WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

SERVICE MANUAL

XCELSIOR® DIESEL-ELECTRIC 40FT. TRANSIT BUS

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

SR1946

Vehicle Identification Number	Unit Number
5FYH8FU16FF047668	7300
5FYH8FU18FF047669	7301
5FYH8FU14FF047670	7302
5FYH8FU16FF047671	7303
5FYH8FU18FF047672	7304
5FYH8FU1XFF047673	7305
5FYH8FU11FF047674	7306
5FYH8FU13FF047675	7307
5FYH8FU15FF047676	7308
5FYH8FU17FF047677	7309
5FYH8FU19FF047678	7310

SR1946 continued

Vehicle Identification Number	Unit Number
5FYH8FU10FF047679	7311
5FYH8FU17FF047680	7312
5FYH8FU19FF047681	7313
5FYH8FU10FF047682	7314
5FYH8FU12FF047683	7315
5FYH8FU14FF047684	7316
5FYH8FU16FF047685	7317
5FYH8FU18FF047686	7318
5FYH8FU1XFF047687	7319
5FYH8FU11FF047688	7320
5FYH8FU13FF047689	7321
5FYH8FU1XFF047690	7322
5FYH8FU11FF047691	7323
5FYH8FU13FF047692	7324
5FYH8FU15FF047693	7325
5FYH8FU17FF047694	7326
5FYH8FU19FF047695	7327
5FYH8FU10FF047696	7328
5FYH8FU1XGF048310	7329
5FYH8FU11GF048311	7330
5FYH8FU13GF048312	7331
5FYH8FU15GF048313	7332
5FYH8FU17GF048314	7333
5FYH8FU19GF048315	7334
5FYH8FU10GF048316	7335
5FYH8FU12GF048317	7336
5FYH8FU14GF048318	7337
5FYH8FU16GF048319	7338
5FYH8FU12GF048320	7339
5FYH8FU14GF048321	7340
5FYH8FU16GF048322	7341
5FYH8FU18GF048323	7342
5FYH8FU1XGF048324	7343
5FYH8FU11GF048325	7344
5FYH8FU13GF048326	7345

SR1946 continued

Vehicle Identification Number	Unit Number
5FYH8FU15GF048327	7346
5FYH8FU17GF048328	7347
5FYH8FU19GF048329	7348
5FYH8FU15GF048330	7349
5FYH8FU17GF048331	7350
5FYH8FU19GF048332	7351
5FYH8FU10GF048333	7352
5FYH8FU12GF048334	7353
5FYH8FU14GF048335	7354
5FYH8FU16GF048336	7355

NEW FLYER

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,

Mike D. Monsigneur
Director of Publications

NEW FLYER | Publications

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☞**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.	

INTRODUCTION

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/TROUBLE-SHOOTING 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.

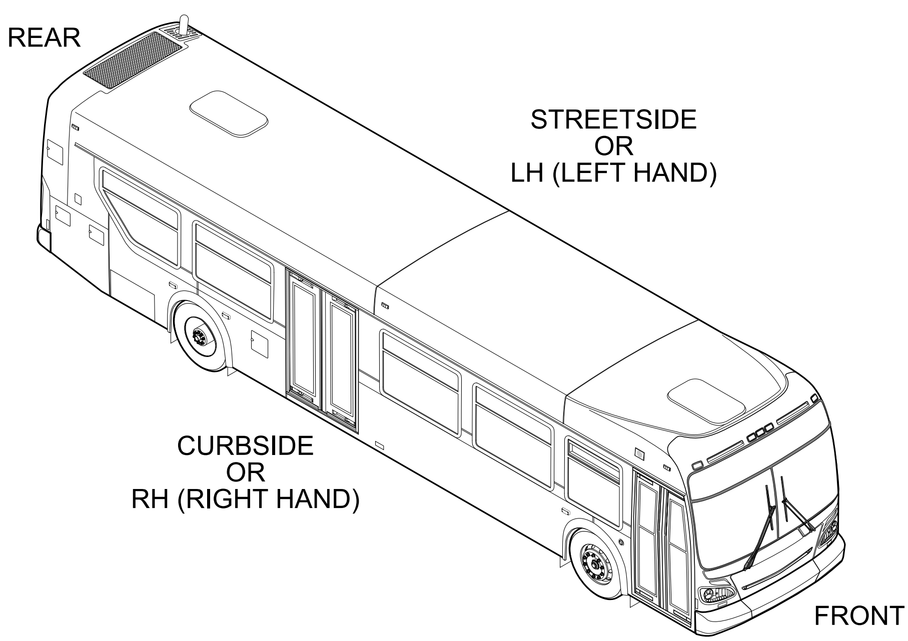
- **SECTION INDEX**

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 — SR1946

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Current Revision Indicated by: — Current Revision Print Date: Jul 20 2020

Rev	Section/Pages Affected	Date
B	Section Intro, Pages: 3 (NHTSA)	Sep 11 2018
B	Section GI, Pages: TOC, 13 (2.2.4 Emergency Release Control Handle-Exit Door), 13 (fig. GI-6) Exit Door Emergency Release Control Handle, 14...20 (3. Vehicle Specifications), 21 (4.1 Brake & Accelerator Interlocks), 40 (fig. GI-16) Wheel Placement in Hoist	May 30 2016
B	Section PM, Pages: TOC, 9...12 (2.5 Preventive Maintenance Guide), 22...24 (2.5.1 Radiator), 47 (2.10.20 Air System Functional Tests), 48 (2.10.22 Window Emergency Release System), 61 (2.10.40 Dual Power Inverter Module), 76...77 (2.18.2 Front Brake Chambers), 78...81 (2.18.3 Rear Brake Chambers), 92 (2.25.10 Parking Brake Control Valve, 92 (2.25.11 Emergency Brake Release Valve), 93...94 (2.25.12 Steering Knuckle Lubrication), 101 (2.26.8 Radiator), 101 (2.26.9 Hybrid Oil Cooler), 108 (2.28.3 Air Dryer), 115 (2.34 Fluid & Lubrication Guide)	May 30 2016
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B	Section 03, Pages:	4 (2.4.2 Front Whee Alignment Specifications), 13 (2.5.6 Caster Angle [specifications])	Sep 11 2018
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B	Section 04, Pages:	22...25 (2.6.3 Diesel Particulate Filter), 43...45 (2.6.11 Exhaust Tubes, Exhaust Flex Connector & Exhaust Blankets), 63 (2.13.1 Description)	May 30 2016
B	Section 06, Pages:	7 (fig. 6-1) Coolant System Fill Levels, 17 (2.7.1 Description), 19 (2.7.3.4 Pressure Test Valve)	May 30 2016
B	Section 08, Pages:	23 (fig. 8-14) Compressor Removal & Installation, 87 (7.1 Leveling Valves, NOTE), 90...91 (fig. 8-28 & list) Rear Leveling Valve Installation, 94 (fig. 8-29) Front Kneeling Valve Installation, 96 (fig. 8-30) Kneeling Valve Assembly	May 30 2016
C	Section 09, Pages:	58...61 (14.3 E-Stroke Troubleshooting)	Jul 20 2020
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C	Section 16, Pages:	35 (3.2.1 Door Panel Adjustments, step8)	Sep 11 2018

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B	Section 16, Pages:	8 (2.5.2 Door Panel Height Adjustment, step4)	Sep 11 2018
B	Section 16, Pages:	TOC, 17...26 (2.9 Entrance Door Operator), 19 (fig. 16-8) Teeter Shaft Index Marking, 21 (fig. 16-10) Cushion Spring & Seal, 21 (fig. 16-11) Adjustment Screw Location, 34...35 (fig. 16-14 & list) Exit Door Base Plate	May 30 2016
B	Section 17, Pages:	TOC, 18 (5. Driver's Draft Shield Door), 18 (fig. 17-16) Driver's Draft Shield Door	May 30 2016
B	Section 19, Pages:	TOC, 8...12 (2.1.25 Operator Screen), 8 (fig. 19-2) Operator Screen, 8 (fig. 19-3) Changing from Trip A to B, 9 (fig. 19-4) Resetting the Trip Counter, 9 (fig. 19-5) Password Entry Screen, 10 (fig. 19-6) Service Mode Screen), 11 (fig. 19-7) Function Readout Screen, 12 (2.1.25.4 Text Messages [Seat Belt])	May 30 2016
B	Section 20, Pages:	TOC, 28 (fig. 20-18) Hydraulic Power Pack Assembly, 29 (3. Skid Plate)	May 30 2016

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General Information

1. SAFETY

1.1. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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.

1.4.3. Wheel Chocks

Use the wheel chocks to block the wheels and prevent inadvertent vehicle movement.

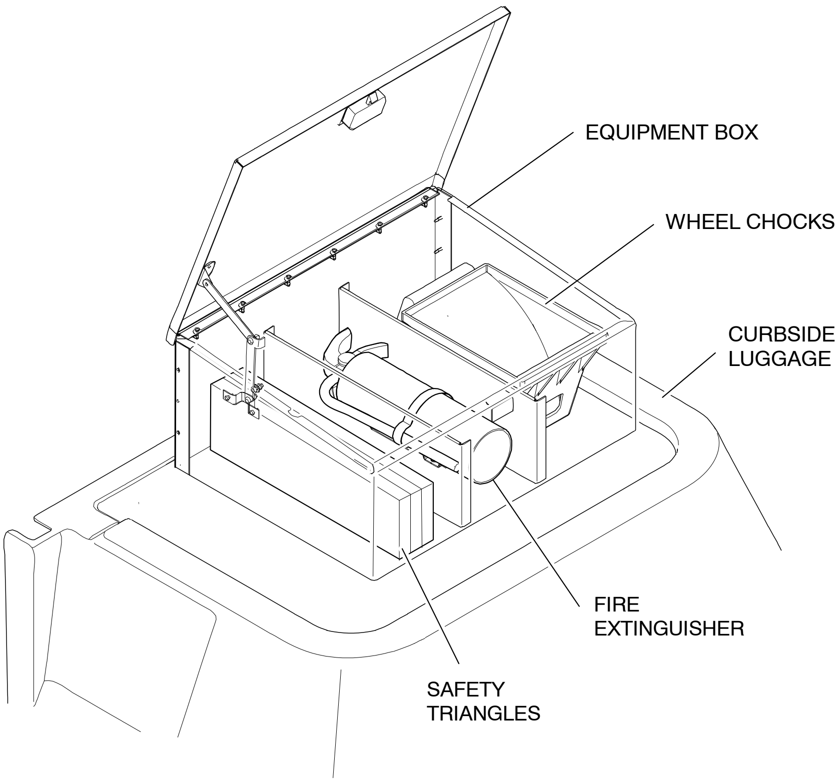


Fig. GI-1: Safety Equipment

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 System

The vehicle is equipped with a Fire Suppression System to extinguish fires within the engine compartment. The system protects the passengers and vehicle against fire. If a fire is detected in the engine compartment an extinguishing agent is discharged to suppress the fire.

The Fire Suppression System components that are located in the driver's area include the Manual Actuator switch and control panel.

☞**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.

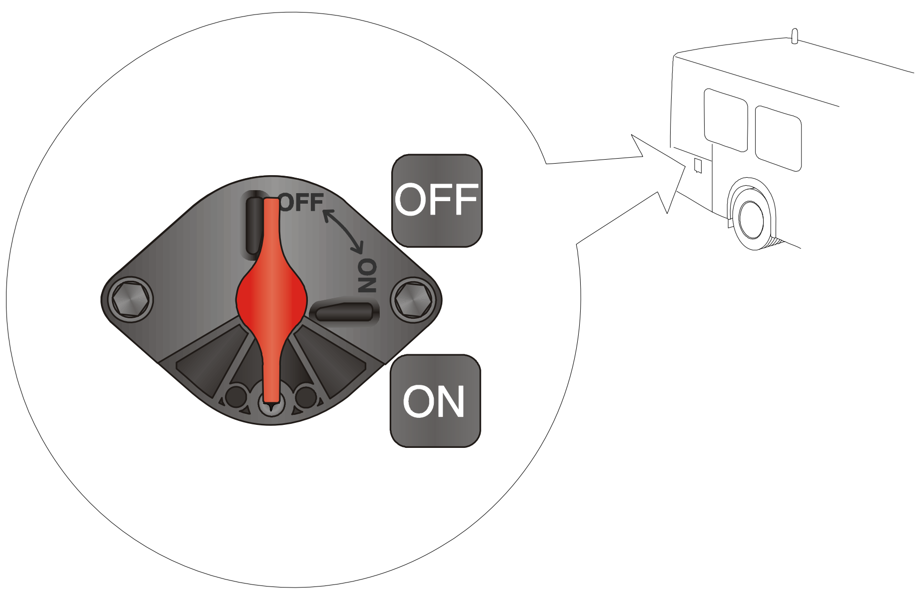


Fig. GI-2: Battery Disconnect Switch

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.

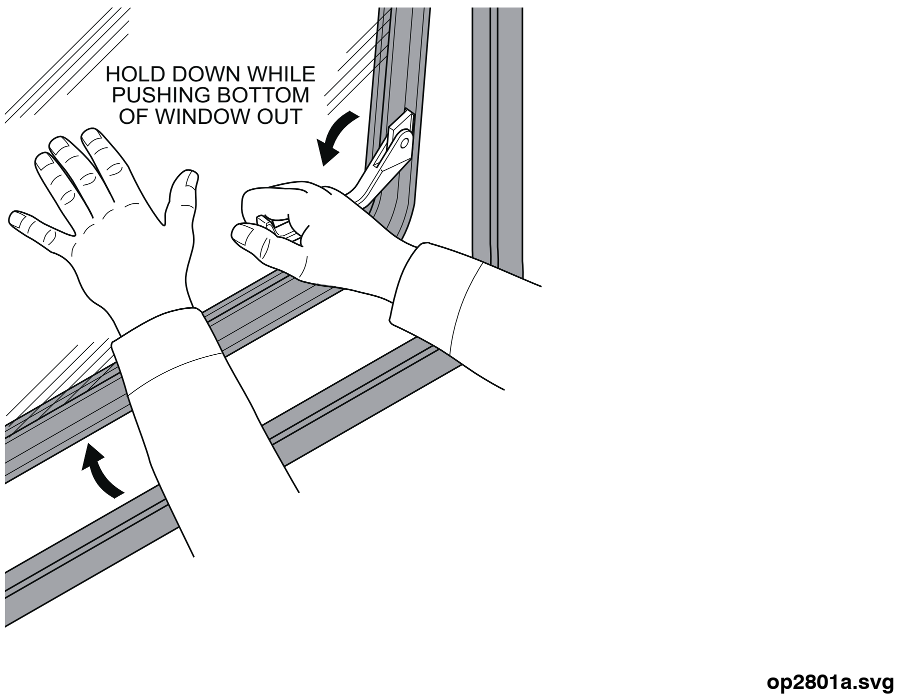


Fig. GI-3: Emergency Release Handle

2.2.2. Roof Hatches

The roof hatches are usable as emergency exits. Proceed as follows to operate the emergency exit: See “Fig. GI-4: Roof Hatch Emergency Exit” on page 11.

1. Pull the red handle at the rear of the hatch to release the locking mechanism. The handle is attached to a cable which will release the retaining pins from the rear hinge.
2. Push upward on the rear section of the hatch, allowing it to swing fully open on the front hinges.

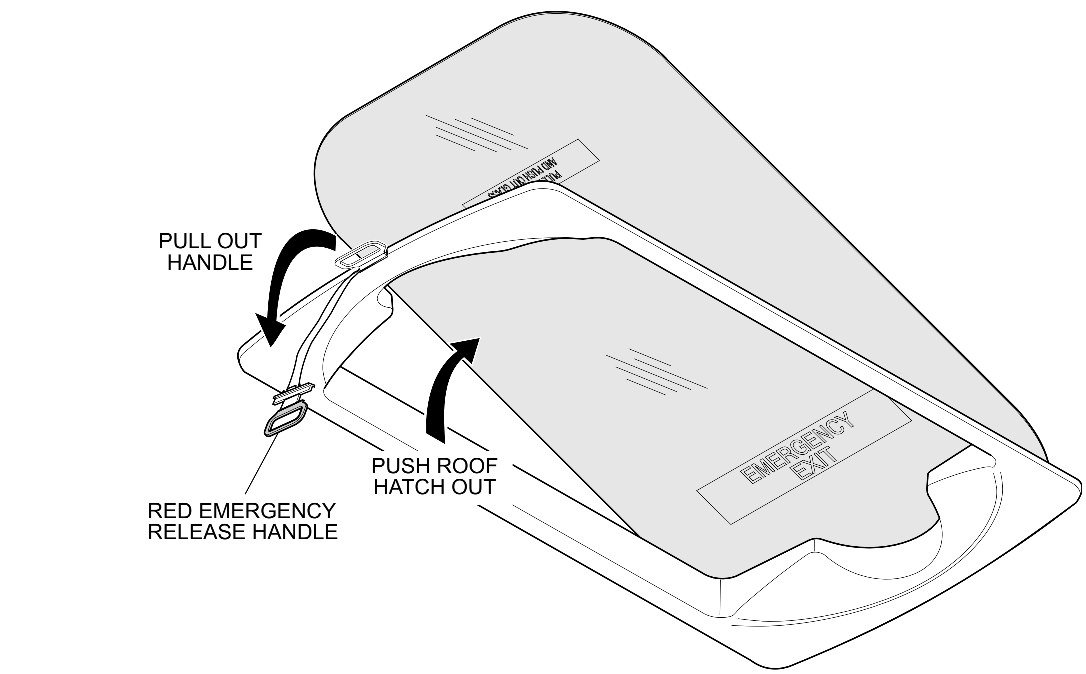


Fig. GI-4: Roof Hatch Emergency Exit

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 door operator, then push the doors open. As the doors open they activate the header and curb lights. See "Fig. GI-5: Entrance Door Emergency Release" on page 12.

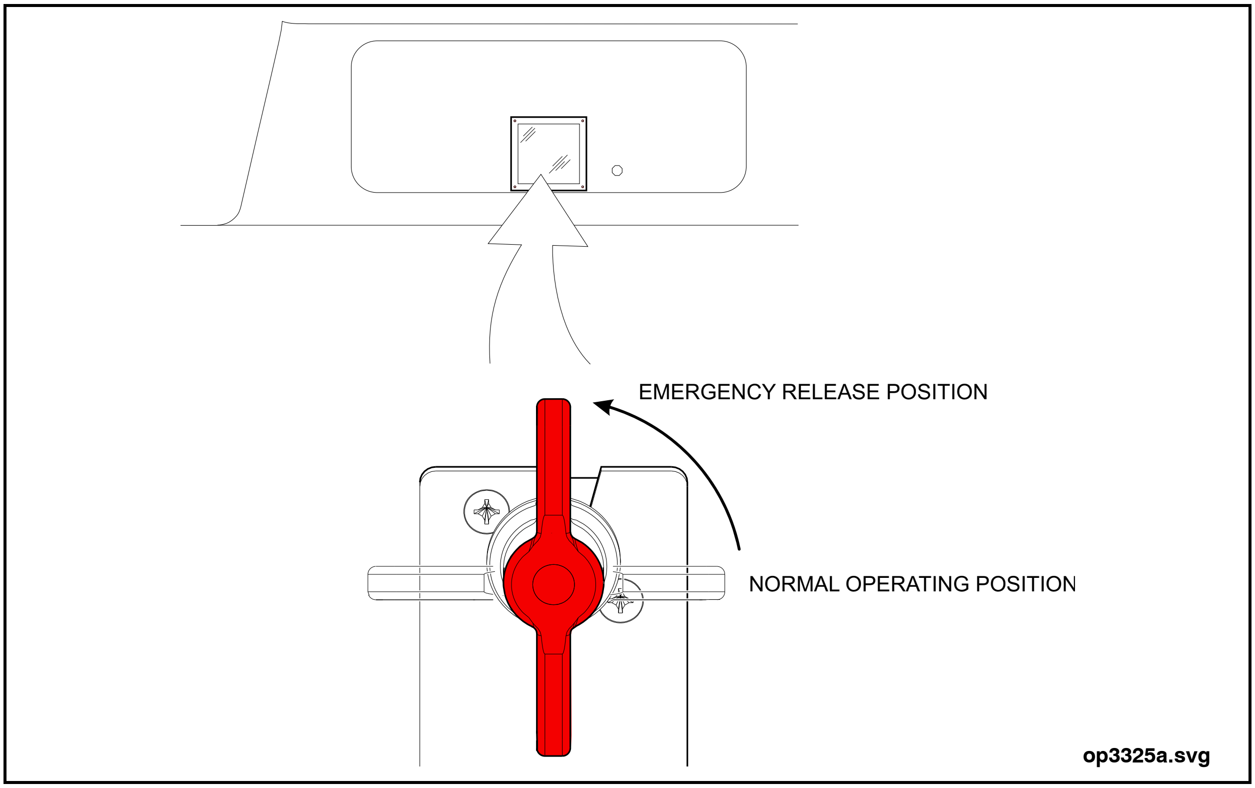


Fig. GI-5: Entrance Door Emergency Release

2.2.4. Emergency Release Control Handle - Exit Door

The exit door emergency release control handle is located to the left of the exit door header, behind a breakable window. In an emergency, break the glass to access the control valve knob. Pull the control handle to release mechanical lock from the door operator, 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 Handle" on page 13.

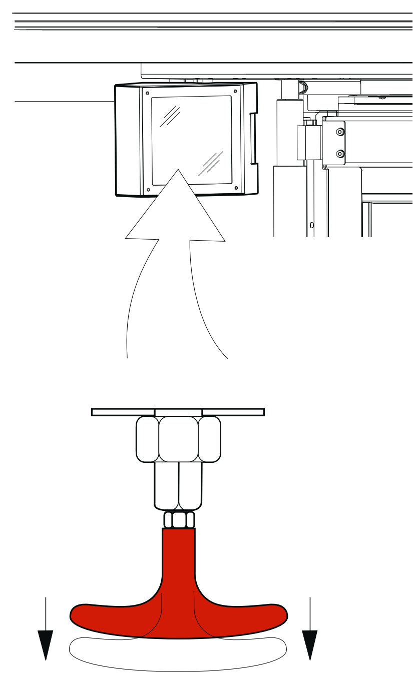


Fig. GI-6: Exit Door Emergency Release Control Handle

3. VEHICLE SPECIFICATIONS

☞**NOTE:**

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

VEHICLE TYPE	
Model	New Flyer XDE40 transit bus
Customer	Washington Metropolitan Area Transit Authority - SR1946
Build Year	2015
ENGINE	
Engine (Units 7300 - 7355)	*Cummins* ISL 9 (2015)
Horsepower	330 HP
Torque	1,050 ft-lb.
FUEL	
Fuel	Ultra low sulphur diesel
Usable Fuel Capacity	125 U.S. gallons (473 liters)
HYBRID DRIVE SYSTEM	
Drive Unit	*Allison* H40EP
Drive Unit Controls	4th Generation
Drive Unit Output Speed (max.)	3,300 RPM
Drive Unit Output Torque (max.)	3,500 ft-lb. (during propulsion)
Regenerative Torque (max.)	1,400 ft-lb. (during braking)
Energy Storage System (ESS)	*Allison* nickel-metal hydride battery pack, Gen 2, roof-mounted
Dual Power Inverter Module (DPIM)	*Allison* hybrid inverter (2010) roof-mounted
DIMENSIONS	
Length (over bumpers)	41 ft. (12.5 m)
Width	8.5 ft. (2.6 m)
Height	10.8 ft. (3.3 m)
Wheelbase	23.6 ft. (7.2 m)
Turning Radius	43 ft. (13.4 m)

Approach/Departure Angle	9°
Vehicle Weight (approx.)	28,950 lbs. (13,130 kg)
Gross Vehicle Weight Rating (GVWR)	43,860 lbs. (19,895 kg)
AXLES & SUSPENSION	
Front Axle	*MAN* VOK-07-F
Front Gross Axle Weight Rating (GAWR)	15,200 lbs. (6,895 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	28,660 lbs. (13,000 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*
WHEELS & TIRES	
Tires	*Goodyear*
Tire Size	305/70R22.5
Inflation Pressure	130 psi

Rim Mounting	10 Bolt hub piloted
Wheels	Aluminum
Maximum Load (single tire)	7,830 lbs. @ 130 psi
Maximum Load (dual tires)	7,390 lbs. @ 130 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
Wear Sensor (front)	End of life wear sensors in brake pads
Wear Sensor (rear)	End of life wear sensors in brake pads
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* RLF2-M7 rootop unit
Defroster	*Mobile Climate Control*
Floor Mounted Heaters	2 *Mobile Climate Control* in passenger area
Coolant Heater	*Proheat* M80
COOLING SYSTEM	
Engine Radiator	*Engineered Machined Products (EMP)* XPL2D - MH9 Radiator/ CAC assembly with Fil-11 pusher-type fans

Hybrid Cooling System	*Engineered Machined Products (EMP)* rooftop oil cooler with 4 electronically-controlled fans
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-15 air dryer
STARTING SYSTEM	
Starting System	*Allison* E V drive unit
CHARGING SYSTEM	
Alternator	*Vanner High Voltage DC to DC converter*
Voltage Equalizer	*Vanner Power Group* 12/24 Volt, 80 Amp Low Voltage Disconnect
Batteries (4)	*Odyssey Extreme Battery*
Battery Type	Maintenance-free Absorbed Glass Mat (AGM)
Battery Group Size	31
Battery Charge Voltage	29.0 ± 0.3 Volts
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* electronic
	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	Fire suppression display panel & manual actuator
MULTIPLEXING SYSTEM	
Multiplexing Module (VMM) System with J1939 Network Communication	*Parker-Vansco* VMM 1615 modules (8)
Instrument Panel	*Parker-Vansco* electronic
AVA/AVL SYSTEM	
AVA/AVL System	*Clever Devices* IVN4 control unit
PASSENGER COUNTING SYSTEM	
Automatic Passenger Counter (APC)	*Clever Devices* with sensors on door modesty panels
DESTINATION & ROUTE SIGNS	
Sign Control	*Luminator* Multi Control Unit (MCU)
Front Destination	*Luminator* SMT series
Side Destination	*Luminator* SMT series
Front Route	*Luminator* SMT series
Rear Route	*Luminator* SMT series
DOORS	
Entrance Door	*Vapor* Gen 4, slide glide
Entrance Door Opening Size	Medium
Exit Door	*Vapor* Activair
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	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 & 4 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*
Sealant	*Altro*
SAFETY FEATURES	
Emergency Escape Exits	3 curbside windows identified with labels
	4 streetside windows identified with labels
	2 roof hatches
Fire Extinguisher	5 lb ABC rating
Fire Extinguisher Location	Curbside luggage rack, in equipment box

Safety Triangles Location	Curbside luggage rack, in equipment box
Wheel Chocks	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 & 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 text message
Fire Suppression System	*Dual Spectrum*
Silent Alarm	Located on side console
Camera System	*Dedicated Micros Transvu2* system with 7 cameras
Wheel Deflector	S1 Gard located forward of rear curbside tire
Driver Protection System	Driver's door system
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

4. STANDARD OPERATING FEATURES

4.1. Brake & Accelerator Interlocks

Interlocks disable the accelerator and apply the rear 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 door is open.
- ❒ Exit door emergency release handle 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 must be momentarily depressed to release the interlocks.

4.2. Lighting

- ❒ The aisle lights switch off when the drive unit 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 drive unit is in neutral [N], the parking brake is applied and both turn signal switches are pushed simultaneously. The lights are extinguished by shifting the drive unit 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.
- ❒ Auxiliary braking operation illuminates the stop lights and stop light indicator.
- ❒ 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 position and the engine is running. They can only be turned off by stopping the engine.

4.3. Drive Unit

- ❒ Drive unit will not shift unless Engine Run switch on engine switch box is set to the FRONT position.
- ❒ Drive unit will not shift unless brake treadle is pressed.
- ❒ Drive unit will not shift unless wheelchair ramp is stowed.
- ❒ Drive unit will not shift if there is no air pressure in front door.
- ❒ Drive unit will not shift if the exit door is open.
- ❒ Drive unit 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.
- ❐ Drive unit must be in neutral [N].
- ❐ Parking brake must be applied.
- ❐ Starting system must not be locked out.
- ❐ Fire suppression system must not indicate any faults.
- ❐ Fuel Filler Access Door must be closed.
- ❐ Door Master Switch must be in the ON position.

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.
- ❐ Drive unit must be in neutral [N].
- ❐ Parking brake must be applied.
- ❐ Starting system must not be locked out.
- ❐ Fire suppression system must not indicate any faults.
- ❐ Fuel Filler Access Door must be closed.
- ❐ Door Master Switch must be in the ON position.

☞**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.
- ❐ 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 drive unit 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.

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.
- ❒ The Door Master switch is set to the OFF position.
- ❒ The exit door sensitive edges are touched when the vehicle is standing and the exit door is not fully open.
- ❒ The exit door emergency release valve is actuated.
- ❒ Low air pressure at the exit door.
- ❒ Stop system - The Stop System indicator illuminates and the buzzer sounds if a problem occurs with the hybrid propulsion system.
- ❒ The Stop Lamps Fault message activates on the instrument panel.
- ❒ Engine fire - If the fire detection system activates a warning message will illuminate and the warning buzzer will sound.
- ❒ The acoustic door sensor operating system has detected a fault or been deactivated by the CLASS power switch.
- ❒ 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.
- ❒ Alternator Fault - if the multiplexing system detects a fault with the alternator.

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.

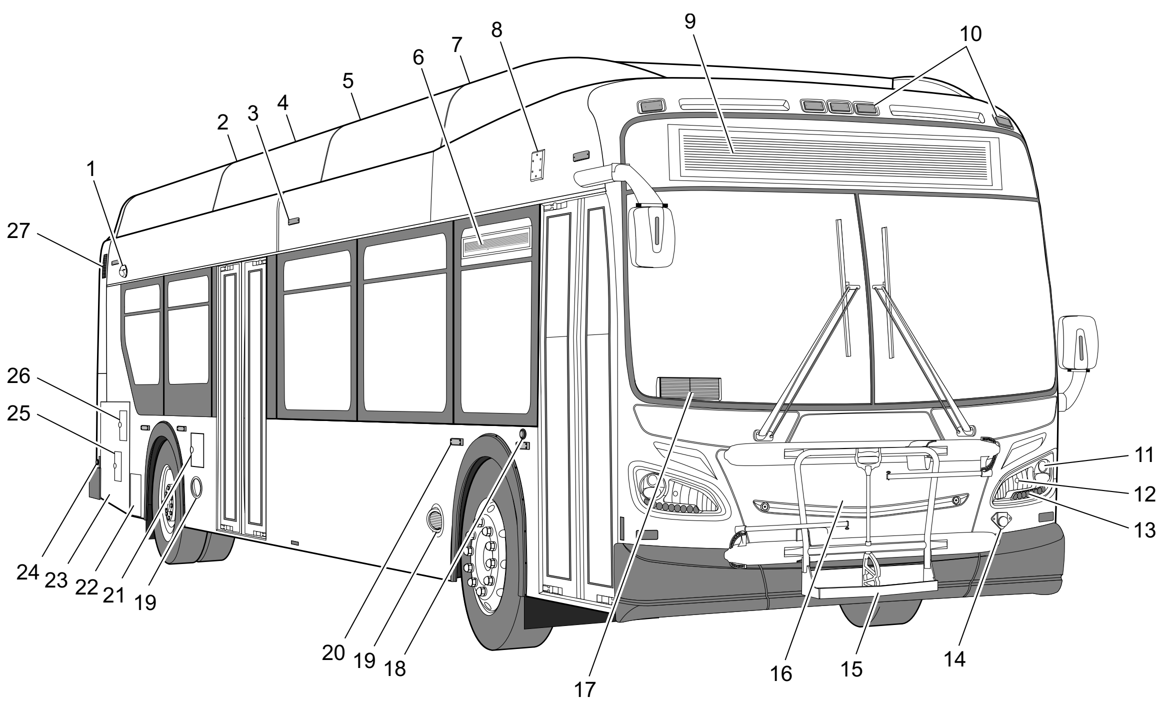
4.7. Multiplexing System

- ❒ 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. Surveillance Camera
2. Dual Power Inverter Module (DPIM) Enclosure
3. Side Marker Light
4. Battery Cooler
5. Hybrid Battery Enclosure
6. Side Destination Sign
7. HVAC Unit
8. Exterior Speaker
9. Front Destination Sign
10. Clearance Marker Lights
11. Headlight, Low Beam
12. Headlight, High Beam
13. Front Turn Light
14. Tow Connector
15. Bike Rack
16. Defroster/Wiper Access Door
17. Front Route Sign
18. Kneeling/Ramp Warning Light
19. Cornering Light
20. Side Turn Light
21. Fuel Filler Access Door
22. Battery Access Door
23. Fusebox Access Door
24. Lower Rear Clearance Light
25. Battery Cutoff Switch Access Door
26. Diesel Exhaust Fluid Manual Fill Access Door
27. Engine Air Intake Grille

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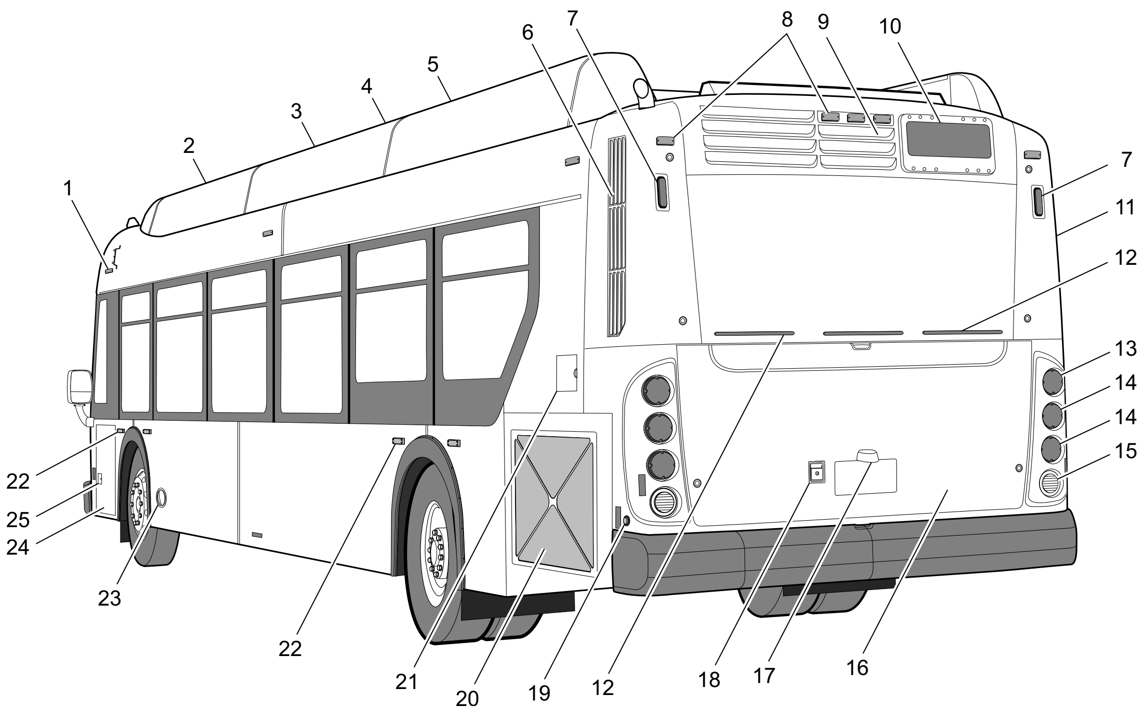
Fig. GI-7: Front Exterior View

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. Side Marker Light
2. Front HVAC Unit
3. Hybrid Battery Enclosure
4. Hybrid Cooler
5. Dual Power Inverter Module (DPIM) Enclosure
6. Muffler Access Door
7. Rear Clearance Marker Light
8. Clearance Marker Lights
9. Exhaust System Grille
10. Rear Route Sign
11. Air Intake Access Door
12. Center Stop Light
13. Turn Signal Light
14. Stop/Tail Light
15. Backup Light
16. Engine Access Door
17. License Plate Light
18. Engine Access Door Latch
19. Lower Rear Clearance Light
20. Radiator Access Door
21. Surge Tank Access Door
22. Side Turn Light
23. Cornering Light
24. Side Console Access Door
25. 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 a cylinder which operates a rack and a gear lever assembly. The base plates are supplied air from the accessories air tank. When the door controller is actuated, the air pressure differential in the base plate cylinder moves the internal rack and 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. Diesel Exhaust Fluid Fill Access

A diesel exhaust fluid fill door is located on the curbside rear of the vehicle. The fill access door is a small hinged door mounted in the rear of the fuse box access door. It is held open and closed by a gas strut.

5.7.3. 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.

5.7.4. 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.

5.7.5. 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.

5.7.6. 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.

5.7.7. Driver's Heater/Defroster Compartment

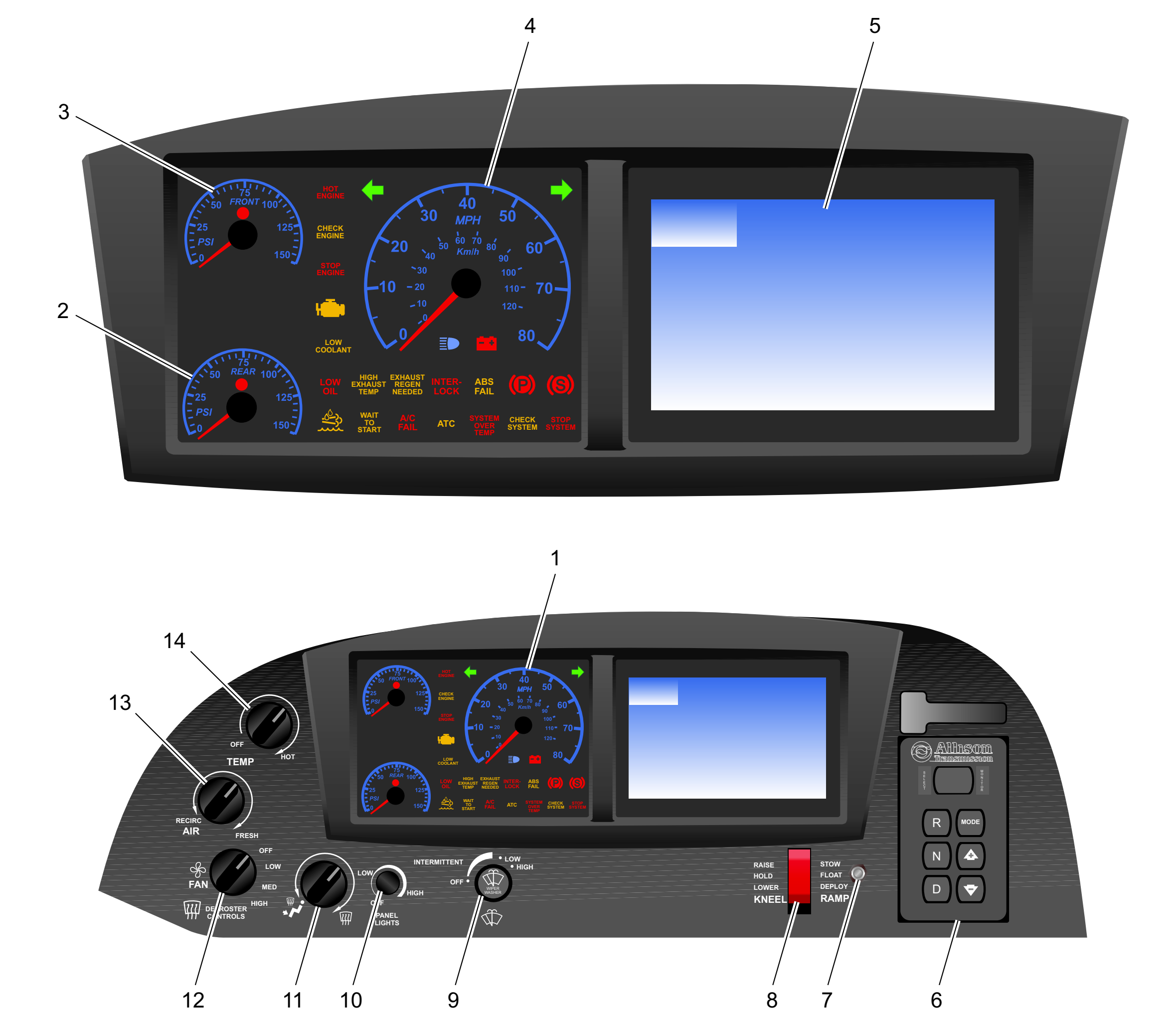
The driver's heater/defroster access door is centered below the two windshield halves on the front mask. It provides access to the heater/defroster and the towing air connections.

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.

