety glasses as disconnecting pressurized lines will cause solid particles deposited in the line to be uncontrollably propelled, and will also cause the hose end to whip randomly as the air escapes.

1.2.4. Electrical System Safety

During electrical diagnosis procedures an understanding of the vehicle's electric circuits is important to understand the results of connecting test equipment.

DANGER

During component removal or installation, ensure that the Master Run switch is set to the STOP-ENGINE position and that the Battery Disconnect switch is set to the OFF position. Failure to follow this procedure may result in personal injury or component damage.

WARNING

DO NOT start the vehicle remotely with the laptop software without first checking that the area is clear of personnel.

CAUTION

Before welding anywhere on vehicle, set Battery Disconnect switch to the OFF position and disconnect all electronic control modules (Multiplexing, engine, transmission, ABS, and so forth). Refer to Section 11 of this manual for additional precautionary information.

1.2.5. Hydraulic System Safety

Observe the following procedures involving hydraulic line maintenance:

WARNING

Pressurized lines should not be disconnected until the pressure is safely and controllably released.

CAUTION

Hydraulic fluid is corrosive and should not be exposed to skin for extensive periods of time. Wear eye protection at all times.

1.2.6. HVAC System Safety

Refer to Section 10 of this manual for comprehensive safety information related to the HVAC system.

1.2.7. Welding/Machining Safety

CAUTION

Before welding anywhere on vehicle, set Battery Disconnect switch to the OFF position and disconnect all electronic control modules (Multiplexing, engine, transmission, ABS, and so forth). Refer to Section 11 of this manual for additional precautionary information.

1.2.8. Paint & Chemicals Safety

1.2.8.1. Painting Safety

WARNING

Follow all proper safety precautions regarding spray painting.

WARNING

The paint booth or work area must be properly ventilated, with filtered exhaust fans removing fumes and over spray. Air make-up induction fans should also be used to supply fresh air to the work area.

CAUTION

Use a filtering mask with the proper filter cartridges. Wear eye protection and proper protective clothing.

CAUTION

The painting area should be a safe distance from any source of flame, spark or other means of combustion. Atomized paint, thinner, cleaner and solvent fumes are highly volatile with an extremely low flashpoint that can cause explosive combustion.

CAUTION

DO NOT smoke or permit anyone else to smoke in or near the painting area.

1.2.8.2. Cleaning Chemicals Safety

WARNING

Because fumes are more dangerous in a small space, be sure the vehicle is well ventilated while using any cleaning agent. Follow the manufacturer's instructions in using such products. Many cleaners may be poisonous or flammable, and their improper use may cause personal injury or damage to the inside of the vehicle. Therefore, when cleaning the interior, DO NOT use volatile cleaning solvents such as: acetone, lacquer thinners, enamel reducers, nail polish removers; or such cleaning materials as laundry soaps, bleaches, or reducing agents (except as noted for fabric cleaning of stains). NEVER use carbon cleaning products.

CAUTION

To avoid possible permanent discoloration on light colored trim, DO NOT let materials with unstable dyes come in contact with seat trim materials until totally dry. Proper cleaning techniques and cleaners must be used on trim materials. Failure to do this on the first cleaning may result in water spots, spot rings, setting of stains, or soilage, all of which make it more difficult to remove in a second cleaning.

1.2.9. Adhesives Safety

WARNING

Overexposure to adhesives used on this vehicle, specifically Sikaflex-252, may cause breathing difficulties, sensitization, headaches, nausea, vomiting. May aggravate respiratory, skin, eye, lung problems and allergies. If the product is applied according to the manufacturer's directions, none of these symptoms should be encountered. A person who is allergic to isocyanate may have a reaction with a level of isocyanate well below the T.L.V. Xylene is a central nervous system depressor and in rare cases, may cause a sensitization of the heart muscle causing arrhythmia.

Ensure the user is provided with a full face mask or safety glasses, a rubber apron, sufficient ventilation, and an eyewash station or shower. In case of overexposure, remove contaminated clothing and shoes, wash with plenty of water, wash clothing before rewearing, and consult a physician. If eyes are exposed, rinse immediately for several minutes. See a physician immediately. In case of inhalation, evacuate to fresh air and consult a physician. In case of ingestion, drink plenty of water or milk. DO NOT induce vomiting. See a physician immediately.

1.2.10. Insulation Foam Safety

WARNING

Insulation foam is installed in the spaces of the frame tubing, between the vehicle inner and outer wall panels. The Insulation Foam is extremely combustible. KEEP OPEN FLAMES AND FLAME SOURCES AWAY FROM THE INSULATION FOAM!

Before performing any work or repairs requiring use of an open flame such as: welding, brazing, acetylene torch cutting or grinding, ensure that the insulation foam is either removed from the area being repaired, or is properly shielded from the open flame.

1.2.11. Gas Spring Disposal

Gas springs must be depressurized and drained of any oil before disposal. For safety and environmental reasons, use the following procedure:

WARNING

Wear a face shield or safety glasses and place a rag over saw blade while cutting.

1. Clamp the rod end of the cylinder in a vise.
2. Mark the cylinder 30 to 35mm from the base end of the cylinder.
3. Cut a crosswise slit in the cylinder in the marked area.
4. Stop sawing as soon as a hissing sound is heard. Allow the unit to depressurize completely.

☞**NOTE:**

Nitrogen is an inert gas. Consequently, gas release is totally safe.

5. Place the cylinder in a drain pan ensuring the cut is facing down. Allow oil to drain completely. Dispose of oil in accordance with environmental regulations.
6. Recycle gas spring as a steel component.

1.3. Vehicle Operation Safety

Do not drive the vehicle if:

- ❐ Indicators, instruments or gauges show that vehicle operating systems are malfunctioning.
- ❐ Exhaust fumes are evident in the passenger compartment.
- ❐ Beneath the vehicle, engine oil, hydraulic fluid, or coolant has been leaking.
- ❐ Seating stanchions and grab rails are loose or damaged.
- ❐ Wheelchair restraints are inoperative
- ❐ Driving mirrors are broken, missing or cannot be properly adjusted.
- ❐ Exterior or interior lights are broken, discolored, or malfunctioning.

Report the occurrence of any of the above to maintenance personnel so the vehicle can be serviced before beginning revenue service.

Before operating the vehicle:

- ❐ Ensure seat belts are fastened.
- ❐ Obstructions do not block or interfere with your safe range of driving and operating vision.
- ❐ Any debris or garbage is removed from the passenger area and the doors. This is important to eliminate any foot obstructions that could cause tripping or falling.
- ❐ All exterior and interior access doors and panels are securely shut and latched.

⚠CAUTION

DO NOT smoke around the fuel storage areas, the fuel filling area or during refueling. Do not smoke in areas where fuel, hydraulic fluid, transmission oil or any other flammable fluid has leaked.

1.4. Safety Equipment

1.4.1. Fire Extinguisher

Use the extinguisher only after the vehicle is in a safe location, and all passengers are evacuated. Use only if there is no risk to your personal safety. See "Fig. GI-1: Safety Equipment" on page 7.

1.4.2. Safety Triangle

Position the triangles at the front and rear of the vehicle to warn other drivers during emergency situations.

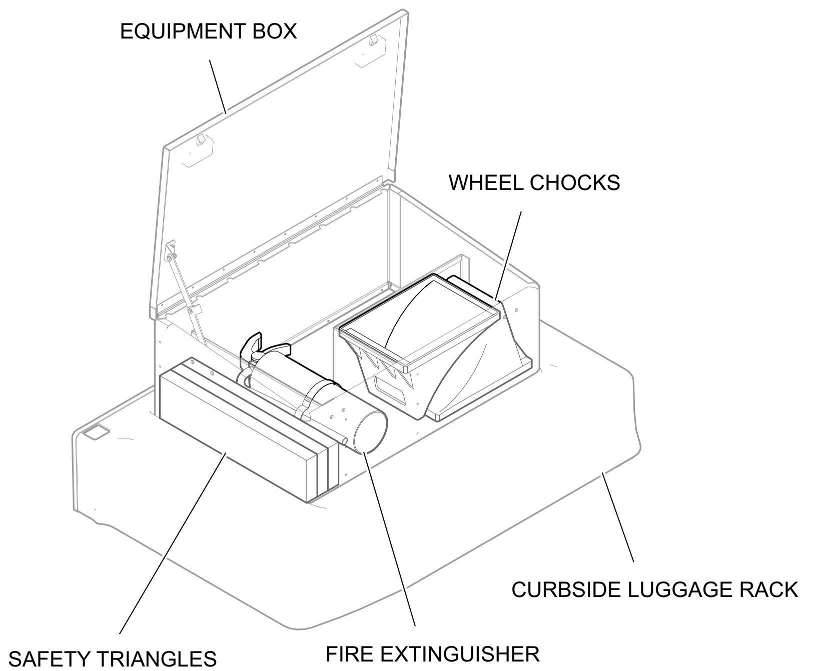


Fig. GI-1: Safety Equipment

1.5. Vehicle Safety Systems

1.5.1. Video Surveillance System

To monitor driver/passenger safety, the vehicle is equipped with a DVR video recorder located in the electronic equipment box. Cameras are located inside and/or outside the vehicle.

1.5.2. Fire Suppression & Gas Detection System

The vehicle is equipped with a Fire Suppression and Gas Detection System. The system protects the passengers and vehicle against fire and gas leaks. If a fire is detected in the engine compartment an alarm will sound and an extinguishing agent will be discharged to suppress the fire. If a gas leak is detected, an alarm will sound.

The Fire Suppression and Gas Detection System components that are located in the driver's area include the Manual Actuator switch and control panel. Refer to Sections 4 & 7 of this manual for a description of these components and the system operation.

☞**NOTE:**

An alarm sounds and the engine shuts down when the Fire Suppression System is activated.

1.5.3. Engine Fire Detection System

The vehicle is equipped with engine fire detection equipment. If an engine fire starts, the Engine Fire indicator on the instrument panel illuminates. Move the vehicle to a safe location. Shut down the engine, shut off all the electrical systems and set the parking brake and evacuate all passengers from the vehicle.

☞**NOTE:**

An alarm sounds when the Fire Detection System activates.

1.5.4. Exit Door Sensitive Edges

Pressure sensitive rubber seals are mounted to the leading edges of the exit door panels. If they encounter an object or passenger during door closure, an alarm sounds and the doors fully reopen. The doors will again close once they have fully reopened.

☞**NOTE:**

The Interlock System prevents the vehicle from moving until the exit doors have fully closed.

1.5.5. Obstruction Detection System

Acoustic sensors are mounted at the top of each door panel and in the center of the exit door header. These sensors enhance the sensitive edge function when the door is closing. They monitor the door pathway while the door is open to prevent premature closing. If they detect an object or passenger during door closure, the doors fully reopen. The doors will again close once they have fully reopened and the object or passenger has cleared the doorway.

☞**NOTE:**

The Interlock System prevents the vehicle from moving until the exit doors have fully closed.

1.5.6. Interlock System

Interlocks disable the accelerator and apply the brakes. Refer to 4.1. "Brake & Accelerator Interlocks" on page 21 in this section for information on interlock operation.

2. EMERGENCY INFORMATION

2.1. Vehicle Evacuation & Shutdown

In the event of an emergency, follow the evacuation and shutdown procedure in the sequence shown:

1. Pull the vehicle over to a safe location.
2. Apply the parking brake
3. Open the front and rear passenger doors.
4. Shutdown the vehicle by setting the Master Run switch to the OFF position.
5. Direct all passengers to a safe area, away from the vehicle.
6. Alert the transit authority of the emergency.
7. Retrieve the Emergency Responder Guide and exit the vehicle.

WARNING

Assess the situation to determine whether it is safe to approach the rear curbside area of the vehicle before proceeding with the following steps.

8. Approach the rear curbside area of the vehicle and open the Battery Disconnect access door.
9. Shut off all 12/24 VDC electrical power to the vehicle by setting the Battery Disconnect switch to the OFF position. See “Fig. GI-2: Battery Disconnect Switch” on page 9.
10. Wait for emergency response personnel to arrive and assist them by providing details of the emergency and handing over the Emergency Responder Guide.

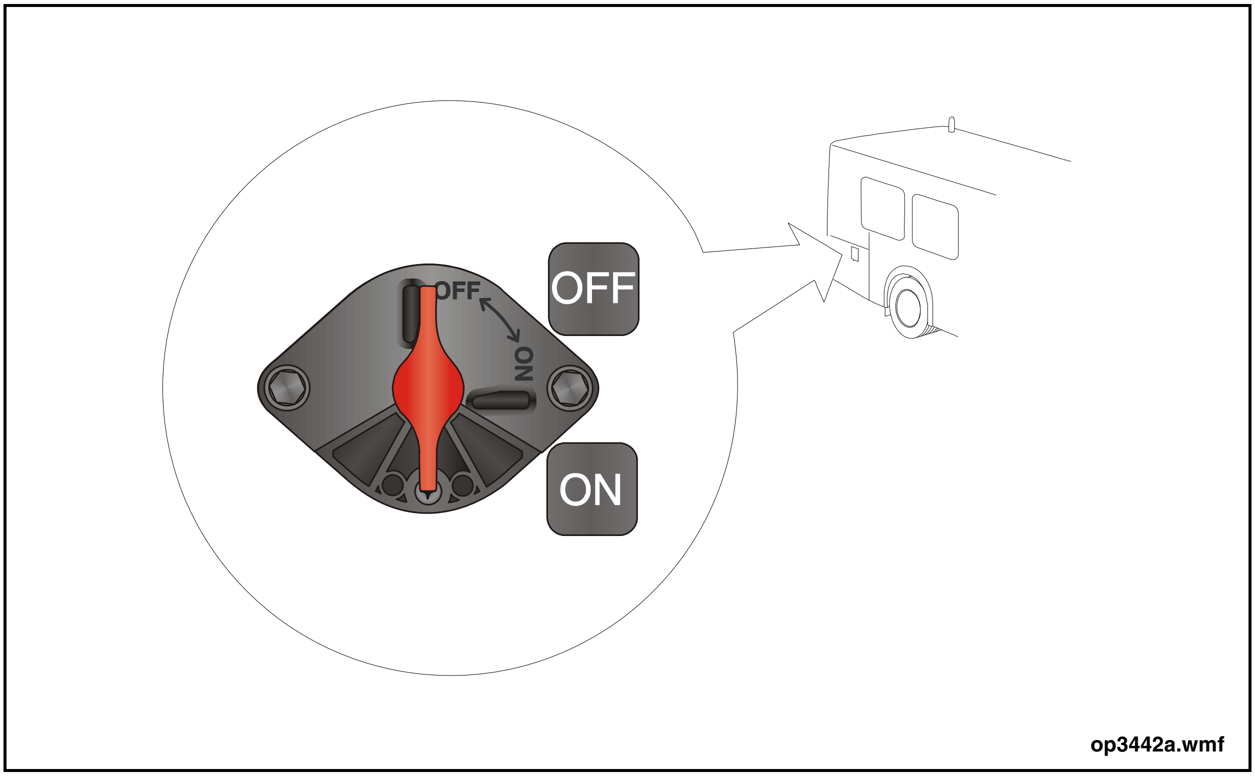


Fig. GI-2: Battery Disconnect Switch

2.2. Escape Exits

2.2.1. Side Windows

The windows which function as emergency exits are identified by labels.

To operate the emergency window, pull the red handle down and hold. Push out on the bottom of the window frame. The window will open on hinges at the top of the frame. To close, release the handle and slam window shut. See "Fig. GI-3: Emergency Release Handle" on page 10.

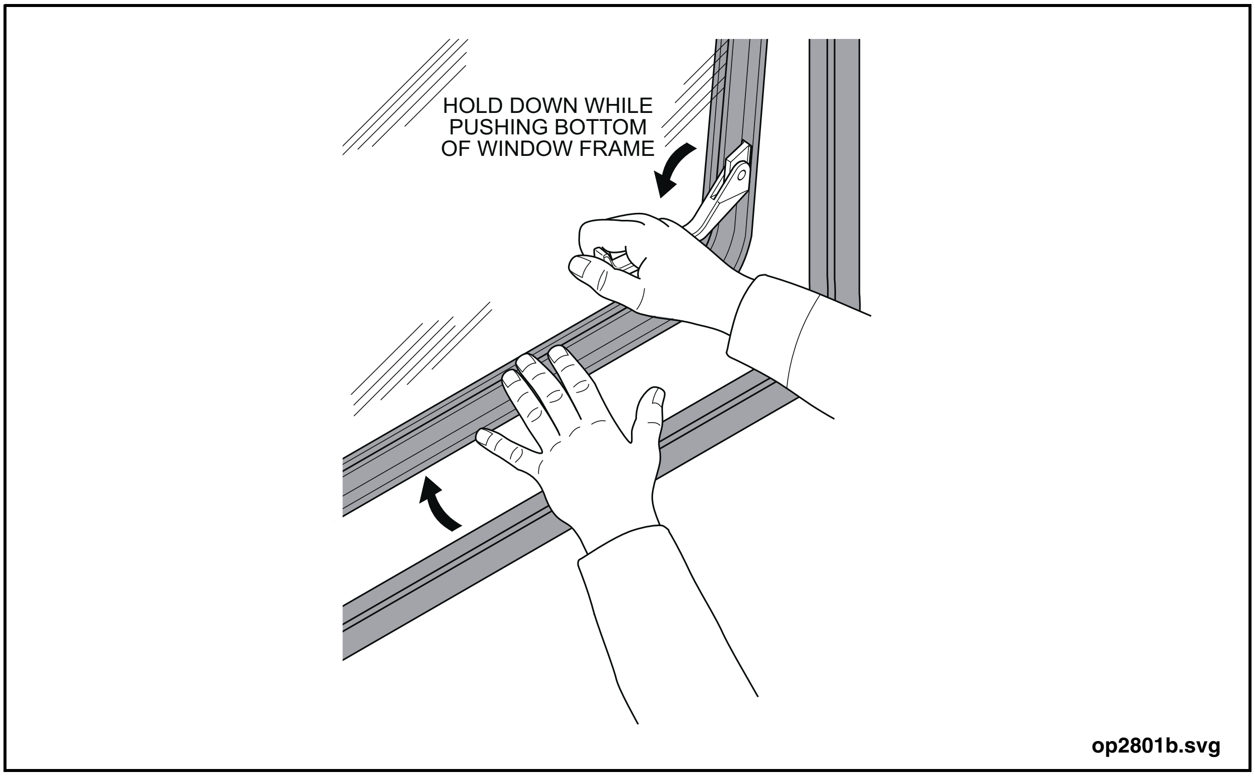


Fig. GI-3: Emergency Release Handle

2.2.2. Roof Hatches

The roof hatch functions as an emergency exit and is identified by a decal on the hatch panel. Proceed as follows to operate the emergency exit: See “Fig. GI-4: Roof Hatch Emergency Exit” on page 11.

2.2.2.1. Opening

1. Rotate the red knob 90° clockwise.
2. Push the red knob into the lid.
3. Continue to push the lid to the fully OPEN position.

2.2.2.2. Closing

1. Ensure the release hinge is in the UPWARD position.
2. Lower the lid into position.
3. Guide the release hinge into the handle base on the lid.
4. Pull down on the top of the lid to force the release hinge and the lid together until you hear the spring loaded handle set in place.
5. Grasp both sides of the lid and pull down to fully close the hatch.
6. Rotate the red knob back into the LATCHED position.

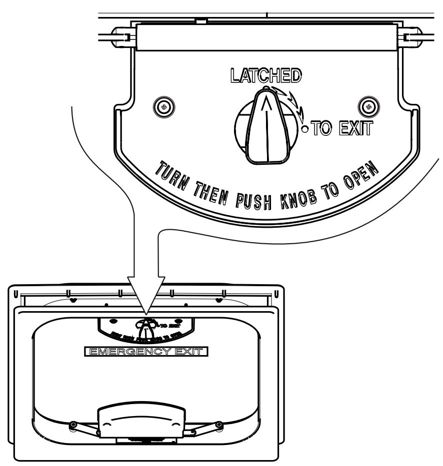


Fig. GI-4: Roof Hatch Emergency Exit

2.2.3. Emergency Release Control Valve - Entrance Door

The entrance door emergency release control valve is located behind a breakable window in the door mechanism access cover. In an emergency, break the glass to access the control valve knob. Rotate the knob 90° counter-clockwise to release air pressure from the emergency release cylinder, then push the doors open. As the doors open they activate the header and curb lights. See “Fig. GI-5: Entrance Door Emergency Release Control Valve” on page 12.

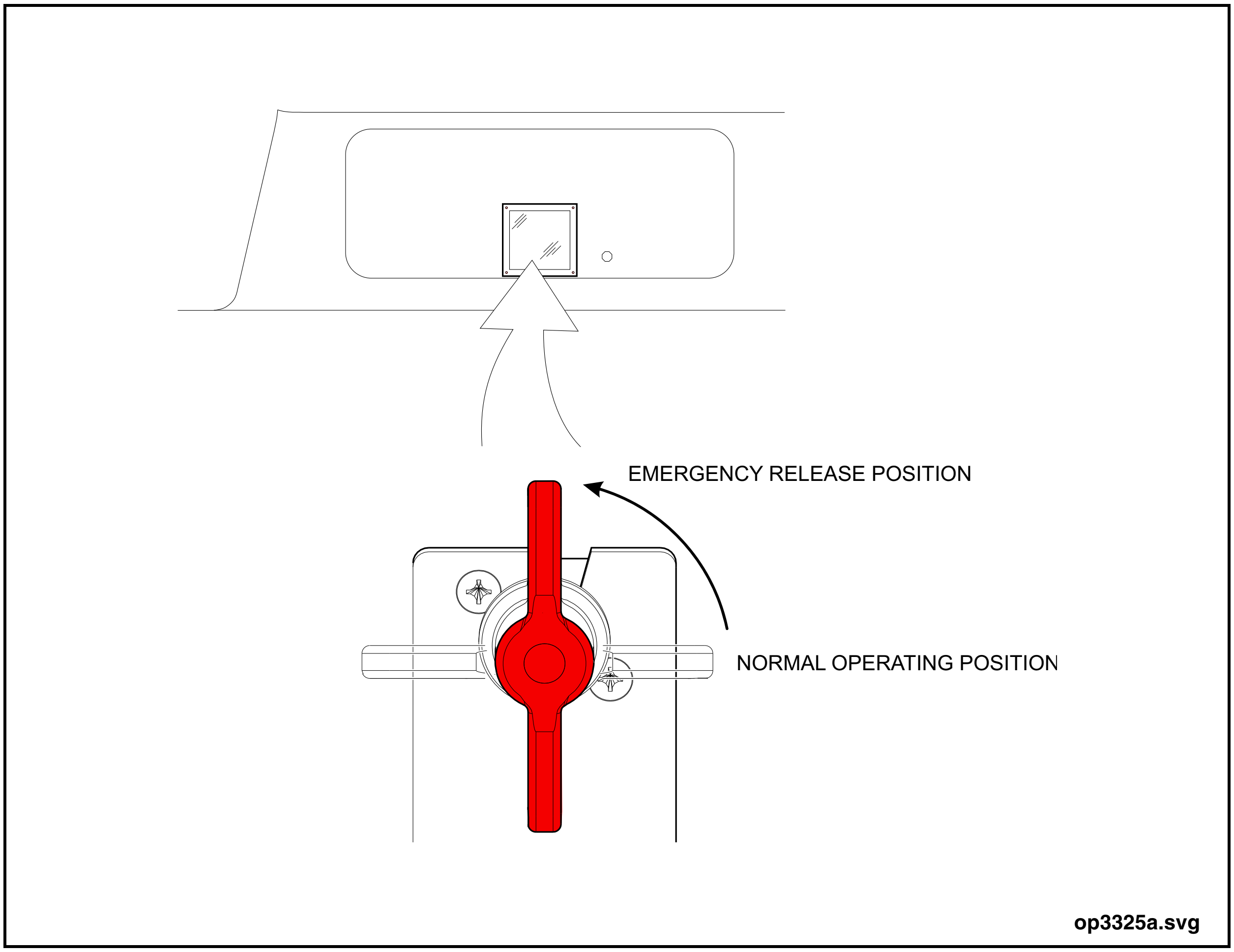


Fig. GI-5: Entrance Door Emergency Release Control Valve

2.2.4. Emergency Release Control Valve - Exit Door

The exit door emergency release control is located to the left of the exit door header, behind a breakable window. In an emergency, break the glass to access the control knob. Rotate the knob 90° counter-clockwise to release air pressure from the emergency release cylinder, then push the doors open. As the doors open they activate the header and curb lights, the brake interlocks, and the Rear Door Open indicator. See “Fig. GI-6: Exit Door Emergency Release Control Valve” on page 13.

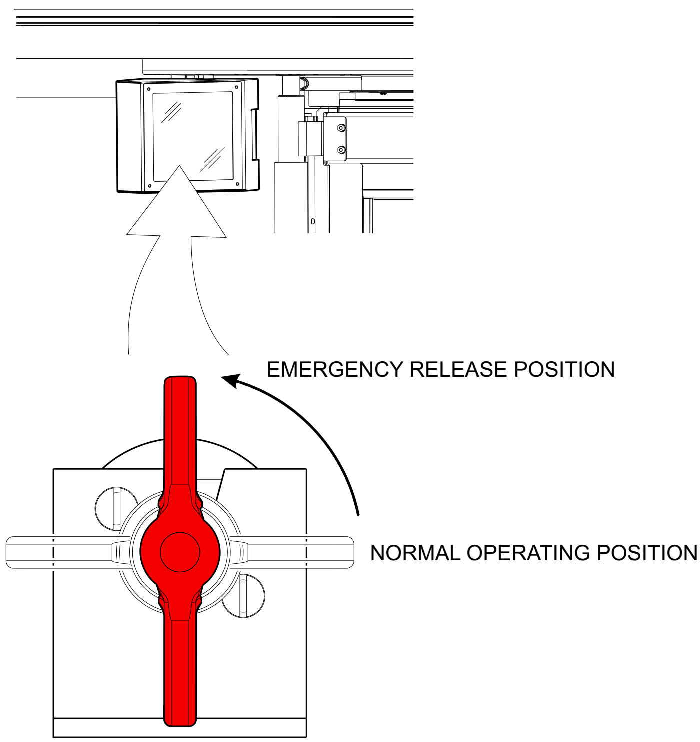


Fig. GI-6: Exit Door Emergency Release Control Valve

3. VEHICLE SPECIFICATIONS

☞**NOTE:**

Refer to the Major Component Layout when reviewing information in this manual.

VEHICLE TYPE	
Model	New Flyer XN40 transit bus
Customer	Washington Metropolitan Area Transportation Authority - SR2107
Build Year	2017
ENGINE	
Engine	*Cummins* L9N (2018)
Horsepower	280 HP
Torque	900 ft-lb.
FUEL	
Fuel	Compressed Natural Gas (CNG)
Usable Fuel Capacity	19,800 std. cu. ft. @ 3,600 psi (24,821 kPa)
TRANSMISSION	
Transmission	*Allison* B400R
Self-Contained Retarder	3 stage - 25% accelerator, 66% front brake, 100% rear brake activated
DIMENSIONS	
Length (over bumpers)	41 ft. (12.5 m)
Width	8.5 ft. (2.6 m)
Height	10.5 ft. (3.2 m)
Wheelbase	23.6 ft. (7.2 m)
Turning Radius	43 ft. (13.1 m)
Approach/Departure Angle	9°
Vehicle Weight (approx.)	30,600 lbs. (13,880 kg)
Gross Vehicle Weight Rating (GVWR)	43,820 lbs. (19,290 kg)

AXLES & SUSPENSION	
Front Axle	*MAN* VOK-07-F
Front Gross Axle Weight Rating (GAWR)	15,180 lbs. (6,803 kg)
Front Axle Ride Height	4" (102 mm)
Suspension Air Springs	*Firestone*
Suspension Shock Absorbers	*Koni*
Rear Axle	*MAN* HY-1350-F (4.56:1)
Rear Gross Axle Weight Rating	28,640 lbs. (12,990 kg)
Rear Axle Ride Height	3.8" (97 mm)
Suspension Air Springs	*Firestone*
Suspension Shock Absorbers	*Koni*
Driveshaft	*Prop Shaft Supply* 1710 with crosstooth flange & half-round connections
STEERING	
Steering Gear	*R.H. Sheppard* M110 with remote miter box
Oil Flow	3.6 gal/min
Pressure Relief	1,850 psi
Steering Column	*Douglas* Autotec 9204 Series
Power Steering Reservoir	*Cummins* reservoir
Power Steering Pump	*Ixetic*
Power Steering Reservoir	2.3 usable gallon steel tank with sight glass and return filter
WHEELS & TIRES	
Tires	*Goodyear*
Tire Size	305/70R22.5
Inflation Pressure	125 psi
Rim Mounting	10 Bolt hub piloted
Wheels	Aluminum
Maximum Load (single tire)	7,590 lbs. (3,443 Kg) @125 psi
Maximum Load (dual tires)	7,121 lbs. (3,230 Kg) @ 125 psi

BRAKE SYSTEM	
Brakes, Mechanical (front)	*Knorr-Bremse* SN7000 air-actuated sliding caliper disc brakes
Brakes, Mechanical (rear)	*Knorr-Bremse* SN7000 air-actuated sliding caliper disc brakes
Service Brake Chamber (front)	*MGM* with e-Stroke
Service Brake Chamber (rear)	*MGM* with e-Stroke
Antilock Braking System (ABS)	*Meritor Wabco* ABS on all wheels
Automatic Traction Control (ATC)	*Meritor Wabco* ATC on rear wheels
Parking Brake Application	Spring brake chamber applied with push/pull control valve located on side console
Parking Brake Release	Spring brake chamber released with application of air from push/pull control valve located on side console
Emergency Brake Application	Spring brake chamber applied with loss of reservoir pressure, modulated with brake treadle application
Emergency Brake Release	Released with push/pull control valve located on side console
Brake Monitoring System	*MGM* e-Stroke display module located inside the electronic equipment enclosure. e-Stroke brake sensor on all brake chambers & a brake alert message on the instrument panel.
HVAC SYSTEM	
HVAC Unit	*Thermo King* T15-M9 rear unit
Defroster	*Mobile Climate Control* Model No. 12-60076
Floor Mounted Heaters	*Mobile Climate Control* Model No. T12-70388 in streetside passenger area
	Mobile Climate Control Model No. T12-70336 in curbside passenger area
Driver's Booster Fan	*Mobile Climate Control* ducted blower
Compressor	*Thermo King S391*
Refrigerant	R407c
COOLING SYSTEM	
Engine Radiator	*Engineered Machined Products (EMP)* MH4 Radiator/CAC assembly with Fil-15 pusher-type fans
Radiator Diagnostics	*EMP* Dual Link CP10
Transmission Oil Cooler	*Rocore* oil to water heat exchanger located in the engine compartment

AIR SYSTEM	
Compressor	*Wabco* twin compressor, 30.4 CFM, 11 tooth
Governor	*Bendix* D2 narrow band (117 to 131 psi)
Air Dryer	*Graham White* QBA-15N air dryer
STARTING SYSTEM	
Starter	*Delco Remy* 42MT, 24 Volt
CHARGING SYSTEM	
Alternator	*Niehoff* C803D
Alternator Voltage	28 Volt
Alternator Current	500 Amp
Alternator Cooling	Air
Voltage Equalizer	*Vanner* Power Group 80A Low Voltage Disconnect (LVD)
Batteries (4)	*Odyssey Extreme Battery*
Battery Type	Maintenance-free Absorbed Glass Mat (AGM)
Battery Type	Deep Cycle
Battery Group Size	31
Battery Charge Voltage	28.7 ± 0.2 Volts
Battery Cranking Capacity	1150 CCA
EXTERIOR LIGHTING	
Headlights	Integrated unit with 12 Volt LED low beam, H11 incandescent high beam & amber LED turn lights
Exterior Stop/Tail Lights	12 Volt LED
Side Turn/Marker Lights	12 Volt LED
Clearance Lights	12 Volt LED
INTERIOR LIGHTING	
Aisle Lights	*TCB* 24 Volt LED lights with dimmable Gen 3 clever boards

INSTRUMENTATION	
Instrument Panel	*Parker-Vansco* DPS70
	User programmable inputs, outputs, gauges, telltales & LCD display
	2 Controller Area Network (CAN) ports for J1939 chassis/ drivetrain networks
	USB device port for communicating with a PC
Overhead Recess Panel	*Clever Devices* Transit Control Head in driver's overhead panel
	Fan control switches
	Fire Suppression Display Panel & Manual Actuator
MULTIPLEXING SYSTEM	
Multiplexing Module (VMM) System with J1939 Network Communication	*Parker-Vansco* VMM 1615 modules (7)
Instrument Panel	*Parker-Vansco* DPS70
AVA/AVL SYSTEM	
AVA/AVL System	*Clever Devices* IVN4 control unit based system with Transit Control Head in driver's overhead panel
PASSENGER COUNTING SYSTEM	
Automatic Passenger Counter (APC)	*Clever Devices* with entrance and exit door sensors
DESTINATION & ROUTE SIGNS	
Sign Control	*Luminator Technology Group* Multi Control Unit (MCU)
Front Destination	*Luminator Technology Group* Horizon SMT series
Side Destination	*Luminator Technology Group* Horizon SMT series
Front Route	*Luminator Technology Group* Horizon SMT series
Rear Route	*Luminator Technology Group* Horizon SMT series
DOORS	
Entrance Door	*Vapor* Electric
Entrance Door Opening Size	Medium
Limit Switches	Inductive proximity switches
Exit Door	*Vapor* Electric

Exit Door Opening Size	Medium
Limit Switches	Inductive proximity switches
Driver's Door Control	5-position door controller located on the side console
Door Entry Control	Entrance door manual dump valve, located on vertical face of driver's side console
Passenger Door Control	Contactless Acoustic Sensors (CLASS)
Passenger Door Control	Exit door driver operated
WINDOWS	
General	*Arow Global*, top tip-in
Mounting	Flush
Frame	Black anodized aluminum
Glazing	Polycarbonate
Tinting	Grey, 50% light transmittance
Driver's Window	Front slider with interior & exterior handles
Glazing	Tempered glass
Tinting	Green, 75% light transmittance
Emergency Escape	3 curbside & 5 streetside identified with labels
SEATING	
Driver's	*Recaro* Ergo Metro AM80
Passenger	*American Seating* Insight
Passenger Seating Quantity	40
Wheelchair Stations	2 (seats fold up & lock)
FLOOR & SUBFLOOR	
Subfloor	Plywood
Flooring	*Altro* Flooring
Sealant	*Altro*

SAFETY FEATURES	
Emergency Escape Exits	3 curbside windows identified with labels
	5 streetside windows identified with labels
	1 roof hatch
Fire Extinguisher	5 lb ABC rating
Fire Extinguisher Location	Curbside luggage rack, in equipment box
Safety Triangles Location	Curbside luggage rack, in equipment box
Entrance Door Emergency Release	Rotary valve located in baseplate above entrance door
Exit Door Emergency Release	Pull handle located behind breakable cover, forward of exit door
Accelerator & Brake Interlocks	*New Flyer* safety system that automatically applies the brakes and disables the accelerator based on vehicle operating conditions.
Sensitive Edges	Exit door panels
Obstruction Detection System	Contactless Acoustic Sensors (CLASS) at exit door
Fire Detection System	Engine compartment mounted fire detectors (2) with instrument panel indicator
Fire Suppression System	*Kidde Dual Spectrum*
Gas Detection System	*Kidde Dual Spectrum*
Silent Alarm	Located on side console
Camera System	*Apollo Video Technology* Roadrunner HD 12 system with 9 cameras
Wheel Deflector	S1 Gard located forward of rear curbside tire
Driver's Draft Shield Door	*Arow Global* AROWGUARD slide system driver's door
ACCESSIBILITY FEATURES	
Wheelchair Ramp	*New Flyer* hydraulic unit with patented hydraulic cylinder/chain drive mechanism
Wheelchair Ramp Width	Flip-out aluminum 32"
Wheelchair Ramp Slope Ratio	1:7
Wheelchair Ramp Max. Load Capacity	600 lbs. (272 kg.)
Kneeling	Front suspension, rapid recovery
Bike Rack	*Sportworks* DL2 2 position

4. STANDARD OPERATING FEATURES

4.1. Brake & Accelerator Interlocks

Interlocks disable the accelerator and apply the brakes. The interlocks function only when the Master Run switch is in DAY-RUN or NIGHT-RUN position and the Door Master switch is in the ON position.

Interlocks apply if any of the following conditions occur:

- ❒ Entrance or exit doors are open or enabled.
- ❒ Exit door emergency release valve is actuated or there is a loss of air pressure at the exit door.
- ❒ Vehicle is kneeling.
- ❒ Wheelchair ramp is not stowed.
- ❒ Parking brake is applied.

The Interlock System is intended to protect passengers from inadvertent vehicle movement. The Door Master switch can be used to disable the system for maintenance purposes or in an emergency.

☞**NOTE:**

The brake treadle drops slightly when the interlock system applies. When the interlocks apply, the multiplexing system logs the application pressure in the brake lines. To release the interlocks, the operator must "push through" the interlock application, exceeding the logged pressure by 10 psi. When released, the treadle will return with the operator's foot to its normal position.

4.2. Lighting

- ❒ The aisle lights switch off when the transmission is shifted into reverse [R].
- ❒ The timer circuit switches the aisle lights off after 30 minutes if the vehicle Master Run switch is switched to STOP-ENGINE or NIGHT-PARK and the aisle lights are left on.
- ❒ All exterior lights switch on for 2 minutes if the engine is running, the transmission is in neutral [N], the parking brake is applied and both turn signal switches are pushed simultaneously. The lights are extinguished by shifting the transmission out of neutral [N]. This feature enables one person to test the exterior light system.
- ❒ All indicators and aisle lights switch off during starter cranking interval.
- ❒ Retarder operation illuminates the stop lights and stop light indicator.
- ❒ Exterior exit door lights are timed to remain illuminated 5 seconds after exit door fully closes.
- ❒ Exit door header lights are timed to switch off 15 minutes after the Master Run switch is positioned to NIGHT-PARK and the exit door is open or enabled.
- ❒ Service compartment lights switch off when the Multiplexing System is deactivated to prevent battery drain.
- ❒ Daytime running lights illuminate when the Master Run switch is in the DAY-RUN or NIGHT-RUN position. They can only be turned off by switching the Master Run switch to NIGHT-PARK or OFF.

4.3. Transmission

- ❒ Transmission will not shift unless Engine Run switch on engine switch box is set to the FRONT position.
- ❒ Transmission will not shift unless brake treadle is pressed.
- ❒ Transmission will not shift unless wheelchair ramp is stowed.
- ❒ Transmission will not shift if there is no air pressure in front door.
- ❒ Transmission shift selector is operable in all the previous cases if the Door Master switch is set to the OFF position.

4.4. Starting

The following conditions must exist when attempting to start the vehicle using the start button located on the driver's side console:

- ❒ Engine Run switch on the engine switch box must be set to the FRONT position.
- ❒ Master Run switch on the driver's side console must be set to either the DAY-RUN or NIGHT-RUN position.
- ❒ Transmission must be in neutral [N].
- ❒ Parking brake must be applied.
- ❒ Starter must not be locked out.

The following conditions must exist when attempting to start the vehicle using the engine switchbox start button located in the engine compartment:

- ❒ Engine Run switch on the engine switch box must be set to the REAR position.
- ❒ Transmission must be in neutral [N].
- ❒ Parking brake must be applied.
- ❒ Starter must not be locked out.

☞**NOTE:**

It may be necessary to hold the engine switchbox start button for several seconds before the starter begins cranking. This delay will occur if the vehicle has been shutdown for an extended time period and the Multiplexing System needs to be re-energized.

- ❒ The voltage regulator does not energize until the vehicle has been running for 3 seconds.
- ❒ Starter automatically cuts out if the engine is cranked for 14 continuous seconds. The starter can be engaged again to crank the engine after a 60 second cool-down period.
- ❒ To activate fast idle, the Engine Run switch must be set to the FRONT position, the transmission must be in neutral [N], the parking brake applied and the Idle Speed switch on the side console must be set to the FAST position while the engine is running.
- ❒ The HVAC System cannot be activated unless the engine is started and running and the Fire Suppression System does not indicate any faults.

4.5. Warning Alarms

An exterior alarm or beeper will sound if any of the following conditions occur:

- ❒ The backup alarm sounds if the transmission is shifted into reverse [R].
- ❒ The backup alarm sounds twice if REAR start is selected.
- ❒ The kneeling/ramp beeper sounds if the vehicle is in the process of kneeling.
- ❒ The kneeling/ramp beeper sounds if the wheelchair ramp is being deployed or stowed.
- ❒ The kneeling/ramp beeper sounds if the vehicle is shut down and the parking brake is not applied.
- ❒ The kneeling/ramp beeper sounds if the driver leaves the driver's seat for two seconds and the parking brake is not applied.

A driver's warning buzzer, located behind the instrument panel, sounds if the engine is running and any of the following conditions occur:

- ❒ Stop engine - The Stop Engine indicator illuminates and the buzzer sounds if the engine ECM has detected a major engine fault. An automatic engine shutdown process will be initiated.
- ❒ Low air pressure - If any brake air tank falls below 75 psi, an indicator light on the instrument panel will illuminate and the warning buzzer will sound.
- ❒ Low oil pressure - If the engine ECU detects an unsafe oil operating pressure, it will cause the indicator light on the instrument panel to illuminate, the warning buzzer to sound, and initiate an automatic engine shutdown process.
- ❒ Low coolant level - The low coolant sensor in the surge tank will detect a low coolant level and illuminate the Low Coolant indicator and activate the warning buzzer.

- ❒ Hot engine - If the engine coolant temperature switch detects an unsafe operating temperature, it will cause the Hot Engine indicator to illuminate and the warning buzzer to sound.
- ❒ Hot transmission - If the Transmission Fluid Temperature switch detects an unsafe operating temperature, it will cause the Hot Transmission indicator to illuminate and warning buzzer to sound.
- ❒ Engine fire - If the fire detection system activates a warning message will illuminate and the warning buzzer will sound.
- ❒ The Door Master switch is set to the OFF position.
- ❒ Low air pressure at the exit door.
- ❒ The exit door emergency release valve is actuated.
- ❒ The exit door sensitive edges are touched when the vehicle is standing and the exit door is not fully open.
- ❒ Alternator Fault - if the multiplexing system detects a fault with the alternator.
- ❒ Seat Belt (Red) - This message appears on the LCD screen and a buzzer sounds when the driver's seat belt is not buckled and the engine is running.
- ❒ The acoustic door sensor operating system has detected a fault or been deactivated by the CLASS power switch.

4.6. Wheelchair Ramp

- ❒ The wheelchair ramp will not work unless the parking brake is on, the transmission is in neutral [N] and the door is open.

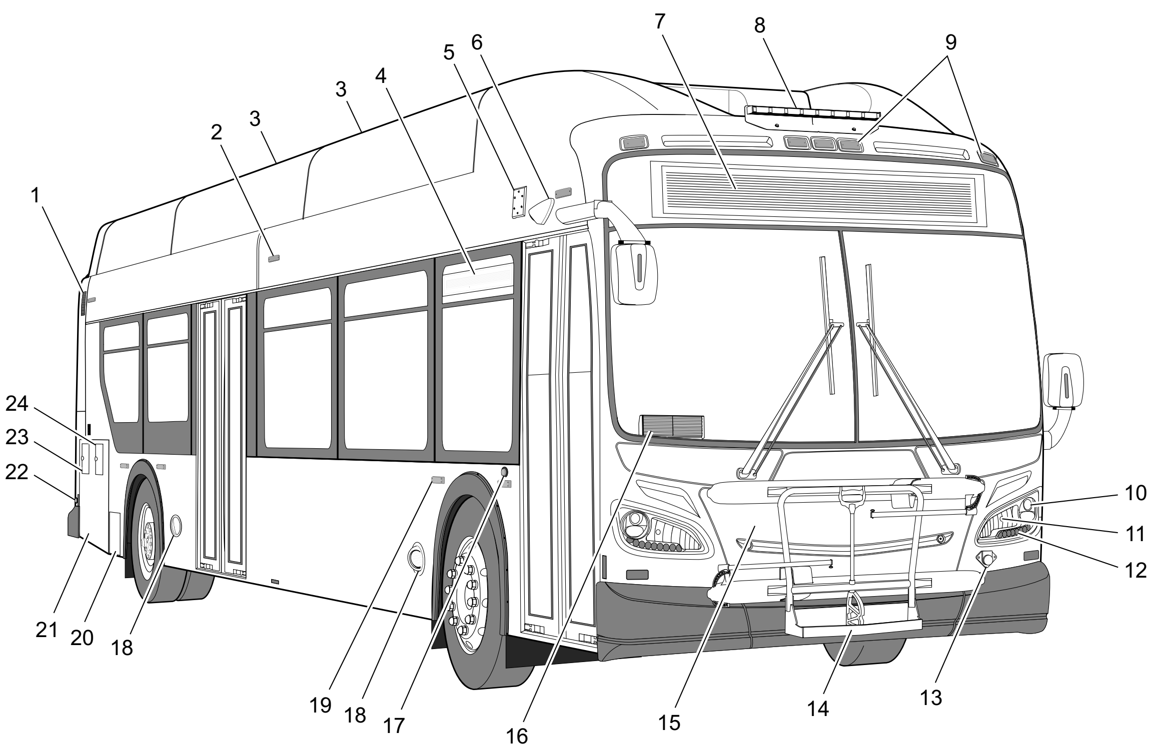
4.7. Multiplexing System

- ❒ The Multiplexing System remains active for 30 minutes after the Master Run switch is set to the OFF position and the Engine Run switch on the rear engine switch box is set to the FRONT position.
- ❒ The Multiplexing System remains active for 2 hours after the Master Run switch is set to the OFF position and the Engine Run switch on the rear engine switch box is set to the REAR or OFF position.

5. EXTERIOR VIEWS

5.1. Structure

The basic frame structure is a semi-monocoque design, which uses high tensile steel plate and tube for structural strength. Full length longitudinal members are used, with cross member pillars, roof bows and bulkheads. All joints are Gas Metal Arc Welded (GMAW). The exterior panels carry no load. Steel tapping plates are GMAW welded to the structure. All fixtures and accessories attached to the structure are drilled and tapped into the tapping plates to maintain the strength of the structure. See “Fig. GI-7: Front Exterior View” on page 24. See “Fig. GI-8: Rear Exterior View” on page 25.



1. Engine Air Intake Grille
2. Side Marker Light
3. CNG Tank Enclosure
4. Side Destination Sign
5. Exterior Speaker
6. Surveillance Camera
7. Front Destination Sign
8. Strobe Light
9. Clearance Marker Lights
10. Headlight, Low Beam
11. Headlight, High Beam
12. Front Turn Light
13. Tow Electrical Connector
14. Bike Rack
15. Defroster/Wiper Access Door
16. Front Route Sign
17. Kneeling/Ramp Warning Light
18. Cornering Light
19. Side Turn Light
20. Battery Access Door
21. Fusebox Access Door
22. Lower Rear Clearance Marker Lights
23. Fuel Filler Access Door
24. Battery Cutoff Switch Access Door

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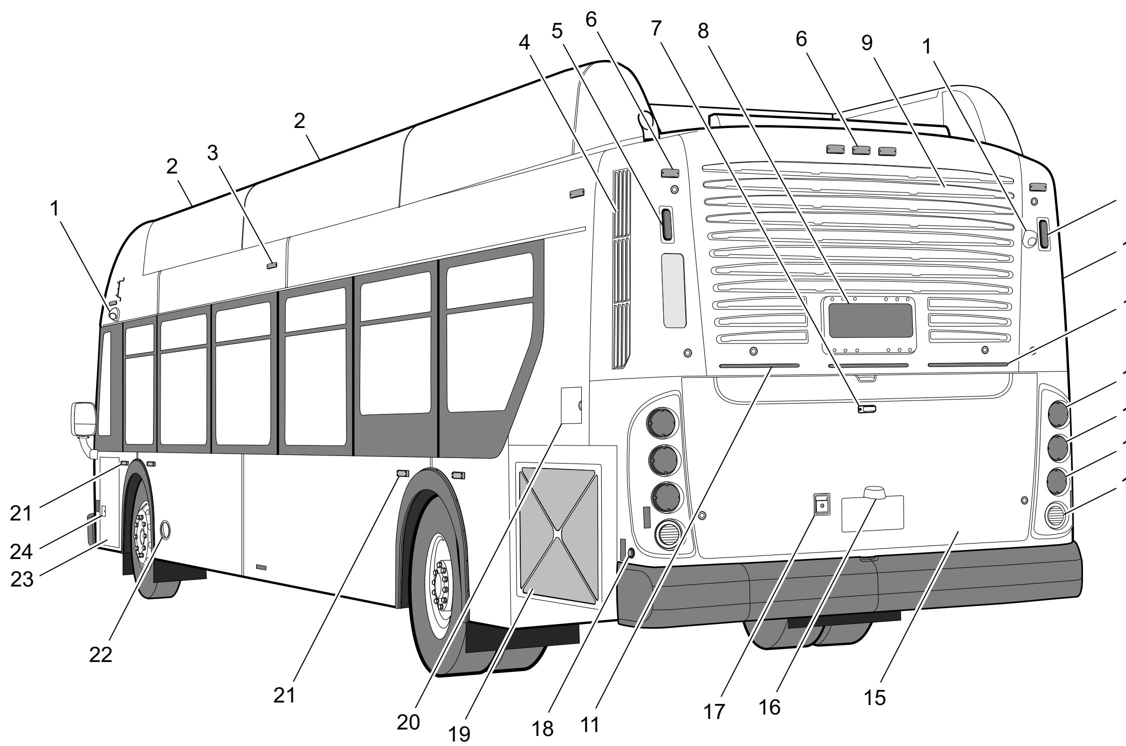
Fig. GI-7: Front Exterior View

5.2. Exterior Panels

The exterior aluminum and fiberglass panels are not part of the basic body structure. The front mask and rear crown panels are molded fiberglass panels. They are secured along the top and sides using stainless steel rivets and high strength sealant/adhesive. The exterior side and pier panels cover the area below the window opening. The roof is composed of two overlapped fiberglass panels with one hole cut at each end for escape hatches.



1. Surveillance Camera
2. CNG Tank Enclosure
3. Side Marker Light
4. Muffler Access Door
5. Upper Turn Signal
6. Clearance Marker Lights
7. Strobe Light
8. Rear Route Sign
9. HVAC Unit Access Door
10. Air Filter Access Door
11. Center Stop Light
12. Turn Signal Light
13. Stop/Tail Light
14. Backup Light
15. Engine Access Door
16. License Plate Light
17. Engine Access Door Latch
18. Lower Rear Clearance Marker Lights
19. Radiator Access Door
20. Surge Tank Access Door
21. Side Turn Light
22. Cornering Light
23. Side Console Access Door
24. Windshield Washer Filler

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Fig. GI-8: Rear Exterior View

5.3. Doors

The entrance and exit doors each consist of two panels fitted with door shafts, roller brackets and glass inserts. Both are slide/ glide style doors. They are opened using the door controller on the driver's side console. A base plate assembly is mounted behind an access panel above each door. Each base plate is equipped with an electric motor which operates a gear assembly connected to a teeter lever on the output shaft. When the door controller is actuated, the electric motor rotates the gear and lever assembly. This action operates connecting rods fastened to the door shaft levers. The levers rotate and the door panels open. A manually operated emergency valve is located next to each door behind a protective cover. Switches on each base plate inform the Multiplexing System of door status. These switches are used as signals for the interlock and wheelchair ramp systems.

5.4. Windows

- ❒ The front windshield consists of three windshield sections that are formed from laminated safety glass and are installed in the front mask apertures.
- ❒ The driver's side window consists of a slide-open sash style window with tinted safety glass and is retained within a clamp style anodized aluminum frame.
- ❒ Passenger windows are located along both sides of the vehicle and consist of tinted safety glass windows retained within a clamp-type anodized aluminum frame. The curbside window located aft of the entrance door has a clear tint on the upper section of the window to allow for side destination sign visibility.

5.5. Lighting

- ❒ The exterior lighting system consists of headlights, turn indicators clearance markers, stop lights, tail lights, backup lights, kneeling lights, and curb lights.
- ❒ The interior lighting system consists of an overhead light located in the driver's area and aisle lighting panels located above the side windows on either side of the vehicle.

5.6. Destination Signs

The destination sign system consists of:

- ❒ Destination sign controller, located in the driver's overhead panel.
- ❒ Front destination sign, located above the windshield
- ❒ Side destination sign, located on the interior of the curbside window, aft of the entrance door.
- ❒ Front route sign, located on the interior curbside corner of the windshield.
- ❒ Rear route sign, located on the exterior of the rear panel.

5.7. Access Compartments

5.7.1. Engine Compartment

The engine access door is located at the rear of the vehicle. The door is equipped with one fixed handle to raise the door, and two assist cylinders to support the door when in the open position. One of the two cylinders is equipped with a safety latch. The door is also equipped with a license plate holder and a license plate lamp.

5.7.2. Upper Corner Pillar Access

The upper corner pillar access doors are located on the streetside and curbside at the rear of the vehicle. These access doors are secured with square-key quarter-turn latches at the rear of the vehicle. They are hinged and pivot 90° outward to allow access to the exhaust system and air cleaner.

5.7.3. Battery Compartment

❒ Battery Tray

The battery tray is a slide out style tray, constructed of acid resistant stainless steel, on stainless steel rollers. Rubber isolation mounts help to isolate the tray from the structure of the vehicle and an isolator pad on the surface of the tray helps to isolate the batteries from the tray. These mounts reduce road vibrations from being transmitted directly to the batteries.

❒ Battery Disconnect Switch

The battery disconnect switch access door is a standard spring loaded door, at the rear of the curbside of the vehicle. The battery system disconnect switch assembly is mounted on the front cover of the fusebox, accessible through or under the right hand access door.

❒ Rear Equipment Box

The rear equipment box, which is accessible through the battery compartment, provides access to the accessory equipment such as; air components, voltage regulator, and assorted fuses.

5.7.4. Surge Tank Compartment

The surge tank access door is spring loaded and is located on the streetside of the vehicle above the engine radiator door. It allows access to the surge tank.

5.7.5. Radiator Compartment

The streetside radiator access door uses a stainless steel piano hinge, two 130 lb. gas struts, and two 5/16" quarter-turn square key locks. The radiator door is an aluminum panel with a perforated stainless steel screen.

5.7.6. Driver's Heater/Defroster Compartment

The driver's heater/defroster access door is centered below the two windshield halves on the front mask. It provides access to the heater/defroster and the towing air connections.

6. INSTRUMENT PANEL

6.1. Description

The instrument panel houses the electronic instrument cluster. The instrument cluster includes gauges, LCD display screen and odometer, telltale indicators, and control buttons. The LCD screen is a programmable unit with diagnostic capabilities. A USB port is located below the instrument panel which is intended for configuring the instrument cluster using a PC.

The instrument panel is also fitted with controls and switches for operating electrical and mechanical devices. See “Fig. GI-9: Instrument Panel” on page 28.

1. Instrument Cluster
2. Rear Air Pressure Gauge
3. Front Air Pressure Gauge
4. Speedometer
5. LCD Screen
6. Shift Selector
7. Ramp Switch
8. Kneel Switch
9. Wiper/Washer Control
10. Panel Lights Dimmer Switch
11. Driver’s Floor Heat Control
12. Defroster Fan Control
13. Defroster Air Recirculation Control
14. Defroster Temperature Control

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Fig. GI-9: Instrument Panel

7. SIDE CONSOLE PANEL

7.1. Description

The driver's side console is located to the left of the driver's seat, below the driver's side window. The panel is fitted with pneumatic and electrical control devices and switches. The aluminum panel and frame are mounted on a set of slider rails for ease of access to the electrical and pneumatic connections mounted to the interior of the drawer-like mechanism. Two 50 lb. spring cylinders support the assembly in the raised position. A side console access door, located on the exterior streetside of the vehicle, also gives access to its lower electrical components, and pressure switches. See "Fig. GI-10: Side Console Panel" on page 30.

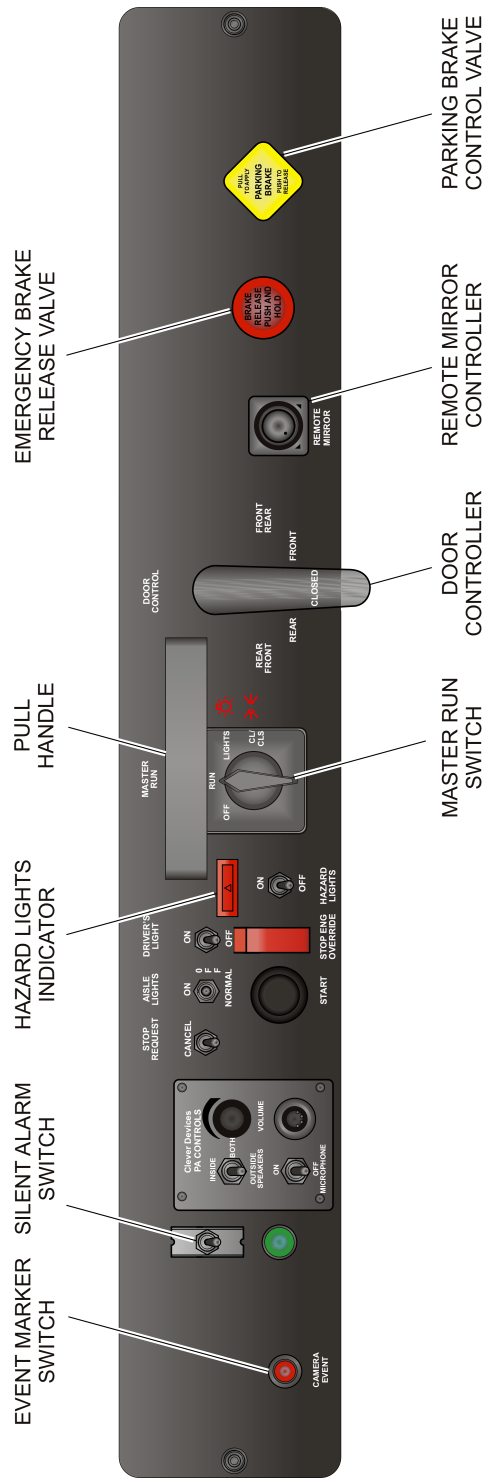

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Fig. GI-10: Side Console Panel

8. AIR TANK INSTALLATION

8.1. Description

Stainless steel air tanks are mounted behind the interior lighting panels along the sides of the vehicle. They are part of a system which includes the engine air intake and air compressor, the air dryer, muffler tank and wet tank. This system provides air to the suspension, brakes, and accessories. Charging fittings are provided in the engine compartment and under the front bumper to allow remote charging of the air system for vehicle towing. See “Fig. GI-11: Air Tank Installation” on page 31.

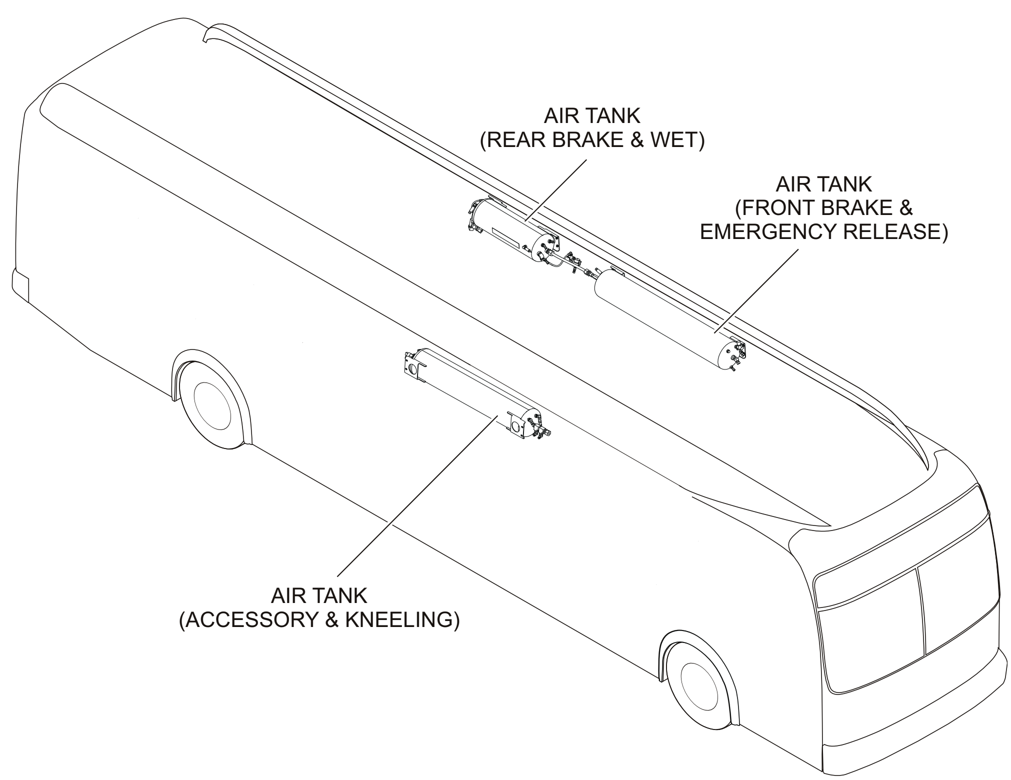


Fig. GI-11: Air Tank Installation

9. AIR TANK DRAIN VALVE LOCATIONS

☞NOTE:

Refer to the Preventive Maintenance Section of this manual for air tank drain intervals.

9.1. Description

Air system tanks are provided with drain lines which terminate in manual drain valves. These valves are accessible at the lower edge of the vehicle at the locations indicated. See “Fig. GI-12: Air Tank Drain Valve Locations” on page 32. Tanks are drained to remove accumulated moisture from the air system and to protect the tanks from possibility of corrosion.

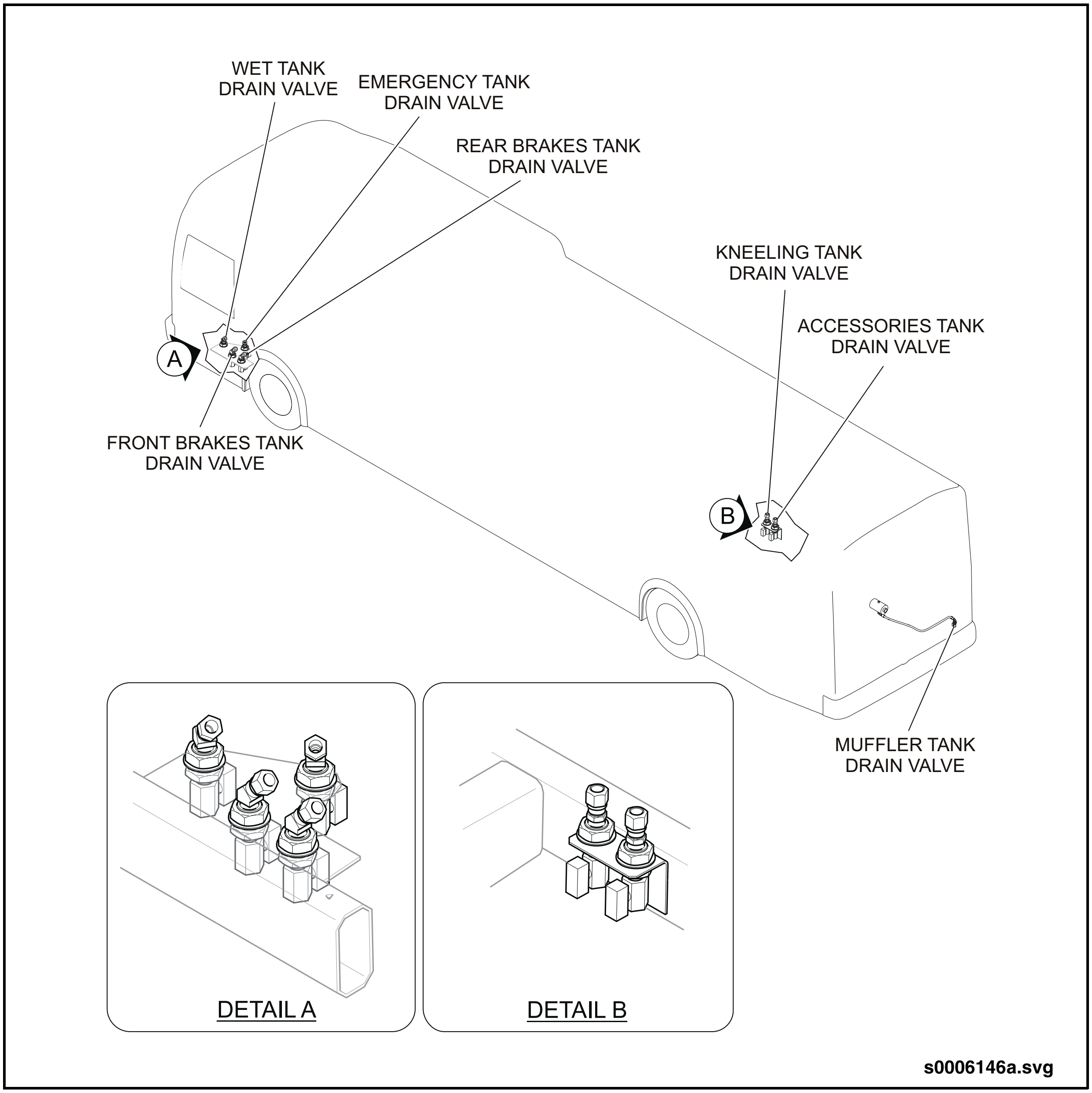


Fig. GI-12: Air Tank Drain Valve Locations

10. PRESSURE SWITCHES

10.1. Front Brake Circuit Pressure Switch

10.1.1. Description

The Front Brake Circuit Pressure switch is an electro-pneumatic 4 psi non-grounded switch used to signal the Multiplexing System when the front brake circuit application pressure reaches or exceeds 4 psi. It is mounted on the E-6 brake valve and accessed through the side console access door.

The switch is not a serviceable item and must be replaced as a unit if found defective.

10.1.2. Operation

When the brakes are applied, air pressure from the brake valve enters the cavity below the switch diaphragm. The air pressure moves the piston until it contacts the leaf spring.

The leaf spring pivots on a fulcrum at 4 psi and snaps a shorting bar which mates with the contact strips. This snap action spring is designed to minimize arcing. The electrical circuit closes, signaling the Multiplexing System.

The Multiplexing System uses the signal from the Front Brake Circuit Pressure switch to activate the brake lights.

10.2. Brake Application Pressure Transducer

10.2.1. Description

The brake application pressure transducer is ruggedly constructed of a stainless steel or aluminum cylindrical body that encloses one-piece stainless steel sensing elements. The transducer has threads and wrench surfaces at one end and a sealed electrical connector at the opposite end. It is mounted on the front brake valve panel plate.

10.2.2. Operation

The pressure transducers transmit an analog signal to the vehicle's multiplexing system. The multiplexing system converts the analog signal into pressure readings which are used to illuminate the brake lights and signal both the retarder system and the brake interlock system.

10.3. Parking Brake/Stop Light Switch

10.3.1. Description

The Parking Brake/Stop Light switch is an electro-pneumatic 60 psi non-grounded switch that completes the electrical circuit and illuminates the stop lights when the park brake is applied. It is located on the pressure reducing valve mounted on the front brake panel. The switch can be used with either 12 or 24 volt systems. See “Fig. GI-13: Pressure Switches” on page 34.

The switch is not a serviceable item and must be replaced as a unit if found defective.

10.3.2. Operation

The switch has normally closed contacts which are held open by spring brake release air pressure. Applying the parking brake reduces air pressure in the spring brake release line. When air pressure in the line drops to 60 psi or less, the spring inside the PS4 switch moves against the diaphragm to close the switch contacts and illuminate the stop lights.

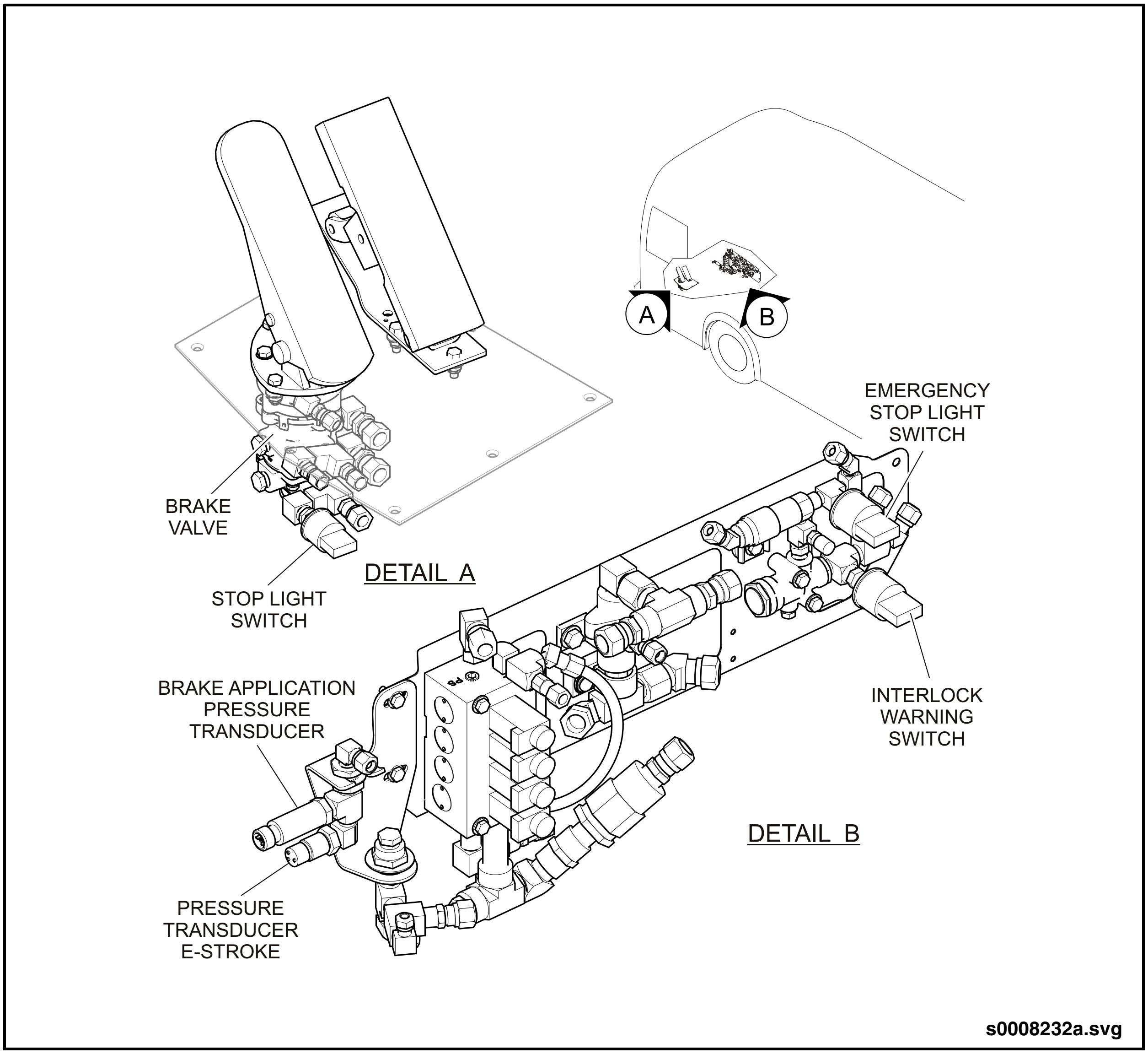


Fig. GI-13: Pressure Switches

10.4. Electronic Stroke Alert Pressure Transducer

10.4.1. Description

This pressure transducer is teed into the front brake apply circuit. It receives power from the brake stroke monitor chassis communication module and supplies a variable voltage signal to the module based on brake application pressure. Refer to Section 9 of this manual for further information on this equipment.

10.4.2. Operation

The transducer receives power from the brake stroke monitor chassis communication module and supplies a variable voltage signal to the module based on brake application pressure. Refer to Section 9 of this manual for further information on this equipment.

11. BRAKE INTERLOCK CONTROL SYSTEM

11.1. Description

The brake interlock control system consists of a pressure reducing valve, a solenoid valve and a brake valve actuator. See “Fig. GI-14: Brake Interlock Valves” on page 36.

- The brake interlock pressure reducing valve receives its air supply from the front or rear brake tank via the emergency/parking brake valve system. The pressure reducing valve is set to regulate the interlock pressure to 70 psi. The outlet of the pressure reducing valve regulator is connected to the brake interlock solenoid valve.
- The brake interlock solenoid valve is normally closed. When energized by the Multiplexing system, it opens and applies pressure from the brake interlock pressure reducing valve to the brake valve actuator on the E-6 brake valve.
- The brake valve actuator on the E-6 brake valve receives air pressure from the pressure reducing valve and the brake interlock solenoid valve and applies the service brakes. This action will mimic a foot application of the brake treadle and will apply both front and rear service brakes.

☞NOTE:

The treadle will fall away from the operator's foot when the interlocks apply.

Releasing the interlocks will require the vehicle operator to push through the interlock application. Applying sufficient pressure on the treadle to exceed interlock pressure by 10 psi will release the interlocks and the treadle will return to its normal position.

☞NOTE:

Interlock application and release will be accompanied by a text message on the instrument panel LCD screen. Refer to Section 19 in this manual for more information on the instrument panel text messages.

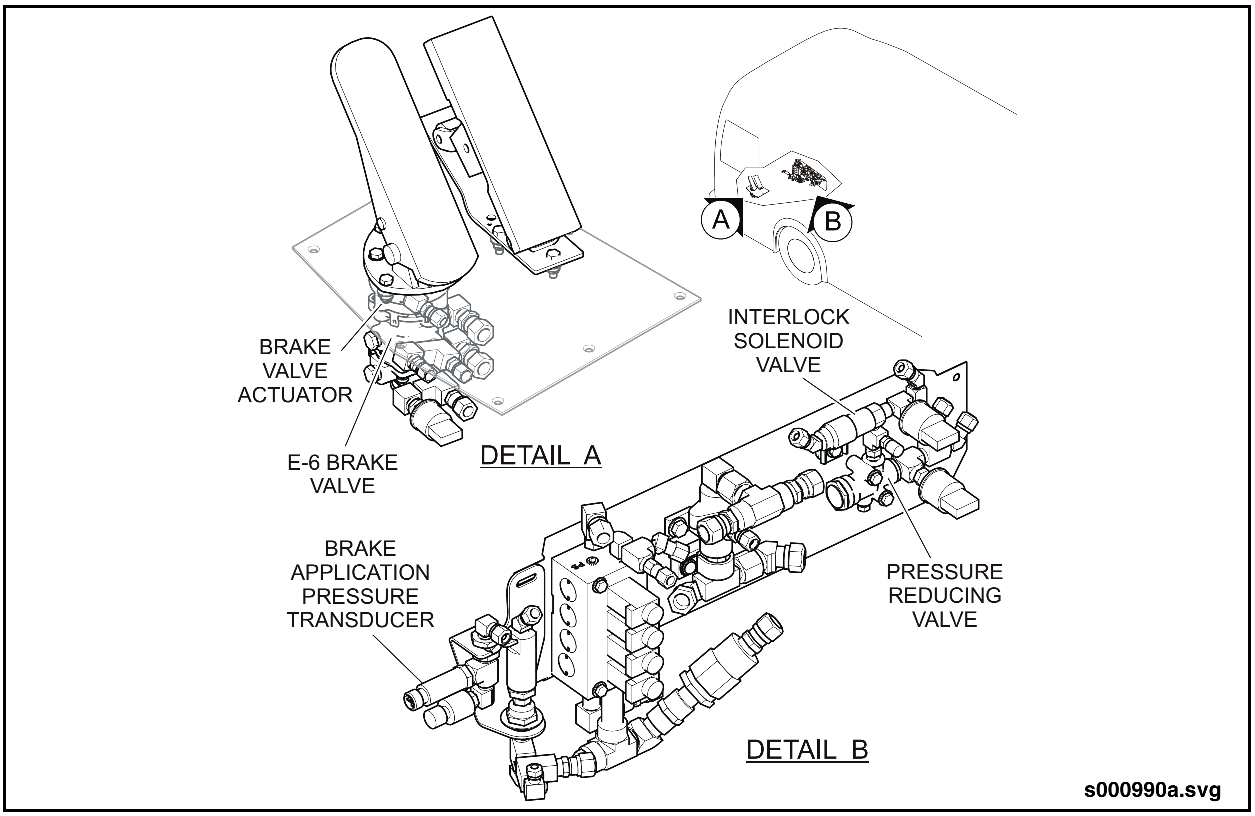


Fig. GI-14: Brake Interlock Valves

12. CNG FUEL SYSTEM

12.1. Description

This vehicle is equipped with a Compressed Natural Gas (CNG) Fuel System. See "Fig. GI-15: Fuel System Layout" on page 37. This system consists of the following components:

- ❒ Eight roof-mounted CNG tanks housed in protective enclosures.
- ❒ A fuel filler box installed on the curbside of the vehicle, which contains a high pressure regulator, two fueling receptacles, a purge valve with a quick connect receptacle, a high pressure gauge, a low pressure gauge, and a low pressure switch.
- ❒ Primary and secondary fuel filters.
- ❒ A closed loop fuel regulating and metering system. Engine fuel components include a low pressure regulator, fuel control valve, gas flow sensor, fuel shut-off valve, fuel mixer, throttle plate, ignition control module and temperature, pressure and speed sensors.
- ❒ A Fire Suppression and Gas Detection System.

Refer to Section 4 and 7 of this manual for further information on the Fuel System and the Fire Suppression and Gas Detection Systems. Refer to Section 4 of this manual for further information on the engine.

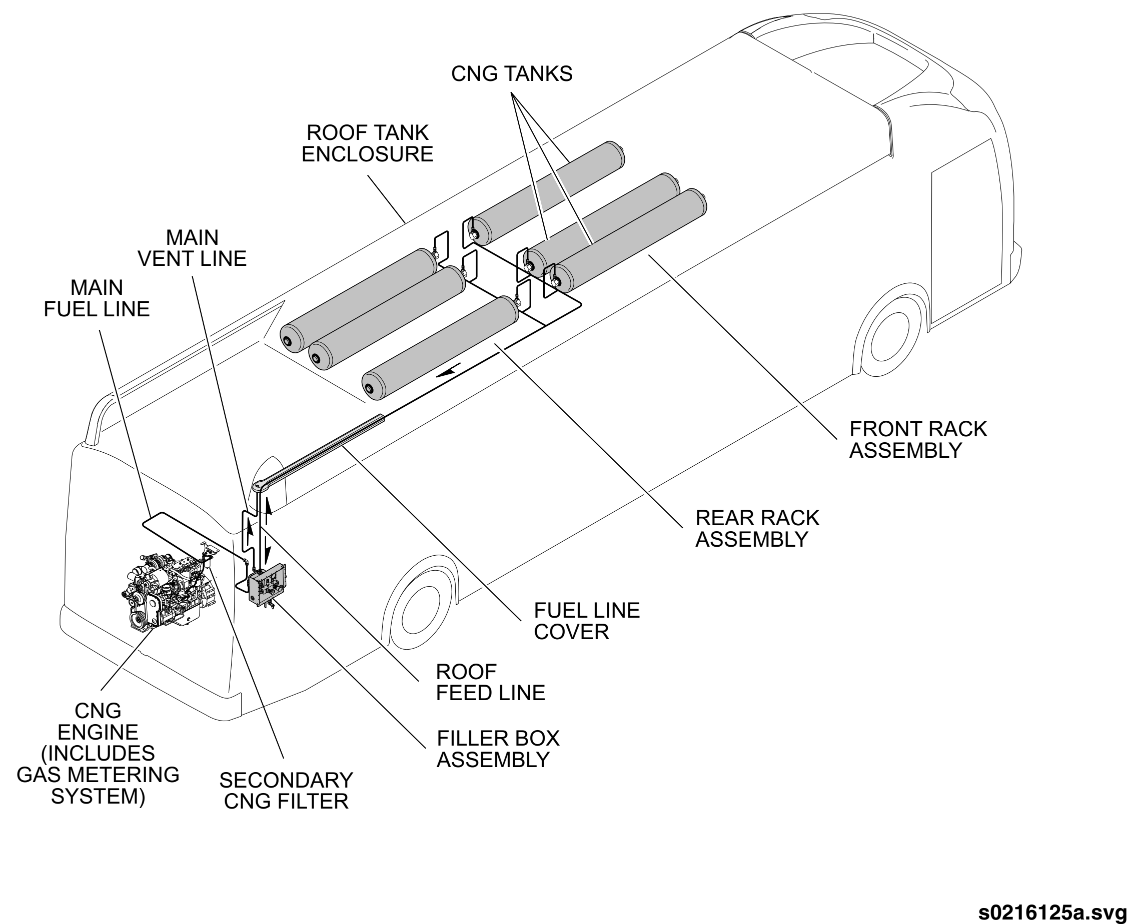


Fig. GI-15: Fuel System Layout

13. RAISING THE VEHICLE

13.1. Safety Procedures

Read this information first, before you attempt to raise the vehicle off the shop floor and set on jack stands. It is important that these instructions and the safety guidelines be closely followed.

Three methods for raising the vehicle for servicing are: lifting with wheel lifts, hoisting with floor hoists and jacking using a specific jacking attachment. These three systems are the only ones endorsed by this manual. All of the working procedures are based on using these systems.

DANGER

DO NOT use non-standard or makeshift lifting or blocking systems. These could result in the vehicle falling off the lifting or blocking equipment resulting in severe injury or death to working personnel.

DO NOT allow individuals to board vehicle while it is supported solely by a raising device.

DO NOT run engine or engage transmission while vehicle is on raising device.

If left on the raising device for any length of time, ensure safety stands are placed under vehicle at the designated areas and that a filtered shop air supply is connected to vehicle. The auxiliary air pressure prevents suspension system leak down which causes the vehicle to sag and become imbalanced while on the safety stand.

13.2. Lifting the Vehicle

WARNING

Make sure the wheel lift system is set up to simultaneously raise all wheels.

1. Position wheel lift, centering each tire exactly between the lift forks. Make sure each tire is tightened up against the stop. See "Fig. GI-16: Typical Wheel Lifts" on page 39. See "Fig. GI-17: Wheel Placement in Hoist" on page 40.
2. Make sure all wheel lifts are sitting squarely on the floor. Also check that the lift forks at the drive wheels support only one (outside) drive wheel on each side of the drive axle.
3. Determine that each tire is squarely seated in the lifting forks before raising. Ensure the wheel lift system is set up to simultaneously lift the four wheel lift points.
4. Always inspect above lift area, before raising vehicle to ensure that nothing will interfere with the procedure or cause damage to the vehicle.
5. Release parking brake.

☞NOTE:

If system air is depleted, either cage spring brakes or connect a filtered shop air supply, 70 psi minimum, to hold off spring brakes. This will also maintain air suspension system pressure.

6. Raise the vehicle high enough to provide adequate working clearance.
7. Position a jack stand squarely under each reinforced jacking point on the frame. Each jack stand must have a minimum weight bearing capacity of 12,000 lbs. (5,443 kg).

WARNING

At this point make sure each jack stand is precisely at the same height and is sitting completely level on the shop floor.

8. Raise the contact pad of each jack stand until it positively seats in the jacking point.
9. Slowly and carefully lower the wheel lifts until the weight of the vehicle is taken up on the jack stands.

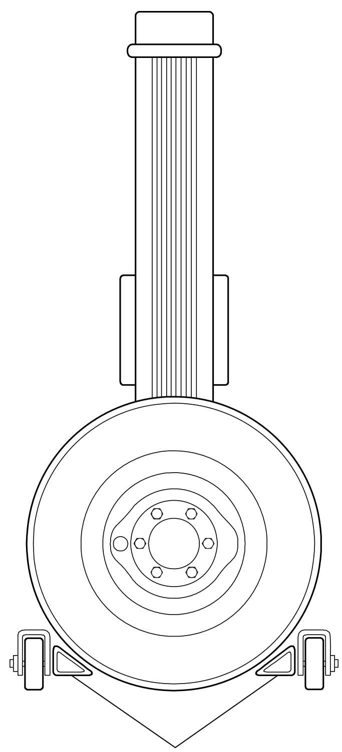


Fig. GI-16: Typical Wheel Lifts

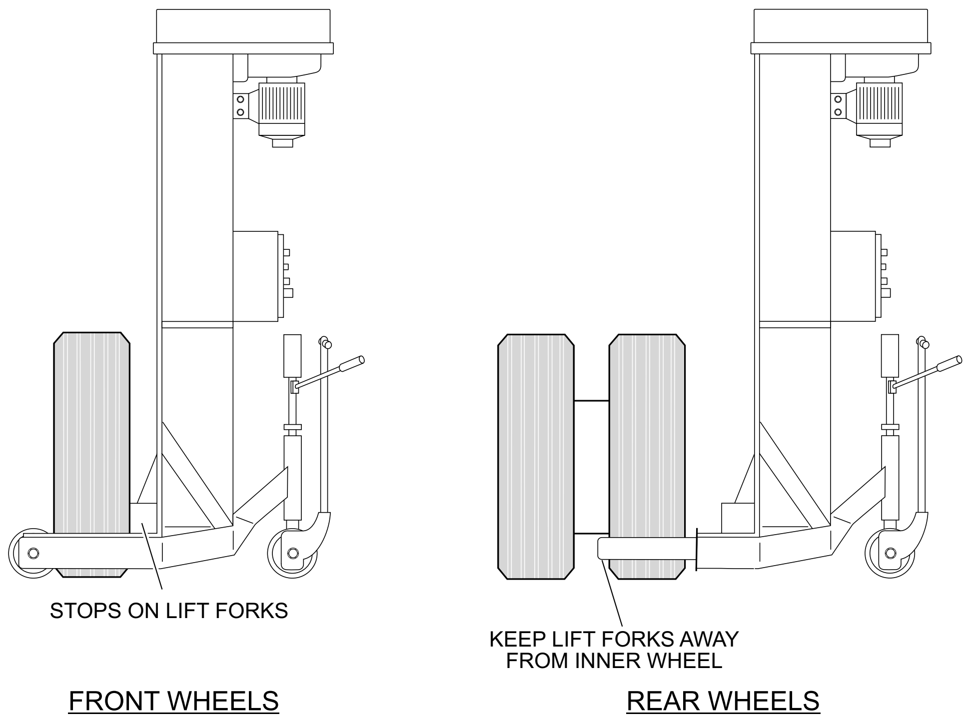


Fig. GI-17: Wheel Placement in Hoist

13.3. Hoisting the Vehicle

1. Position vehicle over hoist and align hoist posts and adapter pads so these will contact the designated points. See “Fig. GI-18: Typical Center Post Hoist” on page 41.

   Note hoisting points:

   ❒ At Rear - hoist on suspension beams below axle.

   ❒ At Front - hoist on hoisting points.

2. Raise hoist posts just enough so that hoist adapter pads positively contact the axle hoist points.
3. Release parking brake.

☞NOTE:

If system air is depleted, either cage spring brakes or connect a filtered shop air supply, 70 psi minimum, to hold off spring brakes. This will also maintain air suspension system pressure.

4. Always inspect above hoist area, before raising the vehicle to ensure that nothing will interfere with the procedure or cause damage to the vehicle.
5. Ensure that hoist adapter pads are still properly located, then raise vehicle.
6. Raise front and rear of vehicle at the same rate, maintaining correct level at all times.
7. Raise the vehicle high enough to provide adequate working clearance.
8. Engage hoist safety locks.

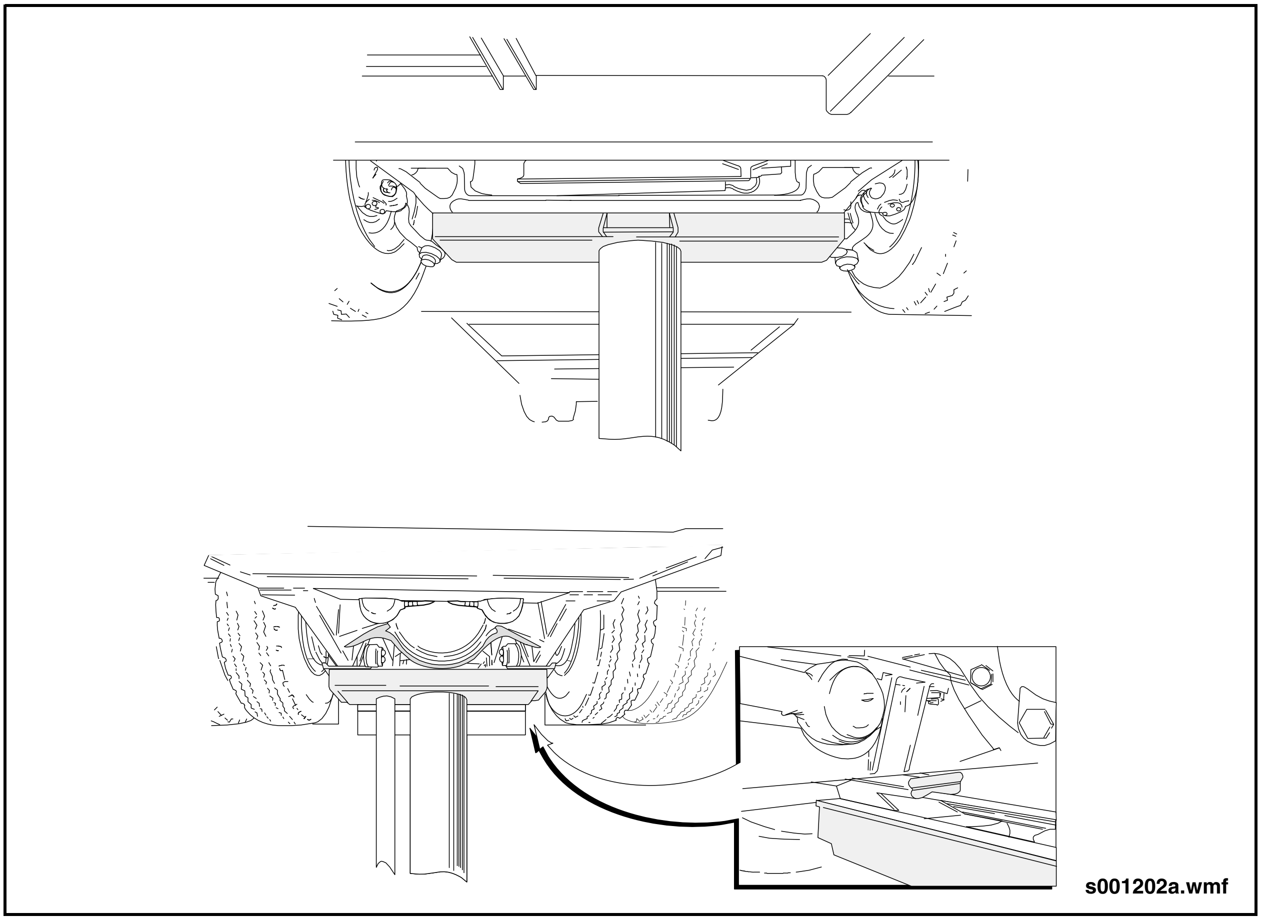


Fig. GI-18: Typical Center Post Hoist

9. Position a jack stand squarely under each reinforced jacking point on the frame. Each jack stand must have a minimum weight bearing capacity of 12,000 lbs. (5,443 kg). See "Fig. GI-19: Jack Stand" on page 42.

WARNING

At this point make sure each jack stand is precisely at the same height and is sitting completely level on the shop floor.

10. Raise the contact pad of each jack stand until it positively seats in the jacking point.
11. Slowly and carefully lower the center post hoists until the weight of the vehicle is taken up on the jack stands.

WARNING

DO NOT position jack stands under rear axle suspension beam.

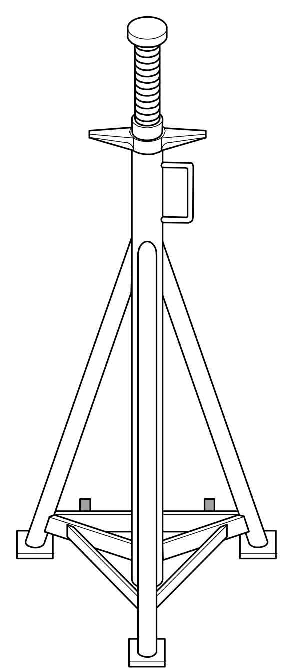


Fig. GI-19: Jack Stand

13.4. Jacking the Vehicle

CAUTION

DO NOT attempt to jack the vehicle on an incline, or rough or uneven surface.

13.4.1. Front Jacking Procedure

A chassis tube assembly is located rearward of the front wheels of your New Flyer vehicle. A jacking adapter assembly available from NFI, is installed into this tube assembly when the front of the vehicle requires jacking. See “Fig. GI-20: Jacking Adapter” on page 43.

1. Apply the park brake.
2. Place blocks behind the rear wheels.
3. On the side requiring jacking, install the jacking adapter as follows:
   a. Locate the chassis tube assembly.
   b. Install the jacking adapter.
   c. Secure the jacking adapter by installing the locking pin through both the chassis tube and the jacking adapter.
   d. Insert the hairpin cotter to secure the locking pin.
4. Using a 10" bottle jack on a stable, level surface, jack the front side of the vehicle as follows:
   a. Position the bottle jack under the jacking adapter point A.
   b. Raise the bottle jack to its maximum height.
   c. Place support blocks under the chassis tube assembly.
   d. Lower the bottle jack to rest the chassis tube assembly on the blocks.
   e. Position the bottle jack under the jacking adapter point B.
   f. Raise the bottle jack to a sufficient height for the required repair.
   g. Place additional support blocks under the chassis tube assembly.
   h. Lower the bottle jack to rest the chassis tube assembly on the blocks.

5. Lower the vehicle using the jacking adapter and bottle jack as follows:
    a. Position the bottle jack under the jacking adapter point B.
    b. Raise the bottle jack to free the support blocks.
    c. Remove support blocks.
    d. Lower the bottle jack to 1/2" before its lowest position.
    e. Place support blocks under the chassis tube assembly.
    f. Lower the bottle jack to rest the chassis tube assembly on the blocks.
    g. Position the bottle jack under the jacking adapter point A.
    h. Raise the bottle jack to free the support blocks.
    i. Remove support blocks.
    j. Lower and remove the bottle jack.
6. Remove the jacking adapter from the chassis tube assembly.
7. Remove the blocks from behind the rear wheels.
8. Lower the vehicle onto the blocks and proceed with the required repair.

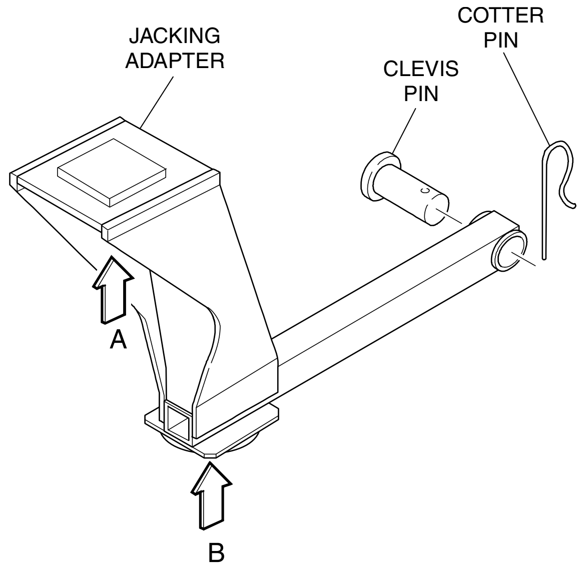


Fig. GI-20: Jacking Adapter

13.4.2. Rear Jacking Procedure

CAUTION

DO NOT attempt to jack the vehicle on an incline or on a rough or uneven surface.

1. Apply the park brake.
2. Ensure the front wheels are facing forward.
3. Place blocks in front of the front wheels.
4. Using a 10" bottle jack on a stable, level surface, jack the rear side of the vehicle as follows:
   a. Locate the appropriate jack stand point under the frame rail at the rear of the vehicle. See “Fig. GI-21: Jacking (hoisting) Points & Stand Placement” on page 44.
   b. Position the bottle jack under the jack stand point.
   c. Raise the bottle jack to a sufficient height for the required repair.
   d. Place support blocks under the frame rail.
   e. Lower the bottle jack to rest the frame rail on the support blocks.
5. Lower the vehicle using the bottle jack as follows:
   a. Position the bottle jack under the jack stand point.
   b. Raise the bottle jack to free the support blocks.
   c. Remove the support blocks.
   d. Lower and remove the bottle jack.
6. Remove the blocks from in front of the front wheels.

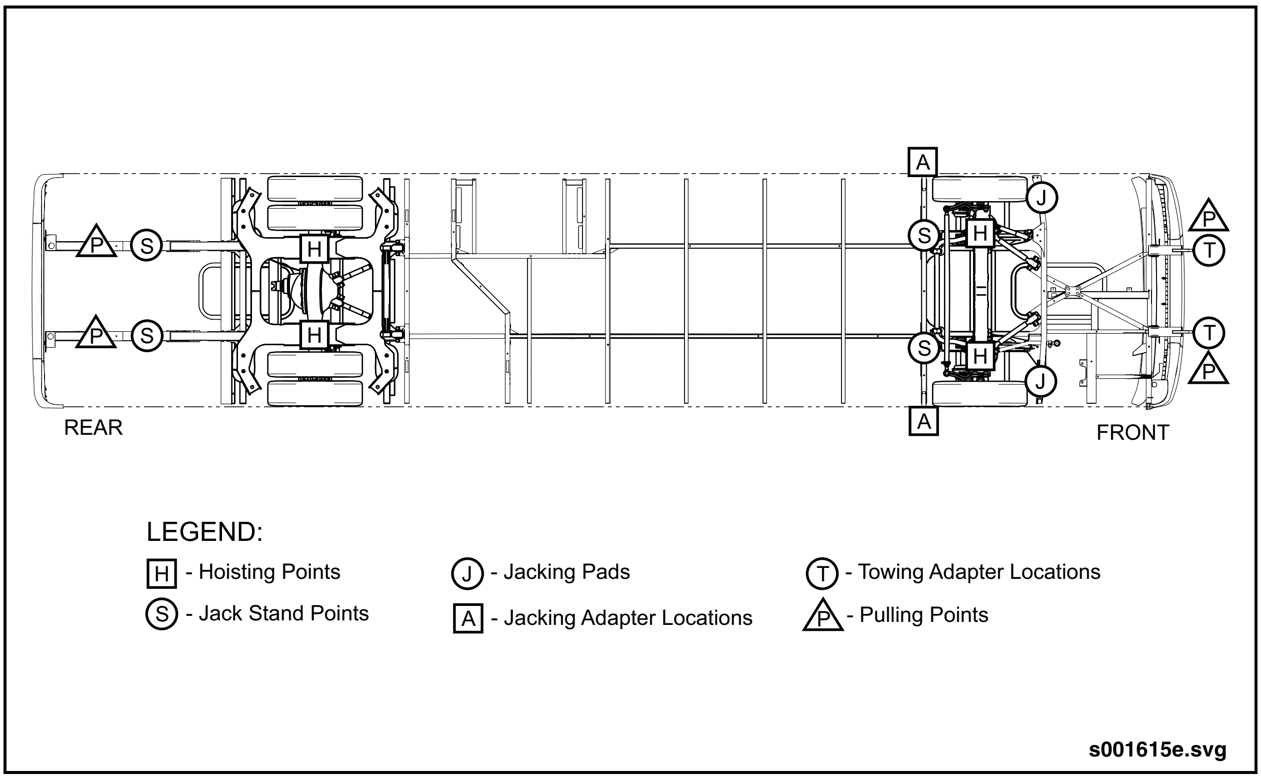


Fig. GI-21: Jacking (hoisting) Points & Stand Placement

14. VEHICLE TOWING

WARNING

Failure to comply with the safety precautions in this section could result in personal injury or vehicle damage. ALWAYS follow the recommended procedures.

NOTE:

The operator of the towing vehicle is ultimately responsible for safely securing and towing the vehicle. Ensure that the operator of the towing vehicle is aware of the safety requirements and towing procedures contained in this section.

14.1. Towing Safety

- ❒ Follow all State (provincial in Canada) and local traffic regulations.
- ❒ A vehicle safety restraint system must be used that is independent of the primary lifting and towing attachments.
- ❒ All loose or protruding parts of a damaged vehicle should be secured prior to towing.
- ❒ Do not go under a vehicle which is being lifted by the towing equipment, unless the vehicle is adequately supported by safety stands or appropriate blocking.
- ❒ No towing operation should be attempted for any reason which jeopardizes the safety of the operator, wrecker, bystanders or other motorists.
- ❒ Do not exceed the recommended maximum speed of 35 mph (55 km/h) while towing.
- ❒ Reduce speed over uneven roads, railway tracks or other obstacles.
- ❒ Do not exceed the maximum front and minimum rear clearance specifications when the vehicle is raised. Refer to 14.2.2.4. “Maximum Lifting Height” on page 51 and Refer to 14.2.2.5. “Minimum Vehicle Ground Clearance” on page 51 in this section for dimensions and measuring methods.
- ❒ The vehicle being towed must have its steering secured with the wheels positioned straight ahead.
- ❒ If the vehicle being towed is not equipped with an electrical plug for operating the vehicle tail lights, a light bar must be placed at the rear bumper of the towed vehicle.

14.2. Description

CAUTION

Care must be taken to ensure that the vehicle will not suffer structural or drive train damage as a result of towing. The driveshaft or both rear axle shafts must be removed when towing, regardless of distance or speed traveled. Damage to the transmission/drive unit may occur if the vehicle is towed without first removing the driveshaft or rear axles.

The New Flyer vehicle can be towed from the front using either the flat or raised method. Refer to 14.2.1. "Flat Towing" on page 46 in this section for flat towing procedures. Refer to 14.2.2. "Raised Towing" on page 48 in this section for raised towing procedures. New Flyer recommends the flat towing method to minimize the likelihood of damage to the vehicle. Extra care must be taken when using the raised towing method to ensure adequate ground clearance at the rear of the vehicle. Rear towing is not recommend due to insufficient ground clearance at the front of the vehicle and the problem of locking the front wheels in a straight position.

☞**NOTE:**

Consult your local Transit Authority for any specific towing procedures and use them carefully in conjunction with the recommended towing procedures contained within this section.

14.2.1. Flat Towing

14.2.1.1.Preparation

1. Prepare the vehicle for towing by removing either the driveshaft or both rear axle shafts. Refer to 14.3. "Driveshaft Removal" on page 52 and Refer to 14.4. "Rear Axle Shaft Removal" on page 52 in this section for procedure.
2. Obtain an approved towing adapter kit if one is not already provided. The towing adapter used for flat towing consists of two L-shaped brackets, clevis pins and cotter pins. Refer to your New Flyer Parts Manual for towing adapter ordering information.

☞**NOTE:**

The towing adapters mount into receivers in the front frame of the vehicle and provide the proper offset and clearance to allow the attachment of towing equipment.

14.2.1.2. Towing Adapter Installation

1. Install each tow adapter into a receiver and locate with a clevis pin. See "Fig. GI-22: Towing Adapter" on page 47.
2. Secure each clevis pin with a cotter pin.
3. Attach the towing vehicle equipment to the tow eye of each towing adapter. The method used will vary depending on the type of towing equipment available.
4. Secure the towing vehicle to the tow adapters. The method used will vary depending on the type of towing equipment available.
5. Attach two safety restraint chains from the towing vehicle to a fixed location on the towed vehicle. See "Fig. GI-23: Safety Chain" on page 48.
6. Connect the towing vehicle air line and electrical harness to the respective tow connectors on the towed vehicle.

☞**NOTE:**

An auxiliary air supply must be provided to the vehicle being towed to release the spring brakes and maintain suspension height. The auxiliary air supply should be a minimum of 100 psi.

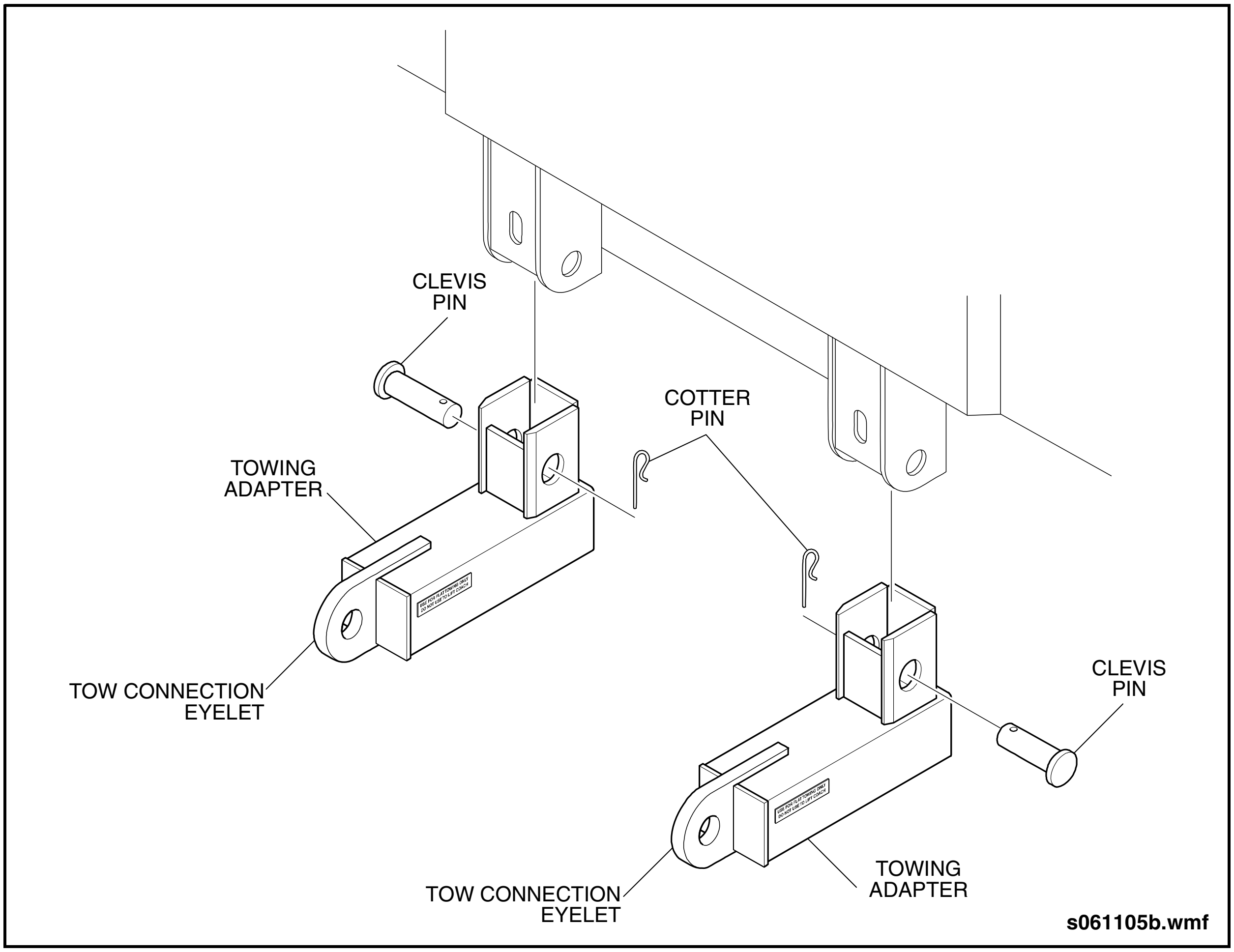


Fig. GI-22: Towing Adapter

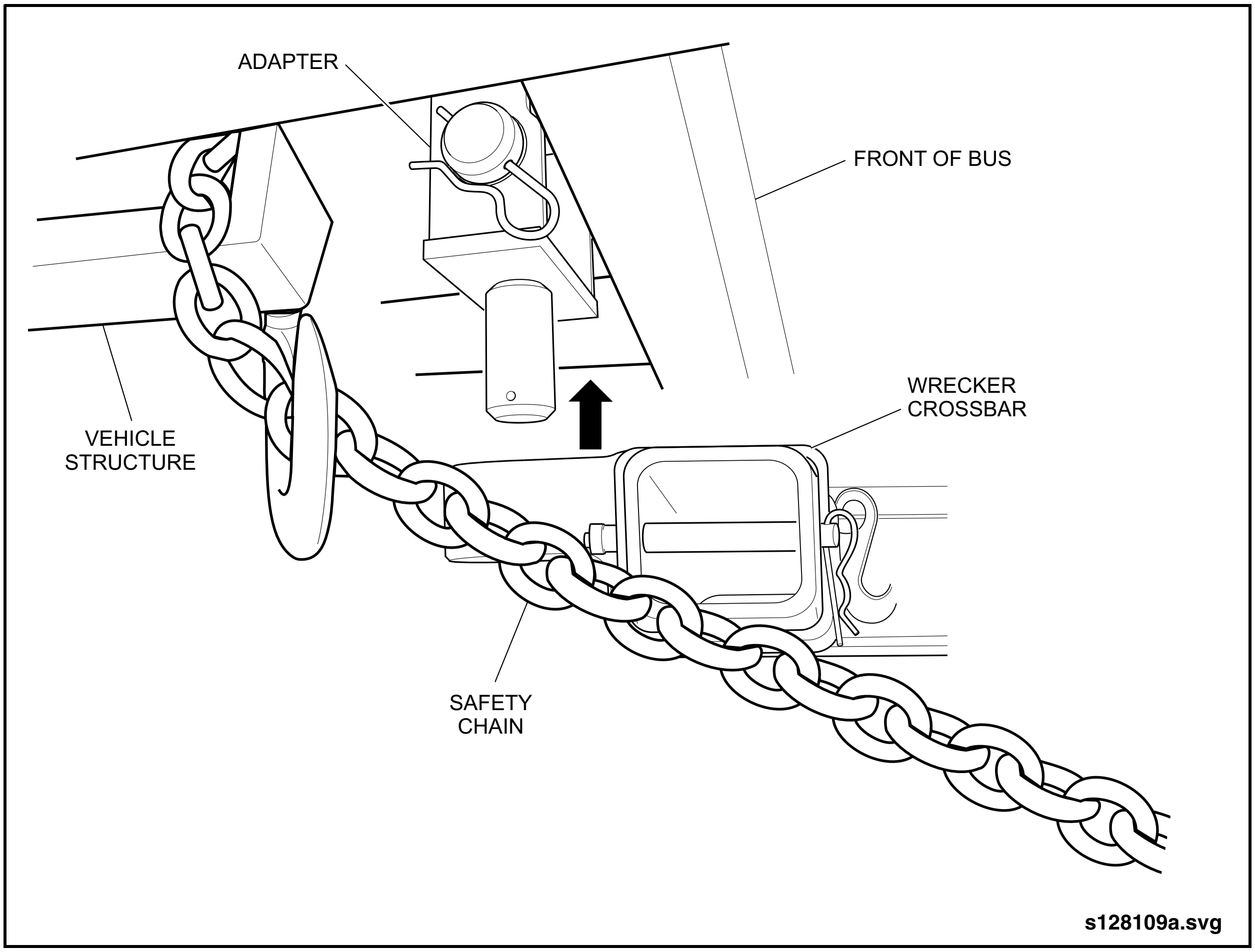


Fig. GI-23: Safety Chain

14.2.2. Raised Towing

14.2.2.1. Preparation

1. Prepare the vehicle for towing by removing either the driveshaft or both rear axle shafts. Refer to 14.3. “Driveshaft Removal” on page 52 and Refer to 14.4. “Rear Axle Shaft Removal” on page 52 in this section for procedure.
2. Obtain an approved towing adapter kit if one is not already provided. The towing adapter kit used for raised towing is a peg and socket configuration that consists of two U-shaped lift adapters that attach to the towed vehicle and two lift receivers that slide onto the towing vehicle crossbar. Refer to your New Flyer Parts Manual for towing adapter ordering information.

☞NOTE:

The towing adapters mount into receivers in the front frame of the vehicle and provide the proper offset and clearance to allow the attachment of towing equipment. The towing adapters are designed to work with Century 9055 Wrecker towing equipment.

14.2.2.2. Lift Adapter/Receiver Installation

1. Install the lift adapters onto the towed vehicle as follows:
   a. Slide lift adapter into vehicle receiver and locate with a clevis pin.
   b. Secure each clevis pin with a cotter pin.
2. Install the lift receivers onto the towing vehicle crossbar and slide into position so that they align with the towed vehicle lift adapters. See “Fig. GI-24: Lift Receiver Installation” on page 49.

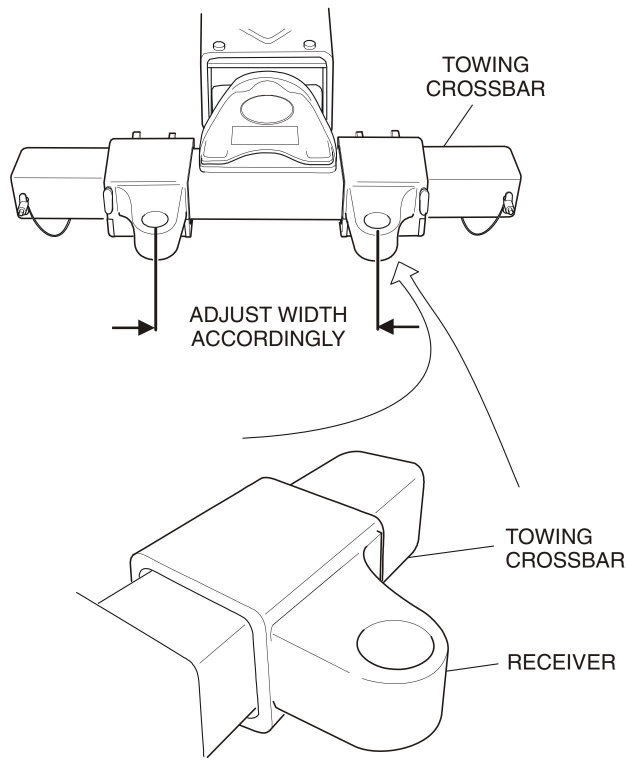


Fig. GI-24: Lift Receiver Installation

14.2.2.3.Raising & Securing the Vehicle

1. Position the wrecker's lifting boom with the lift receivers in place under the pegs of the lift adapters. See "Fig. GI-25: Securing Lift Receivers to Lift Adapters" on page 50.
2. Slowly raise the boom until the socket on the lift receivers engage the pegs on the lift adapters. Make any necessary adjustments to the lift receiver positions to ensure proper engagement.
3. Continue to raise the lifting boom until the lift adapters are fully engaged into the receivers.
4. Insert the lock pin through the lift adapters.
5. Raise the front wheels to the height recommended for the specific vehicle being towed and check vehicle ground clearance. Refer to 14.2.2.4. "Maximum Lifting Height" on page 51 and Refer to 14.2.2.5. "Minimum Vehicle Ground Clearance" on page 51 in this section for recommended limits.
6. Connect the towing vehicle air line and electrical harness to the respective tow connectors on the towed vehicle.

☞NOTE:

An auxiliary air supply must be provided to the vehicle being towed to release the spring brakes and maintain suspension height. The auxiliary air supply should be a minimum of 100 psi.

7. Attach two safety restraint chains from the towing vehicle to a fixed location on the towed vehicle.
8. Check to ensure that all clevis and cotter pins are properly inserted, towing equipment is fully engaged and safety chains are clear of the vehicle body before final raising and towing the vehicle.
9. Secure the steering system as follows:
   a. Rotate the steering wheel to position the wheels in the straight ahead position.
   b. Secure the steering system in this position by looping the driver's seat belt around the lower portion of the steering wheel and clipping it into the seat belt buckle. See "Fig. GI-26: Securing Steering System" on page 51.

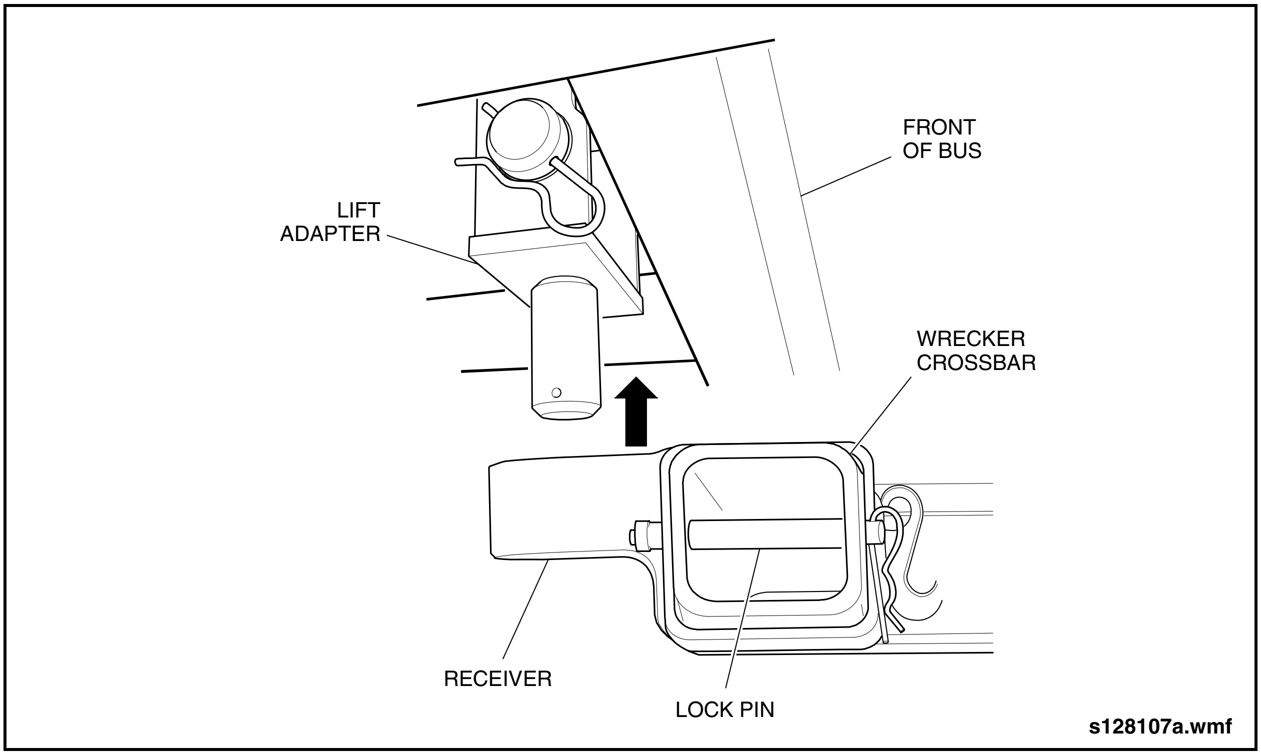


Fig. GI-25: Securing Lift Receivers to Lift Adapters

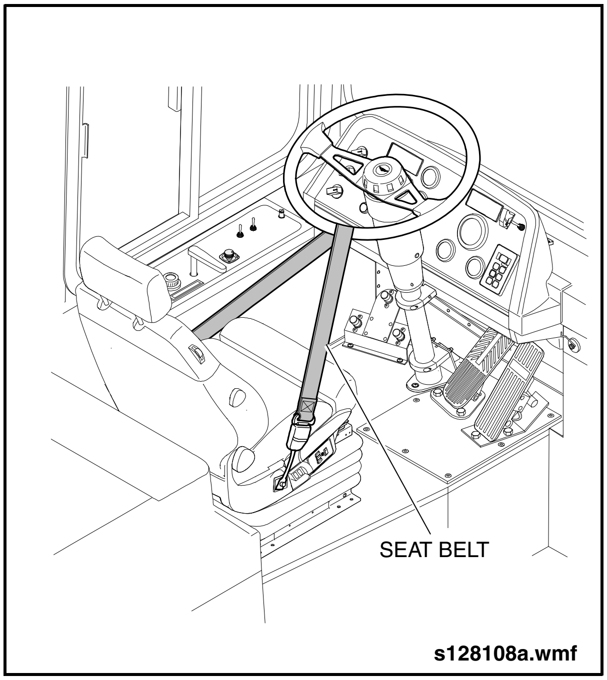


Fig. GI-26: Securing Steering System

14.2.2.4.Maximum Lifting Height

Maximum raised height, as measured from the bottom of the front tire to the ground must not exceed 9.0 inches (22.8 cm).

14.2.2.5.Minimum Vehicle Ground Clearance

Rear bumper clearance must not be less than 12.5 inches (31.75 cm) as measured from the bottom of the bumper to the ground. See “Fig. GI-27: Rear Bumper Clearance Measurement” on page 51.

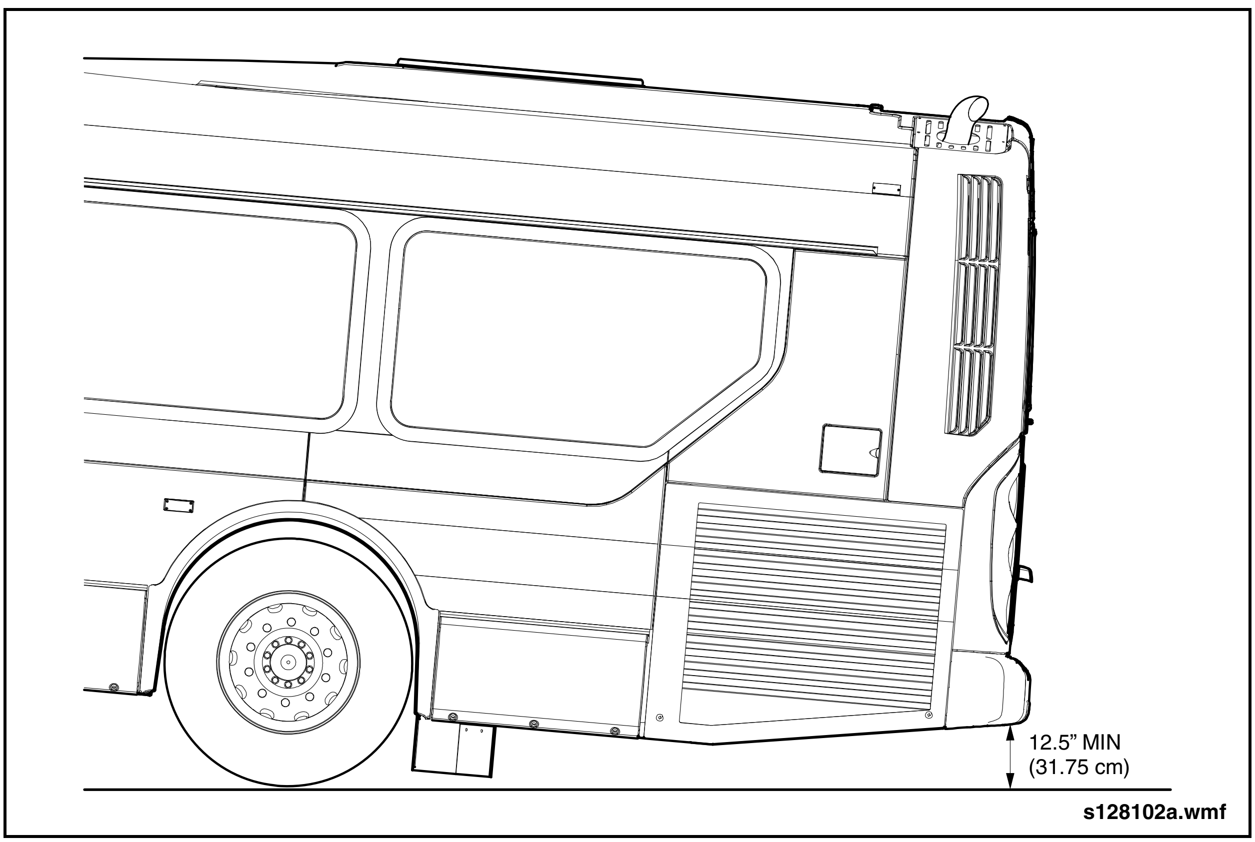


Fig. GI-27: Rear Bumper Clearance Measurement

14.3. Driveshaft Removal

☞**NOTE:**

This procedure describes removing the driveshaft from the interior of the vehicle which eliminates jacking the vehicle and placing it onto supports.

☞**NOTE:**

Removal of axle shafts is not recommended by the axle manufacturer due to the likelihood of debris entering the axle housing while towing the vehicle.

1. Check that the vehicle is on solid ground and is safe to enter.
2. Place safety triangles on the road to warn approaching vehicles.
3. Remove the driveshaft access door and driveshaft plate. Refer to Section 15 of this manual for procedure.
4. Remove the driveshaft and pull it through the access opening.
5. Reinstall the access plate to keep debris out of vehicle
6. Setup the towing equipment and retrieve the safety triangles.

14.4. Rear Axle Shaft Removal

⚠ **CAUTION**

The axle shafts or the driveshaft must be removed before towing the vehicle.

1. Remove the ten M6 bolts that retain the axle shaft to the hub and carefully slide out the axle shaft.
2. Seal the axle housing opening using a commercially available cover plate.
3. Protect the axle shaft and temporarily store inside the vehicle while being towed.
4. Repeat procedure for opposite axle shaft.
5. Vehicle is now ready for towing.

14.5. Spring Brake Release

☞**NOTE:**

The following procedure is required to mechanically release the emergency/parking spring brake during towing if the brakes cannot otherwise be released using air pressure. The brake chamber is considered to be “caged” when the spring is compressed sufficiently to release the emergency/parking brake. Rotating the release bolt counterclockwise will compress the spring.

1. Locate the release bolt in the center of the brake chamber.

⚠ **CAUTION**

DO NOT use impact tools to cage or uncage the brake chamber.

2. Cage the rear brake chamber by unscrewing the release bolt. Do not exceed a force of 74 ft-lb. (100 Nm) during caging. The chamber is caged when the head of the release bolt extends approximately 1.36 ± 0.12" beyond the surface of the brake chamber.

14.6. Vehicle Removal from Ditch

14.6.1. Chain Pulling Procedure

CAUTION

DO NOT use a chain connected directly to the front or rear bumpers to pull the vehicle.

14.6.1.1.Pulling from the Front

1. Connect a chain hook onto one side of each tow adapter pin hole, in the front structural tow connectors, located behind the front bumper.
2. Protect the front bumper during pulling with a 4" x 4" or equivalent wood block placed between the chains and the bottom of the front bumper.
3. With the assistance of a driver to steer the vehicle, release the parking brake and pull the vehicle from the ditch.

14.6.1.2.Pulling from the Back

1. Connect a chain hook onto each tow pin located in each main rail behind the rear bumper.
2. Protect the rear bumper during pulling with a 4" x 4" or equivalent wood block placed between the chains and the bottom of the rear bumper.
3. With the assistance of a driver to steer the vehicle, release the parking brake and pull the vehicle from the ditch.

15. TORQUE INFORMATION

15.1. Bolt Torque Specifications

Always use bolts and nuts with the same torque values and strength as those being replace. Damage to parts and systems can be caused by using bolts and nuts with the wrong specifications.

Bolts and capscrews are identified by either numbers or radial lines on the head.

- ❐ U.S. customary bolts and capscrews have radial lines on the head to indicate the SAE Grade Number. A (SAE) Grade 8 bolt or capscrew head will have 6 radial lines. A (SAE) Grade 5 bolt or capscrew will have 3 radial lines.
- ❐ Metric capscrews and nuts have a Commercial Steel Class Grade Number such as: 8.8, 10.9, 12.9 on the capscrew head or on the surface of the nut. A higher number indicates greater tensile strength.

The following are examples of capscrew identification specifications:

Metric

Bolt, M8 - 1.25 x 25 mm Lg.		
M8	**1.25**	**25 mm**
Major Thread Diameter in Millimeters	Thread Distance in Millimeters	Length in Millimeters

U.S. Customary

Bolt, 5/16" - 18 x 1 1/2" Lg.		
5/16"	**18**	**1 1/2"**
Major Thread Diameter in Inches	Number of Threads per Inch	Length in Inches

☞**NOTE:**

ALWAYS use specific torque values if such are stated in text or accompanying illustrations. Use the torque values in this chart if specific torque values are not specified. If the ft-lb. value is less than 10 ft-lb., converting to in-lb. will allow using a in-lb. torque wrench to produce a more accurate reading. As an example: 6 ft-lb. = 72 in-lb.

The torque values in the charts are noted for SAE Grade 8 or 5 bolts, capscrews and nuts, cadmium plated with hardened washers and non-lubricated threads. The ft-lb. torque value is shown first, with Nm torque value in brackets.

⚠ CAUTION

Before torquing a bolt or nut, clearly identify the type, size and grade. Over-torquing or under-torquing threaded fasteners can damage the components and/or the bolts and nuts. Personal and component safety hazards can be caused by loose, elongated or sheared bolts, capscrews and nuts.

15.2. U.S. Customary Bolts & Capscrews Torque Values

U.S. CUSTOMARY BOLTS & CAPSCREW TORQUE VALUES Grade 8 - Capscrew, Bolt, Nut				
Thread Size	Min.		Max.	
in.	ft-lb.	Nm	ft-lb.	Nm
1/4	*110	13	*120	14
5/16	*215	24	*240	27
3/8	35	48	40	54
7/16	60	82	65	88
1/2	90	125	100	135
9/16	125	170	140	190
5/8	175	240	190	260
3/4	300	410	330	450
7/8	475	645	525	710
1	725	985	800	1085
1 1/8	1050	1425	1175	1600
1 1/4	1475	2000	1625	2200
1 3/8	2000	2720	2200	2980
1 1/2	2600	3530	2850	3870
1 5/8	3450	4680	3800	5150
1 3/4	4300	5830	4800	6500
1 7/8	5500	7450	6100	8300
2	6500	8800	7200	9800

*** = in-lb. Torque Value**

☞ **NOTE:**
All torque values are dry unless otherwise noted.

U.S. CUSTOMARY BOLTS & CAPSCREW TORQUE VALUES Grade 8 - 12 Pt. Hex & Socket Head				
Thread Size	**Min.**		**Max.**	
in.	**ft-lb.**	**Nm**	**ft-lb.**	**Nm**
1/4	*130	15	*145	16
5/16	*270	31	*300	34
3/8	45	61	50	68
7/16	70	95	75	102
1/2	110	150	120	160
9/16	150	205	165	225
5/8	210	285	230	310
3/4	360	490	400	540
7/8	600	815	650	880
1	900	1220	1000	1360
1 1/8	1300	1770	1450	1970
1 1/4	1850	2510	2000	2720
1 3/8	2450	3330	2700	3660
1 1/2	3150	4270	3450	4680
1 5/8	4150	5630	4600	6240
1 3/4	5100	6920	5700	7730
1 7/8	6500	8800	7200	9800
2	7800	10600	8600	11700

*** = in-lb. Torque Value**

☞ **NOTE:**
All torque values are dry unless otherwise noted.

U.S. CUSTOMARY BOLTS & CAPSCREW TORQUE VALUES Grade 5 - Capscrew, Bolt, Nut				
Thread Size	**Min.**		**Max.**	
in.	**ft-lb.**	**Nm**	**ft-lb.**	**Nm**
1/4	*80	9	*90	10
5/16	*180	21	*200	23
3/8	25	34	28	38
7/16	40	54	45	61
1/2	65	88	70	95
9/16	90	125	100	135
5/8	125	170	140	190
3/4	220	300	245	330
7/8	330	450	360	490
1	475	645	525	710
1 1/8	650	880	720	975
1 1/4	900	1220	1000	1360
1 3/8	1200	1630	1350	1830
1 1/2	1500	2040	1650	2240
1 5/8	2000	2720	2200	2980
1 3/4	2500	3390	2750	3730
1 7/8	3150	4270	3500	4750
2	3800	5150	4200	5700

*** = in-lb. Torque Value**

☞**NOTE:**

All torque values are dry unless otherwise noted.

15.3. Metric Capscrews & Nuts

METRIC CAPSCREWS & NUTS						
Thread Size	Grade 8.8		Grade 10.9		Grade 12.9	
mm	ft-lb.	Nm	ft-lb.	Nm	ft-lb.	Nm
6	*60	9	*108	14	*108	14
7	*108	14	14	18	18	23
8	18	25	23	32	27	36
10	30	40	45	60	50	70
12	55	70	75	105	95	125
14	85	115	120	160	145	195
16	130	180	175	240	210	290
18	170	230	240	320	290	400
20	310	420	398	540	478	648

*** = in-lb. Torque Value**

☞**NOTE:**
All torque values are dry unless otherwise noted.

15.4. Pipe Plugs (NPFT)

PIPE PLUGS (NPFT)		
Thread Size (in.)	ft-lb.	Nm
1/8	14 to 18	10 to 13
1/4	19 to 24	14 to 18
3/8	24 to 31	18 to 23
1/2	31 to 39	23 to 29
3/4	45 to 56	33 to 41
1	102 to 127	75 to 94
1 1/4	129 to 161	95 to 119
1 1/2	149 to 187	110 to 138

16. SI (Metric) CONVERSION FACTORS

Consult the chart below for conversion factors to change metric units of measure to U.S. customary or U.S. customary to metric.

SI (Metric) CONVERSION FACTORS			
Conversion	**From**	**To**	**Conversion Factor**
Torque	ft-lb. Nm	Nm ft-lb.	(ft-lb.) x 1.356 (Nm) x .7376
Torque	in-lb. Nm	Nm in-lb.	(in-lb.) x 0.112 (Nm) x 8.85
Air Pressure	psi kPa	kPa psi	(psi) x 6.895 (kPa) x 0.145
Measure	inches millimeters	millimeters inches	(in.) x 25.4 (mm) x 0.039
Measure	inches centimeters	centimeters inches	(in.) x 2.54 (cm) x 0.394
Measure	feet meters	meters feet	(ft.) x 0.304 (m) x 3.28
Measure	miles kilometers	kilometers miles	(miles) x 1.609 (km) x .621
Temperature	Fahrenheit Celsius	Celsius Fahrenheit	(°F -32°) ÷ 1.8 (°C x 1.8) + 32°
Volume - fluid	pints liters	liters pints	(pts.) x 0.473 (l) x 2.01
Volume - fluid	quarts liters	liters quarts	(qts.) x 0.946 (l) x 1.06
Fuel Performance	m/g km/l	km/l m/g	(m/g) x 0.425 (km/l) x 2.353
Volume - fluid U.S.	gallons liters	liters gallons	(gal.) x 3.785 (l) x .264
Volume - fluid Imp.	gallons liters	liters gallons	(gal.) x 4.546 (l) x .220
Volume - Displacement	cubic inches liters	liters cubic inches	(in^3) x 0.016 (l) x 61.02
Volume - Displacement	cubic feet liters	liters cubic feet	(ft^3) x 28.3 (l) x 0.0353
Weight	ounces grams	grams ounces	(oz.) x 28.35 (gr.) x 0.035
Weight	pounds kilograms	kilograms pounds	(lb.) x 0.454 (kg.) x 2.204
Density	lb/gal kg/l	kg/l lb/gal	(lb/gal) x 0.119 (kg/l) x 8.46

Preventive Maintenance

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- open flame
- excessive heat
- production of sparks
- production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Maintenance Safety Procedures

This section of the service manual contains safety information which must be read and understood before attempting any service work on the vehicle. All safety procedures must be followed to ensure the safety of personnel working on or around the vehicle and to prevent any damage to equipment.

1.2.1. General Safety

DANGER

During component removal or installation, ensure that the Master Run switch is set to the STOP-ENGINE position and that the Battery Disconnect switch is set to the OFF position. Failure to follow this procedure may result in personal injury or component damage.

WARNING

DO NOT perform any maintenance on roof-mounted components unless equipment is in place to prevent fall hazards. Ensure maintenance personnel use approved lift platforms or scaffolding and wear approved safety harness when working on the roof of the vehicle.

WARNING

NEVER connect or disconnect a hose or line containing pressure; it may whip. Ensure all system pressure has been depleted before removing a component or line.

WARNING

NEVER exceed recommended system operating pressures.

WARNING

ALWAYS wear safety glasses.

CAUTION

DO NOT attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understood the recommended procedures. Use only the proper tools and observe all safety precautions pertaining to use of those tools.

CAUTION

Ensure replacement hardware, tubing, hose, fittings and so forth, are of equivalent size, type, and strength as original equipment and they are designed specifically for such application and systems.

CAUTION

Repairs requiring machining or welding are not to be attempted unless specifically approved and stated by the vehicle or component manufacturer.

CAUTION

Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.

CAUTION

When working on or around a vehicle, the following safety steps should be undertaken:

- ❒ **Park the vehicle on a level surface, apply the parking brakes and always block the wheels.**
- ❒ **Cordon off, mark or use a clearly defined area to work on the vehicle. The purpose of this is to warn personnel that maintenance is being carried out on the vehicle.**
- ❒ **DO NOT run the engine unless it is necessary to perform maintenance on the vehicle.**

CAUTION

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.

1.2.2. Hoisting/Lifting & Jacking Safety

Refer to the General Information Section of this manual for recommended types of hoists, lifting equipment, and jackstands.

DANGER

Certain procedures may require the vehicle be operated in an elevated position in order to accurately troubleshoot and diagnose a problem. If the vehicle must be running while elevated, become familiar with the repair area prior to starting the engine. Take special care in noting areas which will become hot, electrically energized, and areas where moving and rotating components are located. Limit the work in these areas as personal and equipment safety is at risk.

WARNING

ALWAYS ensure that the vehicle is appropriately hoisted and blocked for procedures which require elevating the vehicle. Be aware of the limitations of the blocking equipment, and always ensure that the jarring and shaking created by component removal and installation procedures does not overload the blocks, or cause the vehicle to become unstable.

1.2.3. Air System Safety

WARNING

ALWAYS drain the air pressure from ALL reservoirs before beginning work on any air system component.

WARNING

Ensure air lines are safely depressurized prior to disconnecting. Wear safety glasses as disconnecting pressurized lines will cause solid particles deposited in the line to be uncontrollably propelled, and will also cause the hose end to whip randomly as the air escapes.

1.2.4. Electrical System Safety

During electrical diagnosis procedures an understanding of the vehicle's electric circuits is important to understand the results of connecting test equipment.

DANGER

During component removal or installation, ensure that the Master Run switch is set to the STOP-ENGINE position and that the Battery Disconnect switch is set to the OFF position. Failure to follow this procedure may result in personal injury or component damage.

WARNING

DO NOT start the vehicle remotely with the laptop software without first checking that the area is clear of personnel.

CAUTION

Before welding anywhere on vehicle, set Battery Disconnect switch to the OFF position and disconnect all electronic control modules (Multiplexing, engine, transmission, ABS, and so forth). Refer to Section 11 of this manual for additional precautionary information.

1.2.5. Hydraulic System Safety

Observe the following procedures involving hydraulic line maintenance:

WARNING

Pressurized lines should not be disconnected until the pressure is safely and controllably released.

CAUTION

Hydraulic fluid is corrosive and should not be exposed to skin for extensive periods of time. Wear eye protection at all times.

1.2.6. HVAC System Safety

Refer to Section 10 of this manual for comprehensive safety information related to the HVAC system.

1.2.7. Welding/Machining Safety

CAUTION

Before welding anywhere on vehicle, set Battery Disconnect switch to the OFF position and disconnect all electronic control modules (Multiplexing, engine, transmission, ABS, and so forth). Refer to Section 11 of this manual for additional precautionary information.

1.2.8. Paint & Chemicals Safety

1.2.8.1. Painting Safety

⚠ WARNING

Follow all proper safety precautions regarding spray painting.

⚠ WARNING

The paint booth or work area must be properly ventilated, with filtered exhaust fans removing fumes and over spray. Air make-up induction fans should also be used to supply fresh air to the work area.

⚠ CAUTION

Use a filtering mask with the proper filter cartridges. Wear eye protection and proper protective clothing.

⚠ CAUTION

The painting area should be a safe distance from any source of flame, spark or other means of combustion. Atomized paint, thinner, cleaner and solvent fumes are highly volatile with an extremely low flashpoint that can cause explosive combustion.

⚠ CAUTION

DO NOT smoke or permit anyone else to smoke in or near the painting area.

1.2.8.2. Cleaning Chemicals Safety

⚠ WARNING

Because fumes are more dangerous in a small space, be sure the vehicle is well ventilated while using any cleaning agent. Follow the manufacturer's instructions in using such products. Many cleaners may be poisonous or flammable, and their improper use may cause personal injury or damage to the inside of the vehicle. Therefore, when cleaning the interior, DO NOT use volatile cleaning solvents such as: acetone, lacquer thinners, enamel reducers, nail polish removers; or such cleaning materials as laundry soaps, bleaches, or reducing agents (except as noted for fabric cleaning of stains). NEVER use carbon cleaning products.

⚠ CAUTION

To avoid possible permanent discoloration on light colored trim, DO NOT let materials with unstable dyes come in contact with seat trim materials until totally dry. Proper cleaning techniques and cleaners must be used on trim materials. Failure to do this on the first cleaning may result in water spots, spot rings, setting of stains, or soilage, all of which make it more difficult to remove in a second cleaning.

1.2.9. Adhesives Safety

WARNING

Overexposure to adhesives used on this vehicle, specifically Sikaflex-252, may cause breathing difficulties, sensitization, headaches, nausea, vomiting. May aggravate respiratory, skin, eye, lung problems and allergies. If the product is applied according to the manufacturer's directions, none of these symptoms should be encountered. A person who is allergic to isocyanate may have a reaction with a level of isocyanate well below the T.L.V. Xylene is a central nervous system depressor and in rare cases, may cause a sensitization of the heart muscle causing arrhythmia.

Ensure the user is provided with a full face mask or safety glasses, a rubber apron, sufficient ventilation, and an eyewash station or shower. In case of overexposure, remove contaminated clothing and shoes, wash with plenty of water, wash clothing before rewearing, and consult a physician. If eyes are exposed, rinse immediately for several minutes. See a physician immediately. In case of inhalation, evacuate to fresh air and consult a physician. In case of ingestion, drink plenty of water or milk. DO NOT induce vomiting. See a physician immediately.

1.2.10. Insulation Foam Safety

WARNING

Insulation foam is installed in the spaces of the frame tubing, between the vehicle inner and outer wall panels. The Insulation Foam is extremely combustible. KEEP OPEN FLAMES AND FLAME SOURCES AWAY FROM THE INSULATION FOAM!

Before performing any work or repairs requiring use of an open flame such as: welding, brazing, acetylene torch cutting or grinding, ensure that the insulation foam is either removed from the area being repaired, or is properly shielded from the open flame.

1.2.11. Gas Spring Disposal

Gas springs must be depressurized and drained of any oil before disposal. For safety and environmental reasons, use the following procedure:

WARNING

Wear a face shield or safety glasses and place a rag over saw blade while cutting.

1. Clamp the rod end of the cylinder in a vise.
2. Mark the cylinder 30 to 35mm from the base end of the cylinder.
3. Cut a crosswise slit in the cylinder in the marked area.
4. Stop sawing as soon as a hissing sound is heard. Allow the unit to depressurize completely.

☞**NOTE:**

Nitrogen is an inert gas. Consequently, gas release is totally safe.

5. Place the cylinder in a drain pan ensuring the cut is facing down. Allow oil to drain completely. Dispose of oil in accordance with environmental regulations.
6. Recycle gas spring as a steel component.

2. PREVENTIVE MAINTENANCE

2.1. Introduction

The transit authority is responsible for the performance of all scheduled maintenance as outlined in this preventive maintenance manual to maintain the New Flyer vehicle warranty. New Flyer reserves the right to deny warranty coverage on claims due to lack of maintenance, misuse, abuse or neglect.

The maintenance intervals indicated in this manual are based upon average vehicle use and typical operating conditions. Unusual vehicle operating conditions, such as geographic environmental conditions, will require service at more frequent intervals. It is the customer's responsibility based upon experience with localized environmental conditions and local regulations to determine if more frequent intervals are required. If you are unsure, please contact your New Flyer Customer Service Technical Support representative.

All the described maintenance operations must be performed by qualified personnel using standard shop practices. All replacement parts used for maintenance services or repairs must be OEM parts or parts with equivalent quality and performance. Use of inferior parts will void the warranty. Warranty claims in question must be supported by preventive maintenance records.

Consumable maintenance items such as (but not limited to) lights, light bulbs, lamps, belts, bushings, and items with progressive wear characteristics, lubricants, fluids, filters, hoses, wiper blades and tires are not covered by warranty.

Refer to the illustrations included with this section as a guide to location of servicing points.

For compliance to warranties covering the following equipment, refer to complete preventive maintenance intervals and procedures contained in the applicable vendor supplied information:

- ❒ Engine
- ❒ Transmission
- ❒ HVAC Unit
- ❒ Fire Suppression & Gas Detection

2.2. Rear Axle Operating Conditions

The rear axle oil change interval is determined by operating conditions that affect the temperature of the oil in the axle. The following criteria have been established to assess the severity of the conditions under which the axle will be operated:

- ❒ Moderate Region - this description will apply to all regions where the average monthly temperature does not exceed 25°C (77°F) for more than two months of the year.
- ❒ Hot Region - this description will apply to all regions where the average monthly temperature exceeds 25°C (77°F) for more than two months of the year.

2.3. Run-In Maintenance

Certain procedures described in this section are designed to ensure a smooth vehicle run-in process. Perform the following procedures as part of vehicle run-in. Thereafter, Refer to 2.5. "Preventive Maintenance Guide" on page 8 in this section for regularly scheduled maintenance intervals on this equipment.

- ❒ Wheels - Check wheel torque upon receipt of vehicle. Refer to Section 1 and 2 of this manual for torque specifications and sequence.
- ❒ Driveshaft - Lubricate upon receipt of vehicle. Refer to 2.11.8. "Driveshaft" on page 38 in this section for lubrication procedure.
- ❒ Rear Axle - Change oil upon receipt of vehicle, Check oil level after first 3,000 miles (4,800 km). Refer to Section 2 of this manual for oil drain and fill procedure. Refer to 2.36. "Fluid & Lubrication Guide" on page 109 in this section for fluid specification.
- ❒ Engine Valve Adjustment - Adjust the overhead valves after the first 15,000 miles (24,140 km), 1000 hours, or one year, whichever occurs first. Refer to your Cummins Operation & Maintenance Manual for inspection and adjustment procedures.

2.4. Conditional Maintenance

The following items are subject to maintenance on a conditional basis and do not have a specific interval assigned against the maintenance requirement:

- ❒ Rear Axle Oil Filter - Replace the rear axle oil filter whenever the differential is removed from the axle housing. Refer to Section 2 of this manual for replacement procedure.
- ❒ Rear Axle Wheel Bearings - Repack wheel bearings and hub cavity with grease whenever the wheel bearings or grease seals are being serviced. Refer to 2.36. "Fluid & Lubrication Guide" on page 109 in this section for grease specification. Refer to Section 2 of this manual for grease repacking procedure.

2.5. Preventive Maintenance Guide

INTERVALS (Daily - Quarterly)			
DAILY	**WEEKLY**	**MONTHLY**	**QUARTERLY**
Exterior Check	Radiator	Air Tanks	HVAC System Inspection & Test
Operational Check	HVAC System Test	Bike Rack Inspection	Radiator
Wheelchair Ramp		HVAC System Inspection	
Wheelchair Tie-Down & Occupant Restraints		Fire Extinguisher	
Floor Covering		Fire Suppression & Gas Detection System	
Crankcase Breather Tube			
Air Intake Piping			
Radiator Hoses Inspection			
Throttle Response Test			
Bike Rack Inspection			
Fire Suppression & Gas Detection System			
S-1 Gard			
CNG Fuel Filter Drainage			

INTERVALS (3,000 - 12,000 mi.)			
3,000 mi. (4,800 km)	**6,000 mi. (9,600 km)**	**7,500 mi. (12,000 km)**	**12,000 mi. (19,300 km)**
Air Filter Restriction Indicator Inspection	Disc Brake Pad Inspection	Cooling & Heating System Pressure Test	Electronic Accelerator
Air Filter Replacement	Wheels & Tires Inspection	Muffler Inspection	S-1 Gard
Charge Air Cooler (CAC) Inspection	Transmission Inspection		Driver's Heater/ Defroster

INTERVALS (3,000 - 12,000 mi.)			
3,000 mi. (4,800 km)	**6,000 mi. (9,600 km)**	**7,500 mi. (12,000 km)**	**12,000 mi. (19,300 km)**
Charge Air Piping Inspection	Engine Oil & Filter Change		Floor Heaters
Exhaust System	Primary CNG Fuel Filter		
	Cooling & Heating System Inspection		
	Driveshaft		
	Steering System Inspection		
	Steering Driveshafts		
	Steering Damper		
	Shock Absorber Inspection		
	Ride Height		
	Air Springs		
	Front & Rear Axles & Suspension		
	Radius Rods		
	Air System Inspection & Functional Tests		
	Driver's Window		
	Window Emergency Release System		
	Interior & Exterior Access Doors		
	Roof Vent/Hatch		
	Splash Guards		
	Windshield Wiper & Washer		
	Driver's Seat		
	Passenger Seats		
	Stanchions & Grab Rails		

INTERVALS (3,000 - 12,000 mi.)			
3,000 mi. (4,800 km)	**6,000 mi. (9,600 km)**	**7,500 mi. (12,000 km)**	**12,000 mi. (19,300 km)**
	Wheelchair Tie-Down & Occupant Restraints		
	Interior Panels		
	Exterior Panels		
	Battery System		
	Wheelchair Ramp Mechanism		
	Driver's Heater/Defroster		
	Floor Heaters		
	Rear HVAC Return Air Filter		
	Rear Axle Breather Tube		
	Engine Compartment Line Routing Inspection		
	Driver's Door		

INTERVALS (15,000 - 30,000 mi.)			
15,000 mi. (24,140 km)	**18,000 mi. (29,000 km)**	**24,000 mi. (38,600 km)**	**30,000 mi. (48,000 km)**
Secondary CNG Fuel Filter	Engine Mounts	Brake Treadle Assembly & Brake Valve	Air Compressor Discharge Lines
Engine Drive Belts	Fire Suppression & Gas Detection System		Turbocharger Inspection
Engine Water Pump Inspection	Power Steering Filter		Engine Vibration Damper Inspection

INTERVALS (36,000 - 48,000 mi.)		
36,000 mi. (58,000 km)	**45,000 mi (72,000 km)**	**48,000 mi. (77,200 km)**
Disc Brake Caliper Inspection	Engine Ignition Coil Inspection & Test	Front End Alignment

INTERVALS (36,000 - 48,000 mi.)		
36,000 mi. (58,000 km)	**45,000 mi (72,000 km)**	**48,000 mi. (77,200 km)**
Power Steering Fluid	Engine Spark Plugs Inspection	Front Brake Chambers
Rear Axle Oil Change (Hot Region Only - see NOTE at the end of this chart)		Rear Brake Chambers

INTERVALS (54,000 - 75,000 mi.)		
54,000 mi. (87,000 km)	**60,000 mi. (96,000 km)**	**75,000 mi. (120,000 km)**
Rear Axle Oil Change (Moderate Region Only - see NOTE at the end of this chart)	Overhead Valve Adjustment	Transmission Filters

INTERVALS (96,000 - 250,000 mi.)		
96,000 mi. (154,500 km)	**150,000 mi. (241,400 km)**	**250,000 mi. (400,000 km)**
Front End Alignment	Transmission Fluid	Support Frame Inspection
	Engine Compartment Access Door Inspection	

INTERVALS (6 Months - 3 Years)			
6 MONTHS	**YEARLY**	**2 YEARS**	**3 YEARS**
D-2 Governor	Fire Extinguisher	Radiator	Under Body Inspection
PR-2 Pressure Protection Valve	Door Sensitive Edge Inspection & Test	Alternator Overhaul	Fire Suppression System
ST-1 Safety Valve	Rear HVAC Unit Area Inspection	Door System Inspection	Air Dryer
SR-7 Spring Brake Modulating Valve	Instrument Panel & Side Console		
SC-1 Single Check Valve	CNG Fuel Tanks		
DC-4 Double Check Valve	Wheelchair Ramp Pump		

INTERVALS (6 Months - 3 Years)			
6 MONTHS	**YEARLY**	**2 YEARS**	**3 YEARS**
RV-1 Pressure Reducing Valve	Air Strainer		
RV-3 Pressure Reducing Valve	QR-1 Quick Release Valve		
R-14 Relay Valve	Radiator		
Brake Foot Valve	Coolant Testing		
Parking Brake Control Valve	Headlight Aim		
Emergency Brake Release Valve	Front & Rear Wheel Bearing Inspection		
Steering Knuckle	Support Frame Inspection		
Engine Compartment Access Door Inspection	HVAC System Inspection & Test		
Bike Rack Servicing	Crankcase Ventilation Filter Replacement		
Air Dryer			
CNG Tank Vent Caps			
HVAC System Test & Lubrication			
Power Steering Miter Box			

INTERVALS (5 - 12 Years)			
5 YEARS	**6 YEARS**	**10 YEARS**	**12 YEARS**
Door Operator Proximity Switches	Fire Suppression System	Door Component Replacement	Fire Extinguisher
Door Component Replacement	Fire Extinguisher		Fire Suppression System
Air Dryer	Booster Pump		
	Cooling System		

☞**NOTE:**

Moderate regions are defined as geographic locations where the average high temperature does not exceed 25°C (77°F) for more than two months of the year.

Hot regions are defined as geographic locations where the average monthly temperature exceeds 25°C (77°F) for more than two months of the year.

2.6. Daily Preventive Maintenance

2.6.1. Exterior Check

- ❐ Wheels are undamaged and studs and nuts are secure.
- ❐ Tires correctly inflated.
- ❐ Vehicle is level.
- ❐ Exterior panels are undamaged.
- ❐ No fluid leaks exist under vehicle.
- ❐ No fluid leaks exist at axles.
- ❐ Surge tank coolant level is correct.
- ❐ Heating system reservoir coolant level is correct.
- ❐ Power steering reservoir level is correct.
- ❐ Engine oil level is correct.
- ❐ Transmission fluid level is correct.
- ❐ CNG fuel tanks are full.

2.6.2. Operational Check

Start the vehicle and check the following for correct condition and operation.

- ❐ Low air warning indicator and buzzer.
- ❐ Instrument panel indicators.
- ❐ Turn signals.
- ❐ Door control.
- ❐ Mirror condition and adjustment.
- ❐ Window and windshield visibility.
- ❐ Windshield wipers and washer.
- ❐ Destination signs.
- ❐ Front and rear doors
- ❐ Exit door sensitive edge
- ❐ Wheelchair ramp.
- ❐ Interior and exterior lights.
- ❐ Steering column.
- ❐ Door master switch.
- ❐ Headlights.
- ❐ Door manual air release valve.
- ❐ Passenger signals.
- ❐ Instrument panel gauges.
- ❐ Brake pedal.
- ❐ Parking brake.
- ❐ Accelerator.
- ❐ Transmission shift selector.
- ❐ Air system charges to 125 psi within 5 minutes if system is fully depleted.

☞**NOTE:**

If any of these systems do not operate correctly, or if a fault indicator illuminates, DO NOT drive the vehicle. Refer to Section 19 of this manual for details on the correct operation of all vehicle controls.

2.6.3. Wheelchair Ramp

Inspect the wheelchair ramp area for cleanliness on a regular basis depending on operating conditions. Exposure to salt, sand, or slush during the winter months may require inspection on a daily basis. Likewise, operating in gritty, dusty conditions during the summer months will require more frequent inspections. Clean any dirt or foreign matter from the ramp, hinge, and operating shaft areas. Inspect the recessed area between the floor and ramp for any accumulation of debris. Manually deploy and stow the ramp to check for smooth operation. Inspect hinge for binding or distortion. Repair or replace hinge as necessary.

2.6.4. Wheelchair Tie-Down & Occupant Restraints

WARNING

If the vehicle was involved in an impact situation, significant enough to have the vehicle towed, then the wheelchair tie-downs, occupant restraints, and anchorages that were in use at the time should be replaced.

The following items should be inspected on a daily basis:

- ❒ Check belt retractor mechanism by extending and releasing belt. Ensure belt retractor operates as designed and functions smoothly.
- ❒ Inspect belts to ensure webbing is not cut, frayed, damaged, or contaminated by polishes, oils, or chemicals.
- ❒ Operate buckles and any locking or release mechanisms. Ensure mechanisms operate smoothly and release completely.
- ❒ Ensure all floor anchors are secure and free of obstructions, debris and dirt. Tighten mounting hardware as required.

☞**NOTE:**

If any mounting hardware requires tightening or adjustment, the fastener must be removed to have the threads cleaned and Loctite 243 reapplied/

- ❒ Ensure all wall anchors for belts are properly secured and allow proper freedom of movement.
- ❒ Ensure floor surface in wheelchair restraint area is undamaged and free of any condition which would impede use of equipment.
- ❒ Ensure the belts are kept clean and recoiled within the retractor when not in use.
- ❒ Ensure all labels detailing use of restraint equipment are undamaged and clearly legible.

2.6.5. Floor Covering

CAUTION

DO NOT clean the vehicle interior with pressure washing equipment. This type of cleaning causes excessive soaking of the floor covering and can result in separation of the rubber floor covering from the floor substrate, warping or deterioration of the floor substrate, and possible damage to floor mounted equipment such as floor heaters.

Inspect the interior flooring for cleanliness on a regular basis depending on operating conditions. Exposure to salt, sand, or slush during the winter months may require inspection on a daily basis.

- ❒ Vacuum or sweep the floor area daily to remove surface soil before it becomes embedded in the rubber floor covering.
- ❒ Wash the floor using a mild detergent and a minimum amount of water to avoid soaking seams and edge areas.
- ❒ Visually inspect rubber flooring for gouges, cracks, seam separation, lifting, or any other damage. Refer to Section 12 of this manual for floor covering repair procedures.

CAUTION

Damaged rubber flooring covering must be repaired immediately to prevent water intrusion and subsequent damage to the wood flooring.

2.6.6. Crankcase Breather Tube

Check breather tube for kinks, dents, or other damage. Also check inside of tube for sludge, debris, or ice formation (in freezing conditions). Clean or replace tube as required

2.6.7. Air Intake Piping

Inspect air intake tubes and hoses, for evidence of wear, punctures, or other damage. Inspect for loose connections and tighten clamps as necessary.

2.6.8. Radiator Hoses Inspection

Inspect radiator rubber hump hoses, for cracks, cuts, or evidence of collapsing. Inspect for loose connections and tighten clamps as necessary.

2.6.9. Throttle Response Test

Quickly depress and release the accelerator pedal. Confirm the engine speed increases when the accelerator pedal is depressed and returns to idle speed when the accelerator pedal is released.

Inspect the accelerator pedal assembly for any foreign objects that can obstruct actuation of the pedal assembly.

2.6.10. Bike Rack Inspection

Inspect the bike rack on a daily basis as follows:

❐ Check for presence of bolts that secure support arms to frame. Replace missing bolts as required.

❐ Ensure that the stow latches are installed. These latches stow the hook arms. Replace missing stow latches as required.

❐ Ensure that the support arms slide in and out smoothly and self-stow on the latch. DO NOT lubricate support arms.

❐ Ensure that the latch handle engages and releases easily without binding.

❐ Check the wheel stop screws (5/16" - 18 Phillips screws) are properly tightened.

❐ Ensure that the rack swings freely and locks in both the deployed and stowed positions.

2.6.11. Fire Suppression & Gas Detection System

Verify that the SYSTEM OK lamp on the fire protection panel is on solid green.

2.6.12. S-1 Gard

As part of the exterior vehicle inspection, ensure the S-1 Gard is securely in place, is installed level to the ground and is undamaged. Make note of any damage, such as twists or tears in the guard material.

2.6.13. CNG Fuel Filter Drainage

NOTE:

The drain interval is dependent on the amount of oil bypassed by the filling station compressor and will vary according to the condition of the compressor. The drain interval may be adjusted so that no more than one ounce of oil is collected between drain intervals.

1. Vent the fuel lines from the engine to the fill box. Refer to “Venting the System” - Stage One in Section 7 of this manual for procedure.
2. Using a 5 mm Allen key, loosen and remove the drain plug from the base of the primary filter. See “Fig. PM-1: CNG Fuel Filter Locations” on page 17.
3. Drain any accumulated contaminant.
4. Clean thread sealant from the drain plug, apply thread sealant approved for 3,600 psi CNG applications such as Swagelok SWAK® anaerobic sealant to the drain plug.
5. Install the drain plug, and torque to 8.2 ft-lb. (11.3 Nm).
6. Open the drain at the base of the secondary filter and allow the filter to vent. Close the drain.
7. Turn the quarter-turn shut-off handle to the ON position.
8. Check around the filter housing and the drain plug for any gas leaks using a combustible gas detector such as the Snap-On ACT 8800®. Liquid solutions such as SNOOP® can also be used. Do not use makeshift soapy water solutions.

NOTE:

Ensure that the fill box door is fully closed before starting the engine.

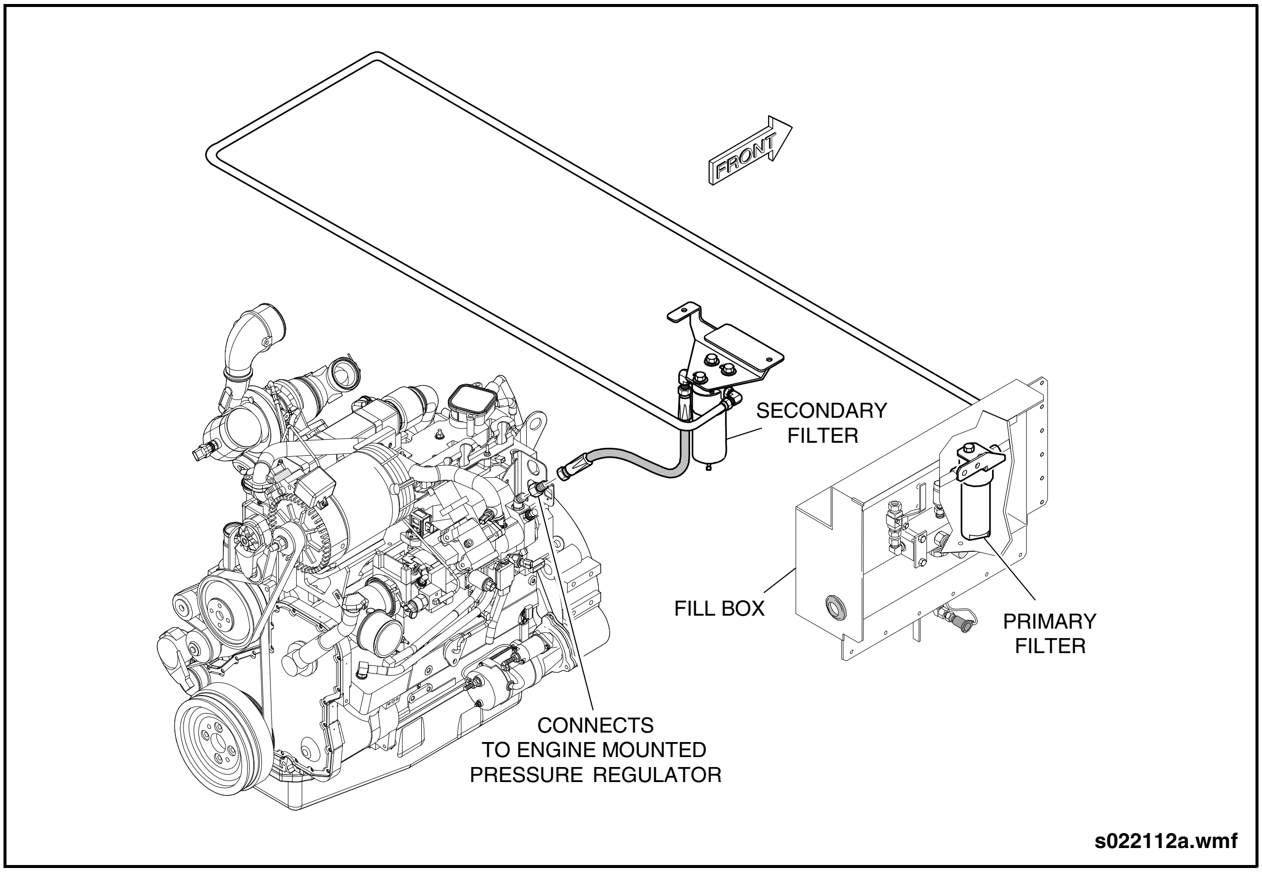


Fig. PM-1: CNG Fuel Filter Locations

2.7. Weekly Preventive Maintenance

2.7.1. Radiator

Test the function of the fan reverse switch and LED indicator on a weekly basis or any time service work is being performed in the engine compartment. Operating the fan reverse switch will not only clear debris from the radiator core, but will also confirm operation of the LED indicator which is used to display diagnostic fault codes. If any active fault codes are indicated, refer to Section 6 of this manual for troubleshooting and vendor information.

2.7.2. HVAC System Test

Operate all systems periodically, especially during the off season. By operating the system weekly for short intervals (5 to 10 minutes) year round, the internal parts of the compressor will remain lubricated. Off-season operation also helps reduce compressor shaft seal leakage and allows early detection of refrigerant loss.

CAUTION

Prior to operating the compressor during winter months, you must warm up the vehicle interior to normal operating temperature of 60 to 76° F (5 to 21° C). Unless this precaution is taken, liquid refrigerant might be forced into the compressor, causing severe damage.

2.8. Monthly Preventive Maintenance

2.8.1. Air Tanks

It is recommended that all air tanks be drained monthly and a record of the contents collected be recorded. Performing these inspections on a regular basis will establish trend monitoring to assess the performance of the compressor (excessive oil passing) and air dyer (saturated desiccant cartridge).

The following factors can influence that amount of water collected and should be taken into consideration before making an assessment:

❒ An outside air source was used to charge the system and did not pass through the air dryer.

❒ Exceptionally high air usage, exceeding 25% compressor duty cycle due to either heavy accessory demand or system leakage

❒ Daily temperature range exceeds 30°F (17°C) resulting in condensation. Under these conditions the presence of small amounts of moisture is normal and should not be considered as an indication that the air dryer is not functioning properly.

☞NOTE:

A small amount of oil in the system is not unusual and should not be considered a reason to replace the desiccant cartridge. Oil stained desiccant can function adequately.

Perform the air tank drain and collection process as follows:

1. Obtain Bendix BASIC test kit or equivalent.
2. Park the vehicle on level ground and chock the wheels.
3. Place the collection cup at each drain valve and slowly drain the air tank. Repeat this process for all air tanks and collect total contents in a single collection cup.
4. Allow contents in collection cup to settle and assess whether fluid is primarily water, oil, or an emulsion.

5. Evaluate volume collected as follows:

   a. More than one unit of oil in a 30 day period will require the desiccant cartridges to be changed and is considered cause for further inspection of the air compressor. Worn pistons or rings will allow oil bypass and may require repair if amount of oil bypassed is excessive. Also inspect compressor discharge line for excessive carbon buildup.

   b. More than one unit of water or emulsion will be cause to conduct an air system leakage test. Refer to Section 8 of this Service Manual for procedure.

   c. More than five units of water in a 30 day period indicates unsatisfactory air dryer performance. Replace air dryer desiccant cartridges.

2.8.2. Bike Rack Inspection

Inspect the bike rack on a monthly basis as part of general maintenance. In addition to the general maintenance inspection, perform specific servicing and repairs resulting from the monthly general maintenance inspection. Refer to Section 13 of this manual for specific servicing and repair procedures.

❐ Ensure that the rack swings freely between stowed and deployed positions.

❐ Ensure that the latch handle easily unlatches without binding in the release position.

❐ Ensure that the latch handle automatically locks the rack in place when moved to the stowed or deployed positions.

❐ Ensure that each support arm hinge permits the support arm to raise and lower without binding or excessive play.

❐ Ensure that the support arm stow latch properly mates with and holds the support arm grip.

❐ Ensure that each support arm grip pulls out smoothly to the end stop, and easily slides back to the stored position and properly self stows on the stow latch when released. DO NOT lubricate the support arm assembly.

❐ Check the pivot bolt assemblies to ensure they are tight.

❐ Check pivot bolt bronze oilite bushings for wear or cracks. Replace as necessary.

❐ Check that all mounting bracket fasteners are tight, including the hardware for the quadrant, pivot plate to bracket pieces, and bracket pieces to vehicle bumper/structure.

❐ Ensure that the instruction labels are intact and legible. Replace any damaged or illegible labels. Clean the bike rack surface with isopropyl alcohol before applying new label.

2.8.3. HVAC System Inspection

Perform a visual inspection of the HVAC system every month or 6,000 miles (9,600 km), whichever occurs first. Refer to your Thermo King Maintenance Manual for procedures.

2.8.4. Fire Extinguisher

Inspect the fire extinguisher every month as follows:

❐ Ensure the fire extinguisher is securely mounted in its proper location.

❐ Check that the safety pin lock is installed.

❐ Ensure that the hose is in good condition and the nozzle is not obstructed.

❐ Confirm that the cylinder pressure indicated on the gauge is within the green operating range.

2.8.5. Fire Suppression & Gas Detection System

Verify the following conditions monthly or every 3,000 miles, whichever comes first:

2.8.5.1. General & Driver's Area

- ❒ No obvious physical damage or condition exists that might prevent system operation.
- ❒ All warning indicators and audible alarm on the control panel are operational by pressing the TEST/RESET button.
- ❒ Seal on manual activation switch is intact and access to switch is unobstructed.

2.8.5.2. Spot Thermal Fire Detectors

- ❒ Verify that all thermal detectors are in place and securely mounted.
- ❒ Verify that there is no obvious physical damage to the thermal detector and that it is free of excess contamination (dirt, oil, grease, and so forth). If necessary, clean using water soaked non-abrasive towel.
- ❒ Verify that the thermal detector wiring harness in engine compartment is properly routed and clamped and no damage evident to the harness.

2.8.5.3. Optical Flame Detectors

- ❒ Status lamp on optical fire detector face is on solid green.
- ❒ Detector's field of view is not obstructed.
- ❒ Windows on face of detector are free of excess contamination (dirt, oil, grease, and so forth). If necessary, clean using water soaked non-abrasive towel.

2.8.5.4. Gas Leak Detectors

- ❒ Verify that the status lamp on the face of the gas sensor is on solid green.

⚠ CAUTION

DO NOT use chemical cleaners on the gas sensor.

- ❒ Verify there is no obvious physical damage to the gas sensor unit and that the unit is free of excess contamination (dirt, oil, grease, and so forth). If necessary, clean using water soaked non-abrasive towel.
- ❒ Verify that no silicone based materials have been used near the gas sensor.

2.8.5.5. Electrical Harnesses

- ❒ Electrical connectors and electrical wiring have no visible damage and all connectors are securely seated.

2.8.5.6. Extinguisher & Distribution System

- ❒ Verify that the extinguisher is correctly oriented and securely mounted.
- ❒ Extinguisher pressure gauge pointer is in the green zone at room temperature. See "Fig. PM-2: Fire Suppression Cylinder Inspection" on page 21.
- ❒ Distribution piping and nozzles are intact and unobstructed and nozzle blow-off caps are in place.
- ❒ Visually inspect extinguisher for damage such as pits, gouges, dents, or corrosion. If a pit, gouge, or cut exceeds a depth of 0.08 inches; if the depth of a dent exceeds 0.25 inches or one-tenth of the average diameter of the dent; or corrosion exceeds a depth of 0.05 inches or a coverage area larger than 15% of the extinguisher's outer surface, have the extinguisher evaluated by a qualified fire protection equipment company familiar with Kidde equipment.

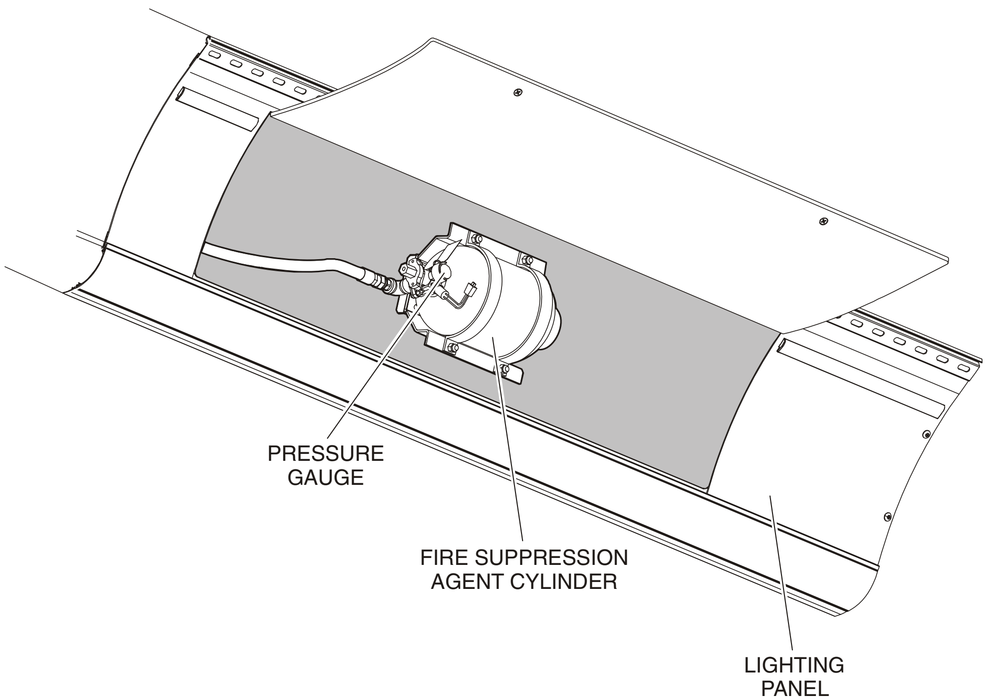


Fig. PM-2: Fire Suppression Cylinder Inspection

2.9. Quarterly Preventive Maintenance

2.9.1. HVAC System Inspection & Test

Perform a check of system operating pressures and temperatures every three months or 18,000 miles (29,000 km), whichever occurs first. Refer to your Thermo King Maintenance Manual for procedures.

2.9.2. Radiator

☞NOTE:

The inspection interval is dependent on local operating conditions. Exposure to harsh conditions such as salt, dirt, and debris may require more frequent inspections. Operating in a less harsh environment, in combination with regular fan reversal operation, may allow for extended inspection intervals.

Inspect and clean the radiator on a quarterly basis or more frequently if operating under harsh conditions.

2.9.2.1. Inspection

1. Check hose connections and tighten clamps as necessary. Cracked, swollen or deteriorated hoses must be replaced.
2. Check radiator and charge air cooling cores for leaks and for accumulation of dirt which obstructs air passage. As required, operate the fan reverse button on the engine gauges panel to assist in removing debris from the cores. Repair all cooling system leaks immediately. See “Fig. PM-3: Radiator Inspection” on page 24.
3. Inspect the radiator mountings and tighten mounting bolts when necessary.
4. Inspect for clearance between fan blades and radiator core and fan shroud.
5. Inspect air recirculation seals at baffles around radiator assembly. Seals must be in good condition.
6. Inspect fan blades for cracks, broken tips, or other damage.
7. Inspect charge air cooler hoses and piping for leaks, holes, cracks, or loose connections.
8. Inspect the radiator and surrounding area for evidence of corrosion as follows:
   a. Inspect the steel fan shroud that encloses the radiator for paint damage or evidence of corrosion. Prime and repaint exposed surfaces as necessary.

   ☞NOTE:

   Stones and road debris may chip the powder coating on the steel fan shroud and provide the potential for corrosion to begin. If unprotected steel and a salt solution are allowed to remain on the system, then the aluminum heat exchanger may also suffer corrosive damage due to stray voltage.

   b. Inspect the lower mounting bracket for corrosion and accumulation of debris. Clean, prime, and repaint as necessary.
   c. Inspect the bottom of the radiator and drain plug for evidence of corrosion. Clean, prime, and repaint as necessary.
   d. Inspect the surrounding structural tubing for evidence of corrosion. Clean, prime, and repaint as necessary.
9. Repair or replace any defective part. Refer to Section 6 of this manual for procedure.

2.9.2.2. Power Washing

⚠CAUTION

DO NOT use excessive pressure or place washer wand within close proximity to radiator/CAC core when power washing otherwise damage to the fins could result. Use a pressure of less than 1200 psi to power wash and maintain a minimum distance of 9 inches from the cores. DO NOT direct power wash at product or safety labels.

⚠CAUTION

The use of steam cleaning or pressure washing equipment can force moisture into electrical connectors and cause corrosion of the terminals Avoid directing high pressure spray toward any electrical connectors.

☞NOTE:

Sodium Chloride (rock salt), Calcium Chloride, and Magnesium Chloride are salts used for road surface treatment during the winter months in areas prone to freezing. These salts are highly corrosive and can accumulate on the radiator assembly and must be removed on a regular basis (monthly when salts are applied to the roads).

Power wash the fan side and heat exchanger side of the radiator in accordance with the following instructions. Use an effective detergent, following manufacturer's instructions, and then flush out the cleanser using the reverse fan cycle and low pressure clean water.

1. Clean the exterior of the radiator from the engine compartment side on an “as required” basis. Use power wash equipment at reduced pressures, not exceeding 1200 psi, and maintain a safe distance, no closer than 9 inches from the heat exchanger.

   ☞NOTE:

   Use a cleaning solution approved for effective removal of road grime and safe for aluminum. In winter months use a solution that is effective for the removal of road salts used in the area.

2. Clean the exterior of the radiator from the streetside of the vehicle on an “as required” basis. Close the screened radiator door and maintain a minimum distance of 12 inches between the wand of the pressure washing equipment and the screened door. Reduce power washing equipment to not exceed 1200 psi.

   ☞NOTE:

   If the radiator cannot be satisfactorily cleaned to provide proper airflow across the core, then the unit will need to be removed from the vehicle for soaking and cleaning. Refer to 2.28.9. “Radiator” on page 96 *in this section for cleaning and flushing procedure.*

2.9.2.3. Grounding (Bonding) Wires

NOTE:

The radiator and coolant tubes are grounded to the vehicle frame to minimize any corrosion resulting from electro-potential differences between dissimilar metals and exposure to electrolytic (salt) solutions. It is important that these grounding connections be maintained.

- ❒ Inspect all ground wires for wear or frayed insulation.
- ❒ Inspect the coolant supply and return tubes and ensure that the stainless steel clamps with ground wires are clean, free of corrosion, and securely attached to the tubes.

CAUTION

The fan shroud must not be grounded to the vehicle frame unless the coolant pipes are also grounded.

- ❒ Inspect the aft side of the radiator shroud to ensure that the ground wire connection is clean, free of corrosion, and securely attached.
- ❒ Inspect the three ground wire connection points on the streetside main frame rail to ensure that the connections are not corroded and are securely attached.

2.9.2.4. System Diagnostic Data

Observe any inactive faults on EMP cooling systems equipped with diagnostic capabilities. Connect the EMPower Connect Service tool to the vehicle diagnostic port and record any inactive faults. Clear faults and check for any recurring faults at subsequent inspections.

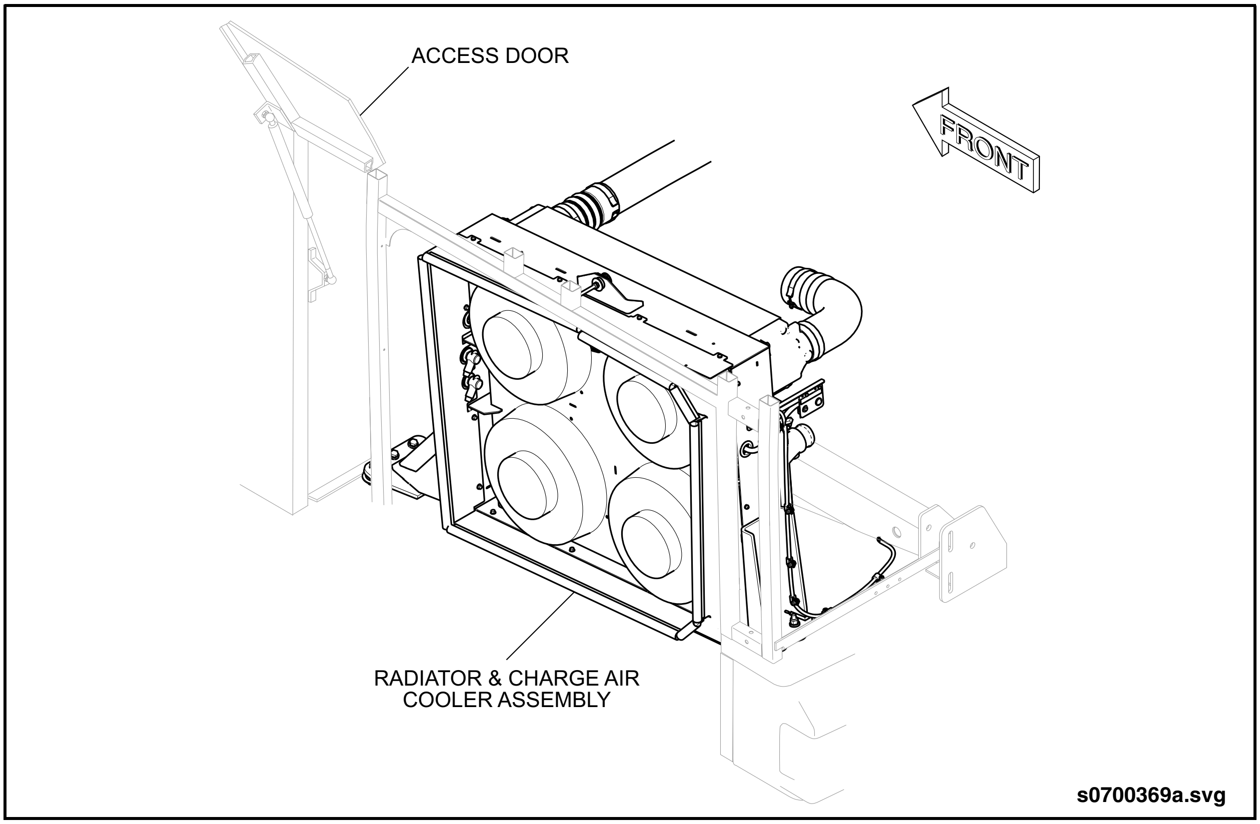


Fig. PM-3: Radiator Inspection

2.10. 3,000 Miles (4,800 km) Preventive Maintenance

2.10.1. Air Filter Restriction Indicator Inspection

Inspect the air filter restriction indicator every 3,000 miles (4,800 km), 250 hours, or 3 months, whichever occurs first. Locate the restriction indicator in the engine compartment and refer to the scale on the indicator that is calibrated in inches of water. Replace the air filter element when the reading reaches 25" H_2O. Refer to 2.10.2. “Air Filter Replacement” on page 26 in this section for replacement procedure.

The service life of an air filter element is affected by several factors including operating environment, hours of operation, and total time in service. The requirement for air filter element replacement is determined by monitoring the reading on the Filter Minder® air filter gauge. This gauge monitors air restriction downstream of the air cleaner assembly. See “Fig. PM-4: Air Filter Restriction Indicator” on page 25.

The air filter gauge is calibrated in inches of water on one side and millimeters of water on the opposite side. The gauge will register and retain the highest air restriction reading experienced during operation. Maximum air restriction readings will be obtained typically during full throttle, full load operation.

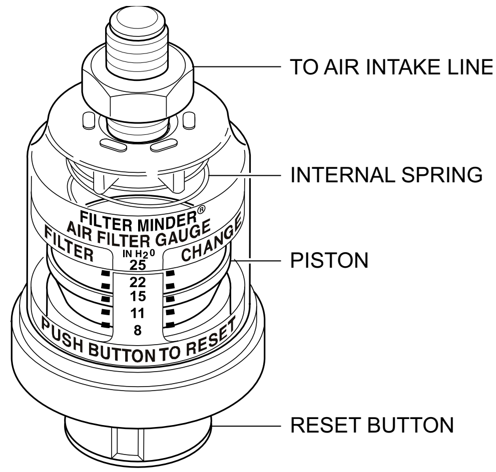


Fig. PM-4: Air Filter Restriction Indicator

2.10.2. Air Filter Replacement

The air filter housing assembly includes a primary and safety element. The primary element provides engine protection during operation and the safety element is designed to prevent contaminates from entering the induction system during servicing. The safety element is located within the filter housing, immediately downstream of the primary element. See “Fig. PM-5: Air Filter Elements” on page 26.

The replacement interval for the primary element is determined by the filter restriction indicator reading. Replace the primary element when the gauge reading is between 18 to 20 inches of water. The safety element should be replaced every third primary element change or whenever the surface of the safety element has become contaminated.

☞NOTE:

There is no need to remove and visually inspect the air filter element if the indicator reading is less than 18" H_2O. Replacing the air filter element at 18" H_2O. will maximize the service life of the filter and minimize any risk associated with excessive handling of the air filter.

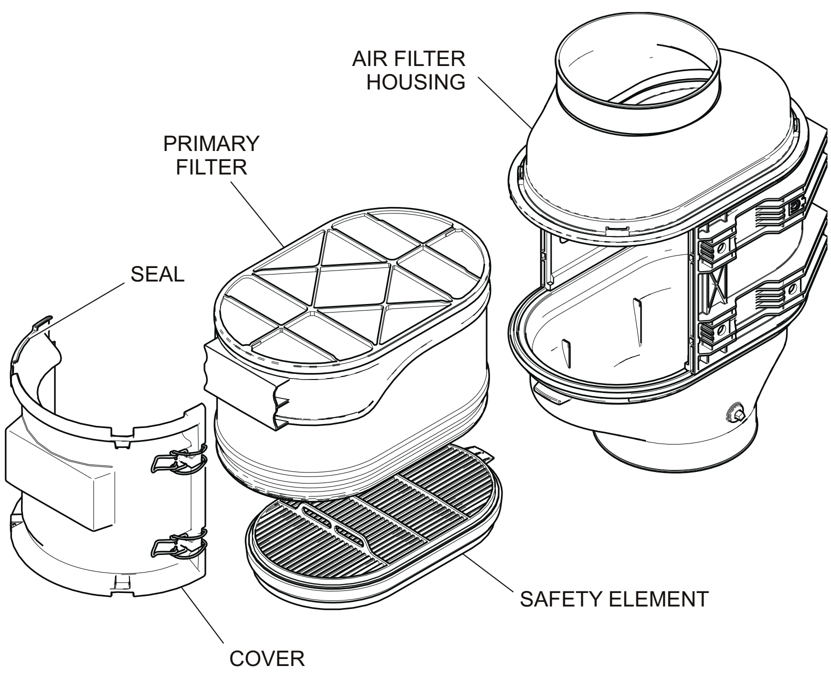


Fig. PM-5: Air Filter Elements

2.10.2.1. Removal

1. Open the air filter access door located on the rear curbside corner of the vehicle.

⚠ CAUTION

The air filter housing is mounted with the clean air outlet pointing downward and care must be used when performing an element replacement to avoid contaminating the induction system during servicing.

2. Remove the air filter housing cover by releasing the four over-center latches located on both sides near the center of the body. Remove the cover by pulling straight out from the housing.
3. Using the plastic handle on the primary element gently lift up on the element to loosen the gasket seal, which will tilt the element to an approximate 5 degree angle. Carefully remove the primary element from housing.
4. Carefully clean out all contaminates from the housing and sealing surfaces with a damp cloth before servicing the safety element.

⚠ CAUTION

The lower elbow located at the base of the vertical air intake pipe must be disconnected before removing the safety filter. Removal of the safety filter may dislodge dirt or other contaminants that could enter the air intake system.

5. If the safety element has to be replaced use the plastic handle on the face of the safety element. Pull the element towards the center of the housing and carefully remove it from the housing to avoid contaminates from entering the induction system.

☞NOTE:

If new elements are not going to be installed immediately, temporarily cover the outlet tube to prevent contaminants from entering the air intake system.

6. Carefully wipe out the safety seal surface in the housing with a damp cloth.

2.10.2.2. Inspection

1. Inspect the rubber seal on air filter housing access door (U-shaped cover with four over-center latches). Replace the access door if the seal is deteriorated or damaged. Refer to your New Flyer Parts Manual for part number of access door.
2. Inspect the clamped connections at the inlet and outlet of the air filter housing. There should be no evidence of bulged or deformed hoses.

⚠ CAUTION

DO NOT exceed 40 in-lbs torque on the hose clamps. Over-tightening the clamps will deform the plastic air filter housing inlet/outlets.

3. Use a bright light to inspect the interior of the air filter housing and check for any evidence of distortion or cracking on the inlet and outlet clamped connections. Replace air filter housing if cracked or damaged. Refer to Section 4 of this manual for replacement procedure.
4. Shine a bright light into the air intake tube leading away from the air filter housing and ensure no evidence of dust trails or other contaminants exist. Remove air intake piping and clean as necessary.

2.10.2.3.Installation

1. Install the safety element using the handle facing up and outward. Insert the safety element tab into the positioning slot before pushing the element down into place.

   ☞NOTE:

   The safety element handle must be towards the service cover opening and completely seated to allow for proper installation of the primary element.

2. Use the handle on the primary element to insert it into the housing at the same angle as it was removed. Insert the element until it makes contact with the inside of the housing. Pull down on the handle to complete the seal.

   ☞NOTE:

   The element must be completely seated to allow for proper installation of service cover.

⚠CAUTION

NEVER use latches to force the element into place.

3. Install service cover with the indexed rib at the top and attach all 4 latches. If the cover doesn't seat, remove and re-check the filter position.
4. Clean and reinstall lower elbow to air intake pipe. Torque T-Bolt clamps at either end of elbow to 85 in-lbs.

2.10.3. Charge Air Cooler (CAC) Inspection

Inspect the CAC every 3,000 miles (4,800 km), 250 hours, or 3 months, whichever occurs first.

Inspect for dirt and debris blocking the fins. Check for cracks, holes, or other damage. If damage is found, refer to Section 6 of this manual and your EMP Service Manual

2.10.4. Charge Air Piping Inspection

Inspect the charge air piping every 3,000 miles (4,800 km), 250 hours, or 3 months, whichever occurs first.

Inspect the charge-air piping and hoses for leaks, holes, cracks, or loose connections. Tighten the hose clamps if necessary. Torque T-bolt clamps to 80 to 90 in-lbs.

2.11. 6,000 Miles (9,600 km) Preventive Maintenance

2.11.1. Disc Brake Pad Inspection

Visually check brake pad wear every 6,000 miles (9.600km) or every 3 months, whichever occurs first. Refer to “Brake Pad Wear Inspection” in Section 1 and 2 of this manual for inspection procedure.

2.11.2. Wheels & Tires Inspection

- ❒ Visually inspect tires for unusual tread wear indicating wheels are out of alignment, suspension damage has occurred or tires are not properly inflated.
- ❒ Visually check that wheel rims are not bent, cracked or damaged.
- ❒ Check tires are same make, model and size.
- ❒ Check wheels are balanced.
- ❒ Visually inspect the wheel check indicators to ensure they are properly installed and the arrow of the indicator is pointing to the center of the adjacent nut.
- ❒ Check wheel nuts are tightened to the specified torques. Refer to Section 1 and Section 2 of this manual for specifications.

☞NOTE:

Refer to “Wheels” in Section 1 and Section 2 of this manual for additional wheel inspection requirements.

2.11.3. Transmission Inspection

Every 6,000 miles (9,600 km) inspect the transmission for the following conditions:

- ❒ Loose bolts (transmission to engine attachment and driveline components).
- ❒ Oil leaks (correct immediately).
- ❒ Worn or frayed electrical harnesses, improper routing. See “Fig. PM-6: Transmission Inspection” on page 29.
- ❒ Damaged or loose oil lines.
- ❒ Worn or out-of-phase driveline yokes and slip joints.
- ❒ Clogged or dirty breather. Replace as required.
- ❒ Transmission fluid that is discolored, has a strong odor, or has exceeded oil analysis limits.
- ❒ Presence of engine coolant in the transmission fluid.

☞NOTE:

Transmission overhaul is required when the transmission has been contaminated with engine coolant.

- ❒ Presence of transmission fluid in the engine cooling system.

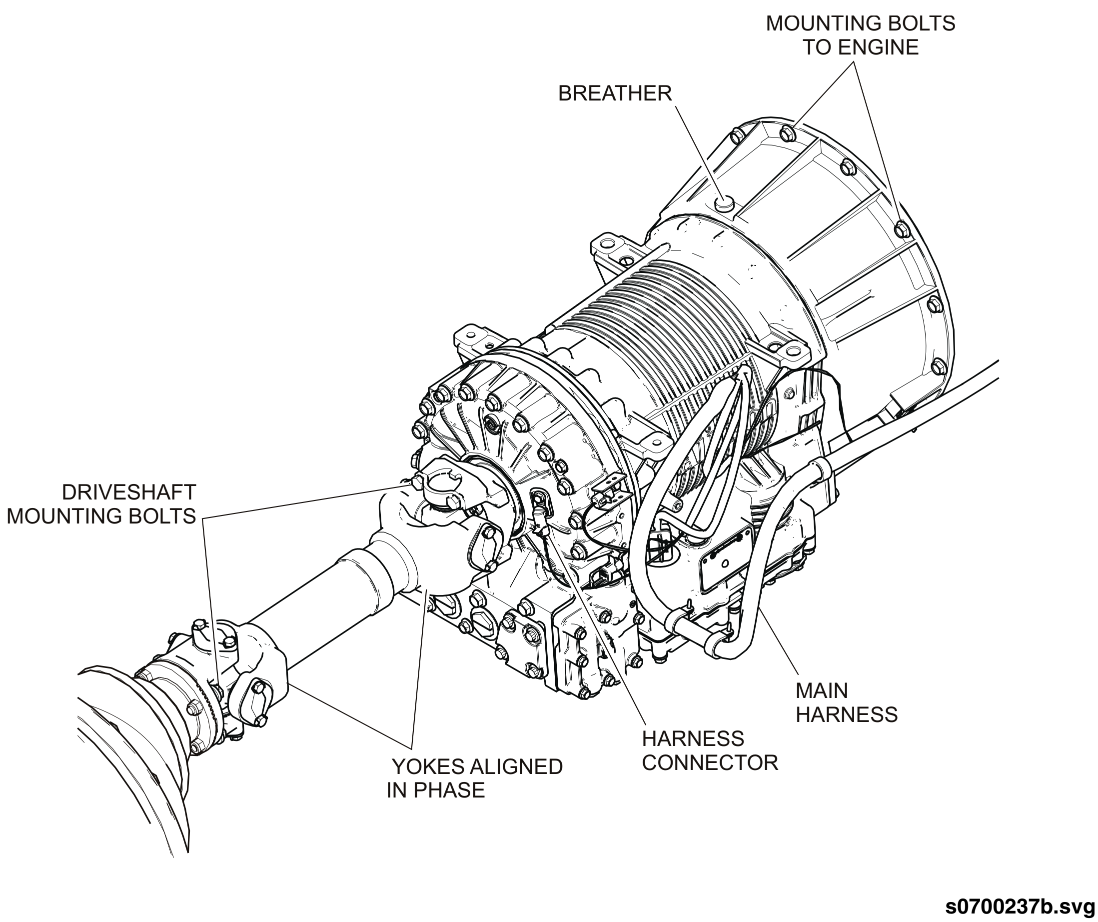


Fig. PM-6: Transmission Inspection

2.11.4. Engine Oil & Filter Change

☞NOTE:

Engine oil and filter change intervals are based on average vehicle speed. Refer to 2.11.4.1. “Engine Oil Change Intervals” on page 31 *in this section and use whichever interval is the shortest. Oil may be blown out through the crankcase breather if the crankcase is overfilled.*

1. Run the engine until its operating temperatures reaches 140°F (60°C). Stop the engine. See “Fig. PM-7: Engine Oil Filter” on page 30.
2. Remove the oil drain plug from the bottom of the oil pan.
3. Allow the oil to drain into a suitable container.
4. Clean the area around the oil filter head. Remove the filter and clean the gasket area.

☞NOTE:

The gasket can stick to the filter head. Ensure it is removed.

5. Fill the replacement filter with clean engine oil. Apply a thin film of lubricating oil to the filter gasket and to the gasket sealing surface.
6. Install the filter on the engine. Follow the directions on the label for correct installation. Do not over-tighten.
7. Clean the engine oil pan drain plug threads. Install the drain plug. Torque the plug on installation 60 ft-lb. (81 Nm).
8. Fill the engine with new oil. Refer to 2.36. “Fluid & Lubrication Guide” on page 109 in this section for oil specification. Engine capacity is 28.0 quarts U.S. (26.5 liters).
9. Start the engine and inspect for leaks at the filter and at the drain plug.
10. Stop the engine. Wait 15 minutes to allow the oil to settle. Correct any leaks.
11. Check the oil level on the dipstick. Add oil as required to bring the level to the high mark on the dipstick.

☞NOTE:

Refer to the Cummins Operation & Maintenance Manual for further engine related preventive maintenance operations.

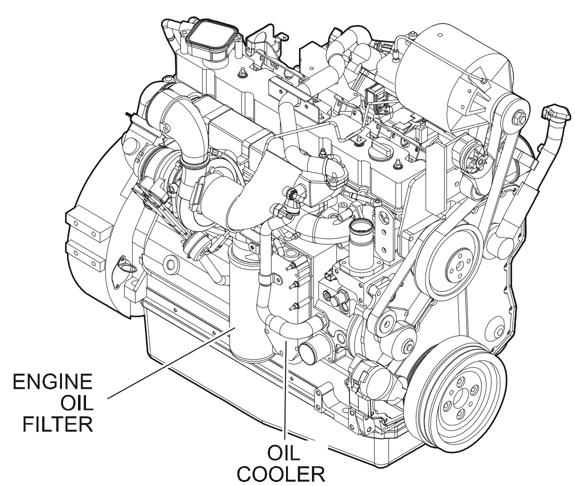


Fig. PM-7: Engine Oil Filter

2.11.4.1.Engine Oil Change Intervals

ENGINE OIL CHANGE INTERVALS			
AVERAGE VEHICLE SPEED	INTERVAL		
	Mileage (km)	Operating Hours	Months
3 - 4 mph (5 - 7 km/h)	1,500 (2,400)	500	6
5 - 6 mph (8 - 10 km/h)	3,000 (4,850)	500	6
7 - 8 mph (11 - 13 km/h)	4,000 (6,450)	500	6
9 - 10 mph (14 - 16 km/h)	5,000 (8,050)	500	6
11 - 15 mph (17 - 24 km/h)	6,000 (9,650)	500	6
Greater than 15 mph (24 km/h)	7,500 (12,000)	500	6

2.11.5. Primary CNG Fuel Filter

Replace primary CNG fuel filter and seal every 6,000 miles (9,600 km). More frequent replacement will be required if large quantities of contaminants are present in the fuel. Proceed as follows:

1. Vent the fuel lines from the engine to the fill box. Refer to “Venting the System” - Stage One in Section 7 of this manual.
2. Using a 5 mm Allen key, loosen and remove the drain plug from the base of the filter.
3. Drain any accumulated contaminant.
4. Clean thread sealant from the drain plug, apply thread sealant approved for 3,600 psi CNG applications such as Swagelok SWAK® an aerobic sealant to the drain plug.
5. Install the drain plug, and torque to 8.2 ft-lb. (11.3 Nm).
6. Use a proper sized wrench to grip the wrench flats of the filter housing.
7. Loosen and slowly and carefully unscrew the housing from the header unit. Firmly grip the bottom filter housing as the internal compression spring will want to push the housing away from the top header unit.
8. Be careful not to drop the filter element or lose the O-ring seal that fits into the groove on the top of the housing.
9. Remove the filter element and examine for wear and contaminant particles on the inside of the filter. If the filter shows little or no contamination, it can be reused.
10. Install the inspected or new filter onto the center tube. Check the O-ring seal in the groove on top of the housing for any damage or flatness. Replace it if it is damaged to any degree. A new O-ring is supplied with each replacement element.
11. Carefully move the housing up into the header unit. The spring will self-center onto the element.
12. Carefully align the housing and header threads, hand tighten, then torque to 30.5 ft-lb. (40.7 Nm).
13. Turn the quarter-turn shut-off handle to the ON position. The handle is in the ON position when it is parallel to the fuel line. Open the individual CNG tank shutoff valves.
14. Check around the filter housing for any gas leaks using a combustible gas detector such as the Snap-On ACT 8800®. This particular unit can detect localized gas leaks from 50 to 1000 PPM. (Parts Per Million). Liquid solutions such as SNOOP® can also be used. Do not use make-shift soapy water solutions.
15. Make sure the fill box door is fully closed after turning the quarter-turn valve ON. This is necessary because the CNG system will not function and the engine will not start until the door proximity sensor enables the electrical system.

2.11.6. Exhaust System

Inspect the condition of the exhaust system components every 6,000 miles (9,600 km) as follows:

- ❒ Inspect muffler for any damage to body, sensors, wiring, or mounting brackets.
- ❒ Inspect exhaust blankets for proper installation, ensuring no cuts, tears, or other damage exists.
- ❒ Inspect exhaust tubes for dents, cracks, leaks, or restrictions.
- ❒ Inspect exhaust flex connector for proper alignment and any evidence of damage. Refer to Section 4 of this manual for alignment procedure.
- ❒ Ensure all exhaust clamps are properly tightened.
- ❒ Ensure all exhaust system mounting brackets and component fasteners are properly tightened.

2.11.7. Cooling & Heating System Inspection

Inspect the radiator, coolant fluid level, antifreeze concentration, and cooling system components every 6,000 miles (9,600 km),

2.11.7.1.Radiator Power & Ground Studs

☞**NOTE:**

This inspection interval is dependent on operating conditions and exposure to road salts. Adjust inspection interval to suit conditions.

1. Locate the power and ground studs on the radiator and pull boots back from pass-through stud. See “Fig. PM-8: Radiator Inspection” on page 33.
2. Wipe grease and any debris from the ring terminal and stud area. Observe if the grease is discolored. If the grease is discolored, thoroughly degrease the area before proceeding.
3. Examine the assembly and if corrosion is found, disassemble the ring terminal from the stud and clean the ring terminals and studs with a brass wire brush. Replace any hardware that shows signs of accelerated corrosion. Reassemble and torque to specification. Refer to Section 6 of your New Flyer Service Manual for assembly torque.
4. Apply dielectric grease to the power and ground studs on both sides of the pass-through stud. Slide protective rubber boots over exposed nuts and studs. Ensure that the vehicle side power and ground boot is securely snapped onto the bushing to form a seal. Refer to 2.11.7.3. “Grease Requirements” on page 34 for grease quantity requirements.

☞**NOTE:**

Use Dow Corning DC-4 Electrical Insulating Compound or equivalent. Use a squeeze tube to dispense 5 grams (which is nearly enough to fill the insulation boot) directly onto the stud or into the boot. If grease is dispensed into the boot, squeeze the boot after covering the stud to ensure the grease is worked onto all surfaces of the stud components.

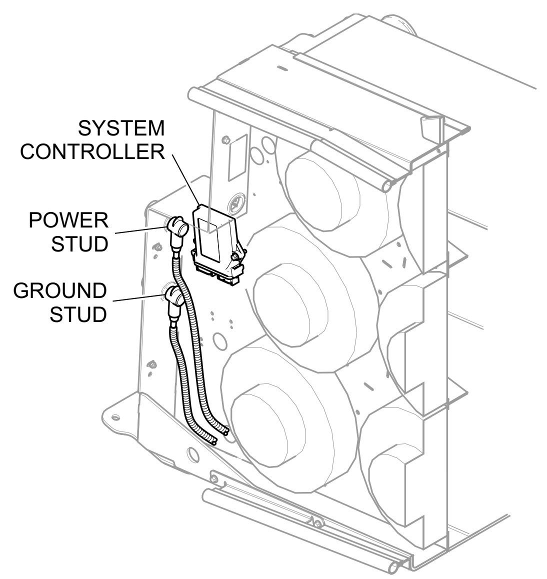


Fig. PM-8: Radiator Inspection

2.11.7.2.Radiator Electrical Connectors

☞**NOTE:**

This inspection interval is dependent on operating conditions and exposure to road salts. Adjust inspection interval to suit conditions.

1. Inspect the fan main harness, ignition, CAN, and system controller electrical connectors to ensure they are clean and properly connected.
2. Ensure harness is properly routed and secured.
3. Open the connectors and inspect terminals for dirt or corrosion. Clean as necessary with contact cleaner and a stiff bristle brush.
4. Reapply a small amount Dow Corning DC4 dielectric grease to the harness side of the connector and reconnect. Refer to 2.11.7.3. “Grease Requirements” on page 34 for grease quantity requirements.

2.11.7.3. Grease Requirements

Use an acid brush to apply a thin coat of clean dielectric grease to the harness side of the connector.

☞**NOTE:**

The fan connectors on systems with 15" fans do not require dielectric grease.

GREASE REQUIREMENTS	
Location	**Grease Quantity (grams)**
Power/Ground Studs with 1 1/8" Dia. Boots	5.0 g
Power/Ground Studs with 1 1/2" Dia. Boots	10.0 g
TMC & CAN Connectors	1.0 g
LED/Pushbutton Connector	0.75 g
Ignition Connector	0.50 g
11" Fan Connector	1.25 g
15" Fan Connector	None

2.11.7.4. Surge Tank Coolant Level

⚠ **WARNING**

DO NOT attempt to open the pressure cap on the surge tank until the system has cooled down and the pressure relief valve has been operated. Opening the pressure cap with pressurized hot coolant can result in scalding injury and loss of coolant.

1. Once the system has cooled down, observe the coolant level through the fluid level markings on the recovery tank. The coolant should be between the COLD MIN and COLD MAX lines marked on the recovery tank.

☞**NOTE:**

If necessary, the coolant level can be checked while system is hot by observing coolant level through the level markings on the recovery tank. The coolant level should not be above the HOT MAX marking shown on the tank. However, the system must be allowed to cool down before the Filler cap is removed.

2. Top off coolant to the correct level as required using premix antifreeze. Refer to 2.36. "Fluid & Lubrication Guide" on page 109 in this section for antifreeze specification. See "Fig. PM-9: Coolant Level Inspection" on page 35.

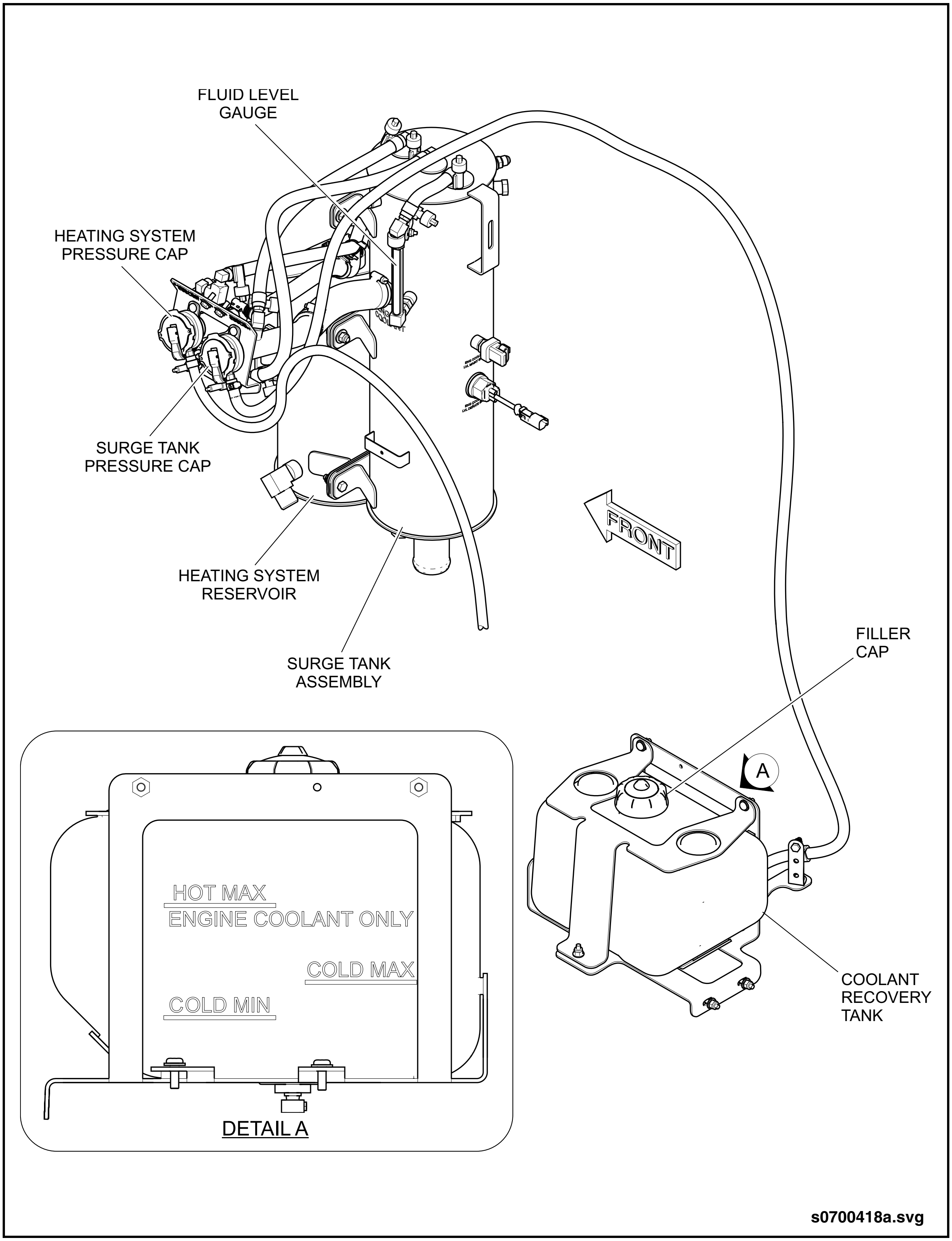


Fig. PM-9: Coolant Level Inspection

2.11.7.5. Heating System Reservoir Coolant Level

WARNING

DO NOT attempt to open the pressure cap on the heating system reservoir until the system has cooled down and the pressure relief valve has been operated. Opening the pressure cap with pressurized hot coolant can result in scalding injury and loss of coolant.

1. Once the system has cooled down, observe the coolant level through the fluid level gauge on the heating system reservoir. The coolant should be between the COLD FULL and HOT FULL lines marked on the reservoir.

   NOTE:

   If necessary, the coolant level can be checked while system is hot by observing coolant level through the level markings on the reservoir. The coolant level should not be above the HOT FULL marking shown on the reservoir. However, the system must be allowed to cool down before the filler cap is removed.

2. Top off coolant to the correct level as required using premix antifreeze. Refer to 2.36. "Fluid & Lubrication Guide" on page 109 in this section for antifreeze specification. See "Fig. PM-10: Heating System Reservoir Fill Level" on page 36.

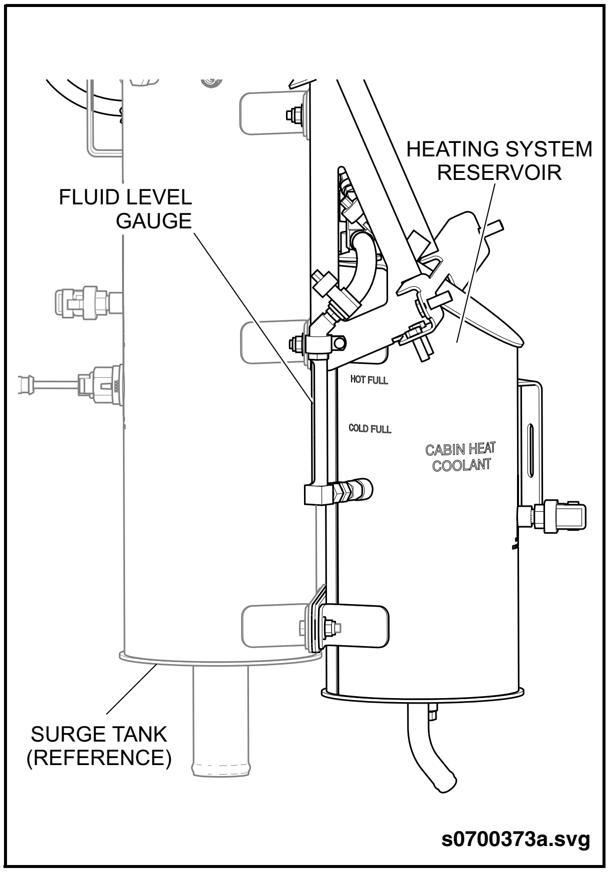


Fig. PM-10: Heating System Reservoir Fill Level

2.11.7.6. Antifreeze

CAUTION

Overconcentration of antifreeze or use of high-silicate antifreeze can cause engine damage. DO NOT use antifreeze concentrations in excess of 60% or less than 40%.

Use only fully formulated coolants meeting ASTM D6210 specification and Cummins Engineering Standard 14603. Refer to 2.36. “Fluid & Lubrication Guide” on page 109 in this section for coolant specification.

Antifreeze broadens the operating temperature range by lowering the coolant freezing point and raising the boiling point. The corrosion inhibitors protect cooling system components from corrosion and prolong component life.

Use a Refractometer to provide a reliable and accurate measurement of freeze point protection and glycol (antifreeze) concentration. Use pre-mixed anti-freeze of 50% distilled water and 50% ethylene glycol to provide year-round protection of -26°F (-32°F).

☞**NOTE:**

Fleetguard Refractometer, part number CC2806 can be ordered through Cummins Filtration.

Antifreeze should also be checked, on a yearly basis, for contamination such as oil, fuel, grease, solder bloom, silica gel, rust, or scaling. Coolant must be replaced and cooling system cleaned and flushed if contamination is evident. Refer to Section 6 of this manual for basic cleaning and flushing procedures. Also refer to Cummins Operation and Maintenance Manual and Cummins Coolant Requirements and Maintenance Bulletin 3666132 for detailed cleaning and flushing procedures.

☞**NOTE:**

Fleetguard Coolant Test Strips can be used to check Sulfate and Chloride levels and can be ordered through Cummins Filtration.

2.11.8. Driveshaft

☞**NOTE:**

For initial run-in period, lubricate driveshaft upon receipt of vehicle. Thereafter, lubricate every 6,000 miles (9,600 km).

2.11.8.1.Inspection

Inspect the driveshaft as follows:

⚠ WARNING

ALWAYS replace fasteners with new OEM parts. DO NOT reuse bolts, bearing strap, or locking plate.

- ❐ Check for a bent tube, evidence of missing balance weights, or other damage. Remove any buildup of foreign material on the shaft.
- ❐ Check that the lugs (ears) of the yokes on the slip yoke are aligned in the same plane (in phase) with the lugs (ears) of the tube yoke. Disassemble and realign shafts if not found to be in phase.
- ❐ Visually inspect the torque witness marks on the driveshaft fasteners. If the marks are illegible or misaligned, replace the fasteners with new OEM fasteners, torque to specification, and apply torque witness mark. Refer to Section 2 of this manual for torque procedure and specifications.
- ❐ Inspect locking plate tabs to ensure they are properly bent up and securing the hex bolts on the bearing cups.
- ❐ Check the output shaft of the transmission and the pinion shaft of the drive axle for excessive radial movement.
- ❐ Check for play in the universal joint by inserting a pry bar against the yoke and prying against the universal joint. Any lateral or sideways movement of u-joint cross within the bearing cap exceeding 0.006 inch is cause for rejection.
- ❐ Check for spline wear using a dial indicator and magnetic base mounted on the driveshaft. See “Fig. PM-11: Driveshaft Spline Inspection” on page 38. Manually applying a push/pull force to the yoke as shown. Indicator reading should not exceed 0.015”. Excessive movement will necessitate disassembly and further inspection of the driveshaft to determine cause.
- ❐ Inspect driveshaft guard to ensure it is undamaged and securely mounted.
- ❐ Inspect driveshaft access door from interior of vehicle to ensure that it is securely latched.

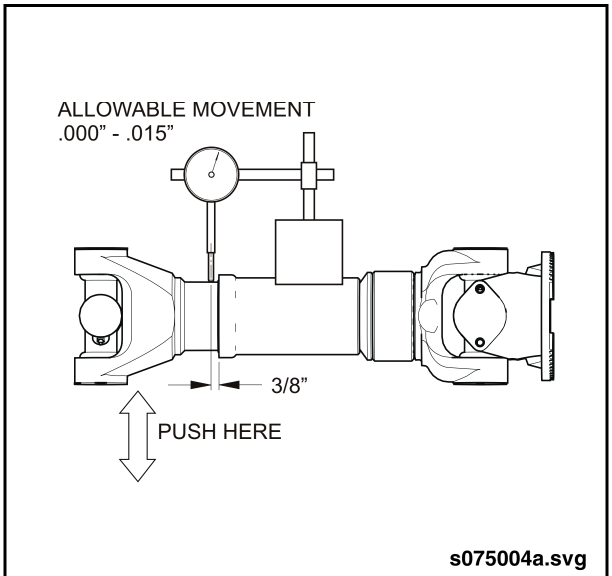


Fig. PM-11: Driveshaft Spline Inspection

2.11.8.2. Lubrication

Refer to 2.36. “Fluid & Lubrication Guide” on page 109 in this section for lubricant specification.

NOTE:

For initial run-in period, lubricate driveshaft upon receipt of vehicle and thereafter inspect and lubricate every 6,000 miles (9,600 km).

Universal Joint

1. Purge lubricate the universal joint by hand-pumping grease into the u-joint grease fitting until grease emerges from all four sealing lips. Do not exceed 5,000 psi grease pressure, otherwise the bearings will be over-pressurized. Refer to Fig. PM-12: “Driveshaft Lubrication Points” on page 39
2. If grease does not purge from all grease seals, proceed as follows:
   a. Use a rubber or brass mallet and tap the yoke ear that is located 180° opposite the cap that won’t purge. Regrease the u-joint.
   b. If the previous step was unsuccessful, hold onto the yoke, and while pushing or pulling the yoke away from the cap that won’t purge. Regrease the u-joint.
   c. If the previous two steps were unsuccessful, loosen the bearing plate bolts 1/16”. Regrease the u-joint.
   d. If the previous three steps were unsuccessful, remove the driveshaft from the vehicle and remove u-joint to inspect for cause of blockage. Replace u-joint if required.

WARNING

DO NOT apply excessive amounts of grease or use high pressure application when lubricating the telescoping spline. Excessive grease can fill the lube cavity in the yoke end of the tube and could restrict length compensating travel.

Telescoping Spline

Apply no more than one ounce of grease at the grease fitting located on the yoke of the spline shaft. Grease should purge from the pressure relief valve in the cup, as well as the dust cap on the opposite end of the slip yoke.

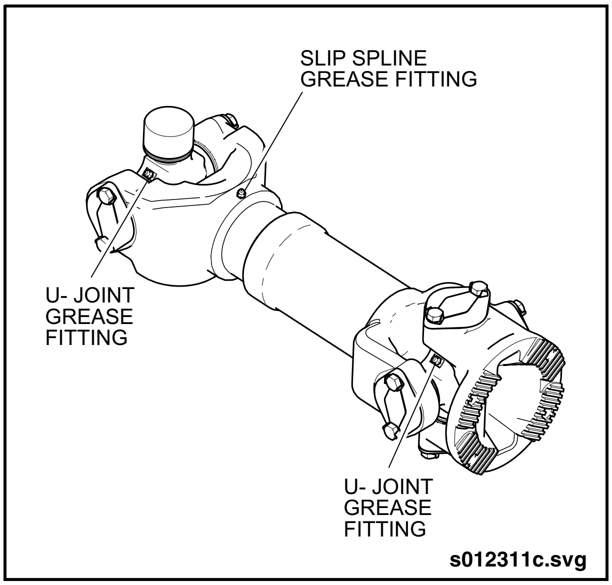


Fig. PM-12: Driveshaft Lubrication Points

2.11.9. Steering System Inspection

☞NOTE:

ALWAYS check wheel alignment following replacement of drag link, center link, or tie-rod ends or any steering components that were damaged.

- ❒ Visually inspect all steering components for any evidence of damage. See “Fig. PM-13: Steering Gear Inspection” on page 41.
- ❒ Inspect the steering gear driveshaft for worn u-joints or loose clamp nuts.
- ❒ Visually inspect steering gear pitman arm and ensure retaining nut is properly locked.
- ❒ Inspect the tie-rod ends on the drag link, steering idler arm, and center link for excessive play. Use a pry bar to lever the component and inspect for excessive movement. Refer to Section 3 of this manual for specific inspection procedures.

☞NOTE:

Excessive movement of the tie rod end typically indicates a worn ball socket and the tie-rod end will require replacement. However if movement is due to a loose fit of the tie-rod end tapered pin in the steering arm, do not attempt to re-tighten the castle nut. Remove the tie-rod end and inspect the bore of the steering arm for wear.

- ❒ Perform a visual torque inspection of all steering component fasteners, including the lock nut on the steering stop adjusting bolt. Ensure that the torque witness marks are in alignment. Any fastener that has illegible or missing witness marks should be re-torqued to specification. Refer to Section 3 of this manual for torque specifications.

☞NOTE:

If the witness marks are no longer aligned, it is an indication that the fastener has loosened and it will be necessary to replace the fastener, torque to specification, and reapply torque witness mark.

❐ Inspect steering gear, hydraulic pump, and hoses for evidence of leakage.

CAUTION

ALWAYS wipe clean the area around the filler cap before removing to prevent contaminants from entering the system.

❐ Inspect hydraulic reservoir fluid level and condition. Replace fluid if dirt, sludge, or water is evident in the system.

☞**NOTE:**

If hydraulic fluid appears frothy it is likely that air is trapped in the system and needs to be bled. Refer to Section 3 of this manual for power steering bleeding procedure.

❐ Check for smooth operation while turning the steering system through a full left and full right turn, Ensure that the power steering gear relief valve activates before contacting steering stops. Refer to Section 3 of this manual if steering stop adjustment is required.

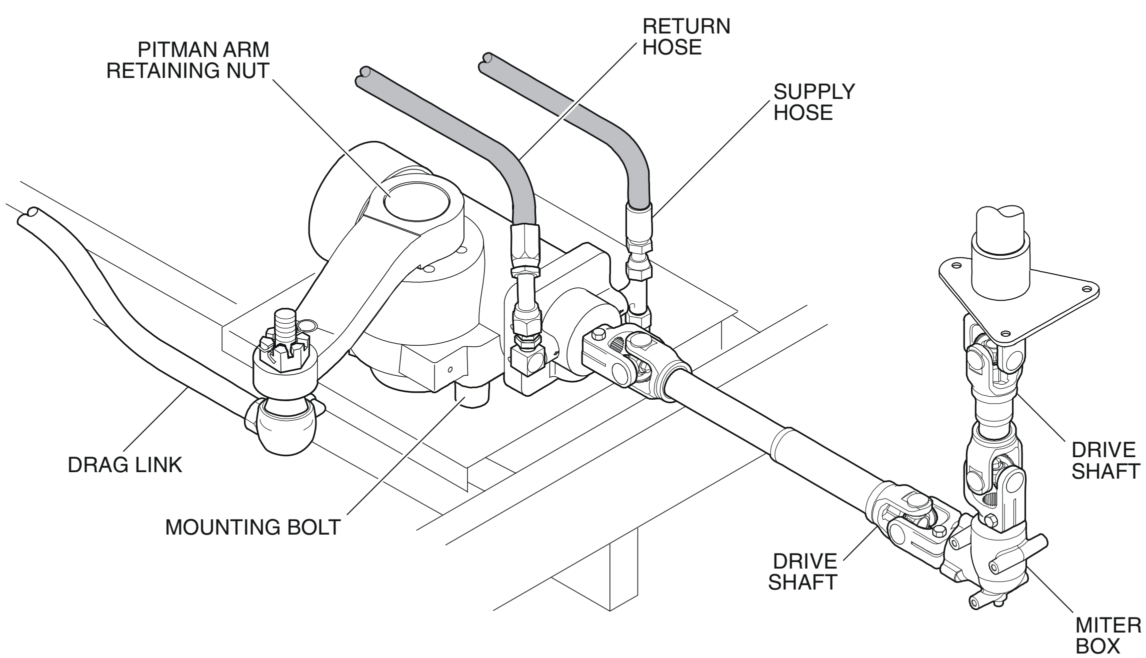


Fig. PM-13: Steering Gear Inspection

2.11.10.Steering Driveshafts

Inspect and lubricate the upper (vertical) and lower (horizontal) steering driveshafts every 6,000 miles (9,600 km). See “Fig. PM-14: Steering Driveshaft Inspection” on page 42.

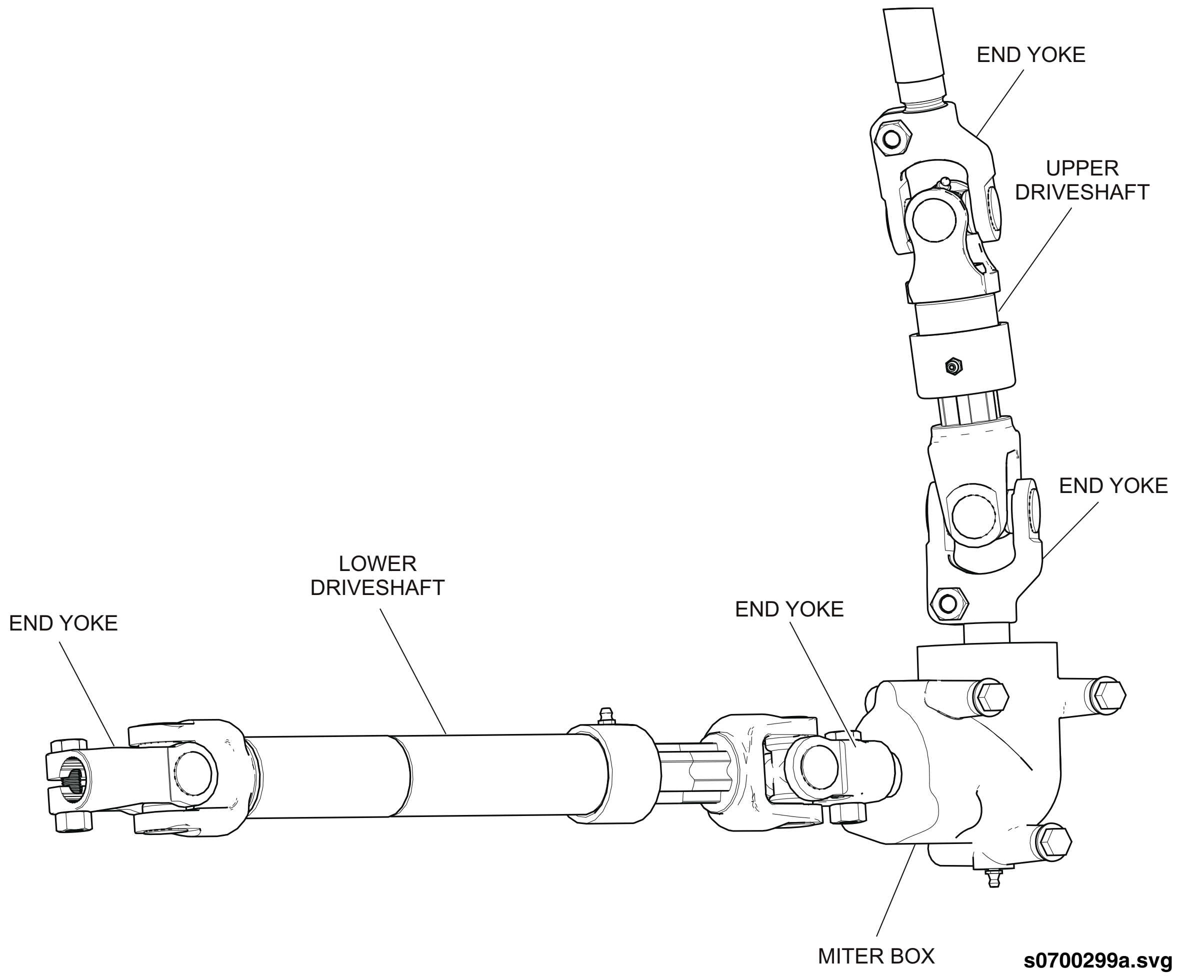


Fig. PM-14: Steering Driveshaft Inspection

2.11.10.1.Inspection

The steering driveshaft will exhibit a certain amount of movement when rotated or forced side to side and can be attributed mostly to U-joint movement. The following inspection provides procedures and allowable limits specific to each area of the steering driveshaft. Do not reject the steering driveshaft for overall play unless one or more of the following inspection points exceeds maximum allowable limits.

1. Visually inspect the steering driveshafts for any evidence of damage.
2. Visually check torque witness marks on clamp fasteners.
3. Inspect the U-joints to ensure that all snap rings are installed and fully seated within the groove on the bearing cup. The bearing cup must not protrude any more than 0.105" beyond the surface of the yoke bore. See “Fig. PM-15: Snap Ring Inspection” on page 44.
4. Inspect the U-joint cross for end play movement within the bearing cups:
   a. Restrain the end yoke from moving and apply lateral side to side force on each U-joint. Note the total back and forth movement of the U-joint cross within the bearing cups. Maximum allowable end play is 0.012" (0.30 mm). km). See “Fig. PM-16: Steering Driveshaft U-Joint Inspection” on page 44.
   b. Repeat the previous step on the same U-joint except apply pressure 90° from previous location.

☞NOTE:

If any of the above readings are suspect, remove the steering driveshaft from the vehicle and clamp the yoke in a vise and measure movement with a dial indicator to confirm.

5. Inspect the U-joint for worn needle bearings and/or cross trunnions:
   a. Apply back and forth rotational force to the yokes on the U-joint and note any relative movement between the U-joint cross and the bearing cups.
   b. No perceptible movement is allowed. Replace steering driveshaft as an assembly.

☞NOTE:

U-joints are not field replaceable, but may be serviced by the manufacturer. Contact Prop Shaft Supply in Elkhorn, Wisconsin for further information on driveshaft overhaul.

6. Inspect the steering driveshaft end yokes for excessive play:
   a. Apply lateral side to side force on each end yoke and note the deflection in the area where the end yoke splines are clamped to the attaching component. See “Fig. PM-17: Steering Driveshaft End Yoke Inspection” on page 44.
   b. Spline movement should be minimal. If the amount of spline movement is questionable, remove the steering driveshaft for closer inspection of the splines as well as the male splines on the attaching component.
7. Check for excessive movement or backlash in the telescoping slip-joint:
   a. Grasp the male and female members of the telescoping slip-joint and apply a back and forth twisting motion while observing or feeling for movement. See “Fig. PM-18: Steering Driveshaft Spline Backlash Inspection” on page 44.
   b. Spline movement should be minimal. If the amount of spline movement is questionable, remove the steering driveshaft for closer inspection of the telescoping splines.
8. If telescoping slip-joint is disassembled, check the nylon coating on the splines for wear, cuts, gouges, or any other damage.
9. If damage is evident, the nylon coating must be stripped from the splines and reapplied. Contact Prop Shaft Supply in Elkhorn, Wisconsin for further information on driveshaft overhaul.

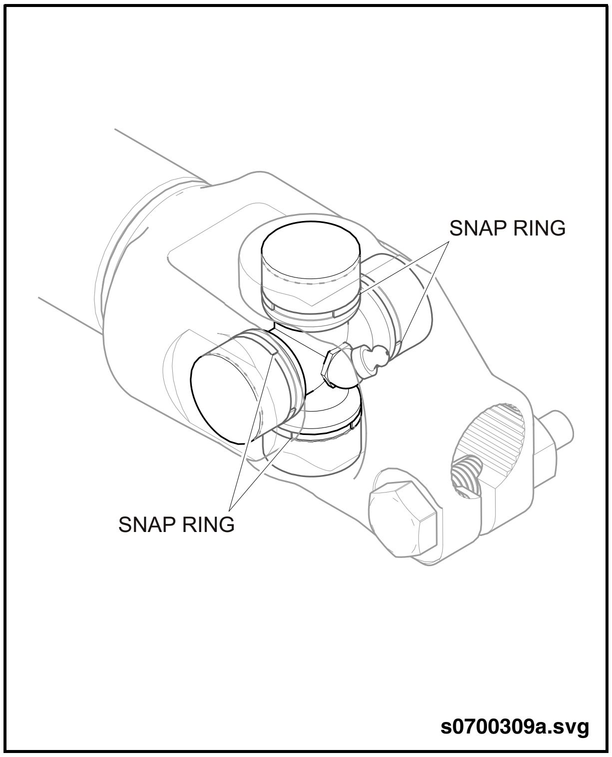


Fig. PM-15: Snap Ring Inspection

Fig. PM-17: Steering Driveshaft End Yoke Inspection

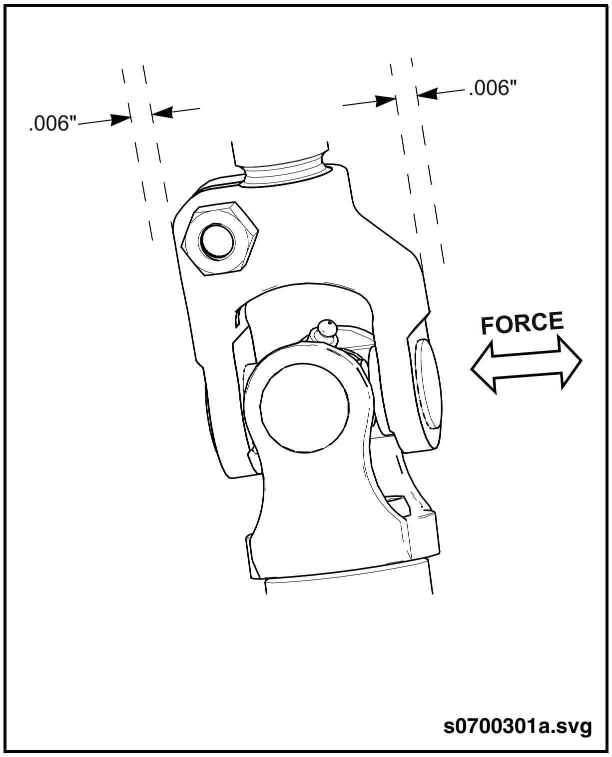


Fig. PM-16: Steering Driveshaft U-Joint Inspection

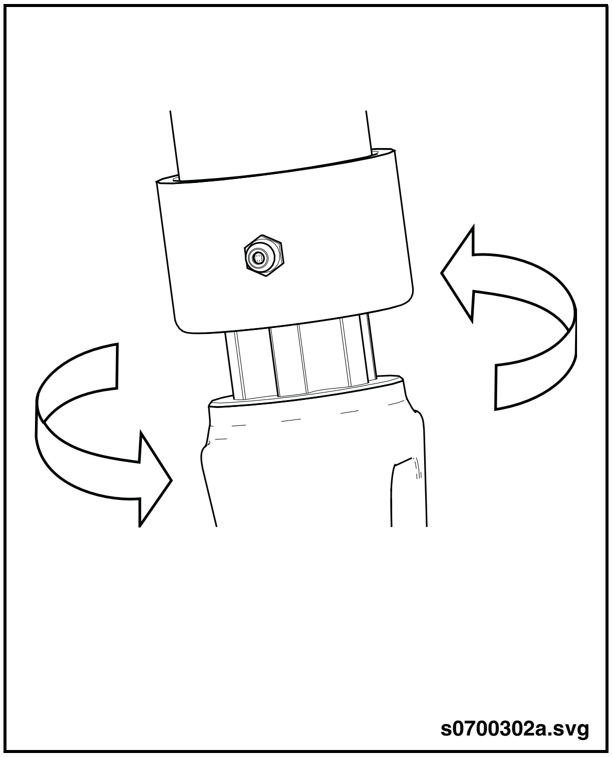


Fig. PM-18: Steering Driveshaft Spline Backlash Inspection

2.11.10.2.Universal Joint Lubrication

1. Locate the grease fittings on the universal joints at both ends of the driveshaft.
2. Purge lubricate through the grease fittings until fresh grease flows out of all four bearing cup seals. Refer to 2.36. “Fluid & Lubrication Guide” on page 109 in this section for grease specifications. See “Fig. PM-19: Steering Driveshaft Lubrication Points” on page 45.
3. If all four bearing cups do not purge lubricate successfully, then it will be necessary to remove the steering driveshaft from the vehicle and tap the opposite cap or rotate the adjacent yoke through its full range of motion while applying grease.
4. Wipe off excess grease from universal joint.

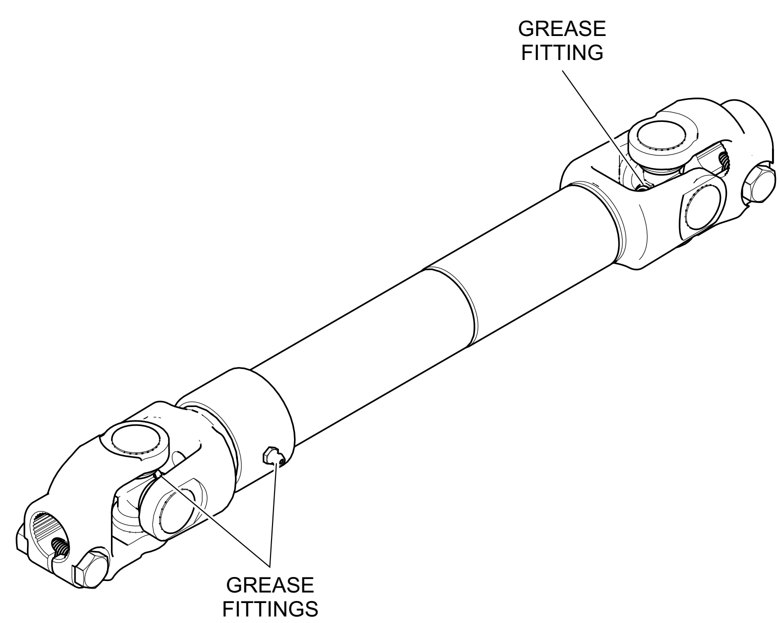


Fig. PM-19: Steering Driveshaft Lubrication Points

2.11.10.3. Telescoping Spline Lubrication

1. Remove the clamping bolt on one end of the steering driveshaft and compress the shaft completely.
2. Locate the grease fitting on the driveshaft slip sleeve and apply grease with 8 to 10 hand pumps.
3. Fully extend and compress shaft a few times to ensure grease is applied to full length of spline.
4. Completely remove yoke shaft and check the seal of the dust cap. Grease must completely fill between both lips of the seal. See “Fig. PM-20: Steering Driveshaft Seal Inspection” on page 46.
5. If dust cap seal is not completely greased, return the yoke shaft to the compressed position and repeat greasing procedure.

☞NOTE:

Ensure the driveshaft is properly reassembled with alignment arrows facing each other. This will ensure the driveshaft remains in phase.

6. Wipe off excess grease from the slip spline.

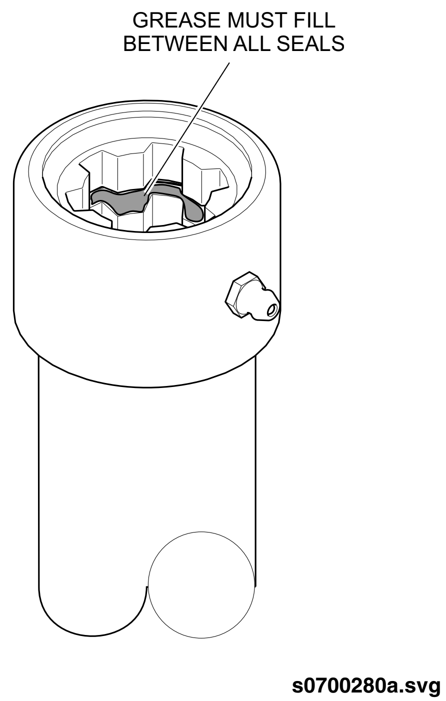


Fig. PM-20: Steering Driveshaft Seal Inspection

2.11.11.Steering Damper

Inspect the steering damper every 6,000 miles (9,600 km) as follows:

- ❒ Check for excessive play at ball joints ends. See “Fig. PM-21: Steering Damper Inspection” on page 47.

☞NOTE:

Maximum allowable axial play is 0.079 in. (2.0 mm). Replace steering damper if ball joint exceeds this limit.

- ❒ Inspect for any external damage to cylinder or piston rod. Replace damper if bent or damaged.
- ❒ Check for evidence of leakage. Replace damper if leaking.
- ❒ Inspect condition of protective sleeve on cylinder and ensure it can move freely and extend approximately 2 inches from cylinder.
- ❒ Inspect exterior surfaces for evidence of corrosion. Clean light surface rust, otherwise replace damper if badly corroded.

☞NOTE:

If maintenance records indicate that the vehicle is experiencing front end steering shimmy, then a cylinder damping inspection should be performed.

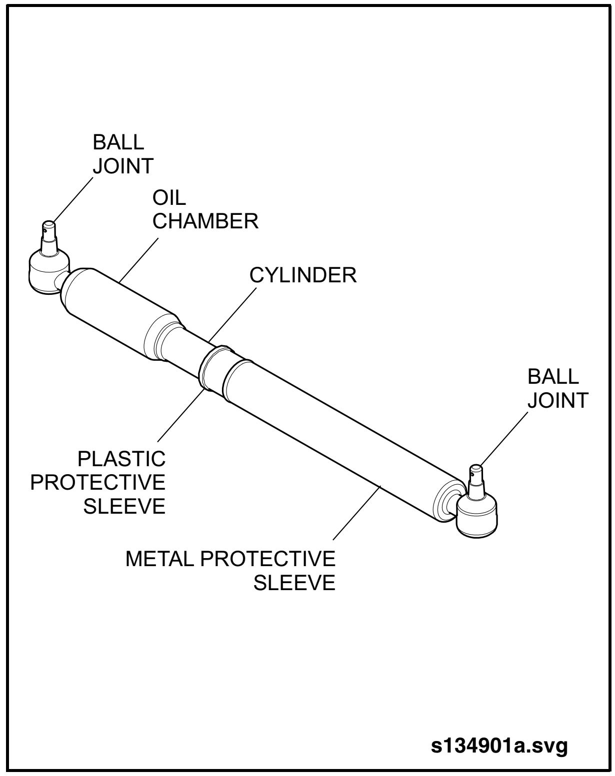


Fig. PM-21: Steering Damper Inspection

2.11.11.1.Cylinder Damping Inspection

1. Remove steering damper from vehicle. Refer to Section 3 of this manual for removal procedure.
2. Hold the steering damper in a vertical position with the oil chamber at the bottom.
3. Extend the piston rod fully by hand.
4. Operate the steering damper twice through its full range of travel in both compression and extension strokes.
5. Hold the steering damper fully extended in the vertical position for at least one minute.

☞NOTE:

Ensure that no pressure is applied to the piston rod while it is in the extended vertical position. The plastic protective sleeve should also be in the fully extended position.

6. Slowly compress the piston rod into the cylinder while noting both the resistance and distance travelled. Stop compressing the piston once resistance is felt.
7. Mark the position of resistance by scribing a line on the plastic protective sleeve that coincides with the position of the metal protective sleeve.
8. Retract the piston upwards until the plastic protective sleeve is fully extended. Measure the distance between the edge of the metal protective sleeve and the mark scribed on the plastic protective sleeve. See “Fig. PM-22: Damper Measurement” on page 48.
9. The piston rod must not travel more than 0.118 in. (3.0 mm) before damping resistance is felt. Replace steering damper if free travel (slip) exceeds these limits.
10. Reinstall steering damper on vehicle. Refer to Section 3 of this manual for installation procedure.

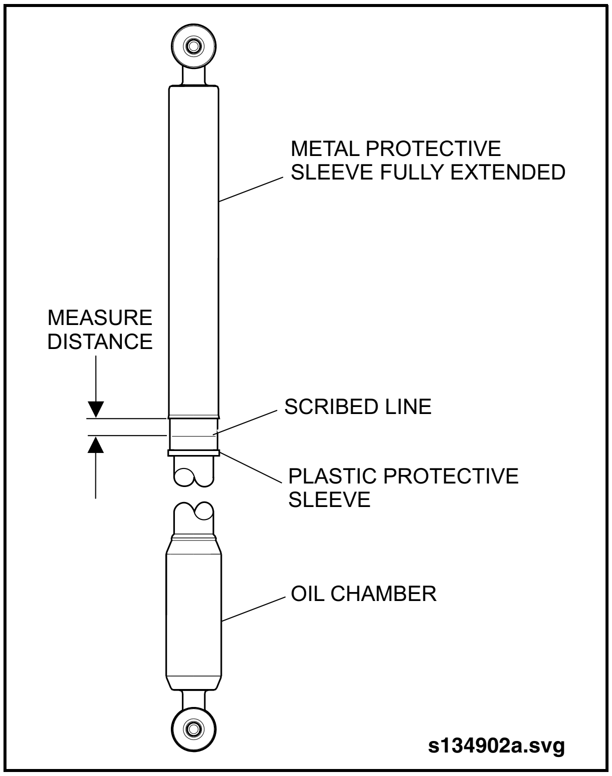


Fig. PM-22: Damper Measurement

2.11.12.Shock Absorber Inspection

Every 6,000 miles (9,600 km) check for and replace all shock absorbers damaged or leaking oil. Check the rubber mounting bushings and replace them if worn. Ensure the shock absorber mounting brackets are tight and the shock absorber is not striking or rubbing the frame or some other part of the chassis.

☞**NOTE:**

A leaking shock will show clear signs of fluid leaking in streams from the upper seal. These streams can most easily be seen when the shock is fully extended and one inspects as far up the main body of the shock (underneath the dust cover or tube) as possible. Misting shocks are often misdiagnosed as failures. A misting shock will form a film on the entire outside of the shock body. Misting is perfectly normal and a necessary function of the shock.

2.11.13.Ride Height

Every 6,000 miles (9,600 km) or after service of air suspension components check the vehicle's ride height. Measure the ride height for the front suspension. Refer to Section 3 of this manual for procedures.

2.11.14.Air Springs

☞**NOTE:**

The air suspension system requires no lubrication.

- ❒ Examine air springs assembly for evidence of cracks, punctures, deterioration, or chafing. Replace with new air springs if any damage is evident. Any surface on upper and lower retainers or on piston that touches air springs should be smooth and free of sharp edges that might cause breaks or damage air springs. Check threads on studs.
- ❒ Check for air leakage at all air springs upper and lower mountings. Coat mountings with soap and water solution and watch for appearance of soap bubbles. No leakage is permissible. If leakage is evident, rubber air springs must be replaced.
- ❒ Check to see that there is sufficient clearance around the complete circumference of the air spring while at its maximum diameter. Make sure contact doesn't exist between any air system component and the outside diameter of the air spring.
- ❒ Check for tightness on all mounting hardware. Retorque to the proper specifications. Refer to "Suspension Torque Specifications" in Section 1 and 2 of this manual for correct values. Do not overtighten.

2.11.15.Front & Rear Axles & Suspension

- ❒ Visually inspect all axle and suspension components for any evidence of damage.
- ❒ Visually inspect all suspension bushings and rubber components for cracks, tears, separation or other damage.
- ❒ Inspect center link, drag link and tie-rod ends for excessive play. Use a pry bar to lever the component and inspect for excessive movement. Refer to Section 1 and 2 of this manual for specific inspection procedures.
- ❒ Perform a visual torque inspection of all axle and suspension fasteners. Ensure that the torque witness marks are in alignment. Any fastener that has illegible or missing witness marks should be retorqued to specification. Refer to Section 1 and 2 of this manual for torque specifications.

☞**NOTE:**

If the witness marks are no longer aligned, it is an indication that the fastener has loosened and it will be necessary to replace the fastener, torque to specification, and reapply torque witness mark.

2.11.16.Radius Rods

☞**NOTE:**

The radius rods are of similar configuration except for the upper radius rod on the front axle which does not have tubular construction, replaceable bushings, nor snap-rings. All other inspection criteria apply.

Inspect all radius rods every 6,000 miles (9,600 km) as follows:

- ❒ Visually inspect torque witness marks on fasteners. If witness marks are not legible, then apply specified torque and paint a witness mark across fastener. Refer to Section 1 & 2 of this manual for torque specifications.
- ❒ Visually inspect radius rod tubes for deformation. Replace radius rod as an assembly if tube is deformed.
- ❒ Inspect bushings for wear by using a pry bar. Apply force both axially and laterally while observing movement. Any excessive relative movement between the rubber component of the bushing and the cross-pin and/or the eye of the radius rod is cause for bushing replacement.

☞**NOTE:**

If axial or lateral movement is suspect, remove radius rod from vehicle and confirm excessive bushing movement by clamping cross-pin in a vise and moving radius rod through its operating range.

- ❒ Visually inspect rubber component of bushing for cracks or separation. Small cracks are acceptable. Separation of the rubber from the metal cover plate or cross-pin is acceptable providing the separation does not exceed 1/3 of the circumference of the bushing.
- ❒ Inspect the metal cover plate of the bushing for cracks. Replace bushing if cover plate is cracked.
- ❒ Inspect snap-ring to ensure it is installed and fully seated. Check for shiny wear marks as evidence of snap-ring movement. Replace bushing and inspect condition of snap-ring groove if snap-ring is missing, broken, or has rotated significantly.
- ❒ If excessive wear, corrosion or other damage is noted in the snap-ring groove or bore of the radius rod during the course of bushing replacement, then the radius rod should be replaced as an assembly.

2.11.17.Air System Inspection & Functional Tests

Inspect the air system hoses and perform a functional test on the air system every 6,000 miles (9,600 km).

2.11.17.1.Air System Hose Inspection

Inspect all flexible underbody hoses used in the braking, suspension, and main air supply systems as follows:

- ❒ Clean any buildup of debris, grime, or grease that would hinder proper visual inspection.
- ❒ Inspect hose condition for cuts, cracks, kinks, deformation, twisted line, charring, blistering, or any other signs of damage. Replace hose if damaged.
- ❒ Inspect hose connections to ensure fittings are properly tightened.
- ❒ Inspect hoses for proper clamping and routing.

2.11.17.2.Air System Functional Tests

Perform and air system functional test. Refer to "Air System Functional Tests" in Section 8 of this manual for procedure.

2.11.18. Driver's Window

Inspect the driver's window every 6,000 miles (9,600 km) as follows:

- ❒ Slide the forward sash fully aft and ensure the sash slides smoothly and makes contact with the window stop.
- ❒ Inspect the condition of the weather-stripping in the lower window channel/track. Clean window channel/track by vacuuming.
- ❒ Inspect the interior and exterior handles to ensure they are securely mounted.

2.11.19. Window Emergency Release System

Perform the following maintenance every 6,000 miles (9,600 km), but not to exceed 90 days. Operation in harsh conditions where windows are exposed to road salts will require more frequent inspections.

1. Activate emergency release system by pulling the emergency release handle and pushing outward on the window frame assembly, applying force to the aluminum frame itself. See “Fig. PM-23: Window Emergency Release” on page 51.

   ☞**NOTE:**

   Do not push on glazing material, specifically acrylic shields.

2. Use a stiff bristle brush to loosen and remove excessive build up (i.e. road salt, dirt, etc.) on the emergency release bar, latches, return spring, and strikes.
3. Depress and hold the emergency release handle and brush the sections of the emergency release bar previously hidden by the frame locator blocks.
4. Use compressed air to blow out all of the loosened build up from all emergency release system components and subframe.
5. Activate the plastic plunger of the emergency release latches several times by hand. If the plunger does not move freely, lubricate plunger with a dry film lubricant. Repeat if necessary.

   ☞**NOTE:**

   Do not lubricate plunger with grease, as this will attract grit and cause binding.

6. Apply a light coating of lithium grease to the top surface of the latch strikes.
7. Depress and release the emergency release handle two or three times to ensure that the system is operating properly.
8. Close the window by pushing on the frame assembly, applying force to the aluminum frame itself, so that it swings open to approximately 45 to 60 degrees and quickly release. The momentum of the frame is normally sufficient to close the window. This may need to be repeated up to five (5) times if the window is new or has not been operated for an extended period of time in order to seat the egress components.

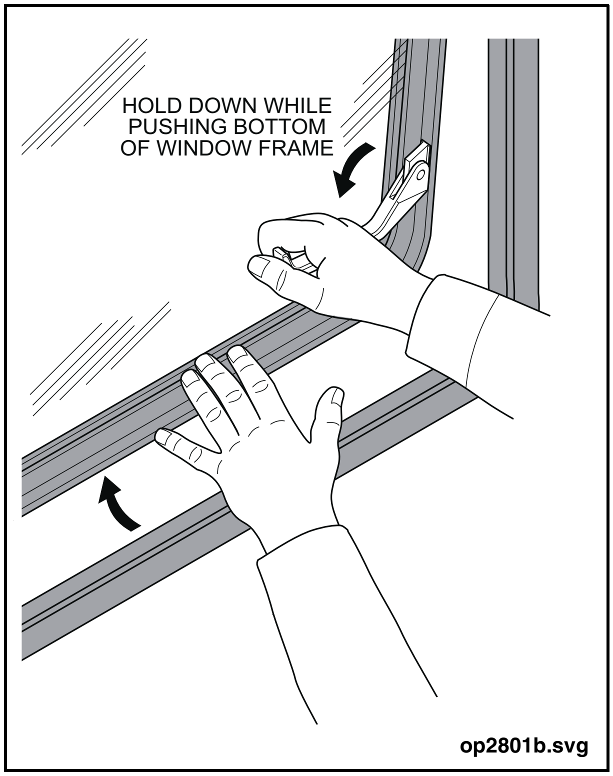


Fig. PM-23: Window Emergency Release

2.11.20.Interior & Exterior Access Doors

Every 6,000 miles (9,600 km) lubricate the piano hinges and latch mechanisms. Refer to Sections 12 or 13 of this manual for panel repair procedures.

2.11.21.Roof Vent/Hatch

Inspect and clean the roof vent/hatch every 6,000 miles (9,600 km).

❒ At each vehicle cleaning interval use a mild soap and water solution to clean the vent/ hatch surfaces and components. Do not use solvents or petroleum based cleaners or coatings. Do not lubricate its moving parts. Refer to 2.11.21.1. “Coatings & Cleaners” on page 52 in this section for additional information on coatings and cleaners.

❒ Inspect the vent/hatch moving parts every 6,000 miles (9,600 km). Make sure the latches close and fasten securely. The latches must fasten securely, with no slack or looseness. If the attaching hardware cannot be tightened, replace the applicable latch parts using new hardware and fasteners. See “Fig. PM-24: Roof Hatch Inspection” on page 53.

❒ In cold climates, check daily and remove any accumulated ice and snow that may restrict movement of the vent/hatch.

2.11.21.1.Coatings & Cleaners

⚠CAUTION

DO NOT use lubricants, paints, solvents or other coatings such as graffiti deterring sprays or cleaners. These chemicals often contain acetone, ether, lacquer thinner or other solvents that can destroy the high strength properties of many engineering plastics. Any damage, weakening, malfunction or failure of the vent/hatch structure because of using improper coatings or cleaners is the responsibility of the transit property.

Graffiti resistant coatings often leave a sticky residue that interferes with the free movement of the ventilator mechanisms. Some of these coatings also contain solvent bases that will reduce the strength of certain components. Using these types of coatings on vents/hatches is not recommended.

If in doubt about a type of cleaner or coating, apply a very small amount to an obscure, small area of the vent/hatch. Observe how the substance reacts to the surface after a short interval. If the surface starts to craze, soften, discolor or dissolve, DO NOT use it.

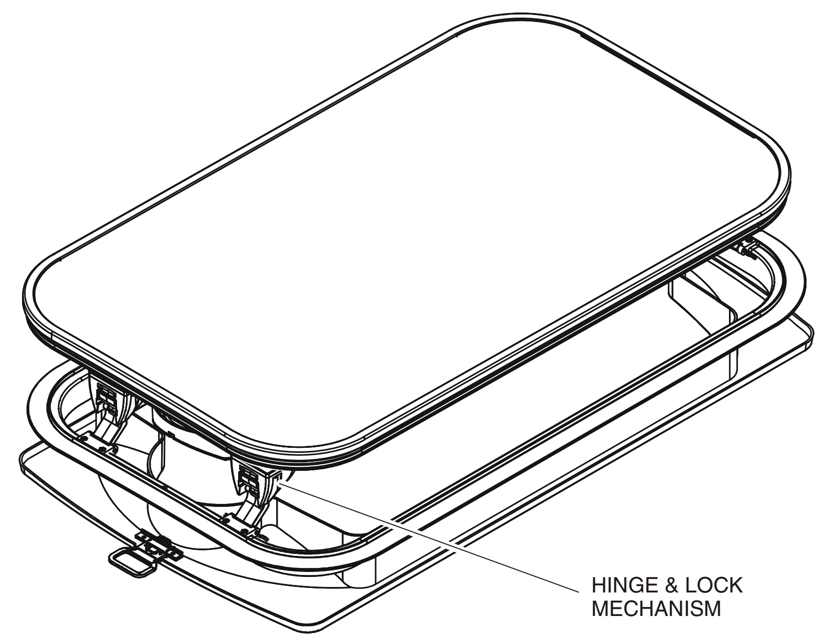


Fig. PM-24: Roof Hatch Inspection

2.11.22. Splash Guards

- ❒ Check splash guards every 6,000 miles (9,600 km) for loose bolts and damage.
- ❒ Tighten loose bolts and replace any unserviceable guards.
- ❒ Check that ground clearance is within specifications.

2.11.23. Windshield Wiper & Washer

- ❒ Check wiper operation and condition.
- ❒ Remove any accumulated dirt and grit from the wiper blade.
- ❒ Check that the washer system emits an adequate flow of washer fluid.

2.11.24. Driver's Seat

Inspect the driver's seat every 6,000 miles (9,600 km) as follows:

- ❒ Inspect seat mounting points and ensure fasteners are properly tightened.
- ❒ Inspect seat belt (if equipped) and ensure webbing is in good condition and belt latches and releases properly.
- ❒ Inspect seat track for cleanliness and lubricate if required.
- ❒ Check operation of all seat adjustment controls to ensure they function properly throughout their full range of adjustment.
- ❒ Check seat cover for abnormal wear, tears, or deterioration.
- ❒ Clean seat as required using a mild detergent and warm water, followed by a clean water rinse. Do not use harsh chemicals.

2.11.25.Passenger Seats

Inspect the passenger seats every 6,000 miles (9,600 km) as follows:

- ❐ Check the mounting hardware for tightness and security. Tighten or replace as required.
- ❐ Inspect seats for rips or tears. Repair, patch or replace as required.

2.11.25.1.General Cleaning

For dirt and general spot removal, fiberglass, composite resin and stainless steel may be cleaned with a non-abrasive, mild household detergent. Test a small, inconspicuous area prior to cleaning. Wipe with a clean, damp cloth and allow to dry.

☞**NOTE:**

Leaving any chemical on fiberglass or composite resin for extended periods can result in damage to the surface. ALWAYS rinse with water after cleaning.

2.11.25.2.Tough Stain & Graffiti Removal

Markings and stains from permanent marker and other compounds like shoe polish or nail polish can be removed from fiberglass, composite resin and stainless steel materials with the following agents (or equivalents):

- ❐ Crown Anti-Vandal Spray 5062 (contains VOC’s)
- ❐ TSW9 Plasti-Master (does not contain VOC’s)

☞**NOTE:**

For Vision Seats, Scotch-Brite pads can be used to remove graffiti markings and return the surface to its original appearance.

2.11.25.3.Vacuum Formed Plastic Components

Use TSW9 Plasti-Master when removing graffiti markings from vacuum-formed plastic components.

2.11.25.4.Upholstery Care

⚠ CAUTION

Extreme care should be taken when selecting a cleaning agent. Solvent-based cleaners should be avoided. Some solutions may leave a residue or discolor the material. Test an inconspicuous area prior to cleaning and follow the manufacturer's directions.

Regularly remove all dust and loose dirt from fabric with a whisk broom or vacuum cleaner. Always begin with lukewarm water and a white cloth for stain removal before applying any cleaning agent. Use foam upholstery cleaner or a mild household detergent and first testing in a small area. Flush the area with water after cleaning.

2.11.26. Stanchions & Grab Rails

Inspect stanchions and grab rails for security of attachment and any evidence of damage. Tighten any loose hardware. Replace any damaged components.

2.11.27. Wheelchair Tie-Down & Occupant Restraints

Perform the following activities every 6,000 miles (9,600 km):

- ❒ Clean belts as required using mild soap and water. Do not use solvents, chemical solutions or strong detergents. If required, soak belts for several hours in water to loosen dirt. Clean, rinse and dry thoroughly before returning to service.
- ❒ Lubricate the tiedown belt buckles at the hinges being careful not to contaminate the webbing.

2.11.28. Interior Panels

Inspect panels for scuffs, cracks and other forms of damage. Clean panels and repair any defects. Refer to Section 12 of this manual for further information on the interior panels.

2.11.29. Exterior Panels

- ❒ Every 6,000 miles (9,600 km) inspect the sealant and caulking of the exterior panel seams, and wheel-housings. Replace where substance has failed.

⚠ CAUTION

Use only the recommended type of sealant, caulk or adhesive. Refer to Section 13 of this manual for recommended type. DO NOT use substitutes.

- ❒ Clean the entire vehicle thoroughly to inspect for paint condition and for metal corrosion damage. Pay particular attention to the lower panels. Repair any areas with paint failure, or corrosion.

☞**NOTE:**

Increase inspection frequency in freezing weather, due to the effect of road deicing materials (salt, calcium chloride and so forth) on metal.

- ❒ Protect painted surfaces with a coating of wax immediately after the vehicle has been cleaned.

⚠ CAUTION

When cleaning the painted surfaces of the vehicle, use a cleaning agent that will not harm the acrylic finish or fiberglass panels. (for example soap and water).

2.11.30.Battery System

WARNING

ALWAYS replace batteries with the same type and size identified in your New Flyer Parts Manual and charge the batteries using the recommended voltage. Over-charging a lead acid battery can produce explosive and hazardous gas. Any change in battery configuration may require modification to the charging system voltage levels and battery service procedures to prevent over-charging and equipment damage. Consult the batter manufacturer's recommendations before installing replacement components.

- ❒ Check external condition of battery and battery cables. Tighten hold-down nuts to prevent batteries from shaking but not so tight as to strain battery case. See "Fig. PM-25: Battery Tray" on page 56.
- ❒ Check the battery cable ends on the battery posts. To ensure good contact, these must be tightened firmly.
- ❒ Check for post or cable end corrosion. If corrosion exists disconnect cables from the posts and clean both with soda solution and a wire brush. Install ends and tighten firmly, then coat with dielectric grease.
- ❒ Check battery for obvious damage such as, cracked case (shows loss of electrolyte), or damaged, cracked, or loose terminal posts.
- ❒ If damage is noted, replace battery.
- ❒ Check battery state of charge and charging rate. Refer to Section 9 of this manual for battery specifications and voltage regulator settings.

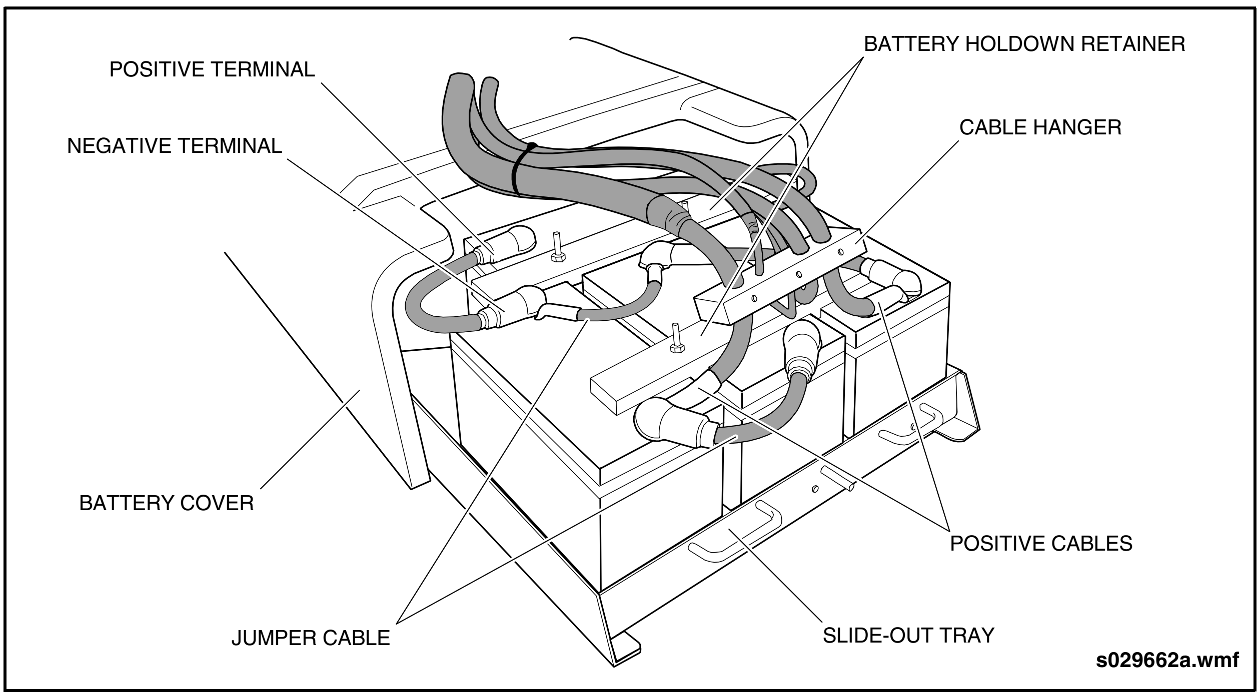


Fig. PM-25: Battery Tray

2.11.31. Wheelchair Ramp Inspection

Inspect & lubricate the wheelchair ramp mechanism every 6,000 miles (9,600 km).

2.11.31.1. Mechanism

- ❒ Inspect and adjust chain tension as required. Refer to Section 20 of this manual for inspection and adjustment procedure.
- ❒ Inspect ramp pump electrical connectors for condition and security. See “Fig. PM-26: Wheelchair Ramp Inspection” on page 57.
- ❒ Inspect electrical harnesses and hydraulic hoses for condition and secure attachment.
- ❒ Inspect fluid level in reservoir. Top up as required.
- ❒ Inspect and tighten mounting hardware as required.
- ❒ Ensure stowed proximity switch is functioning and is positioned to activate at 15° from the STOWED position.

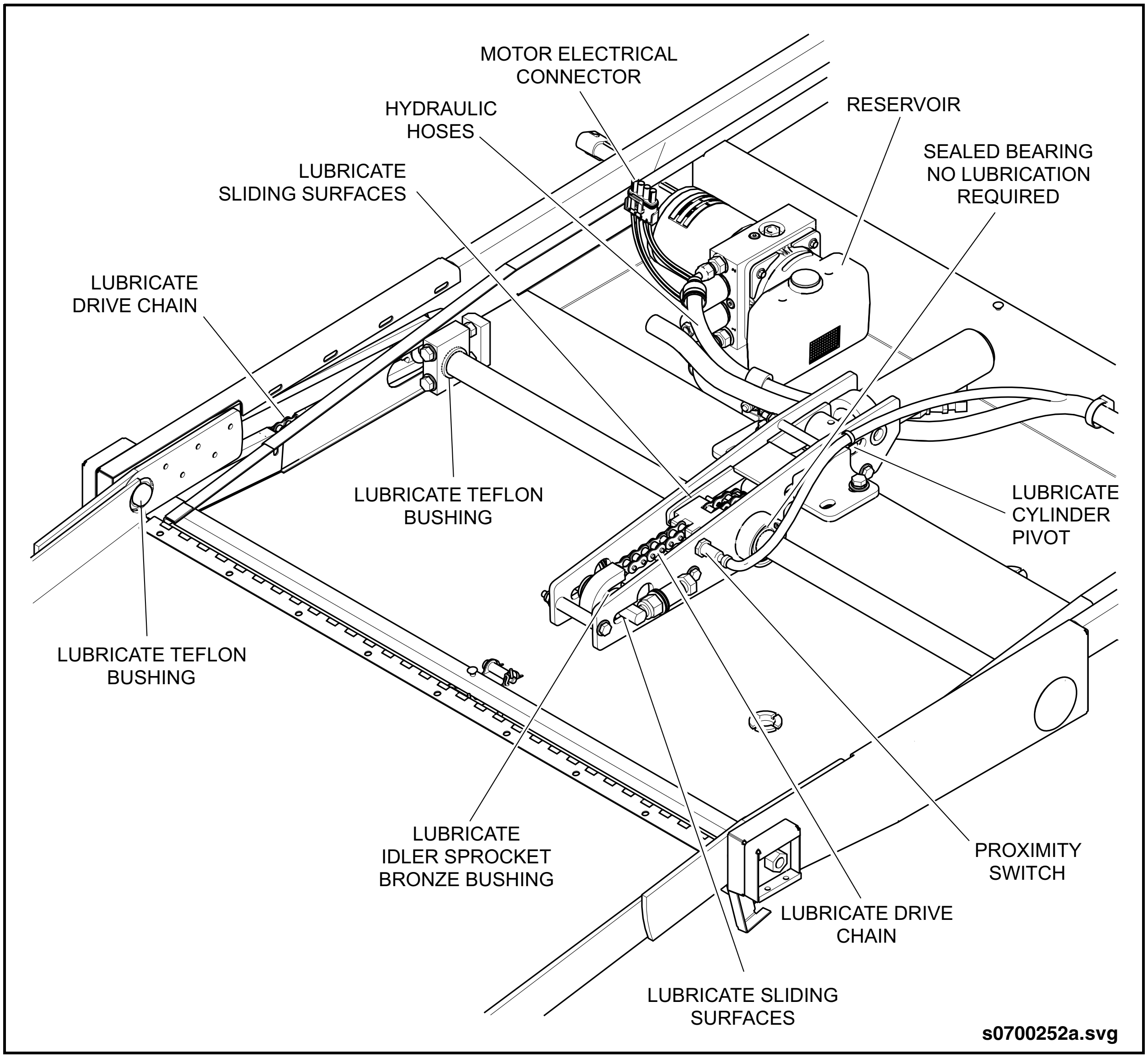


Fig. PM-26: Wheelchair Ramp Inspection

2.11.31.2.Skid Plate

Locate the wheelchair ramp skid plate at the forward edge of the entrance door. See "Fig. PM-27: Ramp Skid Plate Inspection" on page 58. Inspect the skid plate for impact or abrasion damage. Abrasion of the outboard edge is acceptable providing the wear indicator hole on the plate is still evident. Use a 1/8" drill bit to clear the wear indicator hole if plugged with debris. Refer to Section 20 of this manual for skid plate replacement procedure.

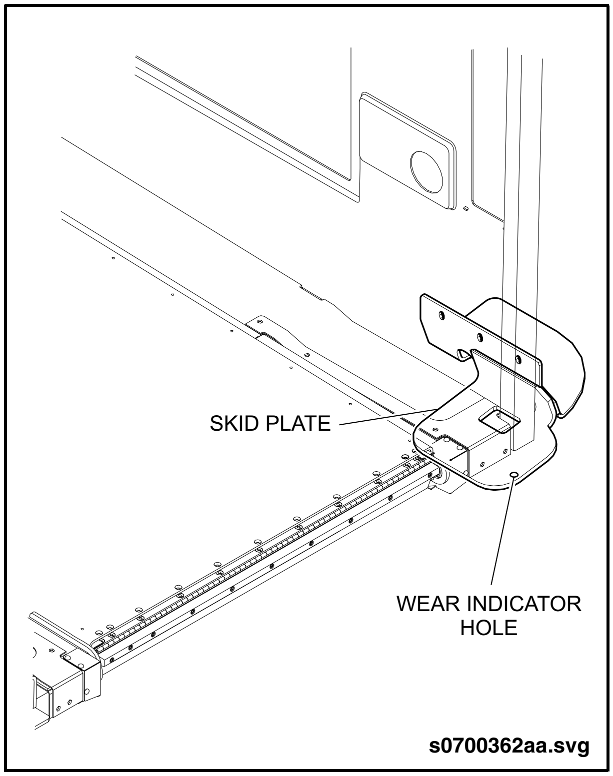


Fig. PM-27: Ramp Skid Plate Inspection

2.11.31.3.Lubrication

Refer to 2.36. "Fluid & Lubrication Guide" on page 109 in this section for lubricant specification. Clean existing lubricated surfaces of any dirt, grime, or dried lubricant and then apply fresh lubricant to the following areas:

- ❒ Drive chain rollers and side plates.
- ❒ Teflon sleeve bushings located on the tensioner blocks.
- ❒ Teflon sleeve bushings located on the LH and RH ramp pivots.
- ❒ Bronze bushing located on idler sprocket.
- ❒ Hydraulic cylinder pivot.
- ❒ Between the sliding surfaces of the mechanism (slots in the support plates and flats on the push shaft and clevis shaft).
- ❒ Hydraulic cylinder pivot points.

Operate the wheelchair ramp through several cycles to distribute the lubricant into the working surfaces.

2.11.32. Driver's Heater/Defroster Inspection

CAUTION

Reposition Battery Disconnect switch to OFF before servicing heater/defroster electrical components to avoid shorts.

- ❒ Inspect air filter. Clean or replace as required. See "Fig. PM-28: Defroster Inspection" on page 59.
- ❒ Inspect electrical plugs for clean contacts. Check wiring for proper routing and for any evidence of rubbing.
- ❒ Inspect condition of coolant hoses and ensure all hoses clamps are properly tightened.

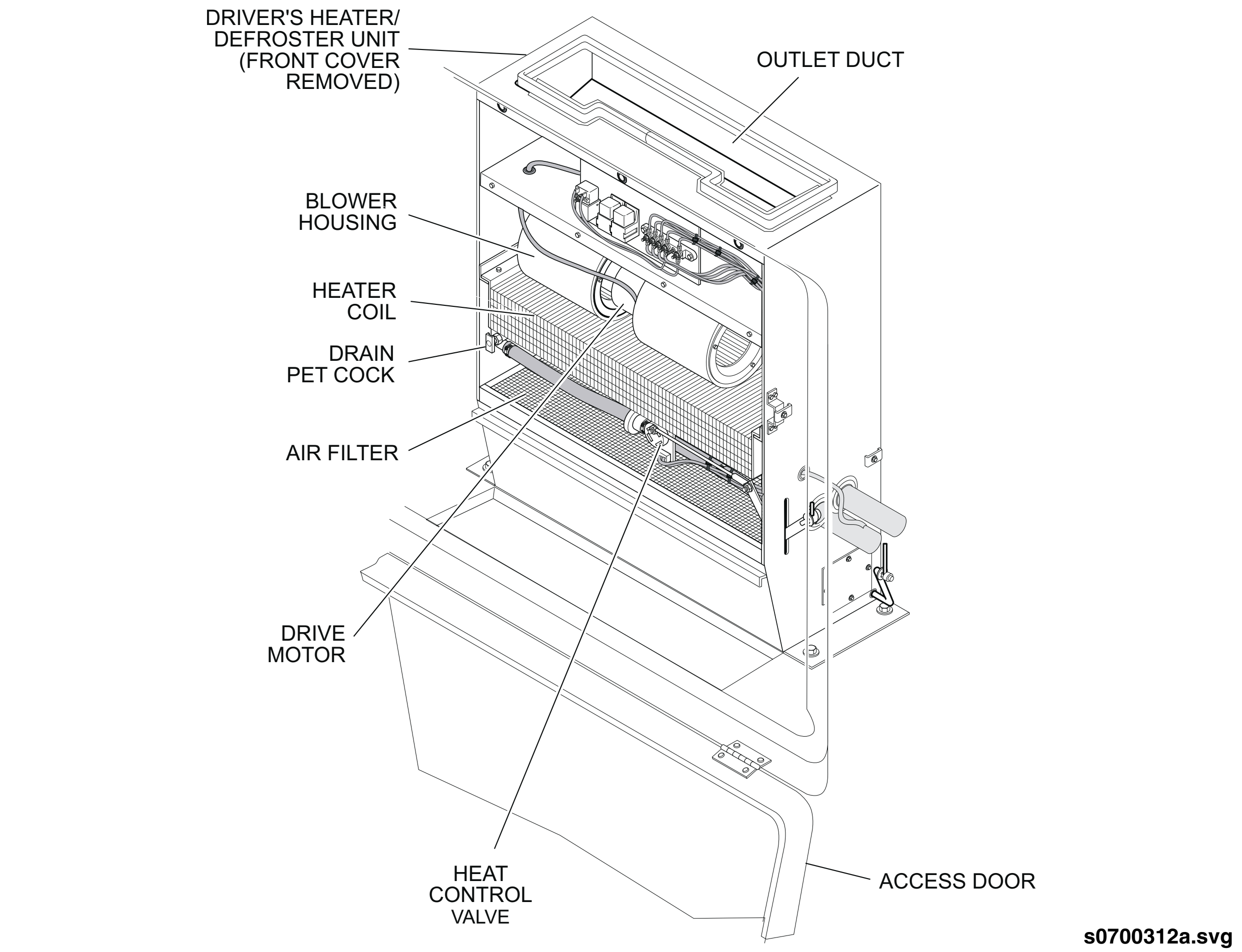


Fig. PM-28: Defroster Inspection

2.11.33. Floor Heaters

- ❒ Inspect the unit for damaged or loose components.
- ❒ Check coolant hose connections for leak.
- ❒ Clean or replace return air filters.

2.11.34. Rear HVAC Return Air Filter

Clean or replace filter as required every 6,000 miles (9,600 km). See “Fig. PM-29: Rear HVAC Return Air Filter” on page 60.

1. Locate the HVAC return air grille at the rear of the vehicle, above the rear seat.
2. Unlatch the return air grille.
3. Release the shock cord from the filter frame.
4. Remove the filter from the filter frame.
5. Remove accumulated debris by blowing compressed air in direction opposite to normal air flow.
6. Wash filter in warm soapy water, rinse, and allow to dry.
7. Installation is the reverse of removal.

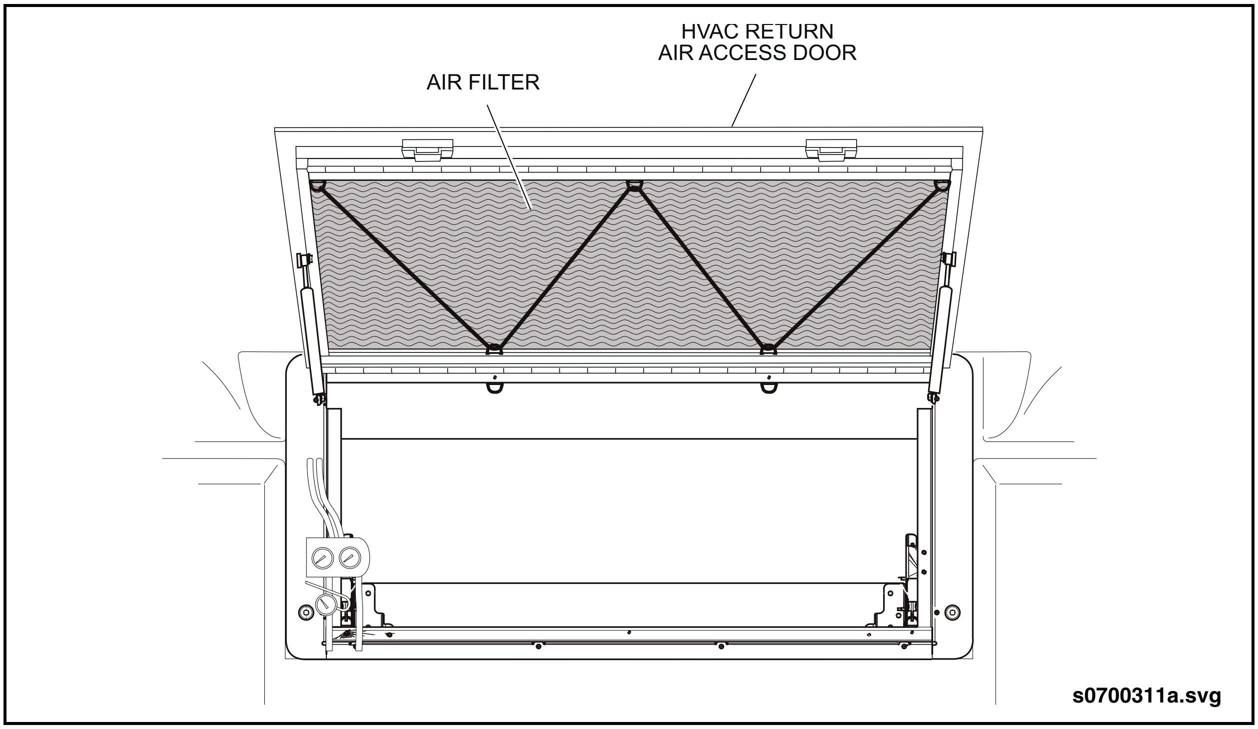


Fig. PM-29: Rear HVAC Return Air Filter

2.11.35.Rear Axle Breather Tube

CAUTION

DO NOT attempt to shorten or otherwise relocate the breather tube. The volume inside the tube acts as an expansion reservoir and must be at least 5 ft (1.5 m) in length.

❒ Check that the breather tube is securely attached to the elbow located on top of the differential housing and is attached to the breather membrane, located on the street-side suspension support. See “Fig. PM-30: Rear Axle Breather Inspection” on page 61.

❒ Clean any sludge or debris accumulation from the breather membrane outlet and ensure that the tube is clear. Replace the breather membrane (valve) if clogged, dirty, or oil soaked. Refer to 2.11.35.1. “Breather Valve Replacement” on page 61 in this section for procedure.

2.11.35.1.Breather Valve Replacement

1. Remove the breather tube from the valve by pushing the collar on the valve towards the valve body. Maintain pressure on the collar while pulling out the tube.
2. Inspect the end of the breather tube before installing new breather valve. Tubing end must be cut square and free from any burrs or rough edges.
3. Push tube into breather valve until seated.

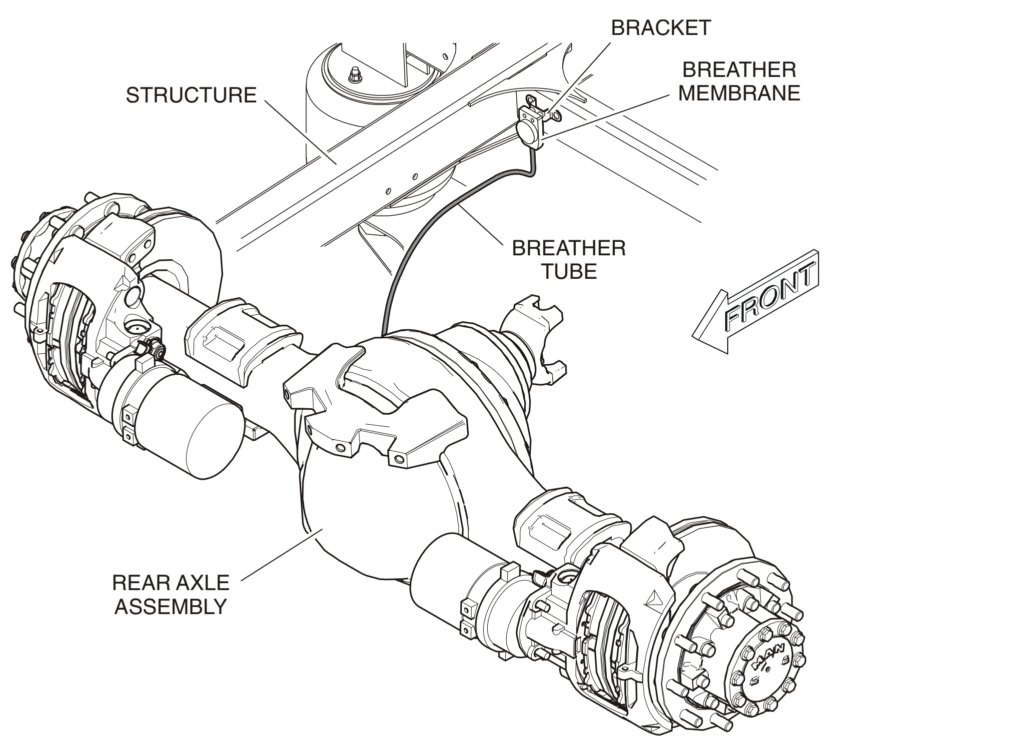


Fig. PM-30: Rear Axle Breather Inspection

2.11.36.Engine Compartment Line Routing Inspection

Perform a visual inspection on the condition and routing of all engine compartment lines every 6,000 miles (9,600 km) or whenever line or harness maintenance/ replacement has occurred. For the purpose of this inspection, engine compartment lines may be defined as all rigid steel lines and copper tubing, flexible lines, hoses, and tubing as well as electrical cables and harnesses. This inspection applies to all lines used in the fuel, air, hydraulic, lubricating, cooling, electrical, and HVAC systems. Open all engine compartment doors and inspection panels to allow complete inspection of the area. It may be necessary to raise the vehicle to properly inspect all lines.

2.11.36.1.Line Condition Inspection

1. Inspect all rigid lines for condition. Repair or replace the line if any of the following conditions are evident:
   a. Abraded or fretted surfaces
   b. Kinked or deformed tubing
   c. Corrosive pitting
   d. Loose mounting flanges or connectors
   e. Fluid or air leakage
   f. Excessive buildup of oily residue, dirt or road grime. Clean as required.
2. Inspect all flexible lines and hoses for condition. Repair or replace the line if any of the following conditions are evident:
   a. Cut, abraded, or frayed protective cover (includes textile, polyester, or steel braid as well as silicone firesleeving).
   b. Crushed, kinked, distorted, or twisted hose.
   c. Charred, heat damaged, cracked, hard, or stiff hose.
   d. Blistered, soft, or deteriorated hose.
   e. Loose mounting flanges or fittings/connectors
   f. Cracked or corroded fittings/connectors.
   g. Fluid or air leakage.
   h. Excessive buildup oily of oily residue, dirt or road grime. Clean as required.
3. Inspect all power cables and wiring harnesses for condition. Repair or replace the cable, harness, and/or protective covering if any of the following conditions are evident:
   a. Loose or corroded connections
   b. Damaged or missing protective insulator boots on positive terminals of power cables.
   c. Lack of dielectric grease on exposed power cable terminals. Clean terminals and reapply dielectric grease.
   d. Crushed, cut, or heat-damaged wire covering (corrugated split-loom).
   e. Blistered, soft, or deteriorated wire insulation.
   f. Excessive buildup of oily residue, dirt or road grime. Clean as required.

2.11.36.2.Line Routing Inspection

1. Inspect all rigid lines for proper routing. Provide additional or repositioned clamping, if the following conditions exist:
   a. Line runs across another line, component, or vehicle structure without being properly clamped.
   b. Line is improperly held by clamp. Select proper clamp size or tighten clamp as necessary. Clamp must fit snugly on line without causing restriction.
   c. Ensure band clamps (typically used to attach rubber hose to metal tubing) are tight.
2. Inspect all flexible lines and hoses for proper routing.
   a. Ensure lines are not routed in close proximity to hot zones such as the turbocharger, engine exhaust, auxiliary coolant heater etc. Provide additional clamps or reposition the existing clamps to obtain the required clearance (minimum 1"). Use brackets or spacers, if necessary, to obtain the required clearance. Provide protective shielding in situations where the optimum clearance cannot be achieved.

CAUTION

DO NOT clamp or cable tie fuel lines to electrical cables/harnesses. Maintain a minimum clearance of 1/2" between fuel lines and electrical cables/harnesses.
DO NOT use cable ties on textile or steel braided lines.

   b. Ensure lines do not run across another line, component, or vehicle structure without being properly clamped.

☞NOTE:
It is permissible to cable tie synflex air lines with synflex fuel lines.

   c. Ensure lines meet the minimum bend radius requirements. Provide a minimum bend radius of six times the diameter of the line. Reposition line or replace with a line of the proper length if necessary.
   d. Ensure flexible lines are routed and clamped so as to provide minimal slack without being taut. Provide additional slack in lines where there could be relative movement between the joined locations. Do not space clamps less than 12 inches apart.
   e. Provide cushioned loop clamps (P-clamps) or plastic split-block style clamps in locations where vibration or road shock may be transmitted to the line. Plastic split-block style clamps are typically used with large diameter lines only.
   f. Inspect condition of P-clamps to ensure they are tight and the rubber cushion is intact and in full contact with the line. Replace P-clamp if the rubber cushion is not of the full enclosure style.
3. Inspect exhaust bellows for correct alignment with exhaust tubes on either side of bellows. Examine the tubes and bellows from above and below, with a 90° angle between the viewing points. The exhaust tubes on either side of the bellows must be aligned parallel with each other and display no offset. Convolutions of bellows must be evenly spaced from one end of the bellows to the other. Replace bellows if it is torn or otherwise damaged. Refer to Section 4 of this manual for further information on this equipment.

4. Inspect all power cables and wire harnesses for proper routing.

⚠CAUTION

DO NOT clamp or cable tie electrical cables/harnesses to fuel lines. Maintain a minimum clearance of 1/2" between fuel lines and electrical cables/ harnesses.

a. Ensure cables/harnesses do not run across another line, component, or vehicle structure without being properly clamped. Ensure that grommets or rubber edging are used wherever the cable/harness passes through a bulkhead or panel.

☞NOTE:

It is permissible to cable tie electrical wire harnesses to synflex air lines but not to textile or steel braided lines.

b. Ensure cables/harnesses are not clamped to another hose or line. Cables/harnesses should be clamped only to stationary structure or brackets.

⚠CAUTION

Damage to the internal wire bundle can occur if the wire loom is clamped to an object subject to excessive vibration. The vibrations can transmit through the cushioned clamp and create relative movement between the internal wire bundle and the corrugated surface of the wire loom, resulting in damage to the wire insulation over a period of time. Use an alternative clamping method that will isolate the vibration or relocate the wire harness and clamp at a different location.

c. Ensure cables/harnesses are secured with P-clamps wherever practical. Harnesses should be clamped no more than 24 inches apart, where possible. Use cable ties to secure any portion of a harness bundle that cannot be secured within the P-clamps. Maintain the same relationship between clamped and unclamped wire harness looms throughout the entire run of the wire bundle. Use cable ties at 12" intervals. Ensure cable ties are not overtightened or supporting too much weight so as to cut into the wire loom.

d. Ensure that cable ties are not used within four inches of the connector. Provide strain relief or otherwise allow some flexion at the terminal connector. It is acceptable, however, to cable tie the terminal connector body itself when it is running parallel with another harness.

e. The excessive length of a harness may require that it be looped. Ensure that the harness is looped in an appropriate area and that the minimum bend radius is observed. Provide a minimum bend radius of six times the diameter of the harness.

f. Inspect condition of P-clamps to ensure they are tight and the rubber cushion is intact and in full contact with the cable/ harness.

2.11.37.Driver's Door

☞NOTE:

Refer to Section 17 of this manual for detailed maintenance procedures.

Inspect the driver's door every 6,000 miles (9,600 km) or six months, whichever occurs first, as follows:

- ❒ Inspect operation of door latch. Lubricate with dry film PTFE spray lubricant.
- ❒ Inspect sliding glass operation (upper/ lower tracks and liners).
- ❒ Inspect door swing/tether strap.
- ❒ Inspect glass stops.
- ❒ Inspect mounting hardware.

2.12. 7,500 Miles (12,000 km) Preventive Maintenance

2.12.1. Cooling & Heating System Pressure Test

WARNING

DO NOT attempt to open the pressure cap on the surge tank until the system has cooled down and the pressure relief valve has been operated. Opening the pressure cap with pressurized hot coolant can result in scalding injury and loss of coolant.

Perform a pressure test on both the cooling system and heating system every 7,500 miles (12,000 km) as follows:

☞**NOTE:**

The pressure caps and pressure test ports for the cooling and heating systems are located side-by-side, behind the surge tank access door.

1. Pressure test the engine cooling system at 16 to 20 psi (110 to 138 kPa) using the pressure test port labeled ENGINE COOLANT. Maintain pressure for one minute while observing gauge reading. If pressure reading drops, check for source of leak and repair as necessary.
2. Pressure test the engine cooling system pressure cap at 12 to 15 psi (83 to 103 kPa) and ensure that it maintains pressure. Increase pressure until the pressure relief actuates. Pressure relief should occur at approximately 18 psi. Also inspect the vacuum relief valve on the underside of the cap to ensure that it functions.
3. Pressure test the vehicle heating system at 16 to 20 psi (110 to 138 kPa) using the pressure test port labeled CABIN HEAT COOLANT. Maintain pressure for one minute while observing gauge reading. If pressure reading drops, check for source of leak and repair as necessary.
4. Pressure test the vehicle heating system pressure cap at 12 to 15 psi (83 to 103 kPa) and ensure that it maintains pressure. Increase pressure until the pressure relief actuates. Pressure relief should occur at approximately 18 psi. Also inspect the vacuum relief valve on the underside of the cap to ensure that it functions.

2.12.2. Muffler Inspection

Inspect the muffler every 7,500 miles (12,000 km), 500 hours, or six months, whichever occurs first. Inspect muffler mounts for any looseness, cracks, or other defects. Inspect muffler inlet, catalyst, and outlet sections for cracks, dents, or other damage. Replace muffler components as required.

2.13. 12,000 Miles (19,300 km) Preventive Maintenance

2.13.1. Electronic Accelerator

Perform the following maintenance every 12,000 miles (19,300 km) or 600 operating hours, whichever comes first:

- ❐ Check the area around the treadle to ensure that nothing will interfere with treadle operation (mats, discarded material and so forth). See “Fig. PM-31: Accelerator Inspection” on page 66.
- ❐ Check the entire treadle assembly for cleanliness.
- ❐ Check the nylon roller on the underside of the pedal and on the transfer lever for freedom of movement.
- ❐ Check all pivot points for freedom of movement, excessive wear and corrosion.
- ❐ Check all fasteners, fittings and retaining rings to verify that they are all properly installed.
- ❐ Actuate the treadle valve by pressing the pedal by hand. The action should be smooth without binding. When the pedal is released, it should return immediately without sticky or sluggish action.
- ❐ Excessive wear and corrosion requires the installation of new bushings.

2.13.2. S-1 Gard

Every 12,000 miles, inspect the guard and receiver as follows:

1. Raise the vehicle. Refer to the General Information Section of this manual for procedure.
2. Inspect guard material for excessive rips or tears. Excessive damage means that the minimal ground clearance of 4.5 ± 0.5" cannot be maintained. Replace guards which do not meet this specification. Scrapes or scarring of the material do not impair its functionality. The guard’s entire lower edge must be level with the ground in order for it to function correctly. Worn guards may display an uneven profile.
3. Excessive wear of guard material may be an indication of suspension problems, such as incorrect ride height adjustment, shock absorber wear, or air spring leaks. Correct suspension problems as required.

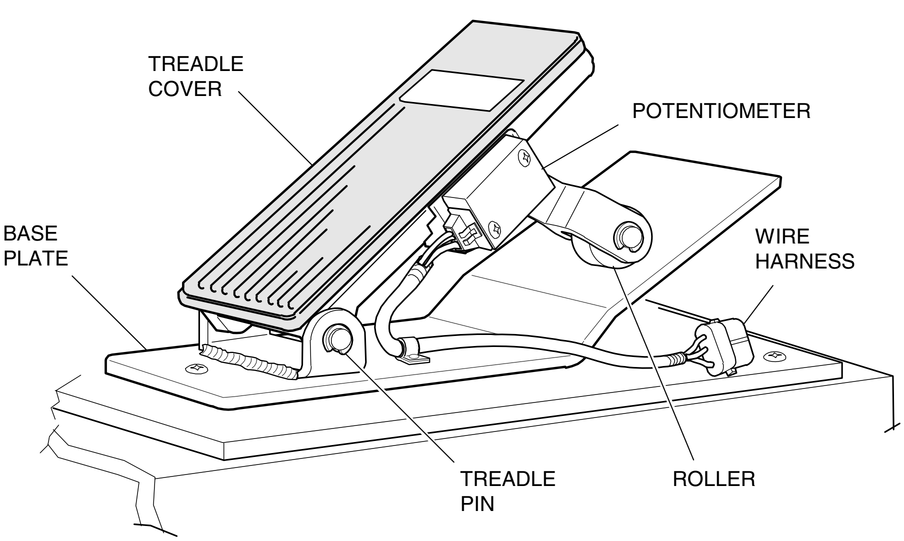


Fig. PM-31: Accelerator Inspection

2.13.3. Driver's Heater/Defroster

Inspect and test the defroster blower motor every 12,000 miles (19,300 km) or as determined by operating conditions. The inspection interval will need to be more frequent during the winter months when the heaters are exposed to slush, salt and grit that have been tracked into the vehicle.

- ❒ Remove defroster access cover to allow detailed inspection of the blower motor and electrical connections.

⚠ CAUTION

DO NOT attempt to clean defroster assembly using pressure washing equipment or using shop air in excess of 60 psi

- ❒ Inspect for buildup of salt or dirt deposits in and around the blower motor. Clean surfaces as necessary to remove contamination.
- ❒ Inspect electrical connectors for loose or corroded connections.
- ❒ Test operation of blower motor at all operating speeds to ensure smooth and quiet operation.
- ❒ If blower motor operation is suspect, use a clamp-on Fluke ammeter, or equivalent, to test current draw at each speed setting. Refer to Section 10 of this manual for defroster motor specifications. Replace blower motors that do not meet the specified operating limits.

☞NOTE:

Disassembly, cleaning, and repair of the blower motor is considered uneconomical and it is recommended that the blower motor be replaced if found defective.

2.13.4. Floor Heaters

Inspect and test the floor heater blower motors every 12,000 miles (19,300 km) or as determined by operating conditions. The inspection interval will need to be more frequent during the winter months when the heaters are exposed to slush, salt and grit that have been tracked into the vehicle.

⚠ CAUTION

Pressure washing vehicle flooring can easily force contamination into the heater assembly. Avoid pressure washing in and around the area where the floor heaters are located or, at least, protect the heaters from any high pressure washing solutions or air pressure exceeding 60 psi.

- ❒ Remove heater assembly access covers to allow detailed inspection of the blower motor and electrical connections.
- ❒ Inspect for buildup of salt or dirt deposits in and around the blower motor. Clean surfaces as necessary to remove contamination.
- ❒ Inspect electrical connectors for loose or corroded connections.
- ❒ Test operation of blower motor at all operating speeds to ensure smooth and quiet operation.
- ❒ If blower motor operation is suspect, use a clamp-on Fluke ammeter, or equivalent, to test current draw at each speed setting. Refer to Section 10 of this manual for heater motor specifications. Replace heater motors that do not meet the specified operating limits.

☞NOTE:

Disassembly, cleaning, and repair of the blower motor is considered uneconomical and it is recommended that the blower motor be replaced if found defective.

2.14. 15,000 Miles (24,140 km) Preventive Maintenance

2.14.1. Secondary CNG Fuel Filter

Every 15,000 miles (24,000 km), 1,000 operating hours or 1 year, whichever comes first.

1. Vent the fuel lines from the engine to the fill box. Refer to “Venting the System” - Stage One in Section 7 of this manual.
2. Open drain on base of filter assembly and vent any gas.
3. Use strap wrench to remove filter assembly from header. Ensure old gasket is extracted from header.
4. Dispose of used filter assembly in an environmentally responsible manner.

CAUTION

Manual over-tightening of the filter assembly can damage the threads or the gasket seal.

5. Install replacement filter assembly on header. Do not lubricate gasket before installation. Turn the filter assembly until the gasket contacts the header surface, then tighten an additional 1/2 to 3/4 turn.

2.14.2. Engine Drive Belts

Inspect alternator, water pump, and HVAC belts every 15,000 miles (24,140 km), 1000 hours, or one year, whichever occurs first. Inspect belts for wear, cracks, fraying, glazing, or other damage. Small transverse cracks running across the ribs are acceptable unless intersected by a longitudinal crack running along the length of the belt. Replace the belt if chunks of material are missing or belt is frayed.

☞**NOTE:**

When replacing with a new belt, ensure that the belt is properly aligned and tensioned. Confirm proper operation of the automatic belt tensioner.

2.14.3. Engine Water Pump Inspection

Inspect the engine water pump every 15,000 miles (24,140 km), 1000 hours, or one year, whichever occurs first.

- ❐ Check the water pump body for indications of water leakage at the weep hole. A chemical streak or chemical buildup at the weep hole is not justification for water pump replacement. If a steady flow of coolant or oil is observed, replace the water pump with a new or rebuilt unit.
- ❐ Make sure the weep hole is open. A small screwdriver or similar tool can be used to remove any debris.

2.15. 18,000 Miles (29,000 km) Preventive Maintenance

2.15.1. Engine Mounts

Every 18,000 miles (29,000 km) inspect the front and rear engine rubber mounts for the following conditions:

- ❒ Cracks
- ❒ Material separation
- ❒ Loose or damaged fasteners

Replace mounts which show any of these signs of damage. Replace damaged fasteners. Retorque loose fasteners. Refer to Section 4 of this manual for correct torque specifications.

2.15.2. Fire Suppression & Gas Detection System

Perform the following maintenance on the fire suppression and gas detection system every 18,000 miles (29,000 km) or every six months, whichever occurs first:

1. Perform a comprehensive fire system test using a Kidde Dual Spectrum System Test Kit, consisting of Thermal Test Kit P/N 420871-1 and KDS document 160188 “Test Kit Manual”.
2. Service the Extinguisher Valve (electrically operated control head) in accordance with KDS document 160296, "Installation, Operation and Maintenance Manual, KDS-25, Vehicle Fire Extinguisher Assembly, 25lb".
3. Test each combustible gas sensor by exposing it to a steady stream of combustible gas for approximately 10 seconds and verifying the following:
   a. The status lamp on the gas sensor should turn from solid green to blinking red, then to solid red.
   b. The gas LEAK lamp on the control panel should turn from off to blinking red, then to solid red and the audible alarm should sound.

☞**NOTE:**

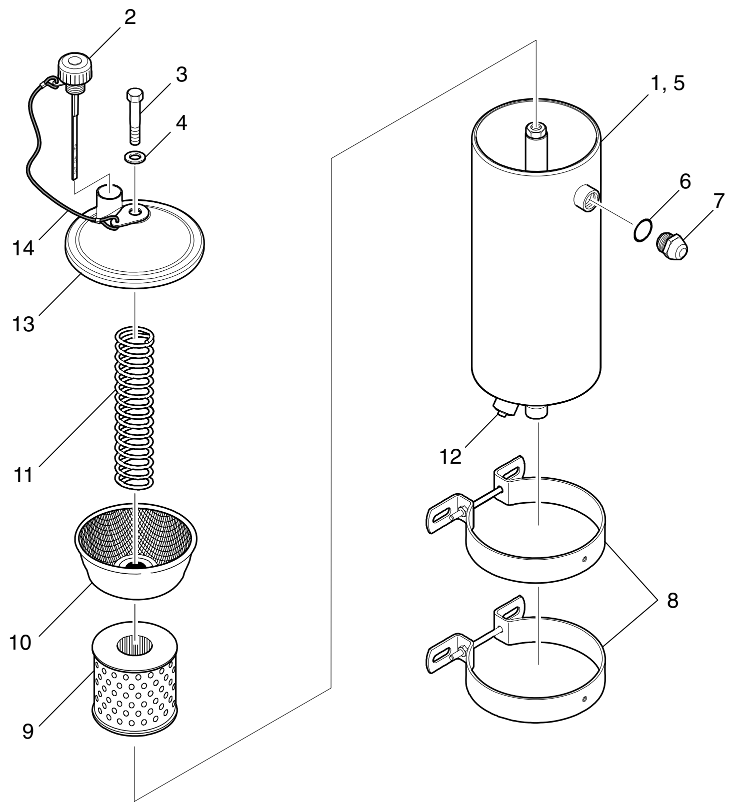
An example of an acceptable source for unburned combustible gas is an unlit butane cigarette lighter or an unlit propane painter’s torch.

4. Test the engine shutdown output of the control panel as follows (or refer to step 5 for alternate procedure):
   a. Start the engine.
   b. Test each combustible gas sensor by exposing it to a steady stream of combustible gas for approximately 10 seconds.
   c. The engine should shutdown 15 seconds after the gas LEAK lamp illuminates solid red on the control panel.
5. Alternatively test the engine shutdown output as follows:
   a. Obtain End-of-Line Shorting Switch (Kidde P/N 420871-97)
   b. Remove the End-of-Line device from the last gas leak detector in series and install the shorting switch in its place.
   c. Start the engine.
   d. Press and hold the switch; the control panel should illuminate blinking red, then illuminate solid red and the audible alarm should sound.
   e. The engine should shutdown 15 seconds after the gas LEAK lamp illuminates solid red on the control panel.

2.15.3. Power Steering Filter

Replace the power steering filter, located in the hydraulic reservoir, every 18,000 miles (29,000 km) or every six months, whichever occurs first.

Dispose of used filter, any spilled hydraulic fluid and used shop rags in an environmentally responsible manner. Start engine and check filter installation for leaks before operating vehicle. Refer to Section 3 of this manual for further information on the reservoir and filter. See "Fig. PM-32: Hydraulic Filter Replacement" on page 70.



1. Reservoir Assembly, Power Steering (Incl. 2...14)
2. Dipstick
3. Bolt
4. Washer
5. Body
6. O-Ring, Glass
7. Glass, Sight
8. Bracket, Mounting
9. Element, Filter
10. Basket
11. Spring, Retaining
12. Plug, 1/2" PT
13. Cover Assembly
14. Lanyard Assembly

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Fig. PM-32: Hydraulic Filter Replacement

2.16. 24,000 Miles (38,600 km) Preventive Maintenance

2.16.1. Brake Treadle Assembly & Brake Valve

Perform maintenance on the brake treadle assembly and brake valve every 24,000 miles (38,600 km), 900 operating hours or three months, whichever occurs first,

- ❒ Remove any accumulated contamination, such as dirt and gravel, from the heel of the treadle, the plunger, the plunger boot and the mounting plate. See “Fig. PM-33: Brake Valve Inspection” on page 72.
- ❒ Clean and inspect the treadle roller, the roller pin, and the hinge pin. Replace any worn, corroded, or damaged parts. Lubricate with Barium grease. Refer to 2.36. “Fluid & Lubrication Guide” on page 109 in this section for lubrication specifications.
- ❒ Inspect the plunger boot for cracks, holes or deterioration and replace boot if damaged.
- ❒ Inspect the plunger for wear or corrosion. Replace plunger if required.
- ❒ Check that the brake treadle mounting plate is securely fastened. Inspect pivot pin holes and plunger bore in mounting plate for wear or corrosion. Replace mounting plate if required.
- ❒ Apply a thin layer of Barium grease between the plunger and the mounting plate bore. Do not use excessive amounts of lubricant.
- ❒ Perform operation and leakage tests on the brake valve. Refer to Section 8 of this manual for test procedures.

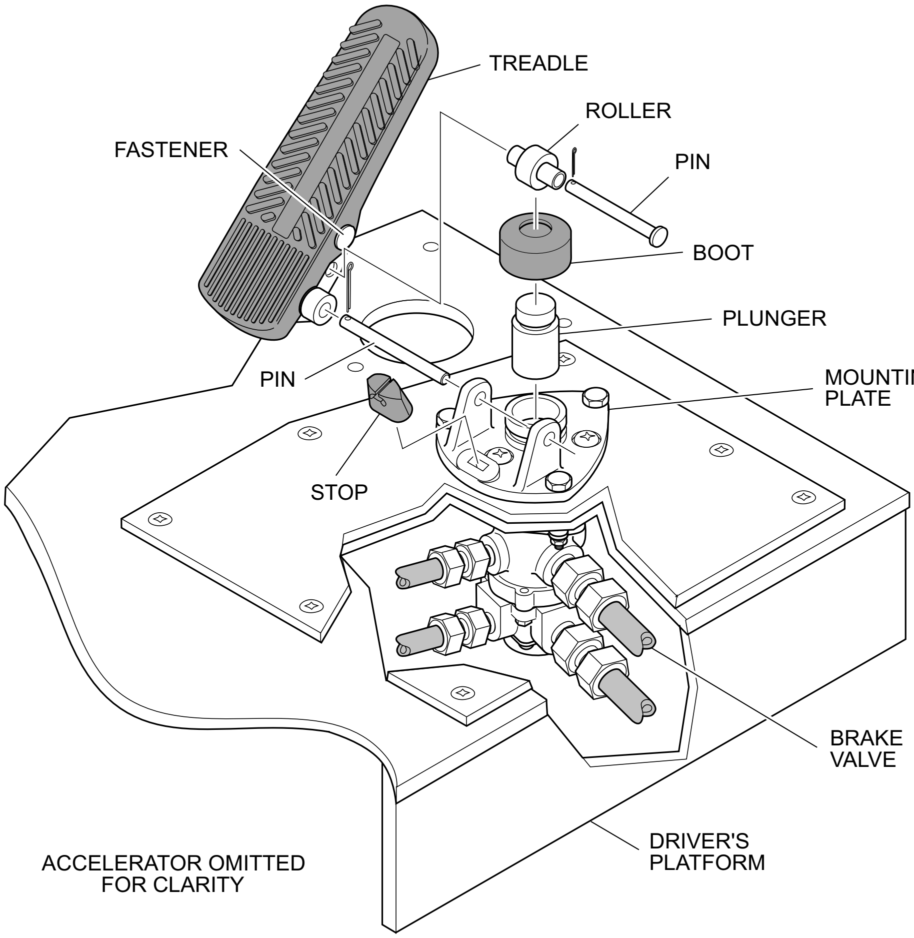


Fig. PM-33: Brake Valve Inspection

2.17. 30,000 Miles (48,000 km) Preventive Maintenance

2.17.1. Air Compressor Discharge Lines

Inspect the air compressor discharge lines for carbon buildup every 30,000 miles (48,000 km), 2,000 operating hours or two years. If the total deposit in a cross-section of the line exceeds 1/16", clean the line, and inspect and clean the air compressor cylinder head and valve assembly. Refer to Section 8 of this manual for procedure.

2.17.2. Turbocharger Inspection

Inspect the turbocharger every 30,000 miles (48,000 km), 2,000 operating hours or two years, whichever occurs first. Refer to your Cummins Operation and Maintenance Manual for inspection procedure.

2.17.3. Engine Vibration Damper Inspection

Inspect the engine vibration damper every 30,000 miles (48,000 km), 2,000 operating hours or two years, whichever occurs first. Refer to your Cummins Operation and Maintenance Manual for inspection procedure.

2.18. 36,000 Miles (58,000 km) Preventive Maintenance

2.18.1. Disc Brake Caliper Inspection

Perform a disc brake caliper inspection every 36,000 miles (58,000 km) or every year, whichever occurs first. A more frequent inspection may be necessary depending on the operating conditions. Perform the following inspections:

- ❐ Inspect the six brake caliper mounting bolts that attach the brake caliper to the axle to ensure the bolts are tight. Refer to Section 1 and 2 of this manual for mounting bolt torque specifications.
- ❐ Caliper Running Clearance - refer to “Adjuster Check” in Section 1 & 2 of this manual for inspection procedure.
- ❐ Guide Pin Covers - check that the protective covers are properly installed on the caliper guide pins and are in good condition. Replace covers if damaged or missing.
- ❐ Adjuster Cap - check that the protective cap is properly installed on the adjuster and is in good condition. Replace adjuster cap if damaged or missing
- ❐ Brake Disc - refer to “Brake Disc Inspection” in Section 1 & 2 of this manual for inspection procedure.
- ❐ Brake Adjuster - refer to “Adjuster Check” in Section 1 & 2 of this manual for inspection procedure

☞**NOTE:**

The brake adjuster should always be inspected and tested whenever brake pads have been replaced

- ❐ Caliper Guide Pin - refer to “Caliper Guide Pin Inspection” in Section 1 & 2 of this manual for inspection procedure.
- ❐ Tappet & Boot Assembly - refer to “Tappet Rubber Boot Inspection” in Section 1 & 2 of this manual for inspection procedure.
- ❐ Guide Pin Inner Boot - refer to “Upper Guide Rubber Boot Inspection” in Section 1 & 2 of this manual for inspection procedure.

2.18.2. Power Steering Fluid

Replace the fluid in the hydraulic reservoir every 36,000 miles (58,000 km) or yearly, whichever occurs first. More frequent change intervals may be required if operating under less than ideal conditions. Severe operating conditions involving extremes of moisture, dust and temperature fluctuations may require a more frequent hydraulic fluid change interval. Refer to 2.36. “Fluid & Lubrication Guide” on page 109 in this section for fluid specifications.

2.18.3. Rear Axle Oil Change

Change the rear axle oil every 36,000 miles (58,000 km), or every year, whichever occurs first. Use this oil change interval only if operating with mineral oil in a hot temperature region. Refer to 2.2. "Rear Axle Operating Conditions" on page 6 in this section for a definition of a hot temperature region. Refer to 2.36. "Fluid & Lubrication Guide" on page 109 in this section for fluid specification.

2.18.3.1.Drain

CAUTION

Differential fluid can reach operating temperatures in excess of 212°F (100°C). Allow adequate time for differential to cool before draining fluid.

1. Ensure vehicle is parked on a level surface or raised to a working height that maintains a level attitude.
2. Place a suitably sized container beneath the differential gear housing.

NOTE:

Differential gear housing oil fill quantity is approximately 4.0 U.S. gallons (15 liters)

3. Remove the fill plug from the front of the differential housing. See "Fig. PM-34: Rear Axle Drain & Fill Locations" on page 74.
4. Remove the drain plug from the bottom of the differential housing and allow the differential to drain completely.

2.18.3.2.Fill

1. Inspect the magnetic drain plug for any significant accumulation of metal particles and wipe clean.

NOTE:

Fine "fuzz-like" metal particles are considered normal but any solid slivers of significant size or chips of metal will require further investigation to determine cause.

2. Clean and inspect the threads of the drain plug before applying Loctite-567 thread sealant. Install and torque the drain plug to 52 ft-lb. (70 Nm).
3. Add slightly less than 4.0 U.S. gallons (15 liters) and allow fluid level to stabilize.
4. Continue to add fluid slowly until the fluid is level with the bottom of the fill plug.
5. Install the fill plug and torque to 52 ft-lb. (70 Nm).

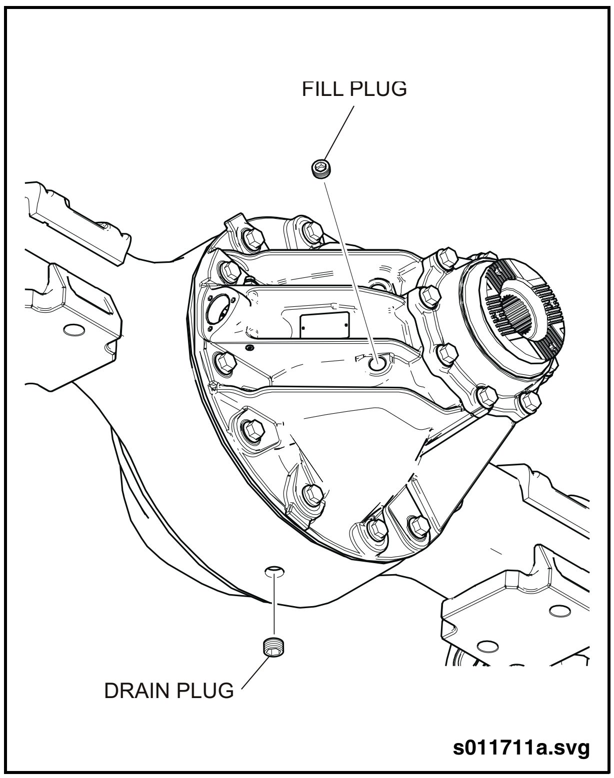


Fig. PM-34: Rear Axle Drain & Fill Locations

2.19. 45,000 Miles (72,000 km) Preventive Maintenance

2.19.1. Engine Ignition Coil Inspection & Test

Check the ignition coils every 45,000 miles (72,000 km), 1500 hours, or 18 months, whichever occurs first. Refer to your Cummins Operation and Maintenance Manual for inspection procedure.

☞**NOTE:**

The recommended 45,000 mile interval is based on an average vehicle speed of 30 mph. Adjust the mileage interval to correspond with the actual average vehicle speed.

2.19.2. Engine Spark Plugs Inspection

Check the spark plugs every 45,000 miles (72,000 km), 1500 hours, or 18 months, whichever occurs first. Refer to your Cummins Operation and Maintenance Manual for inspection procedure.

☞**NOTE:**

The recommended 45,000 mile interval is based on an average vehicle speed of 30 mph. Adjust the mileage interval to correspond with the actual average vehicle speed.

2.20. 48,000 Miles (77,200 km) Preventive Maintenance

2.20.1. Front End Alignment

Perform minor alignment. Refer to Section 3 of this manual for procedure.

2.20.2. Front Brake Chambers

2.20.2.1. Inspection

Perform the following inspection every 48,000 miles (77,200 km):

1. Visually inspect the exterior surfaces of the brake chamber for signs of damage. Replace the brake chamber if damaged. Refer to Section 1 of this manual for replacement procedure.
2. Apply system pressure (minimum 100 psi) to the brake chamber and check for leaks around the circumference of the clamp band and air inlet fittings, using soapy water or leak detection solution.
   a. If bubbles appear around clamp band, release air pressure and torque clamp band nuts to 30 to 35 ft-lbs (41 to 47 Nm). Recheck for leaks. If leaks continue, perform a leakdown pressure test. Refer to 2.20.2.2. “Front Brake Chamber Leakdown Test” on page 77 in this section for test procedure.
   b. If bubbles appear at air hose connection, tighten hose until leaks cease, but do not exceed 40 ft-lb. (54 Nm) If leaks continue, release air pressure and remove air line from inlet port. Inspect threads on hose and fitting. Replace hose or fitting as required Reinstall air line to the brake chamber and recheck for leaks.
   c. If bubbles appear at air inlet fitting, tighten fitting until leaks cease, but do not exceed 30 ft-lb. (41 Nm) If leaks continue, release air pressure and remove fitting from brake chamber Install new fitting with Loctite 567 and tighten two full turns past finger tight. Reinstall air lines to the brake chamber and recheck for leaks. If leaks continue, perform a leakdown pressure test. Refer to 2.20.2.2. “Front Brake Chamber Leakdown Test” on page 77 in this section for test procedure. Replace fitting or brake chamber as required.
3. Check to ensure the mounting stud nuts are torqued to 133 to 155 ft-lb. (180 to 210 Nm).

2.20.2.2. Front Brake Chamber Leakdown Test

☞**NOTE:**

Perform the leakdown test procedure only if bubbles were evident during the initial leak test.

1. Drain vehicle air system.
2. Disconnect service brake hose from brake chamber,
3. Connect brake chamber to pressure test equipment. See “Fig. PM-35: Front Brake Chamber Leak Test Setup” on page 77.
4. Close the exhaust valve.
5. Open the air supply valve and pressurize service chamber to 100 psi.
6. Cycle the unit 2 to 3 times by releasing and applying air pressure from and to the service chamber.
7. Pressurize the service chamber to 100 psi and close the supply valve.
8. Allow the system to stabilize for approximately one minute.
9. Open the air supply valve to restore the 100 psi system pressure.
10. Close the air supply valve and make note of the time.
11. After three minutes, record the final pressure. If the final pressure does not meet the minimum allowable pressure of 91 psi, then the brake chamber will need to be replaced.

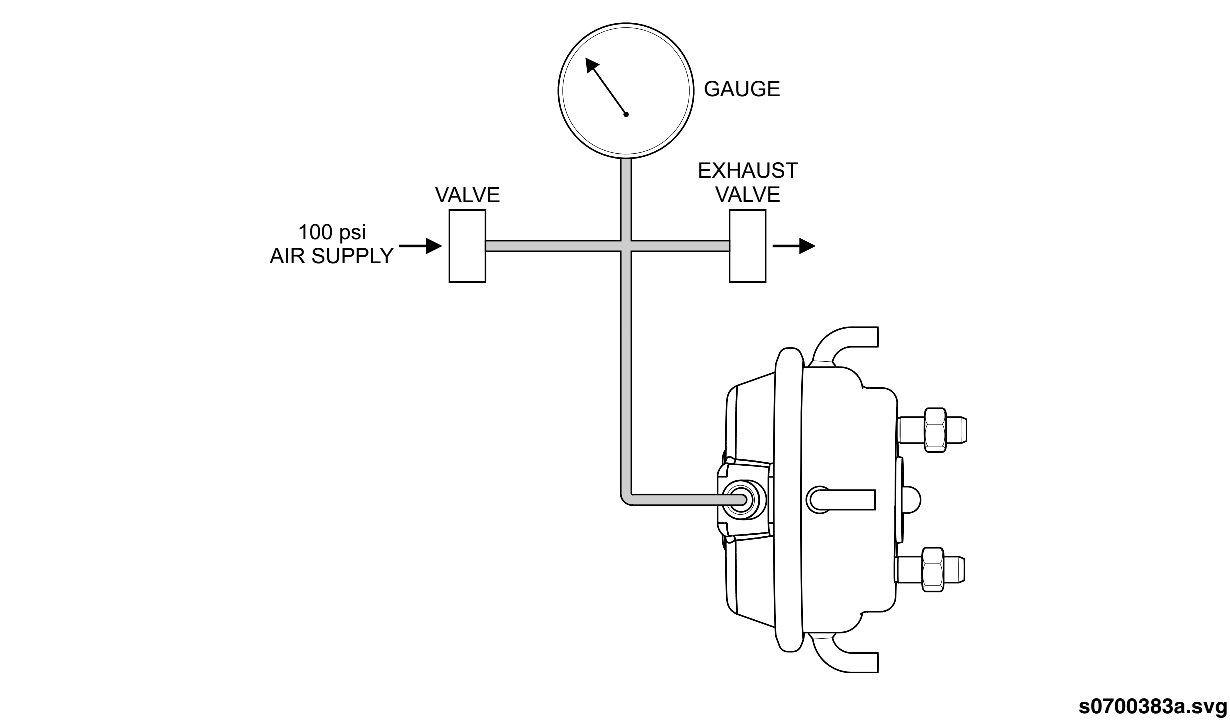


Fig. PM-35: Front Brake Chamber Leak Test Setup

2.20.3. Rear Brake Chambers

2.20.3.1.Inspection

Perform the following inspection every 48,000 miles (77,200 km):

1. Visually inspect the exterior surfaces of the spring brake chamber for signs of damage. Replace the brake chamber if damaged. Refer to Section 2 of this manual for replacement procedure.
2. Apply system pressure (minimum 100 psi) to the spring brake chamber and check for leaks at the head/flange case interface, air inlet fittings, at vent elbows in non-pressure housing, and center seal using soapy water or leak detection solution.
   a. If bubbles appear at the head/flange case interface, a leak is present and If a leak is detected, perform a leakdown pressure test. Refer to 2.20.3.2. “Spring Brake Leakdown Test” on page 80 and Refer to 2.20.3.3. “Service Brake Leakdown Test” on page 81 in this section for test procedure.
   b. Check for leaks from the vent elbow located in the non-pressure housing. If more than one vent elbow is present, plug all but one elbow and check for leaks at the unplugged elbow. If leaks are detected, there is an internal leak. Perform a leakdown pressure test. Refer to 2.20.3.2. “Spring Brake Leakdown Test” on page 80 and Refer to 2.20.3.3. “Service Brake Leakdown Test” on page 81 in this section for test procedure.
   c. For center seal leaks, check for continuous discharge from the service side quick release valve. If a leak is detected, perform a leakdown pressure test. Refer to 2.20.3.2. “Spring Brake Leakdown Test” on page 80 and Refer to 2.20.3.3. “Service Brake Leakdown Test” on page 81 in this section for test procedure.
   d. If bubbles appear at air hose connection, tighten hose until leaks cease, but do not exceed 20 ft-lb. (27 Nm) for the spring brake hose. If leaks continue, release air pressure and remove air line from inlet port. Inspect threads on hose and fitting. Replace hose or fitting as required Reinstall air line to the brake chamber and recheck for leaks.
   e. If bubbles appear at spring brake air inlet fitting, tighten fitting until leaks cease, but do not exceed 30 ft-lb. (41 Nm). If leaks continue, release air pressure and remove fitting from brake chamber Install new fitting with Loctite 567 and tighten two full turns past finger tight. Reinstall air line to the spring brake chamber and recheck for leaks. If leaks continue, perform a leakdown pressure test. Refer to 2.20.3.2. “Spring Brake Leakdown Test” on page 80 in this section for test procedure. Replace brake chamber as required.

3. With spring brake still fully pressurized, apply system pressure (minimum 100 psi) to the service brake chamber and check for leaks around the circumference of the clamp band and air inlet fittings, using soapy water or leak detection solution.

   a. If bubbles appear around clamp band, release air pressure and torque clamp band nuts to 30 to 35 ft-lb. (41 to 47 Nm). Recheck for leaks. If leaks continue, perform a leakdown pressure test. Refer to 2.20.3.3. “Service Brake Leakdown Test” on page 81 in this section for test procedure.

   b. If bubbles appear at service brake air inlet fitting, tighten fitting until leaks cease, but do not exceed 30 ft-lb. (41 Nm). If leaks continue, perform a leakdown pressure test. Refer to 2.20.3.3. “Service Brake Leakdown Test” on page 81 in this section for test procedure. Repair or replace hose and fittings as required.

   c. Check to ensure the mounting stud nuts are torqued to 133 to 155 ft-lb. (180 to 210 Nm).

CAUTION

DO NOT use an impact wrench to tighten the release bolt in the following step.

4. Check to ensure that the release bolt is seated against the head insert and torqued to 50 to 60 ft-lb. (68 to 81 Nm). Fully seating the release bolt ensures that the parking brake will have full stroke capability and seals the release bolt threads, preventing contaminants from entering the brake chamber.

5. Check the external breather tube to ensure there is no damage or cracks in the rubber elbows and ensure the tube is securely engaged a minimum of ½ inch (13 mm) into the rubber elbows and glued together with a high quality rubber cement. Replace with breather tube repair kit if required.

2.20.3.2.Spring Brake Leakdown Test

☞**NOTE:**

Perform the leakdown test procedure only if bubbles were evident during the initial leak test.

1. Drain vehicle air system.
2. Disconnect both brake hoses from brake chamber,
3. Connect pressure test equipment to spring brake chamber port #12. See "Fig. PM-36: Spring Brake Leak Test Setup" on page 80.
4. Close the exhaust valve.
5. Open the air supply valve and pressurize spring brake chamber to 100 psi.

☞**NOTE:**

Some minor movement (0.010 inch maximum) to initially position the head may be noticed at the roll in area of the brake chamber. This is a normal condition.

6. Uncage the spring brake.

⚠CAUTION

Exercise caution in the following step when cycling the air pressure. Be aware of push rod movement.

7. Cycle the unit 2 to 3 times by releasing and applying air pressure from and to the spring brake chamber.
8. Pressurize the spring brake chamber to 100 psi and close the air supply valve.
9. Allow the system to stabilize for approximately one minute.
10. Open the air supply valve to restore the 100 psi system pressure.
11. Close the air supply valve and make note of the time.
12. After three minutes, record the final pressure. If the final pressure does not meet the minimum allowable pressure of 95 psi, then the brake chamber will need to be replaced.

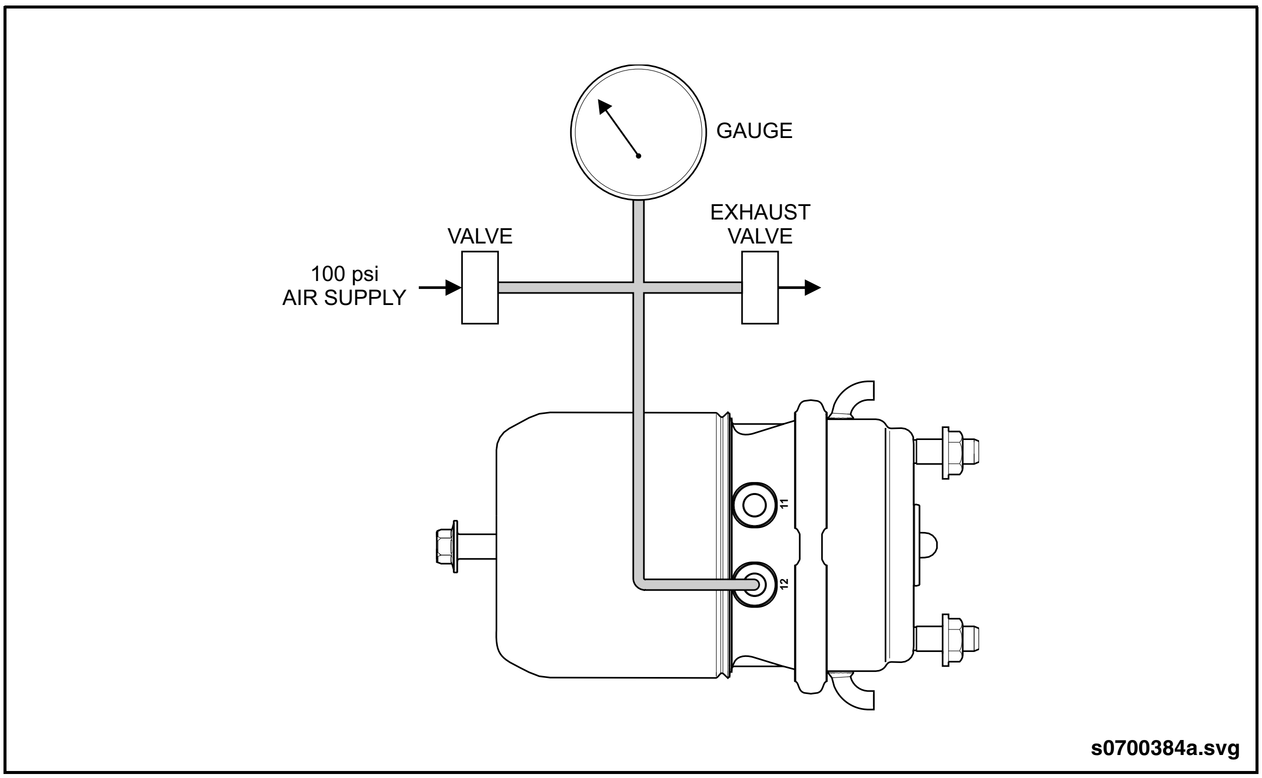


Fig. PM-36: Spring Brake Leak Test Setup

2.20.3.3.Service Brake Leakdown Test

☞NOTE:

Perform the leakdown test procedure only if bubbles were evident during the initial leak test.

1. Drain vehicle air system.
2. Disconnect both brake hoses from brake chamber,
3. Connect pressure test equipment to spring brake chamber port #12 and service brake chamber port #11. See “Fig. PM-37: Service Brake Leak Test Setup” on page 81.
4. Close the exhaust valves.
5. Open the air supply valve to spring brake port #12.
6. Pressurize spring brake chamber to 100 psi.
7. Open the air supply valve to service brake port #11.
8. Pressurize service brake chamber to 100 psi. and close the air supply valve.
9. Allow the system to stabilize for approximately one minute.
10. Open the air supply valve to port #11 and restore the system pressure to 100 psi.
11. Close the air supply valve and make note of the time.
12. After three minutes, record the final pressure. If the final pressure does not meet the minimum allowable pressure of 93 psi, then the brake chamber will need to be replaced.

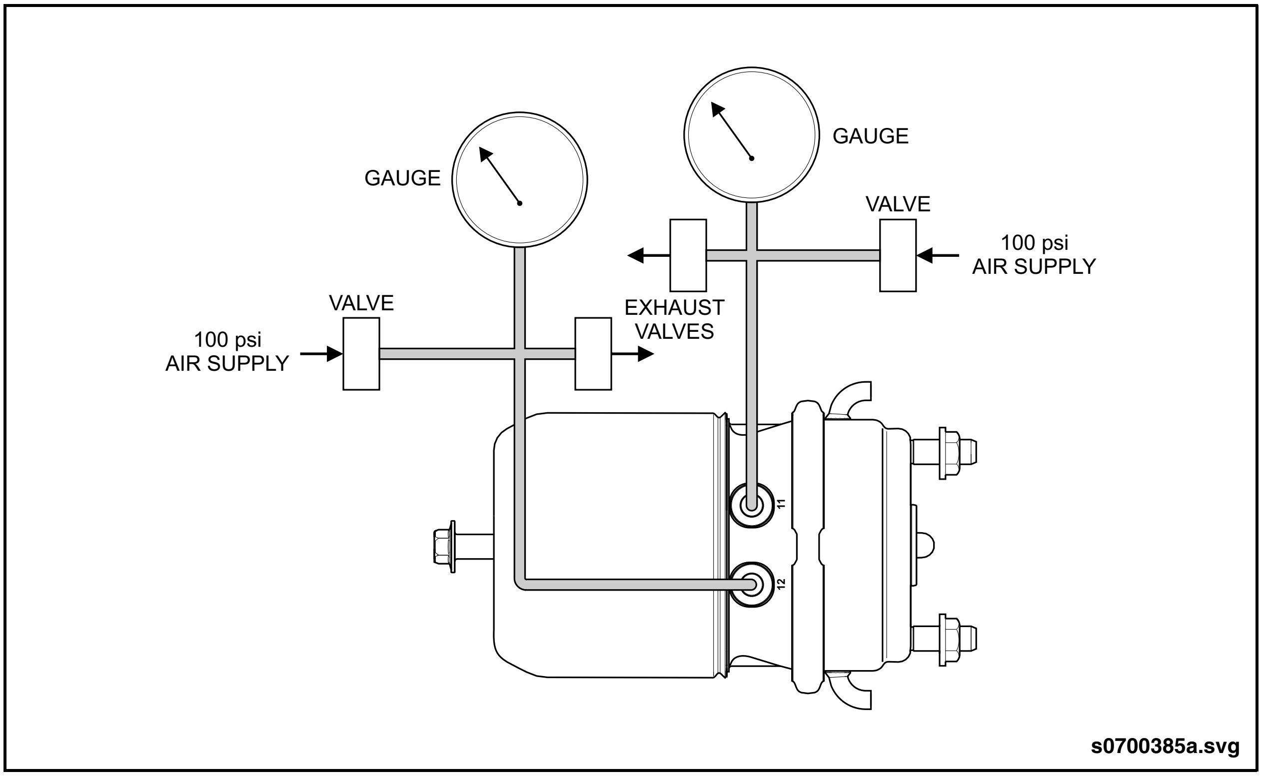


Fig. PM-37: Service Brake Leak Test Setup

2.21. 54,000 Miles (87,000 km) Preventive Maintenance

2.21.1. Rear Axle Oil Change

Change the rear axle oil every 54,000 miles (87,000 km), or every year, whichever occurs first. Use this oil change interval only if operating with mineral oil in a moderate temperature region. Refer to 2.2. "Rear Axle Operating Conditions" on page 6 in this section for a definition of a moderate temperature region. Refer to 2.18.3. "Rear Axle Oil Change" on page 74 in this section for oil change drain and fill procedure. Refer to 2.36. "Fluid & Lubrication Guide" on page 109 in this section for fluid specification.

2.22. 60,000 Miles (96,000 km) Preventive Maintenance

2.22.1. Overhead Valve Adjustment

Adjust the overhead valves after the first 15,000 miles (24,140 km), 1000 hours, or one year of operation, whichever occurs first. Subsequent valve adjustments shall be performed every 60,000 miles (96,000 km), 2,000 hours, or two years, whichever occurs first. Refer to your Cummins Operation & Maintenance Manual for procedure.

2.23. 75,000 Miles (120,700 km) Preventive Maintenance

2.23.1. Transmission Filters

⚠CAUTION

Fluid and filter change frequency is determined by the severity of transmission service. More frequent changes may be necessary if the operating conditions create high levels of contamination or overheating. Perform an oil analysis to determine proper change interval if there is any question as to the severity of the transmission duty cycle. Refer to Allison Service Manual and Allison Service Tip #1099 for more information on oil analysis and recommended change intervals.

☞**NOTE:**

Refer to Allison Service Manual and Allison Service Tips #1099 for more information on fluid and filter change intervals and fluid contamination.

Change both filters every 75,000 miles (120,000 km), 3,000 hours, or 36 months and top up fluid. Refer to 2.25.1. "Transmission Fluid" on page 83 in this section for procedure.

2.24. 96,000 Miles (154,500 km) Preventive Maintenance

2.24.1. Front End Alignment

Perform major alignment. Refer to Section 3 of this manual for procedure.

2.25. 150,000 Miles (241,400 km) Preventive Maintenance

2.25.1. Transmission Fluid

CAUTION

Fluid and filter change frequency is determined by the severity of transmission service. More frequent changes may be necessary if the operating conditions create high levels of contamination or overheating. Perform an oil analysis to determine proper change interval if there is any question as to the severity of the transmission duty cycle. Refer to Allison Service Manual and Allison Service Tip #1099 for more information on oil analysis and recommended change intervals.

☞**NOTE:**

Refer to Allison Service Manual and Allison Service Tips #1099 for more information on fluid and filter change intervals and fluid contamination.

Change both filters every 75,000 miles (120,000 km), 3,000 hrs., or 36 months and top up fluid. Change the fluid every 150,000 miles (240,000 km), 6,000 hrs., or 48 months. See “Fig. PM-38: Transmission Oil Filters” on page 84.

☞**NOTE:**

The transmission should be at the operating temperature of 160 to 200°F (71 to 93°C) when the oil is drained. This will ensure quicker and better drainage. Check oil for contamination. Refer to Section 5 of this manual if contamination exists.

1. Remove the drain plug from the control module and allow the oil to drain. Check the condition of the oil per Section 5 of this manual.
2. To remove each filter, remove six bolts, filter cover, three O-rings, and filter element.
3. To install each filter:
   a. Lube and install the O-rings on the filter element and filter cover.
   b. Install a gasket on the filter cover.
   c. Index each filter/cover assembly to the holes in the channel plate/sump. Push cover assembly to seat seals (do not use bolts to draw cover to sump: this can damage cover/seal/sump).
   d. Install six bolts into each cover and tighten to 42 to 50 ft-lb. (57 to 68 Nm).
4. Inspect the drain plug and install a new O-ring.
5. Reinstall the drain plug and torque to 18 to 24 ft-lb. (25 to 32 Nm).
6. Fill transmission with new oil. Refer to Section 5 of this manual for required quantities.

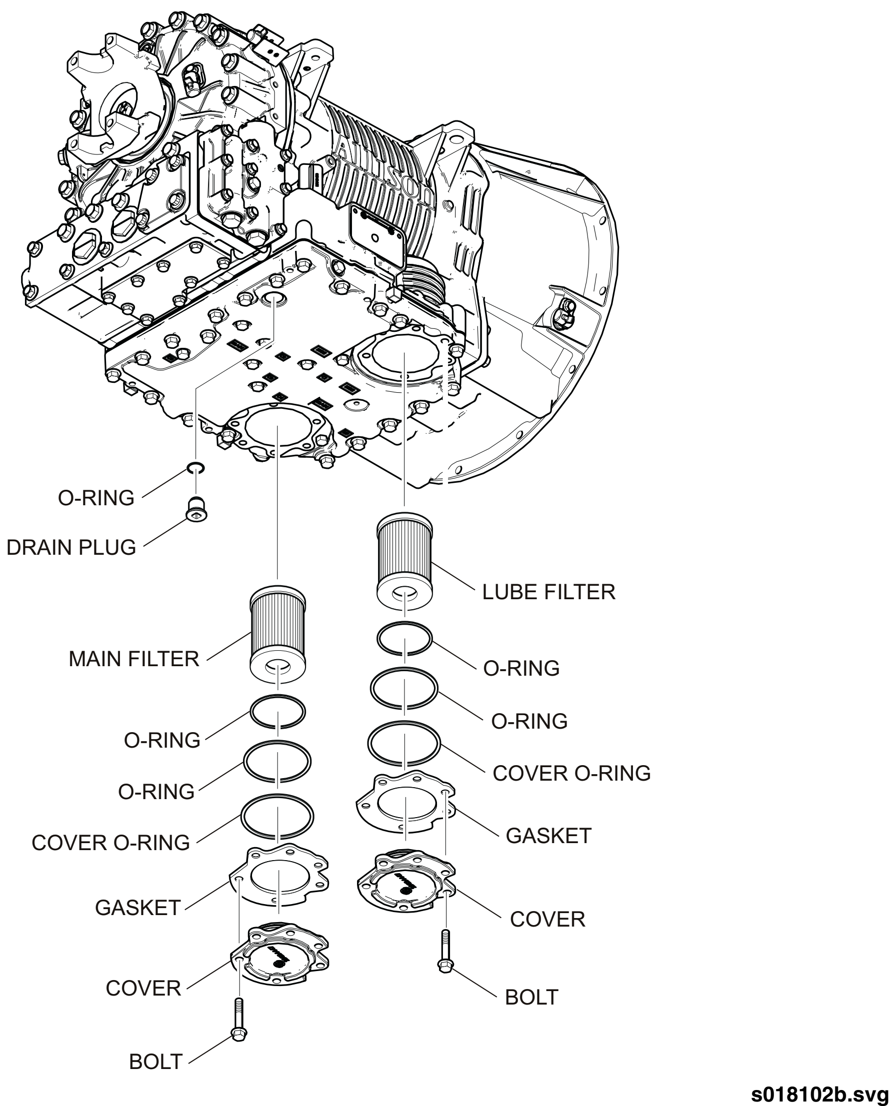


Fig. PM-38: Transmission Oil Filters

2.25.2. Engine Compartment Access Door Inspection

Inspect the two scissor hinges on the engine compartment door every 150,000 miles (241,400 km) as follows:

1. Raise and lower the door slowly while observing the action of the scissor hinges. The hinges should operate smoothly without any binding or deflection. Replace hinge if damaged.
2. Inspect all pivot point fasteners to ensure they are in good condition and properly tightened. Pay particular attention to the uppermost fasteners for possible damage or looseness. See “Fig. PM-39: Scissor Hinge Inspection” on page 85. Replace any damaged fasteners.

☞**NOTE:**

If installing new fasteners, ensure that a light coating of Never-Seez is applied to the inside of the pivot holes, between the moving linkages, and on the underside of the large washers. Wipe off excess grease.

3. Inspect torque witness marks on all fasteners as follows:
   a. If witness marks are legible and aligned, no further action is required.
   b. If witness marks are not aligned, not legible, or missing entirely, then the fastener will need to be loosened and retorqued to 12 ft-lbs. (16 Nm). Reapply torque witness mark.
4. If the hinge is sticking or damaged, replace the hinge assembly.

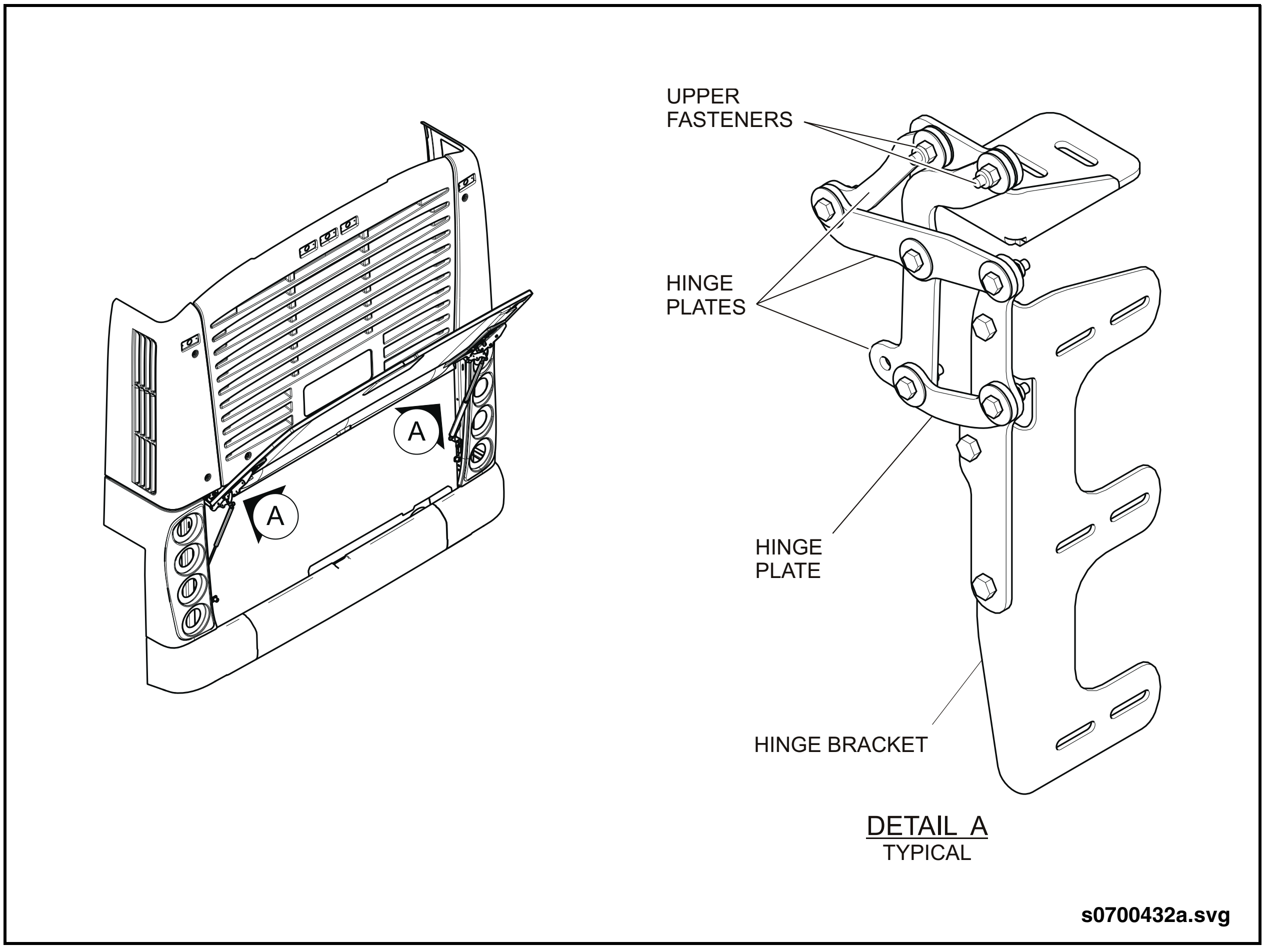


Fig. PM-39: Scissor Hinge Inspection

2.26. 250,000 Miles (400,000 km) Preventive Maintenance

2.26.1. Support Frame Inspection

Inspect the K-member on the support frame after the first 250,000 miles (400,00 km) of operation, and then every year thereafter, as follows:

1. Raise the vehicle. Refer to the General Information Section of this manual for lifting procedures.
2. Locate the fuel tank support frame. See “Fig. PM-40: Support Frame” on page 86.
3. Clean the fuel tank support frame in the area of the bolted K-member to allow for proper visual inspection.
4. Inspect all fasteners to ensure torque witness marks are aligned. Retorque any loose fasteners to 370 to 390 ft-lbs. (500-525 Nm) and reapply torque witness marks.
5. Inspect all welded joints of the K-member for any cracks. Pay particular attention to the location identified on the accompanying illustration as “critical area”. Replace K-member if cracks are evident at any location. Contact New Flyer Parts Department for ordering information.

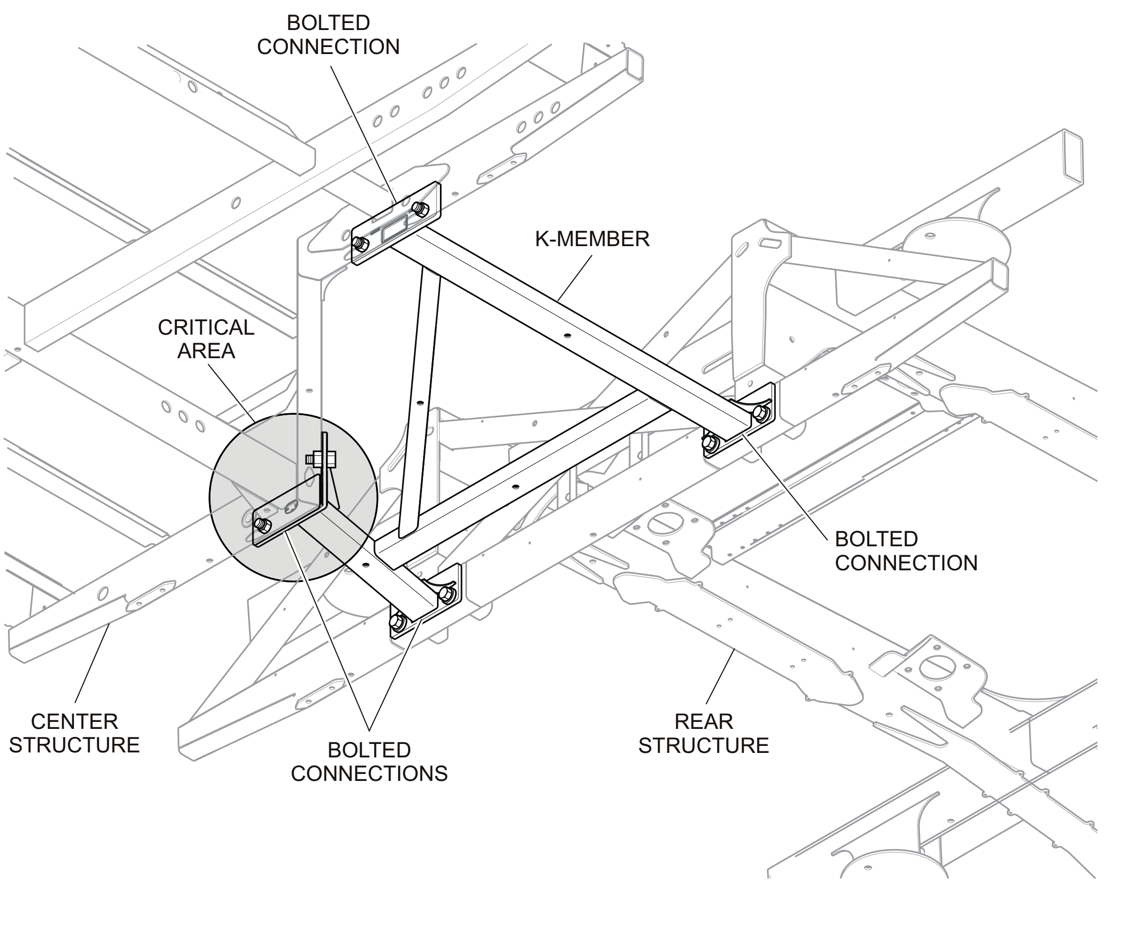


Fig. PM-40: Support Frame

2.27. Six Month Preventive Maintenance

2.27.1. D-2 Governor

Perform an operating and leakage test every six months or 1,500 hours, whichever occurs first. Refer to Section 8 of this manual for procedure.

2.27.2. PR-2 Pressure Protection Valve

Perform an operating test and leakage check of the valve at this interval. Refer to Section 8 of this manual for procedure.

2.27.3. ST-1 Safety Valve

Every six months or 1,500 operating hours perform operating and leakage test. Refer to Section 8 of this manual for test procedure.

2.27.4. SR-7 Spring Brake Modulating Valve

Perform an operating and leakage test every six months or 1,500 hours, whichever occurs first.

WARNING

DO NOT attempt to disassemble and service the valve. The valve contains high spring forces that could result in personal injury if disassembled.

2.27.4.1. Operating Test

1. Block vehicle and hold by means other than vehicle brakes.
2. Charge air system to governor cut-out pressure.
3. Place parking brake control valve in the APPLIED position. Observe that the spring brake actuators apply promptly.
4. Remove the plug from the unused delivery port and install a test pressure gauge known to be accurate.
5. Place the parking brake control valve in the RELEASE position. Observe that the spring brake actuators release fully.
6. With the parking control valve in the RELEASE position, note the gauge pressure reading. Spring brake actuator hold-off pressure should be 107 psi. If the pressure reading is incorrect, the valve must be replaced.
7. Place the parking brake control valve in the APPLIED position: The gauge reading should drop to zero promptly. A slow release of pressure, more than three seconds, would indicate faulty operation. Replace the valve.
8. Maintain the parking brake control valve in the APPLIED position and gradually apply the brake treadle. The reading on the test pressure gauge, installed in the delivery port should increase.
9. Place the parking brake control valve in the RELEASE position.
10. Drain the rear brake reservoir to zero psi.
11. Apply the brake treadle several times and note that the pressure reading on the gauge decreases each time the brake treadle is applied. After several applications, pressure on the gauge will drop to the point where release of the spring brake actuators will no longer occur.

2.27.4.2. Leakage Test

With the air system fully charged and the parking brake control valve in the RELEASE position, coat all the ports, including the exhaust port, with a soap solution. A 1" bubble in three seconds (175 SCCM) is permitted.

If the Spring Brake Modulating Valve does not function as described in the operating test, or leakage is excessive, it is recommended that the valve be replaced.

2.27.5. SC-1 Single Check Valve

Every six months or 1,500 operating hours perform operating and leakage test. Refer to Section 8 of this manual for test procedure.

2.27.6. DC-4 Double Check Valve

Every six months or 1,500 operating hours perform operating and leakage test. Refer to Section 8 of this manual for test procedure.

2.27.7. RV-1 Pressure Reducing Valve

Inspect and test the pressure reducing valve every six months or 1500 operating hours, whichever occurs first. Refer to Section 8 of this manual for procedure.

2.27.8. RV-3 Pressure Reducing Valve

Inspect and test the pressure reducing valve every six months or 1500 operating hours, whichever occurs first. Refer to Section 8 of this manual for procedure.

2.27.9. R-14 Relay Valve

Every six months or 1,500 operating hours perform operating and leakage test. Refer to Section 8 of this manual for test procedure.

2.27.10. Brake Foot Valve

Every six months or 1,500 operating hours perform operating and leakage test. Refer to Section 8 of this manual for test procedure. Check for physical damage such as broken air lines and missing parts.

2.27.11. Parking Brake Control Valve

Perform an operating and leakage test every six months or 1,500 hours, whichever occurs first. Refer to Section 8 of this manual for procedure.

2.27.12. Emergency Brake Release Valve

Perform an operating and leakage test every six months or 1,500 hours, whichever occurs first. Refer to Section 8 of this manual for procedure.

2.27.13. Steering Knuckle Lubrication

Lubricate the upper and lower steering knuckle (kingpin) bearings every six months if operating under harsh winter conditions where the vehicle is exposed to salt spray or extremes of temperature. It is recommended that the bearings be greased before the start of the winter season, and then again immediately following the winter season. Do not grease more frequently than recommended.

☞**NOTE:**

The lubrication interval may be extended to once every year or 36,000 miles (58,000 km), whichever occurs first, if operating under less harsh conditions.

Lubricate the bearings as follows:

1. Ensure the wheels are supporting the weight of the vehicle. Do not lift on the axle or chassis with the wheels hanging unsupported, as this will prevent proper lubrication of the upper bearing.
2. Remove the protective plastic cap from the grease fitting and clean the fitting and surrounding area.
3. Ensure that the adapter on the grease gun properly fits the grease fitting.

⚠ CAUTION

DO NOT over-pressurize the bearing cavity when greasing the bearing, as this could cause the sealing washer, located below the circlip, to bulge outward. Replace sealing washer if distorted.

4. Lubricate the upper bearing first. Use only RenoLit LX-OTP-2 lubricant and continue to apply grease until the old grease begins to escape from between the steering knuckle and axle I-beam. It is not necessary to completely purge all of the old grease.

☞**NOTE:**

If the lower bearing is lubricated first, it will tend to minimize the cavity above the upper kingpin bearing and restrict grease flow to the upper bearing.

5. Lubricate the lower bearing, same as the upper bearing.
6. If difficulty is experienced lubricating either the upper or lower bearing, Refer to 2.27.13.1. “Lubrication Troubleshooting” on page 89 for troubleshooting procedures.
7. Clean any excess grease from the steering knuckle joint as well as the area above the sealing washer.
8. Install protective plastic cap on grease fitting.

2.27.13.1.Lubrication Troubleshooting

Use the following checks and procedures if difficulty is experienced lubricating the bearings:

1. If neither bearing is taking grease, proceed as follows:
    a. Confirm that the weight of the vehicle is on the wheels when applying grease.
    b. Confirm that the proper grease gun adapter is being used.
    c. If excessive greasing pressures are being used, a hydraulic lock may form and prevent the flow of grease. Relieve the excessive pressure by turning the wheels fully left and right several times. If grease pressure will not relieve, proceed to the following step.
    d. Use a thin punch or similar tool to depress the check ball in the grease fitting and allow grease to escape. If grease pressure still won’t relieve, proceed to the following step.
    e. Remove the circlip and sealing washer, wipe off the grease, and turn the wheels fully left and right several times.
    f. Install new grease fitting and ensure it does not protrude into the kingpin cavity. Reinstall sealing washer and circlip.

☞**NOTE:**

Replace the sealing washer if any evidence of distortion or bulging is noted.

2. If only the upper bearing is not taking grease, proceed as follows:
    a. Confirm that the weight of the vehicle is on the wheels when applying grease.
    b. Remove the snap ring and sealing washer and examine the grease fitting to ensure that it is flush with the sealing washer and does not protrude into the kingpin cavity.

☞**NOTE:**

The use of a non-specified grease fitting with longer threads could result in the grease fitting contacting the upper kingpin surface and effectively blocking the flow of grease. Refer to your New Flyer Parts Manual for correct grease fitting application.

2.27.14. Engine Compartment Access Door Inspection

Inspect, clean, and lubricate the scissor hinges on the engine compartment door every six months as follows:

1. Operate the door through its opening range while observing the hinge for smooth operation. Ensure the hinge is not buckled or distorted. Replace the hinge if damaged.
2. Use compressed air to blow out any grit from the pivot points of the hinge.
3. Wipe any displaced lubricant or grit with a clean cloth.
4. If the door is sticking, use a brush to work Never-Seez into all the pivot points of the hinge.
5. Wipe excess lubricant with a clean cloth, being careful not to remove any torque witness marks.

2.27.15. Bike Rack Servicing

Service the bike rack latch mechanism and support arm assembly every six months. Refer to Section 13 of this manual for procedure.

2.27.16. Air Dryer

Replace pre-filter, scrubber, and coalescing filter elements every six months. Refer to Section 8 of this manual for replacement procedures. Refer to your New Flyer Parts Manual for applicable replacement kits.

2.27.17.CNG Tank Vent Caps

The vent tubes on your CNG vehicle are equipped with protective caps. If these caps are missing or damaged, moisture can enter the vent tubes. If this moisture should freeze and expand, it could hamper the operation of the PRD.

WARNING

Failure to perform this inspection may lead to fire or explosion hazard if the CNG in the fuel system vents to atmosphere and is ignited.

In order to ensure that the protective caps on the vent tubes are in place and secure, the following inspection is required:

- ❒ Twice a year at a minimum (once before the start of the winter season) inspect the vent tubes to ensure that all caps are secure and in good condition. Each tank enclosure has two caps per side. As well there is a main vent cap located in the right rear corner of the roof near the air intake. See “Fig. PM-41: Vent Cap Inspection” on page 91.
- ❒ If a cap is missing or in poor condition, remove the vent tube, empty and clean it and reinstall the tube with a new protective cap. Glue in place with Sika-221 adhesive.

NOTE:

Refer to “Workplace & Safety Precautions” and details of “Tubing Handling” in Section 7 of this manual before performing maintenance on the fuel system.

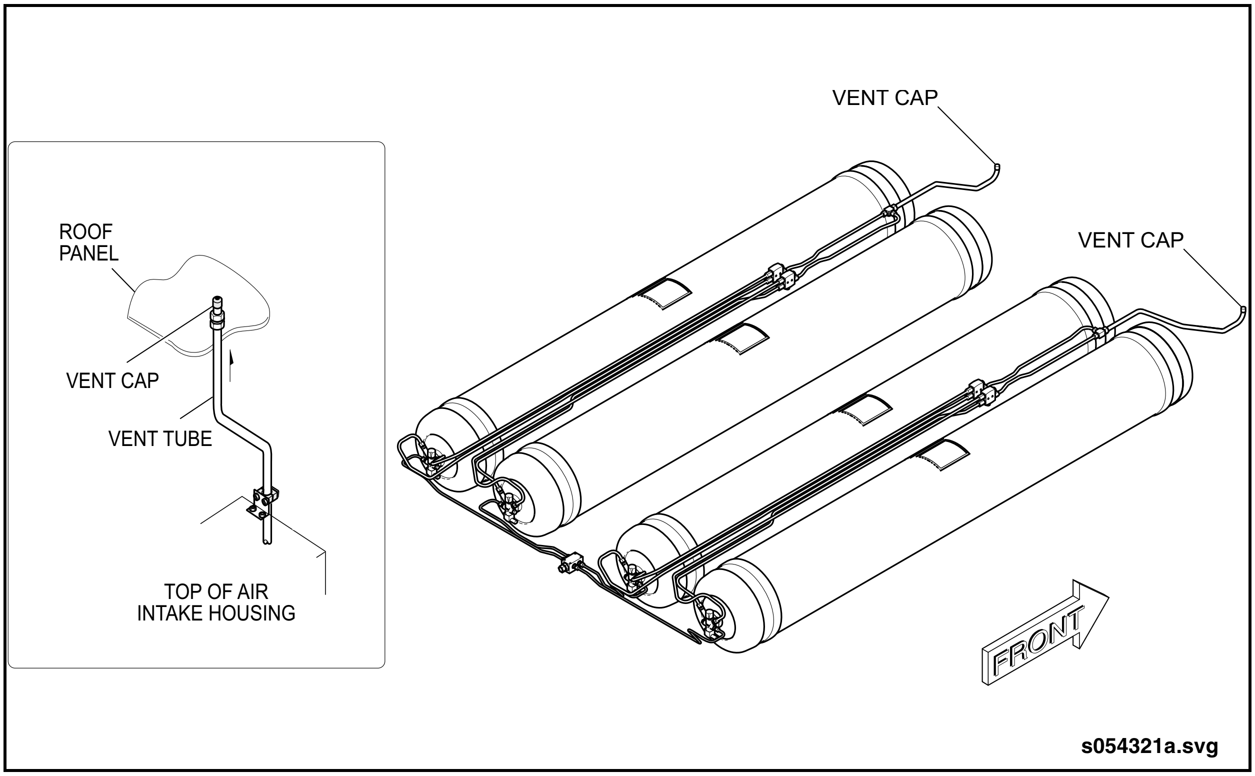


Fig. PM-41: Vent Cap Inspection

2.27.18.HVAC System Test & Lubrication

Perform the following maintenance tasks every six months. Refer to your Thermo King Maintenance Manual for procedures.

- ❒ Check evaporator blower motors speed, voltage, and amperes (all motors).
- ❒ Check condenser blower motors speed, voltage, and amperes (all motors).
- ❒ Lubricate fan shaft bearings with Shell Alvania EP grease.

2.27.19.Power Steering Miter Box

Locate the grease fitting on the bottom of the power steering miter box. Use a manual grease gun and apply only two pumps of grease to lubricate the miter box. Do not apply excessive pressure or quantity of grease that could result in damage to seals. Refer to 2.36. “Fluid & Lubrication Guide” on page 109 in this section for lubricant specification. See “Fig. PM-42: Power Steering Miter Box Lubrication” on page 92.

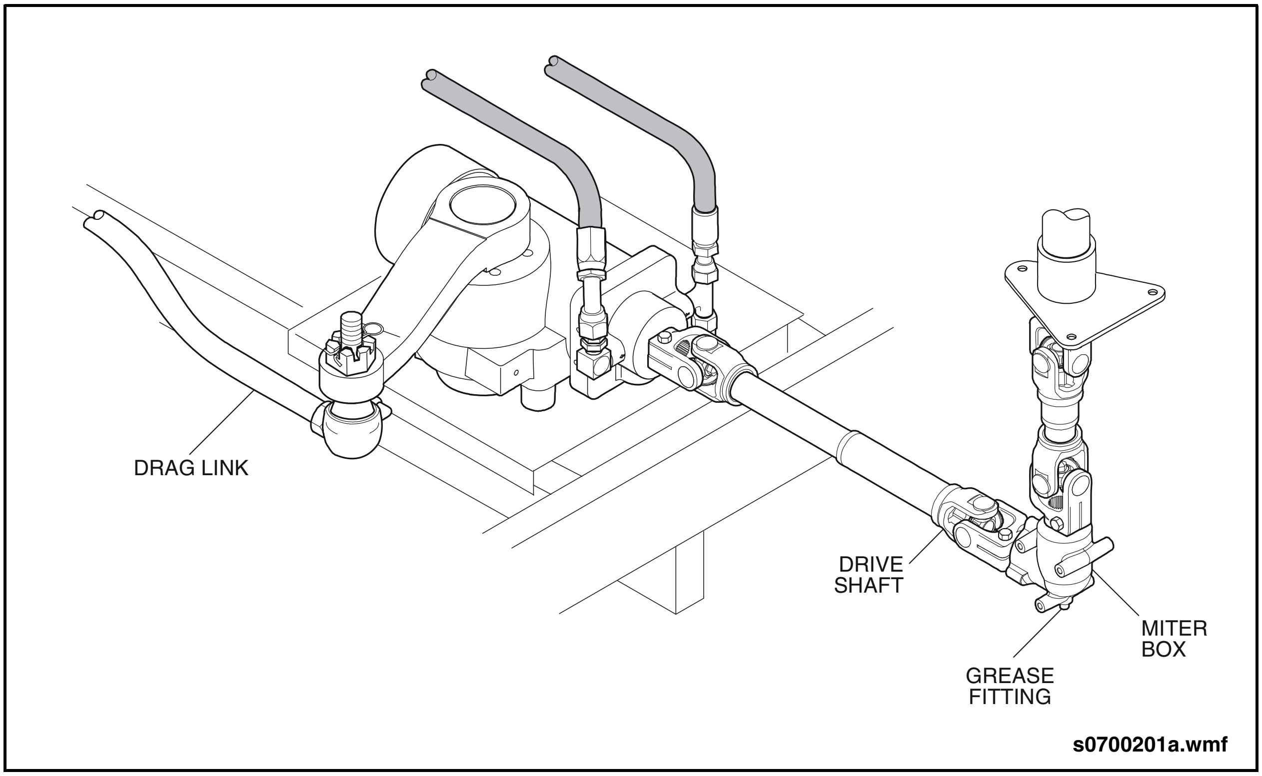


Fig. PM-42: Power Steering Miter Box Lubrication

2.28. Yearly Preventive Maintenance

2.28.1. Fire Extinguisher

Examine every 12 months to ensure extinguisher is operable. Recharge if below the specified weight or pressure is below operable range. Replace any damaged parts. Check hose for obstructions.

Record maintenance use and recharge dates on the fire extinguisher maintenance tag.

2.28.2. Door Sensitive Edge Inspection & Test

Inspect and test the door sensitive edge function every year or 100,000 door operating cycles, whichever occurs first.

- ❒ Visually inspect door sensitive edge for cuts, tears, or other damage. Replace sensitive edge if damaged.
- ❒ Inspect for properly connect tubing from sensitive edge to pressure wave switch.
- ❒ Inspect electrical connections on pressure wave switch.
- ❒ Perform a functional test on the sensitive edge system. Refer to Section 16 of this manual for test procedure.

2.28.3. Rear HVAC Unit Area Inspection

Refer to Section 11 of this manual for procedure.

2.28.4. Instrument Panel & Side Console

Once yearly, inspect the interior of the instrument panel for loose wires. Inspect the interior of the side console for loose wires and chafing air lines. Refer to Section 19 of this manual for further information on these components.

2.28.5. CNG Fuel Tanks

Inspect tanks. Refer to Section 7 of this manual for procedure.

2.28.6. Wheelchair Ramp Pump

2.28.6.1. Hydraulic Fluid

☞NOTE:

The yearly fluid change interval is based on typical transit operating conditions but may need to be adjusted to suit actual operating frequency. Periodic oil samplings may also be taken to determine fluid cleanliness.

Change fluid as follows:

1. Set Battery Disconnect switch to OFF position.
2. Suction fluid from reservoir and dispose of fluid in accordance with local regulations.
3. Disconnect hydraulic lines from ports “1” and “2” on manifold.
4. Manually operate ramp through several operating cycles to expel as much fluid as possible from the actuating cylinder and lines.
5. Inspect filters and screens. Refer to 2.28.6.2. “Screen & Filter Inspection” on page 95 in this section for replacement procedure. See “Fig. PM-43: Hydraulic Power Pack Assembly” on page 95.
6. Connect and tighten hydraulic lines to ports “1” and “2” on the manifold.
7. Fill the reservoir. Refer to 2.36. “Fluid & Lubrication Guide” on page 109 in this section for fluid specifications.
8. Manually place the ramp in the stowed position.
9. Crack open or remove the STOW line at the aft end of the cylinder.
10. Set the Battery Disconnect switch to the ON position.

⚠CAUTION

DO NOT allow the reservoir to run dry while priming the pump.

11. Use the ramp DEPLOY switch to “jog” the unit through short deploy strokes, Gradually increase the length of the deploy strokes until a steady stream of fluid flows from the line without air bubbles.
12. Tighten the STOW pressure line at the aft end of the cylinder and crack open or remove the DEPLOY line at the forward end of the cylinder.
13. Use the ramp STOW switch to “jog” the unit through short stow strokes, Gradually increase the length of the stow strokes until a steady stream of fluid flows from the line without air bubbles.
14. Tighten the DEPLOY line at the forward end of the cylinder.
15. Operate the ramp through several deploy/stow cycles.
16. Top up reservoir to within 1” of filler cap.

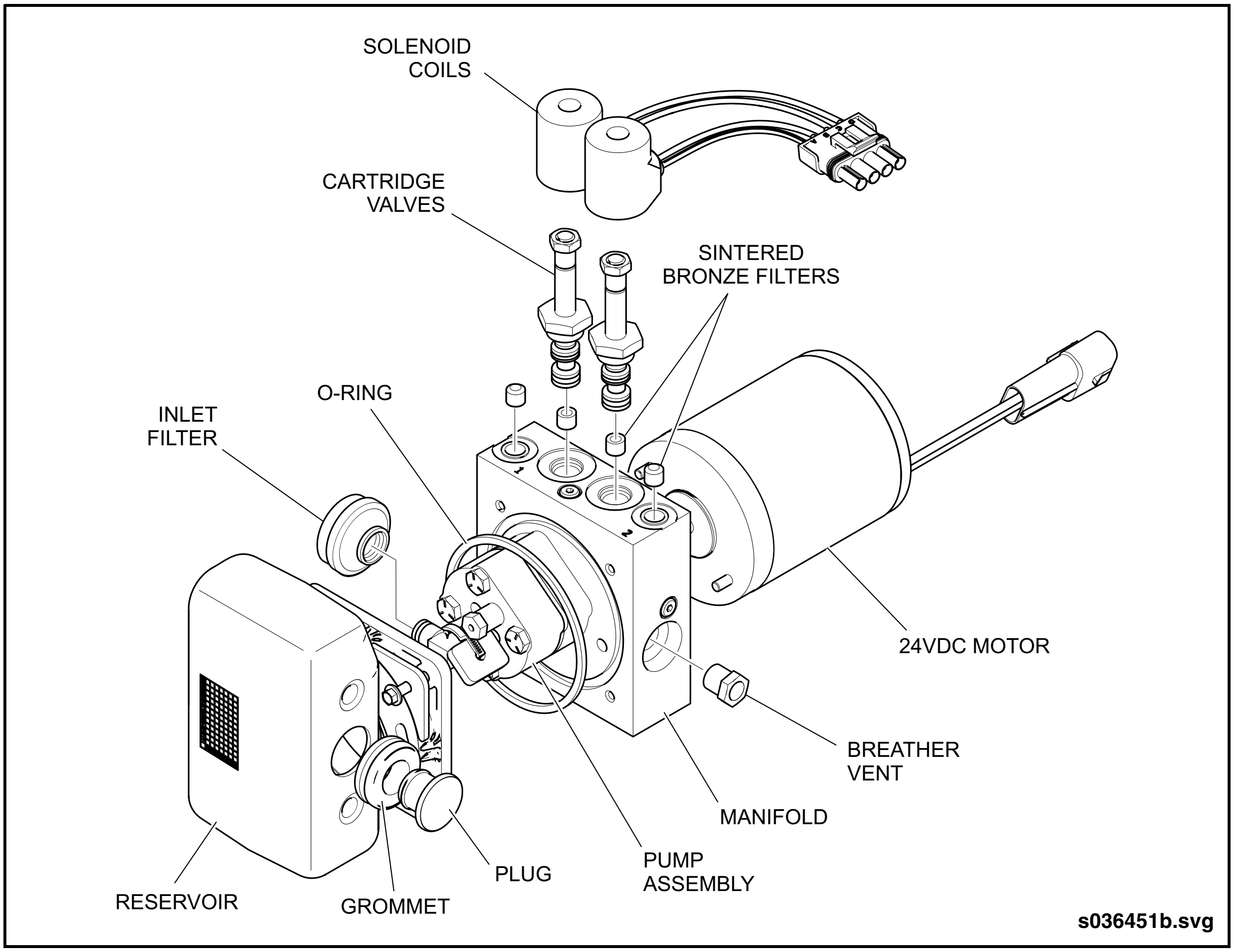


Fig. PM-43: Hydraulic Power Pack Assembly

2.28.6.2.Screen & Filter Inspection

Inspect the inlet (suction) screen as follows:

1. Separate the reservoir from the manifold by removing the four bolts and clamp plates.
2. Remove and discard the O-Ring.
3. Remove inlet filter from pump and clean or replace as necessary.
4. Install new O-Ring and install reservoir onto manifold.
5. Install four bolts with clamp plates and tighten bolts.

Inspect the manifold filters as follows:

1. Disconnect hydraulic lines from manifold ports.
2. Remove elbow fittings from manifold.
3. Use dental pick or similar tool to remove filter from each port.
4. Clean or replace filters as necessary.
5. Reinstall elbow fittings into manifold ports.
6. Install and tighten hydraulic lines.

Inspect the breather vent as follows:

1. Locate the breather vent on top of the pump manifold.
2. Use a hex socket to remove the breather vent from the manifold.
3. Clean or replace the sintered bronze filter as necessary.
4. Reinstall breather vent into manifold.

2.28.7. Air Strainer

Replace the air strainer every year or 36,000 miles, whichever occurs first.

1. Park the vehicle on level ground and chock the wheels.
2. Drain the air tanks.
3. Locate the air strainer on the front brake & kneeling valve panel.
4. Disconnect air line from air strainer.
5. Unthread air strainer assembly from nipple connector.
6. Remove fittings from air strainer and install in same position on new air strainer. Use Loctite 567 thread sealant on pipe threads.
7. Install new air strainer assembly on nipple connector, using Loctite 567 thread sealant on pipe threads.
8. Connect and tighten air line.
9. Charge the air system to operating pressure and check for leaks at the air strainer connections.

2.28.8. QR-1 Quick Release Valve

Perform the following operation and leakage test at every year or 1,500 hours, whichever occurs first:

1. Block the vehicle's wheels and fully charge the air system.
2. Apply the parking brake.
3. Locate the QR-1 Quick Release Valve on the front axle.
4. Apply and release the service brakes several times and observe that the brakes promptly respond at both wheels.
5. Make and hold a full brake application and apply a soap solution to the exhaust port. Leakage of a 1" bubble in 3 seconds is permissible.
6. Maintain full brake application and apply a soap solution to the body and cover. No leakage is permitted between the body and cover.
7. Repair or replace valves that do not function properly or have excessive leakage.

2.28.9. Radiator

Inspect the radiator on a yearly basis as follows:

- ❒ Inspect the main positive and negative power cables for wear or frayed insulation. Ensure the protective rubber boots are in place and in good condition.
- ❒ Check the main power cable connections for tightness and torque to 15 ft-lbs (20 Nm) if necessary.
- ❒ Inspect the condition of the inner and outer nylon bushings on the main power cable pass-through studs.
- ❒ Inspect main wiring harness and connections to TMC controller and all fans.
- ❒ Inspect fuses and fuse holders.
- ❒ Inspect support structure for any damage or loose mounting hardware.

2.28.10. Coolant Testing

☞**NOTE:**

This vehicle was filled at the factory with "Final Charge Global Coolant/Antifreeze". This is an extended life Organic Acid Technology (OAT) coolant. DO NOT use Supplemental Coolant Additives (SCA) or filter elements containing SCA's.

- ❒ Test the coolant on a yearly basis to ensure that it meets specification and that the cooling system is not contaminated. The coolant may remain in service if test results are satisfactory. Obtain a sample of the coolant and submit to a Polaris Laboratories, or equivalent testing laboratory, for analysis.

☞**NOTE:**

Contact Polaris Laboratories at 1-877-808-3750 and advise that you are a New Flyer customer and are requesting a "93 Coolant Package" test. Refer to "http://polarislabs.com/about/worldwide-locations/north-america/" for closest location to forward sample.

2.28.11. Headlight Aim

Check headlight aim on a yearly basis. Refer to Section 9 of this manual for headlight aiming procedures.

2.28.12. Front & Rear Wheel Bearing Inspection

Inspect the wheel bearing end play every year or 36,000 miles (58,000 km), whichever occurs first. Refer to Sections 1 & 2 of this manual for inspection procedure.

2.28.13. Support Frame Inspection

Inspect the K-member on the support frame after the first 250,000 miles (400,00 km) of operation, and then every year thereafter. Refer to 2.26.1. “Support Frame Inspection” on page 86 for inspection procedure.

2.28.14. HVAC System Inspection & Test

Perform an inspection and test of the HVAC system every year. Refer to your Thermo King Maintenance Manual for procedures.

2.28.15. Crankcase Ventilation Filter Replacement

Replace the crankcase ventilation filter every year or 2000 operating hours, whichever occurs first. Refer to the Cummins Operation & Maintenance Manual for replacement procedure.

2.29. Two Year Preventive Maintenance

2.29.1. Radiator

CAUTION

ALWAYS follow the filling and deaeration procedure when flushing the cooling system. Refer to Section 6 of this manual for procedure.

Cooling system and radiator maintenance should be performed every two years, or 80,000 miles, whichever occurs first.

- ❒ Inspect radiator core for any evidence of leakage. Repair as required.
- ❒ Inspect exterior of radiator for buildup of debris or blockage. If required, clean exterior of radiator by soaking. Refer to 2.29.1.1. “Exterior Cleaning” on page 98 in this section for cleaning procedure.
- ❒ Inspect cooling fins for damage and straighten with a fin comb as required.

2.29.1.1.Exterior Cleaning

CAUTION

Avoid the use of high pressure washing or steam cleaning equipment that could bend the cooling fins and result in restricted airflow.

Use the following procedure to remove any buildup of mud, salt, sand, road oils, brake lining dust, or tire rubber/carbon black from the exterior surface of the radiator:

1. Soak the radiator for 24 hours in a hot (150°F) non-caustic detergent solution with all fittings plugged.
2. Use low pressure spray equipment with cleaning solvent to clean the fin louvers.
3. Final rinse with clear water and air dry.
4. Inspect cooling fins and straighten to the original geometry using needle nose pliers or a fin comb.

2.29.1.2.Interior Cleaning/Flushing

CAUTION

ALWAYS follow the filling and deaeration procedure when flushing the cooling system. Refer to Section 6 of this manual for procedure.

This maintenance interval is dependent on the condition of the cooling system and may be extended if no evidence of contamination, such as silicate gel, oil, grease, fuel, scale, rust, or solder bloom are found in the system.

Clean and flush the cooling system on an “as needed” basis only as determined by yearly test results. Refer to 2.28.10. “Coolant Testing” on page 96 in this section for testing procedure.

The cooling system must be cleaned and flushed if contaminants such as silicate gel, oil, grease, fuel, scale, rust, or solder bloom are found in the system. Refer to Cummins Operation and Maintenance Manual and Cummins Coolant Requirements and Maintenance Bulletin 3666132-07 for detailed cleaning and flushing procedures. coolant. Refer to 2.36. “Fluid & Lubrication Guide” on page 109 in this section for recommended coolant.

2.29.2. Alterator Overhaul

☞NOTE:

The interval at which this preventive maintenance should be performed may be modified, depending on operating conditions and previous maintenance history

Replace both front and rear alternator bearings as a set and replace spiral ring seals at the following applicable interval:

- ❒ Transit vehicles operating 16 to 18 hours per day, 6 days per week, should have bearings and spiral ring seals replaced at 2 1/2 year intervals.
- ❒ Transit vehicles operating 20 to 22 hours per day, 7 days per week, should have bearings and spiral ring seals replaced at 2 year intervals.
- ❒ Operating environments with prolonged high engine compartment temperatures will reduce bearing life. Therefore, if the vehicle is operated under such climate conditions, the preceding maintenance intervals should be reduced to 24 and 20 months respectively.

2.29.3. Door System Inspection

Perform the following inspection/maintenance on the major door system components every two years or 250,000 door operating cycles, whichever occurs first:

2.29.3.1. Connecting Rods & Rod End Bearings

- ❒ Visually inspect the fore and aft connecting rods on the baseplate for evidence of bending or distortion. Replace damaged connecting rods.
- ❒ Check jam nuts on the rod ends for tightness.
- ❒ Check for excessive play in the rod ends. Replace worn rod ends.
- ❒ Lubricate rod ends with a few drops of SAE #20 oil. See “Fig. PM-44: Entrance Door Baseplate Lubrication” on page 100. See “Fig. PM-45: Exit Door Baseplate Lubrication” on page 101.

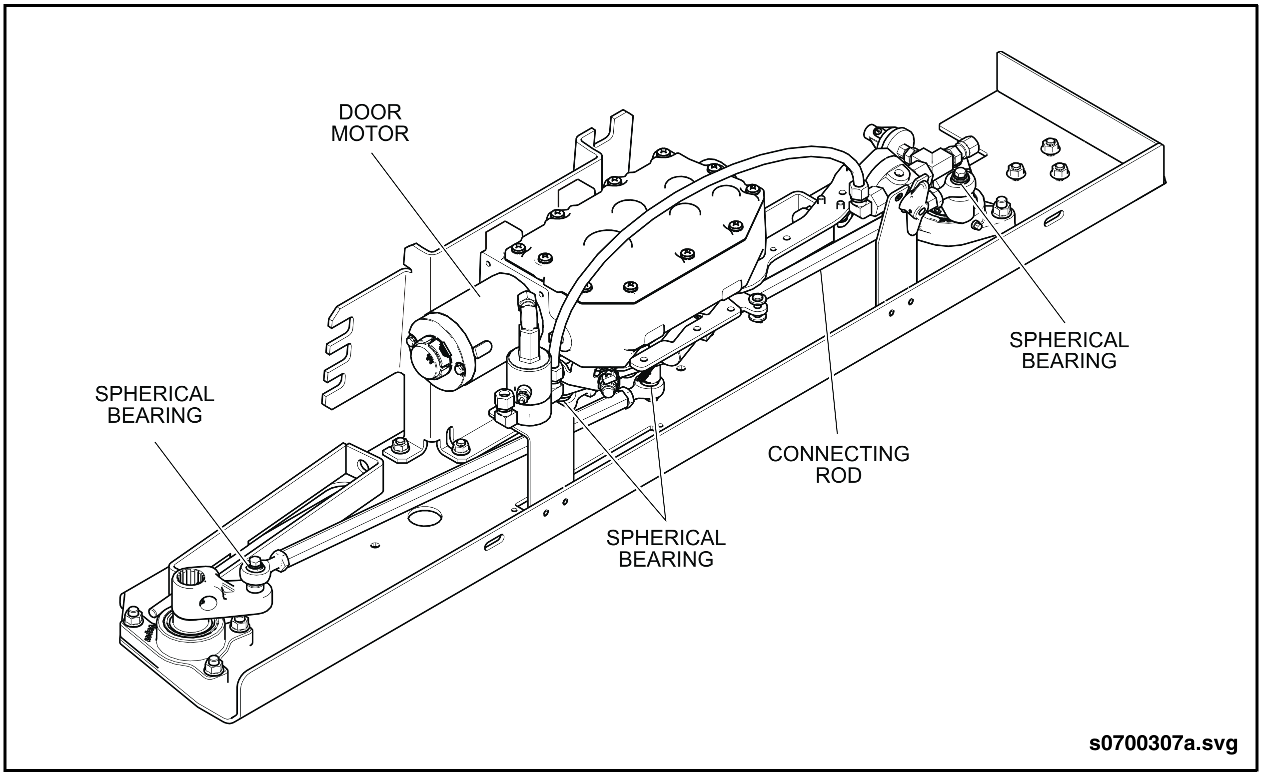


Fig. PM-44: Entrance Door Baseplate Lubrication

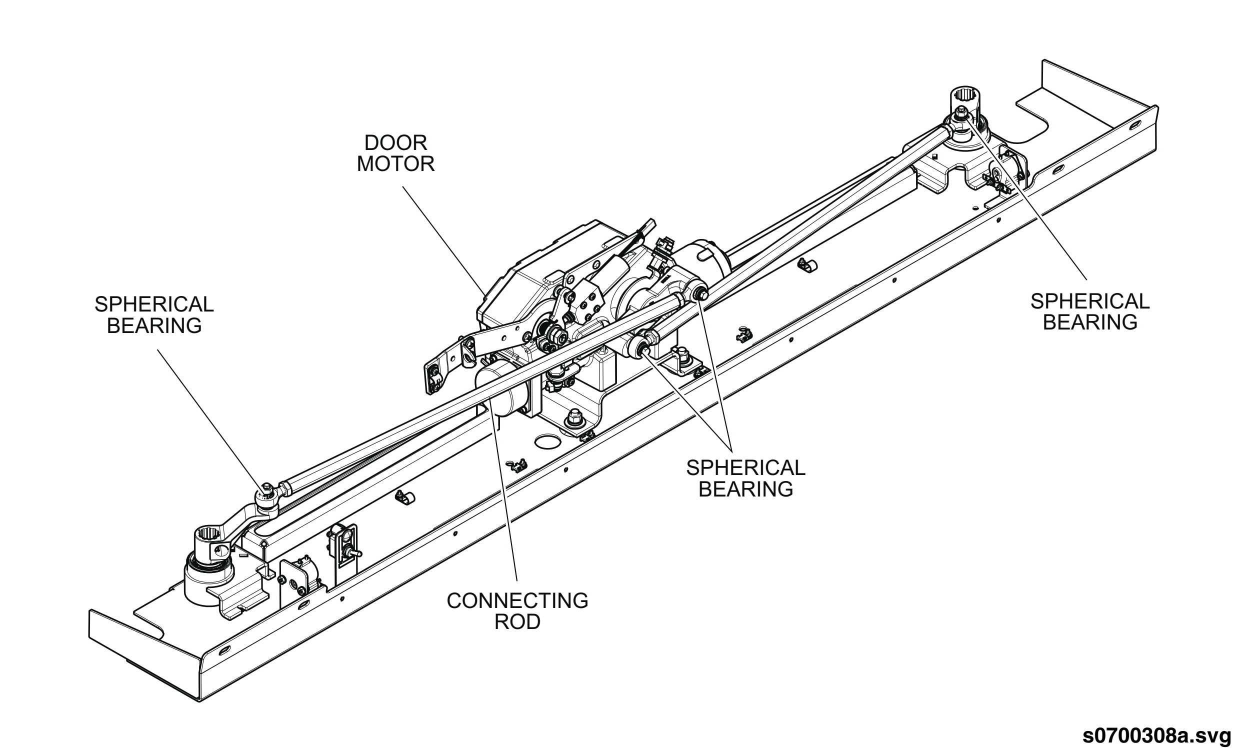


Fig. PM-45: Exit Door Baseplate Lubrication

2.29.3.2. Door Shaft Levers & Mounting Hardware

- ❒ Visually inspect the levers on the upper door shaft for worn splines, cracks or other damage. Replace damaged parts.
- ❒ Check lever clamp bolt (wedge & screw) for tightness.

2.29.3.3. Upper Door Shaft Pivot Bearings

The upper door shaft pivot bearings locate directly on the door baseplate. Check for smooth rotation of door shafts without binding, noise, or excessive radial or axial play. Replace worn or damaged bearings. These are sealed ball bearing assemblies and do not require lubrication.

2.29.3.4. Lower Door Shaft Pivot Bearing

The lower door shaft pivot bearing assemblies are bolted to the vehicle floor and support the door shaft. A spherical bearing rides inside a plain bushing within the lower end of the door shaft. Check for excessive radial play between pivot bearing and the door shaft bushing. Replace pivot bearing and/or bushing if wear exceeds 0.060". DO NOT lubricate pivot bearing.

2.29.3.5. Upper Roller Guide, Brackets, & Bearings

The upper roller bracket assembly is bolted to the door panel and consists of a roller mounted on the shaft of the bracket. The roller tracks within the roller channel (slotted guide) of the baseplate.

- ❒ Manually open the door panel, ensuring that the roller operates smoothly within the roller channel of the baseplate.
- ❒ Inspect the roller for wear or flat spots. DO NOT lubricate the outer surface of the roller.
- ❒ Inspect the bearing shaft on the bracket for wear or scoring. Lubricate the bearing shaft with SAE #20 oil, but DO NOT lubricate the outer surface of the roller.
- ❒ Clean the roller channel in the baseplate but DO NOT lubricate channel.

2.29.3.6.Entrance Door Shaft & Arm Assembly

The upper end of the door shaft consists of a splined shaft with a connecting arm and rod end. The lower end of the door shaft consists of a hollow shaft with a connecting arm and hinged mounting bracket. See "Fig. PM-46: Entrance Door Shaft & Arm Assembly" on page 102.

- ❒ Check door shaft and arm assemblies for any evidence of bending, twisting, or other physical damage. Repair or replace damaged door shaft and arm assemblies as required.
- ❒ Inspect splines on upper end of door shaft for wear, cracks, or other damage. Replace damaged door shaft.
- ❒ Clean the rod end and mounting bracket areas on the upper and lower ends of the door shaft using a clean dry cloth. DO NOT lubricate the sealed spherical bearings on rod ends.
- ❒ Inspect upper and lower mounting brackets for any damage and ensure that they are securely mounted to the door panel.
- ❒ Inspect rod end and shoulder bolt for wear or damage. Replace rod end and/or shoulder bolt if worn or damaged.

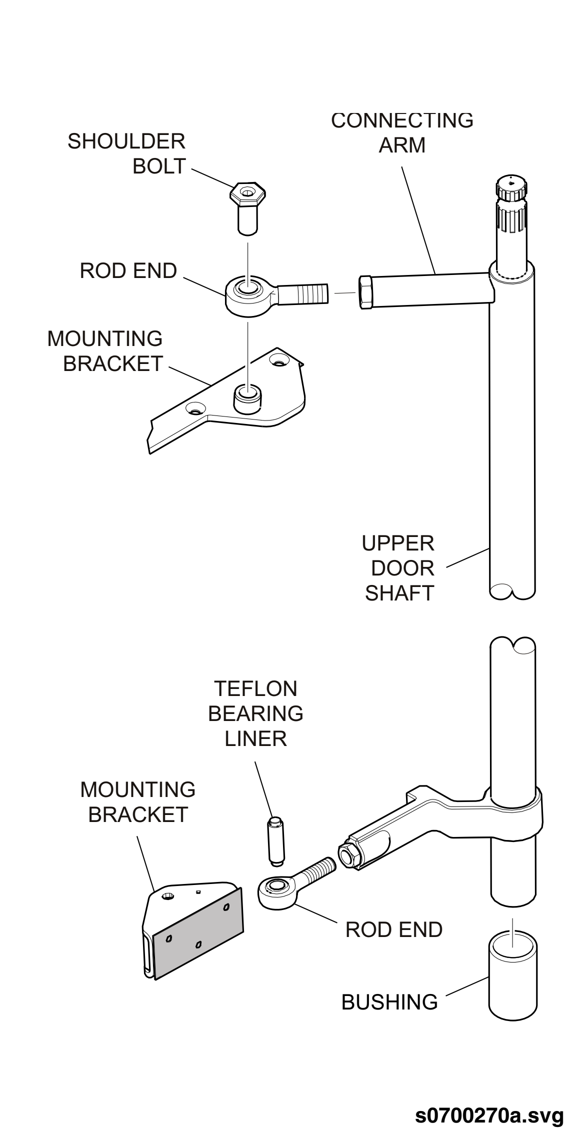


Fig. PM-46: Entrance Door Shaft & Arm Assembly

2.29.3.7. Exit Door Shaft & Arm Assembly

- ❒ The upper and lower hinged mounting brackets attach the door shaft and arm assembly to the exterior side of the door panel. A lubrication fitting is provided on the hinged mounting bracket to allow lubrication of the flanged bronze bushing from the exterior of the vehicle. See "Fig. PM-47: Exit Door Shaft" on page 103. Check door shaft and arm assemblies for any evidence of bending, twisting, or other physical damage. Repair or replace damaged door shaft and arm assemblies as required.
- ❒ Inspect splines on upper end of door shaft for wear, cracks, or other damage. Replace damaged door shaft.
- ❒ Inspect hinged mounting bracket for excessive play.
- ❒ Inspect flanged bronze bushing and pin for wear or scoring. Replace flanged bushing and pivot pin if worn or damaged.
- ❒ Lubricate hinged mounting bracket at grease fitting, using a high pressure, low temperature (-40° F) grease.

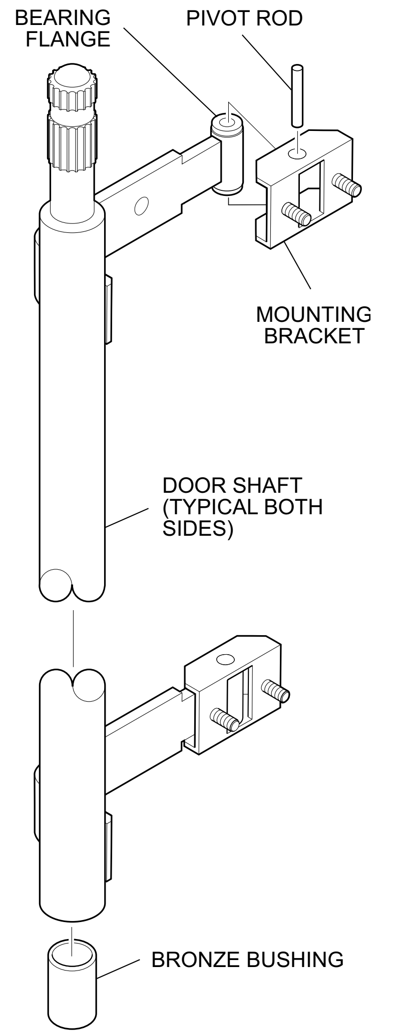


Fig. PM-47: Exit Door Shaft

2.29.3.8. Door Panels

- ❒ Inspect door panels for structural damage. Repair or replace panel if required.
- ❒ Inspect exterior door panel pocket seals for cuts, tears, excessive wear, or other damage. Replace pocket seals if required.
- ❒ Inspect leading edge and door jamb seals for cuts, tears, excessive wear, or other damage. Replace if required.
- ❒ Apply a light film of silicone lubricant on the mating surfaces of the leading edge and door jamb seals and wipe clean with a dry cloth.

2.29.3.9. Door Panel Top & Bottom Seal Assemblies

- ❒ Inspect for damage to brush bristles or rubber seal strip. Replace brush if bristles are damaged.
- ❒ Adjust height of top brush to provide light contact only with the top edge of door panels so as to prevent binding.
- ❒ Adjust height of bottom brush to provide light contact only with the top surface of the flooring so as to prevent binding.

2.29.3.10. Door Operator Proximity Switches

- ❒ Check that the proximity switches function properly.
- ❒ Inspect electrical connections. Repair loose connections.
- ❒ Adjust proximity switch air gap if necessary. Refer to Section 16 of this manual for adjustment procedures.

2.29.3.11. Entrance Door Solenoid Valves

- ❒ Check for proper operation of the emergency release and dump valve solenoids.
- ❒ Inspect electrical connections.
- ❒ Inspect air lines to rotary dump valve and emergency release acutator cylinder. Ensure connections are tight.
- ❒ Inspect emergency release cable for proper operation.

2.29.3.12. Driver's Door Controller

- ❒ Operate the door controller through all positions and check for proper function.
- ❒ Verify that the door controller moves freely without binding. Use a spring scale to measure torque required to rotate controller. Replace door controller if torque exceeds 15 in-lbs.

2.30. Three Year Preventive Maintenance

2.30.1. Under Body Inspection

Refer to Section 11 of this manual for procedure.

2.30.2. Fire Suppression System

Replace the backup battery, located in the driver's area, every three years.

2.30.3. Air Dryer

☞**NOTE:**

The desiccant canister replacement interval is dependent on operating conditions and may need to be adjusted to suit the operating environment. High compressor duty cycles, excessive compressor oil bypass, and high temperatures can shorten the life of the desiccant cartridge.

- ❒ Replace the air dryer desiccant canisters. Refer to Section 8 of this manual for replacement procedure. Refer to your New Flyer Parts Manual for "Desiccant Canisters Replacement Kit".
- ❒ Inspect air hoses for any evidence of damage and ensure connections are properly tightened.

2.31. Five Year Preventive Maintenance

2.31.1. Door Operator Proximity Switches

- ❒ Check that the switches function properly.
- ❒ Check for proper air gap setting between sensor and target. Refer to Section 16 of this manual for adjustment procedures.

2.31.2. Door Component Replacement

It is recommended that the following door components or assemblies be replaced every five years or 500,000 door operating cycles. The replacement interval may need to be adjusted depending on the actual operating conditions. Operating in a harsh environment where the door components are exposed to extremes in temperature, salt spray, sand, grit, or other contaminants will shorten the life expectancy of the door system components.

- ❒ Connecting rods and rod end bearings
- ❒ Upper door shaft pivot bearings
- ❒ Door panel top seal assembly
- ❒ Door panel bottom seal assembly
- ❒ Door panel pocket seals
- ❒ Solenoid valves
- ❒ Sensitive edge system including door edge, transfer tube, pressure wave switch, and mechanical limit switches.

2.31.3. Air Dryer

Perform the following inspections, tests, and component replacements every five years:

2.31.3.1. Inspection & Test

☞**NOTE:**

Refer to Section 8 of this manual for functional test procedures.

- ❒ Electronic control module
- ❒ Heater assembly
- ❒ Thermostat assembly
- ❒ Electrical harness

2.31.3.2. Component Replacement

☞**NOTE:**

Refer to Section 8 of this manual for replacement procedures.

- ❒ Diverter valve
- ❒ Exhaust valve
- ❒ Unloader/turbo valve
- ❒ All check valves

2.32. Six Year Preventive Maintenance

2.32.1. Fire Suppression System

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, "Installation, Operation and Maintenance Manual, Vehicle Fire Extinguisher Assembly, 25 lb.".

2.32.2. Fire Extinguisher

Inspect the fire extinguisher every six years. Clean all parts to ensure they are operable and refill with new powder and repressurize. Refer to National Fire Protection Association (NFPA) Standard No.10 for additional information.

2.32.3. Booster Pump

Replace the pump motor bearings every six years. Refer to Section 10 of this manual for procedure.

2.32.4. Cooling System

☞**NOTE:**

This vehicle was filled at the factory with "Final Charge Global Coolant/Antifreeze". This is an extended life Organic Acid Technology (OAT) coolant. DO NOT use Supplemental Coolant Additives (SCA) or filter elements containing SCA's.

The coolant change interval is dependent on the use of an Extended Life Coolant (ELC) and the condition of the coolant as determined by yearly testing. Refer to 2.28.10. "Coolant Testing" on page 96 in this section for testing procedure. The coolant change interval may continue to be extended if test results are satisfactory.

If the cooling system is not being tested on a yearly basis, then it is recommended that the cooling system be drained, flushed, and refilled at least every six years.

2.33. Ten Year Preventive Maintenance

2.33.1. Door Component Replacement

It is recommended that the following door components or assemblies be replaced every ten years or 1,000,000 door operating cycles. The replacement interval may need to be adjusted depending on the actual operating conditions. Operating in a harsh environment where the door components are exposed to extremes in temperature, salt spray, sand, grit, or other contaminants will shorten the life expectancy of the door system components.

- ❒ Electric door operator
- ❒ Door shaft levers and mounting hardware
- ❒ Lower door shaft pivot bearings
- ❒ Upper roller guides, brackets, & bearings
- ❒ Door panel leading edge seals
- ❒ Door panel jamb seals
- ❒ Driver's door controller
- ❒ Door panels
- ❒ Shaft and arm assemblies
- ❒ Shaft and arm assembly hinged mounting brackets.

2.34. Twelve Year Preventive Maintenance

2.34.1. Fire Extinguisher

Hydrostatically test the fire extinguisher every twelve years. Refer to label on fire extinguisher for test pressure. Clean all parts to ensure they are operable and refill with new powder and repressurize. Record maintenance and recharge date on fire extinguisher inspection tag. Refer to National Fire Protection Association (NFPA) Standard No.10 for additional information.

2.34.2. Fire Suppression System

Have the fire extinguisher cylinder hydrostatically tested by a qualified fire protection equipment company familiar with Kidde Dual Spectrum equipment and in accordance with KDS document 160296, “Installation, Operation and Maintenance Manual, KDS-25, Vehicle Fire Extinguisher Assembly, 25 lb.”.

2.35. Fluid & Lubrication Points

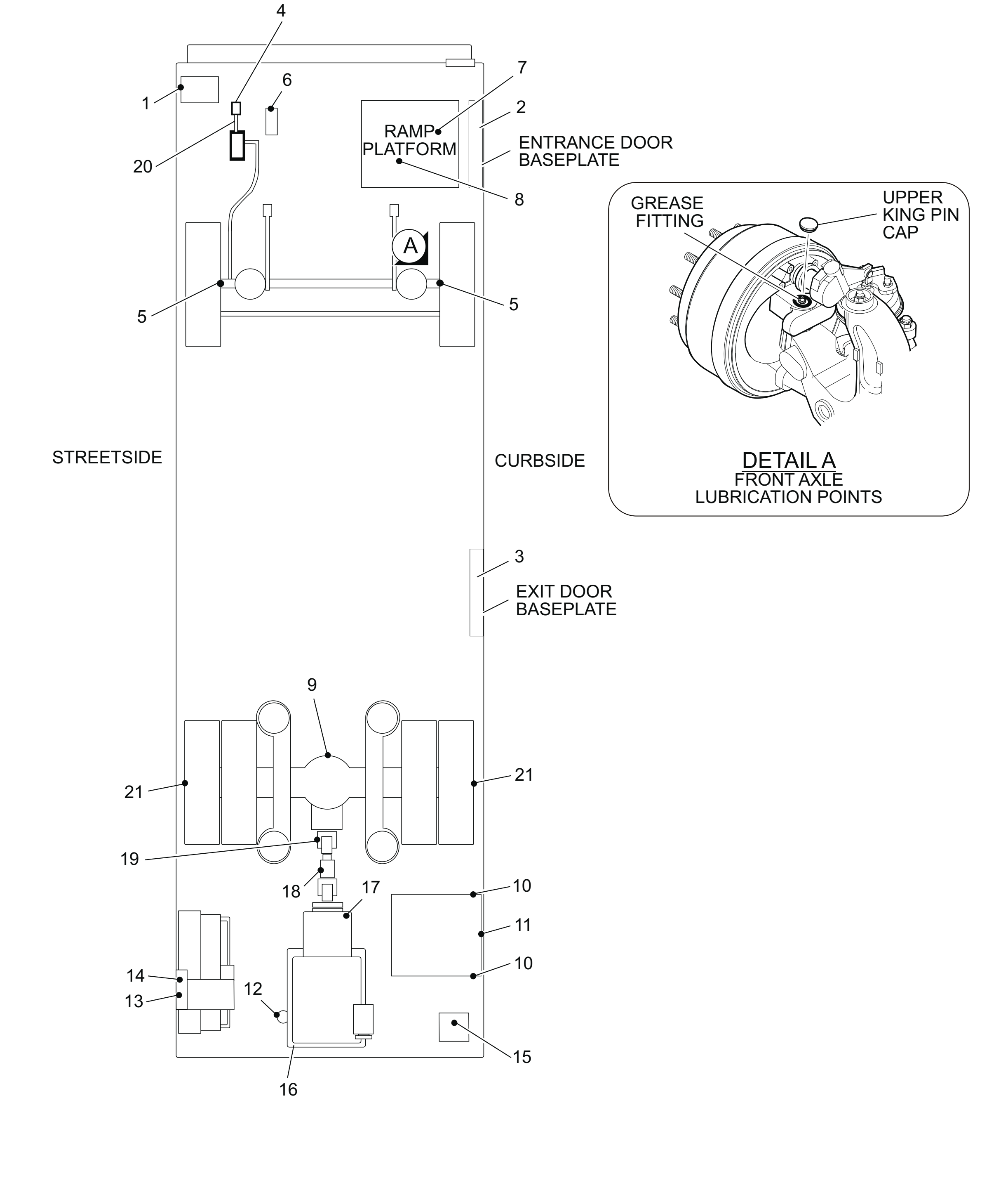


Fig. PM-48: Fluid & Lubrication Points-1

2.36. Fluid & Lubrication Guide

The following Guide is a convenient reference for the lubrication points on your New Flyer vehicle. It provides component locations, lubrication procedures and intervals, and lubricant types. Further preventive maintenance information on each component in this Guide can be found in this section of the manual under the component's specific maintenance interval. See "Fig. PM-48: Fluid & Lubrication Points-1" on page 108.

FLUID & LUBRICATION GUIDE				
Item	**Component**	**Procedure**	**Interval**	**Lube Type**
1	Windshield Washer Bottle		Fill bottle as required	Methylene Alcohol Windshield Washer Fluid
2	Entrance Door Baseplate	Lubricate connecting rod spherical bearings (4 bearings)	Every two years	SAE 20
		Lubricate upper bracket bearing shaft	Every two years	SAE 20
3	Exit Door Baseplate	Lubricate connecting rod spherical bearings (4 bearings)	Every two years	SAE 20
		Lubricate upper bracket bearing shaft	Every two years	SAE 20
		Lubricate door shaft hinged mounting bracket at grease fitting	Every two years	High pressure, low temperature (-40°F) grease
4	Power Steering Miter Box	Refer to 2.27.19. "Power Steering Miter Box" on page 92 in this section for procedure	Every six months	Calcium sulfonate complex grease such as Petro Canada Peerless LLC or equivalent
5	Steering Knuckle Bearings	Refer to 2.27.13. "Steering Knuckle Lubrication" on page 88 in this section for procedure	Every 6 months or 30,000 miles (48,000 km)	Special-Purpose Grease. Refer to 2.36.2. "MAN Axle Approved Greases" on page 115 in this section for listing
6	Brake Treadle & Foot Valve Assembly	Lubricate brake valve plunger, roller & pin	Every 24,000 miles (38,600 km)	Barium Grease per BW-204-M (Bendix #246671) Do not substitute

FLUID & LUBRICATION GUIDE				
Item	**Component**	**Procedure**	**Interval**	**Lube Type**
7	Wheelchair Ramp Mechanism	Lubricate chains, teflon bearings, bronze bushings, and all sliding surfaces	Every six months	White Lithium Grease (Aerosol Spray)
8	Wheelchair Ramp Reservoir	Check fluid	Every 6,000 miles (9,600 km)	DEXRON® - III
		Change fluid	Yearly	DEXRON® - III
9	Rear Axle Carrier	Check for leaks under vehicle	Daily	Mineral-Based Extreme Pressure Gear Oil. Refer to 2.36.1. “MAN Axle Approved Mineral Oils” on page 114 in this section for listing
		Check oil level at carrier fill plug	Check at first 3,000 miles (4,800 km), thereafter every 6,000 miles (9,600 km)	
		Change Oil	Drain & change upon receipt of vehicle, and thereafter change every 36,000 miles (58,000 km) for "hot region" operation. Refer to 2.2. “Rear Axle Operating Conditions” on page 6 in this section for definition. Change every 54,000 miles (87,000 km) for "moderate region" operation. Refer to 2.2. “Rear Axle Operating Conditions” on page 6 in this section for definition.	
10	Battery Slides	Check & keep clean	Every 6,000 miles (9,600 km)	Multi-Purpose Grease
11	Battery Terminals	Check & apply lubricant as required	Every 6,000 miles (9,600 km)	Dielectric Grease such as TruckLite NYK-77

FLUID & LUBRICATION GUIDE				
Item	**Component**	**Procedure**	**Interval**	**Lube Type**
12	Engine Oil Filter	Replace (full-flow, spin-on)	Every 6,000 miles (9,600 km)	Chevron RPM® gas engine oil, 15W-40 or equivalent, meeting Cummins Engineering Specification (CES) 20074 ☞**NOTE:** *The oil packaging must be labeled that it meets the CES 20074 requirement.*
13	Surge Tank	Check sight glass	Daily	Final Charge 50/50® Extended Life Antifreeze
		Drain & fill cooling system. Flush only if required	Test coolant every year. Change interval can be extended dependent on yearly test results.	Final Charge 50/50® Extended Life Antifreeze
14	Heating System Reservoir	Check sight glass	Daily	Final Charge 50/50® Extended Life Antifreeze
		Drain & fill heating system. Flush only if required	Test coolant every year. Change interval can be extended dependent on yearly test results.	Final Charge 50/50® Extended Life Antifreeze
15	Power Steering Reservoir	Check fluid level through sight glass	Daily	TranSynd™ Synthetic Transmission Fluid
		Change filter	Every 18,000 miles (29,000 km)	TranSynd™ Synthetic Transmission Fluid
		Change fluid	Every 36,000 miles (58,000 km)	TranSynd™ Synthetic Transmission Fluid

FLUID & LUBRICATION GUIDE				
Item	**Component**	**Procedure**	**Interval**	**Lube Type**
16	Engine	Check dipstick level	Daily	Chevron RPM® gas engine oil, 15W-40 or equivalent, meeting Cummins Engineering Specification (CES) 20074 ☞**NOTE:** *The oil packaging must be labeled that it meets the CES 20074 requirement.*
		Drain & refill	Every 6,000 miles (9,600 km)	Chevron RPM® gas engine oil, 15W-40 or equivalent, meeting Cummins Engineering Specification (CES) 20074 ☞**NOTE:** *The oil packaging must be labeled that it meets the CES 20074 requirement.*
17	Transmission	Check dipstick level	Daily	TranSynd™ Synthetic Transmission Fluid
		Drain & refill	Change both filters every 75,000 miles (120,000 km), 3,000 hrs., or 36 months & top up fluid. Change the fluid every 150,000 miles (240,000 km), 6,000 hrs., or 48 months. Refer to 2.25.1. "Transmission Fluid" on page 83 in this section for procedure.	
18	Driveshaft Slip Joint	Refer to 2.11.8. "Driveshaft" on page 38 in this section for procedure	Upon receipt of vehicle, and thereafter every 6,000 miles (9,600 km)	Extreme Pressure Grease meeting NLGI Grade 2 specification with operating temperature range of 325°F to -10°F (163°C to -23°C). Use CITGO Lithoplex RT-2 or equivalent
19	Driveshaft U-Joints	Refer to 2.11.8. "Driveshaft" on page 38 in this section for procedure	Upon receipt of vehicle, and thereafter every 6,000 miles (9,600 km)	Extreme Pressure Grease meeting NLGI Grade 2 specification with operating temperature range of 325°F to -10°F (163°C to -23°C). Use CITGO Lithoplex RT-2 or equivalent

FLUID & LUBRICATION GUIDE				
Item	**Component**	**Procedure**	**Interval**	**Lube Type**
20	Steering Driveshafts	Purge lubricate at grease fittings. Refer to 2.11.10. “Steering Driveshafts” on page 42 in this section for procedure	Every 6,000 miles (9,600 km)	Extreme Pressure Grease meeting NLGI Grade 2 specification with operating temperature range of 325°F to -10°F (163°C to -23°C). Use CITGO Lithoplex RT-2 or equivalent
21	Rear Axle Wheel Bearing	Refer to Section 2 of this manual for lubrication procedure	Whenever rear axle bearing or seals are being serviced	Special-Purpose Grease. Refer to 2.36.2. “MAN Axle Approved Greases” on page 115 in this section for listing

☞**NOTE:**

Moderate regions are defined as geographic locations where the average monthly temperature does not exceed 25°C (77°F) for more than two months of the year.

Hot regions are defined as geographic locations where the average monthly temperature exceeds 25°C (77°F) for more than two months of the year.

2.36.1. MAN Axle Approved Mineral Oils

Lubricants used in the rear axle must meet MAN specifications. Oil composition and additives are critical to maintaining the designed operating life of the axle components. The use of unapproved oils has been shown to accelerate the wear rate of internal components and shorten the overall lifespan of the axle. The use of unapproved oils will void the warranty coverage on the axle.

MAN approved lubricants are listed on their website under MAN Approved Service Products. This list is subject to change as new products are approved and added to the list. Always consult the MAN website for the latest listing of approved lubricants.

Customers who wish to use a product, not identified within the following list of approved lubricants should contact their lubricant manufacturer and request that they submit a sample of their product and a copy of a MAN TUC 13.024 Application Form to MAN for testing and approval. This process normally takes 3 to 6 months. Contact your MAN dealer for a copy of the application.

The following table provides a list of approved oils that are available in North America.

MAN AXLE APPROVED MINERAL OILS	
Product Brand Name (Viscosity)	**MAN Specification**
Mobilube HD-A (SAE 85W-90)	MAN 342 M1
Castrol Axle EPX 90 (SAE 90W)	MAN 342 M1
Castrol Axle EPX (SAE 85W-140)	MAN 342 M1
Shell Spirax MB (SAE 90W)	MAN 342 M1
Shell Spirax S3 AX (SAE 85W-140)	MAN 342 M1
Petro Canada TRAXON (SAE 80W-90	MAN 342 M1
Conoco Universal Gear Lubricant (SAE 85W-140)	MAN 342 M1
Conoco Universal Gear Lubricant (SAE 80W-90)	MAN 342 M2
Phillips 66 SMP Gear Oil (SAE 85W-140)	MAN 342 M1
Phillips 66 SMP Gear Oil (SAE 80W-90)	MAN 342 M2
Kendall NS-MP Hypoid Gear Lubricant (SAE 80W-90)	MAN 342 M2
Kendall NS-MP Hypoid Gear Lubricant (SAE 85W-140)	MAN 342 M1

2.36.2. MAN Axle Approved Greases

The lubricants used on MAN axles are special-purpose greases that meet the requirements of the specific application and must not be substituted with alternate grease products.

MAN approved lubricants are listed on their website under MAN Approved Service Products. This list is subject to change as new products are approved and added to the list. Always consult the MAN website for the latest listing of approved lubricants.

Customers who wish to use a product, not identified within the following list of approved lubricants should contact their lubricant manufacturer and request that they submit a sample of their product and a copy of a MAN TUC 13.024 Application Form to MAN for testing and approval. This process normally takes 3 to 6 months. Contact your MAN dealer for a copy of the application.

The following table provides a list of approved greases that are available in North America.

MAN AXLE APPROVED GREASES

Application	Product Brand Name	MAN Specification
Front Axle Steering Knuckle	Fuchs Renolit LX-OTP 2	
Rear Axle Wheel Bearing	Fuchs Renolit LX-PEP 2	MAN 284 Li-H2
	Fuchs Renolit LX-NHU 2	MAN 284 Li-H2

Front Axle & Suspension

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❐ open flame
- ❐ excessive heat
- ❐ production of sparks
- ❐ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Hoisting/Lifting & Jacking Safety

Refer to the General Information Section of this manual for recommended types of hoists, lifting equipment, and jackstands.

DANGER

Certain procedures may require the vehicle be operated in an elevated position in order to accurately troubleshoot and diagnose a problem. If the vehicle must be running while elevated, become familiar with the repair area prior to starting the engine. Take special care in noting areas which will become hot, electrically energized, and areas where moving and rotating components are located. Limit the work in these areas as personal and equipment safety is at risk.

WARNING

ALWAYS ensure that the vehicle is appropriately hoisted and blocked for procedures which require elevating the vehicle. Be aware of the limitations of the blocking equipment, and always ensure that the jarring and shaking created by component removal and installation procedures does not overload the blocks, or cause the vehicle to become unstable.

1.4. Air System Safety

WARNING

ALWAYS drain the air pressure from ALL reservoirs before beginning work on any air system component.

WARNING

Ensure air lines are safely depressurized prior to disconnecting. Wear safety glasses as disconnecting pressurized lines will cause solid particles deposited in the line to be uncontrollably propelled, and will also cause the hose end to whip randomly as the air escapes.

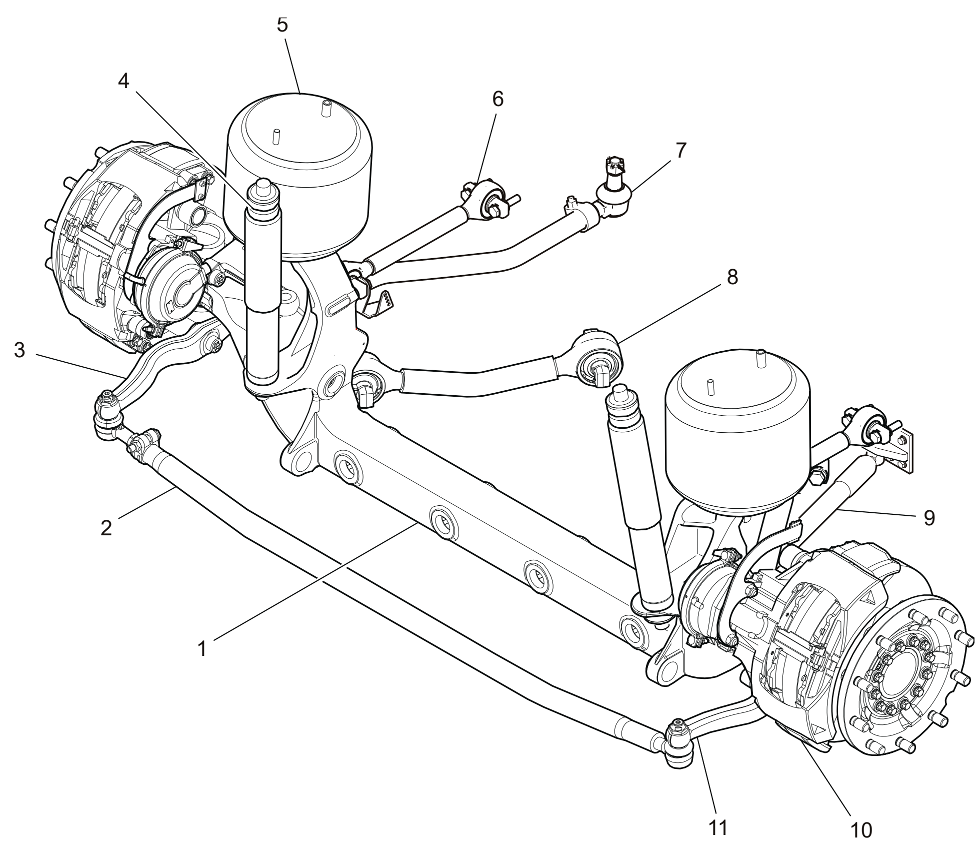
2. FRONT AXLE & SUSPENSION

2.1. Description

This front axle and suspension include the following sub-components and systems:

- Axle Assembly
- Suspension Components
- Brake System
- ABS System

The axle assembly is held in alignment to the vehicle by two upper and lower radius rods. Air spring towers bolted to mounting pads on each side of the axle transmit the weight of the vehicle to the axle. The wheel end assemblies are mounted on steering knuckles fitted with an upper double row needle bearing and a lower double row needle thrust bearing which pivot on king pins to allow vehicle steering. A steering arm attached to the left knuckle receives inputs from the steering system. An adjustable cross tube transmits steering effort to the right-hand knuckle and maintains wheel alignment. A steering damper assembly is used to absorb road shocks and stabilize the steering system. Adjustable stop bolts installed on each knuckle assembly limit right and left turning angles. See “Fig. 1-1: Front Axle & Suspension” on page 2.



1. Axle Beam
2. Center Link Assembly
3. LH Tie Rod Arm
4. Shock Absorber
5. Air Spring
6. Upper Radius Rod
7. Drag Link
8. Lower Radius Rod
9. Steering Damper
10. Disc Brake Assembly
11. RH Tie Rod Arm

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Fig. 1-1: Front Axle & Suspension

2.2. Operation

As the vehicle travels, the axle moves vertically relative to the vehicle chassis. The air springs compress and extend as the wheels go over bumps and dips allowing this movement. The rate of movement is controlled by the shock absorbers. The radius rods maintain alignment of the assembly to the vehicle chassis. A leveling valve connected by an operating link to the axle controls the air pressure in both air springs to maintain ride height and prevent tilting of the vehicle when loading is uneven.

2.3. Removal

1. Drain system air pressure.
2. Raise vehicle using wheel lift or center post lift system. Refer to the General Information Section of this manual for procedure.
3. Place safety stands under vehicle frame and carefully lower vehicle onto stands.
4. Lower lift system slightly more to allow axle assembly to drop about 3" (76 mm).
5. Disconnect drag link from steering arm using hydraulic ball joint press (Items 43, 64, 65, & 66 from special tool list). Turn steering wheel fully to the left to move drag link out of the way.
6. Disconnect leveling valve linkage from the streetside mounting bracket (do not disturb adjustment) and pull down on leveling valve lever to deflate air springs.
7. Disconnect air lines at brake chambers.
8. Disconnect ABS brake sensor harnesses.
9. Remove two M18 bolts from each pivot pin retaining lower radius rods to vehicle frame. See “Fig. 1-2: Lower Radius Rod Removal” on page 4.
10. Remove two M14 bolts from each pivot pin retaining upper radius rods to vehicle frame.
11. Ensure axle is well supported, remove 1/2" nut from left and right axle air spring lower mounting pads.
12. Disconnect lower end of shock absorbers from mounting pad on axle.

☞**NOTE:**

Make sure all Items disconnected from the axle are moved or tied out of the way to prevent interference with axle removal.

⚠ WARNING

Make sure axle assembly is strapped or chained to lifting device to prevent tilting or falling when freed from the frame mounting points.

13. Carefully lower axle and wheel assembly to floor with lift system. Use appropriate lifting equipment to lift the axle onto an adequate work stand. See “Fig. 1-3: Axle Lowered from Vehicle” on page 4.

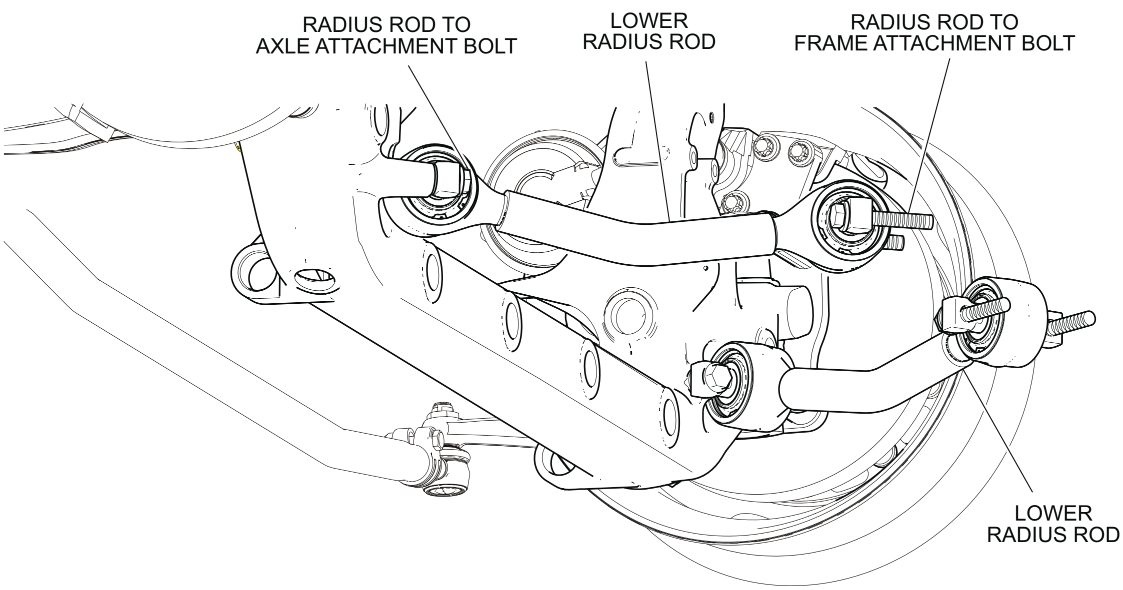
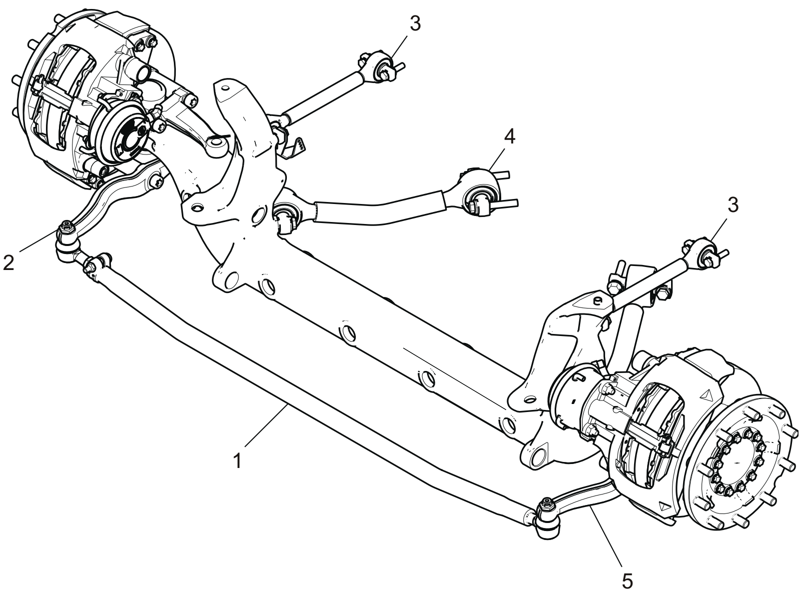


Fig. 1-2: Lower Radius Rod Removal



1. Center Link
2. Tie Rod Arm
3. Upper Radius Rod
4. Lower Radius Rod
5. Tie Rod Arm

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Fig. 1-3: Axle Lowered from Vehicle

2.4. Installation

☞**NOTE:**

Refer to 4.5. "Front Suspension Torque Specifications" on page 43 in this section for all installation torque values.

1. Carefully lift axle into position using appropriate lifting equipment.
2. Install upper radius rod retaining bolts and torque to specification.
3. Connect lower end of shock absorbers to axle and torque mounting hardware to specification.
4. Install 1/2" nut retaining air spring to mounting pad and torque to specification.
5. Install lower radius rods and torque bolt to specification.
6. Connect ABS sensor wiring.
7. Connect air lines to brake chambers.
8. Connect leveling valve linkage.
9. Connect drag link to steering arm. Torque nut to specification and install cotter pin.
10. Lower vehicle and test drive to ensure correct operation.

3. FRONT AXLE

3.1. Description

The front axle and suspension installation consists of a MAN VOK-07-F low floor axle complete with wheel hub assembly, brake caliper & brake disc assembly, center link assembly, tie rod arms and a steering arm. The axle assembly also includes ABS sensor and pulse generating wheel. The brake chambers are mounted directly on the disc brake caliper assembly.

3.2. Front Axle Specifications

Manufacturer .... MAN

Model VOK-07-F

Capacity .... 15,873 lb. (7,200 kg)

Type .... Cast drop beam design

3.3. Maintenance

CAUTION

The repair or reconditioning of front axle components is not allowed. The manufacturer recommends replacing damaged out of specification components. All major components are heat treated and tempered. The components cannot be bent, welded, heated or repaired in any way without reducing the strength or life of the component which can result in a vehicle accident and personal injury. Repair or reconditioning of front axle components will void the warranty.

The following operations on front axle components are prohibited:

- ❒ Welding of or to the steering arms, tie rod arms, knuckles, king pins, axle beams, tie rod assemblies, hubs, brake discs or brakes.
- ❒ Hot or cold bending of the knuckles, steering arms, tie rod arms, ball studs, axle beams or tie rod assemblies.
- ❒ Drilling out of the king pin bores in the axle beam.

Refer to the Preventive Maintenance Section of this manual for front axle maintenance procedures and intervals.

3.4. Tires

3.4.1. Tire Specifications

Manufacturer .... Goodyear

Model.. G652

Size 305/70R22.5

Inflation Pressure .... 125 psi

Maximum Load (single tire) .... 7,590 lbs. @ 125 psi

3.4.2. Maintenance & Replacement

CAUTION

ALWAYS use tire mounting equipment that is specifically designed for the application and will ensure proper tire mounting without incurring any damage. ALWAYS follow manufacturer's recommendations for use of tire mounting equipment.

☞**NOTE:**

In order to maintain compliance with Environmental Protection Agency and regulatory emission standards, ALWAYS replace tires with ones that meet or exceed the rolling resistance performance of the original tires.

☞**NOTE:**

Consult your tire supplier to ensure that the replacement tire meets the required rolling resistance requirements.

Refer to and follow original tire manufacturer's maintenance procedures in conjunction with the scheduled maintenance identified in the Preventive Maintenance Section of this manual.

3.5. Wheels

CAUTION

Special care must be taken when removing, servicing and installing the wheel and tire assembly to ensure operator, mechanic and passenger safety standards are maintained for the service life of the vehicle.

3.5.1. Inspection

There are several factors that determine the serviceability of the wheel. These include, but are not limited to corrosion, bent rim, excess paint build up and cracks. Inspect all parts for damage. Ensure that studs, nuts, mounting surfaces of the hub, drum, and wheels are clean, and free of grease or corrosion.

3.5.1.1. Wheel Assemblies

Ensure that the wheel mounting surfaces do not have excessive paint thickness, and repair if required. Excessive paint thickness, debris, or excessive corrosion on the wheel mounting surfaces will gradually work its way out during operation and the wheel will become loose. This could result in cracked or broken wheels, damaged brake disc, broken studs, and wheel separation from the vehicle.

Inspect all wheels for cracks, elongated bolt holes, correct shape and form, and other defects that would render the wheel unsafe. Wheels with cracks are not considered serviceable. There are no rework limits for cracks on wheels. Any wheel with a crack is considered scrap, and shall not be reworked.Scrap all wheels which show:

- ❒ Cracking
- ❒ Deep corrosion - defined by a corrosive pit being deeper than 1/2 of the material thickness.
- ❒ Pitting
- ❒ Excessive wear on the mounting surfaces
- ❒ Bent flanges
- ❒ Elongated bolt holes
- ❒ Extended use or excessive wear on the disc face
- ❒ Illegible stamping

Excessive bead blasting used to remove paint may have a negative effect on the wheel. Too much metal may be removed during repeated bead blasting. As this may lead to wheel cracking and early wheel failure the wheel must be scrapped. Never rework, weld, braze or otherwise heat any damaged wheel. Do not attempt to straighten bent or damaged flanges.

Wheels may be refinished and returned to service if no out of service conditions are present.

3.5.1.2. Studs

Studs with thread damage from over tightening, being run loose, excessive corrosion or other secondary damage should be removed from service. Refer to 3.6. “Wheel Bolts” on page 9 in this section for stud replacement procedure.

3.5.1.3. Nuts

Thread the nuts onto the studs by hand. Nuts must turn easily by hand. Two-piece flange-nuts may be damaged by extended use, excessive torque, or corrosion. Scrap any nut with cracks in the flange, damaged threads or any nut that does not swivel freely with moderate pressure applied to the flange while rotating the nut. Nuts which no longer rotate freely due to corrosion, wear, or paint build-up may be lubricated. Before reusing flange-nuts, apply (2) drops of 30 weight oil between the flange and the body of the hex nut. If a binding condition still exists it should be removed from service.

3.5.2. Installation

WARNING

This procedure assumes that the vehicle has already been safely jacked up and blocked.

1. Prior to wheel installation, inspect threads of wheel studs and stud nuts. Ensure stud mounting surfaces are clean. Inspect wheel rim center surface for damage.

CAUTION

Replace parts showing even minor damage.

2. Align rim stud holes with wheel studs. See “Fig. 1-4: Hub Piloted Wheels” on page 8.
3. Install wheel against wheel hub flange.
4. Tighten wheel nuts to 100 ft-lb. (136 Nm). Ensure wheel is flush around entire wheel flange mounting surface.
5. Lower vehicle to ground.
6. Using torque wrench, pretorque wheel nuts to 200 ft-lb. (272 Nm). See “Fig. 1-5: Wheel Nut Torquing Sequence” on page 8.
7. Using torque wrench, final torque wheel nuts in sequence to final specification.

NOTE:

Refer to 4.5. “Front Suspension Torque Specifications” on page 43 in this section for final installation torque value. Torque on dry, unlubricated thread only.

CAUTION

BE SURE wheel and tire assembly are at ambient temperatures before checking wheel nut torque.

8. Check torque on all wheel nuts after 50 to 100 miles of operation.

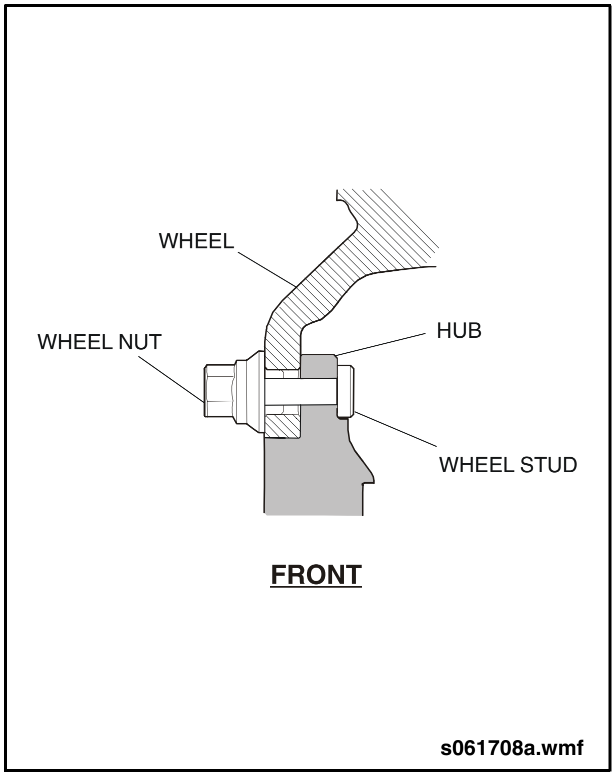


Fig. 1-4: Hub Piloted Wheels

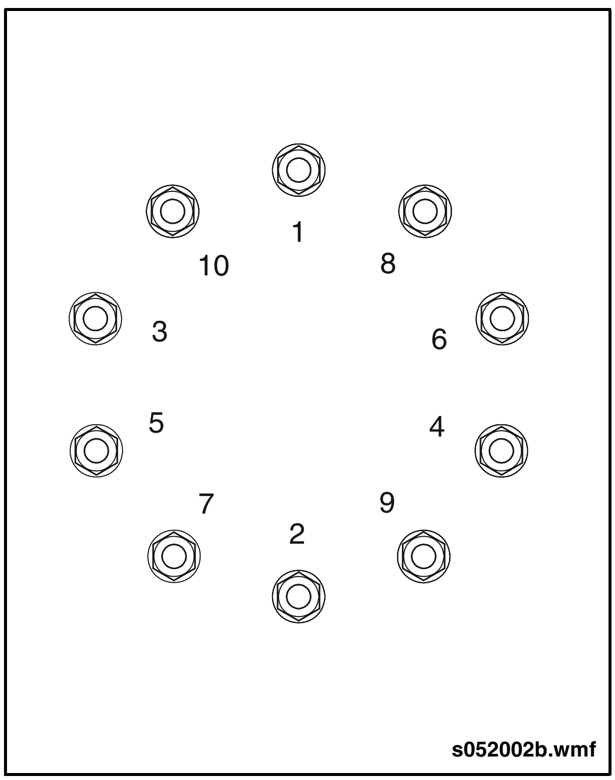


Fig. 1-5: Wheel Nut Torquing Sequence

3.6. Wheel Bolts

3.6.1. Removal

Use a hammer to remove the wheel bolt from the flange. See “Fig. 1-6: Wheel Bolt Removal” on page 9.

3.6.2. Installation

1. Insert a new wheel bolt with the truncated end facing the wheel hub. See “Fig. 1-7: Wheel Bolt Installation” on page 9.
2. Screw the wheel bolt adapter (Item 15 from special tools list) onto the wheel bolt.
3. Install the wheel bolt using the wheel bolt adapter (Item 15 from special tools list) and the impact tool (Item 16 from special tools list).

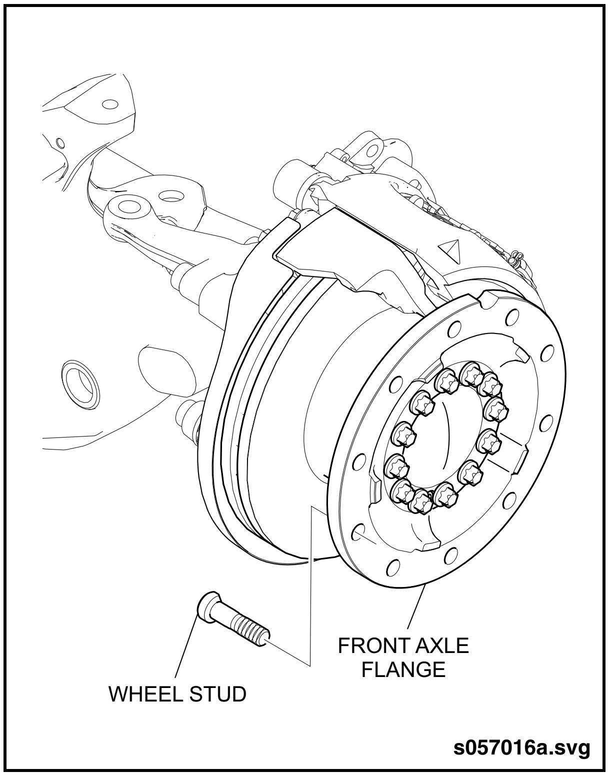


Fig. 1-6: Wheel Bolt Removal

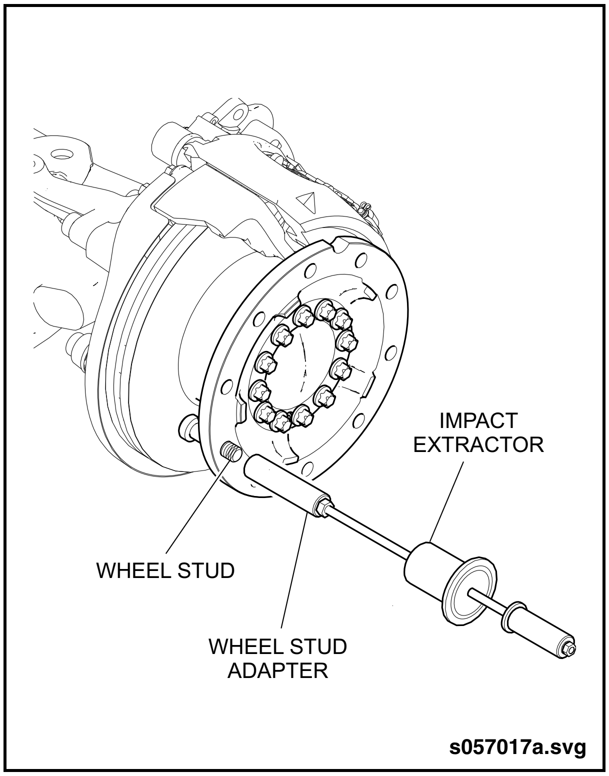
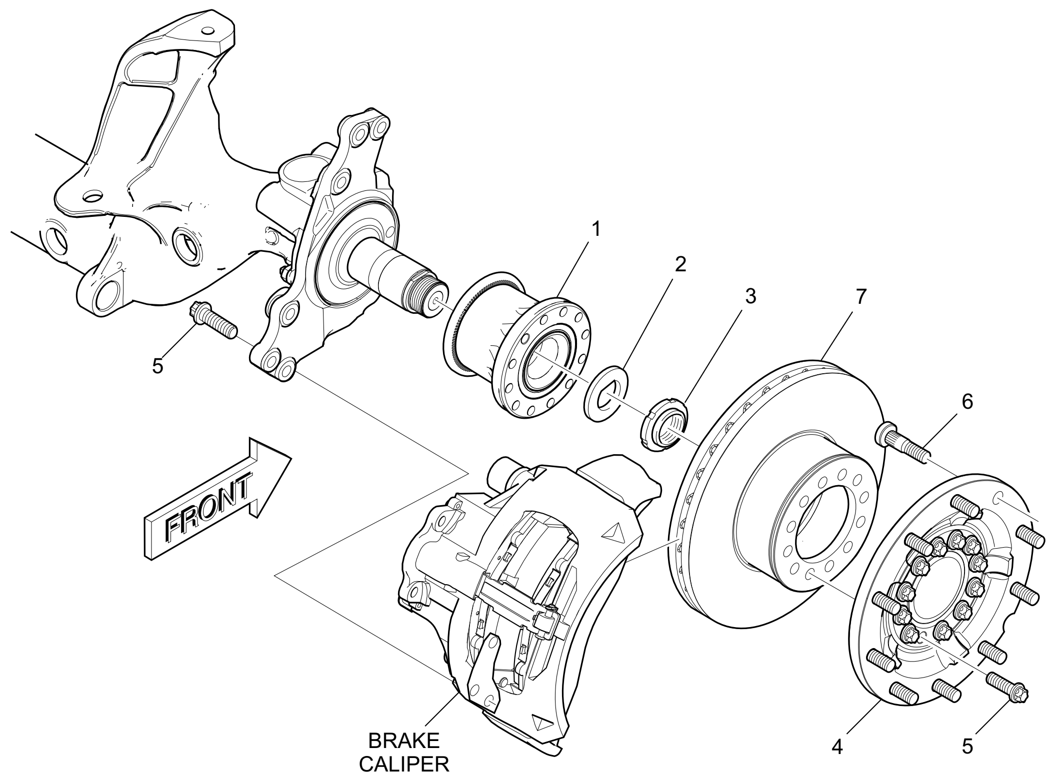


Fig. 1-7: Wheel Bolt Installation

3.7. Wheel Hub

3.7.1. Description

The wheel hub assemblies used on this axle are unitized components. The bearings, hub seal and ABS pulse wheel make up the hub assembly. The bearings are grease lubricated and factory adjusted to provide correct adjustment. The hub is retained to the spindle by a slotted, self locking nut. The wheel driving flange and brake disc are bolted to the end of the hub with 12 capscrews. Wheels are of the hub piloted design and are secured to the hub assembly with ten mounting studs. See “Fig. 1-8: Wheel End Assembly” on page 10.



1. Wheel Hub
2. Thrust Washer
3. Slotted Nut
4. Wheel Flange
5. Bolt
6. Wheel Stud
7. Brake Rotor

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Fig. 1-8: Wheel End Assembly

3.7.2. Inspection

Inspect the wheel hub bearings for excessive play as follows:

1. Raise the vehicle and support the front axle on jack stands.
2. Ensure the brakes are released and the wheels can rotate freely.
3. Attach the base of a magnetic dial gauge to any part of the steering knuckle. See “Fig. 1-9: Wheel Bearing Inspection” on page 11.
4. Align the dial gauge pin perpendicular to the face of the brake rotor and as close as possible to the outer edge of the brake disc. Also ensure that the dial gauge pin is located at either the 6 o'clock or 12 o'clock position.

   ☞NOTE:

   It is important that the dial gauge pin be positioned at the correct distance from the center of the brake disc in order to obtain an accurate reading. The tip of the gauge should be resting approximately 8.25 to 8.5 inches (210 to 215 mm) from the center of the disc.

5. Zero the dial gauge.
6. Grasp the wheel at the top and bottom and rock back and forth while observing the dial indicator reading.

   ☞NOTE:

   If clearance issues resulted in the dial gauge being positioned somewhere other than the 12 o'clock or 6 o'clock position, then ensure the wheel is grasped at a location that corresponds to the dial gauge. As an example, if the dial gauge was located at the 2 o'clock position, then grasp the wheel at the 2 o'clock and 8 o'clock positions and rock back and forth.

7. If total movement exceeds 0.010" (0.25 mm). Replace the wheel hub as an assembly.

   ☞NOTE:

   The wheel hub is a unitized assembly and has no replaceable components.

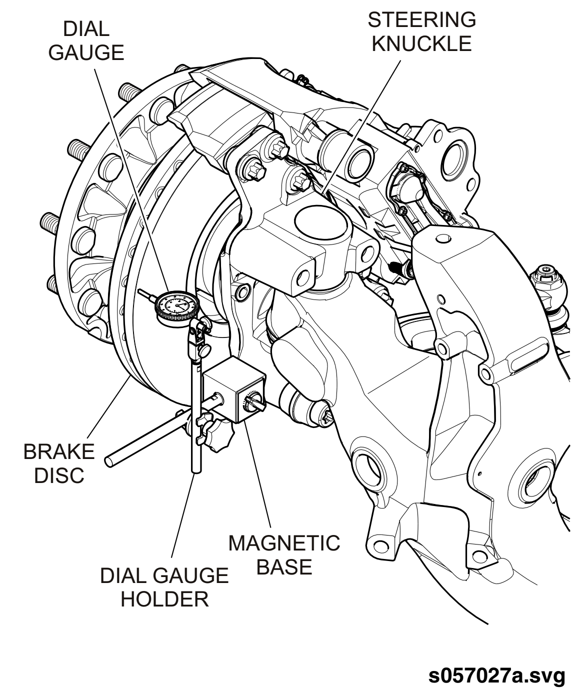


Fig. 1-9: Wheel Bearing Inspection

3.7.3. Wheel Flange Removal

1. Drain the air tanks.
2. Raise the vehicle. Refer to the General Information Section of this manual for procedure.
3. Place jack stands under the vehicle at all jacking locations and lower the vehicle until the weight is taken by the jack stands.
4. Remove the wheels.
5. Assemble flange bolt removal tool (Items 17, 18, 19, 20, 21, 22, 23, 24, 25 from special tools list) and place tool onto two flange mounting bolts. Refer to 3.7.3.1. “Special Tool Assembly” on page 13 for tool assembly instructions. See “Fig. 1-10: Flange Mounting Bolt Removal” on page 12.

☞NOTE:

If the special tools are not available, a regular socket wrench can also be used to remove the flange mounting bolts.

6. Loosen and unscrew two opposite mounting bolts from the wheel flange.
7. Install centering pins (Item 14 from special tools list) into the wheel hub threaded opening. See “Fig. 1-11: Install Centering Pins” on page 12.
8. Loosen and remove all the remaining mounting bolts.

☞NOTE:

Check condition of bolts. DO NOT reuse any mounting bolts with signs of damage or deformity.

9. Loosen the wheel flange from the brake disc by tapping with a copper hammer if necessary.
10. Slide the flange over the alignment pins to remove it from the brake disc.

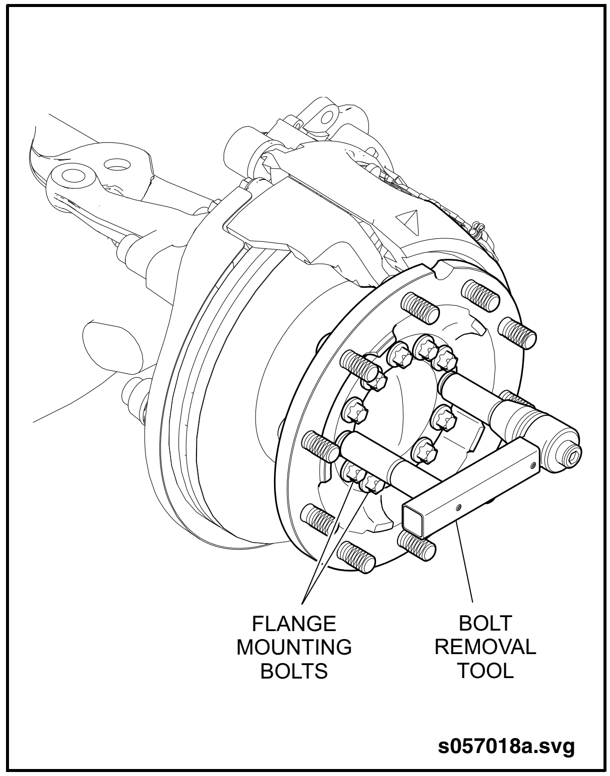


Fig. 1-10: Flange Mounting Bolt Removal

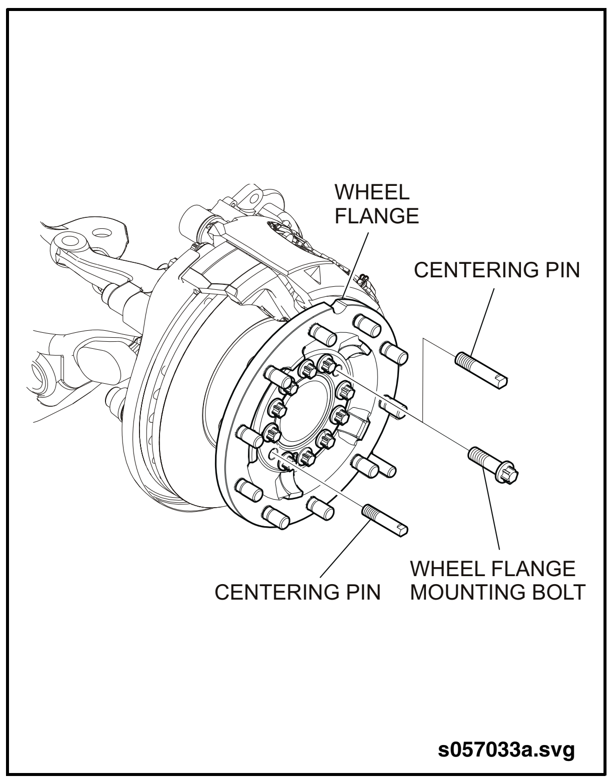
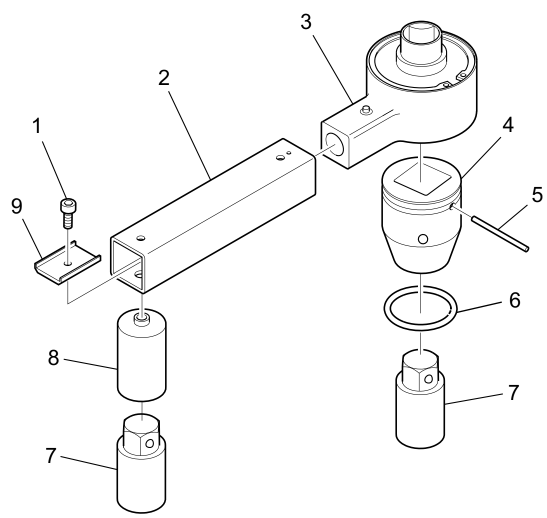


Fig. 1-11: Install Centering Pins

3.7.3.1. Special Tool Assembly

The special tool for removing & installing the wheel flange bolts is comprised of nine individual pieces and must be assembled in accordance with following instructions. See "Fig. 1-12: Special Tool Assembly" on page 13.

1. Insert the torque multiplier into one end of the support square tube.
2. Attach the socket holding tube to the other end of the square support tube and secure with adapter and screw.
3. Attach socket onto the torque multiplier and secure with connecting pin.
4. Secure the connecting pin in place with O-ring.
5. Insert one Torx socket into torque multiplier socket.
6. Insert the remaining Torx socket into the socket holding tube.



1. Screw
2. Support Tube
3. Torque Multiplier
4. Socket
5. Connecting Pin'
6. O-Ring
7. Torx Socket
8. Socket Holding Tube
9. Adapter

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Fig. 1-12: Special Tool Assembly

3.7.4. Wheel Flange Installation

1. Lubricate the contact face of the brake disc and the wheel flange with multipurpose grease.
2. Slide the wheel flange over the centering pins until it is against brake disc.
3. Install flange mounting bolts.

☞NOTE:

Replace any mounting bolts with signs of damage or deformity.

4. Remove the centering pins and install the two remaining mounting bolts.
5. Use the flange bolt tool (Items 17, 18, 19, 20, 21, 22, 23, 24, 25 from special tools list) or a regular torque wrench and socket to torque the 12 Torx-head bolts in a cross-tightening pattern to 288 ft-lb. (390 Nm).

☞NOTE:

The flange bolt tool is a torque multiplier with a ratio of 1:3.5. For a final torque of 288 ft-lb. (390 Nm), set the torque wrench to 82 ft-lb. (111 Nm).

6. Install the wheels and lower the vehicle.

3.7.5. Brake Disc Removal & Installation

Remove the brake disc. Refer to 5.2.9. "Brake Disc" on page 69 in this section for removal procedure.

3.7.6. Hub Unit Removal

1. Remove the Wheel Flange. Refer to 3.7.3. “Wheel Flange Removal” on page 12 in this section for procedure.
2. Remove the brake carrier and caliper assembly. Refer to 5.2.6. “Brake Caliper & Carrier Assembly” on page 60 in this section for removal procedure.
3. Remove the brake disc. Refer to 5.2.9. “Brake Disc” on page 69 in this section for removal procedure.
4. Install slotted nut socket (Item 30 from special tools list) onto slotted nut. See “Fig. 1-13: Wheel Hub Slotted Nut Socket” on page 14.
5. Install counter holder flange, torque multiplier, counter holder and torque reaction arm (Items 31, 32, 33, & 34 from special tools list) on end of hub and over slotted nut socket. See “Fig. 1-14: Wheel Hub Nut Removal” on page 15.
6. Anchor counter holder's torque reaction arm solidly and turn hex on torque multiplier to loosen slotted nut.
7. Remove the special tools from the hub, then remove the slotted nut and thrust washer. Discard and do not reuse the slotted nut.
8. Thread the fitting sleeve (Item 42 from special tools list) onto end of spindle and carefully pull hub assembly off spindle.

☞NOTE:

If hub assembly does not slide off the spindle, then it will be necessary to remove the fitting sleeve and assemble mechanical removal tools in accordance with the following steps.

9. Bolt the puller removal flange (Item 37 from special tools list) onto the hub.
10. Install threaded bushing, puller cap, and spindle screw. (Items 36, 38, & 40 from special tools list) into the puller removal flange. See “Fig. 1-15: Wheel Hub Removal” on page 15.
11. Rotate the spindle screw to pull off hub unit assembly from the steering knuckle spindle.

☞NOTE:

If difficulty is experienced removing the hub with the mechanical tools, then it may be necessary to remove the hub hydraulically. Refer to 3.7.7. “Hub Removal with Hydraulic Puller” on page 15 *in this section for procedure.*

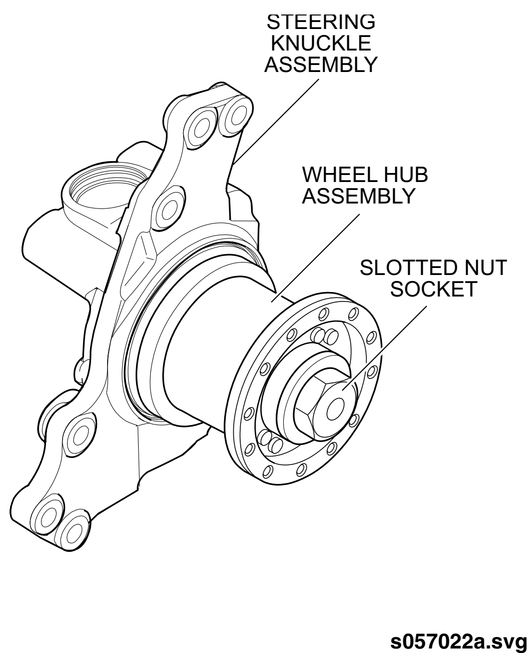


Fig. 1-13: Wheel Hub Slotted Nut Socket

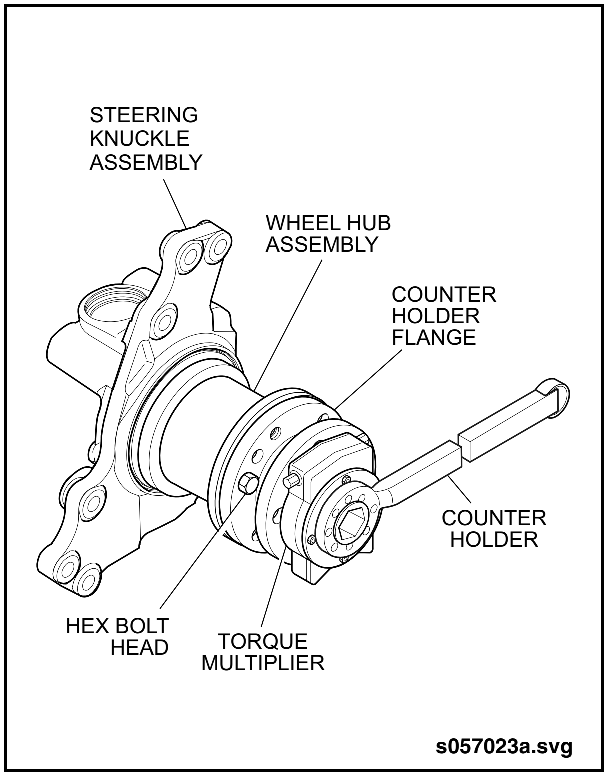


Fig. 1-14: Wheel Hub Nut Removal

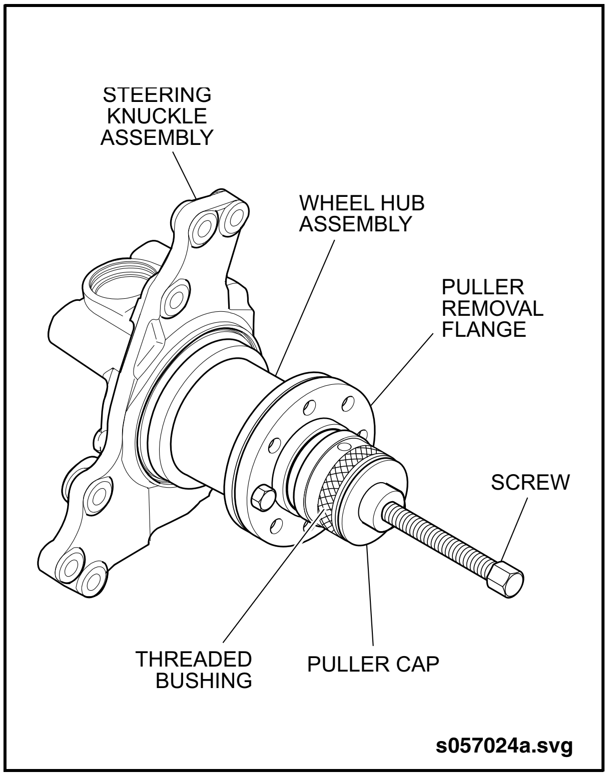


Fig. 1-15: Wheel Hub Removal

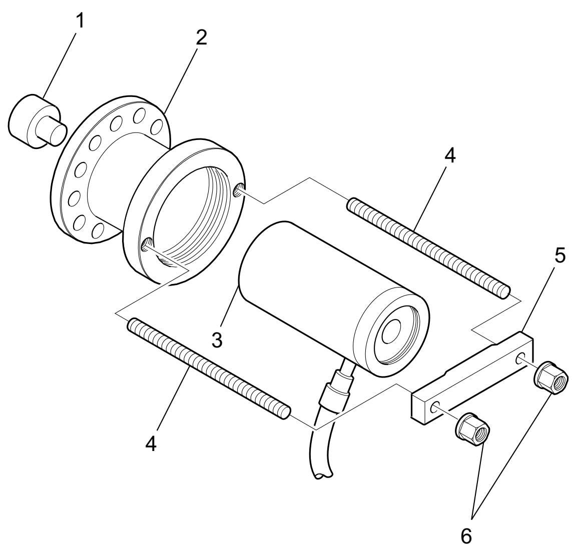
3.7.7. Hub Removal with Hydraulic Puller

1. Assemble the hydraulic puller tool. Refer to 3.7.7.1. “Hydraulic Puller Tool Assembly” on page 15 in this section for assembly instructions.
2. Mount the hydraulic puller on the wheel hub flange using mounting bolts.
3. Tighten the two nuts evenly on the threaded rods until the pressure piece seats against the steering knuckle spindle.
4. Connect the hydraulic pump (Item 43 from special tools list) to the hollow piston cylinder.
5. Remove the hub by applying hydraulic pressure.

3.7.7.1. Hydraulic Puller Tool Assembly

Assemble the individual components of the hydraulic puller tool (Items 43, 44, 45, 46, 47, 48, & 49 from special tools list) in accordance with the following instructions. See “Fig. 1-16: Hydraulic Puller Tool Assembly” on page 16.

1. Insert the pressure piece into the hollow piston cylinder.
2. Screw the two threaded rods into the extractor flange.
3. Insert the hollow piston cylinder into the extractor flange.
4. Install the traverse plate over the two threaded rods and secure with nuts.



1. Pressure Piece
2. Extractor Flange
3. Hollow Piston Cylinder
4. Threaded Rod
5. Traverse Plate'
6. Nut

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Fig. 1-16: Hydraulic Puller Tool Assembly

3.7.8. Hub Unit Installation

1. Lubricate steering knuckle spindle and hub bearings with Molykote-D paste. Apply paste on the machined surface of the spindle where the hub bearings are seated except 3/4" of inner bearing seat.
2. Thread the fitting sleeve (Item 42 from special tools list) onto end of spindle. See "Fig. 1-17: Hub Fitting Sleeve Installation" on page 17.
3. Install hub assembly onto guide sleeve and push hub until it is fully seated.

☞**NOTE:**

If the hub assembly cannot be fully seated by hand, then use the hub installation tools and the following procedure:

4. Bolt puller flange (Item 31 from special tools list) onto end of hub.
5. Install puller assembly (Items 36, 39, 40 & 41 from special tools list) onto the puller flange. See "Fig. 1-18: Wheel Hub Installation" on page 17.
6. Thread end of puller screw into the end of the fitting sleeve and turn handle on puller to push hub assembly onto spindle.
7. Remove the assembly of special tools including the fitting sleeve from the steering knuckle spindle.
8. Install thrust washer and new slotted nut and hand tighten.
9. Install slotted nut socket (Item 30 from special tools list) onto slotted nut.
10. Install counter holder flange (Items 31 from special tools list) on end of hub and over slotted nut socket.
11. Insert the torque wrench and ratchet (Items 35 & 7 from special tools list) into the slotted nut socket.
12. Torque the slotted nut to 546 ft-lb. (740 Nm).
13. Remove special tools.
14. Install brake disc. Refer to 5.2.9. "Brake Disc" on page 69 in this section for procedure.
15. Install wheel flange. Refer to 3.7.4. "Wheel Flange Installation" on page 13 in this section for procedure.

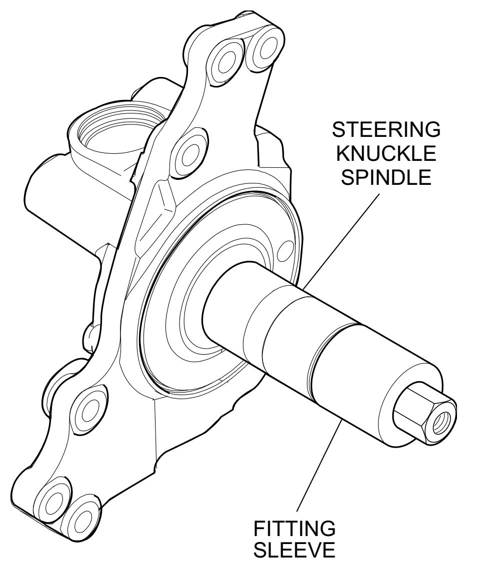


Fig. 1-17: Hub Fitting Sleeve Installation

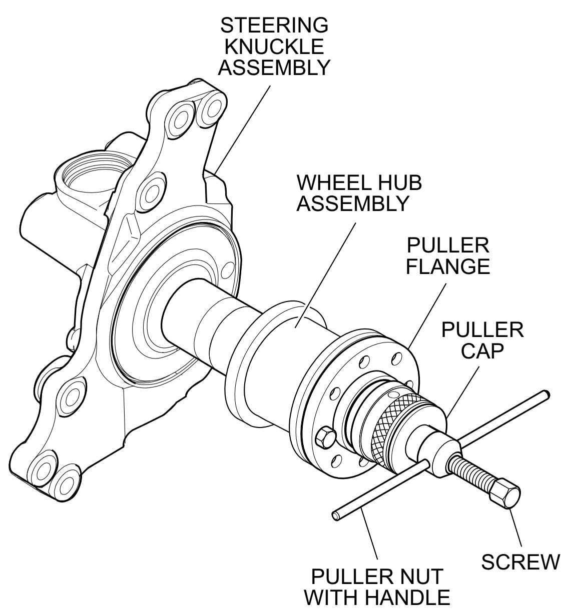


Fig. 1-18: Wheel Hub Installation

3.8. Center Link & Tie Rod Ends

3.8.1. Inspection

1. Visually inspect the center link, clamp and tie rod ends, paying particular attention to the rolled seam of the ball joint. All components must be free of corrosion and physical damage.
2. Inspect the rubber boot on the ball joint for evidence of damage. The rubber boot must be securely retained by the clamping rings and should not rotate by hand.
3. Compress the rubber boot by hand and check that there are no cracks and that no grease emerges.
4. Check the ball joint for axial play by applying vertical force (up and down) to the ball joint. The maximum allowable axial play is 0.079 in. (2.0 mm). Replace center link ball joint if necessary.
5. Check the ball joint for radial play by applying horizontal force (side to side). The maximum allowable radial play is 0.010 in. (0.25 mm).

☞NOTE:

The radial play is considered within tolerance if the axial play is within the maximum allowable tolerance.

6. There must not be any play between the threads on the ball joint and the threads of the center link tube adjusting sleeve.
7. Twist the center link by hand and ensure that the ball joints rotate freely at either end.

3.8.2. Removal

1. Remove and discard self-locking nuts from center link tie rod ends.
2. Assemble the ball joint press (Items 64 & 65) and position over the ball joint. Align the press so the piston is centered on the ball joint and tight. See “Fig. 1-19: Tie Rod End Removal” on page 18.
3. Secure the ball joint press to the vehicle using the safety chain. (Item 66 from special tools list).
4. Connect the hydraulic pump (Item 43 from special tools list) and separate center link tie rod ends from tie rod arms.
5. Loosen center link tie rod end clamp lock nut.
6. Thread tie rod end out of center link.

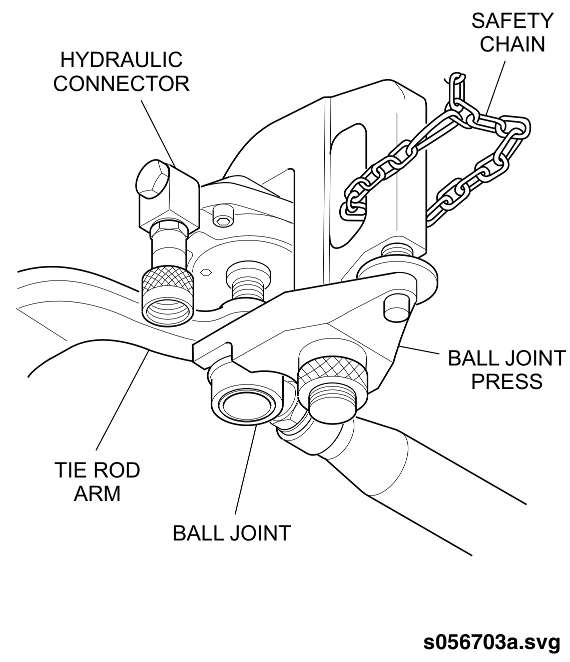


Fig. 1-19: Tie Rod End Removal

3.8.3. Installation

NOTE:

Refer to 4.5. “Front Suspension Torque Specifications” on page 43 in this section for all installation torque values.

1. Thread adjusting sleeve into center link until the end of the hex head on the sleeve is 0.708 ± 0.275 in. (18 ± 7 mm) from the end of the center link. Refer to dimension “A”. See “Fig. 1-20: Tie Rod End Adjustment” on page 19.
2. Hold adjusting sleeve to prevent rotation and thread in tie rod end until center line of ball joint is 2.0 in. (52 ± 7 mm) from end of adjusting sleeve. Refer to dimension “B”.
3. Check that the exposed thread length on the tie rod end (dimension “D”) equals the exposed thread length on the adjusting sleeve (dimension “C”).
4. Apply NEVER-SEEZ®, install center link tie rod ends into tie rod arms.

5. Install new self-locking nut (M24 x 1.5) and torque to specification.

☞NOTE:

Install an 8 mm Allen wrench in end of ball stud to prevent it from rotating while tightening self locking nut.

6. Ensure center link tie rod end clamp is correctly oriented on center link. Ends of clamp must be centered over slot in center link and positioned to allow clamp bolt to pass through machined recess in end of link. See “Fig. 1-21: Center Link Tie-Rod End” on page 19.
7. Install new center link tie rod end clamp lock nut and tighten to specification.
8. Check toe-in and adjust as required. Refer to Section 3 of this manual for procedure.

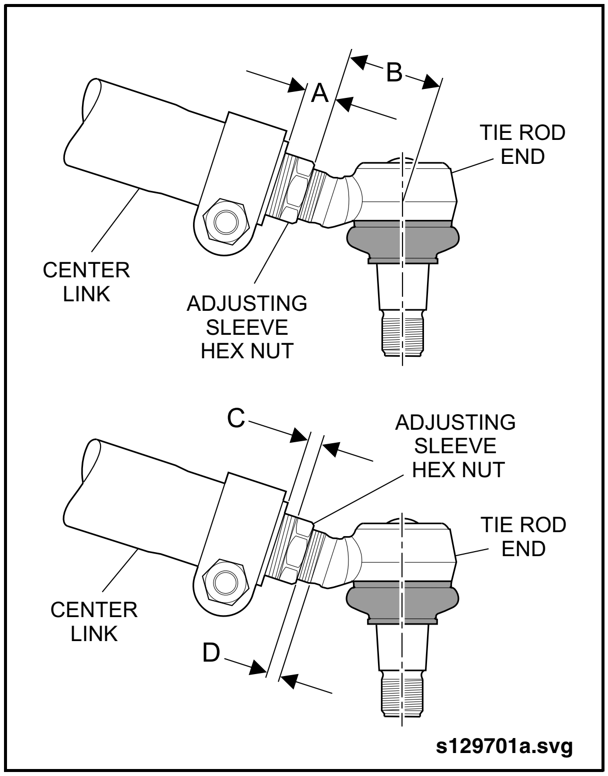
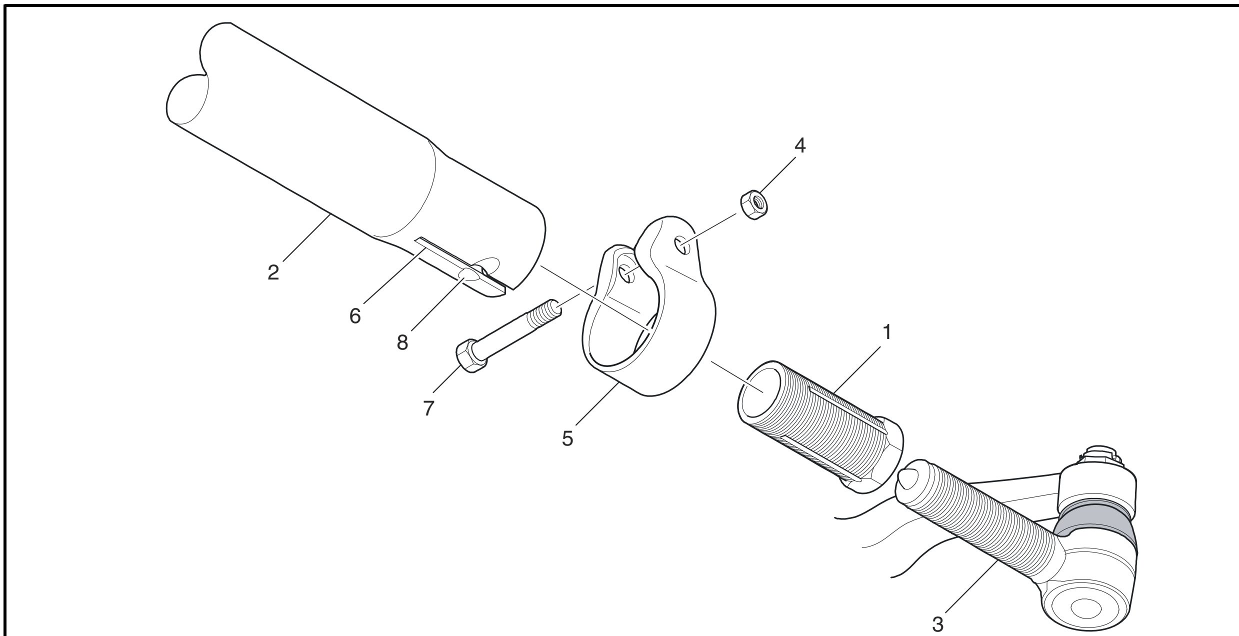


Fig. 1-20: Tie Rod End Adjustment



1. Threaded Sleeve/Nut
2. Center Link
3. Tie Rod End
4. Nut
5. Clamp
6. Slot
7. Bolt
8. Recess

Fig. 1-21: Center Link Tie-Rod End

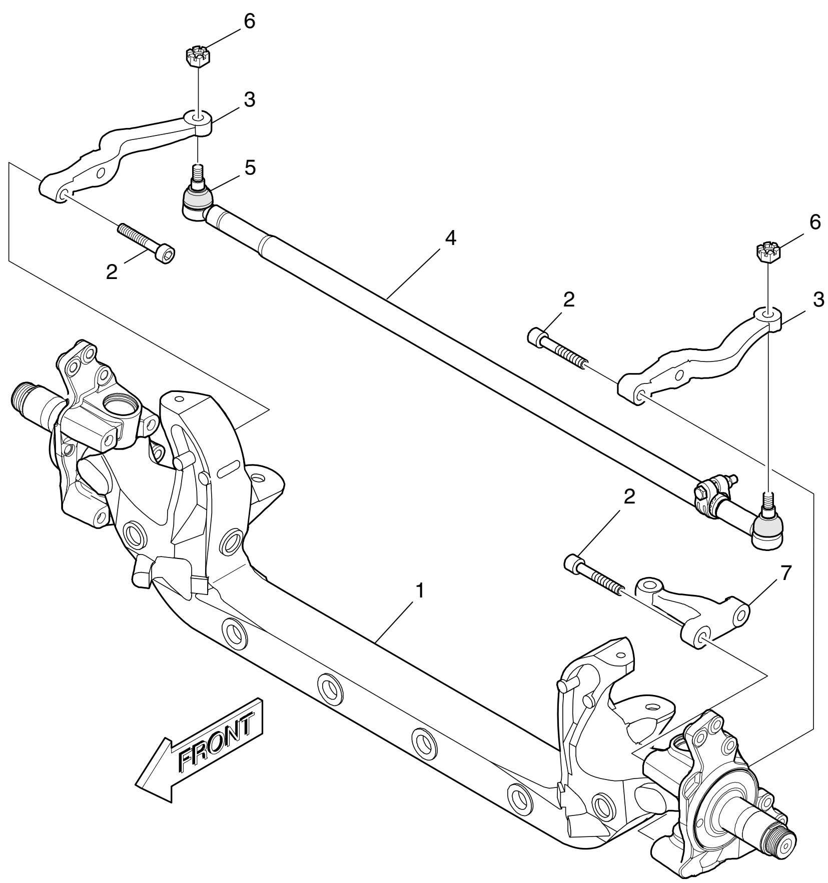
3.9. Tie Rod Arms & Steering Arm

3.9.1. Description

The LH and RH tie rod arms are bolted onto the steering knuckle and serve to connect the steering center link with the steering knuckles. The steering arm is bolted to the streetside steering knuckle and serves to connect the drag link to the steering knuckle. See “Fig. 1-22: Tie Rod & Steering Arms” on page 20.

☞**NOTE:**

The tie rod arms and steering arm are not repairable and cannot be straightened or welded. Replace the tie rod arm or steering arm with a new item if any wear or damage is evident.



1. Axle Beam
2. M22 Bolt
3. Tie Rod Arm
4. Center Link
5. Tie Rod End
6. Lock Nut
7. Steering Arm

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Fig. 1-22: Tie Rod & Steering Arms

3.9.2. Removal

1. Assemble the ball joint press (Items 64 & 65) and position over the drag link ball joint. Align the Press so the piston is centered on the ball joint and tight.
2. Secure the ball joint press to the vehicle using the safety chain. (Item 66 from special tools list.)
3. Connect the hydraulic pump (Item 43 from special tools list) and separate drag link from steering arm.
4. Use internal Torx socket (Item 67 from special tools list) and socket wrench assembly (Items 3, 4, 5, & 6 from special tools list) and remove two M22 bolts from steering arm and each tie rod arm.

☞**NOTE:**

Inspect bolts for damage or deformity and replace if necessary.

3.9.3. Installation

1. Install steering arm using two bolts.
2. Install each tie rod arm using two bolts.
3. Use internal Torx socket (Item 67 from special tools list) and torque wrench assembly (Items 3, 4, 5, & 7 from special tools list) and torque bolts to specification.
4. Connect drag link ball joint to steering arm and tighten to specification. Refer to Section 3 of this manual for installation procedure.

3.10. Steering Knuckle

3.10.1. Description

Steering Knuckle axial play can be verified during knuckle replacement and checked to determine if the king pin is excessively worn after the vehicle has been in service using the following procedure.

3.10.2. Steering Knuckle Specifications

Axial Play ....0.008" (0.2 mm) max
(Setting value after king pin/shim replacement)

Maximum Axial Play........... 0.016" (0.4 mm)
(Wear limit after vehicle has been in use)

3.10.3. Steering Knuckle Axial Play Check

1. Secure the vehicle against rolling.
2. Secure the dial gauge holder to the axle beam or the tie rod arm. See “Fig. 1-23: Dial Gauge Installation” on page 22.
3. Position the dial gauge so that the probe is in contact with the center of the free bottom edge of the axle knuckle.

☞**NOTE:**

The distance between the mounting of the holder and the probe of the dial gauge must be as small as possible.

4. Raise the front axle, set dial gauge to zero.
5. Lower the front axle.
6. Measure the axial play on the dial gauge.
7. Repeat the procedure for the remaining wheel.

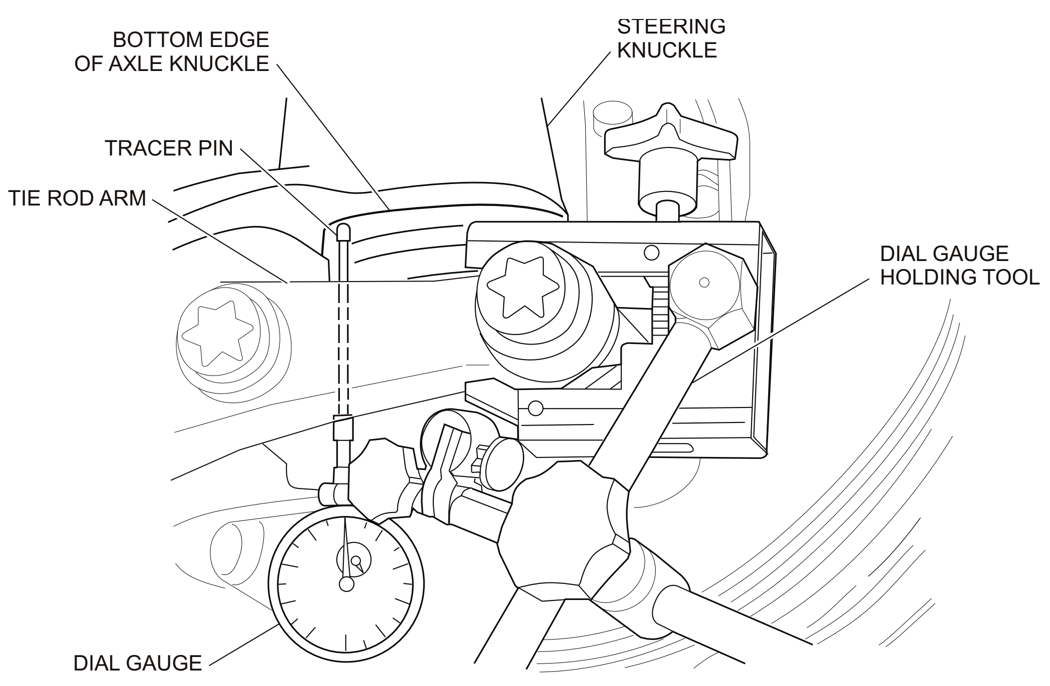


Fig. 1-23: Dial Gauge Installation

3.10.4. King Pin Removal

1. Set Battery Disconnect switch to OFF position.
2. Drain all air tanks.
3. Raise vehicle to working height. Refer to the General Information Section of this manual for procedure.
4. Place jack stands under each jacking point on the vehicle frame. Lower the vehicle and allow the jack stands to take the weight of the vehicle.
5. Remove tire and wheel assembly.
6. Remove brake chamber. Refer to 5.3. “Front Brake Chambers” on page 71 in this section for removal procedure.
7. Remove disc brake pads. Refer to 5.2.5. “Brake Pads” on page 58 in this section for removal procedure.
8. Remove the brake caliper and carrier assembly. Refer to 5.2.6. “Brake Caliper & Carrier Assembly” on page 60 in this section for removal procedure
9. Remove the wheel flange. Refer to 3.7.3. “Wheel Flange Removal” on page 12 in this section for removal procedure.
10. Remove the brake disc. Refer to 5.2.9. “Brake Disc” on page 69 in this section for removal procedure.

☞**NOTE:**

It is not necessary to remove the wheel hub from the steering knuckle. The steering knuckle can be serviced with the wheel hub in place.

11. Disconnect tie rod end from tie rod arm of steering knuckle being serviced. Refer to 3.8. “Center Link & Tie Rod Ends” on page 17 in this section for procedure.

☞**NOTE:**

It is not necessary to separate the tie rod end if the tie rod arm has already been removed from the steering knuckle.

12. Remove the ABS speed sensor. Refer to 6.3. “Front ABS Speed Sensor” on page 76 in this section for procedure.
13. Using the thrust bearing sleeve positioning tool (Item 50 from special tools list) slide the dust guard on the thrust bearing down and away from the axle beam. See “Fig. 1-24: Axle Beam Dust Guard” on page 24.
14. Remove circlips (snap ring) from upper and lower king pin sealing washers. See “Fig. 1-25: King Pin Snap Ring Removal” on page 24.
15. Remove the sealing washers and O-rings.
16. Position king pin press (Items 51 & 52 from special tools list), with pressing ram at the bottom, over steering knuckle.
17. Insert mandrel (Item 55 from special tools list) into press ram and spacer tube (Item 57 from special tools list) into crossbeam on press.
18. Mount king pin press onto steering knuckle ensuring sleeve and mandrel are correctly aligned and press king pin up into spacer tube and out of knuckle. See “Fig. 1-26: King Pin Removal” on page 24.
19. Lift king pin out though bore in press crossbeam using magnetized aligning punch. (Item 53 from special tools list). See “Fig. 1-27: King Pin Removal Tool” on page 25.
20. Retract press ram and remove king pin press and attachments.
21. Remove steering knuckle assembly and spacer shim.

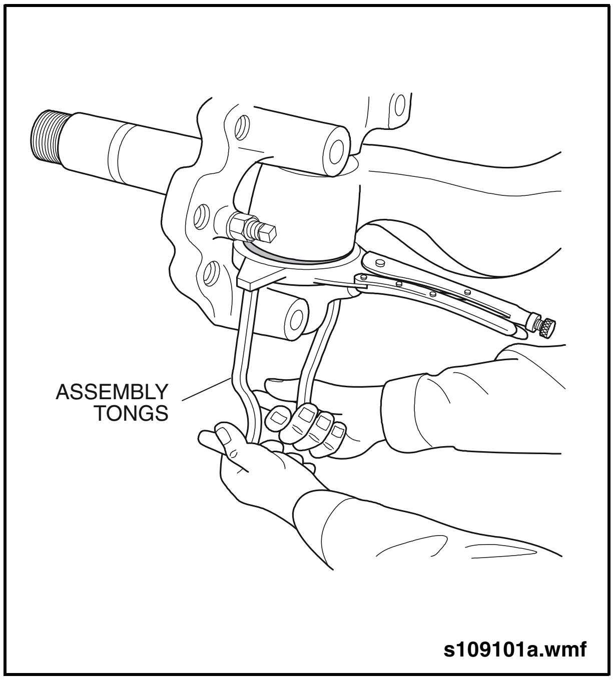


Fig. 1-24: Axle Beam Dust Guard

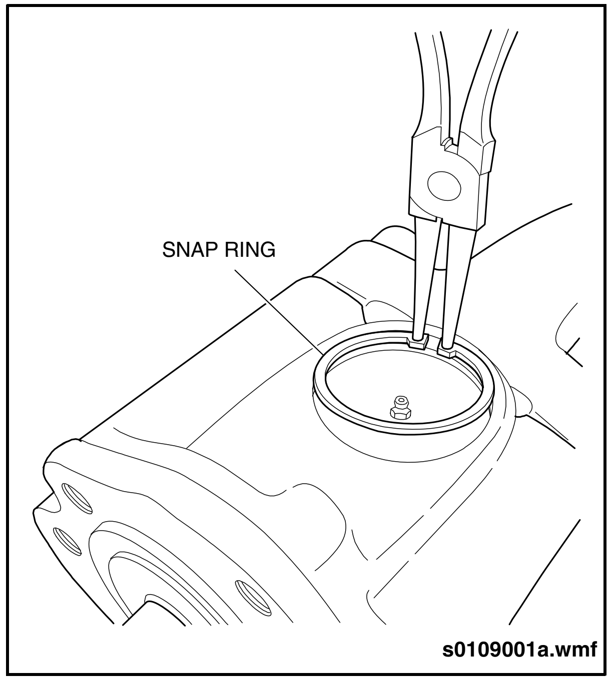


Fig. 1-25: King Pin Snap Ring Removal

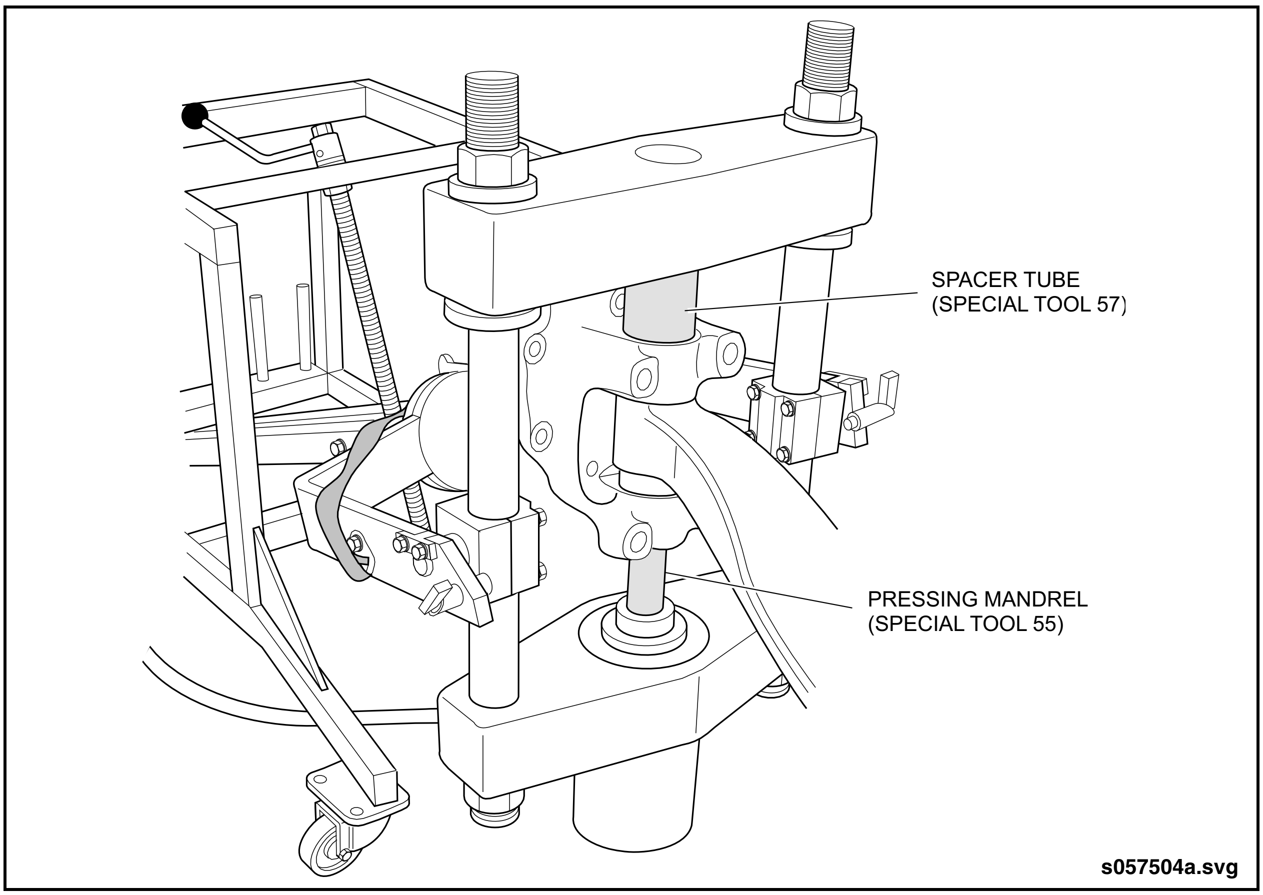


Fig. 1-26: King Pin Removal

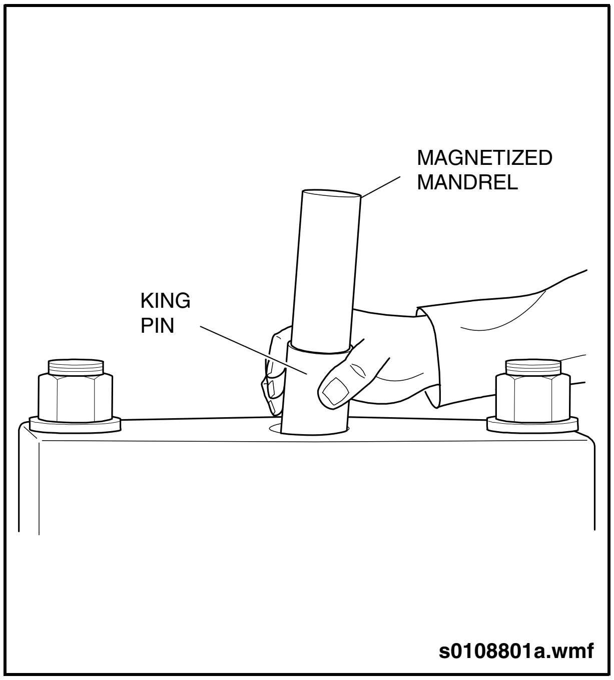


Fig. 1-27: King Pin Removal Tool

3.10.5. King Pin Installation

1. Determine required thickness of steering knuckle axial play control shim.
   a. Measure space between lower surface of upper king pin boss on knuckle and thrust bearing face. Dimension “A”. See “Fig. 1-28: Steering Knuckle Spacer Shim” on page 26.
   b. Measure distance between upper and lower machined faces adjacent to king pin bore on axle beam. Dimension “B”.
   c. Subtract dimension “B” from dimension “A” to obtain the required shim thickness.

NOTE:

The correct axial play is 0.0 to 0.008" (0.0 to 0.2 mm).

2. Retract the press ram and position press with pressing ram on top. Install spacer tube (Item 57 from special tools list) into press cross beam.
3. Position steering knuckle on axle beam and align with king pin bore in axle beam.
4. Install correct shim between thrust bearing and axle beam.
5. Place magnetized end of short centering mandrel (Item 54 from special tools list) against lower end of king pin.
6. Position steering knuckle on spacer tube and press king pin in until the stop is reached.

NOTE:

The Kingpin will only be partially installed and the magnetized centering mandrel can be removed.

7. Install pressing adapter (Item 56 from special tools list) on end of ram and complete the king pin installation. See “Fig. 1-30: King Pin Installation” on page 26.
8. Remove the hydraulic press and special tools then manually move the steering knuckle back and forth, until it contacts the axle and stops. Repeat several times.

NOTE:

It must be possible to turn the steering knuckle easily and through the complete range of motion

9. Using the thrust bearing sleeve positioning tool (Item 50 from special tools list) slide dust guard sleeve on thrust bearing up until it locks into position. See “Fig. 1-29: Thrust Bearing Sleeve Positioning Tool” on page 26.
10. Install upper and lower sealing washer with new O-ring into king pin bore and retain with circlip. See “Fig. 1-31: King Pin & Steering Knuckle Assembly” on page 27.
11. Lubricate both grease fittings. Refer to the Preventive Maintenance Section of this manual for grease specifications.
12. Install a protective plastic cap on the king pin grease fittings.

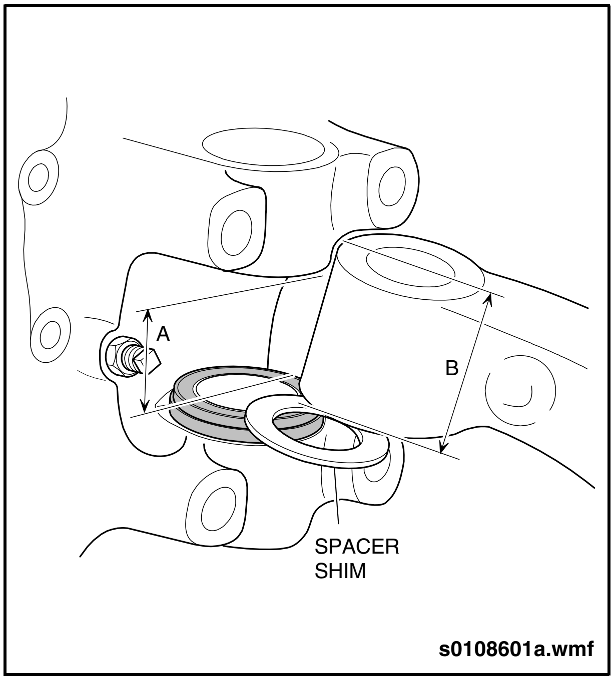


Fig. 1-28: Steering Knuckle Spacer Shim

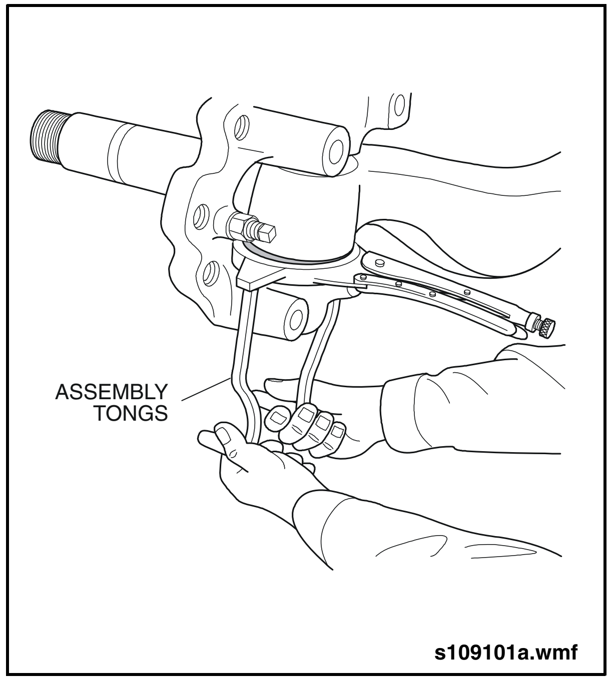


Fig. 1-29: Thrust Bearing Sleeve Positioning Tool

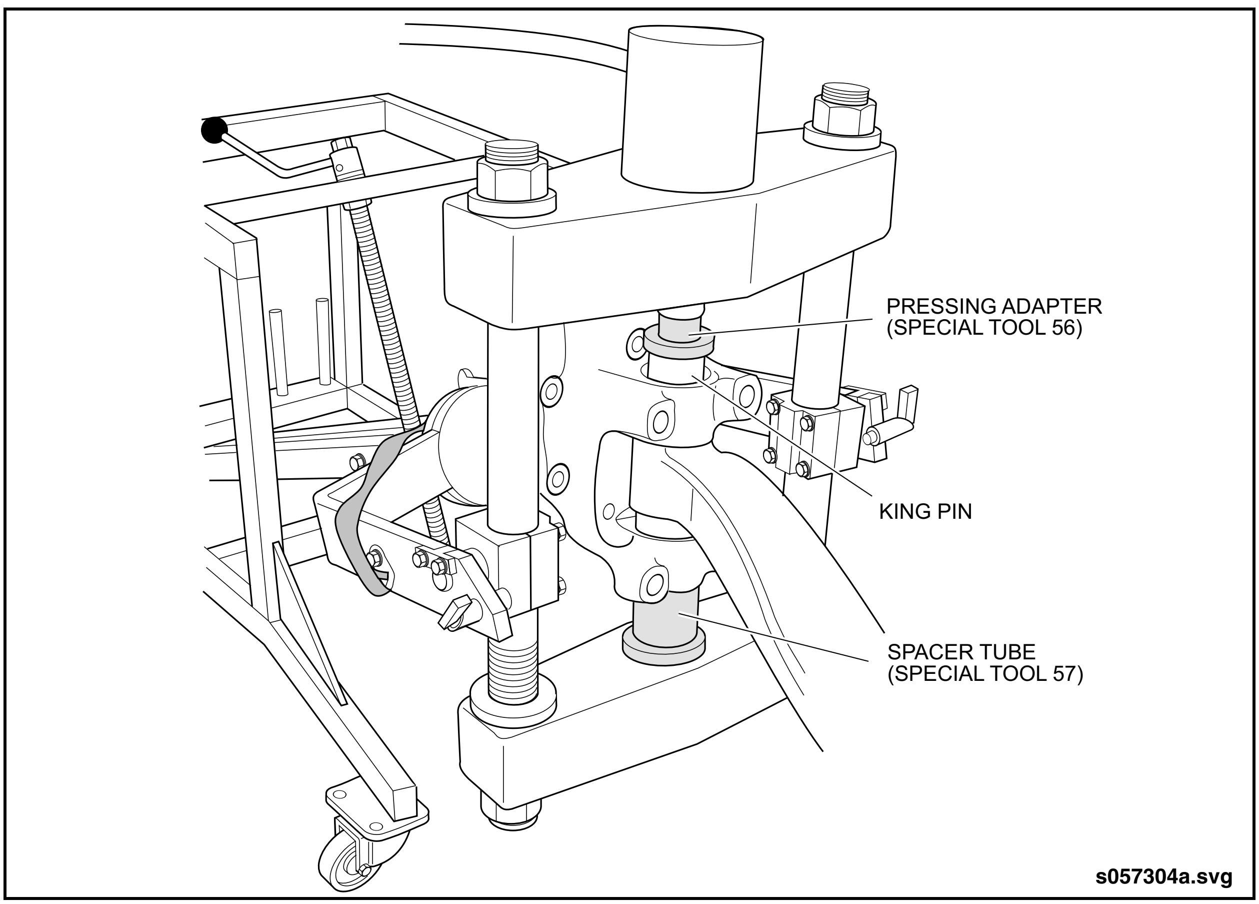
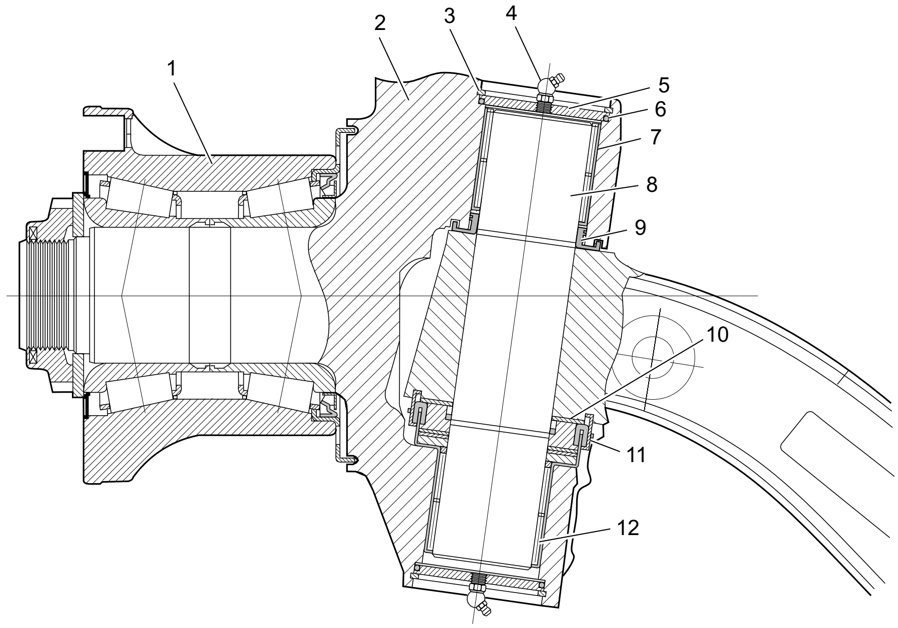


Fig. 1-30: King Pin Installation



1. Hub & Wheel Bearing Unit
2. Steering Knuckle
3. Circlip
4. Grease Nipple
5. Washer, Sealing
6. O-Ring
7. Bearing, Needle
8. King Pin
9. Seal
10. Shim, Spacer
11. Sleeve, Dust Guard
12. Needle & Thrust Bearing Assembly

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Fig. 1-31: King Pin & Steering Knuckle Assembly

3.10.6. King Pin Bearing & Seal Removal

1. Position press ram at the top. Insert spacer tube (Item 57 from special tools list) into press cross beam. Place steering knuckle upside down (lower needle bearing end of knuckle facing up) on spacer tube and secure steering knuckle with retaining strap. Insert long end of pressing mandrel (Item 61 from special tools list) into larger end of pressing adapter (Item 60 from special tools list). Position pressing adapter in king pin bearing bore of steering knuckle and short end of pressing mandrel onto end of press ram. See "Fig. 1-32: King Pin Needle & Thrust Bearing Removal" on page 28.
2. Press needle bearing and thrust bearing assembly out of steering knuckle.
3. Retract press ram and remove pressing adapter.
4. Remove sealing ring and install pressing adapter (Item 60 from special tools list) into center of steering knuckle (small end down) and on inner end of needle bearing. See "Fig. 1-33: King Pin Needle Bearing Removal" on page 29.
5. Slide shorter end of pressing mandrel (Item 61 from special tools list) down through king pin bore of knuckle and into pressing adapter (Item 60 from special tools list).
6. Position long end of mandrel against press ram and press needle bearing out of steering knuckle and into spacer tube (Item 57 from special tools list).

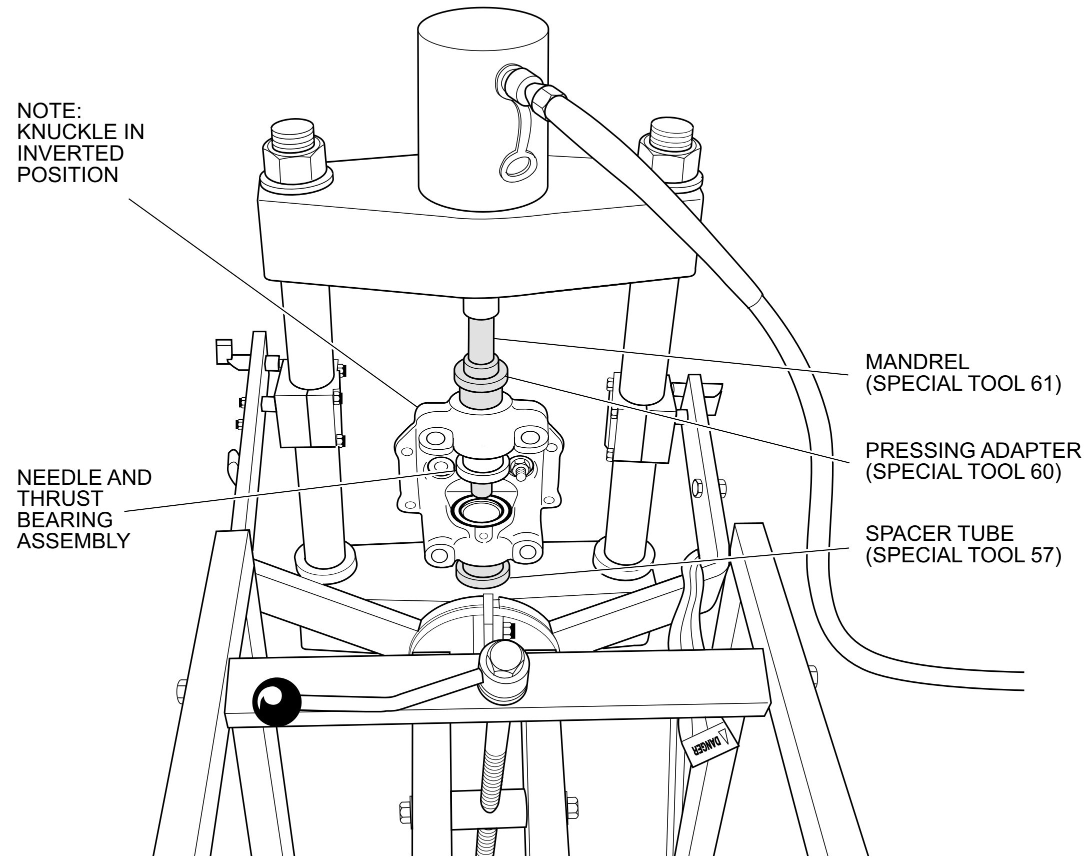


Fig. 1-32: King Pin Needle & Thrust Bearing Removal

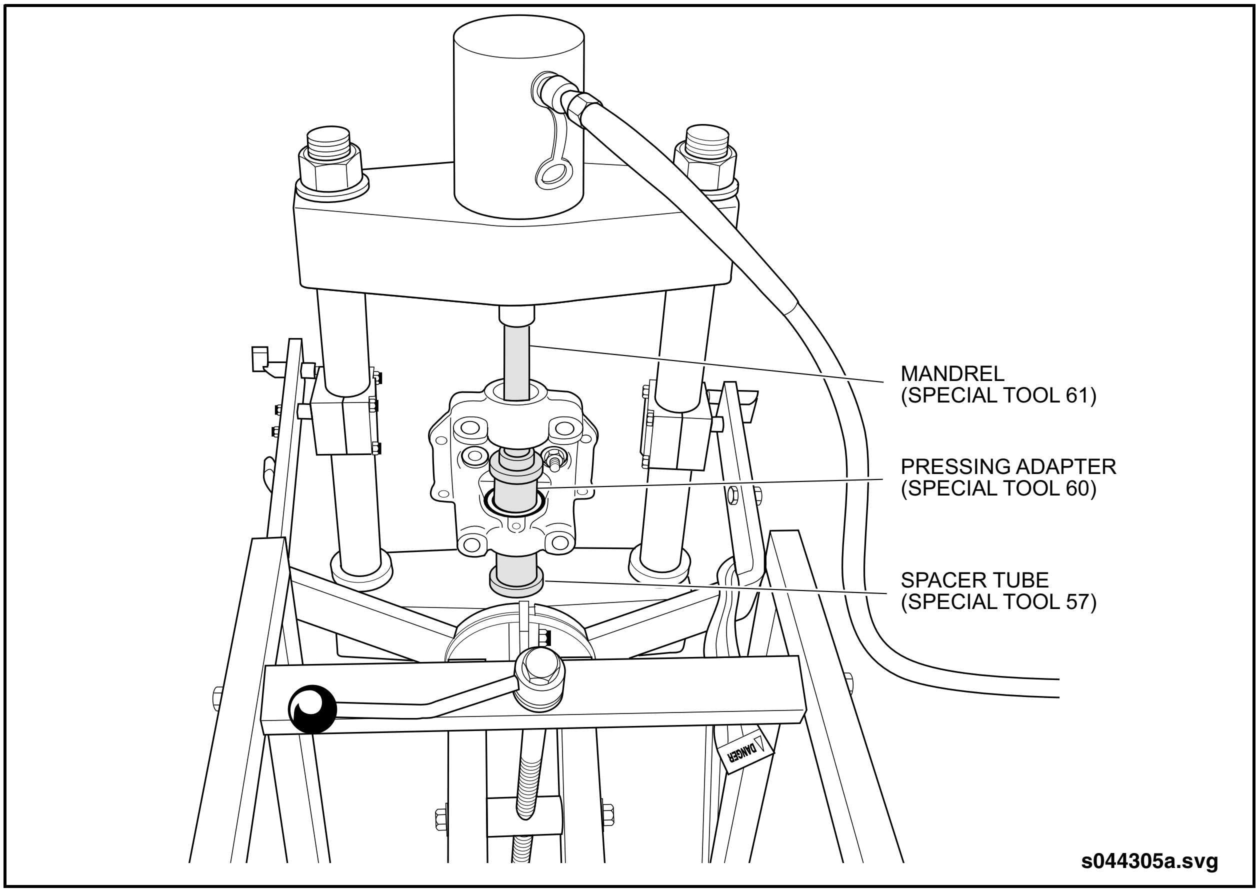


Fig. 1-33: King Pin Needle Bearing Removal

3.10.7. King Pin Bearing & Seal Installation

☞NOTE:

Remove the steering damper bracket if it interferes with any of the pressing tools. To reinstall the bracket, apply Loctite to the bolt threads and torque to 260 ft-lb. (352 Nm).

1. Slide needle bearing assembly onto pressing adapter (Item 62 from special tools list). The packing sleeve will slide out of the bearing. Save the sleeve for reuse.
2. Place pressing adapter and needle bearing into center of steering knuckle and over bearing boss in lower part of knuckle. Ensure smaller end of pressing adapter is towards bearing boss.
3. Slide short end of pressing mandrel (Item 61 from special tools list) through bore of knuckle and into larger end of pressing adapter (Item 62 from special tools list). See “Fig. 1-34: King Pin Needle Bearing Installation” on page 30.
4. Slide pressing adapter (Item 60 from special tools list) over mandrel and into bore of steering knuckle to center mandrel in the bore and act as a guide.
5. Position long end of mandrel against press ram and press needle bearing in until shoulder on pressing adapter (Item 62 from special tools list) seats on steering knuckle.
6. Retract the press ram and remove mandrel and pressing adapters.
7. Reinstall packing sleeve in bearing to prevent bearing needles from falling out when handling the steering knuckle.
8. Lift steering knuckle assembly off spacer tube (Item 57 from special tools list) and rotate 180°. Reinstall on spacer tube ensuring needle bearing and packing sleeve assembly is facing up.

9. Insert pressing adapter (Item 63 from special tools list) into needle bearing and thrust bearing assembly. Do not remove packing sleeve. Ensure flange on pressing adapter seats against thrust bearing.
10. Place pressing adapter and needle bearing and thrust bearing assembly into center of steering knuckle and over bearing boss in lower part of knuckle. Ensure smaller end of pressing adapter is towards bearing boss.
11. Remove packing sleeve from upper needle bearing assembly.
12. Insert short end of pressing mandrel (Item 61 from special tools list) through upper needle bearing assembly and into larger end of pressing adapter. (Item 63 from special tools list).
13. Slide pressing adapter (Item 62 from special tools list) over mandrel and into needle bearing to center mandrel in upper bearing and act as a guide.
14. Position long end of mandrel against press ram and press needle bearing and thrust bearing assembly in until shoulder on pressing adapter (Item 63 from special tools list) seats on steering knuckle. See "Fig. 1-35: King Pin Needle & Thrust Bearing Installation" on page 31.
15. Retract the press ram and remove mandrel and pressing adapters.
16. Install the double-lip seal into the steering knuckle upper bore. See "Fig. 1-36: Steering Knuckle Seal Installation" on page 31.

☞NOTE:

Ensure that the lip on the larger diameter of the seal enters the machined groove in the steering knuckle. Earlier versions of this seal did not have this lip and the steering knuckle did not have the machined groove. Refer to your New Flyer Parts Manual to ensure correct seal is installed to match the steering knuckle configuration.

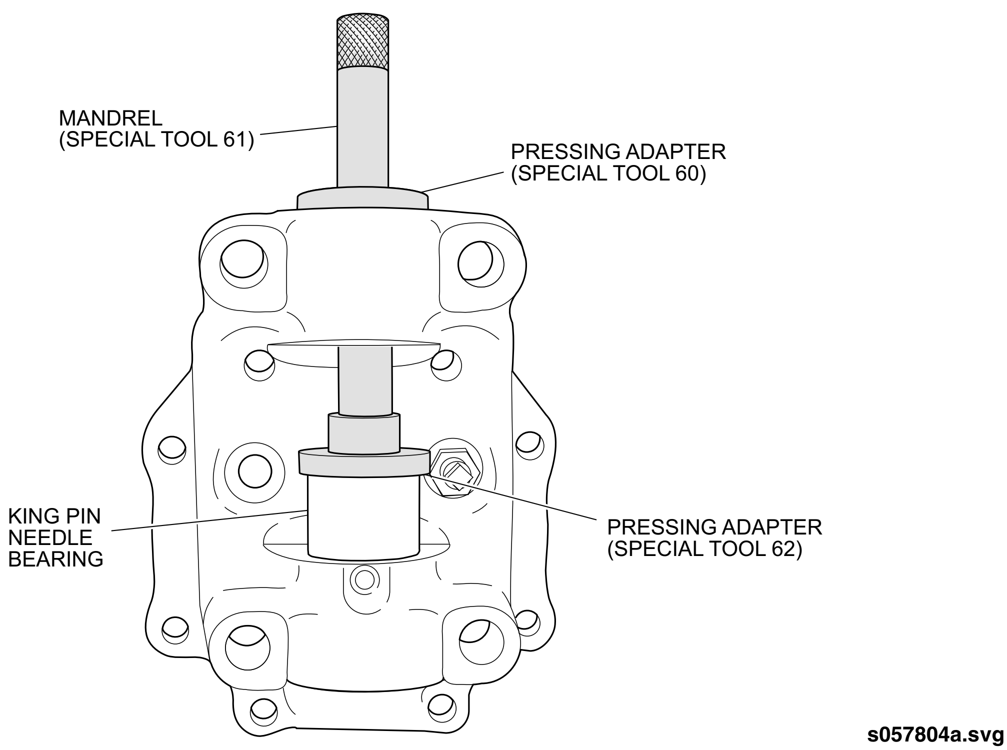


Fig. 1-34: King Pin Needle Bearing Installation

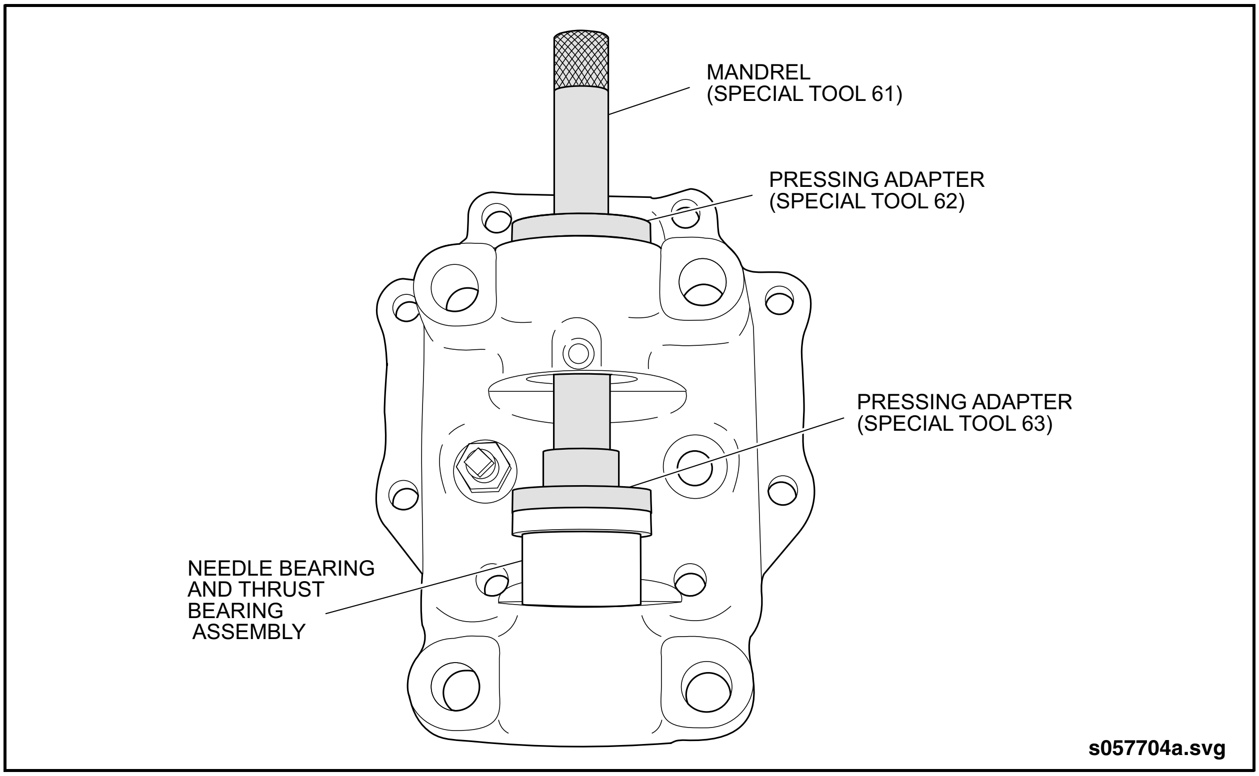


Fig. 1-35: King Pin Needle & Thrust Bearing Installation

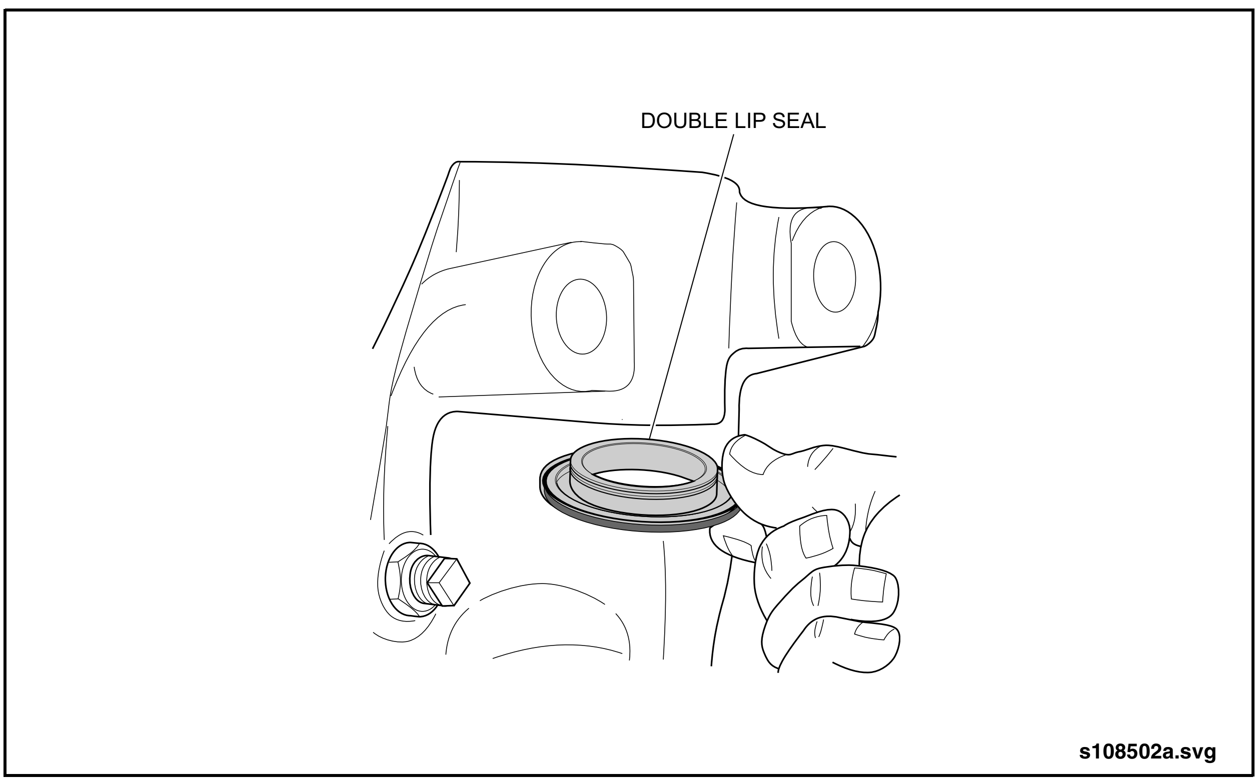


Fig. 1-36: Steering Knuckle Seal Installation

4. FRONT SUSPENSION

4.1. Description

The front axle suspension components include:

- ❒ Front Air Springs
- ❒ Front Radius Rods
- ❒ Front Shock Absorbers

4.2. Front Air Springs

4.2.1. Description

The air spring assembly consists of a rubber bellows mounted on a plate. The upper cover contains two threaded fittings. One fitting attaches the air spring to the chassis; the other is hollow and is used as an air inlet for suspension control. The upper and lower beads are crimped permanently during manufacture and cannot be separated.

4.2.2. Front Air Springs Specifications

Make .... Firestone

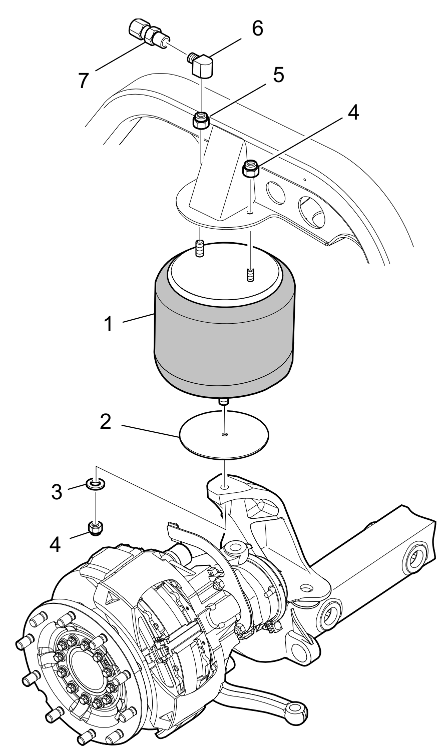
Model 1T15L-4

4.2.3. Operation

The air spring assembly receives air pressure from the vehicle air system and responds to height adjustment inputs from the height control valve or kneeling control. Pressurized air enters the spring though a hollow mounting stud at the top of the spring. The spring action of the bellows allows for movement of the axle as the wheels go over bumps and depressions.

4.2.4. Removal

1. Raise the vehicle using wheel lifts or center post lift. Refer to the General Information Section of this manual for procedure.
2. Use safety stands under frame to hold vehicle in position.
3. Lower wheel lift until there is a 3" (76 mm) space between axle and axle bumper.
4. If system is pressurized, disconnect height control valve rod then pull down valve lever to exhaust air from spring. (mark rod attachment position for reinstallation)
5. Disconnect air line. Remove lower nut attaching air spring to mounting plate. See “Fig. 1-37: Front Air Spring Removal & Installation” on page 32.
6. Remove nuts and washers securing upper end of air spring to chassis.
7. Slide spring out of chassis and remove.



1. Air Spring
2. Mounting Plate
3. Washer
4. Nut
5. Nut
6. Elbow
7. Connector

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Fig. 1-37: Front Air Spring Removal & Installation

4.2.5. Disassembly

The air spring is supplied as a complete assembly, piston bellows and bead plate therefore no disassembly is required.

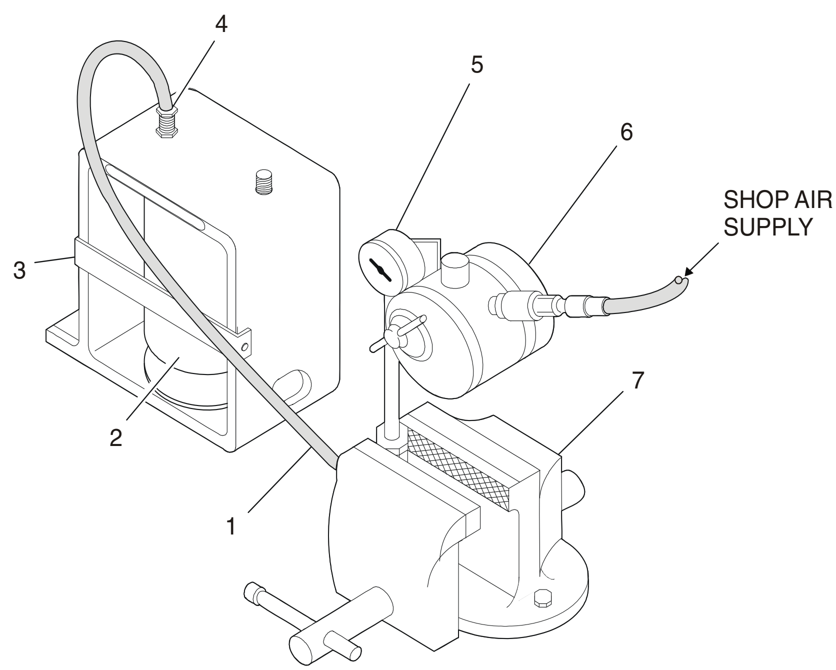
4.2.6. Cleaning & Inspection

1. Clean air springs with soap and water.
2. Check condition of mounting studs and threaded hole.
3. Examine piston for cracking or damage.
4. Examine the bellows assembly for cracks in the rubber or physical damage.

4.2.7. Leak Test Procedure

Test the air springs assembly (positioned in safety cage) for leakage using the pressure test fixture illustrated and the following procedure: See “Fig. 1-38: Leak Test Fixture” on page 33.

1. Thread male end of quick disconnect into air inlet hole of housing.
2. Connect air line and raise air pressure initially to approximately 45 to 55 psi. Air springs should now be properly seated in housing. Check bead ring area for air leaks using a solution of soapy water.
3. If no air leakage is present, raise air pressure to a maximum 120 psi.
4. Disconnect air line, remove test fitting and remove air springs assembly from safety cage.



1. Flexhose
2. Air Spring Assembly
3. Safety Cage
4. Quick Disconnect Fitting
5. Air Gauge
6. Pressure Regulator
7. Bench Vise

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Fig. 1-38: Leak Test Fixture

4.2.8. Installation

☞**NOTE:**

Refer to 4.5. “Front Suspension Torque Specifications” on page 43 *in this section for all installation torque values.*

1. Raise the vehicle using wheel lifts or center post lift. Refer to the General Information Section of this manual for procedure.
2. Use safety stands under frame to hold vehicle in position.
3. Lower wheel lift until there is a 3" (76 mm) space between axle and axle bumper.
4. Align stud in bottom of air spring with holes in mounting plate. Install bolts and torque to specification.
5. Install nuts on upper air spring studs and torque to specification.
6. Lower vehicle.

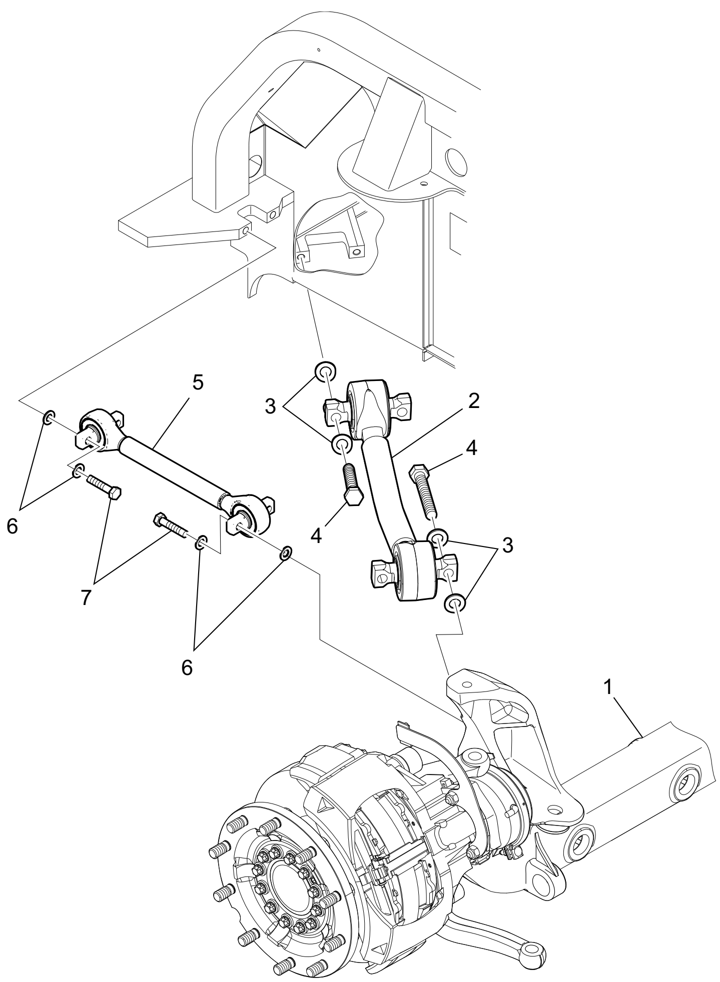
4.2.9. Functional Tests

1. Run engine to build up air pressure.
2. Check for air leaks.
3. Test drive vehicle to verify ride quality and silence of operation.

4.3. Front Radius Rods

4.3.1. Description

The upper radius rods are attached to the spring towers and to the chassis. The lower radius rods are attached to the center of the axle beam and the lower front chassis cross member. See “Fig. 1-39: Upper & Lower Radius Rod Installation” on page 35.



1. Front Axle
2. Lower Radius Rod
3. Washer
4. Bolt
5. Upper Radius Rod
6. Washer
7. Bolt

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Fig. 1-39: Upper & Lower Radius Rod Installation

4.3.2. Upper Radius Rod Specifications

Manufacturer.. MAN

Construction.....Steel body, rubber bushings

Tensile Strength ....70,000 psi

Cross Pin Angle ....0° offset

Mounting Bolt Size M14

4.3.3. Lower Radius Rod Specifications

Manufacturer.......................... ZF Lemforder

Construction.....Steel body, rubber bushings

Tensile Strength ....70,000 psi

Cross Pin Angle ....1° offset

Mounting Bolt Size M18

4.3.4. Operation

The four radius rods hold the axle in alignment to the chassis as it oscillates and moves up and down. Pivot points are rubber bushed to allow movement without transmitting noise or vibration. Shims installed between a radius rod and its mounting point are used to set front axle alignment.

4.3.5. Front Radius Rod Troubleshooting

Drive the vehicle while listening for rattling or clunking sounds as the suspension reacts to surface irregularities. Also listen for clunking sounds when transitioning between acceleration and braking. If noise is evident inspect radius rod mounting hardware and condition of bushings.

4.3.6. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled inspection intervals.

4.3.7. Removal

⚠CAUTION

DO NOT attempt to remove more than one radius rod at a time. Removing two or more radius rods will cause the axle to become unstable.

1. Raise the vehicle. Refer to the General Information Section of this manual for lifting procedures.

☞NOTE:

Radius rod replacement should be done at vehicle ride height to ensure the radius rod bushing is in a neutral load position. The use of wheel lifts is recommended or alternatively supporting the axles with jack stands.

2. Remove the radius rod mounting bolts while taking note of the washer locations and quantity.

☞NOTE:

The hardened washers located between the radius rod cross-pin and the axle or vehicle structure serve as shims for alignment purposes. Always replace washers at each location with the same quantity as originally removed.

3. Remove the radius rod from the vehicle.

4.3.8. Lower Radius Rod Bushing Replacement

☞**NOTE:**

The upper radius rod bushings are not replaceable. Replace the complete radius rod as an assembly if bushings are worn or damaged.

1. Place radius rod on a hydraulic press with snap-ring groove facing up.

☞**NOTE:**

The bushing must be compressed before the snap-ring can be removed.

2. Select a pressing sleeve that will seat on the metal shell of the bushing. Do not press on the rubber portion of the bushing.
3. Slowly compress the bushing until pressure is relieved from the snap ring.
4. Use snap ring pliers to remove the snap ring. Discard snap ring.
5. Reverse the position of the radius rod and tap out the bushing.

☞**NOTE:**

If the bushing is heavily corroded, it may be necessary to remove the bushing with the hydraulic press.

6. Clean and inspect snap-ring groove for wear or damage.
7. Use a wire brush or scraper to remove any rubber that has transferred to the bore of radius rod.
8. Apply lubricant, supplied in kit, to the bushing O.D. and the I.D. of the radius rod bore.
9. Insert bushing into bore of radius rod so that the cross-pin angle is properly aligned. See “Fig. 1-40: Front Lower Radius Rod Bushing Replacement” on page 38.
10. Use a pressing sleeve and press on the metal shell of the bushing sufficiently to compress the bushing and allow insertion of the snap-ring into the groove.
11. Use snap-ring pliers to insert snap-ring into groove. Ensure snap-ring is fully seated.

☞**NOTE:**

The snap-ring should be positioned so that the opening of the snap-ring is facing downward and toward the radius rod tube at a 45° angle.

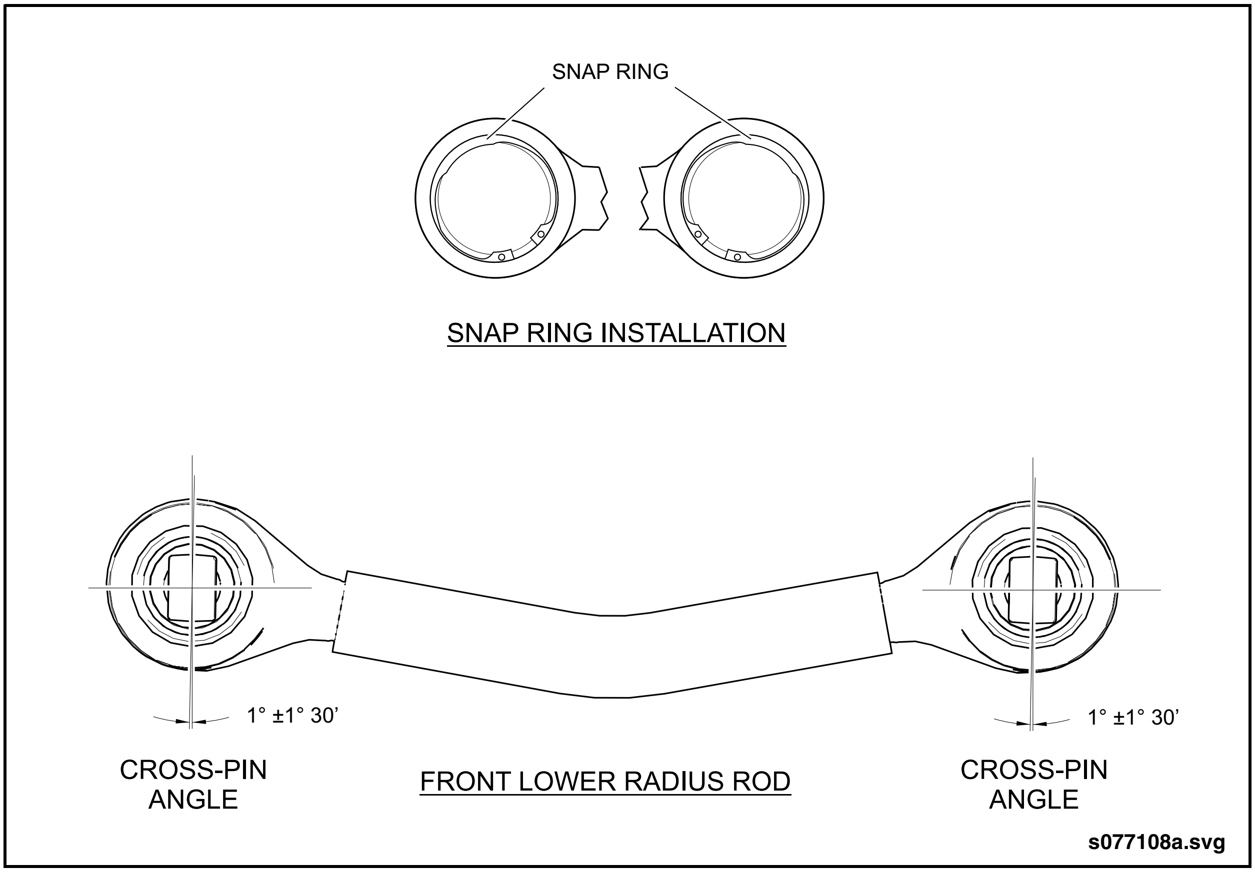


Fig. 1-40: Front Lower Radius Rod Bushing Replacement

4.3.9. Installation

NOTE:

Refer to 4.5. “Front Suspension Torque Specifications” on page 43 in this section for all installation torque values.

1. Install the radius rod in its original location and orientation using the same location and quantity of washers as originally removed. Ensure the bend in the radius rod tube is pointing downward.

   NOTE:

   The mounting bolts should install freely without having to twist or forcibly align the mounting holes in the cross-pin. If difficulty is experienced aligning the radius rod mounting holes with the vehicle structure or axle, remove the radius rod for closer examination and ensure the bushing and cross-pin were installed at the proper angle.

2. Apply Never-Seez® to fastener threads and torque bolts to specification.

4.3.10. Functional Test

Test drive vehicle and check for proper suspension action without noise or vibration.

4.4. Front Shock Absorbers

4.4.1. Description

The two front shock absorbers are a double-acting, telescoping type and consist of a piston, a piston rod, a working cylinder, a reservoir cylinder, a main valve assembly, a bypass valve assembly, and a compression (footvalve) valve assembly. The shock absorbers can be adjusted to compensate for loss of rebound damping force caused by wear of moving parts. These units are of welded construction and cannot be repaired.

4.4.2. Front Shock Absorbers Specifications

Make .... Koni

Model 90-2517

Mounting .... Top pin, bottom pin

Collapsed Length................................ 15.5"

Extended Length................................. 24.5"

Stroke .... 9.0"

4.4.3. Operation

The function of the shock absorber is to absorb the energy caused by movement of the suspension. The shock absorber makes two movements, a bump stroke and a rebound stroke.

❒ Bump Stroke

During the bump stroke, the piston and rod travel into the cylinder. Oil flows from below the piston through orifices and into the upper part of the cylinder, thus equalizing pressure in the cylinder. The piston rod entering the cylinder displaces oil which escapes through the compression valve. The restriction of oil flow through the compression valve produces the bump damping force of the shock absorber.

❒ Rebound Stroke

When the piston and rod travel upwards, oil above the piston is trapped and forced through orifices in the piston and rod. The bypass valve is forced open when the pressure generated by the oil overcomes the force of the bypass valve spring. The resistance to oil flow produces the rebound damping force. The void caused by the piston rod exiting the cylinder is filled with oil from the reservoir entering the cylinder through the compression valve.

4.4.4. Front Shock Absorber Troubleshooting

Perform the following operational test if vehicle ride deterioration is experienced or if shock absorber failure is suspected:

1. Drive the vehicle at moderate speeds for at least 15 minutes to bring shock absorbers up to normal operating temperature.
2. Within a few minutes of driving the vehicle, touch each shock absorber carefully on its body below the dust cover or tube, after first touching a nearby part of the chassis to establish a reference ambient temperature of the metal.
3. All shock absorbers should be warmer than the chassis. A shock absorber that is noticeably cooler than the other shock(s) on the same axle indicates a possible internal failure and warrants removal of the shock absorber for further inspection.
4. Remove the suspected shock absorber and inspect for internal failure by shaking the shock. The rattling sound of internal parts indicates a failure.
5. Inspect the shock absorber for loss of damping force. Refer to 4.4.6. “Cleaning & Inspection” on page 41 in this section for procedure. Replace shock absorber if defective.

☞**NOTE:**

Only replace the shock absorber that is defective. Although it is not necessary to replace shock absorbers in sets, it is recommended that the other shock absorber(s) be given a thorough inspection.

4.4.5. Removal

CAUTION

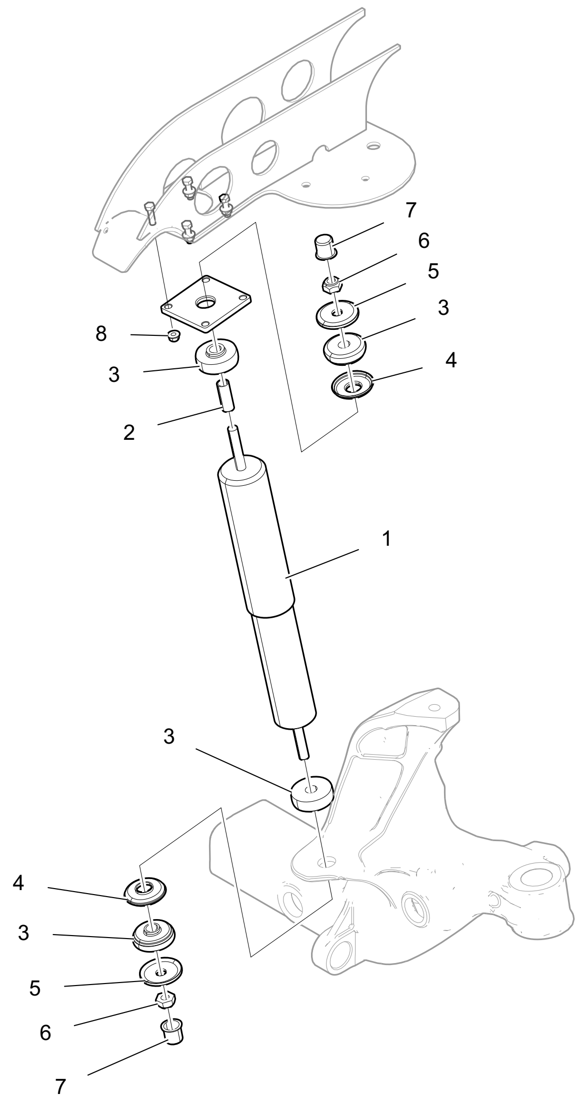
ALWAYS support the weight of the axle when replacing shock absorbers.

1. Raise the vehicle. Refer to the General Information Section of this manual for lifting procedures. Follow all applicable safety requirements.

NOTE:

The upper shock mount requires removal of the mounting plate in order to access the top mounting nut.

2. Remove the four nuts retaining the upper shock mounting plate to the chassis bracket. See “Fig. 1-41: Shock Absorber Installation” on page 40.
3. Remove the protective cap from the lower shock mounting nut and remove the nut.
4. Remove the clamping plate, rubber bushing, and centering ring from the shock stud, noting the location and orientation of the parts.
5. Compress the lower shock sufficiently to remove the shock stud from the lower mounting bracket. Remove the remaining rubber bushing from the shock stud.
6. Remove the shock absorber assembly from the vehicle and disassemble the upper mounting components as follows:
   a. Remove the protective cap from the upper shock mounting nut and remove the nut.
   b. Remove the clamping plate, rubber bushing, and centering ring from the shock stud, noting the location and orientation of the parts.
   c. Remove the remaining mounting plate, rubber bushing and steel sleeve from the shock stud.



1. Shock Absorber Assembly
2. Steel Sleeve
3. Rubber Bushing
4. Centering Ring
5. Clamping Plate
6. Rubber Bushing
7. Nut Cap
8. Flange Nut

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Fig. 1-41: Shock Absorber Installation

4.4.6. Cleaning & Inspection

1. Discard rubber bushings and mounting hardware.
2. Check condition of threads on each end of the bayonet mounting studs.
3. Check for leakage at the piston rod seal. Leakage can most easily be seen with the shock fully extended and will appear as a stream of fluid originating from the piston rod seal.

☞NOTE:

DO NOT replace shock absorbers that exhibit misting. Misting is a normal condition that results from very small amounts of shock fluid evaporating at high operating temperatures through the upper rod seal. This vapor condenses when it reaches the cooler outside air and deposits a film on the outside of the shock body, which in time will attract road debris and dust to form a layer of grime. The evaporation of fluid through the rod seal area helps lubricate and prolong the life of the seal.

4. Inspect the exterior of the shock absorber tube for dents or other physical damage.
5. Inspect the piston rod for bending, scoring, nicks, or other surface imperfections.
6. Hold the shock in its installed position, push in and pull out on the piston rod, while holding the other end stationary to check for bump (compression) and rebound (extension) damping. The shock absorber should extend and compress smoothly in both directions, although more force will be required in extension than compression.

4.4.7. Adjustment

☞NOTE:

The shock absorbers fitted on this vehicle feature adjustable rebound damping. This adjustment can be used to compensate for loss of damping force or additional vehicle weight. New shock absorbers are designed for optimal performance at the minimal damping setting and should be installed as received. Adjust shock absorbers that exhibit deteriorated damping characteristics using the following procedure. Ensure that both shock absorbers on a common axle are adjusted equally.

1. Remove shock absorbers from vehicle in accordance with preceding instructions.
2. Clamp the lower end of the shock absorber in a vise, being careful not to damage the threaded end of the stud.
3. Collapse the shock absorber while slowly rotating it counterclockwise. As it nears the fully collapsed position, the cams on the internal adjusting nut should engage the recesses of the footvalve and a slightly increased resistance to rotation should be felt.
4. Maintain slight pressure on the shock absorber in the fully collapsed position while rotating it counterclockwise and recording the number of turns until the internal stop is reached.
5. Readjust the shock absorber by rotating it clockwise while maintaining slight pressure on the shock absorber in the fully collapsed position. Return the shock absorber to its original setting and rotate an additional 1/2 to 1 full turn to provide increased damping.
6. Pull the piston rod straight out approximately 1/2", without rotating the shaft, until the internal adjusting nut disengages the footvalve.

☞NOTE:

The shock absorber has a range of adjustment of approximately 2 to 3 full turns between the internal stops. DO NOT force rotation of the shock absorber beyond this range.

4.4.8. Installation

1. Assemble the upper shock mounting components as follows:
   a. Slide the steel sleeve and rubber bushing onto the shock stud. Ensure that the flat side of the rubber bushing seats against the shock body.
   b. Place the mounting plate onto the rubber bushing ensuring that the mounting plate seats on the pilot diameter of the rubber bushing.
2. Assemble the remaining upper shock mounting components as follows:
   a. Slide the centering ring and rubber bushing onto the shock stud ensuring that the pilot diameter of the rubber bushing seats within the concave side of the centering ring.
   b. Install the clamping plate onto the rubber bushing ensuring that the concave side of the clamping plate seats against the flat side of the rubber bushing.
   c. Install the M16 self-locking nut and torque to specification.
   d. Install the protective cap over the lock nut.
3. Align the four holes in the upper shock mount plate with the studs on the chassis mounting bracket.
4. Install four lock nuts and torque nuts to specification.
5. Assemble the lower shock mounting components as follows:
   a. Slide the rubber bushing onto the shock stud ensuring that the flat side of the rubber bushing seats against the shock body.
   b. Compress the shock sufficiently to allow the shock stud to enter the lower mounting bracket.
6. Assemble the remaining lower shock mounting components as follows:
   a. Slide the centering ring and rubber bushing onto the shock stud ensuring that the pilot diameter of the rubber bushing seats within the concave side of the centering ring.
   b. Install the clamping plate onto the rubber bushing ensuring that the concave side of the clamping plate seats against the flat side of the rubber bushing.
   c. Install the M16 self-locking nut and torque to specification
   d. Install protective cap over the lock nut.

4.4.9. Functional Test

Road test the vehicle to confirm compliant suspension action and quiet operation. Also check for any evidence of rubbing during operation.

4.5. Front Suspension Torque Specifications

See "Fig. 1-42: Front Suspension Torque Points" on page 45.

FRONT SUSPENSION TORQUE SPECIFICATIONS

ITEM	DESCRIPTION	QTY. (per axle)	BOLT	NUT	TORQUE ft-lb. (Nm)
1	Upper Radius Rod to Frame	4	M14		105 ft-lb. (142 Nm) NEVER-SEEZ®
2	Lower Radius Rod to Frame	4	M18		230 ft-lb. (310 Nm) NEVER-SEEZ®
3	Upper Radius Rod to Axle	4	M14		105 ft-lb. (142 Nm) NEVER-SEEZ®
4	Lower Radius Rod to Axle	4	M18		230 ft-lb. (310 Nm) NEVER-SEEZ®
5	Lower Shock Mounting Nut	2		M16 x 1.5	56 ft-lb. (76 Nm) NEVER-SEEZ®
6	Upper Shock Mounting Nut	2		M16 x 1.5	56 ft-lb. (76 Nm) NEVER-SEEZ®
7	Upper Shock Mounting Plate to Frame	8		3/8" - 16	35 ft-lb. (47 Nm) NEVER-SEEZ®
8	Lower Air Spring to Mounting Plate	2		1/2" UNC Lock	25 to 35 ft-lb. (34 to 47 Nm) NEVER-SEEZ®
9	Upper Air Spring to Frame	2		3/4" UNF	45 ft-lb. (60 Nm) NEVER-SEEZ®
10	Upper Air Spring to Frame	2		1/2" UNC Lock	20 ft-lb. (27 Nm) NEVER-SEEZ®
11	Brake Chamber to Mounting Bracket	4		M16 x 1.5	Initial Torque: 25 ft-lb. (34 Nm) Final Torque: 135 ft-lb. (183 Nm) NEVER-SEEZ®
12	Tie Rod End Clamp Lock Nut	1		M14 x 1.5 Lock	125 ft-lb. (170 Nm) NEVER-SEEZ®
13	Wheel Nut	20		M22 x 1.5	450 to 500 ft-lb. (610 to 680 Nm)
14	Power Steering Gear Mounting Plate to Frame	4	3/4" UNC	3/4" UNC Prevailing Torque	157 to 173 ft-lb. (213 to 235 Nm) NEVER-SEEZ®

FRONT SUSPENSION TORQUE SPECIFICATIONS					
ITEM	**DESCRIPTION**	**QTY. (per axle)**	**BOLT**	**NUT**	**TORQUE ft-lb. (Nm)**
15	Power Steering Gear to Mounting Plate	5	M20 x 1.5"		350 ft-lb. (475 Nm) NEVER-SEEZ®
16	Drag Link to Pitman Arm & Steering Arm	2		Castle Nut	95 to 115 ft-lb. (129 to 156 Nm) NEVER-SEEZ®
17	Drag Link Tie Rod End Clamp Bolt	2		M12	59 to 70 ft-lb. (80 to 90 Nm) NEVER-SEEZ®
18	Steering Driveshaft Yoke Pinch Bolt	2	M10		50 ft-lb. (68 Nm)
19	Steering Miter Box to Frame Bolt	3	3/8" UNC		25 to 30 ft-lb. (34 to 40 Nm) Loctite-272
20	Tie Rod End Nut	2		M24	221 ft-lb. (300 Nm) NEVER-SEEZ®
21	Steering Arm	2	M22 x 1.5 Torx Socket Head		500 ft-lb. (680 Nm)
22	Tie Rod Arm	4	M22 x 1.5 Torx Socket Head		500 ft-lb. (680 Nm)

☞**NOTE:**

All bolts and nylon locknuts are Grade 8 and yellow zinc dichromate coated.
All fasteners are dry unless otherwise noted.

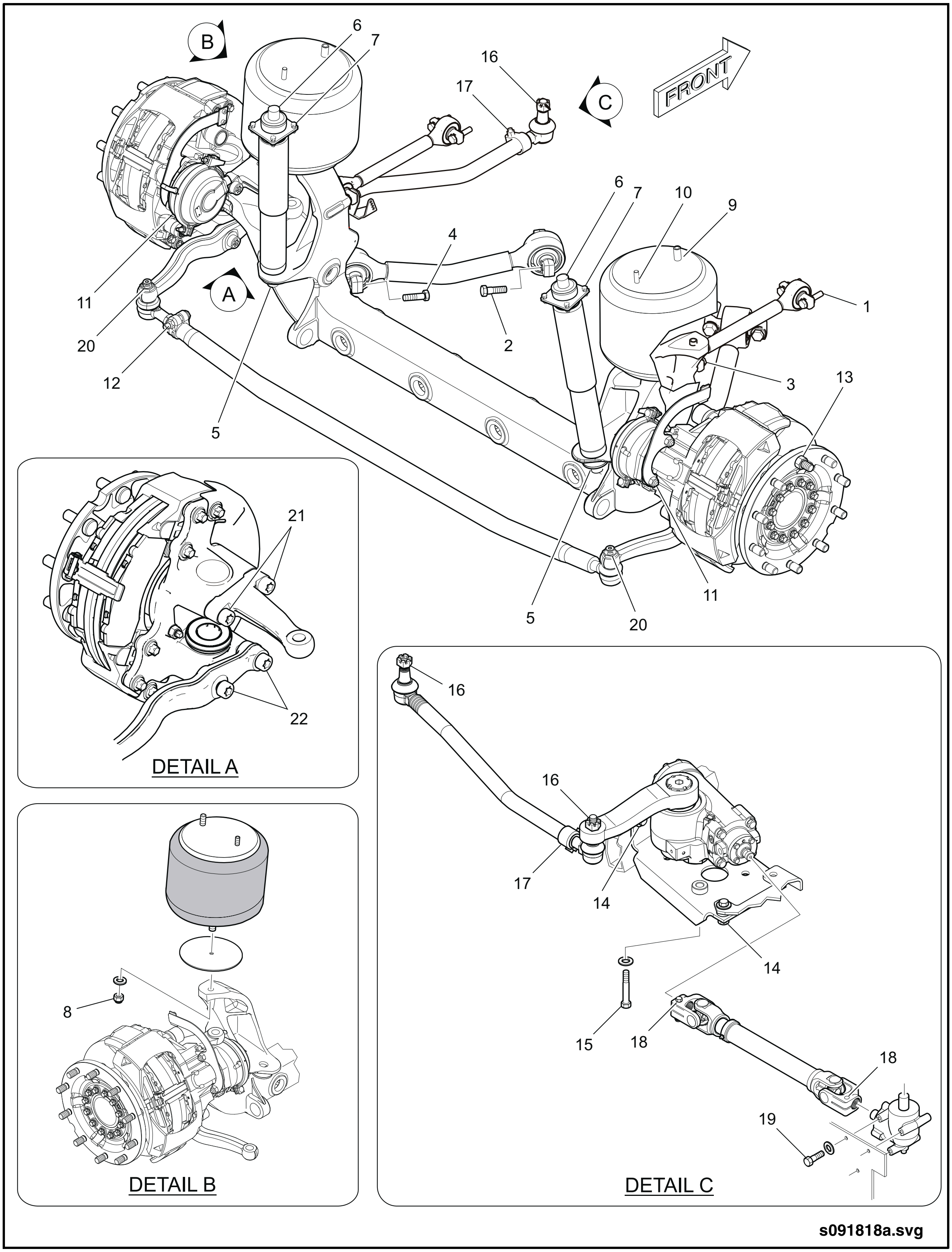


Fig. 1-42: Front Suspension Torque Points

5. FRONT BRAKE SYSTEM

5.1. Description

The front brake system includes:

- ❒ Front Disc Brakes
- ❒ Brake Chambers
- ❒ Anti-Lock Braking (ABS) System

Refer to 5.2. “Front Disc Brakes” on page 46 in this section for information on the disc brakes. Refer to 5.3. “Front Brake Chambers” on page 71 in this section for information on the brake chambers. Refer to 6. “FRONT AXLE ANTI-LOCK BRAKING SYSTEM (ABS) & COMPONENTS” on page 75 in this section for information on the ABS System.

5.2. Front Disc Brakes

5.2.1. Description

The front disc brakes includes the brake caliper, brake carrier, disc pads, and brake disc. See “Fig. 1-43: Disc Brake Assembly” on page 47.

5.2.2. Front Disc Brakes Specifications & Wear Limits

Manufacturer .... Knorr-Bremse

Model..SN 7000

Type.................. Air-actuated sliding caliper

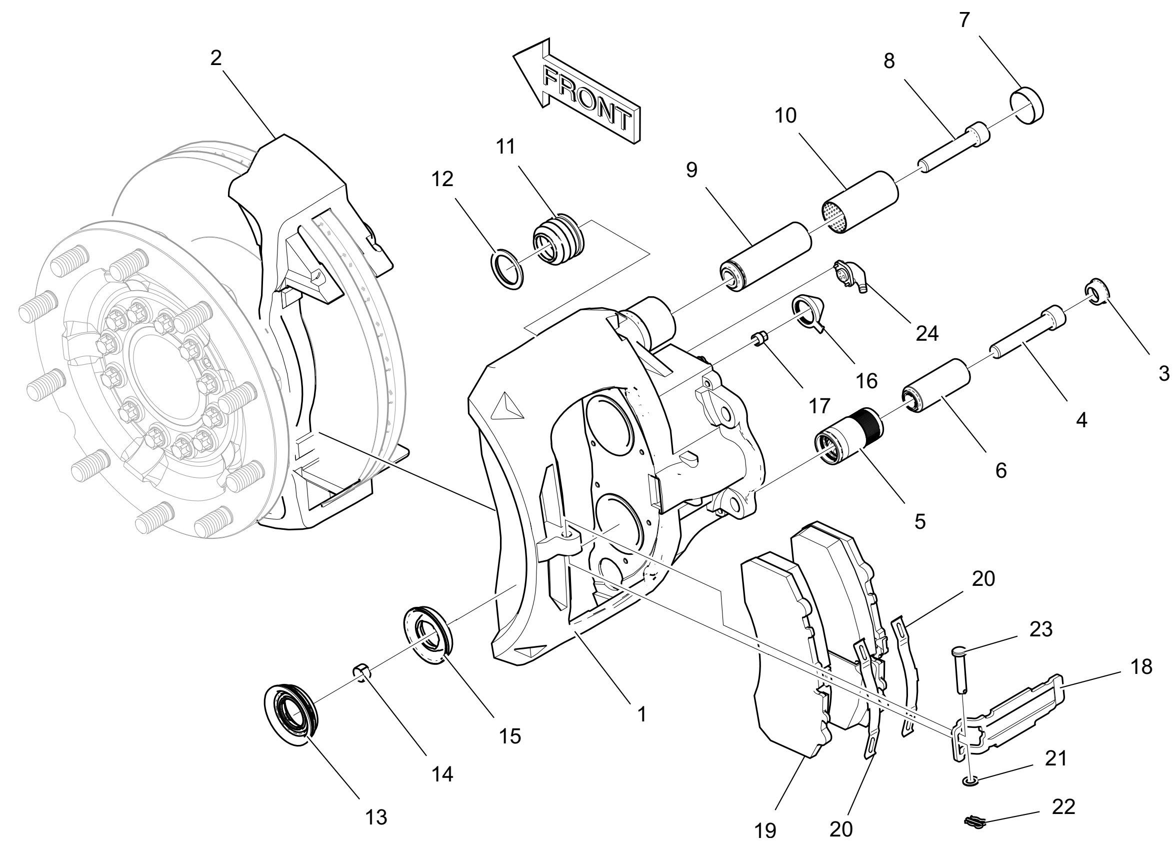
Brake pad clearance
.............0.028 to 0.047" (0.7 to 1.2 mm)

Brake pad thickness (min)
....0.08" (3.0 mm)

Brake disc thickness (min)
......................................1.457" (37 mm)

Brake disc lateral run-out (max)
...................................0.006" (0.15 mm)

Brake caliper guides (max play)
.....................................0.079" (2.0 mm)



1. Disc Brake Caliper Assembly, Front Streetside without Lining (Incl. 2-17)
2. Carrier
3. Cap
4. Cap Screw, Hex Socket Head M16 x 1.5 x 80
5. Bushing, Rubber
6. Pin, Guide
7. Cover
8. Cap Screw, Hex Socket Head M16 x 1.5 x 90
9. Pin, Guide
10. Bushing, Brass
11. Boot, Inner
12. Ring
13. Tappet & Boot Assembly
14. Bushing, Toppet
15. Seal, Inner
16. Cap, Adjuster
17. Adapter, Shear
18. Pad Retainer
19. Pad
20. Spring, Pad Retainer N2G
21. Washer
22. Clip, Spring
23. Pin, Pad Retainer
24. Plug, EBS Port

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Fig. 1-43: Disc Brake Assembly

5.2.3. Operation

☞**NOTE:**

When reviewing the following information on the operation of the disc brake assembly See "Fig. 1-44: Disc Brake Cross Section" on page 49.

During brake application the push rod of the brake chamber extends and moves the actuator lever in the brake caliper. This input force is transferred by an eccentric roller bearing to the bridge section of the caliper. This force is then distributed by the bridge and two threaded tubes to the tappets. The tappets apply force directly to the inboard brake pad. Once the running clearance between the brake pads and brake disc have been overcome, the reaction forces are transmitted by the sliding caliper to the outboard brake pad. The clamping force of the brake pads on the brake disc generates the braking force.

When brake pressure is released, the return spring within the caliper forces the bridge section along with the threaded tubes and lever back to the starting position.

An automatic adjuster mechanism is used to ensure consistent running clearance between the brake pads and brake disc. The adjuster is mechanically connected to the lever and will operate each time the brakes are applied. The running clearance between the pads and brake disc increases as the brake pads wear. This increased clearance will allow the adjuster mechanism to rotate slightly. A drive chain transfers this movement to both threaded sleeves, which rotated inward equally. The rotational inward movement of the threaded sleeves and tappets effectively takes up the additional running clearance as the brake pads wear.

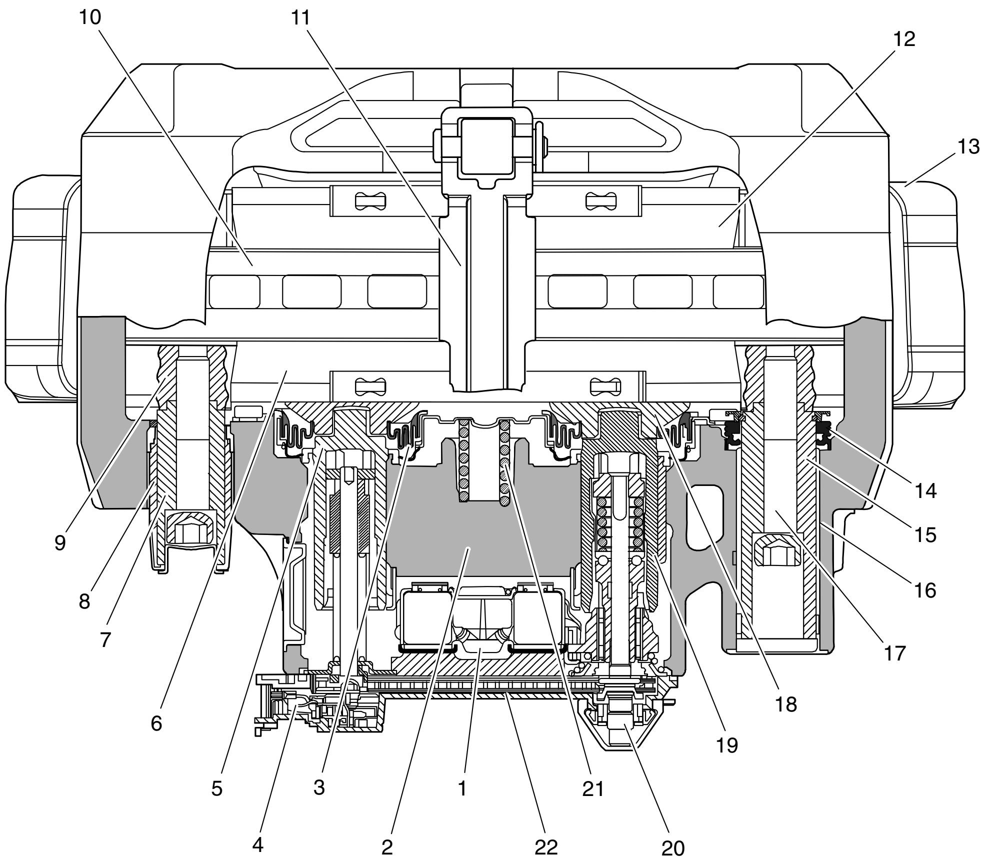
5.2.4. Inspection

The following inspections may be performed with the brake caliper assembly installed on the axle, providing that the following preparatory steps have been taken.

1. Vehicle raised to working height and properly supported with jack stands.
2. Wheel and tire assembly removed.

☞**NOTE:**

Refer to the Preventive Maintenance Section of this manual for the scheduled interval at which the following inspections are to be performed.



1. Actuator Lever	9. Brake Carrier	17. Caliper Bolt
2. Brake Caliper	10. Brake Disc	18. Tappet
3. Tappet Boot	11. Brake Pad Retainer	19. Threaded Tube
4. Wear Sensor	12. Outer Brake Pad	20. Adjuster
5. Threaded Tube	13. Brake Carrier	21. Return Spring
6. Inner Brake Pad	14. Inner Boot	22. Drive Chain
7. Lower Guide Pin	15. Upper Guide Pin	
8. Bushing	16. Brass Bushing	**s122203a.wmf**

Fig. 1-44: Disc Brake Cross Section

5.2.4.1. Adjuster Check

1. Before starting work, ensure that the wheels are chocked and the vehicle cannot roll away.
2. Ensure that service brake and parking brake are in the released condition.
3. Check the supply pressure of the brake system. Connect an additional external supply to prevent pressure drop.
4. Check the brake disc temperature; it should be between 14°F and 122°F (-10°C and 50°C).
5. Push and pull caliper three times in the axial direction to assess any existing air gap. If no movement is possible, clean the disc brake and if necessary, replace the caliper guide pins. Refer to 5.2.7. “Caliper Guide Pins” on page 62 in this section for procedure. Once movement is obtained, continue to step 8.

⚠ CAUTION

Removal of the adjuster cap with a screwdriver, or similar tool, is not allowed. Damage to the seal may result.

6. Pull off the adjuster cap using the tag, taking care not to lose the shear adapter.

⚠ WARNING

Ensure that the brake chamber (service and parking/emergency) is not exerting any pressure on the brake caliper during this test.

7. Push the brake caliper towards the middle of the vehicle.
8. Push brake lining away from tappets.
9. Check the gap between each of the whole tappet surface of both tappets using two feeler gauges simultaneously (feeler gauges must be at least 200 mm long). Each gap must measure between 0.028 to 0.047" (0.7 to 1.2 mm). If the clearance deviates from the specified value, reset and recheck the clearance with new brake pads by proceeding to step 10.
10. Insert new brake pads. Refer to 5.2.5. “Brake Pads” on page 58 in this section for procedure.
11. Set the starting gap by turning the adjuster with the shear adapter backwards and then forwards until a value of 1.3 mm air gap has been achieved (measure between the brake pad and Tappets).

☞NOTE:

When turning backwards a noticeable clicking can be heard and felt.

12. Apply the brakes 20 times with medium pressure (approximately 30 to 40 psi (2 to 3 bar).
13. Check the gap between each of the tappets and inboard pad backplate. Each gap must measure between 0.028 to 0.047" (0.7 to 1.2 mm).

    This must be measured over the whole tappet surface of both tappets using two feeler gauges simultaneously (feeler gauges must be at least 220 mm long). See “Fig. 1-45: Measuring Tappet to Brake Pad Gap” on page 51.

    a. If the air gap is larger than 1.2 mm, proceed to step 14.

    b. If the air gap is smaller than 6 mm, proceed to step 17.

    Additionally, if the gap difference between the two tappets is greater than 0.25 mm then the caliper guide pin clearance must be checked. Refer to 5.2.4.4. “Caliper Guide Pin Inspection” on page 55 in this section for procedure. If the caliper guide pin play is within specification, then the tappets have lost synchronization and the caliper needs to be replaced.

14. If the air gap is larger than 1.2 mm the adjuster must be checked as follows:

    a. Turn the adjuster with adapter 3 clicks counter-clockwise (increasing the air gap).

    CAUTION

    Make sure the wrench or socket can turn freely clockwise during the following procedure.

    b. As a visual aid, position a wrench or socket onto the adjuster (including Adapter. Apply the brake 5 to 10 times (approximately 30 psi (2 bar)), the wrench or socket should turn clockwise (viewed from actuator side) in small increments if the adapter is functioning correctly. See “Fig. 1-46: Checking Adjuster Movement” on page 52.

    c. As the number of applications increases, incremental movement of the wrench or socket will decrease. If the wrench or socket does not turn or turns only with the first application or turns forward and backward with every application, the automatic adjuster has failed and the caliper must be replaced.

15. Lightly grease the contact surface of the adjuster cap with white grease.

    NOTE:

    A new adjuster cap should be fitted even if the brake pads are not being replaced.

16. The tag of the adjuster cap should be positioned to ensure access is maintained for subsequent removal.

17. If the air gap is smaller than 0.6 mm the parameters and functions must be checked as follows:

    a. Apply the brakes to function the brake chamber.

    b. Remove brake chamber. Refer to 5.3. “Front Brake Chambers” on page 71 for procedure.

    c. Check position of lever inside the caliper in its released state.

    d. Inspect the previously removed brake pads. If necessary, remove dirt from brake pads, caliper and carrier.

        i. Check brake pads for wear from the tappets and if necessary replace brake pads.

        ii. Check for abnormal wear of the contact areas of the carrier. If necessary replace the carrier.

    e. Check the brake disc.

18. Check caliper running clearance. Refer to 5.2.4.4. “Caliper Guide Pin Inspection” on page 55 in this section for procedure.

19. Install the brake pads. Refer to 5.2.5. “Brake Pads” on page 58 in this section for procedure.

20. Install the brake chamber. Refer to 5.3. “Front Brake Chambers” on page 71 in this section for procedure.

21. Recheck the adjuster.

22. If the air gap is still smaller than 0.6 mm between both tappets, the brake caliper must be replaced.

23. Install the wheel.

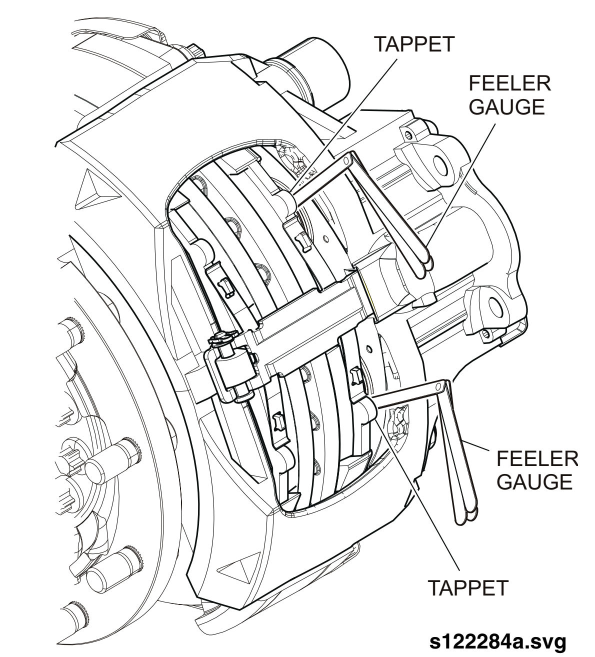


Fig. 1-45: Measuring Tappet to Brake Pad Gap

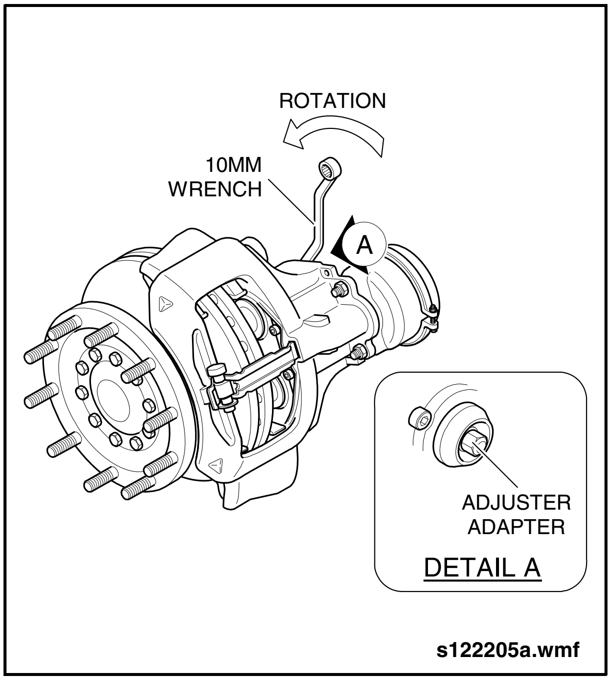


Fig. 1-46: Checking Adjuster Movement

5.2.4.2. Brake Pad Wear Inspection

NOTE:

Brake pad wear can be assessed visually without removing the brake pads using the following procedure.

1. Locate the lower caliper guide pin.
2. Inspect the amount of deformation on the bellows area of the rubber bushing. A fully extended bellows indicates a new brake pad condition. A retracted and bulged bellows (where Dim A <= 1mm) indicates a worn brake pad condition. See “Fig. 1-47: Brake Pad Wear Inspection” on page 53.
3. If a worn condition is indicated, remove the brake pads and measure actual thickness of friction material. Refer to 5.2.5. “Brake Pads” on page 58 in this section for removal procedure. Replace brake pads if measured thickness is less than the specification minimum.
4. If brake pad thickness is within limits, inspect condition of friction surface. Minor material breakout at the edges is permitted but major material breakout is unacceptable. Replace brake pads as necessary.

NOTE:

Replace all brake pads on same axle. DO NOT replace one side only.

5. Measure brake disc thickness. Refer to 5.2.4.3. “Brake Disc Inspection” on page 53 in this section for procedure.

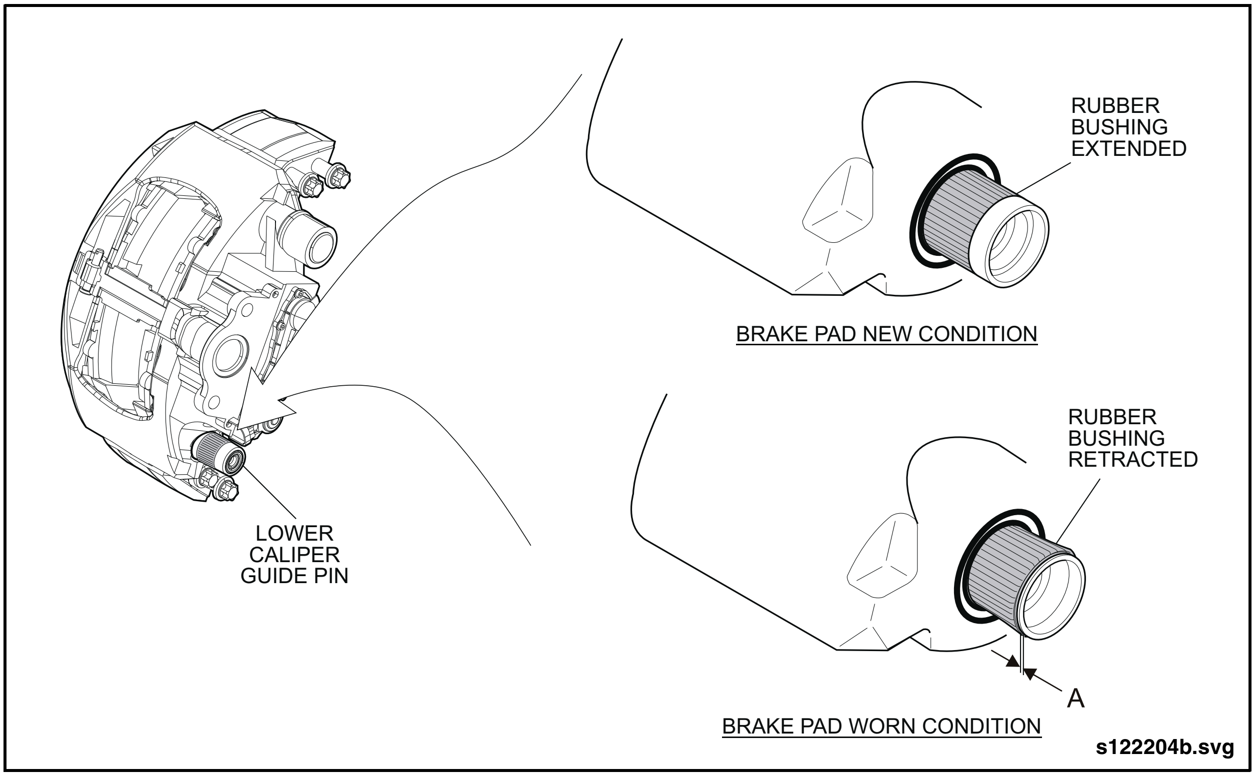


Fig. 1-47: Brake Pad Wear Inspection

5.2.4.3. Brake Disc Inspection

1. Use a measuring caliper (Item 13 from special tools list) to measure brake disc thickness at the thinnest point of the disc, Avoid measuring at the outer edge or a roughened surface. Replace brake disc if thickness is 1.457" (37 mm) or less.

☞NOTE:

If the brake disc measures less than 39 mm when the brake pads are being replaced, replace the disc brake as well.

2. Measure brake disc runout as follows:

☞NOTE:

Confirm that the wheel hub axial play is within limits prior to proceeding with this inspection.

a. Mount dial indicator (Items 29 & 69 from special tools list) so that tip of indicator is perpendicular to brake disc surface at 1.40" (35 mm) down from the outer rim of the rotor. See “Fig. 1-48: Rotor Run-Out Measurement Point” on page 54.

b. Rotate brake disc a complete turn.

c. Total indicated run-out must not exceed 0.006" (0.15 mm).

d. Machine or replace the brake disc if run-out limits are exceeded. Refer to 5.2.9. “Brake Disc” on page 69 in this section for machining procedure.

☞NOTE:

Replace all brake pads on same axle. DO NOT replace one side only.

3. Inspect the brake disc for cracks and scoring. See “Fig. 1-49: Brake Disc Condition” on page 54.

    a. Minor web-like cracks on the braking surface are acceptable. Refer to area “A” shown on illustration.

    b. Cracks less than 0.019" (0.5 mm) deep or wide and running in a radial direction are acceptable providing the cracks do not extend over more than 75% of the width of the braking surface. Refer to area “B” shown on the illustration.

    c. Circumferential scoring of the braking surface not to exceed 0.059" (1.5 mm) per side is acceptable. Refer to area “C” shown on illustration.

    d. Cracks extending into the cooling cavity or into the inner support web are unacceptable.

☞NOTE:

Uneven or scored brake disc surfaces may be cleaned up by machining. To meet safety requirements, the minimum thickness after machining must be greater than 39 mm. Replace brake disc if crack or scoring limits are exceeded. Replace both disc brakes on same axle. DO NOT replace one side only.

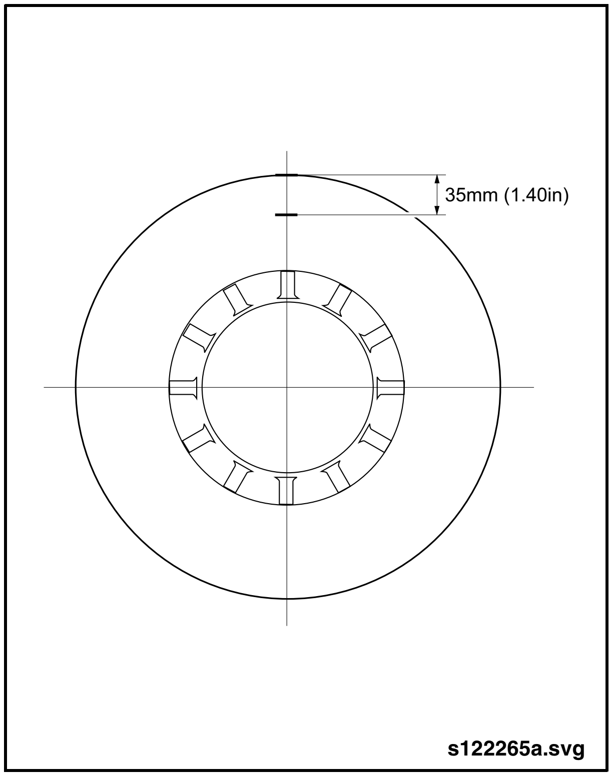


Fig. 1-48: Rotor Run-Out Measurement Point

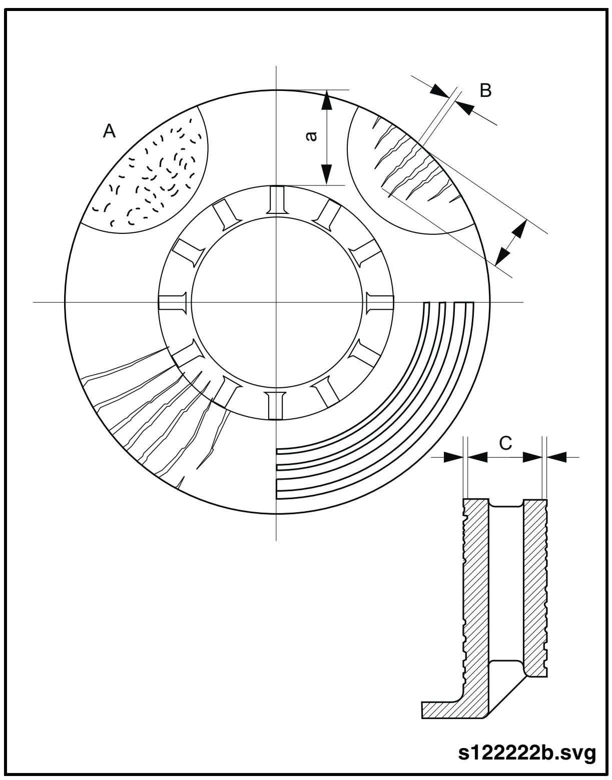


Fig. 1-49: Brake Disc Condition

5.2.4.4. Caliper Guide Pin Inspection

☞NOTE:

Worn caliper guide pins will result in excessive movement in the caliper assembly relative to the brake carrier. Use the following procedure to determine if excessive wear is present:

1. Remove worn brake pads. Refer to 5.2.5. “Brake Pads” on page 58 in this section for removal procedure.

   ☞NOTE:

   Perform brake pad inspection on the removed pad. Refer to 5.2.4.2. “Brake Pad Wear Inspection” on page 52 *in this section for procedure. Replace pads as necessary or reinstall existing pads.*

2. Rewind the tappets back using a wrench and shear adapter. Clean dirt inside and out from guide pin bushing.
3. Lightly apply Fuchs Renolit HLT 2 grease to guide pin.
4. Push the caliper inward fully then pull the caliper outward fully. Movement of the caliper on the guide pins should be smooth throughout the full range of movement (approximately 1.0" (25 mm)). Replace the caliper guide pins if the full range of movement cannot be achieved or if excessive force is required to move the caliper.
5. Temporarily replace the brake pads with a set of new pads during the remainder of this procedure.
6. Check for excessive play in the caliper guide pins as follows:
   a. Pull the caliper fully outward.
   b. Install the adapter onto the brake caliper. See “Fig. 1-50: Adapter Installation” on page 55.
   c. Attach the dial gauge to the floating bearing area with the standing frame in such a way that the tracer pin is under pre-load and pointing towards the recess of the brake caliper. See “Fig. 1-51: Measuring Guide Pin Play” on page 56.
   d. Set the torque wrench to 18 ft-lb. (25 Nm) and push it into the adapter.
   e. Use the torque wrench to push the brake caliper against the driving direction, hold it, and set the dial gauge to “zero”.
   f. Push the brake caliper in the driving direction, hold it, and read the measured value on the dial gauge.
7. Maximum bearing play is 2 mm. If the measured value is outside of the maximum bearing play, replace the brake caliper guides.

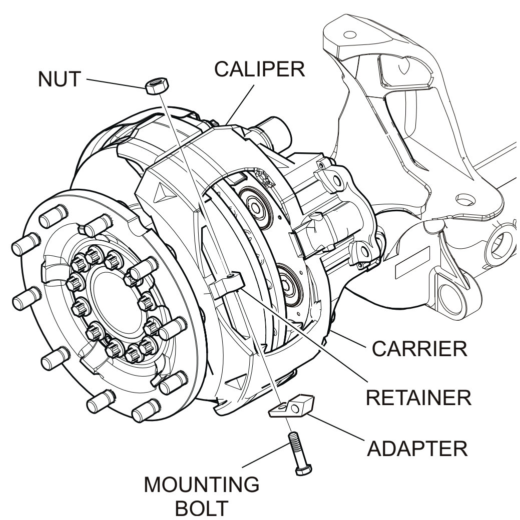


Fig. 1-50: Adapter Installation

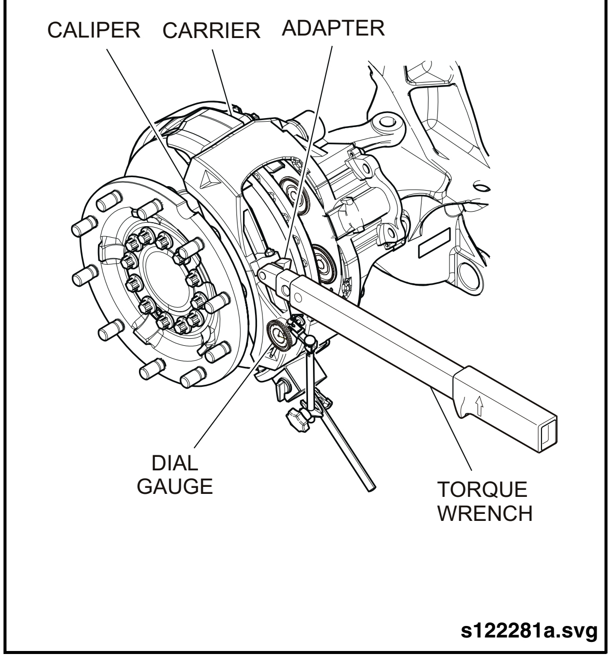


Fig. 1-51: Measuring Guide Pin Play

5.2.4.5. Tappet Rubber Boot Inspection

CAUTION

DO NOT adjust the tappets beyond 1.18" (30 mm) as measured from the surface of the caliper to the tappet thrust face. Turning any further will result in irreparable damage to the adjuster adapter. Penetration of dirt and moisture into the interior of the brake will lead to corrosion and impair the function of the clamping mechanism and the adjusting mechanism.

1. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 58 in this section for removal procedure
2. Rotate the adjuster clockwise until the tappets extend approximately 0.79" (20 mm) from the caliper surface. This will allow full extension of the tappet rubber boot for a proper visual inspection. See “Fig. 1-52: Tappet & Rubber Boot Inspection” on page 57.
3. Inspect the rubber boot for proper seating, wear, cuts, or deterioration. Replace rubber boots as necessary. Refer to 5.2.8. “Tappet & Rubber Boot” on page 66 in this section for replacement procedure.
4. Inspect the tappet thrust surface for scoring, corrosion, or other damage. Replace tappets as necessary. Refer to 5.2.8. “Tappet & Rubber Boot” on page 66 in this section for replacement procedure.

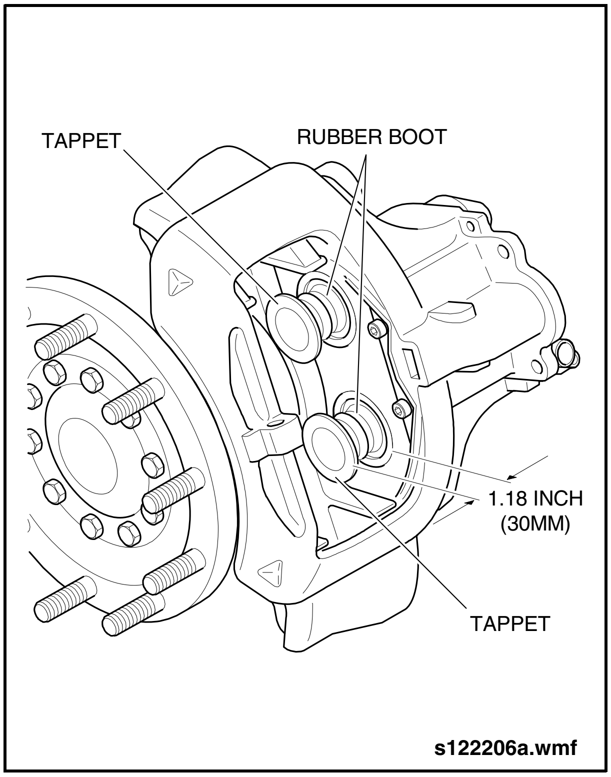


Fig. 1-52: Tappet & Rubber Boot Inspection

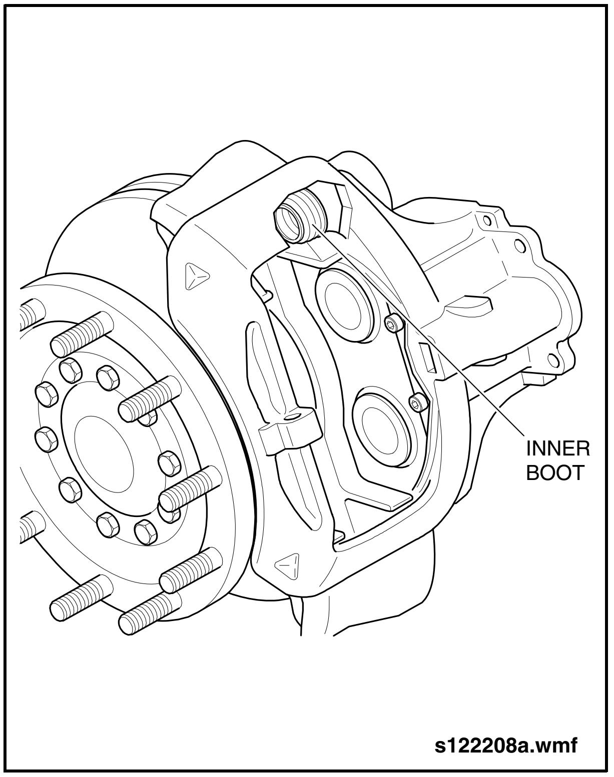


Fig. 1-53: Upper Guide Pin Inner Boot Inspection

5.2.4.6. Upper Guide Rubber Boot Inspection

1. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 58 in this section for removal procedure.
2. Push the caliper fully inward to expose the inner rubber boot on the upper guide pin. See “Fig. 1-53: Upper Guide Pin Inner Boot Inspection” on page 57.
3. Inspect the rubber boot for cracks, tears, wear, or deterioration. Replace as necessary. Refer to 5.2.7. “Caliper Guide Pins” on page 62 in this section for replacement procedure.

5.2.5. Brake Pads

5.2.5.1. Removal

1. Raise the vehicle to working height. Refer to the General Information Section of this manual for procedure.
2. Place jack stands at each of the vehicle jacking points. Lower the vehicle until the weight is taken by the jack stands.
3. Remove wheel and tire assembly.
4. Remove the brake pad retainer as follows:
   a. Remove the spring clip and washer from the retainer pin.
   b. Push down on the retainer and slide out the retainer pin.
   c. Remove the brake pad retainer.
5. Increase brake pad clearance as follows:
   a. Remove the protective cover from the adjuster by using the pull tab. Do not use a screwdriver to pry off the cap, otherwise the seal could be damaged. See “Fig. 1-54: Brake Pad Removal” on page 58.

CAUTION

NEVER attempt to turn the adjuster without using the adjuster adapter. The adapter is designed to shear if excessive force is require to turn the adjuster, thereby preventing damage to internal components. If the adapter is replaced and shears a second time, replace the caliper assembly as internal damage is evident.

   b. Use the adjuster adapter and turn the adjuster counter-clockwise until the brake pads are free.
6. Remove the brake pads from the caliper.

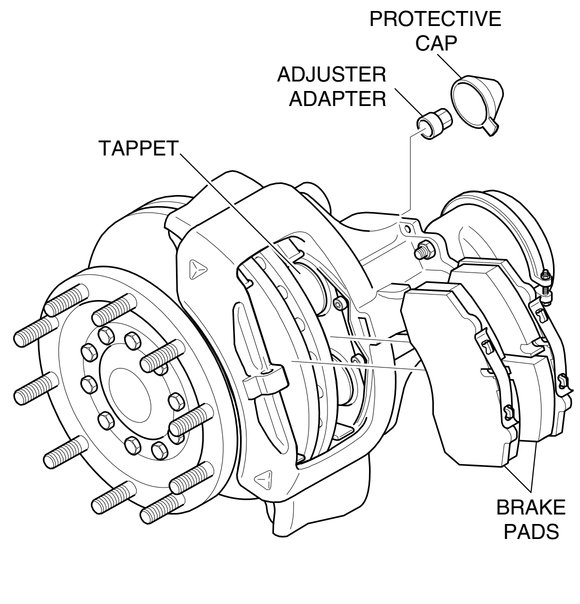


Fig. 1-54: Brake Pad Removal

5.2.5.2. Cleaning & Inspection

WARNING

DO NOT use compressed air to clean brake components as brake dust represents a health hazard.

1. Clean any corrosion or deposits from the brake pad guides using a scraper.
2. Clean away any loose dirt using a damp cloth.
3. Inspect the brake pad retainer and replace if deformed or otherwise damaged.
4. Inspect the rubber boot on the tappet and replace if worn or damaged. Refer to 5.2.8. “Tappet & Rubber Boot” on page 66 in this section for replacement procedure.

5.2.5.3. Installation

☞**NOTE:**

It may be necessary for the abutments of the carrier and guiding surfaces of the brake pad to be coated with a suitable permanent lubricant. See “Fig. 1-55: Areas to Apply Lubricant” on page 59. *The following products are approved for this application: Textar CERA TEC®, ATE Plastilube®, Dow Corning P-40® Paste.*

⚠CAUTION

DO NOT use a copper based lubricant. DO NOT get any lubricant on the pad and/or disc face or guide sleeve parts.

1. Push the brake caliper inward against the stop and insert the inboard brake pad. See See “Fig. 1-56: Brake Pad Installation” on page 60.
2. Pull the brake caliper outward against the stop and insert the outboard brake pad.
3. Install the brake pad retainer as follows:
   a. Insert the inboard end of the pad retainer into the groove and apply sufficient downward pressure to allow insertion of the retaining pin. See “Fig. 1-57: Brake Pad Retainer Installation” on page 60.
   b. Insert new retaining pin and secure with new washer and spring clip.
4. Adjust the brake pad clearance as follows:
   a. Use the adjuster adapter and turn the adjuster clockwise until the pads touch the brake disc surface.
   b. Turn the adjuster back three notches as confirmed by audible clicks.
   c. Actuate the brakes 10 times with minimum 30 psi (2 bar) applied brake pressure. This action will automatically take up any clearance and provide the desired running clearance.
   d. Verify the actual clearance by prying against the inboard brake pad backing plate and using a feeler gauge to measure clearance between the backing plate and tappet. Clearance should be 0.028 to 0.047" (0.7 to 1.2 mm).
5. Lower the vehicle and perform road test to verify satisfactory operation of the brakes.

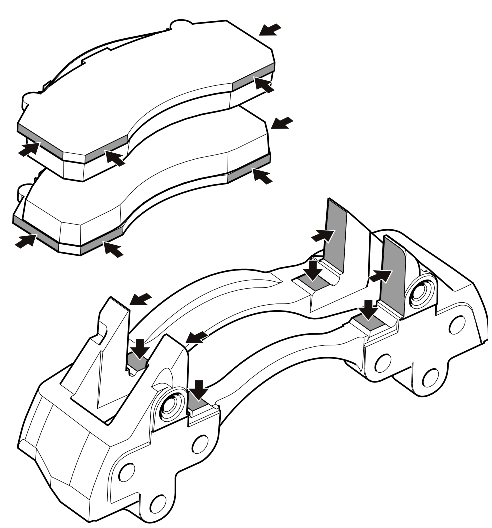


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Fig. 1-55: Areas to Apply Lubricant

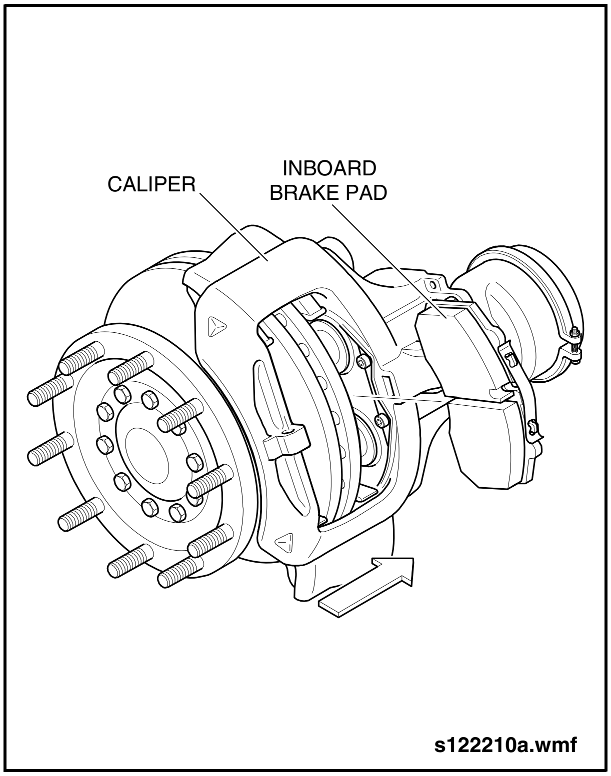


Fig. 1-56: Brake Pad Installation

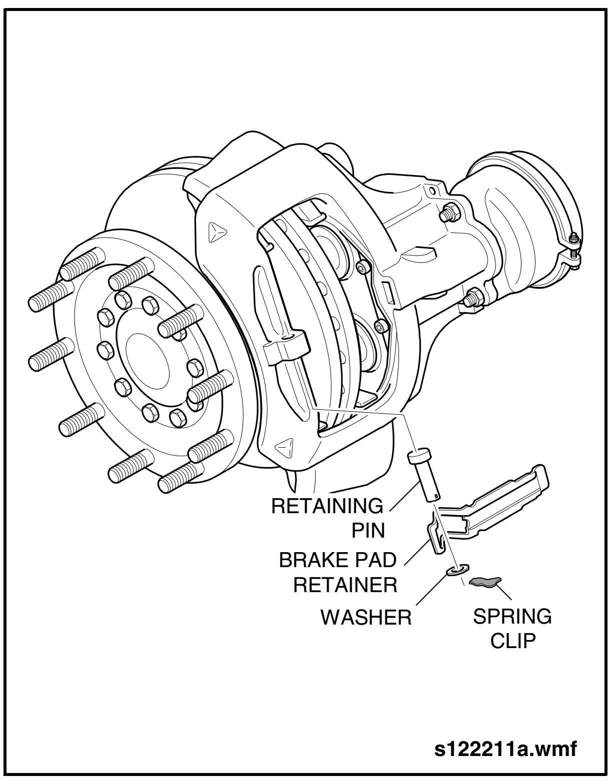


Fig. 1-57: Brake Pad Retainer Installation

5.2.6. Brake Caliper & Carrier Assembly

NOTE:

The following procedure describes removal of the brake caliper and carrier as an assembly from the steering knuckle.

5.2.6.1. Removal

1. Raise the vehicle to working height. Refer to the General Information Section of this manual for procedure.
2. Place jack stands at each of the vehicle jacking points. Lower the vehicle until the weight is taken by the jack stands.
3. Remove wheel and tire assembly.
4. Remove the brake chamber. Refer to 5.3. “Front Brake Chambers” on page 71 in this section for removal procedure.
5. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 58 in this section for removal procedure.

CAUTION

BE SURE to secure the brake caliper to prevent it from falling, prior to removing the mounting bolts. Serious personal injury could result if the brake caliper is allowed to fall.

NOTE:

The tie rod arm must be removed to access the lower caliper mounting bolts. Use internal Torx socket (Item 67 from special tools list) and socket wrench assembly (Items 3, 4, 5, & 6 from special tools list) and remove two M22 bolts from tie rod arm.

6. Install the caliper support fixture (Item 1 from special tools list). See “Fig. 1-58: Brake Caliper Removal” on page 61.
7. Remove the six M18 external torx head bolts that retain the entire caliper and carrier assembly to the steering knuckle and remove the entire caliper and carrier assembly from vehicle. Discard the six mounting bolts.

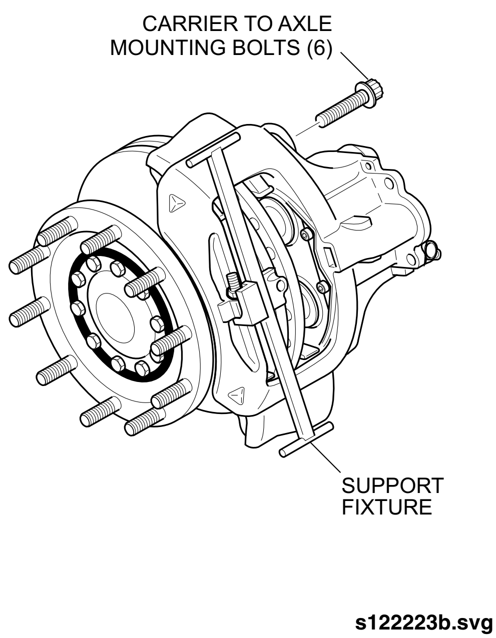


Fig. 1-58: Brake Caliper Removal

5.2.6.2. Installation

1. Install the caliper support fixture (Item 1 from special tools list).
2. Install caliper & carrier assembly onto steering knuckle and install six new M18 external torx head mounting bolts. Tighten the six bolts in an alternating pattern to an initial torque of 184 ft-lb. (250 Nm), then final torque to 288 ft-lb. (390 Nm).
3. Remove the supporting fixture (Item 1 from special tools list).

☞NOTE:

Reinstall tie rod arm using two bolts. Use internal Torx socket (Item 67 from special tools list) and torque wrench assembly (Items 3, 4, 5, & 7 from special tools list) and torque bolts to specification.

4. Make sure the caliper wear sensor port is properly covered and sealed from contaminants prior to placing the vehicle back into service.
5. Install brake pads. Refer to 5.2.5. “Brake Pads” on page 58 in this section for installation procedure.
6. Install brake chamber. Refer to 5.3. “Front Brake Chambers” on page 71 in this section for installation procedure.
7. Install tire and wheel assembly
8. Lower the vehicle and road test the vehicle to verify satisfactory operation of the brakes.

5.2.7. Caliper Guide Pins

☞NOTE:

The following procedure provides removal and installation instructions for the brake caliper guide pins and bushings.

5.2.7.1. Removal

1. Remove the brake chamber. Refer to 5.3. “Front Brake Chambers” on page 71 in this section for removal procedure.
2. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 58 in this section for removal procedure.
3. Remove the protective cover from the upper guide pin by using a small chisel to punch through the center of the cover. Lever out the cover.
4. Pry out the protective cap on the lower guide pin using pliers or similar tool.
5. Install support fixture (Item 1 from special tools list) onto brake caliper.
6. Remove the two M16 socket head bolts that retain the caliper assembly to the brake carrier and lift the caliper assembly off the brake carrier. Discard the two mounting bolts.
7. Fasten the caliper assembly onto mounting fixture with adapter plate (Items 80 & 79 from special tools list). Use two M12 x 110 mm long mounting bolts with M12 nuts to secure caliper to mounting fixture.

   ☞NOTE:

   For reference purposes, the guide pin in the upper position (as installed on the axle) is configured with a brass bushing and a rubber boot on the inner end. The guide pin in the lower position (as installed on the axle) is configured with a rubber bushing and does not use a rubber boot on the inner end of the guide pin.

8. Remove the retaining ring from the rubber boot on the upper guide pin. See “Fig. 1-59: Brake Caliper Guide Pin Removal” on page 63.
9. Pull both guide pins out of the caliper housing.
10. Use a screwdriver or similar tool to push out the inner rubber boot from the guide pin bore.
11. Remove the brass bushing from the upper guide pin bore as follows:
    a. Assemble and install the installer punch, press-in sleeves, spindle, and collar nut (Items 72, 77, 75, 71, & 70 from special tools list). See “Fig. 1-60: Brass Bushing Removal” on page 63.
    b. Pull the brass bushing out of the caliper.
12. Remove the bushing from lower guide pin bore as follows:
    a. Assemble and install the installer punch, press-in sleeves, spindle, and collar nut (Items 72, 77, 75, 71, & 70 from special tools list). See “Fig. 1-61: Rubber Bushing Removal” on page 63.
    b. Pull the bushing out the caliper.

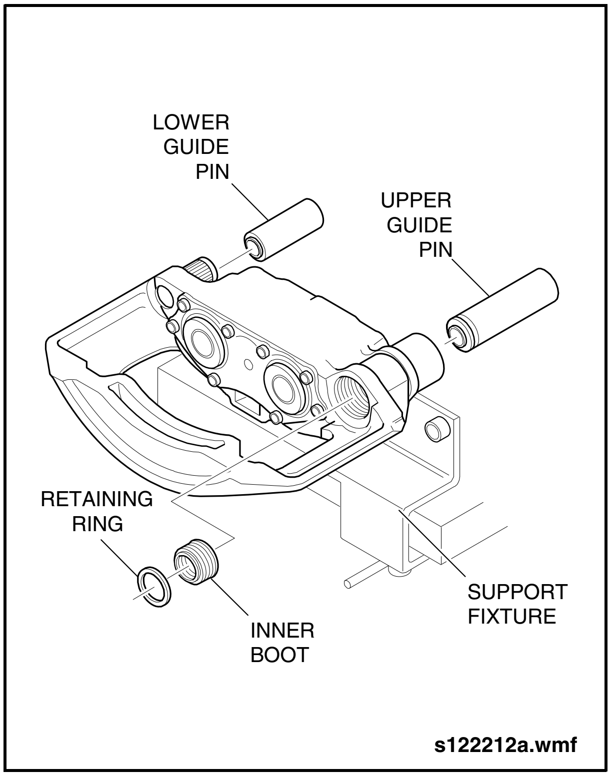


Fig. 1-59: Brake Caliper Guide Pin Removal

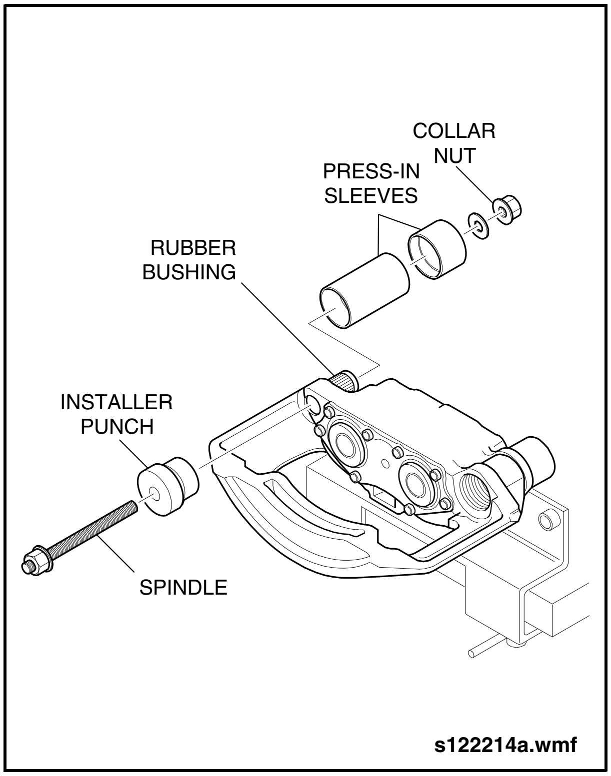


Fig. 1-61: Rubber Bushing Removal

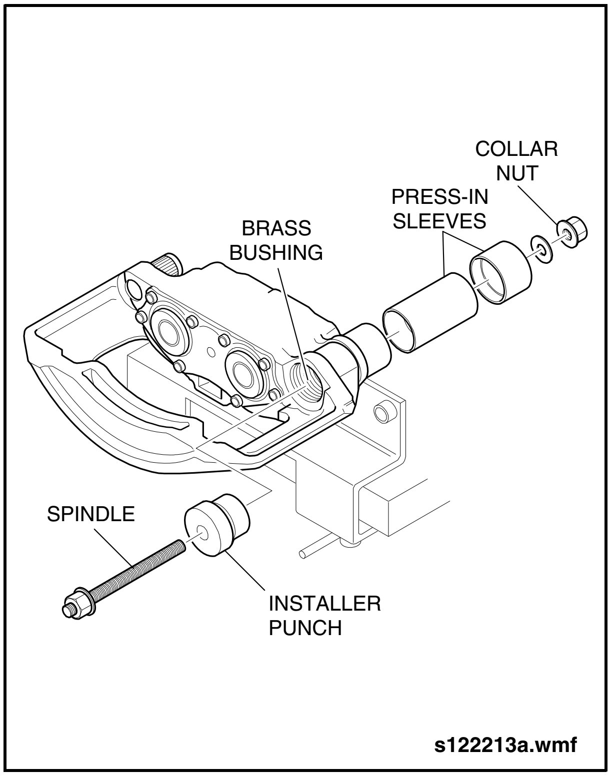


Fig. 1-60: Brass Bushing Removal

5.2.7.2. Inspection

1. Inspect the guide pin bores for corrosion and clean as necessary.
2. Inspect the outside diameter of the guide pins for wear, scoring, or other damage. Replace guide pins as required.
3. Inspect the inner rubber boot for cracks, tears, or deterioration. Replace as required.
4. Thoroughly clean and inspect the brake carrier. Carefully inspect the guide area where the brake pads seat for any damage or excessive wear. Replace carrier as required.

5.2.7.3. Installation

1. Install the bushing in the lower guide pin bore as follows:
   a. Insert bushing into press-in sleeve (Item 78 from special tools list).
   b. Position installation tool with rubber bushing on the brake caliper and mount with spindle and collar nut tools (Items 70, 71, 72, 75, & 77 from special tools list). See “Fig. 1-62: Rubber Bushing Installation” on page 65.
   c. Press the bushing into the caliper bore until the stop on the press-in sleeve is contacted.
2. Install the brass guide bushing in the upper guide pin bore as follows:
   a. Assemble and install the centering sleeve, brass bushing, installer punch, spindle, and collar nut (Items 76, 72, 70, & 71 from special tools list). Ensure that the open side of the centering sleeve is facing away from the caliper. See “Fig. 1-63: Brass Bushing Installation” on page 65.
   b. Press the brass bushing into the caliper bore until the stop on the press-in sleeve is contacted.
   c. Insert the indenting tool (Item 74 from special tools list) into brass bushing from the outside until the stop is contacted. See “Fig. 1-64: Indenting Tool Installation” on page 65.
   d. Screw the indenting bolt into the indenting tool until the stop is reached.
   e. Unscrew the indenting bolt and remove the indenting tool.
3. Install the inner rubber boot as follows:
   a. Insert the folds of the rubber boot into the press-in sleeve (Item 75 from special tools list). See “Fig. 1-65: Inner Boot Installation” on page 65.
   b. Position the press-in sleeve and installer sleeve (Items 73 & 75 from special tools list) on the brake caliper with spindle and collar nut (Items 71 & 70 from special tools list).
   c. Press the bellows into the seat using no more than 70 in-lb. (8 Nm) torque on the collar nut.
4. Use grease supplied with the repair kit and lubricate the rubber bushing, brass bushing, and both guide pins. Install the guide pins into the caliper.
5. Insert the lip of the inner boot into the groove on the guide pin and secure with retaining ring.
6. Remove the caliper from the mounting fixture and install supporting fixture (Item 1 from special tools list) onto caliper.
7. Lift the brake caliper into position on the brake carrier.
8. Install two new M16 socket head caliper mounting bolts, ensuring that the inner boot and retaining ring are properly seated. Torque bolts to 133 ft-lb. (180 Nm) then tighten an additional 90°.
9. Install a new protective cover into the caliper at the upper guide pin location. Use a soft-faced hammer to drive the cover flush with the surrounding surface.
10. Use centering sleeve (Item 76 from special tools list) to install protective cap into caliper at the lower guide pin location. Drive cap into place until centering sleeve stop is contacted. See “Fig. 1-66: Protective Cover & Cap Installation” on page 66.
11. Install the brake pads. Refer to 5.2.5. “Brake Pads” on page 58 in this section for removal procedure.
12. Install the brake chamber. Refer to 5.3. “Front Brake Chambers” on page 71 in this section for removal procedure.

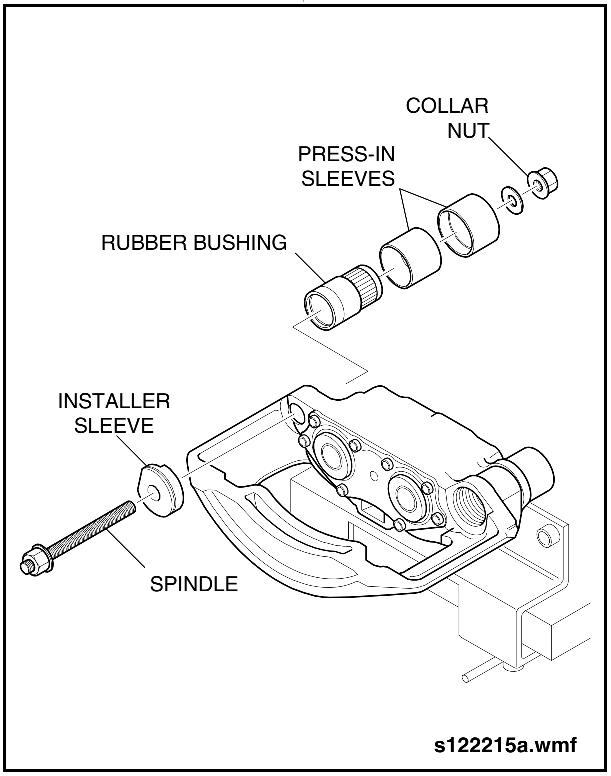


Fig. 1-62: Rubber Bushing Installation

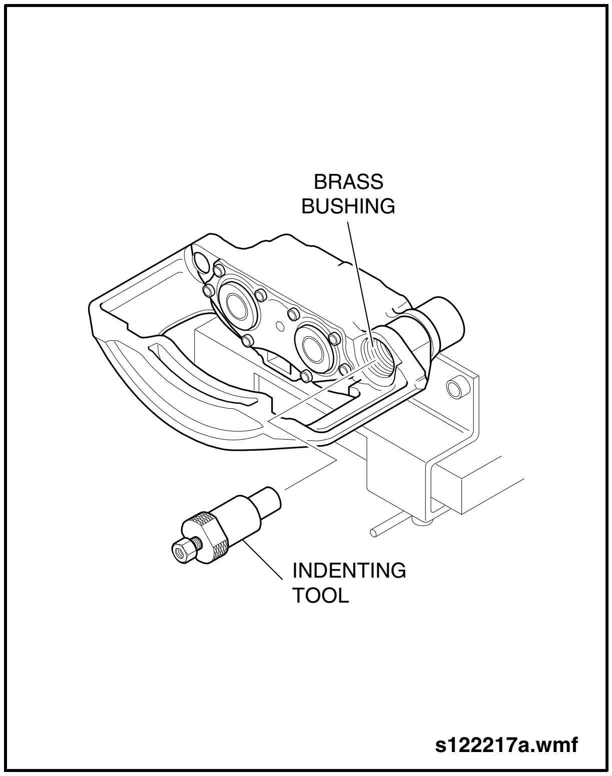


Fig. 1-64: Indenting Tool Installation

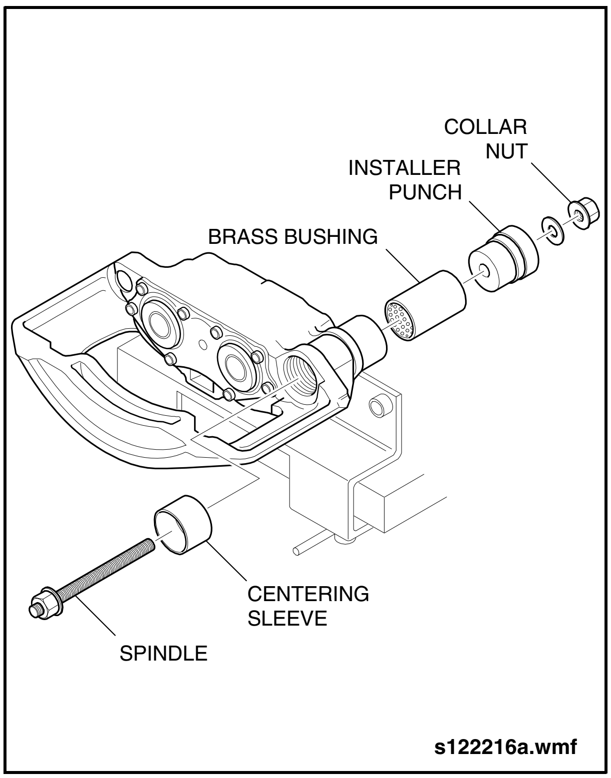


Fig. 1-63: Brass Bushing Installation

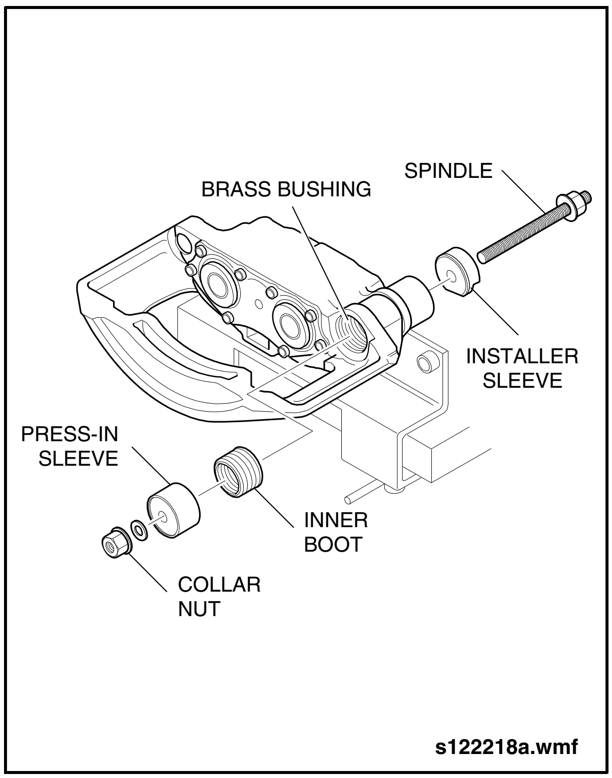


Fig. 1-65: Inner Boot Installation

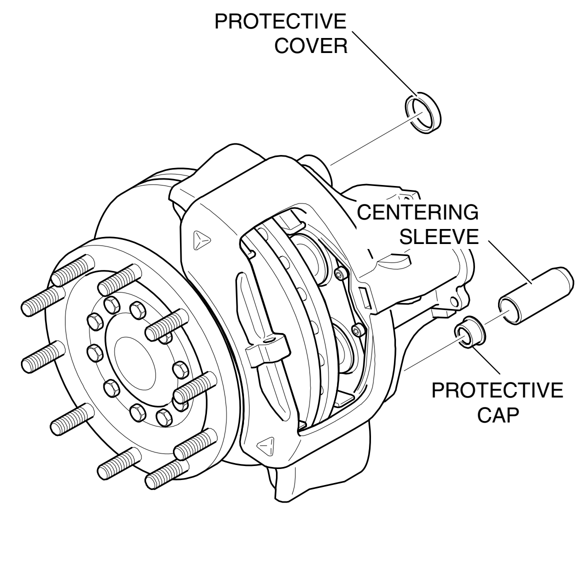


Fig. 1-66: Protective Cover & Cap Installation

5.2.8. Tappet & Rubber Boot

☞NOTE:

The following procedure provides removal/ installation instructions for the brake caliper tappets, rubber boots, and inner seals with the caliper installed on the vehicle.

5.2.8.1. Removal

1. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 58 in this section for removal procedure.

⚠CAUTION

DO NOT adjust the tappets beyond 1.18" (30 mm) as measured from the surface of the caliper to the tappet thrust face. Synchronization between the two threaded tubes can be lost if If the tappets are extended beyond this distance.

2. Rotate the adjuster clockwise until the tappets extend approximately 1.18" (30) from the caliper surface. This will allow full extension of the tappet rubber boot for insertion of the removal tools. See “Fig. 1-67: Unscrewing Tappets” on page 67.
3. Use a sharp knife to cut the rubber boot on the tappet. Insert the press-off fork tool (Item 81 from special tools list) between the tappet and the end of the threaded tube with the flat side of the forks against the threaded tube. See “Fig. 1-68: Removing Tappets” on page 67.
4. Use a hammer and tap on the fork tool to dislodge the tappet from the threaded sleeve.
5. Use a screwdriver to pry the tappet boot out of the seal seat.
6. Turn the adjuster counter-clockwise until the threaded sleeves are fully retracted within the caliper bore.

⚠CAUTION

DO NOT damage the seal seat when removing the inner seal, otherwise the caliper will need to be replaced.

7. Carefully pry the inner seal out of the seal seat. See “Fig. 1-69: Removing Inner Seal” on page 67.
8. Remove the bushing from the end of the threaded sleeve.

5.2.8.2. Inspection

1. Rotate the adjuster clockwise until the end of the threaded sleeve extends 1.18" (30 mm) from the caliper surface. See “Fig. 1-70: Inspecting Threaded Tubes” on page 67.
2. Inspect the threads on the threaded tubes for damage. The caliper will need to be replaced if thread damage is evident.
3. Inspect the bore of the caliper for scoring, corrosion, or other damage in the area of the inner seal seat. Replace caliper if seal seat area damaged.

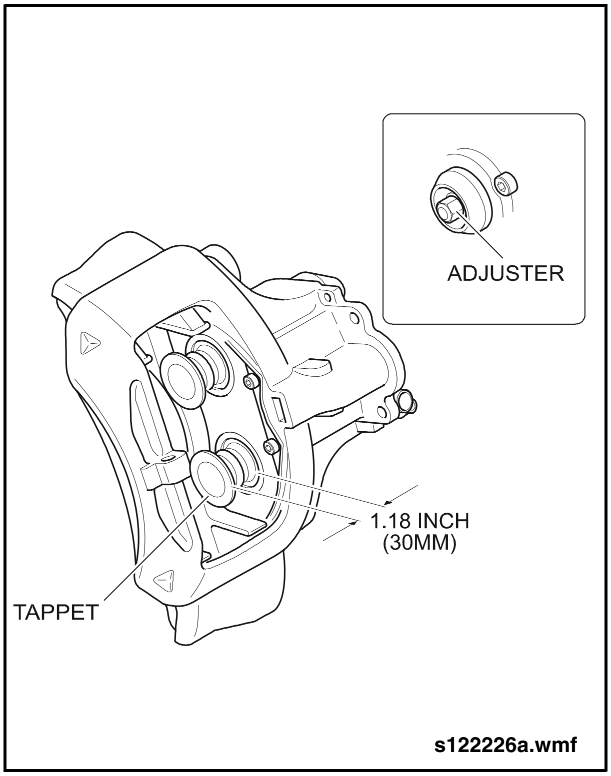


Fig. 1-67: Unscrewing Tappets

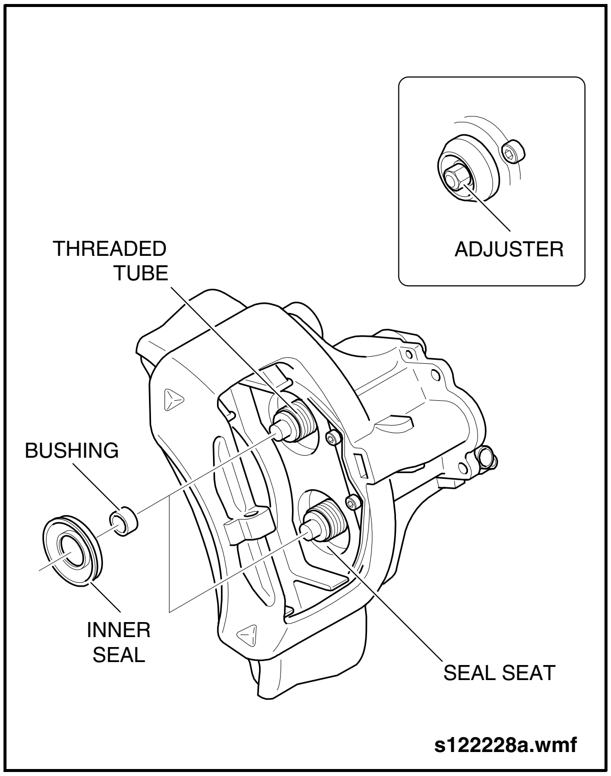


Fig. 1-69: Removing Inner Seal

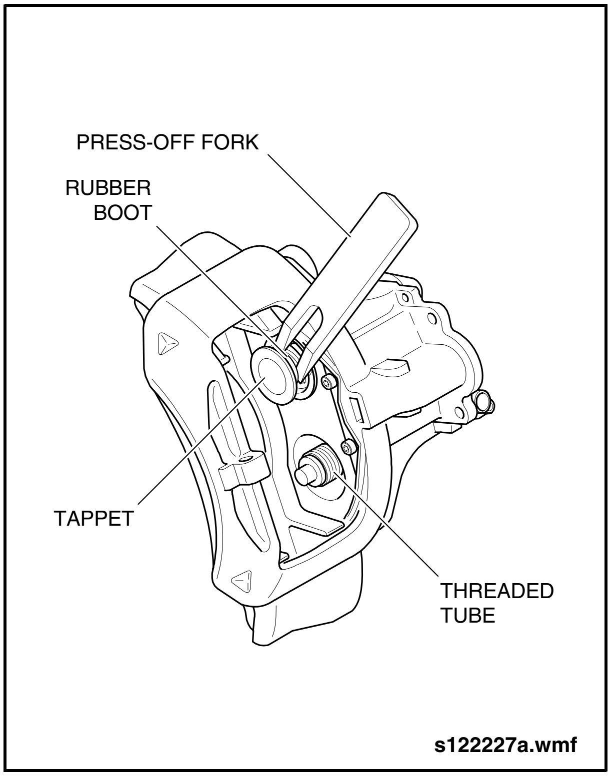


Fig. 1-68: Removing Tappets

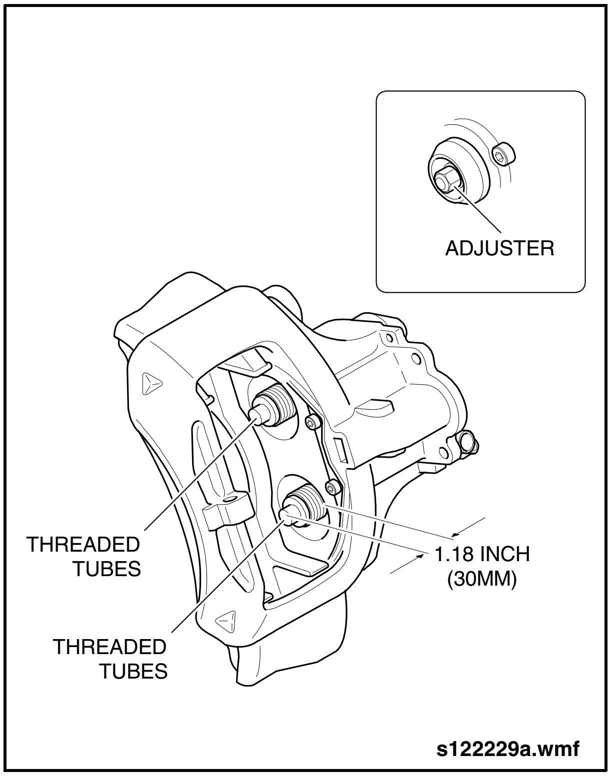


Fig. 1-70: Inspecting Threaded Tubes

5.2.8.3. Installation

☞NOTE:

This procedure can be performed with the caliper mounted to the axle or on a work bench. The special tools used contain two different length bolts depending on the method used. For installation on a work bench, use the longer bolt. For on-vehicle installation, use the shorter bolt.

1. Rotate the adjuster counter-clockwise until the threaded tubes are fully retracted within the caliper bore.
2. Thread the long forcing bolt into the installer sleeve (Item 82 from special tools list). See “Fig. 1-71: Installing Inner Seal” on page 68.
3. Place the new inner seal onto the press-in bushing (Item 83 from special tools list).
4. Place the assembled press-in bushing and inner seal into the installer sleeve. Use the forcing bolt to press the inner seal against the stop in the brake caliper.
5. Rotate the adjuster clockwise until the end of the threaded sleeve extends 0.59" (15 mm) from the caliper surface.

☞NOTE:

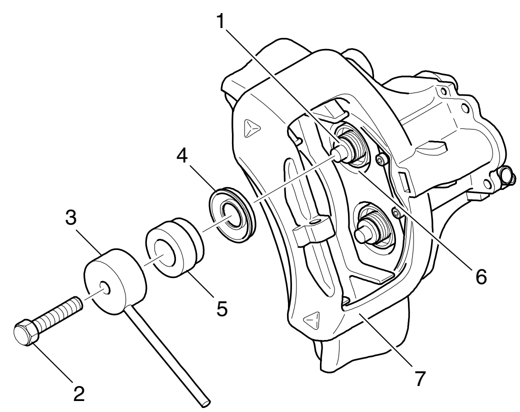
The inner seal must not turn.

6. Apply grease, supplied in the repair kit, onto the end of the threaded sleeves and install new bushings.
7. Turn the adjuster counter-clockwise until the threaded sleeves are fully retracted within the caliper bore.
8. Place the tappet and rubber boot onto the bushing.

☞NOTE:

Ensure the seal seat is clean and free from grease before installing the rubber boot into the seal seat.

9. Hold the installer sleeve (Item 82 from special tools list) against the rubber boot and use the long forcing bolt to press the rubber boot against the stop in the seat. See “Fig. 1-72: Installing Tappet & Rubber Boot” on page 69.
10. Reverse the position of the installer sleeve so that the open end is facing away from the tappet and boot assembly and the head of the forcing bolt is facing the tappet. See “Fig. 1-73: Seating Tappet Against Stop” on page 69.
11. Use the forcing bolt to press the tappet up against the stop on the threaded sleeve.
12. Install the brake pads. Refer to 5.2.5. “Brake Pads” on page 58 in this section for installation procedure.



1. Threaded Tube
2. Forcing Bolt
3. Installer Sleeve
4. Inner Seal
5. Press-In Plate
6. Seal Seat
7. Brake Caliper

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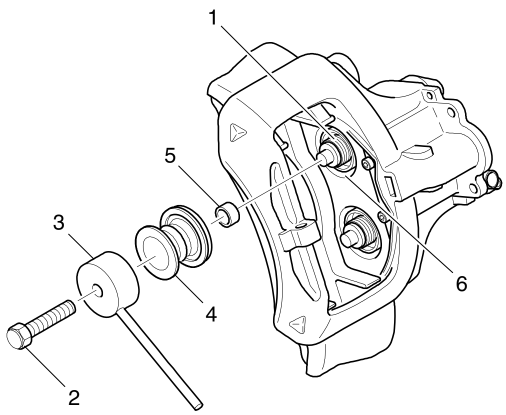
Fig. 1-71: Installing Inner Seal



1. Threaded Tube
2. Forcing Bolt
3. Installer Sleeve
4. Tappet & Rubber Boot
5. Bushing
6. Seal Seat

s122231a.wmf

Fig. 1-72: Installing Tappet & Rubber Boot

5.2.9. Brake Disc

5.2.9.1. Removal

1. Remove the Wheel Flange. Refer to 3.7.3. “Wheel Flange Removal” on page 12 in this section for procedure.
2. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 58 in this section for removal procedure.
3. Remove the brake caliper and brake carrier as an assembly. Refer to 5.2.6. “Brake Caliper & Carrier Assembly” on page 60 in this section for removal procedure.
4. Thread the alignment pins (Item 14 from special tools list) through the brake disc into opposite facing tapped holes in the hub-unit. See “Fig. 1-74: Brake Disc Removal” on page 69.
5. Use the lifting hook (Item 12 from special tools list) and remove the brake disc from the wheel hub by pulling it over the alignment pins.

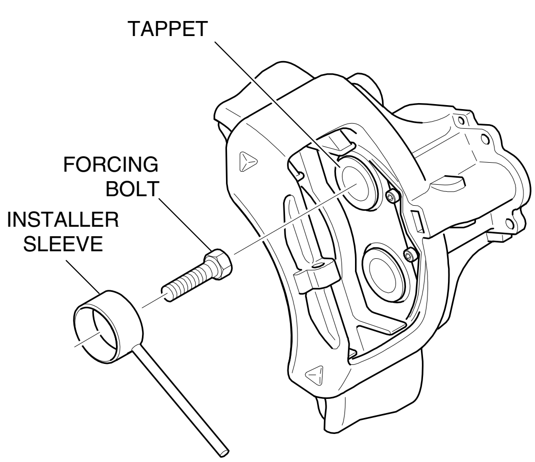


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Fig. 1-73: Seating Tappet Against Stop

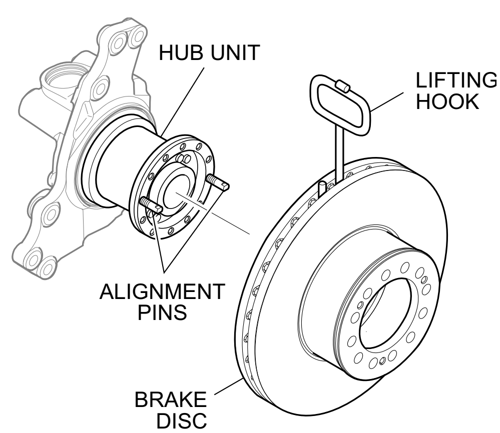

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Fig. 1-74: Brake Disc Removal

5.2.9.2. Installation

1. Inspect the threaded holes in the wheel hub unit and remove any accumulated grease or debris.
2. Clean the contact surface between the wheel hub unit and the brake disc.

CAUTION

DO NOT apply grease to the tapped holes of the wheel hub. Lubricated threads will affect desired torque value. Clean any grease from the threads.

3. Apply a thin layer of Molykote D high-performance lubricant around the front edge contact surface of the hub unit. Ensure grease is applied to the complete circumference and edge of the hub unit.
4. Use the lifting hook (Item 12 from special tools list) and install the brake disc onto the hub unit, using the alignment pins to guide the brake disc into position.
5. Install the Wheel Flange. Refer to 3.7.4. “Wheel Flange Installation” on page 13 in this section for procedure.

5.2.9.3. Machining

CAUTION

DO NOT machine the brake disc to less than 1.535" (39 mm) thickness. Allowance must be made for additional wear while in service and under no circumstances should the minimum disc brake thickness be reduced below 1.457" (37 mm) while in service.

☞**NOTE:**

The brake disc must be machined while installed on the vehicle.

- ❒ *ALWAYS machine equal amounts of material from both sides of the disc.*
- ❒ *ALWAYS machine the minimum amount of material required in restoring disc to serviceable limits.*
- ❒ *ALWAYS machine in several passes, being careful not to take off too much material in one pass.*
- ❒ *ALWAYS machine both brake discs on an axle. Do not machine one disc only.*
- ❒ *ALWAYS replace brake pads in sets whenever brake discs have been machined to ensure proper seating-in of the brake pads and to maintain braking efficiency.*

1. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 58 in this section for removal procedure.
2. Use commercially available brake machining equipment designed to be mounted to brake assembly with the brake disc installed on the axle. Follow manufacturer's instructions for setting up equipment and machining brake disc.
3. Measure machined surface of brake disc. The minimum thickness of the brake disc must not be less than 1.535" (39 mm).

5.3. Front Brake Chambers

5.3.1. Description

The brake chamber is a diaphragm type actuator which converts the energy of air pressure into mechanical force. The diaphragm is held between a pressure plate and non-pressure plate by a clamp ring.

☞**NOTE:**

The brake chamber assembly is a non-serviceable unit and must be replaced as an assembly. DO NOT attempt to disassemble the brake chamber.

5.3.2. Front Brake Chambers Specifications

Manufacturer.......................... MGM Brakes

Model CS24L

Type ....Diaphragm

Maximum Operating Pressure
..................................130.5 psi (9.0 Bar)

Air Volume at Full Stroke (100 psi)
..............................68.1 cu. in. (1115 cc)

Maximum Stroke.................... 2.5" (64 mm)

5.3.3. Operation

Controlled air pressure enters the brake chamber through the inlet port to act on the diaphragm and move the push plate and rod assembly forward. The brake chamber is bolted to the disc brake caliper and is used to actuate the disc brake mechanism.

This forward motion of the push rod acts on an eccentric lever within the caliper assembly and applies the vehicle brakes. The greater the air pressure admitted to the brake chamber, the greater the force applied by push rod. Push rod force is determined by multiplying the delivered air pressure by the effective diaphragm area.

When air pressure is released from the brake chamber, the push rod return spring returns the diaphragm, push plate and rod assembly to their released positions, thereby releasing the brakes.

5.3.3.1. E-Stroke

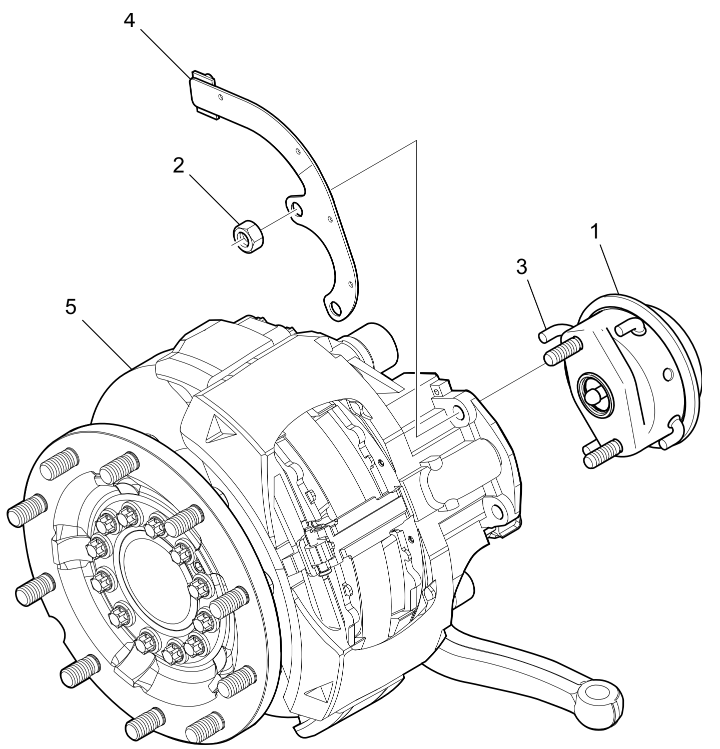
The brake chamber is fitted with an E-Stroke External Sensor Pack (ESP) which monitors movement of the push rod and relays this information to the control module in the driver’s area. Refer to Section 9 of this manual for information on the Electronic Stroke Alert System.

5.3.4. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance and inspection intervals and procedures.

5.3.5. Removal

1. Set Battery Disconnect switch to the OFF position.
2. Chock the wheels.
3. Drain all air tanks.
4. Disconnect the air line from the brake chamber.
5. Disconnect the electrical harness from the ESP sensor pack.
6. Remove the two lock nuts securing the brake chamber to the brake caliper assembly and remove the brake chamber from the vehicle. See "Fig. 1-75: Front Brake Chamber Removal & Installation" on page 72.
7. Place a protective cover over the brake caliper to prevent entry of contaminants.



1. Brake Chamber Assembly
2. Hex Nut
3. Elbow Vent
4. Brake Hose Assembly Bracket
5. Wheel End

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Fig. 1-75: Front Brake Chamber Removal & Installation

5.3.6. Installation

CAUTION

ALWAYS maintain the brake chamber and ESP Sensor Pack spacer as an assembly. DO NOT install a brake chamber without the ESP Sensor Pack installed.

CAUTION

Disc brake chambers must be inspected for seal condition and height measurement before a used brake chamber can be reinstalled.

1. If installing a new brake chamber, ensure that the protective cover is removed from the push rod. If installing a used brake chamber, perform the following inspection:
   a. Note the position of the ESP sensor pack and carefully remove it from the brake chamber. Retain the two O-rings. See “Fig. 1-76: Front Brake Chamber ESP Sensor Pack” on page 74.
   b. Measure the height of the seals on both the ESP sensor pack and brake chamber. The seal must be in good condition and protrude at least 0.118" (3.0 mm) from the ESP sensor pack and brake chamber mounting surfaces.
   c. If either one of the seals measures less than 0.118" (3.0 mm) then the brake chamber or ESP sensor pack must be replaced. The ESP sensor pack may be replaced separately from the brake chamber.
   d. Ensure the ESP sensor pack is correctly positioned on the brake chamber and retained with O-rings.

CAUTION

Cover the brake chamber opening on the brake caliper when cleaning the mounting surfaces so as to prevent entry of any contaminants.

2. Clean the brake chamber, ESP sensor pack and caliper mounting surfaces. Ensure seal recesses on the caliper and ESP sensor pack are clean and free from corrosion, Ensure that any protective covers are removed from the brake caliper.
3. Apply Renolit Unitemp 2 grease to the spherical cup located in the brake caliper and to the end of the brake chamber push rod. Do not apply an excessive amount of grease.
4. Carefully install brake chamber on brake caliper assembly being careful not to scratch or otherwise damage the painted surface or target material of the push rod. Ensure the push rod is not covered with excess grease and is kept clean of dirt.

CAUTION

Ensure that the brake hose bracket is positioned between the lock nuts and the brake caliper. Do not install bracket between brake caliper and brake chamber.

5. Install new M16 lock nuts and torque to specification. Refer to 4.5. “Front Suspension Torque Specifications” on page 43 in this section for torque specification.

☞NOTE:

Ensure that the brake hose bracket is positioned between the lock nuts and the brake caliper.

6. Ensure brake chamber rubber vent tubes do not interfere with the brake caliper. Rotate tubes as necessary, ensuring tubes face either downward or rearward for drainage.

7. Connect air line to brake chamber and torque air line fitting to 36 to 39 ft-lb. (49 to 53 Nm).
8. Connect the electrical harness to the ESP sensor pack.
9. Ensure that the electrical harness is properly routed and clamped as follows:
   a. Sufficient slack should be provided between the ESP sensor pack and first clamping location on the air line fitting.
   b. Additional cable ties should be provided every 6 to 12" along the length of the air line.
   c. Provide slack at the electrical connector location for ease of future servicing.
   d. Run a cable tie through the electrical connector clip and secure connector body to the air line.
10. Start vehicle and charge air system to normal operating pressure.
11. Check for air leaks.
12. Actuate brakes several times and check for proper operation.

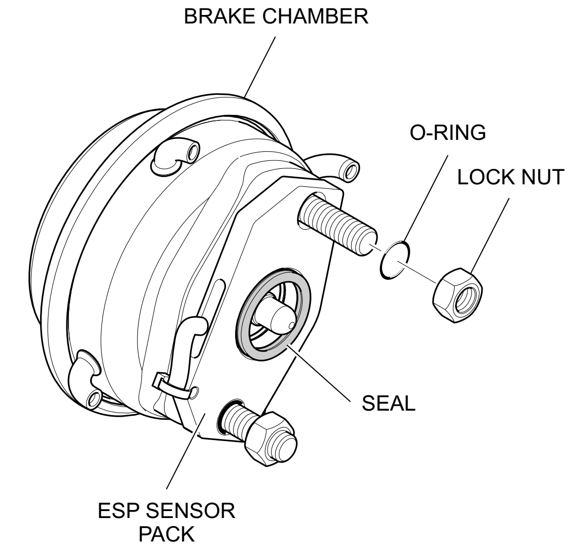


Fig. 1-76: Front Brake Chamber ESP Sensor Pack

6. FRONT AXLE ANTI-LOCK BRAKING SYSTEM (ABS) & COMPONENTS

DANGER

To prevent serious personal injury, put blocks under the front tires to stop the vehicle from moving. Apply the parking brakes.

DO NOT work under a vehicle supported only by jacks. Jacks can slip or fall over and cause serious personal injury.

To prevent serious eye injury, always wear safe eye protection when performing maintenance or service.

6.1. Description

The major components of the ABS System include:

- ❒ ABS Speed Sensor
- ❒ ABS Pulse Generating Wheel
- ❒ ABS Modulator Valves
- ❒ ABS Electronic Control Unit (ECU)

6.2. Operation

ABS is an electronic braking 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. By reducing wheel lock, the system improves vehicle stability and control. In the event of a malfunction in the system, the braking in the affected wheel will return to normal braking.

The system consists of a tooth wheel-mounted on the hub of each monitored wheel. A sensor is installed with its sensing end against each tooth wheel. The sensor continually provides wheel speed information to the Electronic Control Unit (ECU), located above the lighting panel on the streetside of the vehicle, which in turn supplies signals to the ABS modulator valves. The modulator valves control air pressure to each wheel during ABS operation. The valves modulate air pressure to the brake chamber during ABS operation to control braking and prevent wheel lock up.

6.3. Front ABS Speed Sensor

6.3.1. Removal

1. Raise the tire off the ground. Put safety stands under the axle.
2. Pull speed sensor out of sleeve using a twisting motion if necessary. Do not pull on cable. See "Fig. 1-77: Front Speed Sensor Removal & Installation" on page 76.
3. Disconnect sensor cable from chassis harness.
4. Pull sleeve out of bearing bore.

6.3.2. Installation

1. Grease speed sensor retaining sleeve with high-temperature grease and push in to stop in bearing bore on axle.
2. Grease speed sensor. Push sensor into sleeve.

☞NOTE:

Push, DO NOT knock in the sensor. The gap between the speed sensor and the pulse generating wheel is self-adjusting.

3. Ensure that the electrical connector to the speed sensor is correctly routed, and not bent.
4. Use ty-wraps and cable tie tool (Item 59 from special tools list) to secure ABS wiring harness to vehicle structure.

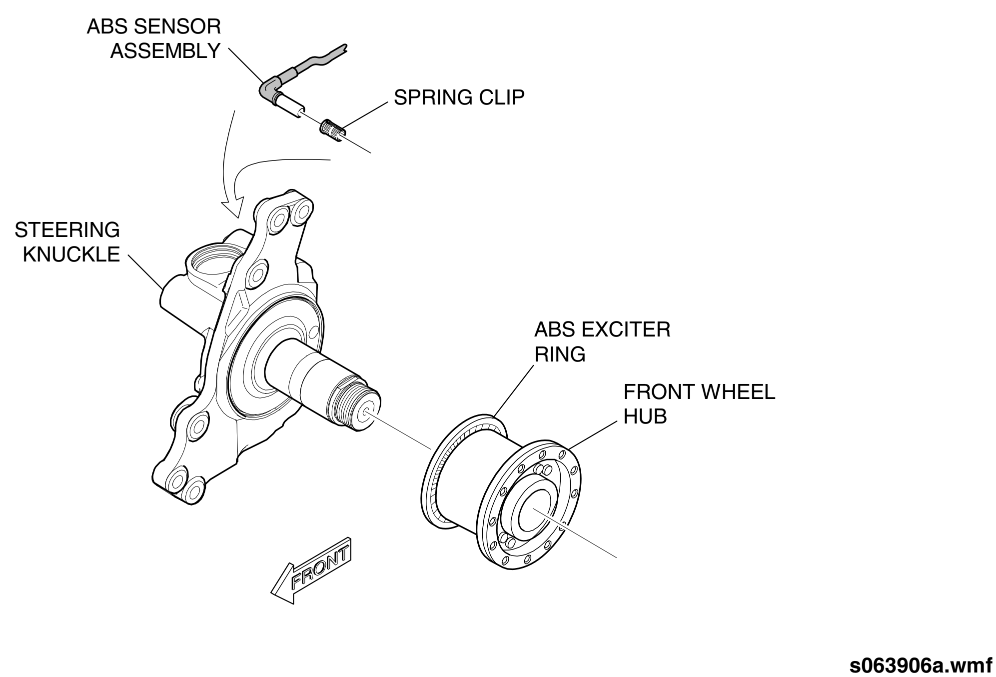


Fig. 1-77: Front Speed Sensor Removal & Installation

6.4. Front ABS Pulse Generating Wheel

☞**NOTE:**

The ABS pulse generating wheel is an integral part of the wheel hub assembly and is not repairable. Replace the complete wheel hub assembly if the ABS pulse generating wheel is damaged.

6.5. Front ABS Modulator Valve

6.5.1. Description

ABS modulator valves are used to control brake application on the front axle. The valves are bracket-mounted to the vehicle structure and located between the brake foot valve and brake chambers. The modulator valve is electrically controlled with a solenoid valve and includes an inlet, outlet and exhaust port.

6.5.2. Operation

During normal brake application the modulator valves are inactive and do not affect the brake application. If the ABS ECU detects an ABS event (impending wheel lock-up) it will energize the solenoids in the modulator valves to control the brake application pressure to the service brake chambers.

To decrease brake application pressure, the ECU will energize the inlet and outlet solenoids of the modulator valve that will close the supply port and open the delivery and exhaust ports. To hold brake application pressure at a given value, the ECU will energize the inlet solenoid and de-energize the outlet solenoid of the modulator valve that will close the supply and exhaust ports.

This modulation of brake application pressure will continue until the impending wheel lock-up condition is alleviated.

6.5.3. Removal

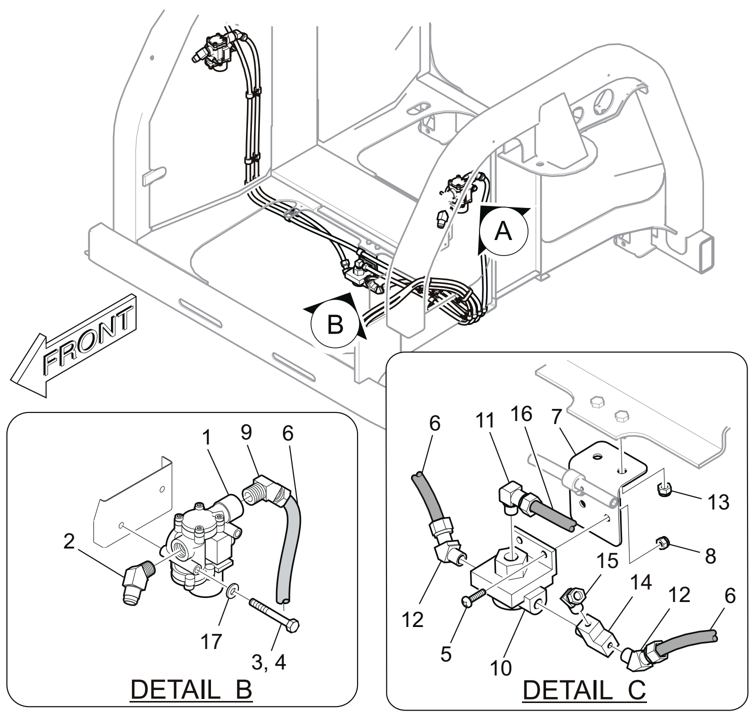
1. Set the Battery Disconnect switch to the OFF position.
2. Disconnect the wiring from the ABS valve.
3. Disconnect the air lines from ports 1 and 2 of the ABS valve. See “Fig. 1-78: Front Modulator Valve Removal & Installation” on page 78.
4. Remove the two mounting bolts and nuts.
5. Remove the ABS valve.

☞**NOTE:**

ABS valves are not serviceable.

6.5.4. Installation

1. Install the ABS valve with two mounting bolts and nuts.
2. Connect the line to the brake chamber to port 2 of the ABS valve. Connect the air supply line to port 1 of the ABS valve.
3. Connect the harness connector to the ABS valve.
4. Set the Battery Disconnect switch to the ON position.



1. Valve Assembly, Modulator 24V
2. Elbow, 45°
3. Bolt, Hex
4. Washer, Lock Spring Type
5. Bolt, Hex
6. Tube, Nylon
7. Bracket, Quick Release Valve
8. Nut, Lock Nylon
9. Elbow, 45°
10. Valve Assembly, Quick Release
11. Elbow, 90°
12. Elbow, 45°
13. Nut, Lock Nylon
14. Tee, Street
15. Elbow, 45°
16. Tube, Nylon
17. Washer Flat

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Fig. 1-78: Front Modulator Valve Removal & Installation

6.6. ABS Electronic Control Unit (ECU)

6.6.1. Description

The ABS System ECU is located on the streetside of the vehicle behind the front advertising panel. See “Fig. 1-79: ABS ECU” on page 79.

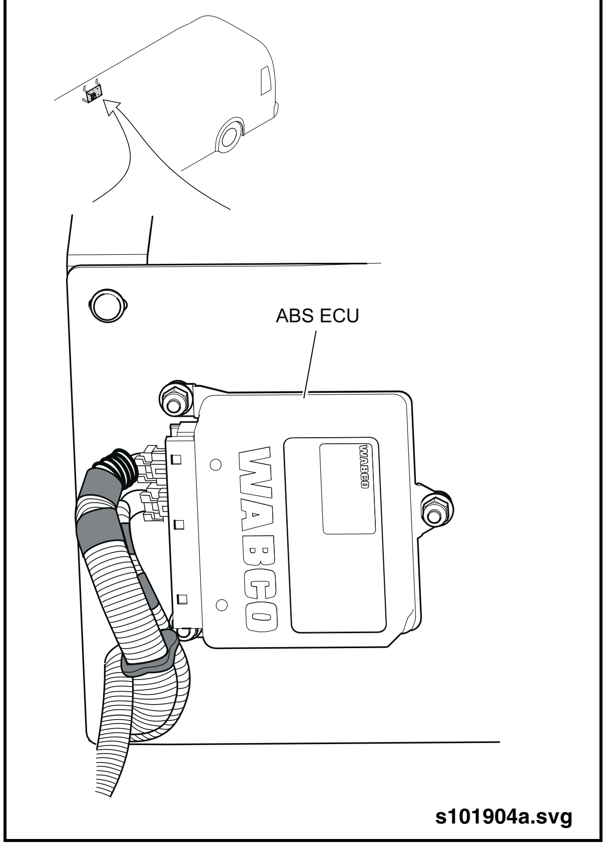


Fig. 1-79: ABS ECU

6.6.2. ABS Troubleshooting

Troubleshooting can be performed on the ABS system using any of the following methods:

- ❐ Blink Code troubleshooting
- ❐ Meritor Wabco TOOLBOX software
- ❐ Pro-Link® Plus diagnostic tool

Refer to 6.6.3. “Blink Code Diagnostics & Troubleshooting” on page 80 in this section for basic information on blink code trouble-shooting concerning the use of the ABS Fail indicator and the ABS switch installed in this vehicle.

Meritor Wabco TOOLBOX software is a PC-based diagnostic tool which can be used to test the ABS system components and display active and stored faults. The user's manual for this software is available for download on meritorwabco.com/toolbox. The software, available from Meritor Wabco, is loaded onto the PC and the PC is connected to one of the vehicle's diagnostic connectors.

The Pro-Link® Plus is a hand-held diagnostic device which can be used in place of blink code troubleshooting. The Pro-Link is fitted with the required cartridge and is connected to one of the vehicle's diagnostic connectors.

Refer to “Multiplexing System Layout” included with your Vehicle Systems Drawing Manual for the locations of the vehicle’s diagnostic connectors.

Refer to 8. “VENDOR SERVICE INFORMATION” on page 88 in this section for further information on the use of the TOOLBOX software and the Pro-Link diagnostic tool. Also refer to this manual for detailed blink code troubleshooting charts and procedures.

6.6.3. Blink Code Diagnostics & Troubleshooting

6.6.3.1. Description

The ABS Fail indicator on the instrument panel indicates system status and displays blink code diagnostics. The indicator lamp works as follows:

- ❒ When the Master Run switch is set to the DAY-RUN position, the indicator illuminates momentarily for a check and then extinguishes. This indicates the system is O.K.
- ❒ The indicator will flash if the normal ABS function is being modified due to road conditions while the vehicle is in operation.
- ❒ The indicator will remain illuminated after the vehicle is started if an existing fault is present.
- ❒ After the system is serviced, the indicator will remain illuminated until the vehicle is driven at speeds above 4 mph (6 kp/h).

The Blink Code system requires use and interpretation of a series of blink codes. A blink code is a series of flashes emitted by the ABS Fail indicator which describes a system fault or condition. Each blink code contains two digits or sets of flashes: a 1 1/2 second pause occurs between each set of flashes in the digit. A four second pause separates the individual codes displayed. Blink code diagnostics are activated by the ABS switch in the front destination sign compartment.

6.6.3.2. Diagnostic Mode

Enter diagnostic mode by activating the ABS switch for one second, and then releasing it.

6.6.3.3. Clear Mode

Enter clear mode to erase faults from the ECU. This is done by activating the ABS switch for three seconds and then releasing it. If the system displays eight quick flashes followed by a system configuration code, the clear was successful. If this does not occur, faults are still active and must be repaired before they can be cleared.

6.6.3.4. System Configuration Code

This is a one digit code consisting of two flashes repeated every four seconds by the ABS switch during clear mode to indicate that all ABS faults have been cleared from ECU memory.

7. FRONT AXLE SPECIAL TOOLS

7.1. Front Axle Special Tools Chart

The following special tools are referenced in the axle servicing text in this section.

Refer to your New Flyer Parts Manual for purchase part numbers. See “Fig. 1-80: Special Tools-1” on page 85. See “Fig. 1-81: Special Tools-2” on page 86. See “Fig. 1-82: Special Tools-3” on page 87.

SPECIAL TOOLS	DESCRIPTION	MAN PART#
1	Supporting Fixture	80.99629.6007
2	Socket, E24	80.99603.0286
3	Retaining Bolt, M8	80.99629.0034
4	Adapter, Wrench	08.06455.0023
5	Socket Wrench, Size 22 Splined	80.99603.0276
6	Wrench Handle, Socket	08.06460.0004
7	Handle, Torque Wrench	08.06450.0007
8	Handle, Screwdriver Torque	08.06510.9026
9	Shaft, Removable Screwdriver	08.06510.9027
10	Bit, Removable Screwdriver	08.06510.9030
11	Gauge, Feeler	08.75310.0806
12	Lifting Hook	80.99629.0031
13	Callipers, Measuring	80.71100.0003
14	Pin, Centering	80.99604.0264
15	Adapter	80.99602.0197
16	Impact Tool	80.99602.0016
17	Torque Multiplier - 1:3.5	80.99619.0006
18	Socket	80.99612.0024
19	Socket - Wheel Flange Bolt	80.99603.0327
20	Support	80.99606.0551
21	Holding Tube, Socket	80.99603.0426
22	Pin, Connecting 36 mm	06.22729.0006
23	O-Ring, 42mm	06.56331.3274

SPECIAL TOOLS	DESCRIPTION	MAN PART#
24	Screw, Cap Cylinder	06.02191.0407
25	Adapter, Tool Assembly	80.99606.0552
26	Handle, Slip On	80.99617.0187
27	Washer	80.99617.0144
28	Gauge, Dial Stand	08.71082.0005
29	Gauge, Dial	08.71000.1205
30	Slotted Nut Spanner Socket	80.99603.0253
31	Counter Holder Flange	80.99606.0465
32	Power Wrench	83.09195.6001
33	Counter Holder	80.99622.5003
34	Reaction Arm	80.99622.5002
35	Ratchet	08.06455.0021
36	Bushing, Threaded M115	80.99606.0251
37	Removal Flange, Hub Unit	80.99606.0744
38	Puller Cap, Threaded	80.99606.0238
39	Cover, Fitting	80.99606.0681
40	Spindle	80.99606.0405
41	Nut, Spindle	80.99606.0241
42	Fitting Sleeve	80.99606.0755
43	Pump, Hydraulic	80.99620.6008
44	Piston Cylinder, Hollow, 200 kN	80.99601.6014
45	Flange Extractor	80.99601.0195
46	Pressure Piece, Hub Unit Bearing, 200 kN	80.99601.0193
47	Rod, Threaded, M20 x 270	80.99601.0194
48	Nut, Collar	06.11116.0107
49	Plate, Traverse	80.99601.0196

SPECIAL TOOLS	DESCRIPTION	MAN PART#
50	Positioning Tool, Thrust Bearing Sleeve	80.99625.6001
51	Fixture, Hydraulic Press	80.99606.6150
52	Press Hydraulic 750 kN	80.99606.6151
53	Punch, Aligning	80.99617.0215
54	Mandrel, Short W/Magnet	80.99617.0197
55	Mandrel, Pressing	80.99617.0183
56	Mandrel, King Pin Press In	80.99617.0179
57	Spacer Tube	80.99604.0228
58	Mandrel, King Pin Cap Installation	80.99617.0195
59	Tool, Cable Tie Tying	80.99629.0029
60	Pressing Adapter	80.99635.0051
61	Mandrel, Guide & Press	80.99617.0190
62	Pressing Adapter	80.99635.0050
63	Pressing Adapter	80.99635.0049
64	Joint Press	80.99601.6024
65	Flat Cylinder	80.99644.6000
66	Chain, Safety	80.99601.6030
67	Torque Adapter, TX100	80.99603.0295
68	Socket Wrench, Size 36 Splined	80.99603.0221
69	Mounting Fixture, Dial Gauge	80.99605.6025
70	Nut, Collar Trapezoidal Thd.	80.99601.0218
71	Spindle, Trapezoidal Thd.	80.99601.0219
72	Punch, Installer	80.99604.0256
73	Sleeve, Installer	80.99604.0257
74	Tool, Indenting	80.99604.0262
75	Sleeve, Press-In	80.99606.0459
76	Sleeve, Centering	80.99616.0066

SPECIAL TOOLS	DESCRIPTION	MAN PART#
77	Sleeve, Press-In	80.99616.0107
78	Sleeve, Press-In	80.99616.0108
79	Plate, Adapter	80.99622.0053
80	Mounting Fixture	80.99622.6005
81	Fork, Press-Off	80.99606.0453
82	Sleeve Installer	80.99606.6080
83	Bushing Installer	80.99616.0109

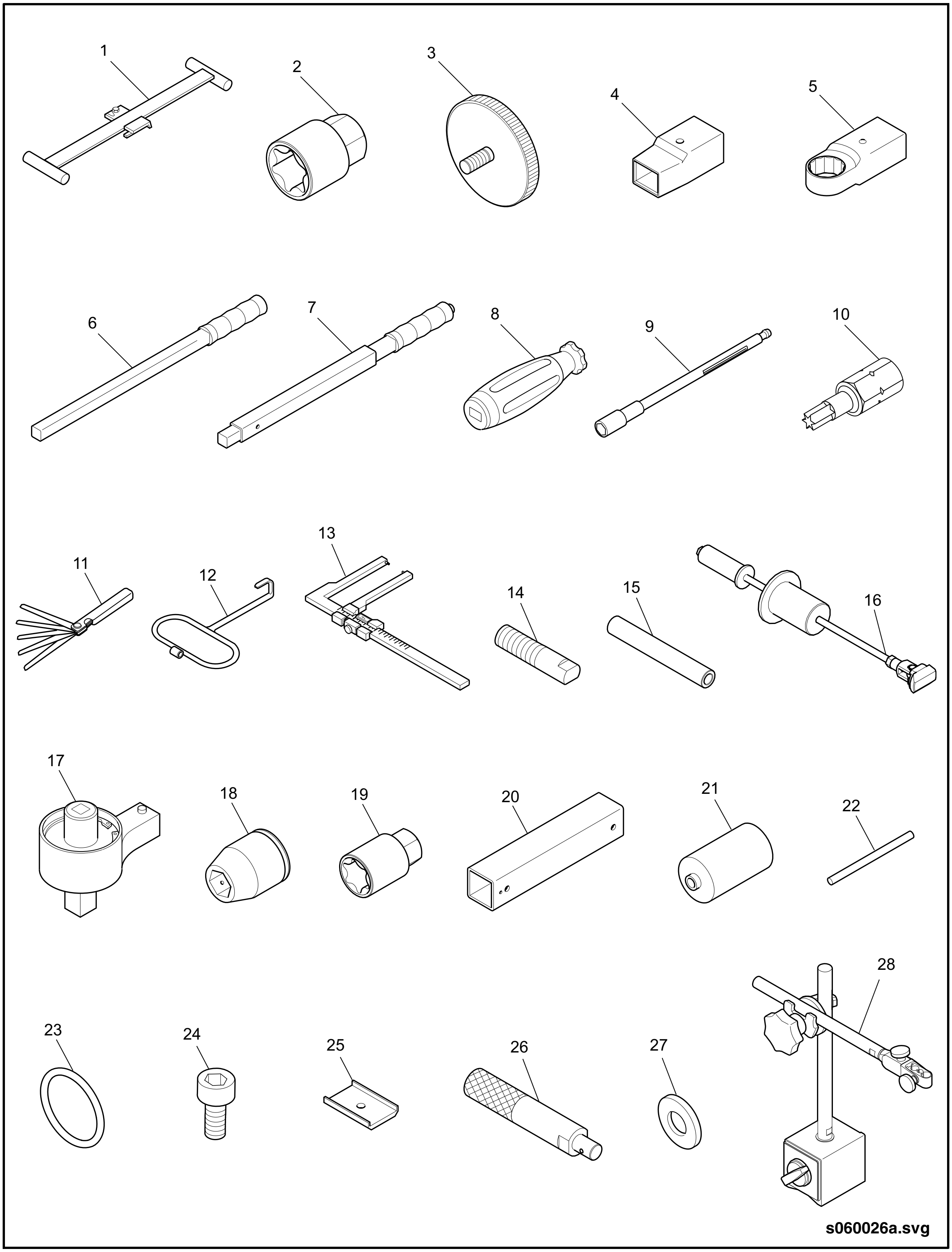


Fig. 1-80: Special Tools-1

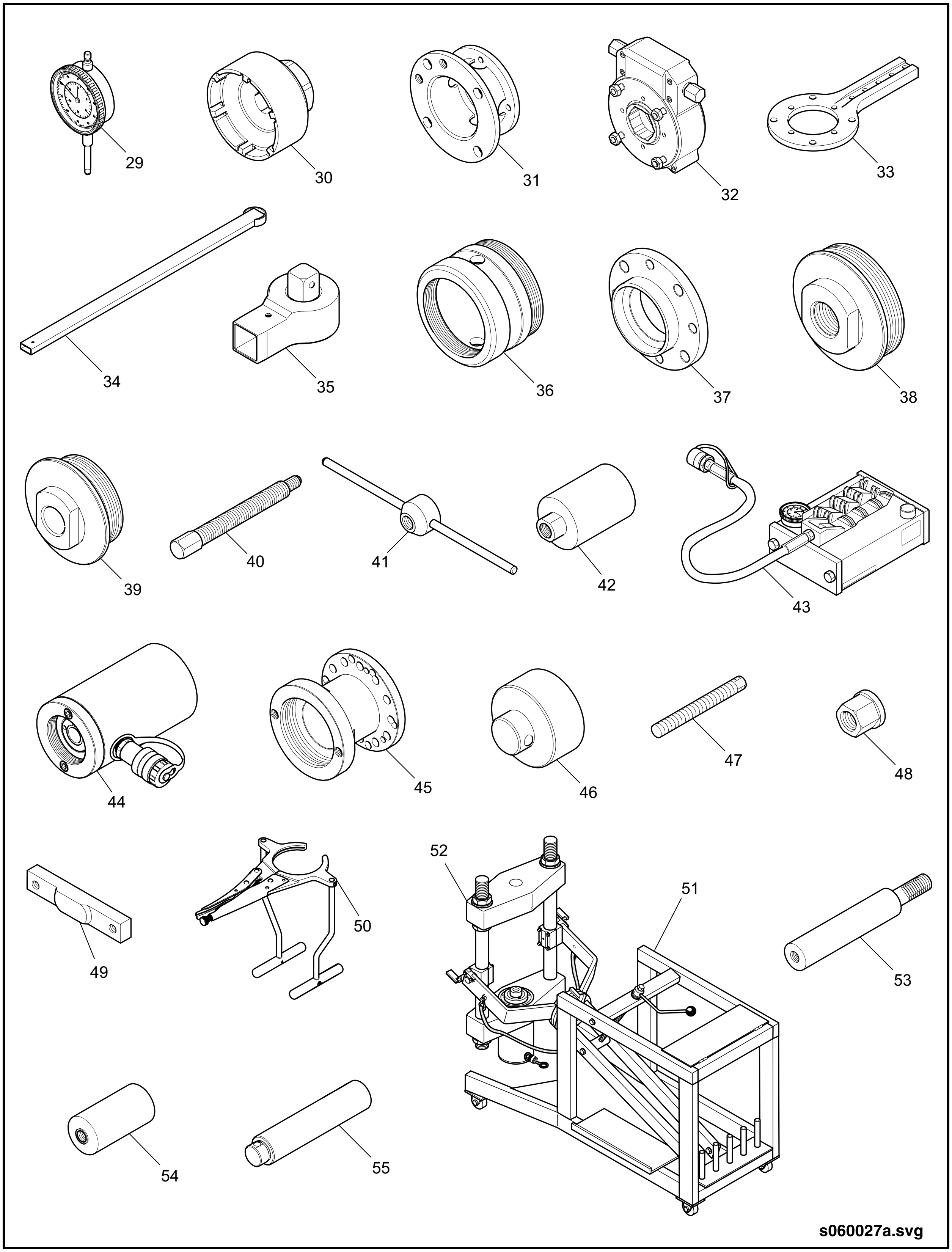


Fig. 1-81: Special Tools-2

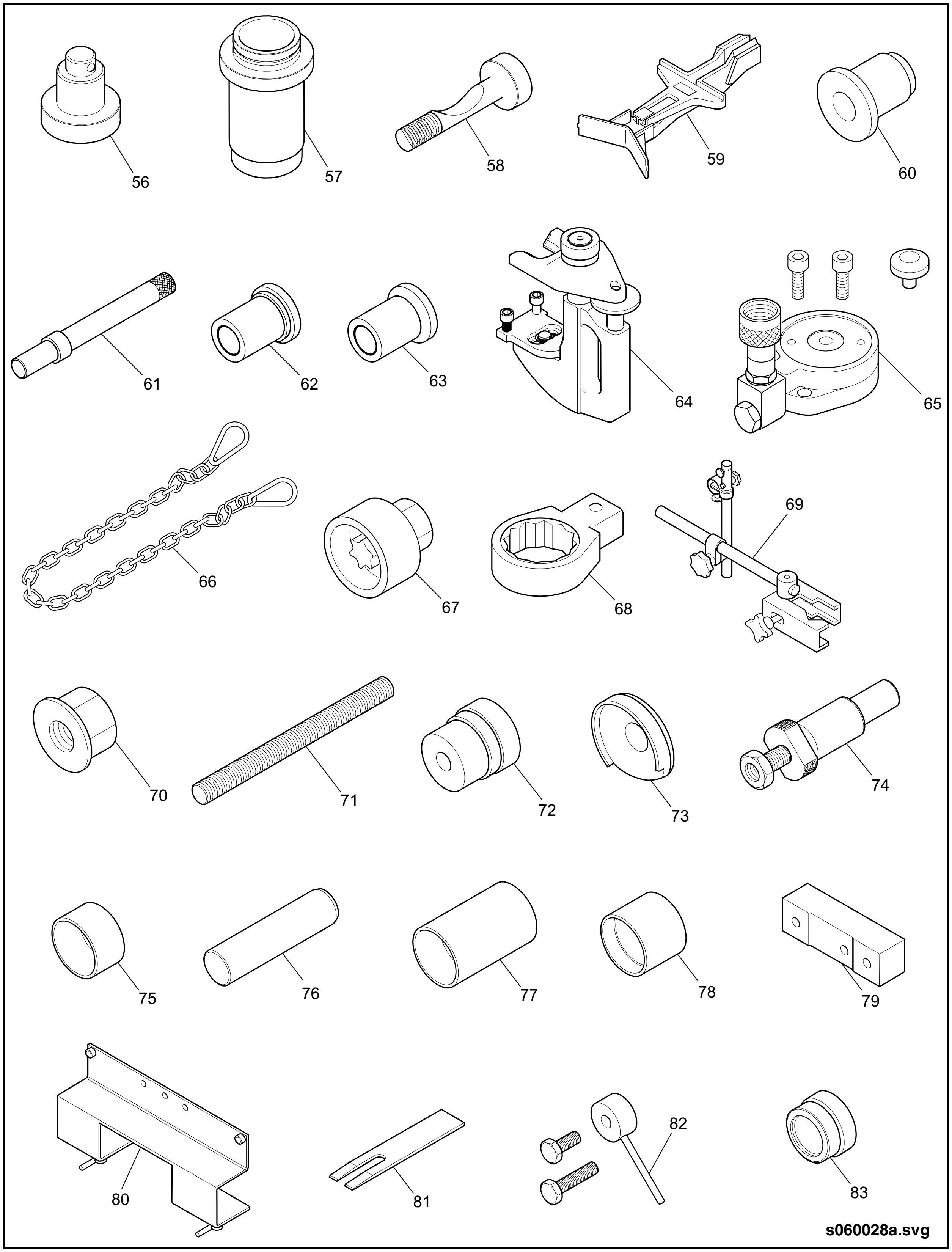


Fig. 1-82: Special Tools-3

8. VENDOR SERVICE INFORMATION

The following supplier manuals contain additional reference information.

8.1. Meritor Wabco Manual

- ❐ Maintenance Manual 112 Anti-Lock Braking System (ABS) for Trucks, Tractors, and Buses for E Version ECUs

Rear Axle & Suspension

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❐ open flame
- ❐ excessive heat
- ❐ production of sparks
- ❐ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Hoisting/Lifting & Jacking Safety

Refer to the General Information Section of this manual for recommended types of hoists, lifting equipment, and jackstands.

DANGER

Certain procedures may require the vehicle be operated in an elevated position in order to accurately troubleshoot and diagnose a problem. If the vehicle must be running while elevated, become familiar with the repair area prior to starting the engine. Take special care in noting areas which will become hot, electrically energized, and areas where moving and rotating components are located. Limit the work in these areas as personal and equipment safety is at risk.

WARNING

ALWAYS ensure that the vehicle is appropriately hoisted and blocked for procedures which require elevating the vehicle. Be aware of the limitations of the blocking equipment, and always ensure that the jarring and shaking created by component removal and installation procedures does not overload the blocks, or cause the vehicle to become unstable.

1.4. Air System Safety

WARNING

ALWAYS drain the air pressure from ALL reservoirs before beginning work on any air system component.

WARNING

Ensure air lines are safely depressurized prior to disconnecting. Wear safety glasses as disconnecting pressurized lines will cause solid particles deposited in the line to be uncontrollably propelled, and will also cause the hose end to whip randomly as the air escapes.

2. REAR AXLE & SUSPENSION

2.1. Description

This rear axle and suspension system incudes the following sub-components and systems:

- ❒ Axle Assembly
- ❒ Axle Suspension Beam
- ❒ Suspension Components
- ❒ Brake System
- ❒ ABS System
- ❒ Driveshaft

The rear axle is mounted to a suspension beam assembly. See “Fig. 2-1: Rear Axle & Suspension Assembly” on page 2. The axle/suspension beam assembly is held in alignment to the chassis by four radius rods. The upper radius rods are attached to the upper part of the differential housing and the vehicle chassis. The lower radius rods are attached to the inner front of the suspension beam and the chassis. Four air spring assemblies are attached to pads provided at the front and rear of the suspension beam. Four double acting shock absorbers, two in front of and two behind the axle, are mounted to the suspension beam and the chassis.

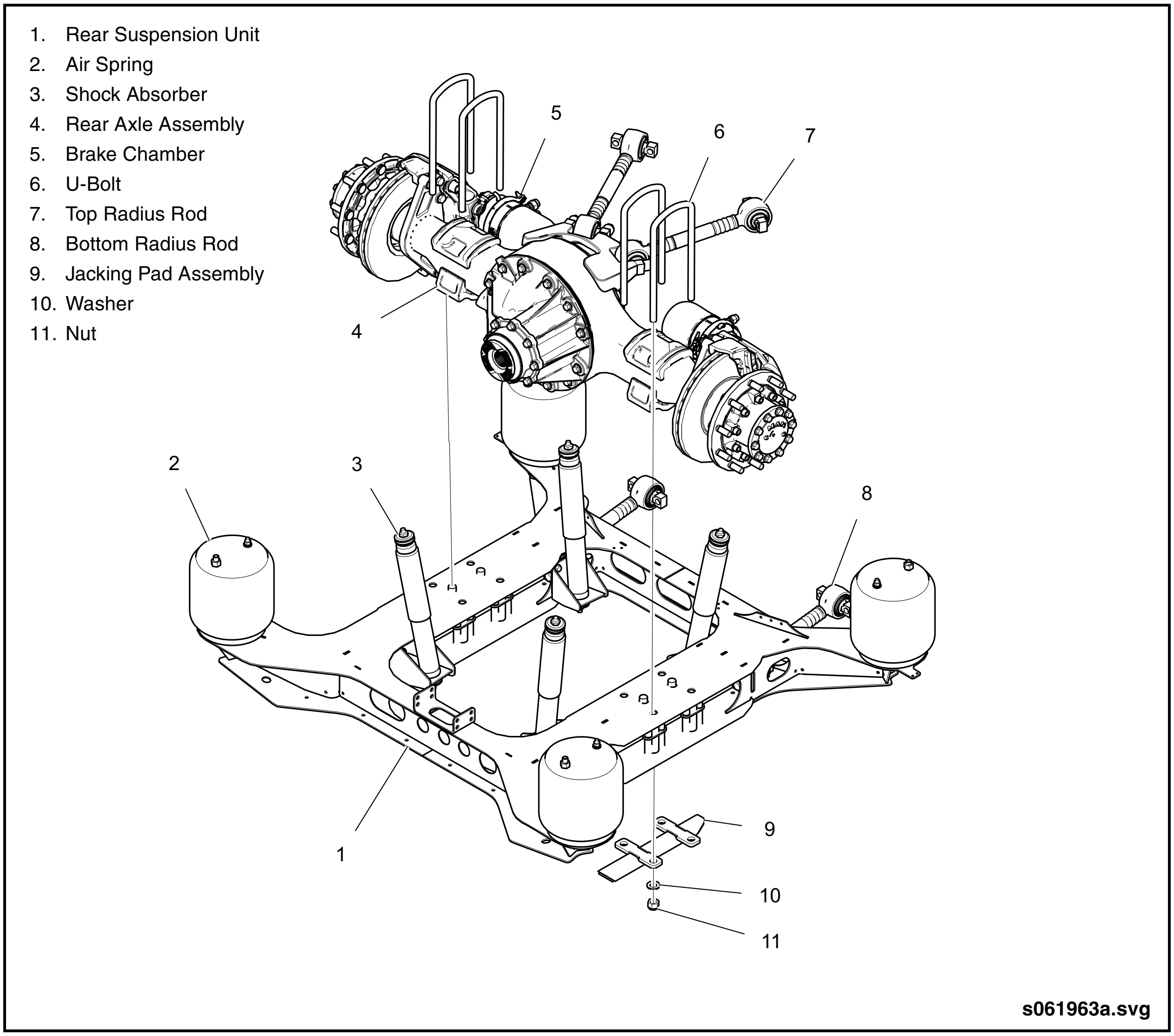


Fig. 2-1: Rear Axle & Suspension Assembly

2.2. Operation

As the vehicle travels, the axle and suspension beam assembly move vertically relative to the vehicle chassis. The air springs compress and extend as the wheels go over bumps and dips allowing this movement. The rate of movement is controlled by the shock absorbers. The radius rods maintain alignment of the assembly to the vehicle chassis. Leveling valves connected by operating links to the left and right front of the suspension beam control the air pressure in each pair of air springs to maintain ride height and prevent tilting of the vehicle when loading is uneven.

2.3. Removal

☞**NOTE:**

The following procedure describes the removal of the axle and suspension beam as a unit with wheels and tires installed.

1. Drain system air pressure.
2. Raise vehicle using wheel lifts or center post lift. Refer to the General Information Section of this manual for procedure.
3. Place safety stands under vehicle frame.
4. Lower rear wheel lift slightly to allow axle assembly to drop approximately 3" (76 mm).
5. Scribe reference marks on the driveshaft and differential flange for alignment purposes during installation. Disconnect the driveshaft and secure it out of the way. Refer to 8. "DRIVESHAFT" on page 144 in this section for information on this component.
6. Unplug ABS sensor harnesses.
7. Remove membrane breather from vehicle structure mounting bracket.
8. Disconnect leveling valve links from suspension beam brackets (do not disturb adjustment). Refer to Section 8 of this manual for disconnect procedure. Pull valve lever down to drain air from air springs.
9. Disconnect upper and lower radius rods at their chassis mounting points and leave opposite end attached to axle and suspension beam.
10. Disconnect the shock absorbers from the axle suspension beam and leave upper shock mounts attached to vehicle structure.
11. Remove the center nut from the bottom of each air spring and leave air spring upper mounts attached to vehicle structure.
12. Tag and disconnect brake chamber air lines.
13. Check for and disconnect any other lines or harnesses routed to the axle or axle components.
14. Carefully lower axle, suspension beam and wheel assembly to floor with wheel lift.

☞**NOTE:**

Make sure assembly is strapped or chained to lifting device to prevent it from tilting or falling.

2.4. Installation

☞**NOTE:**

Refer to the Special Tools Chart in Section 1 of this manual for the disc brake servicing tools.

1. Raise vehicle and support on safety stands.
2. Place axle, suspension beam and wheel assembly on wheel lift, secure with straps or chains to prevent tilting or falling and elevate into position.
3. Install upper and lower radius rods to chassis with bolts and nuts, do not tighten.
4. Align lower air spring mounting hole with suspension beam mounting pad, install and torque nut to specification.
5. Install lower end of shock absorbers to suspension beam with rubber isolators, cupped washers and nuts.
6. Torque shock absorber nuts to specification.
7. Torque upper and lower radius rod bolts to specification.
8. Attach brake chamber air lines to correct locations.
9. Connect ABS sensor harness connectors.
10. Mount membrane breather to vehicle structure mounting bracket.
11. Check for and connect any other lines or harnesses removed during the disassembly process.
12. Align scribe marks on driveshaft and differential flange. Install driveshaft and torque bolts to 69 ± 6 ft-lb. (94 ± 8 Nm). Refer to 8. “DRIVESHAFT” on page 144 in this section for procedure.
13. Connect leveling valve links to original positions on suspension beam brackets.
14. Raise vehicle to free up safety stands. Remove stands and lower vehicle.

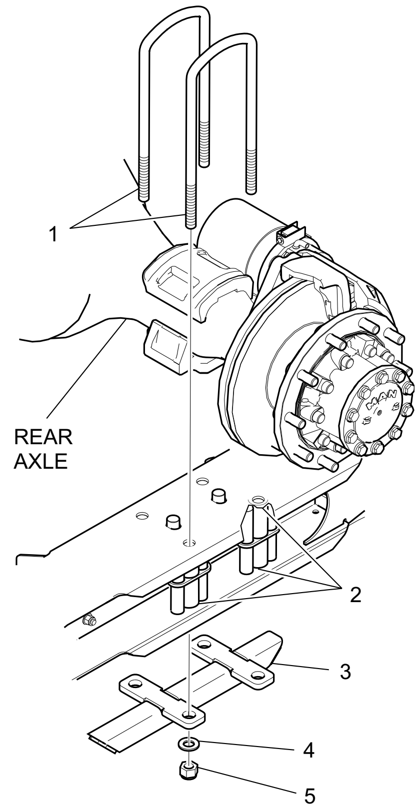
2.5. Disassembly

1. Support axle and suspension beam on jack stands or suitable work stand.
2. Remove wheel and tire assemblies from axle.
3. Remove nuts, spacers and jacking pad assembly from the four U-bolts retaining axle tube to suspension beam. See “Fig. 2-2: Axle to Suspension Beam Mounting Detail” on page 5.

☞**NOTE:**

Sealant has been applied to the U-bolts, stiffener plates and spacer tubes during the installation process. It may be necessary to pry mounting hardware pieces to release and fully remove them.

4. Remove the U-bolts.
5. Use hoisting equipment with a minimum capacity of 10,000 lb. (4,550 kg) to lift the axle assembly onto an axle stand equipped to prevent the axle from rotating when set in place. If necessary, tie the axle to the stand with chains or straps.



1. U-Bolt
2. Sika-221 Adhesive
3. Lifting Pad Assembly
4. Flat Washer
5. Hex Locking Nut

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Fig. 2-2: Axle to Suspension Beam Mounting Detail

2.6. Assembly

☞**NOTE:**

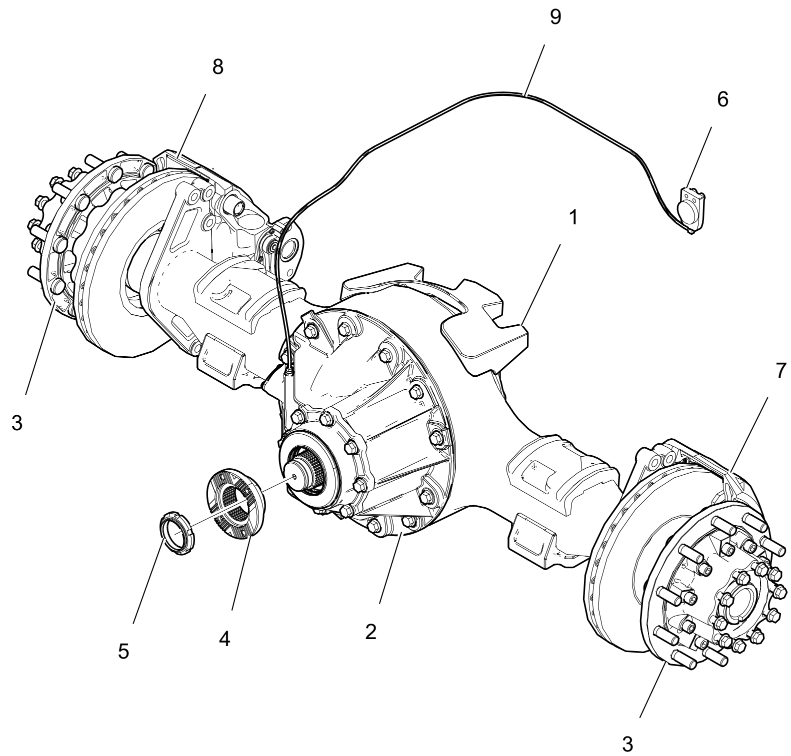
Refer to 4.5. "Rear Suspension Torque Specifications" on page 93 in this section for all assembly and installation torque values.

1. Use appropriate hoisting equipment and carefully lower the axle onto the suspension beam. Align axle mounting pad with dowel pin holes and U-bolt holes in the suspension beam.
2. Install U-bolts (two per side), spacers, and stiffener plates.
3. Coat threads with NEVER-SEEZ®, install lock nuts and torque initially to 50 ft-lb. (68 Nm).
4. Working in a circular pattern from inner to outer bolts, torque bolts to specification.
5. Apply Sikaflex 221 to the edges of the spacer tubes and the stiffener plates to ensure a seal between the top and bottom plates. Also seal the U-Bolt to the top plate holes in the suspension beam.
6. Install tire and wheel assemblies on axle.

3. REAR AXLE

3.1. Description

The rear axle assembly consists of a MAN HY-1350-F low floor hypoid axle complete with wheel hub assembly, brake caliper & brake disc assembly, The axle assembly also includes ABS sensor and pulse generating wheel. The brake chambers are mounted directly on the disc brake caliper assembly. See “Fig. 2-3: Rear Axle Assembly” on page 7.



1. Axle Assembly, Rear 4.56 w/ABS (Incl. 2-9)
2. Differential Assembly, 4.56 Ratio
3. Wheel Hub, Rear
4. Driving Flange, Cross-Serrated w/Ring
5. Nut, Grooved M70 x 1.5
6. Breather, Membrane
7. Disc Brake Caliper Assembly, Front Streetside / Rear Curbside without Lining
8. Disc Brake Caliper Assembly, Front Curbside / Rear Streetside without Lining
9. Tubing, Airbrake 1/4" O.D.

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Fig. 2-3: Rear Axle Assembly

3.2. Rear Axle Specifications

Make .... MAN

Model HY-1350-F

Gear Ratio 4.56

Capacity.................... 28,660 lb. (13,000 kg)

Wheel Studs .... M22 x 1.5 @ 13.189" (335mm) bolt circle

Flange.....................Cross Tooth connection with 5.118" (130mm) Bolt Circle

Input Offset .... Horizontal - 2.75" (70 mm)
.... Vertical - 1.18" (30 mm)

Mounting Pad Angle.............................4.25°

Differential Oil Capacity ....15.3 quart (14.5 l)

3.3. Operation

Drive power is transmitted through a drive-shaft to the flange connection on the input end of the pinion shaft. The pinion shaft transfers power 90° to the axle shafts via the pinion gear and crown wheel. The crown wheel drives the pinion carrier, pinion gear set and side gears.

The flanged end of the axle shaft is bolted to the wheel hub and drives the wheel hub.

3.4. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance requirements.

3.5. Tires

3.5.1. Tire Specifications

Manufacturer ....Goodyear

Model..G652

Size 305/70R22.5

Inflation Pressure .... 125 psi

Maximum Load (dual tires)........... 7,160 lbs. @ 125 psi

3.5.2. Maintenance & Replacement

CAUTION

ALWAYS use tire mounting equipment that is specifically designed for the application and will ensure proper tire mounting without incurring any damage. ALWAYS follow manufacturer's recommendations for use of tire mounting equipment.

☞**NOTE:**

In order to maintain compliance with Environmental Protection Agency and regulatory emission standards, ALWAYS replace tires with ones that meet or exceed the rolling resistance performance of the original tires.

☞**NOTE:**

Consult your tire supplier to ensure that the replacement tire meets the required rolling resistance requirements.

Refer to and follow original tire manufacturer's maintenance procedures in conjunction with the scheduled maintenance identified in the Preventive Maintenance Section of this manual.

3.6. Wheels

CAUTION

Special care must be taken when removing, servicing and installing the wheel and tire assembly to ensure operator, mechanic and passenger safety standards are maintained for the service life of the vehicle.

3.6.1. Inspection

There are several factors that determine the serviceability of the wheel. These include, but are not limited to corrosion, bent rim, excess paint build up and cracks. Inspect all parts for damage. Ensure that studs, nuts, mounting surfaces of the hub, drum, and wheels are clean, and free of grease or corrosion.

3.6.1.1. Wheel Assemblies

Ensure that the wheel mounting surfaces do not have excessive paint thickness, and repair if required. Excessive paint thickness, debris, or excessive corrosion on the wheel mounting surfaces will gradually work its way out during operation and the wheel will become loose. This could result in cracked or broken wheels, damaged brake disc, broken studs, and wheel separation from the vehicle.

Inspect all wheels for cracks, elongated bolt holes, correct shape and form, and other defects that would render the wheel unsafe. Wheels with cracks are not considered serviceable. There are no rework limits for cracks on wheels. Any wheel with a crack is considered scrap, and shall not be reworked.Scrap all wheels which show:

- ❒ Cracking
- ❒ Deep corrosion - defined by a corrosive pit being deeper than 1/2 of the material thickness.
- ❒ Pitting
- ❒ Excessive wear on the mounting surfaces
- ❒ Bent flanges
- ❒ Elongated bolt holes
- ❒ Extended use or excessive wear on the disc face
- ❒ Illegible stamping

Excessive bead blasting used to remove paint may have a negative effect on the wheel. Too much metal may be removed during repeated bead blasting. As this may lead to wheel cracking and early wheel failure the wheel must be scrapped. Never rework, weld, braze or otherwise heat any damaged wheel. Do not attempt to straighten bent or damaged flanges.

Wheels may be refinished and returned to service if no out of service conditions are present.

3.6.1.2. Studs

Studs with thread damage from over tightening, being run loose, excessive corrosion or other secondary damage should be removed from service.

3.6.1.3. Nuts

Thread the nuts onto the studs by hand. Nuts must turn easily by hand. Two-piece flange-nuts may be damaged by extended use, excessive torque, or corrosion. Scrap any nut with cracks in the flange, damaged threads or any nut that does not swivel freely with moderate pressure applied to the flange while rotating the nut. Nuts which no longer rotate freely due to corrosion, wear, or paint build-up may be lubricated. Before reusing flange-nuts, apply (2) drops of 30 weight oil between the flange and the body of the hex nut. If a binding condition still exists it should be removed from service.

3.6.2. Installation

WARNING

This procedure assumes that the vehicle has already been safely jacked up and blocked.

CAUTION

Replace any wheel mounting parts showing any damage.

1. Prior to wheel installation, inspect threads of wheel studs and stud nuts for signs of gouging. Ensure stud mounting surfaces are clean. Inspect wheel rim center surface for damage.
2. Align mounting holes of inner wheel with wheel studs and install inner wheel against wheel hub. Install outer wheel against inner wheel. See “Fig. 2-4: Hub Piloted Wheels - Rear” on page 10.
3. Pretorque wheel nuts 100 ft-lb. (136 Nm). Ensure both wheels are mounted flush around entire hub mounting surface.
4. Lower vehicle to ground.
5. Using torque wrench, pretorque wheel nuts in sequence to 200 ft-lb. (272 Nm). See “Fig. 2-5: Wheel Nut Torquing Sequence” on page 10.
6. Using torque wrench, final torque wheel nuts in sequence to final specification.

NOTE:

Refer to 4.5. “Rear Suspension Torque Specifications” on page 93 in this section for final installation torque value. Torque on dry, unlubricated thread only.

CAUTION

BE SURE wheel and tire assembly are at ambient temperatures before checking wheel nut torque.

7. Check torque on all wheel nuts after 50 to 100 miles of operation.

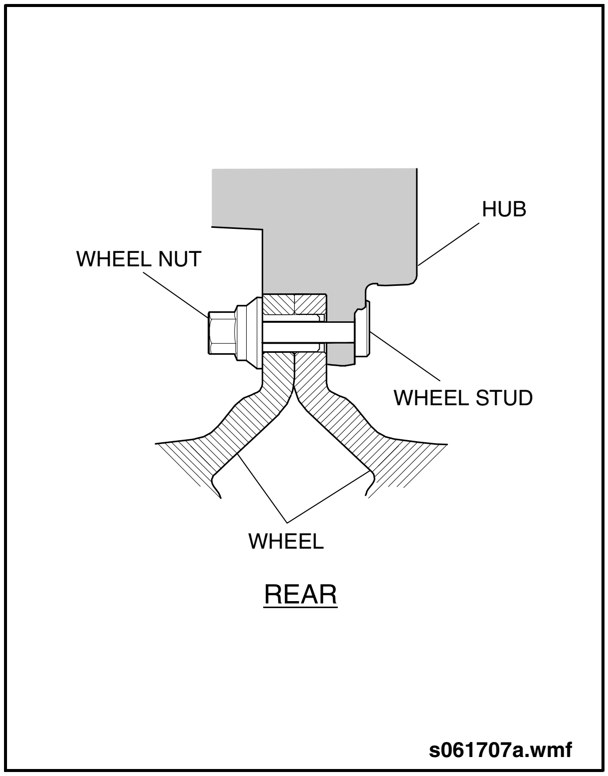


Fig. 2-4: Hub Piloted Wheels - Rear

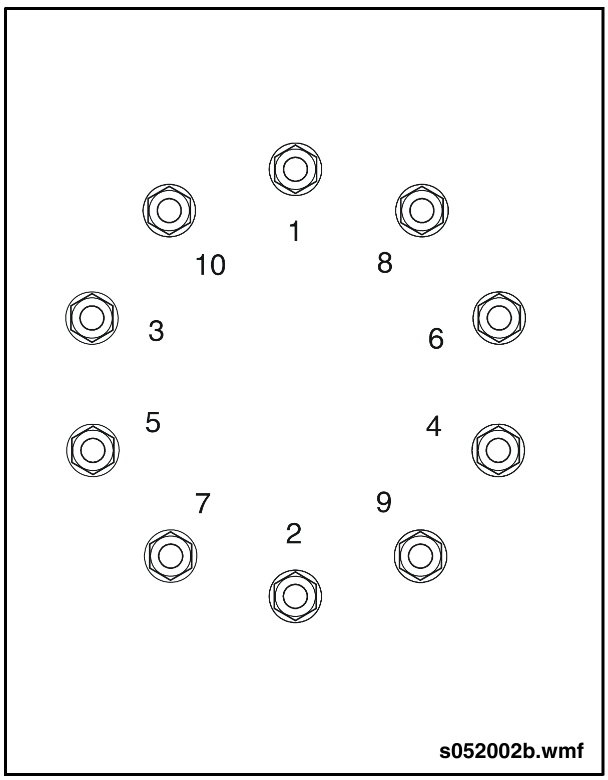


Fig. 2-5: Wheel Nut Torquing Sequence

3.7. Wheel Bolts

3.7.1. Removal

Use a hammer to remove the wheel bolt from the flange. See "Fig. 2-6: Wheel Bolt Removal" on page 11.

3.7.2. Installation

1. Insert a new wheel bolt with the truncated end facing the wheel hub. See "Fig. 2-7: Wheel Bolt Installation" on page 11.
2. Screw the Wheel Bolt Adapter (Item 1 from the special tools list) onto the wheel bolt.
3. Install the wheel bolt using the Wheel Bolt Adapter (Item 1 from the special tools list) and the Impact Tool (Item 2 from the special tools list).

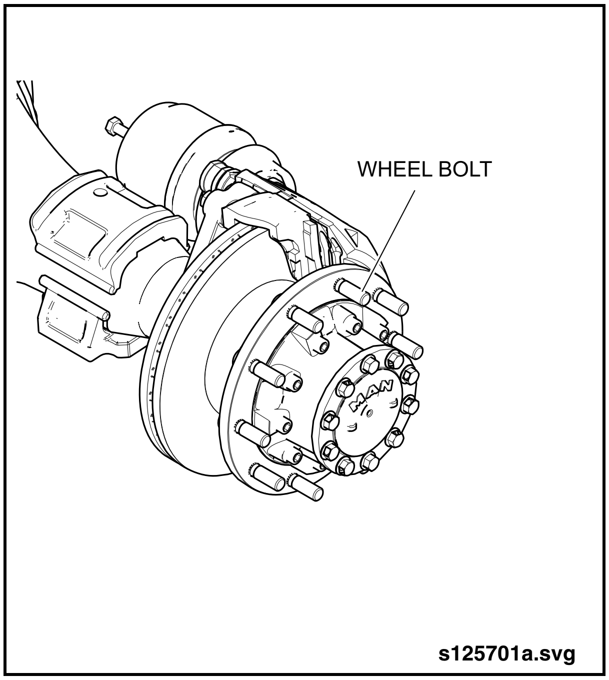


Fig. 2-6: Wheel Bolt Removal

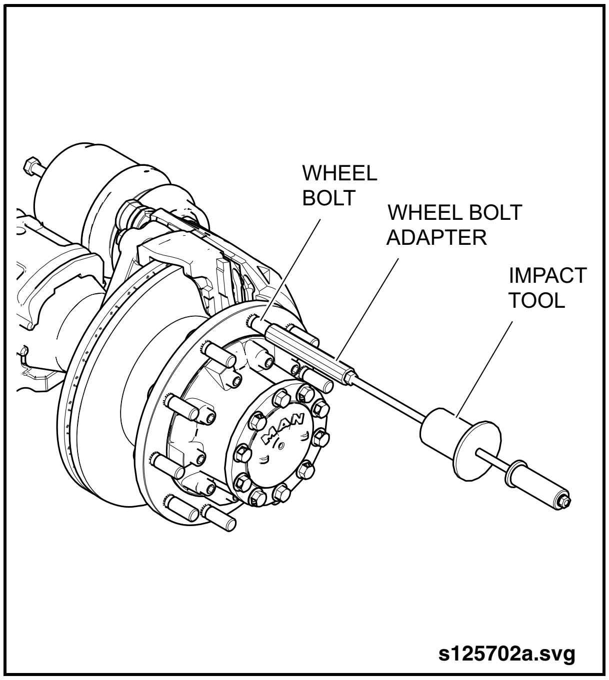


Fig. 2-7: Wheel Bolt Installation

3.8. Axle Shaft

⚠CAUTION

Due to the danger of injury when working with heavy components, always use assistance when moving or lifting the axle shaft.

3.8.1. Removal

☞NOTE:

The parking brake must be applied when removing the axle shaft in order to prevent the axle shaft from rotating while trying to loosen the mounting bolts.

1. Remove and discard the mounting bolts. See “Fig. 2-8: Axle Shaft Removal & Installation” on page 12.
2. Remove the axle shaft and clean the hub and shaft mating surfaces.

☞NOTE:

The axle shafts are of unequal length, with the shorter axle being installed on the streetside. Ensure that each axle is identified as to its location.

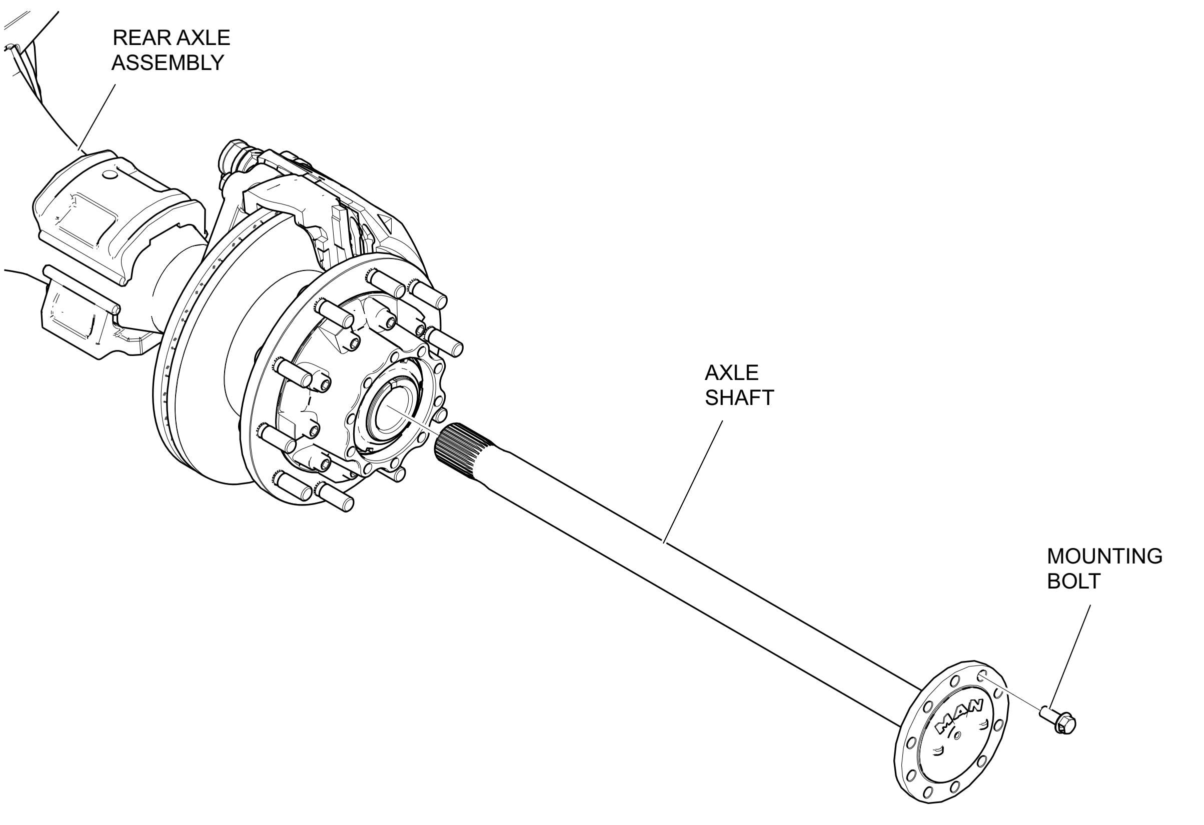


Fig. 2-8: Axle Shaft Removal & Installation

3.8.2. Installation

CAUTION

Due to the danger of injury when working with heavy components, always use assistance when moving or lifting the axle shaft.

CAUTION

Final tightening torque of all fasteners must be performed manually using a torque wrench.

1. Apply a thin coating of ThreeBond white sealing agent on the axle shaft and wheel hub mating surfaces.

CAUTION

The streetside and curbside axle shafts are not interchangeable. Ensure the axle shafts are installed in the correct location as marked during removal.

2. Insert the axle shaft into the axle support, rotating slightly if necessary to insert the shaft into the differential gears.

☞**NOTE:**

The parking brake must be applied when installing the axle shaft in order to prevent the axle shaft from rotating while trying to tighten the mounting bolts.

3. Install new mounting bolts and torque to 266 ft-lb. (360 Nm).

3.9. Rear Wheel Hub

3.9.1. Description

The wheel hub consists of inner and outer tapered roller bearings, inner grease seal with integral ABS pulse wheel, and outer grease seal. The wheel hub is secured to the axle spindle with a locking slotted nut. The wheel bearing clearance is preset and non-adjustable. The wheel bearings require lubrication only if being replaced.

3.9.2. Inspection

Inspect the wheel hub bearings for excessive play as follows:

1. Raise the vehicle and support the rear axle on jack stands.
2. Ensure the brakes are released and the wheels can rotate freely.
3. Attach the base of a magnetic dial gauge to any rigid part of the vehicle structure or axle housing. See “Fig. 2-9: Wheel Bearing Inspection” on page 14.
4. Align the dial gauge pin perpendicular to the face of the brake rotor and as close as possible to the outer edge of the brake disc. Also ensure that the dial gauge pin is located at either the 6 o'clock or 12 o'clock position.

   ☞**NOTE:**

   It is important that the dial gauge pin be positioned at the correct distance from the center of the brake disc in order to obtain an accurate reading. The tip of the gauge should be resting approximately 8.25 to 8.5 inches (210 to 215 mm) from the center of the disc.

5. Zero the dial gauge.
6. Grasp the wheel at the top and bottom and rock back and forth while observing the dial indicator reading.

   ☞**NOTE:**

   If clearance issues resulted in the dial gauge being positioned somewhere other than the 12 o'clock or 6 o'clock position, then ensure the wheel is grasped at a location that corresponds. As an example, if the dial gauge was located at the 2 o'clock position, then grasp the wheel at the 2 o'clock and 8 o'clock positions and rock back and forth.

7. If total movement exceeds 0.010 inch (0.25 mm) remove and inspect the wheel bearings for wear. Replace worn components as necessary.

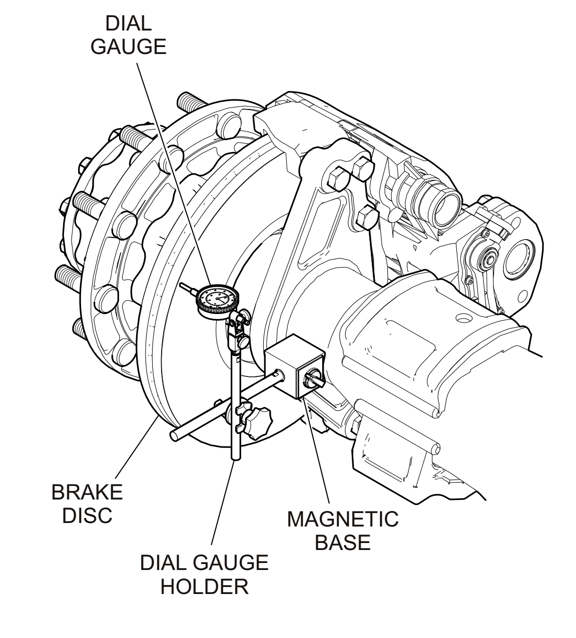


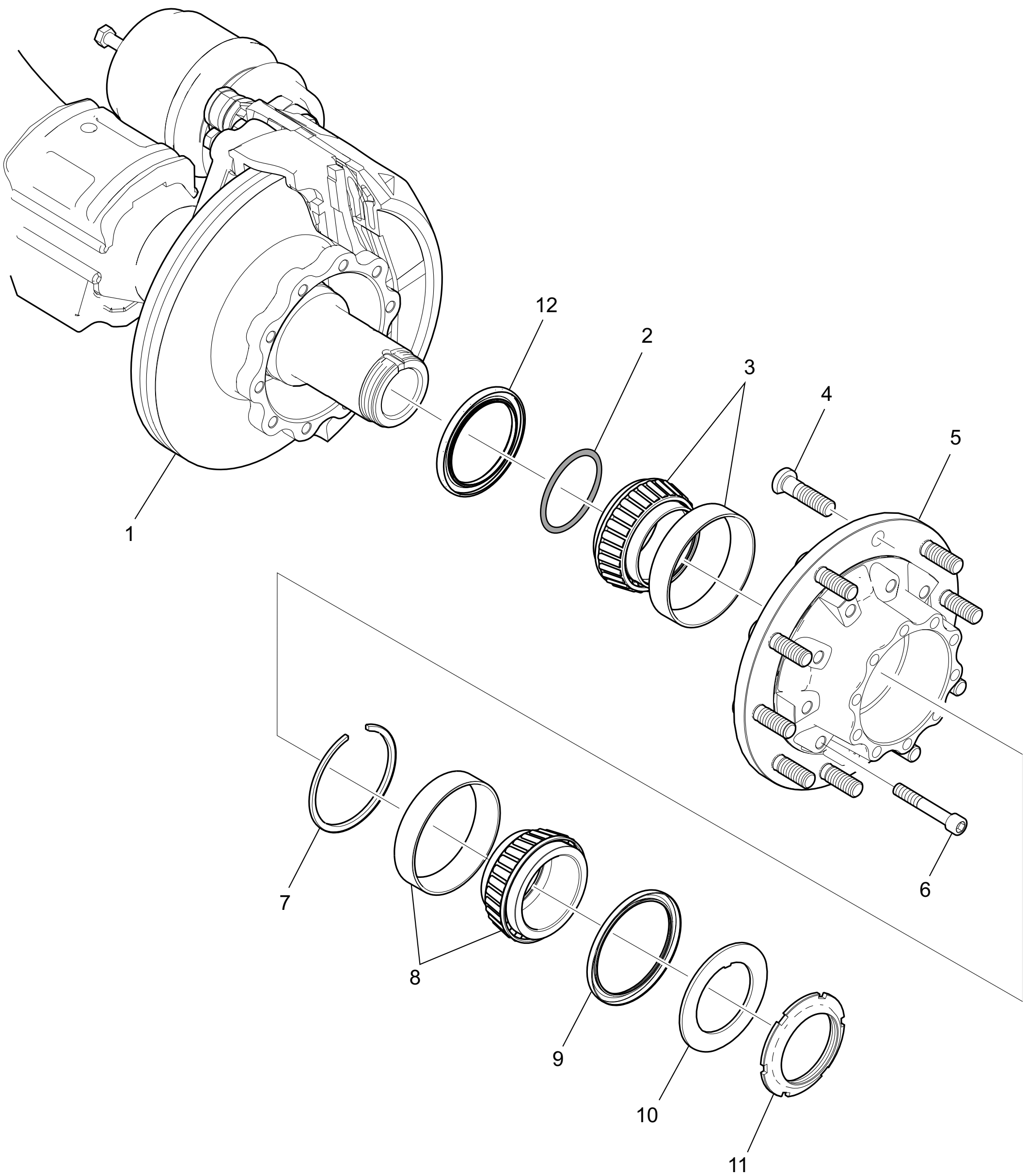
Fig. 2-9: Wheel Bearing Inspection

3.9.3. Removal

CAUTION

Due to the danger of injury when working with heavy components, always use assistance when moving or lifting the wheel hub.

See "Fig. 2-10: Wheel Hub Assembly" on page 15.



1. Brake Disc
2. O-Ring
3. Inner Bearing Assembly
4. Wheel Bolt
5. Wheel Hub
6. Socket Head Screw
7. Retaining Ring
8. Outer Bearing Assembly'
9. Outer Shaft Seal
10. Thrust Washer
11. Slotted Nut
12. Inner Radial Seal/Pulse Wheel

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Fig. 2-10: Wheel Hub Assembly

3.9.3.1. Unlocking Slotted Nut

Unlock the slotted nut by using a punch on the deformed collar of the slotted nut. See "Fig. 2-11: Unlocking Slotted Nut" on page 16.

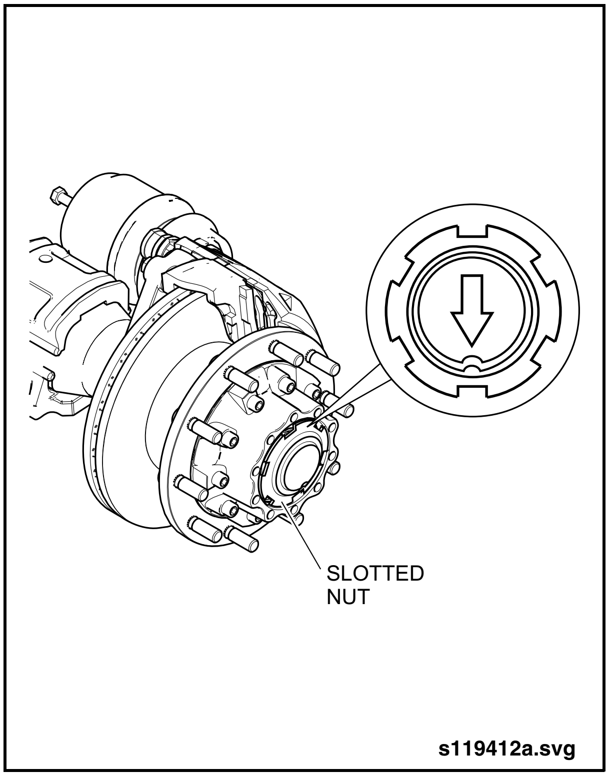

Fig. 2-11: Unlocking Slotted Nut

3.9.3.2. Centering Device Assembly

Assemble the centering device using Items 3, 4, 5, 6 and 7 from special tools list. See "Fig. 2-12: Assembling Centering Device" on page 16.

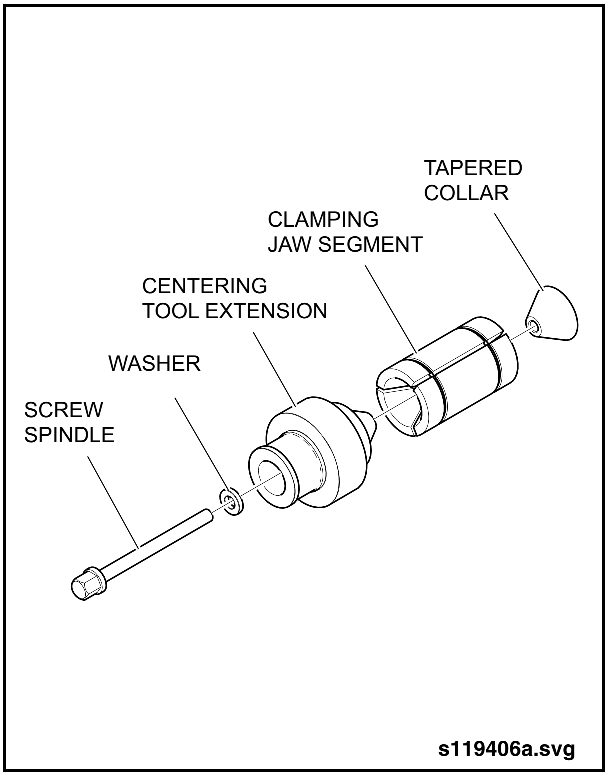

Fig. 2-12: Assembling Centering Device

3.9.3.3. Inserting Centering Device

1. Insert the centering device into the axle stub until it stops. See “Fig. 2-13: Inserting Centering Device” on page 17.
2. Clamp the centering device in place by tightening the screw spindle.

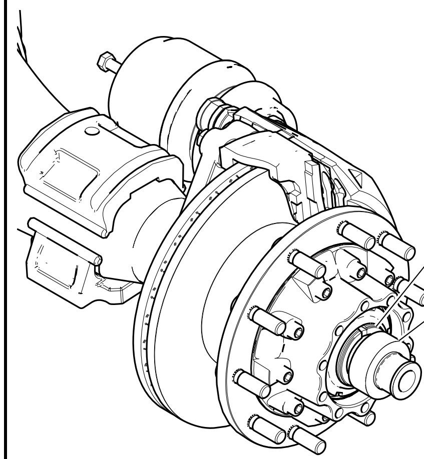

Fig. 2-13: Inserting Centering Device

3.9.3.4. Loosening Slotted Nut

1. Install the Slotted Nut Socket (Item 8 from special tools list) over the centering device and onto the slotted nut. See “Fig. 2-14: Slotted Nut” on page 18.
2. Install the Torque Multiplier (Item 9 from special tools list) on the slotted nut socket and secure it in place with Spindle Screw and Washer (Items 7 & 6 from special tools list).
3. Position Counter-Holder (Item 12 from special tools list) so that the head of the tool slips over the studs on the torque multiplier body and the base of the counter-holder is braced against the floor to counteract the rotational movement of the torque multiplier.
4. Operate the torque multiplier in a counter-clockwise direction to loosen the slotted nut. See “Fig. 2-15: Loosening Slotted Nut” on page 18.
5. Remove the special tools.

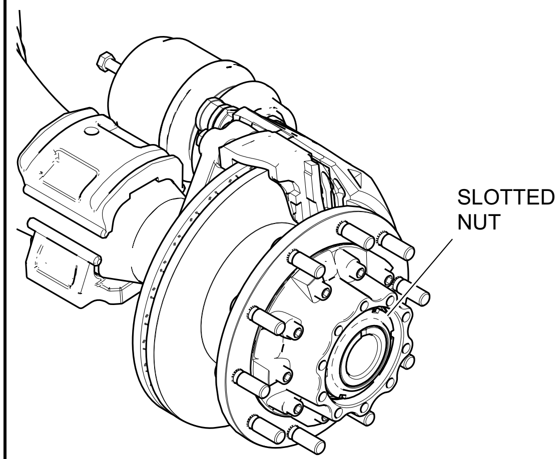

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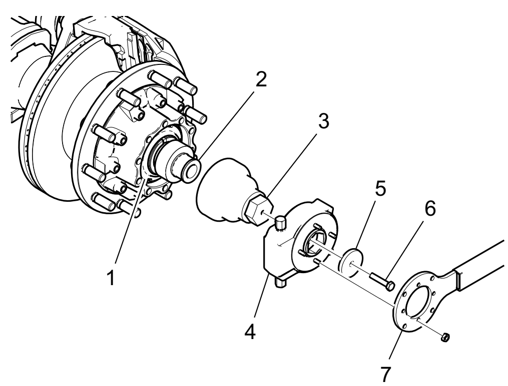
Fig. 2-14: Slotted Nut



1. Slotted Nut’
2. Centering Device
3. Slotted Nut Socket
4. Torque Multiplier
5. Washer
6. Hex Bolt
7. Counter Holder

s119409a.svg

Fig. 2-15: Loosening Slotted Nut

3.9.3.5. Slotted Nut Removal

1. Loosen the wheel hub mounting bolts.
2. Remove the slotted nut and the thrust washer. See "Fig. 2-16: Removing Slotted Nut" on page 19.
3. Discard the slotted nut.

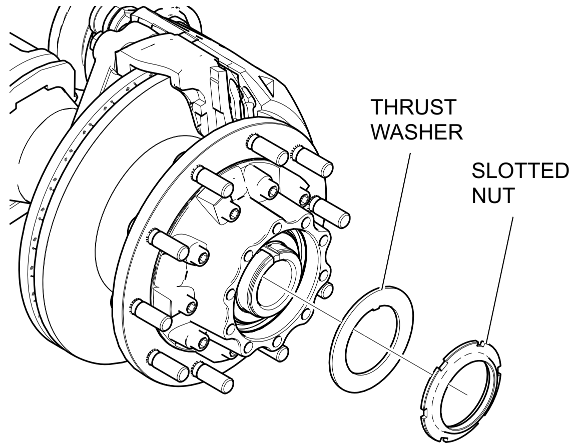


Fig. 2-16: Removing Slotted Nut

3.9.3.6. Wheel Hub Removal

⚠ CAUTION

The wheel hub is heavy. Use a lifting device or assistance if necessary when removing the wheel hub.

1. Remove the wheel hub mounting bolts.

☞NOTE:

The parking brake must be applied when removing the wheel hub in order to prevent the wheel hub from rotating while trying to loosen the mounting bolts.

☞NOTE:

Check condition of bolts. Do not re-use any mounting bolts with signs of damage or deformity.

2. Install threaded Guide Sleeve (Item 13 from special tools list) onto the axle stub and lubricate guide sleeve surface. See “Fig. 2-17: Removing Wheel Hub” on page 20.
3. Pull wheel hub off axle stub and guide sleeve. Use a smooth continuous motion during removal to avoid binding the wheel hub bearings on the guide sleeve. Place wheel hub on a clean work surface.
4. Unscrew Guide Sleeve (Item 13 from special tools list) from axle stub.
5. Clean the wheel hub sealing and contact surfaces. Check for damage. Remove and discard the O-ring.

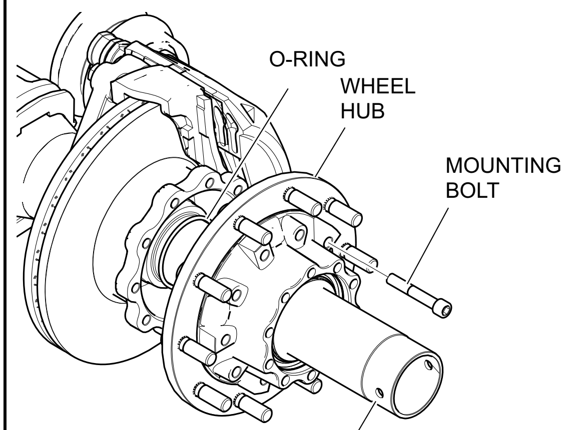


Fig. 2-17: Removing Wheel Hub

3.9.4. Disassembly

3.9.4.1. Retaining Ring Removal

Remove the retaining ring for the wheel hub bearing. See “Fig. 2-18: Removing Retaining Ring” on page 21.

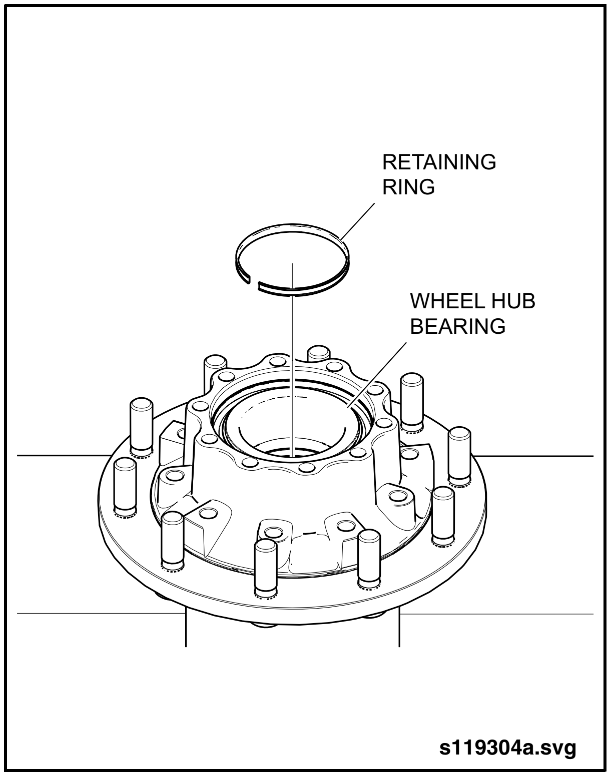


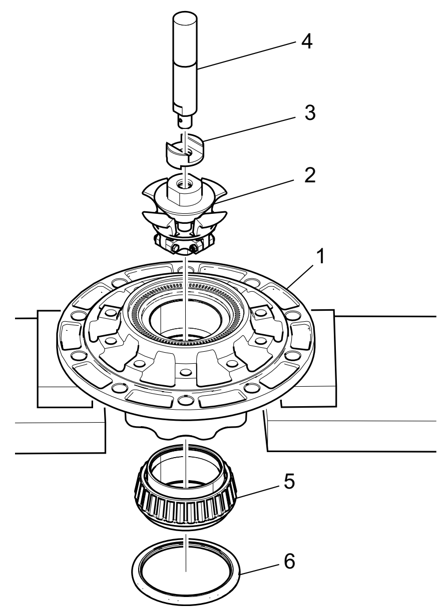
Fig. 2-18: Removing Retaining Ring

3.9.4.2. Outer Tapered Roller Bearing Removal

☞**NOTE:**

The Press-Out Device (Item 17 from special tools list) must not be wedged tight in the wheel hub bearing bore when expanded. Damage to the wheel hub will result.

1. Place the wheel hub on its outer bearing support with wood underneath. Insert the Press-Out Device (Item 17 from special tools list) into the wheel hub.
2. Insert the Slip-On Handle (Item 14 from special tools list) with Press-Out Adapter (Item 16 from special tools list) into the press-out device. See “Fig. 2-19: Removing Outer Tapered Roller Bearing” on page 22.
3. Expand the press-out device by turning the slip-on handle until the stop is reached.
4. Press out the tapered roller bearing and the radial shaft seal.



1. Wheel Hub
2. Press-Out Device
3. Press-Out Washer
4. Slip-On Handle
5. Outer Roller Bearing
6. Radial Shaft Seal

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Fig. 2-19: Removing Outer Tapered Roller Bearing

3.9.4.3. Outer Bearing Outer Race Removal

☞**NOTE:**

The Press-Out Device (Item 17 from special tools list) must not be wedged tight when expanded in the wheel hub.

1. Insert the Press-Out Device (Item 17 from special tools list) into the wheel hub. See “Fig. 2-20: Removing Outer Bearing Outer Race” on page 23.
2. Insert the Slip-On Handle (Item 14 from special tools list) with the Press-Out Adapter (Item 16 from special tools list) into the press-out device
3. Expand the pressing device by turning the slip-on handle until the stop is reached.
4. Press out the bearing outer race.

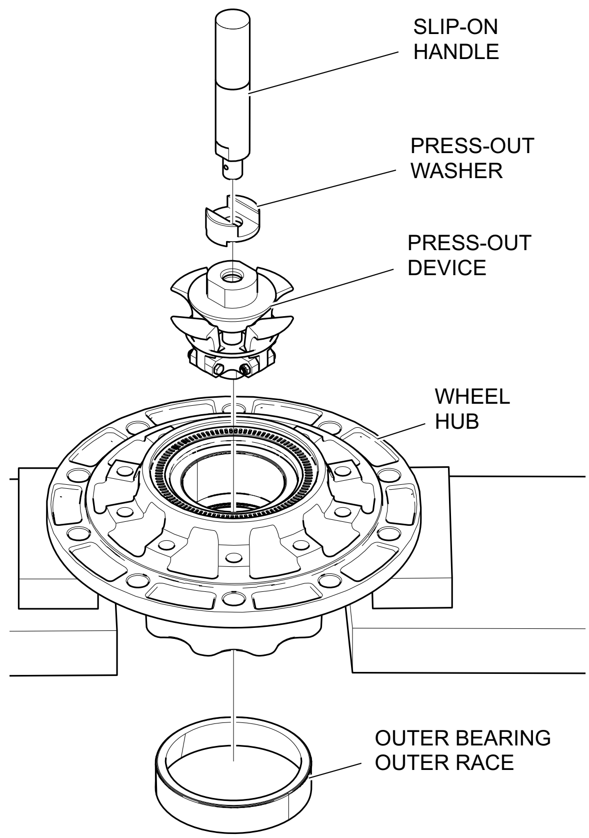


Fig. 2-20: Removing Outer Bearing Outer Race

3.9.4.4. Inner Tapered Roller Bearing Removal

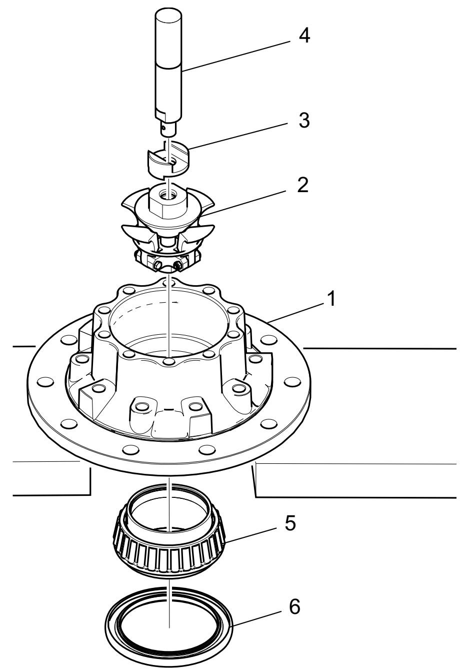
☞NOTE:

The Press-Out Device (Item 17 from special tools list) must not be wedged tight when expanded in the wheel hub.

1. Place the wheel hub on its inner bearing support with wood underneath. See "Fig. 2-21: Removing Inner Tapered Roller Bearing" on page 24.
2. Insert the pressing device into the wheel hub.
3. Insert the Slip-On Handle (Item 14 from special tools list) with Press-Out Adapter (Item 16 from special tools list) into the pressing device.
4. Expand the pressing device by turning the slip-on handle until the stop is reached.
5. Press out the tapered roller bearing and the radial shaft seal with ABS pulse wheel.
6. Remove the radial shaft seal with ABS pulse wheel from the tapered roller bearing.

☞NOTE:

The radial shaft seal with ABS pulse wheel is a press fit on the shoulder of the bearing inner ring and will need to be pressed off. Use an appropriate support fixture for the ABS pulse wheel and select a pressing fixture that will fit the inner ring of the bearing.



1. Wheel Hub
2. Press-Out Device
3. Press-Out Washer
4. Slip-On Handle
5. Inner Roller Bearing
6. Radial Shaft Seal

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Fig. 2-21: Removing Inner Tapered Roller Bearing

3.9.4.5. Inner Bearing Outer Race Removal

☞**NOTE:**

The Press-Out Device (Item 17 from special tools list) must not be wedged tight when expanded in the wheel hub.

1. Place the wheel hub on its inner bearing support with wood underneath. See “Fig. 2-22: Removing Inner Bearing Outer Race” on page 25.
2. Insert the press-out device into the wheel hub.
3. Insert the Slip-On Handle (Item 14 from special tools list) with Press-Out Adapter (Item 16 from special tools list) into the pressing device.
4. Expand the pressing device by turning the slip-on handle until the stop is reached.
5. Press out the bearing outer race.

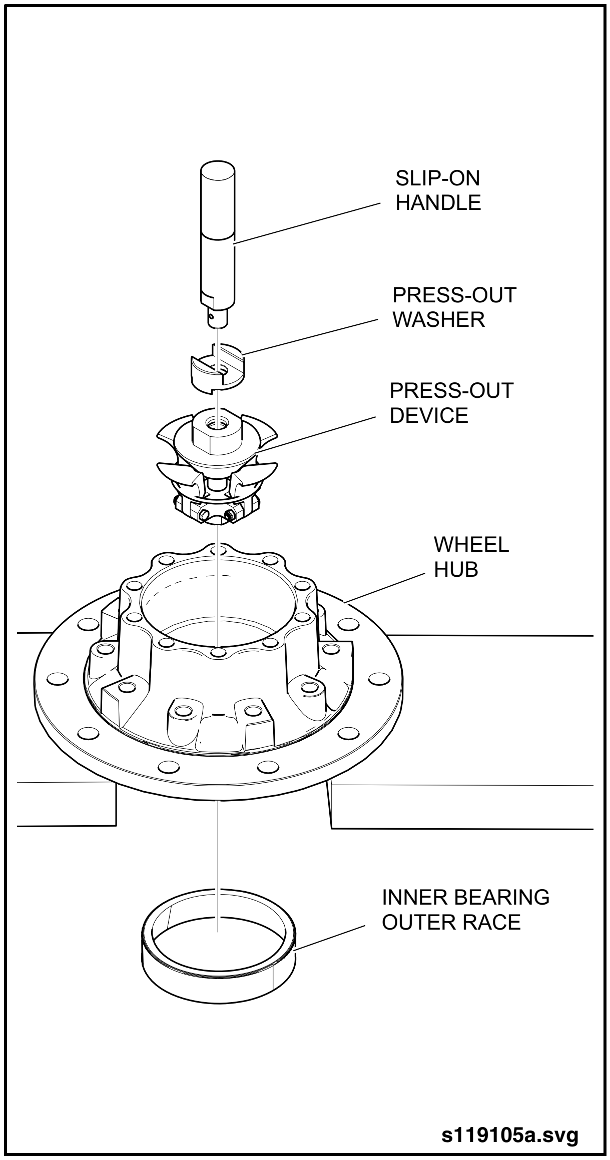


Fig. 2-22: Removing Inner Bearing Outer Race

3.9.5. Assembly

3.9.5.1. Inner Bearing Outer Race Installation

1. Place wheel hub on its outer bearing support with a piece of wood supporting from underneath. See “Fig. 2-23: Installing Inner Bearing Outer Race” on page 26.
2. Assemble the Press-In Plate (Item 18 from special tools list) with the Slip-On Handle (Item 14 from special tools list) and the Washer (Item 15 from special tools list).
3. Press in the bearing outer race as far as the stop with the cone facing outwards.

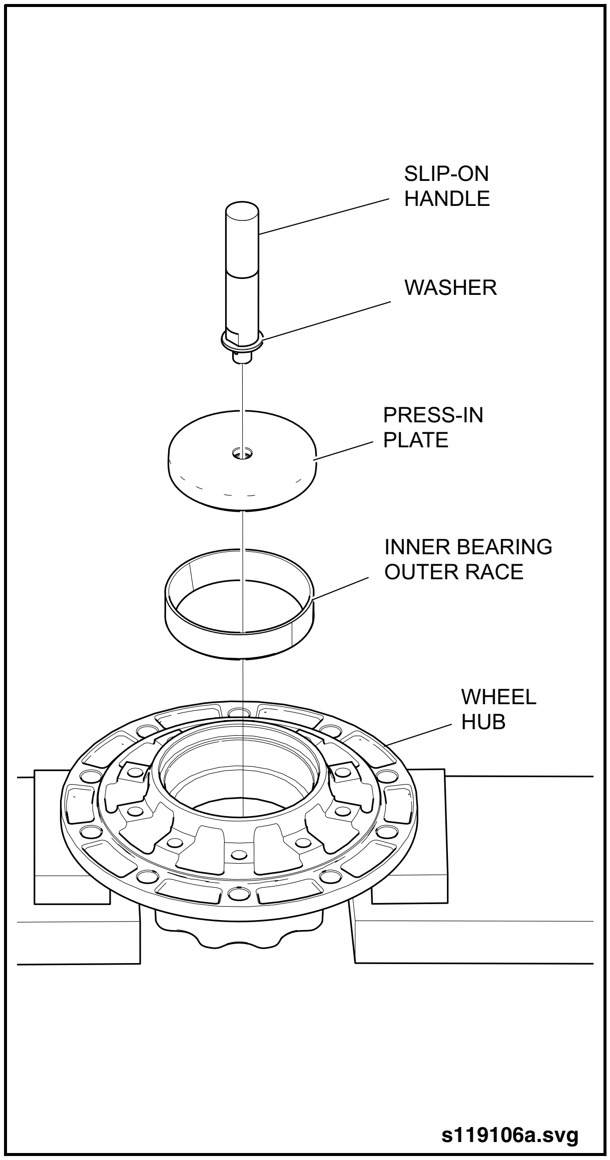


Fig. 2-23: Installing Inner Bearing Outer Race

3.9.5.2. Greasing Hub Unit Wheel Bearings

CAUTION

An excessive quantity of grease leads to excess pressure and leakage in the wheel bearing. DO NOT exceed a grease quantity of 4.2 oz. (120 g).

1. Apply high-temperature grease on the tapered roller bearings. See "Fig. 2-24: Greasing Hub Unit Wheel Bearings" on page 27. Refer to "Fluid & Lubrication Guide" in the Preventive Maintenance Section of this manual for a list of approved greases.
2. Fill the cavity between the tapered roller bearings with the specified high-temperature grease.

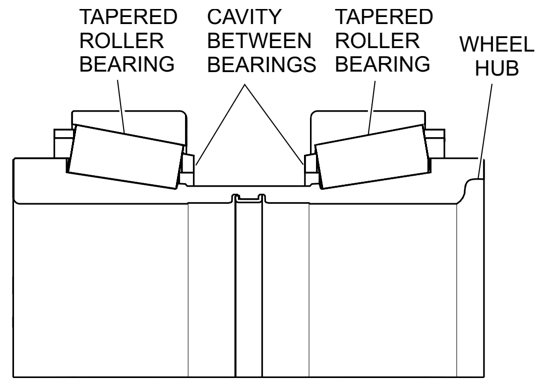


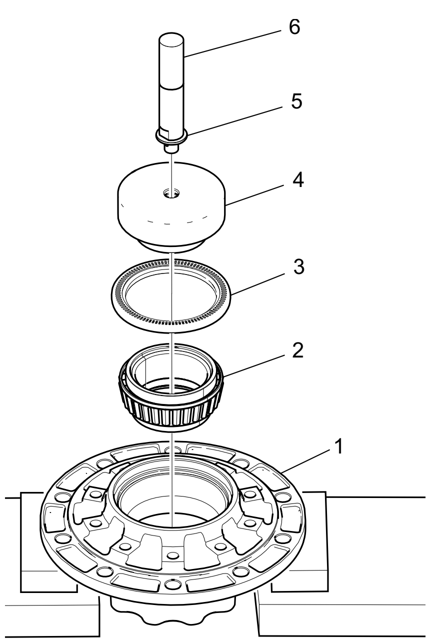
Fig. 2-24: Greasing Hub Unit Wheel Bearings

3.9.5.3. Inner Tapered Roller Bearing Installation

1. Insert the tapered roller bearing into the wheel hub. See "Fig. 2-25: Installing Inner Tapered Roller Bearing" on page 28.
2. Assemble the Pressing Bush (Item 19 from special tools list) with the Slip-On Handle (Item 14 from special tools list) and the Washer (Item 15 from special tools list).
3. Lightly apply gear oil on the contact surfaces of the new radial shaft seal with ABS pulse wheel.
4. Press the radial shaft seal with ABS pulse wheel into the wheel hub so that it seats flush.

3.9.5.4. Outer Bearing Outer Race Installation

1. Place wheel hub on its inner bearing support.
2. Assemble the Press-In Plate (Item 18 from special tools list) with the Slip-On Handle (Item 14 from special tools list) and the Washer (Item 15 from special tools list).
3. Press in the bearing outer race as far as the stop with the cone facing outwards. See "Fig. 2-26: Installing Outer Bearing Outer Race" on page 28.



1. Wheel Hub
2. Inner Tapered Roller Bearing
3. ABS Pulse Wheel
4. Pressing Bush
5. Washer
6. Slip-On Handle

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Fig. 2-25: Installing Inner Tapered Roller Bearing

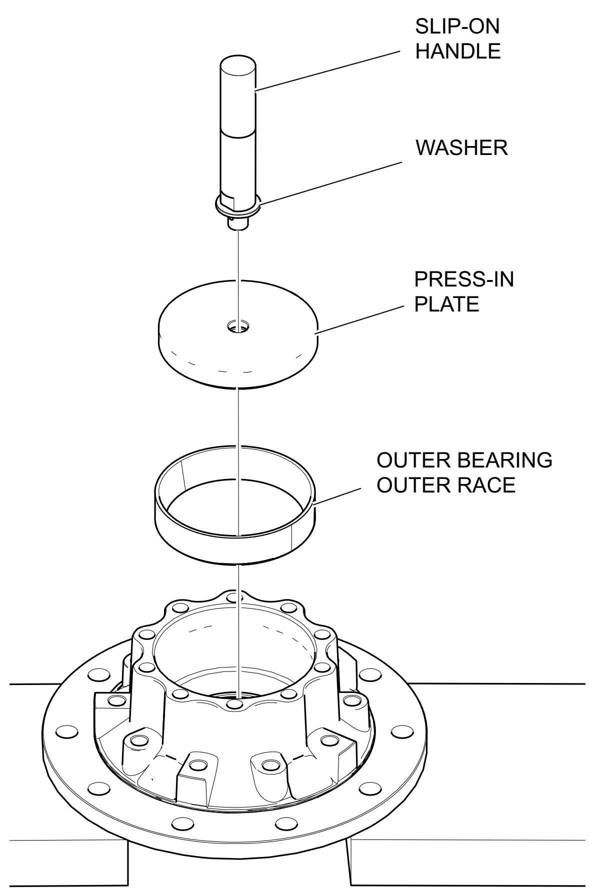

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Fig. 2-26: Installing Outer Bearing Outer Race

3.9.5.5. Outer Tapered Roller Bearing Installation

1. Insert the tapered roller bearing into the wheel hub. See “Fig. 2-27: Installing Outer Tapered Roller Bearing” on page 29.
2. Assemble the Pressing Bush (Item 20 from special tools list) with the Slip-On Handle (Item 14 from special tools list) and the Washer (Item 15 from special tools list).
3. Lightly apply gear oil on the contact surfaces of the new radial shaft seal.
4. Press the radial shaft seal into the wheel hub with the sealing lip outwards, so that it is flush.

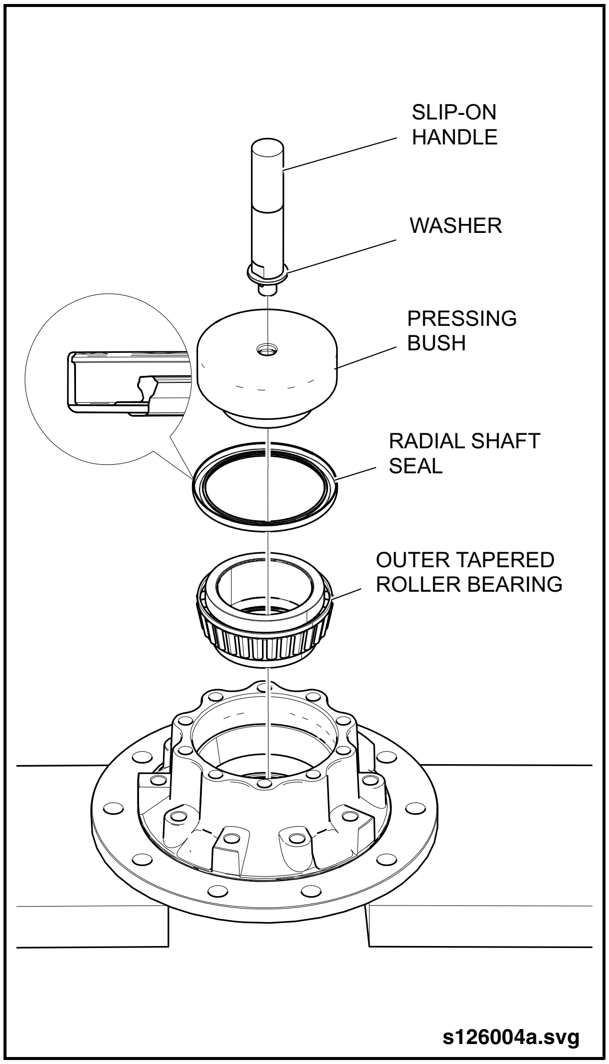


Fig. 2-27: Installing Outer Tapered Roller Bearing

3.9.5.6. Retaining Ring Installation

Install the wheel bearing retaining ring in its groove. Be sure the retaining ring is properly installed into the groove of each bearing to provide proper connection.

3.9.6. Installation

CAUTION

Due to the danger of injury when working with heavy components, always use assistance when moving or lifting the wheel hub.

3.9.6.1. Mounting Wheel Hub

1. Apply a light coat of Molykote-D paste in the wheel hub bearing seat area and on the axle stub. Apply paste on the machined surface of the stub where the hub bearings are seated except 3/4" of inner bearing seat.
2. Insert a new O-ring on the inside of the wheel hub.
3. Install the threaded Guide Sleeve (Item 13 from special tools list) onto the axle stub.
4. Install the wheel hub over the guide sleeve and align it to the brake disc.

☞**NOTE:**

Replace any mounting bolts with signs of damage or deformity.

5. Install mounting bolts.
6. Remove the Guide Sleeve (Item 13 from special tools list).

3.9.6.2. Screwing on Slotted Nut

1. Torque mounting bolts to 207 ft-lb. (280 Nm).
2. Install the thrust washer.
3. Install a new slotted nut.

3.9.6.3. Caging Brake Chamber

1. Allow the wheel hub to rotate by releasing the parking brake.

☞**NOTE:**

If the parking brake is not functional, proceed to the following step.

CAUTION

DO NOT use impact tools to cage or uncage the brake chamber.

2. Cage the spring brake by rotating the brake chamber release bolt counter-clockwise approximately 22 to 23 turns. The force to compress the spring must not exceed 74 ft-lb. (100 Nm) during the caging process. The brake chamber is considered fully caged when the head of the release bolt extends approximately 1.30" beyond the surface of the brake chamber.

3.9.6.4. Inserting Centering Device

1. Insert the centering device into the axle stub until the stop is reached.
2. Clamp the centering device.

3.9.6.5. Tightening Slotted Nut

1. Fit the Slotted Nut Socket (Item 8 from special tools list) over the centering device and onto the slotted nut.
2. Place the Torque Multiplier (Item 9 from special tools list) on the slotted nut socket and secure it in place with Spindle Screw and Washer (Items 7 & 6 from special tools list).
3. Mount the Counter-Holder (Item 12 from special tools list) on the torque multiplier.

CAUTION

The torque multiplier has a 1:8 ratio. Set the torque wrench to 111 ft-lb. (150 Nm) for a final torque of 885 ft-lb. (1200 Nm).

4. Rotate the Torque Multiplier to tighten the slotted nut. Torque the slotted nut to 885 ft-lb. (1200 Nm) while turning the wheel hub constantly.
5. Remove the special tools.

3.9.6.6. Locking Slotted Nut

Lock the slotted nut by using a rounded punch and deforming the collar of the slotted nut into the groove. See "Fig. 2-28: Locking Slotted Nut" on page 31.

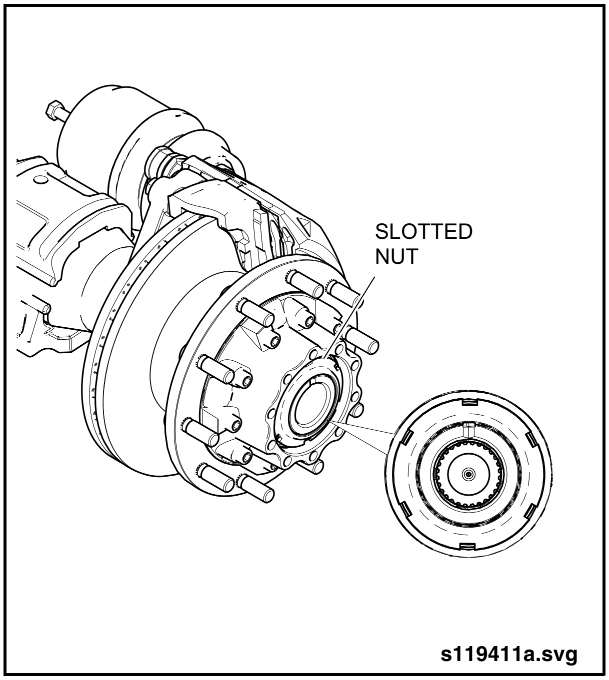


Fig. 2-28: Locking Slotted Nut

3.9.6.7. Uncaging Brake Chamber

CAUTION

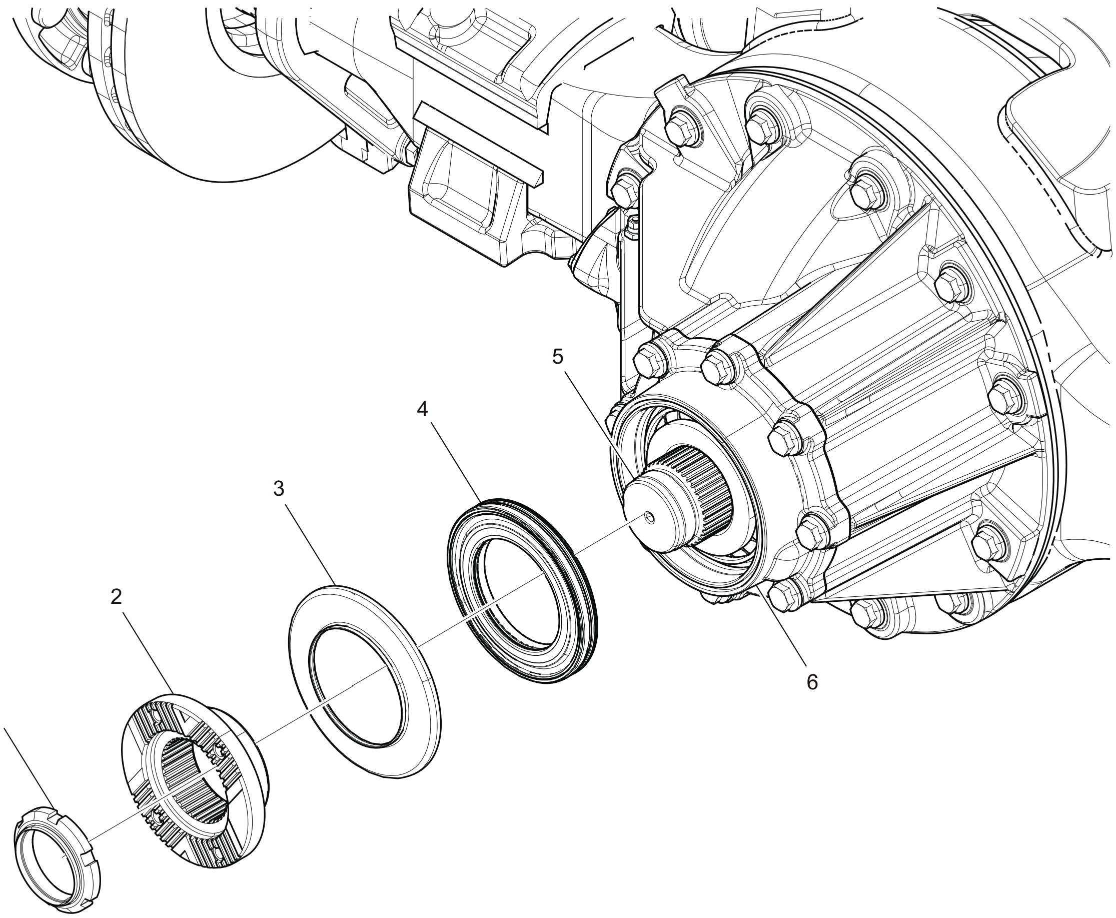
DO NOT use impact tools to cage or uncage the brake chamber.

Uncage the brake chamber by rotating the release bolt clockwise until fully seated. Torque the release bolt 50 to 62 ft-lb. (68 to 81 Nm).

3.10. Pinion Seal Replacement

The following procedure describes replacement of the pinion shaft radial seal with the axle installed on the vehicle. See “Fig. 2-29: Pinion Seal Replacement” on page 32.

Refer to 8. “DRIVESHAFT” on page 144 in this section of the manual for removal and installation procedures.



1. Slotted Nut
2. Input Flange
3. Input Flange Shield
4. Pinion Shaft Radial Seal
5. Drive Pinion Gear Housing

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Fig. 2-29: Pinion Seal Replacement

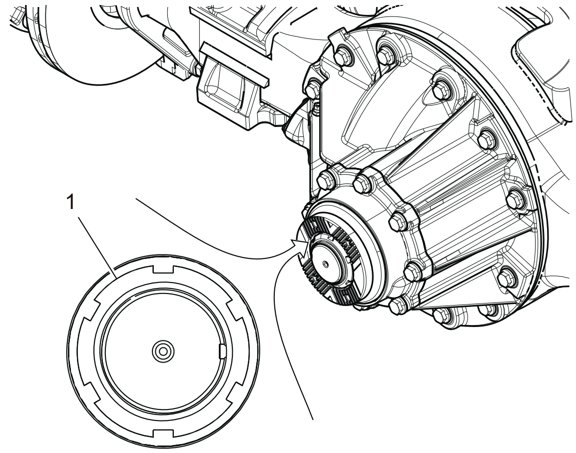
3.10.1. Removal

3.10.1.1.Unlocking Slotted Nut

WARNING

Be sure the dimpled metal is completely bent out from the groove in the pinion shaft. Failure to do so may result in damage to the pinion shaft threads.

1. Unlock the slotted nut using a chisel or punch to bend the dimpled metal out of the slot. See “Fig. 2-30: Unlocking Slotted Nut” on page 33.
2. Assemble special tools as follows:
   a. Position Intermediate Flange (Item 43 from Special Tools List) on input flange and secure with mounting bolts. See “Fig. 2-31: Mounting Input Flange Tool” on page 33.
   b. Place the Slotted Nut Wrench (Item 26 from Special Tools List) onto the slotted nut.
   c. Install the Torque Multiplier (Item 9 from Special Tools List) onto the Intermediate Flange (Item 43 from Special Tools List) and secure using mounting nuts.



1. Slotted Nut

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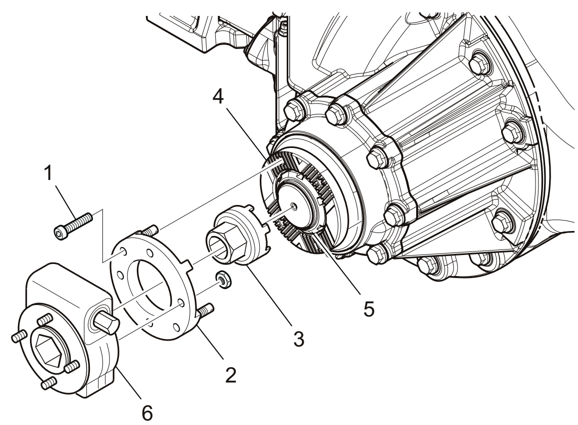
Fig. 2-30: Unlocking Slotted Nut



1. Mounting Bolt
2. Intermediate Flange
3. Slotted Nut Wrench
4. Input Flange
5. Slotted Nut
6. Torque Multiplier

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Fig. 2-31: Mounting Input Flange Tool

3.10.1.2.Removing Slotted Nut

1. Loosen the slotted nut using the torque multiplier. The slotted nut must be turned counter-clockwise to loosen. See “Fig. 2-32: Removing Slotted Nut” on page 34.
2. Remove the special tools.
3. Remove and discard the slotted nut.

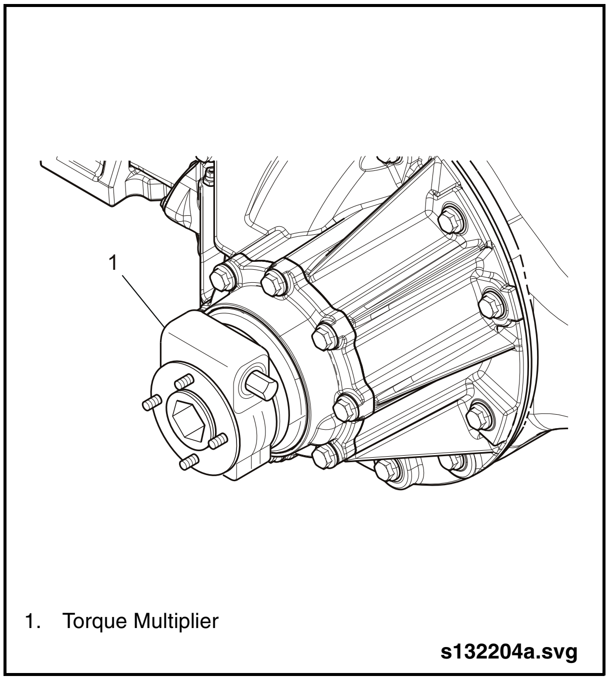


Fig. 2-32: Removing Slotted Nut

3.10.1.3.Removing Input Flange

1. Place the 3-Arm Puller (Item 29 from Special Tools List) and Adapter Piece (Item 35 from Special Tools List) on the input flange.
2. Thread the 3-Arm Puller spindle against the Adapter Piece to remove the input flange. See “Fig. 2-33: Pulling Off Input Flange” on page 34.

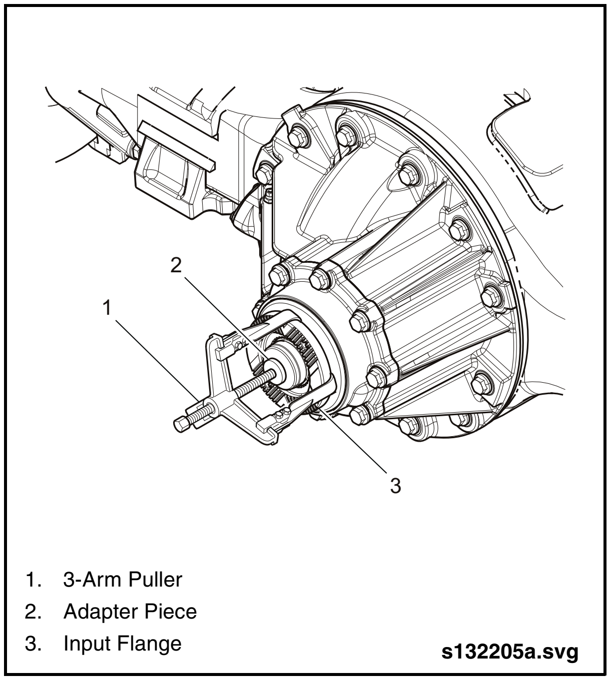


Fig. 2-33: Pulling Off Input Flange

3.10.1.4.Removing Radial Shaft Seal

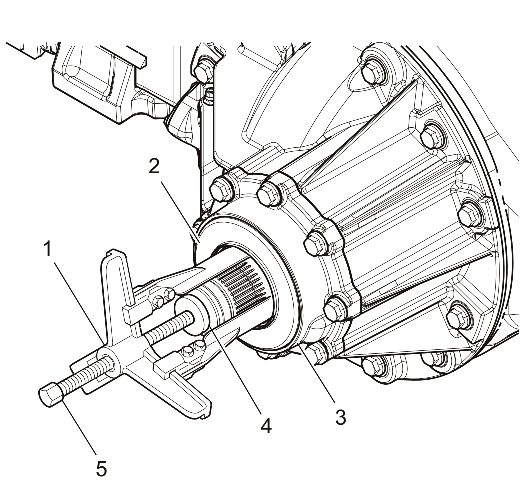
1. Insert the hooks of the 3-Arm Puller (Item 32 from Special Tools List) behind the sealing lips of the radial shaft seal.
2. Place the Spindle Adapter (Item 67 from Special Tools List) on the pinion shaft and thread in the spindle until it contacts the spindle adapter. See “Fig. 2-34: Removing Radial Shaft Seal” on page 35.
3. Pull out the radial shaft seal from the drive pinion gear housing and discard.

3.10.1.5.Removing Input Flange Shield

NOTE:

Removal of the flange shield is required only if the protective shield is has been damaged.

1. Fit the Separator (Item 75 from Special Tools List) under the shield. See “Fig. 2-35: Removing Input Flange Shield” on page 35.
2. Place the Separator and input flange on a press and support with suitable blocks.
3. Assemble the Pressing Plate (Item 74 from Special Tools List) with Detachable Handle (Item 33 from Special Tools List) and place onto the input flange.
4. Place a suitable support beneath the press to prevent the input flange from falling.
5. Press out the input shaft from the protective shield.



1. 3-Arm Puller
2. Pinion Shaft Radial Seal
3. Drive Pinion Gear Housing
4. Spindle Adapter
5. Puller Spindle

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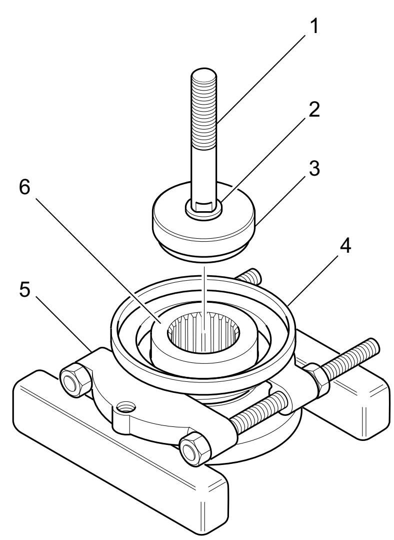
Fig. 2-34: Removing Radial Shaft Seal



1. Detachable Handle
2. Thrust Washer
3. Pressing Plate
4. Input Flange Shield
5. Separator
6. Input Flange

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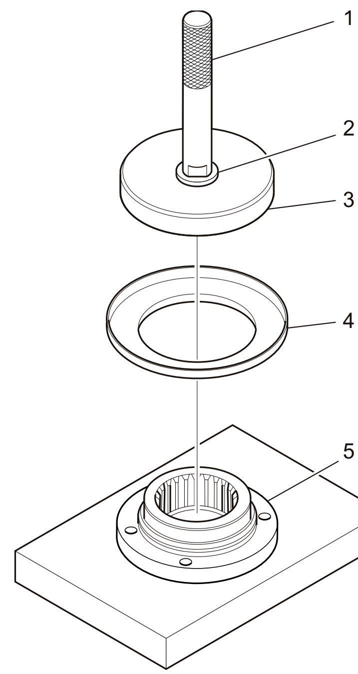
Fig. 2-35: Removing Input Flange Shield

3.10.2. Installation

3.10.2.1.Installing Input Flange Shield

1. Assemble Pressing Plate (Item 71 from Special Tools List) with Detachable Handle (Item 33 from Special Tools List) and Thrust Washer (Item 15 from Special Tools List).
2. Press the new shield onto the input flange as far as possible. See “Fig. 2-36: Installing Input Flange Shield” on page 36.



1. Detachable Handle
2. Thrust Washer
3. Pressing Plate
4. Input Flange Shield
5. Input Flange

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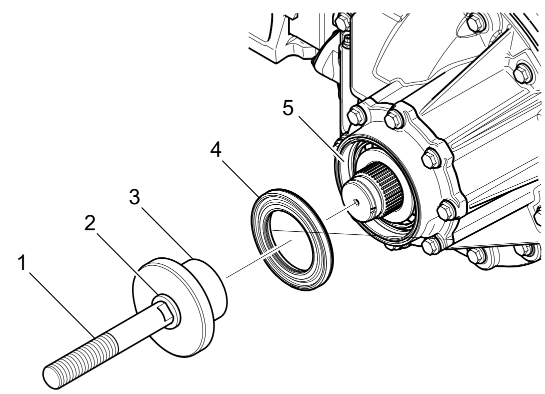
Fig. 2-36: Installing Input Flange Shield

3.10.2.2. Installing Radial Shaft Seal

1. Assemble the Pressing Adapter (Item 34 from Special Tools List) with the Detachable Handle (Item 33 from Special Tools List) and Thrust Washer (Item 15 from Special Tools List).
2. Press the open side of the new radial shaft seal into the drive pinion gear housing as far as possible. See “Fig. 2-37: Installing Radial Shaft Seal” on page 37.



1. Detachable Handle
2. Thrust Washer
3. Pressing Adapter
4. Radial Shaft Seal
5. Drive Pinion Gear Housing

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Fig. 2-37: Installing Radial Shaft Seal

3.10.2.3.Installing Input Flange

1. Apply a thin coat of gear oil to the seal contact surface of the input flange.
2. Install the input flange onto the splines of the pinion shaft and press in by hand.
3. Install new slotted nut and hand tighten.
4. Position Intermediate Flange (Item 43 from Special Tools List) on input flange and secure with mounting bolts.
5. Place the Slotted Nut Wrench (Item 26 from Special Tools List) onto the slotted nut.
6. Install the Torque Multiplier (Item 9 from Special Tools List) onto the Intermediate Flange (Item 43 from Special Tools List) and secure using mounting nuts.

3.10.2.4.Tightening Slotted Nut

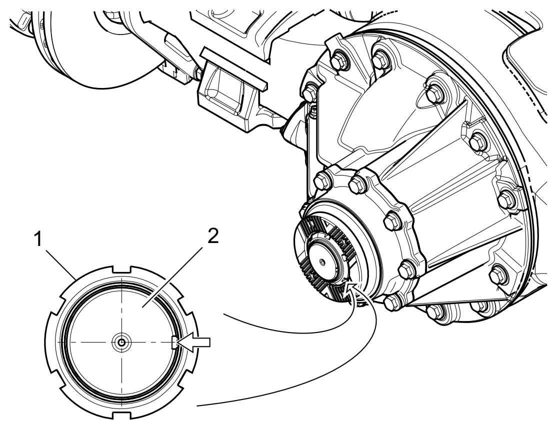
CAUTION

The torque multiplier has a 1:8 ratio. Set the torque wrench to 88 ft-lb. (119 Nm) to achieve an output torque of 701 ft-lb. (950 Nm).

1. Torque the slotted nut to 701 ft-lb. (950 Nm).
2. Remove the special tools.

3.10.2.5.Locking Slotted Nut

Drive the collar of the slotted nut into the groove. See “Fig. 2-38: Locking Slotted Nut” on page 38.



1. Slotted Nut Collar
2. Input Shaft Groove

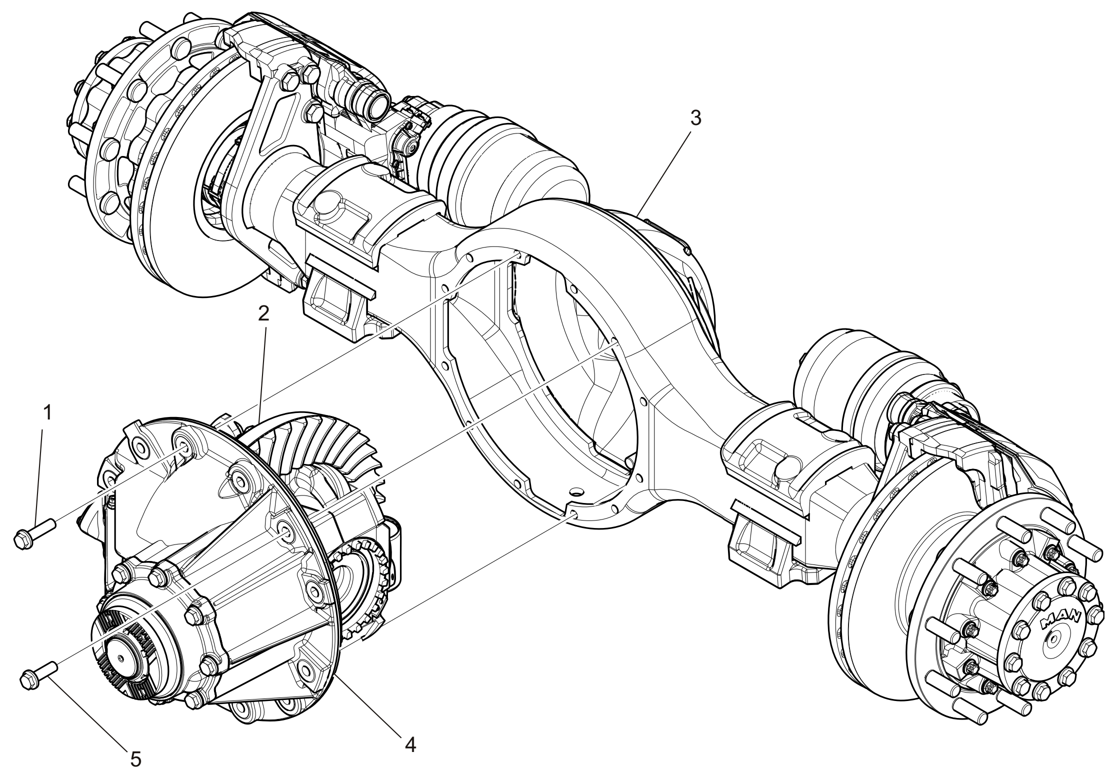
s132210a.svg

Fig. 2-38: Locking Slotted Nut

3.11. Differential Carrier

3.11.1. Removal

The following procedure describes replacement of the differential carrier assembly as a unit. The differential carrier assembly consists of the differential, axle gear housing, & drive pinion gear housing. See “Fig. 2-39: Differential Carrier Removal” on page 39.



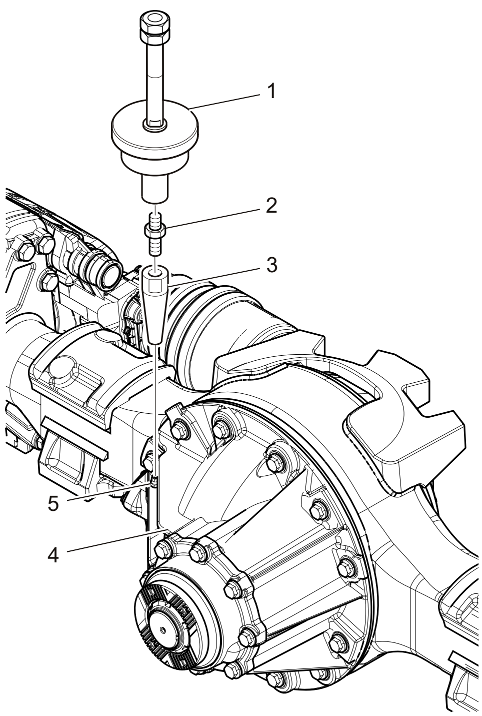
1. Mounting Bolt, M16 x 60 mm
2. Differential
3. Axle Housing
4. Differential Carrier
5. Mounting Bolt, M16 x 50 mm

s132211a.svg

Fig. 2-39: Differential Carrier Removal

3.11.1.1. Removing Breather Connection

1. Unscrew the union nut and breather hose from the breather connection.
2. Assemble the Extractor (Item 42 from Special Tools List) with the Threaded Adapter (Item 41 from Special Tools List) and the Tapered Adapter (Item 40 from Special Tools List). See “Fig. 2-40: Removing Axle Breather Connection” on page 40.
3. Thread the puller attachment onto the breather connection and use the slide hammer action to extract the breather.



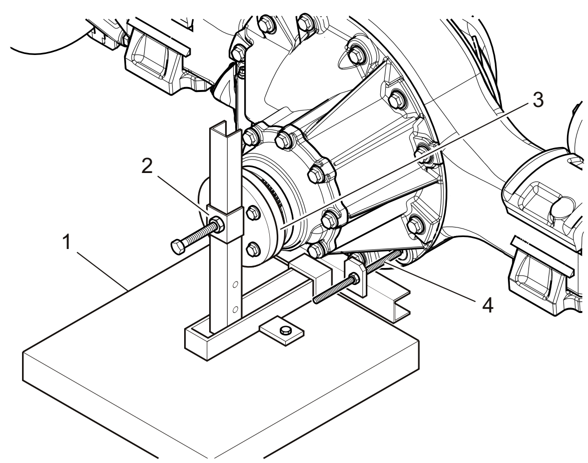
1. Extractor
2. Threaded Adapter
3. Tapered Adapter
4. Breather Pipe
5. Axle Gear Housing

s132212a.svg

Fig. 2-40: Removing Axle Breather Connection

3.11.1.2. Attaching Lifting Device

1. Mount the Lifting Device (Item 36 from Special Tools List) on the Assembly Crown (Item 37 from Special Tools List). See “Fig. 2-41: Differential Carrier Lifting Device” on page 40.
2. Install the assembled Lifting Device and Assembly Crown with Lift Adapter (Item 76 from Special Tools List) onto a hydraulic lifting device.
3. Use the hydraulic lifting device to align the lifting equipment with the input flange.
4. Attach the lifting device to the input flange.
5. Thread the Support Screw (Item 38 from Special Tools List) into the lifting device.
6. Note the location of the support screw and remove the corresponding bolt from the axle gear housing.
7. Prevent the axle gear housing from rotating during removal by threading the support screw into the axle gear housing bolt hole.



1. Assembly Crown
2. Lifting Device
3. Input Flange
4. Support Screw

s126301a.svg

Fig. 2-41: Differential Carrier Lifting Device

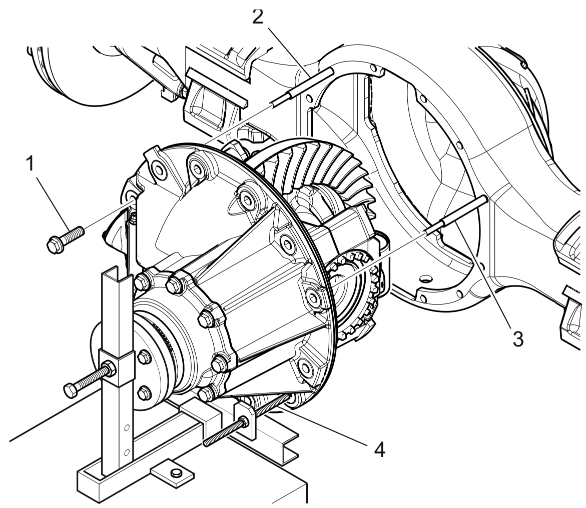
3.11.1.3.Removing Differential Carrier

1. Mark the position of the mounting bolts.

☞NOTE:

Six of the M16 mounting bolts are 50 mm long and the other six are 60 mm long. Ensure that the bolts are reinstalled in the correct location.

2. Remove two opposing mounting bolts and replace with Alignment Pins (Item 78 from Special Tools List). See “Fig. 2-42: Differential Carrier Removal” on page 41.
3. Remove the remaining mounting bolts.
4. Use the lifting device to carefully slide the differential carrier out from the axle housing.
5. Clean the differential carrier and axle housing mating surfaces.
6. Move the differential carrier to a clean work area and remove the lifting equipment.



1. Mounting Bolt
2. Alignment Pin
3. Alignment Pin
4. Support Screw

s126302a.svg

Fig. 2-42: Differential Carrier Removal

3.11.2. Installation

3.11.2.1. Installing Differential Carrier

1. Prior to installing the differential carrier assembly into the axle housing, remove the oil filter, located in the upper area of the axle housing. See "Fig. 2-43: Axle Housing Oil Filter" on page 42.

2. Install a new oil filter with new bolts and washers. DO NOT attempt to clean the oil filter. Torque M8 mounting bolts to 16 ft-lbs. (22 Nm) using Torque Wrench and Ratchet Adapter (Items 87 & 11 from Special Tools List).

☞NOTE:

If new self-locking bolts are not readily available, it is permissible to clean the thread locking compound from the original bolts and reapply medium strength thread locking compound.

3. Mount the Lifting Device and Assembly Crown (Items 36 & 37 from Special Tools List) to the differential and secure it in place with the Support Screw (Item 38 from Special Tools List).

4. Use the hydraulic lift and adapter to position the lifting equipment and differential carrier assembly in line with the axle housing.

5. Apply a thin coating of Loctite-518 Gasket Eliminator face-sealing agent on the differential carrier and axle housing mating faces.

6. Install two Alignment Pins (Item 78 from Special Tools List) into two opposing threaded holes on the axle housing mounting flange.

7. Use the lifting device and hydraulic lift to move the differential carrier toward the axle housing and slide over the alignment pins.

8. Use new mounting bolts and install in locations noted during removal. Hand-tighten only at this time.

☞NOTE:

Six of the M16 mounting bolts are 50 mm long and the other six are 60 mm long. Ensure that the bolts are installed in the correct location.

9. Remove the alignment pins and install the two mounting bolts.

10. Use Torque Wrench with Square Drive (Items 96 and 39 from Special Tools List) and torque bolts to 280 ft-lb. (380 Nm).

11. Remove the support screw from the lifting device and install the last remaining bolt in its place and torque to 280 ft-lb. (380 Nm).

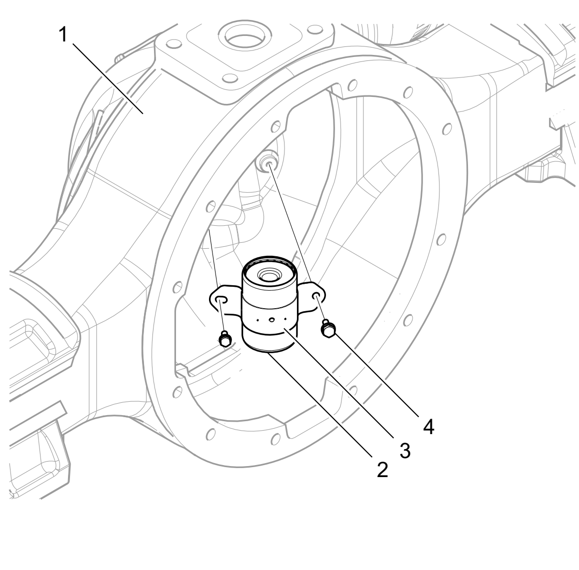
12. Remove the lifting equipment from the input flange.

3.11.2.2. Installing Breather Connection

1. Assemble the Extractor, (Item 42 from Special Tools List) with the Threaded Adapter (Item 41 from Special Tools List) and the Tapered Adapter (Item 40 from Special Tools List).

2. Thread the puller attachment onto the breather connection and use the slide hammer action to drive the breather into the axle housing.

3. Install the breather tube union nut onto the breather connection and tighten.



1. Axle Housing
2. Oil Filter
3. Bracket
4. Mounting Bolt

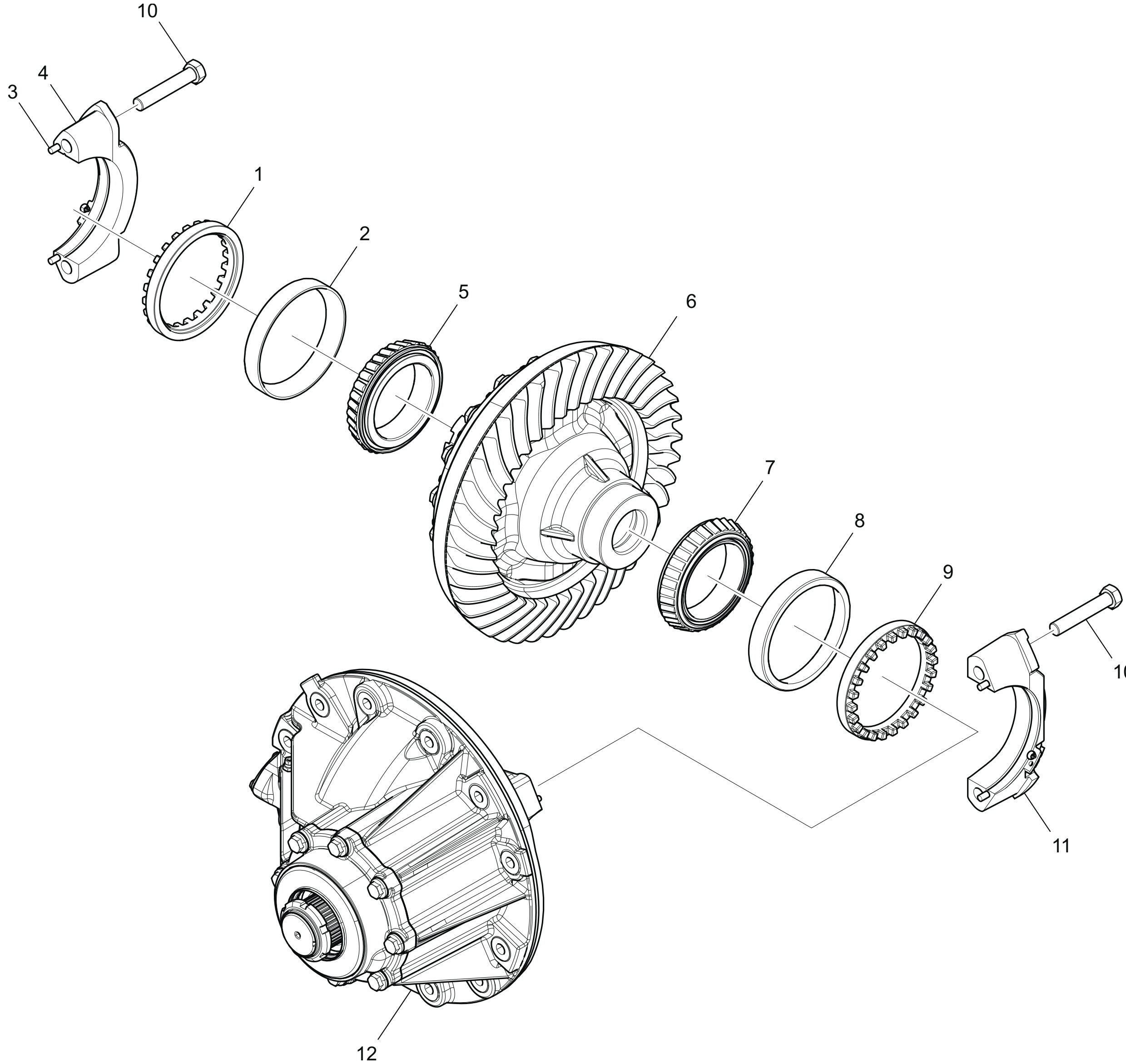
s132213a.svg

Fig. 2-43: Axle Housing Oil Filter

3.12. Differential

3.12.1. Removal

The following procedure describes separating the differential from the differential carrier assembly. See “Fig. 2-44: Differential Carrier Assembly” on page 43.



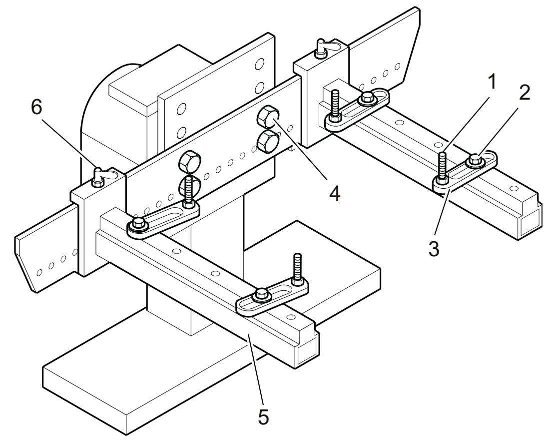
1. Threaded Bearing Adjuster
2. Bearing Outer Race
3. Locating Pin
4. Bearing Cap
5. Tapered Roller Bearing
6. Differential
7. Tapered Roller Bearing
8. Bearing Outer Race
9. Threaded Bearing Adjuster
10. Mounting Bolt
11. Bearing Cap
12. Axle Gear Housing

s132214a.svg

Fig. 2-44: Differential Carrier Assembly

3.12.1.1.Placing Differential Carrier in Stand

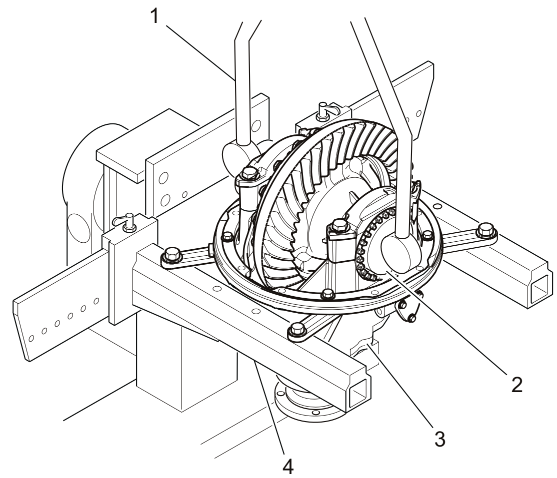
1. Install the Universal Support (Item 48 from Special Tools List) on the Engine Stand (Item 79 from Special Tools List) and tighten the mounting bolts. See "Fig. 2-45: Universal Support" on page 44.
1. Use a hoist with Lifting Device (Item 47 from Special Tools List) and Attachment Plates (Item 49 from Special Tools List) to position the differential carrier assembly above the engine stand with support fixture. See "Fig. 2-46: Positioning Differential Carrier in Stand" on page 44.
2. Adjust the width of the two support arms to support the differential carrier and align the four sliders with the hole pattern in the carrier mounting flange.
3. Tighten all mounting bolts and ensure spring clips are fully engaged.
4. Remove lifting equipment from differential carrier.



1. Stud Bolts
2. Mounting Bolts
3. Sliders
4. Mounting Bolts
5. Universal Support
6. Cotter Pin

s126211a.svg

Fig. 2-45: Universal Support



1. Lifting Device
2. Attachment Plates
3. Drive Axle Housing
4. Universal Support

s126212a.svg

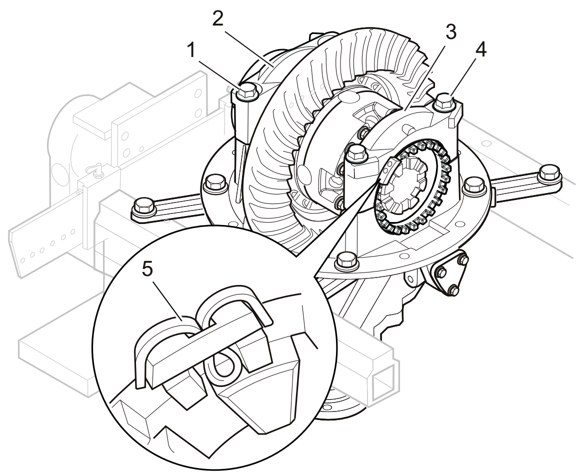
Fig. 2-46: Positioning Differential Carrier in Stand

3.12.1.2.Removing Bearing Caps & Adjusters

1. Remove the split locking pins for the bearing adjusters on both sides. See “Fig. 2-47: Removing Bearing Caps” on page 45.
2. Mark the installation position of the bearing caps.
3. Remove the bearing cap bolts and bearing caps.
4. Remove the bearing caps.
5. Remove the threaded bearing adjusters.