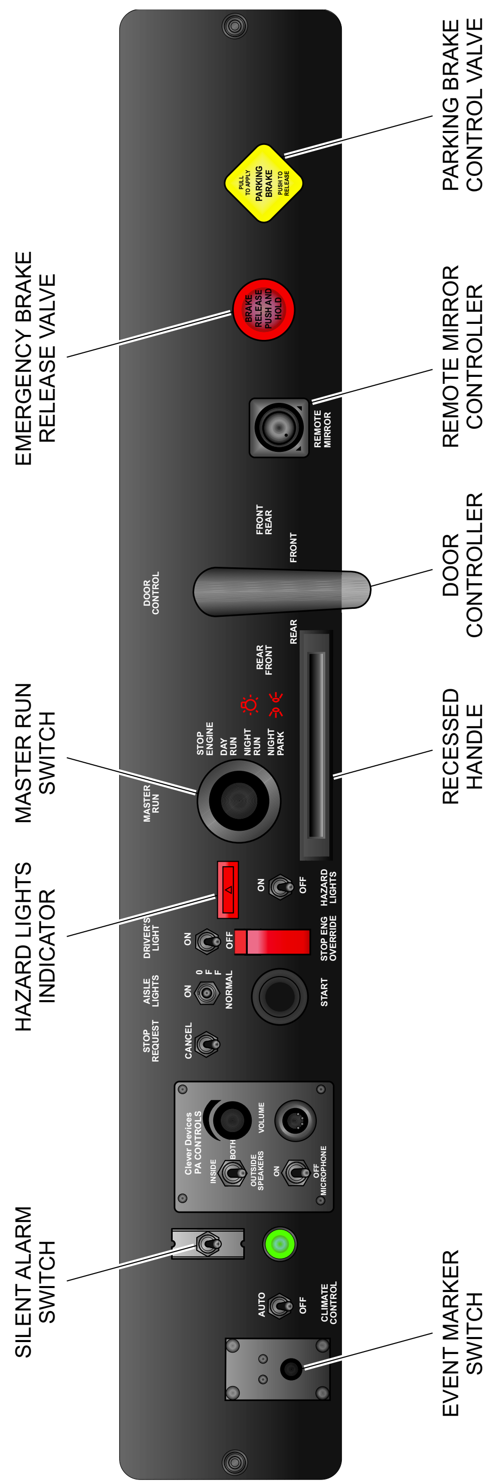

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Fig. GI-10: Side Console Panel

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.

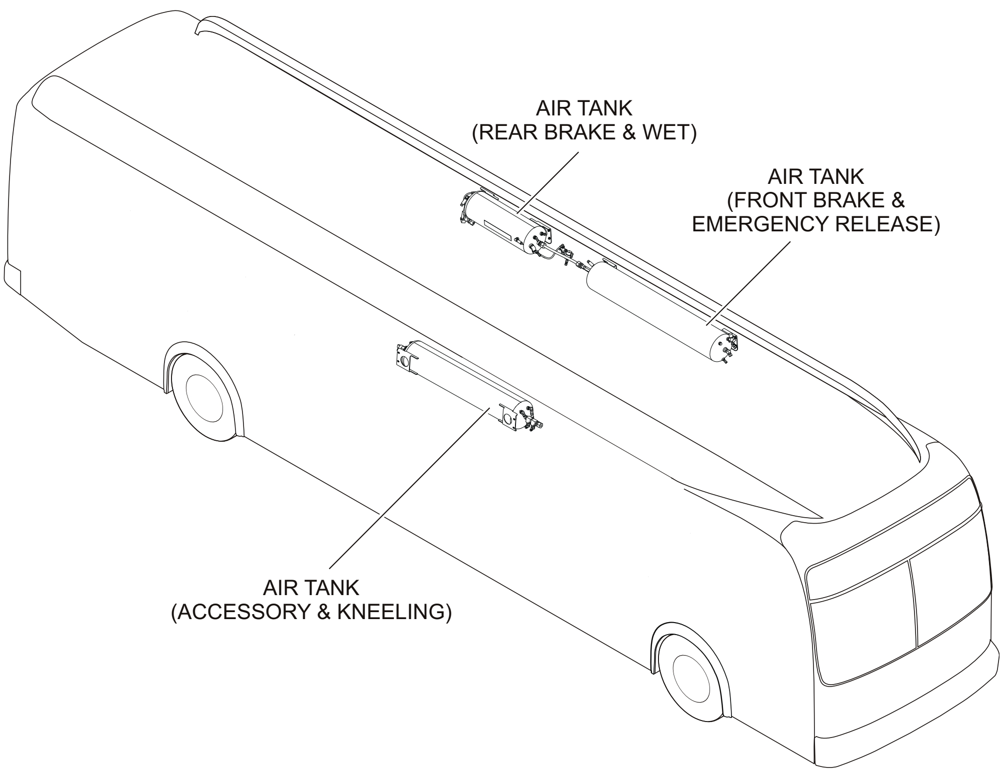

Fig. GI-11: Air Tank Installation

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.

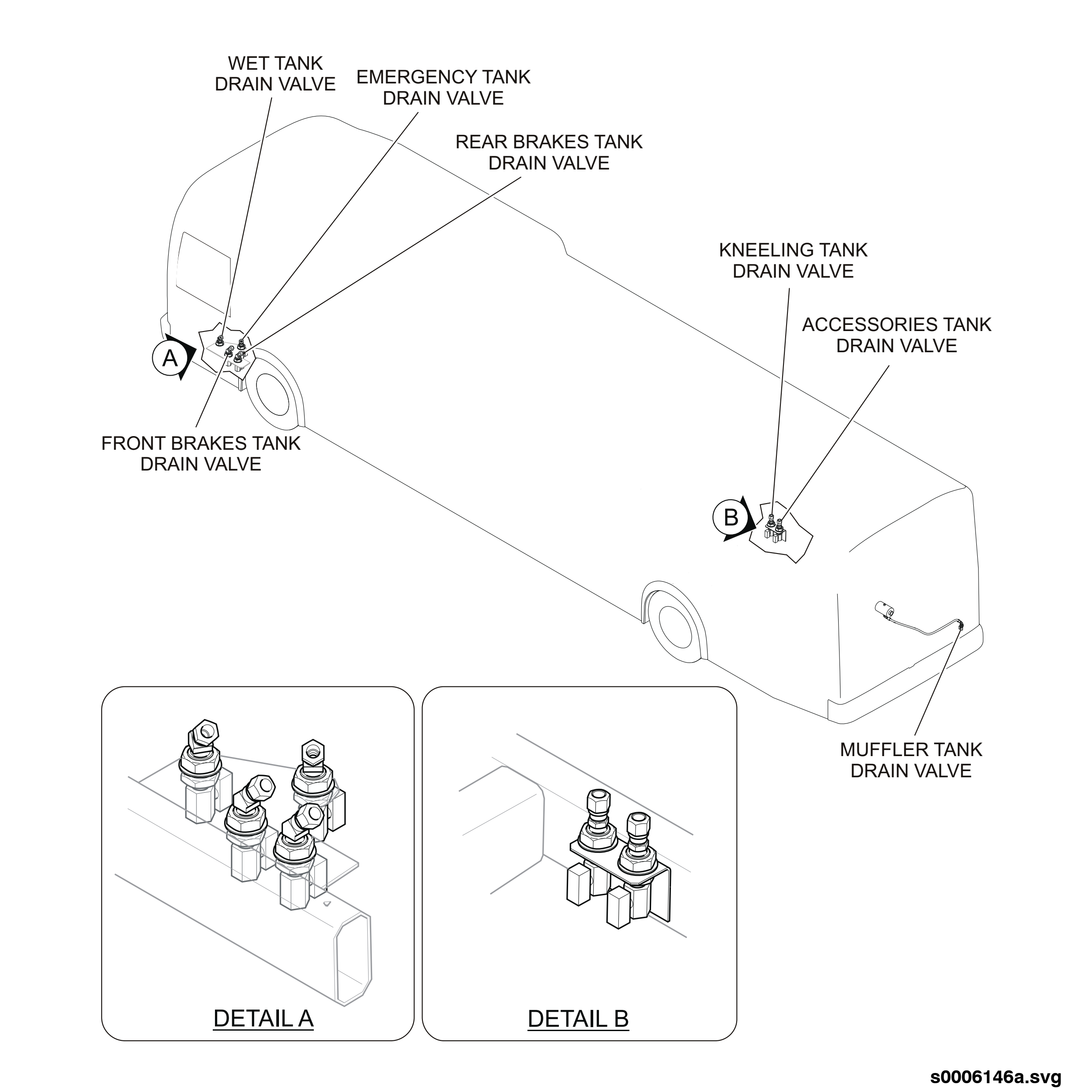

Fig. GI-12: Air Tank Drain Valve Locations

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 & Stop Switches Installation" 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.

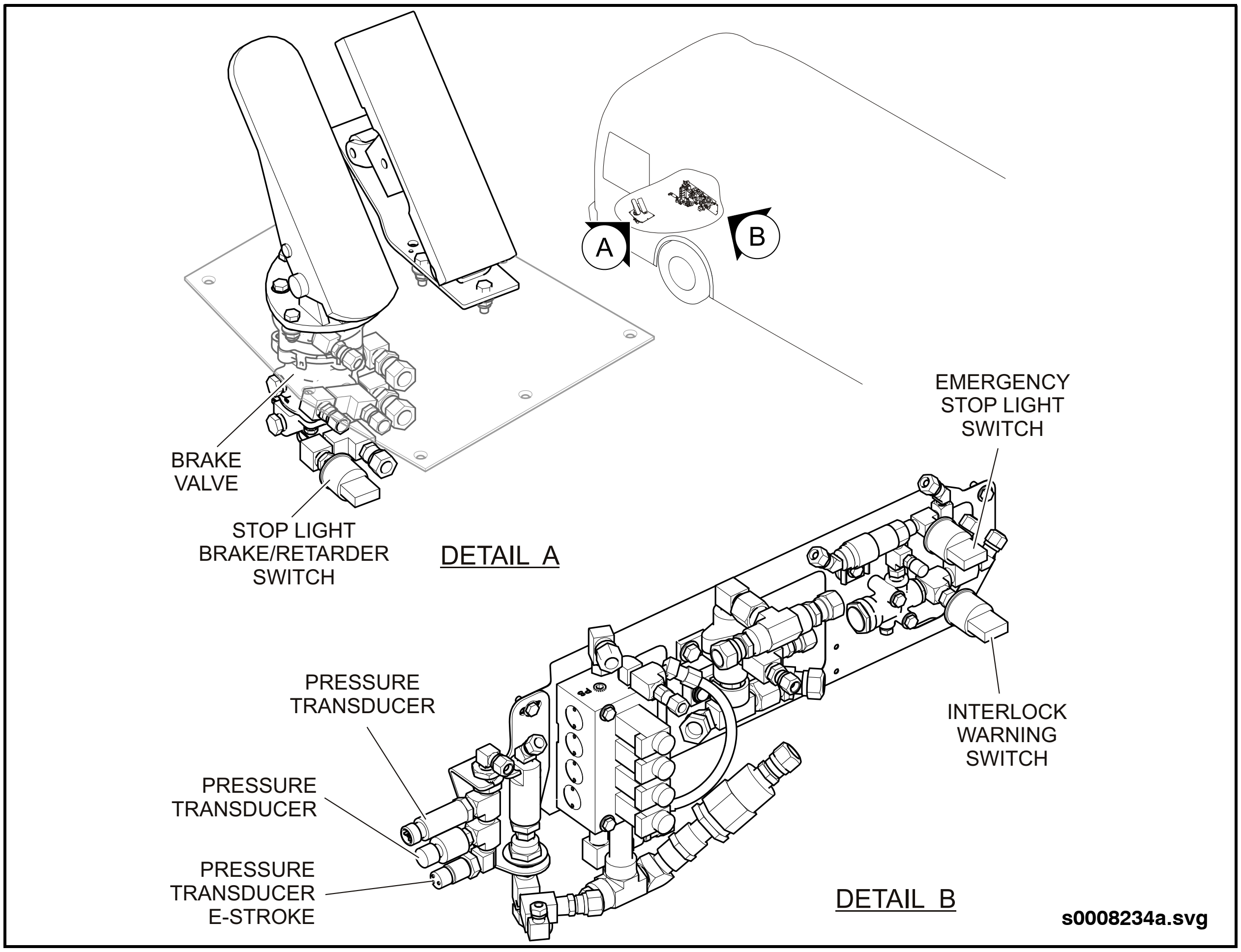

Fig. GI-13: Pressure & Stop Switches Installation

10.4. Brake Application Pressure Transducer (PS15)

10.4.1. Description

The brake application pressure transducer is mounted on the pressure switch bracket and is teed into the Stop Light Pressure switch line. The brake application pressure transducer converts an air pressure input to an analog electrical output. The transducer is not a repairable item and must be replaced as an assembly if defective.

10.4.2. Operation

The pressure transducer senses delivery (D1) air pressure from the brake valve when the brake treadle is applied. The output signal from the pressure transducer is proportional to the applied brake pressure. This signal is used by the Drive Unit Vehicle Control Module (VCM) to control regenerative braking.

10.5. Brake Tank Pressure Sending Units

10.5.1. 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.

10.5.2. Operation

The pressure transducers transmit an analog signal to the vehicle's multiplexing system. The multiplexing system converts the analog signal into pressure readings 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.

10.6. Electronic Stroke Alert Pressure Transducer

10.6.1. 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.

10.6.2. 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 37.

- ❒ 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.

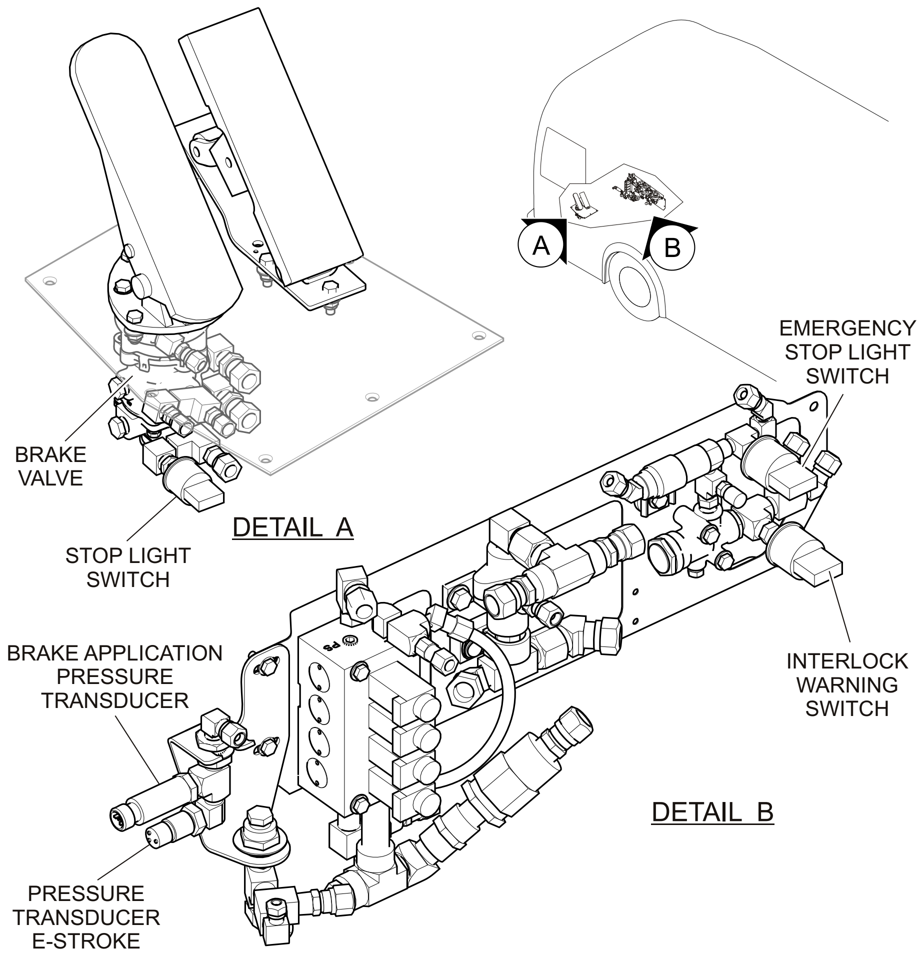

Fig. GI-14: Brake Interlock Valves

12. RAISING THE VEHICLE

12.1. 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.

12.2. Lifting the Vehicle

WARNING

Make sure the wheel lift system is set up to simultaneously raise all four 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-15: Typical Wheel Lifts” on page 39. See “Fig. GI-16: Wheel Placement in Hoist” on page 40.
2. Make sure all four 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.

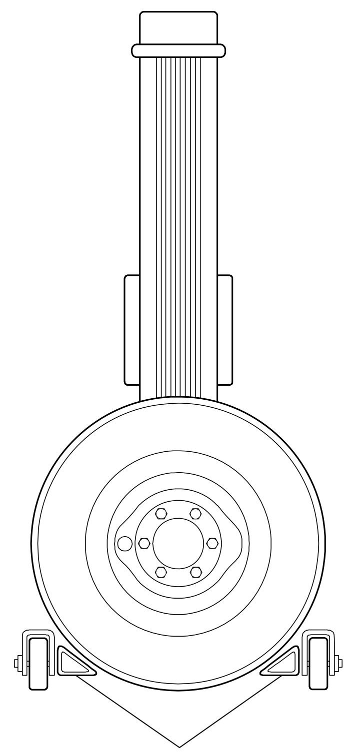

Fig. GI-15: Typical Wheel Lifts

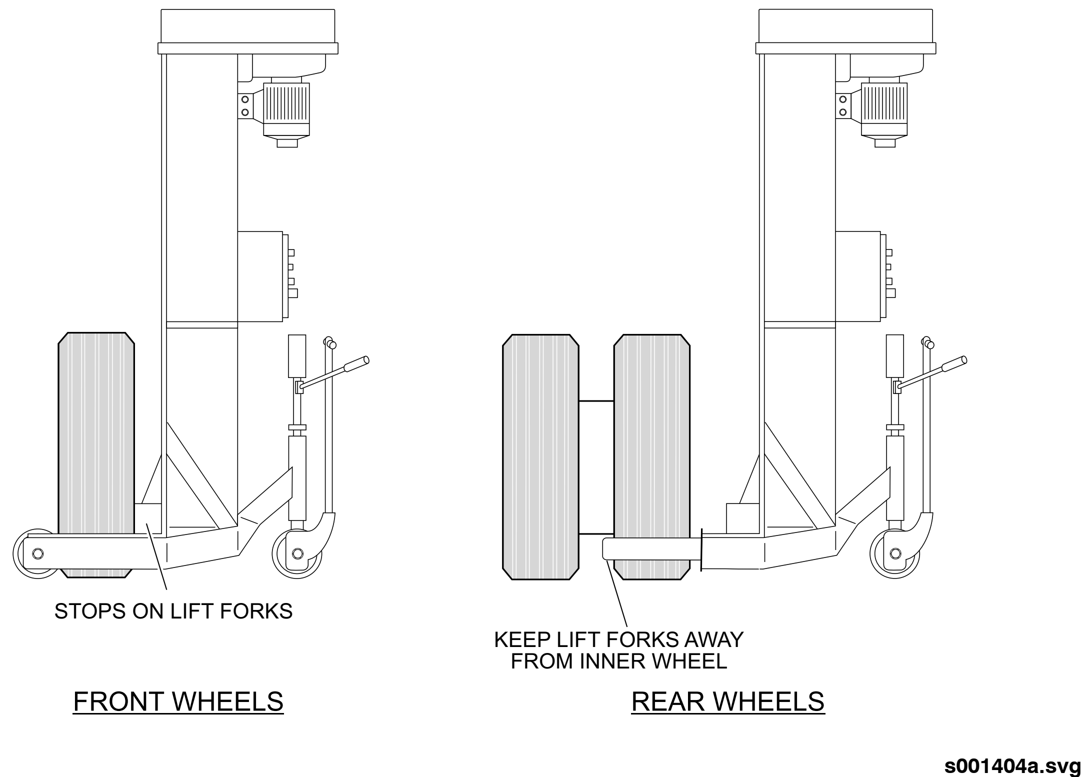

Fig. GI-16: Wheel Placement in Hoist

12.3. 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-17: 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.

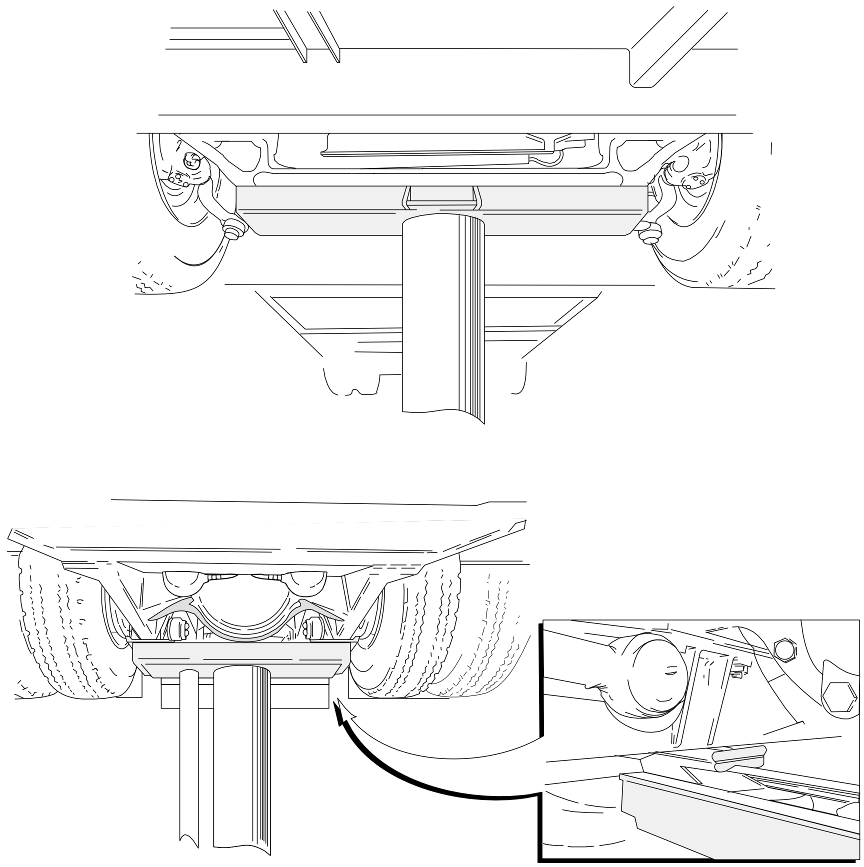

Fig. GI-17: Typical Center Post Hoist

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-18: 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.

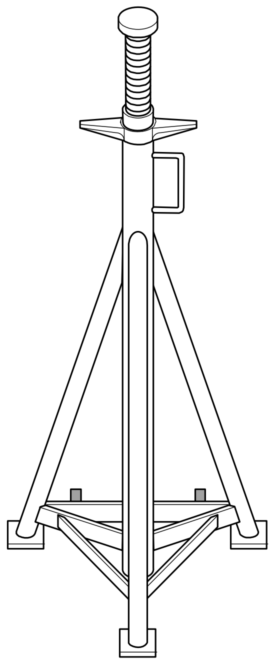

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Fig. GI-18: Jack Stand

12.4. Jacking the Vehicle

CAUTION

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

12.4.1. 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-19: 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.

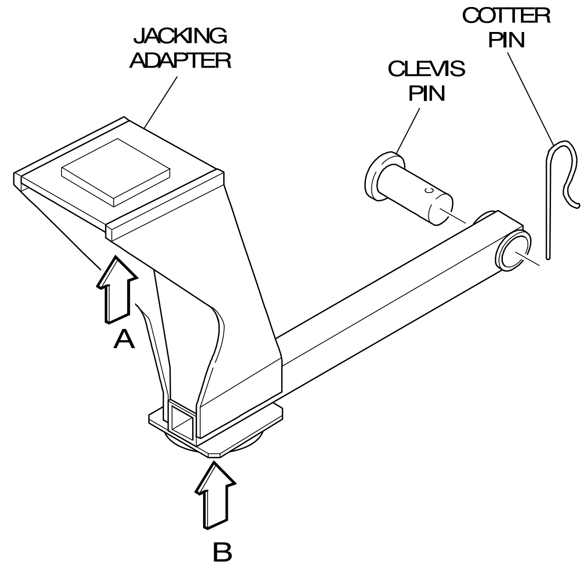


Fig. GI-19: Jacking Adapter

12.4.2. 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-20: 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.

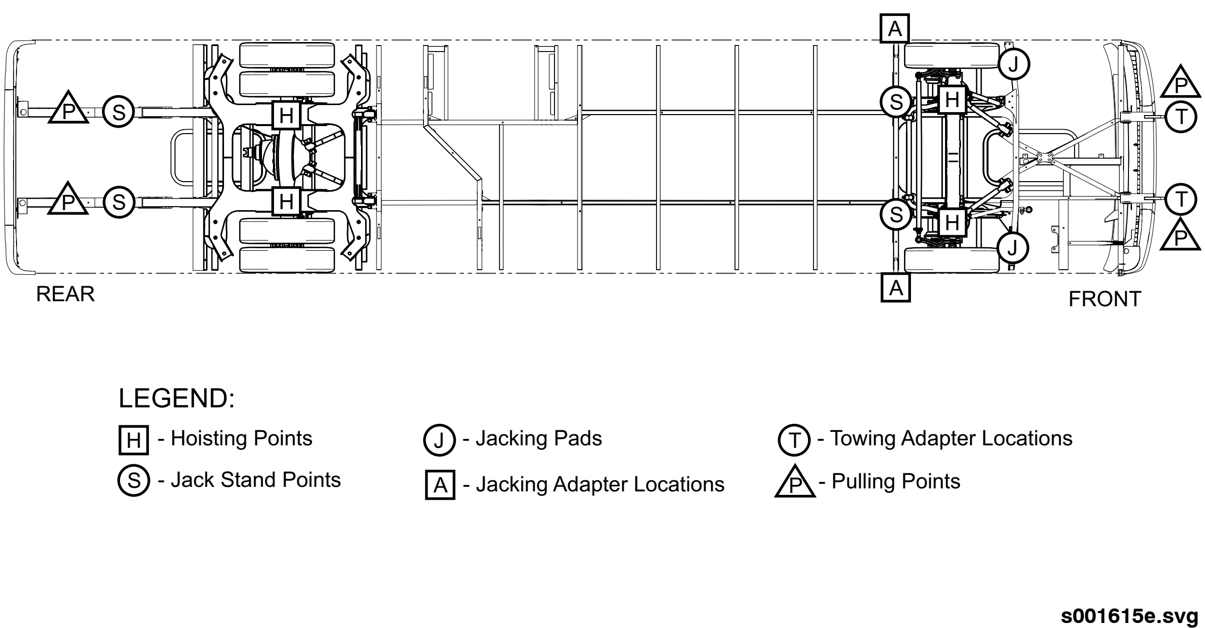


Fig. GI-20: Jacking (hoisting) Points & Stand Placement

13. 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.

13.1. 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 13.2.2.4. “Maximum Lifting Height” on page 51 and Refer to 13.2.2.5. “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.

13.2. 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 13.2.1. “Flat Towing” on page 46 in this section for flat towing procedures. Refer to 13.2.2. “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.

13.2.1. Flat Towing

13.2.1.1. Preparation

1. Prepare the vehicle for towing by removing either the driveshaft or both rear axle shafts. Refer to 13.3. “Driveshaft Removal” on page 52 and Refer to 13.4. “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.

13.2.1.2. Towing Adapter Installation

1. Install each tow adapter into a receiver and locate with a clevis pin. See "Fig. GI-21: 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-22: 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.

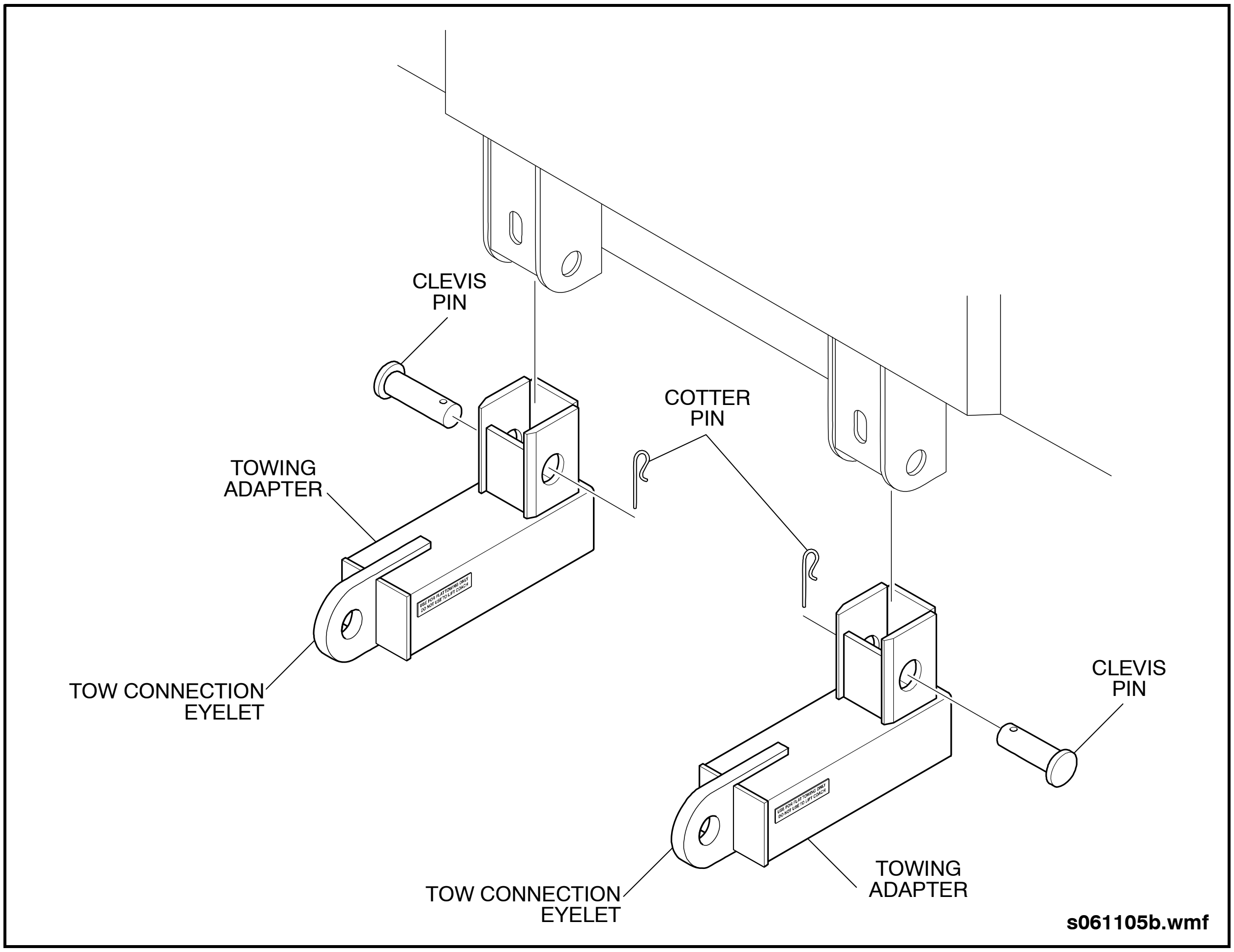


Fig. GI-21: Towing Adapter

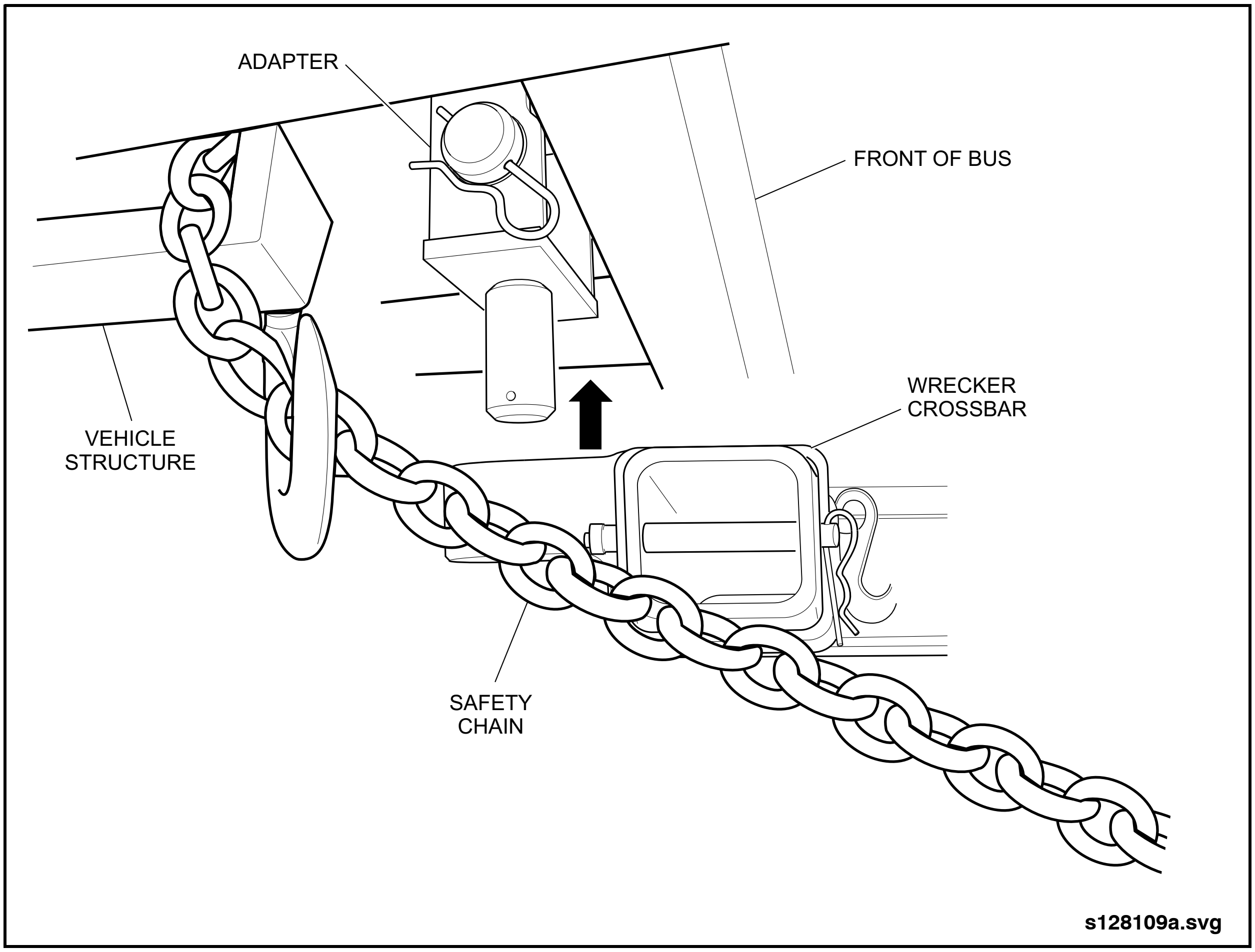


Fig. GI-22: Safety Chain

13.2.2. Raised Towing

13.2.2.1.Preparation

1. Prepare the vehicle for towing by removing either the driveshaft or both rear axle shafts. Refer to 13.3. “Driveshaft Removal” on page 52 and Refer to 13.4. “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.

13.2.2.2. 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-23: Lift Receiver Installation" on page 49.

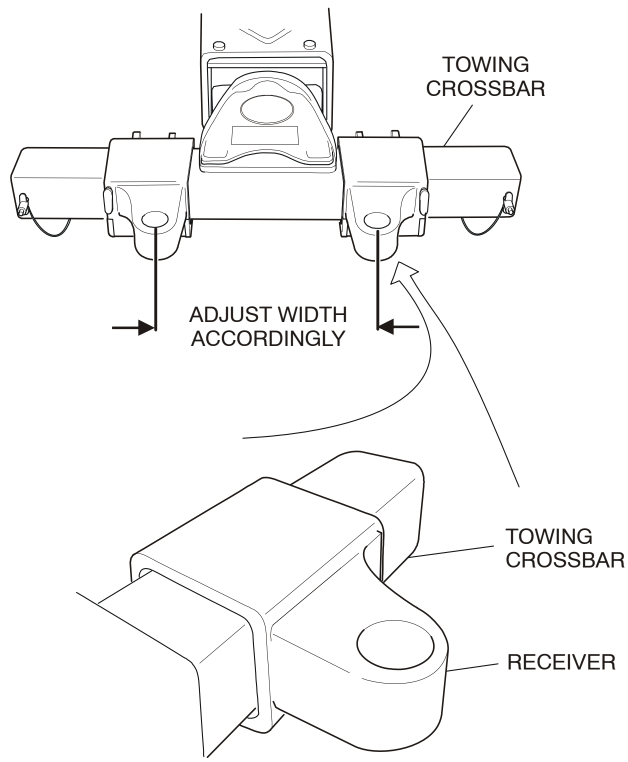


Fig. GI-23: Lift Receiver Installation

13.2.2.3.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-24: 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 13.2.2.4. "Maximum Lifting Height" on page 51 and Refer to 13.2.2.5. "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-25: Securing Steering System" on page 51.

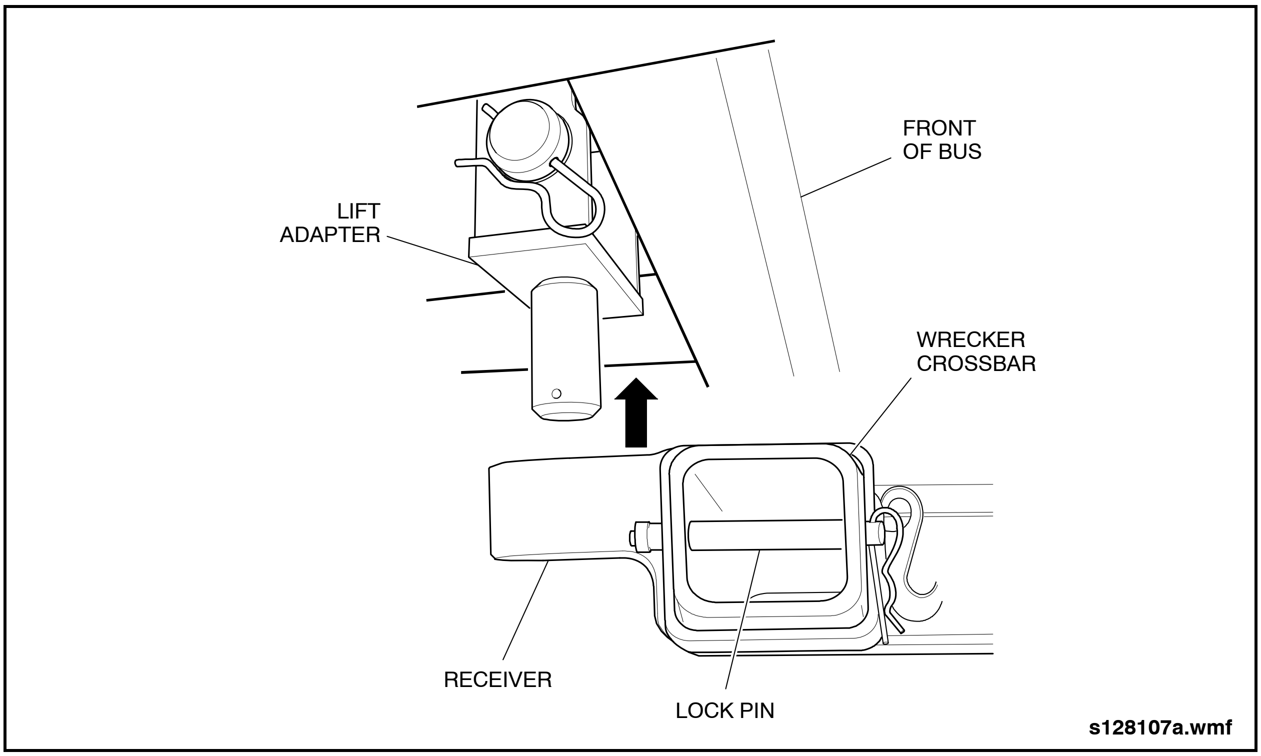


Fig. GI-24: Securing Lift Receivers to Lift Adapters

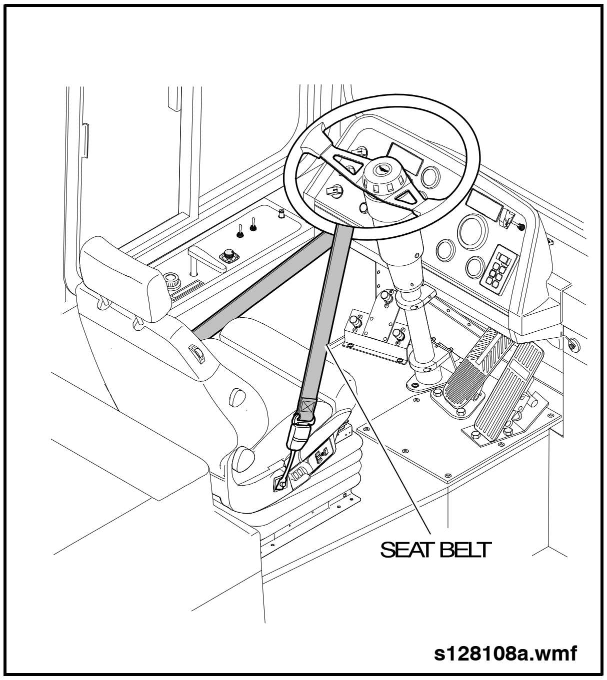


Fig. GI-25: Securing Steering System

13.2.2.4. 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).

13.2.2.5. 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-26: Rear Bumper Clearance Measurement” on page 51.