3.12.1.3.Removing Differential from Housing

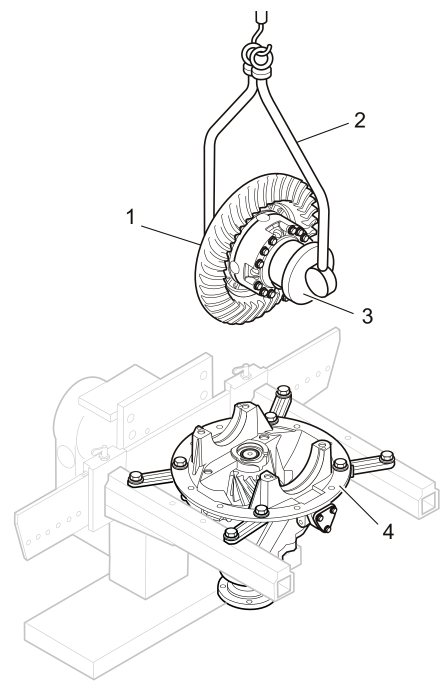
1. Use a hoist with Lifting Device (Item 47 from Special Tools List) and Attachment Plates (Item 49 from Special Tools List) to lift the differential out of the axle gear housing. See “Fig. 2-48: Removing Differential Assembly” on page 45.
2. Move the differential to a work bench and remove the lifting equipment from the differential.
3. Remove the outer races from the tapered roller bearings.



1. Bearing Cap Bolt
2. Bearing Cap
3. Bearing Cap
4. Bearing Cap Bolt
5. Split Locking Pin

s126213a.svg

Fig. 2-47: Removing Bearing Caps



1. Differential Assembly
2. Lifting Device
3. Attachment Plates
4. Drive Axle Housing

s126214a.svg

Fig. 2-48: Removing Differential Assembly

3.12.2. Installation

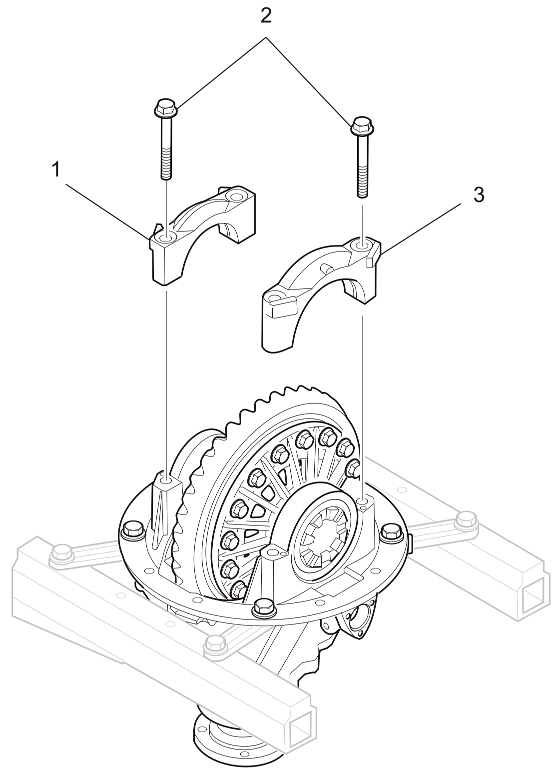
The following procedure describes installing the differential into the differential carrier assembly.

3.12.2.1.Installing Differential Into Housing

1. Apply a thin film of gear oil on both tapered roller bearings.
2. Place the bearing outer races on the tapered roller bearings.
3. Insert the Lifting Device (Item 47 from Special Tools List) and Attachment Plates (Item 49 from Special Tools List) into differential.
4. Hoist differential into position above differential carrier housing.
5. Carefully lower differential onto the housing.
6. Remove the lifting equipment from differential.

3.12.2.2.Installing Bearing Caps & Adjusters

1. Refer to the markings made during removal and position the bearing caps in their original location. See “Fig. 2-49: Bearing Cap Installation” on page 46.
2. Install new mounting bolts and torque to first stage of tightening 44 ft-lbs. (60 Nm).
3. Apply a thin layer of gear oil on the threaded adjusters retainers and then thread them in until lightly seated against the bearings. See “Fig. 2-50: Bearing Adjusters” on page 46.
4. Use the Slotted Nut Wrench (Item 46 from the Special Tools List) to alternately thread in the bearing adjusters while simultaneously rotating the crown gear by hand until the tapered roller bearings have a slight preload.
5. Refer to 3.12.5. “Adjustments” on page 60 in this section for information on setting backlash and bearing preload.



1. Bearing Cap, Differential Side
2. Mounting Bolts
3. Bearing Cap, Crown Gear Side

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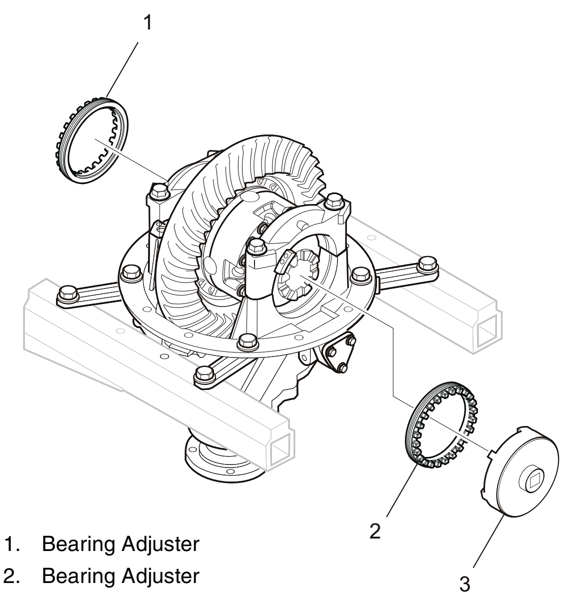
Fig. 2-49: Bearing Cap Installation



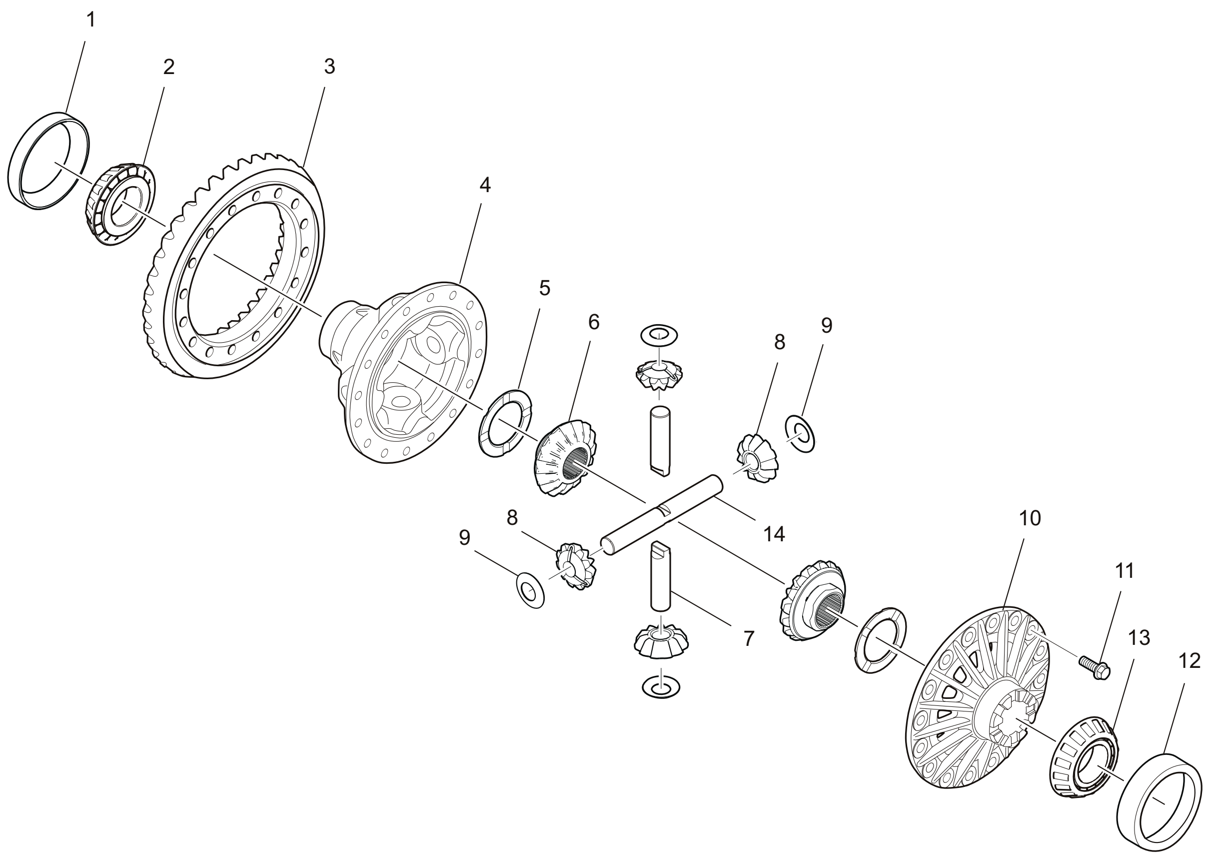
1. Bearing Adjuster
2. Bearing Adjuster
3. Slotted Nut Wrench

s126215a.svg

Fig. 2-50: Bearing Adjusters

3.12.3. Disassembly

The following procedure describes disassembly of the differential tapered roller bearings, crown gear, housing cover, side gears, and pinion gears. See "Fig. 2-51: Differential Assembly" on page 47.



1. Bearing Outer Race
2. Tapered Roller Bearing
3. Crown Gear
4. Differential Housing
5. Thrust Washer
6. Axle Side Gear
7. Differential Pin (2)
8. Pinion Gear
9. Spherical Washer
10. Differential Housing Cover
11. Mounting Bolt
12. Bearing Outer Race
13. Tapered Roller Bearing
14. Differential Pin

s132216a.svg

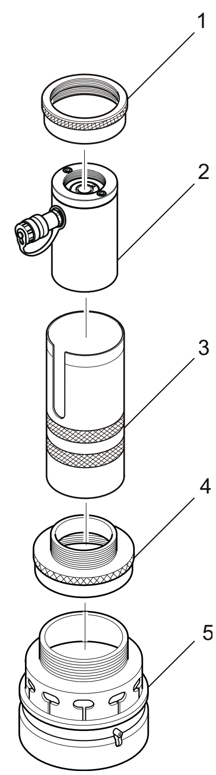
Fig. 2-51: Differential Assembly

3.12.3.1. Removing Tapered Roller Bearings (Hydraulic Method)

☞NOTE:

The tapered roller bearings can be removed either hydraulically or by mechanical means with bearing gripping tools. Both methods are presented here.

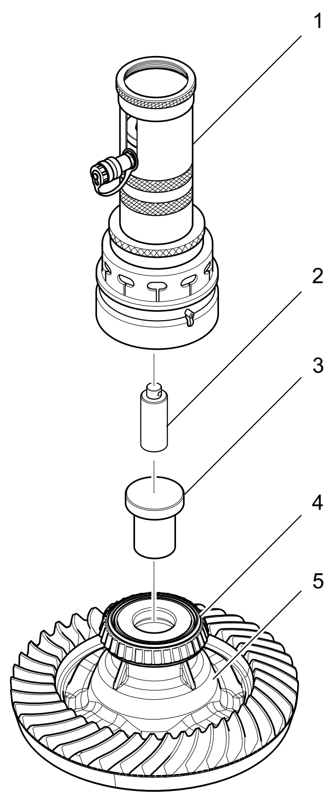
1. Assemble the hydraulic puller as follows:
   a. Install the Threaded Adapter (Item 80 from Special Tools List) onto the Bearing Gripper (Item 93 from Special Tools List). See “Fig. 2-52: Hydraulic Bearing Puller Tool Assembly” on page 48.
   b. Install the Cylinder Support (Item 81 from Special Tools List) onto the Threaded Adapter (Item 80 from Special Tools List).
   c. Insert the Hollow Piston Cylinder (Item 101 from Special Tools List) into the Cylinder Support (Item 81 from Special Tools List).
   d. Install Cap (Item 82 from Special Tools LIst) onto Cylinder Support (Item 81 from Special Tools List).
2. Support and place the differential with the teeth of the crown gear facing up.
3. Install Differential Thrust Piece (Item 50 from Special Tools List) into differential. See “Fig. 2-53: Attaching Hydraulic Puller” on page 49.
4. Insert Hydraulic Puller Thrust Piece (Item 106 from Special Tools List) into hollow piston cylinder.
5. Place the puller onto the tapered roller bearing and press down the outer ring to tension the gripping segments of the tool beneath the bearing.
6. Screw the Threaded Sleeve (Item 83 from Special Tools List) into the hollow cylinder cap until the threaded sleeve contacts the stop inside the hollow piston cylinder.
7. Connect the Hydraulic Pump (Item 102 from Special Tools List) to the connector on the hollow piston cylinder. See “Fig. 2-54: Attaching Hydraulic Pump” on page 49.
8. Operate the hydraulic pump and pull off the tapered roller bearing from differential bearing journal.
9. Remove the tooling and thrust piece from the differential.
10. Turn over the differential and repeat bearing removal process for the other side.



1. Cap
2. Hollow Piston Cylinder
3. Cylinder Support
4. Threaded Adapter
5. Bearing Gripper

s132217a.svg

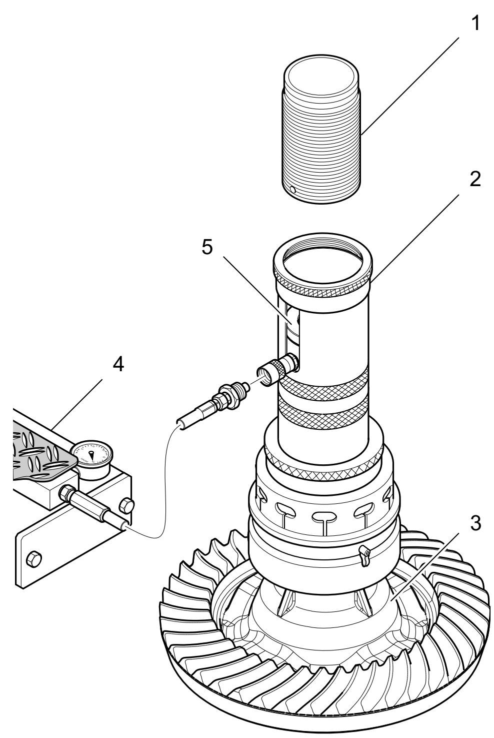
Fig. 2-52: Hydraulic Bearing Puller Tool Assembly



1. Puller
2. Thrust Piece, Hydraulic Puller
3. Thrust Piece, Differential
4. Tapered Roller Bearing
5. Differential

s132218a.svg

Fig. 2-53: Attaching Hydraulic Puller



1. Threaded Sleeve
2. Cap
3. Differential
4. Hydraulic Pump
5. Hollow Piston Cylinder

s132219a.svg

Fig. 2-54: Attaching Hydraulic Pump

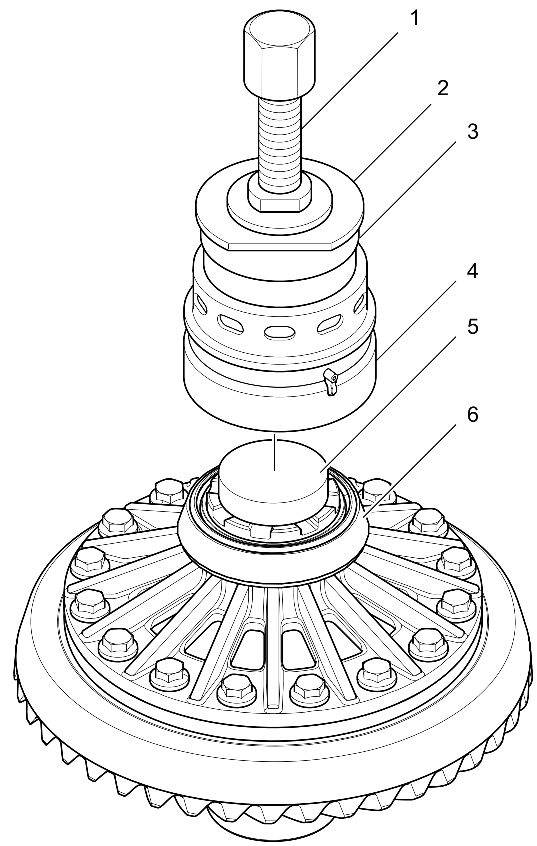
3.12.3.2. Removing Tapered Roller Bearings (Mechanical Method)

1. Insert the Differential Thrust Piece (Item 50 from Special Tools List) into differential. See "Fig. 2-55: Attaching Mechanical Puller" on page 50.
2. Place the Bearing Gripper (Item 93 from Special Tools List) on the tapered roller bearing and press down the outer ring to tension the gripping segments of the tool beneath the bearing.
3. Assemble the Puller Spindle with Reducer and Puller Sleeve (Items 53, 54 & 52 from Special Tools List) and then mount on the bearing gripper. See "Fig. 2-55: Attaching Mechanical Puller" on page 50.
4. Pull off the tapered roller bearing.

☞NOTE:

The maximum travel of the spindle when pulling of the bearing is 1.25" (30 mm). Back off the small spindle and tighten the large spindle by the same amount to reset spindle travel. Repeat pulling procedure.

5. Remove the thrust piece from the differential.
6. Turn over the differential and repeat bearing removal process for the other side.



1. Puller Spindle
2. Reducer
3. Puller Sleeve
4. Bearing Gripper
5. Thrust Piece
6. Tapered Roller Bearing

s126223a.svg

Fig. 2-55: Attaching Mechanical Puller

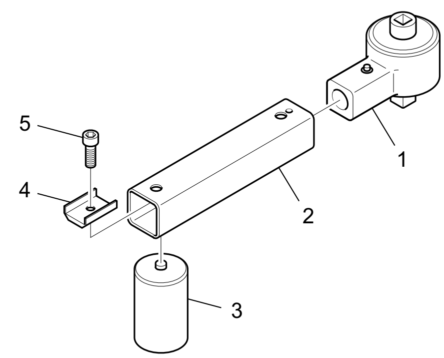
3.12.3.3.Special Tool Assembly

A special tool is required to tighten the bolts that secure the crown gear to the differential housing and this tool may also be used for removal purposes. However, it is acceptable to use an air wrench for removal of the bolts. Assemble the special tool as follows:

a. Attach Support (Item 86 from Special Tools List) with Socket Head Screw (Item 66 from Special Tools List) and Adapter (Item 104 from Special Tools List) to the Brace (Item 57 from Special Tools List). See “Fig. 2-56: Special Tool Assembly” on page 51.

b. Insert the Torque Multiplier (Item 56 from Special Tools List) into the brace.

c. Place the Socket (Item 85 from Special Tools LIst) on the torque multiplier and secure the socket with the Connecting Pin and the Rubber Ring (Items 64 & 103 from Special Tools List).



1. Torque Multiplier
2. Brace
3. Support
4. Adapter
5. Socket Head Screw

s132220a.svg

Fig. 2-56: Special Tool Assembly

3.12.3.4. Removing Crown Gear & Differential Cover

CAUTION

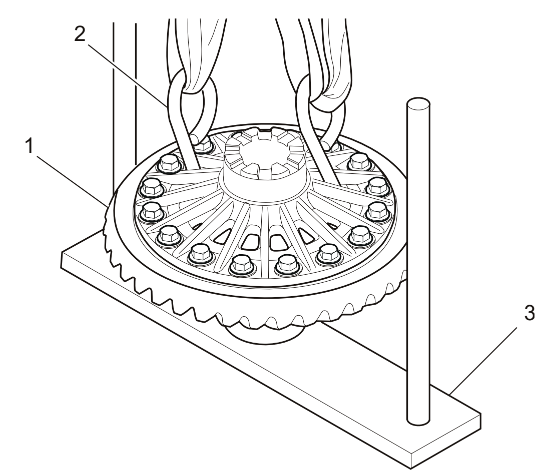
Due to the danger of injury when working with heavy components, the use of a suitable lifting device is required.

1. Clamp Assembly Device (Item 55 from Special Tools List) in a vise.
2. Select a Thrust Piece that will match the differential and install on Assembly Device (Item 55 from Special Tools List).
3. Attach Hooks and Lifting Strap (Items 84 and 62 from Special Tools LIst) to differential and hoist into position onto assembly device. See “Fig. 2-57: Positioning Differential on Assembly Device” on page 52.
4. Remove lifting equipment from differential.
5. Select and install a Counter Brace that will match the differential lock and prevent it from rotating.
6. Install the special bolt removal/tightening tool on each of the crown gear mounting bolts and loosen each bolt. See “Fig. 2-58: Crown Gear Bolt Loosening” on page 53.
7. Remove counter brace from assembly device.
8. Attach Hooks and Lifting Strap (Items 84 and 62 from Special Tools LIst) to differential and lift differential from assembly device.
9. Position differential on work bench with crown gear teeth facing down. Remove lifting equipment.
10. Mark the crown gear in relation to differential housing and cover of differential housing. See “Fig. 2-59: Marking Crown Gear” on page 53.
11. Remove three crown gear bolts offset by 120° and temporarily replace with 3 bolts (M18 x 1.5 x 90 mm). Thread the replacement bolts in enough to fully engage the threads in the crown gear.

☞NOTE:

The three longer bolts are installed to prevent the crown gear from dropping during removal.

12. Remove remaining crown gear bolts.
13. Drive the crown gear off the differential housing by alternately striking each of the three securing bolts with a hammer.
14. Support the crown gear and remove the three securing bolts.
15. Separate cover from differential housing.



1. Differential
2. Lifting Hook & Strap
3. Assembly Device

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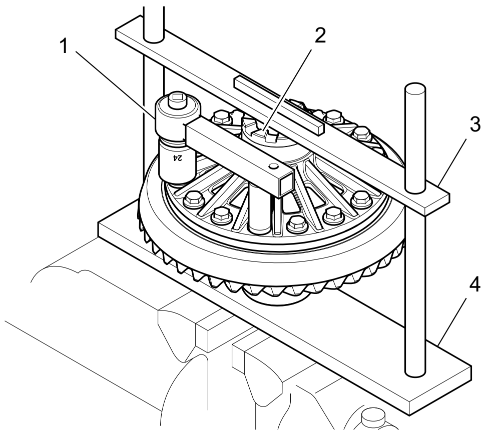
Fig. 2-57: Positioning Differential on Assembly Device



1. Special Tool
2. Lock Teeth
3. Counter Brace
4. Differential Assembling Device

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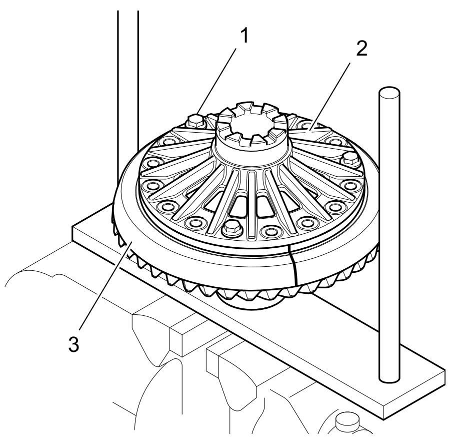
Fig. 2-58: Crown Gear Bolt Loosening



1. Securing Bolt
2. Differential Carrier
3. Crown Gear

s126228a.svg

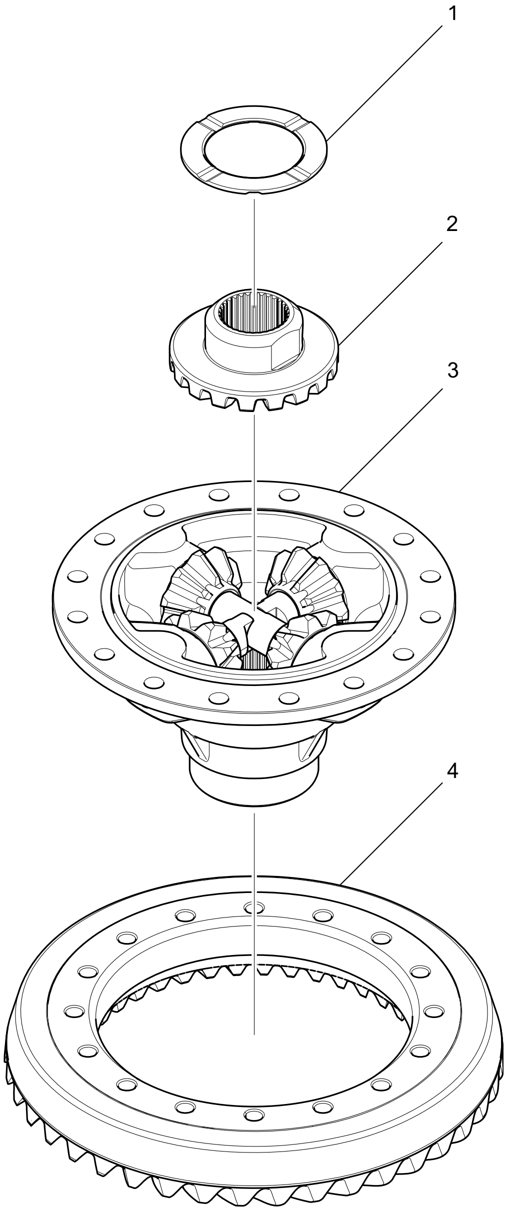
Fig. 2-59: Marking Crown Gear

3.12.3.5. Removing Differential Pinion & Side Gears

⚠CAUTION

Due to the danger of injury when working with heavy components, always use assistance when moving or lifting the differential housing.

1. Remove the differential side gear and thrust washer from the differential housing. See “Fig. 2-60: Differential Side Gear” on page 54.
2. Pull the differential pins (two pieces) out of the differential housing, then pull out the single piece pin. See “Fig. 2-61: Differential Pinion Gears” on page 54.
3. Remove the differential pinion gears with spherical washers from the differential housing.
4. Remove the remaining differential side gear with thrust washer from the differential housing.
5. Check all the parts of the differential for wear and replace as a set if necessary.



1. Thrust Washer
2. Side Gear
3. Differential Housing
4. Crown Gear

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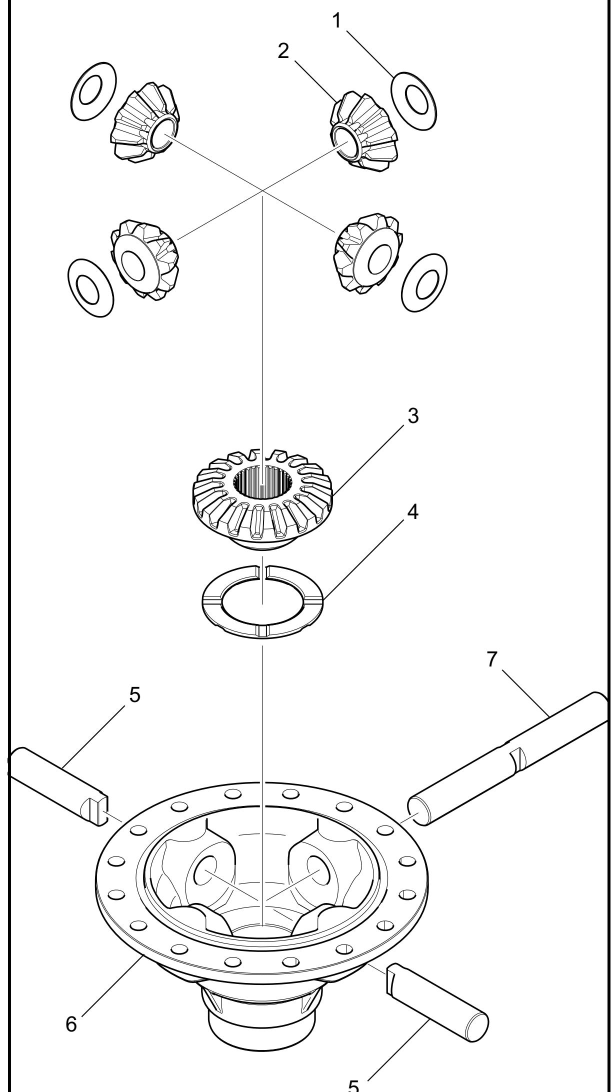
Fig. 2-60: Differential Side Gear



1. Spherical Washer
2. Pinion Gear
3. Side Gear
4. Thrust Washer
5. Differential Pin (2-Piece)
6. Differential Housing
7. Differential Pin

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Fig. 2-61: Differential Pinion Gears

3.12.4. Assembly

CAUTION

Components can be damaged due to incorrectly tightened fasteners. ALWAYS follow recommended torque procedures.

The following guidelines apply during assembly:

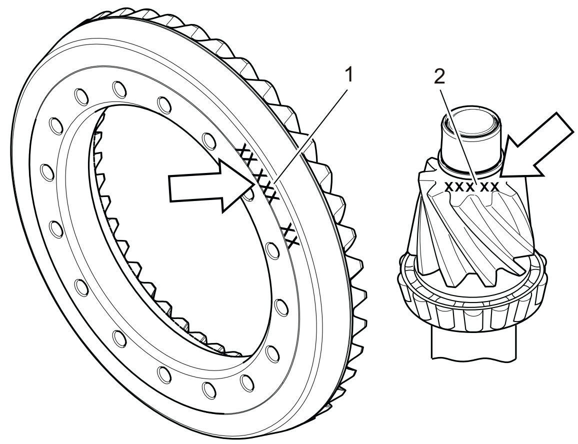
- ❒ If impact wrenches are used, these may only be used for pre-tightening to a maximum of 50% of the final torque value. Final tightening must always be performed manually using a torque wrench.
- ❒ Always replace crown gear and pinion drive gear as a set. The pairing numbers are stamped on the parts as well as an installation dimension. Always replace axle shaft side gears and differential pinions as a set.

3.12.4.1. Gear Pairing Numbers

NOTE:

The reference dimension and pairing numbers for the crown gear and drive pinion are indicated on the drive pinion and the crown gear.

1. Pay attention to the pairing numbers and when fitting a new gear set (crown gear/ drive pinion). See “Fig. 2-62: Gear Pairing Numbers” on page 55.
2. Install the gear set in an drive axle housing corresponding to the ratio.



1. Gear Pairing Number
2. Gear Pairing Numbers

s126233a.svg

Fig. 2-62: Gear Pairing Numbers

3.12.4.2.Installing Differential Pinion Gears

1. Before assembly, thinly apply gear oil on all contact surfaces, thrust washers and tooth contact faces.
2. Insert the axle side gear with thrust washer into the differential housing.
3. Insert the differential pinion gears with spherical washers into the differential housing.
4. Insert the single-piece differential pin through the differential pinion gears and into the differential housing.

☞NOTE:

Insert the differential pins in the differential housing so that the tangs on the end of the two-piece pins engage the slot in the single-piece pin, thereby preventing the differential pins from rotating.

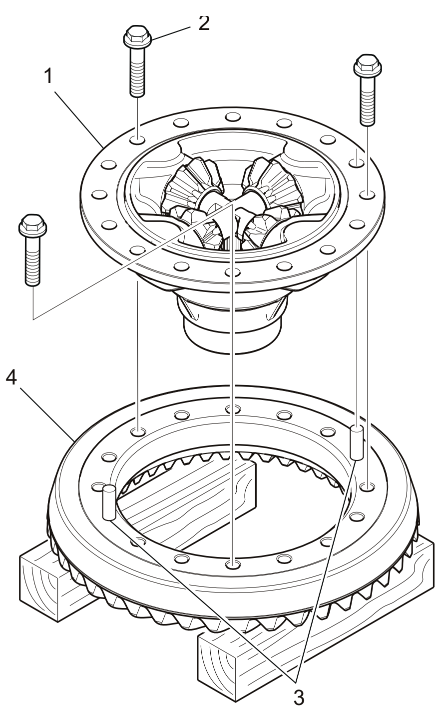
5. Insert the two-piece differential pins through the differential pinion gears and into the corresponding slot of the single-piece pin.

3.12.4.3.Installing Crown Gear

⚠CAUTION

Due to the danger of injury when working with heavy components, always use assistance when moving or lifting the differential housing.

1. Support the crown gear on wooden blocks with the gear teeth facing down. See “Fig. 2-63: Installing Crown Gear” on page 56.
2. Install Centering Pins (Item 68 from Special Tools List) into crown gear.
3. Lower the differential housing over the centering pins, ensuring that the marks on the housing and crown gear are aligned.
4. Install three mounting bolts spaced 120° from each other.
5. Tighten the three mounting bolts evenly until the differential housing is fully seated against the crown gear.
6. Remove centering pins.



1. Differential Housing
2. Mounting Bolts
3. Centering Pins
4. Crown Gear

s132225a.svg

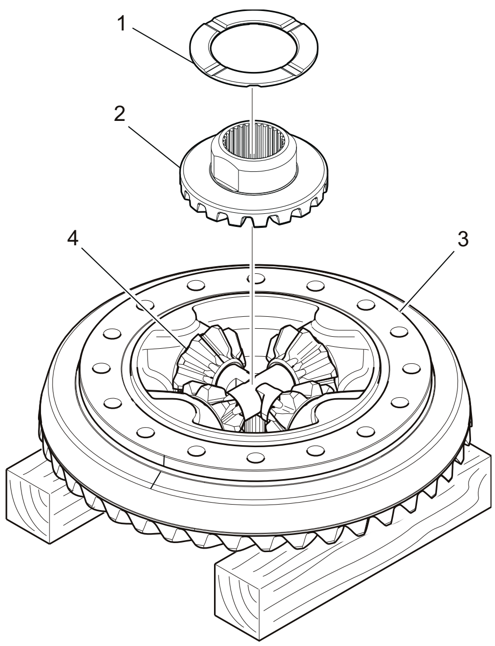
Fig. 2-63: Installing Crown Gear

3.12.4.4.Installing Differential Side Gear (Lock Side)

1. Apply a thin coating of gear oil to the contact surfaces and gear teeth.
2. Install axle side gear onto differential pinion gears. See “Fig. 2-65: Installing Differential Housing Cover” on page 57.
3. Install thrust washer onto side gear.
4. Rotate the side gear and ensure the pinion gears and opposite side gear rotate freely.

3.12.4.5.Installing Differential Housing Cover

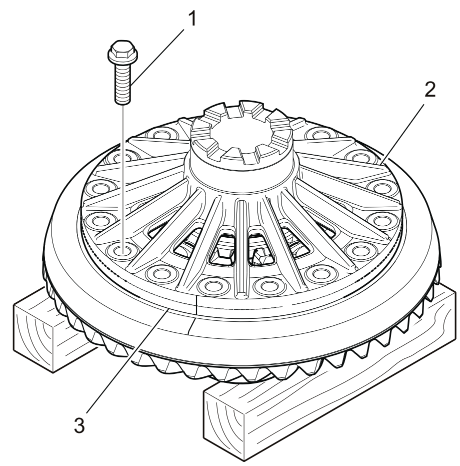
1. Install the differential housing cover on differential housing, ensuring that markings are aligned. See “Fig. 2-65: Installing Differential Housing Cover” on page 57.
2. Install new mounting bolts and hand-tighten only at this time.



1. Thrust Washer
2. Side Gear
3. Differential Housing
4. Pinion Gears

s132226a.svg

Fig. 2-64: Installing Differential Side Gear



1. Mounting Bolt
2. Differential Housing Cover
3. Differential Housing

s132227a.svg

Fig. 2-65: Installing Differential Housing Cover

3.12.4.6.Tightening Crown Gear Mounting Bolts

CAUTION

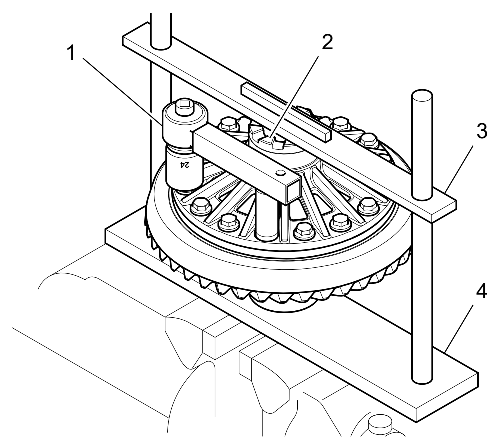
Due to the danger of injury when working with heavy components, the use of a suitable lifting device is required.

1. Attach Hooks (Item 84 from Special Tools List) and Lifting Strap (Item 62 from Special Tools List) to differential.
2. Place the differential on the spigot of the differential Assembly Device (Item 55 from Special Tools List).
3. Remove lifting equipment from differential.
4. Install counter brace onto assembly device and engage the teeth of the lock provision.
5. Tighten all mounting bolts evenly and in diagonal sequence using Torque Wrench and Square Drive (Items 60 and 39 from Special Tools List). Torque bolts to first tightening sequence of 210 ft-lbs. (285 Nm).
6. Install special tightening tool onto mounting bolts. See “Fig. 2-66: Installing Special Tool” on page 58.
7. Set the torque wrench to 122 ft-lbs. (165 Nm).

☞**NOTE:**

The special tightening tool incorporates a torque multiplier with a 3.5:1 ratio. Therefore, the torque wrench must be set to 122 ft-lbs. (165 Nm) to achieve the desired output torque of 420 ft-lbs. (570 Nm).

8. Final tighten mounting bolts evenly and in diagonal sequence using special tightening tool, torque wrench, and square drive. Torque bolts to 420 ft-lbs. (570 Nm).
9. Remove counter brace from assembly device.



1. Special Tool
2. Lock Teeth
3. Counter Brace
4. Differential Assembly Device

s132222a.svg

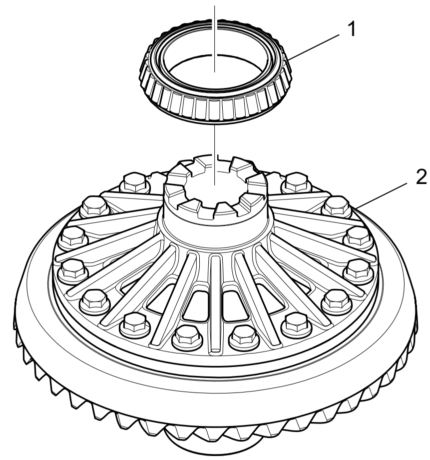
Fig. 2-66: Installing Special Tool

3.12.4.7.Installing Tapered Roller Bearings

⚠CAUTION

Due to the danger of injury when working with heavy and hot components, the use of a suitable lifting device and the wearing of protective gloves is required.

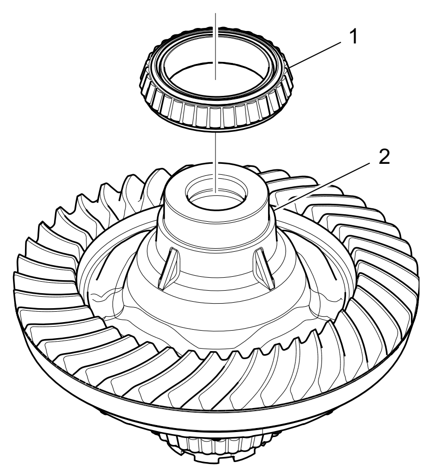
1. Lift the differential off the assembly device using Hooks and Lifting Strap (Items 84 & 62 from Special Tools List).
2. Move differential to work bench and support with crown gear teeth facing down.
3. Remove lifting equipment.
4. Heat the tapered roller bearing to 250°F (120°C).
5. Use protective gloves and install tapered roller bearing onto differential bearing journal, ensuring bearing is fully seated. See “Fig. 2-67: Installing Tapered Roller Bearing on Lock Side” on page 59.
6. Turn the differential over so that the teeth of the crown gear are facing up.
7. Heat the tapered roller bearing to 250°F (120°C).
8. Use protective gloves and install tapered roller bearing onto differential bearing journal, ensuring bearing is fully seated. See “Fig. 2-68: Installing Tapered Roller Bearing on Differential Side” on page 59.



1. Tapered Roller Bearing
2. Differential

s132228a.svg

Fig. 2-67: Installing Tapered Roller Bearing on Lock Side



1. Tapered Roller Bearing
2. Differential

s132229a.svg

Fig. 2-68: Installing Tapered Roller Bearing on Differential Side

3.12.5. Adjustments

The following adjustments must be made prior to installing the differential carrier into the axle housing:

- Backlash - establishes the relative movement between the crown gear and pinion gear.
- Bearing Preload - provides a predetermined load on the tapered roller bearings
- Contact Pattern - provides a visual indication that the pinion installation depth and backlash are correctly set.

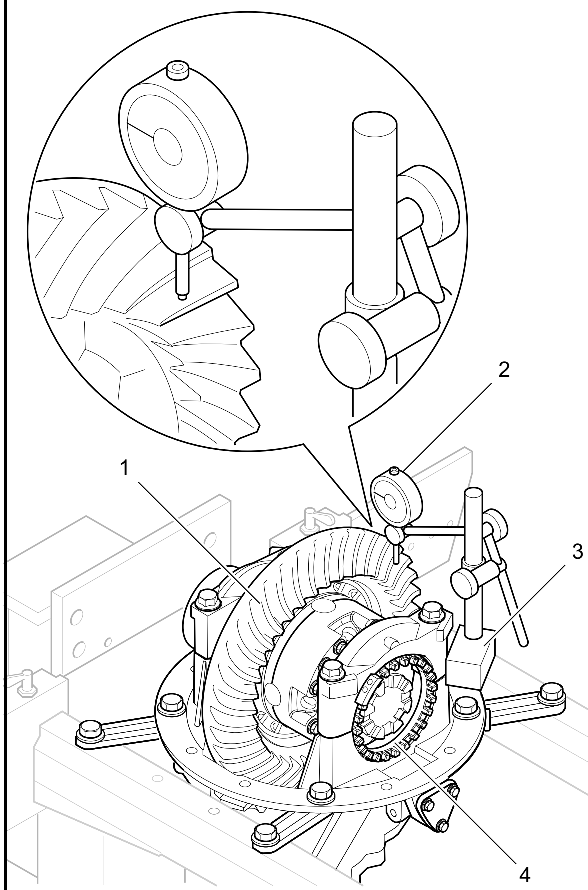
3.12.5.1. Backlash Adjustment

1. Mark the circumference of the crown gear at three locations, equally spaced 120° apart.
2. Place the Dial Gauge Holder with Dial Gauge (Items 45 & 44 from Special Tools List) on the drive axle housing. See "Fig. 2-69: Backlash Adjustment" on page 60.
3. Position the dial gauge tip at right angles on the outer area of the tooth flank and zero the dial gauge.
4. Secure the input flange so as to prevent any movement of the pinion gear.
5. Check the backlash by rotating the crown gear back and forth and observing the dial gauge reading. Perform this procedure at three locations, each offset by 120°.
6. Adjust backlash to 0.010 to 0.014 in. (0.25 to 0.35 mm) by turning the two threaded bearing adjusters alternately, using the Slotted Nut Wrench (Item 46 from Special Tools List).
7. Remove the dial gauge and holder.
8. Tighten the threaded bearing adjuster on the differential side to 15 ft-lb. (20 Nm) using Torque Wrench (Item 59 from Special Tools List), Ratchet Insert (Item 95 from Special Tools List) and Slotted Nut Wrench (Item 46 from Special Tools List).

☞**NOTE:**

Lightly tap on both bearing caps while tightening the threaded adjusters in order to ensure bearings are properly seated.

9. Rotate the crown gear two or three turns and ensure no binding exists.



1. Crown Gear
2. Dial Gauge
3. Dial Gauge Holder
4. Bearing Adjuster

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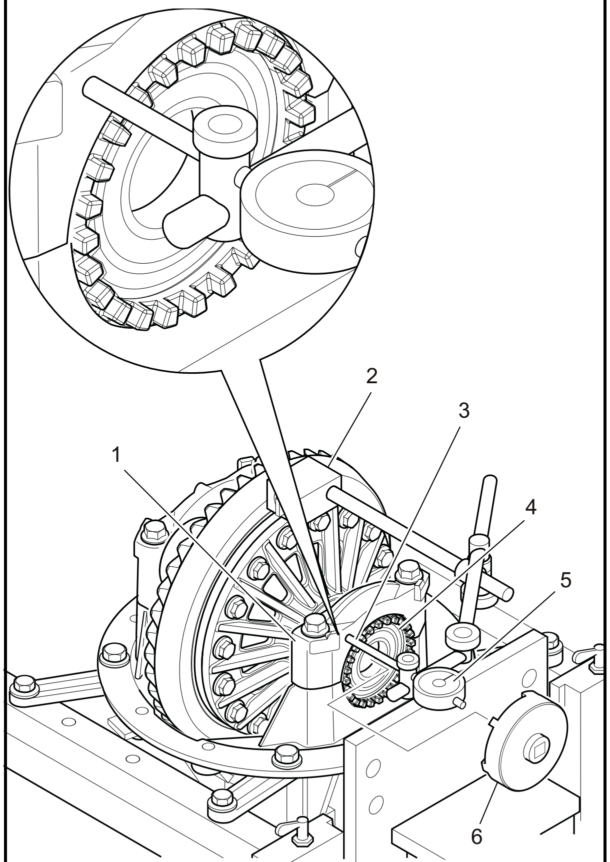
Fig. 2-69: Backlash Adjustment

3.12.5.2. Bearing Preload Adjustment

☞NOTE:

Bearing caps have been previously tightened during assembly to the first stage torque setting of 44 ft-lbs. (60 Nm).

1. Torque bearing cap mounting bolts to final torque setting of 391 ft-lbs. (530 Nm) using Torque Wrench and Square Drive (Items 96 & 39 from Special Tools List).
2. Loosen the threaded bearing adjuster on the differential housing cover side using Slotted Nut Wrench (Item 46 from Special Tools List).
3. Place Dial Gauge Holder with Dial Gauge (Items 45 & 44 from Special Tools List) on the crown gear. See “Fig. 2-70: Setting Bearing Preload Adjustment” on page 61.
4. Position the dial gauge tip at a right angle to the side of the bearing cap and zero the dial gauge.
5. Torque the threaded bearing adjuster on the differential cover housing side to 89 ft-lb. (120 Nm) using Torque Wrench (Item 60 from Special Tools List), Square Drive (Item 39 from Special Tools List) and Slotted Nut Wrench (Item 46 from Special Tools LIst).
6. Observe the reading on the dial gauge and if necessary retighten the threaded bearing adjuster until a bearing preload of 0.006 to 0.010 in. (0.15 to 0.25 mm) is achieved.
7. Recheck backlash and adjust to 0.008 to 0.012 in. (0.20 to 0.30 mm) if required.
8. Remove the dial gauge bracket and dial gauge.
9. Secure both threaded bearing adjusters with new split pins. See “Fig. 2-71: Locking Threaded Bearing Adjusters” on page 62.



1. Bearing Cap
2. Dial Gauge Holder
3. Dial Gauge Tip
4. Bearing Adjuster
5. Dial Gauge
6. Grooved Nut Socket

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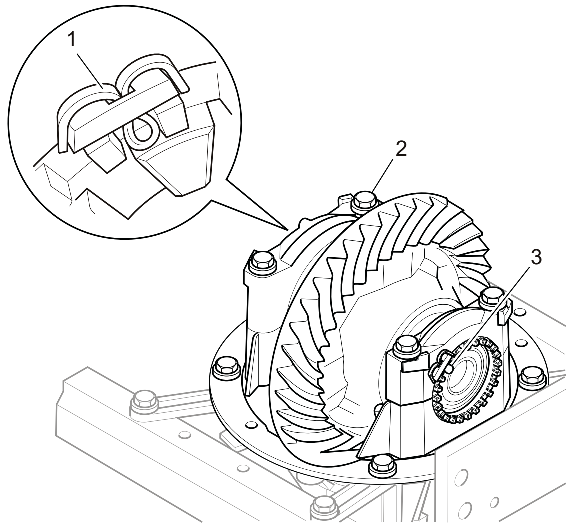
Fig. 2-70: Setting Bearing Preload Adjustment



1. Split Pin
2. Bearing Cap Mounting Bolt
3. Split Pin

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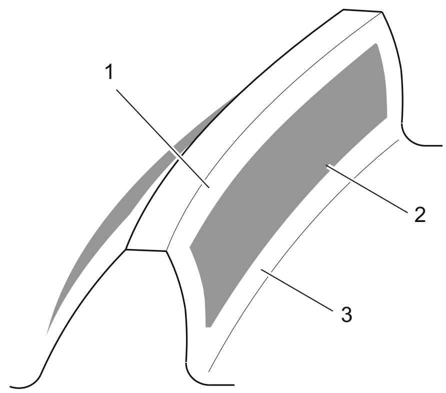
Fig. 2-71: Locking Threaded Bearing Adjusters



1. Tooth Tip
2. Correct Contact Pattern
3. Tooth Root

s132231a.svg

Fig. 2-72: Contact Pattern on Crown Gear

3.12.5.3. Crown Gear Contact Pattern

1. Apply marking paste on both sides of three crown gear teeth spaced 120° apart.
2. Rotate the crown gear back and forth by hand several turns ensuring contact through the marking paste.
3. Check the contact pattern. See “Fig. 2-72: Contact Pattern on Crown Gear” on page 62.
4. An ideal contact pattern would be centered on the tooth, however, the contact pattern is acceptable providing that no portion of the pattern extends to any edge of the gear tooth including the tip, root, heel, or toe.

3.12.5.4. Contact on Tooth Tip

☞NOTE:

Contact at the tip of the gear tooth indicates inadequate gear mesh.

1. If there is contact at the tooth tip, increase the installation depth of the drive pinion by using thinner shims. See "Fig. 2-73: Contact on Tooth Tip" on page 63.
2. Recheck backlash and adjust as necessary. Refer to 3.12.5.1. "Backlash Adjustment" on page 60 in this section for procedure.

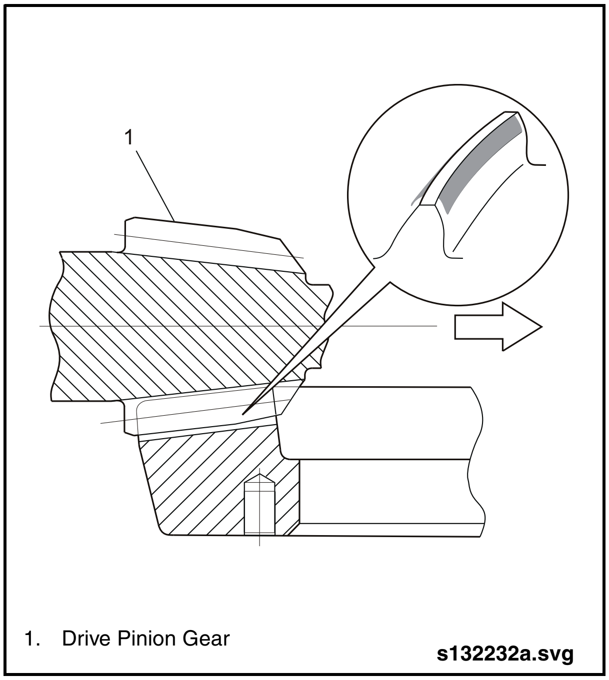


Fig. 2-73: Contact on Tooth Tip

3.12.5.5. Contact on Tooth Root

☞NOTE:

Contact in the root of the gear tooth, indicates excessive gear mesh.

1. If there is contact on the tooth root, reduce the installation depth of the drive pinion by using thicker shims. See "Fig. 2-74: Contact on Tooth Root" on page 63.
2. Recheck backlash and adjust as necessary. Refer to 3.12.5.1. "Backlash Adjustment" on page 60 in this section for procedure.

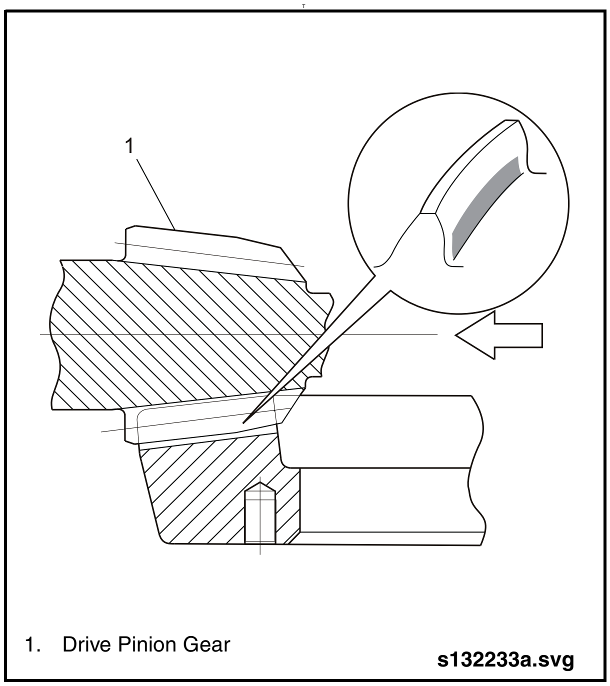


Fig. 2-74: Contact on Tooth Root

3.13. Drive Pinion Gear Housing

3.13.1. Description

The Drive Pinion Gear Housing is a cassette design which allows the pinion drive gear and housing to be removed from the Axle Gear Housing as an assembly. The mating faces on these housings provides a location adjust pinion installation depth with the use of shims. See "Fig. 2-75: Drive Pinion Gear Installation" on page 64.

CAUTION

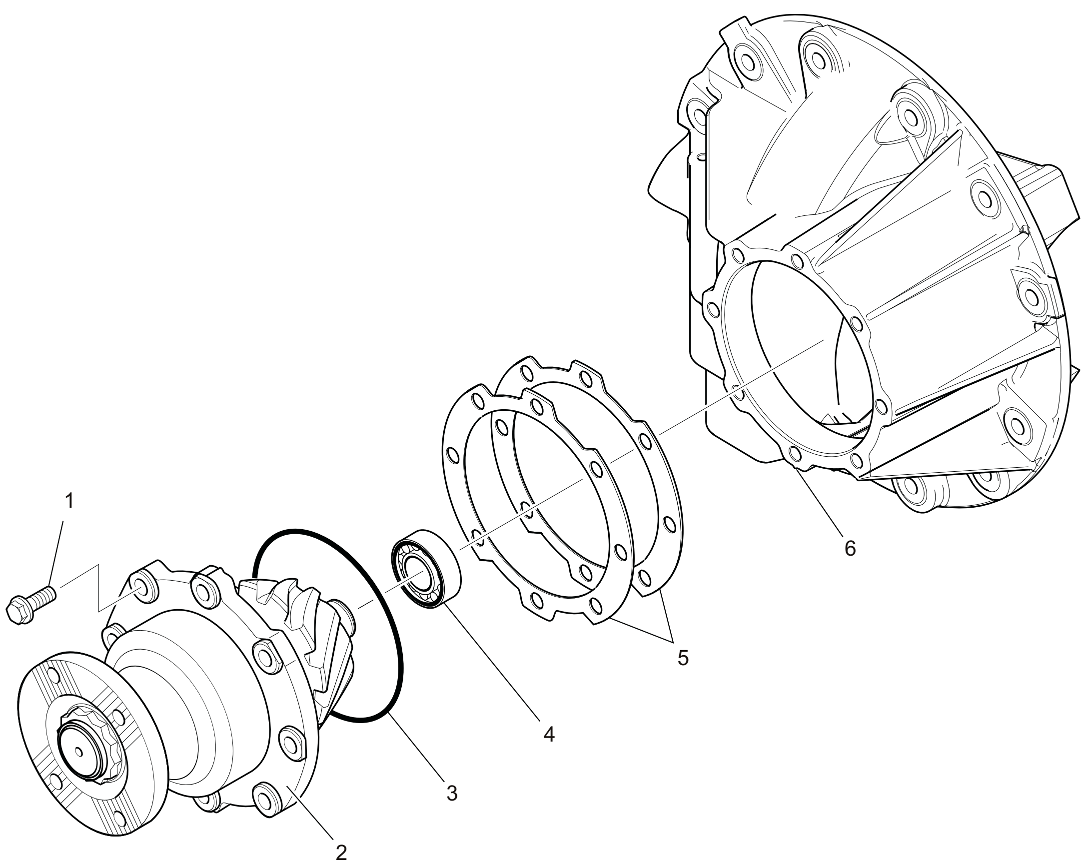
Components can be damaged due to incorrectly tightened fasteners. If impact wrenches are used, these may only be used for pre-tightening to a maximum of 50% of the specified final torque value. Final tightening must always be performed manually using a torque wrench.

NOTE:

Replacement of the crown/pinion gear set or drive pinion gear housing or axle gear housing will require recalculation of the pinion installation depth with resultant shimming adjustments.

NOTE:

Replacement of the roller bearing in the axle gear housing or replacement of tapered roller bearing in the drive pinion gear housing will require that the friction coefficient be rechecked and adjusted with shims as required.



1. Mounting Bolt
2. Drive Pinion Gear Housing
3. O-Ring
4. Roller Bearing
5. Shims
6. Axle Gear Housing

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Fig. 2-75: Drive Pinion Gear Installation

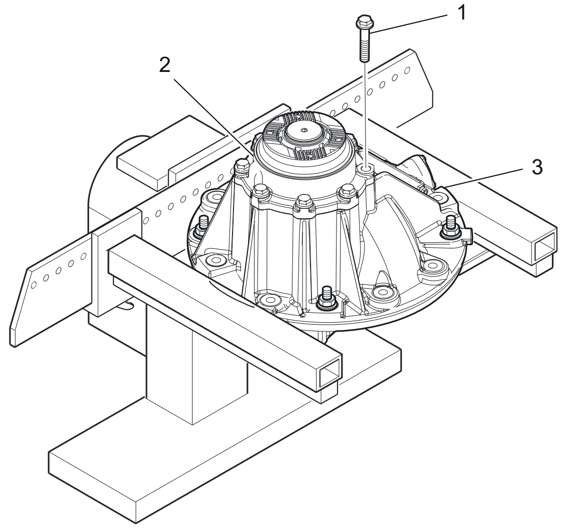
3.13.2. Removal

1. Position the axle gear housing in the Universal Holder (Item 48 from Special Tools List) with the pinion input flange facing up. See "Fig. 2-76: Drive Pinion Gear Housing Removal" on page 65.
2. Mark the position of the drive pinion gear housing in relation to the axle gear housing.
3. Remove the mounting bolts.

CAUTION

Due to the danger of injury when working with heavy components, the use of a suitable support equipment is required. DO NOT attempt to support the weight of the pinion gear housing by hand.

4. Rotate the axle gear housing 180° so that the input flange is facing down. See "Fig. 2-77: Pressing Out Drive Pinion Gear Housing" on page 66.
5. Place a suitable support beneath the drive pinion gear housing so that it does not fall to the floor when pressed out.
6. Press out the drive pinion gear housing from the axle gear housing. Press directly on the end of the pinion gear shaft and not on the roller bearing.
7. Remove and discard the O-ring from the drive pinion gear housing.
8. Remove shims.
9. Clean mating surfaces of drive pinion gear housing and axle gear housing.



1. Mounting Bolt
2. Drive Pinion Gear Housing
3. Axle Gear Housing

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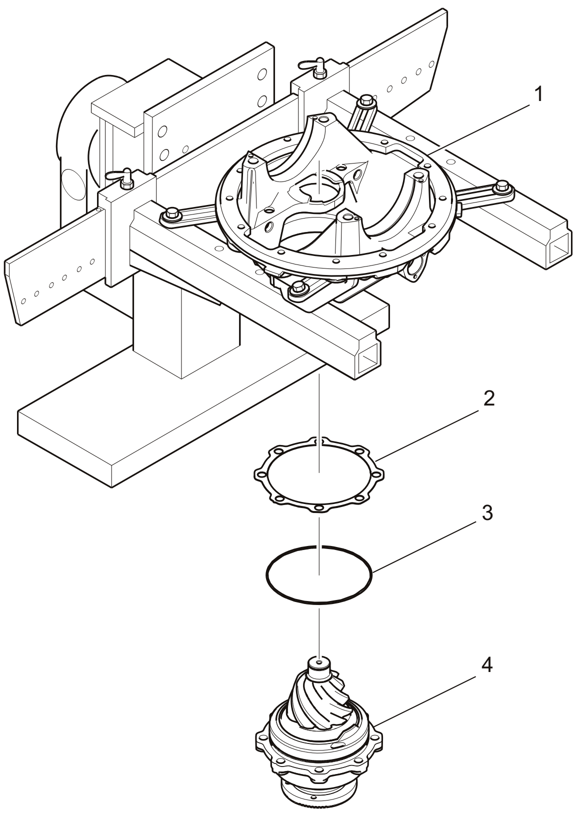
Fig. 2-76: Drive Pinion Gear Housing Removal



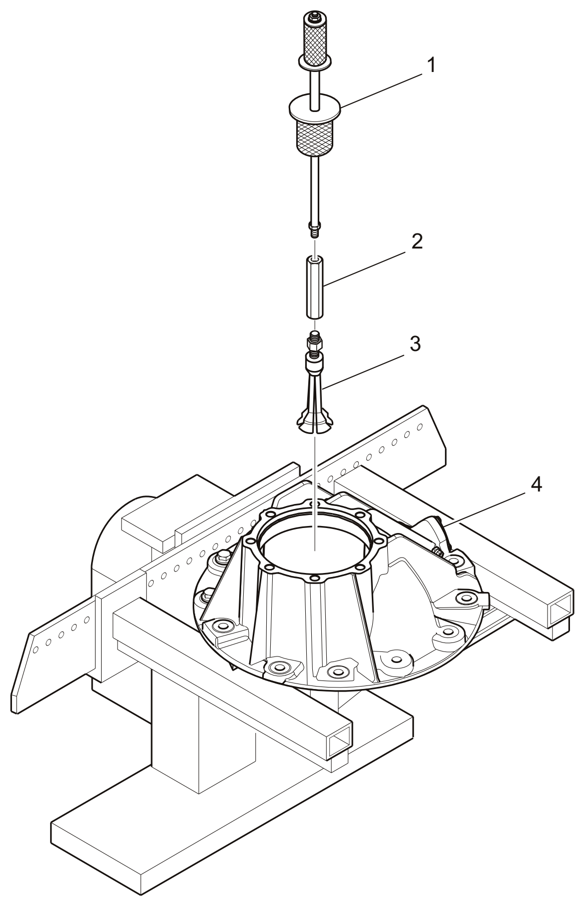
1. Axle Gear Housing
2. Shims
3. O-Ring
4. Drive Pinion Gear Housing

s132235a.svg

Fig. 2-77: Pressing Out Drive Pinion Gear Housing

3.13.2.1.Removing Roller Bearing

1. Rotate the axle gear housing 180° so that the input end is facing up.
2. Assemble the Slide Hammer (Item 2 from Special Tools List) with Threaded Adapter (Item 69 from Special Tools List) and Expandable Puller (Item 70 from Special Tools List). See “Fig. 2-78: Removing Roller Bearing” on page 66.
3. Position the puller under the roller bearing and expand the tool.
4. Use the slide hammer function of the tool to extract the roller bearing from the axle gear housing.



1. Slide Hammer
2. Adapter
3. Expandable Puller
4. Axle Gear Housing

s132236a.svg

Fig. 2-78: Removing Roller Bearing

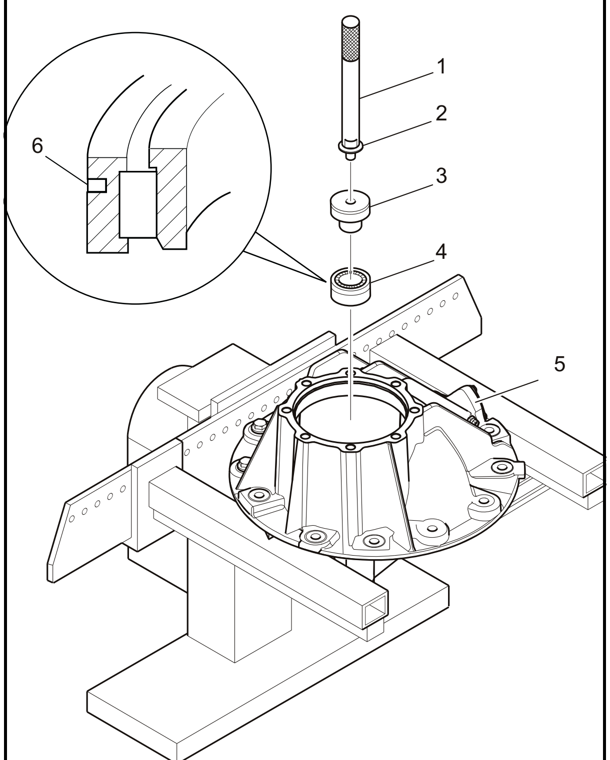
3.13.3. Installation

3.13.3.1.Installing Roller Bearing

1. Assemble Pressing Adapter (Item 88 from Special Tools List), Detachable Handle (Item 33 from Special Tools List) and Thrust Washer (Item 15 from Special Tools List).
2. Press roller bearing into axle gear housing until stop is reached. Ensure roller bearing groove is facing up. See “Fig. 2-79: Installing Roller Bearing” on page 67.

3.13.3.2.Installing Shims

1. Thread Centering Pins (Item 78 from Special Tools List) into axle gear housing.
2. Install shims so that the lug on the shim aligns with the lug marking on the axle gear housing. See “Fig. 2-80: Installing Shims” on page 67.



1. Detachable Handle
2. Thrust Washer
3. Pressing Adapter
4. Roller Bearing
5. Axle Gear Housing
6. Roller Bearing Groove

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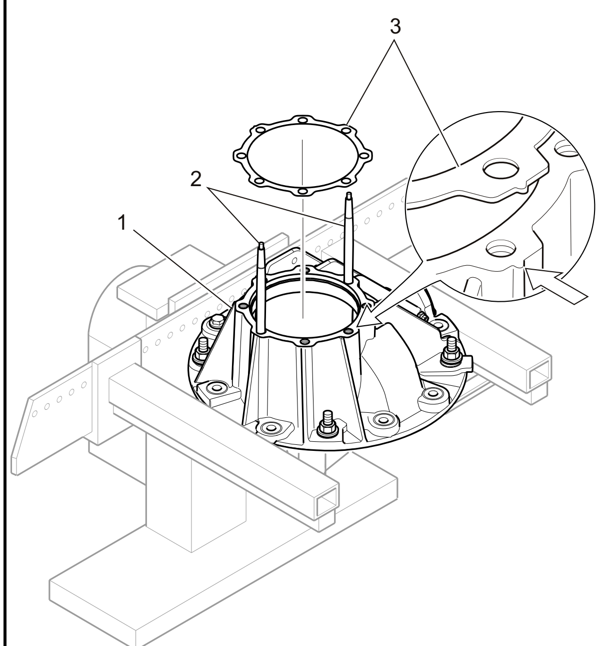
Fig. 2-79: Installing Roller Bearing



1. Axle Gear Housing
2. Centering Pins
3. Shim Lug

s132238a.svg

Fig. 2-80: Installing Shims

3.13.3.3. Installing Drive Pinion Gear Housing

CAUTION

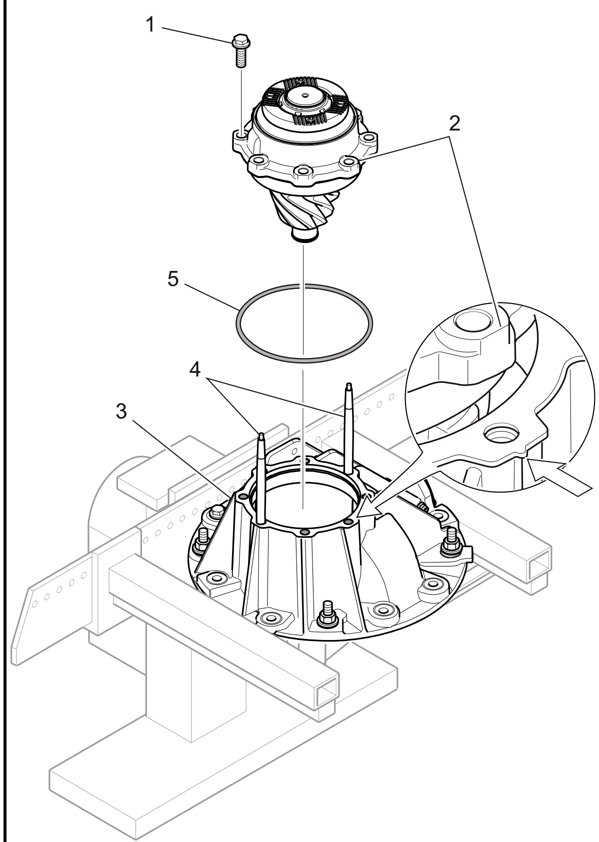
Due to the danger of injury when working with heavy components, the use of a suitable lifting device is required.

1. Thread Eyebolts (Item 89 from Special Tools List) into input flange and use Lifting Chain (Item 90 from Special Tools List) to hoist the drive pinion gear into position.
2. Install new O-ring in groove of drive pinion gear housing.
3. Carefully lower the pinion gear housing over the Centering Pins (Item 78 from Special Tools List), ensuring that marks on the drive pinion gear housing and axle gear housing are aligned. See "Fig. 2-81: Installing Drive Pinion Gear Housing" on page 68.

NOTE:

Ensure that the shims are properly positioned with respect to the axle gear housing. The lug on the shim should align with a corresponding lug on the axle gear housing. Likewise, the notch in the drive pinion gear housing should align with the lug on the shim.

4. Remove the centering pins and lifting equipment.
5. Install new mounting bolts and torque to 280 ft-lbs. (380 Nm) using Torque Wrench and Square Drive (Items 96 & 105 from Special Tools List).



1. Mounting Bolt
2. Drive Pinion Gear Housing
3. Axle Gear Housing
4. Centering Pins
5. O-Ring

s132239a.svg

Fig. 2-81: Installing Drive Pinion Gear Housing

3.13.3.4. Checking & Adjusting Friction Coefficient

☞**NOTE:**

Replacement of the roller bearing in the axle gear housing or replacement of tapered roller bearing in the drive pinion gear housing will require that the friction coefficient be rechecked and adjusted with shims as required.

The following procedure describes the method used to determine whether pinion bearing preload is set correctly. Proper pinion bearing preload can be determined by measuring the force required to rotate the pinion gear. This is referred to as friction coefficient and should be between 6 to 12 ft-lb. (8 to 16 Nm).

☞**NOTE:**

In order to obtain an accurate friction coefficient reading, the drive pinion gear housing should be assembled without the radial shaft seal. Also, for test purposes, the drive pinion gear housing should be installed in the axle gear housing without shims or O-ring.

1. Install input flange on drive pinion gear without radial shaft seal. See "Fig. 2-82: Installing Input Flange Without Seal" on page 70.
2. Install slotted nut and hand-tighten only at this time.

⚠CAUTION

Due to the danger of injury when working with heavy components, the use of a suitable lifting device is required.

3. Thread Eyebolts (Item 89 from Special Tools List) into input flange and use Lifting Chain (Item 90 from Special Tools List) to hoist the drive pinion gear into position.
4. Carefully lower the pinion gear housing over the Centering Pins (Item 78 from Special Tools List), ensuring that marks on the drive pinion gear housing and axle gear housing are aligned.
5. Remove centering pins and lifting equipment.
6. Install mounting bolts and torque to 280 ft-lb. (380 Nm) using Torque Wrench and Square Drive (Items 96 & 105 from Special Tools List).
7. Tighten slotted nut. Refer to 3.10.2.4. "Tightening Slotted Nut" on page 38 in this section for tightening procedure.
8. Place the Friction Tester (Item 77 from Special Tools List) with the Slotted Nut Wrench (Item 26 from Special Tools List) on the slotted nut. See "Fig. 2-83: Mounting Friction Tester" on page 70.
9. Zero the friction tester.
10. Overcome the initial drive pinion gear release torque and read the friction coefficient while rotating the tester in a smooth continuous motion.
11. If the friction coefficient is not within the range of 6 to 12 ft-lb. (8 to 16 Nm), then disassemble the drive pinion gear housing and replace the shim with one of the correct size.

☞**NOTE:**

Thicker shim = lower friction coefficient.
Thinner shim = higher friction coefficient.
Shims are available in 0.002" (0.01 mm) increments and range in thickness from 0.137" to 0.208" (3.50 to 5.30 mm). Refer to your New Flyer Parts Manual for ordering information.

12. Recheck friction coefficient.

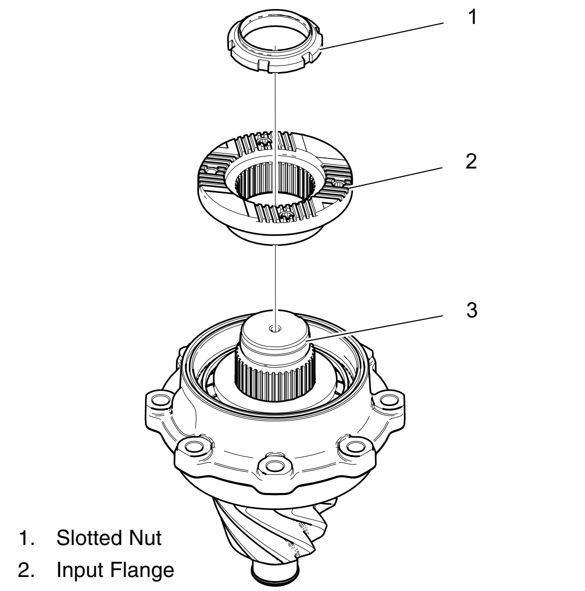


Fig. 2-82: Installing Input Flange Without Seal

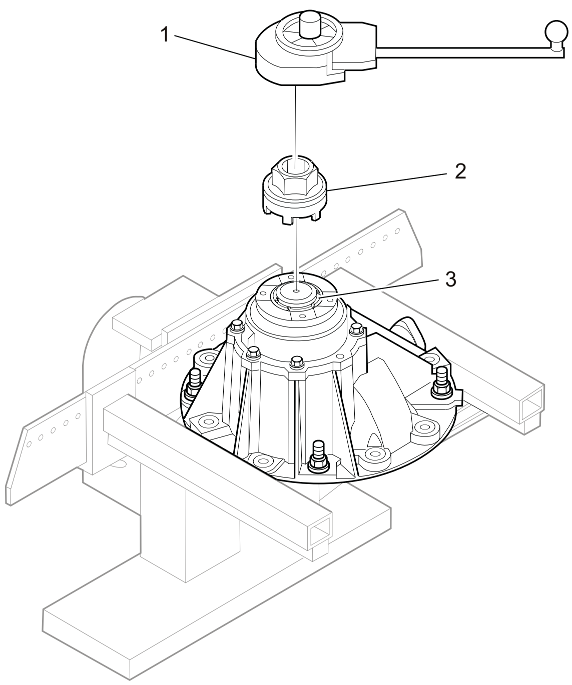


Fig. 2-83: Mounting Friction Tester

3.13.3.5.Determining Drive Pinion Gear Installation Depth

1. Position the axle gear housing in the Universal Holder (Item 48 from Special Tools List) with the input flange facing down.
2. Attach the Auxiliary Bridge (Item 73 from Special Tools List) to the Depth Gauge (Item 72 from Special Tools List)
3. Place the depth gauge with auxiliary bridge across the bearing mounting brackets. See “Fig. 2-84: Pinion Depth” on page 71.
4. Record measurement from bearing bracket to end of pinion gear as Dimension “A”.
5. Record the dimension stamped on the end face of the pinion gear as Dimension “C”. See “Fig. 2-85: Dimension “C”” on page 71.
6. Subtract Dimension “A” from Dimension “C” and record the result as Dimension “S”.

NOTE:

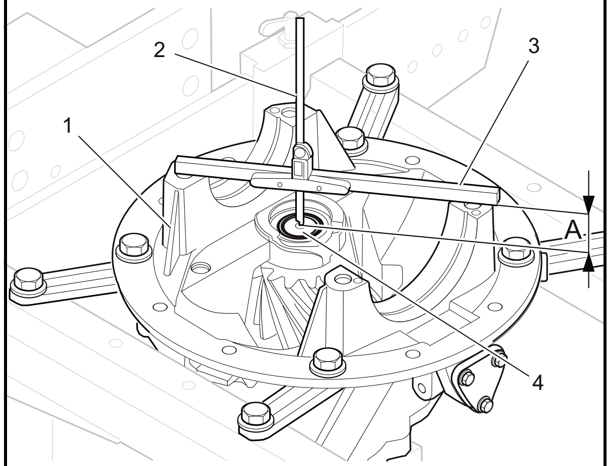
Dimension “S” is the required shim thickness.

7. If Dimension “S” is not equal to zero, then the drive pinion gear will need to be separated from the axle gear housing and the shim thickness adjusted to match Dimension “S”.

NOTE:

Shims are available in thicknesses of:
0.004” (0.10 mm)
0.006" (0.15 mm)
0.008” (0.20 mm)
0.014" (0.35 mm)
0.020" (0.50 mm)

8. Recheck Dimension “A” and ensure it equals Dimension “C”, stamped on the end of the gear.



1. Bearing Mounting Bracket
2. Depth Gauge
3. Auxiliary Bridge
4. End Face of Drive Pinion

s126245a.svg

Fig. 2-84: Pinion Depth

3.13.4. Disassembly

3.13.4.1.Removing Drive Pinion Gear Housing

1. Position drive pinion gear housing on a hydraulic press and place a suitable support beneath the pinion gear to prevent it from dropping. Press out the drive pinion gear. See “Fig. 2-86: Removing Drive Pinion Gear” on page 71.
2. Remove the outer tapered roller bearing from the drive pinion gear housing. See “Fig. 2-87: Drive Pinion Gear Assembly” on page 72.
3. Remove the shim and spacer from the drive pinion gear.

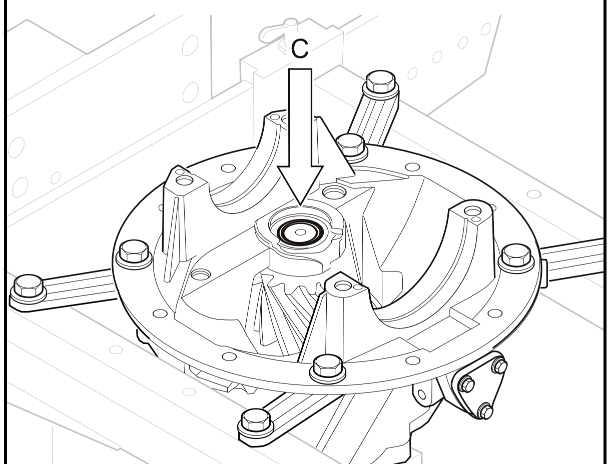


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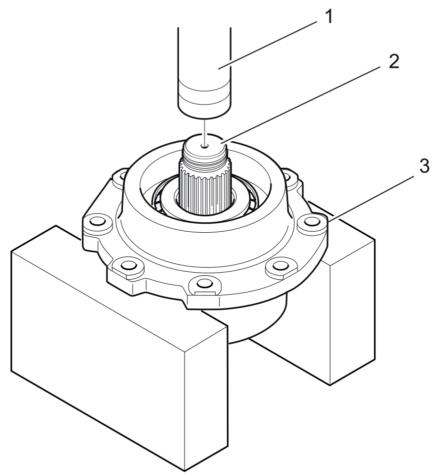
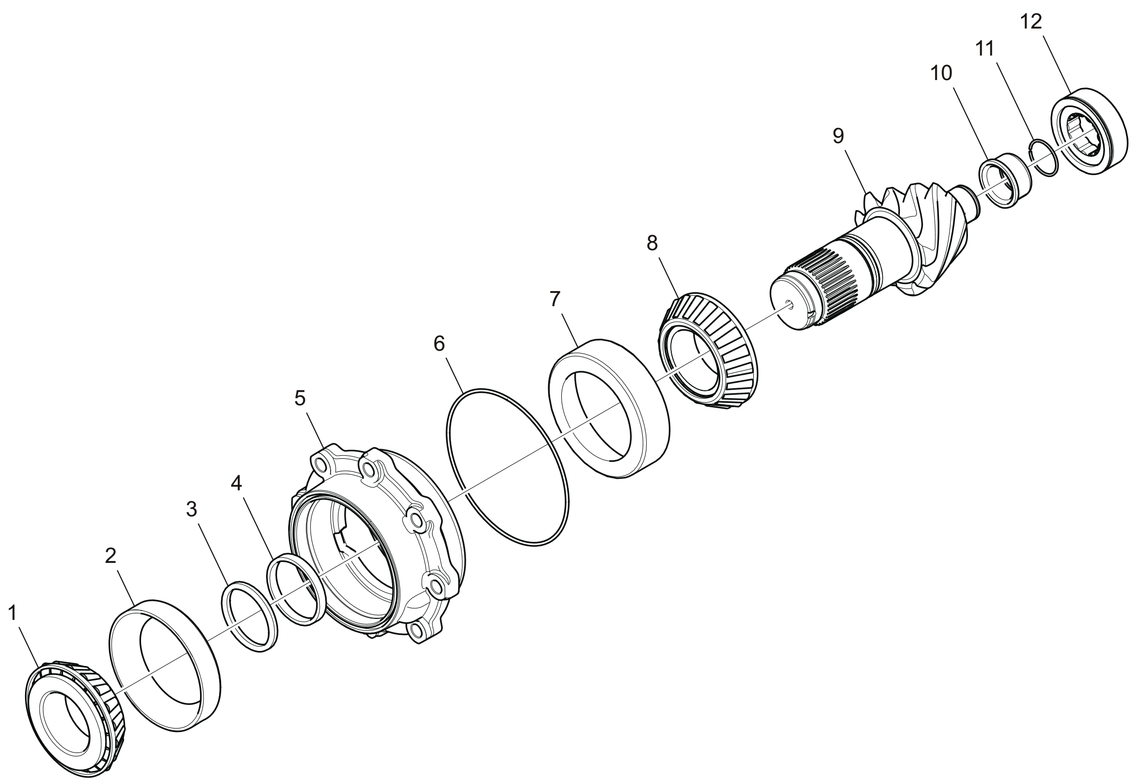
Fig. 2-85: Dimension “C”



1. Hydraulic Press
2. Drive Pinion Gear
3. Tapered Roller Bearing

s126247a.svg

Fig. 2-86: Removing Drive Pinion Gear



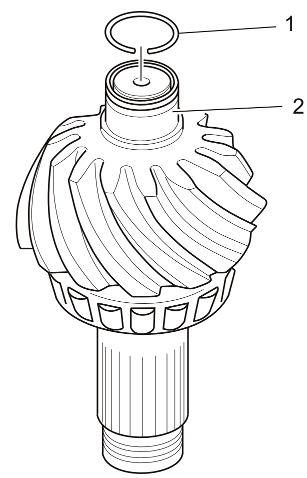
1. Outer Tapered Roller Bearing
2. Outer Bearing Outer Race
3. Shim
4. Spacer
5. Drive Pinion Gear Housing
6. O-Ring
7. Inner Bearing Outer Race
8. Inner Tapered Roller Bearing
9. Drive Pinion Gear
10. Roller Bearing Race
11. Circlip
12. Roller Bearing

s132242b.svg

Fig. 2-87: Drive Pinion Gear Assembly

3.13.4.2.Removing Bearing Inner Race

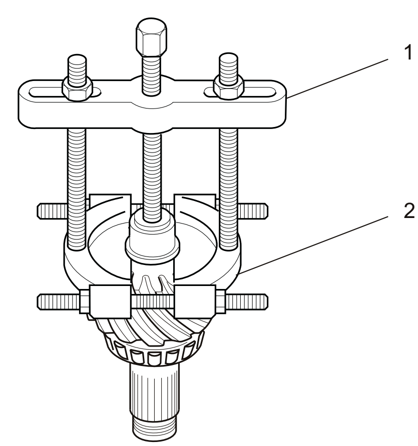
1. Remove the circlip from the roller bearing inner race using internal circlip pliers. See "Fig. 2-88: Removing Bearing Circlip" on page 73.
2. Use a chisel to tap the end of the bearing inner race sufficiently to allow enough clearance for the insertion of the Separator tool.
3. Place Separator (Item 30 from Special Tools List) on bearing inner race, ensuring the tool fully grips beneath the bearing race.
4. Attach Puller (Item 31 from Special Tools List) to Separator. See "Fig. 2-89: Removing Drive Pinion Inner Bearing Race" on page 73.
5. Hold the drive pinion gear from turning and place Box-End Ratchet and Ratchet Handle (Items 91 & 92 from Special Tools List) on spindle of puller. Pull off the bearing inner race from drive pinion gear.



1. Circlip
2. Drive Pinion Gear

s132243a.svg

Fig. 2-88: Removing Bearing Circlip



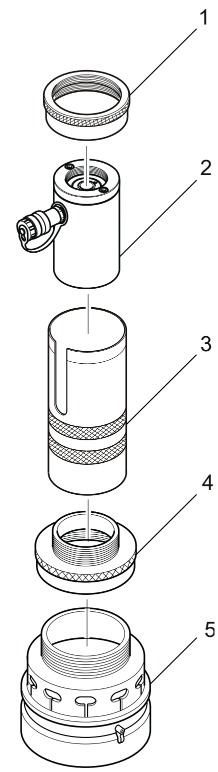
1. Puller
2. Separator

s126248a.svg

Fig. 2-89: Removing Drive Pinion Inner Bearing Race

3.13.4.3. Removing Inner Tapered Roller Bearing

1. Assemble the hydraulic puller as follows:
   a. Install the Threaded Adapter (Item 80 from Special Tools List) onto the Bearing Gripper (Item 93 from Special Tools List). See “Fig. 2-90: Hydraulic Bearing Puller Tool Assembly” on page 74.
   b. Install the Cylinder Support (Item 81 from Special Tools List) onto the Threaded Adapter (Item 80 from Special Tools List).
   c. Insert the Hollow Piston Cylinder (Item 101 from Special Tools List) into the Cylinder Support (Item 81 from Special Tools List).
   d. Install Cap (Item 82 from Special Tools LIst) onto Cylinder Support (Item 81 from Special Tools List).
2. Insert Thrust Piece (Item 106 from Special Tools List) into hollow piston cylinder.
3. Place the puller onto the tapered roller bearing and press down the outer ring of tool to tension the gripping segments of the tool beneath the bearing. See “Fig. 2-91: Attaching Hydraulic Puller” on page 75.
4. Screw the Threaded Sleeve (Item 83 from Special Tools List) into the hollow cylinder cap until the threaded sleeve contacts the stop inside the hollow piston cylinder.
5. Connect the Hydraulic Pump (Item 102 from Special Tools List) to the connector on the hollow piston cylinder. See “Fig. 2-92: Attaching Hydraulic Pump” on page 75.
6. Operate the hydraulic pump and pull off the tapered roller bearing from drive pinion gear.



1. Cap
2. Hollow Piston Cylinder
3. Cylinder Support
4. Threaded Adapter
5. Bearing Gripper

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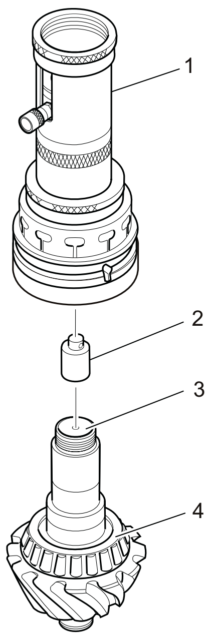
Fig. 2-90: Hydraulic Bearing Puller Tool Assembly



1. Puller
2. Thrust Piece
3. Drive Pinion Gear
4. Tapered Roller Bearing

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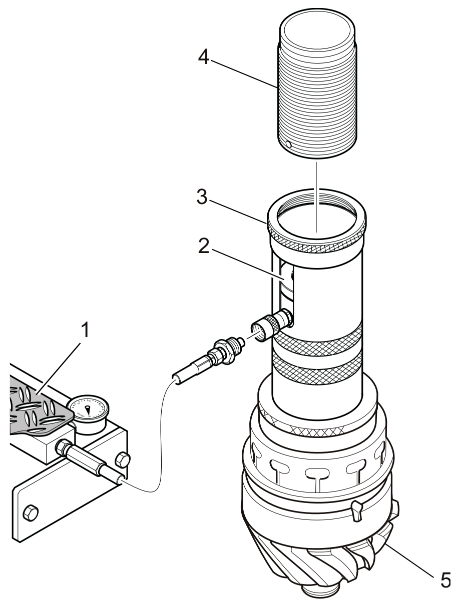
Fig. 2-91: Attaching Hydraulic Puller



1. Hydraulic Pump
2. Hollow Piston Cylinder
3. Cap
4. Threaded Sleeve
5. Drive Pinion Gear

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Fig. 2-92: Attaching Hydraulic Pump

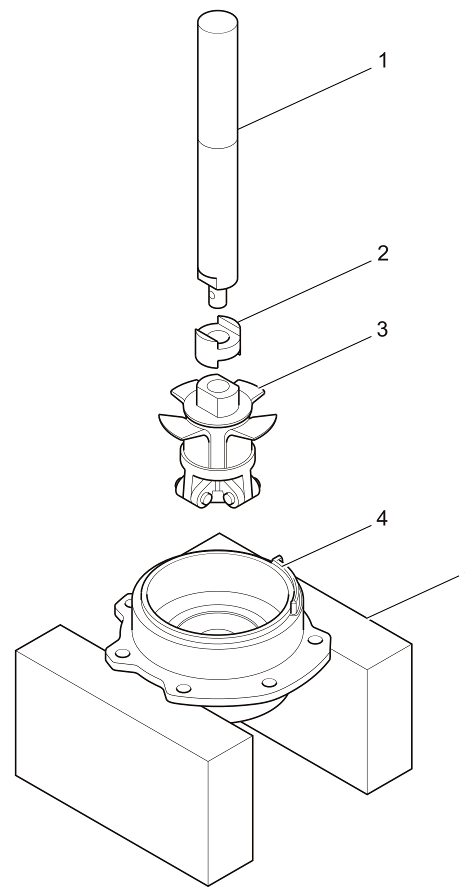
3.13.4.4. Removing Outer Bearing Outer Race

1. Position the drive pinion gear housing on support blocks with the input end facing down. See “Fig. 2-93: Removing Outer Bearing Outer Race” on page 76.
2. Assemble the Detachable Handle and Pressing Device Adapter (Items 33 & 16 from Special Tools List).
3. Use the detachable handle and adapter disc to retract the claws on the Pressing Device (Item 17 from Special Tools List) sufficiently to enter drive pinion gear housing.
4. Position the expandable pressing device so that the claws of the tool are located slightly above the outer bearing outer race.

CAUTION

DO NOT expand the pressing device to the extent that it will bind inside the drive pinion gear housing and possibly cause damage to the housing and/or tool.

5. Use the handle and adapter to rotate the expandable pressing device until the claws of the tool lightly contact the bore of the pinion gear housing and rest on the surface of the outer bearing outer race.
6. Press the outer bearing outer race out of the drive pinion gear housing.



1. Detachable Handle
2. Pressing Device Adapter
3. Pressing Device
4. Drive Pinion Gear Housing
5. Support Blocks

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Fig. 2-93: Removing Outer Bearing Outer Race

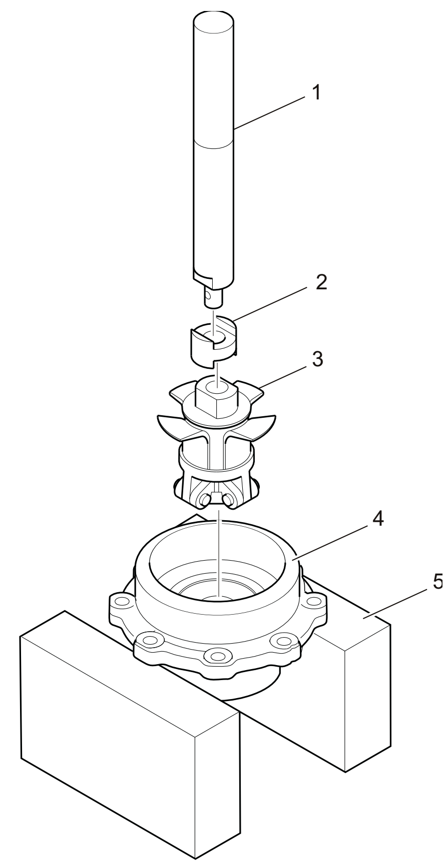
3.13.4.5.Removing Inner Bearing Outer Race

1. Reposition the drive pinion gear housing on support blocks with the input end facing up. See "Fig. 2-94: Removing Inner Bearing Outer Race" on page 77.
2. Assemble the Detachable Handle and Pressure Device Adapter (Items 33 & 16 from Special Tools List).
3. Use the detachable handle and adapter to retract the claws on the Pressing Device (Item 17 from Special Tools List) sufficiently to enter drive pinion gear housing.
4. Position the expandable pressing device so that the claws of the tool are located slightly above the inner bearing outer race. Ensure that the claws of the tool do not engage the step in the bore.

CAUTION

DO NOT expand the pressing device to the extent that it will bind inside the drive pinion gear housing and possibly cause damage to the housing and/or tool.

5. Use the handle and adapter to rotate the expandable pressing device until the claws of the tool lightly contact the bore of the pinion gear housing and rest on the surface of the inner bearing outer race.
6. Press the inner bearing outer race out of the drive pinion gear housing.



1. Detachable Handle
2. Pressing Device Adapter
3. Pressing Device
4. Drive Pinion Gear Housing
5. Support Blocks

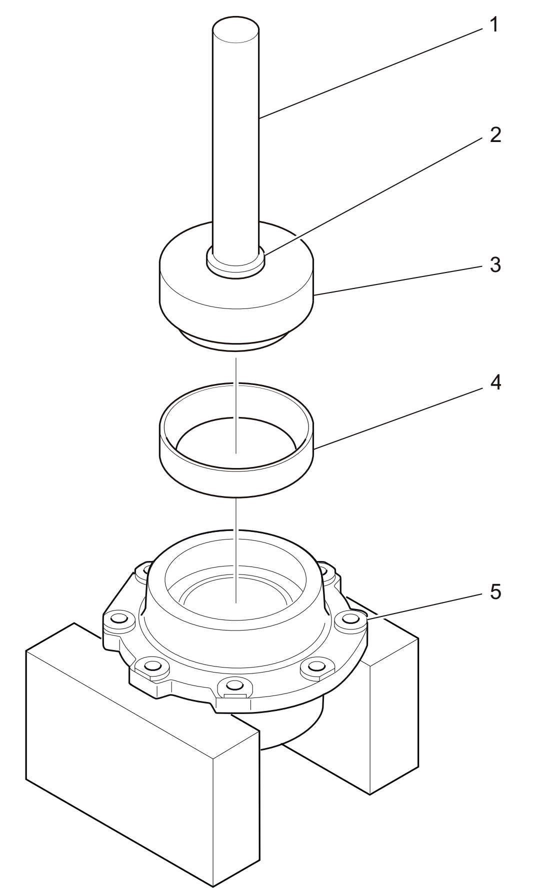
s126251a.svg

Fig. 2-94: Removing Inner Bearing Outer Race

3.13.5. Assembly

3.13.5.1.Installing Outer Bearing Outer Race

1. Assemble the Outer Pressing Plate with the Detachable Handle and Thrust Washer (Items 18, 33 & 15 from Special Tools List). See “Fig. 2-95: Installing Outer Bearing Outer Race” on page 78.
2. Press the outer bearing outer race into the drive pinion gear housing until it has seated.



1. Detachable Handle
2. Thrust Washer
3. Pressing Plate, Outer
4. Outer Bearing Outer Race
5. Drive Pinion Gear Housing

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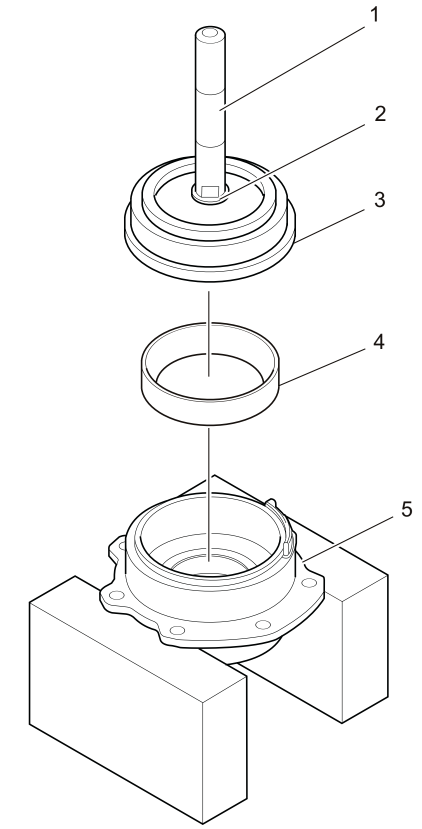
Fig. 2-95: Installing Outer Bearing Outer Race

3.13.5.2.Installing Inner Bearing Outer Race

1. Turn over the drive pinion gear housing.
2. Assemble the Inner Pressing Adapter with the Detachable Handle and Thrust Washer (Items 94, 33 & 15 from Special Tools List). See “Fig. 2-96: Installing Inner Bearing Outer Race” on page 78.
3. Press the inner bearing outer race into the drive pinion gear housing until it has seated.



1. Detachable Handle
2. Thrust Washer
3. Pressing Adapter, Inner
4. Bearing Outer Race
5. Drive Pinion Gear Housing

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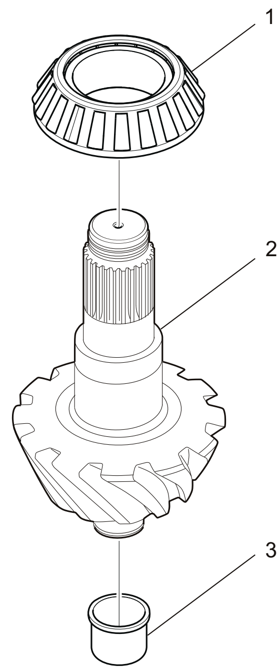
Fig. 2-96: Installing Inner Bearing Outer Race

3.13.5.3. Installing Inner Tapered Roller Bearing & Bearing Inner Race

CAUTION

Wear protective gloves when handling hot parts.

1. Heat the tapered roller bearing to 250°F (120°C).
2. Install the tapered roller bearing on the drive pinion gear, ensuring it is fully seated. See "Fig. 2-97: Mounting Inner Tapered Roller Bearing & Inner Race" on page 79.
3. Heat the bearing inner race to 250°F (120°C).
4. Install the bearing inner race until fully seated with the collar facing the drive pinion gear. See "Fig. 2-98: Installing Bearing Inner Race Circlip" on page 79.
5. Install new circlip in groove on drive pinion gear shaft to retain bearing inner race.



1. Tapered Roller Bearing
2. Drive Pinion
3. Inner Bearing Race

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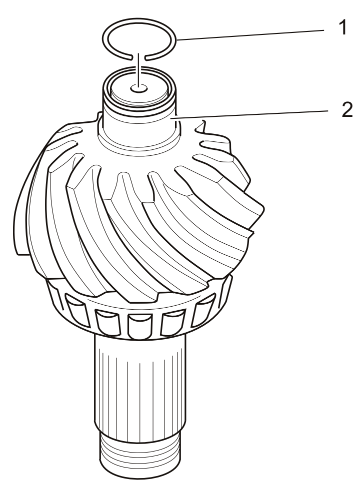
Fig. 2-97: Mounting Inner Tapered Roller Bearing & Inner Race



1. Circlip
2. Drive Pinion Gear

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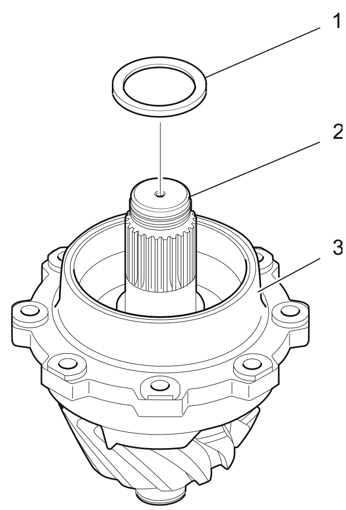
Fig. 2-98: Installing Bearing Inner Race Circlip

3.13.5.4.Installing Drive Pinion Gear Housing

1. Install the drive pinion gear housing onto the drive pinion gear. See "Fig. 2-99: Installing Drive Pinion Gear Housing" on page 80.
2. Install the spacer and shim onto drive pinion gear.

☞NOTE:

Shim thickness is determined by the friction coefficient. Refer to 3.13.3.4. "Checking & Adjusting Friction Coefficient" on page 69 *for checking procedure. If friction coefficient has not been determined, use a 0.157" (4.0 mm) thick shim as an initial starting point.*



1. Shim
2. Drive Pinion Gear
3. Drive Pinion Gear Housing

s132247a.svg

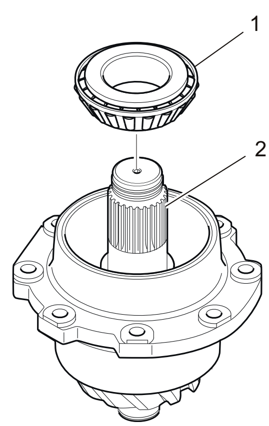
Fig. 2-99: Installing Drive Pinion Gear Housing

3.13.5.5.Installing Outer Tapered Roller Bearing

CAUTION

Wear protective gloves when handling hot parts.

1. Heat the tapered roller bearing to 250°F (120°C).
2. Install the tapered roller bearing on the drive pinion gear, ensuring it is fully seated. See "Fig. 2-100: Installing Outer Tapered Roller Bearing" on page 80.



1. Tapered Roller Bearing
2. Drive Pinion

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Fig. 2-100: Installing Outer Tapered Roller Bearing

4. REAR SUSPENSION

4.1. Description

The rear axle suspension components include:

- ❒ Rear Air Springs
- ❒ Rear Radius Rods
- ❒ Rear Shock Absorbers

4.2. Rear Air Springs

4.2.1. Description

The air spring assembly consists of a rubber bellows mounted on a plate. The upper cover contains two threaded fittings. One fitting attaches the air spring to the chassis; the other is hollow and is used as an air inlet for suspension control. The upper and lower beads are crimped permanently during manufacture and cannot be separated.

4.2.2. Rear Air Springs Specifications

Make .... Firestone

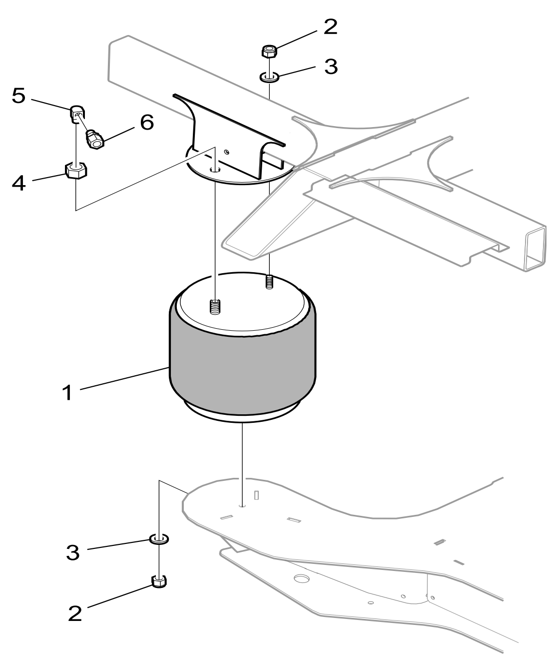
Model 1T15L-4

4.2.3. Operation

The air spring assembly receives air pressure from the vehicle air system and responds to height adjustment inputs from the height control valve or kneeling control. Pressurized air enters the spring though a hollow mounting stud at the top of the spring. The spring action of the bellows allows for movement of the axle as the wheels go over bumps and depressions.

4.2.4. Removal

1. Raise the vehicle using wheel lifts or center post lift. Refer to the General Information Section of this manual for procedure.
2. Use safety stands under frame to hold vehicle in position.
3. Lower wheel lift until there is a 3" (76 mm) space between axle and axle bumper.
4. If system is pressurized, disconnect height control valve rod then pull down valve lever to exhaust air from spring. (mark rod attachment position for reinstallation)
5. Disconnect air line. Remove lower nut attaching air spring to mounting plate. See “Fig. 2-101: Rear Air Spring Removal & Installation” on page 81.
6. Remove nuts and washers securing upper end of air spring to chassis.
7. Slide spring out of chassis and remove.



1. Air Spring, Rear
2. Nut, Lock Nylon 1/2" - 13 UNC
3. Washer, Flat Hardened 1/2"
4. Nut, Lock Prevailing Torque 3/4" Grade C
5. Elbow, 90° Street 1/4" MPT x 1/4" FPT
6. Connector, 1/2" O.D. x 1/4" PT

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Fig. 2-101: Rear Air Spring Removal & Installation

4.2.5. Disassembly

The air spring is supplied as a complete assembly, piston bellows and bead plate therefore no disassembly is required.

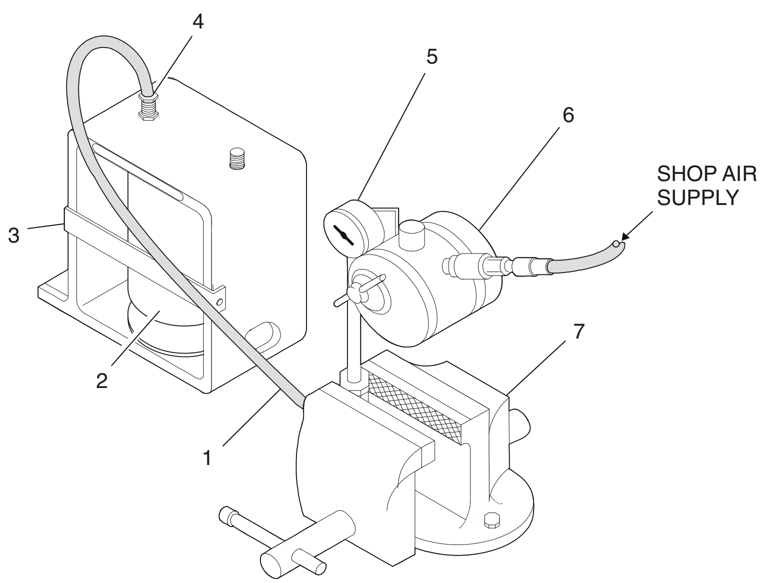
4.2.6. Cleaning & Inspection

1. Clean air springs with soap and water.
2. Check condition of mounting studs and threaded hole.
3. Examine piston for cracking or damage.
4. Examine the bellows assembly for cracks in the rubber or physical damage.

4.2.7. Leak Test Procedure

Test the air springs assembly (positioned in safety cage) for leakage using the pressure test fixture illustrated and the following procedure: See “Fig. 2-102: Leak Test Fixture” on page 82.

1. Thread male end of quick disconnect into air inlet hole of housing.
2. Connect air line and raise air pressure initially to approximately 45 to 55 psi. Air springs should now be properly seated in housing. Check bead ring area for air leaks using a solution of soapy water.
3. If no air leakage is present, raise air pressure to a maximum 120 psi.
4. Disconnect air line, remove test fitting and remove air springs assembly from safety cage.



1. Flexhose
2. Air Spring Assembly
3. Safety Cage
4. Quick Disconnect Fitting
5. Air Gauge
6. Pressure Regulator
7. Bench Vise

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Fig. 2-102: Leak Test Fixture

4.2.8. Installation

☞**NOTE:**

Refer to 4.5. “Rear Suspension Torque Specifications” on page 93 *in this section for all installation torque values.*

1. Raise the vehicle using wheel lifts or center post lift. Refer to the General Information Section of this manual for procedure.
2. Use safety stands under frame to hold vehicle in position.
3. Lower wheel lift until there is a 3" (76 mm) space between axle and axle bumper.
4. Align stud in bottom of air spring with holes in mounting plate. Install bolts and torque to specification.
5. Install nuts on upper air spring studs and torque to specification.
6. Lower vehicle.

4.2.9. Functional Tests

1. Run engine to build up air pressure.
2. Check for air leaks.
3. Test drive vehicle to verify ride quality and silence of operation.

4.3. Rear Radius Rods

4.3.1. Description

The upper and lower rear radius rods consist of hollow steel tubes with crimped rod ends. The rod ends are fitted with rubber bushings and cross pins. The aft end of the upper radius rod attaches to a bracket on the axle housing and the aft end of the lower radius rod attaches to a bracket on the suspension beam. The forward end of the upper and lower radius rods attach to the vehicle structure.

4.3.2. Rear Upper Radius Rod Specifications

Manufacturer.......................... ZF Lemforder

Construction.................. Tubular steel body, rubber bushings with cross-pin

Tensile Strength ....70,000 psi

Front Cross-Pin Angle...........................8.7° from horizontal centerline

Rear Cross-Pin Angle ....11.8° from horizontal centerline

4.3.3. Rear Lower Radius Rod Specifications

Manufacturer.......................... ZF Lemforder

Construction.................. Tubular steel body, rubber bushings with cross-pin

Tensile Strength..........................70,000 psi

Front Cross-Pin Angle .... 7.6° from horizontal centerline

Rear Cross-Pin Angle........................... 7.3° from horizontal centerline

4.3.4. Operation

The upper and lower radius rods locate the rear axle to the vehicle structure and allow for vertical movement of the axle. The rubber bushings in the rod ends absorb thrust loads and are designed to flex during suspension movement. The cross-pins are used as attachment points to the axle and vehicle structure and can be shimmed to adjust alignment thrust angles.

4.3.5. Rear Radius Rod Troubleshooting

Drive the vehicle while listening for rattling or clunking sounds as the suspension reacts to surface irregularities. Also listen for clunking sounds when transitioning between acceleration and braking. If noise is evident inspect radius rod mounting hardware and condition of bushings.

4.3.6. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled inspection intervals.

4.3.7. Removal

CAUTION

DO NOT attempt to remove more than one radius rod at a time. Removing two or more radius rods will cause the axle to become unstable.

1. Raise the vehicle. Refer to the General Information Section of this manual for lifting procedures.

NOTE:

Radius rod replacement should be done at vehicle ride height to ensure the radius rod bushing is in a neutral load position. The use of wheel lifts is recommended or alternatively supporting the axles with jack stands.

2. Remove the radius rod mounting bolts while taking note of the spacer and washer locations and quantity. See “Fig. 2-103: Upper Radius Rod Removal & Installation” on page 85. See “Fig. 2-104: Lower Radius Rod Removal & Installation” on page 86.

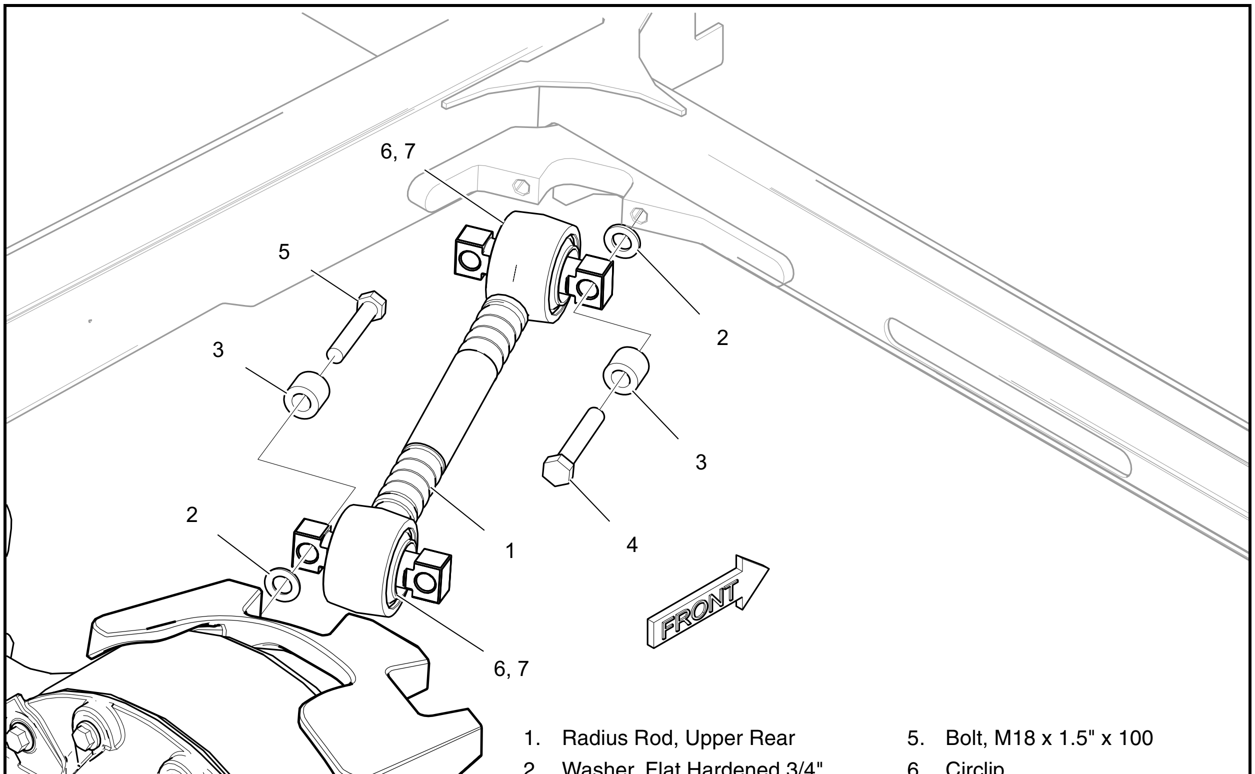
NOTE:

The hardened washers located between the radius rod cross-pin and the axle or vehicle structure serve as shims for alignment purposes. ALWAYS replace washers at each location with the same quantity as originally removed.

3. Remove the radius rod from the vehicle.

NOTE:

The cross-pin angles are different between forward and aft bushings and the radius rod tube is stamped with “FRONT” and a directional arrow to ensure the radius rod is installed correctly. If the marking is not legible, use a paint marker to indicate “FRONT” with a directional arrow.



1. Radius Rod, Upper Rear
2. Washer, Flat Hardened 3/4"
3. Spacer, Radius Rod Mounting
4. Bolt, Hex 3/4" - 10 UNC x 4" Lg.
5. Bolt, M18 x 1.5" x 100
6. Circlip
7. Bushing, 130mm

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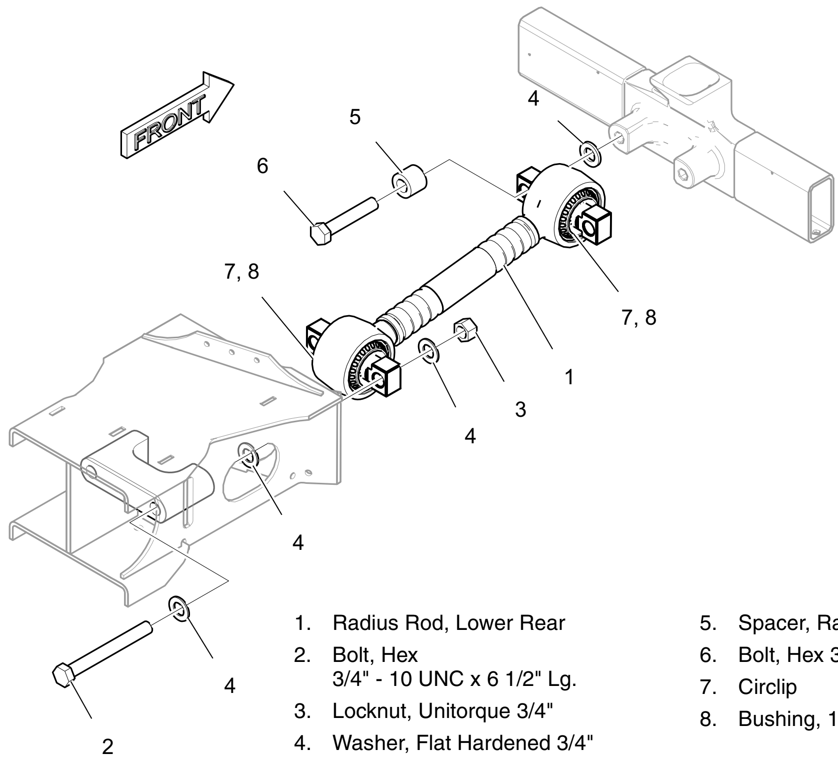
Fig. 2-103: Upper Radius Rod Removal & Installation



1. Radius Rod, Lower Rear
2. Bolt, Hex 3/4" - 10 UNC x 6 1/2" Lg.
3. Locknut, Unitorque 3/4"
4. Washer, Flat Hardened 3/4"
5. Spacer, Radius Rod Mounting
6. Bolt, Hex 3/4" - 10 UNC x 4" Lg.
7. Circlip
8. Bushing, 130mm

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Fig. 2-104: Lower Radius Rod Removal & Installation

4.3.8. Bushing Replacement

☞NOTE:

The following procedure applies to both the upper radius rods and lower radius rods.

1. Place radius rod on a hydraulic press with snap-ring groove facing up.

☞NOTE:

The bushing must be compressed before the snap-ring can be removed.

2. Select a pressing sleeve that will seat on the metal shell of the bushing. Do not press on the rubber portion of the bushing.
3. Slowly compress the bushing until pressure is relieved from the snap ring.
4. Use snap ring pliers to remove the snap ring. Discard snap ring.
5. Reverse the position of the radius rod and tap out the bushing.

☞NOTE:

If the bushing is heavily corroded, it may be necessary to remove the bushing with the hydraulic press.

6. Clean and inspect snap-ring groove for wear or damage.
7. Use a wire brush or scraper to remove any rubber that has transferred to the bore of radius rod.
8. Apply lubricant, supplied in kit, to the bushing O.D. and the I.D. of the radius rod bore.
9. Insert bushing into bore of radius rod so that the cross-pin angle is properly aligned. See “Fig. 2-105: Rear Radius Rod Bushing Replacement” on page 87.
10. Use a pressing sleeve and press on the metal shell of the bushing sufficiently to compress the bushing and allow insertion of the snap-ring into the groove.
11. Use snap-ring pliers to insert snap-ring into groove. Ensure snap-ring is fully seated.

☞NOTE:

The snap-ring should be positioned so that the opening of the snap-ring is facing downward and toward the radius rod tube at a 45° angle.

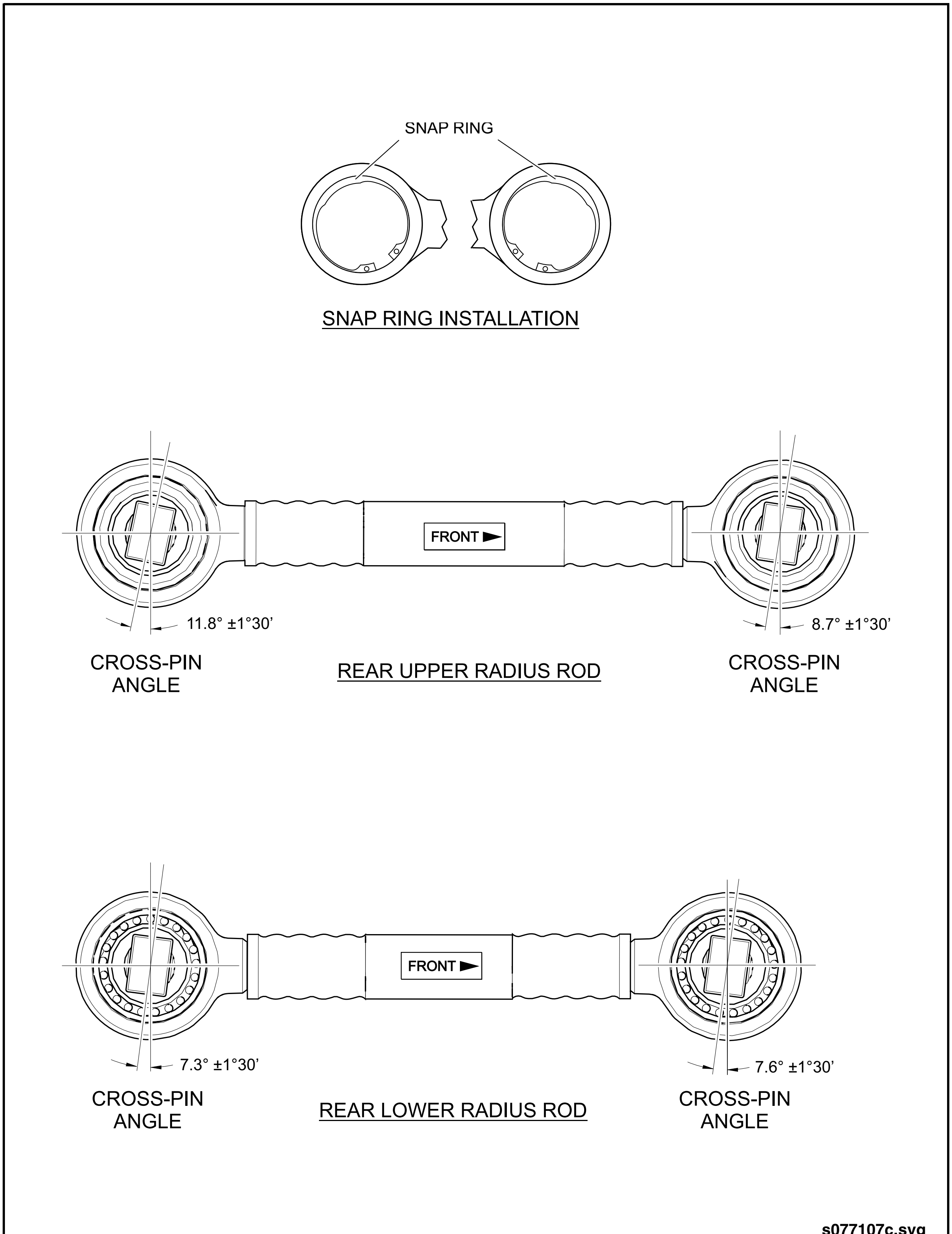


Fig. 2-105: Rear Radius Rod Bushing Replacement

4.3.9. Installation

☞**NOTE:**

Refer to 4.5. "Rear Suspension Torque Specifications" on page 93 *in this section for all installation torque values.*

☞**NOTE:**

The upper and lower radius rods have directional stamps marked "FRONT" on the tubular section of the rod to indicate which end is to be installed towards the front of the vehicle. If the stamp is illegible, locate the cross-pin with the greater angle at the axle end.

1. Install the radius rod in its original location and orientation using the same location and quantity of washers as originally removed. The spacer should be located between the head of the bolt and the radius rod cross-pin. The lower radius rod uses a spacer with the front set of bolts only.

☞**NOTE:**

The mounting bolts should install freely without having to twist or forcibly align the mounting holes in the cross-pin. If difficulty is experienced aligning the radius rod mounting holes with the vehicle structure or axle, remove the radius rod for closer examination and ensure the bushing and cross-pin were installed at the proper angle.

2. Apply Never-Seez® to fastener threads and torque bolts to specification.

4.3.10. Functional Test

Test drive vehicle and check for proper suspension action without noise or vibration.

4.4. Rear Shock Absorbers

4.4.1. Description

The shock absorbers are cylindrical components which dampen suspension movement in varying road conditions. Each shock absorber consists of a cylinder, piston, rod and valves. The rod is fitted with a tubular protective shield.

4.4.2. Rear Shock Absorbers Specifications

Make .... Koni

Model 90-2518

Type .... Bayonet Mount

Maximum Length (body only)
.... 23.11 to 23.34" (587 to 593 mm)

Minimum Length (body only)
.... 13.42 to 13.66" (341 to 347 mm)

Stroke .... 9.68" (246 mm)

Thread Size .... M16 x 1.5"

4.4.3. Operation

The function of the shock absorber is to absorb the energy caused by movement of the suspension. The shock absorber makes two movements, a bump and rebound stroke.

❒ Bump Stroke

During the bump stroke, the piston and rod travel into the cylinder. Oil flows from below the piston through orifices and into the upper part of the cylinder, thus equalizing pressure in the cylinder. The piston rod entering the cylinder displaces oil which escapes through the compression valve. The restriction of oil flow through the compression valve produces the bump damping force of the shock absorber.

❒ Rebound Stroke

When the piston and rod travel upwards, the oil above the piston is trapped and forced through orifices in the piston and rod. The bypass valve is forced open when the pressure generated by the oil overcomes the force of the bypass valve spring. The resistance to oil flow produces the rebound damping force. The void caused by the piston rod exiting the cylinder is filled with oil from the reservoir entering the cylinder through the compression valve.

4.4.4. Removal

CAUTION

ALWAYS support the weight of the axle when replacing shock absorbers.

1. Raise the vehicle. Refer to the General Information Section of this manual for lifting procedures. Follow all applicable safety requirements.

   NOTE:

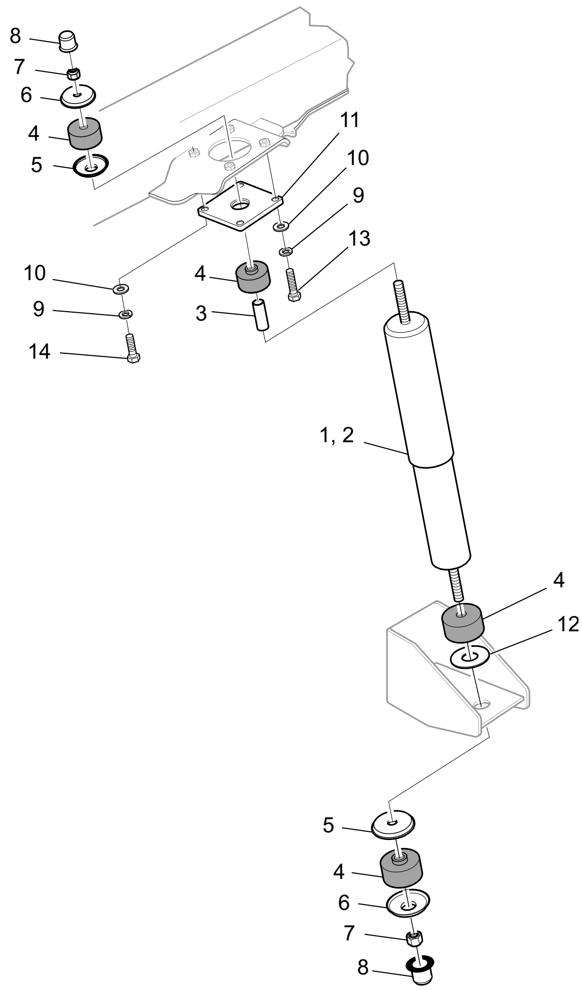
   The upper shock mount requires removal of the mounting plate in order to access the top mounting nut.

2. Remove the four bolts retaining the upper shock mounting plate to the chassis bracket. See "Fig. 2-106: Shock Absorber Removal & Installation" on page 90.

   NOTE:

   The two inboard mounting bolts that retain the air line support bracket are slightly longer to accommodate the thickness of the bracket. Note the location of these bolts for reassembly.

3. Remove the protective cap from the lower shock mounting nut and remove the nut.
4. Remove the clamping plate, rubber bushing, and centering ring from the shock stud, noting the location and orientation of the parts.
5. Compress the lower shock sufficiently to remove the shock stud from the lower mounting bracket. Remove the remaining shock mount plate and rubber bushing from the shock stud.
6. Remove the shock absorber assembly from the vehicle and disassemble the upper mounting components as follows:
   a. Remove the protective cap from the upper shock mounting nut and remove the nut.
   b. Remove the clamping plate, rubber bushing, and centering ring from the shock stud, noting the location and orientation of the parts.
   c. Remove the remaining mounting plate, rubber bushing and steel sleeve from the shock stud.



1. Shock Absorber Assembly
2. Shock Absorber
3. Sleeve, Steel
4. Bushing, Rubber
5. Ring, Centering
6. Plate, Clamping
7. Nut, Hex Locking M16 x 1.5"
8. Cap
9. Washer, Lock Spring Type 3/8"
10. Washer, Flat Hardened 3/8"
11. Plate, Shock Mount
12. Plate, Shock Mount
13. Bolt, Hex 3/8" x 1 1/2" Lg.
14. Bolt, Hex 3/8" x 1 1/4" Lg.

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Fig. 2-106: Shock Absorber Removal & Installation

4.4.5. Disassembly

The shock absorber is a sealed unit. Disassembly is not possible.

4.4.6. Cleaning & Inspection

1. Inspect rubber mounting bushings for wear of deterioration.
2. Check condition of threads on each end of the bayonnet mounting studs.
3. Check for leakage at the piston rod seal.
4. Inspect the exterior of the shock absorber for physical damage.
5. Hold the shock in it's installed position, push in and pull out on the piston rod, while holding the other end stationary to check for bump and rebound damping.

4.4.7. Assembly

The shock absorber is a sealed unit. No assembly is required.

4.4.8. Adjustment

☞**NOTE:**

The shock absorbers fitted on this vehicle feature adjustable rebound damping. This adjustment can be used to compensate for loss of damping force or additional vehicle weight. New shock absorbers are designed for optimal performance at the minimal damping setting and should be installed as received. Adjust shock absorbers that exhibit deteriorated damping characteristics using the following procedure. Ensure that both shock absorbers on a common axle are adjusted equally.

1. Remove shock absorbers from vehicle in accordance with preceding instructions.
2. Clamp the lower end of the shock absorber in a vise, being careful not to damage the threaded end of the stud.
3. Collapse the shock absorber while slowly rotating it counterclockwise. As it nears the fully collapsed position, the cams on the internal adjusting nut should engage the recesses of the footvalve and a slightly increased resistance to rotation should be felt.
4. Maintain slight pressure on the shock absorber in the fully collapsed position while rotating it counterclockwise and recording the number of turns until the internal stop is reached.
5. Readjust the shock absorber by rotating it clockwise while maintaining slight pressure on the shock absorber in the fully collapsed position. Return the shock absorber to its original setting and rotate an additional 1/2 to 1 full turn to provide increased damping.
6. Pull the piston rod straight out approximately 1/2", without rotating the shaft, until the internal adjusting nut disengages the footvalve.

☞**NOTE:**

The shock absorber has a range of adjustment of approximately 2 to 3 full turns between the internal stops. DO NOT force rotation of the shock absorber beyond this range.

4.4.9. Installation

1. Assemble the upper shock mounting components as follows:
   a. Slide the steel sleeve and rubber bushing onto the shock stud. Ensure that the flat side of the rubber bushing seats against the shock body.
   b. Place the mounting plate onto the rubber bushing ensuring that the mounting plate seats on the pilot diameter of the rubber bushing.
2. Assemble the remaining upper shock mounting components as follows:
   a. Slide the centering ring and rubber bushing onto the shock stud ensuring that the pilot diameter of the rubber bushing seats within the concave side of the centering ring.
   b. Install the clamping plate onto the rubber bushing ensuring that the concave side of the clamping plate seats against the flat side of the rubber bushing.
   c. Install the M16 self-locking nut and torque to specification.
   d. Install the protective cap over the lock nut.
3. Align the four holes in the upper shock mount plate with the welded nuts on the chassis mounting bracket.
4. Position the air line support bracket over the two holes on the inboard side of the mount plate.
5. Install four bolts and washers and torque bolts to specification.

☞**NOTE:**

The two inboard mounting bolts that retain the air line support bracket are slightly longer to accommodate the thickness of the bracket. Ensure that the two longer bolts are installed at the bracket location.

6. Assemble the lower shock mounting components as follows:
   a. Slide the rubber bushing and shock mount plate onto the shock stud ensuring that the flat side of the rubber bushing seats against the shock body.
   b. Compress the shock sufficiently to allow the shock stud to enter the lower mounting bracket.
7. Assemble the remaining lower shock mounting components as follows:
   a. Slide the centering ring and rubber bushing onto the shock stud ensuring that the pilot diameter of the rubber bushing seats within the concave side of the centering ring.
   b. Install the clamping plate onto the rubber bushing ensuring that the concave side of the clamping plate seats against the flat side of the rubber bushing.
   c. Install the M16 self-locking nut and torque to specification
   d. Install protective cap over the lock nut.

4.4.10. Functional Test

Road test the vehicle to confirm compliant suspension action and quiet operation. Also check for any evidence of rubbing during operation.

4.5. Rear Suspension Torque Specifications

See “Fig. 2-107: Rear Suspension Torque Points” on page 94.

REAR SUSPENSION TORQUE SPECIFICATIONS					
ITEM	DESCRIPTION	QTY. (per axle)	BOLT	NUT	TORQUE ft-lb. (Nm)
1	Upper Radius Rod to Frame	4	3/4" UNC		300 ft-lb. (407 Nm) NEVER-SEEZ®
2	Upper Radius Rod to Axle Housing	4	M18 x 1.5		300 ft-lb. (407 Nm) NEVER-SEEZ®
3	Lower Radius Rod to Frame	4	3/4" UNC		300 ft-lb. (407 Nm) NEVER-SEEZ®
4	Lower Radius Rod to Axle Housing	4		3/4" UNC Locking	230 ft-lb. (312 Nm) NEVER-SEEZ®
5	Axle to Suspension Beam Nut	8		7/8" UNF Locking	380 ft-lb. (515 Nm) in increments of 100 ft-lb. (135 Nm) NEVER-SEEZ®
6	Air Spring to Suspension Beam	4		1/2" UNC Locking	20 ft-lb. (27 Nm) NEVER-SEEZ®
7	Air Spring to Frame	4		1/2" UNC Locking	19 ft-lb. (26 Nm) NEVER-SEEZ®
8	Air Spring to Frame	4		3/4" UNF Locking	30 ft-lb. (41 Nm) NEVER-SEEZ®
9	Lower Shock to Suspension Beam	4		M16 x 1.5 Locking	56 ft-lb. (76 Nm) NEVER-SEEZ®
10	Upper Shock to Mounting Bracket	4		M16 x 1.5 Locking	56 ft-lb. (76 Nm) NEVER-SEEZ®
11	Upper Shock Mounting Plate	8	3/8" UNC		23 ft-lb. (31 Nm) NEVER-SEEZ®
12	Wheel Nuts	20		M22 x 1.5	450 to 500 ft-lb. (610 to 680 Nm)
13	Brake Chambers	4		M16 x 1.5	Initial Torque: 25 ft-lb. (34 Nm) Final Torque: 135 ft-lb. (183 Nm) NEVER-SEEZ®

☞**NOTE:**

All bolts and nylon locknuts are Grade 8 and yellow zinc dichromate coated.
All fasteners are dry unless otherwise noted.

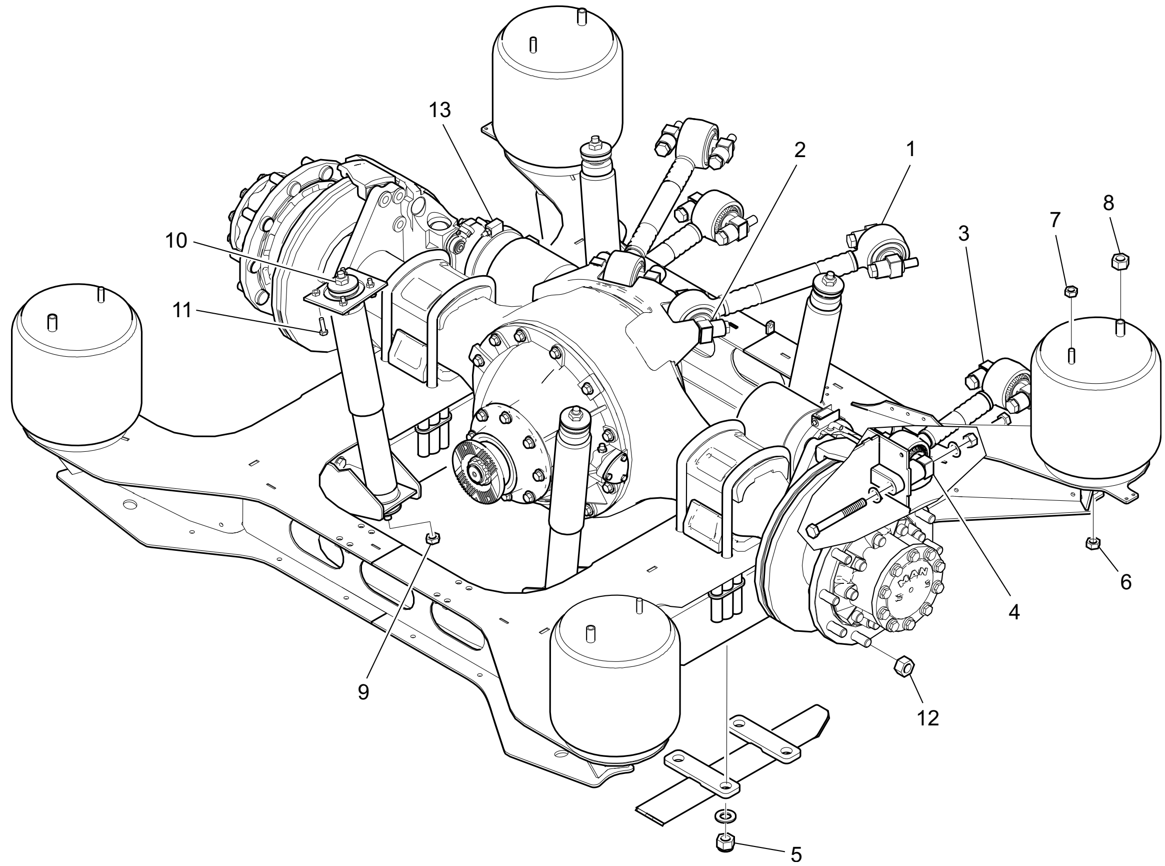


Fig. 2-107: Rear Suspension Torque Points

5. REAR BRAKE SYSTEM

5.1. Description

The rear brake system includes:

- ❒ Rear Disc Brakes
- ❒ Brake Chambers
- ❒ Anti-Lock Braking (ABS) System

Refer to 5.2. “Rear Disc Brakes” on page 95 in this section for information on the disc brakes. Refer to 5.3. “Rear Brake Chambers” on page 121 in this section for information on the brake chambers. Refer to 6. “REAR AXLE ANTI-LOCK BRAKING SYSTEM (ABS) & COMPONENTS” on page 125 in this section for information on the ABS System.

5.2. Rear Disc Brakes

5.2.1. Description

The rear disc brakes includes the brake caliper, brake carrier, disc pads, and brake disc. See “Fig. 2-108: Disc Brake Assembly” on page 96.

5.2.2. Rear Disc Brakes Specifications & Wear Limits

Manufacturer .... Knorr-Bremse

Model..SN 7000

Type.................. Air-actuated sliding caliper

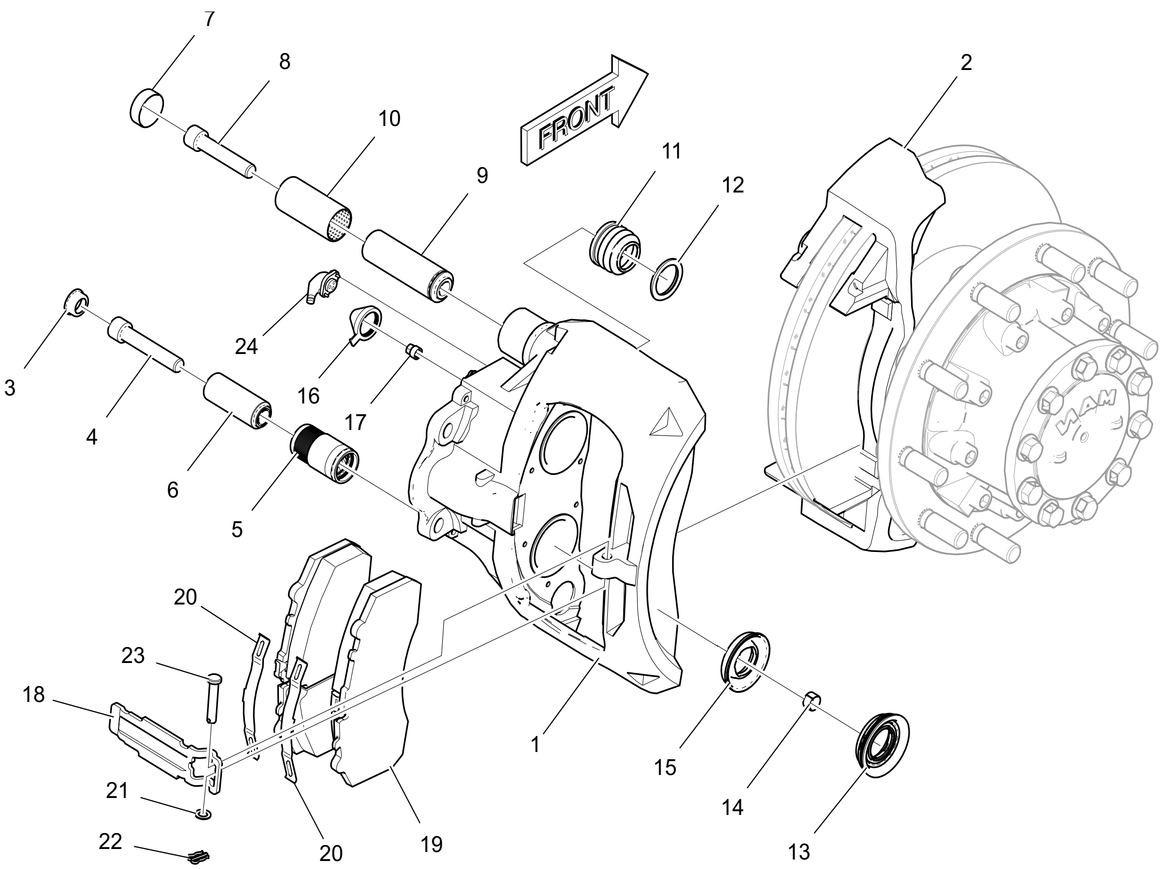
Brake pad clearance
.............0.028 to 0.047" (0.7 to 1.2 mm)

Brake pad thickness (min)
....0.08" (3.0 mm)

Brake disc thickness (min)
......................................1.457" (37 mm)

Brake disc lateral run-out (max)
...................................0.006" (0.15 mm)

Brake caliper guides (max play)
.....................................0.079" (2.0 mm)



1. Disc Brake Caliper Assembly, Rear Streetside without Lining (Incl. 2-17)
2. Carrier
3. Cap
4. Cap Screw, Hex Socket Head M16 x 1.5 x 80
5. Bushing, Rubber
6. Pin, Guide
7. Cover
8. Cap Screw, Hex Socket Head M16 x 1.5 x 90
9. Pin, Guide
10. Bushing, Brass
11. Boot, Inner
12. Ring
13. Tappet & Boot Assembly
14. Bushing, Toppet
15. Seal, Inner
16. Cap, Adjuster
17. Adapter, Shear
18. Pad Retainer
19. Pad
20. Spring, Pad Retainer N2G
21. Washer
22. Clip, Spring
23. Pin, Pad Retainer
24. Plug, EBS Port

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Fig. 2-108: Disc Brake Assembly

5.2.3. Operation

☞**NOTE:**

When reviewing the following information on the operation of the disc brake assembly See “Fig. 2-109: Disc Brake Cross Section” on page 98.

During brake application the push rod of the brake chamber extends and moves the actuator lever in the brake caliper. This input force is transferred by an eccentric roller bearing to the bridge section of the caliper. This force is then distributed by the bridge and two threaded tubes to the tappets. The tappets apply force directly to the inboard brake pad. Once the running clearance between the brake pads and brake disc have been overcome, the reaction forces are transmitted by the sliding caliper to the outboard brake pad. The clamping force of the brake pads on the brake disc generates the braking force.

When brake pressure is released, the return spring within the caliper forces the bridge section along with the threaded tubes and lever back to the starting position.

An automatic adjuster mechanism is used to ensure consistent running clearance between the brake pads and brake disc. The adjuster is mechanically connected to the lever and will operate each time the brakes are applied. The running clearance between the pads and brake disc increases as the brake pads wear. This increased clearance will allow the adjuster mechanism to rotate slightly. A drive chain transfers this movement to both threaded sleeves, which rotated inward equally. The rotational inward movement of the threaded sleeves and tappets effectively takes up the additional running clearance as the brake pads wear.

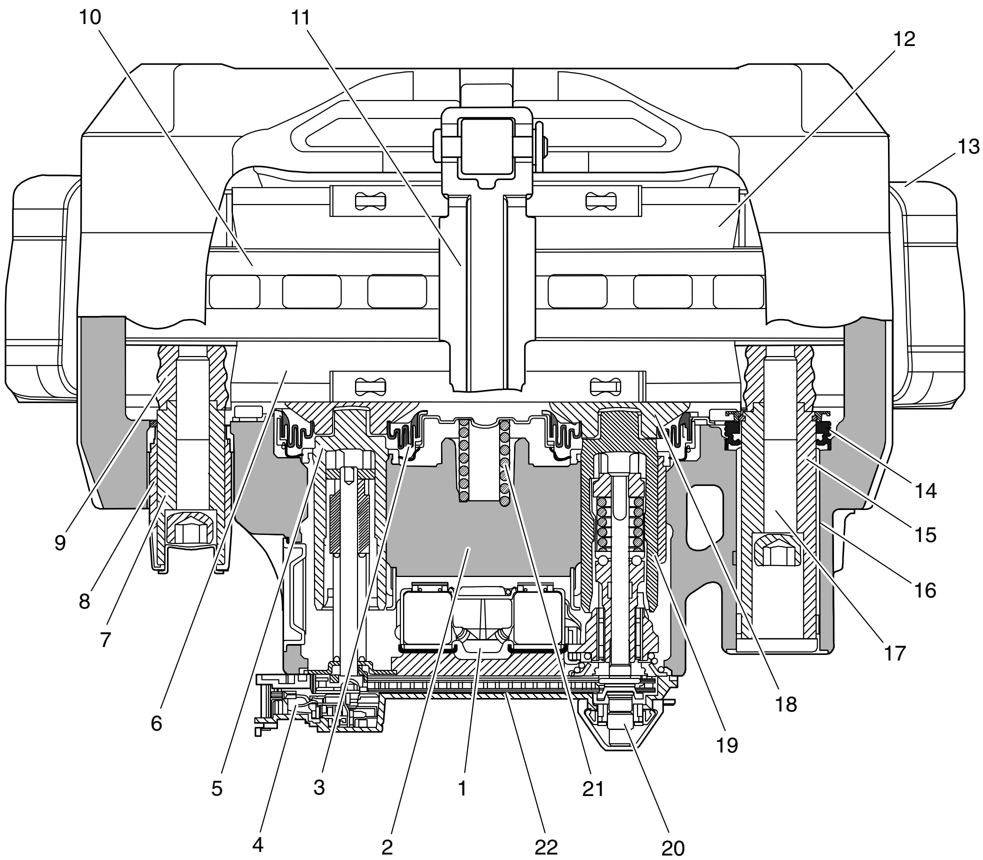
5.2.4. Inspection

The following inspections may be performed with the brake caliper assembly installed on the axle, providing that the following preparatory steps have been taken.

1. Vehicle raised to working height and properly supported with jack stands.
2. Wheel and tire assembly removed.

☞**NOTE:**

Refer to the Preventive Maintenance Section of this manual for the scheduled interval at which the following inspections are to be performed.



1. Actuator Lever
2. Brake Caliper
3. Tappet Boot
4. Wear Sensor
5. Threaded Tube
6. Inner Brake Pad
7. Lower Guide Pin
8. Bushing
9. Brake Carrier
10. Brake Disc
11. Brake Pad Retainer
12. Outer Brake Pad
13. Brake Carrier
14. Inner Boot
15. Upper Guide Pin
16. Brass Bushing
17. Caliper Bolt
18. Tappet
19. Threaded Tube
20. Adjuster
21. Return Spring
22. Drive Chain

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Fig. 2-109: Disc Brake Cross Section

5.2.4.1. Adjuster Check

1. Before starting work, ensure that the wheels are chocked and the vehicle cannot roll away.
2. Ensure that service brake and parking brake are in the released condition.
3. Check the supply pressure of the brake system. Connect an additional external supply to prevent pressure drop.
4. Check the brake disc temperature; it should be between 14°F and 122°F (-10°C and 50°C).
5. Push and pull caliper three times in the axial direction to assess any existing air gap. If no movement is possible, clean the disc brake and if necessary, replace the caliper guide pins. Refer to 5.2.7. “Caliper Guide Pins” on page 111 in this section for procedure. Once movement is obtained, continue to step 8.

⚠CAUTION

Removal of the adjuster cap with a screwdriver, or similar tool, is not allowed. Damage to the seal may result.

6. Pull off the adjuster cap using the tag, taking care not to lose the shear adapter.

⚠WARNING

Ensure that the brake chamber (service and parking/emergency) is not exerting any pressure on the brake caliper during this test.

7. Push the brake caliper towards the middle of the vehicle.
8. Push brake lining away from tappets.
9. Check the gap between each of the whole tappet surface of both tappets using two feeler gauges simultaneously (feeler gauges must be at least 200 mm long). Each gap must measure between 0.028 to 0.047" (0.7 to 1.2 mm). If the clearance deviates from the specified value, reset and recheck the clearance with new brake pads by proceeding to step 10.
10. Insert new brake pads. Refer to 5.2.5. “Brake Pads” on page 107 in this section for procedure.
11. Set the starting gap by turning the adjuster with the shear adapter backwards and then forwards until a value of 1.3 mm air gap has been achieved (measure between the brake pad and Tappets).

☞NOTE:

When turning backwards a noticeable clicking can be heard and felt.

12. Apply the brakes 20 times with medium pressure (approximately 30 to 40 psi (2 to 3 bar).
13. Check the gap between each of the tappets and inboard pad backplate. Each gap must measure between 0.028 to 0.047" (0.7 to 1.2 mm).

    This must be measured over the whole tappet surface of both tappets using two feeler gauges simultaneously (feeler gauges must be at least 220 mm long).See “Fig. 2-110: Measuring Tappet to Brake Pad Gap” on page 100.

    a. If the air gap is larger than 1.2 mm, proceed to step 14.
    b. If the air gap is smaller than 6 mm, proceed to step 17.

    Additionally, if the gap difference between the two tappets is greater than 0.25 mm then the caliper guide pin clearance must be checked. Refer to 5.2.4.4. “Caliper Guide Pin Inspection” on page 104 in this section for procedure. If the caliper guide pin play is within specification, then the tappets have lost synchronization and the caliper needs to be replaced.

14. If the air gap is larger than 1.2 mm the adjuster must be checked as follows:

    a. Turn the adjuster with adapter 3 clicks counter-clockwise (increasing the air gap).

    CAUTION

    Make sure the wrench or socket can turn freely clockwise during the following procedure.

    b. As a visual aid, position a wrench or socket onto the adjuster (including Adapter. Apply the brake 5 to 10 times (approximately 30 psi (2 bar)), the wrench or socket should turn clockwise (viewed from actuator side) in small increments if the adapter is functioning correctly. See “Fig. 2-111: Checking Adjuster Movement” on page 101.

    c. As the number of applications increases, incremental movement of the wrench or socket will decrease. If the wrench or socket does not turn or turns only with the first application or turns forward and backward with every application, the automatic adjuster has failed and the caliper must be replaced.

15. Lightly grease the contact surface of the adjuster cap with white grease.

    NOTE:

    A new adjuster cap should be fitted even if the brake pads are not being replaced.

16. The tag of the adjuster cap should be positioned to ensure access is maintained for subsequent removal.

17. If the air gap is smaller than 0.6 mm the parameters and functions must be checked as follows:

    a. Apply the brakes to function the brake chamber.

    b. Remove brake chamber. Refer to 5.3. “Rear Brake Chambers” on page 121 for procedure.

    c. Check position of lever inside the caliper in its released state.

    d. Inspect the previously removed brake pads. If necessary, remove dirt from brake pads, caliper and carrier.

        i. Check brake pads for wear from the tappets and if necessary replace brake pads.

        ii. Check for abnormal wear of the contact areas of the carrier. If necessary replace the carrier.

    e. Check the brake disc.

18. Check caliper running clearance. Refer to 5.2.4.4. “Caliper Guide Pin Inspection” on page 104 in this section for procedure.

19. Install the brake pads. Refer to 5.2.5. “Brake Pads” on page 107 in this section for procedure.

20. Install the brake chamber. Refer to 5.3. “Rear Brake Chambers” on page 121 in this section for procedure.

21. Recheck the adjuster.

22. If the air gap is still smaller than 0.6 mm between both tappets, the brake caliper must be replaced.

23. Install the wheel.

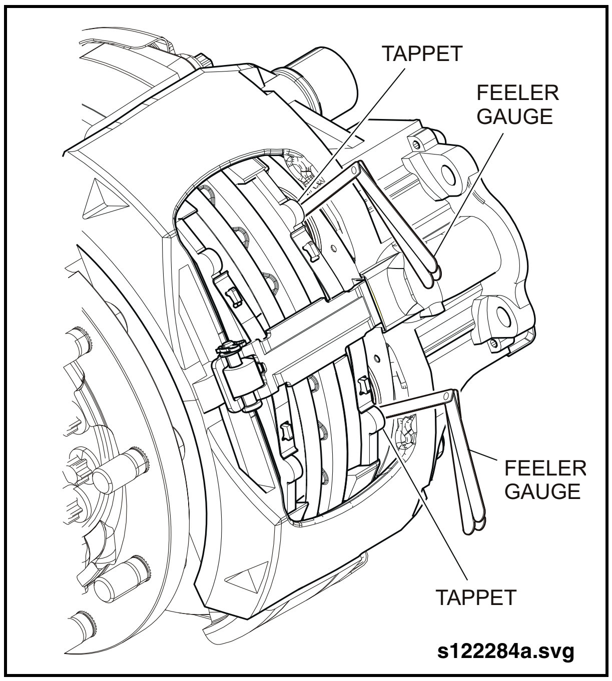


Fig. 2-110: Measuring Tappet to Brake Pad Gap

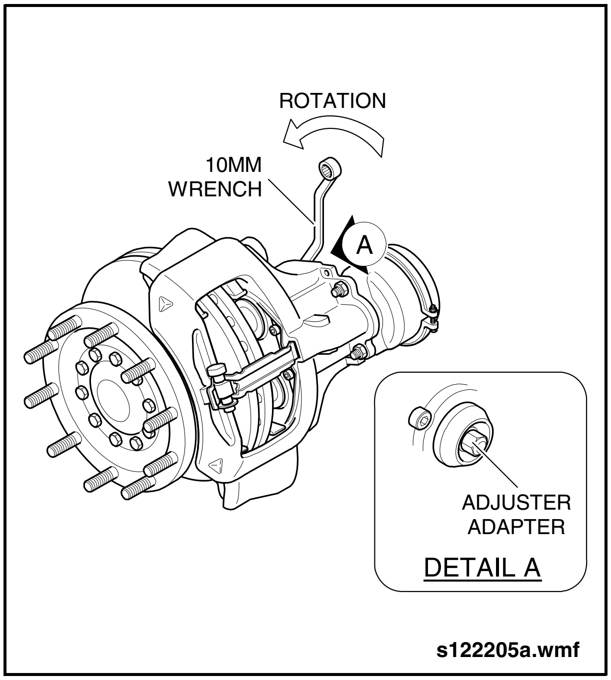


Fig. 2-111: Checking Adjuster Movement

5.2.4.2. Brake Pad Wear Inspection

☞**NOTE:**

Brake pad wear can be assessed visually without removing the brake pads using the following procedure.

1. Locate the lower caliper guide pin.
2. Inspect the amount of deformation on the bellows area of the rubber bushing. A fully extended bellows indicates a new brake pad condition. A retracted and bulged bellows (where Dim A <= 1mm) indicates a worn brake pad condition. See “Fig. 2-112: Brake Pad Wear Inspection” on page 102.
3. If a worn condition is indicated, remove the brake pads and measure actual thickness of friction material. Refer to 5.2.5. “Brake Pads” on page 107 in this section for removal procedure. Replace brake pads if measured thickness is less than the specification minimum.
4. If brake pad thickness is within limits, inspect condition of friction surface. Minor material breakout at the edges is permitted but major material breakout is unacceptable. Replace brake pads as necessary.

☞**NOTE:**

Replace all brake pads on same axle. DO NOT replace one side only.

5. Measure brake disc thickness. Refer to 5.2.4.3. “Brake Disc Inspection” on page 102 in this section for procedure.

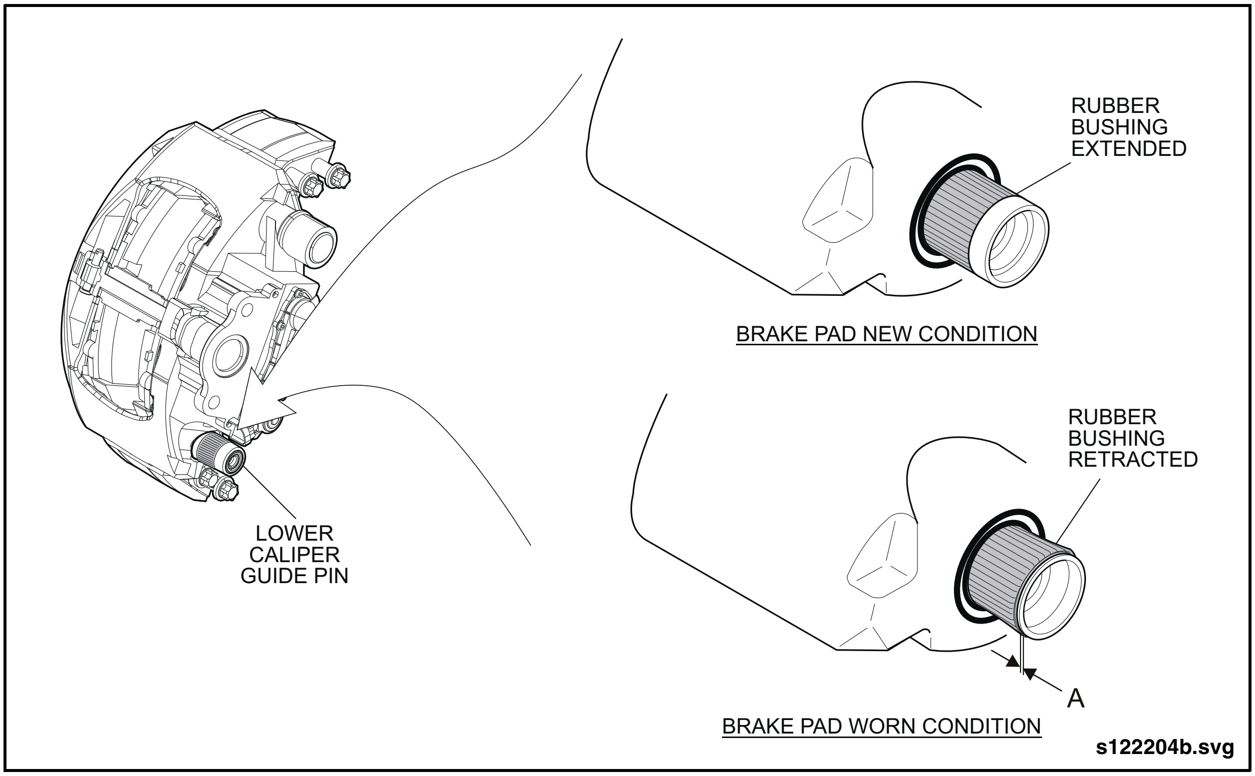


Fig. 2-112: Brake Pad Wear Inspection

5.2.4.3. Brake Disc Inspection

1. Use a measuring caliper (Item 13 from special tools list) to measure brake disc thickness at the thinnest point of the disc, Avoid measuring at the outer edge or a roughened surface. Replace brake disc if thickness is 1.457" (37 mm) or less.

☞**NOTE:**

If the brake disc measures less than 39 mm when the brake pads are being replaced, replace the disc brake as well.

2. Measure brake disc runout as follows:

☞**NOTE:**

Confirm that the wheel hub axial play is within limits prior to proceeding with this inspection.

a. Mount dial indicator (Items 29 & 69 from special tools list) so that tip of indicator is perpendicular to brake disc surface at 1.40" (35 mm) down from the outer rim of the rotor. See “Fig. 2-113: Rotor Run-Out Measurement Point” on page 103.

b. Rotate brake disc a complete turn.

c. Total indicated run-out must not exceed 0.006" (0.15 mm).

d. Machine or replace the brake disc if run-out limits are exceeded. Refer to 5.2.9. “Brake Disc” on page 118 in this section for machining procedure.

☞**NOTE:**

Replace all brake pads on same axle. DO NOT replace one side only.

3. Inspect the brake disc for cracks and scoring. See "Fig. 2-114: Brake Disc Condition" on page 103.

   a. Minor web-like cracks on the braking surface are acceptable. Refer to area "A" shown on illustration.

   b. Cracks less than 0.019" (0.5 mm) deep or wide and running in a radial direction are acceptable providing the cracks do not extend over more than 75% of the width of the braking surface. Refer to area "B" shown on the illustration.

   c. Circumferential scoring of the braking surface not to exceed 0.059" (1.5 mm) per side is acceptable. Refer to area "C" shown on illustration.

   d. Cracks extending into the cooling cavity or into the inner support web are unacceptable.

☞NOTE:

Uneven or scored brake disc surfaces may be cleaned up by machining. To meet safety requirements, the minimum thickness after machining must be greater than 39 mm. Replace brake disc if crack or scoring limits are exceeded. Replace both disc brakes on same axle. DO NOT replace one side only.

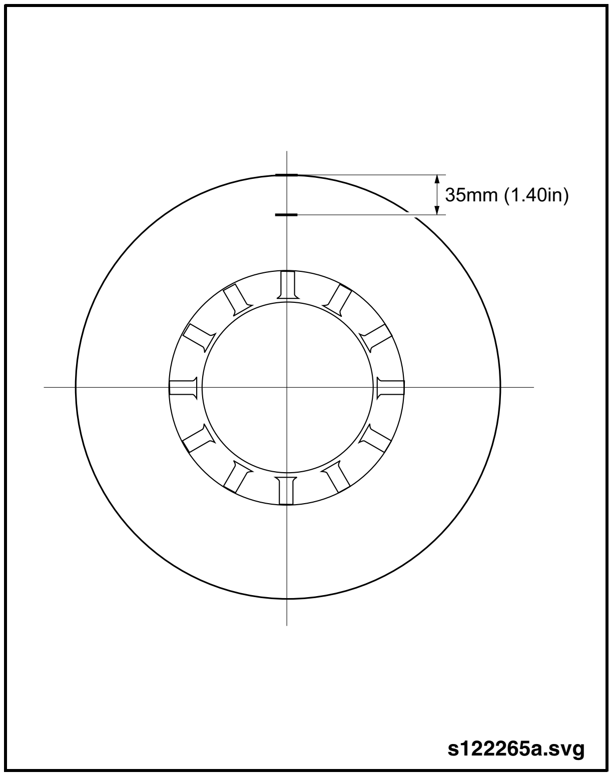


Fig. 2-113: Rotor Run-Out Measurement Point

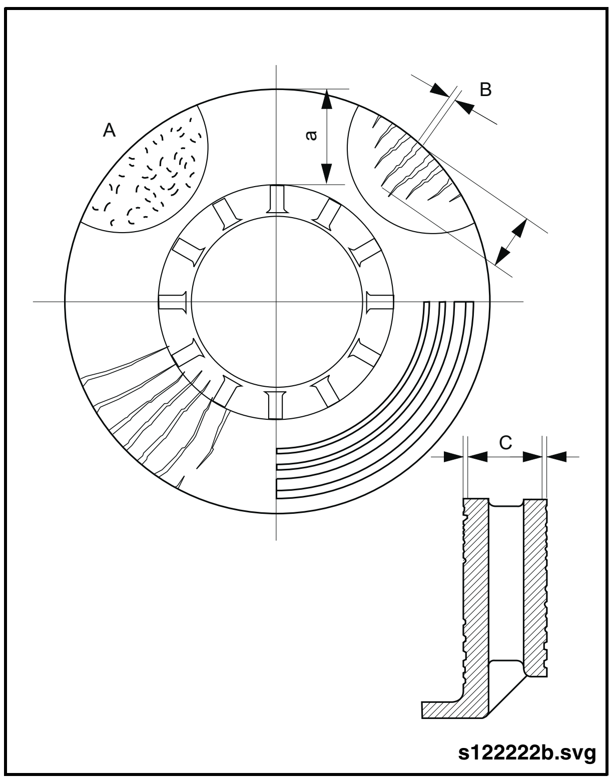


Fig. 2-114: Brake Disc Condition

5.2.4.4. Caliper Guide Pin Inspection

☞**NOTE:**

Worn caliper guide pins will result in excessive movement in the caliper assembly relative to the brake carrier. Use the following procedure to determine if excessive wear is present:

1. Remove worn brake pads. Refer to 5.2.5. “Brake Pads” on page 107 in this section for removal procedure.

   ☞**NOTE:**

   Perform brake pad inspection on the removed pad. Refer to 5.2.4.2. “Brake Pad Wear Inspection” on page 101 *in this section for procedure. Replace pads as necessary or reinstall existing pads.*

2. Rewind the tappets back using a wrench and shear adapter. Clean dirt inside and out from guide pin bushing.
3. Lightly apply Fuchs Renolit HLT 2 grease to guide pin.
4. Push the caliper inward fully then pull the caliper outward fully. Movement of the caliper on the guide pins should be smooth throughout the full range of movement (approximately 1.0" (25 mm)). Replace the caliper guide pins if the full range of movement cannot be achieved or if excessive force is required to move the caliper.
5. Temporarily replace the brake pads with a set of new pads during the remainder of this procedure.
6. Check for excessive play in the caliper guide pins as follows:
   a. Pull the caliper fully outward.
   b. Install the adapter onto the brake caliper. See “Fig. 2-115: Adapter Installation” on page 104.
   c. Attach the dial gauge to the floating bearing area with the standing frame in such a way that the tracer pin is under pre-load and pointing towards the recess of the brake caliper. See “Fig. 2-116: Measuring Guide Pin Play” on page 105.
   d. Set the torque wrench to 18 ft-lb. (25 Nm) and push it into the adapter.
   e. Use the torque wrench to push the brake caliper against the driving direction, hold it, and set the dial gauge to “zero”.
   f. Push the brake caliper in the driving direction, hold it, and read the measured value on the dial gauge.
7. Maximum bearing play is 2 mm. If the measured value is outside of the maximum bearing play, replace the brake caliper guides.

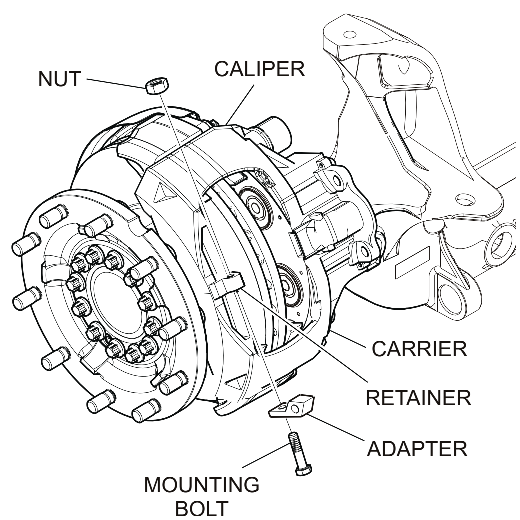


Fig. 2-115: Adapter Installation

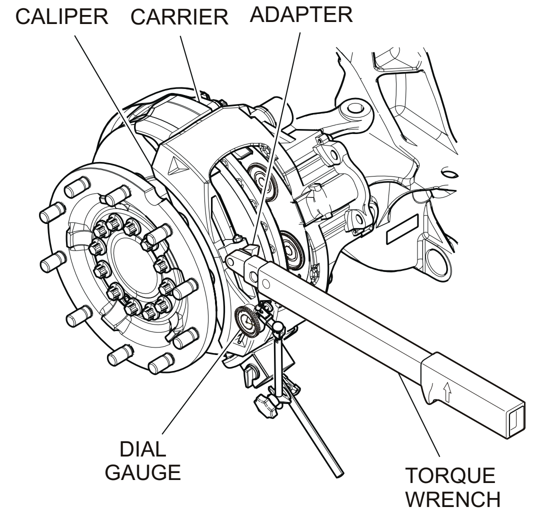


Fig. 2-116: Measuring Guide Pin Play

5.2.4.5. Tappet Rubber Boot Inspection

CAUTION

DO NOT adjust the tappets beyond 1.18" (30 mm) as measured from the surface of the caliper to the tappet thrust face. Turning any further will result in irreparable damage to the adjuster adapter. Penetration of dirt and moisture into the interior of the brake will lead to corrosion and impair the function of the clamping mechanism and the adjusting mechanism.

1. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 107 in this section for removal procedure
2. Rotate the adjuster clockwise until the tappets extend approximately 0.79" (20 mm) from the caliper surface. This will allow full extension of the tappet rubber boot for a proper visual inspection. See “Fig. 2-117: Tappet & Rubber Boot Inspection” on page 106.
3. Inspect the rubber boot for proper seating, wear, cuts, or deterioration. Replace rubber boots as necessary. Refer to 5.2.8. “Tappet & Rubber Boot” on page 115 in this section for replacement procedure.
4. Inspect the tappet thrust surface for scoring, corrosion, or other damage. Replace tappets as necessary. Refer to 5.2.8. “Tappet & Rubber Boot” on page 115 in this section for replacement procedure.

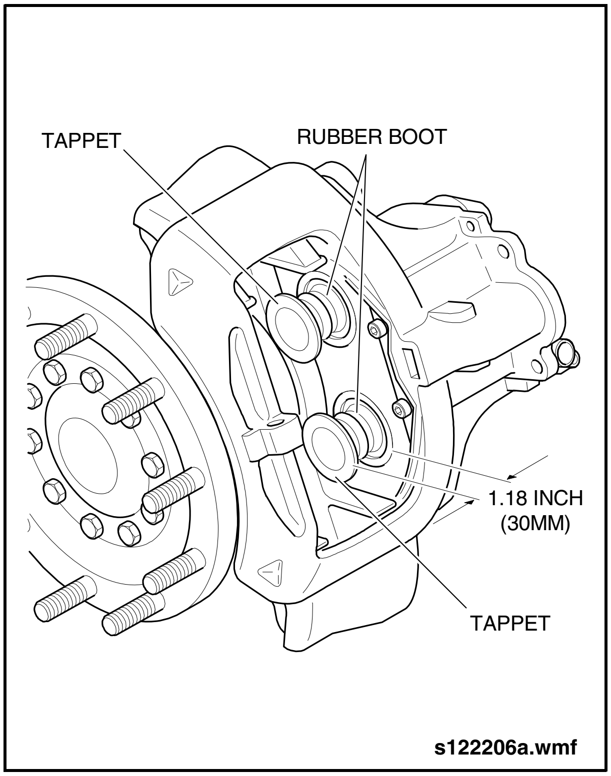


Fig. 2-117: Tappet & Rubber Boot Inspection

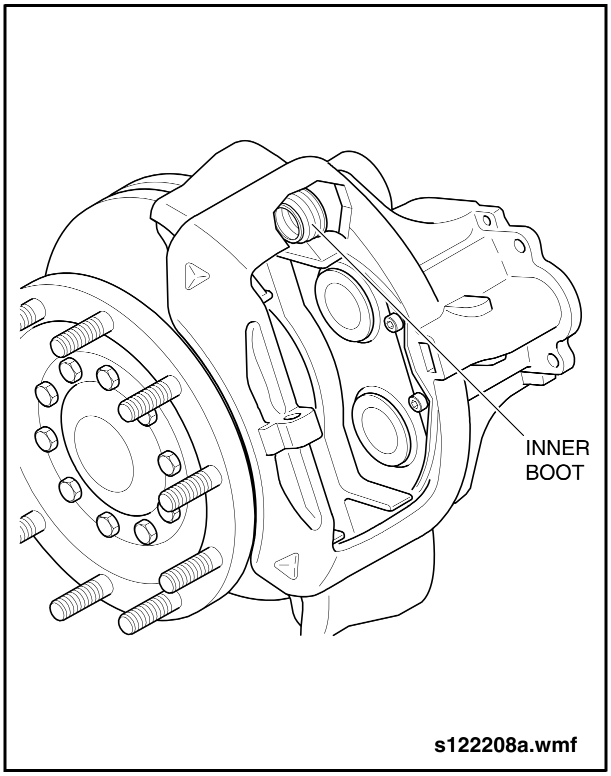


Fig. 2-118: Upper Guide Pin Inner Boot Inspection

5.2.4.6. Upper Guide Rubber Boot Inspection

1. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 107 in this section for removal procedure.
2. Push the caliper fully inward to expose the inner rubber boot on the upper guide pin. See “Fig. 2-118: Upper Guide Pin Inner Boot Inspection” on page 106.
3. Inspect the rubber boot for cracks, tears, wear, or deterioration. Replace as necessary. Refer to 5.2.7. “Caliper Guide Pins” on page 111 in this section for replacement procedure.

5.2.5. Brake Pads

5.2.5.1. Removal

1. Raise the vehicle to working height. Refer to the General Information Section of this manual for procedure.
2. Place jack stands at each of the vehicle jacking points. Lower the vehicle until the weight is taken by the jack stands.
3. Remove wheel and tire assembly.
4. Remove the brake pad retainer as follows:
   a. Remove the spring clip and washer from the retainer pin.
   b. Push down on the retainer and slide out the retainer pin.
   c. Remove the brake pad retainer.
5. Increase brake pad clearance as follows:
   a. Remove the protective cover from the adjuster by using the pull tab. Do not use a screwdriver to pry off the cap, otherwise the seal could be damaged. See “Fig. 2-119: Brake Pad Removal” on page 107.

CAUTION

NEVER attempt to turn the adjuster without using the adjuster adapter. The adapter is designed to shear if excessive force is require to turn the adjuster, thereby preventing damage to internal components. If the adapter is replaced and shears a second time, replace the caliper assembly as internal damage is evident.

   b. Use the adjuster adapter and turn the adjuster counter-clockwise until the brake pads are free.
6. Remove the brake pads from the caliper.

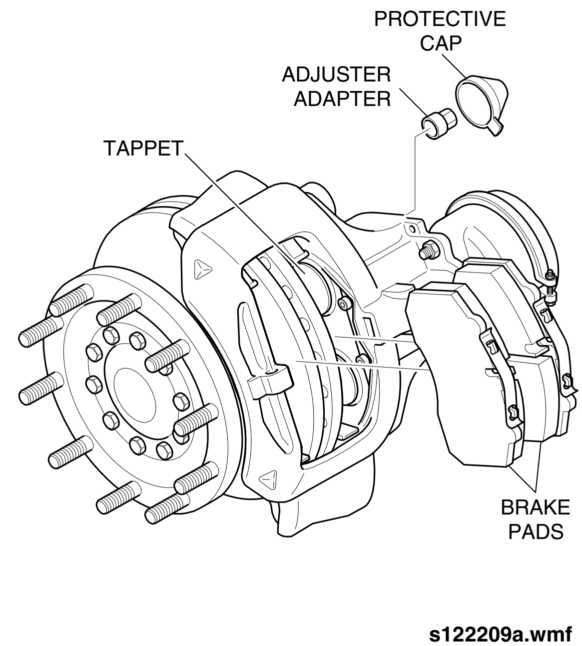


Fig. 2-119: Brake Pad Removal

5.2.5.2. Cleaning & Inspection

WARNING

DO NOT use compressed air to clean brake components as brake dust represents a health hazard.

1. Clean any corrosion or deposits from the brake pad guides using a scraper.
2. Clean away any loose dirt using a damp cloth.
3. Inspect the brake pad retainer and replace if deformed or otherwise damaged.
4. Inspect the rubber boot on the tappet and replace if worn or damaged. Refer to 5.2.8. “Tappet & Rubber Boot” on page 115 in this section for replacement procedure.

5.2.5.3. Installation

☞**NOTE:**

It may be necessary for the abutments of the carrier and guiding surfaces of the brake pad to be coated with a suitable permanent lubricant. See “Fig. 2-120: Areas to Apply Lubricant” on page 108. *The following products are approved for this application: Textar CERA TEC®, ATE Plastilube®, Dow Corning P-40® Paste.*

⚠CAUTION

DO NOT use a copper based lubricant. DO NOT get any lubricant on the pad and/or disc face or guide sleeve parts.

1. Push the brake caliper inward against the stop and insert the inboard brake pad. See See “Fig. 2-121: Brake Pad Installation” on page 109.
2. Pull the brake caliper outward against the stop and insert the outboard brake pad.
3. Install the brake pad retainer as follows:
   a. Insert the inboard end of the pad retainer into the groove and apply sufficient downward pressure to allow insertion of the retaining pin. See “Fig. 2-122: Brake Pad Retainer Installation” on page 109.
   b. Insert new retaining pin and secure with new washer and spring clip.
4. Adjust the brake pad clearance as follows:
   a. Use the adjuster adapter and turn the adjuster clockwise until the pads touch the brake disc surface.
   b. Turn the adjuster back three notches as confirmed by audible clicks.
   c. Actuate the brakes 10 times with minimum 30 psi (2 bar) applied brake pressure. This action will automatically take up any clearance and provide the desired running clearance.
   d. Verify the actual clearance by prying against the inboard brake pad backing plate and using a feeler gauge to measure clearance between the backing plate and tappet. Clearance should be 0.028 to 0.047" (0.7 to 1.2 mm).
5. Lower the vehicle and perform road test to verify satisfactory operation of the brakes.

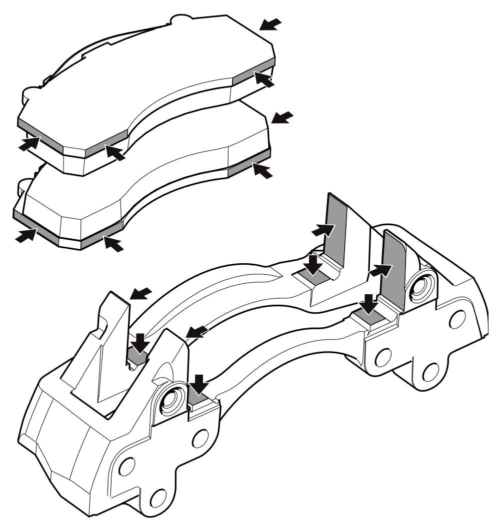


Fig. 2-120: Areas to Apply Lubricant

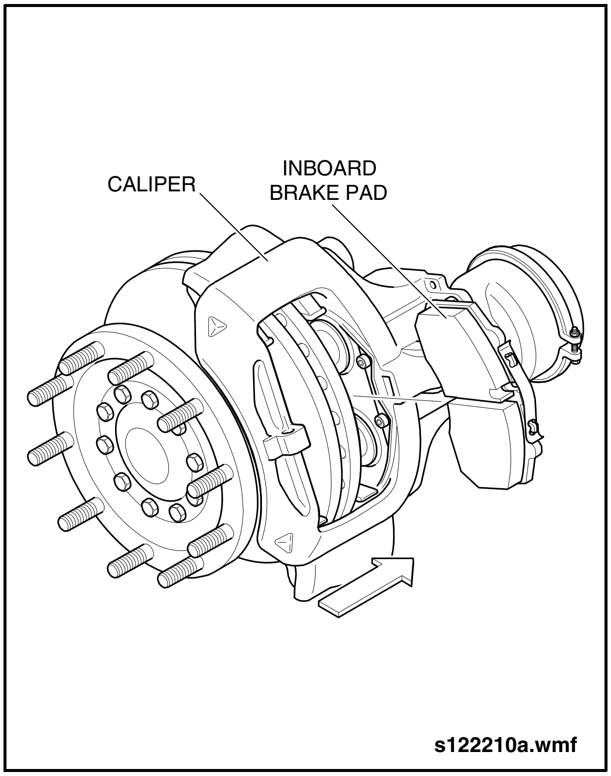


Fig. 2-121: Brake Pad Installation

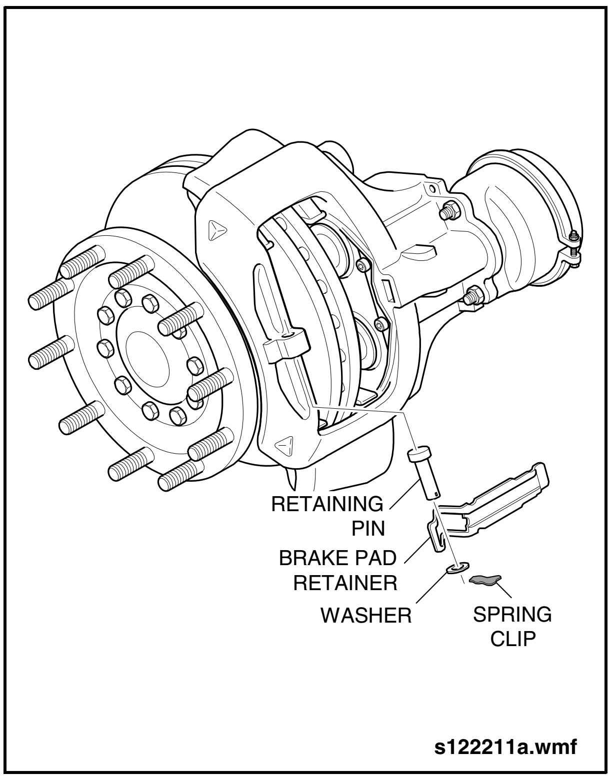


Fig. 2-122: Brake Pad Retainer Installation

5.2.6. Brake Caliper & Carrier Assembly

NOTE:

The following procedure describes removal of the brake caliper and carrier as an assembly from the steering knuckle.

5.2.6.1. Removal

1. Raise the vehicle to working height. Refer to the General Information Section of this manual for procedure.
2. Place jack stands at each of the vehicle jacking points. Lower the vehicle until the weight is taken by the jack stands.
3. Remove wheel and tire assembly.
4. Remove the brake chamber. Refer to 5.3. “Rear Brake Chambers” on page 121 in this section for removal procedure.
5. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 107 in this section for removal procedure.

CAUTION

BE SURE to secure the brake caliper to prevent it from falling, prior to removing the mounting bolts. Serious personal injury could result if the brake caliper is allowed to fall.

NOTE:

The tie rod arm must be removed to access the lower caliper mounting bolts. Use internal Torx socket (Item 67 from special tools list) and socket wrench assembly (Items 3, 4, 5, & 6 from special tools list) and remove two M22 bolts from tie rod arm.

6. Install the caliper support fixture (Item 1 from special tools list). See “Fig. 2-123: Brake Caliper Removal” on page 110.
7. Remove the six M18 hex head bolts that retain the entire caliper and carrier assembly to the steering knuckle and remove the entire caliper and carrier assembly from vehicle. Discard the six mounting bolts.

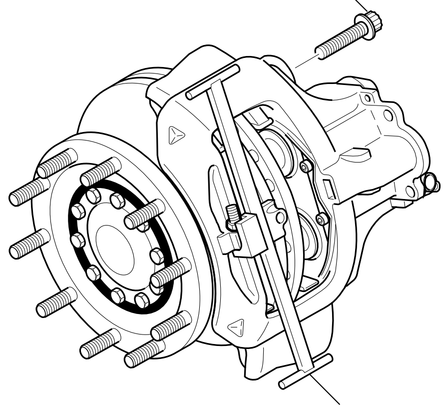


Fig. 2-123: Brake Caliper Removal

5.2.6.2. Installation

NOTE:

Refer to the Special Tools Chart in Section 1 of this manual for the disc brake servicing tools.

1. Install the caliper support fixture (Item 1 from special tools list).
2. Install caliper and carrier assembly onto rear axle and install six new M18 external hex head mounting bolts and tighten the six bolts in an alternating pattern to an initial torque of 184 ft-lb. (250 Nm).

CAUTION

Improper torque can result in stretched bolts. ALWAYS follow the recommended torque procedure.

3. Mark a line on the head of the bolt indicating the vertical position.
4. Final torque the bolt to 288 ft-lb. (390 Nm).
5. Remove the torque wrench and note the angular movement of the bolt head from vertical. The angle that the bolt head (or torque wrench) travelled must be at least 10° but not exceed 130°.

NOTE:

If the bolt does not travel the required angle from initial torque to final torque, then replace with a new bolt and repeat procedure.

6. Remove the supporting fixture (Item 1 from special tools list).
7. Install brake pads. Refer to 5.2.5. “Brake Pads” on page 107 in this section for installation procedure.
8. Install brake chamber. Refer to 5.3. “Rear Brake Chambers” on page 121 in this section for installation procedure.
9. Install tire and wheel assembly
10. Lower the vehicle and road test the vehicle to verify satisfactory operation of the brakes.

5.2.7. Caliper Guide Pins

☞**NOTE:**

The following procedure provides removal/ installation instructions for the brake caliper guide pins and bushings.

5.2.7.1. Removal

1. Remove the brake chamber. Refer to 5.3. "Rear Brake Chambers" on page 121 in this section for removal procedure.
2. Remove the brake pads. Refer to 5.2.5. "Brake Pads" on page 107 in this section for removal procedure.
3. Remove the protective cover from the upper guide pin by using a small chisel to punch through the center of the cover. Lever out the cover.
4. Pry out the protective cap on the lower guide pin using pliers or similar tool.
5. Install support fixture (Item 1 from special tools list) onto brake caliper.
6. Remove the two M16 socket head bolts that retain the caliper assembly to the brake carrier and lift the caliper assembly off the brake carrier. Discard the two mounting bolts.
7. Fasten the caliper assembly onto mounting fixture with adapter plate (Items 80 & 79 from special tools list). Use two M12 x 110 mm long mounting bolts with M12 nuts to secure caliper to mounting fixture.

☞**NOTE:**

For reference purposes, the guide pin in the upper position (as installed on the axle) is configured with a brass bushing and a rubber boot on the inner end. The guide pin in the lower position (as installed on the axle) is configured with a rubber bushing and does not use a rubber boot on the inner end of the guide pin.

8. Remove the retaining ring from the rubber boot on the upper guide pin. See "Fig. 2-124: Brake Caliper Guide Pin Removal" on page 111.
9. Pull both guide pins out of the caliper housing.
10. Use a screwdriver or similar tool to push out the inner rubber boot from the guide pin bore.
11. Remove the brass bushing from the upper guide pin bore as follows:
    a. Assemble and install the installer punch, press-in sleeves, spindle, and collar nut (Items 72, 77, 75, 71, & 70 from special tools list). See "Fig. 2-125: Brass Bushing Removal" on page 112.
    b. Pull the brass bushing out of the caliper.
12. Remove the bushing from lower guide pin bore as follows:
    a. Assemble and install the installer punch, press-in sleeves, spindle, and collar nut (Items 72, 77, 75, 71, & 70 from special tools list). See "Fig. 2-126: Rubber Bushing Removal" on page 112.
    b. Pull the bushing out of the caliper.

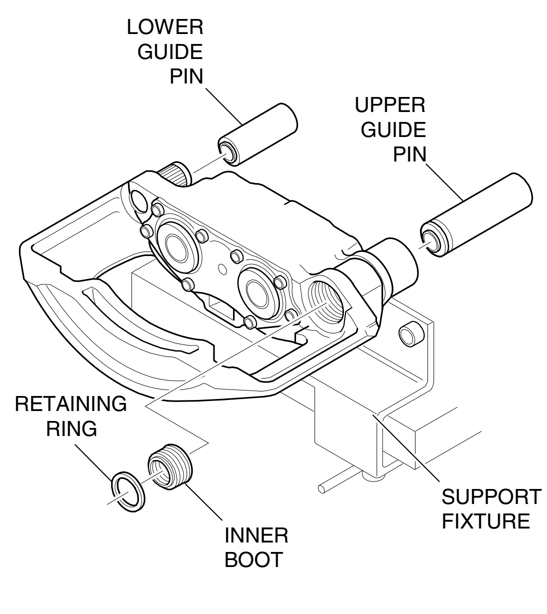


Fig. 2-124: Brake Caliper Guide Pin Removal

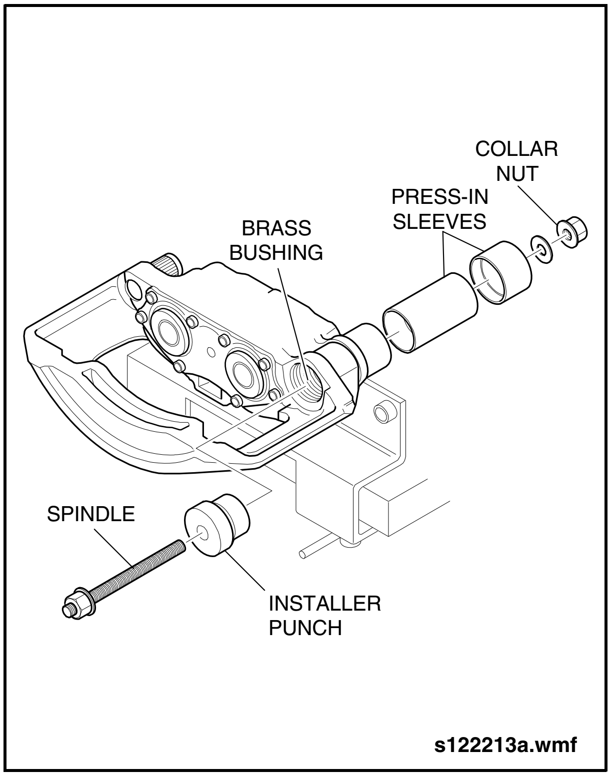


Fig. 2-125: Brass Bushing Removal

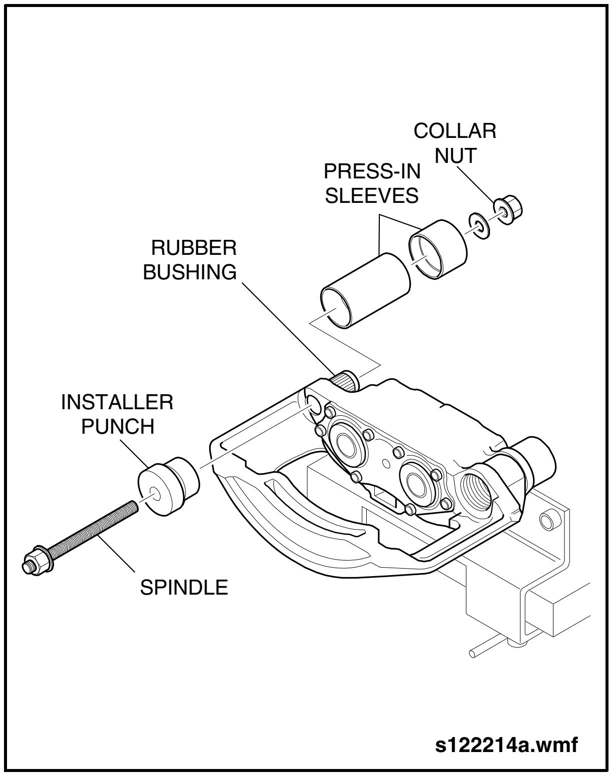


Fig. 2-126: Rubber Bushing Removal

5.2.7.2. Inspection

1. Inspect the guide pin bores for corrosion and clean as necessary.
2. Inspect the outside diameter of the guide pins for wear, scoring, or other damage. Replace guide pins as required.
3. Inspect the inner rubber boot for cracks, tears, or deterioration. Replace as required.
4. Thoroughly clean and inspect the brake carrier. Carefully inspect the guide area where the brake pads seat for any damage or excessive wear. Replace carrier as required.

5.2.7.3. Installation

1. Install the bushing in the lower guide pin bore as follows:

   a. Insert bushing into press-in sleeve (Item 78 from special tools list).

   b. Position installation tool with rubber bushing on the brake caliper and mount with spindle and collar nut tools (Items 70, 71, 72, 75, & 77 from special tools list). See “Fig. 2-127: Rubber Bushing Installation” on page 114.

   c. Press the bushing into the caliper bore until the stop on the press-in sleeve is contacted.

2. Install the brass guide bushing in the upper guide pin bore as follows:

   a. Assemble and install the centering sleeve, brass bushing, installer punch, spindle, and collar nut (Items 76, 72, 70, & 71 from special tools list). Ensure that the open side of the centering sleeve is facing away from the caliper. See “Fig. 2-128: Brass Bushing Installation” on page 114.

   b. Press the brass bushing into the caliper bore until the stop on the press-in sleeve is contacted.

   c. Insert the indenting tool (Item 74 from special tools list) into brass bushing from the outside until the stop is contacted. See “Fig. 2-129: Indenting Tool Installation” on page 114.

   d. Screw the indenting bolt into the indenting tool until the stop is reached.

   e. Unscrew the indenting bolt and remove the indenting tool.

3. Install the inner rubber boot as follows:

   a. Insert the folds of the rubber boot into the press-in sleeve (Item 75 from special tools list). See “Fig. 2-130: Inner Boot Installation” on page 114.

   b. Position the press-in sleeve and installer sleeve (Items 73 & 75 from special tools list) on the brake caliper with spindle and collar nut (Items 71 & 70 from special tools list).

   c. Press the bellows into the seat using no more than 70 in-lb. (8 Nm) torque on the collar nut.

4. Use grease supplied with the repair kit and lubricate the rubber bushing, brass bushing, and both guide pins. Install the guide pins into the caliper.

5. Insert the lip of the inner boot into the groove on the guide pin and secure with retaining ring.

6. Remove the caliper from the mounting fixture and install supporting fixture (Item 1 from special tools list) onto caliper.

7. Lift the brake caliper into position on the brake carrier.

8. Install two new M16 socket head caliper mounting bolts, ensuring that the inner boot and retaining ring are properly seated. Torque bolts to 133 ft-lb. (180 Nm) then tighten an additional 90°.

9. Install a new protective cover into the caliper at the upper guide pin location. Use a soft-faced hammer to drive the cover flush with the surrounding surface.

10. Use centering sleeve (Item 76 from special tools list) to install protective cap into caliper at the lower guide pin location. Drive cap into place until centering sleeve stop is contacted. See “Fig. 2-131: Protective Cover & Cap Installation” on page 115.

11. Install the brake pads. Refer to 5.2.5. “Brake Pads” on page 107 in this section for removal procedure.

12. Install the brake chamber. Refer to 5.3. “Rear Brake Chambers” on page 121 in this section for removal procedure.

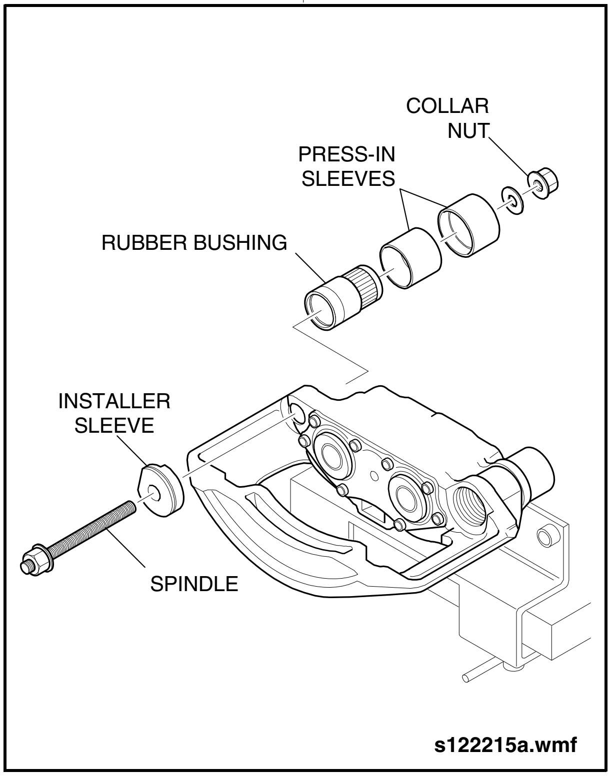


Fig. 2-127: Rubber Bushing Installation

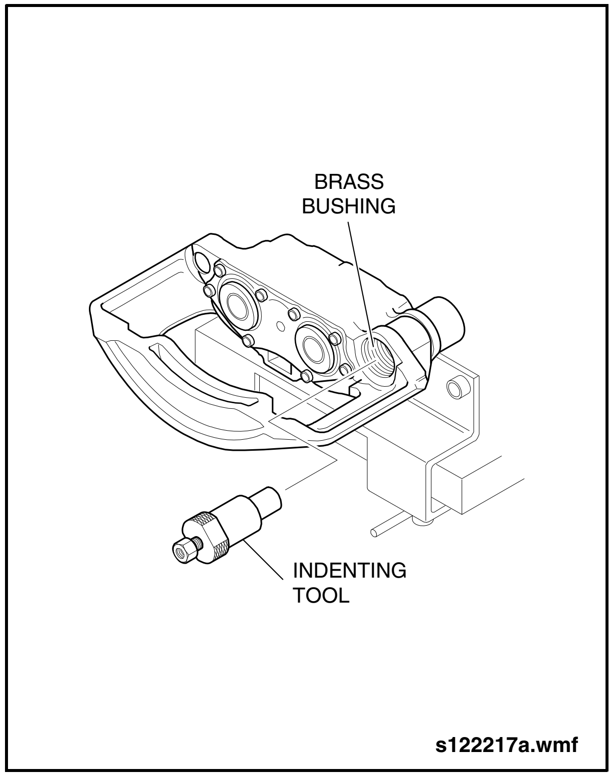


Fig. 2-129: Indenting Tool Installation

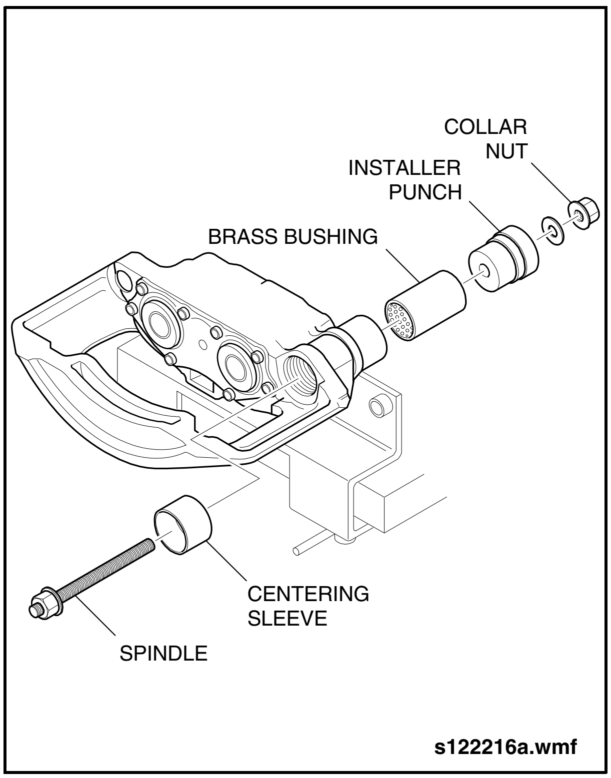


Fig. 2-128: Brass Bushing Installation

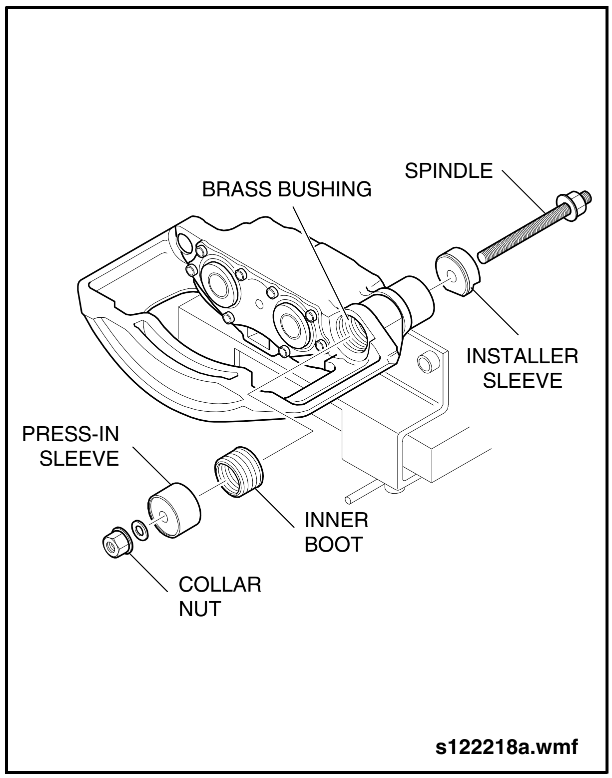


Fig. 2-130: Inner Boot Installation

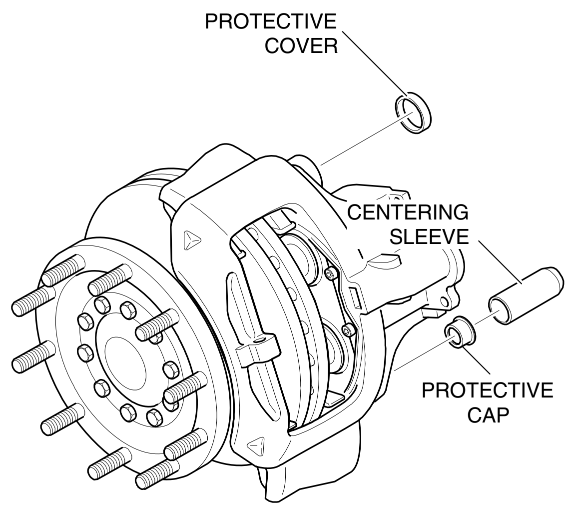


Fig. 2-131: Protective Cover & Cap Installation

5.2.8. Tappet & Rubber Boot

NOTE:

The following procedure provides removal/installation instructions for the brake caliper tappets, rubber boots, and inner seals with the caliper installed on the vehicle.

5.2.8.1. Removal

1. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 107 in this section for removal procedure.

CAUTION

DO NOT adjust the tappets beyond 1.18" (30 mm) as measured from the surface of the caliper to the tappet thrust face. Synchronization between the two threaded tubes can be lost if If the tappets are extended beyond this distance.

2. Rotate the adjuster clockwise until the tappets extend approximately 1.18" (30) from the caliper surface. This will allow full extension of the tappet rubber boot for insertion of the removal tools. See “Fig. 2-132: Unscrewing Tappets” on page 116.
3. Use a sharp knife to cut the rubber boot on the tappet. Insert the press-off fork tool (Item 81 from special tools list) between the tappet and the end of the threaded tube with the flat side of the forks against the threaded tube. See “Fig. 2-133: Removing Tappets” on page 116.
4. Use a hammer and tap on the fork tool to dislodge the tappet from the threaded sleeve.
5. Use a screwdriver to pry the tappet boot out of the seal seat.
6. Turn the adjuster counter-clockwise until the threaded sleeves are fully retracted within the caliper bore.

CAUTION

DO NOT damage the seal seat when removing the inner seal, otherwise the caliper will need to be replaced.

7. Carefully pry the inner seal out of the seal seat. See “Fig. 2-134: Removing Inner Seal” on page 116.
8. Remove the bushing from the end of the threaded sleeve.

5.2.8.2. Inspection

1. Rotate the adjuster clockwise until the end of the threaded sleeve extends 1.18" (30 mm) from the caliper surface. See “Fig. 2-135: Inspecting Threaded Tubes” on page 116.
2. Inspect the threads on the threaded tubes for damage. The caliper will need to be replaced if thread damage is evident.
3. Inspect the bore of the caliper for scoring, corrosion, or other damage in the area of the inner seal seat. Replace caliper if seal seat area damaged.

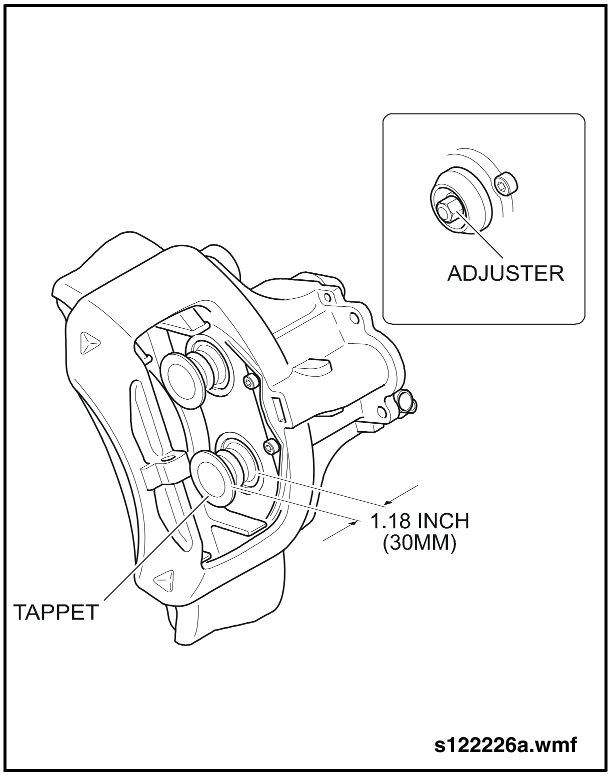


Fig. 2-132: Unscrewing Tappets

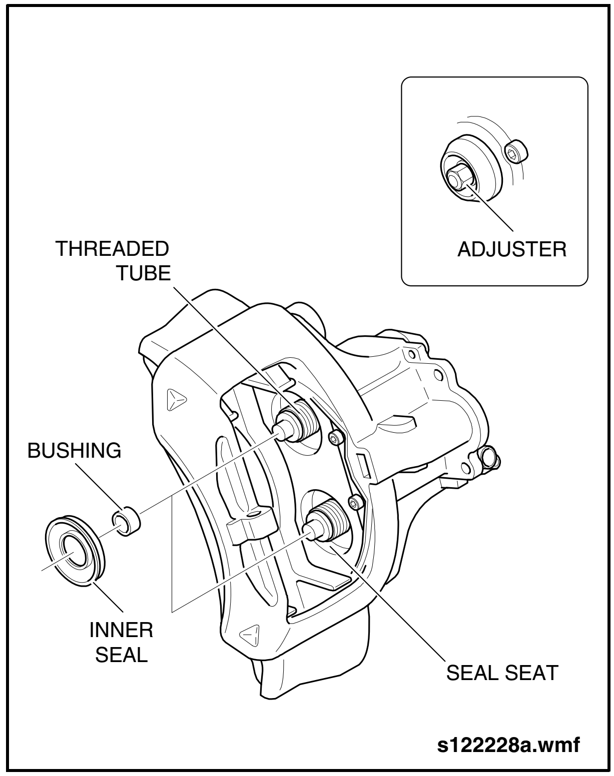


Fig. 2-134: Removing Inner Seal

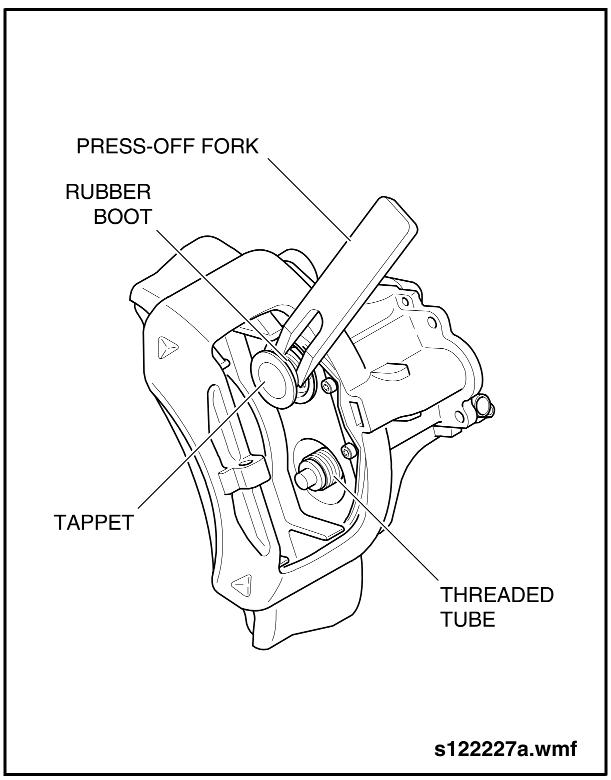


Fig. 2-133: Removing Tappets

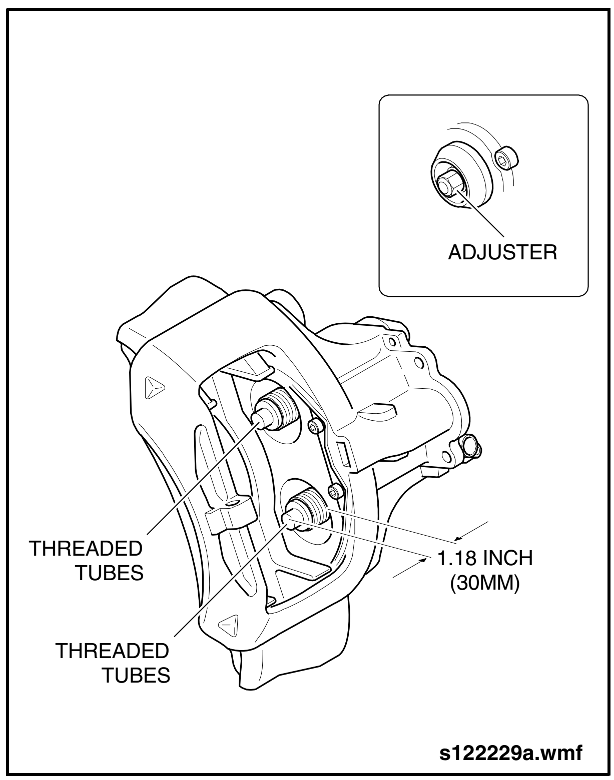


Fig. 2-135: Inspecting Threaded Tubes

5.2.8.3. Installation

☞NOTE:

This procedure can be performed with the caliper mounted to the axle or on a work bench. The special tools used contain two different length bolts depending on the method used. For installation on a work bench, use the longer bolt. For on-vehicle installation, use the shorter bolt.

1. Rotate the adjuster counter-clockwise until the threaded tubes are fully retracted within the caliper bore.
2. Thread the long forcing bolt into the installer sleeve (Item 82 from special tools list). See "Fig. 2-136: Installing Inner Seal" on page 117.
3. Place the new inner seal onto the press-in bushing (Item 83 from special tools list).
4. Place the assembled press-in bushing and inner seal into the installer sleeve. Use the forcing bolt to press the inner seal against the stop in the brake caliper.
5. Rotate the adjuster clockwise until the end of the threaded sleeve extends 0.59" (15 mm) from the caliper surface.

☞NOTE:

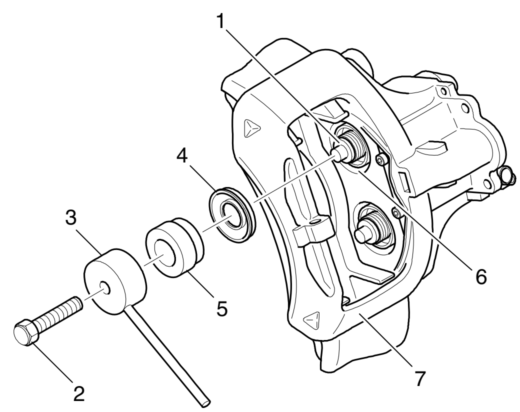
The inner seal must not turn.

6. Apply grease, supplied in the repair kit, onto the end of the threaded sleeves and install new bushings.
7. Turn the adjuster counter-clockwise until the threaded sleeves are fully retracted within the caliper bore.
8. Place the tappet and rubber boot onto the bushing.

☞NOTE:

Ensure the seal seat is clean and free from grease before installing the rubber boot into the seal seat.

9. Hold the installer sleeve (Item 82 from special tools list) against the rubber boot and use the long forcing bolt to press the rubber boot against the stop in the seat. See "Fig. 2-137: Installing Tappet & Rubber Boot" on page 118.
10. Reverse the position of the installer sleeve so that the open end is facing away from the tappet and boot assembly and the head of the forcing bolt is facing the tappet. See "Fig. 2-138: Seating Tappet Against Stop" on page 118.
11. Use the forcing bolt to press the tappet up against the stop on the threaded sleeve.
12. Install the brake pads. Refer to 5.2.5. "Brake Pads" on page 107 in this section for installation procedure.



1. Threaded Tube
2. Forcing Bolt
3. Installer Sleeve
4. Inner Seal
5. Press-In Plate
6. Seal Seat
7. Brake Caliper

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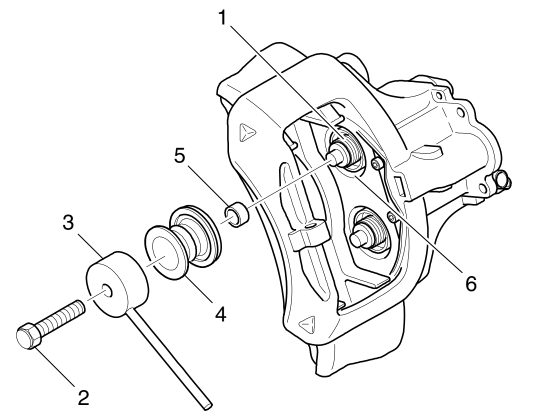
Fig. 2-136: Installing Inner Seal



1. Threaded Tube
2. Forcing Bolt
3. Installer Sleeve
4. Tappet & Rubber Boot
5. Bushing
6. Seal Seat

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Fig. 2-137: Installing Tappet & Rubber Boot

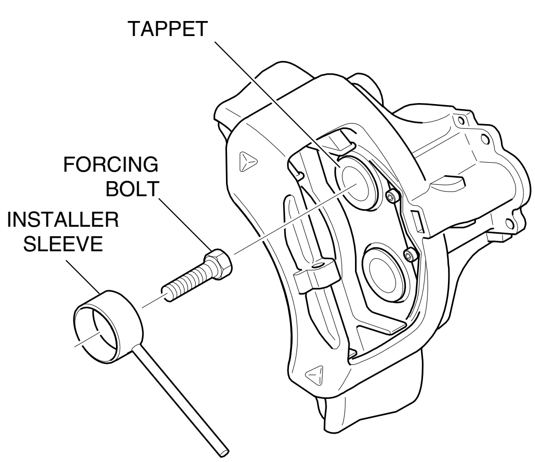

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Fig. 2-138: Seating Tappet Against Stop

5.2.9. Brake Disc

1. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 107 in this section for procedure.
2. Remove the brake caliper & carrier assembly. Refer to 5.2.6. “Brake Caliper & Carrier Assembly” on page 109 in this section for procedure.
3. Remove axle shaft. Refer to 3.8. “Axle Shaft” on page 12 in this section for procedure.
4. Remove slotted nuts from wheel hub. Refer to 3.9. “Rear Wheel Hub” on page 14 in this section for procedure.
5. Install threaded guide sleeve (Item 13 from special tools list) onto the axle stub and lubricate guide sleeve surface. See “Fig. 2-139: Removing Wheel Hub & Brake Disc” on page 119.
6. Pull wheel hub with brake disc off axle stub and over the guide sleeve. Use a smooth continuous motion during removal to avoid binding the wheel hub bearings on the guide sleeve. Place wheel hub and brake disc assembly on a clean work surface.
7. Unscrew guide sleeve (Item 13 from special tools list) from axle stub.
8. Remove the wheel hub mounting bolts. See “Fig. 2-140: Separating Wheel Hub from Brake Disc” on page 119.
9. Remove wheel hub and O-ring from the brake disc.

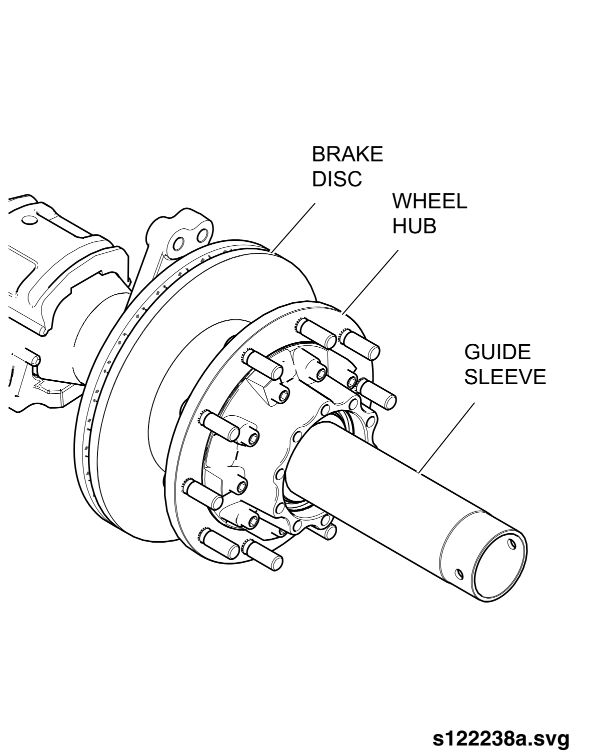


Fig. 2-139: Removing Wheel Hub & Brake Disc

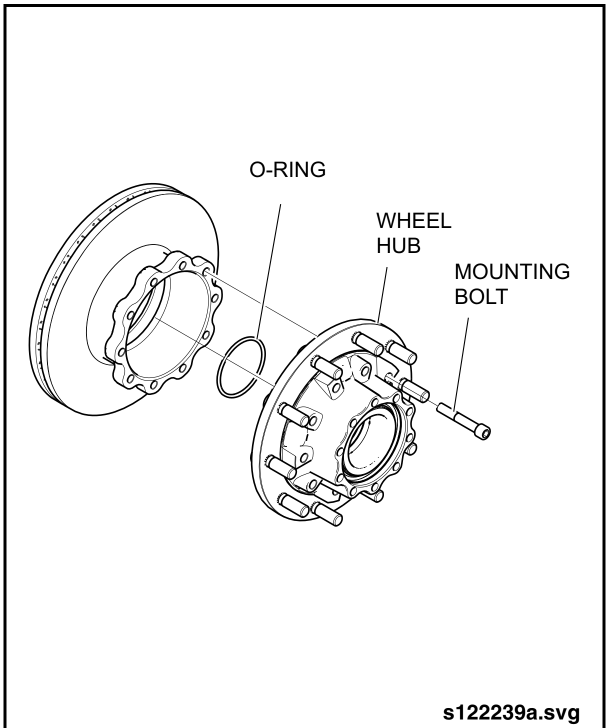


Fig. 2-140: Separating Wheel Hub from Brake Disc

5.2.9.1. Installation

1. Insert a new O-ring into the wheel hub.
2. Mount the wheel hub on the brake disc.
3. Install and hand-tighten all the mounting bolts.

☞**NOTE:**

Check condition of bolts. DO NOT reuse any mounting bolts with signs of damage or deformity.

☞**NOTE:**

Secure the brake disc/wheel hub assembly from rotating while final tightening the mounting bolts.

4. Torque the mounting bolts to 207 ft-lb. (280 Nm).
5. Install the threaded Guide Sleeve (Item 13 from special tools list) onto the axle stub.
6. Apply a light coat of Molykote-D paste in the wheel hub bearing seat area and on the axle stub and guide sleeve. Apply paste on the machined surface of the stub where the hub bearings are seated except 3/4" of inner bearing seat.
7. Install the wheel hub and brake disc over the guide sleeve and onto the axle stub.
8. Remove the guide sleeve (Item 13 from special tools list).
9. Install and tighten wheel hub slotted nuts. Refer to 3.9. “Rear Wheel Hub” on page 14 in this section for procedure.
10. Install axle shaft. Refer to 3.8. “Axle Shaft” on page 12 in this section for procedure.
11. Install the brake caliper and carrier assembly. Refer to 5.2.6. “Brake Caliper & Carrier Assembly” on page 109 in this section for procedure.
12. Install the brake pads. Refer to 5.2.5. “Brake Pads” on page 107 in this section for procedure.

5.2.9.2. Machining

CAUTION

DO NOT machine the brake disc to less than 1.535" (39 mm) thickness. Allowance must be made for additional wear while in service and under no circumstances should the minimum disc brake thickness be reduced below 1.457" (37 mm) while in service.

NOTE:

The brake disc must be machined while installed on the vehicle.

- ❐ *ALWAYS machine equal amounts of material from both sides of the disc.*
- ❐ *ALWAYS machine the minimum amount of material required in restoring disc to serviceable limits.*
- ❐ *ALWAYS machine in several passes, being careful not to take off too much material in one pass.*
- ❐ *ALWAYS machine both brake discs on an axle. Do not machine one disc only.*
- ❐ *ALWAYS replace brake pads in sets whenever brake discs have been machined to ensure proper seating-in of the brake pads and to maintain braking efficiency.*

1. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 107 in this section for removal procedure.
2. Use commercially available brake machining equipment designed to be mounted to brake assembly with the brake disc installed on the axle. Follow manufacturer's instructions for setting up equipment and machining brake disc.
3. Measure machined surface of brake disc. The minimum thickness of the brake disc must not be less than 1.535" (39 mm).

5.3. Rear Brake Chambers

5.3.1. Description

The rear brake chamber is a combination piggy-back configuration. The service brake portion is a diaphragm style actuator and the spring brake portion is a piston style actuator.

☞**NOTE:**

The brake chamber assembly is a non-serviceable unit and must be replaced as an assembly. DO NOT attempt to disassemble the brake chamber.

5.3.2. Rear Brake Chambers Specifications

Manufacturer........................... MGM Brakes

Model....................................... MJB2424ET

Type ....Piston/Diaphragm

Maximum Operating Pressure ....145 psi (10.0 Bar)

Service Brake Air Volume ....82 cu. in. (1344 cc)

Spring Brake Air Volume.............98.5 cu. in. (1614 cc)

Maximum Stroke..................... 3.0" (76 mm)

5.3.3. Operation

5.3.3.1. Service Brakes

Controlled air pressure enters the service brake chamber through the inlet port to act on the diaphragm and move the push plate and rod assembly forward. The brake chamber is bolted to the disc brake caliper and is used to actuate the disc brake mechanism. This forward motion of the push rod acts on an eccentric lever within the caliper assembly and applies the vehicle brakes. The greater the air pressure admitted to the brake chamber, the greater the force applied by push rod. Push rod force is determined by multiplying the delivered air pressure by the effective diaphragm area. When air pressure is released from the brake chamber, the push rod return spring returns the diaphragm, push plate and rod assembly to their released positions, thereby releasing the brakes.

5.3.3.2. Spring Brake (Parking/Emergency Brake)

The parking brake automatically actuates the foundation brakes when there is no air pressure in the spring brake chamber. During normal operation the spring brake chamber is pressurized with air which pushes upon the piston, compressing the power spring, thereby holding the parking brake in the disengaged (released) position.

Since the service brake and spring brake chambers are isolated from each another by a seal, the parking brake cannot interfere with the normal operation of the service brake. Application of the parking brake releases air pressure in the spring brake chamber, enabling the power spring to force the push rod toward the service brake chamber. This motion of the push rod exerts force against the service brake push rod, causing application of the foundation brakes via the brake caliper.

The spring brake chamber is equipped with an integral release bolt that allows manual release of the power spring in service situations where an air supply is not available. The power spring is considered to be caged when the manual release bolt has fully compressed the power spring.

5.3.3.3. E-Stroke

The brake chamber is fitted with an E-Stroke External Sensor Pack (ESP) which monitors movement of the push rod and relays this information to the control module in the driver’s area. Refer to Section 9 of this manual for information on the Electronic Stroke Alert System.

5.3.4. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance and inspection intervals and procedures.

5.3.5. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Chock the wheels.
3. Drain all air tanks.
4. Mark the location of each air line and disconnect air lines from brake chamber.
5. Disconnect the electrical harness from the ESP sensor pack.

⚠CAUTION

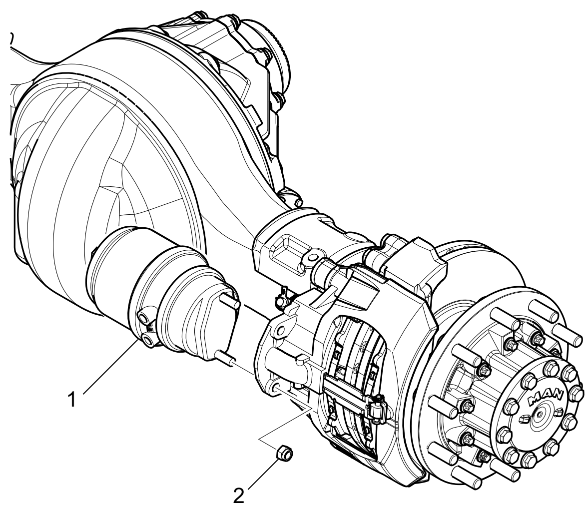
DO NOT use impact tools to cage or uncage the brake chamber.

6. Manually cage the spring brake by rotating the integral release bolt counter-clockwise approximately 22 to 23 turns until the spring is fully caged. The force to compress the spring must not exceed 74 ft-lb. (100 Nm) during the caging process. The brake chamber is considered fully caged when the head of the release bolt extends approximately 1.30" beyond the surface of the brake chamber.

☞NOTE:

For easier turning of the release bolt, apply 95 to 125 psi shop air pressure to the air inlet port marked "Spring". After caging, completely exhaust air from the spring chamber.

7. Remove the two lock nuts securing the brake chamber to the brake caliper assembly and remove the brake chamber from the vehicle. See "Fig. 2-141: Removing Brake Chamber" on page 122.
8. Place a protective cover over the brake caliper to prevent entry of contaminants.



1. Brake Chamber
2. Mounting Nut

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Fig. 2-141: Removing Brake Chamber

5.3.6. Installation

CAUTION

ALWAYS maintain the brake chamber and ESP Sensor Pack spacer as an assembly. DO NOT install a brake chamber without the ESP Sensor Pack installed.

CAUTION

Disc brake chambers must be inspected for seal condition and height measurement before a used brake chamber can be reinstalled.

1. If installing a new brake chamber, ensure that the protective cover is removed from the push rod. If installing a used brake chamber, perform the following inspection:
   a. Note the position of the ESP sensor pack and carefully remove it from the brake chamber. Retain the two O-rings. See “Fig. 2-142: Rear Brake Chamber ESP Sensor Pack” on page 124.
   b. Measure the height of the seals on both the ESP sensor pack and brake chamber. The seal must be in good condition and protrude at least 0.118” (3.0 mm) from the ESP sensor pack and brake chamber mounting surfaces.
   c. If either one of the seals measures less than 0.118” (3.0 mm) then the brake chamber or ESP sensor pack must be replaced. The ESP sensor pack may be replaced separately from the brake chamber.
   d. Ensure the ESP sensor pack is correctly positioned on the brake chamber and retained with O-rings.

CAUTION

Cover the brake chamber opening on the brake caliper when cleaning the mounting surfaces so as to prevent entry of any contaminants.

2. Clean the brake chamber, ESP sensor pack and caliper mounting surfaces. Ensure seal recesses on the caliper and ESP sensor pack are clean and free from corrosion. Ensure that any protective covers are removed from the brake caliper.
3. Apply Renolit Unitemp 2 grease to the spherical cup located in the brake caliper and to the end of the brake chamber push rod. Do not apply an excessive amount of grease.

CAUTION

DO NOT attempt to loosen clamp band bolt in order to rotate and reposition the air inlet ports. DO NOT use clamping tools such as vise grips to hold the push rod. The spring brake actuator contains an internal boot to seal the caliper from contaminants and may be damaged if brake chamber is rotated or if clamping tools are used on the push rod.

4. Carefully install brake chamber on brake caliper assembly being careful not to scratch or otherwise damage the painted surface or target material of the push rod. Ensure the push rod is not covered with excess grease and is kept clean of dirt.
5. Install new M16 lock nuts and torque to specification. Refer to 4.5. “Rear Suspension Torque Specifications” on page 93 in this section for torque specification.
6. Ensure brake chamber rubber vent tubes do not interfere with the brake caliper. Rotate tubes as necessary, ensuring tubes face either downward or rearward for drainage.
7. Connect air line, as marked during removal, from the brake chamber service port to the modulator valve. Torque each end of hose to 36 to 39 ft-lb. (49 to 53 Nm).
8. Connect air line, as marked during removal, from the brake chamber spring port to the R14 brake valve. Torque each end of hose to 18 to 20 ft-lb. (24 to 27 Nm).
9. Connect the electrical harness to the ESP sensor pack.

10. Ensure that the electrical harness is properly routed and clamped as follows:
    a. Sufficient slack should be provided between the ESP sensor pack and first clamping location on the air line fitting.
    b. Additional cable ties should be provided every 6 to 12" along the length of the air line.
    c. Provide slack at the electrical connector location for ease of future servicing.
    d. Run a cable tie through the electrical connector clip and secure connector body to the air line.
11. Start vehicle and charge air system to normal operating pressure.

CAUTION

Ensure the vehicle wheels are chocked during the following procedure.

12. Release the parking brake.
13. Use soapy water or leak detection solution to inspect for air leaks at the spring brake air inlet fittings.
14. With parking brake still released and spring brake fully pressurized, fully apply the brake treadle (minimum 100 psi at service brake chamber).
15. Check for air leaks at the service brake air inlet fittings.
16. Release the brake treadle and exhaust air from the service brake chamber and with air pressure still applied to the spring brake chamber, tighten the release bolt clockwise until it is seated against the head insert. Torque release bolt to 50 to 60 ft-lb. (66 to 81 Nm).
17. Apply parking brake and confirm that the spring brakes apply.

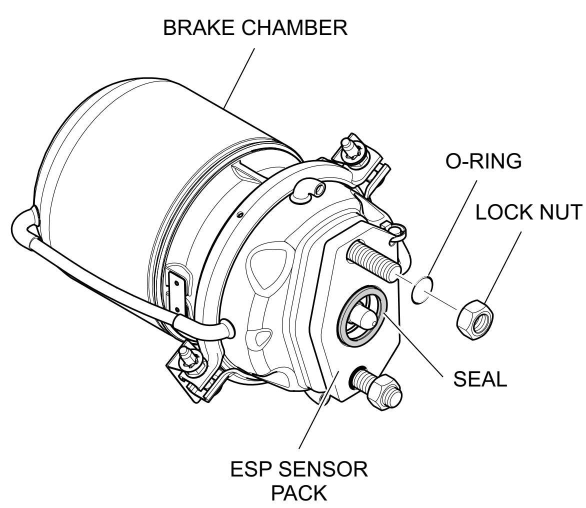


Fig. 2-142: Rear Brake Chamber ESP Sensor Pack

6. REAR AXLE ANTI-LOCK BRAKING SYSTEM (ABS) & COMPONENTS

DANGER

To prevent serious personal injury, put blocks under the front tires to stop the vehicle from moving. Apply the parking brakes.

DO NOT work under a vehicle supported only by jacks. Jacks can slip or fall over and cause serious personal injury.

To prevent serious eye injury, always wear safe eye protection when performing maintenance or service.

6.1. Description

The major components of the ABS System include:

- ABS Speed Sensor
- ABS Pulse Generating Wheel
- ABS Modulator Valves
- ABS Electronic Control Unit (ECU)
- Automatic Traction Control (ATC) Valve

6.2. Operation

ABS is an electronic braking 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. By reducing wheel lock, the system improves vehicle stability and control. In the event of a malfunction in the system, the braking in the affected wheel will return to normal braking.

The system consists of a tooth wheel-mounted on the hub of each monitored wheel. A sensor is installed with its sensing end against each tooth wheel. The sensor continually provides wheel speed information to the Electronic Control Unit (ECU), located above the lighting panel on the streetside of the vehicle, which in turn supplies signals to the ABS modulator valves. The modulator valves control air pressure to each wheel during ABS operation. The valves modulate air pressure to the brake chamber during ABS operation to control braking and prevent wheel lock up.

6.3. Rear ABS Speed Sensor & Sensor Holder

6.3.1. Description

The rear axle ABS sensor is installed in the ABS sensor holder which is press fit onto the axle shaft journal. The ABS sensor and sensor holder are positioned in close proximity to the ABS pulse generating wheel on the wheel hub.

6.3.2. Removal

1. Remove the wheel hub. Refer to 3.9. "Rear Wheel Hub" on page 14 in this section for removal procedure.
2. Remove the brake disc. Refer to 5.2.9. "Brake Disc" on page 118 in this section for removal procedure.
3. Mark the position of the ABS sensor harness hose clamp. See "Fig. 2-143: Removing ABS Sensor Harness Clamp" on page 126.
4. Open the hose clamp and remove it along with the sensor harness clamp.
5. Remove the bolt that retains the ABS sensor to the sensor holder.
6. Remove the ABS sensor.
7. Mark the installation position of the ABS sensor holder with respect to the axle housing.
8. Assemble the Impact Tool (Item 2 from special tools list) with the Seal Race Removal Hook (Item 23 from special tools list).
9. Position the seal race removal hook on the ABS sensor holder. See "Fig. 2-144: Removing ABS Sensor Holder" on page 126.
10. Work alternately at two positions on opposite sides to evenly pull the ABS sensor holder off the axle housing.

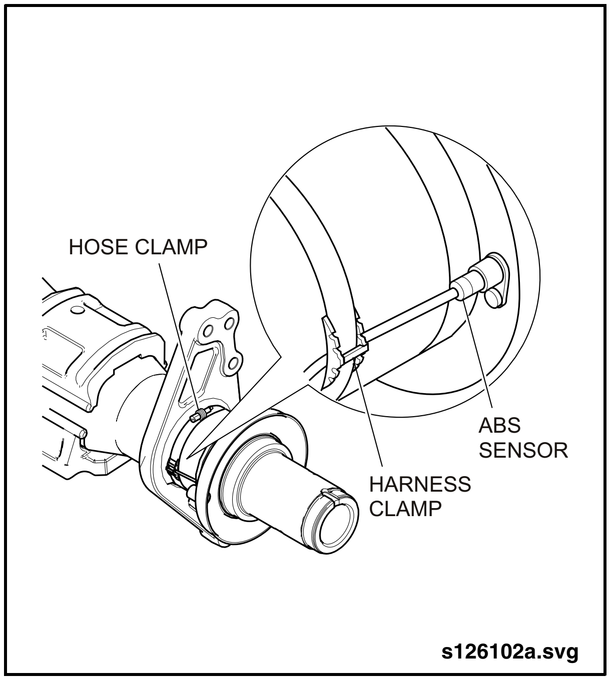


Fig. 2-143: Removing ABS Sensor Harness Clamp

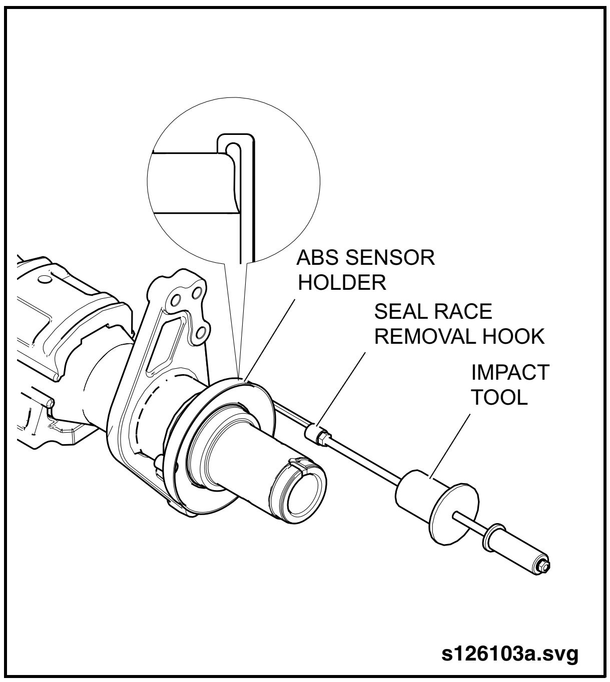


Fig. 2-144: Removing ABS Sensor Holder

6.3.3. Installation

☞NOTE:

The following procedure describes the process necessary to install the ABS sensor holder to a specific distance on the axle housing journal to ensure the proper gap between the ABS sensor and pulse generating wheel.

6.3.3.1. Default Gap Setting

1. Unscrew the three pressure jacking screws in the Assembly Sleeve (Item 25 from special tools list).
2. Place the open dished side of the ABS sensor holder against the assembly sleeve tool. See “Fig. 2-145: Installing ABS Sensor” on page 127.
3. Screw in the three pressure screws until they make light contact with the ABS sensor holder.

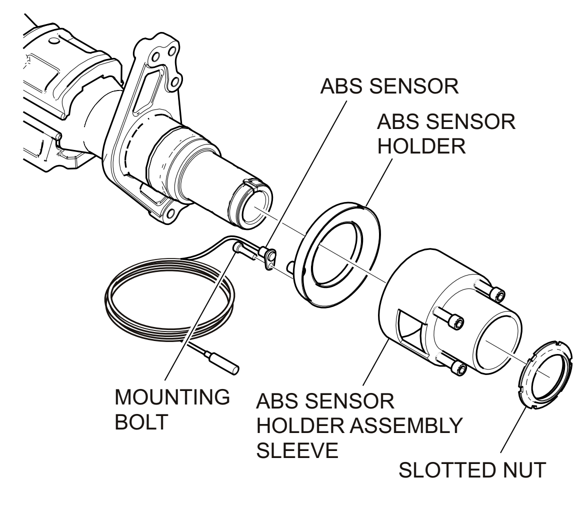


Fig. 2-145: Installing ABS Sensor

6.3.3.2. Positioning ABS Sensor Holder

1. Install the ABS sensor holder onto the axle housing journal using the alignment marks made during the removal procedure.
2. Position the Assembly Sleeve (Item 25 from special tools list) so that the window on the side of the tool aligns with the through-hole on the ABS sensor holder.
3. Install the slotted nut and hand-tighten.
4. Insert the ABS sensor into the sensor holder and secure with mounting bolt.

6.3.3.3. Centering Device Assembly & Installation

1. Assemble the centering device tool using Items 3, 4, 5, 6 & 7 from special tools list. See “Fig. 2-146: Assembling Centering Device” on page 128.
2. Align the measuring surface of the assembly sleeve tool with the ABS sensor.
3. Insert the centering device into the axle housing until the stop is reached.
4. Clamp the centering device by tightening the threaded spindle.

6.3.3.4. ABS Sensor Holder Installation

1. Place the Slotted Nut Socket (Item 8 from special tools list) over the centering device and onto the slotted nut.
2. Install the Torque Multiplier (Item 9 from special tools list) on the slotted nut socket and secure it in place with Spindle Screw and Washer (Items 7 & 6 from special tools list).
3. Position Counter-Holder (Item 12 from special tools list) so that the head of the tool slips over the studs on the torque multiplier body and the base of the counter-holder is braced against the floor to counteract the rotational movement of the torque multiplier. See “Fig. 2-147: Installing ABS Sensor Holder” on page 128.
4. Tighten the slotted nut until the assembly sleeve tool contacts the axle journal.
5. Remove the special tools.

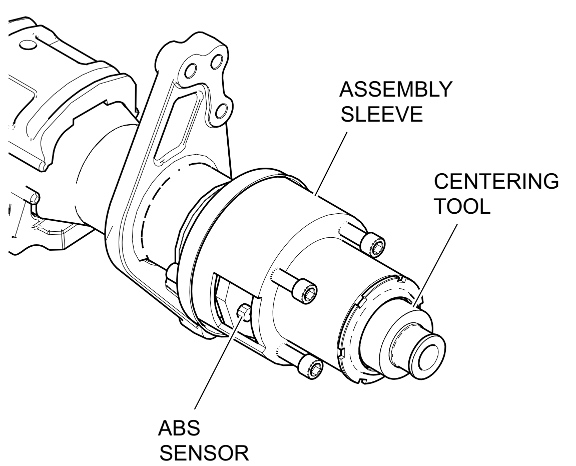
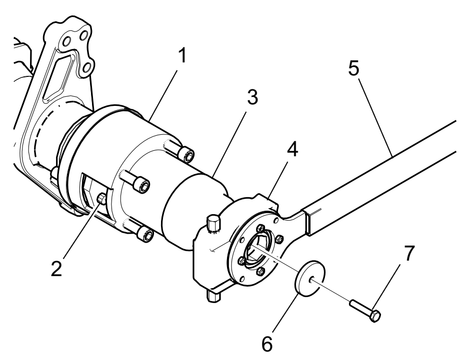


Fig. 2-146: Assembling Centering Device



1. Assembly Sleeve
2. ABS Sensor
3. Slotted Nut Socket
4. Torque Multiplier
5. Counter Holder
6. Washer
7. Hex Bolt

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Fig. 2-147: Installing ABS Sensor Holder

6.3.3.5. Checking & Setting ABS Sensor Gap

☞**NOTE:**

The pressure screws in the assembly sleeve are only allowed to be screwed in slightly in order to set back the ABS sensor holder. Rotating the pressure screws by 90° increases the gap by 0.010 in.(0.25mm).

☞**NOTE:**

The ABS sensor to assembly sleeve tool gap must be 0.014 in. (0.35mm).

1. Use the Feeler Gauge (Item 22 from special tools list) to check the gap between the ABS sensor and the measuring surface of the assembly sleeve tool. See "Fig. 2-148: Setting Gap Width" on page 129.
2. Adjust the gap by rotating the pressure screws evenly until the specified gap is reached.
3. Remove the assembly sleeve tool.

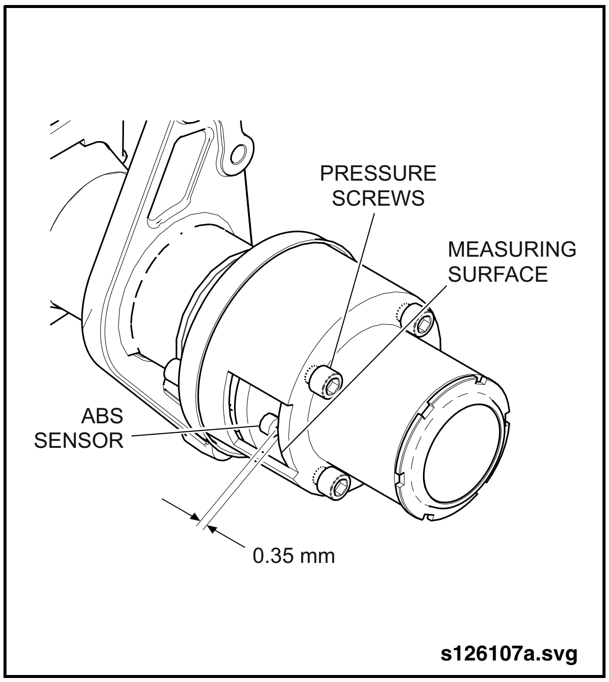


Fig. 2-148: Setting Gap Width

6.3.3.6. Routing ABS Sensor Electrical Harness

CAUTION

Route the ABS sensor electrical harness carefully. Avoid routes where the harness is subject to tension, kinks and wearing against nearby components.

1. Position the hose clamp according to the alignment marks made during the disassembly procedure.
2. Insert ABS sensor harness into the clamp.
3. Position the clamp so that it is parallel and in a straight line with ABS sensor.
4. Tighten the mounting bolt for the hose clamp.
5. Check the ABS system for proper operation.

6.4. Rear ABS Pulse Generating Wheel & Radial Seal

6.4.1. Description

The ABS pulse generating wheel and radial seal assembly is mounted on the inboard side of the wheel hub. The slotted disc portion of the assembly provides the reference signal for the wheel speed which is sensed by the ABS sensor. The ABS sensor is mounted in a holder that is fixed on the axle housing journal. The pulse generating wheel and radial seal assembly is serviced as a unit.

6.4.2. Removal & Installation

Inspect the pulse generating wheel and radial seal assembly for evidence of wear or damage and replace as necessary. Refer to 3.9. “Rear Wheel Hub” on page 14 in this section for replacement procedure.

☞**NOTE:**

Only the bearing retaining ring, and inner bearing need to be removed from the wheel hub assembly in order to replace the pulse generating wheel and radial seal assembly.

6.5. Rear ABS Modulator Valve

6.5.1. Description

ABS modulator valves are used to control brake application on the rear axle. The valves are bracket-mounted to the vehicle structure and located between the brake relay valve and brake chambers. The modulator valve is electrically controlled with a solenoid valve and includes an inlet, outlet and exhaust port.

6.5.2. Operation

During normal brake application the modulator valves are inactive and do not affect the brake application. If the ABS ECU detects an ABS event (impending wheel lock-up) it will energize the solenoids in the modulator valves to control the brake application pressure to the service brake chambers.

To decrease brake application pressure, the ECU will energize the inlet and outlet solenoids of the modulator valve that will close the supply port and open the delivery and exhaust ports. To hold brake application pressure at a given value, the ECU will energize the inlet solenoid and de-energize the outlet solenoid of the modulator valve that will close the supply and exhaust ports.

This modulation of brake application pressure will continue until the impending wheel lock-up condition is alleviated.

6.5.3. Removal

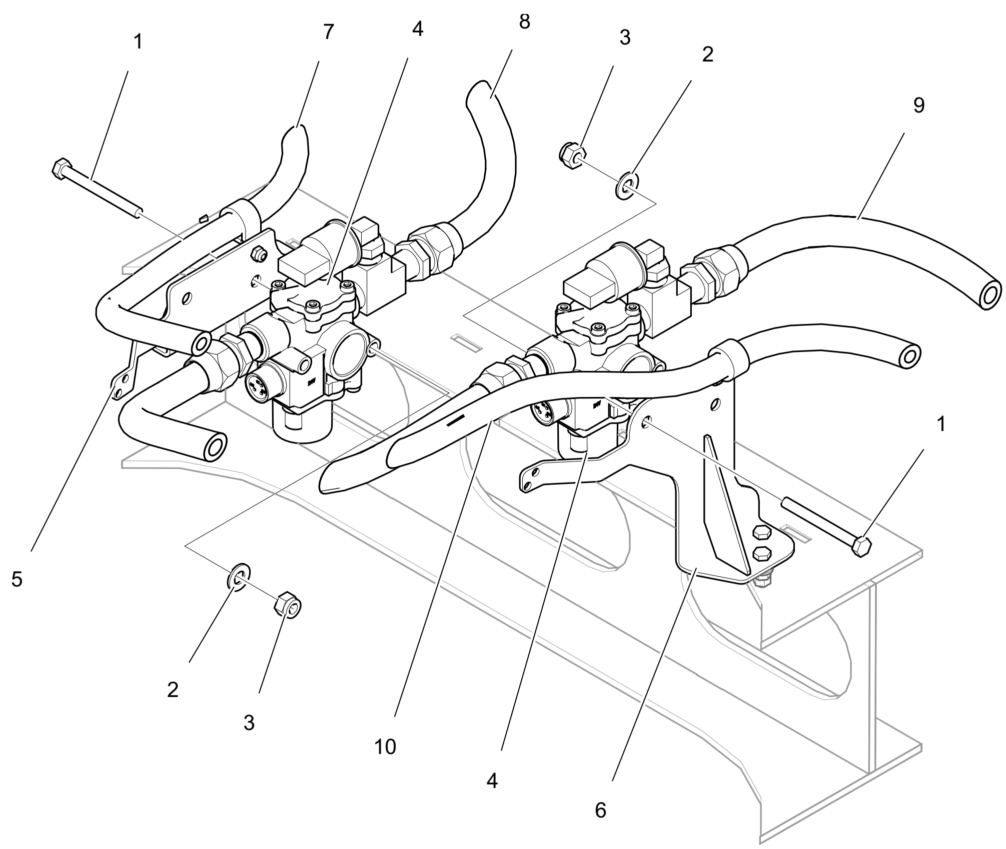
1. Set the Battery Disconnect switch to the OFF position.
2. Disconnect the wiring from the ABS valve.
3. Disconnect the air lines from ports 1 and 2 of the ABS valve. See "Fig. 2-149: Rear Modulator Valve Removal & Installation" on page 131.
4. Remove the two mounting bolts and nuts.
5. Remove the ABS valve.

☞NOTE:

ABS valves are not serviceable.

6.5.4. Installation

1. Install the ABS valve with two mounting bolts and nuts.
2. Connect the line to the brake chamber to port 2 of the ABS valve. Connect the air supply line to port 1 of the ABS valve.
3. Connect the harness connector to the ABS valve.
4. Set the Battery Disconnect switch to the ON position.



1. Bolt, Hex 1/4" - 20 UNC x 4 1/4" Lg.
2. Washer, Flat 1/4"
3. Nut, Lock Nylon 1/4" - 20 UNC
4. Bracket, Modulator Valve Curbside
5. Valve Assembly, Modulator 24V
6. Bracket, Modulator Valve Streetside
7. Hose Assembly 3806 FL 60-81
8. Hose Assembly 3808 FL 23-85
9. Hose Assembly 3808 FL 25-48
10. Hose Assembly 3806 FL 66-19

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Fig. 2-149: Rear Modulator Valve Removal & Installation

6.6. Automatic Traction Control (ATC) Valve

6.6.1. Description

The ATC valve provides brake supply pressure independent of brake treadle application and is used to control a spinning wheel on the rear drive axle. The ATC valve is mounted on the rear brake panel along with the brake relay valve and quick release valves. See “Fig. 2-150: Automatic Traction Control Valve” on page 132.

6.6.2. Operation

The ATC Valve works in conjunction with the ABS system on the drive axle and directs brake pressure to the spinning wheel, via the rear ABS modulator valves.

If one of the drive wheels starts to spin, the ECU will energize the ATC valve to open its supply and delivery ports and route pressure to the rear brake relay valve control port. This signal pressure controls delivery pressure to the service brake chambers via the ABS modulator valves. The ECU will simultaneously energize the ABS modulator valve on the non-spinning wheel to close its supply port and block any applied brake pressure. This action results in only the spinning wheel receiving brake pressure.

6.6.3. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Disconnect air lines from port 1 (supply), port 2 (discharge) and port 3 (treadle) at the ATC valve.
3. Remove two mounting bolts and nuts from valve and remove valve.

6.6.4. Installation

1. Install valve using two bolts and nuts.
2. Connect air supply, discharge and treadle lines to ports of valve.
3. Connect electrical harness connector to valve. Hand tighten only.

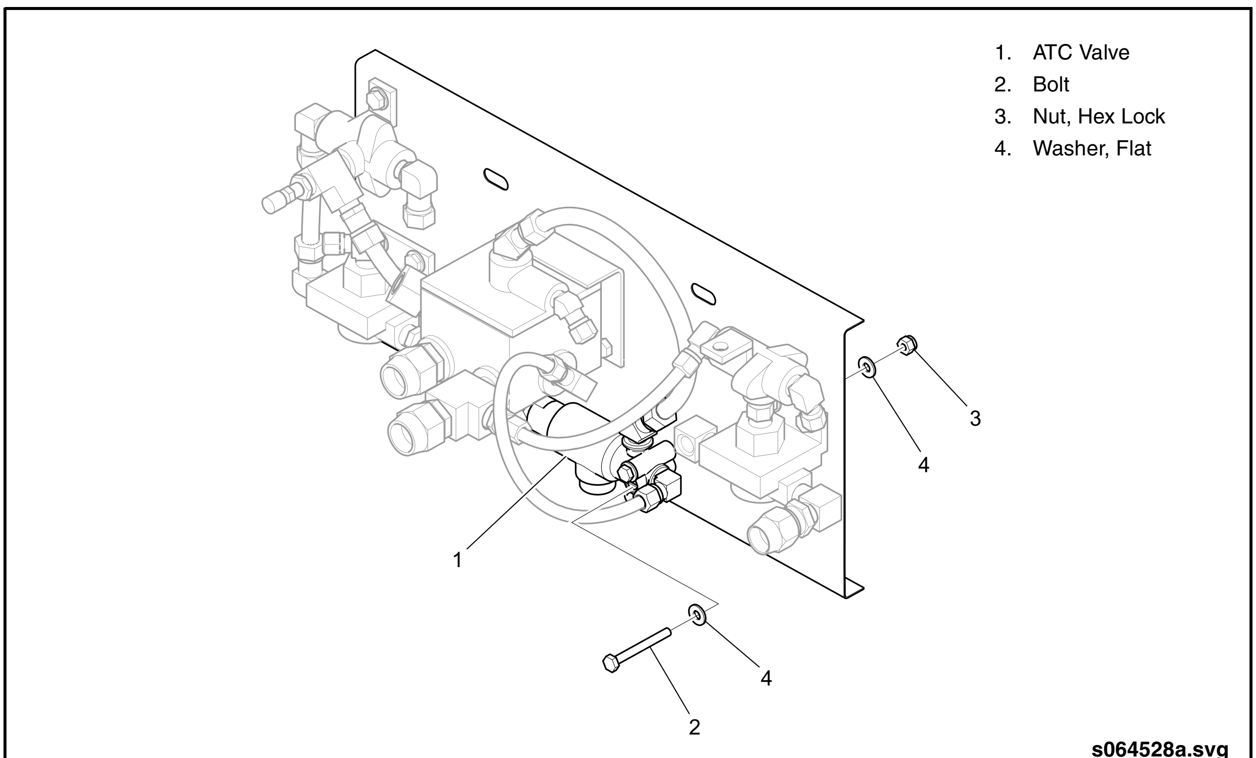

Fig. 2-150: Automatic Traction Control Valve

6.7. ABS Electronic Control Unit (ECU)

6.7.1. Description

The ABS System ECU is located on the streetside of the vehicle behind the front advertising panel. See "Fig. 2-151: ABS ECU" on page 133.

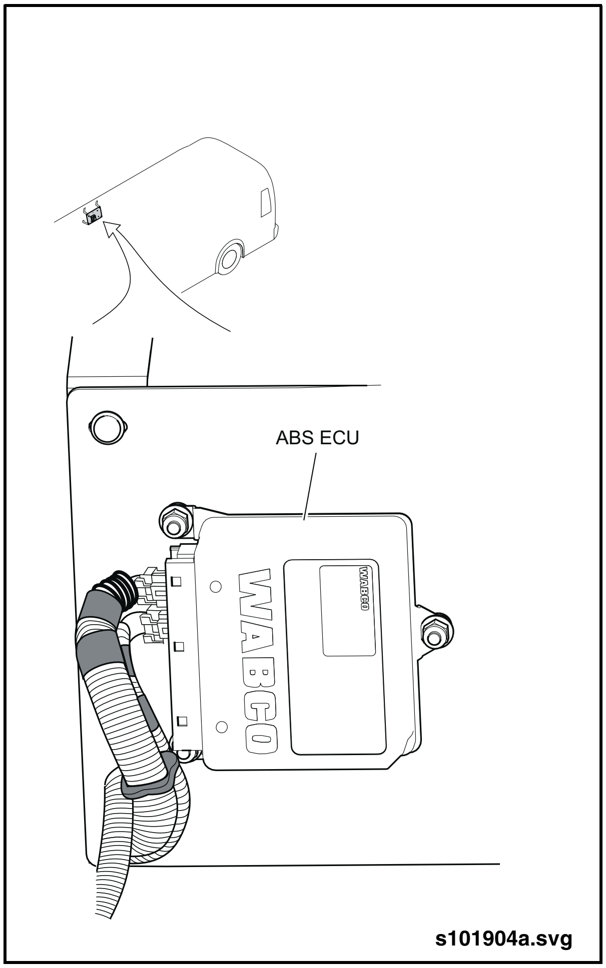

Fig. 2-151: ABS ECU

6.7.2. ABS Troubleshooting

Troubleshooting can be performed on the ABS system using any of the following methods:

- ❒ Blink Code troubleshooting
- ❒ Meritor Wabco TOOLBOX software
- ❒ Pro-Link® Plus diagnostic tool

Refer to 6.7.3. "Blink Code Diagnostics & Troubleshooting" on page 134 in this section for basic information on blink code trouble-shooting concerning the use of the ABS Fail indicator and the ABS switch installed in this vehicle.

Meritor Wabco TOOLBOX software is a PC-based diagnostic tool which can be used to test the ABS system components and display active and stored faults. The user's manual for this software is available for download on meritorwabco.com/toolbox. The software, available from Meritor Wabco, is loaded onto the PC and the PC is connected to one of the vehicle's diagnostic connectors.

The Pro-Link® Plus is a hand-held diagnostic device which can be used in place of blink code troubleshooting. The Pro-Link is fitted with the required cartridge and is connected to one of the vehicle's diagnostic connectors.

Refer to "Multiplexing System Layout" included with your Vehicle Systems Drawing Manual for the locations of the vehicle's diagnostic connectors.

Refer to 9. "VENDOR SERVICE INFORMATION" on page 150 in this section for further information on the use of the TOOLBOX software and the Pro-Link diagnostic tool. Also refer to this manual for detailed blink code troubleshooting charts and procedures.

6.7.3. Blink Code Diagnostics & Troubleshooting

6.7.3.1. Description

The ABS Fail indicator on the instrument panel indicates system status and displays blink code diagnostics. The indicator lamp works as follows:

- ❒ When the Master Run switch is set to the DAY-RUN position, the indicator illuminates momentarily for a check and then extinguishes. This indicates the system is O.K.
- ❒ The indicator will flash if the normal ABS function is being modified due to road conditions while the vehicle is in operation.
- ❒ The indicator will remain illuminated after the vehicle is started if an existing fault is present.
- ❒ After the system is serviced, the indicator will remain illuminated until the vehicle is driven at speeds above 4 mph (6 kp/h).

The Blink Code system requires use and interpretation of a series of blink codes. A blink code is a series of flashes emitted by the ABS Fail indicator which describes a system fault or condition. Each blink code contains two digits or sets of flashes: a 1 1/2 second pause occurs between each set of flashes in the digit. A four second pause separates the individual codes displayed. Blink code diagnostics are activated by the ABS switch in the front destination sign compartment.

6.7.3.2. Diagnostic Mode

Enter diagnostic mode by activating the ABS switch for one second, and then releasing it.

6.7.3.3. Clear Mode

Enter clear mode to erase faults from the ECU. This is done by activating the ABS switch for three seconds and then releasing it. If the system displays eight quick flashes followed by a system configuration code, the clear was successful. If this does not occur, faults are still active and must be repaired before they can be cleared.

6.7.3.4. System Configuration Code

This is a one digit code consisting of two flashes repeated every four seconds by the ABS switch during clear mode to indicate that all ABS faults have been cleared from ECU memory.

7. REAR AXLE SPECIAL TOOLS

7.1. Rear Axle Special Tools Chart

Refer to your New Flyer Parts Manual for purchase part numbers. See “Fig. 2-152: Special Tools-1” on page 139. See “Fig. 2-153: Special Tools-2” on page 140. See “Fig. 2-154: Special Tools-3” on page 141. See “Fig. 2-155: Special Tools-4” on page 142. See “Fig. 2-156: Special Tools-5” on page 143.

SPECIAL TOOLS	DESCRIPTION	MAN PART #
1	Adapter, Wheel Bolt	80.99602.0197
2	Slide Hammer	80.99602.0016
3	Tapered Collar	80.99623.0036
4	Segment, Clamping Jaw	80.99623.6008
5	Extension, Centering Tool	80.99623.0035
6	Washer	80.99623.0038
7	Spindle, Screw	80.99623.0037
8	Socket, Nut Slotted	80.99603.6008
9	Multiplier, Torque 1:8	83.09195.6001
10	Reaction Arm	80.99622.5002
11	Ratchet Insert	08.06410.9072
12	Counter Holder	80.99622.5003
13	Guide Sleeve	80.99606.0534
14	Slip-on Handle, Press-in and Press-out	80.99617.0187
15	Washer, Press-in	80.99617.0144
16	Adapter, Pressing Device	80.99617.0189
17	Press Out Device, Bearing	80.99604.6034
18	Press-in Plate	80.99604.0042
19	Pressing Bush, Inner Tapered Roller Bearing	80.99604.0457
20	Pressing Bush, Outer Tapered Roller Bearing	80.99604.0225
21	Supporting Fixture	80.99629.6007
22	Gauge, Feeler	08.75310.0806
23	Hook, Seal Race Removal	80.99601.0212

SPECIAL TOOLS	DESCRIPTION	MAN PART #
24	Flange, 150mm - 180mm	80.99610.0013
25	Sleeve Assembly, ABS Sensor Holder	80.99604.0224
26	Slotted Nut Wrench	80.99603.0413
27	Threaded Pin, Adapter Flange	80.99606.0577
28	Cotter Pin	06.29220.0203
29	Puller, 3 Arm Input Flange	08.99605.9014
30	Separator, Roller Bearing Inner Race	08.99605.9001
31	Puller, Bearing Separator	08.99605.9011
32	Puller, 3 Arm Input Flange Seal	08.99605.9019
33	Detachable Handle	80.99617.0188
34	Pressing Adapter, Input Flange Seal	80.99604.0488
35	Adapter Piece	80.99609.0013
36	Lifting Device, Differential Removal	80.99606.0016
37	Assembly Crown, Differential Removal	80.99606.0308
38	Support Screw, Differential Removal	80.99606.6098
39	Square Drive	08.06455.0017
40	Adapter, Axle Breather Connection	80.99602.0141
41	Threaded Adapter, Axle Breather Connection	80.99602.0138
42	Extractor, Axle Breather Connection	80.99602.0011
43	Intermediate Flange, 150 mm	80.99603.0414
44	Gauge, Dial	08.71000.3217
45	Holder, Dial Gauge	08.71082.0005
46	Slotted Nut Wrench, Differential Threaded Adjuster	80.99603.0355
47	Lifting Device	80.99606.6116
48	Holder, Universal	80.99606.6130
49	Plate Attachments	80.99606.0578
50	Thrust Piece, Differential	80.99604.0446
51	Bearing Gripper	80.99628.0092

SPECIAL TOOLS	DESCRIPTION	MAN PART #
52	Puller Sleeve	80.99601.0167
53	Spindle, Bearing Puller	80.99601.6000
54	Reducer, Rolex II	80.99634.0001
55	Assembling Device, Differential	80.99606.6132
56	Torque Multiplier - 1:3.5	80.99619.0006
57	Brace	80.99606.0551
58	Adapter Pin	80.99604.6049
59	Torque Wrench, 20 - 100 Nm	08.06450.0002
60	Torque Wrench, 80 - 400 Nm	08.06450.0003
61	Feeler Gauge	08.75310.3306
62	Lifting Strap	09.84068.3115
63	Open-End Wrench	08.06003.9001
64	Pin, Connecting	06.22729.0006
65	Cable Tie Pliers	08.02960.0100
66	Screw, Socket Head	06.02191.0407
67	Spindle Adapter	81.36304.0009
68	Pin, Centering	80.99604.0264
69	Adapter	80.99602.0207
70	Expandable Puller	08.99615.2900
71	Pressing Plate, Input Flange Shield Installation	80.99604.0487
72	Depth Gauge, Electronic	08.71195.9003
73	Support Bar, Electronic Depth gauge	08.71109.0000
74	Pressing Plate, Input Flange Shield Removal	80.99604.0135
75	Separator, Input Flange Shield	08.99605.9003
76	Lift Adapter	80.99616.0129
77	Tester, Friction	80.99619.0008
78	Alignment Pins	80.99617.0020
79	Engine Stand	80.99606.6172

SPECIAL TOOLS	DESCRIPTION	MAN PART #
80	Threaded Adapter	80.99615.0043
81	Cylinder Support	80.99601.0236
82	Cap	80.99601.0238
83	Threaded Sleeve	80.99601.0221
84	Hook	80.99629.0040
85	Socket	08.06142.1528
86	Support	80.99606.0720
87	Torque Wrench, 6 - 50 Nm	08.06450.0006
88	Pressing Adapter, Roller Bearing	80.99604.0092
89	Eyebolt	06.05110.0103
90	Lifting Chain	80.99629.6011
91	Box-End Ratchet	08.06455.0036
92	Ratchet Handle	08.06460.0002
93	Bearing Gripper	80.99628.0112
94	Pressing Adapter, Pinion Bearing Outer Race	80.99604.0178
95	Ratchet	08.06455.0021
96	Torque Wrench	08.06450.0007
97	Handle, Screwdriver Torque	08.06510.9026
98	Shaft, Removable Screwdriver	08.06510.9027
99	Bit, Removable Screwdriver	08.06510.9030
100	Calipers, Measuring	80.71100.0003
101	Piston Cylinder, Hollow 200 kN	80.99601.6014
102	Pump, Hydraulic	80.99620.6008
103	O-Ring, Rubber 42mm	06.56331.3274
104	Adapter, Tool Assembly	80.99606.0552
105	Adapter, Wrench	08.06455.0023
106	Thrust Piece, Hydraulic Puller	80.99601.0192

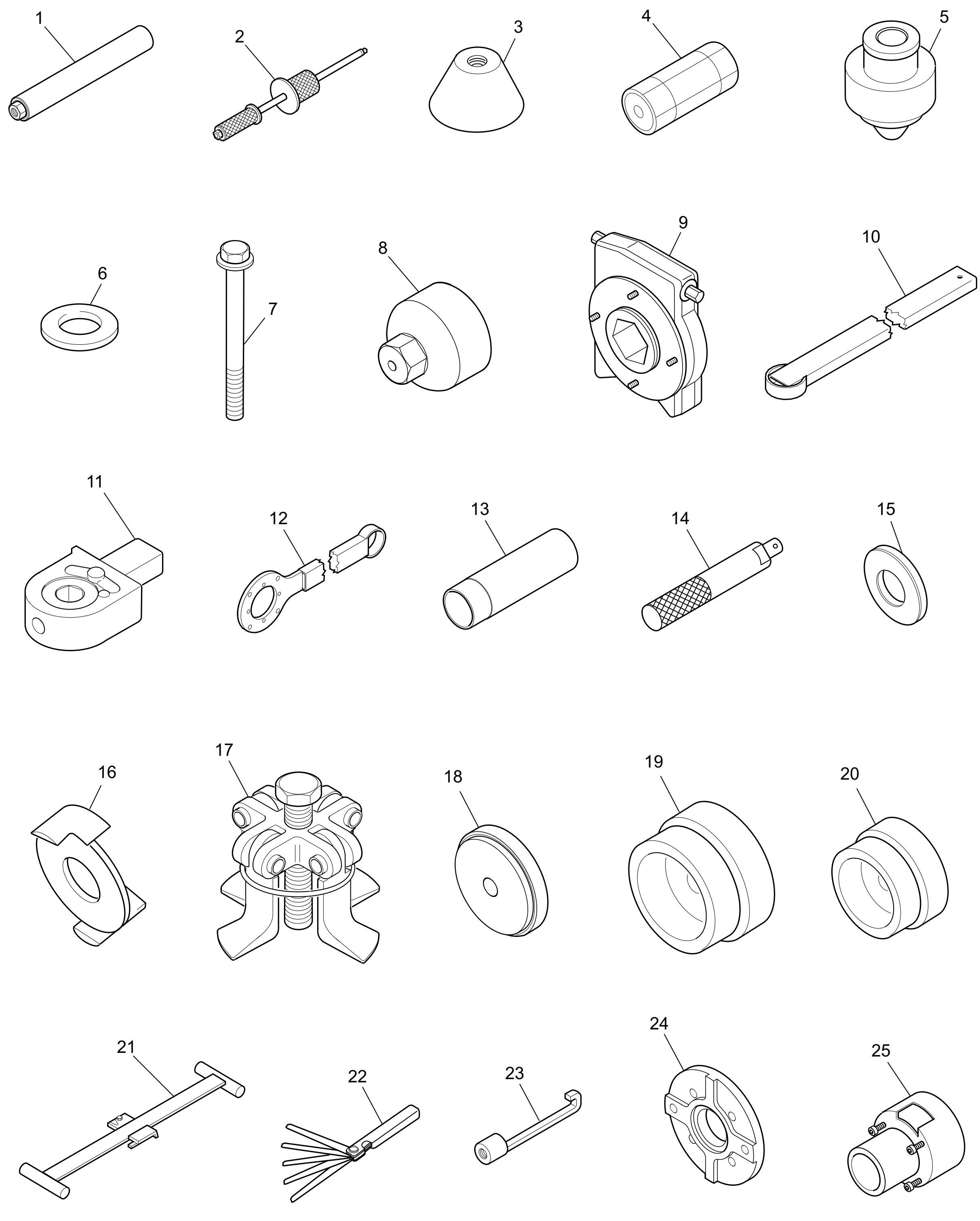

Fig. 2-152: Special Tools-1

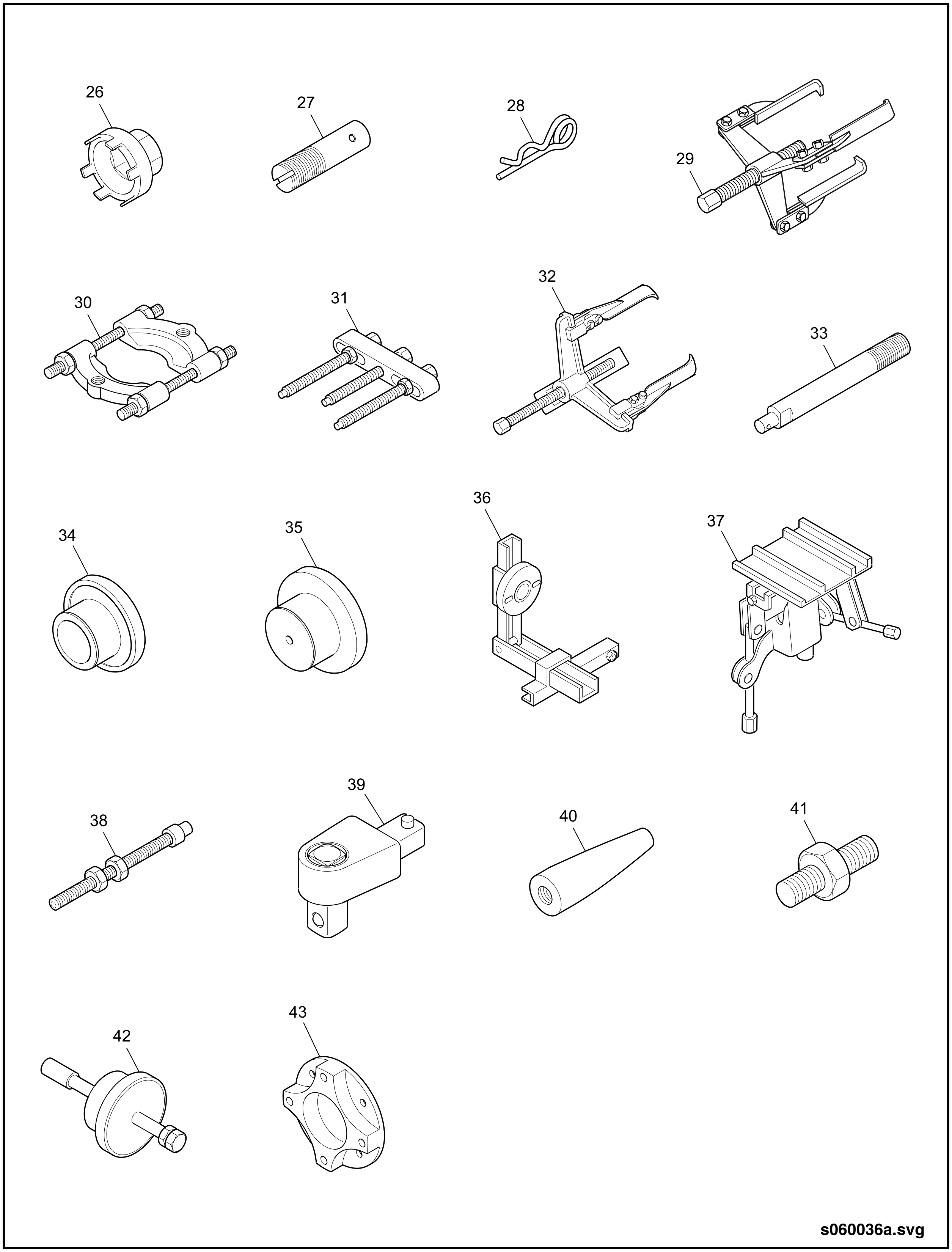

Fig. 2-153: Special Tools-2

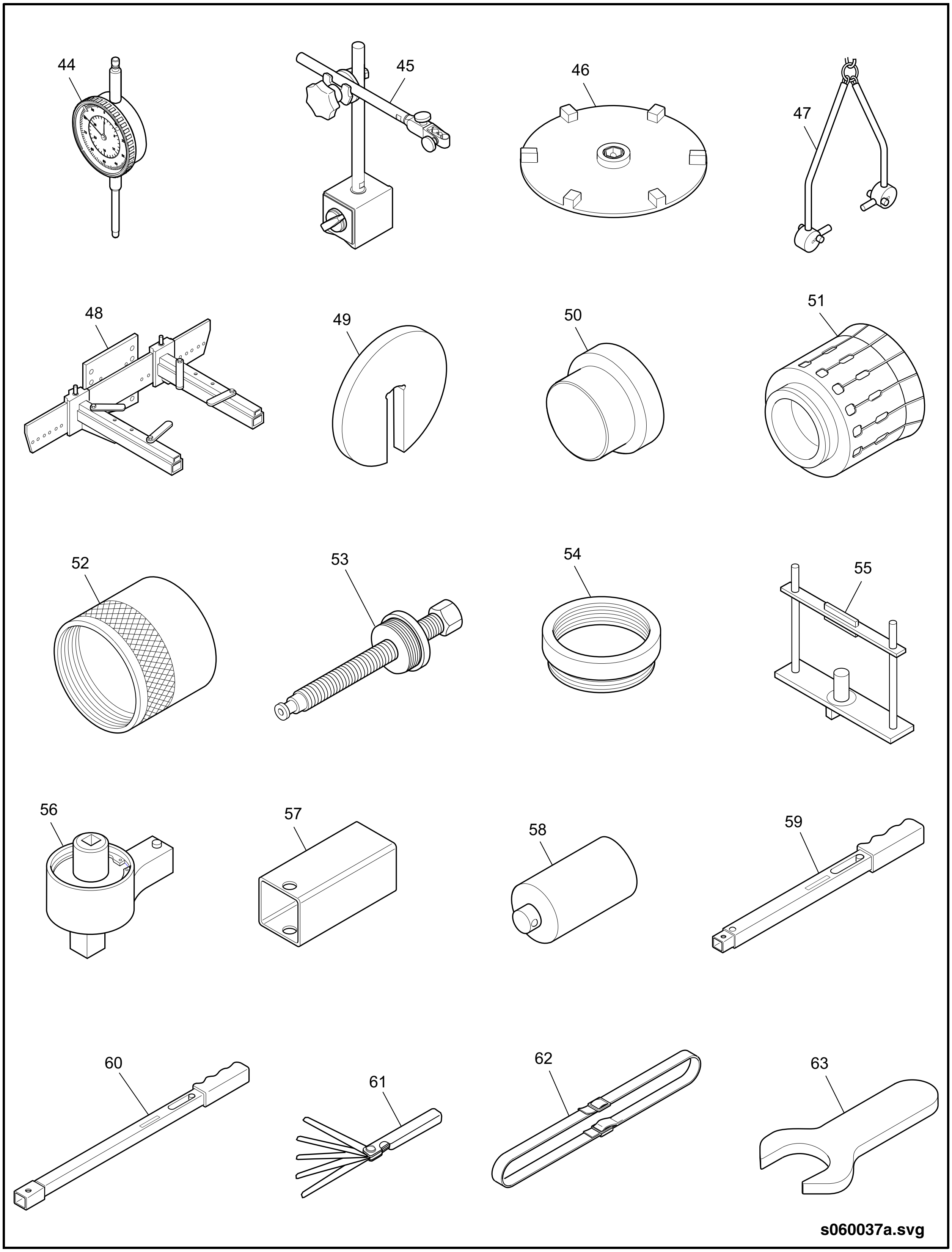

Fig. 2-154: Special Tools-3

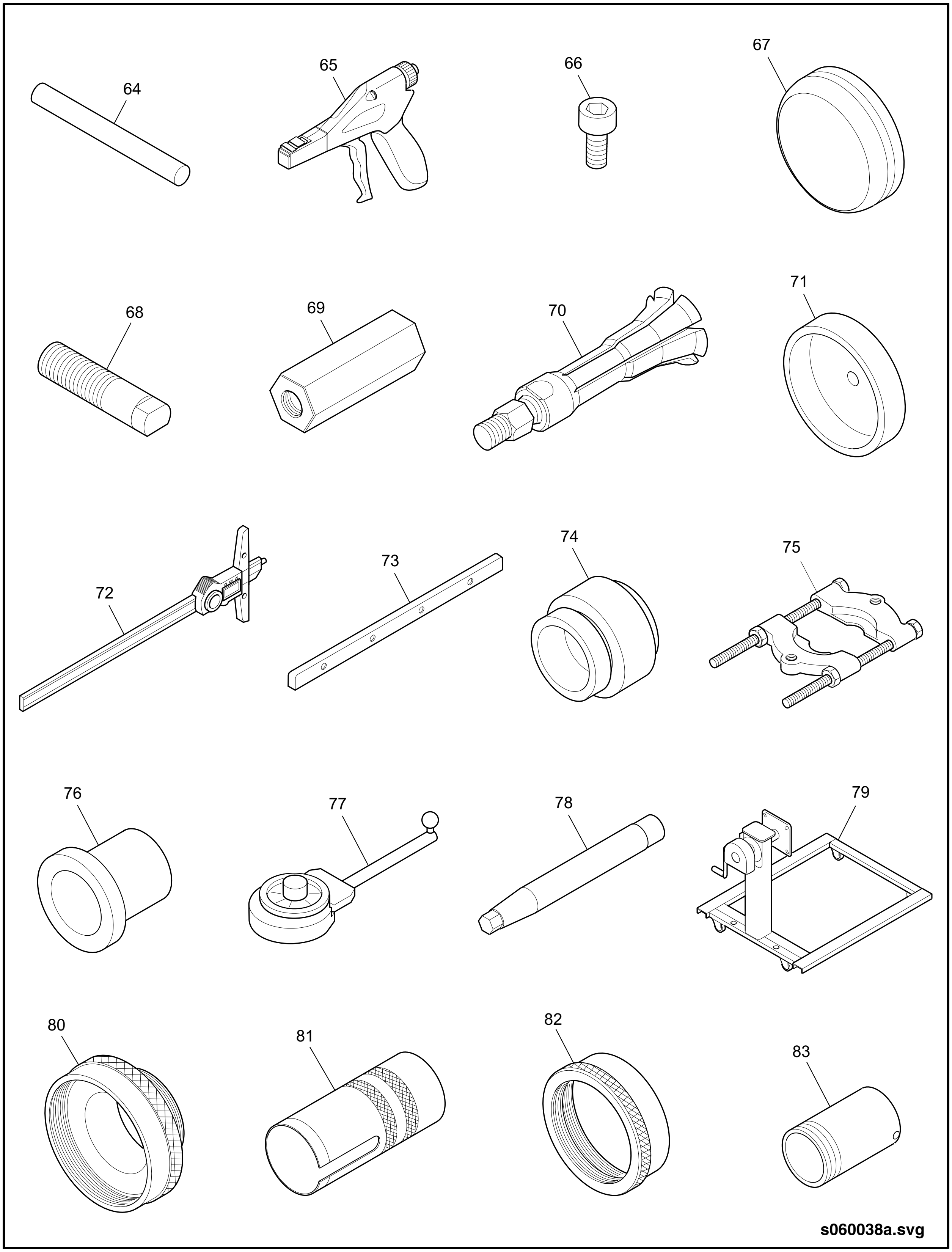

Fig. 2-155: Special Tools-4

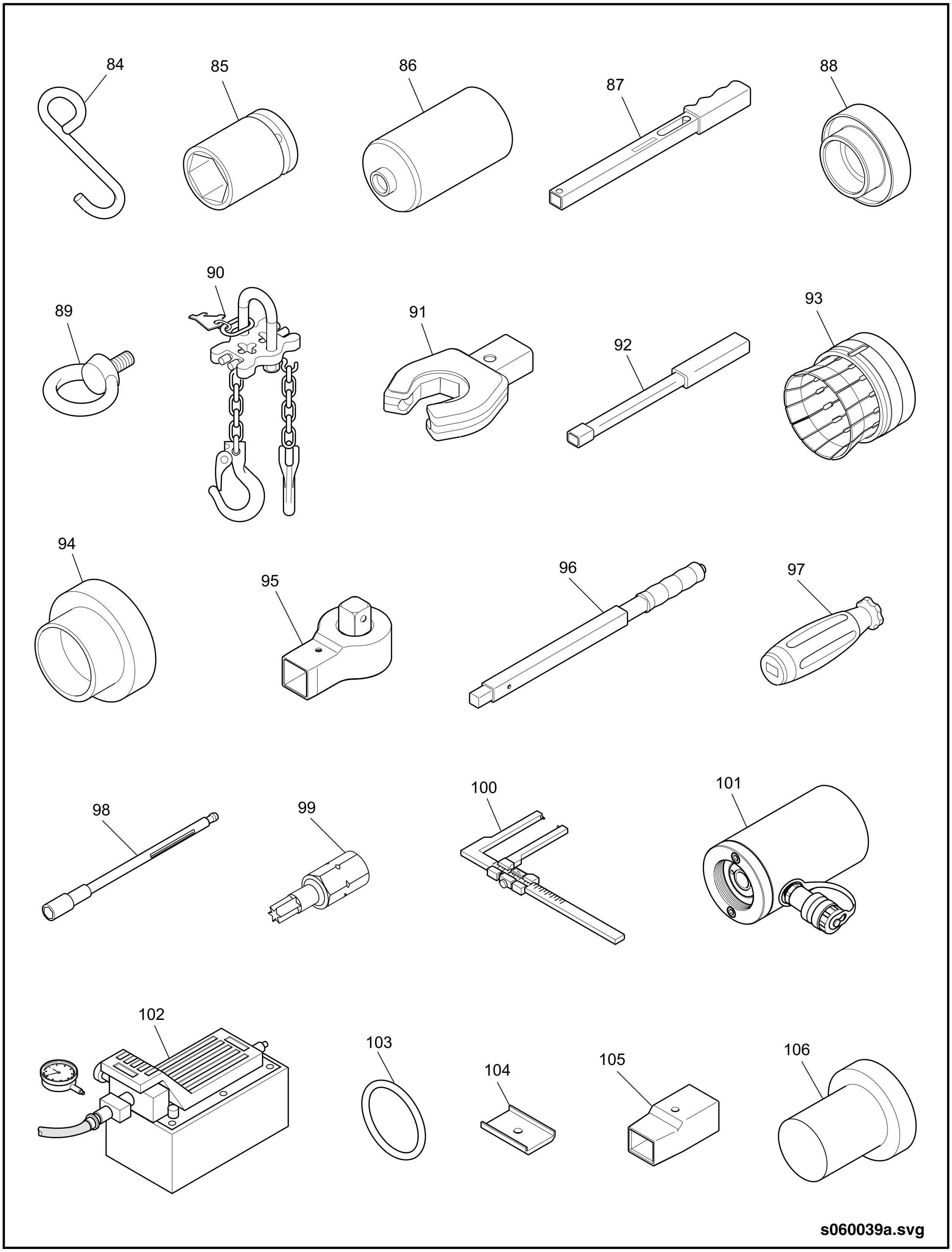

Fig. 2-156: Special Tools-5

8. DRIVESHAFT

8.1. Description

The driveshaft assembly is a short-coupled design that consists of a telescopic intermediate shaft with full round yokes and universal joints at each end. The driveshaft is adapted to the drive axle with a cross-tooth flange and is adapted to the transmission with a half-round yoke. The intermediate shaft is a two-piece splined assembly that compensates for axial movement between the rear axle and transmission. See “Fig. 2-157: Driveshaft Installation” on page 144.

The universal joint cross includes drilled passageways and grease fittings to allow lubrication of the needle bearings without disassembly. The machined trunnions on the ends of the cross engage the needle bearings inside the bearing caps. The bearing cap "wings" provide the flange for securing the bearing cap to the yoke. A lock plate and two bolts are provided for this purpose.

1. Driveshaft Assembly
2. Screw, Lock M12 x 40 Lg.
3. Grease, Mobilux EP-11

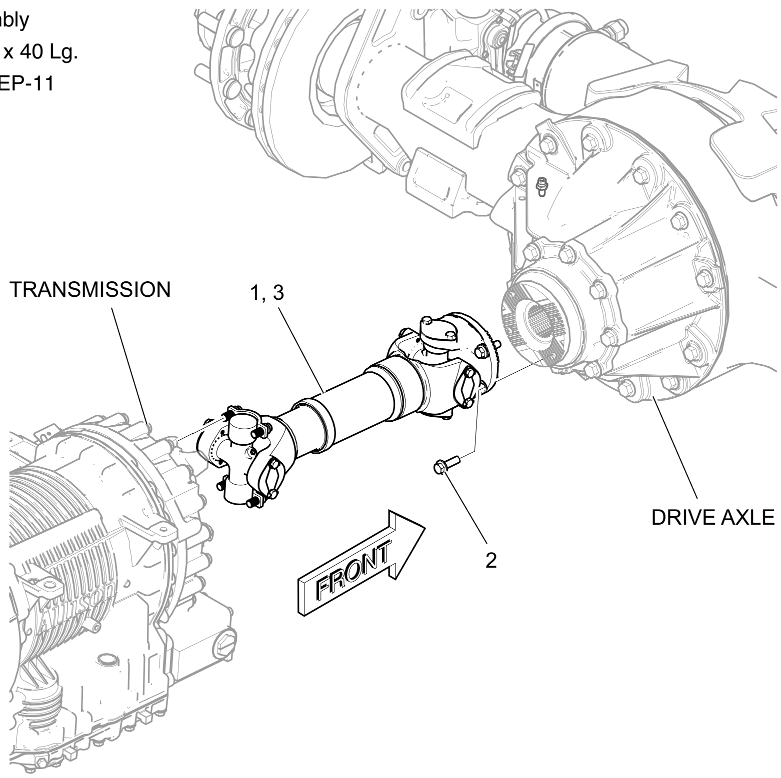

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Fig. 2-157: Driveshaft Installation

8.2. Driveshaft Specifications

Manufacturer.................. Prop Shaft Supply

Model .... 1710 Series

Angular Misalignment Capacity (bump angle) .... 22° minimum, both ends

Balancing Requirement .....0.32 in-oz/10 lbs of shaft weight at 3000 RPM

Extended Length (yoke center-to-center) .... 21.46" (545mm)

Collapsed Length (yoke center-to-center) .... 17.38" (441mm)

Weight (approx) ....70.274 lbs (31.9 Kg)

8.3. Operation

The driveshaft couples and transmits output torque from the transmission to the drive axle. The u-joints allow for operating angles in both the vertical and horizontal planes. The telescopic spline arrangement compensates for axial movement between the transmission and drive axle during suspension movement.

8.4. Maintenance

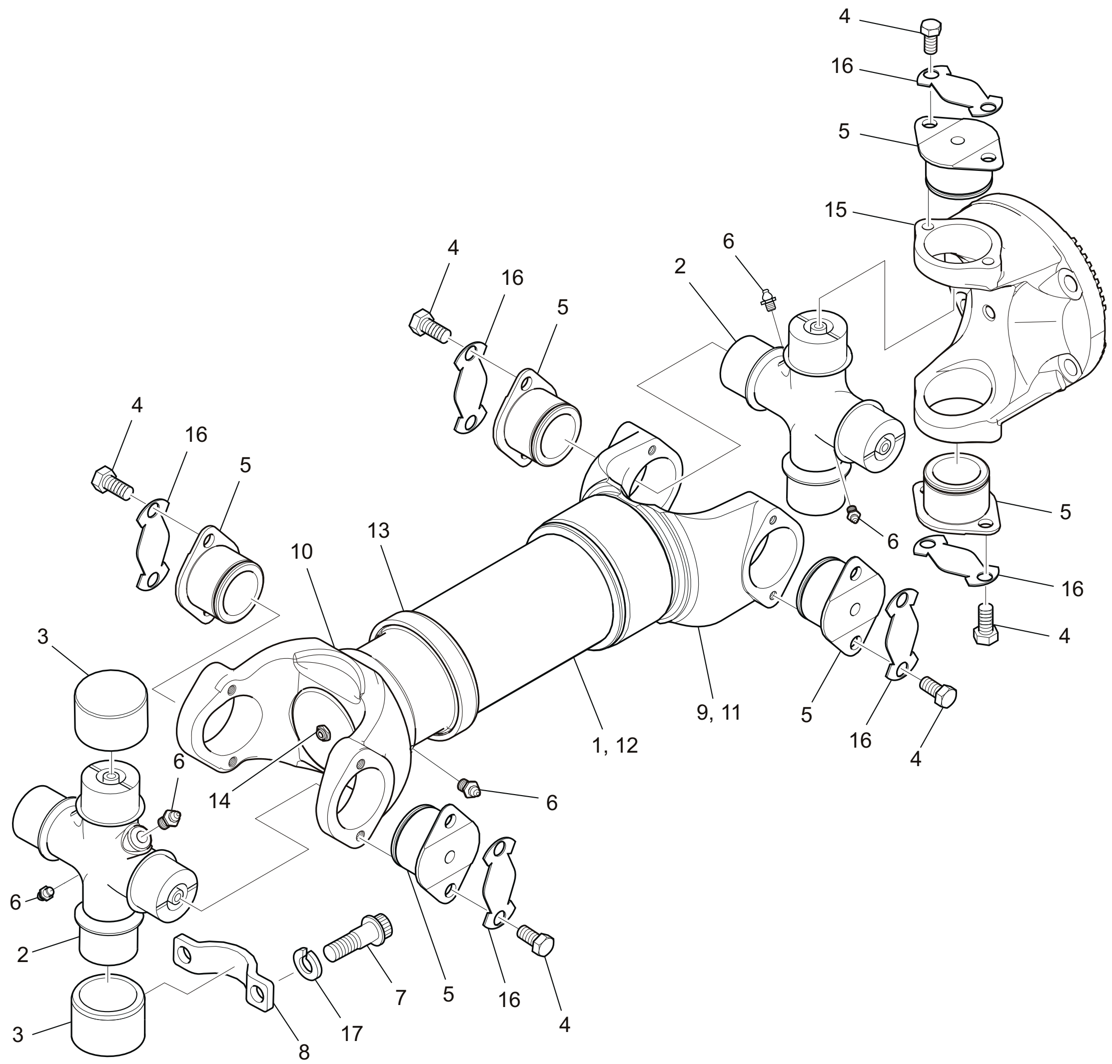
Refer to the Preventive Maintenance Section of this manual for scheduled servicing procedures.

8.5. Removal

⚠ WARNING

DO NOT service the driveline with the engine running. Ensure the engine is shut down and the Battery Disconnect switch is in the OFF position.

1. Place the vehicle on a level surface, and lift the vehicle. Refer to the General Information Section of this manual for procedure.
2. Remove the driveshaft guard.
3. Support driveshaft and remove bolts and bearing straps retaining cross in transmission yoke. See “Fig. 2-158: Driveshaft Assembly” on page 146.
4. Remove bolts retaining driveshaft flange to drive axle and remove driveshaft assembly from vehicle.



1. Driveshaft Assembly, (Incl. 2-20)
2. Cross
3. Cup, Bearing
4. Bolt, Hex
5. Cup, Bearing
6. Fitting, Grease 1/4" - 28 Taper Thread
7. Bolt, Serrated Locking
8. Strap, Bearing
9. Shaft Assembly, Short Coupled (Incl. 10-14)
10. Slip Yoke
11. Shaft, Yoke
12. Seal Can
13. Dust Cap
14. Valve, Relief
15. Flange Yoke
16. Plate, Locking
17. Washer, Lock

Fig. 2-158: Driveshaft Assembly

8.6. Disassembly

CAUTION

DO NOT disassemble the driveshaft unless driveshaft balancing equipment is available. Disassembly and replacement of components will likely disturb the original driveshaft balance and may result in vibration and premature wear. The driveshaft assembly must be balanced to specification before being installed on the vehicle.

1. Bend the tabs of the lock plates away from the bolts.
2. Remove the bolts and lock plates retaining the bearing caps to the yokes.
3. Remove the bearing caps.

☞NOTE:

If necessary, use a commercial bearing puller to remove the bearing caps from the yoke bores.

4. Work the trunnions free of the yoke bores, and remove the universal joint cross from the yoke.
5. Score alignment marks on the male and female portions of the telescoping intermediate shaft.
6. Pull the shafts apart.

8.7. Assembly

WARNING

ALWAYS replace fasteners with new OEM parts. DO NOT reuse bolts, bearing strap, or locking plates.

ENSURE that the driveshaft halves are installed “in phase”. If the alignment marks are not evident, then assemble the shafts so the lugs (ears) of the slip yoke are in line with the lugs (ears) of the tube yoke. This will ensure that the yokes are “in phase”.

DO NOT use a hammer to seat the bearing caps into the yoke bores. A steel hammer can cause the yoke or bearing cap to crack and break off. Serious personal injury and damage to the trunnion, yoke or bearing cap can result.

1. Lubricate the splines and slide the shaft pieces together, using the alignment marks as a guide for proper reassembly.

   ☞**NOTE:**

   The alignment marks ensure that the two shafts are "in-phase". If the alignment marks are not evident, then assemble the shafts so the lugs (ears) of the slip yoke are in line with the lugs (ears) of the tube yoke. This will ensure that the yokes are "in-phase".

2. Install a universal joint cross into the yoke.
3. Position the trunnion portion of the u-joint cross fully into the yoke bore

   ☞**NOTE:**

   Positioning the trunnion as far as possible into the yoke bore makes it easier to center and align the bearing cap with the trunnion.

4. Install the bearing caps through the yoke bores and onto the universal joint cross trunnions.
5. Tap the bearing cap lightly with a leather or rubber mallet to seat the bearing cap into the yoke bores.
6. Install bolts and lock plates, but finger-tighten only at this time.
7. Slide the u-joint cross across to the opposite yoke bore so that the trunnion extends as far as possible into the bore.

CAUTION

DO NOT use a press or excessive force to install the bearing cap. DO NOT strike the "wing" portion of the bearing cap as this will tend to cock the bearing cap in the bore. If the bearing cap does not enter the bore easily with light tapping, then remove and investigate the cause of the misalignment.

8. Center the bearing cap over the trunnion and lightly tap into place until the flange of the bearing cap is seated against the yoke.
9. Install bolts and lock plates. Torque bolts on both bearing caps to 38 to 41 ft-lb. (51 to 56 Nm).
10. Bend up tabs of lock plates so that the tabs seat against the flat of the hex head bolt.
11. Balance the driveshaft in accordance with ISO 1940 G16 standard using equipment specifically designed for this purpose. Refer to 8.2. “Driveshaft Specifications” on page 145 in this section for balancing specifications.

8.8. Installation

WARNING

ALWAYS replace fasteners with new OEM parts. DO NOT reuse bolts, bearing strap, or locking plates.

1. Inspect the condition of the mating flange/ yokes on the transmission and drive axle to ensure they are clean and undamaged.

CAUTION

DO NOT lift and support the driveshaft by the center shaft. Support should only be provided to the inboard yokes.

2. Support the driveshaft and align the universal joint bearing caps in the transmission yoke.
3. Install the bearing straps and capscrews into the yoke.

CAUTION

DO NOT seat the bearing cups into the yoke saddle by tightening down the capscrews. Uneven load distribution, yoke bearing rotation, and damage to the straps and yoke nibs can result.

4. Using a torque wrench, alternately tighten the capscrews to 115 to 135 ft-lb. (155 to 183 Nm).
5. Align the flange on the driveshaft with the flange on the drive axle and install bolts.
6. Tighten each bolt uniformly until the face pads of the flanges are properly seated.
7. Tighten the bolts in an alternating crosswise pattern. Torque to 81 ± 3 ft-lb. (110 ± 4 Nm).
8. Remove the supporting equipment.
9. Install driveshaft guard.

9. VENDOR SERVICE INFORMATION

The following supplier manuals contain additional reference information.

9.1. Meritor Wabco Manual

- ❐ Maintenance Manual 112 Anti-Lock Braking System (ABS) for Trucks, Tractors, and Buses for E Version ECUs

Steering System

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- open flame
- excessive heat
- production of sparks
- production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Hydraulic System Safety

Observe the following procedures involving hydraulic line maintenance:

WARNING

Pressurized lines should not be disconnected until the pressure is safely and controllably released.

CAUTION

Hydraulic fluid is corrosive and should not be exposed to skin for extensive periods of time. Wear eye protection at all times.

1.4. Hoisting/Lifting & Jacking Safety

Refer to the General Information Section of this manual for recommended types of hoists, lifting equipment, and jackstands.

DANGER

Certain procedures may require the vehicle be operated in an elevated position in order to accurately troubleshoot and diagnose a problem. If the vehicle must be running while elevated, become familiar with the repair area prior to starting the engine. Take special care in noting areas which will become hot, electrically energized, and areas where moving and rotating components are located. Limit the work in these areas as personal and equipment safety is at risk.

WARNING

ALWAYS ensure that the vehicle is appropriately hoisted and blocked for procedures which require elevating the vehicle. Be aware of the limitations of the blocking equipment, and always ensure that the jarring and shaking created by component removal and installation procedures does not overload the blocks, or cause the vehicle to become unstable.

2. STEERING SYSTEM

2.1. Description

The power steering system controls the movement of the front axle steering components and the front wheels. The steering system is hydraulically power-assisted. The major components of the steering system include:

- ❐ Steering Column
- ❐ Steering Driveshafts
- ❐ Steering Damper
- ❐ Drag Link
- ❐ Steering Miter Box
- ❐ Power Steering Gear
- ❐ Hydraulic System

☞**NOTE:**

Refer to 3. “HYDRAULIC SYSTEM” on page 44 *in this section for more information on the hydraulic system components.*

2.2. Maintenance

The steering system requires little maintenance. However, care should be taken to keep system components and fluid free of contaminants to ensure maximum operating performance and trouble-free service. The following operations may be accomplished without removing steering components from the vehicle:

1. Check and if necessary, tighten all steering gear mounting bolts, pitman arm retaining nut, drag link to steering arm retaining nuts. Check witness marks and check for wear in steering linkage and other components before making adjustments to steering gear assembly. Refer to “Front Suspension Torque Specifications” in Section 1 of this manual for torque values.

☞**NOTE:**

Reapply witness marks after torquing any fasteners.

2. Check front end alignment as indicated in this section.
3. Prevent internal bottoming of steering gear by carefully checking axle stops periodically. Axle stops should be set to specification. Refer to 2.5.1. “Steering Stops” on page 5 in this section for specification.
4. Check lube level for steering gear and components to prevent malfunction due to inadequate lubrication.
5. Maintain correctly inflated tires.
6. Always use a “puller”, never use a torch or hammer to remove steering arms.
7. Always carefully examine all steering parts which have been subject to “impact” and replace any that are damaged.
8. Correct cause of any play, rattle, or shimmy in any part of the linkage of steering mechanism.
9. Encourage operators to report any malfunction or accident that could have damaged the steering mechanism.
10. Do not attempt to weld any broken steering components. (Replace only with original equipment.)
11. Do not severely cold-straighten any steering system part.
12. Do not heat-straighten or bend any steering system part.
13. Always use new original equipment seals and O-rings during repairs and overhauls.
14. Replacement of single bearing assemblies, or balls, if one or more make a “set” is not recommended.
15. Excessive heat will develop if any power steering gear is held in an extreme right or left turn longer than a few seconds. (Heat developed can damage seals and/or pump.)
16. Use care to prevent even minor hydraulic leaks from continuing.
17. Prevent dirt or foreign particles from entering hydraulic steering systems. (Always clean off around filler caps, before removing, to check oil supply). When the slightest evidence of dirt, sludge, or water is discovered in the system, drain and refill with clean recommended steering fluid.
18. The steering fluid level in the pump reservoir should be checked and fluid added when required. Refer to the Preventive Maintenance Section of this manual for lubrication intervals and fluid specifications.
19. Change reservoir filters as required. Refer to the Preventive Maintenance Section of this manual for filter change intervals.
20. Air in the fluid system will cause spongy action and noisy operation. When any hose has been disconnected or when fluid has been lost for any reason, system must be bled after adding fluid. Refer to 2.12.11. “Bleeding Power Steering Hydraulic System” on page 43 in this section for system bleeding procedure.

2.3. Lubricants & Quantities

The fluid used in the power steering system is the medium by which hydraulic pressures are applied and relieved, under control, to effect steering assist. The fluid also lubricates moving parts and dissipates heat.

The hydraulic reservoir must be kept filled to the proper indicator level and free of air. When filling the reservoir, start the engine and turn the steering wheel from left to right and continue filling until proper level is maintained. Refer to 2.12.11. “Bleeding Power Steering Hydraulic System” on page 43 in this section for system bleeding procedure.

A filter is included with the hydraulic reservoir. Replace this filter when changing the hydraulic fluid. Refer to 3.3. “Reservoir” on page 48 in this section for procedure.

2.4. Front End Alignment

☞NOTE:

If the steering system is out-of-adjustment, inspect the steering arm for damage. Use a magnetic particle or liquid penetrant inspection procedure to inspect the steering arm. Pay particular attention to the bend, the taper and the area near the ball stud.

2.4.1. Introduction

Check the front wheel alignment when the following occur:

1. When the vehicle does not steer correctly.
2. To correct a tire wear condition.

☞NOTE:

Refer to the Preventive Maintenance Section of this manual for alignment intervals.

There are two types of front wheel alignments:

❒ Minor alignment

❒ Major alignment

2.4.1.1. Minor Alignment

Do the minor front wheel alignment in the following sequence:

1. Inspect all the systems that affect the wheel alignment. Refer to 2.2. “Maintenance” on page 3 in this section for procedure.
2. Check and adjust the wheel bearings, wheel stops and turn angles.
3. Check and adjust toe-in.

2.4.1.2. Major Alignment

Do the major front wheel alignment in the following sequence:

1. Set the tire pressure to manufacture setting.
2. Inspect all the systems that affect the wheel alignment.
3. Set the vehicle ride height. Refer to 2.6. “Ride Height” on page 15 in this section for adjustment procedure.
4. Check and adjust the wheel bearings. Refer to Section 1 of this manual for adjustment procedure.
5. Check and adjust the maximum turn angle. Refer to 2.5.1. “Steering Stops” on page 5 in this section for procedure.
6. Check and adjust the pressure relief in the power steering system. Refer to 2.5.1. “Steering Stops” on page 5 in this section for procedure.
7. Check the king pin angle (steering axis) inclination). Refer to 2.5.4. “King Pin Inclination” on page 11 in this section for procedure. Inspect king pin axial play. Refer to “Steering Knuckle” in Section 1 of this manual for procedure.
8. Check the camber angle. Refer to 2.5.5. “Camber Angle” on page 12 in this section for procedure.
9. Check the caster angle. Refer to 2.5.6. “Caster Angle” on page 13 in this section for procedure.
10. Check and adjust the toe-in. Refer to 2.5.7. “Toe-In Adjustment” on page 14 in this section for procedure.

2.4.2. Front Wheel Alignment Specifications

Front Axle Set Back ....0.0 ± 0.1° Max.

Rear Axle Thrust Angle........0.0 ± 0.1° Max.

King Pin ....7°

Camber ....1.0°

Caster ....3 ± 0.2° positive

Toe-In ....0.08"

LH-RH Max. Wheel Cut ....3/8"

Power Steering Relief .... Automatic

2.5. Wheel Alignment Adjustments

2.5.1. Steering Stops

The travel of the steering system is limited by mechanical stops on the steering knuckle and a hydraulic relief setting within the power steering gear.

- ❐ The mechanical stops on the steering knuckle provide a safe minimum clearance between the tire and the chassis.
- ❐ The hydraulic power steering relief provides a means of relieving hydraulic pressure prior to contacting the mechanical steering stop and determines the maximum usable wheel cut or steering angle. Hydraulic relief is provided by automatic relief valve plungers located in the bearing cap and cylinder head.

2.5.1.1. Mechanical Steering Stop Adjustment

The mechanical left-hand and right-hand steering stops are factory preset to obtain a minimum clearance of 3/8" between the tire and the chassis, suspension, or steering components. The maximum usable steering cut is determined by the power steering relief valve which is automatically set to relieve before the axle stop bolt contacts the axle boss.

During the alignment process the mechanical steering stops may need to be reset.

To achieve the required maximum steering angles, first adjust the front axle left and right-hand stop bolts. Proceed as follows:

1. Park vehicle on level surface and chock rear wheels.
2. Raise the vehicle and place jack stands under the front axle. Tire must clear the ground and be free to turn fully left and right.
3. Loosen mechanical stops on axle and screw them in all the way.

☞**NOTE:**

All gap measurements must be made with 20 to 30 lb. force applied to the steering wheel. This force will maintain the angle of the wheel in the turn.

4. Steer wheels to the right and measure the distance from the tire to the drag link. See “Fig. 3-1: Tire to Drag Link Clearance” on page 6. Alternately measure from the center link to the axle housing. See “Fig. 3-2: Center Link to Axle Housing Clearance” on page 6. The smallest allowable gap is 3/8".
5. Adjust axle stop until it just contacts the axle. Torque the lock nut 50 ± 5 ft-lb. (68 ± 7 Nm).
6. Steer wheels to the left and measure the distance from the tire to the steering damper. Alternately measure from the center link to the axle housing. The smallest allowable gap is 3/8".
7. Adjust axle stop until it just contacts the axle. Torque the lock nut 50 ± 5 ft-lb. (68 ± 7 Nm).
8. Reset the automatic plungers. Refer to 2.5.1.2. “Automatic Plunger Adjustment” on page 7 in this section for reset procedure.

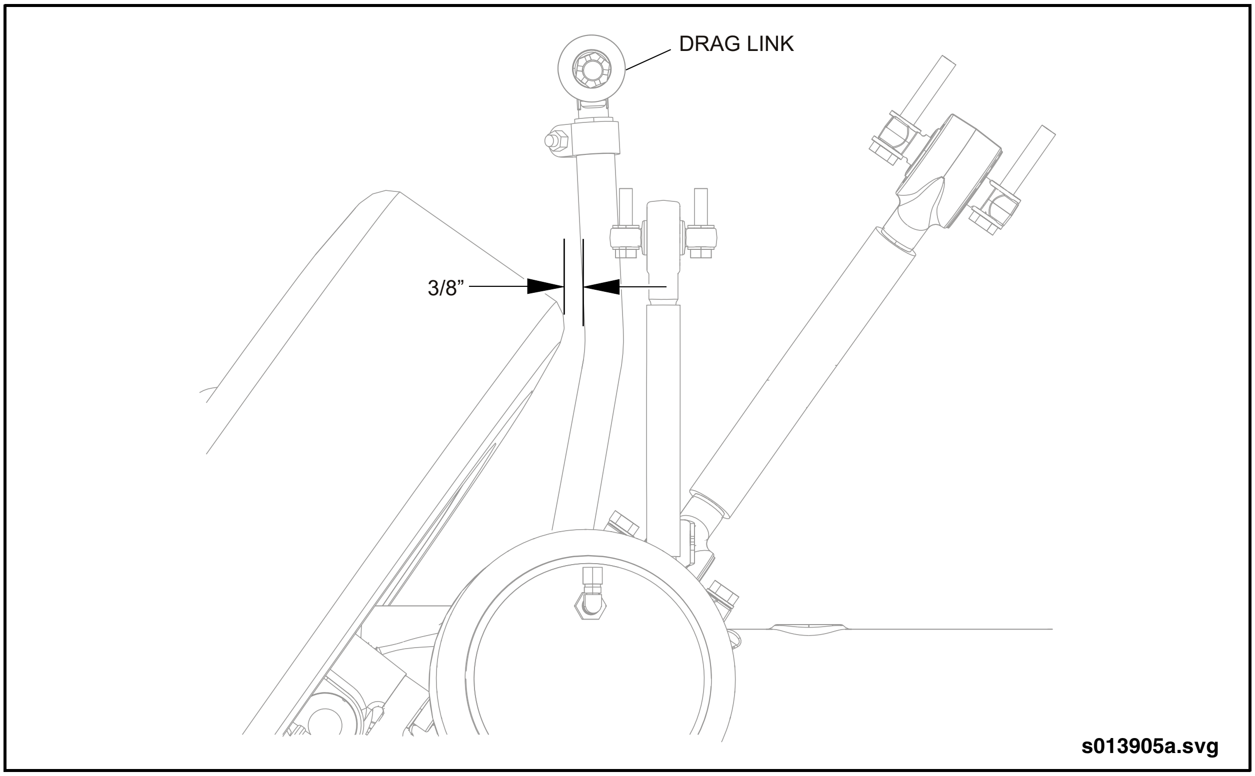


Fig. 3-1: Tire to Drag Link Clearance

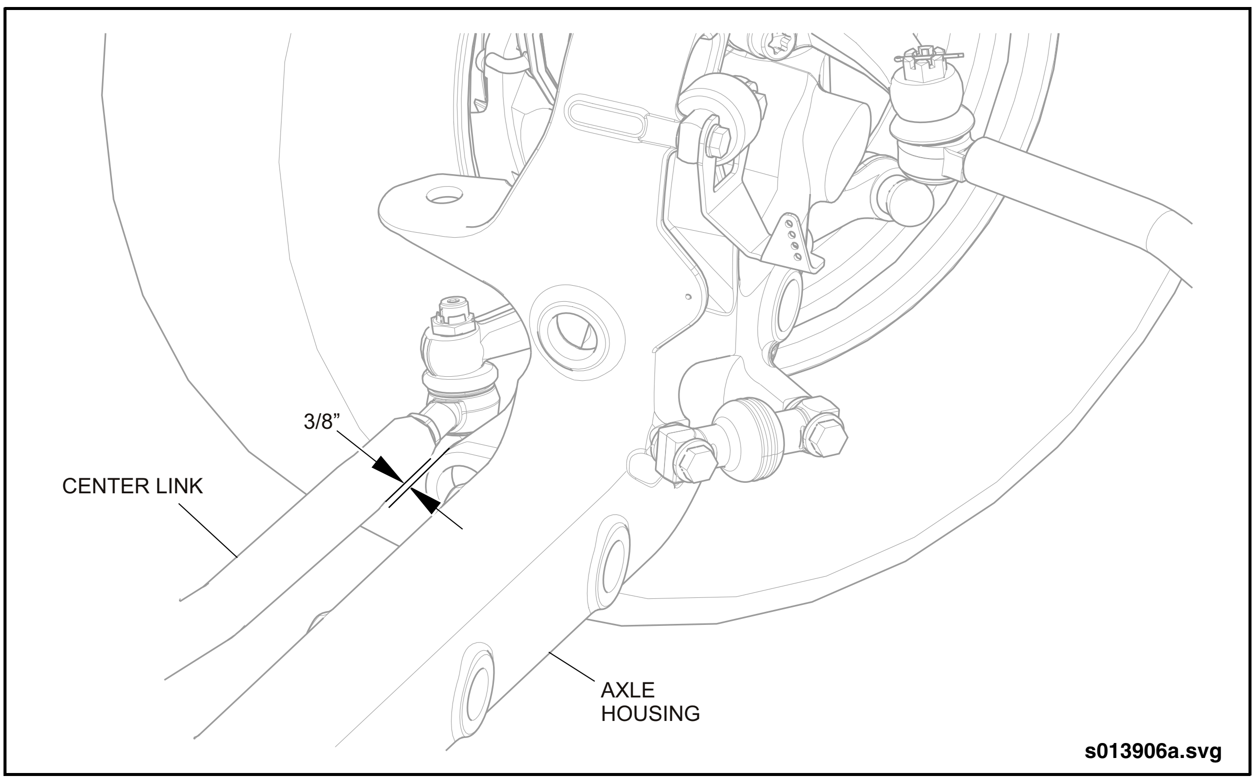


Fig. 3-2: Center Link to Axle Housing Clearance

2.5.1.2. Automatic Plunger Adjustment

The automatic plungers are preset at the factory and do not require adjustment unless the mechanical steering stop setting has changed. Reset the automatic plungers as follows:

1. Park the vehicle on level ground, set the parking brake, and chock the rear wheels.
2. Raise the front axle until the tires clear the ground. Refer to the General Information section of this manual for further information on the jacking procedure.
3. Remove the plastic cap from both steering gear plungers.

CAUTION

Carefully insert the tools into the bore to ensure the bore is not damaged during bottoming of plungers. DO NOT use a screwdriver to perform this procedure. DO NOT use excessive force when seating the plunger.

4. Carefully insert a Punch (Item 1 from the Special Tools List) into the front plunger hole and use a mallet to drive in the plunger until the tool bottoms out against the housing. See “Fig. 3-33: Special Tools” on page 53.
5. Carefully insert Adjustment Tool (Item 2 from the Special Tools List) into the rear plunger hole and drive in the plunger until the bolt bottoms in the tool.
6. Start the vehicle and slowly turn the wheels fully left with the tires still off the ground. Continue turning the wheel until the mechanical stop is reached. This will reset the automatic plunger.
7. Repeat the previous step, except turn the wheel fully right.
8. Return the wheels to the straight ahead position.
9. Shut off the engine and lower the vehicle.
10. Remove chocks from rear wheels.

2.5.2. Front Axle Setback

Front axle setback must be checked and adjusted to ensure that the front axle is 90° to the vehicle centerline and tracks properly.

Setback Specification ....0.0 ± 0.1°

1. Park vehicle on level surface and set parking brake.
2. Install computerized alignment equipment.

☞NOTE:

The vehicle wheel alignment and setback angle were adjusted at the factory using computerized equipment. New Flyer recommends the use of similar equipment when performing alignments.

3. Check setback angle on computer screen. Ensure reading is within specification.

☞NOTE:

An out-of-specification positive reading indicates shimming is required on the streetside upper radius rod. An out-of-specification negative reading indicates shimming is required on the curbside upper radius rod.

4. Select shims as required to correct adjustment to specifications. Each shim consists of an M14 hardened washer that measures 0.10" thick.

☞NOTE:

DO NOT exceed three shims in any one location, as this will affect bolt thread engagement. ALWAYS place shim between the cross-pin of the upper/lower radius rod and the vehicle frame.

5. Loosen radius rod to frame attaching bolts on the side requiring adjustment. See “Fig. 3-3: Front Setback Angle Adjustment” on page 8.

☞NOTE:

Adjust the number of shims equally on the upper and lower radius rods so as not to disturb the caster angle.

6. Remove one bolt and use a pry bar to force radius rod away from mount.
7. Install shim and bolt. Thread bolt part way into bolt hole.
8. Repeat procedure at other bolt.
9. Torque radius rod bolts to specification. Refer to Section 1 of this manual for front suspension torque specifications.
10. Recheck setback angle to ensure it conforms to specification.
11. Check and adjust caster angle as necessary.

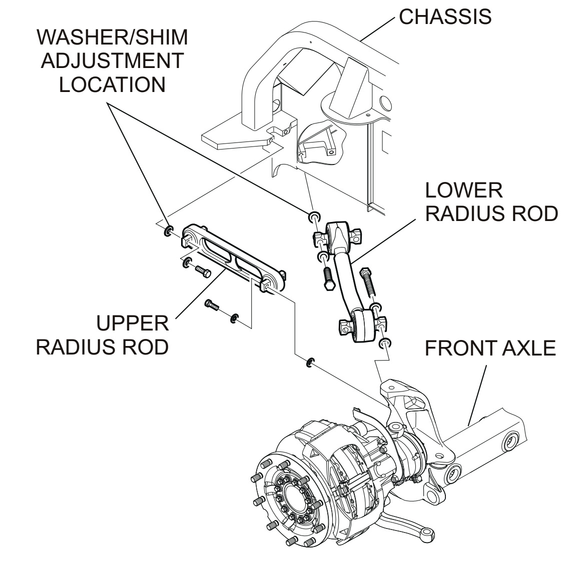


Fig. 3-3: Front Setback Angle Adjustment

2.5.3. Rear Axle Thrust Angle

Rear axle thrust angle must be checked and adjusted to ensure that the rear axle is 90° to the vehicle centerline and tracks properly.

Thrust Angle Specification ....0.0 ± 0.1°

1. Park vehicle on level surface and set parking brake.
2. Install computerized alignment equipment.

☞NOTE:

The vehicle wheel alignment and thrust angle were adjusted at the factory using computerized equipment. New Flyer recommends the use of similar equipment when performing alignments.

3. Check thrust angle on computer screen. Ensure reading is within specification.

☞NOTE:

An out-of-specification positive reading indicates shimming is required on the streetside upper/lower radius rod. An out-of-specification negative reading indicates shimming is required on the curbside upper/lower radius rod.

4. Select shims as required to correct adjustment to specifications. The shims consist of a 3/4" hardened washer that measures 0.125" thick.

☞NOTE:

DO NOT exceed three shims in any one location, as this will affect bolt thread engagement. ALWAYS place shim between the cross-pin of the upper/lower radius rod and the vehicle frame.

5. Loosen radius rod to frame attaching bolts on the side requiring adjustment. See “Fig. 3-4: Rear Thrust Angle Adjustment” on page 10.

☞NOTE:

Adjust the number of shims equally on the upper and lower radius rods so as to not disturb pinion angle.

6. Remove one bolt and use a pry bar to force radius rod away from mount.
7. Install shim and bolt. Thread bolt part ways into bolt hole.
8. Repeat procedure at other bolt.
9. Torque radius rod bolts to specification. Refer to Section 2 of this manual for rear suspension torque specifications.
10. Recheck thrust angle to ensure it conforms to specification.

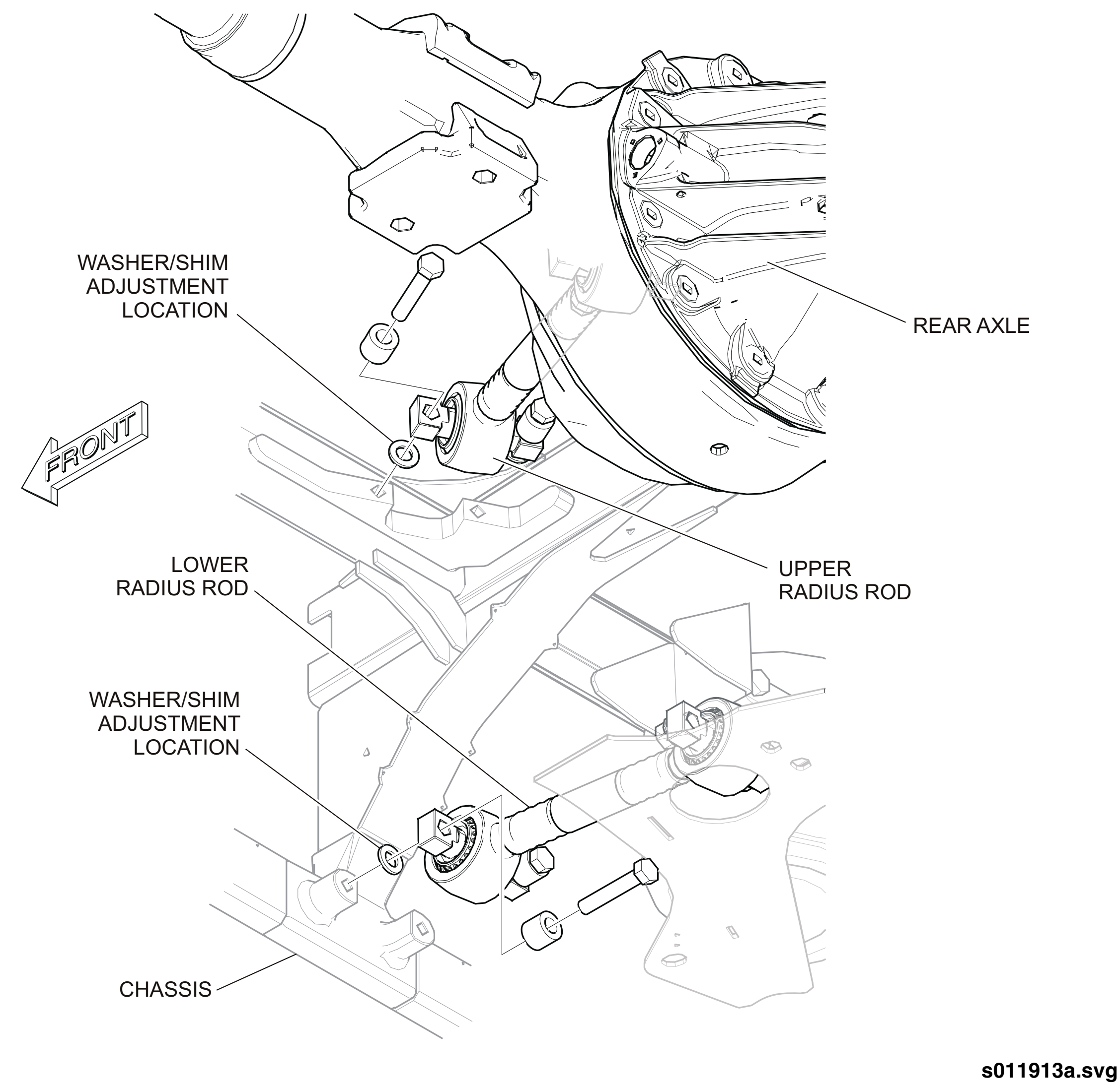


Fig. 3-4: Rear Thrust Angle Adjustment

2.5.4. King Pin Inclination

Specification ....7°

King pin (or steering axis) inclination is the angle measured between the center line of the king pin and the vertical position (as viewed from the front of the vehicle). The king pin inclination and the camber angle put the approximate center of the tire tread in contact with the road. This reduces steering effort and improves directional stability. See “Fig. 3-5: King Pin Inclination” on page 11.

Use an alignment machine to check king pin inclination angle. Follow machine manufacturer’s procedures. The king pin inclination is not adjustable. If the inclination is not at the specified angle, check axle beam and knuckle for damage. Service as necessary.

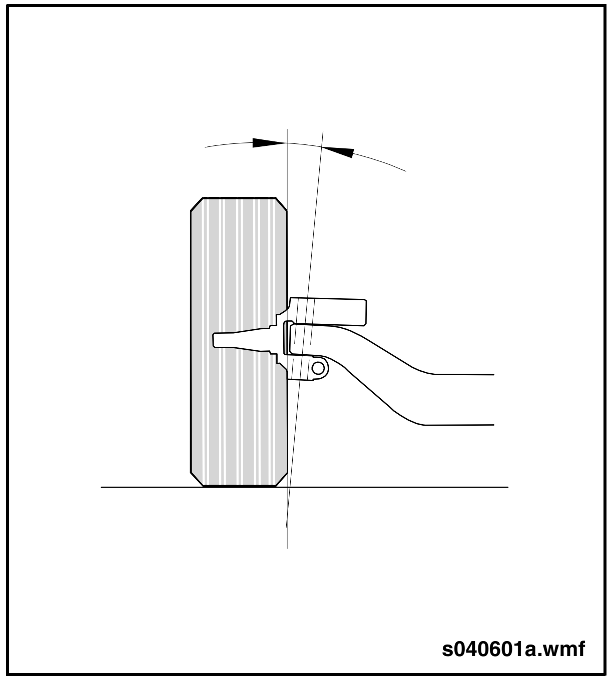


Fig. 3-5: King Pin Inclination

2.5.5. Camber Angle

Specification .... 1.0° (not adjustable)

CAUTION

The camber angle is not adjustable. NFI does not recommend changing the camber angle or bending the axle beam. If the axle beam is bent to change the camber angle, the strength of the axle is reduced and the warranty is voided. The axle may be damaged if bent. An axle damaged by bending may cause a vehicle accident and personal injury.

Camber is the angle of the tire with respect to the ground. Camber is positive when the distance between the top of the wheels is greater than the distance at the ground. A small amount of positive camber is built into the knuckle because camber changes with load. This results in a zero camber angle when the vehicle is operated at the normal load. If camber is out-of-specification by more than 1-1/2°, tire wear will occur. See "Fig. 3-6: Camber Angle" on page 12.

The camber angle is not adjustable. The camber angle is machined into the axle beam. If camber angle is not at the specified angle, check the axle beam and the steering knuckle for damage. Service as necessary.

Use an alignment machine to check the camber angle. Follow machine manufacturer's procedures.

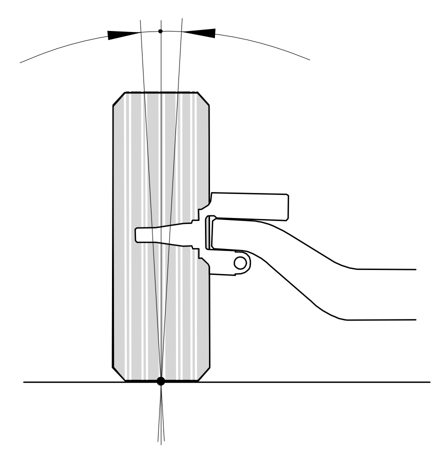


Fig. 3-6: Camber Angle

2.5.6. Caster Angle

Specification .... 3 ± 0.2° (RH)
....3 ± 0.2° (LH)

The caster angle is the angle from the vertical position to the center line of the king pin when seen from the side of the vehicle. See “Fig. 3-7: Caster Angle” on page 13. If the top of the king pin axis is toward the rear of the vehicle, the caster is positive.

Positive caster creates a self-aligning movement to stabilize the vehicle when driving straight ahead. If caster is too much, steering effort will increase or may amplify a shimmy condition.

Left and right-hand caster can be set independently. Adjust caster angle as follows:

1. Park vehicle on level surface and set parking brake.
2. Install computerized alignment equipment.

☞NOTE:

The vehicle wheel alignment angles were adjusted at the factory using computerized equipment. New Flyer recommends the use of similar equipment when performing alignments.

3. Check caster angle on computer screen. Ensure reading is within specification.

☞NOTE:

Excessive positive caster reading indicates shims need to be either removed from the upper radius rod or added to the lower radius rod. Insufficient positive caster reading indicates shims need to be either added to the upper radius rod or removed from the lower radius rod. In order to determine the location where shims should be added or removed, determine the existing front axle setback angle and assess which method will be most advantageous to keeping setback angle within specification.

4. Select shims as required to correct adjustment to specifications. Each shim consists of an M14 hardened washer that measures 0.10" thick.

☞NOTE:

DO NOT exceed three shims at any one location. Ensure that adequate bolt thread engagement remains with the addition of shims. ALWAYS place shim between cross-pin of the radius rod and the vehicle frame.

5. Loosen radius rod to frame attaching bolts on the radius rod requiring adjustment.
6. Remove one bolt and use a pry bar to force radius arm away from mount.
7. Install shim and bolt. Thread bolt part ways into bolt hole.
8. Repeat procedure at other bolt.
9. Torque radius rod bolts to specification. Refer to Section 1 of this manual for front suspension torque specifications.
10. Recheck caster angle to ensure it conforms to specification.

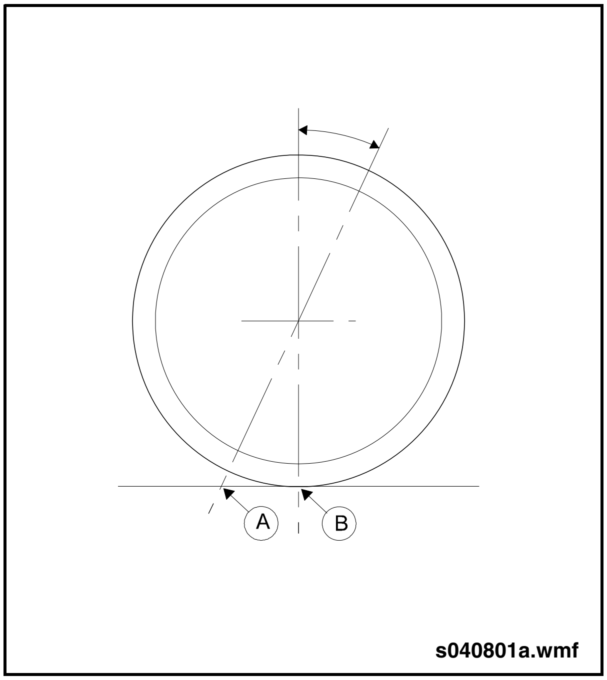


Fig. 3-7: Caster Angle

2.5.7. Toe-In Adjustment

Specification ....0.0 to 0.08"(total toe)
....0.0 to 0.04 (RH)
.... 0.0 to 0.04 (LH)

Toe is the relationship of the distance between the front of the front tires and the rear of the front tires. When the front distance is less than the rear distance, the wheels are "toed-in". Toe-in is designed into the vehicle to counteract the tendency of the tires to toe-out when the vehicle is driven. Incorrect toe-in will result in rapid tire wear.

⚠ CAUTION

Most tire wear is caused by incorrect toe settings. DO NOT change camber or caster settings to correct tire wear problems. If the axle assembly is bent to change caster or camber, the strength of the axle is reduced and the warranty is voided. An axle damaged by bending may cause a vehicle accident and personal injury.

1. Use an alignment machine to check toe setting. Follow machine manufacturer's procedures.

☞NOTE:

DO NOT measure toe-in with the front axle in the raised position. The weight of the vehicle must be on the front axle when toe-in is measured.

2. If the toe measurement is not at the specified distance, refer to the following procedure;
   a. Loosen the tube clamp nut and bolt on the end of the Center Link.
   b. Rotate adjusting sleeve on Center Link until the specified toe-in distance is obtained.
   c. Tighten the nut and bolt on the end of the Center Link to 125 ft-lb. (170 Nm).

2.6. Ride Height

2.6.1. Description

Ride height is measured between the axle and the rubber stop mounted to the frame of the vehicle. See “Fig. 3-8: Ride Height Adjustment” on page 15. Specifications are as follows:

- ❒ Front Ride Height - 4.0" (Dim A)
- ❒ Rear Ride Height - 3.8" (Dim B)

☞NOTE:

Fabricate square spacers of corrugated cardboard to assist in measurement.

Vehicle ride height is adjusted by changing the length of the leveling valve link arm or by changing the link arm anchoring hole position in the link arm anchor mounting bracket. There are two leveling valves at the rear of the vehicle and one at the front. Adjustments on the two rear link arms change the tilt of the vehicle as well as the ride height. Adjustments on the front link arm changes height only.

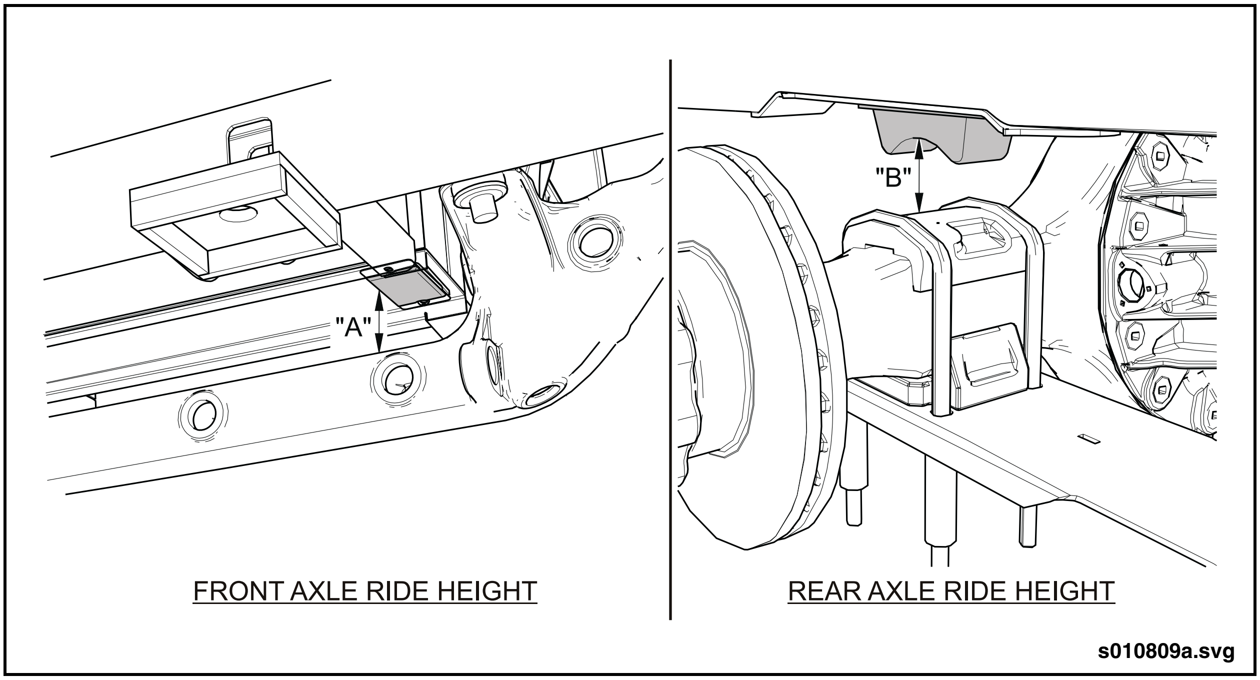


Fig. 3-8: Ride Height Adjustment

2.6.2. Measurement & Adjustment

☞NOTE:

If ride height measurements indicate the vehicle is tilted, correct tilt through height adjustment on the rear axle only.

1. Check for restricted air lines which impair leveling valve operation.
2. Bring air suspension to normal operating pressure.
3. Measure ride height at specified points.
4. If ride height does not meet specifications adjust to specified height as follows:
   a. Loosen the gear clamp on the leveling link.
   b. Set the ride height of the vehicle by manually moving the leveling valve lever until the specified ride height is achieved.
   c. Return leveling valve lever to the neutral position and tighten the gear clamp on the leveling link.
5. Replace leveling valve if it fails to maintain set vehicle ride height.

2.7. Steering Column

2.7.1. Removal

⚠ WARNING

NEVER remove the steering column upper retaining ring. This could lead to loss of components.

1. Telescope the steering column out to its most outward position, and center the steering wheel.
2. Tilt the column all the way down, and pull the upper cover off by grasping the cover at the bottom, closest to the dash. See “Fig. 3-9: Steering Column Installation” on page 17.
3. Tilt the column all the way up, and pull the lower cover off by grasping cover at the bottom, closest to the dash.
4. Pry out horn button and disconnect horn wire.
5. Remove steering wheel retaining nut if steering wheel is to be removed.
6. Use a puller to remove steering wheel.
7. Unbolt U-joint under floor board. Remove steering column clamps.
8. Disconnect wiring attached to column.
9. Remove steering column from vehicle. See “Fig. 3-10: Steering Column Assembly” on page 18.

1. Steering Column Assembly
2. Screw, Socket Cap 5/16" - 18 x 3 1/2" Lg.
3. Support, Steering Column
4. Bolt, Hex 3/8" - 16 UNC x 3/4" Lg.
5. Washer, Flat 3/8"
6. Loctite, 272 Threadlock
7. Miter Box Assembly, 90°
8. Support, Lower Column
9. Shaft Assembly, Upper
10. Shaft Assembly, Lower
11. Screw, PH Cross Recess Tpg. Type F 1/4" - 20 UNC x 2" Lg.
12. Nut, Lock Nylon 5/16" - 18 UNC
13. Clamp, Steering Column Fore
14. Clamp, Steering Column Aft
15. Screw, PH Cross Recess Tpg. Type AB 1/4" x 1" Lg.
16. Steering Wheel
17. Ground Wire Assembly
18. Button, Horn w/Logo
19. Washer, Flat 5/16"
20. Bracket, Steering Column Cover
21. Terminal
22. Tube, Heat Shrink 0.25" I.D. SST
23. Loctite, 425 Threadlocker Blue

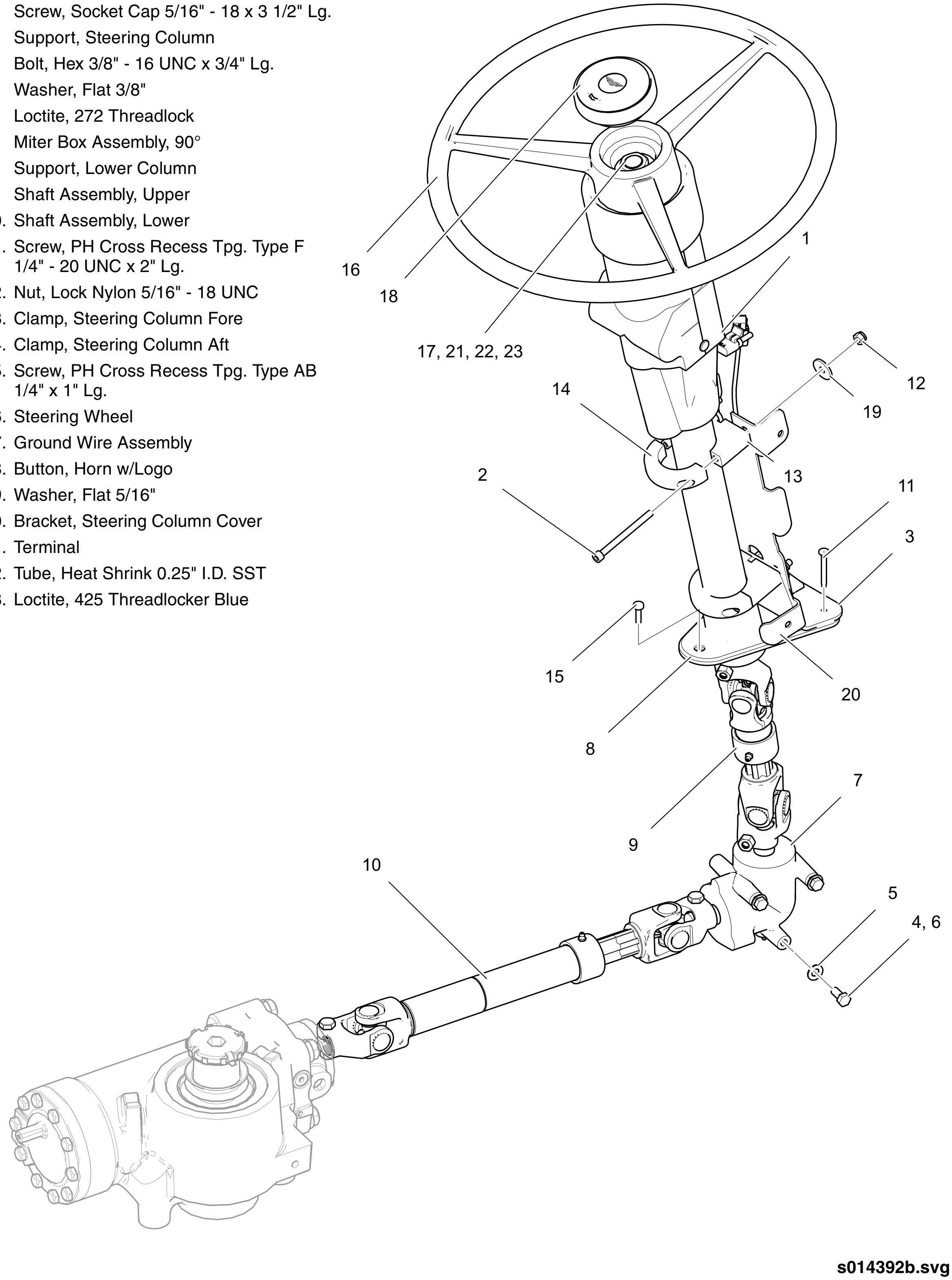
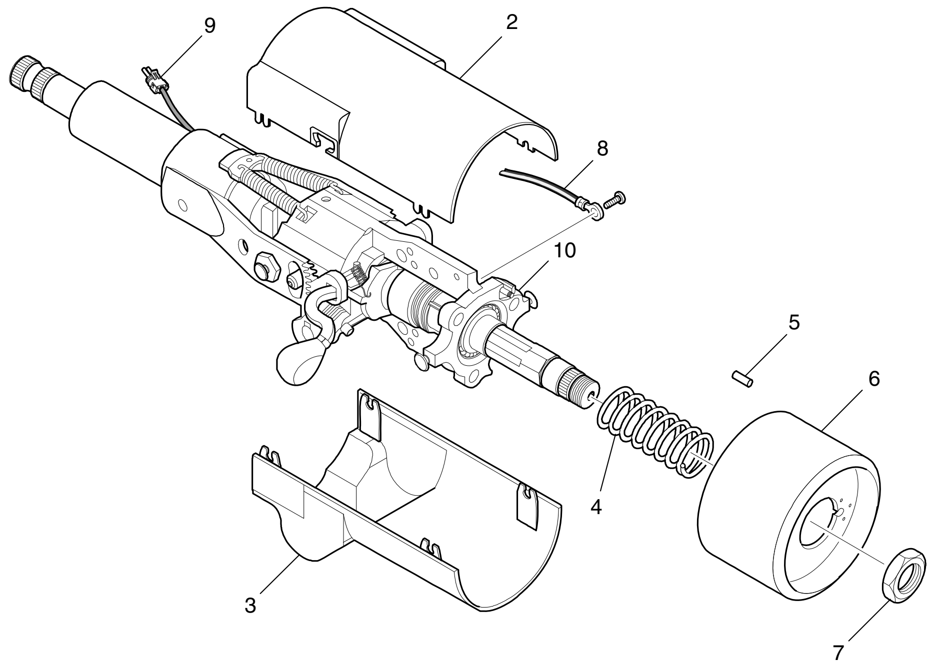


Fig. 3-9: Steering Column Installation



1. Steering Column Assembly (Incl. 2...10)
2. Cover, Upper
3. Cover, Lower
4. Spring
5. Tool, Puller
6. Cover Assembly, Gap Hider
7. Nut, Hex 7/8"
8. Wire Harness Assembly
9. Connector, 2 Way Tower
10. Steering Column, Service Assembly

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Fig. 3-10: Steering Column Assembly

2.7.2. Installation

1. Install steering driveshaft if previously removed. Refer to 2.8. "Steering Driveshafts" on page 23 in this section for installation procedure.
2. With the help of an assistant, install the steering column and loosely install the upper and lower steering column clamps. Ensure the splines on the end of the steering column fully engage the driveshaft clamp.
3. Measure the distance between the tilt pivot point on the steering column and the driver's platform flooring. Pull up on the steering column until the tilt pivot point is 19.79" from the floor. Torque the nuts on the upper and lower steering column clamps to 17 ft-lb. (23 Nm).
4. Torque driveshaft clamp bolts to 50 ft-lb. (68 Nm).
5. Center and install steering wheel and steering wheel nut. Torque nut 60 ± 5 ft-lb. (82 ± 7 Nm).
6. Tilt the column all the way up and reinstall the lower cover.
7. Tilt the column all the way down and reinstall the upper cover.
8. Hook up and install horn button.

2.7.3. Knob Replacement

2.7.3.1. Removal

Loosen the 5/16" nut, and then remove knob by turning it in a counter-clockwise direction.

2.7.3.2. Installation

Thread the new knob on by turning it in the opposite direction. Retighten the 5/16" nut until it contacts the knob. Turn the nut 1/4 turn to tighten it.

2.7.3.3. Functional Test

1. Tilt and telescope the column to ensure the column still functions properly.
2. Pull up and push down on the steering wheel to ensure the shaft and retaining rings are seated properly
3. Test the horn to ensure that it is still functioning properly.
4. Turn the steering wheel from full left to full right lock to lock to ensure that the column rotates freely.

☞**NOTE:**

Refer to 2.7.1. “Removal” on page 16 *and* Refer to 2.7.2. “Installation” on page 18 *in this section to remove the steering column and replace it with a new one if there are any abnormalities felt as the steering wheel is turned. DO NOT attempt to drive the vehicle with a malfunctioning steering column.*

2.7.4. Horn Ring Lubrication

☞**NOTE:**

This procedure is used to apply dielectric grease to the horn contact ring

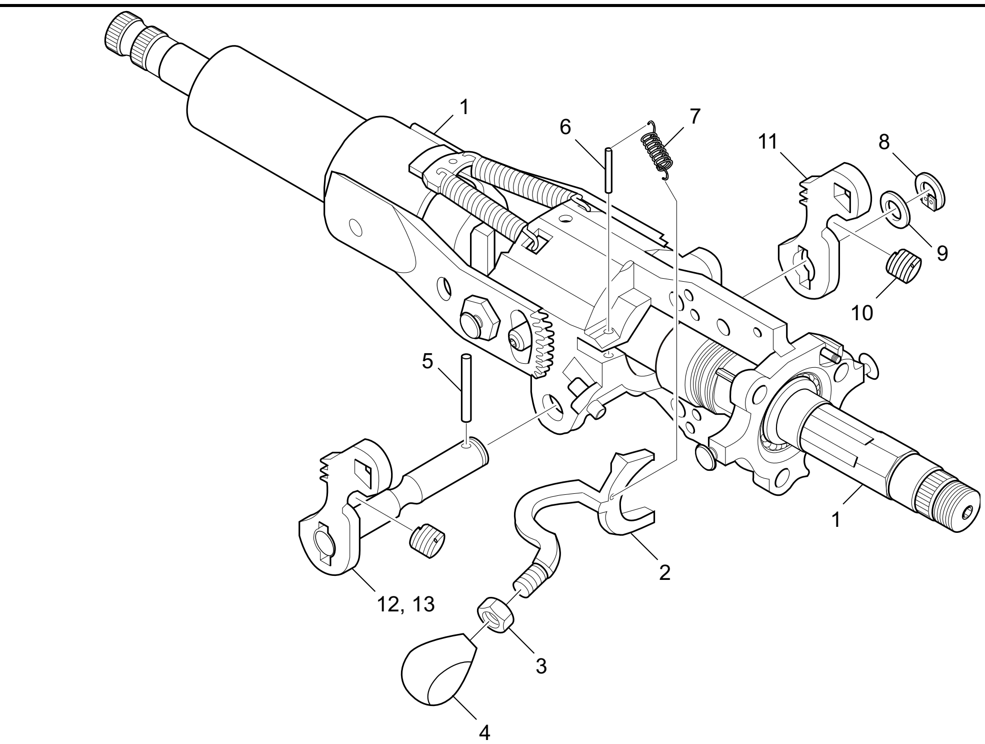
1. Telescope the column out toward the driver.
2. Tilt the column all the way down and pull the upper cover off by grasping the cover at the bottom, closest to the dash.
3. Tilt the column all the up and pull the lower cover off, similar to removing the upper cover.
4. Start the engine so the hydraulic system is active and the steering wheel can move easily.
5. Locate the contact ring
6. Using a soft brush, apply the grease liberally (so that contact ring is completely covered) while turning the steering wheel slowly.
7. Reinstall the upper and lower covers in the reverse order that they were removed.

2.7.4.1. Functional Test

Ensure horn is working by verifying its activation at all tilt and telescoping angles and positions.

2.7.5. Rod & Pawl Replacement

1. Telescope the steering column out to its most outward position.
2. Tilt the column all the way down, and pull the upper cover off by grasping the cover at the bottom, closest to the dash.
3. Tilt the column all the way up, and pull the lower cover off by grasping cover at the bottom, closest to the dash.
4. Remove the retaining ring and washer from end of pawl rod. See “Fig. 3-11: Rod & Pawl Removal” on page 20.
5. Remove pawl from end of rod assembly. Use a plastic hammer to tap rod out of pawl if necessary. Remove spring from pawl.
6. Pull roll pin out of rod.
7. Tilt steering column all the way up and remove knob from end of actuating lever.
8. Slide rod and pawl assembly off actuating lever and casting. Remove spring from pawl.
9. Install spring on replacement rod and pawl and slide rod end into casting. Ensure triangular hole in pawl slides over actuating lever.
10. Install roll pin into hole on end of rod and pawl assembly. Ensure roll pin sticks out an equal distance on either side of shaft.
11. Install spring on pawl and slide pawl over roll pin end of shaft.
12. Install washer and snap ring.
13. Install knob on tilt lever and secure with lock nut.
14. Tilt the column all the way up and down to ensure the pawl releases completely and engages fully with the teeth on the yoke in the locked position.
15. Install upper and lower covers.



1. Steering Column, Service Assembly (Incl. 2...12)
2. Actuator
3. Nut, Lock
4. Knob
5. Pin
6. Pin
7. Spring
8. Ring, Retaining
9. Washer
10. Spring
11. Pawl
12. Rod & Pawl Assembly
13. Grease

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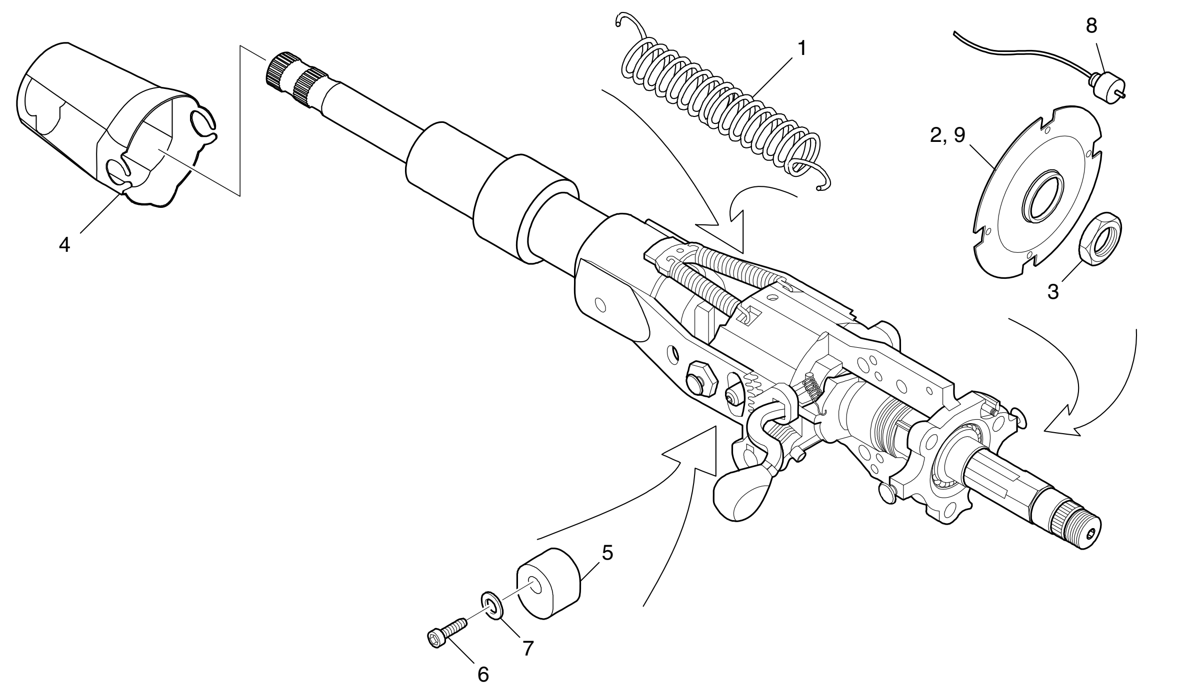
Fig. 3-11: Rod & Pawl Removal

2.7.6. Actuating Lever Replacement

1. Remove rod and pawl assembly Refer to 2.7.5. “Rod & Pawl Replacement” on page 20 in this section for procedure.
2. Remove the roll pin retaining actuating lever to casting.
3. Remove spring from actuating lever.
4. Install spring on replacement lever.
5. Position lever on casting and install roll pin through eye of spring and into casting
6. Install rod and pawl assembly.

2.7.7. Trough Cover Replacement

1. Remove steering column assembly from vehicle.
2. Slide trough cover off tilt bolts and remove from steering column. See “Fig. 3-12: Trough Cover Replacement” on page 21.
3. Install replacement trough cover on steering column and snap into place over tilt bolts.
4. Install steering column.



1. Spring, Extension	4. Cover, Trough	7. Washer
2. Grease Kit	5. Tilt Stop	8. Brush, Horn
3. Nut, Hex 7/8"	6. Screw	9. Contact Assembly

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Fig. 3-12: Trough Cover Replacement

2.7.8. Gap Hider Cover Replacement

This procedure must be done with the column mounted in the vehicle.

1. Using a small flat headed screwdriver, remove the horn button and disconnect the horn wire.
2. Using the steering wheel nut socket, remove the steering wheel nut.
3. Using a steering wheel puller, remove the steering wheel.

☞NOTE:

Use the shaft protector provided in this kit to protect the setscrew from the steering wheel puller.

4. Remove the existing gap hider cover.
5. Install the new gap hider/cover making sure that the flats on the cover match the flats on the shaft. Also ensure that the spring cut end of the last coil is NOT seated on the horn contact.
6. Reinstall the steering wheel.
7. Reinstall the steering wheel nut, and torque to 60 ± 5 ft-lb. (82 ± 7 Nm).
8. Reconnect the horn wire, and reinstall the horn button.

☞NOTE:

Ensure that the horn wire is not trapped by any part of the assembly. The spring cut ends must be 180° away from both horn contacts. The housing and plate may have to be rotated to accomplish this.

9. Telescope the steering column all the way to the inner stops, and out to its outer stops, ensuring that the horn does not activate.
10. Ensure the horn works correctly when activated.

2.7.9. Functional Test

☞NOTE:

The following test must be done prior to test driving the vehicle. The following is to be completed with the steering column tilted all the way up, all the way down, and in its center position.

1. Start the vehicle to activate the hydraulic steering system.
2. Rotate the steering column from full left to full right.
3. While rotating the wheel listen and feel for the following;
   a. Ensure that the rotation does not lock at any point.
   b. Feel for ease and or variation in rotation.
   c. Listen for any unusual noises (snapping, cracking, or popping) as the steering wheel is being rotated.

☞NOTE:

If any of the above are present the steering column must be replaced.

4. Telescope the column to ensure that the telescopic function was not damaged at any point during the removal. Ensure that the column telescopes up and down freely, while moving it in to its Inner stops and then out to its outer stops.
5. During the test drive check the following;
   a. Ease and or variation in rotation.
   b. Ensure the wheel begins to return to the center after turning a corner.
   c. Ensure the wheel does not lock.
   d. Listen for any usual noises during steering wheel operation.

☞NOTE:

If any problems are encountered during this procedure the steering column must be replaced.

2.8. Steering Driveshafts

2.8.1. Description

The steering system uses two sliding driveshaft assemblies to transmit steering inputs from the steering column to the power steering gear. The upper, vertically mounted, shaft is connected to the steering column by means of a universal joint with a splined clamp arrangement.

The lower end of the shaft is similarly attached to the input shaft of the miter box.

The lower, horizontally mounted, driveshaft is connected to the output shaft of the miter box with a splined clamp and universal joint arrangement. The aft end of the driveshaft is similarly attached to the power steering box. The sliding spline configuration allows the shafts to accommodate variations in operating lengths due to angular movements of the shafts.

2.8.2. Removal

2.8.2.1. Upper Vertical Shaft

1. Loosen upper shaft clamp bolt and slide shaft down from steering column.
2. Loosen lower shaft clamp bolt and slide shaft up from miter box input shaft.

2.8.2.2. Lower Horizontal Shaft

1. Loosen forward driveshaft clamp bolt and slide driveshaft off miter box output shaft.
2. Loosen aft driveshaft clamp bolt and slide driveshaft off of steering box shaft.

2.8.3. Installation

2.8.3.1. Upper Vertical Shaft

☞**NOTE:**

Ensure the arrows painted on each half of the driveshaft are in phase (pointing towards each other) when the driveshaft is installed. If a new driveshaft is being installed, DO NOT remove the plastic retaining straps until installation is complete.

1. Install lower universal joint clamp over miter box input shaft. Tighten clamp bolt to 50 ft-lb. (68 Nm).
2. Install upper universal joint clamp over steering column shaft. Tighten clamp bolt to 50 ft-lb. (68 Nm).

2.8.3.2. Lower Horizontal Shaft

1. Install aft universal joint clamp over steering box shaft. Tighten clamp bolt 50 ft-lb. (68 Nm).
2. Install forward universal joint clamp over miter box output shaft. Tighten clamp bolt 50 ft-lb. (68 Nm).

2.8.4. Functional Tests

☞**NOTE:**

Perform the following test prior to test driving the vehicle to ensure the steering system does not bind or lock up.

1. Lock the tilt steering in the center position.
2. With the engine running and the wheels on the ground steer to a full left and full right turn.
3. Check for ease of rotation while steering and listen for any abnormal noises.
4. Repeat the steering check with the column tilted and telescoped to the uppermost and lowermost positions.

⚠CAUTION

Correct any problems before test driving the vehicle.

5. Perform an inspection of the steering driveshafts and recheck the clamp torques. Apply witness marks to the properly torqued fasteners ensuring the marks cross the bolt-head, driveshaft clamp and the nut.

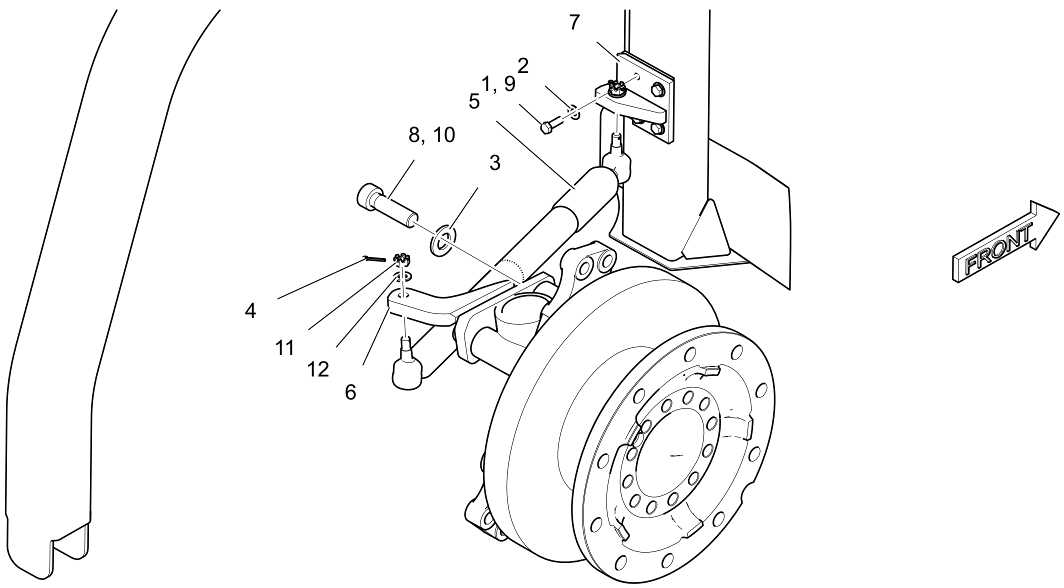
2.9. Steering Damper

2.9.1. Description

The steering damper is installed horizontally between the front axle curbside steering arm and the chassis.

2.9.2. Operation

The steering damper is intended to absorb any irregular steering inputs that may be caused by bad road conditions or emergency vehicle response maneuvers. The steering damper will assist in maintaining safe control of the vehicle. See "Fig. 3-13: Steering Damper Installation" on page 24.



1. Bolt, Hex 3/8" - 16 UNC x 1" Lg.
2. Washer, Flat 3/8"
3. Washer, Flat Hardened 7/8"
4. Pin, Cotter 1/8" NOM 1.0" Lg.
5. Damper, Short Steering w/Sleeves
6. Mounting, Steering Damper Rear
7. Mounting, Steering Damper Front
8. Loctite, 263 Red Threadlocker
9. Never Seize
10. Screw, Torx Cap M22 x 1.5 x 75
11. Nut, Castle M12 x 1.5
12. Washer, M12 x 24 x 2.5

s126402a.svg

Fig. 3-13: Steering Damper Installation

2.9.3. Steering Damper Specifications

Center-to-center dimensions of ball joint ends (Extended) .... 32.28" (820mm)

Center-to-center dimensions of ball joint ends (Compressed) .... 20.55" (522mm)

Force on Extension ....450 lbs.

Force on Compression.....................450 lbs.

Ball Joint Pin Taper 1:10

2.9.4. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled inspection intervals and procedures.

2.9.5. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Raise the vehicle and support it on safety stands. Refer to the General Information Section of this manual for procedure.
3. Remove cotter pins from steering damper ball joints.
4. Remove castle nuts and washers.
5. Use an appropriate tool to separate steering damper from mount assemblies. Exercise care to prevent damaging the ball joint.

2.9.6. Installation

1. If steering damper mounting brackets were removed, reinstall as follows:
   a. Reinstall the bracket to the vehicle frame and torque fasteners to 35 ft-lb. (47 Nm) with Never Seize.
   b. Reinstall the bracket to the axle and torque fasteners to 260 ft-lb. (352 Nm) with Loctite.

   ☞**NOTE:**

   Ensure tapered surfaces are clear of all foreign materials.

2. Install steering damper into steering damper mount assemblies with the bladder towards the front of the vehicle and the ball joints inserted from the bottom.
3. Install castle nuts and washers and torque to 55 ft-lb. (75 Nm) and tighten until cotter pin can be inserted.

   ☞**NOTE:**

   If unable to insert cotter pin, remove the washer and install without it.

4. Install cotter pins into steering damper ball joints to lock castle nuts in place.
5. Lower the vehicle.
6. Set the Battery Disconnect switch to the ON position.

2.10. Drag Link

2.10.1. Description

The drag link assembly consists of a tube and two maintenance-free ball joint ends. One end of the tube is threaded and the other end is crimped onto the ball joint end.

2.10.2. Drag Link Specifications

Center-to-center dimensions
of ball joint ends............ 33.03" (839mm)

Front ball joint (pitman arm)
socket pin taper 1:8

Rear ball joint (axle steering arm)
socket pin taper 1:10

2.10.3. Operation

The rotational output of the steering gear is transmitted axially through the Pitman arm and to the drag link. The drag link transmits this axial movement to the left steering knuckle, causing it to pivot on the king pin axis, and move the wheel.

2.10.4. Inspection

1. Inspect condition of tube for damage. Replace tube if damage is evident. Do not attempt to straighten.
2. Inspect condition of rubber boot on ball joint ends for splits, cuts, or other damage. Replace ball joint if damage would allow ingress of moisture or foreign matter.
3. Inspect ball joint ends for wear. Refer to the following procedure:
   a. Ensure that the steered wheels are in the straight-ahead position and are supporting the weight of the vehicle.
   b. Rock the steering wheel firmly in both directions against the resistance of the tires. The force should be sufficient to load the steering mechanism and joints.
   c. Visually examine the ball joints for excessive movement.

☞**NOTE:**

The ball joint is designed to have clearance between the socket seat and ball pin when unloaded. The ball joint will appear to move or "kick" when this clearance is taken up under load. DO NOT misinterpret this condition as excessive wear. Perform a ball joint end lift measurement to determine whether wear is within acceptable limits.

   d. Perform a ball joint end lift measurement by applying a load through the axis of the pin and measuring its movement relative to the socket body. See "Fig. 3-14: Ball Joint End Lift Measurement" on page 26. Refer to following table for wear limits.

☞**NOTE:**

Use a pry bar to apply the load against the ball joint in direction "B". Use a magnetic base dial indicator to measure the axial movement.

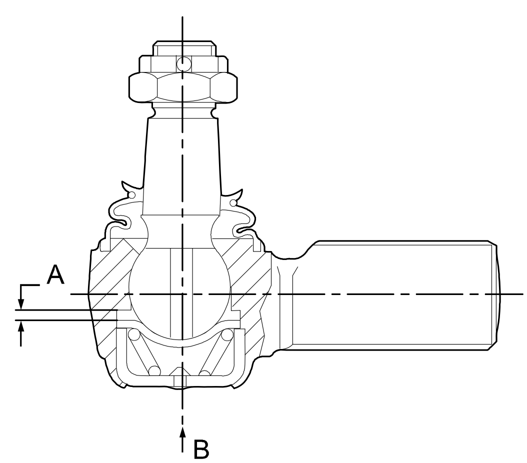


Fig. 3-14: Ball Joint End Lift Measurement

2.10.5. Ball Joint End Lift Measurement

BALL JOINT END LIFT MEASUREMENT			
Designed New End Lift	**Applied Check Load “B”**	**Max. Allowable Check Load**	**Max. Allowable End Lift “A”**
0.85 mm (0.033") max	1000 N (225 lb-force)	2200 N (495 lb-force)	2.0 mm (0.079")

WARNING

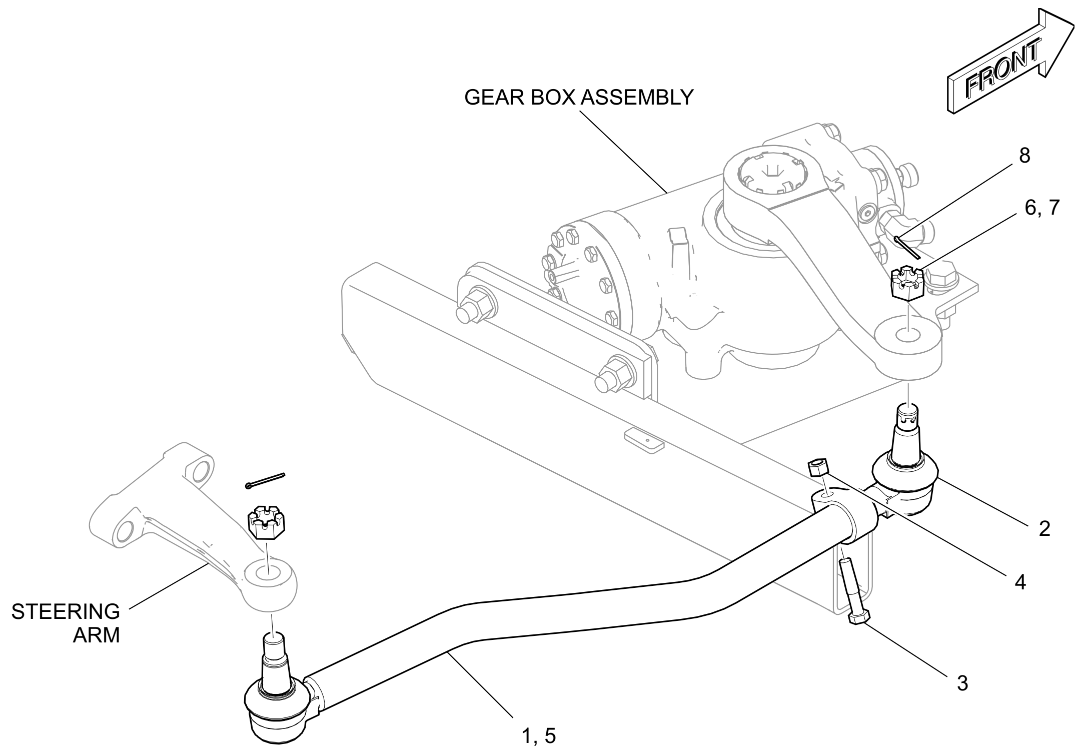
DO NOT exceed maximum checking load or damage to internal components of the ball joint could result.

2.10.6. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Raise the vehicle and support it on safety stands. Refer to the General Information Section of this manual for procedure.
3. Remove castle nuts. See "Fig. 3-15: Drag Link Installation" on page 28.
4. Use an appropriate tool to separate drag link from the axle steering arm and Pitman arm. Exercise care to prevent damaging the rubber boot.

☞NOTE:

The ball joint end that attaches to the axle steering arm is crimped onto the drag link and cannot be replaced individually.



1. Drag Link Assembly, (Incl. 2...6)
2. Socket Assembly
3. Bolt, M12
4. Nut, M12
5. Socket Assembly, Crimped
6. Nut, Castle
7. Never-Seez
8. Pin, Cotter

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Fig. 3-15: Drag Link Installation

2.10.7. Ball Joint Replacement

☞NOTE:

Only the ball joint installed into the steering gear's pitman arm can be replaced. If the ball joint on the axle's steering arm needs to be replaced, the entire drag link must be replaced.

1. Loosen the end clamp.
2. Unthread the ball joint end from the drag link.
3. Thread new ball joint into the drag link and ensure the center-to-center length is correct. See “Fig. 3-16: Drag Link Adjustment” on page 29.
4. Torque clamp 59 to 70 ft-lb. (80 to 95 Nm).

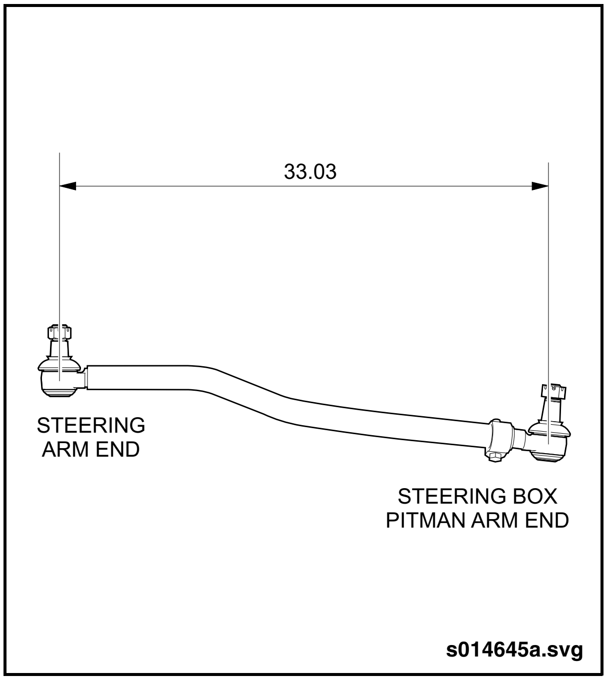


Fig. 3-16: Drag Link Adjustment

2.10.8. Installation

1. Adjust the ball joint end on the pitman arm end of the drag link so that it is in the same vertical plane as the crimped ball joint at the opposite end of the drag link.
2. Ensure center-to-center length is 33.03" (839mm).
3. Install drag link.

☞NOTE:

The front and rear ball joint ends have different socket pin tapers. Ensure that ball joint end with the shallow taper (1:8) is installed in the Pitman arm.

4. Use anti-seize compound on threads and torque castle nuts 95 to 115 ft-lb. (129 to 156 Nm).
5. Torque ball joint end clamp bolt 59 to 70 ft-lb. (80 to 95 Nm).

2.11. Steering Miter Box

2.11.1. Description

The steering miter box transfers inputs from the steering column to the lower (horizontal) steering driveshaft and to the steering gear box.

2.11.2. Steering Miter Box Specifications

Manufacturer.................. R.H. Sheppard Co.

Operating Angle.....................................90°

Lubrication ....Grease Fitting

Gear Ratio .... 1 to 1

Torque Rating ....400 in-lb.

2.11.3. Operation

The upper end of the steering miter box is attached to the steering column U-joint assembly and receives steering inputs from the steering wheel. A set of bevel gears in the steering miter box changes drive direction 90° and outputs through the lower steering driveshaft to the steering gear.

2.11.4. Removal

1. Raise vehicle and support on safety stands. Refer to the General Information Section of this manual for procedure.
2. Remove steering box access panel.
3. Working from underneath vehicle, remove U-joint clamping bolt at each end of the miter box.
4. Slide U-joints off gearbox input and output shafts.
5. Remove three bolts retaining gearbox to mounting plate and remove gearbox.

2.11.5. Installation

1. Position steering miter box on mounting bracket and install three mounting bolts. Apply Loctite-242 and torque bolts 25 to 30 ft-lb. (34 to 40 Nm).
2. Slide input and output shaft U-joints onto splined shafts of gearbox.
3. Install retaining bolts and torque 50 ft-lb. (68 Nm).
4. Install grease fitting. Lubricate with NLG2 chassis lube.

2.11.6. Functional Tests

1. Turn steering wheel to a full left and full right turn to check for free operation.
2. Test drive vehicle.

2.12. Power Steering Gear

2.12.1. Description

The power steering gear consists of a sector shaft, geared piston and torsion bar operated control valve installed in the steering gear housing. The assembly is bolted to the frame of the vehicle under the operator's platform.

2.12.2. Power Steering Gear Specifications

☞**NOTE:**

A number is cast into the steering gear housing and identifies the basic family to which the steering gear belongs. A serial number is also assigned to each steering gear. Stamped letters and numbers on an exposed machined surface of the housing opposite the mounting side, identifies the gear specification.

Manufacturer.................. R.H. Sheppard Co.

Input Torque............. 45 in-lb max @100 psi

Pressure Relief .... 1,850 psi (12,755 kPa)

Minimum Pump Flow .....3.5 gpm (16.1 L/m)

2.12.3. Operation

Steering wheel movement is transmitted to a 90° gear box and driveshaft to the power steering gear input shaft. In neutral the rotary valve is centered by a torsion bar and equal low pressure is applied to both ends of the steering gear piston. Hydraulic oil circulates at back pressure only and provides a cushion and cooling for the internal parts. Rotary valve actuation by the steering wheel working against the torsion bar causes higher pressure to build up on one end of the piston. This pressure differential causes the piston to move in the bore of the gear housing, transmitting a rotary motion to the output shaft and Pitman arm. The drag link transfers this movement to the front axle steering arm to steer the vehicle.

When steering rotation stops, the rotary valve returns to neutral. Automatic relief valve plungers unload the hydraulic pressure when wheels are in a full turn in either direction.

2.12.4. Power Steering Gear Troubleshooting

POWER STEERING GEAR TROUBLESHOOTING	
PROBLEM	**CAUSE**
Oil leak at steering input shaft.	Worn or damaged seal.
Oil leak at output shaft.	Worn or damaged sector shaft seal.
Oil forced out of reservoir or foaming.	Relief plungers not adjusted correctly creating high oil temperature.
Wheel full turn restricted.	Relief plungers not adjusted correctly.
Wheels turn hard in one direction.	Foreign material in relief ball seat in piston of steering gear.
Hard steering or no return to straight ahead from turns.	Steering gear mounting distorted.
Darting or wandering.	Air trapped in steering gear. Loose or worn internal parts.

2.12.5. Removal

1. Open the side console access door.
2. Raise vehicle to a suitable working height. Refer to the General Information Section of this manual for lifting procedure.
3. Open the three steering gearbox access doors.

☞NOTE:

The two hinged lower access doors may be removed at the hinged end to eliminate interference when working beneath the vehicle.

4. Loosen the clamp bolt and disconnect steering driveshaft from steering gear input shaft.

☞NOTE:

Mark relative position of U-joint with input shaft before removal.

5. Disconnect the pressure and return hoses and from steering gearbox and cap the hoses. See “Fig. 3-17: Steering Gearbox Removal & Installation” on page 33.
6. Remove cotter pin and castle nut retaining pitman arm to drag link and disconnect drag link from pitman arm using a two-jaw puller.

☞NOTE:

It may be necessary to loosen the five mounting bolts to allow sufficient movement of the steering gearbox and disengagement of the drag link.

WARNING

The steering gearbox weighs approximately 110 lbs. ALWAYS use appropriate lifting equipment and the assistance of another person when removing or installing the steering gearbox.

7. Position lifting equipment beneath the steering gearbox support plate and support the weight of the steering gearbox.

8. Remove fasteners that secure the support plate to the vehicle structure.

☞NOTE:

Use a shallow 1 1/8” socket to access the bolt head at the aft end of the support plate.

9. Carefully lower the steering gearbox from the vehicle and move to a work bench.

☞NOTE:

The pitman arm may need to be rotated and the steering gearbox angled upwards in order to clear the vehicle structure during the lowering and removal process.

10. Remove the five bolts and spacers that secure the support plate to the steering gearbox.

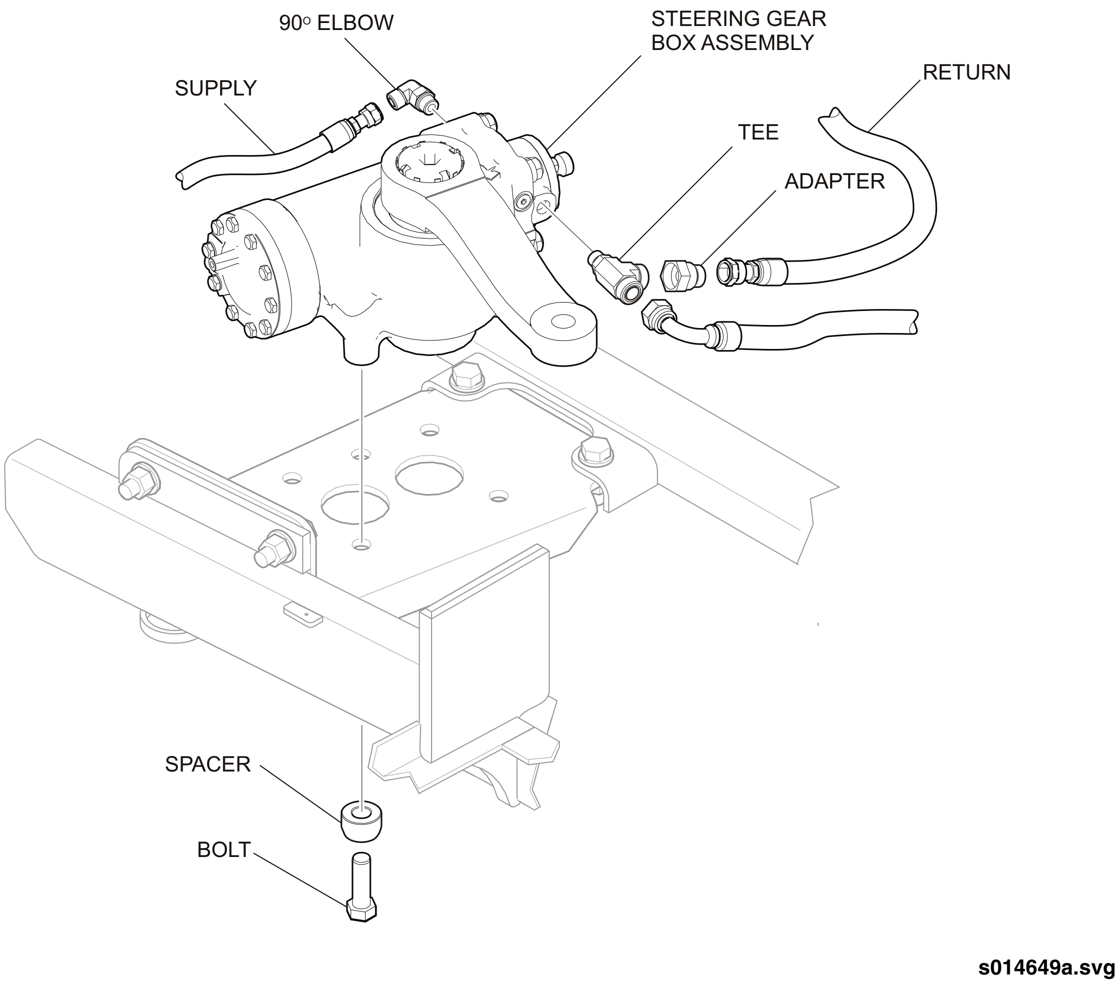


Fig. 3-17: Steering Gearbox Removal & Installation

2.12.6. Disassembly

1. Remove Pitman arm as follows:

   a. Use a small punch and ball peen hammer to bend out two locking tabs on Pitman arm retainer. Do not bend tabs located in slot on Pitman arm.

   b. Coat face of retainer with grease.

   c. Slide Pitman arm puller over Pitman arm and remove retainer. Retainer will act as a jack screw against puller to remove arm.

WARNING

The Pitman arm will be extremely tight. NEVER strike directly on the arm or apply any source of heat to it. Damage to the arm or sector shaft may result, which could lead to a vehicle accident. NEVER weld the Pitman arm or sector shaft.

2. Remove sector shaft rubber boot and snap ring cover. See “Fig. 3-18: Sector Shaft Boot & Cover Removal” on page 35.

   ☞NOTE:

   Use a small chisel or punch and tap lightly against the snap ring cover to remove.

3. Remove and discard the input shaft dust boot.

4. Remove sector shaft snap ring.

5. Remove dust cover from opposite end of sector shaft. See “Fig. 3-19: Sector Shaft Dust Cover Removal” on page 35.

6. Use a soft-faced hammer and tap on the opposite end of the sector shaft until bearing cap is driven out of gearbox housing.

7. Carefully slide sector shaft out of housing.

8. Remove O-ring and backup seal from bearing cap.

   ☞NOTE:

   Take care when removing the excluder seal. DO NOT damage the seal bore.

9. Remove internal excluder seals from the gearbox housing (sector shaft bore) and from the sector shaft bearing cap. See “Fig. 3-20: Cover & Sector Shaft Seal Removal” on page 36.

10. Use a center punch to make reference marks on the steering gear housing and the bearing cap housing to aid in reassembly. See “Fig. 3-21: Bearing Cap & Housing Reference Marks” on page 36.

CAUTION

DO NOT attempt to turn the shaft out of the piston. The recirculating balls must be removed before the shaft can be removed. Shaft damage will occur if it is forced out of the piston.

11. Remove attaching bolts from bearing cap. Turn input shaft until the plunger clears the piston.

CAUTION

The ball guide retainer must be held in place when sliding the piston out of the housing. Recirculating balls can be lost if the retainer is not held in place.

12. Carefully slide piston and bearing cap from housing bore until ball guide retainer is exposed.

    ☞NOTE:

    It may be necessary to rotate the piston to locate the ball guide retainer.

CAUTION

DO NOT crack the ball guide retainer during this operation.

13. Insert a small sheet metal screw into ball guide retainer until two or three threads of screw are engaged. Use small pliers to remove retainer from piston. See "Fig. 3-22: Ball Guide Retainer Removal" on page 36.

☞NOTE:

DO NOT remove the piston at this time. Leave it in the housing with the ball guide exposed.

14. Remove the ball return guides. The steel balls are then free to roll out of the ball cavity in the piston.
15. Carefully rotate shaft in and out several times to free all balls from piston.
16. After removing all 24 balls, remove bearing cap and input shaft from piston.
17. Carefully slide piston out of housing.

☞NOTE:

DO NOT force the shaft. The shaft will slide freely from the piston if all 24 balls are removed.

18. Remove the teflon piston ring and energizing O-ring from the piston.
19. Remove the seal ring and tetra seal from the bearing cap and shaft assembly.

⚠CAUTION

DO NOT disassemble the bearing cap and shaft assembly. There are no serviceable parts in this assembly. Only the input shaft seal is serviceable.

20. Remove cylinder head and discard seal ring and tetra seal.

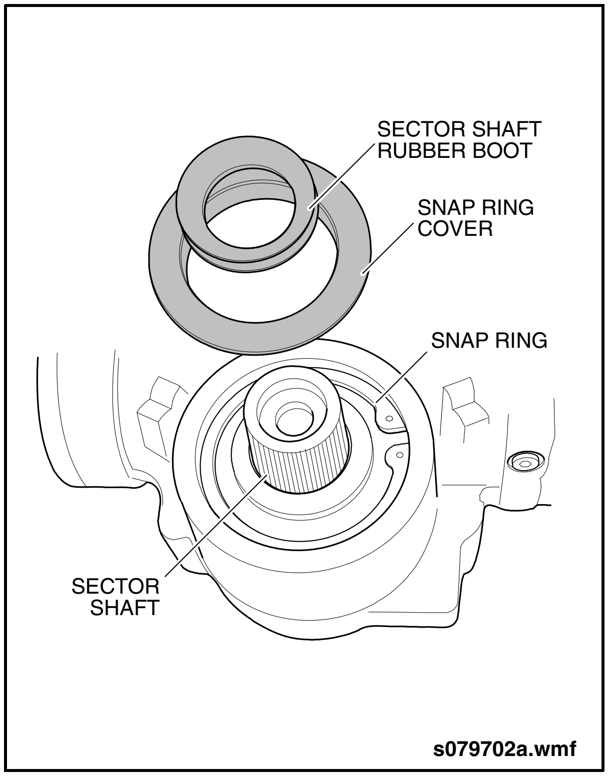


Fig. 3-18: Sector Shaft Boot & Cover Removal

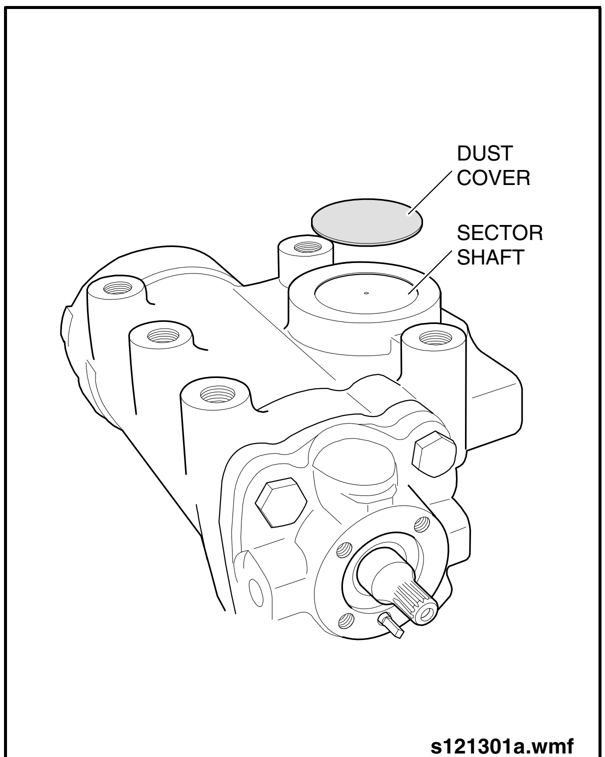


Fig. 3-19: Sector Shaft Dust Cover Removal

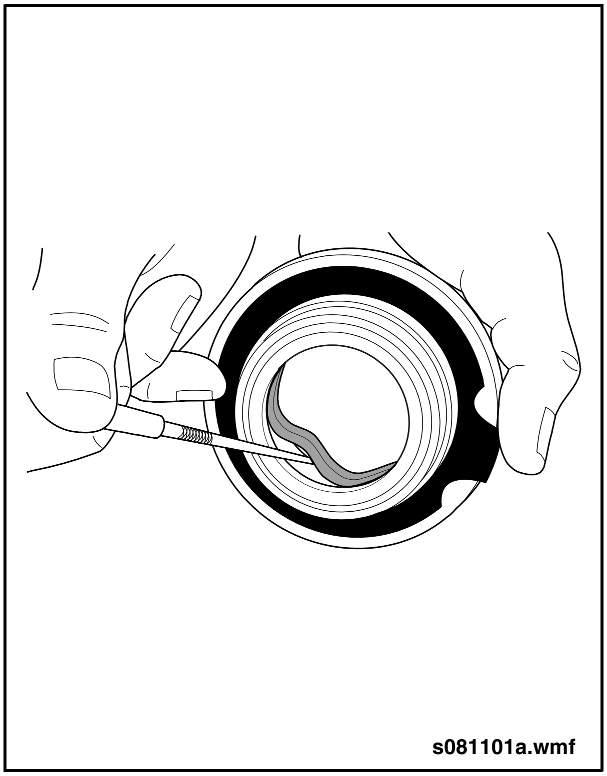


Fig. 3-20: Cover & Sector Shaft Seal Removal

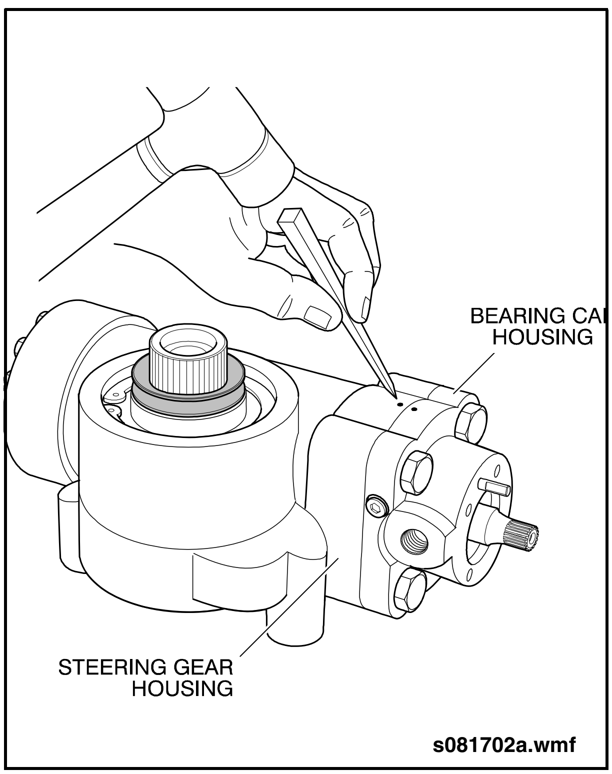


Fig. 3-21: Bearing Cap & Housing Reference Marks

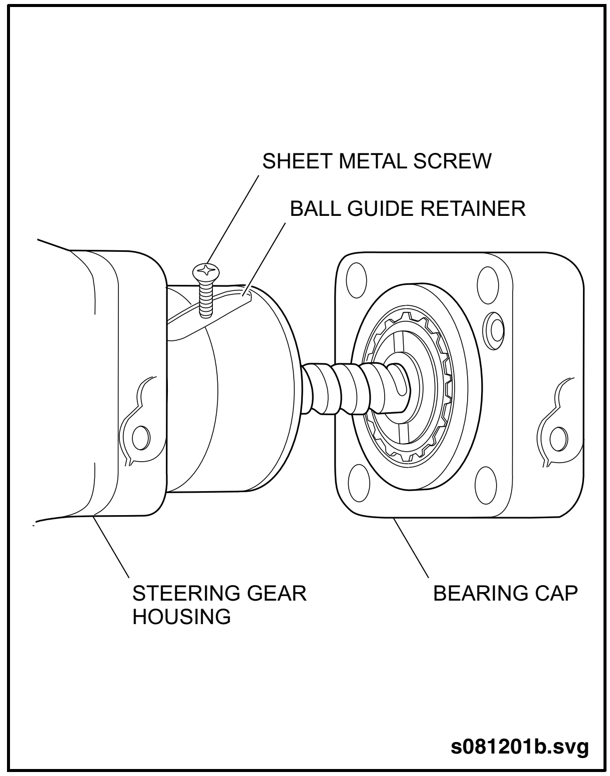


Fig. 3-22: Ball Guide Retainer Removal

2.12.7. Cleaning & Inspection

1. Clean parts with solvent and blow dry with low pressure air.
2. Inspect piston and piston bore for burrs. Remove by polishing with a fine stone or crocus cloth.
3. Inspect thrust washers and bearings on input shaft for excessive wear or damage, replace as required.
4. Inspect output shaft for excessive wear or damage to splines, threads or bearing surfaces.

2.12.8. Auto Plunger Repair

1. Remove automatic relief valve plungers from both ends of unit as follows:

   a. Place the bearing cap or cylinder head in a vise. Remove the plastic plug from the auto plunger hole. Using a 1/4" punch and hammer, drive the auto plunger assembly in until it bottoms in the bore. The spring pin, flange and plunger body should be accessible for repair at this point.

   CAUTION

   Failure to keep the 1/4" punch straight in the bore or hitting the plunger too hard can result in damage to the steering gear or auto plunger assembly.

   b. Carefully insert the screw driver bit into the plunger bore to engage the slotted head of the plunger body. Using the 10mm open end wrench to hold the flange across the flat sides, carefully turn the flange to remove the flange from the plunger body.

   CAUTION

   DO NOT allow the screw driver bit to slip off the plunger body in the process, damage to the bore can result. Discard flange.

   ☞**NOTE:**

   The auto plunger flange is held in place with patch lock and the threads are staked during factory assembly. It will require approximately 15 to 20 in-lb. of torque to remove the flange.

   c. Remove the plunger body from the spring pin and discard. It may be necessary to tap the plunger body to remove it from the spring pin. Use of a 1/8" pin punch is recommended.

2. Install automatic relief plungers in bearing cap and rear cover as follows:

   a. Coat the O-ring of the plunger assembly with a light coat of grease and install the plunger body through the spring pin.

   CAUTION

   Check the plunger bore for nicks or gouges before installing the plunger assembly. Take care not to introduce dirt or contaminants in the plunger bore when reassembling.

   b. Use the screw driver bit and ratchet to hold the plunger body. Screw the flange onto the plunger body using a 10mm open end wrench until the flange contacts the spring pin.

   ☞**NOTE:**

   The plunger body has patch lock on the threads and will require approximately 15 to 20 in-lb. of torque to overcome the patch lock.

   WARNING

   The flange must contact the spring pin. Steering gear damage or a leak can result.

   c. With the flange against the spring pin, use the center punch to stake the threads of the plunger body. Take care not to bend the plunger when staking the threads.

   WARNING

   Use extreme caution when staking the threads of the plunger body. Hitting the threads too hard will bend the plunger and cause steering failure.

   d. Install plastic caps over plungers.

   ☞**NOTE:**

   Refer to 2.12.10. “Installation” on page 42 *in this section for correct setting of automatic relief valve plunger.*

2.12.9. Assembly

1. Install new seal ring on end of piston by placing backup O-ring in piston groove and installing teflon seal over it.

☞**NOTE:**

The teflon seal will stretch as it is fitted over the ring groove. Use a ring compressor to prevent damage to the piston ring. Allow the piston to sit with the seal rings in place so they will shrink to ease installation in the piston bore.

⚠CAUTION

DO NOT press on the lip of the seal.

☞**NOTE:**

The sector shaft seal is a two-piece seal. It will be necessary to bend the seal for installation. Once the seal is installed you may have to work the seal into place with your fingers or a blunt seal pick to properly seat the seal. Press only on the body of the seal.

2. Install sector shaft seal in housing and coat with oil. See “Fig. 3-23: Sector Shaft Seal Installation” on page 40. Ensure lip of seal is toward housing and blue side of seal faces outward.
3. Lightly coat piston and piston bore with oil.

⚠CAUTION

Exercise care when inserting the piston into the housing. It is a close tolerance fit and may jam in the bore. DO NOT force the piston into the housing.

4. Partly insert piston into housing leaving ball guides exposed.

☞**NOTE:**

Make sure you have completed the Auto Repair procedure.

5. Lightly coat new seal ring and tetra seal with grease and install on bearing cap. See “Fig. 3-24: Seal Ring Installation” on page 40. See “Fig. 3-25: Tetra Seal Installation” on page 41.

☞**NOTE:**

Both halves of the ball guide must be held down during ball loading or the balls will come out of their track.

6. Partially insert bearing cap and input shaft assembly into piston, leaving 3" of shaft exposed.

☞**NOTE:**

When properly positioned in the piston, one thread of the valve shaft will be visible through each of the ball feed holes in the piston.

7. Support the bearing cap and shaft assembly with your hand. Install the recirculating balls, one at a time, into the ball guide feed hole closest to the end of the piston.

⚠CAUTION

DO NOT allow the recirculating balls to drop into the rearward hose or feed balls through both holes. Steering gear lock up can result.

8. Slowly turn the input shaft into the piston while feeding the balls into the ball feed hole. As you feed the balls you will feel the shaft being supported as the balls fill the threads.
9. Continue to feed the balls until the balls are visible in the rearward hole of the ball guide cavity.

☞**NOTE:**

Approximately 16 balls will have been installed when they become visible in the rearward hole of the ball guide cavity.

10. Install both halves of the ball guide into the ball guide cavity.

CAUTION

Completely insert the ball guides into the cavity, otherwise the guides will be pushed out of the piston during assembly.

11. Slowly turn bearing cap assembly inward with one hand while inserting steel balls into ball guide with other hand.

NOTE:

Both halves of the ball guide must be held down during ball loading or the balls will come out of their track.

CAUTION

DO NOT back the actuating shaft out of the piston while inserting the steel balls into the ball guide. Doing so will cause the balls to bind on the shaft and damage it.

NOTE:

Twenty four balls must be installed for proper operation.

12. Lubricate new O-ring and install it on ball guide retainer. Insert retainer over ball guide and tap it into place with a rubber hammer.
13. Slide piston into housing until ball guide retainer is secured by housing. Locate rack gear of piston with opening in housing.
14. Carefully work piston ring into cylinder bore.
15. Install four long mounting bolts onto bearing cap to attach bearing cap to housing. Torque 230 to 277 ft-lb. (312 to 376 Nm).

NOTE:

If the bearing cap will not sit flush on the housing, ensure the seal ring or tetra ring is correctly in place. Correct as required.

16. Locate timing mark on piston rack. Turn actuating shaft to center timing mark in pinion bore of housing.
17. Coat end of sector shaft with grease and insert sector shaft into housing. Ensure timing mark on sector shaft lines up between two timing marks on piston rack. See “Fig. 3-26: Sector Shaft Timing Marks” on page 41.
18. Tap end of sector shaft to ensure rack and pinion are completely engaged.
19. Install a new sector shaft oil seal in the sector shaft cover. When properly fitted, the seal will ride between the roller bearing and cover. The black lip of the seal must face the bearing.

NOTE:

The sector shaft seal is a two-piece seal. It will be necessary to bend the seal for installation. Once the seal is installed you may have to work the seal into place with your fingers or a blunt seal pick to properly seat the seal. Press only on the body of the seal.

CAUTION

DO NOT press on the lip of the seal.

20. Install sector shaft cover and retaining snap ring.
21. Install new dust cover. Lightly tap cover until seated.
22. Place new O-ring and tetra seal on cylinder head, grease lightly to hold in place.
23. Attach cylinder head to housing. Torque bolts 53 to 64 ft-lb. (72 to 87 Nm).
24. Pack excluder seal lip areas with grease. Slide excluder seal over sector shaft with lip facing out. Use a 2 1/4" (57 mm) seal driver to press excluder into cover.

NOTE:

When properly installed, the lip of the excluder will face outward and the seal will bottom in the excluder seal groove.

25. Install the frame side dust cover on housing. Thoroughly clean the housing with a suitable solvent and apply a bead of RTV on the edge of the disk to secure it to the housing. Allow adequate time for the RTV to set.
26. Pack lip area of sector shaft boot with grease and install boot over shaft.
27. Clean sector shaft splines before installing Pitman arm.
28. Install sector shaft boot.
29. Install Pitman arm on steering gear output shaft. Align timing mark on Pitman arm with timing mark on output shaft.
30. Inspect tab lock retainer for any damage. Replace retainer if any damage is found.
31. Apply anti-seize compound to threads of sector shaft, retainer and to both sides of friction washer. See “Fig. 3-27: Anti-Seize Compound Application” on page 41.

☞NOTE:

DO NOT apply anti-seize compound to the Pitman arm contact side of the tab lock washer.

32. Screw retainer into output shaft by hand. Align tabs of tab lock washer with notches in Pitman arm. See “Fig. 3-28: Locking Pitman Arm Tabs” on page 41.
33. Torque retainer to 500 ft-lb. (746 Nm). Continue tightening until two tabs on lock washer align with notches in retainer.

⚠ WARNING

NEVER back off the retainer to align the tabs, tighten beyond specified torque if necessary to align tabs.

34. Lock tabs in place with a hammer and punch.

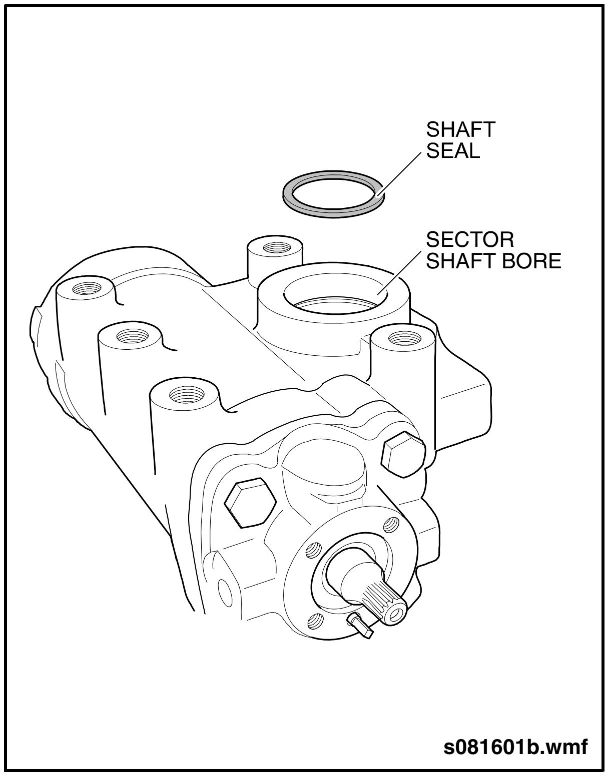


Fig. 3-23: Sector Shaft Seal Installation

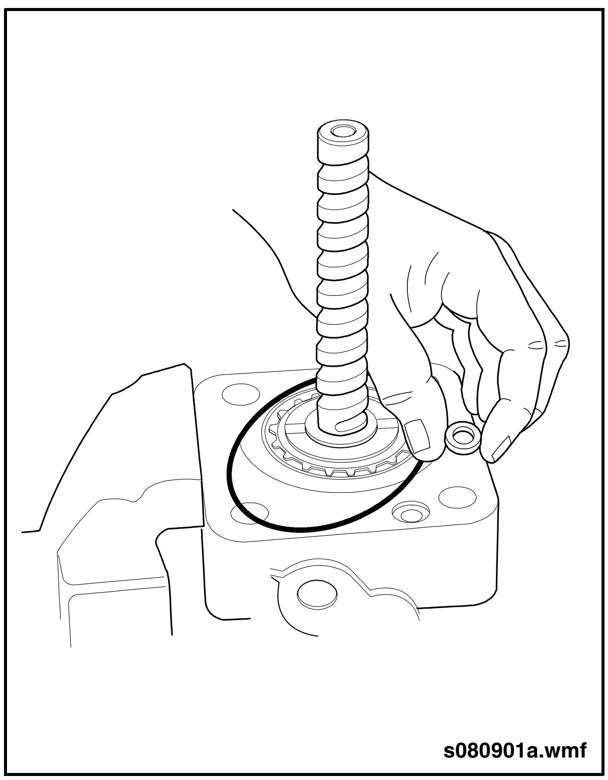


Fig. 3-24: Seal Ring Installation

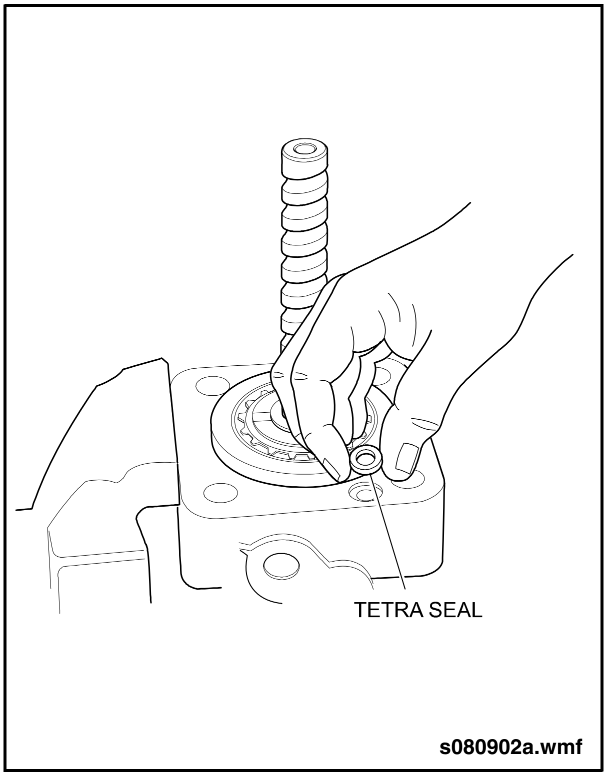


Fig. 3-25: Tetra Seal Installation

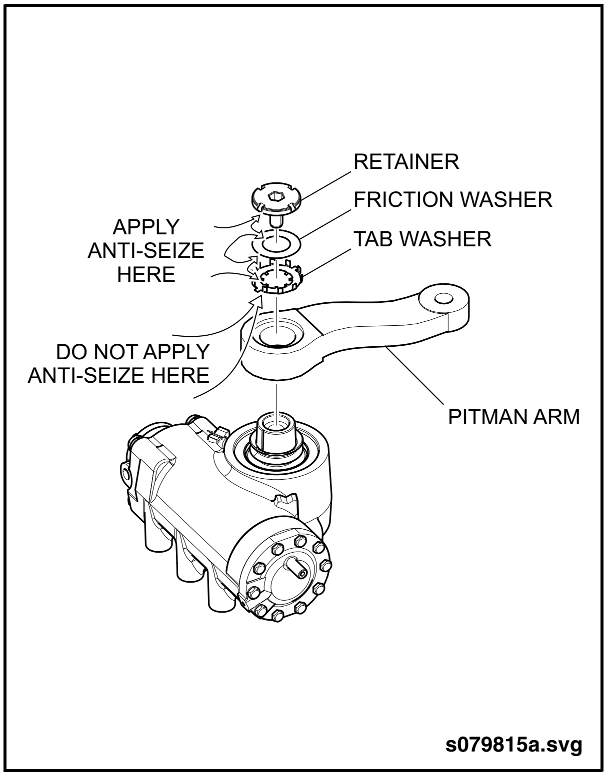


Fig. 3-27: Anti-Seize Compound Application

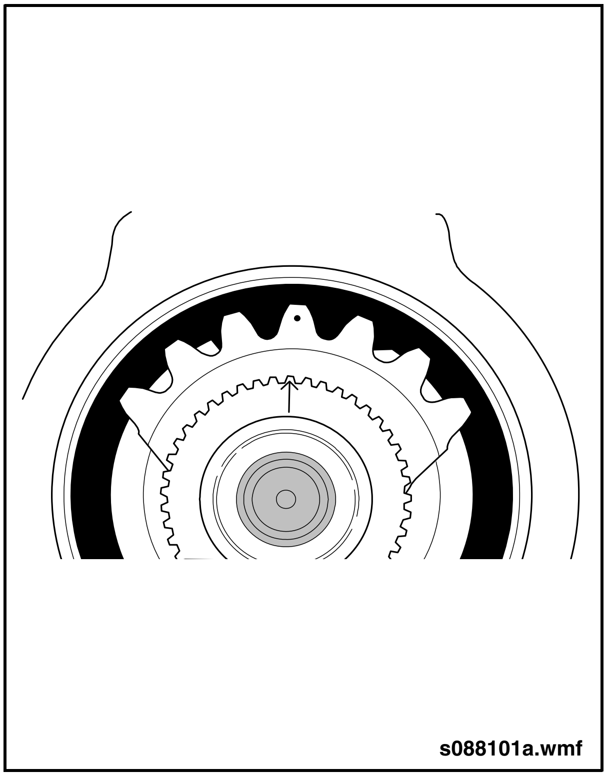


Fig. 3-26: Sector Shaft Timing Marks

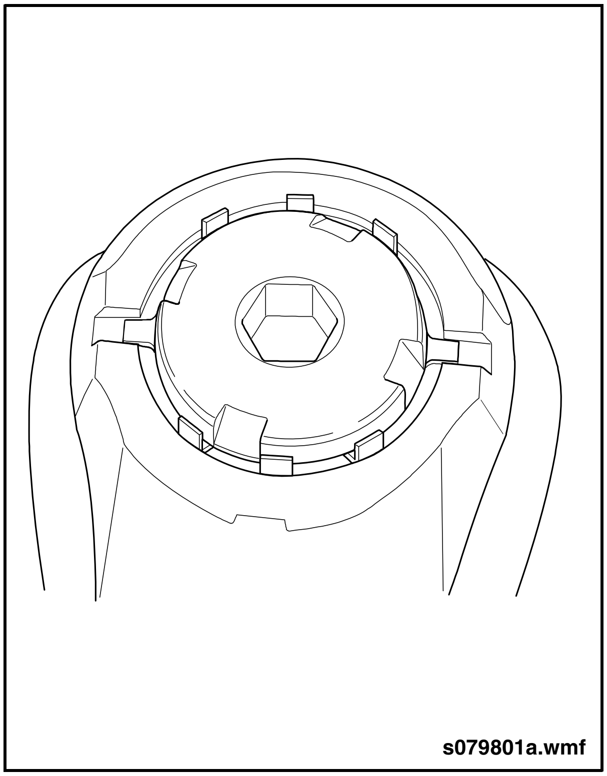


Fig. 3-28: Locking Pitman Arm Tabs

2.12.10.Installation

1. Assemble the support plate to the steering gearbox using five bolts and spacers. Hand-tighten only at this time.

WARNING

The steering gearbox weighs approximately 110 lbs. ALWAYS use appropriate lifting equipment and the assistance of another person when removing or installing the steering gearbox.

2. Use lifting equipment to raise the steering gearbox and support plate into position.
3. Align the support plate holes with the holes in the vehicle structure and install fasteners.
4. Apply NEVER-SEEZ® and torque support plate fasteners to 157 to 173 ft-lb. (213 to 235 Nm).
5. Connect drag link to pitman arm and apply NEVER-SEEZ® to the tie-rod end threads. Install castle nut and torque 95 to 115 ft-lb. (129 to 156 Nm).

☞**NOTE:**

The mounting bolts may need to be loosened to allow sufficient movement of the steering gearbox to align with the drag link.

6. Inspect alignment of slot in castle nut with hole in tie-rod end. If slot is not aligned with hole, continue to tighten castle nut until next slot aligns with hole. Install cotter pin.
7. Apply NEVER-SEEZ® to bolt threads and torque steering gearbox mounting bolts 350 ft-lb. (475 Nm).
8. Align reference mark on steering U-joint to steering gear input shaft and install using clamp bolt and lock nut. Torque nut to 50 ft-lb. (68 Nm).
9. Connect -08 pressure hose and torque fitting to 32 to 35 ft-lb. (43 to 47 Nm.)
10. Connect -10 return hose and torque fitting to 46 to 50 ft-lb. (62 to 68 Nm.)
11. Reinstall and close the removed access doors.
12. Lower vehicle and fill reservoir with oil.
13. Bleed the system. Refer to 2.12.11. “Bleeding Power Steering Hydraulic System” on page 43 in this section for procedure.
14. The steering gear installed on this vehicle is equipped with automatic relief valve plungers which require no adjustment unless the tire size or wheel cut is changed. Refer to 2.5.1. “Steering Stops” on page 5 in this section for procedure should adjustment be required.

2.12.11. Bleeding Power Steering Hydraulic System

Air in the fluid system will cause spongy action and noisy operation. The power steering hydraulic system must be bled whenever the power steering hydraulic pump, steering gear assembly, fluid reservoir, filter assembly, or hydraulic lines have been removed.

CAUTION

DO NOT operate power steering pump with an empty reservoir.

☞NOTE:

Refer to the Preventive Maintenance Section of this manual for power steering fluid specification. Use only the recommended fluid.

1. Fill the hydraulic reservoir tank to the center of the sight glass with recommended oil. Let steering fluid remain undisturbed for about two or three minutes.
2. Raise vehicle until front wheels are off the ground. Refer to the General Information Section of this manual for recommended lifting procedures.

CAUTION

DO NOT hold the wheel in the fully locked position, nor allow the wheel to contact the mechanical stop while bleeding the system. Damage to the steering gearbox could result under this condition if the hydraulic relief plunger is not properly adjusted.

3. Start engine and operate at fast idle speed for two or three minutes. Turn front wheels to the right and left making three complete cycles to remove all air from system.
4. Maintain fluid level in hydraulic reservoir tank to the center of the sight glass. Check system lines and connections for leaks. Continue these procedures until fluid in pump reservoir tank is clear and free of air bubbles.
5. Increase engine speed to approximately half throttle and run engine at this speed until all signs of air bubbles cease to exist in reservoir tank.

   Turn wheels to right and left as before, making three complete cycles.

2.12.12. Functional Tests

1. Check fluid level in reservoir.
2. Start the vehicle and check steering operation.
3. Test drive vehicle.

3. HYDRAULIC SYSTEM

3.1. Description

The hydraulic system supplies hydraulic power to the power steering gear at the front axle. The hydraulic system consists of the following components:

- Power Steering Pump
- Hydraulic Fluid Reservoir & Filter

3.2. Power Steering Pump

3.2.1. Description

The power steering pump is a vane-type hydraulic unit which supplies hydraulic power for operation of the power steering gear.

The pump is flange-mounted to the air compressor. See "Fig. 3-29: Power Steering Pump Installation" on page 44. The hydraulic fluid reservoir and filter is remotely mounted and is connected to the power steering system by hoses.

3.2.2. Power Steering Pump Specifications

Manufacturer .... IXETIC

Displacement..................25 cc/rev (1.53 in^{3})

Flow control ....16L/min (4.23 U.S. gpm)

Pressure relief .... 150 bar (2176 psi)

Rotation ....CW

Mounting....................... SAE A 2-bolt flange

Inlet port ....-12 ORB

Outlet port ....-8 ORB

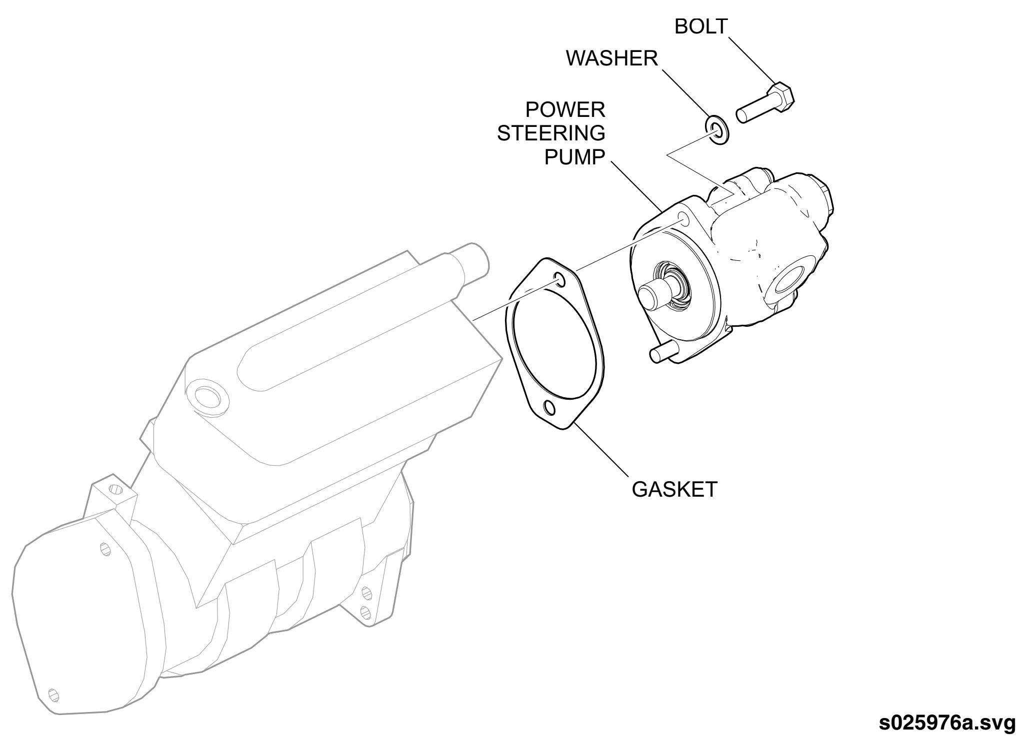


Fig. 3-29: Power Steering Pump Installation

3.2.3. Pump Operation

The major pump components are: a pressure plate, ring, rotor and vanes contained in a multi-ported housing. The pump rotor is driven within the pump ring by a drive shaft, coupled to the fan drive pump.

As the rotor speed increases, centrifugal action causes the vanes and rotor to generate flow by carrying fluid around the elliptical cam ring contour. System pressure, fed behind the vanes, assures sealing contact of vanes on ring contour during normal operation.

The ring is shaped so that two opposing pumping chambers are formed. Radial movement of the vanes, and rotation of the rotor, causes the chamber area between vanes to increase in size at the inlet (large diameter) of the ring. This results in low pressure, or a vacuum in the chamber. The fluid in the pump reservoir is under atmospheric pressure. This pressure differential causes fluid to flow into the pump housing inlet, where it is trapped between the rotating vanes. The fluid is then forced through porting in the pressure plate and discharges into the system at the pressure quadrant (small diameter) of the ring.

Maximum pump delivery and maximum system pressure are determined by the flow control and relief valve located in the pump housing. An orifice in cover limits maximum flow. A pilot-operated type control valve shifts to divert excess fluid delivery to reservoir, thus limiting system pressure to a prescribed maximum.

The total pump delivery can pass through the orifice usually only at low drive speeds.

The large spring chamber is connected to the pressure port through an orifice. Pressure in this chamber equalizes pressure at the other end of the relief valve spool and the light spring holds the spool closed. Pump delivery is blocked from the reservoir port by the spool land.

When pump delivery is more than the flow rate determined by the orifice plug, a pressure build-up forces the spool open against the light spring. Excess fluid is throttled past the spool to the reservoir port. If pressure in the system builds up to the relief valve setting the pilot poppet is forced off its seat. Fluid in the large spring chamber flows through the spool and out to reservoir. This flow causes a pressure differential on the spool, shifting it against the light spring. All pump delivery is thus permitted to flow to reservoir.

⚠ CAUTION

Failure to observe the following precaution can result in scoring and possible seizure of the pump due to a lack of oil for lubrication.

Normally these pumps require no manual priming. However, after engine start up, allow the engine to idle for a short period of time, with no load, until the power steering pump picks up its prime and pressure is built up in the power steering system.

Refer to the Preventive Maintenance Section of this manual for specifications.

⚠ CAUTION

DO NOT use a cloth when adding fluid to the reservoir. Lint will contaminate the fluid and damage the pump.

When adding fluid to the reservoir, pour through a fine wire mesh (200 mesh or finer). Also make sure that air is purged from the pump and lines before operation.

3.2.4. Removal

CAUTION

Escaping hydraulic fluid under pressure can have sufficient force to penetrate your skin causing serious injury. This fluid may also be hot enough to burn. Serious infection or reactions can develop if proper medical treatment is not administered immediately.

☞**NOTE:**

The power steering pump is replaced with either a new or remanufactured unit.

1. Place a clean container under the power steering pump to remove the inlet and pressure lines.
2. Remove the mounting bolts attaching the power steering pump to the air compressor and remove the pump.
3. Remove and discard the gasket.

3.2.5. Installation

1. Ensure mating surface between power steering pump and air compressor are scraped clean.
2. Lubricate male splines on power steering pump and female splines on air compressor driveshaft with Molykote grease.
3. Apply new gasket to sealing surface of power steering pump.
4. Install power steering pump onto air compressor. Ensure splines on pump shaft mate correctly with air compressor.
5. Apply Loctite-243 to bolts and install bolts and washers. Torque bolts to 33 ft-lb. (45 Nm).
6. Connect hoses and fittings to pump. Tighten fittings securely.
7. Refill hydraulic system and bleed system.

3.2.6. Power Steering Pump Troubleshooting

POWER STEERING PUMP TROUBLESHOOTING		
TROUBLE	**POSSIBLE CAUSE**	**REMEDY**
Pump not Delivering Fluid	Fluid intake pipe in reservoir restricted	Check all strainers and filters for dirt and sludge. Clean if necessary.
	Fluid viscosity too heavy to pick up priming	Completely drain the system. Add new filtered fluid of the proper viscosity.
	Air leaks at the intake. Pump not priming	Check the inlet connections to determine where air is being drawn in. Tighten any loose connections. See that the fluid in the reservoir is above the intake pipe opening.
	Relief valve stuck open. (Models with integral relief valve only)	Replace pump.
Insufficient Pressure Build-Up	Relief valve stuck	Replace pump.
	Complete loss of flow from pump	A valve is stuck open permitting free flow to tank. Broken inlet or pressure line.
Pump Making Noise	Pump intake partially blocked	Service the intake strainers. Check the fluid condition and, if necessary, drain and flush the system. Refill with clean fluid.
	Air leaks at the intake or shaft seal. (Oil in reservoir would probably be foamy)	Check the inlet connections and seal to determine where air is being drawn in. Tighten any loose connections and replace the seal if necessary. See that the fluid in the reservoir is above the intake pipe opening.

3.3. Reservoir

3.3.1. Description

The power steering reservoir is bracket mounted in the engine compartment at the rear of the vehicle. The reservoir has a filter and a hydraulic fluid level sight glass. A dipstick is provided to verify fluid level. See “Fig. 3-30: Power Steering Reservoir Installation” on page 48. See “Fig. 3-31: Hydraulic Steering Schematic” on page 49.

3.3.2. Maintenance

☞**NOTE:**

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance requirements.

3.3.3. Removal

1. Place a suitable container beneath the reservoir and remove the drain plug from the base of the reservoir Allow fluid to drain completely.
2. Remove and temporarily cap the two hydraulic hoses from the base of the reservoir.
3. Loosen the four fasteners that attach the reservoir mounting straps to the mounting bracket.
4. Mark the position of the reservoir and loosen the mounting straps sufficiently to allow the reservoir to slip out of the straps.
5. Move the reservoir to a clean working area for disassembly.

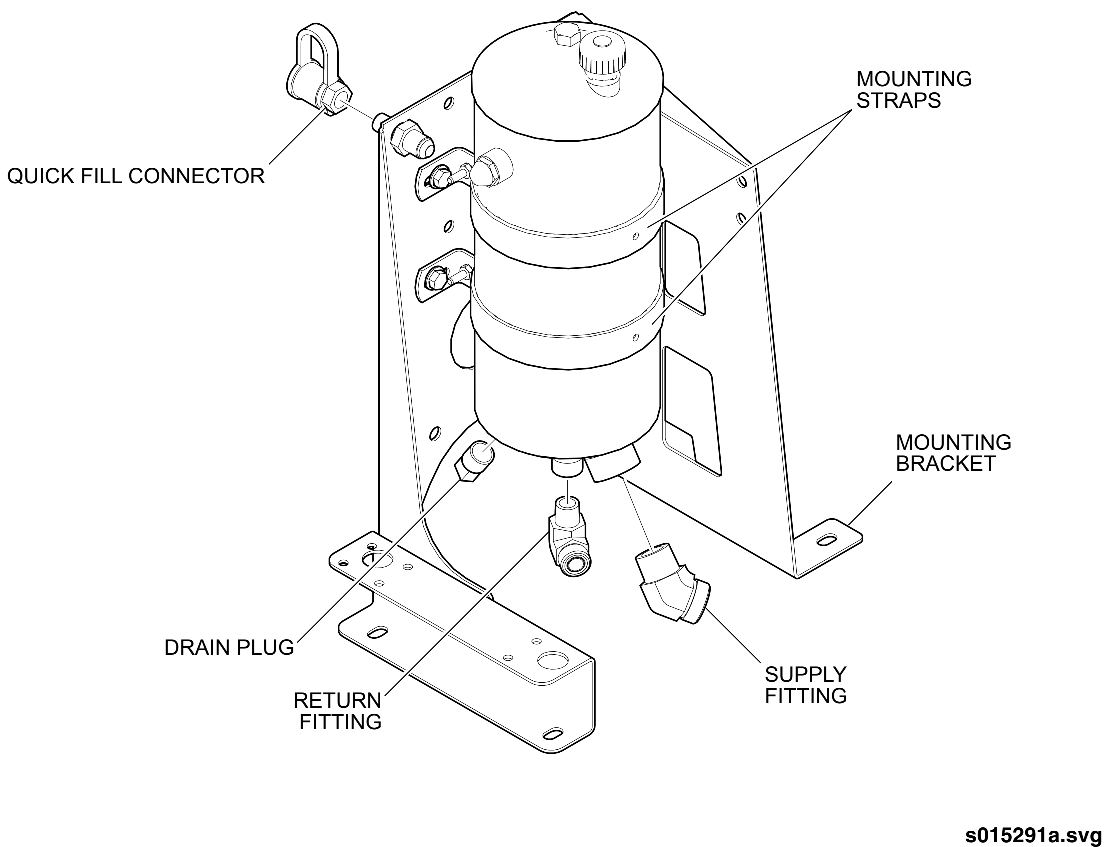


Fig. 3-30: Power Steering Reservoir Installation

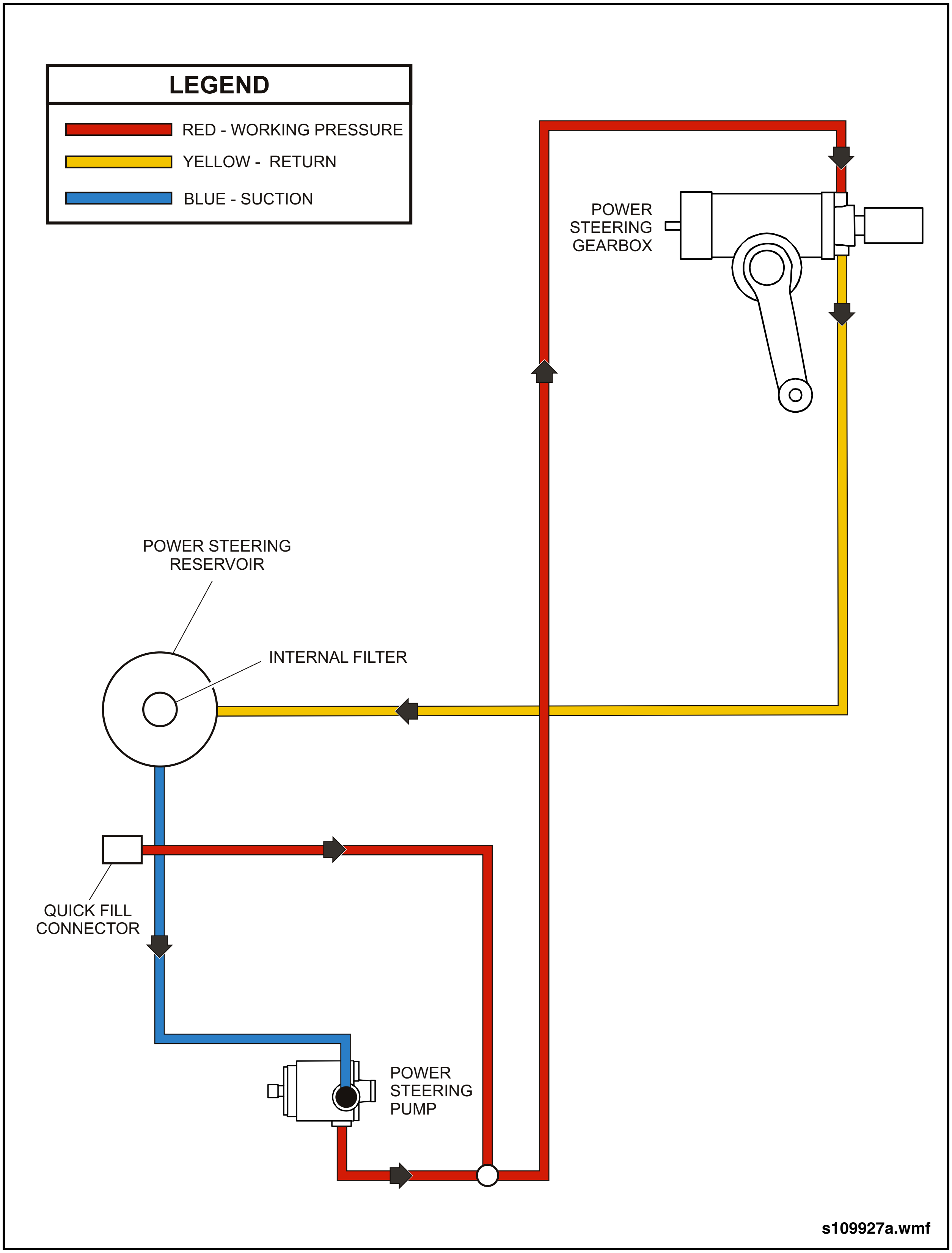


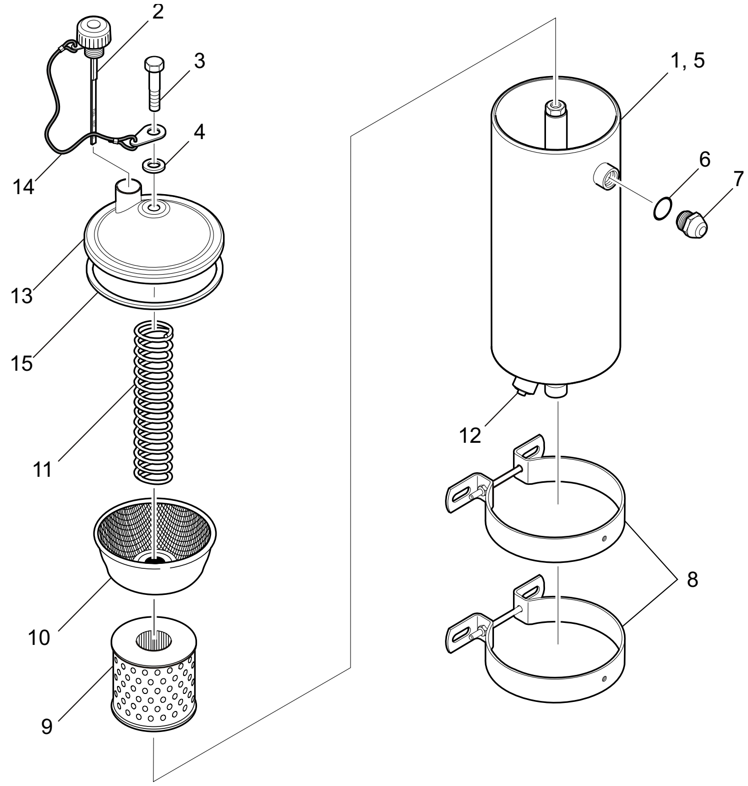
Fig. 3-31: Hydraulic Steering Schematic

3.3.4. Disassembly

CAUTION

The reservoir cap is under pressure from an internal spring. Apply hand pressure to the cover when removing the cover bolt to prevent the cover from springing upward.

1. Remove the center cap bolt and filler cap/ dipstick from the cover assembly. See "Fig. 3-32: Power Steering Reservoir Assembly" on page 50.
2. Remove the spring, basket, and filter from the reservoir body. Discard the filter.
3. Secure the reservoir in a soft-jaw vise.
4. Mark the position of the two elbow fittings on the base of the reservoir and remove the fittings.
5. Remove the sight glass and O-ring from the body of the reservoir.
6. Clean all parts in solvent and wipe dry with a clean lint-free cloth.



1. Reservoir Assembly, Power Steering (Incl. 2-15)
2. Dipstick
3. Screw, Hex 1/2" - 13 x 2.0" Lg.
4. Washer, Sealing .518" x 1" x .080" Nylon
5. Body, Reservoir
6. O-Ring, Glass
7. Glass, Sight
8. Bracket, Mounting 6" I.D.
9. Filter Element, 25 micron
10. Basket
11. Spring, Retaining
12. Plug, 1/2" NPT
13. Cover Assembly
14. Lanyard, 8" Lg.
15. Gasket, 5.35" x 6.09" x .093"

s015232c.svg

Fig. 3-32: Power Steering Reservoir Assembly

3.3.5. Assembly

1. Install the sight glass with a new O-ring. Torque sight glass to 36 in-lb. (41 Nm).
2. Clean and inspect threads on elbow fittings and drain plug.
3. Apply Loctite 567 thread sealant and install elbow fittings into base of reservoir. Tighten fittings 1 1/2 turns past finger-tight, then to the position noted during disassembly. Do not exceed 2 1/2 turns past finger tight.
4. Apply Loctite 567 thread sealant and install drain plug into base of reservoir. Tighten plug two full turns past finger-tight.

CAUTION

When installing new filter, ensure that the packaging and labels have been removed from the element cartridge prior to installing it in the reservoir.

5. Install the filter, basket, and spring into the reservoir body.
6. Position cover onto reservoir body.
7. Install filler cap/dipstick, lanyard, washer, and cover bolt. Torque bolt to 96 in-lb. (108 Nm).

3.3.6. Installation

1. Slide the reservoir into the mounting straps and position as marked during removal.
2. Tighten the mounting straps.
3. Tighten the four fasteners that attach the mounting straps to the mounting bracket.
4. Remove the caps from the hydraulic hoses and install hoses onto fittings.
5. Torque the 5/8" return hose to 46 to 50 ft-lb. (62 to 68 Nm).
6. Torque the 1" supply hose to 92 to 100 ft-lb. (126 to 136 Nm).
7. Fill the reservoir to the level of the sight glass. Refer to the Preventive Maintenance Section of this manual for fluid specifications.

☞**NOTE:**

If maintenance on the power steering system has resulted in a significant loss of fluid, then it will be necessary to bleed the system. Refer to 2.12.11. “Bleeding Power Steering Hydraulic System” on page 43 *in this section for procedure.*

8. Start vehicle and check for leaks. Operate for 15 seconds maximum and stop engine.
9. Top up reservoir as necessary.
10. Repeat previous steps 8 & 9 until the fluid level in the sight glass is stable.

3.3.7. Pressure Filling

WARNING

NEVER fill the Hydraulic System while the engine is running. Hydraulic fluid is flammable and under pressure. ALWAYS wear protective gloves and eye protection when handling hydraulic fluid. Avoid breathing vapors. Hydraulic fluid is poisonous and must not be ingested.

CAUTION

The following pressure fill procedure should ALWAYS be used after performing any maintenance on the hydraulic/ steering system where a significant quantity of fluid has been lost. The use of pressure filling equipment will force fluid through the lines and minimize air entrapment in the system.

1. Set the Battery Disconnect switch to the OFF position.

CAUTION

Ensure that the fluid supply is clean and filtered to 10 micron absolute or finer.

2. Connect a supply hose to the pressure fill coupling located on the power steering reservoir mounting bracket.
3. Fill system until fluid level can be seen in the sight glass.
4. Disconnect the pressure-filling equipment.
5. Start the engine for 15 seconds maximum and stop engine.
6. Top up the reservoir as necessary and check system for leaks.
7. Repeat steps 5 and 6 until the fluid level in the sight glass is stable.
8. Bleed air from the power steering system. Refer to 2.12.11. “Bleeding Power Steering Hydraulic System” on page 43 in this section for procedure.
9. Shut off the engine and top up the reservoir.

4. STEERING SYSTEM SPECIAL TOOLS

4.1. Steering System Special Tools Chart

The following special tools are referenced in the automatic plunger adjustment procedure in this section. Refer to your New Flyer Parts Manual for purchase part numbers. See “Fig. 3-33: Special Tools” on page 53.

SPECIAL TOOL	DESCRIPTION
1	Punch, Steering Pressure Relief
2	Adjustment Tool, Steering Pressure Relief

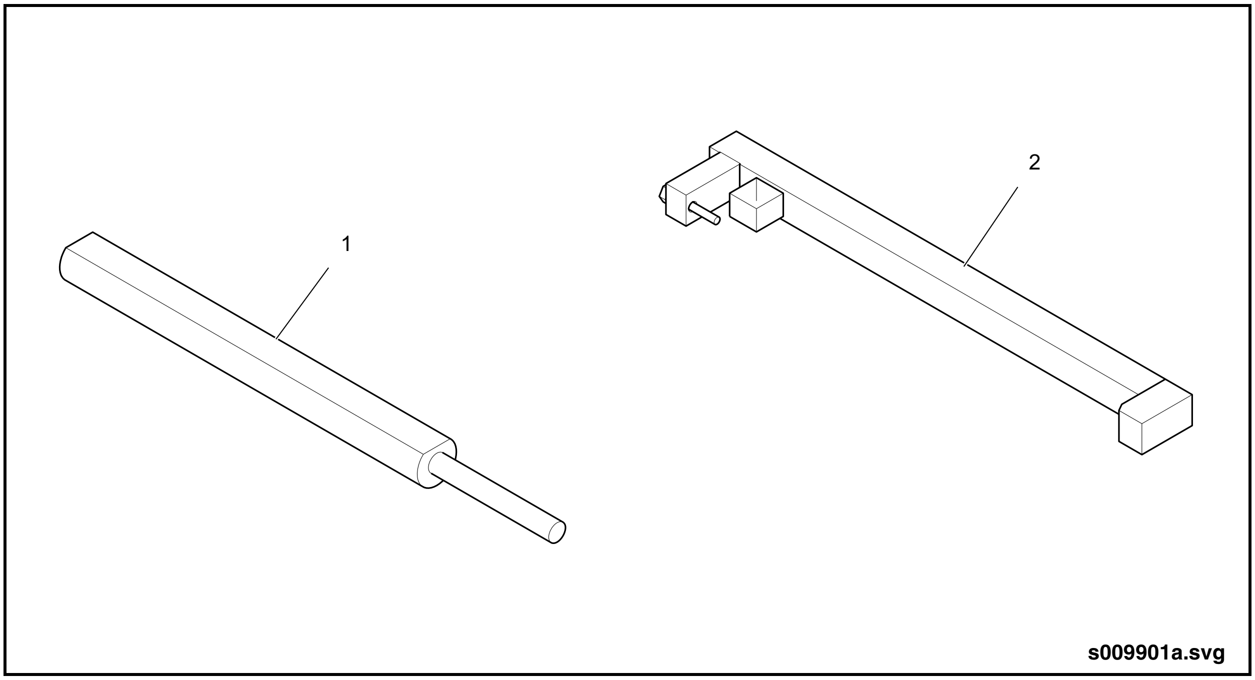


Fig. 3-33: Special Tools

Engine System

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❐ open flame
- ❐ excessive heat
- ❐ production of sparks
- ❐ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to “Maintenance Safety Procedures” in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Hoisting/Lifting & Jacking Safety

Refer to the General Information Section of this manual for recommended types of hoists, lifting equipment, and jackstands.

DANGER

Certain procedures may require the vehicle be operated in an elevated position in order to accurately troubleshoot and diagnose a problem. If the vehicle must be running while elevated, become familiar with the repair area prior to starting the engine. Take special care in noting areas which will become hot, electrically energized, and areas where moving and rotating components are located. Limit the work in these areas as personal and equipment safety is at risk.

WARNING

ALWAYS ensure that the vehicle is appropriately hoisted and blocked for procedures which require elevating the vehicle. Be aware of the limitations of the blocking equipment, and always ensure that the jarring and shaking created by component removal and installation procedures does not overload the blocks, or cause the vehicle to become unstable.

2. ENGINE & ACCESSORIES

2.1. CUMMINS L9N ENGINE (2018)

2.1.1. Description

The engine is an 8.9 liter, four-stroke, inline, six cylinder, gaseous fueled engine. See “Fig. 4-1: Engine Views” on page 3.

The major components and accessories of the engine are:

- ❒ Fuel System (Refer to Section 7 of this manual).
- ❒ Engine Protection System
- ❒ Air Intake System
- ❒ Exhaust System
- ❒ Engine Switch Box
- ❒ Electronic Control Module (ECM)
- ❒ Closed Crankcase Ventilation System

2.1.2. Engine Specifications

Rated Power..............280 HP @ 2200 RPM

Peak Torque .... 900 ft-lb. @ 1300 RPM

Displacement....................8.9 liters (540 in^3)

Firing Order 1-5-3-6-2-4

Aspiration ....Turbo Charge

Engine Weight (dry)...........1700 lb. (773 kg)

Oil Capacity (including filter)........28 U.S. qt. (26.5 liters)

Coolant Capacity (engine only) 13.1 U.S. qt. (12.4 liters)

Refer to the Cummins Operation & Maintenance Manual for further information on the engine.

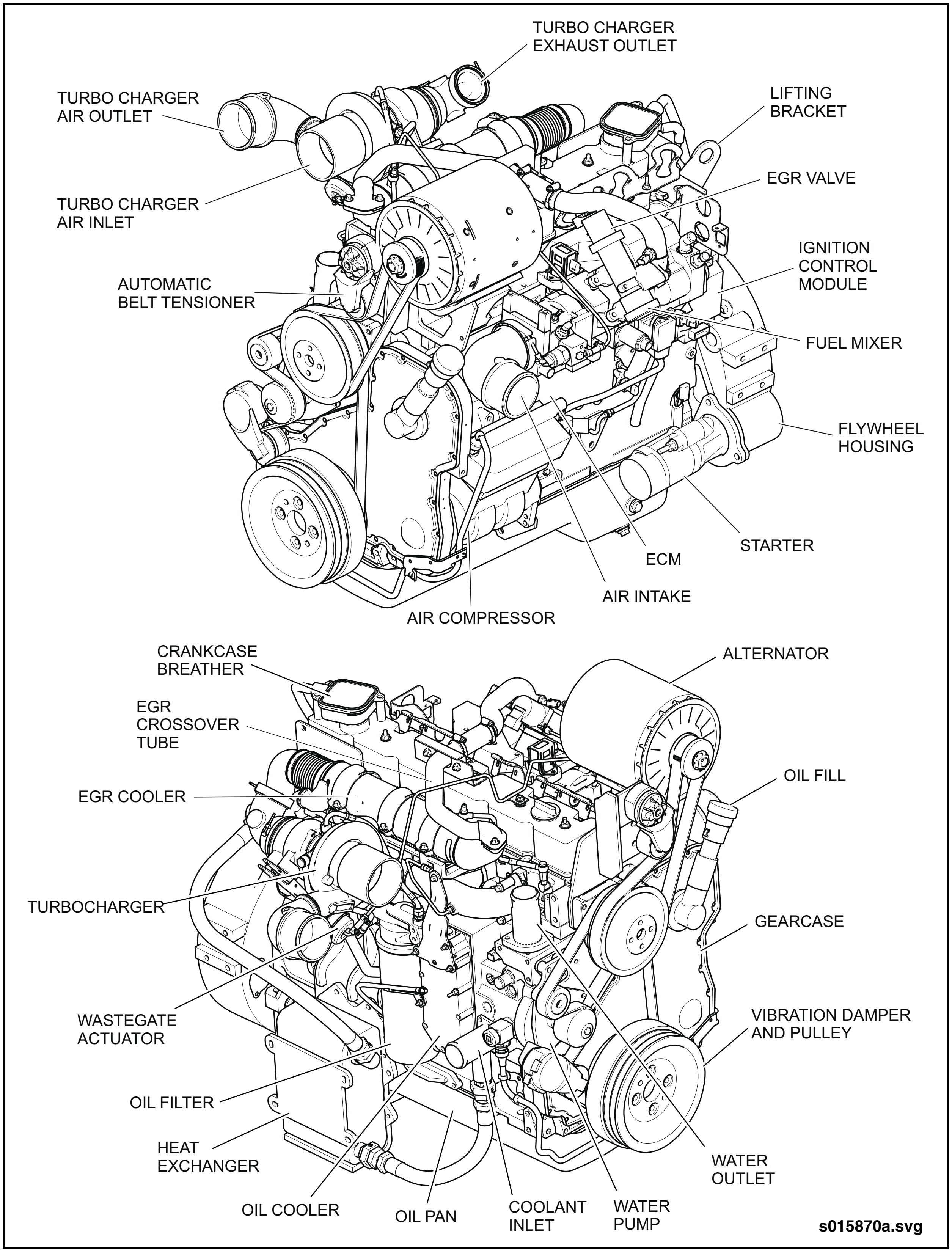


Fig. 4-1: Engine Views

2.1.3. Closed Crankcase Ventilation System

2.1.3.1. Description

The engine incorporates a closed crankcase ventilation system for reducing the exhaust emissions to a near-zero level. The system, located on the curbside of the engine, consists of a closed crankcase ventilation filter (CCVF) and connecting hoses. See “Fig. 4-2: Crankcase Ventilation” on page 4.

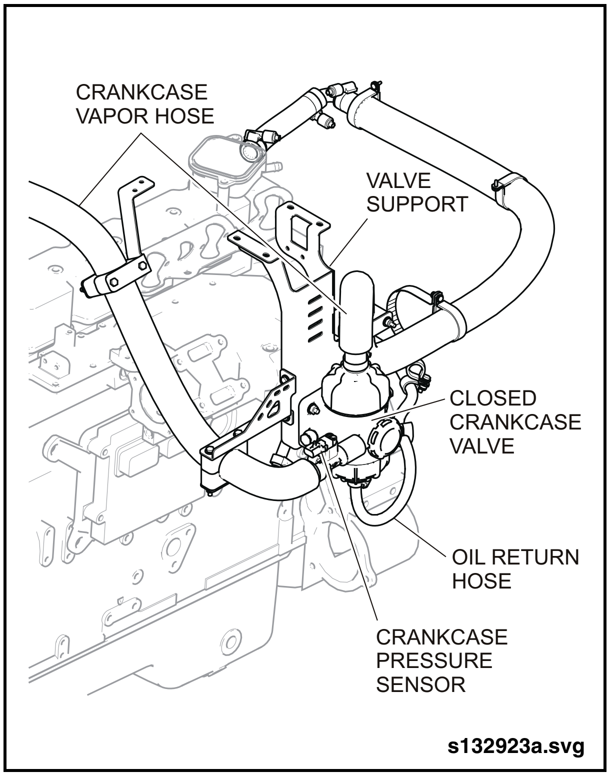


Fig. 4-2: Crankcase Ventilation

2.1.3.2. Operation

Crankcase vapors, or blowby gases, are gases that escape past the piston rings during engine operation. These gases accumulate in the crankcase, and in an open system, vent to the atmosphere. In the closed crankcase ventilation system the gases are burned off in the engine. The system incorporates a filter with a pressure regulator, a coalescing filter and a crankcase pressure sensor. Blowby gases evacuate from the crankcase through the valve cover and flow through a hose to the CCVF. The unit uses the pressure regulator to control crankcase pressure and the coalescing filter to remove the oil from the crankcase vapors. Engine coolant circulates through the CCVF and aids oil vapor condensation. The filtered gases return to the intake air side of the turbocharger for combustion and the removed oil returns to the oil pan.

2.1.4. Engine Protection System

The engine is equipped with an engine protection system. The system monitors critical engine temperatures and pressures, and will log diagnostic faults when an over or under normal operation condition occurs. If an out-of-range condition exists, and an engine action is to be initiated, the operator will be alerted by the check engine indicator on the instrument panel. The indicator will blink or flash when out-of-range conditions continue to get worse. When the red stop engine indicator is illuminated, the driver MUST pull to the side of the road, when safe to do so, and stop the engine to reduce the possibility of engine damage.

☞**NOTE:**

Engine power and speed will be gradually reduced, depending on the level of severity of the observed condition. The engine protection system will not shutdown the engine unless the engine protection shutdown feature has been enabled.

The Engine Protection System monitors the following features;

- ❒ Coolant Temperature
- ❒ Coolant Level
- ❒ Oil Pressure
- ❒ Intake Manifold Temperature
- ❒ Engine Overspeed
- ❒ Fuel Pressure

2.1.5. Engine Troubleshooting

Engine troubleshooting can be performed using a personal computer (PC) and the Cummins INSITE™ software. The PC is connected to the vehicle engine diagnostic connector, which is located on the engine switch box. Contact the Cummins Engine Company, Inc. for further information on this software.

2.1.6. Removal

1. At the CNG Fill Box, set the main shut-off valve in the fuel filter compartment to the OFF position (valve handle perpendicular to main fuel line).
2. Evacuate the remaining CNG by starting the engine and running it until the engine stalls.
3. Set the Battery Disconnect switch to the OFF position and Lockout / Tag-out.
4. Open the engine access door.
5. Unlatch the belt guard door and swing it open. See "Fig. 4-3: Bumpers & Belt Guards" on page 6.
6. Remove the cotter pins from the clevis pins at the guard door hinge and lift up and remove the guard door.

CAUTION

The rear bumper weighs in excess of 50 lbs. Use an appropriate lifting device to support the rear bumper before proceeding.

7. Remove the retaining bolts that secure the bumper to the vehicle.
8. Remove the rear bumper from the vehicle.
9. Set the shutoff valve located between the booster pump and the heat exchanger to the OFF position.
10. Set the shutoff valve located between the degas tank and the heat exchanger to the OFF position.
11. Drain the vehicle air tanks. Refer to the General Information Section of this manual for the Drain Valve locations.

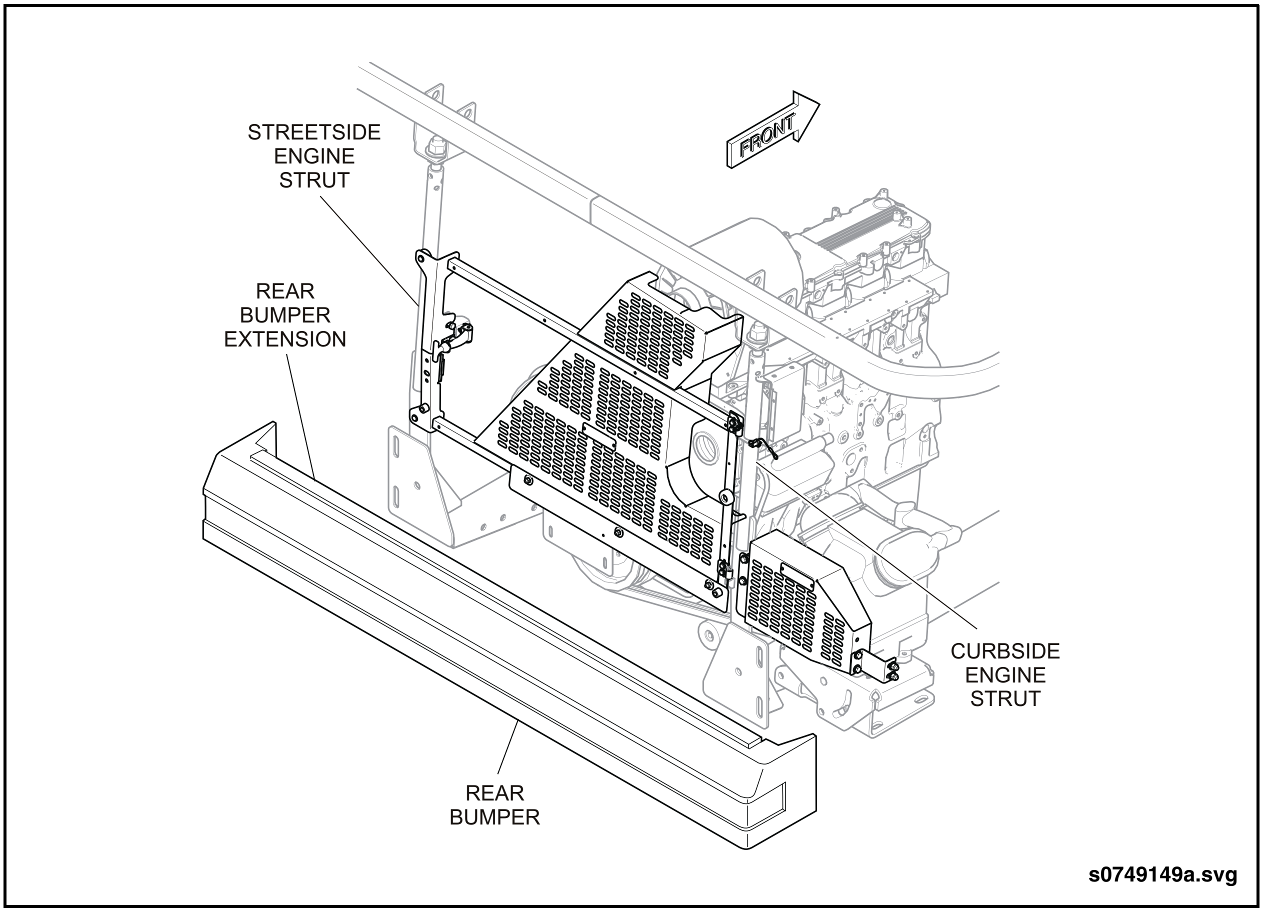


Fig. 4-3: Bumpers & Belt Guards

12. Drain the engine cooling system fluid. Refer to the Cooling section of this manual.
13. Place a suitable container under the drain plug located on the hose that connects the heat exchanger to the booster pump. Remove the plug to drain the coolant stored in the HVAC portion of the heat exchanger.
14. Once the HVAC portion of the heat exchanger is drained, disconnect both hoses connected to the HVAC side of the heat exchanger.
15. Disconnect the stainless steel coolant tubes to make room for the engine mounts when removing the engine. DO NOT disconnect any fitting above the coolant shut-off valves.
16. Loosen the HVAC compressor belt tightening and remove the belt from the compressor.
17. Disconnect all the wire harnesses from engine switch box.
18. Loosen and remove the upper nut on the rear strut braces. Remove the lower strut bolts and remove the struts.
19. Pull out the battery tray.
20. Underneath the vehicle in the transmission area, disconnect the driveshaft from the transmission. Allow the driveshaft to hang onto the rear axle bunk. See “Fig. 4-4: Disconnecting the Driveshaft” on page 8.

21. Disconnect the transmission main harness and speed sensor electrical connector.
22. Disconnect the transmission cooler hoses from the transmission. Plug ports to prevent contamination of fluid.
23. Disconnect engine air compressor and governor lines at the compressor and the inlet hose at the engine air filter elbow.
24. Disconnect charge air tube.
25. Disconnect starter motor electrical connectors.
26. Disconnect electrical harnesses from engine.
27. Disconnect electrical wires from front and rear of alternator.
28. Disconnect clamps on left-hand side engine rail which support lower coolant tube.
29. Disconnect fuel line from engine.
30. Remove tube between surge tank and lower coolant tube.
31. From inside of vehicle, remove air intake clamp at turbo and separate air intake tube from turbo.
32. Loosen and remove the 2 V-band clamps retaining the exhaust elbow. Unbolt the bracket from the engine and remove the elbow.
33. Disconnect the coolant bleed line at the top of the engine.
34. Disconnect coolant lines from thermostat housing.
35. Disconnect and plug the hoses at the power steering pump mounted at the rear of the engine air compressor.
36. Disconnect the output hose from the muffler tank.
37. Check to ensure that all hoses and connectors are disconnected and out of the way.
38. Remove the 3/4" bolt, nut, and washers that attach the LH & RH engine/transmission side rubber mounts to the vehicle main frame rail.

1. Driveshaft
2. Driveshaft Guard
3. Transmission Yoke
4. Transmission

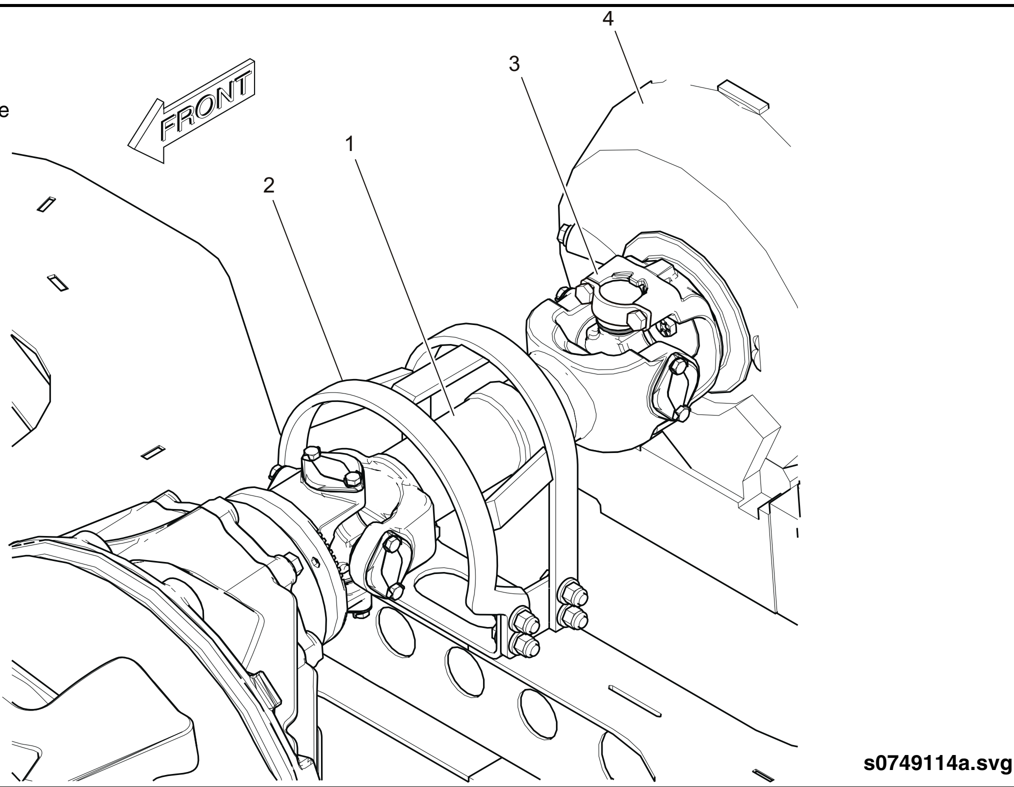


Fig. 4-4: Disconnecting the Driveshaft

39. Position the support dolly beneath the engine and transmission and slowly lower the vehicle until some of the weight of the engine and transmission is taken by the support dolly. The engine mounts should be in a neutral load state at this point. See "Fig. 4-5: Engine & Transmission Mounts" on page 10.

☞**NOTE:**

The engine front mount assembly (located closest to the crankshaft pulley) consists of a mounting bracket and two rubber engine mounts. The complete front mount assembly is bolted to the LH & RH vehicle main frame rails. In the following step it is recommended that the engine and transmission *be removed from the engine compartment with the front mount assemblies attached to the engine. The mounts can be removed and disassembled once the engine and* transmission is *removed from the engine compartment.*

40. Remove the two 5/8" bolts, nuts, and washers that attach each side of the mount assembly to the vehicle LH & RH main frame rails.

41. Carefully roll the support dolly out from the engine compartment. See "Fig. 4-6: Engine Support Dolly" on page 11.

☞**NOTE:**

Lower or raise the vehicle slightly, if necessary, to clear the mounting pads.

⚠CAUTION

Engine lifting brackets are required when hoisting the engine to ensure safe, secure, and properly distributed lifting points. DO NOT attempt to lift engine with brackets or lifting equipment not designed for this purpose.

42. Install approved lifting brackets on the engine if the engine is to be removed from the dolly. Refer to 2.2. "Engine Lift Brackets" on page 13 in this section for lifting bracket installation procedure.

☞**NOTE:**

The original Cummins engine brackets were supplied with the vehicle at time of delivery.

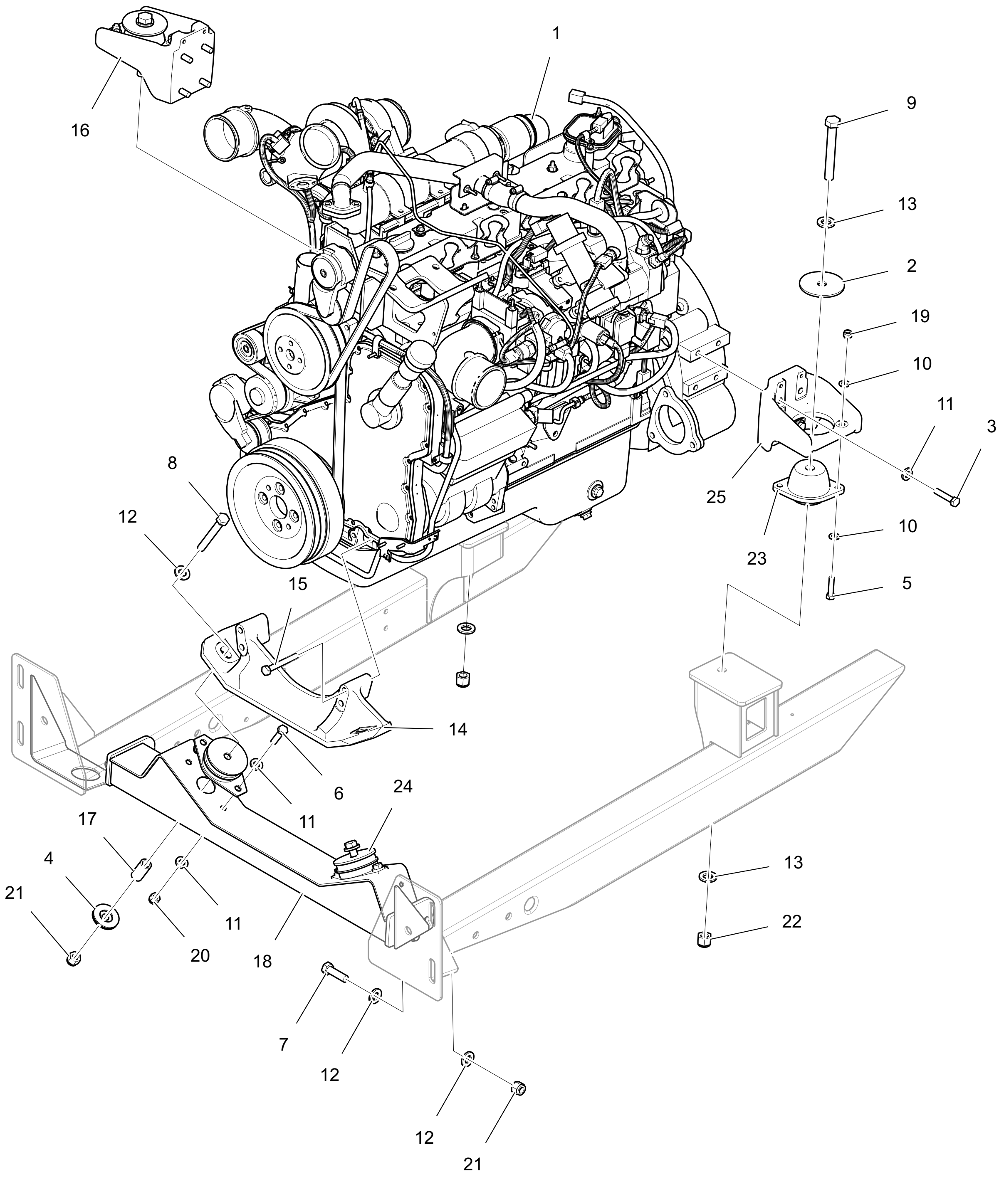


Fig. 4-5: Engine & Transmission Mounts

1. Engine Kit, Cummins L9N (EPA 2018) 280 HP	14. Engine Mount, Front
2. Washer, Snubbing 3.87" O.D.	15. Bolt, Hex M12 x 1.75 x 90
3. Bolt, M12 x 1.75 x 55 CL10.9	16. Engine Mount Bracket, Rear Streetside
4. Washer, Engine Rebound 2.38" O.D.	17. Spacer, Front Engine Mount
5. Bolt, Hex 7/16" - 14 UNC x 1 3/4" Lg.	18. Crossmember, Engine Front
6. Bolt, Hex 1/2" - 13 UNC x 1 3/4" Lg.	19. Nut, Lock Nylon 7/16" - 14 UNC
7. Bolt, Hex 5/8" - 11 UNC x 2" Lg.	20. Nut, Lock Nylon 1/2" - 13 UNC
8. Bolt, Hex 5/8" - 11 UNC x 4 9/16" Lg.	21. Nut, Lock Nylon 5/8" - 11 UNC
9. Bolt, Hex 3/4" - 10 UNC x 5 1/2" Lg.	22. Nut, Lock Nylon 3/4" - 10 UNC
10. Washer, Flat Hardened 7/16"	23. Engine Mount, Rear
11. Washer, Flat Hardened 1/2"	24. Engine Mount, Front
12. Washer, Flat Hardened 5/8"	25. Engine Mount Bracket, Rear Curbside
13. Washer, Flat Hardened 3/4"	

Engine & Transmission Mounts (parts list)

1. Transmission
2. Engine

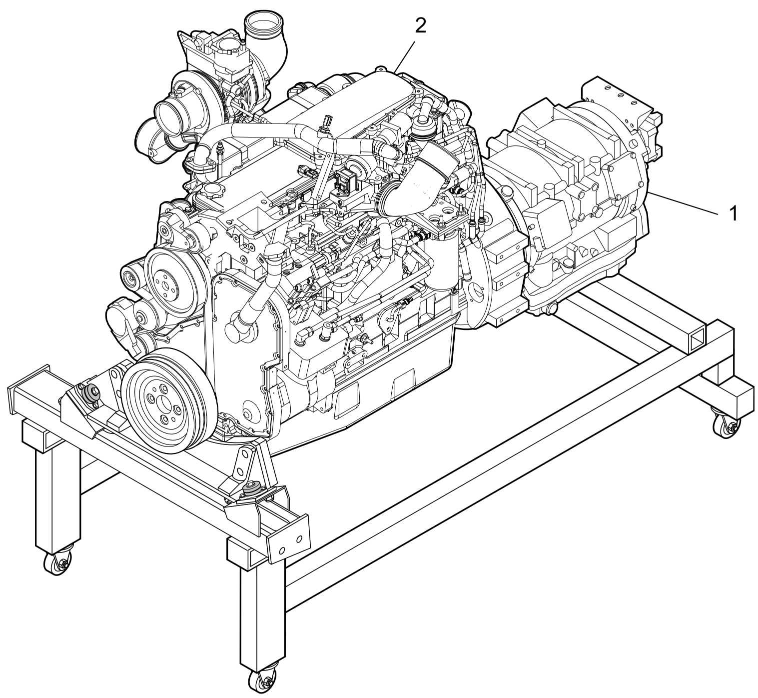


Fig. 4-6: Engine Support Dolly

2.1.7. Installation

☞**NOTE:**

If engine was fitted with lifting brackets during removal from engine dolly, then replace lifting brackets with original CAC and exhaust tube mounting brackets. Refer to 2.2. "Engine Lift Brackets" on page 13 *in this section for lifting bracket installation procedure.*

1. Install engine with attached transmission onto dolly.
2. Roll the engine dolly into the engine compartment and align the rear mounts with the mounting pads on the vehicle frame rails.
3. Insert 3/4" bolts, washers, and lock nuts into left and right-hand side engine mounts. Tighten but do not torque at this time.
4. Align the holes in the front engine support with the holes in the frame rail. Insert 5/8" bolts, washers, and lock nuts into left and right-hand sides of engine support.

☞**NOTE:**

Lower or raise the vehicle as necessary to allow the mounting bolts to freely enter the mounting holes. DO NOT hammer or otherwise force the bolts into the mounting holes.

5. Torque the 3/4" bolts in the left and right-hand side engine mounts to 250 ft-lb. (339 Nm).
6. Torque 5/8" bolts in the front engine support to 160 ft-lb. (215 Nm).
7. Raise the vehicle slightly and remove engine support dolly.
8. Connect coolant hoses disconnected during removal.
9. Connect engine air compressor, governor, pressure and air inlet hoses.
10. Connect engine ECU connectors.
11. Connect alternator electrical connections.
12. Connect power steering pump hoses.
13. Install exhaust elbow to turbo and to exhaust outlet.
14. Connect fuel lines to engine.
15. Install engine switch box.
16. Connect engine switch box electrical harnesses.
17. Install charge air intake lines.
18. Position HVAC compressor correctly and secure compressor to mounting plate.
19. Install HVAC compressor drive belt. Adjust belt tension. Refer to Section 10 of this manual for further information on compressor installation.
20. Install radiator drain plug.
21. From underneath vehicle, attach driveshaft to the transmission.
22. Attach cooler hoses to the transmission.
23. Attach transmission electrical main harness and speed sensor connector.
24. Lower the vehicle.
25. Install engine belt guard to engine struts and support tubes using 3/8" bolts, washers and lock nuts.
26. Fill hydraulic reservoir.
27. Lift the bumper in place with a suitable lifting device. Install and tighten the 4 mounting bolts.
28. Top up coolant level in surge tank.
29. Check engine and transmission fluid levels.
30. Slide the battery tray back into position. Set the Battery Disconnect switch in the battery compartment to the ON position.
31. Set the main CNG shut-off valve to the on position. Run up engine and check for leaks.

2.2. Engine Lift Brackets

2.2.1. Engine Lift Brackets Installation

1. Remove stored engine lift brackets located in the lower streetside corner of the engine compartment. See “Fig. 4-7: Engine Lift Mounting Brackets” on page 13. Retain hardware for re-use.
2. Remove the U-clamp from the front air intake tube and remove the air intake/ exhaust mounting bracket from the engine.
3. Temporarily replace the intake/exhaust mounting bracket with the engine front lift bracket. Use existing hardware and torque bolts to 32 ft-lb. (43 Nm).
4. Remove the U-clamp from the CAC tube at the rear of the engine and remove the CAC mounting bracket from the engine.
5. Temporarily replace the CAC mounting bracket with the engine rear lift bracket. Use existing hardware and torque bolts to 57 ft-lb. (77 Nm). See “Fig. 4-8: Front Lift Bracket” on page 13. See “Fig. 4-9: Rear Lift Bracket” on page 14.

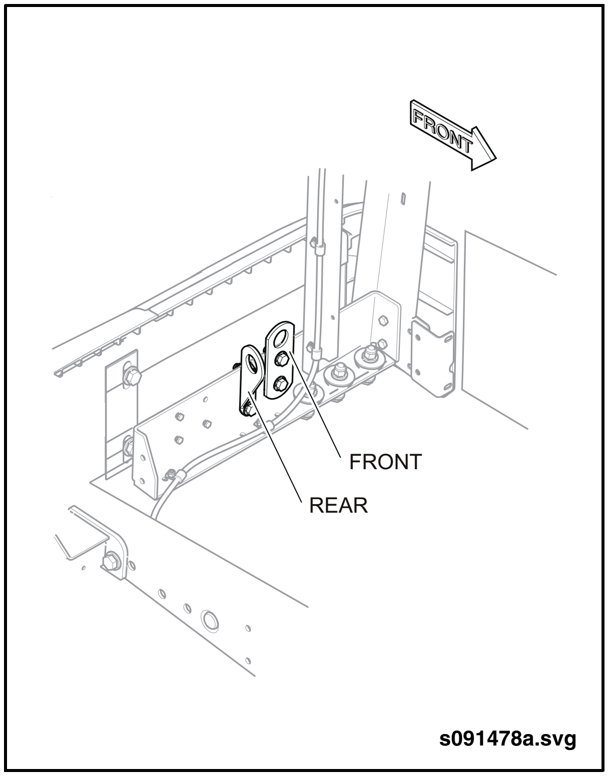


Fig. 4-7: Engine Lift Mounting Brackets

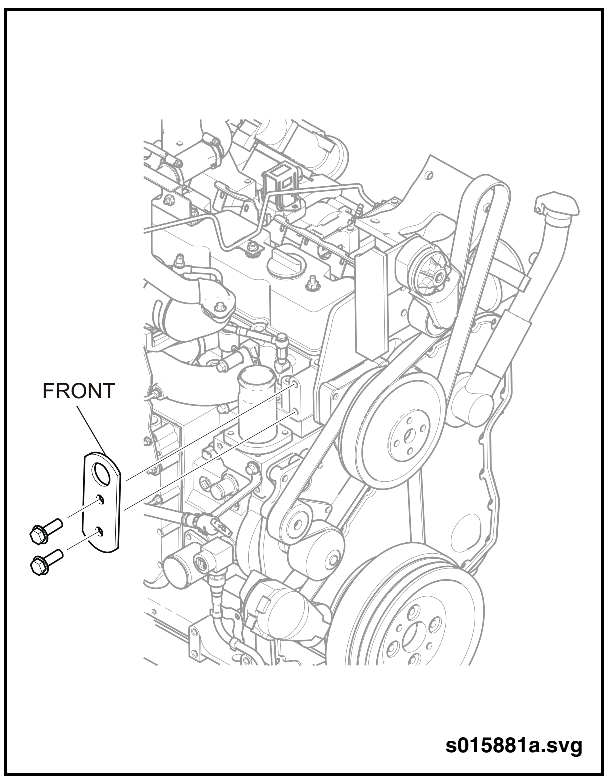


Fig. 4-8: Front Lift Bracket

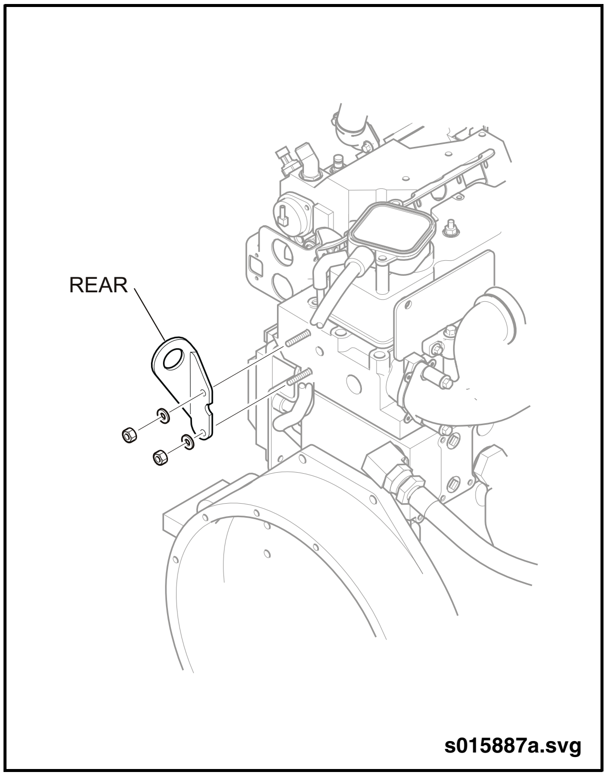


Fig. 4-9: Rear Lift Bracket

2.2.2. Engine Lift Brackets Storage

1. Remove the rear engine lift bracket and replace with the original CAC mounting bracket and hardware. Torque nuts to 57 ft-lb. (77 Nm).
2. Secure CAC tube to bracket with U-clamp.
3. Remove the front engine lift bracket and replace with the original air intake/exhaust mounting bracket and hardware. Torque bolts to 32 ft-lb. (43 Nm).
4. Secure air intake tube to bracket with U-clamp.
5. Store front and rear engine lifting brackets in the lower streetside corner of the engine compartment. Use hardware retained previously to secure the brackets in their stored position.

2.3. Engine Mount Replacement

WARNING

The following procedure requires lifting the vehicle and supporting heavy components with lifts and/or stands. ALWAYS ensure that the equipment being used is designed for the application and that proper lifting procedures are followed. Refer to the General Information Section of this manual for further information on lifting, hoisting, or jacking the vehicle.

2.3.1. Description

The following replacement procedures provide instructions on how to replace front and/or rear engine mounts without removing the engine from the engine compartment. For purposes of reference, the front engine mounts are at the accessory drive pulley end of the engine and the rear mounts are at the flywheel end of the engine.

When replacing a worn or broken engine mount, it is recommended that the mount on the opposite side be replaced as well.

2.3.2. Front Mount Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Unlatch and remove the belt guard.
3. Relieve the tension on the HVAC compressor drive belt.
4. Raise the vehicle to allow for the use of a floor jack.
5. Remove the 5/8" bolt, flat washer, engine rebound washer, spacer, and lock nut that secure the rubber mount to the top engine mount assembly and lower crossmember assembly. See “Fig. 4-10: Front Engine Mounts” on page 15.
6. Remove the two 1/2" bolts, washers, and lock nuts that secure the rubber mount to the lower crossmember assembly.
7. Position a floor jack beneath the engine and place a board across the width of the front portion of the oil pan.

CAUTION

Determine whether raising the engine will have any negative effects to components directly attached to the engine or may impact any components in the immediate area of the engine before raising the engine. Loosen clamps and/or disconnect any lines, tubes, harnesses that may be affected.

8. Raise the engine sufficiently to allow removal of the rubber mount.

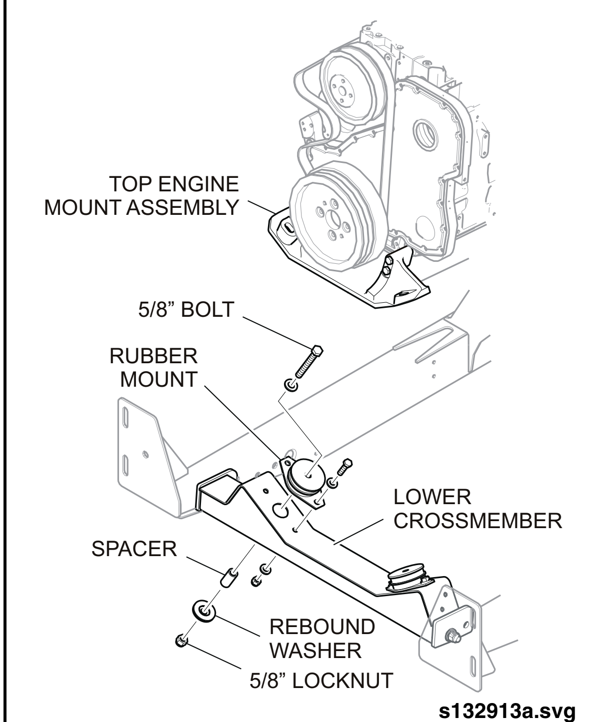


Fig. 4-10: Front Engine Mounts

2.3.3. Front Mount Installation

1. Install a new rubber mount and align the two mounting holes with the two holes in the lower crossmember.
2. Install the two 1/2" bolts, washers, and lock nuts that secure the rubber mount to the lower crossmember. Hand-tighten only at this time.
3. Lower the engine so that the weight of the engine is supported by the rubber mount. Use a tapered punch, if necessary, to ensure the hole in rubber mount aligns with hole in upper engine mount assembly.
4. Install the 5/8" bolt, flat washer, spacer, engine rebound washer, and lock nut. See “Fig. 4-11: Front Engine Mount Cross-Section” on page 16.

☞**NOTE:**

Ensure the recessed side of the engine rebound washer faces the spacer.

5. Torque the 1/2" lock nuts to 70 ft-lb. (95 Nm).
6. Torque the 5/8" lock nut to 160 ft-lb. (217 Nm).

☞**NOTE:**

Ensure the spacer is properly installed and there is clearance between the engine rebound washer and the underside of the crossmember. The spacer is designed to establish this clearance and prevent the rubber mount from being excessively compressed.

7. Check belt tension and alignment and adjust if necessary. Refer to Section 10 of this manual for HVAC belt adjustment procedure.
8. Reinstall and latch belt guard.

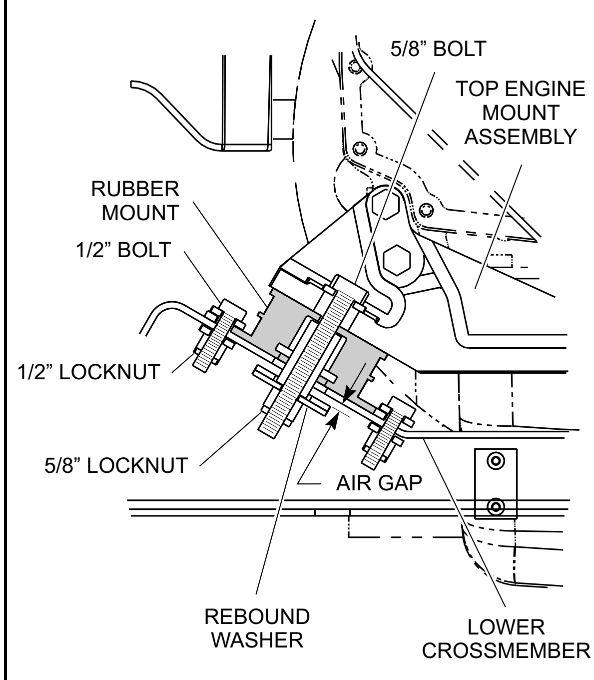


Fig. 4-11: Front Engine Mount Cross-Section

2.3.4. Rear Mount Removal

☞**NOTE:**

The following procedure describes removal of the rubber mount only. There is insufficient access to remove the complete mounting bracket assembly from the engine.

1. Set the Battery Disconnect switch to the OFF position.
2. Raise the rear passenger seat and open and secure the interior engine access door.
3. Raise the vehicle to working height. Refer to the General Information Section of this manual for lifting procedures. The vehicle must be supported by wheel lifts or axle stands. Do not allow axle assembly to hang unsupported.
4. Disconnect the rear leveling valves and bleed air out of both air springs evenly until air springs are deflated and rubber stop on vehicle body contacts the axle housing.

☞**NOTE:**

The leveling valves need to be disconnected and air springs deflated to prevent the suspension leveling system from reacting to the lifting force on the engine when replacing the rear mounts.

5. Remove the 3/4" bolt, washers, snubbing washer, and lock nut that secure the rubber mount to the side engine mount bracket and frame rail bracket. Note the location of the snubbing washer for reinstallation. See “Fig. 4-12: Rear Engine Mount” on page 18.
6. Position a lift table, transmission jack, or similar lifting equipment, beneath the transmission and use wooden blocks to support the weight of the transmission. Spread the lifting load over the width of the transmission to prevent damaging the oil pan.
7. Locate the transmission oil cooler hoses and loosen the clamps and brackets that secure the hoses to the vehicle structure. This will allow the engine to be raised without putting stress on the hoses.
8. Loosen the clamps that secure the CAC tube where it crosses over the rear of the engine. This will allow the engine to be raised without putting stress on the CAC tube.
9. Loosen the clamps that secure the wiring harness running above and across the rear of the engine. This will allow the engine to be raised without damaging the harness.

⚠**CAUTION**

Determine whether raising the engine will have any negative effects to components directly attached to the engine or may impact any components in the immediate area of the engine before raising the engine. Loosen clamps and/or disconnect any lines, tubes, harnesses that may be affected.

☞**NOTE:**

In the following step it will be necessary to raise the engine slightly to gain access to the head of the 7/16" engine mount bolts. For the streetside mount, it is recommended that one person restrain the head of the bolt from beneath while the second person removes the lock nut from the interior side of the vehicle.

10. Raise the engine sufficiently to access and remove the two 7/16" bolts, washers, and lock nuts that secure the rubber mount to the engine side mount assembly.
11. Continue to slowly raise the engine while observing all surrounding components and structure for clearance. The engine will need to be raised approximately 2 1/4", until the rubber portion of the mount can clear the mounting bracket. Slide the rubber mount out from the bracket.

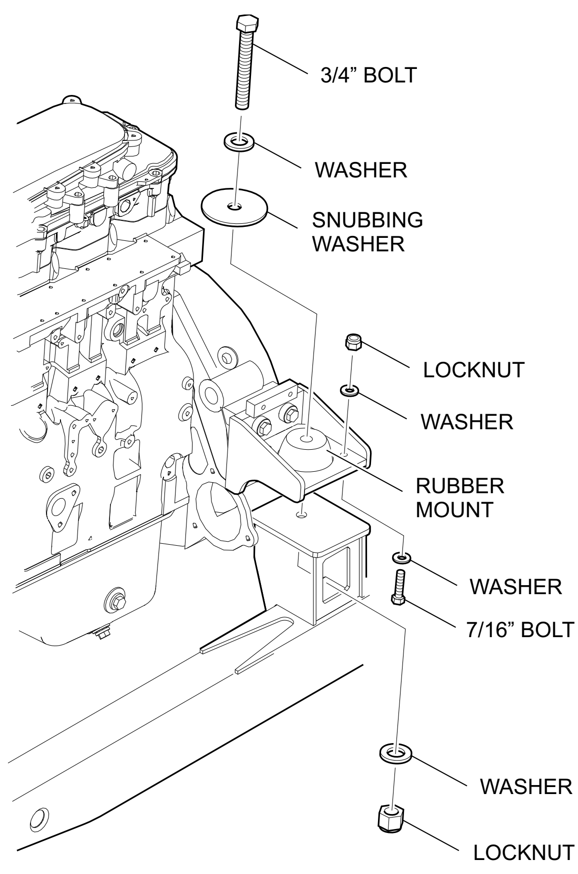


Fig. 4-12: Rear Engine Mount

2.3.5. Rear Mount Installation

1. Install new rubber mount into the engine side mount assembly and secure with the two 7/16" bolts, washers, and lock nuts. Hand-tighten only at this time.
2. Align the hole in the rubber mount with the hole in the frame rail bracket and install the 3/4" bolt, washers, snubbing washer, and lock nut.
3. Torque the 7/16" lock nuts to 50 ft-lb. (68 Nm).
4. Lower the engine, allowing the full weight of the engine to be supported by the mount assembly.
5. Torque the 3/4" lock nut to 250 ft-lb. (339 Nm).
6. Tighten all U-clamps and P-clamps that were previously loosened.
7. Connect leveling valves and allow suspension to reach normal ride height.

   Lower the vehicle and secure all access doors.

2.4. Engine Struts

2.4.1. Description

The engine struts connect the main frame rails to the vehicle structure and are used to tension the main frame rails and support the engine. See “Fig. 4-13: Engine Struts” on page 19.

1. Bolt, Hex 3/4" - 10 UNC x 2 1/2" Lg.
2. Washer, Flat Hardened 3/4"
3. Washer, Flat Hardened 1"
4. Nut, 1-14 UNS Grade 8
5. Nut, Lock Nylon 3/4" - 10 UNC
6. Engine Strut, Curbside
7. Engine Strut, Streetside
8. Never Seize

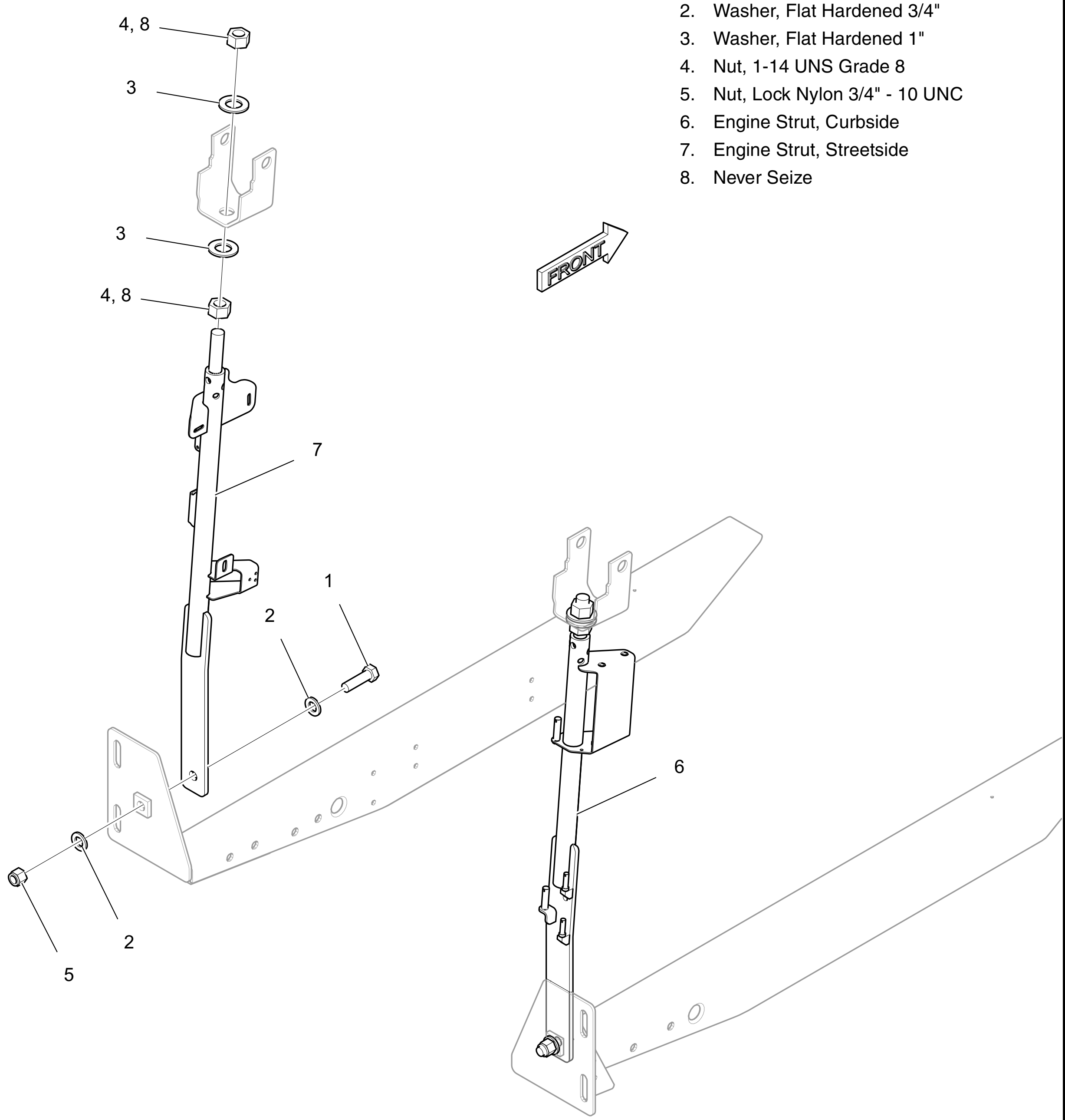


Fig. 4-13: Engine Struts

2.4.2. Removal

1. Loosen the jam nut and remove the 1" upper nut on the engine strut.
2. Remove the 3/4" lock nut, bolt, and washers that attach the lower end of the engine strut to the main frame rail bracket.
3. Remove the engine strut.

2.4.3. Installation

1. Thread a 1" nut on the upper end of the strut until nearly bottomed.
2. Install threaded end of engine strut into upper mounting bracket and loosely install upper nut.
3. Align hole in lower end of strut with hole in main frame rail mounting bracket and secure engine strut to frame rail bracket with 3/4" bolt, washers, and lock nut.
4. Apply Never-Seez to bolt threads and torque lock nut to 250 ft-lb. (339 Nm).
5. Ensure lower 1" nut is backed off, then tighten upper 1" nut until contact is made with upper mounting bracket.
6. Measure the distance between the lower frame rail and upper vehicle structure. See “Fig. 4-14: Engine Strut Tensioning” on page 20.
7. Continue to tighten upper nut until the 44.84" dimension is achieved, and then tighten an additional two turns.
8. Apply Never-Seez to threaded area of engine strut and tighten lower 1" jam nut to 426 ft-lb. (576 Nm).

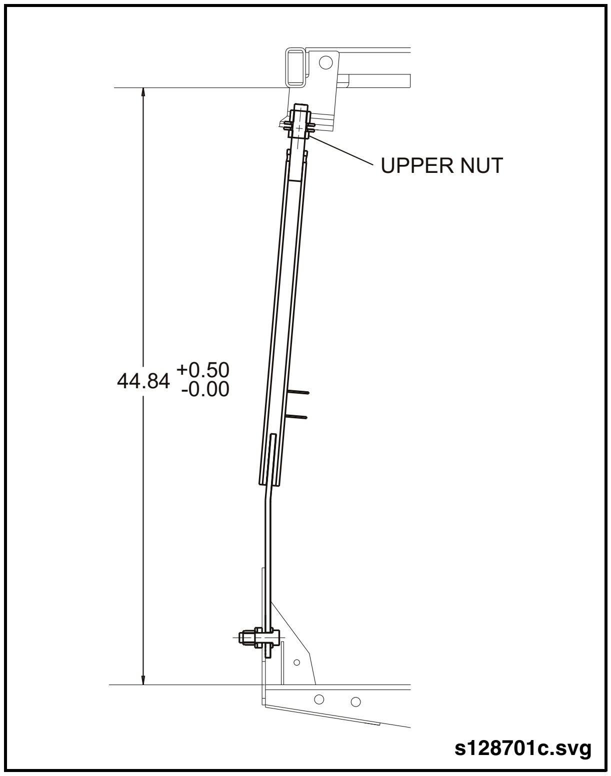


Fig. 4-14: Engine Strut Tensioning

2.5. Belt Guards

2.5.1. Description

An engine belt guard and an HVAC compressor belt guard are located in the engine compartment. Both the engine and HVAC belt guards are hinged with a latch and have a quick release attachment system for easy removal. See "Fig. 4-15: Engine Belt Guards" on page 22.

2.5.2. Engine Belt Guard Removal

1. Unlatch the belt guard by releasing the latch. Swing the belt guard open.
2. Remove the hairpin clip from the upper hinge pin.
3. Lift the belt guard off the hinge pins.

2.5.3. Engine Belt Guard Installation

1. Lower the engine belt guard into position by aligning the hinge pin brackets on the belt guard with the hinge pins on the vehicle structure.
2. Close the belt guard and observe the vertical clearance between the belt guard and alternator pulley and air intake tube. Adjust the hinge bracket as necessary by loosening the hinge bracket fasteners and sliding the hinge bracket within the slotted hole. Tighten mounting fasteners when hinge brackets are properly positioned.
3. Adjust the height of the latch bolt so that the belt guard rests on the shoulder of the bolt.
4. Check the height of the lower belt guard plate to ensure 1/8" to 3/8" clearance from bumper.
5. Secure the belt guard with the latch in the closed position.

2.5.4. HVAC Compressor Belt Guard Replacement

1. Unlatch the belt guard by releasing the latch. Swing the belt guard open.
2. Remove the hairpin clip from the upper hinge pin.
3. Lift the belt guard off the hinge pins.
4. Installation is the reverse of removal.

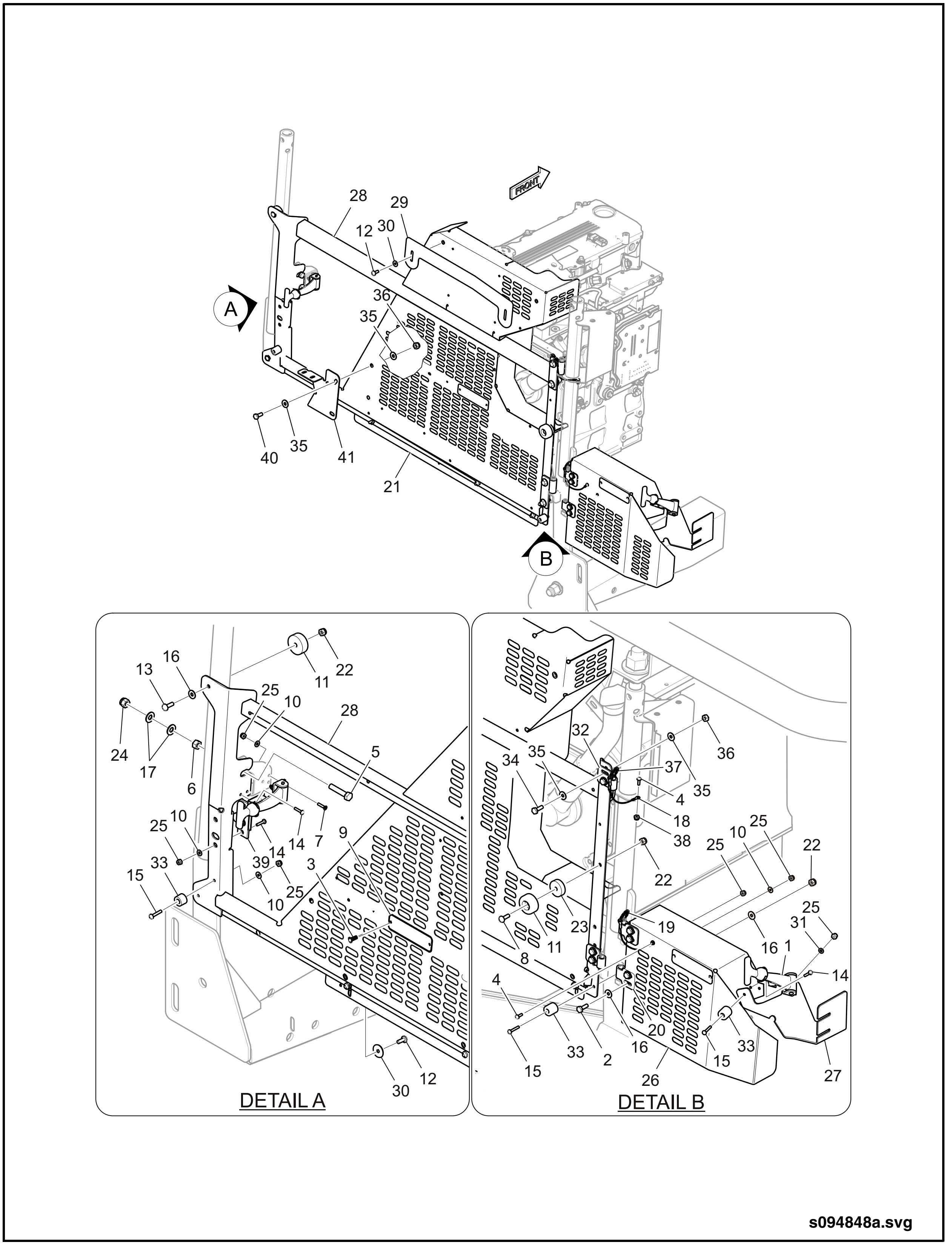


Fig. 4-15: Engine Belt Guards

1. Latch, Rubber
2. Bolt, Hex 1/4" - 20 UNC x 3/4" Lg.
3. Rivet, Low Profile Blind Breakstem Alum. 1/8" x .125/.312"
4. Screw, PH Cross Recess SST #8 - 32 UNC x 1/2" Lg.
5. Bolt, Hex 3/8" - 16 UNC x 1 3/4" Lg.
6. Nut, Hex 3/8" - 16 UNC
7. Screw, FH Cross Recess SST #8 - 32 UNC x 3/4" Lg.
8. Screw, PH Cross Recess SST 1/4" - 20 UNC x 1 1/4" Lg.
9. Decal, Warning Belt Guard
10. Washer, Flat #8
11. Bumper, Rubber 1 1/2"
12. Screw, PH Cross Recess SST 1/4" - 20 UNC x 5/8" Lg.
13. Screw, PH Cross Recess SST 1/4" - 20 UNC x 3/4" Lg.
14. Screw, PH Cross Recess SST #8 - 32 UNC x 3/4" Lg.
15. Screw, PH Cross Recess SST #8 - 32 UNC x 1" Lg.
16. Washer, Flat Hardened 1/4"
17. Washer, Flat Hardened 3/8"
18. Lanyard, Rope 6" SST
19. Ring, Cotter 0.06" x 1.0" SST
20. Bracket, Belt Guard Hinge
21. Plate, Belt Guard Closeout
22. Nut, Lock Nylon 1/4" - 20 UNC
23. Spacer, .28" I.D. x 3/8" Thk.
24. Nut, Lock Nylon 3/8" - 16 UNC
25. Nut, Lock Nylon #8 - 32 UNC
26. Guard, Belt Cover Hinged
27. Bracket, AC Belt Support
28. Frame, Belt Guard
29. Closeout, Belt Guard Upper
30. Washer, Flat SST 1/4"
31. Washer, Flat #8 SST
32. Hinge, Belt Guard Yellow
33. Bumper, Rubber .170" I.D. x .80" O.D. x .78" with Steel Insert
34. Bolt, Hex 5/16" - 18 UNC x 1" Lg.
35. Washer, Flat Hardened 5/16"
36. Nut, Lock Nylon 5/16" - 18 UNC
37. Pin, Hitch Clip
38. Nut, Hex Machine Screw #8 - 32 UNC
39. Latch, LH
40. Bolt, Hex 5/16" - 18 UNC x 3/4" Lg.
41. Bracket, Engine Door Latch

Engine Belt Guards (parts list)

2.6. Air Intake & Air Cleaner Assembly

2.6.1. Description

The air intake system includes the air inlet grille, air intake box, air cleaner assembly, air filter restriction indicator and interconnecting steel tubing, rubber hump hoses and elbows, and clamps. See “Fig. 4-16: Engine Intake System” on page 24.

The air cleaner assembly is a molded plastic housing with a removable access cover for servicing the primary and safety filter elements. The air filter restriction indicator is remotely located near the engine switchbox and is connected to an air intake tube with a flexible hose.

2.6.2. Operation

Air enters the vehicle through a perforated mesh air inlet grille located on the upper rear curbside corner of the vehicle. The air intake box inlet is sealed against the air intake grille with a bulb seal and is internally baffled to prevent moisture intrusion. Air flows downward through primary and safety elements which capture any airborne contaminants. The air filter restriction gauge registers the level of air intake restriction.

2.6.3. Maintenance

Refer to the Preventive Maintenance section of this manual for scheduled inspections on the air filter restriction indicator and air filter element replacement procedures.

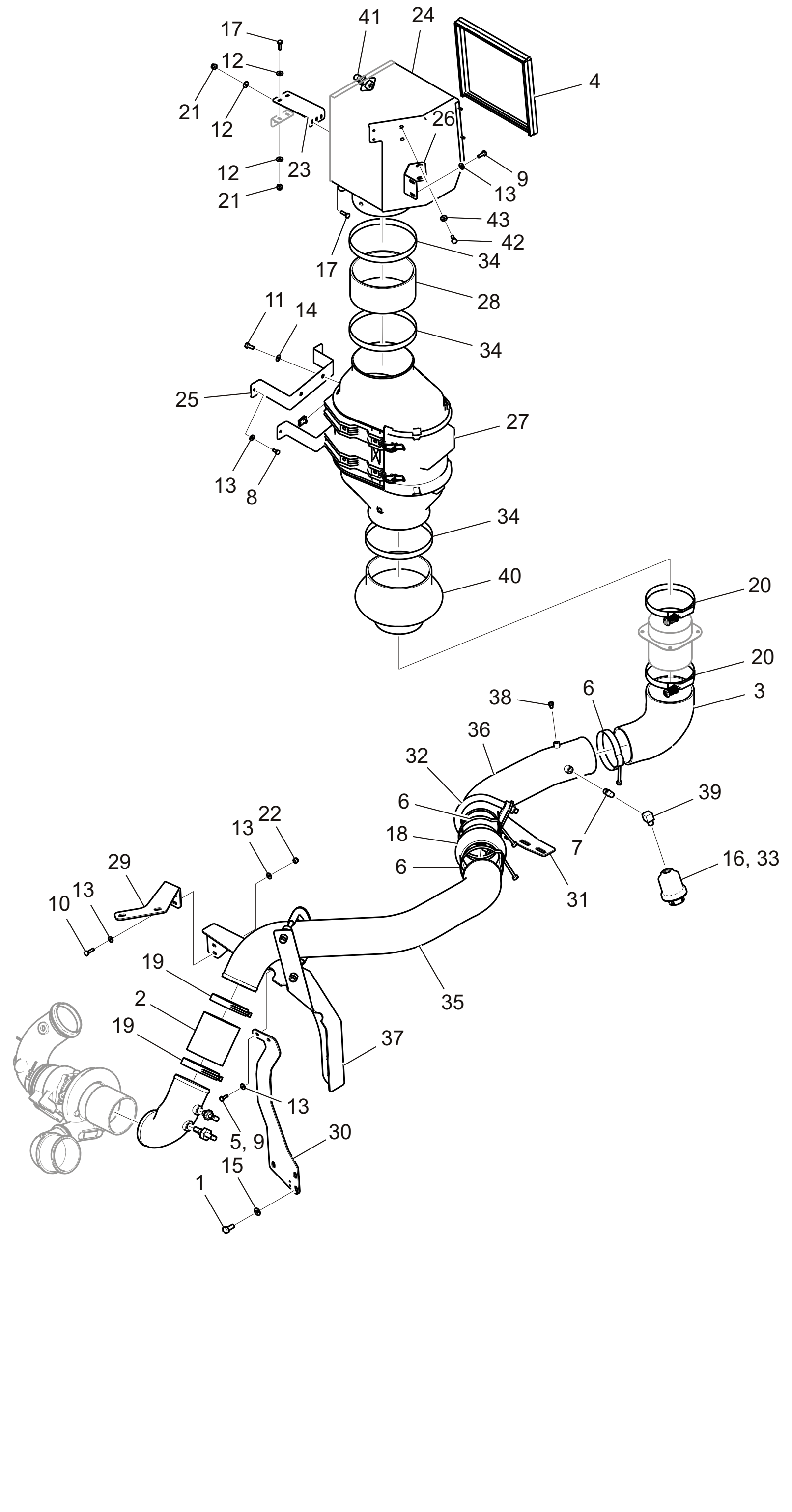


Fig. 4-16: Engine Intake System

1. Bolt, M10 x 1.5 x 25 CL10.9
2. Hose, Silicone 4" Dia.
3. Elbow, Rubber 5"
4. Seal, Bulb
5. Loctite, 243 Blue
6. Clamp, T-Bolt with Spring 4.31" Dia. - 4.62" Dia.
7. Filter, 1/8" PT Air Intake
8. Bolt, Hex 1/4"- 20 UNC x .63" Lg.
9. Bolt, Hex 1/4" - 20 UNC x 3/4" Lg.
10. Bolt, Hex 1/4" - 20 UNC x 1" Lg.
11. Bolt, Hex 5/16" - 18 UNC x 3/4" Lg.
12. Washer, Flat #10
13. Washer, Flat 1/4"
14. Washer, Flat 5/16"
15. Washer, Flat 3/8"
16. Tape, Teflon
17. Screw, Hex SST #10 - 24 UNC x 5/8" Lg.
18. Hose, Hump 4.0" I.D.
19. Clamp, T-Bolt 4 1/4"
20. Clamp, Hose 5 1/2"
21. Nut, Lock Nylon #10 - 24 UNC
22. Nut, Lock Nylon 1/4" - 20 UNC
23. Bracket, Air Intake Housing
24. Housing Assembly, Air Intake
25. Bracket, Support Air Intake
26. Bracket, Support Air Intake Housing
27. Air Cleaner Assembly
28. Hose, 7.0" I.D. x 3.5" Lg.
29. Bracket, Exhaust Tube
30. Bracket, Support Exhaust Tube
31. Bracket, Support Air Intake Tube
32. Clamp, 4" CAC Tube
33. Indicator, Air Restriction
34. Clamp, Hose 7"
35. Tube, Air Intake
36. Tube, Air Intake
37. Bracket, Air Intake/Exhaust
38. Plug, 1/8" - 27
39. Elbow, 90° 1/8" FPT x 1/8" MPT
40. Reducer, Hump 7" to 5"
41. Sensor, Engine Air Intake Temperature
42. Bolt, Hex 1/4" - 20 UNC x 3/4" Lg. SST
43. Washer, Flat SST 1/4"

Engine Intake System (parts list)

2.6.4. Air Intake & Air Cleaner Troubleshooting

AIR INTAKE & AIR CLEANER TROUBLESHOOTING		
PROBLEM	**CAUSE**	**SOLUTION**
Short filter element life	Defective or inaccurate filter restriction indicator	Replace indicator.
	Incorrect air filter application	Refer to your New Flyer Parts Manual for correct air filter element.
	Air leakage upstream of filter	Ensure all clamps are tight and no holes or damage is evident on tubes and hoses. Check air cleaner service cover for leakage.
Premature engine wear	Air leakage downstream of filter element	Ensure all clamps are tight and no holes or damage is evident on tubes and hoses. Ensure turbocharger and engine compressor connections are tight.
	Leakage at filter element	Ensure filter element is properly seated and forms a tight seal with the air filter housing.

2.6.5. Removal

☞**NOTE:**

The following procedure describes removal of the air cleaner assembly and air intake box as an assembly from the vehicle and assumes that the air cleaner assembly and/or air intake box are damaged and require replacement. Routine servicing procedures for the air cleaner elements are covered in the Preventive Maintenance section of this manual.

1. Open the curbside corner pillar access door and rear engine access door.
2. Clean the air cleaner assembly, engine air intake tubes and surrounding areas prior removing any components so as to prevent any contamination from entering the engine air intake system.
3. Loosen the two T-bolt clamps on the rubber elbow located at the base of the vertical air intake tube.
4. Remove the rubber elbow and clamps from the vehicle and immediately cap the horizontal air intake tube leading to the turbocharger to prevent entry of contaminants.
5. The outlet of the air cleaner assembly is attached to a vertical air intake pipe with a hump hose and two clamps. Loosen the lower clamp on the hump hose and separate the hump hose from the air intake tube.
6. Remove the two bolts and washers from the mounting brackets on either side of the air cleaner assembly.

☞**NOTE:**

It is not necessary at this time to remove the single straight support bracket that attaches the air cleaner assembly to the air intake box.

7. Carefully support and tilt the air cleaner assembly outward and remove from the vehicle.

2.6.6. Disassembly

1. Remove the support bracket that attaches the air intake box to the air cleaner assembly. See “Fig. 4-17: Air Intake Box/Cleaner Assembly” on page 26.
2. Loosen the upper clamp and slide the air intake box upwards and off the air cleaner assembly.
3. Loosen the lower clamp on the air clean assembly outlet and remove the hump hose.

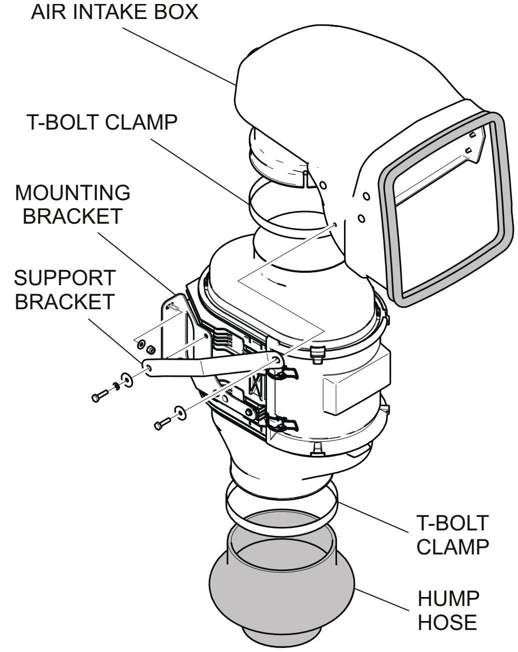


Fig. 4-17: Air Intake Box/Cleaner Assembly

2.6.7. Assembly

1. Slide the air intake box with T-bolt clamp over the inlet of the air cleaner assembly. Do not tighten the T-bolt clamp at this time.
2. Align the intake box with the air cleaner assembly and install the single support bracket.

CAUTION

DO NOT exceed the specified torque value for clamp installation. Excessive tightening will cause the plastic inlet of the air cleaner assembly to distort and possibly crack. ALWAYS use a calibrated torque wrench with a torque range suitable to the application.

3. Torque the T-bolt clamp on the air cleaner inlet to 40 in-lb.
4. Slide the hump hose with T-bolt clamp onto the outlet of the air cleaner assembly. Ensure that the hump hose fully engages the throat of the air cleaner outlet and that the hose clamp is positioned above the sealing bead on the air cleaner outlet and is properly centered.

CAUTION

DO NOT exceed the specified torque value for clamp installation. Excessive tightening will cause the plastic outlet of the air cleaner assembly to distort and possibly crack. ALWAYS use a calibrated torque wrench with a torque range suitable to the application.

5. Torque the T-bolt clamp on the air cleaner outlet to 40 in-lb.

2.6.8. Installation

1. Loosely install T-bolt clamp on hump hose before installing air cleaner and intake box assembly into vehicle.
2. Inspect and clean the vertical intake pipe.
3. Support the air cleaner and intake box assembly and carefully align and slide the hump hose over the vertical air intake pipe while simultaneously aligning the air cleaner housing with the mounting brackets on either side. Torque to 120 in-lb (13.5 Nm).
4. Apply Loctite 242 threadlocker to the threads of the bolts and install bolts with washers through mounting bracket and into threaded holes of air cleaner housing. Do not over tighten mounting bolts.
5. Ensure hump hose is properly seated over vertical air intake tube and T-bolt clamp is properly positioned. Torque T-bolt clamp to 85 in-lb.
6. Close the corner pillar access doors and check to ensure the bulb seal on the air intake box forms a proper seal against the access door.

2.7. Exhaust System

2.7.1. Description

The exhaust system consists of a muffler and tailpipe assembly, a turbo outlet exhaust tube, a flexible exhaust bellows, a muffler inlet exhaust tube, and exhaust blankets. The exhaust system is mounted using isolator mounting bracket, muffler clamps, V-bands, and U-clamps.

2.7.2. Inspection

The exhaust system should be inspected for restrictions and leaks whenever exhaust system components are serviced or replaced. Kinks or crimped piping can result in excessive back-pressure which can cause increased fuel consumption, power loss and possible engine damage. Exhaust leaks are commonly the result of loose clamps, corroded or punctured exhaust tubes or muffler. Damaged parts should be replaced and loose clamps should be tightened securely.

☞**NOTE:**

When installing new parts into exhaust system leave clamps loose until components have been installed. After complete installation of parts, the system should be aligned to allow clearance of engine and exhaust system piping. The clamps should now be tightened firmly to hold the piping in this alignment. It is recommended that the U-clamps and V-band clamps be replaced at the same time as the connecting component.

2.7.3. Muffler

2.7.3.1. Description

The muffler consists of four segments: an inlet section, two catalyst sections and an outlet section. The muffler also incorporates an oxygen sensor and a temperature sensor located at the muffler outlet. The engine ECM monitors the outputs from sensors. See "Fig. 4-18: Muffler Assembly" on page 29.

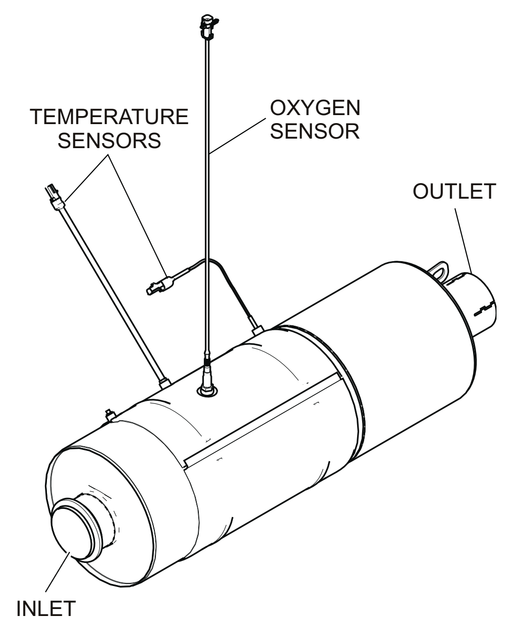


Fig. 4-18: Muffler Assembly

2.7.3.2. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Open all access doors and remove close-outs to gain access to the muffler.
3. Disconnect the muffler temperature and oxygen sensor electrical connections from the muffler.
4. Remove the V-clamp connector from the muffler inlet.
5. Remove the bolts, nuts, and washers from the lower mounting bracket.
6. Remove the two bolts that attach the upper mounting bracket to the vehicle.
7. Attach lifting equipment to muffler lifting bracket and remove muffler assembly from vehicle.

2.7.3.3. Installation

1. Use lifting equipment and carefully lower muffler assembly into vehicle. Align muffler so that lower mounting bracket lines up with the bracket tabs on the muffler.
2. Secure muffler to lower mounting bracket using bolts, nuts, and washers.
3. Attach exhaust tube to muffler inlet using a V-clamp. Torque to 120 in-lb. (13.5 Nm).
4. Align upper mounting bracket so that exhaust tailpipe is oriented correctly. Tighten U-clamp and upper mounting bracket.

   ☞**NOTE:**

   Ensure that adequate clearance exists between exhaust system components and vehicle structure.

5. Connect the muffler temperature and oxygen sensor electrical connections to the muffler.
6. Close the access doors and re-install any closeouts removed during the removal procedure.
7. Set the Battery Disconnect switch to the ON position.
8. Run up the engine and check the exhaust system for correct operation and leaks.

2.7.4. Exhaust Tubes, Exhaust Flex Connector & Exhaust Blankets

2.7.4.1. Removal

1. Cut the stainless steel wire using side cutters and unlace the exhaust blankets. Remove exhaust blankets.
2. Remove the V-band clamps from the exhaust tube at the muffler inlet and from one end of the exhaust flex connector. Remove exhaust tube. See “Fig. 4-19: Exhaust Tube Removal” on page 32.
3. Remove V-band clamp from other end of exhaust connector and remove exhaust flex connector.
4. Remove U-clamp from mounting bracket and V-band clamp from turbo outlet. Remove the exhaust tube.

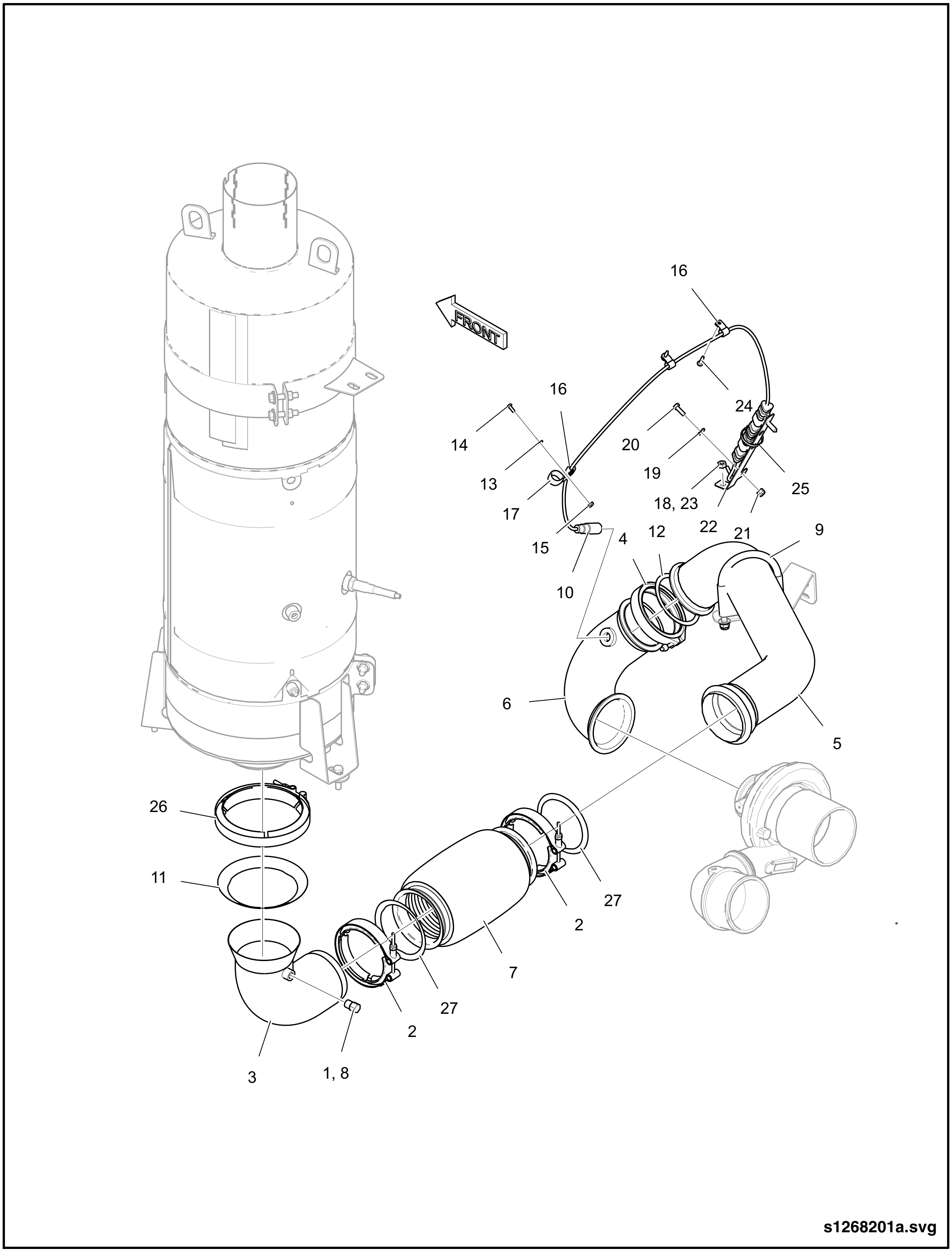


Fig. 4-19: Exhaust Tube Removal

1. Plug, 1/4" NPT SST	15. Nut, Hex Machine Screw #10 - 24 UNC
2. Clamp, 4.75" Exhaust V-Band	16. Clamp, "P" .375" SST/Teflon
3. Tube, Exhaust Muffler	17. Clamp, "P" SST/Teflon 0.750"
4. Clamp, 4" Exhaust V-Band	18. Nut, SST M8 x 1.25
5. Tube, Exhaust Flex/Turbo ISL	19. Washer, Flat SST 1/4"
6. Tube, Exhaust Turbo ISL	20. Bolt, Hex 1/4" - 20 UNC x 3/4" Lg. SST
7. Connector, Flex	21. Nut, Lock Nylon 1/4" - 20 UNC SST
8. Never Seize	22. Bracket, Oxygen Sensor Harness
9. U-Clamp, 3 1/2"	23. Loctite, 243 Blue
10. Sensor, Oxygen	24. Screw, PH Cross Recess Tpg. Type F #10 - 24 UNC x 3/4" Lg.
11. Gasket, Marmon 5"	25. Cable Tie, High Temperature
12. Gasket, Marmon 3.5"	26. Clamp, Marmon 5"
13. Washer, Flat SST #10	27. Gasket, Marmon 4"
14. Screw, PH Cross Recess SST #10 - 24 UNC x 1/2" Lg.	

Exhaust Tube Removal (parts list)

2.7.4.2. Installation

1. Loosely assemble and install V-clamp on the exhaust tube at the turbo outlet and loosely install the U-clamp to the mounting bracket.
2. Loosely assemble remaining exhaust tube on muffler inlet.
3. Align the exhaust tubes using the Flex Connector Alignment Tool. Refer to your New Flyer Parts Manual for tool part number.
4. Collapse alignment tool and position in between the exhaust tubes.
5. Rotate both ends of the alignment tool until it locks into the expanded position (locating pin should be out of the slot and in contact with edge of the slotted end of the tool). Make sure that the flanged end of the exhaust tubes are properly seated to the tool. See “Fig. 4-20: Flex Connector Alignment Tool” on page 35.

☞**NOTE:**

Adjustment of muffler and/or exhaust tubes might be necessary to achieve proper alignment. If the tool does not align or does not fit between the exhaust tube ends, loosen the following: upper muffler clamp and 3 lower muffler base bolts, muffler elbow V-Band clamp, downpipe V-band, downpipe U-Bolt and turbo charge connection V-Band Install the tool to exhaust tubes.

6. After verifying that the tubes and tool are all aligned, tighten the V-band clamp on the turbo charger connection to 124 in-lb. (14 Nm). Tighten U-clamp.Tighten V-band clamp on the muffler connection to 120 in-lb. (13.5 Nm). Tighten bolts on the muffler base if these were loosened.
7. Loosen V-band clamps on the tool and slide them out of the way. Collapse the tool by rotating both ends and slipping the pin to the slot. Remove the tool.
8. Install exhaust flex connector and attach loosely to exhaust tube with V-clamp.

9. The following criteria must be met while aligning exhaust tubes and exhaust flex connector:

   a. Adequate clearance must be maintained between exhaust components and vehicle structure.

   b. Ensure the exhaust flex connector is installed without any twisting applied to it so that its convolutions are straight and equally spaced from one end to the other.

   c. Directional flow arrow on the exhaust flex connector outlet flange must point towards the muffler side of the installation.

   d. The exhaust flex connector length shall be 9.25 ± 0.18" when measured between the crimping rings on either end. Adjust muffler exhaust tube as required to achieve this dimension. See “Fig. 4-21: Exhaust Flex Connector Installation” on page 35.

   e. Examine the tubes and flex connector from above and below, with a 90° angle between the viewing points. The exhaust tubes on either side of the exhaust flex connector must be aligned parallel with each other and display no offset.

10. When installation is correct, torque the V-band clamps to 75 in-lb. (8.5 Nm).

11. Install each section of exhaust blanket by wrapping the blanket around the tube so that the seam is at the bottom. Compress the blanket sufficiently so that the seam is closed with ends of the insulation butting together. Ensure seam is overlapped with the blanket flap.

    ☞**NOTE:**

    Plastic tie-wraps may be used to temporarily hold the blanket in place while lacing the blanket together.

12. Lace the blanket together using stainless steel wire. Form a loop in the wire and hook it around the first rivet/hook. Lace the wire across the blanket to close the seam.

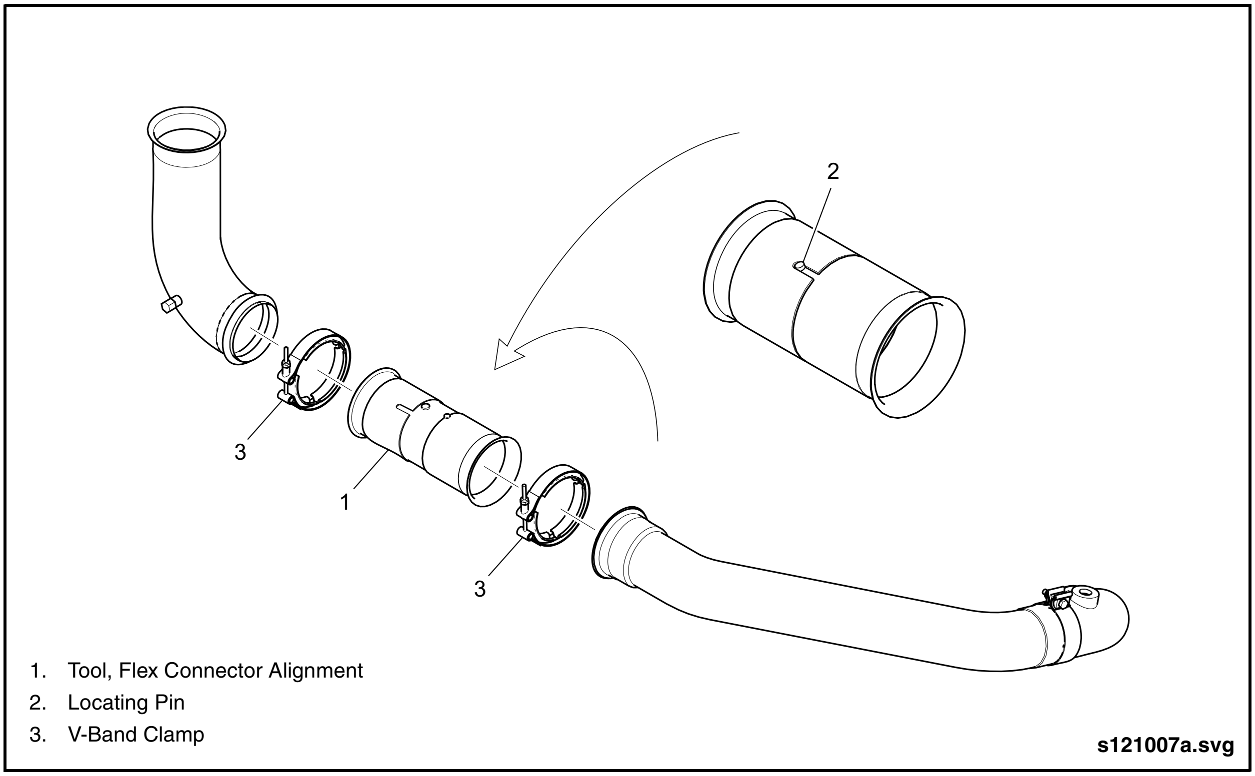


Fig. 4-20: Flex Connector Alignment Tool

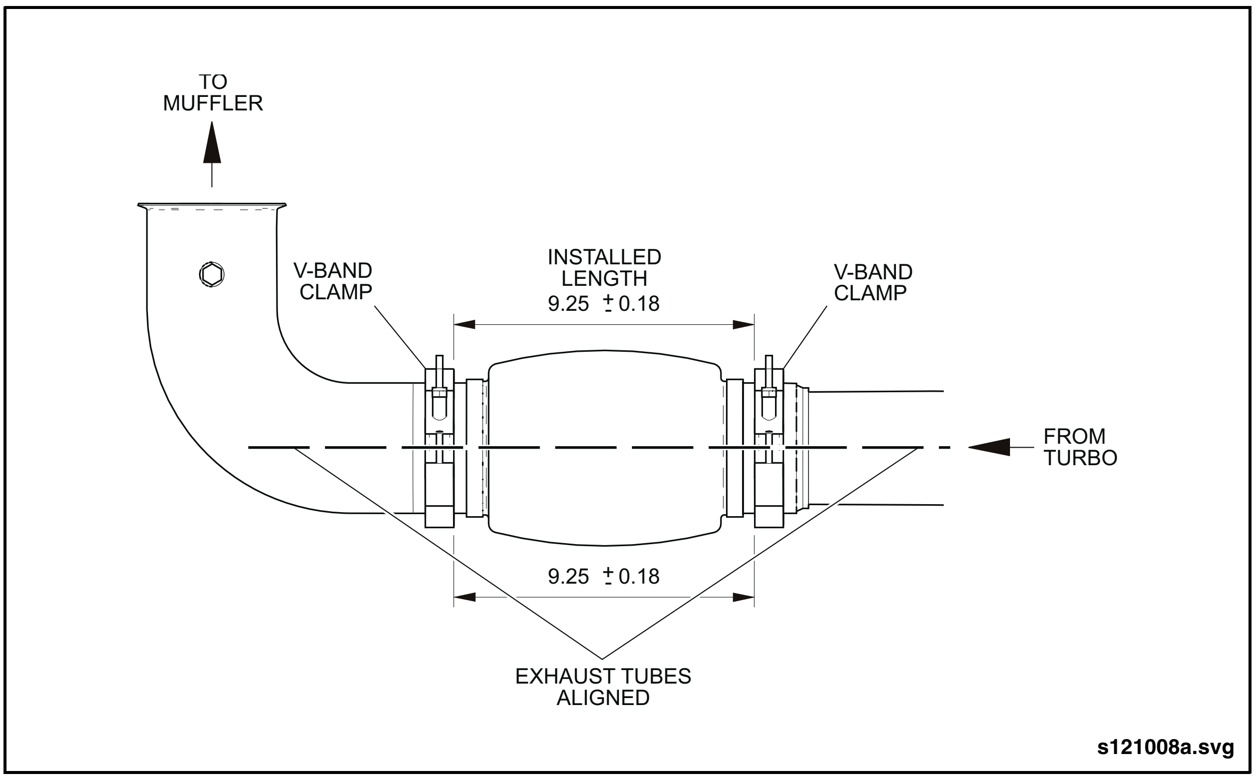


Fig. 4-21: Exhaust Flex Connector Installation

2.8. Engine Switch Box

2.8.1. Description

The engine switch box is located in the engine compartment and is visible immediately upon opening the engine door. It contains the following:

See “Fig. 4-22: Engine Switch Box” on page 37.

- ❒ Engine Run switch - used to select front or rear engine starting.
- ❒ Start Button - used for starting the engine from the rear of the vehicle.
- ❒ Compartment Lights switch - used to illuminate engine compartment.
- ❒ Cabin Coolant Fill Mode switch - used during coolant filling process to open all heating system solenoid valves.
- ❒ Low Cabin Coolant Indicator - illuminates when the cabin coolant level is below the minimum acceptable level.
- ❒ Engine Diagnostic Connector - used for connecting diagnostic hardware during service.
- ❒ CAN Communicator - used to display engine data and diagnostic information.
- ❒ Auxiliary Power Connector - a 24VDC connector used to illuminate the aisle lights while the vehicle is not powered on.
- ❒ Rad Fan Reverse switch - used for operating the cooling fans in reverse to clear debris from the radiator core.
- ❒ Rad Fan Diag lamp - flashes a blink code that is used to diagnose faults in the electronic fan control system.

2.8.2. Operation

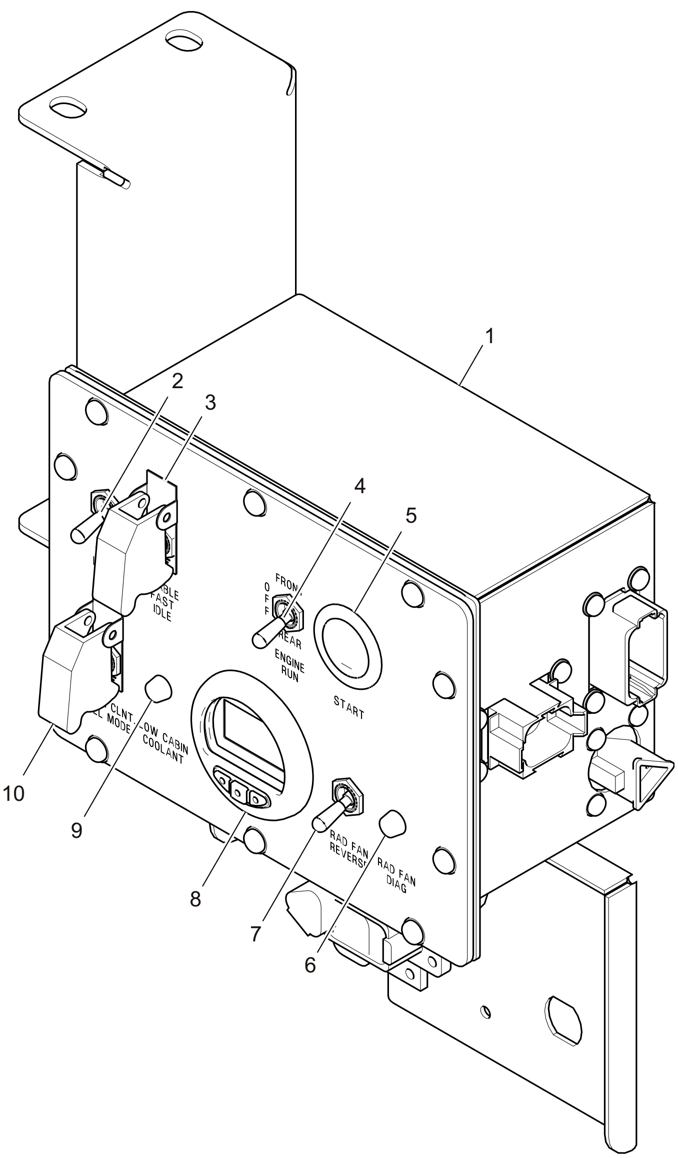
Before attempting to start the engine from the engine compartment make certain that:

1. The parking brakes are applied.
2. Master Run switch is turned to the STOP-ENGINE position.
3. Shift selector is in neutral [N] position.
4. Check that the Battery Disconnect switch is in the ON position.

⚠ CAUTION

DO NOT switch from REAR to FRONT while engine is running.

Locate the Engine Run switch on the engine compartment switch box and set the switch to the REAR position. Check for any obstructions to the moving parts of the engine before starting. Push and hold the start push button to engage the starting system. Release as soon as engine starts. The engine can be stopped by setting the Engine Run switch to the OFF position.



1. Engine Switch Box Assembly
2. Switch, SPST WP Maintain
3. Guard, Toggle Switch
4. Switch, Toggle SPDT Maintained On-Off-On
5. Switch, Push Button
6. Lamp, LED Amber 12V
7. Switch, SPST Moment
8. Gauge, CAN Communicator
9. Lamp, LED Amber 12V
10. Guard, Toggle Switch

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Fig. 4-22: Engine Switch Box

2.8.3. CAN Communicator

2.8.3.1. Description

The CAN-Communicator provides a graphic display in a compact form. This gauge is connected to the vehicle SAE J1939 (CAN) data bus. The gauge can display data and diagnostics, both active and stored faults from the individual ECMs, directly from the vehicle data bus.

2.8.3.2. Operation

There are 3 buttons for navigating through the screens of its menu system which display's diagnostics, parametric data and popup warnings.

Diagnostic capabilities include both active and stored fault codes from the ECU. Data can be viewed as a single parameter or as three parameters, which the user can scroll through to view additional data. C-COM is also populated with warning messages to alert the user to conditions on the vehicle.

The setup menu screens provide customization to the data line items and warning messages that can be displayed. The setup menus allow users to change measurement units and to set the display contrast and brightness.

The backlit liquid crystal display (LCD) is 106 pixels wide and 56 pixels high, providing clear, legible graphics. Backlighting can be controlled through the menu. A dead-fronted warning indicator is positioned above the graphic display window and is capable of illuminating as an amber or red warning for active fault codes and popup warnings, respectively.

2.8.3.3. Data Parameters

The following are the standard data parameters.

- ❒ Vehicle Speed
- ❒ Engine RPM
- ❒ Engine Oil Pressure
- ❒ Coolant Temperature
- ❒ Engine Oil Temperature
- ❒ Battery Voltage
- ❒ Turbo Boost Pressure
- ❒ Transmission Oil Temperature
- ❒ Engine Hours

2.8.3.4. Popup Warning Messages

The following are the standard popup warning messages.

- ❒ Coolant Temperature
- ❒ Engine Oil Pressure
- ❒ Engine Oil Temperature
- ❒ Transmission Temperature
- ❒ Battery Voltage
- ❒ Check Engine
- ❒ Stop Engine
- ❒ Check Transmission

Refer to 4. “VENDOR SERVICE INFORMATION” on page 45 in this section for more information on this device.

2.9. Engine Oil Diagnostic Fitting

2.9.1. Description

The engine is equipped with an oil sampling push button to allow quick engine oil diagnostics, such as checking for presence of metallic particles in the oil. The push button is located on the engine strut, on the streetside of the vehicle.

2.10. Heat Exchanger

2.10.1. Description

The heat exchanger is mounted on the streetside of engine and provides a liquid-to-liquid exchange of heat between the engine cooling system and the vehicle heating system. See “Fig. 4-23: Heat Exchanger” on page 39.

2.10.2. Operation

The engine water pump circulates hot coolant from the engine block through the heat exchanger and the coolant returns, through a hose, to the inlet of the water pump. The vehicle heating system coolant is also circulated through the heat exchanger and flows from the booster pump to the heating system components.

The heat from engine coolant is given off to the surrounding heating system coolant as each circuit flows through the heat exchanger. The heat exchanger provides the primary source of heat for the vehicle heating system.

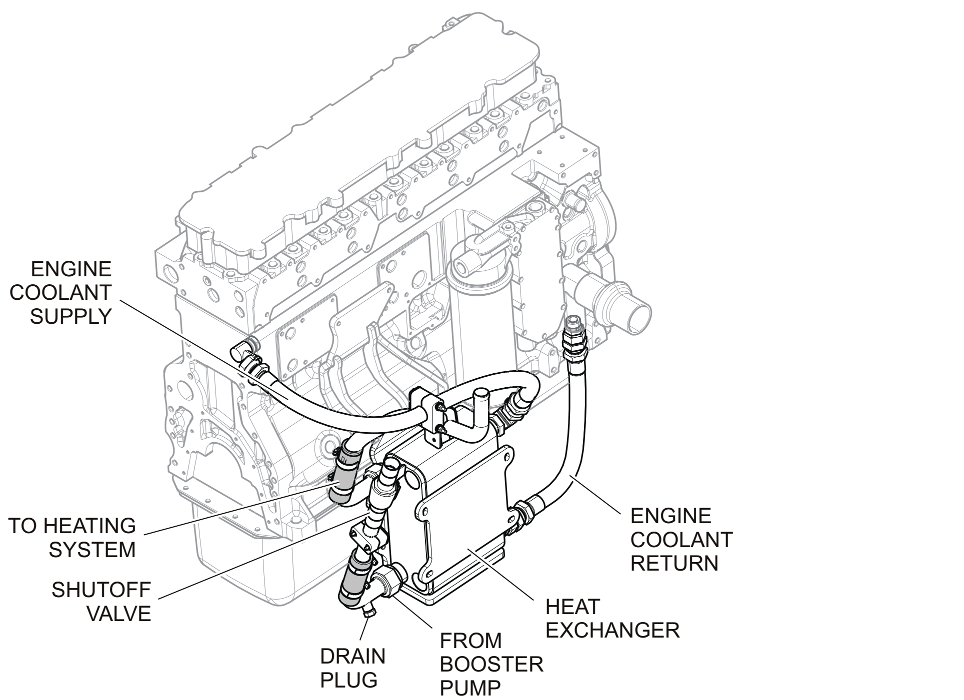


Fig. 4-23: Heat Exchanger

2.10.3. Removal

WARNING

DO NOT service the heat exchanger or open either pressure cap on the reservoir or surge tank if the system is hot or under pressure. Hot coolant can cause scalding burns if pressure caps are opened or lines are disconnected. ALWAYS allow time for the coolant temperatures to drop and ALWAYS use the pressure cap lever to relieve system pressure before servicing the system.

1. Relieve system pressure using the manual pressure relief valve on both the surge tank and the reservoir filler caps. Remove the filler caps.
2. Close the vehicle heating system supply and return shutoff valves.
3. Place a suitable container beneath the heat exchanger.
4. Disconnect the engine coolant return hose from the heat exchanger and allow the engine to drain.
5. Disconnect the engine coolant supply hose from the heat exchanger.
6. Remove the drain plug on the heating system lower coolant tube and allow the system to drain.
7. Disconnect the lower vehicle heating system coolant hose from the heat exchanger.
8. Disconnect the upper vehicle heating system coolant hose from the heat exchanger.
9. Remove the fasteners that attach the heat exchanger to the engine mounting bracket.
10. Remove the heat exchanger from the vehicle.

2.10.4. Installation

1. Align the heat exchanger bracket with the engine mounting bracket, install fasteners and tighten.
2. Connect and tighten vehicle heating system hoses to the heat exchanger.

☞**NOTE:**

Refer to “Hose Clamp Torque Specifications” in Section 6 of this manual for torques values.

3. Connect and tighten engine cooling system hoses to heat exchanger. Use a backup wrench on the fitting adapters and torque the hose fittings 40 to 49 ft-lb. (54 to 66 Nm).
4. Reinstall and tighten the coolant tube drain plug.
5. Open the vehicle heating system supply and return shutoff valves.
6. Top up and deaerate the engine cooling system using the pressure fill connector. Refer to “Filling & Deaeration” in Section 6 of this manual for procedure.
7. Top up the vehicle heating system and perform a deaeration procedure. Refer to Section 10 of this manual for procedure.

3. FIRE SUPPRESSION & GAS DETECTION SYSTEM

3.1. Description

This vehicle is equipped with a Fire Suppression and Gas Detection system. See “Fig. 4-25: Fire Suppression System” on page 42. Refer to Section 7 of this manual for information on the Gas Detection System. The Fire Suppression System consists of the following components:

- ❒ Fire suppression and gas detection display panel - located in the driver’s overhead panel.
- ❒ Manual actuator button - located on the side console.
- ❒ Extinguishing agent cylinder - located in a streetside overhead light compartment.
- ❒ Discharge nozzles (4) - located in the engine compartment.
- ❒ Optical sensors (3) - located in the engine compartment.
- ❒ Gas Sensors (5) - two in the rooftop fuel tank compartment, one mounted to the roof in the passenger area, one in the A/C compartment and one in the engine compartment.
- ❒ Thermal Lug Sensing Element (TLSE) Sensor located in the engine compartment.
- ❒ Battery backup control module - located in the driver's overhead compartment.
- ❒ Batteries (2) - located in the front destination sign compartment.
- ❒ System Reset switch - located in the front destination sign compartment.

3.2. Operation

The state of the system is constantly monitored and is displayed to the driver via the display panel. The system provides visual and audible indicators to the driver when the state of the system changes.

3.2.1. Normal Condition

During normal operating conditions (appropriate system power applied and no fault conditions present), the Display panel indicates system "OK". See “Fig. 4-24: Fire Suppression & Gas Detection Control Panel” on page 41.

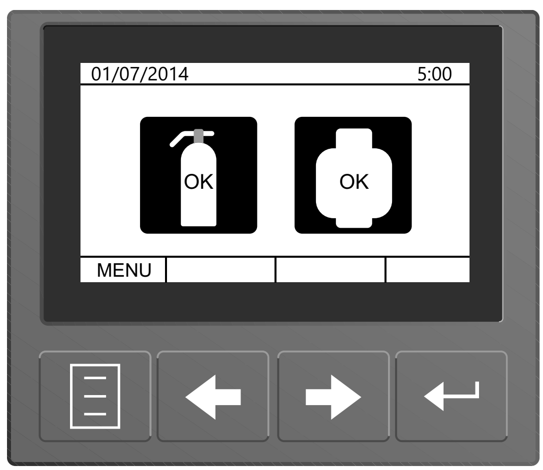
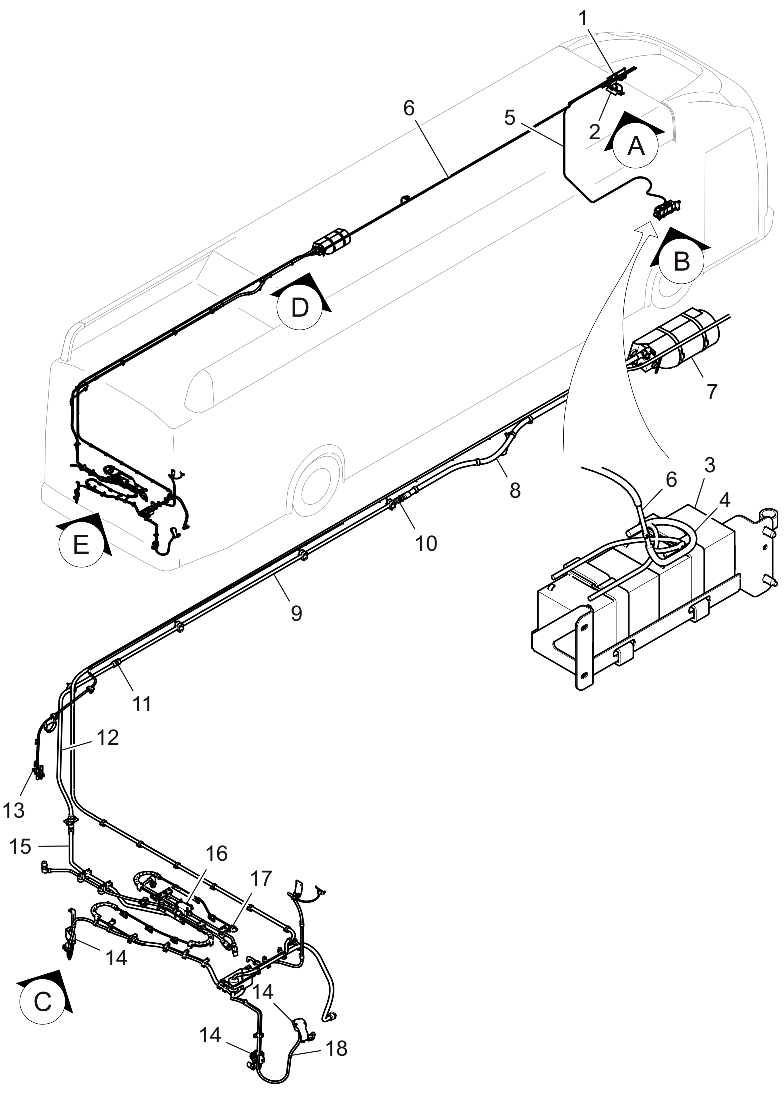


Fig. 4-24: Fire Suppression & Gas Detection Control Panel



1. Module Battery Backup Assembly
2. Display Panel Assembly
3. Battery Backup Assembly
4. Harness, Battery Backup to Battery
5. Harness, Battery Backup Module to Battery
6. Harness, Main Fire Suppression
7. Cylinder Assembly, Extinguisher Horizontal
8. Hose, -12 FS FL76.0
9. Tube, Agent Cylinder SST
10. Union, .75" Tube to -12 AN
11. Union, .75" Tube to 0.75" Tube
12. Tube, Agent Cylinder SST
13. Thermostat, Spot 450°F
14. Sensor, Fire & Heat
15. Tube, Discharge SST
16. Nozzle Assembly, Fire Suppressant
17. Harness, Linear Fire Detection 10'
18. Harness, Engine Compartment

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Fig. 4-25: Fire Suppression System

3.2.2. Fire Scenario

When a fire sensor detects, the following occurs immediately:

- ❒ The display turns constant red and the Fire Detection icon is displayed.
- ❒ The text on screen indicates the area in which the detection occurred.
- ❒ HVAC shutdown activates.
- ❒ A 15 second countdown starts.
- ❒ The Buzzer starts intermittent beeping which accelerates as the timer approaches Zero.
- ❒ "SILENCE" and DELAY" buttons appear.

Upon the completion of the 15 second countdown, the following occurs:

- ❒ Display remains constant red and System Deployment icon and the text "Engine Shutdown Activated" are displayed.
- ❒ Continuous beep occurs.
- ❒ Engine Shutdown activates.
- ❒ If a fire senor is in Zone 1 (Engine Compartment) activated, the extinguisher activates.
- ❒ 3 seconds after the countdown is completed a reset button appears

☞**NOTE:**

The system must be reset and the extinguisher(s) removed and replaced in accordance with the OEM manual.

⚠ **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" button 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.

The Manual Activation switch may be activated at any time to immediately discharge the fire extinguisher and shutdown the engine and HVAC.

☞**NOTE:**

The system must be reset and the extinguisher(s) removed and replaced in accordance with the OEM Manual

⚠ **WARNING**

The extinguisher discharge may cause an obscuring cloud behind and near the vehicle.

3.2.3. System Fault Scenarios

Fire Sensor Trouble - Display backlight flashes yellow, text on screen indicates the detection zone in which the fault exists, and the buzzer intermittently beeps until the fault is cleared.

Extinguisher Trouble - Display backlight turns constant yellow, text on screen indicates the extinguisher in which the fault exists, and the buzzer intermittently beeps until the fault is cleared.

Manual Activation Trouble - Display backlight flashes yellow, text on screen indicates the a manual discharge fault exists, and the buzzer intermittently beeps until the fault is cleared.

Low Voltage - If the voltage to the system drops below 22 volts, a low voltage condition is indicated. The display backlight flashes green, the text on screen indicates that a low voltage condition exists, and the buzzer intermittently beeps until the low voltage state is eliminated.

☞**NOTE:**

Below 12 volts, the system disables itself and provides an indication on the display that the system is in a low voltage state and is disabled.

3.3. Maintenance

New Flyer has included the OEM manual created for these vehicles as part of the Transit Information Viewer (TIV) on CD-ROM. Refer to 4. “VENDOR SERVICE INFORMATION” on page 45 in this section for all maintenance operations relating to the Fire Suppression and Gas Detection system.

4. VENDOR SERVICE INFORMATION

The following supplier manuals contain additional reference information.

4.1. Cummins L9N Manuals

- ❒ Custom Parts Manual
- ❒ Troubleshooting Manual
- ❒ Service Manual
- ❒ Operation & Maintenance Manual
- ❒ Owners Manual

4.2. Forster Manual

- ❒ Can-Communicator User Guide

4.3. Kidde Dual Spectrum Fire Suppression Manual

- ❒ Operation & Maintenance

Transmission System

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❒ open flame
- ❒ excessive heat
- ❒ production of sparks
- ❒ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Hoisting/Lifting & Jacking Safety

Refer to the General Information Section of this manual for recommended types of hoists, lifting equipment, and jackstands.

⚠ DANGER

Certain procedures may require the vehicle be operated in an elevated position in order to accurately troubleshoot and diagnose a problem. If the vehicle must be running while elevated, become familiar with the repair area prior to starting the engine. Take special care in noting areas which will become hot, electrically energized, and areas where moving and rotating components are located. Limit the work in these areas as personal and equipment safety is at risk.

⚠ WARNING

ALWAYS ensure that the vehicle is appropriately hoisted and blocked for procedures which require elevating the vehicle. Be aware of the limitations of the blocking equipment, and always ensure that the jarring and shaking created by component removal and installation procedures does not overload the blocks, or cause the vehicle to become unstable.

2. TRANSMISSION SYSTEM

2.1. Description

The Transmission System consists of the following components. See "Fig. 5-1: Transmission System Layout" on page 2.

- Allison B400R Transmission
- Push Button Shift Selector (PBSS)
- Transmission Control Module (ECU)
- Retarder Accumulator
- Hydraulic & Air Hoses & Electrical Harnesses

2.2. Operation

The transmission couples the engine's output to the input of the vehicle's drive axle. It provides fully automatic power shifting to maintain control of the vehicle speed.

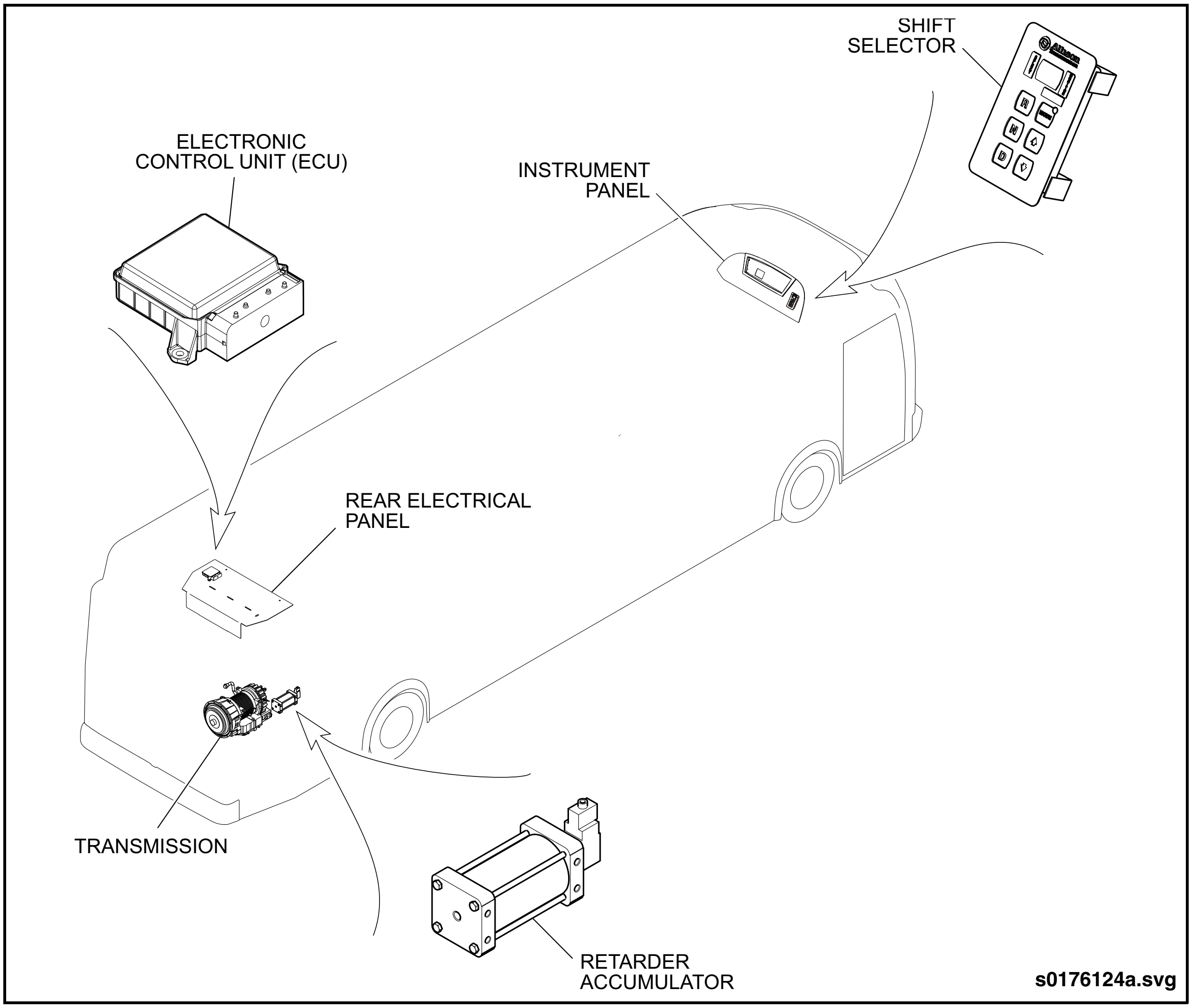


Fig. 5-1: Transmission System Layout

3. ALLISON B400R TRANSMISSION

3.1. Description

The major modules of the B400R transmission include the input module, main housing and gear module, control module and output module. The transmission incorporates six forward speeds, lockup clutch with torsional damper, integral retarder, integral oil filters, and an adaptive electronic closed-loop control system with self-diagnostic capabilities. The input module mates to the engine flywheel housing and serves as the main support point for the transmission as well as providing a connection to the engine through a flexplate and adapter. The transmission output shaft is splined to accept a 1710 series 1/2 round yoke that connects to the driveline. See “Fig. 5-2: Transmission Assembly Views” on page 4.

3.2. Transmission Specifications

Manufacturer .... Allison Transmission

Product Family.......................... 3000 Series

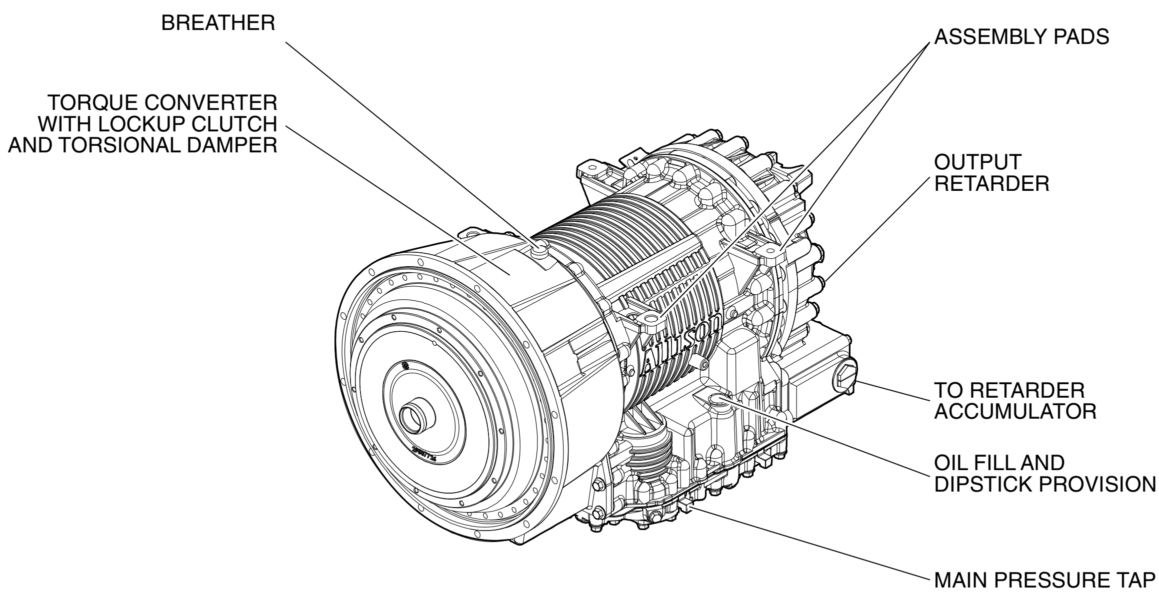
Model..B400R

Controls ....5th Generation

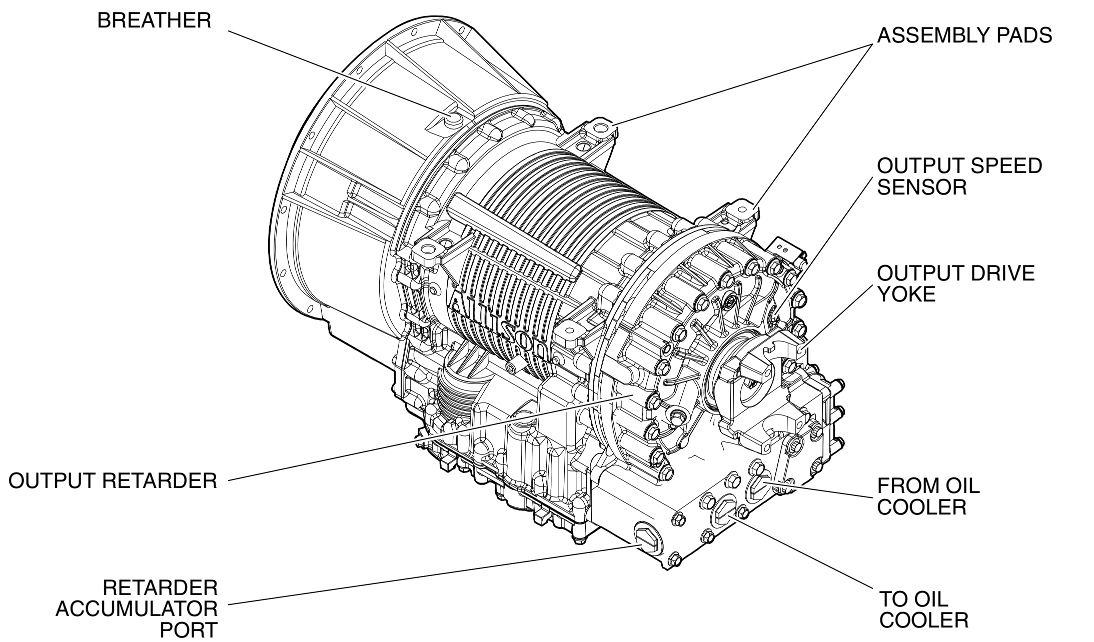
Dry Weight.........................615 lbs. (279 kg)

Length ....28.29" (718.6 mm)

Depth (centerline to lowest point)
.... 12.9 in. (327.7 mm)



B400R TRANSMISSION LEFT FRONT VIEW



B400R TRANSMISSION LEFT REAR VIEW

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Fig. 5-2: Transmission Assembly Views

3.3. Operation

The ECU receives control inputs from the shift selector and inputs from the sensors in the transmission control module. It processes this information and sends shift commands to the control module. The ECU also provides diagnostic information, which can be read as codes through the shift selector or downloaded using the Allison DOC diagnostic tool.

3.3.1. Reduced Engine Load At Stop (RELS)

This transmission implements the RELS feature allowing the engine to improve fuel efficiency every time the vehicle stops. The driving load is released (similar to neutral) whenever the vehicle comes to a stop and the brake treadle is applied. The vehicle multiplexing system is programmed to also apply and latch the brake interlocks whenever the RELS feature is active. This is a safety feature intended to prevent vehicle rollback during the time span between when the brake treadle is released and the accelerator is applied. The interlocks will not unlatch until the accelerator treadle is pressed slightly.

3.3.2. Auto-Neutral

The transmission uses J1939 CAN messaging to automatically select neutral whenever the parking brake is applied. The vehicle multiplexing is also programmed to select auto-neutral whenever the brake interlocks have been applied for five minutes. Auto-neutral is sometimes referred to as “forced neutral” because the transmission is forced into neutral without operator intervention. The shift selector drive indicator [D] will begin flashing when entering auto-neutral mode. To re-engage the drive mode, the operator must apply the brake treadle, select neutral [N], then select drive [D].

3.3.3. Retarder Operation

The retarder is a hydro-dynamic brake. It consists of a fluid accumulator and a retarder housing. A rotor in the retarder housing is splined to the transmission output shaft. Fluid from the accumulator fills and pressurizes the retarder housing when the retarder is applied. This slows the rotor, the transmission output shaft and the vehicle.

The retarder is applied in three successive stages as follows:

- ❒ 25% applied when the operator releases the accelerator treadle.
- ❒ 66% applied when the operator applies sufficient pressure to the brake treadle to produce 1 psi pressure in the rear brake circuit as measured by a pressure transducer.
- ❒ 100% applied when the operator applies sufficient pressure to the brake treadle to produce 4 psi pressure in the front brake circuit as measured by a pressure switch.

The retarder disengages when the operator presses the accelerator treadle. At speeds below 6 mph (10 km/h) the retarder is inactive.

3.4. Maintenance

☞**NOTE:**

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance requirements.

3.4.1. Transmission Oil Maintenance

3.4.1.1. Oil Storage & Handling

Oil must be handled in clean containers and fillers to prevent foreign material entering the transmission. Lay dipstick in a clean place while filling the transmission.

WARNING

Containers or fillers that have been used to handle antifreeze or engine coolant solution must not be used for transmission fluid. Antifreeze and coolant solutions contain ethylene glycol which, if introduced into the transmission, can cause the clutch plates to fail.

3.4.1.2. Proper Oil Level

Because the transmission oil cools, lubricates, and transmits hydraulic power it is important that the proper oil level is maintained at all times. If the oil level is too low the converter and clutches will not receive an adequate supply of oil. If the level is too high the oil will aerate, the transmission will overheat, and oil may be expelled through the breather or dipstick tube. See “Fig. 5-3: Transmission Fluid Level Dipstick” on page 6.

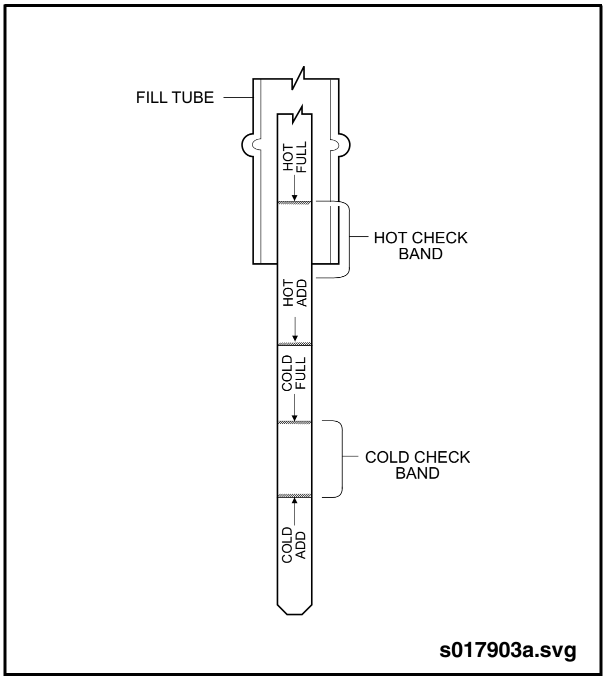


Fig. 5-3: Transmission Fluid Level Dipstick

3.4.2. Oil Check Procedure

Clean around the end of the fill tube before removing the dipstick. Dirt or foreign matter must not be permitted to enter the oil system because it can cause valves to stick, cause undue wear of transmission parts, or clog passages. Check the oil level by the following procedures and record 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. Unexpected and possibly sudden vehicle movement may occur if these precautions are not taken.

Always check the oil level at least twice. Consistency is important in maintaining accuracy. If inconsistent readings persist, check the transmission breather to ensure it is clean and not blocked with debris.

3.4.2.1. Cold Check

☞**NOTE:**

The only purpose of the Cold Check is to determine if the transmission has enough oil to be safely operated until a Hot Check can be made.

1. 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 Check band if the transmission oil is below normal operating temperature.

2. Run the engine for at least one minute. Shift to first (drive) [1 or D] and then to reverse [R] to clear the hydraulic circuits of air. Then shift to neutral [N] and allow the engine to idle (500 to 800 RPM).
3. After wiping the dipstick clean, check the oil level. If the oil 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.
4. If the oil level is not within the Cold Check band, add or drain oil as necessary to bring the level to the middle of the Cold Check band.

3.4.2.2. Hot Check

1. Perform a Hot Check at the first opportunity after the normal operating temperature 160 to 200°F (71 to 93°C) has been reached.

CAUTION

The oil must be hot to ensure an accurate check. The oil level rises as temperature increases.

2. Operate the transmission in drive range until normal operating temperature is reached: 160 to 200°F (71 to 93°C) sump temperature, 180 to 220°F (82 to 104°C) converter-out temperature.
3. Park the vehicle on a level surface and shift to neutral. Apply the parking brake and allow the engine to idle (500 to 800 RPM).
4. After wiping the dipstick clean, check the oil level. The safe operating level is anywhere within the Hot Check band on the dipstick.
5. If the level is not within this band, add or drain oil as necessary to bring the level to the top of the Hot Check band.

3.4.2.3. Oil Contamination

❒ Examining Oil Condition

At each oil change, examine the oil which is drained for evidence of dirt or water. A normal amount of condensation will emulsify in the oil during operation of the transmission. However, if there is evidence of water, check the cooler (heat exchanger) for leakage between the water and oil area. Oil in the water side of the cooler (heat exchanger) is another sign of leakage. This, however, may indicate leakage from the engine oil system.

❒ Metal Particles

Metal particles in the oil (except for the 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, cooler, and all other areas where the particles could lodge.

⚠ CAUTION

If excessive metal contamination has occurred, replacement of the oil cooler and replacement of all bearings within the transmission is recommended.

❒ 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, and varnish deposits resulting from coolant contamination must be removed. Friction clutch plates contaminated with ethylene glycol must be replaced.

❒ Filling Transmission Oil

The refill amount is less than the initial fill because some of the oil remains in the external circuits and transmission cavities. Refer to 3.4.2. “Oil Check Procedure” on page 7 in this section for checking the oil level after refill.

☞**NOTE:**

Refer to the Preventive Maintenance Section of this manual for oil change procedure.

❒ Breather

The breather is located at the top of the transmission converter housing. it serves to prevent pressure buildup within the transmission and must be kept clean and the passage open. The prevalence of dust and dirt will determine the frequency at which the breather requires cleaning.

⚠ CAUTION

Use care when cleaning the transmission. Spraying steam, water or cleaning solution directly at the breather can force the water or solution into the transmission.

Always use a proper size wrench to remove or replace the breather. Pliers or a pipe wrench can crush or damage the stem and produce metal chips which could enter the transmission.

3.4.3. Transmission Oil Diagnostic Fitting

The transmission is equipped with an oil diagnostic fitting to allow quick transmission oil diagnostics, such as checking for presence of metallic particles in the oil. The fitting is on manifold that is mounted to the streetside engine strut.

3.5. Transmission Troubleshooting

The transmission will display diagnostic trouble codes and fluid levels on the shift selector. Refer to 4. “PUSH BUTTON SHIFT SELECTOR” on page 17 in this section for more information on accessing diagnostic trouble codes and fluid level information. Refer to 7. “VENDOR SERVICE INFORMATION” on page 29 in this section for complete information on troubleshooting the transmission system.

3.6. Removal

⚠ CAUTION

Before attempting any work on the transmission ensure the following:

- ❒ **Master Run switch is in the OFF position.**
- ❒ **Rear Engine Service switch in the OFF position.**
- ❒ **Disconnect battery via Battery Disconnect switch.**
- ❒ **Clean exterior of transmission and adjoining surfaces with either steam or a solvent.**
- ❒ **DO NOT directly use pressure or steam on electrical connections, seal areas, or at the breather. Water/solvent may be forced into these areas causing damage or corrosion.**
- ❒ **Observe all safety precautions related to overhead procedures if vehicle is to be hoisted.**

Transmission removal can be performed three possible ways. Ensure your work place fits the project.

- ❒ The vehicle is placed over the top of a service pit.
- ❒ The vehicle may be hoisted in the air at all wheels using approved wheel hoists.
- ❒ The engine and transmission are removed from the rear of the vehicle.

☞**NOTE:**

In some cases, it may be easier to remove the engine and transmission as a unit and then separate the transmission from the engine flywheel housing. However, the transmission can be separated from the engine in the engine bay and removed as a separate unit. The following removal procedure is based on removing the transmission separately. Refer to Section 4 of this manual for procedure when the engine and transmission assembly are removed together. When the transmission is removed from the vehicle without removal of the entire engine and transmission assembly, the transmission must be lowered through the bottom of the vehicle.

1. Raise the vehicle.
2. Set the Battery Disconnect switch to the OFF position.
3. Drain transmission fluid.
4. Disconnect driveshaft from transmission yoke.
5. Disconnect oil cooler and retarder lines.
6. Disconnect transmission module wiring harness and sensor connectors.
7. Remove access cover to expose the flexplate to flywheel bolts. See “Fig. 5-4: Flexplate Access Cover” on page 10.
8. Manually rotate engine until one flexplate to flywheel bolt is centered in opening.

9. Remove bolt and rotate engine until next bolt is centered in the opening. Repeat process until all 6 - M10 bolts are removed.
10. Remove clamp securing transmission dip stick tube and remove tube assembly.
11. Support transmission with a commercial transmission jack.

WARNING

Before disconnecting the transmission from the engine, ensure that it is properly secured to prevent it from falling. Use a hoist or jack that can safely support the weight. DO NOT use makeshift lifting devices.

12. Loosen but do not remove completely four equally spaced transmission to flywheel housing bolts. See “Fig. 5-5: Transmission to Engine Connection” on page 11.
13. Loosen and remove the eight remaining bolts.
14. Carefully separate transmission from engine until heads of loosened bolts contact mounting flange.

WARNING

Make absolutely sure the transmission will not slip or roll. Retain the transmission to the lift with straps or chains.

CAUTION

Severe damage to the torque converter may occur if the transmission is not supported properly.

15. Remove final four bolts and move transmission away from engine.
16. Ensure all items are disconnected before lowering the transmission.
17. Lower transmission and hoist to a work stand or work area.

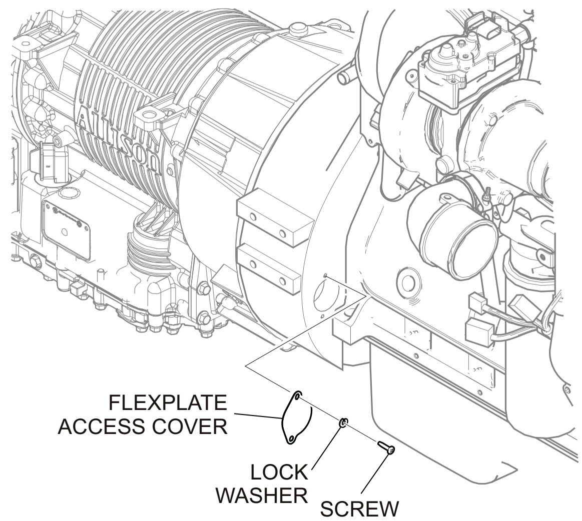
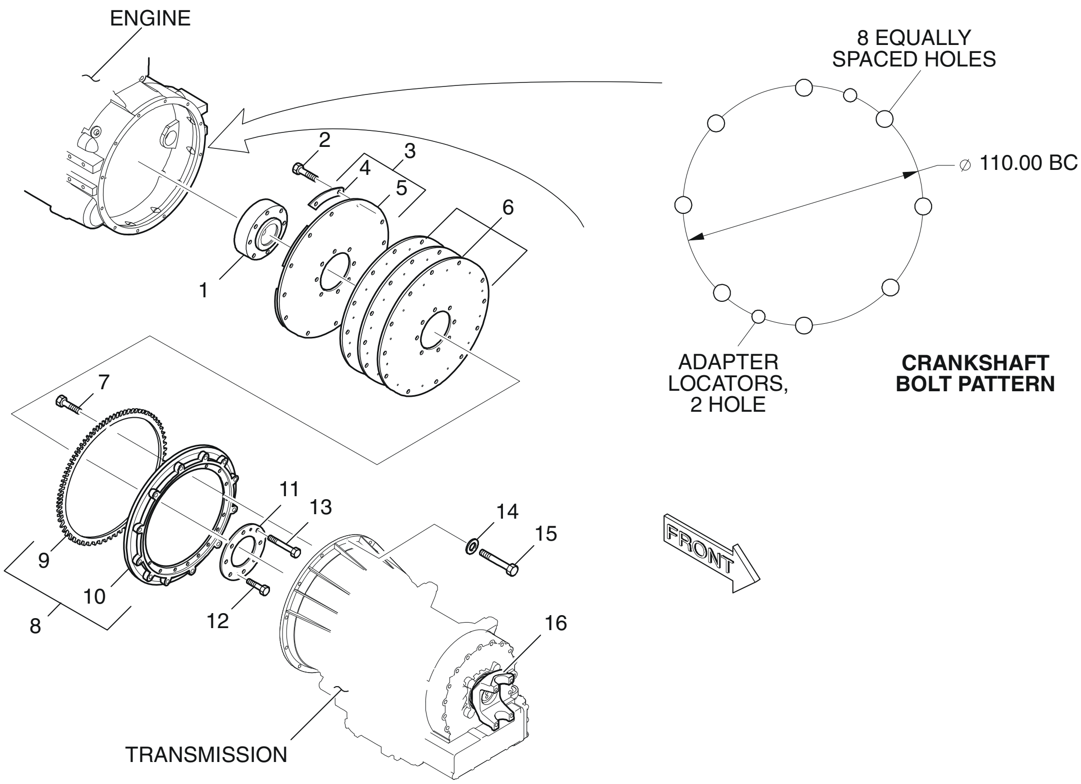


Fig. 5-4: Flexplate Access Cover



1. Hub, Adapter
2. Bolt M10, Flexplate
3. Flex Plate Assembly, (Incl. 4 & 5)
4. Plate, Bolt
5. Flex Plate
6. Flex Plate
7. Bolt, M8 x 1.25 mm x 25 mm
8. Adapter Assembly, Gear (Incl. 9 & 10)
9. Gear, Ring
10. Adapter, Flex Plate
11. Plate, Wear
12. Bolt, M6
13. Bolt, Crankshaft
14. Washer, Flat
15. Bolt, M10
16. Yoke, Half

s018008b.wmf

Fig. 5-5: Transmission to Engine Connection

3.7. Disassembly

Refer to 7. "VENDOR SERVICE INFORMATION" on page 29 in this section for complete information on transmission disassembly.

3.8. Assembly

Refer to 7. "VENDOR SERVICE INFORMATION" on page 29 in this section for complete information on transmission assembly.

3.9. Installation

3.9.1. Installing Transmission Output Drive Yoke

If the output drive yoke was removed from the transmission splined output shaft for servicing or parts replacement, Install as follows:

1. Install the output drive yoke onto the transmission splined output shaft.
2. Tighten the bolt retaining the output drive yoke to 52 to 59 ft-lb. (71 to 80 Nm).

3.9.2. Installing Oil Filler Tube & Seal

The transmission has oil filler tube openings on both the left and right sides. Combinations of tubes or expansion plugs may be used. Make sure the unused tube opening has a plug installed.

1. The oil filler tube may be installed before the transmission is installed into the vehicle, unless doing so will interfere with transmission installation.

⚠ CAUTION

Use the existing fasteners to install the oil filler tube. Using fasteners that are too long may cause cracks (leaks) in the main housing.

2. Install the oil filler tube seal into the main housing. Install the filler tube through the oil seal. Align the tube bracket with its attachment location. Tighten the oil fill tube bolt to 18 to 21 ft-lb. (24 to 29 Nm).
3. If only one filler tube is used, a plug and seal are installed on the opposite side. The plug is fully seated when the underside of the plug head contacts the seal.

3.9.3. Installing Transmission

☞NOTE:

The following installation procedure assumes that the engine is installed in the vehicle. Refer to Section 4 of this manual for instructions on removing and installing the engine and transmission as a unit.

3.9.3.1. Hub Adapter Installation

☞NOTE:

The following procedure details the installation of the hub adapter and flexplates onto the engine, if they were previously removed.

1. Install hub adapter onto engine crankshaft. See "Fig. 5-6: Transmission to Engine Cross-Section" on page 13.
2. Install four flexplates onto hub adapter with wear plate.

☞NOTE:

One of the flex plates has bolt plates on the outer bolt circle and should be installed facing the engine.

3. The wear plate that attaches the flex plates to the hub adapter should be installed with the stamped part number facing away from the engine.
4. Center and secure the wear plate and flexplates to the hub adapter by installing two M6 x 1.0 x 16 mm bolts and torque to 88 to 115 in-lb. (10 to 13 Nm). Ensure that the outer holes in the flexplates are still aligned with one another.
5. Install eight crankshaft bolts and torque to 101 ft-lb. (137 Nm).
6. Rotate the engine crankshaft so that one of the flexplate holes is centered within the flywheel housing access opening.

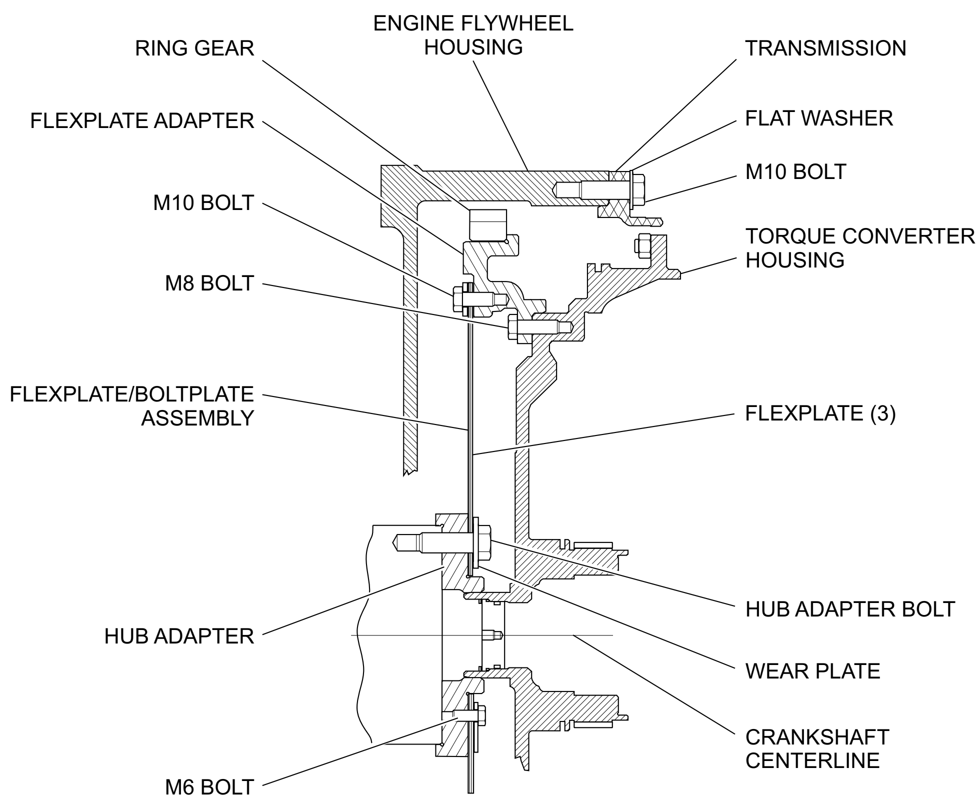


Fig. 5-6: Transmission to Engine Cross-Section

3.9.3.2. Torque Converter Adapter Installation

☞**NOTE:**

The following procedure details the installation of the torque converter adapter and ring gear onto the engine, if they were previously removed.

1. Install torque converter adapter/ring gear assembly onto the torque converter housing using ten M8 x 1.25 x 25 mm bolts. Torque bolts to 27 ft-lb. (36 Nm).
2. Apply molybdenum-disulfide grease (Molykote) to nose of torque converter where it pilots into crankshaft hub adapter.

3.9.3.3. Transmission Join-Up & Alignment

1. Raise the vehicle. Refer to the General Information Section of this manual for recommended lifting procedures.

⚠CAUTION

The transmission weighs approximately 610 lbs (279 kg). Use appropriate lifting equipment.

2. Lift the transmission with the special lifting apparatus located on the four assembly pads cast into the transmission housing. See "Fig. 5-7: Lifting Transmission" on page 15.
3. Position the transmission onto a transmission jack, lifting table, or other equipment designed specifically for this purpose and secure to prevent movement.
4. Move the transmission into position so that it is aligned with engine but separated by several inches. Align the threaded hole in the torque converter adapter with the hole in the flexplate.

☞**NOTE:**

Insert a long tapered punch through the engine flywheel access opening and through the hole in the flexplate. Rotate the torque converter by hand until the alignment punch enters the threaded hole in the torque converter adapter.

5. Slowly slide the transmission into place ensuring that the pilot nose of the torque converter engages the engine hub adapter

☞**NOTE:**

The use of threaded guide pins in the engine flywheel housing will aid alignment of the transmission housing mounting holes with engine flywheel housing.

⚠CAUTION

DO NOT use excessive force or mounting bolts to draw the transmission against the flywheel housing.

6. Ensure that the transmission housing seats squarely against the engine flywheel housing. If interference is encountered, move the transmission away from the engine and investigate the cause.
7. Remove guide pins and install all twelve M10 bolts but hand-tighten only.
8. Ensure transmission is fully seated and then final tighten four bolts located at 90° intervals to 38 to 45 ft-lb. (52 to 61 Nm). Torque remaining bolts to 38 to 45 ft-lb. (52 to 61 Nm).

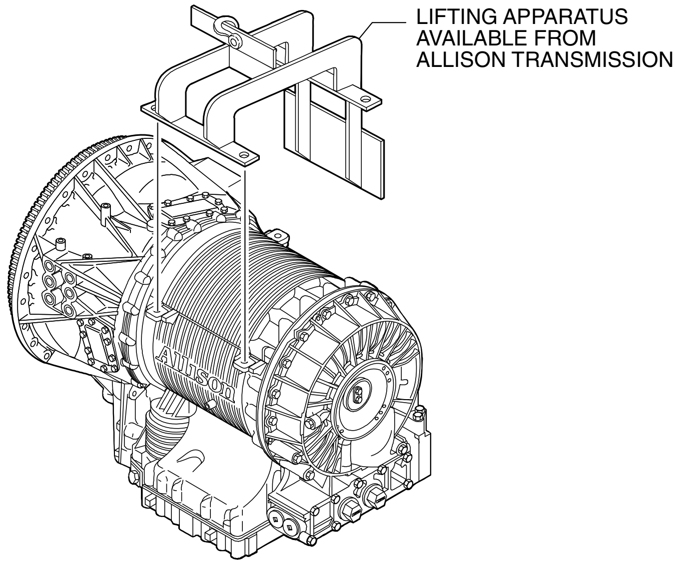


Fig. 5-7: Lifting Transmission

3.9.3.4. Flexplate Attachment to Torque Converter Housing

1. View through the flywheel access opening and inspect the alignment of the hole in the flexplate with the threaded hole in the torque converter adapter. If necessary, use a tapered punch to align the holes.
2. Install one M10 x 1.5 x 30 mm bolt through the flexplate and into the adapter. Finger-tighten only at this time.
3. Remove plug and install engine barring tool into opening located above starter motor, rotate crankshaft 180°, and install another bolt and finger-tighten.
4. Rotate crankshaft to align next bolt hole, install bolt and finger tighten. Repeat procedure until all twelve bolts are installed.
5. Final tighten all six bolts to 50 ft-lb. (68 Nm) using the previous barring tool procedure to rotate the engine.
6. Remove barring tool and reinstall plug into opening.
7. Reinstall flywheel access cover plate and secure with two bolts.

3.9.3.5. Final Installation

1. Connect driveshaft to output yoke of transmission. Refer to Section 2 of this manual for procedure.
2. Connect transmission module and sensor harness connectors. See “Fig. 5-8: Transmission Wiring Harness” on page 16.
3. Install transmission fill tube and retaining clamp.
4. Install transmission cooler and retarder hoses.

   ☞**NOTE:**

   If the transmission was removed for repair because of an internal failure, the transmission cooler, and interconnecting hoses will have to be cleaned and flushed.

5. Fill transmission with fluid to correct level. Refer to the Preventive Maintenance Section of this manual for fluid specification.
6. Set the Battery Disconnect switch to the ON position.
7. Start engine and check for leaks. Top up fluid level if necessary. Refer to 3.4.2. “Oil Check Procedure” on page 7 in this section for procedure.

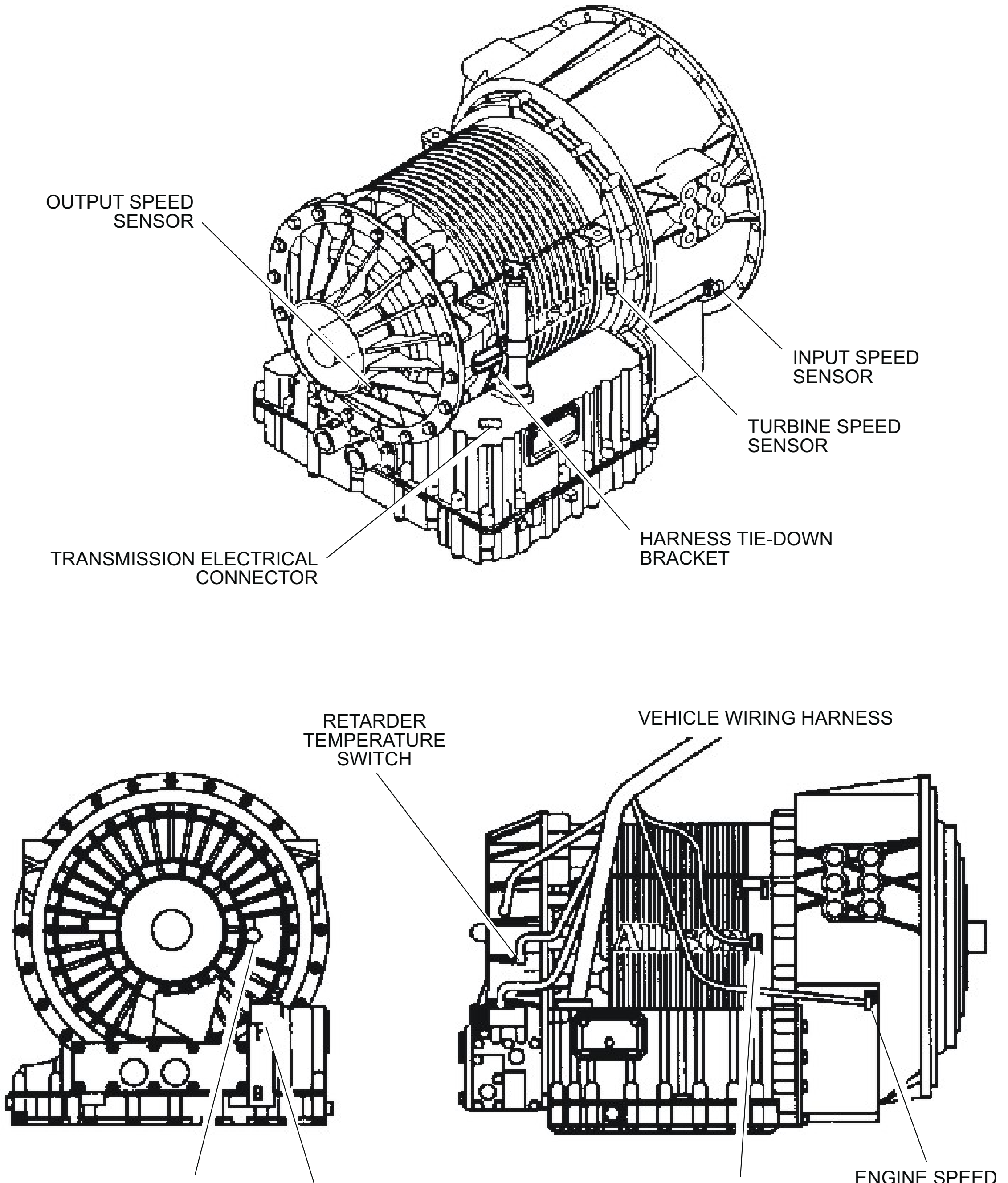


Fig. 5-8: Transmission Wiring Harness

4. PUSH BUTTON SHIFT SELECTOR

4.1. Description

The Push Button Shift Selector (PBSS) is the driver interface module used to command and control the transmission system. See “Fig. 5-9: Push Button Shift Selector” on page 17. It is mounted in the instrument panel with brackets and hardware and connected to the transmission system via an electrical harness.

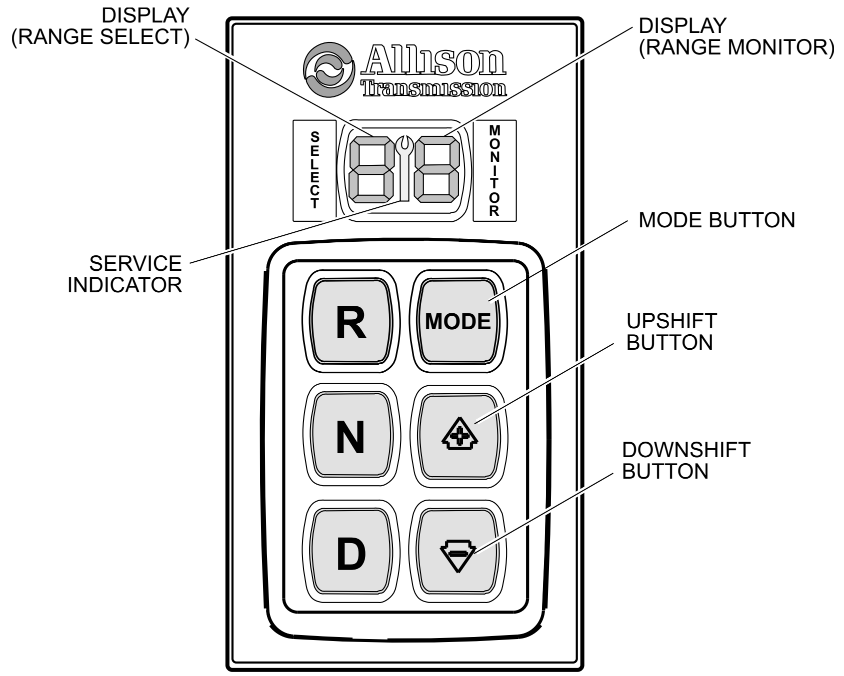


Fig. 5-9: Push Button Shift Selector

4.2. Operation

The PBSS is used by the operator to select Neutral [N], Reverse gear [R], or a range of forward gears. When a forward gear range has been selected, the transmission starts in the lowest gear of the range and, as conditions permit, automatically upshifts to the highest gear in the selected range.

☞**NOTE:**

During certain operating conditions the control system may inhibit transmission operation or range shifts.

The following table indicates the information that will be displayed on the shift selector during normal operation:

SHIFT SELECTOR DISPLAY INFORMATION	
DISPLAY	**DESCRIPTION**
SELECT	Indicates the gear range selected
MONITOR	Indicates the actual gear being operated in
SERVICE INDICATOR (Wrench Icon)	Displayed at start-up for a bulb check and will turn off if no service conditions exist.

4.2.1. Shift Selector Operation

WARNING

If you leave the vehicle and the engine is running, the vehicle can move suddenly and you or others could be injured. If you must leave the engine running, do not leave the vehicle until you put the transmission in NEUTRAL, and ensure that the engine is at low idle, and apply the park brake and emergency brakes and make sure they are properly engaged, and chock the wheels and take any other steps necessary to keep the vehicle from moving.

The vehicle service brakes, park brake, or emergency brake must be applied whenever NEUTRAL is selected to prevent unexpected vehicle movement. Selecting NEUTRAL does not apply the vehicle brakes.

- [R] REVERSE - selects Reverse gear.
- [N] NEUTRAL - selects Neutral. The area around the [N] button is a raised ridge so the driver can identify the pushbuttons by touch, without looking at the display. It is not necessary to press this button prior to starting the vehicle.
- [D] DRIVE - selects the highest available forward range. The transmission shifts to the starting gear and will automatically upshift through the gears, as operating conditions permit, until the highest available gear is attained.
- UPSHIFT and DOWNSHIFT Arrow Buttons - these buttons are used to change the range selected to a higher or lower forward range:
  - One press of the DOWNSHIFT button sets range SELECT to the same range as the current range attained, shown in the MONITOR position on the display. This is referred to as Express Preselect.
  - Each subsequent press of the DOWNSHIFT button decreases the range selected by one range.
  - One press of the UPSHIFT button increases the range selected by one range.
  - If the UPSHIFT or DOWNSHIFT button is held continuously, the selected range will continue to change up or down until the button is released or until the highest or lowest possible range of gears is selected.
- MODE Button - pressing the MODE button invokes a secondary shift schedule or a special operating function. Pressing the MODE button also toggles to the next Diagnostic Trouble Code (DTC) while in the DTC display mode. And it clears active and inactive DTCs from the ECU memory.
- Select & Monitor - during normal operation with [D] Drive selected, the SELECT section of the display shows the highest attainable forward range for the shift schedule in use. The MONITOR section displays the gear range that has been commanded in the transmission. Reverse [R] and Neutral [N] are likewise displayed when appropriately selected and in use. The display of any other character in the SELECT or MONITOR section denotes a nonstandard operating condition.
- Backlighting - all six keypad buttons are continually backlit during normal vehicle operation.
- Diagnostic Functions - pressing the UPSHIFT and DOWNSHIFT buttons simultaneously with the transmission in Neutral invokes a service or diagnostic function as shown in the following table:

UPSHIFT & DOWNSHIFT DIAGNOSTIC FUNCTION		
1st PRESS	**2nd PRESS**	**3rd PRESS**
Oil Level Sensor (OLS)	Diagnostics	Normal Range Display

4.2.2. Shift Inhibits

The control system will invoke built-in logic to protect against certain types of abusive operation. These inhibits are designed to protect the transmission in the event of abusive operation. The following shift inhibits may occur:

- Engine Speed Inhibit - Inhibits neutral-to-range shifts when engine speed is greater than 900 rpm. The ECU indicates that a shift has been inhibited by flashing the range SELECT digit on the shift selector.

☞NOTE:

If the engine speed drops below the inhibit speed within 3 seconds, the inhibit will self-clear and the requested shift will be commanded.

- Direction Change Inhibit - Inhibits forward/ reverse directional changes if one of the following conditions is detected:
  - Output shaft speed of approximately 225 rpm or higher.
  - Throttle position greater than approximately 40%.

The ECU indicates that a shift has been inhibited by flashing the range SELECT digit on the shift selector.

☞NOTE:

If the output shaft speed or throttle position drops below the inhibit threshold within 3 seconds, the inhibit will self-clear and the requested shift will be commanded.

4.2.3. Electronic Fluid Level Check

Check the fluid level electronically from the shift selector as follows:

☞NOTE:

The ECU delays the fluid level check until the fluid temperature is above 104°F (40°C) or below 220°F (104°C). Check transmission fluid only once the water temperature gauge has stabilized.

1. Park the vehicle on a level surface and shift to neutral [N].
2. Apply the parking brake and allow the engine to idle at 500 to 800 rpm.
3. Make sure the transmission output shaft speed is at 0 rpm.
4. Allow a settling period of two minutes to allow the oil to return to the sump.
5. Simultaneously press the Upshift and Downshift arrows once. If conditions do not allow fluid level to be checked, a code will appear. Refer to 4.2.3.1. “Invalid for Display Codes” on page 21 in this section for information.
6. If the oil level is OK the display will state: “TRANS OIL LEVEL OK”.
7. If the oil level is Low the display will state: “OIL LOW X QTS” where X represents the quantity of quarts.
8. If the oil level is High the display will state: “OIL LEVEL X QTS HI” where X represents the quantity of quarts.
9. Exit the fluid level display mode by pressing any range button on the shift selector.

☞NOTE:

Recheck oil levels if oil is added or removed as a result of this check. The Oil Level Sensor (OLS) has a range of LO 4 to HI 3. Actual levels may exceed these limits.

4.2.3.1. Invalid for Display Codes

Invalid for Display is activated when conditions do not allow the fluid level to be determined. Use the following chart to help determine the cause and solution.

INVALID FOR DISPLAY CODES	
DISPLAY	**DESCRIPTION**
SETTLING / OK	Settling time too short
ENG RPM / TOO LOW	Engine RPM too low
ENG RPM / TOO HIGH	Engine RPM too high
MUST BE / IN NEU	[N] Neutral must be selected
OIL TEMP / TOO LOW	Sump fluid temperature too low
OIL TEM / TOO HIGH	Sump fluid temperature too high
VEH SPD / TOO HI	Output shaft speed
SENSOR / FAILED	Sensor failure

4.2.4. Diagnostic Trouble Code Check

Active and historic Diagnostic Trouble Codes (DTC) can be displayed on the display portion of the shift selector. Active DTCs are current in the ECU and affect the processing decisions. Historic codes are retained in memory and don't necessarily affect the ECU's processing decisions.

Up to five DTCs may be displayed, one-at-a-time, from the selector once the diagnostic display mode has been initiated by the operator. Each DTC is 5 characters in length and will be labelled “Active” or “Inactive”.

Read DTCs from the shift selector as follows:

1. Park the vehicle on a level surface, apply the parking brake and switch the engine off.
2. Rotate the Master Run switch to the DAY-RUN or NIGHT-RUN position.
3. Simultaneously pushing the UPSHIFT and DOWNSHIFT buttons five times to enter the diagnostic mode.
4. Press the MODE button to read the next code, if any, in the queue. Refer to 7. “VENDOR SERVICE INFORMATION” on page 29 in this section for a complete listing and description of all DTCs.
5. Clear active DTCs by pressing and holding the MODE button for ten seconds.

   ☞**NOTE:**

   Any codes that cause the CHECK TRANS message to appear are considered severe enough to warrant immediate attention.

   If an active indicator is cleared while the transmission is locked in range because of an active code, the transmission remains in that locked range even after clearing. Neutral [N] must be manually selected or the ignition must be cycled.

   Some Codes will self-clear once the conditions that caused the active code are not present. Some codes require the Master Run switch to be cycled off before they can be cleared from active status.

   If the conditions that activated the code are still present, the code will become active again.
6. Exit the diagnostic mode by simultaneously pressing the Upshift and Downshift arrows once.

   ☞**NOTE:**

   The diagnostic mode can also be exited by pressing any range button [D] Drive, [N] Neutral or [R] Reverse. After approximately 10 minutes of inactivity at the PBSS the diagnostic mode automatically exits and returns to normal operating mode.

4.3. Shift Selector Troubleshooting

In the event of loss of the CAN communications link, limited communication between the ECU and PBSS continues through the Direction Signal wire 134. This limited communication permits the operator to select the operating direction to allow the vehicle to be removed from service or driven to a service location. Range upshifts and downshifts during CAN communications loss will not be recognized. The shift selector will not display the transmission range. The selector will display "cat eyes" (-/- -/-).

Refer to 7. "VENDOR SERVICE INFORMATION" on page 29 in this section for complete information on troubleshooting the Push Button Shift Selector and Transmission System.

The following table indicates the information that will be displayed on the shift selector during diagnostic or inhibited conditions:

SHIFT SELECTOR TROUBLESHOOTING	
DISPLAY	**DESCRIPTION**
SELECT (Blank)	Diagnostic code is set which holds the transmission in the current range. The MONITOR display will indicate the range in which the transmission is locked. ☞**NOTE:** *The CHECK TRANS indicator on the instrument panel will be activated.*
SELECT (Flashing)	Indicates a requested shift is either temporarily or permanently inhibited. The inhibit may clear if the cause of the inhibit clears within 3 seconds of the shift request. Otherwise the operator must re-select the desired range.
SERVICE INDICATOR (Wrench Icon)	Alerts of a service issue related to the clutch, filter or fluid life. The indicator will be lit steadily or flashing depending on the condition monitored.
INIT FAULT	Displayed if the ECU does not complete initialization after the Master Run switch has been switched to DAY-RUN or NIGHT-RUN. ☞**NOTE:** *A diagnostic code will be activated in association with this condition.*
Blank Display	Indicates a lack of power to the selector or failure of the CAN (J1939) link.
Double Cat-Eyes (-/- -/-)	Indicates a failure of the CAN communication link. The cat-eyes are illuminated in both the SELECT and MONITOR locations after approximately 12 seconds of blank display. ☞**NOTE:** *A diagnostic code will be activated in association with this condition.*

4.4. Removal

1. Park the vehicle on a level surface, apply the parking brake and chock the wheels to prevent vehicle movement.
2. Rotate the Battery Disconnect switch to the OFF position.
3. Gain access to the shift selector in the dash.
4. Disconnect the electrical connectors at the rear of the shift selector.
5. Remove and retain the mounting hardware and mounting brackets holding the shift selector to the instrument panel.
6. Remove the shift selector.

4.5. Installation

1. Install the shift selector into the cut-out on the instrument panel and hold in place.
2. Install the mounting brackets onto the rear of the shift selector and secure with the mounting hardware.
3. Tighten the mounting hardware until the shift selector is securely held in the cut-out but do not over-tighten.
4. Connect the electrical harnesses to the shift selector.
5. Test the operation of the shift selector.

5. TRANSMISSION ELECTRONIC CONTROL UNIT (ECU)

5.1. Description

The transmission ECU controls the operation of the transmission and interfaces with the vehicle J1939 Multiplexing System. The ECU is mounted on the rear electrical panel, which is located behind an interior access door at the rear of the vehicle. See "Fig. 5-10: Electronic Control Unit (ECU)" on page 25.

5.2. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Unlatch and open the rear electrical panel access door, located above the rear seat.
3. Locate the transmission ECU on the rear electrical panel and unplug the vehicle wiring harness from the ECU electrical connector.
4. Remove the three retaining screws and remove the ECU from the panel. Note the quantity and location of washers.

5.3. Installation

1. Position the ECU on the mounting standoffs on the electrical panel, ensuring washers are correctly installed.
2. Apply Loctite-243 to the threaded fasteners and secure ECU to panel using three screws and washers.
3. Connect the vehicle wiring harness to the ECU electrical connector.
4. Close and latch the rear electrical panel access door.
5. Set the Battery Disconnect switch to the ON position.

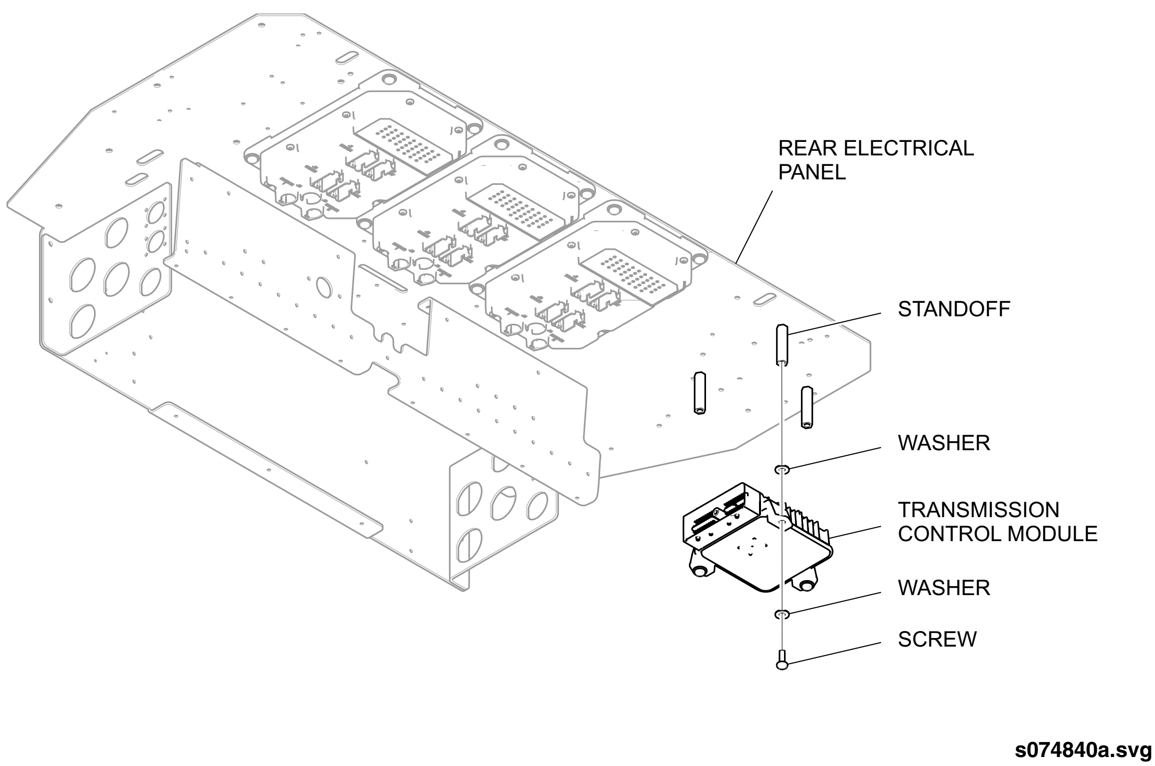


Fig. 5-10: Electronic Control Unit (ECU)

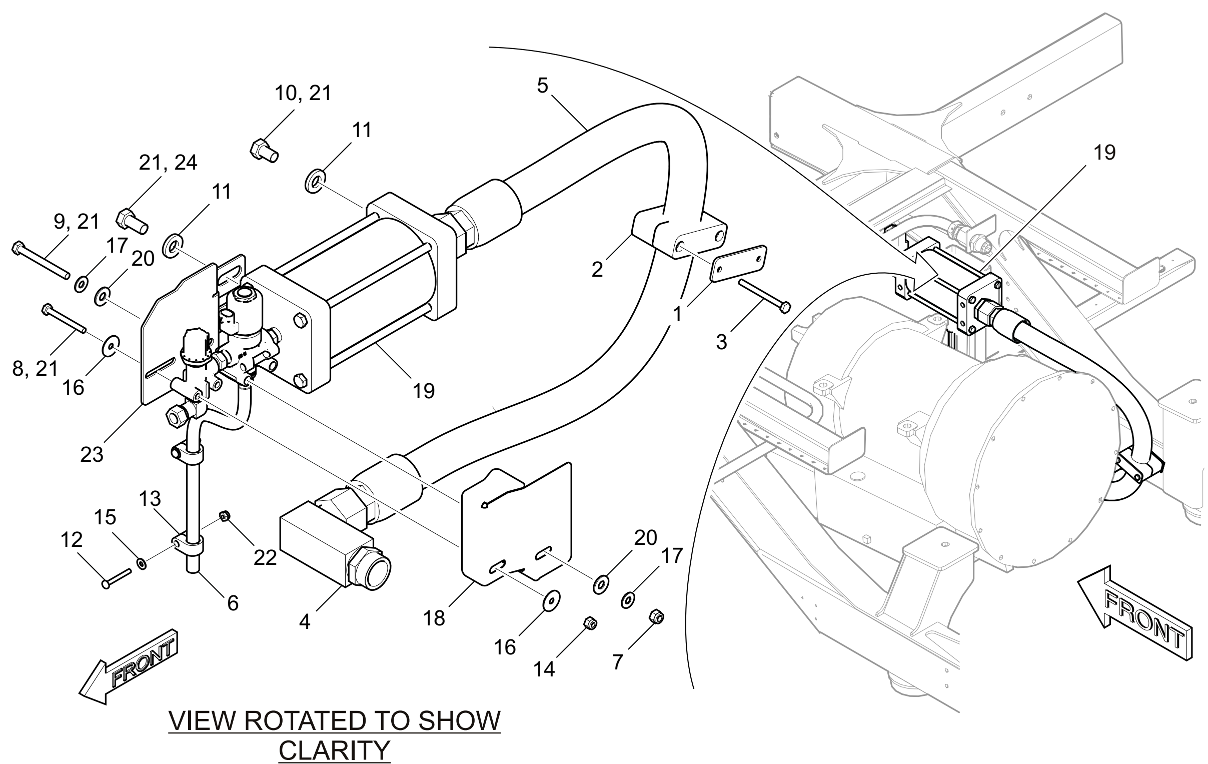
6. RETARDER ACCUMULATOR

6.1. Description

The retarder accumulator is remotely mounted near the transmission on a curb-side vehicle frame member. The oil side of the retarder accumulator is connected to the transmission with a hydraulic hose. The accumulator solenoid is mounted on the air side end cap of the accumulator. Air is supplied from the accessory air tank via an air hose and a pressure reducing valve to the solenoid. See “Fig. 5-11: Accumulator Removal & Installation” on page 26.

The retarder accumulator is comprised of the following:

- piston
- cylinder
- two end caps



1. Plate, Cover 2" Tube
2. Clamp, Hose 1.57" O.D.
3. Bolt, Hex 1/4" - 20 UNC x 2 3/4" Lg.
4. Elbow, 90° 20 ORB x 20 JIC
5. Hose, EQ1 - 20 FL 52.0
6. Tube, Overflow
7. Nut, Lock Nylon SST 5/16" - 18 UNC
8. Bolt, Hex SST 1/4" - 20 UNC x 2 1/4" Lg.
9. Bolt, Hex 5/16" - 18 UNC x 3" SST Lg.
10. Bolt, Hex 1/2" - 13 UNC x 3/4" Lg.
11. Washer, Flat Hardened 1/2"
12. Screw, PH Cross Recess SST #10 - 24 UNC x 1 1/2" Lg.
13. Clamp, 0.625" Dia.
14. Nut, Lock Nylon 1/4" - 20 UNC SST
15. Washer, Flat SST #10
16. Washer, 1/4" x 1" x .063" SST
17. Washer, Flat 5/16" SST
18. Cover, Accumulator Solenoid
19. Accumulator Assembly
20. Washer, Flat SST 3/8"
21. Never Seize
22. Nut, Lock Nylon #10 - 24 UNC
23. Cover, Accumulator Solenoid
24. Bolt, Hex SST 1/2" - 13 UNC x 1" Lg.

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Fig. 5-11: Accumulator Removal & Installation

6.2. Operation

The retarder accumulator serves as an oil storage device to provide immediate response to retarder demand and allow quick filling of the transmission retarder module. The ECU determines retarder demand and energizes the accumulator solenoid, which applies air pressure to the top of the accumulator piston. The piston is driven downward, rapidly expelling the oil within the cylinder and filling the transmission retarder housing. The retarder stator, rotor, and housing all have integral vanes, which react to pressurize the oil and thereby resist output shaft rotation. During retarder inactivity, oil is evacuated from the retarder housing and the accumulator is recharged.

A pressure reducing valve lowers system air pressure to 100 psi for accumulator operation. Refer to Section 8 of this manual for more information on the pressure reducing valve.

6.3. Removal

1. Drain transmission oil and disconnect oil line from accumulator.
2. Drain air system and disconnect air lines from accumulator solenoid.
3. Disconnect wiring from solenoid.
4. Remove mounting bolts, accumulator, and solenoid.

6.4. Disassembly

☞**NOTE:**

Accumulator solenoid is non-serviceable and is to be replaced as an assembly.

1. Remove solenoid and fitting from accumulator end cap. See “Fig. 5-12: Accumulator Assembly‘” on page 27.
2. Remove four tie rod bolts and separate hydraulic and gas end caps from cylinder body.
3. Remove piston and discard lip seals and seal ring.

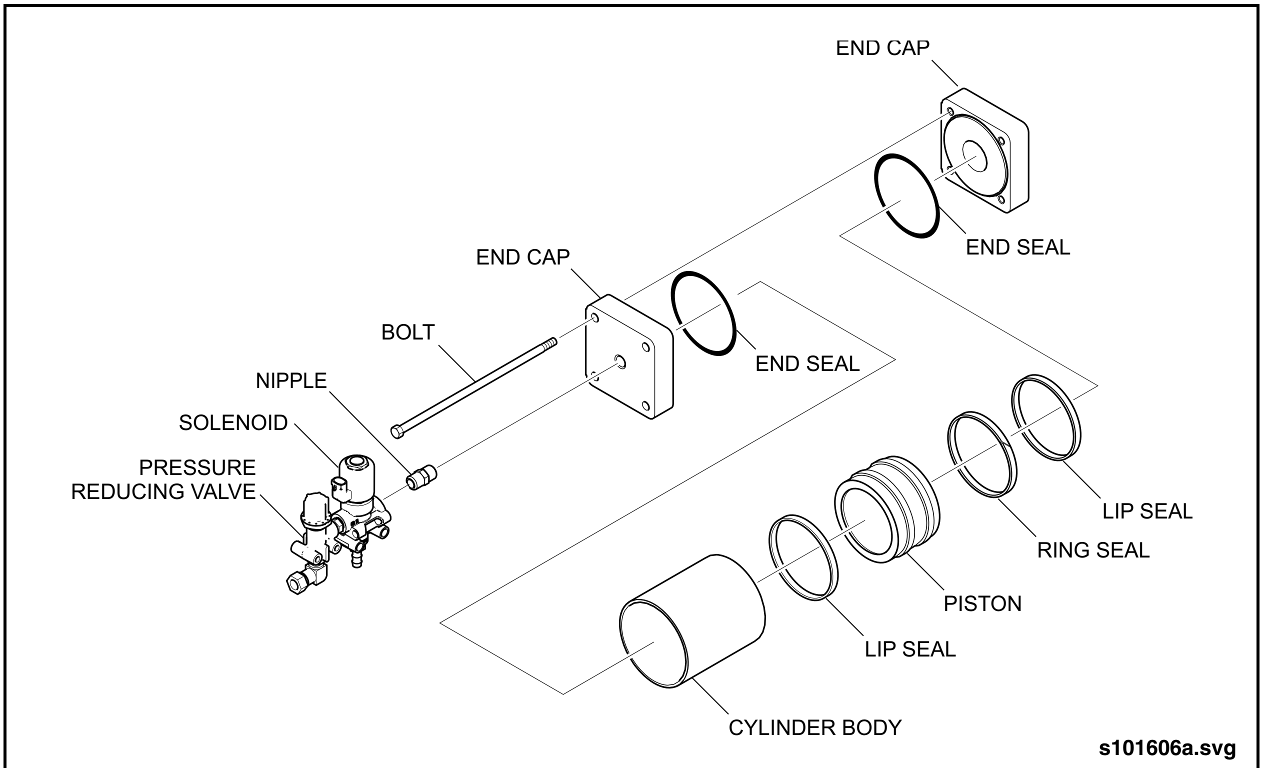


Fig. 5-12: Accumulator Assembly‘

6.5. Cleaning & Inspection

1. Thoroughly clean all parts in mineral spirits.
2. Inspect piston for evidence of wear or scoring.
3. Inspect cylinder for scoring or wear. I.D. of cylinder not to exceed an average bore diameter of 4.010" (four measurements taken approximately 45° apart).
4. Inspect condition of internal threads on gas end cap.
5. Inspect tie rod bolts for deformation or thread damage.

6.6. Assembly

1. Install two new lip seals and seal ring on piston.
2. Lubricate piston seals with transmission fluid and install piston into cylinder bore.
3. Install new end seals into grooves in end caps and assemble to cylinder body with tie rod bolts.
4. Torque tie rod bolts 24 to 27 ft-lb. (32 to 36 Nm).
5. Install solenoid and fitting on accumulator end cap.

6.7. Installation

1. Install accumulator and solenoid assembly to mounting bracket using four bolts. Torque bolts 50 to 60 ft-lb. (68 to 81 Nm).
2. Install oil line from transmission to top of accumulator.
3. Connect air lines to solenoid.
4. Connect wiring to solenoid valve.
5. Fill transmission with oil to correct level. Refer to the Preventive Maintenance Section of this manual for oil specifications and filling procedures.

6.8. Functional Test

Test drive vehicle to check for proper retarder operation.

7. VENDOR SERVICE INFORMATION

The following supplier manuals contain additional reference information.

7.1. Allison B400 Transmission Manuals

- ❒ Parts Manual
- ❒ Service Manual
- ❒ Quick-Tech Troubleshooting Guide
- ❒ Troubleshooting Manual
- ❒ Principles of Operation
- ❒ Mechanics Tips
- ❒ Operators Manual

Cooling System

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❒ open flame
- ❒ excessive heat
- ❒ production of sparks
- ❒ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Hoisting/Lifting & Jacking Safety

Refer to the General Information Section of this manual for recommended types of hoists, lifting equipment, and jackstands.

⚠ DANGER

Certain procedures may require the vehicle be operated in an elevated position in order to accurately troubleshoot and diagnose a problem. If the vehicle must be running while elevated, become familiar with the repair area prior to starting the engine. Take special care in noting areas which will become hot, electrically energized, and areas where moving and rotating components are located. Limit the work in these areas as personal and equipment safety is at risk.

⚠ WARNING

ALWAYS ensure that the vehicle is appropriately hoisted and blocked for procedures which require elevating the vehicle. Be aware of the limitations of the blocking equipment, and always ensure that the jarring and shaking created by component removal and installation procedures does not overload the blocks, or cause the vehicle to become unstable.

2. ENGINE COOLING SYSTEM

2.1. Description

☞**NOTE:**

Refer to the Power Plant Cooling Circulation Diagram when reviewing this information.

⚠ **WARNING**

Operate the pressure relief valve, located on the surge tank filler tube, before doing any work on the cooling system. Severe injury can occur if this is not observed.

☞**NOTE:**

Refer to "Vehicle Heating System" in Section 10 of this manual for information on the heating system.

The engine cooling system includes the following major components:

- ❒ Radiator/charge air cooler - Refer to 2.7. "Radiator/Charge Air Cooler" on page 12 for a description of this component.
- ❒ Engine water pump.
- ❒ Surge tank - Refer to 2.9. "Surge Tank" on page 22 for a description of this component.
- ❒ Coolant recovery tank - Refer to 2.10. "Coolant Recovery Tank" on page 27 for a description of this component.
- ❒ Transmission cooler - Refer to 2.8. "Transmission Cooler" on page 18 for a description of this component.
- ❒ Connecting hoses, tubes, & piping.

2.2. Operation

The fan system draws cooling air through the radiator/charge air cooler core.

A liquid coolant constantly flows throughout the sealed cooling system when the engine is running. The engine is cooled by this liquid. In addition, this liquid:

- ❒ Cools the air compressor via a water jacket.
- ❒ Cools transmission oil by carrying heat away from heat exchanger (transmission oil cooler).
- ❒ Cools the turbocharger oil sump.
- ❒ Cools the exhaust gases by carrying away heat from the EGR cooler.
- ❒ Cools the dosing module in the exhaust aftertreatment system.
- ❒ Warms the Diesel Exhaust Fluid (DEF) tank

Liquid coolant for the cooling system is added through surge tank filler cap or a remote pressure fill connector in the engine compartment. Pressure within the cooling system is maintained by a pressure cap on the surge tank filler neck.

Low coolant and hot engine indicators on the instrument panel warn the operator if liquid in the cooling system becomes too low or too hot. An alarm buzzer will also sound.

2.3. Coolant Circulation

Coolant circulation during warm-up differs from circulation after engine has reached normal operating temperature as explained in the following headings.

2.3.1. Engine Warm-Up

Engine water pump circulates coolant into cylinder block by way of engine oil cooler. After circulating through block and cylinder heads, coolant enters thermostat housing.

When engine is cold (below 180°F or 82°C) the thermostats are closed and they prevent coolant from flowing into radiator, so the coolant returns to the water pump through by-pass openings in housing.

During warm-up, coolant also circulates through the air compressor cylinder head and transmission oil cooler.

2.3.2. After Engine Warm-Up

When coolant reaches the temperature at which engine thermostats open, coolant begins to flow through radiator. Heat at this time is sufficient to actuate the fan control module and cause the electric fans to operate. Coolant continues to circulate through the air compressor and transmission oil cooler.

2.4. Engine Coolant

2.4.1. Description

This vehicle has been prefilled with an antifreeze solution composed of 50% ethylene glycol, 50% distilled water, plus corrosion inhibitors. This concentration is recommended for best overall performance. Use of antifreeze concentrations over 67% (67% antifreeze and 33% water) will lead to poor heat transfer and freeze protection and possible silicate dropout. Concentrations below 33% (33% antifreeze and 67% water) offer too little freeze and corrosion protection and are not recommended.

CAUTION

Use extreme care when depressurizing and removing the filler cap from the surge tank. 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.

2.4.2. Inspection Capacity

The capacity of the basic engine cooling system cylinder block, head, thermostat housing and oil cooler housing is 13.1 quarts (12.4 liters).

To obtain the total amount of coolant required in the cooling system of a unit, the additional capacity of related equipment should be obtained from the equipment supplier. Otherwise, capacity of the particular cooling system may be determined by filling the system with water, then draining and measuring the amount required.

2.4.3. Draining

WARNING

DO NOT work on the cooling system if the engine is hot. Hot engine coolant is under pressure and can cause scalding burns if filler caps are opened or lines are disconnected. ALWAYS allow time for the coolant temperatures and pressure to drop before servicing the system.

1. Ensure that the coolant temperature is 122°F (50°C) or lower.
2. Open the rear engine access door.
3. Open the interior engine access door.
4. Open the surge tank access door.
5. Locate the surge tank pressure cap.

☞**NOTE:**

The surge tank pressure cap is labeled ENGINE COOLANT.

6. Relieve the cooling system pressure by operating pressure relief lever on the surge tank pressure cap. Open the pressure cap once the pressure has been relieved.
7. Raise the vehicle to gain access to radiator drain cock and under vehicle coolant hoses. Refer to the General Information Section of this manual for approved lifting procedures.
8. Place a suitable container under the radiator drain cock. Open the drain cock and drain coolant.

☞**NOTE:**

Drain all liquids into suitable containers for disposal. Coolant must be recycled or disposed of in accordance with all applicable regulations. If coolant is to be recovered, make sure all containers are clean and chemical free.

9. Locate and remove any drain plugs from coolant tubes and transmission oil cooler, if equipped.
10. Replace the coolant filter, if equipped, and record installation date and vehicle mileage.
11. Reinstall and tighten all drain plugs and close all drain cocks once engine and radiator are completely drained.

2.4.4. Filling & Deaeration

CAUTION

The following fill and deaeration procedure must be performed any time maintenance has been performed on the engine cooling system components. It is necessary to bleed the system prior to running the engine in order to prevent air locks in the water pump and also prevent the low coolant sensor in the surge tank from activating and shutting down the engine.

For emergency fill applications, where pressure fill equipment is not available, wait for the engine and coolant to cool then remove the surge tank pressure cap. Manually fill through the fill port. Be sure to replace the pressure cap prior to operating the vehicle.

1. Ensure that all drain plugs have been installed and drain cocks have been closed.
2. Locate the pressure cap on the surge tank filler neck and open the pressure vent lever.
3. Loosen the cap on the coolant recovery tank.
4. Locate the engine coolant pressure-fill connector in the engine compartment. See “Fig. 6-1: Pressure Fill Connectors” on page 6.

☞**NOTE:**

There are two pressure-fill connectors located side by side in the engine compartment. Ensure that the connector labeled ENGINE COOLANT is used during the following procedure.

5. Connect the pressure filling equipment to the quick-coupler and add coolant until the surge tank is full. Stop filling when coolant reaches Cold Max level on the coolant recovery tank.

☞**NOTE:**

Ensure pressure fill equipment is pressure regulated to 10 psi or less. Dispense coolant at less than 6 gallons per minute. Supply reservoir must be of adequate volume to ensure pump does not draw air during fill process. Supply coolant must be clean and of the same specification required for the vehicle cooling system. Refer to the Preventive Maintenance Section of this manual for coolant specification. Refer to your New Flyer parts manual for part numbers and ordering information for the pressure fill equipment.

⚠**CAUTION**

The EGR valve MUST be disconnected during the deaeration process. The EGR cooler is susceptible to thermal damage if operated without sufficient coolant.

6. Disconnect the electrical connection from the EGR valve.

☞**NOTE:**

Disconnecting the EGR valve will cause Fault Code 2272 to become active. Disregard indications of Fault Code 2272 during the deaeration procedure.

☞**NOTE:**

Operation at high idle with the EGR valve disconnected may cause misfire faults to become active when no misfire is actually occurring.

7. Connect Cummins INSITE™ electronic service tool and perform the following actions:
    a. Record the current value of "Maximum Engine Speed without Vehicle Speed Source" parameter located in the "Vehicle Speed Source" section of "Features and Parameters".
    b. If the current maximum engine speed value is higher than 2000 RPM, adjust the speed to 2000 RPM.
    c. Use the Cummins INSITE™ electronic service tool to monitor coolant temperature during the deaeration process. Discontinue the deaeration process if coolant temperatures exceed 195°F (90°C) and investigate the cause before continuing procedure.
8. Start the engine and run at low idle for two minutes and ensure coolant level in surge tank does not drop.

☞**NOTE:**

If coolant level should drop, shut down engine and top up until surge tank is full.

9. Run engine at fast idle (1000 - 1600 RPM) for five minutes.
10. Shut down engine and check for coolant leaks and correct as necessary.

⚠**CAUTION**

DO NOT allow engine speed to exceed 2000 RPM while the EGR valve is disconnected. Operation at higher RPM in this mode can result in engine damage.

11. Start engine and run at full RPM, but no more than 2000 RPM, until thermostat opens (approximately 180°F (82°C)

☞**NOTE:**

If running the vehicle outdoors in cooler weather, it may necessary to block off the radiator portion of the Radiator/CAC Cooler to promote warm-up and opening of the thermostat.

12. Reduce engine speed to low idle and operate for another two minutes to normalize engine temperature.
13. Shut down engine.
14. Add coolant through the pressure-fill connector until coolant level is between the COLD MAX and HOT MAX markings on the coolant recovery tank. See “Fig. 6-2: Coolant System Fill Levels” on page 7.
15. Connect the electrical connector to the EGR valve.

16. Connect Cummins INSITE™ electronic service tool and restore the "Maximum Engine Speed without Vehicle Speed Source" parameter to its original value as previously recorded.
17. Troubleshoot any active fault codes and clear all inactive fault codes.
18. Remove the pressure filling equipment.
19. Close the pressure vent lever on the surge tank pressure cap.
20. Tighten the cap on the coolant recovery tank.

2.4.5. Cooling System Flushing

Refer to the Preventive Maintenance Section of this manual for scheduled flushing intervals. Also refer to Cummins Operation and Maintenance Manual for recommended cleaning and flushing procedures.

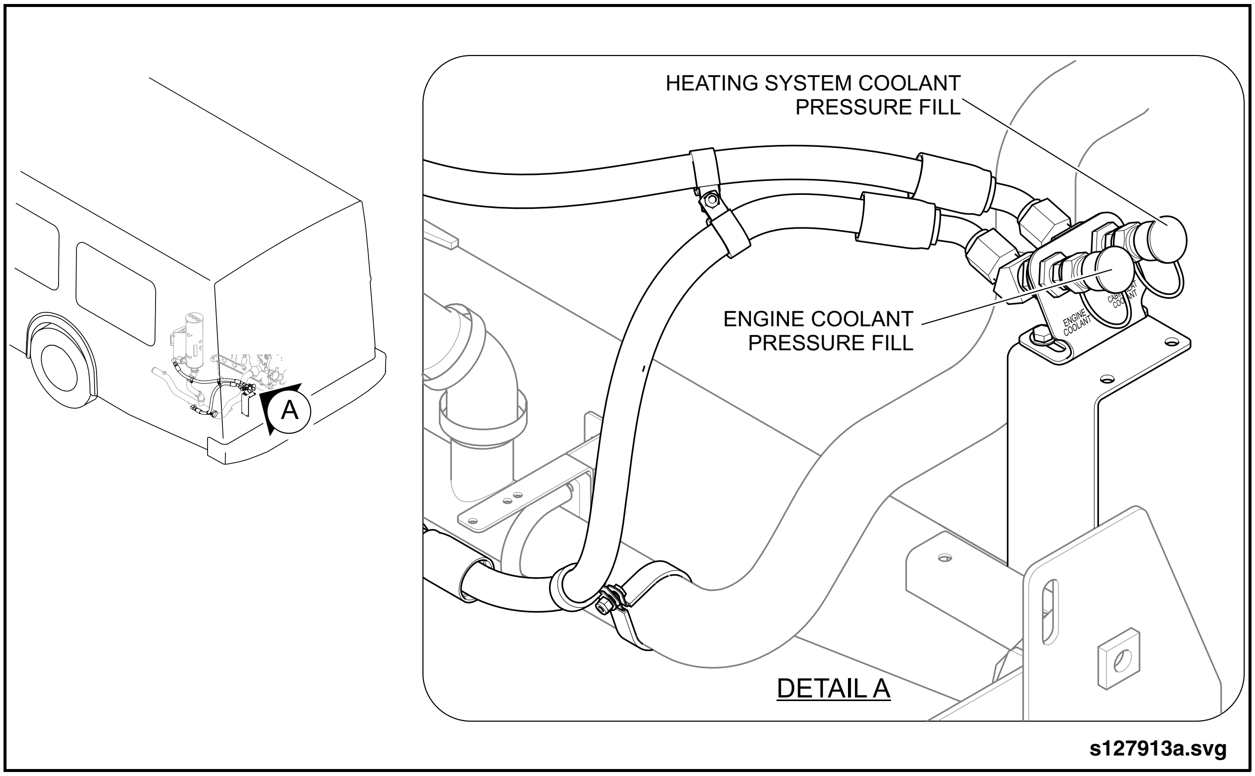


Fig. 6-1: Pressure Fill Connectors

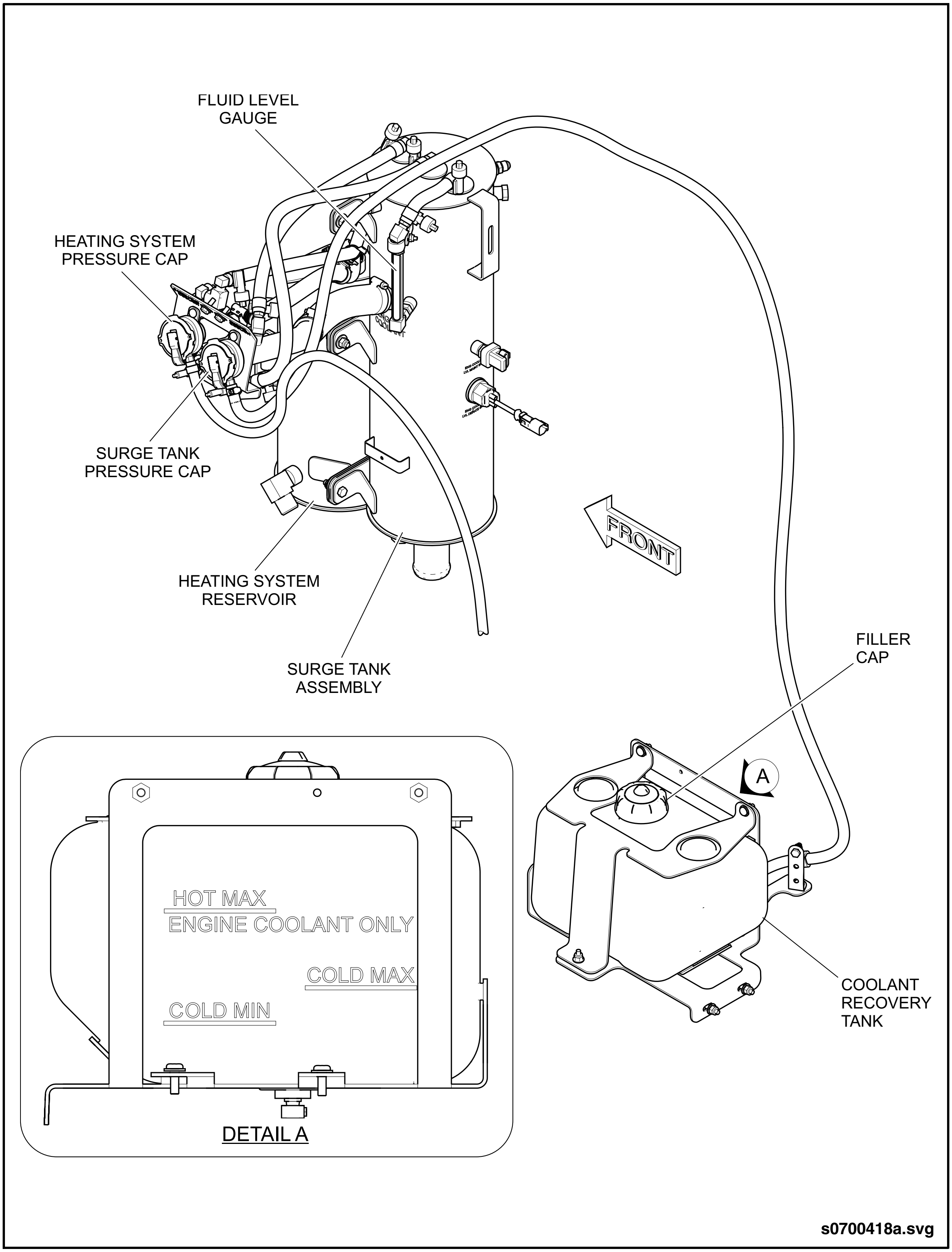


Fig. 6-2: Coolant System Fill Levels

2.5. Cooling System Pressure Test

2.5.1. Description

Pressure testing the engine cooling and HVAC Systems ensures that the vehicle is free of leaks and is holding pressure for optimal performance. A pressure test tool is required with a pressure regulator of a 0 to 50 psi rating. The pressure/leak test procedures are described as follows:

- ❒ Pressure Test Tool Setup
- ❒ Leak Test Cooling System: Before Filling
- ❒ Leak Test Cooling System: After Filling
- ❒ Leak Test Cooling System: After Road Test

2.5.1.1. Pressure Test Tool Setup

⚠ WARNING

The cooling system is under pressure and contains hot fluids that can spill or spray and cause serious scalding injuries. Allow an appropriate amount of time for the cooling system to cool down below 120°F (49°C) before working on the cooling system unless otherwise noted.

1. Remove the cap on the Schrader valve.
2. Connect the charging chuck of the pressure test tool (Item 1 from the special tools list) to the Schrader valve.
3. Close the shutoff valve of the pressure test tool.
4. Ensure that the pressure relief cap is installed, fully seated and that the relief valve is closed.
5. Remove the filler cap from the coolant recovery tank.
6. Ensure that all manual valves in the booster pump lines, coolant lines, and HVAC lines are set to the OPEN position.

⚠ CAUTION

Secure the pressure tester and air lines before making a connection to a pressurized air hose. Failure to properly secure the pressure tester and air lines can result in injury to personnel and damage to equipment.

7. Attach a shop air line to the quick coupler on the pressure tester.

2.5.1.2. Leak Test Cooling System before Filling

1. Press and hold the button on the pressure test tool to pressurize the system.

CAUTION

DO NOT pressurize the cooling system above 25 psi otherwise cooling system damage can occur. Adjust the pressure regulator accordingly before opening the pressure test tool shutoff valve.

2. Allow the pressure to build above 18psi and then release the button.

NOTE:

The pressure relief cap relieves excess pressure and then the pressure holds.

3. Release the button on the pressure test tool and observe the pressure reading on the pressure test tool regulator. Allow the system to stabilize for 5 minutes. The system should stabilize at a minimum of 15 psi.
4. Note the pressure regulator reading once stabilized.
5. Allow the vehicle to stand for an additional 10 minutes. If, after 10 minutes, the pressure reading drops by more than 0.5 psi from the noted stabilized pressure in the previous step, the leak test has failed.
6. If the pressure test failed in the previous step, maintain system pressure between 10 to 14 psi and troubleshoot the system by applying soapy water spray on all hoses, and hose connections. Repair/replace leaking hoses (indicated by bubbles forming in the applied soapy water) and retighten any loose hose connections. Refer to 2.11. “Hose Clamp Torque Specifications” on page 29 in this section for torque values. Repeat this task until the test passes.
7. When the test has passed, close the shutoff valve and disconnect the pressure test tool from the vehicle.
8. Vent the pressure by using the pressure relief valve on the pressure relief cap.
9. Check the coolant level and fill cooling system as needed. Refer to 2.4.4. “Filling & Deaeration” on page 4 in this section for more information.

2.5.1.3. Leak Testing Cooling System after Filling

☞**NOTE:**

This task requires a Stant Engine Coolant System Pressure Tester Hose and Head Kit with the hose plugged or capped.

1. Vent the engine cooling system pressure at the pressure relief cap.
2. Install the pressure test tool.
3. Remove the pressure relief cap.
4. Install the Stant Engine Coolant System Pressure Tester Hose and Head Kit.
5. Rotate the pressure release bar on the Stant Pressure Tester Cap in the counter-clockwise direction to close the pressure relief valve.

⚠ **CAUTION**

DO NOT pressurize the cooling system above 25 psi otherwise cooling system damage can occur. Adjust the pressure regulator accordingly before opening the pressure test tool shutoff valve.

6. Open the shutoff valve of the pressure test tool.
7. Press and hold the button on the regulator to pressurize the cooling system to 25 psi.
8. Release the button and allow the system pressure to stabilize for 5 minutes. If, after 5 minutes, the pressure drops below 23 psi, press and hold the button on the pressure test tool regulator to re-pressurize the system to 25 psi and then release the button.
9. Note the pressure regulator reading once stabilized.
10. Allow the vehicle to stand for an additional 10 minutes. If, after 10 minutes, the pressure reading drops by more than 0.5 psi from the noted stabilized pressure in the previous step, the leak test has failed.
11. If the pressure test failed in the previous step, maintain system pressure between 10 and 14 psi and troubleshoot the system by applying soapy water spray onto all hoses, and hose connections. Repair/ replace leaking hoses (indicated by bubbles forming in the applied soapy water) and retighten any loose hose connections. Refer to 2.11. “Hose Clamp Torque Specifications” on page 29 in this section for torque values. Repeat this task until the test passes.
12. When the test passes, close the shutoff valve of the pressure test tool and vent the coolant system pressure by rotating the pressure release bar on the Stant Pressure Tester Cap in the clockwise direction.
13. Disconnect the pressure test tool from the vehicle and remove the Stant Pressure Tester Cap.
14. Install the original pressure relief cap to and fasten the cover back onto the Schrader valve.

2.5.1.4. Leak Testing Cooling System after Road Test

WARNING

The cooling system is under pressure and contains hot fluids that can spill or spray and cause serious scalding injuries. This task may require close proximity to hot components. Ensure all safety precautions are taken before proceeding.

CAUTION

For this test, DO NOT attach the shop air line to the pressure test tool until specifically mentioned.

1. While the coolant is still hot (above 180°F (49°C)) and with the engine running, install the pressure test tool. Close the pressure test tool shutoff valve before installing.
2. Verify that the pressure reading is between 15 to 20 psi and is stable. If the pressure is within range and is stable, the leak test has passed - proceed to step 5 of this task. Otherwise, proceed to the next step.
3. If the pressure test failed in the previous step allow the coolant to cool to or below 120°F (49°C) Connect a shop air hose to the pressure test tool, open the pressure test tool shutoff valve and maintain system pressure between 10 and 14 psi.
4. Troubleshoot the system by applying soapy water spray onto all hoses, and hose connections. If a leak is detected (bubbles forming in the soapy water spray), Repair/replace leaking hoses and retighten any hose connections. Refer to 2.11. “Hose Clamp Torque Specifications” on page 29 in this section for torque values.
5. When the leak test has passed, close the shutoff valve of the pressure test tool and vent the coolant system pressure.
6. Disconnect the pressure test tool from the vehicle.

2.6. Maintenance

☞**NOTE:**

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance procedures and intervals.

2.7. Radiator/Charge Air Cooler

WARNING

Make sure the vehicle is in neutral, the parking brake is applied, and the wheels are blocked before doing any work or diagnostic procedures on the radiator/ charge air cooler.

Disconnect the main negative battery cable and/or switch off the Battery Disconnect switch first before installation or servicing.

Use extreme caution when working on systems under pressure (for example; coolant, hydraulic fluids, air, and so forth).

Make sure the work area is ventilated and well lit.

Make sure charged fire extinguishers are in the work area.

Reinstall all safety guards, shields, and covers after servicing the vehicle.

Make sure all tools, parts, and service equipment are removed from the engine compartment and vehicle after all work is done.

Use extreme caution when working on systems containing fluids which may be hot, corrosive or hazardous.

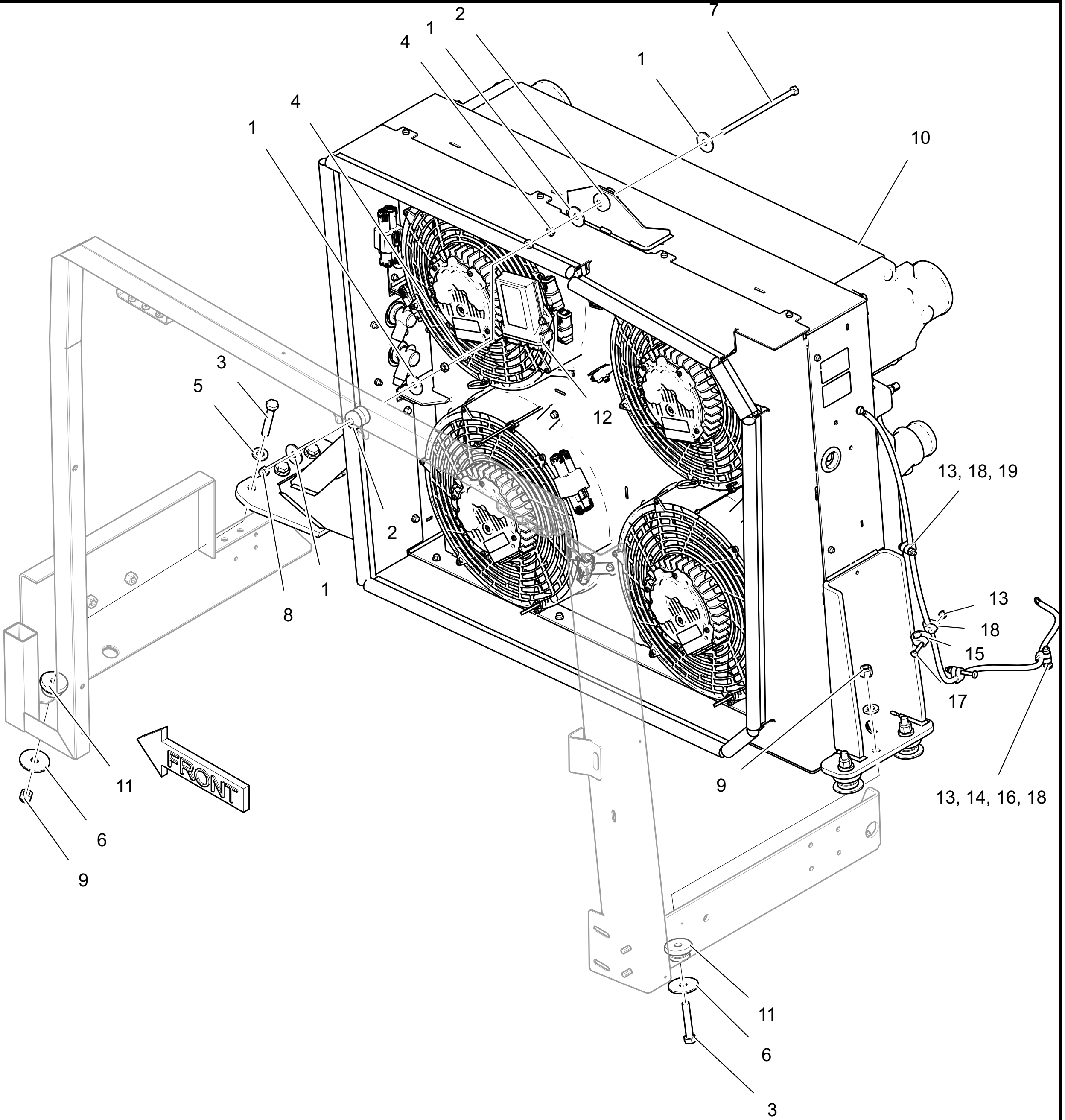
Ensure that all system power and ground connection points are torqued to specifications to prevent system damage. Failure to follow specified torque requirements at any point of the vehicle system power and ground can result in loose connections which can damage electronic components on the system.

2.7.1. Description

This vehicle is equipped with an EMP MH4 combined radiator/charge air cooler assembly. The assembly includes the following major components:

- ❒ Radiator
- ❒ Charge air cooler
- ❒ Four electric fans
- ❒ TMC system controller
- ❒ Wiring harness
- ❒ J1939 CAN vehicle interface cable
- ❒ Power and ground studs
- ❒ Ground cable
- ❒ LED diagnostic lamp
- ❒ Fan reverse button

The radiator/charge air cooler assembly is located at the streetside rear corner of the vehicle. The assembly is cushion-mounted to the vehicle structure and can be accessed by a hinged door that is grilled for ventilation. The charge air cooler is stacked on top of the radiator and both units are enclosed by a fan shroud which provides a mounting location for the electric cooling fans. The system controller is bracket-mounted to the front face of the radiator/charge air cooler assembly. See “Fig. 6-3: Radiator/Charge Air Cooler Installation” on page 13.



4. Washer, Flat 1.5" O.D
5. Mount, Rubber
6. Bolt, Hex 1/2" - 13 UNC x 2 3/4" Lg.
7. Nut, Hex Jam 3/8" - 16 UNC
8. Washer, Flat Hardened 1/2"
9. Washer, Snubbing
10. Bolt, Hex 3/8" - 16 UNC x 7.0" Lg. Fully Threaded
11. Nut, Lock Nylon 3/8" - 16 UNC
12. Nut, Lock Nylon 1/2" - 13 UNC
13. Radiator & CAC Assembly
14. Mount, Center Bonded
15. Controller, Radiator/Charge Air Cooler Assembly Pre-Programmed
16. Nut, Lock Nylon 1/4" - 20 UNC
17. Washer, Flat 1/4"
18. Clamp, 0.625" Dia.
19. Bolt, Hex 1/4" - 20 UNC x 1 1/2" Lg.
20. Bolt, Hex 1/4" - 20 UNC x 2 1/4" Lg.
21. Clamp, 0.375" Dia.
22. Bolt, Hex 1/4" - 20 UNC x 1 1/4" Lg.

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Fig. 6-3: Radiator/Charge Air Cooler Installation

2.7.2. Radiator/Charge Air Cooler Specifications

Manufacturer............. Engineered Machined Products (EMP)

Model MH4

Radiator ....Aluminum tanks and bar/plate core with 8.5 fins/inch & 50 hot row core

Charge Air Cooler ....Aluminum tanks and bar/plate core with 8.5 fins/inch & 16 hot row core

Cooling Fans .... Four EMP FiL-15, 15" diameter electric fans (pusher type)

Fan Speed .....Variable speed 0 - 4350 RPM (default ON @ 3300 RPM

Current draw @28 VDC .... 228 amps max

CAN Communication ....SAE J1939 protocol with diagnostic system reporting

System Fault Indicator.................... Flashing LED codes

Fan Control.......... Independent temperature control for coolant and charge air

2.7.3. Operation

The radiator consists of a welded aluminum assembly which functions as a liquid-to-air heat exchanger and is mounted beneath the charge air cooler. Hot engine coolant is received from the upper radiator hose, circulates through the radiator, and is drawn back to the engine by the water pump via the lower radiator hose. Cooling fans draw ambient air from outside the vehicle through the access door grille, and direct the air through the radiator core thereby lowering and maintaining the coolant temperature to the degree necessary for efficient engine operation.

The charge air cooler is a welded aluminum assembly which functions as an air-to-air heat exchanger and is mounted on top of the radiator. Compressed air from the engine turbocharger is directed through the charge air cooler before being delivered to the engine air intake manifold. Cooling fans draw ambient air from outside the vehicle through the access door grille, and direct the air through the charge air cooler core thereby lowering the temperature of the compressed air which results in denser air being sent to the engine intake manifold for increased engine efficiency.

A bulb seal used to increase cooling efficiency and is fastened around the radiator to provide an airtight seal against the radiator access door and to prevent recirculation of the hot air exiting through the radiator/charge air cooler assembly. This hot air, if permitted to pass around the sides or bottom of the radiator/charge air cooler, will reduce system efficiency and may cause overheating of the engine.

The four FiL-15 fans are individually controlled by the TMC system controller. The TMC system controller commands fan speed by referencing the input from information received on the vehicle J1939 CAN bus.

The TMC system controller will command the appropriate fans to a speed based on the high and low temperature set points for the charge air cooler or radiator. This is done to minimize the amount of electrical power being consumed by the fans for the amount of cooling required for the vehicle.

The radiator/charge air cooler diagnostic lamp and cooling fan reverse button are located on a bracket mounted beneath the engine compartment gauges. The red LED lamp is used for troubleshooting purposes and will flash blink codes if a problem is detected in the radiator/charge air cooler system. The fan reverse button is used to verify system operation and/or clean out debris from the radiator/charge air cooler cores. Setting the Master Run switch to either DAY-RUN or NIGHT-RUN and pressing the button will operate the fans in reverse direction at high speed for 20 seconds, followed by operation in the normal direction at low speed for 10 seconds. This process will assist in removing debris from the radiator and charge air cooler cores and also confirm proper operation of all cooling fans.

The J1939 CAN vehicle interface cable provides a communication link between the radiator/charge air cooler system and the vehicle multiplexing system. System diagnostics and operating parameters can be accessed via the J1939 network using a personal computer and EMP diagnostic software.

Stray voltage can be carried by the coolant when coolant tubes are separated from the radiator via a non-conducting hose connection. With the coolant tubes and radiator not bonded to the same ground point, electrolysis can occur between the pipes and the radiator, causing accelerated corrosion. The grounding wires from the radiator and coolant tubes connect to the vehicle chassis, eliminating the electrical potential and stopping the electrolytic corrosion.

2.7.4. Maintenance

☞NOTE:

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance intervals and requirements.

2.7.5. Radiator/Charge Air Cooler Troubleshooting & Repair

☞NOTE:

Refer to 4. "VENDOR SERVICE INFORMATION" on page 31 *in this section for further information.*

2.7.6. Removal

☞NOTE:

The following procedure covers removal of the radiator and charge air cooler assemblies as a unit from the vehicle.

1. Set the Battery Disconnect switch to the OFF position.
2. Open the engine compartment and the radiator compartment access doors.

⚠CAUTION

Ensure that the cooling system has been depressurized at the surge tank. Close the heating system supply and return shutoff valves, located in the engine compartment, prior to draining the cooling system. Refer to HVAC System layout for shutoff valve locations.

3. Remove the drain plug from the lower radiator tube and drain the engine coolant into a suitable container.
4. Loosen the hose clamps and remove the two upper CAC hoses from the charge air cooler.
5. Loosen the hose clamps and remove the radiator hoses from the radiator.
6. Disconnect the wiring harness from the fan reverse switch/LED diagnostic lamp.
7. Pull back the protective covers on the positive (+) and negative (-) power studs and disconnect the positive and negative power cables.
8. Loosen the jam nuts and remove the lock nut from the upper mounting bolt.
9. Disconnect the ignition input signal wire connector and the J1939 CAN vehicle interface wire connector, both located on the right hand side of the unit.
10. Disconnect the grounding wire from the chassis connection point.

⚠WARNING

Radiator/charge air cooler assembly is very heavy. Use a forklift or other appropriate lifting system to support and remove the unit. Strap the radiator/charge air cooler assembly to prevent the unit from tipping during removal and transportation to a work area.

11. Support the weight of the radiator/charge air cooler and remove the fasteners that attach the upper mounting link rod to the radiator mounting bracket and vehicle structure. Remove the link rod.
12. Remove the two fasteners that attach the left side of the radiator support channel to the rear mounting bracket.
13. Remove the two fasteners that attach the right side of the radiator support channel to the vehicle structure.

☞NOTE:

The lower radiator support channel will remain attached to the radiator as the unit is being removed from the vehicle.

14. Carefully remove the radiator/charge air cooler assembly from the vehicle.

2.7.7. Installation

1. Use appropriate lifting equipment and move the radiator/charge air cooler assembly into position.
2. Align the mounting holes in the radiator support channel with the vehicle structure and install the bolts, washers and nuts on the left side and right side. Do not tighten fasteners at this time.
3. Align the holes in the upper mounting brackets on the charge air cooler and vehicle structure. Install the upper mounting bolt, washers, jam nuts and locking nut but don't final tighten at this time.
4. Adjust the position of the radiator to ensure full contact of the bulb seal with the radiator access door closed. Tighten the upper mounting jam nuts to maintain radiator position and torque to 43 ft-lb. (58 Nm).
5. Tighten all mounting hardware. Torque the lower mounting bolts to 50 ft-lb. (68 Nm).
6. Pull back the protective covers on the positive (+) and negative (-) power studs and connect the positive and negative power cables using lock washer and nut. Torque nut to 15 ft-lb. (20 Nm).
7. Connect the grounding wires to the chassis connection point. Torque to 14 ft-lb. (19 Nm). Apply Zinc primer, if necessary, to cover base metal.
8. Connect the ignition input signal wire connector and the J1939 CAN vehicle interface wire connector, both located on the left hand side of the unit, to vehicle wiring harness.
9. Connect the wiring connector on the right hand side of the unit to the fan reverse switch/LED diagnostic lamp harness.
10. Connect the two upper CAC hoses to the charge air cooler and tighten the hose clamps.

   ☞**NOTE:**

   Hose and tube connections are designed with a slight interference fit. Lubricate tubes to aid hose installation.

11. Connect the radiator hoses to the radiator and tighten the hose clamps.

   ☞**NOTE:**

   Be sure to reinstall the lower radiator hose drain plug.

12. Set the Battery Disconnect switch to the ON position.
13. Refill the cooling system and purge air out of the system before starting the vehicle. Refer to 2.4.4. “Filling & Deaeration” on page 4 in this section for procedure. Also refer to the Preventive Maintenance Section of this manual for fluid specification.

2.8. Transmission Cooler

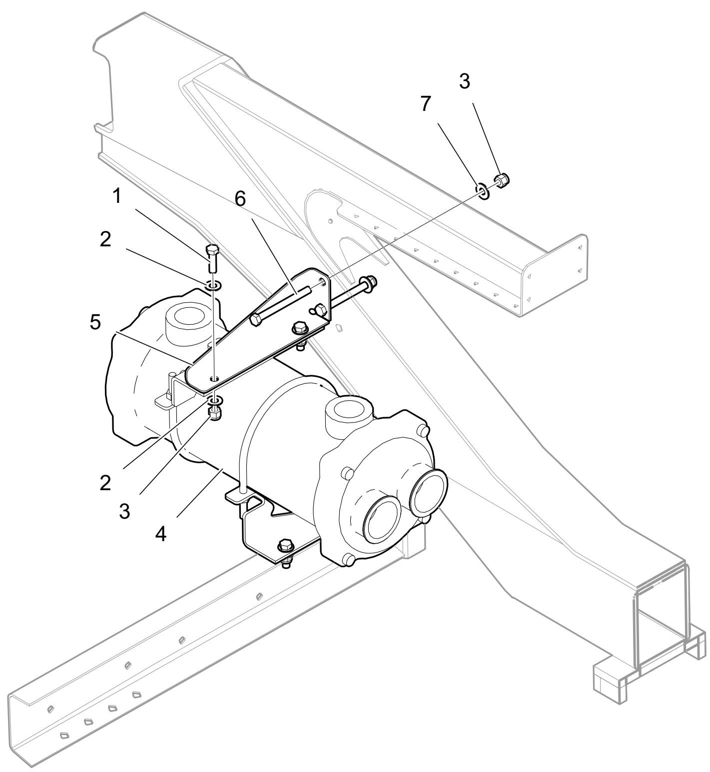
2.8.1. Description

The oil cooler is used to cool the transmission fluid by transferring heat from the fluid to the engine coolant. Hot fluid from the transmission is cooled as it circulates around the cooler core assembly before returning to the transmission.

Coolant from the engine cooling system is circulated through the cooler core assembly where it absorbs heat before returning to the engine. At regular service intervals the oil cooler and its external connections should be inspected for evidence of water or fluid leaks. Remove and clean cooler when inspection indicates any leakage or malfunction or at the time the transmission is repaired or overhauled.

2.8.2. Removal

1. Drain the radiator. Refer to 2.4.3. “Draining” on page 4 for draining procedure.
2. Clean the area around inlet and outlet ports, then disconnect the two transmission fluid lines. Plug the open ends of both lines to prevent fluid loss and contaminants from entering. See “Fig. 6-4: Transmission Cooler Installation” on page 18.
3. Loosen the hose clamps and disconnect the coolant lines. Plug the lines to prevent contaminants from entering.
4. Remove the bolts attaching the cooler to the mounting bracket and remove the cooler.
5. Clean the exterior of the cooler, then drain the fluid and coolant remaining in the cooler.



1. Bolt, Hex 3/8" - 16 UNC x 1 1/4" Lg.
2. Washer, Flat 3/8"
3. Nut, Lock Nylon 3/8" - 16 UNC
4. Transcooler Assembly
5. Bracket, Mounting
6. Bolt, Hex 3/8" - 16 UNC x 3 3/4" Lg.
7. Washer, Flat SS 3/8"

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Fig. 6-4: Transmission Cooler Installation

2.8.3. Disassembly

1. If the mounting brackets are being replaced, mark their positions and spacing relative to the housing before removing. See “Fig. 6-5: Transmission Cooler Assembly” on page 20.
2. Mark the positions of both end caps relative to the housing.
3. Remove the bolts from both end caps and remove the end caps. Discard the gaskets and O-rings.
4. Remove the division rib and seal from the bundle assembly.
5. Note that one end of the bundle, with the larger cupped tube plate, protrudes from the housing. Mark the rotational position of the bundle cupped tube plate (header plate) relative to the housing.
6. Press the bundle assembly from the housing as follows:
   a. Support the bundle assembly on an arbor press with the smaller, non-protruding end facing upward.

      ☞**NOTE:**

      Support the housing on its mounting flange so that sufficient room will be provided to press out the bundle from the housing.

   b. Cut a circular piece of plywood to match the diameter of the cooling tube bundle.
   c. Place the piece of plywood on top of the tubes of the smaller diameter cupped tube plates.

      ⚠**CAUTION**

      Use care not to bend the sides of the cup or any of the tubes that pass through the cooler.

   d. Use the arbor press to carefully press the bundle assembly out of the housing.
7. Remove and discard the O-rings in the grooves of the housing at either end.

2.8.4. Cleaning

2.8.4.1. Oil Side

The oil cooler should be cleaned at every transmission overhaul or whenever the transmission fluid becomes contaminated.

1. Immerse the bundle assembly and housing in a paraffin or degreasing tank to remove all traces of oil.

   ⚠**CAUTION**

   DO NOT use a heated cleaning bath if using vapor solvents for cleaning.

2. Immerse the bundle assembly in a heated detergent bath and move back and forth vigorously to remove stubborn carbon deposits.

   ⚠**CAUTION**

   NEVER use stiff metal brushes or probes which may damage the tubes, baffles, and/or headers.

   ☞**NOTE:**

   Agitation of the detergent by a steam or compressed air jet will expedite the cleaning process. DO NOT exceed 10 psi pressure.

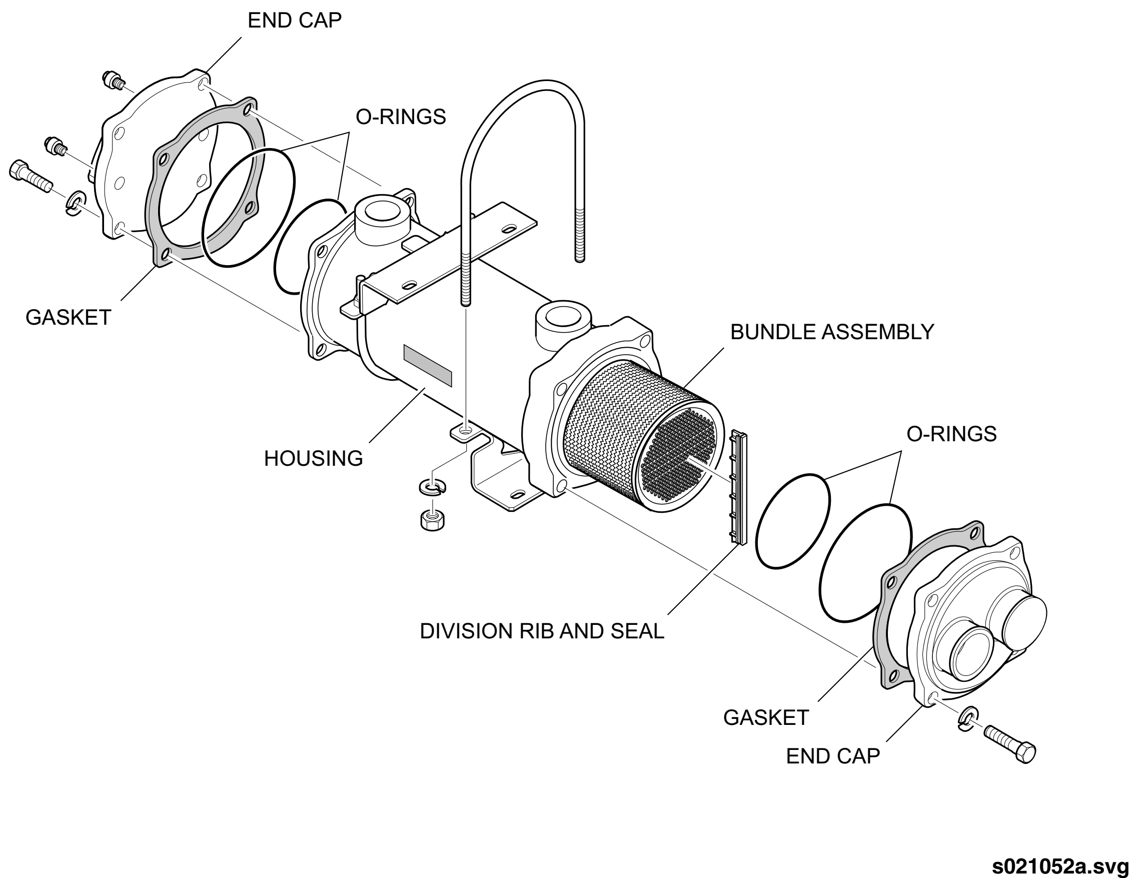


Fig. 6-5: Transmission Cooler Assembly

2.8.4.2. Water Side

A badly scaled cooler can be cleaned by immersing the bundle assembly in suitable inhibited acid solvent. Ensure the oil side of the bundle has been thoroughly cleaned before proceeding with an acid bath.

WARNING

ALWAYS wear protective clothing and a face shield when working with acids. NEVER add water to acid.

1. Mix a 4% solution of hydrochloric acid with water. Ensure that the acid is added to the water and not vice-versa.
2. Heat the solution to 120°F to promote the descaling process.
3. Immerse the bundle in the acid solution and allow the effervescent action to take place.
4. Remove the bundle from the bath once the effervescing has ceased and rinse in hot water.
5. Inspect for cleanliness and, if necessary, repeat the cleaning process.
6. Once the bundle is clean, neutralize by immersing the bundle in a boiling solution of soda. Use one pound soda crystals to five gallons water.
7. Final rinse bundle in hot fresh water.

2.8.5. Assembly

1. Lubricate the inside of the housing with a light coating of oil.

☞NOTE:

Use new O-rings and gaskets during assembly.

2. Lubricate the small O-ring and insert in the housing groove. This O-ring goes on the end of the housing that does not have a machined step.
3. Lubricate and install the larger O-ring in the groove at the opposite end of the housing.
4. Inspect the bundle assembly for any handling damage and ensure that the tube plate cups are not damaged.
5. Place the housing on a clean flat surface with the large end facing up.
6. Lubricate around the O.D. of the tube plate cups.
7. Insert the smaller end of the bundle assembly into the housing by hand while ensuring the marks made during removal are aligned.

☞NOTE:

It is important that original alignment is maintained to ensure that internal baffles on the bundle align with the oil ports on the housing.

8. Continue to press the bundle assembly as far as possible by hand, using care not to pinch or nick the O-rings.
9. Move the partially installed assembly to the arbor press. Support the housing with the large end up.
10. Place the wooden pressing plate on top of the cooler tubes of the bundle assembly.

⚠CAUTION

DO NOT use excessive force to press the bundle assembly. If installation does not go smoothly, remove the bundle, inspect, and reinstall.

11. Carefully press the bundle assembly into the housing until it seats against the machined groove.
12. Lubricate and install O-rings on the tube plate cups in the chamfers provided in the housing.
13. Install new gasket and end cap on the smaller end of the housing. Install bolts and washers and hand-tighten only at this time.
14. Install a new division rib and seal at the opposite (large) end of the bundle. Ensure that the division rib is properly oriented with respect to the coolant ports on the end cap. Press the division rib into the tubes of the bundle so that the tangs of the division rib engage the tubes.
15. Install end cap with coolant ports in same position as marked during removal.
16. Install bolts and washers and tighten in a two-stage criss-cross pattern. Final torque bolts to 20-22 ft-lbs. (27-30 Nm).
17. Torque bolts on the opposite end cap using the same procedure.
18. Reinstall the mounting brackets, if previously removed, in the same position and spacing as marked during removal. Torque U-bolt nuts to 10 ft-lbs. (14 Nm).

2.8.6. Installation

1. Align the oil cooler on its mounting bracket and install and tighten the mounting hardware.
2. Install the transmission oil lines and torque hose end swivel nuts 127 to 133 ft-lb. (172 to 180 Nm).

☞NOTE:

Hose and tube connections are designed with a slight interference fit. Lubricate tubes to aid hose installation.

3. Install the coolant hoses and tighten the hose clamps. Refer to 2.11. “Hose Clamp Torque Specifications” on page 29 in this section for torque specification.
4. Fill and deaerate the engine cooling system. Refer to 2.4.4. “Filling & Deaeration” on page 4 in this section for procedure.
5. Recheck coolant and transmission fluid levels and top up if necessary.

2.9. Surge Tank

2.9.1. Description

The engine cooling system surge tank is located in the engine compartment on the streetside of the vehicle, inboard from the radiator.

☞**NOTE:**

A separate vehicle heating system reservoir, filler cap, and Schrader valve are located adjacent to the engine cooling system surge tank. Refer to Section 10 of this manual for information on the heating system reservoir.

The engine cooling system surge tank includes the following components:

- ❒ Pressure Cap & Relief Valve
- ❒ Coolant Level Sensors
- ❒ Fluid Level Gauge
- ❒ Pressure Test Valve
- ❒ Pressure Fill Connector - located in the engine compartment.

The surge tank access door provides access to the filler cap, pressure relief valve, fluid level gauge, pressure test Schrader valve. The coolant sensors are accessible from the engine compartment. See “Fig. 6-6: Surge Tank Installation” on page 23.

2.9.2. Surge Tank Specification

Type.................... Welded steel construction

Size (approx.) .... 7.0" Dia. x 27.75" high

Capacity (approx.) ....3.9 gal.

Tank Pressure Rating ....
..............25 psi (172 kPa) with water test

Filler Cap with Relief Valve
.............pressure rating 18 psi (124 kPa)
..................operating range 16 to 20 psi
.... (97 to 124 kPa)

2.9.3. Operation

The surge tank provides a reservoir for the cooling system and allows for coolant expansion. The surge tank also removes air entrapped in the system using hose connections to locations where air may be entrapped. The coolant is routed to the coolant recovery tank when the pressure in the surge tank exceeds the relief valve pressure rating. The Schrader valve is used to check the cooling system pressure.

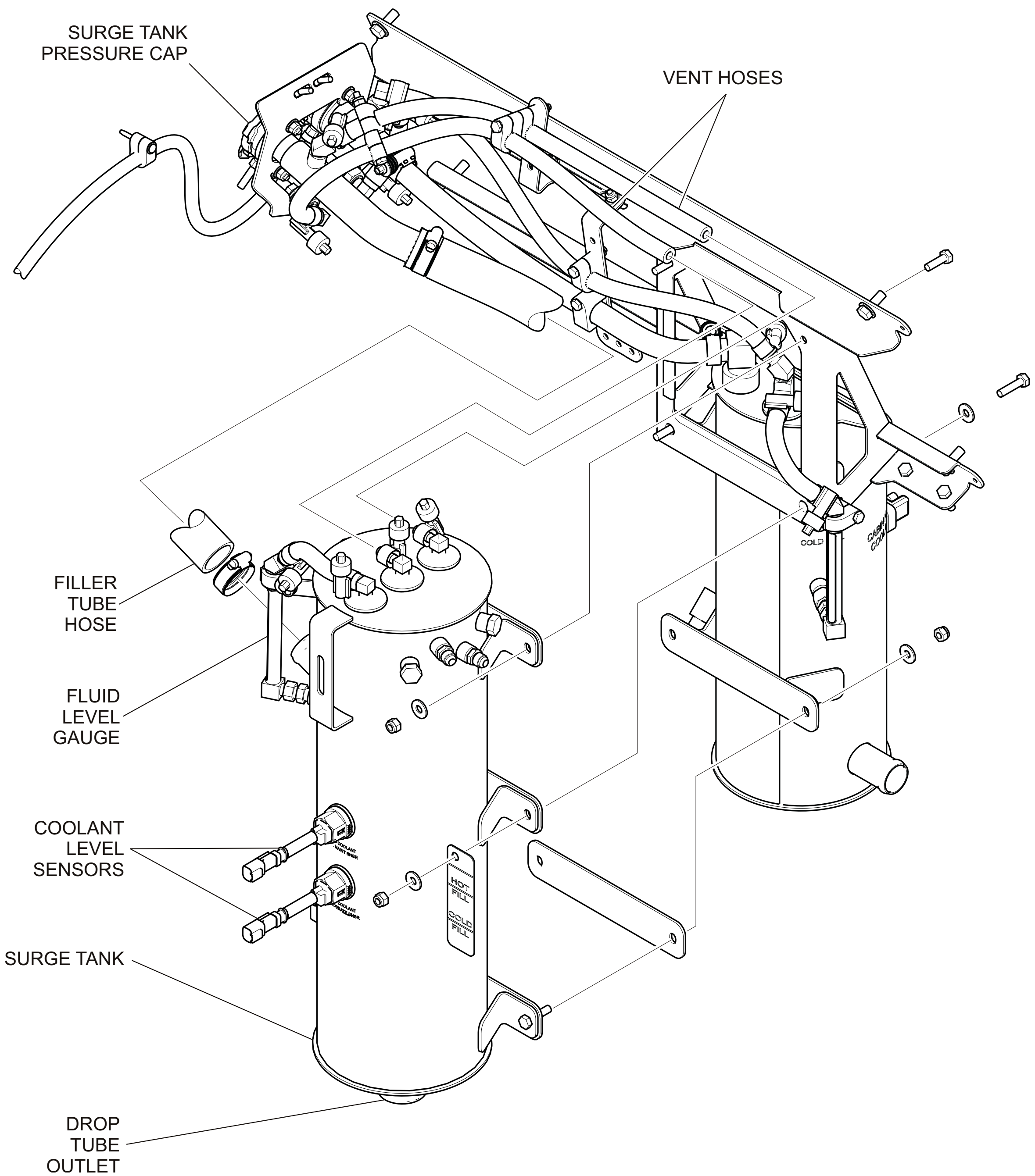


Fig. 6-6: Surge Tank Installation

2.9.3.1. Pressure Control Cap & Relief Valve

WARNING

Allow engine cooling system to cool, relieve cooling system pressure and open filler cap slowly. Keep away from hot coolant and surfaces to avoid injury.

The pressure control and a relief valve are integral with the cap. The pressure control maintains cooling system pressure preventing the loss of coolant. A vacuum valve in the filler cap opens to prevent the collapse of hoses when the cooling system cools and creates a vacuum. See “Fig. 6-7: Surge Tank & Heating Reservoir Pressure Caps” on page 24.

Clean and inspect the filler cap when the cooling system is serviced. Also test the operation of the control cap pressure relief valve and vacuum valve.

NOTE:

Refer to the Preventive Maintenance Section of this manual for pressure testing scheduled intervals and test procedure.

2.9.3.2. Coolant Level Sensors

Two coolant level sensors are used in the surge tank to detect the absence of fluid at the probe tip. One sensor is used to activate the Low Coolant indicator (red) on the instrument panel and the other is used to send a signal to the engine ECU and initiate an engine shutdown. The sensors are accessible from the engine compartment and are non-serviceable. No adjustments are required.

2.9.3.3. Fluid Level Gauge

A fluid level gauge is mounted on the side of the surge tank to provide a quick visual indication of the fluid level in the surge tank. The gauge is connected with an adapter at the bottom and a hose at the top.

2.9.3.4. Pressure Test Valve

The pressure test valve is used to check cooling system operating pressures and is also used to pressure test the system.

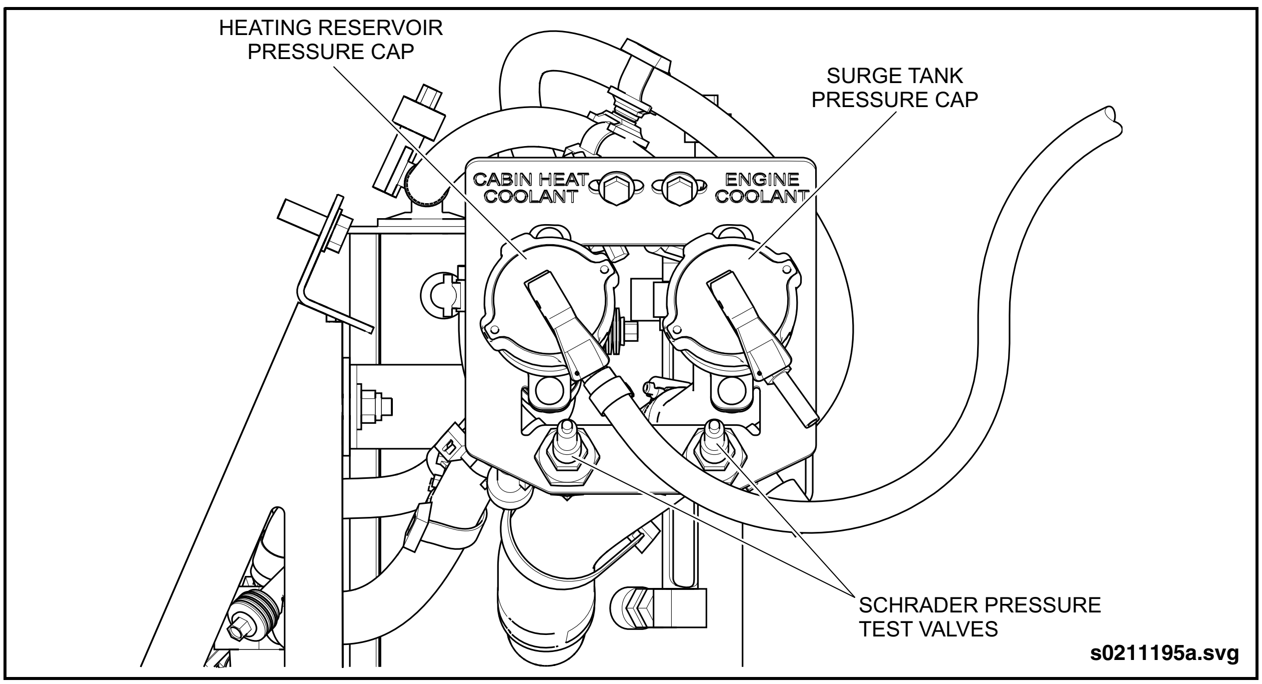


Fig. 6-7: Surge Tank & Heating Reservoir Pressure Caps

2.9.4. Removal

1. Relieve system pressure using the manual pressure relief valve on the filler cap. Remove the filler cap.
2. Locate the drain plug on the bottom of the surge tank and drain the coolant into a suitable container.
3. Loosen the clamp and disconnect the drop tube hose from the bottom of the surge tank.
4. Loosen the clamp and disconnect the fill hose at the surge tank spigot location.
5. Tag and disconnect the vent hoses from the surge tank.
6. Tag and disconnect the coolant sensor electrical connections.
7. Remove the fasteners securing the surge tank to the top, center, and bottom mounting brackets.
8. Remove the surge tank from the vehicle.
9. Remove coolant sensors, fittings, and fluid gauge as required. See “Fig. 6-8: Surge Tank Assembly” on page 26.
10. Clean the surge tank and inspect it for cracks or damage.

2.9.5. Installation

1. Assemble the surge tank with the coolant sensors, fluid gauge, and fittings as required. Torque coolant sensors to 15 ft-lb. (20 Nm).

☞**NOTE:**

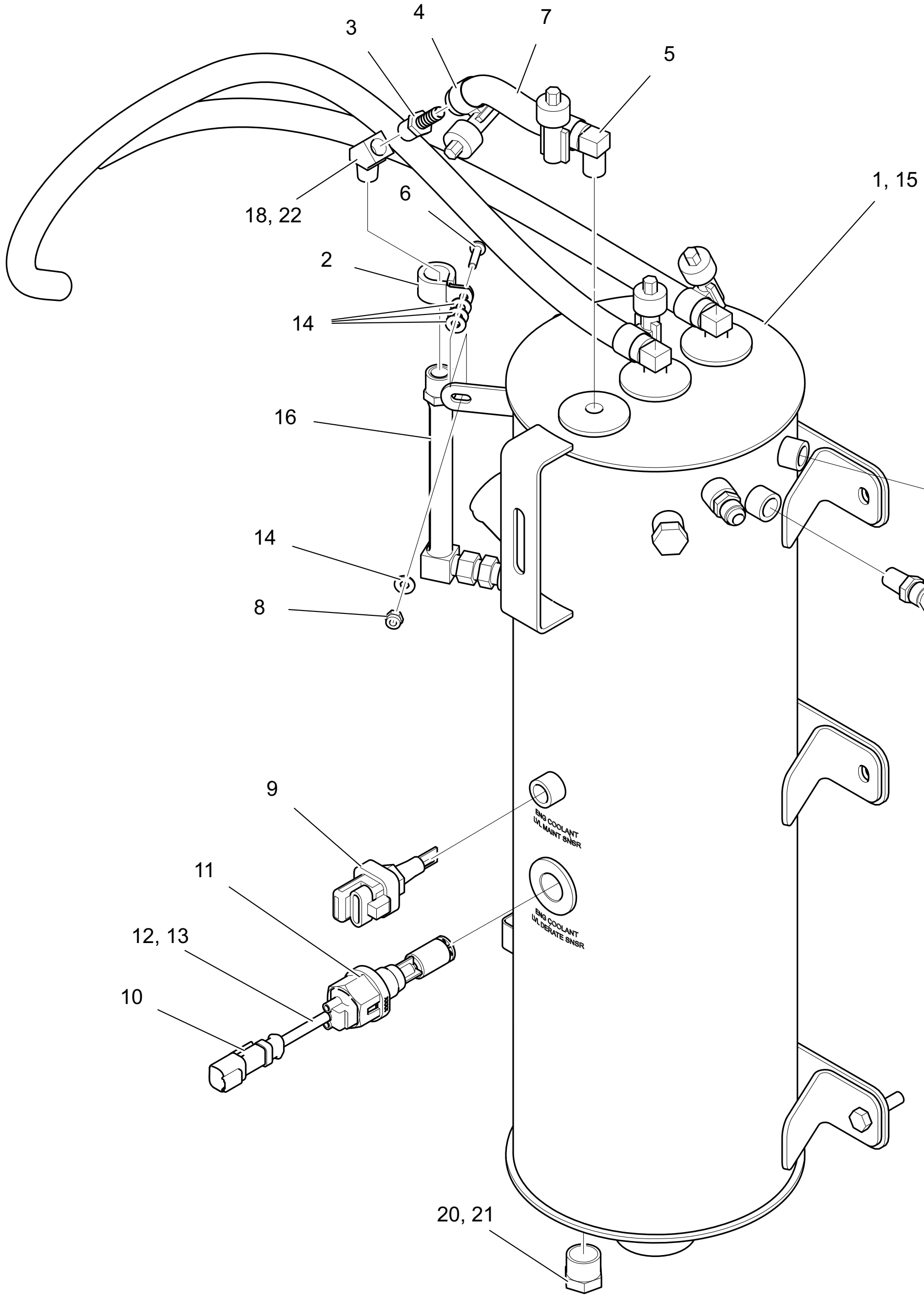
Upper and lower coolant sensors are interchangeable and sensor orientation is not important.

2. Align the surge tank integral brackets with the vehicle mounting brackets and install and tighten fasteners.

☞**NOTE:**

Hose and tube connections are designed with a slight interference fit. Lubricate tubes to aid hose installation.

3. Reconnect all hoses and vent lines and torque hose clamps to specification. Refer to 2.11. “Hose Clamp Torque Specifications” on page 29 in this section for torque specification.
4. Connect coolant sensor electrical connectors to vehicle wiring harness.
5. Apply Loctite 567 thread sealant to the drain plug and tighten two full turns past finger tight.
6. Add coolant through the filler cap location until the surge tank is full.
7. Reinstall the pressure cap.
8. Start the engine and check for leaks.
9. Top up coolant as necessary.



1. Surge Tank Assembly, (Incl. 2-10, 14-22)
2. Clamp, "P" .625" SST/HT
3. Fitting, Barbed 1/4" MPT x 3/8" I.D.
4. Clamp, Hose 0.56" Dia. - 1.06" Dia.
5. Elbow, 90° Barb Hose 1/4" NPT x 3/8" I.D.
6. Screw, PH Cross Recess SST #10 - 24 UNC x 3/4" Lg.
7. Hose, Silicone 9mm I.D. x 4' Lg.
8. Nut, Lock Nylon #10 SST
9. Sensor, Coolant Level Indicator
10. Sensor Assembly, Low Coolant Level Engine Shutdown (Incl. 11-13)
11. Sensor, Low Coolant Level
12. Loom, Convoluted High Temperature Split .40"
13. Tape, High Temperature Aluminum
14. Washer, Flat SST #10
15. Surge Tank, Welded
16. Gauge, Coolant Level
17. Plug, Hex 1/4" PT
18. Elbow, 45° 1/4" NPT x 1/4" FPT Brass
19. Adapter, 1/4" NPT x 3/8" JIC Brass
20. Loctite, 567 White
21. Plug, Hex Head 1/2" MPT
22. Never Seize

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Fig. 6-8: Surge Tank Assembly

2.10. Coolant Recovery Tank

2.10.1. Description

The coolant recovery tank is mounted in the engine compartment and is accessible from the engine access door. It is a non-pressurized translucent tank and is vented to the atmosphere through the fill cap. Markings are provided indicating COLD MIN, COLD MAX and HOT MAX for servicing.

2.10.2. Coolant Recovery Tank Specifications

Type .... Molded Translucent Plastic

Capacity .... 2.5 gal. (9.5 L)

Cap .... Top Vented, Nylon

2.10.3. Operation

The coolant recovery tank is connected to the surge tank's pressure control cap with a hose. As coolant in the surge tank heats up it expands, increasing the coolant system pressure. When the coolant system pressure exceeds the relief valve setting on the pressure control cap, the coolant is released to the coolant recovery tank. As the system cools and the coolant contracts a vacuum is formed in the surge tank, drawing the coolant from the recovery tank back into the surge tank.

2.10.4. Removal

⚠ WARNING

Allow engine cooling system to cool before servicing and relieve pressure in cooling system before servicing.

1. Operate the lever on the pressure cap to relieve cooling system pressure.
2. Locate the coolant recovery tank on the lower streetside corner of the engine compartment and remove the filler cap.
3. Place a container beneath the coolant recovery tank.
4. Loosen the hose clamp and disconnect the hose from the bottom of the coolant recovery tank and drain the coolant.
5. Remove the upper and lower fasteners that attach the tank cage to the tank mounting bracket. See “Fig. 6-9: Coolant Recovery Tank” on page 28.
6. Remove the coolant recovery tank from the mounting bracket.
7. Clean the coolant recovery tank and inspected it for damage.

2.10.5. Installation

1. Position the coolant recovery tank on the support bracket.

☞NOTE:

The tank has raised circular surfaces that must clear the circular openings in the tank cage. The cage should sit flat on the top of the tank without causing any deformation to the tank.

2. Align and install the tank cage over the tank. Apply Loctite 243 and tighten the upper and lower fasteners.
3. Connect the hose to the fitting on the bottom of the coolant recovery tank and tighten hose clamp.
4. Add coolant to the coolant recovery tank until fluid level is at the COLD MAX line.
5. Install coolant recovery tank fill cap.
6. Check pressure relief lever on surge tank pressure cap to ensure it is closed.

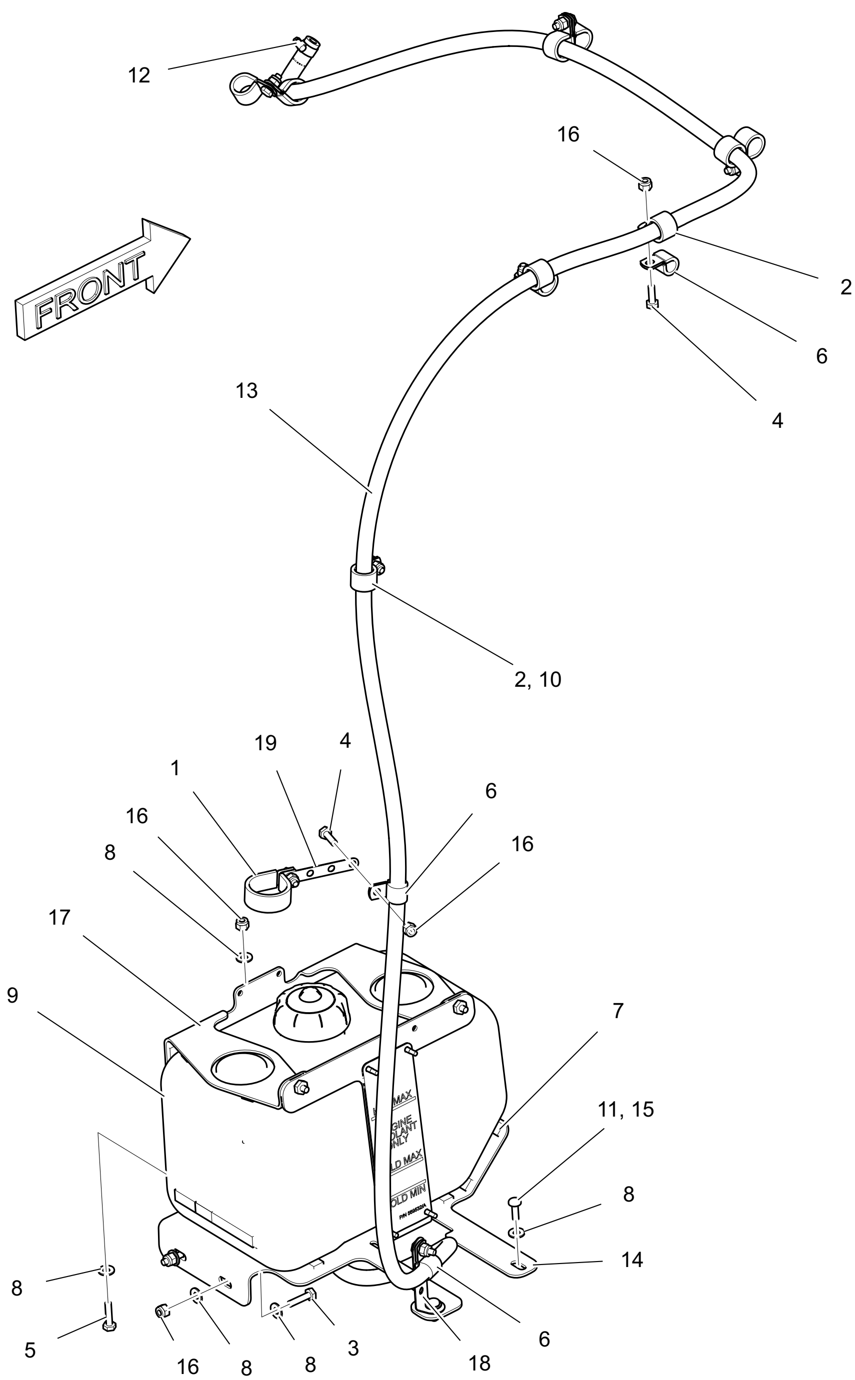


Fig. 6-9: Coolant Recovery Tank

1. Clamp, "P" 1.50" SST/HT
2. Clamp, "P" 3/4" SST/HT
3. Bolt, Hex SST 1/4" - 20 UNC x 1" Lg.
4. Bolt, Hex 1/4" - 20 UNC x 3/4" Lg.
5. Bolt, Hex 1/4" - 20 UNC x 1" Lg.
6. Clamp, "P" 1/2" SST/HT
7. Tape, Spacer Rubber
8. Washer, Flat 1/4"
9. Tank Assembly, Coolant Recovery
10. Loom, Thermal L-Wrap 1"
11. Loctite, 243 Blue
12. Clamp, Hose 5/16"
13. Hose, Silicone 5/16" I.D. Drain
14. Bracket, Coolant Recovery Tank Lower
15. Screw, PH Cross Recess SST 1/4" - 20 UNC x 3/4" Lg.
16. Nut, Lock Nylon 1/4" - 20 UNC
17. Bracket, Coolant Recovery Tank Cage
18. Bracket, Mounting 90° P-Clip
19. Plate, Mounting P-Clip

Coolant Recovery Tank (parts list)

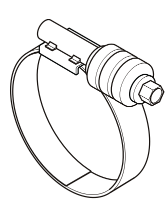
2.11. Hose Clamp Torque Specifications

☞**NOTE:**

Hose and tube connections are designed with a slight interference fit. Lubricate tubes to aid hose installation.

The following torque chart provides a listing of the various hose clamps used in the cooling system and the applicable torque for the specific clamp. The size of clamp (clamp width) will determine the torque value.

IDEAL - TRIDON HOSE CLAMP TORQUE SPECIFICATIONS

Item	Clamp	Description	Width	Torque (in-lb.)
1		Ideal Smartseal Stainless Steel Clamp	0.625	125 in-lb.
2		Ideal Waveseal Stainless Steel Clamp	0.562	80 in-lb.
3		Ideal Flexgear Stainless Steel Clamp	0.562	50 in-lb.

NOTES:
1. Torque Smartseal and Waveseal clamps at 75 RPM or less.
2. Torque Flexgear clamps at 250 RPM or less.
3. Retorque Smartseal and Waveseal clamps after 30 minutes.

3. COOLING SYSTEM SPECIAL TOOLS

3.1. Cooling System Special Tools Chart

The following special tool is referenced in the cooling servicing text in this section.

Refer to your New Flyer Parts Manual for purchase part numbers. See “Fig. 6-10: Special Tools” on page 30.

SPECIAL TOOLS	DESCRIPTION
1	Cooling System Pressure Tester

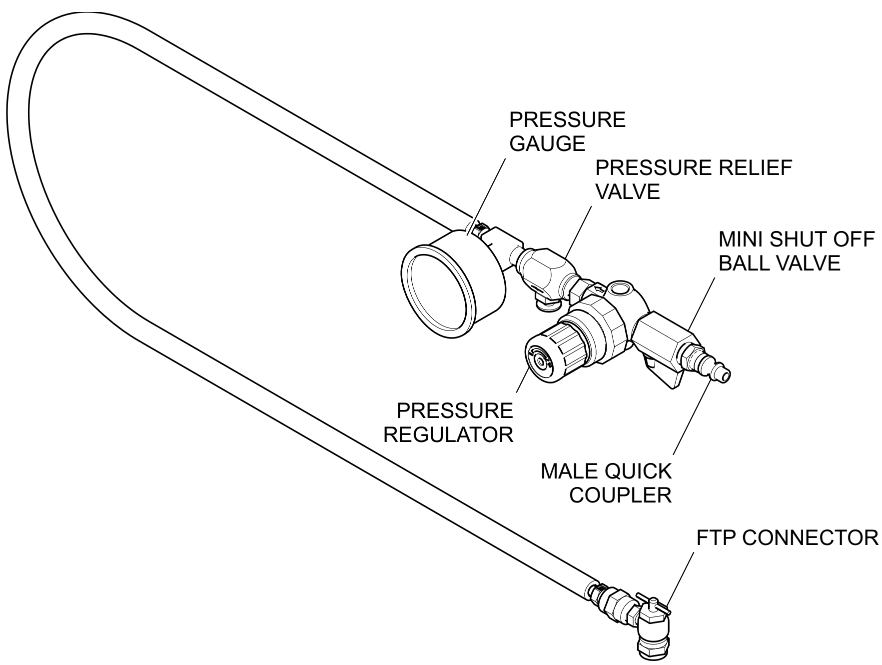


Fig. 6-10: Special Tools

4. VENDOR SERVICE INFORMATION

The following supplier manuals contain additional reference information.

4.1. Engineered Machined Products (EMP) Manual

- ❒ MH4 Cooling System Service Manual
- ❒ MH4 Cooling System Troubleshooting Manual

Fuel System

1. SAFETY

1.1. CNG Safety

CAUTION

Exercise caution when working around CNG installations located on the roof of vehicles. Wear appropriate safety harnesses and non-slip safety footwear.

1.2. Special CNG Safety Signs

All required CNG safety signs must be installed, highly visible and easily read in the predominant languages of the local area, in compliance with U.S. Federal State and local guidelines.

1.3. CNG Safety Procedures

Natural gas has a higher ignition temperature than gasoline making it safer to use. A heat source of 495°F (257°C) can ignite gasoline. Natural gas requires a heat source of 1200°F (649°C) for ignition.

Although natural gas has a higher ignition temperature point than gasoline or diesel fuel it is still absolutely necessary to exercise extreme caution when working near or with a Compressed Natural Gas (CNG) fuel system.

For safety reasons, an odorant called Mercaptan is added so that any gas leaks can be easily detected. This has a very distinctive and disagreeable odor. Gas concentrations as small as 0.5% (too small to ignite) are identified by this unpleasant odor.

WARNING

Occasional handling or breathing of this fuel is not hazardous to your health. However, heavy concentrations displacing over 21% oxygen air content can cause drowsiness and eventual asphyxiation by displacing oxygen in the lungs.

1.4. Safety Procedures

WARNING

DO NOT perform any maintenance on roof-mounted components unless equipment is in place to prevent fall hazards. Ensure maintenance personnel use approved lift platforms or scaffolding and wear approved safety harness when working on the roof of the vehicle.

Refer to “Maintenance Safety Procedures” in the General Information Section of this manual for general and system-specific safety procedures.

1.5. Hoisting/Lifting & Jacking Safety

Refer to the General Information Section of this manual for recommended types of hoists, lifting equipment, and jackstands.

DANGER

Certain procedures may require the vehicle be operated in an elevated position in order to accurately troubleshoot and diagnose a problem. If the vehicle must be running while elevated, become familiar with the repair area prior to starting the engine. Take special care in noting areas which will become hot, electrically energized, and areas where moving and rotating components are located. Limit the work in these areas as personal and equipment safety is at risk.

WARNING

ALWAYS ensure that the vehicle is appropriately hoisted and blocked for procedures which require elevating the vehicle. Be aware of the limitations of the blocking equipment, and always ensure that the jarring and shaking created by component removal and installation procedures does not overload the blocks, or cause the vehicle to become unstable.

1.6. Working Safety

WARNING

- ❐ Natural gas is stored in special high pressure storage cylinders at a compressed pressure of 3,600 psi (24,800 kPa). Special training and government certification is required to install, repair, remove or service any component of a CNG fuel system. This would include the main storage and fueling facility or the vehicle on board fuel system.
- ❐ Have positive pressure, self-contained breathing apparatus available for emergency use. Make sure ALL personnel working with the CNG fuel system are trained to use this emergency respiratory protection equipment.
- ❐ Have fire extinguishers placed strategically throughout the CNG servicing and refueling area. The extinguishers must be rated as the class and type capable of extinguishing a natural gas fueled fire such as: ABC, CO_2 charged extinguishers.
- ❐ Do not use a match, cigarette lighter or other open flame or ignition source to search for a suspected high pressure natural gas leak.
- ❐ Use certified leak detection equipment, such as the Snap-On ACT 8800® combustible gas detector or a certified industrial grade solution such as SNOOP® to detect leaks.
- ❐ Trouble lights, flashlights or emergency lantern-type lights must comply with Class 1, D type coding for use in leak detection or any other work on or around a CNG storage facility or vehicle fuel system. Only lighting or electrical equipment complying with this coding can be used within close proximity of CNG storage/dispensing equipment and the vehicle fuel system.
- ❐ Follow the same safety procedures applicable to other hydrocarbon vapor producing fuels such as gasoline or diesel fuel. Any potential source of ignition such as smoking, lighting matches or a cigarette lighter or any excessive heat producing process must be kept clear of the vehicle fuel system and the CNG storage and handling area.
- ❐ Welding, flame cutting, torching or any process or work producing sparks or hot particles is not to be done on, around or within the immediate area of CNG storage facilities or the vehicle CNG system.
- ❐ Work on or around piping, tubing or components of a CNG system requiring open flame, excessive heat or producing sparks can only be done if the parts and components have been thoroughly purged of all traces of natural gas and have been disconnected from the fuel cylinders.
- ❐ CNG lines installed in this vehicle are marked with yellow tape for ease of identification and safety of service personnel.
- ❐ Service personnel should be familiar with National Fire Protection Association (NFPA) standard 52 regarding CNG fuel systems.

1.7. Work Area Safety

WARNING

- ❒ **Areas designated for CNG refueling and system maintenance must have the boundaries clearly marked with fences, barriers and impact barrier posts installed according to U.S. Federal State and local regulations.**
- ❒ **If the CNG storage tank is enclosed in a building, adequate ventilation and pressure relief venting must be in place in compliance with all U.S. Federal State, and local regulations in force regarding storage and dispensing of Compressed Natural Gas (CNG).**
- ❒ **Indoor locations must be vented using air supply inlets and outlets to provide uniform air movement. Air inlets must be located on exterior walls near floor level. Air outlets must be located at a high point of the enclosed area in the exterior walls or roof.**
- ❒ **The ventilation system must be running continuously or activated by a continuous monitoring natural gas detection system. This monitoring system will automatically start up the ventilation system if a gas concentration of no more than 20% of the lower flammable limit is detected. The fueling system must automatically shut down if the ventilation system fails.**
- ❒ **The storage tank pressure relief valve must be channeled to vent gas blow-by outdoors and then upward to atmosphere. Blow-by gas must be safely directed away from buildings, equipment or public areas such as sidewalks.**
- ❒ **Have fire extinguishers placed strategically throughout the CNG servicing and refueling area. The extinguishers must be rated as the class and type capable of extinguishing a natural gas fueled fire such as: ABC, CO_2 charged extinguishers.**
- ❒ **Access doors to emergency shut-off valves must never be locked. This is to allow access during times of emergencies.**

2. GLOSSARY

2.1. Terms & Acronyms

The purpose of this glossary is to familiarize you with some of the terms and abbreviations (Acronyms) general and specific to the systems and components used in this CNG fuel system. This information is not to be considered a comprehensive catalog of all acronyms and terms used in this section. It is presented as a general reference only.

AGA – American Gas Association

ANSI – American National Standards Institute

ASTM – American Society for Testing & Material

BAP – Barometric Absolute Pressure

CGA – Compressed Gas Association or Canadian Gas Association

CNG – Compressed Natural Gas

COALESCING – High & Low Pressure Natural Gas Filter

DOT – Department of Transport

DVM – Digital Volt Meter

ECU – Engine Control Unit

FAP – Fuel Absolute Pressure

FET – Field Effect Transistor

FRT – Fuel Regulated Temperature

FSS – Fire Suppression System

LED – Light Emitting Diode

LEL – Lower Explosive Limit

MAP – Manifold Absolute Pressure

MDS – Methane Detection System

MERCAPTAN – Natural Gas Odorant

NFPA – National Fire Protection Association

NGV – Natural Gas Vehicle

OTS – Oil Temperature Sensor

OV – Operating Voltage

PCU – Power Conditioning Unit

POT – Potentiometer

PPM – Parts Per Million

PRD – Pressure Relief Device

PSI – Pounds Per Square Inch

PSV – Pulse Width Modulated Solenoid Valve

ROM – Read Only Memory

SAE – Society of Automotive Engineers

SCF – Standard Cubic Feet

SRAM – Static Random Access Memory

VIN – Vehicle Identification Number

3. COMPRESSED NATURAL GAS FUEL SYSTEM (CNG)

3.1. Description

The Cummins natural gas engine utilizes a closed loop fuel metering system. Engine fuel components include a low pressure regulator, fuel control valve, gas flow sensor, fuel shut-off valve, fuel mixer, throttle plate, ignition control module and temperature, pressure and speed sensors. An oxygen reference sensor is mounted in the turbocharger exhaust outlet. The engine Electronic Control Module (ECM) uses the oxygen reference sensor voltage output to regulate the fuel mixture. Refer to Section 4 of this manual for a more complete description of the engine.

3.2. CNG as a Fuel

Natural gas is a flammable, colorless, tasteless, and non-toxic light gas weighing approximately one third less than air. It rises and rapidly diffuses in air when released to the atmosphere.

Asphyxiation can occur if natural gas displaces the normal 21% oxygen air content in a confined area lacking adequate ventilation. For safety, natural gas is odorized to be detected at concentration of 0.5%, which is well below the level of causing drowsiness or supporting combustion.

Natural gas is a simple hydrocarbon and is commonly called Methane. This is the largest component of natural gas, accounting for about 95% of the total volume. Natural gas (Methane) is similar in composition to gasoline and diesel fuels, but is richer in hydrogen. Natural gas is extremely energy-efficient.

3.3. Fuel Quality Required

3.3.1. Fuel Composition

The characteristics specified in the following chart identify the minimum quality level recommended by Cummins for use in NGF (Natural Gas Fueled) engines.

⚠ CAUTION

Using fuel not meeting Cummins requirements may result in poor performance and possibly non-warrantable engine damage.

Refer to SAE J1616 “Compressed Natural Gas Vehicle Fuel Recommended Practise” for additional information.

3.3.2. Fuel Composition Specifications

FUEL COMPOSITION SPECIFICATIONS		
PROPERY	**LIMIT**	**ASTN Test Method**
Hydrocarbon	**Mole Percent**	**D 1945**
Methane	90% Min.	
Ethane	4% Max.	
Propane	1.7% Max.	
CO_2 + N2	3% Max.	
C4 and Higher	0.7% Max.	
Other Gaseous Species	**Mole Percent**	
Hydrogen	0.1% Max.	D 2650
Carbon Dioxide	3% Max.	D 1945
Carbon Monoxide	0.1% Max.	D 1945
Oxygen	0.5% Max.	D 1945
Nitrogen	7% Max.	D 2504
Other Species		
Methanol	0% Mass	No Test Method - Footnote 1
Sulfur, Total	10 ppm Mass	
Performance Related Properties		
Motor Octane Number	115 Min.	D 2623
Wobbe Number	1300-1377 BTU/ft^3	D 3588
Contaminants	Footnote 2	
Pressure Water Dew Point Temperature Max.	Footnote 3	D 1142
Pressure Hydrocarbon Dew Point Temperature Max.	Below which will form 1% condensate	D 1945
Odorant	Footnote 4	

Footnote to the table:

1. Test Method is provided in Title CCR Section 94112
2. The compressed natural gas shall not contain dust, sand, dirt, gums, oils or other substances in an amount sufficient to be injurious to the fuel station equipment or the vehicle being fueled.
3. The dew point at vehicle fuel storage container pressure shall be at least 10°F below the 99.0% winter design temperature listed in Chapter 24, Table 1 of “Climate Conditions for the United States, in American Society of Heating, Refrigerating and Air Conditioning Engineer’s (ASHRAE) Handbook, 1989 Fundamentals volume”. Testing for vapor shall be in accordance with ASTMD 1142, utilizing the Bureau of Mines apparatus.
4. The natural gas at ambient conditions must have a distinctive odor potent enough for its presence to be detected down to a concentration in air of 1% by volume.

3.4. Major CNG System Components

☞**NOTE:**

Refer to the CNG Fuel System Color Layout when reviewing this information.

3.4.1. Description

The natural gas fuel system includes the following components:

- ❒ Six rooftop mounted fuel tanks which are housed in two tank rack modules.
- ❒ Tank mounted high pressure solenoid valves with manual shutoff valve and pressure relief device (PRD).
- ❒ Main fuel line.
- ❒ CNG fill box with two Sherex fill receptacles and a high pressure gauge.
- ❒ A low fuel pressure switch.
- ❒ A primary coalescing high pressure filter.
- ❒ An ITT regulator.
- ❒ A secondary engine-mounted coalescing low pressure filter and low pressure CNG gauge.
- ❒ A closed loop controlled fuel regulating and metering system.
- ❒ Associated fittings and hardware (tubing, hoses, connections).
- ❒ A purge line shut-off valve below fill box.
- ❒ Pressure Relief Devices (PRD) with vent tubes.
- ❒ CNG ground stud.

3.5. CNG Fill System

3.5.1. Description

The natural gas fuel system delivers the needed CNG fuel to the engine in the following way:

1. High pressure solenoid valves control fuel flow from the tanks. The tank solenoids are energized open as long as the start button is depressed or engine speed is over 400 RPM. CNG at high pressure flows out of each cylinder and merges with a main fuel supply line.
2. CNG travels to the back of the vehicle through the main fuel supply line and then down to a main shut-off valve.
3. CNG flows through the main shut-off valve and a fill manifold with a high pressure gauge and a refueling receptacle.
4. CNG flows through a primary high pressure coalescing filter.
5. CNG enters an ITT regulator. The regulator reduces the natural gas from 3,600 psi (24,800 kPa) to 94 to 120 psi (648 to 827 kPa).
6. CNG flows from the regulator outlet port, through low pressure gauge, and a secondary filter to the closed loop fuel metering system.
7. CNG is now reduced to a constant low pressure slightly above the turbocharger (boost) pressure and flows to the engine gas mixer. The gas mixer processes the air and natural gas into a homogeneous mixture before sending it to the engine.

3.6. Component Description & Operation

3.6.1. Fuel Cylinders

See "Fig. 7-1: CNG Tank Assembly" on page 8.

Max. Operating Pressure .... 3,600 psi (24,800 kPa)

Volume .... 3,300 SCF (93.3 m³)

Construction .... All-Carbon Fiber

Length .... 119.5 in (3.0 m)

Diameter.............................. 15.8 in (0.4 m)

Weight .... 162 lbs. (73.5 kg)

Service Life.................................. 20 years

3.6.1.1. Codes and Compliances

USA .... NFPA 52

Canada.............................. CAN/CSA B109

North America .... ANSI/AGA NGV 3.1/CGA 12.3 and NGV 12.3-M95

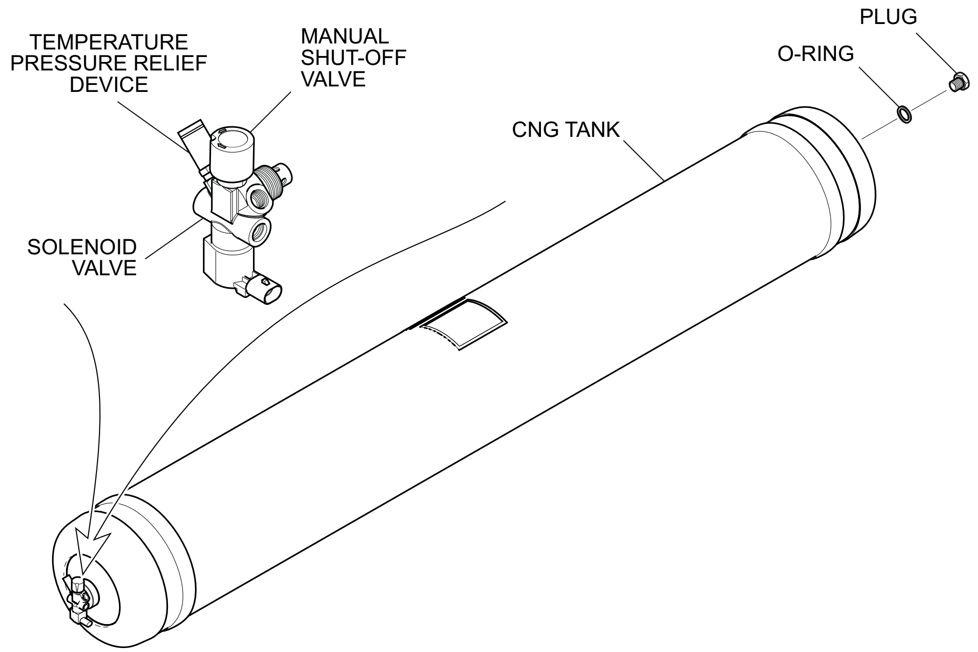
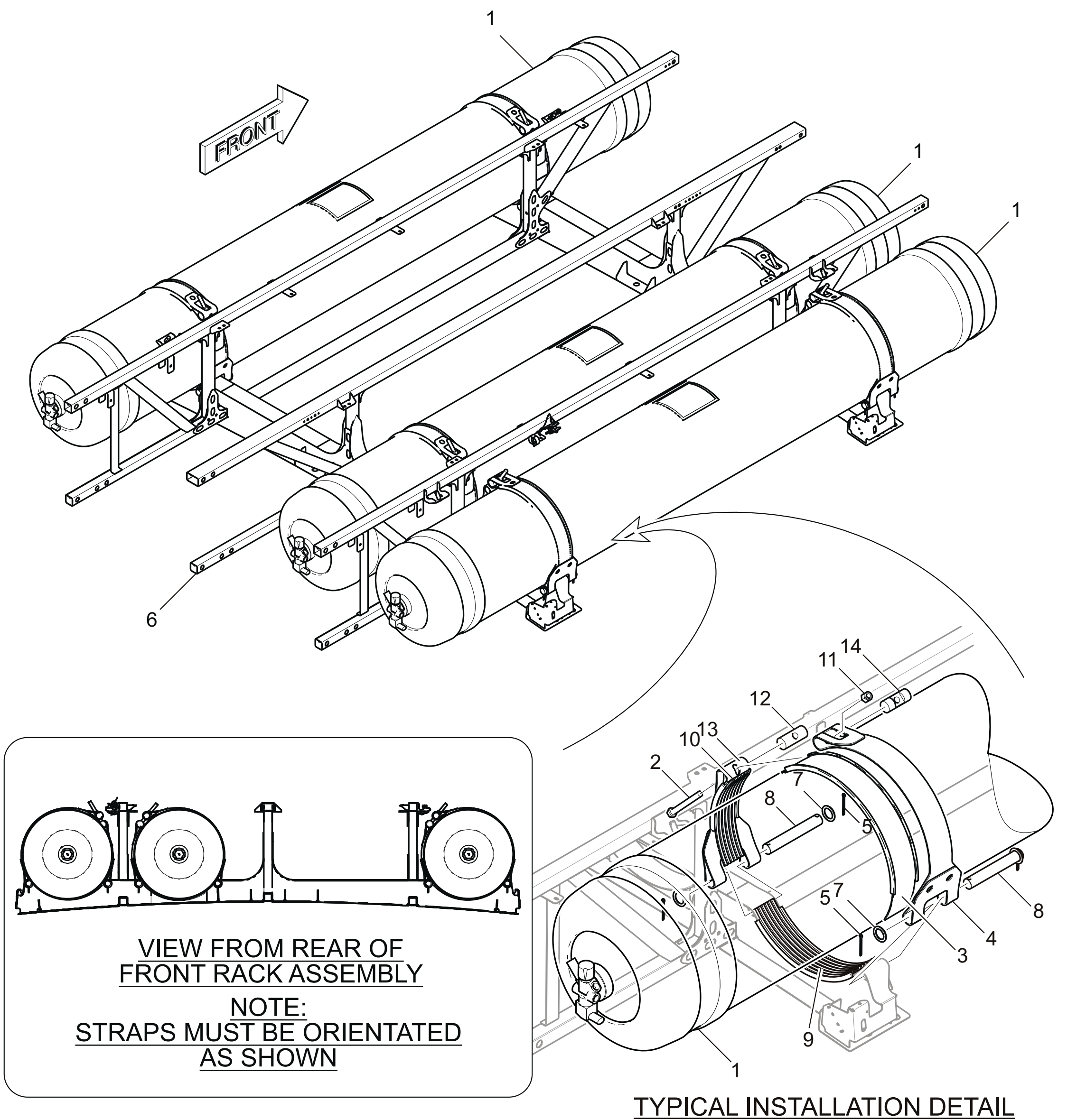


Fig. 7-1: CNG Tank Assembly

3.6.2. Fuel Cylinder Grouping

The fuel tanks are mounted lengthwise in a tank bay on the vehicle roof in two groups. Each tank has a normally closed high pressure solenoid valve controlled by the vehicle's Multiplexing System. Each solenoid valve has an integral check valve to permit fueling of the tank. The tanks are connected by fuel lines and by vent lines containing thermally-actuated Pressure Relief Devices (PRDs). The vent lines relieve system pressure during emergency situations. See "Fig. 7-2: Fuel Tank Installation - Front CNG" on page 9. See "Fig. 7-3: Fuel Tank Installation - Rear CNG" on page 10.



1. Tank Assembly, CNG
2. Bolt, HHCS Tap
3. Pad, Rubber Long Strap
4. Strap, Long
5. Pin, Cotter
6. Rack Assembly, CNG Module
7. Washer, Flat
8. Pin, Hinge
9. Pad, Rubber Saddle
10. Pad, Rubber Short Strap
11. Nut, Lock
12. Pin, Rocker with Slot
13. Strap, Short
14. Pin, Rocker

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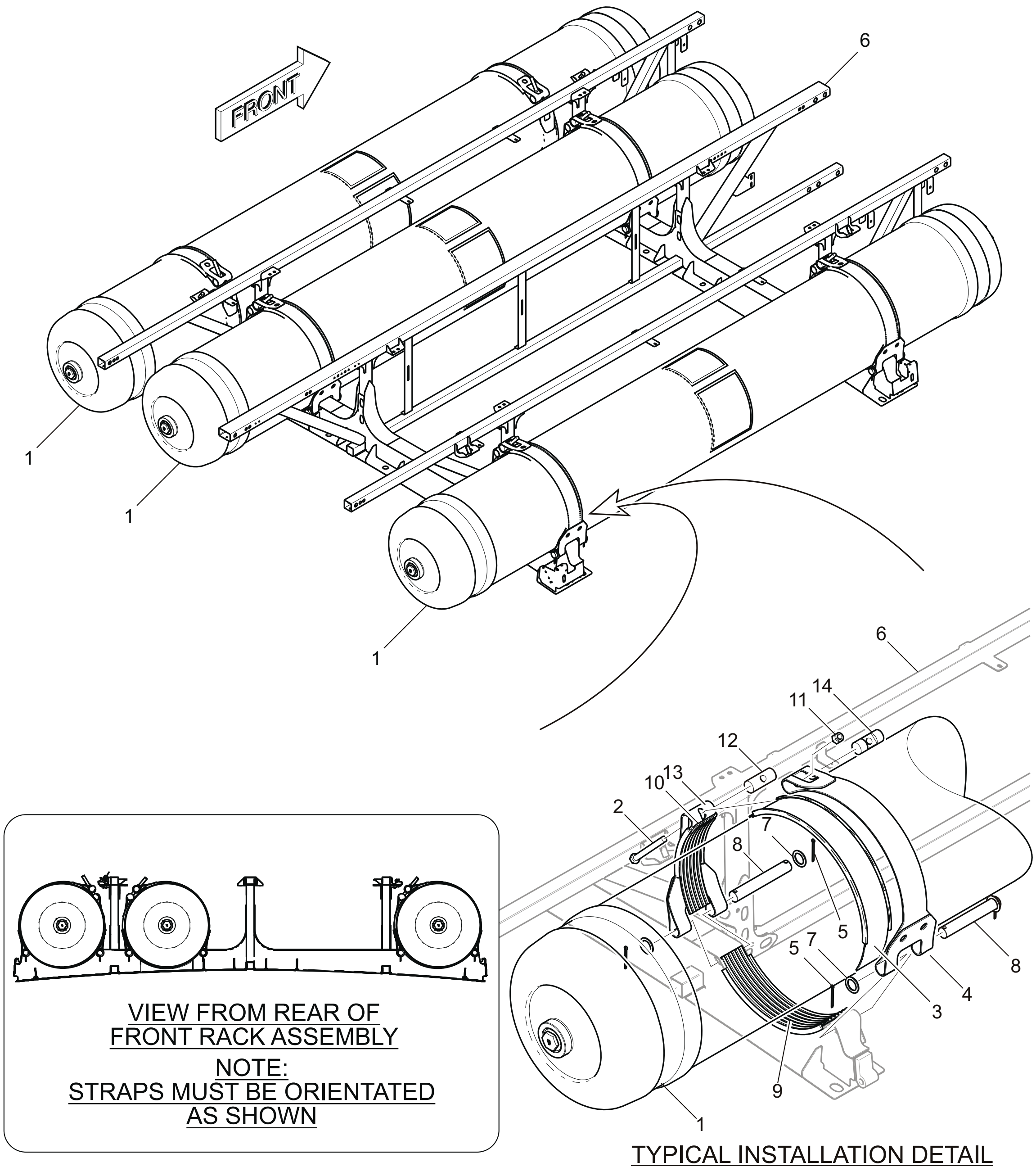
Fig. 7-2: Fuel Tank Installation - Front CNG



1. Tank Assembly, CNG
2. Bolt, HHCS Tap
3. Pad, Rubber Long Strap
4. Strap, Long
5. Pin, Cotter
6. Rack Assembly, CNG Module
7. Washer, Flat
8. Pin, Hinge
9. Pad, Rubber Saddle
10. Pad, Rubber Short Strap
11. Nut, Lock
12. Pin, Rocker with Slot
13. Strap, Short
14. Pin, Rocker

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Fig. 7-3: Fuel Tank Installation - Rear CNG

3.6.3. Pressure Relief Device (PRD)

Each Compressed Natural Gas (CNG) Fuel tank solenoid valve contains an integral thermally activated Pressure Relief Device (PRD) and is also connected to a remotely mounted temperature activated PRD located further downstream of the stainless steel vent lines. Both PRDs are designed to activate when exposed to a temperature of 230 +/- 9 °F (110 +/- 5°C), venting the CNG fuel away from the connected fuel tank(s) through the vent lines.

WARNING

Pressure relief devices are sensitive to temperature. DO NOT steam clean the pressure relief devices. DO NOT expose them to temperatures which exceed 180°F (82°C).

3.6.4. Solenoid Valves

A high pressure solenoid valve with integral PRD is installed on the outlet of each fuel tank. All solenoid valves are energized (open) when the Master Run switch is in the DAY-RUN or NIGHT-RUN position, the fuel door is closed, the fire detection system status is normal, and the engine ECU gas solenoid status is valid.

The solenoid valves are de-energized (closed) during refueling. This directs the incoming fuel through the integral check valves into the fuel cylinders.

These solenoid valves will de-energize and shut off fuel for any of the following reasons:

1. Proximity switch on fuel filler door is open.
2. The fuel tank solenoid valves are also controlled by a Fire Warning and Suppression System. The solenoid valves are energized (open) allowing fuel flow only if suppression systems are activated (ON), the sensor contact switches are open (not sending a signal) and the engine ignition is on. If any one of these conditions does not exist or is interrupted, the CNG fuel delivery system will shut down and the engine will stop. Each of these solenoid valves is equipped with a manual shut-off dial and interconnected through a single manifold block. Turn the dial in the clockwise direction to close the valve, and in the counterclockwise direction to open the valve. These solenoid valves also are equipped with an integrated Pressure Relief Device (PRD) set to vent at 110°C.

☞**NOTE:**

Refer to 4.9. “CNG High Pressure Solenoid Valve” on page 44 *in this section for further information.*

3.6.5. Quarter-Turn Shut-Off Valves

The quarter-turn shut-off valves are mechanical ball valves with a handle. The main shut-off valve is located inside the CNG fill box and is installed between the main supply line and the fill block. This valve controls fuel supply to the engine and is in the open (normal) position when the handle is in the upward vertical position. The purge line shut-off valve is located beneath the CNG fill box and is installed between the fill block and the purge line. This valve controls fuel venting to a CNG recovery system and is in the open (venting) position when the handle is in the downward vertical position.

CAUTION

Although the shut-off valve is closed, the fuel tanks, distribution lines, the vent lines, and the main supply line above the shut-off valve are still under high pressure.

3.7. CNG Fill Box

3.7.1. Description

The fill box provides the main routing for high pressure CNG flowing to and from the quarter-turn shut-off valve. The fill box houses the two refueling receptacles, the high pressure gauge, the low pressure switch, the primary filter, the ITT regulator and the low pressure gauge. See “Fig. 7-4: CNG Fill Box Assembly” on page 12.

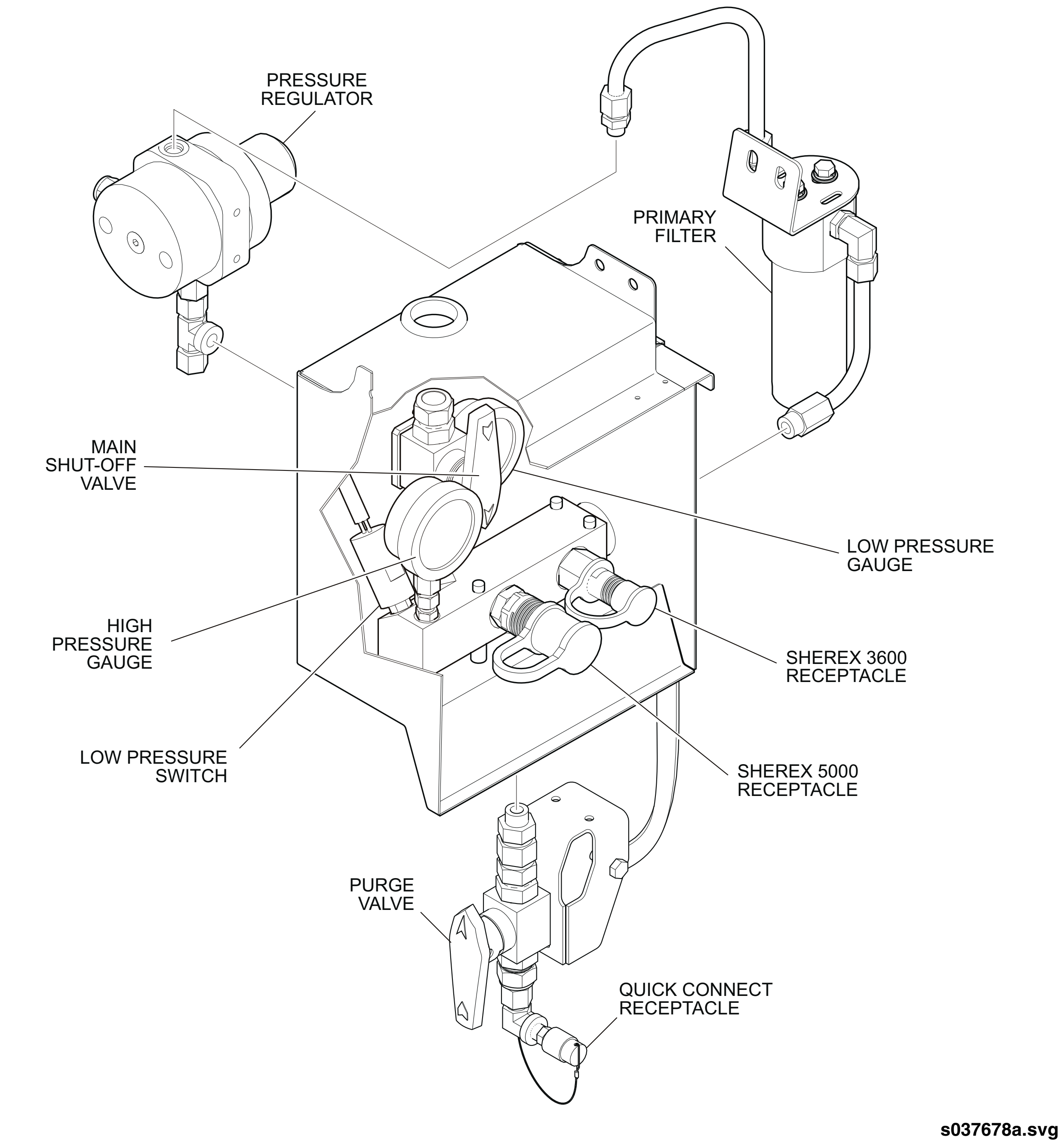

Fig. 7-4: CNG Fill Box Assembly

3.7.2. High Pressure Gauge

A high pressure gauge is installed in the fuel fill box. The gauge dial is calibrated from 0 to 6,000 psi (0 to 41,368 kPa). The normal reading on this gauge should be 200 to 3,600 psi (1,375 to 24,800 kPa) at 70°F (21°C). This will depend on whether the tanks are almost empty (lower reading) or completely or almost full (higher reading).

3.7.3. Refueling Receptacles

Two Sherex receptacles are mounted on the fill box. Both are rated to 3,600 psi (24,800 kPa).

☞**NOTE:**

The fill box contains an interlock proximity sensor to prevent the vehicle from starting during refueling. When the fill box door is open, the contact of the interlock proximity sensor is open. The engine ignition is disabled and the high-pressure solenoid valve shuts off to prevent fuel flow to the gas mixer.

☞**NOTE:**

The Door Master switch only overrides the door and throttle interlocks. It does not override ignition inhibit that is activated when the fill box door is open and the proximity sensor is open. You cannot override this system to start the engine or keep it running if the door is open.

3.7.4. ITT Regulator

The ITT regulator is a single-stage reduction CNG regulator which consists of a cast body equipped with a 1/4" NPT pressure relief outlet, two 3/8 NPT coolant outlets, a 9/16 - 18 SAE J1926 gas inlet and a 3/4 - 16 SAE J1926 gas outlet. Natural gas enters the inlet port at 3,600 psi and is regulated to an outlet flow of 94 to 120 psi. The pressure relief valve operates at a pressure of 270 ± 60 psi.

3.7.5. Pressure Regulator Temperature Control

Engine coolant is routed through the regulator from the engine to radiator coolant return line. This keeps the regulator at a high enough temperature to prevent the regulating mechanism from freezing and stopping fuel flow.

The gas rapidly expands when released into the fuel system at the regulators, resulting in a rapid temperature drop. This causes any moisture within the gas to freeze at the orifice point or surrounding area in the high pressure regulators. The coolant must be mixed for a temperature of -35°F (-37°C).

3.7.6. Low Pressure Gauge

The low pressure gauge is located downstream of the Regulator. The gauge dial is calibrated from 0 to 200 psi (0 to 1375 kPa). The normal reading on this gauge should be 94 to 120 psi (648 to 827 kPa).

3.7.7. Primary High Pressure Filter

The primary high pressure filter is located just upstream of the fuel regulator. The filter assembly is bracket-mounted to the back side of the fill box.

3.7.8. Low Fuel Pressure Switch

The Low Fuel Pressure switch is located on the fill manifold and senses tank pressure. The switch will cause the Low Fuel indicator on the instrument panel to illuminate when fuel pressure drops to approximately 500 psi.

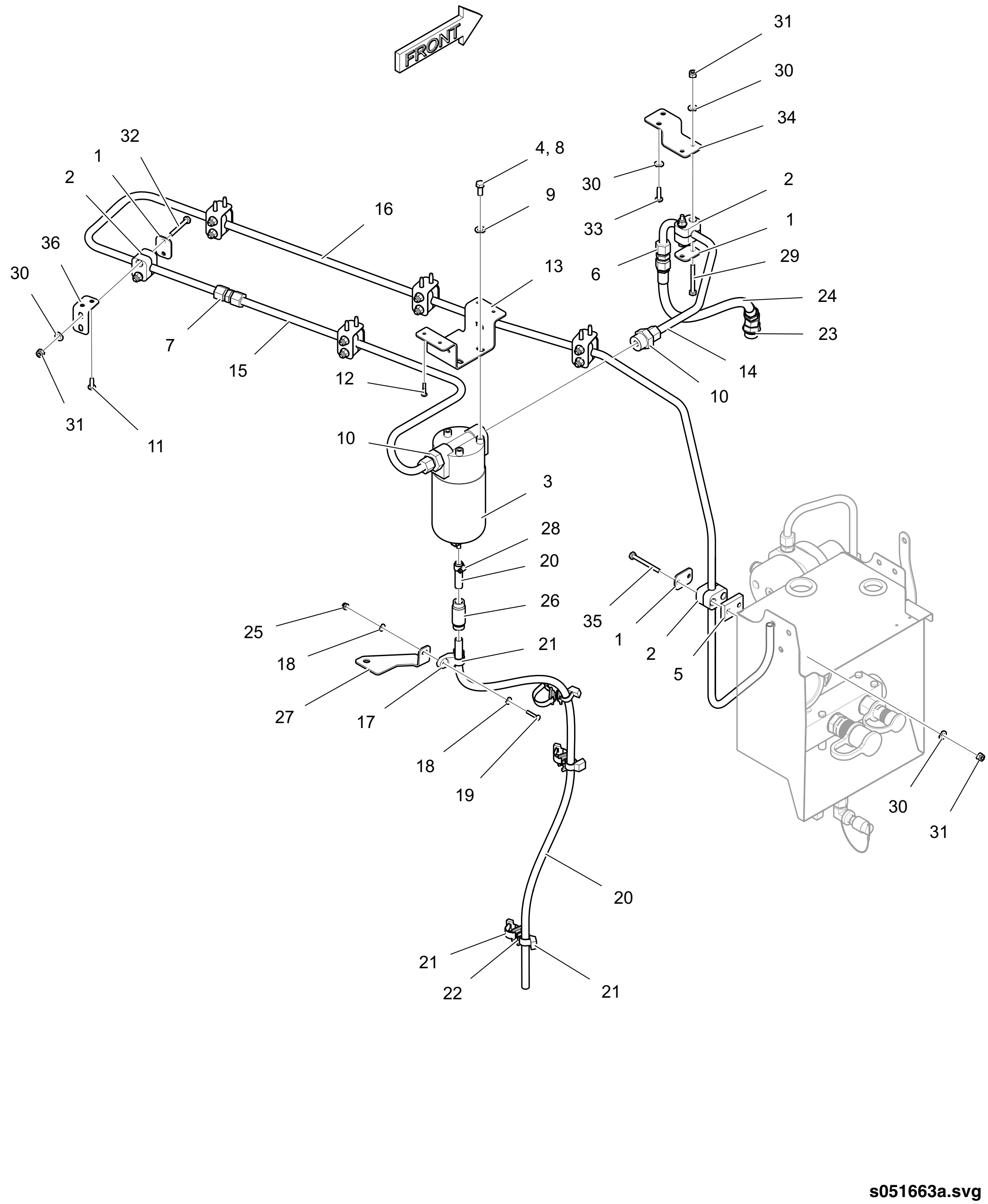

Fig. 7-5: Fuel Line Installation

1. Plate, Cover 1/2" Tube
2. Clamp, Single 1/2" Tube
3. Filter Assembly, Secondary CNG
4. Loctite, 243 Blue
5. Spacer, CNG Fuel Line
6. Connector, 1/2" x 1/2" Tube
7. Union, 1/2" x 1/2" SST
8. Bolt, Hex 5/16" - 18 UNC x 3/4" Lg.
9. Washer, Flat 5/16"
10. Connector, 1 1/16" x 1/2"
11. Screw, PH Cross Recess Tpg. Type F 1/4" - 20 UNC x 3/4" Lg.
12. Rivet, Mono Blind SST 3/16" x .064/.420"
13. Bracket, CNG Filter
14. Tube, 1/2" Dia. SST
15. Tube, 1/2" Dia. SST
16. Tube, 1/2" Dia. SST
17. Mount, Cable Tie 3/16" Eye
18. Washer, Flat #10
19. Screw, PH Cross Recess SST #10 - 24 UNC x 1" Lg.
20. Tube, Nylon 5/8" O.D. Orange
21. Cable Tie, 4/5" W x 8 1/2" Lg.
22. Spacer, Dual Swivel Saddle
23. Elbow, 45° 7/8" ORB x 3/4" JIC
24. Hose Assembly, CNG Fuel
25. Nut, Lock Nylon #10 - 24 UNC
26. Fitting, PTC -8 Union Brass
27. Bracket, Support P-Clip
28. Clamp, Hose 5/16"
29. Bolt, Hex 1/4" - 20 UNC x 2 1/4" Lg.
30. Washer, Flat 1/4"
31. Nut, Lock Nylon #10 - 24 UNC
32. Bolt, Hex 1/4" - 20 UNC x 2" Lg.
33. Screw, PH Cross Recess Tpg. Type F 1/4" - 20 UNC x 1" Lg.
34. Bracket, CNG Fuel Line
35. Bolt, Hex 1/4" - 20 UNC x 2 1/2" Lg.
36. Bracket, End Line Support

Fuel Line Installation (parts list)

3.8. CNG Secondary Low Pressure Filter

3.8.1. Description

The CNG secondary low pressure filter is bracket-mounted on the curbside of the engine. A stainless steel line connects the secondary filter to the fuel regulator in the CNG fill box. See "Fig. 7-5: Fuel Line Installation" on page 14.

3.9. CNG Ground Stud

The vehicle is equipped with a CNG ground stud for eliminating static electricity during fueling and defueling operations. The ground stud is mounted to the vehicle structure and it is accessible from the fuse box access door. See “Fig. 7-6: CNG Ground Stud” on page 16.

☞**NOTE:**

The ground stud is coated with dielectric grease. Reinstall the dust boot to the ground stud when disconnecting the ground cable.

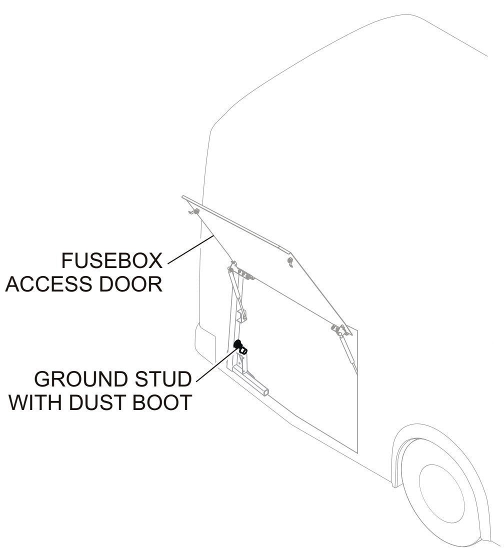

Fig. 7-6: CNG Ground Stud

4. MAINTENANCE & SERVICING

4.1. Workplace Safety Precautions

4.1.1. CNG Safety

Natural gas is stored under pressure in gas form in special high-pressure storage cylinders at up to 3,600 psi (24,800 kPa). This type of storage is safe, economical, easy to use, and maintain; provided certain safety procedures are followed when working with and around the system.

Have fire extinguishers placed strategically at easily accessible locations throughout the CNG servicing and refueling area. The extinguishers must be rated as the class and type capable of extinguishing a natural gas fueled fire such as: ABC, CO_2 charged extinguishers.

Although natural gas has a higher ignition temperature point than gasoline or diesel fuel, it is still absolutely necessary to exercise extreme caution when working near or with a CNG fuel system.

Follow the same safety procedures applicable to other hydrocarbon vapor-producing fuels such as gasoline or diesel fuel. Any potential source of ignition such as smoking, lighting matches, a cigarette lighter, or any excessive heat producing process must be kept clear of the vehicle fuel system and the CNG storage and handling area.

WARNING

Because natural gas is stored in fuel cylinders at a compressed pressure of 3,600 psi (24,800 kPa), special training and government certification is required to install, repair, remove, or service any component of a CNG fuel system. This includes the main storage and fueling facility and the vehicle fuel system.

WARNING

Natural gas is an asphyxiant; which means it can interfere with the flow of oxygen to the lungs. Therefore, heavy concentrations in enclosed or non-ventilated areas can cause drowsiness and eventually suffocation.

☞NOTE:

Natural gas is odorized with a chemical called Mercaptan that gives CNG its typical disagreeable smell. This provides a safety factor alerting you to the presence of CNG in the air caused by a leak in some area of the fuel system. Gas concentrations as minute as 0.5%, which are too small to ignite or interfere with breathing, will be recognized by this unpleasant odor.

1. While the CNG vehicle is in the shop, set the quarter-turn shut-off valve in the fill box to OFF unless CNG is required for running or checking. Turn the quarter-turn shut-off valve to the OFF position until it detents against the stop. The handle is in the closed position when it is perpendicular to the fuel flow pipe.
2. Run the engine to use up CNG from the shut off fuel system section.
3. Do not vent CNG by loosening a fitting! Even downstream of the regulator the gas is at 94 to 120 psi (648 to 827 kPa). Between the regulator and the fuel tanks gas is at 3,600 psi (24,800 kPa).
4. Do not vent CNG to atmosphere to purge the fuel system or empty the fuel tanks. Although CNG rises and dissipates in air quickly, a safety hazard could result. Ecologically, raw, unburned natural gas (methane) can contribute to the atmospheric breakdown of ozone.
5. Back fill the CNG in the fuel tanks to the main storage facility tank(s) to empty the tanks for maintenance or for emergency reasons.

CAUTION

Ensure positive pressure is maintained during defueling to prevent collapse of tank liner.

6. All maintenance tasks on the natural gas system must be performed by certified and qualified personnel.
7. A vehicle involved in an accident which damages any part of the natural gas fuel system must be retested after repair by certified personnel.
8. Do not smoke, ignite matches, cigarette lighters, or any other device that will produce a flame or spark within 100 feet (30 meters) of the fueling station.
9. Follow the same rule regarding smoking or spark/flame producing equipment when opening the fuel filling compartment access door on the vehicle or if near any part of the CNG fuel system.

DANGER

DO NOT perform any corrective action or other maintenance on a pressurized system. Perform component servicing or maintenance only after the affected zone has been isolated and depressurized. Refer to 4.3. “CNG Venting Procedure” on page 20 **in this section for depressurizing procedure.**

10. Identify leaking connections and fittings using a combustible gas detector such as the Snap-On ACT 8800®. This particular unit can detect localized gas leaks from 50 to 1000 PPM. Liquid solutions such as SNOOP® can also be used. Do not use make-shift soapy water solutions.

WARNING

DO NOT attempt to find the source of a gas leak by using a MATCH or CIGARETTE LIGHTER!

11. Open the entrance and exit doors to allow any leaked gas to vent to atmosphere. Natural gas is lighter than air and will immediately rise and dissipate.
12. Refer to 5.9. “Initial Fill Procedure” on page 72 in this section whenever installing and filling new tanks. Observe all cautions in this procedure.

WARNING

Natural gas storage and delivery are high pressure systems. The system components and the methods and procedures for maintenance and service must comply with government certification and regulations. Therefore, ONLY personnel GOVERNMENT CERTIFIED to work on high pressure natural gas systems and components may repair, service or install ANY PART of the vehicle CNG system.

CAUTION

Individuals other than certified and qualified service personnel are NOT to attempt ANY TYPE of adjustment, maintenance, or troubleshooting on the CNG fuel storage or delivery systems. If a leak occurs during vehicle operation, the CNG detectors will shut off the fuel supply solenoid valves, stopping the vehicle. The vehicle driver MUST NOT ATTEMPT TO SEARCH FOR A GAS LEAK! Certified maintenance personnel will do this.

4.2. Check List

4.2.1. General

Service personnel should check the following before putting the vehicle into transit service. Any problems discovered should be fixed immediately by qualified high pressure gas certified service personnel.

4.2.2. Exterior

Make a visual check of the CNG Fuel system before starting the vehicle. A check of the fire suppression/gas detection panel has to be made after the bus is started.

1. Make a smell check for any leaking gas.

☞NOTE:

Gas can be smelled at a very minute concentration of only 0.5%, which is not enough to activate the gas sensors. If you smell gas, DO NOT OPERATE THE VEHICLE. Have qualified service personnel immediately identify the leak source and make the necessary part adjustment, repair the part (if it is certified as a repairable part), or replace the part.

☞NOTE:

Identify leaking connections and fittings using a combustible gas detector such as the Snap-On ACT 8800®. This particular unit can detect localized gas leaks from 50 to 1000 PPM (Parts Per Million).

2. Open the fill box door and make sure the quarter-turn gas shut-off valve is on. The handle should be in the vertical position. Ensure the manual shut-off valves on the individual tanks are in the ON position.
3. Check the high and low pressure gauge reading. The high pressure gauges should show 200 to 3,600 psi (1,375 to 24,800 kPa), the low pressure gauge, located on the engine panel, should show 94 to 120 psi (648 to 827 kPa).

☞NOTE:

The gauges may show extremely low or no pressure if the engine has not been running for a couple of days. During this interval, the high pressure solenoid valves have been de-energized, preventing flow of high pressure gas downstream of the valves.

To verify gauge function, do the following:

4. The solenoid valves must be energized to allow gas to flow through the regulating system to the fuel mixer. This requires the fill box door to be closed and the Master Run switch to be set to the DAY-RUN or NIGHT-RUN position.

☞NOTE:

Make sure the fill box door is firmly closed before attempting to start the engine. The fill box contains a proximity sensor to prevent the engine from starting when the door is open. The engine ignition is disabled and the high pressure solenoid valves are shut off to prevent fuel flow to the gas mixer when the proximity sensor is open.

5. Start the engine.
6. The solenoid valves will energize and allow fuel to flow through the filtering and regulating system to the fuel mixer, starting the engine.
7. Run the engine up for a minute or so to allow the fuel delivery system to stabilize, then shut the engine down.
8. Open the fill box door and check the high and low pressure gauges for pressure readings. The high pressure gauge should show 200 to 3,600 psi (1,375 to 24,800 kPa), the low pressure gauge, located on the engine panel, should show 94 to 120 psi (648 to 827 kPa).

Low gauge readings could result from gas leaks or possibly defective gauges. Tighten any connectors or fittings identified as leaking after system is vented. Defective, malfunctioning components must be replaced. Refer to 4.6. “Component Maintenance & Servicing” on page 35 in this section for information on removing, servicing (if component is serviceable) and installing fuel system components.

4.3. CNG Venting Procedure

4.3.1. CNG Fuel System Zones

For venting purposes, the CNG fuel system is divided into three distinct zones. See “Fig. 7-7: Fuel System Venting Zones” on page 21. Any maintenance, repairs, or replacement of components in the CNG fuel system require that the affected zone be vented of pressurized gas. Each zone has its own specific venting procedure that must be followed. The fuel system zones are defined as follows:

- ❐ Zone One - the area between the engine and main (emergency) shut-off valve in the fill box. This area includes the primary and secondary fuel filters, pressure regulator, high and low pressure gauges, low fuel pressure switch (if installed), fuel fill receptacle(s), and manual purge valve.
- ❐ Zone Two - the area between the main (emergency) shut-off valve in the fill box and the fuel tanks. This area includes the main shut-off valve, and all lines and fittings up to but not including the tank solenoid valves, pressure relief devices, and fuel tanks.
- ❐ Zone Three - the area including the fuel tanks solenoid valves, pressure relief devices, PRDs and fuel tanks.

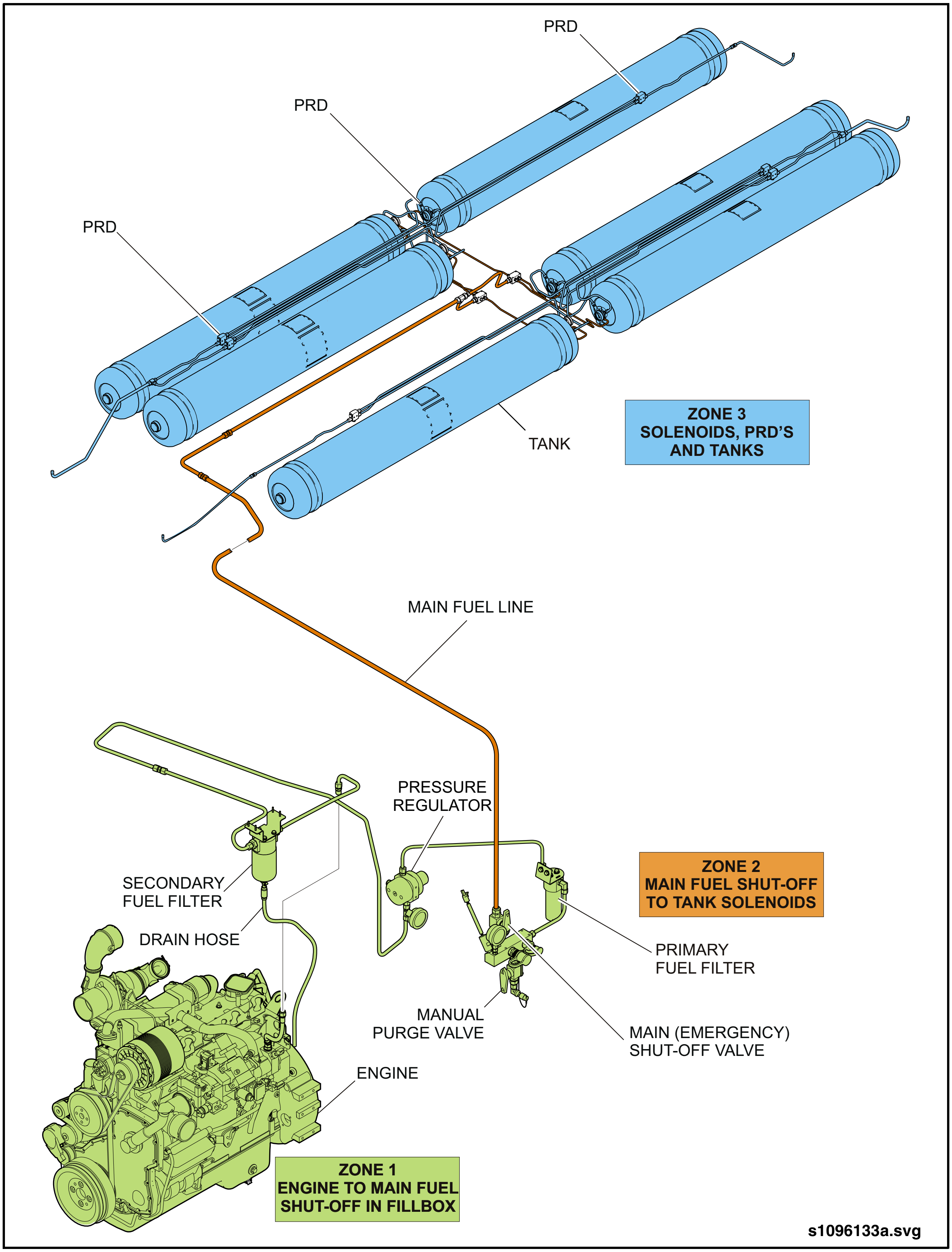

Fig. 7-7: Fuel System Venting Zones

4.3.2. Venting Preparation

WARNING

The presence of ignition sources may lead to an explosion hazard. DO NOT use jumper wires from an external power source to energize tank solenoid valves during the venting process.

DO NOT leave the vehicle unattended during the venting process. Ensure all shut-off valves are properly locked out or tagged so as to prevent inadvertent opening of a valve during the venting process. Ensure that the high pressure gauge is tagged to identify high pressure within the system whenever Zone One or Zone Two areas have been vented.

DO NOT vent gas directly from the purge line shut-off valve directly to atmosphere. Ensure that the discharged gas is connected to a recovery system or is safely redirected through a vent stack in accordance with local environmental regulations.

Prior to conducting any venting activity ensure the following steps are followed:

1. Minimize the pressure in the fuel tanks by driving the vehicle, if practical, to use up as much of the fuel as possible.
2. Perform the venting procedure outdoors.
3. Allow adequate time for the exhaust system to become cool to the touch.
4. Provide a direct ground for the purge line and for the recovery system to dissipate static charges that may build up during venting. Use a No. 3 gauge wire to connect to a suitable ground such as a water main or a pipe that is installed 8 feet (2.4 m) into the ground.
5. Connect a bonding wire from the fueling station to the CNG ground stud on the vehicle.

4.3.3. Zone One Venting Procedure

☞**NOTE:**

It will be necessary to run the engine in order to depressurize the entire Zone One area. Opening the purge line shut-off valve will only vent the area between the main (emergency) shut-off valve and the pressure regulator. If the engine cannot be run, proceed to "Zone One Alternate Venting Procedure".

Vent the area between the engine and the main (emergency) shut-off valve as follows:

1. Close the main fuel supply by rotating the main (emergency) shut-off valve to the fully closed (horizontal) position. See "Fig. 7-8: Fill Box" on page 23.
2. Start the engine and operate at idle speed until the engine stalls.
3. Set the Battery Disconnect switch to the OFF position.
4. Connect a line from the recovery system to the purge line shut-off valve.
5. Slowly rotate the purge line shut-off valve to the fully open (vertical) position.
6. Allow any remaining gas in Zone One to completely depressurize as indicated by a "zero" reading on the low pressure gauge and no further flow through the vent line.

☞**NOTE:**

If the high pressure gauge reads "zero" but the low pressure gauge is still reading a positive pressure, then it is likely the engine stalled before all fuel in the lines was consumed. Proceed to Step 6 in "Zone One Alternate Venting Procedure".

CAUTION

The area immediately upstream of the main (emergency) shut-off valve is still pressurized even though the high pressure gauge reads "zero". Only the Zone One area has been depressurized. Ensure that the high pressure gauge is tagged to indicate this condition and that the main shut-off valve is locked out to prevent inadvertent opening during maintenance or repair.

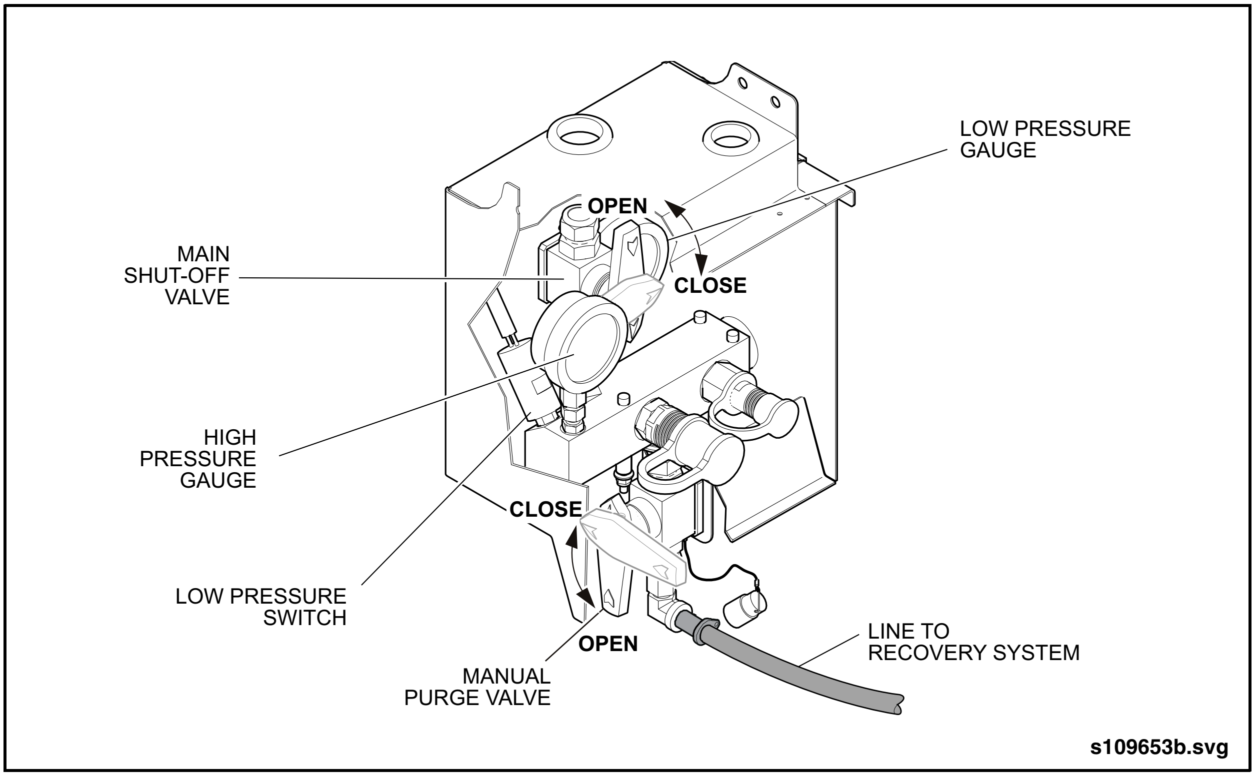

Fig. 7-8: Fill Box

4.3.4. Zone One Alternate Venting Procedure

☞ **NOTE:**

The following procedure is to be used only if the engine cannot be run.

1. Set the Battery Disconnect switch to the OFF position.
2. Close the main fuel supply by rotating the main (emergency) shut-off valve to the fully closed (horizontal) position.
3. Connect a line from the recovery system to the purge line shut-off valve.
4. Slowly rotate the purge line shut-off valve to the fully open (vertical) position.
5. Allow the lines between the pressure regulator and the main (emergency) shut-off valve to completely depressurize as indicated by a zero reading on the high pressure gauge and no further flow through the vent line.
6. Locate the drain cock or plug on the bottom of the secondary fuel filter.
7. Carefully crack open, but do not remove the drain fitting, and allow the lines between the engine and the pressure regulator to fully depressurize as indicated by a zero reading on the low pressure gauge.

⚠ CAUTION

The area immediately upstream of the main (emergency) shut-off valve is still pressurized even though the pressure gauge reads “zero”. Only the Zone One area has been depressurized. Ensure that the pressure gauge is tagged to indicate this condition and that the main shut-off valve is locked out to prevent inadvertent opening during maintenance or repair.

4.3.5. Zone Two Venting Procedure

Vent the area between the main (emergency) shut-off valve and the fuel tank solenoid valves, but not including the fuel tank solenoid valves or fuel tanks, as follows:

1. Set the Battery Disconnect switch to the OFF position.
2. Close the fuel tank solenoid valves manually by rotating the valve knobs. See "Fig. 7-9: Manually Closed Solenoid Valve" on page 24.
3. Ensure the main (emergency) shut-off valve is open.
4. Connect a line from the recovery system to the purge line shut-off valve.
5. Slowly rotate the purge line shut-off valve to the fully open (vertical) position.
6. Allow the gas in Zone Two to completely depressurize as indicated by a "zero" reading on the high pressure gauge and no further flow through the vent line.

CAUTION

The fuel tank solenoid valves, pressure relief devices, and fuel tanks are still pressurized even though the pressure gauge reads "zero". Only the Zone One and Zone Two areas have been depressurized. Ensure that the pressure gauge and fuel tank solenoid valves are tagged to indicate this condition and that the shut-off valve is locked out to prevent inadvertent operation during maintenance or repair.

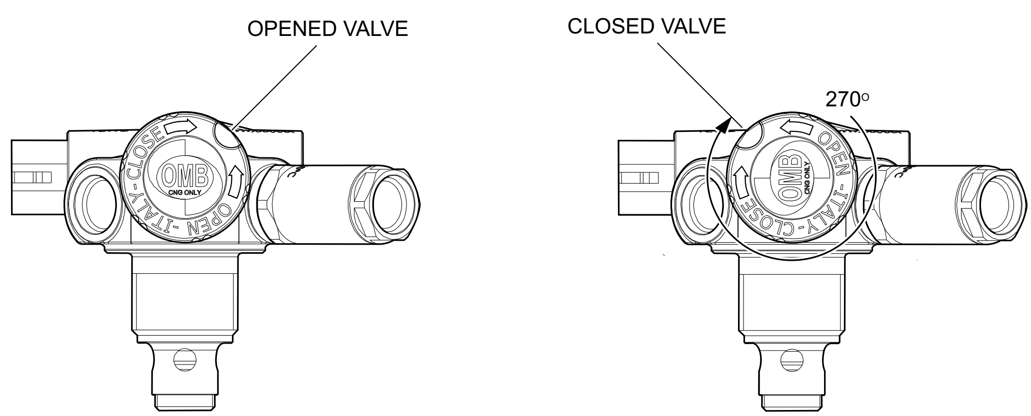

Fig. 7-9: Manually Closed Solenoid Valve

4.3.6. Zone Three Venting Preparation

WARNING

Serious injury could result if the following procedure is not followed exactly as described. Multiple fuel tank systems must be vented in a specific sequence determined by the condition of the tank solenoid valves. DO NOT initiate any Zone Three venting until the condition of each tank solenoid valve is determined and its status is identified. Perform a functional test of each solenoid valve. Refer to 4.3.6.1. "Tank Solenoid Valve Testing Procedure" on page 25 **in this section. Vent the individual tanks in the following order:**

1. **Solenoid valves that are stuck open.**
2. **Solenoid valves that are operating normally.**
3. **Solenoid valves that are stuck closed or not operating.**

4.3.6.1. Tank Solenoid Valve Testing Procedure

WARNING

The following procedure must be followed exactly to prevent serious injury. This procedure is used to identify any malfunctioning tank solenoid valve and must be performed prior to conducting Zone Three venting.

1. Set the Battery Disconnect switch to the OFF position.
2. Set Master Run switch on driver's side console to the STOP-ENGINE position.
3. Check and record the system pressure indicated on the high pressure gauge located in the fill box.
4. Disconnect electrical power to the tank solenoid valves by unplugging the electrical connector at each tank solenoid valve.
5. Close the fuel tank solenoid valves manually by rotating the valve knobs.

WARNING

All tank solenoid valves must be CLOSED during this procedure and remain CLOSED.

6. Ensure the main (emergency) shut-off valve is open.
7. Connect a line from the recovery system to the purge line shut-off valve.
8. Slowly rotate the purge line shut-off valve to the fully open (vertical) position.

9. Allow the gas in Zones One and Two to completely depressurize as indicated by a “zero” reading on the pressure gauge and no further flow through the vent line.
10. Rotate the purge line shut-off valve to the closed (horizontal) position.
11. Manually open the fuel tank solenoid valve to be tested by rotating the valve knob.
12. Energize the tank solenoid valve as follows:
    a. Connect the electrical connector to the tank solenoid valve.
    b. Set the Battery Disconnect switch to the ON position.
    c. Set the Engine Run switch in the engine compartment to the OFF position.
    d. Apply the parking brake.
    e. Position the Master Run switch to NIGHT-PARK.
    f. Press the Start push button on the driver's side console momentarily and release.
13. Allow the pressure to build until stabilized. Pressure should be same as what was previously recorded in step 3.

☞NOTE:

The tank solenoid valve is either electrically inoperative or stuck closed mechanically if the system does not pressurize. Identify the condition of the tank solenoid valve and tag accordingly.

14. De-energize the tank solenoid valve by setting the Master Run switch to the STOP-ENGINE position.
15. Slowly rotate the purge line shut-off valve to the fully open (vertical) position.
16. Allow the gas in Zones One and Two to completely depressurize as indicated by a “zero” reading on the pressure gauge and no further flow through the vent line.
17. Rotate the purge line shut-off valve to the closed (horizontal) position.
18. Wait approximately five minutes, then check the pressure in the system downstream of the tank solenoid valve.

☞NOTE:

Any increase of pressure in the line indicates that the tank solenoid valve is leaking or partially stuck open. Identify the condition of the tank solenoid valve and tag accordingly.

19. Close the fuel tank solenoid valve manually by rotating the valve knob.
20. Repeat the procedure for each tank solenoid valve being tested.

4.3.7. Zone Three Venting Procedure

⚠ WARNING

DO NOT attempt to remove any fittings, lines, or components from the fuel tanks if excessive resistance to rotation is experienced during removal. This could indicate that the tank is still pressurized. Investigate and confirm that the tank is fully depressurized before continuing removal of any fittings, lines, or components.

Vent the entire fuel system including the fuel tanks in the following sequence:

4.3.7.1. Venting Tank (Solenoid Valves Stuck Open)

☞**NOTE:**

The following procedure assumes that the solenoid valve is partially or fully stuck open and will need to be replaced.

1. Set the Battery Disconnect switch to the OFF position.
2. Disconnect electrical power to the tank solenoid valves by unplugging the electrical connector at each tank solenoid valve.
3. Close the fuel tank solenoid valves manually by rotating the valve knobs.

⚠ WARNING

All tank solenoid valves must be CLOSED during this procedure and remain CLOSED

4. Ensure the main (emergency) shut-off valve is open.
5. Connect a line from the recovery system to the purge line shut-off valve.
6. Manually open the solenoid valve on the tank to be vented by rotating the valve knob.
7. Energize the tank solenoid valve as follows:
   a. Connect the electrical connector to the tank solenoid valve.
   b. Set the Battery Disconnect switch to the ON position.
   c. Set the Engine Run switch in the engine compartment to the OFF position.
   d. Apply the parking brake.
   e. Position the Master Run switch to NIGHT-PARK.
   f. Press the Start push button on the driver's side console momentarily and release.

☞**NOTE:**

The tank solenoid valve needs to be energized for the following reasons:

- ❒ *The tank solenoid valve may be stuck in a partially open position which would result in a longer than normal time to vent. Energizing the solenoid will allow the valve to open fully.*
- ❒ *The tank solenoid valve may be sticking open intermittently and may not vent unless the solenoid is energized.*

⚠ CAUTION

DO NOT open the purge line shut-off valve until the line pressure has stabilized, indicating that the tank solenoid valve has opened as fully as possible.

8. Slowly rotate the purge line shut-off valve towards the open (vertical) position until maximum flow is achieved.
9. Allow the tank to completely depressurize as indicated by a “zero” reading on the pressure gauge and no further flow through the vent line.
10. De-energize the tank solenoid valve by setting the Master Run switch to the STOP-ENGINE position.
11. Close the fuel tank solenoid valve manual shut-off by rotating the valve knob.
12. Rotate the purge line shut-off valve to the closed (horizontal) position.
13. Remove and replace the defective solenoid valve. Refer to 4.9. “CNG High Pressure Solenoid Valve” on page 44 in this section for procedure.
14. Refer to 4.3.9. “Pressure Equalizing Procedure” on page 30 in this section if the tank will not be repressurized immediately.

4.3.7.2. Venting Tank (Solenoid Valves Operating Normally)

1. Set the Battery Disconnect switch to the OFF position.
2. Disconnect electrical power to the tank solenoid valves by unplugging the electrical connector at each tank solenoid valve.
3. Close the fuel tank solenoid valves manually by rotating the valve knobs.

WARNING

All tank solenoid valves must be CLOSED during this procedure and remain CLOSED.

4. Ensure the main (emergency) shut-off valve is open.
5. Connect a line from the recovery system to the purge line shut-off valve.
6. Open the solenoid valve manual shut-off on the tank to be vented by rotating the valve knob.
7. Record the actual system pressure.
8. Slowly rotate the purge line shut-off valve to the fully open (vertical) position.
9. Allow the gas in Zone Two to completely depressurize as indicated by a “zero” reading on the pressure gauge and no further flow through the vent line.
10. Rotate the purge line shut-off valve to the closed (horizontal) position.
11. Energize the tank solenoid valve as follows:
    a. Connect the electrical connector to the tank solenoid valve.
    b. Set the Battery Disconnect switch to the ON position.
    c. Set the Engine Run switch in the engine compartment to the OFF position.
    d. Apply the parking brake.
    e. Position the Master Run Switch to NIGHT-PARK.
    f. Press the Start push button on the driver’s side console momentarily and release.

CAUTION

DO NOT fully open the purge line shut-off valve in the following step.

12. Slowly rotate the purge line shut-off valve to the fully open (vertical) position.
13. Allow the gas in Zone Three to completely depressurize as indicated by a “zero” reading on the pressure gauge and no further flow through the vent line.
14. Rotate the purge line shut-off valve to the closed (horizontal) position.
15. Repeat the procedure for each tank requiring venting.
16. Remove the tank solenoid valves, if required, and perform the necessary maintenance of Zone Three components. Refer to 4.9. “CNG High Pressure Solenoid Valve” on page 44 in this section for procedure.
17. Refer to 4.3.9. “Pressure Equalizing Procedure” on page 30 in this section if the tank will not be repressurized immediately.

4.3.8. Venting Tank (Solenoid Valve Stuck Closed or Not Operating)

1. Set the Battery Disconnect switch to the OFF position.
2. Close the fuel tank manual shut-off valve and discharge the gas from Zone 1 and Zone 2.

☞**NOTE:**

The manual shut-off must be closed for the valve with the damaged coil, as well as all neighboring valves involved in the system, even if they are functioning properly.

3. Unscrew the valve's coil nut.
4. Remove the coil nut being careful not to drop the internal O-ring.
5. Remove the coil being careful not to drop the protection gasket.
6. Exchange the faulty coil with a good one from the neighboring valve or the mainte-

nance tooling. After installing the coil onto the faulty valve, proceed to step 9 to defuel the fuel tank.

7. If exchanging the coil does not work to fix the solenoid, the internal components of the solenoid are defective. The internal solenoid components can be bypassed by proceeding as follows:

    a. Ensure that the manual shut-off is fully closed.

    CAUTION

    Some residual gas may be trapped inside the solenoid valve.

    b. Carefully unscrew the solenoid sleeve using a 25 mm wrench

    c. Disassemble the solenoid sleeve.

    d. Take out the solenoid internal parts. See “Fig. 7-10: Solenoid Sleeve and Internal Parts” on page 29.

    e. Reassemble the solenoid sleeve. Torque to 14.8 ft-lb. ± 1 ft-lb. (20 ± 1 Nm) without the internal parts.

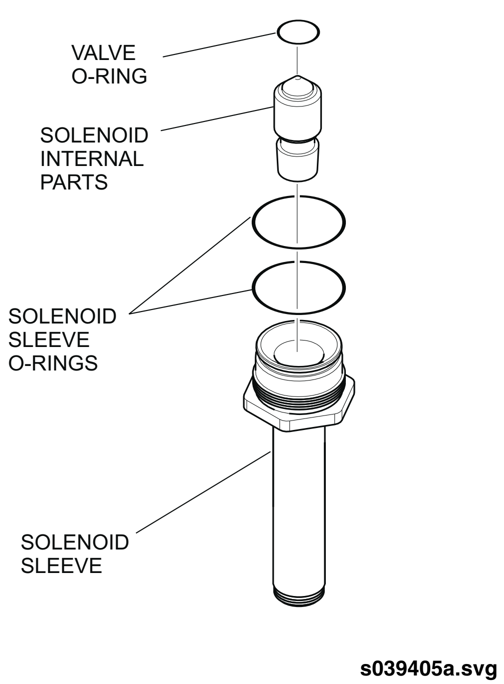

Fig. 7-10: Solenoid Sleeve and Internal Parts

8. t is now possible to discharge the gas from the fuel tank by carefully opening the manual shut-off valve.

WARNING

All tank solenoid valves must be CLOSED during this procedure and remain CLOSED.

9. Ensure the main (emergency) shut-off valve is open.

10. Connect a line from the recovery system to the purge line shut-off valve.

11. Record the actual system pressure.

12. Slowly rotate the purge line shut-off valve to the fully open (vertical) position.

13. Allow the gas in Zone Two to completely depressurize as indicated by a "zero" reading on the pressure gauge and no further flow through the vent line.

14. Rotate the purge line shut-off valve to the closed (horizontal) position.

15. Open the solenoid valve manual shut-off on the tank to be vented by rotating the valve knob.

CAUTION

DO NOT fully open the purge line shut-off valve in the following step.

16. Slowly rotate the purge line shut-off valve to the fully open (vertical) position.

17. Allow the gas in Zone Three to completely depressurize as indicated by a "zero" reading on the pressure gauge and no further flow through the vent line.

18. Rotate the purge line shut-off valve to the closed (horizontal) position.

19. Remove the tank solenoid valve, if required, and perform the necessary maintenance of Zone Three components. Refer to 4.9. “CNG High Pressure Solenoid Valve” on page 44 in this section for procedure.

20. Refer to 4.3.9. “Pressure Equalizing Procedure” on page 30 in this section if the tank will not be repressurized immediately.

4.3.9. Pressure Equalizing Procedure

WARNING

DO NOT open a PRD vent line or tank plug until it has been determined that the line is depressurized. Ensure the adjacent tank is also depressurized if that tank shares the same PRD vent line.

CAUTION

DO NOT seal a tank that has been vented unless it can be repressurized immediately. A sealed tank can be damaged if a vacuum forms due to temperature changes. If a vacuum should occur, condition the tank at a temperature above 60°F (16°C) for eight hours and then pressurize before returning tank to service. Refer to 5.9. "Initial Fill Procedure" on page 72 **in this section for procedure.**

1. Locate the plug on the opposite end of the tank from the solenoid valve.
2. Remove the plug.
3. Cover, but do not seal the open port in the end of the tank. Use a lint-free cloth or other suitable cover that will prevent contamination entry, yet allow the tank to breathe.

CAUTION

Reinstall the plug before refilling the tanks with CNG.

4. Apply a light coating of silicone grease on the new O-ring and install the plug into the end port of the tank. Torque the 2" - 12 threaded plug 200 to 220 ft-lb. (271 to 298 Nm).

   Alternatively, a PRD vent line may be disconnected to allow pressure equalization. Proceed as follows:

1. Locate the high-pressure vent tubes on the vented tank. See "Fig. 7-11: Vent Tube Location" on page 31.
2. Disconnect the line on the high pressure side of the PRD located at the end of the vent line.
3. Cover, but do not seal, the open lines with a lint-free cloth or other suitable cover that will prevent contamination entry (water, oil, dust, debris), yet allow the line to vent.

CAUTION

Reinstall the vent line before refilling the tanks with CNG.

4.3.10. Returning Vehicle to Service

1. Ensure required maintenance has been completed and there is no pressure in the lines downstream of the tank solenoid valves.
2. Close the purge line shut-off valve and disconnect line from CNG recovery system.
3. Manually open the solenoid valves on all tanks by rotating the knob.
4. Refuel the tanks.
5. Leak test the system.

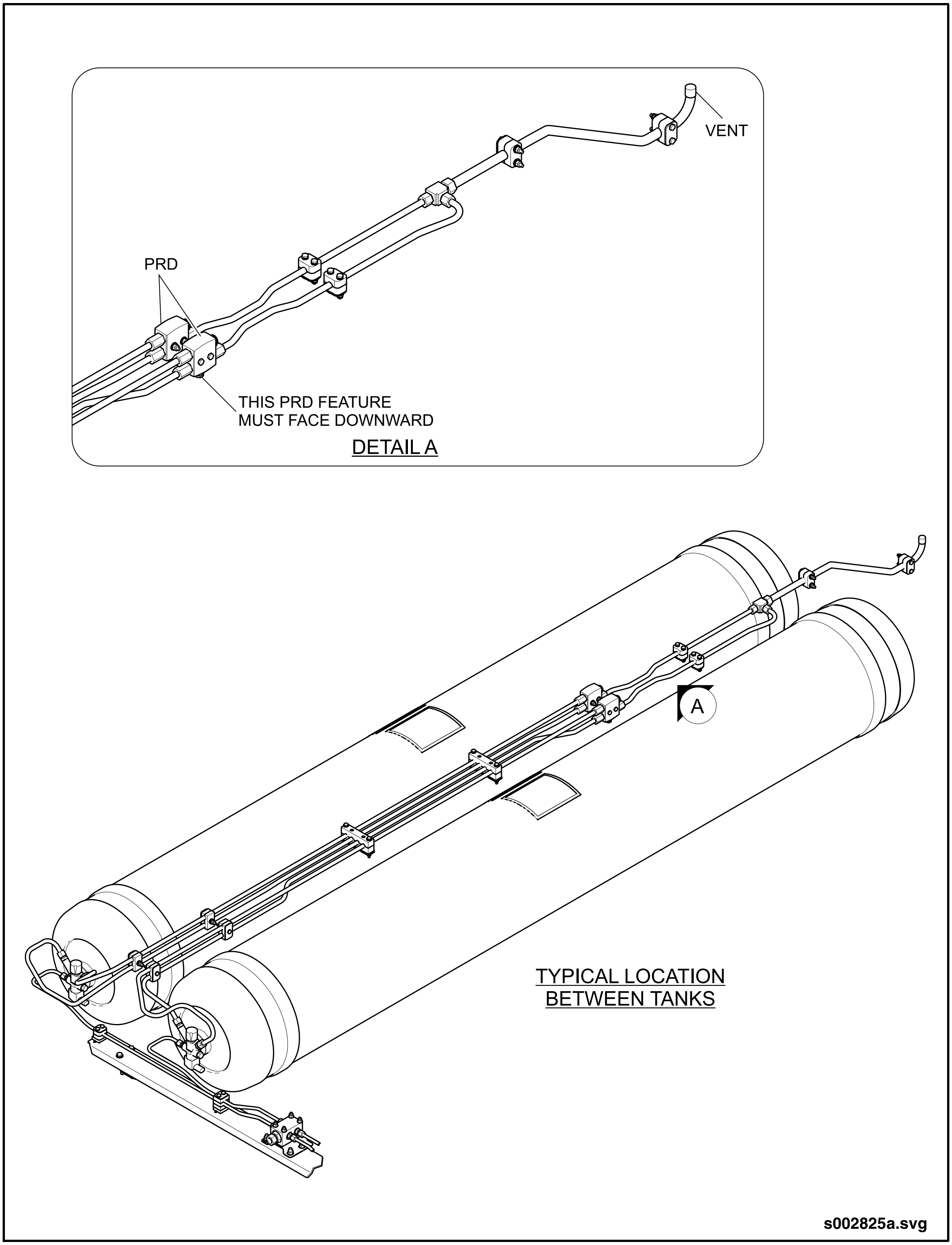

Fig. 7-11: Vent Tube Location

4.4. CNG Tank Contamination

Possible contamination (dust, debris, oil, water, etc.) of the fuel tanks may be indicated by the following:

1. Reduced mileage range.
2. Poor engine performance.

If contamination is suspected carry out the following procedure:

1. Remove the vehicle primary and secondary fuel filters and check for contaminants.
2. Check the oil consumption of the fill station compressor. Compressor oil may be passed into the vehicle fuel system.
3. Check the fill station compressor oil and water filtration systems. Poor filtration systems will allow contaminants to enter the vehicle fuel system.
4. Check the operation of the CNG tank solenoid valves. Refer to 4.9. “CNG High Pressure Solenoid Valve” on page 44 in this section for procedure.
5. Check the settled fuel system pressure after refueling for correct full system pressure. If insufficient fueling is suspected then check that the temperature compensation of the fill station is operating correctly.
6. If contamination of the CNG tanks is still suspected after carrying out the previous checks, contact:

WARNING

DO NOT perform any internal inspections of CNG composite tanks. Contact New Flyer Customer Service Support.

4.5. Leaks in CNG System

DANGER

DO NOT perform any corrective action or other maintenance on a pressurized system. Perform component servicing or maintenance only after the affected zone has been isolated and depressurized. Refer to 4.3. "CNG Venting Procedure" on page 20 **in this section for depressurizing procedure.**

4.5.1. Dealing with Minor Leaks

1. Shut down all operating systems.
2. Open the fill box and shut off the quarter-turn shut-off valve. The handle is vertical and aligned with the gas line when the valve is open. Turn the quarter-turn shut-off valve to the OFF position by pulling the handle to the right and down until it detents against the stop.
3. Leave the CNG rack module rooftop doors open so that any leaked gas will disperse to the atmosphere. Remember, natural gas is lighter than air and will rise.
4. Do not smoke or allow anyone else to smoke or operate any devices that may create a spark within 100 feet (30 meters) of the vehicle.
5. Troubleshoot the system to identify the leaking connection or component. Use an industry standard combustible gas detector to identify leaking connections and fittings. If a component such as a fitting hose or tube needs to be replaced or tightened, follow the procedure outlined previously for isolating the high pressure side of the system and venting the low pressure side for component removal.

4.5.2. Dealing with Major Leaks

If gas is leaking or venting from the fuel tanks:

Gas will vent from the fuel tanks if the temperature activated PRD (Pressure Relief Device) activates, venting gas to atmosphere. The PRD opens at 230°F (110°C). The venting tank(s) will continue to do so until the pressurized gas is dispersed to atmosphere.

☞NOTE:

Natural gas weighs approximately one third less than air. It rises quickly and rapidly diffuses with air when released to atmosphere.

1. Open the overhead doors manually if the vehicle is parked inside the garage. Do not operate any electrical overhead doors or electrical switches.
2. Do not operate any of the electrical switches on the side panel or dash.
3. Leave the doors open so that any leaked gas will disperse to the atmosphere. Remember, natural gas is lighter than air and will rise.
4. If it is safe to do so, Turn the quarter-turn shut-off valve to the OFF position by pulling the handle to the right and down until it detents against the stop.
5. Do not smoke, allow anyone else to smoke, or operate ANY devices that may create a spark within 300 feet (91 meters) of the vehicle.
6. Do not attempt to enter the fuel tank bay until the tank(s) has (have) finished venting and the CNG has dissipated to atmosphere.
7. After the CNG has vented completely and the tank bay is free of gas, inspect the vented tank(s) and shut-off valves to determine what caused the PRD to activate and cause the CNG to vent. Correct the problem and install a new PRD.

⚠ WARNING

It is mandatory that a NEW PRD unit be installed. DO NOT attempt to repair or modify the old PRD unit and reuse it. The fuel cylinder may also require replacement. Have the fuel tank condition appraised by an inspector certified by the fuel tank manufacturer. If the fuel tank is considered damaged beyond a safe operating condition, it must be replaced.

Have the leak repaired by qualified and certified maintenance personnel. Identify leaking connections and fittings using a combustible gas detector such as the Snap-On ACT 8800®. This particular unit can detect localized gas leaks from 50 to 1000 PPM. (Parts Per Million). Liquid solutions such as SNOOP® can also be used. Do not use make-shift soapy water solutions.

Remove and replace fuel system components. Refer to 4.6. “Component Maintenance & Servicing” on page 35 in this section for procedure.

4.6. Component Maintenance & Servicing

DANGER

DO NOT perform any corrective action or other maintenance on a pressurized system. Perform component servicing or maintenance only after the affected zone has been isolated and depressurized. Refer to 4.3. "CNG Venting Procedure" on page 20 **in this section for depressurizing procedure.**

☞**NOTE:**

Use only approved replacement parts. No substitutions are allowed on components requiring repair or replacement.

4.6.1. Description

In most cases, gas leakage will be the major concern with the CNG fuel system.

Leakage will mainly occur around fittings and connectors, and generally can be corrected by tightening the connections to specifications. Most fitting and connector manufacturers such as Swagelok® provide lots of technical information on how to properly install and tighten connections and how to properly handle and bend tubing. Particular attention must be given to skillful work methods, use of proper tools and cleanliness.

Refer to information provided in this section on areas regarding fittings, connections, tubing and work methods. This is for easy reference and also because these basic areas of the CNG fuel system are very important to a leak-free, efficient and safe operating fuel system.

Major CNG high pressure fuel system components are manufactured to exacting and precise tolerances, using sophisticated components and systems. The failure or malfunction rate for system parts such as fuel tanks, shut-off valves, PRD (Pressure Relief Device) valves, regulators, fill box gauges, solenoids and check valves is extremely low because of the exacting standards imposed for components used in high pressure CNG systems. In all cases components are engineered to a factor of four to ensure safe, consistent and long-term operation.

This section provides information on removing, repairing any serviceable components and installing these components. Many parts in the CNG fuel system are non-serviceable and, if not working or malfunctioning, will be removed and replaced with a new part.

Serviceable or non-serviceable/replacement only parts will be identified in this section along with the required procedure for removal/installation and/or servicing.

4.6.2. Safety

Refer to 4.1. "Workplace Safety Precautions" on page 17 in this section for all safety requirements. In particular note that all service personnel working with CNG fuel system maintenance and service must be government certified for work on high pressure gas systems. Only people with special training and government certification can install, repair, remove or service any component of a CNG fuel system.

Follow the same safety procedures applicable to other hydrocarbon vapor producing fuels such as gasoline or diesel fuel. Any potential source of ignition such as smoking, lighting matches or a cigarette lighter or any excessive heat producing process must be kept clear of the vehicle fuel system and the CNG storage and handling area.

1. While the CNG vehicle is in the shop, set the quarter-turn shut-off valve to OFF unless CNG is required for running or checking. The handle is in the off position when it is perpendicular to the fuel flow line. As an added precaution, close the individual CNG tank shut-off valves.
2. Identify leaking connections and fittings using a combustible gas detector such as the Snap-On ACT 8800®. This particular unit can detect localized gas leaks from 50 to 1000 PPM (Parts Per Million). Liquid solutions such as SNOOP® can also be used. Do not use make-shift soapy water solutions.
3. Do not use a match, cigarette lighter or other open flame or ignition source to search for a suspected high pressure natural gas leak.
4. Have fire extinguishers placed strategically throughout the CNG servicing and refueling area. The extinguishers must be rated as the class and type capable of extinguishing a natural gas fueled fire such as: ABC, CO_2 charged extinguishers.
5. Welding, flame cutting, torching or any process or work producing sparks or hot particles is not to be done on, around or within the immediate area of CNG storage facilities or the vehicle CNG system.
6. Work on or around piping, tubing or components of a CNG system requiring open flame, excessive heat or producing sparks can only be done if the parts and components have been thoroughly purged of all traces of natural gas.
7. Trouble lights, flashlights or emergency lantern-type lights must comply with Class 1, D type coding for use in leak detection or any other work on or around a CNG storage facility or vehicle fuel system. Only lighting or electrical equipment complying with this coding can be used within close proximity of CNG storage/dispensing equipment and the vehicle fuel system.

4.6.3. High or Low Pressure Gauge Removal & Installation

Remove and replace a gauge as follows:

1. Refer to 4.3.3. “Zone One Venting Procedure” on page 22 in this section for procedure.
2. Remove the malfunctioning pressure gauge from the line. It may be necessary to have the gauge supplier pressure test and recalibrate the sending mechanism. If the valve is repairable, reinstall the repaired unit. Replace the gauge if it is not serviceable.

CAUTION

The workplace, tools and the work method must be extremely clean when working with high pressure CNG components and fittings. Minute scratches, scuffs or abrasions on mating surfaces can cause gas leaks. Use only proper tools that are matched to the job, fittings and components.

DO NOT use make-shift work methods. DO NOT use VISE-GRIP® type pliers, water pump type adjustable pliers, pipe wrenches or any other type of gripping tool not designed or matched for use on high pressure CNG fittings, connectors or couplings.

If you attempt to work with the wrong tools, the connections will be ruined, causing UNSAFE gas leaks. Use only thread sealants approved for 3,600 psi CNG systems such as Swagelok SWAK® anaerobic sealant.

3. Use a Swagelok® gap inspection gauge for checking all connections for proper tightness. The fittings require tightening if the size-matched gauge end slides between the connections. Tighten until the gauge end does not slide between the connections.
4. Turn the quarter-turn shut-off valve to the ON position. The handle is in the on position when it is aligned (parallel) with the fuel fine.
5. Turn the ignition on to activate the starter. The solenoid valves will then energize and allow fuel to flow through the filtering and regulating system to the fuel mixer, starting the engine.
6. Run the engine up for a minute or so to allow the fuel delivery system to stabilize, then shut the engine down.
7. Open the fill box door and check the high and low pressure gauges for pressure readings. The high pressure gauges should show 200 to 3,600 psi (1,375 to 24,800 kPa), the low pressure gauge should show 94 to 120 psi (648 to 827 kPa).
8. Check for any leaking connections and fittings using a combustible gas detector such as the Snap-On ACT 8800®. This particular unit can detect localized gas leaks from 50 to 1000 PPM (Parts Per Million). Liquid solutions such as SNOOP® can also be used. Do not use make-shift soapy water solutions.
9. Make sure the dust cover is installed on the filler receptacle.
10. Make sure the access door is fully closed after the walk-around inspection. This is necessary because the CNG system will not function and the engine will not start until the door proximity sensor enables the ignition system.
11. Start the engine and make sure the “SYSTEM OK” indicator illuminates on the fire suppression control panel.
12. Do a lamp test on the fire suppression monitor panel by pushing the Push to Test button. This will illuminate all the warning lights on the sensor warning panel. If any of the indicators do not light up, stop the engine and get maintenance to troubleshoot the system.

4.6.4. High & Low Pressure Filter Element Replacement

The primary high pressure coalescing filter is located just upstream of the regulator. The secondary low pressure spin-on filter is located downstream of the regulator. The coalescing filter unit contains a replaceable 1 micron filter element. See “Fig. 7-12: Primary High Pressure Filter” on page 38. See “Fig. 7-13: Secondary Low Pressure Filter” on page 39. Refer to the Preventive Maintenance Section of this manual for the filter replacement schedule and procedures.

CAUTION

The gas must be turned off at the quarter-turn shut-off valve and the system depressurized downstream of the quarter-turn shut-off valve before working on the high and low gas filters.