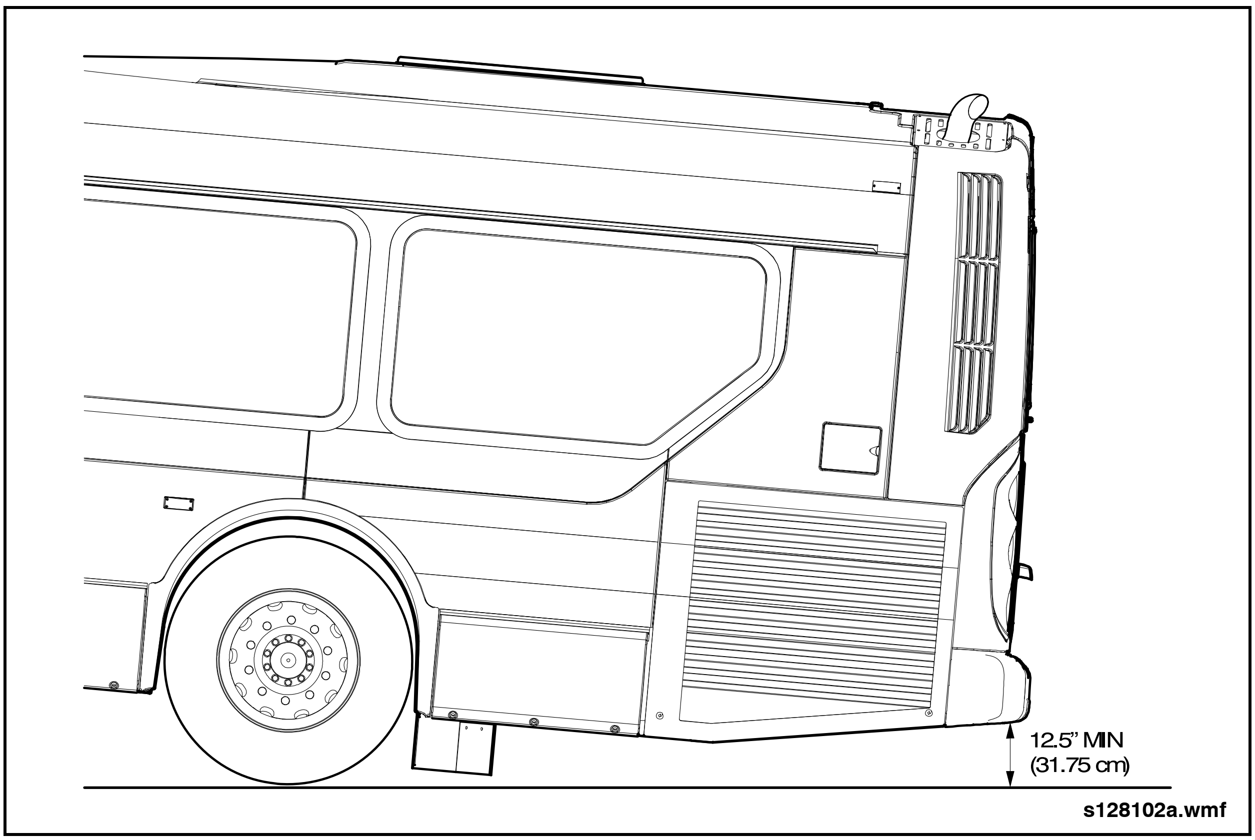


Fig. GI-26: Rear Bumper Clearance Measurement

13.3. 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.

13.4. 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.

13.5. 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.

13.6. Vehicle Removal from Ditch

13.6.1. Chain Pulling Procedure

CAUTION

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

13.6.1.1.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.

13.6.1.2.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.

14. TORQUE INFORMATION

14.1. 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.

14.2. 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.

14.3. 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.

14.4. 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

15. 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. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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
- ❒ Drive Unit
- ❒ HVAC Unit
- ❒ Auxiliary Coolant Heater
- ❒ Fire Suppression System

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 2.10.4. “Driveshaft” on page 27 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 2.34. “Fluid & Lubrication Guide” on page 113 in this section for fluid specification.

❒ Drive Unit - Change the control main filter only within the first 5,000 miles (8,000 km. Refer to 2.23.1. “Drive Unit Fluid & Filter Change” on page 86 in this section for filter change procedure.

☞**NOTE:**

The intervals in this schedule are based upon use of TranSynd™ synthetic transmission fluid or equivalent and Allison High Capacity Filters. Contact your Allison dealer for further details.

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 2.34. “Fluid & Lubrication Guide” on page 113 in this section for grease specification. Refer to Section 2 of this manual for grease repacking procedure.

2.5. Preventive Maintenance Guide

INTERVALS (Daily - Monthly)		
DAILY	**WEEKLY**	**MONTHLY**
Exterior Check	Radiator	Bike Rack Inspection
Operational Check	Auxiliary Coolant Heater	Air Tanks
Wheelchair Ramp		Fire Suppression System
Wheelchair Tie-Down & Occupant Restraints		Fire Extinguisher
Bike Rack Inspection		
Fire Suppression System		
Primary (Suction) Fuel Filter		
S-1 Gard		
Floor Covering		
Crankcase Breather Tube		
Aftertreatment Exhaust Piping		
Air Intake Piping		

INTERVALS (Quarterly - 7,500 mi.)		
QUARTERLY	**6,000 mi. (9,600 km)**	**7,500 mi. (12,000 km)**
Radiator	Disc Brake Pad Inspection	Air Filter Restriction Indicator Inspection
	Wheels & Tires Inspection	Air Filter Replacement
	Drive Unit Inspection	Charge Air Cooler & Piping
	Driveshaft	
	Steering System Inspection	
	Steering Driveshafts	
	Steering Damper	
	Engine Oil & Filter Change	

INTERVALS (Quarterly - 7,500 mi.)		
QUARTERLY	**6,000 mi. (9,600 km)**	**7,500 mi. (12,000 km)**
	Primary (Suction) Fuel Filter Replacement	
	Secondary (Pressure) Fuel Filter Replacement	
	Exhaust System	
	DEF Tank	
	Cooling System	
	Shock Absorber Inspection	
	Ride Height	
	Air Springs	
	Front & Rear Axles & Suspension	
	Radius Rods	
	Air System 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	
	Wheelchair Tie-Down & Occupant Restraints	
	Interior Panels	
	Exterior Panels	

INTERVALS (Quarterly - 7,500 mi.)		
QUARTERLY	**6,000 mi. (9,600 km)**	**7,500 mi. (12,000 km)**
	Battery System	
	Wheelchair Ramp Inspection	
	Driver's Heater/Defroster	
	Floor Heaters	
	HVAC Return Air Filter	
	Rear Axle Breather Tube	
	Engine Compartment Line Routing Inspection	
	Dual Power Inverter Module	
	Hybrid Battery Pack Air Filter	
	Hybrid Oil Cooler Assembly	
	Energy Storage System (ESS)	

INTERVALS (12,000 - 18,000 mi.)		
12,000 mi. (19,300 km)	**15,000 mi. (24,000 km)**	**18,000 mi. (29,000 km)**
Electronic Accelerator	Cooling System Pressure Test	Engine Mounts
S-1 Gard		Fire Suppression System
Driver's Heater/Defroster		Engine Bypass Oil Filter
Floor Heaters		Power Steering Filter

INTERVALS (24,000 - 36,000 mi.)		
24,000 mi. (38,600 km)	**30,000 mi. (48,000 km)**	**36,000 mi. (58,000 km)**
Brake Treadle Assembly & Brake Valve	Fuel Tank	Disc Brake Caliper Inspection
	Engine Drive Belts	Power Steering Fluid
		Rear Axle Oil Change (Hot Region Only - see NOTE at the end of this chart)

INTERVALS (48,000 - 54,000 mi.)		
48,000 mi. (77,200 km)	**50,000 mi, (80,500 km)**	**54,000 mi, (87,000 km)**
Front End Alignment	Drive Unit Control Main Filter Change	Rear Axle Oil Change (Moderate Region Only - see NOTE at the end of this chart)
Front Brake Chambers		
Rear Brake Chambers		

INTERVALS (60,000 - 100,000 mi.)		
60,000 mi. (96,000 km)	**96,000 mi. (154,500 km)**	**100,000 mi. (160,000 km)**
Fuel Tank	Front End Alignment	Drive Unit Fluid & Filter Change
Air Compressor Discharge Lines		
Crankcase Breather Element		

INTERVALS (200,000 mi. - Yearly)		
200,000 mi. (321,000 km)	**6 MONTHS**	**YEARLY**
Muffler Particulate Filter	D-2 Governor	Door Sensitive Edge Inspection & Test
Diesel Exhaust Fluid Filter	PR-2 Pressure Protection Valve	Wheelchair Ramp Pump Hydraulic Fluid
DEF Tank Inlet Filter	ST-1 Safety Valve	Instrument Panel & Side Console
	SR-7 Spring Brake Modulating Valve	Fire Extinguisher
	SC-1 Single Check Valve	Auxiliary Coolant Heater
	DC-4 Double Check Valve	QR-1 Quick Release Valve
	RV-3 Pressure Reducing Valve	Air Strainer
	R-14 Brake Relay Valve	Radiator
	Brake Foot Valve	Hybrid Oil Cooler
	Parking Brake Control Valve	Headlight Aim
	Emergency Brake Release Valve	Front & Rear Wheel Bearing Inspection
	Steering Knuckle Lubrication	Coolant Testing
	Bike Rack Servicing	
	Air Dryer	
	Power Steering Miter Box	

INTERVALS (2 - 5 Years)		
2 YEARS	**3 YEARS**	**5 YEARS**
Radiator	Under Body Inspection	Door Motor Rebuild
Door System Inspection	Fire Suppression System	Door Operator Proximity Switches
	Air Dryer	Door Component Replacement
		Air Dryer

INTERVALS (6 - 12 Years)		
6 YEARS	**10 YEARS**	**12 YEARS**
Fire Suppression System	Door Component Replacement	Fire Extinguisher
Fire Extinguisher		Fire Suppression System
Booster Pump		
Cooling System		
Video Surveillance System		

☞**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.

2.6. 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.
- ❒ Power steering reservoir level is correct.
- ❒ Engine and drive unit fluid levels are correct.
- ❒ Fuel tanks are full.
- ❒ Diesel exhaust fluid tank is 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.
- ❒ Drive unit 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. 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.

2.6.6. Fire Suppression System

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

2.6.7. Primary (Suction) Fuel Filter

Inspect see-through collection bowl on primary fuel filter for evidence of water or contaminants. Drain collection bowl if required.

2.6.8. 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.

2.6.9. 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.

2.6.10. 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

2.6.11. Aftertreatment Exhaust Piping

Inspect exhaust aftertreatment system for leaks cracks, and loose connections. Inspect for leaks at V-band connections and tighten clamps as necessary.

2.6.12. 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.

2.7. 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 trouble-shooting and vendor information.

2.7.2. Auxiliary Coolant Heater

☞**NOTE:**

The coolant heater may be programmed to start whenever coolant temperature is below a preset temperature, regardless of heating system inputs. In this situation the coolant heater will operate automatically during a cold engine start and the need to manually operate the heater on a weekly basis will be unnecessary.

The coolant heater should be operated on a weekly basis during the non-heating season to ensure that fresh fuel is in the unit's critical components. Operating the coolant heater on a regular basis will preclude any starting problems at the beginning of the heating season.

2.8. Monthly Preventive Maintenance

2.8.1. 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.

2.8.2. 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 P/N 5013711 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 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.

2.8.3. Fire Suppression System

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

2.8.3.1. 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.

2.8.3.2. Thermal Linear Detector

- ❒ Verify that the thermal detection cable in the engine compartment is properly routed and clamped and no damage is evident to the cable.
- ❒ Verify that the end of line device (EOD) is properly installed at the end of the cable and is not damaged.

2.8.3.3. 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.

2.8.3.4. Electrical Harnesses

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

2.8.3.5. 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-1: 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.

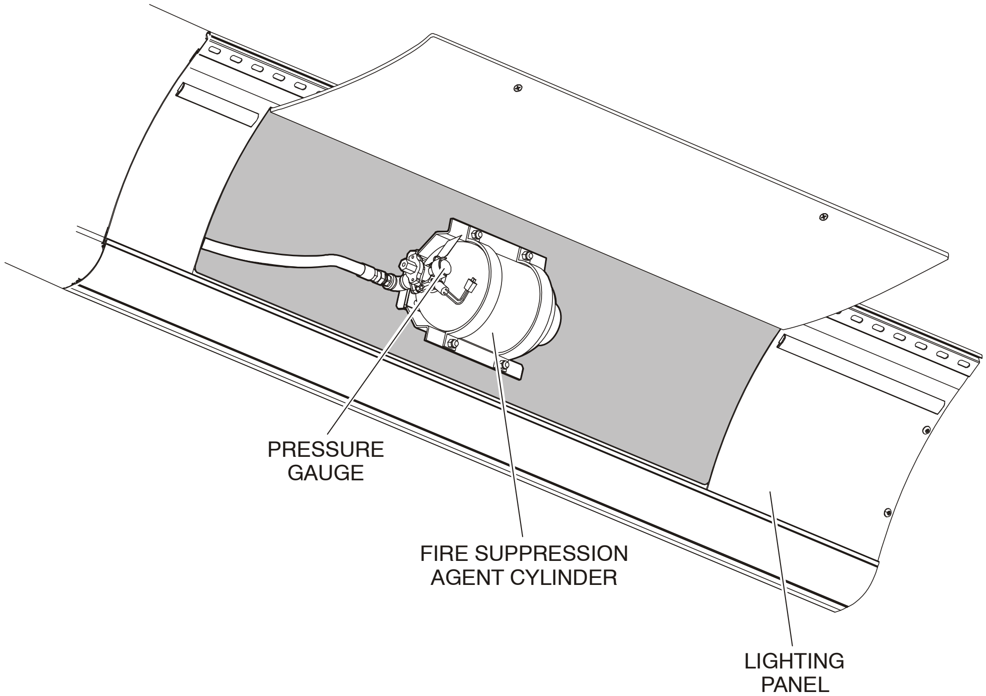


Fig. PM-1: Fire Suppression Cylinder Inspection

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.

2.9. Quarterly Preventive Maintenance

2.9.1. 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.

2.9.1.1. 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-2: 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.

2.9.1.2. 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 2.27. "Two Year Preventive Maintenance" on page 103 *in this section for cleaning and flushing procedure.*

2.9.1.3. 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.

2.9.1.4. 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.

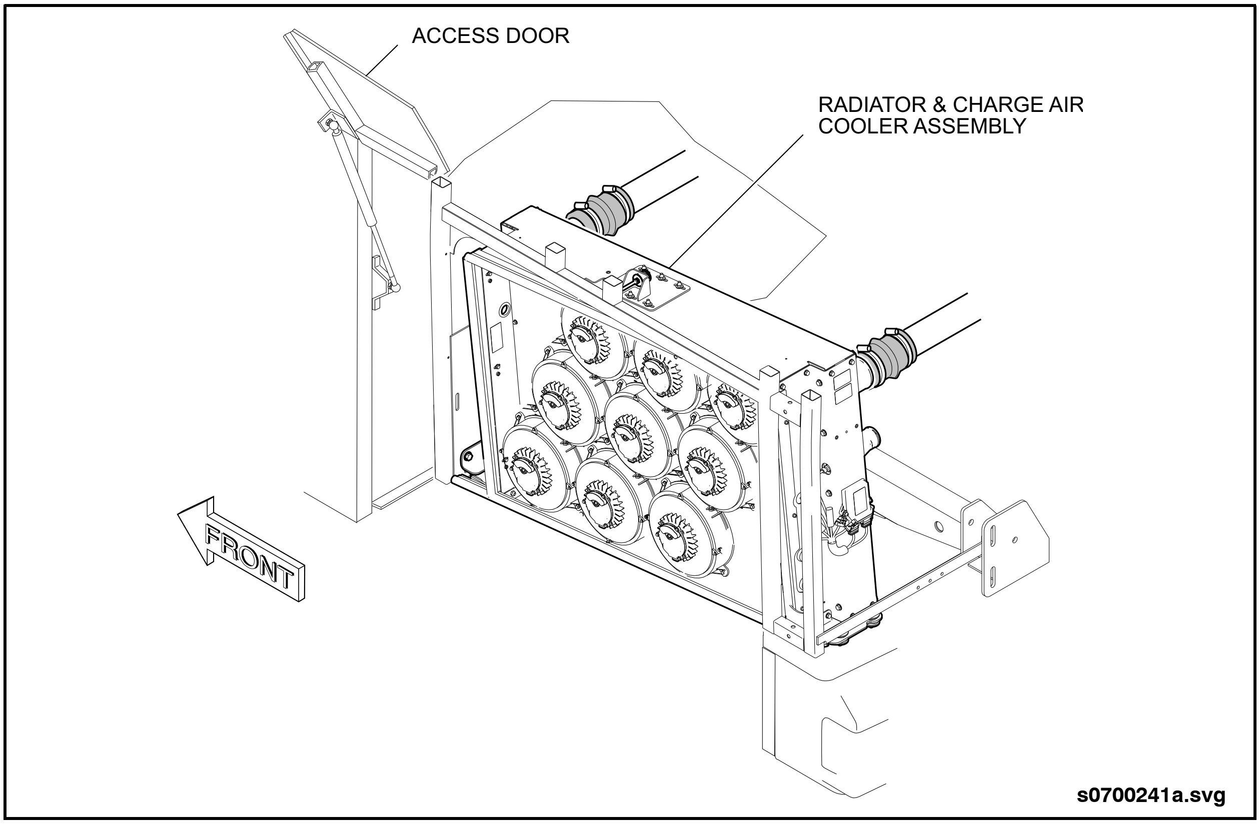


Fig. PM-2: Radiator Inspection

2.10. 6,000 Miles (9,600 km) Preventive Maintenance

2.10.1. 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.

2.10.2. 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.

2.10.3. Drive Unit Inspection

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

- ❒ Loose bolts (drive unit to engine attachment and driveline components).
- ❒ Oil leaks (correct immediately).
- ❒ Worn or frayed electrical harnesses, improper routing. See “Fig. PM-3: Drive Unit Inspection” on page 26.
- ❒ Damaged or loose oil lines.
- ❒ Worn or out-of-phase driveline yokes and slip joints.
- ❒ Clogged or dirty breather. Replace as required.

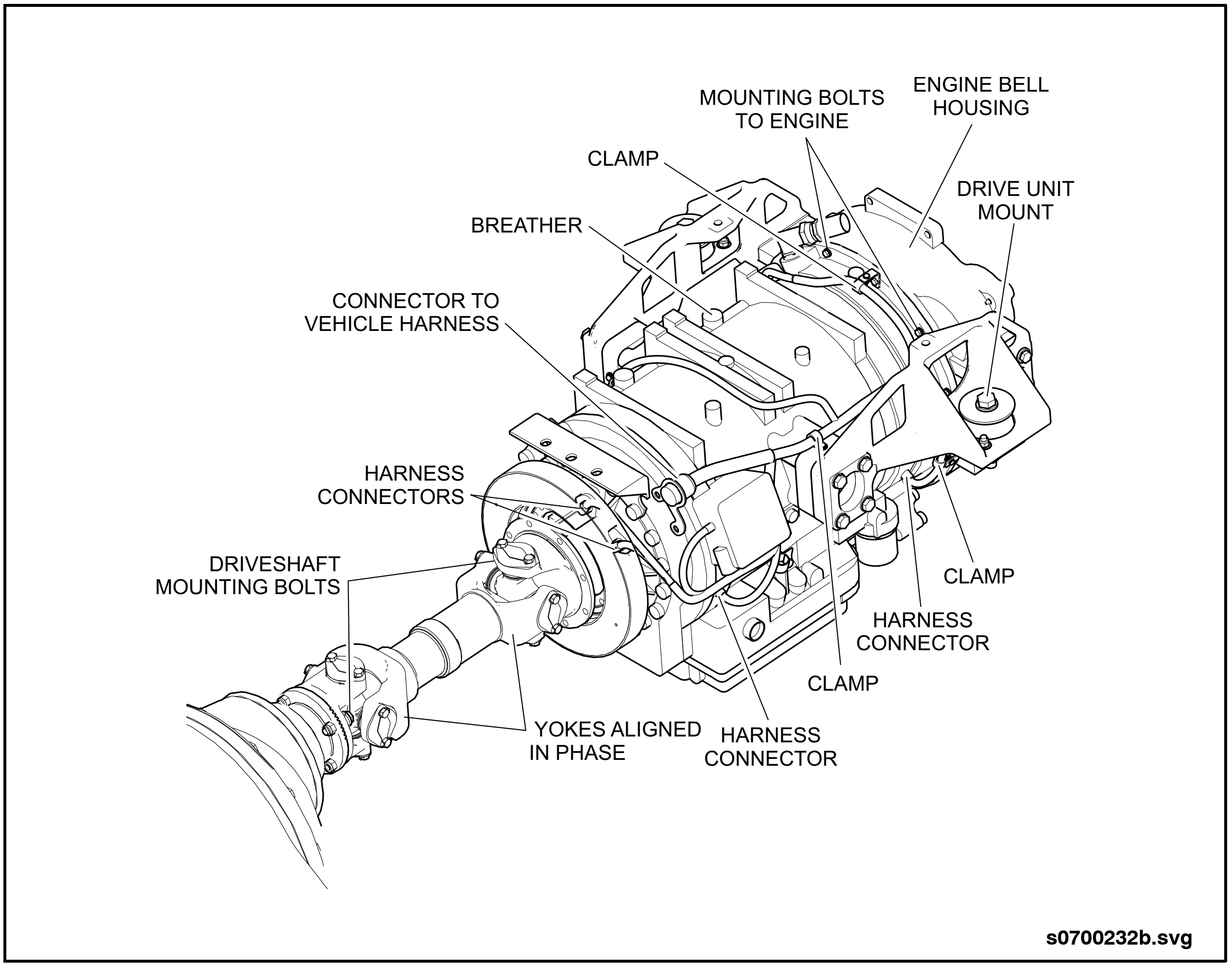


Fig. PM-3: Drive Unit Inspection

2.10.4. Driveshaft

☞**NOTE:**

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

2.10.4.1.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-4: Driveshaft Spline Inspection” on page 27. 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.

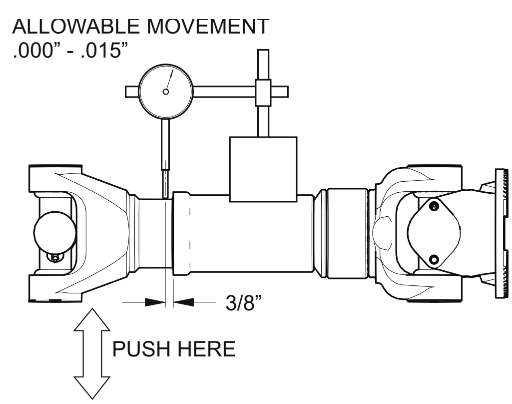


Fig. PM-4: Driveshaft Spline Inspection

2.10.4.2. Lubrication

Refer to 2.34. "Fluid & Lubrication Guide" on page 113 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-5: "Driveshaft Lubrication Points" on page 28
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.

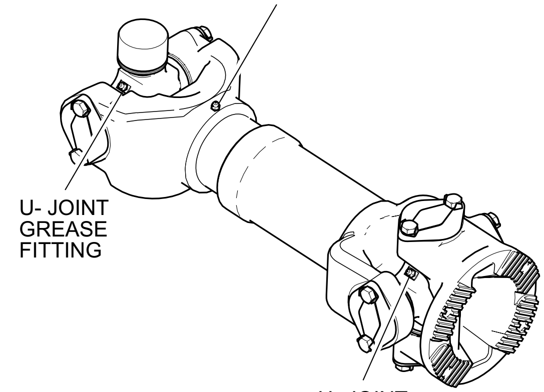


Fig. PM-5: Driveshaft Lubrication Points

2.10.5. 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-6: Steering Gear Inspection” on page 30.
- ❒ 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.

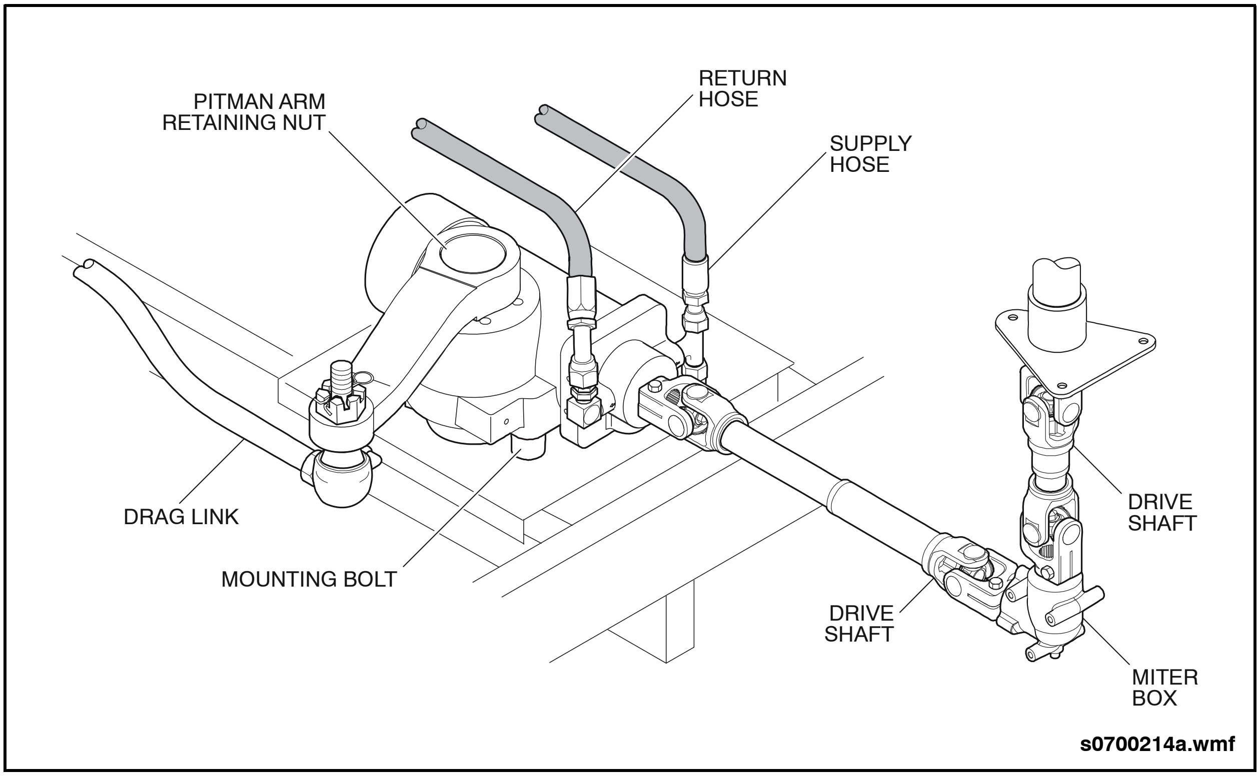


Fig. PM-6: Steering Gear Inspection

2.10.6. Steering Driveshafts

Inspect and lubricate the upper (vertical) and lower (horizontal) steering driveshafts every 6,000 miles (9,600 km). See “Fig. PM-7: Steering Driveshaft Inspection” on page 31.

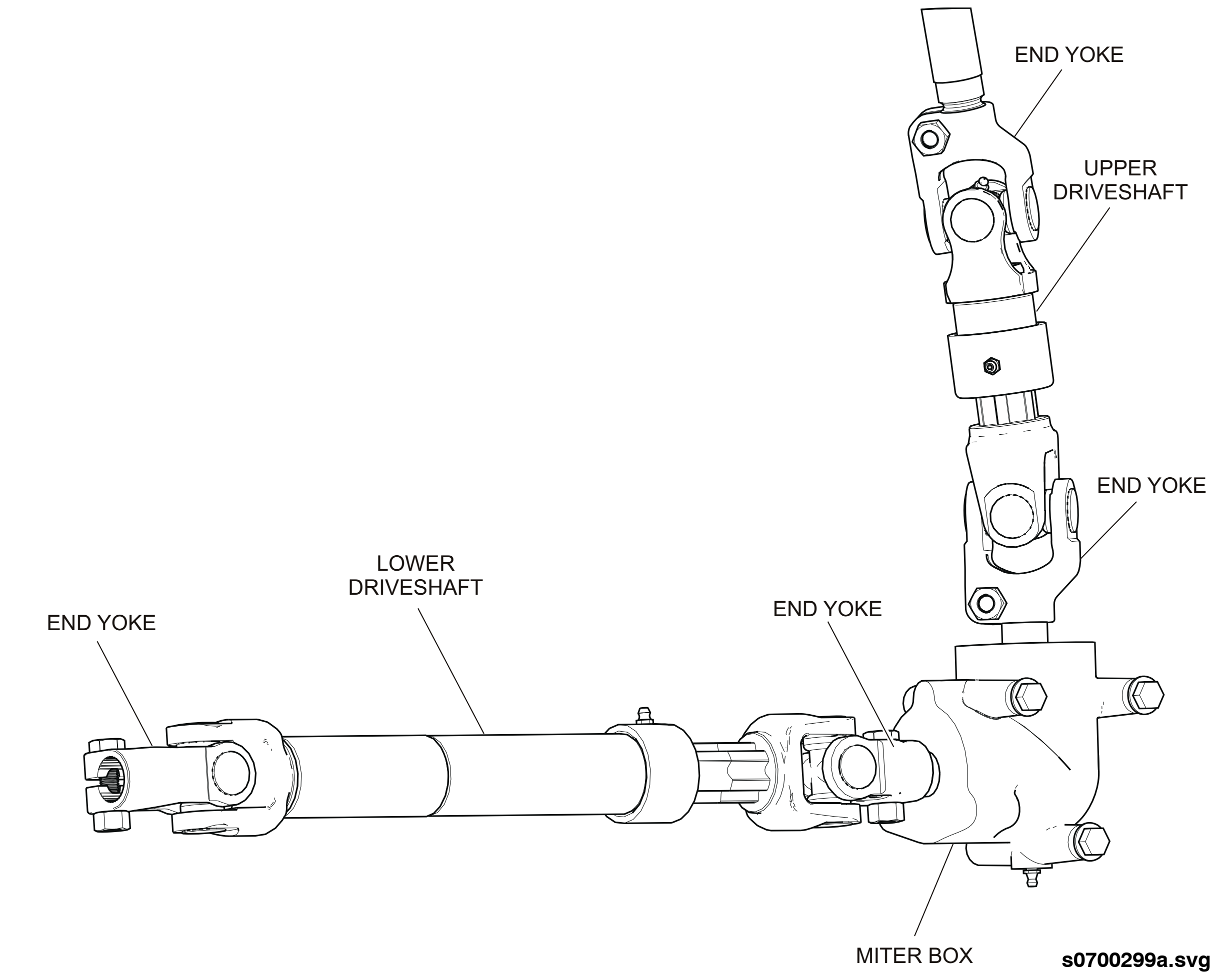


Fig. PM-7: Steering Driveshaft Inspection

2.10.6.1.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-8: Snap Ring Inspection” on page 33.
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). See “Fig. PM-9: Steering Driveshaft U-Joint Inspection” on page 33.
   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-10: Steering Driveshaft End Yoke Inspection” on page 33.
   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-11: Steering Driveshaft Spline Backlash Inspection” on page 33.
   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.

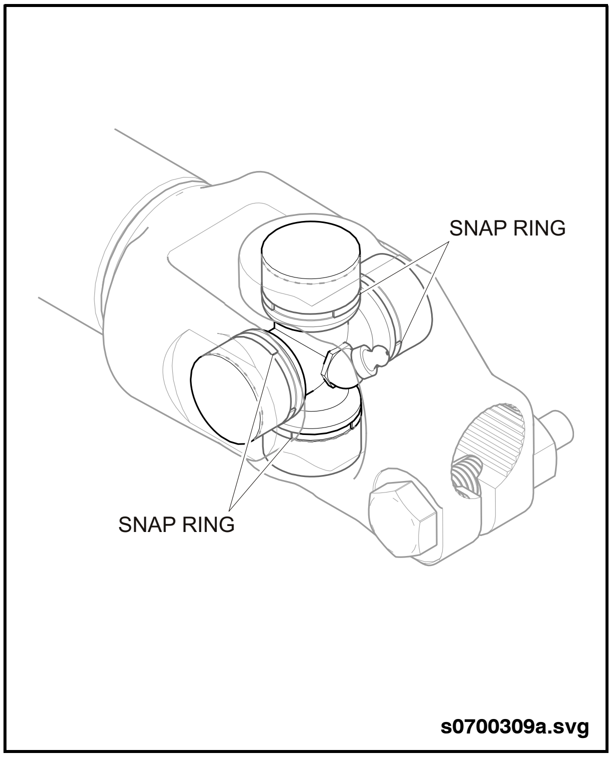


Fig. PM-8: Snap Ring Inspection

Fig. PM-10: Steering Driveshaft End Yoke Inspection

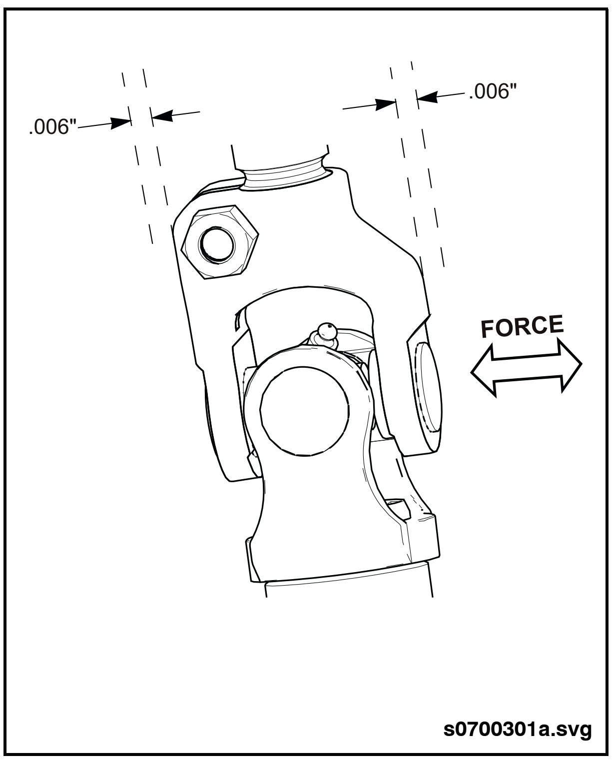


Fig. PM-9: Steering Driveshaft U-Joint Inspection

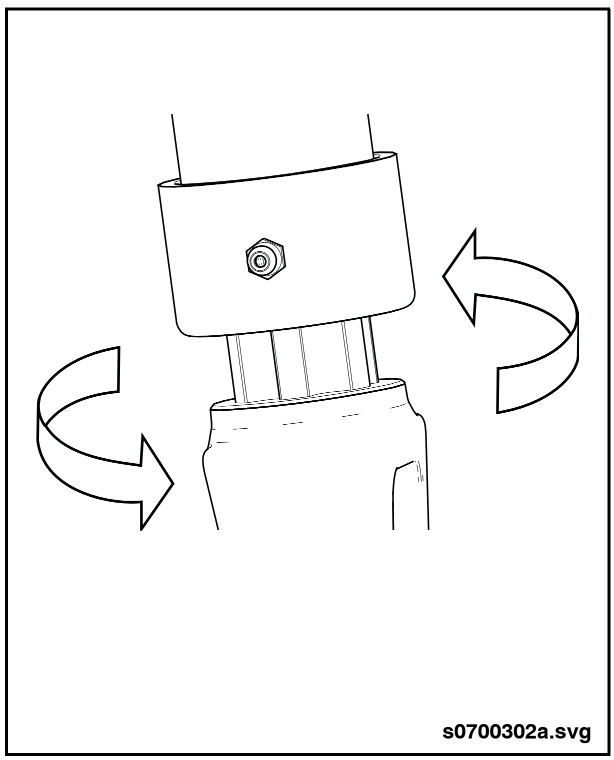


Fig. PM-11: Steering Driveshaft Spline Backlash Inspection

2.10.6.2.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 2.34. “Fluid & Lubrication Guide” on page 113 in this section for grease specifications. See “Fig. PM-12: Steering Driveshaft Lubrication Points” on page 34.
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.

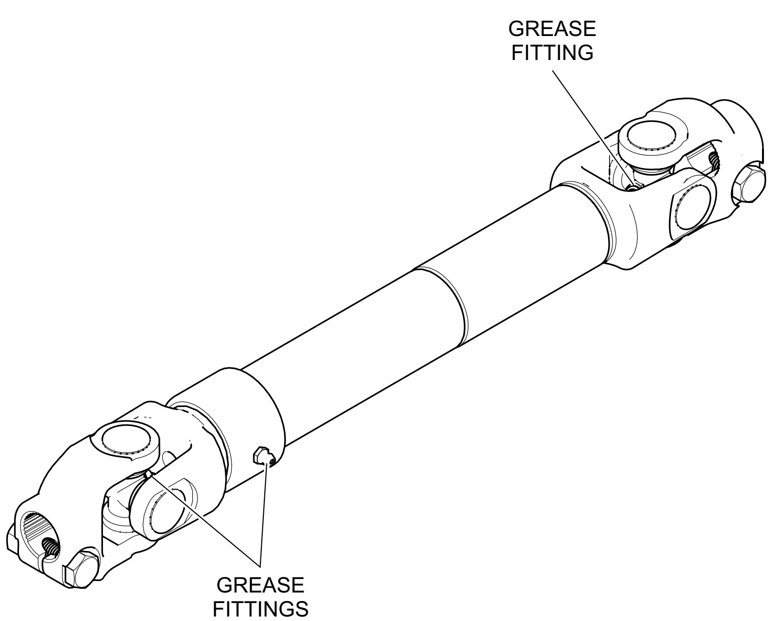


Fig. PM-12: Steering Driveshaft Lubrication Points

2.10.6.3.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-13: Steering Driveshaft Seal Inspection” on page 35.
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.

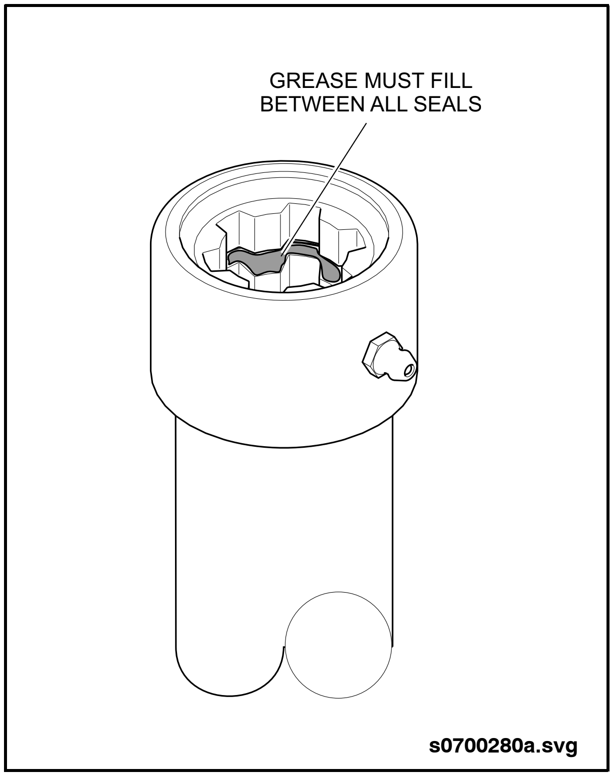


Fig. PM-13: Steering Driveshaft Seal Inspection

2.10.7. 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-14: Steering Damper Inspection" on page 36.
- ❒ 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.

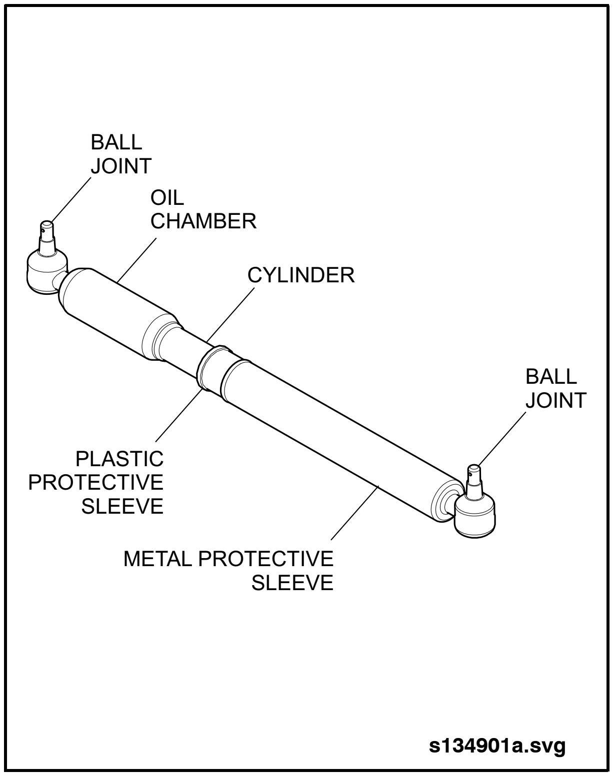


Fig. PM-14: Steering Damper Inspection

2.10.7.1.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-15: Damper Measurement” on page 37.
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.

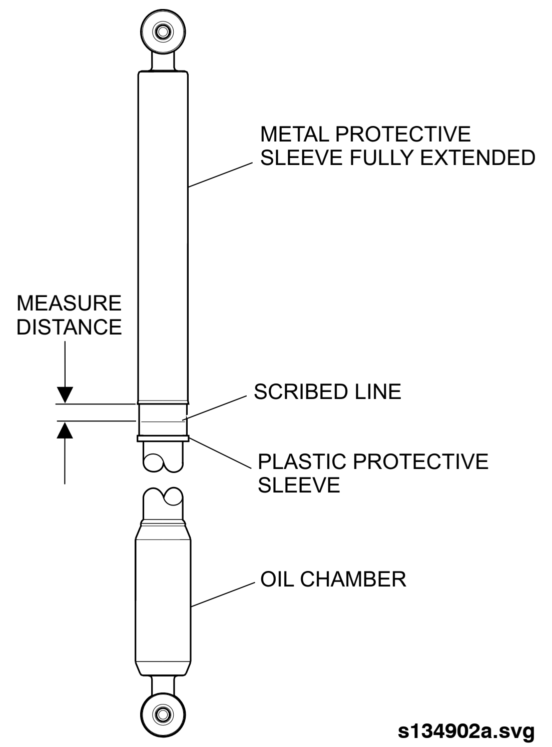


Fig. PM-15: Damper Measurement

2.10.8. Engine Oil & Filter Change

☞NOTE:

Engine oil and filter change intervals are based on average vehicle speed. Refer to 2.10.8.1. "Engine Oil Change Intervals" on page 39 *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.
2. Remove the oil drain plug from the bottom of the oil pan. See "Fig. PM-16: Engine Oil Filter" on page 38.
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 2.34. "Fluid & Lubrication Guide" on page 113 in this section for oil specification. Engine capacity is 25.2 quarts U.S. (23.8 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.