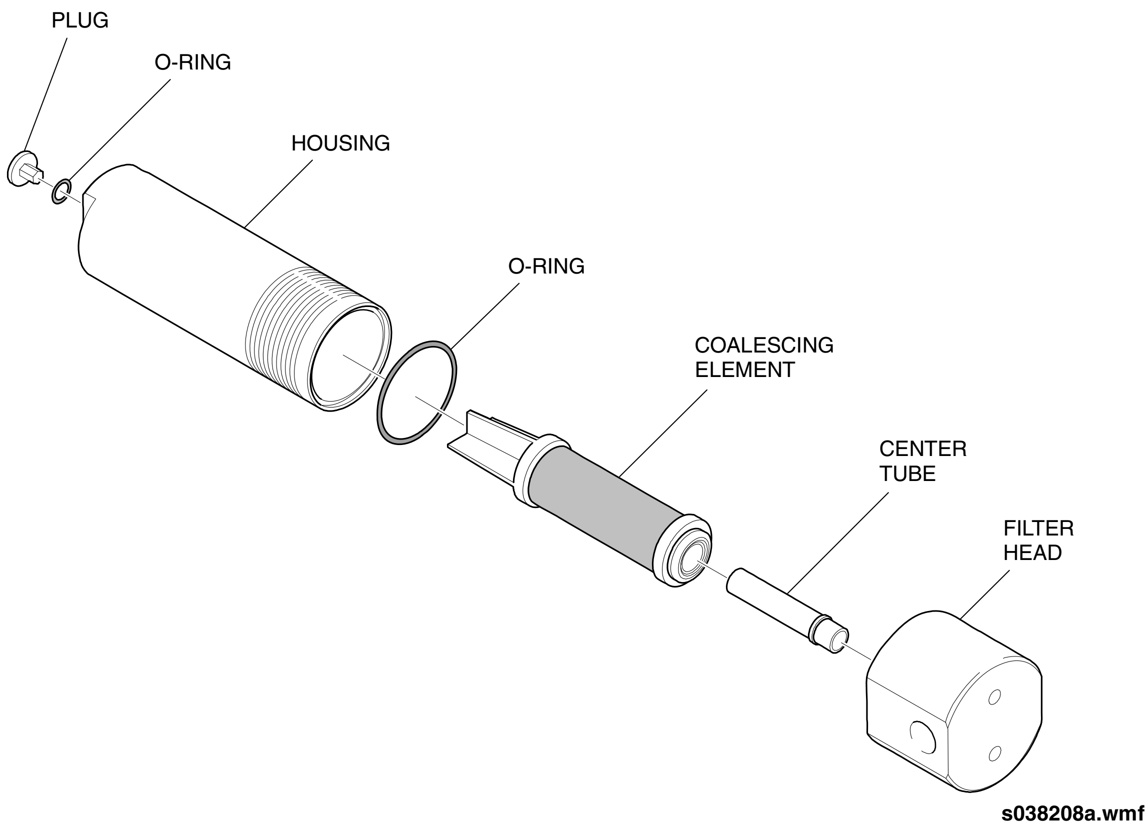

Fig. 7-12: Primary High Pressure Filter

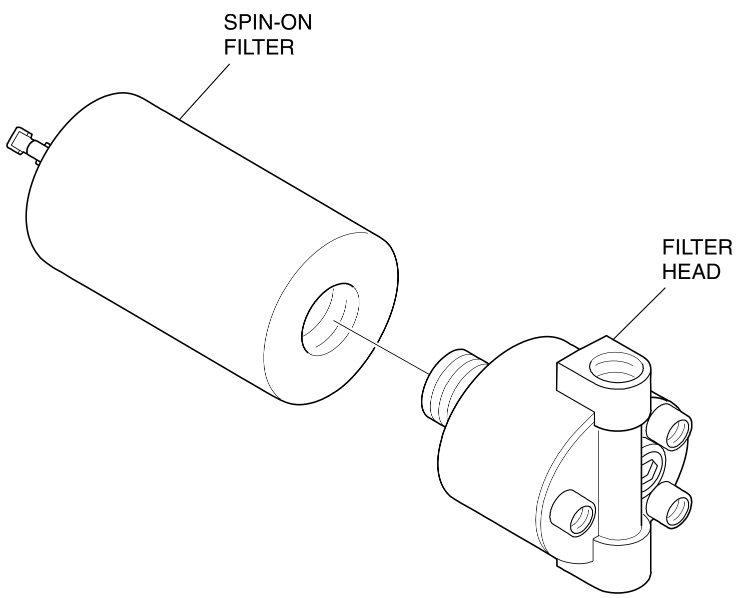

Fig. 7-13: Secondary Low Pressure Filter

4.6.4.1. Fuel Source

Screw-type compressors tend to pass more fluid contaminants such as water and residual pump lubricating oil into the CNG.

Reciprocating (piston) type compressors tend to pass less fluid contaminants into the CNG.

The fueling station coalescing filter replacement frequency also influences the cleanliness of the pumped CNG.

4.7. ITT Regulator

4.7.1. Maintenance

The ITT regulator initially will not be field serviceable. The regulator must be replaced if it malfunctions and the defective unit shipped to the factory for inspection and overhaul.

4.7.2. Removal

CAUTION

The workplace, tools and the work method must be extremely clean when working with high pressure CNG components and fittings. Minute scratches, scuffs or abrasions on mating surfaces can cause gas leaks. Use only proper tools that are matched to the job, fittings and components.

DO NOT use make-shift work methods. DO NOT use VISE-GRIP® type pliers, water pump type adjustable pliers, pipe wrenches or any other type of gripping tool not designed or matched for use on high pressure CNG fittings, connectors or couplings.

If you attempt to work with the wrong tools, the connections will be ruined, causing UNSAFE gas leaks. Use only thread sealants approved for 3,600 psi (24,800 kPa) CNG systems such as Swagelok SWAK® anaerobic sealant.

1. Refer to 4.3.3. “Zone One Venting Procedure” on page 22 in this section for procedure.

CAUTION

Before disconnecting the solenoid wiring lead connector, make sure the ignition is off. Also disconnect the battery leads.

2. Drain some coolant from the cooling system to drain the coolant lines connected to the regulator. Doing this will prevent coolant from spilling into the component enclosure.
3. Loosen the hose clamps on the coolant lines at the side of the regulator. Remove the coolant hose from the regulator being careful not to rotate the regulator coolant bowl. Carefully wipe up any residual coolant from the hoses that may spill into the component enclosure or on the regulators, filters or other parts.
4. Loosen and back off the Inlet and outlet gas line connections. Do not bend or twist tubing to pull the threaded fittings free of the threaded ports. Also remove the 90° angled vent hose from the vent port to allow more work space, if necessary.

CAUTION

Vent port is special undercut fitting. DO NOT bend or twist. Damage to this will hamper PRD function of ITT regulator.

5. At this point, loosen the bolts holding the regulator to the back of the fill box. Gently work the regulator from between the inlet and outlet lines.
6. Visually inspect the regulator for any signs of physical damage. Wipe clean and set aside for shipment to the factory for inspection and overhaul.

4.7.3. Installation

1. Follow this procedure when installing the coolant hose fittings on a new or rebuilt regulator. Otherwise, the coolant bowl will rotate on the body of the regulator and coolant will leak from damaged bowl O-rings.
   a. Apply sealant to the threads of the coolant hose fittings. If liquid sealant is used, apply sparingly to avoid cooling system contamination.
   b. Hand tighten the fittings into the bottom of the regulator coolant bowl.
   c. Torque the fittings to 20 to 30 ft-lb. (27 to 40 Nm) while preventing bowl rotation. To do this, use a support bar between the fittings at the hex part while tightening each fitting with a socket or box end wrench.

   ☞**NOTE:**

   DO NOT hold the coolant bowl in a vise. This could cause bowl distortion and coolant leaks.

   d. To check the bowl and fittings for leaks, install a cap or plugged hose on one fitting and pressurize the other fitting with shop air at 5 to 100 psi.
2. Align the regulator with the inlet and outlet fittings. Install using two bolts, lock washers and flat washers.
3. Align the inlet and outlet gas line connections with the respective threaded ports on the regulator and thread on finger tight.
4. Install the two coolant hoses into the coolant bowl on the regulator housing.
5. Use a Swagelok® gap inspection gauge for checking all gas line connections for proper tightness. The fittings require tightening if the size-matched gauge end slides between the connections. Tighten until the gauge end does not slide between the connections.
6. Install the 90° angled vent hose onto the vent port and position as previously installed.

⚠**CAUTION**

Vent port is special undercut fitting. DO NOT bend or twist. Damage to this will hamper PRD function of ITT regulator.

7. Pour the drained coolant back into the cooling system.
8. Turn the quarter-turn shut-off valve handle to the ON position. The handle is in the on position when it is aligned (parallel) to the fuel line.

   ☞**NOTE:**

   Make sure the fill box door is firmly closed before attempting to start the engine. The fill box contains a proximity sensor to prevent the engine from starting when the door is open. The engine ignition is disabled and the high-pressure solenoid valves are shut off to prevent fuel flow to the gas mixer when the proximity sensor is open.

9. Turn the ignition on to activate the starter. The solenoid valves will then energize and allow fuel to flow through the filtering and regulating system to the fuel mixer, starting the engine.
10. Run the engine up for a minute or so to allow the fuel delivery system to stabilize, then shut the engine down.
11. Open the fill box door and check the high and low pressure gauges for pressure readings. The high pressure gauges should show 200 to 3,600 psi (1,375 to 24,800 kPa), the low pressure gauge should show 94 to 120 psi (648 to 827 kPa).
12. Check the regulator connections using a combustible gas detector such as the Snap-On ACT 8800®. This particular unit can detect localized gas leaks from 50 to 1000 PPM.

    ☞**NOTE:**

    Liquid solutions such as SNOOP® can also be used. DO NOT use make-shift soapy water solutions.

4.7.4. Regulator Coolant Bowl Seal Replacement

1. Set Battery Disconnect switch to OFF position.
2. Allow engine to cool to ambient temperature.
3. Operate manual pressure relief valve on coolant surge tank to relieve any residual pressure.
4. Place a suitable container under radiator and drain sufficient coolant to lower coolant level below regulator valve bowl.
5. Loosen coolant hose clamps at regulator and disconnect hoses from regulator.
6. Clean regulator and bowl of any spilled coolant.
7. Scribe regulator bowl and body with reference mark for reassembly.
8. Remove bowl retaining screw and O-ring from base of bowl and pull bowl away from body to remove.
9. Remove and discard small O-ring from retaining screw and large O-ring from regulator body.
10. Clean O-ring groove in regulator body to ensure all sealing material and dirt is removed.
11. Use a soap and water solution to check regulator inlet gas cap for bubbles. If leakage is indicated, replace regulator assembly.
12. Lightly lubricate O-rings with petroleum grease. Install large O-ring in regulator body seal groove and place small O-ring on bowl retaining screw.
13. Align reference marks on regulator bowl and body and install bowl straight on without twisting.
14. Ensure bowl is fully seated and centered and install retaining screw with O-ring.
15. Hold bowl to prevent rotation and torque retaining screw 54 to 66 in-lb. (6.1 to 7.5 Nm).
16. Connect coolant lines to bowl fittings and refill cooling system.
17. Set Battery Disconnect switch to ON position. Run engine and check for leaks.

4.8. Sherex Fueling Receptacles

4.8.1. Description

Sherex fueling receptacles are specifically designed for CNG fueling using Sherex fueling nozzles. Receptacles come complete with a protective cap and have an integral high flow back check valve.

4.8.2. Maintenance

4.8.2.1. Inspection

Ensure all visible surfaces of receptacle are clean and free of any debris, dirt or oil deposits. Check for physical damage. Check receptacles, dust caps and mounting hardware periodically to ensure all parts are secure, correctly mounted, function properly and are leak free.

4.8.2.2. Removal

1. Refer to 4.3.3. “Zone One Venting Procedure” on page 22 in this section and vent the work area.

⚠ CAUTION

DO NOT apply wrench or use any tool on the body of the receptacle. Hold receptacle by adapter shaft hexagon flats only.

2. Remove receptacle, observing previous caution on handling.
3. Discard O-ring. Clean and inspect for damage, especially to threads.

4.8.2.3. Installation

1. Ensure dust cap and O-ring seal are installed on replacement receptacle. Use only Sherex mounting and sealing hardware. Do not mix hardware with other manufacturers' components.
2. Inspect the filler block and fitting for dirt and signs of wear. Clean threads and all sealing surfaces. Inspect receptacle O-ring seal for damage.
3. Lightly lubricate adapter shaft seal with silicone grease Dow Corning III. Insert the receptacle shaft into the block/fitting and finger tighten. Ensure that O-ring seats correctly.

⚠ CAUTION

DO NOT apply wrench or use any tool on the body of the receptacle. Hold receptacle by adapter shaft hexagon flats only.

4. Using a torque wrench, tighten the receptacle adapter shaft into the block fitting. Torque 30 to 35 ft-lb. (40 to 47 Nm).

☞NOTE:

The fill box contains an interlock proximity sensor to prevent the vehicle from starting during refueling. When the fill box door is open, the contact of the interlock proximity sensor is OPEN. The engine ignition is interlocked and the high-pressure solenoid valves shut off to prevent fuel flow to the gas mixer.

☞NOTE:

The Door Master switch only overrides the door and throttle interlocks. It does not override ignition inhibit that is activated when the fill box door is open and the ignition interlock proximity sensor is open. You cannot override this system to start the engine or keep it running if the door is open.

4.9. CNG High Pressure Solenoid Valve

4.9.1. Description

Each fuel tank has a high pressure solenoid valve which is used for fuel supply to the engine and which allows fueling of the tank. The valve incorporates a solenoid for these functions. Each valve contains the following components.

- ❒ Two common inlet/outlet ports
- ❒ A coil connector
- ❒ Identification marking
- ❒ Manual knob to open/close the valve
- ❒ Internal double O-ring system
- ❒ Glass bulb temperature pressure relief device and port
- ❒ Live port
- ❒ Solenoid
- ❒ Valve body mating threads

4.9.2. Operation

The valve's solenoid is electrically actuated through the engine ECM. When the solenoid opens fuel flows through the outlet port of the valve to the main fuel line. When the engine shuts down the solenoid is de-energized. During fueling the solenoid is de-energized and the fuel flows into the tank through the valve's integral check valve. The check valve feature prevents reverse fuel flow when the solenoid is de-energized.

4.9.3. Functional Test

1. Disconnect the electrical connector from each of the fuel tank solenoid valves.
2. Leave the main quarter-turn shut-off valve open. Start the engine and run the vehicle until the gas in the fuel lines from the tanks is expended and the engine stops.
3. Close the fuel tank solenoid valves manually by rotating the valve knob. See “Fig. 7-14: Electronic Tank Valve” on page 45.
4. Electrically reconnect one of the tank valves. Open the manual lockdown on the valve and start the engine. If the engine does not start or the fuel lines do not pressurize, label the valve NOT OPENING.

☞**NOTE:**

An audible clicking noise indicates that the solenoid is working.

5. Disconnect the electrical connector while the vehicle is still running. If the vehicle does not stall the valve may be leaking internally. Close the manual lockdown on this valve.
6. Repeat steps 4 and 5 for each tank valve. Any valve labeled NOT OPENING should be tested using an external 24 volt power supply. If the valve opens, the vehicle electrical system may be at fault. If the valve fails to open, the tank should be manually vented and the valve replaced. Refer to 4.3. “CNG Venting Procedure” on page 20 in this section for procedure.
7. Reconnect all electrical connectors and open all manual lockdowns.

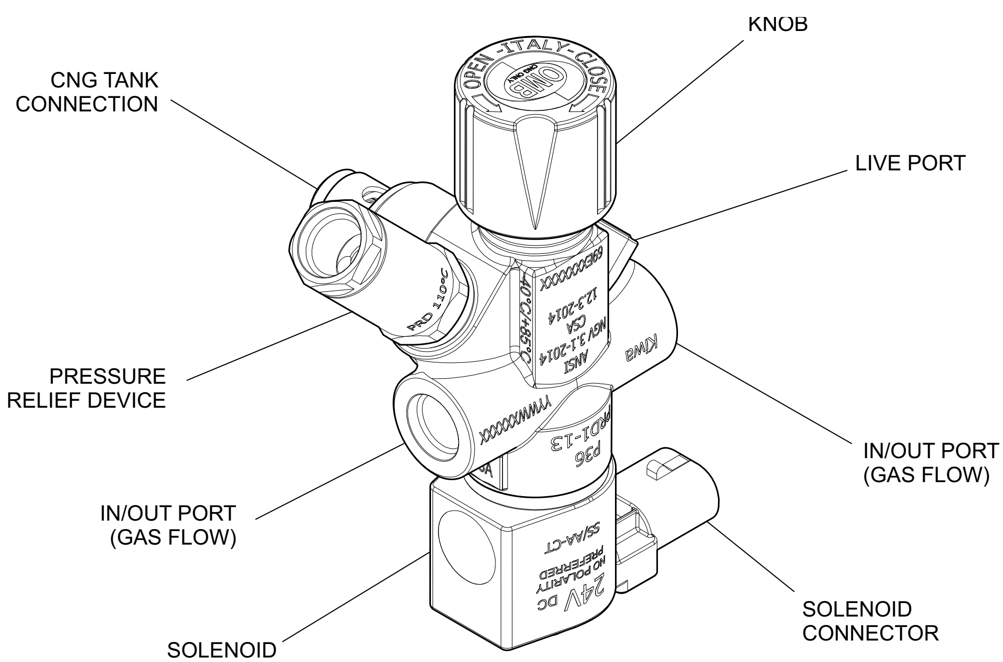

Fig. 7-14: Electronic Tank Valve

4.9.4. Solenoid Fault Control Module

The Solenoid Fault Control Module monitors the electrical status of each high pressure solenoid valve. If the module detects an electrical fault with any solenoid valve, it will display a "CNG Valve Fault" text message on the instrument panel display screen. The Solenoid Fault Control Module is mounted on the rear electrical panel, located at the rear of the vehicle.

☞**NOTE:**

The Solenoid Fault Control Module will detect electrical faults only and will not detect a mechanical fault with the solenoid valve. Refer to 4.3.7.1. “Venting Tank (Solenoid Valves Stuck Open)” on page 27 *in this section for comprehensive solenoid valve test procedures.*

4.9.5. Valve Removal from Tank

1. Vent the fuel tank. Refer to 4.3.7. “Zone Three Venting Procedure” on page 26 in this section for procedure.

⚠CAUTION

The fuel tank fittings are low-torque style. They can easily be damaged if proper care is not taken.

2. Disconnect the fuel lines, the fuel vent line, and the electrical connector of the solenoid valve of the tank being serviced.
3. Use ESA special mounting tools and a torque wrench to unscrew the valve in a counterclockwise direction for 10° ONLY!

⚠CAUTION

At this point, verify the removal torque does not exceed 5 ft-lb (7 Nm). STOP immediately if the torque is higher because there is still pressure in the tank.

DO NOT remove the valve from the tank until all gas has been expended or vented.

4. Carefully remove the valve if the removal torque does not exceed 5 ft-lb (7 Nm). Some residual pressure will be released during removal.

☞**NOTE:**

Do not disassemble any part of the valve. Send it to the OEM, Agility Fuel Solutions for analysis.

4.9.6. Installation of Valve on Tank

For proper installation the valve must be correctly installed by properly trained maintenance personnel.

Installation tools required include a torque wrench, ESA special mounting tools and Parker Super O-Lube or suitable substitute for the O-ring. Proceed as follows:

1. Apply silicone grease lubricant to the O-ring sparingly.
2. Carefully engage the valve body threads to the CNG tank 1 1/8 - 12 UNF port fitting.
3. Manually thread the valve onto the tank.
4. Torque the valve to 83 ± 13 ft-lb.
5. Apply a light coating of silicone grease on the O-rings and install the male adapter and plug into the 9/16" - 18 threaded ports of the solenoid valve. Torque the fittings 20 to 30 ft-lb. (27 to 47 Nm).
6. Rotate the tank as required to align plumbing ports.

☞**NOTE:**

Refer to 5.8. “Tank Installation” on page 71 *in this section for procedure.*

7. Install PRD vent and fill/engine feed lines onto the standard connectors and tighten Swagelok® fitting. Refer to 6.1.6.1. “How the Swagelok® Fitting Works” on page 80 in this section for Swagelok fitting installation instructions.
8. Attach the electrical leads.
9. Fill the fuel tanks from the storage facility.
10. Check the solenoid valve for leaks using combustible gas detector such as the Snap-On ACT 8800®. This particular unit can detect localized gas leaks from 50 to 1000 PM.

☞**NOTE:**

Liquid solutions such as SNOOP® can also be used. DO NOT use make-shift soapy water solutions.

11. Make sure the quarter-turn shut-off valve is in the ON position. The handle is in the on position when it is aligned (parallel) with the fuel line.

☞**NOTE:**

Make sure the fill box door is firmly closed before attempting to start the engine. The fill box contains a proximity sensor to prevent the engine from starting when the door is open. The engine ignition is disabled and the high-pressure solenoid valves are shut off to prevent fuel flow to the gas mixer when the proximity sensor is open.

12. Turn the Master Run switch to DAY or NIGHT operating position. Turn the ignition on to activate the starter. As the starter spins the engine up to 400 RPM, the solenoid valves will energize and allow fuel to flow through the filtering and regulating system to the fuel mixer, starting the engine.

☞**NOTE:**

If the engine does not start, make sure the fill box is firmly closed and that the solenoid valve wires are connected.

13. Run the engine up for a minute or so to allow the fuel delivery system to stabilize, then shut the engine down.

DANGER

DO NOT perform any corrective action or other maintenance on a pressurized system. Perform component servicing or maintenance only after the affected zone has been isolated and depressurized. Refer to 4.3. “CNG Venting Procedure” on page 20 **in this section for depressurizing procedure.**

14. Recheck the solenoid valve and the run/fill loop connections with the Snap-On ACT 8800® combustible gas detector. Tighten any fittings as required. Use a backup wrench to prevent overtightening.

15. Open the fill box door and check the high and low pressure gauges for pressure readings. The high pressure gauge should show 200 to 3,600 psi (1,375 to 24,800 kPa), the low pressure gauge should show 94 to 120 psi (648 to 827 kPa).

4.10. Fuel Door Proximity Switch Adjustment

1. Turn switch adjusting nuts in until metal pad on door touches switch before door is fully closed.
2. Turn switch adjusting nuts out in small increments until door fully closes.
3. Turn adjusting nut out an additional 3 turns. The maximum gap is 0.19" (5 mm) between the switch and the door plate.
4. Tighten lock nuts against mounting bracket.
5. Test system for correct operation by ensuring vehicle starts when fuel fill box door is closed.

☞**NOTE:**

Thread pitch on Proximity switch is 1 mm. Each turn of the adjusting nut will move the switch 1 mm.

5. CNG FUEL TANKS

5.1. Glossary of Terms

Abrasion Damage – Damage to composite caused by wearing, grinding or rubbing away of the composite material by friction.

All-Composite (Type 4) Tank – A fuel tank made primarily from non-metallic materials such as plastic and high strength fiber reinforced composites. The tank may incorporate metal ports for attachment of valves and other plumbing devices.

Boss – The aluminum fittings at the ends of the container, which contain the ports for installation of valves, pressure relief devices and blank plugs.

Blank Plug – A threaded plug with O-ring seal used to block container ports not occupied by a valve or pressure relief device.

Blunt Impact – A forceful blow to the surface of the tank which does not cut, gouge or significantly indent the surface. This type of impact may induce damage, such as delamination which is not readily apparent by visual examination.

Carbon Fiber – One of the types of reinforcement fibers used in the composite overwrap.

Clips – The portion of the bracket assembly that interfaces the strap to the Rail Cleat or bracket base.

CNG – Compressed Natural Gas.

Condemned Tank – A container that has been damaged beyond repair and must be removed from service.

Crazing – Hairline cracking of the resin, giving it an opaque, “frosty” appearance.

Cut Damage – Damage caused by a sharp object in contact with the composite surface that breaks or cuts the composite fibers.

Cylinder: Preferred term for “tank” in CNG applications and systems.

Cylinder Region – The cylindrical portion of the tank.

Delamination – A form of composite damage in which a separation develops between layers of the composite. This type of damage usually results from excessive localized loading perpendicular to the surface of the laminate.

Destroyed – Alteration of a fuel container to make it physically unusable. Drilling of a hole, 1/2" diameter or larger, completely through the wall and liner is an acceptable means of destroying a tank.

Domes – The closed end portions of the fuel container.

Door – A fiberglass structure hinged and latched protecting the top and sides of the tank pack assembly.

Entrapped Air – As referred to in this document, it is the air volume that is trapped between the HDPE liner and the corresponding composite overwrap.

Factory Inspection – An inspection and evaluation performed at Agility Fuel Solutions of the container by utilizing comprehensive testing techniques that are not available for field inspection.

Fairing – Metal frame/fiberglass covered assembly. Typically installed on the front and rear of some tank pack assemblies.

Field Inspection – Inspection performed on container installed in a vehicle.

Filament Winding – An automated process used for orienting strands of high strength fibers and plastic resin to construct composite tanks.

Fill Line – A high-pressure line used to conduct gas into the tank through the valve assembly or assemblies.

Foam Insert – Impact absorbing material located under the fiberglass wrap designed to protect the tangent area from damage.

Frame – General term that is used to describe the metal structure of the tank pack. The frame encloses and supports the tanks, brackets and pressure lines, fairings, and doors also attach to the frame.

FSCM: Fuel system control module.

Glass fiber: One type of reinforcement fibers used in the cylinder structural wrap. Also fiber used in the external sacrificial wrap. Glass fiber is also referred to as fiberglass.

Hardware – General description of valves, PRD's and any other component that will attach to the container.

Impact Damage – Damage caused by dropping or by a blow from another object. Impact damage may be at the surface, internal to the structure, or both.

Inspection Stamp – The stamp applied to the label by a registered inspector, indicating acceptance of the three year required inspection. The stamp shall identify the inspecting individual.

Level 1 Damage – Minor damage that is considered inconsequential to safe operation of the tank.

Level 2 Damage – Damage which is more severe than Level 1 damage. This level of damage is rejectable. Additional evaluation and/or repair may allow the tank to be returned to service.

Level 3 Damage – Damage which is sufficiently severe that it is not repairable and is unfit for continued service. Tanks with Level 3 damage are condemned and must be destroyed.

Liner – An internal component of the tank which prevents leakage of gas through the composite tank structure.

Manufacturers Label(s) – The label(s) containing the official markings required by the U.S. DOT, FMVSS304, ANSI/CSA NGV2, ISO 11439, CSA B51-Part 2 (Canada), and/or other national standards as may apply. The label markings shall include a "CNG Only" designation, manufacturer's symbol or trademark, manufacturer's model number, type designation, serial number, month and year of manufacture, service pressure, the inspector's symbol or trademark and the date when the service life of the tank will expire.

Maximum Fill Pressure – The fill pressure allowed to obtain the settled service pressure at 70°F (21°C). For all tanks, maximum fill pressure under ANSI/CSA NGV2 is 125% of the rated Service Pressure.

Mounting Brackets – The devices used to secure fuel tanks in a vehicle. The brackets are specially designed to restrain composite tanks without causing damage and to accommodate tank growth caused by changes in internal pressure.

Mounting Bolts – These are the bolts that secure the mounting bracket bases to the frame of the vehicle.

NGV – Natural Gas Vehicle.

Ports – The openings at the ends of the tank in which valves, pressure relief devices and blank plugs or other hardware is installed.

Pressure Relief Device Supports – Vertical frame supports for Tank Packs attaching the mounting blocks to support the pressure lines.

Pressure Relief Device (PRD) – A device installed in direct contact with internal pressure in the container that will release the contained gas in specific emergency conditions. Excessive temperature, excessive internal pressure or both may activate the device. Thermally activated pressure relief devices are required in all installations.

Rail Cleat – Bottom frame members on a Tank Pack to which tank bracket Clips are attached.

Registered Inspector – An individual who has completed the Agility Fuel Solutions NGV Fuel Container Training class and is registered with Agility Fuel Solutions with a certificate in response to passing the training class exam. As a registered inspector this individual will have received proper training and a registered stamp that will allow performance of three year inspections on Agility Fuel Solutions fuel containers.

Rejected Tank – A tank that must be removed from service and evaluated further before final disposition.

Resin – Epoxy material in the composite overwrap which fills the space between individual reinforcing fibers.

Service Life – Specified number of years from the date of manufacture that the tank may be used. The expiration date for a specific container is printed on the manufacture's label. A fuel container is to be destroyed at the end of its service lift.

Service Pressure – The settled pressure at a uniform gas temperature of 70°F and full gas content. Also referred to as nominal pressure or working pressure.

Skirts – A fiberglass structure that runs the length of the tank pack (both sides) and fastens to the skirt brackets if so equipped. Skirts cover the gap between the bottom of the tank pack and the roof top.

Solenoid valve: A device installed in one of the tank ports that is used to open or close off gas flow into or out of the tank. The valve is turned on or off electrically. The valve can be closed manually, if necessary with special tools following a defined procedure.

Solid Plug – A threaded plug with O-ring seal used to block tank ports not occupied by a valve or pressure relief device.

Strap – The part of the bracket assembly that connects with the base or clips and wraps around the tank to hold the tank to the frame or base.

Strap Bolts – The bolt that secures the straps to the tank.

Tangent Area – The area of the container where the cylinder section meets the dome section of the container.

Tank Pack – A general description to apply to all multiple tank systems contained within a frame that include the related pressure and vent lines assemblies.

Tap Test – An inspection technique in which the surface of a Agility Fuel Solutions tank is tapped with a small solid object, such as a “Coin”, to detect delaminations. A delaminated area will emit a different sound than an area that is not damaged. This inspection can only be performed on the cylinder region of a TUFF-SHELL™ tank and not in the domes.

Thermal Trigger – The thermal trigger is the portion of a thermally activated pressure relief device which is actuated by excessive heat input and activates the relief device.

Transition Bracket – An attachment bracket used to interface between the tank pack and the vehicle frame.

Valve, Manual – A device installed in one of the ports of the tank which is used to regulate gas flow into or from the tank. The valve is turned on or off manually with a handle.

Valve, Solenoid – A device installed in one of the ports of the tank which is used to regulate gas flow into or from the tank. The valve is turned on or off electronically.

Vent Line – A high pressure line used to conduct gas from a pressure relief device to a location outside of the vehicle where gas may be safely discharged. Vent lines are required where pressure carrying components are installed in a closed compartment.

Vent Enclosure – A low-pressure gas-tight enclosure used to collect and conduct gas that may permeate through O-rings or leak from plumbing connections to a location where gas may be safely discharged outside the vehicle. The enclosure typically made of low-density polyethylene, encloses the neck of the boss port on the valve, plug and all CNG fittings. The vent enclosure must not interfere with heating or operation of the PRD. This vent system is required for installations where the container is installed in a closed compartment.

5.2. Tank Description

Each cylinder is 120" (305 cm) long and 15.7" (39.9 cm) in diameter weighing about 162 lbs. (73.5 kg). A cylinder stores 3,300 standard cubic feet (SCF) of compressed natural gas at 3,600 psi (24,800 kPa).

The cylinders are constructed of a gas-tight thermoplastic liner overwrapped with carbon fiber composite. Agility Fuel Solutions TUFFSHELL design enhances tank durability. Anodized aluminum bosses are provided at each end of each tank. The basic fuel tank design is qualified to the "American National Standard for Basic Requirements for Compressed Natural Gas Vehicle (NGV) Fuel containers", ANSI/CSA NGV2.

Each tank has a solenoid valve with integral check valve which is used for fuelling.

5.3. Tank Identification

Each tank has a label showing:

- ❒ fuel type (CNG ONLY)
- ❒ psi rating (3,600 psi)
- ❒ serial number (SN XXXX–XXX)
- ❒ part number (PN 240270-034)
- ❒ manufacturing date/maximum operating temperature range (05–94/180°F)
- ❒ tank expiry date ("DO NOT USE AFTER XX-XXXX YEARS").

☞**NOTE:**

This will be the expiry date by month and year.

5.4. Tank Location & Mounting

The fuel tanks are mounted lengthwise in a tank bay on the vehicle roof. The fuel tanks sit in mounting bases and are retained by straps. Both the bases and straps are lined with a rubber pad providing a flexible yet secure attachment point. A rack module with latched doors protects the fuel tanks and related components from damage and the elements. Refer to Section 15 of this manual for rack module maintenance procedures.

5.5. Tank Inspection

☞**NOTE:**

Walking on the tanks is acceptable. However, personnel must check their footwear for presence of any objects which might damage the tanks before walking on them.

5.5.1. Description

These Agility Fuel Solutions compressed natural gas (CNG) tanks have been certified by the American Gas Association Laboratories as conforming to the requirements for Type NGV2-4 fuel containers defined in the ANSI/CSA NGV2 specification “Basic Requirements For Compressed Natural Gas Vehicle (NGV) Fuel Containers”. This specification was specifically developed to address the requirements of on-board fuel storage in a vehicle.

Although ANSI/CSA NGV2 specification requires periodic visual inspection at intervals of 36 months, or less, tanks should be inspected every 12 months. If the vehicle has been involved in an accident the cylinders must be inspected before returning to service. Inspections should also be performed if a vehicle is involved in a fire or a collision.

These guidelines are for inspection of all composite NGV Fuel Containers manufactured by Agility Fuel Solutions and used as fuel tanks in vehicles powered by compressed natural gas.

5.5.2. Inspection Guidelines

The purpose of this information is to provide sufficient data and details about NGV fuel tanks manufactured by Agility Fuel Solutions so that a trained inspector can effectively examine composite fuel tanks, assess their condition and determine if they are safe for continued service. Minor repair procedures are also identified which may be used to prolong the useful life of fuel tanks with minor surface damage. These guidelines should be used along with other applicable standards and specifications.

Information regarding proper NGV fuel tank installation which is not directly related to inspection of the composite fuel tank is also included. This additional information is provided as a reminder of critical installation points and is not intended to supersede or replace other applicable specifications. In particular, the inspector should be knowledgeable of NFPA 52 and/or CAN/CGA-B109 requirements and the Agility Fuel Solutions “NGV Fuel Container Inspection Guidelines”.

☞**NOTE:**

All information in this section regarding CNG fuel tank inspection is based on specific information from this Agility Fuel Solutions publication, or in most cases, is reproduced word-for-word from this document.

Please read and understand all aspects of these guidelines prior to performing an inspection of a Agility Fuel Solutions NGV fuel tank. A glossary of terms used in these guidelines is provided.

5.5.3. Information Sources

Any questions pertaining to locating or training of inspectors and interpretation or use of these guidelines should be directed to:

- ❒ Agility Fuel Systems Cylinder Division
  5117 NW 40th Street
  Lincoln, NE 68524 USA
  Phone: (402) 470-8440
  Toll-free: 800-279-TANK (8265)
  Fax: (402) 470-0019
  support@agilityfs.com

5.5.3.1. Available Publications List

The following documents may be useful in performing an inspection and servicing of composite NGV fuel tanks manufactured by Agility Fuel Solutions. Note that some of these documents are produced by Agility Fuel Solutions and some are government or government agency documents. It would be advisable to especially obtain publications containing government regulations and guidelines regarding CNG systems.

- ❒ "Methods For Visual Inspection of Natural Gas Vehicle (NGV) Fuel Tanks and their Installations", CGA C-6.4, available from:
  Compressed Gas Association, Inc.
  14501 George Carter WY, Suite 103
  Chantilly, VA 20151-2928
  Phone: 703 788 2700
  www.cganet.com
- ❒ "Recommendations for the Disposition of Unserviceable Tanks",
  CGA C-2 available from:
  Compressed Gas Association, Inc.
  14501 George Carter WY, Suite 103
  Chantilly, VA 20151-2928
  Phone: 703 788 2700
  www.cganet.com
- ❒ "Compressed Natural Gas (CNG) Vehicular Fuel Systems", ANSI/NFPA 52, available from:
  National Fire Protection Association
  1 Batterymarch Park,
  P.O. Box 9101,
  Quincy, MA 02269-9101
  Phone: 800 344 3555
  www.nfpa.org
- ❒ Basic Requirements for Compressed Natural Gas Vehicle (NGV) Fuel Tanks", ANSI/CSA NGV2, available from:
  CSA America, Inc.
  8501 East Pleasant Valley Road
  Cleveland, OH 44131
  Phone: 216 524 4990
  www.csa-america.org
- ❒ "High Pressure Tanks for the On-Board Storage of Natural Gas as a Fuel for Automotive Vehicles",
  CSA B51 Part 2, available from:
  Canadian Standards Association
  178 Rexdale Boulevard
  Rexdale (Toronto), Ontario, Canada
  M9W 1R3 CANADA
  Phone: 800 463 6727
  www.csa.ca
- ❒ "Federal Motor Vehicle Safety Standards: Compressed Natural Gas Fuel Tanks" DOT FMVSS 304, available from:
  Department of Transportation, National Highway Traffic Safety Administration
  1200 New Jersey Ave, SE
  Washington DC 20590
  Phone: 202 366 4000
  www.dot.gov
- ❒ "METI/KHK TECH. STD. #9" Technical Standard and Interpretation of Compressed Natural Gas Fuel Tanks. The High Pressure Gas Safety Institute of Japan
  Toranomon, Minato-ku,
  Tokyo Japan 105-8447
  Phone: 81 3 3436 2201
  www.khk.or.jp/e-khk.htm

- ❒ Service Bulletin 95-001 “Painting NGV Fuel Tanks”
- ❒ Service Bulletin 97-07-001 “Pressure Relief Device Replacement for Superior (P/N 1120SX6SF) and GFI (P/N T1-100) Manual Valves with Circle Seal (P/N RV 99-245) and Mirada (P/N B-51715) PRD’s”
- ❒ Service Bulletin 97-08-001 “Venting Procedures”
- ❒ Service Bulletin 97-08-002 “Fill Procedures”
- ❒ Service Bulletin 00-02-001 “Inspection for Water in the Vent Line and Pressure Relief Device”
- ❒ Service Bulletin 96-12-001 “Label Installation Procedures TUFFSHELL™ NGV Fuel Tanks”
- ❒ Service Bulletin 00-11-001 “Honda Provided Superior/GFI Solenoid Valve on Agility Fuel Solutions CNG Fuel Tanks”
- ❒ Service Bulletin 03-06-001 “Crush Washer Replacement Procedure”
- ❒ “TUFFSHELL™ all-composite NGV Fuel Tanks” size and capacity chart
- ❒ NGV Tank Inspection Record
- ❒ Agility Service Bulletin "CNG Regulator Troubleshooting, ENP-088"
- ❒ Agility Service Bulletin "High Pressure Filter Maintenance, ENP-114"
- ❒ Agility Service Bulletin "Welding and Hot Work Precautions, ENP-422"
- ❒ Agility Service Bulletin "Firefighters First Responder Guide for CNG and LNG Vehicle Fuel Systems, ENP-084"
- ❒ Agility Service Bulletin "Service Facility Fuel Handling Equipment, ENP-380"
- ❒ Agility Service Bulletin "Safely Working on CNG Fuel Systems, ENP-391"
- ❒ Agility "CNG Fuel Cylinder Inspection Manual, ENP-558"

5.5.3.2. Tank Design Information

Agility Fuel Solutions fuel tanks are constructed with a high strength composite tank wall consisting of carbon in an epoxy resin.

Agility Fuel Solutions has provided TUFF-SHELL features in the design of its tanks to maximize resistance to damage inducing events. These include a damage resistant outer layer, impact resistant, energy materials in the dome regions, and an external coating to minimize the effect of environments and exposure to sunlight.

These features significantly reduce, but do not eliminate, the possibility of a serious accident caused by inappropriate installation, use and maintenance of the composite tank. Periodic inspection is an integral element of the maintenance requirements for safe operation of an NGV fuel tank.

Safe operation of a composite fuel tank is also dependent on proper installation and use of safety devices.

The tank must be mounted in a manner which adequately restrains the tank but does not induce damage. The tank expands and contracts as the pressure in the tank increases and decreases. This causes the tanks diameter and length to vary, depending on pressure. The tank mounting system must be able to accommodate this movement without inducing excessive loads to the bracket or causing abrasion of the tank. Agility Fuel Solutions mounting brackets are specifically designed for use with Agility Fuel Solutions tanks and tested by The American Gas Association Laboratories for conformance to the mounting requirements of NFPA 52. Use of other brackets may result in tank damage or improper restraint of the tank, either of which could result in a hazardous situation.

Each fuel tank must be protected by at least one quick response thermally activated pressure relief device (PRD) approved by Agility Fuel Solutions for use with its tanks. This device may be installed on the tank valve or may be installed in the port opposite that occupied by the tank valve. The PRD may also be installed in a manifold assembly that is connected directly to the tanks internal pressure. Installations where tanks greater than 65" in length are used require use of a PRD at both ends of the fuel tank. Use of a PRD at both ends of the tank is also recommended in installations where it is possible for the tank to be exposed to severe heating without significant heating of a single PRD. The installation on this vehicle uses 2 PRD devices per tank.

5.5.4. Inspection Intervals & Procedures

Inspect the tank(s) promptly if the following situations have occurred.

CAUTION

Composite tanks manufactured in conformance with the ANSI/CSA NGV2 specification should be inspected by a trained inspector at intervals of 36 months or 36,000 miles, whichever comes first.

1. The fuel tank, or vehicle in which it is installed, is involved in a fire, is subjected to impact, is exposed to excessive heat or is believed to have potentially been damaged by any means.

NOTE:

Tanks which have been involved in an incident which may have damaged the tank, or which exhibit indication of potential Level 2 or Level 3 damage should be depressurized prior to inspection.

2. The fuel tank installation should also be inspected at any time unusual behavior is observed. Unusual behavior may include, but is not limited to, emission of natural gas odor, unexpected loss of gas pressure, rattling or other indications of looseness, unusual snapping or hissing sounds.
3. The fuel tank is transferred to another vehicle or the tank installation is changed significantly.

WARNING

Failure to perform inspections on a regular basis, or promptly in the case of a potentially damaging incident or unusual behavior, may result in a serious accident causing severe damage and injury.

WARNING

Before depressurizing the container, ground the venting orifice with a 3-gauge wire minimum to an appropriate ground source at least 8 feet (2.44 meters) in the ground. Rapid discharge can generate a static electrical charge, which may be sufficient to ignite the escaping gas. When venting the container, it must be in a well-ventilated area free of ignition and heat sources. DO NOT vent the container in an area where the flammable gas may accumulate and ignite.

5.5.5. Preparation for Inspection

The surface of the tank should be clean and free of dirt or other debris which impedes the ability to clearly determine the condition of the external surface of the tank. Shields or covers should be removed, where possible, to ensure access to the maximum tank surface area for inspection. It is not necessary to remove the tank from the vehicle if it is possible to determine that visually inaccessible surfaces are protected by the vehicle and that there is little potential for damage to the inaccessible surfaces.

The tank owner/vehicle operator should be questioned regarding any known conditions or incidents which may have caused damage to the tank. These include, but are not limited to, dropping of the tank, impacts to the tank, exposure to excessive heat or fire, vehicle accidents, and exposure to harsh chemicals. Information regarding any unusual observations about the tank, service history of the tank and any repairs which may have been made since its last inspection should be considered.

5.5.6. Installation Inspection

The initial inspection should examine the general fuel tank installation. This inspection should:

1. Determine the installation complies with applicable regulations.
2. Verify that the fuel tank is being used only for the storage of compressed natural gas.
3. Verify that the tank was manufactured by Agility Fuel Solutions and that the service pressure and tank serial number are clearly legible on the tank label.

☞**NOTE:**

This manual and instructions also apply to tanks manufactured by Agility Fuel Solutions and Brunswick.

4. The tank must be destroyed if the identity (model/part number and serial number) cannot be clearly established and identified from the tank label and other sources such as sales contracts, bills of sale, invoices or warranty forms. Contact Agility Fuel Solutions NGV Customer Service if the label is damaged or not firmly attached.

☞**NOTE:**

For containers manufactured after July of 1999; if the label is missing or damaged, the serial number of the container is etched on one of the bosses.

5. Verify that the tank service life has not expired. For example, the label might identify the service life as "DO NOT USE AFTER XX-XXXX." The tank must be removed from service and destroyed when the service life expires.
6. Verify that the service pressure rating listed on the tank label is greater than or equal to vehicle markings for service pressure.
7. Determine potential for damage due to location in vehicle. Could tank be damaged by tools, shifts of cargo, road debris, or proximity to exhaust system?
8. Verify that the surface of the tank is not in contact or close proximity to objects which could cut, gouge or abrade the surface of the tank. This includes cables, tubing, vehicle components or mounting bracket components. A minimum of 0.5" clearance completely around the tank is recommended. Additional clearance may be required in areas where the vehicle may flex during operation.
9. Verify that installations in which tanks are enclosed in a vehicle are vented external to the vehicle. The vent line from the pressure relief device (PRD) should be a high pressure line which is adequately secured to the vehicle to prevent whipping in the event of PRD activation. The vent line exit should be free of debris and be oriented so as to not trap fluids. A lightweight cap which can easily be expelled by pressure in the vent line may have been used to prevent accumulation of debris in the vent line.
10. Verify that lines connected to the tank are installed in a manner to prevent damage to the plumbing when the vehicle flexes or the tank expands under pressurization.

5.5.7. Mounting Bracket Inspection

Tanks are mounted in brackets which restrain them without damaging tank or vehicle. The mounting system allows the tanks to contract or expand without abrasion as internal pressure varies. The tank to bracket interface is lined with a rubber pad to limit tank movement.

Tanks need not be removed for the following inspections. However, if they are, the mounting bolts must be retorqued correctly on installation. New rubber pads must be installed to ensure correct tank fit. New self-locking nuts must be installed.

Inspection of the mounting brackets should include the following.

1. Verify the tank is firmly restrained. The tank and mounting brackets should be firmly attached to the vehicle and not permit rocking or other evidence of tank looseness.
2. Verify that the tank straps are in place and are securing the tank from movement. Check for lock nut witness marks being undisturbed, if witness marks were applied when the strap bolts and lock nuts were installed.

CAUTION

DO NOT retorque the strap bolts and lock nuts if the initial torque of 45 ± 5 ft-lb. has fallen off after tank installation. What is important is that the straps are in place and are preventing tank movement. Further torquing could compress the rubber pads and damage the tanks, the straps and the mounting bolts when the tank is refueled.

3. Verification that the bolts which secure the brackets to the vehicle are present and tight. Brackets bolted to sheet metal panels should use large washers (3" outside diameter minimum) to prevent pull-through of the bolts through the vehicle's sheet metal. A 1/2" SAE washer must be used between the bolt and mounting brackets to prevent the bolt from pulling through the slot in the base of the mounting bracket.
4. Verification that the rubber pads are centered in place, have not been worn through and are in good condition. Replacement pads, if required, may be acquired from NF Parts Division.
5. Verification that the brackets are in good condition and suitable for continued service. Hardware, bolts or vehicle attachment points exhibiting severe corrosion or cracking of the mounting should be repaired or replaced.

5.5.8. PRD Inspection

Pressure relief devices (PRD) are installed in the vent lines running from each tank. All PRD's must be connected in a manner that ensures that the PRD can vent the contents of the tank regardless of whether the tank valve is in the closed or open position.

Only quick response PRD's approved for use with Agility Fuel Solutions tanks are to be used with these tanks. Approved devices are listed in Section 7 of the Parts Manual for this vehicle. The parts are available from NF Parts Division.

Inspection of the PRD should include the following.

1. Check the PRD for any external damage, including corrosion or mechanical damage to the body. Check in particular around fittings and bolts, and adjacent to mounting surfaces.

⚠ WARNING

Before depressurizing the container, ground the venting orifice with a 3-gauge wire minimum to an appropriate ground source at least 8' (2.44 meters) in the ground. Rapid discharge can generate a static electrical charge, which may be sufficient to ignite the escaping gas. When venting the container, it must be in a well-ventilated area free of ignition and heat sources. DO NOT vent the container in an area where the flammable gas may accumulate and ignite.

2. Ensure mounting bolts on the body are tight.
3. Inspect the vent line to ensure that there is no evidence of water accumulation or dirt.
4. Ensure that there is a functioning method of relieving normal pressure build-up while keeping water out of the vent lines. If vent line closures or caps are missing or compromised, the PRD and vent line must be inspected for any signs of water infiltration. Evidence of water in the PRD indicates a probable need to replace the PRD.
5. Verify that the supply lines are not kinked or damaged.
6. Leak check system.

5.5.8.1. Leak Testing

Leak testing is the only test of the PRD that is possible. Leaks will either be found at the seal of the inlet fitting, or through the Venting port. If the PRD leaks at the vent side, the PRD is faulty and should be replaced

Leak testing at the inlet fitting can be performed with a commercial leak testing fluid, or with a methane detector.

To leak test at the outlet of the PRD, first isolate the vent line of the PRD from other devices. Use of a methane detector is preferred. If using a liquid leak detector, make sure that fluid doses not get into the PRD as this could contaminate the PRD.

☞NOTE:

Methane detectors measure the concentration of gas, not flow. To measure flow, use a bubble flower meter, so long as it is used indoors with constant ambient conditions.

5.5.8.2. Reuse & Replacement

⚠ DANGER

If the PRD has been activated or exposed to fire, it cannot be reset or reused. It must be removed from service and either destroyed or returned to the manufacturer.

A PRD that is removed must only be replaced by an identical part unless approved otherwise by the tank manufacturer.

5.5.8.3. Removal

☞NOTE:

The PRDs are installed in Stainless steel lines, rigidly clamped to the tank assembly structure. It may be necessary to release the clamps to allow movement of the lines and create enough clearance to remove the PRDs.

1. Defuel tanks. Refer to 4.3.7. “Zone Three Venting Procedure” on page 26 in this section for procedure.
2. Note the PRD orientation and fitting configuration of the PRD prior to removal.
3. Loosen the Swagelok® fittings and disconnect vent lines from PRD inlet and outlet ports. See “Fig. 7-15: PRD Installation” on page 60.
4. Remove the mounting bolts.
5. Remove PRD from vehicle.
6. Remove the ORB fittings from the PRD. Fittings can be reused if not damaged. Discard O-rings and replace with new ones.

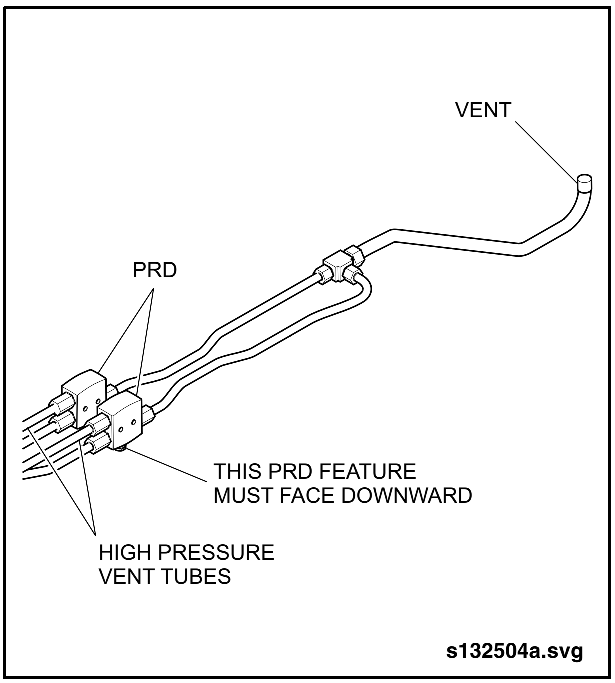

Fig. 7-15: PRD Installation

5.5.8.4. Installation

1. Place a new O-ring onto the ORB fitting and install fittings into PRD. Torque fitting 37 to 41 ft-lb. (50 to 56 Nm).

☞NOTE:

Ensure the fitting configuration matches the position noted during removal.

2. Mount the PRD ensuring its orientation matches the position noted during removal.
3. Connect the vent lines to the PRD connectors, ensuring the vent lines are fully seated within the Swagelok® fittings, and then tighten the Swagelok® fittings. Refer to 6.1. “Connections, Fittings & Tubing Maintenance” on page 73 in this section for Swagelok® tightening procedures.
4. Tighten any clamps that were loosened during removal.

5.5.9. Composite Tank Inspection

The composite fuel tank may be damaged without showing significant damage on the surface. Therefore, this inspection must be performed carefully. Since the inspection depends primarily on visual observation, the surface of the tank should be accessible, clean and well illuminated. Always carefully inspect damage depth as shown. See "Fig. 7-16: Inspection of Damage Depth" on page 62. Paint removal for inspection is not permitted.

The tank inspection consists of four primary elements:

1. Review of tank service history.
2. Visual examination.
3. Coin tap.
4. Factory inspection.

❒ Tank Service History – The inspector should review inspection/service records for the tank prior to inspection. Knowledge of the service history and interviews of the vehicle owner/operator may provide insight which will aid the inspection process. Refer to 5.5.5. "Preparation for Inspection" on page 56 in this section for procedure.

❒ Visual Examination – Visual examination of the composite tank surface is the primary means of detecting tank damage. Evidence of potential damage includes cuts, fractures, material removal, discoloration of the tank surface, and deterioration of the surface. Refer to 5.5.5. "Preparation for Inspection" on page 56 in this section for procedure.

❒ Coin Tap Examination – Potential defects may be also be detected by variations in sound emitted by light tapping of the composite surface with a small object, such as a coin. Variations in sound, such as transition from a "solid" to a "hollow" or "dead" response to tapping may indicate the presence of a delamination in the composite wall, a serious form of composite damage.

☞**NOTE:**

The coin tap should only be performed in the cylinders area of the tank. The energy absorbing features of the dome (end) areas of the container make it extremely difficult to detect delamination. False indications may be heard if the test is performed in the dome areas.

❒ Factory Inspection – Tanks which are known or suspected to have been subjected to a potentially damaging incident, or which exhibit evidence of damage not specifically identified as acceptable by these guidelines should be removed and may be sent to Agility Fuel Solutions for more extensive evaluation. Arrangements for factory inspection services may be made by contacting Agility Fuel Solutions NGV Customer Service. Refer to 5.5.3. "Information Sources" on page 52 in this section.

Section 6 of the "Guidelines for Visual Inspection & Requalification of Fiber Reinforced High Pressure Cylinders", CGA C-6.2 published by the Compressed Gas Association, Inc. provides additional illustrations of damage to composite high pressure cylinders. The CGA document, CGA C-6.2 should be used to supplement the inspection criteria contained in these guidelines. Refer to 5.5.3. "Information Sources" on page 52 in this section.

These guidelines use the same nomenclature for levels of damage as defined in the CGA C-6.2 document. Level 1 damage is acceptable and repair is not required. Level 2 damage is rejectable damage which requires repair, more thorough evaluation or destruction of the tank, depending on severity. Level 3 damage is sufficiently severe that the tank cannot be repaired and must be destroyed.

The composite surface of the tank should be inspected for evidence of damage.

5.5.9.1. Damage Level Classification

DAMAGE LEVEL CLASSIFICATION		
Damage Levels Rework Type	Scratch/Gouge & Abrasion Depth	
	Inches	Millimeters
Level 1	0 ≤ 0.010	0 ≤ 0.25
Level 2a (rework in the field)	0.011 ≤ 0.035	0.26 ≤ 0.89
Level 2b (Factory Inspection)	0.036 ≤ 0.050	0.90 ≤ 1.27
Level 3 (Condemn)	Greater than 0.050	Greater than 1.27
Level 1 - Damage is minor and deemed inconsequential.		
Level 2 - Damage is rejectable damage, which requires rework and more thorough evaluation of the container depending on severity.		
Level 3 - Damage is severe enough that the container cannot be repaired and must be destroyed.		

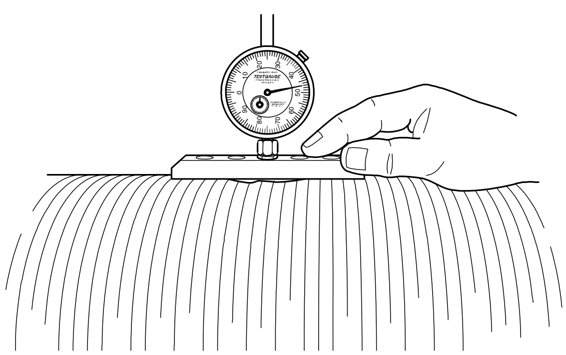

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Fig. 7-16: Inspection of Damage Depth

5.5.10. Cuts, Scratches & Abrasions

Cut damage will cause deeper fiber break than scratch damage. This type of damage is more difficult to measure because of the loose fibers in the damaged area.

Scratches in the composite surface result in surface fiber damage. Scratches will typically be less than 0.010" (0.25 mm) in depth and cause only minor fiber break.

Abrasion damage may be the result of many cycles of an object rubbing lightly on the surface of the container or due to few cycles under high loading will tend to be smooth and somewhat polished in appearance. Surfaces abraded under high loading will tend to appear as a group of parallel gouges or cuts as opposed to a polished surface.

Containers exhibiting evidence of abrasion under high loading, should also be examined as though the surface were subjected to impact.

Cut, scratch, and abrasion damage can lead to the unraveling of composite. Unraveling is level 2b damage. Contact Agility Fuel Solutions customer service if any unraveling has begun.

5.5.11. Impact Damage

Composite tanks are resistant to damage from impacts, but may incur severe structural damage and pose a safety hazard if subjected to excessive localized loading. Impact damage may be incurred during shipping, handling or in-service. These impacts may be the result of dropping the tank prior to installation or due to in-service conditions such as a vehicle accident.

Impact damage differs from other forms of tank damage in that the tank wall may suffer more severe damage within the wall of the tank than at the surface of the tank. This is particularly true if the surface of the object impacting the tank is blunt and relatively smooth. The surface of a composite tank tends to return to its original shape after an impact and, therefore, does not dent like an all-metal tank. However, localized surface deformation can occur but may not exceed damage Level 2a. Refer to 5.5.9.1. “Damage Level Classification” on page 62 in this section for further information.

Impact damage may cause delamination between and fractures of the composite layers used to construct the tank. Surface damage associated with impact loading may include cutting, gouging, scraping, scuffing, chipping, puncture, fiber breakage, loose fibers, resin cracking or change in coloration or appearance. The surface must be carefully examined for these types of indications. Known areas of impact should be marked to aid in the inspection process.

Accurate depth measurement of damage requires removing all loose fibre associated with the damage. Once the loose fibers are removed damage level can be determined. Known areas of impact should be marked to aid in the inspection process.

⚠CAUTION

DO NOT reuse any tank showing impact damage. Follow instructions in this section regarding disposition of damaged tanks.

Known areas of impact and zones of detectable surface damage must be inspected for evidence of damage within the wall. Evidence of damage within the wall includes:

1. Permanent deformation of the tank surface resembling denting of an all-metal tank is evidence of severe internal damage. Containers exhibiting this type of damage should be investigated for Level 3 damage.

   ☞NOTE:

   This condition does not include highly localized imprinting at the surface such as might result from events such as impact by a small stone.

2. Softness or deflection of the tank wall. The tank wall should be rigid and not easily deformable. Softness of the tank wall is evidence of severe internal damage. Tanks exhibiting this condition are condemned and must be destroyed. Tanks exhibiting softness in the dome areas only may be sent to Agility Fuel Solutions for factory inspection.

3. Damage to tank bosses. Impact to the ends of the tank, including the valves, plumbing and pressure relief devices should be investigated to ensure composite damage has not been sustained.

   Differences in sound are evidence of damage within the composite wall. Containers exhibiting this type of damage must be removed from service. The containers may be subjected to further field evaluation, if necessary by factory inspection at Agility Fuel Solutions or be condemned and destroyed.

4. Localized areas of surface crazing. Tanks which incur impact damage may exhibit circular, oval, or linear zones of crazing of the composite surface. The crazing may also be accompanied by a change in coloration. Each area exhibiting these types of indications should be subjected to the "coin" tap test. Questionable areas should also be subjected to factory inspection.

   ☞**NOTE:**

   Small random hairline cracks in the resin surface parallel to the reinforcing fibers are common in composite pressure tanks and are not a cause for concern. A group of cracks that are more closely spaced than generally observed on the tank and have a localized circular, oval, or linear pattern are evidence of impact damage.

5. Differences in sound emitted by performance of a "coin" tap test in the potentially damaged area relative to the surrounding area. The coin tap test is a tool used to identify delamination within the composite wall and should be performed only when the composite surface has been impacted. The coin tap test will not reveal delamination from abrasion damage, because abrasion damage will not delaminate underlaying layers. The coin tap test is performed, by tapping the surface of the composite with a quarter or larger coin, grasped between the fingers. The tapping sound emitted by the surface should be compared in zones of potential damage relative to surrounding areas where damage is not suspected. The coin tap test must be confined to the cylinder portion of the tank. False indications may be heard if this is attempted in the dome (end) areas. See "Fig. 7-17: Coin Tap Test" on page 64.

⚠CAUTION

The "coin" tap test should be performed only by a certified inspector. Any uncertainties resulting from these inspections shall be resolved by removing the tank from service and performance of a factory inspection. Contact Agility Fuel Solutions NGV Customer Service regarding questions arising during the inspection and to make arrangements for factory inspection services.

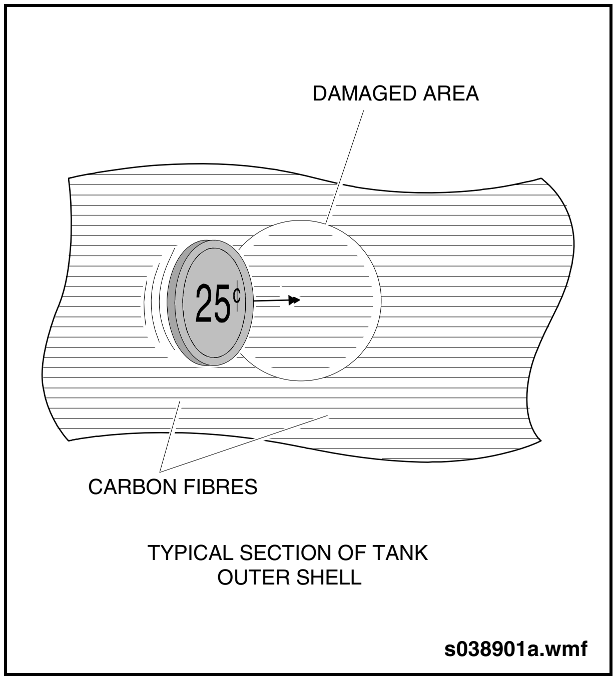


Fig. 7-17: Coin Tap Test

5.5.12. Fire & Excessive Heat Damage

NGV Fuel Tanks manufactured by Agility Fuel Solutions have a maximum service temperature of 180°F (82.2°C). Excessive heating, such as may occur if the tank is not properly located relative to an exhaust system or involved in a fire, may cause significant damage. Evidence of heat damage is darkening, charring or sooting of the surface in the area of exposure. Severe exposure may result in resin removal and loose fibers. Other signs of heat damage are melting of the plastic on the labels and discoloration of the bosses. See “Fig. 7-18: Discoloration Indicating Heat Damage” on page 65.

Tanks showing evidence of fire or excessive heat exposure are defined as having Level 3 damage and are to be removed from service, condemned and destroyed.

5.5.13. Gas Leakage

Tanks which exhibit apparent gas leakage must be removed from service. Contact Agility Fuel Solutions Customer Service to report the condition and obtain information regarding additional tank testing and deposition. Tanks with confirmed gas leakage are condemned.

☞NOTE:

Bubbles are typically observed on the composite surface for several hours after pressurization, particularly after the initial pressurization after installation. The bubbles are caused by air trapped between the liner and composite being forced through the composite when the tank is pressurized. These bubbles should subside after several hours. See “Fig. 7-19: Entrapped Air” on page 65.

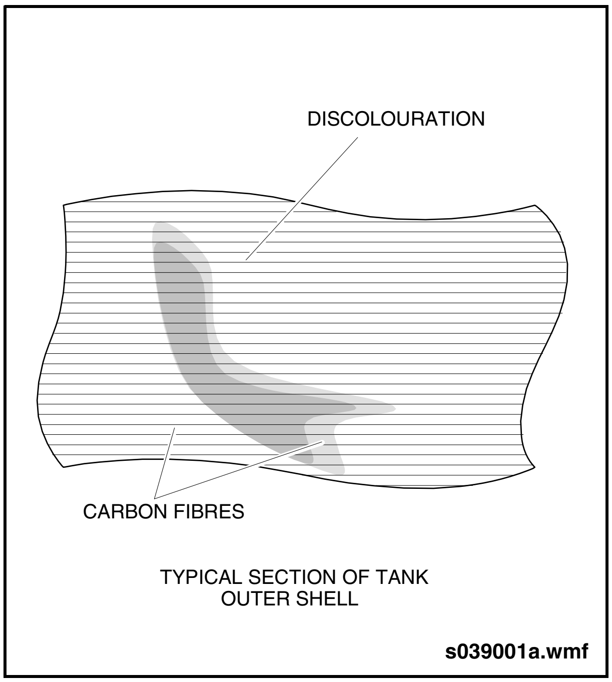


Fig. 7-18: Discoloration Indicating Heat Damage

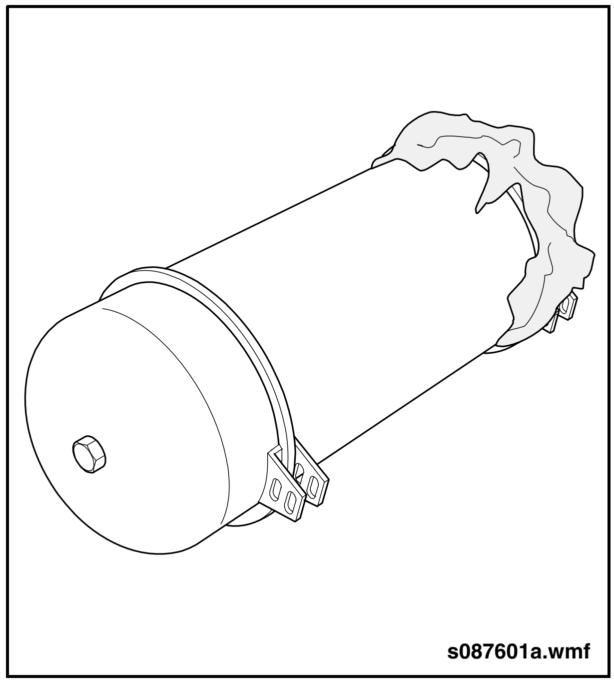


Fig. 7-19: Entrapped Air

5.5.14. Chemical Damage

The tank should be examined for evidence of chemical attack. The materials used in the tank are resistant to chemical agents encountered in the normal fuel tank environment. The tank, however, should be maintained in a clean state and should not be allowed to have prolonged exposure to moisture, automotive fluids or corrosive agents. The installation should drain freely and not trap fluids or debris.

Chemical damage of the composite will appear as alteration of the surface. This includes discoloration, etching, blistering, swelling, softening, and resin removal. In extreme cases, the composite may exhibit fractures and broken or loose fibers.

Minor discoloration and etching is defined as Level 1 damage and is considered acceptable provided the chemical has been removed and the tank surface cleaned.

☞ **NOTE:**

Any evidence of blistering, swelling, softening, and resin removal, broken or loose fibers or fractures is Level 3 damage. The tank must be condemned, removed from service and destroyed.

5.5.15. Non-Structural Anomalies

Frequently, tanks may exhibit superficial anomalies that have no effect on the structural quality of the tank.

Non-structural anomalies include the following:

1. Fiber gaps on the surface of the dome area. Fiber gaps do not include loose fiber that has separated from the surface of the composite. See “Fig. 7-20: Fiber Gaps” on page 66.
2. Resin and paint runs, which may appear as a hard circle or spot on the tank surface.
3. Excessive resin on the composite surface.
4. Splices on the external TUFFSHELL™ wrap.

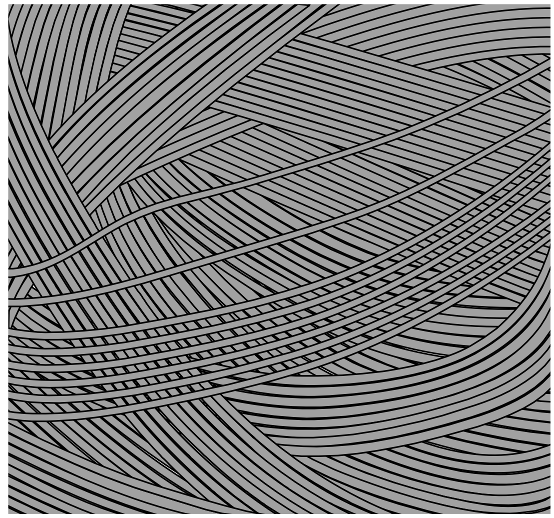


Fig. 7-20: Fiber Gaps

5.5.16. Weathering

The tank may exhibit degradation of the external coating after prolonged exposure to sunlight and weathering. This may result in discoloration and/or potential deterioration of the coating on exposed surfaces. This condition is Level 1 damage. The affected surface should be reworked after completion of the inspection process by hand filing or sanding. Paint area with polyurethane paint.

5.5.17. Painting

The surface may be prepared for painting by removing loose material with a steel hand brush and wiping with acetone. Use of a powered brush, sand or grit blasting, peening, power sanding, grinding and chemical strippers is prohibited. Hand sanding with a fine grit paper is permissible providing it is used only to remove deteriorated coating or to deglaze the surface.

5.5.18. Tank Disposition

Tanks inspected in accordance with these guidelines will be handled one of four ways. These are:

1. The container has no damage or Level 1 damage and is deemed acceptable. The container may remain in service. See “Fig. 7-21: Lvl. 1-Cut or Scratch Damage (acceptable)” on page 67.
2. The container has Level 2a damage that may be reworked in the field and the container can be returned to service. See “Fig. 7-22: Lvl. 2a-Loose Fiber Damage (customer rework)” on page 67.
3. The container has Level 2b damage that cannot be fully assessed in a field inspection and must be subjected to factory inspection. See “Fig. 7-23: Lvl. 2b-Gouge Damage (requires factory inspection)” on page 67.
4. The container has Level 3 damage and is condemned, removed from service and destroyed. See “Fig. 7-24: Lvl.3-Abrasion Damage (condemn)” on page 68. See “Fig. 7-25: Lvl.3-Impact Damage Gouge (condemn)” on page 68.

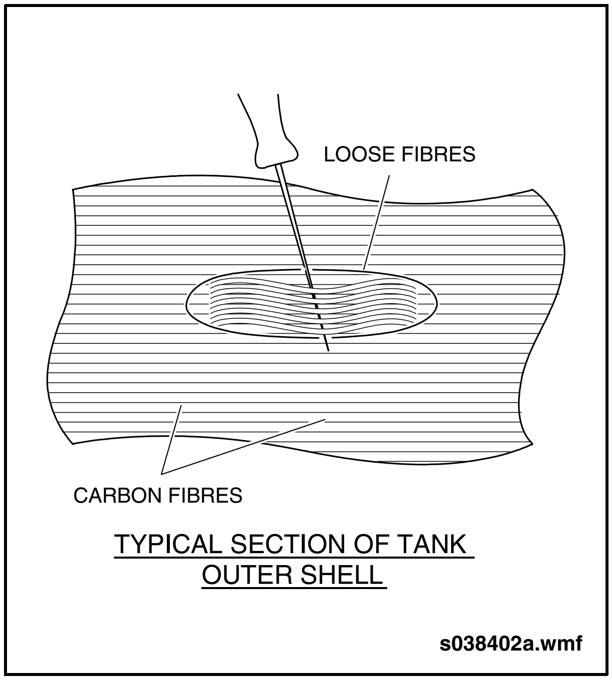


Fig. 7-22: Lvl. 2a-Loose Fiber Damage (customer rework)

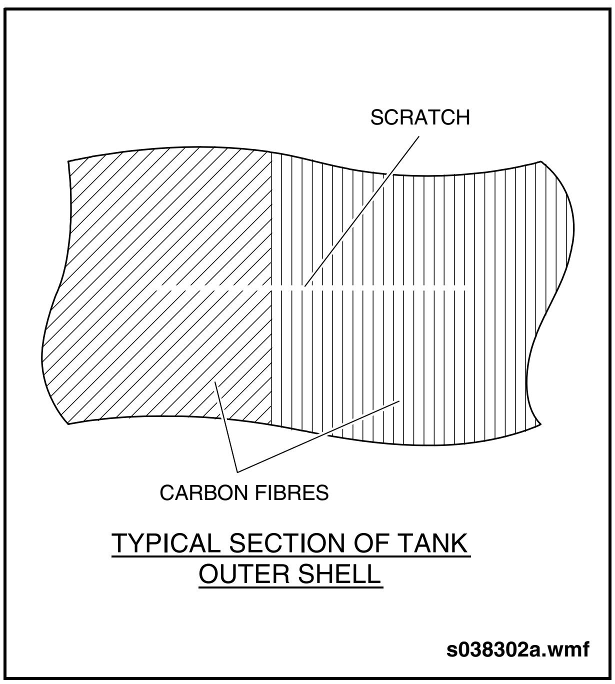


Fig. 7-21: Lvl. 1-Cut or Scratch Damage (acceptable)

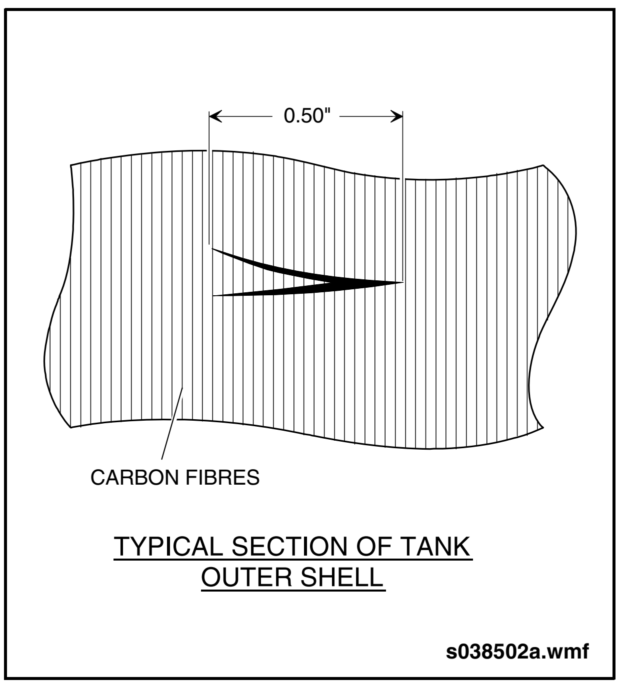


Fig. 7-23: Lvl. 2b-Gouge Damage (requires factory inspection)

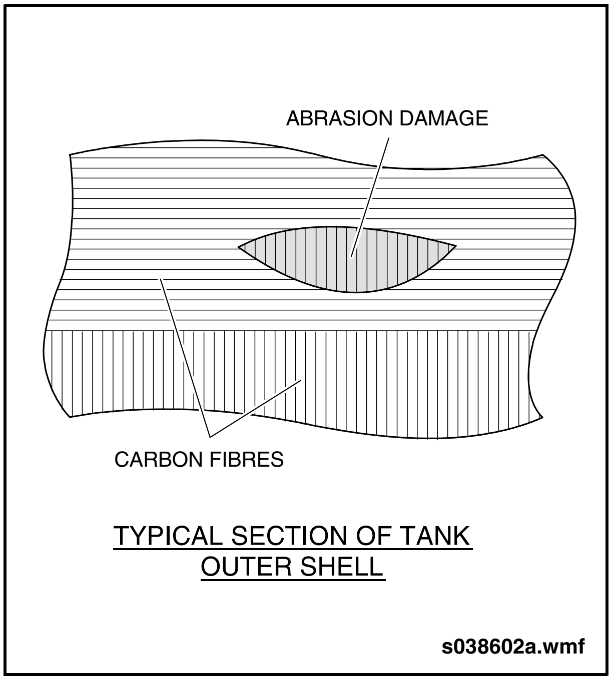


Fig. 7-24: Lvl.3-Abrasion Damage (condemn)

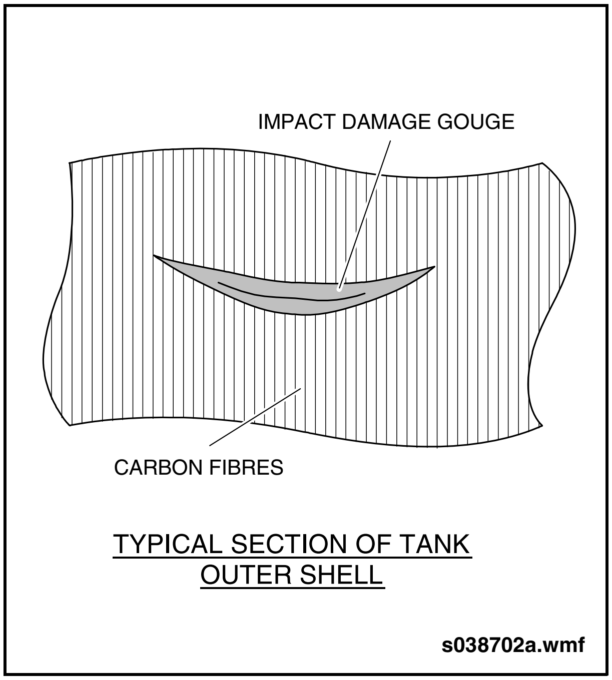


Fig. 7-25: Lvl.3-Impact Damage Gouge (condemn)

5.5.19. Inspection Documentation

The inspector shall place a mark on tanks passing the inspection criteria in one of the inspection blocks on the manufacturer's label and the duplicate manufacturer's label if used. The marking shall indicate the inspecting agency and the date of inspection. The inspector shall also identify on the vehicle labels the fuel tank's next required inspection date. The next inspection date must not exceed 36 months or the expiration date for the tank's service life, whichever is earlier.

The inspector shall document the following inspection information. A copy of this data shall be provided to the vehicle operator.

1. Date of inspection/service.
2. Reason for inspection.
3. Service performed by.
4. Tank serial number(s).
5. Vehicle make, model and identification number (VIN#).
6. Vehicle mileage.
7. Description, damage level and location of damage observed.
8. Description of repairs performed.
9. Notation of factory inspection, if applicable.
10. Deposition of tank (i.e. returned to service, factory inspection required or condemned and destroyed).
11. Next required inspection date. (Not later than service life expiration date).

5.6. Tank Destruction

Tanks which are condemned must be clearly marked as "CONDEMNED" at the time of inspection. The marking shall be affixed to the manufacturer's label and the duplicate manufacturer's label, if used.

The tank must be destroyed as soon as practical. The destruction method used must permanently render the tank inoperable and clearly indicate the intent to destroy the tank. An acceptable method of destroying a tank is drilling a 1/2", or larger, hole completely through the tank wall and internal liner.

WARNING

The vessel will contain residual gas fumes after depressurization. Precautions should be taken to ensure residual fumes are not ignited during destruction. Vent all pressure from the cylinder and displace residual fumes with compressed nitrogen. If compressed nitrogen is not available, flushing the cylinder with water will displace residual fumes. NEVER use compressed air to purge the cylinder. Wait at least 8 hours to ensure no gas remains before drilling holes.

5.7. Tank Removal

A tank will normally only be removed if damage is obvious or suspected, a regulation tank inspection has disclosed a level of damage that needs to be factory inspected and accessed or the tank expiry date has been reached.

Tank removal will require complete emptying of the tanks. Scheduling this procedure for a time before refueling when the tanks are nearly empty will be easier if possible, or if delaying until this time will not make an unsafe condition. Back fill any remaining gas into the storage facility. Unless completely unavoidable, do not vent any CNG to atmosphere. Run the engine to empty the system downstream of the tanks of remaining pressurized gas.

5.7.1. Working Safety

1. Natural gas storage and delivery are high pressure systems. The system components and the methods and procedures for maintenance and service must comply with government certification and regulations. Only personnel government certified to work on high pressure natural gas systems and components may repair, service or install any part of the vehicle CNG system.
2. Follow the same safety procedures applicable to other hydrocarbon vapor-producing fuels such as gasoline or diesel fuel. Any potential source of ignition such as smoking, lighting matches, a cigarette lighter, or any excessive heat producing process must be kept clear of the vehicle fuel system and the CNG storage and handling area.
3. The workplace, tools and the work method must be extremely clean when working with high pressure CNG components and fittings. Minute scratches, scuffs or abrasions on mating surfaces can cause gas leaks. Use only proper tools that are matched to the job, fittings and components.
4. Do not use make-shift work methods. Do not use VISE-GRIP® type pliers, water pump type adjustable pliers, pipe wrenches or any other type of gripping tool not designed or matched for use on high pressure CNG fittings, connectors or couplings.
5. If you attempt to work with the wrong tools, the connections will be ruined, causing UNSAFE gas leaks. Use only stick or tape-type thread sealants approved for CNG systems.
6. The CNG tanks weigh 162 lbs. (73.5 kg). Use a safe lifting method to lower and raise the tanks from the mounting brackets down to and up from the shop floor.
7. Make sure the work area is clean and remote from any dust producing areas or activities. Also have a secure base or cradle to support the tank for inspection or work.

5.7.2. Disconnecting Fittings & Lines

☞**NOTE:**

It may be necessary to remove some adjacent lines to make tank removal easier and to prevent damage to lines and fittings.

1. Empty the CNG tanks by Back filling any remaining gas into the storage facility. Unless completely unavoidable, do not vent any CNG to atmosphere. Run the engine to empty the system downstream of the tanks of remaining pressurized gas.

☞**NOTE:**

Refer to 4.3.7. "Zone Three Venting Procedure" on page 26 *in this section for procedures on isolating individual tanks from the system. This allows venting and removal of individual tanks without disturbing the entire system.*

2. Disconnect the fuel line, the PRD line, and the electrical connection at the solenoid/ check valve of the tank(s) being removed.
3. Disconnect the vent lines at the rear of the tank(s).
4. Alternately loosen and then remove the 1/2" - 13 locknuts fastening each tank restraining strap tab to the mounting base.
5. Attach straps or slings securely to the tank. Use a safe method to lower the empty tank(s) to the shop floor. Move the tank to the work area and place in the work stand or cradle provided for this purpose.
6. Refer to 5.5. "Tank Inspection" on page 52 in this section for detailed procedures to identify the various types and levels of tank damage. Carefully follow the guidelines regarding tank replacement and how to effectively destroy a tank that is unrepairable or has reached the service expiry date.

5.8. Tank Installation

Installation is essentially the reverse of removal. Apply all of the previously mentioned safety procedures. Use proper lifting equipment and safe lifting procedures that will not endanger personnel or damage the tank(s) or vehicle sides and roof.

☞**NOTE:**

ALWAYS use new strap rubber pads and lock nuts. Make sure the rubber pads on the mounting brackets and retaining straps are even with no overlaps, are not damaged or overly flattened. If these conditions are present, the ribbed pads must be replaced.

1. Install tank gently between the two mounting bases. Rotate tank as required to properly align ports in solenoid valve with the fuel lines and PRD plumbing. Tank may be adjusted fore and aft in mounts to ensure proper valve/ fuel line/ PRD line alignment. Install lines onto valve and finger tighten to ensure proper fit.
2. Install the retaining straps at each end of the tank(s). Thread the new locknuts onto the retaining bolts, finger tight. Alternately and evenly tighten and torque the nuts to 45 ± 5 ft-lb.

☞**NOTE:**

After tightening and torquing the nuts, a gap of 1/8 to 1 1/4" (6.25 to 32 mm) should be present between the strap tabs and the bracket bases. DO NOT retorque after the limit of 45 ± 5 ft-lb. is reached.

3. Tighten fuel line and PRD line and install the electrical connection at the solenoid/ check valve of the tank(s) and the vent lines at the rear of the tank(s).
4. Install and connect any adjacent lines that were disconnected and removed to assist in tank removal.
5. Use a Swagelok® gap inspection tool to check each fitting for proper tightness. Additional tightening is required if the tool slides between the fittings. The fitting is sufficiently tightened if the tool doesn't fit between the nut and body hex.

☞**NOTE:**

At this time, check the rest of the tank system connections with the Swagelok® gap inspection tool. Tighten fittings if required before charging the tanks with CNG.

6. Couple the filler hose connection to the Sherex filler receptacle and fill the tanks with CNG.
7. Check all of the tank system connections and fittings back to the main line leading down to the quarter-turn shut-off valve for leaks. Use a combustible gas detector such as the Snap-On ACT 8800®. This particular unit can detect localized gas leaks from 50 to 1000 PPM.

☞**NOTE:**

Liquid solutions such as SNOOP® can also be used. DO NOT use make-shift soapy water solutions.

⚠DANGER

DO NOT perform any corrective action or other maintenance on a pressurized system. Perform component servicing or maintenance only after the affected zone has been isolated and depressurized. Refer to 4.3. “CNG Venting Procedure” on page 20 **in this section for depressurizing procedure.**

8. Also check all the connections and fittings on the main components in the fill box and the fuel line installation using a gap inspection tool. Tighten as required and check for leaks using the combustible gas detector.

5.9. Initial Fill Procedure

5.9.1. New Tank Installation

☞NOTE:

This procedure is not required for tanks currently in service.

⚠CAUTION

Tanks should not be left in a cold climate prior to the initial fill for more than 30 minutes. Premature tank liner failure can occur if the tanks have been installed into service at room temperature, exposed to the cold and then filled.

After installation, if the tanks are not going to be filled immediately, tanks should be pressurized to a minimum of 100 psi (690 kPa) if the vehicle is to be moved from a warm environment, above 50°F (10°C), to a cold environment below 32°F (0°C). Doing so will ensure the tank liners are not exposed to negative pressure caused by temperature changes.

Prior to filling the tanks, ensure the tanks are warmed to a minimum of 60°F (16°C) for 8 hours.

☞NOTE:

Connect a bonding wire from the fueling station to the CNG ground stud on the vehicle prior to fueling and defueling operations. Refer to 3.9. "CNG Ground Stud" on page 16 *in this section for procedure.*

5.9.2. Tank Filling

This procedure is for only initial (first time) fueling after the tank has been open to the ambient atmosphere and when the outside ambient temperatures (where the fueling is taking place) is 10°F (-12°C) or less. It does not have to be done if the vehicle has been run to low pressure through normal vehicle use.

The vehicle must be warmed for 8 hours at or above 60°F (16°C) prior to starting this procedure and must be fueled within 30 minutes once the vehicle is brought into the cooler temperatures.

1. Ensure the tank-mounted solenoid valves are open by manually rotating the valve knobs fully counter-clockwise.
2. Fill the vehicle to 450 ± 50 psi (Turn the filling station valve to the fully open position). The vehicle should then sit a minimum of 1 hr.

☞NOTE:

Filling from a compressor avoids the large pressure drop associated with filling from a cascade. Allowing the vehicle to sit lets the tanks liner seat out against the composite. Cold liners are less flexible than warm liners and need this time to seat.

3. Use SNOOP® leak detector and the vehicle's pressure gauge to detect leaks.
4. If there is a leak either the SNOOP® leak detector will detect the gas and/or the pressure gauge will read a pressure drop.
5. If there is a leak vent the lines of fuel and then tighten the fitting. The test can then resume at the last pressure reached.

☞NOTE:

If the leak persists, unscrew the nut, examine the ferrules and wipe them and the nut with a clean cloth.

☞NOTE:

The remainder of this procedure can be done using a cascade system.

6. Increase pressure to 2,000 psi.
7. Repeat Steps 3 to 5.
8. Increase pressure to the legal limit.
9. Repeat Steps 3 to 5.
10. Hold this pressure for a minimum of 10 minutes and check the fittings with SNOOP® leak detector.
11. If a fitting has been repaired, repeat the test from the last pressure reached.

☞NOTE:

Remember to complete the entire test at each pressure.

12. The last portion of this test must be a minimum of ten minutes long to observe any pressure loss.

6. CNG PRESSURE CONTROL & PLUMBING

6.1. Connections, Fittings & Tubing Maintenance

DANGER

DO NOT perform any corrective action or other maintenance on a pressurized system. Perform component servicing or maintenance only after the affected zone has been isolated and depressurized. Refer to 4.3. "CNG Venting Procedure" on page 20 **in this section for depressurizing procedure.**

6.1.1. Description

Some basic information is provided in this section regarding fittings, connections, tubing and work methods. This is for easy reference and also because these basic areas of the CNG fuel system are very important to a leak-free, efficient and safe operating fuel system.

Major CNG high pressure fuel system components are manufactured to exacting and precise tolerances, using precision quality materials. The failure or malfunction rate for system parts such as the connections, fittings and tubing is extremely low because of the exacting standards imposed for components used in high pressure CNG systems. All components are engineered to safety factor of two to four to ensure safe, consistent and long-term operation.

Gas leakage will generally be the major concern with the CNG fuel system. Leakage will mainly occur around fittings and connectors, and generally can be corrected by tightening the connections to specifications. Most fitting and connector manufacturers such as Swagelok® provide lots of technical information on how to properly install and tighten connections and how to properly handle and bend tubing. Particular attention must be given to skillful work methods, use of proper tools and cleanliness.

CAUTION

The workplace, tools and the work method must be extremely clean when working with high pressure CNG components and fittings. Minute scratches, scuffs or abrasions on mating surfaces can cause gas leaks.

If you attempt to work with the wrong tools, the connections will be ruined, causing UNSAFE gas leaks. Use only thread sealants approved for 3,600 psi (24,800 kPa) CNG systems such as Swagelok® SWAK® anaerobic sealant.

DO NOT use make-shift work methods. DO NOT use VISE-GRIP® type pliers, water pump type adjustable pliers, pipe wrenches or any other type of gripping tool not designed or matched for use on high pressure CNG fittings, connectors or couplings.

6.1.2. Tubing Specifications

Replacement tubing for the CNG fuel system must be of the same type and quality specified in the following guidelines.

The following table defines the tubing used in the CNG fuel system. Use this reference if tubing has to be replaced. Replacement tubing must meet or exceed the defined specifications. Do not substitute tubing of any other type or specification.

TUBING SPECIFICATIONS	
Type 304 or 316 STAINLESS STEEL - high quality, fully annealed, seamless hydraulic tubing.	
Suitable for bending and flaring.	
Free of any scratches, abrasions or scuffs.	
Tubing must conform to ASTM (American Society for Testing & Material) A269	
Tubing must have a hardness of Rb80 or less.	
TUBE O.D.	**WALL THK.**
0.375	0.049
0.500	0.065
0.750	0.095
1.000	0.120

6.1.3. Tubing Handling

Use only proper tools that are matched to the job, fittings and components.

Good tubing handling practices will greatly reduce scratches and minor abrasions that ultimately cause connection leaks.

Never drag tubing out of a tubing rack. Doing this can gouge the O.D. if any burrs are on the end of the tubing below in the rack.

Do not drag tubing across cement, gravel or asphalt surfaces which could cause scratching.

All tools such as tube cutters and hacksaws must be sharp. Use a good cutting technique. Do not try to take a deep cut with each cutter rotation or each hacksaw cutting stroke.

Always deburr the tube ends. The tube will enter the fitting bore easier and will slide all the way through the ferrules without damaging the ferrule sealing edge.

6.1.4. Tube Bending

Different types of tube bending equipment is available. Use all approved industry guidelines, tools and work methods for cutting, bending and fitting fuel line tubing being used in a high pressure CNG fuel system.

Do not use tube bending equipment or methods that will not properly bend the tubing specified for this CNG fuel system. The tools and method should produce bends that are smooth and graduated, not flattened or kinked. Improper tools and bending methods can elongate and thin the bending area tubing walls, and also cause stress-induced overhardening.

6.1.4.1. Tubing Bend Radius

The tubing bend radius is defined as the radius to the center of the tubing. Tube material, wall thickness and tube bending equipment used will determine the smallest bend radius available. The accompanying table provides some indication of what minimum bend radius may be expected from available tube bending equipment. This information is provided only as a guideline. Follow the instructions and recommendations provided by the bending equipment manufacturer regarding minimum radius bends.

☞**NOTE:**

This table only shows the tubing sizes that are used in the vehicle CNG fuel system.

Proper tubing bending and alignment with fittings and connections will ensure good leak free and trouble free connections.

TUBING BEND RADIUS

TUBE O.D. (in.)	BEND RADIUS
3/8" (0.375)	1.00
1/2" (0.500)	1.50
3/4" (0.750)	2.00

⚠CAUTION

DO NOT use tubing that is a different size than the tubing specified for the vehicle CNG system.

6.1.4.2. Tube Benders

Hand benders and production benders are either COMPRESSION or DRAW type.

1. Compression Type Tubing Bender

   The form, or Bender Die is stationary and the follow block or Roll support rotates around to bend the tubing. The tubing end clamped in the Bender Die remains stationary (clamped), while the end extending through the Roll Support is drawn around the Bender die by the Roll support. See "Fig. 7-26: Compression Type Tube Benders" on page 76.

2. Draw Type Tubing Bender

   The first tubing end is retained by the Clamp on the Rotating Bending form. The other (second) end of the tubing is positioned in the Stationary Pressure Die. The rotating Bending Form moves the clamped tubing end drawing the second tubing end through, or past, the Stationary Pressure Die, forming the bend. See "Fig. 7-27: Draw Type Tube Benders" on page 76.

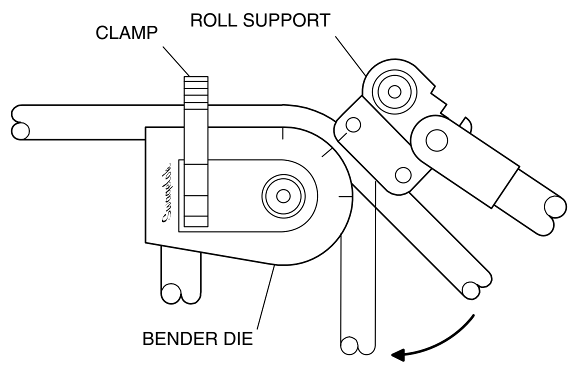


Fig. 7-26: Compression Type Tube Benders

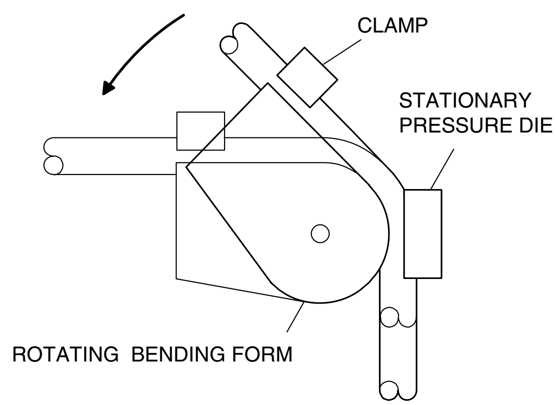


Fig. 7-27: Draw Type Tube Benders

6.1.4.3. Tubing Bends Near Fittings

Tubing bends too close to, or that extend into a fitting may cause leaks. Be careful to allow adequate straight tubing length from the shoulder of the fitting to the beginning of the bend. See "Fig. 7-28: Tube Bends Near Fittings" on page 77.

Inspect the length of tubing that will be inserted into a fitting for proper roundness. An excessively oval or out-of-round tubing end could scratch the fitting surface and cause a leak.

When a section of bent tubing is being connected, make sure the tubing is properly aligned with the fitting before inserting and tightening. If the tube end and the fitting are misaligned, do not try to "spring" fit by applying excessive force. Doing this will overstress the connection and tubing, creating the potential for a leak.

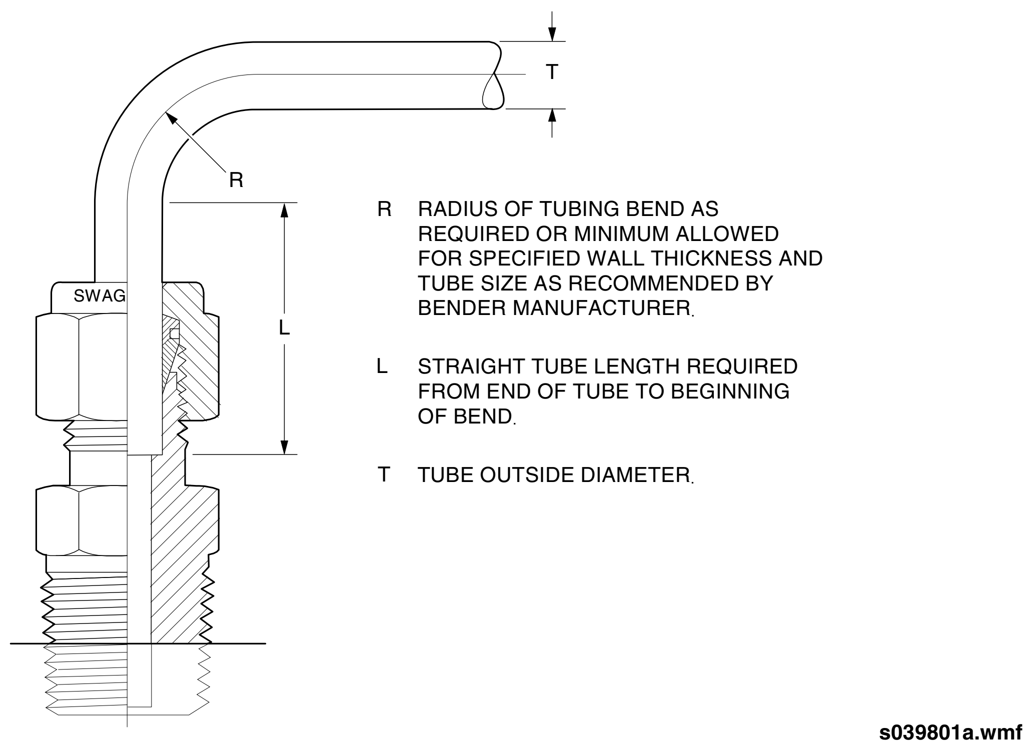


Fig. 7-28: Tube Bends Near Fittings

6.1.5. Tube Cutting

Using a tube cutter or a hacksaw are the two most common methods of cutting tubing. Most C-frame hand held and operated tube cutters do not have a cutter wheel designed for use on harder tubing materials such as stainless steel type 304 or 316.

Tubing cutters are available to handle hard tubing material such as stainless steel type 304/316. Types of cutters recommended for this material are units such as the Swagelok® tube cutter (MS-TC-308) or similar types offered by other tube cutter manufacturers.

These cutter types have cutting wheels specifically designed for efficiently cutting harder tubing materials such as stainless steel.

6.1.5.1. Tube Cutting Technique

The tube cutter cutting wheels "PUSH" metal aside and down rather than actually "CUTTING" through the tubing. Therefore, a dull cutting wheel, or one not suited to a harder metal, tends to raise excessive metal on the tubing end O.D. and I.D. A dull cutting wheel also work hardens the tubing area near the cut because of excessive pressure from the support rollers.

The tubing "cut" is made by constantly turning in the tightening screw knob which advances the cutting wheel deeper into the tubing, while also rotating the cutters around the tubing circumference. Rushing this process by applying too much cutting wheel pressure will result in poor cuts and excessive cutting wheel wear.

A 1/8 turn of the tightening screw knob for each two revolutions of the cutting wheel around the tubing circumference is optimum for stainless steel tubing.

After the cut is made, use a good quality deburring tool to thoroughly clean off raised metal on the tubing O.D. and I.D.

⚠ CAUTION

Be very careful not to scratch or mar the tubing end that will be inserted into the ferrule inside the connection or fitting. Any minute surface abrasion will cause a leak because of the high system pressure and molecular structure of CNG.

6.1.6. Connections & Fittings

The fittings and connections used on the CNG fuel system are precision made, high quality Swagelok® flareless mechanical grip fittings. These consist of a body, nut, front ferrule and back ferrule. This type of fitting provides a leak free connection when installed properly. See “Fig. 7-29: Swagelok® Fitting Components” on page 79.

CAUTION

DO NOT interchange or mix fittings or parts of fittings in this CNG fuel system with fittings made by other manufacturers.

DO NOT make-up and tighten fittings when the fuel system is pressurized.

NEVER disassemble new or unused fittings before using.

NEVER turn the fitting body. Firmly hold the fitting body and turn the tightening nut.

Use a Swagelok® gap inspection gauge to make sure the fitting “pulls up” sufficiently.

DO NOT bleed down CNG in the system by loosening a fitting nut or fitting plug.

Use only thread lubricants and sealants approved for 3,600 psi (24,800 kPa) CNG systems.

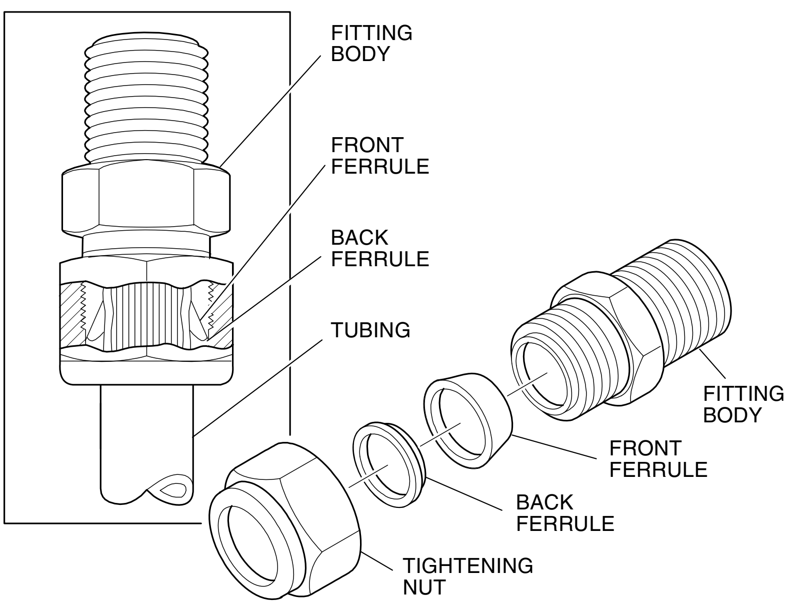


Fig. 7-29: Swagelok® Fitting Components

6.1.6.1. How the Swagelok® Fitting Works

The tubing end is first inserted into the fitting until it bottoms against the fitting body inner shoulder. The nut is then finger tightened and then wrench-tightened to 1 1/4 turns past the indexed point.

Turning the tightening nut first draws the back ferrule forward against the front ferrule. The continuing pressure of the tightening nut then continues to draw the back ferrule against the front ferrule, forcing the front ferrule forward and inward. This mechanical action forces the tubing wall to conform to the inner surfaces of the fitting body and the back and front ferrules.

Greater resistance is encountered as more tubing is deformed, which causes the back ferrule to provide a second hold or grip on the tubing wall. Heavy wall tubing will attain a tighter grip because of its greater resistance to front ferrule action, which increases back ferrule hold or grip.

6.1.6.2. Connecting Fittings & Tubing

Fittings come completely assembled, ready for use. Disassembly before use is unnecessary, and if such is done, can result in dirt or foreign material getting into the fitting and causing leaks.

Fitting and tubing connection is a simple, efficient procedure:

1. Inspect the tubing for correct wall thickness. Ensure that tube is not oval, there is no damage evident and the end is cut square/flush.
2. Insert the tubing into the fitting all the way until the tubing end bottoms against the inside shoulder of the fitting body. Finger tighten the nut.
3. Mark a reference line on the nut at the “6 O-clock” position. See “Fig. 7-30: Tubing/ Fitting Connection & Reference Line” on page 80.
4. Support the fitting body with a back-up wrench. Tighten the nut 1 full turn until the scribed mark aligns at the “6 O-clock” position, then make a 1/4 turn to align the mark at the “9 O-clock” position. See “Fig. 7-31: Tightening Nut 1-1/4 Turns” on page 81.

☞NOTE:

Tightening the nut 1 1/4 turns moves the nut 1/16" forward, providing maximum ferrule “draw up” against the tubing wall. This provides maximum tubing/fitting sealing and holding.

5. Use a Swagelok® gap inspection gauge to verify the correct fitting tightness. Attempt to insert the gauge size that matches the fitting size (for example 3/8" gap gauge for a 3/8” fitting) between the tightening nut and the fitting body hex. See “Fig. 7-32: Swagelok® Gap Inspection Gauge” on page 81.
6. If the gauge slides between the tightening nut and fitting body hex, the fitting is not tight enough.
7. If the gauge does not slide between the tightening nut and fitting body hex, the fitting is “pulled up” or tightened enough.

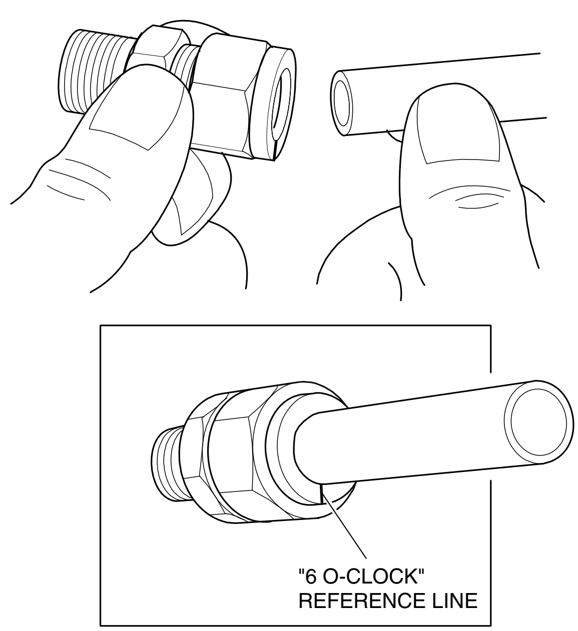


Fig. 7-30: Tubing/Fitting Connection & Reference Line

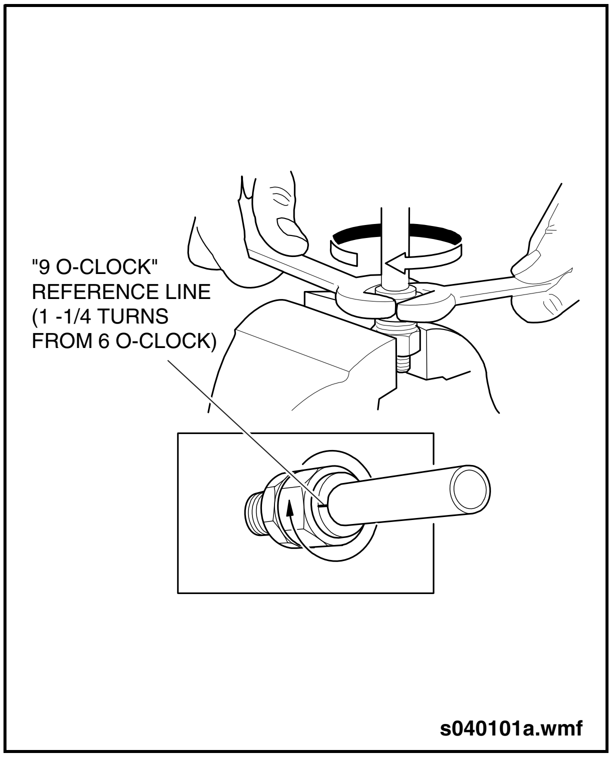


Fig. 7-31: Tightening Nut 1-1/4 Turns

6.1.6.3. Retightening a Fitting

Fittings can be disconnected and retightened many times without causing a leak. Retighten a fitting as follows:

1. Mark the tube at the back of the nut and a line along the nut and body flats.
2. Disassemble the connection.
3. Insert the tubing end with the previously set ferrules attached into the fitting body.
4. Make sure the tubing bottoms against the inner shoulder of the fitting body. Finger tighten the nut. See “Fig. 7-33: Retightening Previously Connected Fitting” on page 81.
5. Tighten the nut with the wrench, until the original tightening position is reached. Then snug up slightly with the wrench. Use a backup wrench to prevent overtightening.

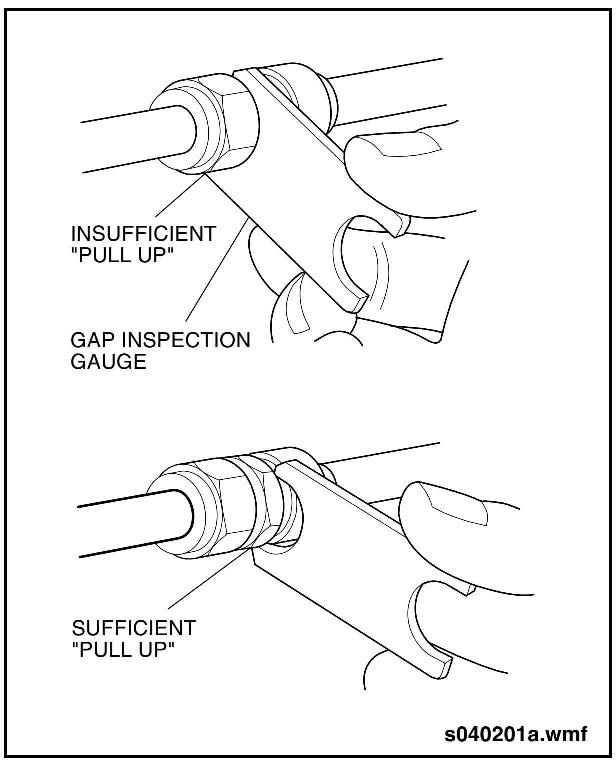


Fig. 7-32: Swagelok® Gap Inspection Gauge

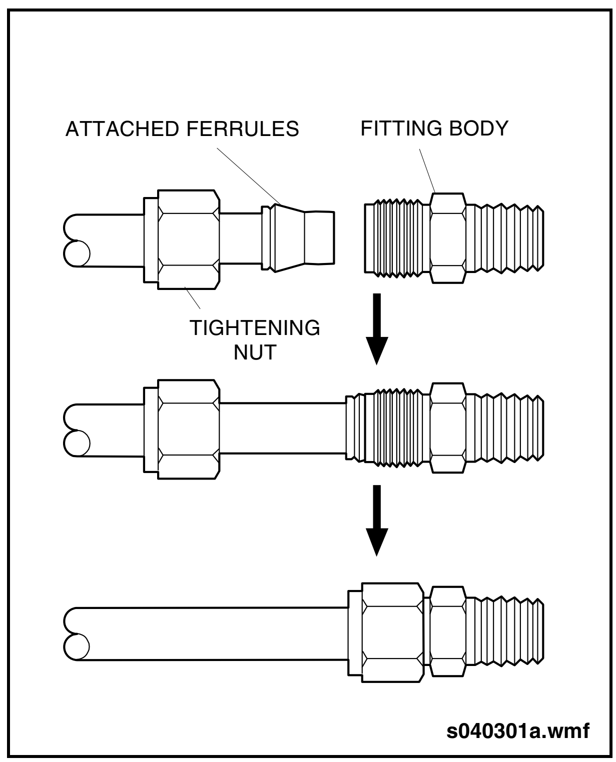


Fig. 7-33: Retightening Previously Connected Fitting

7. GAS DETECTION SYSTEM

7.1. Description

This vehicle is equipped with a Dual Spectrum Fire Suppression and Gas Detection System. Refer to Section 4 of this manual for information on the Fire Suppression System. See “Fig. 7-35: Gas Detection System” on page 84. The system consists of the following components:

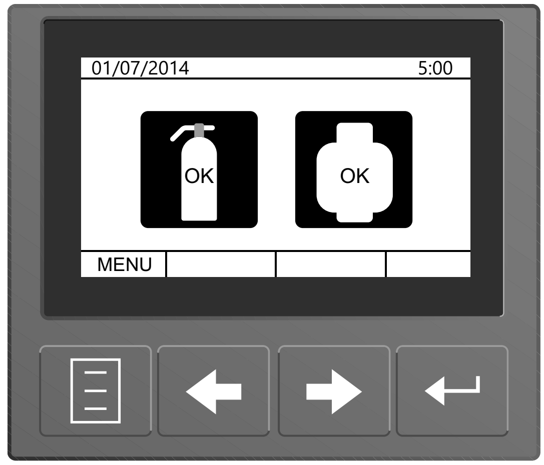
- Fire suppression and gas detection control panel (1) - in driver’s area.
- Gas sensors (4) - two in rooftop fuel tank bay, one in A/C compartment, and one in engine compartment.

7.2. Operation

The state of the system is constantly monitored and is displayed to the driver via the display panel. The system provides visual and audible indicators to the driver when the state of the system changes.

7.2.1. Normal Condition

During normal operating conditions (appropriate system power applied and no fault conditions present), the Display panel indicates system "OK". See “Fig. 7-34: Fire Suppression & Gas Detection Control Panel” on page 82.



s073720a.svg

Fig. 7-34: Fire Suppression & Gas Detection Control Panel

7.2.2. System Fault Scenarios

Gas Sensor Trouble - Display backlight flashes yellow, text on screen indicates that a fault exists in the gas circuit, and the buzzer intermittently beeps until the fault is cleared.

7.2.3. Gas Trace Leak (20% LEL) Scenario

When a trace gas leak is detected, the display's backlight flashes red, text on screen indicates that a trace level of gas has been detected and the buzzer intermittently beeps until the gas dissipates or exceeded the significant gas leak threshold.

7.2.4. Gas Significant Leak (50% LEL) Scenario

When a significant gas leak is detected, the following occurs immediately:

- ❒ The display turns constant red and the Gas icon is displayed.
- ❒ The text on screen indicates a significant gas leak has been detected.
- ❒ A 15 second countdown starts.
- ❒ The Buzzer starts intermittent beeping which accelerates as the timer approaches zero.
- ❒ "SILENCE" and DELAY" buttons appear.

Upon completion of the 15 second countdown, the following occurs:

- ❒ Display remains constant red and System Deployment icon and the text “Significant Gas Leak Detected” are displayed.
- ❒ Continuous beep occurs.
- ❒ Engine Shutdown activates.
- ❒ 3 seconds after the countdown is completed a reset button appears.

7.3. Gas Detection System Troubleshooting

Refer to 8. “VENDOR SERVICE INFORMATION” on page 86 in this section for troubleshooting information and also additional information on the operation of the system.

7.4. Maintenance

Refer to the Preventive Maintenance Section of this manual for maintenance intervals and procedures.

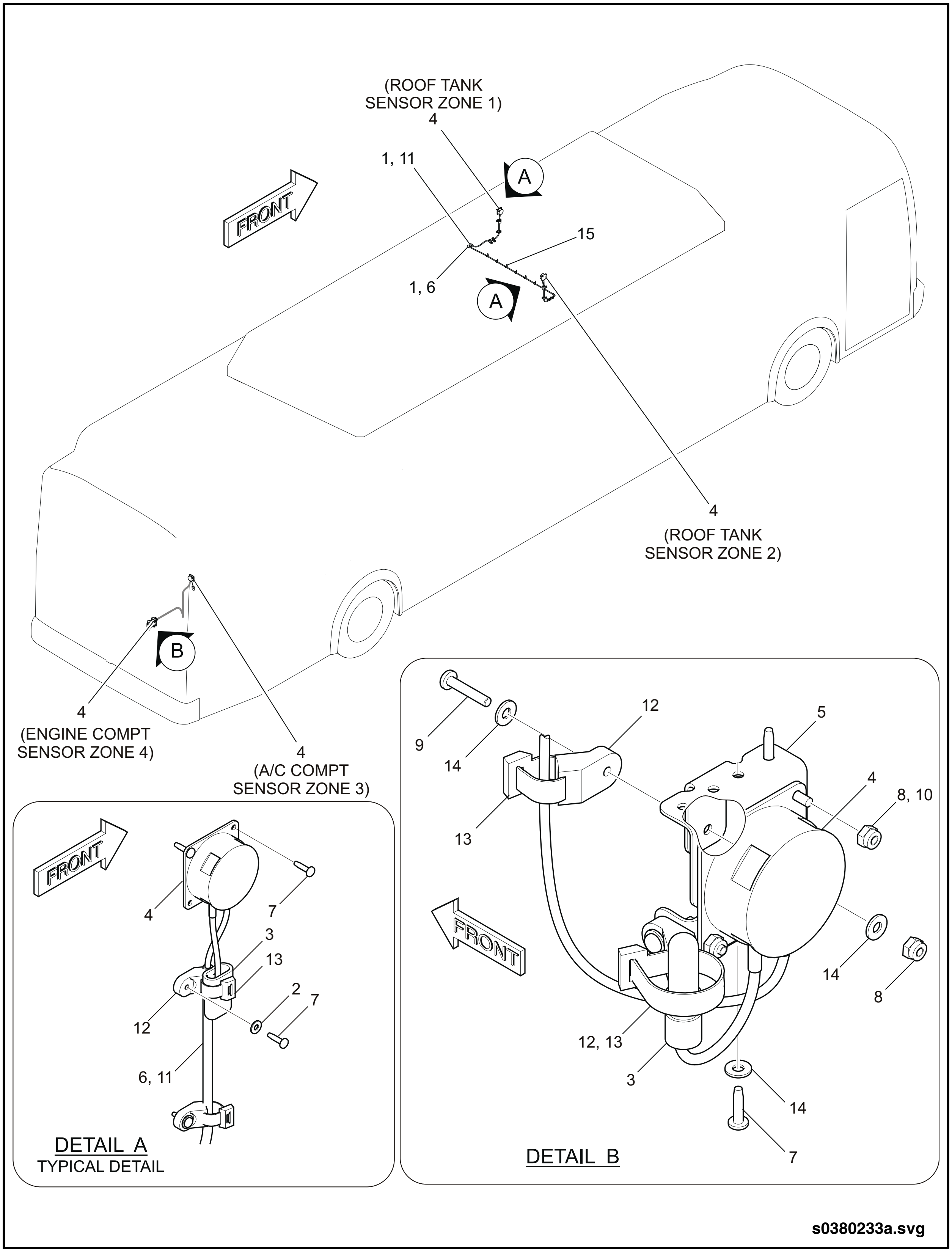


Fig. 7-35: Gas Detection System

1. Adhesive, SIKA 221 White
2. Washer, Flat #10
3. Connector, End of Line
4. Sensor, Gas Detection
5. Bracket, Gas Sensor Mounting
6. Harness, Gas Detection Roof 8'
7. Screw, PH Cross Recess Tpg. Type F #10 - 24 UNC x 3/4" Lg.
8. Nut, Lock Nylon #10 - 24 UNC
9. Screw, PH Cross Recess SST #10 - 24 UNC x 1" Lg.
10. Loctite, 243 Blue
11. Harness, Gas Detection Roof 48" Lg.
12. Mount, Cable Tie 3/16" Eye
13. Cable Tie, 1/2" W x 20" Lg.
14. Washer, Flat SST #10
15. Cable Tie, 7" Lg. Black

Fig. 7-36: Gas Detection System (parts list)

8. VENDOR SERVICE INFORMATION

The following supplier manuals contain additional reference information.

8.1. Kidde Dual Spectrum Fire Suppression Manuals

❒ Operation & Maintenance

Air System

Table of Contents

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- open flame
- excessive heat
- production of sparks
- production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Hoisting/Lifting & Jacking Safety

Refer to the General Information Section of this manual for recommended types of hoists, lifting equipment, and jackstands.

DANGER

Certain procedures may require the vehicle be operated in an elevated position in order to accurately troubleshoot and diagnose a problem. If the vehicle must be running while elevated, become familiar with the repair area prior to starting the engine. Take special care in noting areas which will become hot, electrically energized, and areas where moving and rotating components are located. Limit the work in these areas as personal and equipment safety is at risk.

WARNING

ALWAYS ensure that the vehicle is appropriately hoisted and blocked for procedures which require elevating the vehicle. Be aware of the limitations of the blocking equipment, and always ensure that the jarring and shaking created by component removal and installation procedures does not overload the blocks, or cause the vehicle to become unstable.

1.4. Air System Safety

WARNING

ALWAYS drain the air pressure from ALL reservoirs before beginning work on any air system component.

WARNING

Ensure air lines are safely depressurized prior to disconnecting. Wear safety glasses as disconnecting pressurized lines will cause solid particles deposited in the line to be uncontrollably propelled, and will also cause the hose end to whip randomly as the air escapes.

2. GLOSSARY OF ACRONYMS

ABL	Air Bag Left
ABR	Air Bag Right
ABS	Anti-Lock Braking System
ACCUM	Accumulator - Transmission Retarder
ATC	Automatic Traction Control
B	Balance Port
BRV	Brake Relay Valve
BVA	Brake Valve Actuator
C	Control Port
CV	Check Valve
D	Delivery Port
DCV	Double Check Valve
DS	Driver's Seat
DV	Drain Valve
E	Exhaust Port
EBR	Emergency Brake Release
E-6	Brake Application Valve
KBL	Kneeling Block
LV	Leveling Valve
LVL	Leveling Valve Left
LVR	Leveling Valve Right
MODV	Modulator Valve (ABS)
MV	Magnetic Valve
MV NC	Magnetic Valve - Normally Closed
MV NO	Magnetic Valve - Normally Open
MV3	Magnetic Valve (NC) - Door Control
MV6	Magnetic Valve (NC) - Retarder Control
P	Pressure Port
PC	Park Control Port
PP1	Parking Brake Control Valve
PPV	Pressure Protection Valve
PS	Pressure Switch
PS4	Pressure Switch - Parking Brake/Stop Light
PS5	Pressure Switch - Front Brake Circuit
PS6	Pressure Switch - Entrance Door
PS8	Pressure Switch - Interlock Warning
PT3	Pressure Transducer - Rear Brake Circuit
PTV	Pressure Test Valve
QR-1	Quick Release Valve
R	Reservoir Port
R14	Relay Valve with Double Check Valve
RDV	Rotary Dump Valve
RV1	Pressure Reducing Valve
RV3	Pressure Reducing Valve
S	Supply Port
SERV	Service Port
SR7	Spring Brake Modulating Valve
SV	Safety Valve
TRNSDCR	Transducer Pressure Sender (E-Stroke)
UNL	Unload Port - Governor

3. AIR SYSTEM

☞NOTE:

For a better overall understanding of the air system have the color schematic available when reviewing this section.

3.1. Description

The New Flyer Industries air system is comprised of several interconnected components which supply air pressure for the brake system, suspension system and optional air operated components.

Various types of valves are used to control system pressures in several areas of the vehicle and are connected with other components by means of air lines.

Three types of air lines are used in the construction of the New Flyer Industries vehicle. These being copper, flexible Teflon with a braided stainless steel jacket and color coded nylon tubing.

Air system pressure is monitored on the driver's dash panel by means of front and rear brake circuit air pressure gauges. Integral safety systems, including check valves and spring brake chambers, are incorporated to provide for emergency brake application in the event of a line rupture or air system leak.

3.2. Main Air Supply System

(Refer to Main Air Supply System Schematic No.1)

3.2.1. Compressor & Governor Operation

The on board air supply is from an engine driven Air Compressor (1) running at engine speed. The compressor is supplied air through a Tube (2) connected to the engine's air intake system.

The air compressor is controlled by a Governor (3). When air pressure in the Wet Tank (9) is below 117 psi, a signal is sent to the Governor (3) to close the valves and start the compressor. When air pressure reaches 131 psi, the governor is signaled to stop the compressor from pumping air.

Wet tank air pressure can be checked at a Pressure Test Valve (4) at the governor.

Air flows from the Compressor (1) through a teflon hose to the Muffler Tank (5) which acts as a shock absorber and carbon trap. The muffler tank is equipped with a Safety Valve (6) and a Drain Valve (7).

Compressed air passes from the Muffler Tank (5), to the Air Dryer (8) where it is filtered and dried, passes through an internal check valve and then enters the Wet Tank (9). A drain Valve (10) is provided for draining off accumulated moisture or oil.

When the wet tank reaches 131 psi it signals the compressor to unload. When the compressor is in the unload mode (131 psi air pressure), the Air Dryer (8) is signaled to purge and expel moisture and oil.

The Muffler Tank Safety Valve (6) is set at 200 psi, the Wet Tank Safety Valve (11) is set at 150 psi, and the Air Dryer (8) Safety Valve is set at 175 psi to protect the system against over-pressurization if the compressor doesn't cut out.

☞NOTE:

The cascading type air system used in this vehicle requires all tanks to reach 131 psi in order for the wet tank to reach 131 psi.

3.2.2. Service & Towing Air Supply

The vehicle air system can be charged, during servicing, with compressed air from an outside source by coupling an air hose to the Rear Charging Fitting (15) which is connected through a Check Valve (16) to the Muffler Tank (5).

A Front Charge Fitting (12) and Air Towing Connector (13) are provided for towing purposes. The towing vehicle provides system air pressure through the Charge Fitting (12) and Check Valve (14). The Towing Connector (13) receives the towing vehicle's brake application pressure.

3.3. Front Brake System

(Refer to Front Brake System Schematic No. 2)

3.3.1. Air Supply

Air from the wet tank feeds the two brake system tanks simultaneously. A 2150 in^3 Front Brake Reservoir Tank (1) provides air pressure for the front axle brakes. The reservoir is protected by a Check Valve (2) which maintains operating pressure if there is a leak in any other area of the system. A Drain Valve (3) is provided for manually draining condensation from the tank.

An Air Pressure Transducer (4) activates an alarm and illuminates the Low Air (red) indicator LED in the gauge until the system pressure is at 75 psi. Front Brake Reservoir pressure is indicated on the dash-mounted pressure gauge.

3.3.2. Service Brake Application

The front brakes are applied by depressing the brake foot treadle to activate the Brake Foot Valve (5). This causes air to flow from the supply (S2) side of the valve to the delivery (D2) side. Delivery (D2) pressure flows through a Quick Release Valve (7), continues through the ABS Modulator Valves (8) and is applied to the left and right Brake Chambers (9).

The Brake Foot Valve (5) delivery pressure (D2) closes the contacts in the Stop Light Pressure Switch (6) at 4 psi, which illuminates the brake lights.

Delivery pressure (D2) is also supplied to the control (C) port of the Spring Brake Modulating Valve (10).

☞**NOTE:**

Refer to 3.6. “Emergency/Parking Brake System” on page 8 in this section for information on the Spring Brake Modulating Valve.

3.4. Rear Brake System

(Refer to Rear Brake System Schematic No. 3)

3.4.1. Air Supply

Air pressure for the rear axle brakes is supplied by a 1200 in^3 Rear Brake Reservoir Tank (1). A Drain Valve (3) is provided for manually draining condensation from the tank.

The Rear Brake Reservoir (1) provides a constant supply of air to the supply (S) port and the balance (B) port, through ATC valve (6), of the Rear Brake Relay Valve (5) and the supply (S1) port of the Brake Foot Valve (4).

An Air Pressure Transducer (2) activates an alarm and lights the Low Air (red) indicator LED in the gauge until the rear brake system pressure is at 75 psi. Rear Brake Reservoir pressure is indicated on the dash-mounted pressure gauge.

3.4.2. Service Brake Application

The rear brakes are applied by depressing the brake foot treadle to activate the Brake Foot Valve (4) causing air to flow through from the supply (S1) to the delivery (D1) side of the valve. A Pressure Transducer (12) monitors brake application pressure and provides a signal to the brake light circuit and transmission retarder system. This Pressure Transducer also provides a reference signal to the interlock system.

A second Pressure Transducer (13) provides a signal to the e-Stroke System.

Refer to Section 9 in this manual for more information on the Electronic Stroke Alert System.

Delivery (D1) pressure flows to the control (C) port of the Rear Brake Relay Valve (5). The delivery (D1) pressure received at the Brake Relay Valve (5), directs air flow from the supply (S) side to the delivery (D) side of the valve.

☞**NOTE:**

A 5.5 psi differential is built into the Brake Relay Valve. As an example, a 10 psi signal equates to 4.5 psi delivery pressure.

The air then flows through the ABS Modulator Valves (9) to the service side of the Rear Axle Brake Chambers (10), applying the brakes.

3.4.3. Spring Brake Release

Delivery (D) side air from the Brake Relay Valve is also supplied to the balance (B) port of the Spring Brake Modulating Valve (7) to direct system pressure to the emergency side of the Rear Brake Chambers (10). This system ensures the brakes are not “compounded”, that is, both spring brake and service brakes applied at the same time.

☞**NOTE:**

Spring brakes apply when no air pressure is in the spring brake chamber.

☞**NOTE:**

Refer to 3.6. “Emergency/Parking Brake System” on page 8 *in this section for detailed information on the Spring Brake Modulating Valve.*

3.4.4. Anti-Lock Braking System (ABS) Operation

ABS control is provided on the front and rear axle brake systems. Operation is typical for both axles. During normal brake application the Modulator Valves (9) are inactive and do not affect the brake application.

If the ECU detects an ABS event (impending wheel lock-up) it will energize the solenoids in the Modulator Valves (9) to control the brake application pressure to the Service Brake Chambers (10).

To decrease brake application pressure, the ECU will energize the inlet and outlet solenoids of the Modulator Valve (9) which will close the supply port and open the delivery and exhaust ports. To hold brake application pressure at a given value, the ECU will energize the inlet solenoid and de-energize the outlet solenoid of the Modulator Valve (9), which will close the supply and exhaust ports.

This modulation of brake application pressure will continue until the impending wheel lock-up condition is alleviated.

3.4.5. Automatic Traction Control (ATC) Operation

The ATC Valve (6) works in conjunction with the ABS system on the drive axle and directs brake pressure to the spinning wheel, via the Modulator Valves (9).

If one of the drive wheels starts to spin, the ECU will energize the ATC valve (6) to open its supply and delivery ports and route pressure to the Rear Brake Relay Valve (5) balance (B) port. This signal pressure controls delivery (D) pressure to the service Brake Chambers (10) via the Modulator Valves (9). The ECU will simultaneously energize the Modulator Valve (9) on the non-spinning wheel to close its supply port and block any applied brake pressure. This action results in only the spinning wheel receiving brake pressure.

3.5. Brake Interlock System

(Refer to Brake Interlock System Schematic No. 4)

☞**NOTE:**

Brake interlock application is functional only if the parking brake is released. Both front and rear brakes are applied during interlock operation.

The Double Check Valve (1) receives air supply from the front or rear brake tanks and delivers to the Pressure Reducing Valve (2) through the normally open (non-applied) Parking Brake Control Valve (16) and Emergency Brake Release Valve (17).

This air supply from the Parking Brake Control Valve (16) is also supplied as a parking brake control signal (PC) to the Spring Brake Modulating Valve (12). A Pressure Switch (3) is located in the parking brake control line and provides a signal to extinguish the Park Brake indicator on the instrument panel when the parking brakes are released.

The Pressure Reducing Valve (2) reduces system pressure to 70 psi and directs to the Brake Valve Actuator (BVA) Solenoid (4). A Pressure Test Valve (5) is located in the supply line to the BVA solenoid and is used to check regulated pressure setting.

The BVA Solenoid (4) is energized open whenever interlock application is required, such as exit door or wheelchair ramp operation. Air flows from the supply (S) to the delivery (D) side of the BVA Solenoid (4) and to the Brake Valve Actuator (7). A Pressure Switch (6) monitors delivery pressure to the Brake Valve Actuator and is used as part of the Interlock system.

The Brake Valve Actuator (7) functions to apply the Brake Foot Valve (8), independent of driver input, and deliver air through the (D1) and (D2) ports.

☞**NOTE:**

The Brake Valve Actuator (7) acts on the Brake Foot Valve (8) the same as what would occur during normal service brake application.

Delivery (D1) pressure is directed to the rear brake chambers (11) via the Rear Brake Relay Valve (9) and Modulator Valves (10).

Delivery (D2) pressure from the brake foot valve is directed to the front brake chambers (15) via the Quick Release Valve (13) and Modulator Valves (14).

Once the event that initiated brake interlock application is no longer active, the brake interlocks can be released by applying additional (greater than interlock) pressure on the brake treadle, and then releasing.

3.6. Emergency/Parking Brake System

(Refer to Emergency/Parking Brake System Schematic No. 5)

The rear axle is equipped with spring loaded brakes. For both parking and emergency brake operation, the brake chambers apply a predetermined spring force on the brakes.

3.6.1. Spring Loaded Brakes

The internal spring in the Rear Brake Chamber (10) will push the rod out if no air pressure is applied. Applying air pressure to the emergency port forces an internal piston to compress the spring and release the brakes.

Applying air to the service side with emergency brakes released applies the brakes in a normal manner.

The Spring Brake Modulating Valve (9) provides anti-compounding protection to the rear axle brakes. This anti-compounding protection prevents both the spring (emergency) brakes and service (normal) brakes from being applied at the same time.

3.6.2. Parking Brakes

The parking brakes are applied by pulling UP on the Parking Brake Control Valve Plunger (4) located on the driver's side console. This closes the supply (S) port on the Parking Brake Control Valve (4) and connects the delivery (D) port to exhaust (E). Air is exhausted from the park control line that signals the Spring Brake Modulating Valve (9).

Loss of air pressure at the Spring Brake Modulating Valve (9) park brake control port opens the delivery ports to exhaust. This action exhausts air from the emergency side of the Brake Chambers (10) allowing the brake chamber springs to extend and apply the parking brakes. The Parking Brake Control Valve (4) is in the APPLY position if there is no air in the system. Above 40 psi the Parking Brake Control Valve (4) can be pushed DOWN to the RELEASE position.

In the RELEASE position, (valve plunger DOWN) air flows to the exhaust (E) port of the Emergency Brake Release Valve (8), out through the delivery (D) port and is applied to the park control (PC) port of the Spring Brake Modulating Valve (9). This activates the Pressure Switch (11), extinguishing the parking brake indicator on the dash.

The Front Brake Air Tank (1) supplies air through a Check Valve (12) to the supply (S) port of the Spring Brake Modulating Valve (9). The park control signal to the Spring Brake Modulating Valve (9) allows air from the supply (S) port to flow through the delivery (D) ports to the emergency side of the Spring Brake Chambers (10). This compresses the internal spring and releases the parking brakes.

3.6.3. Emergency Brake Release

Air is supplied from the Front Brake Tank (1) and the Rear Brake Tank (2) to either side of the Double Check Valve (3) and through a tee connection which directs air to the Parking Brake Control Valve (4) and Emergency Release Tank (5). The Emergency Release Tank (5) is protected by a Check Valve (6) and is drained of moisture through a Manual Drain Valve (3). If total system air pressure is lost, the Emergency Release Tank (5) retains pressure for emergency brake release.

The Emergency Brake Release (EBR) valve (8) is used to release the spring brakes after they have been automatically applied during an emergency (loss of air supply). Pushing and holding down the button on the EBR valve (8) will allow air pressure from the Emergency Release Tank (5) to flow through the supply (S) and delivery (D) ports of the EBR valve (8) and to the park control (PC) port of the Spring Brake Modulating Valve (9). Air flows from the delivery (D) port of the Spring Brake Modulator Valve (9), to the emergency side of the Rear Brake Chambers (10).

☞**NOTE:**

The spring brakes are held in the released position only as long as the EBR button is depressed.

3.6.4. Emergency Brake Application & Modulation

A sudden loss of air pressure from the Parking Brake Control Valve (4) will result in immediate application of the Emergency Brakes (10) without modulated control.

A loss of air pressure from the Rear Brake Tank (2) will disable the rear service brakes. To maintain rear brake function in this situation, the Spring Brake Modulating Valve (9) will release a modulated amount of air from the Emergency Spring Brake Chambers (10) when the brake valve treadle is applied.

☞**NOTE:**

The amount of air released from the Emergency Spring Brake Chambers (10) will be proportional to brake treadle application.

Lack of air pressure at the balance (B) port of the Spring Brake Modulating Valve (9) will allow the pressure sensed at the control (C) port to control the rate at which air is exhausted through the exhaust port. This action will result in controlled application of the rear spring brakes in relation to brake treadle movement.

3.7. Accessories, Suspension & Leveling System

(Refer to Accessories, Suspension & Leveling System Schematic No. 6)

Air from the Front Brake Reservoir Tank (1) supplies the Accessories Tank (3) through a Pressure Protection Valve (2). This valve allows pressure to build in the front brake tank to 90 psi before opening and allowing the Accessories Tank (3) to come to full pressure. If the accessory tank fails or all accessory air is lost, the valve closes at 75 psi ensuring pressure is retained in the braking system.

Check Valves (8 & 15) maintain air pressure in the front and rear suspension and leveling systems in the event of loss of air from the Accessories Tank (3).

The Accessories Tank (3) is fitted with a Manual Drain Valve (6). Air feeds to the Driver's Seat (DS), and through an in-line Air Strainer (9), through Rotary Dump Valve (10) to the entrance door.

3.7.1. Suspension & Leveling Valves

3.7.1.1. Leveling Valve Air Flow

Leveling Valves (11 & 12) are mounted on the frame on each side of the rear axle suspension. A Single Leveling Valve (13), is mounted on the frame at the left-hand side of the front suspension. A link connects the leveling valves to the suspension. This system keeps the vehicle and suspension at the desired ride height regardless of load.

The valve arm moves up and applied air passes through the valve to the Rear Air Springs (17) when the suspension is compressed. The valves release air when the suspension extends. A 7° (3.5° UP & 3.5° DOWN) neutral zone on each valve allows normal suspension travel during operation without continually correcting the air pressure.

If the Front Air Springs (14) are compressed (deflated), air will flow from the pressure (P) port to the (C1) port in the Leveling Valve (13). If the Air Springs (14) are extended (inflated), air will flow from the C1 port to the exhaust (E) port in the Leveling Valve (13).

3.7.1.2. Normal Front Suspension Leveling Operation

Air from the Accessories Tank (3) flows through Check Valve (15) and is applied to the pressure (P) port of the Leveling Valve (13).

If the vehicle is below ride height, the Leveling Valve (13) will direct air from its pressure (P) port through the delivery (C1) port and a tee fitting where air will enter the LVL and LVR ports of the Kneeling Block (16). Air then exits the Kneeling Block through ports ABL and ABR where it is routed to the Air Springs (14).

The Air Springs (14) will continue to fill until vehicle ride height is reached. At that point the Leveling Valve (13) will close the connection between the pressure (P) port and delivery (C1) port and vehicle ride height will be maintained.

If the vehicle should exceed the specified ride height, the Leveling Valve (13) will close the pressure (P) port and direct the delivery (C1) port to the exhaust (E) port. This will reduce air volume in the Air Springs (14) and lower vehicle suspension until the specified ride height is reached.

The Leveling Valve (13) will maintain the required suspension ride height by either admitting air through the pressure (P) port or by exhausting air through the exhaust (E) port.

3.7.1.3. Normal Rear Suspension Leveling Operation

Air from the Accessories Tank (3) flows through a Check Valve (8) to the pressure (P) port of the rear LH and RH Leveling Valves (11 & 12). The Leveling Valves distribute air through ports (C1 & C2) to the fore and aft Air Springs (17).

At normal ride height, the Leveling Valves (11 & 12) ports are closed. If the suspension exceeds the LEVEL position, the Leveling Valves (11 & 12) exhaust air through the exhaust (E) port, reducing volume in the Air Springs (17) until the proper suspension level is reached. The Leveling Valves (11 & 12) will maintain the required suspension ride height by either admitting air through the pressure (P) port or exhausting air through the exhaust (E) port as necessary.

3.7.2. Entrance Door Operation

When the door controller is in the CLOSED position, air from the Accessories Tank (3) is routed through an in-line Air Strainer (9), Rotary Dump Valve (10) before being applied to the entrance door baseplate. The air passes through a baseplate mounted Door Control Mag Valve (20), Rotary Dump Valve (18), and maintains constant pressure on a Cable Release Cylinder(19). A Normally Open Pressure Switch (7) provides the Multiplexing System with a signal to indicate system pressure.

3.7.3. Retarder Operation

3.7.3.1. Retarder Applied

The retarder is activated in three stages as follows:

- ❐ release the accelerator - first stage (25% applied)
- ❐ 1 psi brake application - second stage (66% applied)
- ❐ 4 psi brake application - third stage (100% applied)

These three stages of activation energize the Retarder Control Mag Valve (4) pressure (P) and (A) ports and apply retarder braking to the Transmission (5). Pressure Reducing Valve (21) reduces system pressure to 100 psi before it is applied to the Retarder Control Mag Valve (4).

3.7.3.2. Retarder Deactivated

When the brake treadle is lifted, the Retarder Control Mag Valve (4) de-energizes. This isolates the transmission accumulator from the air supply and deactivates transmission retarder braking.

3.8. Kneeling System

(Refer to Kneeling System Schematic No. 7)

3.8.1. Front Kneeling Operation

Air for the Kneeling System is supplied by the Kneeling Tank (3). The Kneeling Tank receives air from the integral Accessories Tank (1). An internal Check Valve (2) allows air to flow from the Accessories Tank to the Kneeling Tank in one direction only. Air from the Kneeling Tank (3) is directed to the pressure (P) port of the Kneeling Block (4). An inline Check Valve (5) is located at the pressure (P) port of the Kneeling Block (4). The Kneeling Tank (3) can be drained through the Drain Valve (7).

During normal operation the Leveling Valve (8) controls air volume in the front air springs to maintain suspension ride height. Setting the Kneel switch, located on the instrument panel, to the LOWER position closes the (LVL) and (LVR) ports. The KNEEL solenoid on the Kneeling Block (4) energizes and opens the (ABL) and (ABR) ports directing air from the Air Springs (6), through the exhaust port to atmosphere. This action lowers (kneels) the vehicle front suspension. When the vehicle suspension reaches the bottom of the kneeling cycle, the KNEEL solenoid on the Kneeling Block (4) de-energizes and maintains the vehicle front suspension in the lowered kneeling position.

The ride height position of the leveling valve, prior to kneeling, is recorded by the Multiplexing System and is used to restore the vehicle to ride height during the RAISE cycle.

3.8.2. Raising Front Suspension

The Kneeling Block (4) provides fast fill operation for air springs in the RAISE mode. The valve is controlled by input from the Multiplexing System, which records the ride height position prior to kneeling, and continues to fill the suspension until the same position is sensed during the RAISE cycle.

☞**NOTE:**

A position sensor on the leveling valve provides a ride height signal to the Multiplexing System just prior to kneeling. This information is used for controlling the final RAISE and LOWER position of the vehicle during the KNEELING cycle.

Setting the Kneel switch to the RAISE position energizes the RAISE solenoid on the Kneeling Block (4). This raises the vehicle front suspension by routing air from the Kneeling Tank (3) through the Check Valve (5) to the pressure (P) port of the Kneeling Block (4). Air is now directed from the Kneeling Block pressure (P) port through the (ABL) and (ABR) ports to the Front Air Springs (6). As the Air Springs (6) reach the proper inflation level, the Kneeling Block (4) RAISE solenoid is de-energized. This opens the Kneeling Block (4) leveling valve (LVL) and (LVR) ports to the air spring (ABL) and (ABR) ports. The Leveling Valve (8) will now maintain normal front suspension ride height.

3.9. Air System Functional Tests

☞**NOTE:**

These are static tests only.

3.9.1. System Pre-Test

1. Place blocks behind and in front of the wheels to prevent the vehicle from rolling.
2. Examine all air lines for dents or kinks.
3. Examine all rubber hoses for deterioration, drying out and overheating.
4. Examine hose supports for security of attachment.
5. Examine exterior of metal components for corrosion, mechanical damage and security of attachment.
6. Examine brake chambers for damage and security of attachment.

3.9.2. Governor Cut-Out & Compressor Test

1. Ensure air system is fully charged.
2. Reduce air system pressure to below 40 psi through multiple applications of the brake treadle.
3. Start the engine and run the vehicle at fast idle. Confirm that the ABS indicator on the instrument panel remains illuminated for 4 seconds after vehicle start-up and then extinguishes.

   ☞**NOTE:**

   The Low Air indicator on the instrument panel and the air system warning buzzer will be active until system air pressure reaches approximately 75 psi, at which point they should switch off. Before proceeding with remainder of tests, make repairs if Low Air indicator or warning buzzer do not function as described.

4. When the air pressure gauge reaches 40 psi, start a stopwatch and time how long it takes to reach the governor cut-out pressure. Confirm the following:
   a. The air system builds up to operating pressure within 6 minutes.
   b. The governor cuts out at system operating pressure (governor cut-out rating).
5. Make several brake applications to drop system pressure below the governor cut-in pressure rating. Confirm the governor cuts in and the compressor begins to pump air into the system.
6. Adjust or replace governor as required. Refer to 4.2. "Governor D-2" on page 29 in this section for procedures.
7. If air system build-up time exceeds the specified rate:
   a. Check compressor air inlet for restrictions.
   b. Check compressor discharge port and line for carbon. Clean or replace as required.
   c. With governor in unloaded mode, listen at compressor inlet for air leakage. If leakage is heard, apply a small amount of oil around unloader pistons. If no leakage is indicated, leakage is through compressor discharge valves.
   d. Check for damaged or kinked Teflon discharge hoses.
   e. Check for excessive air leakage throughout the system.
   f. Check for faulty discharge check valves in air dryers.
   g. Check for faulty shop-fill single check valve.
   h. Check for faulty safety valve.
   i. Check for plugged or saturated dryer desiccant.
   j. Check for worn out compressor.
8. Repeat test after repairs are made to confirm correct operation.

3.9.3. Reservoir Supply Leakage Test

1. Start the engine and charge the air system. Stop the engine.
2. Allow system air pressure to stabilize for one minute.
3. Observe instrument panel air gauges for two minutes. A 2 psi drop within 2 minutes is acceptable.
4. If leakage exceeds the allowable limit, check the following using a leak tester or test solution:
   a. Supply lines and fittings (tighten as required).
   b. Spring brake modulating valve.
   c. Brake foot valve.
   d. Parking brake control valve.
   e. Emergency brake release valve.
   f. Spring brake actuators.
   g. Wet tank safety valve.
   h. Governor.
   i. Compressor discharge valves.
5. Repair as required. Repeat test to confirm repairs before proceeding.

3.9.4. Delivery Leakage Test

1. Start the engine and charge the air system. Stop the engine.
2. Make and hold a 90 to 100 psi brake application.
3. Allow pressure to stabilize for 1 minute. Begin timing for 2 minutes and observe instrument panel air gauge. A 2 psi pressure drop within 2 minutes is acceptable.
4. If leakage exceeds allowable limit, check the following using a leak test solution:
   a. Service lines and fittings (tighten as required).
   b. Stop light switches.
   c. Brake chamber diaphragms.
   d. ABS modulator valves.
   e. Brake relay valve.
   f. Spring brake modulating valve.
   g. Check valves.
   h. ATC valve (if equipped).
5. Repair as required. Repeat test to confirm repairs before proceeding with remaining tests.

3.9.5. Emergency/Parking Brake & Check Valve Integrity Test

☞**NOTE:**

The following procedure will test the operation of the parking brake system, emergency brake system, and emergency brake release system (where equipped). This procedure will simulate vehicle operation in emergency mode with loss of air supply at one or more tanks. Perform these tests in the sequence listed in order to avoid duplicate or redundant testing.

1. Park the vehicle on level ground and chock the wheels.
2. Start the engine and charge the air system to cut-out pressure
3. Stop the engine.
4. Ensure the wheels of the vehicle are chocked and release the park brake.
5. Drain the wet tank. The front and rear brake tanks should retain full pressure.
6. Drain the front axle brake tank. The low air warning lamp on the front brake tank gauge should illuminate and the low air buzzer should sound. The rear brake tank should retain full pressure.
7. With no air pressure in the front brake tank, make a service brake application. The rear axle brakes should apply and the rear brake lamps should illuminate.
8. Slowly drain the rear axle brake tank. The parking brake control valve should pop to the applied position when the rear reservoir reaches approximately 45 psi.

☞**NOTE:**

DO NOT use the brake treadle to bleed down the rear axle brake tank. Rapid pumping of the brake treadle will cause pressure pulsations that can result in premature application of the spring brakes, resulting in a false pressure reading.

☞**NOTE:**
Ensure that the interlocks are NOT applied when bleeding down the system.

☞**NOTE:**
The following step applies to vehicles equipped with an Emergency Brake Release (EBR) valve. Otherwise, proceed to step 10.

9. Actuate the Emergency Brake Release control by pressing and holding the knob in the down position. The park brakes at the rear axle should release and remain released as long as the control is held in the down position. Release the control. The park brakes at the rear axle should reapply. Repeat this cycle until the park brakes fail to release. Drain the emergency brake release tank. The park brakes should remain in the applied position.
10. Close all tank drain valves, start the engine, and recharge the air system to cut-out pressure.
11. Stop the engine and release the park brake.
12. Drain the rear axle brake tank. The low air warning lamp on the rear brake tank gauge should illuminate and the low air buzzer should sound. The front brake tank should retain full pressure
13. With no air pressure in the rear brake tank, make a service brake application. The front and rear axle brakes should apply and release at least once, the rear brake lamps should illuminate, and the parking brake should remain released.
14. Test is complete. Close all reservoir drain valves, start the engine, and recharge the air system to cut-out pressure.
15. If the brakes do not operate as described in the test procedure, check the following for leakage and correct as required:
    a. Fittings.
    b. Kinked lines.
    c. Single check valves.
    d. Double check valves.
    e. Parking brake control valve.
    f. Emergency release valve (if equipped).
    g. Brake relay valve.
    h. Spring brake modulating valve.
    i. Brake foot valve.
    j. ABS modulator valves.
    k. ATC valve (if equipped).

4. MAIN AIR SUPPLY SYSTEM COMPONENTS

WARNING

When working on or around air brake systems and components, the following precautions should be observed:

- ❒ **ALWAYS block vehicle wheels. Stop engine when working under a vehicle. Make certain to drain air pressure from all reservoirs before beginning any work on the vehicle. Depleting vehicle air system pressure may cause vehicle to roll. Keep hands away from chamber push rods; they may apply as 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 certain 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 understand 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 use of those tools.**
- ❒ **Use only approved replacement parts and components.**
  - ❒ **Only components, devices, mounting and attaching hardware specifically designed for use in air brake systems should be used.**
  - ❒ **Replacement hardware, tubing, hose, fittings and so forth, should be of equivalent size, type, length, and strength as the original equipment.**
  - ❒ **Make certain that when replacing tubing or hose, all supports, clamps or suspending devices that were originally installed are reinstalled or replaced if they are missing.**
- ❒ **Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.**

CAUTION

Using alcohol in the air brake system as a means to dry the air or prevent system freezing during cold weather is not acceptable. Studies indicate that alcohol removes the lubrication from the system components, causing faulty system function. Also, the materials used for the seals in these components are not alcohol-safe and will deteriorate at an accelerated rate leaving the brake system prone to failure. Using alcohol or alcohol-based fluids in your air brake system will void the warranty on these components.

4.1. Wabco Twin Cylinder Air Compressor

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Main Air Supply System Components" when performing maintenance on these components.

4.1.1. Description

The compressor is mounted to the engine gear case cover and driven by a splined coupling on the engine accessory driveshaft. Engine oil pressure is supplied to the compressor and oil drains back into the engine crankcase from the compressor flange opening. Hoses attached to the cylinder head circulate coolant from the engine to cool the compressor.

4.1.2. Operation

The compressor runs continually while the engine is running. Compression of air is controlled by the governor. It sends a signal to unload the compressor when the maximum pre-set pressure (131 psi) is attained or to resume pumping when the system pressure falls to the cut in point (117 psi).

4.1.3. Air Compressor Troubleshooting

AIR COMPRESSOR TROUBLESHOOTING		
CONDITION	**POSSIBLE CAUSE**	**SOLUTION**
Compressor passes excessive oil (for example, the presence of oil at exhaust air brake system valve, oil in air dryer desiccant, and so forth)	Blocked or restricted oil return	Clean oil drain passages in the compressor and on the engine surface. Verify proper passage alignment.
	Contaminated inlet air or oil	Replace damaged, defective or dirty engine air filter. Repair any leaking, damaged or defective compressor air intake components. Change engine lubricating oil. ☞**NOTE:** *To avoid this condition, make sure oil and filter maintenance schedules are followed. Refer to the Preventive Maintenance Section of this manual for procedure.*
	Restricted air inlet or excessive vacuum present at compressor inlet	Verify engine or compressor air cleaner is functioning properly. Replace if necessary. Repair compressor air inlet kinks or excessive bends.
	Excessive engine crankcase pressure	Verify engine crankcase venting is to manufacturer's specification.
	Compressor duty cycle too high	Check system for leaks. Make necessary repairs.
	None of the above, but condition persists	Replace the compressor.
Compressor leaks oil	Physical damage or internal problems with compressor	Replace the compressor.
Compressor continuously cycles	Compressor unloader piston leaking	With compressor unloaded check for air leakage. If leaking, replace the cylinder head.
	Governor air leak	Refer to 4.2. "Governor D-2" on page 29 in this section for governor maintenance and troubleshooting procedures.

AIR COMPRESSOR TROUBLESHOOTING		
CONDITION	**POSSIBLE CAUSE**	**SOLUTION**
	Dryer purge valve air leakage	Check for air dryer malfunction. Refer to 4.2. “Governor D-2” on page 29 in this section for procedure.
	Air leak at governor-compressor attachment	Inspect connection for physical damage. Inspect and repair connection.
	Excessive reservoir contamination	Drain reservoirs.
	None of the above, but conditions persists	Replace the compressor.
No air delivery Low air delivery Low air pressure	Discharge line blockage	Check for freeze-up in the discharge line. Check low spots and eliminate any traps in the discharge line. Inspect and repair compressor discharge port and clear any line restrictions. Replace damaged lines as necessary. Check for carbon build-up. If carbon has built up, make sure cooling lines are not kinked or restricted. If carbon has built up in the discharge line, replace the line.
	Inlet line kinked or restricted	Inspect the compressor air induction line for kinks and restrictions. Repair or replace as necessary.
	Governor malfunction or misadjustment	Check for proper loader/ unloader cycles of compressor. Refer to 4.2. “Governor D-2” on page 29 in this section for governor maintenance and troubleshooting procedures.
	External contamination	Replace broken, defective or dirty air filter. Clean contaminants from surface of compressor.
	Air dryer purge valve stuck open or leaking	Check for air dryer malfunction. Refer to 4.6. “QBA15 Air Dryer” on page 37 in this section for procedure.
	Chafed or worn discharge line	Replace faulty sections of discharge line.

AIR COMPRESSOR TROUBLESHOOTING		
CONDITION	**POSSIBLE CAUSE**	**SOLUTION**
	Loose or leaking air line connections	Verify all connections are secure. Tighten connections where necessary. Inspect port threads for damage. If damage is extensive, replace cylinder head.
	Damage to compressor valves and/or valve seats	Replace the cylinder head.
	Leaking or malfunctioning internal pressure relief valve	Replace the cylinder head.
Noisy air compressor	Loose drive hub Loose accessory drive coupling	Check fit of drive coupling. Ensure hub is completely seated and crankshaft nut is tight. Inspect crankshaft for damage. Replace compressor if crankshaft is damaged.
	None of the above, but condition persists	Replace the compressor.
Broken connecting rod or crankshaft	Oil starvation to crank pin or front main bearing	Check oil pressure. Verify oil passage is free of obstructions. Make necessary repairs.
	Failed fan drive and power steering pumps	Verify fan drive and power steering pumps are in proper operating order. Refer to Section 6 of this manual for procedure.
Compressor leaks engine coolant	Loose fitting	Check fittings at compressor and engine for leaks and verify fittings are properly torqued.
	Cracked coolant port	Replace cylinder head.
	Porosity in cylinder head	Replace cylinder head.
	Leaking of gasket internal to the cylinder head	Verify cylinder head bolts are properly torqued. Make necessary adjustments. Inspect gasket for cracks or signs of water. Replace if necessary. Replace cylinder head.
	None of the above, but condition persists	Replace the compressor.

AIR COMPRESSOR TROUBLESHOOTING		
CONDITION	**POSSIBLE CAUSE**	**SOLUTION**
Compressor pressurizes coolant system or coolant leakage to compressor inlet	Leaking of gasket internal to the cylinder head	Inspect gasket. Replace if necessary.
	Cavitation or corrosion in cylinder head	Replace the cylinder head.
	Porosity in cylinder head or cylinder head cracked	Replace the cylinder head.
	None of the above, but condition persists	Replace the compressor.
Unloader leakage	Possible internal damage, including worn or damaged unloader piston O-ring, porosity in unloader piston bore, loose or leaking seal at unloader piston bore	Replace the compressor cylinder head assembly.
Compressor head gasket failure	Discharge line blocked due to freezing or carbon build-up	Check for trap (low spots) in lines. Make necessary repairs. Clear discharge line. Replace line if necessary. Check for carbon build-up. If carbon build-up is present, replace the discharge line.
	Frozen or blocked line to governor	Clear blocked line. Replace line if necessary. Check for air dryer malfunction. Repair or replace as required. Refer to 4.6. “QBA15 Air Dryer” on page 37 in this section for procedure.
	Governor malfunction	Repair or replace the governor. Refer to 4.2. “Governor D-2” on page 29 in this section for procedure.
	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 the cylinder head.
	None of the above, but condition persists	Replace the compressor cylinder head assembly.

4.1.4. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Drain the wet tank and muffler tank. Refer to the General Information Section of this manual for drain valve locations.
3. Close the coolant supply and return shutoff valves.

☞**NOTE:**

The coolant supply shutoff valve is located in the booster pump delivery line. The coolant return shutoff valve is located in the radiator return line.

4. Raise the vehicle to a suitable working height. Refer to the General Information Section of this manual for lifting procedure.
5. Remove the power steering pump from the end of the compressor. It is not necessary to disconnect the hydraulic lines.

☞**NOTE:**

Fabricate a blanking plate to match the compressor mounting flange. Use the blanking plate with existing gasket to seal any oil from leaking out of the compressor when removing the unit from the vehicle.

6. Disconnect the compressor oil hose at the engine block location. See “Fig. 8-1: Compressor Removal & Installation” on page 23.
7. Disconnect the governor air hose from the compressor.
8. Loosen the hose clamp and disconnect the air supply line from the compressor.
9. Disconnect the delivery hose from the compressor and loosen the 45° ORB fitting.
10. Use a thin offset wrench to disconnect the coolant inlet line adjacent to the air delivery port.
11. Disconnect the coolant return line from the quick disconnect fitting by compressing the tabs on the connector while pulling upward.

⚠ WARNING

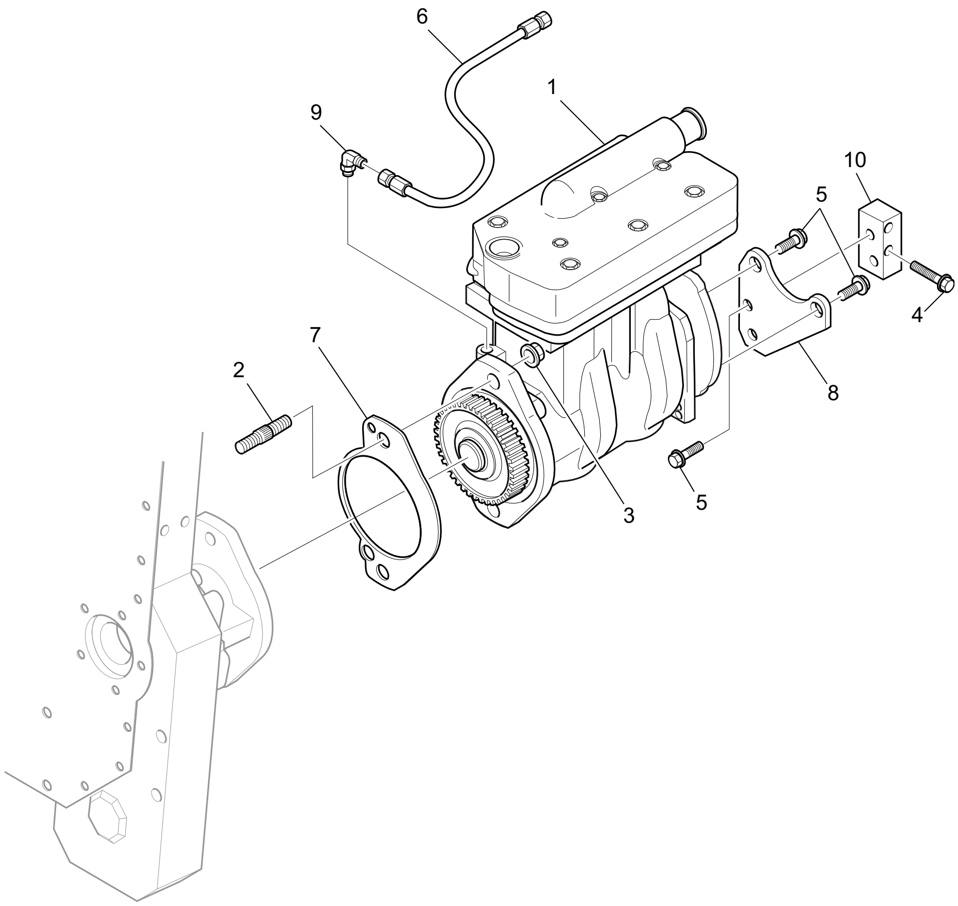
The air compressor is heavy. Use suitable lifting equipment or the assistance of another person to support the weight of the air compressor.

12. Remove the two lock nuts that attach the compressor to the engine.
13. Support the compressor and remove the two bolts that attach the mounting spacer to the engine block.

☞ **NOTE:**

It is not necessary to remove the mounting bracket from the compressor at this time. The oil supply line will also remain attached to the compressor during removal from the vehicle.

14. Carefully slide the compressor off the mounting studs and remove from the vehicle.
15. Place the compressor on a work bench and remove the oil hose, mounting bracket, and fittings.



1. Compressor
2. Stud
3. Nut
4. Screw
5. Screw
6. Oil Hose
7. Gasket
8. Spacer
9. Elbow
10. Spacer Mount

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Fig. 8-1: Compressor Removal & Installation

4.1.5. Installation

1. Transfer and install the fittings, oil hose, and mounting bracket to the replacement air compressor. Clean all mounting surfaces.

⚠ WARNING

The air compressor is heavy. Use suitable lifting equipment or the assistance of another person to install the air compressor.

2. Install a new gasket on the compressor mounting flange and carefully slide the compressor over the two engine mounting studs. Secure compressor to engine using two lock nuts.

☞**NOTE:**

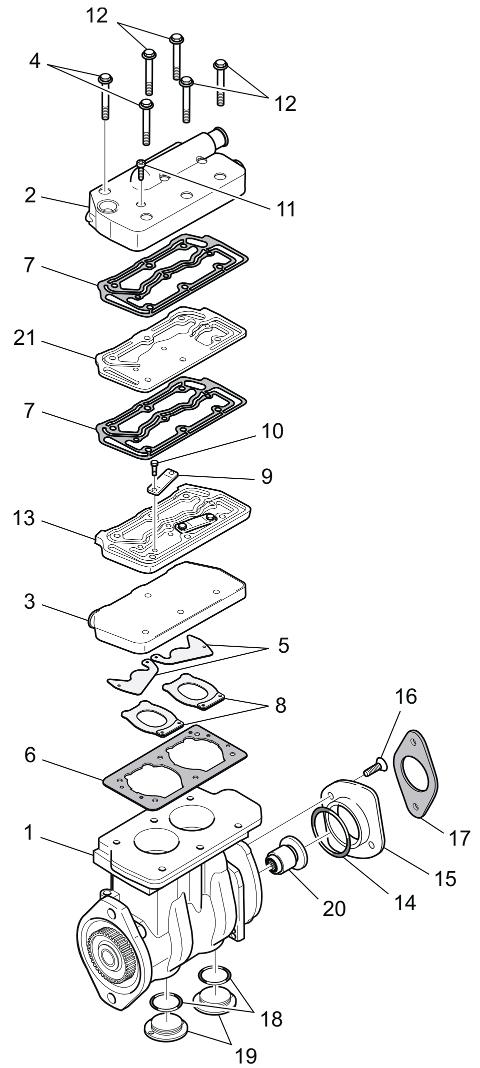
Twin cylinder air compressors do not require the piston position to be timed to the engine.

3. Align the spacer block with the threaded holes on the engine block and install two bolts. Tighten all mounting fasteners.
4. Install the coolant supply and return lines on the compressor.
5. Connect the air delivery hose to the 45° elbow fitting. Tighten the nut on the ORB elbow fitting, then tighten the delivery hose fitting.
6. Connect the air supply hose to the compressor and tighten the hose clamp.
7. Connect the governor air hose to the compressor.
8. Connect the oil hose to the engine block.
9. Use a new gasket and install the power steering pump on the compressor. Refer to Section 3 of this manual for installation procedure.
10. Open the coolant supply and return shutoff valves.
11. Lower the vehicle and top up the engine coolant at the surge tank as required.
12. Set the Battery Disconnect to the ON position, start the engine, operate at fast idle, and allow the air system to fully charge.
13. Check for any air, coolant, or oil leaks.

4.1.6. Cylinder Head Components

4.1.6.1. Disassembly

1. Remove the six M8 head bolts and the three M6 Torx screws holding the head to the compressor. Discard the bolts and screws. See “Fig. 8-2: Air Compressor Assembly” on page 25.
2. Remove the head gasket, both intake reed valves and both sliding leaf unloader valves. Discard these parts.
3. Carefully separate the upper head/cover and lower manifold assembly. Be careful not to nick or otherwise damage any of the machined surfaces of these parts. Retain the thin aluminum cooling plate and discard the two gaskets.
4. Remove the two M5 screws holding each exhaust valve and remove both exhaust valves. Discard these parts.



1. Air Compressor
2. Cover Head
3. Inlet Valve
4. Bolt, 80mm Lg.
5. Sliding Leaf Valve
6. Cylinder Head Gasket
7. Gasket
8. Intake Valve
9. Exhaust Valve
10. Screw
11. Screw
12. Bolt
13. Manifold Assembly
14. O-Ring
15. Pump Adapter
16. Screw
17. Gasket
18. Seal Ring
19. Sump Plug
20. Spline Adapter
21. Coolant Plate

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Fig. 8-2: Air Compressor Assembly

4.1.6.2. Cleaning & Inspection

1. Carefully remove any remaining gasket material and deposits from machined surfaces.
2. Do not soak the head assembly in cleaning solvent as it may damage the unloader O-rings. The two unloader plungers in the manifold and the pressure relief valve in the head cannot be serviced. Use caution when cleaning to avoid getting debris in this area.

4.1.6.3. Assembly

1. Place the manifold on a clean bench and install the two exhaust valves. Torque the M5 screws to 45 ± 4.5 in-lb. (5 ± 0.5 Nm) and then tighten an additional 90° +15°/-5° clockwise rotation.
2. Install a new gasket on the manifold, the cooling plate, then the other new gasket.
3. Install the head cover onto the assembled manifold and cooling plate assembly. Install and hand-tighten three M6 Torx screws to hold the assembly together. Do not final tighten at this time.
4. Turn the head assembly over and place the two unloader valves over their guide pins. Place the two intake valves over their guide pins, ensuring the pads are facing up and the valves will lie flat against the head openings.

☞**NOTE:**

Use a small amount of Unisikon GL301 grease under the valves to ensure they remain in place for the remainder of the assembly process.

5. Install a new head gasket, ensuring the unloader hole in the gasket aligns with the unloader passageway in the cylinder head. Also ensure the gasket fits over the two guide bushings in the manifold.
6. Support the crankcase in an appropriate fixture and install the head assembly onto the crankcase, ensuring the guide bushings enter the counterbores in the crankcase.
7. Install six new head bolts, then tighten the six head bolts and three screws to the specified torque and sequence listed in the torque chart. Refer to 4.1.9. “Compressor Head Torque Specifications” on page 28 in this section for torque values. See “Fig. 8-3: Compressor Head Assembly Torque Pattern” on page 27.

CAUTION

It is critical that the torque and rotational tightening procedure be followed exactly as described in order to obtain a successful service life from the unit. Use a calibrated torque wrench and make accurate measurements during the rotational tightening process.

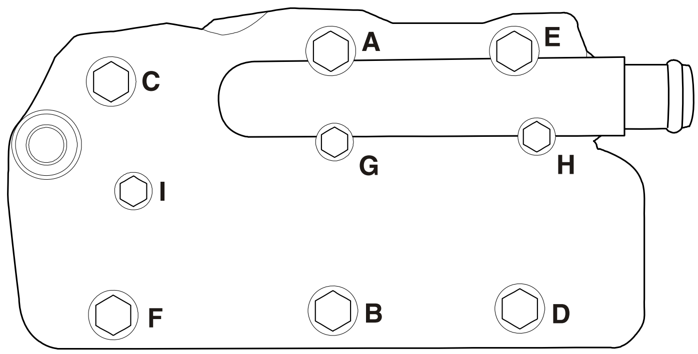


Fig. 8-3: Compressor Head Assembly Torque Pattern

4.1.7. Rear Seal & Adapter

4.1.7.1. Disassembly

1. Remove the fan drive and power steering pumps from the compressor. Refer to Section 6 of this manual for removal procedure.
2. Remove the two M6 flat head screws that attach the pump adapter to the compressor housing.
3. Remove and discard the pump adapter.
4. Remove and discard the O-ring seal.

4.1.7.2. Assembly

1. Lubricate the new O-ring with engine oil and insert into the fillet pocket formed by the corner of the bearing and the wall of the crankcase.
2. Install the adapter into the rear opening of the compressor, ensuring the screw holes in the adapter align with the threaded holes in the compressor.
3. Secure the adapter in place using two M6 flat head screws. Torque screws to 60 in-lb. (6 Nm).
4. Install the fan drive and power steering pumps. Refer to Section 6 of this manual for installation procedure.

4.1.8. Sump Plug & Seal

4.1.8.1. Disassembly

1. Remove the two socket head screws from each of the two sump plugs.
2. Carefully pry out the sump plugs from the compressor sump.
3. Remove and discard the O-ring.

4.1.8.2. Assembly

1. Inspect the sump plug bore for nicks or burrs and wipe clean.
2. Lubricate the O-rings with engine oil and install onto the sump plugs.
3. Press the sump plugs into the bore, ensuring the screw holes in the sump plug align with the threaded holes in the compressor sump.
4. Apply medium strength liquid thread lock to the screw threads and install socket head screws. Torque screws to 90 ± 9 in-lb. (10 ± 1 Nm).

4.1.9. Compressor Head Torque Specifications

COMPRESSOR HEAD TORQUE SPECIFICATIONS				
STEP	BOLT	TORQUE (Nm)	TORQUE (ft-lb.)	ROTATION (Degrees)
1	A	15 (±1.5)	11 (±1)	
2	B	15 (±1.5)	11 (±1)	
3	C	15 (±1.5)	11 (±1)	
4	D	15 (±1.5)	11 (±1)	
5	E	15 (±1.5)	11 (±1)	
6	F	15 (±1.5)	11 (±1)	
7	A	25 (±2)	18.5 (±1.5)	
8	B	25 (±2)	18.5 (±1.5)	
9	C	25 (±2)	18.5 (±1.5)	
10	D	25 (±2)	18.5 (±1.5)	
11	E	25 (±2)	18.5 (±1.5)	
12	F	25 (±2)	18.5 (±1.5)	
13	A			270 (±10°)
14	B			180 (±10°)
15	C			180 (±10°)
16	D			180 (±10°)
17	E			270 (±10°)
18	F			180 (±10°)
19	G	6 (±.6)	4.5 (±.5)	
20	H	6 (±.6)	4.5 (±.5)	
21	I	6 (±.6)	4.5 (±.5)	
22	G			90° (+15/-5°)
23	H			90° (+15/-5°)
24	I			90° (+15/-5°)

4.2. Governor D-2

WARNING

Refer to “WARNING” and “CAUTION” at the beginning of “Main Air Supply System Components” when performing maintenance on these components.

4.2.1. Description

The governor, operating in conjunction with the compressor unloading mechanism, automatically controls the air pressure in the air brake or air supply system between the desired, predetermined maximum and minimum pressures. The compressor runs continually while the engine runs, but the actual compression of air is controlled by the governor actuating the compressor unloading mechanism which stops or starts compressor when the maximum or minimum reservoir pressures are reached. The D-2 governor has a piston upon which air pressure acts to overcome the pressure setting spring and control the inlet and exhaust valve to either admit or exhaust air to or from the compressor unloading mechanism.

The governor is remotely-mounted in close proximity to the fusebox.

Porting consists of 3 reservoir ports (1/8" PT, 3 unloader ports (1/8" PT) and 1 exhaust port (1/8" PT). See “Fig. 8-4: Governor Exterior Ports” on page 29.

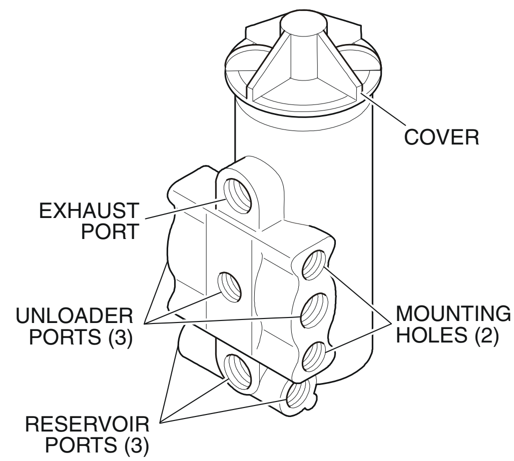


Fig. 8-4: Governor Exterior Ports

4.2.2. Operation

Reservoir air pressure enters the governor reservoir port. This pressure moves the piston and the inlet and exhaust valve against the pressure setting spring. As reservoir pressure reaches the cut-out setting of the governor (131 psi), the exhaust stem seats on the inlet and exhaust valve to close the exhaust passage and open the inlet passage. Reservoir pressure then flows around the inlet valve, through a passage in the piston, and out the unloader port. Air also flows around the piston, which is enlarged at one end.

When reservoir pressure drops to the cut-in setting of the governor (117 psi), the pressure setting spring overcomes the force exerted on the piston. The inlet valve then closes and the exhaust opens. The air in the unloader line then escapes back through the piston, through the exhaust stem, and out the exhaust port.

4.2.3. Operating Test

1. Start the vehicle engine and build up air pressure in the air brake system and check the pressure registered by a dash or test gauge at the time the governor cuts out, stopping the compression of air by the compressor.
2. With the engine still running, make a series of brake applications to reduce the air pressure and observe the pressure at which the governor cuts-in the compressor.
3. Never condemn or adjust the governor pressure settings unless they are checked with an accurate test gauge or a dash gauge that is registering accurately. Refer to 4.2.6. “Adjustment” on page 31 in this section for procedure.

☞**NOTE:**

The range between the cut-in and cut-out pressure is not adjustable. Standard cut-in pressure for this vehicle is 117 psi. Standard cut-out pressure is 131 psi.

4.2.4. Leakage Test

Leakage tests on the D-2 Governor should be performed in both cut-in and cut-out position.

❒ Leakage Test: Cut-In Position

Apply soap solution around cover and on exhaust port. Slight bubble leakage permitted. Excessive leakage indicates a faulty inlet valve or lower piston O-ring.

❒ Leakage Test: Cut-Out Position

Apply soap solution around cover and on exhaust port. Slight bubble leakage permitted. Excessive leakage indicates a faulty exhaust valve seat, exhaust stem, O-ring, or upper piston O-ring.

If the governor does not function as described or leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired with approved parts.

4.2.5. Removal

⚠ **WARNING**

During component removal and installation, ensure the Battery Disconnect switch is in the OFF position.

1. Block and hold vehicle by means other than air brakes.
2. Drain air brake system.
3. Disconnect reservoir air line.
4. Remove governor mounting bolts, then governor.

4.2.6. Adjustment

1. Mount governor on suitable test rack or on vehicle.
2. To adjust the D-2 Governor build up reservoir pressure and note at what pressure the governor cuts out. If the cut-out pressure is below the desired pressure, remove the cover, loosen the adjusting screw nut and with a screw driver turn the adjusting screw counter-clockwise until the governor cuts out at the desired pressure. If the cut-out pressure is higher than desired the adjusting screw should be turned clockwise to lower the pressure. After setting the cut-out pressure it is important that the adjusting nut be tightened. See "Fig. 8-5: Governor Adjustment" on page 31.

NOTE:

The range between the cut-in and cut-out pressure is not adjustable. Standard cut-in pressure for this vehicle is 117 psi. Standard cut-out pressure is 131 psi.

CAUTION

DO NOT overadjust. Each 1/4 turn of the screw alters the pressure setting by 4 psi.

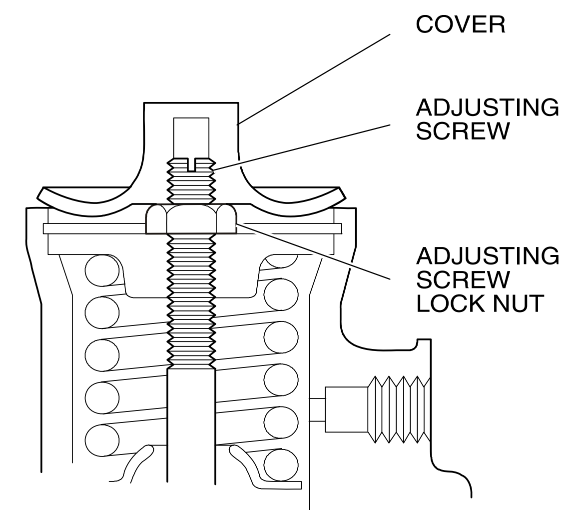


Fig. 8-5: Governor Adjustment

4.2.7. Installation

WARNING

During component removal or installation, ensure the Battery Disconnect switch is in the OFF position.

1. Inspect governor body prior to installation to ensure plugs are installed in the ports that are not being used. Also ensure that ports being used are clean and open.
2. Use two bolts and washers to attach governor assembly to mounting plate.
3. Inspect air lines for cleanliness prior to installing on governor. Install air lines, as marked during removal, to applicable ports on governor body.
4. Test governor operation. Refer to 4.2.3. "Operating Test" on page 30 in this section for test procedure.

4.3. RV-3 Pressure Reducing Valve

⚠ WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Main Air Supply System Components" when performing maintenance on these components.

4.3.1. Description

The pressure reducing valve is a normally open pressure control device that reduces system air pressure and maintains a constant, specified, pre-set pressure on its output. The pressure reducing valve is not adjustable and is set at 70 psi ± 5 psi. See "Fig. 8-6: Pressure Reducing Valve Cross Section" on page 32.

The pressure reducing valve is mounted between the wet tank and the front brakes tank as a component of the brake interlock system.

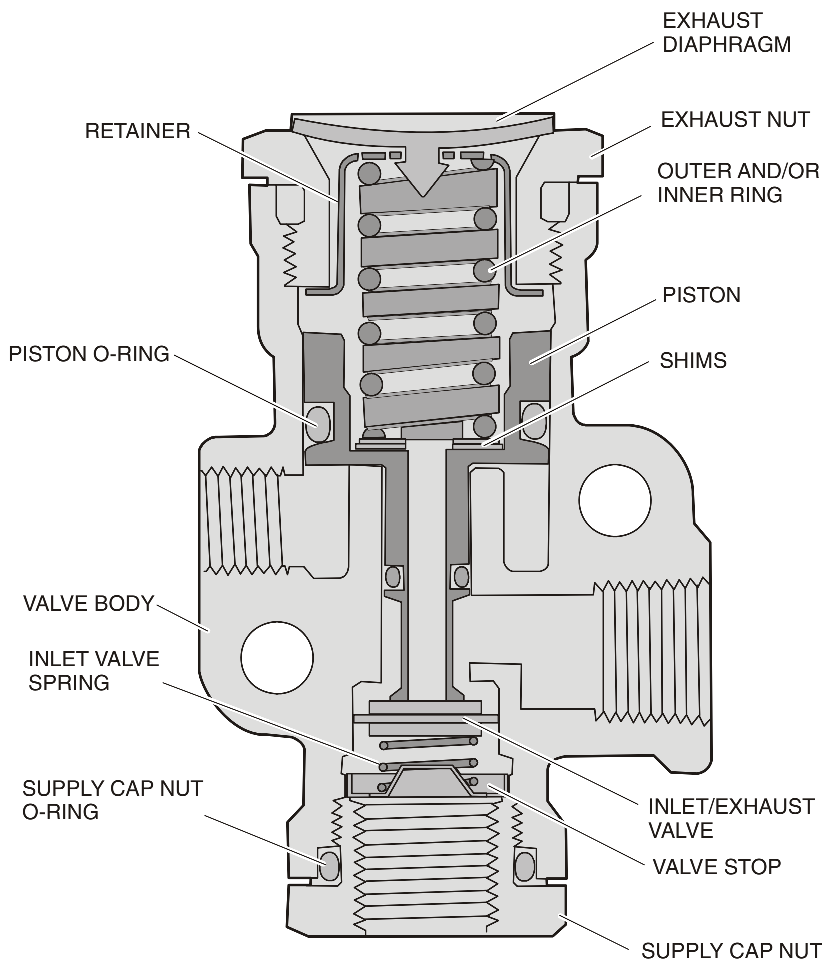


Fig. 8-6: Pressure Reducing Valve Cross Section

4.3.2. Operation

With no air pressure present at the supply port, the inlet valve is unseated and open while the exhaust passage through the center of the piston is sealed by the exhaust valve. Compressed air entering the supply port flows out the delivery port. Air simultaneously flows between the piston stem and valve body to the underside of the piston.

When air pressure on the piston overcomes spring force, the piston moves and the valve spring forces the inlet valve on its seat, closing off the supply of air. The exhaust remains closed.

If air pressure in the delivery line drops, spring force on the piston overcomes air pressure. Subsequent piston movement will unseat the inlet valve allowing additional air pressure into the delivery line.

When air pressure in the delivery line exceeds the pressure setting of the valve, the force exerted by the air pressure will be greater than the spring force. The piston will move away from the exhaust valve, permitting air to flow past the exhaust valve, through the hollow piston stem and out the exhaust port. The inlet valve remains seated.

4.3.3. Operating & Leakage Test

☞**NOTE:**

Test gauges in the supply and delivery lines are required for both of the following tests and should be removed upon completion.

4.3.3.1. Operating Test

Connect accurate test gauges in the supply and delivery lines of the pressure reducing valve, and ensure that supply air pressure is at 131 psi. Delivery pressure should be 70 psi ± 5 psi. The valve must be replaced if reading is outside this value.

4.3.3.2. Leakage Test

Ensure supply air pressure is at 131 psi. Apply a soap solution to the supply port and exhaust port. Leakage should not exceed a 1" diameter bubble in 5 seconds. If leakage exceeds this rate, the valve must be replaced.

4.3.4. Removal

☞**NOTE:**

Operating and leakage tests must be performed after replacing the pressure reducing valve.

1. Set the Battery Disconnect switch to the OFF position
2. Drain pressure from the vehicle air system.
3. Obtain access to the pressure reducing valve.

☞**NOTE:**

The pressure reducing valve and solenoid valve must be removed as an assembly

4. Disconnect the inlet and outlet air lines from the regulator and solenoid valve.
5. Remove the mounting bolts which secure the pressure reducing valve and solenoid valve assembly to the panel.
6. Remove the pressure reducing valve and solenoid valve assembly from the vehicle.

4.3.5. Installation

1. Secure the pressure reducing valve and solenoid valve assembly to the panel.
2. Attach inlet and outlet air lines to the pressure reducing valve and solenoid valve assembly.
3. Perform operating and leakage tests.

4.4. RV-1 Pressure Reducing Valve

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Main Air Supply System Components" when performing maintenance on these components.

4.4.1. Description

The RV-1 pressure reducing valve is used to reduce air pressure and maintain it at a constant specified pre-set pressure below that of the supply pressure. The RV-1 pressure reducing valve limits the air pressure applied to the transmission's retarder. Refer to Section 5 of this manual for more information on the transmission retarder. The pressure reducing valve has a 1/4" delivery port on the side and a 1/4" supply port on the bottom. Two 9/32" mounting holes are cast into the body. A lockwire and seal are installed for a tamper proof setting.

4.4.2. RV-1 Pressure Reducing Valve Specification

Pressure Setting ....100 psi

4.4.3. Operation

The pressure setting of the pressure reducing valve is determined by the setting of the adjusting cap, which exerts a force on the spring on top of the piston. Compressed air enters the supply port and passes out the delivery port. When the air pressure on the bottom of the piston overcomes the force of the spring on top of the piston, the piston moves upward and the inlet valve spring forces the inlet valve on its seat, closing off the supply of air. As the pressure in the delivery line drops, the force of the spring above the piston becomes greater than the air pressure below the piston, allowing the piston to move downward, moving the inlet valve off its seat and allowing air to pass out the delivery port. If pressure in the delivery line exceeds the pressure setting of the pressure reducing valve, the force exerted by the air pressure below the piston will be greater than the spring force above the piston. The piston will move up from the exhaust valve, permitting air to pass by the exhaust valve, through the hollow piston and valve guide and escape through the slot in the adjusting cap. When the force of the spring above the piston overcomes that of the air pressure below the piston, the exhaust valve is seated, and the pressure in the delivery line is the same as the setting of the pressure reducing valve.

4.4.4. Operating Test

Connect a 120 psi pressure source to the supply port and connect an accurate test gauge to the delivery. Observe the gauge with the supply pressure applied, this is the delivery pressure (the inlet valve is closed). If the pressure delivered is more than ± 5 psi from the pressure indicated on the tag attached to the valve or vehicle manual, the valve can be readjusted. Momentarily bleed off some of the delivery pressure. Discontinue bleed off and recheck the delivery pressure. The delivery pressure should again be within ± 5 psi of the pressure indicated on the tag.

4.4.5. Leakage Test

Check for leakage at the adjustment cap base with soap solution. Leakage should not exceed 100 SCCM or a 1" bubble in 5 or less seconds. Excessive leakage may indicate a leaking piston O-ring or inlet/exhaust valve.

4.4.6. Valve Adjustment

If the RV-1 valve does not deliver as described, and leakage is minimal, the valve can be readjusted as follows.

1. Remove lockwire.
2. Loosen the cap lock nut while holding the adjusting cap stationary.
3. Turn the adjusting cap clockwise to increase pressure, counter clockwise to reduce pressure.
4. The lock nut should be tightened after readjustment, while holding the adjustment cap stationary.
5. Recheck the delivery pressure as described.
6. Reattach the lockwire and replace the seal if used. If the RV-1 valve does not function as described or if excessive leakage occurs, replace it.

4.4.7. Removal

1. Block and hold the vehicle by means other than air brakes.
2. Drain the service and isolated reservoirs.
3. Disconnect the air lines from the pressure reducing valve.
4. Loosen the valve mounting bolts and remove the valve.

4.4.8. Installation

1. Check and clean air lines to valve.
2. Mount the valve securely with bolts and lockwashers.
3. Reconnect the lines to the valve.

4.5. Interlock Solenoid Valve

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Main Air Supply System Components" when performing maintenance on these components.

4.5.1. Description

The Solenoid Valve is mounted on the brake/kneeling valve panel and has threaded fittings with wrench surfaces and a sealed electrical connector. It is constructed with a steel body, brass manifold and viton seats.

4.5.2. Interlock Solenoid Valve Specifications

Operating Voltage
..... 12 volt nominal (9-16 volts operating)

Current Draw
.... less than 0.5 amps at 70°F

Rated Pressure........................150 psi max.

Allowed Leakage
.... no more than 20 SCCW

Fitting Installation Torque
....300 in-lbs max.

Weight............................220 grams (8.0 oz)

4.5.3. Operation

The solenoid valve is activated by an electrical signal from the multiplexing system and delivers regulated air pressure from the pressure reducing valve to the Brake Valve Actuator installed at the top of the E-6 brake valve. The Brake Valve Actuator receives the regulated air pressure and applies the service brakes. Deactivating the solenoid valve removes regulated pressure from the brake valve actuator, releasing the interlocks.

4.5.4. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Drain the air system to remove pressure in the lines.
3. Obtain access to the solenoid valve.

☞**NOTE:**

The solenoid valve and pressure reducing valve must be removed as an assembly.

4. Tag and disconnect the air lines from the solenoid valve and regulator assembly. Mark lines for later reassembly.
5. Disconnect the electrical connector to the solenoid valve.
6. Remove the mounting bolts which secure the solenoid valve and pressure reducing valve assembly to the panel.
7. Remove the solenoid valve and pressure reducing valve from the vehicle.

4.5.5. Installation

1. Install solenoid valve and pressure reducing valve assembly to the panel.
2. Connect the airlines to the assembly.
3. Connect electrical connector to solenoid valve.
4. Set the battery disconnect switch to the ON position.
5. Perform operating and leakage tests.

4.6. QBA15 Air Dryer

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Main Air Supply System Components" when performing maintenance on these components.

4.6.1. Description

The QBA15 Air Dryer is a complete filtration and self-regenerating drying package used to collect and remove air system contaminants before they enter the brake system. The unit consists of two desiccant canisters, pre-filter assembly, diverter assembly, electronic control module, and main body. The air dryer is bracket-mounted on the rear streetside of the vehicle.

4.6.2. Operation

Air from the compressor enters the air dryer through the filtration tower inlet and passes through a permanent, self-cleaning stainless steel pad which captures and holds heavy carbon particles and oil sludge. The air then passes through a 5-micron filter element which removes oil, water, and small carbon particles. When the compressor unloads, an air signal from the governor actuates the unloader valve in the air dryer which discharges accumulated contaminants to the atmosphere.

The electronic control module controls operation of the diverter valve assembly. A typical operating cycle consists of an air signal out the right-hand valve for 48 seconds, then no signal from either valve for 12 seconds, followed by a switch over to the left-hand valve for 48 seconds, then no signal from either valve for 12 seconds. This cycling is continuous as long as power is applied to the control module and the engine is running.

The diverter valve directs the airflow through a 0.03-micron coalescing element which collects the coalesced oil in a sump until it can be discharged to atmosphere at the end of each drying cycle. The air then passes upward through the adsorptive desiccant bed where it is dried. The air now exits through a check valve and to the air system wet tank.

The regeneration process is initiated by the electronic control module which transmits an air signal to the diverter valve assembly. The flow of wet air to the right-hand tower is stopped and the tower is rapidly depressurized to atmosphere. The dry filtered air from the left-hand tower is directed back through the diverter assembly where a small portion passes through a fixed orifice, causing the pressure to drop to near atmospheric level and expanding to a much lower dewpoint. This super dry air now flows to the right-hand tower that is being regenerated and passes through and strips any moisture from the desiccant. The regeneration air also passes through the coalescing element and flushes the accumulated oil contaminants through the open exhaust valve to atmosphere. After 48 seconds the air signal from the electronic controller stops, the exhaust valve closes, and for the next 12 seconds the regenerating air pressurizes the regenerating tower. Once the right-hand tower has been pressurized, the electronic controller switches air signals to isolate the other tower, thereby reversing the process and allowing regeneration of the wet desiccant tower and wet air to be dried by the regenerated desiccant tower.

4.6.3. Removal

1. Remove the three air lines from the air dryer. See "Fig. 8-7: Air Dryer Installation" on page 38.
2. Disconnect the electrical lead from the air dryer electronic control module.
3. Remove the four bolts that attach the air dryer to the mounting bracket. Remove the air dryer from the vehicle.

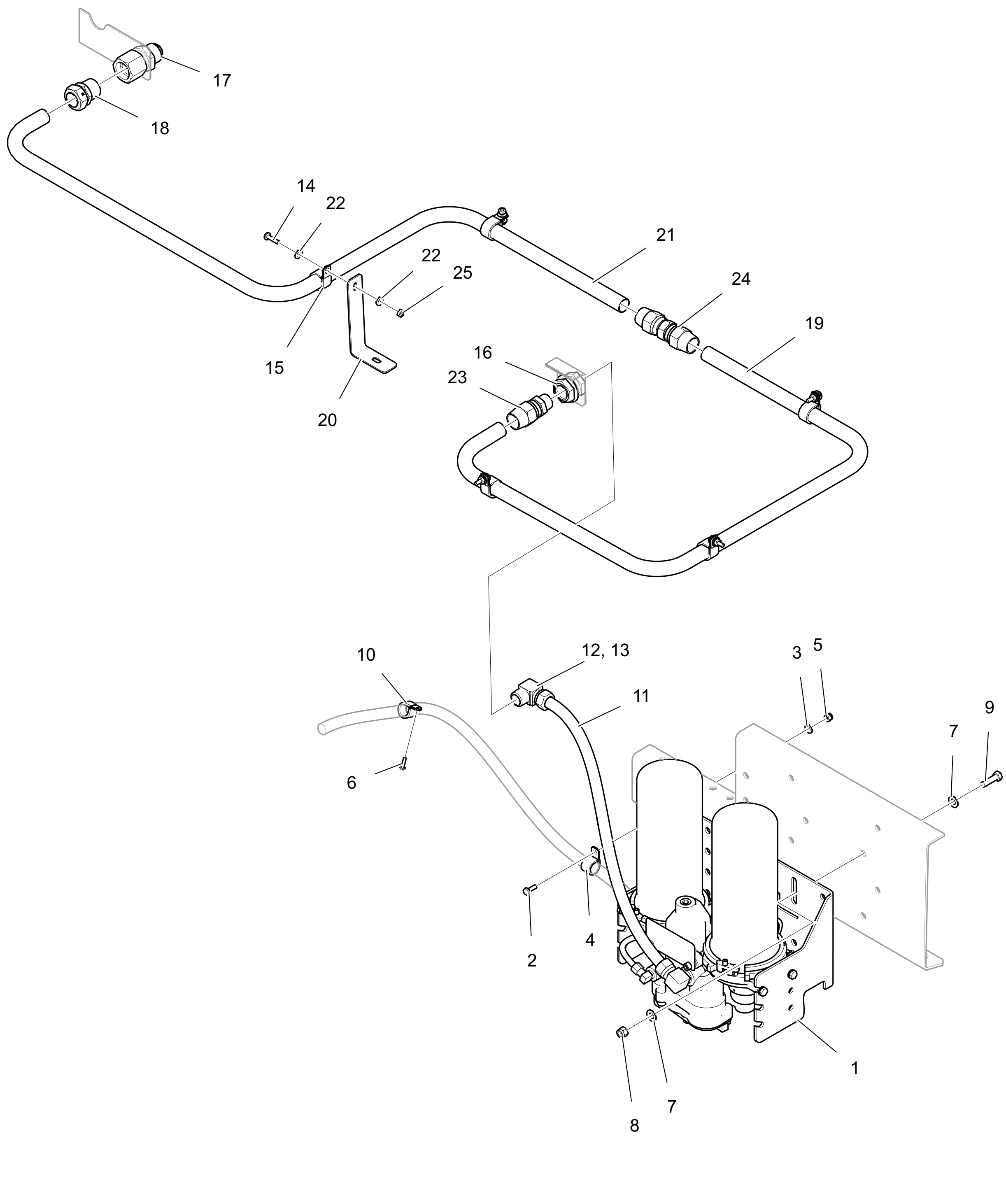


Fig. 8-7: Air Dryer Installation

1. Air Dryer Assembly	14. Screw, PH Cross Recess 1/4" - 20 UNC x 1" Lg. SST
2. Bolt, Hex 1/4" - 20 UNC x 3/4" Lg.	15. Clamp, "P" 1.000" SST/HT
3. Washer, Flat 1/4"	16. Connector, Anchor 3/4" FPT
4. Clamp, "P" .750" SST/HT	17. Connector, 16 JIC x 1" FPT Blkhd.
5. Nut, Lock Nylon 1/4" - 20 UNC	18. Connector, Straight 1" MPT x 1" O.D.
6. Screw, PH Cross Recess Tpg. Type F #10 - 24 UNC x 3/4" Lg.	19. Tube, Air Dryer
7. Washer, Flat 3/8"	20. Bracket, Tube Support
8. Nut, Lock Nylon 3/8" - 16 UNC	21. Tube, Air Dryer
9. Bolt, Hex 3/8" - 16 UNC x 1 1/4" Lg.	22. Washer, Flat SST 1/4"
10. Clamp, "P" .750" SST/HT	23. Connector, 3/4" MPT x 1" O.D.
11. Tube, Nylon 3/4" Green	24. Union, 1" O.D. x 1" O.D.
12. Elbow, 90° 3/4" NTA x 3/4" MPT	25. Nut, Hex Machine Screw 1/4" - 20 UNC
13. Loctite, 567 White	

Air Dryer Installation (parts list)

4.6.4. Disassembly

1. Remove the desiccant canisters as follows:
   a. Release the safety retainer by removing the screw with a 5/32" Allen wrench. Swing the safety retainer outward to expose the retaining ring. See “Fig. 8-8: Air Dryer Assembly” on page 40.
   b. Spread the retaining ring open using retaining ring pliers.
   c. Pull upward on the desiccant canister while holding the retaining ring spread open. Discard O-rings.
2. Remove pre-filter element and scrubber element from the pre-filter body as follows:
   a. Remove three screws from the bottom plate using a 1/4" Allen wrench.
   d. Thread one screw into the threaded hole in the center of the bottom plate to pull the plate out of the pre-filter body.
   e. Remove and discard pre-filter element, spring, scrubber, discs, and all O-rings.

☞**NOTE:**

Earlier versions of this air dryer manufactured prior to March 1, 2003 used a retaining ring to hold the scrubber and discs in place. Current models use an extended cap to hold parts in place. Use retaining ring pliers to remove retaining ring if this item if installed.

3. Remove unloader assembly from pre-filter body as follows:
   a. Remove the unloader cover by removing two screws using a 3/16" Allen wrench.
   b. Pull the unloader assembly out of the body using pliers. Discard unloader valve, crush seal, screens (2), and perforated discs (2). Note the position of the screens and discs.

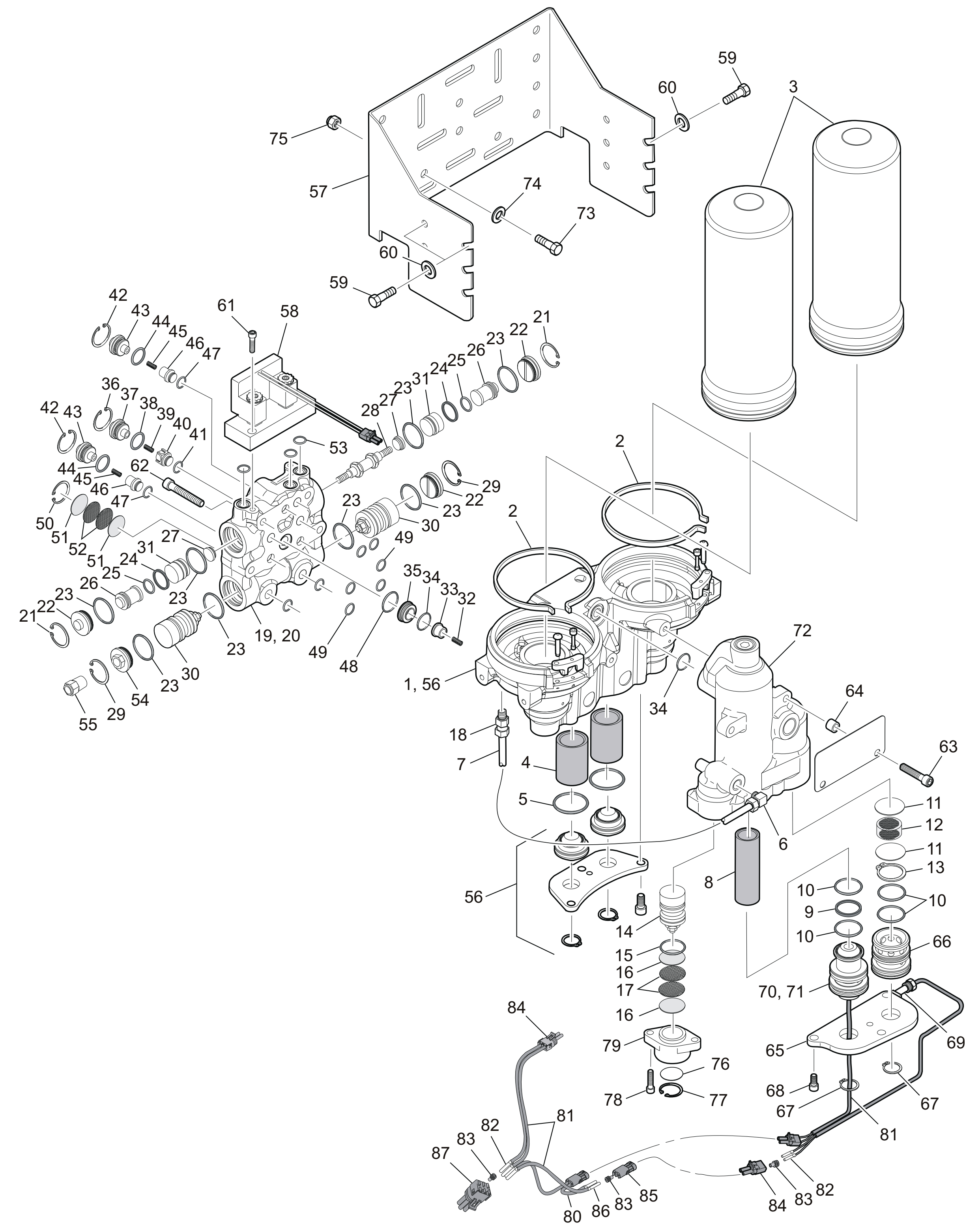


Fig. 8-8: Air Dryer Assembly

1. Air Dryer Assembly, QBA15NX5 (Incl. 2-19, 56-87)	29. Retaining Ring	59. Bolt, Hex 5/16" -18 x 5/8" Lg.
2. Retainer	30. Valve	60. Washer, 5/16"
3. Canister, Desiccant Filled	31. Diverter Sleeve	61. Bolt
4. Coalescing Element	32. Spring	62. Bolt
5. O-Ring	33. Valve	63. Bolt
6. Fitting Tube	34. O-Ring	64. Spacer
7. Hose	35. Seat, Valve	65. Plate
8. Prefilter Element	36. Retaining Ring	66. Scrubber
9. O-Ring	37. Cap	67. Retaining Ring
10. O-Ring	38. O-Ring	68. Bolt
11. Scrubber Disc	39. Spring	69. Heater Assembly
12. Scrubber Element	40. Poppet	70. Thermostat Assembly
13. Retaining Ring	41. O-Ring	71. Prefilter Nose
14. Unloader Valve	42. Retaining Ring	72. Body
15. Crush Seal	43. Cap	73. Bolt, Hex 3/8" -16 x 1 1/4" Lg.
16. Perforated Disc	44. O-Ring	74. Washer, 3/8"
17. Screen	45. Spring	75. Nut, Hex 3/8" -16
18. Fitting Tube	46. Poppet	76. O-Ring
19. Diverter Valve Assembly, (Incl. 20-55)	47. O-Ring	77. Retaining Ring
20. Housing	48. O-Ring	78. Bolt
21. Retaining Ring	49. O-Ring	79. Unloader Cover
22. End Cap	50. Retaining Ring	80. Wire, Exane 16 GA White
23. O-Ring	51. Perforated Disk	81. Cable, Exane
24. Seal	52. Screen Disk	82. Female Terminal
25. O-Ring	53. O-Ring	83. Cable Seal
26. Piston	54. End Cap	84. Connector Assembly, 2F
27. Cap	55. Fitting Tube	85. Connector Assembly, 2M
28. Stem	56. Coalescer Housing	86. Male Terminal
	57. Bracket, Mounting	87. Connector Assembly, 4F
	58. Electronic Control Module	

Air Dryer Assembly (parts list)

4. Remove the coalescing elements from the main body as follows:
   a. Remove three screws from the bottom plate using a 1/4" Allen wrench.
   b. Thread one screw into the threaded hole in the center of the bottom plate to pull the plate out of the main body.
   c. Remove and discard the coalescing elements and O-rings.
5. Remove two capscrews that retain the electronic control module to the diverter assembly. Note the position of the controller relative to the diverter valve assembly. Remove controller and discard the three port seals.
6. Remove diverter valve assembly from main body by removing four screws, using a 1/4" Allen wrench. Discard O-rings.
7. Remove flow check valve from main body. Discard valve, valve seat, spring, and O-ring.
8. Remove the orifice check valves (2), and solid check valve, from the diverter assembly as follows:
   a. Remove retaining ring from the orifice check valve (2). Remove and discard all parts including retaining ring, cap, orifice poppet, spring, and O-rings.
   b. Remove retaining ring from the solid check valve. Remove and discard all parts including retaining ring, cap, poppet, spring, and O-rings.

9. Remove the diverter valve from the diverter assembly as follows:
   a. Remove diverter valve retaining rings and end caps from both sides of diverter valve body.
   b. Unthread both pistons from valve stem using a 3/16" Allen wrench. Remove and discard all parts including valve stem, pistons, end caps, O-rings, teflon seals, and retaining rings.
10. Remove exhaust valves (2) and exhaust muffler from diverter assembly as follows:
   a. Remove exhaust valve retaining rings and end caps from both sides of diverter valve body.
   b. Remove exhaust muffler retaining ring, screens (2), and discs (2). Note the order in which the screens and discs are removed.
   c. Remove exhaust cartridge (2) by inserting a screwdriver through the open exhaust muffler port. Carefully push the cartridge out of the valve bore being careful not to scratch the bore surfaces.
   d. Remove O-ring from bottom of bore where exhaust cartridge was just removed.
   e. Discard all removed parts.

4.6.5. Cleaning & Inspection

1. Clean all parts in mineral spirits. Use a soft bristle brush to clean inside of bores.
2. Dry parts using compressed air.
3. Do not attempt to clean desiccant canisters. Replace as an assembly.
4. Do not attempt to repair electronic control unit. Replace as an assembly if defective.
5. Inspect diverter valve bores for nicks, scratches, or other damage. Replace diverter valve body if damaged.
6. Inspect valve seat of solid check valve and orifice check valve for nicks, scratches, or other damage. Replace diverter valve body if damaged.

4.6.6. Assembly

CAUTION

Ensure that all retaining rings are fully seated within the groove during installation. Verify that all retaining rings are properly installed before applying air pressure to the unit.

☞NOTE:

Use Dow Corning 55M or equivalent to lubricate O-rings during assembly.

1. Assemble and install exhaust valves (2) and exhaust muffler into diverter valve body as follows:
   a. Lubricate and install new O-ring on exhaust cartridge and insert exhaust cartridge into bore of diverter valve body.
   b. Lubricate and install new O-ring on end cap and install end cap into bore of valve body.
   c. Install new retaining ring, ensuring ring is properly seated in groove.
   d. Repeat procedure for exhaust cartridge on other side.
   e. Install the exhaust muffler screens and discs in the order removed. The coarse perforated discs should sandwich the two inner fine wire screen discs.
   f. Install new retaining ring in bore, ensuring that ring is fully seated in groove.
2. Assemble and install diverter valve assembly into valve body as follows:
   a. Install new O-ring on each piston.
   b. Install new teflon seal over previously installed O-ring.
   c. Install pistons into bore of valve and thread onto valve stem. Check that the pistons move back and forth freely within the bore of the valve body.
   d. Lubricate new O-rings and install on each end cap and install end cap into bore of valve body.
   e. Use new retaining rings to hold end caps in place, ensuring ring is properly seated in groove.
3. Install solid check valve and orifice check valves (2) into diverter valve body as follows:
   a. Lubricate new O-ring and install on orifice poppet.
   b. Install orifice poppet with O-ring into check valve bore.
   c. Lubricate and install new O-ring on end cap.
   d. Insert new spring into counterbore of poppet then install end cap, ensuring spring enters counterbore in end cap.
   e. Install new retaining ring, ensuring ring is properly seated in groove.
   f. Repeat procedure for other orifice check valve.
   g. Lubricate new O-ring and install on poppet of solid check valve.
   h. Install poppet with O-ring into check valve bore.
   i. Lubricate new O-ring and install on end cap.
   j. Slide new spring over pin on end cap and insert end cap into check valve bore, ensuring pin on end cap engages hole in poppet valve.
   k. Install new retaining ring, ensuring ring is properly seated in groove.
4. Lubricate and install new O-ring on flow check valve seat.
5. Install spring, check valve, and check valve seat with O-ring into main body.

☞NOTE:

Check the revision level on the unit nameplate. If the air dryer is revision level 3 or earlier then the pin in the check valve bore must be removed prior to installing new check valve parts.

6. Lubricate and install new O-rings between main body and diverter valve assembly.
7. Install diverter valve assembly and secure with four screws, using a 1/4" Allen wrench.

8. Lubricate new port seals and install in counterbore of diverter valve body assembly prior to installing electronic control module.
9. Install electronic controller using two capscrews, ensuring controller is correctly positioned on diverter valve assembly.
10. Install new coalescing elements into the main body.
11. Lubricate and install new O-rings on the bottom plate.
12. Install bottom plate with O-rings and retain with three screws using a 1/4" Allen wrench.
13. Assemble and install the unloader assembly into the pre-filter assembly as follows:
    a. Lubricate the external O-ring on the unloader valve.
    b. Lubricate and install crush seal O-ring between valve and cover.
    c. Assemble the screens and discs so that the two finer wire mesh screens are sandwiched between the coarse perforated discs.
    d. Install the cover and retain with two screws using a 3/16" Allen wrench.
14. Assemble and install the pre-filter element and scrubber element into the pre-filter body as follows:
    a. Lubricate and install O-rings on each cap.

☞NOTE:

The replacement kit includes extra O-rings to service earlier versions of this air dryer, which used the same size O-rings on the lower seal of the caps. On current models ensure that the larger O-ring, identified by a red dot, is placed on the lower seal of the cap. Discard the extra O-rings in the kit.

    b. Install spring and filter element into body.
    c. Install disc and scrubber.
    d. Install bottom plate and retain with three screws using a 1/4" Allen wrench.
15. Install the desiccant canisters as follows:
    a. Lubricate and install O-rings on canister.
    b. Spread the retaining ring open using retaining ring pliers and install the canister.
    c. Tap lightly on the canister with a soft-face hammer to ensure that it is fully seated and squeeze the retaining ring closed.

⚠ WARNING

DO NOT operate the air dryer without the safety retainer in position. The canister is a safety hazard if it is not locked in place.

    d. Swing the safety retainer to the closed position, ensuring that the ends of the retaining ring are held captive by the retainer. Secure retainer in place with the screw using a 5/32" Allen wrench.

4.6.7. Installation

1. Install the air dryer and attach to the mounting bracket using four bolts.
2. Connect the electrical lead to the electronic control module.
3. Install the three air lines.

4.6.8. Functional Test

1. Start the vehicle, set the engine speed to fast idle, and allow pressure in the air system to build.
2. Check all hoses and fittings for leaks and repair as necessary.
3. Check the exhaust port on the diverter valve, located on the back of the air dryer just below the electronic controller. A slight flow of air should be evident from the exhaust muffler. Check that the flow of air is maintained for approximately 48 seconds, then off for 12 seconds, then back on for 48 seconds. This cycle will continue as long as the engine is running.
4. Check operation of the unloader valve when the air compressor unloads. A brief burst of air will be discharged out the unloader port which is located on front, bottom of the air dryer.

4.7. Air Tanks

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Main Air Supply System Components" when performing maintenance on these components.

4.7.1. Description

Stainless steel air tanks are mounted on either side of the vehicle behind the fluorescent light panels. The tanks supply compressed air to the vehicle's brake, suspension and accessories systems.

New Flyer air tanks are built in accordance with SAE Standard Air Brake Reservoir Test Code and Inspection Procedure SAE J-10-a. They are made from steel sheet, with stamped heads and rolled shells. The seams are electrically welded and each tank is internally coated for corrosion resistance. Each tank is tested at 300 psi hydrostatic pressure.

4.7.2. Operation

The reservoirs in an air brake system primarily serve to store energy in the form of compressed air. They also cool the air as delivered from the compressor and thereby condense water vapor into a liquid and collect oil passed by the compressor. This water and oil collects as an emulsion; the greatest amount in the reservoir nearest the compressor.

4.7.3. Integral Check Valve

4.7.3.1. Operation

The integral check valve provides a one-way passage of air from the upstream compartment to the downstream. This protects the service brake system in case of failure in the compressor, discharge lines or first reservoir compartment.

4.7.3.2. Removal

1. Remove wet/rear brake air tank from vehicle. Refer to 4.7.5. "Removal" on page 47 in this Section for procedure.
2. Remove the 1 1/4 x 3/4 NPT Hex reducer bushing located on the end of the tank.
3. With a long extension, carefully locate and remove check valve from the internal compartment divider that splits the tank.

4.7.3.3. Installation

1. With the tank facing down and access opening at lower side, carefully install check valve in the internal compartment divider.
2. Ensure check valve is securely tightened.
3. Ensure no debris has entered tank.
4. Install 1 1/4 x 3/4 NPT Hex reducer bushing securely.
5. Install tank in vehicle.

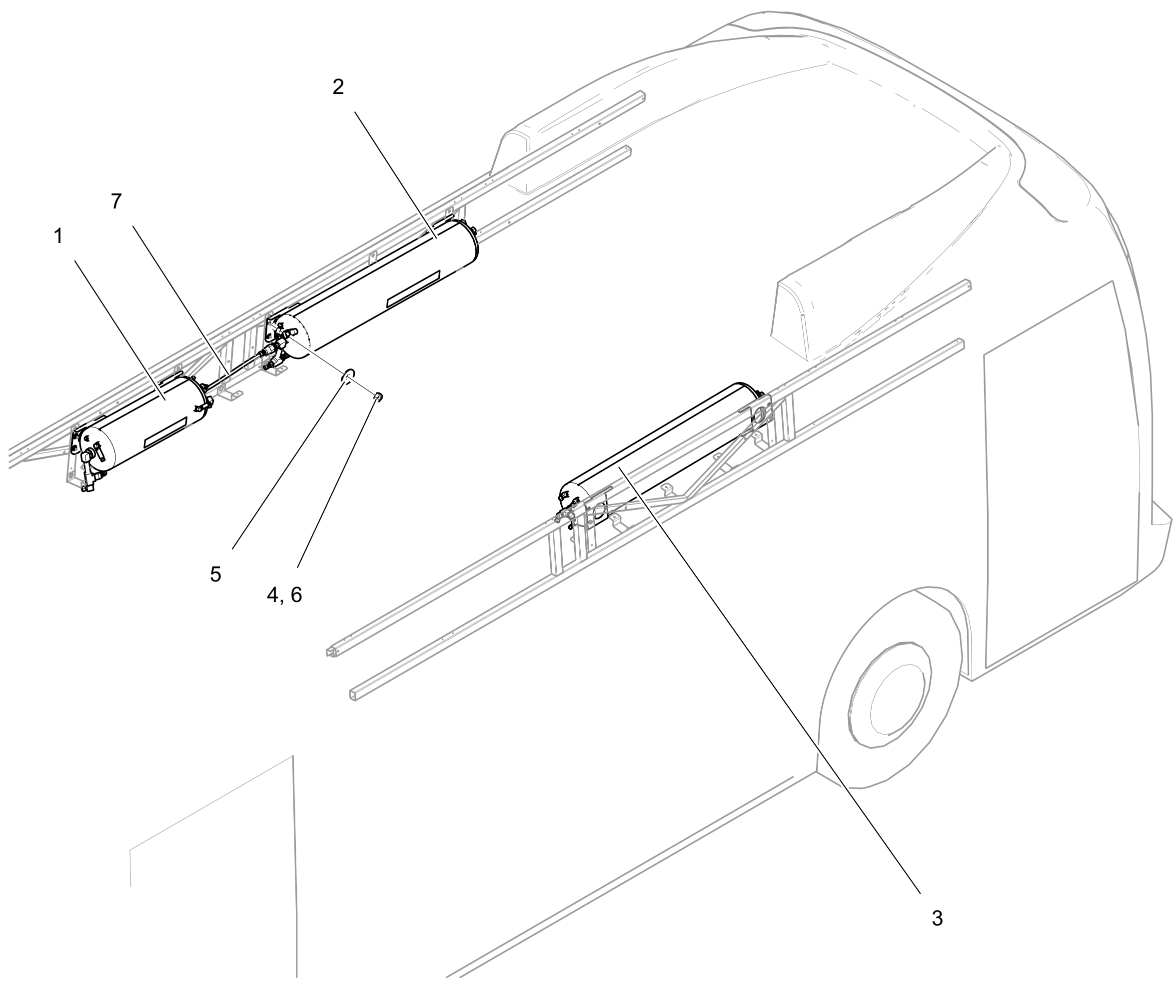
4.7.4. Cleaning & Inspection

Wash all metal parts in a good cleaning solvent and dry them thoroughly. All rubber parts should be wiped clean. Inspect springs for distortion, corrosion, and cracks. Inspect valves and valve seats for nicks, cuts and burrs. Inspect all rubber parts for swelling and deterioration.

Replace all parts, particularly rubber parts, not considered serviceable during these inspections.

4.7.5. Removal

1. Drain pressure from the air system.
2. Obtain access to the air tank behind the fluorescent light panels. See “Fig. 8-9: Air Tank Locations” on page 47.
3. Disconnect inlet and outlet air lines from both ends of air tank.
4. Remove clamps which retain air tank to vehicle structure.
5. Remove air tank from vehicle.



1. Air Tank Assembly, Wet & Rear Brakes
2. Air Tank Assembly, Front Brakes & Emergency
3. Air Tank Assembly, Kneeling & Accessories
4. Loctite, 243
5. Washer, Large 5/16"
6. Nut, Hex 5/16" - 18 UNC
7. Tube, Nylon 5/8" Green

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Fig. 8-9: Air Tank Locations

4.8. ST-1 Safety Valve

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Main Air Supply System Components" when performing maintenance on these components.

4.8.1. Description

The safety valve protects the air brake system against excessive air pressure build-up. The valve consists of a spring loaded ball valve which vents pressure to atmosphere if reservoir pressure rises above the pressure setting of the valve, which is determined by the force of the spring. The valve is installed in a port in the wet tank.

4.8.2. Operation

The governor cut-out pressure is set at 131 psi. A safety valve with a setting of 150 psi air pressure would force the ball valve off its seat, and allow reservoir pressure to vent to atmosphere through the exhaust port in the spring cage.

When reservoir pressure decreases sufficiently, the spring force will seat the ball check valve, sealing off reservoir pressure. This would occur at approximately 135 psi for the 150 psi valve. It is important to note that the desired pressure setting of the safety valve is determined by the governor cut-out pressure. The opening and closing pressures of the safety valve should always be in excess of the governor cut-out pressure setting. The pressure setting is stamped on the lower wrench flat of the valve.

Normally, the safety valve remains inoperative and only functions if for any reason reservoir pressure rises above the setting of the valve. Constant "popping off" or exhausting of the safety valve can be caused by a faulty safety valve, faulty governor, faulty compressor unloading mechanism, or a combination of any of the preceding.

4.8.3. Removal

WARNING

During component removal or installation, ensure the Battery Disconnect switch is in the OFF position.

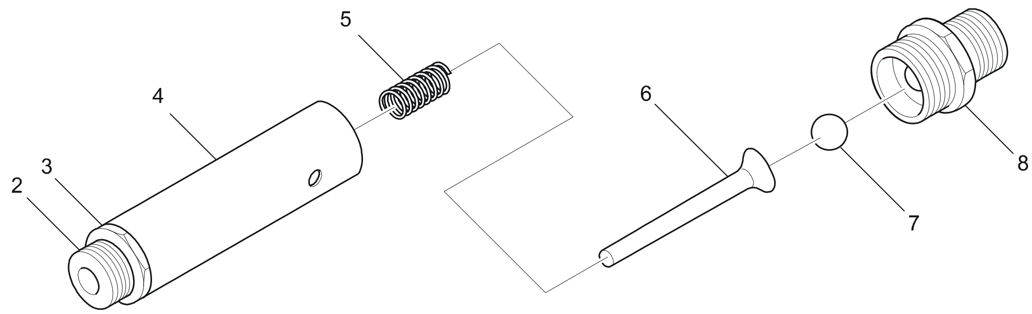
1. Block wheels or otherwise secure vehicle and drain reservoirs.
2. Using wrench flat closest to wet tank reservoir, unscrew valve from reservoir.

4.8.4. Installation

Safety valve should be installed in same reservoir that compressor discharge line is connected to. Install in a convenient location in a top port of the reservoir. If safety valve is installed horizontally, exhaust port should point down; stem of the valve should face rear of vehicle.

4.8.5. Disassembly

1. Clamp lower wrench flat in vise (flat nearest pipe thread).
2. Using upper wrench flat, unscrew lock nut. Unscrew and remove spring cage from body of valve. See "Fig. 8-10: Safety Valve Assembly" on page 49.
3. Remove ball valve, spring and release pin from spring cage.



1. Safety Valve ST-1 (Incl. 2...8)
2. Nut, Adjustable
3. Nut, Lock
4. Cage, Spring
5. Spring
6. Pin, Release
7. Ball, Steel
8. Body

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Fig. 8-10: Safety Valve Assembly

4.8.6. Cleaning & Inspection

Clean all parts in mineral spirits. Inspect all parts. All parts not considered serviceable should be replaced.

4.8.7. Assembly

1. Place the ball valve in body.
2. Install spring and release pin in spring cage with adjusting screw.
3. Position the release pin over ball valve. Screw body with ball into the spring cage. Tighten securely.
4. Adjust for proper setting.

4.8.8. Adjustment

The pressure setting of the safety valve is stamped on the cover wrench flat (closest to the pipe thread). If setting is not known, determine governor cut-out pressure setting and adjust safety valve so that the safety valve closes at a pressure setting somewhat above governor cut-out pressure setting.

To adjust, the safety valve must be connected to an air system with air pressure in excess of desired setting. It is important that an accurate gauge be used to check pressure settings while make adjustments.

4.8.8.1. Raising Pressure Setting

1. Loosen lock nut.
2. Turn adjusting nut clockwise to obtain correct pressure setting.
3. Tighten lock nut.

4.8.8.2. Lowering Pressure Setting

1. Loosen lock nut.
2. Turn adjusting nut counter-clockwise to obtain correct pressure setting.
3. Tighten lock nut.

4.8.9. Operating Test

With air pressure in the system, pull the exposed end of the valve stem removing the spring load from the ball check valve. Air should exhaust from the valve's exhaust port. Release the stem, the air flow should stop. Failure of valve to pass operating test would indicate the valve should be disassembled, cleaned and rebuilt. Refer to 4.8.5. “Disassembly” on page 48 and Refer to 4.8.7. “Assembly” on page 49 in this section for procedure. Refer to 4.8.8. “Adjustment” on page 49 in this section if adjustment is necessary.

4.8.10. Leakage Test

Coat the exhaust port with soap solution. A leakage of a 1" bubble in 5 seconds is permitted. Excessive leakage indicates dirt in valve, faulty ball valve or seat. Valve should be disassembled, cleaned and rebuilt. Refer to 4.8.5. “Disassembly” on page 48 and Refer to 4.8.7. “Assembly” on page 49 in this section for procedure.

4.9. Air Lines & Fittings

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Main Air Supply System Components" when performing maintenance on these components.

4.9.1. Description

The air system comprises several interconnected components which supply and control air pressure for the brake system, suspension system and operational air operated components. These components are linked together with airlines.

Three types of air lines are used in the air system. These are: copper, flexible Teflon™ with a braided stainless steel jacket, and color coded nylon tubing. Nylon and copper lines are fitted with brass compression fittings that require no special tools and are easily replaced when required.

The tubing is protected, where required, by a sheath of black loom that is both flexible and weather resistant.

System airlines tubing meet both FMVSS and CMVSS air brake specifications for North America.

4.9.2. Inspection

A thorough visual inspection includes:

1. Checking condition of clamps, guards and shields.
2. Removing excess dirt to expose any hidden air line faults.
3. Checking air lines for abnormalities.

   The following conditions require immediate shut down and line replacement.

- ❐ Damaged or cut areas
- ❐ Heat cracked or charred
- ❐ Kinked, crushed, flattened or twisted line
- ❐ Blistered or degraded line

A leakage test requires the air system to be charged. Air system pressure is monitored by front and rear brake circuit air pressure gauges located on the driver`s instrument panel. A severe leak or rupture in the system will prompt intregal safety systems (check valves, spring brake chambers) to provide brake application.

With the system fully charged check for small leaks by brushing a solution of soap and water onto the air fittings. A leak exists if bubbles occur. Tighten or replace fittings/ lines where leakage occurs. To check brake air lines apply brake and coat all tubing and hose connections with solution. No leakage is permissible. Some leaks may be corrected by tightening the connection.

DANGER

Block and hold vehicle by means other than air brakes before servicing air brake lines.

A trouble symptom such as a slow brake application or release indicates a restricted or clogged air line. Disconnect the suspected line at both ends and clear with a blast of compressed air to correct. Other components will operate abnormally if similar air line blockage occurs.

4.9.2.1. Air Line Replacement

To replace flexible Teflon type air line order a complete hose assembly. Color coded nylon and copper air lines are available in one foot increments for field assembly. Associated fittings are supplied with nut, insert and sleeve. All components are available to order from New Flyer Parts.

Nylon and copper air lines are easily assembled without the use of special tools but care must be taken to ensure parts are free of burrs, cuttings and dirt. Foreign particles will destroy sealing seats in air control units. Prior to assembly check that components are the same size and type as the ones being replaced.

1. Cut tubing squarely to the required length.
2. Place the nut and sleeve over tubing
3. Insert tubing into fitting until bottomed onto seat.
4. Connect tubing nut to mating fitting component and finger tighten.
5. Consult the following table to wrench tighten.
6. Install nut and sleeve at opposite end of line as required.

   Ensure that there are no kinks in the tubing when it is installed and secure when necessary. Spare tubing should be stored in clean surroundings with ends plugged.

4.9.2.2. Thread Sealant

All fittings, when fitted to valves or other fittings, should be assembled using tape or semi-liquid pipe sealant.

Tape should only be used on tapered pipe threads.

TUBE SIZE	ADDITIONAL NUMBER OF TURNS
1/4"	3
3/8" and 1/2"	4
5/8" and 3/4"	3 1/2"

5. BRAKE SYSTEM COMPONENTS

WARNING

When working on or around air brake systems and components, the following precautions should be observed:

- **ALWAYS block vehicle wheels. Stop engine when working under a vehicle. Depleting vehicle air system pressure may cause vehicle to roll. Keep hands away from chamber push rods; they may apply as 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 certain 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 understand 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 use of those tools.**
- **Use only approved replacement parts and components.**
  - **Only components, devices, mounting and attaching hardware specifically designed for use in air brake systems should be used.**
  - **Replacement hardware, tubing, hose, fittings and so forth, should be of equivalent size, type, length, and strength as the original equipment.**
  - **Make certain that when replacing tubing or hose, all supports, clamps or suspending devices that were originally installed are reinstalled or replaced if they are missing.**
- **Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.**

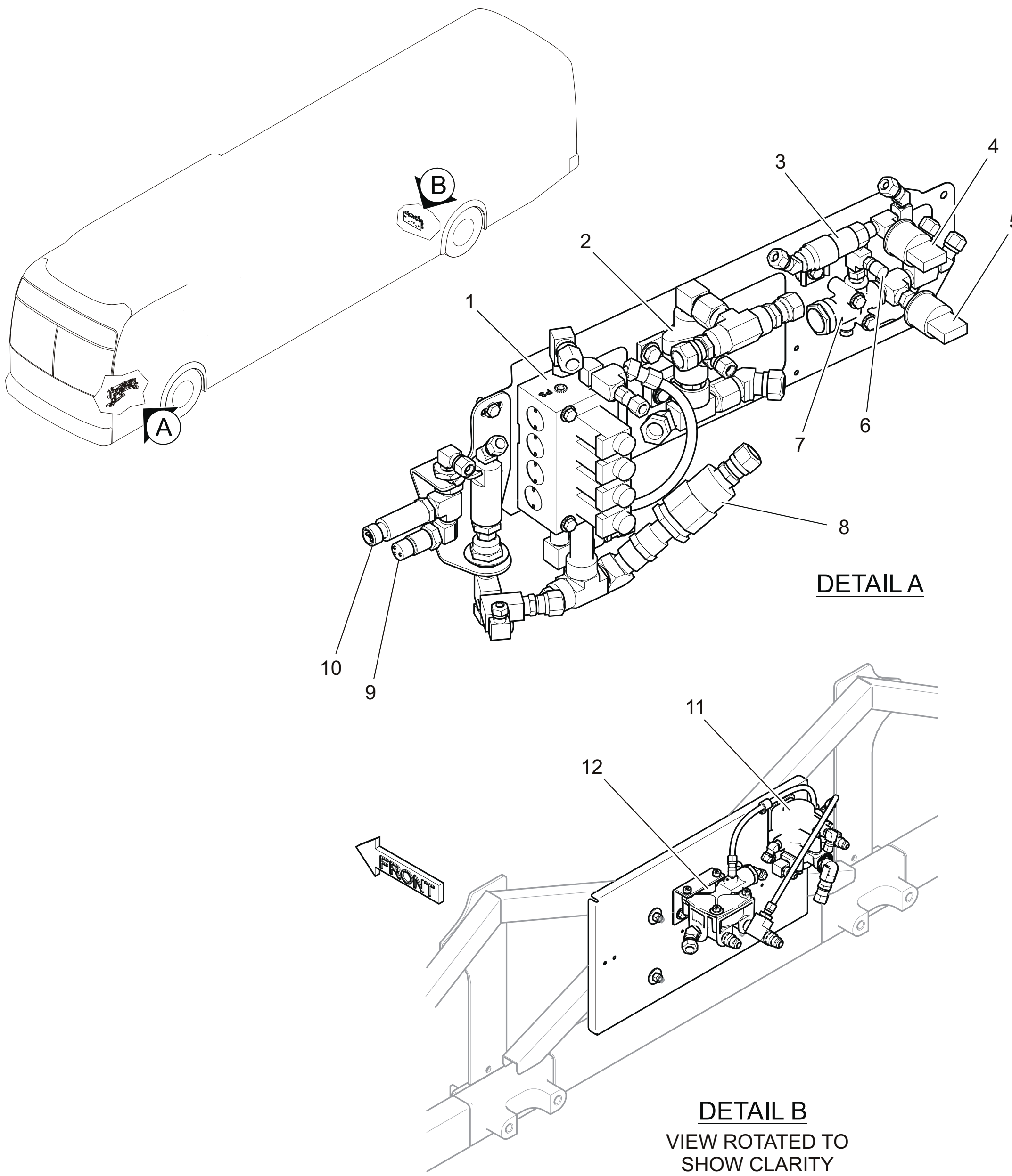
CAUTION

Using alcohol in the air brake system as a means to dry the air or prevent system freezing during cold weather is not acceptable. Studies indicate that alcohol removes the lubrication from the system components, causing faulty system function. Also, the materials used for the seals in these components are not alcohol-safe and will deteriorate at an accelerated rate leaving the brake system prone to failure. Using alcohol or alcohol-based fluids in your air brake system will void the warranty on these components.

5.1. Description

The front brake system component bracket is mounted to the vehicle structure below the driver's platform. The rear brake system component bracket is mounted to the vehicle structure aft of the rear axle. See "Fig. 8-11: Brake System Components" on page 53. Major brake system components include:

- Quick Release Valves
- Double Check Valves
- Brake Relay Valve
- Check Valve
- Spring Brake Modulating Valve
- Pressure Transducers



1. Front Kneeling Valve
2. Double Check Valve
3. Solenoid 12V
4. Switch, Pressure 4 psi
5. Switch, Pressure 60 psi
6. Pressure Test Valve
7. Pressure Reducing Valve
8. Double Check Valve
9. Pressure Transducer, 250 psi
10. Pressure Transducer 150 psi
11. Spring Brake Control Valve
12. Relay Valve, R-15

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Fig. 8-11: Brake System Components

5.2. Single Check Valve

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Brake System Components" when performing maintenance on these components.

5.2.1. Description

The In-Line Single Check Valve is a device placed in an air line to allow air flow in one direction only and to prevent flow of air in the reverse direction.

The three types of In-Line Single Check Valves used in service are:

- ❒ The ball type.
- ❒ The disc type with integral seat.
- ❒ The disc type with a replaceable seat; the replaceable seat being made of either metal or rubber.

An arrow indicating the direction of air flow is cast into the body of the valve.

5.2.2. Operation

Air flow in the normal direction moves the check valve ball or disc from its seat, and the flow is unobstructed. Flow in the reverse direction is prevented by the seating of the ball or disc, which is caused by a drop in upstream air pressure and assisted by the spring.

5.2.3. Removal

1. Block and hold vehicle by means other than air brakes.
2. Completely drain all reservoirs.
3. Disconnect air lines at single check valve and remove.

☞**NOTE:**

Valves which malfunction are replaced with new units.

5.2.4. Installation

WARNING

During component removal or installation, ensure the Battery Disconnect switch is in the OFF position.

1. Check and, if necessary, clean or replace air lines to valve.
2. Install valve making certain that it is installed correctly with respect to the desired air flow. An arrow indicating the direction of air flow is cast into the body of the valve.

5.2.5. Operating & Leakage Test

☞**NOTE:**

Depending upon installation, it may be easier or necessary to completely remove check valves so that the following checks may be made.

With air pressure present at outlet side of check valve and the inlet side open to atmosphere, coat the open end of the check valve with soap suds; a 1" bubble in 5 seconds is permissible.

If the check valve does not function as described, or leakage is excessive, it is recommended that it be replaced with a new unit.

5.3. Double Check Valve

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Brake System Components" when performing maintenance on these components.

5.3.1. 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.

HVSG manufactures two types of 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 sources, whereas the disc type has a movable disc.

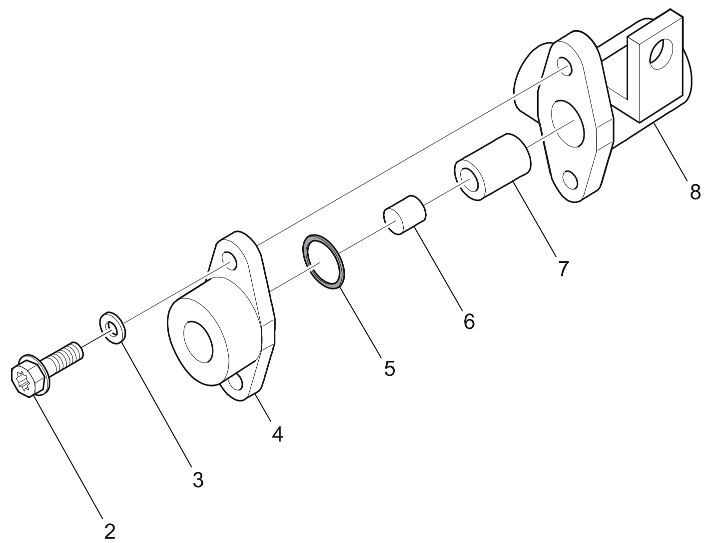
5.3.2. Operation

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.

A Double Check Valve is used 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.

5.3.3. Disassembly

1. Remove end cap from valve. See "Fig. 8-12: Double Check Valve Assembly" on page 56.
2. Remove shuttle and/or shuttle guide.



1. Valve Assembly, Double Check (Incl. 2...8)
2. Screw
3. Washer, Special
4. Cap
5. O-Ring
6. Shuttle
7. Guide, Shuttle
8. Body

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Fig. 8-12: Double Check Valve Assembly

5.3.4. Cleaning & 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.

5.3.5. Assembly

1. Install shuttle and shuttle guide.
2. Coat all static seals such as O-rings, grommets and so forth with BW 650M Silicone lubricant (BW 291126). It is not necessary to lubricate shuttles or discs.
3. Install end cap.

5.3.6. Operating & Leakage Test

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 1” bubble in five seconds.
   c. Repeat Step “b” applying air to other inlet port while checking opposite inlet port for leakage.

If Double Check Valve does not function as described or if leakage is excessive, it is recommended that the valve be replaced.

5.4. E-6 Brake Valve

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Brake System Components" when performing maintenance on these components.

5.4.1. Description

☞**NOTE:**

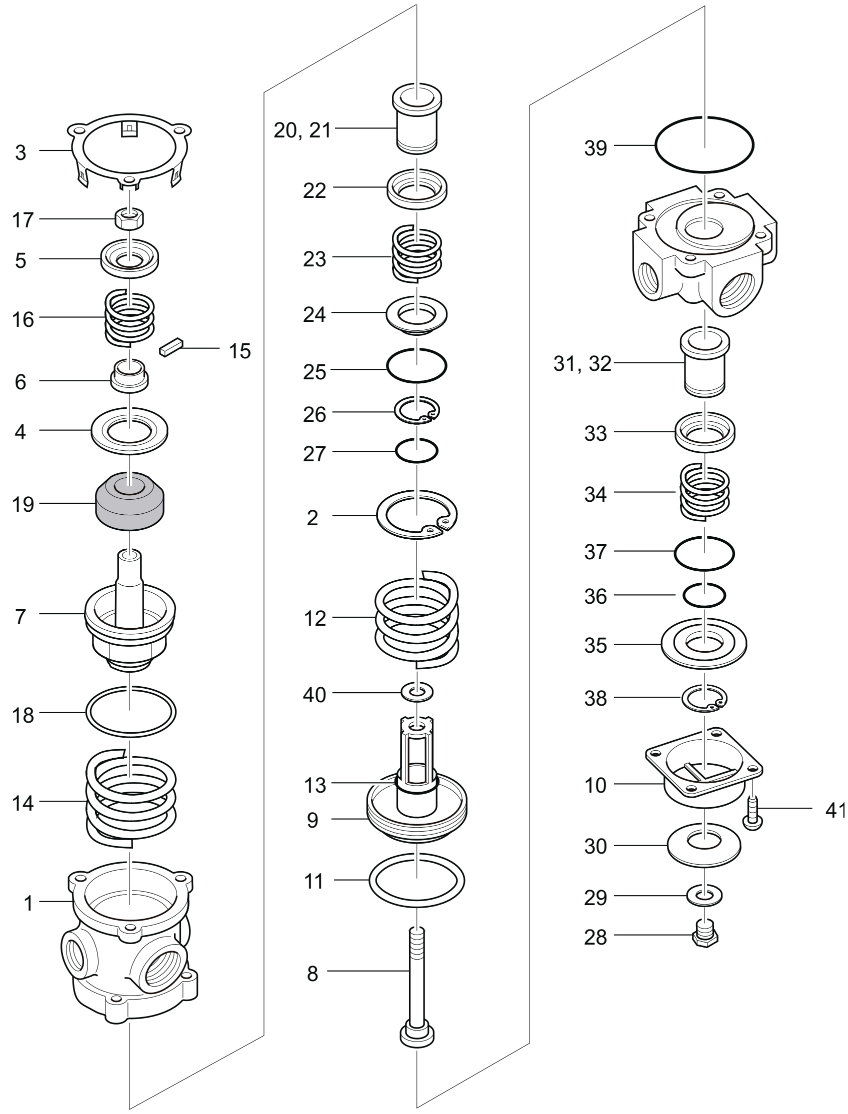
A Brake Valve Actuator (BVA) is attached to the E-6 Brake valve. See "5.5. Brake Valve Actuator" on page 64. *in this section for information on this component.*

The E-6 Brake Valve is a floor mounted, treadle operated type brake valve with two separate supply and delivery circuits for the primary (Rear) and secondary (Front) braking, which provides the driver with a graduated control for applying and releasing the brakes.

The E-6 Brake Valve is equipped with a rubber spring housed in an upper body assembly. The circuits in the E-6 Brake Valve are identified as follows: The No. 1 circuit portion is that portion of the valve between the spring seat which contacts the plunger and the relay piston; the No. 2 circuit portion is that portion between the relay piston and the exhaust cavity. See "Fig. 8-13: E-6 Brake Valve Assembly" on page 58.

The No. 1 circuit portion of the valve is similar in operation to a standard single-circuit air brake valve, and under normal operating conditions the No. 2 circuit portion is similar in operation to a relay valve.

Both No. 1 and No. 2 circuit portions of the Brake Valve use a common exhaust protected by an exhaust diaphragm.



1. Valve Assembly, Brake E-6 (Incl. 2-20, 27-31 & 39-41)
2. Ring, Retaining
3. Retainer
4. Seat, Spring
5. Guide, Spring
6. Nut, Spring Seat
7. Piston, Primary
8. Stem
9. Piston, Relay
10. Cover, Exhaust
11. O-Ring
12. Spring, Relay Piston
13. O-Ring
14. Spring, Return Piston
15. Filter, Vent
16. Spring, Stem
17. Nut
18. O-Ring
19. Spring, Rubber
20. Inlet & Exhaust Valve Assembly, Upper (Incl. 21-26)
21. Inlet & Exhaust Valve
22. Retainer, Valve
23. Spring
24. Retainer, O-Ring
25. O-Ring
26. Ring, Retainer
27. O-Ring
28. Screw
29. Washer, Diaphragm
30. Diaphragm
31. Inlet & Exhaust Valve Assembly, Lower (Incl. 32-38)
32. Inlet & Exhaust Valve
33. Retainer, Valve
34. Spring
35. Retainer, O-Ring
36. O-Ring
37. O-Ring
38. Ring, Retaining
39. O-Ring
40. Washer, Rubber
41. Screw, Hex Torx 1/4"

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Fig. 8-13: E-6 Brake Valve Assembly

5.4.2. Operation

5.4.2.1. Applying: Normal Operation - No. 1 Circuit Portion

When the brake treadle is depressed, the plunger exerts force on the spring seat, graduating spring, and No. 1 piston. The No. 1 piston which contains the exhaust valve seat, closes the No. 1 exhaust valve. As the exhaust valve closes, the No. 1 inlet valve is moved off its seat allowing air to flow out the No. 1 delivery port.

5.4.2.2. Applying: Normal Operation - No. 2 Circuit Portion

When the No. 1 inlet valve 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, which contains the exhaust seat and closes the No. 2 exhaust valve. As the No. 2 exhaust valve closes, the No. 2 inlet valve is moved off its seat allowing the air to flow out the No. 2 delivery port. Because of the small volume of air required to move the relay piston, action of the No. 2 circuit portion of the valve is almost simultaneous with the No. 1 circuit portion.

5.4.2.3. Applying: Loss of Air in the No. 2 Circuit

Should air be lost in the No. 1 circuit, the function will be as follows: As the brake treadle is depressed and no air pressure is present in the No. 1 piston will mechanically move the relay piston allowing the piston to close the No. 2 exhaust valve and open the No. 2 inlet valve and allow air to flow out the No. 2 delivery port.

5.4.2.4. Balanced: No. 1 Circuit Portion

When the No. 1 delivery pressure acting on the piston equals the mechanical force of the brake pedal application, the No. 1 piston will move and the No. 1 inlet valve will close, stopping the further flow of air from the No. 1 supply line through the valve. The exhaust valve remains closed preventing any escape of air through the exhaust port.

5.4.2.5. Balanced: No. 2 Circuit Portion

When the air pressure on the No. 2 side of the relay piston approaches that being delivered on the No. 1 side of the relay piston base, the relay piston moves closing the No. 2 inlet valve and stopping further flow of air from the supply line through the valve. The exhaust remains closed as the No. 2 delivery pressure balances the No. 1 delivery pressure.

When applications in the graduating range are made, a balanced position in the No. 1 portion is reached as the air pressure on the delivery side of the No. 1 piston equals the effort exerted by the driver's foot on the treadle. A balanced position in the No. 2 side of the relay piston closely approaches the air pressure on the No. 1 side of the relay piston. See “Fig. 8-14: E-6 Dual Brake Valve Cross Section” on page 59.

When the brake treadle is fully depressed, both the No. 1 and No. 2 inlet valves remain open and full reservoir pressure is delivered to the actuators.

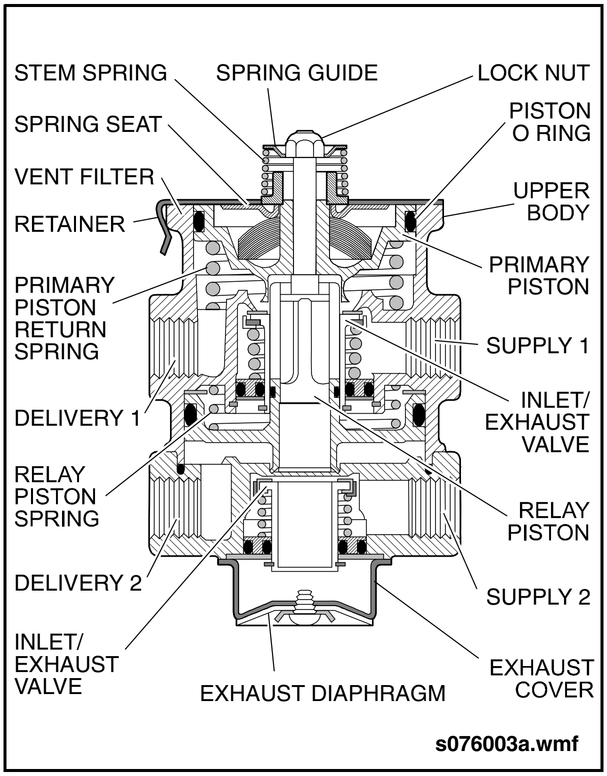


Fig. 8-14: E-6 Dual Brake Valve Cross Section

5.4.2.6. Releasing: No. 1 Circuit Portion

With the brake treadle released, mechanical force is removed from the spring seat, graduating spring, and No. 1 piston. Air pressure and spring load moves the No. 1 piston, opening the No. 1 exhaust valve, allowing air pressure in the No. 1 delivery line to exhaust out the exhaust port.

5.4.2.7. Releasing: No. 2 Circuit Portion

With the brake treadle release, air is exhausted from the No. 1 circuit side of the relay piston. Air pressure and spring load move the relay piston, opening the No. 2 exhaust valve allowing air pressure in the No. 2 delivery line to exhaust out the exhaust port.

5.4.3. Removal

1. Set the parking brake and block the wheels of the vehicle.

☞NOTE:

Refer to 1. "SAFETY" on page 1 *in this section for complete information on securing the vehicle for servicing.*

2. Drain the air pressure from the air system.
3. Open the side console access door located below the driver's window.
4. Hoist the vehicle to gain access to the brake valve. Refer to "Raising the Vehicle" in the General Information section.
5. Remove the front steering gearbox access panel below the vehicle.
6. Locate the brake valve assembly under the driver's platform and mark the orientation for correct reinstallation.
7. Tag the electrical harnesses and air lines connecting to the brake valve and disconnect them.
8. Temporarily support the brake valve under the vehicle.
9. From inside the vehicle, remove the two cotter pins and pins securing the treadle to the brake treadle assembly. Remove the treadle.
10. Remove the three countersunk bolts and washers from the brake treadle mount.
11. Remove the brake valve from below vehicle.

5.4.4. Disassembly

1. Remove Brake Valve Actuator (BVA). Refer to 5.5. “Brake Valve Actuator” on page 64 in this section for procedure.
2. Remove the Phillips head screw securing the exhaust diaphragm and washer to the exhaust cover.
3. Remove the four screws that secure the exhaust cover to the lower body.
4. Remove the No. 2 inlet and exhaust valve assembly 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 from the lower body.
   a. While depressing spring seat, remove retaining ring.
   b. Remove spring seat and coil spring.
7. Using a 3/8" wrench, hold the lock nut on the threaded end of the stem in the primary piston. Insert a screwdriver in the exhaust passage through the center of the valve and engage the slotted head of the stem.

CAUTION

Before proceeding with the disassembly, note that the lock nut and stem are used to contain the No. 1 piston return spring, stem spring and the relay piston spring. The combined force of these springs is approximately 50 lbs. 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.

8. Remove lock nut, spring seat, stem spring, primary piston, and primary piston return spring. Remove O-ring.
9. Remove adapter. Remove O-ring from adapter.

5.4.5. Cleaning & 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, using only genuine replacement parts.

5.4.6. Assembly

Prior to reassembling, lubricate all O-rings, O-ring grooves, piston bores and metal moving surfaces with Dow Corning 55-M pneumatic grease.

☞NOTE:

All torque specified in the manual are assembly torque and can be expected to fall off, after assembly is accomplished. DO NOT torque after initial assembly torque fall.

1. Install the No. 1 inlet and exhaust assembly in the upper body and place the retaining ring to secure it. Be sure the retaining ring is seated completely in its groove.
2. Place screwdriver, blade up, in vise. Place stem in relay piston - upper body sub-assembly over the blade of the screwdriver with blade engaged in the slot in the head of the stem.
3. Place the washer over the stem. This washer should be installed in all valves.
4. Install primary return spring in upper body piston bore.
5. Install the primary piston - rubber spring sub-assembly over the stem, into the upper body piston bore.
6. Compress the primary and relay pistons into the upper body from either side and hold them compressed, either manually or mechanically.

⚠CAUTION

Before proceeding with the disassembly, note that the lock nut and stem are used to contain the No. 1 piston return spring, stem spring and the relay piston spring. The combined force of these springs is approximately 50 lbs. 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.

7. Place the stem spring over the spring seat nut and the spring seat over the stem.
8. Install the lock nut on the stem and torque to 10 to 20 in-lb.
9. Install the primary piston retainer over the piston, making certain all three lock tabs have engaged the outer lip of the body.

5.4.7. Operating Check

Check the delivery pressure of both No. 1 and No. 2 circuits using test gauges known to be accurate. 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 No. 1 circuit delivery pressure will be about 2 psi greater than the No. 2 circuit delivery pressure with both supply reservoirs at the same pressure. This is normal for this valve.

☞NOTE:

A change in vehicle braking characteristics or a low pressure warning may indicate a malfunction in one or the other brake circuit, 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.

5.4.8. 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 previously or leakage is excessive, it is recommended that it be replaced with a new or remanufactured unit, or repaired.

5.4.9. Installation

1. Support the brake valve from below the vehicle and install the countersunk bolts through the treadle base into the brake valve's threaded holes.
2. Tighten bolts.
3. Reinstall treadle onto base.
4. Reconnect the air lines to the brake valve as noted during removal.
5. Reconnect the electrical harnesses to the brake valve.
6. Reinstall the steering gearbox access panel.
7. Close the side console access door.
8. Recharge the air system and test the brake system.

5.5. Brake Valve Actuator

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Brake System Components" when performing maintenance on these components.

5.5.1. Description

The Brake Valve Actuator (BVA) is a brake application device that is mounted directly on the E-6 Brake Valve and functions as part of the brake interlock control system.

5.5.2. Operation

The brake interlock control system consists of a pressure reducing valve, a solenoid valve and the brake valve actuator.

The brake interlock pressure reducing valve receives its air supply from the front or rear brake tank via the emergency/parking brake valve system. The pressure reducing valve is set to regulate the interlock pressure to 70 psi. The outlet of the pressure reducing valve regulator is connected to the brake interlock solenoid valve.

The brake interlock solenoid valve is normally closed. When energized by the Multiplexing system, it opens and applies pressure from the brake interlock pressure reducing valve to the brake valve actuator on the E-6 brake valve.

The brake valve actuator on the E-6 brake valve receives air pressure from the pressure reducing valve and the brake interlock solenoid valve and applies the service brakes. This action will mimic a foot application of the brake treadle and will apply both front and rear service brakes.

☞**NOTE:**

The treadle will fall away from the operator's foot when the interlocks apply.

Releasing the interlocks will require the vehicle operator to push through the interlock application. Applying sufficient pressure on the treadle to exceed interlock pressure by 10 psi will release the interlocks and the treadle will return to its normal position.

☞**NOTE:**

Interlock application and release will be accompanied by a text message on the instrument panel LCD screen. Refer to Section 19 in this manual for more information on the instrument panel text messages.

5.5.3. Removal of BVA from Brake Valve

1. Remove the brake valve assembly from the vehicle. Refer to 5.4. “E-6 Brake Valve” on page 57 in this section for procedure.
2. Place the brake valve onto a clean work surface with the BVA on top.
3. Mark the position of the BVA in relation to the brake vale assembly.
4. Remove the three socket screws securing the BVA to the brake valve.
5. Remove the BVA from the brake valve.
6. Mark the rotation of the elbow fitting and remove it from the BVA.

5.5.4. Installation

1. Place the BVA on the brake valve assembly align it with the marks made during removal.
2. Install the three socket screws and tighten.
3. Inspect the threads of the elbow fitting to be sure they are not damaged or contain slivers, burrs, dirt or other contaminants.
4. Apply Loctite 567 evenly, without air pockets, around the circumference of the threads. Leave the first 1/2 to 1 1/2 threads clean and completely cover, at minimum, the next three threads.
5. Install the elbow fitting into the BVA and tighten until finger-tight.
6. Apply two full turns past finger-tight, rotating until the fitting is 15° past horizontal, as noted during removal.

5.6. R-14 Relay Valve

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Brake System Components" when performing maintenance on these components.

5.6.1. Description

The brake relay valve speeds up the application and release of the rear brakes. The valve is mounted on a plate in front of the rear axle. It operates as a remote controlled brake valve that delivers or releases air to the brake chambers in response to the control air delivered to it from the foot brake valve.

5.6.2. Operation

5.6.2.1. Application

Under normal conditions, the internal biased double check valve assures that the primary signal controls the valve. Air pressure delivered to the primary control port is prevented from flowing to the secondary control port by the biasing check valve. The air then enters the cavity above the relay piston and moves the piston down. The exhaust seat moves down with the piston and seats on the bellmouth end of the modulation tube, sealing off the exhaust passage. Further movement of the piston slides the modulation tube down causing the supply valve to unseat, permitting supply air to flow from the reservoir, past the open supply valve and into the service brake chambers. In the event of a loss of the primary control line, the biasing check valve mechanism in the cover of the brake relay valve will move, shutting off the primary control passage, and allow the secondary control line to apply the air pressure needed to operate the valve. See “Fig. 8-15: R-14 Relay Valve Cross Section” on page 65.

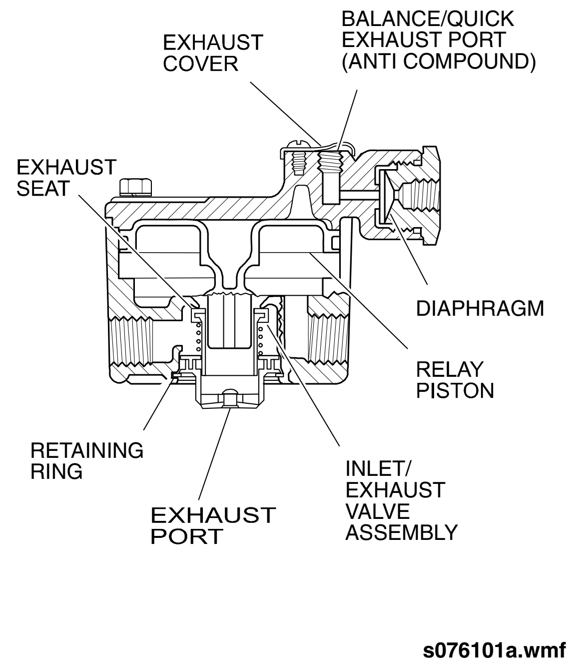


Fig. 8-15: R-14 Relay Valve Cross Section

5.6.2.2. Balance

The air pressure being delivered by the open supply valve also is effective on the bottom area of the relay piston. When service air pressure beneath the piston equals the control air pressure above, the piston lifts slightly allowing the modulation tube return spring to slide the modulation tube upwards closing off the supply port. The exhaust remains closed as long as the control line pressure balances the delivery line pressure. If delivered air pressure is changed, the valve reacts instantly to the change, holding the brake application at that level.

5.6.2.3. Exhaust or Release

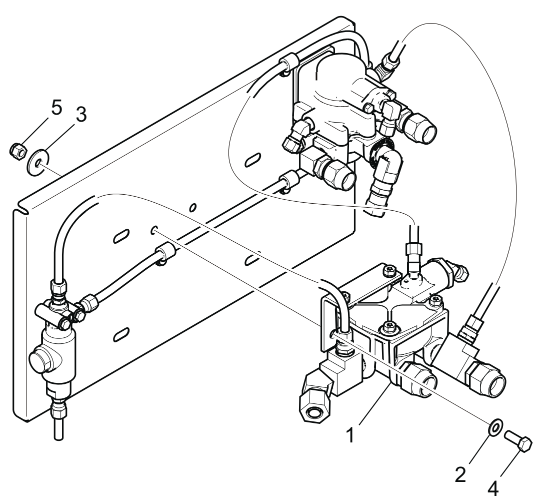
When control air pressure in the cavity above the relay piston is exhausted from the line, air pressure beneath the piston lifts the relay piston and exhaust seat away from the modulation tube opening the exhaust passage. With the exhaust passage open, the air pressure in the brake chambers is then permitted to exhaust through the exhaust port, releasing the brakes.

5.6.3. Removal

1. Block and hold vehicle by means other than air brakes.
2. Drain air brake system reservoirs.
3. Identify air lines to facilitate reinstallation prior to disassembly.
4. Remove as much contamination as possible from the exterior of the valve and disconnect air lines from valve being careful to prevent any foreign matter from entering the open ports.
5. Remove mounting bolts and then valve. See “Fig. 8-16: R-14 Relay Valve Installation” on page 66.

5.6.4. 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.



1. R-14 Relay Valve
2. Washer
3. Washer
4. Bolt
5. Nut

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Fig. 8-16: R-14 Relay Valve Installation

5.6.5. Operation & Leakage Test

1. Chock the wheels and fully charge the brake system.
2. Make several brake applications and check for prompt application and release at each rear wheel.
3. The following test will check for internal air leakage past exhaust valve seat or past the inlet/exhaust valve O-ring.
   a. Release the service brakes.
   b. Locate the exhaust valve at the bottom of the relay valve. Use a soap solution and coat the exhaust port and the area around the retaining ring.
   c. Leakage equivalent to a 1" bubble in 3 seconds is permitted.
4. The following test will check for internal air leakage past the relay piston exhaust seat or past the O-ring in the valve body cover.
   a. Apply and maintain full service brake pressure.
   b. Locate the exhaust valve at the bottom of the relay valve. Use a soap solution and coat the exhaust port and the area around the retaining ring.
   c. Leakage equivalent to a 1" bubble in 3 seconds is permitted.
   d. Use a soap solution and coat the outside of the valve where the cover joins the body. No leakage is allowed in this area.

☞NOTE:

If the valve does not function as described, or if leakage is excessive, it is recommended that the valve be replaced as an assembly. Refer to your New Flyer Parts Manual for correct assembly part number.

5.7. SR-7 Spring Brake Modulating Valve

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Brake System Components" when performing maintenance on these components.

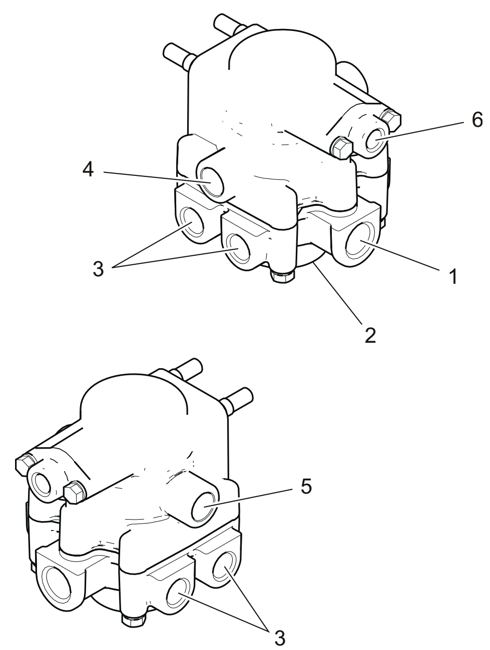
5.7.1. Description

The SR-7 Spring Brake Modulating Valve (SBMV) is used in conjunction with a dual air brake system and spring brake actuators. The SBMV performs the following functions:

- ❒ Provides a rapid application of the spring brake actuator when the parking brake is applied.
- ❒ Modulates the spring brake actuator application using the brake foot valve, should a failure occur in the primary (rear) service brake system.
- ❒ Prevents compounding of service and spring brake forces.

The SBMV is configured with the following ports. See “Fig. 8-17: SR-7 Spring Bake Modulating Valve” on page 67.

- ❒ Park control port - receives front/rear brake supply pressure via a double check valve and parking brake control valve.
- ❒ Supply port - receives constant air pressure from secondary (front) brake reservoir
- ❒ Balance port - receives primary (rear) delivery pressure.
- ❒ Control port - receives secondary (front) delivery pressure.
- ❒ Delivery ports (2) - delivers supply pressure to spring brake chamber.



1. Supply Port
2. Exhaust Port
3. Delivery
4. Control
5. Balance
6. Parking Brake Control

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Fig. 8-17: SR-7 Spring Bake Modulating Valve

5.7.2. Operation

SBMV operating modes:

- ❒ Charging spring brake actuators below 107 psi.
- ❒ Charging spring brake actuators above 107 psi.
- ❒ Normal service application
- ❒ Parking brake application
- ❒ Service application with loss of air in primary (rear) circuit
- ❒ Anti-compounding

5.7.2.1. Charging Spring Brake Actuators below 107 psi

During initial air system charging, with parking brake released, air flows to the parking brake control valve. This air pressure acts on the control piston and main piston to open the inlet valve. The inlet valve allows secondary (front) reservoir pressure to flow from the supply port to the delivery ports. Air will continue to flow to spring brake chambers as system pressure is building and will release the spring brakes. Air flow will cease once spring brake pressure builds to 107 psi.

5.7.2.2. Charging Spring Brake Actuators above 107 psi

Once the delivery pressure to the spring brakes reaches 107 psi (nominal), the inlet and exhaust valves close (lap position) and maintain the spring brake hold-off pressure at 107 psi. (nominal).

5.7.2.3. Normal Service Application

During a service brake application, the SBMV remains in the lap position with the inlet and exhaust valves closed and monitors the presence of air pressure in both primary and secondary delivery circuits.

5.7.2.4. Parking Brake Application

During a parking brake application, the air pressure in the parking brake control line is exhausted through the exhaust port in the parking brake control valve. This allows the main and control pistons to move up, thereby seating the inlet valve and unseating the exhaust valve. Air from the spring brakes is exhausted through the SBMV exhaust valve.

5.7.2.5. Service Application with Loss of Primary Circuit

The SBMV will function to provide modulated spring brake application in a situation where the primary (rear) brake circuit has lost air pressure. The SBMV senses loss of primary circuit air pressure at the balance port which causes an imbalance on the main piston. Air pressure from the secondary (front) brake application circuit acts on the underside of the main piston forcing it up. This action closes the inlet valve and opens the exhaust valve. As a result, air is exhausted from the spring brakes in proportion to the secondary brake application pressure. A 30 psi secondary brake application will exhaust spring brake pressure to approximately 60 psi.

5.7.2.6. Service Application with Loss of Secondary Circuit

The SBMV will function to maintain the spring brakes in the released position in a situation where the secondary (front) brake circuit has lost air pressure. The external check valve in the secondary supply line will seal the SBMB and prevent air leakage to atmosphere. Primary air supply will be delivered through the Parking Brake Control Valve and supplied to the parking brake control port of the SBMV. This supply air will flow through the internal inline check valve and become the delivery pressure to the spring brakes. This delivery air will maintain 107 psi (nominal) in the spring brake chambers.

5.7.2.7. Anti-Compounding

When the parking brake is in the applied position, air pressure is removed from the SBMV park control port, thereby allowing air to exhaust from the spring brakes chamber and allow the spring brakes to apply. A service brake application, with the parking brakes still applied, will cause air pressure received at the SBCS balance and control ports to act on the Control Piston, forcing it downward. This action will allow brake application pressure to flow to the spring brake chamber, thereby releasing the spring brakes and preventing compounded brake application.

5.7.3. Maintenance

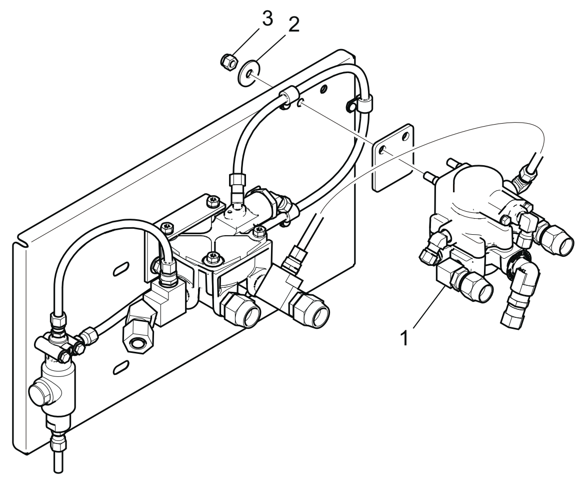
Refer to the Preventive Maintenance section of this manual for maintenance intervals and procedures.

5.7.4. Removal

☞NOTE:

There are no replaceable parts within the SBMV assembly. Replace the SBMV as a unit.

1. Set the Battery Disconnect switch to the OFF position.
2. Drain air from all air tanks.
3. Locate the SBMV on the rear brake valve plate. See “Fig. 8-18: SR-7 Spring Bake Modulating Valve Installation” on page 69.
4. Mark the location and disconnect all air lines from SBMV.
5. Unplug electrical connector from the pressure transducer.
6. Remove the two lock nuts and washers securing the SBMV to the rear brake valve plate and remove the SBMV from the vehicle.
7. Mark the location and position of all fittings prior to removal.
8. Remove the check valve, pressure transducer, and all fittings from body of SBMV.



1. SR-7 Spring Brake Control Valve
2. Washer
3. Nut

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Fig. 8-18: SR-7 Spring Bake Modulating Valve Installation

5.7.5. Installation

1. Apply Loctite 567 thread sealant on the threads of all NPT fittings and install in the replacement SBMV at the location and position noted during removal. Tighten all NPT fittings two turns past finger tight or until aligned as originally installed.
2. Install and secure the SBMV to the rear brake valve plate using two locknuts and washers.
3. Plug the electrical connector from the vehicle harness into the pressure transducer.
4. Connect all air lines to locations marked during removal.

5.8. PR-2 Pressure Protection Valve

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Brake System Components" when performing maintenance on these components.

5.8.1. Description

The pressure protection valve is a normally closed, pressure control valve which can be referred to as a non-exhausting sequence valve. See "Fig. 8-19: PR-2 Pressure Protection Valve Cross Section" on page 70. One of these valves is installed in the inlet of the front brake tank to supply specific air pressure to the Accessories tank.

The PR-2 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. Valves are provided with two 9/32" mounting holes through the body. The closing pressure of the PR-2 is externally adjustable. See "Fig. 8-20: PR-2 Pressure Protection Valve Assembly" on page 70.

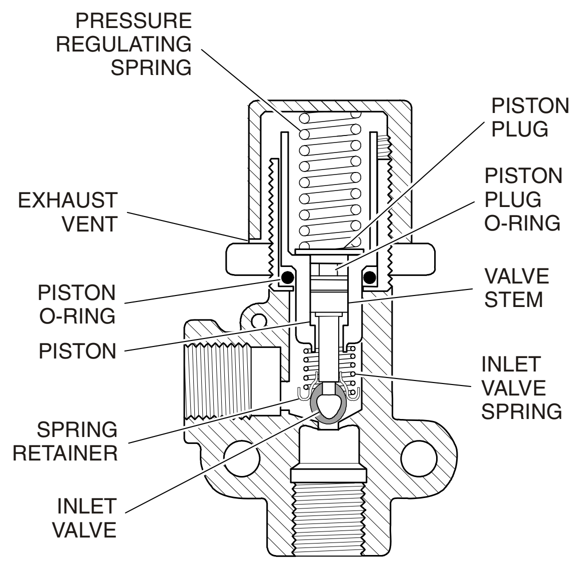
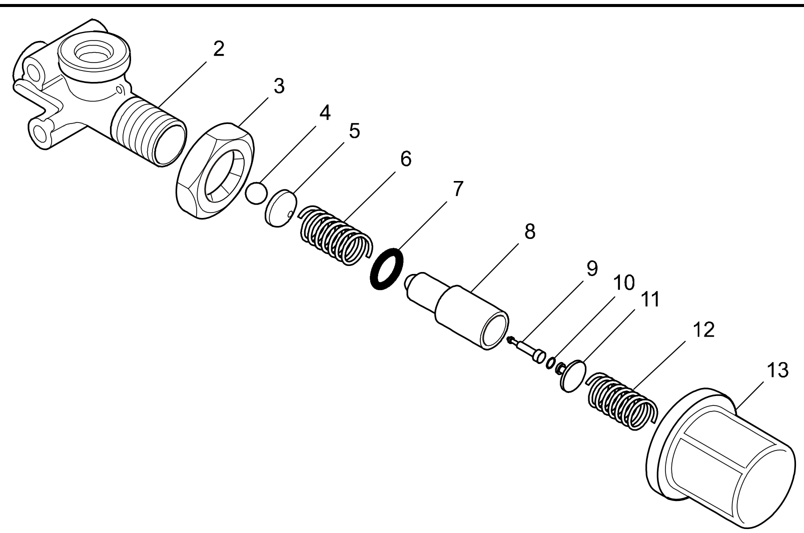


Fig. 8-19: PR-2 Pressure Protection Valve Cross Section



1. Pressure Protection Valve (Incl. 2...13)
2. Body
3. Nut
4. Valve
5. Guide
6. Spring, Valve
7. O-Ring, Piston
8. Piston
9. Stem
10. O-Ring, Stem
11. Plug
12. Spring
13. Cap, Adjusting

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Fig. 8-20: PR-2 Pressure Protection Valve Assembly

5.8.2. Operation

Air entering the supply port is initially prevented from flowing out the delivery port by the inlet valve which is held closed by the pressure regulating spring above the piston. When sufficient air pressure builds beneath the piston to overcome the setting of the regulating spring, the piston will move, causing the inlet valve to unseat (open), and allow air to flow out the delivery port. As long as air pressure at the supply port and beneath the piston remains above the specified closing pressure, the inlet valve will remain open.

☞**NOTE:**

The PR-2 closing pressure is noted on the label affixed to the valve. Opening pressure of the PR-2 valve is 15 to 20 psi higher than closing pressure.

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.

5.8.3. Removal

WARNING

During component removal or installation, ensure the Battery Disconnect switch is in the OFF position.

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.

5.8.4. Installation

1. Reinstall 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.

5.8.5. Operating & Leakage Check

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. (PR-3 and PR-4 valves are not adjustable.)

5.8.5.1. Operating Check

1. Provide a pressure gauge and drain valve at the supply side and delivery side of the pressure protection valve being checked.
2. Build up the air system to full pressure and shut off the engine.
3. While watching the gauges on the supply and delivery sides of the valve, slowly begin to exhaust pressure from the delivery side. Note that both gauges will show pressure loss until the closing pressure of the pressure protection valve is reached.

   The pressure protection valve should close at approximately (± 5 psi) the pressure indicated on the valve's label. 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.

5.8.5.2. Leakage Check

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 1” bubble in three seconds or longer is acceptable.
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 1” bubble in five seconds or more is acceptable.

☞**NOTE:**

Replace the pressure protection valve if it does not operate as described or leakage is excessive.

5.9. QR-1 Quick Release Valve

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Brake System Components" when performing maintenance on these components.

5.9.1. 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 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. 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:**

QR-1 Valves with a pressure differential employ a spring and spring seat.

Porting consists of one brake valve port, two delivery ports and one exhaust port.

5.9.2. 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.

5.9.3. Removal

WARNING

During component removal or installation, ensure the Battery Disconnect switch is in the OFF position.

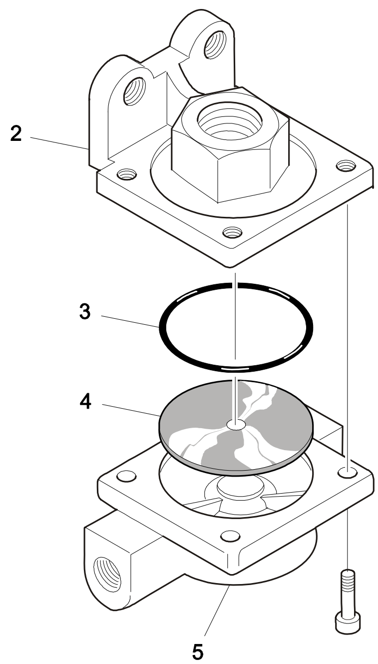
1. Block vehicle wheels and hold vehicle by means other than air brakes.
2. Drain all air brake system reservoirs.
3. Disconnect air lines from valve.
4. Remove mounting bolts, then valve.

5.9.4. Installation

1. Mount valve with exhaust port pointing down; securely tighten mounting bolts.
2. Connect air lines to valve (brake valve application line to top port; brake chamber line to side ports).

5.9.5. Disassembly

1. Remove four screws.
2. Remove diaphragm. See "Fig. 8-21: QR-1 Quick Release Valve Assembly" on page 74.
3. Remove cover O-ring.



1. Quick Release Valve Assembly (Incl. 2...5)
2. Cover
3. Ring, Sealing
4. Diaphragm
5. Body

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Fig. 8-21: QR-1 Quick Release Valve Assembly

5.9.6. Cleaning & 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.

5.9.7. Assembly

1. Install diaphragm.
2. Install O-ring in cover groove; install cover and tighten screws evenly and securely. (Torque to 30 to 60 in-lb.)
3. Perform tests. Refer to 5.9.8. “Operating & Leakage Test” on page 74 in this section for procedure.

5.9.8. Operating & Leakage Test

1. While holding a foot brake valve application;
   a. Coat exhaust port with soap solution; 1" bubble in three seconds leakage is permitted.
   b. Coat body and cover with soap solution. No leakage permitted between body and cover.
2. 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.

5.10. Pressure Switches

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Brake System Components" when performing maintenance on these components.

5.10.1. Front Brake Circuit Pressure Switch

5.10.1.1. Description

The Front Brake Circuit Pressure switch is an electro-pneumatic 4 psi non-grounded switch used to signal the Multiplexing System when the front brake circuit application pressure reaches or exceeds 4 psi. It is mounted on the E-6 brake valve and accessed through the side console access door.

The switch is not a serviceable item and must be replaced as a unit if found defective.

5.10.1.2. Operation

When the brakes are applied, air pressure from the brake valve enters the cavity below the switch diaphragm. The air pressure moves the piston until it contacts the leaf spring.

The leaf spring pivots on a fulcrum at 4 psi and snaps a shorting bar which mates with the contact strips. This snap action spring is designed to minimize arcing. The electrical circuit closes, signaling the Multiplexing System.

The Multiplexing System uses the signal from the Front Brake Circuit Pressure switch to activate the brake lights.

5.10.1.3. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Drain the air system to remove pressure in the lines.
3. Open the access door below the driver's side window and locate the Stop Light Pressure switch.
4. Disconnect the electrical connector and air line from the switch.
5. Remove switch from the threaded fitting.

5.10.1.4. Installation

1. Install switch into the threaded fitting.
2. Connect electrical connector to switch.
3. Close access door
4. Set Battery Disconnect switch to ON position.

5.10.2. Brake Application Pressure Transducer

5.10.2.1. Description

The brake application pressure transducer is ruggedly constructed of a stainless steel or aluminum cylindrical body that encloses one-piece stainless steel sensing elements. The transducer has threads and wrench surfaces at one end and a sealed electrical connector at the opposite end. The pressure transducer monitors brake application pressure on the rear brake circuit and transmits an analog signal to the vehicle's Multiplexing System.

5.10.2.2. Brake Application Pressure Transducer Specifications

Pressure Range .... 0 - 150 psi

Supply Voltage .... 10 - 32 VDC

Output Voltage .... 1 - 5 VDC

Supply Current ....<10mA

Thread ....1/4 NPT

5.10.2.3. Operation

The pressure transducer is connected to the brake foot valve's rear brake circuit delivery port. The Multiplexing System converts the analog signal into pressure readings which are used to illuminate the brake lights and signal both the retarder system and the brake interlock system.

5.10.2.4. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Drain the air system to remove pressure in the lines.
3. Obtain access to the transducer on the E-6 brake valve assembly.
4. Disconnect the electrical connector from the transducer.
5. Remove the transducer.

5.10.2.5. Installation

1. Inspect the threads to be sure they are not damaged or contain slivers, burrs, dirt or other contaminants.
2. Apply Loctite-567 evenly, without air pockets, around the circumference of the thread, leaving the first 1/2 to 1 1/2 threads clean while completely covering a minimum of the next three threads.

☞**NOTE:**

Ensure the sensor port remains unblocked by thread sealant.

3. Install the pressure transducer and finger tighten.
4. Using a wrench, fully tighten the transducer two full turns past finger-tight.

5.10.3. Parking Brake/Stop Light Switch

5.10.3.1.Description

The Parking Brake/Stop Light switch is a normally closed 60 psi switch used to illuminate the parking brake indicator on the instrument panel when the parking brake is applied. This switch is also used to illuminate the vehicle brake lights and service brake light indicator whenever the parking brake is applied.

The electrical contacts in the switch are held closed by spring pressure until the air brake system pressure below the diaphragm overcomes the 60 psi pressure setting of the switch spring.

5.10.3.2.Operation

When air pressure at the supply port and under the diaphragm is above 60 psi, the electrical contacts remain open because the air pressure underneath the diaphragm overcomes the pressure exerted by the spring above the diaphragm.

When the parking brake is applied and air pressure below the diaphragm drops below 60 psi, the spring pressure overcomes the air pressure below the diaphragm. The diaphragm moves and closes the electrical contacts, illuminating the dash-mounted parking and service brake and also illuminating the brake lights.

5.10.3.3.Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Drain the air system to remove pressure in the lines.
3. Open the access door below the driver's side window and locate the pressure switches installation. See "Fig. 8-22: Pressure & Stop Switches Installation" on page 78.
4. Disconnect the electrical connector from the switch being replaced.
5. Remove the switch from the threaded fitting.

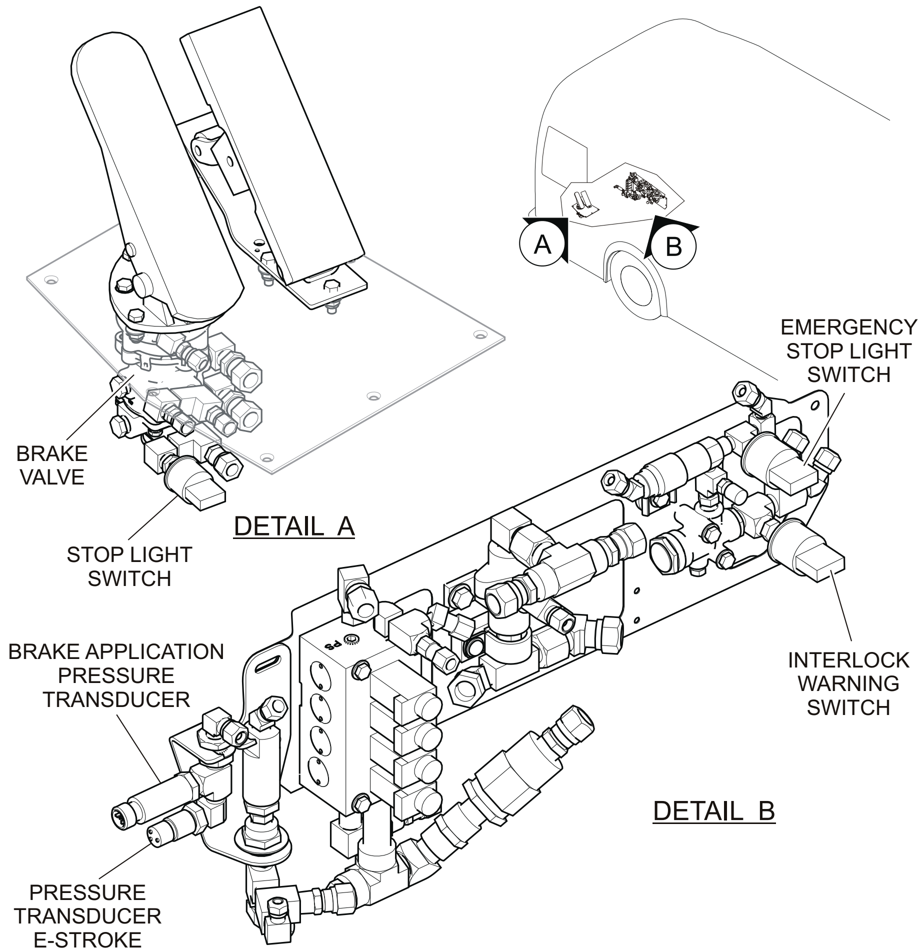


Fig. 8-22: Pressure & Stop Switches Installation

5.10.3.4.Installation

1. Install switch into threaded fitting.
2. Connect electrical connector to switch.
3. Close access door.
4. Set Battery Disconnect switch to ON position.

5.10.3.5.Leakage Test

With air pressure present at the supply port, coat the pressure switch with soap solution. No leakage permitted.

5.10.3.6. Operating Test

1. Repeat Leakage Test.
2. Ensure the Battery Disconnect switch is ON.
3. Locate the rear switch box in the engine compartment. Set the Engine Run switch to the FRONT position.
4. Position the Master Run switch on the driver's area side console to DAY-RUN.
5. Apply the parking brake. When the parking brake system pressure drops below 60 psi, the contacts on the pressure switch should close, causing the dash-mounted parking and service brake indicators to illuminate.
6. If the dash indicators do not illuminate, check switch operation as follows:
   a. Ensure Battery Disconnect switch is OFF (for example no power to vehicle).
   b. Drop system pressure below 60 psi.
   c. Open the side console access door on the streetside of the vehicle. Locate the parking Brake/Stop Light switch mounted on Spring Brake Control Valve. The contacts on this pressure switch should be in a closed position, due to the drop in system pressure. Position can be verified by measuring resistance at the switch as follows:

- ❒ Disconnect the electrical connector.
- ❒ Using an ohmmeter, measure the resistance across the switch terminals. Reading should be zero ohms. Reconnect pressure switch. If the pressure switch contacts do not close when system pressure drops below 60 psi, the ohmmeter will read infinite resistance. Replace switch, and repeat operating test.

5.10.4. Brake Tank Pressure Sending Units

5.10.4.1.Description

The pressure transducers are ruggedly constructed of stainless steel cylindrical bodies that enclose one-piece stainless steel sensing elements. The sensors have threads and wrench surfaces at one end and a sealed electrical connector at the opposite end. They are mounted directly on the brake system air tanks.

5.10.4.2.Brake Tank Pressure Sending Units Specifications

Pressure Range.......................... 0 - 150 psi

Supply Voltage......................... 10 - 32 VDC

Output Voltage .... 1 - 5 VDC

Supply Current.................................<10mA

Thread ....1/4 NPT

5.10.4.3.Operation

The pressure transducers transmit an analog signal to the vehicle's multiplexing system. The multiplexing system converts the analog signal into pressure readings are displayed on individual instrument panel gauges corresponding to each brake system air tank. The LED indicator on the gauge face will illuminate and a warning buzzer will sound if the air pressure drops below 70 psi.

5.10.4.4.Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Drain the air system to remove pressure in the lines.
3. Obtain access to the air tank behind the aisle light panels.
4. Disconnect the electrical connector from the transducer.
5. Remove the transducer.

5.10.4.5.Installation

1. Inspect the threads to be sure they are not damaged or contain slivers, burrs, dirt or other contaminants.
2. Apply Loctite 567 evenly, without air pockets, around the circumference of the thread, leaving the first 1/2 to 1 1/2 threads clean while completely covering a minimum of the next three threads.

☞**NOTE:**

Ensure the sensor port remains unblocked by thread sealant.

3. Install the pressure transducer and finger tighten.
4. Using a wrench, fully tighten the transducer two full turns past finger-tight.

5.10.5. Electronic Stroke Alert Pressure Transducer

5.10.5.1. Description

This pressure transducer is teed into the front brake apply circuit. It receives power from the brake stroke monitor chassis communication module and supplies a variable voltage signal to the module based on brake application pressure. Refer to Section 9 of this manual for further information on this equipment.

5.10.5.2. Operation

The transducer receives power from the brake stroke monitor chassis communication module and supplies a variable voltage signal to the module based on brake application pressure. Refer to Section 9 of this manual for further information on this equipment.

5.10.5.3. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Drain the vehicle air system to remove pressure in the line.
3. Open the exterior side console access door below the driver's window and locate the pressure switch bracket assembly.
4. Disconnect the electrical connector and air line from the transducer.
5. Remove clamp attaching the transducer to the pressure switch bracket assembly and remove the transducer.

5.10.5.4. Installation

1. Attach the transducer to the pressure switch bracket using a clamp.
2. Connect the air line and electrical connector to the transducer.
3. Close the access door.
4. Set the Battery Disconnect switch to ON, start the vehicle, and allow air system to pressurize.
5. Check for leaks.

6. EMERGENCY & PARKING BRAKE SYSTEM COMPONENTS

WARNING

When working on or around air brake systems and components, the following precautions should be observed:

- **ALWAYS block vehicle wheels. Stop engine when working under a vehicle. Make certain to drain air pressure from all reservoirs before beginning any work on the vehicle. Depleting vehicle air system pressure may cause vehicle to roll. Keep hands away from chamber push rods; they may apply as 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 certain 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 understand 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 use of those tools.**
- **Use only approved replacement parts and components.**
  - **Only components, devices, mounting and attaching hardware specifically designed for use in air brake systems should be used.**
  - **Replacement hardware, tubing, hose, fittings and so forth, should be of equivalent size, type, length, and strength as the original equipment.**
  - **Make certain that when replacing tubing or hose, all supports, clamps or suspending devices that were originally installed are reinstalled or replaced if they are missing.**
- **Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.**

CAUTION

Using alcohol in the air brake system as a means to dry the air or prevent system freezing during cold weather is not acceptable. Studies indicate that alcohol removes the lubrication from the system components, causing faulty system function. Also, the materials used for the seals in these components are not alcohol-safe and will deteriorate at an accelerated rate leaving the brake system prone to failure. Using alcohol or alcohol-based fluids in your air brake system will void the warranty on these components.

6.1. Emergency Brake Release Valve

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Emergency & Parking Brake System Components" when performing maintenance on these components.

6.1.1. Description

The push pull control valve, located on the parking brake tower on the side of the side console switch panel, is used to release the rear spring brakes after they have been automatically applied after an emergency. This limited operation allows the operator to move the vehicle to a safe area.

6.1.2. Operation

The valve supplies air pressure from the emergency release tank through the spring brake control valve to release the spring brakes. The spring brakes will automatically apply if the air system pressure drops below 40 psi.

To operate the control valve, push down and hold down. This will allow air pressure to release the brakes. Releasing the valve knob shuts off the air supply and allows the rear spring brakes to reapply.

WARNING

The emergency release valve is for emergency use only. DO NOT drive the vehicle with defective brakes.

6.1.3. Removal

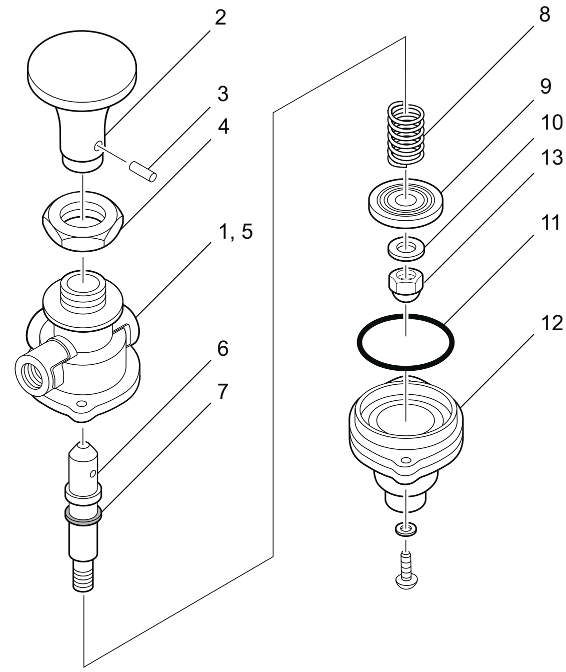
CAUTION

Securely block and/or hold the vehicle by a means other than the air brakes and drain all reservoirs.

1. Open the side console to gain access to the parking brake components.
2. Drive the button roll pin out with a punch and remove the button. See “Fig. 8-23: Emergency Release Valve Assembly” on page 84.
3. Disconnect and tag the three air lines to the valve.
4. Hold the release valve and remove the panel mounting nut, remove the valve from inside the side console panel.

☞**NOTE:**

If the valve is being replaced, remove the three elbow connections and fit to the new valve. Ensure that the elbows are aligned correctly.



1. Emergency Release Valve (Incl. 2...13)
2. Knob
3. Pin, Spiral
4. Nut, 7/8"
5. Body, Valve
6. Plunger
7. O-Ring
8. Spring, Plunger
9. Valve, Inlet & Exhaust
10. Washer, Special
11. Ring, Seal
12. Cover, Valve
13. Nut

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Fig. 8-23: Emergency Release Valve Assembly

6.1.4. Installation

Installation is the reverse of removal. Ensure that the valve is located correctly for connection of the air lines.

6.1.5. Disassembly

1. Remove the two cap screws which retain the lower cover and remove cover. Remove the sealing ring.
2. Insert a small punch through the roll pin hole in the stem and remove the lock nut with a 7/16" wrench.
3. Remove inlet-exhaust valve, plunger and spring.
4. Remove O-ring from plunger.

☞**NOTE:**

Assemble in the reverse order to disassembly.

6.1.6. Operating & Leakage Test

1. Connect a 120 psi air source to the supply port. Insert an accurate test gauge into the supply line and provide a means of controlling the supply pressure. A small volume supply, with a gauge, should be connected to the delivery port.
2. With a 120 psi supply pressure, the button pulled out (exhaust position), leakage at the exhaust port or plunger stem should not exceed a 1" bubble in 5 seconds. There should be no leakage between the upper and lower body.
3. Push the button in and manually hold in this position. Leakage at the exhaust port or plunger stem should not exceed a 1" bubble in 3 seconds.

6.2. Parking Brake Control Valve

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Emergency & Parking Brake System Components" when performing maintenance on these components.

6.2.1. Description

The parking brake control valve is a push-pull manually operated control valve with an exhaust function. See "Fig. 8-24: Parking Brake Control Valve Cross Section" on page 85.

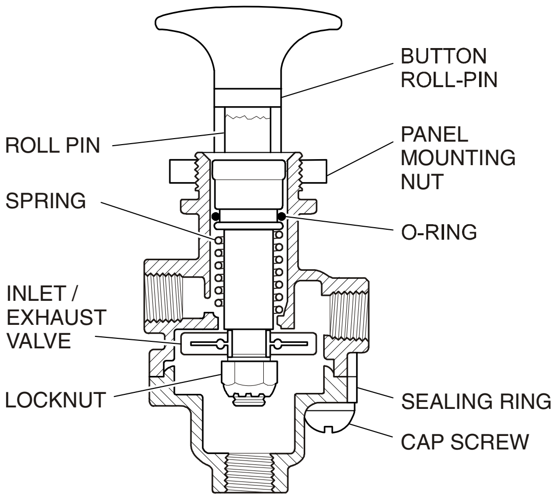


Fig. 8-24: Parking Brake Control Valve Cross Section

6.2.2. Operation

When the valve is pulled UP in the APPLY position, air is exhausted from the emergency side of the brake chambers which allows the rear brake chamber springs to extend and apply the brakes.

When the valve is pushed DOWN, air is supplied via various valves to the rear spring brake chambers. This compresses the springs in the chambers and releases the brakes.

The parking brake control valve is in the APPLIED position if there is no air in the system, above 40 psi (276 kPa) the valve can be moved to the RELEASED position.

6.2.3. Removal

CAUTION

Securely block and/or hold the vehicle by a means other than the air brakes and drain all reservoirs.

1. Remove the screws from parking brake tower close-out panel and remove panel. See "Fig. 8-25: Parking & Emergency Release Valve Installation" on page 86.
2. Drive button roll pin out with a punch and remove button.
3. Remove and tag three air lines to valve.
4. Remove panel mounting nut and remove valve.

NOTE:

If the valve is being replaced, remove the three elbow connections and fit to the new valve. Ensure that the elbows are aligned correctly.

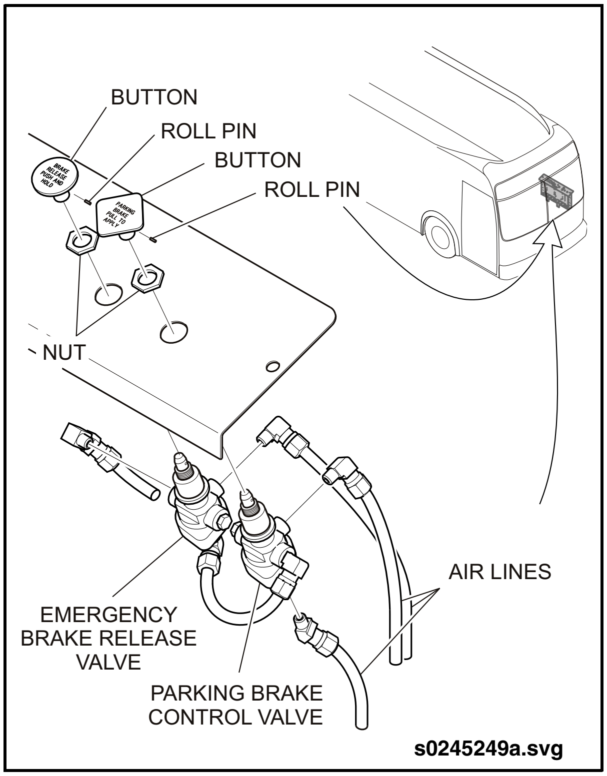


Fig. 8-25: Parking & Emergency Release Valve Installation

6.2.4. Installation

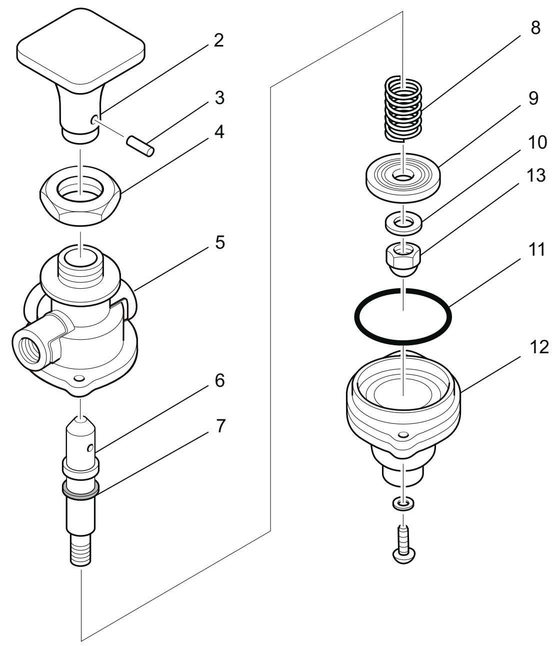
Installation is the reverse of removal. Ensure that the valve is located correctly for connection of the air lines.

6.2.5. Disassembly

1. Remove two cap screws retaining lower cover and remove cover. Remove sealing ring.
2. Insert a small punch through roll pin hole in stem and remove lock nut with a 7/16" wrench. See “Fig. 8-26: Parking Brake Control Valve Assembly” on page 87.
3. Remove inlet-exhaust valve and plunger and spring.
4. Remove O-ring from plunger.

☞**NOTE:**

Assemble in the reverse order to disassembly.



1. Valve Assembly, Parking Brake Control (Incl. 2...13)
2. Button
3. Pin, Spiral
4. Nut, 7/8"
5. Body, Valve
6. Plunger
7. O-Ring
8. Spring, Plunger
9. Valve, Inlet & Exhaust
10. Washer, Special
11. Ring, Seal
12. Cover, Valve
13. Nut

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Fig. 8-26: Parking Brake Control Valve Assembly

6.2.6. Operating & Leakage Test

1. Connect a 120 psi air source to the supply port. Insert an accurate test gauge into the supply line and provide a means of controlling the supply pressure. A small volume supply, with a gauge, should be connected to the delivery port.
2. With a 120 psi supply pressure, the button pulled out (EXHAUST position), leakage at the exhaust port or plunger stem should not exceed a 1" bubble in 5 seconds. There should be no leakage between the upper and lower body.
3. Push the button in. Leakage at the exhaust port or plunger stem should not exceed a 1" bubble in 3 seconds.
4. Reduce the supply pressure, at a pressure of 40 psi the button should pull out automatically, exhausting the delivery pressure.

☞NOTE:

If the valve fails to operate correctly or if leakage is excessive it should be replaced with a New Flyer replacement part.

7. ACCESSORIES, SUSPENSION, LEVELING & KNEELING SYSTEM COMPONENTS

WARNING

When working on or around air brake systems and components, the following precautions should be observed:

- **ALWAYS block vehicle wheels. Stop engine when working under a vehicle. Make certain to drain air pressure from all reservoirs before beginning any work on the vehicle. Depleting vehicle air system pressure may cause vehicle to roll. Keep hands away from chamber push rods; they may apply as 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 certain 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 understand 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 use of those tools.**
- **Use only approved replacement parts and components.**
  - **Only components, devices, mounting and attaching hardware specifically designed for use in air brake systems should be used.**
  - **Replacement hardware, tubing, hose, fittings and so forth, should be of equivalent size, type, length, and strength as the original equipment.**
  - **Make certain that when replacing tubing or hose, all supports, clamps or suspending devices that were originally installed are reinstalled or replaced if they are missing.**
- **Devices with stripped threads or damaged parts should be replaced. Repairs requiring machining should not be attempted.**

CAUTION

Using alcohol in the air brake system as a means to dry the air or prevent system freezing during cold weather is not acceptable. Studies indicate that alcohol removes the lubrication from the system components, causing faulty system function. Also, the materials used for the seals in these components are not alcohol-safe and will deteriorate at an accelerated rate leaving the brake system prone to failure. Using alcohol or alcohol-based fluids in your air brake system will void the warranty on these components.

7.1. Leveling Valves

WARNING

Refer to “WARNING” and “CAUTION” at the beginning of “Accessories, Suspension, Leveling & Kneeling System Components” when performing maintenance on these components.

☞NOTE:

Refer to Section 3 of this manual for ride height adjustment procedures.

7.1.1. Description

Three leveling valves are installed on this vehicle and used in the leveling process. Two are mounted at the rear axle and one at the front axle. Each of the valves is equipped with a pressure inlet port, an exhaust port and two outlet ports to supply air to the suspension bellows. The Front axle valve uses only one outlet port to supply the left and the right suspension bellows via the kneeling valve. A position sensor is also attached to the rotary control shaft of the front leveling valve. This sensor is used for properly kneeling and returning the vehicle to ride height. Refer to 7.2. “Kneeling Valve” on page 94 in this section for more information on this component. Refer to 3. “AIR SYSTEM” on page 3 in this section for complete information on leveling valve air flow and operation.

Each valve has a control lever attached to the valve's rotary control shaft. The lever is connected to a linkage that attaches to the vehicle structure. During suspension movement the linkage will either lift the lever up or push the lever down. This movement of the lever causes the control shaft to rotate either clockwise or counterclockwise.

7.1.2. Operation

When the suspension moves down, due to a load placed on the vehicle, the lever will be forced upwards rotating the shaft and thus opening the inlet port to the bellows. This will allow compressed air to fill the bellows causing the vehicle to rise. This rising motion will cause the lever to move down and the control shaft to again rotate and close the ports when the vehicle has reached its operating position. The opposite will occur when the vehicle suspension moves up as it loses its load or weight.

The position sensor, on the front leveling valve, sends a signal to the vehicle's multiplexing system which is used during the kneeling process to lower the vehicle.

7.1.3. Removal

WARNING

During component removal or installation, ensure the Battery Disconnect switch is in the OFF position.

DANGER

Before disconnecting any leveling valve air lines, securely support body by placing blocks under vehicle at jack pads. Refer to the General Information Section of this manual for further information on raising the vehicle.

Exhaust air from air supply system by opening drain cock in suspension air tank. After the above precautions have been taken remove leveling valve as follows:

1. Disconnect valve over-travel lever from the valve link. Pull lever downward to release compressed air from bellows. See "Fig. 8-27: Front Leveling Valve Installation" on page 91. See "Fig. 8-28: Rear Leveling Valve Installation" on page 92.
2. Disconnect air supply line and bellows air line from valve. Tape ends closed.
3. Disconnect the electrical connector from the valve sensor (front valve only).
4. Remove washers and locknuts attaching valve to mounting bracket and remove valve assembly.

1. Loctite, 243
2. Nut, Hex 1/4" - 20 UNC
3. Washer, Flat 1/4"
4. Link Assembly, Leveling Valve
5. Valve, Leveling w/Sensor

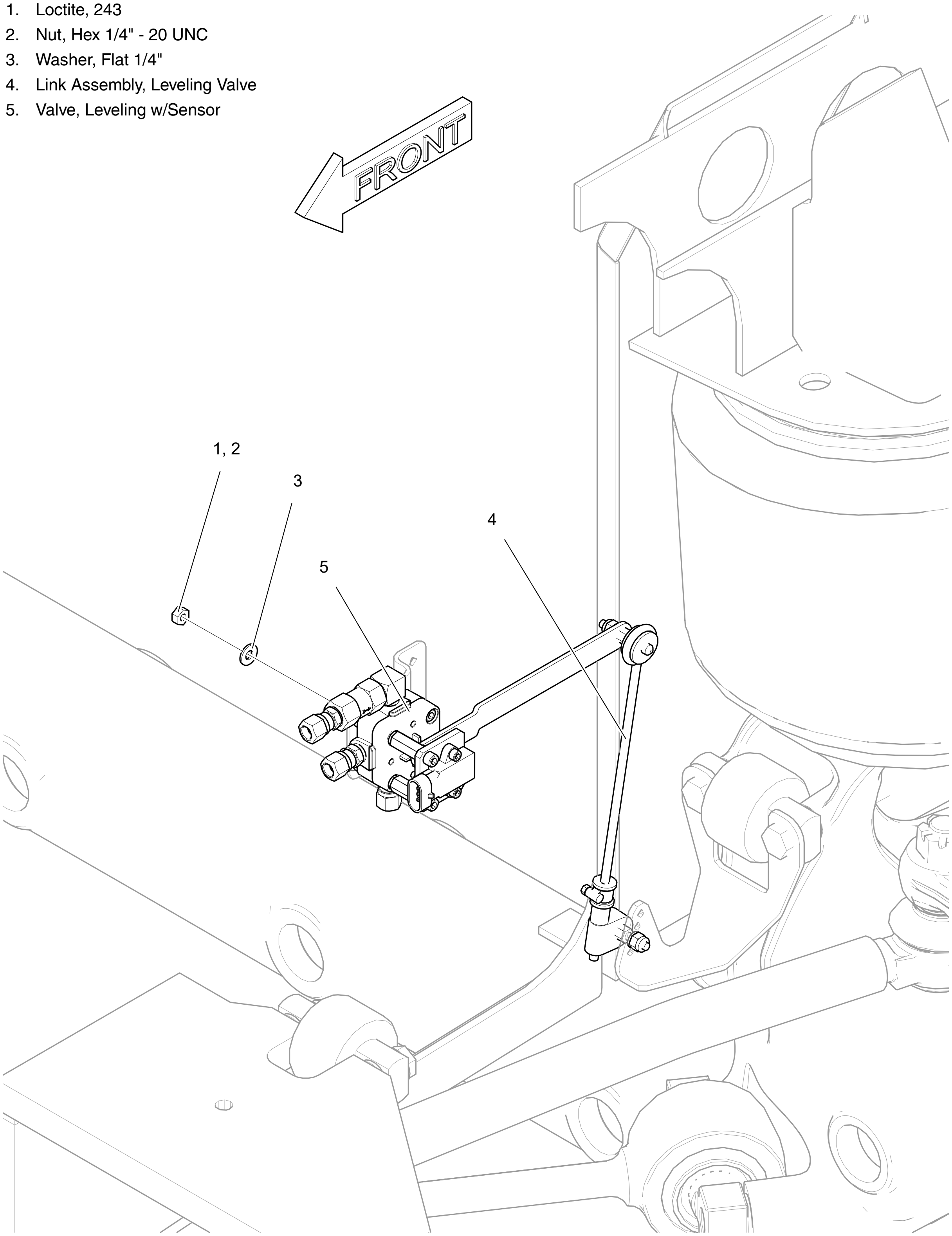


Fig. 8-27: Front Leveling Valve Installation

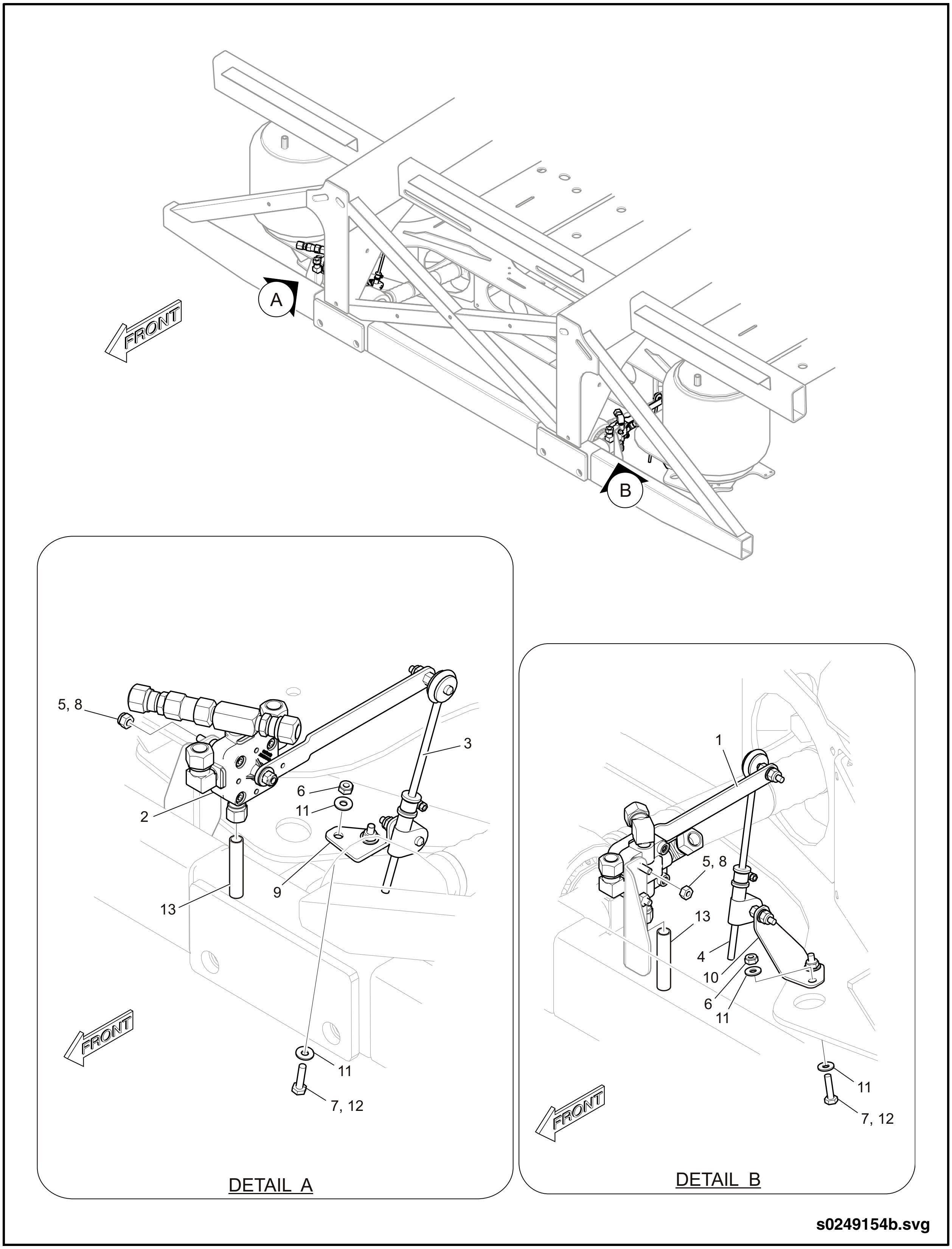


Fig. 8-28: Rear Leveling Valve Installation

1. Valve Assembly, Leveling Streetside	8. Nut, Hex 1/4" - 20 UNC
2. Valve Assembly, Leveling Curbside	9. Bracket, Curbside Leveling Valve
3. Link Assembly, Leveling Valve Curbside	10. Bracket, Streetside Leveling Valve
4. Link Assembly, Leveling Valve Streetside	11. Washer, Flat SST 1/4"
5. Loctite, 243 Blue	12. Adhesive, SIKA 221 White
6. Nut, Hex Lock Steel 1/4" - 20 UNC	13. Tube, Nylon 3/8" Blue
7. Bolt, Hex SST 1/4" - 20 UNC x 1" Lg.	

Rear Leveling Valve Installation (parts list)

7.1.3.1. Air Leakage Test - Valve Removed

☞**NOTE:**

The valve must be removed from vehicle for this check.

1. Clean exterior of control valve assembly.
2. Connect air pressure line to air inlet port, then open the air pressure (80 to 110 psi).
3. Submerge valve assembly in a container of water, then watch for air bubbles when the over-travel lever is in the center position. No air should escape from any point of control valve assembly.
4. If bubbles appear from the bellows port, the air inlet valve assembly is defective and must be replaced.
5. Remove air pressure line from air inlet fitting and connect it to bellows port. If bubbles appear at the air inlet check valve port, check valve unit is defective and must be replaced.

7.1.4. Installation

1. Before installing valve, ensure that the air line fittings are clean and undamaged. Replace line connector rubber gaskets if deteriorated or damaged.
2. Do not USE sealing compound on threads. Sealer is unnecessary, and if used, may cause valve cores to stick.
3. Absolute cleanliness is essential when installing valves. Dirt and sealing compound must be kept out of valves. Even minute particles of foreign matter may become lodged in valve cores or flapper valves and may seriously affect operation of suspension system.
4. Install the valve as follows:
   a. Position valve on mounting bracket. Attach with locknuts and washers and tighten to torque. Refer to the General Information Section of this manual.
   b. Connect air supply line to air inlet adapter. Connect bellows air line to bellows adapter. Tighten air line fittings firmly.
   c. Connect electrical connector to the position sensor (front valve only).
   d. Connect valve over-travel lever to valve link. Build up air pressure in system and test for leaks with soapy water solution.

7.1.4.1. Air Leakage Test - Valve Installed

☞**NOTE:**

This Air leakage check can be done while valve is installed on the vehicle. In either case (testing on or off the vehicle) air system pressure must be applied to valve.

1. Submerge the exhaust line of the valve in a container of water.
2. If air bubbles escape with the handle in the center position (normal position), valve is faulty and must be replaced.
3. Apply soapy water to body, housing and around shaft.
4. If bubbles appear, valve is faulty and must be replaced.

7.2. Kneeling Valve

WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Accessories, Suspension, Leveling & Kneeling System Components" when performing maintenance on these components.

7.2.1. Description

The kneeling valve is a normally closed (N.C.) four solenoid operated valve, which is used to control the kneeling operation. The kneeling valve is located behind the front axle on the curbside of the vehicle and is accessed from the underside of the vehicle.

7.2.2. Operation

Setting the Kneel switch, located on the instrument panel, to the LOWER position energizes the KNEEL solenoid on the kneeling valve and provides a direct path between the (ABL), (ABR), and (EX) ports. This allows air to exhaust from the air springs and the vehicle to lower.

Setting the Kneel switch to the RAISE position energizes the raise solenoid on the kneeling valve and provides a direct path between the (P), (ABR), and (ABL) ports. This allows supply air a direct path to the air springs and allows a quick fill of the air springs to raise the vehicle toward normal ride height.

7.2.3. Maintenance

Maintenance on the kneeling valve is limited to replacement of the solenoids, gaskets, and O-rings. The O-rings and gaskets are available as a repair kit. Refer to your New Flyer Parts Manual for part ordering information.

7.2.4. Kneeling Valve Port Designations

The kneeling valve consists of a multi-port body with four solenoids located on the manifold. The port designations and function are as follows:

KNEELING VALVE PORT DESIGNATIONS	
PORT I.D.	**FUNCTION**
P	Supply pressure from accessory tank
PS	Alternate supply port, not used
ABL	Delivery pressure to left side air springs
ABR	Delivery pressure to right side air spring
LVL	Delivery port to leveling valve
LVR	Delivery Port to Leveling Valve
EX	Exhaust port to atmosphere

7.2.5. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Raise the vehicle to a suitable working height. Refer to the General Information Section of this manual for lifting procedure.
3. Open the forward steering gearbox access doors to gain access to the kneeling valve. Refer to Section 15 of this manual for information on the steering gearbox access doors.
4. Disconnect the airlines connected to the kneeling valve and tag them for later reconnection.
5. Disconnect the solenoid cable connector.
6. Remove the four bolts and washers securing the kneeling valve to the bracket. See “Fig. 8-29: Front Kneeling Valve Installation” on page 96.
7. Remove the kneeling valve.

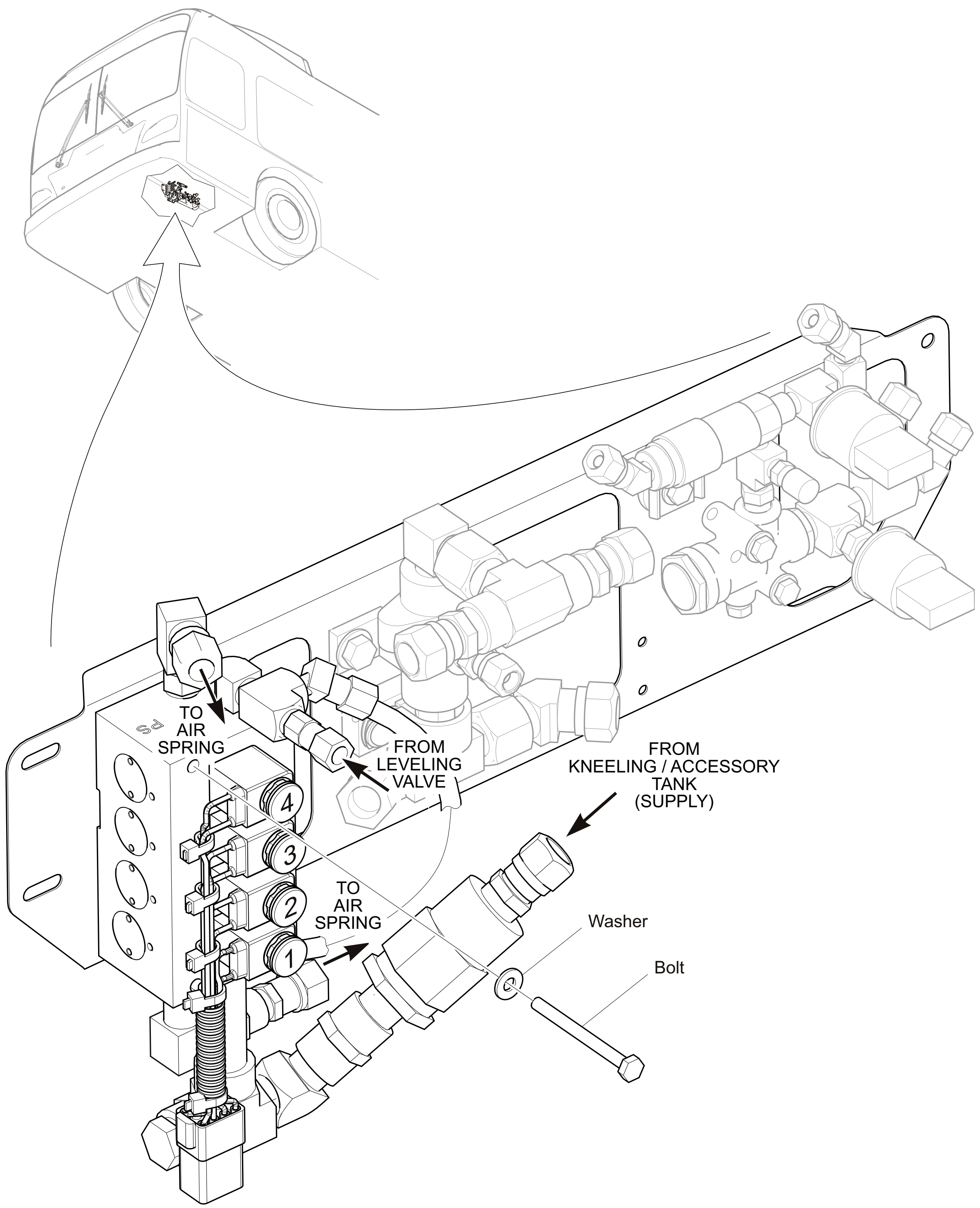
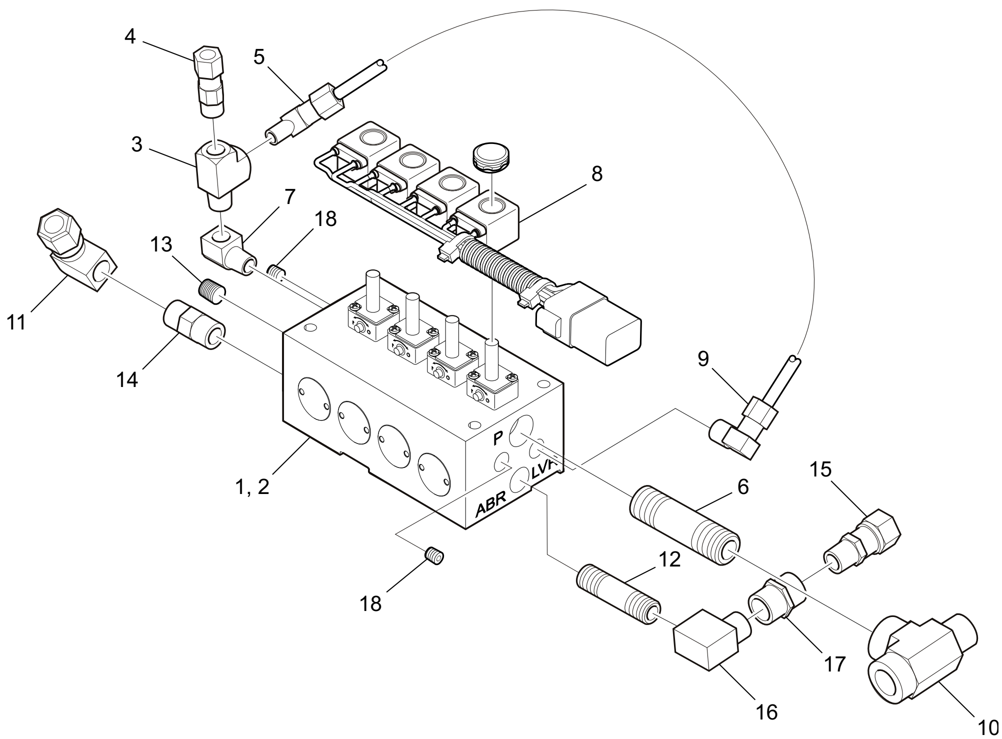


Fig. 8-29: Front Kneeling Valve Installation

7.2.6. Installation

1. Install kneeling valve and bracket assembly to vehicle using original fasteners.
2. Install all air lines to kneeling valve. See “Fig. 8-30: Kneeling Valve Assembly” on page 97.
3. Plug in the electrical connectors from the three solenoids to the vehicle harness.
4. Set the Battery Disconnect switch to the ON position.
5. Start the vehicle and charge the air system to operating pressure.
6. Check for air leaks at the kneeling valve connections.
7. Operate the Kneel switch through lowering and raising cycles to ensure the kneeling valve is functioning properly.



1. Kneeling Valve Assembly, Front (Incl. 2-18)
2. Valve Assembly, Solenoid 4-Station
3. Tee, Street 1/4" NPT
4. Connector, 3/8" O.D. x 1/4" MPT
5. Elbow, 45° 3/8" O.D. x 1/4" NPT
6. Nipple, 1/2" NPT x 3" Lg.
7. Elbow, Street 1/4" NPT
8. Coil Assembly, w/Diode 8 Pin Connector
9. Elbow, 90° 3/8" O.D. x 1/4" PT
10. Tee, Street 1/2" NPT
11. Elbow, 90° 1/2" O.D. x 3/8" NPTF
12. Nipple, 3/8" NPT x 2" Lg.
13. Plug, Countersunk Head 1/4" NPT
14. Nipple, Hex 3/8" NPT
15. Connector, 1/2" O.D. x 3/8" PT
16. Elbow, 90° Street x 3/8" PT
17. Coupling, 3/8" PT
18. Plug, 1/16" NPT w/ .040" Orifice

s035211b.svg

Fig. 8-30: Kneeling Valve Assembly

Electrical System

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❐ open flame
- ❐ excessive heat
- ❐ production of sparks
- ❐ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Electrical System Safety

During electrical diagnosis procedures an understanding of the vehicle's electric circuits is important to understand the results of connecting test equipment.

⚠DANGER

During component removal or installation, ensure that the Master Run switch is set to the STOP-ENGINE position and that the Battery Disconnect switch is set to the OFF position. Failure to follow this procedure may result in personal injury or component damage.

⚠WARNING

DO NOT start the vehicle remotely with the laptop software without first checking that the area is clear of personnel.

⚠CAUTION

Before welding anywhere on vehicle, set Battery Disconnect switch to the OFF position and disconnect all electronic control modules (Multiplexing, engine, transmission, ABS, and so forth). Refer to Section 11 of this manual for additional precautionary information.

1.4. Welding/Machining Safety

⚠CAUTION

Before welding anywhere on vehicle, set Battery Disconnect switch to the OFF position and disconnect all electronic control modules (Multiplexing, engine, transmission, ABS, and so forth). Refer to Section 11 of this manual for additional precautionary information.

2. MULTIPLEXING SYSTEM

2.1. Description

NOTE:

Refer to the Multiplexing System Layout when reviewing this information.

The Vehicle Multiplexing Module (VMM) system uses a series of remotely-mounted, Controller Area Network (CAN) connected modules to transmit information and operate components throughout the vehicle. The system consists of several VMM 1615 solid state modules located throughout the vehicle. See “Fig. 9-1: Rear Panel” on page 2. See “Fig. 9-2: Exit Door Module Installation” on page 3. See “Fig. 9-3: Side Console Module Installation” on page 3. The modules are interconnected by a shielded CAN communication cable which is part of the wiring harness.

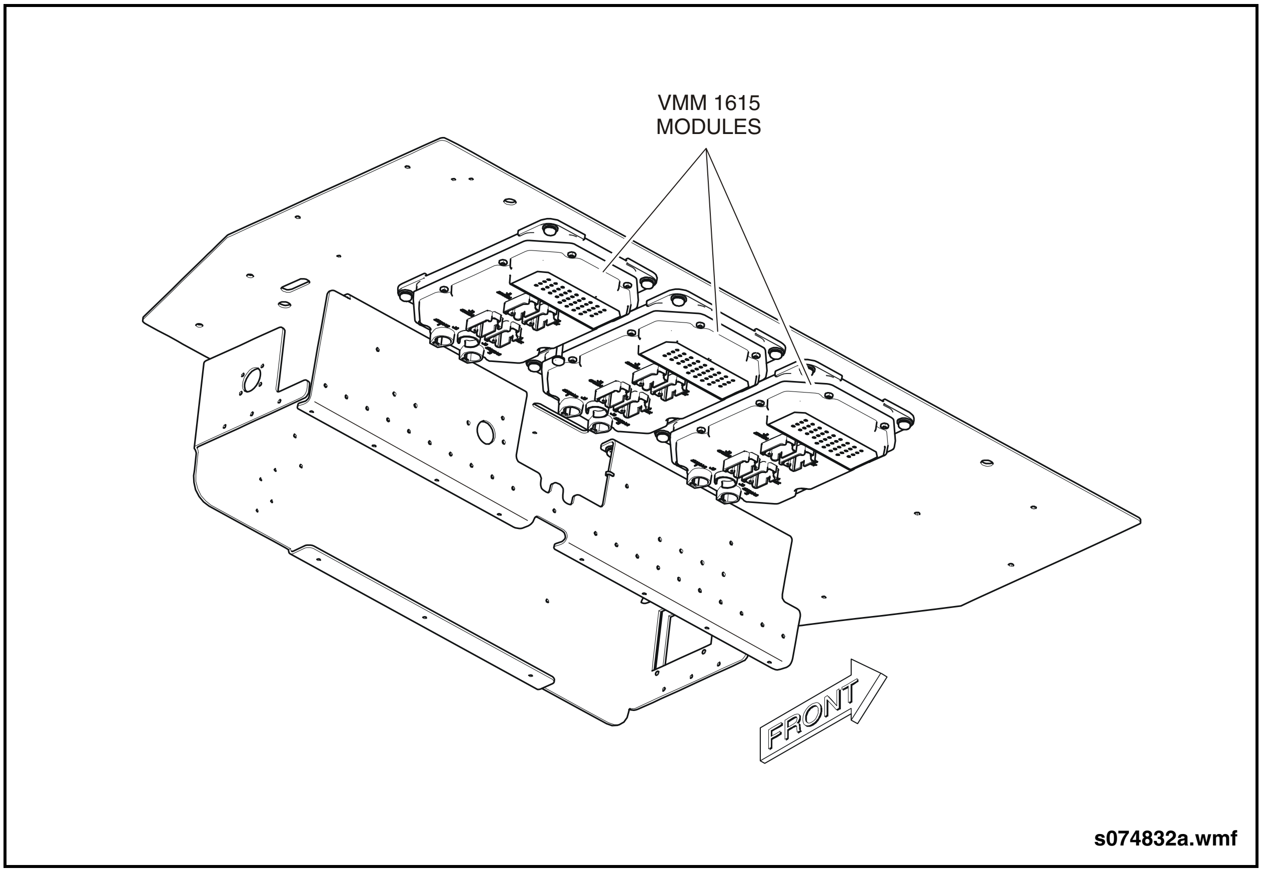


Fig. 9-1: Rear Panel

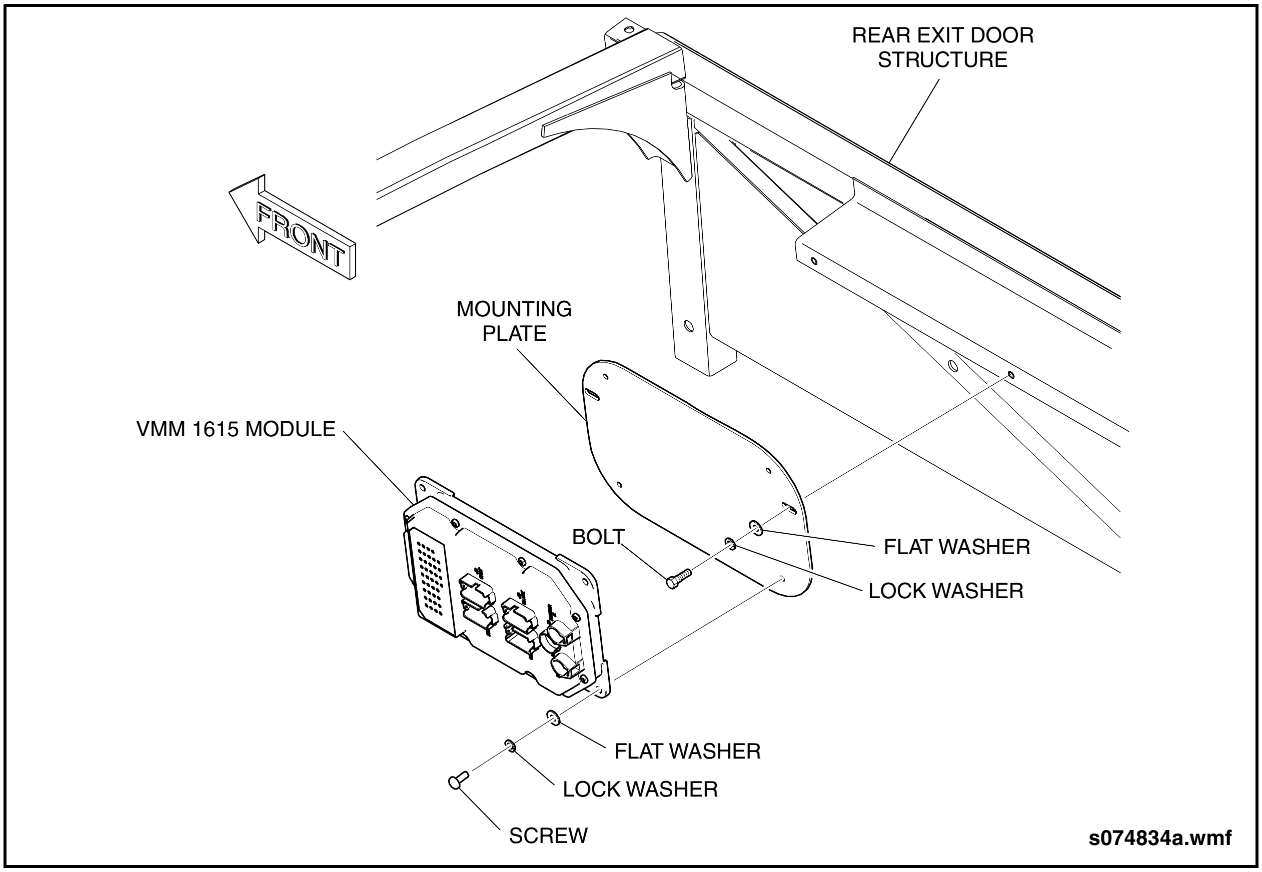


Fig. 9-2: Exit Door Module Installation

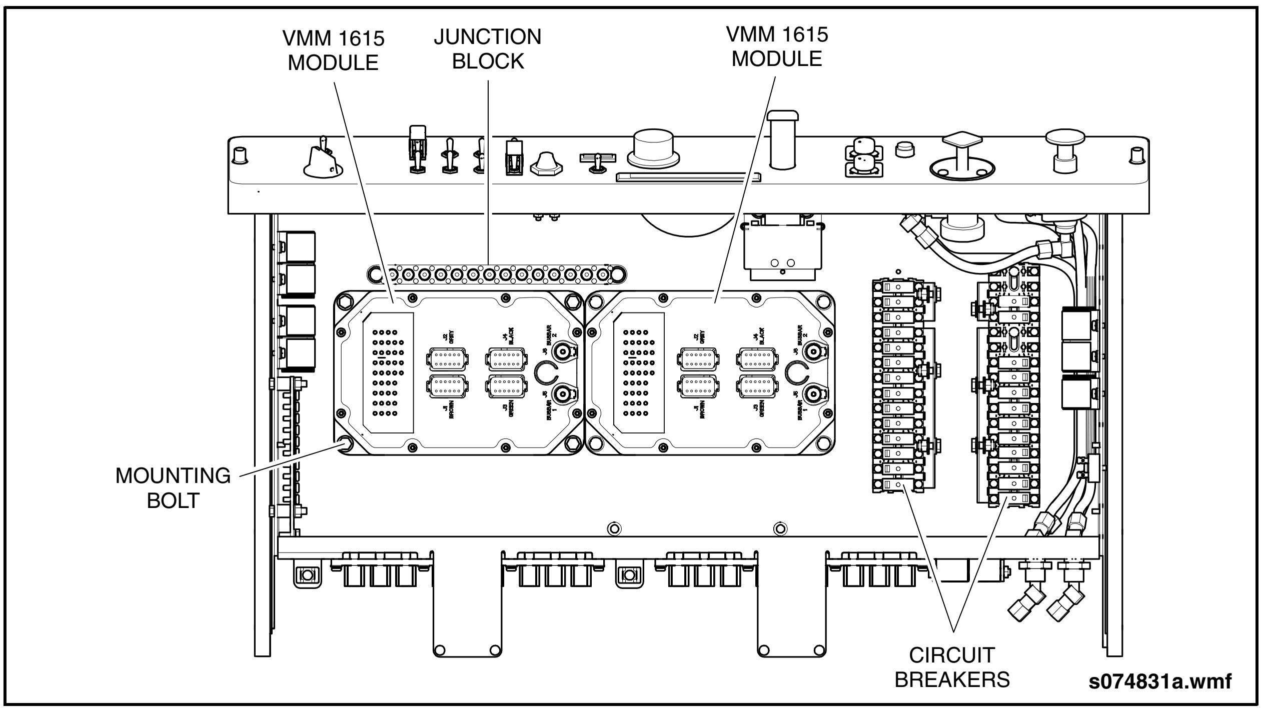


Fig. 9-3: Side Console Module Installation

2.2. VMM 1615

2.2.1. Description

The VMM1615 is a general purpose electronic controller. It has 16 inputs and 15 outputs as well as two CAN/J1939 communication ports.

The VMM1615 has seven digital inputs; five of the inputs are used for reading active high/low signals, one input is used for reading active high signals, and one input is used for active high power control. In addition, it has eight inputs capable of reading analog voltages, and one DC coupled frequency input.

The VMM1615 has 12 high-side outputs with a maximum Pulse Width Modulation (PWM) frequency of 500 Hz, four of which are capable of accurate current sensing. It also has one low-side output that is capable of current sensing with a maximum PWM frequency of 1500 Hz, and two solid state relay outputs. These outputs can drive a variety of load types. Built to meet and exceed SAE J1455 environmental standards with enhanced diagnostics and Windows-based ladder logic programming. The modules are plug and play configurable, and have status LEDs that indicate the condition of inputs, outputs, power, and network activity.

The VMM 1615 is equipped with four color-coded connectors and two high-current power connection points. Connectors J5 and J6 are the high-current power source for the output circuits on the module. Connector J1 (Brown) is an input, output and network connector. Connector J2 (Grey) is an input and output connector. Connector J3 (Green) is an input and output connector. And J4 (Black) contains inputs, outputs and addressing inputs for module configuration. Each module contains a set of diagnostic LEDs which can be used to monitor the inputs and outputs, input power and controller area network (CAN) activity. See “Fig. 9-4: VMM 1615 Module” on page 4.

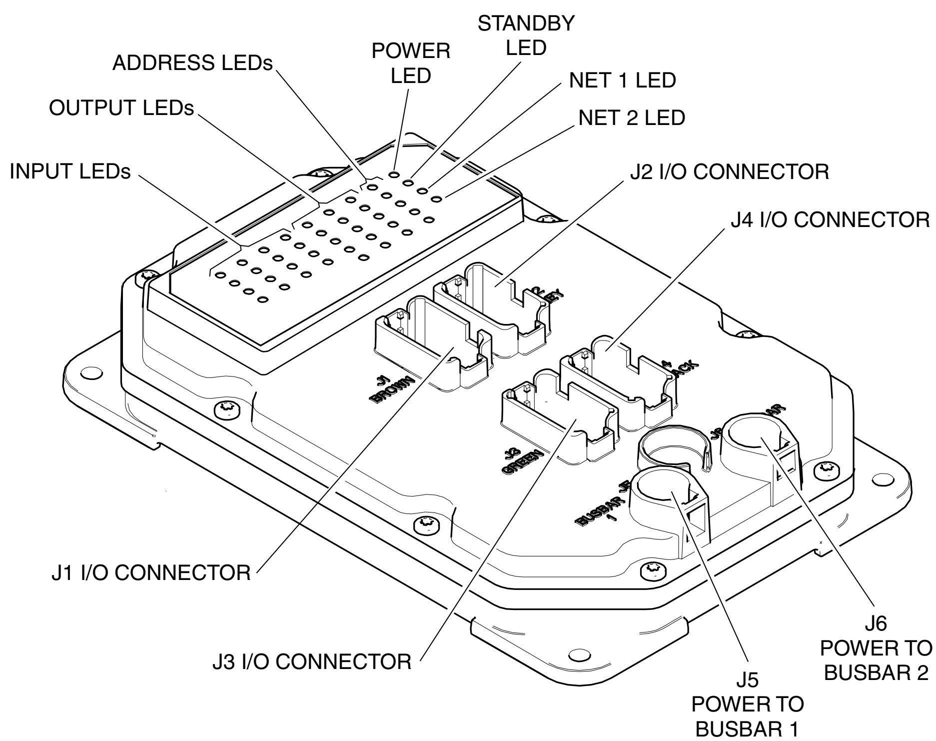


Fig. 9-4: VMM 1615 Module

2.2.2. Removal

1. Open access door or remove panels as required to access module.
2. Identify harness connector positions at module.
3. Carefully unplug harness connectors from center of module.
4. Carefully unplug power connectors from the end of the module.
5. Remove four screws and any other hardware retaining the module to the panel and remove the module.

2.2.3. Installation

1. Position module on panel, install retaining screws and tighten.
2. Install any auxiliary mounting hardware.
3. Plug harness connectors into module.
4. Plug power connectors in ensuring locking tabs snap into position.
5. Install removed panels and close access doors.

2.2.4. VMM 1615 Troubleshooting

The VMM 1615 module has 16 input LEDs, 15 output LEDs, a Standby LED, 2 Network Status LEDs and a power/health indicator LED. The PWR LED has three states, ON, OFF and FLASHING. When the PWR LED is on solid the unit is operating correctly. If the PWR LED is off the module is not receiving power or it is in the power save mode. If the PWR LED is flashing a fault has been detected on one of the outputs.

The NET LED flashes when there is network communication between two or more units in the system. If the NET LED is not flashing, there is a problem with the network cabling. To verify the network cable, measure the resistance between pins 8 and 9 and 10 and 11 on the Brown J1 harness connector. Ohmmeter should indicate approximately 60 ohms resistance. If the measured reading deviates from this value, check for the following:

- ❐ Missing terminating resistor in the network cable.
- ❐ Bad connections at the network cable Y splices.
- ❐ Broken wire in the network cable.

The input LEDs have an ON and OFF state. If an input LED is ON, the corresponding input for the LED is active. If the LED is OFF the input is inactive. Refer to "ES-I/O Assignment" in the Vehicle Systems Drawing Manual to determine the type and voltage level for each input prior to testing. If there is no change of potential when the input changes from inactive to active, the input device or wiring is defective. Digital inputs must have a ground potential to be activated. Inputs programmed as analog require 0.5 volts to activate the input. Inputs programmed as frequency require a 10 Hz or greater signal to activate.

The output LED's have three states, ON, OFF and FLASHING. If an output LED is ON, the corresponding output for the LED is active. If the LED is OFF the output is inactive. If the LED is flashing the corresponding output is faulted. Five types of faults will cause an output LED to flash:

- ❐ Short circuit to power.
- ❐ Short circuit to ground.
- ❐ Over current.
- ❐ Open load.

Refer to 18. “VENDOR SERVICE INFORMATION” on page 112 in this section for more diagnostic and troubleshooting information on the VMM 1615 module.

2.3. J1939 Controller Area Network (CAN) Cable

2.3.1. Description

The various ECU's and VMM modules used in the vehicle communicate information using a standard protocol called the SAE J1939 Recommended Practice for Serial Control and Communication Vehicle Network (SAE J1939 CAN). The driveline J1939 network consists of engine, transmission, and ABS ECU's and is separate from the VMM J1939 network, which consists of the VMM 1615 module. Refer to "ES-Network Topology" and "Multiplexing System Layout" for lead connections.

The J1939 network cables consist of twisted pair, shielded cables that connect the various ECU's or VMM modules located throughout the vehicle. Each end of the network cable is terminated with a 120 ohm resistor to reduce reflections of the electrical signals.

2.3.2. CAN Cable Troubleshooting

1. Troubleshoot the driveline J1939 network cable as follows:
   a. Attempt to read the engine, transmission, and ABS codes at each of the diagnostic connectors (engine compartment switchbox, and driver's area). The network cable is intact between the nine-pin diagnostic connector and the ECU if diagnostic codes can be read at each of the diagnostic connectors.
   b. Set the Battery Disconnect switch to the OFF position.
   c. Disconnect the network cable from all driveline ECU's. This is necessary as the ECU's can affect the resistive measurement.
   d. Refer to Electrical Schematic "ES-Engine EN" and check continuity of the entire network cable loop between the CAN "+" and CAN "-" wires using an Ohmmeter. Loop resistance should measure 60 Ohms.

   ☞**NOTE:**

   The diagnostic connectors located behind the driver's seat or on the engine compartment switch box are convenient places to take the reading.

   e. Check for an open or missing terminating resistor if the loop resistance measures 120 Ohms. Although each resistor is 120 Ohms, they are installed in parallel and the combined resistance value would be 60 Ohms.
   f. Check for an open circuit (break in the wiring) if the Ohmmeter reading indicates infinity or an "out of limits" value. Check for a poor electrical connection if a significant resistance value is measured.
   g. Remove the terminating resistors from either end of the network cable.
   h. Check the CAN "+" wire for continuity by connecting one lead of the Ohmmeter to the CAN "+" terminal at one end of the network cable. Run a jumper wire from the CAN "+" terminal at the opposite end of the cable and connect the other end of the jumper wire to the remaining lead on the Ohmmeter. No significant resistance should be measured.
   i. If significant resistance or an open condition is measured, move the jumper lead down the network cable to each connector and retest at the connector until the fault is isolated.
   j. Repeat the previous steps for the CAN "-" wire.

2. Troubleshoot the VMM J1939 network cable as follows:

   a. Set the Battery Disconnect switch to the OFF position.

   b. Disconnect network cable connections from all VMMs, and SCU, as resistance values could be affected during cable continuity tests.

   c. Refer to Electrical Schematic "ES-Primary Networks PN" and check continuity of the entire network cable loop between the CAN "+" and CAN "-" wires using an Ohmmeter. Loop resistance should measure 60 Ohms.

   ☞**NOTE:**

   The CAN "+" and CAN "-" wires can be easily accessed from any module location where the network cable has been disconnected.

   d. Check for an open or missing terminating resistor if the loop resistance measures 120 Ohms. Although each resistor is 120 Ohms, they are installed in parallel and the combined resistance value would be 60 Ohms.

   e. Check for an open circuit (break in the wiring) if the Ohmmeter reading indicates infinity or an "out of limits" value. Check for a poor electrical connection if a significant resistance value is measured.

   f. Remove the terminating resistors from either end of the network cable.

   g. Check the CAN "+" wire for continuity by connecting one lead of the Ohmmeter to the CAN "+" terminal at one end of the network cable. Run a jumper wire from the CAN "+" terminal at the opposite end of the cable and connect the other end of the jumper wire to the remaining lead on the Ohmmeter. No significant resistance should be measured.

   h. If significant resistance or an open condition is measured, move the jumper lead down the network cable to each connector and retest at the connector until the fault is isolated.

   i. Repeat the previous steps for the CAN "-" wire.

3. ELECTRICAL SYSTEM

3.1. Description

The electrical system is a 12/24 VDC split system, negatively grounded. All components are rated at 12 or 24 Volts DC depending on the system in which they are employed. Care should be taken to ensure all replacement parts are clearly identified on their nameplates as being 12 or 24 Volts rated.

Severe damage to the alternator, regulator, battery cables, starter and so forth may result if the battery is not connected “Negative” to ground. Turn off battery disconnect switch before replacing or servicing a battery.

Ensure cables are securely tightened to battery posts and charging system components. All ground connection points should be checked periodically to ensure proper grounding is maintained.

Circuit breakers and wire gauges are sized based on the individual circuit current requirements. Replacements should be of the same rating and size.

Never replace a wire with one of a smaller size. All wires are color coded with wire markers on both ends to identify circuit function. Harness routing and tie wrapping should be periodically inspected to ensure the system is maintained.

CAUTION

DO NOT turn off the main disconnect switch, or disconnect the battery, or use a defective battery while the engine is running. When this occurs a substantial “load dump” could result that would damage electrical components. “Load dumps” in the electrical system are normally absorbed by the battery.

3.2. Electronic Control Modules

3.2.1. Description

This vehicle is equipped with engine, transmission, and ABS multiplexing equipment. These control modules have preprogrammed diagnostic and control capabilities. Refer to Section 4 and 5 of this manual for engine and transmission control module function and support information. Refer to Section 1 and 2 of this manual for information on the ABS control module.

The +24 VDC electrical bus bar (refer to Electrical Schematics) provides the power source for the engine Electronic Control Module (ECM), and the ABS Electronic Control Unit (ECU).

These control modules also provide direct input to instrument panel warning indicators such as Check Engine, Stop Engine, and ABS Fail.

CAUTION

New Flyer Industries will assume no responsibility for alterations or substitutions to the electrical system without prior authorization from our engineering department.

4. CHARGING SYSTEM

4.1. Description

The charging system is made up of the alternator and voltage regulator. The function of the charging system is to provide 24V to the electrical/multiplexing system and to recharge the battery system.

☞NOTE:

Refer to 7. “BATTERY SYSTEM” on page 65 *in this section for more information on this component.*

4.2. Charging System Troubleshooting

⚠CAUTION

Electrical system is negatively grounded. Connecting the batteries or battery charger with the positive terminal grounded will burn out the alternator diodes and vehicle wiring because of high current flow. NEVER operate the alternator with an open circuit (field terminals connected and output terminal disconnected).

With no battery or electrical load in the circuit (open circuit) the alternator voltage will build up to an excessive value, damaging the diodes, internal wiring and possibly causing a fire in the vehicle. Make sure all connections in the charging circuit are secure.

The alternator output terminal is energized whenever the batteries are connected. If work is to be done near the alternator, set the Battery Disconnect switch to OFF.

DO NOT operate the alternator with the field circuit grounded. Grounding the field circuit will overload the system and damage components.

Charging System troubleshooting procedures in this section should be followed in the sequence presented:

- ❒ Preliminary Diagnosis - an “on-vehicle” test to identify charging system problems and their symptoms.
- ❒ System Conditions - describes symptoms identified during “Preliminary Diagnosis” and lists possible causes and recommended corrective action.
- ❒ Bench Tests - dynamic bench testing is typically performed if “on-vehicle” test results are not available or to confirm results of “Preliminary Diagnosis”. Bench testing includes “No Load”, “Full Load”, and “Regulator Bypass” tests. Refer to 4.3. “Alternator” on page 14 in this section for Bench Testing procedures.
- ❒ Static Tests - these tests will confirm results of “on-vehicle” and bench tests. Partial disassembly of alternator is required. Refer to 4.3. “Alternator” on page 14 in this section for Bench Testing procedures.

4.2.1. Preliminary Diagnosis

Tools & Equipment

- ❒ Digital Multimeter (DMM)
- ❒ Digital Inductive Ammeter

The No Gen indicator light on the instrument panel indicates abnormal operation of the charging system. If the light illuminates during operation, trouble with the charging system is indicated. Refer to “ES-Power & Starting” electrical schematic. Perform the following preliminary checks to identify symptoms before conducting any indepth troubleshooting. See “Fig. 9-5: Alternator Wiring Schematic” on page 10.

1. Verify system connections and condition of wiring. Check that connections are clean and tight at the battery terminals, battery disconnect switch, “B” terminal of magnetic starter switch, “B+” and “B-” terminals on alternator, wiring connector plug between alternator and regulator, “D+” and “IGN” terminals on regulator.
2. Determine battery voltages and state of charge. If batteries are discharged, recharge or replace batteries as necessary. Refer to 7. “BATTERY SYSTEM” on page 65 in this section for information on checking state of charge and charging procedures.

NOTE:

The charging system cannot be properly tested unless batteries are charged to at least 95% of full charge. Battery state of charge must not vary more than 0.2 volts between batteries.

3. Connect voltmeter and ammeter to alternator. Connect red lead of DMM to alternator “B+” terminal and black lead of DMM to alternator “B-” terminal. Clamp inductive ammeter on “B+” cable.
4. Start vehicle and set engine speed to fast idle. Observe charging voltage readings.

CAUTION

Shut down the engine immediately if charge voltage is 33 volts or greater. Electrical system damage may occur if charging system is allowed to operate at high voltage.

5. If charging voltage is at or below voltage regulator setpoint, allow charging system to operate for several minutes to normalize operating temperature. Refer to 4.5. “Voltage Regulator” on page 39 in this section to determine setpoint value.
6. Observe voltage and amperage readings over a ten minute period. Charge voltage should increase and charge amps should decrease over this time period.

NOTE:

It is normal for batteries to accept an increasing charging rate over a ten minute period, following a cold start. Immediately after the engine starts, charging voltage will typically be lower than the regulator setpoint with medium amps. The charging voltage will increase and amps will decrease after 3 to 5 minutes of charging. After 5 to 10 minutes of charging, the system voltage should be at, or very close to, the regulator setpoint and the amps should be reduced to a minimum.

7. Batteries are considered fully charged if charge voltage is at regulator setpoint and charge amps remain at their lowest value for 10 minutes. Refer to 4.2.2. “System Conditions” on page 11 in this section for procedure if charging system is not performing properly.

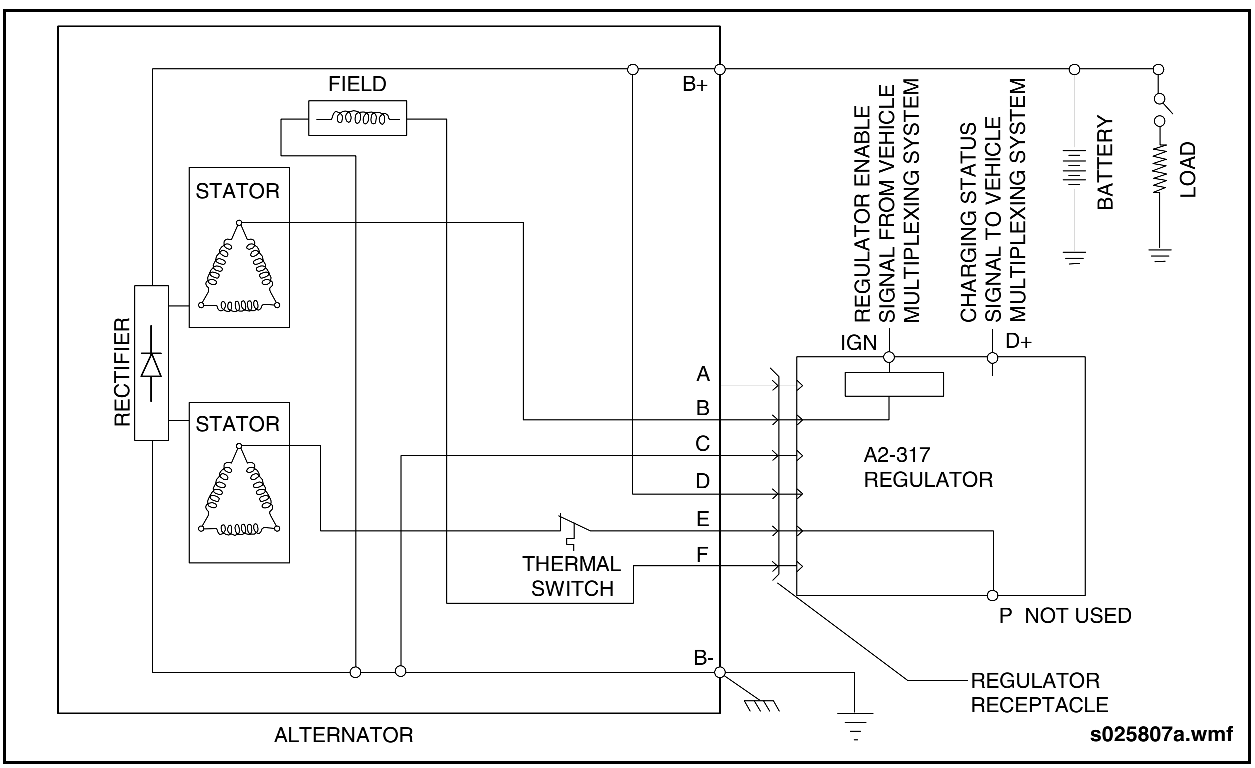


Fig. 9-5: Alternator Wiring Schematic

4.2.2. System Conditions

SYSTEM CONDITIONS		
SYMPTOM	**CAUSE**	**ACTION**
Low voltage output	Loose alternator drive belt	Check belt condition and adjust tension. Refer to Engine OEM Service Manual.
	Low battery state of charge	Charge or replace batteries as necessary.
	Vehicle current demand exceeds alternator capacity	Reduce electrical load on system.
	Defective wiring or poor ground	Check and repair as required.
	Low regulator setpoint	Adjust alternator setpoint to correct value. Refer to 4.5. “Voltage Regulator” on page 39 in this section for procedure.
	Defective alternator or regulator	Replace component
High voltage output	Incorrect regulator application	Refer to your New Flyer Parts Manual for correct part number.
	High regulator setpoint	Adjust regulator setpoint to correct value. Refer to 4.5. “Voltage Regulator” on page 39 in this section for procedure.
	Defective alternator or regulator	Replace component
No voltage output	Loose or broken alternator drive belt	Check belt condition, replace if necessary, and adjust tension. Refer to Engine OEM Service Manual for belt tensioning procedure.
	No battery voltage at alternator “B+” terminal with Battery Disconnect switch ON	Check for battery voltage at all connections between alternator and batteries. Repair connections or defective wiring.
	Poor ground circuit	Set Battery Disconnect switch to OFF and use a DMM check resistance between alternator “B-” terminal and battery ground. Repair wiring or connections if any resistance is evident in the ground circuit.
	Over Voltage Cut Out (OVCO) tripped	Reset OVCO. Refer to 4.5. “Voltage Regulator” on page 39 in this section for procedure.
	Defective alternator or regulator	Replace component

SYSTEM CONDITIONS		
SYMPTOM	**CAUSE**	**ACTION**
No Gen indicator illuminated	Defective alternator or regulator	See “Fig. 9-6: Chart - 1 No Gen Indicator Illuminated” on page 12.
Regulator amber LED flashing	Low system voltage - electrical load exceeds alternator rating at present rotor speed	Decrease vehicle electrical load or increase engine speed. LED should flash green. If not, check drive belt and charging system connections.
Regulator amber LED illuminates steady	Alternator fault - shorted rectifier	Replace alternator.
Regulator red LED flashing	High system voltage - may occur during normal load switching	OVCO will trip and disable charging system if flashing for more than 3 seconds. LED will then illuminate steady.
Regulator red LED illuminates steady	OVCO tripped	Overvoltage condition. Refer to 4.5. “Voltage Regulator” on page 39 in this section and attempt OVCO reset. Perform additional diagnosis. See “Fig. 9-8: Chart - 2 Over Voltage Cut Out Circuit” on page 14.

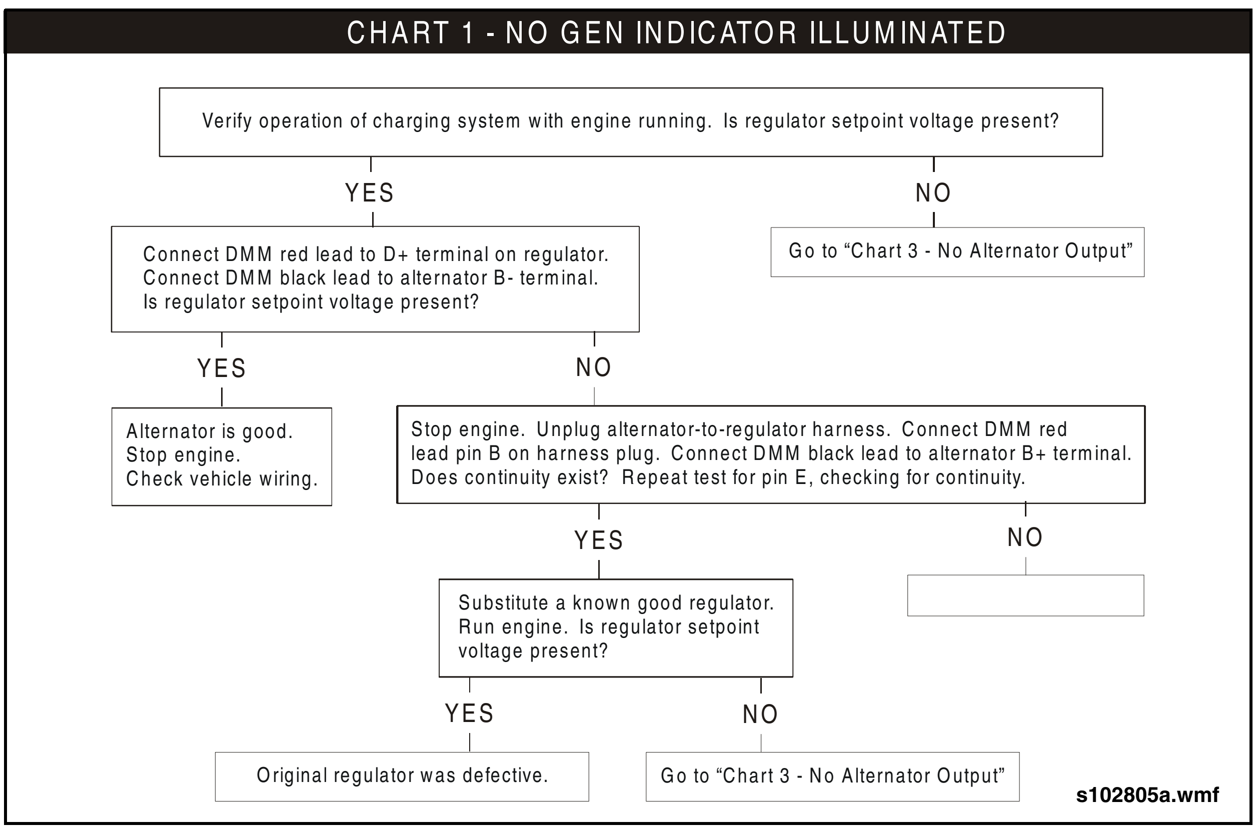


Fig. 9-6: Chart - 1 No Gen Indicator Illuminated

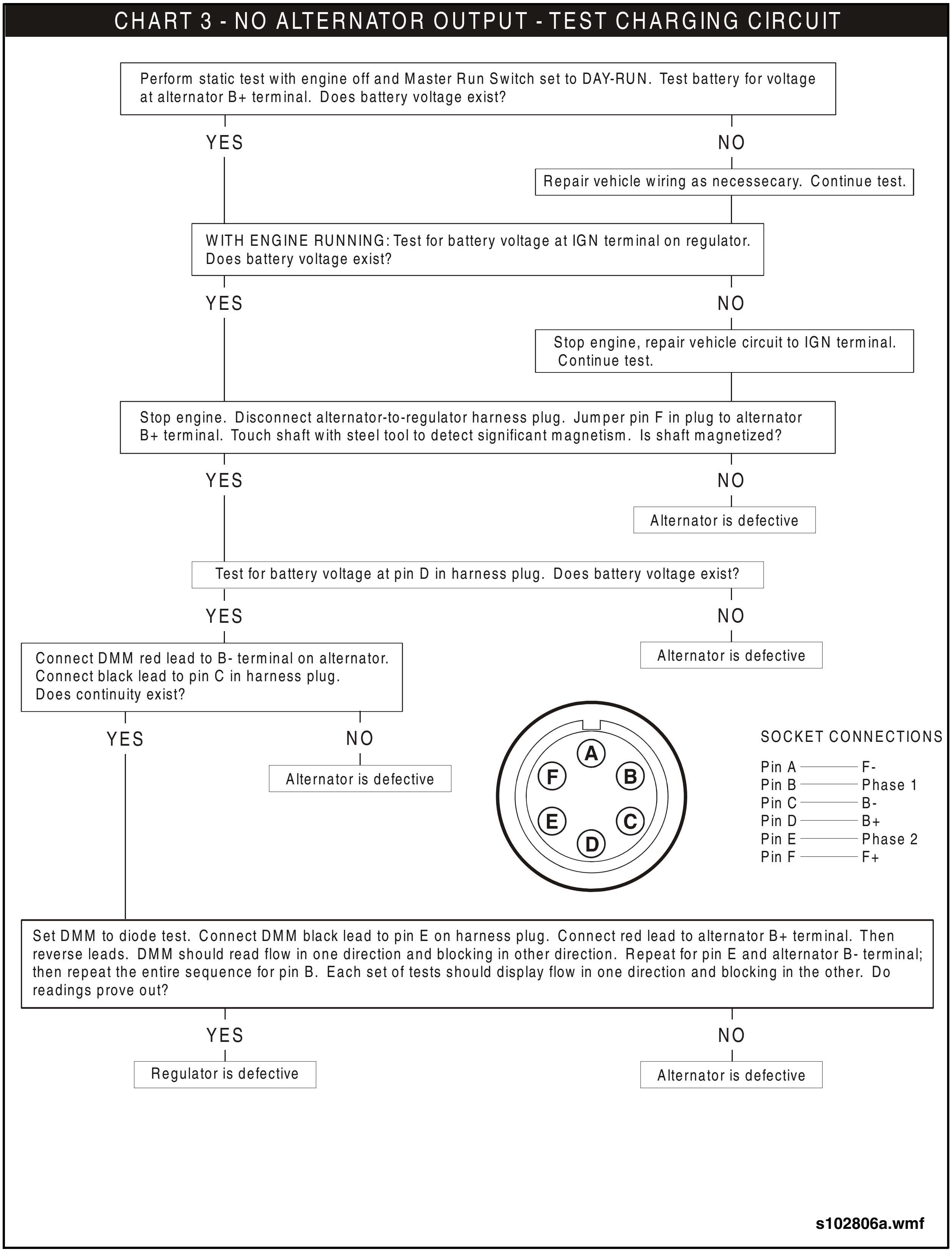


Fig. 9-7: Chart - 3 No Alternator Output

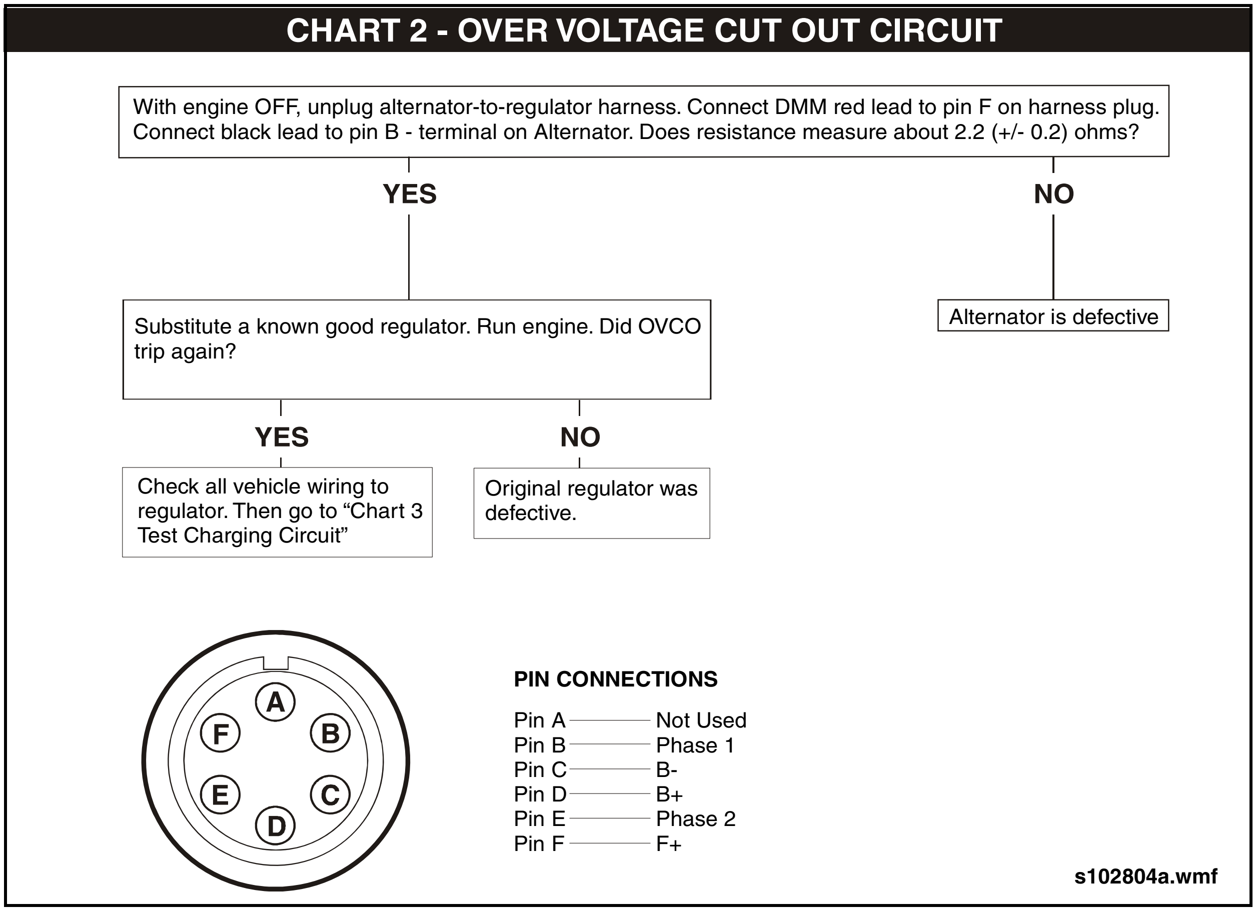


Fig. 9-8: Chart - 2 Over Voltage Cut Out Circuit

4.3. Alternator

4.3.1. Description

The alternator is bracket-mounted on the front of the engine and is belt-driven through the accessory drive pulley. The unit is a brushless, six phase, externally energized, self-rectifying design using dual stators and rotors. The unit is air cooled by an integral front mounted fan. An electronic voltage regulator is mounted on top of the alternator drive housing.

4.3.2. Alternator Specifications

Manufacturer .... C.E. Niehoff

Model... C803D

Rated Voltage................................. 28 VDC

Rated Output.............................. 500 Amps

Maximum Recommended Speed
....8000 RPM

Weight .... 125 lbs. (56.7 kg)

4.3.3. Operation

The alternator provides electrical energy to operate the vehicle electrical system and to recharge the batteries. Refer to 7. “BATTERY SYSTEM” on page 65 in this section for information on this component. The shell assembly contains the dual stator windings and the stationary field coil assembly. A shaft and core assembly is fitted with rotors at each end and rotates within the shell assembly.

The stationary field coil is energized through the regulator and controls the magnetic strength of the rotor. As the shaft and core assembly rotates, the rotors induce current into the stator windings. The A/C current is internally rectified through a set of diodes and output through the “B+” terminal of the alternator.

4.3.4. Bench Tests

Tools & Equipment

- ❒ Digital Multimeter (DMM)
- ❒ Digital Inductive Ammeter
- ❒ Test bench with 30 to 40 horsepower motor able to drive alternator to 8000 RPM. Install alternator on test bench in accordance with test bench manufacturer's instructions. Ensure test batteries are at 95% or higher state of charge. Run alternator at 5000 RPM.

4.3.4.1. No Load Test

Test Conditions: Run alternator at 5000 RPM with no load.

NO LOAD TEST		
AMPS	**VOLTS**	**DIAGNOSIS**
High	Low	Test bench battery is discharged or defective. Recharge or replace batteries.
High	Normal	Allow time to stabilize while monitoring volts. If volts rise above normal range, regulator and/or field coil must be replaced. If amps fall, charging system is OK.
High	High	STOP TEST. Regulator and/or field coil should be replaced. Refer to 4.3.5. “Static Tests” on page 17 in this section for procedure.
Low	Low	Alternator and/or regulator must be repaired or replaced. Proceed to “Regulator Bypass Test”.
Low	Normal	Regulator is OK. Proceed to "Full Load Test".
Low	High	STOP TEST. Alternator is defective, bench equipment is not working properly, or alternator is wired incorrectly to bench.

4.3.4.2. Full Load Test

Test Conditions: Run alternator at 5000 RPM and set load to 500 ± 50 amps.

FULL LOAD TEST		
AMPS	**VOLTS**	**DIAGNOSIS**
High	Low	Test bench battery is discharged or defective. Recharge or replace batteries.
High	Normal	Charging system is OK.
High	High	STOP TEST. Regulator and/or field coil should be replaced. Refer to 4.3.5. “Static Tests” on page 17 in this section for procedure.
Low	Low	Alternator and/or regulator must be repaired or replaced. Refer to 4.3.4.3. “Regulator Bypass Test” on page 16 in this section for procedure.
Low	High	STOP TEST. Alternator is defective, bench equipment is not working properly, or alternator is wired incorrectly to bench.

4.3.4.3. Regulator Bypass Test

⚠ CAUTION

Perform this test only when directed by other tests in this section. Perform this test only as long as necessary to obtain the required readings. DO NOT ground the field coil for more than a few seconds.

Use test tool CEN A10-129 (available from C.E. Niehoff) or similar hookup to bypass regulator. Run alternator under the same conditions as the “Full Load Test”. Note whether the amps rise to within ± 10% of rated output when connecting “F-” to ground. Note whether amps fall when disconnecting “F-” from ground.

REGULATOR BYPASS TEST		
CONNECT FIELD TO GROUND	**DISCONNECT FIELD FROM GROUND**	**DIAGNOSIS**
Amps rise	Amps fall	Alternator is OK. Replace regulator only if low amps/low volts are indicated by “No Load” or “Full Load” tests.
No change	No change	Alternator must be repaired. Refer to 4.3.5. “Static Tests” on page 17 in this section for procedure.

4.3.5. Static Tests

CAUTION

Alternator must not be powered during static tests. Connections required during testing can cause shorts and damage alternator.

NOTE:

The purpose of the static tests are to confirm results of previous on-vehicle and bench testing. The following tests are to be performed with the alternator removed from the vehicle. Total disassembly of the alternator should not be required for all tests.

Tools & Equipment

- ❒ Digital Multimeter (DMM)
- ❒ Digital Inductive Ammeter
- ❒ Regulator Tester

4.3.5.1. Regulator Test

A specialized regulator tester is required to test all regulator functions. Follow the regulator tester manufacturer's instructions to perform tests. If a regulator tester is not available, the regulator can be tested only for a shorted field-switching transistor as follows:

1. Set DMM to Ohms in autorange scale.
2. Unplug alternator-to-regulator harness from regulator and connect meter leads to sockets "F" and "D" in the regulator receptacle. See "Fig. 9-9: Alternator Harness & Regulator Connections" on page 17. Observe reading. Reverse leads and again observe meter reading. If DMM reads zero in either direction, field-switching transistor is shorted. Replace regulator.

NOTE:

If regulator failure is indicated, check alternator field coil as possible cause.

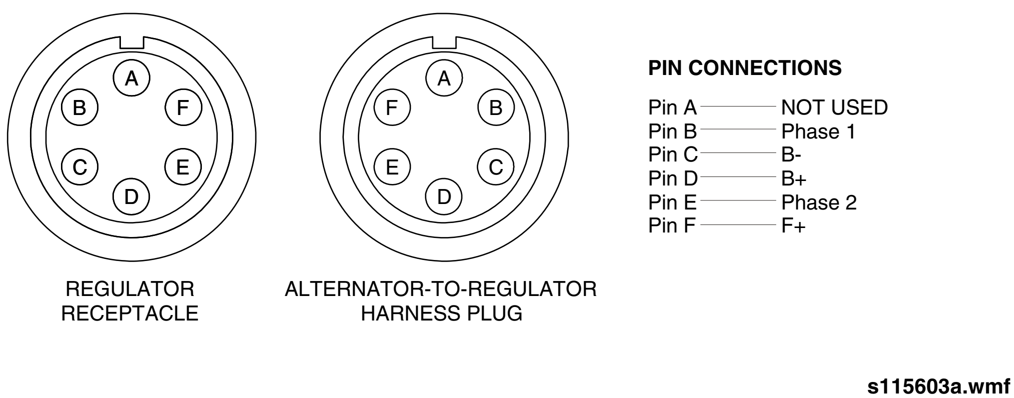


Fig. 9-9: Alternator Harness & Regulator Connections

4.3.5.2. Alternator Field Coil Test

Test for open or shorted field coil as follows:

1. Set DMM to lowest range on the Ohms scale.
2. Connect meter leads across pins “C” and “F” in the regulator harness plug. DMM should read 2.2 ± 0.2 ohms.

If field coil shorts to ground and causes a continuous OVCO trip, regulator will shut off alternator. In that event, unit will have to be partially disassembled to test for continuity of field coil at field coil leads inside ADE rectifier/housing assembly.

4.3.5.3. Internal Circuit Tests

Internal circuit tests consist of “Pin-to-Pin Test”, “Diode Test”, and “PC Board Test”. Test the alternator-to-regulator wiring harness and internal wiring of the alternator by probing the pins in the harness plug. Do not disassemble the alternator beyond what the test requires. Replace any component that fails the test.

Pin-to-Pin Test

Check for visible signs of damaged components, including carbon tracks on PC boards.

PIN-TO-PIN TEST

Meter Setting	Meter (+) Lead Connection	Meter (-) Lead Connection	Circuit Tested	Expected Reading
Ohms	Pin “C”	Alt “B-” terminal	Regulator ground	0 Ohms
Ohms*	Pin “F”	Alt “B-” terminal	Field coil resistance	2.2 ± 0.2 ohms
Diode Test	Pin “B”	Alt “B+” terminal	Phase winding & diode	<0.7 volts (flow)
Diode Test	Alt “B+” terminal	Pin “B”	Phase winding & diode	OL (blocking)
Diode Test	Pin “B”	Alt “B-” terminal	Phase winding & diode	OL (blocking)
Diode Test	Alt “B-” terminal	Pin “B”	Phase winding & diode	<0.7 volts (flow)
Ohms	Pin “D”	Alt “B+” terminal	Regulator power	0 Ohms
Diode Test	Alt “B+” terminal	Alt “B-” terminal	All diodes in parallel	OL (blocking)
Diode Test	Alt “B-” terminal	Alt “B+” terminal	All diodes in parallel	<0.8 volts (flow)
Diode Test	Alt “B-” terminal	Pin “E”	Phase winding & diode	<0.7 volts (flow)**
Diode Test	Pin “E”	Alt “B-” terminal	Phase winding & diode	<0.7 volts (flow)**
Diode Test	Alt “B+” terminal	Pin “E”	Phase winding & diode	OL (blocking)
Diode Test	Pin “E”	Alt “B+”	Phase winding & diode	<0.7 volts**

* Field coil must be connected to test circuit.
** Test terminal switch continuity inside rectifier housing if expected reading not obtained.

Diode Test

Remove phase leads and PC boards from modules. Repeat tests for each module.

See "Fig. 9-10: Alternator Diode Module Terminal Designations" on page 19.

DIODE TEST			
Meter Scale	**Meter (+) Lead Connection**	**Meter (+) Lead Connection**	**Expected Reading**
Diode Test	Terminal 1	Terminal 2	<0.7 volts (flow)
Diode Test	Terminal 1	Terminal 3	OL (blocking)
Diode Test	Terminal 2	Terminal 1	OL (blocking)
Diode Test	Terminal 3	Terminal 1	<0.7 volts (flow)

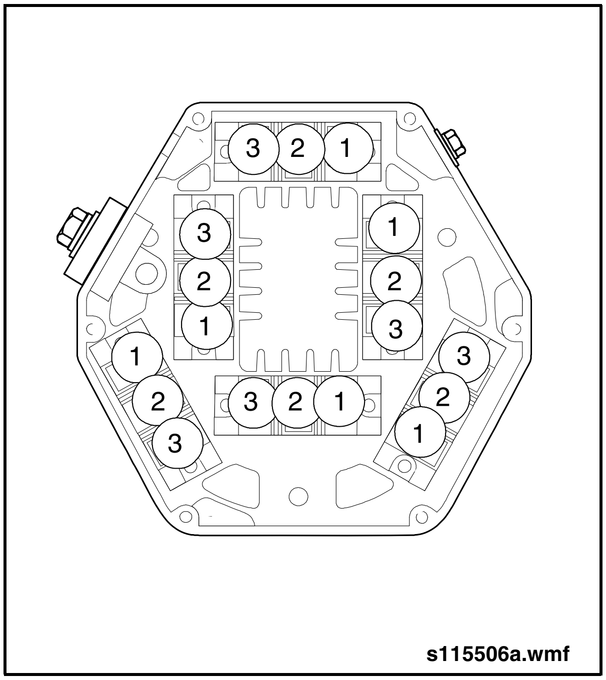


Fig. 9-10: Alternator Diode Module Terminal Designations

PC Board Test

Remove PC Boards from modules and arrange in order. See “Fig. 9-11: Alternator PC Board Test” on page 20. Repeat tests for each board. Replace boards that do not charge during tests. PC boards are not repairable.

PC BOARD TEST			
Meter Scale	**Meter (+) Lead Connection**	**Meter (+) Lead Connection**	**Expected Reading**
Ohms	Terminal 1	Terminal 2	See Reading #1
Ohms	Terminal 2	Terminal 1	See Reading #2
Ohms	Terminal 1	Terminal 3	See Reading #1
Ohms	Terminal 3	Terminal 1	See Reading #2

- ❒ Reading #1 - Meter will show increase in resistance as meter charges capacitors on PC board. Meter will show OL (infinity) when capacitors are fully charged.
- ❒ Reading #2 - Meter will show negative value and a decrease in resistance as meter discharges capacitor. Meter will show OL (infinity) when capacitors are fully discharged, then meter will show positive value and resistance will increase as meter recharges capacitor. Meter will show OL (infinity) when capacitors are fully charged.

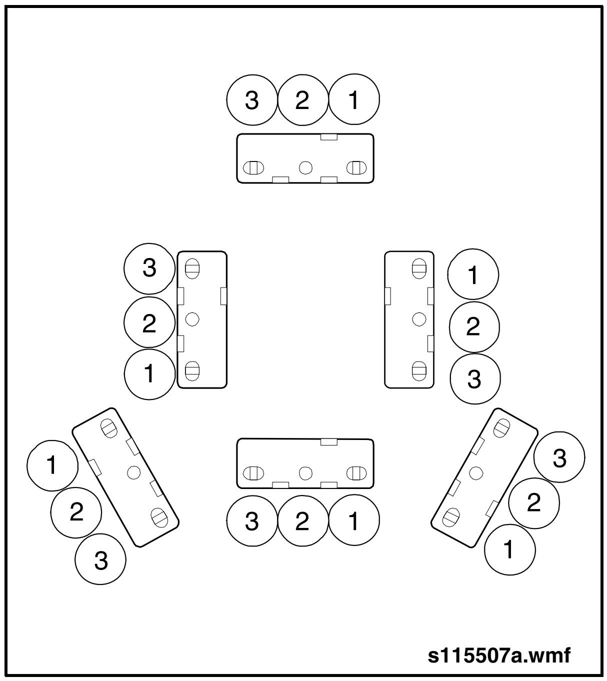


Fig. 9-11: Alternator PC Board Test

4.3.6. Stator Tests

NOTE:

Stator tests will show the condition of the phase lead from ring terminal at diode end of lead to soldered connection at phase winding. Phase windings should be tested on a bench stator tester, following tester instructions. The stator windings in this alternator are delta-wound and as such need a specialized stator tester to perform individual testing of each phase coil winding. Follow manufacturer's test instructions.

Before performing stator tests:

1. Set DMM to ohms scale and make sure meter is zeroed.
2. Check stator for burnt insulation or loose coil.
3. Disconnect phase leads. See "Fig. 9-12: Phase Lead Connections" on page 21.

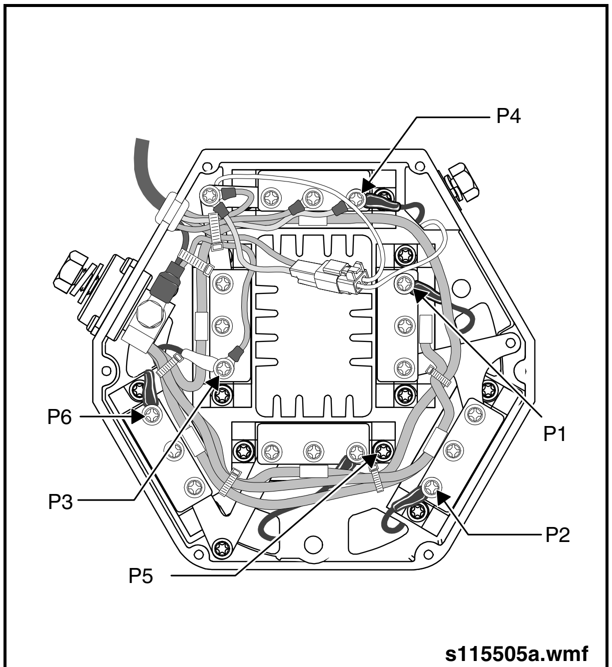


Fig. 9-12: Phase Lead Connections

Stator-to-Stator Continuity

1. Connect one meter lead to phase lead P1, connect other meter lead to each phase lead P4, P5, and P6. Repeat for P2 and P3 phase lead.
2. Meter should read OL (infinity) each time. If meter reads a value, replace stator.

Grounded Stator

1. Connect one meter lead to "B-" terminal on alternator, connect other meter lead to each phase lead P1, P2, and P3.
2. Connect one meter lead to "B-" terminal on alternator, connect other meter lead to each phase lead P4, P5, and P6.
3. If resistance reads other than OL (infinity) at any connection, stator is grounded to shell. Replace stator.

4.3.7. Removal

CAUTION

When replacing the drive belt, do not cut the belt to remove it as the spring loaded pulley will snap back violently. This may damage or shear the pulley stop and render it unserviceable. If a hand is placed between the tensioner pulley and top idler pulley when this occurs, severe hand or finger injury will result.

1. Set the battery disconnect switch to the OFF position.
2. Release belt tension and remove belt. Use a 3/4" drive breaker bar to rotate the tensioner pulley upwards and relieve belt tension. See "Fig. 9-13: Alternator Installation" on page 22.
3. Disconnect cables from the alternator and wires from the regulator.
4. Loosen clamp and remove air hose from rear of alternator.
5. Loosen and remove (4) alternator mounting bolts under the support bracket.
6. Support weight of alternator and remove alternator.

1. Alternator Assembly
2. Pulley Assembly, 8 Groove
3. Screw
4. Washer, Lock
5. Bolt, Hex 1/2” x 1 1/2” Lg.
6. Washer, Flat Hardened 1/2”
7. Belt, V-Ribbed
8. Belt Tensioner
9. Washer, Flat

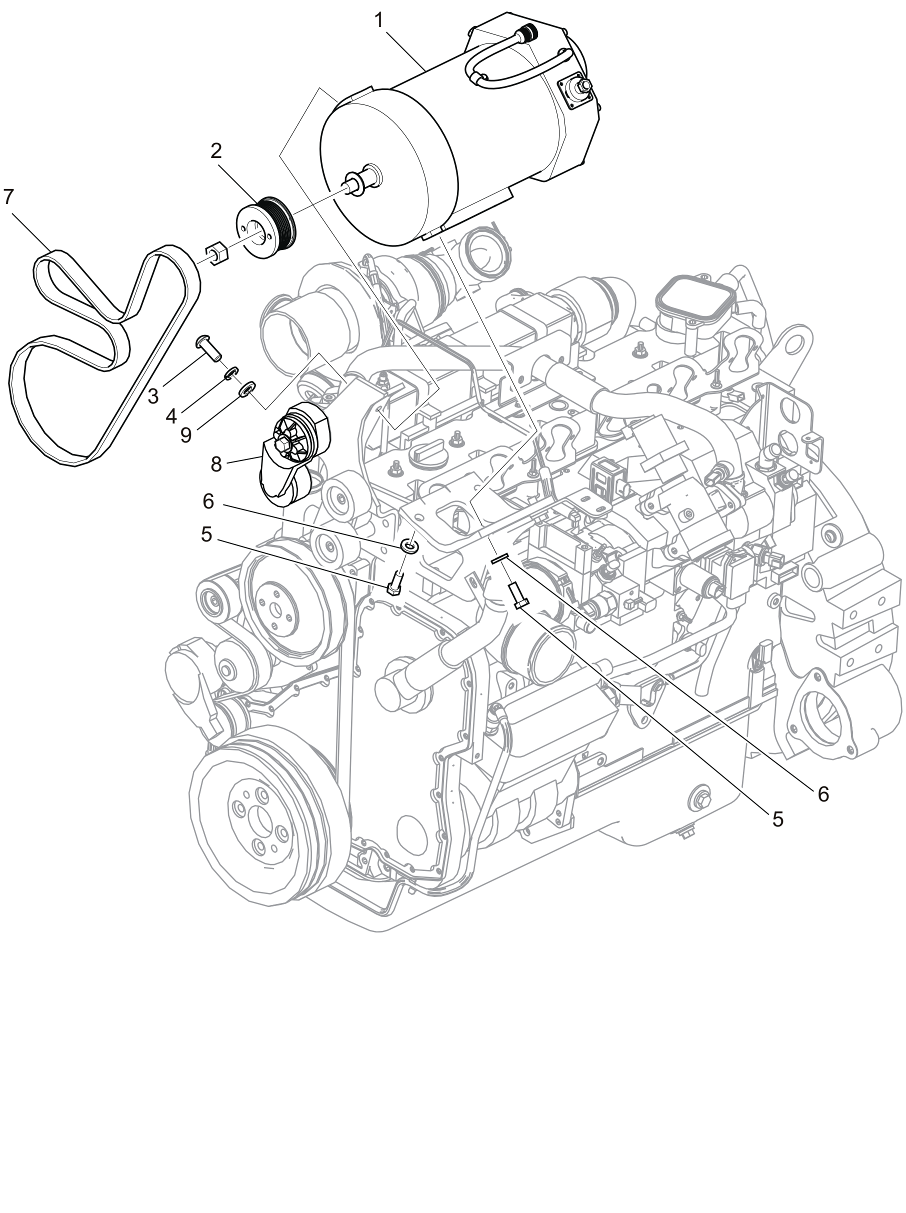


Fig. 9-13: Alternator Installation

4.3.8. Disassembly

1. Disconnect harness at regulator and remove regulator from rectifier housing.
2. Remove pulley nut, pulley, woodruff key, from the alternator Drive End (DE). See "Fig. 9-14: Alternator Assembly" on page 24.
3. Remove fan guard hardware, fan guard, and fan. Remove spiral ring from fan and discard. See "Fig. 9-15: Fan Guard & Fan Removal" on page 26.
4. Remove the duct housing from the Anti-Drive End (ADE). See "Fig. 9-16: Duct Housing Removal" on page 26.
5. Remove rectifier housing assembly as follows:
   a. Remove hardware from phase lead terminals P1 through P6. Label the phase leads for reassembly. See "Fig. 9-17: Field Coil Lead Removal" on page 27.
   b. Unlatch field coil leads from harness at connector. Mark a dot on the white field coil lead attached to black wire from harness to identify F+ wire connection.
   c. Indicate correct position of rectifier/ housing assembly by scribing a mark across assembly and shell.
   d. Remove hardware from rectifier/housing assembly.
   e. Separate rectifier/housing assembly from shell.
6. Remove ADE housing as follows:
   a. Remove hardware holding outer ADE ring carrier to shaft.
   b. Remove outer ring carrier from shaft.
   c. Scribe a mark across the ADE housing and shell to ensure correct alignment during reassembly.
   d. Remove and discard the ADE housing locknuts.
   e. Use ADE housing removal tool and engage housing arms. (Item 2 from Special Tools List). Rotate the tool handle clockwise and pull end housing out of shell. See "Fig. 9-18: ADE Housing Removal" on page 27.
   f. Remove and discard O-rings from housing inner bore.
7. Remove the ADE rotor as follows:
   a. Remove one screw from the ADE rotor and scribe a line across the center of the screw hole and onto the rotor face. This mark will be used on reassembly to ensure correct rotor alignment.
   b. Remove remaining screws and remove rotor from shaft. See "Fig. 9-19: ADE Rotor Removal" on page 27.

☞NOTE:

Use the following procedures if the rotor does not remove easily or appears to be rusted to the core:

a. Loosen rust using an air chisel with a rounded-point hammer bit to vibrate the areas between the screw holes on the rotor face.

b. Use a 3-jaw puller with working jaws latched on the sides of the rotor plate to lift rotor off core. Use caution when working with the 3-jaw puller if the rotor is rusted to the core as damage to the rotor could result.

8. Remove the DE housing as follows:
   a. Scribe a mark across the DE housing and shell to ensure correct alignment during reassembly.
   b. Remove and discard the ADE housing locknuts.
   c. Use DE housing removal tool and engage housing arms. (Item 4 from Special Tools List). Use a wrench to rotate the bolt on the tool clockwise and pull end housing out of shell. The shaft will remain with the housing because the shaft is pressed into the DE bearing. Be careful not to damage stator or field coil when removing DE housing from shell. See "Fig. 9-20: DE Housing Removal" on page 27.

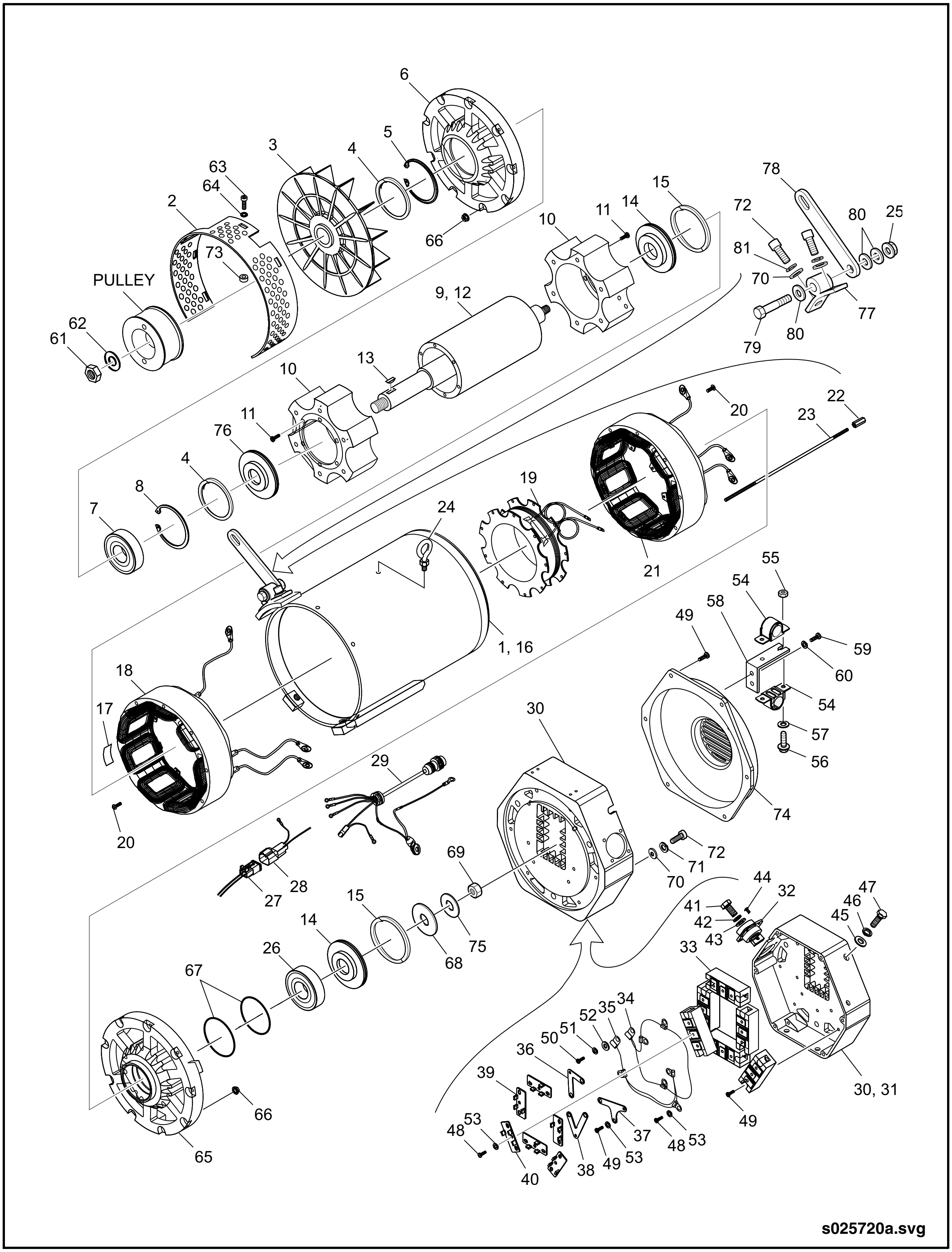


Fig. 9-14: Alternator Assembly

1. Alternator Assembly, (Incl. 2-9, 14-16, 25-30, 54, 58, 61-65, 68)
2. Guard, Fan
3. Fan
4. Ring, Spiral
5. Ring, Beveled Retaining
6. DE Housing
7. DE Bearing
8. Ring, Flat Retaining
9. Shaft, Core and Rotor Assembly (Incl. 10, 12)
10. Rotor Assembly, (Incl. 11)
11. Screw, Torx Taptite #10 - 32 UNC
12. Shaft and Core Assembly, (Incl. 13)
13. Key, Woodruff #9 3/16" x 3/4" Lg.
14. Carrier, Ring
15. Ring, Spiral
16. Shell, Stator and Field Coil Assembly (Incl. 17-19, 21, 23-24)
17. Wedge, Stator
18. Stator, DE
19. Field Coil, (Incl. 20)
20. Screw, Pan Head #6 - 32 UNF
21. Stator, ADE (Incl. 22)
22. Nut, Hex #8 - 32 UNC x .56
23. Stud
24. Eyebolt, 3/8" -16 UNC x 1.75"
25. Nut, Lock Flanged 7/16" -14 UNC
26. ADE Bearing
27. Shell, Connector
28. Shell, Connector
29. Harness, Regulator
30. Rectifier Housing Assembly, (Incl. 31-53)
31. Housing, Rectifier
32. Output Stud
33. Diode Module
34. Wire, Inner Loop
35. Wire, Outer Loop
36. "L" Link
37. "T" Link
38. "V" Link
39. PC Board
40. PC Board
41. Bolt, M12 x 1.75 x .98 Lg.
42. Washer, Lock 12 I.D. x 18 O.D.
43. Washer, Flat .52" I.D. x 1" O.D.
44. Screw, Pan Head #8 - 32 x 1/2"
45. Washer, Flat .40" I.D. x 1" O.D.
46. Washer, Lock 10 I.D. x 16 O.D.
47. Bolt, M10 x 1.50 x .20 Lg.
48. Screw, Pan Head M6 x 1 x .47 Lg.
49. Screw, Pan Head M6 x 1 x 17.6mm
50. Bolt, Hex M8 x 1.25 x 20 Lg.
51. Washer, Belleville M8
52. Washer, Flat .34" I.D. x .68" O.D.
53. Washer, Lock .26" I.D. x .47" O.D.
54. Cable Clamp Assembly, (Incl. 55-57)
55. Nut, Lock M6 x 1mm
56. Screw, Hex M6 x 1 x 20mm
57. Washer, Belleville .25" I.D. x .50" O.D. x .02" Thk.
58. Bracket Assembly, Cable Clamp (Incl. 59-60)
59. Bolt, Socket M6 x 1 x 12mm
60. Washer, Belleville .25" I.D. x .50" O.D. x .02" Thk.
61. Nut, M20 x 1.5mm
62. Washer, Belleville 20 I.D. x 40 O.D. x 2.5mm Thk.
63. Bolt, Torx Plus 1/4" -20 UNC x .63" Lg.
64. Washer, Lock .26" I.D. x .47" O.D. x .06" Thk.
65. ADE Housing, (Incl. 66-67)
66. Nut, Flange Lock #8 - 32 UNC
67. O-Ring
68. Washer, Flat .69" I.D. x 1.75" O.D. x .14" Thk.
69. Nut, M16 x 1.5mm
70. Washer, Flat .41" I.D. x .80" O.D. x .06" Thk.
71. Washer, Lock .45" I.D. x .79" O.D. x .11" Thk.
72. Screw, Button Hex M10 x 1.5 x 25mm
73. Bushing, .28" I.D. x 0.62" O.D. x 0.25" Thk.
74. Duct Housing
75. Washer, Belleville .64" I.D. x 1.57" O.D. x .08" Thk.
76. Carrier, Ring
77. Bracket, Damper
78. Support Link
79. Bolt, Hex 7/16" - 14 UNC
80. Washer Flat .47 x .92 x .06
81. Washer, Lock 10 I.D. x 16 O.D. x 2.5mm Thk.
82. Nut, Lock M6 x 1mm

Alternator Assembly (parts list)

9. Press the shaft out of the DE bearing as follows:
   a. Support DE housing and press out shaft.
   b. Remove and save the retaining rings from either end of the bearing.
   c. Press bearing out of drive housing from back side of housing. See “Fig. 9-21: DE Bearing Removal” on page 28.
10. Remove the six screws securing the front rotor to the shaft and remove rotor from shaft.

☞**NOTE:**

Use the following procedures if the rotor does not remove easily or appears to be rusted to the core:

a. Loosen rust using an air chisel with a rounded-point hammer bit to vibrate the areas between the screw holes on the rotor face.

b. Use a 3-jaw puller with working jaws latched on the sides of the rotor plate to lift rotor off core. Use caution when working with the 3-jaw puller if the rotor is rusted to the core as damage to the rotor could result.

11. Use a puller to remove DE ring carrier from shaft.
12. Use a puller to remove ADE bearing from shaft.
13. Use a puller to remove inner ADE ring carrier from shaft.

4.3.9. Remove field coil as follows:

a. Scribe marks at the following locations prior to removing the field coil. This will ensure that the field coil and stators will be properly located during reassembly: See “Fig. 9-22: Scribe Marks for Field Coil Location” on page 28.

i. On the DE and ADE edges of the shell that align with the missing screw in the DE and ADE field coil bobbin ears.

ii. On the ADE edge of the shell where the field coil leads exit the stator.

b. Remove field coil screws from the drive end and the anti-drive end.

c. Use field coil & stator tool (Item 3 from Special Tools List) to rotate the field coil bobbin ears away from the stator tabs. Remove field coil through the anti-drive end of the shell, being careful not to damage phase and field coil leads when removing field coil from shell.

d. If field coil will be replaced, transfer dot marked in “Disassembly” step 5.b. to correct field coil lead on new field coil. Make sure dot is on correct field coil lead to prevent miswiring when reassembling unit.

14. Press the ADE stator and DE stator out of the shell as follows:

a. Ensure scribe marks are visible on DE and ADE edges of shell where tabs are missing on DE and ADE stators.

b. Remove hardware securing through-studs at the anti-drive end only. Remove through-studs from the drive end.

c. Position the field coil & stator tool (Item 3 from Special Tools List) so that the handle protrudes through the drive end of the shell and the pressing surface of the tool seats against the ADE stator. Press out the ADE stator.

d. Reposition the tool so that the handle protrudes through the anti-drive end of the shell and the pressing surface of the tool seats against the DE stator. Press out the DE stator. See “Fig. 9-23: DE Stator Removal” on page 28.

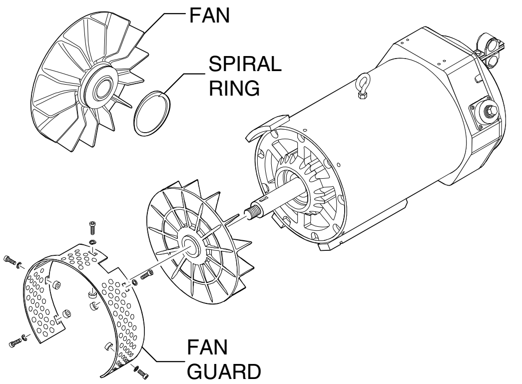


Fig. 9-15: Fan Guard & Fan Removal

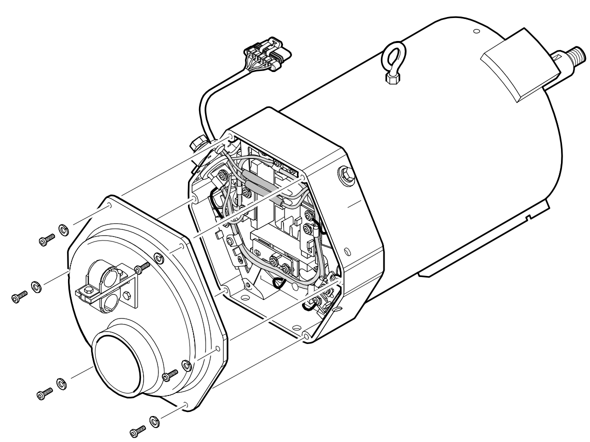


Fig. 9-16: Duct Housing Removal

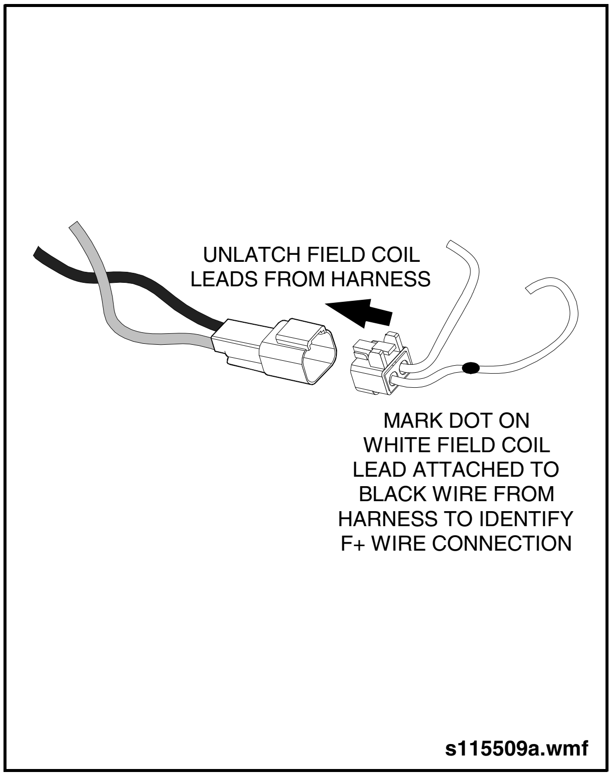


Fig. 9-17: Field Coil Lead Removal

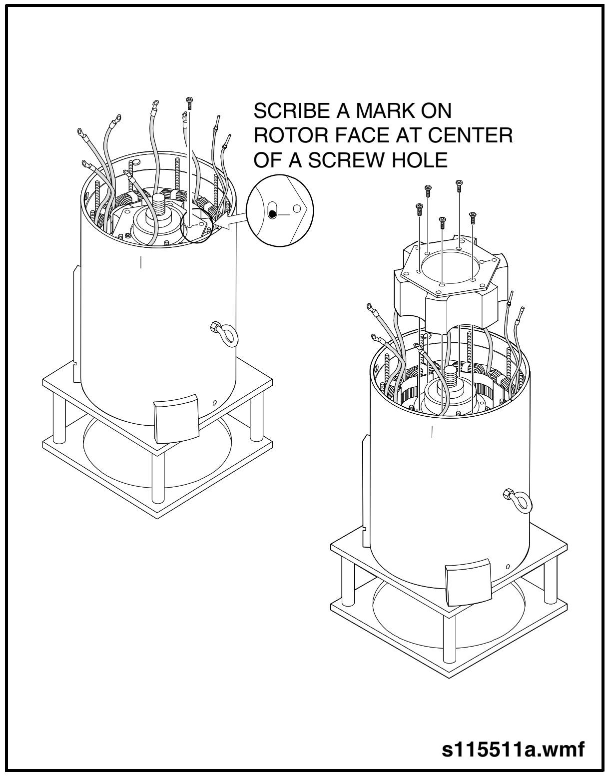


Fig. 9-19: ADE Rotor Removal

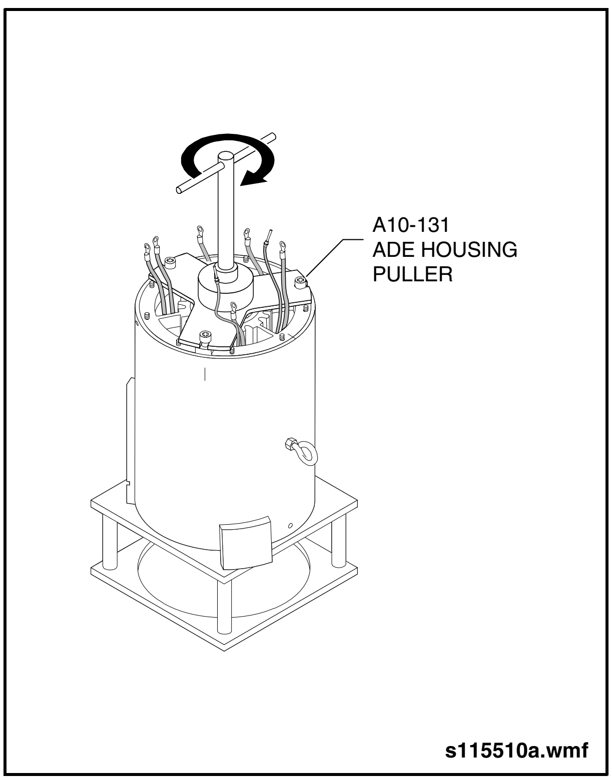


Fig. 9-18: ADE Housing Removal

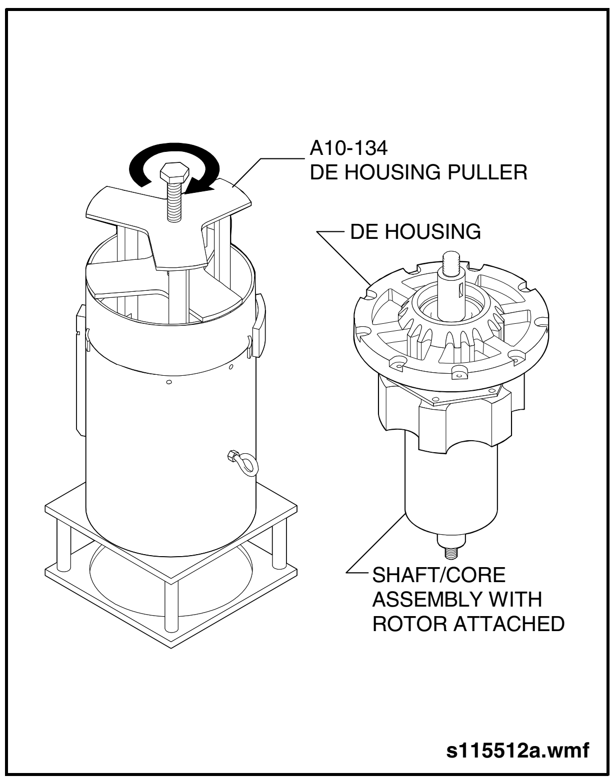


Fig. 9-20: DE Housing Removal

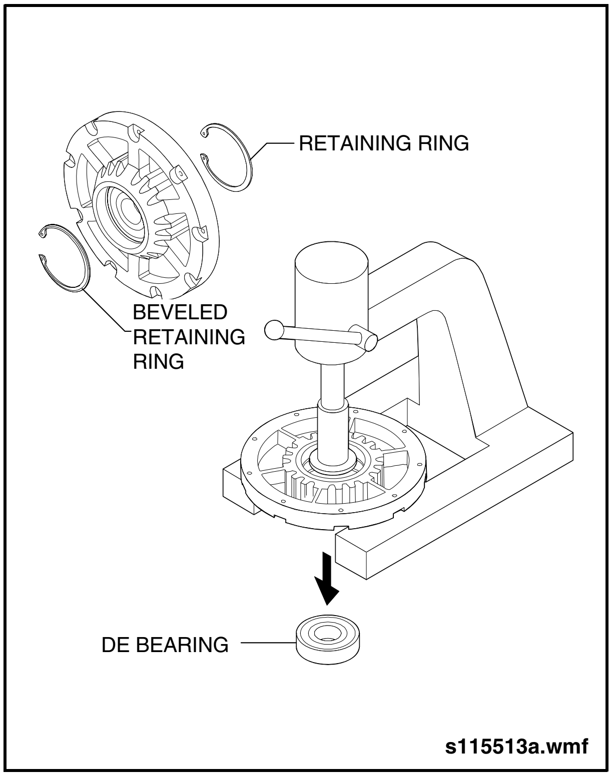


Fig. 9-21: DE Bearing Removal

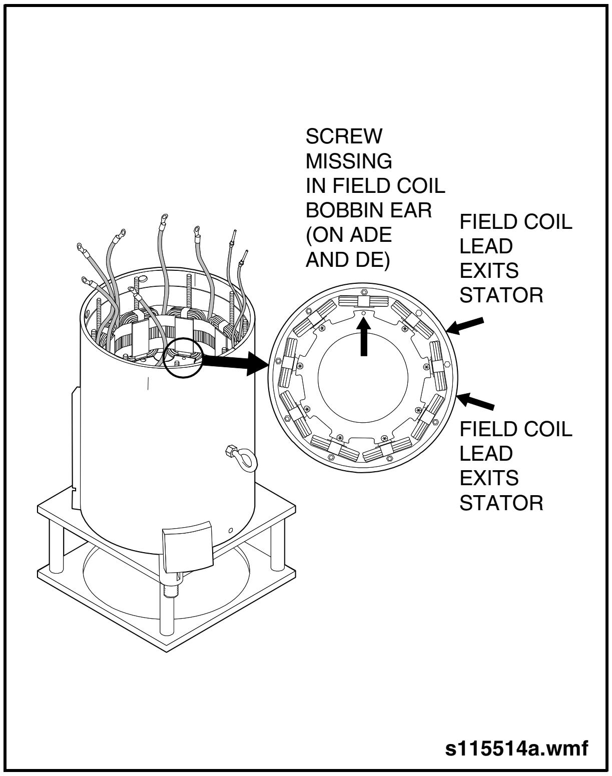


Fig. 9-22: Scribe Marks for Field Coil Location

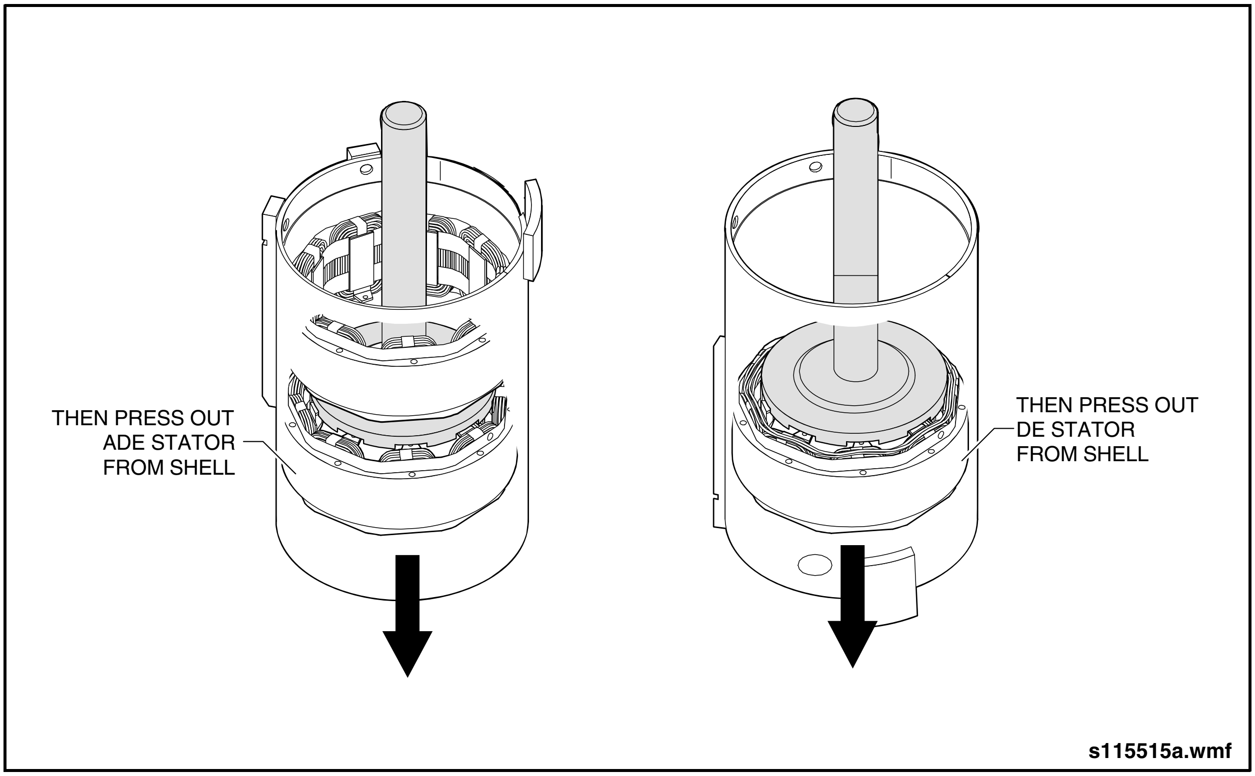


Fig. 9-23: DE Stator Removal

4.3.10. Assembly

CAUTION

Use care not to damage the phase leads when installing the stators into the shell.

1. Install the drive end (DE) stator as follows:
    a. Position the shell on the press support fixture so that the drive end of the shell is facing up. See “Fig. 9-24: DE Stator Installation” on page 32.
    b. Align the scribe mark on the shell with the missing tab on the DE stator.
    c. Position the stator insertion tool (Item 1 from Special Tools List) on the DE stator and press the stator into position using a spray lubricant if necessary. Continue pressing the stator until it is seated against the shoulder in the drive end of the shell.
2. Install the anti-drive end (ADE) stator as follows:
    a. Reposition the shell on a press support fixture so that the anti-drive end of the shell is facing up.
    b. Align the scribe mark on the shell with the missing tab on the stator.
    c. Thread DE stator phase leads through openings in ADE stator.
    d. Install six insertion studs provided with insertion tool into six holes in stator.
    e. Position the stator insertion tool (Item 1 from Special Tools List) on the ADE stator and press the stator into position using a spray lubricant if necessary. Continue pressing the stator until it is seated against the shoulder in the anti-drive end of the shell.
    f. Remove the temporary insertion tool studs from the ADE stator.
    g. Insert through-studs from drive end with lock nuts in position on drive end of studs.

h. Use lock nuts to secure through-studs on anti-drive end of shell. Use a suitable adhesive such as Loctite-222. Follow manufacturer's instructions. Torque nuts on anti-drive end and drive end to 30 in-lb. (3.4 Nm).

3. Install field coil as follows:

☞NOTE:

If new field coil will be installed, ensure that dot on old field coil lead was transferred to new field coil.

a. Insert field coil from drive end, aligning with scribe mark on shell. See “Fig. 9-25: DE Field Coil Installation” on page 32.

b. Push field coil leads through the spaces between stator windings.

c. Align bobbin ears over stator tabs from anti-drive end. Use stator & field coil tool (Item 3 from Special Tools List) to rotate field coil and center screw holes. See “Fig. 9-26: ADE Field Coil Installation” on page 33.

⚠CAUTION

DO NOT install screws into the scribe marked holes in the following step. These scribe marked holes align with the missing stator tabs and attempting to install screws in these holes would result in the screws falling in the shell cavity and causing damage to parts during operation.

d. Secure field coil with screws in both the anti-drive end and the drive end. Use Loctite-222 on the screw threads and torque screws to 20 in-lb. (2.3 Nm). See “Fig. 9-27: Field Coil Screw Installation” on page 33.

4. Install DE rotor as follows:

a. Place DE rotor on shaft. Center the screw holes in shaft with the screw holes in rotor face. See “Fig. 9-28: DE Rotor Installation” on page 33.

b. Secure rotor with screws. Use a suitable adhesive such as Loctite-222 on the screw threads, following manufacturer's instructions. Torque screws to 75 in-lb. (8.5 Nm).

5. Assemble DE bearing, housing, and shaft as follows:

a. Install flat retaining ring in groove of bearing bore closest to anti-drive end of housing. See “Fig. 9-29: DE Bearing & Housing Assembly” on page 33.

b. Press bearing into DE bearing bore using DE bearing outer race tool (Item 6 from Special Tools List) placed on the bearing outer race.

c. Install beveled retaining ring in remaining groove.

d. Wind a new spiral ring in groove around ring carrier. Lubricate spiral ring with Dupont™ Krytox GPL 225 or equivalent. Install ring carrier in DE housing.

e. Place rotor on support blocks and press DE housing onto rotor shaft. Place DE bearing inner race tool (Item 8 from Special Tools List) on bearing inner race when pressing DE housing onto rotor shaft. Rotate shaft and ensure bearing moves freely.

⚠CAUTION

Use care in the following step not to damage the stator windings or through-studs during assembly. Also ensure that the support blocks are tall enough for the shaft to clear the bench.

6. Install the DE housing and rotor shaft assembly into shell as follows:

a. Support the shell assembly on blocks with the drive end facing up. Align the scribe marks on the shell and DE housing and carefully insert the DE housing assembly with shaft into the shell assembly. Ensure the DE housing is fully seated against the shell assembly.

b. Apply Loctite-222 to the threads of the through-studs and install new locknuts. Torque locknuts to 45 in-lbs. (5.1 Nm).

7. Install ADE rotor and ring carrier as follows:

    a. Place ADE rotor on shaft and align scribe marks.

    b. Loosely install all screws except for the screw for the marked hole. Ensure the scribe mark in the last hole is aligned before tightening screws. Apply a suitable adhesive such as Loctite-222 on the screw threads, following manufacturer's instructions. Torque screws to 75 in-lb. (8.5 Nm).

    c. Wind a new spiral ring in groove around inner ADE ring carrier. Lubricate spiral ring with Dupont™ Krytox GPL 225 or equivalent.

    d. Press ring carrier onto shaft.

8. Install ADE housing as follows:

    a. Install new O-rings in ADE bearing bore. Lubricate O-rings with with Dupont™ Krytox GPL 225 or equivalent.

    b. Align scribe marks, then set ADE housing in position, pulling phase leads and field coil leads through vent holes in ADE housing. Rotate shaft to make sure phase leads or field coil leads do not interfere with rotor.

    c. Install new locknuts on through-studs. Use a suitable adhesive, such as Loctite-222. Follow manufacturer's instructions. Torque locknuts to 45 in-lbs (5.1 Nm).

9. Install ADE bearing and outer ADE ring carrier as follows:

    a. Press bearing on shaft using ADE bearing inner race tool (Item 7 from Special Tools List) placed on bearing inner race.

    b. Wind a new spiral ring in groove around outer ADE ring carrier. Lubricate spiral ring with Dupont™ Krytox GPL 225 or equivalent.

    c. Press ring carrier onto shaft.

    d. Secure ring carrier with washer and nut. Torque nut to 50 ft-lbs. (67.8 Nm).

10. Install rectifier/housing assembly as follows:

    a. Replace any parts necessary inside the rectifier/housing assembly before installing assembly on the ADE housing. Refer to 4.3.12. “Rectifier/Housing Assembly Component Replacement” on page 35 in this section for component replacement instructions.

    b. Align scribe marks, then set rectifier/housing assembly in position, pulling phase leads and field coil leads through vent holes in assembly. Rotate shaft to make sure rotor does not interfere with phase leads or field coil leads.

    c. Secure rectifier/housing assembly with hardware. Use a suitable adhesive such as Loctite-222. Follow manufacturer's instructions. Torque bolts to 15 ft-lbs. (20.3 Nm).

    d. Insert phase leads P1 through P6 between PC boards and diode modules at positions shown in Figure “Phase & Field Coil Assembly Lead Assembly”.

CAUTION

Make sure insulation sleeve on phase lead covers arm of terminal ring to avoid possible short. Make sure phase lead is positioned under PC board to prevent loosening from vibration.

    e. Torque all hardware. Refer to 4.3.11. “Phase & Field Coil Assembly & Torque Specifications” on page 34 in this section for torque values.

    f. Coat all terminations on all diode modules with Dow Corning® 1-2577 Low VOC RTV coating or equivalent. Do not use coating containing acetic acid (vinegar smell) on electrical components. Apply second coat of same coating on upper surface of lower diode module to seal upper seam between PC board and diode module.

    g. Connect field coil leads as shown in Figure “Phase & Field Coil Lead Assembly”.

11. Install ADE duct housing as follows:

    a. Position ADE duct housing on rectifier/housing assembly.

b. Install fasteners using a suitable adhesive, such as Loctite-222 on the screw threads. Follow manufacturer's instructions. Torque screws to 120 in-lb. (14 Nm).

12. Install fan and fan guard on drive end as follows:

a. Wind new spiral ring in groove around fan hub. Lubricate with DuPont™ Krytox GPL 225 or equivalent.

b. Place fan on shaft.

c. Install fan guard. Make sure grommets and inserts are in place. Fasten with screws. Use a suitable adhesive such as Loctite-222 on screws. Follow manufacturer's instructions. Torque screws to 120 in-lb. (14 Nm).

13. Install pulley on drive end as follows:

a. Install woodruff key.

b. Install pulley. Fasten with hardened washer and pulley nut. Use pulley nut torque tool (Item 5 from Special Tools List) to torque nut to 120 ft-lb. (163 Nm).

14..Install regulator as follows:

a. Install regulator on rectifier housing using screws. Torque screws to 75 in-lb. (8.5 Nm).

b. Plug in alternator-to-regulator harness into regulator.

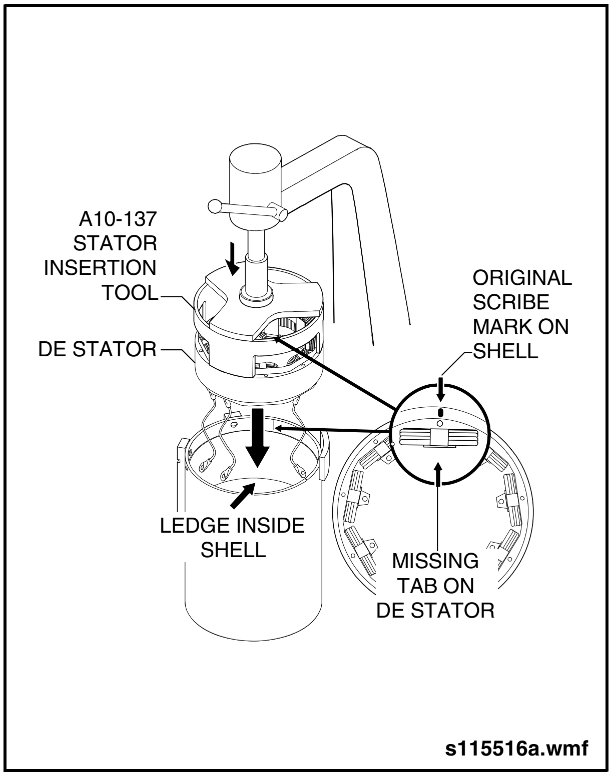


Fig. 9-24: DE Stator Installation

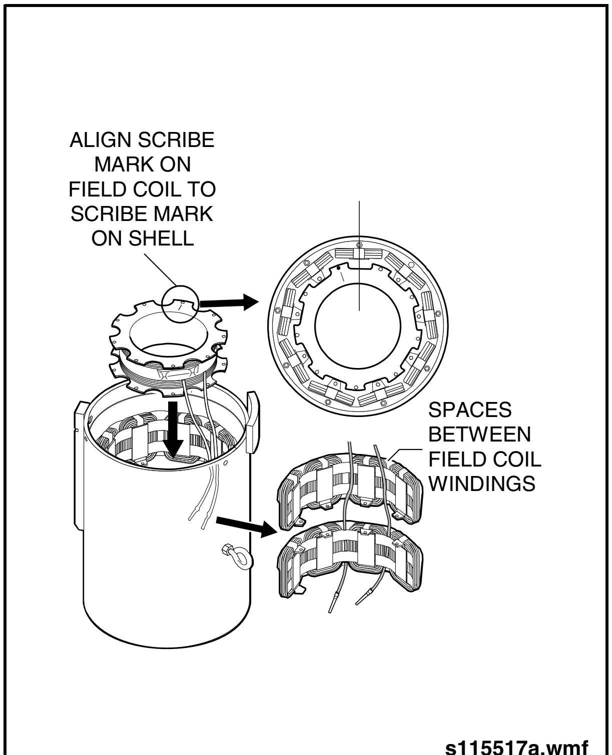


Fig. 9-25: DE Field Coil Installation

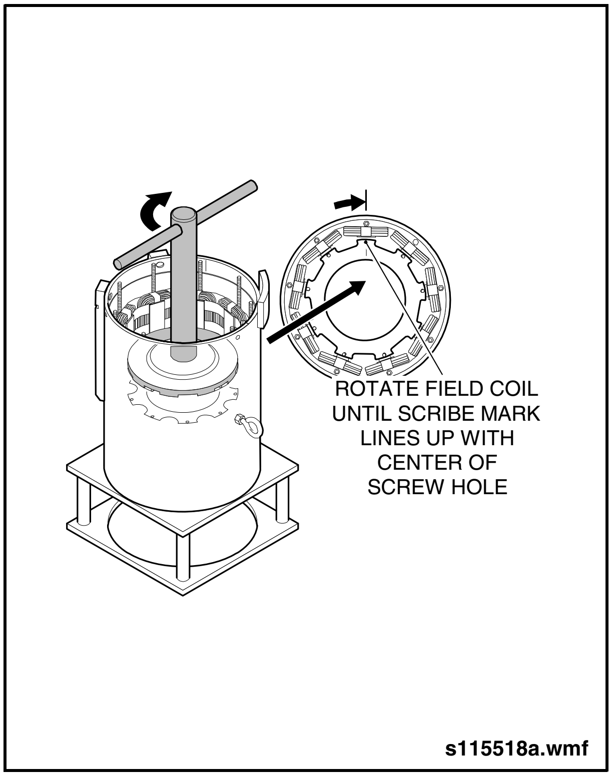


Fig. 9-26: ADE Field Coil Installation

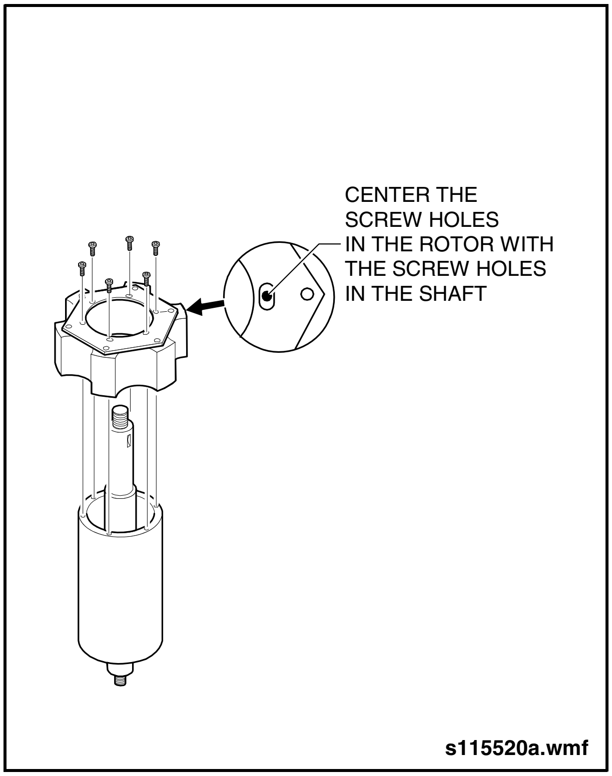


Fig. 9-28: DE Rotor Installation

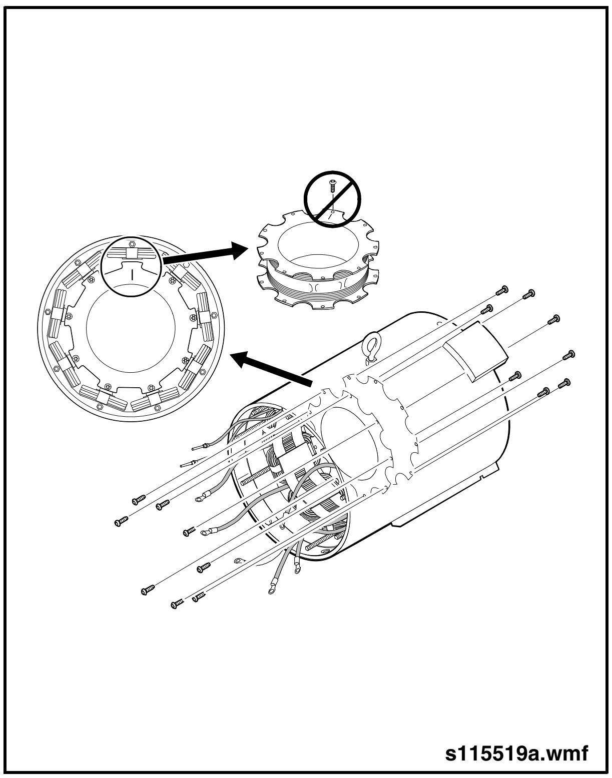


Fig. 9-27: Field Coil Screw Installation

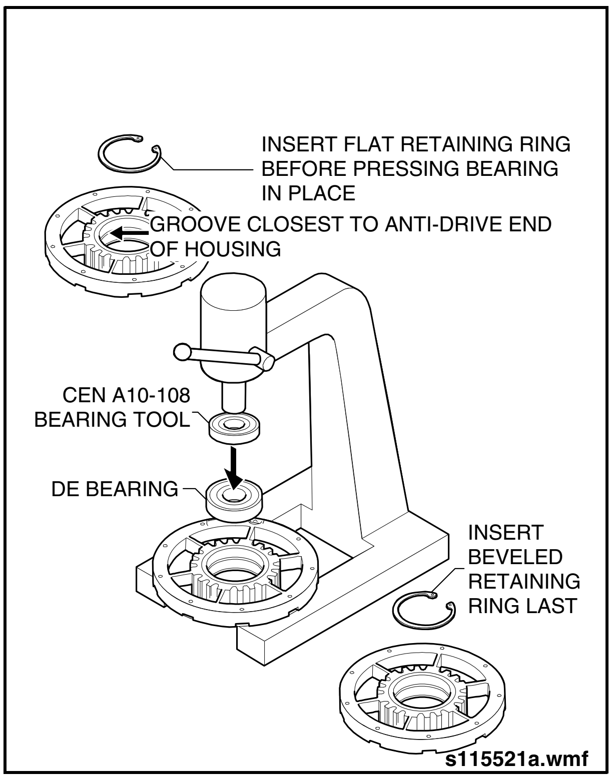


Fig. 9-29: DE Bearing & Housing Assembly

4.3.11. Phase & Field Coil Assembly & Torque Specifications

See "Fig. 9-30: Phase & Field Coil Assembly" on page 35.

PHASE & FIELD COIL ASSEMBLY & TORQUE SPECIFICATIONS

ITEM	DESCRIPTION	TORQUE	COMMENT
1	Green wire from harness and white wire from field coil	120 in-lb. (13.6 Nm)	Install wires onto "L" link with lockwasher & screw
2	Red wire from harness	65 in-lb. (7.4 Nm)	Install wire on top of PC board
3	P4 phase lead and white wire from harness	65 in-lb. (7.4 Nm)	Install P4 phase lead under the PC board. Install white wire on top of PC board.
4	F- field coil lead	N/A	Insert field coil lead into white lead connector from harness
5	F+ field coil lead (marked with dot)	N/A	Insert field coil lead into black lead connector from harness
6	Diode modules & link plates	120 in-lb. (13.6 Nm)	Torx screws with lockwashers (15 places)
7	Brown wire from harness	65 in-lb. (7.4 Nm)	Install brown wire on top of PC board
8	PC boards, inner loop wire, outer loop wire	65 in-lb. (7.4 Nm)	Phillips screws with lockwashers (18 places)
9	Upper surface of lower diode module	N/A	
10	Internal B+ terminal	15 ft-lb. (20.3 Nm)	Stacking order: output stud, rectifier terminals, thermal switch, flat washer, belleville washer, bolt

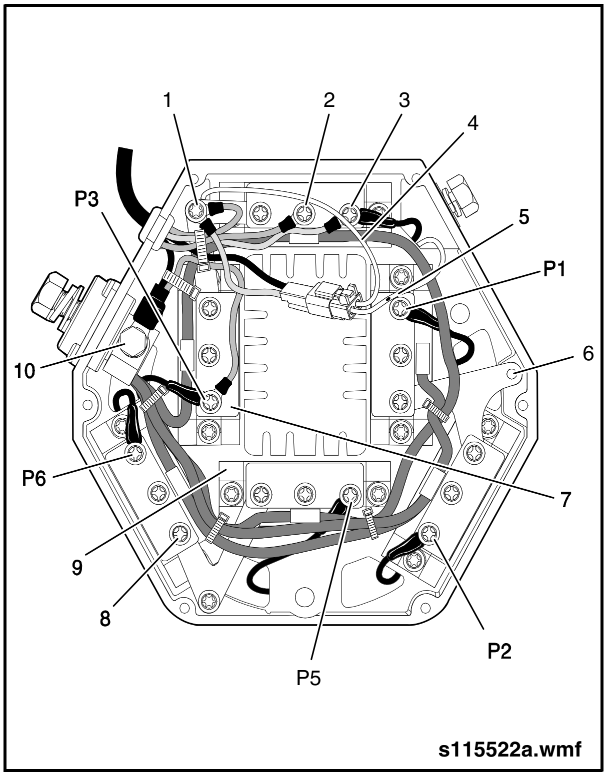


Fig. 9-30: Phase & Field Coil Assembly

4.3.12. Rectifier/Housing Assembly Component Replacement

1. Disassemble only as many parts as necessary to replace defective component.
2. When replacing a diode module, apply a layer of heat sink compound, such as GC/ Waldom HSC#10-8109 zinc oxide-filled silicone or its equivalent, on the back of the module between the module and rectifier/ housing surface.
3. Install diode modules and PC boards in correct orientation. Loosely fasten hardware. See "Fig. 9-31: Rectifier/Housing Assembly Component Arrangement" on page 35.
4. If thermal switch needs to be replaced, either order thermal switch kit regulator harness with thermal switch factory-wired. Install per enclosed instructions. Refer to your New Flyer Parts Manual for ordering information.
5. After rectifier components have been replaced and wiring is reconnected, affix wire ties.

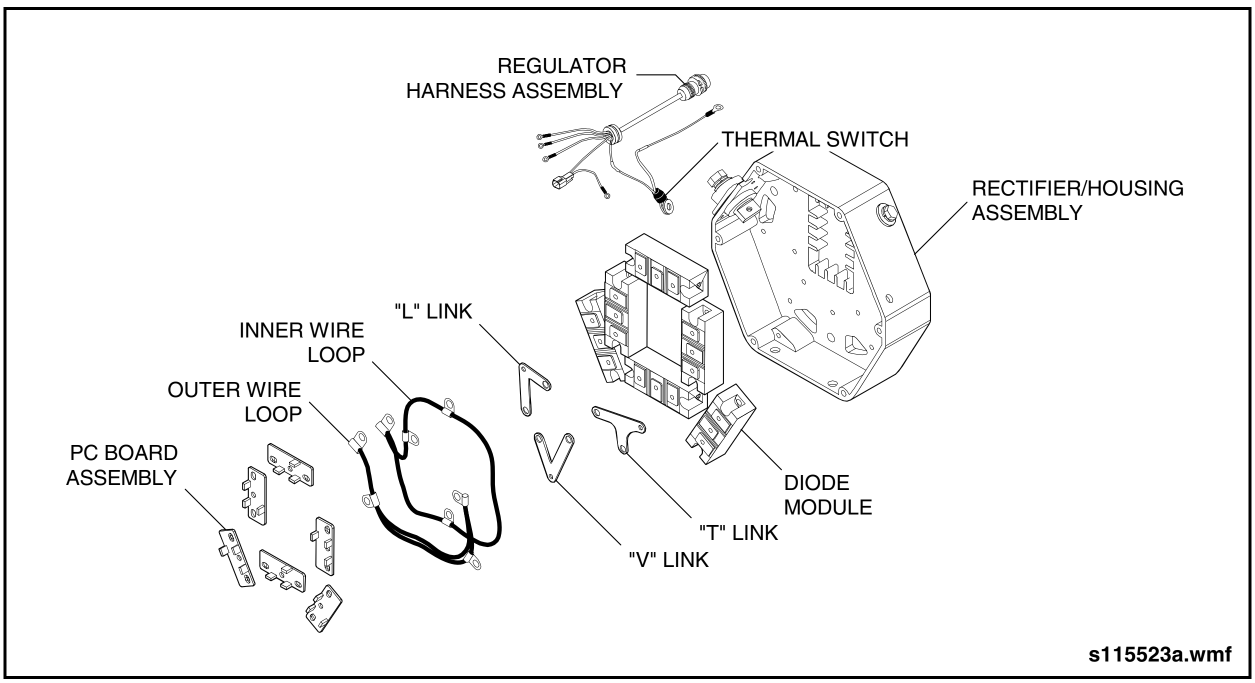


Fig. 9-31: Rectifier/Housing Assembly Component Arrangement

4.3.13. Installation

1. Install mounting bracket to gear case and support brace if they were removed. Torque (3) mounting bolts 25 ft-lb. (34 Nm).
2. Position alternator on mounting bracket. Align holes in alternator mounting base with bracket.
3. Install (4) alternator to bracket bolts, torque to 60 to 65 ft-lb. (81 to 88 Nm).
4. Install the belt carefully over the alternator, accessory drive and idler pulleys. Use a 3/4" drive breaker bar to rotate the tensioner upwards to allow belt installation. Ensure that the belt is properly positioned on the pulleys before releasing the tensioner or taking up the slack.
5. Connect cable leads to alternator and wires to regulator.
6. Install air hose to rear of alternator and tighten clamp.
7. Torque alternator “B+” terminal bolt to 22 ft-lb. (30 Nm). Torque alternator “B-” bolt to 11 ft-lb. (15 Nm). Torque regulator “D+” and “E” terminal lock nuts to 30 in-lb. (3.4 Nm).

4.3.14. Functional Test

☞**NOTE:**

Ensure batteries are fully charged before conducting alternator output test.

1. Start vehicle and operate engine at fast idle.
2. Turn on all vehicle loads, including interior and exterior lights, and air conditioning.
3. Measure charge voltage at alternator. Voltage reading should be 28 ± 0.2 volts (regulator setpoint).
4. Check battery cable voltage drop. There should be no more than 0.4 volt drop from alternator to battery.
5. Road test vehicle for approximately 20 minutes.
6. Repeat output test immediately following road test.

4.4. Alternator Special Tools

4.4.1. Alternator Special Tools Chart

Refer to your New Flyer Parts Manual for purchase part numbers. See “Fig. 9-32: Special Tools” on page 38.

SPECIAL TOOLS	
SPECIAL TOOL	**DESCRIPTION**
1	Stator Insertion Tool
2	ADE Housing Removal Tool
3	Field Coil & Stator Tool
4	DE Housing Removal Tool
5	Pulley Nut Torque Tool
6	DE Bearing Outer Race Tool
7	ADE Bearing Inner Race Tool
8	DE Bearing Inner Race Tool
9	6-Pin Inline Harness Tool

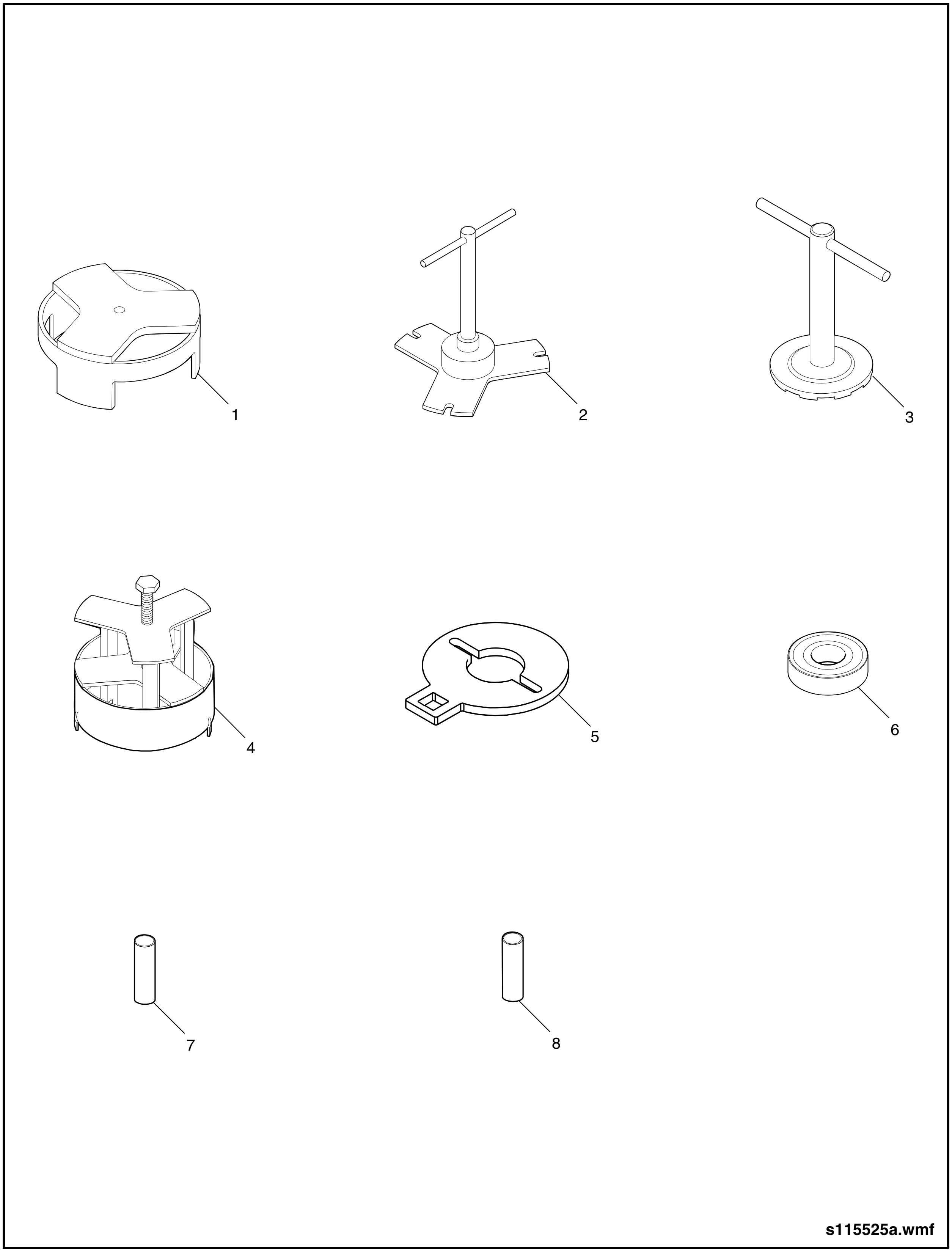


Fig. 9-32: Special Tools

4.5. Voltage Regulator

WARNING

Over-charging a lead acid battery can produce explosive and hazardous gas. Any change in battery configuration from the equipment originally supplied on your New Flyer vehicle may require modification to the charging system voltage levels and battery service procedures to prevent overcharging and equipment damage.

4.5.1. Description

The voltage regulator used on this vehicle is an electronic solid state unit with diagnostic capability and a temperature/Voltage sensing harness. A tricolor LED indicator is located on the end of the unit. The regulator is located in the fuse box.

4.5.2. Voltage Regulator Specifications

Make ....Niehoff

Model A2-377

Circuit Protection
............................Automatic over-voltage
.... field circuit cutout

Connection Points
.... 6 pin connector
.... IGN, D+, P terminals

4.5.3. Operation

The regulator equipped with the temperature/Voltage sensing harness automatically regulates the charge voltage for the battery based on the temperature of the battery. The regulator is a sealed unit and is equipped with an over-voltage cutout (OVCO) feature. This feature causes the regulator to open the alternator field circuit whenever electrical system voltage above 33 volts is detected for more than 3 seconds. This shuts the alternator off. The circuit is reset by shutting down and then restarting the engine. The regulator will then operate normally. A four position voltage adjustment switch is built into the regulator that must be set according to the battery type installed in the vehicle. The IGN terminal receives power from the vehicle to excite the alternator field. The D+ terminal is powered once the alternator begins to charge.

The LED indicators on the unit provides the following indications and status:

LED INDICATIONS & STATUS

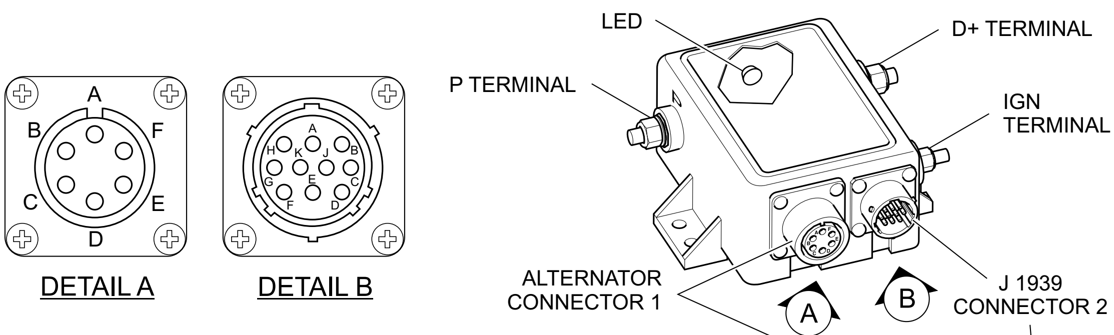
INDICATION	STATUS
GREEN steady	Alternator and regulator operating normally.
AMBER steady	Low system voltage - electrical load exceeds alternator rating at present rotor speed. Will also flash if alternator has not output.
AMBER flashing	Alternator fault - no output.
RED steady	High system voltage - may occur during normal load switching.
RED flashing	OVCO tripped.

4.5.4. Voltage Regulator Set Point

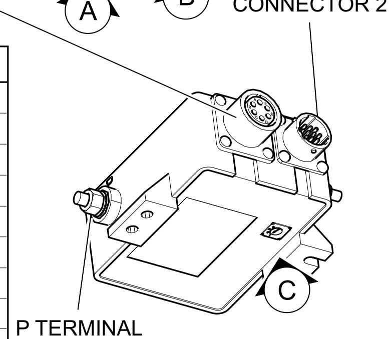
1. Determine the battery type installed in the vehicle.
2. Select the appropriate switch setting according to battery type. See “Fig. 9-33: Regulator Electrical Connections” on page 40.

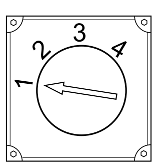
4.5.5. Voltage Regulator Troubleshooting

The main diagnostic feature is the LED indicator. It works like a voltmeter, measuring charging voltage. Table , “LED INDICATIONS & STATUS,” on page 39. If the over voltage shutdown circuit has been activated, a voltage spike probably occurred which caused the cutout feature to operate. Reset the circuit by shutting down and restarting engine. If the circuit operates and then shuts down the alternator field circuit, retry the restart procedure. If cutout still occurs, substitute a known good regulator for the suspect one. If cutout still occurs, unplug regulator and test alternator field coil resistance. Refer to 4.3.5.2. “Alternator Field Coil Test” on page 18 in this section for procedure. Refer to wiring schematics to identify all wiring circuits and terminals.



CONNECTOR 1 PIN FUNCTIONS	CONNECTOR 2 PIN FUNCTIONS
PIN A TEMP. SENSE	PIN A J1939+
PIN B NOT USED	PIN B J1939-
PIN C B-	PIN C SHIELD
PIN D B+	PIN D B-
PIN E PHASE	PIN E } MFR USE ONLY
PIN F FIELD	PIN F } MFR USE ONLY
	PIN G } MFR USE ONLY
	PIN H BATT TEMP. SENSE
	PIN J BATT VOLT. SENSE
	PIN K LEADER FOLLOWER SELECT





REGULATOR SELECT SWITCH POSITION		
SWITCH POSITION	TEMPERATURE-VOLTAGE SENSOR NOT USED	TEMPERATURE-VOLTAGE SENSOR USED
POSITION 1	27.5 V	MAINTENANCE (D CATEGORY)
POSITION 2	28.0 V	MAINTENANCE FREE (GROUP 31)
POSITION 3	28.5 V	AGM
POSITION 4	29.0 V	**DO NOT USE POSITION #4**

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Fig. 9-33: Regulator Electrical Connections

4.5.6. Removal

1. Stop engine and set the Battery Disconnect switch to OFF position.
2. Locate the regulator inside the fuse box.
3. Unplug the connector to alternator connector. Remove wires from IGN and D+ terminals and tag for reinstallation.
4. Remove the mounting screws and remove regulator.

4.5.7. Installation

1. Reinstall the regulator and torque mounting screws to 75 in-lb. (8.5 Nm).
2. Connect the regulator connectors.
3. Connect wire to regulator IGN terminal. Torque M5 terminal nut on regulator 40 in-lb. (4.5 Nm).
4. Connect wire to D+ terminal. Torque M6 terminal nut on regulator 40 in-lb. (4.5 Nm).

5. BATTERY MANAGEMENT SYSTEM

5.1. Description

The battery management system connects, disconnects and regulates the 12VDC and 24VDC battery power circuits. The battery management system is used to protect the batteries from excessive drain - prolonging the life of the batteries and ensuring there is power available for starting the vehicle. See “Fig. 9-34: Battery Management System” on page 42.

The battery management system consists of the following components:

- Bi-stable power relay (2) in fusebox
- Equalizer in fusebox
- Batteries in battery compartment
- Battery temperature sensor in battery compartment
- Current sensors in fusebox
- Electronic timer relay in side console Multiplexing System/Network

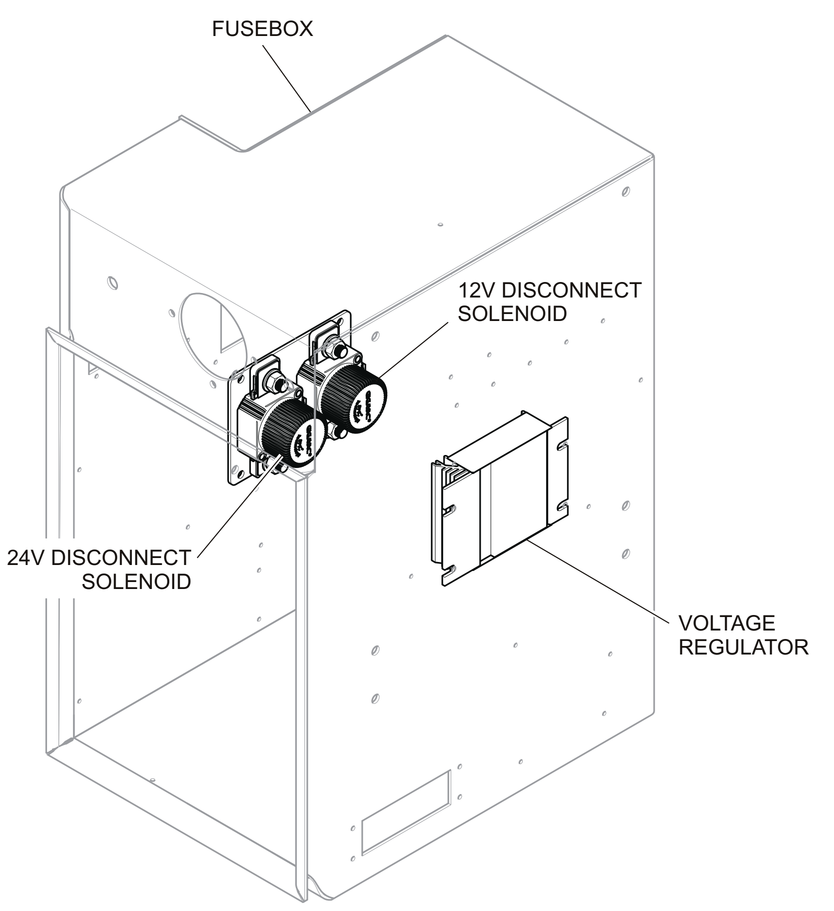


Fig. 9-34: Battery Management System

5.2. Operation

The operator sets the Master Run Switch (MRS) to the DAY RUN or NIGHT RUN position which engages the 12VDC and 24VDC bi-stable battery disconnect relays and provides power to the multiplexing system. The operator then presses the engine start button to start the vehicle.

When the engine is running, the voltage regulator monitors the voltage, current, and temperature of the batteries and regulates the charging voltage from the alternator. While current is being drawn from the batteries, the voltage equalizer ensures that all batteries are drained equally to prevent unequal load balancing and premature battery failure. Refer to 5.3. “Voltage Equalizer” on page 44 in this section for more information on this component.

When the engine is not running and the hazard lights are not on, the multiplexing system initiates several timers that, when any one timer fully times out, disengages the 12VDC and 24VDC bi-stable relays to prevent unnecessary battery drain.

5.3. Voltage Equalizer

5.3.1. Description

The battery voltage equalizer is located in the battery compartment and bracket-mounted to the side structure on the curb-side of the vehicle. The voltage equalizer is a power management system used to obtain a 12 VDC power source from a 24 VDC electrical system and to have the batteries function as if they are in series and parallel at the same time. In addition to providing regulated 12 VDC power, the system ensures that battery voltages remain equal. The voltage equalizer incorporates an internal electronic monitor which is a device that monitors several critical functions in the electrical system. See "Fig. 9-35: Battery Voltage Equalizer Installation" on page 44.

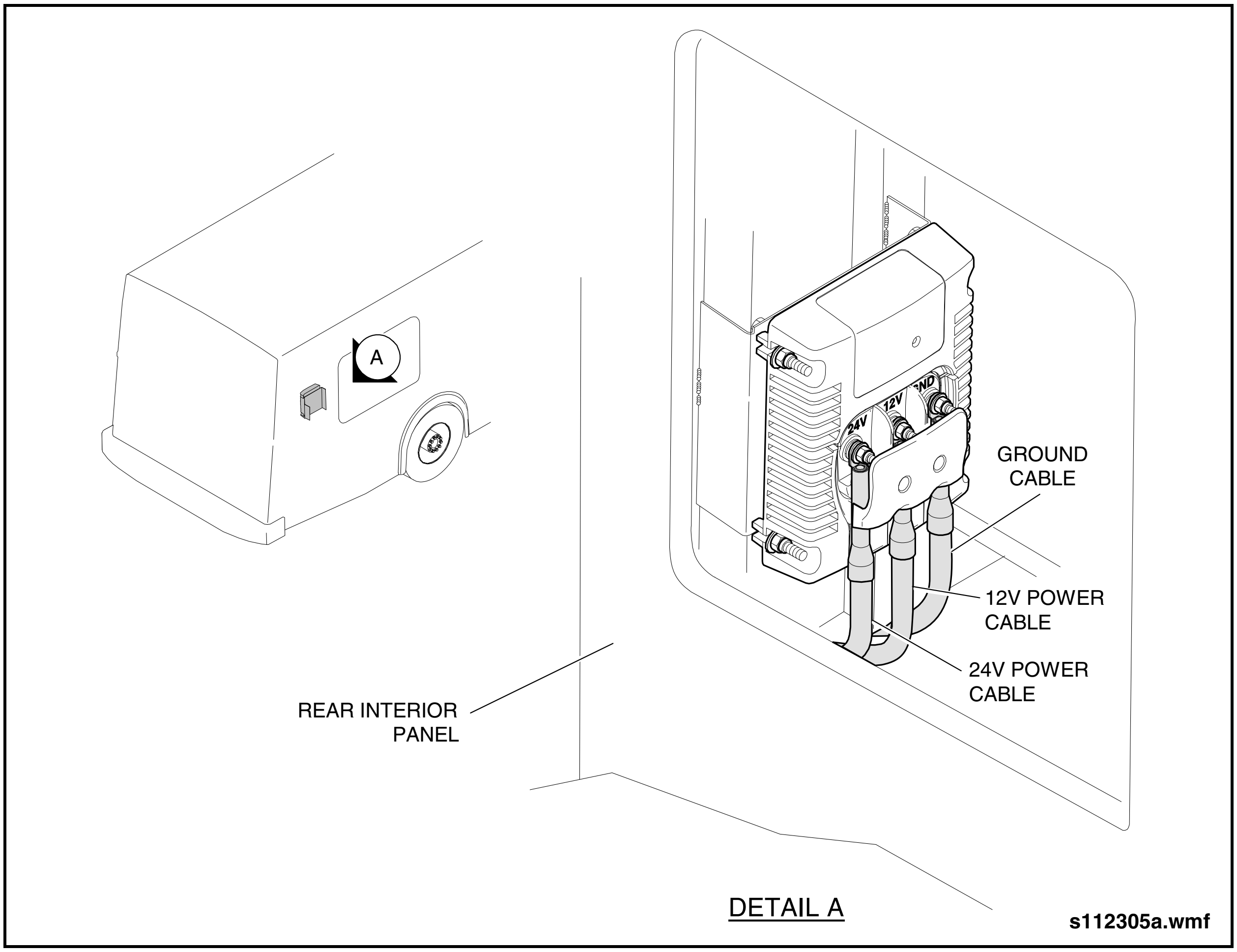


Fig. 9-35: Battery Voltage Equalizer Installation

5.3.2. Voltage Equalizer Specifications

Manufacturer.......... Vanner Power Group

Model.................................. 80 - 80 CAN

Input Voltage 24V .... 18 to 32 volts

Maximum 24V Input Amps .... 43 amps

Output Amps 12V .... 0 to 80 amps

5.3.3. Operation

The voltage equalizer is connected to the battery system at the 12 VDC, 24 VDC, and ground points. The voltage equalizer maintains voltage balance between the batteries and therefore the charge acceptance rate of each battery to within 0.05 volts at light load and 0.1 volts at full rated load.

When the voltage of the battery that is supplying the 12 VDC vehicle load is higher than or equal to the other battery, the equalizer is operating in a standby mode, for example it is not transferring power from its 24 VDC input to its 12 VDC output.

When a 12 VDC load is present and the voltage in the battery supplying the 12 VDC load is less than the voltage in the other battery, then the voltage equalizer activates and transfers sufficient current from the other battery to satisfy the load and maintain an equal voltage and charge in both batteries.

The CAN (Controller Area Network) Capable Smart Monitor is a device designed to monitor and report the status of several critical functions in the vehicle electrical system. This unit provides real-time fault signals over the CAN bus to the vehicle electrical system controller. Fault indications can then be given from the vehicle's electrical system controller.

5.3.3.1. Smart Monitor Functionality

Smart Monitor functionality requires that the Monitor Ignition Input (Terminal B) be connected to +24v in order to be active. The Smart Monitor connections include the following:

A Switched Sensor Supply Output

This output is used to provide +5v for the current sensors. The +5v output is switched for low power shutdown and sleep mode operation.

B Smart Monitor Ignition (Enable) Input

This input powers the equalizer monitor. When this pin is taken to +24V the monitor becomes active.

C CAN Shield

This connection is used to make common the shield on the CAN cable. This is required for noise considerations in vehicle electrical systems.

D Public CAN Low

This is the connection for the vehicle's public CAN bus. The Smart Monitor will communicate faults to the vehicle's electrical system controller via the CAN bus.

E Public CAN High

This is the connection for the vehicle's public CAN bus. The Smart Monitor will communicate faults to the vehicle's electrical system controller via the CAN bus.

G Dual Current Sensor, High Range Output (+24V)

The monitor can record high amperage cranking current (up to 600A) on the +24V battery bank. The high current output of the dual current sensor should be connected to this input.

H Sensor Ground

Connect ground for current sensors and Smart Sensors here.

J Dual Current Sensor, Low Range Output (+24V)

The monitor can record the low amperage incoming and outgoing battery current on the +24V battery bank. The low range output of the dual current sensor should be connected to this input.

K Single Current Sensor (+12V) Signal Input

The monitor can record incoming and outgoing battery current on the lower battery. The output from the current sensor monitoring the +12v output line should be connected to this input.

L Temperature Sensor

The monitor can record the temperate of the batteries. The output from the temperature sensor should be connected to this input.

M +24V Battery Remote Sense

If this pin is connected directly to the +24V battery positive by a separate line, it will improve the accuracy of the Equalizer balance of the batteries when load current is drawn.

N +12V Battery Remote Sense

If this pin is connected directly to the +12V battery positive by a separate line, it will improve the accuracy of the Equalizer balance of the batteries when load current is drawn.

P Battery Ground Remote Sense

If this pin is connected directly to the battery ground by a separate line, it will improve the accuracy of the Equalizer balance of the batteries when load current is drawn.

5.3.3.2. Remote Sense (Terminals M, N, & P)

There are three inputs for this function, +24, +12, and ground. They are for remote sense of the battery voltage. This makes the Equalize function insensitive to wire, fuse and connection voltage drops. All three sense lines must be connected for this function to work properly. It is usual for the battery connections to be brought to a distribution point from where connections are made to the rest of the vehicle. Since the battery charge current is the only current which the battery cables carry for most of the time it is convenient to connect the sense wires to these distribution points. This should not introduce a significant error. In fact, when the system stabilizes and the batteries are charged there will be almost no error.

The sense wires can be 16 or 18AWG as the input impedance is high, and the wire gauge can be set for mechanical strength requirements. This allows cost savings and freedom of configuration in the Equalizer power connection wiring, and more freedom in Equalizer location. The equalizer current carrying wire gauge can be the minimum size listed in this manual's wire size table for a given Equalizer rating, up to four times the distance listed. This sets a maximum voltage drop of 0.4V which is reasonable from efficiency and fault detection considerations.

5.3.4. Voltage Equalizer Testing

1. If the battery voltage is below 24V, start the vehicle or apply a 24V battery charger to the batteries.
2. With the engine running, turn ON 12V loads up to the equalizer rated capacity. Measure DC amps on the equalizer +12V cable to verify load amperages.

NOTE:

The following readings are all taken at the equalizer.

3. Measure and record the voltage between the equalizer +12V and GND terminals. This is referred to as Battery A voltage.
4. Measure and record the voltage between the equalizer +24V and +12V terminals. This is referred to as Battery B voltage.
5. Subtract Battery A voltage from Battery B voltage and compare readings.

NOTE:

An overload condition exists when the 12 volt loads exceeds the equalizer's rated capacity. The overload condition will not damage the equalizer but may cause damage to the batteries. To correct an overload condition the 12 volt load must be reduced or the equalizer capacity must be increased.

VOLTAGE EQUALIZER TESTING

Voltage Comparison	Equalizer Status	
Battery A is lower than Battery B but within 0.05 volt	OFF	Stand by mode
Battery A is lower than Battery B by 0.05 to 0.10 volts	ON	Normal operating mode
Battery A is lower than Battery B by more than 0.10 volts	ON	Self protection mode due to an overload condition.
Battery A is lower than Battery B by more than 0.10 volts	OFF	The equalizer is not functioning correctly
Battery A is higher than Battery B	Abnormal condition - suspect that Battery B is defective or has a 12V load connected to it.	

5.3.5. Replacement Procedure

WARNING

Ensure the wire connections to the equalizer are installed exactly as described. Incorrectly connected wires can damage the unit and possibly cause fires.

1. Set the Battery Disconnect switch to the OFF position.
2. Obtain access to the equalizer through the curbside panel at the rear of the vehicle interior.
3. Remove the two screws and the protective plastic cover from the equalizer.
4. Tag and disconnect the three wires from the terminal studs and disconnect the multi-pin Deutsch connector from the equalizer.
5. Remove the nuts and lock washers from the front mounting studs. Loosen, but do not remove, the lock nuts on the rear studs sufficiently to allow tilting the unit and sliding it off the rear studs.
6. Installation is the reverse of removal.

NOTE:

Torque the nuts on the wire terminals to 120 in-lb. (13.5 Nm) during installation.

5.4. Battery Disconnect Relay System

Two bi-stable, solenoid actuated relays are connected in series with the 12VDC and 24VDC contacts of the battery disconnect switch. The relays are controlled by a one-shot electrical signal to an internal field effect transistor (FET) that pulses either side of the coil, changing the position of the solenoid and either opening or closing the electrical contacts. The bi-stable relay solenoids are held by magnets and do not require an active signal to maintain its state.

The battery disconnect relay system disconnects power to all but the following components:

- ❒ Engine Control Module
- ❒ Transmission Control Module
- ❒ Voltage Equalizer
- ❒ Master Run Switch
- ❒ Front / Rear engine starting switch
- ❒ Fire Suppression System

6. ELECTRICAL STARTING SYSTEM

6.1. Description

The starter is a heavy-duty unit, solenoid operated through an enclosed shift lever and equipped with a sprag-type over-running clutch. A removable plug in the shift lever housing permits adjustment of pinion clearance. The nose housing can be rotated to obtain a number of different solenoid positions with respect to the mounting flange.

Armature shaft is supported in bronze bushings at three points: in commutator end frame, in shift lever housing and in nose housing. Positive lubrication is provided at each bushing and contacts the armature shaft. A waste-filled oil reservoir for each wick provides a large oil supply.

O-ring seals are used between commutator end frame and field frame and between shift lever housing and field frame. A solenoid linkage seal and lip-type armature shaft seal (at shift lever housing) prevent entry of oil into solenoid case and starter main case.

Four brush holders mounted on the brush holder plate carry the one-piece brushes. As shown on internal wiring diagram, two sets of brushes are connected to the ground terminal stud on commutator end frame; these connections are made through the brush holder mounting plate. The other two sets of brushes are insulated from mounting plate and connect to field coil leads.

6.2. Operation

☞**NOTE:**

The Multiplexing System limits continuous starter operation to 14 seconds. The starter circuit is then disconnected for 60 seconds to allow the starter to cool down.

The solenoid windings are energized when the ignition start button is pushed. The resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear and the solenoid main contacts to close and cranking takes place. In case of butt engagement, the motor is not energized to prevent damage to the pinion and gear teeth.

When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened, at which time the return spring causes the pinion to disengage. When the engine starts, the “start” circuit is automatically broken by a starter control circuit (which is sensitive to alternator output). This prevents excessive overrun and damage to the drive and armature windings.

6.3. Removal

☞**NOTE:**

Before removing starter, make preliminary checks.

1. Turn Battery Disconnect switch off.
2. Remove wires and cable from starter and solenoid. Tag all wiring for identification purposes when reinstalling starter.
3. Secure a suitable strap around the starter, then remove the three bolts and lock washers attaching starter to engine. Carefully remove starter. See "Fig. 9-36: Starter Motor Installation" on page 50.

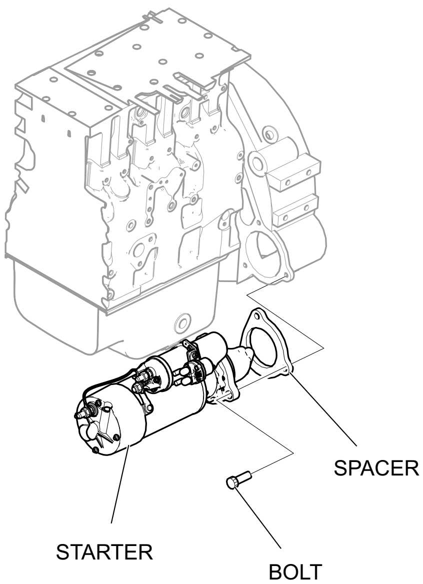


Fig. 9-36: Starter Motor Installation

6.4. Maintenance

6.4.1. Lubrication

All wicks and oil reservoirs should be saturated with SAE 20 oil and splines underneath the clutch should be lubricated with a light coat of SAE 20 oil, periodically, or at time of engine overhaul.

All connections should be kept clean and tight and brushes inspected for wear.

6.4.2. Brush Inspection

1. Remove the four (4) attaching bolts and separate the commutator end cap from field frame. Inspect brushes for wear.

   When brushes are worn down to less than 1/2 their original length, they must be replaced. Original length is 3/4" (19.05 mm).

2. Ensure that brush holders are clean and brushes are not binding in holders. The full brush surface should ride on the commutator to give proper performance.
3. Check by hand to ensure that the brush springs are giving firm contact between the brushes and commutator. If springs are distorted or discolored, they should be replaced.
4. Be sure all leads are secure in brushes and that terminal clips are properly soldered to leads.

6.4.3. Brush Removal

1. From the insulated/ground terminal, carefully noting orientation, remove all parts including the solenoid ground lead. Check the condition of insulators and sealing features and consider replacing them if they are damaged or excessively worn.
2. Remove the four (4) Commutator End (CE) screws and CE housing.
3. Remove the four (4) brush springs, four (4) brush screws, and four (4) brushes. This also releases the ground terminal and lead assembly.

6.4.4. Brush Installation

1. Install the four (4) brush springs, ensuring they are in the same position as removed. Hit or press on the spring face until it is completely seated.
2. Install ground terminal and lead assembly. Attach the terminal's negative leads and negative brush leads to the brush plate with two (2) screws. Torque the screws 20 to 40 in-lb. (2.3 to 4.5 Nm).
3. Attach the positive brush and field leads to the brush plate with two (2) of the brush screws. Torque screws 20 to 40 in-lb. (2.3 to 4.5 Nm).
4. Install the square fiber insulator onto the ground stud.
5. Apply bearing type grease onto CE housing's inner diameter where the frame O-ring is seated and apply a small amount of SAE 20 oil into the bushing area.
6. Install CE housing over the locator pins and CE screws, ensuring the square fiber washer is properly aligned with the anti-turn feature on the CE housing.
7. Torque the CE screws 40 to 60 in-lb. (4.5 to 6.8 Nm).
8. First insert the small round fiber insulator and then the rubber bushing over the Insulated/ground stud into the hole on the CE housing. Installing the rubber bushing prior to installing the CE housing can pinch the bushing and destroy its sealing capabilities.
9. Install the large round fiber washer and the remaining parts in the same order as were removed. Torque the large nut on the ground stud 20 to 25 ft-lb. (27.0 to 33.8 Nm).

6.5. Electrical Starting System Troubleshooting

6.5.1. Starter Circuit Inspection

1. Before removing any unit in the cranking circuit for repair, the following preliminary checks should be made:

   a. To ensure battery is fully charged, perform battery tests.

   b. Wiring: Inspect wiring for damage. Inspect all connections for corrosion or looseness. Clean and tighten all cable connections as required.

   c. Magnetic switch, solenoid and control switches: Inspect all switches to determine their condition. Connect a jumper lead around any switch suspected of being defective. If the system functions properly using this method, check and/or replace the by-passed switch.

   d. Motor: If the battery, wiring and switches are in satisfactory condition and the engine is known to be functioning properly, remove the starter motor. With starter motor removed from the engine, check to see that armature is not “frozen” in position by prying on the pinion with a screwdriver. Tight bushings, a bent armature shaft or a loose pole shoe screw will prevent the armature from turning freely. If the armature is frozen or does not turn freely, the motor should be disassembled and the problem corrected. However, if the armature rotates freely, the motor should be given the following no-load test before disassembly.

6.5.2. Starter No-Load Test

To perform test, make test connections as follows:

1. Connect an ammeter in series with the positive (+) cable from the two 12-volt batteries and the BAT terminal of the starter solenoid. See “Fig. 9-37: No-Load Test” on page 52.
2. Connect a switch in the open position from the starter solenoid BAT terminal to the solenoid switch (S) terminal.
3. Connect a lead from the starter commutator end terminal to battery negative (-) terminal.
4. Connect a voltmeter from the solenoid motor (M) terminal to commutator end terminal on the starter motor.
5. Install RPM indicator (tachometer) to end of armature shaft to determine armature RPM.
6. Close the switch and note the RPM, current and voltage reading. It is not necessary to obtain the exact voltage specified.

   Reading should be:

   Volts - 20
   Min. Amps - 50
   Max. Amps - 90
   Min. RPM - 6300
   Max. RPM - 8400

7. If exact voltage reading is desired, connect a carbon pile across one of the two 12-volt batteries to reduce voltage to specified value.

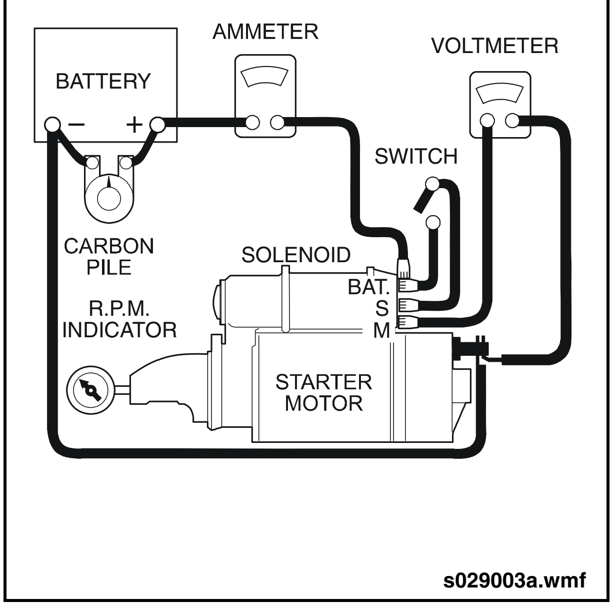


Fig. 9-37: No-Load Test

6.5.3. No-Load Test Result

1. Rated current draw and no-load speed indicates normal condition of the starter motor.
2. Low free-speed and high current draw indicates:
   a. Excessive friction: tight, dirty, or worn bushings, bent armature shaft or loose pole shoes allowing armature to drag.
   b. Shorted armature: this can be further checked on a growler after disassembly.
   c. Grounded armature of fields: check further after disassembly.
3. Failure of starter to operate with high current draw indicates:
   a. A direct ground in the terminal or fields.
   b. “Frozen” bushings. This should have been determined by turning the armature by hand.
4. Failure to operate with no current draw indicates:
   a. Open circuit: this can be checked after disassembly by inspecting internal connections and tracing circuit with a test lamp.
   b. Open armature coils: inspect the commutator for badly burned bars after disassembly.
   c. Broken brush springs, worn brushes, high insulation between the commutator bars or other causes which would prevent good contact between the brushes and commutator.
5. Low no-load speed and low current draw indicates high internal resistance due to poor connections, defective leads, or commutator “varnish” and causes listed under step 4 preceding.
6. High free-speed and high current draw indicates shorted fields. If shorted fields are suspected, replace the field coil assembly and check for improved performance.

6.5.4. Starter Solenoid Switch Troubleshooting

The basic solenoid circuit with dual windings is shown. The hold-in winding is connected from the (S) terminal to the (M) terminal.

1. When the start switch is closed: both windings are energized and the magnetism produced by each acts together to strongly attract the plunger into the core. The pull-in winding current returns to the battery through the motor windings. See “Fig. 9-38: Solenoid Winding Check” on page 55.
2. With the motor cranking: the hold-in winding magnetism is sufficient to hold the plunger in and the contact disc shorts out the pull-in winding, thereby avoiding excessive heat.
3. When the switch is opened: battery current flows through the contact disc to the (M) terminal and through the pull-in winding in the reverse direction and the hold-in winding in the normal direction. The two magnetic fields oppose and essentially cancel out each other. The return springs cause the solenoid to return to its original position thus completing the cranking cycle.
4. The solenoid can be checked electrically by connecting a battery of the specified voltage, a switch and an ammeter to the two solenoid windings. With all leads disconnected from the solenoid, make test connections as shown.

❒ Connect switch and ammeter to the (S) and (M) terminals.

❒ To reduce the voltage to the specified value, if needed, connect the carbon pile between the battery and (M) terminal as shown.

❒ If a carbon pile is not needed, connect a jumper directly from the battery to the (M) terminal.

CAUTION

To prevent overheating, DO NOT leave the pull-in winding energized more than 15 seconds. The current draw will decrease as the winding temperature increases.

An operational method is as follows:

a. Connect battery to (S) terminal and to (G) terminal. See “Fig. 9-39: Testing Solenoid Winding” on page 55.

b. A plunger inserted inside solenoid should be magnetically attracted. If not, hold-in winding is open.

c. Connect battery to (S) terminal and to (M) terminal. See “Fig. 9-40: Testing Solenoid Pull-In Winding” on page 55. A plunger inserted inside solenoid should be magnetically attracted. If not, pull-in winding is open.

d. Connect battery to (M) terminal and to (G) terminal. A plunger inserted inside solenoid should not be magnetically attracted. If it is, windings are shorted.

e. Connect battery from (G) terminal to solenoid case or metal ground. A plunger inserted inside solenoid should not be magnetically attracted. If it is, windings are grounded.

5. Solenoid requires no periodic maintenance other than keeping the terminals clean and tight.
6. Always check action of solenoid if it has been removed. If unit fails to function, first check wiring before condemning the solenoid. Solenoid windings can be checked for current draw, open circuit, or shorts. Adjust carbon pile for specified voltage reading, then record amperage reading.
7. A burned solenoid coil, excessively carbonized terminal contacts or contact disc should be replaced (contact disc can be reversed). Also check resistance between solenoid motor terminal stud and "hold-in" winding terminal lug, since oxidation sometimes insulates the terminal lug from the terminal stud (resistance should be no more than 0.2 ohms). Whenever solenoid is removed from the starter motor, pinion clearance must be checked and properly adjusted.

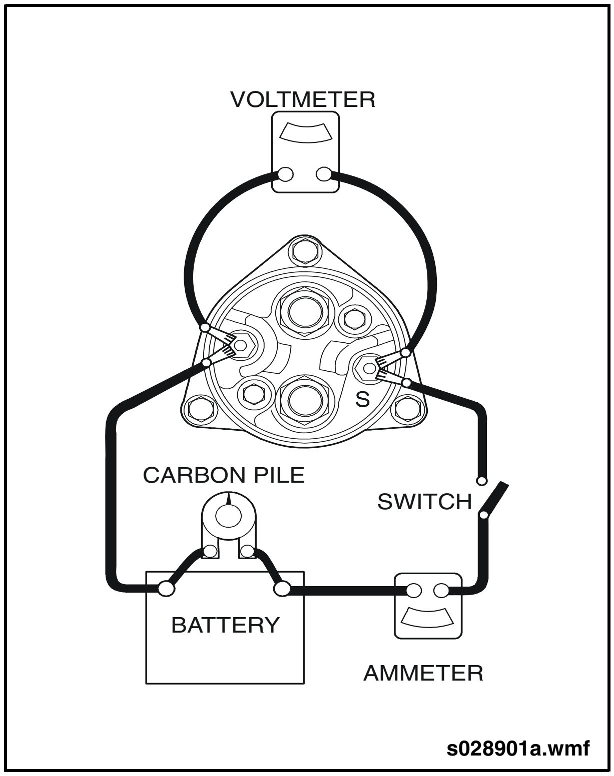


Fig. 9-39: Testing Solenoid Winding

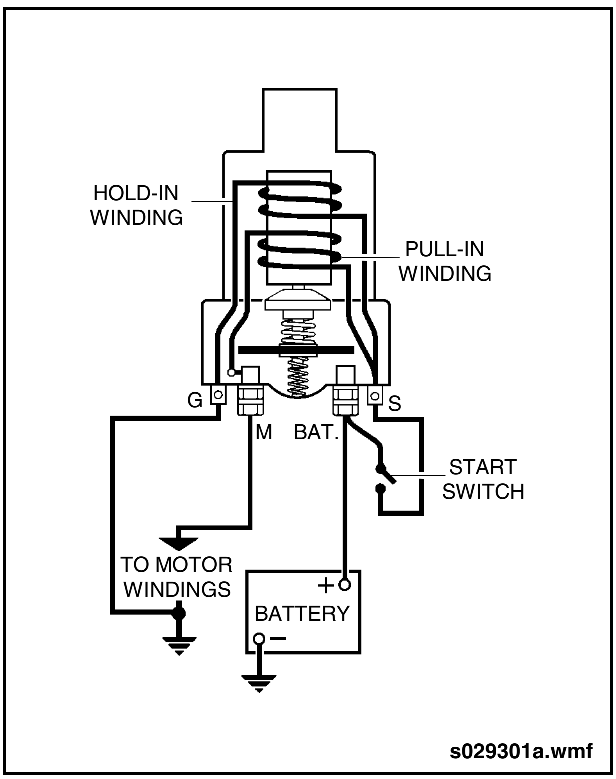


Fig. 9-38: Solenoid Winding Check

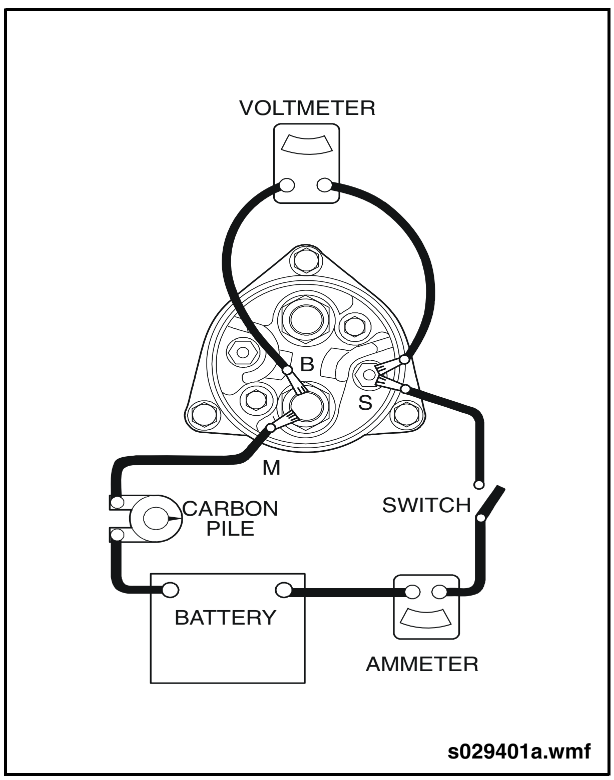


Fig. 9-40: Testing Solenoid Pull-In Winding

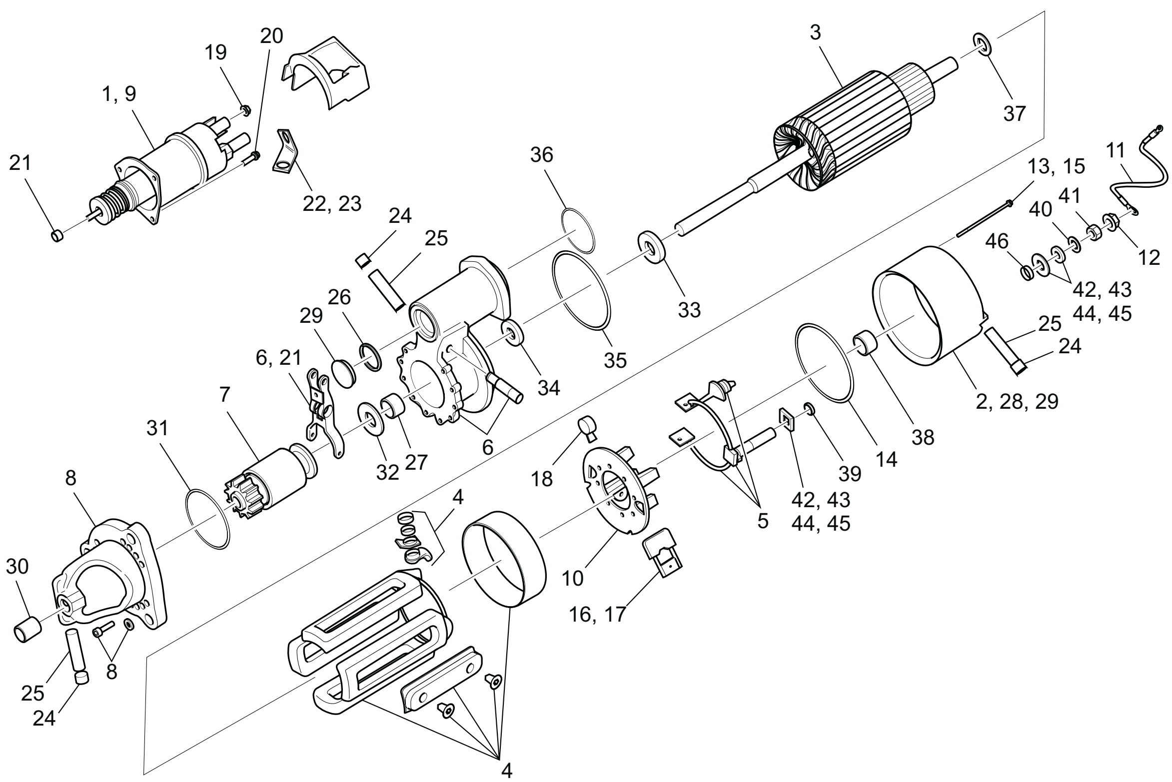
6.6. Disassembly

Normally the starter motor should be disassembled only as far as necessary to repair or replace defective parts.

WARNING

As a precaution, safety glasses should be worn when disassembling the starter motor.

1. Note the relative position of the solenoid, lever housing, nose housing and commutator end for later reassembly. See “Fig. 9-41: Starter Motor Assembly” on page 57.
2. Disconnect field coil connector from solenoid motor terminal and ground return lead from solenoid.
3. From the insulated/ground terminal, carefully noting orientation for reassembly, remove all parts including the solenoid ground lead. Check the condition of insulators and sealing features and consider replacing them if they are damaged or excessively worn.
4. Remove the four (4) CE attaching screws and CE housing. If the armature thrust washer is struck to the CE housing hub, remove it and place it on the armature shaft.
5. Remove the remaining insulators from the ground stud, carefully noting orientation for reassembly. Check the condition of insulators and sealing features and consider replacing them if they are damaged or excessively worn.
6. Remove attaching screws to separate brush plate assembly from field frame.
7. Separate nose housing and field frame from lever housing by removing attaching bolts.
8. Remove pinion stop.
9. Remove armature and clutch assembly from lever housing.
10. Separate solenoid from lever housing by pulling apart.
11. It is not necessary to further disassemble starter unless parts require replacement. Refer to 6.6.1. “Inspection, Tests & Repair of Starter” on page 58 in this section for procedure.



1. Starter Motor Assembly, 24V (Incl. 2-42)
2. C.E. Housing Assembly
3. Armature Assembly
4. Field Coil Assembly
5. Terminal & Lead Assembly
6. Housing Assembly, Lever
7. Drive Assembly
8. Housing Assembly, Drive
9. Switch, Solenoid
10. Brush Plate Assembly
11. Lead Assembly, C.E. Housing
12. Nut, C.E. Housing with Washer
13. Screw, C.E. Frame Attachment with Washer
14. O-Ring, On Motor Frame C.E. End
15. Screw, C.E. Frame Attachment with Washer
16. Screw
17. Brush
18. Spring, Brush
19. Nut, Shunt Lead to Switch Attachment
20. Screw, Solenoid
21. Nut, Plunger Rod Guide Adjusting
22. Connector, Solenoid
23. Connector, Solenoid
24. Cup, C.E. Housing
25. Wick, Oil Reservoir Lever Housing
26. Gasket, Inspection Plug Lever Housing
27. Bushing, Lever Housing
28. Wick, Oil Reservoir D.E.
29. Cup, Oil Reservoir D.E.
30. Bushing, Drive Housing
31. O-Ring, Drive Housing & Lever Housing
32. Washer, Brake
33. Washer, Space D.E.
34. Seal, Oil Lever Housing
35. O-Ring, Lever Housing & Frame
36. O-Ring, Switch & Lever Housing
37. Washer, Thrust C.E.
38. Bushing, C.E. Housing
39. Washer, C.E. Housing
40. Washer, Lock Internal Tooth 1/2"
41. Nut, Hex Jam 1/2" - 13 UNC
42. Insulation, C.E. Terminal (Incl. 43-46)
43. Insulator
44. Insulator
45. Insulator
46. Bushing

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Fig. 9-41: Starter Motor Assembly

6.6.1. Inspection, Tests & Repair of Starter

CAUTION

The drive assembly, armature and field frame and coils assembly should not be cleaned in any degreasing tank or with grease dissolving solution, Since these would dissolve the lubricant in the drive mechanism and damage the insulation in the armature and field coils.

All parts except the drive should be cleaned with mineral spirits and a brush. The drive should be wiped with a clean cloth.

NEVER use emery cloth to clean commutator.

6.6.2. Brushes & Holders

Refer to 6.4.2. "Brush Inspection" on page 51 in this section for information on brush inspection and replacement.

6.6.3. Armature

If the armature commutator is worn, dirty, out-of-round, or has high insulation, the armature should be put in a lathe and the commutator turned down.

The insulation should then be undercut 1/32" (0.794 mm) wide and 1/32" deep and the slots cleaned out to remove any trace of dirt or copper dust. As a final step in this procedure, the commutator should be sanded lightly with No. 00 sandpaper to remove any burrs left as a result of the undercutting procedure. Do not cut deeper than necessary to remove rough spots or out-of-round condition.

Check the armature for open and/or short circuits and grounds as follows:

1. Open circuit test

   Open circuits are usually caused by excessively long cranking periods. The most likely place for an open circuit to occur is at the commutator riser bars. Inspect the points where the conductors are joined to the commutator bars for loose connections. Poor connections cause arcing and burning of commutator bars as the cranking motor is used. If the bars are not too badly burned, repair can often be done by soldering (or welding) the leads in the riser bars (using Rosin Flux) and turning down the commutator in a lathe to remove the burnt material. The insulation should then be undercut as noted previously.

2. Short circuit test

   Short circuits in the armature are located by the use of a growler. When armature is rotated in the growler with a steel strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short circuit is located. Shorts between bars are sometimes produced by brush dust or copper between the bars. These shorts can be eliminated by cleaning out the slots. See "Fig. 9-42: Checking Armature (shorts)" on page 59.

3. Ground test

   Grounds in the armature can be detected with a 110-volt test lamp and test probes. If the lamp lights with one test probe placed on commutator and the other on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure, which is often brought about by overheating due to excessively long cranking periods, or by accumulation of brush dust between the commutator bars and the steel commutator ring.

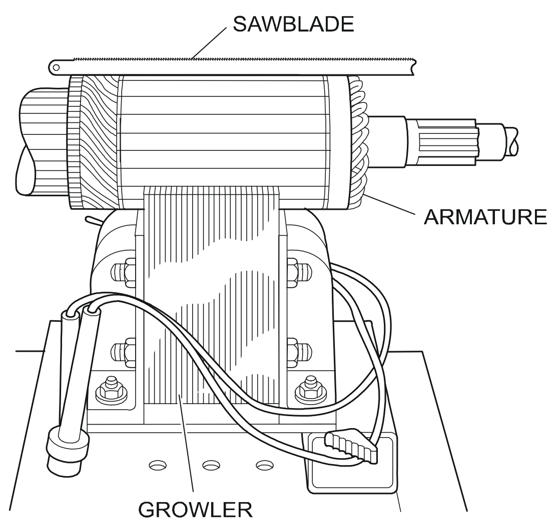


Fig. 9-42: Checking Armature (shorts)

6.6.4. Field Coils

Internal wiring circuit is shown. The field coils can be checked for grounds and opens using a test lamp as follows:

1. Grounds

   The field coil ground connection must be disconnected during this test. Connect one lead of the 110-volt test lamp to the field frame and the other lead to the field connector terminal stud on the field frame. If the lamp lights, at least one of the field coils is grounded and must be repaired or replaced.

   NOTE:

   This check cannot be made unless the ground connection is disconnected.

2. Opens

   Connect one test lamp lead to the terminal stud on field frame and the other in turn to each of the field coil leads which connect to the brush holders; the lamp should light. If lamp fails to light, the field coils are open.

3. Replacement

   Remove the eight (8) pole shoe screws and four (4) pole shoes. If sealing on screws are damaged, replace them with new pole shoe screw assemblies.

   Remove the field coil assembly, insulation strip, terminal insulator and grommet.

   Install the inside terminal insulator, field coil assembly and insulation strip into the frame.

   Install the four (4) pole shoes, with notched end toward the Commutator End, and eight (8) pole shoe screws. Torque screws 15 to 50 ft-lb. (20.3 to 67.8 Nm). Consider hitting the coil terminals slightly to ensure they don’t touch the insulation paper. This will also help to avoid any rubbing between the armature and terminals.

6.6.5. Commutator End Frame

1. Remove Commutator End Housing. Refer to 6.6. "Disassembly" on page 56 in this section for procedure.
2. Remove all parts from the CE housing assembly. If reconditioning the CE housing, remove the bushing, cup and wick.
3. Soak new wick in SAE 20 weight oil for several hours to allow the oil to penetrate and install into the housing.
4. Align the cup with the wick hole, open end down, and tap it into place until it is flush with the housing. It is best to use a deep well socket or similar device about the same size as the outside diameter of the wick cap. Strike it with a hammer until the cup top is flush with the casting.
5. Install the CE housing bushing using a large pin punch which has about the same outside diameter as the bushing.
6. Install the O-ring onto the frame groove.
7. Install the square fiber insulator and fiber washer onto the ground stud.
8. Apply bearing type grease onto CE housing's inner diameter where the frame O-ring is seated and apply a small amount of SAE 20 oil into the bushing area.
9. Install CE housing over the locator pins and install CE attaching screws, assuring the square fiber washer is properly aligned with the anti-turn feature on the CE housing. Refer to 6.7. "Assembly" on page 63 in this section for complete assembly procedure.

6.6.6. Shift Lever Housing

Inspect oil seal and bushing in shift lever housing for evidence of damage or excessive wear.

Replace bushing, if necessary. New oil seal lip must point inward.

If shift lever appears excessively loose on lever shaft, worn parts can be replaced by removing retaining ring from exposed small end of lever shaft, then driving shaft out of housing. When installing lever and shaft, use new O-rings in grooves in shaft.

6.6.7. Drive Housing

Inspect bushing in nose housing for wear. Replace bushing, if necessary.

6.6.8. Drive Assembly

Drive pinion must rotate freely in overrunning direction and must not slip in cranking direction. The drive assembly can be serviced as follows: See "Fig. 9-43: Drive Clutch Assembly" on page 61.

1. Disassembly

   Using suitable tools, remove the pinion stop cup and split washer from sleeve.

   ☞**NOTE:**

   In removing the pinion stop cup it will probably be damaged. Use new cup at assembly.

   Remove pinion, spring retainer outer cup, spring and spring retainer inner cup.

2. Inspection & Repair

   Inspect spring and spring retainer cups. If not in good usable condition, replace with new part. Inspect pinion. If teeth are chipped or cracked, replace pinion. Inspect sleeve bushings.

   If bushings do not meet specifications listed at end of this group, press old bushings out of sleeve and press new bushings into place. Ream bushings to specifications listed at end of this group.

3. Assembly

   Install spring retainer inner cup, spring and spring retainer outer cup on sleeve. Install pinion and pinion stop cup on clutch sleeve. Install split-type washers in groove at end of clutch sleeve.

   Position clutch sleeve assembly in a vise, then with pinion seated firmly against the pinion stop cup and using suitable tools, bend pinion stop cup lip over split washers, locking pinion stop and split washers together

   ☞**NOTE:**

   DO NOT lubricate the stops (sprags) as they are lubricated for life.

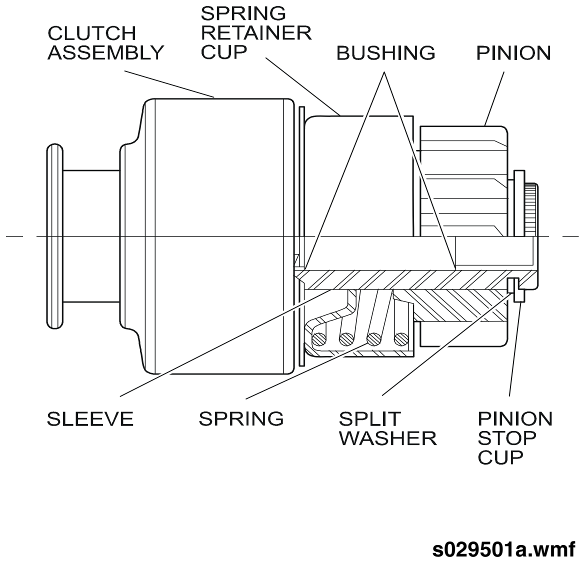


Fig. 9-43: Drive Clutch Assembly

6.6.9. Solenoid

6.6.9.1. Removal

1. Loosen 3/4" nut on solenoid motor terminal or loosen E8 Torx Head solenoid motor terminal screw.
2. Remove E8 Torx Head screw at field connection on starter frame.
3. Remove 3/4" nut from solenoid motor terminal or remove E8 Torx Head solenoid motor terminal screw.
4. Remove solenoid to starter field connector strap.
5. Remove top 3/8" nut and washer assembly from ground terminal of solenoid.
6. Remove flexible ground cable from the solenoid ground terminal.
7. Remove access plug and gasket from front of lever housing, ensuring gasket is removed.
8. Remove 1/2" plunger nut, carefully as follows:

WARNING

Proper care must be exercised when completing this step to avoid personal injury and property damage. Also, to avoid overheating and possible damage to the solenoid, power should not be applied in excess of one minute.

DANGER

Solenoid must be energized for removal of 1/2" plunger nut to prevent plunger from rotating and damaging the rubber boot. Ensure stamped metal connector strap is disconnected to prevent motor from rotating.

   a. Apply power to solenoid between switch “S” (positive lead) and ground (negative lead) terminals. Seat the plunger by simultaneously pushing on 1/2" plunger nut.
   b. Remove 1/2" plunger nut carefully, so it does not drop into motor, and discard.
   c. Remove power immediately after nut is removed.

9. Remove three E8 Torx Head solenoid mounting screws.
10. Remove complete solenoid and plunger assembly from lever housing.

6.6.9.2. Installation

1. Slide solenoid over lever housing register.
2. Orient solenoid so that the flat flange on the solenoid metal case aligns with the flat flange on the housing.
3. Verify that the plunger rod is inside the shift lever guide.
4. Install three E8 Torx Head solenoid mounting screws and torque 125 to 190 in-lb. (14.1 to 21.5 Nm).
5. Install a new 1/2" plunger nut by hand finger tight.

WARNING

Use of force can rotate the plunger and damage the rubber boot.

6. Check and adjust pinion clearance.
7. Install access plug and gasket to front of lever housing and tighten to a minimum of 72 in-lb. (8.1 Nm).
8. Install solenoid-to-motor field connector strap, using strap, as follows:
   a. Install E8 Torx Head field terminal screw on starter frame finger tight.
   b. Install E8 Torx Head screw on solenoid motor terminal finger tight.
   c. Tighten E8 Torx Head screw at starter frame 75 to 95 in-lb. (8.5 to 10.7 Nm).
   d. Tighten E8 Torx Head screw at solenoid motor terminal 75 to 95 in-lb. (8.5 to 10.7 Nm).
9. Remove top 3/8" nut and washer assembly from solenoid ground terminal and install flexible ground cable.
10. Install 3/8" ground terminal nut and washer assembly and tighten to 16 to 38 in-lb. (1.8 to 4.3 Nm).
11. Check motor for proper function before installation.

6.7. Assembly

1. Lubricate splines of armature shaft with SAE 20 oil, then insert drive end of armature shaft through shift lever housing until shaft just extends through housing. Place O-rings and collar over armature shaft and position in counter-bore in housing. Place brake washer over end of shaft.
2. Position drive clutch assembly in lever housing with lugs on lever yoke engaging groove in drive clutch shift collar, then push armature shaft through housing and drive clutch.
3. Place gasket in counter-bore in shift lever housing, then install drive housing over armature shaft and position at lever housing, with marks made prior to disassembly aligned. Attach drive housing to lever housing with six socket head screws, tighten screws to 13 to 17 ft-lb. (18 to 23 Nm) torque.
4. Install new O-ring in groove in field frame side of shift lever housing. Install field frame over armature and position against shift lever housing as noted prior to disassembly. Attach lever housing to field frame with five cap screws and lock washers. Torque 12 to 16 ft-lb. (16 to 22 Nm).
5. Position solenoid with plunger rod end inserted into shift lever housing. Fasten solenoid case to shift lever housing with three cap screws and lock washers. Through the opening in opposite end of lever housing, make sure plunger rod passes through plunger rod guide in shift lever.
6. Place thrust washer over commutator end of armature shaft. Place new O-ring in groove around commutator end frame. Pull the armature out of the field frame just far enough to permit the brush to be placed over the commutator. Connect field coil leads and brush leads to brush holders.

   Align commutator end frame and armature with field frame as noted prior to disassembly. Attach end frame to field frame with cap screws and lock washers. Torque cap screws 40 to 60 ft-lb. (4.5 to 6.8 Nm).

   ☞**NOTE:**

   Insert the small round fiber insulator and then the rubber bushing over the ground stud into the hole on the CE housing. Installing rubber bushing prior to installing the CE housing can pinch the bushing and destroy its sealing capabilities. Install the large round fiber washer and the remaining hardware in the same order the parts were removed. Torque the large nut on ground stud 20 to 25 ft-lb. (27.0 to 33.8 Nm).

7. Connect solenoid ground lead to terminal stud on commutator end frame.
8. Saturate all wicks and fill oil reservoirs with SAE 20 oil.

9. Adjust pinion clearance as directed below:

   a. Connect a battery to the solenoid. See “Fig. 9-44: Starter Motor Pinion Clearance Check” on page 64.

DANGER

Ensure stamped metal connector strap is disconnected to prevent motor from rotating.

WARNING

Proper care must be exercised when completing this step to avoid personal injury and property damage. Also, to avoid overheating and possible damage to the solenoid, power should not be applied in excess of one minute.

   b. Solenoid must be energized to prevent plunger from rotating and damaging the rubber boot while tightening plunger nut to adjust pinion clearance. Warning: Ensure stamped metal connector strap is disconnected to prevent motor from rotating. Apply appropriate power to solenoid between switch “S” (positive lead) and ground (negative lead) terminals.

   c. Seat the plunger by simultaneously pushing on 1/2" plunger nut.

   d. Adjust 1/2" plunger nut to obtain correct distance between the pinion face and the inside of the machined surface of the nose housing. This distance must conform to between 0.328" and 0.390" (8.3 to 9.9 mm). While measuring, apply slight pressure against the pinion to take the slack out.

   e. Disconnect power immediately after pinion is properly adjusted.

10. Install connector strap on the solenoid “motor” terminal and field frame stud.

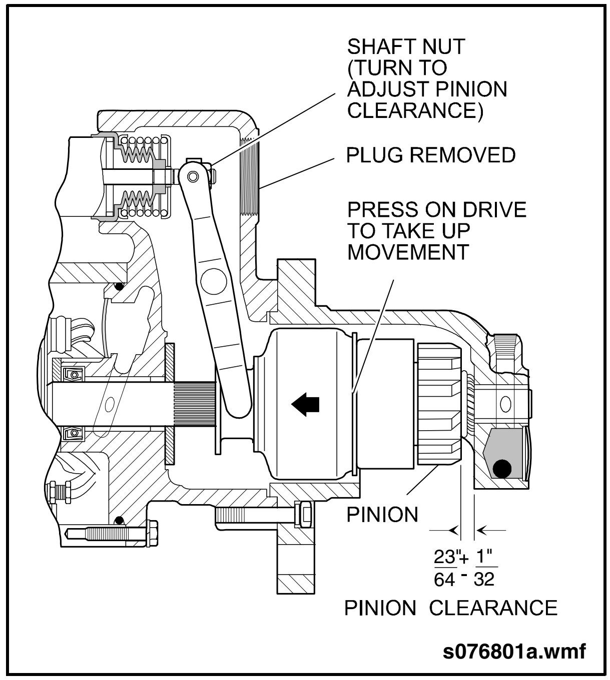


Fig. 9-44: Starter Motor Pinion Clearance Check

6.8. Installation

☞NOTE:

Before installing starter, perform “no-load” test.

1. Use a suitable strap to raise the motor into position.
2. Place spacer between starter and engine flywheel housing and install starter using three M12 bolts. Torque bolts to 75 ft-lb. (102 Nm).
3. Connect cables and wires to their respective terminals. Torque positive and negative terminal nut 1/2" - 13 UNC to 20 to 25 ft-lb. (27 to 34 Nm). Torque solenoid “S” terminal nut #10 - 32 to 15 to 30 in-lb.
4. Set Battery Disconnect switch to the ON position and check operation of starter motor.

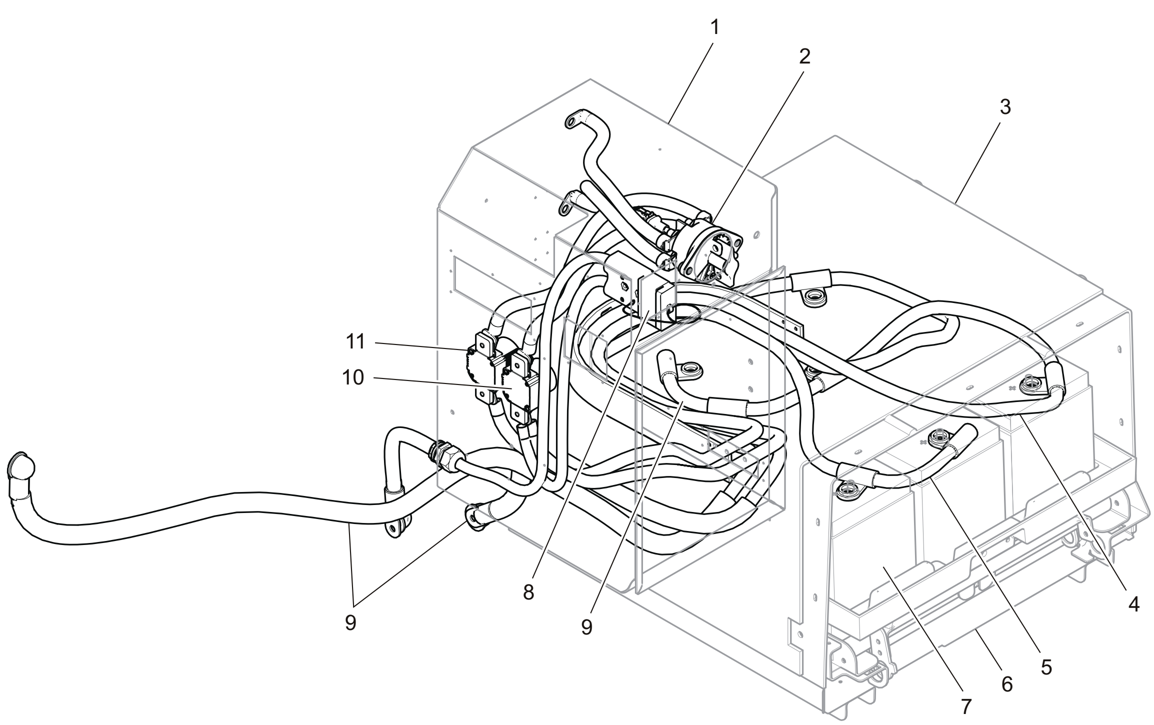
7. BATTERY SYSTEM

7.1. Description

The battery system consists of the vehicle batteries and tray, the battery disconnect switch, and the vehicle fuses. The battery tray is located at the rear curbside of the vehicle behind an access door. It is a stainless steel assembly which houses the batteries and which is equipped with steel rollers and a grab handle to allow ease of access. See “Fig. 9-45: Battery Tray” on page 65. The battery disconnect switch is located on the fusebox, above the battery tray. See “Fig. 9-46: Battery Disconnect Switch & Fuses” on page 66. This switch isolates the batteries from the vehicle electrical system. It must be set to the OFF position whenever electrical maintenance is performed. A cutoff switch access door is provided in the main battery access door to allow disconnection of electrical power without having to open the battery access door. The vehicle fuses are located in the fusebox adjacent to the battery tray. Refer to the PS (Power & Starting) Electrical Schematic for the battery system electrical connections.

☞**NOTE:**

ALWAYS set Battery Disconnect switches to the OFF position before disconnecting battery cables. Engine must be OFF before any disconnecting.



1. Fusebox
2. Disconnect Switch
3. Cover
4. Battery to Relay Power Cable PS3PC 12V
5. Battery to Relay Power Cable PS29PC 24V
6. Slide Tray
7. Batteries
8. Jumpstart Assembly
9. Ground to Groundpoint Battery PS12PC
10. Relay 400A
11. Relay 400A

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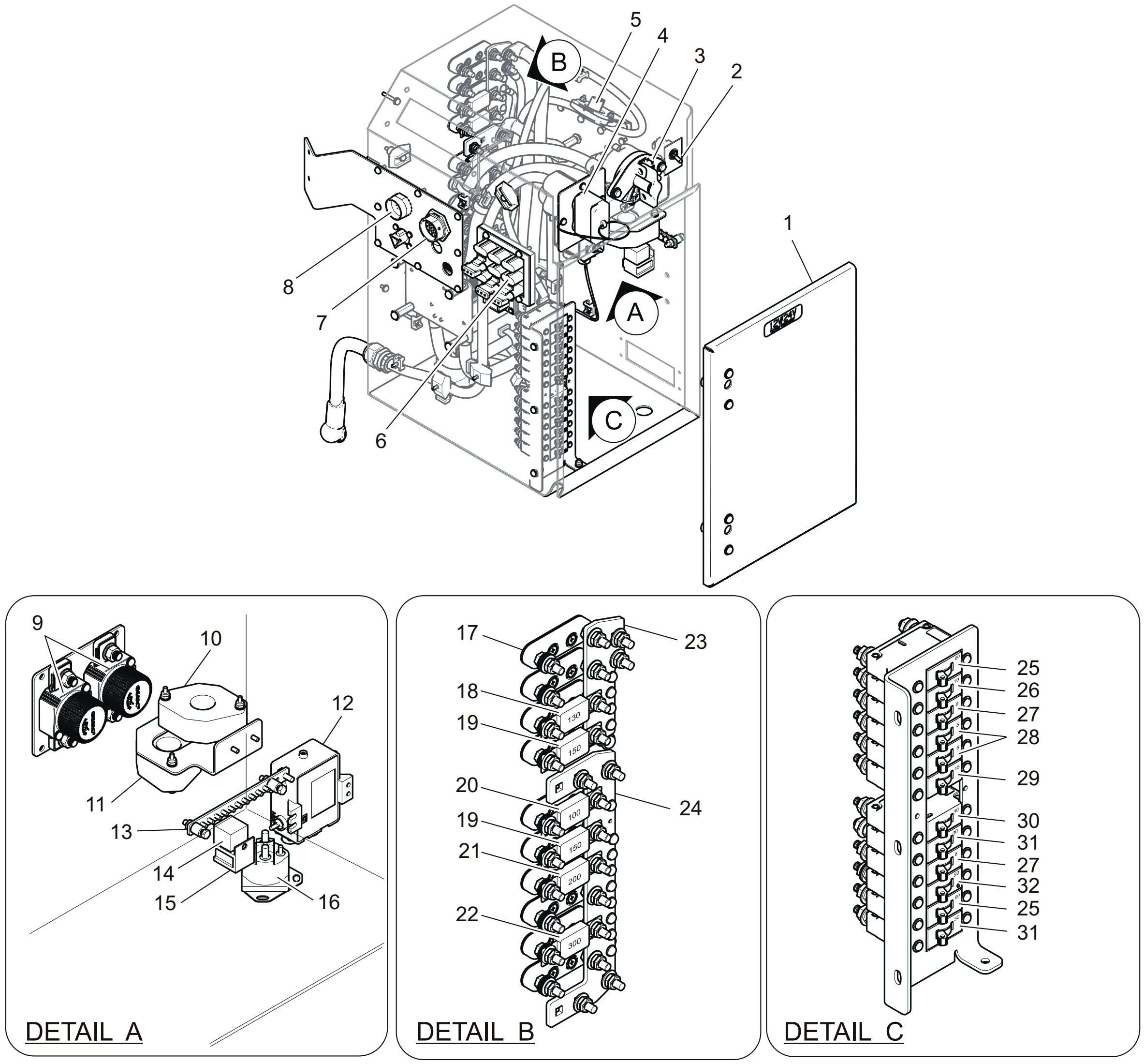
Fig. 9-45: Battery Tray



1. Fusebox Access Door Assembly
2. Switch, Service Light
3. Switch, Battery Disconnect
4. Jumpstart Assembly
5. Fusebox Service Light
6. Connector, Packard 9-3 CCT
7. Fusebox Harness Assembly
8. Power Lead Harness
9. Power Relay 400A
10. Current Sensor
11. Dual Sensor
12. Voltage Regulator
13. Bus Bar, 12 Position Ground
14. Relay, 24V SPDT w/Diode
15. Module, Relay Socket
16. Magnetic Starter Switch
17. Block, Fuse
18. Fuse, Limiter 130A
19. Fuse, Limiter 150A
20. Fuse, Limiter 100A
21. Fuse, Limiter 200A
22. Fuse, Limiter 300A
23. Bus Bar, 12V
24. Bus Bar, 24V
25. Breaker, 60 AMP Long Delay
26. Breaker, 10 AMP Long Delay
27. Breaker, 6 AMP Long Delay
28. Breakers, 5 AMP Long Delay
29. Breaker, 15 AMP Long Delay
30. Breaker, 30 AMP Instant Trip
31. Breaker, 30 AMP Long Delay
32. Breaker, 50 AMP Motor Start Delay

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Fig. 9-46: Battery Disconnect Switch & Fuses

7.2. Battery Disconnect Switch

7.2.1. Description

The Battery Disconnect switch is located inside the battery compartment, on the face of the fusebox cover. This rotary switch serves to disconnect the batteries from the vehicle 12/24V electrical systems. It is accessible through the battery access door. To disconnect the batteries from the electrical system, rotate the battery disconnect switch to the OFF position. Always rotate this switch to the OFF position before disconnecting any battery cables.

☞**NOTE:**

Use several wrappings of electrical tape to insulate any disconnected power cable ends or battery terminals that could be accidentally grounded during maintenance activity.

7.2.2. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Disconnect the negative battery cables from the batteries.
3. Remove the front access panel on fusebox to provide access to the Battery Disconnect switch.
4. Unplug the wiring harness connector from the Battery Disconnect switch.
5. Tag and remove the power cables from the back side of the Battery Disconnect switch.
6. Remove the two bolts, nuts, and washers that secure the Battery Disconnect switch to the fusebox panel.
7. Use a sharp knife to cut through the sealant between the edge of the Battery Disconnect switch and the mounting surface of the fusebox panel.
8. Remove the Battery Disconnect switch from the fusebox.

7.2.3. Installation

1. Clean the switch mounting surface on the fusebox panel.
2. Apply Sika 221 adhesive to the edges of the mounting surface of the Battery Disconnect switch.
3. Secure Battery Disconnect switch to fusebox panel using original fasteners.
4. Install the power cables, as noted during removal, and torque the nuts to 14 ft-lb. (19 Nm).
5. Plug in the wiring harness connector.
6. Install the front fusebox access panel.
7. Connect the negative cables on the batteries.
8. Set the Battery Disconnect switch to the ON position and confirm proper operation of the switch.

7.3. Jumpstart Installation

CAUTION

DO NOT use conventional jumper cables when starting the vehicle. ALWAYS use an approved jumpstart adapter that is designed to be used with the vehicle jumpstart quick-connector.

7.3.1. Description

This vehicle is provided with a jumpstart installation for emergency starts. The installation consists of a quick-connect jumpstart connector which is wired directly to the vehicle 24VDC power supply and ground circuits. The connector is mounted below the battery disconnect switch on the rear equipment box.

Refer to the PS (Power and Starting) Electrical Schematic for the wiring connections for the electrical starting and the battery systems.

CAUTION

Before connecting an external voltage, ensure that the Battery Disconnect switch is ON.

7.4. Fusebox Assembly

7.4.1. Description

The fusebox assembly is located directly above the battery tray in the battery compartment. The main components of the fusebox assembly include the Battery Disconnect switch, voltage regulator, fuse panel, circuit breaker panel, and Compartment Light switch. Refer to 7.2. “Battery Disconnect Switch” on page 67 in this section for more information on this component.

7.4.2. Fusebox Torque Chart

CAUTION

ALWAYS torque electrical connections to specified torque when replacing any components. Loose connections can result in arcing, component damage, and possibly fire.

FUSEBOX TORQUE CHART

DEVICE	FASTENER	TORQUE ft-lb. (Nm)
Battery Disconnect Switch to Power Cables	Lock Nut	14 ft-lb. (19 Nm)
Circuit Breakers	Lock Nut 1/4" - 20 UNC	2.5 ft-lb. (3.4 Nm)
Fuse Limiters	Lock Nut 5/16" - 24 UNF	10 ft-lb. (13.5 Nm) see Note 1
Magnetic Starter Relay Power Cables	Lock Nut 5/16" - 18 UNC	12 ft-lb. (16.3 Nm)
Bi-Stable Power Relays	M10 x 1.5 x 22	125-175 in-lbs (14 - 19.7 Nm) Dry
Note 1: Install fuse and end directly against bus bar without washer in between. Use required number of washers on panel side to level fuse with panel.		

7.5. Batteries

WARNING

ALWAYS replace batteries with the same type and size identified in your New Flyer Parts Manual and charge the batteries using the recommended voltage. Over-charging a lead acid battery can produce explosive and hazardous gas. Any change in battery configuration may require modification to the charging system voltage levels and battery service procedures to prevent overcharging and equipment damage. Consult the battery manufacturer's recommendations before installing replacement components.

7.5.1. Description

This vehicle is equipped with 12 volt deep cycle heavy duty maintenance free Absorbed Glass Mat (AGM) batteries. The batteries have sealed pressure valves to allow gases to escape and should never be opened. Electrolyte is absorbed in the glass mat and cannot be added to these batteries. Batteries are equipped with threaded positive and negative terminals.

☞**NOTE:**

Opening the vent caps will void the battery warranty.

7.5.2. Batteries Specifications

- ❐ 12 volt
- ❐ 31 group size
- ❐ 1150 cold cranking amperes
- ❐ 205 minute reserve capacity
- ❐ 100 AH battery capacity

7.5.3. Removal

1. Set the Battery Disconnect switches to the OFF position.
2. Remove the wing nut and washers and pivot the battery tray retainer bracket downward. Slide the battery tray out to the fully extended position.
3. Note the positive and negative terminals on the batteries and tag the cables before removing. Refer to Battery Hookup decal on the inside of the fusebox door.
4. Disconnect the cables from the negative terminals of the battery.
5. Disconnect the cables from the positive terminals of the battery, including the jumper cable.
6. Remove the three nuts from the battery holdown retainer. Remove the cable hanger with cables and tie out of the way. Remove the battery holdown retainer.
7. Carefully lift and remove the batteries from the tray.

7.5.4. Installation

1. Install the batteries into the tray with the positive and negative terminals arranged as originally removed.
2. Secure the batteries in place using the holdown retainer and nuts. Position the battery cable hanger and bracket in place and secure.
3. Connect the positive cables and jumper cable to their respective terminals as marked on removal. Torque to 10-15 ft-lb. (14-20 Nm).
4. Connect the negative cables to the battery negative terminal. Torque to 10-15 ft-lb. (14-20 Nm).
5. Ensure exposed battery terminals are protected with a coating of dielectric grease. Ensure protective rubber boots are installed over the positive terminal connectors.
6. Slide the battery tray into the fully retracted position.
7. Pivot the battery tray retainer bracket upwards to engage the stud on the battery tray. Install flat washer, lock washer, and wing nut.
8. Set the Battery Disconnect switch to the ON position.

7.5.5. Battery Charging

BATTERY CHARGING	
State of Charge to Open Circuit Voltage Comparison	
Charge	**Battery Open Circuit Voltage**
100%	12.84 Volts or Higher
90%	12.7 Volts
80%	12.58 Volts
60%	12.32 Volts
40%	12.1 Volts
20%	11.82 Volts
10%	11.7 Volts

☞**NOTE:**
The true open circuit voltage of a battery can only be determined after the battery has been removed from the load (charge or discharge) for a minimum of 8 hours.

Observe the following when charging the batteries:

❒ An adapter kit should be used in charging threaded-terminal batteries when they are out of the vehicle.

❒ When the threaded-terminal battery is in the vehicle, connect the charger's leads to the studs or nuts at the battery's terminals.

❒ Use a 40A rated battery charger with a charging profile that provides a constant current during the bulk charging stage, followed by two stages of constant voltage charge. See "Fig. 9-47: Battery Charging Profile" on page 72.

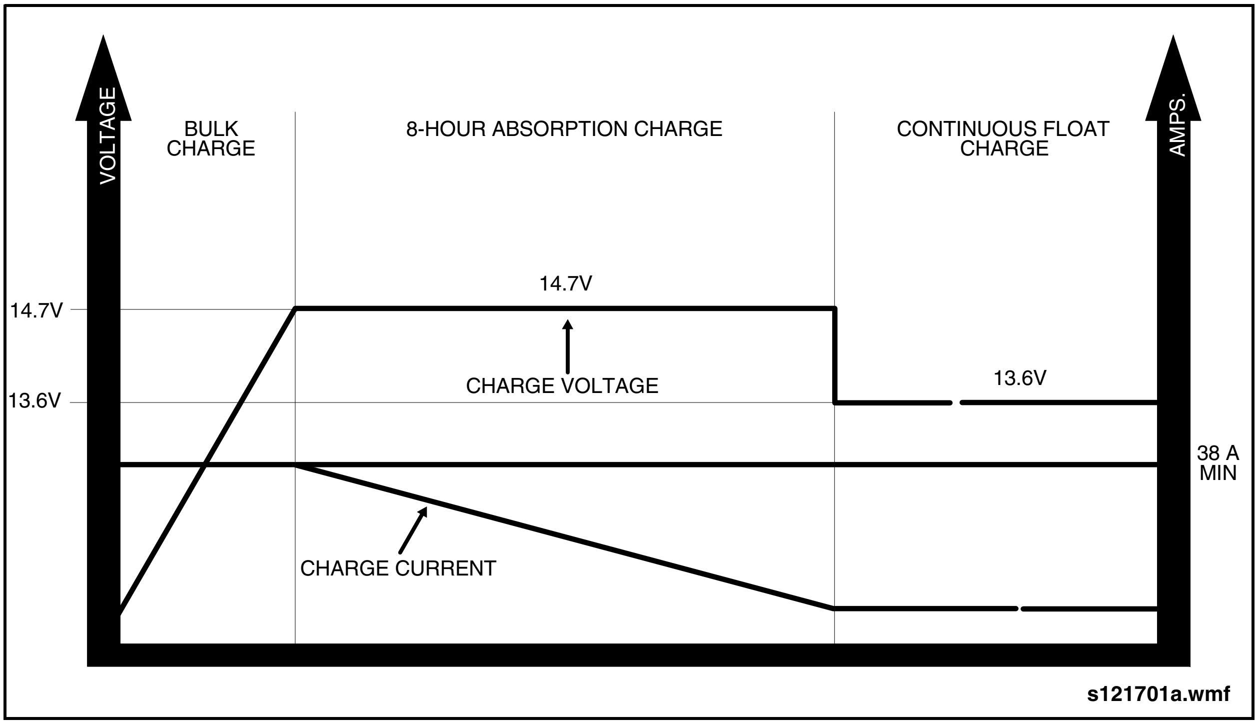


Fig. 9-47: Battery Charging Profile

7.5.6. Functional Test

7.5.6.1. Visual Inspection

1. Check outside of battery for a broken or cracked case.
2. If damage is evident, the battery should be replaced.
3. Check for loose battery terminals, cable connections, and for evidence of corrosion.
4. Correct as required before proceeding with test.

7.5.6.2. Load Test

⚠ WARNING

Wear safety goggles when working with batteries. Immediately flush any areas of skin which have been in contact with battery acid. When disconnecting battery cables, ALWAYS disconnect the negative cable first.

1. Set the Battery Disconnect switch to the OFF position.
2. Disconnect the cables from the battery.
3. Assemble adapters, if available, onto battery leads. Adapters are available from battery manufacturer.
4. Connect voltmeter and battery load tester across battery terminals.
5. If adapters are not available, attach tester clamps to contact lead pads. Tighten hex nuts to hold clamps against lead pads.
6. Recharge battery if open circuit voltage is below 75%. Refer to 7.5.5. “Battery Charging” on page 71 in this section for procedure.
7. Apply a load equal to 1/2 the cold cranking amps for 15 seconds.
8. Voltage should stabilize above 9.6 volts while under load.
9. If voltage is below 9.6 volts recharge battery and repeat test.
10. Replace battery if voltage is below specifications. Clean battery and return to service if voltage is acceptable.

7.5.7. Batteries Troubleshooting

Check for the following conditions if the batteries pass the functional test, yet do not perform well in service:

1. Vehicle accessories left on for long periods of time.
2. Faulty vehicle charging system.
3. High wiring resistance.
4. Vehicle loads exceeding alternator capacity.
5. Shorted wiring.
6. Extended slow speed driving with high electrical loads.
7. Loose or corroded battery connections.
8. Improper battery charging.
9. High resistance connections or defects in cranking system.
10. Lengthy vehicle storage with batteries not disconnected. Batteries connected to stored vehicles can discharge in a six to eight week period, due to small current drains.
11. Discharged batteries can freeze and be difficult to recharge.

7.6. Battery Tray

7.6.1. Description

The battery tray is accessed from a hinged door on the rear curbside corner of the vehicle. The battery tray provides a convenient means of accessing the batteries and includes a stainless steel slide-out tray with rollers and a grab handle. The battery tray is enclosed by a protective plastic cover. Refer to 7.5. “Batteries” on page 70 in this section for information on the batteries. See “Fig. 9-48: Battery Tray Components” on page 74.

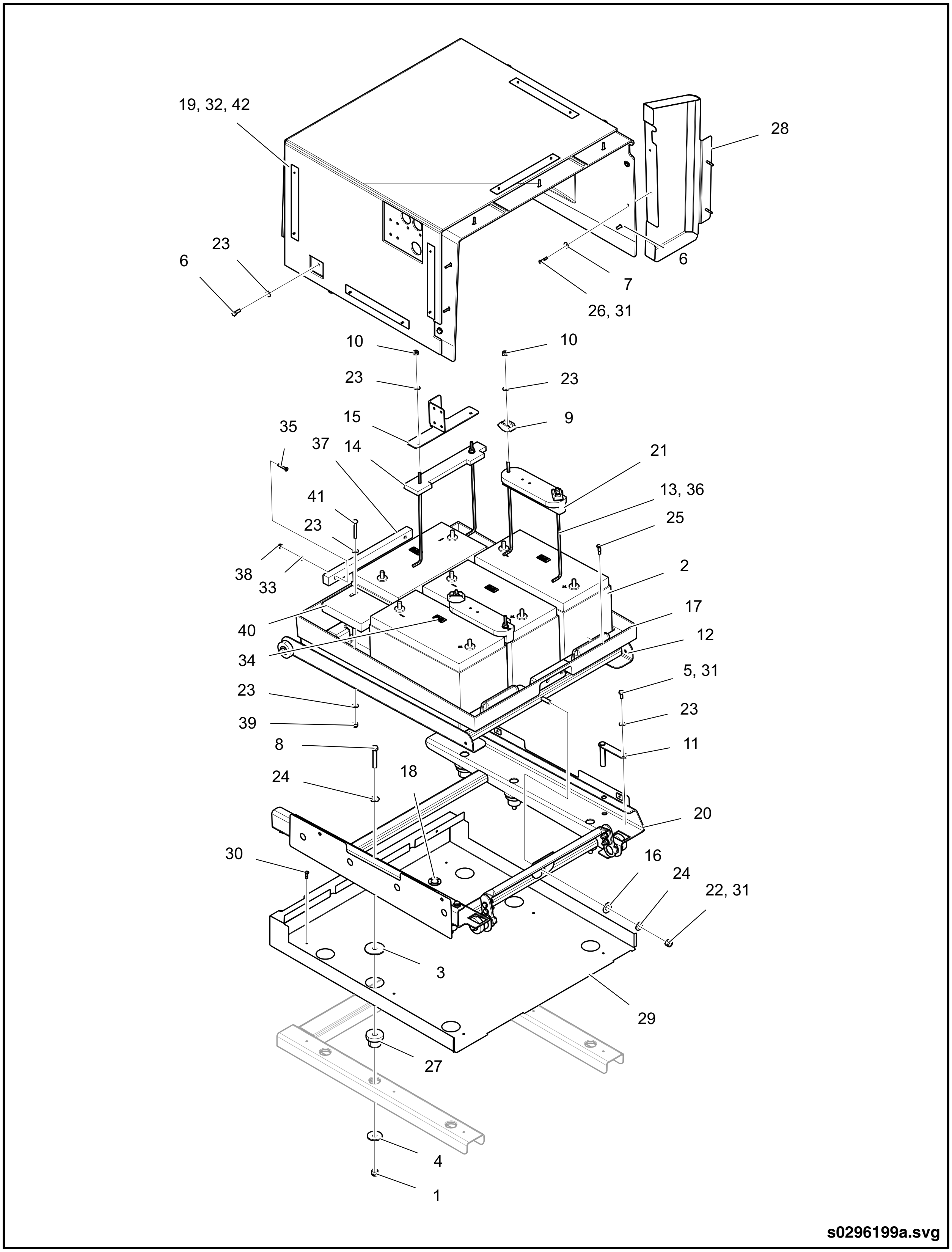


Fig. 9-48: Battery Tray Components

1. Nut, Hex Lock SST 3/8" - 16 UNC	22. Nut, Lock Nylon SST 3/8" - 16 UNC
2. Battery, 1150 CCA 12V	23. Washer, Flat SST 1/4"
3. Washer, SST Upper Vibration Mounting	24. Washer, Flat SST 3/8"
4. Washer, SST Lower Vibration Mounting	25. Rivet, Blind CSK SST 1/4" x .160/.475
5. Bolt, Hex SST 1/4" - 20 UNC x 5/8" Lg.	26. Rivet, Mono Blind SST 3/16" x .064/.420"
6. Bolt, Hex SST 1/4" - 20 UNC x 3/4" Lg.	27. Mount, Center Bonded
7. Washer, Flat SST #10 .625" O.D.	28. Cover, Tray Channel
8. Bolt, Hex SST 3/8" - 16 UNC x 2 1/4" Lg.	29. Battery Cover, Welded
9. Mount, Cable Tie 2-Way 1/4" Eye	30. Rivet, Mono Blind SST 3/16" x .064/.270"
10. Nut, Hex Nylon 1/4" - 20 UNC SST	31. Loctite, 243 Blue
11. Tray Stop, Battery	32. Adhesive, SIKA 221 White
12. Battery Tray Support Assembly	33. Washer, Flat SST #10
13. Hold Down, Battery	34. Indicator, Temperature Strip
14. Spacer, Battery	35. Screw, #10 - 24 x 1 1/4" Lg.
15. Bracket Assembly, Cable	36. Tube, Nylon 3/8" Brown
16. Washer, Flat SST 7/16"	37. Retainer, Battery
17. Tray, Battery	38. Nut, Lock Nylon #10 - 24 UNC
18. Ejector, Dust/Water	39. Nut, Lock Nylon 1/4 -2 0 UNC
19. Cover Assembly, Battery Tray	40. Spacer, Battery
20. Battery Slider Assembly	41. Screw, PH Cross Recess SST 1/4 - 20 UNC x 2” Lg.
21. Spacer, Battery	42. Akitvator, SIKA 205

Battery Tray Components (parts list)

7.6.2. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Remove the lock nut and flat washers from the center stud of the battery tray grab handle.
3. Pull down on the grab handle to lever the front rollers upward onto the track, then slide out the battery tray to the fully extended position.
4. Remove the batteries. Refer to 7.5. “Batteries” on page 70 in this section for battery removal procedure.
5. Remove the four 1/4" bolts that secure the plastic battery cover to the slider tray and remove the cover.
6. Drill out the four rivets that attach the lower plastic battery tray to the support tray and remove the plastic tray.
7. Remove the battery tray stops, located on either side of the slider tray assembly, and pull out the support tray.
8. Note the location of the special flat washers and remove the six 3/8" fasteners that attach the slider assembly to the vehicle structure. Remove the slider assembly and lower mounting bracket.

☞NOTE:

It will be necessary to drill out the six rivets if the lower mounting bracket needs to be removed.

9. Remove the six rubber mounts from the vehicle structure.

7.6.3. Inspection

1. Inspect the rubber mounts for excessive wear, cuts, deterioration or other damage. Replace as required.
2. Inspect the rollers and pivot mechanism on the slider tray assembly. Replace worn or damaged parts as required.
3. Inspect the rollers on the support tray and replace if worn or damaged.
4. Check that the rubber dust/water ejector, located in the lower mounting bracket, functions properly. Replace the ejector if cracked, hardened, or otherwise damaged.

7.6.4. Installation

1. Insert the six rubber mounts into the chassis structure as follows:

   a. Apply rubber lubricant to both the rubber mounts and chassis structure.

   b. Insert the mounts into the structure as far as possible by hand, using a twisting motion.

   CAUTION

   Ensure that the O.D. of the assembly driver head does not exceed the diameter of the steel insert; otherwise the rubber mount may be damaged.

   c. Insert an assembly driver in the metal insert of the mount and press the mount into the structure until fully seated.

2. If previously removed, position the openings in the lower mounting bracket over the rubber mounts and align the mounting holes in the bracket with holes in the structure. Secure the bracket to the structure using six 3/16" rivets

3. Install the slider assembly, aligning the six mounting legs with the rubber mounts. Secure slider assembly using 3/8" bolts, nuts, and washers in the same position noted during removal. Torque bolts to 15 ft-lbs. (20 Nm).

4. Install the support tray and battery tray stops.

5. Install and attach the lower plastic battery tray to the support tray using four 1/4" rivets.

6. Fully extend the battery tray and install the batteries. Refer to 7.5. “Batteries” on page 70 in this section for battery installation procedure.

7. Close the battery tray, raise grab handle, and secure handle in place with lock nut and washers.

8. Install the plastic battery cover and secure with four 1/4" bolts.

9. Set the Battery Disconnect switch to the ON position.

7.7. Temperature Indicator

7.7.1. Description

A non-reversible temperature indicator strip is installed on top of each battery for ease of temperature monitoring.

7.7.2. Temperature Indicator Specifications

Manufacturer......... Omega Engineering Inc.

Temp. Indicators (°F)............. 140, 150, 160, 170, 180

Accuracy .... 1.8°F (1°C)

7.7.3. Operation

The indicator strip cells turn black as they are exposed to higher temperatures.

7.7.4. Removal

1. Lift a corner of the strip and remove.
2. Remove any remaining adhesive residue.

7.7.5. Installation

1. Ensure the mounting surface is clean and dry.
2. Install the strip using the adhesive backing.

8. EXTERIOR LIGHTS

See “Fig. 9-49: Exterior Lamps” on page 79.

8.1. Headlights

8.1.1. Description

The headlight assemblies contain an LED low beam, an LED amber turn light and an LED high beam. The headlights have a 12V power voltage and voltage range of 10-16 VDC. Each headlight assembly is controlled by a built-in driver module.

8.1.2. Operation

The low beam headlights operate at full intensity when the Master Run switch is in either the DAY-RUN or NIGHT-RUN positions. The high beam headlights operate only when the Master run switch is in NIGHT-PARK and the high beam foot switch is activated. The LED headlight module will output a signal to the LCD display on the instrument panel if a headlight or turn signal fails to operate.

8.1.3. Removal

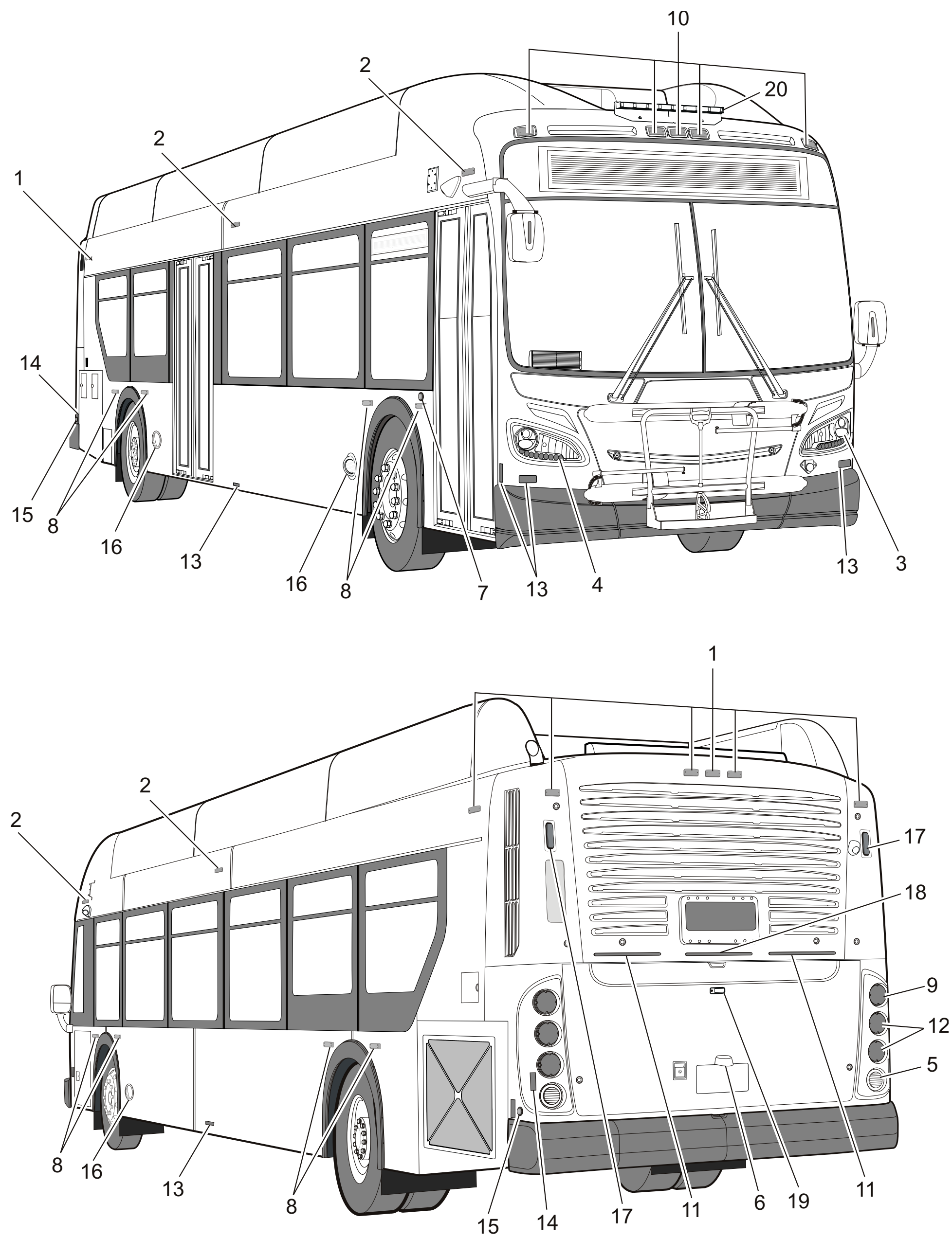
☞**NOTE:**

Replacing a faulty low beam, high beam, or turn signal light requires the replacement of the complete headlight assembly.

1. Set the Battery Disconnect switch to the OFF position
2. Gain access to the headlight assemblies by opening the exterior wiper motor access door, interior LH lower dash panel access door, and interior RH lower dash panel access door. See “Fig. 9-50: Headlight Removal & Installation” on page 80.
3. Access the headlight assembly from the interior of the vehicle and disconnect the wiring harness.
4. Remove the nuts and washers that retain the headlight assembly to the front mask and remove the unit from the vehicle.

8.1.4. Installation

1. Install a new headlight assembly using the original washers and nuts.
2. Connect the wiring harness to the headlight assembly and secure the harness with cable ties.
3. Close and secure all access doors.
4. Set the Battery Disconnect switch to the ON position and test operation of the headlight assembly.
5. Adjust the headlight if required. Refer to 8.1.5. “Headlight Aiming” on page 80 in this section for aiming procedure.



1. Lamp Assembly, Identification Red LED
2. Lamp Assembly, Identification Amber LED
3. Headlight Assembly, w/LED Turn Signal Streetside
4. Headlight Assembly, w/LED Turn Signal Curbside
5. Lamp Assembly, White LED
6. Lamp Assembly, Licence Plate LED
7. Lamp Assembly, Amber LED
8. Lamp Assembly, Amber LED
9. Lamp Assembly, Amber LED
10. Lamp Assembly, Identification Amber LED
11. Lamp Assembly, Red LED
12. Lamp Assembly, Stop Red LED
13. Reflector, Amber
14. Reflector, Red
15. Lamp Assembly, Red LED
16. Lamp Assembly, White LED
17. Lamp Assembly, Turn Signal LED
18. Reflector, Red\
19. Lamp Assembly, Strobe Amber
20. Lamp Assembly, Strobe Light Bar Amber LED

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Fig. 9-49: Exterior Lamps

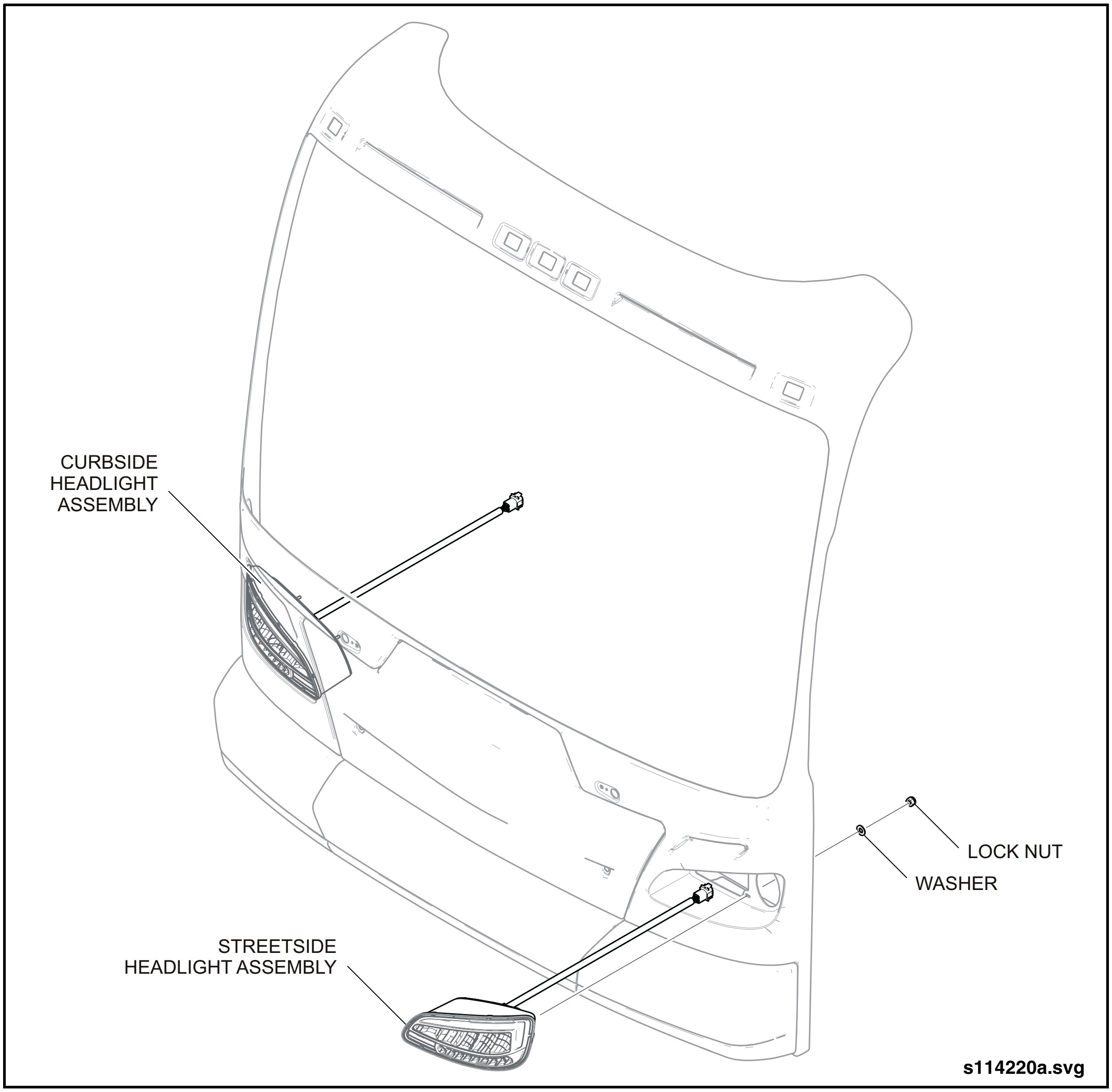


Fig. 9-50: Headlight Removal & Installation

8.1.5. Headlight Aiming

The LED headlights should be checked at regular intervals to ensure that they are properly aimed in accordance with local vehicle regulations. The headlight assembly is a single unit containing the low beam, high beam, and turn light. A single vertical adjustment screw, accessible from the interior of the vehicle, is provided for aiming the headlight assembly. Proper high beam setting is achieved when the low beam is set correctly.

The preferred method of aiming headlights is with the use of specialized optical headlight aiming equipment and is described in the following procedure. If specialized equipment is not available, headlights can be aimed using prescribed markings on a wall and parking the vehicle a specified distance from the wall. Refer to 8.1.6. “Headlight Aiming (Alternate Procedure)” on page 82 in this section for aiming instructions.

1. Move the vehicle to a level surface and set the parking brake.
2. Ensure that the tires are properly inflated and that the vehicle ride height is set per specifications. Refer to Section 3 of this manual for ride height adjustment procedures.
3. Open the interior LH and RH lower dash panel access doors to gain access to the headlight adjusting screw.

☞NOTE:

The following steps assume the use of Canbuilt commercial headlight aiming equipment. Headlight aiming equipment from other manufacturers will require different alignment procedures. Consult the equipment manufacturer's instructions for specific procedures.

4. Compensate for floor slope as follows:
   a. Positioning the aimer at the front of the vehicle.
   b. Turn on the laser by turning the knob on the laser housing.

⚠WARNING

DO NOT stare into the aimer's laser beam as damage to the eyes may result. The aimer emits class II laser radiation at a wavelength of 630 to 680 nm with a power output of less than 1 mW.

   c. Measure the center of the laser beam height from the floor at the front wheel and at the back wheels.
   d. The distance from the floor should be the same. If it is not, adjust the floor slope knob on the aimer's base until they are equal.

5. Place the aimer in front of one headlamp approximately 10 to 14 in. (25 to 35 cm) from the headlamp assembly.
6. Rotate the aimer positioning pointer to the front of the aimer. Adjust the aimer so that the positioning pointer is at the center of the round lens of the low beam then rotate the pointer back into its stored location.
7. Square the aimer to the front of the vehicle as follows:
   a. Choose two symmetrical points on the front of the vehicle, located at the same height. The upper part of the headlight assembly or two points on the defroster/wiper access door may work.
   b. Looking through the lateral alignment visor, make both chosen points lie on the visor's wire, by slightly rotating the aimer.
   c. The aimer is now ready to test the headlights.
8. Set the Master Run switch to NIGHT-RUN to operate the headlights. Ensure that the high beam is off.
9. Observe the pattern displayed on the screen and determine the required direction of adjustment. See "Fig. 9-51: Headlight Aiming" on page 82.
10. Use the adjusting screw on the back of the headlight assembly to vertically position the headlight in the desired target area of the aiming equipment.

☞NOTE:

Use a 5/32" socket to turn the adjusting screw. Rotate the screw CW to raise the beam pattern and CCW to lower the beam pattern.

11. When the adjustment is completed, turn off the headlights, remove the headlight aiming equipment, and close and secure all access doors.

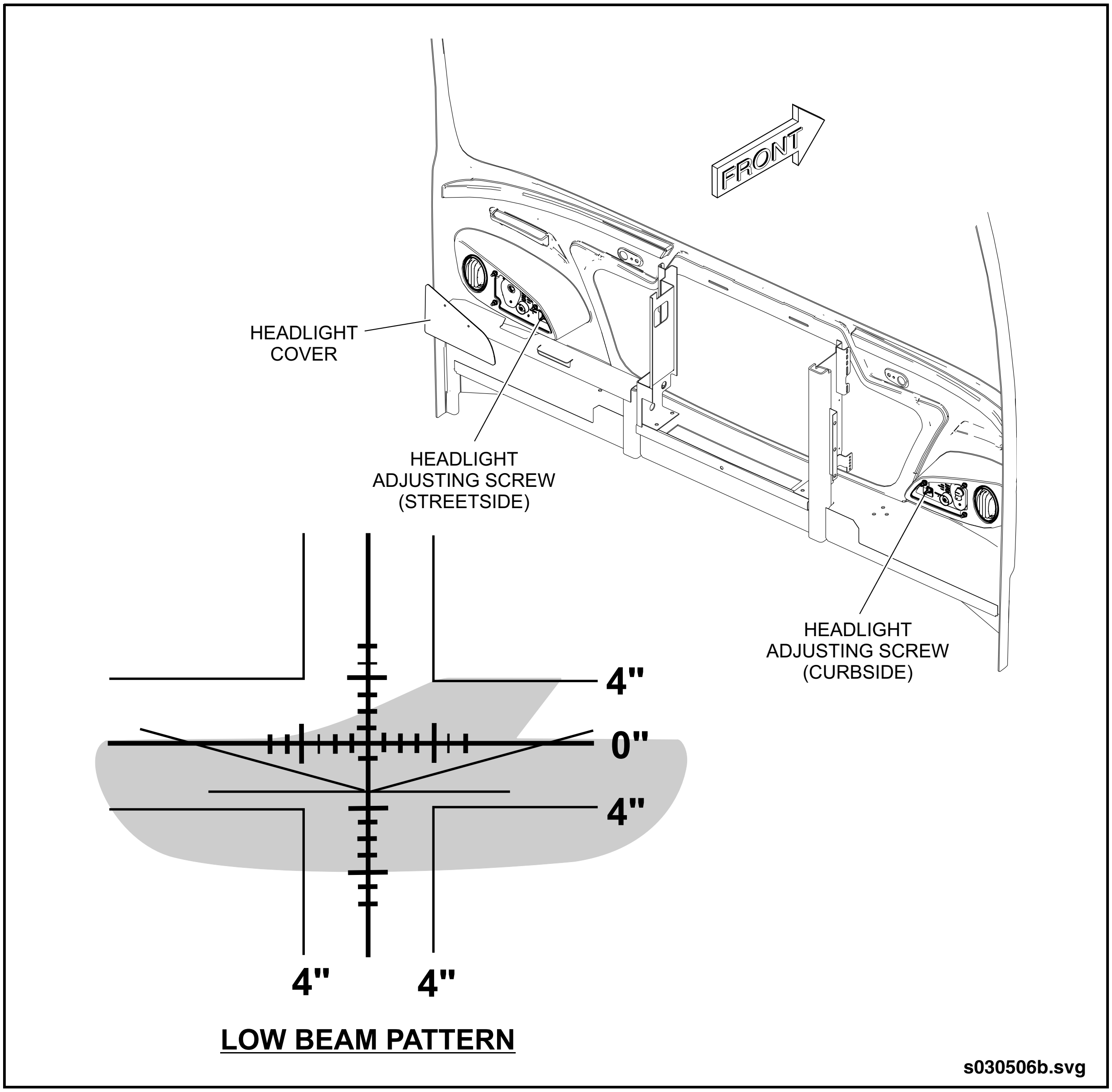


Fig. 9-51: Headlight Aiming

8.1.6. Headlight Aiming (Alternate Procedure)

☞**NOTE:**

The following procedure describes how to set up headlight aiming marks for the low beam lights. Markings can be made directly on the wall surface if practical, otherwise use a 4' x 8' sheet of plywood, or suitable equivalent, painted white.

1. Draw a vertical line C-C on the aiming surface representing centerline of vehicle. Extend this centerline at a right angle along the floor so that it can be used to position the vehicle square to the aiming surface. See “Fig. 9-53: Low Beam Headlight Aiming” on page 84.
2. Position vehicle on level floor with low beam headlights 25' (7.62 m) from the aiming surface. Centerline of vehicle must be positioned so that it is at a right angle to the vertical surface.
3. Measure height of low beam headlight centers from floor and mark this height on

vertical surface. Draw a horizontal line A-A on vertical surface at this height. Extend this line to approximate the width of the vehicle.

☞NOTE:

The center of the low beam is marked with a dimple molded into the headlight assembly. If the dimple is not present, measure to the center of the round lens surrounding the low beam elements. See “Fig. 9-52: Low Beam Center Location” on page 83.

4. Measure distance between centers of outer (low beam) lights and divide this distance equally on both sides of centerline C-C. Draw a vertical line (D-D and E-E) through each of these points.
5. Draw a line on an upward angle to the right from the intersection of lines A-A and D-D. Draw a similar line from the intersection of lines A-A and E-E. These angled lines, approximately 45°, represent the kink where the cutoff line bends upward.

☞NOTE:

The upward bend angle of the cutoff line needs to be added to the aiming marks once the first set of low beam lights have been centered and adjusted vertically. Draw a line corresponding to the illuminated upward angle.

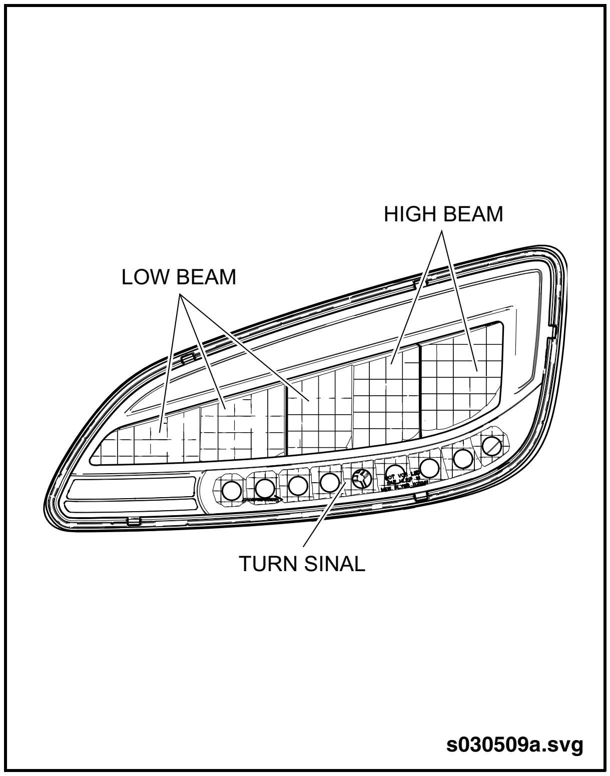
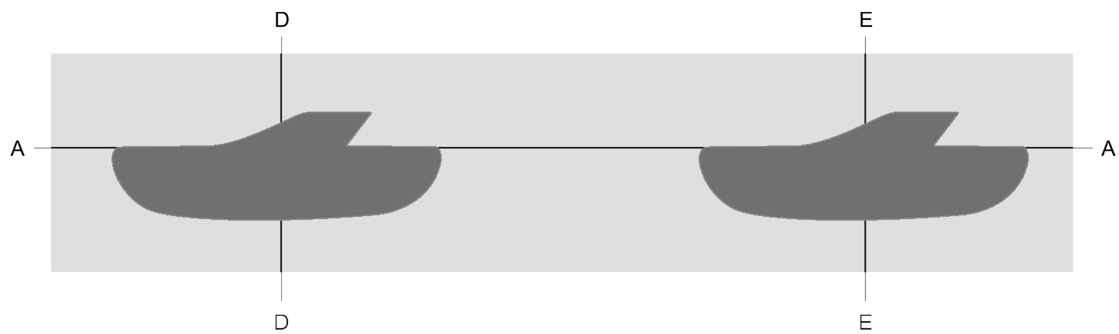
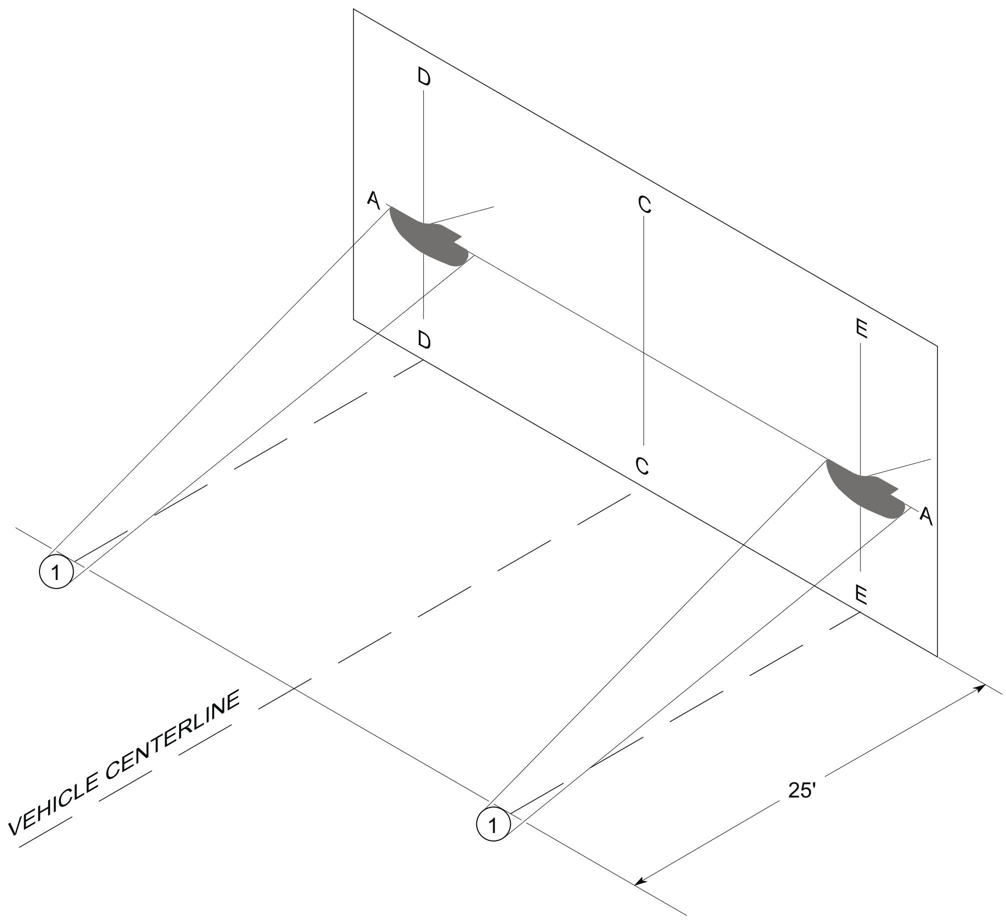


Fig. 9-52: Low Beam Center Location



CORRECTLY AIMED LOW BEAMS



LOW BEAM AIMING MARKS

L E G E N D	
A-A HEADLIGHT VERTICAL CENTERLINE	E-E HEADLIGHT HORIZONTAL CENTERLINE (CS)
B-B HORIZONTAL CUT-OFF LINE	1 HEADLIGHT ASSEMBLY
C-C CENTERLINE	
D-D HEADLIGHT HORIZONTAL CENTERLINE (SS)	

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Fig. 9-53: Low Beam Headlight Aiming

9. INTERIOR LIGHTS

9.1. Aisle Lights

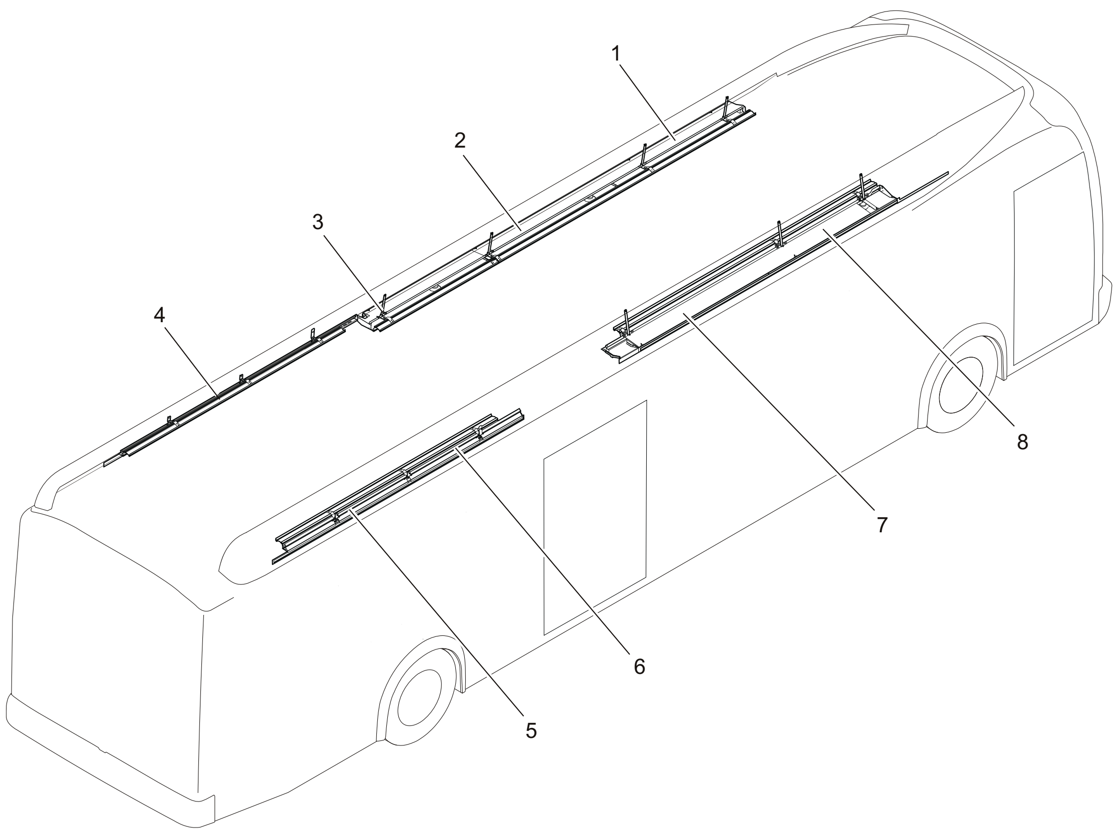
9.1.1. Description

The aisle light panels are located above the side windows on either side of the passenger aisle. See “Fig. 9-54: Aisle Lights Layout” on page 85.

Each lighting panel consists of one or more banks of lights, depending on the length of the panel. Each bank of lights consists of a clever board installed in series with several basic boards. The clever board provides the power entry and dimming capability for the entire bank. The power entry and dimming connector installed on each clever board is referred to as a “finger board”. See “Fig. 9-55: LED Aisle Lights Assembly” on page 86.

Each LED board contains surface-mounted LEDs arranged in a single row pattern. The dimming level for the light banks is factory preset. Dimmable lighting panel banks can be adjusted using a programming fob. Refer to 9.1.5. “Dimming Adjustments” on page 88 in this section for adjustment procedure.

The LED boards are protected with a plastic translucent lens that runs the entire length of the lighting panels. The lighting panels also include speakers for the vehicle P.A. System as well as duct liners and distribution vents for the heating system.



1. Pre-Programmed to Dim to Off
2. Pre-Programmed to Dim to 50%
3. Pre-Programmed to Not Dim
4. Pre-Programmed to Not Dim
5. Pre-Programmed to Not Dim
6. Pre-Programmed to Not Dim
7. Pre-Programmed to Dim to 50%
8. Pre-Programmed to Dim to Off

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Fig. 9-54: Aisle Lights Layout

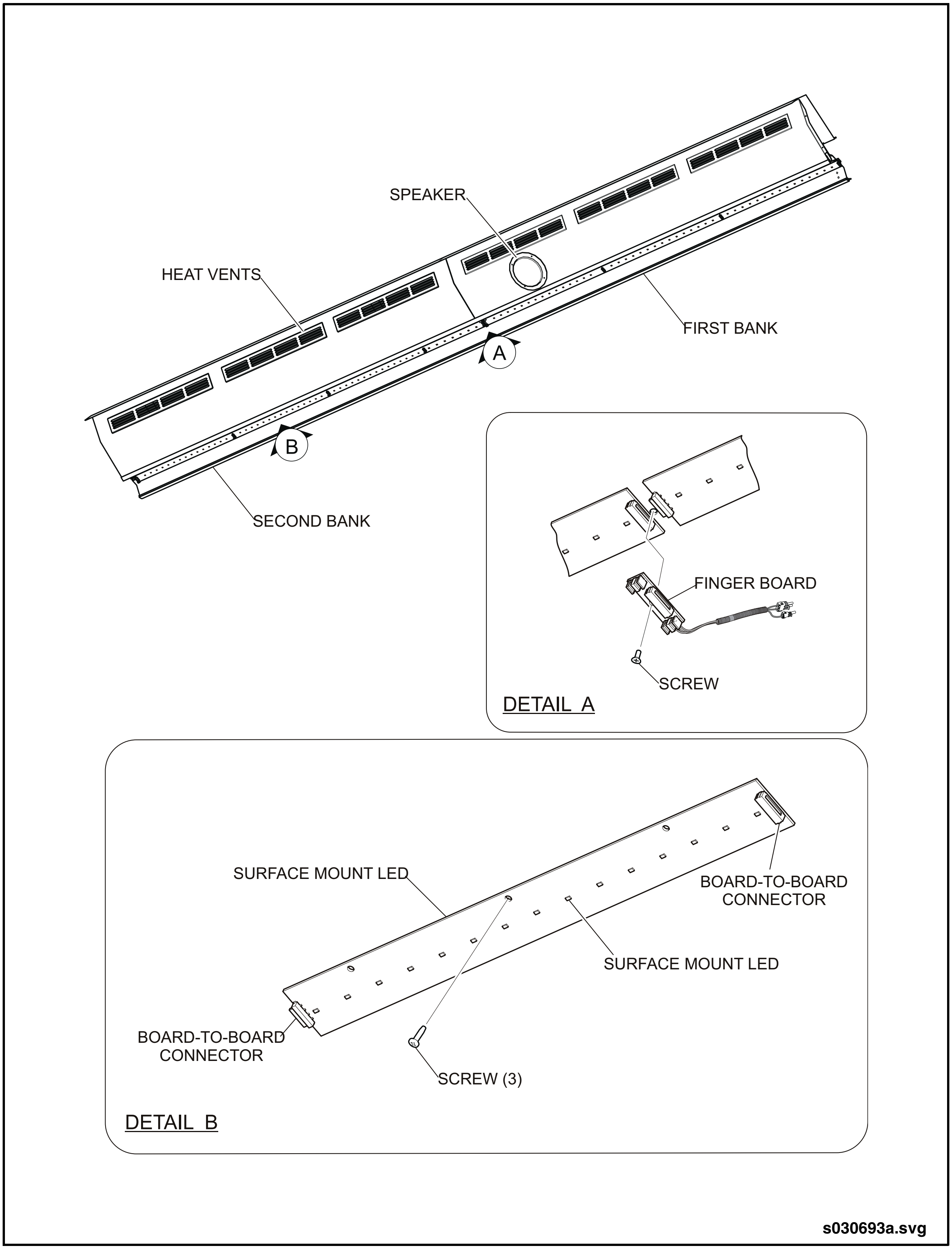

Fig. 9-55: LED Aisle Lights Assembly

9.1.2. Aisle Lights Specifications

Manufacturer........................ TCB Industries

Model .... GEN 3 with Clever Boards

Lighting Panel .... Aluminum, powder-coated c/w speaker and duct liner

Voltage ....24 VDC

LED's .... 15 per board @ 0.125 W each

Speakers............................... 8 Ohms, 30 W

9.1.3. Operation

The Aisle Lights switch on the side console provides the operator control of the aisle lights based on the programming configuration for the ON, NORMAL and OFF settings of this switch. Refer to Section 19 of this manual for more information on the operation of the Aisle Lights switch.

9.1.4. Aisle Lights Troubleshooting

☞**NOTE:**

Refer to Electrical Systems Drawings "ES-Electrical Schematics-IL" and the Vansco PLC Program when performing troubleshooting.

Troubleshooting the lighting panels should always be performed in the following sequence:

1. Confirm lighting program - Refer to Section 19 of this manual for definition of which panels illuminate or dim and under what conditions.
2. Identify the symptoms and the conditions under which the problem occurs. Example: one bank of lights fail to illuminate during NIGHT-RUN with aisle lights switch in NORMAL position and entrance door closed. Establish the conditions under which the lighting panel should illuminate.
3. Confirm that the proper inputs and outputs are present at the VMM modules during the condition identified in the previous step.
4. If proper inputs not received at VMM module(s), then trace vehicle wiring circuit for power at switches, connectors, and fuses.
5. If proper outputs confirmed at VMM module(s), then check lighting panel connectors for voltage.
6. Check finger board connector for power and dimming signals as applicable. Confirm ground circuit from lighting panel to vehicle ground.

9.1.4.1. Troubleshooting Tips

It is important to understand the operating principles of the LED lighting boards in order to properly troubleshoot problems. The following list of operating characteristics and possible problems will help isolate the condition and minimize time spent troubleshooting.

Each lighting bank consists of one clever board and several basic boards. The clever board receives the power and dimming inputs and transmits these signals through the series-connected board-to board connectors on each of the basic boards.

- ❒ If the clever board loses a power or dimming signal, then all basic boards in that bank that are connected to the clever board will lose the power or dimming signal.
- ❒ If the clever board and one or more downstream basic boards illuminate, but the remainder don't, then the likely problem is with a board-to-board connector at one of the basic boards.

Each lighting board has its own driver that is capable of powering 30 LED's. The LED's are electrically connected in groups.

- ❒ If a lighting board driver fails, then all LED's in that board will fail to illuminate. The driver is not repairable and the board must be replaced.
- ❒ If only some LED's in a lighting board fail to illuminate, then an internal connection within the board has failed and the board must be replaced.

The root cause of many electrical problems can be traced to loose or corroded electrical connectors. This is very typical of intermittent problems. Inspect the electrical connections at the following locations:

- ❒ Vehicle harness connection to lighting panel harness.
- ❒ Finger board - remove IDC connector cover and check for improperly crimped wires.
- ❒ Board-to-board connectors - slide cover back and inspect terminals. Ensure the three screws fastening the lighting board to the panel are secure. Sometimes loosening these screws and repositioning the lighting board will correct the faulty connection.

9.1.5. Dimming Adjustments

The dimmable lighting panels normally operate at 50% lighting intensity and increase to 100% when the entrance door is open. The factory preset dimming level can be adjusted individually on each bank of lights. The following instructions describe the adjustment procedure:

1. Remove the lens. Refer to 9.1.6.1. “Lens” on page 89 in this section for procedure.
2. Set the Master Run switch to NIGHT-RUN and set the Aisle Light switch to a position that will illuminate all lights. Ensure that the entrance door remains closed during the adjustment procedure.
3. Identify the bank of lights that need to be adjusted and locate the clever lighting board on that particular bank of lights.

   ☞**NOTE:**

   The clever board provides the power and dimming signal for the downstream basic lighting boards in each bank of lights. The clever board receives power and dimming signals from the finger board and can be easily identified by the three-wire connector on the end of the board.

4. Locate the two push buttons labeled UP and DOWN on the clever lighting board.
5. Turn on the interior lights and cycle the passenger doors to trigger the LED board dim function.

   ☞**NOTE:**

   The board must receive a 24V signal, measured at the yellow wire, to trigger the dim function. The boards will not adjust if the 24V signal is not present.

6. Press the UP button to increase the intensity or the DWN button to decrease the intensity until the desired level of intensity is reached. See “Fig. 9-56: Lighting Board Dimming Adjustment” on page 88.

   ☞**NOTE:**

   Each press of the button will change lighting intensity by 5%. The dimming level can be adjusted within the range of 0% to 100% lighting intensity.

7. Test the operation of aisle lights and ensure that the dimmable lighting panels increase to 100% lighting intensity when the entrance door is opened.
8. Repeat to adjust other banks. Replace the lens once all adjustments have been made.

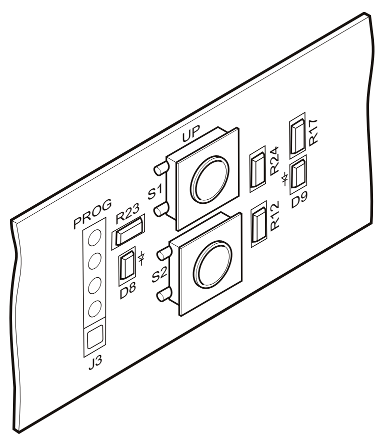

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Fig. 9-56: Lighting Board Dimming Adjustment

9.1.6. Removal

9.1.6.1. Lens

☞NOTE:

The lens is one continuous piece and runs the entire length of the lighting panels. Servicing the LED lighting panels will require removal of the full length of the lens.

1. Remove the end cover.
2. Starting at one end, compress the upper edge of the lens to release it from the mounting channel. See "Fig. 9-57: Lens Removal" on page 89.

☞NOTE:

An additional person will be required to support the lens while the other person is working along the length of the lens to release it from the mounting channel.

3. Once the upper edge has been released, carefully work along the length of the lens to release the lower edge. Ensure that the lens is properly supported during removal to avoid excessive bending and possible lens damage.

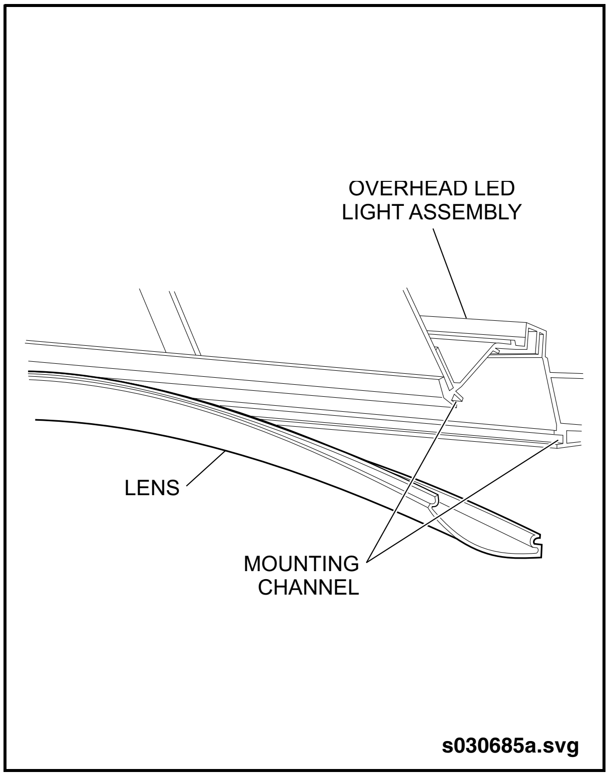

Fig. 9-57: Lens Removal

9.1.6.2. LED Lighting Board

☞NOTE:

The LED boards are not repairable and must be replaced as an assembly if defective

1. Remove the lens. Refer to 9.1.6.1. "Lens" on page 89 in this section for procedure.
2. Slide the cover back on the board-to-board connectors on each end of the lighting board.
3. Remove the three mounting screws that attach the LED lighting board to the lighting panel.
4. Remove the lighting board from the lighting panel.

9.1.6.3. Finger Board

1. Remove the lens. Refer to 9.1.6.1. "Lens" on page 89 in this section for procedure.
2. Locate the finger board which is typically installed at the beginning of a bank of lighting boards. See "Fig. 9-58: Finger Board Assembly" on page 90.
3. Use a machinist's scribe or dental pick to pry off the cover on the IDC connector of the finger board.

☞NOTE:

Typically there will be one cover for the power (red) and ground (black) wires located at one end of the finger board and another cover at the opposite end for the dimming signal (yellow) wire.

4. Note the position of the wires for reassembly and then carefully pull the wires out of the Insulation Displacement Connector (IDC) and clean any residual insulation from the blades of the connector.
5. Remove the single mounting screw.
6. Remove the finger board by sliding it outward from the lighting board.

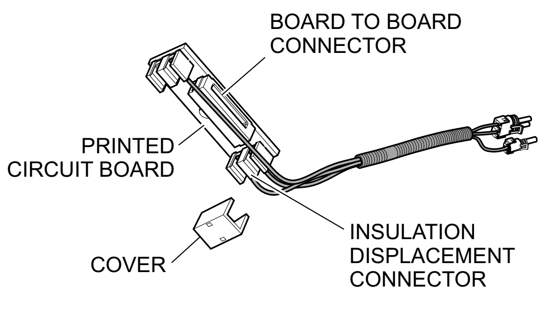

Fig. 9-58: Finger Board Assembly

9.1.7. Installation

9.1.7.1. Lens

1. Position the length of lens beneath the lighting panels and support on the seat backs.
2. Start at one end and insert the lower lip of the lens into the mounting channel, ensuring that the end of the lens is flush with the end of the lighting panel.

☞NOTE:

An additional person will be required to support the lens as it is being raised into position.

3. Continue to work along the length of the panels, inserting the lower lip of the lens into the mounting channel while another person follows behind, compressing the upper lip on the lens into the mounting channel.
4. Reinstall end cover.

9.1.7.2. LED Lighting Board

1. Position the lighting board on the panel ensuring that the board is correctly oriented and the male/female board-to-board connectors properly align their mating counterparts.
2. Install and tighten the three mounting screws.
3. Slide the cover over the board-to-board connectors to ensure the connectors are locked in place.

9.1.7.3. Finger Board

1. Place the finger board in position and slide it into the lighting board connector.
2. Secure the finger board to extrusion with a single screw.
3. Place the red wire into the IDC and press wire into position with the insertion tool tip (commercially available tool).
4. Repeat the previous step for the black and yellow wires.
5. Snap the IDC connector covers in place.
6. Reinstall lens.

10. DOOR MASTER SWITCH

10.1. Description

The Door Master switch is a two-position toggle switch located in the driver's overhead panel. The switch is labeled ON for normal operation and OFF for emergency operation.

10.2. Operation

WARNING

The Door Master switch is primarily intended to be used in emergency situations to disable the brake and accelerator interlock system and allow the vehicle to be moved. Positioning the Door Master switch in the OFF position will disable the exit door function and several safety features including:

- ❒ **Vehicle can be shifted without foot on brake treadle.**
- ❒ **Vehicle can be shifted and vehicle moved with wheelchair ramp deployed.**
- ❒ **Exit doors can be opened with the vehicle in motion by using the emergency release control valve. Brake interlocks will not apply in this situation.**

The Door Master toggle switch controls power to the brake interlocks and exit door. When the switch is in the ON position, the entrance and exit doors are fully functional. In this mode, opening the exit door, kneeling the vehicle or operating the wheelchair ramp engages the interlocks. Engaging the interlocks applies the brakes and deactivates the accelerator.

Positioning the Door Master switch in the OFF position disables the brake and accelerator interlocks and inhibits operation of the exit door controller. The entrance door, however, remains fully functional. A warning buzzer sounds and the Rear Door Open indicator illuminates on the instrument panel. In this mode, the exit door only opens if the emergency release control valve is activated. The control valve is located behind the breakable window to the left of the exit door.

10.3. Functional Tests

WARNING

Observe the necessary safety precautions while conducting the following test. Ensure that the wheels are chocked to prevent inadvertent vehicle movement. Advise all personnel to stand clear of the vehicle during testing.

10.3.1. Normal Operation Test

Test normal operation of the Door Master switch and interlock system as follows:

1. Start the engine, apply the parking brake, and shift into neutral [N]. Ensure the Door Master switch is set to the ON (normal) position.
2. Move the door controller to position #3, #4, or #5 to enable the exit door. The brake and accelerator interlocks should apply.
3. Test application of the brake and accelerator interlocks by releasing the parking brake and slowly applying the accelerator treadle. The engine should remain locked in the idle setting and not respond to accelerator treadle movement. The rear stoplights should remain illuminated even with the parking brake released and no application of the brake treadle.
4. Test normal release of the brake and accelerator interlocks by moving the door controller to position #1 to disable the exit door. Shift into drive [D] and then press on the brake treadle. The combination of having the vehicle in gear and the brake treadle applied will unlatch the interlocks. Shift back into neutral [N].
5. Verify that the interlocks are released by lightly applying the accelerator treadle and confirming that the engine responds to accelerator movement and that the rear stop lights are extinguished.

10.3.2. Emergency Operation Test

Test emergency operation of the Door Master switch as follows:

1. Apply the accelerator and brake interlocks by re-establishing the conditions defined in steps 1 & 2 of "Normal Operation Test".
2. Set the Door Master switch to the OFF (emergency) position. This will release the brake and accelerator interlocks and disable exit door function.
3. Verify that the interlocks have been deactivated by releasing the parking brake and lightly applying the accelerator treadle. The engine should respond to accelerator movement and the rear stop lights should extinguish.

10.4. Door Master Switch Troubleshooting

1. Set the Battery Disconnect switch to the OFF position.
2. Disconnect wire leads from Door Master switch and test function of switch.
   a. Set the switch to the ON position and test for continuity between the switch terminals using an ohmmeter.
   b. Set the switch to the OFF position and test for an open circuit between the switch terminals using an ohmmeter.
3. Replace the switch if it fails to meet either of the preceding test criteria.
4. Connect the wire leads to the switch.
5. Set the Battery Disconnect switch to the ON position.
6. Set the Master Run switch to the DAY-RUN or NIGHT-RUN position and set the Door Master switch to the ON (normal/closed) position.
7. Use a voltmeter and connect probes between one of the switch terminals and ground. A reading of approximately 24V should be obtained. Move the positive lead of the voltmeter to the other switch terminal. A reading of approximately 24V should be obtained.
8. Set the Door Master switch to the OFF (emergency/open) position. Use a voltmeter and test for 24V at both switch terminals as described in the preceding step. A reading of approximately 24V should be obtained on the input terminal only. Refer to Electrical Schematics for wire lead identification.

11. HORNS & WARNING ALARMS

11.1. Electric Horn

11.1.1. Description

- ❐ Two electric horns are mounted on the front bulkhead plate. Each horn is carefully adjusted and inspected during manufacture and should operate indefinitely without attention. If a horn does become inoperative, it must be replaced. See “Fig. 9-59: Horns Installation” on page 93.
- ❐ If a horn fails to operate, the trouble may be in the external circuit. Quick checks may be made with a jumper lead as follows, to isolate trouble:
- ❐ Open side console door for access to horn relay. Connect a jumper lead from No. 2 terminal on horn relay to ground. If horns operate, the trouble is in the horn control circuit (between horn button and horn relay). If horns do not operate, remove jumper lead and proceed to next step.
- ❐ Momentarily, connect a jumper lead between No. 1 and 3 terminals on horn relay. If horn operates, the relay is defective.

11.2. Warning Alarms

☞NOTE:

Refer to the General Information Section of this manual for information on warning alarms.

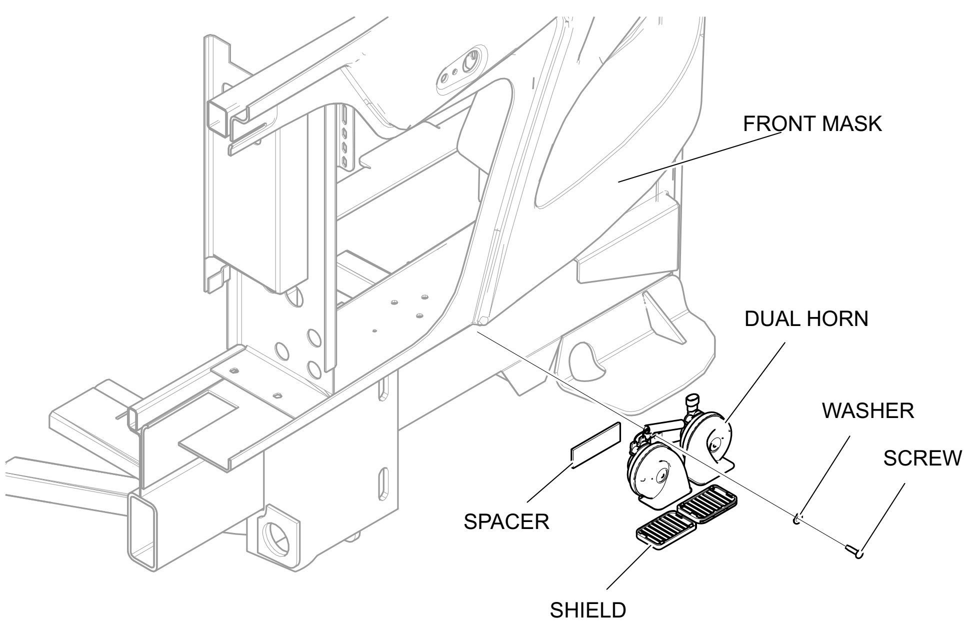

Fig. 9-59: Horns Installation

12. AUTOMATIC VEHICLE ANNOUNCEMENT (AVA) SYSTEM

12.1. Description

An AVA/AVL System is installed on this vehicle. This system is integrated with the public address system and destination sign system. The AVA/AVL system provides control of schedule adherence, vehicle messaging and annunciation, calls to dispatch, GPS position and status and route lists. The system includes the following components: See “Fig. 9-60: AVA Installation” on page 95.

- ❐ IVN4 controller - located in the electronic equipment enclosure.
- ❐ Transit control head (TCH) module - located on the driver’s overhead panel.
- ❐ Interior LED message display sign - ceiling-mounted in the HVAC cover.
- ❐ Automatic Volume Control (AVC) microphone - ceiling-mounted opposite the exit door.
- ❐ Quad-band antenna - roof-mounted.
- ❐ Public Address (PA) speakers - located in the interior of the vehicle with one exterior above the entrance door.
- ❐ A handset located on the sidewall below the driver's locker

12.2. Operation

12.2.1. IVN Transit Control Head

The destination/route sign system can be operated in either automatic or manual mode. The automatic mode utilizes the Intelligent Vehicle Network (IVN) Transit Control Head (TCH) as the operating interface.

The front panel of IVN has a series of status LEDs to indicate the current state and operation of the unit. See “Fig. 9-61: Front Panel Indicators” on page 96.

1. Controller, Universal Radio Logic
2. Module, Smartyard
3. Controller, IVN4
4. Radio Handset
5. Module, Transit Control Head
6. Sign, LED Interior
7. Microphone Assembly, Interior

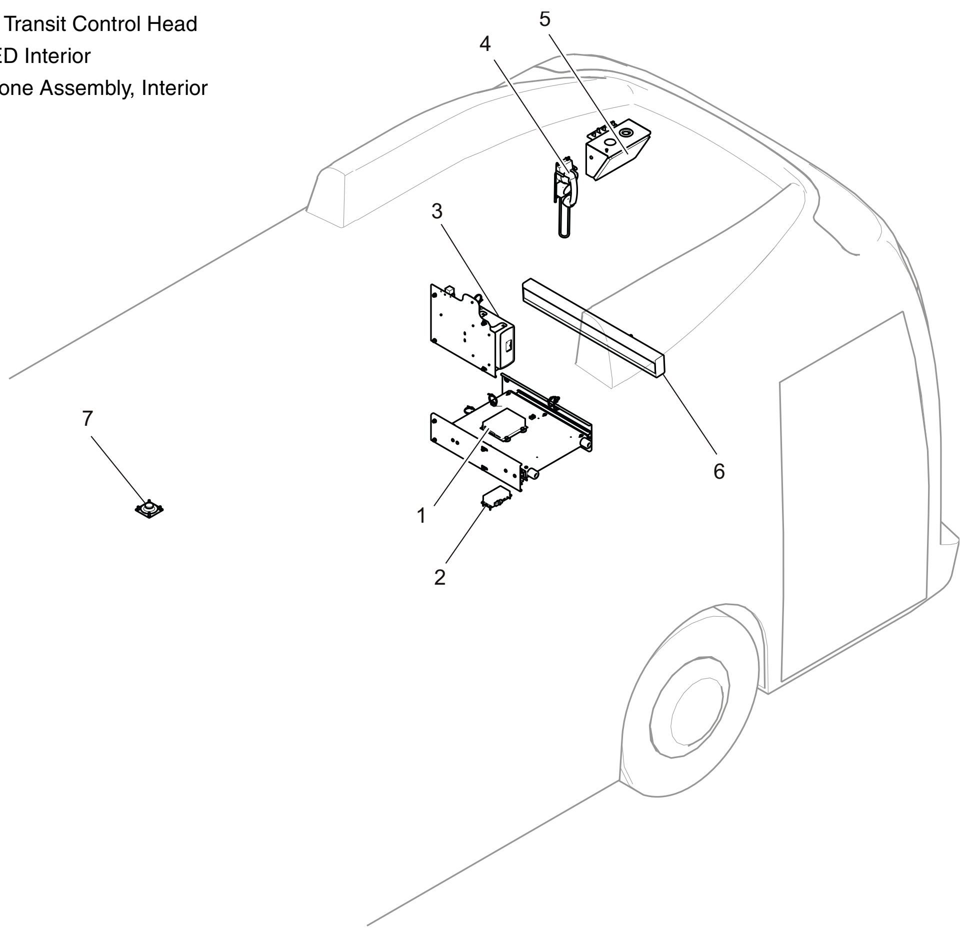

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Fig. 9-60: AVA Installation

Refer to Clever Devices Intelligent Vehicle Network Operator's Manual for further information on this system

LED #	LED Definition	LED Activity	During Boot
LED1	SSD	Blink RED when mSATA access activity	Blinking
LED2	Cellular	Blink or solid RED when Cellular Modem activity	Off
LED3	Wi-Fi	Blink or solid RED when WLAN activity	Off

LED #	LED Definition	LED Activity	During Boot
LED5	RS232 Select	ORG if JP3 selects COM3 RS232, off if RS485	On
LED6	BW / APP	GRN blinks	On
LED7	PA Link	Blinks GRN during Ehternet activity to PA Board IOP	On
LED8	Main Link	Blinks GRN during Ethernet activity to Main Board IOP	Blinking
LED9	IOP	Blinks GRN when Main Bd. IOP is active, 50% duty 1 Hz	Blinking
LED10	Stand-by	YEL when Main Board in Power Save Mode	Off
LED11	Power	GRN when input power is acceptable limits	On

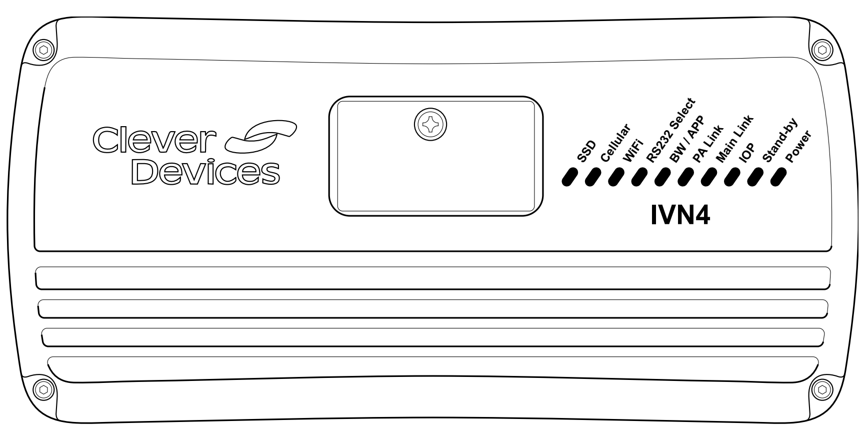


Fig. 9-61: Front Panel Indicators

13. AUTOMATIC PASSENGER COUNTER (APC) SYSTEM

13.1. Description

This vehicle is equipped with an APC system that uses overhead infrared sensors at the entrance and exit doorways to collect ridership information. The APC sensors interface with the AVA/AVL system. See “Fig. 9-62: APC Installation” on page 97.

- ❒ APC sensors are located above the entrance and exit door baseplates.
- ❒ APC harness assembly.

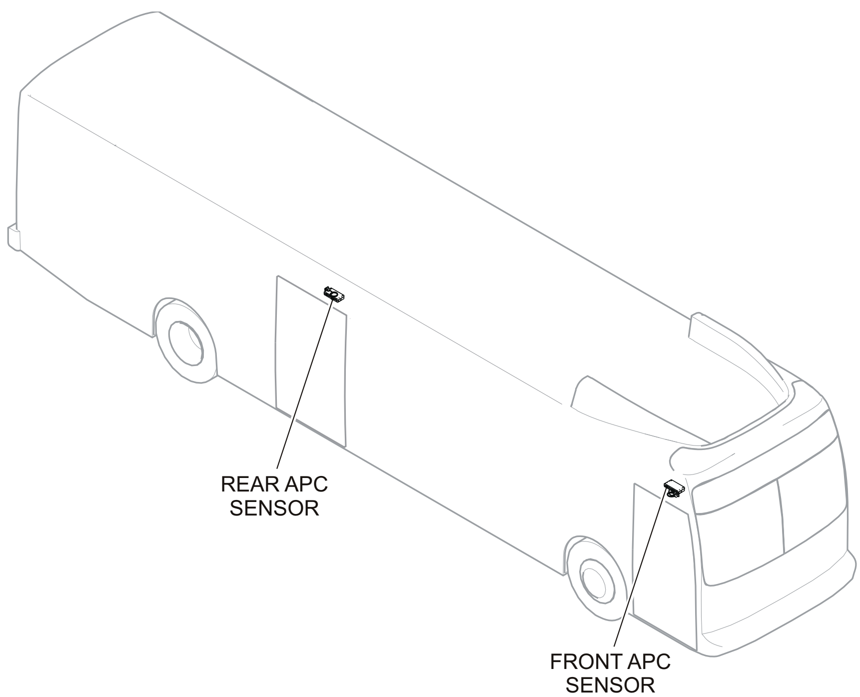


Fig. 9-62: APC Installation

14. VIDEO SURVEILLANCE SYSTEM

14.1. Description

The video surveillance system records events as they occur on the vehicle. See "Fig. 9-63: Video Surveillance System" on page 99. The system consists of:

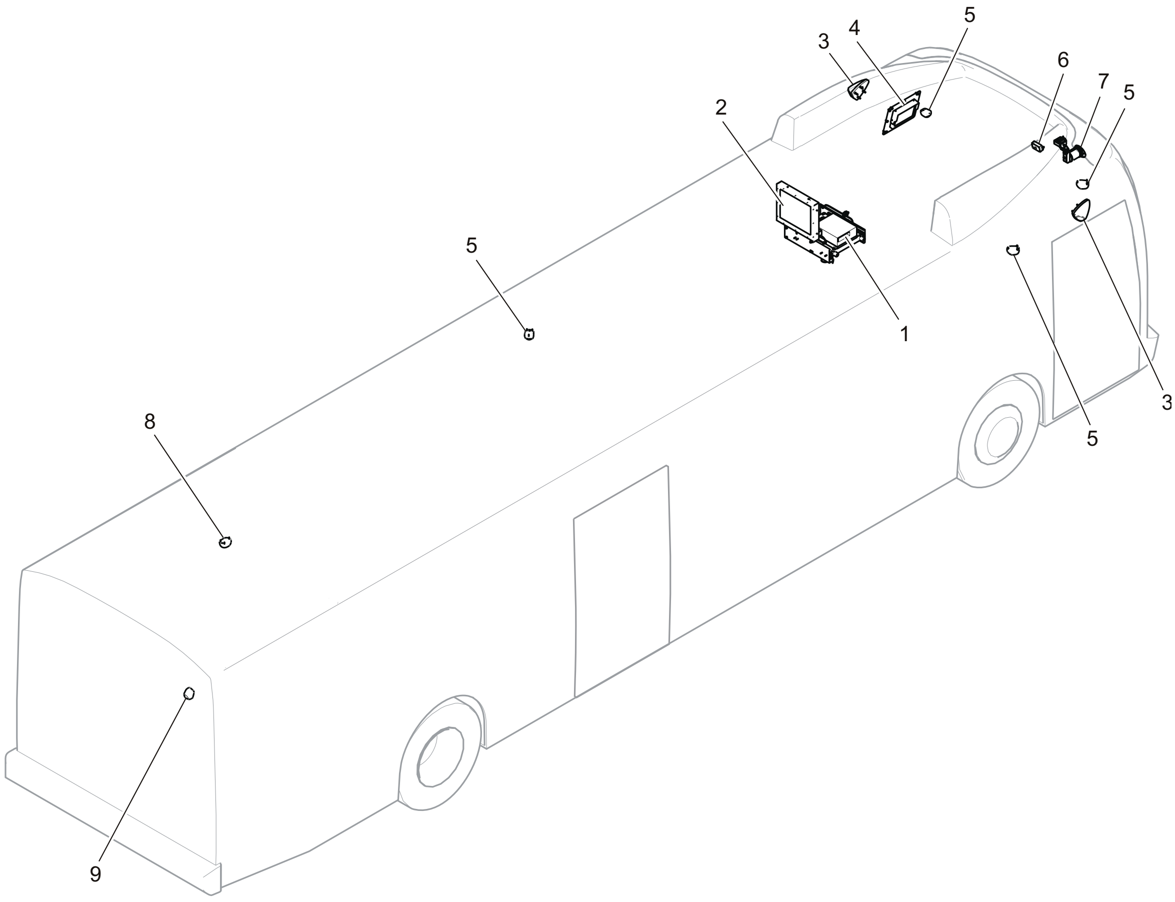
- Digital video recorder in the electronic equipment enclosure.
- Nine cameras in the interior and exterior of the vehicle.
- An Event Marker Switch and DVR status light located on the driver's side console
- A microphone located on the front destination sign enclosure door.
- 3-Axis accelerometer in electronic equipment enclosure.
- 10" monitor located in the driver area.
- 19" monitor mounted to the rear facing panel of the electronic equipment enclosure.

14.2. Operation

The Event Marker switch allows event marking of incidents for storage and retrieval on the DVR hard drive. An accelerometer is built into the unit and in the event of a collision, signals the DVR to save the event.

The DVR power relay is activated when the Master Run switch is set to either the DAY-RUN, NIGHT-RUN or NIGHT-PARK position. When the available storage capacity is full, the DVR will automatically purge the oldest image data to make room for new image data.

The LCD screen on the instrumentation displays an interior view of the exit doors when the exit doors are open. The screen also displays an exterior view of behind the vehicle when the shift selector is placed into reverse. The cameras mounted across the exit doors and the camera mounted to the rear crown provide the respective video feeds.



1. Video Surveillance Tray Assembly
2. 19" LCD Monitor
3. Camera, 4.8mm SS/CS
4. 10" LCD Monitor
5. Camera, 2.5mm
6. Axis Accelerometer
7. Camera, 2.8mm - 12mm Forward
8. Camera, 3.6mm
9. Camera, 2.9 mm Rear

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Fig. 9-63: Video Surveillance System

15. ELECTRONIC STROKE ALERT (e-STROKE)

15.1. Description

The e-STROKE System provides real-time monitoring of the push rod stroke in each brake chamber. The system consists of:

- ❒ Electronic sensor-equipped brake chambers at each wheel.
- ❒ A 50 psi brake pressure transducer located on the pressure switch bracket below the side console panel.
- ❒ A Chassis Communication Module (CCM) located on the forward face of the street-side wheelhousing. See "Fig. 9-64: E-Stroke Chassis Communication Module" on page 100.
- ❒ A Brake Alert message on the instrument panel display screen.
- ❒ Brake Lining Wear indicators in the brake lining at each wheel.
- ❒ Interconnecting wiring harness.
- ❒ Diagnostic lamp in the electronic equipment enclosure.

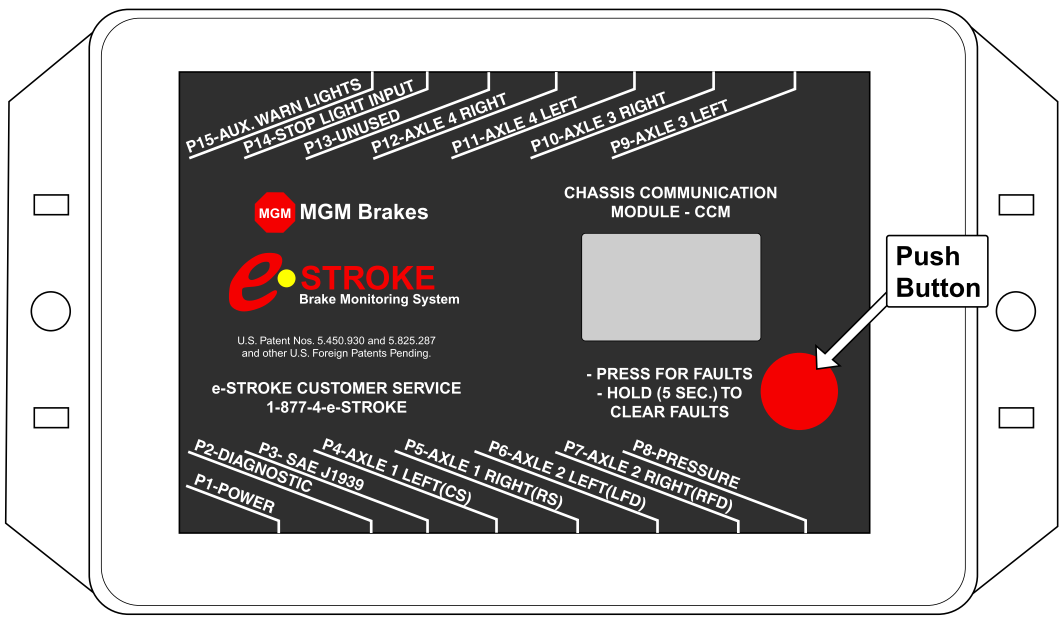


Fig. 9-64: E-Stroke Chassis Communication Module

15.2. Operation

The e-Stroke system continuously monitors the vehicle braking system while in operation and the Brake Alert message will appear on the instrument panel display screen if any active fault conditions are present. The message will disappear when the fault is no longer active or has been repaired. Inactive faults are stored in memory and can be retrieved by using blink codes and the system warning indicator.

☞**NOTE:**

Blink codes will be displayed for active blink codes only if an active fault is occurring at the time. The active fault will need to be repaired and the Brake Alert message extinguished before any stored inactive faults can be displayed.

Blink codes can be displayed using the following sequence:

1. To retrieve the active or in-active stored fault codes, press the red push button on the front of the e-Stroke module for one second and release. This will start the blink code sequence.
2. Observe the Brake Monitoring System Module and count the blink codes. Refer to 15.2.2. “Blink Code Definitions” on page 102 in this section for blink code definitions.
3. The blink codes will be displayed in a loop until the Master Run switch is shut off or the fault codes are cleared.
4. To clear the fault codes press and hold the red push button on the front of the module for a minimum of five seconds and release.
5. The warning light will blink 10 times acknowledging that the stored fault codes have been cleared.

15.2.1. Blink Code Timing

BLINK CODE TIMING	
CONDITION	**DURATION**
Indicator ON	0.5 seconds
Indicator OFF	0.1 seconds
Pause between digits	1.5 seconds
Pause between faults	4 seconds

☞**NOTE:**

Pressing the push button for five seconds will clear stored fault codes but will not correct the cause of the original fault.

15.2.2. Blink Code Definitions

BLINK CODE DEFINITIONS			
FIRST DIGIT	TYPE OF FAULT	SECOND DIGIT	LOCATION OF FAULT
1	No fault	1	No fault (only if first digit = 1)
2	Non-functioning brake	1	Front axle - left
		2	Front axle - right
		3	Rear axle - left
		4	Rear axle - right
3	Over-stroked brake	1	Front axle - left
		2	Front axle - right
		3	Rear axle - left
		4	Rear axle - right
4	Dragging brake	1	Front axle - left
		2	Front axle - right
		3	Rear axle - left
		4	Rear axle - right
5	e-Stroke sensor fault	1	Front axle - left
		2	Front axle - right
		3	Rear axle - left
		4	Rear axle - right
6	Lining wear warning	1	Front axle - left
		2	Front axle - right
		3	Rear axle - left
		4	Rear axle - right
7	e-Stroke system fault	1	Pressure Transducer
		2	SAE J1708/J1939 Communication
10	e-Stroke fault codes cleared		

15.2.3. Diagnostic Program

The e-Stroke RS-232 diagnostic program may be used to acquire the following information from the brake monitoring system:

- ❒ Current wheel-specific brake and lining status
- ❒ Stored fault history
- ❒ System status
- ❒ Module information: software version, configuration, serial number

The diagnostic program kit includes diagnostic program software CD, RS-232 diagnostic/programming harness, and USB high-speed serial adapter harness. Refer to MGM Brakes User Guide for information on using the program.

15.3. E-Stroke Troubleshooting

E-STROKE TROUBLESHOOTING

FAULT TYPE	FAULT SYMPTOM	POSSIBLE CAUSE	RECOMMENDED ACTIONS
Power Source	System Warning Light dose not illuminate	Electrical	1, 3, 4
Power Source	Warning Light stays on or unable to access CCM using diagnostic tool	Electrical	1, 2, 3, 4
Dragging Brake	CCM indicates dragging brake: Left and Right of same Axle	Air Control	5, 6, 8
Dragging Brake	CCM indicates dragging brake on (1) wheel end only	Foundation Brake	6, 7, 10, 11, 12
Non-Functioning	CCM indicates non-functioning brakes on left and right	Air Control	8
Non-Functioning	CCM indicates non-functioning brake on a single axle.	Foundation Brake	6, 7, 9, 10, 11, 12
CCM indicates Over Stroke Condition	CCM indicates out of adjustment condition. Excess actuator stroke with pressure between 12-50 PSI	Foundation Brake	6, 7
Non-Functioning and Over-Stroke Fault	A combination of multiple Non-Functioning, Over-Stroke, and Drag faults on one wheel end	Foundation Brake	See Low Caliper Running Clearance
Low Caliper Running Clearance	Low caliper running clearance fault detected (Non-Function/Over Stroke faults may be recorded for Wheel End as well)	Foundation Brake	7, 10, 11
Sensor Fault	CCM indicates Active Sensor Fault or Erratic Fault Conditions on same wheel.	Electrical	10, 11
Pressure Transducer	Pressure Transducer Fault or Non-Functioning Fault Reported for Multiple Axles.	Electrical	11

E-STROKE TROUBLESHOOTING ACTIONS	
RECOMMENDED ACTION KEY	**RECOMMENDED ACTIONS**
1. Verify System Input Power	Verify Master Run Switch is in DAY-RUN or NIGHT-RUN
	Verify Input Power is turned ON.
	Verify System is NOT connected to Battery Power.
	Verify e-STROKE CCM power source is properly functioning
	Check CCM Power Cable for Electrical Shorts, Cut Wires, or Damaged Connectors.
	Test Vehicle System Voltage. e-STROKE System Input Voltage must be between 10-30 Volts DC.
2. Verify J1939 Connection	Check CCM J1939 connection .
	Verify CCM is configured for J1939 data network speed (250kbs vs 500 kbs).
	Check for e-STROKE on network diagram in Vehicle Electrical Schematics
3. Verify Warning Light Operation	Check for faulty warning lamp by applying signal voltage to test. ☞ **NOTE:** *CCM will "Blink" a voltage signal from the Alarm Output during start up.*
	Verify Multiplexing system is working
4. Possible CCM Malfunction	CCM Alarm output constant voltage, Warning Light remains On after Start Up indicates CCM is not operating properly.
	Lack of warning light bulb check after System Power (Recommended Action 1) and Warning Light (Recommended Action 3) are verified indicates CCM is not operating.
5. Possible Vehicle Operator Error	Parking Brakes applied while vehicle is moving.

E-STROKE TROUBLESHOOTING ACTIONS	
RECOMMENDED ACTION KEY	**RECOMMENDED ACTIONS**
6. Inspect Foundation Brake and Caliper for mechanical or operational issue	Verify that caliper lever arm fully returns back to starting position and does not remain applied.
	Inspect Foundation Brake and Caliper for seized components (i.e. caliper guide pins).
	Inspect Caliper and Actuator Boots/Seals for damage or tears.
	Inspect Brake Pad Linings for irregularities or damage (i.e. foreign material stuck in pads, excessive pad wear or part of pad missing).
7. Inspect Caliper Running Clearance Adjustment	Verify Caliper Adjustment refer to Section 1 or Section 2 of this Manual for procedure
	Verify caliper adjuster operation. Refer to Section 1 or 2 of this manual for Adjuster Check Procedure.
	Running Clearance below (0.030") may reduce actuator stroke resulting in Non-Function Faults reported. ☞**NOTE:** *Potential causes: 1) Caliper Adjuster Malfunctioning 2) Incorrect clearance set at pad service 3) New lining expansion during initial heat cycle.*
8. Possible Service Brake Air Control Issue	Check for Dirt, Moisture, or Ice in Air System (Air Line or Valve blockage).
	Confirm Proper Operation of Interlocks Function (Apply/Release).
	Confirm Proper QR Valve Operation (Apply/Release).
	Confirm Valve Control Wiring. Refer to Vehicle System Drawings
9. Brake Actuator Inspection	Check Brake Chamber for Service Diaphragm leak.
	Check Parking Brake Spring Chamber for Leak (Diaphragm or Piston)
	☞**NOTE:** *Refer to the PM section of this Manual for Brake Chamber Inspection procedures.*

E-STROKE TROUBLESHOOTING ACTIONS	
RECOMMENDED ACTION KEY	**RECOMMENDED ACTIONS**
10. Inspect Sensor Harness and Connectors	Check cable and wires for loss of connection, damage, cuts, pinch's, corrosion, shorts.
	Check Exterior Wheel End
	Check CCM connectors for Damaged/Bent/Loose Terminals, Corrosion. Ensure connector is fully installed into CCM.
	Check Harness Connections at Artic Joint (if applicable).
	Drag Fault could be from broken ground wire.
11. Verify Sensor Condition and Operation	Confirm correct Wheel End Location by unplugging Exterior Sensor Connector (>60 sec) and confirm Sensor Fault at correct wheel w/ Diagnostic Tool (I.e. Front Left Wheel End should show Sensor Fault on Axle 1 Left).
	Inspect Sensor for damage or Signs of Corrosion.
	Verify Sensor Voltage function. Check sensor voltage at CCM connector with system power and wheels chocked. Test green signal wire to black ground wire. Brakes Released 0.1-1.99 VDC, Brakes Applied >2.00 VDC Sensor Fault if <0.10 VDC after 60 Seconds. Sensor Power: Red power wire to black ground wire. Voltage should read >4.8 VDC
	Pressure Transducer: Inspect e-STROKE Pressure Transducer and wiring. Use Diagnostic Tool to verify Pressure Transducer read < 0.3 psi with NO brake application.
12. Inspect e-STROKE Brake Actuator Piston Rod Reflective Target	Remove Brake Actuator and inspect Piston Rod Ball End Reflective Target Material for Grease, Dirt or Damage.
	Clean Grease from Piston Rod Reflective Targets with clean/dry rag. **CAUTION** **DO NOT use solvents.** **NOTE:** *Grease on the Black or Red targets can cause a Drag Fault indication.*

16. FLEET MANAGEMENT SYSTEM

16.1. Description

This vehicle is equipped with a Fleetwatch data logger and transceiver used to capture and report vehicle performance and fault codes from the existing J1939 network. The data logger modules are located inside the ducting between the light panels and roof above the entrance door and just before the articulated joint on the curbside of the vehicle. See “Fig. 9-65: Fleet Management System” on page 107.

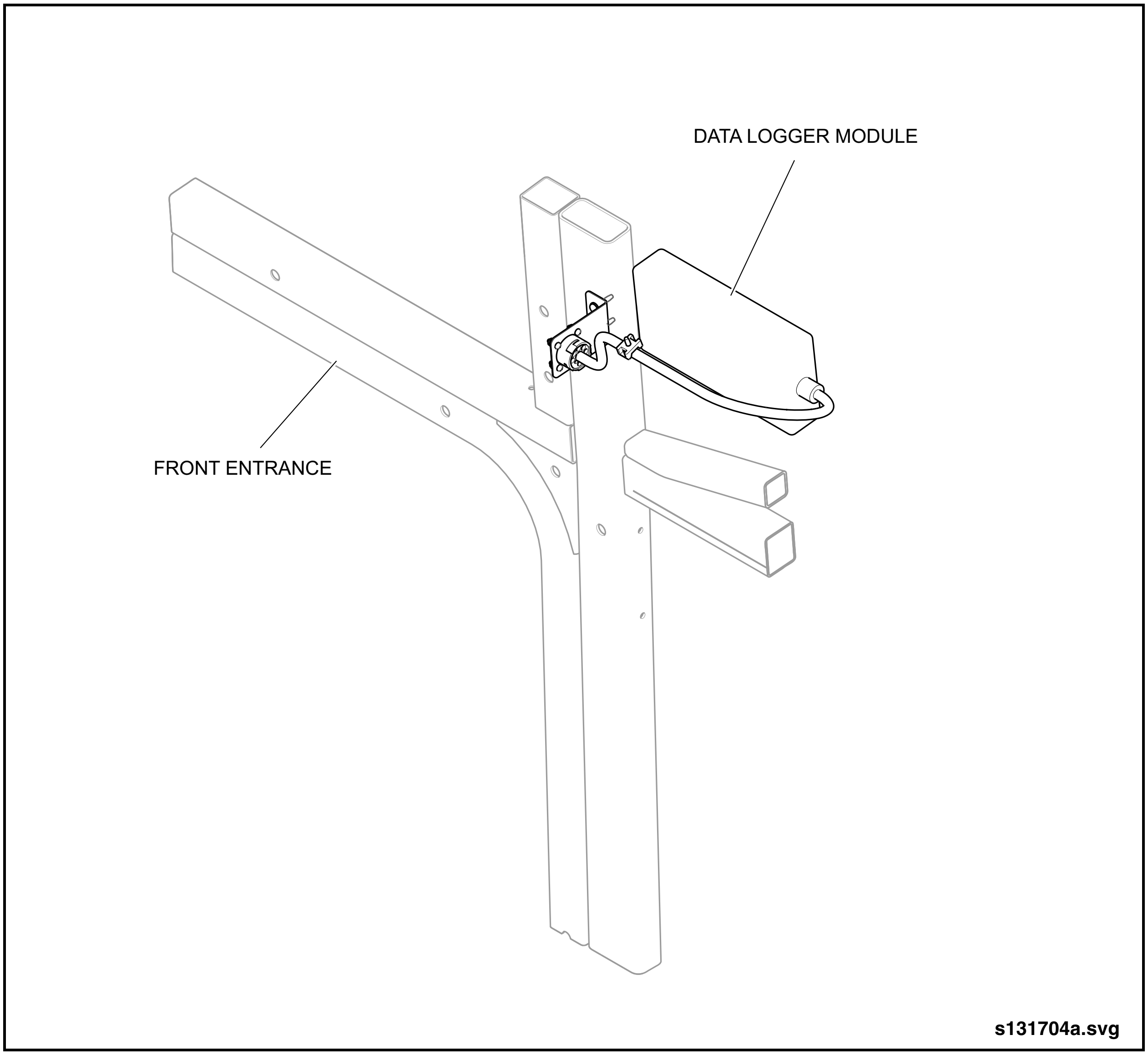


Fig. 9-65: Fleet Management System

16.2. Operation

Data can be collected and reported on demand to a wireless Fleetwatch receiver station located in a service lane. Vehicle number, total mileage and engine hours are reported each reading. The user can select a set of items such as engine and transmission/drive unit fault codes. These are recorded with the date and time of the beginning and ending of the last occurrence observed. The data logger can be integrated with the Fleetwatch fluid management system to report engine oil pressure and coolant temperature etc. for the previous 24 hours including minimum and maximum values observed.

16.3. Fleet Management System Troubleshooting

1. Ensure the correct vehicle number is programmed into the data logger by reading it with the receiver station MR55.
2. Check power is being supplied to the onboard modules. Power should be in the 9-32 VDC range.
3. Open the logger module by removing the lid. Check all wires and connectors. Make sure wires are stripped correctly and secured in the right positions in the connectors according to the diagrams in the lid of the module.
4. Ensure all connectors are plugged into the correct positions. Ensure orange/yellow indicator light is on.

16.4. Removal

1. Remove the lighting panel and then the duct liner to access the data logger module.
2. Disconnect the vehicle interface harness from the data logger.
3. Remove the mounting hardware securing the data logger plate.
4. Remove the data logger module from the roof panel (velcro mounted).

16.5. Installation

1. Place the data logger assembly into the duct and mount it to the Velcro strips.

☞**NOTE:**

The transceiver must be facing the window in order to work properly. Check that there is no metal between the transceiver and the outside of the vehicle.

2. Connect the wire harnesses and clip it in place.
3. Reinstall the duct panel and advertisement panel.

17. ELECTRICAL SYSTEM SCHEMATICS

17.1. General

These schematics identify the various components of the electrical system, locations and specific data and are useful to troubleshoot the system. The schematics and related subject matter are disclosed in confidence and must be returned upon request. See “Fig. 9-66: VMM Schematic” on page 109.

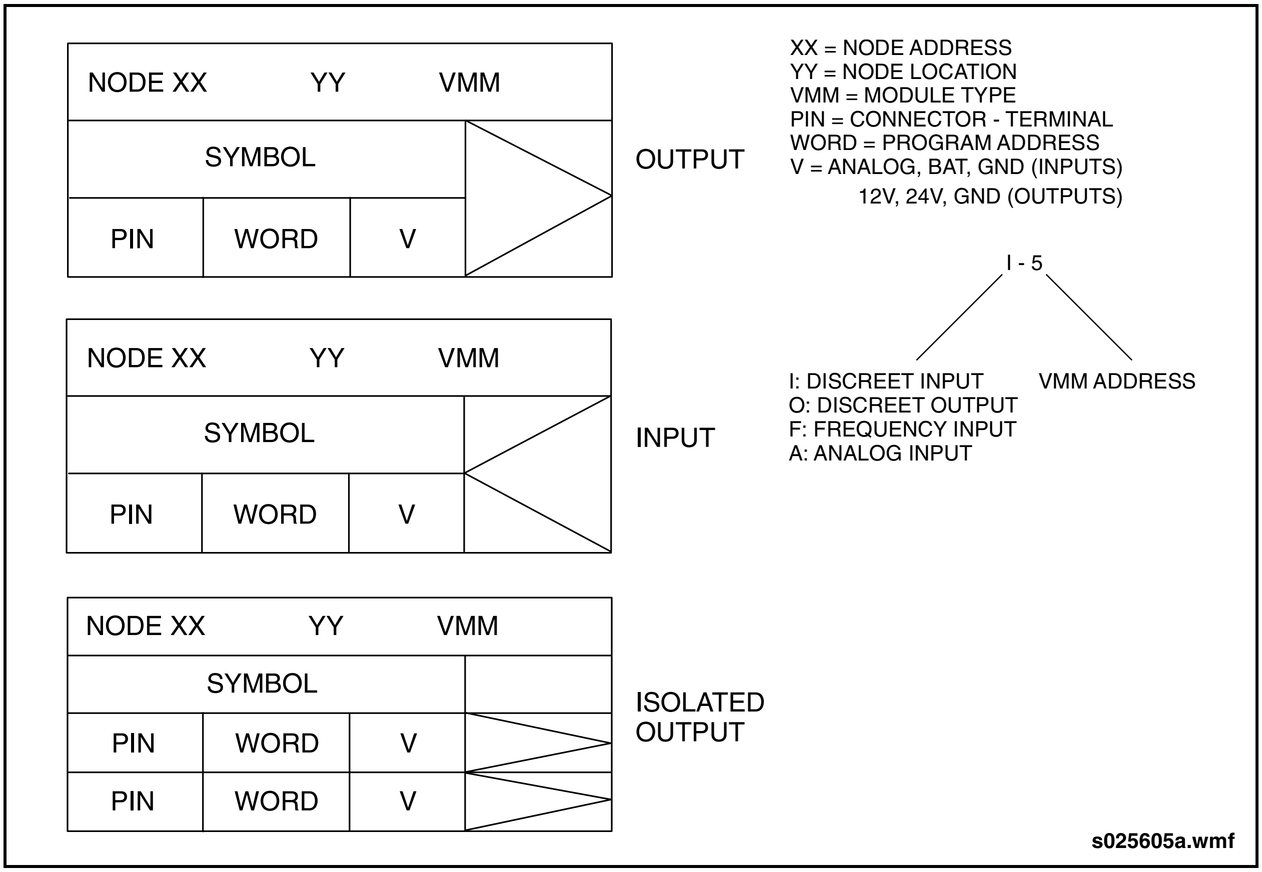


Fig. 9-66: VMM Schematic

17.2. Reading Schematics

Three codes are used for locating an I/O device; an address code (for the electronic control system), page code (to locate the device on a schematic), and a location code (the physical location on the vehicle).

Each schematic has a horizontal grid from 1 to 9, and a vertical grid from A to G. A two letter page code which is derived from the function in the vehicle that the schematic page represents is found in the title of each schematic.

A device legend explaining the I/O is included in the upper right corner of the schematic. Within each arrow of the schematic symbol is a location code to assist in finding the device. This location code gives the physical location of the I/O device on the vehicle (for example SC - the side console panel).

The schematic page titled “I/O Assignments” shows the input and output connections to each module. The inputs/ outputs are shown in tables with their address code, a brief description, and page code. To locate the input/output on a schematic use the given page code to match the schematic title (for example from schematic “I/O Assignments” input, hazard switch (address code I2-4) is shown with a DS page code, then input can be located on the schematic titled DS (Driver’s Signals).

Having located the device on the schematic (by matching address codes), the location code-SC can be found. Therefore the device is located in the side console panel of the vehicle.

17.3. Wire Codes

An abbreviated form of the address is stamped on the wire connected to each I/O device. By simply looking at the wire, you can determine immediately what input or output is connected to any device controlled by the electronic control system.

For example, output O17-3 could be connected to the control module via wire EL80. If this wire runs to a terminal and splits to more devices, the wire at the electronic control system would be labeled EL80A, and the other wires would be labeled EL80B, EL80C and so forth.

Wiring not connected to the electronic control system is stamped with a code derived from the position of the wire on the schematic. The wire code is built up from the schematic code, the grid location, a digit from 1 to 9, and a letter if there are several wires connected to a common terminal.

Every wire running directly from a circuit breaker to a distinct load has a unique number, not a letter suffix.

17.4. Wire Colors

The following wire colors are used throughout the vehicle:

24 VOLT POWER .... RED

12 VOLT POWER ....LIGHT BLUE

ELECTRONIC CONTROL INPUT WIRING
....YELLOW

GROUNDS .... WHITE

SWITCHED POWER/GROUND ....TAN

The communication network is shown as a double line.

17.5. Page Codes

Each schematic has a horizontal grid from 1 to 9, and a vertical grid from A to G. A two letter page code which is derived from the function in the vehicle that the schematic page represents is found in the title of each schematic.

Here are the page codes for electrical schematics:

PAGE CODES	
PAGE CODE	**TITLE**
GI	General Information
PD	Power Distribution
IO	I/O Assignments
NT	Network Topology
PN	Primary Networks
PS	Power & Starting
EN	Engine
TR	Transmission
CN	CNG
CC	Climate Control
DC	Door Controls
DS	Driver's Signal
EL	Exterior Lighting
IL	Interior Lighting
LI	Lighting
LK	Kneeling
CP	Communication Provisions
AF	Auxiliary Functions
FS	Fire Suppression
AB	Anti-Lock Braking
IP	Instrument Panel
SP	Spare Wires

17.6. Device Nomenclature

Where a device is supplied by a third party as part of a system, and is given a code by the vendor, that same code is used on the NFI schematic. For example, connectors supplied by ZF on their harnesses will be labeled BN(X) on the NFI schematic, just as they are in the ZF documentation.

Unique devices require no code for identification purposes, and are labeled on the schematic according to function.

Multiple devices such as circuit breakers and fuses are assigned a code based on the schematic page on which they are found. Thus F4DS is found on page DS, although it may feed loads found on other pages. This is clearly marked on the schematic.

18. VENDOR SERVICE INFORMATION

The following supplier manuals contain additional reference information.

18.1. Vansco Manuals

- ❒ VMM 1210/1280/1615 Software User Guide
- ❒ VMM 1615 Hardware User Guide

HVAC System

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❒ open flame
- ❒ excessive heat
- ❒ production of sparks
- ❒ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

⚠ WARNING

DO NOT perform any maintenance on roof-mounted components unless equipment is in place to prevent fall hazards. Ensure maintenance personnel use approved lift platforms or scaffolding and wear approved safety harness when working on the roof of the vehicle.

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. HVAC System Safety

⚠ DANGER

DO NOT operate the compressor with the discharge valve closed. This condition causes internal pressure, which can cause an explosion

⚠ DANGER

NEVER apply heat to a sealed refrigeration system or container. Heat increases internal pressure, which might cause an explosion.

⚠ DANGER

Refrigerant in the presence of an open flame, spark or electrical short produces toxic gases that are severe respiratory irritants.

⚠ DANGER

Keep your hands, clothing and tools clear of fans, pulleys, or belts when working on a unit that is running. Loose clothing might entangle moving fans, pulleys, or belts, causing serious injury or possible death.

⚠ DANGER

DO NOT inhale refrigerant. Use caution when working with refrigerant or a refrigeration system in any confined area with a limited air supply, such as a bus or garage. Refrigerant displaces air and can cause oxygen depletion, resulting in suffocation and possible death.

⚠ WARNING

Ensure that your gauge manifold hoses are in good condition before using them. Never let them come in contact with moving belts, motor, engine pulleys or hot surfaces. Defective gauge equipment can damage components or cause serious injury.

WARNING

ALWAYS wear goggles or safety glasses when working around air conditioning systems or batteries. Refrigerant liquid, oil and battery acid can permanently damage your eyes.

WARNING

Use extreme caution when drilling holes in the unit. Holes might weaken structural components. Holes drilled into electrical wiring can cause a fire or explosion.

WARNING

Exposed coil fins can cause lacerations. Service work on the evaporator or condenser coils is best left to a certified Thermo King technician.

WARNING

Be careful when using ladders or scaffolding to install or service air conditioning systems. A work platform is recommended for servicing rooftop units. Follow the equipment manufacturer's instructions, safety labels and warnings.

CAUTION

Ensure that all mounting bolts are tight and are the correct length for their application. Improper torque and incorrect bolt lengths can result in damage to equipment.

CAUTION

If soldering is required, use dry nitrogen to purge the system during any solder operations. Refer to your Thermo King Maintenance Manual for additional information on using pressurized nitrogen.

1.4. Electrical Hazards

WARNING

Be careful to not accidentally ground any live circuit when working on the HVAC system. The amount of amperage available from the alternator can cause severe burns if accidentally shorted to ground with metal objects, such as tools.

WARNING

DO NOT wear jewelry, watches, or rings because they increase the risk of shorting out electrical circuits and damaging equipment or causing severe burns.

WARNING

Use caution when working with electrical circuits that have capacitors. Some capacitors hold a significant charge that might cause burns or shocks if accidentally discharged. Make sure capacitors are discharged before working on electrical circuits.

CAUTION

ALWAYS wear an electrostatic discharge (ESD) wrist strap and connect the opposite end to chassis ground when working on circuits that contain microprocessors. This precaution will prevent electrostatic discharge from damaging circuits.

CAUTION

ALWAYS set the Battery Disconnect switch to the OFF position whenever working on HVAC electrical circuits that are not required to be energized. This will prevent accidental shorting of any live circuits.

1.5. Refrigerant Hazards

DANGER

DO NOT use a Halide torch when servicing the HVAC system. When a flame comes in contact with refrigerant, toxic gases are produced that might cause suffocation or event death.

DANGER

Store refrigerant in proper containers, out of direct sunlight and away from intense heat. Heat increases pressure inside storage containers, which can cause them to burst.

DANGER

DO NOT use oxygen or compressed air for leak testing systems. Oxygen mixed with refrigerant is combustible.

WARNING

Wear protective garments and goggles or safety glasses when working with refrigerant to prevent frostbite and eye injuries.

WARNING

ALWAYS wear butyl lined gloves when handling refrigerant to help prevent frostbite.

CAUTION

All charging using the newer refrigerants (Azeotropic blends) must be done in the liquid state. Failure to do this will decrease system operating efficiency. Refer to the charging procedures found in your Thermo King Maintenance Manual.

CAUTION

When recovering or transferring refrigerant, use a process that prevents refrigerant from escaping into the atmosphere. Refrigerant damages the earth's upper ozone layer.

CAUTION

Refrigerant in a liquid state evaporates rapidly when exposed to the atmosphere, freezing anything it contacts. Be careful when handling refrigerant to protect your skin from frostbite.

1.5.1. First Aid

1.5.1.1. Frostbite

Warm the affected skin to body temperature as soon as possible.

1.5.1.2. Eyes

Immediately flush eyes with large amounts of water. CALL A PHYSICIAN.

1.5.1.3. Skin

Flush area with large amounts of warm water. DO NOT apply heat. Remove contaminated clothing and shoes. Wrap burns with dry, sterile, bulky dressing to protect from infection. CALL A PHYSICIAN.

☞**NOTE:**
Wash contaminated clothing before reuse.

1.5.1.4. Inhalation

Move victim to fresh air and apply CPR (cardio-pulmonary resuscitation) or mouth-to-mouth resuscitation to restore breathing, if necessary. Stay with the victim until emergency personnel arrive.

1.6. Refrigerant Oil Hazards

⚠ WARNING

Protect your eyes from contact with refrigerant oil. The oil can cause serious eye injuries. Avoid prolonged or repeated contact with refrigerant oil. To prevent irritation, wash your hands and clothing thoroughly after handling the oil.

⚠ CAUTION

DO NOT mix refrigerant oils because that can cause system damage.

⚠ CAUTION

ALWAYS use dedicated equipment to prevent contaminating the system with the wrong type of oil or refrigerant.

⚠ CAUTION

ALWAYS use the specified oil listed in your Thermo King Maintenance Manual. Check the ID label on the HVAC equipment to confirm that the correct oil type is being used.

⚠ CAUTION

When servicing Thermo King units, DO NOT use equipment that might be contaminated with Polyalkylene Glycol (PAG) oils.

⚠ CAUTION

Store refrigerant oil in an approved sealed container to avoid moisture contamination.

⚠ CAUTION

DO NOT expose refrigerant oil to the atmosphere any longer than necessary. The oil will absorb moisture, which results in much longer evacuation times and possible system contamination.

⚠ CAUTION

ALWAYS wipe up spills immediately. Refrigerant oil can damage paints and rubber materials.

1.6.1. First Aid

1.6.1.1. Eyes

Immediately flush eyes with water for at least 15 minutes. CALL A PHYSICIAN. Wash skin with soap and water.

1.6.1.2. Ingestion

DO NOT induce vomiting. Immediately contact local poison control center or physician.

2. HEATING/AIR CONDITIONING SYSTEMS

CAUTION

Servicing heating system components may result in air being introduced into the system. It is necessary to completely bleed any air entrapped air prior to operating the heating system. Refer to 2.2.6. "Heating System Filling & Deaeration" on page 7 **for fill and bleeding procedure.**

2.1. Description

NOTE:

Refer to the HVAC System Layout when reviewing this information.

The Heating, Ventilation, & Air-Conditioning (HVAC) System is designed to regulate the temperature of the vehicle interior as well as dehumidify and filter the air. The major components of the vehicle HVAC System include:

- ❒ Rear-mounted HVAC unit.
- ❒ HVAC display panel located on HVAC unit.
- ❒ Refrigerant compressor located in the engine compartment.
- ❒ Driver's heater/defroster unit located centrally behind the front dash panel.
- ❒ Auxiliary floor heaters located on the floor, against the sidewalls.
- ❒ Booster pump located in the engine compartment.
- ❒ Vehicle heating system reservoir located in the engine compartment.
- ❒ Heat exchanger mounted on the streetside of the engine.
- ❒ Coolant pressure fill connector located in the engine compartment.

2.2. Operation

2.2.1. Air Circulation

The HVAC unit blower assembly draws interior air through the filter panel located in the access door. Air is forced across the heater/evaporator coils and circulated throughout the interior of the vehicle via overhead ducts located above the lighting panels.

The driver's heater/defroster blower assembly draws air through a filter located inside the defroster compartment. The defroster air recirculation control, located on the instrument panel, allows the driver to select interior air, outside air, or a blend of each. The air is circulated through ducts behind the dash panels to defroster outlets below the front windshield and to a heat outlet beneath the instrument panel.

2.2.2. Coolant Circulation

The vehicle heating system is a closed loop system which is isolated from the engine cooling system and is provided with an independent reservoir, and circulation pump.

The coolant booster pump draws coolant from the vehicle heating system reservoir and delivers it to the engine-mounted heat exchanger where heat is transferred from the engine coolant to the vehicle heating system coolant. Heating system coolant then flows to the HVAC unit heater coil, interior heater coils, and driver's heater/defroster unit heater coil.

Coolant returns from the vehicle heating system to the heating system reservoir where an integral degas chamber allows any entrapped air to be vented.

Manual shutoff valves are installed in the coolant supply and return lines located in the engine compartment and beneath the driver's platform. A solenoid controlled coolant shutoff valve is located inside the HVAC unit and inside the defroster compartment. Heating system drain plugs are located in the lower radiator tube and in the base of the reservoir tank. A drain cock is also provided in the driver's heater/defroster return line.

2.2.3. Refrigerant Circulation

Refrigerant flow is maintained by the HVAC compressor located in the engine compartment and driven by the engine crankshaft pulley. Refrigerant vapor from the compressor enters the condenser module.

The expansion valve admits liquid refrigerant from the condenser module to the evaporator coils located in evaporator module. Refrigerant vapor then returns to the compressor.

2.2.4. Theory of Operation

In a typical vehicle unit, interior vehicle air is drawn through the return air grille. This air passes through a filter, evaporator coil and heater coil where it is dehumidified and cooled or heated per mode of system operation.

When the compressor starts operation, the pressure in the suction line and evaporator coil is reduced, causing the refrigerant gas to flow into the compressor. The compressor compresses the refrigerant gas causing an increase in temperature and pressure. The compressor discharges this high temperature, high pressure refrigerant gas into the condenser. The outside air passing through the condenser coil is cooler than the temperature of the hot refrigerant gas. This temperature difference causes the hot refrigerant gas to give up its heat, thus lowering the temperature of the hot refrigerant gas. When this occurs, the refrigerant changes state from a vapor to a liquid (condenses). The receiver tank stores the refrigerant to meet the varying demands of the expansion valve. The refrigerant leaves the receiver tank through the liquid line and flows through the filter-drier (dehydrator) to the expansion valve. The filter-drier (dehydrator) removes moisture from the system.

The expansion valve meters the liquid into the evaporator coil. As vehicle air flows through the evaporator coil, the refrigerant picks up heat from the air and causes the refrigerant inside the evaporator coil to boil and change to a vapor. The air is cooled and returned to the vehicle. The compressor pumps the heated gas out of the evaporator coil and into the condenser coil causing the cycle to repeat itself. By removing heat from the vehicle faster than it can enter, the unit maintains the desired temperature.

If heat mode is selected, a booster pump circulates warm coolant through the heater coil.

The air is then warmed as it passes through the heater coil. Warm air is circulated maintaining thermostat setpoint temperature.

2.2.5. Heating System Draining

WARNING

DO NOT service the vehicle heating system or open the pressure cap on the reservoir if the system is hot or under pressure. Hot coolant can cause scalding burns if pressure caps are opened or lines are disconnected. ALWAYS allow time for the coolant temperatures to drop and ALWAYS use the pressure cap lever to relieve system pressure before servicing the system.

1. Ensure that the coolant temperature is 122°F (50°C) or lower.
2. Open the rear engine access door.
3. Open the interior engine access door.
4. Ensure that the heating system supply and return shutoff valves are in the open position.
5. Open the surge tank/reservoir access door.
6. Locate the heating system reservoir pressure cap.

   ☞**NOTE:**

   The heating system pressure cap is labeled CABIN HEAT COOLANT.

7. Relieve the heating system pressure by operating the lever on the pressure cap of the heating system reservoir. Open the pressure cap once the pressure has been relieved.
8. Raise the vehicle, if necessary, to gain access to the reservoir and degas tank drain plugs. Refer to the General Information Section of this manual for approved lifting procedures.
9. Place a suitable container under the heating system reservoir and degas tank. Remove the drain plugs and drain coolant.

   ☞**NOTE:**

   Drain all liquids into suitable containers for disposal. Coolant must be recycled or disposed of in accordance with all applicable regulations. If coolant is to be recovered, make sure all containers are clean and chemical free.

10. Place a suitable container under the heater/defroster. Open the drain cock, located in the return hose, and drain the coolant.
11. Reinstall and tighten all drain plugs and close all drain cocks once the heating system has been completely drained.

2.2.6. Heating System Filling & Deaeration

☞**NOTE:**

The following procedure describes the recommended pressure-fill method to be used when a significant quantity of coolant needs to be replaced and any entrapped air purged from the system. Refer to 2.2.6.2. "Final Coolant Level Verification" on page 9 *in this section for manual fill procedure.*

2.2.6.1. Initial Pressure Fill

1. Ensure that all drain plugs have been installed and drain cocks have been closed.
2. Ensure that the heating system supply and return shutoff valves are in the open position.
3. Set the Battery Disconnect switch to the ON position.
4. Set the Master Run switch to DAY-RUN position.
5. Set the Climate Control switch to the HEAT position.
6. Set the Defroster Temperature Control to the maximum heat setting.
7. Set the Defroster Fan Speed Control to the low speed setting.
8. Locate the pressure cap on the vehicle heating system reservoir.

   ☞**NOTE:**

   The heating system pressure cap is labeled CABIN HEAT COOLANT.

9. Open the pressure relief lever and loosen the pressure cap. DO NOT remove the pressure cap from the filler neck.

10. Locate the vehicle heating system pressure-fill connector in the engine compartment. See “Fig. 10-1: Pressure Fill Connectors” on page 9.

☞**NOTE:**

There are two pressure-fill connectors located side by side in the engine compartment. Ensure that the connector labeled CABIN HEAT COOLANT is used during the following procedure.

11. Connect the pressure filling equipment to the quick-coupler and add coolant until it is above the HOT FULL mark on the reservoir sight gauge. Stop filling.

☞**NOTE:**

Ensure pressure fill equipment is pressure regulated to 10 psi or less. Dispense coolant at less than 6 gallons per minute. Supply reservoir must be of adequate volume to ensure pump does not draw air during fill process. Supply coolant must be clean and of the same specification required for the vehicle cooling system. Refer to the Preventive Maintenance Section of this manual for coolant specification. Refer to your New Flyer parts manual for part numbers and ordering information for the pressure fill equipment.

12. Set the Engine Run switch in the engine compartment to the REAR position.

⚠**CAUTION**

DO NOT allow the booster pump to run dry while operating the Coolant Fill Mode switch. Always maintain a coolant level that is visible in the reservoir sight gauge.

13. Set the Cabin Coolant Fill Mode switch to the ON position and monitor the coolant level in the reservoir sight gauge.

☞**NOTE:**

Operating the Coolant Fill Mode switch will energize the booster pump and open the heating system solenoid valves to allow coolant circulation through all heating system components.

14. Maintain the coolant level in the reservoir sight gauge below the COLD FULL mark, but above the level that would activate the Low Coolant light on the engine switchbox.

☞**NOTE:**

It may be necessary to cycle either the Coolant Fill Mode switch or the pressure-fill system ON and OFF to maintain a fluid level at the COLD FULL mark.

15. Continue the filling process until the coolant level remains stable for five minutes at the COLD FULL mark on the reservoir sight gauge. Stop filling.

16. Set the Cabin Coolant Fill Mode switch to the OFF position.

17. Disconnect the pressure-fill equipment.

18. Close the pressure relief valve lever and tighten the pressure cap.

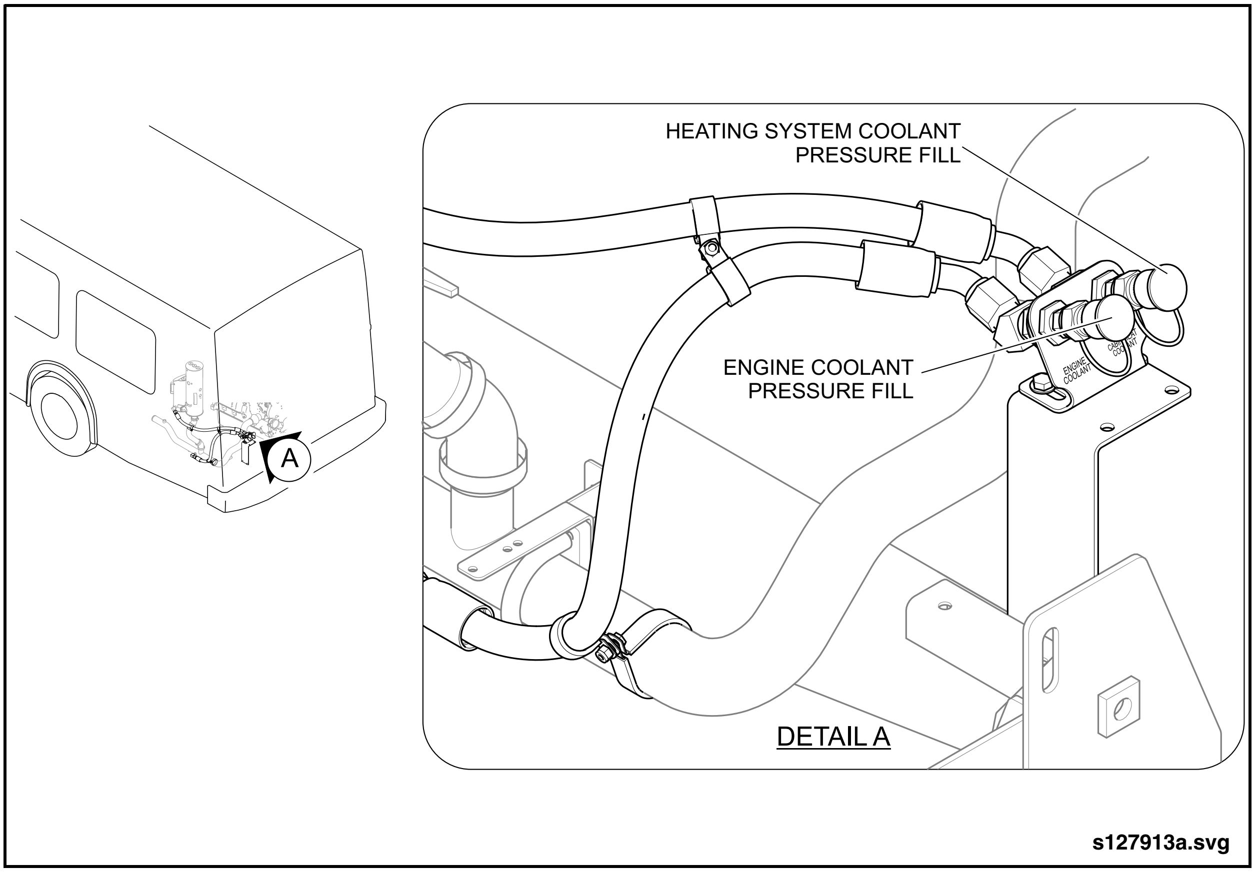


Fig. 10-1: Pressure Fill Connectors

2.2.6.2. Final Coolant Level Verification

☞**NOTE:**

The following procedure is used to verify the proper coolant level when the vehicle heating system is hot.

1. Operate the engine until the thermostat opens and engine coolant is at 190°F (88°C).
2. Shut down the engine.
3. Set the Master Run switch to DAY-RUN position.
4. Set the Climate Control switch to the HEAT position.
5. Set the Defroster Temperature Control to the maximum heat setting.
6. Set the Defroster Fan Speed Control to the low speed setting.
7. Check the pressure in the heating system by using the pressure test fitting located below the pressure cap labeled CABIN HEAT COOLANT.

WARNING

DO NOT open the pressure relief lever on the pressure cap if system pressure is over 10 psi. DO NOT remove the pressure cap from the filler neck.

8. SLOWLY open the pressure relief lever and loosen the pressure cap.
9. Set the Engine Run switch on the engine switchbox to the REAR position.
10. With the engine coolant at 190°F (88°C), start the engine and operate at fast idle.
11. Set the Coolant Fill Mode switch to the ON position and monitor the coolant level in the heating system reservoir sight gauge.

12. After five minutes of running at fast idle, the heating system should be at operating temperature. Check the level on the reservoir sight gauge.
    a. If the level is at or below the COLD FULL mark, remove the pressure cap and add coolant until the level is at the HOT FULL mark.
    b. If the level is at or slightly below the HOT FULL mark, no further action is required.
13. Close the pressure relief valve and tighten the pressure cap.
14. Shutdown the engine.

2.2.6.3. Manual Fill & Top Up

WARNING

DO NOT service the vehicle heating system or open the pressure cap on the reservoir if the system is hot or under pressure. Hot coolant can cause scalding burns if pressure caps are opened or lines are disconnected. ALWAYS allow time for the coolant temperatures to drop and ALWAYS use the pressure cap lever to relieve system pressure before servicing the system.

☞**NOTE:**

The following procedure is to be used during regular inspections if the fluid level is below the COLD FULL mark, or if the fluid level is not visible in the sight gauge, or if the low coolant warning light is illuminated.

1. Locate the heating system supply and return shutoff valves in the engine compartment and close the valves.
2. Locate the pressure cap labeled CABIN HEAT COOLANT and slowly open the pressure relief valve on the cap.
3. Remove the pressure cap from the filler neck.
4. Add coolant to the heating system reservoir until level with the COLD FULL mark on the sight gauge.
5. Install and tighten the pressure cap.
6. Close the pressure relief valve.
7. Open the vehicle heating system supply and return shutoff valves.

2.3. Heating System Pressure Test

2.3.1. Description

Pressure testing the heating system ensures that the vehicle is free of leaks and is holding pressure for optimal performance. A pressure test tool is required with a pressure regulator that has a 0 to 50 psi rating.

The pressure/leak test procedures are described as follows:

- ❒ Pressure Test Tool Setup
- ❒ Leak Test Heating System

2.3.2. Pressure Test Tool Setup

⚠ WARNING

The heating system is under pressure and contains hot fluids that can spill or spray and cause serious scalding injuries. Allow an appropriate amount of time for the cooling system to cool down below 120°F (49°C) before working on the cooling system unless otherwise noted.

1. Ensure the shutoff valves (located upstream and downstream of the booster pump / degas tank) are fully in the OPEN position.
2. Ensure all drain cocks are closed and all drain plugs are installed.

☞**NOTE:**

This procedure requires the use of the Pressure Test Tool (Item 1 from special tools list). Refer to Section 6 in this manual for tool listing and illustration.

3. Connect the charging chuck of the Pressure Test Tool (Item 1 from special tools list) to the pressure test valve. Refer to Section 6 in this manual for tool listing.
4. Close the shutoff valve of the pressure test tool.
5. Ensure that the heating system pressure relief cap is installed, fully seated, and that the relief valve is closed.

⚠ CAUTION

Secure the pressure tester and air lines before making a connection to a pressurized air hose. Failure to properly secure the pressure tester and air lines can result in injury to personnel and damage to equipment.

6. Attach a shop air line to the quick coupler on the pressure tester.

2.3.3. Leak Test Heating System

☞**NOTE:**

Perform Heating System Draining and Pressure Test Tool Setup before proceeding.

1. Press and hold the button on the pressure test tool to pressurize the system.

⚠ **CAUTION**

DO NOT pressurize the system above 25 psi otherwise system damage can occur. Adjust the pressure regulator accordingly before opening the pressure test tool shutoff valve.

2. Allow the pressure to build above 18 psi and then release the button on the pressure test tool.
3. The pressure relief valve should vent pressure and then hold at 15 to 20 psi. If the pressure relief cap is not venting pressure, release the button on the pressure test tool and then vent the heating system pressure by using the relief valve on the pressure relief cap, or set the pressure test tool regulator to 0 psi if the relief valve cannot be manually opened. Remove the pressure relief cap and replace with a new one and then repeat this task from step 1.
4. Release the button on the pressure test tool and observe the pressure reading on the pressure test tool regulator. Allow the system to stabilize for 5 minutes. The system should stabilize at a minimum of 15 psi.
5. Note the pressure regulator reading once stabilized.
6. Allow the vehicle to stand for an additional 10 minutes. If, after 10 minutes, the pressure reading drops by more than 0.5 psi from the noted stabilized pressure in the previous step, the leak test has failed.
7. If the leak test failed in the previous step, maintain system pressure between 10 to 14 psi and troubleshoot the system by applying soapy water spray on all hoses, and hose connections. Repair/replace leaking hoses (indicated by bubbles forming in the applied soapy water) and retighten any loose hose connections. Refer to Hose Clamp Torque Specifications in this section. Repeat this task until the test passes.
8. When the test has passed, close the shutoff valve of the pressure test tool and then disconnect the pressure test tool from the vehicle.
9. Vent the heating system pressure by using the pressure relief valve on the pressure relief cap.
10. Check the coolant level and fill cooling system as needed. Refer to 2.2.6. “Heating System Filling & Deaeration” on page 7 in this section for more information.

2.4. HVAC Unit

2.4.1. Description

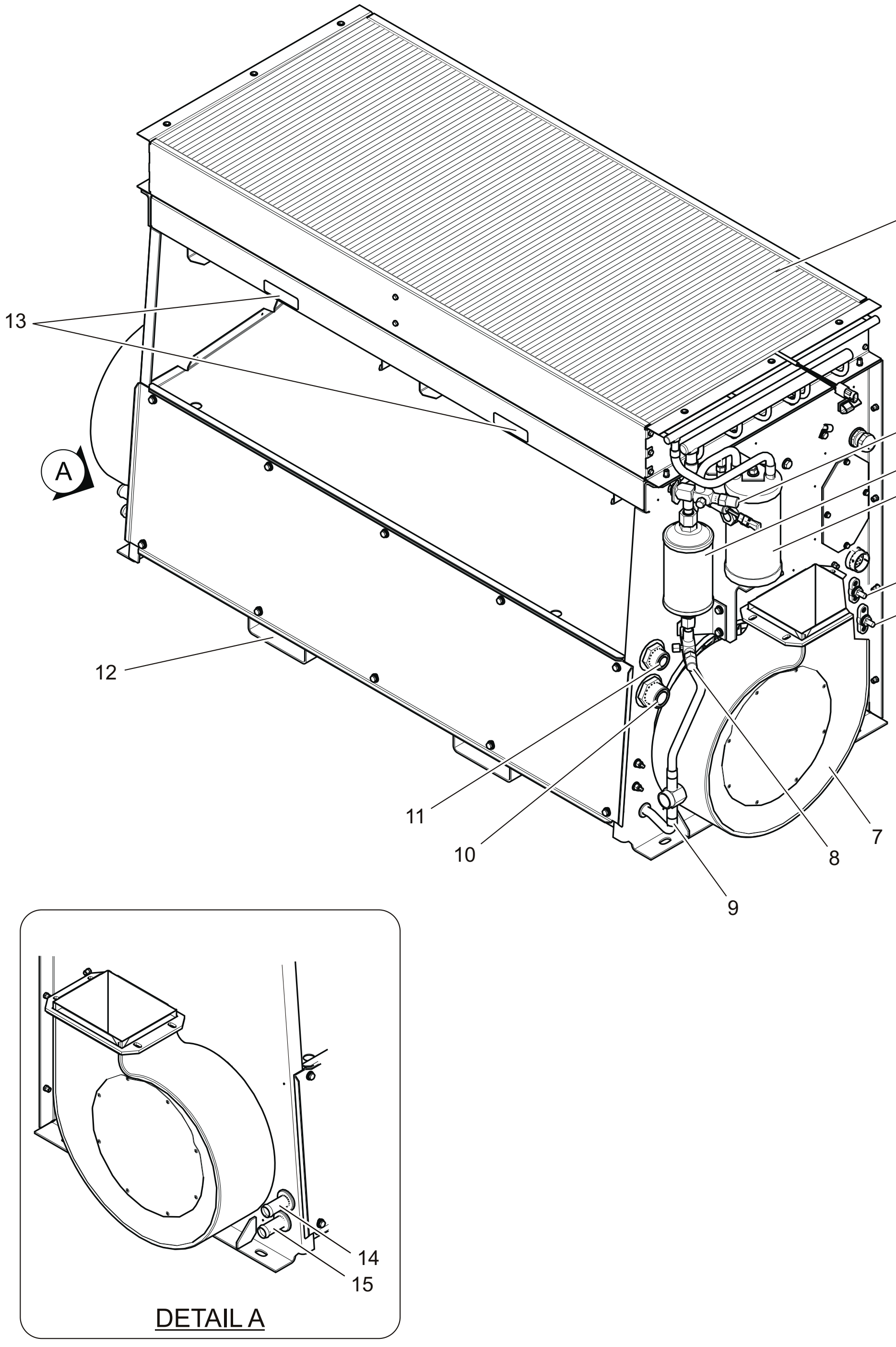
The T15 series is a one-piece condenser/evaporator/heater assembly specifically designed to fit the A/C compartment of transit vehicles. The unit is located in the rear above the engine compartment. It operates with a Thermo King compressor, and is designed to interface with in-vehicle components such as the compressor and booster pump.

The condenser coil mounts horizontally at the top of the unit, and the evaporator and heater coils are installed in the lower section of the unit. The return air filters are mounted in front of the evaporator coil and are accessible through the return air grille.

The condenser, evaporator and heater coils are constructed with corrugated aluminum fins and mechanically expanded copper tubes. Foam insulation is installed in the evaporator/heater area, which minimizes operational noise levels and reduces heat gain (during cool mode) or heat loss (during heat mode).

An exterior A/C access door is located at the rear of the vehicle above the engine compartment. It provides access to the evaporator motor, condenser motors, electrical controllers, power connectors, receiver tank, drier, liquid line sight glass, expansion valve, coolant valve and pressure relief valve. See “Fig. 10-2: Main Features of HVAC Unit” on page 14.

An interior A/C door is located internally at the rear of the vehicle. It provides access to the system electrical controls, including the Intelligaire III controller, control panel and pressure gauges. See “Fig. 10-3: Interior HVAC Components” on page 15.



1. Condenser Coil
2. Service Valve
3. Dryer
4. Receiver Tank
5. Ground Connection
6. Power Connection
7. Blower Housing
8. Service Valve
9. Sight Glass
10. Suction Line Connection
11. Discharge Line Connection
12. Forklift Pocket
13. Condenser Fan Motor
14. Coolant Outlet
15. Coolant Inlet

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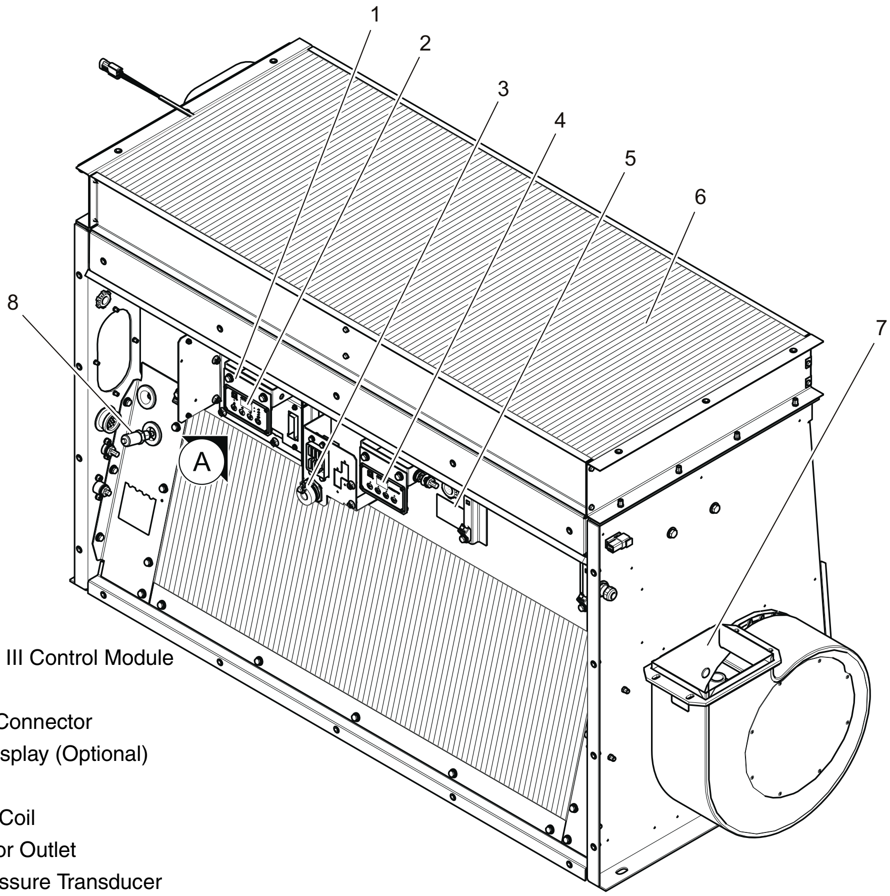
Fig. 10-2: Main Features of HVAC Unit



1. IntelligAIRE III Control Module
2. Display
3. Diagnostic Connector
4. Pressure Display (Optional)
5. Nameplate
6. Condenser Coil
7. Blower Motor Outlet
8. Suction Pressure Transducer

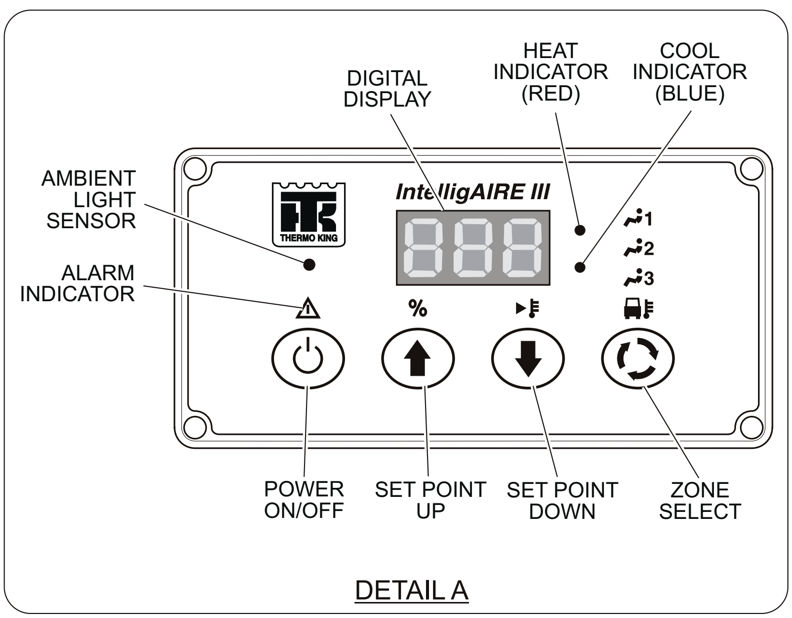


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Fig. 10-3: Interior HVAC Components

2.4.2. HVAC Unit Specifications

Manufacturer..................Thermo King Corp.

Model..T15-M9

Condenser Fan Motors 24VDC

Blower Motors...................................24VDC

Refrigerant Type R407c

2.4.3. Operation

DANGER

DO NOT operate the compressor with the discharge valve closed. This condition increases internal pressure, which can cause an explosion.

The vehicle is equipped with a Multiplexing System, which interfaces the T15 unit with the Climate Control switch on the side console. It also allows interface with other HVAC components such as the compressor, and boost pump as well as monitor system operation. The Climate Control switch allows the driver to select HVAC system modes of operation.

Depending on the input received from the mode switch, the electronic control system activates the appropriate control circuits to meet system demands, and regulate vehicle temperature. See "Fig. 10-4: HVAC Unit Installation" on page 16.

Refer to the Thermo King Maintenance Manual for specific details of operational mode.

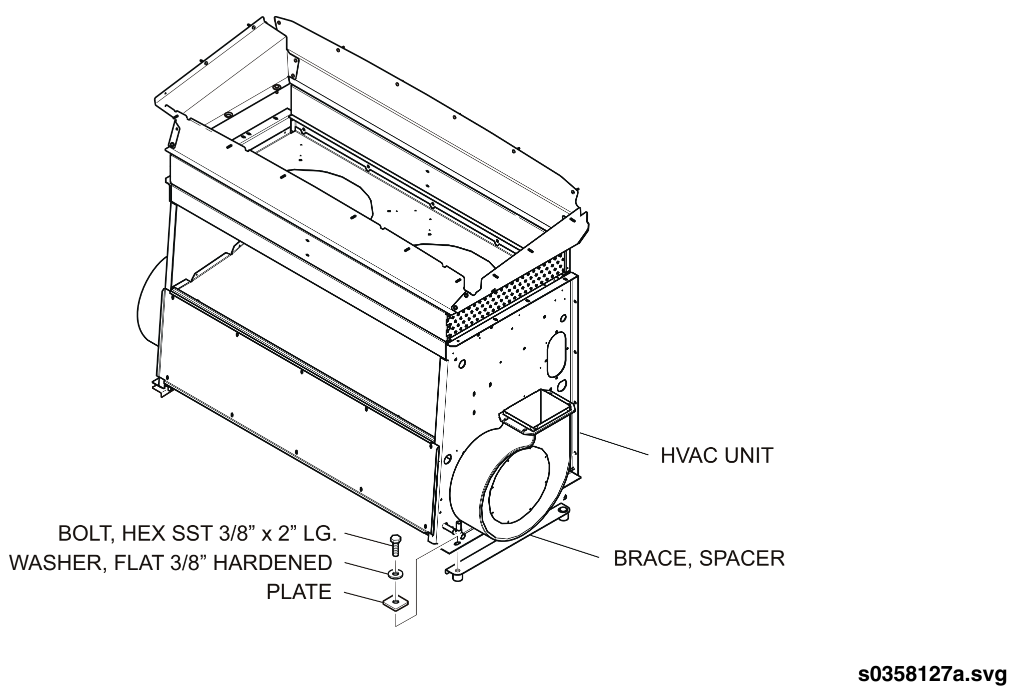

Fig. 10-4: HVAC Unit Installation

2.4.4. Maintenance

DANGER

ALWAYS follow recommended safety procedures specific to the HVAC System when servicing the system. Refer to 1.3. "HVAC System Safety" on page 1 **in this section for safety information.**

Refer to the Preventive Maintenance Section of this manual for service intervals and procedures. Refer to 3. "VENDOR SERVICE INFORMATION" on page 59 in this section for further detailed information on service intervals and procedures.

2.4.5. Removal

WARNING

DO NOT perform any maintenance on roof-mounted components unless equipment is in place to prevent fall hazards. Ensure maintenance personnel use approved lift platforms or scaffolding and wear approved safety harness when working on the roof of the vehicle.

1. Set the Battery Disconnect switch to the OFF position.
2. Open the rear HVAC access door and disconnect the gas struts and electrical connectors for the route sign and clearance lights.
3. Support the door in the horizontal position, using a forklift or similar lifting equipment. and remove the mounting bolts from both hinge brackets. Lower and move the HVAC access door to a safe location.

☞**NOTE:**

Access door must be removed in order to provide forklift lifting clearance.

4. Evacuate the refrigerant from the A/C system. Refer to your Thermo King Maintenance Manual for evacuation procedure.
5. Disconnect and plug refrigerant lines.
6. Drain coolant from the HVAC heater core.
7. Disconnect and plug coolant hoses.
8. Open HVAC access door in the rear interior of vehicle and locate the electrical connectors on the curbside of the HVAC unit. Unplug all HVAC electrical connectors that interface with vehicle wiring system.
9. Locate the electrical connector on the streetside of the HVAC unit and unplug the electrical connector that interfaces with the vehicle wiring system.
10. Remove the fasteners and disconnect the fan outlet ducts on either side of the HVAC unit. See "Fig. 10-5: HVAC Unit" on page 18.

☞**NOTE:**

It will be necessary to cut through the butyl tape and sealant to disconnect the outlet duct adapters from the HVAC unit.

11. Disconnect all drain tubes from base of HVAC unit.
12. Move to the rooftop of the vehicle and remove the fasteners that attach the condenser grill frame and air deflector (if equipped) to the vehicle rooftop. See "Fig. 10-6: Condenser Grill Assembly" on page 19.

☞**NOTE:**

Use a sharp thin blade knife to cut through the Sika adhesive that attaches the condenser grille frame to the roof.

13. Remove LH, RH, front, and rear plenum panels as follows:

☞ **NOTE:**

Make a note of the size and location of the Rubatex seals used between the plenum panels, HVAC condenser mounting flange and vehicle structure. This will aid in proper positioning of the new Rubatex seals during installation.

   a. Scrape away Sika from fasteners and cut through Sika at plenum panel joints.

   b. Remove all fasteners that join plenum panels together and remove fasteners that attach plenum panels to vehicle structure.

   c. Disconnect the ambient temperature sensor from the RH plenum panel.

   d. Remove the three fasteners on either side that attach the side plenum panels to the condenser frame.

   e. Cut through the Sika adhesive to separate the plenum panels from the vehicle structure.

☞ **NOTE:**

The plenum panels will likely be damaged during the course of removal and will need to be replaced with new panels during installation.

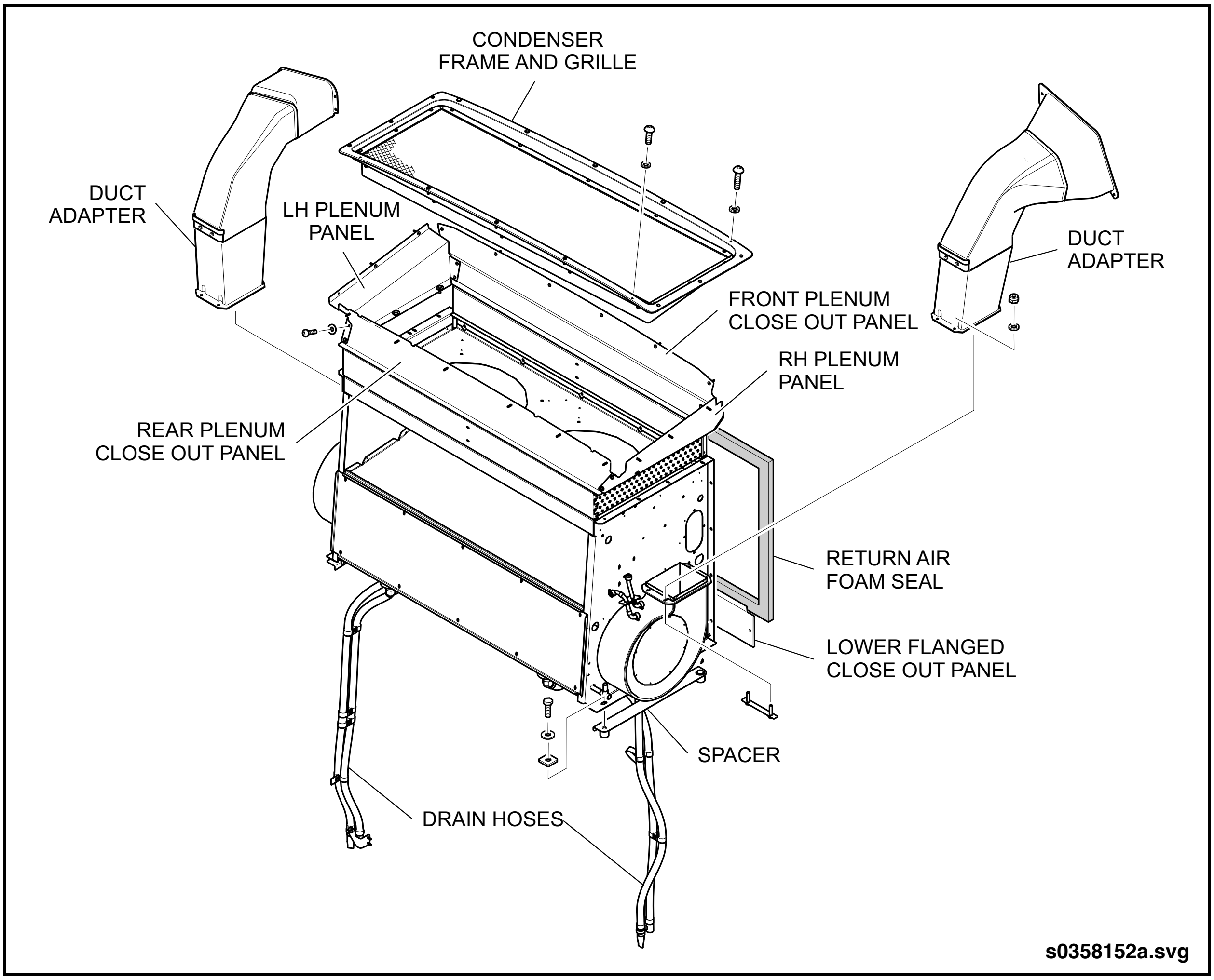

Fig. 10-5: HVAC Unit

14. Remove the mounting fasteners from each corner of the HVAC unit. Note the assembly order of the bolt, washer, plate, and spacer.
15. Use the forklift channels on the base of the HVAC unit to support the unit with a forklift.
16. Slide a piece of sheet metal between the HVAC unit and compartment walls on either side to protect the fire suppression system components (if equipped) during removal.

CAUTION

ALWAYS use an additional person as a spotter during the removal process to ensure all lines, hoses, cables, and harnesses have been disconnected and no obstructions exist that would interfere with the removal of the HVAC unit.

17. Support the weight of the HVAC unit with the forklift and very slowly move HVAC unit rearward until it clears the HVAC compartment.
18. Remove the return air foam seal from the HVAC unit and discard.
19. Remove lower close out flange panel from HVAC unit and retain panel and screws for installation on replacement HVAC unit.

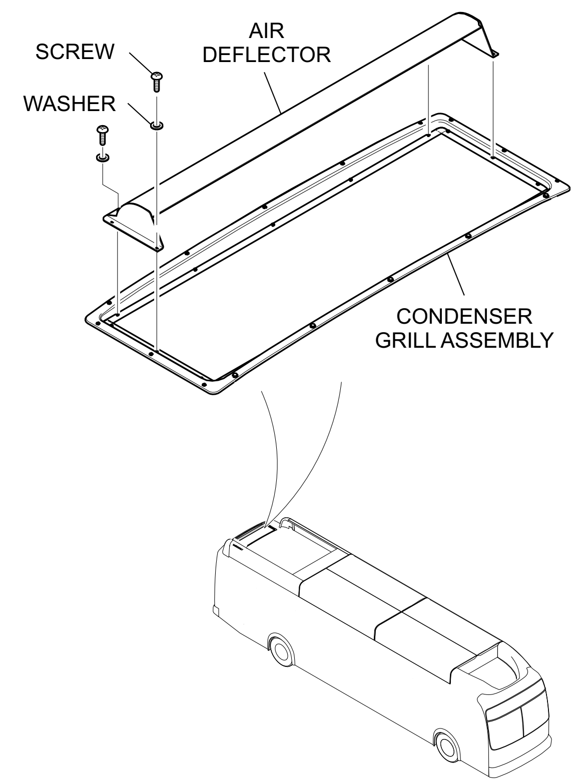

Fig. 10-6: Condenser Grill Assembly

2.4.6. Cleaning & Preparation

1. Clean all mounting surfaces in HVAC compartment and rooftop plenum. Scrape clean any remnants of Rubatex seal, caulking, or sealants.
2. Ensure that air distribution ducts are properly fastened and sealed at rear panel connection.
3. Ensure that all harnesses and lines that pass through the rear panel are properly sealed. Recaulk with Sika White 221 as necessary.
4. Ensure all disconnected hoses, lines, cables, and harnesses are tied out of the way.
5. Apply Rubatex seal 0.5" wide x 0.125" thick along the full width of the lower edge of the HVAC unit that will be in contact with the lower flanged close out panel. See "Fig. 10-7: Rubatex Seal Installation" on page 20.

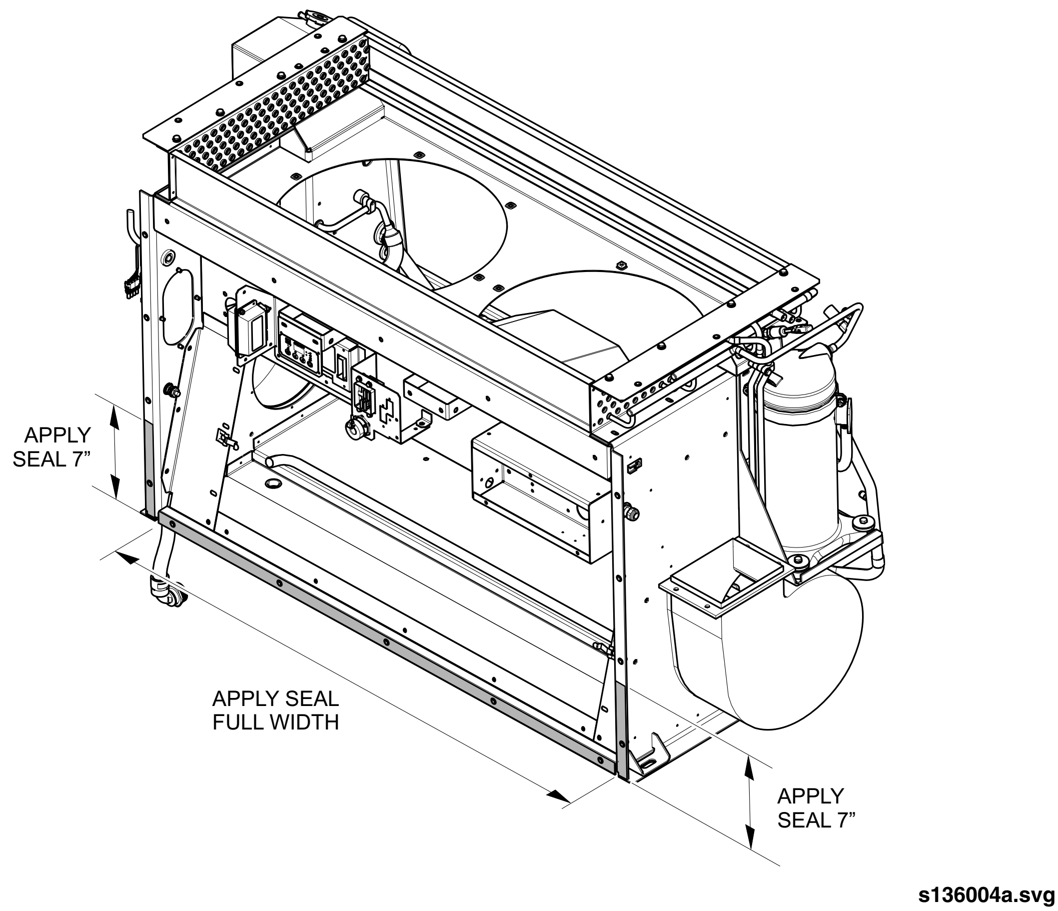

Fig. 10-7: Rubatex Seal Installation

6. Apply Rubatex seal 0.5" wide x 0.125" thick along both sides of the HVAC unit that will be in contact with the lower flanged close out panel. Approximately 7 inches of seal will be required on each side.
7. Apply Sika Black 252 to the upper four corners of the condenser, if not already applied. Seal the openings where the condenser tube forms a loop to protect against any water intrusion.
8. Install lower flanged close out panel with original screws. Ensure flange end faces towards front of vehicle.
9. Install a new return air foam seal on the HVAC unit. Apply the self-adhesive side of the seal against the unit, ensuring a proper gap between the lower edge of the seal and flanged close out panel. Do not stretch the foam seal. See “Fig. 10-8: Return Air Seal Installation” on page 21.

☞**NOTE:**

Start at the bottom when applying the seal. A gap of 0.29 in. should be maintained between the lower edge of the seal and the flanged close out panel. The seal should extend approximately 0.79 in. above the upper edge of the HVAC unit.

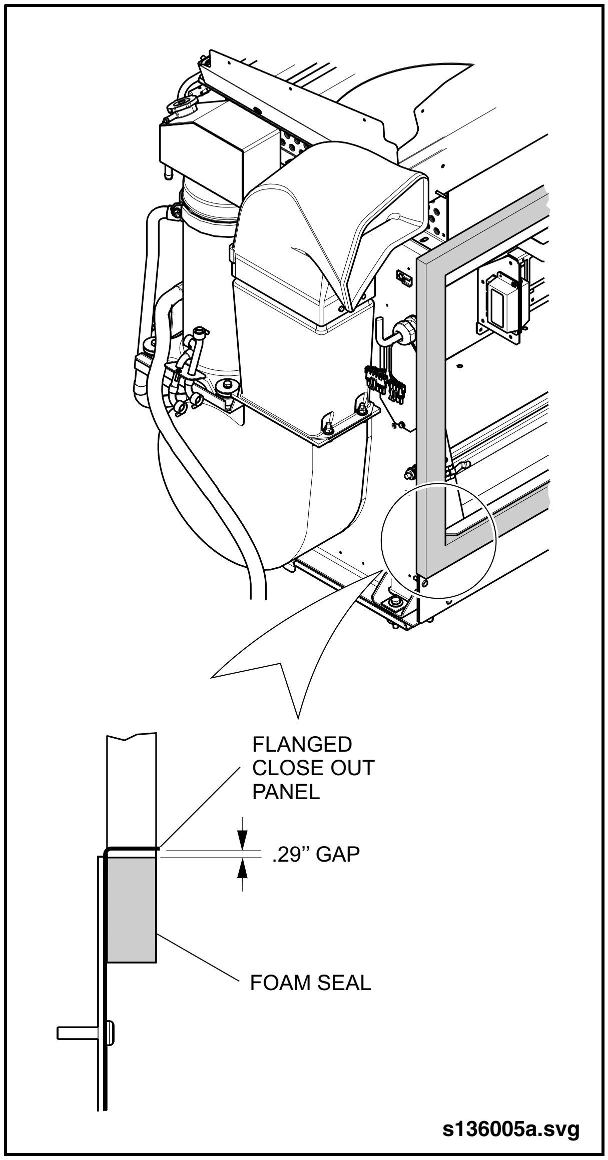

Fig. 10-8: Return Air Seal Installation

2.4.7. Installation

WARNING

DO NOT perform any maintenance on roof-mounted components unless equipment is in place to prevent fall hazards. Ensure maintenance personnel use approved lift platforms or scaffolding and wear approved safety harness when working on the roof of the vehicle.

1. Raise the HVAC unit with a forklift and carefully move into position while simultaneously aligning mounting spacers at each corner and aligning air outlet ducts with duct adapters.
2. Lower the HVAC unit on the mounting spacers, ensuring the mounting pads on the unit align with the spacers and threaded holes in the vehicle structure.
3. Apply Never-Seez to bolt threads and install mounting bolts, washers, and plates in proper assembly order, as noted during removal. Hand-tighten only at this time.
4. Apply a bead of butyl sealant to the flange of the outlet duct and attach outlet duct adapters. Apply Never-Seez to mounting studs and secure with 5/16" lock nuts and flat washers. Seal joint by wrapping with butyl tape 1.0" wide x 0.062" thick.
5. Apply forward pressure to the HVAC unit to ensure the return air foam seal is properly compressed. The HVAC unit will be properly positioned when there is a 0.65 in. gap between the flanged edge of the close out panel and the vehicle structure square tubing in the return air opening. See “Fig. 10-9: HVAC Unit Installation Measurement” on page 23.
6. Final tighten mounting bolts once unit is properly positioned. Torque bolts to 15 ft-lb. (20 Nm).

☞**NOTE:**

The assembly process for the plenum panels should be followed in the sequence described in the following steps and will require application of Sika White 221 sealant and appropriate size of Rubatex seal between plenum panels, HVAC condenser flange, and vehicle structure. It is important to properly seal the plenum panels and condenser flange to prevent intrusion of water.

7. Apply Rubatex seal 0.5 in. wide x 0.125 in. thick to the top of the condenser mounting flange. Seal joints with Sika White 221 sealant.
8. Apply Rubatex seal 1.0 in. wide x 0.125 in. thick on the surface of the vehicle structure that is in contact with the front plenum close out panel. Apply Sika 221 White sealant to the edges of the Rubatex seal.
9. Install the front plenum close out panel to the vehicle structure and secure with #10-24 self-tapping tri-lob screws.
10. Pre-assemble the rear plenum close out panel with the LH & RH side plenum panels using #10-24 screws and washers.
11. Apply Rubatex seal 1.0 in. wide x 0.125 in. thick on the surface of the vehicle structure that is in contact with the rear plenum close out panel and LH & RH side panels. Apply Sika 221 White sealant to the edges and joints of the Rubatex seal.
12. Install the rear plenum close out panel and LH & RH side panels to the vehicle structure and secure with 10-24 self-tapping tri-lob screws. Use 1/4-20 machine screws and washers to attach LH & RH side panels to front plenum close out panel.

13. Use 1/4" - 20 machine screws and washers to attach LH & RH plenum panels to condenser mounting flange.

☞**NOTE:**

Ensure Rubatex seal covers 100% of the mounting surface between condenser flange and plenum and is covered with a bead of Sika White 221 sealant.

14. Seal all plenum joints and seams and cover all fasteners with Sika White 221 sealant.

☞**NOTE:**

Ensure all joints and seams are completely covered with adhesive to prevent the possibility of water intrusion into the compartment.

15. Reconnect ambient temperature sensor.
16. Install condenser grille frame and air deflector (if equipped) as follows:
    a. Scrape clean any existing sealant residue from roof panel.
    b. Clean adhesive contact surfaces with Sika 205 Activator and applying with a clean white lint-free cloth. Allow activator to flash-off a minimum of 10 minutes, but no longer than 60 minutes before applying adhesive.
    c. Apply a bead of Sika 221 White sealant to mating flange of grille assembly.
    d. Secure grille assembly to roof using screws and washers.
    e. Remove all squeezed out adhesive and tool to a smooth finish.
17. Reconnect all HVAC electrical connectors to vehicle wiring harnesses.
18. Connect coolant hoses.
19. Connect refrigerant lines.
20. Charge the A/C system. Refer to your Thermo King Maintenance Manual for recharging procedure.
21. Set Battery Disconnect switch to the ON position.
22. Top up the vehicle heating system and perform a deaeration procedure. Refer to 2.2.6. "Heating System Filling & Deaeration" on page 7 in this section for fill and deaeration procedure.
23. Test the heating and air-conditioning systems for proper operation.

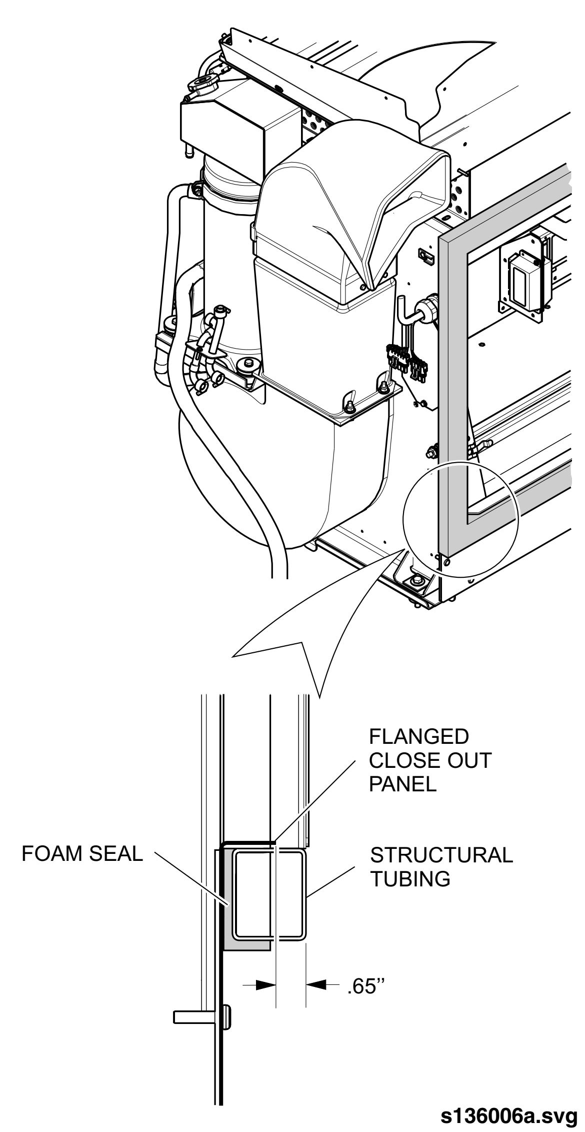

Fig. 10-9: HVAC Unit Installation Measurement

2.5. IntelligAIRE III Control System

2.5.1. Controller

The Intelligaire III Controller is a microprocessor equipped unit used to control the vehicle HVAC System. It provides the necessary control logic for all operating modes and has several programmable and diagnostic features such as:

- ❐ Programmable pre-heater function with real time clock activation to activate the system when the vehicle is shut off
- ❐ Technician capable override function for ease of troubleshooting
- ❐ Active fault code display
- ❐ Real time alarm and code storage with date and time stamp
- ❐ Optional pressure display panel

A single display module is capable of providing all functions. The default setting is “Automatic Control” for damper control, fan speed and operating mode. The controller can be programmed for manual control of the operating modes, fan speed and damper settings when manual switches are preferred. The Display Module can be used for set up parameter limits and has temperature read outs for the discharge air sensor and hybrid battery cooling coil (if equipped). The module has an auto dimming feature. It will illuminate or dim automatically depending on the ambient light conditions. The controller and display panel are accessible through the interior return air grille in the ceiling of the vehicle. See “Fig. 10-10: HVAC Control Panel” on page 24.

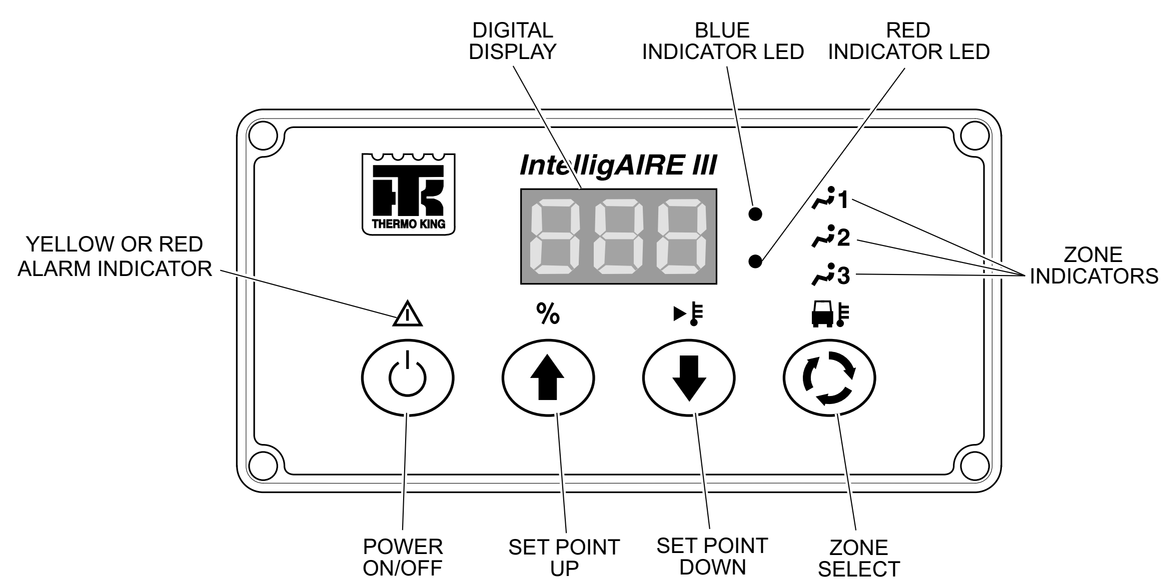

Fig. 10-10: HVAC Control Panel

2.5.2. J1939 CAN Interface

The Intelligaire III Controller uses an internal Controller Area Network (CAN) bus to communicate with the HVAC unit, and display module. The main HVAC module also has a second CAN port that can plug directly into the vehicle's J1939 network.

☞**NOTE:**

Refer to 3. "VENDOR SERVICE INFORMATION" on page 59 *in this section for further information on the Intelligaire III Control System.*

2.5.3. HVAC Display Module Controls

2.5.3.1. Power Button

The power button is used to turn the system on and off. If the power button is off and power is applied to the display module, the back lighting for the buttons will remain on and the LED indicators and 3-digit display will be turned off. In this mode, the display module will continue communicating with the main module. If the power button is on, the LED indicators and 3-digit display will be lit as determined by the operating mode.

2.5.3.2. Set Point Up & Down Buttons

The temperature set point is adjusted by first selecting the zone to be configured, and then pressing the up or down button once. The set point icon will light and the 3-digit display will show the current temperature set point. Pressing the up or down button again will increment or decrement the set point by 1 degree. If no button is pressed within a 3 second timeout period, the display will return to the inside temperature for the zone selected.

2.5.3.3. Zone Select Button

The temperature set point for the three inside zones and the outside ambient temperature can be displayed. The information displayed on the 3-digit display will coincide with the zone that is selected. Pressing the zone select button will cycle through each enabled zone as well as the outside ambient temperature.

2.5.3.4. Alarm Indicators

The yellow alarm indicator will light to indicate a "check" alarm is currently active. These alarms include sensor readings out of range, open or shorted loads, etc. and may be viewed using the alarm code readout mode on the display module or by using the CAN Diag PC tool. These alarms will clear automatically when the condition is corrected.

The red alarm indicator will light to indicate a "shutdown" alarm has occurred. These alarms include high pressure cut out, low pressure cut out and compressor over temperature conditions. The compressor remains off in this mode and can only be reset by cycling the power button.

2.5.3.5. Heating & Cooling Indicators

The red and blue LED indicators on the right hand side of the 3 digit display will light to indicate the current operating mode of the HVAC unit. The blue indicator will light whenever the compressor is running and the red indicator will light whenever the heat valve is operating.

2.5.4. Intelligaire III Control System Diagnostics

☞**NOTE:**

Refer to 3. "VENDOR SERVICE INFORMATION" on page 59 *in this section for information on the Intelligaire III Control System diagnostics.*

2.6. Compressor

2.6.1. Description

This vehicle is equipped with a Thermo King S391 helical lobed screw compressor. See "Fig. 10-11: Main Features of HVAC Compressor" on page 26. The compressor is belt driven by the engine through a heavy-duty electric clutch. Components of the compressor include:

- ❐ Discharge Service Valve - used to close off discharge line to condenser when compressor is removed from the system.
- ❐ Suction Service Valve - used to close off the compressor from the suction line when the refrigeration system is being serviced.
- ❐ Clutch - electrically operated clutch to engage and disengage the compressor as commanded by the HVAC electric control system.
- ❐ Pressure Switches - these cutout switches protect the system from high or low refrigerant pressures.
- ❐ Suppression Diode Assembly - protects the electrical system from reverse voltage spikes when the clutch field coil is de-energized.

2.6.2. Compressor Specifications

Manufacturer .... Thermo King Corp.

Model... S391

Type............................Helical Lobed Screw

Displacement...................... 23.86 cu. in./rev
(391 cc/rev)

Maximum Speed .... 3000 rpm

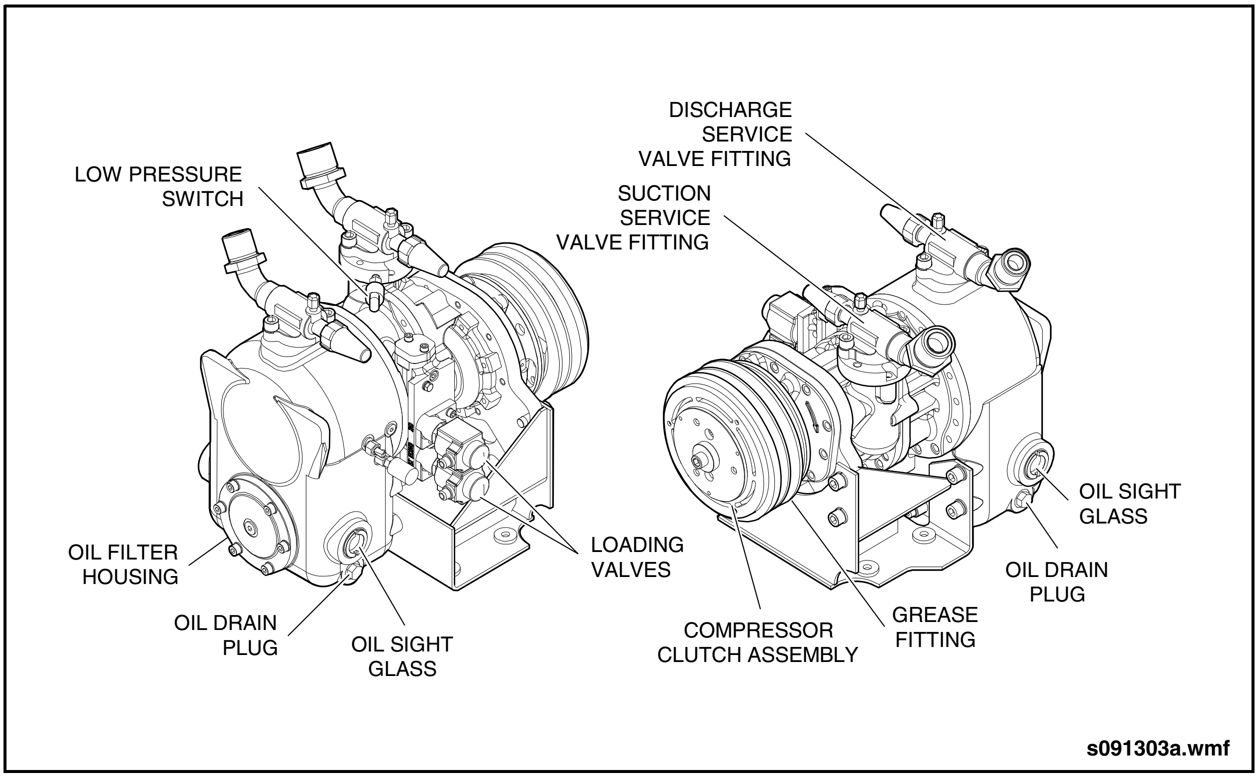

Fig. 10-11: Main Features of HVAC Compressor

2.6.3. Operation

DANGER

DO NOT operate the compressor with the discharge valve closed. This conditions increases internal pressure, which can cause an explosion.

The function of the compressor is to pump the low pressure gas out of the evaporator so that a rapid and continuous boiling action is maintained in the evaporator coil. The low pressure gas is compressed and forced into the condenser coil where it is cooled by air passing through the coil. The heat removed by the air flowing through the condenser causes it liquefy (condense).

2.6.4. Maintenance

DANGER

ALWAYS follow recommended safety procedures specific to the HVAC System when servicing the system. Refer to 1.3. "HVAC System Safety" on page 1 **in this section for safety information.**

Refer to the Preventive Maintenance Section of this manual for service intervals and procedures. Refer to 3. "VENDOR SERVICE INFORMATION" on page 59 in this section for further detailed information on service intervals and procedures.

2.6.5. Compressor Mounts

The compressor is bolted to a mounting plate. The mounting plate is bolted to and pivots on a support bracket. The turnbuckle links the mounting plate and the support bracket. The turnbuckle and a slot in the mounting plate permit final tensioning adjustment of the compressor belt. After the turnbuckle is adjusted, a tension clamp (bolt bar) secures the mounting plate to the support bracket and maintains belt tension. An idler roller is mounted on a bracket next to the engine. It dampens belt oscillations during compressor operation. See "Fig. 10-12: A/C Compressor Installation" on page 27.

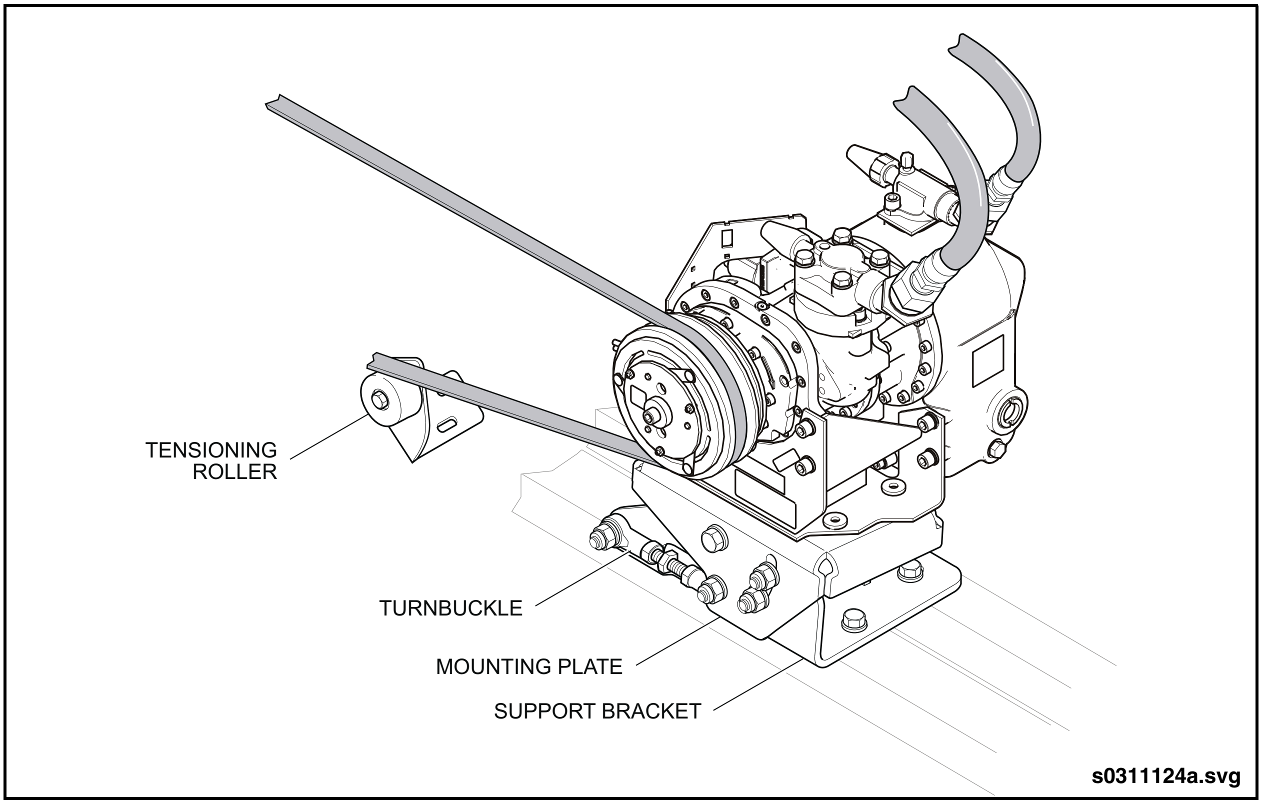

Fig. 10-12: A/C Compressor Installation

2.6.6. Compressor Removal

1. Evacuate the compressor and disconnect from system. Refer to the Thermo King Maintenance Manual for procedure. Observe all safety precautions and environmental regulations.
2. Loosen the 3/4" bolt retaining the compressor mounting plate to the support bracket.
3. Loosen the two 5/8" nuts on the bolts clamping the compressor mounting plate to the support bracket.
4. Back off turn buckle to relieve belt tension and remove belt.
5. Support compressor, remove 4 bolts retaining compressor to the mounting plate and remove compressor.

2.6.7. Compressor Installation

⚠CAUTION

The brass washer at both ends of the discharge hose is not reusable. Install new brass washer or washers when reconnecting the discharge hose.

1. Position the compressor on the mounting plate and hand-tighten the four 3/8" bolts.

☞NOTE:

Some installations may require the use of a laser alignment tool due to space limitations preventing the use of a straight edge.

2. Use a straightedge or laser alignment tool to ensure the compressor pulley is aligned with the crankshaft pulley. Slide the compressor forward or aft on the mounting plate slotted holes until the pulleys are visually aligned. Torque the four 3/8" mounting bolts to 35 ft-lb. (47 Nm).
3. Install the belt and adjust the turnbuckle to obtain 190 lb. force on the belt.
4. Torque the 3/4" pivot bolt that retains the mounting plate to the support plate to 304 ft-lb. (412 Nm).
5. Torque the two 5/8" lock nuts that retain the mounting plate to the support plate to 172 ft-lb. (233 Nm).
6. Adjust the position of the roller on the lower run of the belt so that it is centered beneath the belt and that a clearance of 0.06 to 0.12 inch exists.
7. Back off the turnbuckle one full turn to relieve tension on the turnbuckle.
8. Verify that the compressor pulley is properly aligned with the crankshaft pulley by measuring the angular deviation of the belt at each pulley. The sum of the two angular measurements must not exceed 0.5°. Readjust the fore/aft position of the compressor as required to meet the alignment requirements.

⚠CAUTION

Use a backup wrench on the mating tube fitting nut when tightening the lines to prevent kinking, twisting, or stressing the tube.

9. Lubricate seals with refrigerant oil and install new O-ring in suction line and new brass sealing washer in discharge line. Connect lines to compressor and torque fittings to 180 to 190 ft-lb. (244 to 258 Nm)
10. Recharge the system. Refer to Thermo King Maintenance Manual for procedure and observe all safety precautions and environmental regulations.
11. Operate the A/C compressor and check for proper operation. Check belt tension after run-in and readjust to 180 to 190 lb. force if required.

2.7. Driver's Heater/Defroster

2.7.1. Description

The driver's heater/defroster is located in the driver's area in the front dash panel. The defroster assembly consists of a heater core, blower motor, resistor module, and servo valves to control coolant flow and input and output air flow. This unit is operator controlled by switches located on the instrument panel.

2.7.2. Heater/Defroster Specifications

Heating ....56880 btu/hr (150° T.D) @3.6 GPM

Airflow .... 462 CFM @ max speed

Voltage 24V

Current (Low Speed) 5.4A

Current (Med Speed) 7.0A

Current (High Speed)............................8.5A

Vehicle Interface
.... 21 pin Deutsch connector

2.7.3. Operation

The defroster provides climate control for the driver's area. Heated liquid coolant is delivered to the defroster from the engine and bypassed or circulated through the defroster's heater core depending on the position of the dash controls. Servo actuators in the defroster activate with the dash controls to control the defroster temperature setting by regulating the amount of coolant flowing through the heater core. They also direct the airflow to provide exterior, interior recirculated air or a mix. The foot heat control provides heated airflow to the lower portion of the driver's area. Refer to Section 19 of this manual for more information on the operation of the Climate Controls.

2.7.4. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled intervals and service procedures.

2.7.4.1. Blower Assembly Replacement

1. Set Battery Disconnect switch to the OFF position.
2. Open front defroster access door and remove defroster access plate. See "Fig. 10-13: Heater/Defroster Assembly" on page 30.
3. Unplug electrical connectors from blower motor and resistor module.
4. Remove fasteners securing blower assembly to unit. Remove motor, blower housing, and resistor module as an assembly from the defroster unit.
5. Installation is reverse of removal.

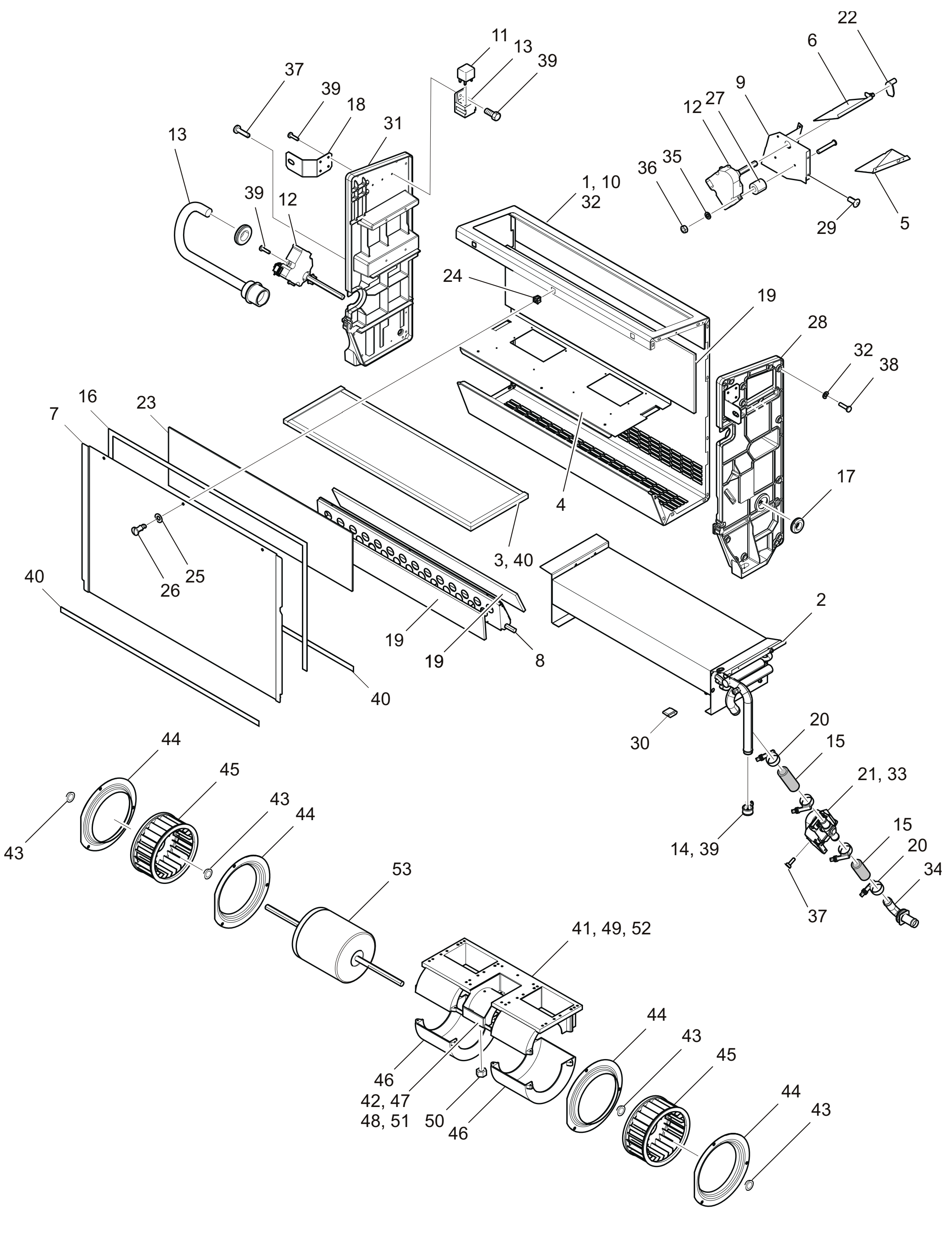

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Fig. 10-13: Heater/Defroster Assembly

1. Heater/Defroster Assembly, 24V (Incl. 2-41)
2. Coil, Heater
3. Filter
4. Plate, Blower
5. Plate
6. Door, Flapper
7. Cover, Front
8. Door, Flapper
9. Plate
10. Casing
11. Relay, 24V
12. Actuator, Motor 24V
13. Harness, Wiring
14. Clamp, Hose P-Type #12
15. Hose, 4-Ply
16. Neoprene, 1/16" x 2"
17. Grommet
18. Bracket
19. Seal, Foam 1/4" Thk.
20. Clamp, Gear
21. Valve Assembly, Heater Control
22. Bushing, Snap 3/16"
23. Foam, 1/8" Thick
24. Receptacle
25. Retainer
26. Stud, Oval Slotted
27. Spacer, Nylon 1/2"
28. Plastic Side, RH
29. Rivet, 1/8" SST
30. Clip, Coil
31. Plastic Side, LH
32. Washer, Flat #10
33. Tie Wrap
34. Tube Assembly, Copper
35. Washer, M4
36. Nut, Lock #8 - 32
37. Screw, Tpg, #8 - 32 x 1/2" Lg.
38. Rivet, Blind SST 3/16" .126/.250
39. Screw, #10 - 16 x 5/8" Lg.
40. Seal, 3/16" x 1/2"
41. Blower Assembly, (Incl. 42-53)
42. Bracket, Resistor
43. Clip
44. Venturi
45. Wheel, Blower
46. Housing, Top
47. Resistor, 3 Speed Aluminum
48. Pad, Motor
49. Housing, Blower
50. Nut, Lock Nylon #10 - 32
51. Screw, PH Cross Recess SST #10 - 32 UNF x 3/4" Lg.
52. Pad, Motor
53. Motor, 24V

Heater/Defroster Assembly (parts list)

2.7.4.2. Heater Coil Replacement

1. Close coolant supply and return valves located on the streetside of vehicle.
2. Open front defroster access door and remove defroster access plate.
3. Disconnect coolant hoses from heater coil and drain coolant into a suitable container.
4. Remove fasteners from heater coil mounting brackets and remove heater coil from defroster unit.
5. Installation is the reverse of removal.
6. Top up the vehicle heating system and perform a deaeration procedure. Refer to 2.2.6. “Heating System Filling & Deaeration” on page 7 in this section for fill and deaeration procedure.
7. Start the engine, activate the heating system, and check for leaks.

2.7.5. Heater/Defroster Troubleshooting

☞NOTE:

Ensure that all electrical connections are clean and making proper contact before conducting troubleshooting procedures. Pay particular attention to the resistor module and motor connections.

This troubleshooting chart provides information to diagnose the various electrical components of the heater/defroster unit including the defroster blower motor, relays, variable fan speed control switch, and heater control valve limit switch. Refer to ES-Defroster Schematic in your New Flyer Vehicle System Drawing Manual.

HEATER/DEFROSTER TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	RECOMMENDED ACTION
Defroster motor inoperative.	No Power.	Refer to 2.7.5.1. "Vehicle Wiring Check" on page 33 in this section for procedure.
	Faulty ground.	Check 21-pin Deutsch connector. Verify that cavity D on the connector is grounded to the vehicle.
	Motor seized.	Replace motor.
	Blower wheel obstructed or damaged	Remove obstruction.
	Motor open circuit.	Replace motor.
Defroster motor operates at high speed only.	Faulty resistor module (low or medium speed resistor).	Refer to 2.7.5.2. "Component Diagnosis" on page 34 in this section for procedure. Replace resistor module if defective.
Defroster motor operates at low and medium speed only.	Faulty high speed relay.	Refer to 2.7.5.2. "Component Diagnosis" on page 34 in this section for relay testing procedure. Replace high speed relay if defective.
	Faulty switch contacts on defroster fan speed control.	Replace defroster fan speed control. Refer to Section 19 of this manual for procedure.
Defroster motor operates at medium and high speeds only.	Faulty resistor module (low speed resistor open).	Refer to 2.7.5.2. "Component Diagnosis" on page 34 in this section for procedure. Replace resistor block if defective.
	Faulty contact on defroster fan speed control.	Replace defroster fan speed control. Refer to Section 19 of this manual for procedure.
Frequent replacement of resistor module required.	Excessive current draw.	Test motor current draw (refer to specifications). Replace motor if defective.
Defroster motor noisy.	Defroster motor bearings worn.	Replace defroster motor as an assembly.
	Blower wheel rubbing.	Replace blower wheel if damaged.

HEATER/DEFROSTER TROUBLESHOOTING		
SYMPTOM	**POSSIBLE CAUSE**	**RECOMMENDED ACTION**
Insufficient or no heat	No demand signal from heat control on instrument panel.	Test manual heat control switch. Refer to 2.7.5.2. "Component Diagnosis" on page 34 in this section.
	Heat control valve actuator faulty.	Test heat control valve actuator. Refer to 2.7.5.2. "Component Diagnosis" on page 34 in this section.
No air flow to driver's foot area	No demand signal from foot heat control on instrument panel.	Test foot heat control switch. Refer to 2.7.5.2. "Component Diagnosis" on page 34 in this section.
	Foot heat control valve actuator faulty.	Test foot heat control valve actuator. Refer to 2.7.5.2. "Component Diagnosis" on page 34 in this section.
Fresh air or recirculated air control not functioning properly	No demand signal from fresh/ recirculate control on instrument panel.	Test fresh/recirc control switch. Refer to 2.7.5.2. "Component Diagnosis" on page 34 in this section.
	Fresh/recirculate control valve actuator faulty.	Test fresh/recirc control valve actuator. Refer to 2.7.5.2. "Component Diagnosis" on page 34 in this section.

2.7.5.1. Vehicle Wiring Check

1. Set Master Run switch to the DAY-RUN position.
2. Open the defroster/wiper access door to gain access to the defroster power harness. See "Fig. 10-14: Defroster Components" on page 34.

   The following tests are performed with vehicle power applied to the heater/ defroster unit. Use care when making test connections. Connect negative lead of voltmeter to cavity D (ground) on the 21-pin Deutsch connector and the positive lead to the indicated connector and cavity in each of the following test steps. Refer to vehicle Electrical Schematic.
3. Set Defroster Fan Speed switch to OFF and check for 24V at cavity B and H of the connector.

   ☞**NOTE:**

   If no power is indicated at these cavities, check for a tripped circuit breaker or faulty ground circuit. Refer to vehicle electrical schematic.
4. Set Defroster Fan Speed switch to LOW and check for 24V at cavity F of the connector.
5. Set Defroster Fan Speed switch to MED and check for 24V at cavity A of the connector.
6. Set Defroster Fan Speed switch to HIGH and check for 24V at cavity C of the connector.

   ☞**NOTE:**

   If power is not indicated at any of the fan speed settings, remove Defroster Fan Speed control switch from instrument panel to confirm switch function.
7. Rotate the temperature control counterclockwise from OFF to HOT and observe the voltage output at cavity N of the connector. Voltage should increase proportionately in response to movement towards the HOT position.

   ☞**NOTE:**

   If no power is indicated at cavity N check for a faulty control switch on the instrument panel.

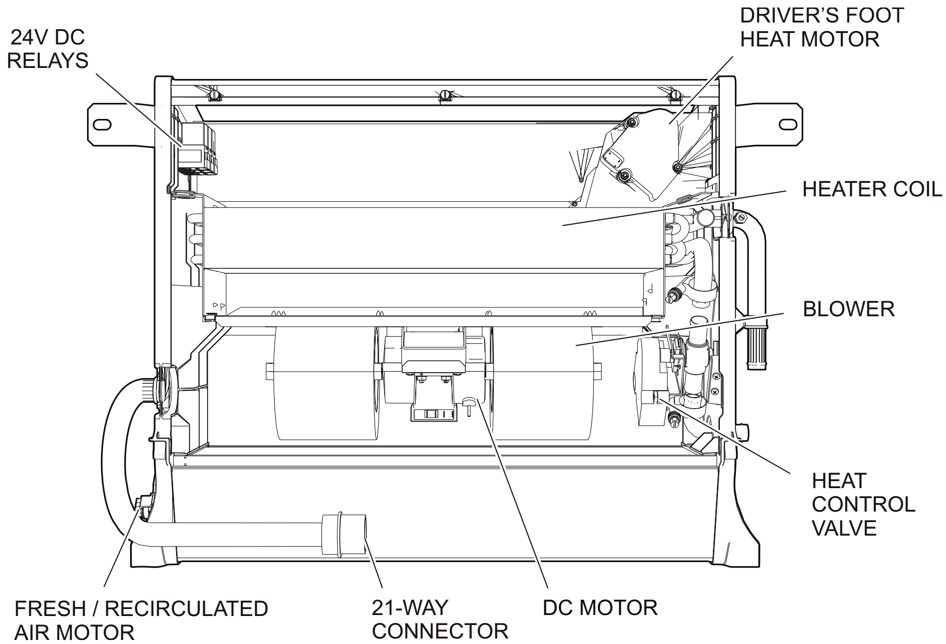


Fig. 10-14: Defroster Components

2.7.5.2. Component Diagnosis

Resistor Module

1. Remove the resistor module from the heater/defroster unit and test as follows:

☞**NOTE:**

Resistors and thermal cutoff devices are located inside the sealed module. The following diagnostic tests will need to be conducted at the terminal connection points on the module end.

   a. Test the resistance between the Motor terminal and the High Speed terminal. Verify that the value is 0 ohms. See "Fig. 10-15: Resistor Module" on page 35.

   b. Test the resistance between the Motor terminal and the Low Speed terminal. Verify that the value is 1.85 ohms ± 10%.

   c. Test the resistance between the Motor terminal and the Medium Speed terminal. Verify the value is 1 ohms ± 10%.

   d. Test the resistance between the Medium Speed terminal and the Low Speed terminal. Verify the value is 0.85 ohms ± 10%.

Resistance readings must conform to these specified values. Measurements that are higher than these specified values will result in improper defroster motor operation. Open circuit readings indicate component failure within the module. In both cases, the module must be replaced.

Electrical Relays

1. Remove the three 24V relays and test as follows:

   a. Check for continuity between terminals No. 30 and No. 87A using an ohmmeter.

   b. Check resistance of coil winding by connecting an ohmmeter between terminals No. 85 and No. 86. Resistance should be 360 ohms ± 10%.

   c. Connect the positive lead from a 24V power supply to terminal No. 86.

d. Connect the negative lead from the power supply to terminal No. 85.

e. Turn the power supply ON. The relay should energize. Confirm that contacts are closed by checking for continuity between terminals No. 30 and No. 87, using an ohmmeter.

Electrical Actuators (Servo Motors)

There are three separate actuators that control the heater control valve, fresh/recirculate flapper valve, and foot heat flapper valve. The following test applies to all actuators.

1. Unplug 6-way connector from actuator.
2. Provide 24VDC power supply to pin A of actuator.
3. Provide vehicle ground to pin C.
4. Use the signal line, pin D, to operate the actuator as follows:

   a. Provide 24VDC power to pin D. Actuator should drive the operating device fully CCW, viewed from the connector side.

   b. Remove power from pin D and provide vehicle ground to pin D. Actuator should drive the operating device fully CW, viewed from the connector side.

   c. Replace actuator if operation is faulty.

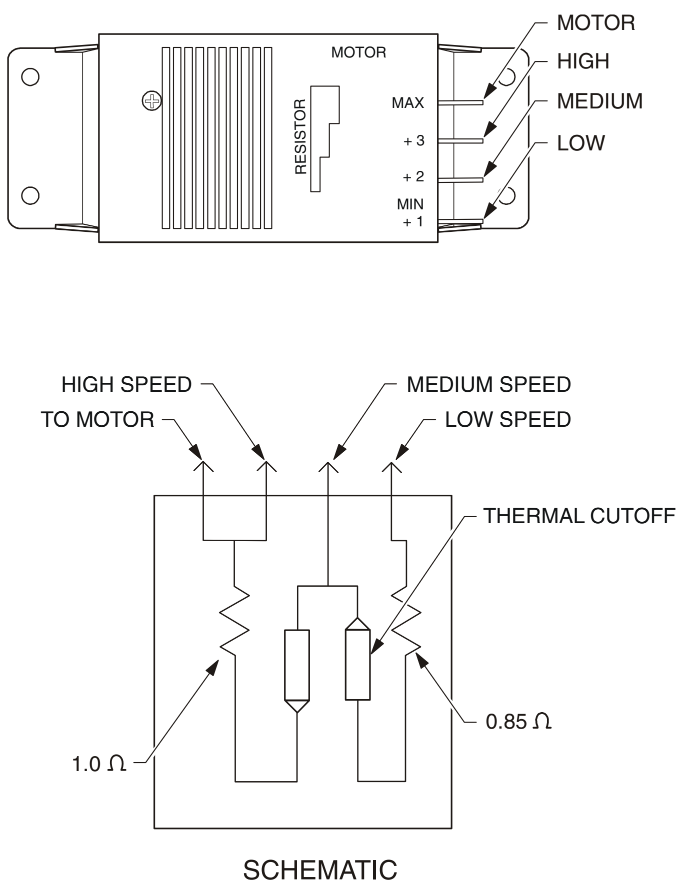


Fig. 10-15: Resistor Module

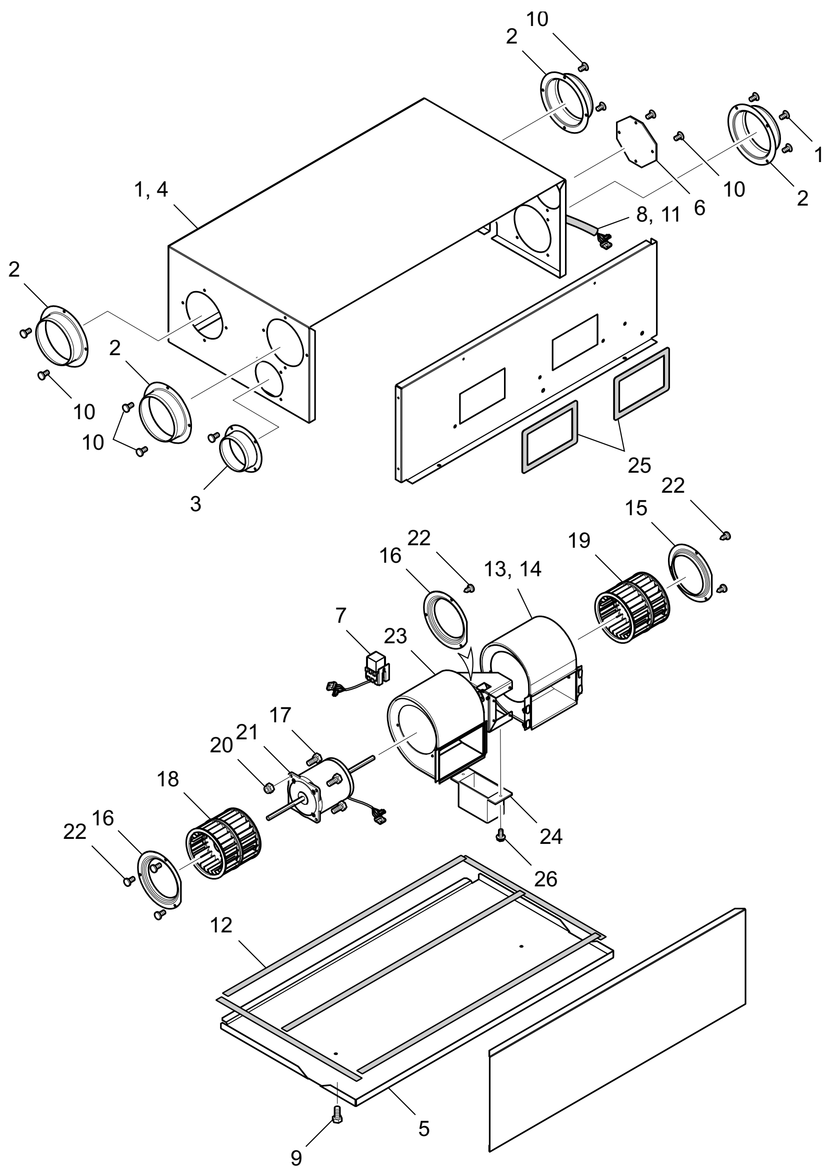
2.8. Booster Fan

2.8.1. Description

The driver's booster fan is mounted to the ceiling at the front of the vehicle. The input to the booster fan is connected to the HVAC ducts, behind the lighting panels, with flexible hoses. Refer to Fig. 10-16: “Driver’s Booster Fan” on page 37 The output of the booster fan is ducted, with flexible hoses, to louvered registers in the driver's overhead panel and the entrance door mechanism box. Access to the booster fan is provided through a ceiling mounted access door. Refer to section 15 in this manual for more information on the front HVAC Access door.

2.8.2. Operation

The booster fan functions to ensure the driver and the entrance area are provided with conditioned air from the HVAC unit. A control knob on the driver's overhead panel regulates booster fan motor speed.



1. Booster Fan Assembly, 24V (Incl. 2…26)
2. Adapter, Hose 4"
3. Adapter, Hose 3"
4. Casing
5. Cover
6. Plate
7. Relay, 24V
8. Harness, Wire
9. Screw, Hex HD #10 - 32 x 3/8" Lg.
10. Rivet, SS 3/16"x .315"
11. Tie Wrap
12. Neoprene, 1/16"x 2"
13. Blower, 24V (Incl. 14…26)
14. Housing, Blower
15. Venturi, Streetside
16. Venturi, Curbside
17. Motor, 24V
18. Wheel, Blower CW
19. Wheel, Blower CCW
20. Nut, Lock Nylon #10 - 32
21. Screw, Hex HD #10 - 32 x 1/2" Lg.
22. Screw, Pan HD Phil #6 x 1/4"
23. Housing, Blower
24. Controller Assembly, 24V
25. Seal, 24.2" Lg.
26. Stud, Oval Slotted

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Fig. 10-16: Driver's Booster Fan

2.9. Floor Heaters

2.9.1. Description

The heaters are located on the streetside and curbside of the vehicle, forward of the exit door. They are floor-mounted. The heaters consist of a stainless steel housing, heater coil, blower, speed control relays and resistors and an air filter.

2.9.2. Floor Heater Specifications

Heating .... 41,000 BTU/H
(at 150°F Temperature Differential)

Air Flow .... 350 CFM (at High Speed)

Current .... 3.7 A (at 27V High Speed)
.... 1 A (at 27V Low Speed)

2.9.3. Operation

The floor heaters receives heated engine coolant whenever the Climate Control switch is in the HEAT mode. Low speed and high speed blower operation is determined by the rooftop HVAC unit.

2.9.4. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance requirements.

2.9.5. Removal

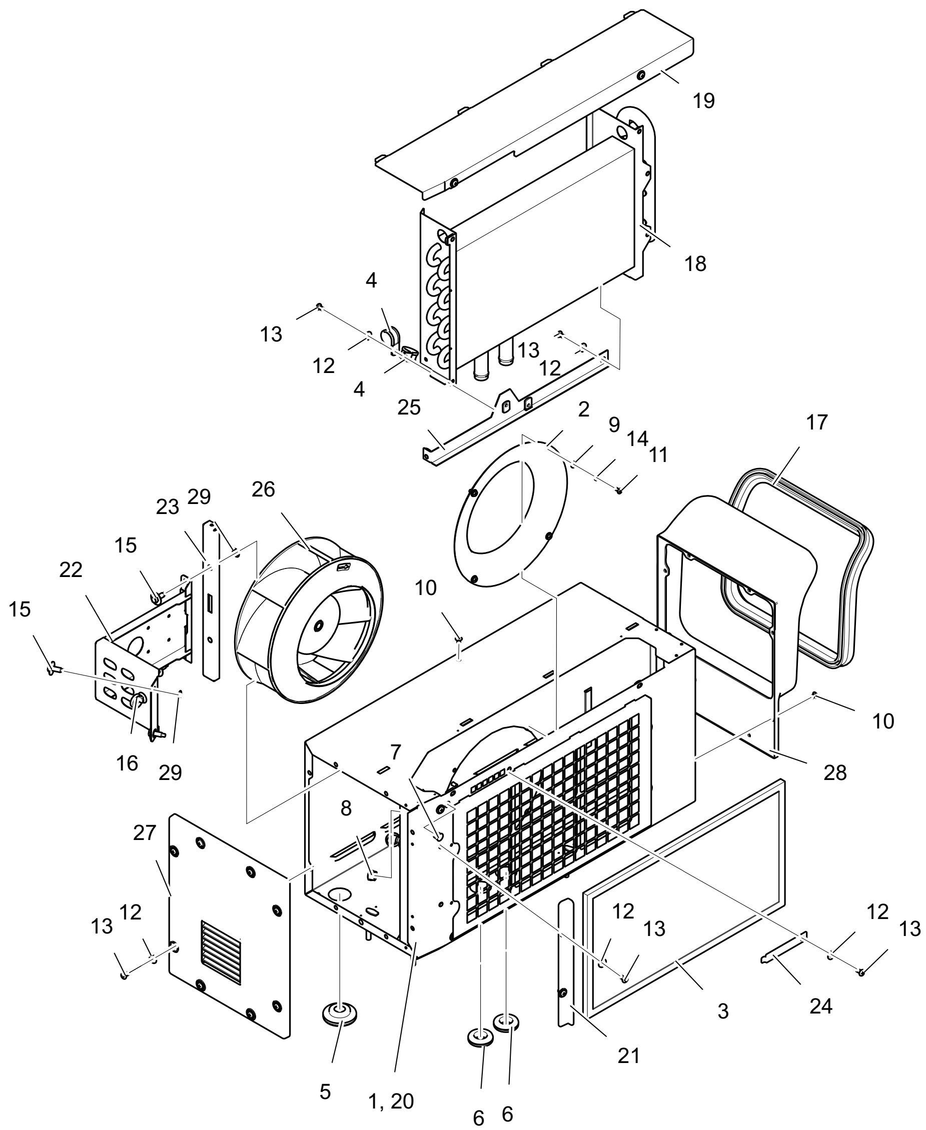
1. Shut off coolant supply and return valves to the heater system.
2. From underneath the vehicle, disconnect the coolant supply and return hoses from the heater taking care to catch any spilled coolant in an appropriate container.
3. Disconnect the electrical connector from the vehicle wiring harness.
4. Remove the nuts and washers fastening the heater to the vehicle floor.
5. From inside the vehicle, pull the heater up and remove from the vehicle.

☞**NOTE:**

The floor holes for the heater hoses are sealed with Butyl tape and Sikaflex. It may be necessary to cut through and remove the sealant before you can remove the heater.

2.9.6. Disassembly

1. Remove the filter retainer and slide the filter out. See “Fig. 10-17: Streetside Heater Assembly” on page 39. See “Fig. 10-18: Curbside Heater Assembly” on page 40.
2. Remove the top cover fasteners and remove the cover.
3. Remove the side cover fasteners and remove the covers.
4. Disconnect the electrical connector to the blower motor assembly.
5. Remove the blower retainer bracket fasteners and remove the retainers.
6. Remove the blower assembly.
7. Remove the divider fasteners.
8. Pull the divider out of the casing.
9. Remove the fasteners retaining the heater coil to the casing and remove the heater coil.



1. Heater Assembly, Streetside (Incl. 2-29)
2. Venturi
3. Filter, Air
4. Clamp, Hose P-Type #12
5. Grommet, 5/8"
6. Grommet
7. Plug, 3/8"
8. Plug, 1/2" Hole
9. Washer, Flat #8 SST
10. Rivet, SST 3/16" x .315"
11. Screw, PH #8 - 32 x 3/8" SST
12. Washer, Flat #10
13. Screw, Phil, HD 10 - 24 x 3/8" SST
14. Washer, Lock External Tooth M4
15. Screw, Hex HD 1/4" - 20 x 3/4" Dog Point
16. Tie Wrap
17. Seal, Bulb
18. Coil, Heater
19. Cover, SST
20. Casing, SST
21. Retainer, Filter
22. Bracket, Blower
23. Bracket
24. Plate
25. Support, Coil
26. Motor Fan, 24V
27. Cover
28. Duct, Plastic Outlet
29. Retainer, Push-On

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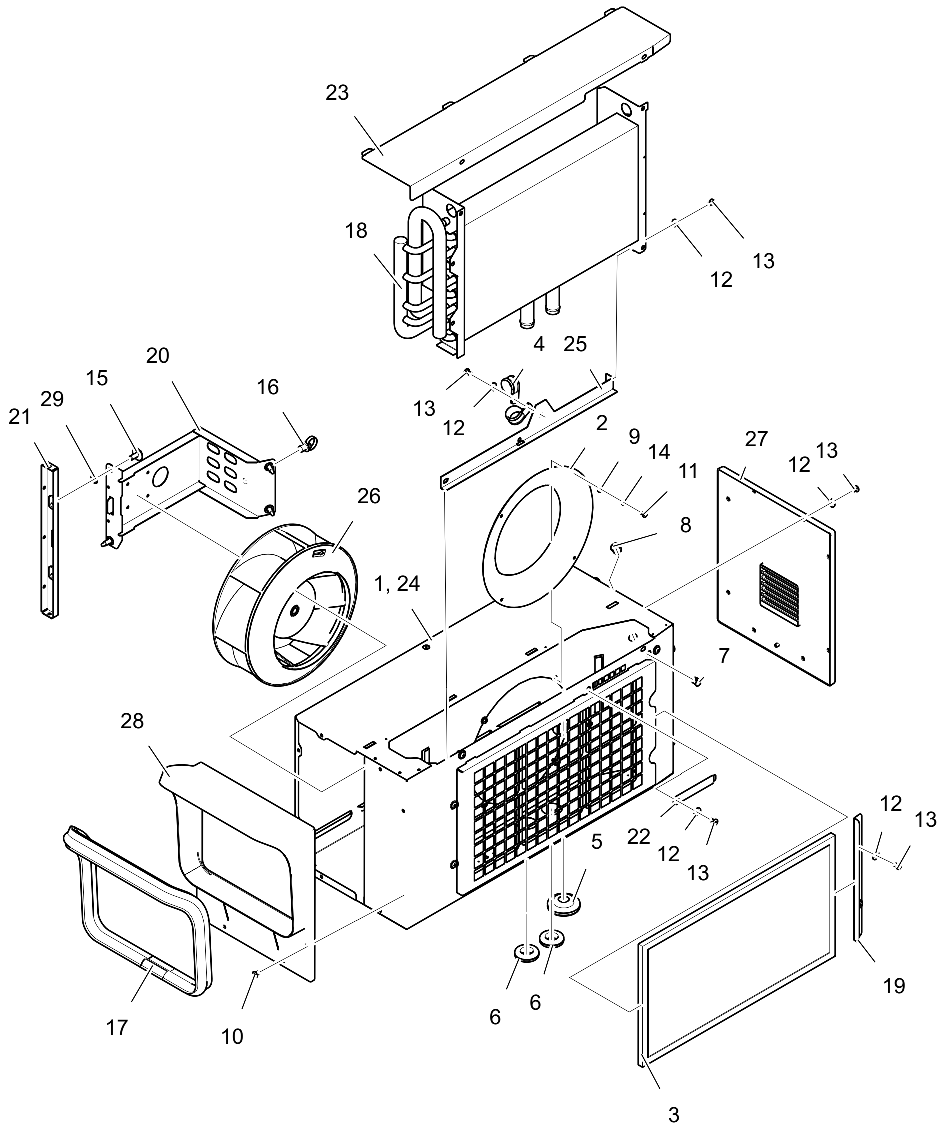
Fig. 10-17: Streetside Heater Assembly



1. Heater Assembly, Curbside (Incl. 2-29)
2. Venturi
3. Filter, Air
4. Clamp, Hose P-Type #12
5. Grommet, 5/8"
6. Grommet
7. Plug, 3/8"
8. Plug, 1/2" Hole
9. Washer, Flat #8 SST
10. Rivet, SST 3/16" x .315"
11. Screw, PH #8 - 32 x 3/8" SST
12. Washer, Flat #10
13. Screw, Phil, HD 10 - 24 x 3/8" SST
14. Washer, Lock External Tooth M4
15. Screw, Hex HD 1/4" - 20 x 3/4" Dog Point
16. Tie Wrap
17. Seal, Bulb
18. Coil, Heater
19. Retainer, Filter
20. Bracket, Blower
21. Bracket
22. Plate
23. Cover, SST
24. Casing, SST
25. Support, Heater Coil
26. Motor Fan, 24V
27. Cover
28. Duct, Plastic Outlet
29. Retainer, Push-On

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Fig. 10-18: Curbside Heater Assembly

2.9.7. Assembly

1. Install the heater coil to the casing and secure in place with mounting fasteners.
2. Install the divider to the casing.
3. Install the blower assembly and secure in place with retainer brackets and fasteners.
4. Connect the electrical connector.
5. Attach the side covers with previously removed fasteners.
6. Install the top cover.
7. Slide the filter into the heater and install the filter retainer.

2.9.8. Installation

1. Clean the sealant from the existing heater mounting holes.
2. Apply butyl tape around heater inlet and outlet tubes.
3. Install the heater into the vehicle from inside.
4. From underneath the vehicle, install and tighten mounting fasteners.
5. Connect the electrical connector to the vehicle wiring harness.
6. Connect the coolant supply and return hoses and torque clamps to 4.2 ± 1.7 ft-lb (5.6 ± 2.3 Nm)
7. Apply Sikaflex to seal the heater tube holes.
8. Open coolant supply and return valves to the heater system.
9. Top up the vehicle heating system and perform a deaeration procedure. Refer to 2.2.6. “Heating System Filling & Deaeration” on page 7 in this section for fill and deaeration procedure.

2.9.9. Floor Heaters Troubleshooting

☞NOTE:

Ensure that all electrical connections are clean and making proper contact before conducting troubleshooting procedures. Pay particular attention to the motor connections.

This troubleshooting chart provides information to diagnose the various electrical components of the heater/ unit including the blower motor, speed relays, variable fan speed resistors, and temperature sensor. Refer to the "ES-Curbside Floor Heater" and "ES-Climate Control CC" schematics in the Vehicle Systems Drawing Manual.

FLOOR HEATERS TROUBLESHOOTING

SYMPTOM	POSSIBLE CAUSE	RECOMMENDED ACTION
Heater motor inoperative	No power	Perform Vehicle Wiring Check in this section.
	Faulty ground	Check connection to cavity "D" on vehicle wiring harness interface. Verify that cavity "D" is properly grounded to the vehicle.
	Motor seized	Replace motor
	Blower wheel obstructed or damaged	Remove obstruction
	Motor open circuit	Refer to 2.9.9.2. "Component Diagnosis" on page 43 in this section for procedure. Replace motor as an assembly if defective
	Faulty fan speed resistor or resistors	Refer to 2.9.9.2. "Component Diagnosis" on page 43 in this section for procedure. Replace wire harness if a resistor is defective.
	Faulty fan speed relay or relays	Refer to 2.9.9.2. "Component Diagnosis" on page 43 in this section for procedure. Replace relay if defective.
Heater motor noisy	Heater motor bearings worn	Replace motor as an assembly.
	Blower wheel rubbing	Replace blower wheel if bent or damaged.

2.9.9.1. Vehicle Wiring Check

1. Set Master Run switch to the DAY-RUN position but do not start engine.
2. Remove the cover of the heater unit to gain access to the heater components.

⚠CAUTION

The following test is performed with vehicle power applied to the heater unit electrical connector. Use care when making connections and taking measurements. Connect negative lead of voltmeter to terminal in cavity D (ground) and the positive lead to the indicated terminal in each of the following test steps. Refer to "ES-Climate Control CC" electrical schematic.

3. Check for 24VDC at the terminal in cavity A.

☞NOTE:

If no power is indicated at terminal in cavity A, check for a tripped 6A circuit breaker or faulty ground circuit. Refer to vehicle electrical schematic.

2.9.9.2. Component Diagnosis

1. Set the Master Run switch to the STOP-ENGINE position.
2. Unplug the relays from their sockets and test as follows:
   a. Use an ohmmeter to ensure continuity exists between terminals No. 30 and No. 87A.
   b. Check the resistance of the relay coil winding by connecting the positive lead of the ohmmeter to terminal No. 85 and the negative lead of the ohmmeter to terminal No. 86. Resistance should be 360 Ohms ± 10%.
   c. Connect the positive lead from a 24VDC power supply to terminal No. 86.
   d. Connect the negative lead from the power supply to terminal No. 85. The relay should energize.
   e. Maintain the test conditions from the previous step and confirm that relay contacts are closed by checking for continuity with an ohmmeter across terminals No. 30 and No. 87.
3. Unplug the 3-pin motor connector and test the fan speed resistors as follows:

☞NOTE:

Refer to the Heater schematic in the Vehicle Systems Drawing Manual.

   a. Use an ohmmeter to check the resistance between terminal B and c on the motor connector. The value should be 10K Ohms.
   b. Check the resistance between terminal B on the motor connector and 87 on the R1 relay connector. The value should be 56K Ohms.
   c. Check the resistance between terminal B on the motor connector and 87 on the R2 relay connector. The value should be 20K Ohms.

☞NOTE:

Replace the wire harness if measurements indicate a resistor is short-circuited, open, or deviates greatly from the specified values.

☞NOTE:

If the motor still fails to operate, replace the drive motor.

2.10. Booster Pump

2.10.1. Description

The booster pump is an integral motor and pump assembly that uses an electronically commutated DC motor and magnetically driven impeller pump. The booster pump is a seal-less design, which allows removal of the motor section from the pump without draining the coolant. The booster pump is mounted to the vehicle frame on the street-side of the engine compartment.

2.10.2. Booster Pump Specifications

Manufacturer........................ Ametek/Rotron

Operating Voltage......................24 Volts DC

Current Draw .... 4.8 Amps

Flow Rate .... 18 GPM

Speed...3100 RPM

2.10.3. Operation

The booster pump receives coolant from the heating system reservoir and delivers it to the HVAC unit and also to the driver's heater/defroster unit. The booster pump is operational when the engine is running and the electronic control system receives a heat request signal from either the HVAC unit or driver's heater/defroster unit.

2.10.4. Booster Pump Troubleshooting

BOOSTER PUMP TROUBLESHOOTING		
PROBLEM	**POSSIBLE CAUSE**	**SOLUTION**
Motor inoperative	No electrical power at pump.	Check voltage at motor red (+) lead. Refer to electrical schematic ES - Climate Control and Vansco VMM program to verify output signal.
	Loose or corroded electrical connections	Tighten and clean connections
Motor operates but flow insufficient	Restricted lines	Check inlet and discharge lines for blockage. Verify that ball valve in inlet line is fully open.
	Pump has decoupled from motor	Check current draw. Refer to 2.10.5. “Functional Tests” on page 46 in this section for procedure.
	Magnetic cup loose on rotor shaft	Tighten setscrews.

2.10.5. Functional Tests

1. With the unit installed in the vehicle, attach an inductive type DC ammeter, with a range of 500 mA to 10 amps, over the red (+) lead on the motor. Attach a voltmeter to the red (+) and black (-) leads of the motor.
2. Operate the booster pump and confirm that voltage reading is approximately 27.6 VDC. The following ammeter readings indicate various conditions:
   a. Reading of 2.5 to 5.5 Amps indicates normal operating condition.
   b. Reading of 0.5 to 1.0 Amp indicates that the motor has decoupled due to pump seizure. Remove pump assembly and inspect for obstruction.
   c. Reading of 7.0 Amp or higher indicates excessive torque required to drive the pump assembly Remove pump assembly and inspect for restriction or binding condition.
   d. Reading of 7.0 Amp or higher indicates possible motor bearing failure. Remove the motor assembly from the pump and test motor current draw. If current for the motor alone exceeds 1.5 amps, then replace the motor bearings.
   e. Reading of 100 mA or less indicates improper supply voltage. Verify proper supply voltage.

2.10.6. Maintenance

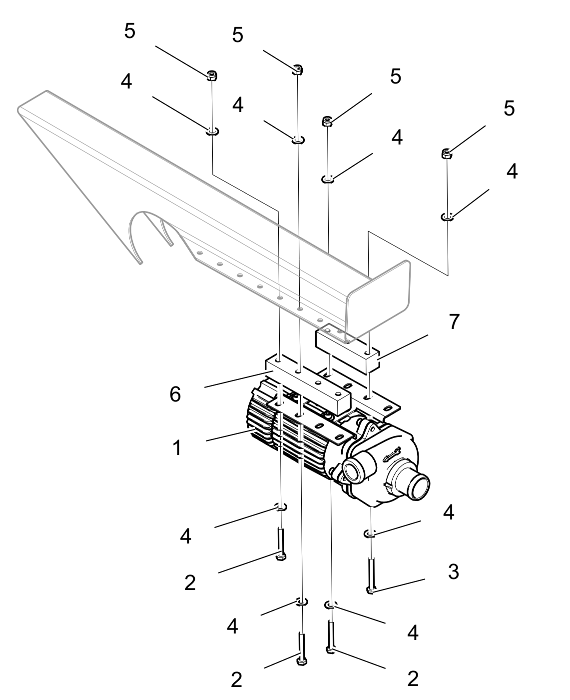
Refer to the Preventive Maintenance Section of this manual for scheduled intervals and service procedures.

2.10.7. Removal

☞NOTE:

The following procedure describes removal of the booster pump and motor as an assembly. If the motor only is being serviced, then it is not necessary to drain coolant or disconnect the coolant hoses. The motor can be separated from the pump and removed for servicing as a separate item.

1. Set Battery Disconnect switch to the OFF position.
2. Disconnect electrical leads from motor. See “Fig. 10-19: Booster Pump Installation” on page 46.
3. Close shut-off valves in the coolant supply and return lines.
4. Place a drain pan beneath the booster pump.
5. Loosen the clamps and disconnect the coolant supply and discharge hoses from the booster pump.
6. Remove all fasteners that attach the booster bump baseplate to the vehicle. Note the location of any washers, spacers, or brackets.
7. Remove the booster pump assembly from the vehicle.



1. Booster Pump Assembly, 27V
2. Bolt, Hex 1/4" - 20 UNC x 1 3/4" Lg.
3. Bolt, Hex 1/4" - 20 UNC x 2" Lg.
4. Washer, Flat 1/4"
5. Nut, Lock Nylon 1/4" - 20 UNC
6. Spacer, Pump
7. Spacer, Pump

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Fig. 10-19: Booster Pump Installation

2.10.8. Installation

1. Align the holes in the booster pump baseplate with the holes in the mounting bracket.
2. Install and tighten all fasteners and any washers, spacers, clamps, or brackets in the same position as noted during removal.
3. Connect coolant supply and discharge hoses and tighten hose clamps to 70 in-lbs. (8 Nm).
4. Plug in electrical connector.
5. Open coolant shut-off valves.
6. Top up coolant to correct level.
7. Set the Battery Disconnect switch to the ON position.
8. Top up the vehicle heating system and perform a deaeration procedure. Refer to 2.2.6. “Heating System Filling & Deaeration” on page 7 in this section for fill and deaeration procedure.

2.10.9. Pump Removal & Disassembly

1. Mark the position of the pump housing with respect to the connector ring housing and connecting housing. See “Fig. 10-20: Booster Pump Assembly” on page 48.
2. Remove the four socket head screws that attach the baseplate to the motor.
3. Remove the pump housing assembly from the connecting housing by removing the four socket head screws and washers.
4. Remove and discard the connecting housing gasket.
5. Disassemble the pump as follows:
   a. Remove four flathead screws and separate housing connector ring from pump housing.
   b. Remove impeller housing.
   c. Remove and discard round gasket.
   d. Remove the impeller assembly from the impeller shaft.
   e. Remove the thrust washer from the pump housing.

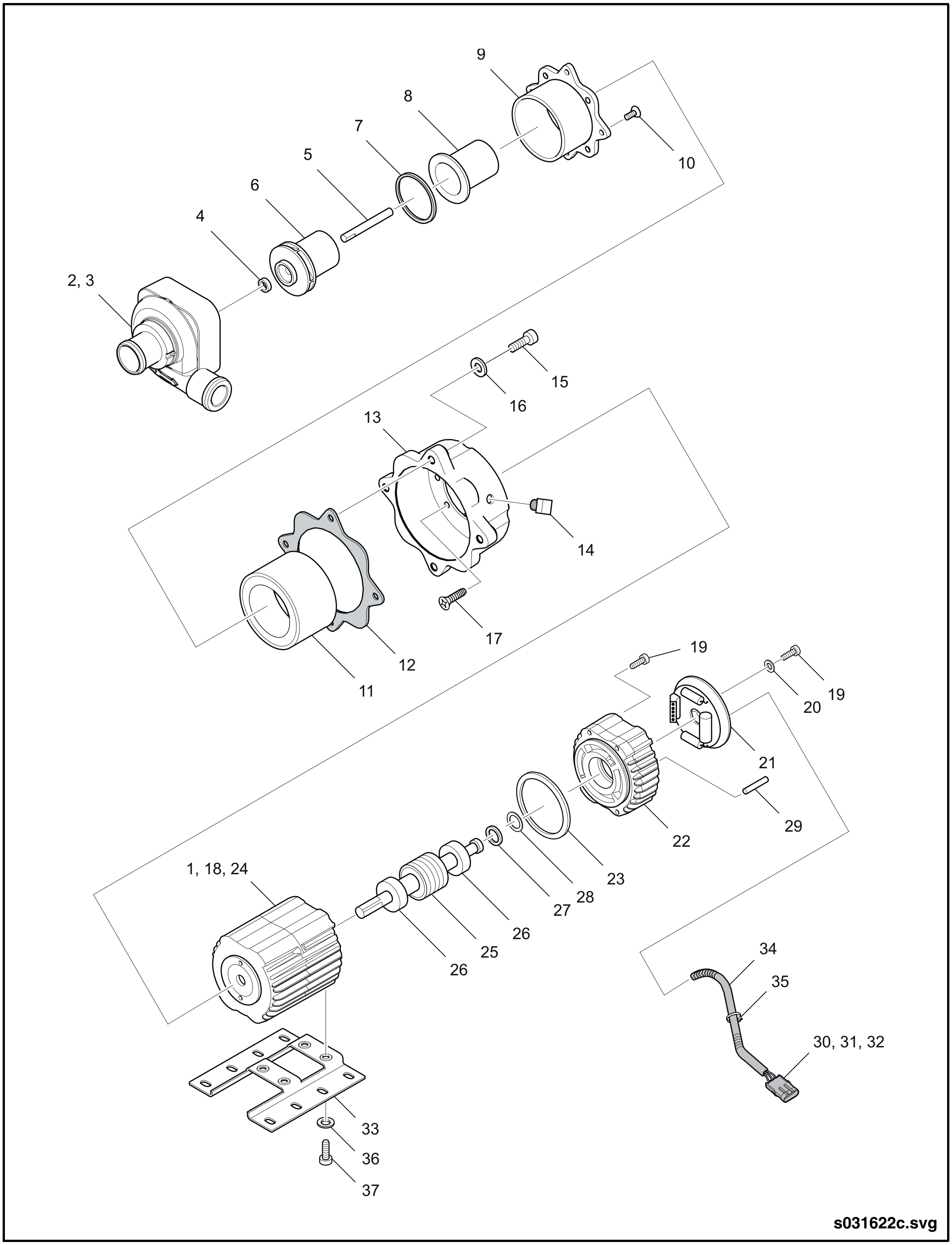


Fig. 10-20: Booster Pump Assembly

1. Booster Pump Assembly, 27V (Incl. 2-9, 18)	20. Washer, Flat #6
2. Magnet, Drive	21. Electrical Assembly
3. Housing, Connecting	22. Housing, Electronics
4. Washer, Flat	23. O-Ring
5. Screw, Socket Head Cap 1/4" - 20	24. Stator & Housing Assembly
6. Gasket, Connecting Bracket	25. Shaft & Rotor Assembly
7. Plug, Plastic Threaded	26. Bearing, Ball
8. Screw, Flat Head	27. Washer, Wave
9. Housing Assembly, Booster Pump (Incl. 10-17)	28. Shim
10. Housing, Pump	29. Tubing, Heatsink
11. Washer, Thrust	30. Shell, Female Connector
12. Shaft, Impeller	31. Terminal, Male
13. Impeller Assembly	32. Seal, Cable
14. Gasket	33. Base Plate
15. Housing, Impeller	34. Loom, Nylon 1.45" Lg.
16. Housing, Connector Ring	35. Cable Tie
17. Screw, FH	36. Washer, Flat 1/4"
18. Motor, 27V (Incl. 19-37)	37. Screw, Socket Head Cap 1/4" - 20 UNC x .50" Lg.
19. Screw, Pan Head #6 - 32 UNC x .75" Lg.	

Booster Pump Assembly (parts list)

2.10.10. Connecting Housing Disassembly

☞**NOTE:**

Remove the connecting housing from the motor if visual inspection indicates that parts require replacement.

1. Remove the plastic threaded plug from the connector housing and rotate the drive magnet until a set screw is aligned with the access hole.
2. Loosen the setscrew.
3. Rotate the drive magnet until the second set screw is aligned with the access hole.
4. Loosen the second setscrew and slide the drive magnet off the motor shaft.
5. Remove the four flathead screws and remove the connecting housing from the motor assembly.

2.10.11. Pump Cleaning & Inspection

1. Inspect the impeller assembly, thrust washer, and pump housing for cracks, dents, worn surfaces, or other damage.
2. Replace worn or damaged parts as necessary.
3. Clean all parts that will be reused.

2.10.12. Pump Assembly & Installation

1. Install the thrust washer in the pump housing.
2. Attach the impeller assembly to the impeller shaft.
3. Install a new round gasket between the impeller assembly and the impeller housing.
4. Slide the impeller housing over the impeller assembly, being careful not to pinch or bend the gasket.
5. Align the connector ring housing with the pump housing using the reference marks made during removal.
6. Apply Loctite 242 to the screw threads and install four flathead screws to secure connecting ring to pump housing.
7. Torque screws to 120 to 130 in-lb. (13.5 to 14.6 Nm).
8. Test the pump for leaks.

2.10.13.Connecting Housing Assembly

1. Apply Loctite 242 to the threads of the four flathead screws and attach connecting housing to motor.
2. Torque screws to 25 to 35 in-lbs. (26 to 28 dNm).
3. Insert the drive magnet into the connector housing, aligning the flats on the motor shaft with the setscrew locations on the drive magnet.

   ☞**NOTE:**

   Ensure that the inside face of the drive magnet is flush with the end of the motor shaft.

4. Apply Loctite 271 or 272 to the first three threads of the setscrews and install the setscrews into the drive magnet. Torque both setscrews to 50 to 55 in-lb. (56 to 62 dNm).
5. Insert the plastic threaded plug into the hole on the side of the connecting housing.
6. Install pump housing onto connecting housing, ensuring blast direction (outlet) is correctly oriented, as marked during removal.
7. Apply Loctite 242 to the threads of the four socket head screws and secure pump housing to connecting housing with screws and flat washers.
8. Torque screws to 55 to 60 in-lbs. (62 to 68 dNm).

2.10.14.Motor Bearing Replacement

☞**NOTE:**

The motor may be separated from the booster pump without removing the pump section from the vehicle.

☞**NOTE:**

The following procedure describes the removal of the shaft and rotor assembly to access the motor bearings. Refer to “Circuit Board/Heat Sink Replacement” in this section if further disassembly of the motor is required.

2.10.14.1.Motor Removal

1. Set Battery Disconnect switch to the OFF position.
2. Disconnect electrical leads from motor.
3. Separate the motor from the pump assembly by removing the four socket head screws and washers that attach the connecting housing to the pump housing.
4. Remove all fasteners that attach the booster bump baseplate to the vehicle. Note the location of any washers, spacers, or brackets.
5. Remove the motor assembly from the vehicle and move to a clean work area.
6. Remove the connecting housing from the motor. Refer to 2.10.10. “Connecting Housing Disassembly” on page 49 in this section for procedure.

2.10.14.2.Shaft & Rotor Disassembly

1. Remove the four recessed panhead screws that attach the electronics housing to the motor housing.

   ☞**NOTE:**

   Do not remove the circuit board assembly on the end of the electronics housing.

2. Carefully remove the electronics housing from the motor housing while noting the location of the shim and wave washer on the end of the bearing shaft.

   ☞**NOTE:**

   The wave washer and shim must be reinstalled in the same position during assembly.

3. Remove the shaft and rotor assembly from the motor, being careful not to chip or otherwise damage the encoder magnet located on the end of the shaft.

   ☞**NOTE:**

   If the encoder magnet is damaged, the entire shaft and rotor assembly must be replaced.

2.10.14.3.Ball Bearing Replacement

1. Remove the ball bearings from the shaft/rotor assembly.

⚠ CAUTION

The ball bearings are press fit on the shaft and will need a press to be removed. Support the bearing and apply force to the shoulder of the shaft/rotor assembly. DO NOT apply force to the encoder magnet.

2. Discard the bearings.
3. Clean the ball bearing seat using No. 800 emery cloth and lubricate shaft as needed.

⚠ CAUTION

DO NOT apply force to the encoder magnet when pressing the new bearings onto the shaft/rotor assembly.

4. Install new bearings on the shaft/rotor using a bearing press fixture. Support the inner race of bearing while pressing the shaft until the bearing is fully seated.

2.10.14.4.Shaft & Rotor Assembly

⚠ CAUTION

Use care not to damage the encoder magnet on the end of the shaft/rotor assembly when installing shaft/rotor assembly into stator housing. Ensure that the shaft/rotor assembly does not contact the stator of the stator housing.

1. Carefully install the shaft/rotor assembly, with installed bearings, into the stator housing assembly.
2. Position the wave washer and shim, as originally positioned, on the end of the shaft/rotor assembly nearest the electronics housing.
3. Install new O-ring and assemble electronics housing on stator housing assembly using four panhead screws.
4. Torque screws to 18 to 20 in-lb. (20 to 23 dNm).
5. Verify that shaft/rotor assembly is assembled correctly by pushing on the end of the shaft. The shaft should spring back if properly installed.

☞NOTE:

If the shaft does not spring back, remove screws completely, reposition electronics housing on stator housing and retorque screws.

2.10.14.5.Motor Testing & Installation

1. Connect the motor lead wires to a 24V power supply, ensuring correct polarity.
2. Set the input voltage to 27.6V and energize the motor.
3. Verify that the motor is rotating clockwise, as viewed from the motor end with the wire leads.
4. Use an ammeter to verify that current draw is approximately 1 amp after one minute of operation.
5. Reassemble the motor to the pump. Refer to 2.10.13. “Connecting Housing Assembly” on page 50 in this section for assembly procedure.

2.10.15.Circuit Board/Heat-Sink Replacement

☞NOTE:

The following procedure describes the steps required to separate the motor from the pump and replace the circuit board/ heat sink assembly.

2.10.15.1.Removal

1. Remove the motor from the pump. Refer to 2.10.9. “Pump Removal & Disassembly” on page 47 in this section for removal procedure.
2. Note the location where the motor lead wires exit the circuit board/heat-sink assembly with respect to the electronics housing. Scribe a mark on the electronics housing.
3. Remove the two panhead screws and washers on the rear of the circuit board/ heat-sink assembly.
4. Carefully remove the circuit board/heat-sink assembly from the electronics housing.
5. Identify and disconnect the stator lead wires from the terminal header on the circuit board/heat-sink assembly.
6. Remove and discard the circuit board/ heat-sink assembly.
7. Remove all old RTV sealant and clean mating surfaces between circuit board/ heat-sink assembly and electronics housing.

2.10.15.2.Installation

1. Attach the stator lead wires to the circuit board/heat-sink assembly as marked during removal.
2. Apply a bead of electronics-compatible RTV sealant, such as Dow Corning 3145, around the edge of the electronics housing.

⚠CAUTION

Ensure that the lead wires between the stator housing and circuit board/heat-sink assembly do not rub on the shaft/ rotor assembly.

3. Position the circuit board/heat-sink assembly in its original position, as marked during disassembly, and secure in position with two panhead screws and washers.

2.10.15.3.Testing

1. Install an ammeter in the circuit and connect a 24 VDC power supply to the red (+) and black (-) motor lead wires. Record current draw with no load condition.
2. Remove the two panhead screws and rotate the PCB/heat-sink assembly 15° in either direction until the lowest current draw is obtained. The current draw should be approximately one amp at rated speed after one minute of run-in without pump attached. The motor should be rotating in a clockwise direction as viewed from the electronics housing end of the motor.
3. Install and torque the two panhead screws to 14 to 16 in-lb. (16 to 18 dNm).
4. Re-energize the motor and verify clockwise rotation and current draw of approximately 1 amp after one minute of operation.
5. Reinstall motor on pump. Refer to 2.10.13. “Connecting Housing Assembly” on page 50 in this section for procedure.

2.11. Heating System Reservoir

2.11.1. Description

The heating system reservoir is located in the engine compartment on the streetside of the vehicle, inboard from and above the radiator.

☞**NOTE:**

A separate engine cooling system surge tank, filler cap, and Schrader valve are located adjacent to the heating system reservoir. Refer to Section 6 of this manual for information on the surge tank.

The vehicle heating system reservoir includes the following components:

- ❒ Pressure Cap & Relief Valve
- ❒ Coolant Level Sensor
- ❒ Fluid Level Gauge
- ❒ Pressure Test Valve
- ❒ Pressure Fill Connector - located in the engine compartment.

The surge tank access door provides access to the pressure cap, pressure relief valve, and pressure test Schrader valve. The coolant level sensor and fluid level gauge are accessible from the engine compartment. See “Fig. 10-21: Heating System Reservoir Installation” on page 54.

2.11.2. Operation

The tank provides a reservoir for the heating system and allows for coolant expansion. The reservoir, along with the degas tank, also removes air entrapped in the system. The Schrader valve is used to check the heating system pressure.

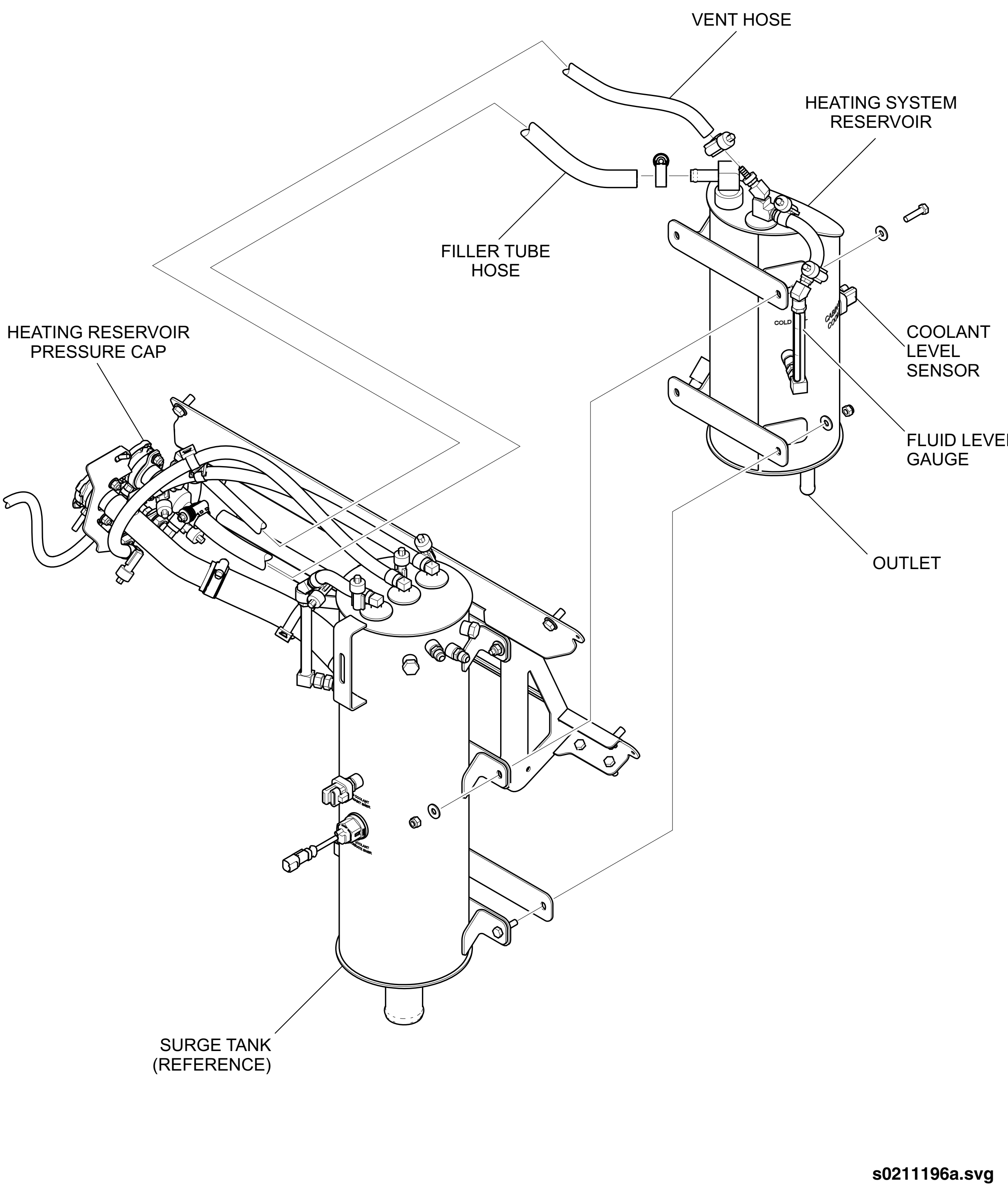


Fig. 10-21: Heating System Reservoir Installation

2.11.2.1.Pressure Control Cap & Relief Valve

WARNING

Allow heating system to cool, relieve system pressure and open filler cap slowly. Keep away from hot coolant and surfaces to avoid injury.

The pressure control and a relief valve are integral with the cap. The pressure control maintains heating system pressure preventing the loss of coolant. A vacuum valve in the pressure cap opens to prevent the collapse of hoses when the heating system cools and creates a vacuum. See “Fig. 10-22: Heating Reservoir & Surge Tank Pressure Caps” on page 55.

Clean and inspect the pressure cap when the heating system is serviced. Also test the operation of the control cap pressure relief valve and vacuum valve.

☞NOTE:

Use a commercially available cooling system pressure tester to test the pressure control cap.

2.11.2.2.Coolant Level Sensor

A coolant level sensor is used in the reservoir tank to detect the absence of fluid at the probe tip. The sensor is used to activate the Low Coolant indicator on the engine switchbox. The sensor is accessible from the engine compartment and is non-serviceable. No adjustments are required.

2.11.2.3.Fluid Level Gauge

A glass fluid level gauge is mounted on the side of the reservoir tank to provide a quick visual indication of the fluid level in the reservoir. The gauge is connected with an adapter at the bottom and a hose at the top. Markings on the reservoir indicate COLD FULL and HOT FULL.

2.11.2.4.Pressure Test Valve

The pressure test valve is used to check cooling system operating pressures and is also used to pressure test the system.

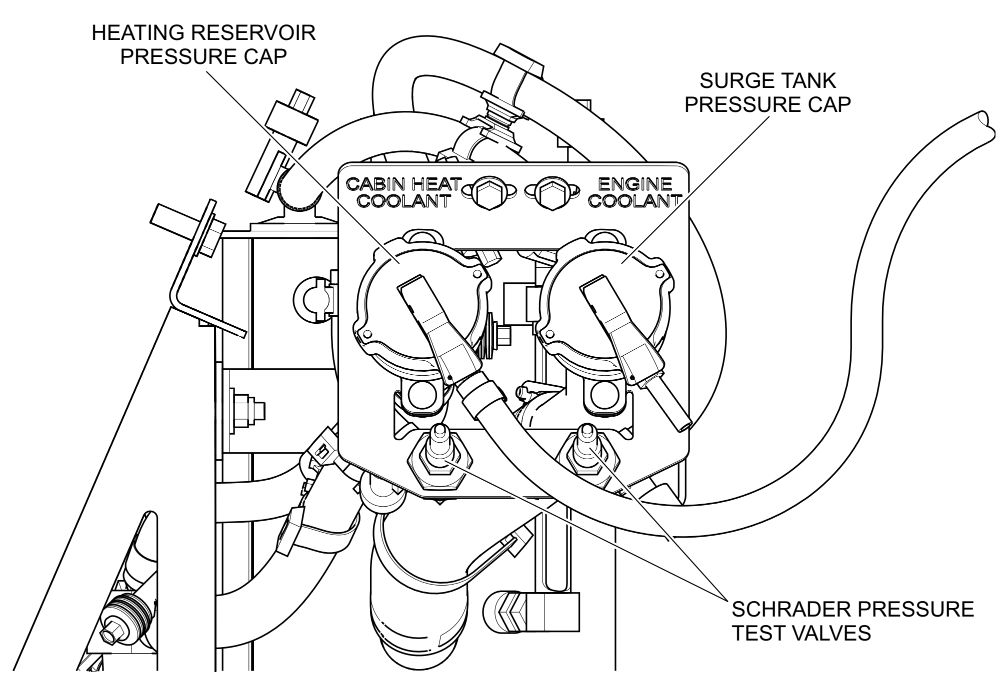


Fig. 10-22: Heating Reservoir & Surge Tank Pressure Caps

2.11.3. Removal

WARNING

DO NOT service the vehicle heating system or open the pressure cap on the reservoir if the system is hot or under pressure. Hot coolant can cause scalding burns if pressure caps are opened or lines are disconnected. ALWAYS allow time for the coolant temperatures to drop and ALWAYS use the pressure cap lever to relieve system pressure before servicing the system.

1. Relieve system pressure using the manual pressure relief valve on the filler cap. Remove the filler cap.
2. Locate the drain plug on the bottom of the reservoir and drain the coolant into a suitable container.

   ☞**NOTE:**

   Draining the reservoir will also drain the degas tank.

3. Loosen the hose clamp and disconnect the hose from the bottom of the reservoir.
4. Loosen the hose clamps and disconnect the fill hose and vent hose at the top of the reservoir.
5. Disconnect the pressure fill hose from the reservoir.
6. Disconnect the degas tank hose from the reservoir.
7. Disconnect the coolant sensor electrical connection.
8. Remove the fasteners securing the reservoir to the upper and lower mounting brackets.

   ☞**NOTE:**

   Retain the spacer plate used on the lower mounting bracket for installation.

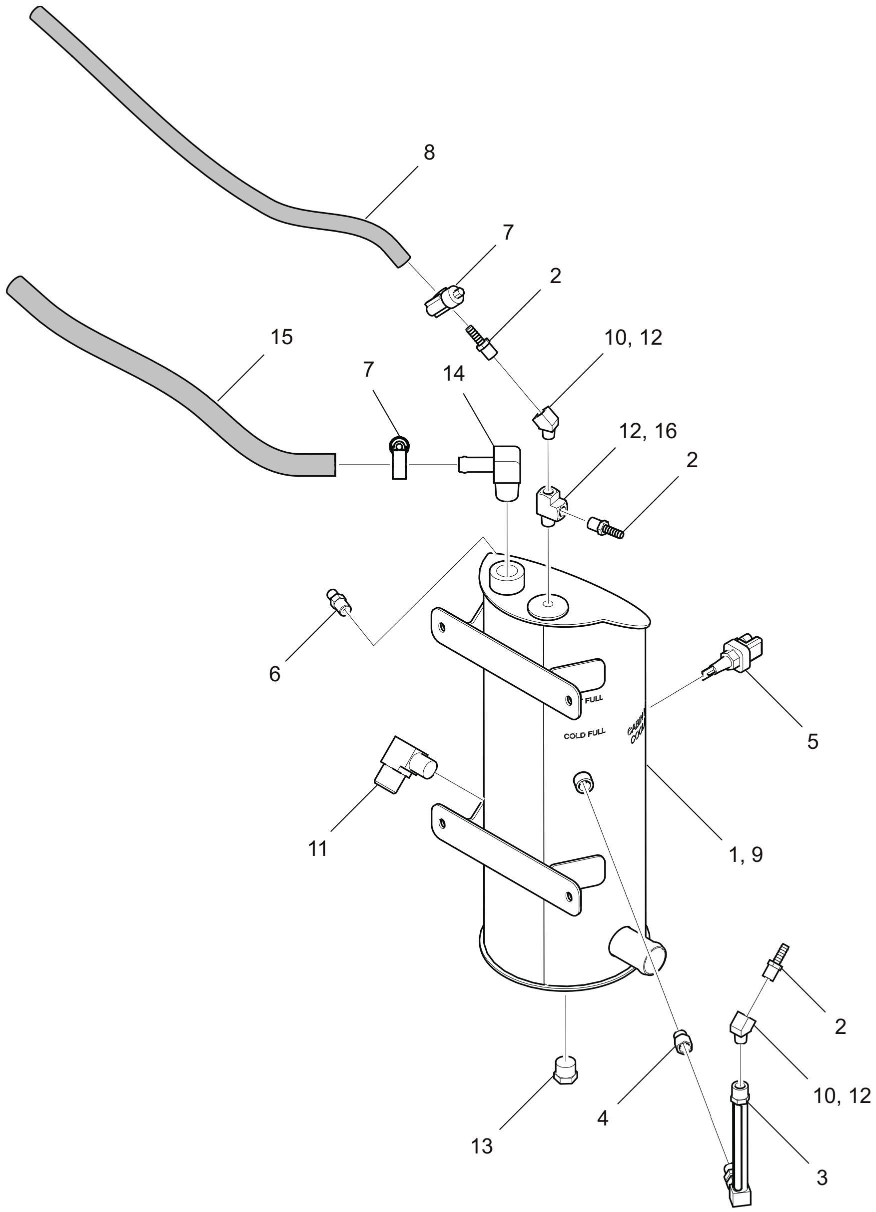
9. Remove the reservoir from the vehicle.

2.11.4. Cleaning & Inspection

1. Remove coolant sensor, fittings, and fluid gauge as required. See “Fig. 10-23: Heating System Reservoir Assembly” on page 57.
2. Clean the reservoir and inspect it for cracks or damage.

2.11.5. Installation

1. Assemble the reservoir with the coolant sensor, fluid gauge, and fittings as required. Torque coolant sensor to 15 ft-lb. (20 Nm).
2. Align the reservoir integral brackets with the vehicle mounting brackets and lower spacer plate and install and tighten fasteners.
3. Reconnect all hoses and vent lines and torque hose clamps to specification. Refer to 2.12. “Hose Clamp Torque Specifications” on page 58 in this section for torque specification.
4. Connect coolant sensor electrical connector to vehicle wiring harness.
5. Apply Loctite 567 thread sealant to the drain plug and tighten two full turns past finger tight.
6. Top up the vehicle heating system and perform a deaeration procedure. Refer to 2.2.6. “Heating System Filling & Deaeration” on page 7 in this section for fill and deaeration procedure.



1. Reservoir Assembly, Heating System (Incl. 2-16)
2. Fitting, Barbed 1/4" MPT x 3/8" I.D.
3. Gauge, Coolant Level
4. Adapter, 1/4" PT x 1/4" PT
5. Sensor, Low Fluid Level
6. Plug, 1/4" NPT SST
7. Clamp, 0.56" Dia. - 1.06" Dia.
8. Hose, Silicone 9mm I.D. x 4' Lg.
9. Heating System Reservoir, Welded
10. Elbow, 45° 1/4" NPT x 1/4" FPT Brass
11. Adapter, Elbow 90° ext Pipe to 37° Flare
12. Loctite, 567 White
13. Plug, Hex Head 1/2" MPT
14. Fitting, 90° 3/4" NPT x 5/8" Barb
15. Hose, Silicone 15mm I.D. x 4' Lg.
16. Tee, Street 1/4" PT

s0212207a.svg

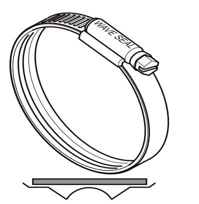
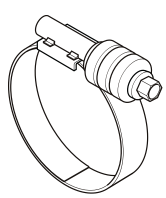
Fig. 10-23: Heating System Reservoir Assembly

2.12. Hose Clamp Torque Specifications

☞**NOTE:**

Hose and tube connections are designed with a slight interference fit. Lubricate tubes to aid hose installation.

The following torque chart provides a listing of the various hose clamps used in the cooling system and the applicable torque for the specific clamp. The size of clamp (clamp width) will determine the torque value.

IDEAL - TRIDON HOSE CLAMP TORQUE SPECIFICATIONS				
Item	**Clamp**	**Description**	**Width**	**Torque (in-lb.)**
1		Ideal Smartseal Stainless Steel Clamp	0.625	125 in-lb.
2		Ideal Waveseal Stainless Steel Clamp	0.562	80 in-lb.
3		Ideal Flexgear Stainless Steel Clamp	0.562	50 in-lb.

NOTES:
1. Torque Smartseal and Waveseal clamps at 75 RPM or less.
2. Torque Flexgear clamps at 250 RPM or less.
3. Retorque Smartseal and Waveseal clamps after 30 minutes.

3. VENDOR SERVICE INFORMATION

The following supplier manuals contain additional reference information.

3.1. Thermo King Manuals

- ❒ RLF2-M13 Maintenance Manual
- ❒ IntelligAIRE III Controller Diagnostic Manual

Structures & Chassis

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- open flame
- excessive heat
- production of sparks
- production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Welding/Machining Safety

⚠ CAUTION

Before welding anywhere on vehicle, set Battery Disconnect switch to the OFF position and disconnect all electronic control modules (Multiplexing, engine, transmission, ABS, and so forth). Refer to Section 11 of this manual for additional precautionary information.

1.4. Paint & Chemicals Safety

1.4.1. Painting Safety

⚠ WARNING

Follow all proper safety precautions regarding spray painting.

⚠ WARNING

The paint booth or work area must be properly ventilated, with filtered exhaust fans removing fumes and over spray. Air make-up induction fans should also be used to supply fresh air to the work area.

⚠ CAUTION

Use a filtering mask with the proper filter cartridges. Wear eye protection and proper protective clothing.

⚠ CAUTION

The painting area should be a safe distance from any source of flame, spark or other means of combustion. Atomized paint, thinner, cleaner and solvent fumes are highly volatile with an extremely low flashpoint that can cause explosive combustion.

⚠ CAUTION

DO NOT smoke or permit anyone else to smoke in or near the painting area.

1.4.2. Cleaning Chemicals Safety

WARNING

Because fumes are more dangerous in a small space, be sure the vehicle is well ventilated while using any cleaning agent. Follow the manufacturer's instructions in using such products. Many cleaners may be poisonous or flammable, and their improper use may cause personal injury or damage to the inside of the vehicle. Therefore, when cleaning the interior, DO NOT use volatile cleaning solvents such as: acetone, lacquer thinners, enamel reducers, nail polish removers; or such cleaning materials as laundry soaps, bleaches, or reducing agents (except as noted for fabric cleaning of stains). NEVER use carbon cleaning products.

CAUTION

To avoid possible permanent discoloration on light colored trim, DO NOT let materials with unstable dyes come in contact with seat trim materials until totally dry. Proper cleaning techniques and cleaners must be used on trim materials. Failure to do this on the first cleaning may result in water spots, spot rings, setting of stains, or soilage, all of which make it more difficult to remove in a second cleaning.

1.5. Adhesives Safety

WARNING

Overexposure to adhesives used on this vehicle, specifically Sikaflex-252, may cause breathing difficulties, sensitization, headaches, nausea, vomiting. May aggravate respiratory, skin, eye, lung problems and allergies. If the product is applied according to the manufacturer's directions, none of these symptoms should be encountered. A person who is allergic to isocyanate may have a reaction with a level of isocyanate well below the T.L.V. Xylene is a central nervous system depressor and in rare cases, may cause a sensitization of the heart muscle causing arrhythmia.

Ensure the user is provided with a full face mask or safety glasses, a rubber apron, sufficient ventilation, and an eyewash station or shower. In case of overexposure, remove contaminated clothing and shoes, wash with plenty of water, wash clothing before rewearing, and consult a physician. If eyes are exposed, rinse immediately for several minutes. See a physician immediately. In case of inhalation, evacuate to fresh air and consult a physician. In case of ingestion, drink plenty of water or milk. DO NOT induce vomiting. See a physician immediately.

2. STRUCTURES & CHASSIS

2.1. Description

The vehicle structure and chassis is fabricated mainly from steel tubing and reinforcing gussets and consists of the following subassemblies:

- ❒ Front Chassis
- ❒ Center Chassis
- ❒ Rear Chassis
- ❒ Front Structure
- ❒ Sidewall Structure
- ❒ Roof Structure

The vehicle structure and chassis are comprised mainly of carbon steel, but ferritic stainless steel is also used in some areas to aid in corrosion protection. Ferritic stainless steel requires special welding procedures and electrodes when repairing these areas of the vehicle structure. Contact New Flyer Technical Services for additional information on the location of ferritic stainless steel parts and associated welding procedures whenever repairs are necessary.

Structural components can be repaired and replaced by competent craftsmen with proper tools and equipment. Welders repairing the structure and chassis of the New Flyer vehicle shall meet the qualifications for “All Position” welding per Part II of the AWS Standard “Qualifications For Metal Arc Welding”.

2.2. Warranty Limitation

New Flyer Industries reserves the right to refuse warranty on any section or part of the body structure welded on or in any way modified or repaired by other than New Flyer approved personnel. New Flyer also reserves the right to refuse warranty on any component failure deemed to be the result of any unauthorized modification.

2.3. Identification

Each vehicle structure can be identified by the Chassis Identification Number plate riveted to the engine cradle.

2.4. Welding Procedures

2.4.1. Welding Electronic Precautions

Large voltage spikes will occur when striking an arc during arc welding or plasma cutting operations. These voltage spikes can easily damage electronic modules in the vehicle electrical systems. The various modules used in the Multiplexing System share chassis grounds and therefore simply disconnecting the battery cables will not afford the protection required. All electronic module grounds must be isolated from the vehicle chassis ground whenever performing arc welding or plasma cutting operations on the vehicle.

Taking the following precautions will minimize the potential for electronic module damage:

- ❐ Turn off all vehicle electrical loads and set the Master Run switch to the STOP-ENGINE position.
- ❐ Set the Battery Disconnect switch to the OFF position.
- ❐ Ensure the welding ground clamp is of adequate size for the welder and that the clamp is as close as possible to the area being welded.
- ❐ Make sure the welding clamp makes a good connection to the ground surface. Remove any paint or coatings so that bare metal is exposed at the ground point.
- ❐ Ensure that the cable ground side of the clamp makes a good ground with the vehicle if using a one-sided ground clamp. Do not rely on the opposite side of the clamp to make the ground connection.
- ❐ Do not attach the ground clamp to a vehicle ground terminal bar. The terminal bar may be a ground point for an electronic module.
- ❐ Do not position the welding ground clamp in a location that would place a vehicle electronic ground point between the repair area and the welding ground clamp.
- ❐ If welding on different vehicle frame rails always relocate the welding ground clamp to the frame rail that is being repaired.
- ❐ Do not route welder electrical cables directly across from or near any of the vehicle's electrical wiring harnesses.

CAUTION

Adhering to the preceding precautions will minimize the likelihood of damage to any electronic modules, however, to ensure no damage occurs it is recommended that all electronic modules be disconnected including:

- ❒ **Engine ECM - disconnect the vehicle interface harness connector.**
- ❒ **Transmission ECU - disconnect the vehicle interface harness connector.**
- ❒ **Anti-Locking Braking System (ABS) ECM - disconnect the 18-pin connector "X1".**
- ❒ **Vansco Multiplexing Modules (VMM) - disconnect all VMM1615 modules.**
- ❒ **EMP Radiator - disconnect positive and negative power cables from radiator. Unplug connector from TMC system controller located on radiator.**
- ❒ **Destination Sign - disconnect the vehicle interface harness connector.**
- ❒ **Instrument Panel - disconnect all wiring connectors from the backside of the instrument panel.**
- ❒ **HVAC (Intelligaire III Controller) - disconnect vehicle interface harness connector.**
- ❒ **Fire Suppression & Gas Detection Display Panel - disconnect the vehicle interface harness connector.**
- ❒ **Vanner Voltage Equalizer - disconnect all ground and ground sensing connectors.**
- ❒ **E-Stroke Communication Module - disconnect the vehicle interface connector.**
- ❒ **AVA/AVL Systems - disconnect the vehicle interface connector from IVN controller.**
- ❒ **Video Surveillance System - disconnect the vehicle interface connector from the video recorder unit.**
- ❒ **Vapor Door Control Module - disconnect the J11 power connector.**
- ❒ **Transit Control Head - disconnect the connectors from transit control head unit.**

2.4.2. General Welding Procedures

2.4.2.1. Welding Electrode Selection

Use the following welding electrodes for joining materials:

WELDING ELECTRODE SELECTION

STRUCTURE TYPE	ELECTRODE
Carbon Steel to Carbon Steel	ER-49S 3
Ferritic SST to Carbon Steel	ER-309L Si
Ferritic SST to 304/304L SST	ER-309L Si
Ferritic SST to Ferritic SST	ER-309L Si
304/304L SST to Carbon Steel	ER-309L Si
304/304L SST to 304/304L SST	ER-308L Si

☞ **NOTE:**

Carbon Steel to Carbon Steel can also use ER-309L Si.
All welds are to be made with E7018, low hydrogen, welding rods or ER705-3 wire.
Weld gaps should not exceed thickness of material up to a maximum of 1/8".

1. Remove all old weld using carbon arc (air-arc), grinder, or pneumatic chipper when required.

DANGER

Faulty welding or improper installation could cause property damage, personal injury or death. Refer to 2.2. “Warranty Limitation” on page 3 **in this section limiting New Flyer’s liability.**

2. Oxygen-acetylene torches should not be used. If a carbon arc is used, the area to be rewelded should be ground to remove carbon deposits.
3. The area enclosed by the weld zone plus two inches to either side of the weld zone must be cleaned to the base metal by wire brush, removing all grease, oil, rust and scale from surfaces to be joined. The temperature of the steel parts to be welded together must be at or above 10°C before commencing to weld.

2.4.3. Straightening

The use of heat when straightening structural parts of the body is not recommended, since heat affects structural characteristics of certain alloys especially heat-treated parts.

All body structural members should be straightened cold; any part bent or buckled sufficiently to show strains or cracks after straightening, should be replaced or properly reinforced.

2.4.4. Cutting

CAUTION

Refer to 2.4.1. “Welding Electronic Precautions” on page 4 **in this section if using a plasma cutter.**

When cutting a structural member, cut at an angle of 30°. Thus, actual length of cut is twice the width of piece being cut and stress or load is distributed over a longer joint when welded.

Cutting can be done by torch, although use of saw is preferred since cut is cleaner and less material is removed.

2.4.5. Reinforcing

CAUTION

Before reinforcing any part, determine the cause of failure. Reinforcing a point of apparent failure without correcting underlying cause of failure may transfer stress to other parts not engineered for such stress, resulting in development of new failures. Since the body is designed to be flexible, rigid reinforcement in any part of body may nullify the design.

Reinforcing can be made of flat, angle or channel stock, whichever is most suitable for the purpose. Reinforcements should be sufficiently long to distribute load evenly over a considerable area and thickness should not exceed that of member being reinforced. Reinforcements should be welded to broken parts.

2.4.6. General Stainless Steel Welding Procedure

2.4.6.1. Cleaning

The surface of the parts to be welded must be free of grease, oil, paint, dirt, etc. Cleaning should be done immediately before welding to prevent the formation of oxides. A clean surface will provide a smoother, stronger joint. Use a stainless steel wire brush to remove burrs and oxides. Gloves should be worn to prevent contamination of the weld surface by hand oil or dirt.

2.4.6.2. Preheating

Preheat is not required for most 300 austenitic grade stainless steels. The base metal should be brought to room temperature, 60 to 75°F. Preheat is necessary when welding thicker ferritic or martensitic grades. It is also needed when joining thick metals or metals containing a high percentage of carbon.

2.4.6.3. Welding

- ❒ All stainless steel weld joints are to be welded in accordance with American Welding Society code “AWS D1.6 Structural Welding Code - Stainless Steel”.
- ❒ All welds joining austenitic SS to austenitic SS are to be made using 308/308L welding wire; otherwise use 309/309L welding wire when at least one side of the weld joint contains ferritic SS or carbon steel.
- ❒ Weld gaps should not exceed the thickness of the material to maximum of 1/8".

2.4.6.4. Post-Heating & Post-Weld Cleaning

Post-heating may be required to relieve internal stresses caused by the concentration of heat in the weld area. Post-heating slows down of the cooling process to minimize cracking. This is a good procedure to use when joining thick metals.

Shielded metal arc and flux cored welding leaves a slag residue on the weld. Remove slag with a chipping hammer or by grinding. Stainless steel is much more sensitive to sharp edges. Any weld toes or weld craters that contain sharp edges must be ground down to a smooth profile.

2.4.6.5. Weld Inspection

When inspection is required, liquid penetrant inspection (LPI) is the specified non-destructive test procedure. Austenitic stainless steels are not magnetic, and will not respond to magnetic particle inspection. Contact New Flyer should details be required for the LPI process.

Once stainless steel is welded, the area does not need any further corrosion protection. Stainless steel is inherently corrosion resistant. If a dissimilar weld was made, or if the weld was a carbon steel weld, corrosion treatment is required to obtain adequate protection.

2.4.7. Austenitic Stainless Steel to Austenitic Stainless Steel Welding Procedure

2.4.7.1. Shielded Metal Arc Welding (SMAW)

Use a 308/308L type welding rod, of appropriate thickness for the material being repaired. For most scenarios, an electrode thickness of 1/8" should be adequate. New Flyer does not employ SMAW to fabricate bus frames and the recommended welding rods have not been tested. Follow the power requirements suggested by the electrode manufacturer. Most SMAW electrodes do not permit welding in the vertical down position.

2.4.7.2. Gas Metal Arc Welding (GMAW)

Electrode 308/308L at a diameter of 0.035" is to be used with a shielding gas containing 98% Ar-2% CO2. Shield gas flow rate of 30 cfh is adequate. For material thicknesses up to and including 0.134", set weld machine to 18 volts and a wire feed speed of 310 inches per minute. This should result in amperage of approximately 131 amps. For material thicknesses greater than 0.134", set weld machine to 22.5 volts and a wire feed speed of 400 inches per minute. This should result in amperage of approximately 161 amps. This procedure is valid in all welding positions.

2.4.8. Austenitic or Ferritic Stainless Steel to Carbon Steel Welding Procedure

2.4.8.1. Shielded Metal Arc Welding (SMAW)

Use a 309/309L type welding rod, of appropriate thickness for the material to being repaired. Most welds involving dissimilar metals are performed on thick material. An electrode thickness of 3/16" should be adequate. New Flyer does not employ SMAW to fabricate bus frames and the recommended welding rods have not been tested. Follow the power requirements suggested by the electrode manufacturer. Most SMAW electrodes do not permit welding in the vertical down position.