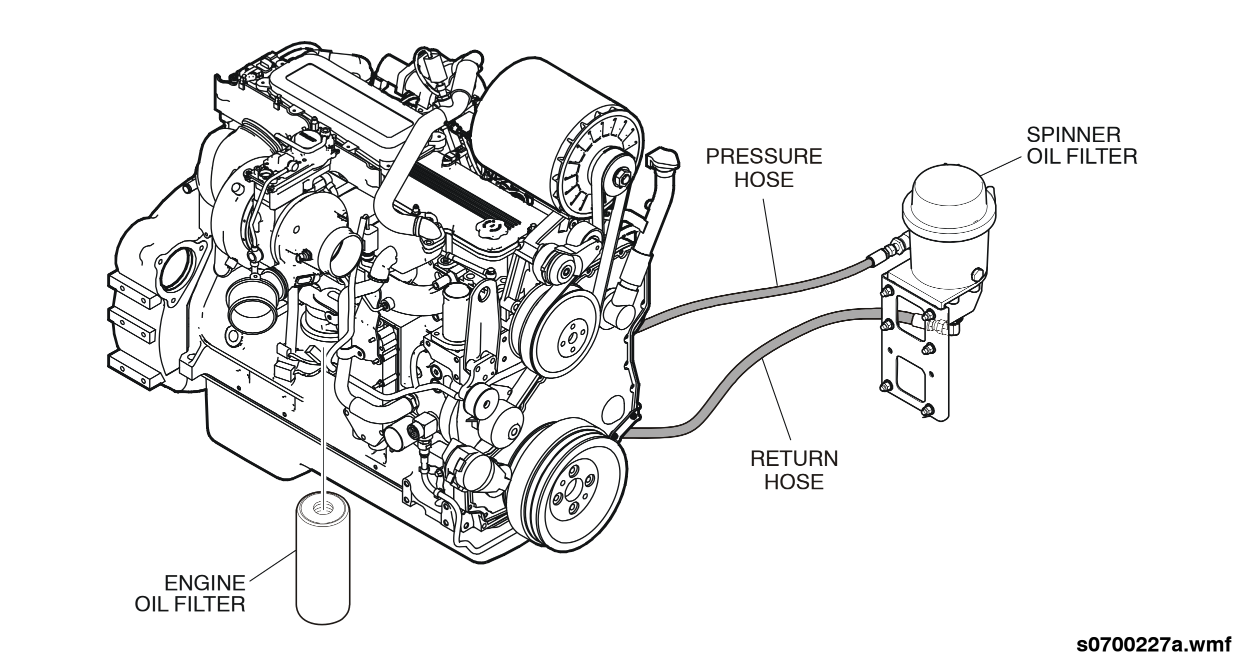


Fig. PM-16: Engine Oil Filter

2.10.8.1. Engine Oil Change Intervals

ENGINE OIL CHANGE INTERVALS			
AVERAGE VEHICLE SPEED	INTERVAL		
	Mileage (km)	Operating Hours	Months
10 - 15 mph (16 - 24 km/h)	6,000 (9,600)	500	6
8 - 10 mph (13 - 16 km/h)	5,000 (8,000)	500	6
6 - 8 mph (9.6 - 13 km/h)	4,000 (6,400)	500	6
4 - 6 mph (6.4 - 9.6 km/h)	3,000 (4,800)	500	6
2 - 4 mph (3.2 - 6.4 km/h)	1,500 (2,400)	500	6

2.10.9. Engine Bypass Oil Filter

☞**NOTE:**

Do not remove the cover from the filter unit or disturb the cover seal until required at the scheduled rotor replacement interval.

Perform a visual inspection of the Spinner II Bypass Oil Filter every 6,000 miles (9,600 km) or every engine oil change. Inspect the oil and air line connections for tightness. Inspect the condition and routing of oil and air lines. Ensure that the filter housing and mounting bracket are fitted with isolation mounts and that the fasteners are properly tightened.

2.10.10.Primary Fuel Filter Replacemen

Replace the primary fuel filter element every 6,000 miles (9,600 km), 500 operating hours, or every six months, whichever comes first. Replace the element earlier if plugging is indicated by the fuel level rising in the filter above the label near the top of the element. See “Fig. PM-17: Engine Fuel Filters” on page 40.

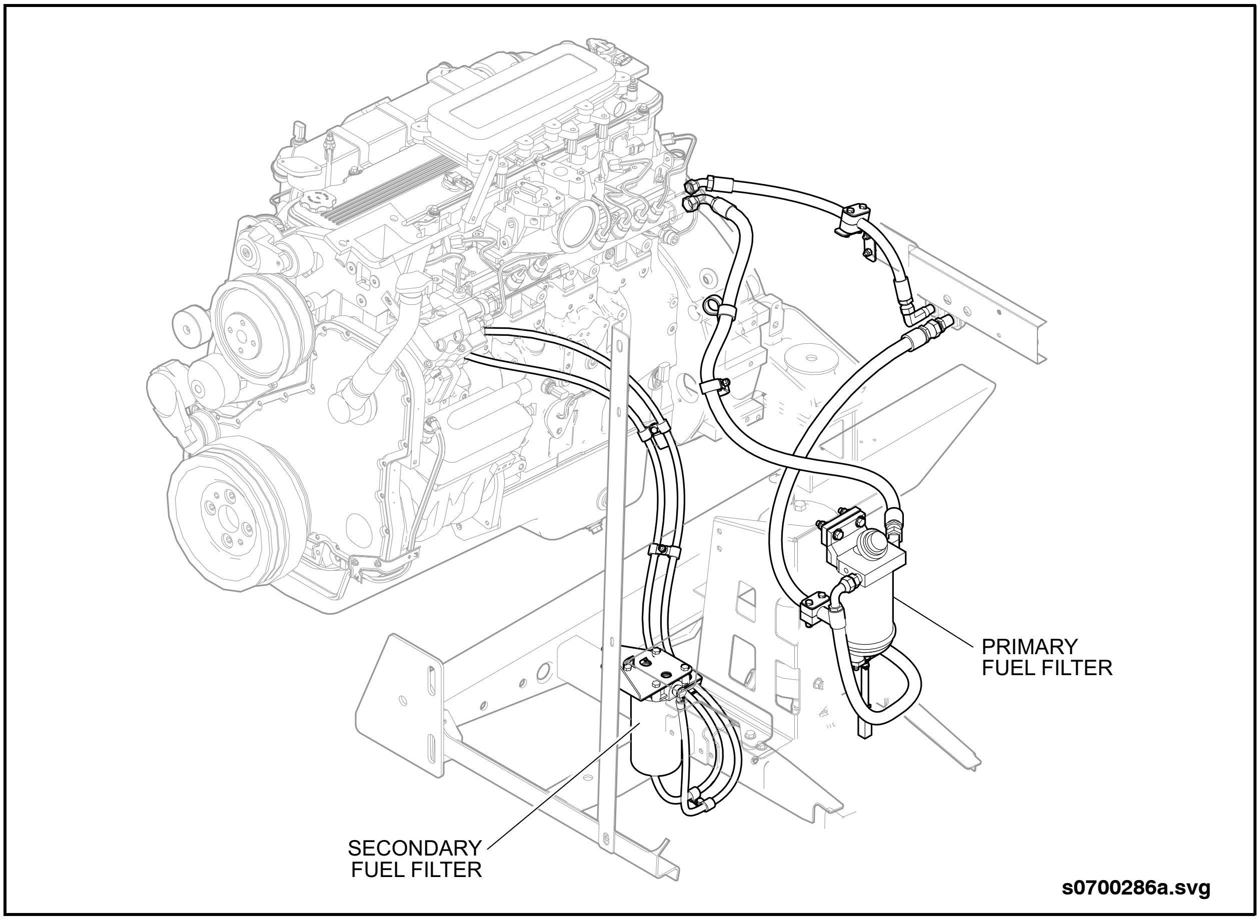


Fig. PM-17: Engine Fuel Filters

2.10.11. Secondary (Pressure) Fuel Filter Replacement

Replace the secondary fuel filter every 6,000 miles (9,600 km), six months, or 500 operating hours, whichever occurs first.

☞ **NOTE:**

The fuel filter is a non-serviceable spin-on type. DO NOT attempt to clean and reuse the filter assembly.

⚠ CAUTION

Clean the fuel filter head and surrounding area to prevent the introduction of contaminants into the fuel system.

1. Use a filter strap wrench to unscrew the filter assembly from the filter head. Discard the filter.
2. Inspect the filter head to see whether the filter seal ring is stuck to the sealing surface of the filter head. Remove the seal ring with an O-ring pick, if necessary.

⚠ CAUTION

DO NOT pre-fill the secondary fuel filter prior to installation. ALWAYS use the engine lift pump to prime the fuel system before starting the engine.

3. Inspect new filter to ensure the center seal ring is installed on the filter spud.
4. Install the filter in accordance with the instructions provided with the filter. Do not over tighten the filter.
5. Prime the fuel system. Refer to 2.10.11.1. “Fuel System Priming” on page 41 in this section for procedure.

2.10.11.1. Fuel System Priming

⚠ WARNING

DO NOT open the high pressure fuel system with the engine running. High pressure fuel spray can cause serious injury or death.

⚠ CAUTION

DO NOT attempt to pre-fill the secondary filter element prior to starting the engine. Filling the filter through the center opening will allow a certain amount of fuel to bypass the 5 micron filter media within the filter, thereby allowing unfiltered fuel into the fuel system and possibly leading to engine fuel pump or injector damage.

Always prime the fuel system prior to starting the engine to avoid excessive cranking intervals, erratic engine operation, or setting engine fault codes. Proceed as follows:

1. Locate the engine run switch in the engine compartment and set the switch to the REAR position.
2. Allow the engine lift pump to cycle for approximately 30 seconds before it automatically shuts off.
3. Reset the run switch from REAR to OFF and then back to REAR position again. The lift pump should cycle for another 30 seconds. Repeat this process three or four times to allow purging all the air from the fuel filter and lines.
4. Start the engine and operate at fast idle to purge any remaining air from the system.

2.10.12.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.

2.10.13.DEF Tank

☞NOTE:

The DEF tank inspection interval will be dependent on operating and environmental conditions. Adjust to a more frequent inspection interval if tank exterior is very dirty or if filler cap has a heavy deposit of DEF crystals.

Inspect the DEF tank every 6,000 miles (9,600 km) as follows:

1. Inspect security of DEF tank mounts and tightness of fittings, hoses, clamps, and electrical connector.
2. Inspect exterior of DEF tank for cleanliness and clean as necessary. Use a low pressure setting and maintain a distance of at least 18" if using pressure wash equipment. DO NOT direct pressure spray at the filler cap/adapter interface.
3. Inspect underside of filler cap for a buildup of dirt or DEF crystals. Clean filler cap as necessary. Refer to 2.10.13.1. “Filler Cap Cleaning” on page 42 in this section for cleaning procedure.

☞NOTE:

The filler cap may be replaced separately if damaged. Refer to your New Flyer Parts Manual for part number.

2.10.13.1.Filler Cap Cleaning

1. Inspect the immediate area around the filler cap and adapter. Wipe off any accumulations of dirt or crystals from the immediate area so as to prevent contamination from entering the tank when the filler cap is removed.
2. Remove the lanyard by sliding the end over the tap on filler cap.
3. Rotate the cap counter-clockwise until it comes to a stop. Pull filler cap from DEF tank adapter.
4. Place the cap in a pan of clean, warm water filled such that the level of the water is halfway between the bottom of the blue base and the surface of the cap imprinted with the words "DEF ONLY".

☞NOTE:

Ensure that the cap is not completely immersed in the water as this may affect the venting capabilities of the cap.

5. Allow the filler cap to soak in the water for approximately five minutes.
6. Remove the filler cap from the water and shake to remove excess water. If any DEF crystals remain on the sealing surface of the cap, wipe the seal with a damp cloth.
7. Wipe the tank adapter with a damp cloth and place the filler cap onto the adapter.
8. Rotate the filler cap clockwise until the stop is contacted.
9. Reattach the lanyard by sliding the small opening of the lanyard over the tap on the cap. Ensure the lanyard is fully seated in the groove of the tab.

2.10.14.Cooling System

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

2.10.14.1.Radiator

1. Locate the power and ground studs on the radiator and pull boots back from pass-through stud. See “Fig. 18: Radiator Inspection” on page 43.
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 5 grams (5 cc or 1 tsp) of di-electric 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.

☞**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.

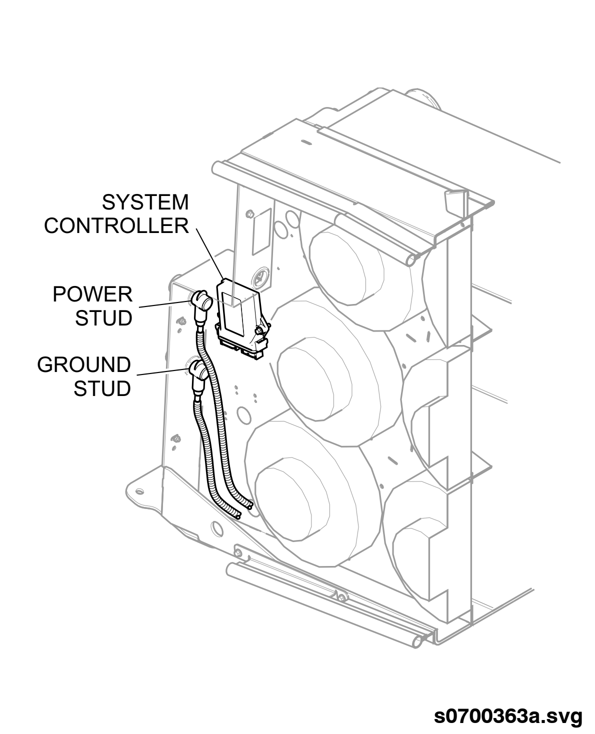


Fig. 18: Radiator Inspection

2.10.14.2. 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 MIN COLD and MAX COLD 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 MAX HOT marking shown on the tank. However, the system must be allowed to cool down before the filter cap is removed.

2. Top off coolant to the correct level as required using premix antifreeze. Refer to 2.34. "Fluid & Lubrication Guide" on page 113 in this section for antifreeze specification. See "Fig. PM-19: Surge Tank Inspection" on page 44.

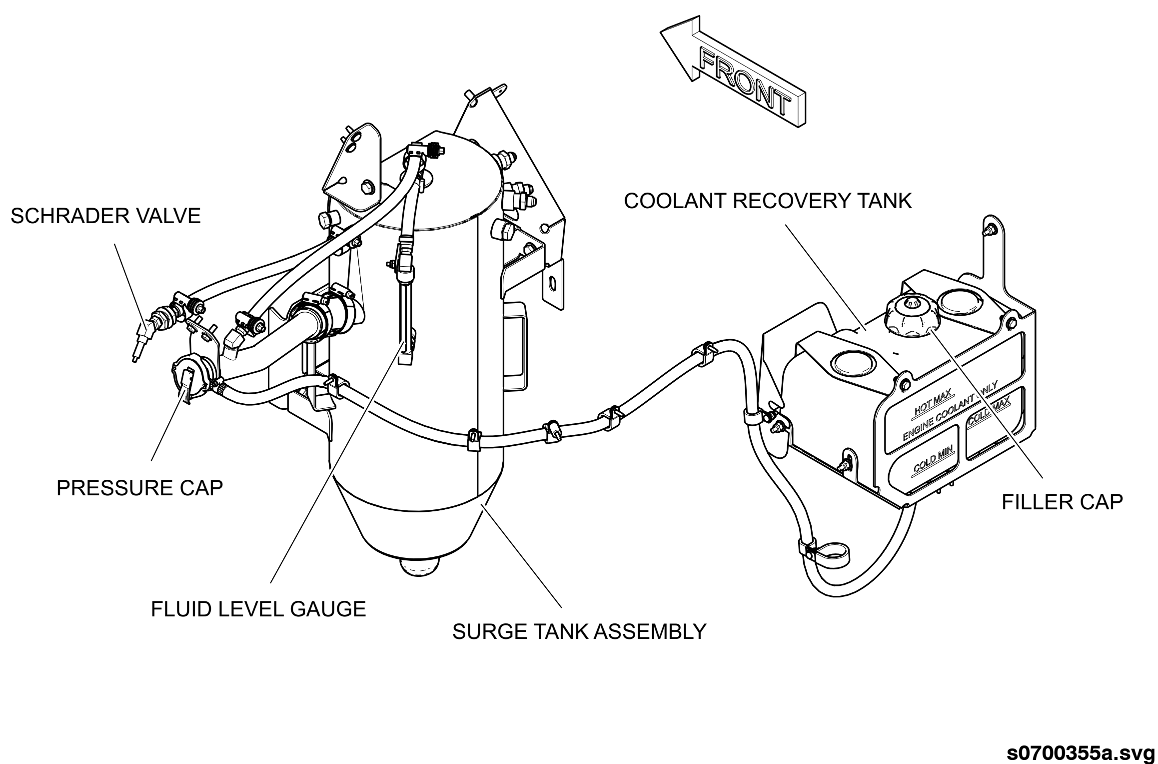


Fig. PM-19: Surge Tank Inspection

2.10.14.3.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 2.34. “Fluid & Lubrication Guide” on page 113 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.

2.10.15. 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.

2.10.16. 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 and rear suspension. Refer to Section 3 of this manual for procedures.

2.10.17. 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.

2.10.18. 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.

2.10.19. 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.

2.10.20. Air System Functional Tests

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

2.10.21. 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.

2.10.22.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. See “Fig. PM-20: Window Emergency Release” on page 48.
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 sub-frame.
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 ensuring all latches are properly engaged.

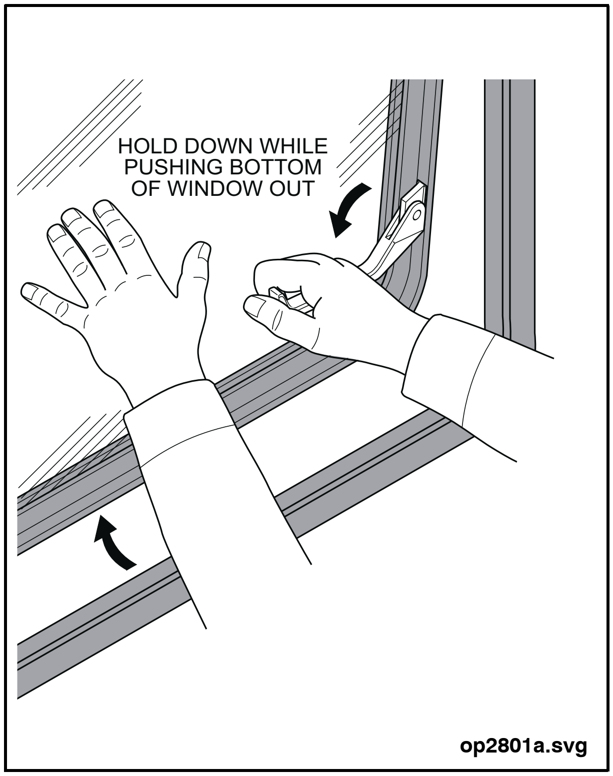


Fig. PM-20: Window Emergency Release

2.10.23.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.

2.10.24.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 2.10.24.1. “Coatings & Cleaners” on page 49 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-21: Roof Hatch Inspection” on page 49.
- ❒ In cold climates, check daily and remove any accumulated ice and snow that may restrict movement of the vent/hatch.

2.10.24.1.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.

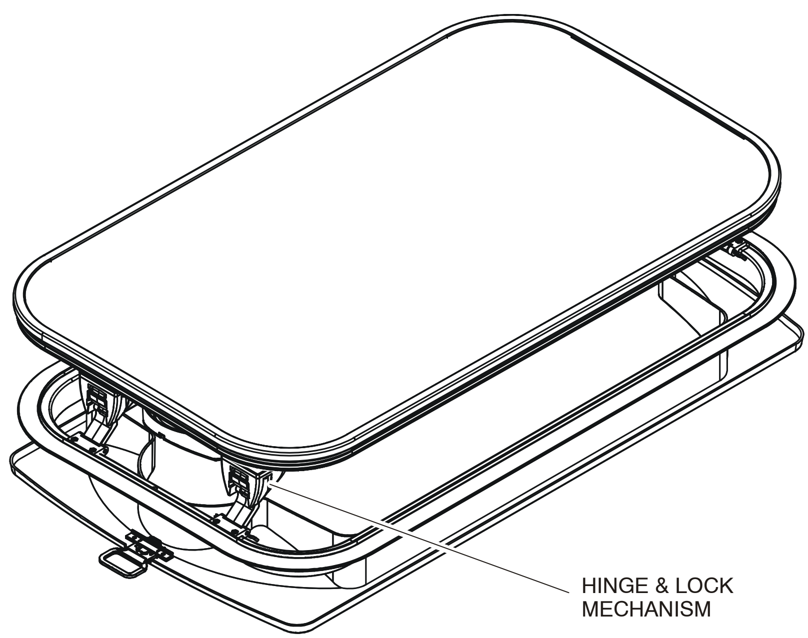


Fig. PM-21: Roof Hatch Inspection

2.10.25. 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.

2.10.26. 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.

2.10.27. 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.

2.10.28. 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.

2.10.28.1. 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.

2.10.28.2. 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.

2.10.28.3. Vacuum Formed Plastic Components

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

2.10.28.4.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.

2.10.29.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.

2.10.30.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.

2.10.31.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.

2.10.32.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).

2.10.33.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-22: Battery Tray" on page 52.
- ❒ 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.

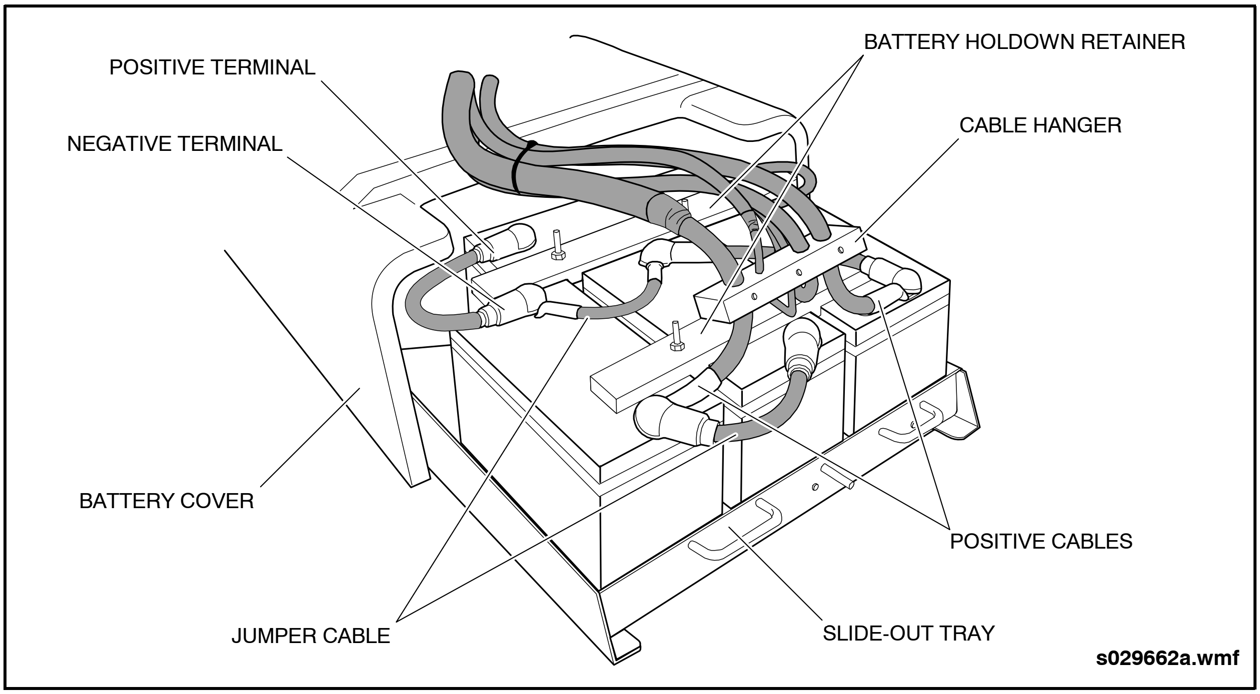


Fig. PM-22: Battery Tray

2.10.34.Wheelchair Ramp Inspection

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

2.10.34.1.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-23: Wheelchair Ramp Inspection” on page 53.
- ❒ 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.

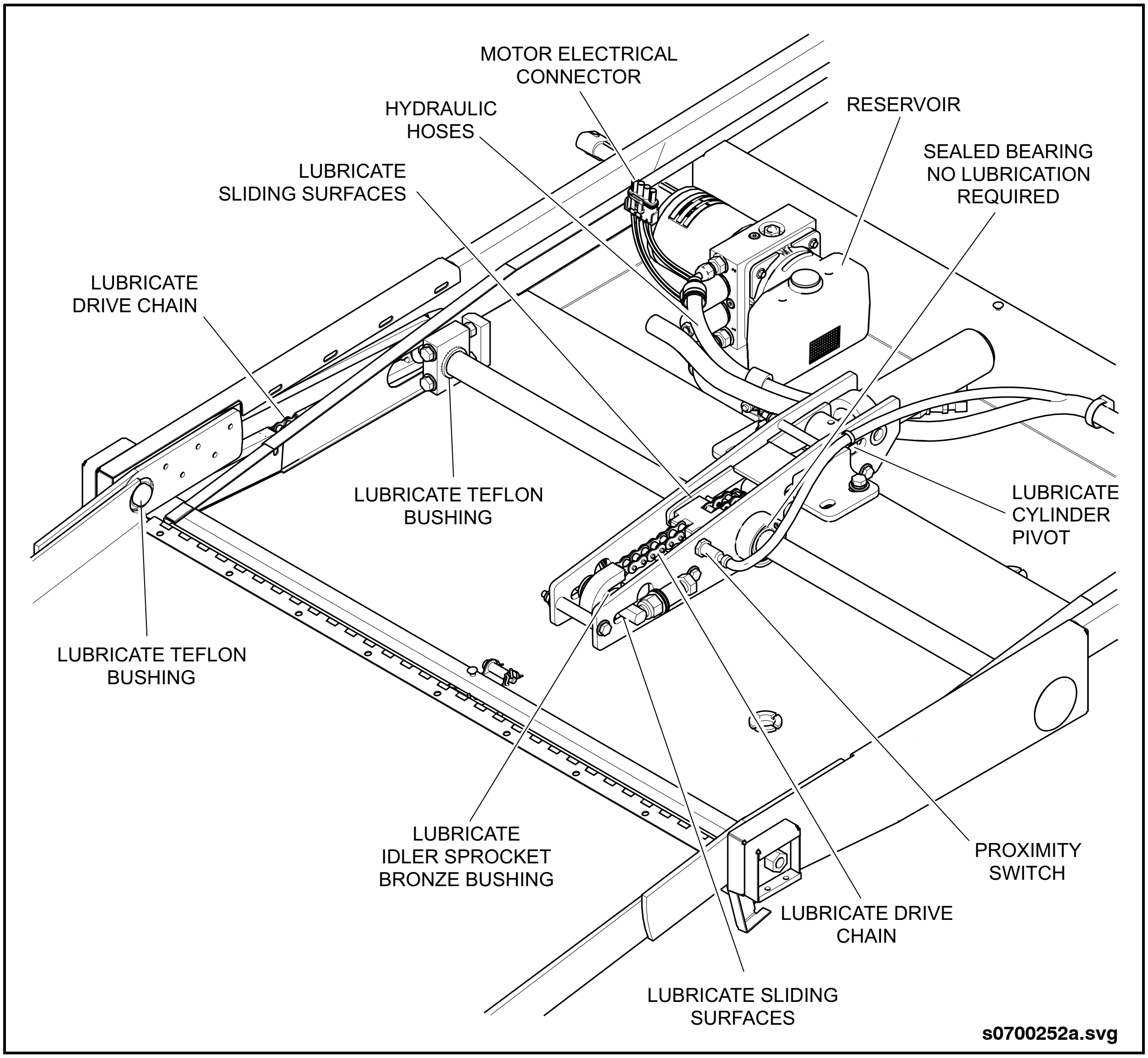


Fig. PM-23: Wheelchair Ramp Inspection

2.10.34.2.Skid Plate

Locate the wheelchair ramp skid plate at the forward edge of the entrance door. See "Fig. PM-24: Ramp Skid Plate Inspection" on page 54. 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.

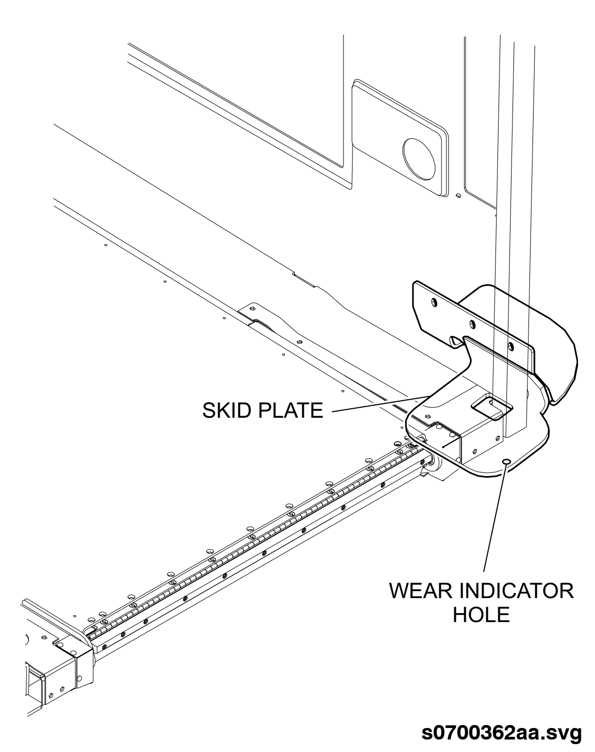


Fig. PM-24: Ramp Skid Plate Inspection

2.10.34.3.Lubrication

Refer to 2.34. "Fluid & Lubrication Guide" on page 113 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.

2.10.35. 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-25: Defroster Inspection" on page 55.
- ❒ 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.

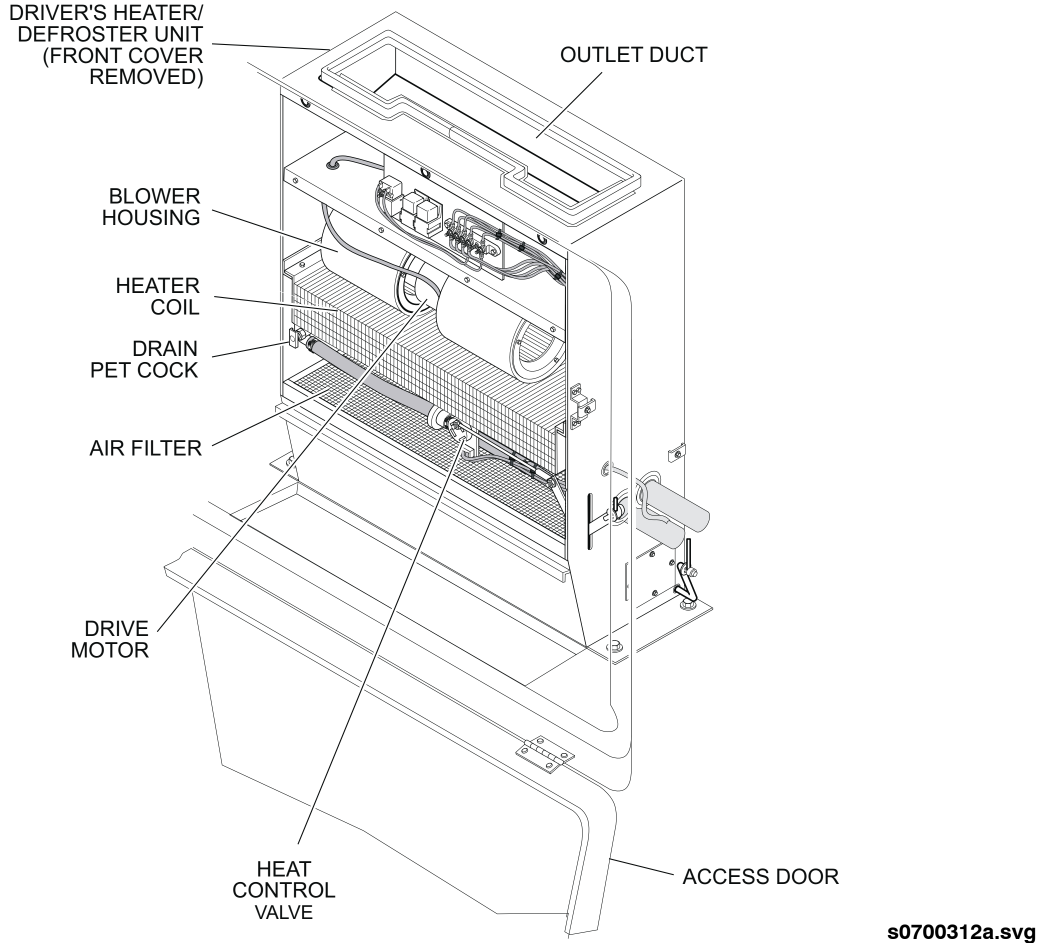


Fig. PM-25: Defroster Inspection

2.10.36.Floor Heaters

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

2.10.37.HVAC Return Air Filter

Clean or replace filter as required every 6,000 miles (9,600 km). See “Fig. PM-26: HVAC Return Air Filter” on page 56.

1. Locate the HVAC return air grille on the ceiling of the vehicle.
2. Unlatch the return air grille and allow the grille to swing downward.
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.

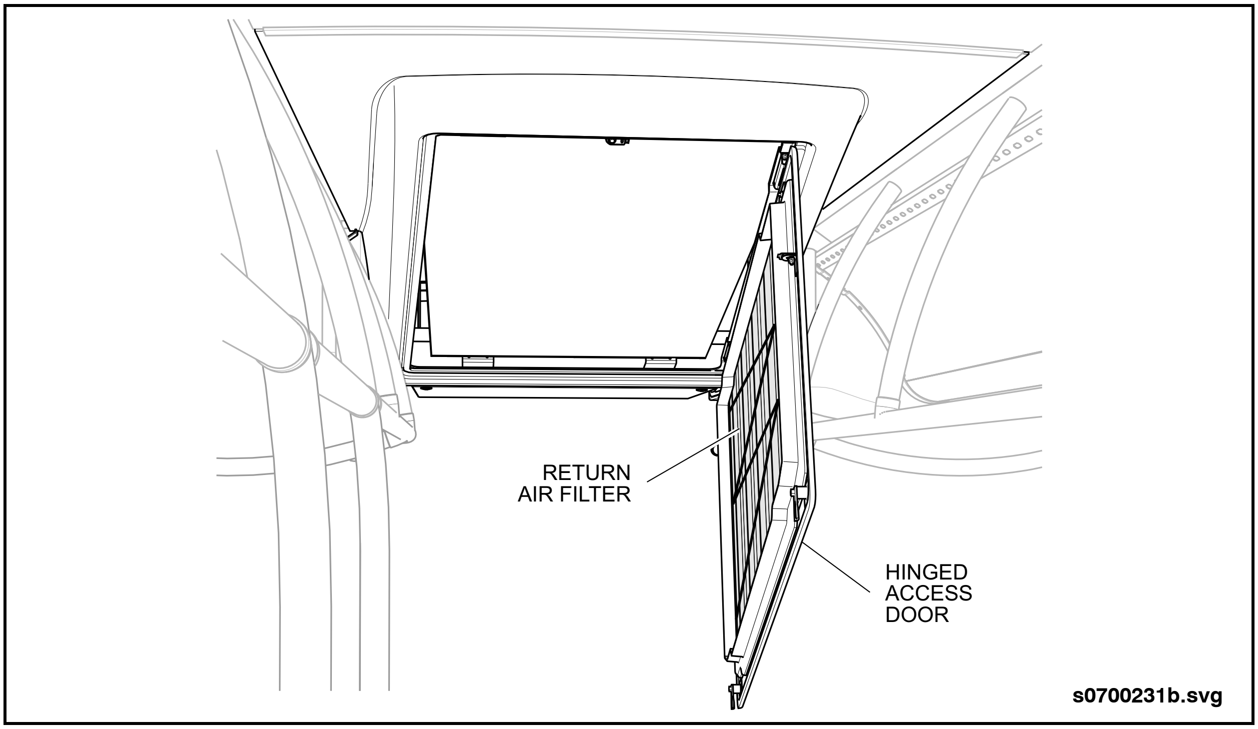


Fig. PM-26: HVAC Return Air Filter

2.10.38. 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-27: Rear Axle Breather Inspection” on page 57.

❒ 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 2.10.38.1. “Breather Valve Replacement” on page 57 in this section for procedure.

2.10.38.1. 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.

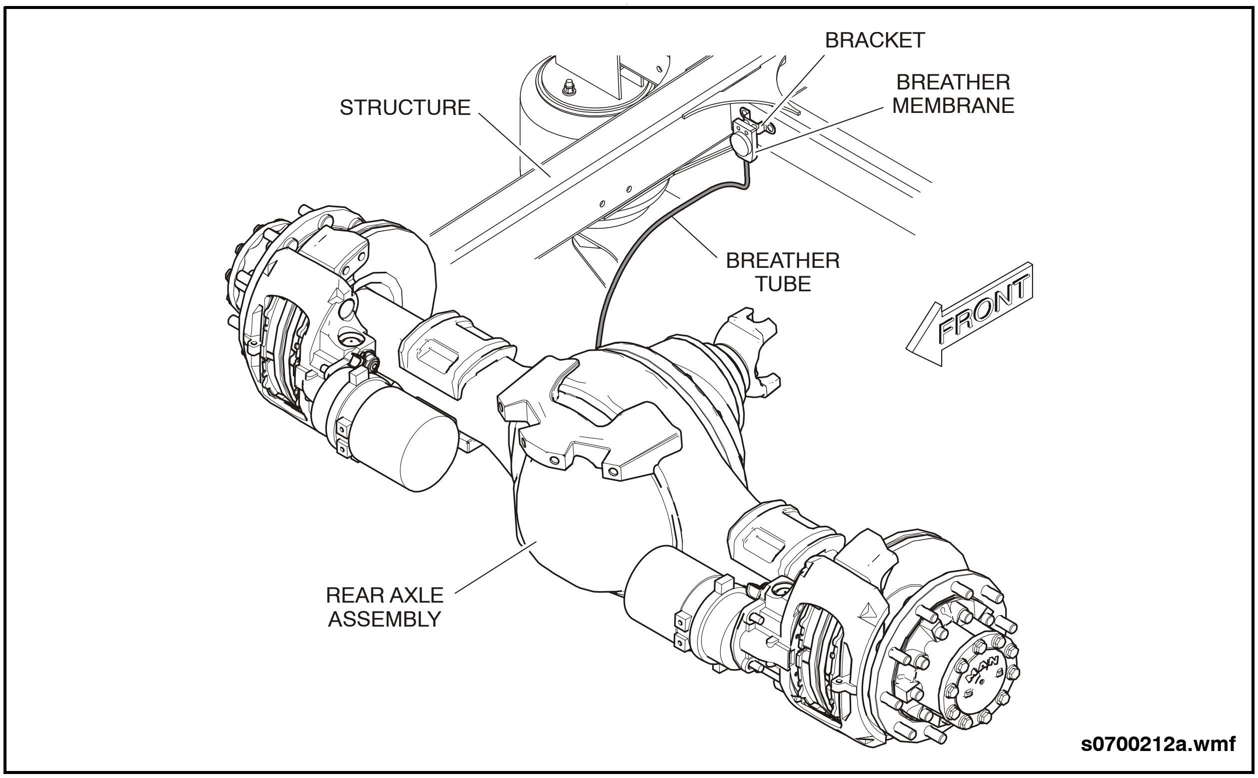


Fig. PM-27: Rear Axle Breather Inspection

2.10.39. 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.

2.10.39.1. 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 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 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.

2.10.39.2.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 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 over-tightened 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.

2.10.40. Dual Power Inverter Module

DANGER

Refer to 1.1. "High Voltage Safety" on page 1 **in this section and familiarize yourself with the safety requirements before performing any maintenance or repair on the Allison E P System™. Refer to Allison E P Systems™ Service Manual.**

WARNING

Use work platforms or scaffolding whenever working on roof-mounted components. Ensure maintenance personnel use an approved safety harness.

Inspect the roof-mounted DPIM every 6,000 miles (9,600 km) as follows:

- ❒ Set the Battery Disconnect switch to the OFF position.
- ❒ Inspect the oil supply and return hoses for leakage. Tighten hose connections as required. Refer to Fig. PM-28: "Dual Power Inverter Module (DPIM)" on page 61
- ❒ Inspect the oil hoses for any evidence of fretting, chafing, or other damage. Replace damaged hoses as required.
- ❒ Inspect the oil hoses to ensure they are properly routed and clamped.
- ❒ Inspect the high voltage cables for any evidence of fretting, chafing, or other damage. Replace damaged cables as required.
- ❒ Inspect the high voltage cables to ensure they are properly routed and clamped.
- ❒ Inspect the DPIM rubber mounts for wear, deterioration, or other damage. Replace rubber mounts as a set if damaged.

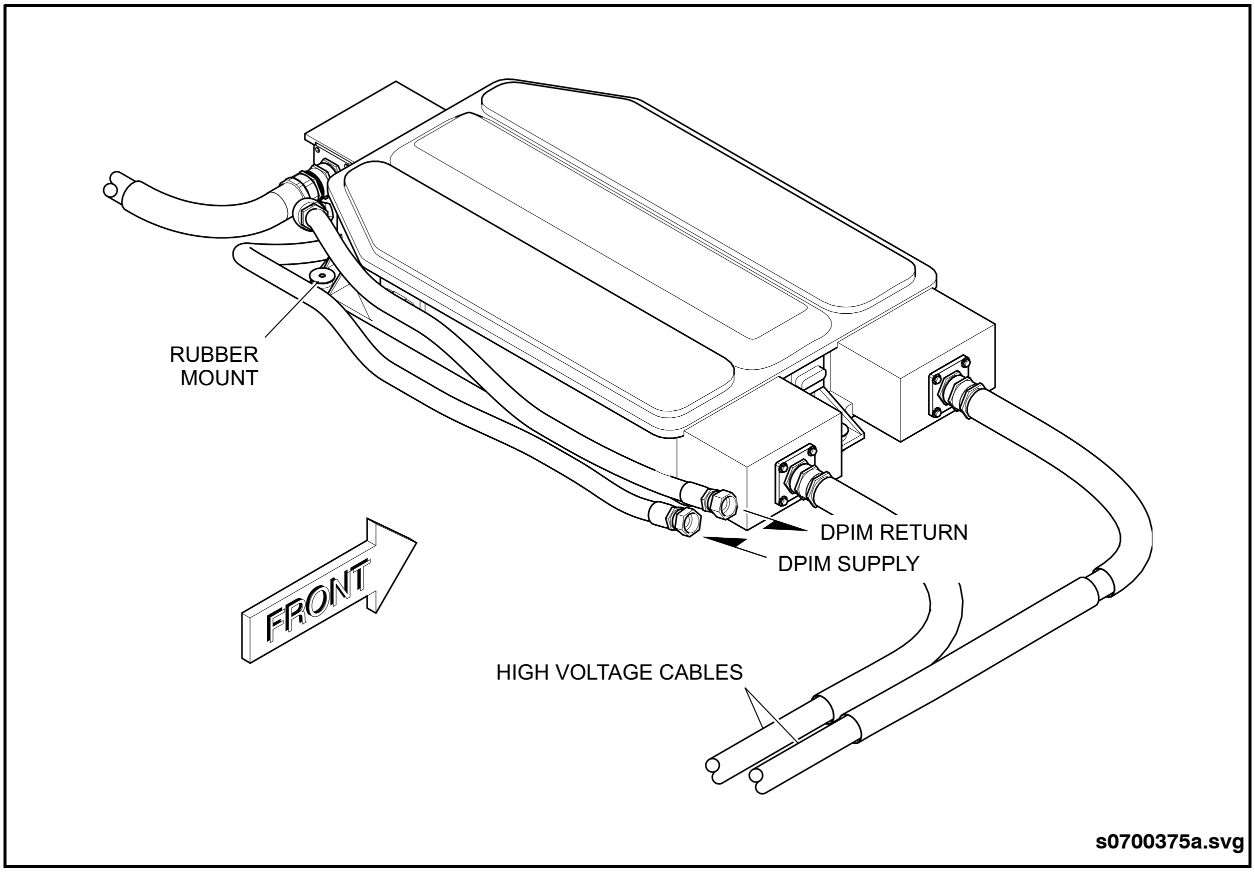


Fig. PM-28: Dual Power Inverter Module (DPIM)

2.10.41.Hybrid Battery Pack Air Filter

Every 6,000 miles (9,600 km) inspect the air filter in the rooftop battery pack cooling installation. Clean or replace as required.

See “Fig. PM-29: Hybrid Battery Pack Air Filter” on page 62.

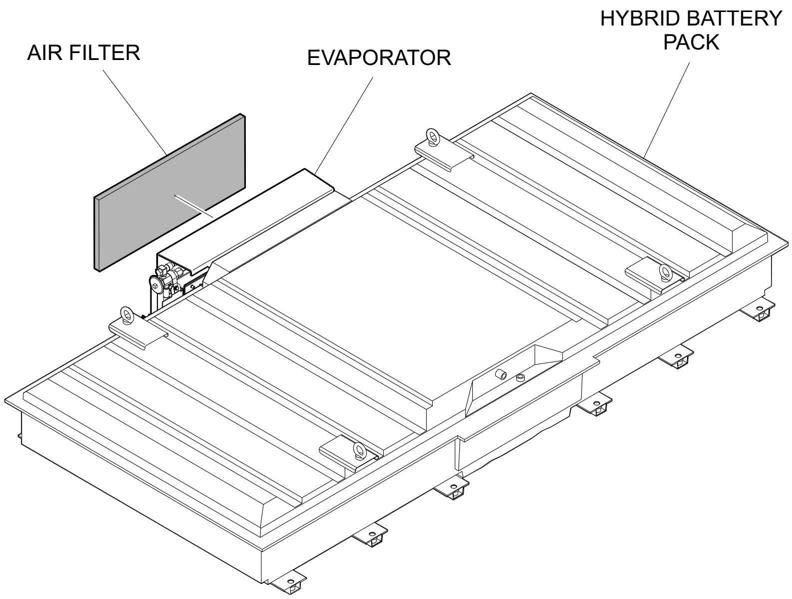


Fig. PM-29: Hybrid Battery Pack Air Filter

2.10.42. Hybrid Oil Cooler Assembly

WARNING

Use work platforms or scaffolding whenever working on roof-mounted components. Ensure maintenance personnel use an approved safety harness.

Inspect the roof-mounted hybrid oil cooler every 6,000 miles (9,600 km) as follows:

1. Set the Battery Disconnect switch to the OFF position.
2. Clean any debris from the fan shrouds and ensure airflow is unrestricted. See "Fig. PM-30: Hybrid Oil Cooler Inspection" on page 63.
3. Inspect the fan shrouds for secure mounting.
4. Inspect the fan blades to ensure they are not broken, chipped, cracked, or otherwise damaged.
5. Rotate the fan blade to ensure it moves freely and does not rub against the shroud.
6. Check electrical connections at each fan as well as main harness to ensure they are tight and no corrosion is evident.
7. Inspect oil cooler supply and return line connections for any evidence of leakage. Ensure lines are properly routed with no evidence of fretting or chafing.

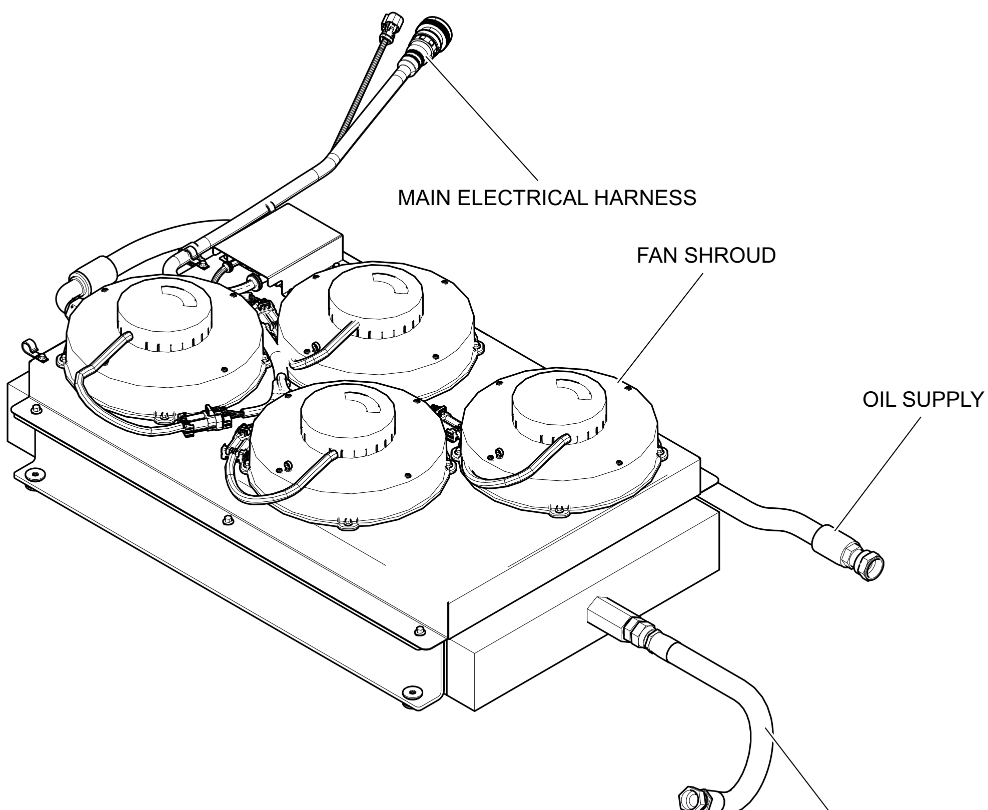


Fig. PM-30: Hybrid Oil Cooler Inspection

2.10.43. Energy Storage System (ESS)

Inspect the ESS every 6,000 miles (9,600 km) for the following conditions:

- ❒ Loose bolts on mounting components and ground straps
- ❒ Loose, worn, or frayed electrical components
- ❒ Improperly routed vehicle electrical harness
- ❒ Damage to the housing
- ❒ Dirt and debris collected in inlet filter
- ❒ Damage to HVIL cover bolts
- ❒ Torque of HVIL cover bolts
- ❒ Damage to main signal connector
- ❒ Torque of main signal connector

2.11. 7,500 Miles (12,000 km) Preventive Maintenance

2.11.1. Air Filter Restriction Indicator Inspection

Inspect the air filter restriction indicator every 7,500 miles (12,000 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 if the reading exceeds 18" H_2O.

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-31: Air Filter Restriction Indicator” on page 65.

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.

Air filter element replacement is required when the filter media has trapped approximately 80% of its load carrying capacity. This capacity equates to an air filter gauge reading of 18 to 20 inches of water. The air filter element is considered to have reached its maximum service life at this point and must be replaced. Refer to 2.11.2. “Air Filter Replacement” on page 66 in this section for replacement procedure.

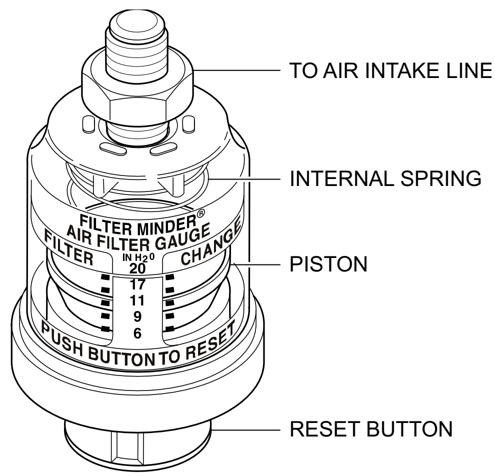


Fig. PM-31: Air Filter Restriction Indicator

2.11.2. 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-32: Air Filter Elements” on page 66.

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.

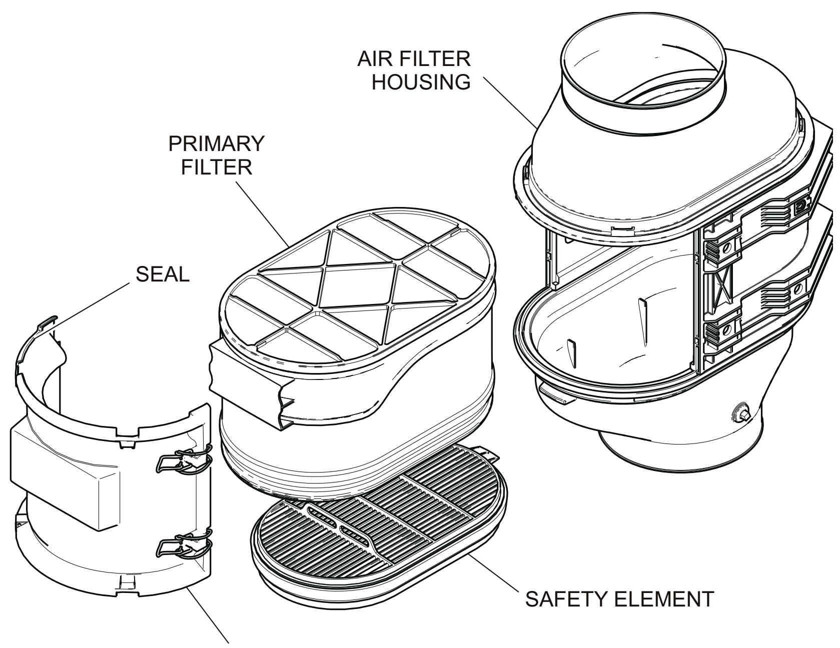


Fig. PM-32: Air Filter Elements

2.11.2.1.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.

2.11.2.2.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.

2.11.2.3.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.

2.11.3. Charge Air Cooler & Piping

Inspect the charge air cooler & piping every 7,500 miles (12,000 km), 250 hours, or 3 months, whichever occurs first.

- ❒ Inspect the charge air cooler (CAC) 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 for replacement procedures.
- ❒ Inspect the charge air piping and hoses for leaks, holes, cracks, or loose connections. Tighten the hose clamps if necessary.

2.12. 12,000 Miles (19,300 km) Preventive Maintenance

2.12.1. 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-33: Accelerator Inspection” on page 69.
- ❐ 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.

2.12.2. 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.

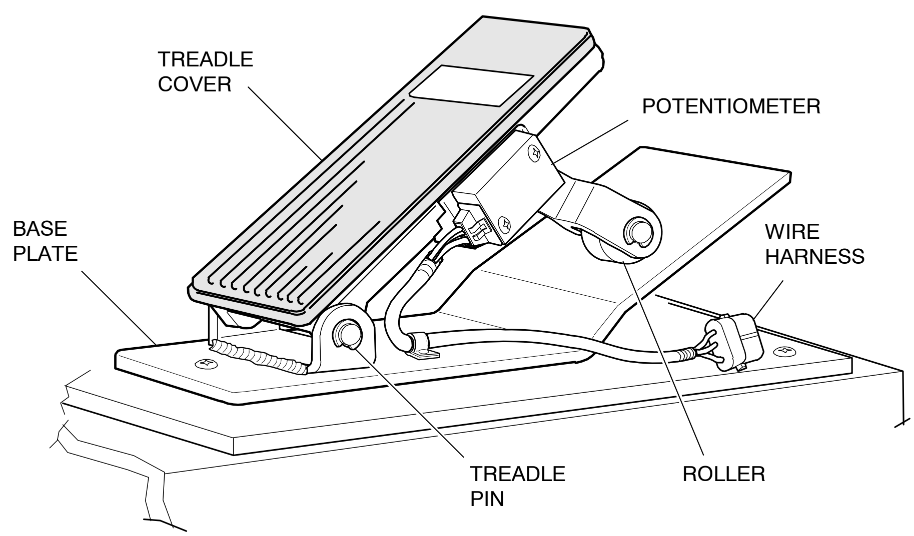


Fig. PM-33: Accelerator Inspection

2.12.3. 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.

2.12.4. 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.

2.13. 15,000 Miles (24,000 km) Preventive Maintenance

2.13.1. Cooling 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 cooling system pressure test every 15,000 miles (24,000 km) as follows:

1. Pressure test the cooling system at 16 to 20 psi (110 to 138 kPa) using a commercially available pressure tester. 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 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.

2.14. 18,000 Miles (29,000 km) Preventive Maintenance

2.14.1. 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.

2.14.2. Fire Suppression System

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

- ❒ Perform a comprehensive fire system test according to KAD Generic AFSS Checkout Procedure R10027 using a Kidde Fire System Test Set P/N 420871-2.

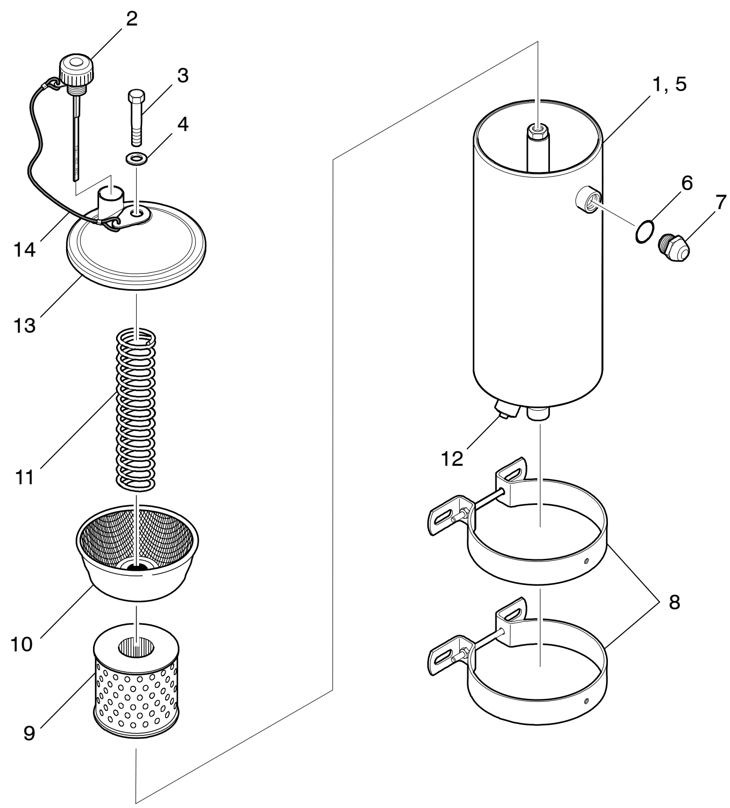
2.14.3. Engine Bypass Oil Filter

Perform a functional test and servicing of the Spinner II Bypass Oil Filter every 18,000 miles (29,000 km) or every third oil change, whichever occurs first. Refer to Section 4 of this manual for filter servicing procedure.

2.14.4. 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-34: Hydraulic Filter Replacement” on page 72.



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-34: Hydraulic Filter Replacement

2.15. 24,000 Miles (38,600 km) Preventive Maintenance

2.15.1. 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-35: Brake Valve Inspection” on page 73.
- ❒ 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 2.34. “Fluid & Lubrication Guide” on page 113 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.

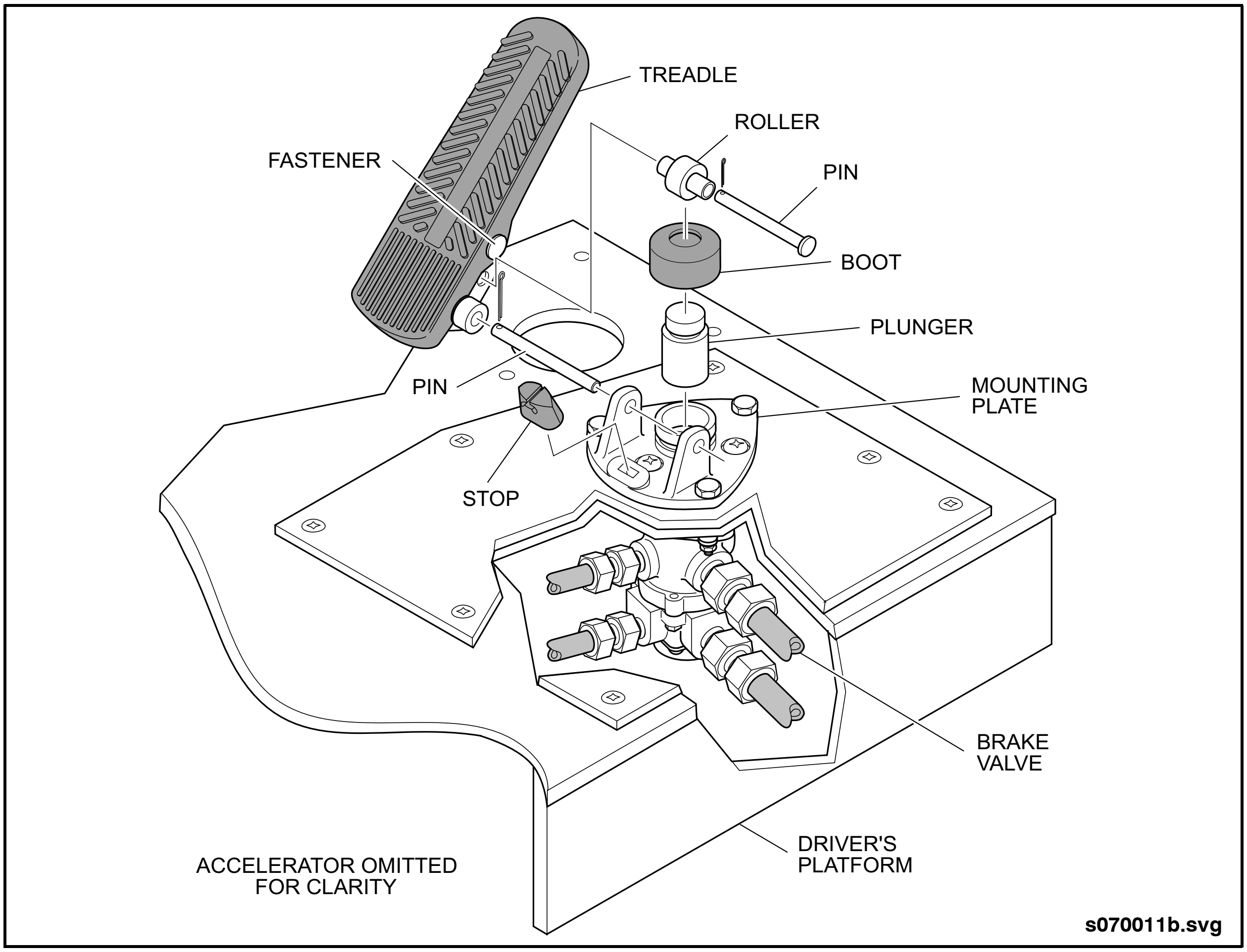


Fig. PM-35: Brake Valve Inspection

2.16. 30,000 Miles (48,000 km) Preventive Maintenance

2.16.1. Fuel Tank

Open the drain at the bottom of the Fuel Tank every 30,000 miles (48,000 km) to drain off any water and/or sediment.

2.16.2. Engine Drive Belts

Inspect water pump and HVAC belts every 30,000 miles (48,000 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.

2.17. 36,000 Miles (58,000 km) Preventive Maintenance

2.17.1. 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 “Brake Pad Clearance Inspection” in Section 1 and 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 and 2 of this manual for inspection procedure.
- ❒ Brake Adjuster - refer to “Automatic Adjustment Inspection” in Section 1 and 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 and 2 of this manual for inspection procedure.
- ❒ Tappet & Boot Assembly - refer to “Tappet Rubber Boot Inspection” in Section 1 and 2 of this manual for inspection procedure.
- ❒ Guide Pin Inner Boot - refer to “Upper Guide Rubber Boot Inspection” in Section 1 and 2 of this manual for inspection procedure.

2.17.2. 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 2.34. “Fluid & Lubrication Guide” on page 113 in this section for fluid specifications.

2.17.3. 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 2.34. "Fluid & Lubrication Guide" on page 113 in this section for fluid specification.

2.17.3.1. 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-36: Rear Axle Drain & Fill Locations" on page 75.
4. Remove the drain plug from the bottom of the differential housing and allow the differential to drain completely.

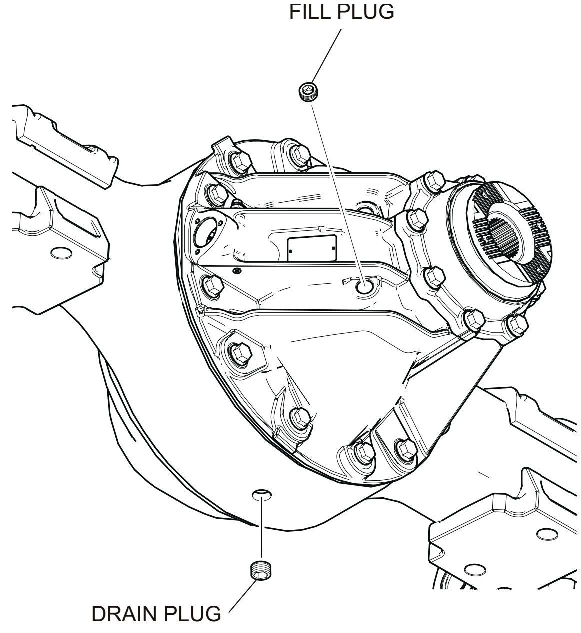


Fig. PM-36: Rear Axle Drain & Fill Locations

2.17.3.2. 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).

2.18. 48,000 Miles (77,200 km) Preventive Maintenance

2.18.1. Front End Alignment

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

2.18.2. Front Brake Chambers

2.18.2.1.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 2.18.2.2. “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 2.18.2.2. “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).

2.18.2.2. 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-37: 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.

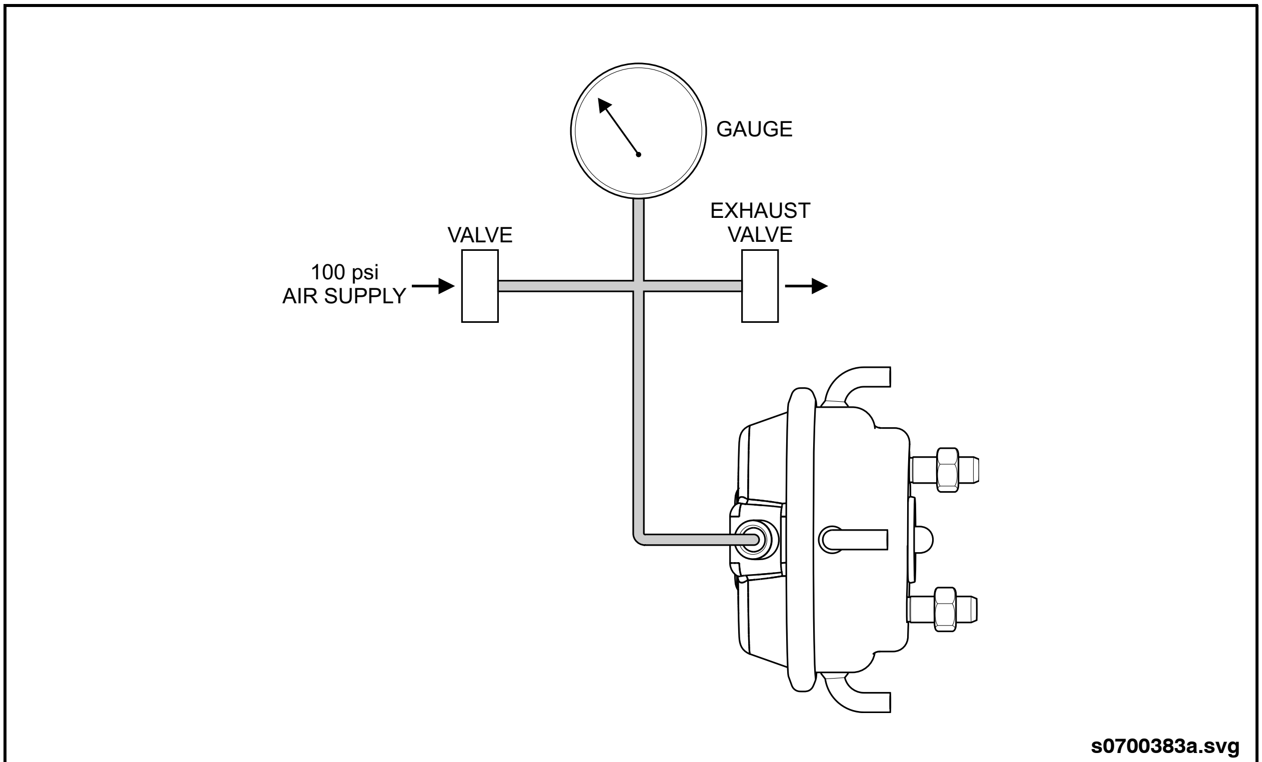


Fig. PM-37: Front Brake Chamber Leak Test Setup

2.18.3. Rear Brake Chambers

2.18.3.1. 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 2.18.3.2. “Spring Brake Leakdown Test” on page 80 and Refer to 2.18.3.3. “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 2.18.3.2. “Spring Brake Leakdown Test” on page 80 and Refer to 2.18.3.3. “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 2.18.3.2. “Spring Brake Leakdown Test” on page 80 and Refer to 2.18.3.3. “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 2.18.3.2. “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 2.18.3.3. "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 2.18.3.3. "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.

2.18.3.2.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-38: 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.

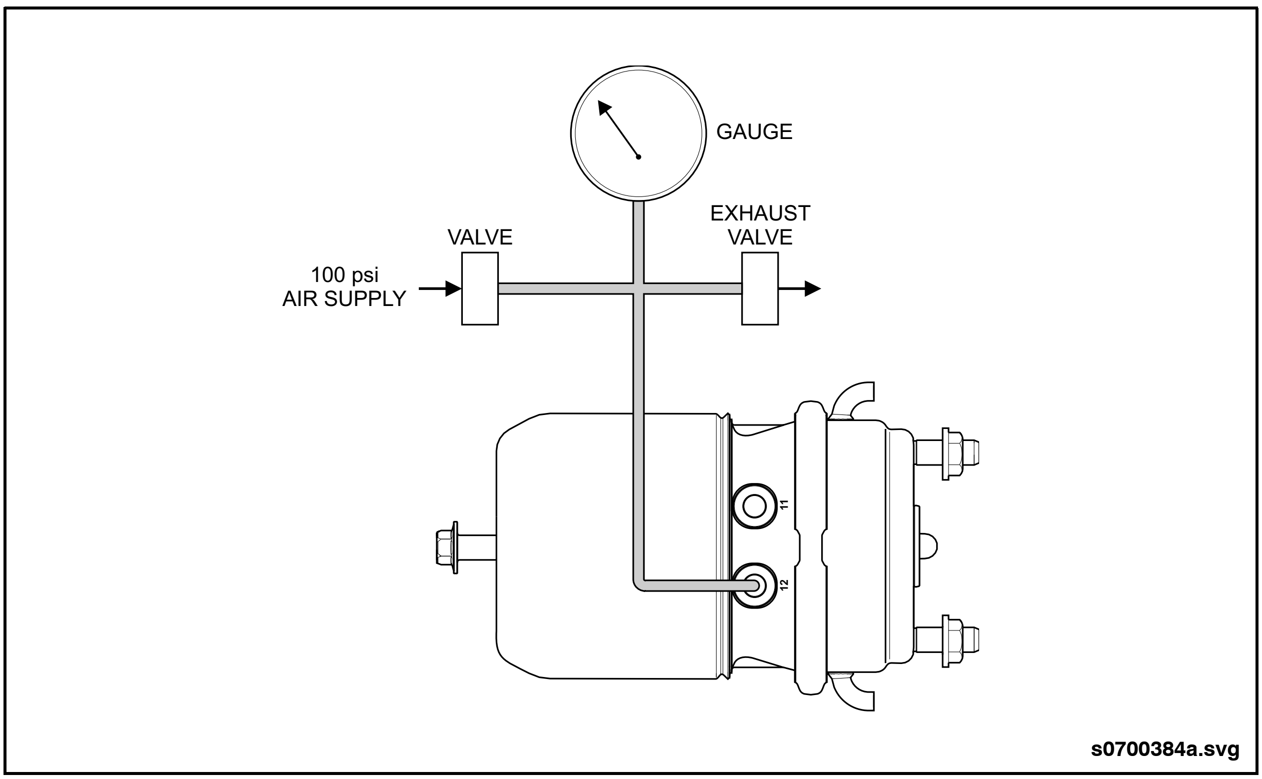


Fig. PM-38: Spring Brake Leak Test Setup

2.18.3.3. 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-39: 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.

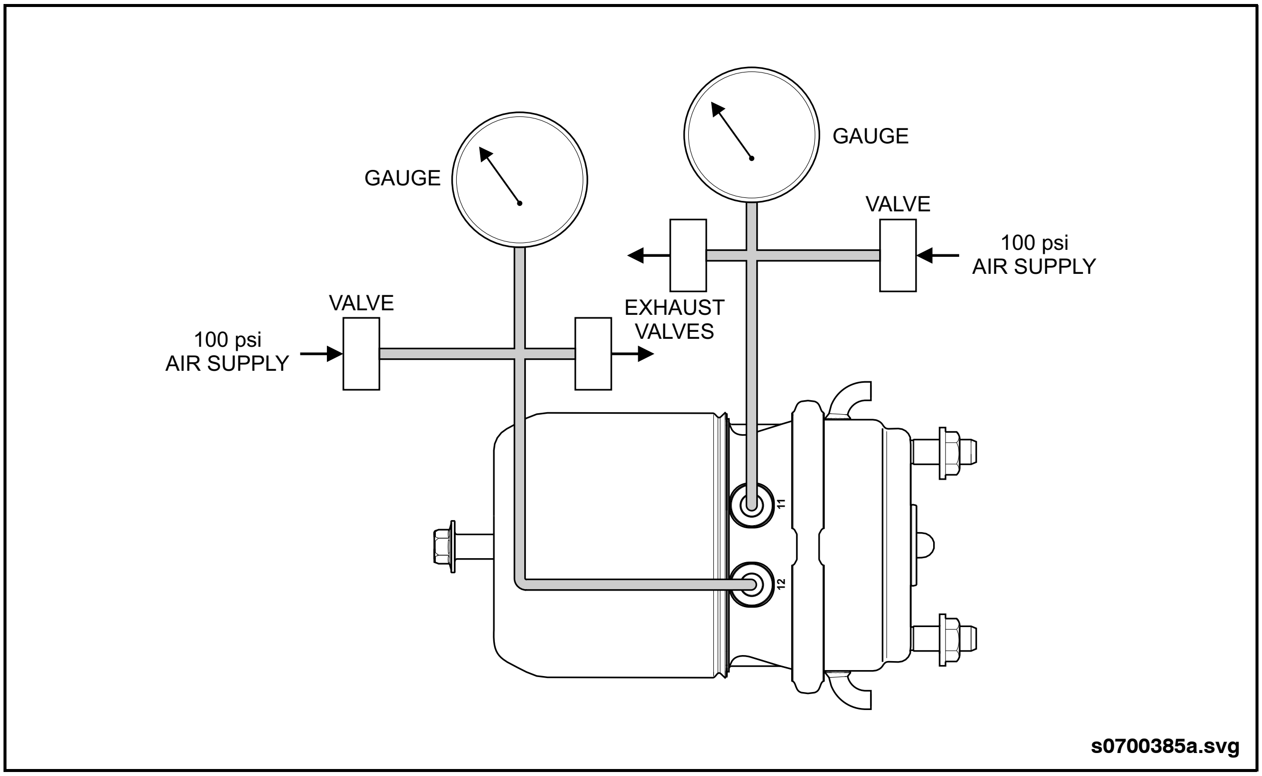


Fig. PM-39: Service Brake Leak Test Setup

2.19. 50,000 Miles (80,500 km) Preventive Maintenance

2.19.1. Drive Unit Control Main Filter Change

CAUTION

Fluid and filter change frequency is determined by the severity of drive unit 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 drive unit duty cycle. Refer to Allison H40/50EP Systems™ Service Manual for more information on oil analysis.

☞**NOTE:**

Change control main oil filter after first 5,000 miles (8,000 km) and thereafter every 50,000 miles (80,500 km).
Change fluid and lube filter every 100,000 miles (161,000 km) intervals).
Change internal sump pick-up filter at overhaul.
Refer to Allison H40/50EP Systems™ Service Manual and Allison Service Tip #1099 for more information on fluid and filter change intervals and fluid contamination.

Change drive unit control main filter as follows:

1. Park vehicle on a level surface, set drive unit in neutral [N].
2. Apply parking brake and chock wheels to ensure vehicle cannot move.

☞**NOTE:**

Refer to the General Information Section of this manual for lifting procedures.

3. Remove the spin-on Control Main Filter using a filter wrench. Drain filter into a suitable container. See “Fig. PM-40: Drive Unit Oil Filters” on page 83.
4. Remove the magnet from the threaded filter adapter, clean, and reinstall.
5. Lubricate gasket on filter with clean drive unit fluid and install new spin-on Control Main Filter. Use filter wrench and torque to 75 to 100 in-lb. (8.5 to 11.5 Nm).
6. Add fluid to replenish the quantity lost during filter replacement.
7. Start engine and run at fast idle. Check for leaks.
8. Check the fluid level once the drive unit has reached operating temperature. Refer to Section 5 of this manual for procedure. Add or drain fluid as required.

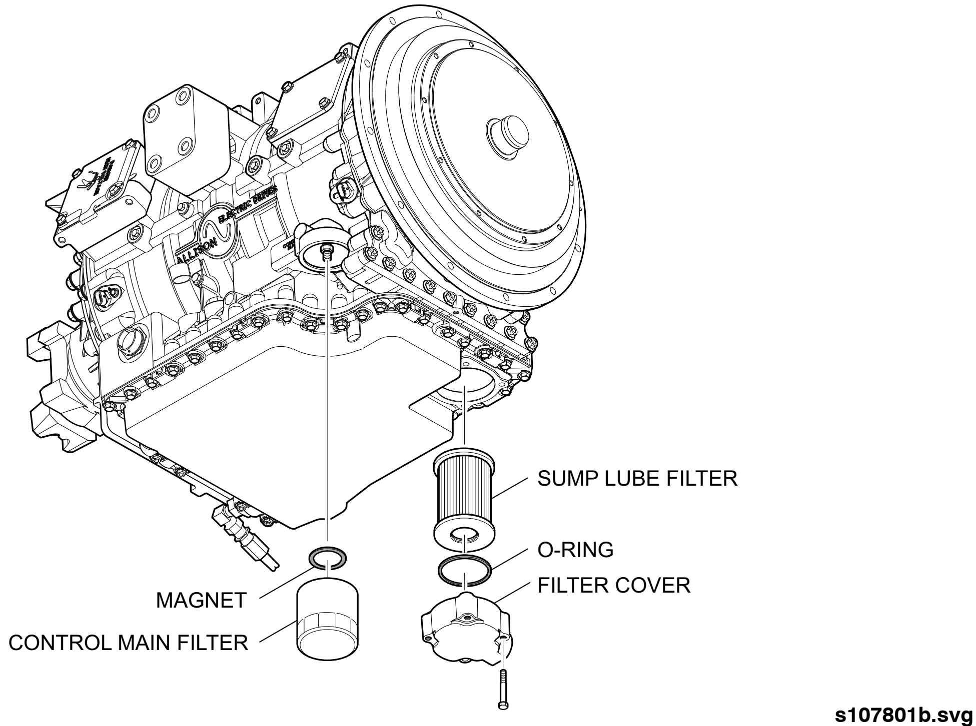


Fig. PM-40: Drive Unit Oil Filters

2.20. 54,000 Miles (87,000 km) Preventive Maintenance

2.20.1. 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 2.17.3. “Rear Axle Oil Change” on page 75 in this section for oil change drain and fill procedure. Refer to 2.34. “Fluid & Lubrication Guide” on page 113 in this section for fluid specification.

2.21. 60,000 Miles (96,000 km) Preventive Maintenance

2.21.1. Fuel Tank

Every 60,000 miles (96,000 km) or twelve months, whichever comes first, tighten all fuel tank mountings and brackets. At the same time, check the seal in the fuel tank cap, the breather hole in the cap, and the condition of the flexible fuel lines. Repair or replace the parts as necessary.

2.21.2. Air Compressor Discharge Lines

Inspect the air compressor discharge lines for carbon buildup every 60,000 miles (96,000 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.

2.21.3. Crankcase Breather Element

Replace the crankcase breather element every 60,000 miles (96,000 km) or 2,000 hours, whichever occurs first.

2.21.3.1.Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Steam clean the crankcase breather cover area and dry with compressed air.
3. Remove the eleven bolts that attach the crankcase breather cover to the crankcase breather base. See “Fig. PM-41: Crankcase Breather” on page 84.

☞NOTE:

The six bolts that attach the breather base to the valve cover do not need to be removed.

4. Remove the breather cover.
5. Remove the breather element from the breather base and discard.

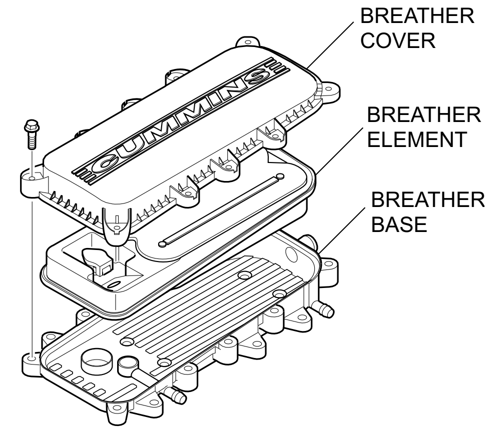


Fig. PM-41: Crankcase Breather

2.21.3.2.Inspection & Cleaning

1. Inspect the breather cover and base for cracks or other damage.
2. Clean any debris or sludge buildup from inside the breather cover and base. Be careful not to allow debris or cleaning fluid to enter the crankcase when cleaning the breather base.

2.21.3.3.Installation

1. Lubricate the O-ring on the new breather element with engine oil.
2. Install the new breather element onto the breather base.
3. Install the breather cover using eleven bolts. Torque bolts to 44 in-lb. (5 Nm) in the sequence shown. See “Fig. PM-42: Breather Cover Torque Sequence” on page 85.

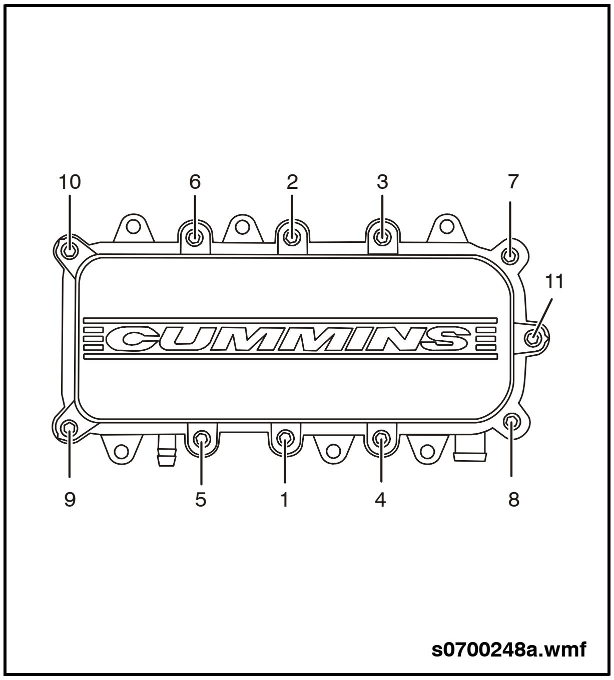


Fig. PM-42: Breather Cover Torque Sequence

2.22. 96,000 Miles (154,500 km) Preventive Maintenance

2.22.1. Front End Alignment

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

2.23. 100,000 Miles (161,000 km) Preventive Maintenance

2.23.1. Drive Unit Fluid & Filter Change

CAUTION

Fluid and filter change frequency is determined by the severity of drive unit 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 drive unit duty cycle. Refer to Allison H40/50EP Systems™ Service Manual for more information on oil analysis.