2.4.8.2. Gas Metal Arc Welding (GMAW)

Electrode 309/309L at a diameter of 0.035" is to be used with a shielding gas containing 98% Ar-2% CO2. Shield gas flow rate of 30 cfh is adequate. For all material thicknesses, set weld machine to 24 volts and a wire feed speed of 475 inches per minute. This should result in amperage of approximately 175 amps. This procedure is valid in all welding positions.

2.4.9. Ferritic SS to Ferritic SS or Ferritic SS to Austenitic SS Welding Procedure

Electrode 309/309L at a diameter of 0.035" is to be used with a shielding gas containing 98% Ar-2% CO2.

For material thicknesses of 0.188", 0.250 and 0.375" use a shield gas flow rate of 35 cfh. Set the weld machine to 28 volts and a wire feed speed of 600 inches per minute. This should result in a current of approximately 190 amps. This procedure is valid for fillet welds on corner, tee or lap joints, in the flat and horizontal welding positions.

For material thicknesses of 0.060", 0.080", 0.125", 0.188" use a shield gas flow rate of 35 cfh. Set weld machine to 28 volts and a wire feed speed of 550 inches per minute. This should result in amperage of approximately 190 amps. This procedure is valid for fillet welds on corner, tee or lap joints in the flat, horizontal and vertical down welding positions.

For material thicknesses of 0.060" and 0.080" use a shield gas flow rate of 30-35 cfh. Set weld machine to 27 volts and a wire feed speed of 550 inches per minute. This should result in amperage of approximately 180 amps. This procedure is valid for flare or bevel groove welds in the flat and horizontal welding positions.

For material thicknesses of 0.125" and 0.188" use a shield gas flow rate of 30-35 cfh. Set weld machine to 28 volts and a wire feed speed of 600 inches per minute. This should result in amperage of approximately 190 amps. This procedure is valid for flare or bevel groove welds in the flat and horizontal welding positions.

For material thicknesses of 0.060, 0.080, and 0.125" use a shield gas flow rate of 30-35 cfh. Set weld machine to 23 volts and a wire feed speed of 400 inches per minute. This should result in amperage of approximately 160 amps. This procedure is valid for flare or bevel groove welds in overhead positions.

3. CORROSION PROTECTION

3.1. Prevention

Periodically clean the under-structure to remove dirt accumulation from flanges, ledges, channels and so forth. These places hold dirt and salt in direct contact with steel and aluminum surfaces. Use of an under-structure spray as part of the regular washing, with an occasional and more thorough cleaning with a high pressure spray is recommended.

3.2. Corrosion Treatment

3.2.1. Introduction

The under structure of your New Flyer vehicle has been protected during manufacture using the following products:

- ❒ Ganicin™ - Structure Primer consisting of primer base and zinc powder: protects exterior surfaces of structural steel components.
- ❒ Tufcote™ UC-1006™ - Underbody Coating: a chip resistant coating covering the underbody of the vehicle.
- ❒ Tufcote™ UC-7101™ - Interior Tube Coating: protects interior surfaces of tubular steel components.

☞**NOTE:**

All of the above listed products are supplied by Xalta Coatings and can be obtained through your local distributor.

3.2.2. VOC Regulations

All Volatile Organic Compounds (VOC) must be compliant with local regulations. Consult your local supplier and ensure that the supplied product meets requirements for the intended application. Refer to 3.3. “Primer Application” on page 13 in this section for alternative low VOC products and application procedures.

3.2.3. Surface Preparation

The vehicle frame and chassis must be prepped through several processes to adequately protect the structure and chassis from premature corrosion.

3.2.4. Replacement Structure

1. Replacement structural members must be thoroughly washed with a Chemkleen CL90 and water solution using a high pressure wand. This process will remove dirt and oil from the surface to be treated.
2. Thoroughly rinse the cleaned structure with water using a high pressure wand.
3. Allow the steel members to dry thoroughly.

☞NOTE:

The structure must be dirt and grease free before grit blasting, to prevent dirt and oil from being imbedded into the grit blasted pores.

4. Grit blast the cleaned and dry structure to bare metal. Grit blast all surfaces to an SSPC-SP-6 profile of 1.0 to 2.0 mils. Wheel abrade any spots missed grit blasting which still have rust, millscale or weld spatter still present.

☞NOTE:

SSPC-SP-6/NACE No. 3 "Commercial Blast Cleaning" is a standard available from SSPC: The Society for Protective Coatings.

5. Use compressed air to remove all grit from structure surface. Work down from the top of the blast area.

⚠CAUTION

If available, sandblasting can be used for cleaning bulkheads, brackets and other structural members. However, sand blasting should not be used for cleaning the side paneling of vehicle body. Extreme care should be taken not to sandblast excessively.

☞NOTE:

This procedure must be followed exactly to produce a properly iron phosphate treated metal surface. This will provide the bonding surface required for adequate primer adhesion for corrosion protection.

6. Parts coated with zinc structure primer and underbody coating with a damage area not more than 1/8" in width may be repaired by applying underbody coating over the damage area.
7. Damaged undercoated areas more than 1/8" in width must be cleaned to bare metal. Clean 2" around the damage area in all directions.
8. Tube type frame members closed at both ends must be drilled to allow insertion of the spray tip into the tube. The hole should be 1/2" in diameter and approximately midway along the length of the tube to permit complete spray coverage.
9. Use caulking sealant (Sika-221) to seal between side panels and frame, between floor and frame and anywhere water could seep into.
10. Allow caulking to skin over for a minimum of 15 minutes.
11. Mask exposed fittings and hoses.

3.2.5. Existing Structure

For parts coated with previously applied zinc rich primer only, sandblast or wheel abrade the repair area to bare metal, and reapply primer as described. Observe requirements of steps 3. through 8. of “Replacement Structure” to properly treat damaged area before application of primer. See “Fig. 11-1: Untreated Repair Area” on page 12. See “Fig. 11-2: Surface Cleanup” on page 12.

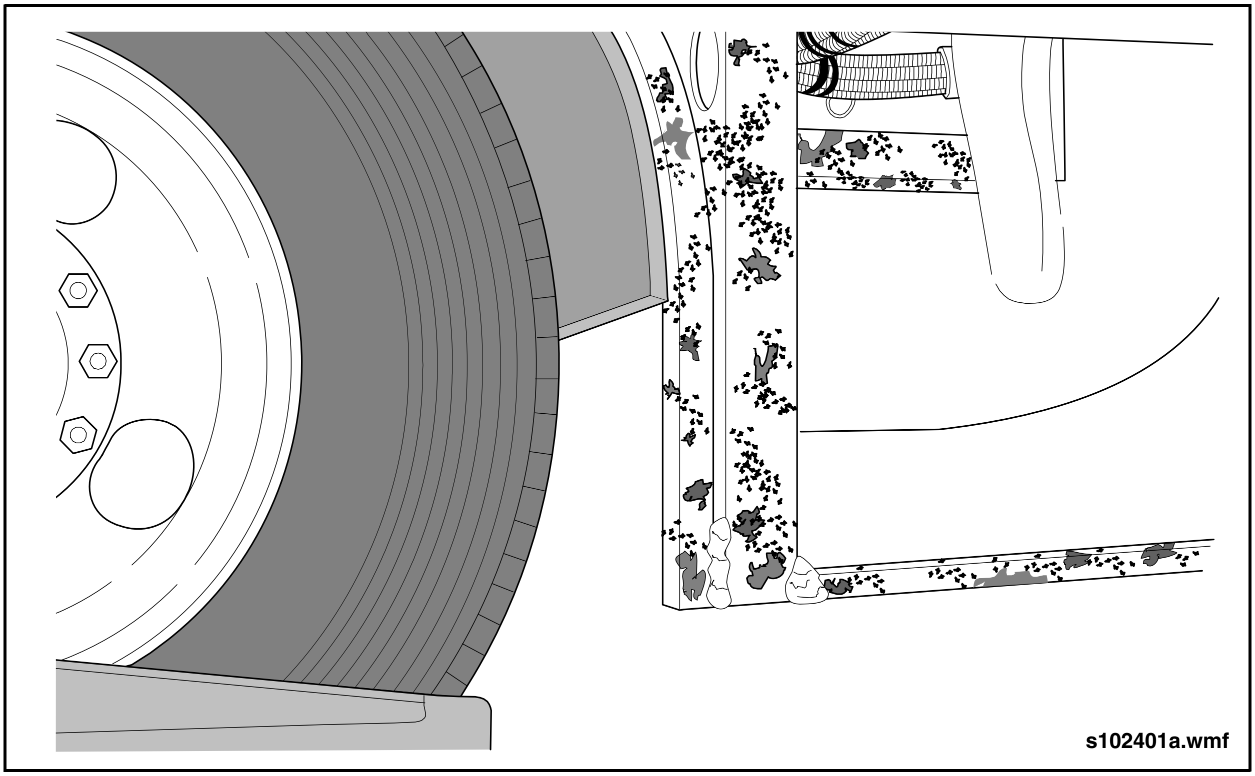


Fig. 11-1: Untreated Repair Area

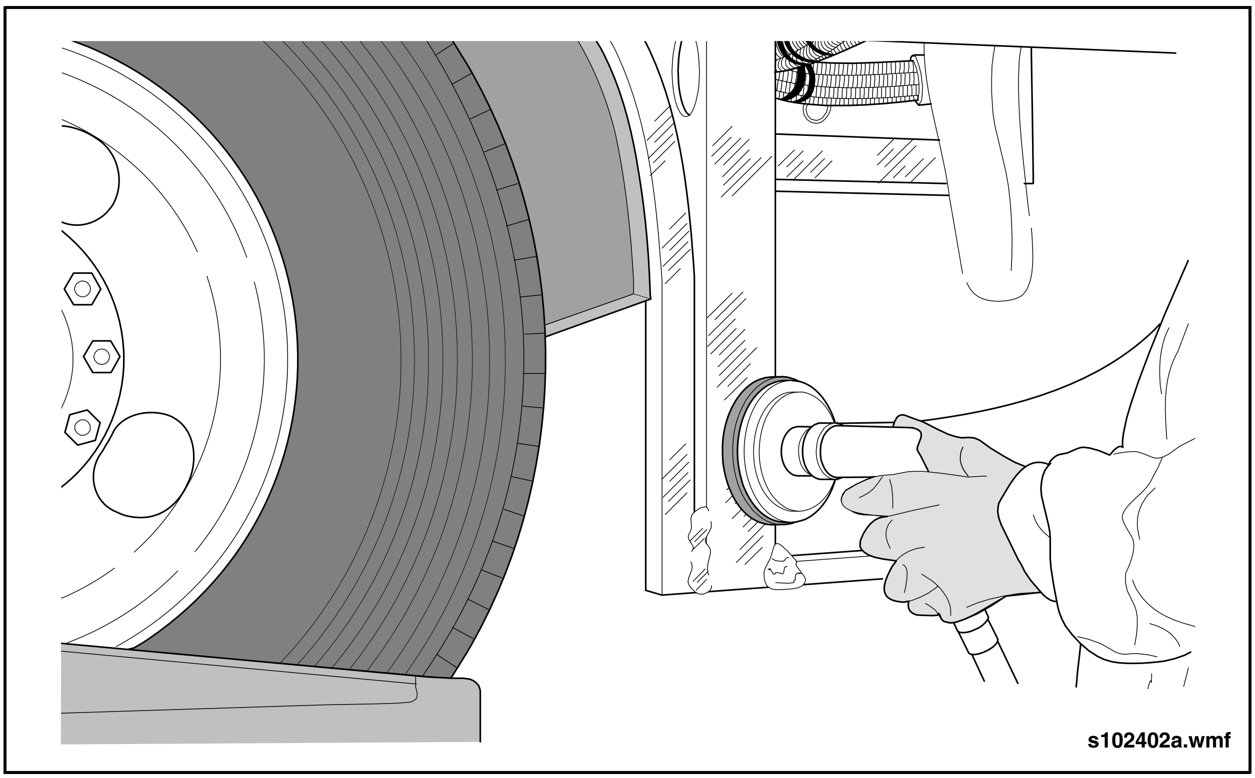


Fig. 11-2: Surface Cleanup

3.3. Primer Application

Primer is applied to all metal parts forming the structure.

WARNING

Observe all workplace safety standards and procedures. Wear chemical splash protection goggles or a face shield. Use an organic vapor respirator with a dust and mist prefilter as atmospheric conditions require. Wear chemical resistant protective clothing for skin protection such as gloves, apron, coveralls and safety footwear, as required.

WARNING

Ensure that the primer product being used is in compliance with local VOC regulations. Refer to 3.4. "Low VOC Primer Application" on page 14 **in this section for alternative low VOC primer and application procedures.**

1. Work in a properly ventilated area with an exhaust and intake system that will safely and efficiently remove fumes and supply fresh air.
2. Prepare the primer: 1 gallon 63P1500 primer base to 29 lbs 347YB1500 zinc dust. Pour the zinc dust into the primer slowly with constant agitation. When finished, filter the prepared primer through a 40 micron mesh screen into the applicator reservoir.

☞NOTE:

Do not apply primer if the ambient temperature is below 35°F or above 110°F. Ensure the substrate is at least 5°F above the dew point and that the relative humidity is less than 90%.

3. Apply primer using a brush or appropriate spraying equipment. Wet film thickness should be 6.5 mils. This will result in a dry film of 3.0 to 4.0 mils. Film thickness is important to ensure adhesion and corrosion protection. See "Fig. 11-3: Primer Application" on page 14.

☞NOTE:

Air mix spray gun must maintain an air atomization pressure of 60 lb., with a fluid pressure set at 1,000 psi. Airless spray gun operates at a fluid pressure of 2,000 to 4,000 psi. Primer may be mixed with up to 10% thinner when using an air mix sprayer or up to 5% when using an airless sprayer.

4. Ensure all surfaces are properly coated and allow a minimum of 4 hours curing time.

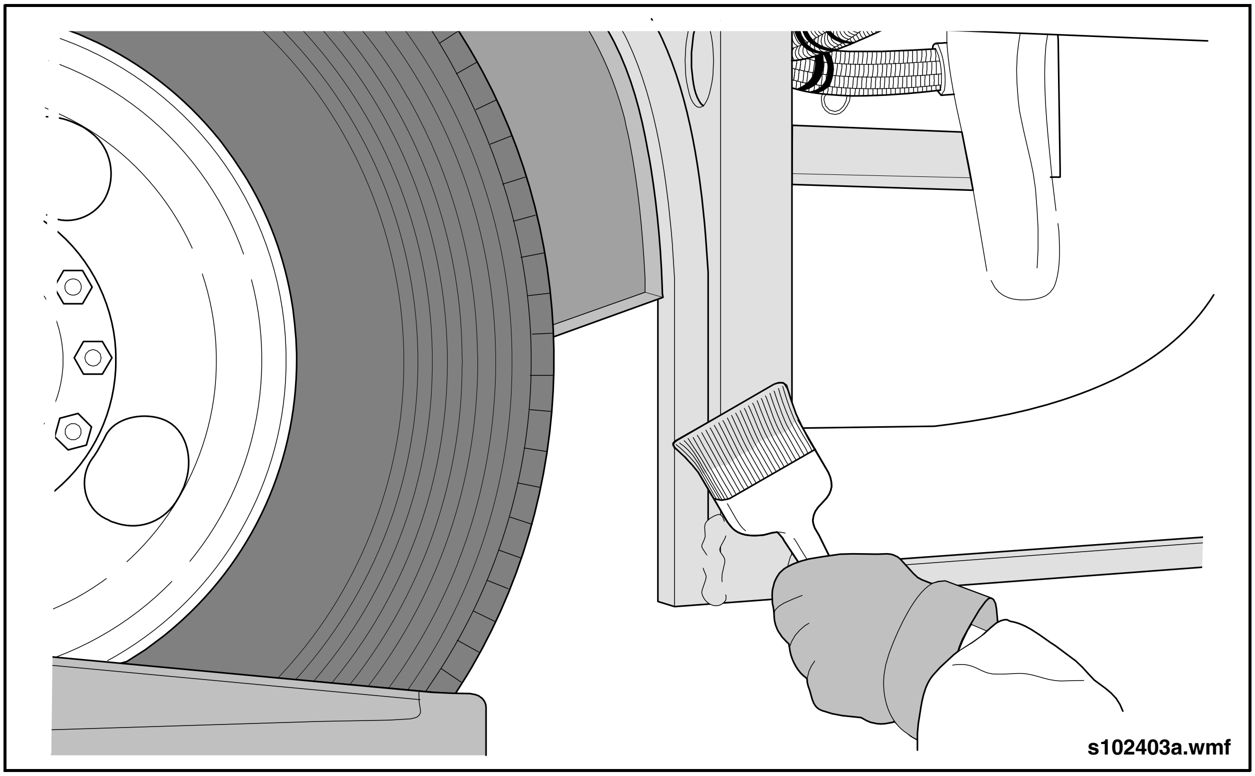


Fig. 11-3: Primer Application

3.4. Low VOC Primer Application

3.4.1. Description

The following product and procedure applies in situations where local VOC regulations will not permit the use of the standard Ganicin™ structure primer. The following product is available from Axalta Coatings and is an acceptable low VOC alternative:

- ❒ Corlar™ 2.1 ST™ - Satin High Solids Epoxy Mastic: a high performance direct-to-metal (DTM) coating or topcoat.

WARNING

Observe all workplace safety standards and procedures. Wear chemical splash protection goggles or a face shield. Use an organic vapor respirator with a dust and mist prefilter as atmospheric conditions require. Wear chemical resistant protective clothing for skin protection such as gloves, apron, coveralls and safety footwear, as required.

3.4.2. Mixing

3.4.2.1. Components

- ❒ Corlar 2.1 ST Base:
  - ❒ 1LB25P - light base (124 oz/gal)
  - ❒ 2MB25P - medium base (120 oz/gal)
  - ❒ 3DB25P - deep base (116 oz/gal)
  - ❒ 4NB25P - neutral base (112 oz/gal)
- ❒ Corlar VF-525 Activator

3.4.2.2. Mix Ratio

Mix Corlar 2.1 ST Base and Corlar VF-525 Activator 1:1 part by volume.

3.4.2.3. Activation

1. Using a shear mixer at low speed so to create a small vortex, mix the base.
2. Using the same procedure, mix the activator.
3. Slowly add 1 part Corlar VF-525 activator to 1 part Corlar 2.1 ST base.

4. Mix thoroughly; DO NOT shake.

☞**NOTE:**

There is no induction time required - painting may begin immediately.

3.4.2.4. Reduction

- ❐ Airless Spray - reduce 2-5% by volume with Y-32035 thinner.
- ❐ Conventional Spray - reduce 7-10% by volume with Y-32035 thinner.
- ❐ Maximum Pot Life - reduce 15% by volume with Y-32035 or RT001P thinner.
- ❐ Hot Windy Conditions - reduce 10-15% by volume with T-8054 thinner when using conventional spray method.
- ❐ Brush or Roller Application - reduce 10-15% by volume with RT001P thinner.

⚠ **WARNING**

In order to maintain compliance with 2.08 lbs/gal VOC regulations, proper reduction and reducer product must be used. DO NOT substitute with other thinners.

- ❐ VOC Restricted Areas - reduce 10% by volume by adding T-1025 thinner and constantly mixing.

☞**NOTE:**

Reduction by 15% will result in reduced maximum film thickness.

3.4.2.5. Pot Life

Pot life is 8 hours @ 70°F (21°C) when reduced 15% by volume with Y-32035 or RT001P thinner.

3.4.3. Application

⚠ **WARNING**

Work in a properly ventilated area with an exhaust and intake system that will safely and efficiently remove fumes and supply fresh air.

3.4.3.1. Surface Preparation

The following processes, in order of preference, can be used to prepare the steel surface for primer application:

- ❐ Commercial blast cleaning in accordance with SSPC standard SP6.
- ❐ Power tool clean in accordance with SSPC standard SP 3.
- ❐ Hand tool clean in accordance with SSPC standard SP 2.

3.4.3.2. Application Conditions

Do not apply if material, substrate, or ambient temperature is below 35°F (2°C) or above 100°F (38°C). For intermittent service temperatures above 250°F (121°C), do not topcoat.

3.4.3.3. Roll Application

Use Wooster Pro/Doo-Z, or equivalent, roller with 1/2” to 3/4” nap. Keep roll wet. Roll in one direction, rewet, then cross-roll.

3.4.3.4. Brush Application

Use Wooster China bristle 3” to 4” brush or equivalent.

3.4.3.5. Spray Application

☞**NOTE:**

Use the manufacturers listed below as a guide. Others may be used. Changes to tip size or pressure may be required to achieve proper application.

CONVENTIONAL SPRAY			
	Binks	**DeVilbiss**	**SATA**
Spray Gun	2001	JGA	K3RP
Fluid Nozzle	67SS	D (2.2)	1.1
Pot Pressure			25
Atomizing Pressure			36
Air Cap	67PB	64 HD	

HVLP SPRAY		
	Binks	**DeVilbiss**
Spray Gun	Mach 1	GTi
Fluid Nozzle	905 (2.3)	2.0
Air Cap	905P	2000

AIRLESS SPRAY	
Pump	Graco Extreme 33:1
Airless Gun	Graco 207945
Fluid Hose	3/8” x 50’ max.
Tips	414-527
Minimum Pressure to avoid fingering	2400 psi. min.

3.4.3.6. Application Notes

- ❐ If using D fluid nozzle, minimize reduction to avoid runs and sags.
- ❐ When applying over inorganic zinc primers, a mist coat is recommended for best results to minimize bubbling. Apply a mist coat and allow bubbles to break. Apply a full wet coat after mist coat.
- ❐ Under certain high humidity and low temperature conditions, an amine blush is possible. This blush should be removed before proceeding with next coat by wiping surface with an alcohol-base solvent.
- ❐ Epoxies chalk with extended exposure to sunlight. Lack of ventilation, incomplete mixing, mis-catalyzation or the use of heaters that emit carbon dioxide and carbon monoxide during application and initial stages of curing may cause yellowing to occur.

3.4.3.7. Re-Coat

Recoating of Corlar 2.1 ST should be done as soon as possible after dry to touch, a minimum of 3-5 hours at 70°F (21°C), up to overnight.

If you cannot recoat within 7 days up to 30 days, and you have not exposed the Corlar 2.1 ST to strong exterior sunlight and elevated temperatures over 100°F (38°C), you should water wash with a minimum of 1500 psi to remove any surface contamination.

If you cannot recoat before 30 days and have exposed the Corlar 2.1 ST surfaces to strong exterior sunlight and elevated temperatures over 100°F (38°C), you should either:

- ❐ Option 1 - Water wash the surface with a minimum of 1500 psi and apply 1-2 mils DFT tack-mist coat Corlar 2.1 ST over the existing Corlar 2.1 ST painted surface and topcoat within 3-5 hours up to overnight.
- ❐ Option 2 - Water wash the surface with a minimum of 1500 psi and abrasively brush-blast in accordance with SSPC standard SP7 (sweep blast) and topcoat within 3-5 hours up to overnight.

3.4.3.8. Clean-Up Thinners

Use T-8054 or MEK.

3.4.4. Dry Times

Cure times shown below are at recommended thickness of 5 mils DFT and 50% relative humidity.

DRY TIMES			
	50°F (10°C)	70°F (21°C)	90°F (32°C)
To Touch	3-4 hours	2-3 hours	1-2 hours
To Handle	8 hours	4 hours	2 hours
To Recoat	5 hours	3 hours	2 hours
Full Cure	14 days	7 days	4 days

3.5. Underbody Coating Application

Underbody coating is factory applied to all the under chassis areas exposed to road spray.

☞NOTE:

DO NOT apply underbody coating to the following components: axles, bellows, suspension beams, radius rods, steering box, leveling valves, brake valves, safety valves, drain cocks, and the air dryer.

1. Do not apply the underbody coating if the material, substrate, or ambient temperature is less than 50°F, or above 95°F
2. Stir the underbody coating before applying.
3. Spray repair areas with a wet film thickness of 20 mils while maintaining a spray distance of 12 to 15" (30 to 38 cm). Dry film thickness to be 10 mils minimum. See “Fig. 11-4: Underbody Application” on page 18.
4. If underbody coating will not adhere properly, wash area with appropriate solvent and allow to dry for 5 to 10 minutes. Repeat spraying process and allow underbody coating to set for a minimum of 10 minutes.

☞NOTE:

DO NOT allow freezing of the repaired area for a minimum of 24 hours.

5. Allow adequate air flow to ensure even drying. Material should be dry to touch in 30 to 60 minutes, dry hard in 24 hours and fully cured in 72 hours.

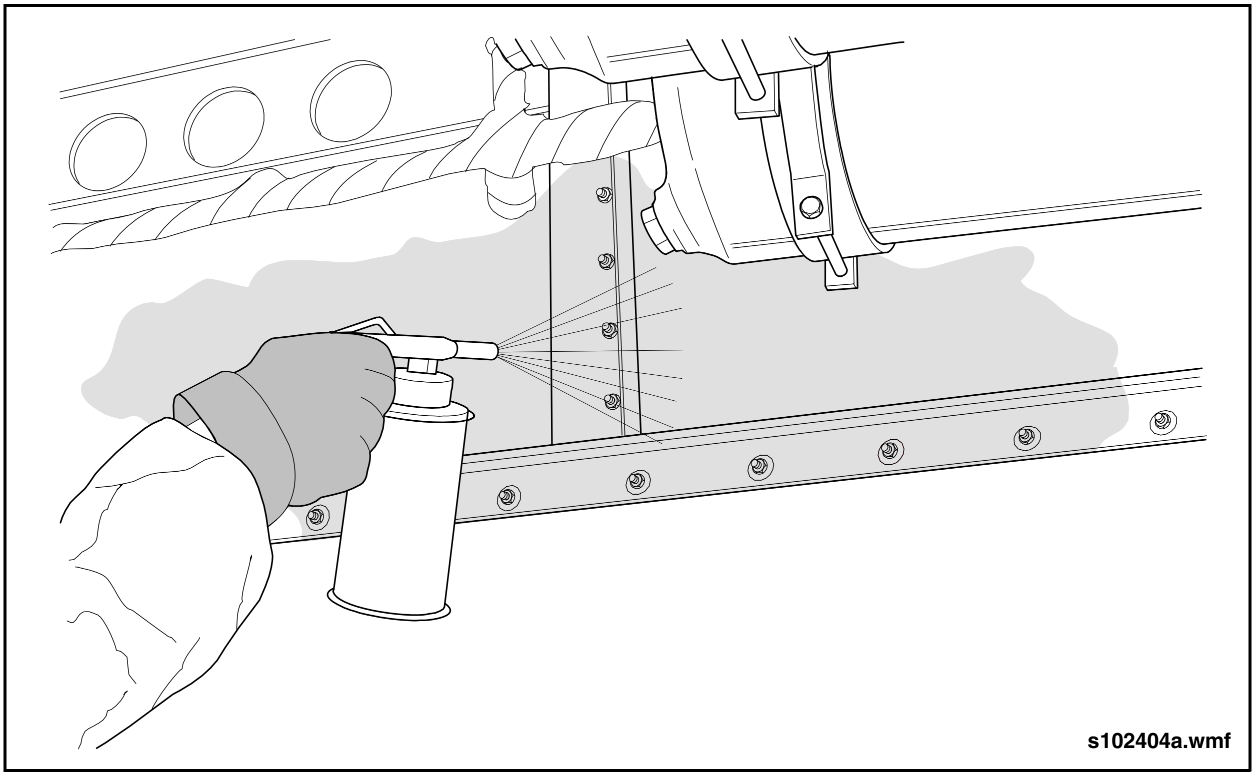


Fig. 11-4: Underbody Application

3.6. Interior Tubing Coating

Any tubing that is being replaced must be internally coated with Interior Tube Coating.

1. Insert spray nozzle into tube through 1/2" hole previously drilled and spray sufficient compound to fully coat the internal faces of the tubing. See “Fig. 11-5: Interior Tube Application” on page 19.
2. Remove spray nozzle and install sealing plugs.

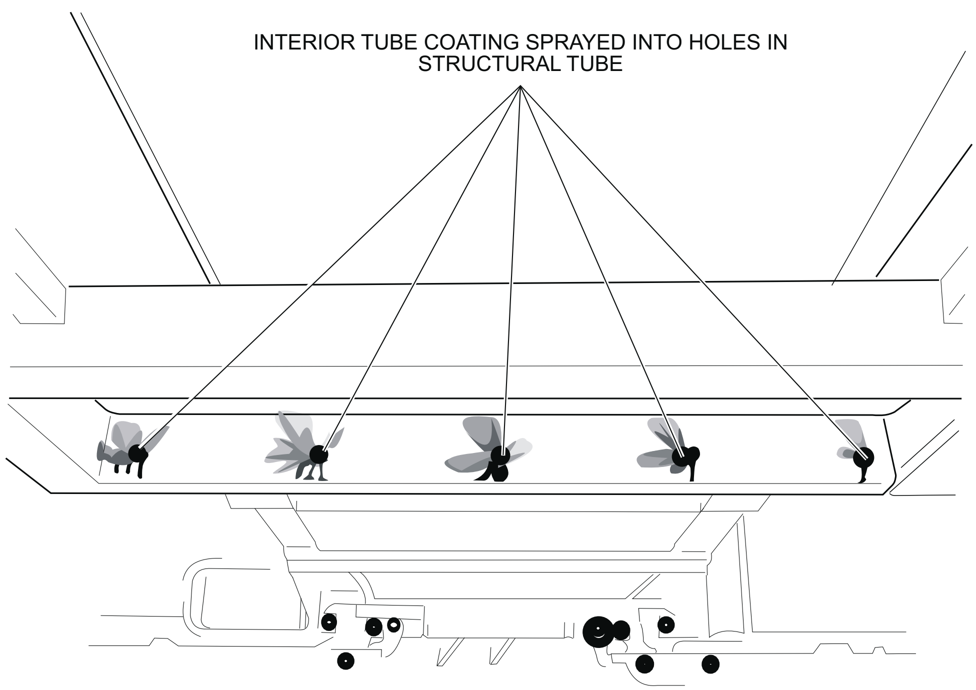


Fig. 11-5: Interior Tube Application

3.7. Corrosion Warranty Inspection

☞**NOTE:**

New Flyer Industries requires that the inspection, maintenance and record keeping requirements covered in this document be performed. Failure to perform these procedures may void the corrosion warranty on affected units.

3.7.1. Frequency of Inspection

The maximum benefit from the corrosion protection of your vehicle can only be achieved with proper care and maintenance. No protection that can be applied to a vehicle can totally protect the vehicle from all the damage to which it may be subjected. Damage from stones, gravel and other vehicles can remove the coatings and leave the metal open to the elements. The most effective method available that can come close to preventing corrosion is an inspection policy and consistent maintenance of the coatings.

The vehicle under body must be fully inspected and cleaned as outlined in this document every three (3) years. Failure to inspect and keep accurate records of these inspections will result in the warranty of the coating system being voided. Please be advised that any curbing or other incidents that may have removed the corrosion protection coating must be repaired within 1 month of incident.

3.7.2. Inspection Procedure

The areas to inspect on a constant basis are areas of high physical wear and high air movement. The area with high impact are areas like behind the wheel wells and structural members that face the front of the vehicle. These areas will face the full impact of road debris, as in stones, and face the most paint erosion.

Areas of high air movement, like intake vents and air conditioning units must be inspected as well. These areas tend to collect dust and dirt that can hold moisture and promote erosion and corrosion in all types of parts.

The following areas are to be inspected. Refer to 3.7.1. “Frequency of Inspection” on page 20 in this section for stated frequency. Prior to the inspection the vehicle should be raised and a preliminary inspection should be given to the under body to find the areas of road debris build-up. These areas should be paid extra attention due to the fact that this debris can hold moisture and promote corrosion.

3.7.2.1. Under Body Inspection

1. Perform preliminary inspection for dirt/sand built-up.
2. Clean any excess dirt/sand using a stream of high pressure water with a weak detergent. Ensure the entire structure is cleaned thoroughly including the top surfaces of structural tubes, gusset faces, lap joints and interior corners where structural members are welded at an angle.
3. Start at the front of the vehicle. The area between the front bumper and the front axle will show the minimum amount of erosion/corrosion from water and road debris.
4. Front wheel wells should be looked at next. Bare fiberglass at wheel wells means that the vehicle has been in a high erosion area (for example gravel roads).
5. The area from the front wheel wells to the rear bumper should be examined for areas of missing primer or underbody coating. Structural members that face the direction of travel will experience the worst erosion from road debris being brought up from the tires.
6. Inspect suspension bunks for paint erosion.
7. Inspect the main structural rails above the rear axles. Check at the structural lap joints for loose adhesive. Clean any collected dirt and look for peeling primer and eroded undercoating. Lap joints are areas where crevice and pitting can have the most detrimental affect.
8. Inspect the top of the tubes located at the bottom of the side panels for dirt and moisture. Check for corrosion and paint peeling.
9. Ensure all drain holes are clean and not plugged.
10. Check all lap joints. Any lap joint with missing sealant must be cleaned with high pressure water and sealed with a urethane caulking as per the repair manual.

☞**NOTE:**

Any holes, caused by accidents, in side panels, pier panels or roof panels should be filled to prevent water from entering into and sitting behind the paneling. This moisture can be held next to structural tubing and promote high levels of corrosion if allowed to remain.

3.7.2.2. Rear HVAC Area

Inspect this area for accumulation of water, dirt or other debris. Refer to the Preventive Maintenance Section of this manual for inspection frequency. Also refer to the OEM Maintenance Manual for related inspection requirements.

1. Open the rear HVAC access door.
2. Examine the rear shelf area where the unit sits for dirt, sand or other material that may hold moisture. The rear shelf, should have any debris removed during every inspection; however, this area should also be blown dry to prevent moisture from sitting on the surface.
3. Inspect the rear shelf area for surface corrosion. Treat affected areas as follows:
    a. Clean and treat surfaces to remove rust.
    b. Blast, sand, or abrade surface to bare metal. Refer to 3.2. “Corrosion Treatment” on page 10 in this section for procedure.
    c. Apply Zinc primer to a minimum thickness of 8 mils wet or 3 mils dry. Refer to 3.3. “Primer Application” on page 13 in this section for procedure.
4. Inspect and clean the unit drip pan as follows:
    a. Remove any accumulation of water, dirt, or debris.
    b. Inspect drain hose, drain spout and connections.
    c. Inspect the drip pan edges to ensure they are properly sealed. Apply Sika-221 adhesive to fill any voids.
5. The top intake grill should be taken off and the coils should be looked at for accumulation of dirt and sand.
6. Inspect and clean the unit drip pan to remove any accumulation of water, dirt, or debris. All hoses and drain spouts should be cleaned.
7. Inspect the outlet louvers on the rear access door and clean as necessary.

3.7.3. Repairs for Undercoated Areas

1. Any scratches, gouges or cracks found in the underbody coating that reached the primer or steel underneath must be repaired by first thoroughly grinding the area to remove any contamination and rust. All bare metal surfaces must be primed with Ganicin™ (available from the New Flyer Parts Division). If the underbody coating has been penetrated but the under lying primer is still intact, no repairs are necessary.
2. Any adhesive missing from lap joints should be replaced by thoroughly cleaning the area of dirt and grease, and applying the urethane adhesive.
3. The Tufcote™ UC-1006™ undercoating can then be applied to the required thickness. Tufcote™ UC-1006™ is available from the New Flyer Parts Division.

3.7.4. Repairs for Non-Undercoated Areas

1. Any area which does not have the underbody coating must be repaired by grinding the area and the 1/4" around the damaged area. The bare metal must be primed with Ganicin™.
2. Tufcote™ UC-1006™ must be applied to the determined thickness. This product is available from the New Flyer Parts Division.

3.7.4.1. Areas of Structure Hidden by Paneling

New Flyer does not expect maintenance personnel to inspect the structure underneath paneling, during the above process. Nevertheless, if the customer must replace a panel for any reason they must take the time to inspect the structure for dust or dirt that may have accumulated. Any dirt should be cleaned and the area dried out at this time and the structure examined for corrosion. Any corrosion or loose primer should be repaired before paneling is replaced. Any tubing replaced due to accident damage must have its interior walls under coated with Tufcote™ UC-7101™ available from the New Flyer Parts Division.

3.7.5. Record Keeping

The warranty states that all inspections and repairs must be documented and kept on file for the life of the warranty. The following is the minimum of what should be recorded:

1. The Vehicle Serial Number.
2. The date of the last repair/inspection.
3. The reason for the inspection and/or reason for the vehicle being in the shop.
4. What was found and what was done to repair the vehicle. This includes if it was surface corrosion or if there was a perforation of the structure. Include a photograph of the affected area if possible.
5. The name of the inspector.
6. The name of the worker doing the repair.
7. Was a New Flyer service representative called? If so, who?

   If you are unsure which products were used on your vehicle order, please contact the New Flyer Customer Services Dept.

Interior Panels & Applied Parts

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- open flame
- excessive heat
- production of sparks
- production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Cleaning Chemicals Safety

⚠ WARNING

Because fumes are more dangerous in a small space, be sure the vehicle is well ventilated while using any cleaning agent. Follow the manufacturer's instructions in using such products. Many cleaners may be poisonous or flammable, and their improper use may cause personal injury or damage to the inside of the vehicle. Therefore, when cleaning the interior, DO NOT use volatile cleaning solvents such as: acetone, lacquer thinners, enamel reducers, nail polish removers; or such cleaning materials as laundry soaps, bleaches, or reducing agents (except as noted for fabric cleaning of stains). NEVER use carbon cleaning products.

⚠ CAUTION

To avoid possible permanent discoloration on light colored trim, DO NOT let materials with unstable dyes come in contact with seat trim materials until totally dry. Proper cleaning techniques and cleaners must be used on trim materials. Failure to do this on the first cleaning may result in water spots, spot rings, setting of stains, or soilage, all of which make it more difficult to remove in a second cleaning.

1.4. Adhesives Safety

⚠ WARNING

Overexposure to adhesives used on this vehicle, specifically Sikaflex-252, may cause breathing difficulties, sensitization, headaches, nausea, vomiting. May aggravate respiratory, skin, eye, lung problems and allergies. If the product is applied according to the manufacturer's directions, none of these symptoms should be encountered. A person who is allergic to isocyanate may have a reaction with a level of isocyanate well below the T.L.V. Xylene is a central nervous system depressor and in rare cases, may cause a sensitization of the heart muscle causing arrhythmia.

Ensure the user is provided with a full face mask or safety glasses, a rubber apron, sufficient ventilation, and an eyewash station or shower. In case of overexposure, remove contaminated clothing and shoes, wash with plenty of water, wash clothing before rewearing, and consult a physician. If eyes are exposed, rinse immediately for several minutes. See a physician immediately. In case of inhalation, evacuate to fresh air and consult a physician. In case of ingestion, drink plenty of water or milk. DO NOT induce vomiting. See a physician immediately.

1.5. Insulation Foam Safety

WARNING

Insulation foam is installed in the spaces of the frame tubing, between the vehicle inner and outer wall panels. The Insulation Foam is extremely combustible. KEEP OPEN FLAMES AND FLAME SOURCES AWAY FROM THE INSULATION FOAM!

Before performing any work or repairs requiring use of an open flame such as: welding, brazing, acetylene torch cutting or grinding, ensure that the insulation foam is either removed from the area being repaired, or is properly shielded from the open flame.

2. INTERIOR PANELS

2.1. Description

Interior panels include the following:

- ❒ Front Dash Panels
- ❒ Sidewall Panels
- ❒ Pier Panels
- ❒ Rear Panels
- ❒ Ceiling Panels

2.2. Cleaning

CAUTION

DO NOT spray or brush liquid cleaning solutions onto the dash panels or any other areas that may have electrical components behind the surface or nearby. ALWAYS use a cloth dampened with cleaning solution to clean these areas.

The acrylic/PVC panels used in the interior of the vehicle have excellent stain and soilage resistance. If a surface does become stained, the best procedure is to first clean the surface with a household concentration of detergent and water or an ammoniated type household cleaner. Alcohol solutions such as automobile windshield washer solvents can also be used. The use of a short, fine, stiff-bristled brush and vigorous scrubbing strokes will give the best results in removing most stains.

If the stain cannot be removed using standard cleaning methods, immerse a stiff bristled brush in ethyl cellosolve or perchloroethylene. These solvents are suitable for removing stains such as felt-tip markers, wax crayons and lipstick.

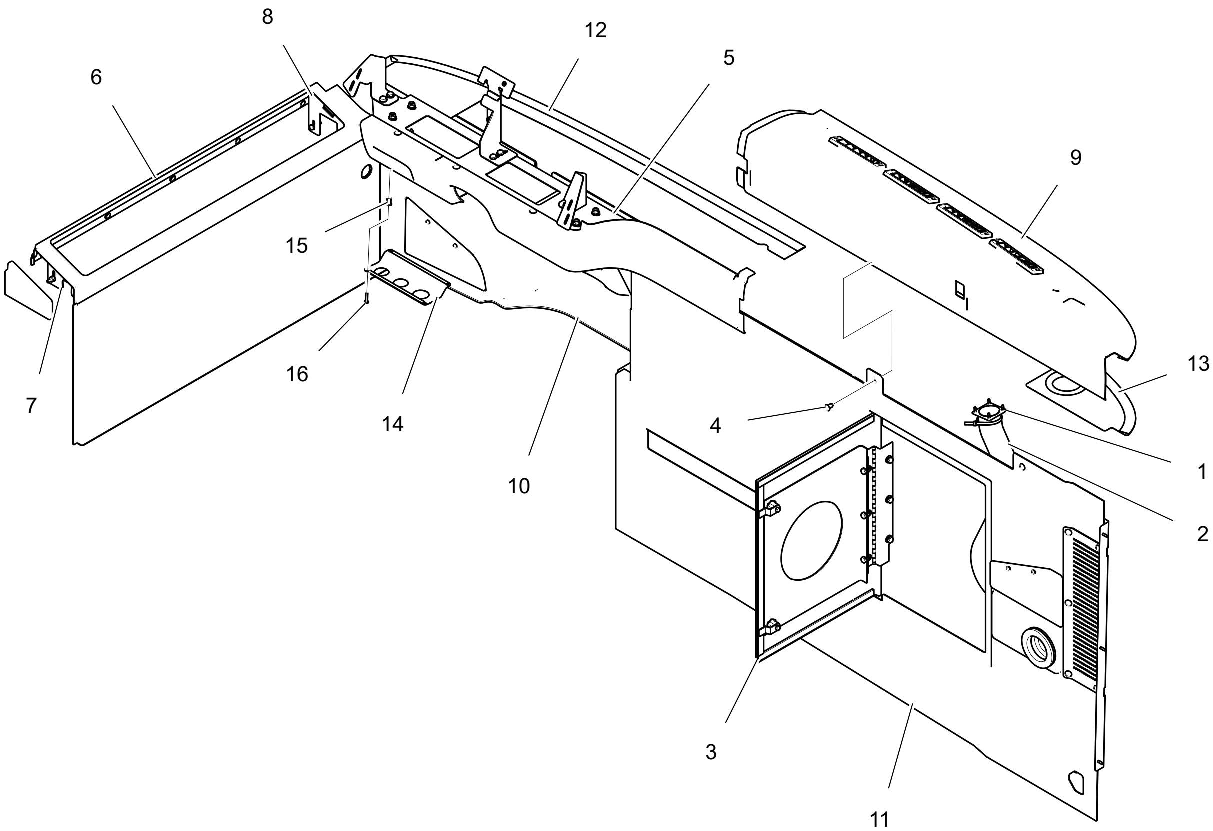
2.3. Interior Panel Replacement

The panels used within the interior of the vehicle are assembled with a combination of adhesives, structural tape, screws, rivets, push-in fasteners, and snap-in moldings. Procedures specific to each panel must be followed in order to guarantee a satisfactory installation. Detailed instructions including cleaning, priming, bonding, and attachment procedures are provide in New Flyer engineering installation drawings. Please contact New Flyer Customer Service for detailed installation procedures (engineering installation drawings) and material requirements for the specific panel being replaced. Refer to panel replacement in this section for a basic description of how the panels are attached to the vehicle.

2.4. Front Dash Panels

2.4.1. Description

The front dash panels include the upper & lower RH dash panels, upper LH dash panel, LH kick panel, side console panel assembly, and associated closeout panels. These panels are constructed of 0.118" thick Kydex thermoplastic acrylic/PVC formed sheets. See “Fig. 12-1: Dash Panels Installation” on page 4.



1. Adapter, 2" Dia.
2. Air Hose
3. Door Assembly, Dash Panel Access
4. Clip, Push In
5. Frame Assembly, Instrument Panel
6. Enclosure Assembly, Side Console
7. Bracket, Side Console LH
8. Bracket, Side Console RH
9. Panel Assembly, Upper Dash RH
10. Panel Assembly, Kick Lower
11. Panel Assembly, Lower Dash RH
12. Panel, Closeout Dash LH
13. Panel, Closeout Dash RH
14. Cover, Dash Access
15. Nut, Jack
16. Screw

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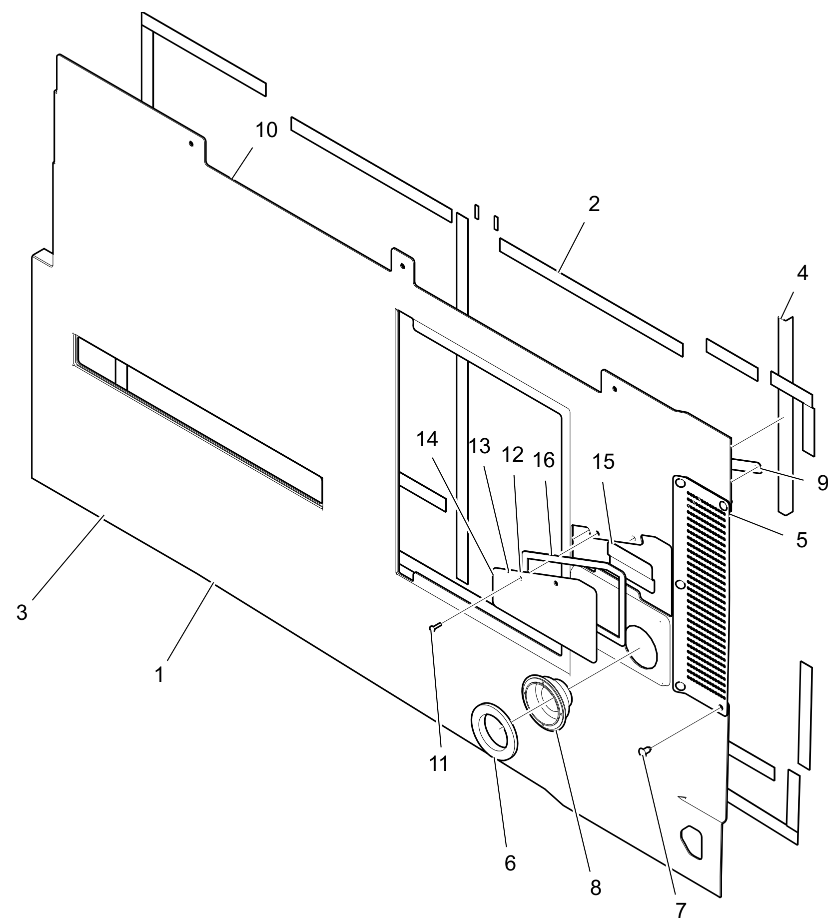
Fig. 12-1: Dash Panels Installation

2.4.2. Lower RH Dash Panel Replacement

The lower RH dash panel covers the lower dash area from the entrance door to the driver's platform. The panel is attached to the vehicle structure using double-sided tape and push-in clips. See "Fig. 12-2: Lower RH Dash Panel Installation" on page 5.



1. Panel Assembly, Lower Dash RH (Incl. 2...16)
2. Tape, Double Sided
3. Plate, Lower RH Dash
4. Plate, Striker
5. Panel Assembly, Headlamp
6. Louver
7. Clip, Push In
8. Adapter, 2" Dia.
9. Plate, Headlamp Access Cover
10. Adhesive, Plexus MA920
11. Screw, PH Cross Recess Tpg. Type F #10 - 24 UNC x 3/4" Lg.
12. Headlamp Access Cover Assembly, (Incl. 13...16)
13. Adhesive, Plexus MA920
14. Template, Headlamp Access Cover
15. Bracket
16. Seal, Rubatex 0.5" W x 0.06" Thk.

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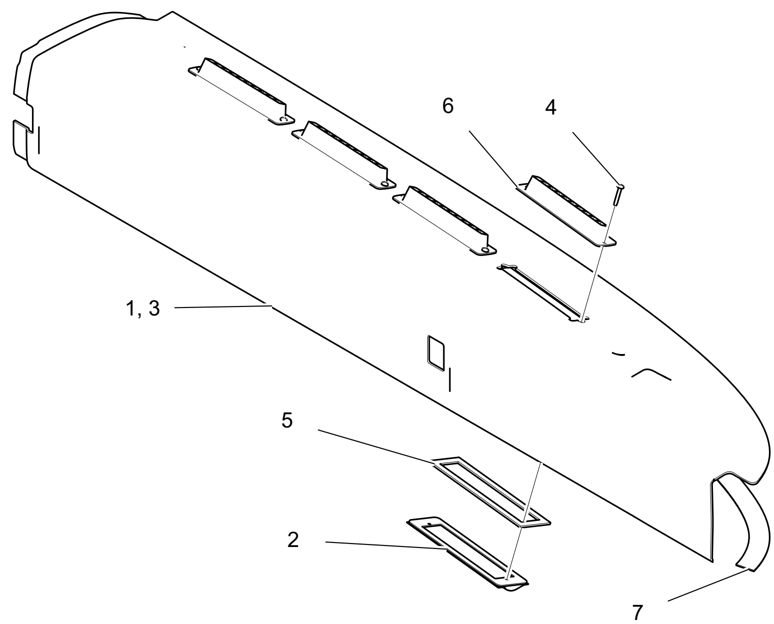
Fig. 12-2: Lower RH Dash Panel Installation

2.4.3. Upper RH Dash Panel Replacement

The upper RH dash panel is located immediately above the lower RH dash panel and includes the defroster outlet ducts. The panel is attached to the vehicle structure using Velcro tape. See "Fig. 12-3: Upper RH Dash Panel Installation" on page 6. .



1. Panel Assembly, Upper Dash RH (Incl. 2...7)
2. Screen, Defroster Duct
3. Panel, Upper Dash
4. Screw, OH Tpg. Type F #8 - 32 UNC x 1" Lg. Black
5. Seal, Rubatex 0.125" Thk. x 0.38" W
6. Air Deflector
7. Velcro, Tape 25mm Black Loom

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Fig. 12-3: Upper RH Dash Panel Installation

2.4.4. Upper LH Dash Panel Replacement

The upper LH dash panel is located below the instrument panel and is attached to the instrument panel frame base with 7 push-in clips. See "Fig. 12-4: Upper LH Dash Panel Installation" on page 7.

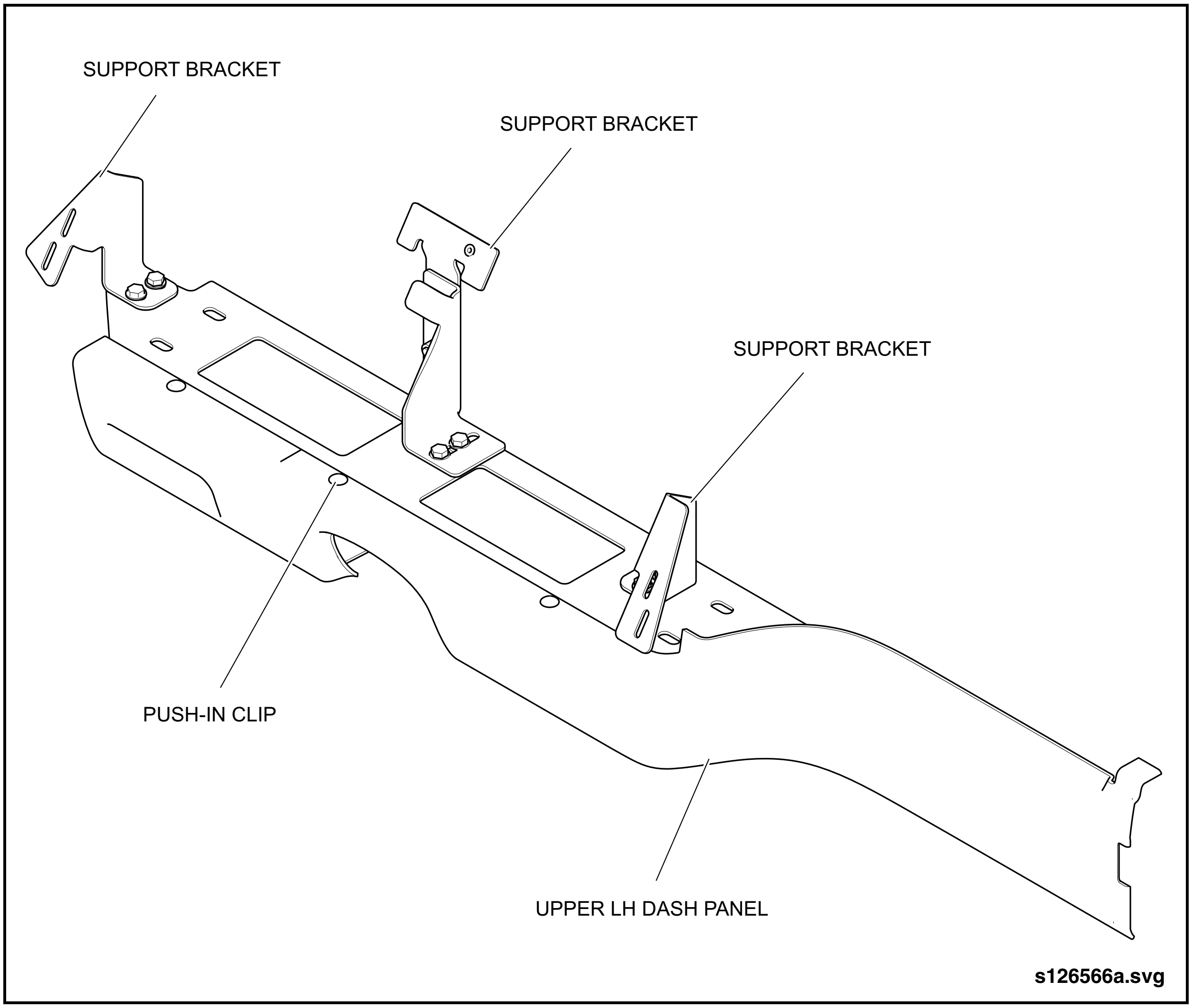
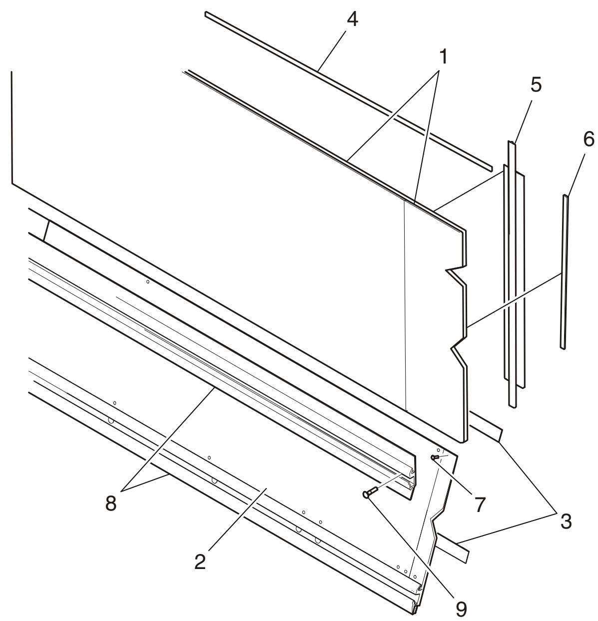


Fig. 12-4: Upper LH Dash Panel Installation

2.4.5. LH Kick Panel Replacement

The LH kick panel assembly consists of upper and lower kick plate and a driver's foot duct bonded together as a unit. The kick panel assembly is attached to the instrument panel frame base with push-in clips. See “Fig. 12-5: Side Wall & Kick Panel Assembly” on page 8.



1. Sidewall Panel
2. Kick Panel
3. Seal
4. Tape
5. Moulding
6. Foam Spacer
7. Rivet
8. Seat Track
9. Seat Rail Rivet

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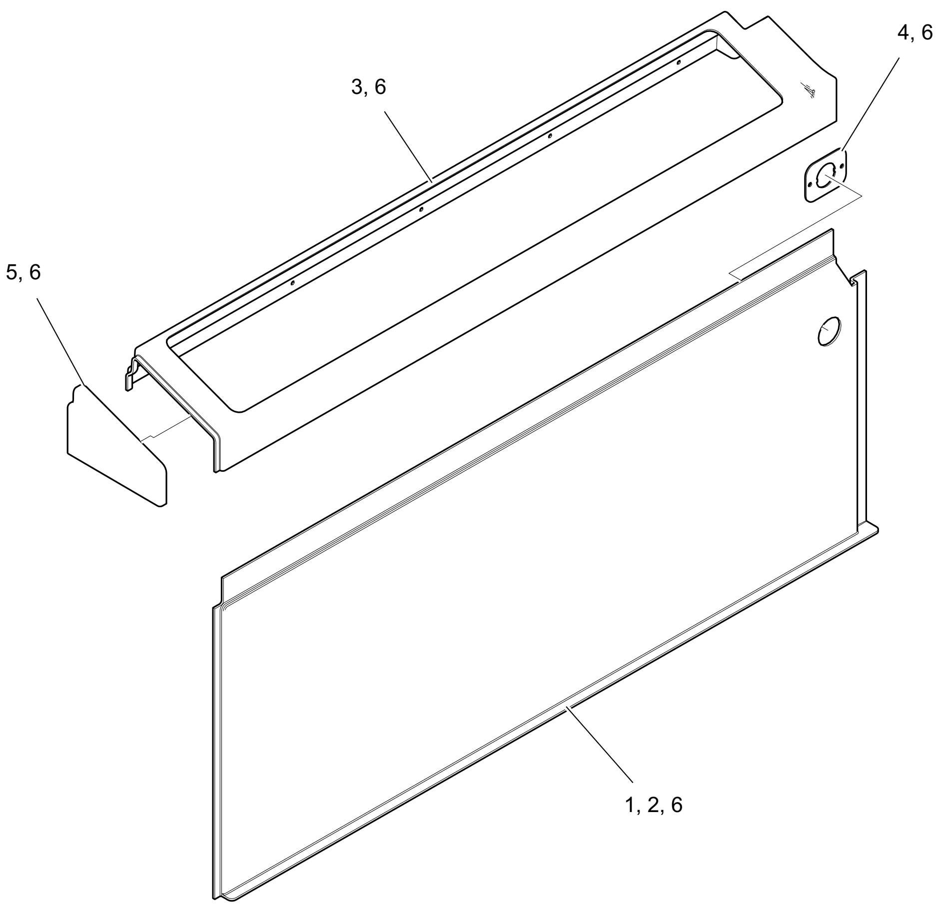
Fig. 12-5: Side Wall & Kick Panel Assembly

2.4.6. SC Panel Assembly Replacement

The side console enclosure consists of a side panel, top cover, and end covers bonded together as a unit. The top cover is fastened to the vehicle structure with 5 screws and the side panel is attached using double-sided tape. See “Fig. 12-6: Side Console Enclosure” on page 9.



1. Enclosure Assembly, Side Console (Incl. 2...5)
2. Panel, Side Console
3. Panel, Side Console Cover
4. Plate
5. Cap End, LH Console
6. Adhesive, Plexus MA920

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Fig. 12-6: Side Console Enclosure

2.5. Sidewall Panels

2.5.1. Description

The sidewall panels include the main sidewall panels, located below the windows, and the lower kick panels (gusset panels), located between the floor and the seat rail. These panels are constructed of 0.090" thick Kydex thermoplastic acrylic/PVC formed sheets. The main sidewall panels are covered with carpet. The vertical seams of the sidewall panels are covered with aluminum moldings.

2.5.2. Main Sidewall Panel Replacement

The main sidewall panels are attached to the vehicle side structure using spacer tape and Sika 221 adhesive. The lower edge of the panel seats within the channel of the seat rail.

2.5.3. Lower Kick Panel Replacement

The upper and lower edges of the kick panels are seated within the channel of the upper and lower seat rails and retained by rivets.

2.6. Pier Panels

2.6.1. Description

The pier panels are located above the sidewall panels and are used to fill the space between the windows. These panels are constructed of 0.090" thick Kydex thermoplastic acrylic/PVC formed sheets.

2.6.2. Pier Panel Installation

☞**NOTE:**

The interior pier panels are installed after the sidewall panels and the speaker panels are installed.

1. Dry-fit pier panel onto structure to confirm fit, then remove it.
2. Clean structure with Sika 205 cleaner using a lint-free cloth. Allow 30 minutes for air drying.
3. Peel off the backing and place two vertical strips of 1/8x 3/8" spacer tape onto structure. Keep the spacer tape 1" away from edges of structural members. See “Fig. 12-7: Pier Panel Installation” on page 11.
4. Apply a continuous bead of white Sika 221 adhesive to structure near edge of pier panel.
5. Install pier panel to structure within 15 minutes of applying adhesive. Press firmly with up and down motion using a cloth. The perimeter of the pier panel must be completely sealed.
6. Remove excessive adhesive with cloth and cleaner.
7. Allow 8 hours for curing at room temperature.

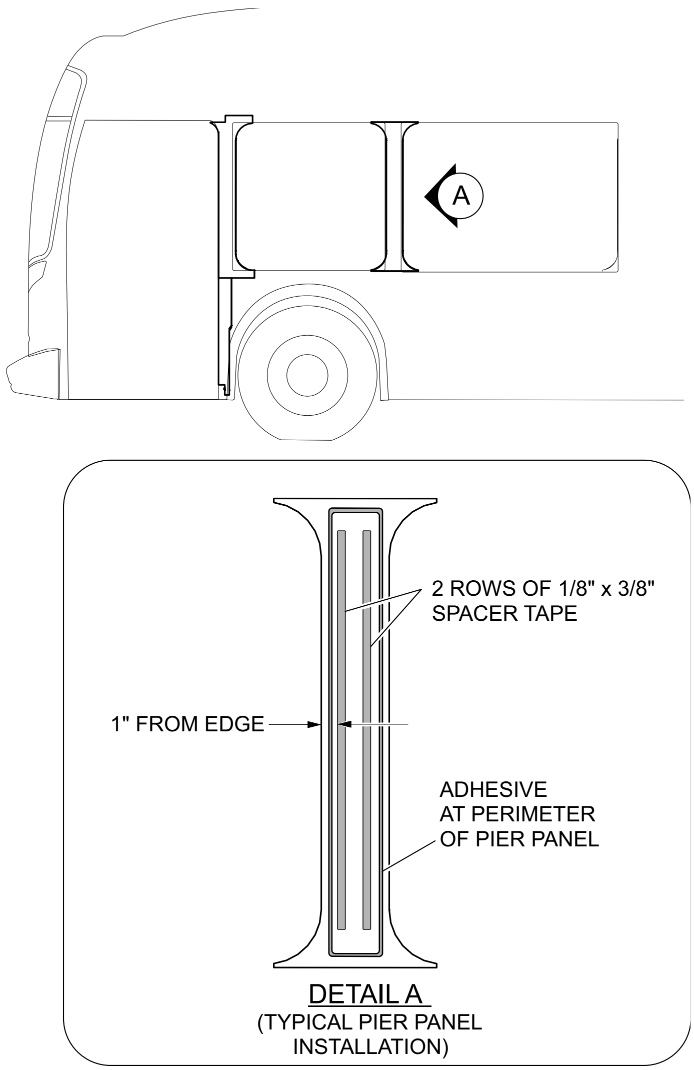


Fig. 12-7: Pier Panel Installation

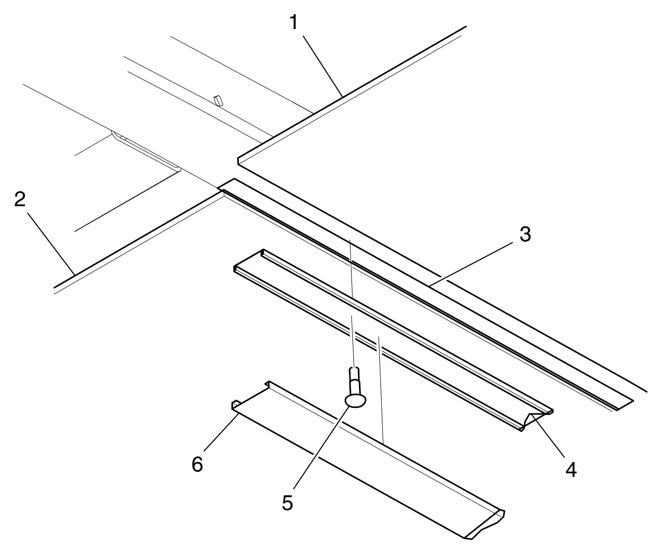
2.7. Ceiling Panels

2.7.1. Description

The ceiling panels consist of the driver's area ceiling panel, lower deck ceiling panels, and upper deck ceiling panels. These panels are constructed of 0.150" thick Kydex thermoplastic acrylic/PVC formed sheets. The seam joints are covered by stainless steel moldings.

2.7.2. Ceiling Panel Replacement

The ceiling panels are attached to the vehicle roof structure using high strength double-sided acrylic foam bonding tape. The outboard edges of the panels seat within the channel of the stanchion mounting extrusion. The inboard edges of the panels are clamped by a base molding that is riveted to the ceiling structure. A stainless steel cover molding snaps onto the base molding to cover the joint. See “Fig. 12-8: Ceiling Panel Installation” on page 12.



1. Ceiling Panel
2. Ceiling Panel
3. Tape
4. Base Moulding
5. Rivet
6. Cover Moulding

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Fig. 12-8: Ceiling Panel Installation

2.8. Rear Bulkhead Panel

2.8.1. Description

The rear bulkhead panel is located above the rear seat and extends to the ceiling and side-wall panels. The rear panel assembly consists of a melamine panel covering a plywood panel and insulation. It is fastened to the vehicle structure with Sika adhesive and screws. There are two access openings on either side of the rear panel and a large opening for the return air filter and HVAC access in the center. Refer to Section 15 of this manual for information on the return air filter and access panels. See "Fig. 12-9: Rear Panel Installation" on page 13.

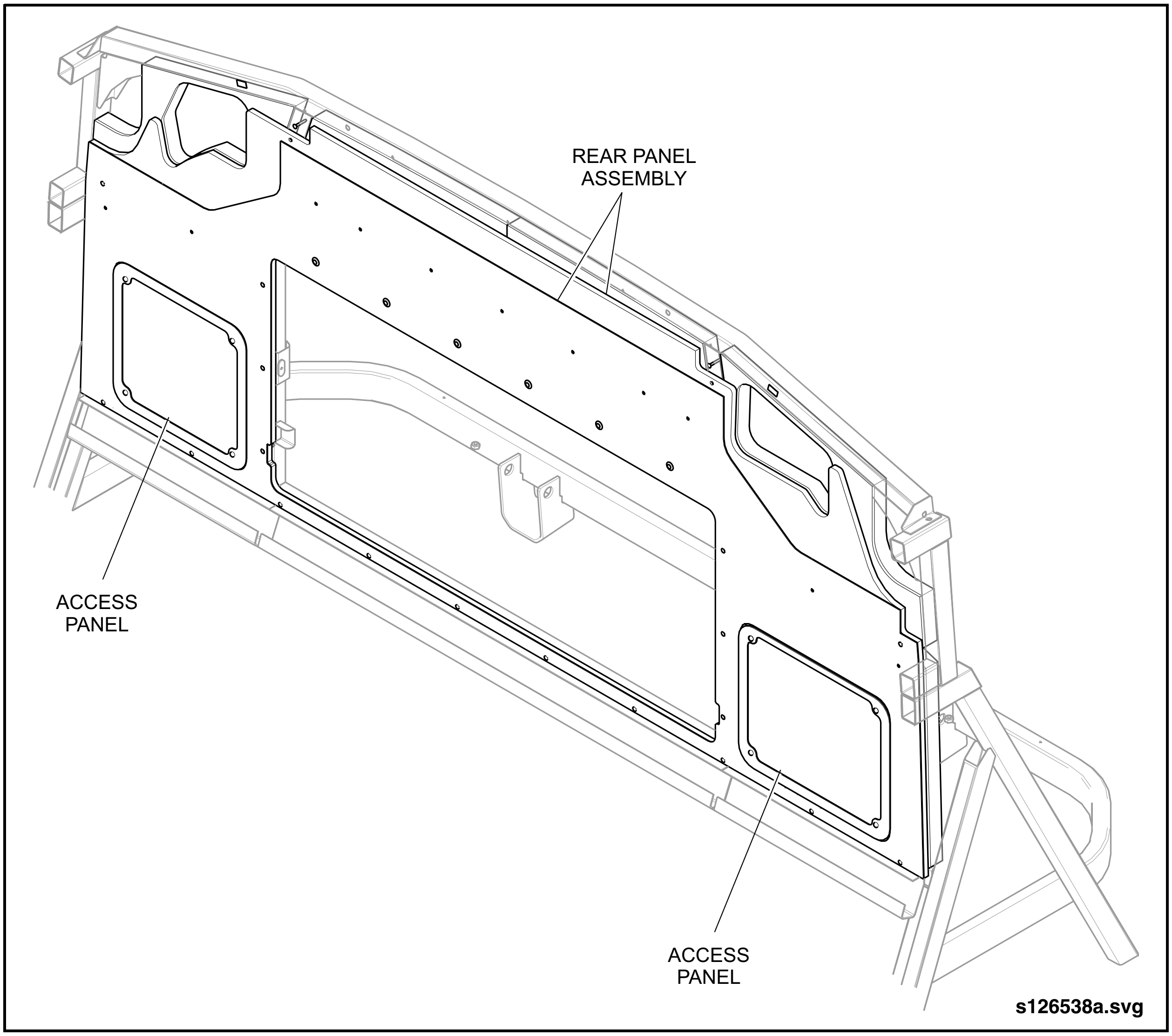


Fig. 12-9: Rear Panel Installation

2.9. Advertising Panels

2.9.1. Description

The advertising panels are concave lengths of sheet plastic, installed between the aisle lights and the ceiling of the vehicle. Mounting channels are fastened horizontally to the panels to allow for the insertion of advertising signs.

2.9.2. Removal

1. Carefully pull out the flexible joiner strips from each edge of the panel that is being removed.

   ☞**NOTE:**

   Depending on the location, it may be necessary to remove transition panels or other closeout panels before the advertising panel can be removed.

2. Start at one end of the panel and apply pressure to bow the panel inward while at the same time lifting upward to release the lower edge from the mounting channel.
3. Grip the lower edge of the exposed panel and gently twist outward. Continue to work along the length of the panel until the entire panel is released from the channel.
4. Pivot the panel upward to the horizontal position so that the lip on the panel can be lifted out of the upper mounting channel.

2.9.3. Installation

Installation is the reverse of removal.

2.10. Rivets

2.10.1. Recommended Rivet Drill Sizes

RECOMMENDED RIVET DRILL SIZE								
RIVET DIAMETER		DRILL SIZES			HOLE SIZE			
					MINIMUM		MAXIMUM	
inches	(mm)	size	inches	(mm)	inches	(mm)	inches	(mm)
3/32	2.38	#40	0.098	2.49	0.097	2.46	0.100	2.54
1/8	3.18	#30	0.129	3.26	0.129	3.28	0.132	3.35
5/32	3.97	#20	0.161	4.09	0.160	4.06	0.164	4.17
3/16	4.76	#10	0.194	4.92	0.192	4.86	0.196	4.96
1/4	6.35	F	0.257	6.53	0.256	6.50	0.261	6.63

2.10.2. Drilling Procedure

1. Use a clean, sharp, properly ground drill.
2. Center drill in the chuck so that drill will run true.
3. Hold drill perpendicular to the drilling surface.
4. To ensure proper hole alignment and to prevent burrs and chips from lodging between the panels, the parts should be tack riveted to prevent “creep” and hole misalignment during the drilling operation.

2.10.3. Installation & Selection

1. Wherever possible use a solid aluminum rivet.
2. Where it is not possible to get conventional riveting tools in place, a 3/16" stainless steel mono bolt may be used.

2.10.4. Removal

1. In thick material, drive out the rivet stem using a tapered steel drift pin. In thin material, drill the tapered portion of the stem away to destroy the lock.
2. Drill nearly through the head of the rivet using a drill the same size as the rivet shank. Break off rivet head.
3. Drive out remaining rivet shank with a pin having a diameter equal to the rivet shank.

3. FLOORING

3.1. Description

The flooring used on this vehicle consists of a sectional sub floor base with a rubberized floor covering. See “Fig. 12-10: Flooring Material” on page 16.

1. Adhesive
2. Sub Floor Base
3. Adhesive
4. Flooring
5. Sealant
6. Self Tpg. Screw

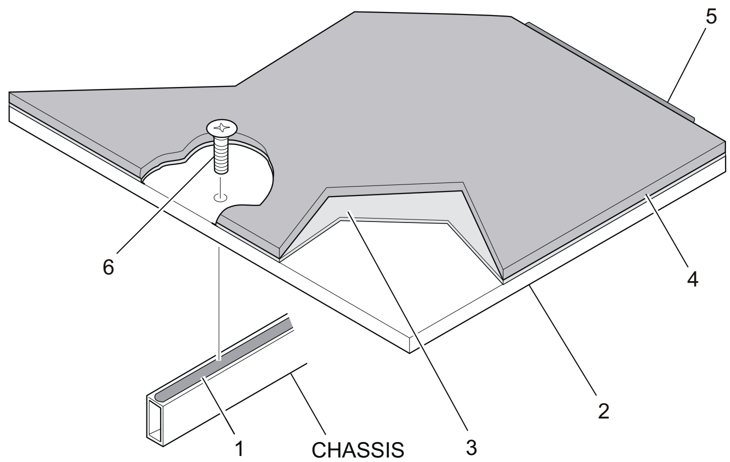


Fig. 12-10: Flooring Material

3.2. Plywood Flooring

3.2.1. Description

The plywood floor is of multi-ply construction with a hardwood face and back and is ACQ pressure treated. The plywood sheets used in the upper deck of the vehicle include a constrained layer damped panel for reduction of sound transmittance. The plywood panels are bonded to the vehicle floor structure using Sika 221 adhesive and spacer tape and are secured with self-tapping screws.

3.3. Floor Covering

3.3.1. Description

The floor covering is a multi-layer rubberized covering with a wear resistant anti-slip outer surface. The floor covering is installed in multiple pre-cut sections and is bonded to the sub flooring.

3.3.2. Flooring Specifications

Manufacturer/Model
..... Altro Plasticized Vinyl, Color Chroma

Adhesive
.......3M Fastbond Contact Adhesive 30H

Sealant.............................. Altro, Color Blue

Weld Thread .... Altro, Color Blue

3.3.3. Cleaning

Do not clean the vehicle interior with pressure spray equipment. This method of cleaning causes excessive soaking of the floor covering, floorboard separation and warping, deterioration of seams or soaking of vinyl or cloth material and possible electrical short circuits.

During the winter months, a certain amount of salt is tracked inside the vehicle by passengers. This can damage the floor covering and flooring. Frequent cleaning and keeping the area as dry as possible will help reduce salt damage. Make immediate repairs when deterioration or damage is detected.

Clean the floor as follows:

1. Sweep or vacuum floor.
2. Prepare a solution of degreasing detergent and warm water. Use a detergent with a pH level of 10 or less and dilute as recommended by manufacturer.
3. Using a mop, liberally apply detergent solution to floor surface.
4. Allow solution to work for at least 3 minutes. Do not let solution dry; apply additional detergent if required.
5. Scrub the surface to remove soil marks using a medium stiff bristled deck brush or blue or green scrubbing pad.
6. Pick up the solution using a mop or wet vacuum.
7. Rinse flooring with a mop, using clean cool water to remove detergent. Change water often to ensure it remains clean.

☞**NOTE:**

For tough stains apply warm water and an oxygen-based bleach onto stain. Let it stand for 3 minutes. Scrub with scrubbing pad or brush. Rinse with clean cool water and let dry. ALWAYS test a small area first before proceeding.

3.3.4. Repair

Damaged floor covering can be repaired by cutting out the localized area of damage and patching with a new piece of floor covering cut to size. Refer to following removal and installation instructions.l

3.3.4.1. Flooring Removal

1. Cut out portion of flooring to be removed.
2. Use heat gun and putty knife to remove flooring.
3. Clean floor with acetone or xylene.

⚠CAUTION

DO NOT apply cleaning solvent to floor that is not compatible with polyester resins.

DO NOT apply excessive point loading when removing flooring (for example screwdrivers or pry bars).

3.3.4.2. Flooring Installation

1. Surface must be clean and dry. If flooring is to be installed over plywood, ensure wood humidity does not exceed 75%. Use fans to circulate the air and allow wood to dry for 10 to 12 hours.
2. Fill all gaps and irregularities in wood floor with filler and sand flush when dry.
3. Carefully measure and cut flooring to fit repair area. Seam gaps should not exceed 1/32" (0.8 mm)
4. Place replacement flooring on repair area to ensure it fits correctly.
5. Apply adhesive to floor surface repair area and rubber flooring.

   ☞NOTE:

   Use water-based adhesive to bond flooring to wood surfaces. Use contact adhesive to bond flooring to metal surfaces.

6. Allow adhesive to dry to a non-tacky state before installing flooring.
7. Carefully position flooring on repair area. Do not allow contact with floor until in correct position as it will adhere immediately.
8. Use a metal roller to press flooring down and eliminate any air bubbles.
9. Groove out seams to 1/2 to 3/4 of the thickness of the flooring using a hand groover and a straight edge.

   ☞NOTE:

   DO NOT groove until ready to weld. Avoid accumulation of dirt in the grooves.

10. Clean seams and bonding surfaces of dirt and residue.
11. Ensure speed welding tip on heat gun is clean. Use a wire brush to remove any debris.
12. Pre-heat heat gun to approximately 932°F (500°C) (setting 6 on a variable setting gun). Nozzle should be pointing upwards during this pre-heat period.

    ☞NOTE:

    Heat gun and nozzle are available from New Flyer Parts.

13. Test weld a piece of scrap material with the weld rod to ensure temperature is correct and fusion is taking place.
14. Feed weld rod into speed welding tip.
15. Starting as close as possible to end of seam, press weld rod down into groove with speed welding tip, ensuring toe of tip is parallel to the vinyl surface. See “Fig. 12-11: Floor Welding Thread Installation” on page 19.
16. Pull gun towards you while maintaining a slight downward pressure.
17. Any spots which are missed have to be re spot welded.

18. Ensure that heat gun is kept perpendicular to floor. With your spare hand, alternately check that the welded seam is securely bonded, and that the rod is feeding freely.

☞NOTE:

Maintain a constant rate of welding (weld speed should be 1.3 seconds per inch). A good floor weld is achieved using a combination of suitable heat and correct speed of travel with the heat gun. See “Fig. 12-12: Correct Floor Weld” on page 19.

The weld thread and flooring will burn if the heat setting is too high or the gun is moved too slowly. The weld will not fuse if the heat setting is too low or the gun is moved too quickly.

19. Trim the weld bead in two stages using a spatula knife that has been sharpened on one side only. This will make trimming easier and minimize the risk of digging in.

    a. Place trim plate over weld rod. Insert spatula knife into trim plate. Push knife forward and trim off top portion of weld rod.

    b. Allow weld to cool to room temperature and remove excess weld with spatula knife. Keep knife at as shallow an angle to the floor as possible to minimize the risk of digging in.

20. Test weld for proper fusion: pull on the weld thread to determine if weld has properly fused to flooring. If weld thread breaks or lifts flooring off floor before letting go, welding procedure was successful.

21. Use sealant on seams that cannot be welded with weld thread.

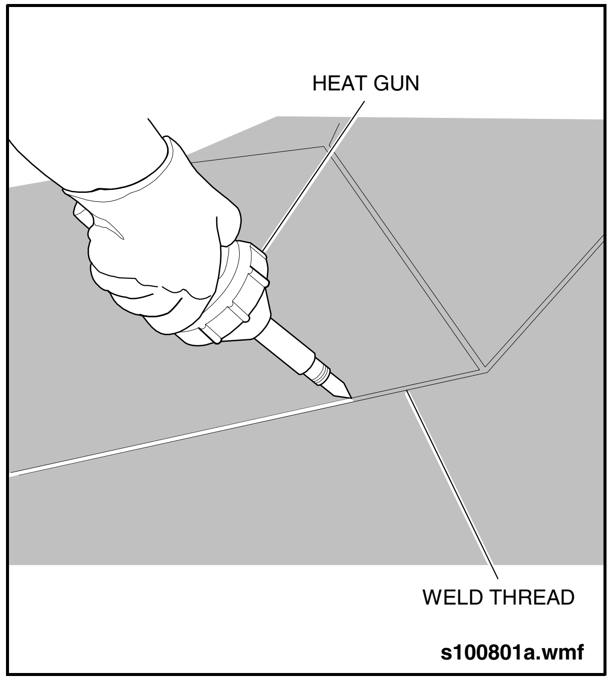


Fig. 12-11: Floor Welding Thread Installation

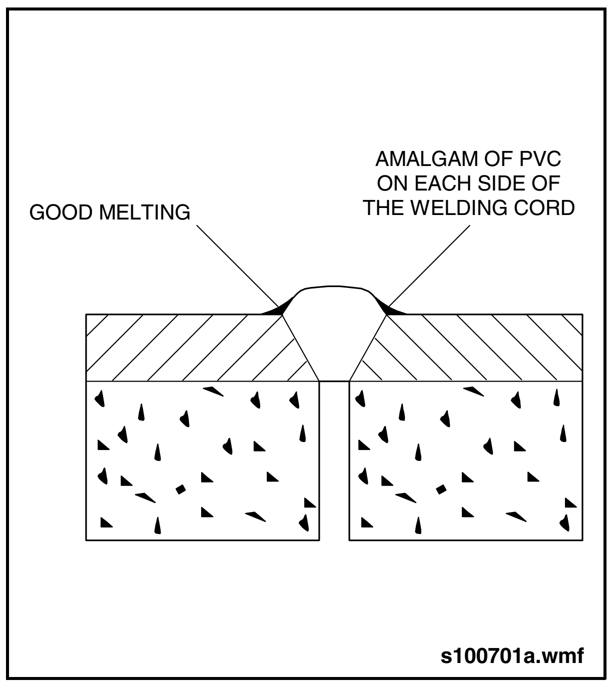


Fig. 12-12: Correct Floor Weld

4. SAFETY EQUIPMENT

4.1. Fire Extinguisher

4.1.1. Description

The fire extinguisher is a 5 lb. multi-purpose dry chemical fire extinguisher. See “Fig. 12-13: Safety Equipment Installation” on page 20.

CAUTION

The fire extinguisher contains a compressed gas. Avoid breathing dust. FIRST AID - if inhaled, remove victim to fresh air. For eye contact, flush with running water for at least 15 minutes. Call physician. For skin contact, wash with soap and water. Call physician if irritation persists.

4.1.2. Operation

1. The fire extinguisher is suitable for use above -65°F (-54°C). Remove safety pin and squeeze lever as shown on instruction label on fire extinguisher.

WARNING

DO NOT direct at surface of burning liquid from closer than 10 feet (3 meters).

2. Recharge immediately after use.

NOTE:

Refer to instruction label on fire extinguisher for recharge procedure.

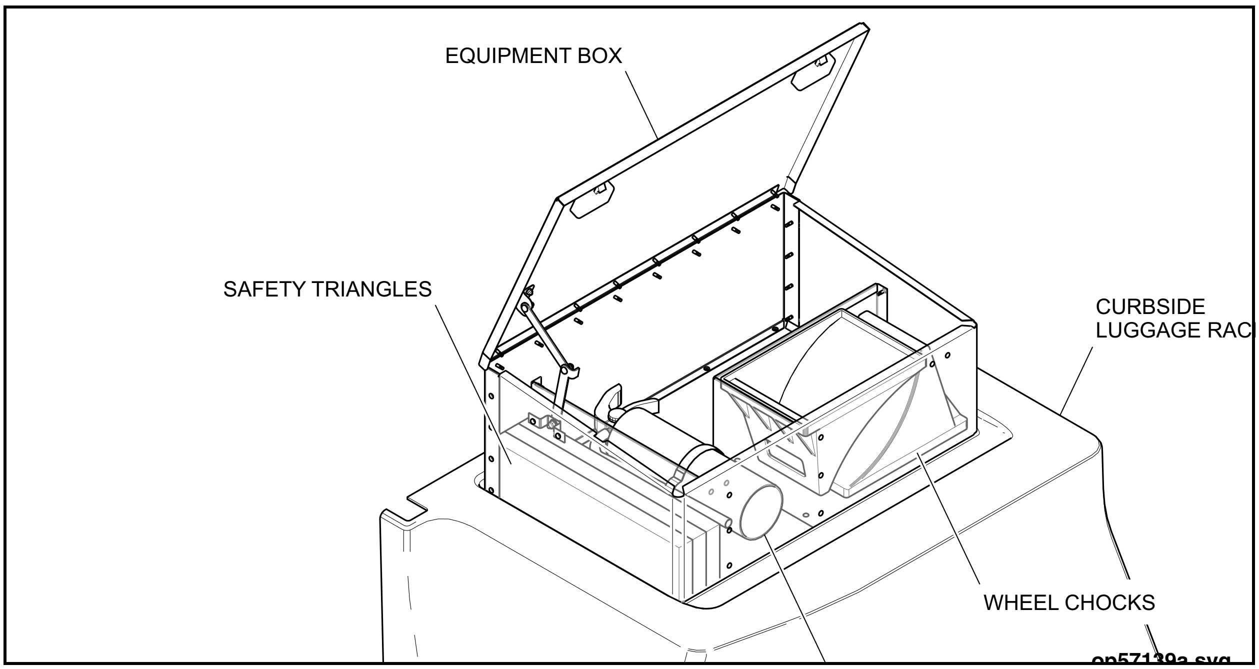


Fig. 12-13: Safety Equipment Installation

4.2. Safety Triangles

4.2.1. Description

Safety triangles are used to warn oncoming traffic of a potential hazard should the vehicle be out of service on the roadside.

4.3. Wheel Chocks

4.3.1. Description

Wheel chocks are located in the safety equipment box on the curbside luggage rack. Consult your local transit authority for instructions on the use of wheel chocks.

5. INTERIOR MIRRORS

5.1. Description

The following mirrors are located throughout the vehicle interior:

- ❐ Aisle Mirror - The aisle mirror is located under the front destination sign close-out. Its convex glass surface provides a wide view of the entrance door and passenger area.
- ❐ Upper Right Mirror - Located to the right of the aisle mirror, the upper right mirror is used to view the rear mirror.
- ❐ Exit Door Area Mirror - The exit door area mirror is located on the stanchion at the exit door. This mirror provides a view of the exit door area when looking through the upper right mirror from the driver's seat.
- ❐ Bike Rack Mirror - A bike rack mirror mounted to the right of the aisle mirror allows the driver to view the bike rack.
- ❐ Overhead Entrance Mirror - This mirror is located on the entrance door access panel. Adjust this mirror to provide a view of the entrance and curb outside. This will provide the operator with a view to check for any obstructions when kneeling a vehicle or when closing the door.

Exterior Panels & Applied Parts

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❒ open flame
- ❒ excessive heat
- ❒ production of sparks
- ❒ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

⚠ WARNING

DO NOT perform any maintenance on roof-mounted components unless equipment is in place to prevent fall hazards. Ensure maintenance personnel use approved lift platforms or scaffolding and wear approved safety harness when working on the roof of the vehicle.

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Painting Safety

⚠ WARNING

Follow all proper safety precautions regarding spray painting.

⚠ WARNING

The paint booth or work area must be properly ventilated, with filtered exhaust fans removing fumes and over spray. Air make-up induction fans should also be used to supply fresh air to the work area.

⚠ CAUTION

Use a filtering mask with the proper filter cartridges. Wear eye protection and proper protective clothing.

⚠ CAUTION

The painting area should be a safe distance from any source of flame, spark or other means of combustion. Atomized paint, thinner, cleaner and solvent fumes are highly volatile with an extremely low flashpoint that can cause explosive combustion.

⚠ CAUTION

DO NOT smoke or permit anyone else to smoke in or near the painting area.

1.4. Adhesives Safety

WARNING

Overexposure to adhesives used on this vehicle, specifically Sikaflex-252, may cause breathing difficulties, sensitization, headaches, nausea, vomiting. May aggravate respiratory, skin, eye, lung problems and allergies. If the product is applied according to the manufacturer's directions, none of these symptoms should be encountered. A person who is allergic to isocyanate may have a reaction with a level of isocyanate well below the T.L.V. Xylene is a central nervous system depressor and in rare cases, may cause a sensitization of the heart muscle causing arrhythmia.

Ensure the user is provided with a full face mask or safety glasses, a rubber apron, sufficient ventilation, and an eyewash station or shower. In case of overexposure, remove contaminated clothing and shoes, wash with plenty of water, wash clothing before rewearing, and consult a physician. If eyes are exposed, rinse immediately for several minutes. See a physician immediately.

In case of inhalation, evacuate to fresh air and consult a physician. In case of ingestion, drink plenty of water or milk. DO NOT induce vomiting. See a physician immediately.

1.5. Insulation Foam Safety

WARNING

Insulation foam is installed in the spaces of the frame tubing, between the vehicle inner and outer wall panels. The Insulation Foam is extremely combustible. KEEP OPEN FLAMES AND FLAME SOURCES AWAY FROM THE INSULATION FOAM!

Before performing any work or repairs requiring use of an open flame such as: welding, brazing, acetylene torch cutting or grinding, ensure that the insulation foam is either removed from the area being repaired, or is properly shielded from the open flame.

2. EXTERIOR PANELS

2.1. Description

Exterior panels include the following:

- ❒ Sidewall
- ❒ Upper Exterior Side (Pier) Panels
- ❒ Front Mask
- ❒ Roof

☞**NOTE:**

Before any replacement of any exterior panel, an inspection of the structure must be done.

Any damage to the structure or the protective primer must be repaired immediately.

Records must be kept for every repair made.

- ❒ Date of repair.
- ❒ Description of damage.
  - ❒ Is a repair to the structure necessary? Yes/No
  - ❒ Repair to the panel only? Yes/No
- ❒ VIN____________
- ❒ Was New Flyer notified? Yes/No
- ❒ Name of inspector_______________

2.2. Rivets

2.2.1. Recommended Rivet Drill Size

RECOMMENDED RIVET DRILL SIZE								
RIVET DIAMETER		DRILL SIZES			HOLE SIZE			
					MINIMUM		MAXIMUM	
inches	(mm)	size	inches	(mm)	inches	(mm)	inches	(mm)
3/32	2.38	#40	0.098	2.49	0.097	2.46	0.100	2.54
1/8	3.18	#30	0.129	3.26	0.129	3.28	0.132	3.35
5/32	3.97	#20	0.161	4.09	0.160	4.06	0.164	4.17
3/16	4.76	#10	0.194	4.92	0.192	4.86	0.196	4.96
1/4	6.35	F	0.257	6.53	0.256	6.50	0.261	6.63

2.2.2. Drilling Procedure

1. Use a clean, sharp, properly ground drill.
2. Center drill in the chuck so that drill will run true.
3. Hold drill perpendicular to the drilling surface.
4. To ensure proper hole alignment and to prevent burrs and chips from lodging between the panels, the parts should be tack riveted to prevent “creep” and hole misalignment during the drilling operation.

2.2.3. Installation & Selection

1. Wherever possible use a solid S/S rivet.
2. Where it is not possible to get conventional riveting tools in place, a 3/16" stainless steel mono bolt may be used.

2.2.4. Removal

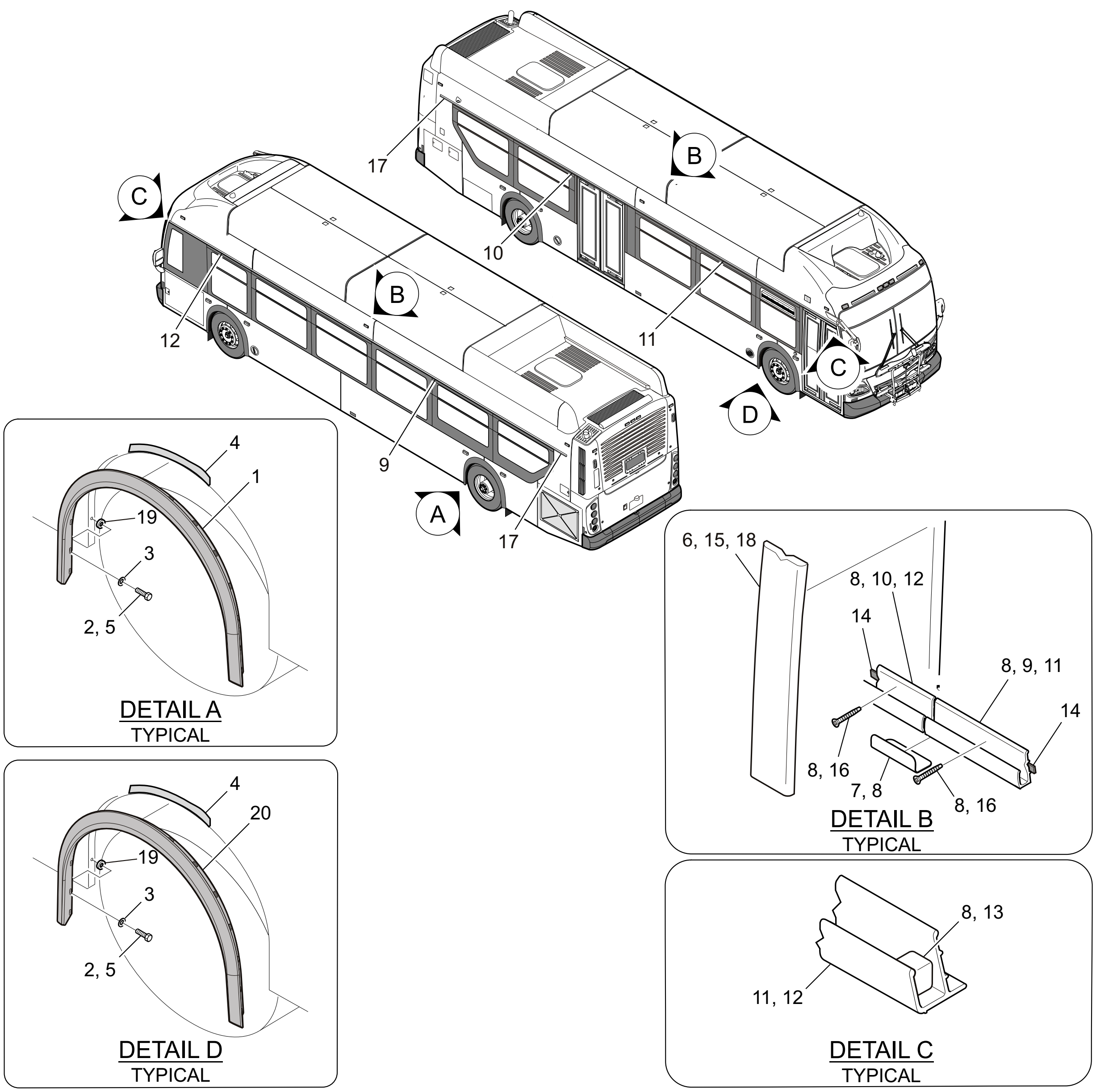
1. In thick material, drive out the rivet stem using a tapered steel drift pin. In thin material, drill the tapered portion of the stem away to destroy the lock.
2. Drill nearly through the head of the rivet using a drill the same size as the rivet shank. Break off rivet head.
3. Drive out remaining rivet shank with a pin having a diameter equal to the rivet shank.

2.3. Sealants, Caulk & Adhesives

2.3.1. Description

☞**NOTE:**

Application of sealants and caulking is critical to prevent corrosion of vehicles in service. Care is to be taken that all the areas around wheel housing are adequately sealed as these areas are subject to high salt spray concentrations. See “Fig. 13-1: Molding & Trim” on page 5.



1. Fender, Polyurethane
2. Bolt, Hex 1/4" - 20 UNC x 3/4" Lg. SST
3. Washer, Flat 1/4" SST
4. Tape, Butyl .12" x .50" Black
5. Adhesive, SIKA 221 Black
6. Aktivator, SIKA 205
7. Expansion, Drip Rail 1.09" x 2.5" Lg.
8. Adhesive, SIKA 221 White
9. Molding, Drip Rail Rear Streetside
10. Molding, Drip Rail Rear Curbside
11. Molding, Drip Rail Front Curbside
12. Molding, Drip Rail Front Streetside
13. Plug, Drip Rail
14. Spacer, Foam 1/8" x 3/8" Black
15. Adhesive, SIKA 252 White
16. Screw, Thread Cutting #10 - 32 UNF x 1 1/4" Lg.
17. Molding, Window Trim 4.5" x 1.56" x .20"
18. Panel, Roof Cap Overlap
19. Spacer, 0.281" I.D. x 1.25" O.D.
20. Fender, Polyurethane

s0322678a.svg

Fig. 13-1: Molding & Trim

2.3.2. Butyl Tape Sealant (Grey)

❒ 0.06 x 1" (1.59 x 25.4 mm)

The butyl tape is to be applied in strips directly from rolls. Locate tape 0.06 to 0.12" (1.59 to 3.18 mm) away from exposed edges to avoid excessive squeeze out of sealant. Do not attempt to clean up butyl material that may have extruded from joints.

Apply as follows:

1. Apply continuous strips between wheel housing and body side structure.
2. Apply a continuous strip between floor and heater duct retaining flanges.
3. Apply continuous strips all around roof vents, between vent frame and roof panel.
4. Apply continuous strips around harness entry points.

⚠ **WARNING**

Use rubber gloves when handling. Apply only in a well ventilated, non-smoking area. Check labels for warnings.

2.3.3. Sikaflex-221 Elastic Adhesive/Sealant

2.3.3.1. Description

Sikaflex-221 is a fast-curing polyurethane-based adhesive sealant. It is a moisture-cured non-sag system. It provides a permanent elastic bond to fasten materials with dissimilar coefficients of expansion.

2.3.3.2. Properties

Density .... 1.23 kg/L

Tack-free time .... 1 to 2 hours

Cure Rate .... 4 mm/24 hours @ 70°F (21°C)

Shore A Hardness .... 40 to 45

Elongation at Break 600%

Application Temperature .... 41 to 104°F (5 to 40°C)

Service Temperature
.... -40 to 194°F (-40 to 90°C)
.... (briefly up to 248°F/120°C)

Colors .... White/Black

2.3.4. Loctite-567 Pipe Sealant

2.3.4.1. Description

Loctite-567 is designed for the locking and sealing of metal tapered threads and fittings.

2.3.4.2. Properties

Material .... Acrylic

Chemical Type .... Methacrylate Ester

Appearance (Uncured) .....Smooth, Creamy, off-white paste

Components .... Single component

Viscosity...High

Primary Cure Method .... Anaerobic

Secondary Cure Method................ Activator

Application ....Thread Sealing

Strength ....Low

2.3.4.3. Operation

The sealant is applied to the threads of metal fittings and cures when confined in the absence of air between close fitting metal surfaces. Cured sealant prevents leakage and component loosening due to shock and vibration.

2.3.4.4. Component Assembly

1. For best results, clean all surfaces (external and internal) with a Loctite cleaning solvent and allow to dry.
2. If the material is an inactive metal or the cure speed is too slow, spray with Activator 7471 or 7649 and allow to dry.
3. Apply a 360° bead of sealant to the leading threads of the male fitting, leaving the first thread free. Force the material into the threads to thoroughly fill the voids.
4. Assemble components and tighten fittings.
5. Properly tightened fittings will seal instantly to moderate pressures.

☞**NOTE:**

For maximum pressure resistance and solvent resistance allow the product to cure a minimum of 24 hours.

2.3.4.5. Disassembly

1. Disassemble parts with standard hand tools.
2. Where hand tools do not work because of excessive engagement length or large diameters (over 1"), apply localized heat to approximately 250°C. Disassemble while hot.

2.3.4.6. Cleanup

Cured product can be removed with a combination of soaking in a Loctite solvent and mechanical abrasion such as a wire brush.

2.3.5. Sikaflex-252 Adhesive/Sealant

2.3.5.1. Description

Sikaflex-252 is a polyurethane-based material which cures on exposure to air. The chemical reaction is set in motion as soon as the adhesive is extruded or the cartridge is opened. Initially plastic in consistency, it cures to form a high-grade elastomeric adhesive.

2.3.5.2. Properties

Density .... 1.14 ± 0.03 kg/L

Cure System ....Moisture Cure

Tack-Free Time* .... 40 min. approx.

Rate of Cure* .... 4 mm approx. per 24 hrs.

Shore A Hardness (DIN 53 505)
.... 55 approx.

Elongation at Break (DIN 53 504)
.... >300%

Tensile Strength (DIN 5. 504)
....................................4 N/mm^2 approx.

Lap-Shear Strength*...................... 3 N/mm^2

Tear Propagation Strength (DIN 53 515)
.... 9 N/mm approx.

Shrinkage (DIN 52 451)..............6% approx.

Application Temperature.............. 41 to 95°F (5 to 35°C)

Service Temperature
.... -40 to 194°F (-40 to 90°C)
.....................(briefly up to 248°F/120°C)

* Temperature 70°F (21°C) 65% rel hum

2.3.5.3. Uses

Use as an external panel adhesive (except for roof panels) which is applied to the entire perimeter surface of the panel.

2.3.6. 3M-550 Fast Cure Adhesive/Sealant with Accelerator AC61

2.3.6.1. Description

3M-550FC is a polyurethane-based adhesive sealant and it is mixed with AC61 accelerator for faster curing. Mixing is done with special two component dispensing equipment.

2.3.6.2. Properties

Appearance ....Smooth Paste

Color .... Accelerator Grey 550FC Gray Mixed at 10:1 ratio

Skin Formation..................... 15 ± 5 minutes

Tensile Strength in 1 hour .... >70 psi

Tensile Strength after 24 hr cure.......300 psi

Shore A Hardness (ISO 868 - 3).......40 - 45

Modulus at 100% Elongation .... 1.0 MPa (150 psi)

Elongation at Break ....>250%

Temperature Resistance.......-22°F to 176°F (-30°C to +80°C)

Ratio Mix: 550FC to AC61 .... 10:1 (volume measurements)

2.3.6.3. Uses

Use as an external panel adhesive, applied to the perimeter surface of the panel.

2.3.7. Sika-205 Cleaner

Sika-205 Cleaner is a special cleaner for the pretreatment of bond faces prior to bonding or sealing with Sikaflex products.

2.3.7.1. Application Method

Apply in a thin film to the bond face. Let dry 10 minutes.

2.3.8. Sika-206G&P Primer

2.3.8.1. Description

Sika-206G&P Primer is a black, moisture-curing liquid for the treatment of bond surfaces before bonding with Sikaflex products. It can also be used to touchup scratches and minor paint damage.

2.3.8.2. Properties

Density ....1.0 kg/L

Flash Point................................ 24°F (-4°C)

Drying Time ....10 min. to 24 hrs. depending on temperature & rel hum

Application Temperature..............50 to 86°F (10 to 25°C)

Shelf Life ....9 months

2.3.8.3. Application Method

Ensure substrate is clean and free from all traces of dust and grease. Apply primer in a thin layer using a paintbrush, felt tip, or other suitable application equipment. Allow 10 minutes drying time.

2.4. Removal

CAUTION

Follow all proper safety precautions regarding spray painting. Use a filtering mask with the proper filter cartridges for this type of paint. Wear eye protection and proper protective clothing. The paint booth or work area must be properly ventilated, with filtered exhaust fans removing fumes and over spray. Air make-up induction fans should also be used to supply fresh air to the work area. The painting area should be a safe distance from any source of flame, spark or other means of combustion. Atomized paint, thinner, cleaner and solvent fumes are highly volatile with an extremely low flashpoint that can cause explosive combustion. DO NOT smoke or permit anyone else to smoke in or near the painting area.

2.4.1. Structural Panel Types

Structural panels are aluminum and fiberglass construction. The aluminum panels are preprimed with a peel-off protective plastic skin. The fiberglass panels have a Gelcoat finish on one side. Rivet holes have to be drilled in the fiberglass panels.

2.4.2. Panel Removal

The structural adhesive/sealant bonding the panels to the frame provides a strong surface bond between the panel and frame. This strong bonding is necessary to make the panel a structural component of the frame. A panel should only be removed if it is damaged beyond a point of external surface repair.

The panel may be salvaged for repair and reinstallation if reasonable care is taken during the panel removing procedure. If care is not exercised, the panel will be irreparably damaged and will have to be replaced. Ultimately, salvaging the panel is dependent upon the degree of initial damage and whether the panel has the structural strength to be removed in one piece.

Tools and supplies required: vice grips putty knife, or utility knife with a sharp blade, lacquer thinner and absorbent shop rags.

1. Use the putty knife or utility knife blade soaked in lacquer thinner to cut into the adhesive between the panel and frame at a corner of the panel.

   ☞**NOTE:**

   The lacquer thinner does not dissolve the adhesive, but acts as a releasing agent between the adhesive and primer.

2. Pry one corner of the panel up enough to grasp with the vice grips and start to pull on the vice grips. This should start the panel to pull away from the frame.
3. Continue to cut or scrape the adhesive where contact is made at the panel and frame, and simultaneously pull the panel away with the vice grips.
4. Keep doing this until all of the panel is freed from the bonded adhesive and pulls away from the frame.

   ☞**NOTE:**

   Depending on the initial condition of the panel and care taken during the removal process, the panel may tend to curl up during removal. If this occurs, replace the panel.

5. Scrape the remaining adhesive from the frame.

CAUTION

All remnants of the adhesive must be removed from the frame. Use the putty knife wet with lacquer thinner to scrape the remnants of adhesive from the frame surface. Scraping may remove some primer from the frame. ALWAYS reprime the entire perimeter area of the frame to maintain corrosion protection.

2.4.3. Frame Repriming

1. Scuff sand the affected frame area using 180 to 220 grit emery paper with a disk sander.
2. Wipe the worked area of the frame down with Sika-205 cleaning solvent.
3. Use the recommended Sika-206G+P Primer to thoroughly cover the sanded frame areas.

2.5. Substrate Preparation & Bonding

2.5.1. Introduction

Refer to the following guidelines before application of adhesive and bonding of new panels.

2.5.2. Preprimed Aluminum

1. Clean the bonding surface to remove dirt, grease, and oil, using Sika-205 Cleaner and clean white cloths.
2. No priming is required for this material.
3. Use a caulking gun to apply Sika-252, 221 or 201 Adhesive.

2.5.3. Unprimed Aluminum

1. Clean the bonding surface to remove dirt, grease, and oil, using Sika-205 Cleaner and clean white cloths.
2. Prime the bonding surface using Sika-206G+P Primer and a brush. Ensure the aluminum surface cannot be seen through the primer.
3. Use a caulking gun to apply Sika-252, 221 or 201 Adhesive.

2.5.4. Steel Primed with PPG Red/Grey Primer

1. Clean the bonding surface to remove dirt, grease, and oil, using Sika-205 Cleaner and clean white cloths.
2. Brush apply Sika-206G+P black Primer over the red/grey structural primer. Ensure the undercoat primer cannot be seen through the black primer.
3. Use a caulking gun to apply Sika-252, 221 or 201 Adhesive.

2.5.5. Stainless Steel

1. Clean the bonding surface to remove dirt, grease, and oil, using Sika-205 Cleaner and clean white cloths.
2. Priming is not necessary for this material.
3. Use a caulking gun to apply Sika-252, 221 or 201 Adhesive.

2.5.6. Fiberglass

1. Remove mold release paraffin wax on interior surfaces using 36 grit sanding paper.
2. Clean the bonding surface to remove dirt, grease, and oil, using Sika-205 Cleaner and clean white cloths.
3. No priming is required for this material.
4. Use a caulking gun to apply Sika-252, 221 or 201 Adhesive.

2.6. Panel Applications

2.6.1. General Panel Replacement

The panels used on the exterior of the vehicle are installed with a combination of adhesives and structural tape. Procedures specific to each panel must be followed in order to guarantee a satisfactory installation. Detailed instructions including cleaning, priming, bonding, and attachment procedures are provide in New Flyer engineering installation drawings. Please contact New Flyer Customer Service for detailed installation procedures (engineering installation drawings) and material requirements for the specific panel being replaced.

2.7. Sidewall Panels

2.7.1. Description

Sidewall panels are the exterior fiberglass panels that cover the side structure from the bottom of the window to the bottom of the structure. The panels are installed with a combination of adhesive and structural tape. Procedures specific to each panel must be followed in order to guarantee satisfactory installation. See “Fig. 13-2: Side Panel Application-1” on page 13. See “Fig. 13-3: Side Panel Application-2” on page 14.

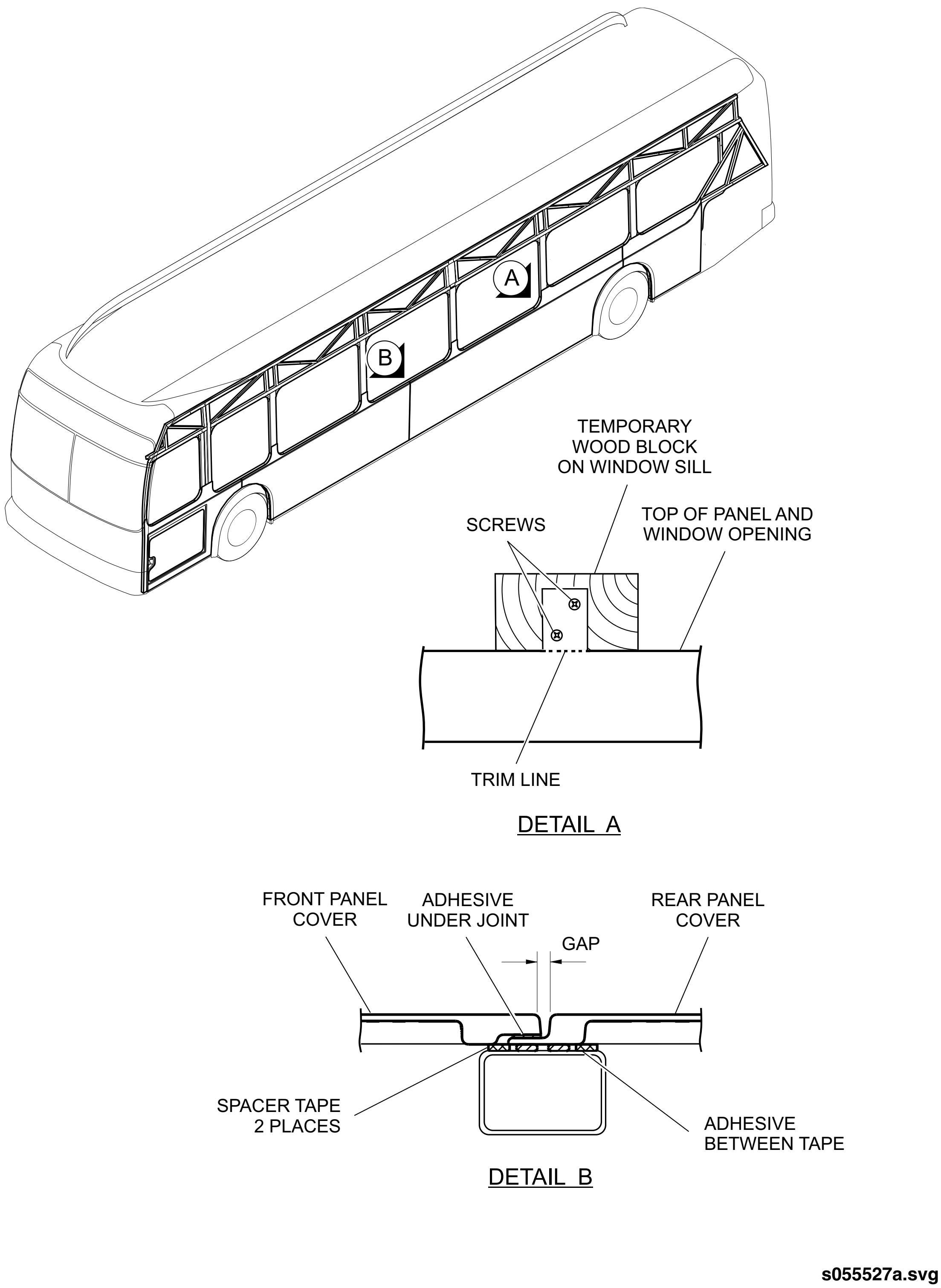


Fig. 13-2: Side Panel Application-1

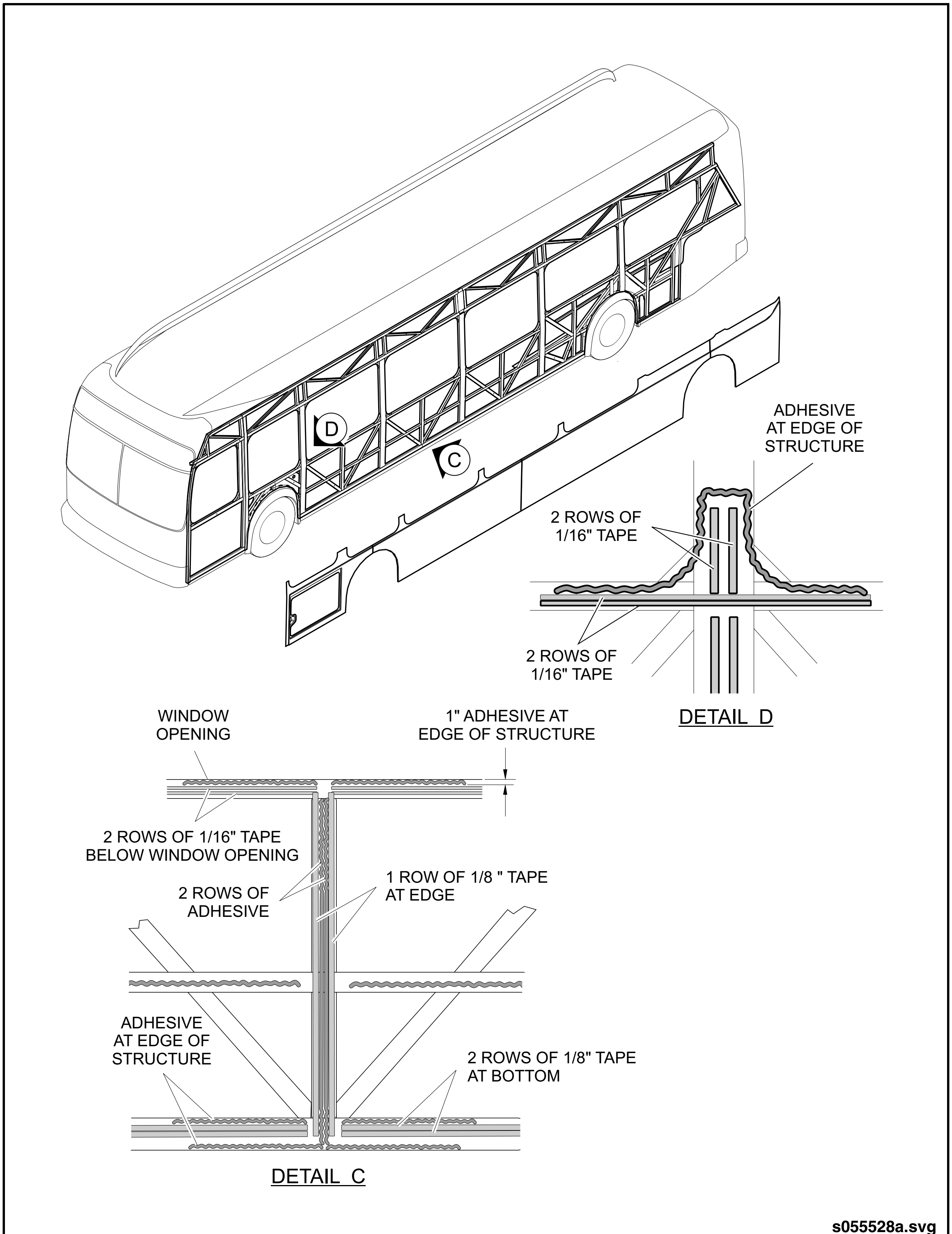


Fig. 13-3: Side Panel Application-2

2.7.2. Side Panel Installation

1. Install the side panel as follows:
   a. Dry-fit the side panels onto structure using temporary wood blocking and clamping devices. Place wood blocking onto the window sills and fasten the tabs of the panels to the wood blocking using screws. See Detail A in Figure. If all side panels are replaced start at the rear of the vehicle. Ensure that the top edges of side panels are flush with the structural window openings.
   b. If only one panel is replaced push vertical lip of rear panel under vertical lip of front panel. See Detail B in Figure.
   c. Arrange the panels so that they overlap at the vertical edges with a gap of approximately 1/4" between the adjacent panels. See Detail B in Figure.
   d. Use clamping devices to secure panels to structure. Remove protective plastic in areas where panels are clamped.
   e. Remove dry-fitted panels from vehicle.
2. Clean structure with Sika 205 cleaner using a lint-free cloth. Allow 30 minutes for air drying.
3. Peel off the backing and place two rows of 1/8" thick structural tape along the bottom of the structure. Keep the tape 1" away from the edges of horizontal structural member. See Detail C in Figure.
4. Apply two rows of 1/8" thick structural tape on vertical structural members where two panels are joined. Place the tape near the edges of the structure. See Detail C in Figure.
5. Place one row of 1/8" thick structural tape on narrow vertical structural members and two rows on wide vertical structural members.
6. Place two rows of 1/16" thick structural tape on horizontal structural members below window openings. Keep the tape 1" away from edge of structural members. See Detail D in Figure.

☞**NOTE:**

Check that the backing is removed from all structural tape.

7. Clean the entire inside surface of the side panels using Sika 205 cleaner and a lint-free cloth. Allow 30 minutes for air drying.
8. Apply a continuous bead of white adhesive Sika 221 to horizontal structural members near edges. The beads should 3/8" wide by 7/16" high.

☞ **NOTE:**

The adhesive must be applied within one hour of applying the cleaner.

9. Apply two rows of adhesive beads between tapes at vertical structural members where two panels are joined. See Detail C in Figure.
10. Apply adhesive to structure so that the entire perimeter of the panels are sealed to prevent moisture penetration.
11. Apply a small bead of adhesive to joint where two panels are meeting. The adhesive needs to be covered with the overlapping panel. See Detail B in Figure.
12. Apply the panels to structure within 15 minutes of applying the adhesive. Secure panels with clamping devices and wood blocking at the window sills.
13. Check that all the edges of panels are flush with the structure. Apply even pressure in an up and down motion using a cloth or roller.
14. Remove squeeze-out adhesive using soapy-water spray and a putty knife. Window and door openings must be free of adhesive to prevent interference. Remove panel protective film.

☞**NOTE:**

DO NOT use Sika cleaner to remove squeeze-out adhesive from bonded joints. The cleaner could weaken the bonding.

15. Allow 8 hours for curing at room temperature.
16. Cut the tabs flush with side panels. See Detail A in Figure.

2.8. Side Pier Panels

2.8.1. Description

The pier panels are located above the sidewall panels and are used to fill the space between the windows. These panels are constructed of 0.08" thick sheet aluminum.

2.8.2. Pier Panel Installation

☞**NOTE:**

DO NOT install pier panels until side panels are installed.

1. Wipe panels with a clean dry cloth, then wipe with a clean cloth dipped in Sika-205 Cleaner. Allow to dry for 5 to 10 minutes.
2. Dip a clean white cloth in Sika-205 Cleaner and wipe area of structure where adhesive will be applied. Wipe structure dry using a second dry white cloth. Allow to dry for 5 to 10 minutes.
3. Install side wall insulation pieces as required.
4. Remove backing from 1/8" x 3/8" wide double sided spacer tape and install on structure, approximately 1" from outer edge of vertical structures and approximately 3/4" from top and bottom edges for horizontal structures. This will allow adhesive to squeeze out without contaminating double sided tape.

☞**NOTE:**

Refer to the New Flyer Bonding specification (engineering drawing) for proper spacer tape location of pier panels. Contact New Flyer Customer Service for engineering installation drawings.

5. Using a V-cut nozzle, apply a continuous and unbroken 0.47" bead of Sika-221 Adhesive to perimeter of structure where edge of panel will contact frame. Apply a thick bead of Sika-221 Adhesive to top edge of side panel where pier panel abuts side panel.
6. Remove backing from spacer tape and place pier panel onto structure. Ensure panel is flush with window opening. Manually press panel onto spacer tape to ensure good adhesion.
7. Check squeeze out along entire perimeter of panel. Backfill any areas with voids to ensure a watertight seal.
8. Remove excess squeeze out along edges of panel and window openings using a water spray bottle and a putty knife. If necessary use abrasive paper to remove cured adhesive. Do not use Sika-205 Cleaner as it will prevent curing of the adhesive.
9. Fill all gaps between the structure and panels with adhesive.
10. Fill all gaps between filler panels and pier panels with adhesive.
11. Fill all gaps between window openings and panels.
12. Sand all gaps smooth to ensure window clamp will seal against the panels.

☞**NOTE:**

Clean out excess adhesive from the entrance and exit door openings to allow proper door trim installation.

2.9. Front Mask Panels

2.9.1. Description

The front mask is a molded fiberglass panel that contains the apertures for the windshield and headlights. It is installed on the front of the vehicle using adhesives, monobolt rivets and bolted brackets.

2.9.2. Front Mask Panel Installation

WARNING

Protective gloves and safety goggles are mandatory when using Sikaflex-252, 201 or 221 Adhesives. They are also mandatory when using Sika-205 Cleaner, or Sika-206G+P Primer; if used in an enclosed area, a respirator with an organic vapor cartridge is also mandatory.
DO NOT wear gloves when operating drills or screw guns.
Ensure proper disposal of controlled products.

1. Place front mask panel on structure to ensure correct fit. Mask must fit flush and square at all four corners of structure without distortion. Check to ensure the following:
   - ❒ No gaps exist between top corners of mask and roof.
   - ❒ No gaps exist between mask and side console.
   - ❒ No gaps exist between mask surface and windshield cut out.
   - ❒ Defroster opening is centered relative to vertical uprights of structure.
   - ❒ Bottom plate structure is not bowed and not preventing mask from sitting flush.
2. Remove mask from structure.
3. Scuff the front 1 5/8" of the roof panel.
4. Remove any dry caulking that may interfere with mask installation.
5. Clean panel and structure surfaces to be joined using Sika-205 Cleaner and a clean lint-free cloth. Allow to dry for 10 to 60 minutes. See “Fig. 13-4: Front Mask Panel Application” on page 19.
6. Apply Sika-206G+P Primer to joining surfaces on panel and structure. Allow to dry for 10 to 60 minutes.
7. Install spacer tape to interior contact surface of front mask (above and below windshield opening) and frame members of front structure.

   ☞NOTE:

   Adhesive must be applied within one hour of primer application.
8. Apply two continuous beads of Sika-252 Adhesive along mating surface of roof panel and mask.
9. Apply a continuous bead of Sika-252 Adhesive above spacer tape on center beam.
10. Apply one continuous bead of Sika-252 Adhesive along streetside A post.
11. Apply two continuous beads of Sika-252 Adhesive along curbside (entrance door insert tube) A post.
12. Apply one continuous bead of Sika-252 Adhesive above spacer tape on inside of front mask and along both ends of mask mating surface.

13. Apply two continuous beads of Sika-252 Adhesive along front face of lower beam.

14. Apply Sikaforce-7780 along the top edge of the front mask to create a flush seal. See “Fig. 13-5: Front Mask Lap Joint” on page 20.

☞NOTE:

Front mask must be installed within 40 minutes of adhesive application.

15. Install front mask over front edge of roof panel and into contact with front structure. Clamp assembly into position. Do not over tighten clamps Allow adhesive to dry for 3 to 4 hours before removing clamps.

16. Apply a bead of adhesive along the perimeter of the front mask support bracket and adhere it to the mask.

17. Apply sealant along top edge of front mask and along interior top edges of mask at bottom closeout and tool into place to create an edge fillet seal.

18. Seal gaps between windshield cutout and front structure using Sika-221 Sealant (black).

19. Drill nine equally spaced holes (0.191") in lower portion of front mask and install monobolt rivets.

20. Apply foam rubber seal to perimeter of defroster door and defroster side plates.

21. Position defroster door in front mask.

22. Use door as template to mark position of hinge mounting holes.

23. Drill four 0.136" holes in structure and attach defroster door to vehicle using rivets.

24. Position the mask support bracket and tighten the mounting bolts.

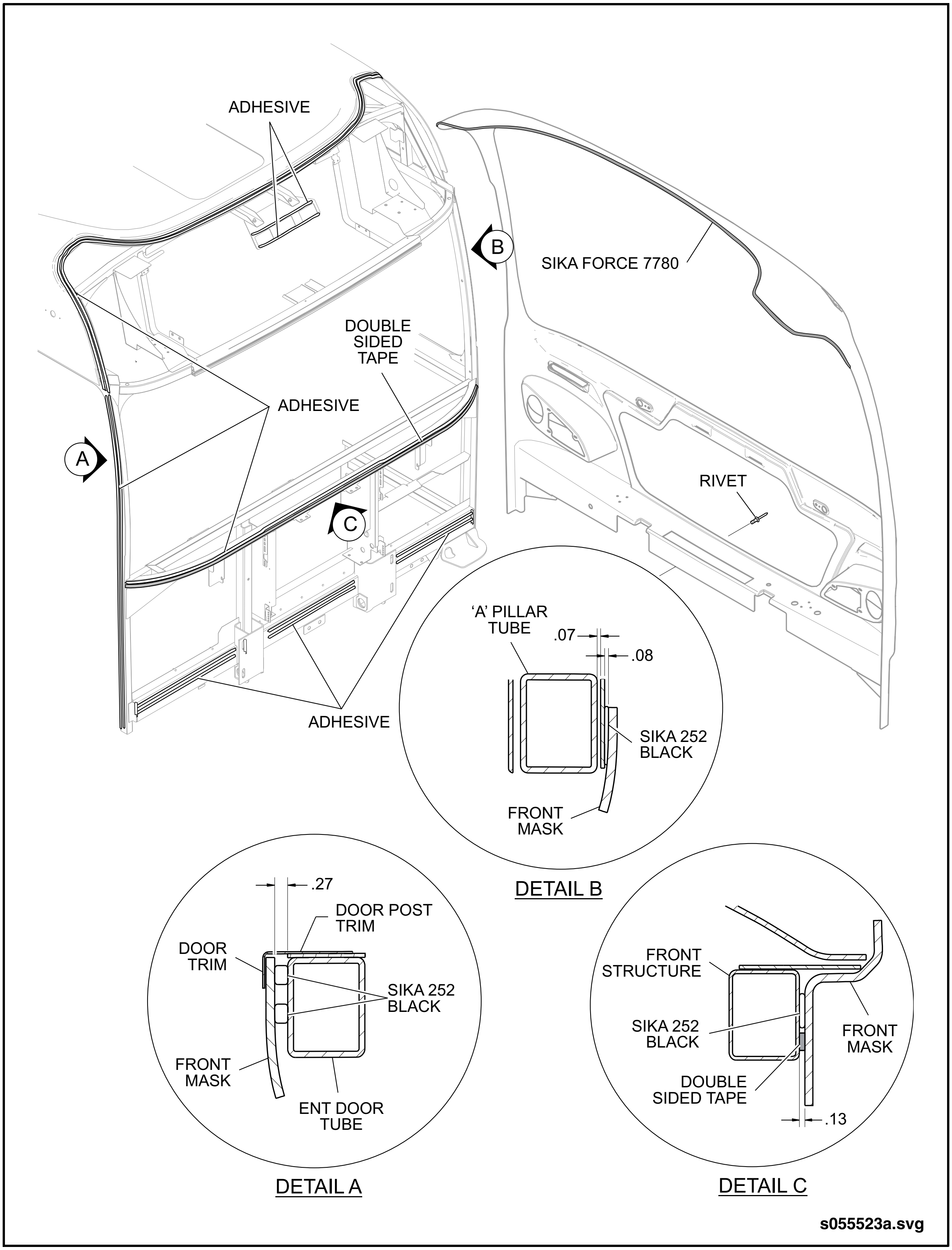


Fig. 13-4: Front Mask Panel Application

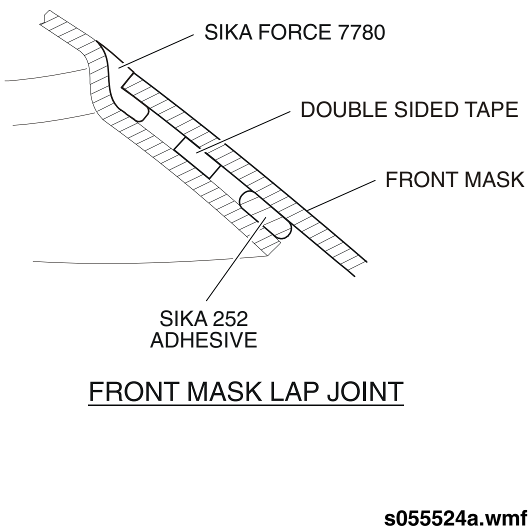


Fig. 13-5: Front Mask Lap Joint

2.10. Roof Panels

2.10.1. Description

Two roof panels cover the top exterior of the vehicle. They are made from molded fiberglass and contain openings for the roof vents and to allow the structure-mounted roof studs to protrude through. The roof panels are attached with adhesive and spacer tape.

2.10.2. Roof Panels Installation

1. Ensure that exterior pier panels, roof insulation, and antenna ground planes are installed. Install cork spacers to vehicles with roof top studs. See “Fig. 13-6: Roof Panel Installation” on page 22.
2. Test fit roof panel to structure to ensure that all roof bows are parallel to each other within 1/8" before proceeding.
3. Measure roof sections to verify correct length and side dimensions. Check for cracks or voids in fiberglass.
4. Remove any remaining tape used to hold pier panel joiner strips in place.
5. Trim off any dried adhesive squeeze-out that might interfere with roof panel installation.
6. Install foam roof channel spacers into the ceiling support channels using Sika-221 to bond the foam spacers against the bottom of the channels. Apply 6" high density spacer tape stitches along one top edge of the foam spacers.
7. Install 3/16" x 3/8" wide high density spacer tape along entire length of each roof bow. Extend tape over each end of roof bow and over the edge of each end, being careful to not plug the drain hole on roof bows.
8. Apply spacer tape around front roof hatch opening. Remove spacer tape release paper strip around the bonded hatch.
9. Wipe bonding surface with Sika-205 Cleaner and lint free cloth to ensure it is dust and residue free. Allow 10 minutes for Sika-205 Cleaner to dry.
10. Apply a 3/8" diameter bead of Sika-221 Sealant near the center of all roof bows and on top of each foam spacer.
11. Wipe the pre-primed perimeter edge along the bottom, with Sika Activator on the resin side.
12. Apply 1/8" x 3/8" spacer tape along full length of vehicle Position tape 1/4" below top edge of pier panel and filler strips. Peel off 8 inches of release paper from the spacer tape at the rear and allow it to hang down.
13. Apply one continuous circular bead of Sika-221 Sealant below the tape, along the entire length of the vehicle where the roof panels are to be bonded. Avoid contaminating the spacer tape.

☞NOTE:

Use caution when applying black Sika-206G+P Primer to white gelcoat roof panels. The primer can cause stains that cannot be removed. Primer application must not exceed the width of the overlapping panel.

14. Lower the rear roof panel into place and let it relax with its own weight while holding sides away from structure. All roof studs and cutouts must line up. Press center lap joint down, to ensure panel is sitting on spacer tape.

15. Starting at the rear, peel release paper off spacer tape up to center joint.

16. Press bottom edge of roof panel into contact with spacer tape and adhesive. If bulging occurs, press down on center of bulge and work outwards using a panel roller.

☞NOTE:

DO NOT use cinch straps to draw the panel to the mainframe structure.

17. Apply a continuous circular bead of 550FC Adhesive/AC61 Accelerator Sealant near outer edge of center lap joint. Apply a second continuous circular bead near the inner or forward edge. See “Fig. 13-7: Roof Panel Cross Section” on page 22.

☞NOTE:

Mixing of the adhesive and accelerator is done with special two component dispensing equipment.

☞NOTE:

Roof panel must be installed within seven minutes of applying the lap joint beads.

18. Lower the front roof panel into place and let it relax with its own weight. Ensure that all roof studs and cutouts line up and joint overlap is correctly aligned to ensure even distribution of glue load with NO squeeze out.

☞NOTE:

DO NOT use cinch straps to draw the panel to the mainframe structure.

19. Press center lap joint onto rear roof panel and press down front roof panel into contact with spacer tape.

20. Peel release paper off spacer tape up to front mask joint. Press bottom edge of roof panel into contact with spacer tape and adhesive. If bulging occurs, press down on center of bulge and work outwards using a panel roller.

21. Press down on center lap joint. If necessary, carefully stand on roof with one foot on lap joint and other on top of panel supported by structure plate. There should be no squeeze out.

☞NOTE:

DO NOT use Sika-205 Cleaner to clean off excess wet adhesive from a bonded joint. The cleaner will taint the Sikaflex and not allow it to harden.

22. Ensure all roof stud holes are completely sealed with Sika-221 Adhesive. Smooth off with a putty knife. Ensure threaded ends of studs are free of adhesive.

23. Seal gap between roof panel and side console panel with Sika-221 Adhesive after front mask has been installed.

24. After painting, apply black Sika-221into the center lap joint flush with top of roof panel.

25. After all roof panels are installed, insert screws as shown. See “Fig. 13-6: Roof Panel Installation” on page 22.

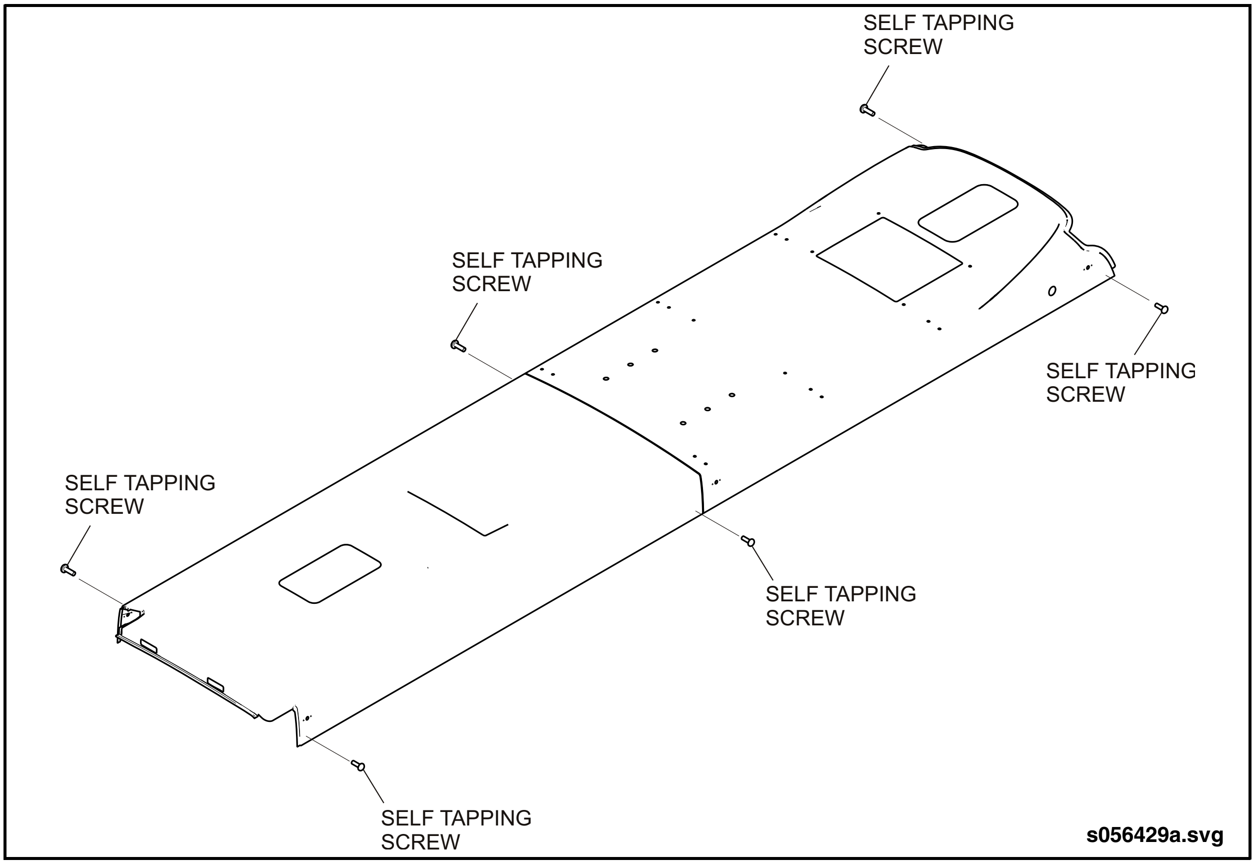


Fig. 13-6: Roof Panel Installation

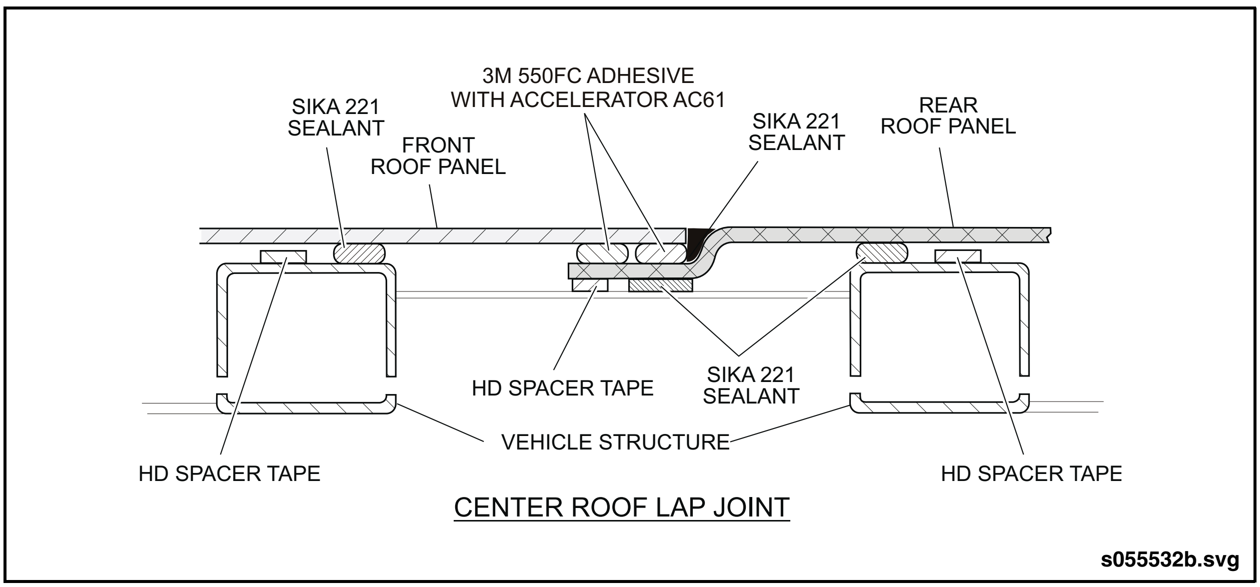


Fig. 13-7: Roof Panel Cross Section

2.11. Roof Cap Overlay

2.11.1. Roof Cap Overlay Installation

1. Dry fit the roof cap overlay to the roof panels where the roof panels meet. The overlay must be centered over the roof panel seam and fit flush. See “Fig. 13-8: Roof Cap Overlay Installation” on page 23.
2. Place a mark on the overlay near the drip rail where trimming may be necessary. Place lines on the roof panels so that the overlay can be centered over the roof seam.
3. Remove the overlap and trim it as required. Remove burrs and rough edges. Scuff the inside radius to improve the sealant adhesion.
4. Scuff the roof panels at the vertical seams between the marks inscribed earlier.
5. Clean the roof panel and the inside of the overlay with Sika Glass and Surface Cleaner. Allow a minimum of two minutes for drying.
6. Apply Sika Aktivator to the bonding area and to the inside of the overlay. Wipe dry with a paper towel and allow to dry for 3 minutes.
7. Prime the surface of the roof panel between the marked lines and the underside of the overlay using Sika Primer-206.
8. Allow the primer to set for 30 to 60 minutes.
9. Apply two triangular beads of Sika-222 to the underside of the overlay.
10. Place the overlay over the panel seam between the marked lines. Apply uniform pressure to the overlay to ensure proper bonding.
11. Apply a bead of Sika-222 Sealant along the top edge of the overlay to prevent seepage of water.
12. Remove excessive sealant immediately using a soft cloth and soapy water.
13. Allow the sealant to cure at room temperature for five hours.

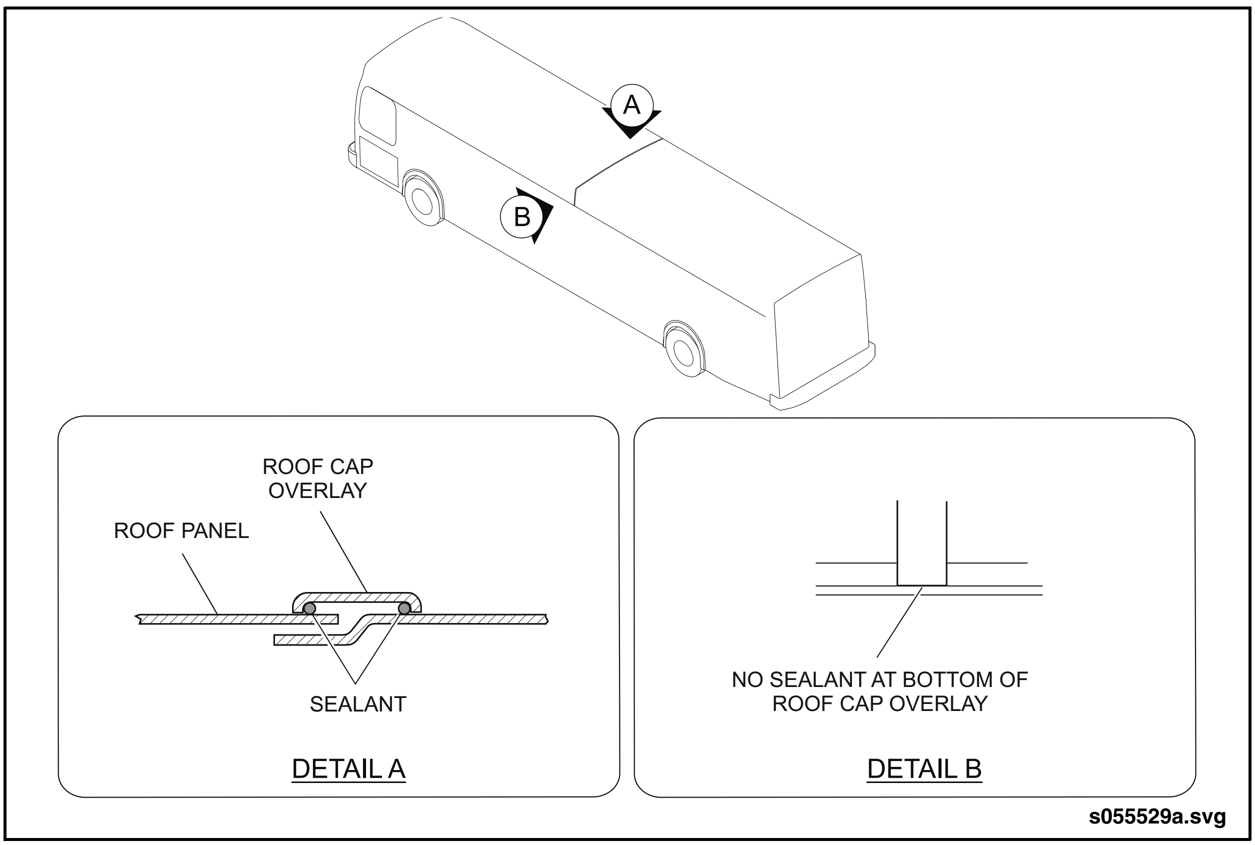


Fig. 13-8: Roof Cap Overlay Installation

2.12. Fiberglass Panels

2.12.1. Fiberglass Panel Repair

Fiberglass parts are repaired by filling the damaged area with fiberglass cloth and resin or strand fiberglass and resin. The repair should be allowed to harden before finishing. 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 later under respective headings. For best results, the ambient temperature should be 70 to 75°F for repairs.

CAUTION

Some people experience a skin reaction to resins. When and if this happens, wipe off skin with denatured alcohol or a good thinner. There are several protective hand creams on the market and use of one of these creams is recommended.

If any disc grinding or sanding is to be done in an enclosed area, a respirator should be used. Goggles should also be worn whenever grinding or sanding is done.

Extreme care must be taken if sander is electrically operated as dust of some resins is combustible when subjected to sparks or open flame.

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 attachment. 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 (No. 150 grit or finer), scissors or tin snips, wax paper or cellophane sheets, small 3" paint roller, paint brush, putty knife, acetone and one or more heat lamps.

2.12.1.1.Using Fiberglass Cloth

1. Where necessary, sand paint away around damaged area. On underside of vehicle, scrape away undercoating from damaged area and wipe clean with solvent. Grind or file 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 to be repaired will improve the adhesion of the resin.

2. If paneling is warped from original shape, use C-clamps and improvised clamp plates to align surfaces.
3. Preheat area to be repaired using one or two heat lamps positioned 12 to 15" from repair.

⚠ **CAUTION**

200°F is the high limit for this material and to go higher will risk material distortion or crystallization.

4. Cut fiberglass cloth with scissors or tin snips one to three inches larger than area to be repaired. Build-up area to desired height.
5. Mix desired quantity of resin and hardener to one quart of Vibrin 135 resin. Do not use wax cups for mixing and do not allow resin to enter hardener can or vice versa. Mixture which is too thin can be thickened to desired consistency by adding powdered filler. Two tablespoons of filler to 1/2 pint of mix will usually supply desired consistency.
6. Saturate layers of fiberglass with mixture, then place laminates over damaged area. Smooth out wrinkles and make sure general contour of area is maintained. Bubbles and wrinkles can be rolled out using a roller.

⚠ **CAUTION**

Once the resin and hardener have been mixed, the pot-life (working time) of the mix is approximately 15 minutes. Any accidental contamination to the skin, clothing, tools and so forth must be removed within this period. Use acetone to remove uncured resin.

7. Heat resin material again placing lamps 12 to 15" 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. Feather edge and sand.
8. After making repair, small pits or irregularities may appear in finished surfaces. Imperfections should be repaired using a liberal amount of chopped strand or filler mixed with resin to form a paste. Refer to 2.12.1.2. “Using Fiberglass Paste” on page 25 in this section for procedure.

2.12.1.2.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 vehicle, scrape away undercoating from damaged area and wipe clean with solvent.

Preheat the area to be repaired using heat lamps. Mix desired quantity of resin and hardener (refer to manufacturer’s instructions on container). Add powdered fiberglass strand into mixture to thicken it into a putty state. If repair is to be made on a vertical surface several layers of material may be used.

A hacksaw blade held flat to adjacent contour and then pulled, using sawing action across repair when the resin is in the jell stage, will remove excess resin from repair. Finish repair in the same manner as when using fiberglass cloth.

2.12.2. Gelcoat Finish

2.12.2.1. Gelcoat Surface Repair

This first procedure covers any small chips or scratches in the fiberglass panel Gelcoat surface.

1. Inspect the panel and mark any chips, pits or small scratches in the Gelcoat surface.

☞NOTE:

Refer to 2.12.4. "Larger Fiberglass Panel Damage" on page 27 *in this section for preliminary repair work that must be done before the gelcoat side is repaired, if the panel has damage greater than superficial chips, scratches or small cracks.*

2. Use acetone to clean around the area to a radius of 1/2 to 3/4", depending on the size of the chip or scratch.
3. Sand rough edges with coarse sandpaper (80 to 90 grit) to roughly feather out to the smooth surface.
4. Mask off the area and apply a layer of Gelcoat finishing putty over the prepped area.

☞NOTE:

The Gelcoat putty is prepared by mixing colored Gelcoat with powdered fiberglass filler. Add two drops of Cadox catalyst to a teaspoon (tsp.) size lump of Gelcoat mix. Vary this formula proportionally for larger mixes. Depending on ambient temperature and humidity, the average pot life (working time) is approximately 15 minutes.

5. Apply heat to speed hardening. Use a hot air gun or heat lamps. A safe heat range for this process is 150 to 200°F (66 to 93°C). Move the hot air gun continually over the curing surface. Place heat lamps, if used, 12 to 15" from the surface and continually monitor the curing process.

⚠CAUTION

DO NOT overheat, as this will cause yellow discoloring of the white Gelcoat.

6. Wet sand the cured filler in increasing grit stages, working from 400, 600, 1200, and 1200 micro-fine wet sanding paper.
7. Buff polish the finished area starting with medium-cut cleaner buffing compound and finishing with a fine cleaner buffing compound.

2.12.3. Preprimed Finish

Preprimed Fiberglass Panel Paint Preparation

1. Wash down panel with a degreasing and cleaning solution.
2. Sand panel with 360 grit sandpaper.
3. Buff with 600 grit Scotch sanding pad.
4. Air blow dust off panel.
5. Wash down with a degreasing and cleaning solution.
6. Fill any pits or scratches with fine spot putty.
7. Fine sand and blow off residual dust.

2.12.4. Larger Fiberglass Panel Damage

Larger fiberglass panel damage can be repaired by applying fiberglass matting to the back of the panel (non-gelcoat side).

1. Mark the damaged area, leaving approximately a 2 to 3" overlap. Cut and trim a piece of fiberglass matting to fit within the overlapped area.
2. Roughen the marked area with coarse grit emery paper. Wipe the area with acetone to remove any traces of grease or oil. Wipe dry.
3. Prepare enough fiberglass resin to thoroughly saturate the fiberglass matting patch.

☞NOTE:

DO NOT use excess hardener as this will actually hinder the fiberglass and resin compound from curing properly. A properly mixed ratio of resin to hardener compound will have a pot life of approximately 15 to 20 minutes. Air temperature and humidity also affect the curing time of the resin/ hardener compound. The optimum temperature should be 70 to 75°F (21 to 24°C) with relatively low humidity. Lower temperatures and high humidity will cause longer curing time.

4. Wet the fiberglass matting completely with resin. Position the resin soaked fiberglass matting within the marked area.
5. Thoroughly work into place using a brush or small roller. If the damaged area needs to be built up, apply successive layers of fiberglass matting. The resin can also be thickened by adding filler powder.

☞NOTE:

Don't over-thicken, as the matting must still be able to be thoroughly soaked for proper application.

6. After the patch has cured, lightly disk sand any exceptionally rough or high spots.
7. Turn the panel over and repair the gelcoat side. Refer to 2.12.2.1. "Gelcoat Surface Repair" on page 26 in this section for procedure.

2.13. Painting Procedures & Preparation (Single Stage)

This information provides guidelines and data for prepping, priming and topcoating of the major substrates used on New Flyer vehicles. Following this information and applying normal paint shop professional application procedures will ensure surface finishes that will meet optimum OEM standards. Always apply all relevant paint shop safety procedures and guidelines for a safe working environment.

CAUTION

These products are intended for Industrial Use and should only be used by professionally trained personnel using proper safety equipment. Follow all proper safety precautions regarding spray painting.

Use a filtering mask with the proper filter cartridges for this type of paint. Wear eye protection, protective gloves and proper protective clothing.

The paint booth or work area must be properly exhausted, using explosion proof ventilation equipment to remove fumes and over spray. Air make-up induction fans should also be used to supply fresh air to the work area.

The painting area should be a safe distance from any source of flame, spark or other means of combustion. Atomized paint, thinner, cleaner and solvent fumes are highly volatile with an extremely low flashpoint that can cause explosive combustion. Do not smoke or permit anyone else to smoke in or near the painting area.

2.13.1. Substrate Treatment Preparation

2.13.1.1.Stainless Steel

1. Wash surface with Axalta Chromax 3939S lacquer and enamel cleaner.
2. Alternatively, spot blast around rivet heads.
3. Scuff surface with 80 grit sandpaper, using dual action sander.
4. Clean with Axalta Chromax 3939S lacquer and enamel cleaner.
5. Apply primer. Refer to 2.13.1.4. “Primer” on page 28 in this section for procedure.

2.13.1.2.Aluminum

1. Wash surface with soap and water.
2. Scuff with Scotch Brite 7447 (red).
3. Clean with Axalta Chromax 3909S low VOC surface cleaner.
4. Apply primer. Refer to 2.13.1.4. “Primer” on page 28 in this section for procedure.

2.13.1.3.Fiberglass

1. Clean surface with Axalta Chromax 3909S low VOC surface cleaner.
2. Scuff with Scotch Brite 7447 (red) or sand with 400 grit sandpaper by hand or 320 grit DA.
3. Clean with Axalta Chromax 3909S low VOC surface cleaner.
4. Apply primer. Refer to 2.13.1.4. “Primer” on page 28 in this section for procedure.

2.13.1.4.Primer

1. Blend equal parts of Axalta Chromax 2540S epoxy primer with equal parts of Axalta Chromax 2505S epoxy activator. allowing for a 30 minute induction period.
2. Apply one full wet coat to achieve recommended film build of 0.7 to 1.0 dry film thickness.
3. Air dry primer for one hour at 75°F (24°C) or bake at 140°F (60°C) for 30 minutes.
4. Primer must be scuffed if not top-coated within 24 hours.

2.13.1.5.Spot Primer

☞**NOTE:**

Small imperfections may be filled with DGP 41/42 spot putty.

1. Mix 4 parts of Axalta 373P26339 fill primer with 1 part 15305S activator and 1 part DT reducer.
2. Apply 2 to 3 full wet coats to achieve a recommended dry film thickness of 2 to 4 mils.
3. Allow to dry from 1 to 2 hours. Sand with 400 to 600 grit sandpaper. Spot primer may be force dried for 30 minutes at 140°F (60°C).
4. Apply single-stage topcoat.

2.13.2. Single Stage Topcoat

Use Imron Elite Productive Topcoat (EX Quality) with any of the following activators:

- ❒ 15303S™ Low Temp Activator, 15305S™ Mid Temp Activator
- ❒ 15307S™ High Temp Activator
- ❒ 15308S™ Very High Temp Activator

2.13.2.1.Mix Ratio

Thoroughly mix prior to activation. The use of a Cyclone® shaker is recommended. Combine components and mix thoroughly. Filter material prior to spray application.

2.13.2.2.Component Volume

3 parts Imron Elite Productive Topcoat (EX Quality)

1 part Activator 15303S, 15305S, 15307S, or 15308S

2.13.2.3.Additives

- ❒ Pot Life Extension - Add 2 oz. 189S™ Accelerator per RTS gallon.
- ❒ Increased cure (small area repair, stripes) - Add up to 2 oz. 389S™ Accelerator per RTS gallon.

☞**NOTE:**

Accelerator 8989S™ will shorten pot life and is not recommended.

2.13.2.4.Viscosity

Depending on color, the activated paint will have a viscosity of 10-20 seconds in a #3 Zahn cup.

2.13.2.5.Pot Life - 70°F (21°C)

- ❒ 30 minutes as activated
- ❒ 1 hour with 189S accelerator
- ❒ 45 minutes with 389S accelerator

2.13.2.6.Application Equipment

Refer to spray equipment documentation for setting recommendations.

- ❒ Pressure Pot (recommended)
- ❒ Gravity Feed
- ❒ Suction Spray
- ❒ Air-Assisted Airless

2.13.2.7.Application Conditions

Do not apply if material, substrate or ambient temperature is less than 50°F (10°C) or above 110°F (43°C). The substrate must be at least 5°F (3°C) above the dew point. Relative humidity should be below 90%.

2.13.2.8.Application Process

- ❒ Pressure pot fluid delivery should be set for 10-12 ounces per minute.
- ❒ Apply using a cross-coat technique - a wet coat using a top-to-bottom motion and a medium-wet second coat using a side-to-side motion. Flash 30 seconds to 5 minutes between coats. In general, the shorter the flash the smoother the appearance.
- ❒ When recoating Imron Elite Productive Topcoat with itself, sanding is required if the enamel has air dried more than 16 hours or has been force dried.

2.14. Painting Procedures & Preparation (Basecoat/Clearcoat)

This information provides guidelines and data for prepping, priming and topcoating of the major substrates used on New Flyer vehicles. Following this information and applying normal paint shop professional application procedures will ensure surface finishes that will meet optimum OEM standards. Always apply all relevant paint shop safety procedures and guidelines for a safe working environment.

CAUTION

These products are intended for Industrial Use and should only be used by professionally trained personnel using proper safety equipment. Follow all proper safety precautions regarding spray painting.

Use a filtering mask with the proper filter cartridges for this type of paint. Wear eye protection, protective gloves and proper protective clothing.

The paint booth or work area must be properly exhausted, using explosion proof ventilation equipment to remove fumes and over spray. Air make-up induction fans should also be used to supply fresh air to the work area.

The painting area should be a safe distance from any source of flame, spark or other means of combustion. Atomized paint, thinner, cleaner and solvent fumes are highly volatile with an extremely low flashpoint that can cause explosive combustion. Do not smoke or permit anyone else to smoke in or near the painting area.

2.14.1. Substrate Treatment Preparation

2.14.1.1. Stainless Steel

1. Wash surface with Axalta Chromax 3939S lacquer and enamel cleaner.
2. Alternatively, spot blast around rivet heads.
3. Scuff surface with 80 grit sandpaper, using dual action sander.
4. Clean with Axalta Chromax 3939S lacquer and enamel cleaner.
5. Apply primer. Refer to 2.13.1.4. “Primer” on page 28 in this section for procedure.

2.14.1.2. Aluminum

1. Wash surface with soap and water.
2. Scuff with Scotch Brite 7447 (red).
3. Clean with Axalta Chromax 3909S low VOC surface cleaner.
4. Apply primer. Refer to 2.13.1.4. “Primer” on page 28 in this section for procedure.

2.14.1.3. Fiberglass

1. Clean surface with Axalta Chromax 3909S low VOC surface cleaner.
2. Scuff with Scotch Brite 7447 (red) or sand with 400 grit sandpaper by hand or 320 grit DA.
3. Clean with Axalta Chromax 3909S low VOC surface cleaner.
4. Apply primer. Refer to 2.13.1.4. “Primer” on page 28 in this section for procedure.

2.14.1.4. Primer

1. Blend equal parts of Axalta Chromax 2540S epoxy primer with equal parts of Axalta Chromax 2505S epoxy activator. allowing for a 30 minute induction period.
2. Apply one full wet coat to achieve recommended film build of 0.7 to 1.0 dry film thickness.
3. Air dry primer for one hour at 75°F (24°C) or bake at 140°F (60°C) for 30 minutes.
4. Primer must be scuffed if not top-coated within 24 hours.

2.14.1.5.Spot Primer

☞NOTE:

Small imperfections may be filled with DGP 41/42 spot putty.

1. Mix 4 parts of Axalta 373P26339 fill primer with 1 part 15305S activator and 1 part DT reducer.
2. Apply 2 to 3 full wet coats to achieve a recommended dry film thickness of 2 to 4 mils.
3. Allow to dry from 1 to 2 hours. Sand with 400 to 600 grit sandpaper. Spot primer may be force dried for 30 minutes at 140°F (60°C).
4. Apply basecoat/clearcoat.

2.14.2. Basecoat

Use Imron Elite Productive Basecoat (EW Quality) with any of the following activators:

- ❒ 1530XS Activator
- ❒ 15303S™ Low Temp Activator
- ❒ 15305S™ Mid Temp Activator
- ❒ 15307S™ High Temp Activator

2.14.2.1.Mix Ratio

Thoroughly mix prior to activation. The use of a Cyclone® shaker is recommended. Combine components and mix thoroughly. Filter material prior to spray application.

2.14.2.2.Component Volume

3 parts Imron Elite Productive Basecoat (EW Quality)

1 part Activator 1530XS, 15303S, 15305S, or 15307S.

2.14.2.3.Additives

- ❒ Pot Life Extension - Add 2 oz. 189S™ Accelerator per RTS gallon.
- ❒ Increased cure (small area repair, stripes) - Add up to 2 oz. 389S™ Accelerator per RTS gallon or add up to 1 oz. 8989S per RTS gallon.

☞NOTE:

Accelerator 389S or 8989S™ will shorten pot life and is not recommended.

2.14.2.4.Viscosity

Depending on color, the activated paint will have a viscosity of 10-18 seconds in a #3 Zahn cup.

2.14.2.5.Induction Time

No induction time required

2.14.2.6.Pot Life - 70°F (21°C)

- ❒ 30 minutes as activated
- ❒ 1 1/2 hour with 189S accelerator
- ❒ 45 minutes with 389S accelerator
- ❒ 20 minutes with 8989S accelerator

2.14.2.7.Application Equipment

Refer to spray equipment documentation for setting recommendations.

- ❒ Pressure Pot (recommended)
- ❒ Gravity Feed
- ❒ Suction Spray
- ❒ Air-Assisted Airless

2.14.2.8.Application Conditions

Do not apply if material, substrate or ambient temperature is less than 50°F (10°C) or above 110°F (43°C). The substrate must be at least 5°F (3°C) above the dew point. Relative humidity should be below 90%.

2.14.2.9.Application Process

- ❐ Pressure pot fluid delivery should be set for 10-12 ounces per minute.
- ❐ Apply using a cross-coat technique - a wet coat using a top-to-bottom motion and a medium-wet second coat using a side-to-side motion. Flash 30 seconds to 5 minutes between coats. In general, the shorter the flash the smoother the appearance.
- ❐ When recoating Imron Elite Productive Basecoat with itself, sanding is required if the enamel has air dried more than 16 hours or has been force dried.
- ❐ Basecoat must be clearcoated

2.14.2.10.Drying Times

The following drying times are based on 77°F ((25°C) and 50% relative humidity at the recommended film thickness and using 189S accelerator and 15305S activator:

- ❐ Dry to touch - 30 minutes
- ❐ Tack free - 60 minutes
- ❐ Tape free (solids) - 90 minutes
- ❐ Tape free (metallics) - 90 minutes
- ❐ Dry to clearcoat - 30 minutes to 16 hours

☞**NOTE:**

Activator 15303S and 15307S can be used at the prescribed ratio to adjust spray latitude for overspray melt-in and drying and tape times.

2.14.3. Clear Coat

Use Imron Elite 8430S Clearcoat with any of the following activators:

- ❒ 15303S™ Low Temp Activator
- ❒ 15305S™ Mid Temp Activator
- ❒ 15307S™ High Temp Activator
- ❒ 15308S™ Very High Temp Activator

2.14.3.1.Mix Ratio

Thoroughly mix prior to activation. Combine components and mix thoroughly. Filter material prior to spray application.

2.14.3.2.Component Volume

2 parts Imron Elite 8430S Clearcoat

1 part Activator 15303S, 15305S, 15307S, or 15308S.

2.14.3.3.Additives

Pot Life Extension and improve dry time - Add up to 2 oz. 189S™ accelerator per activated gallon.

2.14.3.4.Viscosity

A viscosity of 12-14 seconds in a #3 Zahn cup.

2.14.3.5.Pot Life - 70°F (21°C)

- ❒ 60 minutes as activated
- ❒ 90 minutes with 189S accelerator

2.14.3.6.Application Equipment

Refer to spray equipment documentation for setting recommendations.

- ❒ Pressure Pot (recommended)
- ❒ Gravity Feed
- ❒ Suction Spray

2.14.3.7.Application Conditions

Do not apply if material, substrate or ambient temperature is less than 50°F (10°C) or above 110°F (43°C). The substrate must be at least 5°F (3°C) above the dew point. Relative humidity should be below 90%.

2.14.3.8.Application Process

- ❒ Allow Axalta basecoat to dry 30 minutes prior to application of clearcoat.
- ❒ Apply 2 medium-wet coats to 1.8 to 2.5 mils dry film build. Flash 8-10 minutes between coats.
- ❒ For pressure pot application fluid delivery should be set for 10-12 fluid oz/min.
- ❒ Allowing air flow to continue in the booth for at least one hour following application of the clearcoat in air-dry situations is recommended.
- ❒ Adding 1 to 2 oz. / RTS Gal. of DuPont 459S™ anti-cratering additive is recommended to control defects caused by surface contamination
- ❒ Optimum polishing time: 2 to 48 hours after cool down if force dried, or 16 to 48 hours if air dried at 70°F (21°C).
- ❒ When recoating 8430S™ with itself, sanding is required if the enamel has air dried more than 16 hours or has been force dried.

3. BUMPERS

3.1. Front Bumper

3.1.1. Description

The front bumper is constructed of an extruded aluminum bumper structure fitted with three energy-absorbing rubber modules.

3.1.2. Removal

1. Raise the vehicle. Refer to the General Information Section of this manual for recommended lifting procedure.
2. Support the bumper.
3. Remove the bolts, washers and spacers that attach the bumper to the vehicle structure. Note the number of spacers that are used at each location. See “Fig. 13-9: Front Bumper Installation” on page 34.
4. Remove the bumper from the vehicle.
5. Remove and discard the neoprene bumper isolator from the bumper mount.

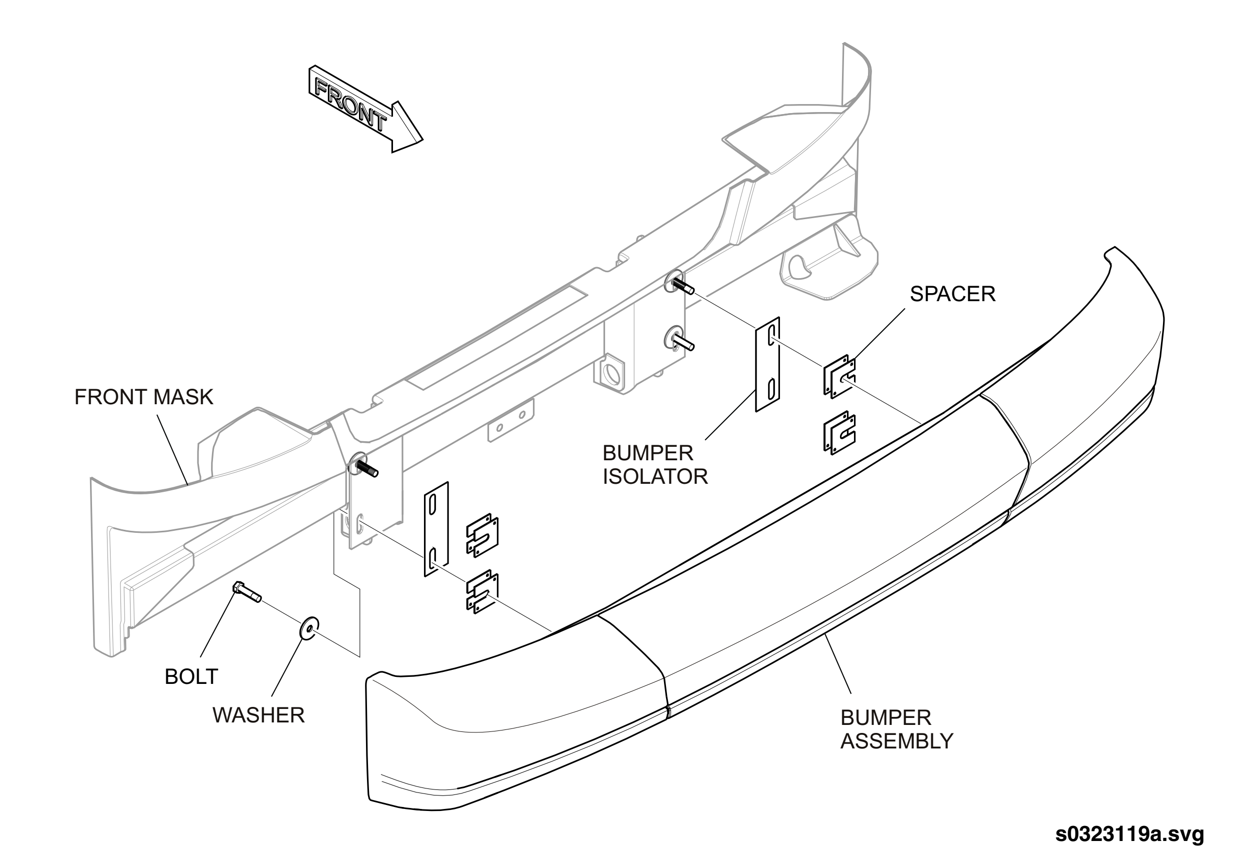


Fig. 13-9: Front Bumper Installation

3.1.3. Disassembly

1. Remove the screws securing the rubber modules to the bumper back structure. The modules consist of a center module and two corner modules.See “Fig. 13-10: Front Bumper Assembly” on page 35.
2. Slide off the corner modules from the bumper structure.
3. Slide off the center module from the bumper structure.

3.1.4. Assembly

1. Install the center module on the bumper structure by sliding the module rubber lip into the bumper groove. Check that the center module is centered on the bumper structure. The outer skin of the rubber module must wrap around the top and bottom of the bumper structure.
2. Secure the center module with self-tapping screws.
3. Slide the corner modules onto the bumper structure. The corner modules must be pushed flush against the center module.
4. Secure the corner modules with self-tapping screws.

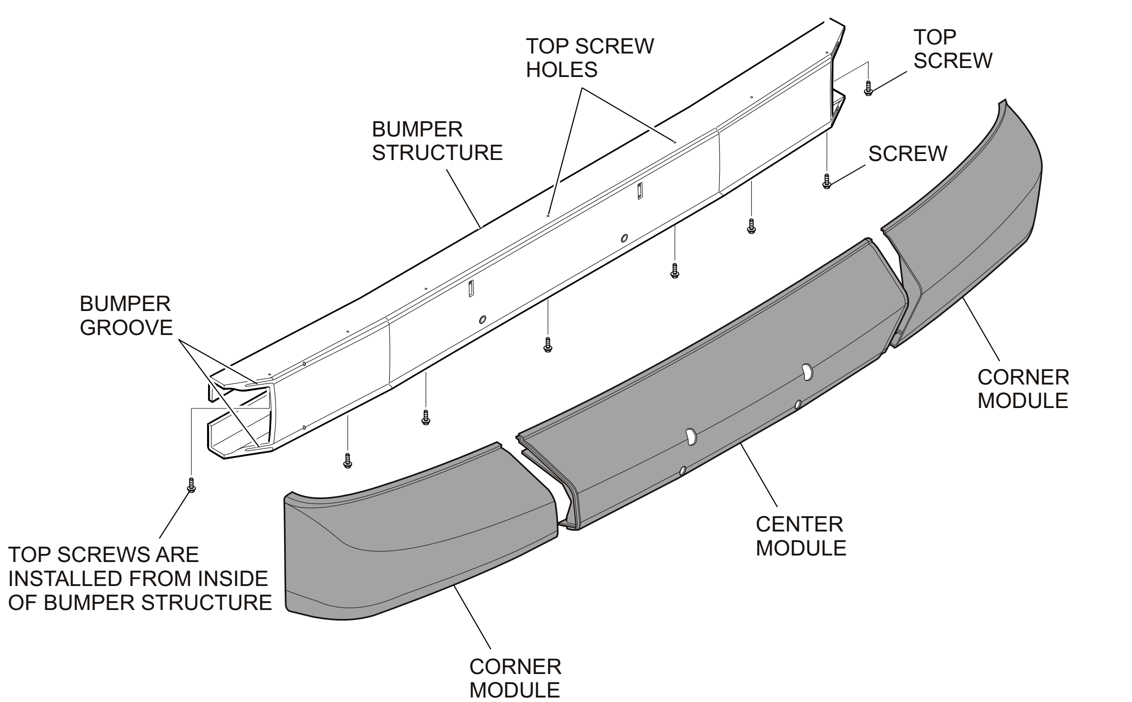


Fig. 13-10: Front Bumper Assembly

3.1.5. Installation

1. Install new neoprene bumper isolators on the vehicle structure mounts so that the adhesive side adheres to the mounts. The slots in the isolator must align with the slots on the mounts.
2. Place a washer on each bolt and apply Loctite 263 thread locker to the threads of the bolt.
3. Insert the bolt and washer from the back side of the bumper mounts.
4. Install the original number of spacers on each bolt as noted during removal.
5. Support the bumper and carefully move it into position so that the threaded holes in the bumper align with the mounting bolts.
6. Snug up the bolts while simultaneously positioning the bumper to achieve a consistent vertical gap of 0.21 in. (5 mm). between the top of the bumper and the front mask/wiper access door. See “Fig. 13-11: Front Bumper Gap Adjustment” on page 36.
7. Torque the bolts to 106 ft-lbs. (144 Nm).
8. Recheck the vertical gap.
9. Check the gap between each corner of the bumper and the front mask. Gap should be 0.12 +/- 0.06 in. (3 +/- 1.5 mm).
10. Readjust the corner gaps on the bumper, if necessary, by removing or adding spacers.

☞NOTE:

If mounting bolts are loosened, it will be necessary to reapply Loctite and retorque.

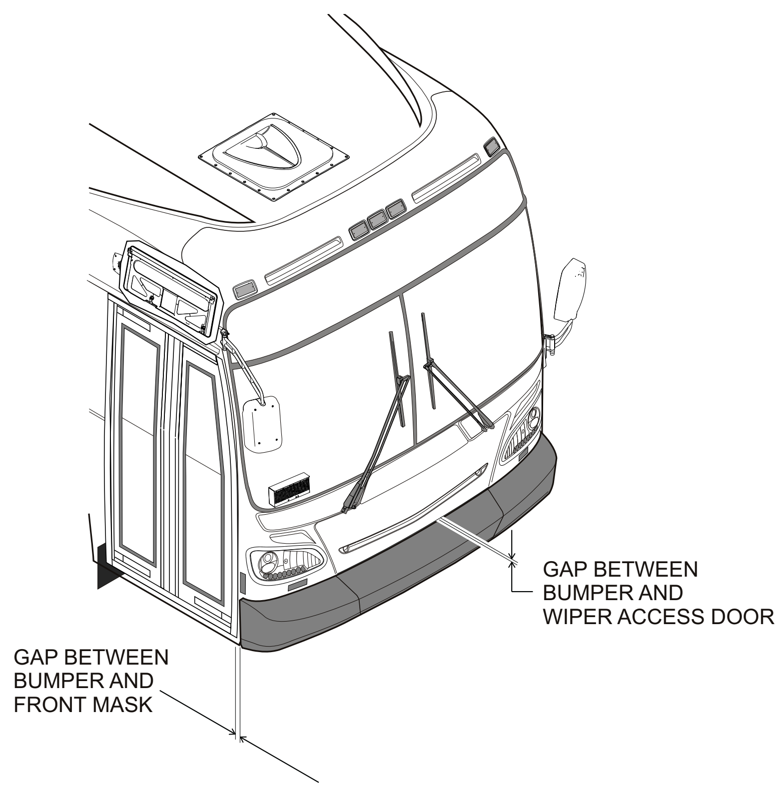


Fig. 13-11: Front Bumper Gap Adjustment

3.2. Rear Bumper

3.2.1. Description

The rear bumper is constructed of an extruded aluminum bumper structure fitted with three energy-absorbing rubber modules.

3.2.2. Removal

1. Raise the vehicle. Refer to the General Information Section of this manual for recommended lifting procedure.
2. Support the bumper.
3. Remove the bolts, washers and spacers that attach the bumper to the vehicle structure. Note the number of spacers that are used at each location. See “Fig. 13-12: Rear Bumper Installation” on page 37.
4. Remove the bumper from the vehicle.
5. Remove and discard the neoprene bumper isolator from the bumper mount.

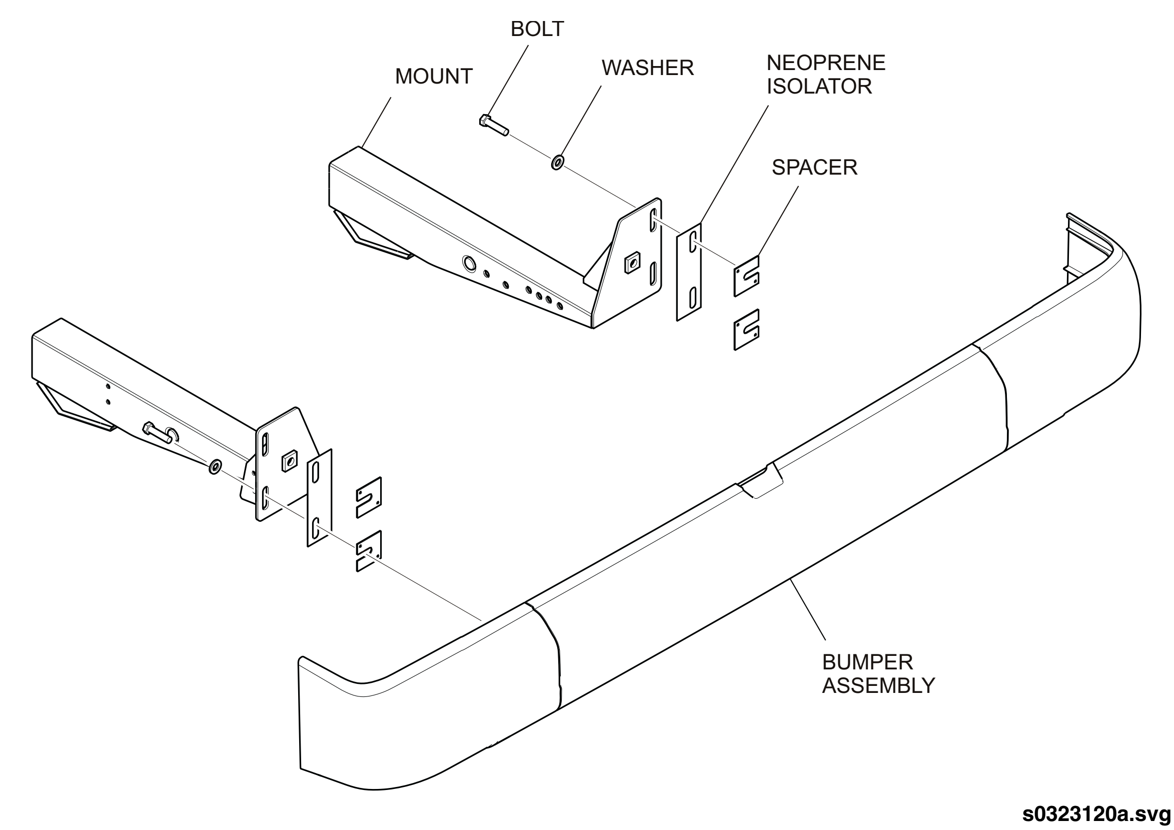


Fig. 13-12: Rear Bumper Installation

3.2.3. Disassembly

1. Remove the aluminum finger/splash guard from the bumper back structure. See "Fig. 13-13: Rear Bumper Assembly" on page 38.

   NOTE:

   It is not necessary to remove the finger/ splash guard if the bumper back structure is being reused.

2. Remove the screws securing the rubber modules to the bumper back structure. The modules consist of a center module and two corner modules.
3. Slide off the corner modules from the bumper structure.
4. Slide off the center module from the bumper structure.
5. Inspect the bumper strips to ensure the weld nuts are not damaged. Replace bumper strips as required.

   NOTE:

   The bumper strip consists of a plate and weld nut that is free to slide within the channel of the back structure.

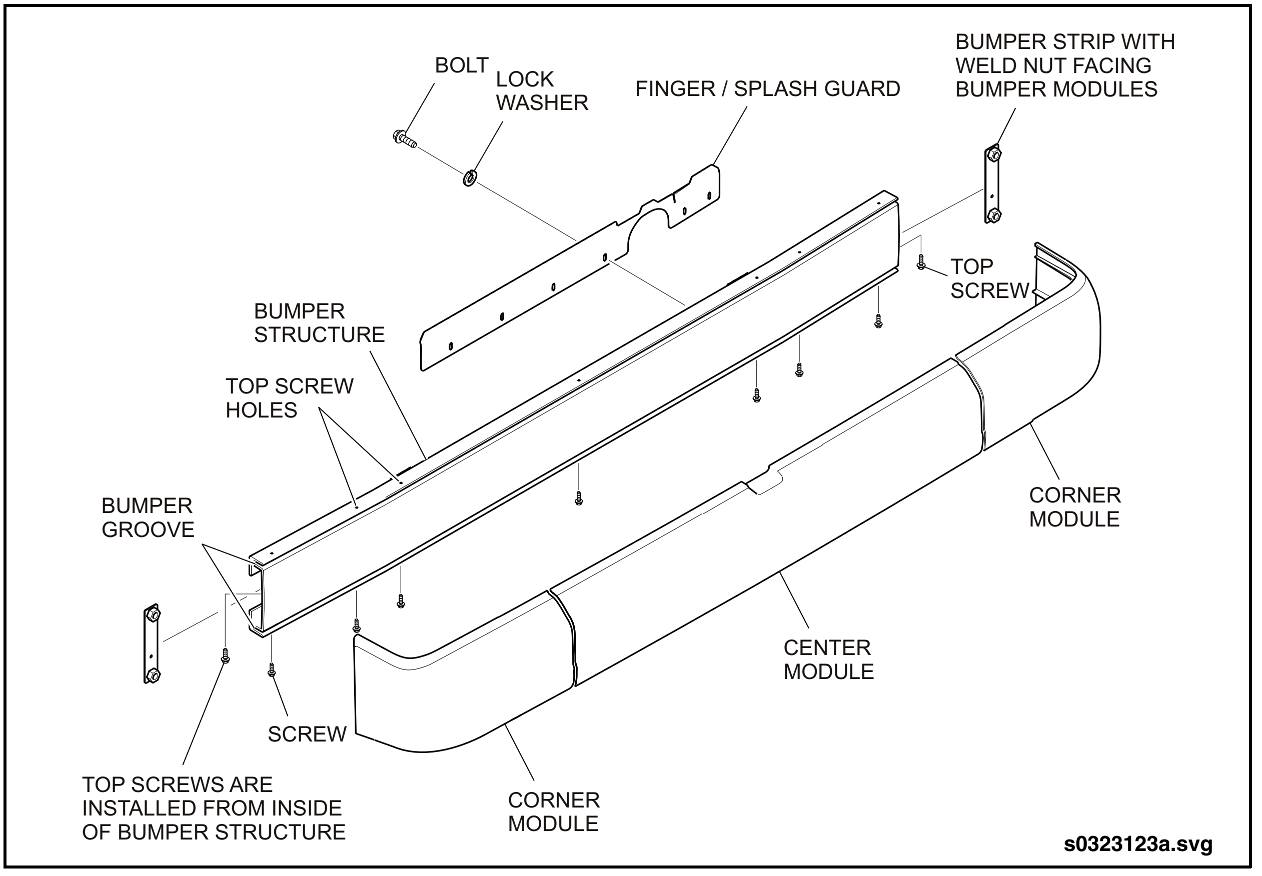


Fig. 13-13: Rear Bumper Assembly

3.2.4. Assembly

1. Install the center module on the bumper structure by sliding the module rubber lip into the bumper groove. Check that the center module is centered on the bumper structure. The outer skin of the rubber module must wrap around the top and bottom of the bumper structure.
2. Secure the center module with self-tapping screws.
3. Slide the corner modules onto the bumper structure. The corner modules must be pushed flush against the center module.
4. Secure the corner modules with self-tapping screws.

WARNING

Ensure that the finger/splash guard is adjusted so that fingers cannot pass through the opening and to provide maximum protection from water intrusion.

5. Apply Loctite 263 thread locker to the threads of the bolts and install the aluminum finger/splash guard. Ensure the upper lip of the guard is facing the inside of the engine compartment.

3.2.5. Installation

1. Install new neoprene bumper isolators on the vehicle structure mounts so that the adhesive side adheres to the mounts. The slots in the isolator must align with the slots on the mounts.
2. Place a washer on each bolt and apply Loctite 263 thread locker to the threads of the bolt.
3. Insert the bolt and washer from the back side of the bumper mounts.
4. Install the original number of spacers on each bolt as noted during removal.
5. Support the bumper and carefully move it into position so that it is centered on the vehicle structure.
6. Ensure the bumper strips are properly located within the back structure and the weld nuts are facing the rubber bumper modules.
7. Snug up the bolts while simultaneously positioning the bumper to achieve a consistent vertical gap of 0.28 to 0.38 in. (7 to 10 mm). between the top of the bumper and the engine access door. See "Fig. 13-14: Rear Bumper Gap Adjustment" on page 40.
8. Torque the bolts to 106 ft-lbs. (144 Nm).
9. Recheck the vertical gap.
10. Check the gap between each corner of the bumper and the respective radiator or battery or fusebox door. Gap should be 0.10 to 0.37 in. (3 to 9 mm).
11. Readjust the corner gaps on the bumper, if necessary, by removing or adding spacers.

☞**NOTE:**

If mounting bolts are loosened, it will be necessary to reapply Loctite and retorque.

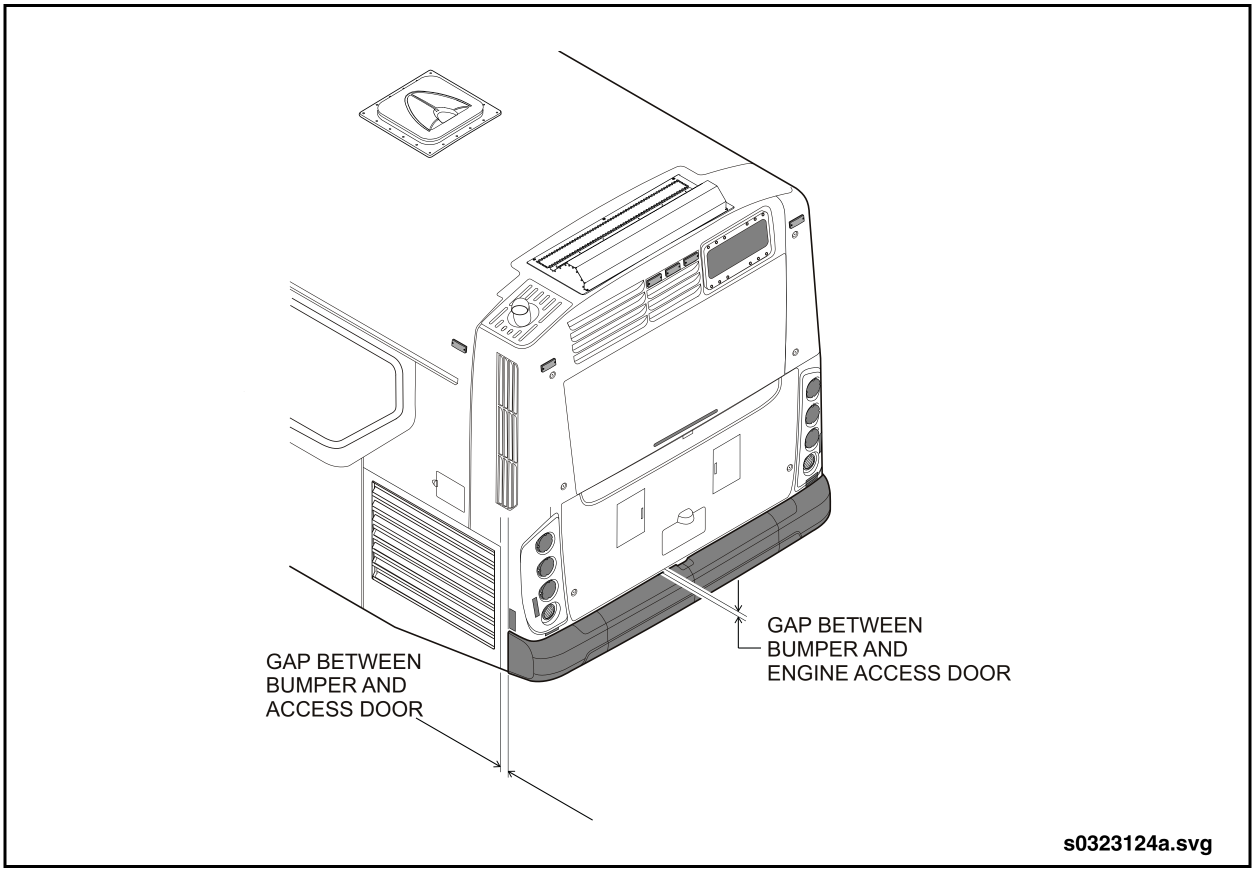


Fig. 13-14: Rear Bumper Gap Adjustment

3.2.6. Bumper Module Repair

Minor damage to the bumper modules, including scratches and gouges, can be repaired using the following procedure:

1. Clean and prepare the surface as follows:
   a. Clean and scuff the repair area using SEM Scuff and Clean #38338. Follow the manufacturer's instructions for cleaning. If plastic cleaner is not available, use soap and water to clean repair area followed by rinsing with clear water and drying.
   b. Prepare the substrate using SEM 3835 Plastic Prep. Follow the manufacturer's instructions for use.

   ☞**NOTE:**

   Lacquer thinner, acetone, alcohol, and similar solvents are not acceptable cleaners and may adversely affect the repair.

2. Use 80 grit sandpaper and sand the locally damaged area until all the paint is removed. Proceed to Step 3 for repairs involving minor surface imperfections or scratches. Proceed to Step 4 for repairs involving deep gouges.
3. Remove only enough material from the substrate to provide a roughened surface for the repair material to adhere.
4. Grind a V-groove in the damaged area using a 24 grit sanding disc.

   ☞**NOTE:**

   Grind or sand using low speed and light pressure to avoid heat buildup that could melt or smear the substrate and adversely affect the repair

5. Continue sanding approximately 4 to 5 inches beyond the repair area to remove the paint and provide a roughened surface to feather the repair material.
6. Clean surface as described previously in Step 1. Proceed to Step 7 for minor repair or proceed to Step 8 for deep gouge repair.
7. Mix equal amounts of 3M Structural Adhesive #8101 and apply per manufacturers instructions using a smooth plastic spatula. Press firmly into repair area to eliminate air pockets. Apply sufficient buildup of material to allow for sanding and blending to surrounding contours.
8. Mix equal amounts of Flexible SEM-Weld (either #39927 or #39928) and apply per manufacturers instructions using a smooth plastic spatula. Apply a sufficient amount of repair material to fill the damaged area and press firmly into repair area to eliminate air pockets. Apply sufficient buildup of material to allow for sanding and blending to surrounding contours.
9. Allow repair material to cure in accordance with manufacturer's recommendations. Proceed to Step 10 for minor repair or proceed to Step 11 for deep gouge repair.
10. Block-sand the repair area to the surrounding contours using 240 grit sandpaper. Finish sanding using 400 grit sandpaper.

    ☞**NOTE:**

    Any low spots or voids can be filled in with additional repair material. Minor pin holes can be repaired using PPG Spot Putty #DFL1 Dark Grey.

11. Block-sand the repair area to the surrounding contours using 80 grit sandpaper. Finish sanding using 180 grit sandpaper.

    ☞**NOTE:**

    Any imperfections can be filled by applying a skin-coat of additional repair material.

12. Top coat paint refinish the repair area as follows:
    a. Sand 3 to 4 inches around the repaired area using 240 grit followed by 400 grit sandpaper.
    b. Clean surface as described previously in Step 1.
    c. Apply two medium wet coats of SEM Bumper Coater (Black) #399103.

    ☞**NOTE:**

    Allow paint to cure 45 minutes to one hour between coats. Lightly sand between coats using 400 grit sandpaper.

3.2.6.1. Repair Materials

The following materials are commonly available from most automotive supply stores or automotive paint finishing suppliers:

- ❐ 3M #8101 Structural Adhesive
- ❐ SEM #3835 Plastic Prep
- ❐ SEM #39927 Flexible SEM-Weld (for large areas)
- ❐ SEM #39928 Flexible SEM-Weld (10 oz. tube for small areas)
- ❐ SEM #39103 Bumper Coater (Black)
- ❐ PPG Spot Putty #DFL1 Dark Grey

4. SPLASH GUARDS & MUD FLAPS

4.1. Splash Guards

4.1.1. Description

The vehicle is equipped with splash guards located along the span of the front and rear axles and mud flaps at each wheel housing. The splash guards and mud flaps contain splashing and spray from the wheels.

4.1.2. Front Splash Guard Replacement

1. Raise the vehicle to working height. Refer to the General Information Section of this manual for procedures.
2. Support the splash guard. See "Fig. 13-15: Front Splash Guard" on page 43.
3. Remove the bolts, tapping screws and retainers from the splash guard.
4. Remove the splash guard from the vehicle.
5. Installation is the reverse of removal. Do not overtighten the self-tapping screws.

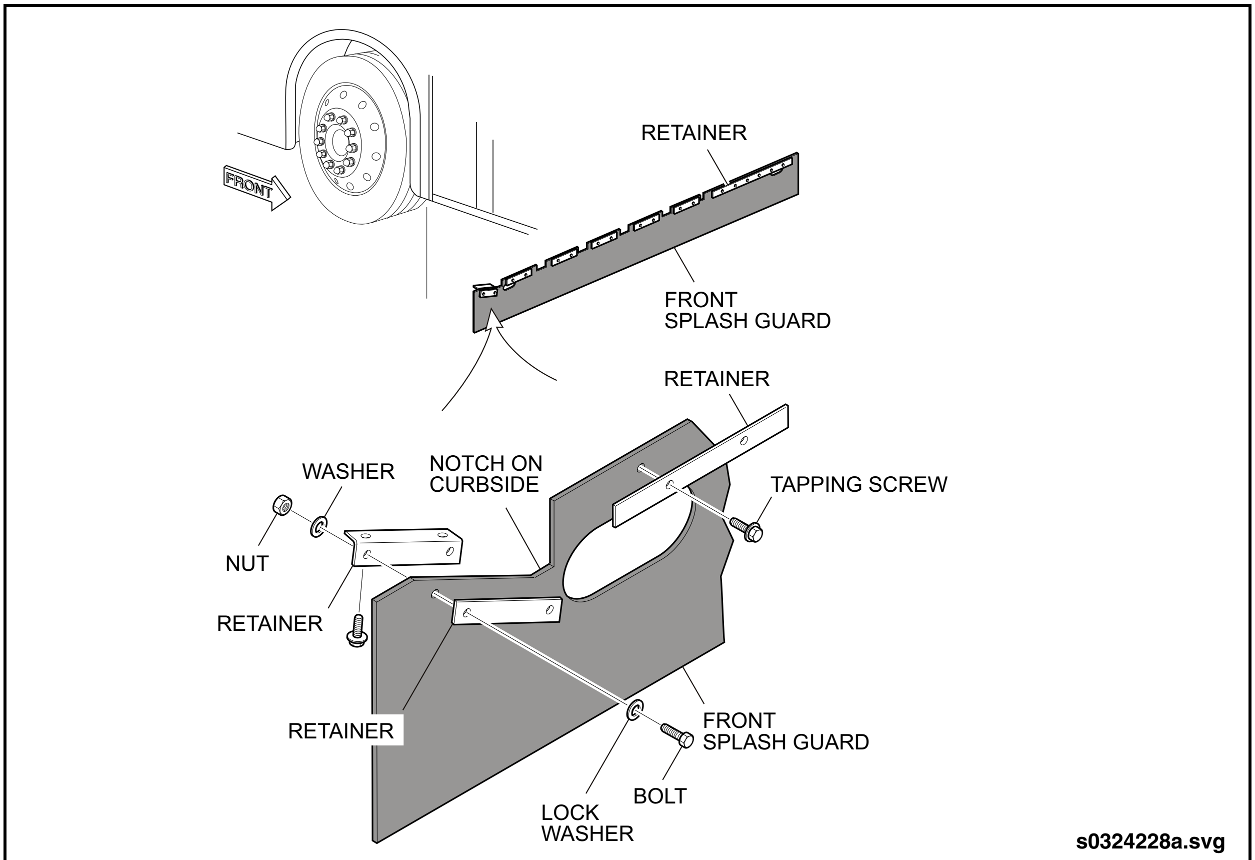


Fig. 13-15: Front Splash Guard

4.1.3. Rear Splash Guard Replacement

1. Raise the vehicle to working height. Refer to the General Information Section of this manual for procedures.
2. Support the splash guard. See "Fig. 13-16: Rear Splash Guard" on page 44.
3. Remove the bolts, lock nuts and retainers from the splash guard.
4. Remove the splash guard from the vehicle.
5. Installation is the reverse of removal.

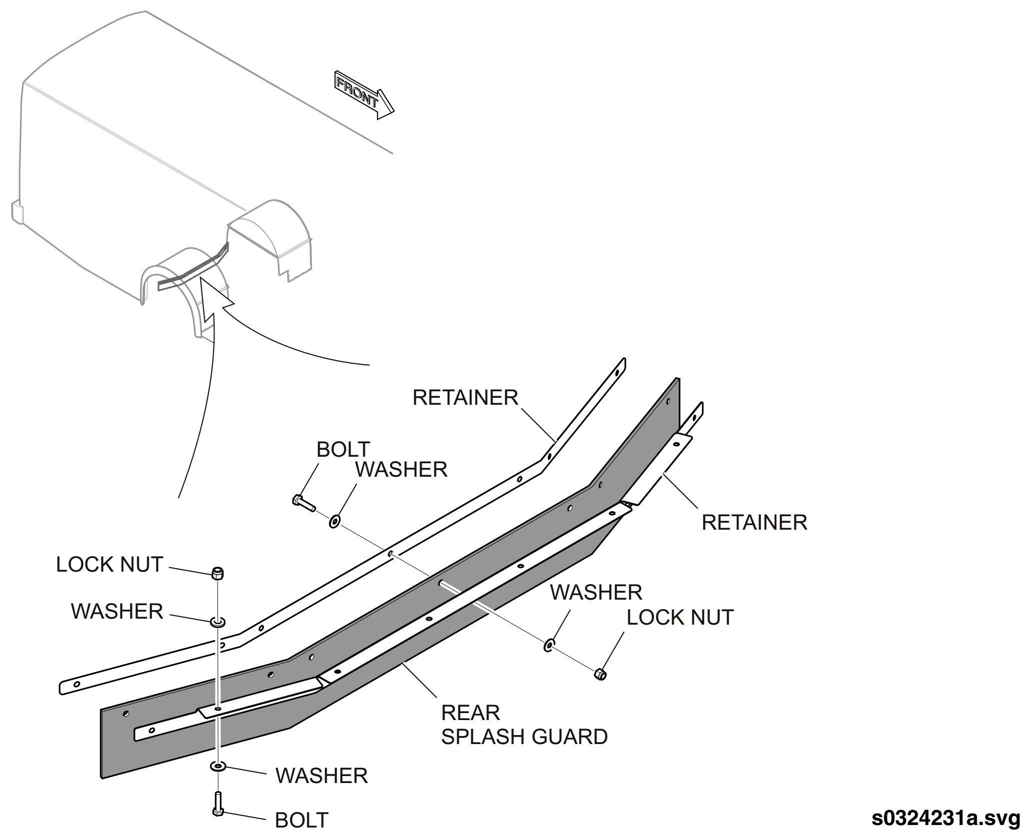


Fig. 13-16: Rear Splash Guard

4.2. Mud Flaps

4.2.1. Description

The vehicle is equipped with mud flaps at each wheel housing. The mud flaps contain splashing and spray from the wheels.

4.2.2. Front Mud Flap Replacement

1. Raise the vehicle to working height. Refer to the General Information Section of this manual for procedures.
2. Remove the bolts, lock nuts, tapping screws and retainers from the mud flap mount. See “Fig. 13-17: Front Mud Flap” on page 45.
3. Remove the mud flap from the vehicle.
4. Installation is the reverse of removal. Apply Never-Seez to the fasteners. Do not over-tighten tapping screws.

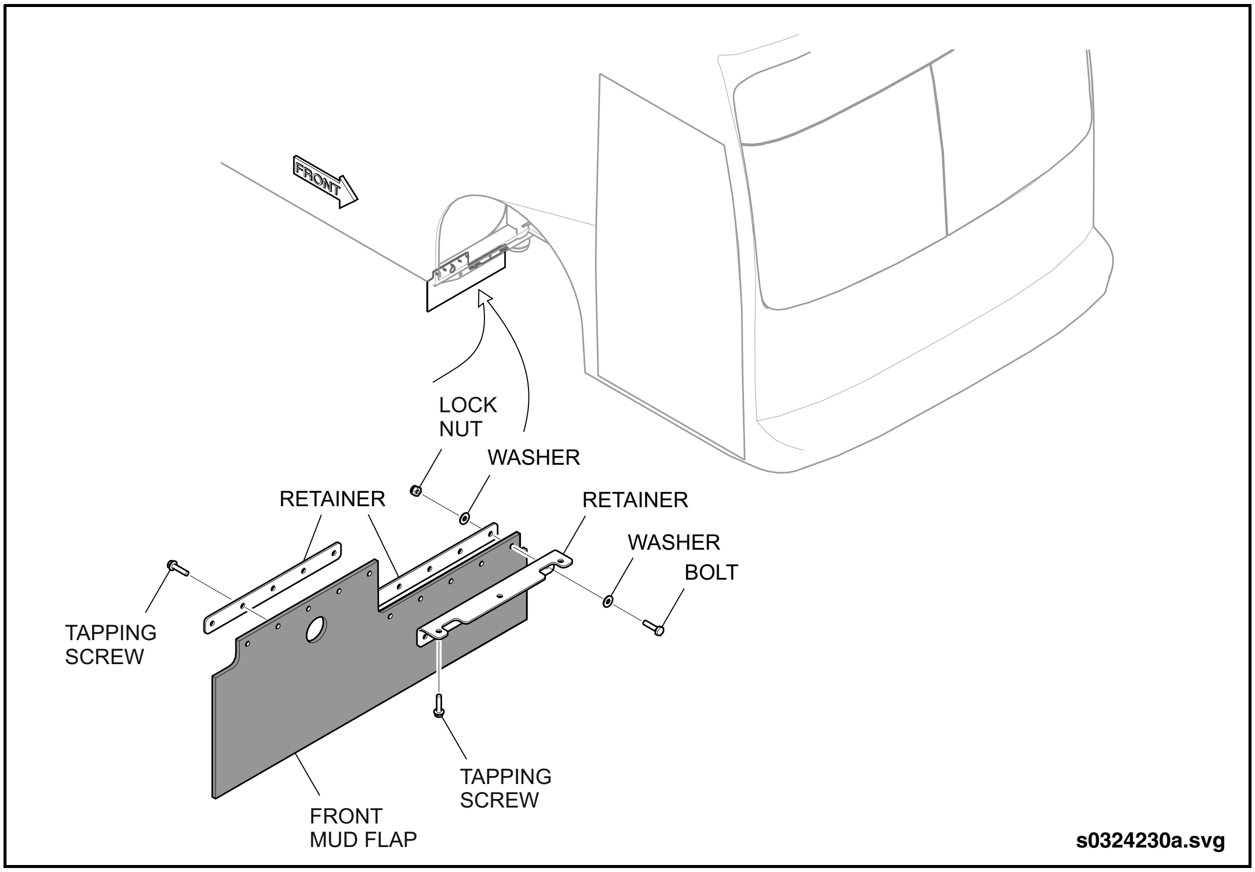


Fig. 13-17: Front Mud Flap

4.2.3. Rear Mud Flap Replacement

1. Raise the vehicle to working height. Refer to the General Information Section of this manual for procedures.
2. Remove the bolts, lock nuts and retainers from the mud flap mount. See “Fig. 13-18: Rear Mud Flap” on page 46.
3. Remove the mud flap from the vehicle.
4. Installation is the reverse of removal. Apply Never-Seez to the fasteners.

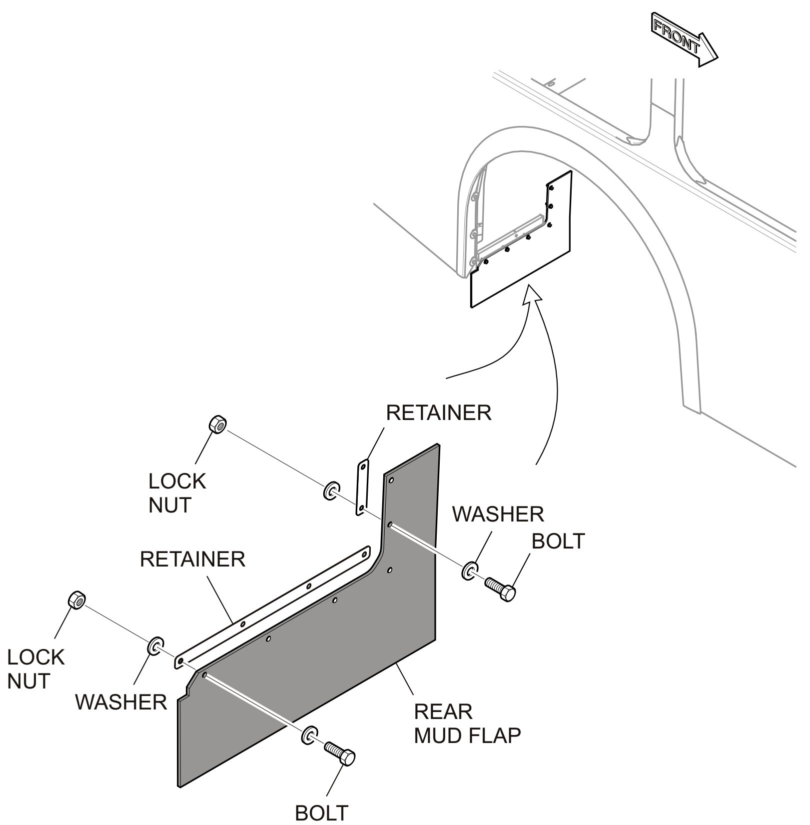


Fig. 13-18: Rear Mud Flap

5. S-1 GARD

5.1. Description

The S-1 Gard is a protective molded bumper mounted in front of the rear curbside wheels.

5.2. Operation

The S-1 Gard is designed as a contoured deflector shield that reduces the space between the bottom of the vehicle and the curb or road surface in front of the curbside wheels. Should an object fall in the proximity of the rear (or center) curbside wheels, the reduced gap created by the S-1 Gard contour is designed to reduce the possibility of the object being run over by the wheels of the vehicle.

5.3. Maintenance

Refer to the Preventive Maintenance section of this manual for scheduled maintenance procedures and intervals.

5.3.1. Removal

1. Raise the vehicle. Refer to the General Information Section of this manual for procedure.
2. Remove the 2 bolts and lock washers which secure the S-1 Gard into the receiver channel.
3. Slide the S-1 Gard out of the receiver channel.

5.3.2. Installation

1. Slide the S-1 Gard into the receiver channel.
2. Apply loctite 243 to mounting bolts. Secure the S-1 Gard in the channel with the mounting bolts and washers. S-1 Gard is correctly positioned when its outer edge is approximately 0.5" inboard of the first tire tread.
3. Torque bolts 53 ± 3 ft-lb. (72 ± 4 Nm).
4. Lower vehicle to the ground. With vehicle air system fully charged and ride height correctly set, S-1 Gard must have a ground clearance of 5.5".

6. MIRRORS

6.1. Exterior Mirrors

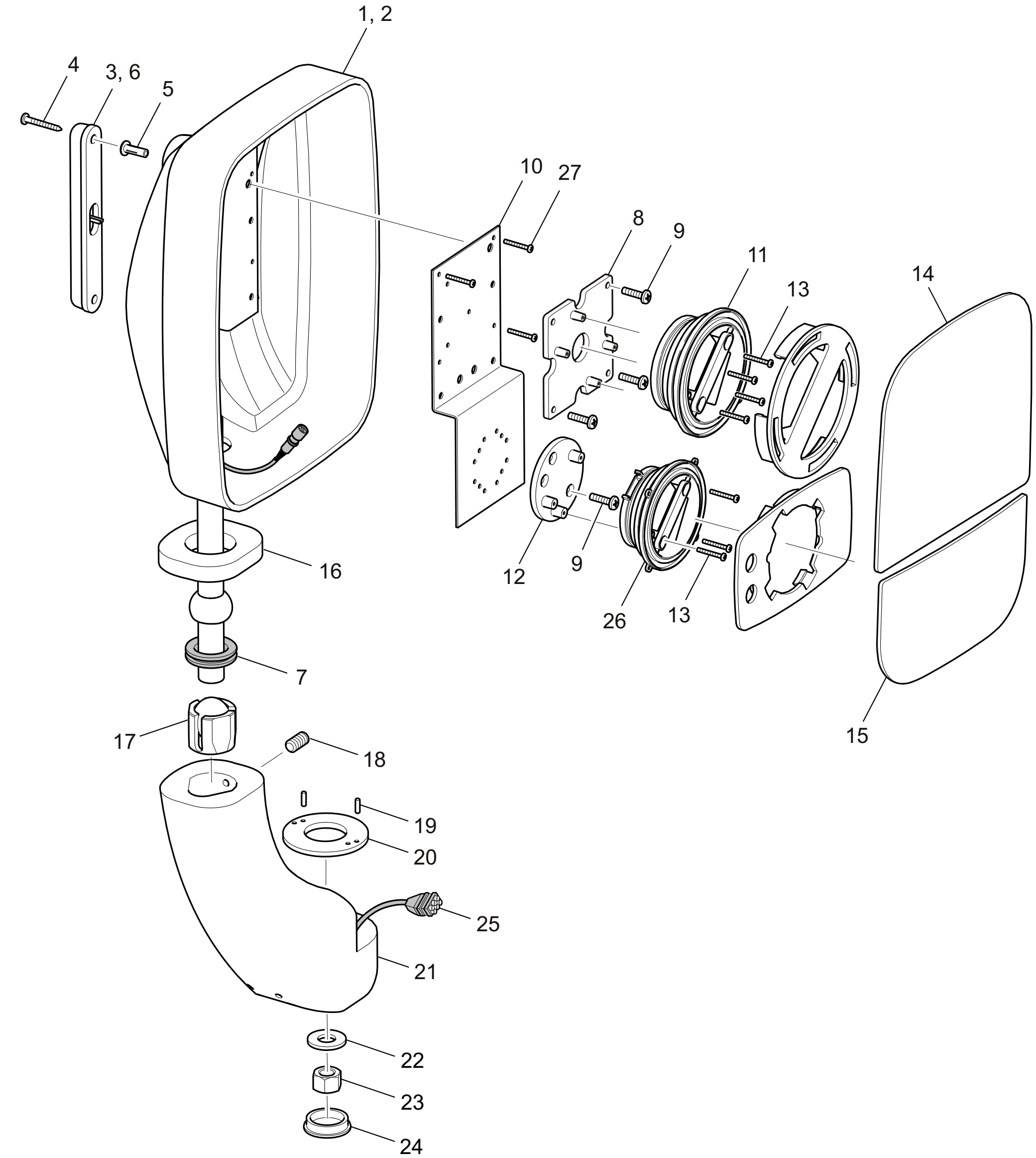
A curbside mirror and a driver's side mirror are provided on this vehicle.

6.1.1. Driver's Side Mirror

The mirror assembly is mounted forward of the lower front edge of the driver's window. It consists of a heated mirror head and support arm assembly. The mirror has upper flat rectangular and lower convex surfaces, and an integral turn signal light. See "Fig. 13-19: Exterior Driver's Side Mirror Assembly" on page 49.

6.1.2. Curbside Mirror

This mirror is located above and in front of the entrance door. It consists of a heated mirror assembly attached to a support arm which is connected to a chassis-mounted support housing. The mirror is a remotely-adjusted two-part assembly. It consists of an upper rectangular mirror, a lower convex mirror for wide angle viewing, and an integral turn signal light. See "Fig. 13-20: Exterior Curbside Mirror Assembly" on page 50.



1. Mirror Assembly, Driver's Side (Incl. 2-3, 7-27)
2. Housing, 8" x 11" w/ Insert
3. LED Light Assembly, 6" (Incl. 4-6)
4. Screw, Pan Head #8 - 32 x 1 1/4"
5. Plusnut, #8 - 32
6. LED, 12V Amber
7. Grommet
8. Plate, Motor Medium
9. Screw, #10 - 16 x 3/4" PH
10. Plate and Shaft
11. Motor, Manual
12. Plate, Small Motor
13. Screw, Pan HD #4 x 7/8" Lg.
14. Glass, Flat
15. Glass, Convex
16. Gasket, 1/2"
17. Collet, Coated 1.3125"
18. Screw, Set 3/8" - 16 x 1/2"
19. Pin, Roll .125" x .5625"
20. Race, Special
21. Arm, Mirror
22. Washer, Flat 1/2" SST
23. Nut, Stover 1/2" - 13 SST
24. Cap, Plastic Black
25. Harness, Mirror Arm
26. Mechanism, Tip Tap
27. Screw, #10 x 3/4" PH

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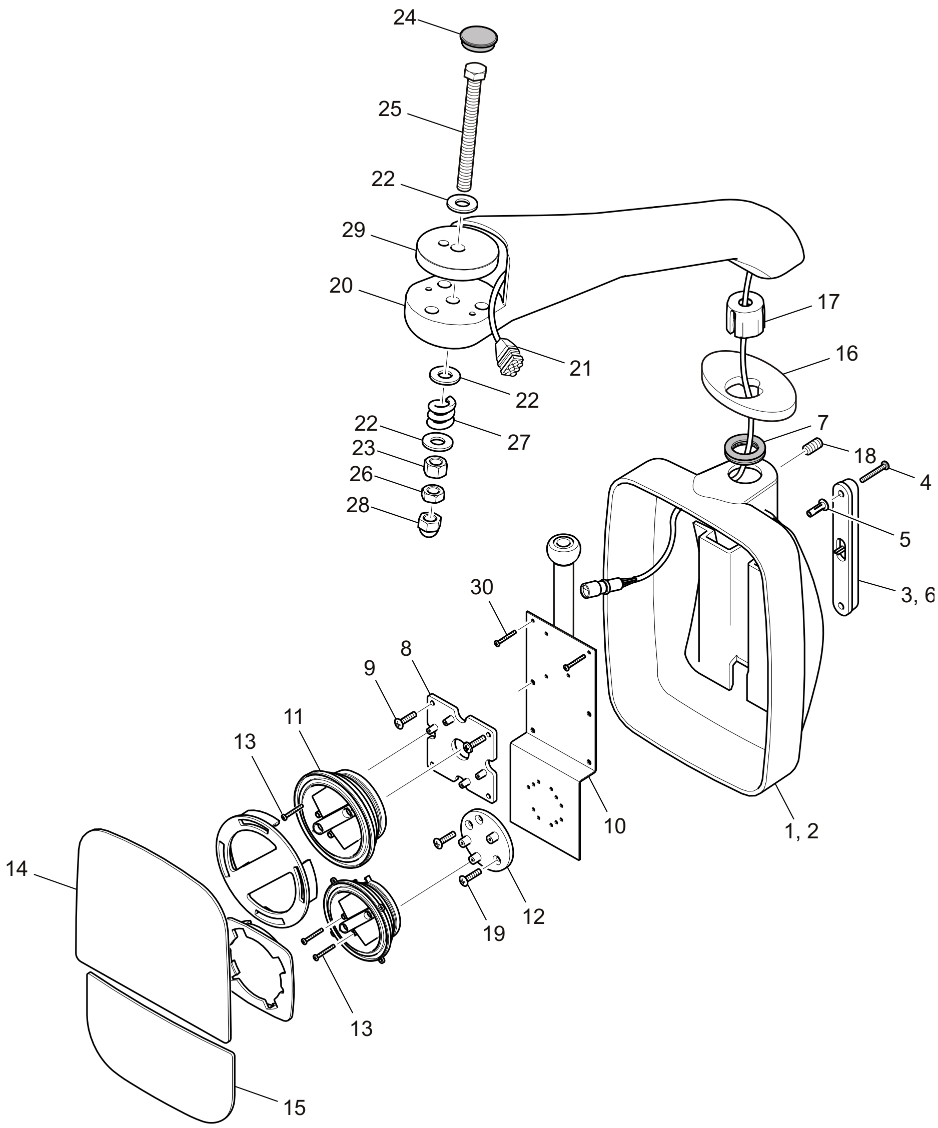
Fig. 13-19: Exterior Driver's Side Mirror Assembly



1. Mirror Assembly, Curbside (Incl. 2-3, 7-30)
2. Housing, 8" x 11" w/ Insert
3. LED Light Assembly, 6" (Incl. 4-6)
4. Screw, Pan Head #8 - 32 x 1 1/4"
5. Plusnut, #8 - 32
6. LED, 12V Amber
7. Grommet
8. Plate, Motor Medium
9. Screw, #10 - 16 x 3/4" PH
10. Plate and Shaft
11. Motor, Dual Electric 12V with Heat
12. Plate, Small Motor
13. Screw, Pan HD #4 x 7/8" Lg.
14. Glass, Flat
15. Glass, Convex
16. Gasket 1/2"
17. Collet, Coated 1.3125"
18. Screw, Set 3/8" - 16 x 1/2"
19. Screw, Flat Head
20. Arm, Mirror
21. Harness, Mirror 32"
22. Washer, Flat 1/2" SST
23. Nut, Stover 1/2" - 13 SST
24. Cap, Plastic Black
25. Bolt, Hex Head 1/2" - 13
26. Locknut, Center
27. Spring, Compression 1" SST
28. Nut, Acorn 1/2" - 13 SST
29. Washer, Plastic
30. Screw, #10 x 3/4" PH

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Fig. 13-20: Exterior Curbside Mirror Assembly

6.2. Mirror Servicing

6.2.1. Removal

1. Disconnect electrical wiring.
2. Remove acorn nut and lock nut retaining mirror arm to mounting bracket.

6.2.2. Disassembly

1. Pry upper plastic edge of carrier away from glass and remove glass.

☞NOTE:

Be very careful to avoid chipping or breaking the mirror glass.

2. Repeat procedure for lower glass.
3. Remove sheet metal screws retaining carrier assemblies to housing.

6.2.3. Assembly

1. Position upper and lower carrier assemblies into housing, ensuring cable is routed rear opening of housing.
2. Secure carrier assemblies to rear housing using sheet metal screws.
3. Position glass on carrier while carefully holding one retaining plastic edge outwards.
4. Ensure glass is under retaining edge and release edge.

☞NOTE:

When correctly installed, both retaining edges will be over the edge of the glass.

6.2.4. Installation

1. Align hole in mounting arm with hole in mounting bracket and install retaining bolt
2. Align mirror head correctly, tighten bolt and install acorn nut.
3. Plug electrical connector to mirror assembly.

7. WINDSHIELD WIPER & WASHER

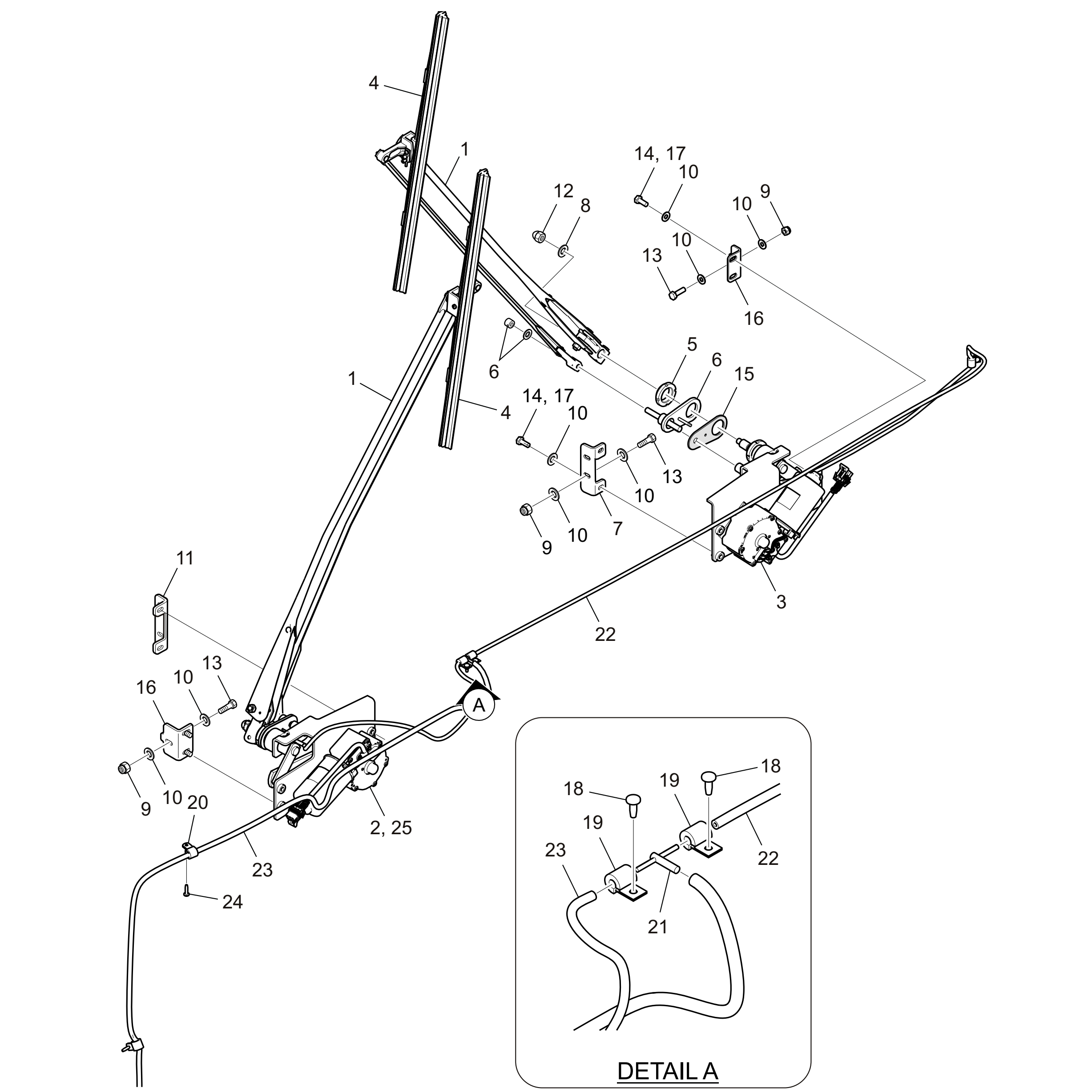
7.1. Windshield Wiper

7.1.1. Description

The windshield wipers are two-speed electrically operated units. The wiper motors are mounted to brackets located behind access panels below the windshield. The wiper assemblies are fitted with parallel arms to hold the wiper blades in a vertical position as they sweep across the windshield. Arms are fitted with wet arm adapters and tubes that supply fluid from the washer bottle to the arms.

7.1.2. Removal

1. Pull wiper arm away from windshield and insert nail or small pin in wiper arm hole, close to hinge point. Release arm. Arm should be held away from windshield. See “Fig. 13-21: Windshield Wiper & Motor Installation” on page 53.
2. Remove acorn nut from operating shaft and mark relationship of arm to shaft for reinstallation.
3. Unplug windshield washer hose at front panel.
4. Loosen arm-clamping bolt.
5. Loosen Allen head set screw retaining cap nut on idler arm pivot and remove cap nut, wiper blade and arm assembly.
6. Remove spanner nut from operating shaft, pull out spacer and pivot assembly and disconnect washer hose from assembly. Remove spacer and pivot assembly.
7. Disconnect electrical connectors at motor.
8. Remove four bolts retaining mounting bracket to vehicle and remove wiper motor assembly.



1. Wiper Arm Assembly, Wet
2. Wiper Motor & Bracket Assembly, Streetside
3. Wiper Motor & Bracket Assembly, Curbside
4. Wiper Blade
5. Nut, Spanner
6. Outer Spacer Assembly
7. Angle, Wiper Inner Curbside
8. Washer, Flat Nylon 10.5" ID
9. Nut, Lock Nylon 5/16" - 18 UNC
10. Washer, Flat 5/16"
11. Angle, Wiper Inner Streetside
12. Nut, Low Crown 3/8" x 24 UNC
13. Bolt, Hex 5/16" - 18 UNC x 1" Lg.
14. Loctite, 243 Blue
15. Gasket, Outer Spacer
16. Angle, Wiper Support
17. Bolt, Hex 5/16" - 18 UNC x 3/4" Lg.
18. Screw, Self Tapping #10 - 24 x 1/2" Lg.
19. Clamp, Cushion "P" 1/4"
20. Clamp, "P" .375" SST/HT
21. Tee
22. Hose, 7/64" I.D.
23. Hose, 5/32" I.D.
24. Screw, PH Cross Recess Tpg. Type F #10 - 24 UNC x 3/4" Lg.
25. Tape, Butyl Cork

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Fig. 13-21: Windshield Wiper & Motor Installation

7.1.3. Installation

1. Position motor on vehicle, install mountings bolts and tighten.
2. Connect electrical connectors.
3. Route windshield washer hose through hole in mask.
4. Install gasket on spacer and pivot assembly and connect washer hose to tube fitting. Position pivot assembly on vehicle. Apply Never-Seez and install spanner nut. Torque to 10 to 12 ft-lb. (14 to 16 Nm).
5. Install wiper operating arm in originally marked position.
6. Apply Never-Seez and tighten arm clamping bolt to 65 to 70 in-lb. (7.3 to 7.9 Nm).
7. Install idler arm and cap nut on pivot shaft. Tighten Allen head set screw to retain cap nut to shaft.
8. Install nylon washer and acorn nut on operating arm shaft and tighten securely.
9. If wiper blade was removed from wiper arm install wiper blade and retaining screw. Tighten screw until blade can no longer pivot then loosen screw 1/4 turn.
10. Pull wiper arm away from windshield and remove previously installed nail or small pin from wiper arm pivot. Release arm.
11. Operate wipers on wet glass to verify sweep and blade angle. If adjustment is required, proceed as follows:
    a. Move wiper arm to mid position on windshield.
    b. Lengthen or shorten idler arm as required to hold wiper blade in vertical position.
    c. Operate wipers while observing that the wiper pattern is centered and blades are not touching the windshield seals.
    d. If sweep is off center, reposition operating arm on wiper shaft and recheck operation.

7.2. Windshield Washer

7.2.1. Description

The windshield washer is controlled by the wiper/washer control knobs, which are located on the instrument panel. When the control knob is pressed the washer bottle motor operates and causes washer fluid to be sprayed onto the windshield. The motor is externally mounted beside the washer bottle. The motor stops operating when the switch is released.

7.2.2. Removal

1. Open side console access panel door below driver’s window.
2. Disconnect hose between washer bottle and motor at motor. See “Fig. 13-22: Washer Bottle Installation” on page 55.
3. Disconnect the hose from the filler cap by removing the attaching clamps.
4. Remove the six bolts from the base of the washer bottle support plate.
5. Remove washer bottle from vehicle.

☞**NOTE:**

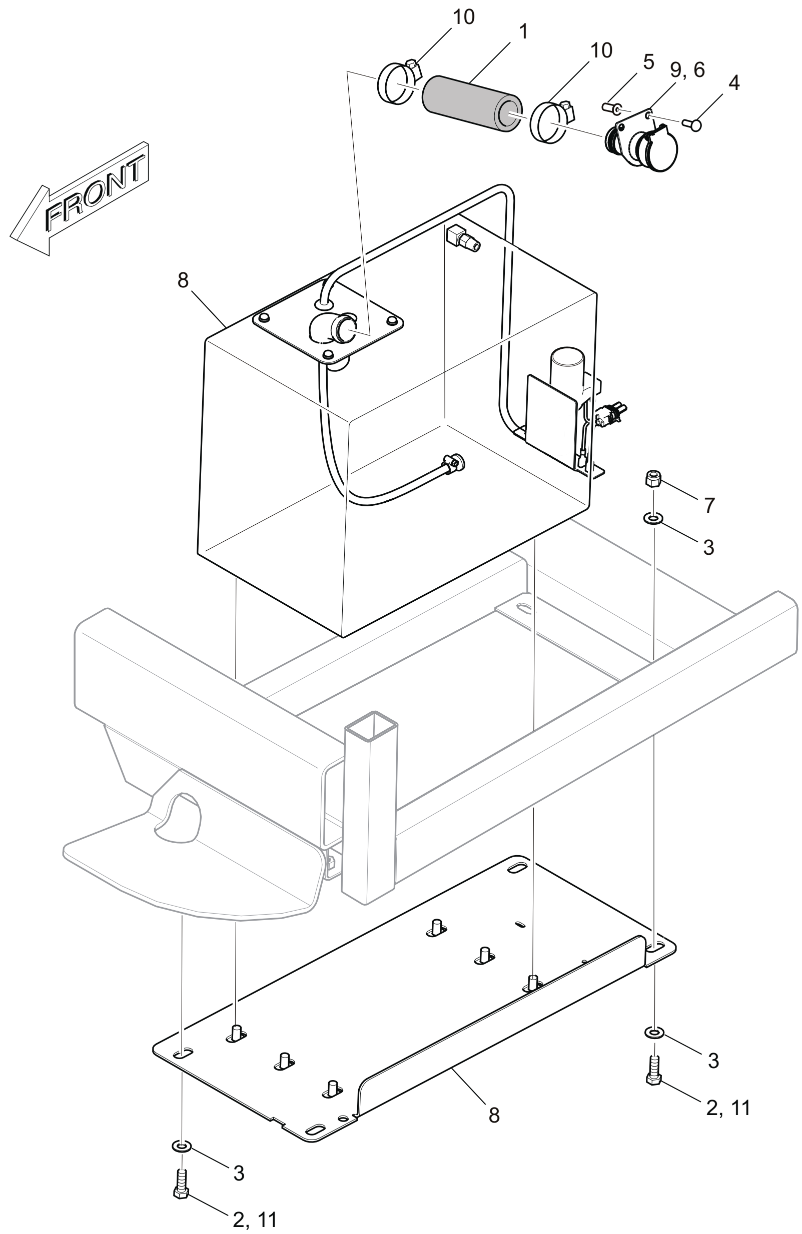
To be replaced only as an assembly.

7.2.3. Inspection

Remove the four screws securing the cover plate to the washer bottle. Check for foreign material in reservoir. Remove the filter from the bottom of the inlet hose. Clean if dirty or clogged.

7.2.4. Installation

1. Secure washer bottle onto the support plate using six hex bolts, washers and lock washers.
2. Connect hose to motor.
3. Attach hose to filler cap using clamps.
4. Close side console access door.
5. Start vehicle and test washer operation.



1. Hose, Rubber 1 1/8" I.D.
2. Bolt, Hex 3/8" - 16 UNC x 1" Lg.
3. Washer, Flat 3/8"
4. Screw, PH Cross Recess SST 1/4" - 20 UNC x 3/4" Lg.
5. Insert, 1/4" - 20 UNC
6. Adhesive, SIKA 221 White
7. Nut, Lock Nylon 3/8" - 16 UNC
8. Washer Bottle Assembly
9. Filler Cap Assembly
10. Clamp, Gear 1.50" - 1.75"
11. Loctite, 243

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Fig. 13-22: Washer Bottle Installation

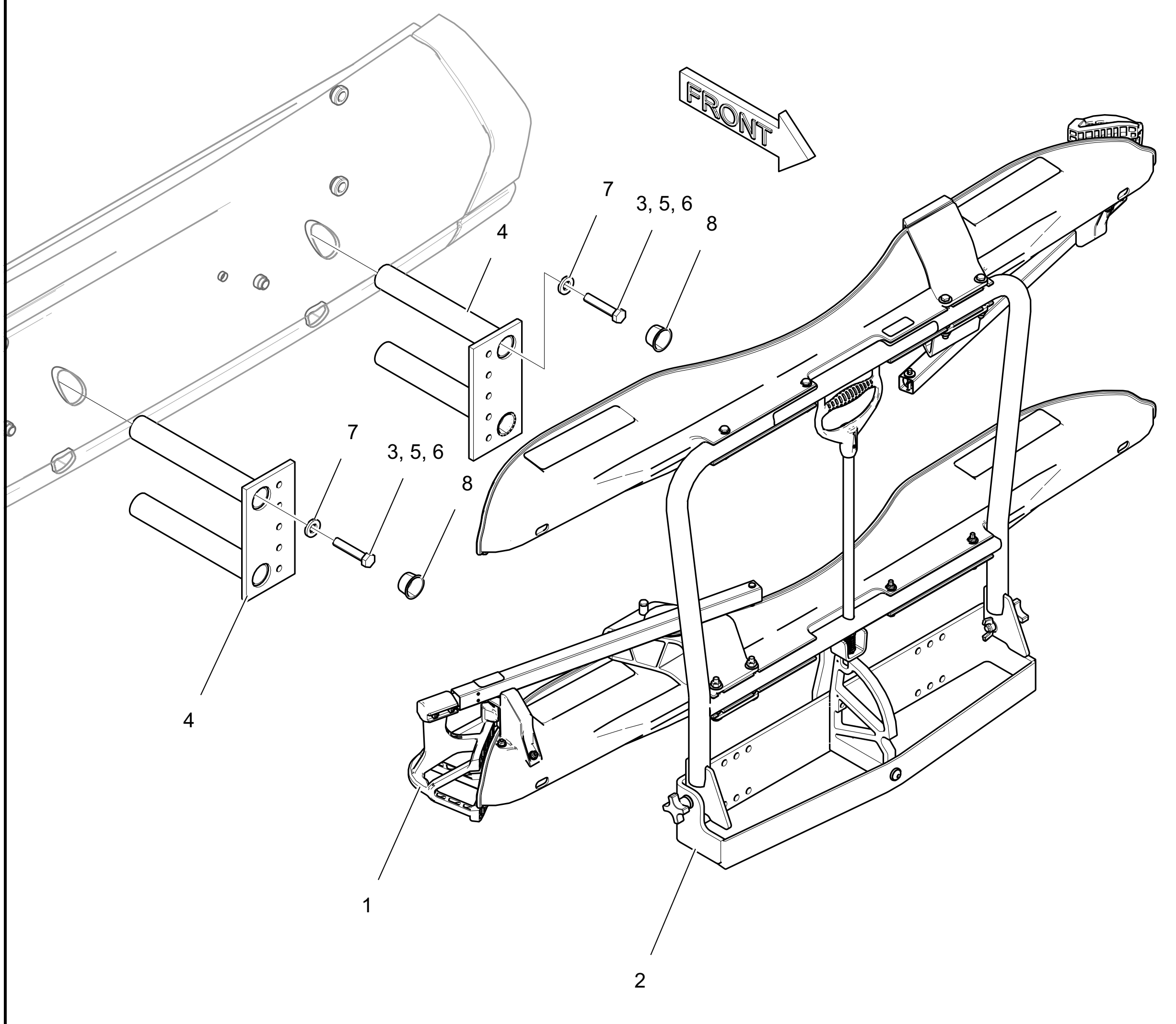
7.2.5. Washer System Troubleshooting

WASHER SYSTEM TROUBLESHOOTING		
PROBLEM	**CAUSE**	**SOLUTION**
Fails to Spray Washer Fluid.	Reservoir empty.	Add proper fluid.
	Improper washer fluid concentration if below 32°F (0°C).	Store vehicle or parts in heated area, then purge fluid system with low temperature solution.
	Contamination in tubing or nozzles.	Clean with compressed air. Replace if necessary.
	Tubing damage.	Replace section.
	Tubing bent or disconnected.	Realign tubing and/or refit. Trim end to ensure proper fit.
	Clogged inlet filter.	Clean or replace filter.
Switch Operated, but System Inoperative.	Switch defective.	Replace switch.
	Motor defective.	Replace motor.
Inadequate Expulsion of Proper Washer Solution.	Tubing failure.	Replace tubing.
	Motor defective.	Replace motor.
	Partially restricted inlet filter.	Clean or replace filter.
Slow Operation.	Motor defective.	Replace motor.
	Improper solution.	Replace with proper solution.
Fluid Stream Improperly Directed.	Nozzles adjusted incorrectly.	Reposition nozzles.

8. BIKE RACK SYSTEM

8.1. Description

This vehicle is equipped with a bicycle rack system. It is mounted to the front of the vehicle and allows passengers to load and unload their bicycles without driver assistance. See "Fig. 13-23: Major Components of Bike Rack" on page 57.



1. Bike Rack Assembly
2. Plate Assembly, Pivot
3. Loctite, 243 Blue
4. Standoff Slide In, Bike Rack Bumper
5. Kit, Bolt (Incl. 6-8)
6. Bolt, 1/2" - 13 x 2 1/2"
7. Washer, 1/2"
8. Cap, Plastic

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Fig. 13-23: Major Components of Bike Rack

8.2. Operation

⚠CAUTION

To ensure safe vehicle operation, NEVER load a bike onto the bike rack which will in any way obstruct the headlamps. ALWAYS verify that the headlamps are unobstructed whenever a bike has been loaded onto the bike rack.

8.2.1. Loading

1. Remove water bottles, pumps or other loose items from bike prior to loading.
2. Squeeze bike rack handle UP to release latch.
3. Fold down bike rack.
4. Lift bike onto rack, fitting wheels into proper wheel slots.
5. Raise the support arm over the front tire so that the hook rests at the highest point on the front wheel. Bike is now held firmly in place.

8.2.2. Unloading

1. Unload from curb or from front of vehicle.
2. Raise support arm off the tire.
3. Lift bike out of wheel slots and set down.
4. If there are no other bikes on the rack, lift it until the rack swings into the lock position against the vehicle.

8.3. Maintenance

☞NOTE:

Refer to the Preventive Maintenance section of this manual for scheduled maintenance procedures and intervals.

8.3.1. Bike Rack Servicing

1. If the bike rack is not raising and lowering with ease, check the two pivot bolt assemblies for incorrect installation or wear. Replace the assemblies if damaged. Check that the pivot tabs are straight and aligned to properly pivot the bike rack. Straighten the tabs as required.
2. Check the pivot plate for correct alignment and damage. Remove and straighten the pivot plate if it is not straight.
3. Check the stow latch and the support arm grip latching teeth. If they are broken or worn, replace the necessary parts.
4. Check the wheel stop for damage. Replace if necessary.
5. Check the urethane wheel wells for cracks or damage. Replace if necessary. To replace, remove the six screws attaching the tray to the frame. The tray engages with two sleeves in the location of the wheel stop. Use a screw driver or small pry bar to spread the tray flanges off the two sleeves. Slide the wheel stop off of the tray. Reverse steps for installation of the new tray.
6. Examine the structural integrity of the round tubing of the main frame. Repair or replace the bike rack if damaged.

8.3.2. Latch Mechanism Servicing

1. Check the latch handle for damage. Replace if necessary. See “Fig. 13-24: Latch Mechanism Servicing” on page 59.
2. Check the latch handle tube for straightness. Straighten or replace if necessary.
3. Examine the wear of the plastic insert in the tip of the latch pin. Replace the insert if the quadrant is being marred by the latch pin.
4. If the latch pin does not properly track on the quadrant, check that the quadrant is attached tightly and squarely to the pivot plate. Replace the quadrant if damaged.
5. Examine latch components:
   a. Check that the roll pin fixing the return spring is fully engaged.
   b. Clean and check the spring for wear or damage. Replace spring if it is distorted or not functioning properly.
   c. Check the latch pin housing for damage.

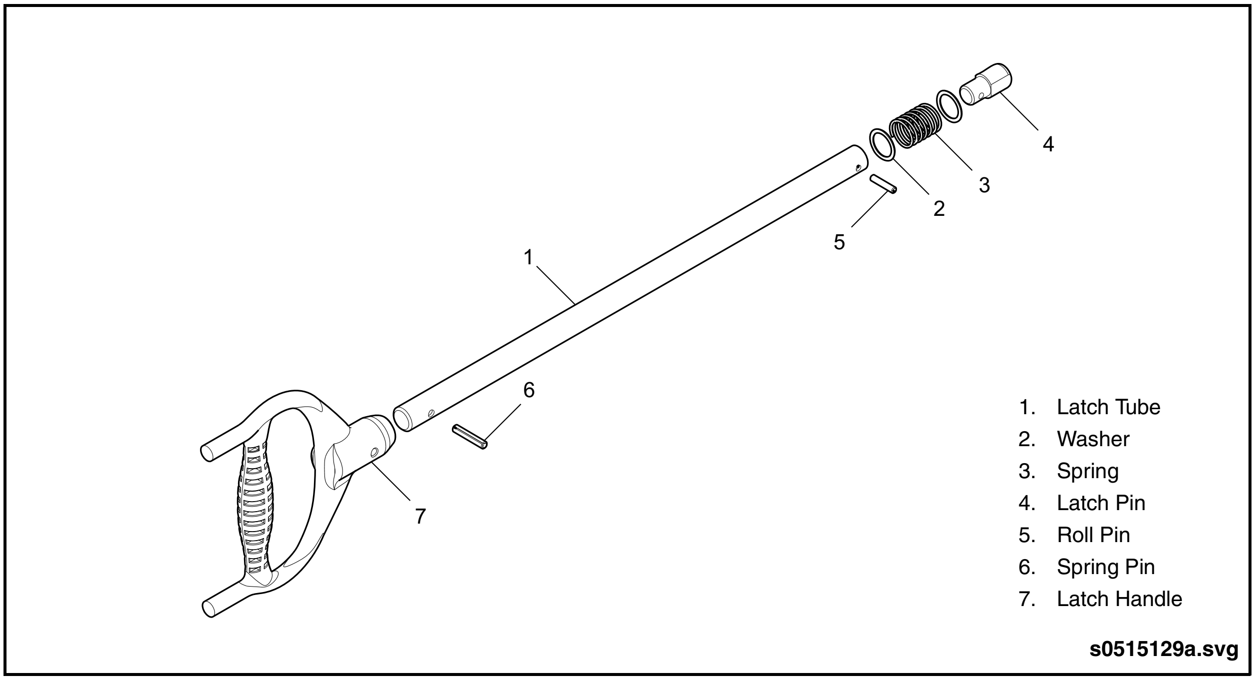


Fig. 13-24: Latch Mechanism Servicing

8.3.3. Support Arm Servicing

1. Examine components inside the support arm assembly. See “Fig. 13-25: Support Arm Servicing” on page 60.

   a. Remove the bolts attaching the support arm assembly to wheel stop.

   b. Remove the support arm grip.

   ☞**NOTE:**

   The lower Phillips screw fixes one end of the spring. Remove the roll pin from the base of the support arm housing. This fixes the other end of the spring.

   c. Carefully slide the support arm spar out from the bottom end of the support arm housing. Make note of how the two nylon slider bushings fit at the base of the support arm spar. Also note that the four upper bushings engage into the four holes in the housing. Re-assembling the upper bushings may require some practice.

   d. Remove the roll pin on the support arm housing to free the support arm spring. Clean the spring and examine it for wear, overstress, or cyclical fatigue. Pay special attention to the end hooks of the spring. Replace the spring as necessary.

   e. Clean the inside of the stainless steel support arm housing using a stainless steel brush. Do not use a non-stainless wire brush.

   f. Examine the upper and lower bushings. Replace them if they are excessively worn or marred. Replace them if the support arm spar is not tracking correctly (i.e. there is too much twist).

   g. Reassemble the support arm assembly in the reverse order of steps a-d. Use a simple hook made of stiff wire or similar tool to pull the spring into position when re-inserting the roll pin through the base of the support arm housing and the end hook of the spring.

   h. Check the operation of the support arm assembly once again. Each support arm hook should pull out smoothly, stop at the stop screw, easily slide back into the stowed position, and properly self stow when it is released.

2. If the support arm spar is bent is should be replaced.

3. Examine the support arm assembly mounting pivot. Check the pivot for side play. Side play can be adjusted by tightening the 3/8-16 nylock nut. Do not over-tighten. The pivot should be free with a small amount of play. With the support arm assembly vertical and fully retracted lightly push the grip towards the front of the bus and then away from the bus. If total movement exceeds 2", replace the worn parts. Do not lubricate the mounting pivot.

1. Split Ring
2. Clevis Pin
3. Support Arm Housing
4. Phillips Screws
5. Support Arm Grip
6. Upper Bushings
7. Spring
8. Support Arm Spar
9. Lower Bushings

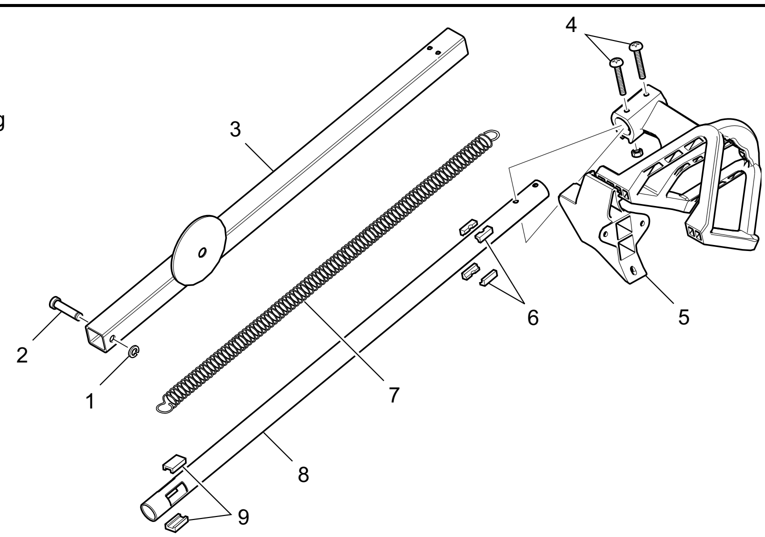


Fig. 13-25: Support Arm Servicing

Windows

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❒ open flame
- ❒ excessive heat
- ❒ production of sparks
- ❒ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

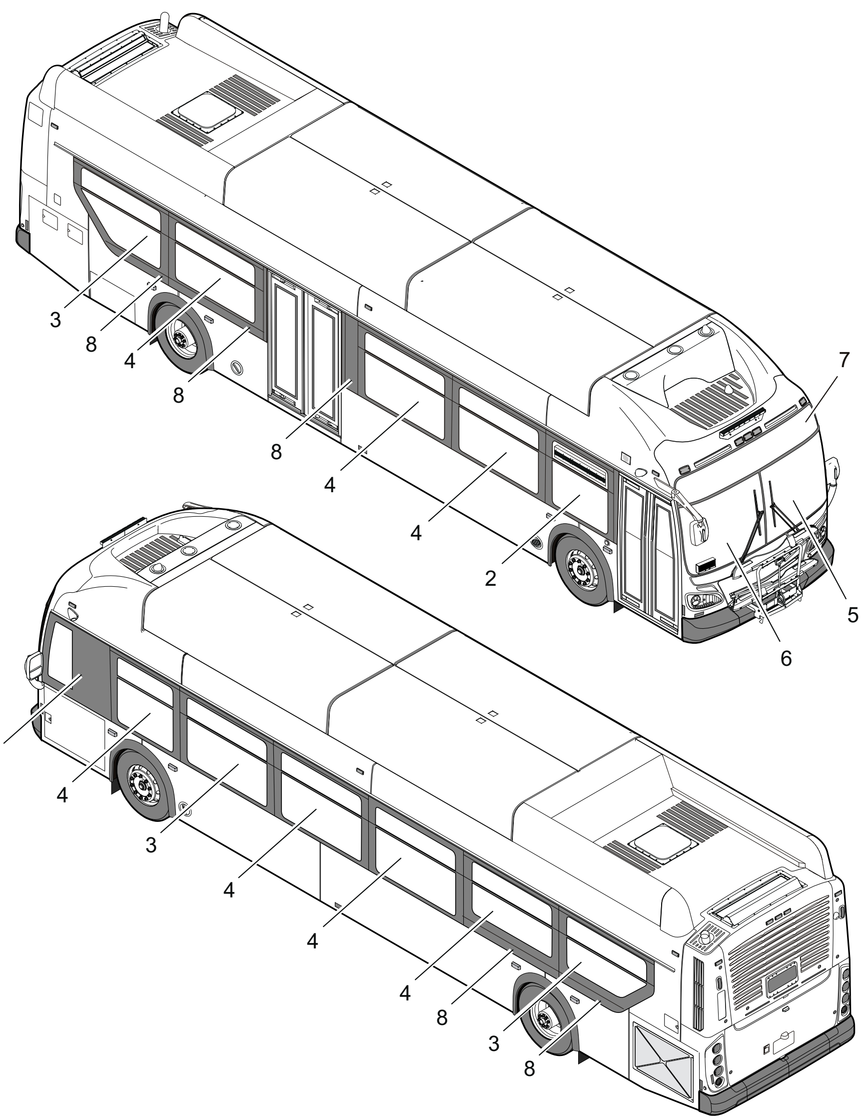
2. WINDOWS

2.1. Description

This vehicle is equipped with a seal-retained windshield and side windows. See “Fig. 14-1: Windows Installation” on page 2. Side windows consist of a frame, a sub-frame, a clamp ring and flush-mounted glass.

The following side window assemblies are installed on the vehicle:

- ❒ Driver’s window
- ❒ Destination sign window
- ❒ Side emergency windows
- ❒ Side non-emergency windows
- ❒ Infill glass



1. Window Assembly, Driver’s
2. Window Assembly, Side Destination Sign
3. Window Assembly, Side Non-Emergency
4. Window Assembly, Side Emergency
5. Windshield, Streetside
6. Windshield, Curbside
7. Glass, Destination
8. Glass Assembly, Pier

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Fig. 14-1: Windows Installation

2.2. Windshield

2.2.1. Description

The windshield consists of streetside, curbside, and upper destination sign glass sections. These three separate glass sections are retained within the front mask by an EPDM molded seal. The perimeter seal has two sets of channels. One channel is bonded to the front mask fiberglass aperture on the vehicle and the other channel to the windshield glass. A wedge-shaped rubber insert (lace) exerts pressure on the channel in the rubber seal, forcing it tight against the window. See “Fig. 14-2: Windshield” on page 3.

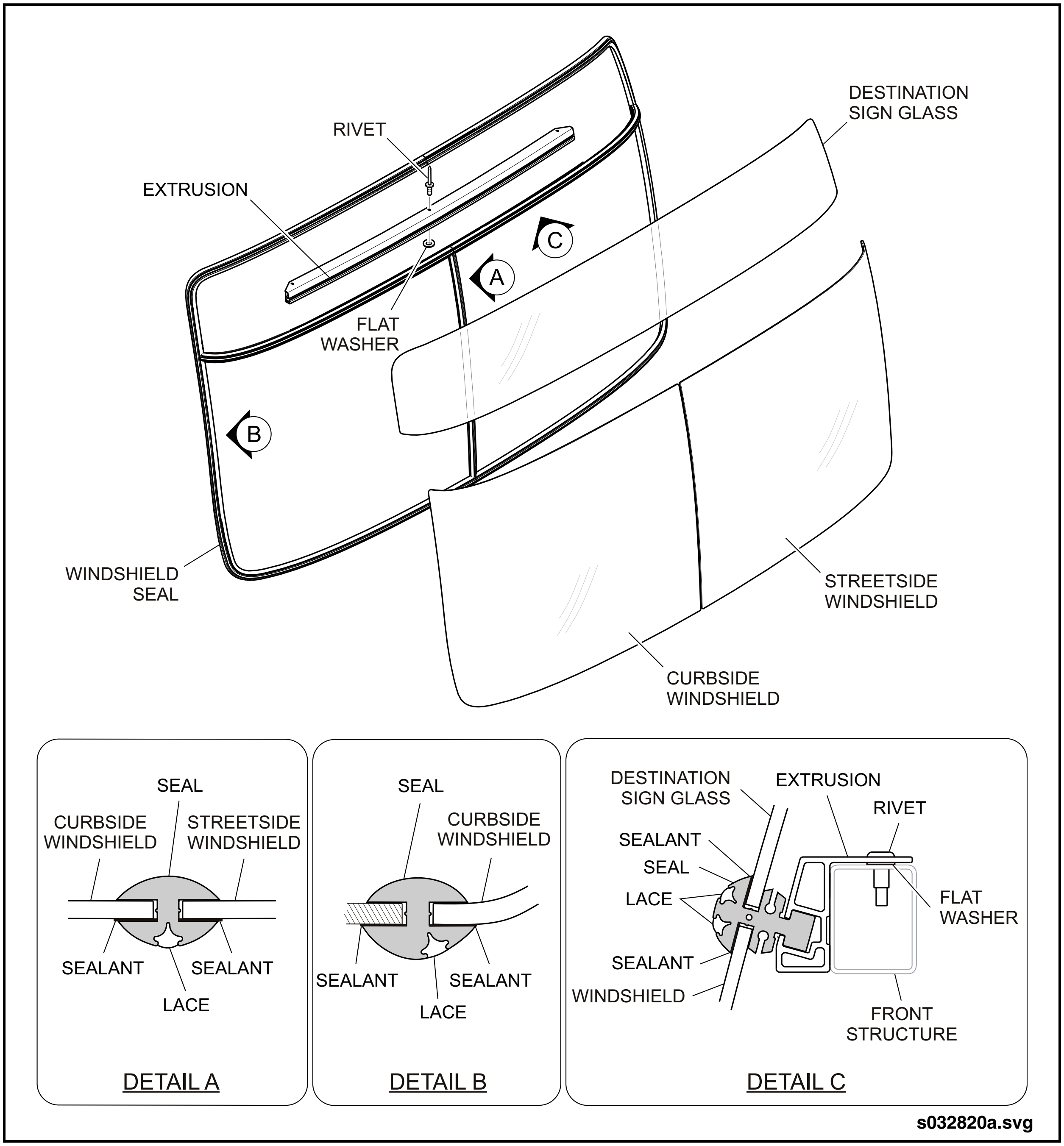


Fig. 14-2: Windshield

2.2.2. Removal

⚠ WARNING

Wear protective gloves and use glass handling equipment when handling glass.

1. Pry one end of the lace out of the rubber window seal and pull to remove the entire length from the perimeter of the glass being removed.
2. Carefully cut through the sealant adhering the glass to the rubber seal.

⚠ CAUTION

DO NOT damage window seal when separating it from glass.

3. With help of an assistant, pry the rubber window seal away from the glass and remove the glass from the opening.
4. Clean the excess sealant from the rubber window seal.

2.2.3. Installation

⚠ CAUTION

This installation is to be performed by qualified personnel only.

1. Inspect the window seal for cracks and damage. The seal must be flexible and in good condition at all three glass sections. Inspect seal groove in window seal where windshield section is removed.

☞NOTE:

Replace the entire window seal if any section of the window seal is damaged or in poor condition.

⚠ CAUTION

DO NOT lubricate the seal or the windshield opening with soapy water, as this may seep in between the windshield layers and cause fogging of the glass.

2. Lubricate the seal groove with an alcohol based glass cleaning foam.

⚠ WARNING

Wear protective gloves and use glass handling equipment when handling glass.

3. Wipe the edges of new glass and lubricate them with an alcohol based glass cleaning foam.

4. With the help of an assistant, pry open the bottom retaining groove where it meets the vertical seal at center of vehicle, use the installation tool. See “Fig. 14-3: Installation Tool” on page 5. Push the glass corner into seal groove. If installing the destination sign glass, start at the lower streetside or curbside corner.
5. Work along the bottom seal then do the vertical seals. Do the top seal at last.
6. Check that the windshield is seated properly inside window seal.
7. Pry the window seal away from glass and place a continuous bead of black butyl sealant into glass retaining groove. See Details A, B, & C in Windshield illustration. Insert the lace into window seal using lace tool. See “Fig. 14-4: Installing Lace” on page 5. Thread the lace through eye of lace tool and push the lace into lace groove. Work along the bottom seal then do the vertical seals. Do the top seal at last.
8. Cut off excessive length of lace and push it into groove.
9. Remove the squeeze-out sealant from glass and glass seal using mineral oil.
10. Check that the windshield is installed properly and perform a water leakage test.

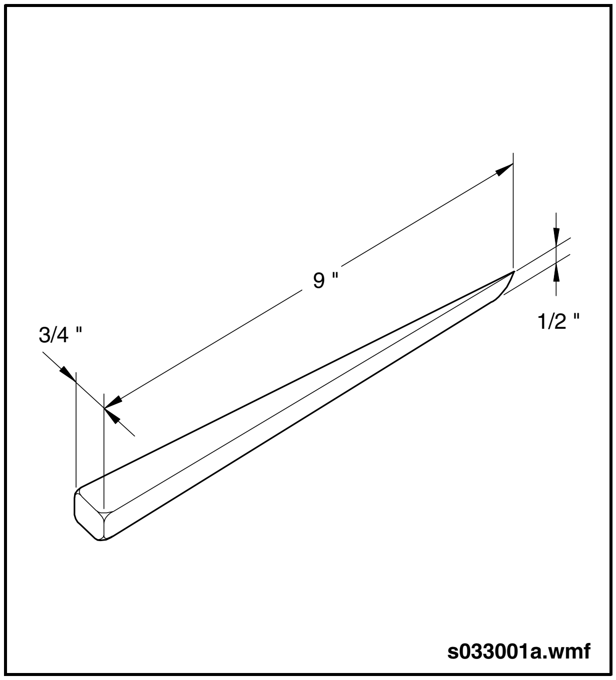


Fig. 14-3: Installation Tool

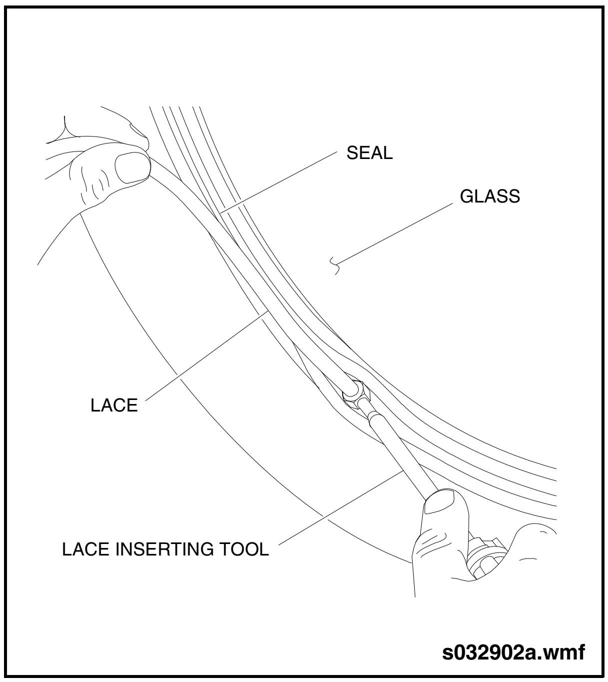


Fig. 14-4: Installing Lace

2.3. Driver's Window (MV204)

2.3.1. Description

The driver's window is an emergency release style window with a forward slider portion and an aft fixed portion. The window assembly consists of a frame, a subframe, a clamp ring, and flush mounted tempered glass sections. See "Fig. 14-5: Driver's Window Assembly" on page 6.

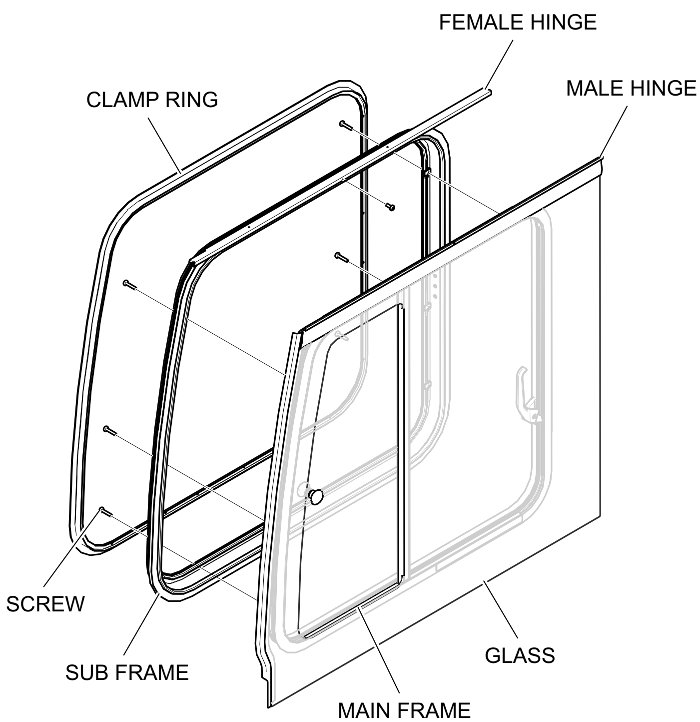


Fig. 14-5: Driver's Window Assembly

2.3.2. Main Frame Removal

WARNING

Window assemblies are heavy. Ensure two persons at a minimum are available to perform the removal and installation of window assemblies. Ensure prop rod is securely positioned as injury can result if it falls out.

NOTE:

Window servicing is limited to replacement of the entire window assembly, or replacement of the flush-mounted glass. The following procedure describes how to separate the main frame from the subframe and is used prior to glass replacement. Refer to 2.7. "Flush Window Glass Replacement" on page 20 *in this section for glass replacement procedure.* Refer to 2.9. "Window Assembly Replacement" on page 33 *in this section if the entire window is being replaced.*

1. From the inside of the vehicle, remove the six screws that attach the main frame to the subframe and prop the window open with a prop rod. Use an Allen wrench to remove the two socket head screws from the underside of the subframe. Remove the centering screw from the top of the female hinge attached to the window frame. See "Fig. 14-6: Driver's Window Frame Removal" on page 7.
2. Remove the main frame by rotating it a bit past 90°, then moving the assembly towards the inside of the window to disengage the hinge.

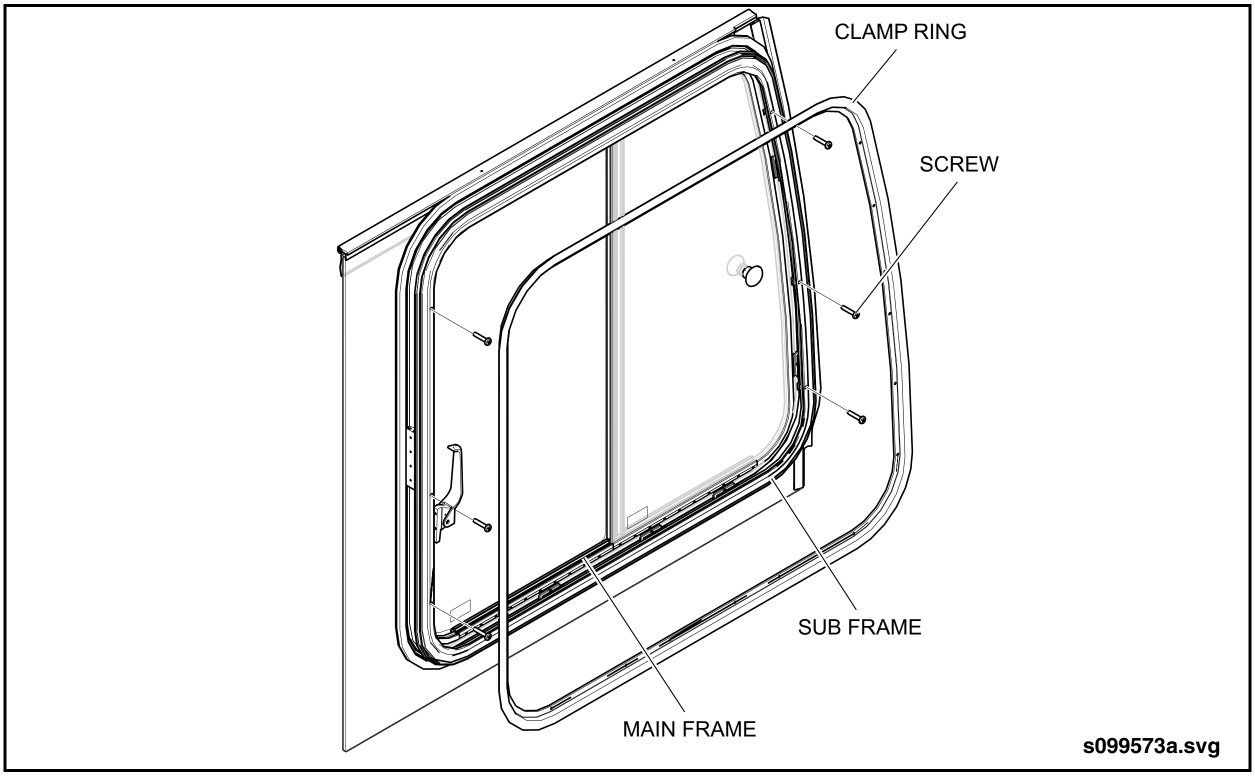


Fig. 14-6: Driver's Window Frame Removal

2.3.3. Main Frame Installation

1. Supporting the main frame from both sides, ensure the centering screw on the subframe aligns with the notch on the male hinge.
2. Engage the two hinge halves correctly.

CAUTION

Female hinge can be damaged if hinges are not properly engaged and an attempt is made to close the window.

3. If the assembly rotates down into place it is installed correctly.

WARNING

Ensure prop rod is securely positioned as injury can result if it falls out.

4. Push out the frame assembly to approximately 80° and secure in place with a prop rod.
5. Use an Allen wrench to install the two socket head screws into the underside of the subframe. Install the centering screw into the top of the female hinge attached to the window frame.
6. With someone on the outside of the window pushing in, install the six screws that were removed during main frame removal.

2.3.4. Glass Replacement

Refer to 2.7. "Flush Window Glass Replacement" on page 20 in this section for glass replacement procedures.

2.3.5. Driver's Fixed Meet Rail Replacement

1. Refer to 3. "GLASS OFFSET GUIDE" on page 38 in this section to determine the proper offset for the frame to the glass and which locator blocks are required to achieve these dimensions.
2. Set locator blocks to the distance determined for correct glass to frame offset. Refer to 3. "GLASS OFFSET GUIDE" on page 38 in this section for correct locator blocks to be used.
3. Dry fit fixed meet rail to ensure proper fit before final installation.
4. Clean all bonding surfaces (glass and fixed meet rail) with isopropyl alcohol. Allow alcohol to dry.
5. Run a consistent bead of Simson 70-08 adhesive along the center of the fixed meet rail. Refer to NOTES which precede "Bonding Frame to Glass" procedure in this section for special considerations when applying adhesive.
6. Align fixed meet rail with the locator block and set rail into place.
7. Squeeze the fixed meet rail on to the glass to ensure there is a proper bond between the fixed meet rail and the glass.
8. Allow the adhesive to cure for 24 hours before handling the glass. Water can be sprayed on the adhesive to promote curing.

2.3.6. Driver's Window Handle Replacement

2.3.6.1. Removal

1. From inside the bus, slide the sash about half way open.

WARNING

Ensure hands are not in direction of travel of the blade as injury could result.

2. Use a utility knife to carefully cut the bond between the handle and the glass ensuring not to scratch or gouge the glass.
3. Repeat previous step for exterior handle.

2.3.6.2. Cleaning

1. Use a razor blade to remove any old sealant remaining on the handles or on the glass surface. Ensure not to scratch the glass or any exposed area of the handle.
2. Clean the bonding surfaces of the handles and glass with isopropyl alcohol.

2.3.6.3. Installation

1. On the outer edges of the handles, apply a 1/2" to 1" long strip of double-sided tape.
2. Apply a 3/8" tall bead of Simson 70-08 adhesive between the two pieces of tape on each of the handles.

☞**NOTE:**

Install handle within 10 minutes or adhesive will skin over.

3. Align the back of the handle with the back side of the frit (black masked area of glass). Also center the handle vertically between the frit.
4. Press down on handle until double sided tape touches glass.
5. Apply tape around the perimeter of handle, 1/8" from the edge of the handle. Apply a bead of Simson 70-08 around the perimeter of handle. Remove excess adhesive with finger to ensure seal has a professional appearance.
6. Remove tape.
7. Repeat steps 3 through 6 for the other handle.
8. Let the adhesive cure for a minimum of 24 hours before using the handles.

2.4. Side Emergency Window (MV200 & MV202)

2.4.1. Description

Side emergency windows function as emergency exits and are identified by decals on the window panels, and emergency release handles on the fore and aft lower sections of the window frame. Certain of these windows have top tip-in style hoppers. Refer to 2.4.5. “Sash Assembly Removal” on page 14 and Refer to 2.4.6. “Sash Assembly Installation” on page 15 in this section for the servicing of this portion of these windows. Each window assembly consists of a main frame, a subframe, a clamp ring, and flush mounted glass. See “Fig. 14-7: Side Emergency Window Assembly” on page 10.

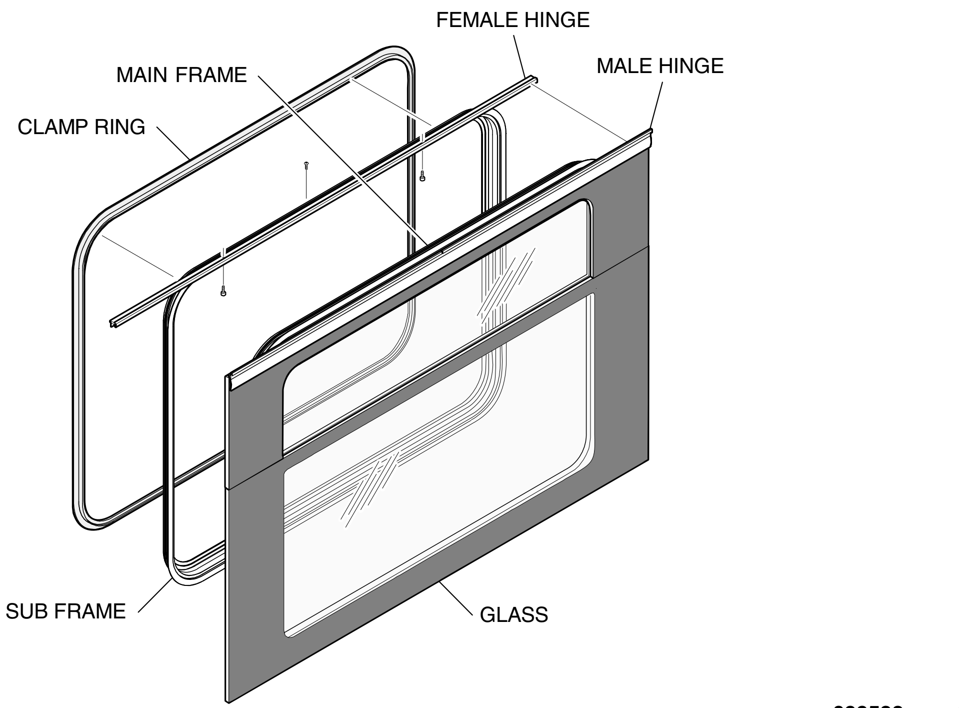


Fig. 14-7: Side Emergency Window Assembly

2.4.2. Operation

Operate the emergency window as follows:

1. Pull the red emergency handle down and hold it in this position. See "Fig. 14-8: Side Emergency Window Operation" on page 11.
2. Push out on the bottom of the window frame. The window will open and rotate outwards on hinges at the top of the frame.
3. To close the window, release the emergency handle and allow the window to slam shut. Ensure all latches are properly engaged.

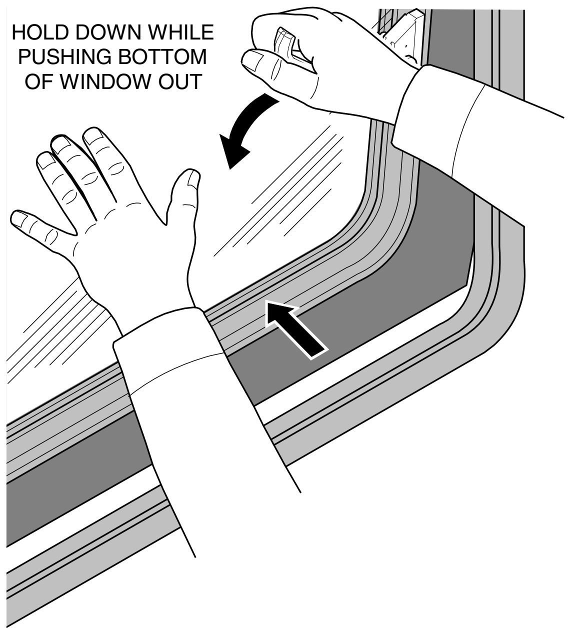


Fig. 14-8: Side Emergency Window Operation

2.4.3. Main Frame Removal

WARNING

Window assemblies are heavy. Ensure two persons at a minimum are available to perform the removal and installation of window assemblies. Ensure prop rod is securely positioned as injury can result if it falls out.

NOTE:

Window servicing is limited to replacement of the entire window assembly, replacement of the upper sash, or replacement of the flush-mounted glass. The following procedure describes how to separate the main frame from the subframe and is used prior to glass replacement. Refer to 2.7. “Flush Window Glass Replacement” on page 20 *in this section for glass replacement procedure.* Refer to 2.9. “Window Assembly Replacement” on page 33 *in this section if the entire window is being replaced.*

1. Remove the centering screw from the female hinge attached to the top of the sub frame. Activate the emergency release handle and open the main frame. Use a prop rod to safety support the window in the open position. Use an Allen wrench to remove the (2) 10 - 24 UNC screws from the underside of the subframe. See “Fig. 14-9: Subframe Screw Removal” on page 12.
2. Remove the main frame by rotating it a bit past 90°, and then forcing it towards the inside of the window to disengage the hinge.

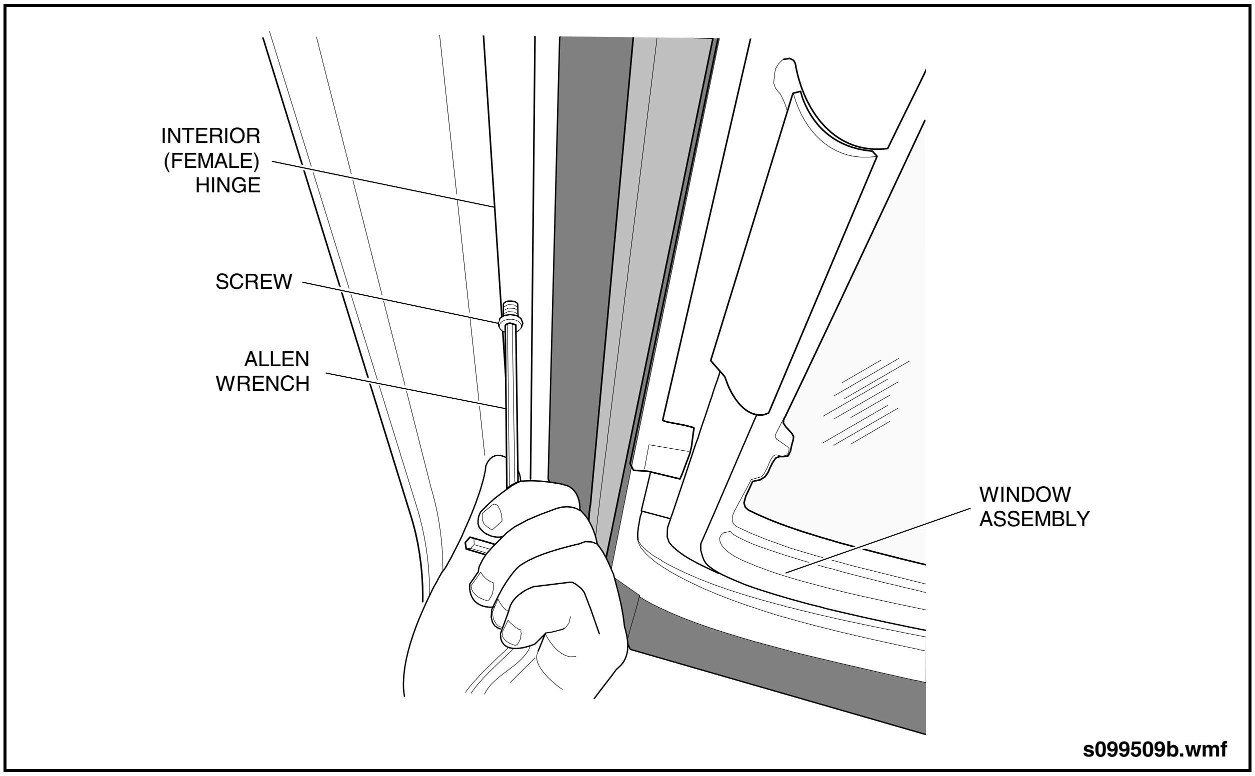


Fig. 14-9: Subframe Screw Removal

2.4.4. Main Frame Installation

1. Supporting the main frame from both sides, ensure the centering screw on the subframe aligns with the notch on the male hinge.

CAUTION

Female hinge can be damaged if hinges are not properly engaged and an attempt is made to close the window.

2. Engage the two hinge halves correctly. See "Fig. 14-10: Correct Engagement" on page 13.
3. If the assembly rotates down into place it is installed correctly.

WARNING

Ensure prop rod is securely positioned as injury can result if it falls out.

4. Push out the main frame to approximately 80° and secure in place with a prop rod.
5. Use an Allen wrench to install the two socket head screws into the underside of the subframe. Install the centering screw into the top of the female hinge attached to the window frame.
6. Ensure a light coating of white lithium grease is applied to the top surface of the three emergency release strikes.
7. Support the window from the bottom center; open the window to approximately 40 to 60° and release. The momentum is normally sufficient to cause the window to shut.

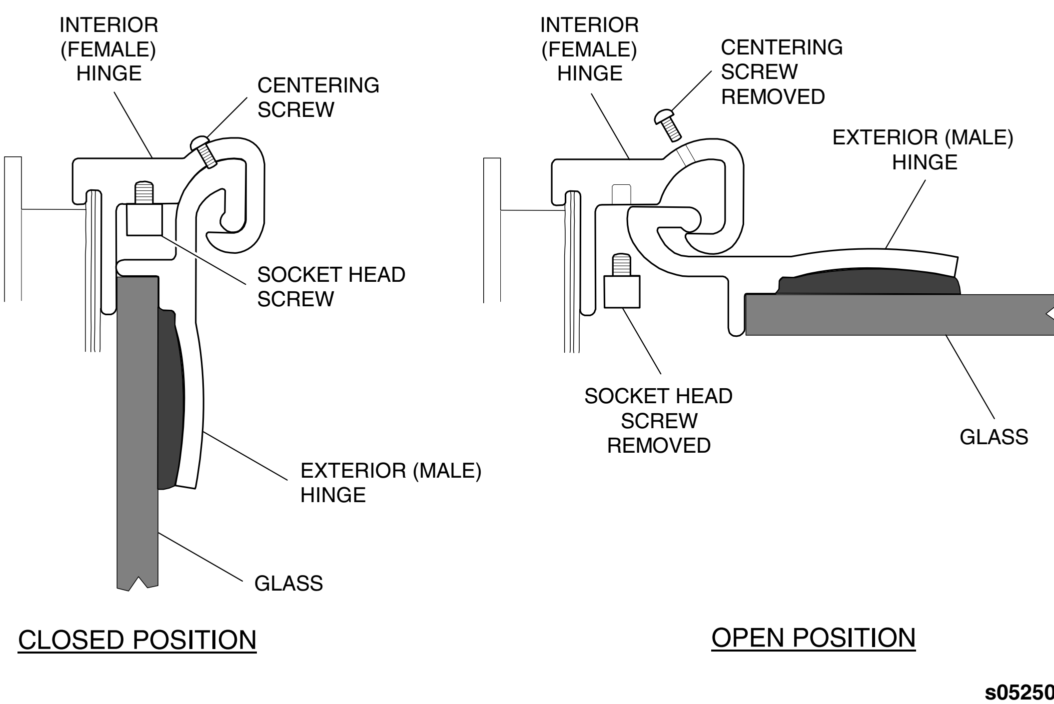


Fig. 14-10: Correct Engagement

2.4.5. Sash Assembly Removal

☞NOTE:

The following procedure applies to Side Emergency and Side Non-Emergency window assemblies.

1. Using Allen wrench, remove the sash lock screw from the sash strike.
2. Loosen the (4) 8 - 32 x 1" long flat head screws enough to remove the gas springs from the retainers. See “Fig. 14-11: Window Sash Removal” on page 14.
3. Close the sash again, and remove the (4) 8 - 32 x 3/8" pan head screws from the sash stop.
4. Remove the sash assembly & sash stop together.
5. Rotate the sash stop down & out to remove it from the sash.

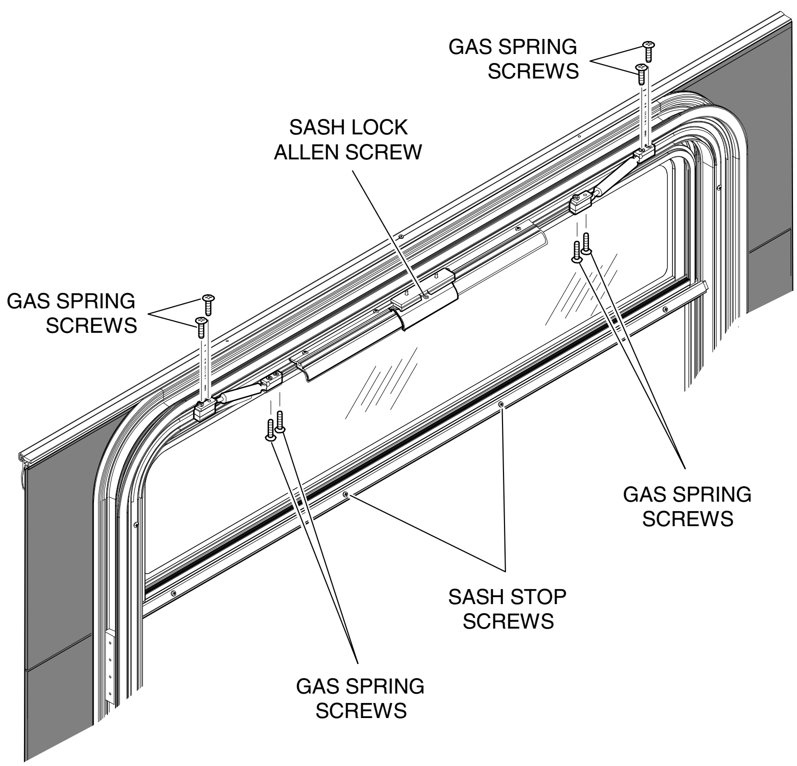


Fig. 14-11: Window Sash Removal

2.4.6. Sash Assembly Installation

☞**NOTE:**

The following procedure applies to Side Emergency and Side Non-Emergency window assemblies.

1. Install the sash stop on the sash assembly.
2. Install the sash assembly back into the transom.
3. When the sash assembly is in place, install the (4) 8 - 32 x 3/8" pan head screws back into the sash stop.
4. Insert the gas springs into the retainers and tighten down the 8 - 32 x 1" long flat head screws.
5. Check the sash to make sure it is operating properly.

2.4.7. Glass Replacement

Refer to 2.7. “Flush Window Glass Replacement” on page 20 in this section for glass replacement procedures.

2.5. Side Non-Emergency Window (MV201 & MV208)

2.5.1. Description

Non-emergency style windows are similar in style to the side-emergency windows, but have no emergency release handles. The window assembly consists of a frame, a subframe, a clamp ring, and flush mounted glass. See “Fig. 14-12: Side Non-Emergency Window Assembly” on page 16.

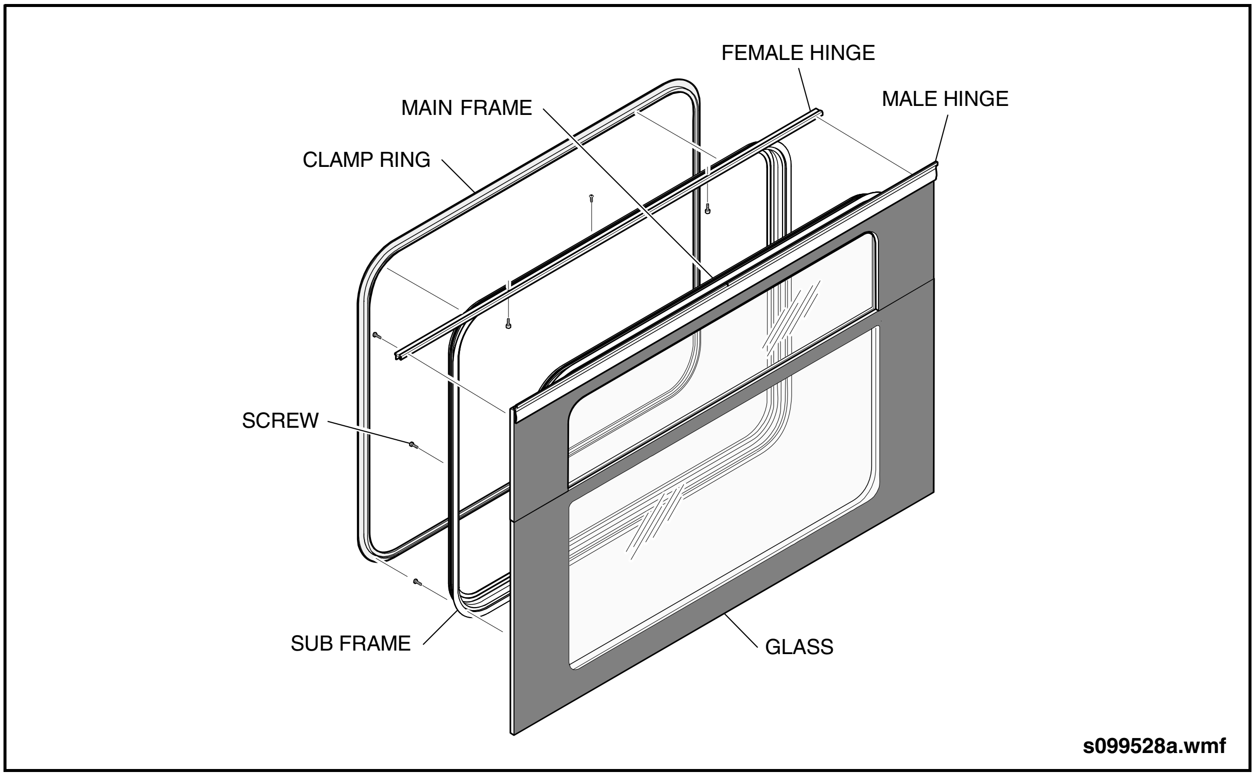


Fig. 14-12: Side Non-Emergency Window Assembly

2.5.2. Main Frame Removal

WARNING

Window assemblies are heavy. Ensure two persons at a minimum are available to perform the removal and installation of window assemblies. Ensure prop rod is securely positioned as injury can result if it falls out.

NOTE:

Window servicing is limited to replacement of the entire window assembly, replacement of the upper sash, or replacement of the flush-mounted glass. The following procedure describes how to separate the main frame from the subframe and is used prior to glass replacement. Refer to 2.7. “Flush Window Glass Replacement” on page 20 *in this section for glass replacement procedure.* Refer to 2.9. “Window Assembly Replacement” on page 33 *in this section if the entire window is being replaced.*

1. Remove the centering screw from the female hinge attached to the top of the sub frame. From the inside of the vehicle, remove the six screws that attach the frame to the subframe and prop the window open with prop rod. Use an Allen wrench to remove the two socket head screws from the underside of the subframe. See “Fig. 14-13: Non-Emergency Window Frame Removal” on page 17.
2. Remove the main frame by rotating it a bit past 90°, then moving the assembly towards the inside of the window to disengage the hinge.

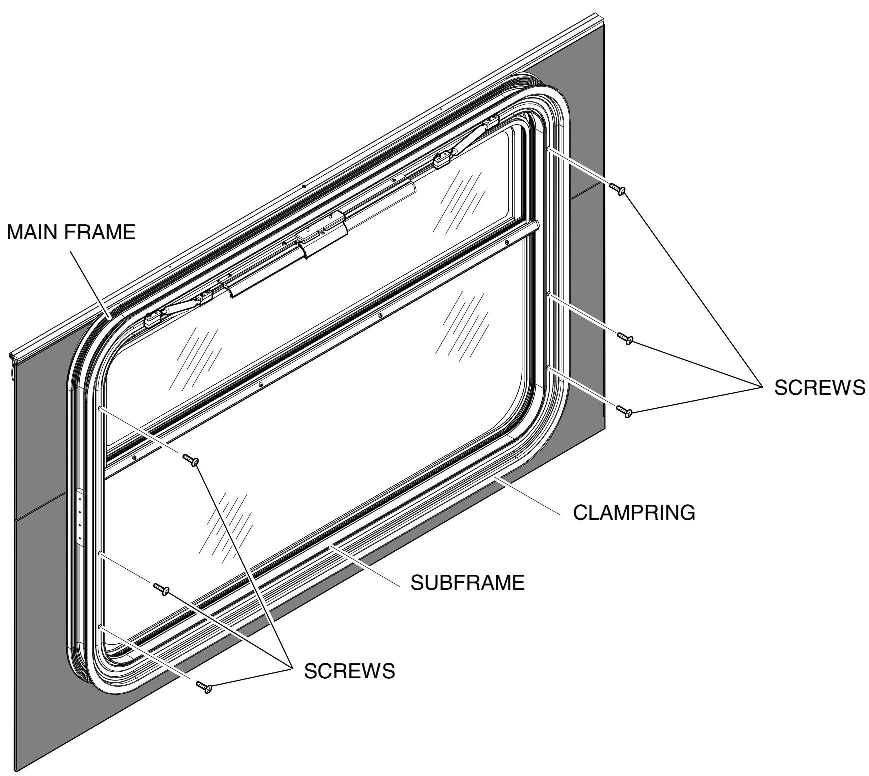


Fig. 14-13: Non-Emergency Window Frame Removal

2.5.3. Main Frame Installation

1. Supporting the main frame from both sides, ensure the centering screw on the subframe aligns with the notch on the male hinge.
2. Engage the two hinge halves correctly.

CAUTION

Female hinge can be damaged if hinges are not properly engaged and an attempt is made to close the window.

3. If the assembly rotates down into place it is installed correctly.

WARNING

Ensure prop rod is securely positioned as injury can result if it falls out.

4. Push out the frame assembly to approximately 80° and secure in place with a prop rod.
5. Use an Allen wrench to install the two socket head screws into the underside of the subframe. Install the centering screw into the top of the window's female hinge.
6. With someone on the outside of the window pushing in, install the six screws that were removed during main frame removal.

2.5.4. Sash Assembly Removal

Refer to 2.4.5. "Sash Assembly Removal" on page 14 and Refer to 2.4.6. "Sash Assembly Installation" on page 15 in this section for sash removal and installation procedures.

2.5.5. Glass Replacement

Refer to 2.7. "Flush Window Glass Replacement" on page 20 in this section for glass replacement procedures.

2.6. Side Destination Sign Window (MV207)

2.6.1. Description

The window assembly consists of a frame, a subframe, clamp ring, and flush mounted glazing. The upper glazing is clear and the lower glazing is tinted. See “Fig. 14-14: Side Destination Sign Window” on page 19. This window is an emergency egress style with fixed upper and lower panes that cannot be opened for ventilation.

This window subframe can be removed using the same procedure as the other Side Emergency Windows. Refer to 2.4. “Side Emergency Window (MV200 & MV202)” on page 10 in this section for servicing procedures.

☞**NOTE:**

The MV207 window has fixed glazing. The procedures for removing the sash assemblies do not apply to these windows.

Refer to 2.7.7.3. “Fixed Over Fixed Capping the Joint Procedure” on page 27 in this section for special glass section sealing requirements.

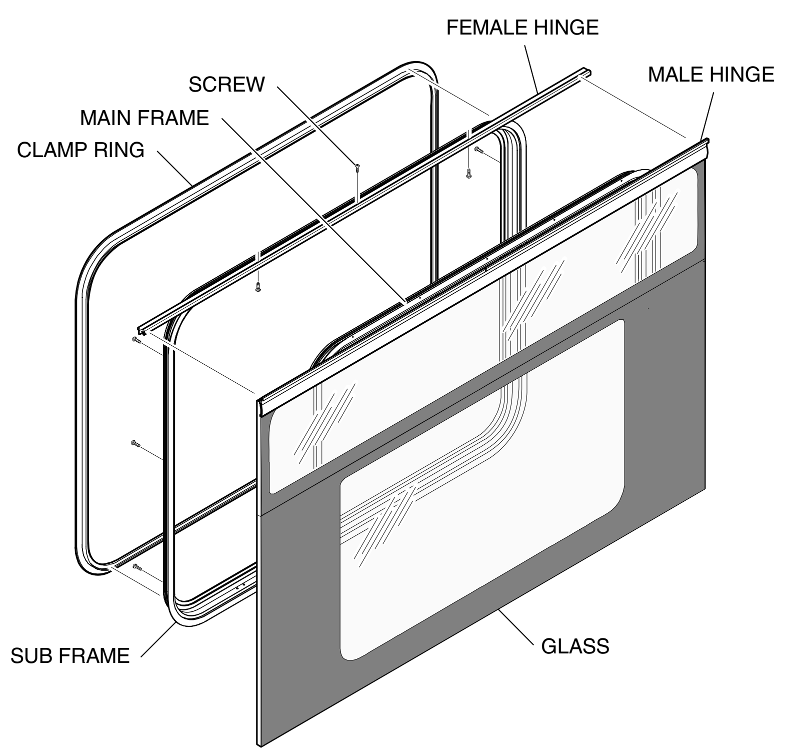


Fig. 14-14: Side Destination Sign Window

2.7. Flush Window Glass Replacement

☞**NOTE:**

Information on Flush Window Glass Replacement was developed by AROW Global Inc.

WARNING

Observe extreme care when performing the following procedures. Wear protective safety glasses and cut-resistant work gloves. Window assemblies are heavy, and should be moved by a minimum of two persons working together.

2.7.1. Fixed Glass Removal

1. Separate the main frame from the sub frame. Refer to 2.3.2. “Main Frame Removal” on page 7 in this section for the window assembly on which you are working.
2. Lubricate the bond between the frame and glass with the glass cleaner.
3. Using the air knife with a sharp blade cut the bond between the glass and the frame. See “Fig. 14-15: Cutting of Bond Between Frame & Glass” on page 20. Use glass cleaner to keep the bond wet during cutting.
4. Slightly lift on the frame as you are cutting to keep the blade from getting stuck.

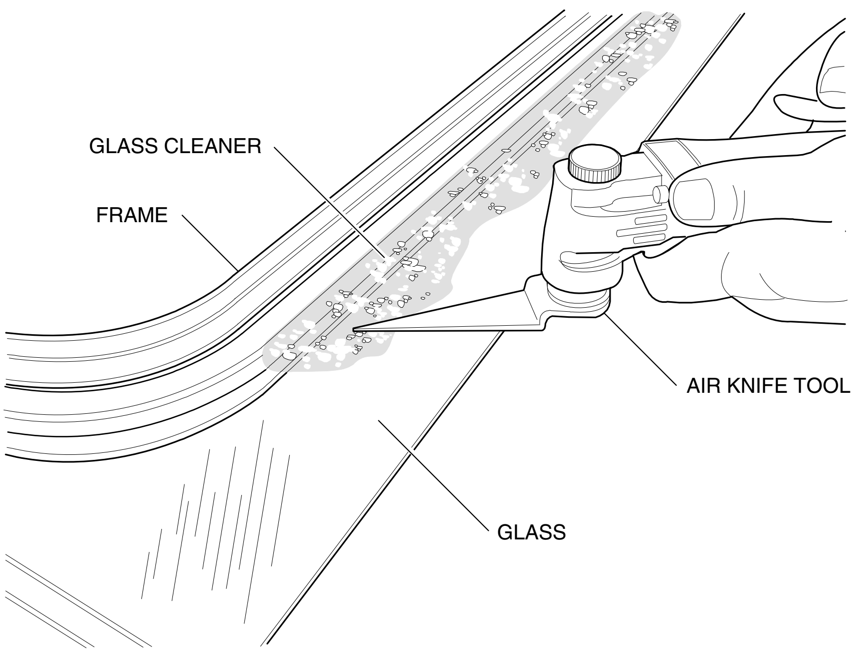


Fig. 14-15: Cutting of Bond Between Frame & Glass

2.7.2. Male Hinge Removal

1. Lubricate the bond between the male hinge and the glass.
2. Using the air knife cut the bond between the male hinge and the glass. See “Fig. 14-16: Cutting of Bond Between Male Hinge & Glass” on page 21. Slightly lift up on the male hinge to prevent the blade from getting stuck.

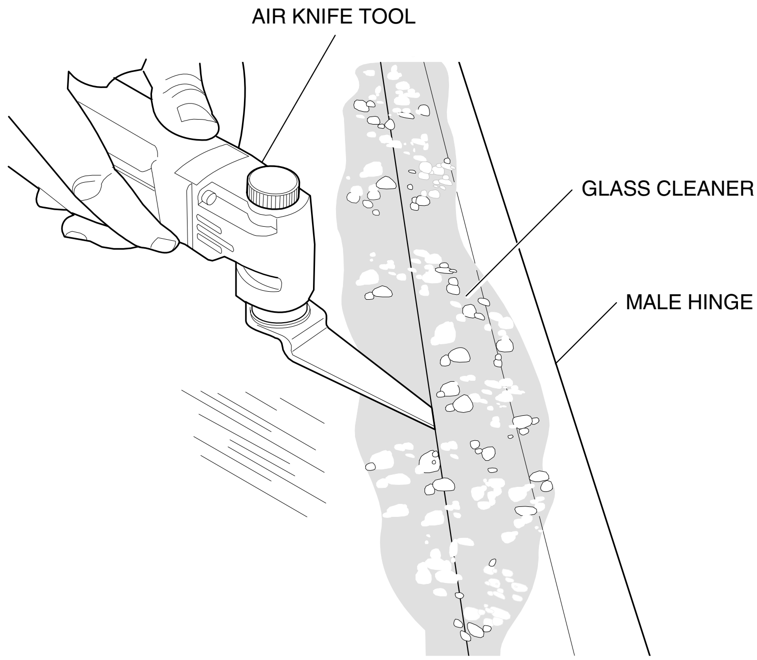


Fig. 14-16: Cutting of Bond Between Male Hinge & Glass

2.7.3. Male Hinge Cleaning

Using a razor bade in a holder remove any excess bonding adhesive from the male hinge.

2.7.4. Frame Cleaning

Use a razor blade in a holder to remove any excess bonding adhesive from the frame. Only a small amount of residual adhesive is permissible on the frame.

2.7.5. Bonding Frame to Glass

☞NOTES:

1. *All alcohol used for cleaning the bonding surfaces must be completely dried prior to applying adhesive. Contact between the alcohol and adhesive will prevent the adhesive from curing.*
2. *There is a 10 minute maximum time limit from the time you start applying the adhesive to the time the frame or hinge is set onto the glass. If this is not completed within the time limit the adhesive must be removed and the procedure will have to be restarted.*
3. *A continuous bead of the correct shape and size must be maintained to ensure a water tight bond.*
4. *Once the frame or hinge is set onto the glass they must not be pulled away from the glass for repositioning. This will result in water leaks or a low strength bond.*
5. *Read and follow the technical data sheet for the Simson 70-08 adhesive.*

1. Refer to 3. “GLASS OFFSET GUIDE” on page 38 in this section to determine the proper offset for the frame to the glass.
2. Set plywood blocks to the distance determined for correct glass to frame offset and clamp into place.
3. Set blocks on both sides and the top of the glass. See “Fig. 14-17: Frame to Block Alignment” on page 23.

☞NOTE:

For replacement of the driver’s window flush glass, Refer to 2.8.2. “Bonding Driver Frame to Glass” on page 32 *in this section for procedure.*

4. Dry fit the frame to check for correct offset distance before applying adhesive. For most applications the frame is to be centered between the front and rear edge of the glass.

☞NOTE:

The positional tolerance of the frame relative to the glass is ± 1/32".

☞NOTE:

When dry fitting the driver’s window flush glass, check the width and height of the glass. The overall height will be dependant on the tolerance of the frame, ± 1/16".

5. Clean all bonding surfaces (glass and frame) with isopropyl alcohol. Allow alcohol to dry.
6. Enlarge V-notch on the supplied Simson 70-08 applicator tip. The height of the V-notch is to be between 1/2" and 5/8".
7. Run a test bead on a piece of scrap paper to ensure the correct size and shape of bead is produced.
8. Using the lip on the frame as a guide, run a consistent bead of Simson adhesive around the frame of the window. See “Fig. 14-18: Adhesive Application” on page 23.
9. Align frame with blocks and press down on the frame to ensure there is a proper bond between the glass and the frame. The lip on the window frame used as a guide during adhesive application should contact the glass when the frame is fully set in place.
10. Allow adhesive to cure for 24 hours before handling the window. The weight of the frame is sufficient to prevent it from lifting off of the glass while the adhesive cures. Spray water on the adhesive as required to promote curing.

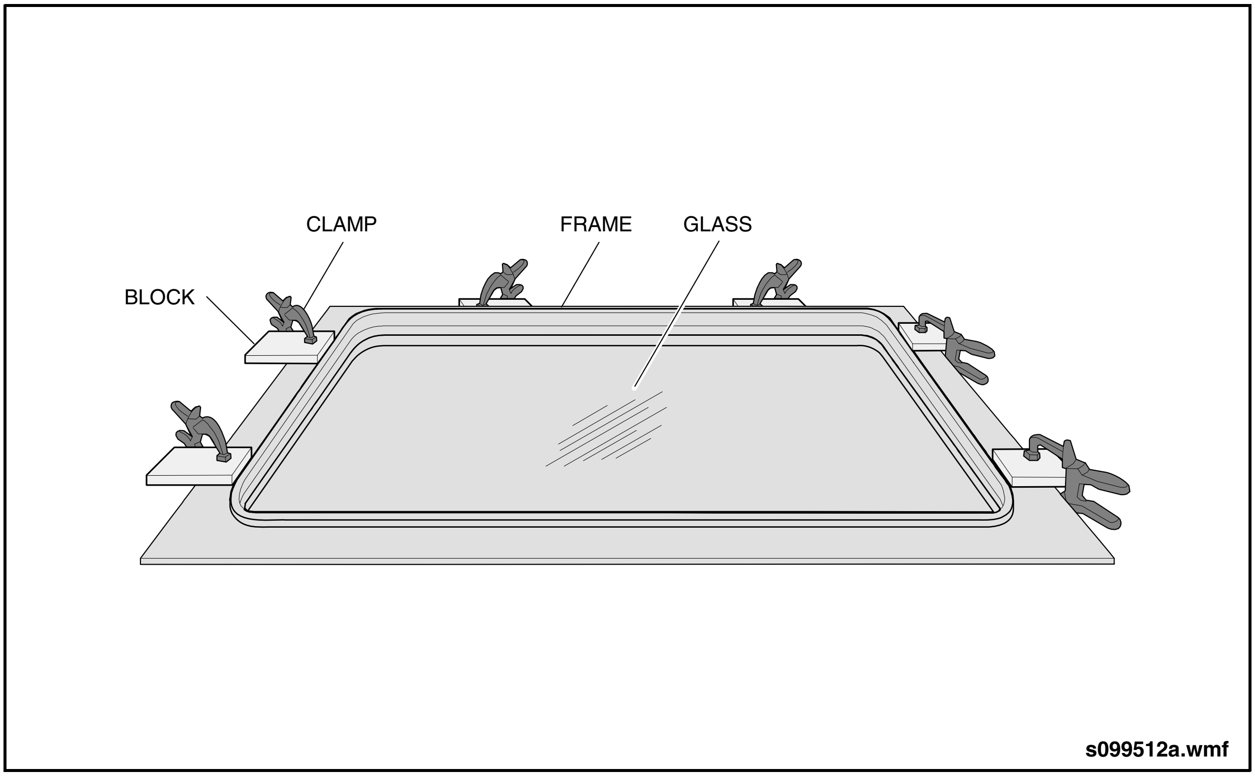


Fig. 14-17: Frame to Block Alignment

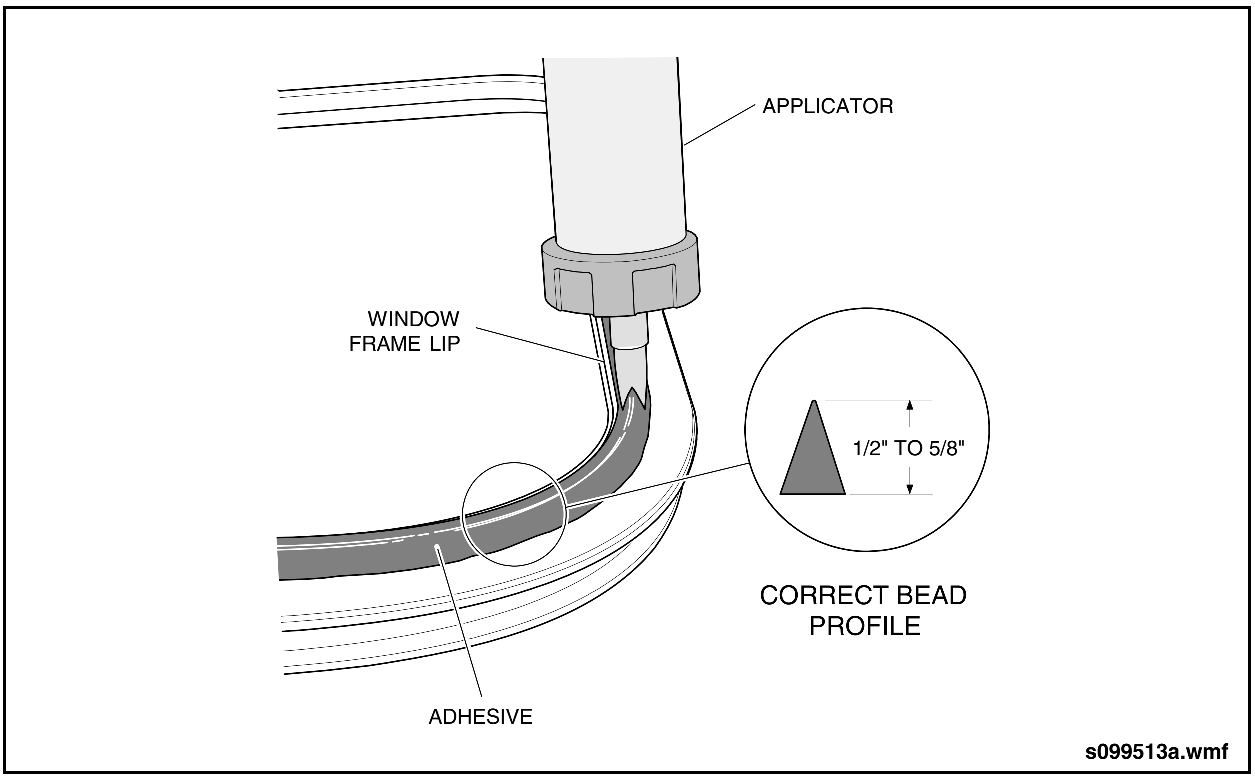


Fig. 14-18: Adhesive Application

2.7.6. Bonding Male Hinge to Glass

1. Clean all bonding surfaces (glass and male hinge) with isopropyl alcohol. Allow alcohol to dry.
2. Apply two beads of Simson adhesive along the full length of the male hinge. See “Fig. 14-19: Male Hinge Adhesive Application” on page 24.
3. Align the male hinge to the glass.
4. Press male hinge into place on the glass.
5. Clean off excess Simson adhesive at the ends of the hinge with a plastic scraper.
6. Ensure the hinge is positioned properly. The top flange of the hinge should be positioned against the top of the glass. The maximum allowable gap is 1/32". The bottom of the male hinge should correctly contact the exterior surface of the glass. The ends of the hinge extrusion are to be flush with the edges of the glass. See “Fig. 14-20: Flange & Hinge to Glass Contact” on page 25.
7. Clamp the male hinge into place. The clamps must be placed so that the force of the clamps does not slide the hinge away from the glass. See “Fig. 14-21: Male Hinge Clamping” on page 25.
8. Allow the Simson adhesive to cure for 48 hours prior to reinstalling the window on the vehicle. Spray water on the adhesive as required to promote curing.

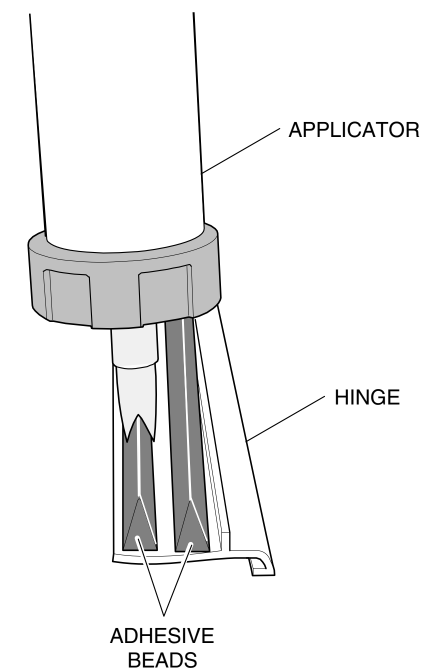


Fig. 14-19: Male Hinge Adhesive Application

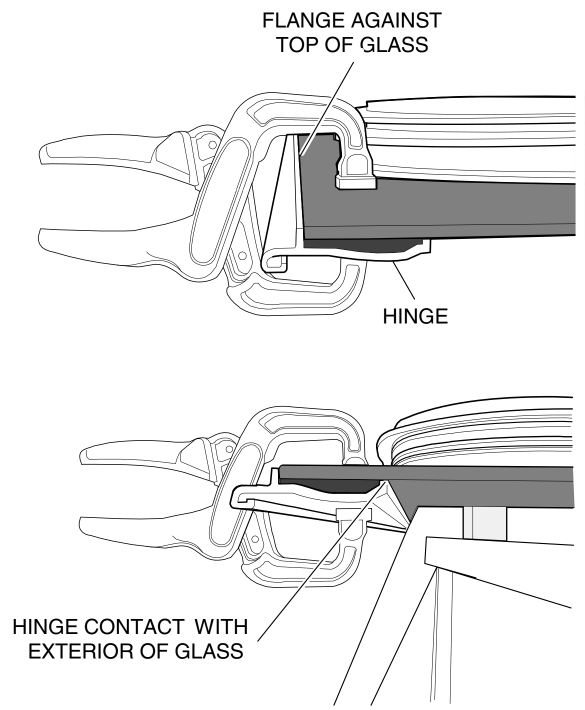


Fig. 14-20: Flange & Hinge to Glass Contact

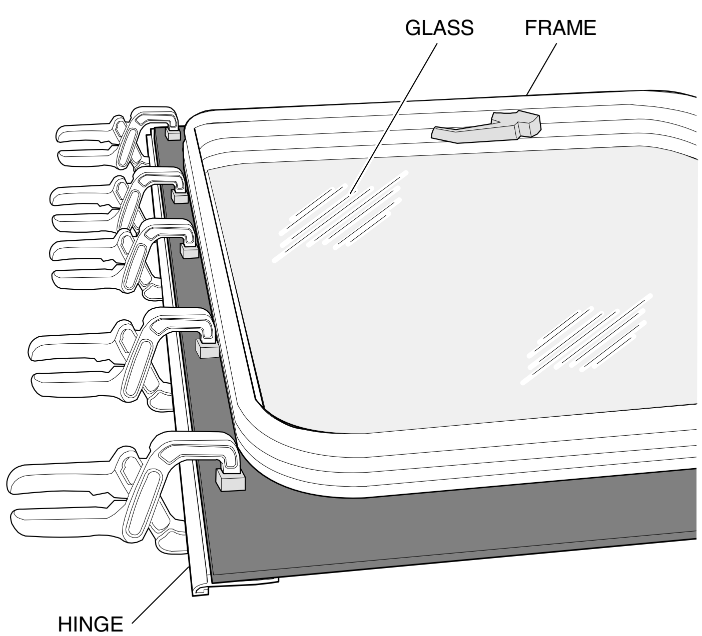


Fig. 14-21: Male Hinge Clamping

2.7.7. Fixed over Fixed Bonding

☞NOTE:

The following procedure applies to window assemblies which have fixed upper and lower glass sections which meet at a joint, such as the Destination Sign window.

2.7.7.1. Lower Glass Replacement Procedure

1. Remove the glass. Refer to 2.7.1. “Fixed Glass Removal” on page 20 in this section for procedure.
2. Clean frame. Refer to 2.7.4. “Frame Cleaning” on page 22 in this section for procedure.
3. Refer to 3. “GLASS OFFSET GUIDE” on page 38 in this section to determine the proper offset for the frame to the glass.
4. Set the plywood blocks with clamps to the distance determined from the offset guide.
5. Dry fit the frame to check for correct offset distance before applying adhesive. For most applications the frame is to be centered between the front and rear edge of the glass. Check the width and height of the glass. The overall height will be dependant on the tolerance of the frame, ± 1/16".
6. Clean all bonding surfaces (glass and frame) with isopropyl alcohol. Allow alcohol to dry.
7. Apply adhesive. Refer to 2.7.5. “Bonding Frame to Glass” on page 22 in this section for procedure.
8. Align frame with blocks and set frame into place.
9. Press down on the frame to ensure there is a proper bond between the glass and the frame. The lip on the window used for a guide to apply the adhesive should contact the glass when the frame is fully set into place.
10. Ensure the upper and lower glass is co-linear. Maximum tolerance is ± 1/16".
11. Move the side blocks over the glass joint to maintain the upper and lower glass on the same plane.
12. Allow the Simson adhesive to cure for 24 hours before handling the window. Spray water on the adhesive as required to promote curing.
13. Cap the joint. Refer to 2.7.7.3. “Fixed Over Fixed Capping the Joint Procedure” on page 27 in this section for procedure.

2.7.7.2. Upper Glass Replacement Procedure

1. Remove the glass. Refer to 2.7.1. "Fixed Glass Removal" on page 20 in this section for procedure.
2. Clean frame and hinge. Refer to 2.7.4. "Frame Cleaning" on page 22 and "Male Hinge Cleaning" in this section for procedures.
3. Refer to 3. "GLASS OFFSET GUIDE" on page 38 in this section to determine the proper offset for the frame to the glass.
4. Set the plywood blocks with clamps to the distance determined at the top and sides of the glass.
5. Dry fit the frame to check for correct offset distance before applying adhesive. For most applications the frame is to be centered between the front and rear edge of the glass. Check the width and height of the glass. The overall height will be dependant on the tolerance of the frame, ± 1/16".
6. Clean all bonding surfaces (glass and frame) with isopropyl alcohol. Allow alcohol to dry.
7. Apply adhesive. Refer to 2.7.5. "Bonding Frame to Glass" on page 22 in this section for procedure.
8. Align frame with blocks and set frame into place.
9. Press down on the frame to ensure there is a proper bond between the glass and the frame. The lip on the window used for a guide to apply the adhesive should contact the glass when the frame is fully set into place.
10. Ensure the upper and lower glass is co-linear.
11. Move the side blocks over the glass joint to maintain the upper and lower glass on the same plane.
12. Allow the adhesive to cure for 24 hours before handling the window. Spray water on the adhesive as required to promote curing.
13. Cap the joint. Refer to 2.7.7.3. "Fixed Over Fixed Capping the Joint Procedure" on page 27 in this section for procedure.
14. Bond male hinge to glass. Refer to 2.7.6. "Bonding Male Hinge to Glass" on page 24 in this section for procedure. Allow the hinge to cure for 48 hours before reinstalling.

2.7.7.3. Fixed Over Fixed Capping the Joint Procedure

☞**NOTE:**

This procedure applies to windows which have fixed upper and lower glass sections which meet at a joint, such as the Side Destination Sign Window.

1. Apply backing tape to the back side of the window where the glass extends beyond the frame.
2. Mask off the exterior of the window along both sides of the glass joint.
3. Prep the joint with isopropyl alcohol. Allow alcohol to dry.
4. Fill the joint with Simson 70-08 adhesive.
5. Using the plastic tool smooth the joint.
6. Remove the masking tape.
7. Allow the joint to cure for 48 hours prior to reinstalling the window on the vehicle. Spray water on the adhesive as required to promote curing.

2.7.8. Tip-in Bonding Procedure

2.7.8.1. Upper & Lower Glass Procedure

Refer to 2.7.7. "Fixed over Fixed Bonding" on page 26 in this section for glass replacement. Refer to 2.7.8.2. "Tip-in Joint Sealing Procedure" on page 28 in this section for sealing requirements for windows containing an upper tip-in glass joint.

2.7.8.2. Tip-in Joint Sealing Procedure

1. Open the tip-in sash.
2. Wipe down the joint between the transom and glass with isopropyl alcohol. See "Fig. 14-22: Transom & Glass Joint" on page 28.
3. Apply masking tape to the top of the transom and to the glass edge.
4. Run a bead of Simson 70-08 sealant down the joint between the transom and lower glass
5. Smooth out the joint with a finger after applying the sealant.
6. Remove masking tape to reveal sealed joint. See "Fig. 14-22: Transom & Glass Joint" on page 28.
7. Seal the inside of the window at the frame/ transom joint. The sash will have to be removed to inspect this area of the window. See "Fig. 14-24: Transom Joint Seal" on page 29.

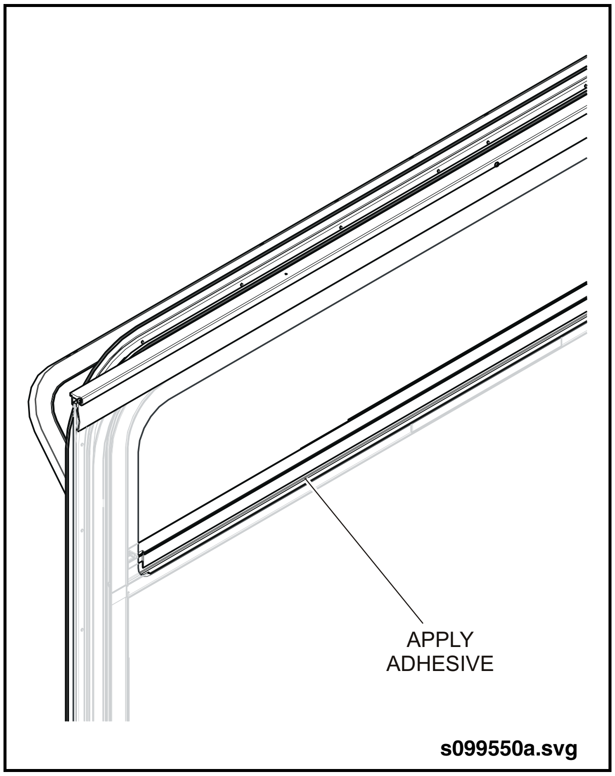


Fig. 14-22: Transom & Glass Joint

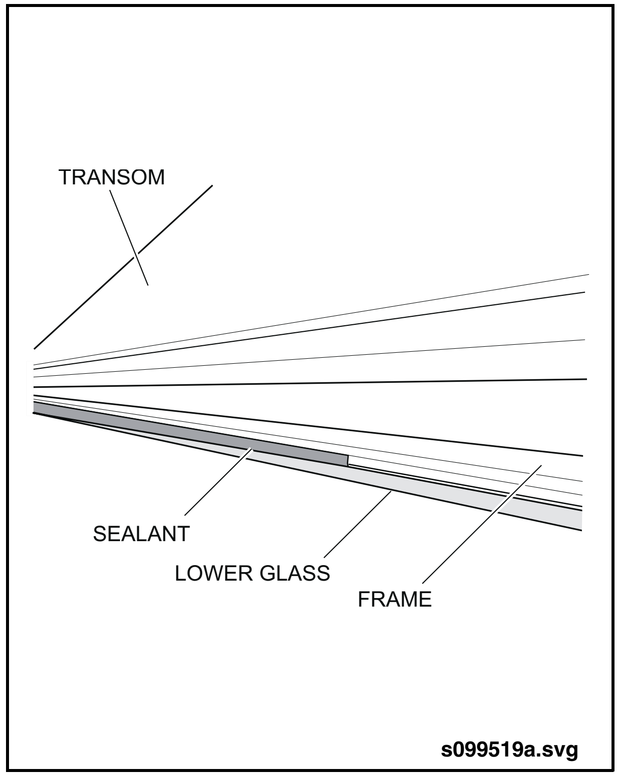


Fig. 14-23: Transom & Glass Joint Seal

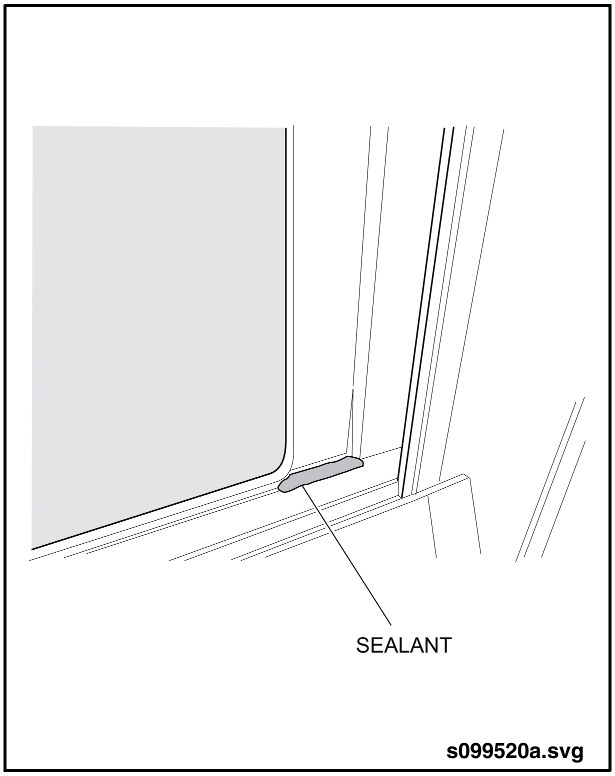


Fig. 14-24: Transom Joint Seal

2.7.9. Infill Glazing Installation

2.7.9.1. Vehicle Surface Preparation

1. Scuff the surface of bonding area with a purple 3M pad.
2. Clean the surface thoroughly using Sika glass and hard surface cleaner. Use a clean paper towel and wipe in one direction only, turning the towel over when it becomes soiled.
3. Apply Sika activator to the bonding area. Pour a small amount onto a clean, lint-free paper towel and wipe in one direction. Turn the towel over, or use multiple towels to maintain area cleanliness.
4. Wipe area dry with clean paper towels and allow to dry for three (3) minutes.
5. Apply Sika primer 206 to the bonding area with a brush roller in one continuous stroke. DO NOT brush back and forth.

   ☞**NOTE:**

   After each application discard roller in accordance with all applicable disposal regulations.

6. Allow the Sika primer to dry for 30 minutes.

2.7.9.2. Infill Glazing Preparation

1. Remove dust from glazing using Sika glass and hard surface cleaner. Use a clean paper towel and wipe in one direction only, turning the towel over when it becomes soiled.
2. Apply Sika activator to the bonding area. Pour a small amount onto a clean, lint-free paper towel and wipe in one direction. Turn the towel over, or use multiple towels to maintain area cleanliness.
3. Wipe the glazing bonding area dry using a clean, dry lint-free paper towel. Allow glazing to dry for three (3) minutes.
4. Install foam tape to back of replacement glazing approximately one inch from glazing edge. See "Fig. 14-25: Infill Glazing Seal Installation" on page 30.
5. Apply a 1/2" high V-shaped bead of Sikaflex adhesive around the entire perimeter of the outer seal strips and equally spaced between the vertical strips.
6. Press glazing into place on the vehicle opening. Apply pressure over the entire panel to ensure adhesive fully bonds to vehicle.

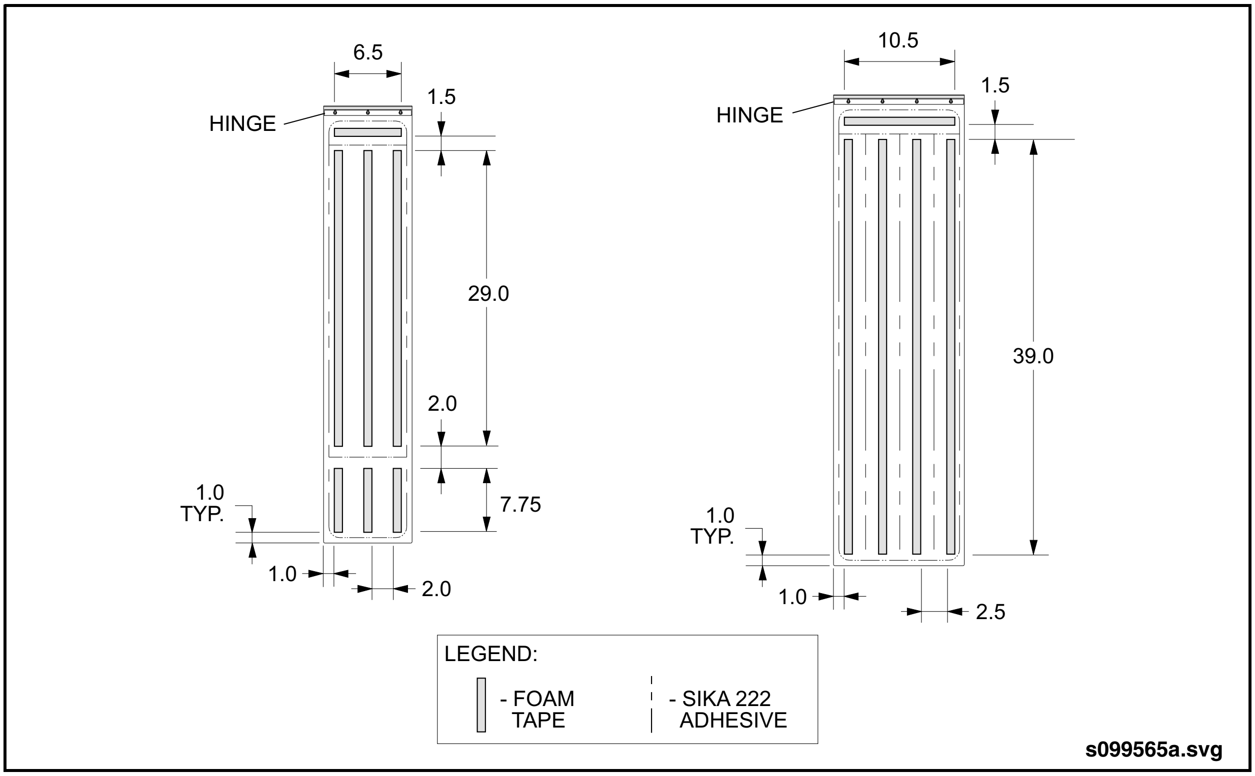


Fig. 14-25: Infill Glazing Seal Installation

2.7.9.3. Lower Infill Glazing Preparation

1. Remove dust from glazing using Sika glass and hard surface cleaner. Use a clean paper towel and wipe in one direction only, turning the towel over when it becomes soiled.
2. Apply Sika activator to the bonding area. Pour a small amount onto a clean, lint-free paper towel and wipe in one direction. Turn the towel over, or use multiple towels to maintain area cleanliness.
3. Wipe the glazing bonding area dry using a clean, dry lint-free paper towel. Allow glazing to dry for three (3) minutes.
4. Install foam spacer tape and adhesive to back of replacement glazing as follows See “Fig. 14-26: Lower Infill Glazing Seal Installation” on page 31.
   - ❒ Install three equally spaced strips of foam tape along the length of the glazing. Leave 3" from the ends and 1" from the sides free of foam tape. Apply the foam tape in a double layer to achieve a thickness of 1/4"
5. Apply a 1/2" high V-shaped bead of Sikaflex adhesive around the entire perimeter of the outer seal strips and equally spaced between the vertical strips.
6. Press glazing into place on the vehicle bonding area until the spacer tape adheres to the surface. Apply pressure over the entire panel to ensure adhesive fully bonds to vehicle.

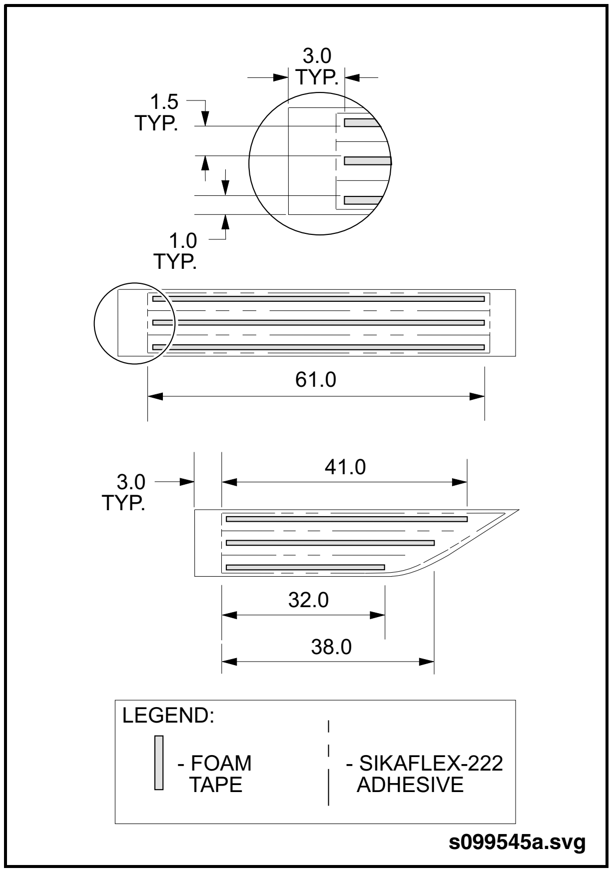


Fig. 14-26: Lower Infill Glazing Seal Installation

2.8. Driver's Window Bonding Procedure

2.8.1. Fixed Meet Rail Procedure

1. Refer to 3. “GLASS OFFSET GUIDE” on page 38 in this section to determine the proper offset for the meet rail to the glass edge.
2. Set the plywood blocks with clamps to the distance determined from the offset guide.
3. Dry fit fixed meet rail to ensure proper fit.
4. Clean all bonding surfaces (glass and fixed meet rail) with isopropyl alcohol. Allow alcohol to dry.
5. Run a consistent bead of Simson adhesive along the center of the fixed meet rail. Refer to 2.7.5. “Bonding Frame to Glass” on page 22 in this section for general information on adhesive.
6. Align fixed meet rail with the block and set rail into place.
7. Squeeze the fixed meet rail onto the glass to ensure there is a proper bond between the fixed meet rail and the glass.
8. Allow the adhesive to cure for 24 hours before handling the glass. Spray water on the adhesive as required to promote curing.

2.8.2. Bonding Driver Frame to Glass

1. Remove the glass. Refer to 2.7.1. “Fixed Glass Removal” on page 20 in this section for procedure.
2. Clean frame and hinge. Refer to 2.7.4. “Frame Cleaning” on page 22 in this section for procedure.
3. Refer to 3. “GLASS OFFSET GUIDE” on page 38 in this section to determine the proper offset for the frame to the glass edge.
4. Set the plywood blocks with clamps to the distance determined to the top and back of the glass.
5. Dry fit the frame to check for correct offset distance before applying adhesive. Check the width and height of the glass. The overall height will be dependant on the tolerance of the frame, ± 1/16".
6. Clean all bonding surfaces (glass and frame) with isopropyl alcohol. Allow alcohol to dry.
7. Refer to 2.7.5. “Bonding Frame to Glass” on page 22 in this section for procedure.
8. Align frame with blocks and set frame into place.
9. Press down on the frame to ensure there is a proper bond between the glass and the frame. The lip on the window used for a guide to apply the adhesive should contact the glass when the frame is fully set into place.
10. Bond male hinge to glass. Refer to 2.7.6. “Bonding Male Hinge to Glass” on page 24 in this section for procedure. Allow the hinge to cure for 48 hours.

2.9. Window Assembly Replacement

WARNING

ALWAYS use appropriate lifting equipment designed specifically for the task, or use the assistance of additional personnel when replacing the window.

The following is the procedure for removing and reinstalling a complete window assembly from the vehicle.

2.9.1. Removal

1. Support the window assembly from outside the vehicle.
2. Remove all screws from the interior clamp ring.
3. Remove the clamp ring.
4. Apply pressure to the interior side of the window assembly and force the window assembly outward from the vehicle window opening.

2.9.2. Installation

Before you install the window, inspect the window opening. It should not have damaged surfaces or lack of sealant at the joints. Inspect the window assembly perimeter and the clamp ring seals as well.

1. Install the window assembly from the exterior of the vehicle and push into place.
2. Center the window assembly in opening.
3. Support the window assembly from outside the vehicle.
4. Install the clamp ring from the interior of the vehicle. Ensure the joint is at the top of the window.
5. Install the first six screws in the locations shown and apply an initial torque of 20 in-lb. in the sequence shown. See "Fig. 14-27: Initial Screw Tightening Sequence" on page 34.
6. Install remaining screws and apply initial torque of 20 in-lb. in the order of installation.
7. Apply final torque of 45 in-lb. to all screws in proper sequence. See "Fig. 14-28: Final Screw Tightening Sequence" on page 34.

After you complete the window installation, check the operation of window sliders. Verify function of emergency release handle and latches on egress style windows.

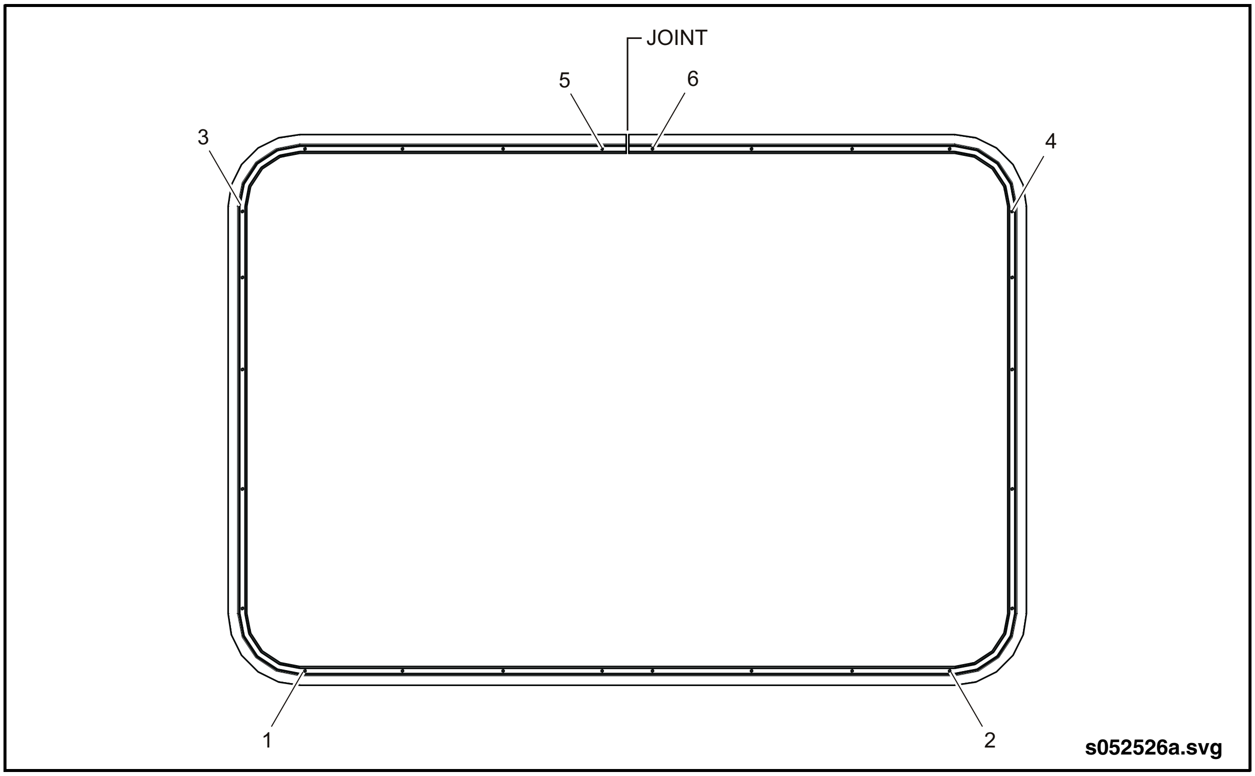


Fig. 14-27: Initial Screw Tightening Sequence

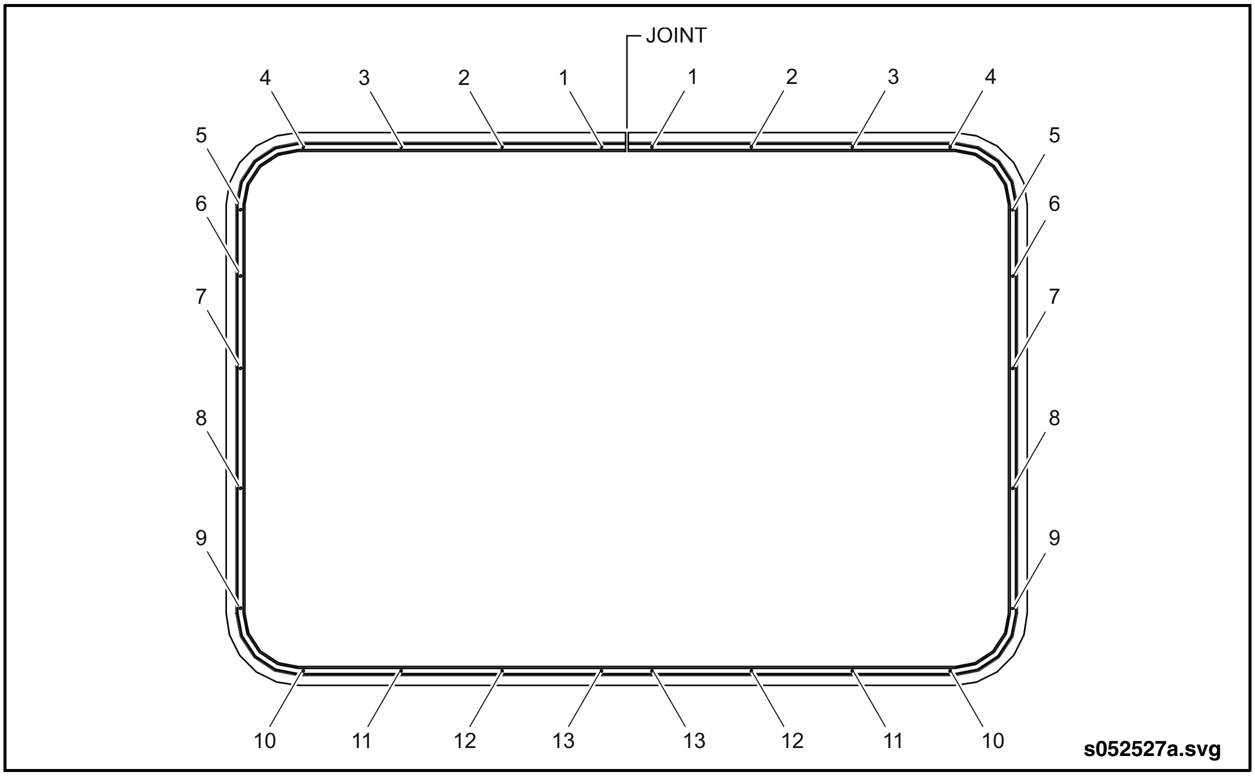


Fig. 14-28: Final Screw Tightening Sequence

2.10. Vandal Shields

2.10.1. Description

Plastic 1/8" acrylic shields are installed against the glazing of the window assemblies on this vehicle. They serve as a sacrificial barrier which protects the window glazing from vandalism.

2.10.2. Removal

NOTE:

Two suction cups and glass cleaner will be required to remove and install the acrylic shields

1. Lubricate the retainer rubber around the perimeter of the shield with glass cleaner.
2. Apply two suction cups on the shield, about 1/3 of the way in from both ends and force the shield upward.
3. Bow the shield enough so that the bottom edge no longer engages with the frame. Keep shield bowed, slide down and pull out of window. See “Fig. 14-29: Acrylic Shield Removal” on page 35.

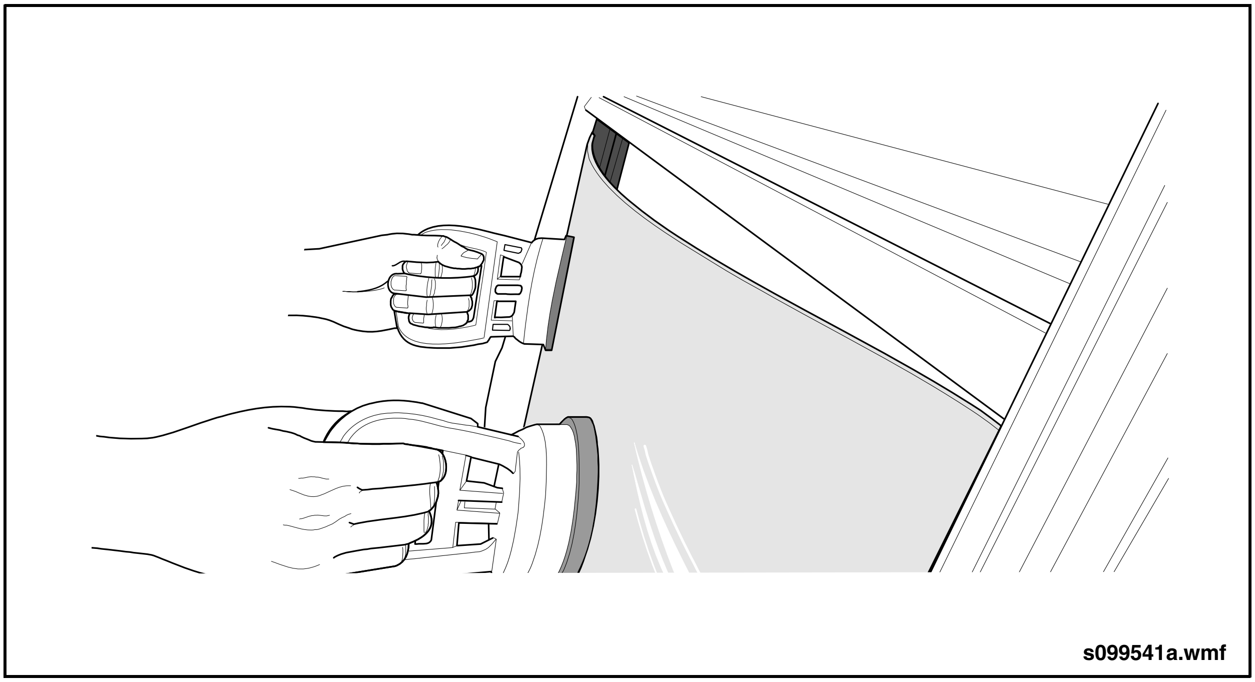


Fig. 14-29: Acrylic Shield Removal

2.10.3. Installation

1. Apply a generous amount of glass cleaner to the shield retainer rubber.
2. Wipe off any excess that may be on the glass and shield.
3. Apply suction cups to shield as described in step 2 of shield removal.
4. Bow the shield enough to get the sides of the shield installed as well as the top.
5. Force the shield upward and install the bottom edge of the shield.
6. Force the shield downward as far as it will go. Center the shield left to right and ensure the edges of the shield can't be seen sticking outside the retainer rubber.

2.10.4. Removing & Installing New Shield Retainer Rubber

☞**NOTE:**

A small pick or screwdriver will be required to perform this procedure.

☞**NOTE:**

This rubber should only be removed if damaged.

1. At one of the corners, insert a small pick or screwdriver and remove from groove. See "Fig. 14-30: Shield Retainer Rubber Removal" on page 36.
2. Pull the rubber out around the perimeter of the window.
3. Installation is the reverse of removal.

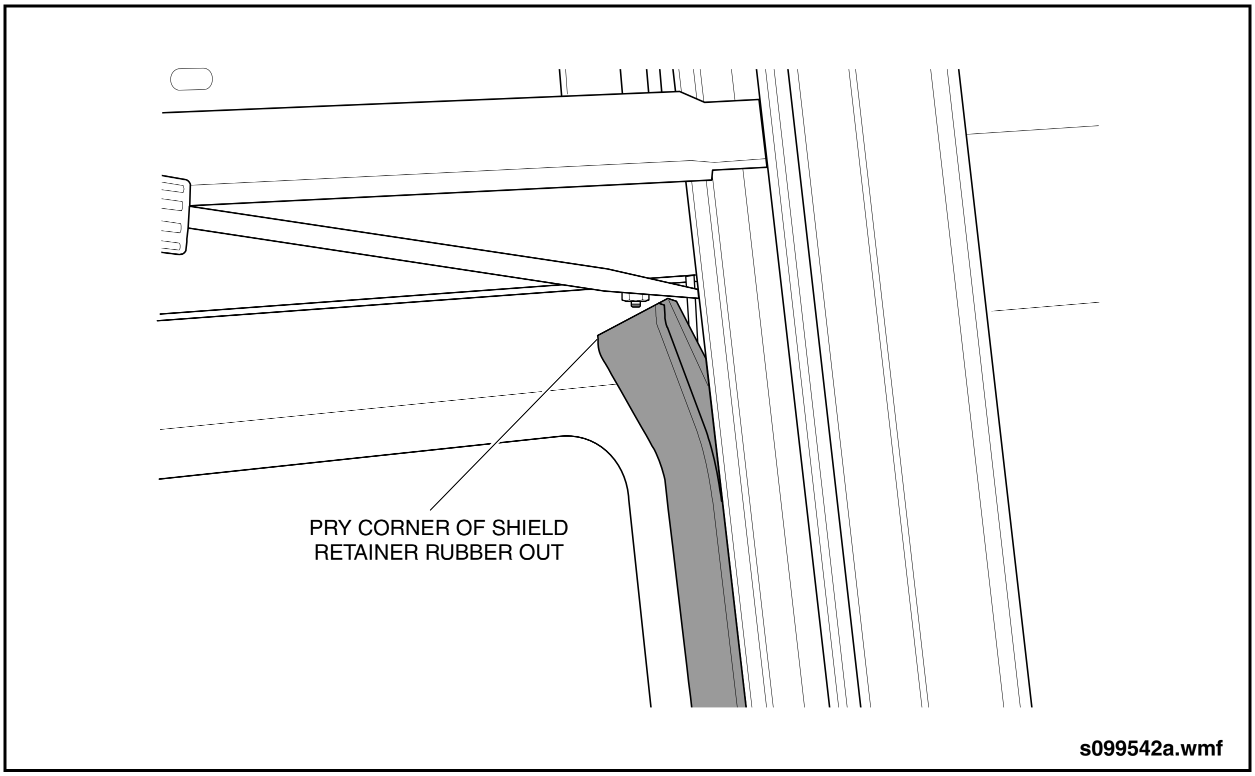


Fig. 14-30: Shield Retainer Rubber Removal

2.10.5. Cleaning Acrylic Shields

☞**NOTE:**

Periodic cleaning is required if regular replacement of guards due to vandalism does not occur.

1. Wash with window cleaner or a mild soap or detergent and lukewarm water solution, using a clean soft cloth and as much of the soap solution as possible.
2. Use a good grade of hexane, naptha, or kerosene to remove tar, grease, paint, etc.
3. Solvent residue should be removed by washing immediately.

☞**NOTE:**

NEVER use scouring compounds, gritty cloths, leaded or ethyl gasolines or solvents such as alcohol, acetone, benzene, carbon tetrachloride, or lacquer thinner to clean the plastic guards.

3. GLASS OFFSET GUIDE

3.1. Glass Offset Guide Chart

GLASS OFFSET GUIDE CHART			
Xcelsior® Window Size	Glass Offset		
	Top	Sides	Bottom
43.64" x 42.60"	1.03"	3.19"	1.91"
49.31" x 42.60"	1.03"	3.19"	1.91"
62.28" x 42.60"	1.03"	3.20"	1.91"
62.28" x 35.12"	1.03"	3.20"	9.41"
72.28" x 42.60"	1.03"	3.20"	1.91"
40.83" x 40.10" (Curved Driver's Window)	1.03"	Rear Edge 6.45"	4.28"
Driver's Window Meet Rail	**Top Glass Edge to Meet Rail Offset**		
	2.25"		

Access Doors & Panels

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❒ open flame
- ❒ excessive heat
- ❒ production of sparks
- ❒ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

⚠ WARNING

DO NOT perform any maintenance on roof-mounted components unless equipment is in place to prevent fall hazards. Ensure maintenance personnel use approved lift platforms or scaffolding and wear approved safety harness when working on the roof of the vehicle.

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Gas Spring Disposal

Gas springs must be depressurized and drained of any oil before disposal. For safety and environmental reasons, use the following procedure:

⚠ WARNING

Wear a face shield or safety glasses and place a rag over saw blade while cutting.

1. Clamp the rod end of the cylinder in a vise.
2. Mark the cylinder 30 to 35mm from the base end of the cylinder.
3. Cut a crosswise slit in the cylinder in the marked area.
4. Stop sawing as soon as a hissing sound is heard. Allow the unit to depressurize completely.

☞NOTE:

Nitrogen is an inert gas. Consequently, gas release is totally safe.

5. Place the cylinder in a drain pan ensuring the cut is facing down. Allow oil to drain completely. Dispose of oil in accordance with environmental regulations.
6. Recycle gas spring as a steel component.

2. INTERIOR ACCESS DOORS

2.1. Maintenance

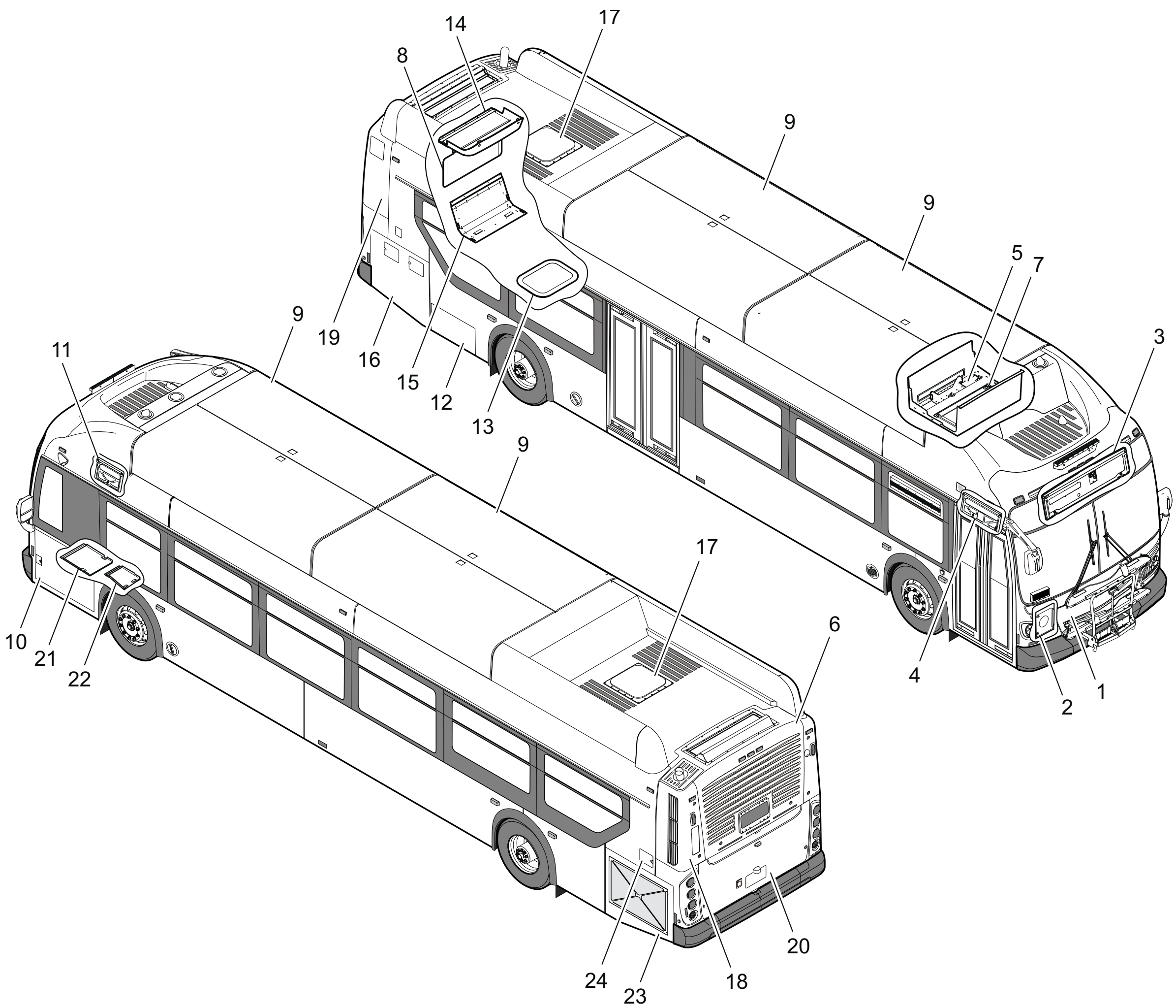
Refer to the Preventive Maintenance Section of this manual for scheduled maintenance requirements on the interior access doors.

2.2. Front Destination Sign Access

The front destination sign access door is located at the front of the vehicle above the windshields. This door allows access to the destination sign. It is held open by two gas struts and held closed by two wing quad latches. See “Fig. 15-1: Access Door Locations” on page 3.

2.3. Entrance Mechanism Access

The entrance mechanism access door is located directly above the entrance door. It allows access to the door mechanism for servicing and maintenance. This door is held open by a gas strut and held closed by two quarter-turn wing latches.



1. Door Assembly, Defroster Access
2. Door Assembly, Dash Panel Access
3. Door Assembly, Front Destination Sign Access
4. Door Assembly, Mechanism Box
5. Door Assembly, Stop Request Access
6. Door Assembly, Rear HVAC Access
7. Door Assembly, Access
8. Door Assembly, Return Air Grille Access
9. Door, CNG Tanks Access
10. Door Assembly, Side Console Access
11. Door Assembly, Driver's Locker
12. Door, Battery Access
13. Door Assembly, Driveshaft/Traction Motor Access
14. Door Assembly, Rear Electronic Equipment Access
15. Door Assembly, Transmission/Drive Unit Access
16. Door Assembly, Fusebox Access
17. Roof Hatch Assembly
18. Door Assembly, Upper Corner Pillar Streetside
19. Door Assembly, Upper Corner Pillar Curbside
20. Door Assembly, Engine Access
21. Door Assembly, Steering Box Access
22. Door Assembly, Radius Rod Access
23. Door Assembly, Radiator Access
24. Door Assembly, Surge Tank Access

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Fig. 15-1: Access Door Locations

2.4. Engine & Transmission Access

The engine and transmission access door is located underneath the three rear center seats. To open the door proceed as follows:

1. Lift the front of the seat. The assembly will pivot on the piano hinge attached to the upper part of the backrest.
2. Continue pivoting the assembly upwards until the gas struts are fully extended.
3. Locate the locking gas strut and engage the lock. See “Fig. 15-2: Engine & Transmission Access Doors” on page 5.
4. Allow the seat to pivot down slightly until the seats are supported by the locked gas strut.

WARNING

Ensure the seat assembly is properly secured. Improper securing of the seat assembly could allow it to fall accidentally while accessing the engine or transmission and can cause serious personal injury.

5. Insert a T-handle into the square key latch-holes securing the door and turn each of the latches 1/4 turn to release the door.
6. Carefully lift the door assembly. It will pivot on the piano hinge attached to the upper part of the access opening.
7. Continue pivoting the assembly upwards until the access door back is parallel to the floor.
8. Locate the support tube.
9. Lift the free end of the tube up and index it with the peg on the bottom of the access door assembly.
10. Allow the access door to pivot down slightly so the peg engages into the open end of the support tube.
11. Install the safety pin through the cross-drilled hole in the tube and peg to safely secure the access door assembly in the raised position.

WARNING

Ensure the access door assembly is properly secured with the support tube and safety pin is installed to prevent the access door assembly from being lifted further from the raised position. Improper securing of the access door assembly could allow it to fall accidentally while accessing the engine or transmission and can cause serious personal injury.

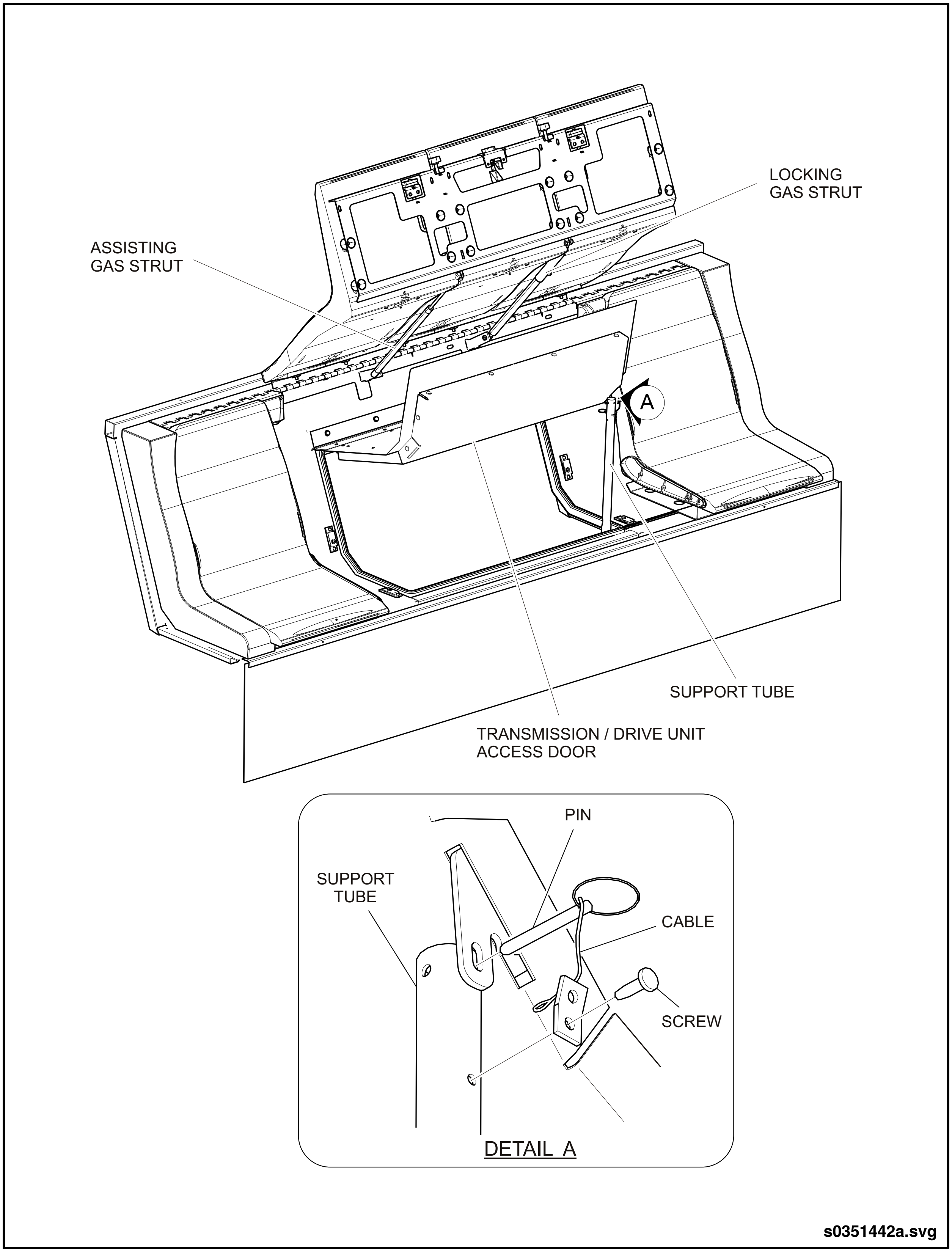


Fig. 15-2: Engine & Transmission Access Doors

2.5. Driveshaft Access

A driveshaft access door and access plate are located in the floor at the rear of the vehicle. See “Fig. 15-3: Driveshaft Access” on page 6.

To access the driveshaft from inside the vehicle:

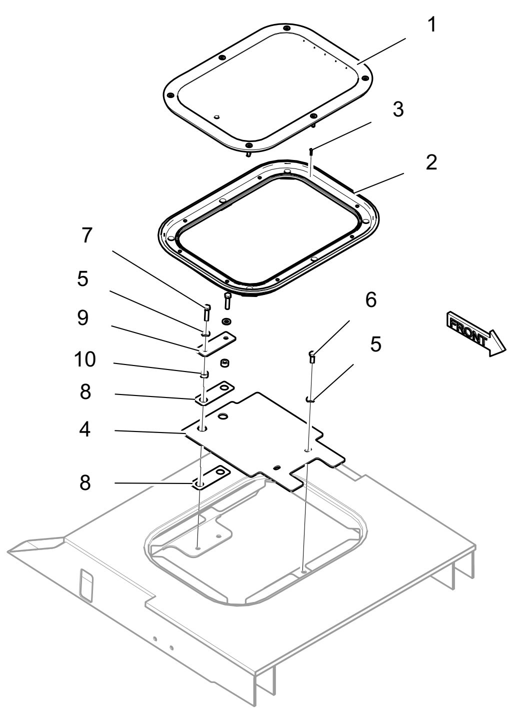
1. Use a square key to turn the 1/4 turn latches on the interior access door.
2. Remove the 4 bolts from the driveshaft shield beneath the access door and carefully remove it.

☞NOTE:

The four 1/2" bolts retaining the driveshaft shield are fastened into nuts that have been welded in place. The plate and mounting hardware can be removed and installed from inside the vehicle.

To install the driveshaft shield:

1. Install the driveshaft shield onto the subfloor angle supports using the four 1/2" bolts.
2. Insert the driveshaft access door into the floor opening and use a square key to turn the 1/4 turn latches to secure the door in place.



1. Door Assembly, Driveshaft Access
2. Adhesive, SIKA 221 White
3. Screw, Tri Lob FH Cross Recess SST #10 - 24 UNC x 1" Lg.
4. Plate, Driveshaft Guard
5. Washer, Flat Hardened 1/2"
6. Bolt, Hex 1/2" - 13 UNC x 1 1/4" Lg.
7. Bolt, Hex 1/2" - 13 UNC x 2" Lg.
8. Spacer Plate, Nylon
9. Plate, Driveshaft Load
10. Spacer, Driveshaft

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Fig. 15-3: Driveshaft Access

2.6. Return Air Filter & HVAC Access

The interior A/C access door is located behind the rear bench seat and provides access to the HVAC unit and return air filter. The access door is secured with square-key quarter-turn latches at the bottom and hinges upward. The door is held open with gas struts. See "Fig. 15-4: Return Air Filter & HVAC Access" on page 7.

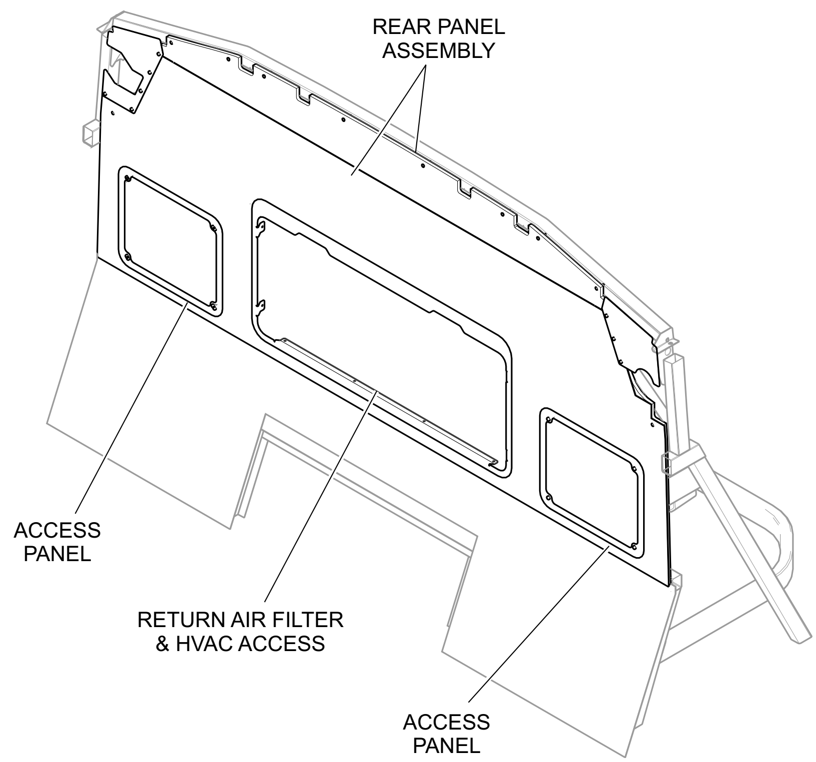


Fig. 15-4: Return Air Filter & HVAC Access

2.7. HVAC Center Cover Access

The interior A/C center cover access door is located in the ceiling of the vehicle, forward of the return air grille. It is secured with square-key quarter-turn latches on the rearward edge of the access door and a hinge on the forward edge. The door opens downward and provides access to the booster fan. A detachable lanyard prevents the access door from falling open uncontrollably.

2.8. Stop Request Sign Access

The Stop Request Sign access door is located between the Return Air Grille and the HVAC center cover access doors. It is secured with square-key quarter-turn latches on the rearward edge and a hinge on the forward edge. The door swings downward and provides access to the stop request sign.

2.9. RH Lower Dash Panel Access

The RH lower dash panel access door is located in the lower dash, near the entrance door. It is secured with square key latches and hinges outward to allow access to the curbside headlight assembly.

2.10. Rear Electronic Equipment Compartment Access

The rear electronic equipment access door is located directly above the rear bench. It allows access to the electrical components for servicing and maintenance. This door is secured by two square-key quarter-turn latches and pivots open rearward on a hinge.

2.11. Driver's Locker Access

The driver's locker access door is located directly above the driver's side window. This door is held open by a gas strut and held closed by a quarter-turn wing latch.

2.12. Rear Panel Access (Streetside & Curbside)

The rear panel access doors are part of the rear panel located behind the rear bench seat. The curbside door allows access to the voltage equalizer and the streetside door allows access to various electrical harnesses. The doors are held in place with screws.

3. EXTERIOR ACCESS DOORS

3.1. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance requirements on the exterior access doors.

3.2. Defroster Access

The defroster access cover allows exterior access to the defroster. It is fitted with two hinges on its upper edge and is closed using two quarter-turn latches.

3.3. Side Console Access

The side console access door is located under the driver's window. This door allows access to the front electrical panel, circuit breakers and fuses that protect operator controlled circuits of vehicle electrical systems. It is held open by two gas struts and closed by two square-key quarter-turn latches.

3.4. Steering Gearbox Access

Two exterior access doors are located beneath the vehicle and provide access to the steering gearbox and miter box. The access doors are retained with square-key latches and are hinged to open downward. A closeout panel, located near the access doors, can be removed if additional access is required in this area. Remove the three bolts that attach the panel to vehicle structure.

3.5. Battery Access

The battery access door is located behind the rear wheel on the curbside and allows access to the batteries, primary fuel filter. It is secured with two square-key quarter-turn latches and held open by one gas strut.

3.6. Radiator Access

The radiator access door is located on the streetside, at the rear of the vehicle. It enables access to the radiator, charge air cooler and hydraulic oil cooler for cleaning and servicing. This grilled door is held open by two gas struts and secured closed with two square-key quarter-turn latches.

3.7. Surge Tank Access

The surge tank access door is located above the radiator access door. This door requires a square key to open and allows for easy filling and checking of the engine cooling system. It is spring loaded to remain either open or closed.

3.8. Engine Access

The engine access door is located at the rear of vehicle. It provides access to the hydraulic reservoir, alternator, engine assembly, and engine switch panel. This door is equipped with a fixed handle to raise, and two gas struts to support the door. The door is held closed by two square-key quarter-turn latches. The door is equipped with a strobe light that illuminates when the entrance and exit doors are open, the master run switch is in the RUN position and the shift selector is in drive or reverse.

3.9. Fuel Filler Access

The fuel filler access door is located on the curbside of the vehicle within the fusebox access door. The door provides access to the CNG fill box, which contains high and low pressure gauges, and fill manifold with fill receptacle. A proximity switch in the door mechanism automatically shuts off the fuel system if the door is opened when the vehicle is operating. The vehicle cannot be started unless the door is properly closed.

3.10. Fuse Box Access

The fuse box access door is located on the curbside, at the rear of the vehicle. It enables access to the battery disconnect switch, jumpstart assembly and fuses for servicing. This door is held open by two gas struts and secured closed with two square-key quarter-turn latches.

3.11. Battery Disconnect Switch Access

The battery disconnect switch access door is a small hinged door mounted in the front of the fuse box access door. This door allows access to the battery disconnect switch, compartment light switch, and jumpstart connection without opening the fuse box access door. It is held open and closed by a gas strut.

3.12. Upper Corner Pillar Access

The upper corner pillar access doors are located on the streetside and curbside at the rear of the vehicle. See “Fig. 15-5: Streetside Corner Pillar” on page 10. See “Fig. 15-6: Curbside Corner Pillar” on page 10. These access doors are secured with square-key quarter-turn latches at the rear of the vehicle. They are hinged and pivot 90° outward to allow access to the exhaust system and air intake components.

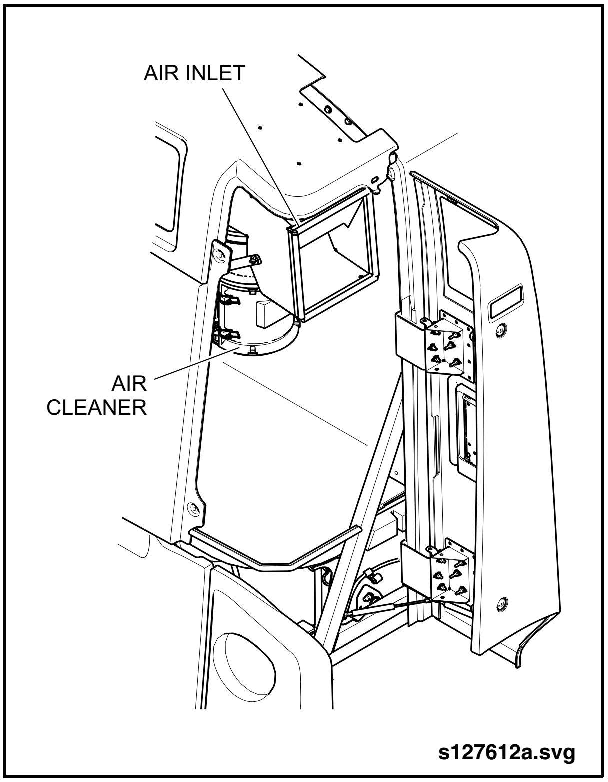


Fig. 15-6: Curbside Corner Pillar

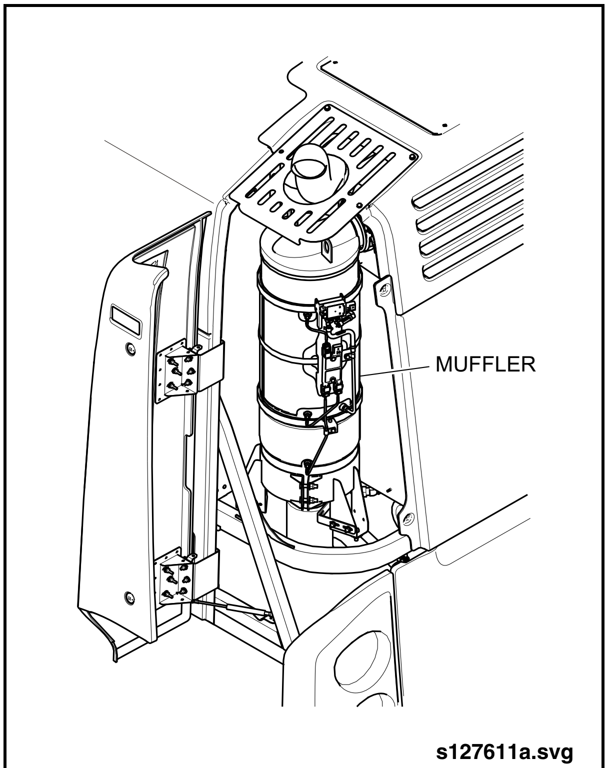


Fig. 15-5: Streetside Corner Pillar

3.13. Exterior A/C Access

The exterior A/C access door is located at the rear of the vehicle above the engine compartment. It is equipped with two gas cylinders. This door provides access to the HVAC unit motors, controller motor resistors, receiver tank, drier, liquid line sight glass, expansion valve, coolant valve, and high pressure relief valve.

4. CNG TANK ACCESS

4.1. Description

The roof-mounted CNG fuel tanks and main fuel lines are housed in protective modules. Each module consists of two fiberglass door assemblies which are secured to the tank support structure with hinges. Each door is a molded fiberglass assembly which incorporates a rotary handle and two rotary latches, mounted to reinforcing plates. Safety Walk material has been applied to the modules to prevent technicians from slipping on the structure during maintenance. The fore and aft ends of the module are closed off with protective nosings.

4.2. Operation

4.2.1. Opening

1. Remove the cotter pins securing the door panel to the tank structure.
2. Lift the latch handle from the recess in the center of the panel.
3. Rotate the handle to unlatch the door panel and rotate the panel outward.

☞**NOTE:**

The tank access doors are prevented from opening beyond their design limits by lengths of cord which are secured to the two reinforcing plates in the center of each door and to angles on the roof structure. These lanyards are intended as temporary supports only. Ensure the prop rods are properly secured before beginning maintenance activities.

4. Secure the doors in the open position with the prop rods at both ends.

4.2.2. Closing

1. Disconnect the prop rods and stow them in their proper clips.
2. Carefully lower the access door into the closed position, taking care to align the holes at the front and rear of the panel with the vertical pins from the CNG tank rack structure.
3. Press the door into position until both rotary latches are fully latched.
4. Secure the door in place for vehicle operation by installing the cotter pins through the cross-drilled holes in the vertical pins extending through the access door panels.

4.3. Maintenance

⚠ WARNING

DO NOT perform any maintenance on roof-mounted components unless equipment is in place to prevent fall hazards. Ensure maintenance personnel use approved lift platforms or scaffolding and wear approved safety harness when working on the roof of the vehicle.

4.3.1. General

⚠ WARNING

The CNG doors are heavy and could cause injury if closed without caution. Also be cautious and avoid situations which could cause you to fall from the coach roof.

Ensure the doors open and close freely, with no binding, and that the locking latches operate smoothly. Periodically check the eyebolt-retaining setscrew in the base of the latch for security of attachment. Tighten as required. Examine doors regularly for dents and tearing damage to the fiberglass material. Remove any debris which accumulates along the mold line where the doors meet the roof to prevent clogging and interference with the hinges.

4.3.2. Latch Operational Check

☞NOTE:

Apply anti-seize lubricant to the latch mechanism, if not already present.

☞NOTE:

DO NOT press down on the door to close it tightly. DO NOT slam the door. DO NOT stand on the door or press down on the latches.

The latches on the CNG tank access doors should function as follows:

1. The latch should be able to close to the first latch setting, which is the partially latched position.
2. The latch should then be able to close further to the second latch setting, which is the fully latched position.
3. The release mechanism should be functional from both latch setting positions.

4.3.3. Strike Pin Adjustment

☞NOTE:

It is more important that the door latches fully than it is for the door to fit tightly. Adjust the strike pins until the door fits as tightly as possible while still latching fully.

1. With the door open, loosen the strike pin and/or mounting bracket bolts.
2. Adjust the strike pin and/or mounting bracket up or down.

☞NOTE:

Moving the strike pin upwards will improve door latching ability. Moving the strike pin downwards will tighten the fit of the door, but this may cause the door to stop latching fully when closed.

3. Tighten the strike pin and/or mounting bracket bolts.
4. Close the door and check the door latches are both fully latched, open the door, readjust if necessary and retest.

4.3.4. Tank Access Door Alignment

1. Loosen the large 1/2" nut (two per door) on door hinge so door can move freely. See “Fig. 15-7: Tank Access Door Adjuster” on page 13.
2. Loosen the 1/4" jam nut on the door adjuster.
3. Use door adjuster to align doors to adjacent doors, front roof hump and roof panels.

NOTE:

The overall allowable misalignment between adjacent body lines is 0.25".

4. Ensure bottom edge of door clears the roof panel when in the closed and open positions.
5. After final door adjustment:
   a. Torque large 1/2" nuts to 53 ft-lbs.

CAUTION

The adjuster is not load bearing, do not over tighten the 1/4" jam nut.

   b. Tighten the small 1/4" jam nut to lock the adjuster hardware.

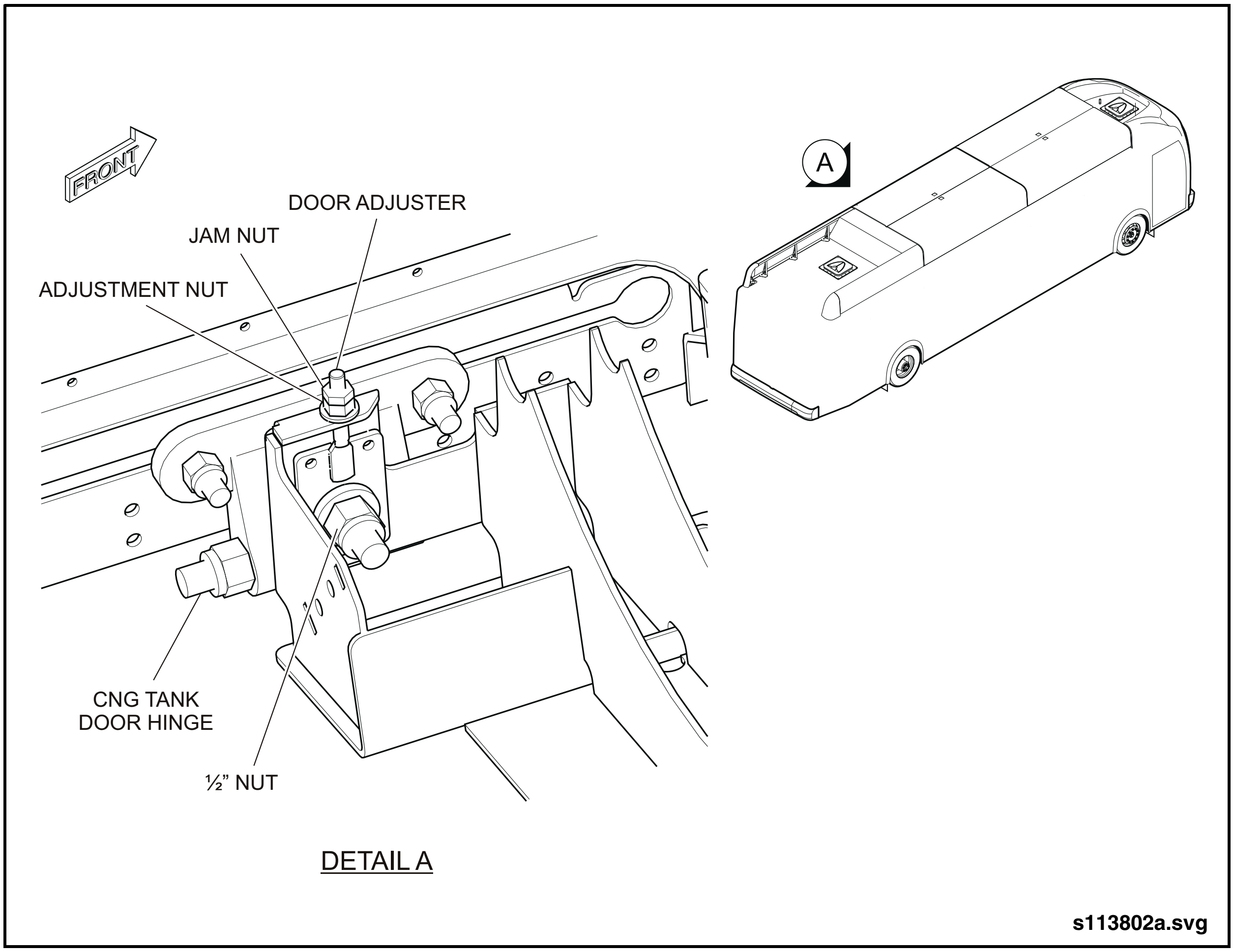


Fig. 15-7: Tank Access Door Adjuster

4.3.5. Tank Access Door Removal

WARNING

It is strongly recommended that scaffolding or similar work platforms be used when removing and installing the tank access doors on the rooftop of the vehicle. ALWAYS wear fall protection equipment.

1. Open the tank access door. Refer to 4.2. “Operation” on page 11 in this section for access door opening procedure. See “Fig. 15-8: CNG Tank Access Door Installation” on page 15.
2. Use the assistance of another person to allow removal of the tether cable from the rack rail as follows:
   a. Move and support the door so that tension is relieved from the tether cables.

WARNING

DO NOT remove both tether cables at the same time. Remove and reinstall one tether cable at a time. Ensure lifting equipment is attached and supporting the access door before removing and reinstalling the second tether cable.

   b. Hold the eyelet nut on the inside of the door while removing the 5/16” bolt on the outside of the door.
   c. Feed the eyelet through loop on the opposite end of the wire cable and release the cable from the rack rail.
   d. Reinstall the tether cable to the access door and tighten 5/16” bolt.
   e. Use an overhead chain hoist or similar lifting equipment to pick up on the loop of the tether cable.
   f. Repeat the previous steps on the second tether cable.
3. Ensure the weight of the door is supported and balanced.
4. Remove the hinge bolt from each of the door hinges.
5. Carefully lift and remove the tank door from the rooftop of the vehicle.

4.3.6. Tank Access Door Installation

1. Install wire cables and tether plates onto replacement door, if not already done so.
2. Use the loop in the wire cables to attach to the lifting equipment.
3. Carefully move the tank door into position while aligning the hinge.
4. Insert the hinge bolt and tighten the lock nut at each hinge location.
5. Remove the lifting equipment and, with the assistance of another person, support the door in a partially open position.
6. Remove and then reinstall each tether cable in a similar fashion as was originally done during the removal process. Ensure the cable is properly looped around the rack rail.
7. Check door opening, closing and latching operation.
   a. Adjust door hinges as necessary. Refer to 4.3.4. “Tank Access Door Alignment” on page 13 in this section for adjustment procedure.
   b. Check the latch operation. Refer to 4.3.2. “Latch Operational Check” on page 12 in this section for procedure.
   c. Adjust the strike pin as necessary. Refer to 4.3.3. “Strike Pin Adjustment” on page 12 in this section for adjustment procedure.
8. Secure the door in place for vehicle operation by installing the cotter pins through the cross-drilled holes in the vertical pins extending through the access door panels.

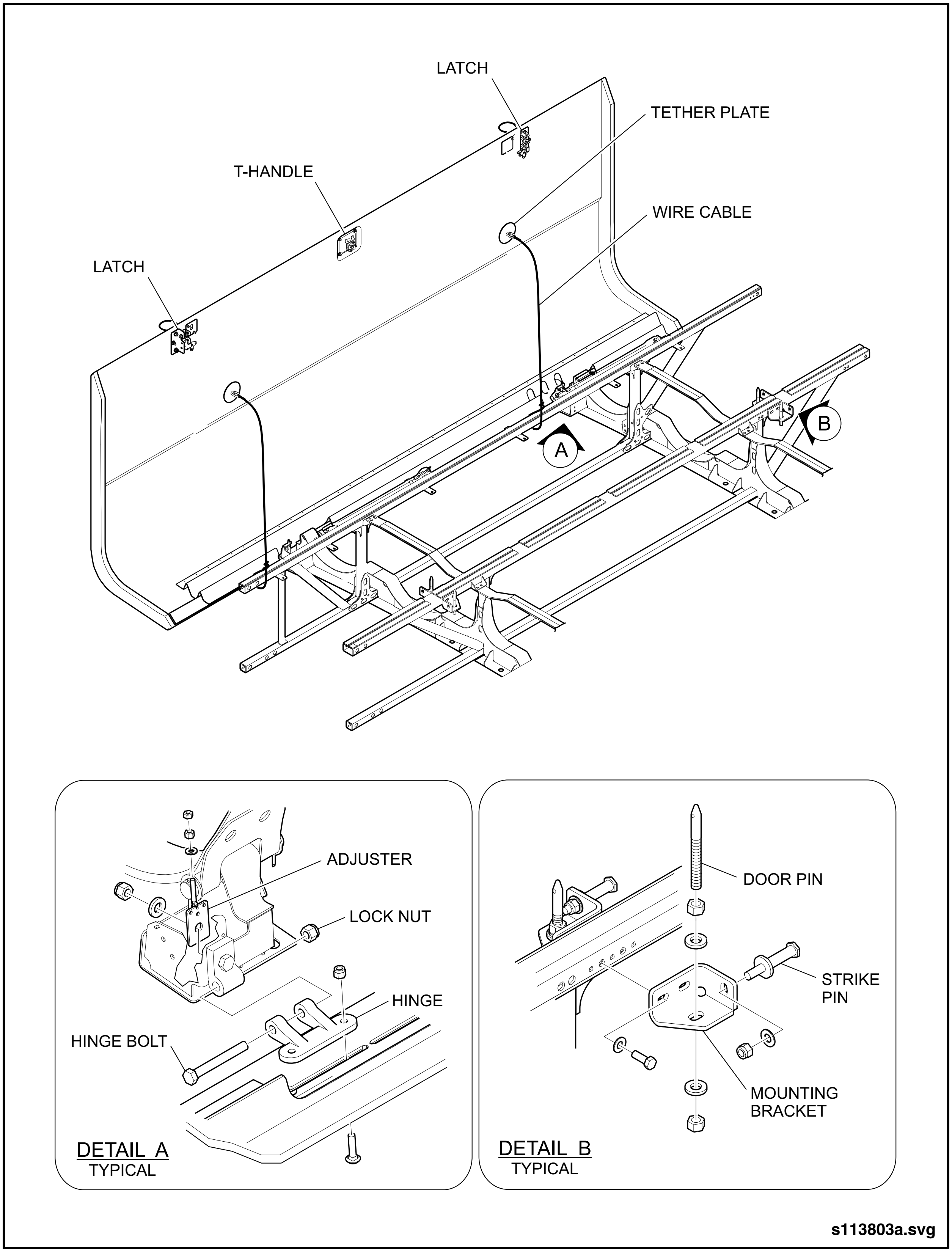


Fig. 15-8: CNG Tank Access Door Installation

5. ROOF VENT/HATCHES

5.1. Front Manual Hatch

5.1.1. Description

A multi-position vent is located on the front section of the roof. This vent can be opened to allow fresh air into the vehicle and in an emergency the hatch can be used as an escape exit.

5.1.2. Operation

5.1.2.1. Ventilation

Without touching the emergency handle, grasp the handholds and push up to obtain any of the three venting positions:

- ❐ Open front end for air intake.
- ❐ Open rear end for air exhaust.
- ❐ Full open venting position.

To close, grasp the handles and pull the hatch downward into the closed position. Do not touch the emergency handle.

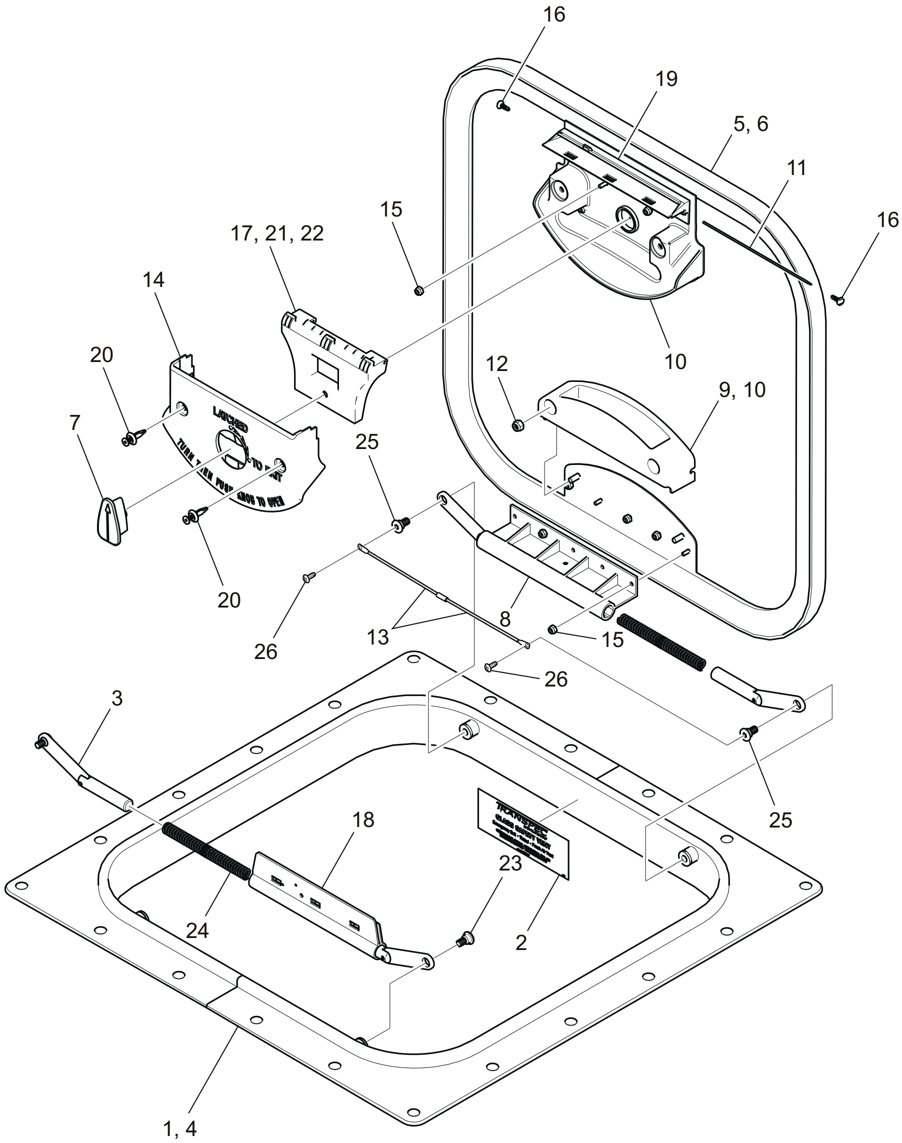
5.1.2.2. Emergency Exit

Opening

1. Rotate the red knob 90° in either direction. See “Fig. 15-9: Front Roof Vent/Hatch” on page 17.
2. Push the red knob into the lid.
3. Continue to push the lid to the fully open position.

Closing

1. Ensure the release hinge is in the upward position.
2. Lower the lid into position.
3. Guide the release hinge into the handle base on the lid.
4. Pull down on the top of the lid to force the release hinge and the lid together until you hear the spring loaded handle set in place.
5. Grasp both sides of the lid and pull down to fully close the hatch.
6. Rotate the red knob back into the latched position.



1. Roof Hatch Assembly, (Incl. 2-5, 24-26)
2. Decal, Dual Purpose Safety Vent
3. Link and Plunger
4. Frame, Roof Hatch
5. Kit, Lid Replacement (Incl. 6-17)
6. Panel, Glass with Gasket
7. Knob, Release
8. Hinge, Fixed
9. Base Shield, White
10. Cover, Fixed Hinge
11. Pin, Hinge
12. Nut, 1/4 - 20 SST
13. Cable, Retention
14. Release Hinge Shield w/Rivets
15. Nut, Lock #8 - 32
16. Fastener, Plastic
17. Release Handle Assembly, White (Incl. 18-23)
18. Hinge, Roof Hatch Release Handle
19. Base, Handle
20. Rivet, Handle Shield
21. Release Handle
22. Spring, Release Handle
23. Bolt, Shoulder 5/16" - 18 UNC
24. Spring, Plunger
25. Bolt, Shoulder 5/16" - 18 UNC 6 - 32 Hole
26. Screw, PH HD SST #6 - 32 UNC x 5/16" Lg.

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Fig. 15-9: Front Roof Vent/Hatch

5.1.3. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance requirements.

The roof vent/hatch components are rust proof with lifetime finishes. Moving parts are Teflon coated to eliminate the need for lubrication.

5.1.4. Removal

WARNING

DO NOT perform any maintenance on roof-mounted components unless equipment is in place to prevent fall hazards. Ensure maintenance personnel use approved lift platforms or scaffolding and wear approved safety harness when working on the roof of the vehicle.

1. Raise hatch to vent position.
2. Release escape lever and open hatch.
3. Detach retaining cable from bottom link.
4. Remove two screws attaching links to frame.
5. Remove through frame opening.

5.1.5. Installation

WARNING

DO NOT perform any maintenance on roof-mounted components unless equipment is in place to prevent fall hazards. Ensure maintenance personnel use approved lift platforms or scaffolding and wear approved safety harness when working on the roof of the vehicle.