NOTE:

Change fluid and lube filter every 100,000 miles (161,000 km) intervals).
Refer to Allison H40/50EP Systems™ Service Manual and Allison Service Tip #1099 for more information on fluid and filter change intervals and fluid contamination.

Change drive unit fluid as follows:

1. Park vehicle on a level surface, set drive unit in neutral [N].
2. Apply parking brake and chock wheels to ensure vehicle cannot move.

NOTE:

Refer to the General Information Section of this manual for lifting procedures.

3. Remove the drain plug at the rear of the oil pan using a 3/8" square drive socket.
4. Allow all fluid to drain.

NOTE:

DO NOT drain the fluid when the drive unit is cold, as contaminants will settle below the level of the drain plug. Drain the fluid while it is still warm and any contaminants are still in suspension.

5. Install the drain plug and torque to 18 to 24 ft-lb. (25 to 32 Nm).

Change the lube filter as follows:

1. Remove the four bolts that retain the canister Sump Lube Filter cover to the drive unit. Remove cover and canister element and drain fluid into a suitable container. Discard O-ring.
2. Install new O-ring on filter cover and lubricate with clean drive unit fluid.
3. Install new element into cover and install cover and element onto drive unit. Secure cover in place with four bolts.
4. Fill the drive unit with approved fluid. Refer to 2.34. “Fluid & Lubrication Guide” on page 113 in this section for fluid specification.

NOTE:

Drive unit fluid capacity is approximately 16 quarts (15 liters) plus any quantity drained down from the DPIM or oil cooler lines.

5. Start engine and run at fast idle. Check for leaks.
6. Check the fluid level once the drive unit has reached operating temperature. Refer to Section 5 of this manual for procedure. Add or drain fluid as required.

2.24. 200,000 Miles (321,000 km) Preventive Maintenance

2.24.1. Muffler Particulate Filter

Every 200,000 miles or 6,500 operating hours remove the muffler particulate filter and send it to an authorized Cummins repair location for cleaning or replacement. Specialized cleaning equipment is required to perform this maintenance. Refer to Section 4 of this manual for further information on this equipment and the removal procedure for the muffler and the particulate filter.

2.24.2. Diesel Exhaust Fluid Filter

Replace the diesel exhaust fluid filter every 200,000 miles (321,000 km) or 6,500 operating hours, whichever occurs first.

2.24.2.1. Removal

1. Set the Master Run switch to the STOP-ENGINE position and allow at least 5 minutes for the purge cycle to complete before servicing the filter.

☞NOTE:

The purge cycle occurs automatically following vehicle shut down and will pump all fluid from the lines back into the tank. The dosing module, located on the Selective Catalyst Reduction (SCR) device will emit an audible pumping sound throughout the purge cycle.

2. Set the Battery Disconnect switch to the OFF position once the purge cycle is completed.
3. Locate the filter housing on the bottom of the SCR Supply Module, Inspect the area around the seal and vent of the filter cap for signs of leakage. See “Fig. PM-43: Diesel Exhaust Fluid (DEF) Filter” on page 88.

☞NOTE:

Diesel exhaust fluid leaks leave a white deposit. If deposits are found, inspect components for defects. Refer to 2.24.2.2. “Cleaning & Inspection” on page 87 in this section for inspection requirements.

4. Unscrew the diesel exhaust fluid filter cap.

☞NOTE:

There may be residual diesel exhaust fluid in the filter housing. Place a container below the diesel exhaust fluid filter cap to catch any spillage.

5. Remove and discard the equalizing element and filter element.

☞NOTE:

Examine the filter elements for evidence of contamination prior to discarding the element. Refer to 2.24.2.2. “Cleaning & Inspection” on page 87 in this section for inspection procedure.

2.24.2.2. Cleaning & Inspection

1. Inspect the diesel exhaust filter for debris or contamination using visual and aromatic indicators. If debris is evident, also check:

- ❒ Diesel exhaust fluid tank pick up screen. Refer to Cummins Service Manual.
- ❒ The dosing unit inlet connector Refer to Cummins Service Manual.

☞NOTE:

Refer to "Contamination/Incorrect Fluid" in Section 4 of this manual for flushing procedures. Also refer to Cummins Service Manual for additional information on contaminated diesel exhaust fluid.

2. Clean the filter cap with warm water and a clean cloth.
3. Inspect the filter cap for cracks or holes that could create a diesel exhaust fluid leak path.
4. Check the condition of the threads on the filter cap. Replace the filter cap if thread damage is evident.
5. Inspect the threads of the filter housing on the SCR Supply Module. This is especially important if the filter cap was damaged. Replace the entire SCR Supply Module if thread damage is evident.

2.24.2.3.Installation

NOTE:

Lubrication of the diesel exhaust fluid filter o-rings is not required.

1. Slide the diesel exhaust fluid filter equalizing element into the diesel exhaust fluid filter cartridge.
2. Insert the filter assembly into the housing of the SCR module.
3. Install the filter cap and torque to 177 in-lb. (2.0 Nm).

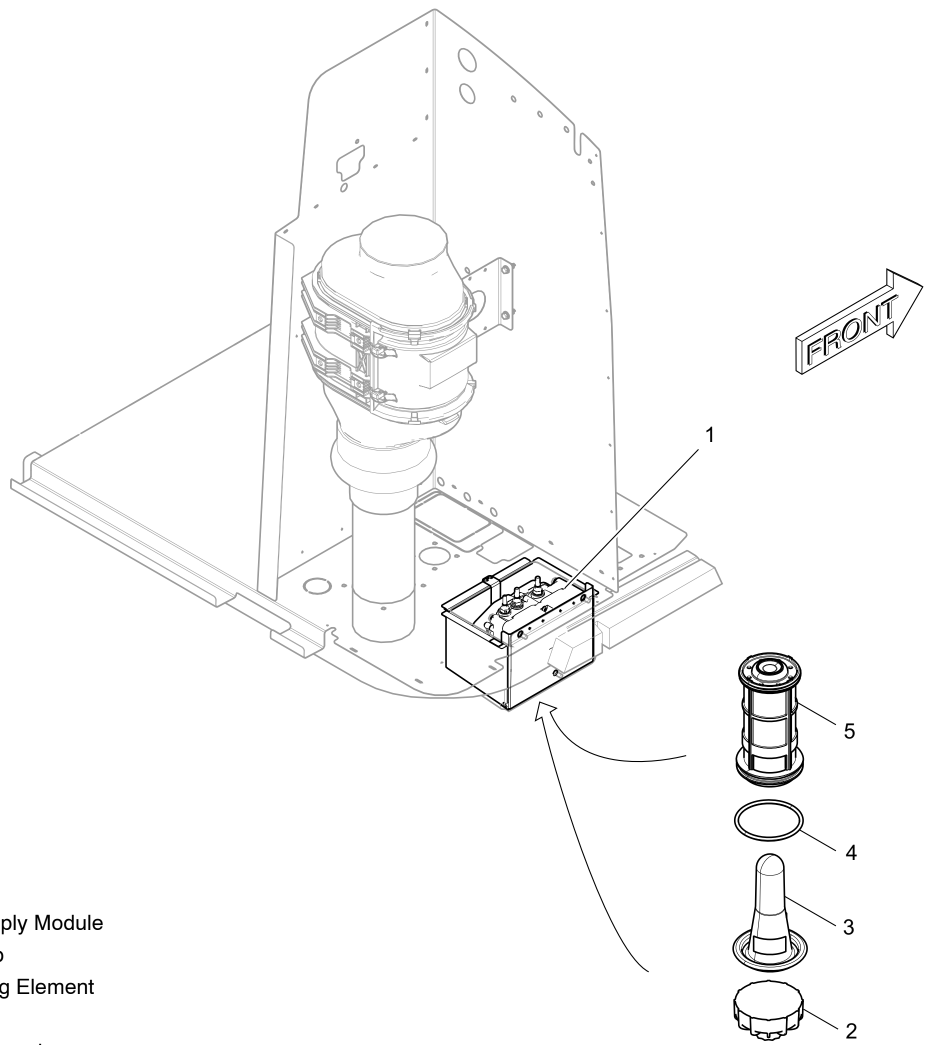
CAUTION

NEVER operate the vehicle with the filter cap removed.

4. Start the vehicle and check for leaks.

NOTE:

The aftertreatment diesel exhaust fluid dosing system will not prime until the correct SCR temperatures are reached. To verify that there are no diesel exhaust fluid leaks, initiate a stationary regeneration to get the SCR system up to temperature.



1. SCR Supply Module
2. Filter Cap
3. Equalizing Element
4. O-Ring
5. Filter Element

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Fig. PM-43: Diesel Exhaust Fluid (DEF) Filter

2.24.3. DEF Tank Inlet Filter

☞ **NOTE:**

The DEF tank filter replacement interval will be dependent on operating and environmental conditions. Manually filling the tank through the filler cap offers potential for entry of contaminants. Adjust to a more frequent replacement interval if suction filter appears dirty or has an accumulation of DEF crystals.

Replace the DEF tank inlet filter every 200,000 miles (321,000 km) or 6,500 operating hours, whichever occurs first, as follows:

☞ **NOTE:**

The multi-function head unit assembly (MFHU) must be removed from the DEF tank in order to replace the inlet filter.

1. Set the Battery Disconnect switch to the OFF position.
2. Disconnect the electrical connectors, coolant lines, and DEF fluid lines from the multi-function head unit assembly of the DEF tank. See "Fig. PM-44: DEF Tank Inlet Filter" on page 90.
3. Mark the position of the MFHU relative to the DEF tank.
4. Remove the two T25 Torx screws securing the retaining ring to the tank and remove the retaining ring.

⚠ CAUTION

DO NOT pull on wiring harnesses or fittings when trying to remove filter head from tank.

5. Use a flat head screwdriver to gently pry under the head unit while simultaneously pulling on the top of the unit. Continue prying and pulling until the mounting base is free from the tank.

⚠ CAUTION

DO NOT pull directly upward on MFHU when removing it from the tank as this might damage the head unit and seal bore. ALWAYS angle the unit out of the tank to prevent damage.

6. Pull the MFHU out of the tank until the inlet filter approaches the opening in the tank. Angle the MFHU and fold the filter element upwards. Continue to carefully remove the MFHU until completely free of the tank bore.
7. Remove the T15 Torx filter retention screw located near the bottom of the DEF suction tube. Discard the screw.
8. Pull the filter off the suction tube and discard the filter.

☞ **NOTE:**

Examine the filter and if extremely dirty or contaminated, it is recommended that the tank be cleaned internally.

9. Position the suction tube housing of the new filter onto the bottom of the suction tube and press the filter flush against the bottom of the heater tube fin. Align the filter so that the retention screw can be installed into the housing.
10. Install a new retention screw.
11. Apply a thin layer of O-ring lubricant to the bore seal O-ring.

CAUTION

DO NOT push the MFHU directly into the tank as this could damage the unit.

12. Fold the filter element upward and position the bottom of the MFHU inside the tank bore at an angle. Carefully work the unit through the bore until the bottom of the unit and filter are inside the tank.

CAUTION

DO NOT press directly on the fittings when installing the MFHU into the tank.

13. Position the MFHU as marked during removal and press the on the top of the blue mounting base until completely seated in the tank bore.
14. Replace the retaining ring on the head unit and install the two T25 Torx screws. Torque the screws 20 to 30 in-lb.
15. Reconnect the electrical connectors, coolant lines, and DEF fluid lines to the MFHU.
16. Reset Battery Disconnect switch to ON position.
17. Start engine and check for coolant or DEF line leaks.

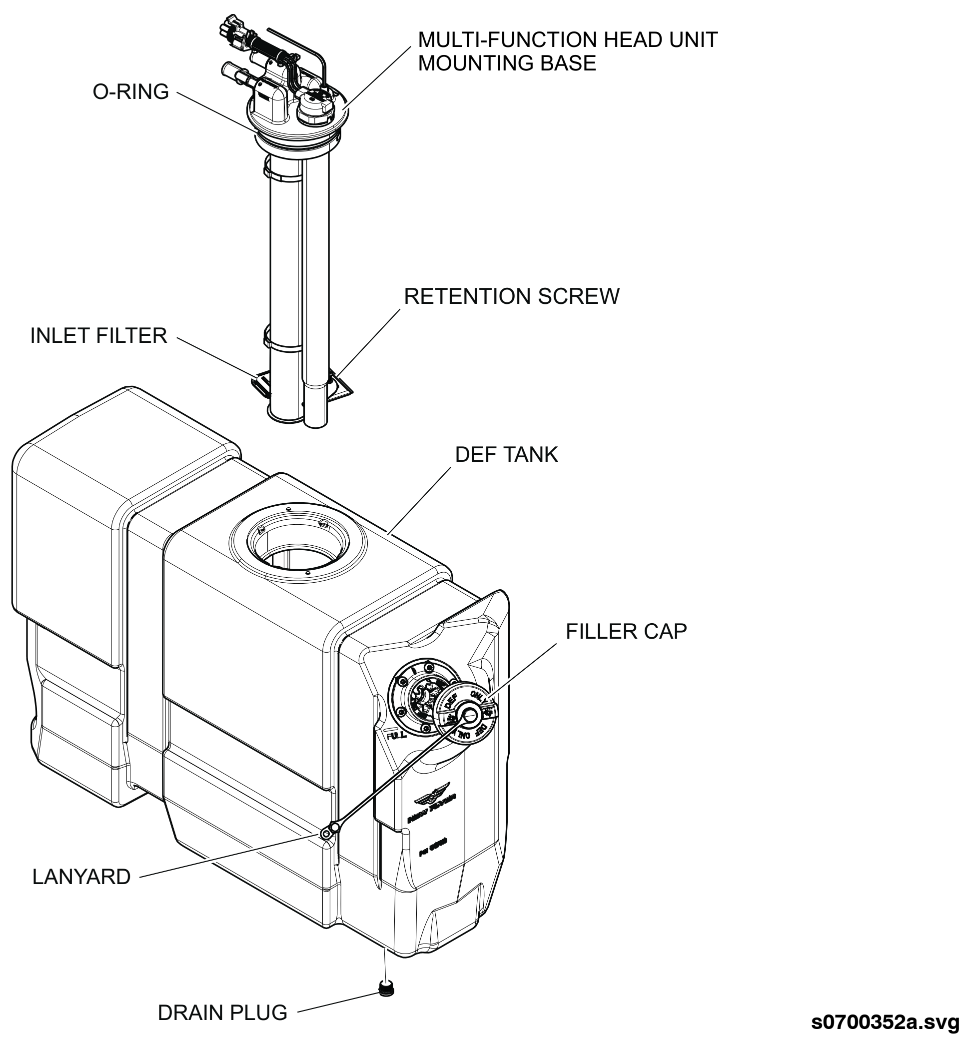


Fig. PM-44: DEF Tank Inlet Filter

2.25. Six Month Preventive Maintenance

2.25.1. 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.

2.25.2. 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.

2.25.3. 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.

2.25.4. 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.

2.25.4.1.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.

2.25.4.2.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.

2.25.5. 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.

2.25.6. 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.

2.25.7. 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.

2.25.8. R-14 Brake Relay Valve

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

2.25.9. 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.

2.25.10. 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.

2.25.11. 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.

2.25.12. 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.
1. Remove the protective plastic cap from the grease fitting and clean the fitting and surrounding area.
2. 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.

3. 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.

4. Lubricate the lower bearing, same as the upper bearing.
5. If difficulty is experienced lubricating either the upper or lower bearing, Refer to 2.25.12.1. “Lubrication Troubleshooting” on page 94 for troubleshooting procedures.
6. Clean any excess grease from the steering knuckle joint as well as the area above the sealing washer.
7. Install protective plastic cap on grease fitting.

2.25.12.1. 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.

2.25.13. 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.

2.25.14. 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.

2.25.15. 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 2.34. “Fluid & Lubrication Guide” on page 113 in this section for lubricant specification. See “Fig. PM-45: Power Steering Miter Box Lubrication” on page 95.

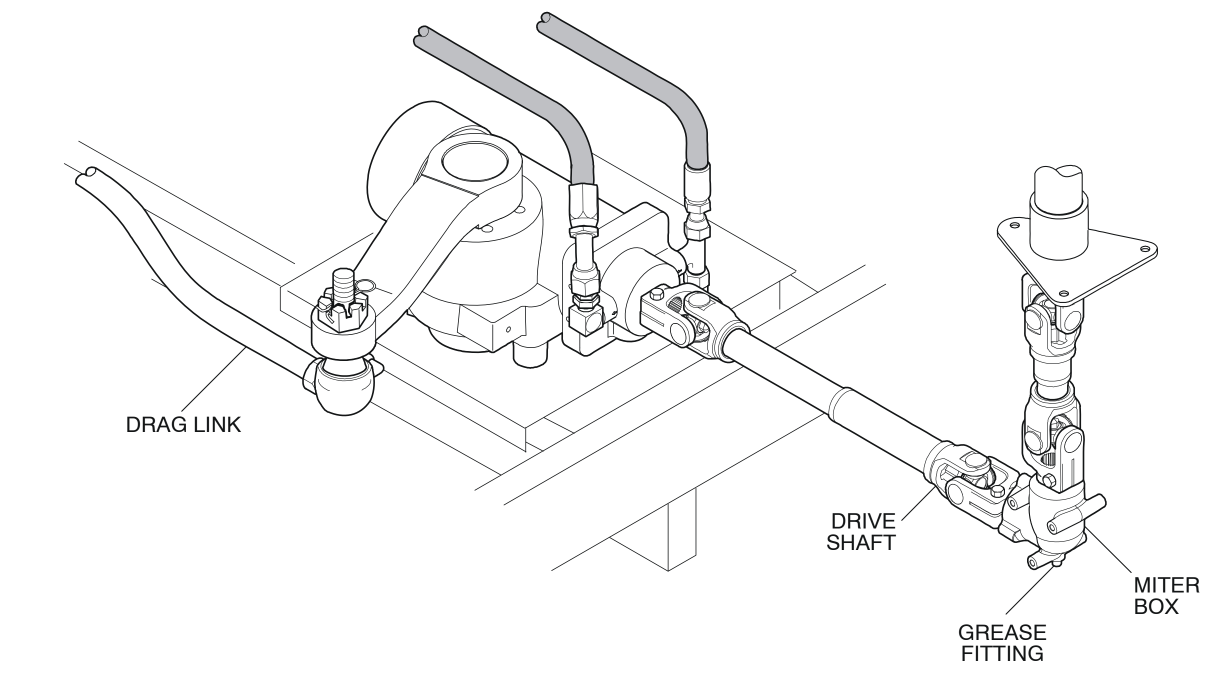


Fig. PM-45: Power Steering Miter Box Lubrication

2.26. Yearly Preventive Maintenance

2.26.1. 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.

2.26.2. Wheelchair Ramp Pump

2.26.2.1. 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 2.26.2.2. “Screen & Filter Inspection” on page 97 in this section for replacement procedure. See “Fig. PM-46: Hydraulic Power Pack Assembly” on page 97.
6. Connect and tighten hydraulic lines to ports “1” and “2” on the manifold.
7. Fill the reservoir. Refer to 2.34. “Fluid & Lubrication Guide” on page 113 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.

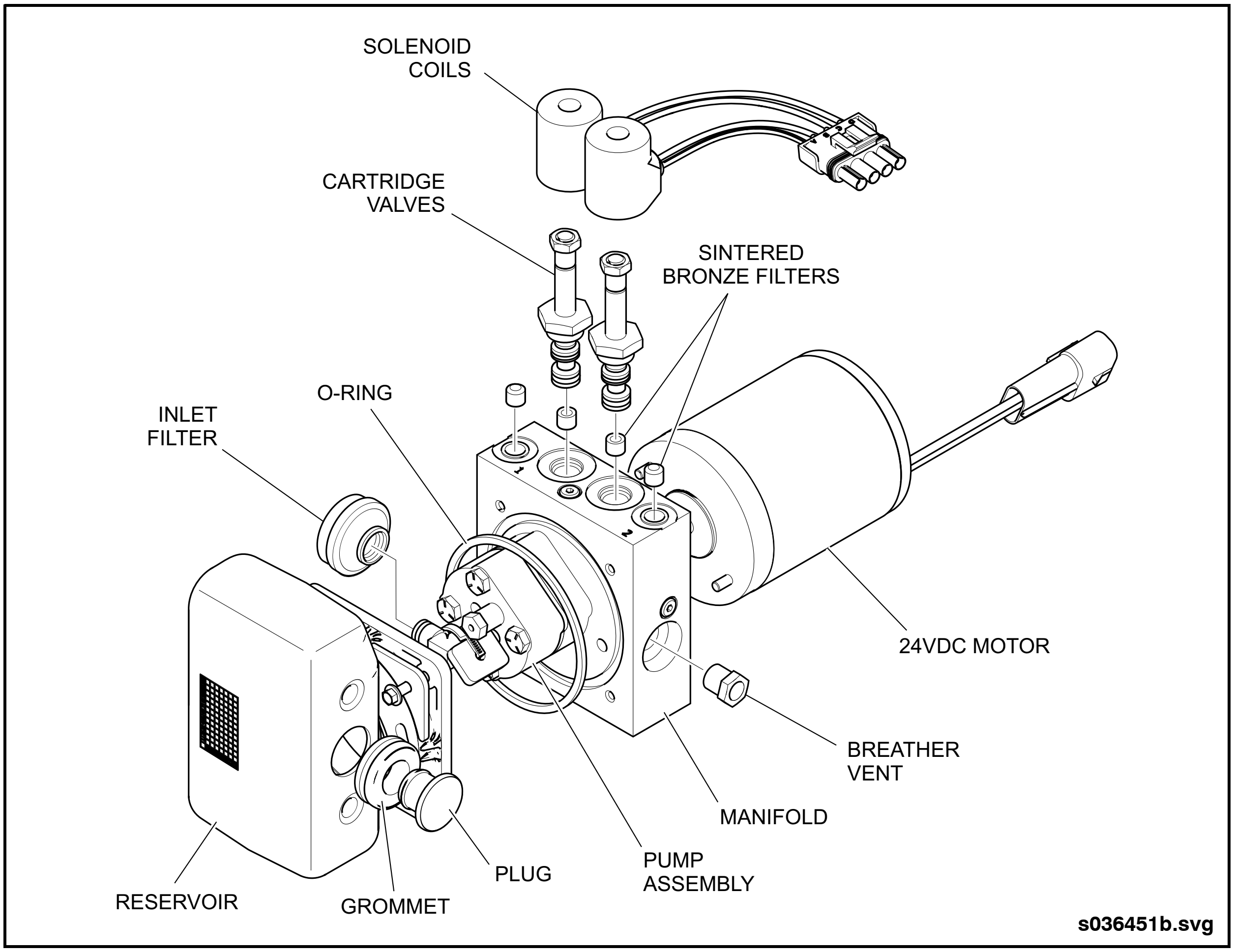


Fig. PM-46: Hydraulic Power Pack Assembly

2.26.2.2.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.

2.26.3. 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.

2.26.4. 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.

2.26.5. Auxiliary Coolant Heater

Perform a maintenance tune-up every year or 1000 flame hours, whichever occurs first. Perform the maintenance in the sequence indicated.

☞**NOTE:**

The flame hours can be determined from the G-II PCM data download.

☞**NOTE:**

A higher duty cycle may require a more frequent maintenance schedule, i.e. two or three times per year.

2.26.5.1.Preparation

1. Set the Battery Disconnect switch to the OFF position.
2. Gain access to the auxiliary coolant heater in the engine compartment.
3. Close the shutoff valves for the coolant supply and return lines to the heater.
4. Disconnect fuel supply line at the auxiliary coolant heater.

2.26.5.2. Heater Enclosure

⚠ CAUTION

DO NOT pressure wash the heater.

- ❒ Clean any accumulated debris or dust from the components.
- ❒ Ensure the opening around the exhaust pipe is clear.
- ❒ Visually inspect all the components for wear or damage.
- ❒ Ensure that the burner head air intake is clear.
- ❒ Inspect the air inlet hose and air inlet box for damage, kinks, debris, or other restrictions. Ensure the inlet box and tube are securely mounted and all clamps are tight.

2.26.5.3.Exhaust System

- ❒ Ensure that the exhaust system is vented safely away from the vehicle.
- ❒ Inspect the exhaust pipe for holes, dents, restrictions, or severely corroded areas.
- ❒ Ensure all heat shields and/or thermal blankets are in good condition.
- ❒ Ensure that the exhaust pipe clamp is tight and the exhaust pipe is secure.
- ❒ Replace any damaged exhaust system components.

2.26.5.4.Heat Exchanger

- ❒ Remove the burner head assembly and combustion tube to access the inside of the heat exchanger.
- ❒ Inspect and clean the inside and outside of the combustion tube.
- ❒ Clean any combustion deposits that may have accumulated on the heat exchanger fins in order to maintain optimum heat output.
- ❒ Use a wire brush to loosen the deposits and a vacuum to draw them out. Refer to 2.26.5.5. “Heat Exchanger Cleaning” on page 99 in this section for alternate cleaning procedure.
- ❒ Ensure exhaust pipe is clean and free from restriction.

2.26.5.5.Heat Exchanger Cleaning

- ❒ Ensure all exposed electrical connectors are covered and protected from water spray.

CAUTION

DO NOT pressure wash or steam clean the outside of the heat exchanger or any part of the burner head.

- ❒ Use a steam cleaner or pressure washer to clean the inside of the heat exchanger and exhaust pipe.

2.26.5.6.Cooling System

- ❒ Inspect all heater hoses and connections for signs of leakage, cracks, hardening, or any other damage.
- ❒ Repair or replace damaged cooling system components as required.

2.26.5.7.Power Source

- ❒ Check the power source connections to ensure wiring connections are tight and no corrosion is evident.
- ❒ Check that all of the seals on the power connector are present and in good condition. Replace if necessary.

2.26.5.8.Fuel System

- ❒ Check the fuel system lines and connections for damage, cracks, or hardening from age.
- ❒ Inspect all clamps on the fuel lines to ensure they are secure.

2.26.5.9.Fuel Filter

5. Remove and inspect filter. Clean or replace as necessary. See “Fig. PM-47: Proheat Fuel Filter” on page 100.

- ❒ Clean O-ring and seat.
- ❒ Refer to your Proheat Service Manual for detailed filter inspection and replacement procedures.

2.26.5.10.Fuel Nozzle

- ❒ Inspect fuel nozzle stem and O-ring for contamination and/or damage. Replace if damaged.
- ❒ Disassemble fuel nozzle and inspect and clean distributor, fuel orifice, air passages, head, and stem. Use electrical contact cleaner or warm soapy water for cleaning.

☞NOTE:

A soft bristled brush may be used to aid in cleaning the distributor. DO NOT use welding torch tip cleaner or similar tool for cleaning orifices.

- ❒ Refer to your Proheat Service Manual for detailed fuel nozzle disassembly and assembly procedures

2.26.5.11.Compressor Air Filter

- ❒ Replace inlet air filter annually or more often if auxiliary coolant heater is exposed to dusty conditions. See “Fig. PM-48: Proheat Air Filter” on page 100.
- ❒ Ensure that the air filter installed on the same side as the compressor and is seated correctly into the PCM housing.

2.26.5.12.Compressor

☞NOTE:

Ensure that the compressor air filter and the fuel nozzle have been serviced prior to performing the compressor test.

Check compressor air pressure setting. Refer to “Test Procedure - Air Compressor Pressure” in the Proheat Service Manual for detailed testing procedures.

2.26.5.13.Electrical System

- ❒ Check the internal and external wiring harnesses for missing or damaged seals or corrosion at the connectors. Replace if required.
- ❒ Inspect PCM for missing electrical connector plugs. Replace as necessary.

2.26.5.14.Operation Test

1. Ensure that the fuel supply line, coolant lines, and electrical harnesses are installed and properly tightened.
2. Open the shutoff valves for the coolant supply and return to the heater.
3. Set the Battery Disconnect switch to the ON position.
4. Start the vehicle. Run the heater for 15 minutes or until the heater cycles “OFF” and then “ON” again.
5. Check the following during the test:
   a. Combustion process - check for smoke or raw fuel odor from the exhaust pipe.
   b. Fuel system leaks.

   ☞NOTE:

   Refer to your Proheat Service Manual if any combustion or fuel system problems are encountered.

   c. Check coolant lines for leaks.
   d. Check for correct heating system process.

2.26.5.15.Timer/Toggle Switch Supplemental/ Preheat

Check heater operation under specified heater “ON” signals when operating in NORMAL, PREHEAT, and SUPPLEMENTAL modes.

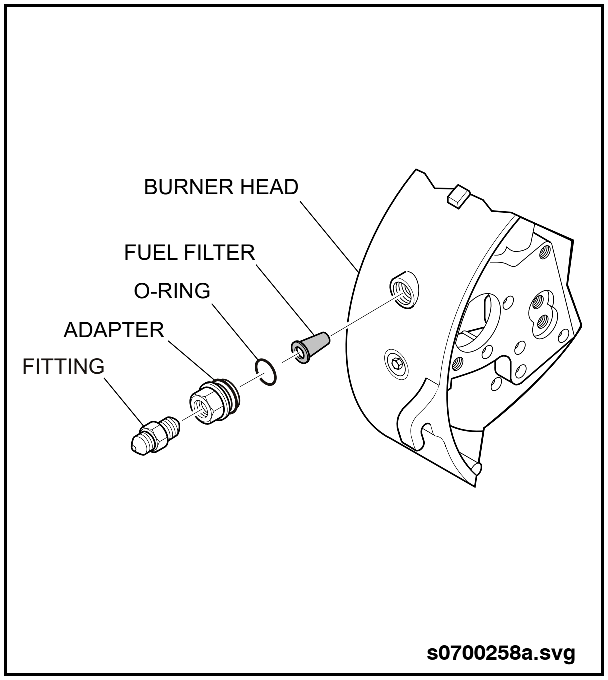


Fig. PM-47: Proheat Fuel Filter

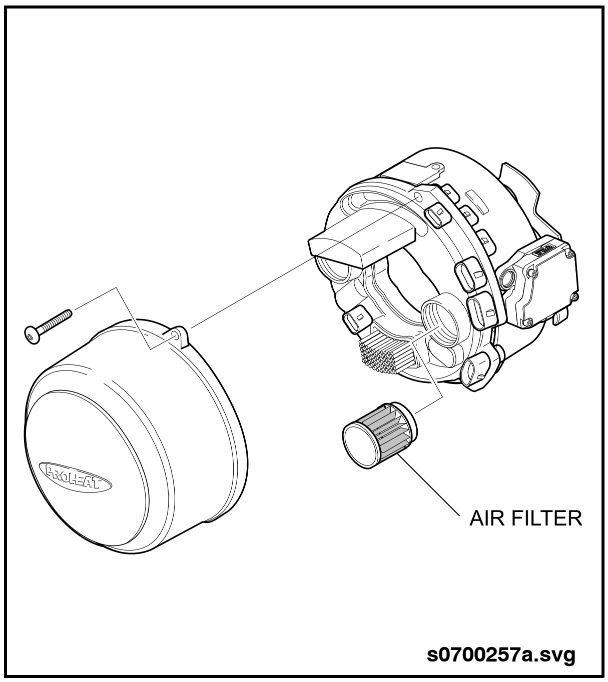


Fig. PM-48: Proheat Air Filter

2.26.6. 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.

2.26.7. 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.

2.26.8. 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-lb. (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.

2.26.9. Hybrid Oil Cooler

Inspect the oil cooler on a yearly basis as follows:

- ❒ Inspect the main harness and fan connectors. Ensure all wires and pin connectors are intact.
- ❒ Inspect fuses and fuse holders.
- ❒ Inspect support structure for any damage or loose mounting hardware.

2.26.10. Headlight Aim

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

2.26.11. 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.

2.26.12. 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.

2.27. Two Year Preventive Maintenance

2.27.1. 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 2.27.1.1. "Exterior Cleaning" on page 103 in this section for cleaning procedure.
- ❐ Inspect cooling fins for damage and straighten with a fin comb as required.

2.27.1.1. 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.

2.27.1.2. 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 2.26.12. "Coolant Testing" on page 102 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 2.34. "Fluid & Lubrication Guide" on page 113 in this section for recommended coolant.

2.27.2. 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:

2.27.2.1. 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-49: Entrance Door Baseplate Lubrication” on page 104. See “Fig. PM-50: Exit Door Baseplate Lubrication” on page 105.

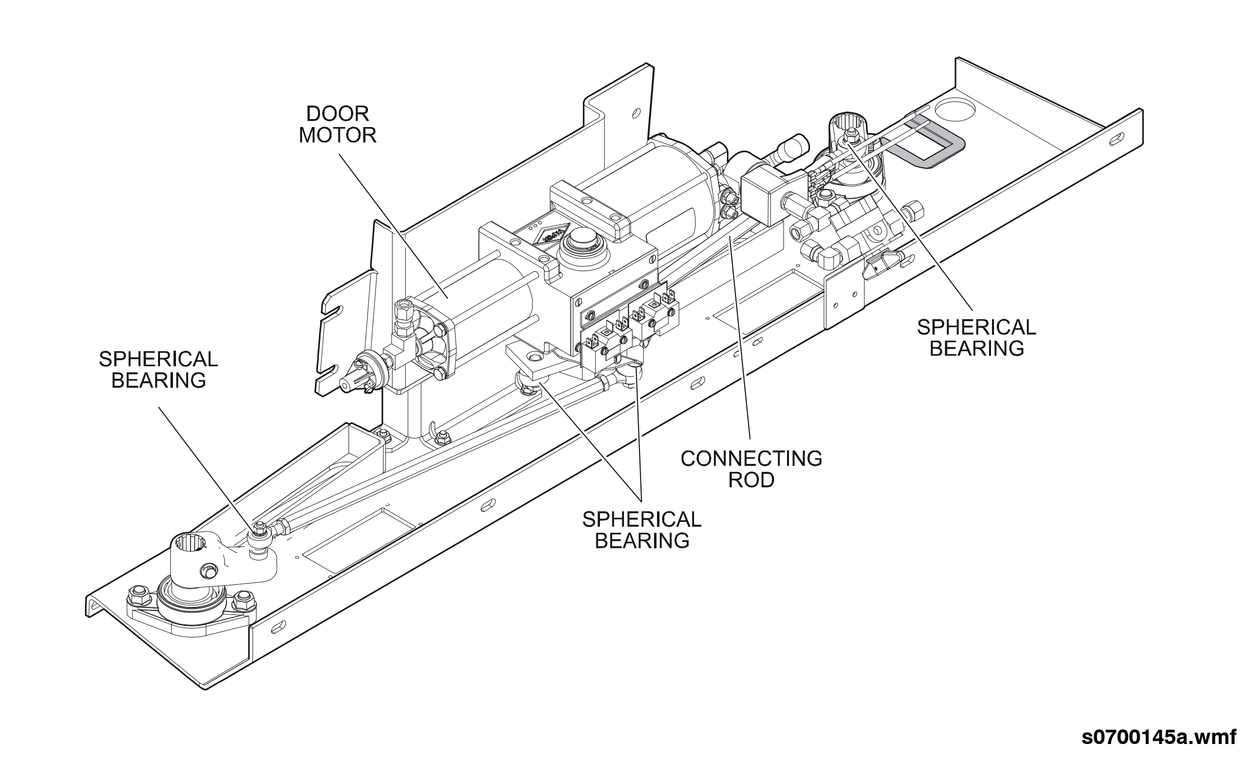


Fig. PM-49: Entrance Door Baseplate Lubrication

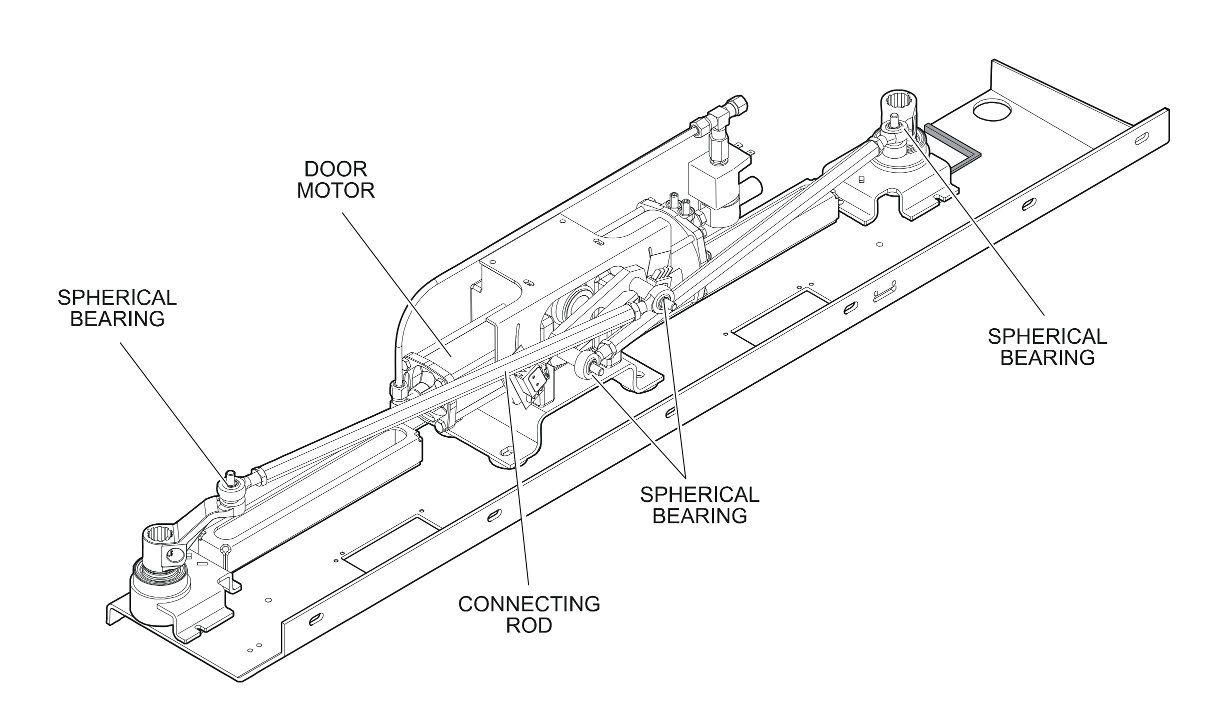


Fig. PM-50: Exit Door Baseplate Lubrication

2.27.2.2. 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.

2.27.2.3. 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.

☞**NOTE:**

The forward bearing is a sealed bearing and does not require periodic lubrication. The aft bearing is a self-aligning type bearing and requires periodic lubrication at the grease fitting.

2.27.2.4. 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.

2.27.2.5. 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.

2.27.2.6. 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-51: Entrance Door Shaft & Arm Assembly” on page 106.

- ❒ 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.

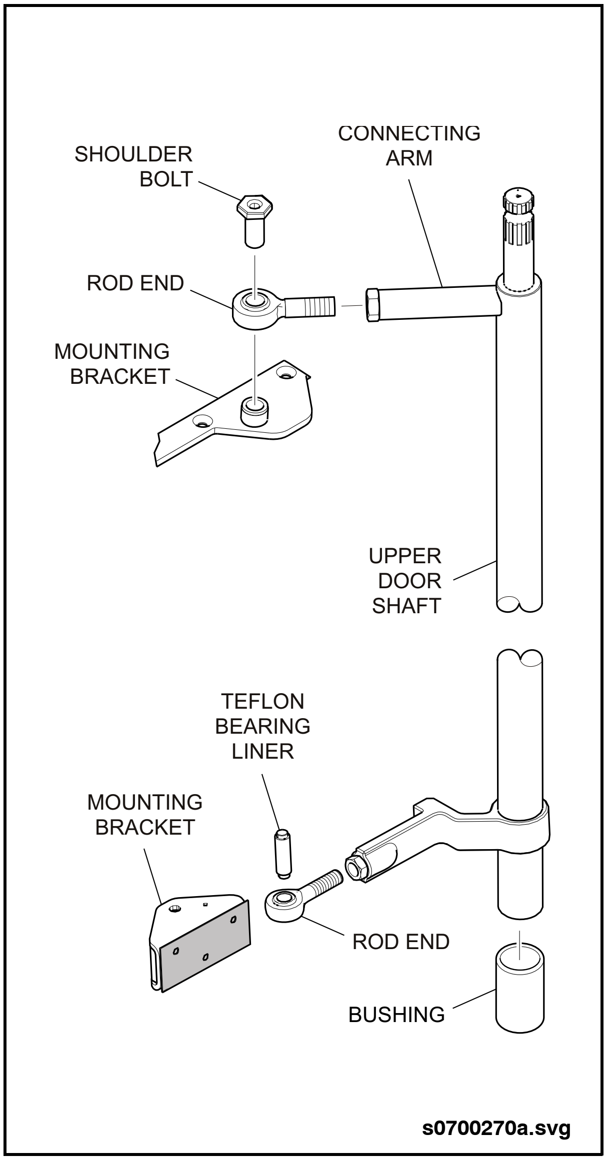


Fig. PM-51: Entrance Door Shaft & Arm Assembly

2.27.2.7. 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-52: Exit Door Shaft” on page 107. 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.

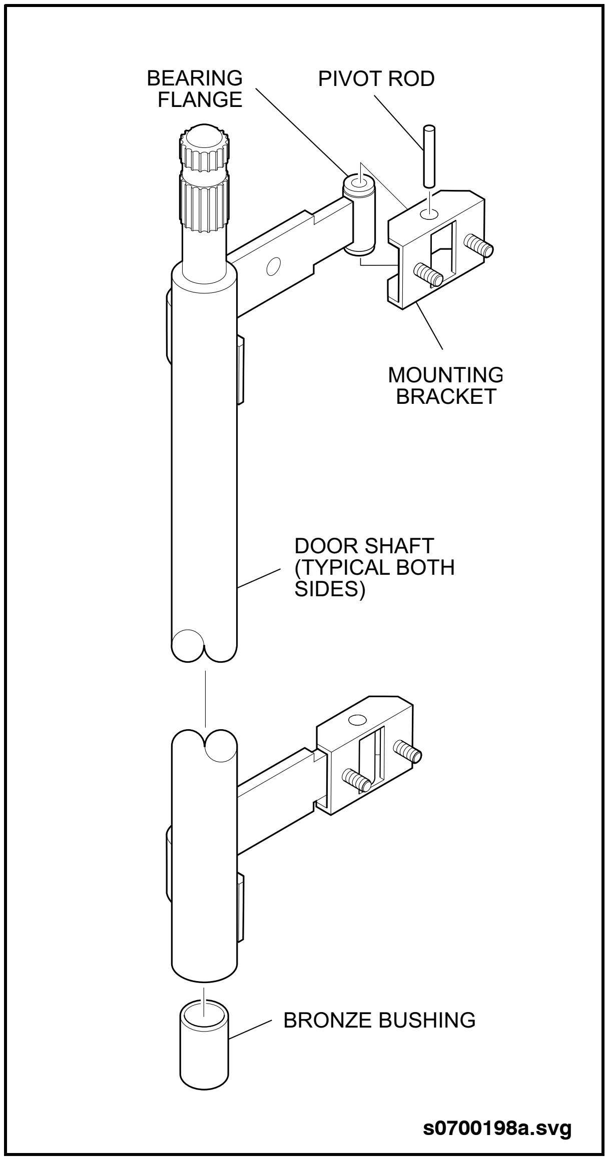


Fig. PM-52: Exit Door Shaft

2.27.2.8.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.

2.27.2.9.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.

2.27.2.10.Solenoid Valves

- ❒ Check for proper operation.
- ❒ Inspect electrical connections.
- ❒ Inspect air lines to solenoid and ensure connections are tight.

2.27.2.11.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.

2.28. Three Year Preventive Maintenance

2.28.1. Under Body Inspection

Refer to Section 11 of this manual for procedure.

2.28.2. Fire Suppression System

Replace the backup battery, located in the driver's area, every three years.

2.28.3. 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.

2.29. Five Year Preventive Maintenance

2.29.1. Door Motor Rebuild

The door motor (differential engine) should be disassembled, cleaned, inspected, and re-lubricated every five years or 500,000 door operating cycles, whichever occurs first. Refer to Section 16 of this manual for rebuild procedure.

2.29.2. 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.

2.29.3. 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.

2.29.4. Air Dryer

Perform the following inspections, tests, and component replacements every five years:

2.29.4.1.Inspection & Test

☞**NOTE:**

Refer to Section 8 of this manual for functional test procedures.

- ❒ Electronic control module
- ❒ Heater assembly
- ❒ Thermostat assembly
- ❒ Electrical harness

2.29.4.2.Component Replacement

☞**NOTE:**

Refer to Section 8 of this manual for replacement procedures.

- ❒ Diverter valve
- ❒ Exhaust valve
- ❒ Unloader/turbo valve
- ❒ All check valves

2.30. Six Year Preventive Maintenance

2.30.1. 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.”.

2.30.2. 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.

2.30.3. Booster Pump

Replace the pump motor bearings every six years. Refer to Section 10 of this manual for procedure.

2.30.4. 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 2.26.12. “Coolant Testing” on page 102 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.

2.30.5. Video Surveillance System

Replace the backup batteries, located in the driver’s area, every five years.

2.31. Ten Year Preventive Maintenance

2.31.1. 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.

- ❒ Door operator/differential engine
- ❒ 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.

2.32. Twelve Year Preventive Maintenance

2.32.1. 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.

2.32.2. 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.".

2.33. Fluid & Lubrication Points

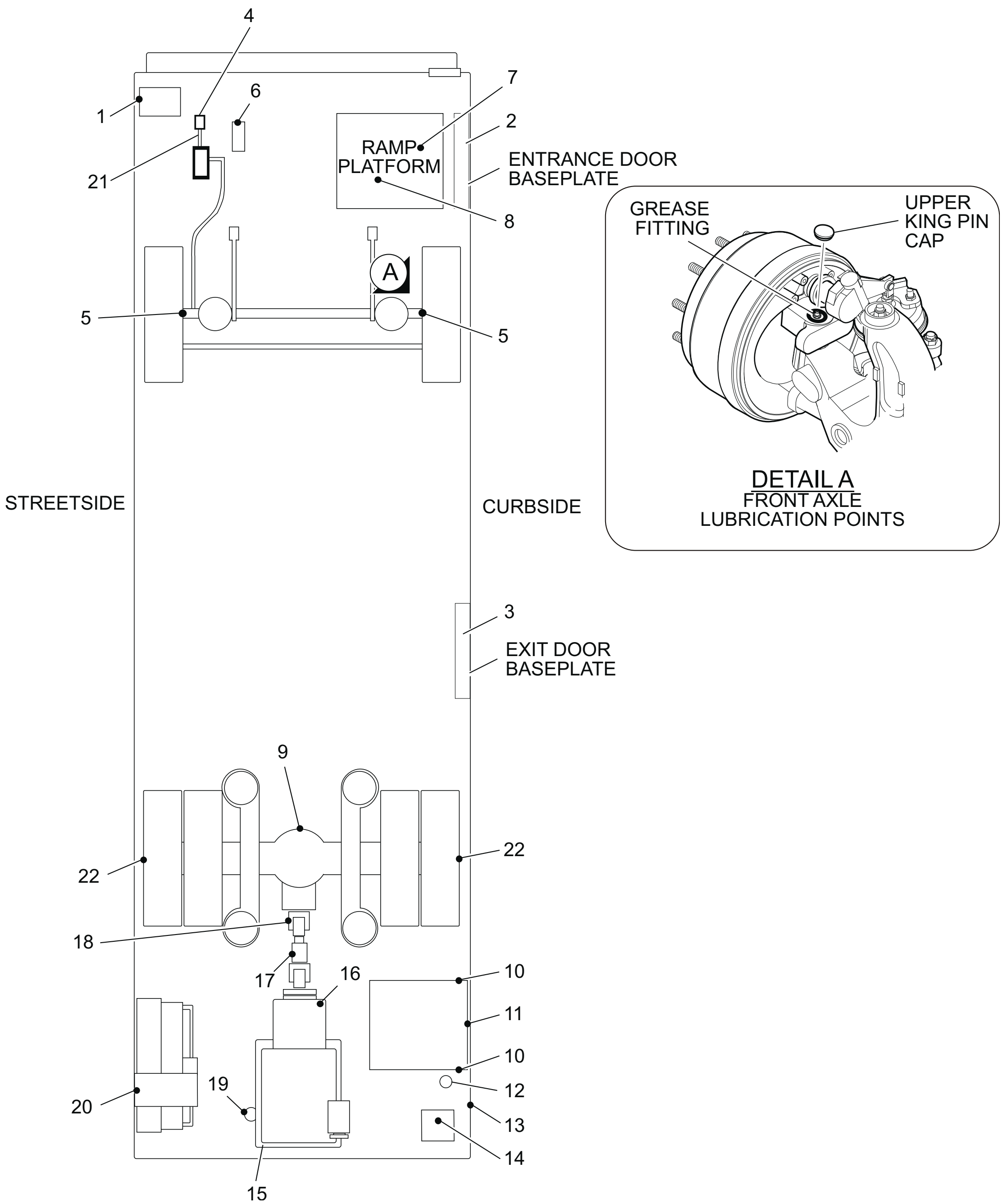


Fig. PM-53: Fluid & Lubrication Points

2.34. 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-53: Fluid & Lubrication Points" on page 112.

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 2.25.15. "Power Steering Miter Box" on page 95 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 2.25.12. "Steering Knuckle Lubrication" on page 93 in this section for procedure	Every 6 months or 30,000 miles (48,000 km)	Special-Purpose Grease. Refer to 2.34.2. "MAN Axle Approved Greases" on page 117 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)
7	Wheelchair Ramp Mechanism	Lubricate chains, teflon bearings, bronze bushings, & all sliding surfaces	Every six months	White Lithium Grease (Aerosol Spray)

FLUID & LUBRICATION GUIDE				
Item	**Component**	**Procedure**	**Interval**	**Lube Type**
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 2.34.1. “MAN Axle Approved Mineral Oils” on page 117 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, & 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
12	Diesel Exhaust Fluid Filter	Change filter	Every 200,000 miles (321,000 km)	API Certified Stabilized Urea Premix meeting ISO 22241-1 standard
13	Diesel Exhaust Fluid Tank	Check fluid & fill as required using pressure fill port	Daily	API Certified Stabilized Urea Premix meeting ISO 22241-1 standard

FLUID & LUBRICATION GUIDE				
Item	**Component**	**Procedure**	**Interval**	**Lube Type**
14	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
15	Engine	Check dipstick level	Daily	Chevron Delo 400 LE 15W-40 (API CJ-4)
		Drain & refill	Every 6,000 miles (9,600 km)	Chevron Delo 400 LE 15W-40 (API CJ-4)
16	Drive Unit	Check dipstick level	Daily	
		Drain & refill	Change control main oil filter at 5,000 miles (8,000 km) & thereafter every 50,000 miles (80,500 km). Change fluid & lube filter every 100,000 miles (161,000 km)	
17	Driveshaft Slip Joint	Refer to 2.10.4. "Driveshaft" on page 27 in this section for procedure	Upon receipt of vehicle, & 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
18	Driveshaft U-Joints	Refer to 2.10.4. "Driveshaft" on page 27 in this section for procedure	Upon receipt of vehicle, & 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	Engine Oil Filters	Replace (full-flow, spin-on)	Every 6,000 miles (9,600 km)	Chevron Delo 400 LE 15W-40 (API CJ-4)
20	Surge Tank	Check sight glass	Daily	Final Charge 50/50® Extended Life Anti-Freeze
		Drain & fill cooling system. Flush only if required	Every two years or 80,000 miles (128,000 km)	Final Charge 50/50® Extended Life Anti-Freeze

FLUID & LUBRICATION GUIDE				
Item	**Component**	**Procedure**	**Interval**	**Lube Type**
21	Steering Driveshafts	Purge lubricate at grease fittings. Refer to 2.10.6. “Steering Driveshafts” on page 31 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
22	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 2.34.2. “MAN Axle Approved Greases” on page 117 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.

2.34.1. 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. 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 80W-90)	MAN 342 M1
Castrol Axle EPX 90 (SAE 80W-90)	MAN 342 M1
Shell Spirax MB 90 (SAE 80W-90)	MAN 342 M1
Petro Canada TRAXON XL Synthetic Blend (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

2.34.2. 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. 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. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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.

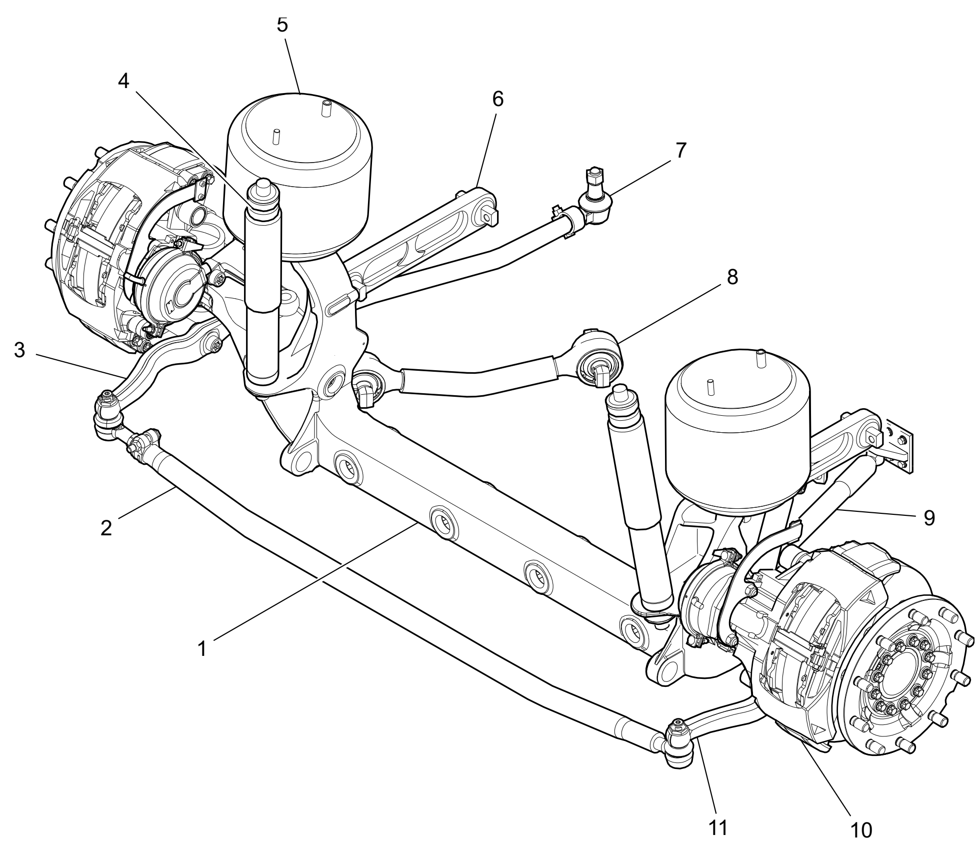
2. FRONT AXLE & SUSPENSION

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 harness.
9. Disconnect brake wear sensor harness from vehicle harness.
10. 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.
11. Remove two M14 bolts from each pivot pin retaining upper radius rods to vehicle frame.
12. Ensure axle is well supported, remove 1/2" nut from left and right axle air spring lower mounting pads.
13. 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 assembly is strapped or chained to lifting device to prevent tilting or falling when freed from the frame mounting points.

14. 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.

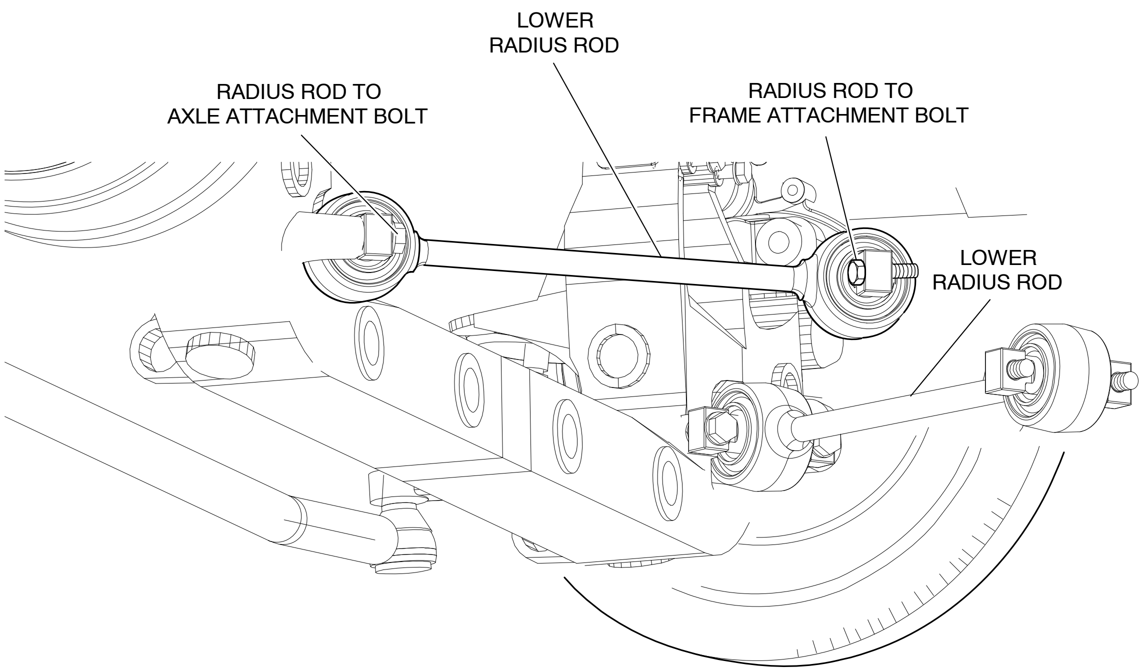
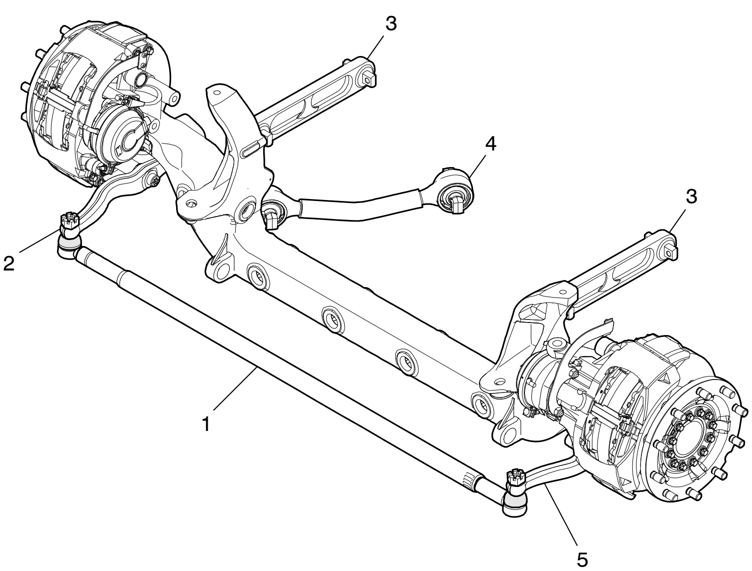


Fig. 1-2: Lower Radius Rod Removal



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 45 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 harness.
7. Connect brake wear sensor harness to vehicle wiring harness.

☞**NOTE:**

If the round sensor connector between the wear sensor harness and the extension harness is unplugged during the removal procedure, check that the rubber seal is not damaged or deformed. Ensure the wear sensor connector is properly pushed into the cable extension connector upon re installation. The cable extension connector has locking tabs which lock in position when the sensor's plug is inserted correctly.

⚠CAUTION

A damaged seal or improperly seated connector will not provide a watertight seal between the sensor connector and the extension cable connector. Penetration of water can lead to corrosion on connector pins and cause sensor failure.

8. Connect air lines to brake chambers.
9. Connect leveling valve linkage.
10. Connect drag link to steering arm. Torque nut to specification and install cotter pin.
11. 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 .... 130 psi

Maximum Load (single tire) .... 7,830 lbs. @ 130 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 (EPA 2014-2016) 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 45 *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.

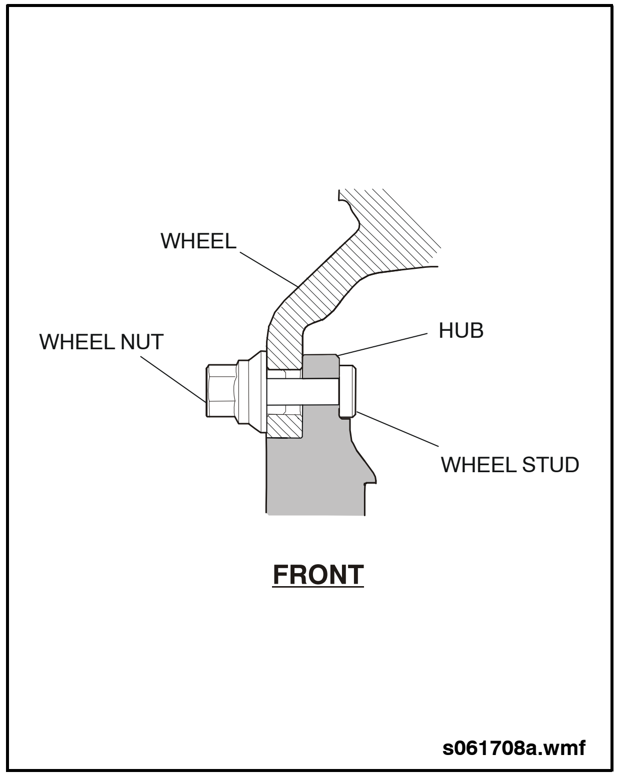


Fig. 1-4: Hub Piloted Wheels

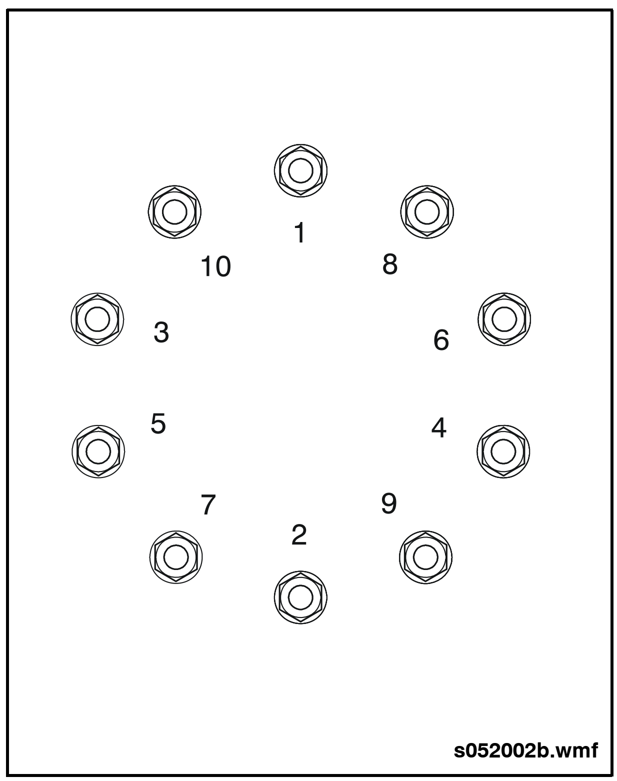


Fig. 1-5: Wheel Nut Torquing Sequence

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).

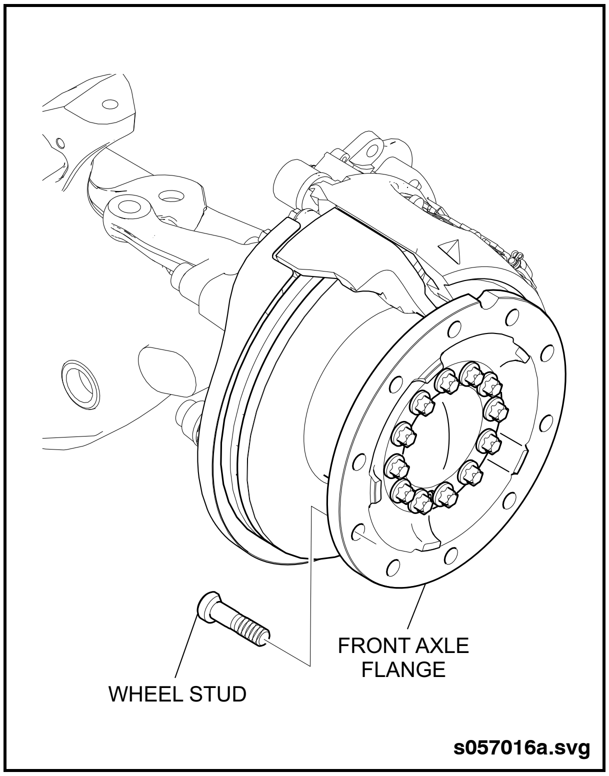


Fig. 1-6: Wheel Bolt Removal

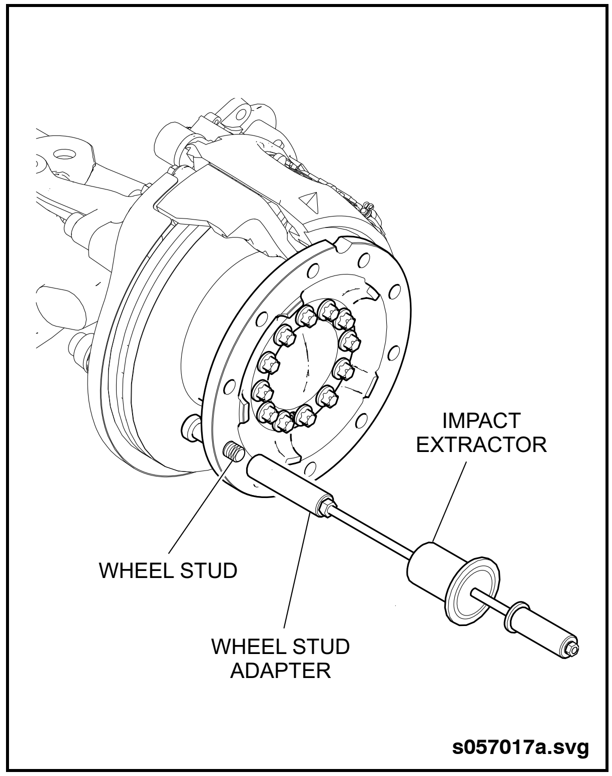
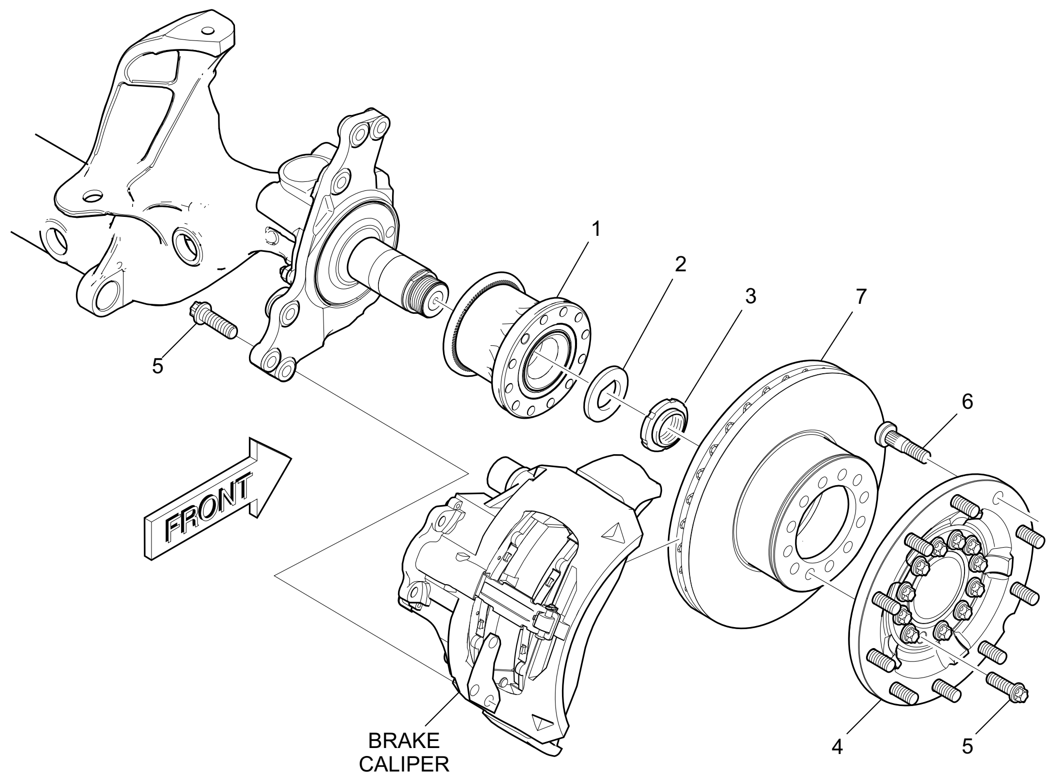


Fig. 1-7: Wheel Bolt Installation

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.

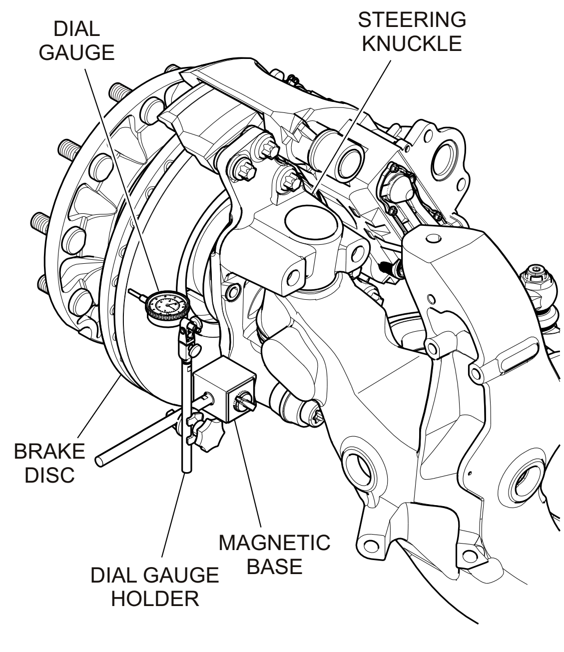


Fig. 1-9: Wheel Bearing Inspection

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.
6. Use the special tool to loosen all the flange mounting bolts.
7. Support the wheel flange and completely remove the mounting bolts.
8. Remove the flange from the brake disc.

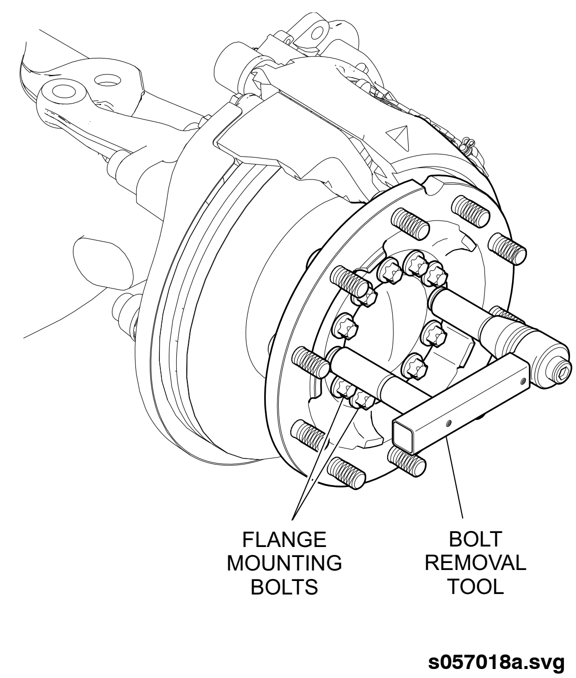


Fig. 1-10: Flange Mounting Bolt Removal

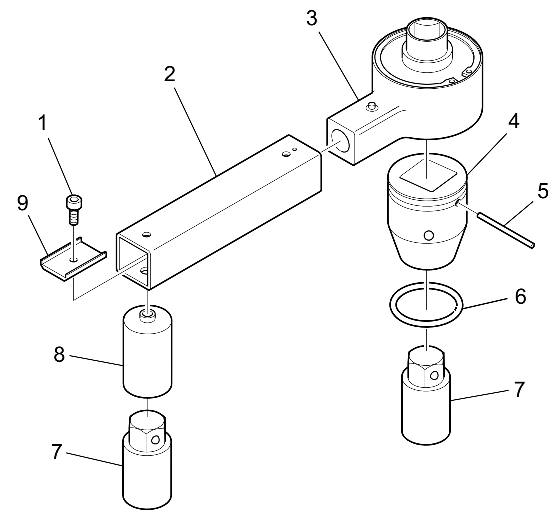
3.7.3.1. Special Tool Assembly

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. 1-11: 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.

☞**NOTE:**

Check condition of bolts. DO NOT reuse any mounting bolts with signs of damage or deformity.



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. 1-11: 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. Install wheel flange against brake disc and install 12 Torx-head bolts.

☞**NOTE:**

Replace any mounting bolts with signs of damage or deformity.

3. Use the flange bolt tool (Items 17, 18, 19, 20, 21, 22, 23, 24, 25 from special tools list) to torque 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).

4. 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 72 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 63 in this section for removal procedure.
3. Remove the brake disc. Refer to 5.2.9. "Brake Disc" on page 72 in this section for removal procedure.
4. Install slotted nut socket (Item 30 from special tools list) onto slotted nut. See "Fig. 1-12: Wheel Hub Slotted Nut Socket" on page 15.
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. 1-13: Wheel Hub Nut Removal" on page 16.
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. 1-14: Wheel Hub Removal" on page 16.
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 16 *in this section for procedure.*

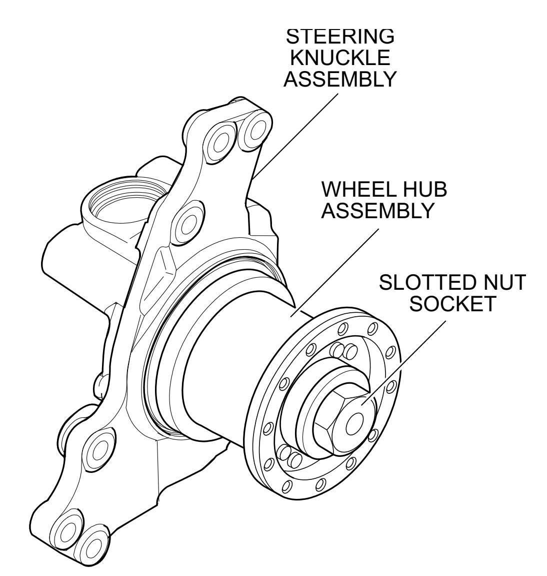


Fig. 1-12: Wheel Hub Slotted Nut Socket

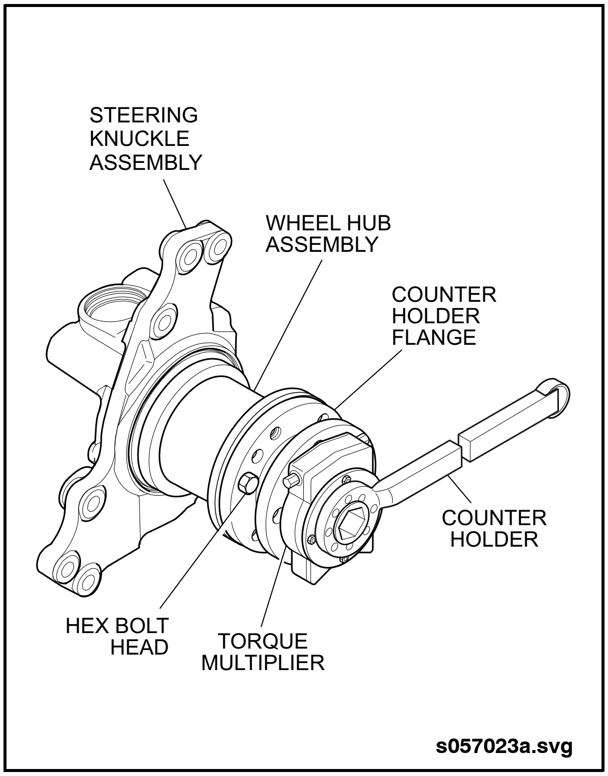


Fig. 1-13: Wheel Hub Nut Removal

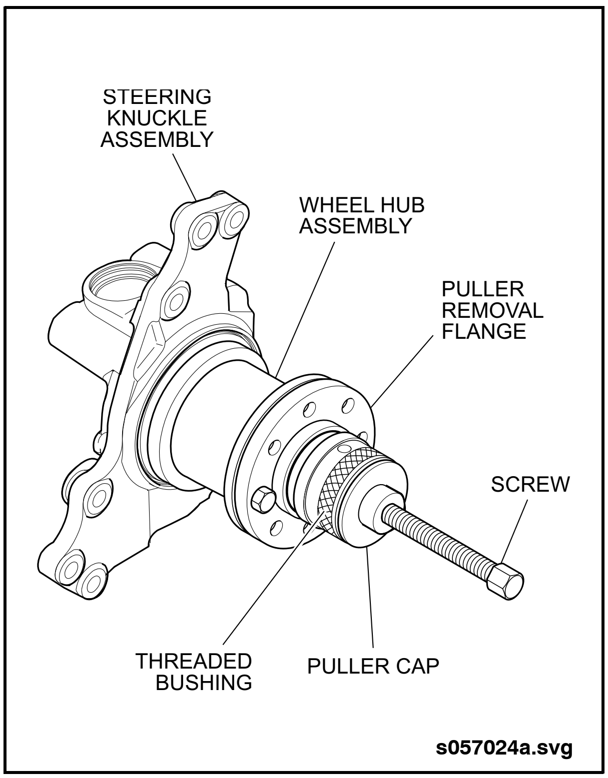


Fig. 1-14: Wheel Hub Removal

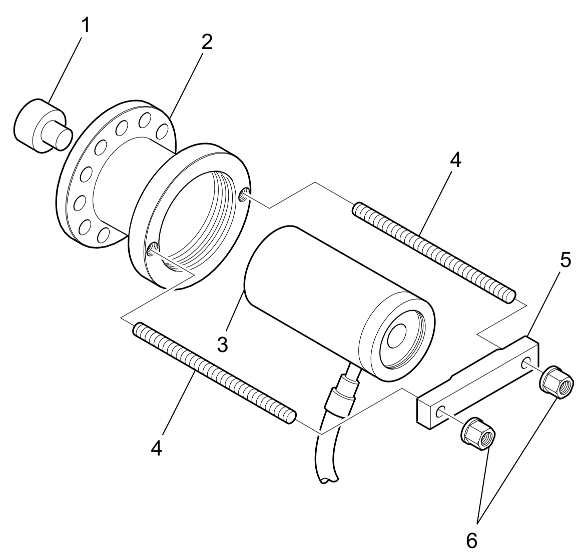
3.7.7. Hub Removal with Hydraulic Puller

1. Assemble the hydraulic puller tool. Refer to 3.7.7.1. “Hydraulic Puller Tool Assembly” on page 17 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. 1-15: Hydraulic Puller Tool Assembly" on page 17.

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. 1-15: 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. 1-16: Hub Fitting Sleeve Installation” on page 18.
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. 1-17: Wheel Hub Installation” on page 18.
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 72 in this section for procedure.
15. Install wheel flange. Refer to 3.7.4. “Wheel Flange Installation” on page 14 in this section for procedure.

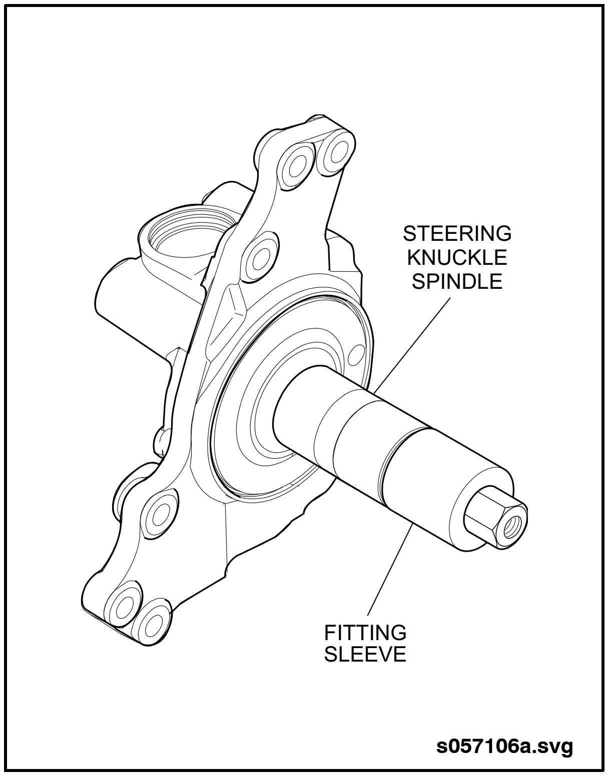


Fig. 1-16: Hub Fitting Sleeve Installation

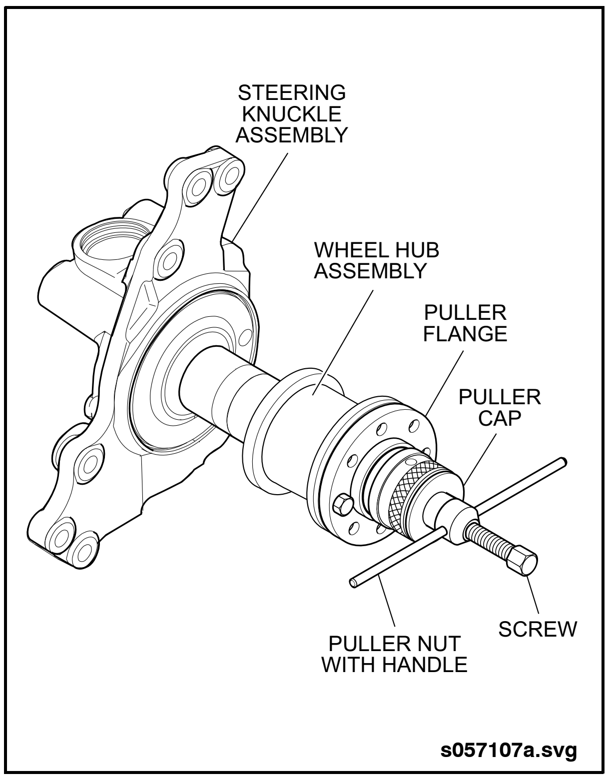


Fig. 1-17: Wheel Hub Installation

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. 1-18: Tie Rod End Removal" on page 19.
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.