1. Tilt hatch as required to raise it up through the frame opening.
2. Align the links with the mounting holes in the frame. Install the two mounting screws and tighten lightly.
3. Attach retaining cable.
4. Adjust for a tight waterproof seal at the opening, by moving the hatch either up or down as required for proper alignment. Tighten the two mounting screws.
5. Water test hatch for leakage around seal. Lower the hatch further as directed in Step 4 if any leakage is evident. No water leakage is allowed.

5.1.6. Special Hinge Replacement

CAUTION

The hinge assembly is a critical component. DO NOT remove the hinge from the cover assembly. Special fasteners with tamper resistant heads are used in this assembly and are installed to critical torque specifications. These special fasteners are designed in this way to prevent tampering. If the hinge is damaged, the entire cover assembly must be replaced.

The hinge is attached to a hidden tapping plate. The tapping plate is permanently laminated between the inner and outer cover assemblies and cannot be inspected or replaced. Usually, if the hinge is damaged, the tapping plate is also damaged. The entire cover assembly must be replaced if the hinge is damaged.

Entrance & Exit Doors

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❐ open flame
- ❐ excessive heat
- ❐ production of sparks
- ❐ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Air System Safety

⚠ WARNING

ALWAYS drain the air pressure from ALL reservoirs before beginning work on any air system component.

⚠ WARNING

Ensure air lines are safely depressurized prior to disconnecting. Wear safety glasses as disconnecting pressurized lines will cause solid particles deposited in the line to be uncontrollably propelled, and will also cause the hose end to whip randomly as the air escapes.

1.4. Electrical System Safety

During electrical diagnosis procedures an understanding of the vehicle's electric circuits is important to understand the results of connecting test equipment.

⚠ DANGER

During component removal or installation, ensure that the Master Run switch is set to the STOP-ENGINE position and that the Battery Disconnect switch is set to the OFF position. Failure to follow this procedure may result in personal injury or component damage.

⚠ WARNING

DO NOT start the vehicle remotely with the laptop software without first checking that the area is clear of personnel.

⚠ CAUTION

Before welding anywhere on vehicle, set Battery Disconnect switch to the OFF position and disconnect all electronic control modules (Multiplexing, engine, transmission, ABS, and so forth). Refer to Section 11 of this manual for additional precautionary information.

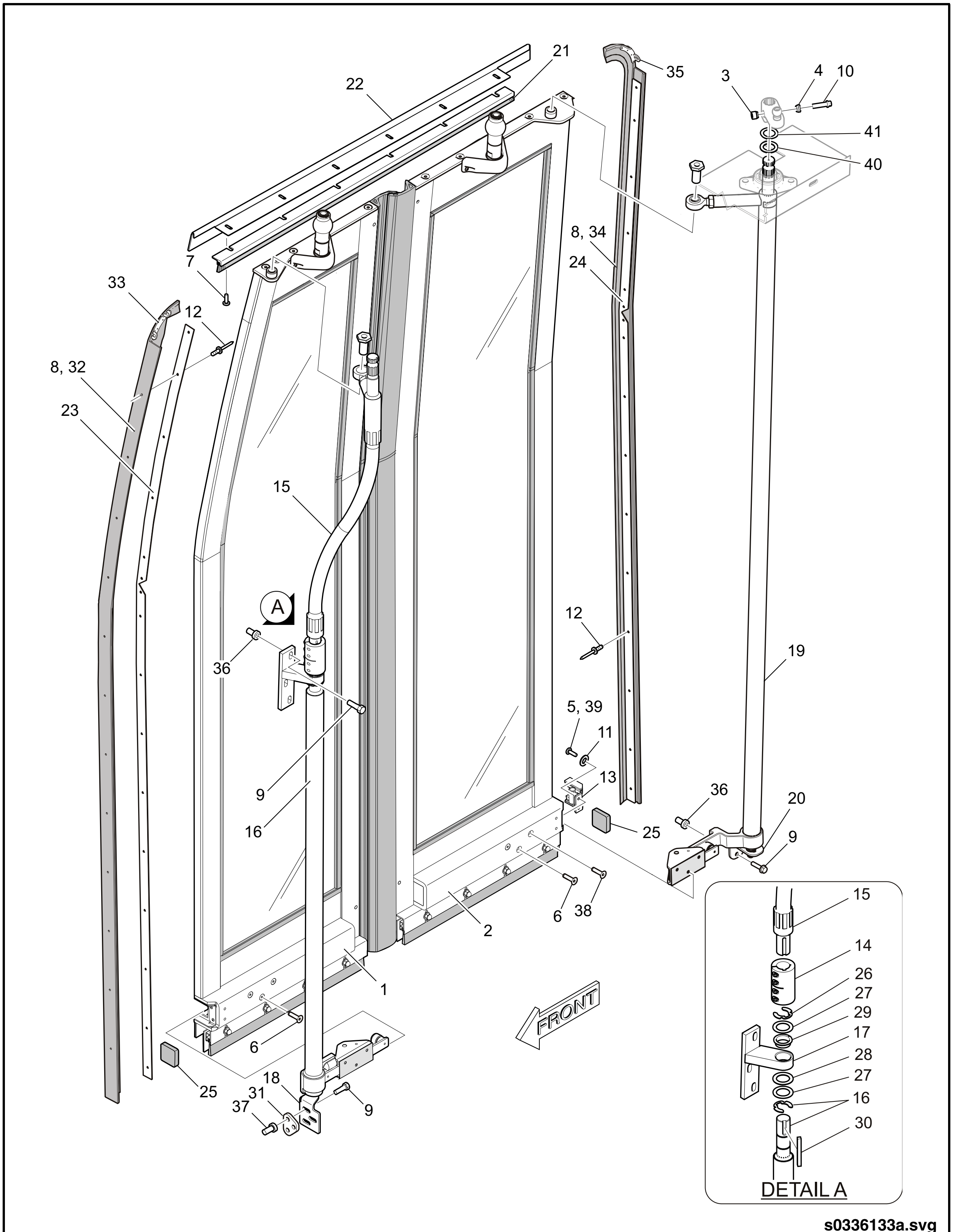

Fig. 16-1: Entrance Door

2. VAPOR/NFI SLIDE GLIDE ENTRANCE DOOR

2.1. Description

The Vapor/NFI slide glide entrance door is electrically operated. The door system consists of a door controller and operator mounted horizontally on a shelf plate above the door panels. See “Fig. 16-2: Entrance Door Base Plate” on page 4. The operator, when operated, causes the rod actuating assembly to apply torque to the two hinge posts, and arm assemblies, which are mounted vertically from the base of the door portal up through the shelf plate, one on each side of the door opening. The slide glide door panels are affixed to the post and arm assemblies by upper and lower arm rod ends. See “Fig. 16-1: Entrance Door” on page 2.

The door panels are sealed into the door portal by means of weather seals that abut the door frame on the outboard side of each panel. The door panel leading edges are sealed by means of an overlapping seal, the rearward (aft) panel with the backing seal and the forward (fore) panel with the over seal. Each door panel is also equipped with a lower brush that closes the space between the bottom of the door panel and the top of the floor. Another brush is fastened to the upper door portal blocking the space between the shelf plate. The slide glide door operates in such a manner as to offer optimum height and width of opening by sliding the door panels open at 90° to the vehicle body while using very little space for movement for the opening mechanism.

1. Entrance Door Assembly, Fore
2. Entrance Door Assembly, Aft
3. Wedge, w/Thread
4. Wedge, w/o Thread
5. Screw, PH Cross Recess SST 1/4" - 20 UNC x 1/2" Lg. Black
6. Screw, FH 1/4" - 20 x 0.75" Lg. Black
7. Screw, PH Cross Recess Tpg. Type F #10 - 24 UNC x 3/4" Lg. Black
8. Adhesive, SIKA 221 Black
9. Bolt, Hex Lock Flanged 5/16" Black
10. Bolt, 12 PT 3/8" - 24 UNC x 1 1/4" Lg.
11. Washer, Flat SST 1/4"
12. Rivet, Low Profile Blind Breakstem Alum. 3/16" x .500/.781 Black
13. Seal, Pocket Entrance
14. Coupler, Shaft Fore
15. Drive Shaft Assembly, Entrance Door Fore
16. Door Shaft & Arm Assembly, Fore
17. Bracket, Door Shaft Mount
18. Pivot Assembly, Fore
19. Door Shaft & Arm Assembly, Aft
20. Pivot Assembly, Aft
21. Brush, Entrance Door Upper
22. Seal, Entrance Door Header
23. Retainer, Jamb Seal Fore
24. Retainer, Jamb Seal Aft
25. Seal, Bottom Corner
26. Ring, Retaining .860" I.D. x 1.415" O.D. Steel
27. Washer, Special 1.00" I.D. x 1.50" O.D. SST
28. Washer, Thrust .998" I.D. x 1.514" O.D. Bronze
29. Bearing, Door Shaft Fore
30. Key, Square 1/4" SST
31. Spacer, Entrance Door Pivot
32. Seal, Door Jamb Fore
33. Bracket, Jamb Seal
34. Seal, Door Jamb Aft
35. Bracket, Jamb Seal
36. Insert, Steel 5/16" - 18 UNC x .027" - .150"
37. Insert, Steel 5/16" - 18 UNC x .150" - .312"
38. Screw, FH 1/4" - 20 x 1.00" Lg. Black
39. Loctite, 243 Blue
40. Washer, Special 1" I.D. x 1 1/2" O.D.
41. Washer, Steel 1" I.D. x 1 1/2" O.D. x 18 GA

Entrance Door (parts list)

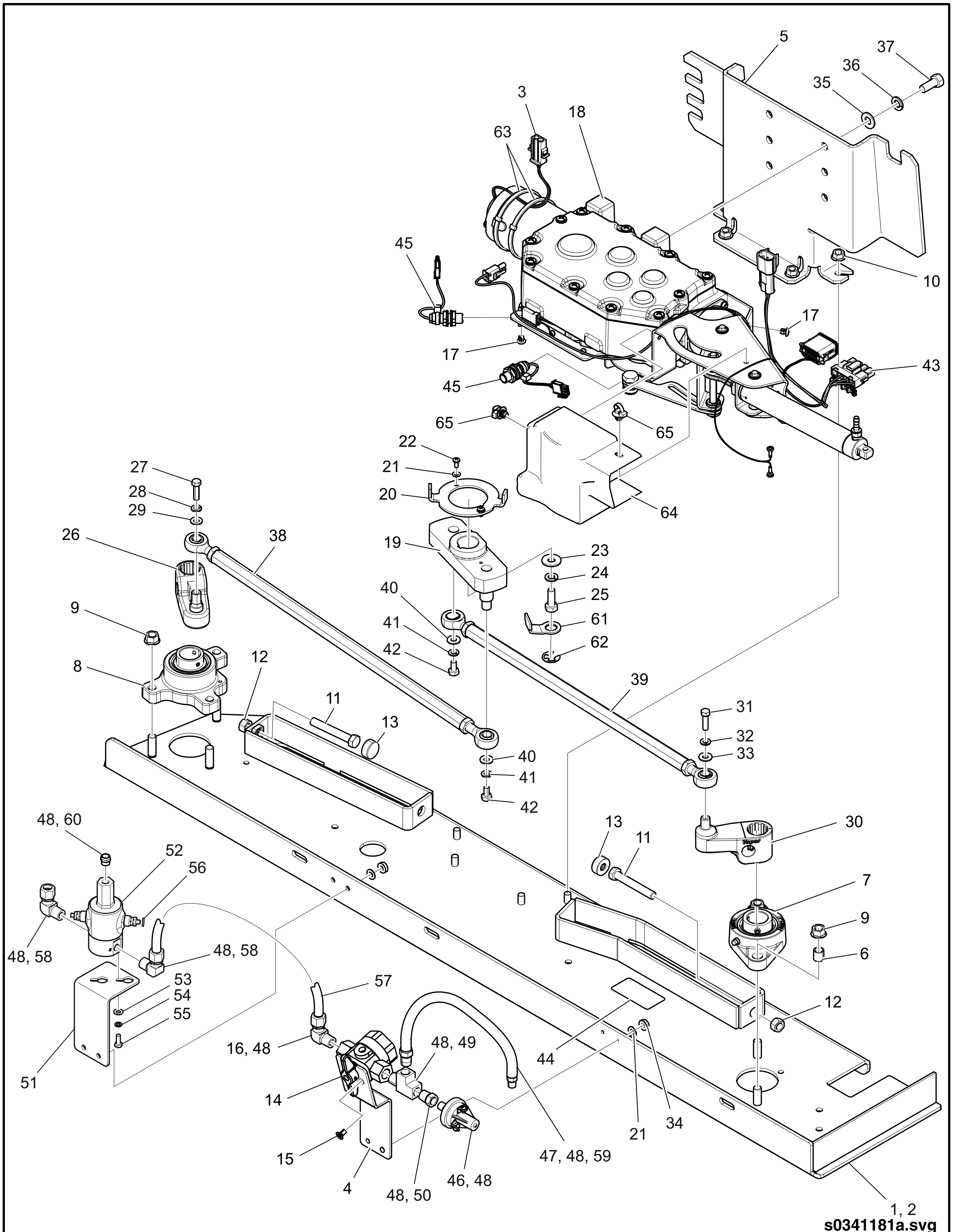

Fig. 16-2: Entrance Door Base Plate

1. Base Plate Assembly, Entrance Door (Incl. 2-26, 30, 34-65)
2. Base Plate, Welded
3. Cable, Encoder
4. Bracket, Rotary Valve
5. Plate, Door Operator
6. Bushing, 3/8" I.D. x 1/2" O.D.
7. Bearing, Ball
8. Bearing, Block
9. Nut, Hex Locking 3/8" - 16
10. Nut, Hex Locking 5/16" - 18 UNC
11. Screw, Hex Head Cap 3/8" - 16 x 2.50
12. Nut, Hex 3/8" - 16 UNC
13. Cap, Neoprene
14. Air Cock
15. Screw, FH Cross Recess #8 - 32 UNC x .31
16. Elbow, Nylon Tube Fitting Brass 3/8"
17. Clip, Tie Holder
18. Door Operator Assembly
19. Teeter
20. Target, Door Position Sensor
21. Washer, Flat #8 - .375" O.D. x .035" Thk.
22. Screw, PH Cross Recess SEM Ex #8 - 32 x .38
23. Washer, Teeter
24. Washer, 0.324 x 0.787
25. Bolt, Teeter with Lock
26. Lever Assembly, Door Shaft (Incl. 27-29)
27. Screw, Locking Torque Patch
28. Washer, Lock Special 1/4" -.109 W x .062" Thk.
29. Washer, 1/4" - .562 O.D. x .049 Thk.
30. Lever Assembly, Door Shaft (Incl. 31-33)
31. Screw, Locking Torque Patch
32. Washer, Lock Special 1/4" -.109 W x .062" Thk.
33. Washer, 1/4" - .562 O.D. x .049 Thk.
34. Nut, Hex Keps #8-32 UNC
35. Washer, Flat 3/8" - .813" O.D. x .065" Thk.
36. Washer, Lock Special 3/8" - .141" W x .094" Thk.
37. Screw, Locking Torque Patch
38. Connecting Rod Assembly
39. Connecting Rod Assembly
40. Spacer
41. Washer, Lock Special 1/4" -.109 W x .062" Thk.
42. Screw, Hex Head Cap 1/4" - 20 x .50"
43. Harness, Wiring
44. Label, Identification
45. Proximity Switch
46. Switch, Pressure
47. Hose
48. Sealant, Teflon
49. Tee, Pipe Fitting Brass 1/4"
50. Fitting, Pipe with Brass Bushing 1/4"
51. Bracket, Mag Valve
52. Valve, Solenoid
53. Washer, Plain #10 - .438" O.D. x .032" Thk.
54. Washer, Lock #10
55. Screw, Hex Head TRM #10
56. Washer, Lock #10
57. Tubing, Nylon
58. Fitting, Nylon Tube
59. Conduit, Convoluted 12.25" Lg.
60. Vent, Breather
61. Lock, Teeter Bolt
62. Ring, Retaining
63. Tie, Harness
64. Cover, Emergency Release
65. Push Mount, Cable Tie

Entrance Door Base Plate (parts list)

2.2. Door Safety Features

WARNING

Any malfunction or deviation of adjustment of the doors or safety systems, should receive immediate corrective action. No vehicle should be operated in transit service with door safety systems disconnected.

2.2.1. Service Brake Interlock

Your New Flyer vehicles are equipped with a service brake interlock. The interlock is activated by opening or authorizing the rear exit door.

2.2.2. Throttle Interlock

The throttle (accelerator) interlock is activated by opening or authorizing the exit doors or by initiating the operation of a kneeling system or wheelchair ramp. The power to the throttle treadle is cut off, preventing the inadvertent increase of engine RPM by the driver.

2.3. Operation

2.3.1. Door Power Up Operation

The control will monitor the door closed sensor at power up to determine the door position. The control also uses an encoder to determine door position but does not retain this information after the power is removed. The door will synchronize the encoder each time the door is in the closed position. The encoder is tested at power by jogging the motor to confirm that the encoder is functioning.

☞**NOTE:**

To initiate the power-on self test set the Master Run switch to the OFF position and then set the battery disconnect switch to the OFF position. Wait for a minimum of 10 seconds before reconnecting the battery system and setting the MRS switch to DAY RUN or NIGHT RUN.

If a fault is detected during the power-on self test, the LED indicators on the door controller will flash in different patterns as shown in the following table:

LED OPERATION

	Power	Fault	Maint.	Setup
Normal	ON	OFF	OFF	OFF
Encoder Failure	ON	ON	OFF	FLASHING
Low Voltage	ON	FLASHING	FLASHING	FLASHING
Controller Fault	ON	ON	OFF	OFF

2.3.2. Door Closed

If the door closed sensor is detected at power-up, the controller will perform a test to determine if the door is closed. When the test has passed the control is placed in the door fully closed state.

2.3.3. Door Not Closed

If the door closed sensor is not detected at power-up, the controller will be placed in the door fault state. At this point the control does not know if the door is open or closed. The door open signal is sent to the vehicle. When a door command signal change from open to close is detected, the door will move slowly to the closed position. When the door stops moving, the position encoder will be synchronized with the door.

2.3.4. Front Door Close Obstruction

The front doors do not have a sensitive edge to detect obstructions when closing. The control can detect an obstruction as the door is closing. It cannot detect an obstruction during the last few inches of the door closing movement. A front door closing obstruction is determined by the control monitoring the front door movement. If an obstruction is detected during the closing, the door will stop and recycle to the open position. There will be a one second delay once the door has reached the door fully open position. After the delay the controller will then respond to the door command signal. If the signal indicates a door close command, the door will start to close. If the command is in the door open command, the door will remain in the open position.

2.3.5. Front Door Open Obstruction

The door will stop when an obstruction is detected as the door is opening. After a 1 second delay, the door will continue to move in the opening direction. If an obstruction is detected again, the door will stop for one second and then resume opening. After three attempts to open, the door will stop and enter the fault state. Commanding the door to close will clear the fault and return to normal operation.

2.3.6. Emergency Release Logic

2.3.6.1. Emergency Release Sensor

This sensor is used to monitor the status of the emergency release clutch in the gearbox. The engagement of the emergency release clutch is confirmed when the target is detected by the emergency release proximity sensor. When the target is detected, the signal from proximity sensor is 24VDC. The signal wire is connected to pin J9-2 on the base plate connector J9. When the emergency release has been activated, the target arm rotates away from the proximity sensor. The emergency release proximity sensor signal will be near 0VDC. The controller will detect the low signal state and then the software will switch to the emergency release state.

2.3.6.2. Emergency Release State

When the controller enters the emergency release state, the J5-7 emergency release signal, J5-8 door fully open and J5-9 door fully closed output will change state.

These changes are assuming that the door is fully closed:

- ❐ J5-7 emergency release signal is will change from 24 VDC to 0 VDC
- ❐ J5-8 door fully open signal is will change from 0 VDC to 24 VDC
- ❐ J5-9 door fully closed signal is will change from 24 VDC to 0 VDC

These changes are assuming that the door is fully open:

- ❐ J5-7 emergency release signal is will change from 24 VDC to 0 VDC
- ❐ J5-8 door fully open signal, no change 24 VDC
- ❐ J5-9 door fully closed signal no change 0 VDC

In this state the control will be monitoring the J9-5 air pressure switch and J5-3 door command input signals.

2.3.6.3. Emergency Release Reset Mechanical Release Cylinder

The controller will not attempt to reset the door while the bus is in motion. In the case of a bus with a mechanical emergency release cylinder, the J5-3 door command input is monitored to detect a transition from 24VDC to 0VDC. This transition represents the door command signal transition from an open command to a closed command. When the sequence is detected, the controller will attempt to reengage the clutch by driving the motor in the forward and reverse directions. The sequence is repeated 5 times, when the clutch resets to the engaged position, the emergency release arm and target will rotate back to the normal position and is detected by the emergency release proximity sensor.

The controller will then proceed to move the door to the closed position. When fully closed, the following signals will change state.

- ❐ J5-7 emergency release signal is will change from 0VDC to 24VDC
- ❐ J5-8 door fully open signal is will change from 24VDC to 0VDC
- ❐ J5-9 door fully closed signal is will change from 0VDC to 24VDC

2.4. Maintenance

Refer to the Preventive Maintenance section of this manual for scheduled maintenance requirements.

2.5. Door Controller

2.5.1. Description

The door controller is an electronic module that controls the function of the electric door motor. It consists of an electronic module with seven connectors for interfacing to the vehicle electrical system and diagnostic computers. The door controller also contains four LED indicator lights. The door controller is bracket mounted above the door baseplate and is accessible through the mechanism access door. See “Fig. 16-3: Door Controller” on page 9.

2.5.2. Door Controller Specifications

Supply Voltage
Nominal .... 24 to 28 VDC
Range................................ 20 to 36 VDC

Supply Current (typical)
......2 to 10 Amps during door movement

☞NOTE:

The current can reach 20 Amps during a door obstruction event. The preload current at end of door cycle is 16 Amps for 500 milliseconds.

Motor Drive
Max Current (short-circuit shutdown)
.... 30A

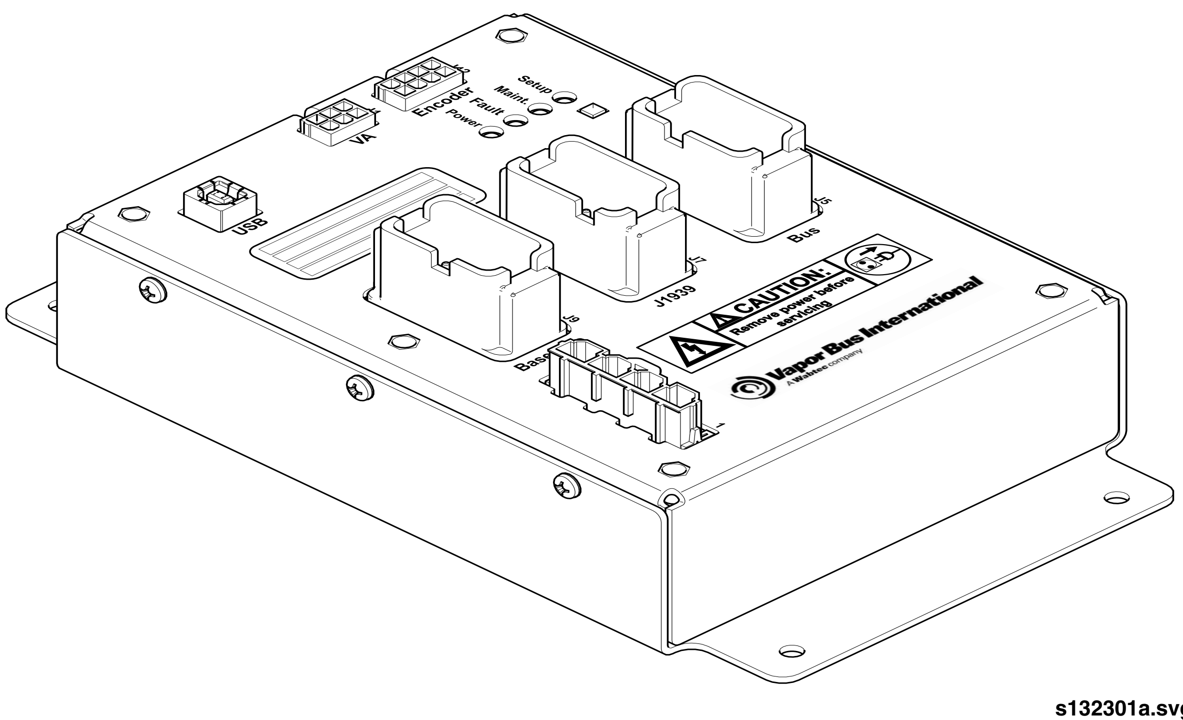

Fig. 16-3: Door Controller

2.5.3. Operation

The Door Controller receives inputs from the multiplexing system and the door baseplate sensors and switches. It uses these inputs to determine door state (open or closed) and the intended state (driver's control) and supplies the appropriate control signals for door motor operation. See “Fig. 16-4: System Schematic” on page 11.

2.5.4. Controller Inputs

The controller has been designed with optically coupled input circuitry. Each input can be configured for an active high or active low signal. The standard configuration is active high.

2.5.4.1. Speed Interlock/Door Enable Input

The Speed Interlock / Door Enable input is used to enable the door controller to allow the door to cycle open and closed. When the signal is low, the motor drive circuit is disabled.

For an entrance door, this signal can be connected to a vehicle speed signal, or a signal providing the necessary logic required to cycle the door open and closed.

For an exit door, this input is connected to a vehicle speed signal to prevent the door from cycling open while the vehicle is in motion.

2.5.4.2. Air Dump Pressure Switch Input

This input is wired to a pressure switch that is used monitor the air pressure supplied to the emergency release cylinder. The state of the pressure switch is used to automatically reengage the mechanical operator.

2.5.4.3. Door Closed Input

This signal comes from the proximity sensor located on the gearbox. It senses a metal bracket attached to the teeter lever. When the sensor detects the bracket, the door is in the closed position.

2.5.4.4. Door Command Input

This input commands the controller to open and close the door. A high signal will command the door to open. The door will close when the signal goes low.

2.5.4.5. Emergency Release Input

This signal comes from a proximity sensor located on the gearbox. This sensor monitors the emergency release mechanism. During normal operation this input is high from the sensor. If the emergency release mechanism is activated this signal will be low.

2.5.4.6. Sensitive Edge Input

This input is wired to a sensitive edge pressure switch. When the pressure switch has sensed an obstruction, this signal to this input goes high. This will stop the doors from closing and then re-open them.

2.5.4.7. Logic Power Input

This input powers the controller on and off. A low current (less than 1 amp) 24 VDC signal will turn on the controller allowing the controller to be powered down when the Master Run Switch is turned off.

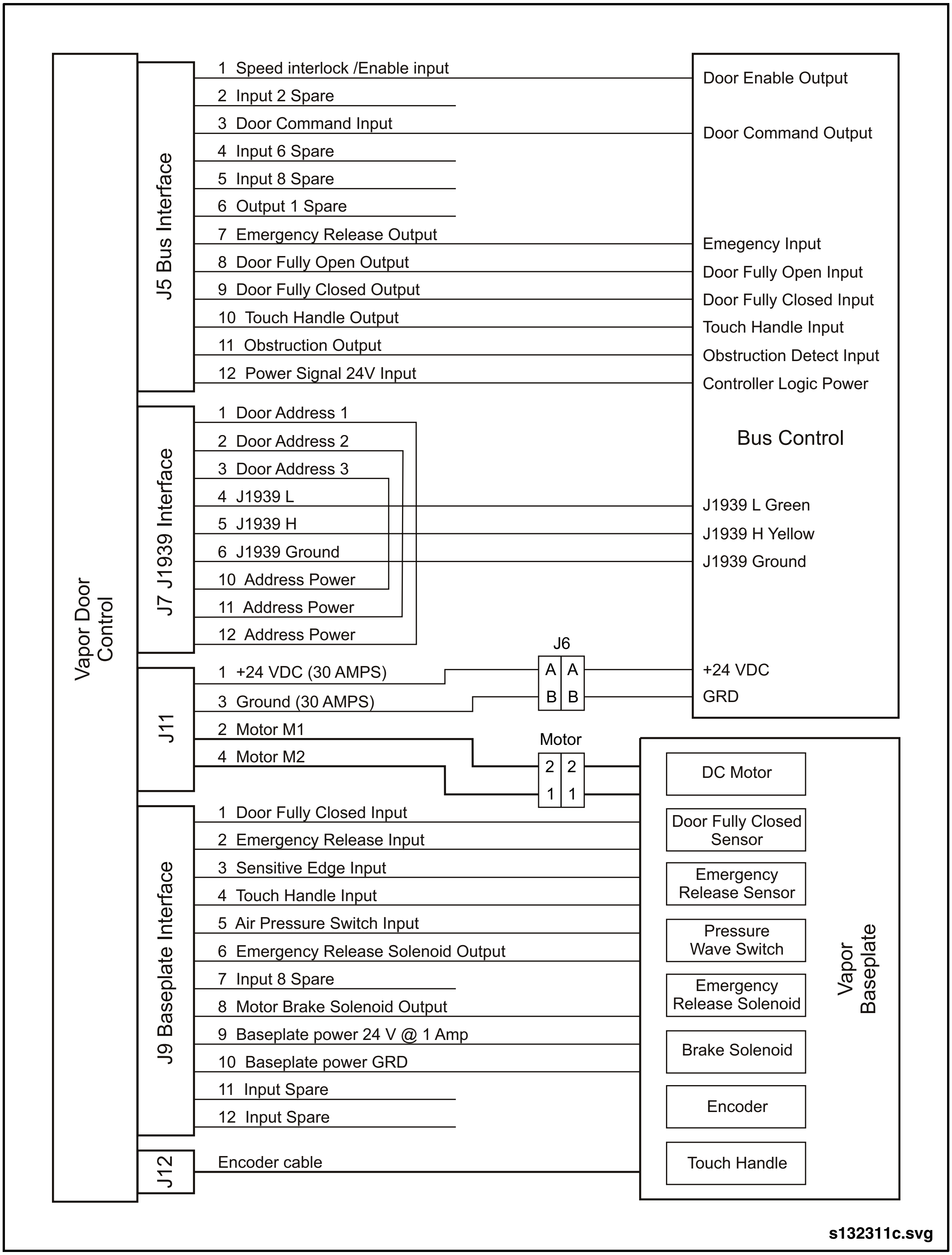

Fig. 16-4: System Schematic

2.5.5. Controller Outputs

The controller outputs are high side switches rated at 1 Amp. When active these drivers will supply a signal at the vehicle supply voltage. The logic for the vehicle interface is configurable to the requirements of the OEM.

2.5.5.1. Emergency Release Output

When the controller is in the emergency release state, this output will be on. During normal operation this output is off.

2.5.5.2. Door Fully Open Output

The output will be on when the controller is in the door fully open position.

2.5.5.3. Door Fully Closed Output

This output will be on when the controller is in the door fully closed position.

2.5.5.4. Door Obstruction Signal Output

This output will pulse on for a short duration when the controller has detected an obstruction.

2.5.5.5. Emergency Release Solenoid Output

This output is connected to the release reset solenoid. This output is turned on to activate the solenoid to allow the emergency release to reset.

2.5.5.6. Motor Brake Output

This output is connected to the motor brake solenoid. When turned on, the motor brake will disengage to allow the electric operator to move the doors.

2.5.6. LED indicators

Setup LED

The setup LED is active during the Quick Setup door linkage adjustment procedure.

Maintenance LED

The maintenance LED does not have a function. It will momentary indicate the controller is saving data to the file system.

Fault LED

The fault LED indicates when the controller has entered a fault state. To exit the fault state, command the door to the close position.

Power LED

The power LED indicates when the controller is powered.

2.5.7. J1939 J7 Connector (door position)

The controller has the ability to function on a J1939 network. Connector J7 contains the connection points for the J1939 network as well as inputs which can be used for door position information. The connector that contains the door position jumpers are attached to the door baseplate harness. The front door is always position 0 and does not require a connector with jumper wires. This allows a single controller part number to be placed in any door position on the vehicle.

2.5.8. Control Connectors

☞**NOTE:**

Refer to the ES-DC Door Control System Schematic in the Vehicle System Drawing manual for information on which connectors and signals are used.

2.5.8.1. J1 Voice Annunciator (Vapor)

The plug for this connector is supplied on the Vapor Voice Annunciator.

2.5.8.2. J12 Quadrature Encoder (Vapor)

The plug for this connector is supplied on the Vapor encoder cable.

2.5.8.3. J5 Bus Interface (Grey) (OEM Supplied)

Deutsch Grey with a 12 pin Connector-Plug with Wedge Lock

2.5.8.4. J7 J1939 Interface (Black) (OEM Supplied)

Deutsch Black with a 12 pin Connector-Plug with Wedge Lock

2.5.8.5. J9 Baseplate Interface (Green) (Vapor)

The plug for this harness is supplied on the Vapor Baseplate Harness.

2.5.8.6. J11Power and Motor (Vapor)

The plug for this connector is supplied on the Vapor Power/Motor Cable

2.5.8.7. J13 USB Port

This port is for programming and diagnostics.

2.5.9. Diagnostic Program

Vapor provides a diagnostic application that runs on a Windows PC. It is used for parameter setting and controller diagnostics.

2.5.10. Setup & Basic Parameters

2.5.10.1.Parameter Settings

There are several parameters that can be adjusted to configure the door performance.

- ❒ Open cushioning start
- ❒ Open cushioning length
- ❒ Close cushioning start
- ❒ Close cushioning length
- ❒ Open speed
- ❒ Close speed

2.5.10.2.Controller Inputs & Output Status

The status of all the signal inputs and outputs can be monitored. The state of each output can be changed for testing.

2.5.10.3.Controller Testing

The operation of the door can be controlled using the diagnostic application. The door can be manually opened, closed or automatically cycle.

2.5.10.4.Controller Status

The following status information from the door can be monitored.

- ❒ Door controller state
- ❒ Door fault status
- ❒ Door opening time
- ❒ Door closing time

2.5.10.5.Serial Port Setup

The screen is used for setting up the serial port configuration. The Interface can be set to any communications port. See "Fig. 16-5: Serial Port Setup" on page 14.

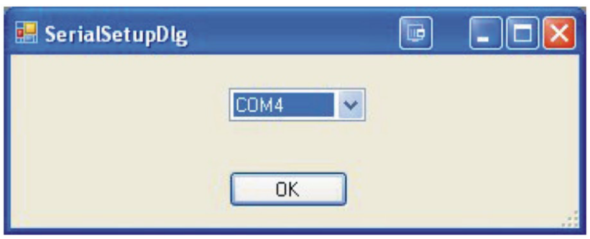

Fig. 16-5: Serial Port Setup

2.5.10.6.Product ID

The product ID window will show the firmware version information when the PC is communicating. See "Fig. 16-6: Product ID" on page 14.

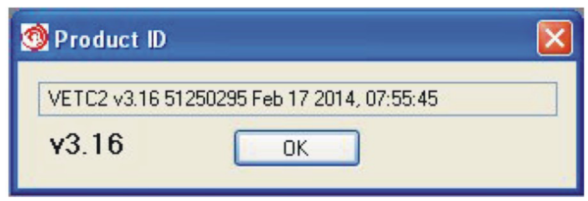

Fig. 16-6: Product ID

2.5.11. Advanced Parameters

This window is used for adjusting controller parameters. See “Fig. 16-7: Advanced Parameters” on page 15.

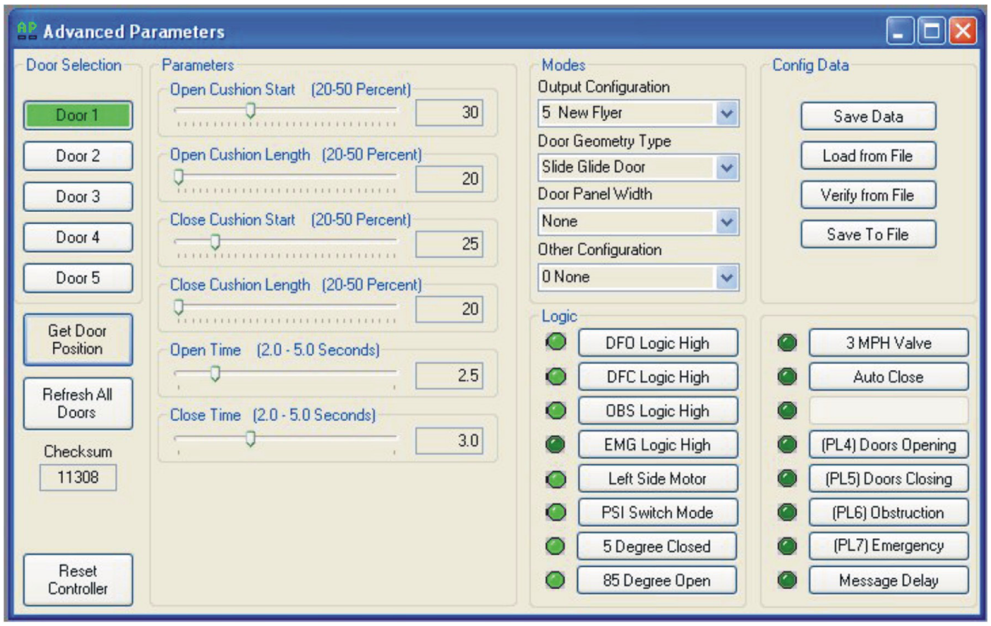

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Fig. 16-7: Advanced Parameters

2.5.11.1. Open Cushion Start (20-50% of teeter lever rotation)

This parameter controls the point in the door travel where the cushion starts. The value refers to the last 20-50 percent of the teeter lever rotation before the door is open. See "Fig. 16-8: Open Cushion Length" on page 16.

2.5.11.2. Open Cushion Length (20-50% of teeter lever rotation)

This parameter controls the duration of the cushion speed deceleration. See "Fig. 16-8: Open Cushion Length" on page 16.

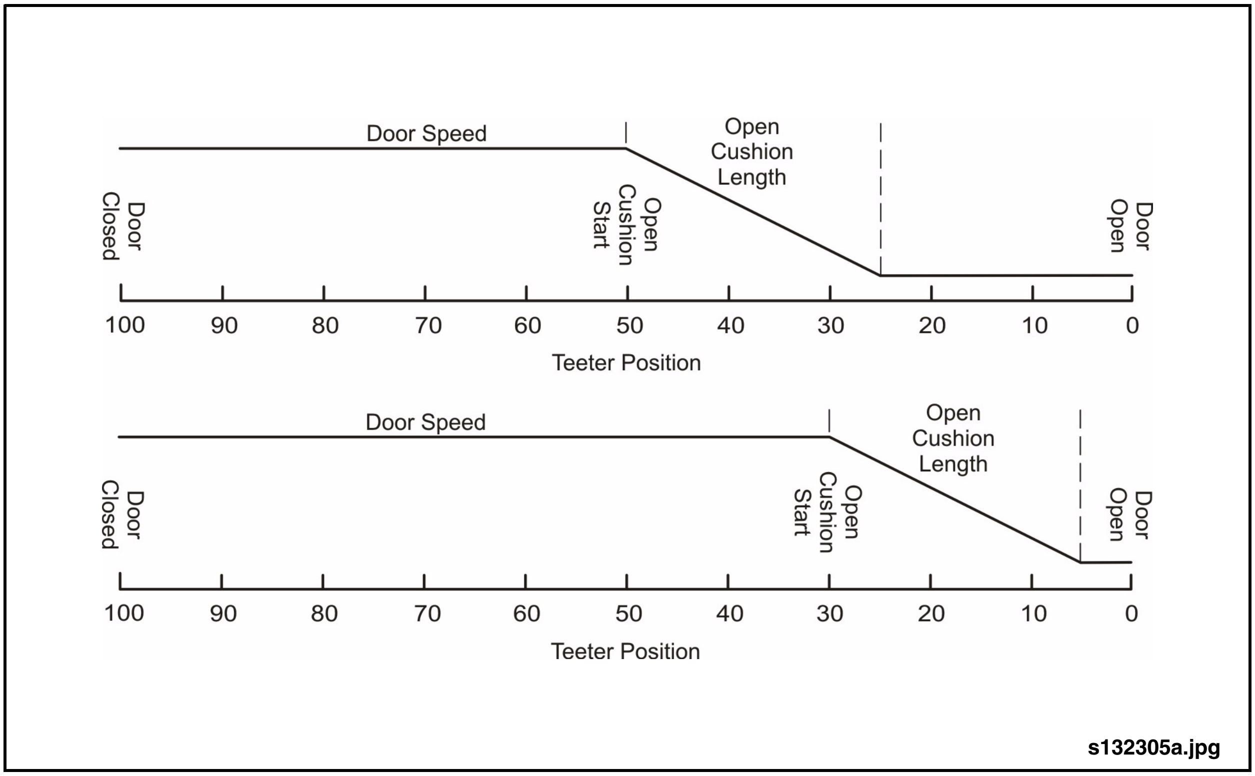

Fig. 16-8: Open Cushion Length

2.5.11.3. Close Cushion Start (20-50% of teeter lever rotation)

This parameter controls the point in the door travel where the cushion starts. The value refers to the last 20-50 percent of the teeter lever rotation before the door is closed. See “Fig. 16-9: Closed Cushion Length” on page 17.

2.5.11.4. Close Cushion Length (20-50% of teeter lever rotation)

This parameter controls the duration of the cushion speed deceleration. See “Fig. 16-9: Closed Cushion Length” on page 17.

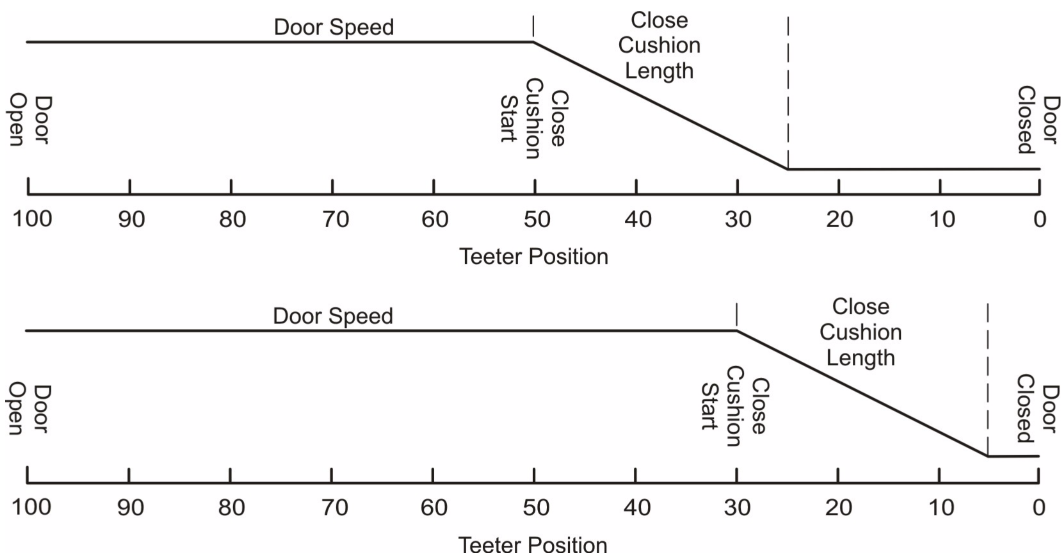

Fig. 16-9: Closed Cushion Length

2.5.11.5.Open Time

The Open Time slider control adjusts the value stored in the open time parameter to a value between 2 and 5 seconds.

2.5.11.6.Close Time

The Close Time slider control adjusts the value stored in the close time parameter to a value between 2 and 5 seconds.

2.5.11.7.Reset Controller

This button will reset the controller.

☞**NOTE:**

The following operations should only be performed by Authorized Persons.

2.5.11.8.Save Data

This button will send the parameters to controller and then store them in the file system.

2.5.11.9.Load from File

This button is used to retrieve the parameters setting from a file on the computer.

2.5.11.10.Verify from File

This button is used to verify the controller settings are programmed.

2.5.11.11.Save to File

This button will save the parameters to a file on the computer.

2.5.11.12.Output Configuration

This selection box is for configuring the electric controller for the vehicle logic.

Always set the output configuration to "New Flyer". See "Fig. 16-10: Output Configuration" on page 18.

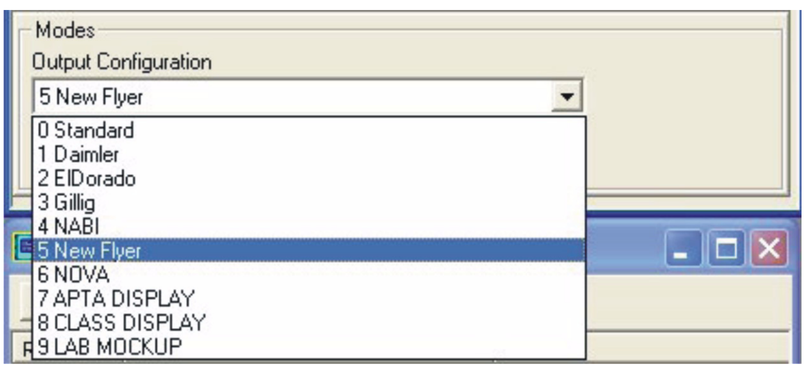

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Fig. 16-10: Output Configuration

2.5.11.13.DFO Logic High

This button configures the Door Fully Open output signal high when active.

2.5.11.14.DFC Logic High

This button configures the Door Fully Closed output signal high when active.

2.5.11.15.OBS Logic High

This button configures the Obstruction output signal high when active.

2.5.11.16.EMG Logic High

This button configures the Emergency output signal high when active.

2.5.11.17.Left Side Motor

This selection button is used to configure the orientation of the electric operator gearbox. There are two versions of operator gearbox, the difference is in which side the operator the emergency release pull cylinder is located. The motor direction changes depending on the operator model.

2.5.11.18.PSI Switch Mode

This button configures function of the PSI switch to reset the emergency release when PSI is returned to the system.

2.5.11.19.Degree Closed (5°)

This button configures the door fully closed output to change when the door is closed before door preload is applied.

2.5.11.20.Degree Open (85°)

This button configures the door fully open output to change when the door is open before door preload is applied.

2.5.11.21.3 MPH Valve

This button configures the J9-6 output to drive a 3 MPH air solenoid valve. The logic for the valve controlled from the J5-1 speed interlock input.

2.5.11.22.Auto Close

This toggle button configures the door auto close feature. This feature will close the door if not fully closed at power reset. This feature was added for coaches with passenger controlled CLASS systems.

2.5.11.23. (PL4) Doors Opening

This toggle button configures the Vapor Voice Annunciator (if equipped) to trigger playlist 4 that plays the "Doors Opening" message.

2.5.11.24. (PL5) Doors Closing

This toggle button configures the Vapor Voice Annunciator (if equipped) to trigger playlist 5 that plays the "Doors Closing" message.

2.5.11.25. (PL6) Obstruction

This toggle button configures the Vapor Voice Annunciator (if equipped) to trigger playlist 6 that plays the "Warning" message.

2.5.11.26. (PL7) Emergency

This toggle button configures the Vapor Voice Annunciator (if equipped) to trigger playlist 7 that plays the "Emergency" message.

2.5.11.27.Message Delay

This button configures the control to delay 1.5 seconds before the door moves.

2.5.12. Door Cycling Window

This screen allows the user to manually control the door and view system data. See "Fig. 16-11: Door Cycling Window" on page 21.

2.5.12.1.Door State

This box will display the current state of the controller.

2.5.12.2.Open Door

This button will command the door to open. Using this method of opening the door will disable the Door Command Electrical Input. Reset the controller to re-enable the Door Command Electrical Input.

2.5.12.3.Close Door

This button will command the door to close. Using this method of closing the door will disable the Door Command Electrical Input. Reset the controller to re-enable the Door Command Electrical Input.

2.5.12.4.Start Door Cycle

This button will enable the auto door cycling mode. This feature causes the door to cycle at an 8 second rate. Press the door open or closed button to start.

2.5.12.5.Stop Door Cycle

This button will stop the auto door cycling mode.

2.5.12.6.Clear Times

This button clears the door open and closed timing data.

2.5.12.7.Dump Log Files

Pressing the Dump Log Files button will display a log of events.

2.5.12.8.Dump System Files

Pressing the Dump System Files button will display the system data.

2.5.12.9.Dump Count Data

Pressing the Dump Count Files button will display the count data.

2.5.12.10.Clear System Data

Pressing the Clear System Data button will clear the system data.

2.5.12.11.Clear Count Data

Pressing the Clear Count Data button will clear the count data.

2.5.12.12.QS Encoder

This button is part of the quick setup procedure. The operator will rotate to the door fully open position and then back to the fully closed position to calibrate the encoder.

2.5.13. Inputs/Outputs Window

This windows show the status on the inputs and outputs. The override section is used to force the status of an output channel. See "Fig. 16-12: Inputs/Outputs Window" on page 21.

2.5.13.1.QS Home

This button is part of the quick setup procedure. The operator will open and then return to the door home position. This is the position that the door adjustments are performed.

2.5.13.2.QS Preload

This button is part of the quick setup procedure. The operator will be driven to the predetermined pre-load closed force.

2.5.13.3.QS Encoder

This button is part of the quick setup procedure. The operator will rotate to the door fully open position and then back to the fully closed position to calibrate the encoder.

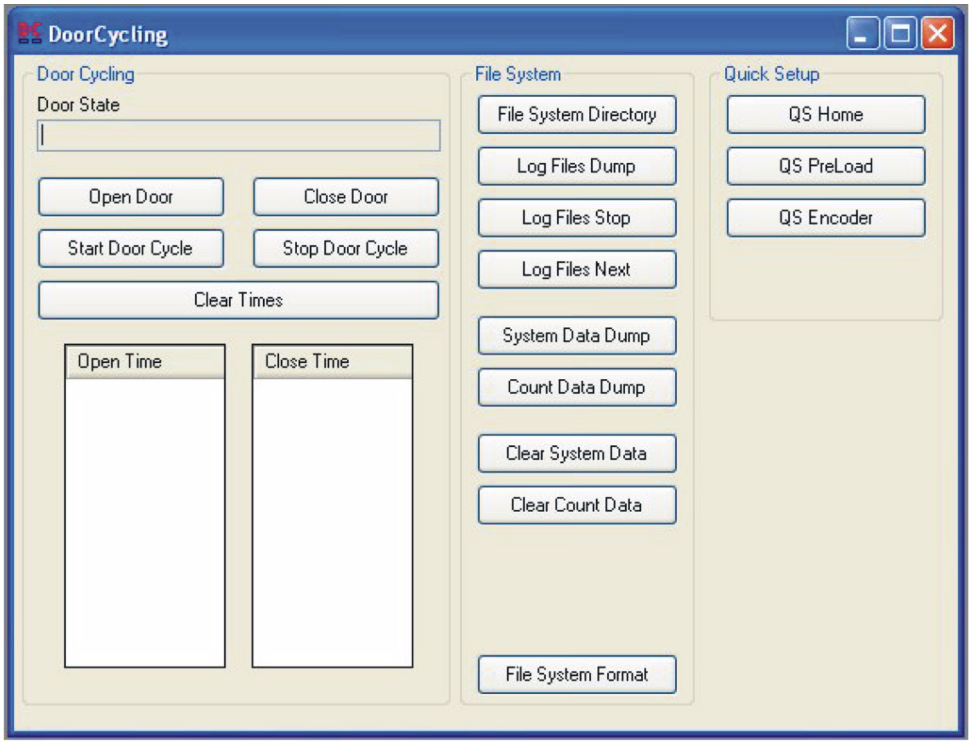

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Fig. 16-11: Door Cycling Window

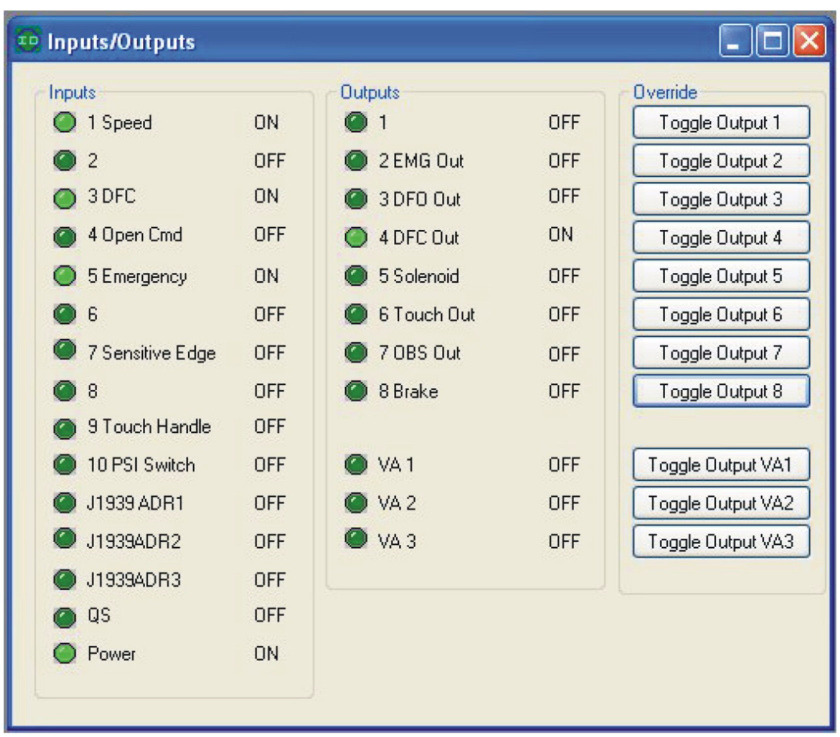

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Fig. 16-12: Inputs/Outputs Window

2.5.14. Text Monitor Window

This windows show the status of the controller as it is running. This window will show fault and error messages. See “Fig. 16-14: Text Monitor Window” on page 22.

2.5.15. Bluetooth Name

This window is used to configure the Bluetooth name for ETO control. This is the name that is display when another Bluetooth device is attempting to discover it. The text field is 14 characters in length, typically you would enter a bus fleet number and door position. The Bluetooth connection is only available for 10 minutes after the bus has been powered up. See “Fig. 16-13: Bluetooth Name” on page 22.

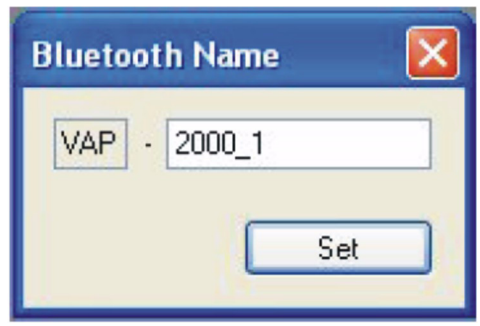

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Fig. 16-13: Bluetooth Name

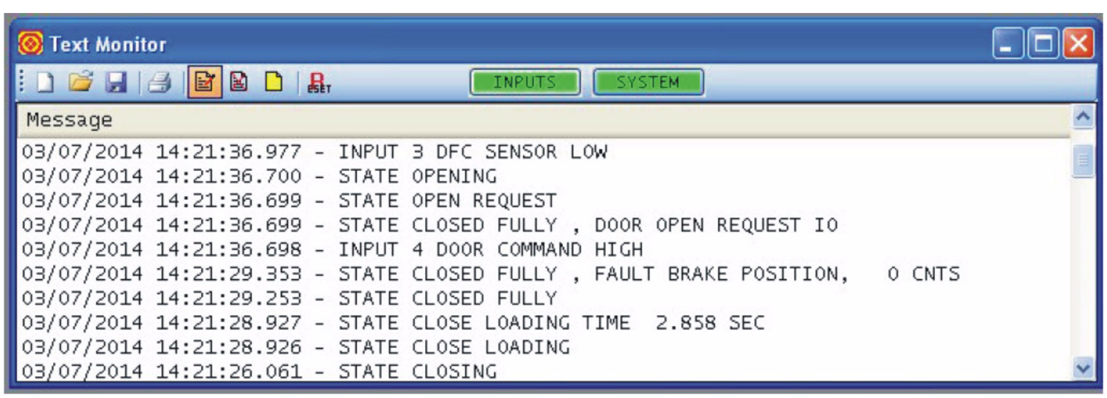

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Fig. 16-14: Text Monitor Window

2.6. Entrance Door Adjustment Procedure

Adjustment of the entrance door assembly is performed in the following four stages and in the following sequence.:

- ❒ Door panel alignment
- ❒ Door stop adjustment (initial)
- ❒ Connecting rod adjustment
- ❒ Door panel lower brush and upper portal splash guard adjustment

Adjustment slots for door alignment are provided in the baseplate, the forward shaft support bracket, the forward shaft bottom bracket, the aft shaft bottom bracket and the door panel bottom seals. See “Fig. 16-15: Entrance Door Adjustment Points” on page 24.

2.6.1. Door Panel Alignment

Before making any adjustments to the doors, ensure that the door panels seat into their proper positions when closed.

☞**NOTE:**

These adjustments must be made prior to installation of jamb seals.

1. Set the Battery Disconnect Switch to the OFF position.
2. Remove fore panel lower pocket seal. Retain seal and mounting hardware for reinstallation.
3. Loosen closed position stop jamb nut on aft panel and rotate stop screw counter clockwise to allow for maximum aft shaft rotation in the closed position.
4. Disconnect connecting rods from door shaft levers to allow for individual manual operation of each door panel.
5. Manually rotate both door panels to the “ideal” fully closed position. Ensure forward panel leading edge seal is overlapping the aft panel seal.
6. Verify metal to metal gap between door panels is 4.00" to 4.25" from top to bottom. Gap between door panel trailing edge and pillar trim for both fore and aft panels should be approximately 3/4".
7. If required, loosen baseplate mounting bolts and adjust the fore/aft position of base plate to achieve the require 3/4" gap. Tighten baseplate mounting bolts after adjustment.
8. Rotate door panels to fully closed position. Verify that lower edge of each panel is collinear and that lower brush seals are directly over edge of the vehicle floor.
9. Ensure door panel leading edge seals (near the bottom of the doors) are making adequate contact to form a water resistant seal. If required, adjust the inboard/outboard position of the fore and aft door panel lower pivots to attain an adequate seal.

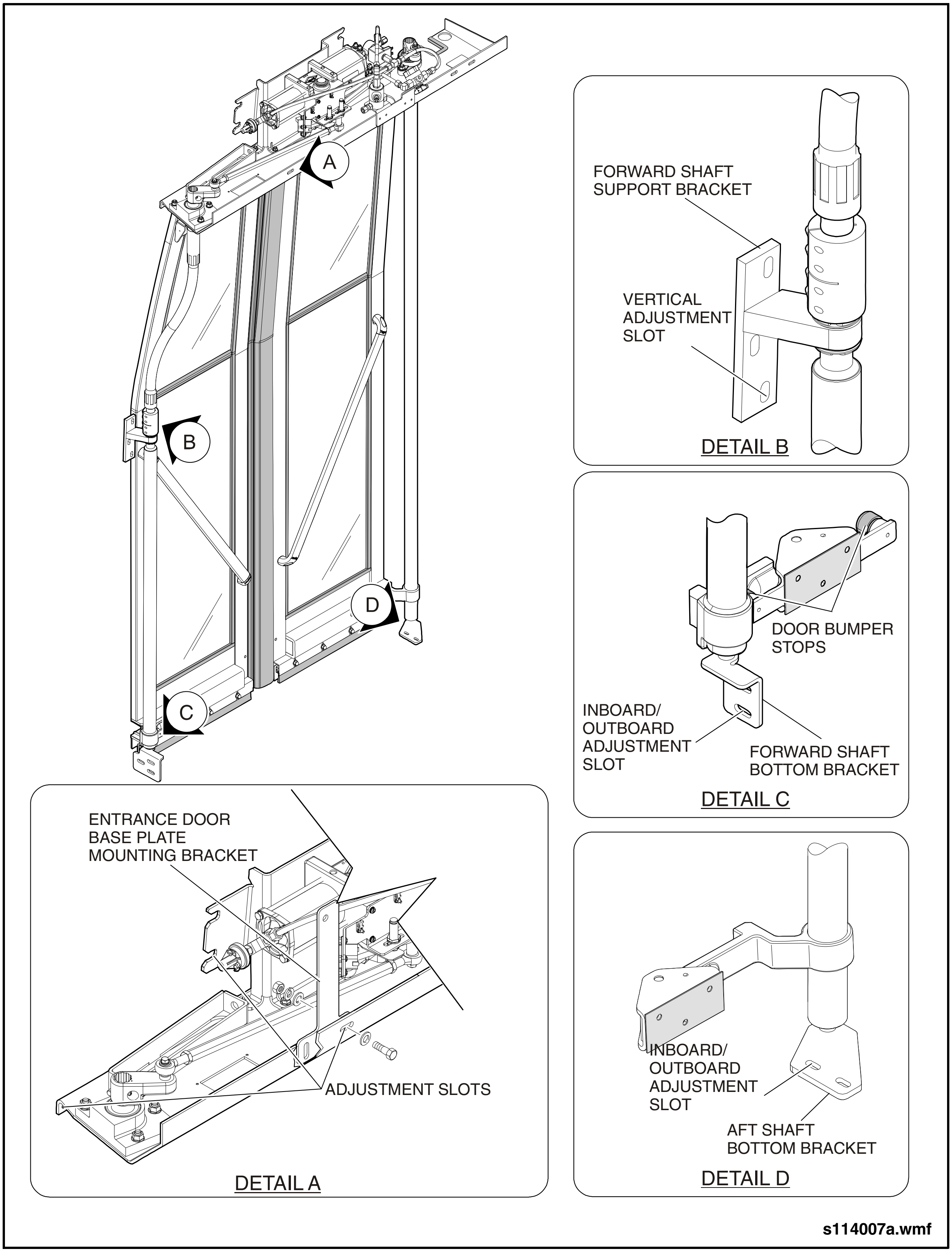


Fig. 16-15: Entrance Door Adjustment Points

2.6.2. Door Panel Height Adjustment

The height of each panel must be adjusted to allow light contact (approximately 1/16") between the top edge of each panel and the upper brush seal. If there is a gap, the doors panels must be raised by adding shims between each respective door shaft lever and pillow block bearing collar.

1. Measure gap between the edge of each panel and bristles of the upper brush. To determine required shim pack for each panel, add 1/16" to measured gap.
2. Remove door shaft operating lever and loosen bearing collar set screws to allow for vertical movement of each shaft. Retain all hardware for reinstallation of levers.
3. Install spacer washers as required (1.00" ID) onto each stub shaft. Ensure spacer washers rest flush against pillow block bearing collars.
4. Reinstall door shaft levers ensuring timing marks on shaft and lever are aligned. Tighten pillow block bearing collar set screws and torque operating lever lock bolts to 47 ft-lb. (64 Nm). See “Fig. 16-16: Timing Marks” on page 25.
5. Adjust vertical position of fore shaft upper bearing bracket (mounted to “A” pillar) to center lower shaft arm in door panel pocket when door is closed.
6. Reinstall fore panel lower pocket seal.

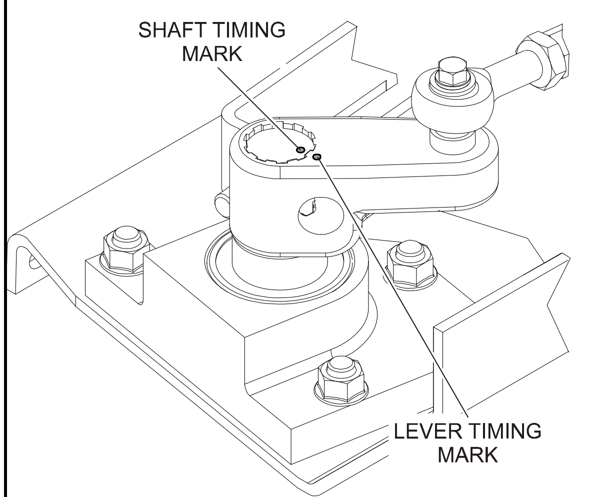


Fig. 16-16: Timing Marks

2.6.3. Aft Panel Closed Position Stop Adjustment

1. Manually rotate both door panels to the “ideal” fully closed position. Ensure fore panel leading edge seal is overlapping the aft panel seal.
2. With the doors in this position the metal-to-metal door panel leading edge gap should be a minimum of 4.00". See “Fig. 16-17: Door Closure Adjustment” on page 26.
3. While holding the door in the “ideal” closed position, turn the stop screw clockwise until the bumper tip just contacts the adjacent surface of the upper arm.
4. Secure this adjustment by tightening the stop screw jam nut.

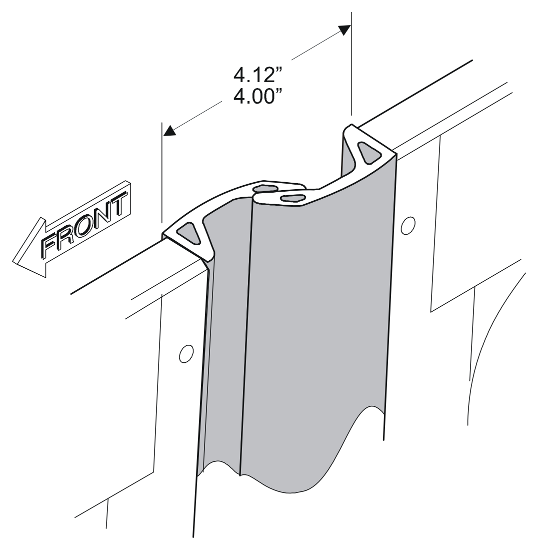


Fig. 16-17: Door Closure Adjustment

2.6.4. Fore & Aft Panel Open Stop Adjustments

1. Manually rotate both panels to the “ideal” open position. The panels should be parallel to each other and perpendicular to the door threshold.
2. Adjust door open stop screws in base plate guide tracks to achieve the required door open position. Secure adjustment by tightening stop screw jam nuts.

2.6.5. Connecting Rod Adjustment

2.6.5.1. Quick Door Linkage Adjustment

The door controller has a setup button that will assist in the door linkage adjustment. The yellow button is located next to the Setup LED indicator on the front of the control. Press this button for 5 seconds to start the quick setup mode. The setup LED indicator will be lit when in quick setup mode. If the emergency release was activated, pressing the quick setup button will re-engage the door operator.

⚠ WARNING

The electric door operator, door panels and door linkage will be in motion during this adjustment and caution should be taken to prevent bodily harm.

2.6.5.2. Step 1 (home position)

☞**NOTE:**

This step is normally performed with the door linkage removed.

During the home position location process, the teeter lever may rotate more than 360 degrees when searching for the home position. When the motor stops, the teeter is in the home position. Note that the keyway on the teeter shaft is almost vertical. Connect and adjust the door linkage rods so that the doors are closed. Do not over tighten the door panels (excessive door close preload).

2.6.5.3. Step 2 (door close preload)

Press and then release the setup button again and the controller will move the teeter to the fully closed position.

Reconnect and adjust the door linkage until the proper amount of preload has been achieved to provide a tight door seal. The Setup LED will still be on and the controller still in the Setup mode.

2.6.5.4. Step 3 (encoder calibration)

Pressing and releasing the setup button again will run the encoder calibrate process. The door will open fully and then close at a slow speed allowing the encoder position to be calibrated. When complete, the setup LED will turn off and the door can be operated normally.

2.6.5.5. Door Test Box

The door test box can be used to assist in door setup when the vehicle is not electrically fully functional. See “Fig. 16-18: Door Test Box” on page 27. This test box is connected to a 24VDC 15 Amp supply. There are cables that are connected to the electric operator control to provide power and control signals. The Power On switch will turn on the electric operator. The door open and close switch will command the door.

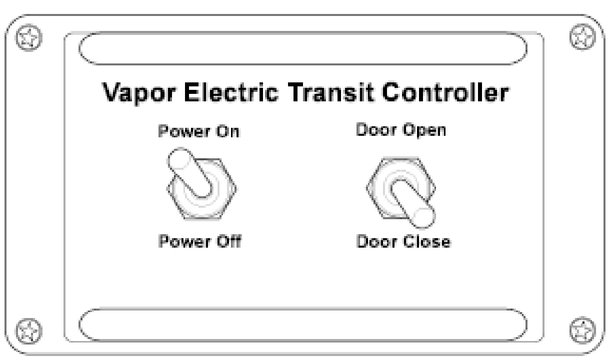


Fig. 16-18: Door Test Box

2.6.6. Door Pocket Seals

Door pocket seals are located on the fore and aft panel lower pockets.

Verify that sealant is correctly applied to prevent water ingress. Apply sealant to both corners of each pocket seal as required.

2.6.7. Door Panel Lower Brush & Upper Portal Splash Guard Adjustment

1. Operate the door controller to the closed position.
2. Loosen retaining hardware and slide the brush assembly upwards or downwards in the slots until the brush just makes contact with the floor. Maximum 1/16" compression is acceptable.
3. Tighten the retaining hardware to secure the seal in place.
4. Operate the door controller to the open position.
5. Adjust upper portal splash guard height to allow splash guard to clear door panel by a minimum of 1/16".
6. Cycle door from closed to open position several times to ensure that brush does not drag excessively and splash guard clears the door panels.

2.7. Door Speed Adjustments

2.7.1. Description

Opening and closing speeds and door cushioning are software adjustable through a computer connected to the electronic door controller.

☞**NOTE:**

Perform all other mechanical adjustment procedures before adjusting the door opening and closing speeds.

2.7.2. Door Speed Adjustment Specifications

Opening time .... 2.5 to 3.0 seconds

Closing time.................... 3.0 to 3.5 seconds

⚠ WARNING

Closing speed should be adjusted to ensure the specified amount of time between initiation of closure and full door closed position.

2.7.3. Adjustment Procedure

1. Adjust door closing speed to specification as measured between initiation of closing and the door fully closed position. Refer to 2.5.9. “Diagnostic Program” on page 13 in this section for information on connecting to the door controller and setting door operating parameters.
2. Adjust door opening speed to specification as measured between initiation of opening and the door fully opened position.

2.8. Emergency Release

2.8.1. Door Emergency Release

In the case of an emergency, the door gearbox can be disengaged allowing the door to be freely pushed open. The release mechanism has a rotary dump valve located behind a breakable cover. When turned, the valve allows air to escape and activates the spring loaded release cylinder. The cylinder disengages an internal clutch, allowing the teeter lever to rotate freely. A proximity sensor detects that the emergency release mechanism has been activated.

2.8.2. Entrance Door Emergency Release

Before exiting the vehicle, the driver rotates the Master Run switch to OFF which removes power from the magnetic dump valve solenoid. Air exhausts from the emergency release device, disengaging the clutch on the electric operator. The doors enter a neutral state and can be operated manually by hand. Rotating the Master Run switch to ON will apply power to the Command State dump valve. Once adequate air pressure is achieved the emergency release device will initiate the homing sequence by engaging the clutch on the electric operator. The door will slowly move to the fully closed position, regardless of the door's commanded state. Obstruction detection is active during the homing sequence. Once the door reaches the fully closed (home) position, the door will return to the normal operating state and respond to commands via the driver's door controller. For example: If the driver's door controller is in the open position during the homing sequence, the door will move to the full open position *after* reaching the fully closed (home) position.

2.9. Door Manual Control Valve

2.9.1. Description

The door panels may be manually opened by exhausting the air from the release cylinder. The door manual control valve is located on the front vertical face of the side console.

To manually open the doors rotate the handle 90°, wait for the air pressure to exhaust and push open the door panels.

2.10. Door Shaft/Arm Assemblies & Bearings

2.10.1. Description

The shaft and arm assemblies are attached to the door panels and held in place by upper and lower bearings. The upper bearings are seated in the door mechanisms base plate assembly and hold the weight of the shafts and doors. The lower bearings are attached to the floor to control lateral movement. These components function together as part of the door assembly to open and close the doors.

2.10.2. Removal/Installation

1. Set Battery Disconnect switch to OFF position.
2. Remove the door panel from the door shaft and arm assembly as follows:
   a. Support the door panel and remove the three screws from each location where the door panel is attached to the door shaft arm.
   b. Carefully disengage the door panel from the door shaft arms and from the baseplate roller guide.
   c. Set the panel aside, being careful to protect the glass and finish.
3. Remove the door shaft and arm assemblies as follows:
   a. Open the entrance mechanism access door.
   b. Disconnect the connecting rod ends from the door shaft lever.
   c. Note the alignment marks on the door shaft/lever and remove screw and wedge that fasten the lever to the shaft. Remove the lever from the shaft.
   d. Remove the two nuts that attach the upper bearing assembly to the baseplate and lift the bearing assembly from the door shaft.
   e. Mark the position of the lower mounting brackets (fore & aft door shafts) and the forward shaft support bracket (fore door shaft only). Remove the bolts from the mounting brackets and carefully slide out the door shaft and arm assemblies from the baseplate.
4. Installation is the reverse of removal with the following steps to be noted:
   a. Install door shaft and arm assembly mounting brackets in the positions originally marked; otherwise position the brackets in the mid-point of the adjustment slots.
   b. Ensure door shaft lever and U-joint splines are correctly indexed to the door shaft splines per the alignment marks.
   c. Ensure that the dowel pins are engaged before tightening the three screws that fasten the door shaft arms to the door panel.
   d. Refer to 2.6. “Entrance Door Adjustment Procedure” on page 23 in this section for final adjustments.

2.11. Connecting Rod Assemblies

2.11.1. Description

The connecting rod assemblies direct the action of the door operator to the door levers. The connecting rods also act as turnbuckle for door adjustment and as such are threaded right-hand at the teeter plate end (operator) and left-hand at the rod end (lever). The rod ends are secured to the motor teeter lever by a stud, nut and washer. The rod ends are secured to the door levers by a stud, nut and washer.

2.11.2. Removal

☞**NOTE:**

It is recommended that connecting rod ends be replaced, when necessary, with exactly the same thread protrusion as the old part. This practice will eliminate the need to adjust the door panels. One end should be removed at a time.

1. Access the connecting rods by opening the hinged panel over the door.

⚠CAUTION

While hinged panel above door is open, it protrudes into the stepwell area becoming a hazard for anyone entering the vehicle. Remove the panel to alleviate problem.

2. Remove the nut and lockwasher from the teeter plate end and the nut and lockwasher from the rod end.
3. Place the connecting rod in a vice with the ends protruding as if they were still mounted in the vehicle.
4. Loosen the jam nut at the rod end (left-hand thread) or at the rod end (right-hand thread) while holding the end in position.
5. Count the number of revolutions necessary to remove the end.

2.11.3. Installation

1. Replace the jam nut on the new end.
2. Insert the end into the connecting rod and turn it the same number of revolutions as were required to remove the end.
3. Lock the jam nut in place.
4. Lightly coat the friction surfaces with SAE #20 oil.
5. Repeat the procedure as required for additional end replacements.
6. Reverse the steps to complete the installation.

2.12. Door Proximity Switch Adjustments

1. Use a feeler gauge to verify the gap between the proximity switch and the target. The gap should be 0.08 +/- 0.005".
2. If the gap is not within range, loosen the nuts holding the switch and then reposition the switch.
3. Cycle the door open and closed to verify that the proximity sensor is detecting the target properly.

2.13. Door Panels

2.13.1. Description

The door panels consist of several extruded aluminum pieces. Two vertical sides are joined at the top and bottom of the door panel by extruded inserts. The extruded center sections are secured by screws from the outside vertical sides forming a rigid frame work. The entire assembly is bonded into one piece.

Minor damage to the door sections may be repaired with the use of body filler. Major damage may require replacement of the entire door sub-assembly.

2.14. Door Glass

2.14.1. Description

Your slide glide entrance and exit doors are fitted with glass inserts. The windows are made of laminated safety glass to allow translucence and protection against glass fragments in the event of breakage.

Keep windows clean for vision purposes. Rubber moldings should be cleaned of road grime and salt.

2.14.2. Removal

⚠CAUTION

Windows in this vehicle are laminated safety glass and should be handled with care while wearing gloves and approved eye protection.

☞**NOTE:**

The door windows are locked in place by a single formed seal with a locking lip.

1. Have an assistant inside the vehicle to keep the glass from falling.
2. Be sure the door is securely closed.
3. Using an appropriate tool, lift up a corner of the locking lip and insert tool under the lip and over the door panel.
4. Smoothly pull the tool around the window until the locking lip has been forced inside the door panel.
5. Gently push the window to the assistant inside the vehicle.
6. Clean the window frame area of dirt, rubber and old sealant.
7. Discard the old window and it is recommended that a new seal be used in place of the old one.

2.14.3. Installation

1. Position the new seal around the new door glass.
2. Lubricate the seal with a soap and water solution or a commercial seal lubricant.
3. Have the assistant place the window in the frame and gently push on it while the locking lip is positioned.
4. Insert the seal tool over the panel and under the lip.
5. Pull the tool smoothly around the window frame while the assistant simultaneously pushes lightly on the glass until lip is fully in position.

3. VAPOR/NFI SLIDE GLIDE EXIT DOOR

3.1. Description

The Vapor/NFI exit door of this vehicle is a slide glide door. The door functions the same as the entrance door. See “Fig. 16-19: Exit Door” on page 34. The base plate assembly above the door contains the door controller, the door operator lever assembly, door shaft levers, proximity switches and pressure switch connected to the door sensitive edges. See “Fig. 16-20: Exit Door Base Plate” on page 36. Refer to 3.8. “Sensitive Edges” on page 42 in this section for information on that system.

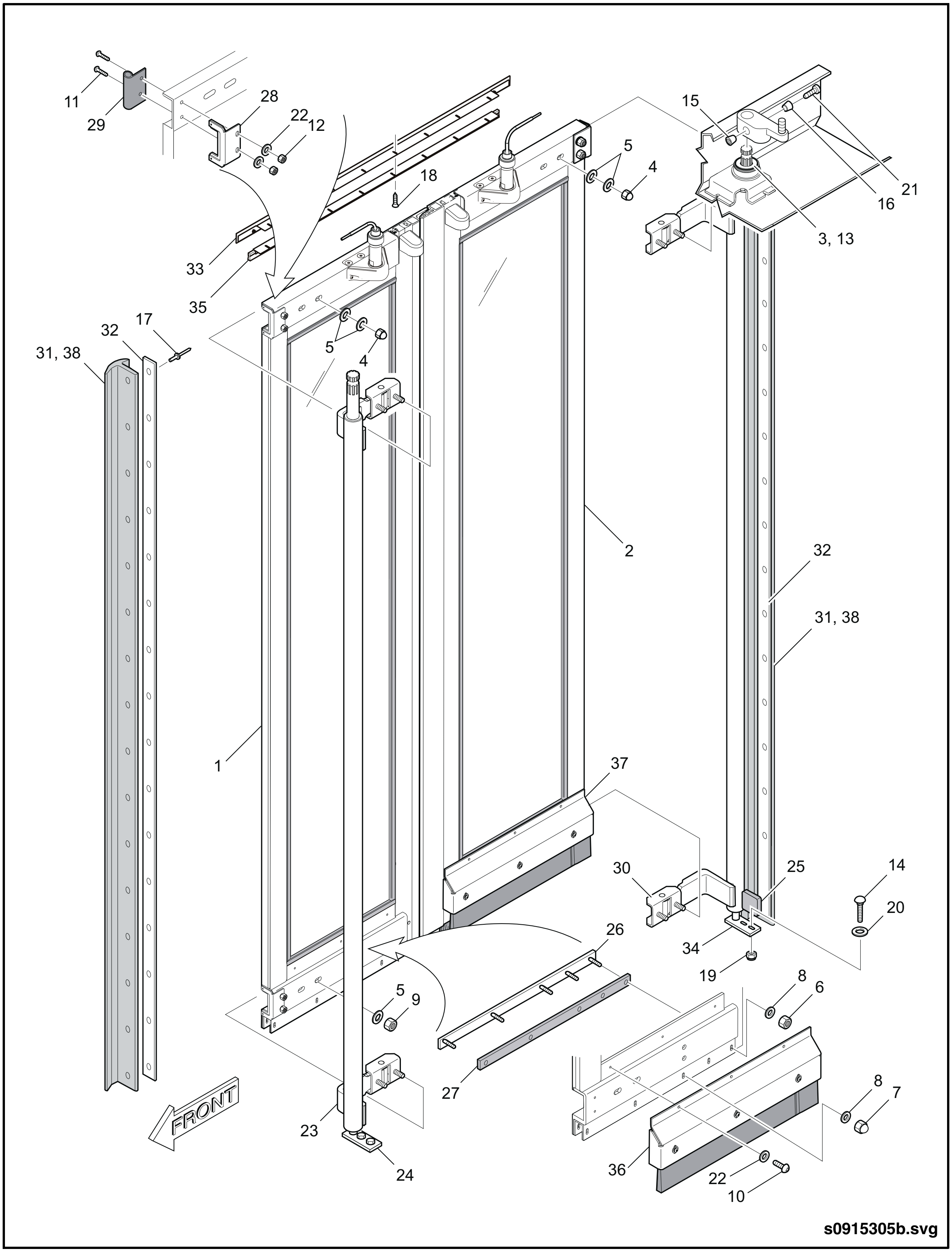


Fig. 16-19: Exit Door

1. Exit Door Assembly, Fore
2. Exit Door Assembly, Aft
3. Washer, Special
4. Nut, Crown 3/8" - 16 UNC Black
5. Washer, Flat 3/8" Black
6. Nut, Lock Nylon #10 - 32 UNF
7. Nut, Hex Acorn #10 - 32 UNC
8. Washer, Plain #10 - .438" O.D. x .032" Thk.
9. Nut, Hex Locking 3/8" - 16
10. Screw, PH Cross Recess SST #10 - 32 UNF x 3/8" Black
11. Screw, HD #10 - 32
12. Nut, Hex #10 - 32
13. Washer
14. Bolt, Carriage 316 SST 1/4" - 20 UNC x 2" Lg.
15. Wedge, w/Thread
16. Wedge, w/o Thread
17. Rivet, Blind Black Painted 3/16" x .187/.437
18. Screw, PH Cross Recess Tpg. Type F #10 - 24 UNC x 3/4" Lg.
19. Nut, Hex SST 1/4" - 20 UNC
20. Washer, Flat SST 1/4"
21. Screw, 12 PT 3/8" - 24 UNC x 1 1/4" Lg.
22. Washer, Flat SST #10 Black
23. Door Shaft & Arm Assembly, Fore
24. Pivot Assembly, Fore
25. Seal, Bottom Corner
26. Strip, Retaining
27. Seal, Rubber
28. Pocket Seal Assembly
29. Extrusion
30. Door Shaft & Arm Assembly, Aft
31. Seal, Jamb
32. Retainer, Jamb Seal
33. Seal, Upper Wide Xcelsior®
34. Pivot Assembly, Aft
35. Brush Assembly, Upper
36. Brush Assembly, Lower Fore
37. Brush Assembly, Lower Aft
38. Adhesive, SIKA 221 Black

Exit Door (parts list)

3.2. Operation

3.2.1. Door Power Up Operation

The control will monitor the door closed sensor at power up to determine the door position. The control also uses an encoder to determine door position but does not retain this information after the power is removed. The door will synchronize the encoder each time the door is in the closed position. The encoder is tested at power by jogging the motor to confirm that the encoder is functioning.

3.2.2. Door Closed

If the door closed sensor is detected at power-up, the controller will perform a test to determine if the door is closed. When the test has passed the control is placed in the door fully closed state.

3.2.3. Door Not Closed

If the door closed sensor is not detected at power-up, the controller will be placed in the door fault state. At this point the control does not know if the door is open or closed. The door open signal is sent to the vehicle. When a door command signal change from open to close is detected, the door will move slowly to the closed position. When the door stops moving, the position encoder will be synchronized with the door.

3.2.4. Rear Door Close Obstruction

The rear doors use sensitive door edge sensors to detect an obstruction while closing. The sensitive edge signals will wire into the electric operator control. The electric operator will monitor and react to the sensitive edge signal during the entire time that the door is closing until the door is fully closed. If a sensitive edge is detected during a door closing movement, the door will stop and then recycle open. There will be a one second delay once the door has reached the door fully open position. After the one second delay the controller will then respond to the door command signal. If the signal indicates a door close command, the door will start to close. If the command is in the door open command, the door will remain in the open position. The electric operator control can also detect a closing obstruction by monitoring the door movement.

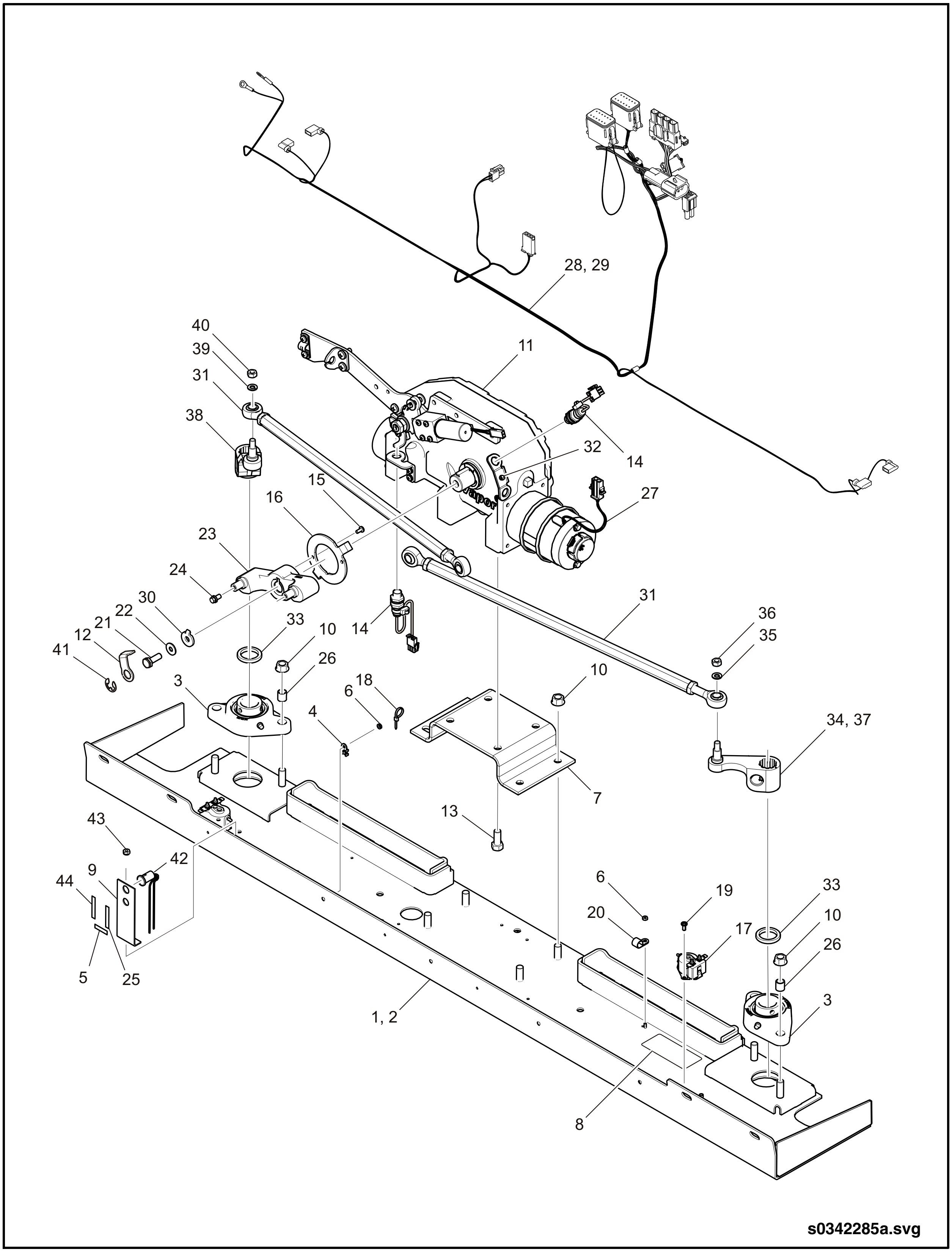


Fig. 16-20: Exit Door Base Plate

1. Base Plate Assembly, Exit Door (Incl. 2-34, 38, 41-44)	24. Screw, Hex 1/4" - 20 x .50"
2. Base Plate, Welded	25. Label, Class Light
3. Bearing, Ball	26. Bushing, 3/8" I.D. x 1/2" O.D.
4. Clip, Harness	27. Cable, Encoder
5. Label, Class Light	28. Harness, Door Position
6. Nut, Hex Keps #6 - 32 UNC	29. Harness, Wiring
7. Plate, Engine Mounting	30. Washer, Teeter
8. Label, Identification	31. Connecting Rod Assembly
9. Bracket, Mounting	32. Clip, Tie Holder
10. Nut, Hex 3/8" - 16	33. Spacer, Lever
11. Door Operator Assembly	34. Lever Assembly, Door Shaft RH (Incl. 35-37)
12. Lock, Teeter Bolt	35. Washer, Lock Spring 5/16" - .125" W x .078" Thk.
13. Screw, Hex 3/8" - 16 x .63"	36. Nut, Hex 5/16" - .125" W x .078" Thk.
14. Proximity Switch	37. Shaft Lever
15. Screw, PH Cross Recess #8-32 x .38	38. Lever Assembly, Door Shaft LH (Incl. 39-40)
16. Target, Door Open Sensor	39. Washer, Lock Spring 5/16" - .125" W x .078" Thk.
17. Switch, Pressure Wave	40. Nut, Hex 5/16" - .125" W x .078" Thk.
18. Tie, Harness	41. Ring, Retaining
19. Screw, PH Cross Recess#6-32 x .25	42. Indicator Light, 28V DC
20. Clamp, Cable Hanger	43. Nut, Hex #8 -32
21. Bolt, Teeter with Lock	44. Label, Class Light Status/On/Off
22. Washer, 0.324 x 0.787	
23. Teeter	

Exit Door Base Plate (parts list)

3.3. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance requirements.

3.4. Exit Door Adjustment Procedure

This section covers the adjustment of rear door panels and linkage.

3.4.1. Door Panel Adjustments

1. Before attempting to make any adjustments make sure connecting rods have been removed from the door shaft levers. Each panel can now be moved independently of each other. Also check that all door bracket mounting studs are centered within their respective slots, including the upper roller assembly and lower pivot assembly mounting hardware. This will establish a starting point for all panel alignment adjustments.
2. Measure the door shaft center to the center distance at the top of the opening. If necessary, adjust the lower pivot in the forward or aft direction to obtain the same door shaft spacing at the bottom of the opening. Make sure the door shafts are square with the vehicle floor. Tighten mounting hardware to secure the adjustment.
3. Manually close the doors. Check for approximately a 7/8" gap between the door trailing edge seal and the jamb seal retainer along the entire door length. If adjustment is required, loosen the four acorn nuts securing the door to the door mounting brackets and move the panel forward or aft as required. Tighten all mounting hardware after making adjustments.

4. With the doors in the fully closed position, check that the top brush forms a tight seal with the top of the doors. If gaps exist, install additional spacers between the door shaft lever and bearing to raise the door enough to form a tight seal. See “Fig. 16-21: Door Shaft Lever Shim Adjustment” on page 38.
5. Loosen the front and rear door top seal retainer and adjust the height of the top rubber seal so that it overlaps the top edge of the doors by approximately 1/16" when the doors are in the fully closed position. The top edge of the doors should wipe across the seal as they open. Tighten the retaining strip mounting hardware to secure the adjustment.
6. Adjust the front and rear door lower brush seals by first loosening the 10 - 32 acorn nuts securing the brush to the lower brush holder. Move the brush down until the bristles fill the step tread grooves. Secure the adjustment by tightening the 10 - 32 acorn nuts.
7. Manually push the doors to their full open position. Verify that the doors open to a 90° angle with respect to the step edge. If necessary, loosen the four 5/16" - 18 roller bracket assembly mounting screws and adjust roller bracket to obtain a 90° door open position. Tighten screws to secure the adjustment.
8. Reattach the connecting rods to the door shaft levers using hardware removed. Torque the wedge nuts located on the upper front and aft door shafts to 47 ft-lb. (64 Nm).
9. Manually open and close the doors. Verify that the leading panel overlaps the trailing panel during closing. If the edges bind during closing, lengthen the leading panel connecting rod and shorten the trailing panel connecting rod enough to eliminate the interference.
10. With the doors in the closed position, verify that the leading door edge metal to metal distance is 4.15" across the entire door length. See “Fig. 16-22: Door Closure Adjustment” on page 38. If adjustment is necessary, loosen the 3/18" - 16 acorn nuts securing the door panel to the door mounting brackets and move the panel forward or aft as required. Tighten mounting hardware to secure the adjustment.

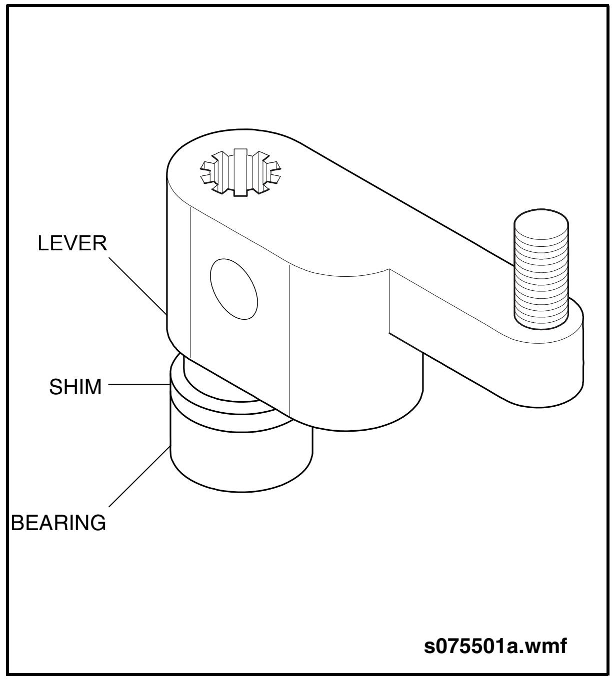


Fig. 16-21: Door Shaft Lever Shim Adjustment

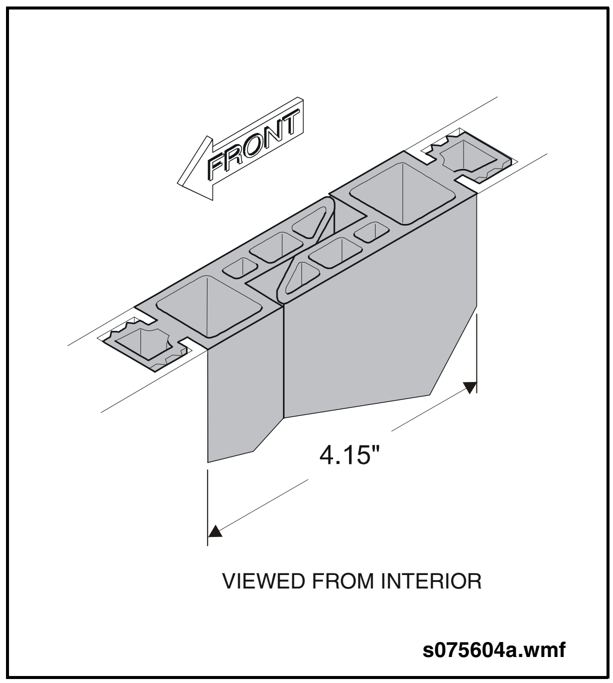


Fig. 16-22: Door Closure Adjustment

3.4.2. Connecting Rod Adjustment

The door controller has a setup button that will assist in the door linkage adjustment. The button is located next to the Setup LED indicator on the front of the control. Press this button for 5 seconds to start the quick setup mode.

WARNING

The electric door operator, door panels and door linkage will be in motion during this adjustment and caution should be taken to prevent bodily harm.

3.4.2.1. Step 1 (home position)

During the home position location process, the teeter lever may rotate more than 360 degrees when searching for the home position. When the motor stops, connect and adjust the door linkage rods so that the doors are closed. Do not over tighten the door panels (excessive door close preload).

3.4.2.2. Step 2 (door close, adjust linkage)

Press and then release the setup button again and the controller will move the teeter to the fully closed position. Reconnect and adjust the door linkage until the proper amount of preload has been achieved to provide a tight door seal. The Setup LED will still be on and the controller still in the Setup mode.

3.4.2.3. Step 3 (encoder calibration)

Pressing the setup button again will run the encoder calibrate process. The door will open and then close at a slow speed allowing the encoder position to be calibrated. When complete, the door can be run normally.

3.4.3. Door Test Box

The door test box can be used to assist in door setup when the vehicle is not electrically fully functional. This test box is connected to a 24VDC 15 Amp supply. There are cables that are connected to the electric operator control to provide power and control signals. The Power On switch will turn on the electric operator. The door open and close switch will command the door.

3.5. Door Proximity Switch Adjustments

1. Use a feeler gauge to verify the gap between the proximity switch and the target. The gap should be 0.08 +/- 0.005".
2. If the gap is not within range, loosen the nuts holding the switch and then reposition the switch.
3. Cycle the door open and closed to verify that the proximity sensor is detecting the target properly.

3.6. Door Speed Adjustments

3.6.1. Description

Opening and closing speeds and door cushioning are software adjustable through a computer connected to the electronic door controller.

☞**NOTE:**

Perform all other mechanical adjustment procedures before adjusting the door opening and closing speeds.

3.6.2. Door Speed Adjustment Specifications

Opening time .... 2.5 to 3.0 seconds

Closing time.................... 3.0 to 3.5 seconds

⚠ **WARNING**

Closing speed should be adjusted to ensure the specified amount of time between initiation of closure and full door closed position.

3.6.3. Adjustment Procedure

1. Adjust door closing speed to specification as measured between initiation of closing and the door fully closed position. Refer to 2.5.9. “Diagnostic Program” on page 13 in this section for information on connecting to the door controller and setting door operating parameters.
2. Adjust door opening speed to specification as measured between initiation of opening and the door fully opened position.

3.7. Exit Door Emergency Release Cable

3.7.1. Description

The exit door emergency release cable is located to the left of the exit door, behind a hinged access door and a breakable panel marked for emergency use. The handle is red in color and is part of the emergency release cable. The emergency release cable is attached to the emergency release arm on the baseplate above the exit door.

3.7.2. Operation

Pulling the emergency release handle retracts the emergency cable which is attached to the emergency release arm on the baseplate. This action causes the release arm to rotate and release the latch plunger, thereby allowing the door panels to be manually pushed open.

3.7.3. Emergency Cable Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Access the baseplate and disconnect the emergency release cable clevis at the emergency release arm connection point.
3. Remove the cable clamp from the door operator. Disconnect the emergency cable from the opposite end by opening the hinged door on the emergency release cover.
4. Loosen the upper jam nut until it slides off the control cable housing.
5. Pull the cable assembly out of the mounting bracket.

3.7.4. Emergency Cable Installation

1. Tighten conical nut against the end of the thread cable fitting.
2. Using two 3/4" open end wrenches, mount the emergency cable assembly to the emergency cover assembly.
3. Take the opposite end of the emergency cable assembly and pull the spring toward the cable jacket exposing the cable and guide it into the slot of the cable guide bracket. Release the spring when centered in the cable guide bracket hole.
4. Gently guide the emergency cable assembly thru the cable guide bracket hole ensuring press-nut is on the handle side of the guide bracket.
5. Re-install the pin, washers and cotter pin thru the clevis and release arm.
6. Reinstall the cable clamp previously removed over the emergency cable jacket. Do not tighten cable clamp screws at this time.
7. Position jacket to obtain 3/16" pre-travel between the clevis and pin. While holding the jacket in position, tighten the cable clamp screws.
8. With the emergency cover assembly still open, pull on emergency cable handle to activate. Make sure that the spring at the clevis end does not compress solid. Confirm that the latch plunger extends to hold the release arm in position.
9. Set the Battery Disconnect switch to the ON position.
10. Test emergency operation of the door.

3.8. Sensitive Edges

3.8.1. Description

The sensitive door edge system consists of a soft rubber edge with a sealed chamber, a PVC transfer tube and a pressure airwave switch and which interfaces with the electrical control system. See “Fig. 16-23: Door Edge to Panel Interface” on page 42.

When the sealed chamber (door edge) is momentarily deflected, (for example by an obstruction), a pressure wave is created which is transmitted via the PVC tubing to the pressure switch.

The pressure wave deflects the diaphragm of the switch, closing its contacts only momentarily since the built-up pressure is quickly equalized through the switch pressure compensating orifice. See “Fig. 16-24: Switch Contacts” on page 43.

The switch is supplied with the sensitivity properly factory preset for the sensitive edge arrangement being utilized. See “Fig. 16-25: Air Wave Switch” on page 43.

Upon closure of the pressure wave switch contacts, the door control system is signaled to reverse (reopen). Refer to the DC (Door Controls) Electrical Schematic in Section 9 of this manual. The system will then reinitiate the closing cycle.

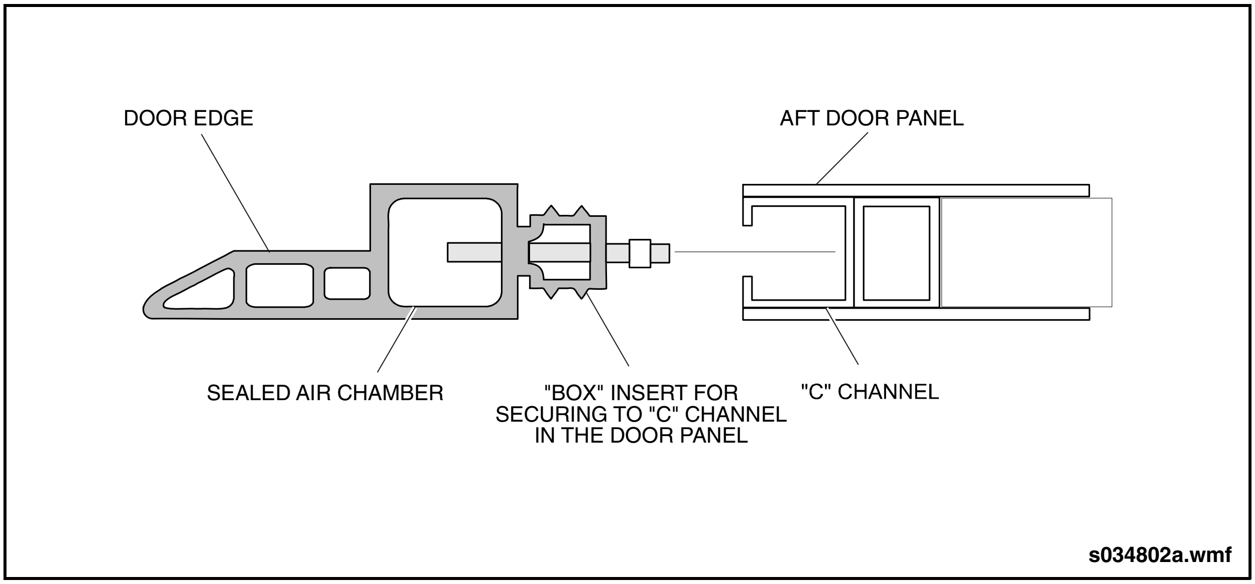


Fig. 16-23: Door Edge to Panel Interface

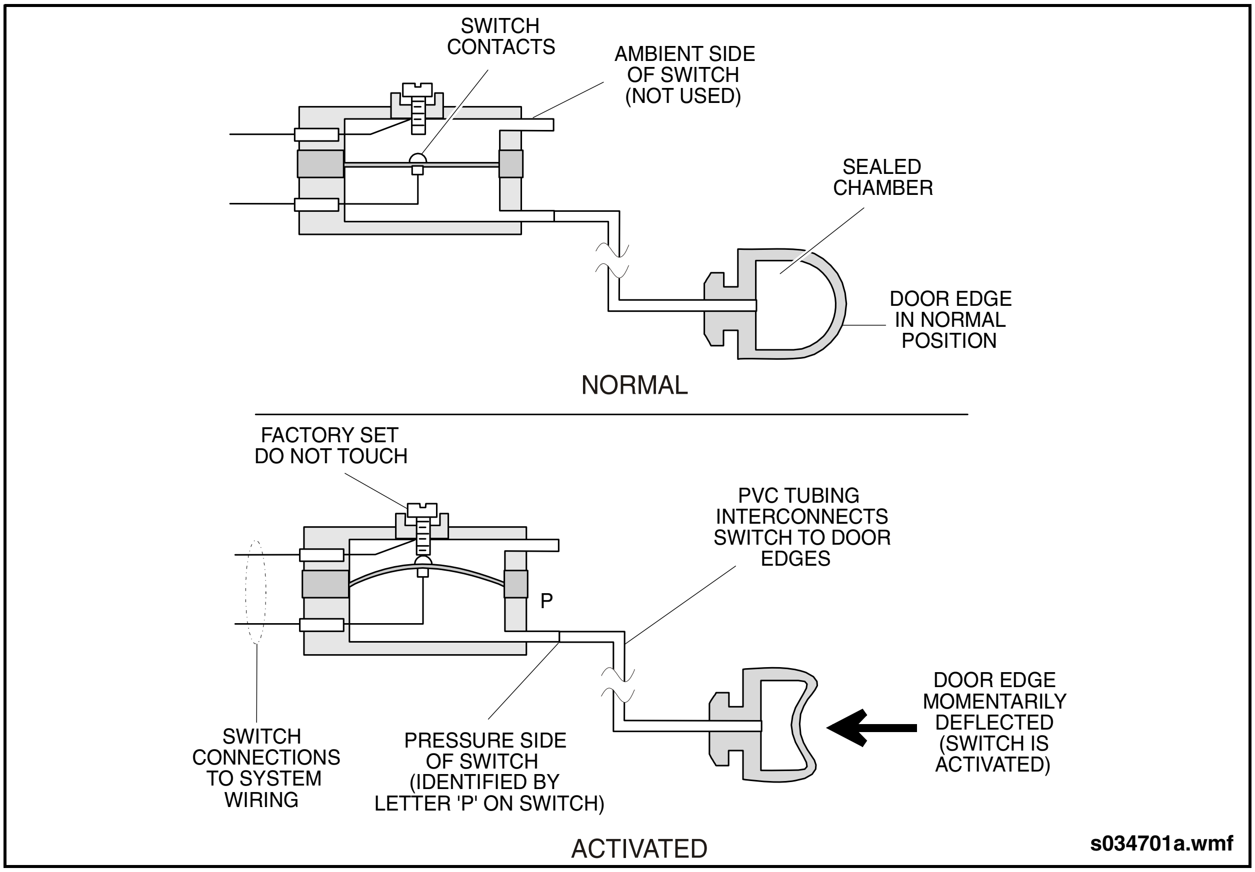


Fig. 16-24: Switch Contacts

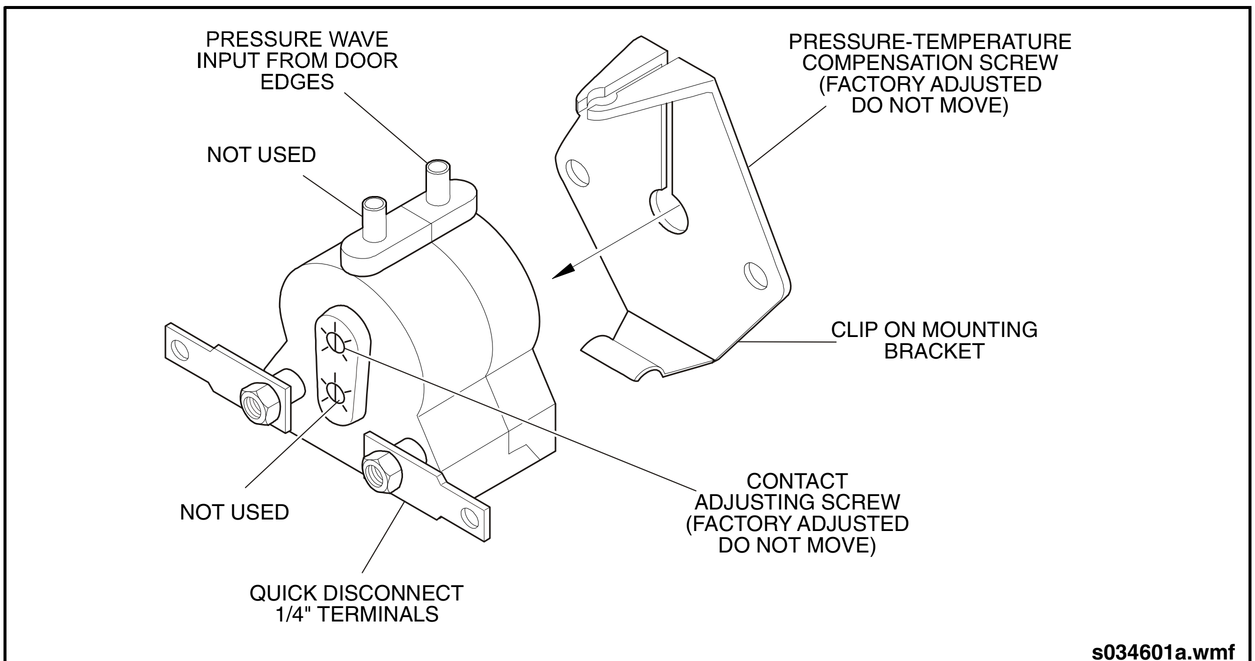


Fig. 16-25: Air Wave Switch

3.8.2. Functional Test

☞NOTE:

The following test is used to verify that the sensitive edges are functioning. All door linkage adjustments must be completed before switch adjustments are made.

1. Ensure that the system is at full air pressure, the vehicle is parked and the parking brake is set.
2. Open the doors to be checked.
3. Set the doors to close.
4. Standing outside the vehicle and while the doors are closing, firmly pinch the sensitive edge seal on the left hand door panel. The doors should reopen. See "Fig. 16-26: Pinch Test" on page 44.
5. Repeat steps 3 and 4 for the right hand door panel.
6. Standing outside the vehicle with the door closing, hold a 1 inch diameter rod (hardwood or metal approximately 18 in. (45.72 cm) long) perpendicular to the side of the vehicle at the vertical centerline of the door opening, 12 inches above the bottom of the door panels. See "Fig. 16-27: Rod Test" on page 44.
7. The doors should reopen when the door edges contact the rod.
8. Repeat steps 6 and 7 two more times. First with the rod held at the mid point of the door opening and again with the rod held at a point 12 inches below the top of the door panels.
9. If the doors open when tested according to steps 4 through 8, the sensitive edge system is working properly.
10. If the doors fail to open at any testing step, this may indicate a problem with a component of the sensitive edge system (sensitive edge seals, pressure wave switches, tubing or connection point). Verify proper operation of these components and then repeat this test procedure.

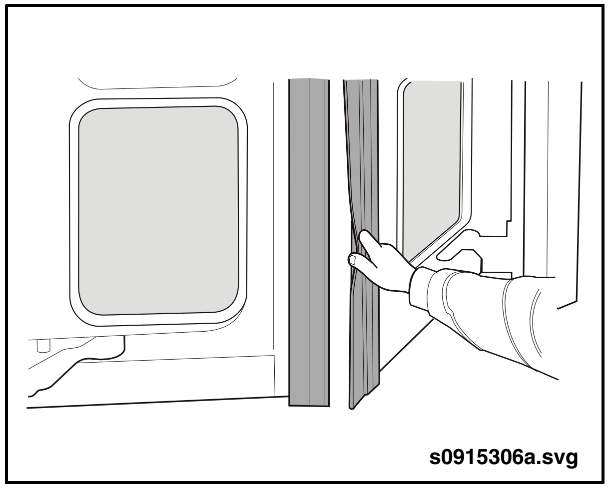


Fig. 16-26: Pinch Test

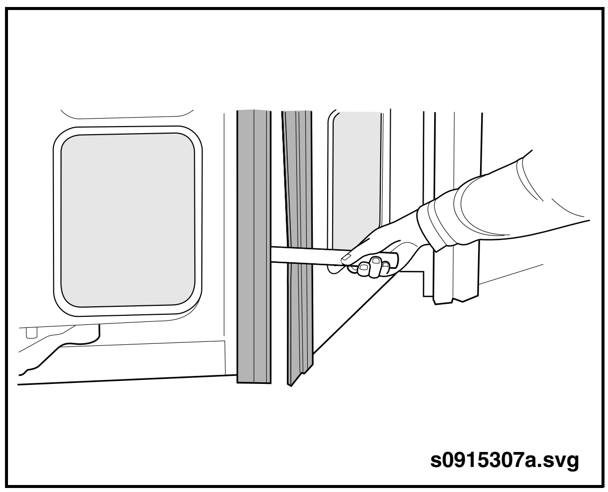


Fig. 16-27: Rod Test

3.8.3. Maintenance

Sensitive edge systems should be periodically checked following Proximity switch adjustments.

Many times a simple visual inspection for cuts, tears and disconnected tubing will indicate a need for service.

CAUTION

When performing body work on a transit vehicle, be sure to thoroughly mask edges before repainting. Several types of vehicular finishes contain chemicals which attack the neoprene rubber (such as polisocyanates used in polyurethane enamel activator).

3.8.4. Installation

Most edges have a “T” or a box-shaped cross-section on one side which matches a T-slot or C-channel on the leading edge of the door.

To install the edge on the door: lubricate the back side of the edge with a liquid soap (this is preferable to silicone or oil lubricants since the soap may be rinsed off with water after installation). Start the bottom of the edge into the top of the door by aligning the retaining section of the edge with the matching slot or channel.

Proceed to pull the edge into the slot or channel along the length of the door. The last (top) six inches of the edge (the area where a short section of PVC tubing protrudes) should be held away from the door. Connect this tubing to a length of PVC tubing sufficient to reach the pressure wave switch. Route the PVC tubing through the access hole in the door panel. The remaining six inches of edge may now be squeezed sideways into the slot using a dull putty knife on the box or “T” area. The PVC tubing should be routed up to the pressure wave switch. Allow excess tubing at all moving joints and cover exposed sections with spiral wire wrap or equivalent. Be sure that the tubing is not kinked anywhere. Refer to 3.8.4.1. “Flexible Conduit Installation” on page 45 in this manual for proper conduit routing instructions. Connect the end of the tubing to the open port on the pressure wave switch.

3.8.4.1. Flexible Conduit Installation

The following procedure describes the routing requirements of the flexible conduit used between the door panel and baseplate. The sensitive edge PVC tubing and CLASS sensor wiring (if equipped) are routed from leading edge of each door panel, upward through the hollow shaft of the roller bracket, and inward along the baseplate. The PVC tubes terminate at their respective pressure wave switch and the CLASS sensor wiring (if equipped) terminates at the CLASS controller, located above the baseplate. The PVC tube and wiring harness are protected with a spiral wrapped loom.

Inspect the flexible conduit for proper installation and routing as follows:

1. Close the door panels and feed the flexible conduit from each door panel upward through the shaft of their respective roller bracket, being careful not to pinch or otherwise damage the conduit.
2. Locate the P-clamp on the baseplate and insert a short piece of foam tape inside the P-clamp. Refer to your New Flyer Parts Manual for part number of foam tape.
3. Route the flexible conduit on the forward door panel through the P-clamp. Position the P-clamp perpendicular to the baseplate door channel and torque the clamp to 13 in-lbs.
4. Route the flexible conduit on the aft door panel through the P-clamp. Position the P-clamp at approximately 30° to the baseplate door channel and torque the clamp to 13 in-lbs. See “Fig. 16-28: Flexible Conduit Routing” on page 46.

CAUTION

Nylon tywraps must be applied over the spiral wrap and not directly on the tubing or wiring harness itself. DO NOT over-tighten the nylon tywrap as this could constrict the sensitive edge tubing and prevent proper operation of the sensitive edge system.

5. Carefully route the remaining cable assembly to next closest and convenient tywrap mounting clip on the baseplate. Route the cable assembly to avoid potential contact with moving parts or sharp edges. Secure conduit to mounting clips with nylon tywraps.
6. Connect the sensitive edge tubing from each door panel to its respective pressure wave switch.
7. Connect the CLASS sensor wiring (if equipped) from each door panel to their respective connectors on the CLASS controller.
8. Manually operate both door panels and observe the movement of the flexible conduit as the doors open and close. Verify that the conduit does not kink or snag at any point throughout their range of travel. Light cable contact with the baseplate or vehicle structure at the extreme ends of travel is acceptable. If necessary, adjust the orientation of the conduit and P-clamps to ensure these requirements are met.

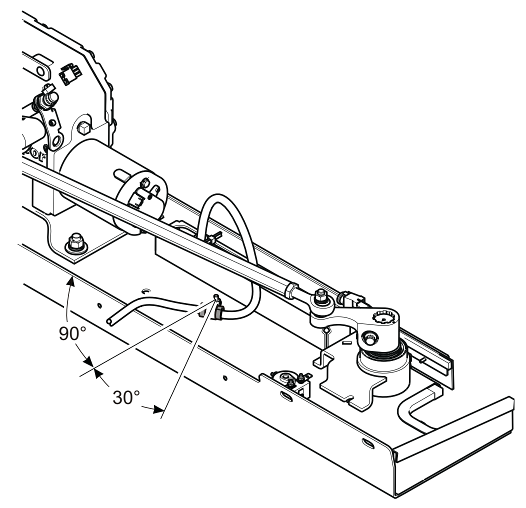


Fig. 16-28: Flexible Conduit Routing

9. Upon completion of flexible conduit installation:
   a. Test the function of the sensitive edge system. Refer to 3.8.2. “Functional Test” on page 44 in this section for test procedure.
   b. Test the function of the CLASS system (if equipped). Refer to 3.8.2. “Functional Test” on page 44 in this section for test procedure.

3.9. CLASS™ Exit Door Sensing System

3.9.1. Description

The Contact-Less Acoustic Sensing System (CLASS) is an acoustic sensing system that allows passengers to initiate door opening and exit the vehicle without physical contact with the doors.

The CLASS™ system consists of three ultrasonic sensors and a signal processing and control unit (controller) for the exit door. Left and right panel sensor units are fitted to the door panels and a middle sensor unit is mounted beneath the door baseplate.

3.9.2. Operation

Moving the driver's door controller to positions #3, #4, or #5 enables the exit door and causes the sensors to emit bursts of ultrasonic pulses to survey specific spaces within the doorway. The echoes received by the sensors are analyzed by the controller to determine whether or not an object (typically a person) is present. When an object is detected, the controller provides a signal to the electronic control system, which initiates the appropriate response.

The panel sensors are directly mounted on each door panel and project a relatively narrow downward beam angle. Their function is to detect the presence of an object (typically a hand) in the immediate vicinity of the door panel leading edges and initiate door opening. These panel sensors also enhance the sensitive edge function when the door is closing. The middle sensor unit has a wider beam angle and its function is to monitor the door pathway while the door is open to prevent premature closing.

When the exit door is enabled (door controller in positions #3, #4, or #5) and the sensors detect a passenger in the defined zones, the controller sends a "door open request" signal to the electronic control system. The system energizes the door open mag valve and maintains the door in the open position until otherwise signaled by the controller. Once the passenger(s) exits the doorway and the exit area is clear, the "door open request" signal is removed and the door is allowed to close.

3.9.3. Exit Door Sensing System Troubleshooting

☞**NOTE:**

All references to "J1-X" refer to the Vehicle Interface Harness connector to the CLASS controller mating connector J1, where "X" is the pin location designator. Refer to Electrical Schematic "ES-Door Controls".
System Voltage refers to the operating voltage of the vehicle (typically +24V).

1. Make sure that the exit door is closed, and the doorway is clear of any people or objects.
2. Turn on CLASS (by turning on the vehicle Master Run switch).
3. Enable the exit door. (the green light should illuminate).
4. Verify that the SEND light (on the end of the CLASS controller) is on. If the SEND light is on, proceed to step 6. If the SEND light is not on, perform step 5.
5. Perform measurements with respect to J1-24 (CLASS ground) and verify the following:
    a. Verify that the CLASS controller is receiving power (System Voltage) at Pin 1 of the ON/OFF switch (+24V). If power is not found at Pin 1 of the switch (+24V), check the connections to the exit door local power source.
    b. Verify that the CLASS controller is receiving power (System Voltage) at J1-18 (ON/OFF). If power is not found at J1-18 (ON/OFF), verify that the On/Off switch is ON, and verify the connection to the front-mounted ON/OFF switch.
    c. Verify that the CLASS controller is receiving power (System Voltage) at J1-7 (ENABLE). If power to not found at J1-7 (ENABLE), check that the green light is on, and verify the connection to the appropriate limit switch.
    d. Verify that there is System Voltage at J1-5 (5° from the Nearly Closed switch).

6. If the SEND light is on, place an object in the beam area of the left panel sensor as follows:
   a. Make sure that the object is oriented so as to reflect sound back to the sensor.
   b. Make sure the object is at least 10", and no more than 40" from the face of the sensor.
   c. If necessary, move the object slowly up or down to make sure it is not in a dead zone.
7. Verify that the left light (on the end of the CLASS controller) is on when the object is in the sensor's beam area.
8. If the left light is not on proceed as follows:
   a. Verify that the sensor is transmitting ultrasound pulses by lightly placing a finger on the white circle at the face of the sensor. A slight vibration should be felt when the sensor is transmitting. (This vibration is not at the frequency of the ultrasound pulse; it is the repetitive trigger pulse, which occurs every 20 to 25 milliseconds when the sensor is transmitting).
   b. If no vibration can be felt, verify that the sensor is correctly plugged into the controller and in the correct location.
9. If the left light goes on, the door should have opened. If not:
   a. Verify the door is physically unlocked and capable of opening.
   b. Verify that J1-18 is connected to System Voltage.
   c. Verify that J1-13 (OPEN) is connected to the vehicle Multiplexing System at the appropriate input (refer to electrical schematic “ES-Door Controls”) and is at System Voltage (referenced to Vehicle/PLC Ground) when the left light is on. On some vehicles, this connection may be through a diode.
10. Repeat steps 6-9 for the RIGHT sensor and RIGHT light.
11. Once the door is fully open, repeat steps 7-9 for the CENTER sensor and CENTER light. The door must remain fully open while verifying the center sensor. If necessary, block the door open and ensure that the Fully Open switch remains activated. Verify System Voltage is at J1-1.
12. If the Center light is not on, in addition to the actions to step 8a and 8b, verify that the Fully Open switch is activated and the Fully Closed switch is deactivated.

3.9.4. Functional Test

1. Verify Master Run switch is in DAY-RUN/ NIGHT-RUN position, the CLASS Power switch is off, and the driver's door control handle is in the Rear Door Closed position.
2. Turn on the CLASS Power switch while observing the LED's on the CLASS controller housing.
   a. Verify that the SEND light and LEFT, CENTER, and RIGHT DETECT lights flash on at least once.
   b. After previous step is complete, verify all lights are off.
3. Move the driver's door control handle to the Rear Door Open position and ensure that the green light above the rear door is on. Verify that the SEND light on the CLASS controller housing is on.
4. Place a hand in the area indicated to be used to open the door. Verify that the door opens.
5. Once the door opens fully, stand so as to be detected by the center sensor. Verify that the door either remains open or, if it starts to close, reopens after closing partially.

   ☞**NOTE:**

   The door behavior depends on the electronic control system or controller.

6. Move back to allow the door to close almost fully. Just before it is fully closed, place a hand so as to be detected by the left panel sensor. Verify that the door reopens. Repeat this procedure for the right panel sensor.
7. Repeat step 6, allowing the door to fully close before placing a hand under the sensor, and make sure to place the hand under the sensor more than one second after the door passes the 5° point. Verify that the door reopens.

   ☞**NOTE:**

   The green light above the rear door must still be on.

8. Repeat step 7, with the driver's door control handle in the rear door closed position. Place a hand under the sensor within one second of the door's passing the 5° point. Verify that the door reopens.
9. Repeat step 8, but place a hand under the sensor more than one second after the door passes the 5° point. Verify that the door does not reopen and that the SEND light on the CLASS controller housing is off.

   ☞**NOTE:**

   Steps 7 through 9 assume that Timer 2 is set to one second. Adjust calculations if required.

4. DRIVER'S DOOR CONTROL

4.1. Description

The door controller consists of two normally open momentary microswitches, which are operated by a mechanical plunger and handle.

The Vapor type door controller consists of two single pole, double throw electrical switches, both of which are cam actuated. The cam is fixed to a rotating adapter assembly and has two raised surfaces that come in contact with the switch push buttons. The adapter assembly permits a secure interface between the door controller and the customer's control system.

Four possible combinations can be obtained for front and rear door operation. A predetermined number of these combinations can be obtained by adding stops to limit the movement of the selector handle. This feature affords the option of having a #2, #3, #4, or #5 position controller. See "Fig. 16-29: Door Controller Positions" on page 51.

4.2. Inspection

Periodic inspection of the controller should be made to ensure that the controller is mounted securely and that all its components are tightly fastened. Any accumulation of dirt on the controller should be removed by brushing and vacuuming; this will protect the electrical contacts of the switches. Check controller functions through all positions.

4.3. Overhauling

In the event of a malfunction, remove the controller from the vehicle and replace with a spare.

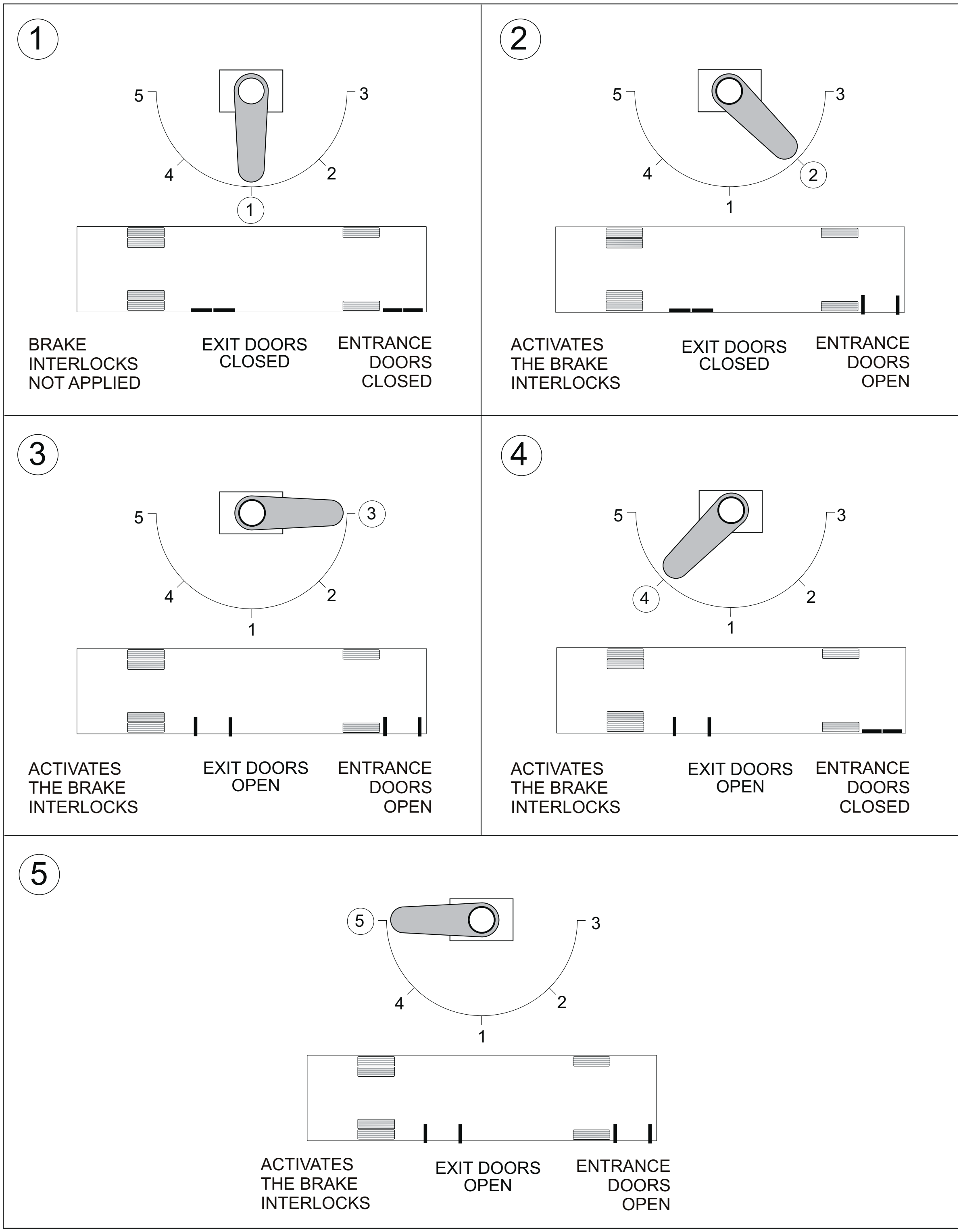


Fig. 16-29: Door Controller Positions

4.3.1. Disassembly

1. Remove the adapter assembly by loosening the 10 - 32 hex head machine screws and lock washers and lift the assembly from the controller collar. See "Fig. 16-30: Door Controller Assembly" on page 53.
2. Detach the wiring harness by removing the pan head screws and flat washers from both switches.
3. Remove the front door snap action switch by unscrewing the two 8 - 32 socket head cap screws and removing the 8 - 32 hex nuts, lock washers and spacers.
4. The rear door snap action switch and switch insulator may be removed by loosening and removing the two 6 - 32 round head machine screws, lock washers, flat washers and tapping pad.
5. Remove any controller stops that may be present. Unscrew and remove any 10 - 32 socket head machine screw(s), acorn nut(s) and No. 10 split lock washer(s). Mark their location(s) for proper positioning during reassemble.
6. Detach the bullet catch bracket from the bracket assembly. Unscrew and remove the two 1/4" - 20 socket head cap screws, lock washers and flat washers.

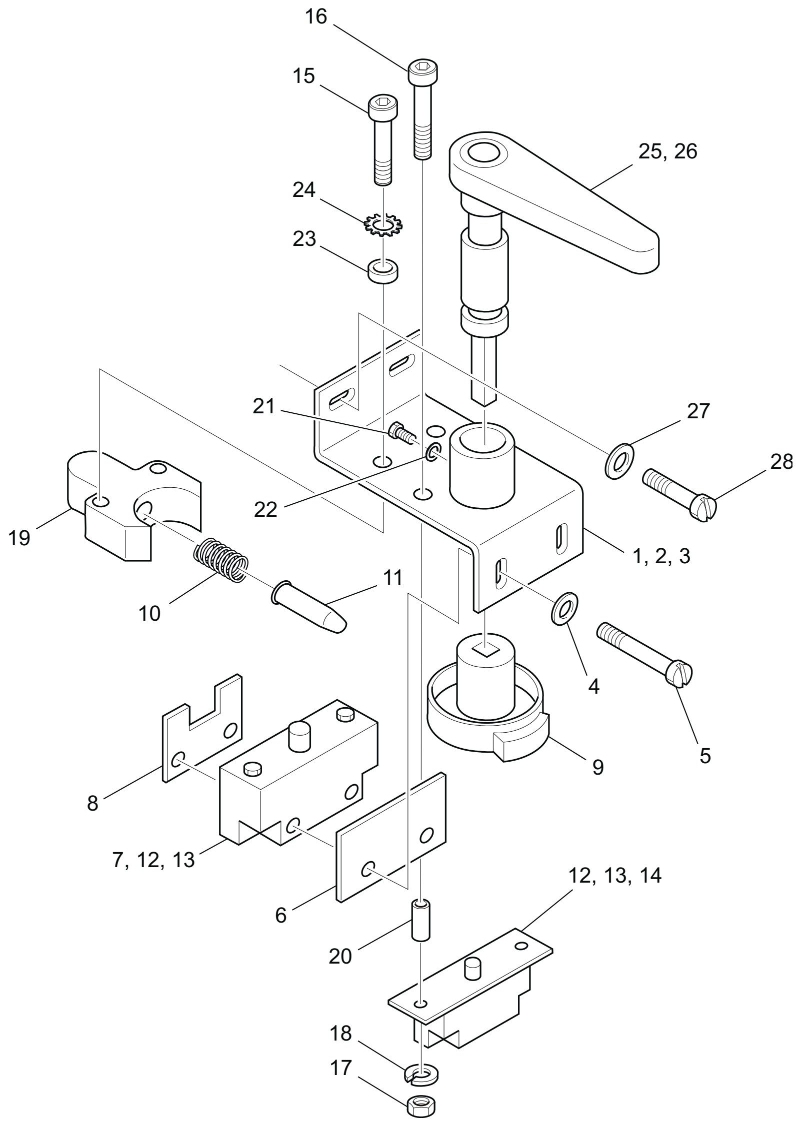
☞**NOTE:**

As the bullet catch bracket is removed, the index plunger and index plunger spring will fall from it.

7. Slide the actuator cam out of the sleeve in the bracket assembly.

4.3.1.1. Cleaning

All disassembled parts should be cleaned with Chlorothene NU. Use a brush dipped in the solvent when cleaning the switches and the actuator cam and wipe dry (do not soak).



1. Door Controller Assembly, (Incl. 2-24)
2. Bracket Assembly, Mounting
3. Label, Identification
4. Washer, Plain #6 - .312" O.D. x .028" Thk.
5. Screw, PHD Rec. Sem #6 - 32 UNC x 1 1/4" Lg.
6. Insulator, Switch
7. Switch, Snap Action
8. Pad, Tapping
9. Cam, Actuator
10. Spring
11. Plunger
12. Washer, Lock #8
13. Screw, PHD Rec. Sem #8 - 32 UNC x .31" Lg.
14. Switch, Snap Action
15. Screw, 1/4" - 20 UNC x 3/4" Lg.
16. Screw, #8 - 32 UNC x 1" Lg.
17. Nut, Hex #8 - 32 UNC
18. Washer, Lock #8
19. Bracket, Bullet Catch
20. Spacer
21. Screw, #10 - 32 UNC
22. Washer, Lock #10
23. Washer, Flat 1/4"
24. Washer, Lock External 1/4"
25. Handle Assembly, Door Controller (Incl. 26)
26. Bushing
27. Washer, Flat SST 1/4"
28. Screw, PH Cross Recess SST 1/4" - 20 UNC x 1/2" Lg.

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Fig. 16-30: Door Controller Assembly

4.3.2. Reassembly

Before reassembly, all bearing surfaces should be lightly coated with Lubriplate No. 110. Reassemble the controller as follows:

1. Position the actuator cam with its drive end through the hole in the bracket assembly.
2. Insert the index plunger spring and the index plunger into the bullet catch bracket. Mount the bullet catch bracket to the bracket assembly with the two socket head cap screws, lock washers and flat washers. Torque the screws to 46 in-lb.
3. Replace any controller stops that have been removed. Insert socket head machine screws in the holes marked during disassembly. Secure with acorn nuts and split lock washers. Socket head machine screw heads should be on the same side of the bracket assembly as the actuator cam.
4. Mount the rear door switch and switch insulator to the bracket assembly. Use the round head machine screws, lock washers, flat washers and tapping pad.
5. Mount the front door switch using the two spacers. Secure with two socket head cap screws, hex nuts and lock washers.
6. Attach the harness assembly to both switches. Secure with pan head screws and flat washers.
7. Attach the adapter assembly to the bracket assembly and secure it with hex head machine screw and split lock washer. Torque the screw to 30 in-lb.

4.3.3. Testing after Reassembly

4.3.3.1. Test Equipment Required

- ❒ Ohmmeter (Simpson 261 or similar)
- ❒ Gauges, Feeler Type

4.3.3.2. Testing - Mechanical

1. Actuate the rear door switch. The clearance between the switch button and the cam rise surface must be a minimum of 0.015" to have positive switch actuation and to prevent the bottoming out of the switch button causing damage to the switch. Check switch in deactuated position for minimum gap of 0.005" between switch button and flat cam surface.
2. Actuate the front door switch. The clearance between switch button and cam surface can be from 0.030" to 0.005" This will make positive actuation and prevent switch button from bottoming, causing damage to switch.

⚠ CAUTION

DO NOT force the gauge. This could damage the switch when it is forced to bottom.

If these clearances are not within specified limits, loosen the mounting hardware of the switch being tested and adjust accordingly.

3. Operate the controller through all positions. There must be no binding and operation should be smooth.

4.3.3.3. Testing - Electrical

1. Connect the leads of an ohmmeter to the N.C. “A” contact terminals. The ohmmeter should indicate infinity with the switch actuated. Zero ohms should be indicated when the switch is deactuated.
2. Connect the leads of the ohmmeter to the N.O. “B” contact terminals. The ohmmeter should indicate infinity with the switch deactuated. Zero ohms should be indicated when the switch is actuated.

4.3.4. Storing

If the controller is not going to be put back into use immediately after servicing, store controllers in a glassine bag in a clean dry area.

Seating & Stanchions

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❒ open flame
- ❒ excessive heat
- ❒ production of sparks
- ❒ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Air System Safety

⚠ WARNING

ALWAYS drain the air pressure from ALL reservoirs before beginning work on any air system component.

⚠ WARNING

Ensure air lines are safely depressurized prior to disconnecting. Wear safety glasses as disconnecting pressurized lines will cause solid particles deposited in the line to be uncontrollably propelled, and will also cause the hose end to whip randomly as the air escapes.

1.4. Cleaning Chemicals Safety

⚠ WARNING

Because fumes are more dangerous in a small space, be sure the vehicle is well ventilated while using any cleaning agent. Follow the manufacturer's instructions in using such products. Many cleaners may be poisonous or flammable, and their improper use may cause personal injury or damage to the inside of the vehicle. Therefore, when cleaning the interior, DO NOT use volatile cleaning solvents such as: acetone, lacquer thinners, enamel reducers, nail polish removers; or such cleaning materials as laundry soaps, bleaches, or reducing agents (except as noted for fabric cleaning of stains). NEVER use carbon cleaning products.

⚠ CAUTION

To avoid possible permanent discoloration on light colored trim, DO NOT let materials with unstable dyes come in contact with seat trim materials until totally dry. Proper cleaning techniques and cleaners must be used on trim materials. Failure to do this on the first cleaning may result in water spots, spot rings, setting of stains, or soilage, all of which make it more difficult to remove in a second cleaning.

2. DRIVER'S SEAT (Recaro Ergo Metro AM80)

WARNING

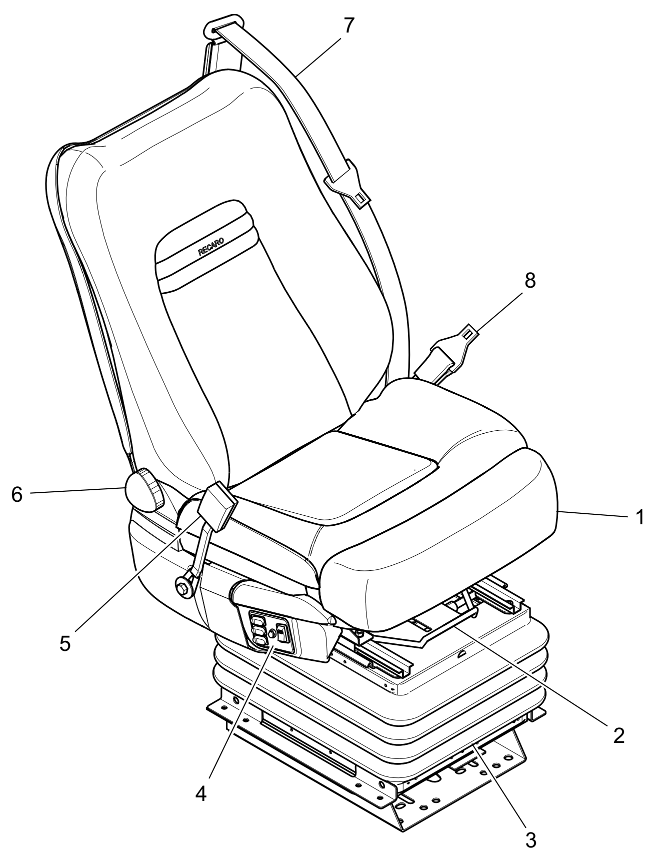
DO NOT adjust the seat while driving. Loss of control of the vehicle could result and cause an accident if attempting to adjust the seat while driving.

DO NOT modify and/or prevent retraction of the restraint system (seat-belt). Doing so can cause the safety restraint system to function improperly or fail. The seat-belt webbing strap(s) should be tight against the occupants lap and/or torso.

Adequate air ride height must be obtained to avoid bottoming out of the suspension in the seat. Ride height must be between mid-height adjustment to full-up. Personal injury may result from excessive bottoming out of the seat suspension.

2.1. Description

The Recaro Ergo Metro AM80 driver's seat is an adjustable air suspension seat consisting of a steel frame base and back panel and molded foam cushions. The seat-belt retracts to holders beside the seat cushion. See "Fig. 17-1: Driver's Seat" on page 2.



1. Thigh Extension Cushion Length Adjustment
2. Fore/Aft Locking Device
3. Bellows
4. Driver's Seat Switch Panel
5. Seat-Belt Clip
6. Backrest Adjustment
7. Shoulder Belt
8. Retractable Seat-Belt

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Fig. 17-1: **Driver's Seat**

2.2. Operation

Controls adjust the positioning of the seat and seat cushions to suit the needs of the individual. Make position adjustments to provide for the best driving visibility and control. See "Fig. 17-2: Driver's Seat Switch Panel" on page 3.

WARNING

Keep hands away from pinch points between the seat and the vehicle operator's compartment, even when adjusting the seat. Keep hands away from the underside of the seat if adjusting the seat using a seat track auto actuator. ALWAYS use both release levers when actuating rake adjust downward. Keep fingers free from between the plastic side covers when actuating rake adjust upwards. ALWAYS adjust thigh extension fore/aft by grasping the center of the high extension in the front center of the seat cushion. When using manual fore/aft adjustment with rake adjust in the full-down position keep fingers from between the adjust handle and the bottom of the high extension frame.

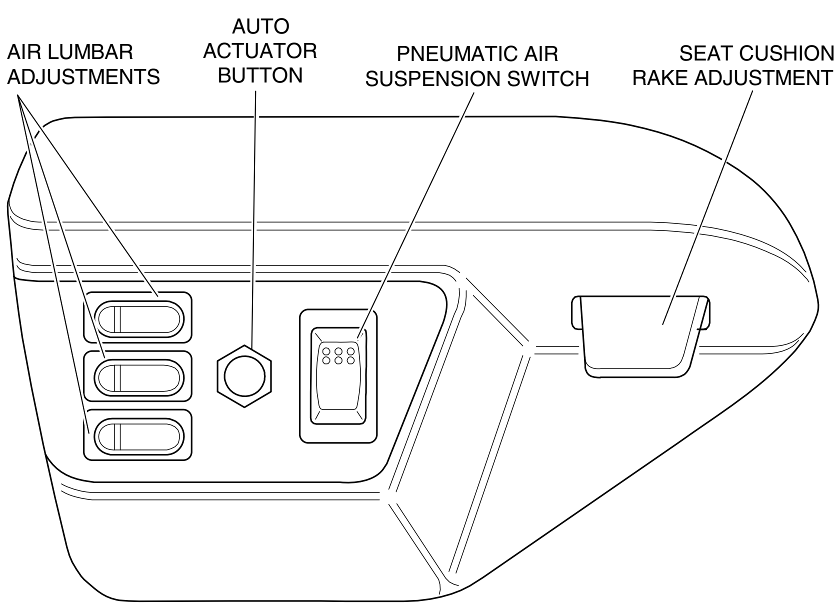


Fig. 17-2: Driver's Seat Switch Panel

2.2.1. Headrest Support

Horizontal and vertical adjustments can be made to the headrest. Pull up from the bottom or push down on the top of the headrest until the desired height is obtained. To adjust the tilt, pull forward or push back on the top of the headrest until it pivots to the desired angle.

2.2.2. Thigh Extension Cushion Length Adjustment

The front part of the seat cushion can be extended up to 2" (50 mm) by pulling the front of the thigh extension forward or backward to a desired length.

2.2.3. Back Recline Adjustment

Adjust the backrest to the desired recline position by turning the control knob located at the bottom of the backrest.

2.2.4. Shock Adjustment Lever

The shock adjustment lever is located on the RH side of the seat, aft of the seat switch panel. The shock adjustment lever is used to control the damping rate of the shock and thereby affect the rate of upward and downward movement of the air spring.

2.2.5. Manual Fore/Aft Adjustment

Lifting the manual adjustment bar allows you to slide the seat forward and back.

2.2.6. Switch Panel Lumbar Adjustments

WARNING

DO NOT disable and/or modify the lumbar mechanism in the seat. Lumbar adjustments help support the lower back and maintain proper chiropractic curvature of the spine. The inability to adjust lumbar can exacerbate pre-existing injuries to the lower back.

Three rocker switches control each of three air lumbar support cells. Push switch forward to inflate; rearward to deflate.

2.2.7. Air Track Release

To release tracks and move the seat fore and aft, push Auto Actuator button and shift body for desired distance.

2.2.8. Pneumatic Air Suspension Switch

Push the Pneumatic Air Suspension switch up to raise seat suspension. Push this switch down to lower seat suspension.

2.2.9. Seat Cushion Rake Adjustment

The front part of the seat can be adjusted from a 0 to 20° angle by pulling the seat cushion rake adjustment handle up and moving the thigh extension up and down to the desired angle.

2.2.10. Adjustable D-Ring

For the 3-point lap and shoulder belt, pull knob forward to move the D-ring UP. Pull knob and push D-ring DOWN to lower.

2.3. Maintenance

2.3.1. Removal

1. Pull back seat bellows far enough to access air line connection.
2. Disconnect air line connection to seat.
3. Loosen and remove 8 mm bolts and washers securing seat to riser.

2.3.2. Installation

1. Position seat on riser and install M8 bolts and flat washers.
2. Torque bolts to 15.5 to 16.5 ft-lb. (20 to 25 Nm).
3. Connect air line and position bellows against seat frame.

2.3.3. Seat Cushion Replacement

1. To remove the seat cushion, remove the two 10 mm lock nuts on the underside of the thigh extension and lift up to release it from the rake adjustment frame. See “Fig. 17-3: Seat Cushion” on page 5.
2. Pull either rear corner of the seat cushion up and out to release it from the Velcro that holds it into place. Slide the cushion forward to unhook it from the J-retainer that holds the front edge to the seat cushion pan.
3. To separate the seat cover from the cushions, undo the Velcro on all four sides and pull the cushion out. Remove the staples on the thigh extension cover and pull the plastic retainers from the front and rear to remove the plastic housing, then remove the thigh extension foam cushion.
4. Assemble seat cushion and thigh extension to seat cushion cover.
5. Position seat cushion assembly on seat pan and hook J-retainer to front edge of seat cushion pan.
6. Push seat cushion down and rearwards to engage Velcro retaining strips.
7. Position thigh extension on rack adjustment frame and install retaining nuts.

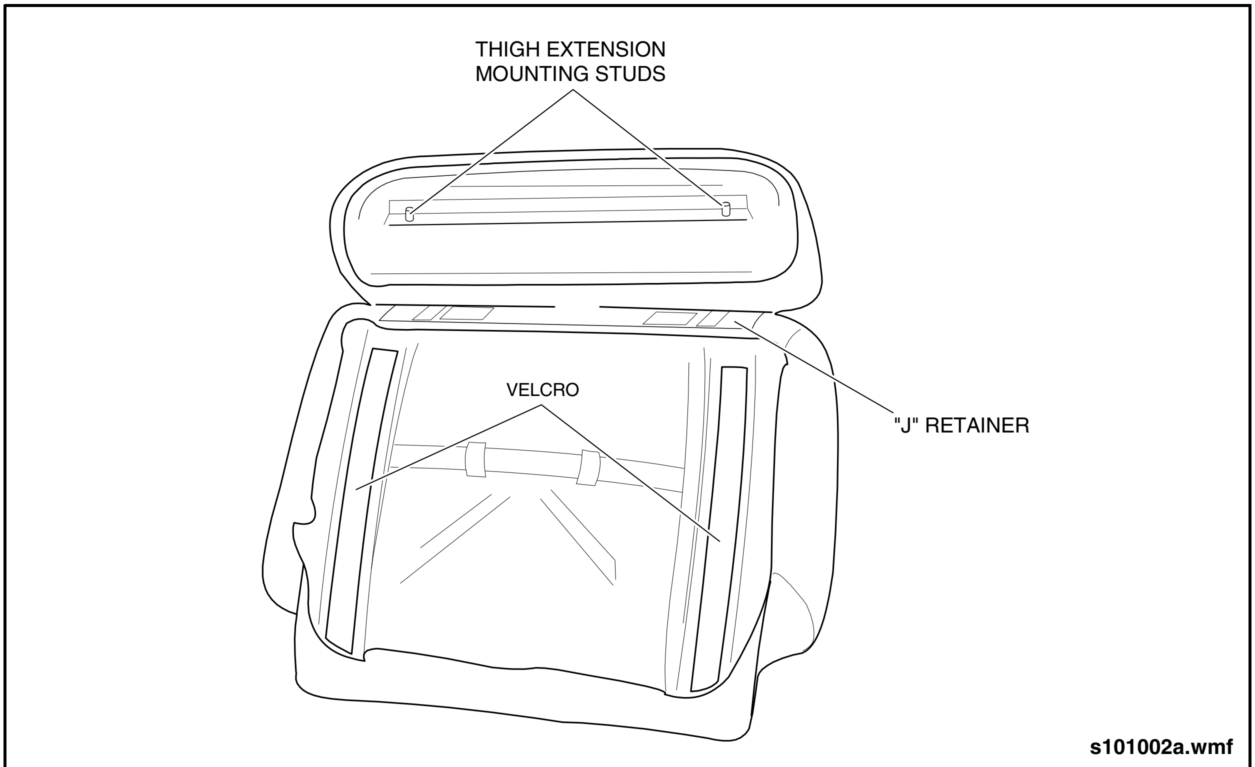


Fig. 17-3: Seat Cushion

2.3.4. Seat Back Cover Replacement

1. To remove the seat back cover, remove the four Phillips head screws retaining the back panel. Remove rear trim molding and tilt the seat back fully forward. Tilt the back panel away from the seat and slide it out of the grooved retainer which attaches it to the seat back cover. See “Fig. 17-4: Seat Back Cover” on page 6.

2. Pry the seat cover retaining tabs on the backside of the frame up slightly to allow removal of the seat back cover. See “Fig. 17-5: Seat Back Cover Retaining Tabs” on page 7. Lift tabs only enough to allow cover retaining strips to pass. Be careful not to break or damage the metal tabs on the back frame. Undo both sides and then the top hold down strip. Unhook the right and left side seat back cover lower corner tabs. Reach up under the backrest foam and press on the two retaining clips to release the headrest. Lift headrest out of seat back. See “Fig. 17-6: Headrest Retaining Clips” on page 7.

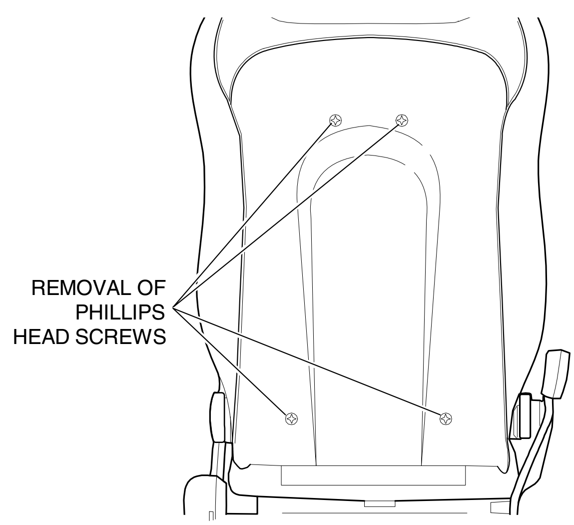


Fig. 17-4: Seat Back Cover

3. Release the seat back cover from the Velcro strip retaining it in place and remove the seat back cover from the foam cushion.

☞NOTE:

The upper part of the seat back foam cushion is glued to the seat back and should not be separated from the seat back unless replacement is necessary.

4. Install seat back cover over backrest and foam cushion.

5. Insert headrest grommets into recesses in foam cushion and attach top hold down strip to hooks on backrest.

6. Working from the top down, attach the sides of the seat back cover to the hooks.

7. Push the grooved retainer, attached to the lower part of the seat back cover, under the seat back and pull it out behind the seat.

8. Work both lower corner strips of cover under seat back and attach to lower hooks on seat back.

9. Tilt seat back fully forward, align grooved retainer on seat back cover with J-retainer on back panel and slide back cover into position. See “Fig. 17-7: Cover Retainer” on page 8.

10. Attach back cover to seat back with four Phillips head screws.

11. Install rear trim molding and retain with screws.

12. Install head rest into grommets in seat back and push down until it latches.

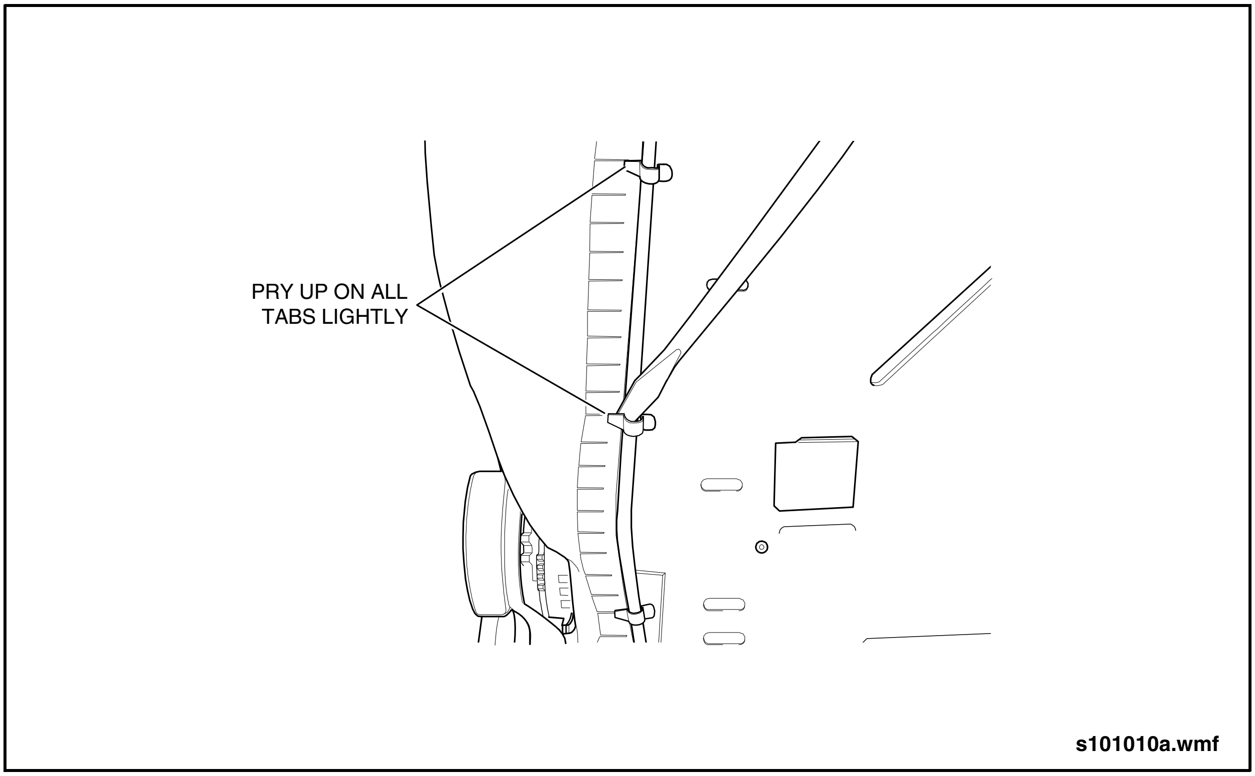


Fig. 17-5: Seat Back Cover Retaining Tabs

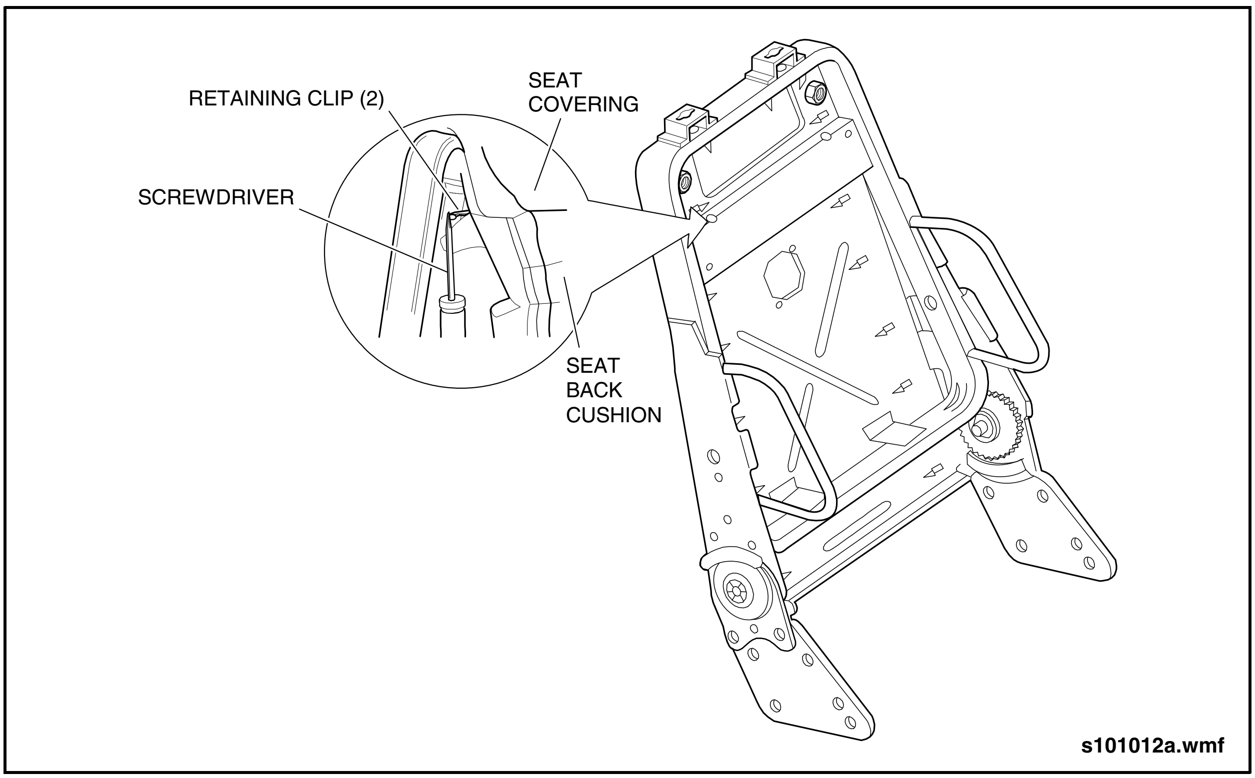


Fig. 17-6: Headrest Retaining Clips

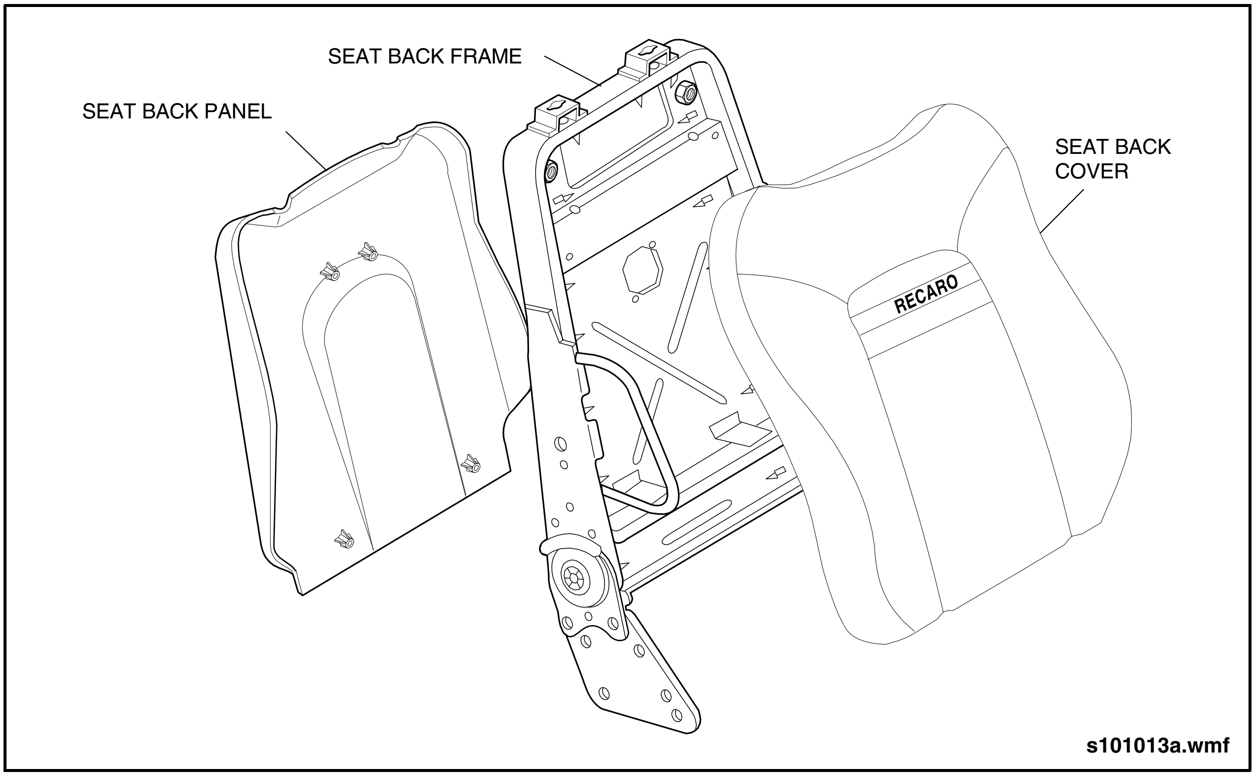


Fig. 17-7: Cover Retainer

2.3.5. Headrest Cover Replacement

1. To remove headrest cover, place a flat edge screwdriver in J-retainer seam and lift up to release and gently pull insert out. Remove cover with foam from headrest frame. Separate foam pad from headrest cover. See “Fig. 17-8: Headrest Cover” on page 8.

☞NOTE:

Front of foam has concave surface and front of headrest frame has notches on support rods.

2. To reassemble headrest, insert foam into cover. Ensure concave side faces towards front of cover (front of cover has J-retainer and rear has plastic edge). Ensure cover seams are flat. Insert frame into foam pad with notches on support rods to the front.
3. Fold the rear edge over towards the foam and insert into the J-retainer.

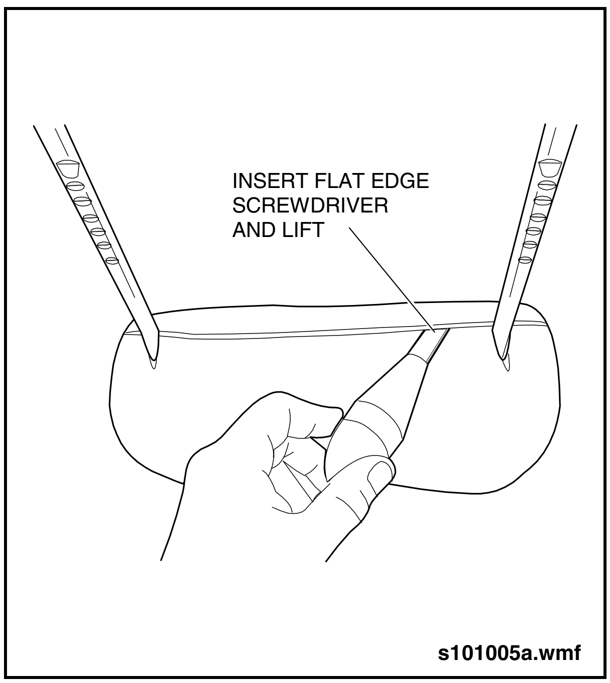


Fig. 17-8: Headrest Cover

2.3.6. Lumbar Bag Replacement

1. Remove seat back cover and lift foam backrest away from seat back to expose lumbar bag.
2. Lift side of seat cushion and remove two screws retaining control panel to seat.
3. Disconnect air lines from control panel.
4. Remove air bag assembly from support hooks on backrest frame.
5. Install new lumbar bag assembly on backrest frame by sliding bottom tabs into square slots and attaching top to hooks on seat back. See “Fig. 17-9: Seat Lumbar Bags” on page 9.
6. Route air lines between frame tube and backrest cover plate and along inside of back frame side mount, then to outside of seat cushion pan and control panel.
7. Attach air lines to control panel. The red hose attaches to the top, the clear in the center and the blue at the bottom.
8. Attach control panel to seat and install seat back cover.

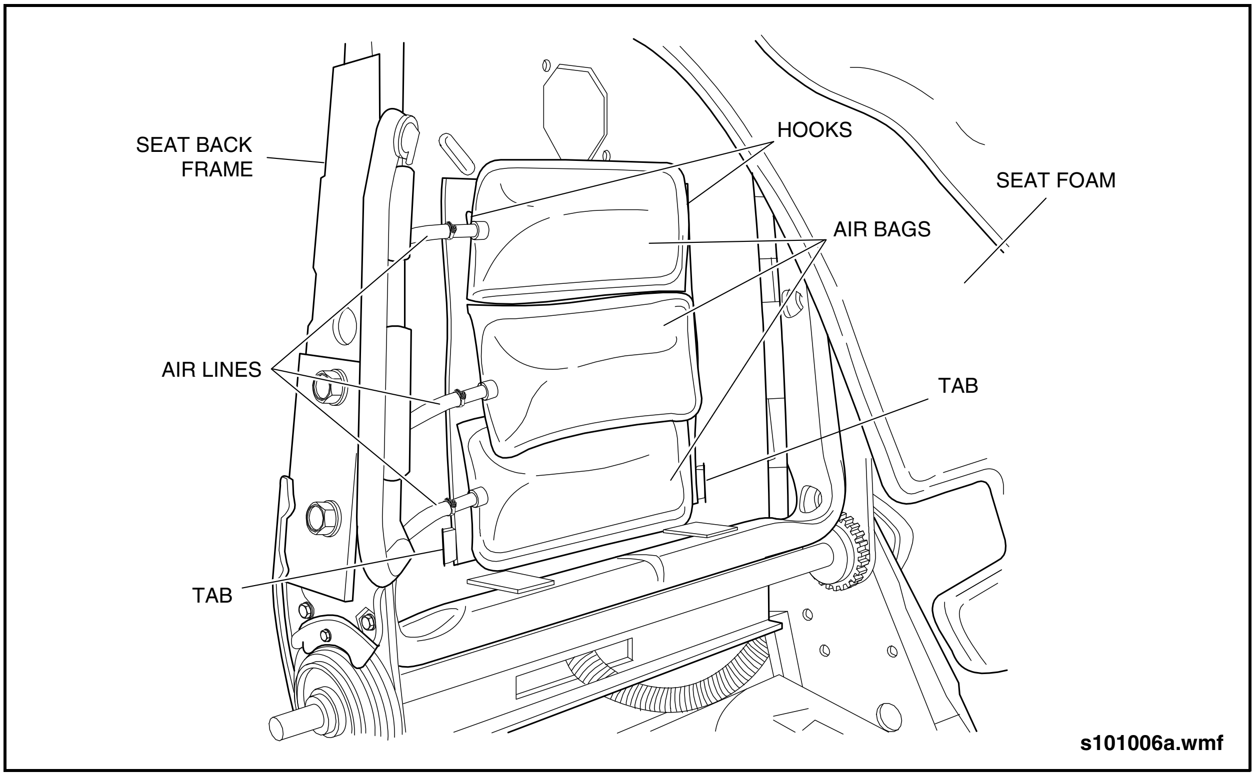


Fig. 17-9: Seat Lumbar Bags

2.3.7. Regulator Valve Replacement

1. Remove front pushpins retaining boot to seat frame.
2. Remove cushion and cushion pan.
3. Lift up front of seat pan and block with a wooden block or similar material to prevent suspension from closing.
4. Locate and remove 10 mm bolt on scissors cross bar and remove. See “Fig. 17-10: Scissors Cross Bar Bolt” on page 10.
5. Disconnect air lines at quick connect fittings and remove regulator.
6. Reverse procedure to reinstall.

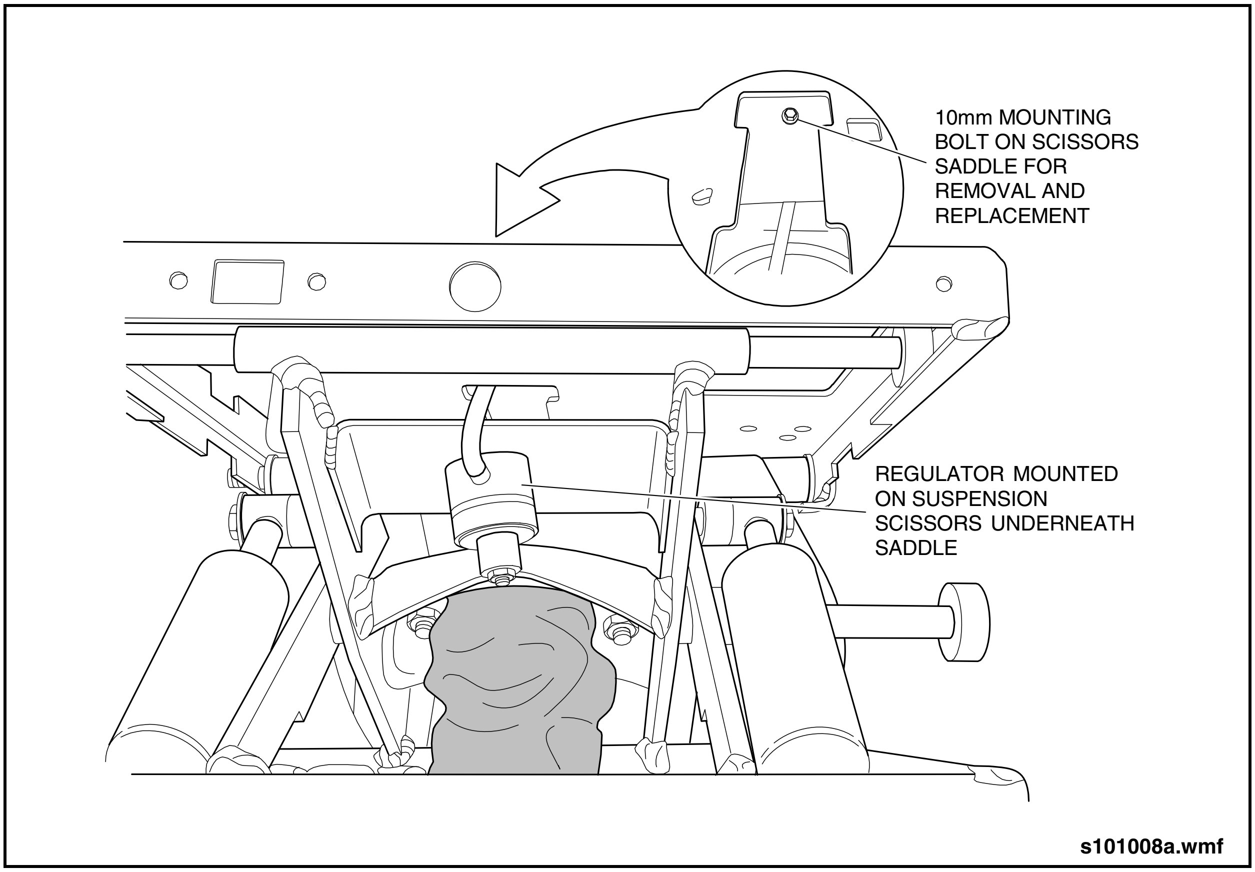


Fig. 17-10: Scissors Cross Bar Bolt

2.3.8. Shock Replacement

1. Remove seat from unit to provide required access to lower suspension, remove push-pins from the lower portion of the rubber boot to access inner suspension components.
2. Place a wooden block into the scissors area to keep the suspension in the up position. Release and remove the airlines, remove the 14mm bolt on top of air spring saddle.
3. Remove the rubber bumper at the front of the suspension to provide adequate clearance for scissors removal. To remove front bumper push in the center with a small flat tip screwdriver to elongate rubber stop and pull forward to release.
4. Remove the bearing shaft retaining nut at the right rear of the suspension lower mounting plate. See “Fig. 17-11: Suspension Mounts” on page 12.
5. Remove the bearing shaft and tip the suspension forward leaving the air spring attached to the lower plate. Turn the upper suspension assembly counter clockwise to expose the nylon bushings that the suspension rides on. (Turning clockwise will allow removal of the upper suspension assembly leaving the lower plate by itself).
6. To remove either shock, remove the push on nuts and slide the shock off the mounting studs.
7. Replace the shock with bushings, roller, and push nut.
8. Position scissors assembly on suspension lower mounting plate. Install lower bearing shaft and nut.
9. Install front rubber bumper.
10. Install bolt in air spring upper mount.
11. Remove wood block and install boot assembly using push pins.
12. Install seat on vehicle.

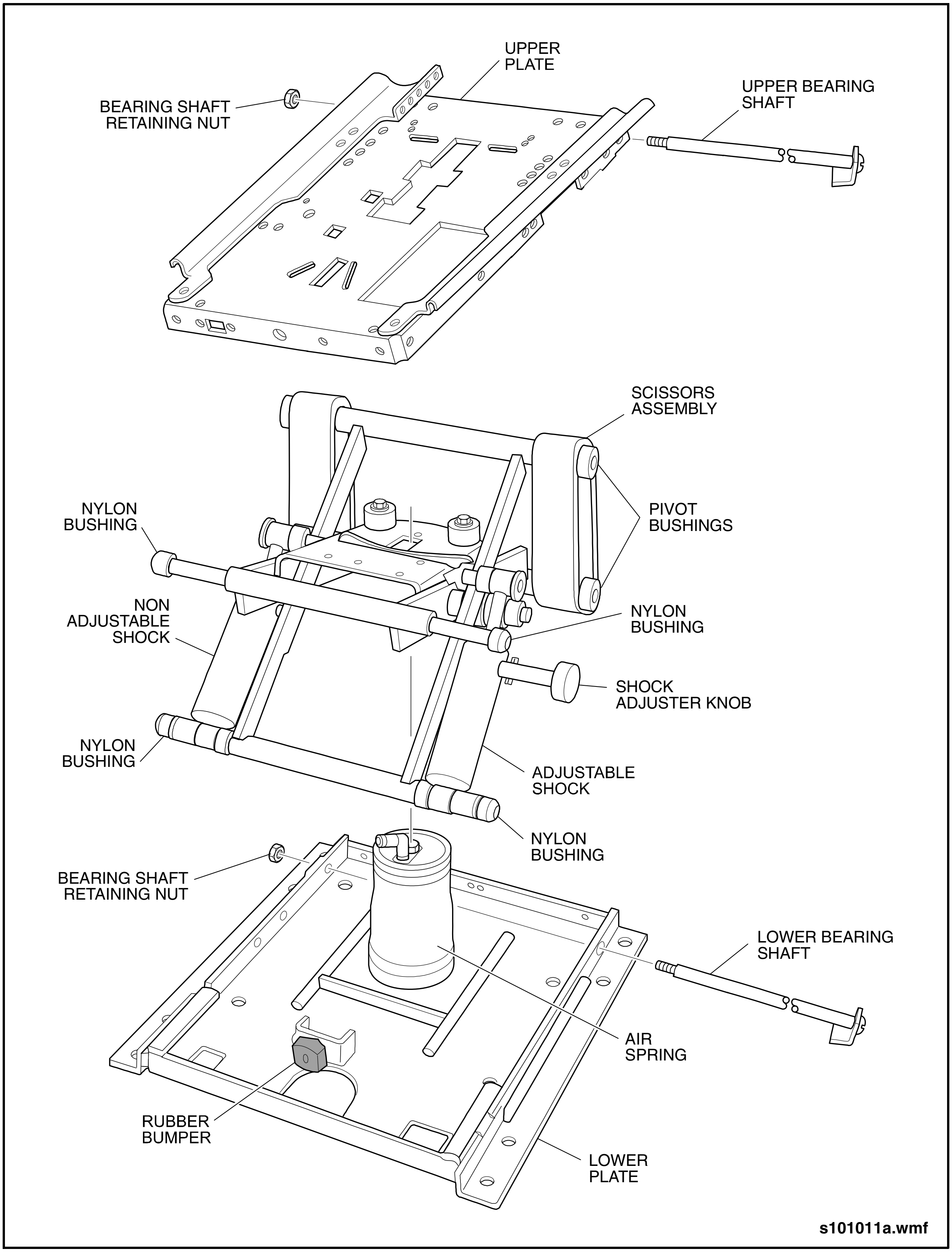


Fig. 17-11: Suspension Mounts

2.3.9. Air Spring Replacement

1. Remove seat from unit to provide required access to lower suspension, remove push-pins from the lower portion of the rubber boot to access inner suspension components.
2. Place a wooden block into the scissors area to keep the suspension in the up position. Release and remove the airlines, remove the 14 mm bolt on top of air spring saddle.
3. Remove the lower bearing shaft and separate the rear of the scissors mechanism from the lower suspension frame.
4. Remove the Phillips head bolt retaining air spring to lower suspension frame and remove air spring.
5. Install new air spring to lower suspension frame and secure with Phillips head bolt.
6. Position scissors assembly on lower suspension frame and install lower bearing shaft and retaining nut.
7. Install front rubber bumper and upper air spring retaining bolt. Connect air lines
8. Remove wooden block and attach boot to lower suspension frame using push pins.
9. Install seat on vehicle.

2.3.10. Two Point Seat-Belt Replacement

WARNING

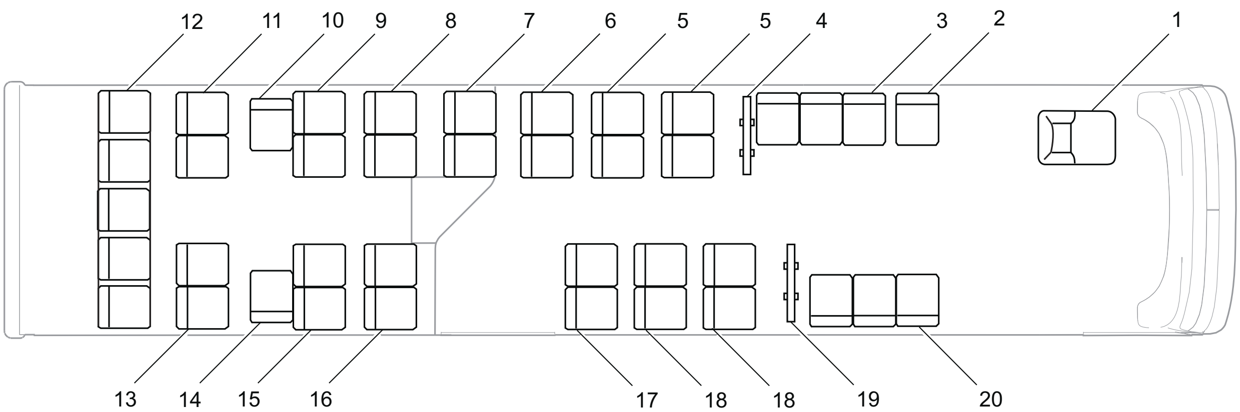
When replacing a seat-belt assembly, use all the new components in the service kit. Failure to install the seat-belt assembly to Recaro specifications could cause bodily harm in the event of an accident. Please follow and read instructions carefully and if there are any difficulties please contact Recaro technical services at (248) 364-3818.

1. Remove cosmetic bolt cover and remove 5/8" bolt.
2. To replace retractor, put angle bracket on back of retractor for left or right side mounting and put bolt back through; tighten down to 38 ft-lb. (52 Nm). Replace cosmetic cap.
3. To replace buckle, install washer on bolt and replace back on bracket at a 43° angle and tighten to 38 ft-lb. (52 Nm). Replace cosmetic cap.

3. PASSENGER SEATING

3.1. Mounting Passenger Seats

The vehicle is equipped with a combination of two, three and five-passenger transverse and longitudinal sets. The seats located in the wheelchair area are of a flip-up and lock design. The center section of the five-passenger rear seat is designed to flip up to allow access to the engine and transmission compartments. All other seats are fixed and are supported by pedestals and the side wall seat rail. See “Fig. 17-12: Seating Layout” on page 14.



1. Drivers Seat Assembly
2. Seat Assembly, 1 Passenger Longitudinal Flip-Up
3. Seat Assembly, 3 Passenger Longitudinal Flip-Up
4. Barrier, Streetside
5. Seat Assembly, 2 Passenger Transverse
6. Seat Assembly, 2 Passenger Transverse
7. Seat Assembly, 2 Passenger Transverse
8. Seat Assembly, 2 Passenger Transverse
9. Seat Assembly, 2 Passenger Transverse
10. Seat Assembly, 1 Passenger Longitudinal
11. Seat Assembly, 2 Passenger Transverse
12. Seat Assembly, 5 Passenger Rear Cross
13. Seat Assembly, 2 Passenger Transverse
14. Seat Assembly, 1 Passenger Longitudinal
15. Seat Assembly, 2 Passenger Transverse
16. Seat Assembly, 2 Passenger Transverse
17. Seat Assembly, 2 Passenger Transverse
18. Seat Assembly, 2 Passenger Transverse
19. Barrier, Curbside
20. Seat Assembly, 3 Passenger Longitudinal Flip-Up

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Fig. 17-12: Seating Layout

3.2. Inspection

Check the mounting hardware for tightness and security. Tighten or replace as required. Inspect seats for rips or tears. Repair, patch or replace as required.

3.3. General Cleaning

For dirt and general spot removal, fiberglass, composite resin and stainless steel may be cleaned with a non-abrasive, mild household detergent. Test a small, inconspicuous area prior to cleaning. Wipe with a clean, damp cloth and allow to dry.

☞**NOTE:**

Leaving any chemical on fiberglass or composite resin for extended periods can result in damage to the surface. ALWAYS rinse with water after cleaning.

3.3.1. Tough Stain & Graffiti Removal

Markings and stains from permanent marker and other compounds like shoe polish or nail polish can be removed from fiberglass, composite resin and stainless steel materials with the following agents (or equivalents):

- ❒ Crown Anti-Vandal Spray 5062 (contains VOC's)
- ❒ TSW9 Plasti-Master (does not contain VOC's)

☞**NOTE:**

For Vision Seats, Scotch-Brite pads can be used to remove graffiti markings and return the surface to its original appearance.

3.3.2. Vacuum Formed Plastic Components

Use TSW9 Plasti-Master when removing graffiti markings from vacuum-formed plastic components.

3.3.3. Upholstery Care

⚠ **CAUTION**

Extreme care should be taken when selecting a cleaning agent. Solvent-based cleaners should be avoided. Some solutions may leave a residue or discolor the material. Test an inconspicuous area prior to cleaning and follow the manufacturer's directions.

Regularly remove all dust and loose dirt from fabric with a whisk broom or vacuum cleaner. Always begin with lukewarm water and a white cloth for stain removal before applying any cleaning agent. Use foam upholstery cleaner or a mild household detergent and first testing in a small area. Flush the area with water after cleaning.

3.4. Seat Insert Replacement

The seat bottom and seat back inserts can be replaced if excessively soiled or damaged.

3.4.1. Removal

1. Grasp the seat bottom insert at the front corners of insert and pull upward to release the insert stud from the clip.

☞NOTE:

If difficulty is experienced gripping the seat insert, then it may be necessary to use a pry tool at the corner locations. Use care not to mar the surface of the seat shell.

2. Once the studs are released from the clips, push the seat bottom insert aft to release the keyhole retainer from the screw head.
3. Remove the seat back insert in a similar fashion, except pull at the upper corners to release the insert studs from the clips.
4. Slide the seat back downward to release the keyhole retainer from the screw head.

3.4.2. Installation

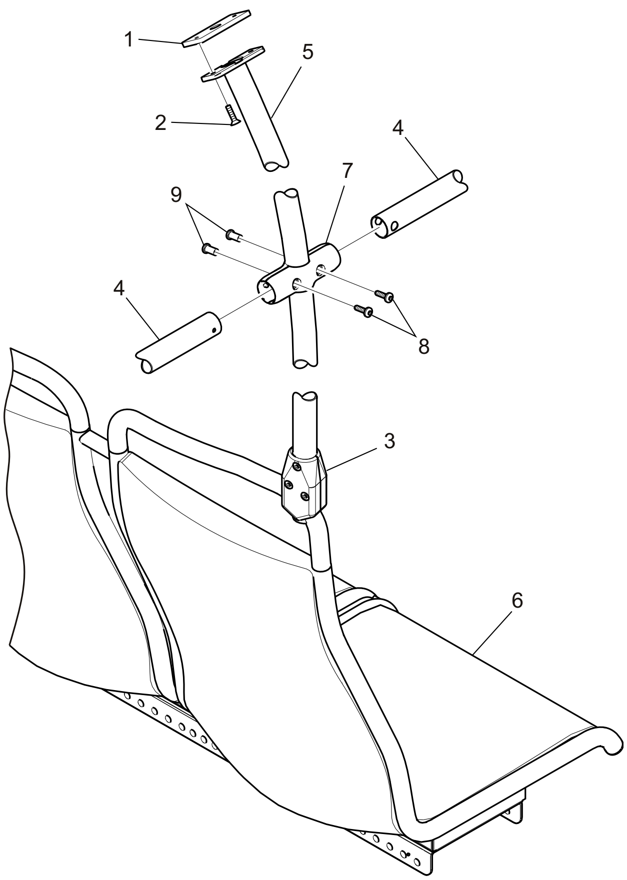
1. Place the seat back onto the shell so that the screw head on the insert engages the keyhole retainer on the seat shell.
2. Push the seat back downward until the studs on the insert align with the clips in the seat shell. Press down firmly to secure the seat back insert to the shell.
3. Place the seat cushion insert onto the shell so that the screw head on the insert engages the keyhole retainer on the seat shell.
4. Slide the seat cushion forward until the studs on the insert align with the clips in the seat shell. Press down firmly to secure the seat cushion insert to the shell.

4. STANCHIONS & GRABRAILS

4.1. Description

Vertical stanchions and horizontal grab rails are located along both sides of the aisle and provide support to standing passengers. Horizontal grab rails are also mounted transversely between the vertical stanchions and vehicle structure to provide additional support. The stanchions and grabrails are constructed of tubular stainless steel and are attached to one another using cross fittings, tee fittings, and cup fittings.

The upper end of the vertical stanchion is fitted with a mounting plate that is bolted to an overhead support extrusion. The lower end of the vertical stanchion is bolted to the passenger seat frame or grab bar using a stanchion cup fitting. See “Fig. 17-13: Stanchions & Grabrails” on page 17.



1. Mounting Plate	4. Horizontal Grab Rail	7. Cross Fitting
2. Screw	5. Vertical Grab Rail	8. Screw
3. Stanchion Cup	6. Passenger Seat	9. Sleeve Nut

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Fig. 17-13: Stanchions & Grabrails

4.2. Removal

☞ **NOTE:**

Depending on the location of the vertical stanchion or horizontal grab rail, it may be necessary to remove the adjacent stanchion mounting hardware to allow enough movement when separating the components.

1. Remove the snap-in cover from around the top of the vertical stanchion.
2. Remove the fasteners from the mounting plate that attaches the upper end of the stanchion to the overhead support extrusion. See “Fig. 17-14: Stanchion Upper Mounting” on page 18.
3. Loosen the attaching hardware on the tee fitting or cross fitting that attaches the vertical stanchion to the horizontal grabrail. See “Fig. 17-15: Tee & Cross Fitting Connection” on page 18.
4. Remove the vertical stanchion and grabrail.

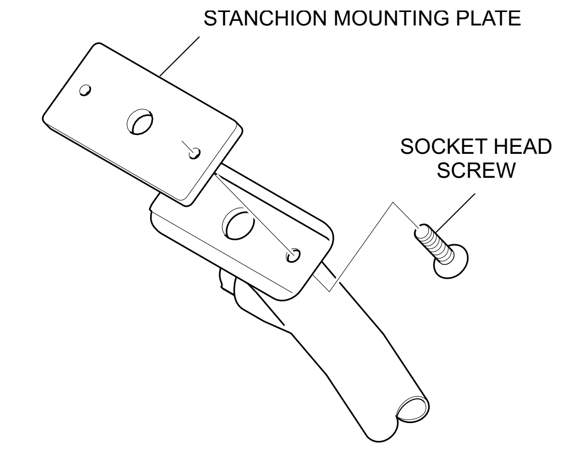


Fig. 17-14: Stanchion Upper Mounting

4.3. Installation

1. Dry fit all stanchion components together. Trim or make any adjustments necessary until proper stanchion and grab rail fit is achieved.
2. Install the stanchions into their lower cups and install the fasteners to secure the top of the stanchion to the mounting plate in the support extrusion, but do not tighten at this time.
3. Join the stanchion to the grab rail, ensuring the parts are fully seated together.
4. Apply 1 to 2 drops of Loctite 242 and final tighten the upper mounting fasteners. Torque screws 60 to 72 in-lb.
5. Reinstall snap-in cover trim around the top of the vertical stanchion.

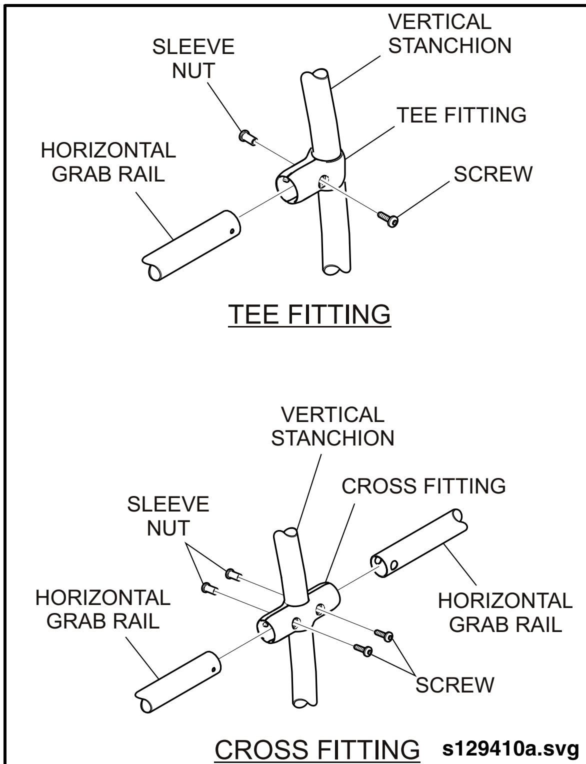


Fig. 17-15: Tee & Cross Fitting Connection

5. DRIVER'S DOOR

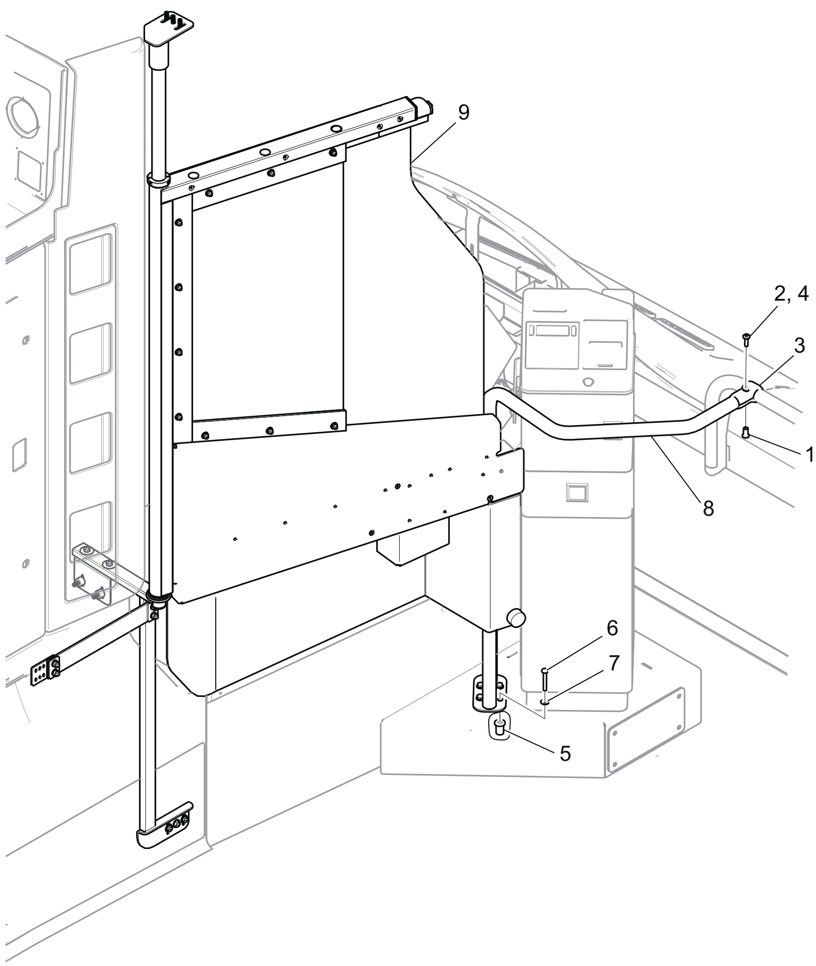
5.1. Description

The driver's door is intended for providing privacy and protection for the driver. It consists of a swing door with a transparent shield that is fixed at the rear and sliding at the front. The farebox stanchion contains the door striker. See "Fig. 17-16: Driver's Door Installation" on page 19.

5.2. Operation

5.2.1. Opening & Closing Door

1. To open door, push the latch handle towards the door and push the door open. See "Fig. 17-17: Driver's Door Operation" on page 20.
2. To close door, grip the door handle and pull the door firmly to engage the latch.



1. Nut, Sleeve PH 1/4" - 20 UNC SST
2. Screw, BH 1/4" - 20 x .87 SST
3. Fitting, Tee 2 Pins Yellow
4. Loctite, 243 Blue
5. Insert, SST 5/16" - 18 UNC x .027" - .150"
6. Bolt, Hex SST 5/16" - 18 UNC x 1 1/2" Lg. Black
7. Washer, Flat SST 5/16" Black
8. Stanchion, Farebox
9. Driver's Door Assembly

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Fig. 17-16: Driver's Door Installation

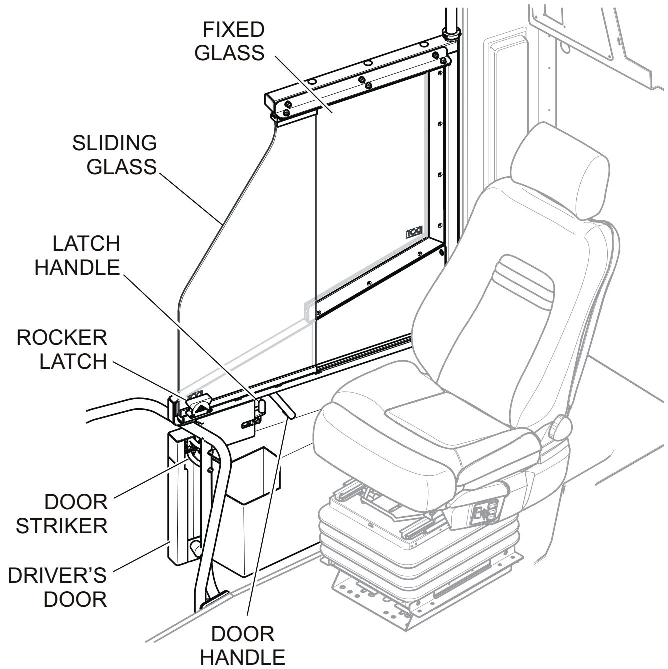


Fig. 17-17: Driver's Door Operation

5.2.2. Opening & Closing Sliding Shield

1. To open slider, pull the rocker latch back until the sliding shield is open and release the rocker latch.
2. To close slider, push the rocker latch forward until the sliding shield is closed and release the rocker latch.

5.3. Maintenance

5.3.1. Glass Cleaning

WARNING

Never use scouring compounds, gritty cloths, leaded or ethyl gasolines or solvents such as alcohol, acetone, benzene carbon tetrachloride, or lacquer thinner to clean glass. These cleaning methods will permanently damage the glass.

Wash with a mild soap or detergent and lukewarm water solution. Use a clean soft cloth or sponge to wipe as much of the soap solution as possible. To remove tar, grease, paint etc. use a good grade of hexane, naphtha, or kerosene. Solvent residue should be removed immediately. Use warm soapy water to clean the remaining components of the driver's door.

5.3.2. Latch Adjustment

1. Remove the latch cover by removing the plastic nut covers, nuts, washers and screws. See "Fig. 17-18: Latch Cover Removal & Installation" on page 21.
2. Loosen the adjustment nuts. See "Fig. 17-19: Latch Adjustment Assembly" on page 21.

NOTE:

DO NOT remove adjustment nuts.

3. Align the latch striker in the center of the latch assembly.
4. Tighten the adjustment nuts.
5. Reinstall the latch cover.

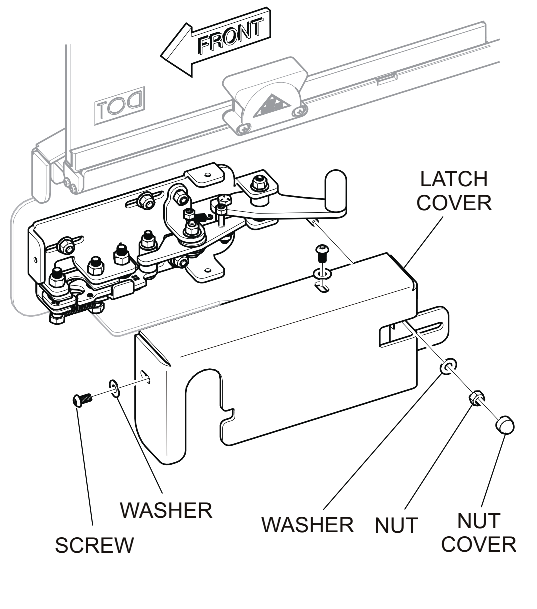


Fig. 17-18: Latch Cover Removal & Installation

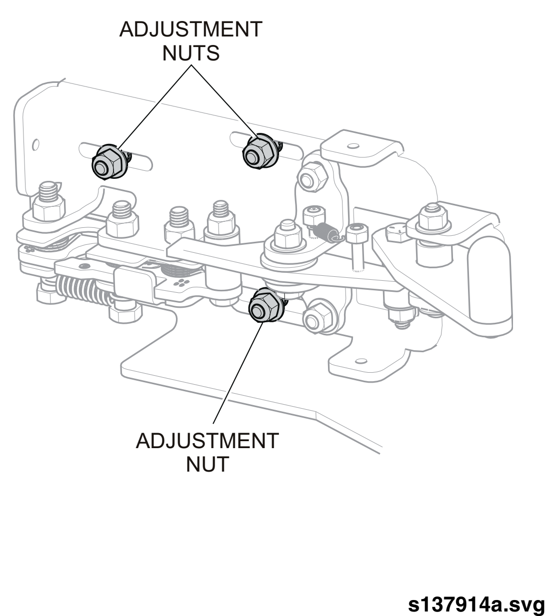


Fig. 17-19: Latch Adjustment Assembly

5.3.3. Upper Slider Track Adjustment

1. Remove nut covers.
2. Loosen but do not fully remove the nuts.
3. Adjust the slider track until the sliding sash is centered. See “Fig. 17-20: Upper Slider Track Adjustment” on page 22.
4. Make vertical adjustments to the slider track until there is approximately a 1/64" gap between the mating surfaces of the track liner and sliding sash.

☞**NOTE:**

If more adjustment is necessary, refer to lower track adjustment.

5. Tighten lock nuts to 75 in-lbs.
6. Slide sash to verify operation is smooth.
7. Replace nut covers.

5.3.4. Lower Slider Track Adjustment

1. Remove latch cover.
2. Remove nut covers.
3. Loosen but do not remove nuts.
4. Lower or raise the lower sliding track to allow for proper adjustment of upper track. See “Fig. 17-22: Lower Slider Track Adjustment” on page 22.
5. Tighten nuts to 75 in-lbs.
6. Install nut covers.
7. Install latch cover.

5.3.5. Sliding Sash Replacement

1. Remove upper and lower stop plates. See See “Fig. 17-21: Sliding Sash Replacement” on page 22.
2. Remove sash by disengaging rocker latch until sash disengages top and bottom sliders.
3. Install sash by disengaging rocker latch and inserting sash until it engages top and bottom sliders.
4. Replace upper and lower stop plates. Apply Loctite 243 to hardware and torque to 23 in-lbs.

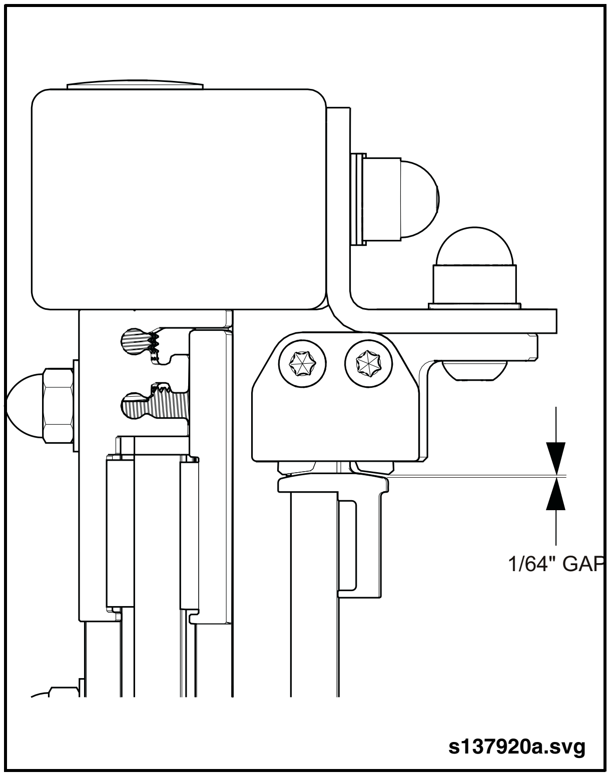


Fig. 17-20: Upper Slider Track Adjustment

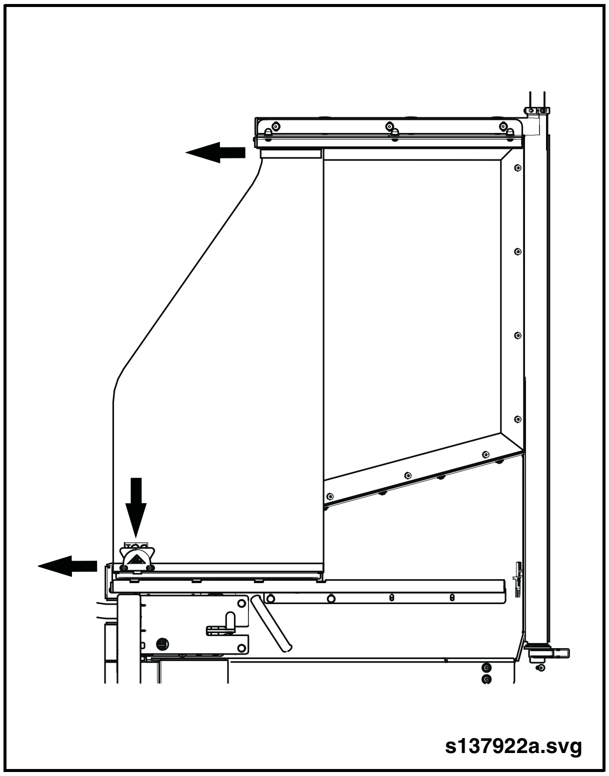


Fig. 17-21: Sliding Sash Replacement

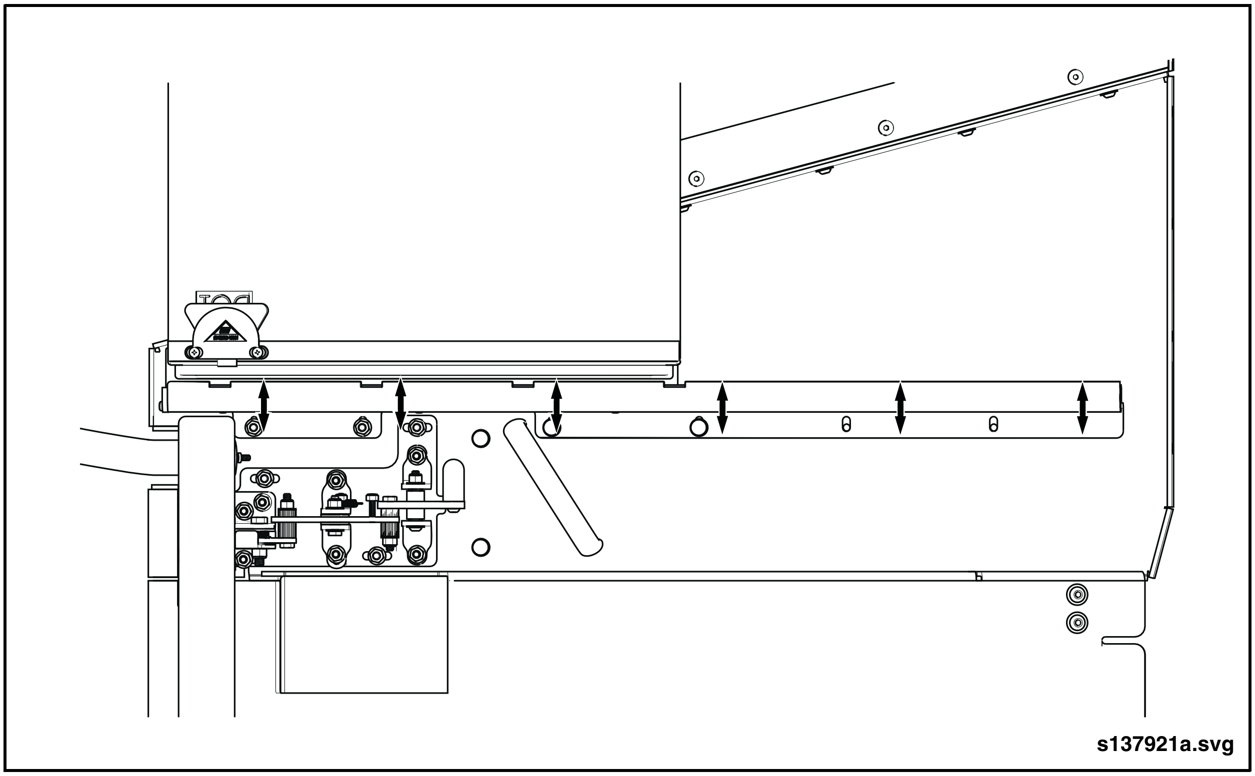


Fig. 17-22: Lower Slider Track Adjustment

5.3.6. Slider Track Liner Replacement

1. Remove the Sliding Sash. Refer to 5.3.5. “Sliding Sash Replacement” on page 21 for procedure.
2. Wedge a screwdriver between aluminum slider track and plastic liner.
3. Pry plastic liner out 1/8". See “Fig. 17-23: Sliding Track Liner Replacement” on page 23.
4. Using appropriate vice grips, pull the liner out.
5. Insert new liner. It should slide freely in.
6. Replace stop plates and reinstall sliding sash.

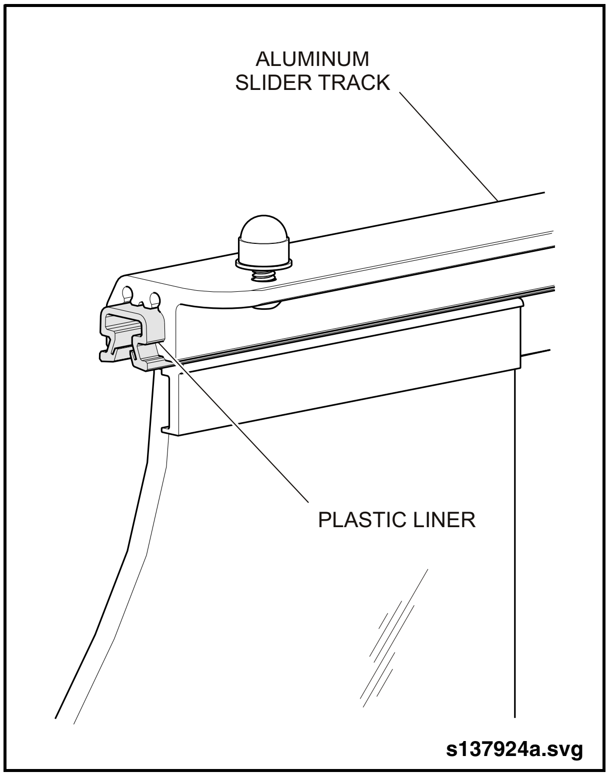


Fig. 17-23: Sliding Track Liner Replacement

5.3.7. Fixed Glass Replacement

1. Remove sliding sash. Refer to Sliding Sash replacement for procedure.
2. Remove the upper sliding track. Refer to Upper Sliding Track adjustment for procedure.
3. Remove nut covers.
4. Loosen hardware but do not remove nut from bolts.
5. Insert an automotive glass pry bar. Pry the glass away using motion shown in drawing. The intention of this step is to break the bond of the three clamps from the glass to remove it. It may require prying from both sides of the clamps.
6. Using appropriate glass cleaner, spray both sides around clamps for lubrication.
7. Firmly grip and slide glass from frame.
8. Spray glass cleaner in upper and lower clamps before installation of glass.
9. Firmly grip glass and slide it into clamps until fully seated.
10. Tighten hardware to 75 in-lbs. in accordance with pattern. See “Fig. 17-24: Fixed Glass Clamp Torque Sequence” on page 24.
11. Reinstall upper track, sliding sash, and ensure upper sliding track is adjusted.

5.3.8. Tether Strap Adjustment

1. Adjust the tether strap to prevent the door from contacting structures.
2. Remove the tether strap hardware and retainer from door.
3. Reinstall the tether strap.
   - ❒ Tighten strap: use right hand slots.
   - ❒ Loosen strap: use left hand slots.
4. Once tether strap tension is correct. Tighten hardware to 75 in-lbs.

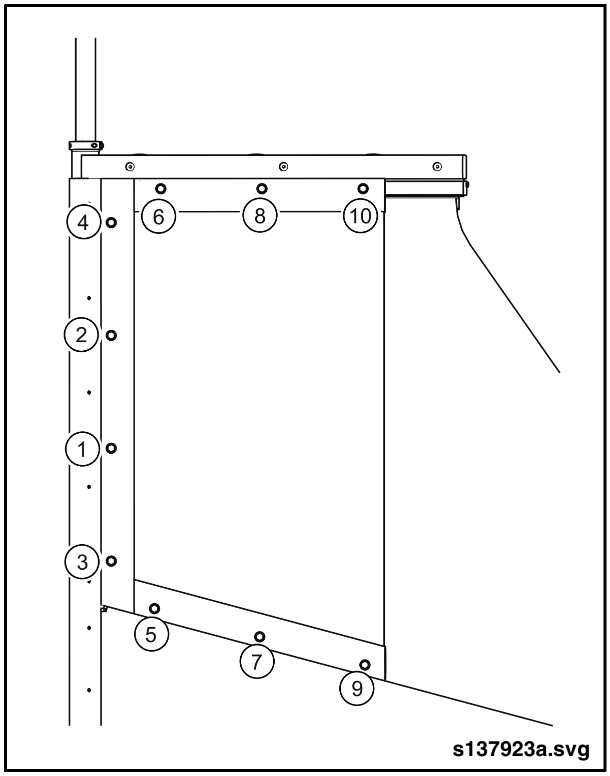


Fig. 17-24: Fixed Glass Clamp Torque Sequence

6. WHEELCHAIR RESTRAINT SYSTEM

6.1. Description

The forward seat positions are equipped with a Wheelchair Restraint System for security of handicapped passengers. For optimum passenger safety be sure to follow the operating procedures to complete all the necessary restraint system connections. See "Fig. 17-25: Wheelchair Restraint System" on page 26.

6.2. Operation

6.2.1. Positioning the Wheelchair

Position the wheelchair in the restraint area as follows:

1. Move the longitudinal flip-up seat cushions up to the lock position.
2. Back the wheelchair into the restraint area, facing forward (facing driver's windshield).
3. Set the wheelchair brake.

6.2.2. Rear Wheelchair Restraints

Attach the rear wheelchair restraint belts as follows:

1. Lift the belt release handle on the barrier and pull on the belt hooks to extend them.
2. Attach the rear wheelchair restraint belts to a solid rear frame member of the wheelchair.
3. Lift the belt release handle to tighten belts.

6.2.3. Front Wheelchair Restraints

Attach the front wheelchair restraint belts as follows:

1. Ensure the wheelchair is positioned directly against the side restraint.
2. Extend the front wheelchair restraint belt and attach the hooked end around a solid frame member of the wheelchair.
3. Pull downward on the belt tightening handle until the wheelchair is firmly snugged up against the side restraint.

6.2.4. Passenger Securement

WARNING

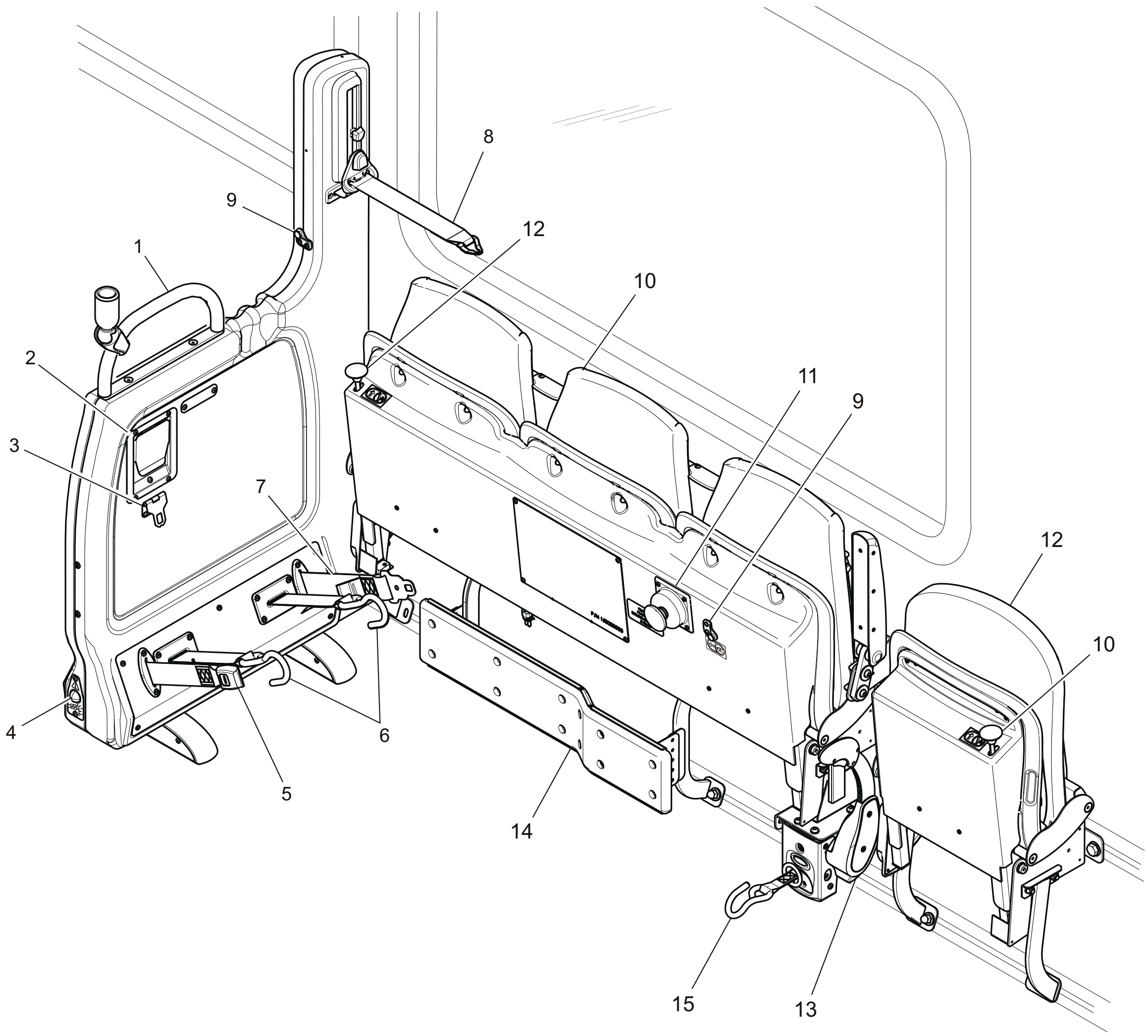
Restraints should not be held away from body by wheelchair components.

Secure wheelchair occupant as follows:

1. Extend both ends of lap belt and connect together at occupant's hip area on aisle side. Do not place belt over armrest.
2. Extend window-side shoulder belt and connect to stud on lap belt.
3. Ensure that belt clips and buckle are securely engaged.

6.3. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled inspections of the wheelchair restraint system.



1. Wheelchair Barrier	7. Lap Belt	13. Front Belt Release Handle
2. Rear Belt Release Handle	8. Shoulder Belt	14. Wheelchair Side Restraint
3. Belt Clip Hanger	9. Belt Hook	15. Front Wheelchair Restraint Belt
4. Emergency Release Button	10. Flip-Up Seat Assembly	
5. Passenger Belt Clip	11. Stop Request Push Button	
6. Rear Wheelchair Restraint Belts	12. Flip-Up Mechanism Release Knob	

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Fig. 17-25: Wheelchair Restraint System

Destination Signs

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❒ open flame
- ❒ excessive heat
- ❒ production of sparks
- ❒ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Electrical System Safety

During electrical diagnosis procedures an understanding of the vehicle's electric circuits is important to understand the results of connecting test equipment.

DANGER

During component removal or installation, ensure that the Master Run switch is set to the STOP-ENGINE position and that the Battery Disconnect switch is set to the OFF position. Failure to follow this procedure may result in personal injury or component damage.

WARNING

DO NOT start the vehicle remotely with the laptop software without first checking that the area is clear of personnel.

CAUTION

Before welding anywhere on vehicle, set Battery Disconnect switch to the OFF position and disconnect all electronic control modules (Multiplexing, engine, transmission, ABS, and so forth). Refer to Section 11 of this manual for additional precautionary information.

2. DESTINATION SIGNS

2.1. Description

The Destination Sign System consists of:

- ❒ Multi Control Unit (MCU)
- ❒ Front destination sign
- ❒ Side destination sign
- ❒ Front route sign
- ❒ Rear route sign
- ❒ Associated wiring harnesses and connectors.

☞**NOTE:**

New Flyer has included the Vendor Service Manual to aid in repair and troubleshooting of the electronic sign. Refer to 3. “VENDOR SERVICE INFORMATION” on page 13 *in this section for applicable references.*

2.2. Multi Control Unit (MCU)

☞**NOTE:**

The following information provides basic introductory information on MCU and Luminator Destination Sign System operation. Your transit authority management establishes policies about system operation and should be consulted before its use. Manuals are available from Luminator which provide more information about the Multi Control Unit and the Luminator Destination Sign System.

2.2.1. System Description

The vehicle’s destination/route signs are controlled by an Multi Control Unit (MCU) located in the driver’s overhead panel. The MCU consists of a liquid crystal display (LCD) display screen with six soft keys, six corresponding hard keys, keypad with numbered (0-9) switches, enter key, and left/right arrow keys.

The sign system is controlled through programmed instructions stored in MCU memory through its liquid crystal display (LCD) touchscreen and keypad. Messages displayed on the vehicle signs can also be displayed on the MCU touchscreen.

☞**NOTE:**

The touch sensitive soft keys labeled on the LCD touchscreen will vary per the menu being displayed and are functionally identical to the blue hard keys located directly beneath them and can be used interchangeably.

The codes translate into message writing data preprogrammed into the system’s memory. The message writing data then controls the signs to display the selected information.

The system data processor begins sending and updating message writing data for the MCU to display when the system is powered-up. Turning the Master Run switch from STOP-ENGINE to DAY-RUN or NIGHT-RUN will power-up the system. Boot and application code versions momentarily display when power is applied to the MCU, followed by a brief system initialization message. The last message entered before power shutdown then displays on the MCU.

Powering-down occurs when the Master Run switch is turned to STOP-ENGINE. Upon powering-down, front and side destination signs will blank immediately or after a preset delay.

2.2.2. Operating the MCU

Basic operation of the Sign System involves presetting transit authority message codes into the sign system using the MCU. The message codes correlate to preprogrammed destination names, public relations messages, and route numbers unique to each transit authority. If required, multiple sets of message codes may be entered to allow for a quick and complete sign change while in route. Key function and basic operation instructions are described in the two sections that follow. See “Fig. 18-1: Multi Control Unit (MCU)” on page 3.

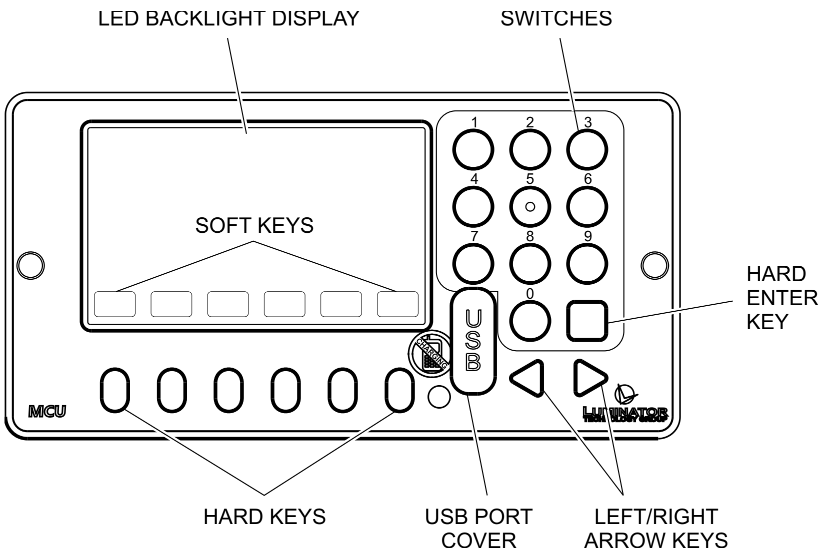

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Fig. 18-1: Multi Control Unit (MCU)

2.2.3. MCU Operating Keys

Six soft keys are located on the bottom of the LCD display screen. The function of these softkeys is identical to the corresponding hard keys located directly below the display screen. The soft keys and hard keys can be used interchangeably. The keys function as follows:

- ❒ MENU - used to access advanced programming (some may require a password).
- ❒ RUN - used to enter run number. This function is determined by transit authority programming.
- ❒ ROUTE - used to enter route number. This function is determined by transit authority programming.
- ❒ P/R - used to enable public relations message code entry. This switch may be disabled if public relation messages are not available.
- ❒ ROUTE - press to enable route number entry. Route number entry may be either coded or be the actual route number for display.
- ❒ DEST A and DEST B - used to enable respective destination message code entry for message display change. These switches are permanently enabled.

All destination and public relations (P/R) messages can be set an viewed from the MCU.

2.2.4. Basic Operating Procedures

Basic operating procedures are as follows:

Set RUN number - press the RUN key on the default screen. Enter the run number via the MCU number pad and then press ENTER. The message “RUN button not used” will appear if the manual entry feature has been disabled.

☞**NOTE:**

To change a RUN number, use the left/right arrow keys to highlight a number and then press CLEAR (or press DEL to delete an entire string).

Set ROUTE number - press the ROUTE key on the default screen. Use the MCU keypad to enter a route number or left/right arrow keys to highlight a letter, then press SELCT to select it. After entering the route number, press the hard ENTER key. The route number just entered will be displayed on the MCU as well as on the route signs. This route number will persist when you go from DEST A to DEST B without having to re-enter it.

☞**NOTE:**

To change a ROUTE number, use the right arrow key to move the square cursor to the end of the string and then use the left arrow key to move cursor back to the left to erase existing numbers (you cannot simply overwrite them).

Set Public Relations (P/R) message - press the P/R key on the default screen. Enter the P/R message code number via the MCU number pad and press ENTER. The P/R code number will display on the MCU display screen and the route signs approximately 5 seconds after it is entered.‘

☞**NOTE:**

To change a P/R code number (or clear the message altogether) use the left/right arrow keys to highlight a number and press CLEAR to erase it (or press DEL to delete an entire string) then press ENTER.

Set Destination A or B message - press the DestA key on the default screen to set the DestA message. Enter the destination code number via the OKD number pad and press the hard ENTER key. The destination code number will display on the MCU display screen and the route signs approximately 5 seconds after it is entered. Setting Destination B is performed in the same manner as setting Destination A.

☞**NOTE:**

To change a Route Number press the desired number keys. Current content is cleared to accept the new data.

Set Display Brightness Level - press MENU on the default screen to access menu options. From the MENU screen press the PREF key. From the PREF screen press the BRGHT key. From the BRGHT screen touch the brightness level bar at the top of the screen or use the left/right arrow keys to set the brightness level, then press OK.

☞**NOTE:**

To return the display to the original factor default brightness level press the DFLTS key from the PREF screen , then press YES

2.2.5. Maintenance

☞**NOTE:**

Refer to the Luminator Service Manual for detailed maintenance procedures.

2.2.6. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Open the MCU cover. Using a Phillips screwdriver, loosen the two front bezel screws. As each screw turns, the threaded cam latch behind the panel will turn to release its grip.
3. When both screws are loose, remove the MCU from the panel and disconnect the wiring at the rear.

☞**NOTE:**

Ensure the wiring is secured and does not fall out of reach behind the panel.

2.2.7. Installation

1. Set the Battery Disconnect switch to the OFF position.
2. Connect the wires to the rear of the MCU.
3. Attach the MCU panel to the access panel using the two retaining screws. Close the MCU cover.
4. Close and secure the panel and set the Battery Disconnect switch to the ON position.

2.2.8. Testing

Test the system. Refer to 3. “VENDOR SERVICE INFORMATION” on page 13 in this section for testing procedure.

2.3. Front Destination Sign

2.3.1. Description

The front destination sign is located in front of the vehicle above the windshield. The 100% LED Horizon™ Gen IV sign consists of a combined main power supply and RS-485 data controller, four display board assemblies, and a power/data cable. The sign assembly is mounted to the vehicle using a shock isolating support bar. The front destination sign compartment can be accessed from the interior of the vehicle through a hinged access door.

2.3.2. Operation

Refer to 2.2. "Multi Control Unit (MCU)" on page 2 in this section for information on front destination sign operation.

⚠ WARNING

Disconnect power to the sign system before performing any maintenance or repair. Discharge and ground the circuit before working on it. Follow electrostatic charge prevention practices by using a wrist ground strap or anti-static grounded floor mat while handling any printed wiring assembly (PWA).

2.3.3. Cleaning

1. Set Battery Disconnect switch to the OFF position.
2. Open front destination sign access door.
3. Loosen the clamps on the shock pad pivots and rotate the sign assembly 90° towards you.

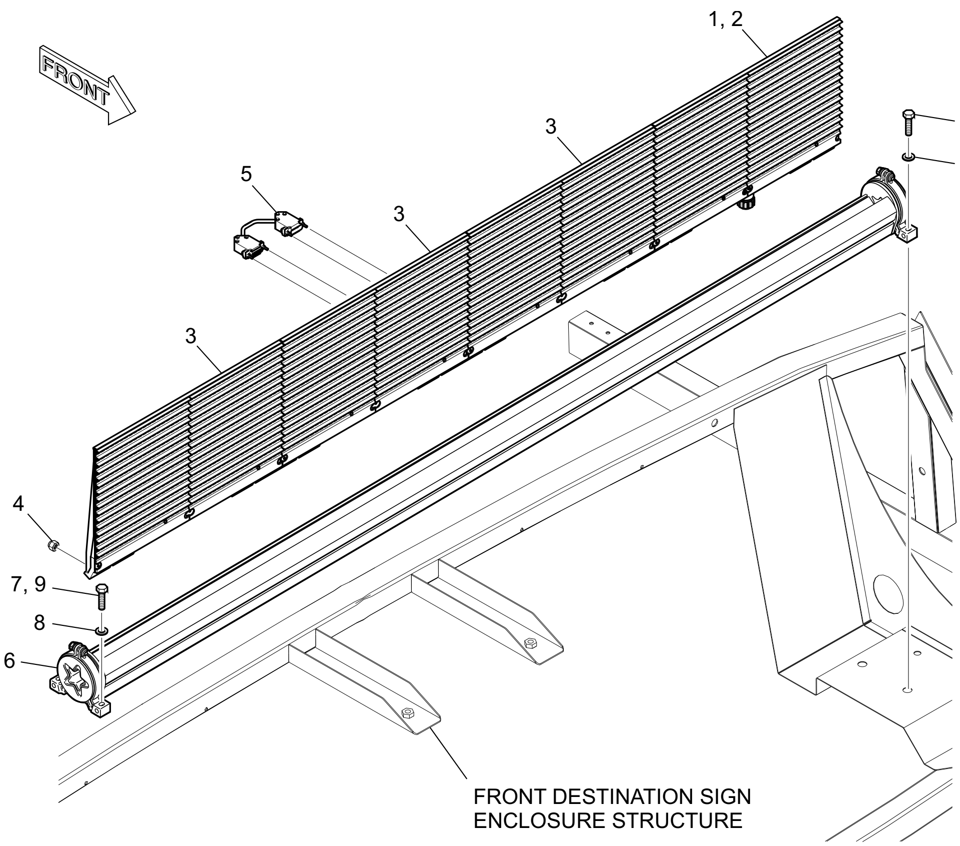
⚠ CAUTION

DO NOT use cleansers, solvents, rags, or brushes that may scratch or damage plastic surfaces and seals.

4. Clean sign assembly using compressed air, vacuum, or a clean soft cloth.
5. Rotate sign assembly to vertical position and lock in place by tightening clamps on shock pad pivots.

2.3.4. Removal

1. Set Battery Disconnect switch to the OFF position.
2. Open front destination sign access door.
3. Disconnect vehicle wiring harness from sign.
4. Remove two bolts and washers from both ends of the mounting support bar. See "Fig. 18-2: Front Destination Sign Installation" on page 7.
5. Lift sign assembly off mounting studs and remove through destination sign access door.



1. Destination Sign, Front Assembly (Incl. 2...5)
2. Display Board Assembly, Master
3. Display Board Assembly, Slave
4. Nut, Self Locking
5. Cable Assembly, Power/Data
6. Bracket Set, Sign Mounting
7. Loctite, 243
8. Washer, Flat 1/4"
9. Bolt, Hex 1/4" - 20 UNC x 1 1/4" Lg.

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Fig. 18-2: Front Destination Sign Installation

2.3.5. Disassembly

1. Disconnect the data/power cables connecting the four display boards in series.
2. Remove the two retaining nuts from the master display board and then remove the master display board. Repeat this step for the remaining three slave display boards.
3. Disassemble the support bar assembly as follows:

   a. Loosen the clamps on the shock pad pivot and remove the shock pads from either end of the support bar.

   b. Remove the three screws and remove the end pivot from either end of the support bar.

   c. Slide the T-bolt bars out from the support bar.

2.3.6. Assembly

1. Assemble the support bar assembly as follows:
   a. Insert the T-bolt bars into the support bar. The short T-bolt bar is located at the power supply end of the support bar.
   b. Install the end pivots at either end of the support bar and secure with three screws.
   c. Assemble the shock pad pivot and pivot mount onto each end of the support bar assembly.
   d. Tighten shock pad pivot clamps, ensuring head of bolt is facing towards the rear of the vehicle.
2. Install the master display board to the mounting bar first, using the self-locking nuts. Install the three slave boards in series, in the same way, making sure that the slave board with the termination jumper is installed last in the chain.

   ☞**NOTE:**

   If necessary, loosen the clamps on the end of the support bar assembly and adjust the sign display boards to the vertical position. Tighten clamps.
3. Connect each board in series by attaching the power/data wiring cables to the J1 and J2 DB15 connectors between each board. Fasten each connector with a phillips head screw.

2.3.7. Installation

1. Align sign assembly mounts over the studs in the destination sign compartment. Secure with bolts and washers.
2. Connect vehicle power harness and RS485 DB15 data harness to the master board of the front destination sign.
3. Set Battery Disconnect switch to ON position.
4. Set the Master Run Switch to the DAY RUN or NIGHT RUN position.
5. Test destination sign operation.

2.3.8. Testing

Test the sign. Refer to 3. “VENDOR SERVICE INFORMATION” on page 13 in this section for testing procedure.

2.4. Side Destination Sign

2.4.1. Description

The side destination sign is located on the curbside, of the vehicle, in the upper portion of the first window of the vehicle. It is an LED type of sign, making the sign easily visible, even in bright sunshine. The sign is operator controlled from an operator display keyboard located in the driver's overhead panel.

2.4.2. Operation

Refer to 2.2. "Multi Control Unit (MCU)" on page 2 in this section for the side destination sign operation.

2.4.3. Removal

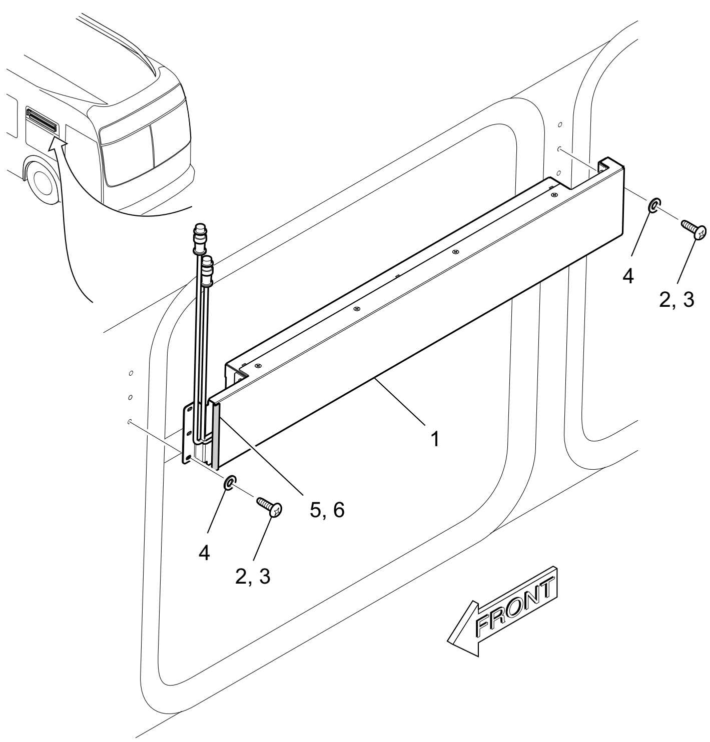
1. Set the Battery Disconnect switch to the OFF position.
2. Disconnect the electrical connections to the sign, and tag for reinstallation. See "Fig. 18-3: Side Destination Sign Installation" on page 9.
3. Remove the retaining screws holding the sign in place and remove the sign.

2.4.4. Installation

1. Secure the sign in place, using the retaining screws.
2. Reconnect the electrical connection.
3. Set the Battery Disconnect switch to the ON position.

2.4.5. Testing

Test the sign. Refer to 3. "VENDOR SERVICE INFORMATION" on page 13 in this section for testing procedure.



1. Destination Sign, Side Assembly
2. Screw, PH Cross Recess Tpg. Type F 1/4" - 20 UNC x 1" Lg.
3. Loctite, 243
4. Washer, Flat 1/4"
5. Channel, Rubber
6. Tape, Adhesive

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Fig. 18-3: Side Destination Sign Installation

2.5. Front Route Sign

2.5.1. Description

The front route sign is an electronic style sign. It is bracket-mounted on the front dash of the vehicle. See “Fig. 18-4: Front Route Sign Installation” on page 11.

2.5.2. Operation

Refer to 2.2. “Multi Control Unit (MCU)” on page 2 in this section for front route sign operation.

2.5.3. Removal

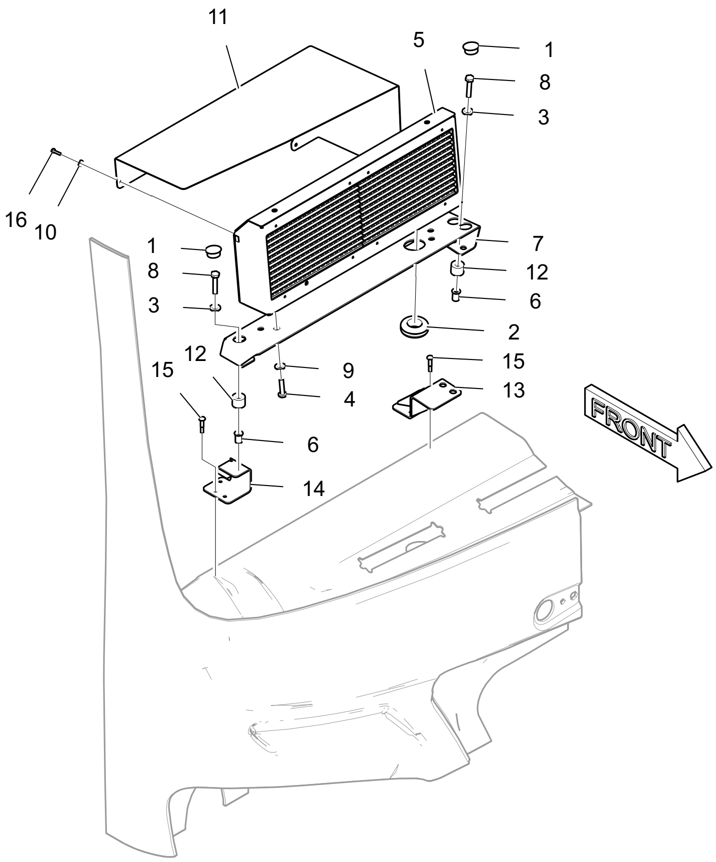
1. Set the Battery Disconnect switch to the OFF position.
2. Remove the mounting screws from the mounting bracket.
3. Raise the unit and disconnect the electrical connector.
4. Remove the unit from the vehicle.
5. Service the unit. Refer to the Luminator Service Manual for procedure.

2.5.4. Installation

1. Install unit on bracket with screws, lock washers and washers.
2. Attach electrical connector.
3. Set the Battery Disconnect switch to the ON position.

2.5.5. Testing

Test the sign. Refer to 3. “VENDOR SERVICE INFORMATION” on page 13 in this section for testing procedure.



1. Plug, Button 3/4" Dia.
2. Grommet, Rubber
3. Washer, Flat 1/4" Black
4. Screw, PH Cross Recess SST 1/4" - 20 UNC x 1" Lg. Black
5. Route Sign, Front Assembly
6. Insert, Aluminum 1/4" - 20 UNC x .027" - .165"
7. Bracket, Destination Sign
8. Bolt, Hex 1/4" - 20 UNC x 1 1/4" Lg. Black
9. Washer, Flat SST 1/4" Black
10. Washer, Flat #6 Black
11. Plate, Glare Shield Front Sign
12. Spacer, 0.50 Thk. X 0.75 O.D.
13. Bracket, Front Route Sign Streetside
14. Bracket, Front Route Sign Curbside
15. Rivet, Mono Blind SST 3/16" x .064/.420"
16. Screw, PH Cross Recess SST #6 - 32 UNC x 5/8" Lg. Black

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Fig. 18-4: Front Route Sign Installation

2.6. Rear Route Sign

2.6.1. Description

The rear route sign is installed in the upper rear curbside corner of the vehicle. It is an LED sign. See “Fig. 18-5: Rear Route Sign Installation” on page 12.

2.6.2. Operation

Refer to 2.2. “Multi Control Unit (MCU)” on page 2 in this section for the rear route sign operation.

2.6.3. Removal

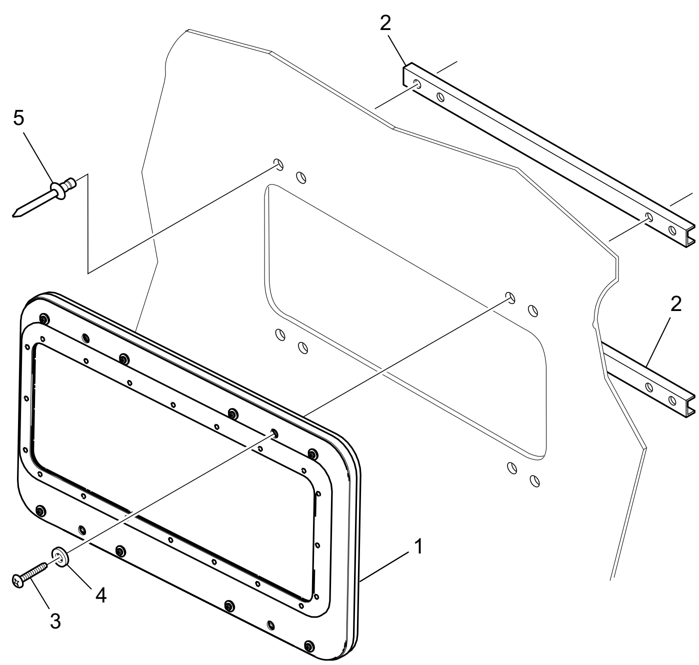
1. Set the Battery Disconnect switch to the OFF position.
2. Remove the retaining screws from the rear sign.
3. Pull the sign outward and disconnect the wiring.
4. Remove the rear sign from the vehicle.

2.6.4. Installation

1. Set the Battery Disconnect switch to the OFF position.
2. Connect vehicle wiring to sign.
3. Reinstall the rear sign and attach with the retaining screws and washers.
4. Set the Battery Disconnect switch to the ON position

2.6.5. Testing

Test the sign. Refer to 3. “VENDOR SERVICE INFORMATION” on page 13 in this section for procedure.



1. Route Sign, Rear Assembly
2. Bracket, Rear Route Sign
3. Screw, PH Cross Recess SS #10 - 32 UNF x 2" Lg.
4. Washer, Flat SS #10
5. Rivet, Blind Black Painted 3/16" x .187/.437

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Fig. 18-5: Rear Route Sign Installation

3. VENDOR SERVICE INFORMATION

The following supplier manuals contain additional reference information.

3.1. Luminator Manuals

- ❐ MCU Operation & Maintenance Manual

Driver’s Controls

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❒ open flame
- ❒ excessive heat
- ❒ production of sparks
- ❒ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to “Maintenance Safety Procedures” in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Electrical System Safety

During electrical diagnosis procedures an understanding of the vehicle's electric circuits is important to understand the results of connecting test equipment.

DANGER

During component removal or installation, ensure that the Master Run switch is set to the STOP-ENGINE position and that the Battery Disconnect switch is set to the OFF position. Failure to follow this procedure may result in personal injury or component damage.

WARNING

DO NOT start the vehicle remotely with the laptop software without first checking that the area is clear of personnel.

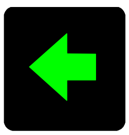
CAUTION

Before welding anywhere on vehicle, set Battery Disconnect switch to the OFF position and disconnect all electronic control modules (Multiplexing, engine, transmission, ABS, and so forth). Refer to Section 11 of this manual for additional precautionary information.

2. INSTRUMENTATION & CONTROLS

2.1. Instrument Panel

The instrument panel is located directly in front of the driver and provides a visual display of the vehicle operating systems as well as providing controls for the various systems. The instrument panel cluster is a programmable electronic unit with diagnostic capabilities. See "Fig. 19-1: Instrument Panel" on page 3.



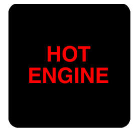
2.1.1.Turn Indicators (Green)

WARNING

If turn signal indicators do not operate as described, DO NOT OPERATE THE VEHICLE.

The turn indicators, symbolized by directional arrows, flash on either side of the instrument panel when the right-hand or left-hand floor-mounted turn signal switch is pressed.

When the Hazard switch is activated, both turn indicators flash together. Failure of these lights to flash normally indicates that the flasher module is not functioning.



2.1.2.Hot Engine Indicator (Red)

The Hot Engine indicator will illuminate if the engine exceeds its normal operating temperature and overheats. The Hot Engine indicator is accompanied by a warning buzzer.

☞**NOTE:**

If this indicator remains illuminated, the Engine Protection System engages, initiating an automatic engine shutdown sequence.

2.1.3.Check Engine Indicator (Amber)

CAUTION

If after engine start-up the Check Engine indicator remains illuminated, advise service personnel. Avoid extended periods of operation with this indicator illuminated.

The Check Engine indicator illuminates if the engine requires service. The indicator is controlled by the vehicle's Multiplexing System which monitors engine sensor output. The Multiplexing System will illuminate the indicator if sensor output signals fall outside of a predetermined range.

1. Instrument Cluster
2. Rear Air Pressure Gauge
3. Front Air Pressure Gauge
4. Speedometer
5. LCD Screen
6. Shift Selector
7. Ramp Switch
8. Kneel Switch
9. Wiper/Washer Control
10. Panel Lights Dimmer Switch
11. Driver's Floor Heat Control
12. Defroster Fan Control
13. Defroster Air Recirculation Control
14. Defroster Temperature Control

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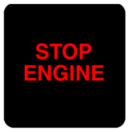
Fig. 19-1: Instrument Panel



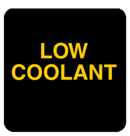
2.1.4.Stop Engine Indicator (Red)

The Stop Engine indicator illuminates if an engine operating condition occurs that will result in damage to the engine. The indicator is controlled by the vehicle's Multiplexing System which monitors engine sensor output. If the Multiplexing System illuminates the indicator it also initiates an engine shut-down sequence.

As an operation check, the Stop Engine indicator should remain illuminated momentarily when the engine is started.

☞NOTE:

If this indicator remains illuminated, the engine will continue running for 30 seconds. Use the time to drive out of traffic to a safe area.

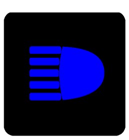


2.1.5.Low Coolant Indicator (Amber)

The Low Coolant indicator illuminates if too little coolant is in the engine to maintain normal engine operating temperature.

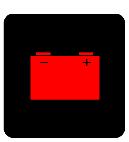
☞NOTE:

If this indicator remains illuminated, the Engine Protection System engages to initiate an automatic engine shutdown sequence.



2.1.6.High Beam Indicator (Blue)

The high beam indicator, symbolized by a lit headlight, illuminates when the vehicle headlights are in the high beam mode of operation. Pressing the dimmer switch returns the headlights to normal low beam operation.



2.1.7.No Gen Indicator (Red)

⚠CAUTION

If the no gen indicator remains illuminated while the engine is operating, DO NOT OPERATE THE VEHICLE.

The no gen indicator, symbolized by a battery, illuminates when the alternator is not charging. The no gen indicator illuminates when the Master Run switch is in the DAY-RUN or NIGHT-RUN position and the engine is not operating. The no gen indicator turns off once the engine is operating.

2.1.8.Low Oil Indicator (Red)

⚠CAUTION

If the Low Oil alarm continues and the indicator lamp remains illuminated, DO NOT OPERATE THE VEHICLE.

The Low Oil indicator illuminates if the engine oil pressure is too low for proper engine lubrication. The Low Oil indicator is accompanied by a warning buzzer.

Before starting the engine, positioning the Master Run switch to DAY-RUN or NIGHT-RUN illuminates the Low Oil indicator and sounds its alarm. This occurs momentarily and is a normal electrical system test.

☞NOTE:

If this indicator remains illuminated, the Engine Protection System engages to initiate an automatic engine shutdown sequence.

2.1.9.Interlock Indicator (Red)

The Interlock indicator illuminates when the interlocks apply. This is a safety system that disengages the accelerator and applies the brakes when operating the exit door, the kneeling system or the wheelchair ramp.

2.1.10.ABS Fail Indicator (Amber)

The ABS Fail indicator illuminates if the ABS System requires service. Engine start-up illuminates the indicator momentarily as part of a system check. It is also used during diagnostics to display the blink code.

2.1.11.Parking Brake Indicator (Red)

The parking brake indicator, symbolized by a circled letter “P” illuminates when the parking brake control valve is applied. Activating the parking brake illuminates the stop lights indicator and all red stop lamps.

☞**NOTE:**

The parking brake indicator will begin to flash if the E-Stroke System activates.

2.1.12.Stop Lights Indicator (Red)

⚠ **WARNING**

If the stop lights indicator does not operate as described, DO NOT OPERATE THE VEHICLE.

The stop lights indicator, symbolized by a circled letter S, illuminates each time the service brake or parking brake control valve is applied. If under these circumstances the indicator does not illuminate, then any or all rear stop lights are malfunctioning.

☞**NOTE:**

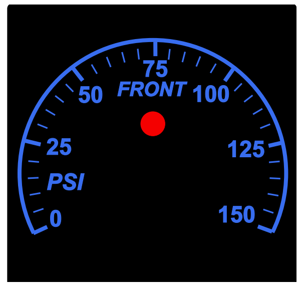
The stop lights indicator will begin to flash if the E-Stroke System activates.

2.1.13.A/C Fail Indicator (Red)

The A/C Fail indicator illuminates if the heating, ventilating and air conditioning (HVAC) unit malfunctions.

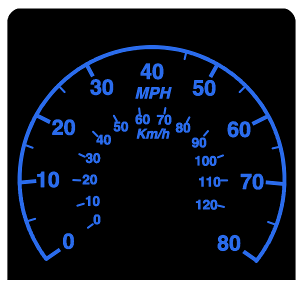
2.1.14.ATC Indicator (Amber)

The ATC indicator illuminates when the Automatic Traction Control System is operating to limit drive wheel spin on slippery surfaces.



2.1.15.Air Pressure Gauges

Individual analog air pressure gauges are used to monitor the vehicle’s front and rear air brake systems. An LED indicator in the center of the gauge illuminates and a warning buzzer sounds if air pressure drops below 75 psi (517 kPa). If air pressure exceeds the normal operating range, the LED indicator will flash. Normal operating pressure range is 117 to 131 psi (807 to 903 kPa).



2.1.16.Speedometer

This gauge indicates the vehicle’s forward speed. The speedometer will initialize as soon as the Master Run switch is set to the DAY-RUN or NIGHT-RUN position. During this self-test process the gauge will sweep full scale and then return to the zero point.

2.1.17. Operator Screen

The LCD touch screen provides indicators and text messages to warn the driver of potential problems. The screen will change color, from blue to amber to red, depending on the severity of the warning message. See “Fig. 19-2: Operator Screen” on page 6. The screen has a trip odometer, hour meter and a clock in the upper left hand corner.

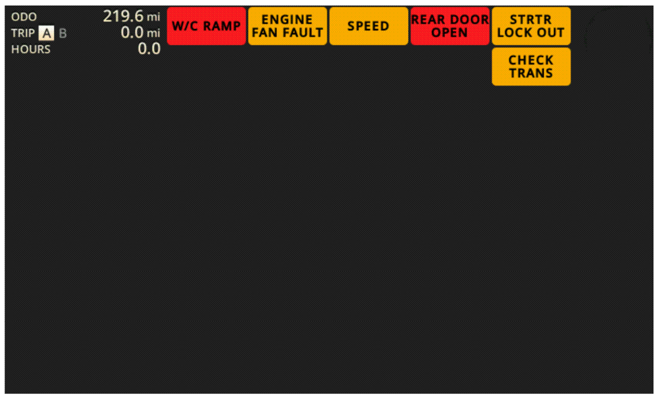


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Fig. 19-2: Operator Screen

Toggle between Trip A and B by touching the odometer portion of the screen. See "Fig. 19-3: Changing from Trip A to B" on page 7.

Reset the trip counter by pressing and holding for 1 second. See "Fig. 19-4: Resetting the Trip Counter" on page 7.

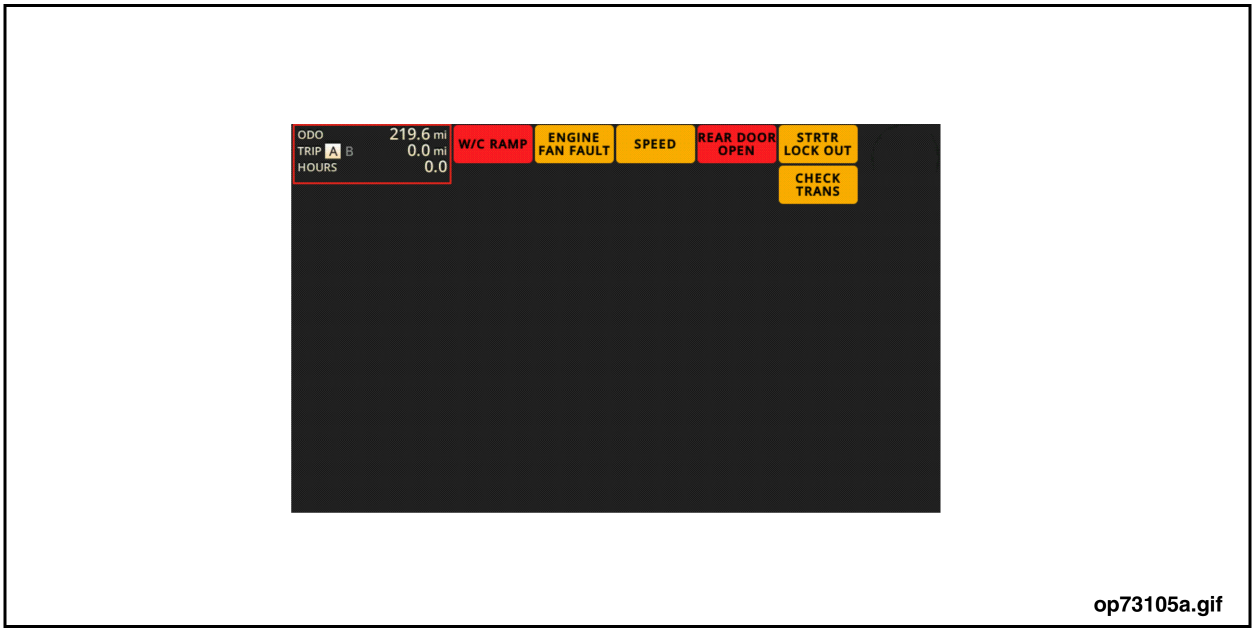


Fig. 19-3: Changing from Trip A to B

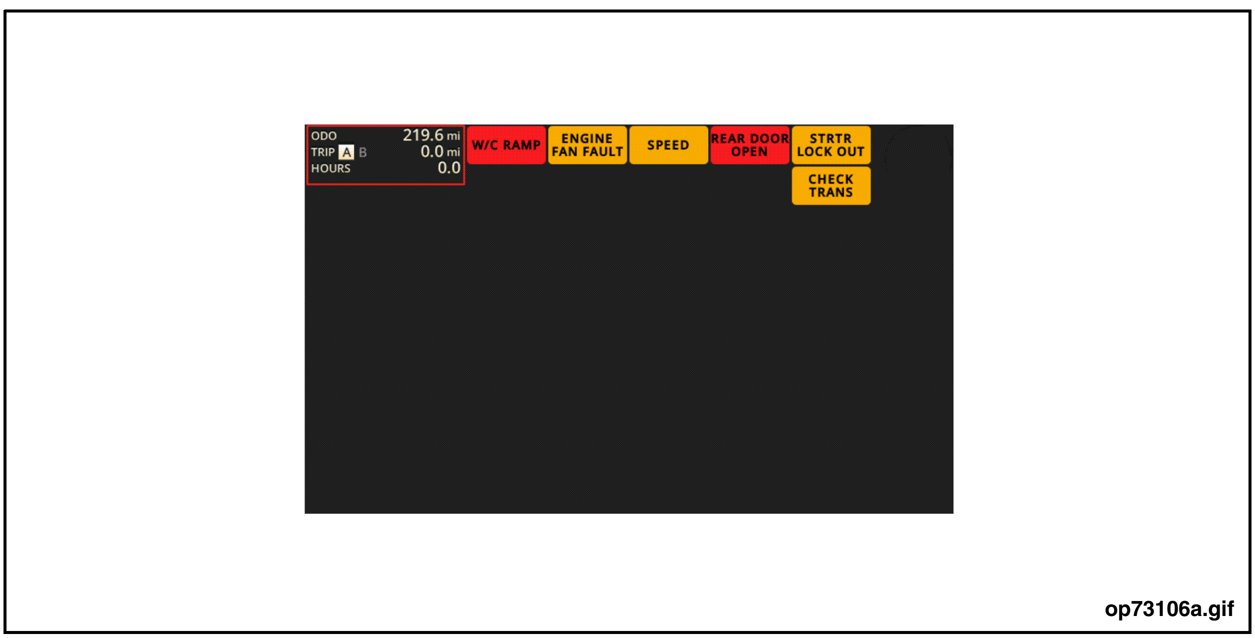


Fig. 19-4: Resetting the Trip Counter

2.1.17.1. Function Readout Displays

- ❒ Voltmeter (12V) - the voltmeter indicates the voltage levels in the vehicle's 12 volt electrical system. The normal operating range is between 11 and 14 volts. See "Fig. 19-5: Function Readout Display" on page 8.
- ❒ Voltmeter (24V) - the voltmeter indicates the voltage levels in the vehicle's 24 volt electrical system. The normal operating range is between 24 and 28.5 volts.

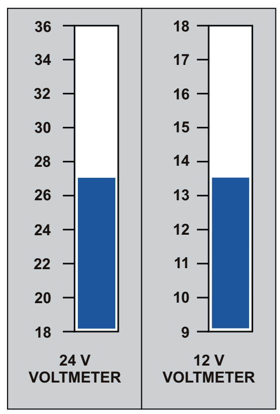


Fig. 19-5: Function Readout Display

2.1.17.2.Text Messages

- ❒ RH Headlight Fault (Amber) - The RH Headlight Fault message will appear on the LCD screen to indicate a fault with a low beam headlight.
- ❒ RH Turn Fault (Amber) - The RH Turn Fault message will appear on the LCD screen to indicate a fault with the right-hand turn light.
- ❒ LH Headlight Fault (Amber) - The LH Headlight Fault message will appear on the LCD screen to indicate a fault with the low beam headlight.
- ❒ LH Turn Fault (Amber) - The LH Turn Fault message will appear on the LCD screen to indicate a fault with the left-hand turn light.

⚠CAUTION

If the Hot Trans message appears for more than 30 seconds, move the vehicle to a safe location, shut down the engine, and apply the parking brake.

- ❒ Hot Trans (Red) - The Hot Trans message will advise that the oil in the transmission exceeds the maximum rated operating temperature. Immediately move the vehicle to a safe area and shut down the system.
- ❒ Check Trans (Amber) - The Check Trans message will appear if the transmission electronics has detected a potentially serious problem in the transmission. If this message appears, DO NOT OPERATE THE VEHICLE.
- ❒ Starter Lock Out (Amber) - The Starter Lock Out message will appear if the starter enters the protect mode after 14 cumulative seconds of cranking.
- ❒ Kneel Snsr Fault (Amber) - This message will appear if the kneeling sensors malfunction during the kneeling process.

☞NOTE:

If the Kneel Snsr Fault message appears, kneeling will continue to function using time-based kneel and raise intervals.

- ❒ Low Fuel Pressure (Red) - The Low Fuel Pressure message will appear when the fuel pressure has dropped to a level below that of the engine manufacturers recommended range.
- ❒ Stop Request (Red) - This message appears on the LCD screen when the passenger signal system has been activated.
- ❒ Wheelchair Stop Request (Amber) - This message appears on the LCD screen when the wheelchair passenger signal system has been activated.
- ❒ Seat Belt (Red) - The Seat Belt message appears when the driver's seat belt is unfastened.
- ❒ RTRDR ON (Amber) - This message will appear on the LCD screen to indicate that the transmission retarder is in operation.
- ❒ Fuel Door Open (Amber) - The Fuel Door Open message will appear when the fuel filler access door has been opened.
- ❒ Low Fuel (Amber) - The Low Fuel indicator illuminates when the level of diesel fuel in the tank has reached the minimum level for reliable vehicle operation.

- ❐ Brake Alert (Amber) - The Brake Alert message appears if an abnormal braking event occurs on any brake such as failure to activate, excessive brake stroke, dragging brakes, or over-heated brake linings.
- ❐ Interlock Fault (Red) - The Interlock Fault message will appear on the LCD screen to indicate a fault has been detected with the Interlock System.
- ❐ Engine Fire (Red) - This message appears and a warning buzzer sounds when there is a fire in the engine compartment.
- ❐ Stop Lamp Fault (Red) - This message will appear on the LCD screen and the buzzer will sound to indicate a fault with a stop lamp circuit.
- ❐ Tail Lamp Fault (Amber) - This message will appear on the LCD screen to indicate a fault with a tail lamp circuit.
- ❐ Ext Lamp Fault (Amber) - This message will appear on the LCD screen to indicate a fault with an exterior lamp circuit.
- ❐ Park Brake Unset (Red) - The Park Brake Unset message will appear if the driver leaves the driver's seat for five seconds without applying the parking brake. The message will also appear if the master run switch is set to STOP-ENGINE or NIGHT-PARK and the parking brake has not been applied.
- ❐ Day Run (Amber) - this message will advise that the master run switch is in the DAY-RUN position.
- ❐ A/C Stop (Amber) - The A/C stop message will appear on the LCD screen when a fault with the A/C system has been detected.
- ❐ Rear Door Open (Red) - The Rear Door Open message appears when the door controller is turned to position 2, 4 or 5 to enable the rear exit door.
- ❐ Kneel (Amber) - The Kneel message will appear to indicate that the vehicle is below normal ride height.
- ❐ W/C Ramp (Red) - The Wheelchair Ramp message will appear any time the ramp is not fully stowed.
- ❐ Engine Fan Fault (Amber) - The Engine Fan Fault message will appear if a fault is detected with the radiator electronically controlled fan system.
- ❐ CNG Valve Fault (Amber) - The CNG Valve Fault message will appear if a fault is detected in the electrical circuit of the CNG fuel tank solenoid valve.
- ❐ Low Cab Clnt (Amber) - The Low Cabin Coolant message will appear and the buzzer will sound when cabin coolant level is too low.

2.1.18. Shift Selector Operation

WARNING

If you leave the vehicle and the engine is running, the vehicle can move suddenly and you or others could be injured. If you must leave the engine running, DO NOT leave the vehicle until you put the transmission in NEUTRAL, and ensure that the engine is at low idle, and apply the park brake and emergency brakes and make sure they are properly engaged, and chock the wheels and take any other steps necessary to keep the vehicle from moving.
The vehicle service brakes, park brake, or emergency brake must be applied whenever NEUTRAL is selected to prevent unexpected vehicle movement. Selecting NEUTRAL does not apply the vehicle brakes.

- [R] REVERSE - selects Reverse gear.
- [N] NEUTRAL - selects Neutral. The area around the [N] button is a raised ridge so the driver can identify the pushbuttons by touch, without looking at the display. It is not necessary to press this button prior to starting the vehicle.
- [D] DRIVE - selects the highest available forward range. The transmission shifts to the starting gear and will automatically upshift through the gears, as operating conditions permit, until the highest available gear is attained.
- UPSHIFT and DOWNSHIFT Arrow Buttons - these buttons are used to change the range selected to a higher or lower forward range:
  - One press of the DOWNSHIFT button sets range SELECT to the same range as the current range attained, shown in the MONITOR position on the display. This is referred to as Express Preselect.
  - Each subsequent press of the DOWNSHIFT button decreases the range selected by one range.
  - One press of the UPSHIFT button increases the range selected by one range.
  - If the UPSHIFT or DOWNSHIFT button is held continuously, the selected range will continue to change up or down until the button is released or until the highest or lowest possible range of gears is selected.
- MODE Button - pressing the MODE button invokes a secondary shift schedule or a special operating function. Pressing the MODE button also toggles to the next Diagnostic Trouble Code (DTC) while in the DTC display mode. And it clears active and inactive DTCs from the ECU memory.
- Select & Monitor - during normal operation with [D] Drive selected, the SELECT section of the display shows the highest attainable forward range for the shift schedule in use. The MONITOR section displays the gear range that has been commanded in the transmission. Reverse [R] and Neutral [N] are likewise displayed when appropriately selected and in use. The display of any other character in the SELECT or MONITOR section denotes a nonstandard operating condition.

2.1.19. Ramp Switch

CAUTION

The Ramp toggle switch is a momentary type. If pressure is removed, the switch returns to the center FLOAT position and operation ceases.

This is a three-position switch that controls the wheelchair ramp.

DEPLOY

This position activates the ramp from the closed position to the open position.

NOTE:

The interlocks apply, the audible alarm sounds and the exterior warning light flashes when the ramp is not in the STOWED position.

FLOAT

This position shuts off power to the pump, allowing the ramp to free-fall to either the open or the closed position. Upon cycle completion this becomes an off position.

STOW

This position is used to move the ramp from the open to the closed position.

2.1.20. Kneel Switch

CAUTION

When placed in the RAISE position, the Kneel toggle switch will latch and continue to raise the vehicle until full ride height is reached at which point the raising action will automatically stop. In order to interrupt the raising operation during its cycle, the toggle switch must be set to the HOLD position.

This three-position momentary switch is used to operate the vehicle's kneeling system. The kneeling system lowers the front of the vehicle approximately 3 to 4 inches by exhausting air from both front suspension air springs. Boarding the vehicle becomes easier, particularly for small children and the handicapped.

NOTE:

The interlocks apply when the vehicle is operated in the KNEEL mode.

LOWER

This position lowers the vehicle, activating the interlocks, the audible alarm and the exterior warning light. The instrument panel Kneel indicator also illuminates.

NOTE:

The Kneel toggle switch is a momentary spring loaded switch that will operate in the LOWER position only as long as pressure on the switch is maintained.

RAISE

This position raises the vehicle automatically to its full ride height. Once the vehicle has reached normal ride height, the interlocks will release (with doors closed), the alarm will silence and the exterior warning light and Kneel indicator will both extinguish.

Holding the switch in the RAISE position raises the vehicle for as long as the switch is held or until the vehicle reaches normal ride height. Once the vehicle is at normal ride height, the vehicle will stop rising even if the switch is held.

NOTE:

Closing the switch guard locks the switch in the RAISE position.

HOLD

During the kneeling cycle, this position stops kneeling operations, however, it does not silence the alarms and extinguish the exterior warning light. The Kneel indicator and the interlocks remain activated.

2.1.21. Wiper/Washer Control

The Wiper Control switch operates the left-hand and right-hand wiper motors. Rotating the switch through the intermittent position will vary the delay of the wiper sweep in times of light rain. In the low or high position the wipers operate at fixed speeds. Pushing down on the knob operates the windshield washer pump to spray fluid onto the windshield.

☞**NOTE:**

The windshield washer bottle filler is located near the left headlight.

2.1.22. Panel Lights Dimmer Switch

The Panel Lights Dimmer switch controls the brightness of the instrument panel lighting. Rotating the dimmer knob clockwise increases the brightness and counterclockwise decreases the brightness of the panel lights.

2.2. Driver's Climate Controls

See "Fig. 19-6: Driver's Area Climate Controls" on page 14.

2.2.1. Driver's Floor Heat

The driver's floor heat control is located on the instrument panel and controls the defroster/heater outlet to the floor area of the driver's platform. Turn the knob counter-clockwise to increase the floor heat setting.

☞NOTE:

Use the Temperature control knob on the instrument panel to set the floor heat air temperature.

2.2.2. Defroster Fan Control

The defroster Fan knob on the instrument panel controls the speed of the driver's heater/defroster fan. Turning the knob from the extreme left (OFF position) to the right provides variable fan speed settings.

2.2.3. Defroster Air Recirculation Control

The Air knob on the instrument panel controls the amount of fresh air circulated through the driver's heater/defroster system. This knob can be set to recirculate all or a portion of air entering the heater compartment and admit a corresponding amount of fresh air.

2.2.4. Defroster Temperature Control

The Temp knob on the instrument panel controls the temperature of the air blowing from the defroster. Turn the knob from left to right to decrease temperature and from right to left to increase temperature.

Fig. 19-6: Driver's Area Climate Controls

2.3. Side Console Switch Panel

See “Fig. 19-7: Side Console Panel” on page 16.

2.3.1. Silent Alarm Switch

Activating the silent alarm switch will prompt the destination signs to display a distress message and the tail and clearance lights to flash.

2.3.2. P.A. Control Panel

The control panel is used to select the desired speakers and adjust the volume. The receptacle is provided to plug in the microphone. The switch is used to control the microphone plug.

2.3.3. Stop Request Switch

The Stop Request toggle switch controls the stop request indicators of the passenger signal system. Pushing the toggle switch to CANCEL and releasing deactivates the instrument panel indicator and the chime.

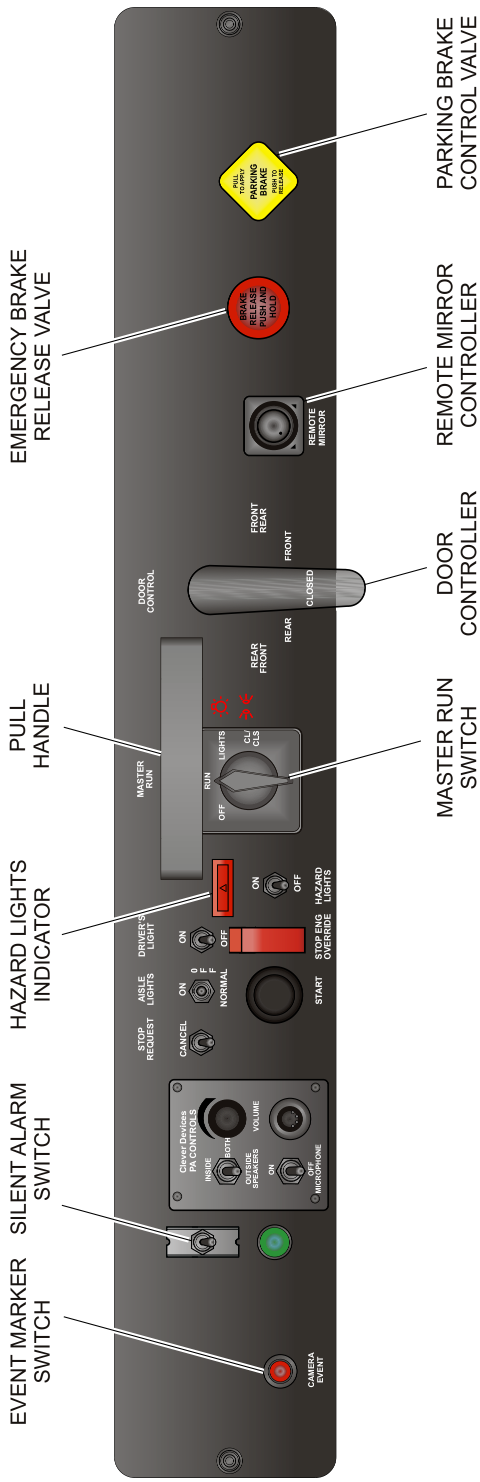


Fig. 19-7:   Side Console Panel

2.3.4. Aisle Lights Switch

The following table displays the lights that will be illuminated based on the positions of the Aisle Lights switch and Master Run switch. See "Fig. 19-8: Interior Lighting Panels" on page 18.

AISLE LIGHTS SWITCH OPERATION		
AISLE LIGHTS SWITCH POSITION	MASTER RUN SWITCH POSITION	ILLUMINATED LIGHTS
ON	DAY-RUN	Streetside (1, 2, 3, 4) Curbside (1, 2, 3, 4)
ON	NIGHT-RUN	Streetside (1, 2, 3, 4) Curbside (1, 2, 3, 4)
ON	NIGHT-PARK	Streetside (1, 2, 3, 4) Curbside (1, 2, 3, 4)
NORMAL	DAY-RUN	Streetside (1, 2, 3, 4) Curbside (1, 2, 3, 4)
NORMAL	NIGHT-RUN	Streetside (1, 2, 3, 4) Curbside (1, 2, 3, 4)
NORMAL	NIGHT-PARK	Streetside (None) Curbside (3, 4)
OFF	ANY POSITION	Streetside (None) Curbside (None)

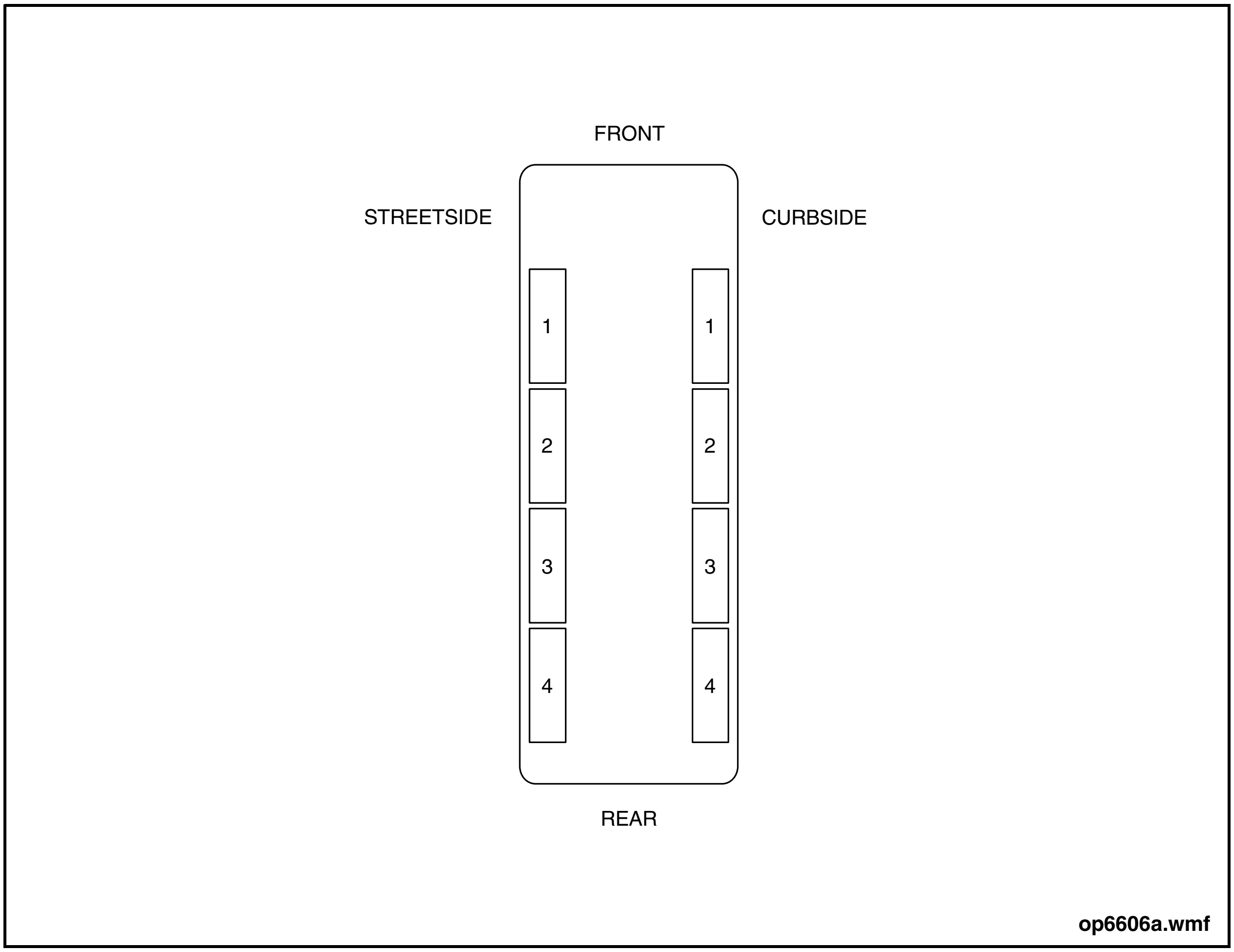


Fig. 19-8: Interior Lighting Panels

2.3.5. Driver's Light Switch

The Driver's Light toggle switch is a two-position switch that controls the light above the driver.

2.3.6. Hazard Lights Switch Indicator

The Hazard Lights Switch indicator illuminates when the Master Run switch is in the NIGHT-RUN or NIGHT-PARK position. It serves only to highlight the position of the Four-Way Hazard Lights switch.

2.3.7. Master Run Switch

The Master Run switch is a 4-position rotary switch. The DAY-RUN, NIGHT-RUN, and NIGHT-PARK positions are used to activate the vehicle Multiplexing System and energize various 12/24V electrical circuits. The STOP-ENGINE position is used to shutdown the engine and de-energize the Multiplexing System and most 12/24V electrical circuits except those associated with safety functions. The Battery Disconnect switch must be set to the OFF position in order to disconnect the remaining 12/24V circuits from the vehicle batteries. The following table provides a list of circuits energized by the various Master Run switch positions:

☞**NOTE:**

The Multiplexing System is programmed to remain active for 30 minutes after the Master Run switch is set to the STOP-ENGINE position.

MASTER RUN SWITCH OPERATION

CIRCUIT OR SYSTEM	STOP-ENGINE	DAY-RUN	NIGHT-RUN	NIGHT-PARK
Headlights, high beam			x	
Headlights, low beam		x	x	
Four-way hazard lights	x	x	x	x
Turn lights (Note 3)	x	x	x	x
Stop lights		x	x	
Clearance/marker lights			x	x
Tail lights			x	x
License plate light			x	x
Backup lights & alarm (Note 1)		x	x	
Aisle lights, normal (Note 3)	x	x	x	x
Aisle lights, on (Note 3)	x	x	x	x
Instrument panel illumination			x	x
Instrument panel dimmer			x	x
Driver's lamp (Note 3)	x	x	x	x
Service compartment lights (Note 3)	x	x	x	x
Entrance & exit door lights with door open (Note 2)		x	x	x
Instrument panel warning indicators		x	x	
Shift selector		x	x	
Brake & accelerator interlocks		x	x	

MASTER RUN SWITCH OPERATION				
CIRCUIT OR SYSTEM	**STOP-ENGINE**	**DAY-RUN**	**NIGHT-RUN**	**NIGHT-PARK**
Destination sign operation		x	x	x
Door controller		x	x	x
Horns	x	x	x	x
Retarder Braking (Note 1)		x	x	
Driver’s alarm		x	x	
Parking brake alarm (Note 3)	x			x
Fire suppression & alarm	x	x	x	x
Gas detection & alarm	x	x	x	x
Kneeling operation & alarm		x	x	
Wheelchair ramp & alarm		x	x	x
Passenger signal system		x	x	
HVAC system (Note 1)		x	x	
Wiper controls		x	x	
Remote mirrors		x	x	
Surveillance cameras		x	x	x
AVA system		x	x	
Note 1: Engine must be running Note 2: DAY-RUN also requires W/C ramp deployed Note 3: Multiplexing system must be active				

2.3.8. Door Controller

WARNING

Positioning the Door Master switch to OFF disables the brake interlocks and the exit door controller.

The door controller opens and closes the entrance and exit doors. See “Fig. 19-9: Door Controller” on page 21. The five positions of the controller and the related door functions are as follows:

- ❒ Position #1 (CLOSED): Entrance door closed, exit door disabled.
- ❒ Position #2 (FRONT): Entrance door open, exit door disabled.
- ❒ Position #3 (FRONT REAR): Entrance door open, exit door open.
- ❒ Position #4 (REAR): Entrance door closed, exit door open.
- ❒ Position #5 (REAR FRONT): Entrance door open, exit door open.

  When the exit door is open, the brake and accelerator interlocks apply automatically and the stop lights indicator illuminates.

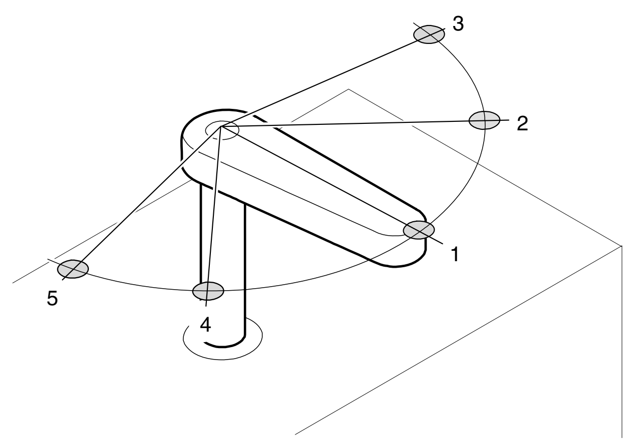


Fig. 19-9: Door Controller

2.3.9. Parking Brake Control Valve

WARNING

If the air pressure is below 40 psi (276 kPa), the parking brake valve will return to the applied position.

The parking brake control valve controls the application or the release of the parking brake. Pulling up on the control knob applies the parking brake. Pushing down on the knob releases the parking brake.

2.3.10. Emergency Brake Release Control Valve

This valve supplies the air pressure to release the rear brakes if the air system pressure drops below 40 psi (276 kPa) and the rear brakes apply automatically. Pushing down and holding the valve allows the air pressure to release the rear brakes. Releasing the valve knob shuts off the air pressure supply, allowing the rear brakes to re-engage.

☞**NOTE:**

The emergency brake release is for emergency use only. It allows the operator to move the vehicle away from a potentially dangerous location when the air system has failed. The rear brakes remain released as long as the valve is pressed. The brakes will drag at about 65 psi (448 kPa) even though the parking brake is in the released position.

2.3.11. Remote Mirror Controller

The Remote Mirror Control switch allows the operator to adjust the curbside mirror from the driver's seat.

2.3.12. Four-Way Hazard Lights Switch

The Hazard Lights toggle switch has an ON and OFF position. When the switch is ON, the instrument panel turn indicators and the exterior signal lights flash.

When the switch is OFF, the exterior signal lights function only as turn signals. The exterior signal lights and instrument panel turn indicators flash when the left or right turn signal foot-switch is pushed and held.

Activate the four-way hazard lights when the transit vehicle is stopped or parked in an area and may block traffic or present a possible hazard to following or approaching vehicles. Also use the four-way hazard lights when the vehicle is being towed.

2.3.13. Stop Engine Override Switch

WARNING

Apply the Stop Engine Override switch only for emergencies, such as moving the vehicle from traffic to a safe stopping area. The override interval is 30 seconds. Repeat the switch cycle to activate a repeat override sequence, if necessary.

The Stop Engine Override toggle switch is used to override the engine shutdown system in an emergency. The switch also prompts the engine diagnostics system to flash codes on the Check Engine indicator located on the instrument panel.

2.3.14. Start Push Button

WARNING

Put the shift selector in neutral [N] and apply the parking brake before starting the engine. If the parking brake indicator does not illuminate, DO NOT OPERATE THE VEHICLE.

This momentary push button on the side console allows the operator to start the engine without leaving the driver's seat.

☞**NOTE:**

The Multiplexing System limits continuous starting system operation to 14 seconds; the starter circuit is then disconnected for 60 seconds to allow the starting system to cool down.

2.3.15. Silent Alarm Indicator

This indicator illuminates when the silent alarm system is activated.

2.3.16. Camera Event Switch

Press this button to mark an incident on the Video Surveillance System DVR for easy retrieval and playback.

2.4. Foot Operated Controls

See “Fig. 19-10: Driver’s Foot Controls” on page 23.

2.4.1. Brake Treadle

The brake treadle, located to the left of the accelerator treadle, controls the application and release of the service brakes. The brake treadle also controls the regenerative braking function.

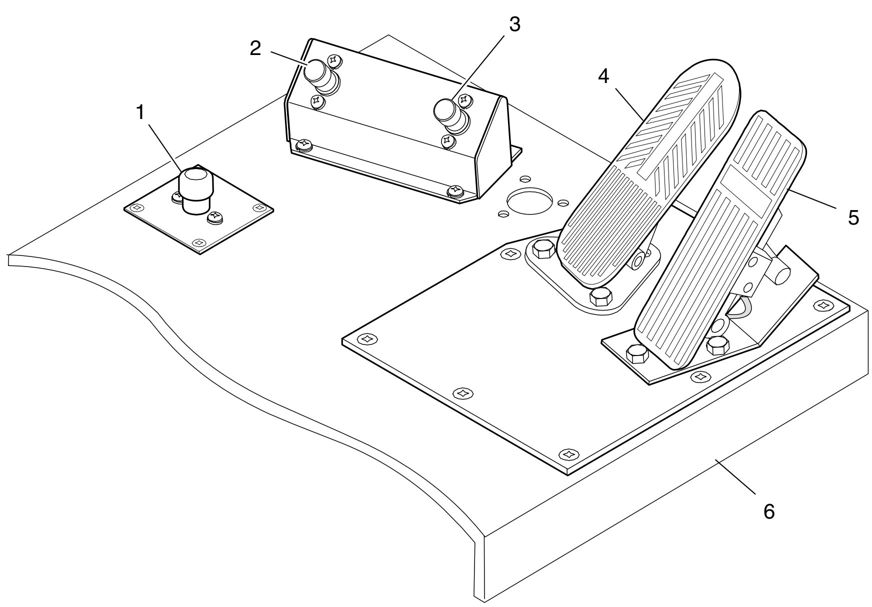
Brake application is proportional to the amount of treadle movement applied. Pressing the brake treadle illuminates the stop lights and the stop lights indicator.

☞NOTE:

The brake treadle drops slightly when the Interlock System applies. To release the brake interlock system, apply sufficient pressure to the brake treadle to “push through” the interlock application. The interlock message will disappear from the instrument panel LCD screen and the treadle will return with the operator’s foot to its normal position.

☞NOTE:

This vehicle incorporates an E-Stroke System which will activate warning indicators if the brakes remain applied after the brake treadle has been released.



1. Headlight Dimmer Switch
2. Left Turn Signal Switch
3. Right Turn Signal Switch
4. Brake Treadle
5. Accelerator Treadle
6. Driver’s Platform

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Fig. 19-10: Driver’s Foot Controls

2.4.2. Accelerator Treadle

The accelerator treadle, located to the right of the brake treadle, controls the engine throttle. Acceleration of the engine is proportional to the amount of treadle movement applied.

☞**NOTE:**

Accelerator treadle will be disabled if the vehicle is operated with the E-stroke System activated.

2.4.3. Headlight Dimmer Switch

The Headlight Dimmer switch is a heel-activated click-in switch located adjacent to the side console. Pressing the switch changes the headlight operating mode between either high beam or low beam. The blue high beam indicator on the instrument panel indicates the high beam mode.

2.4.4. Turn Signal Switches

Two bracket-mounted, momentary-on switches control the right and left turn signal lights when held depressed. Left or right turn signal indicators on the instrument panel illuminate when respective floor switch is activated.

2.5. Miscellaneous Controls

See “Fig. 19-11: Miscellaneous Switches” on page 25.

2.5.1. Door Master Switch

WARNING

Greater attention to passenger safety must be given whenever operating the vehicle with the Door Master switch in the OFF position, as this position disables several safety features and will allow the following conditions to occur:

- **Vehicle can be moved with entrance and/or exit door open (brake interlocks disabled).**
- **Vehicle can be shifted without foot on brake treadle.**
- **Vehicle can be shifted and vehicle moved with wheelchair ramp deployed.**
- **Exit doors can be opened at any speed by using the emergency release control valve.**

The Door Master toggle switch controls power to the brake interlocks and exit door. When the switch is in the ON position, the entrance and exit doors are fully functional. In this mode, opening the exit door, kneeling the vehicle or operating the wheelchair ramp engages the interlocks. Engaging the interlocks applies the brakes and deactivates the accelerator.

When the switch is In the OFF position, the brake interlocks are released (interlocks will not engage). The entrance door remains fully functional and the exit door does not function. A warning buzzer sounds and the Rear Door Open indicator illuminates on the instrument panel. In this mode, the exit door only opens if the emergency release control valve is activated. The control valve is located behind the breakable window to the left of the exit door.

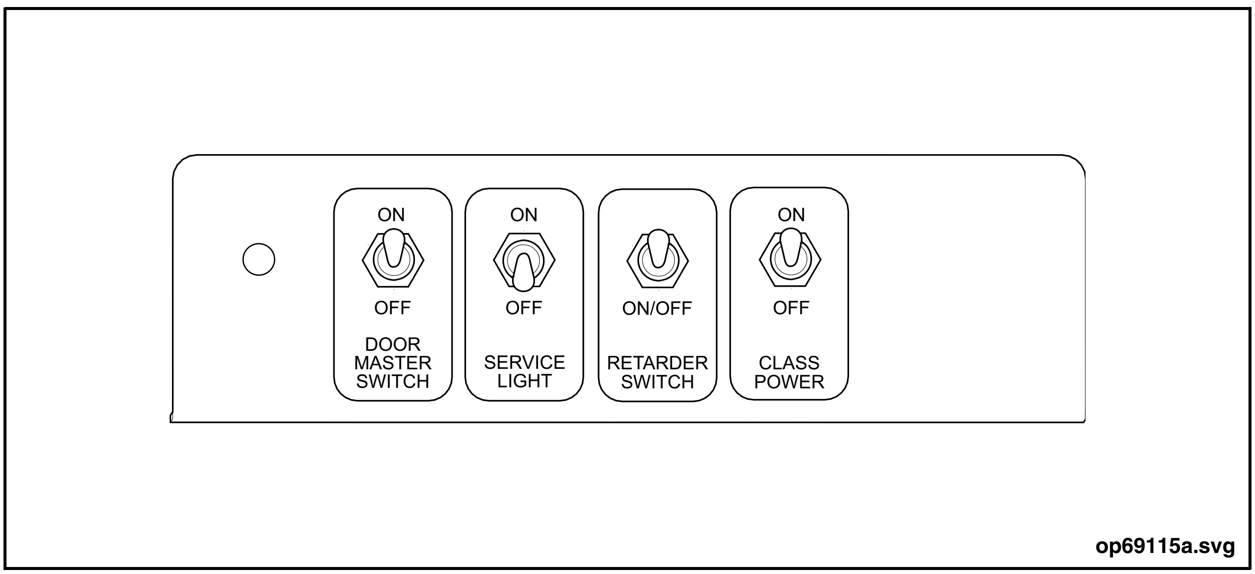


Fig. 19-11: Miscellaneous Switches

2.5.2. Service Light Switch

The Service Light switch controls the lamp in the destination sign compartment.

2.5.3. Retarder Switch

The Retarder switch, located in the destination sign compartment, is a momentary toggle switch that controls power to the Retarder System. Pulling the switch down and releasing alternately turns on and off the Retarder System.

☞**NOTE:**

Consult your transit authority for specific operating conditions during which the Retarder switch should be used.

2.5.4. CLASS Power Switch

This switch is located in the destination sign compartment and controls power to the exit door sensor module. The ON position allows the acoustic sensing system to operate normally. The OFF position deactivates the system.

2.5.5. Entrance Door Manual Control Valve

This air control valve is located beside the driver, just below the side console. Turning it to the OFF position releases the air controlling the entrance door. This allows manual operation of the door for initial vehicle entry. For normal entrance door operation, position the door manual control valve to ON.

3. INSTRUMENT REPAIRS

3.1. Instrument Panel

3.1.1. Description

The instrument panel houses the electronic instrument cluster. The instrument cluster includes gauges, LCD display screen and odometer, telltale indicators, and control buttons. The LCD screen is a programmable unit with diagnostic capabilities. A USB port is located below the instrument panel which is intended for configuring the instrument cluster using a PC.

The instrument panel is also fitted with controls and switches for operating electrical and mechanical devices.

3.1.2. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Drain the vehicle air tanks.
3. Tilt the steering wheel away from the instrument panel.
4. Remove the bezel by prying it away from the instrument panel. See “Fig. 19-12: Instrument Panel Repair & Installation” on page 27.
5. Remove the two machine screws at the top of the instrument panel.
6. Disconnect the USB port below the instrument panel.
7. Pull the instrument panel away to access the connectors on the back side of the panel.

☞NOTE:

The lower corners of the instrument panel are secured with Velcro tape.

8. Disconnect all electrical plugs and connectors from the instrument panel. Tag all wire connectors.
9. Disconnect all cables from defroster controls
10. Remove the instrument panel from the dash.

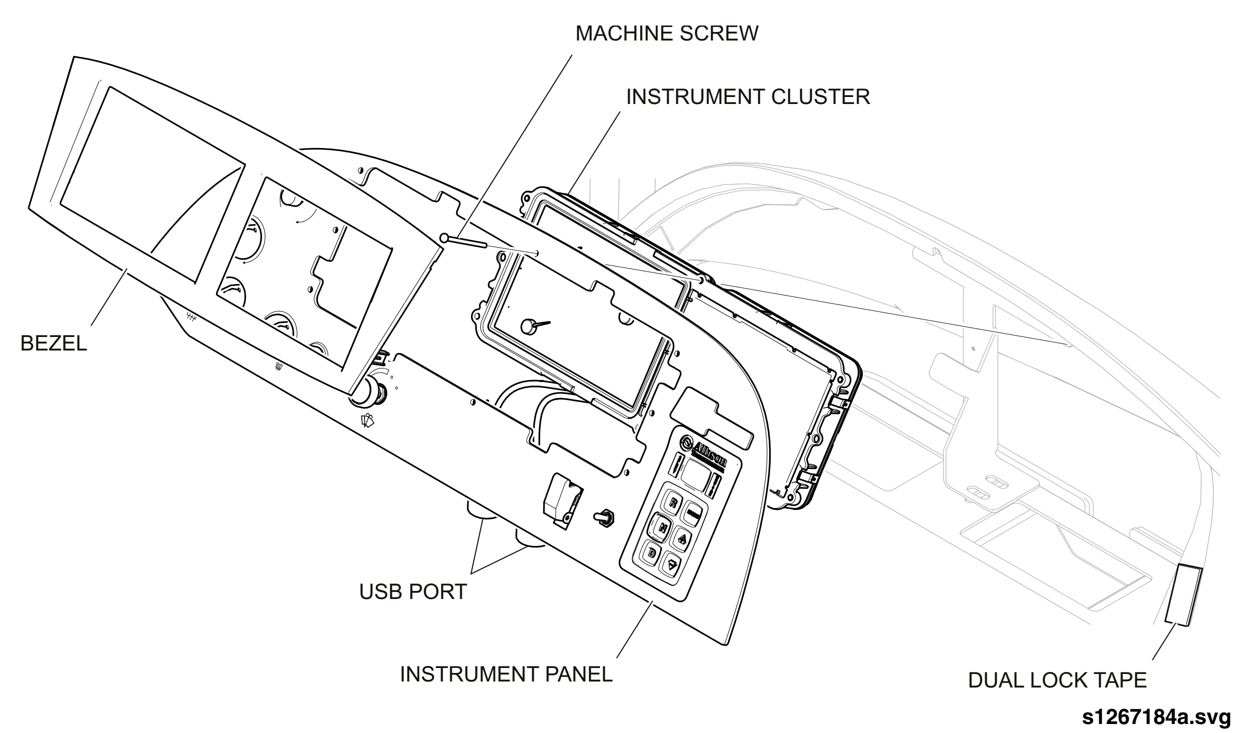


Fig. 19-12: Instrument Panel Repair & Installation

3.1.3. Disassembly

1. Remove the self-tapping screws holding the instrument cluster and remove it from the instrument panel.

   ☞**NOTE:**

   The electronic instrument cluster is not repairable and must be replaced as an assembly.

2. Remove the pushbutton shift selector by removing two nuts from retaining bracket and remove pushbutton shift selector from front side of panel.

3. Remove toggle switches as follows:

   a. Tag and disconnect electrical leads from switch.

   b. Remove the retaining nut on the face of the panel and remove the switch from the back of the panel.

4. Remove mechanical controls as follows:

   a. Remove the control knob from the device by loosening the setscrew on the knob.

   b. Remove the retaining nut from the face of the panel and remove the control switch from the back of the panel.

5. Remove electrical controls as follows:

   a. Remove the control knob from the device by loosening the setscrew on the knob.

   b. Remove the retaining nut from the face of the panel and remove the control switch from the back of the panel.

3.1.4. Assembly

Assemble the instrument panel by reversing the disassembly procedure.

3.1.5. Installation

1. Remove the existing Velcro tape and clean the contact areas. Apply new Velcro tape to the left and right side on dash panel.
2. Place the instrument panel in front of the dash and reconnect all electrical and mechanical connections.
3. Reconnect the USB port below the dash panel.
4. Attach the instrument panel to the dash using the machine screws.
5. Set the Battery Disconnect switch to the ON position.
6. Start the engine and check operation of instrumentation and controls.

3.2. Side Console

3.2.1. Description

The driver's side console is located to the left of the driver's seat, below the driver's side window. The aluminum panel and frame are mounted on a set of slider rails for ease of access to the electrical and pneumatic connections mounted to the interior of the drawer-like mechanism. Two 50 pound spring cylinders support the assembly in the raised position and retain it in the stowed position. A side console access door, located on the exterior street-side of the vehicle, also gives access to its lower electrical components, and pressure switches. The console is electrically attached to the vehicle using wire harnesses and cables that run up from under the vehicle. The toggle switches, and Pull-Off Dial switches are attached to its face using nuts and spiral lock washers. The Door Control Handle, a five tier switch, is attached from the underside of the console.

3.2.2. Operation

The side console houses the Vehicle Start, Lighting, HVAC, Parking Brake and Door Opening Controls. All control signals are sent from the side console to the Multiplexing System, using the two I/O modules located in the console. The Multiplexing System will allow system operation once it confirms that all preprogrammed parameters are met to activate the system. Current limiters which prevent damage to electrical components are described separately in this section.

3.2.3. Maintenance

3.2.3.1. Toggle Switch Replacement

1. Set the Battery Disconnect switch to the OFF position.
2. Loosen the captive screws at either end of the side console. Pull on the access handle and raise the console. See "Fig. 19-13: Side Console Repair" on page 30.
3. Remove the switch securing nut from the face of the panel.
4. Carefully push the switch down through the top of the console.
5. Disconnect all wires from the rear of the switch, and tag them for reinstallation.
6. Insert the new switch into the hole and attach the securing nut to the face of the panel.
7. Connect all wires to the switch.
8. Lower the side console panel and tighten the captive securing screws at either end.
9. Set the Battery Disconnect switch to the ON position.

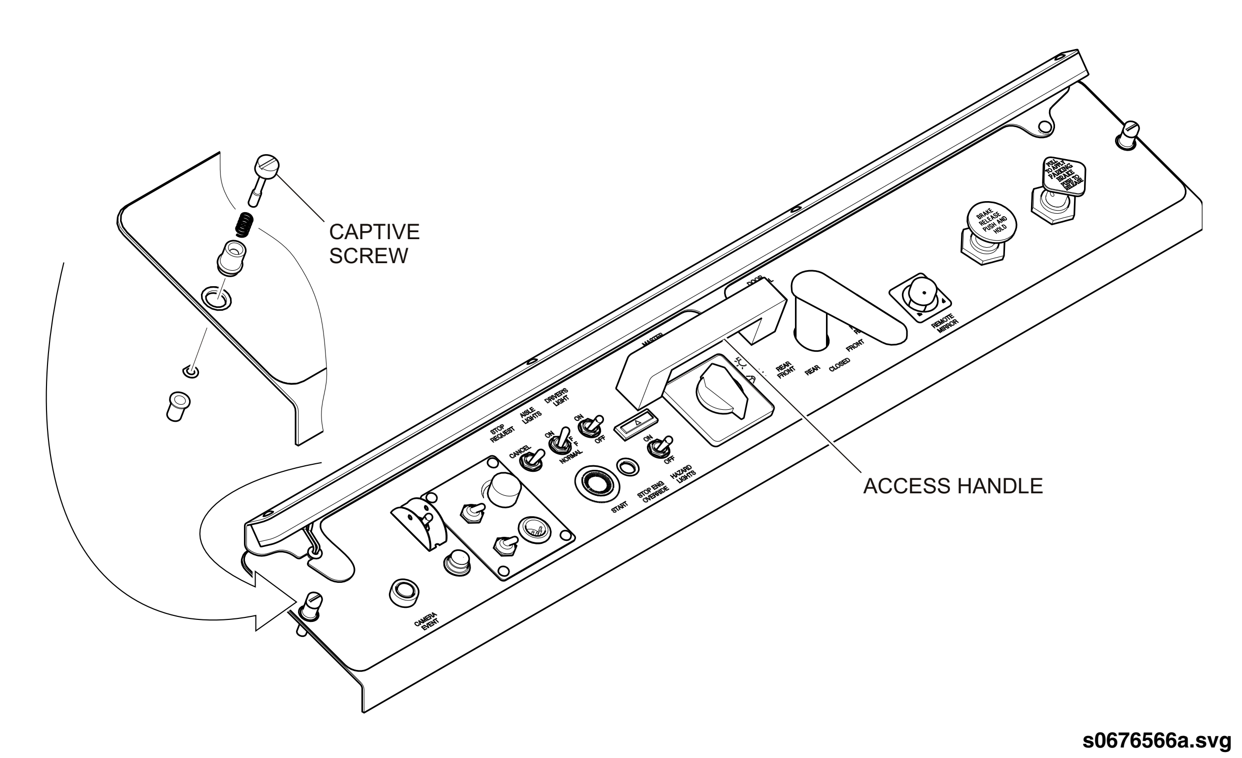


Fig. 19-13: Side Console Repair

3.2.3.2. Dial Switch Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Loosen the captive screws at either end of the side console. Pull on the access handle and raise the console.
3. Remove the pull-off dial from the front of the switch, by loosening the securing screw from the side of the switch.
4. Remove the switch securing nut from the face of the panel.
5. Carefully remove the switch from the bottom of the console.
6. Remove the attaching electrical connection.
7. Insert the new switch into the hole and attach the securing nut to the face of the panel.
8. Reattach the electrical connection to the switch.
9. Reattach the securing nut the bottom of the switch and attach the dial using the securing screw on the dial's side.
10. Lower the side console panel and tighten the captive screws at either end.
11. Set the Battery Disconnect switch to the ON position.

4. ACCELERATOR CONTROL

4.1. Description

The accelerator position sensor is used in vehicles equipped with electronically controlled engines. A signal is provided to the engine fuel control system in proportion to the degree of pedal actuation. A solid state potentiometer delivers the signal to the engine. This treadle incorporates hardened pin and replace able bushings at all pivot points. The rubber pedal cover is replaceable. The potentiometer and wire harness are replaceable as an assembly. Other than routine inspection and cleaning, very little maintenance is required.

4.2. Cleaning & Lubrication

1. Clean all the metal parts in a petroleum base cleaning solvent, such as mineral spirits (Stoddard solvent) or kerosene and air dry.
2. Check for excessively worn, damaged, or corroded parts. Replace bushings and shaft as required. See “Fig. 19-14: Accelerator” on page 32.
3. Lubricate pivot pins and roller with a thin layer of dry lubricant (Molykote 321 or equivalent).

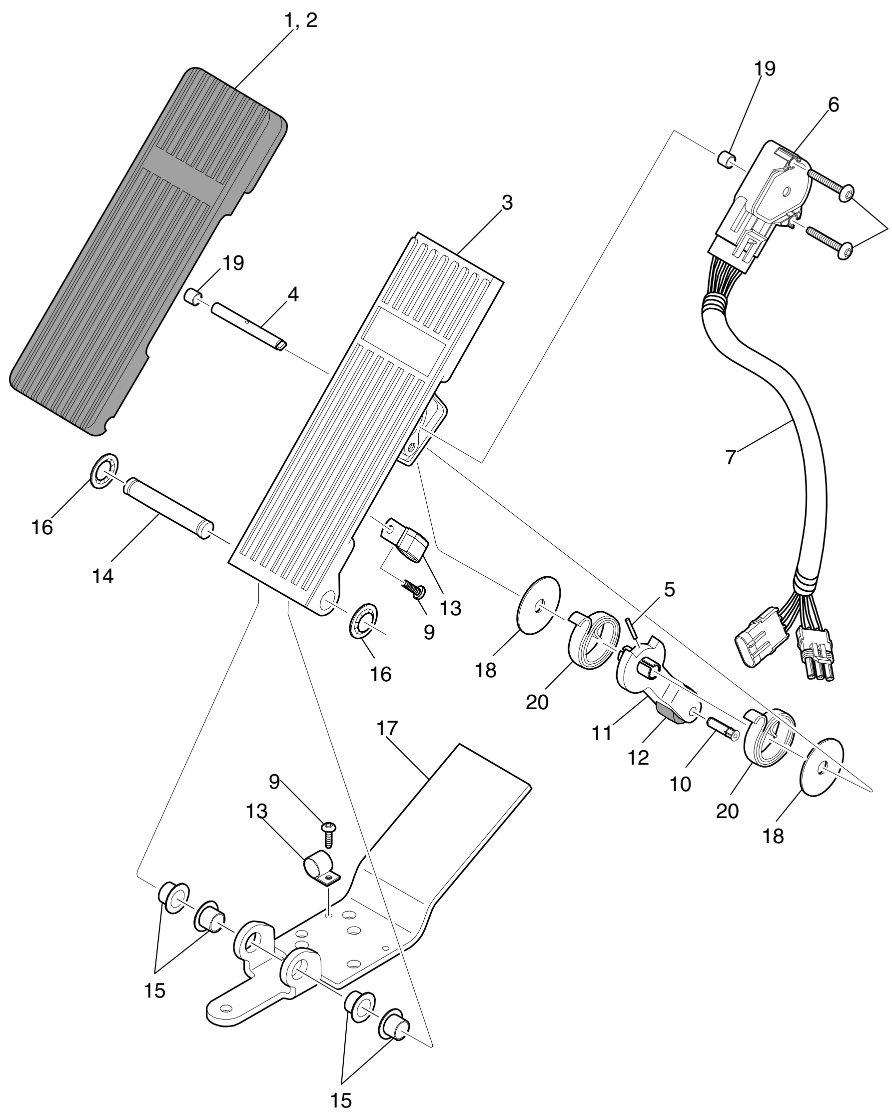
☞**NOTE:**

DO NOT use grease or oils, they will attract and retain contaminants.

4. Reinstall the nylon roller. Install bushings in pedal pivot holes (if applicable) and put pedal back on treadle base, taking care to install spring coils with the pivot pin.

4.3. Potentiometer Replacement

1. Set the Battery Disconnect switch to the OFF position.
2. Remove two screws which retain potentiometer in base of pedal. Disconnect wiring harness. Discard harness and potentiometer.
3. Install replacement potentiometer by aligning slot on potentiometer with tang on pinion in base of pedal. Rotate potentiometer 10 to 15° clockwise to align screw holes on potentiometer with holes in base of pedal. Install screws and torque 15 to 20 in-lb. Do not over tighten screws.
4. Connect wiring harness to vehicle wiring.
5. Set the Battery Disconnect switch to the ON position. Test drive vehicle and confirm correct operation of treadle.



1. Accelerator Assembly, Electronic (Incl. 2...20)
2. Cover, Treadle
3. Treadle
4. Shaft, Sensor
5. Pin, Spring 0.125 x 1.00" Lg.
6. Potentiometer, Sensor
7. Harness, Sensor
8. Screw, Truss
9. Screw, Pan #8
10. Shaft, Roller
11. Lever, Treadle
12. Roller
13. Clamp, Wire 0.50"
14. Pin, Treadle
15. Bushing, 1-Guide
16. Nut, Push
17. Base Plate
18. Washer, Thrust Outer
19. Bushing
20. Spring

s030701g.wmf

Fig. 19-14: Accelerator

5. STEERING & HORN

5.1. Description

☞NOTE:

Refer to Section 3 of this manual for further discussion or breakdown of steering components.

The tilt/telescopic wheel turns front wheels with aid of the steering hydraulic system (while engine is running).

CAUTION

DO NOT turn steering wheel if engine is not operating except in emergency situations.

DO NOT OPERATE VEHICLE if any of the following conditions exist:

- ❒ **Binding or resistance in steering wheel operation (with vehicle in motion).**
- ❒ **Unusual noises related to steering.**
- ❒ **Steering wheel vibration.**
- ❒ **Looseness of steering.**
- ❒ **Looseness, binding or resistance in tilt/ telescopic mechanism.**

The horn button is located in center of steering wheel. To sound horn, press down on button. Horn will sound until button is released.

Wheelchair Ramp

1. SAFETY

1.1. CNG Safety

This vehicle is equipped with a high pressure CNG fuel system. Special training is required for all service personnel involved in the maintenance of this system. Maintenance involving welding, flame cutting, torching or the production of sparks or hot particles is not permitted around or in the immediate vicinity of the CNG storage facilities or the vehicle CNG system.

Purge all traces of natural gas from any components of the CNG system requiring maintenance before performing any procedures involving:

- ❐ open flame
- ❐ excessive heat
- ❐ production of sparks
- ❐ production of hot particles

Refer to Section 7 of this manual for further safety information regarding your vehicle's CNG fuel system.

1.2. Safety Procedures

Refer to "Maintenance Safety Procedures" in the General Information Section of this manual for general and system-specific safety procedures.

1.3. Hydraulic System Safety

Observe the following procedures involving hydraulic line maintenance:

⚠ WARNING

Pressurized lines should not be disconnected until the pressure is safely and controllably released.

⚠ CAUTION

Hydraulic fluid is corrosive and should not be exposed to skin for extensive periods of time. Wear eye protection at all times.

2. WHEELCHAIR RAMP

2.1. Description

The wheelchair ramp assembly is located at the entrance door and consists of the following major components:

- ❐ Pivoting, fold-out aluminum ramp
- ❐ Recessed stainless steel ramp enclosure
- ❐ Hydraulically operated, chain-driven operating mechanism
- ❐ Power pack assembly consisting of electric motor, hydraulic pump, and manifold with control solenoids.
- ❐ Proximity switch, warning beeper, and electrical harnesses.

See “Fig. 20-1: Ramp Assembly Major Components” on page 2.

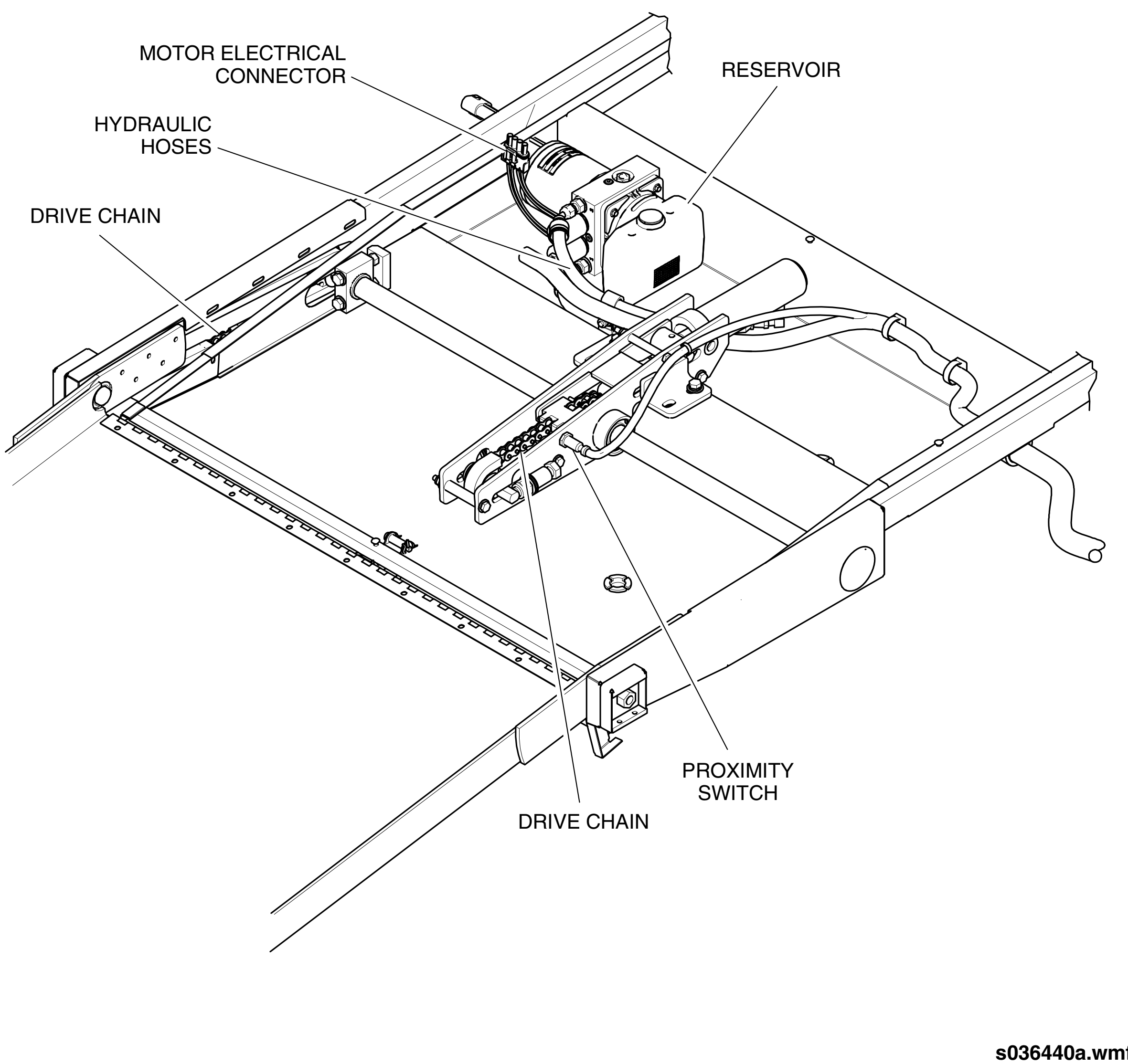


Fig. 20-1: Ramp Assembly Major Components

2.2. Operation

The wheelchair ramp is a hydraulically operated, chain-driven, fold-out ramp assembly. Refer to 2.2.1. “Hydraulic Operation” on page 3 in this section for a description of the hydraulic system operation and Refer to 2.2.2. “Mechanical Operation” on page 3 in this section for a description of the mechanical components operation. Also refer to Section 19 of this manual for information on the operation of the Ramp switch

2.2.1. Hydraulic Operation

☞**NOTE:**

Refer to the Entrance Door Wheelchair Ramp Hydraulic Schematic when reviewing this information.

The wheelchair ramp is controlled by the three-position Ramp switch located on the instrument panel. Switch positions and hydraulic functions are as follows:

- ❒ DEPLOY - This position activates the pump and the S2 solenoid in the valve block. The oil from the pump flows out of the manifold block and applies pressure to the base end of the ramp operating cylinder. The ramp then moves from the stowed position and starts through its arc until fully deployed. Oil from the rod end of the cylinder returns to the pump and reservoir through the S1 solenoid in the manifold block. A restrictor in the return oil circuit prevents the ramp from travelling faster than the pump oil supply as the ramp passes the vertical position.
- ❒ STOW - This position activates the pump and the S1 solenoid in the valve block. The oil from the pump flows out of the manifold block and applies pressure to the rod end of the ramp operating cylinder. The ramp then moves from the deployed position and starts through its arc until fully stowed. Oil from the base end of the cylinder returns to the pump and reservoir through the S2 solenoid in the manifold block. A restrictor in the return oil circuit prevents the ramp from travelling faster than the pump oil supply as the ramp passes the vertical position.
- ❒ FLOAT - This is the normal position of the switch. In this position the hydraulic pump and both solenoids (S1 & S2) are deactivated and the ramp will float to either DEPLOYED or STOWED position. When the solenoids are deactivated, the base and rod ends of the cylinder and the reservoir are hydraulically interconnected. This allows the weight of the ramp to operate the cylinder. The restrictors in the solenoid block prevent rapid oil flow and limit ramp travel speed. Manual operation is possible in this position.

2.2.2. Mechanical Operation

- ❒ DEPLOY - The hydraulic cylinder piston rod extends and acts on the push channel which is connected to a drive and idler sprocket by a chain spacer block and drive chain. The drive sprocket rotates the main drive shaft and the secondary drive sprockets located at either end of the shaft. A drive chain connects each of the secondary drive sprockets to a sprocket and pivot plate assembly which is fastened to the ramp. Actuation of the chain drive mechanism causes the ramp to pivot and swing outward until fully deployed.
- ❒ STOW - Operation of the ramp mechanism in the STOW mode is basically reverse of the DEPLOY operation. The hydraulic cylinder piston rod retracts and pulls on the push channel which in turn, through the drive sprockets, chains, and drive shaft, returns the ramp to the stowed position.

2.2.3. Proximity Switch Operation

An inductive normally-closed (N.C.) proximity switch is threaded into the RH (forward) support plate and senses movement of the push channel. There is no target (push channel) in front of proximity switch when the ramp is in the stowed position. The proximity switch is closed and sends a signal to the multiplexing system that the ramp is stowed.

As the ramp is deployed, the target (push channel) will move in front of the proximity switch at approximately 15° from the fully stowed position. The proximity switch will sense the target and become open (no signal to the multiplexing system). This signal is used to activate the brake and accelerator interlocks during ramp deployment and also illuminate the W/C Ramp indicator on the instrument panel.

2.2.4. Manual Operation

⚠ WARNING

Exercise caution when operating the ramp in manual mode. The hydraulic system will not provide dampening after the first deploy cycle and will fall freely. Ensure that you do not position yourself in the way of the ramp when it is falling to either the deployed or stowed positions.

The wheelchair ramp can be operated manually in the case of an emergency or failure of the hydraulic/electric system. Operate the ramp manually as follows:

1. Pull up on the lift strap, located on the edge of the ramp, and then grip the ramp with both hands and carefully raise the ramp to the vertical position.

⚠ WARNING

Ensure no one else is in the immediate area of the ramp, inside or outside of the vehicle.

2. Allow the ramp to free fall from the vertical position to the fully extended deploy position.

☞NOTE:

On the first manual deploy cycle, the hydraulic system will provide a dampening action to slow the ramp descent. Dampening will not be provided on subsequent cycles.

3. Stow the ramp manually by grasping the ramp plate with both hands and lifting to the vertical position.

⚠ WARNING

Ensure no one else is in the immediate area of the ramp inside the vehicle.

4. Allow the ramp to free fall from the vertical position to the stowed position.

☞NOTE:

When operating the ramp in the manual mode, oil will flow very slowly to fill the opposing side of the piston, taking approximately one minute. If the ramp is allowed to rest in the deployed position for at least one minute before stowing, then dampening action will be provided. However, if the ramp is returned from the deploy position to the stow position in less than one minute, then little or no dampening will be provided.

2.3. Maintenance

Refer to the Preventive Maintenance Section of this manual for regularly scheduled maintenance intervals and procedures.

2.4. Wheelchair Ramp Troubleshooting

WHEELCHAIR RAMP TROUBLESHOOTING		
SYMPTOM	**POSSIBLE CAUSE**	**SOLUTION**
Excessive resistance, binding, or jerking when deploying or stowing ramp	Problem in hydraulic system	Inspect hydraulic system. Refer to 2.4.1. “Hydraulic System Diagnosis” on page 7 in this section for procedure.
	Misaligned drive shaft	Align drive shaft. Refer to 2.7.3.7. “Ramp Mechanism Initial Adjustments” on page 25 in this section for procedure.
	Improperly adjusted drive chain(s)	Align drive chains. Refer to 2.7.3.7. “Ramp Mechanism Initial Adjustments” on page 25 in this section for procedure.
	Damaged or binding ramp pivot assemblies	Inspect LH & RH pivot assemblies. Clean debris and any buildup of dirt or grease from the pivot area. Apply lubricant to the pivot assembly bushing. Refer to the Preventive Maintenance Section of this manual for lubricant specification and procedure.
Ramp does not function in STOW or DEPLOY positions	Faulty ramp toggle switch	Replace ramp toggle switch
	No power to electric motor	Refer to electrical schematic and check fuse, ramp pump relay, ramp switch, and electrical connector at motor. Repair or replace defective component
	Entrance door not fully open	Check and adjust mechanical door stop Check and adjust door open limit switch
Ramp motor operates but ramp will not stow	Faulty S1 solenoid valve	Perform solenoid electrical test. Refer to 2.4.3. “Solenoid Testing” on page 8 in this section for procedure. Replace faulty solenoid.
Ramp motor operates but ramp will not deploy	Faulty S2 solenoid valve	Perform solenoid electrical test. Refer to 2.4.3. “Solenoid Testing” on page 8 in this section for procedure. Replace faulty solenoid.

WHEELCHAIR RAMP TROUBLESHOOTING		
SYMPTOM	**POSSIBLE CAUSE**	**SOLUTION**
Ramp functions opposite of the ramp switch STOW and DEPLOY positions	Incorrect hydraulic hose connections	Refer to 2.4.1. “Hydraulic System Diagnosis” on page 7 in this section to determine proper hose connections
	Solenoids incorrectly wired	Confirm wires on connector between solenoids and vehicle harness are correctly installed
Ramp slams when deploying	S1 solenoid not fully closing	Replace S1 solenoid
Ramp slams when stowing	S2 solenoid not fully closing	Replace S2 solenoid
Ramp slams when stowing or deploying	Internal leakage in actuating cylinder or manifold block	Replace manifold block. If problem still exists, replace actuating cylinder
Ramp is stowed but interlocks remain on, W/C indicator on instrument panel remains illuminated, and ramp motor/ pump continues to run	Faulty proximity switch (open circuit)	Test operation of proximity switch. Refer to 2.4.4. “Proximity Switch Testing” on page 8 in this section for procedure. Adjust or replace switch as necessary.
	Faulty wiring	Refer to electrical schematic and check fused power supply to proximity switch. Check ground circuit. Confirm output to multiplexing system with switch in normally-closed position. Repair wiring as required
Ramp deploys but W/C Ramp indicator on instrument panel does not illuminate	Multiplexing system is receiving a STOWED signal from the proximity sensor instead of a DEPLOY signal	Test operation of proximity switch. Refer to 2.4.4. “Proximity Switch Testing” on page 8 in this section for procedure. Adjust or replace switch as necessary. Refer to electrical schematic and check wiring connections at proximity switch for possibility of power wire being short-circuited to signal wire.

2.4.1. Hydraulic System Diagnosis

The following checks and test procedures will help diagnose and isolate problems in the hydraulic system.

1. Confirm that the hydraulic hoses are properly connected between the hydraulic block and the actuating cylinder. The hose from the S1 port of the hydraulic block should be connected to the rod end of the cylinder. The hose from the S2 port should be connected to the base end of the cylinder.
2. Isolate the hydraulic system to determine whether the excessive resistance or binding is a mechanical or hydraulic problem. Remove the hoses from the manifold block. Install clean, extended length Teflon hoses into the manifold S1 and S2 ports and place the ends of the hoses into a glass jar. Manually move the ramp from the stowed to the deploy position. If there is resistance to movement then the problem is mechanical.

   ☞**NOTE:**

   If dirty or contaminated fluid is evident in the glass jar then the system will need to be flushed. Refer to 2.4.2. “Hydraulic System Flushing” on page 7 *in this section for procedure.*

3. Maintain the test hoses in the glass jar as described in the previous step. Briefly operate the ramp switch in both the DEPLOY and STOW positions. Fluid should flow freely from the S1 hose when in the DEPLOY position and from the S2 hose when in the STOW position.
4. If only one of the hoses allowed fluid to flow then check to see whether;
   a. the solenoid is functioning for the hose without flow. Replace solenoid if defective.
   b. the restrictor orifice is blocked in the line for the hose without flow. Replace the manifold block if orifice is blocked.
5. If little or no flow is evident during test, then inspect for a faulty pressure relief valve. Replace the manifold block if pressure relief valve is stuck open.

2.4.2. Hydraulic System Flushing

If dirty or contaminated fluid is noted in the system then the following flushing procedure will need to be performed:

1. Remove the plug from the reservoir and drain all fluid.
2. Manually operate the ramp through several cycles while draining the fluid, so as to force fluid back to the reservoir.
3. Disassemble reservoir from manifold and replace inlet filter and O-ring.
4. Reassemble reservoir and manifold.
5. Reinstall plug and fill reservoir with clean fluid. Manually operate ramp through several cycles to force fluid through the system.
6. Repeat steps 2 and 5 until fluid is clean.

2.4.3. Solenoid Testing

☞**NOTE:**

Refer to Electrical Schematic "ES-Kneeling LK" when performing solenoid tests.

Manually deploy the ramp, remove the access cover plate, and disconnect the wring harness to the solenoids.

2.4.3.1. S1 Solenoid

Test the S1 stow solenoid as follows:

1. Set the ramp switch to the STOW position and check for 24 VDC between pins "C" and "D". If reading is OK, proceed to step 4.
2. Check for 24 VDC output from multiplexing module. Refer to electrical schematic for module address.
3. Check that pin "D" on connector is providing a good ground.
4. Use an Ohmmeter to measure resistance between pins "C" and "D" of the connector on the solenoids.

⚠CAUTION

DO NOT measure resistance on the vehicle supply side of the wiring connector.

5. Replace solenoid if resistance value does not fall within 27.9 ± 2.0 Ohms.

2.4.3.2. S2 Solenoid

Test the S2 deploy solenoid as follows:

1. Set the ramp switch to the DEPLOY position and check for 24 VDC between pins "A" and "B". If reading is OK, proceed to step 4.
2. Check for 24 VDC output from multiplexing module. Refer to electrical schematic for module address.
3. Check that pin "B" on connector is providing a good ground.
4. Use an Ohmmeter to measure resistance between pins "A" and "B" of the connector on the solenoids.

⚠CAUTION

DO NOT measure resistance on the vehicle supply side of the wiring connector.

5. Replace solenoid if resistance value does not fall within 27.9 ± 2.0 Ohms.

2.4.4. Proximity Switch Testing

The proximity switch is a normally-closed (N.C.) inductive switch. The switch is powered when the vehicle is either in DAY-RUN or NIGHT-RUN. A signal is sent to the multiplexing system when there is no target in proximity to the switch (STOW position). When the switch is in proximity to the target, the switch becomes "open" and no signal is sent to the multiplexing system (DEPLOY position).

Test the proximity switch as follows:

1. Remove the access cover from the ramp and confirm that the proximity switch is uncovered by the push channel when in the stowed position.
2. Turn the Master Run switch to DAY-RUN and then place a metal object over the face of the proximity switch. The interlocks should apply and the W/C Ramp indicator on the instrument panel should illuminate.
3. Remove the metal object and confirm that the interlocks release and the W/C Ramp indicator extinguishes.
4. Manually deploy ramp and confirm that the interlocks apply and the W/C Ramp indicator illuminates as soon as the target (push channel) comes within close proximity to the switch.

2.5. Removal

☞**NOTE:**

The following procedure describes the removal of the entire ramp assembly as a unit from the vehicle, including operating mechanism and hydraulic power pack. Refer to 2.7. “Ramp Operating Mechanism” on page 12 *in this section for detailed servicing procedures on this assembly.*

1. Set the Battery Disconnect switch to the OFF position.
2. Manually deploy the ramp.
3. Remove the interior dash access cover and disconnect the electrical cables to the wheelchair ramp. See “Fig. 20-2: Ramp Installation” on page 10.
4. Remove the nut from the conduit connector and release the two clamps attaching the conduit to the vehicle structure.
5. Remove the floor closeout plates from around the wheel chair ramp.
6. Remove the ramp access cover to expose the hydraulic pump and chain drive mechanism. See “Fig. 20-3: Ramp Assembly” on page 11.
7. Remove the two 5/16" bolts that secure the operating mechanism to the vehicle structure.

☞**NOTE:**

The ramp operating mechanism mounting bracket has four slotted holes. The front (outboard) holes are used to secure the operating mechanism to the weld-nuts in the vehicle structure. These two bolts need to be removed in order to separate the ramp operating mechanism from the ramp enclosure.

8. Remove the two screws that secure the inboard corners of the ramp to the structure angle brackets.
9. Remove the four 1/4" bolts that secure the outboard corners of the ramp to the structure angle brackets.

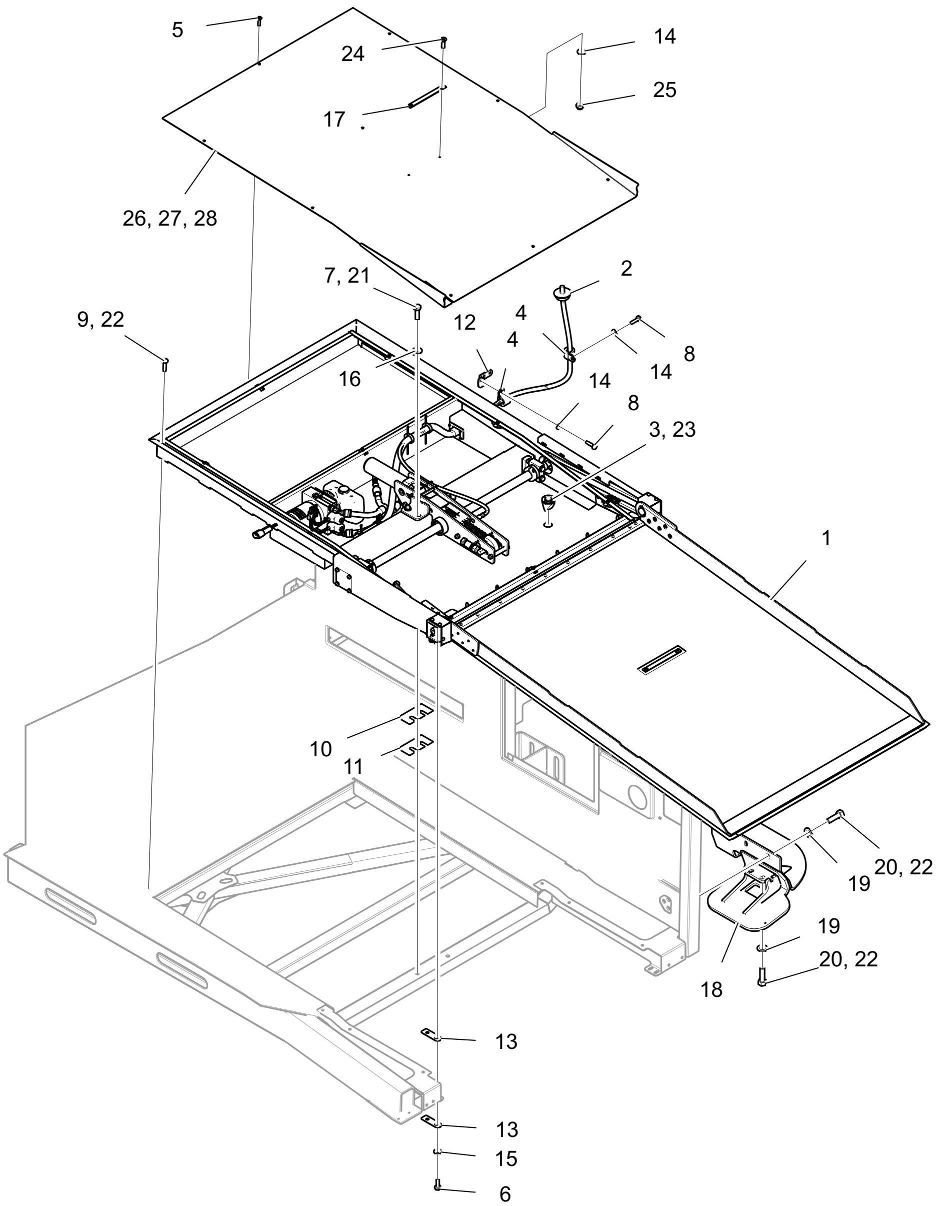
☞**NOTE:**

Spacer plates are used at the outboard corners. Note the position and retain these spacers for reinstallation.

10. Manually stow the ramp.
11. Using appropriate lifting equipment, remove the ramp from the vehicle, taking care to avoid damaging the electrical cables and conduit.

☞**NOTE:**

The ramp has been sealed to the floor using flooring sealant. It may be necessary to cut the sealant to complete the ramp removal.



1. Wheelchair Ramp Assembly
2. Grommet, Rubber 1.5" O.D. x .50" I.D. x .18" Thk.
3. Ejector, Dust/Water
4. Clamp, "P" .750" SST/HT
5. Screw, FH Cross Recess SST #10 - 24 UNC x 3/4" Lg.
6. Bolt, Hex 1/4" - 20 UNC x 3/4" Lg. SST
7. Bolt, Hex SST 5/16" - 18 UNC x 1" Lg.
8. Screw, PH Cross Recess Tpg. Type F #10 - 24 x 3/4" Lg. SST
9. Screw, SST Cross Recess Tpg. Type F 1/4" - 20 UNC x 1" Lg.
10. Spacer, Wheelchair Ramp .050" Thk.
11. Spacer, Wheelchair Ramp .037" Thk.
12. Bracket, Mounting P-Clamp
13. Spacer, Wheelchair Ramp .063" Thk.
14. Washer, Flat SST #10
15. Washer, Flat SST 1/4"
16. Washer, Flat 5/16" SST
17. Spacer, Wheelchair Ramp .625" Width x 6.00" Lg.
18. Skid Plate
19. Washer, Flat 3/8"
20. Bolt, Hex 3/8" - 16 UNC x 1 1/4" Lg.
21. Loctite, 263 Red Threadlocking
22. Loctite, 243 Blue
23. Adhesive, SIKA 221 Black
24. Screw, FH Cross Recess SST #10 - 32 UNF x 5/8" Lg.
25. Nut, Nylon Lock #10 - 32 SST
26. Cover Assembly, 32" with Full Metal Jacket (Incl. 27-28)
27. Plate, Cover 32" Ramp
28. Paint, Safety Yellow

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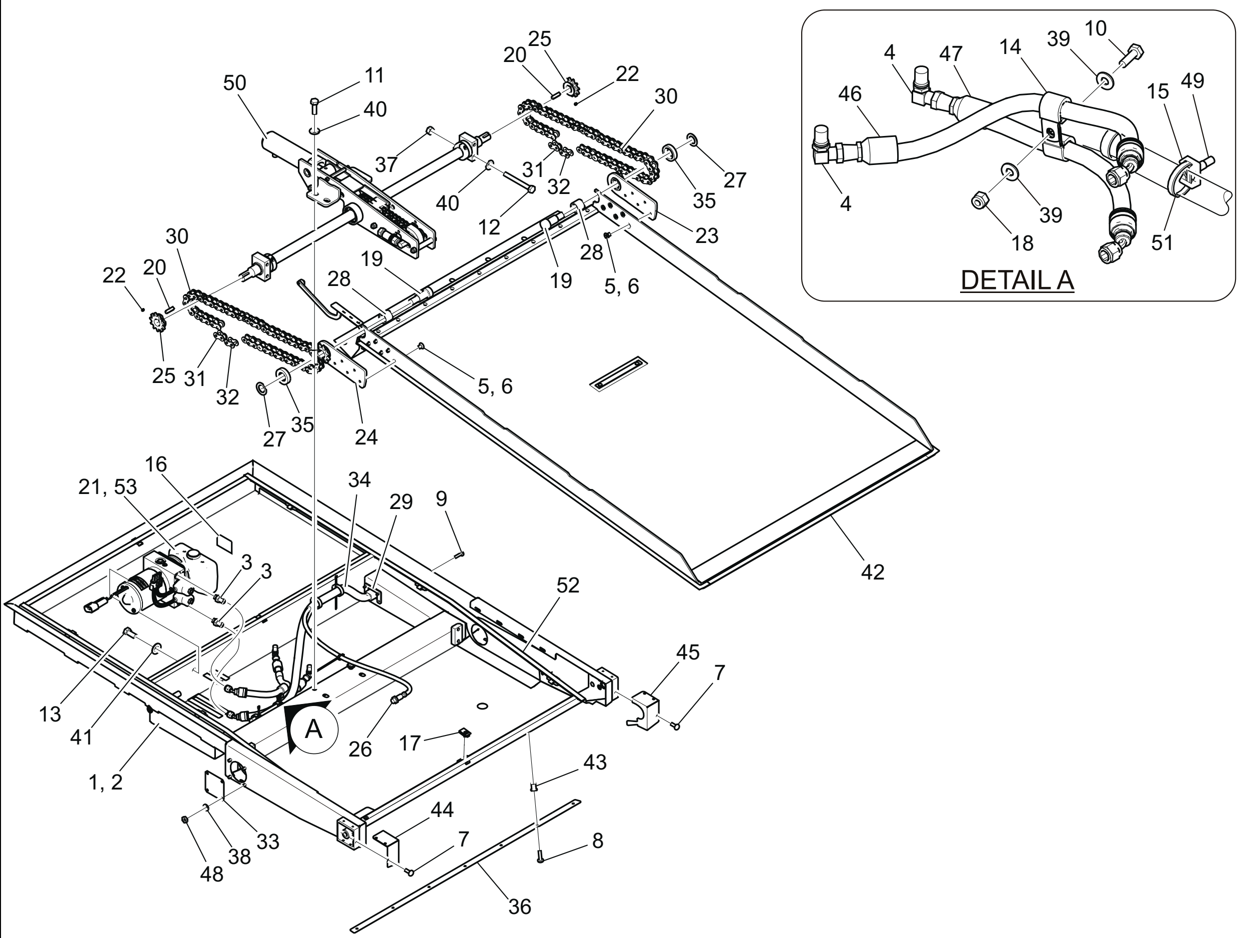
Fig. 20-2: Ramp Installation



1. Wheelchair Ramp Assembly, Entrance (Incl. 2-53)
2. Box Assembly, SST
3. Fitting, #4 ORB Adapter
4. Fitting, #4 ORB 90° Elbow
5. Loctite
6. Screw, FH Cross Recess SST 1/4" - 28 UNF x 3/8" Lg.
7. Screw, PH Cross Recess SST #10 - 24 UNC x 1/2" Lg.
8. Screw, PH Cross Recess SST #10 - 24 UNC x 3/4" Lg.
9. Screw, PH Cross Recess SST #8 - 32 UNC x 5/8" Lg.
10. Bolt, Hex 1/4" - 20 UNC x 3/4" Lg.
11. Bolt, Hex 5/16" - 18 UNC x 1" Lg.
12. Bolt, Hex 5/16" - 18 UNC x 2 3/4" Lg.
13. Bolt, Hex 3/8" - 16 UNC x 3/4" Lg.
14. Clamp, "P" .562" SST/HT
15. Base, Cable Mount
16. Decal, Fill Line
17. Receptacle, Clip-On
18. Nut, Hex SST 1/4" - 20 UNC
19. Screw, SST 5/8" X 1" Lg.
20. Key, SQ 3/16" x 3/4" Lg.
21. Pump Assembly, Ramp
22. Screw, Set #10 - 32 UNF x 1/8" Lg.
23. Pivot Ramp Assembly, LH
24. Pivot Ramp Assembly, RH
25. Sprocket
26. Switch, Proximity
27. Washer, Thrust 5/8" x 1" x 1/16"
28. Bearing Sleeve, 5/8" x 7/8" x 3/4"
29. Bracket
30. Chain, Roller # 41 x 36 Lg.
31. Link, Connecting #41
32. Link, Offset #41 AC
33. Cover, Pivot Mount Channel
34. Harness
35. Spacer, Wheelchair Ramp
36. Plate, Rubber Closeout
37. Nut, Hex SST 5/16" - 18 UNC
38. Washer, Flat SST #10
39. Washer, Flat SST 1/4"
40. Washer, Flat SST 5/16"
41. Washer, Flat SST 3/8"
42. Ramp Assembly, 32"
43. Insert, SST #10 - 24 UNC
44. Wheelchair Ramp Chain Cover Assembly
45. Wheelchair Ramp Chain Cover Assembly
46. Hose Assembly, FC510-04 13.06 FL
47. Hose Assembly, FC510-04 10.13 FL
48. Nut, Hex SST #10-32 UNF
49. Rivet, Mono Blind SST 1/4" x .080/.375
50. Mechanism Assembly, 32"
51. Cable Tie, 4" Lg. Black
52. Seal, Rubatex 0.5" W x 0.06" Thk.
53. Loom, Convoluted Split .38"

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Fig. 20-3: Ramp Assembly

2.6. Installation

1. Using appropriate lifting equipment, position the ramp into the flooring cutout, taking care to avoid pinching the electrical wires and conduit.
2. Apply downward pressure on the perimeter flange facing the driver's platform and manually open the ramp into the deployed position.
3. Align the open slots on the operating mechanism with the weld-nuts in the vehicle structure.
4. Install the 5/16" bolts but do not tighten.
5. Install the screws at the inboard corners of the wheel chair ramp ensuring ramp flanges are snug to the top of the flooring.
6. Align the outboard end of the ramp to the structure angles and install spacer plates, washers and the four 1/4" bolts. Torque all bolts to 18 ft-lb ± 1 ft-lb (24 Nm ± 1 Nm).
7. Install the floor close-out plates and apply sealant to any gaps between the ramp and the floor.
8. Install the cover. Ensure the perimeter gap between the cover plate and the ramp outer channel does not exceed a maximum of 5/8" (16mm) and that the ramp is able to move into the stowed position without contacting the cover.

WARNING

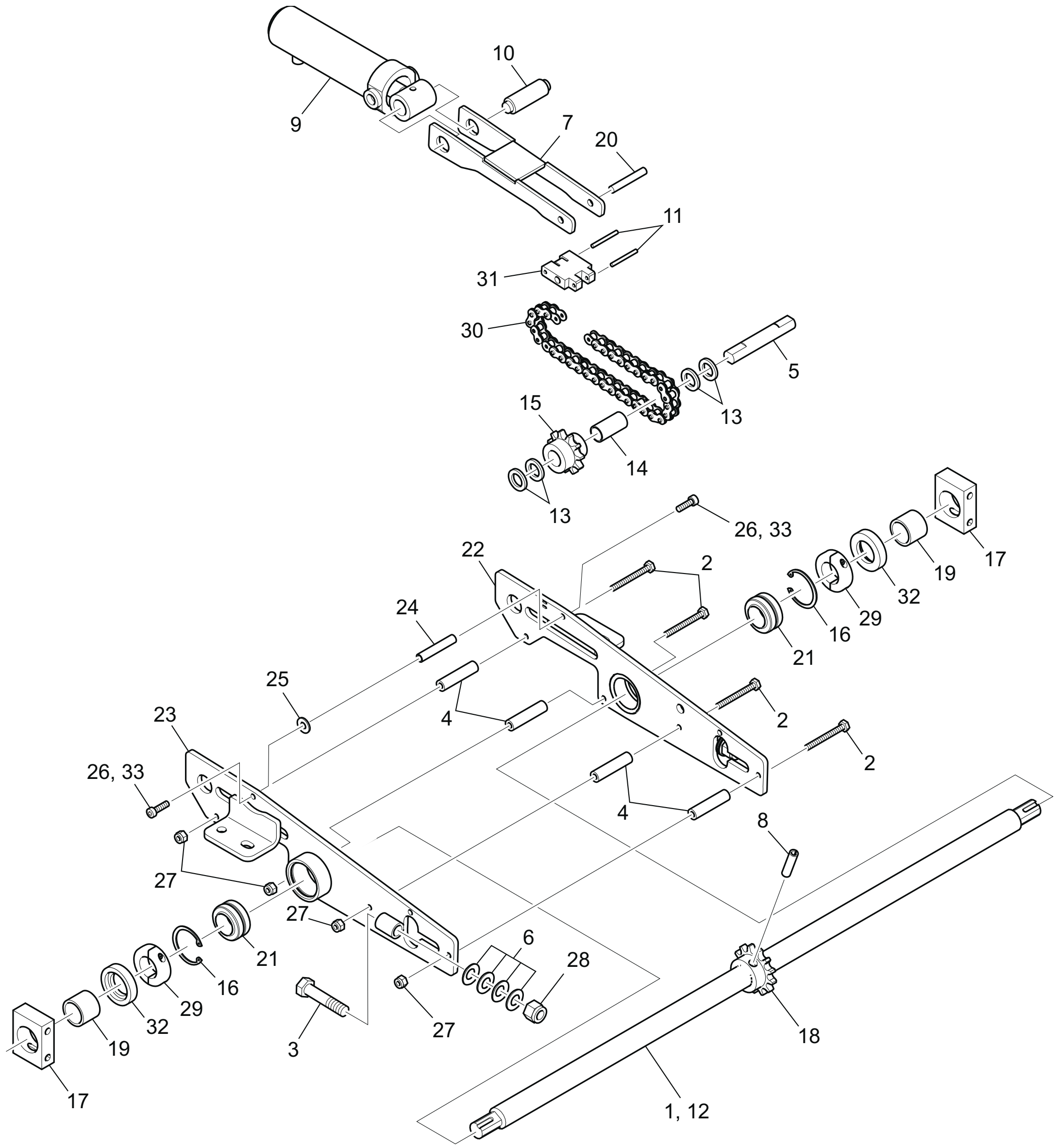
The maximum gap of 5/8" (16mm) is an American Disabilities Association (ADA) specification. This gap dimension MUST NOT be exceeded around the perimeter of the cover plate.

9. Route the conduit to the hole in the front mask and secure the connector in place with the threaded nut. Secure the conduit in place with two clamps. Reconnect the cables and install the interior dash access cover.
10. Install the floor closeout plates.
11. Set the Battery Disconnect switch to the ON position.
12. Test the function of the ramp.

2.7. Ramp Operating Mechanism

2.7.1. Description

The ramp operating mechanism includes the mechanical, hydraulic, and electrical components that drive the hydraulic cylinder, drive shafts, sprockets, chains, and pivot plates. Refer to 2.8. “Hydraulic Power Pack & Cylinder” on page 27 in this section for descriptive information and servicing procedures on the hydraulic operating components. See “Fig. 20-4: Ramp Mechanism Assembly” on page 13.



1. Mechanism Assembly, 32" (Incl. 2-33)
2. Bolt, Hex SST 1/4" - 20 UNC x 3" Lg.
3. Bolt, Hex SST 1/2" - 13 UNC x 2 1/4" Lg.
4. Spacer, Bushing
5. Shaft, Clevis
6. Spring Disk
7. Push Channel Assembly
8. Pin, Spring
9. Cylinder Assembly, 1503.5
10. Shaft, Push
11. Pin, Dowel
12. Shaft, 1" Diameter
13. Washer, Thrust 5/8" I.D.
14. Sleeve Bearing, Bronze .625 x 0.75 x 1.5" Lg.
15. Sprocket Assembly
16. Retainer
17. Block Tensioner 1"
18. Sprocket
19. Sleeve Bearing, 1" x 1.25" x 1" Lg.
20. Pin, Dowel
21. Bushing, Spherical 1" I.D.
22. Bracket, Wheelchair Mechanism LH
23. Bracket, Wheelchair Mechanism RH
24. Standoff, #8 - 32 x 2.0" Lg.
25. Washer, #10 x 3/8" x 0.05 Thk
26. Screw, Hex Socket SST #10 - 32 UNF x 3/4" Lg.
27. Nut, Lock Nylon 1/4" - 20 UNC SST
28. Nut, Lock Nylon SST 1/2" UNC
29. Collar, Wheelchair Ramp
30. Chain, Roller
31. Chain Spacer, Block
32. Spacer, Wheelchair Ramp
33. Loctite, 243

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Fig. 20-4: Ramp Mechanism Assembly

2.7.2. Disassembly

2.7.2.1. Ramp Plate Removal

☞**NOTE:**

Ramp plate removal can be performed with ramp mechanism installed in the vehicle.

1. With the ramp plate in the stowed position remove the nine 10-32 screws and rubber flap and trim pieces from each side of the ramp plate.
2. Remove the seven 10-24 screws and closeout plate that attach the rubber cover to the bottom of the ramp box. See “Fig. 20-5: Rubber Hinge Cover” on page 14.
3. Manually deploy ramp plate.
4. Remove the eleven 10-24 screws that attach the cover to the ramp box. Remove the cover by lifting the inner edge and pulling inward to disengage the cover slot from the hinge arm.
5. Support the ramp plate in a horizontal position and remove the five Phillips flat head screws on each side of the ramp plate that secure the pivot plate and sprocket to the ramp plate. See “Fig. 20-6: Ramp Plate Removal” on page 14.
6. Carefully slide the ramp plate complete with piano hinge, rubber cover, and hinge arm out of ramp box and move the assembly to a work area for further disassembly as required. Refer to 2.7.2.2. “Hinge & Cover Removal” on page 15 in this section for disassembly procedures.

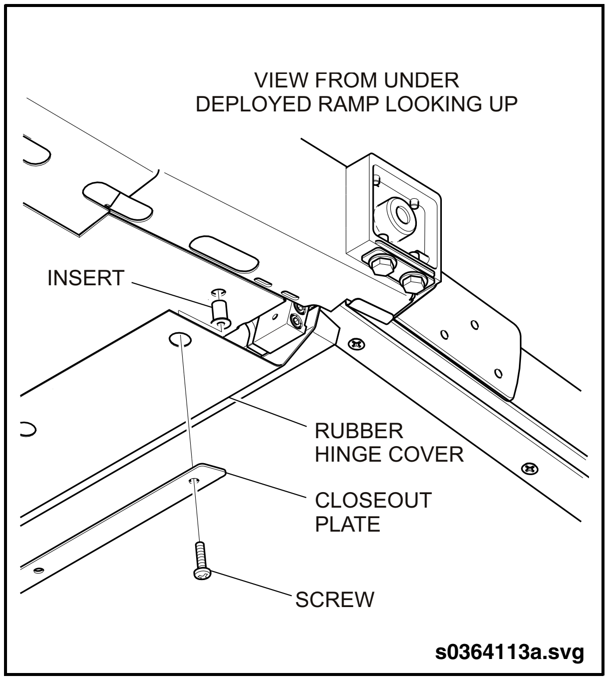

Fig. 20-5: Rubber Hinge Cover

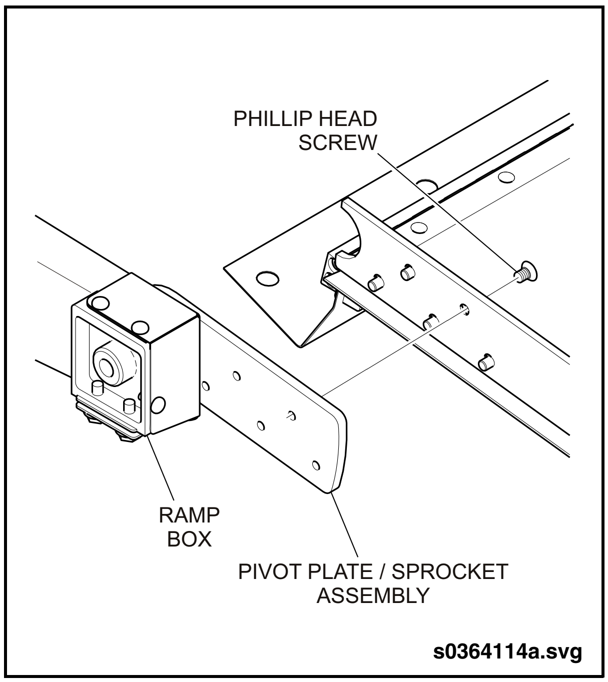

Fig. 20-6: Ramp Plate Removal

2.7.2.2. Hinge & Cover Removal

☞NOTE:

The following procedure describes the replacement of the piano hinge and rubber cover on the ramp plate with the ramp plate removed from the vehicle.

1. Remove the eleven 10-32 screws that attach the trip deflector plate and hinge assembly to the ramp plate. See “Fig. 20-7: Hinge & Cover Assembly” on page 15.
2. Remove the ten 10-24 socket head screws that attach the front closing bar to the hinge and closeout block. Separate the front closing bar, hinge assembly, rubber cover, and closeout block.
3. Remove the hinge arm and roller assembly from the closeout block by removing the two 10-24 socket head screws. Separate the spacer and hinge arm assembly from the closeout block.
4. Inspect the roller on the hinge arm and replace if required by removing the 8-32 socket head screw that fastens the roller to the hinge arm.

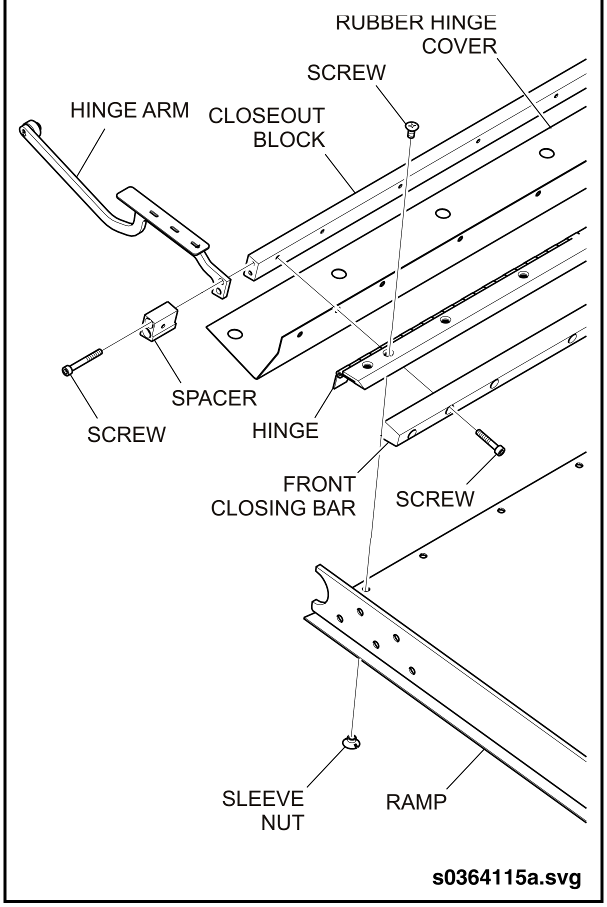

Fig. 20-7: Hinge & Cover Assembly

2.7.2.3. Drive Sprockets, Chain, & Pivot Plate Removal

☞**NOTE:**

The removal of these components can be performed while installed in the vehicle or with the ramp box removed from the vehicle. The following procedure describes component removal while installed in the vehicle.

1. Remove the ramp box top cover.
2. Relieve chain tension by loosening the lock nuts and two bolts from each of the tensioner blocks. See “Fig. 20-8: Tensioner Block” on page 16.
3. Loosen the four bolts that attach the mechanism support plates to the ramp box. See “Fig. 20-9: Mechanism Mounting” on page 16.
4. Disconnect the master link on the LH and RH drive chains and lift chain from sprockets. See “Fig. 20-10: Drive Chain & Sprocket” on page 17.
5. Remove the drive sprockets from the main driveshaft by loosening both setscrews in drive sprockets and sliding sprockets off shaft. Retain square keys for reassembly.

☞**NOTE:**

Alternatively, the drive sprockets can remain on the main driveshaft and be removed once the operating mechanism has been moved to a work bench.

6. Remove ramp pivot plate/sprockets as follows:
   a. Remove the shoulder screw that secures the sprocket to the ramp box.
   b. Slide out the shoulder bolt, Teflon bushing, and thrust washers, noting the location of the different sized thrust washers.
   c. Remove the pivot plate/sprocket assembly from the ramp box.

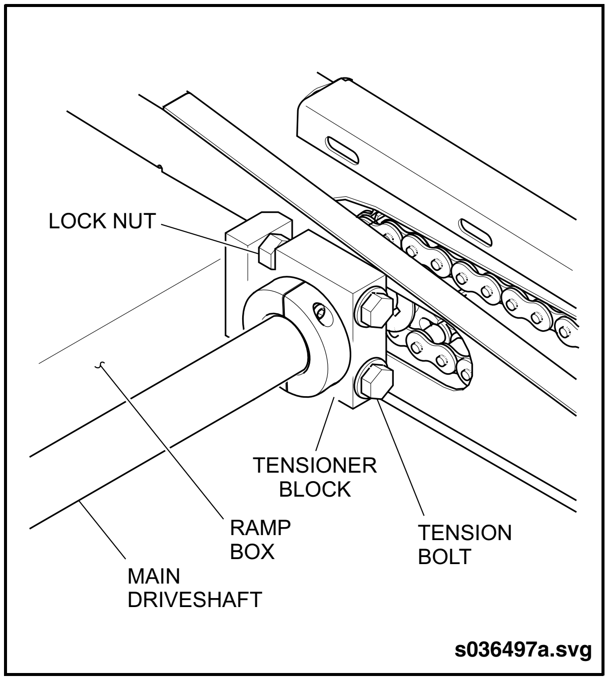

Fig. 20-8: Tensioner Block

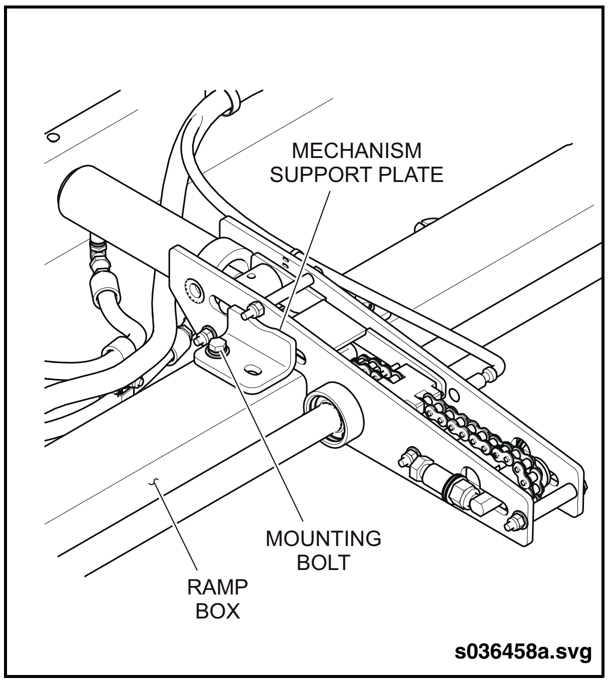

Fig. 20-9: Mechanism Mounting

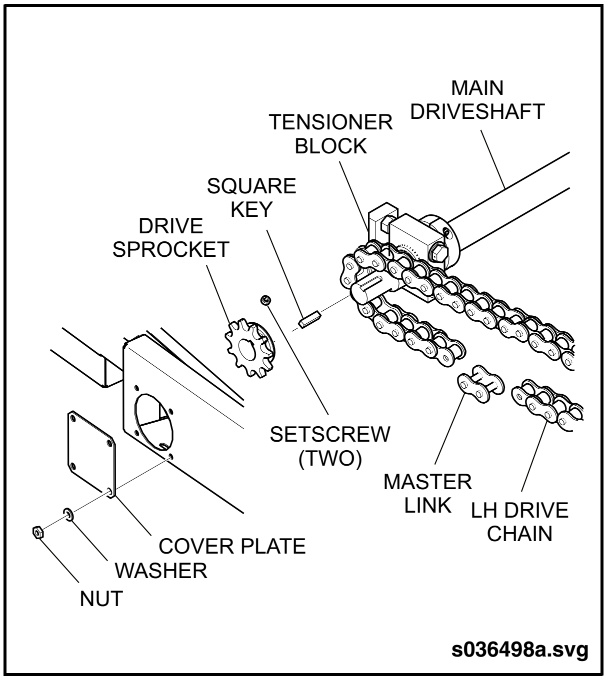

Fig. 20-10: Drive Chain & Sprocket

2.7.2.4. Operating Mechanism Removal

NOTE:

The removal of the operating mechanism can be performed while installed in the vehicle or with the ramp box removed from the vehicle. The following procedure describes operating mechanism removal while installed in the vehicle and assumes that the ramp box cover, drive sprockets and chains have been previously removed. Refer to 2.7.2.3. “Drive Sprockets, Chain, & Pivot Plate Removal” on page 16 *in this section for procedure to remove these components.*

NOTE:

Ensure all work is performed in a clean work area and that all hydraulic hoses and ports are properly protected and capped.

1. Unplug the electrical connectors from the motor harness and proximity switch.
2. Disconnect and cap the hydraulic lines and ports on the actuating cylinder.
3. Remove the four bolts that attach the mechanism support plates to the ramp box.
4. Remove the two adjusting bolts and lock nuts from each of the tensioning blocks.
5. Remove the four nuts and washers and remove the square cover plate from the LH side of the ramp box.
6. Carefully lift the ramp operating mechanism and remove it from the ramp box.

NOTE:

Slide the LH end of the shaft into the 2 1/4" hole and angle the mechanism so that the ends of the shaft will clear the inside edges of the ramp box.

2.7.2.5. Ramp Power Pack Removal

NOTE:

Refer to 2.8. “Hydraulic Power Pack & Cylinder” on page 27 *in this section for removal procedures.*

2.7.2.6. Operating Mechanism Disassembly

☞**NOTE:**

Ensure all work is performed in a clean work area and that all hydraulic hoses and ports are properly protected and capped.

1. Remove the protective plugs from the actuating cylinder and manually extend the cylinder (deployed position). Reinstall protective caps.
2. Remove the proximity switch from the RH side support plate.
3. Remove the two adjustment bolts from each of the tensioner blocks and slide blocks off the main driveshaft.
4. Relieve chain tension on the actuating cylinder drive sprockets by loosening the adjustment nuts located on either side of the idler sprocket. See “Fig. 20-11: Chain Tension Adjustment” on page 18.

☞**NOTE:**

DO NOT attempt to loosen the head of the bolt as it is held captive by the side support plates. Always use the hex head nut to adjust chain tension.

5. Remove the idler sprocket by pushing out the clevis shaft. Note the location and quantity of thrust washers. Remove the bronze bushing from the bore of the sprocket.
6. Remove the two pins that attach the drive chain to the chain spacer block. Remove the chain and spacer block. See “Fig. 20-12: Drive Chain & Spacer Block” on page 19.

☞**NOTE:**

The chain spacer block serves to connect the push channel to the drive chain and effectively becomes the chain master link.

7. Drive out the spring pin that retains the drive sprocket to the main driveshaft.
8. Remove the collar and the spacer from both ends of the main driveshaft.
9. Slide the main driveshaft out of the side support plates, noting the orientation of the drive sprocket collar.
10. Remove internal snap rings that retain the spherical bearings in the side support plates. Remove bearings from support plates.
11. Separate the LH & RH side support plates by removing the upper hex standoff, four through-bolts, spacers, nuts, and washers.

☞**NOTE:**

The fastener located at the top-most hole of the support plates uses a hex-shaped standoff that is threaded at either end and held in place with 10-32 UNF screws.

12. Remove the adjusting bolts from each of the side support plates, noting the location and positioning of the Belleville washers.
13. Separate the push channel from the actuating cylinder by pressing out the connecting push shaft.

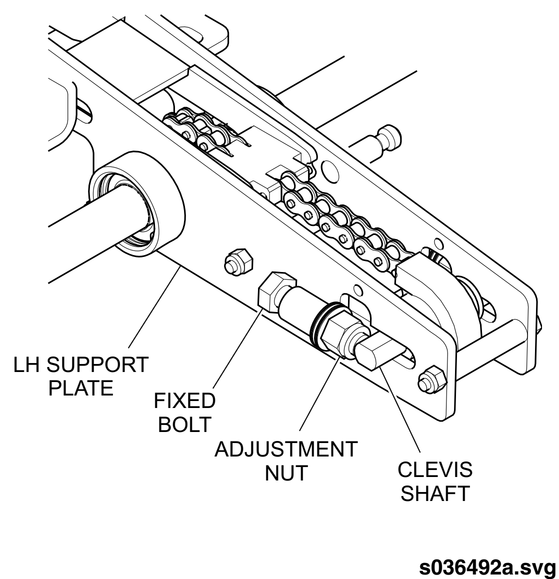

Fig. 20-11: Chain Tension Adjustment

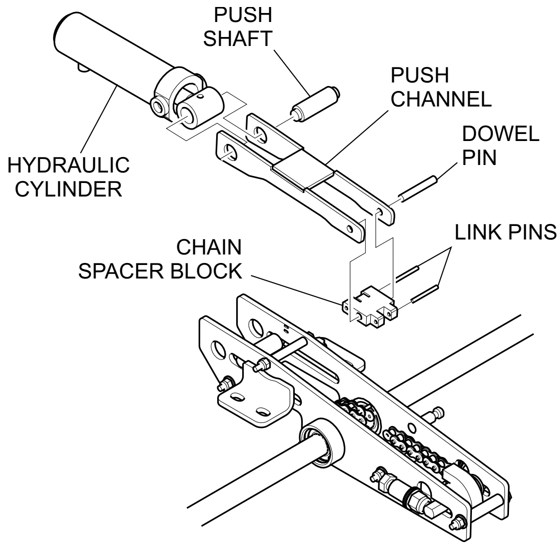

Fig. 20-12: Drive Chain & Spacer Block

2.7.3. Assembly

2.7.3.1. Ramp Plate Installation

1. Carefully move ramp plate assembly into position so that hinge arm enters ramp box and holes in ramp plate align with holes in pivot plates on ramp box.
2. Apply Loctite 243 to screw threads and secure ramp plate to each pivot plate with five Phillips flat head screws. Torque screws to 8 ft-lbs.
3. Slide the cover onto the ramp box, ensuring that the hinge arm engages the slot in the cover. Secure cover to ramp box with eleven 10-24 screws.
4. Manually stow the ramp plate.
5. Attach the rubber cover to the bottom of the ramp box using closeout plate and seven 10-24 screws.
6. Fasten the rubber flap and trim pieces on each side of the ramp plate using nine 10-32 screws on each side. Ensure that the curved portion of the rubber flap faces downward.

2.7.3.2. Hinge & Cover Installation

1. Install new roller on hinge arm, if required, and secure with 8-32 socket head screw.
2. Attach spacer and hinge arm assembly to closeout block with two 10-24 socket head screws.
3. Assemble the closing bar, hinge assembly, rubber cover, and closeout block and secure together with ten 10-24 socket head screws.
4. Position the previously assembled components on the ramp plate, aligning the holes in the trip deflector plate with the holes in the ramp plate.
5. Apply Loctite 243 to screw threads and secure components to ramp plate with eleven 10-32 screws. Torque screws to 24 in-lbs.

2.7.3.3. Drive Sprockets, Chain, & Pivot Plate Installation

☞**NOTE:**

If the operating mechanism was removed from the ramp box, install the side sprockets onto the main driveshaft before installing the mechanism.

1. Assemble the ramp pivot plate/sprocket assembly using Teflon bushing, shoulder bolt, and thrust washers. Ensure Teflon bushing is fully seated in sprocket counterbore and the shoulder bolt is lubricated with lithium grease. See “Fig. 20-13: Pivot Plate Installation” on page 21.

☞**NOTE:**

Ensure that the bronze thrust washers and shoulder bolt are properly installed. Both washers go between the Teflon bushing and the ramp box. The thin washer faces the Teflon bushing and the thick washer faces the ramp box. The head of the shouldered bolt bears directly against the Teflon bushing.

2. Insert assembled ramp pivot plate/sprocket assembly into ramp box. Apply Loctite 243 to the threads of the shoulder bolt and torque bolt to 42 ft-lbs. (57 Nm).

☞**NOTE:**

Ensure that the pivot plate/sprocket assembly rotates freely within the ramp box.

3. Install sprockets on either end of main driveshaft ensuring square key is properly located and both setscrews are tightened.
4. Fully extend the actuating cylinder to the deployed position.
5. Place the LH & RH drive chains onto the sprockets and connect with master link.

☞**NOTE:**

Assemble the master link on the lower run of the chain. The master link location should align with the edge of the pivot plate when the ramp is in the deployed position.

6. Position the pivot plate at a downward angle of approximately 9° to represent the ramp plate in the deployed position when connecting the chains. See “Fig. 20-14: Pivot Plate Alignment” on page 21.
7. Align the operating mechanism and adjust the chain tension. Refer to 2.7.3.7. “Ramp Mechanism Initial Adjustments” on page 25 in this section for adjustment procedures.
8. Move the spacers and collars against the tensioner block and secure in place.

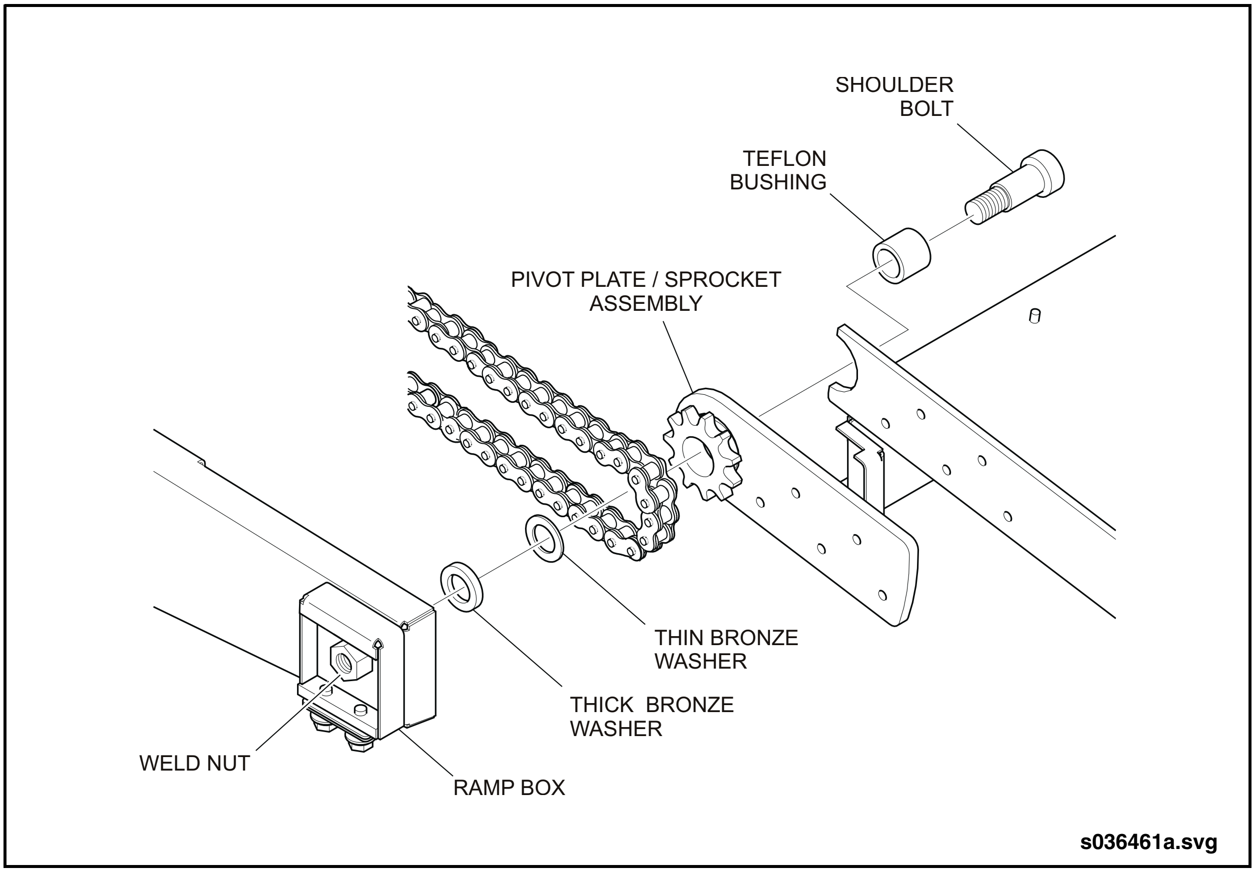

Fig. 20-13: Pivot Plate Installation

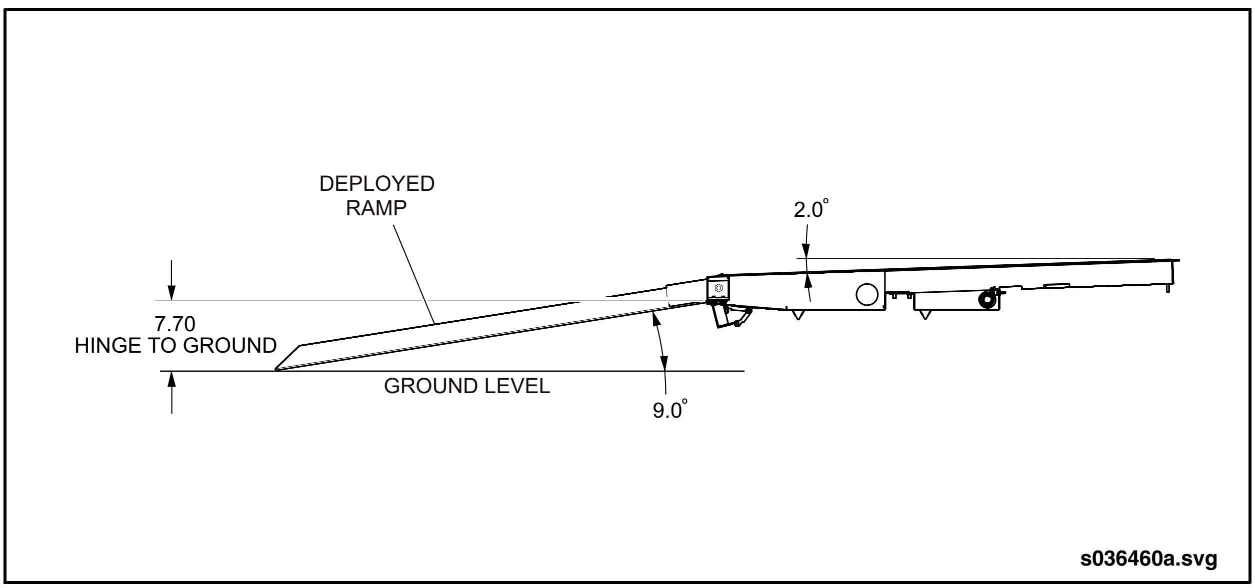

Fig. 20-14: Pivot Plate Alignment

2.7.3.4. Operating Mechanism Assembly

☞NOTE:

The following assembly procedure describes a specific sequence that assembles the mechanism components onto the RH side support plate and then sliding the LH support plate onto the built up assembly. Difficulty with installing the chain spacer block (master link) could occur if this sequence is not followed.

1. Partially assemble the LH & RH support plates as follows:
   a. Pack the spherical bearings with lithium grease and insert into the bores of the side support plates. Retain the bearings with internal snap rings.

   ☞NOTE:

   The internal snap ring has a sharp edge on one side and a smooth rounded edge on the opposite side. Install the snap ring with the smooth rounded edge facing the thrust load (bearing side).

   b. Install the adjusting bolts into the sleeves located at the end of each side support plate. The flat on the hex head bolt should seat against the side support plate. Install the Belleville washers and locknut. Leave the adjusting nut in the full slack position at this time. See “Fig. 20-15: Adjusting Bolt Installation” on page 24.

   ☞NOTE:

   The Belleville washers must be installed in an alternating convex, concave stack arrangement.

2. Apply lithium grease to the ends of the push shaft and the slots in the LH & RH side support plates. Assemble the push channel to the rod eye of the actuating cylinder, ensuring that the cylinder is in the fully retracted position.
3. Position the push channel against the RH support plate ensuring that the push shaft engages the slot in the RH support plate.
4. Assemble the chain spacer block (master link) to the push channel using a pin. Ensure the wide slot end of the spacer block is facing toward the cylinder.
5. Connect the end links of the chain to the spacer block using two pins. See “Fig. 20-16: Chain Spacer Block Installation” on page 24.
6. Lubricate the bronze bushing with lithium grease and insert into idler sprocket (11T).
7. Engage the teeth of the idler sprocket with the chain and position the idler sprocket with two thrust washers against the RH side support plate.

   ☞NOTE:

   Ensure idler sprocket teeth are centered between the side support plates. The small diameter collar on the sprocket should face the RH side support plate.

8. Lubricate clevis shaft with lithium grease and insert through idler sprocket.
9. Hold the main driveshaft with the keyways facing upward and slide drive sprocket (13T) onto shaft.

   ☞NOTE:

   The collar on the drive sprocket should face the LH side support plate.

10. Rotate the drive sprocket so that the holes in the collar line up with the hole in the driveshaft. Ensure that the tooth that aligns with the spring pin hole faces downward.

   ☞NOTE:

   The drive sprocket tooth alignment with respect to the keyways on the end of the shaft must be maintained in order to ensure that the ramp is fully deployed when the actuating cylinder is fully extended. If the drive sprocket is not properly installed on the driveshaft, then the timing between the ramp plate and the actuating cylinder will be incorrect.

11. Install spring pin to lock sprocket to driveshaft.
12. Slide the driveshaft and sprocket assembly through the RH support plate and bearing. Engage the teeth of the drive sprocket with the chain so that the angle of the shaft keyways and the spring pin are at 71° from horizontal. See “Fig. 20-17: Drive Sprocket Installation” on page 24.
13. Insert one hex standoff, four bolts and spacers into the RH side support plate.

☞**NOTE:**

The hex standoff is located at the upper-most hole on the support plate.

14. Install two thrust washers over the clevis shaft on the idler sprocket.
15. Slide the LH side support plate and bearing over the main driveshaft and align support plate with the four bolts. Ensure the ends of the push shaft and clevis shaft engage their respective slots in the LH side support plate.
16. Install washers and lock nuts on the four through-bolts and tighten.
17. Position the hex standoff, located at the upper-most hole, so that the flats on the hex are parallel with the sides of the support plates. This positioning is necessary so as to avoid interference with the access cover plate. Secure the hex standoff using 10-32 UNF socket head screws with lock washers.
18. Operate the mechanism from fully retracted to fully extended. A 0.010" feeler gauge should fit between the sides of the push channel and the side support plates during the entire retract and extend cycle.
19. Slide the collar and spacer over each end of the main driveshaft. Leave loose at this time.

☞**NOTE:**

Spacers and collars will be positioned and final tightened during installation.

20. Lubricate the Teflon bushings with lithium grease and insert into tensioner blocks. Slide tensioner blocks onto ends of main driveshaft.

☞**NOTE:**

If new bushings are being installed, the holes in the tensioner block will have to be drilled out to original diameter to allow the bolts to clear the O.D. of the bushing.

21. Install the proximity switch so that face of the switch is flush or just slightly set back from the face of the RH side support plate.

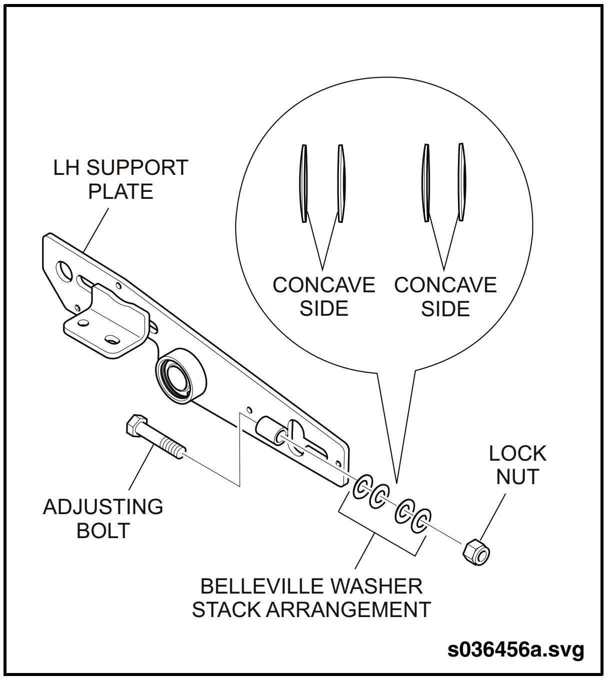

Fig. 20-15: Adjusting Bolt Installation

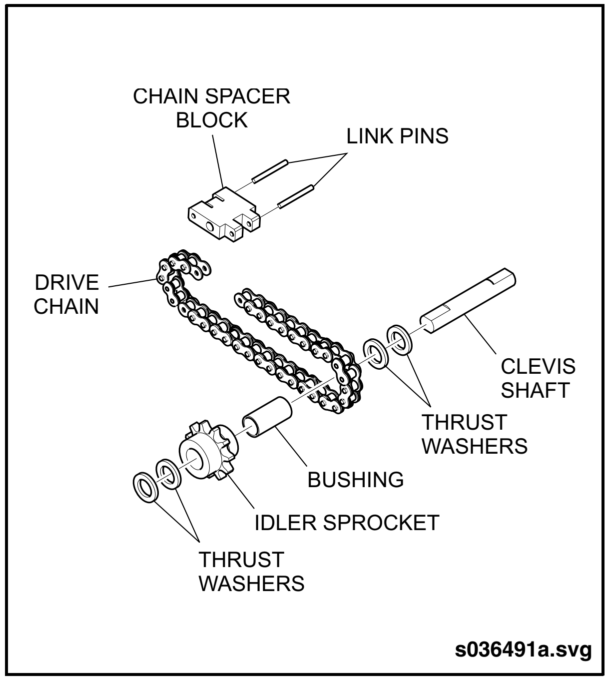

Fig. 20-16: Chain Spacer Block Installation

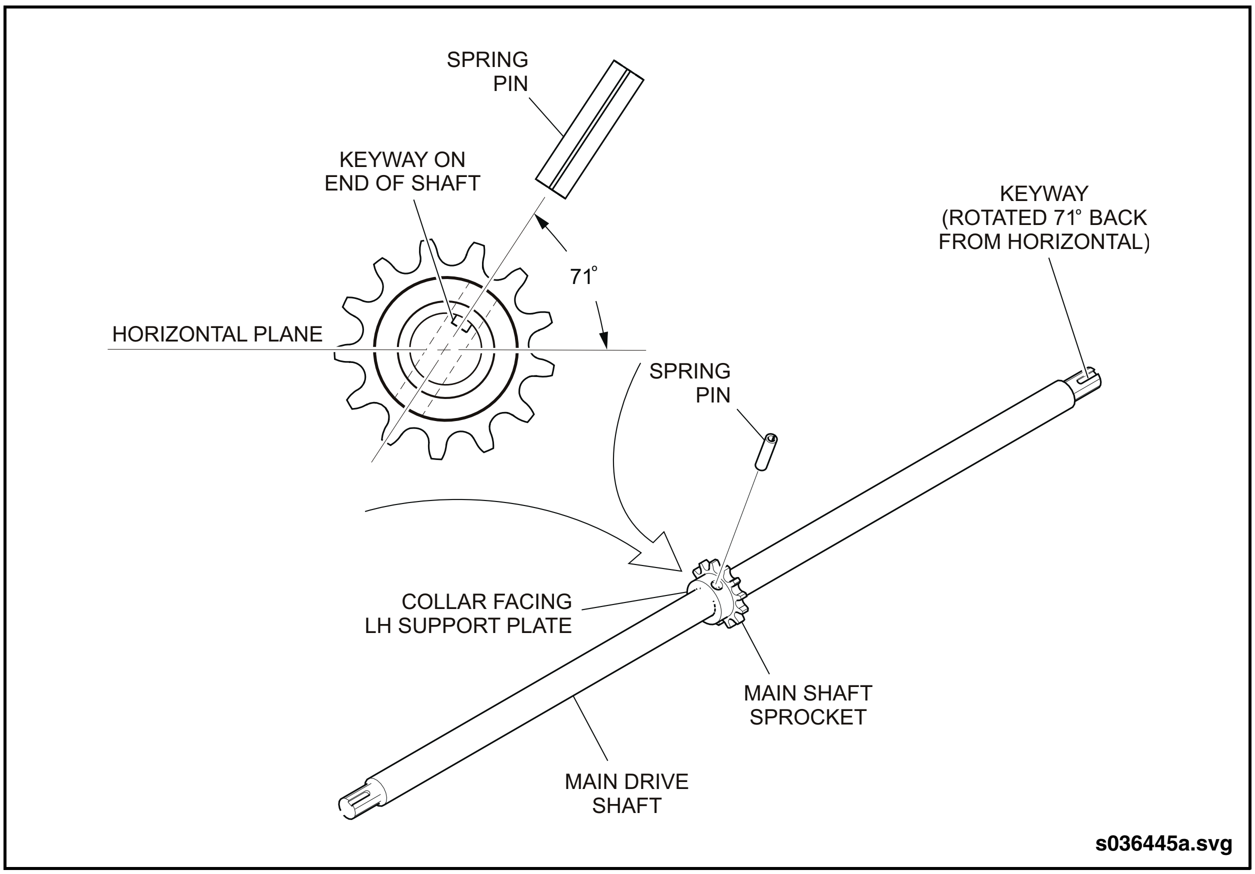

Fig. 20-17: Drive Sprocket Installation

2.7.3.5. Ramp Power Pack Installation

☞**NOTE:**

Refer to 2.8. "Hydraulic Power Pack & Cylinder" on page 27 in this section for installation procedures.

2.7.3.6. Operating Mechanism Installation

1. Position the operating mechanism inside the ramp box at an angle so that the LH end of the drive shaft enters the 2 1/4" hole in the ramp box. Slide the mechanism into place, centering over the mounting holes.
2. Install the LH side cover plate using four nuts and washers.
3. Align the tension blocks with the corresponding threaded holes in the ramp box. Install two bolts and lock nuts in each tensioner block but do not tighten to adjust chain at this time.
4. Snap in the two access plugs at either end of the drive shaft.
5. Operate the mechanism so the actuating cylinder is in the fully extended (deployed) position.

2.7.3.7. Ramp Mechanism Initial Adjustments

1. Set the center drive chain tension by tightening the locknuts on the adjusting bolts equally. Under normal thumb pressure, the deflection of the chain should be 0.10".

☞**NOTE:**

The clevis shaft must remain perpendicular to the drive chain when chain is being tensioned.

2. Adjust the LH & RH drive chains using the adjustment bolts on the tensioner blocks. Tighten the upper and lower bolts equally while at the same time tightening the LH & RH tensioner blocks equally. Under normal thumb pressure, the deflection of the chain should be 0.31".
3. Continue to adjust LH & RH drive chain tension equally until most of the slack is removed. Final tensioning will be performed when the ramp plate is installed.

☞**NOTE:**

Maintain the main driveshaft perpendicular to the sides of the ramp box while tensioning the chain. Measure from a point near the LH outer end of the main driveshaft to a point on the face of the ramp box. Measure corresponding points on the RH side and compare measurements with LH side to ensure operating mechanism is mounted squarely.

4. Tighten the two rear (inboard) bolts that secure the mechanism support bracket to the ramp box.

☞**NOTE:**

Ramp mechanism final adjustments will be performed with the ramp mechanism installed in the vehicle.

2.7.3.8. Ramp Mechanism Final Adjustments

1. Install the ramp box into the vehicle. Refer to 2.6. "Installation" on page 12 in this section for procedure.
2. Set the drive chain tension with the ramp plate installed. Manually operate ramp through a couple of deploy and stow cycles while checking for excessive resistance, binding, or jerking during operation.
3. If operation is unsatisfactory check for proper alignment of operating mechanism within the ramp box. Refer to 2.7.3.7. "Ramp Mechanism Initial Adjustments" on page 25 in this section for alignment procedure.
4. If jerky operation is noted or the ramp flops when coming over the top, there is likely excessive slack in the drive chains. Adjust chain tension as follows:
   a. Loosen the four bolts that secure mechanism support bracket to the ramp box.
   b. Loosen the lock nuts on the tensioner blocks.
   c. Tighten the LH & RH tensioner bolts equally and in small increments until excessive slack is taken up.
   d. Tighten tension adjusting bolt lock nuts.
   e. Tighten four bolts that secure mechanism support bracket to the ramp box.
   f. Recheck ramp operation.
5. Check that the ramp reaches the fully deployed position (9° angle) when the cylinder is fully extended. If the ramp plate does not fully deploy, then recheck the sprocket and chain timing. Refer to 2.7.3.3. "Drive Sprockets, Chain, & Pivot Plate Installation" on page 20 in this section for procedure.
6. Operate the ramp hydraulically through several deploy and stow cycles. Confirm proper operation of vehicle interlocks when ramp is deploying.
7. Check for correct proximity switch adjustment if interlocks are not functioning. The face of the switch should be flush or slightly recessed with the face of the RH support plate. The gap between the proximity switch and target (push channel) must not exceed 5/32" (4.0 mm).

2.8. Hydraulic Power Pack & Cylinder

2.8.1. Description

The Hydraulic Power Pack consists of a reservoir, electric motor, pressure relief valve, and a solenoid-operated control valve assembly used to operate the hydraulic actuating cylinder.

2.8.2. Hydraulic Power Pack & Cylinder Specifications

Motor:
Voltage.......................................24 VDC
Length (Including connector)
................250mm ± 6mm (9.84" ± 0.25")

Control Valves:
Type .... Solenoid Actuated
Cartridge Valves - 2P3W
Voltage.......................................24 VDC

Reservoir:
Material..Plastic
Volume......................322ml (0.34 Quart)
Port Size ....SAE -4 (7-16-20 UNF)
w/.023 dia. Orifice

Pressure Relief Valve:
Rating ....1750 psi

2.8.3. Operation

The Hydraulic motor pumps fluid from the reservoir and forces it through the solenoid valve-controlled ports. Hydraulic fluid actuates the hydraulic cylinder which operates the ramp deploy/stow mechanism.

2.8.4. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance requirements and intervals.

2.8.5. Hydraulic Power Pack & Cylinder Troubleshooting

Refer to 2.4. “Wheelchair Ramp Troubleshooting” on page 5 in this section for troubleshooting procedures.

2.8.6. Removal

1. Disconnect the solenoid electrical connector and the motor electrical connector. See “Fig. 20-18: Hydraulic Power Pack Assembly” on page 28.
2. Disconnect the hydraulic hoses and plug the ports.
3. Remove the bolt holding the power pack to the ramp frame and remove the power pack.

☞NOTE:

Wiring may be attached with single-use nylon locking straps. Note the location of these straps, and which wires are being bundled together or secured to conduit or frame members, so replacement straps can be properly secured to maintain service integrity.

☞NOTE:

Refer to your New Flyer Parts Manual for Power Pack replacement parts information.

2.8.7. Installation

1. Install power pack and secure with the mounting bolt and washers.
2. Remove caps from ports and attach the hydraulic hoses.
3. Connect the solenoid electrical connector and the motor electrical connector.
4. Secure harness bundles and hoses with nylon straps.

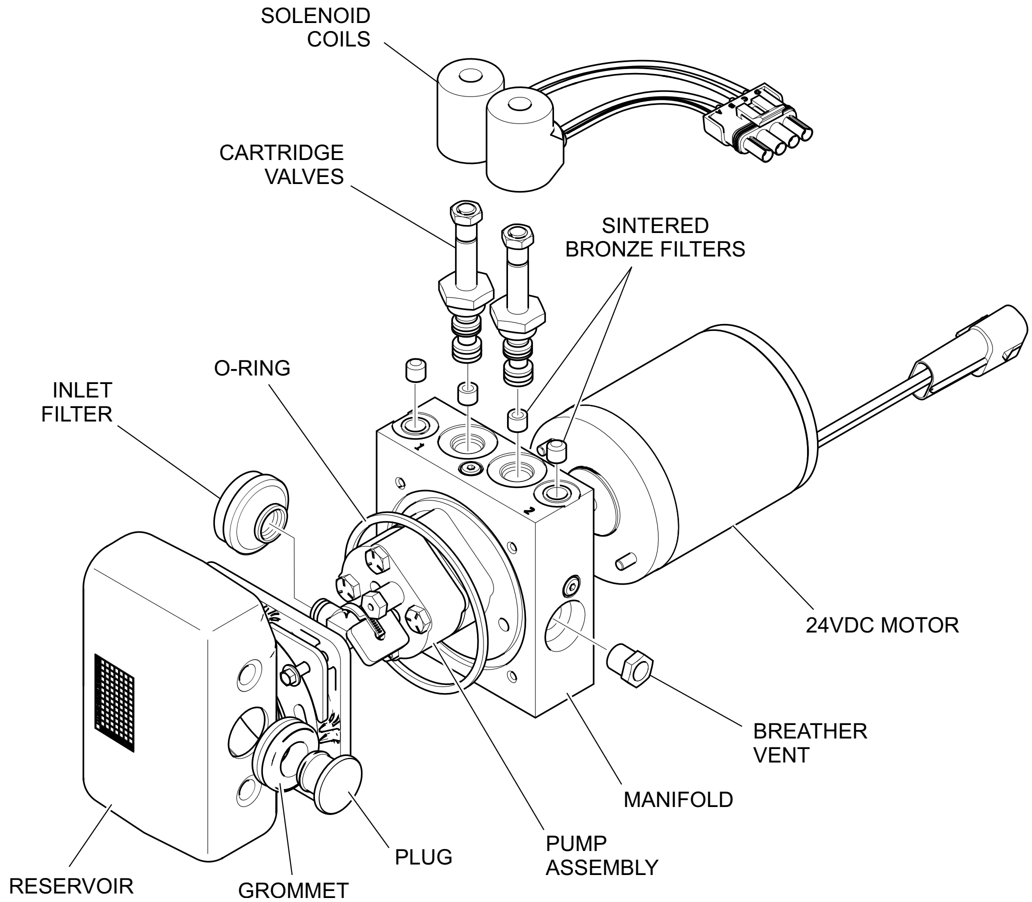

Fig. 20-18: Hydraulic Power Pack Assembly

3. SKID PLATE

3.1. Description

The skid plate is a welded and contoured assembly mounted to the chassis at the forward, curbside corner of the wheelchair ramp.

3.2. Operation

The skid plate protects the wheelchair ramp from road obstructions, like curbs, that could damage the ramp mechanism while the vehicle is in motion. The skid plate has a wear mark in the skidding surface for indicating wear amount.

3.3. Removal

1. Park the vehicle on a level surface and rotate the Master Run switch to the OFF position.
2. Raise and support the vehicle. Refer to the General Information Section of this manual for procedure.
3. Locate the access hole in the skid plate and remove the two vertical bolts and washers through the access hole.
4. Support the weight of the skid plate.
5. Remove the three horizontal bolts securing the skid plate to the side of the chassis.
6. Remove the skid plate from the vehicle.

3.4. Installation

1. Support the skid plate in position against the vehicle structure.
2. Apply Loctite-243 to the bolt threads and install the washers and bolts.
3. Torque the bolts to 28 ft-lb. (38 Nm).

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