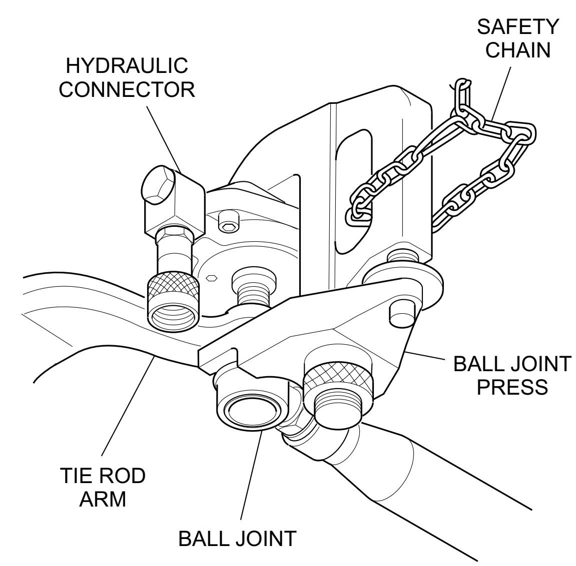


Fig. 1-18: Tie Rod End Removal

3.8.3. Installation

☞**NOTE:**

Refer to 4.5. "Front Suspension Torque Specifications" on page 45 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. 1-19: Tie Rod End Adjustment" on page 20.
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. 1-20: Center Link Tie-Rod End" on page 21.
7. Tighten center link tie rod end clamp lock nut (M14 x 1.5) to specification.
8. Check toe-in and adjust as required. Refer to Section 3 of this manual for procedure.

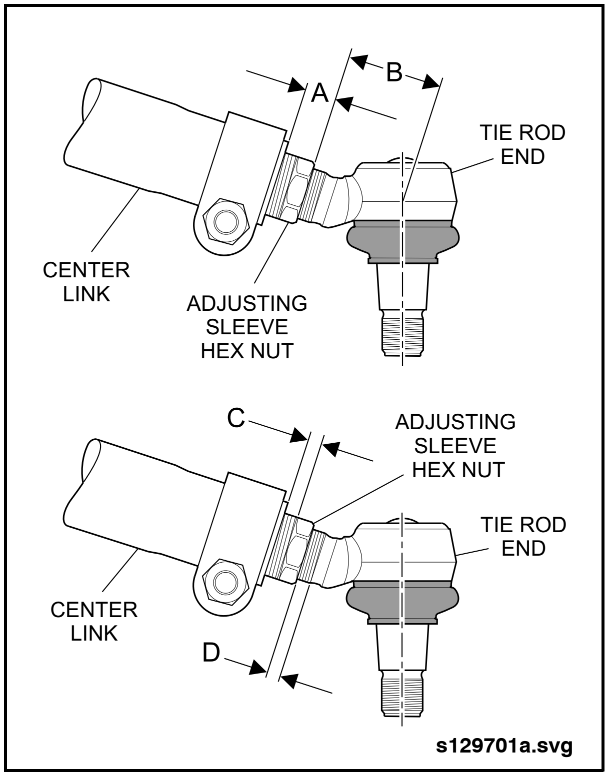
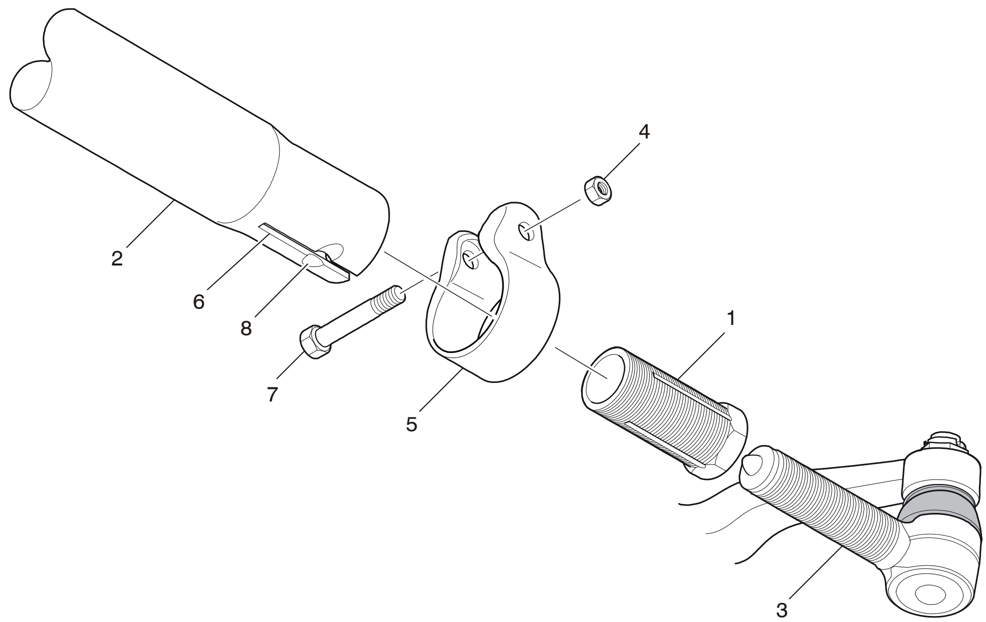


Fig. 1-19: Tie Rod End Adjustment



1. Threaded Sleeve/Nut
2. Center Link
3. Tie Rod End
4. Nut
5. Clamp
6. Slot
7. Bolt
8. Recess

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Fig. 1-20: Center Link Tie-Rod End

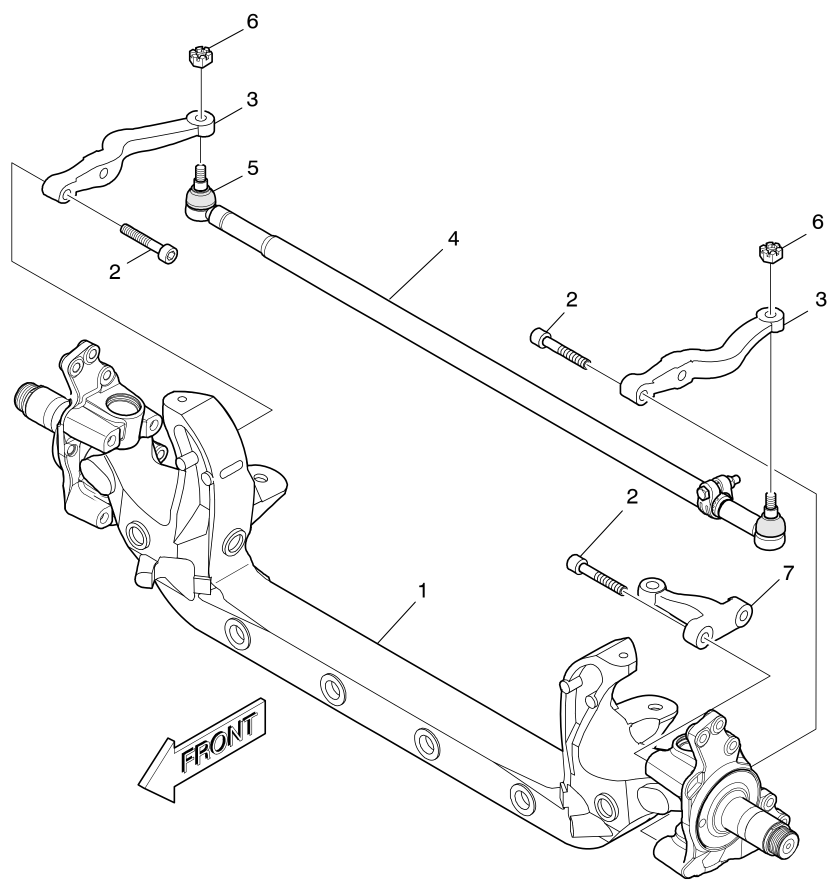
3.9. Tie Rod Arms & Steering Arm

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. 1-21: Tie Rod & Steering Arms” on page 22.

☞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. 1-21: 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.

3.9.3. Installation

1. Install steering arm using two new self-locking bolts.
2. Install each tie rod arm using two new self-locking 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.
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.

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 74 in this section for removal procedure.
7. Remove disc brake pads. Refer to 5.2.5. “Brake Pads” on page 59 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 63 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 72 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 19 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 81 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. 1-22: Axle Beam Dust Guard” on page 24.
14. Remove circlips (snap ring) from upper and lower king pin sealing washers. See “Fig. 1-23: 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. 1-24: King Pin Removal” on page 25.
19. Lift king pin out though bore in press cross-beam using magnetized centering man-drel. (Item 53 from special tools list). See “Fig. 1-25: King Pin Removal Tool” on page 26.
20. Retract press ram and remove king pin press and attachments.
21. Remove steering knuckle assembly and spacer shim.

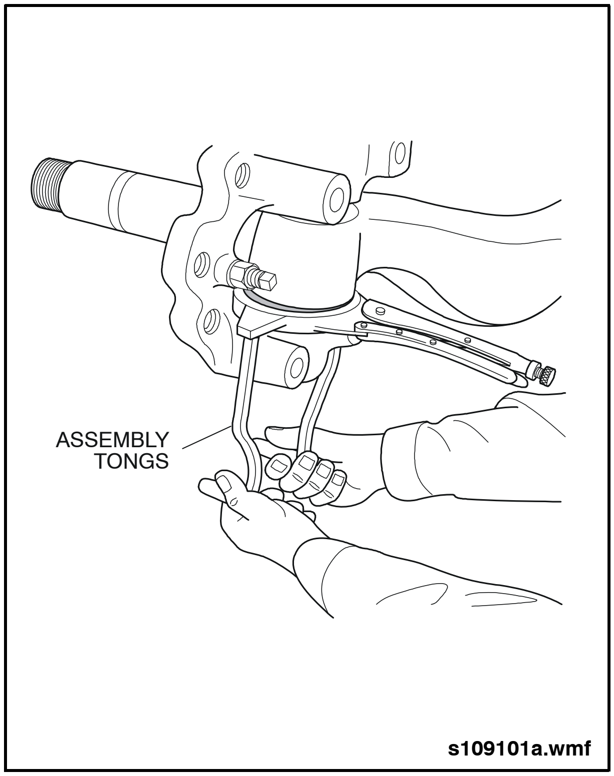


Fig. 1-22: Axle Beam Dust Guard

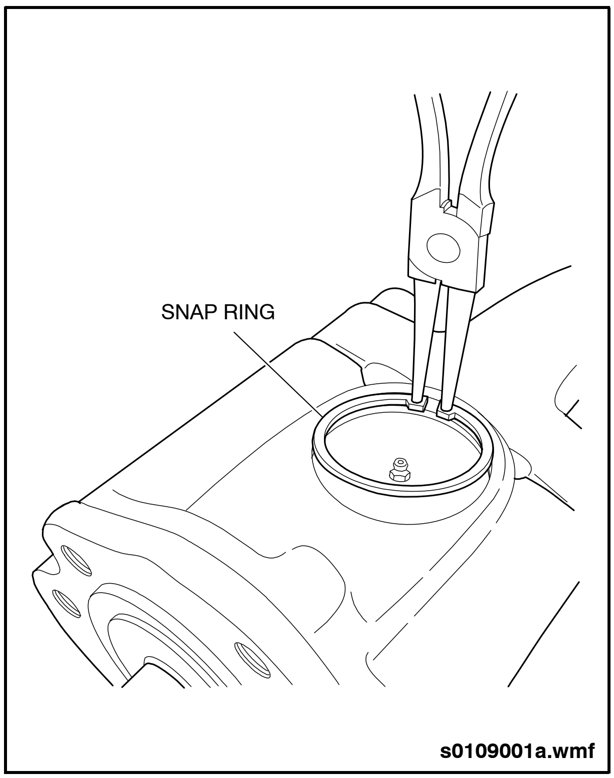


Fig. 1-23: King Pin Snap Ring Removal

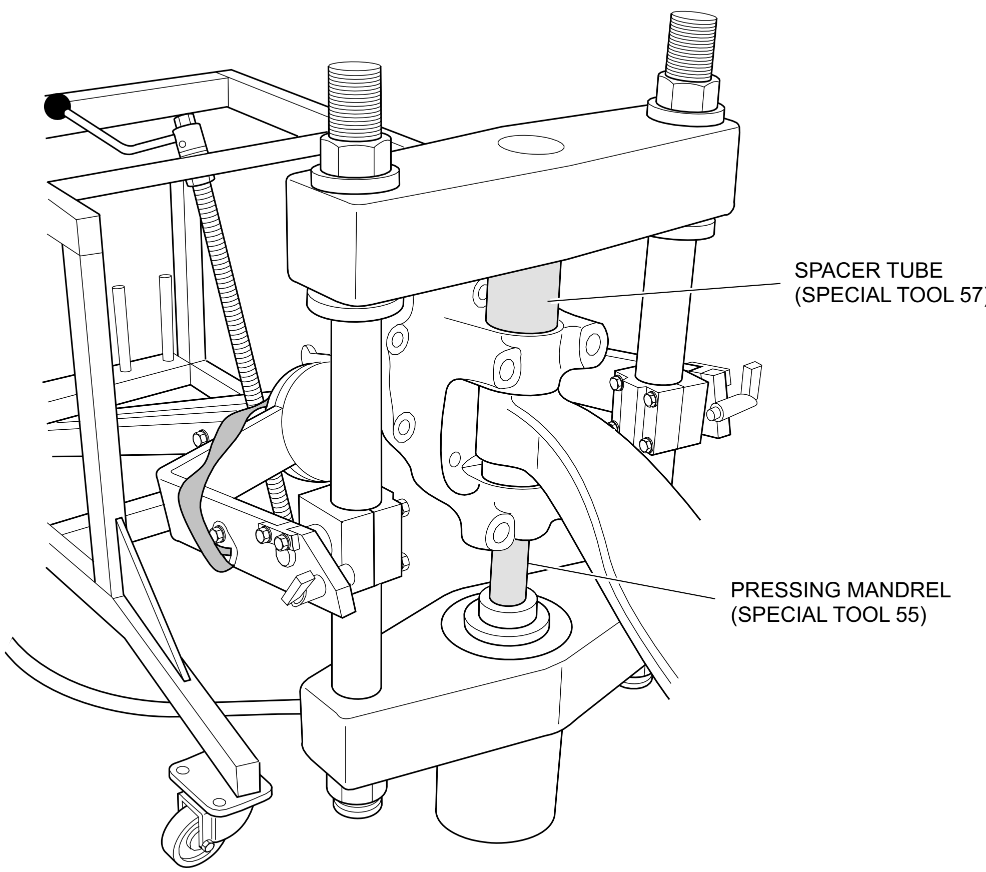


Fig. 1-24: King Pin Removal

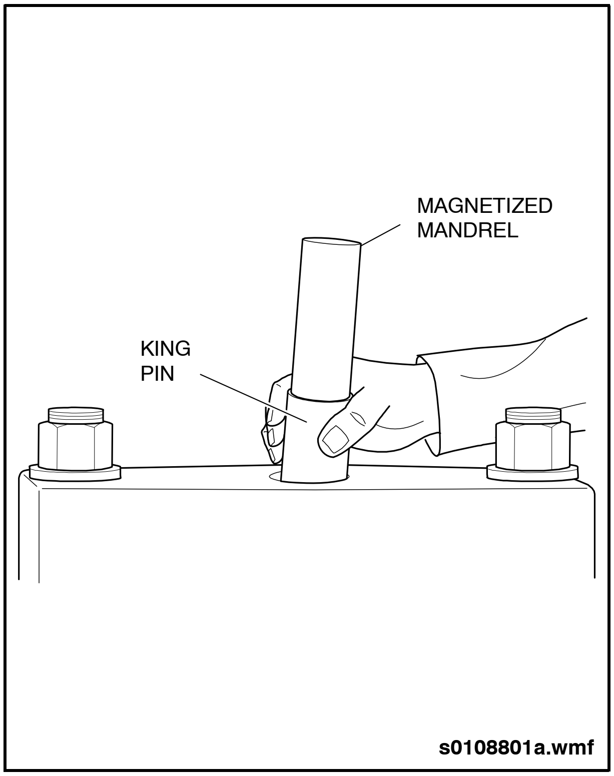


Fig. 1-25: King Pin Removal Tool

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. 1-26: Steering Knuckle Spacer Shim” on page 27.
    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. 1-28: King Pin Installation” on page 28.

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. 1-27: Thrust Bearing Sleeve Positioning Tool” on page 27.

10. Install upper and lower sealing washer with new O-ring into king pin bore and retain with circlip. See “Fig. 1-29: King Pin & Steering Knuckle Assembly” on page 29.

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.

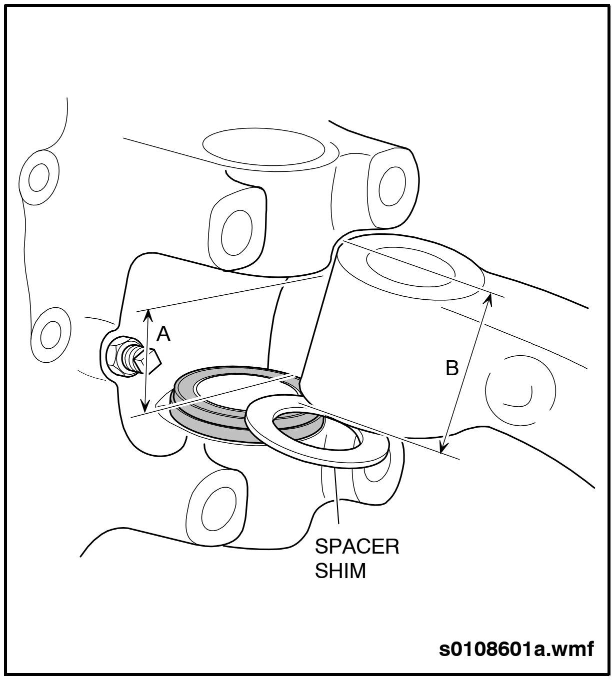


Fig. 1-26: Steering Knuckle Spacer Shim

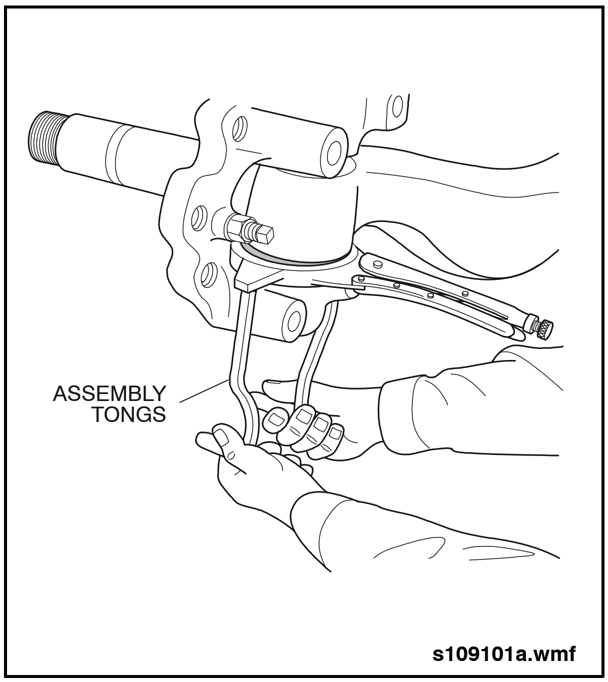


Fig. 1-27: Thrust Bearing Sleeve Positioning Tool

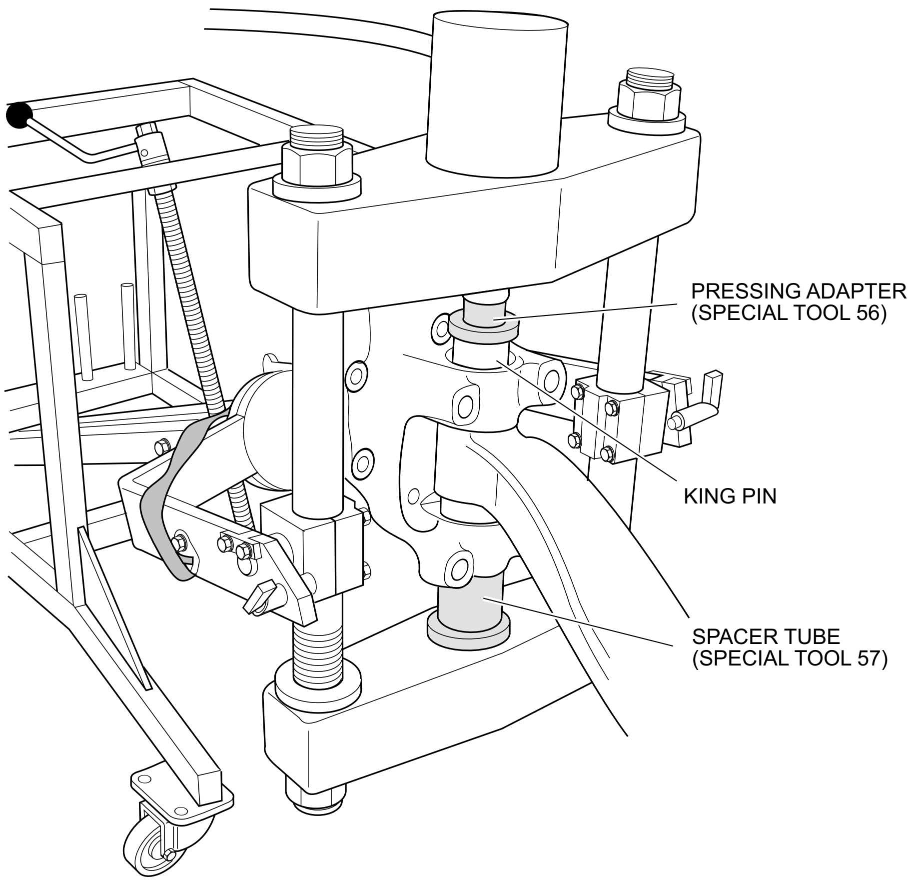
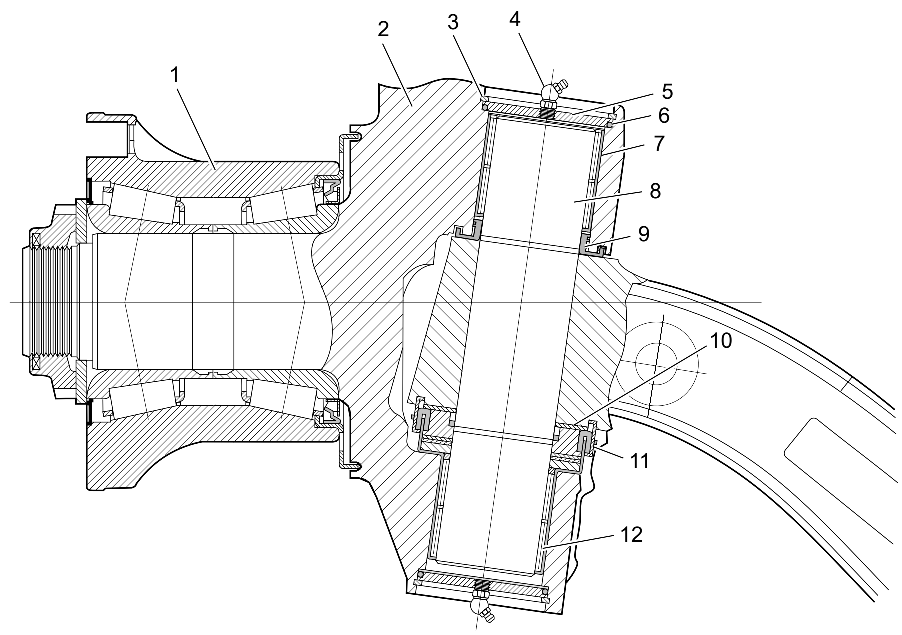


Fig. 1-28: King Pin Installation



1. Hub & Wheel Bearing Unit	5. Washer, Sealing	9. Seal
2. Steering Knuckle	6. O-Ring	10. Shim, Spacer
3. Circlip	7. Bearing, Needle	11. Sleeve, Dust Guard
4. Grease Nipple	8. King Pin	12. Needle & Thrust Bearing Assembly

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Fig. 1-29: 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. 1-30: King Pin Needle & Thrust Bearing Removal” on page 30.
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. 1-31: King Pin Needle Bearing Removal” on page 31.
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).

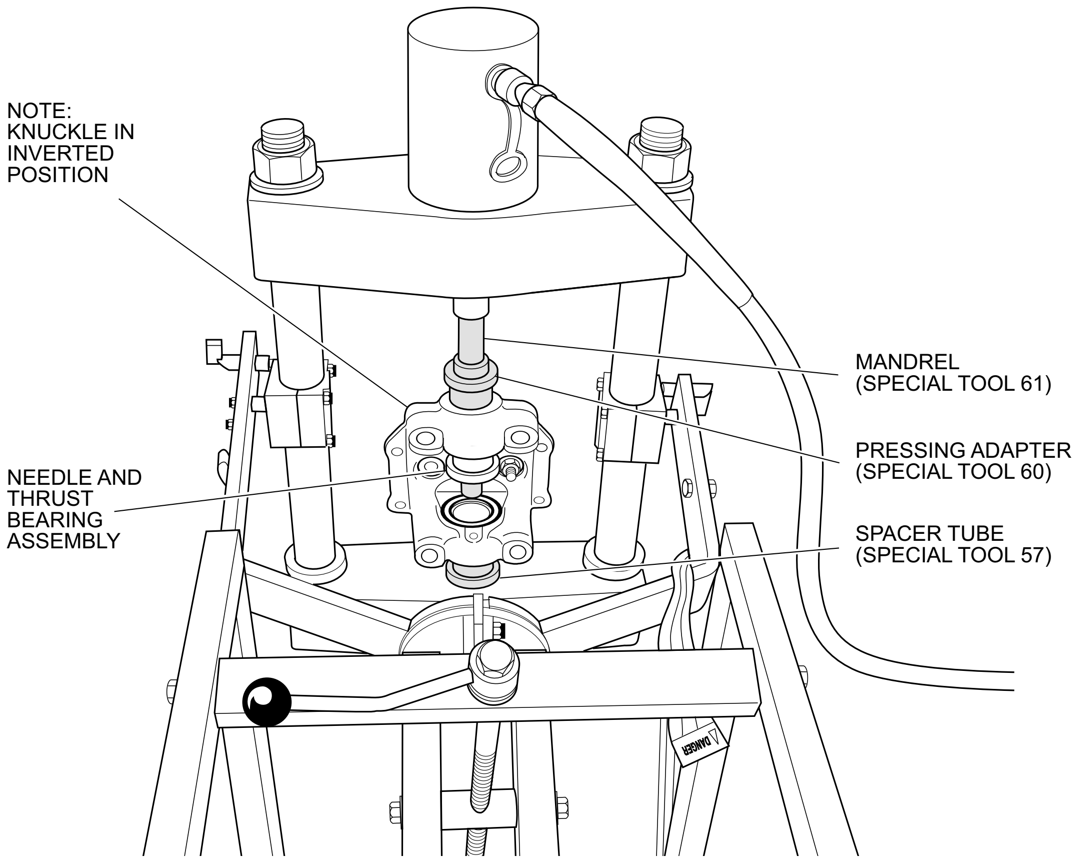


Fig. 1-30: King Pin Needle & Thrust Bearing Removal

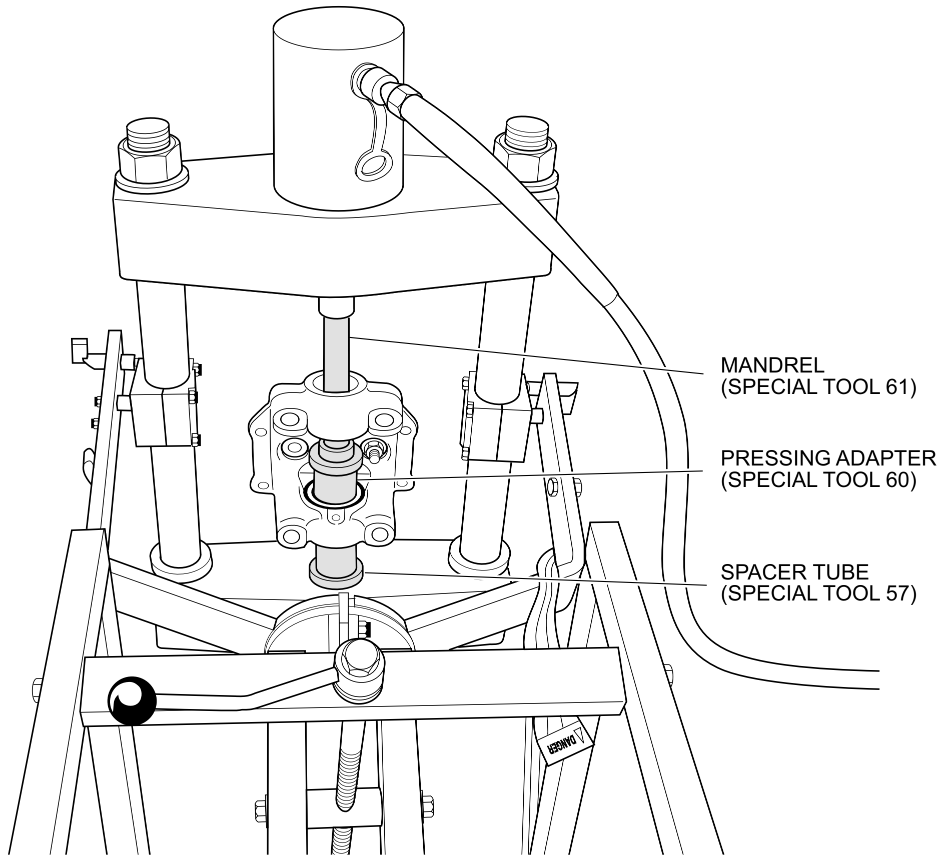


Fig. 1-31: King Pin Needle Bearing Removal

3.10.7. King Pin Bearing & Seal Installation

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. 1-32: King Pin Needle Bearing Installation” on page 32.
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. 1-33: King Pin Needle & Thrust Bearing Installation” on page 33.
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. 1-34: Steering Knuckle Seal Installation” on page 33.

☞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.

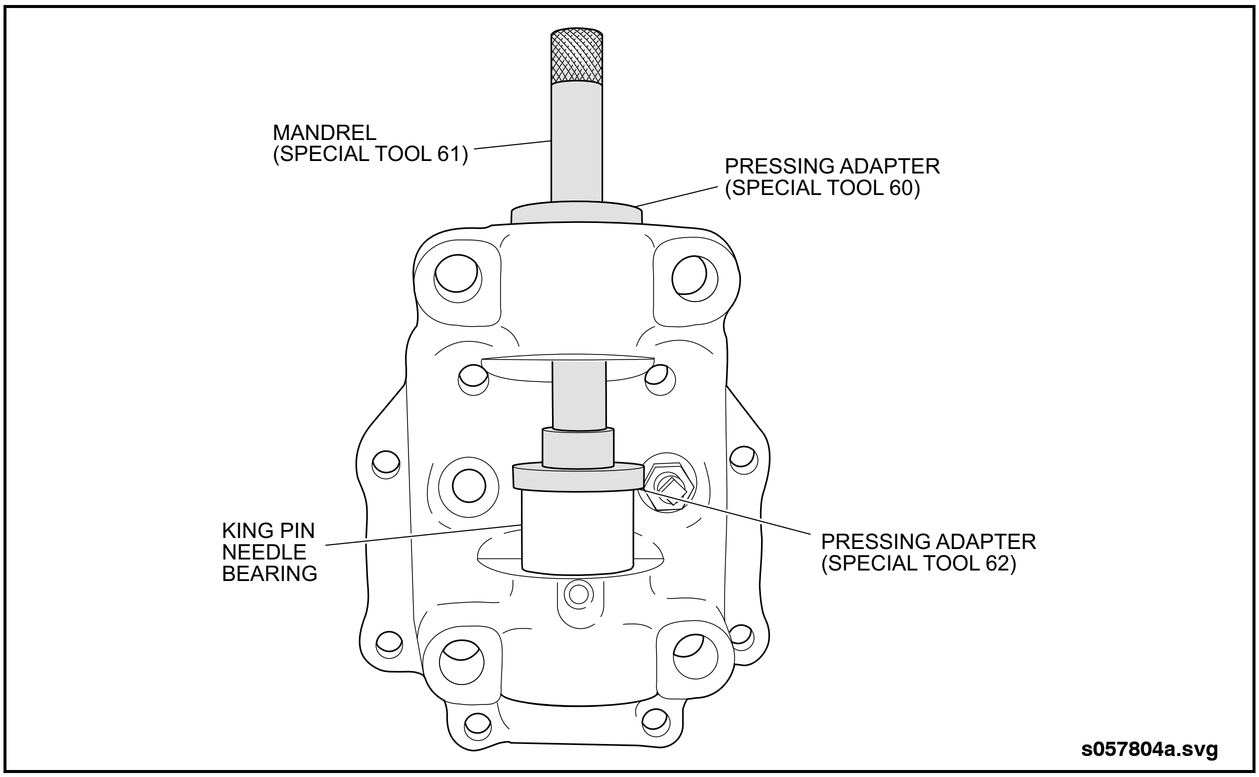


Fig. 1-32: King Pin Needle Bearing Installation

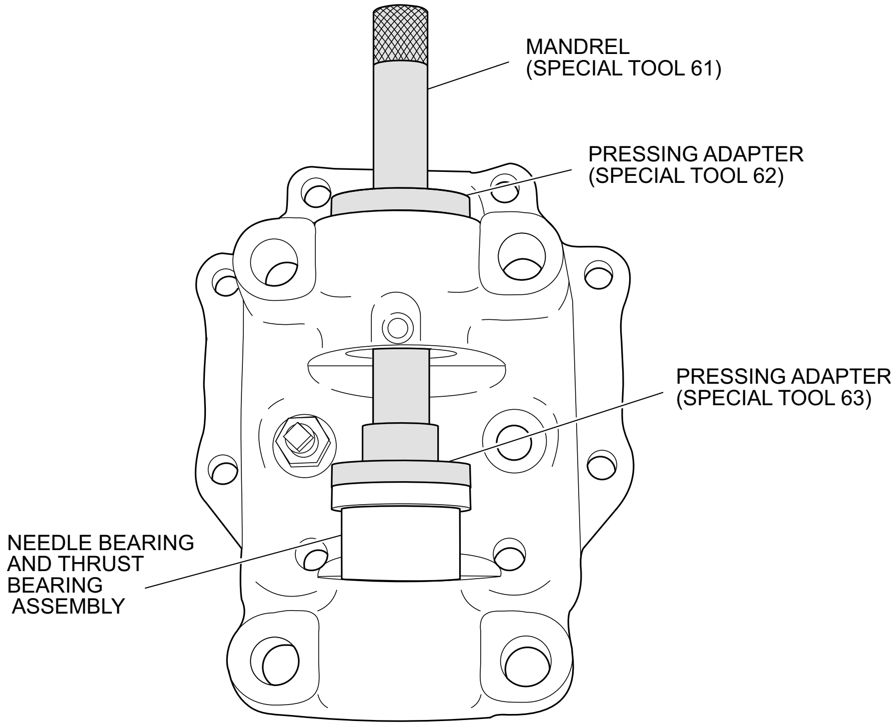


Fig. 1-33: King Pin Needle & Thrust Bearing Installation

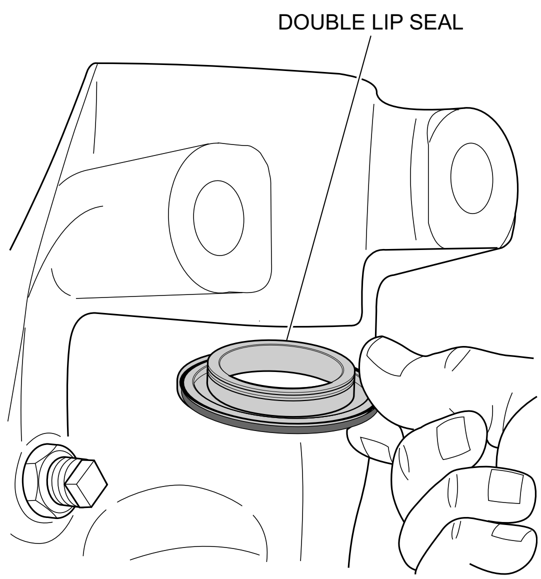


Fig. 1-34: Steering Knuckle Seal Installation

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

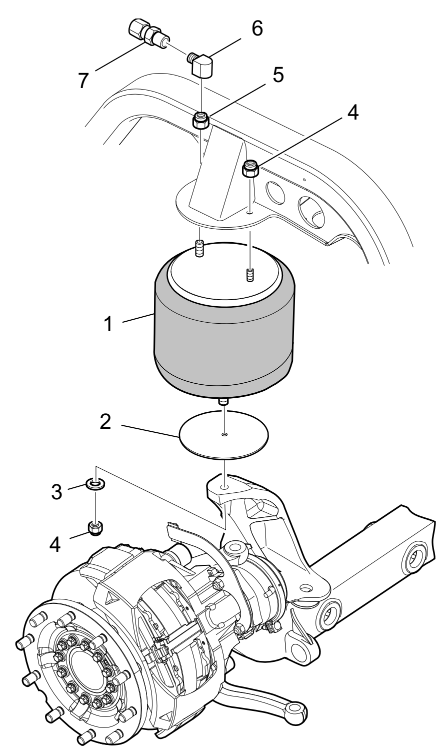
Model 1T15LP-5

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. 1-35: Front Air Spring Removal & Installation” on page 34.
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. 1-35: 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.

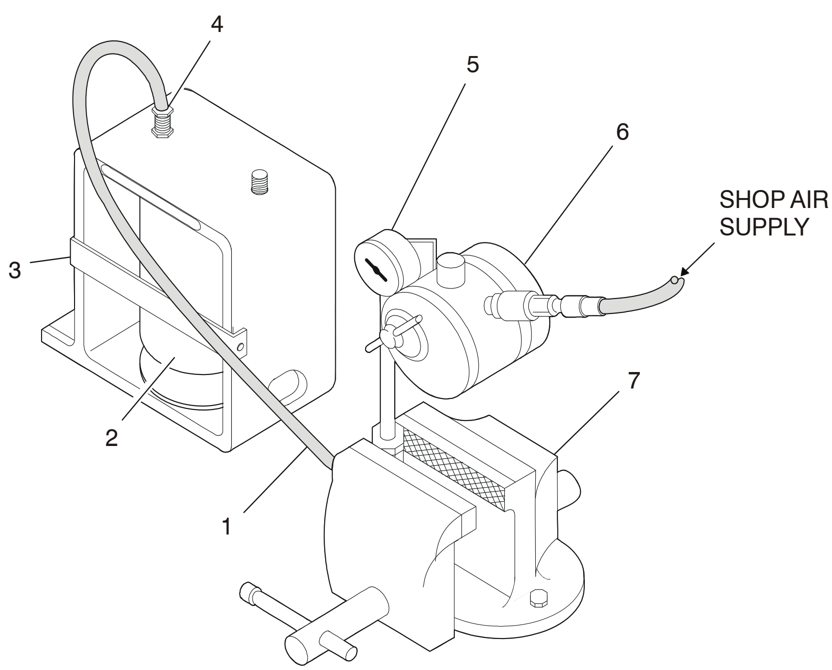
4.2.6. Cleaning & Inspection

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. 1-36: Leak Test Fixture” on page 35.

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. 1-36: Leak Test Fixture

4.2.8. Installation

☞**NOTE:**

Refer to 4.5. "Front Suspension Torque Specifications" on page 45 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.

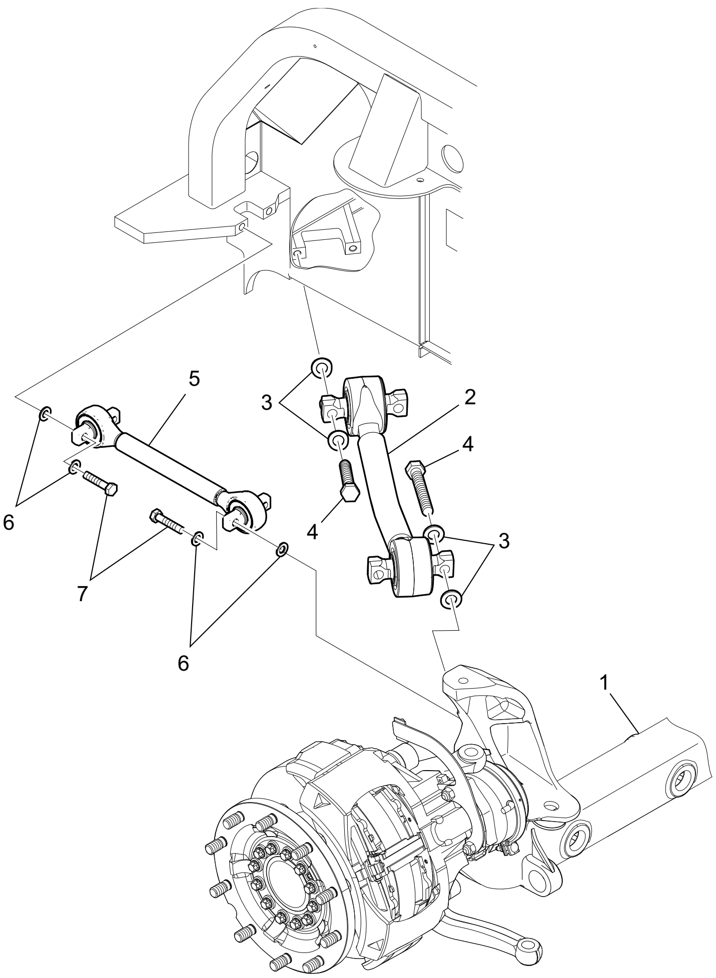
4.2.9. Functional Tests

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. 1-37: Upper & Lower Radius Rod Installation” on page 37.



1. Front Axle
2. Lower Radius Rod
3. Washer
4. Bolt
5. Upper Radius Rod
6. Washer
7. Bolt

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Fig. 1-37: 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. 1-38: Front Lower Radius Rod Bushing Replacement” on page 40.
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.

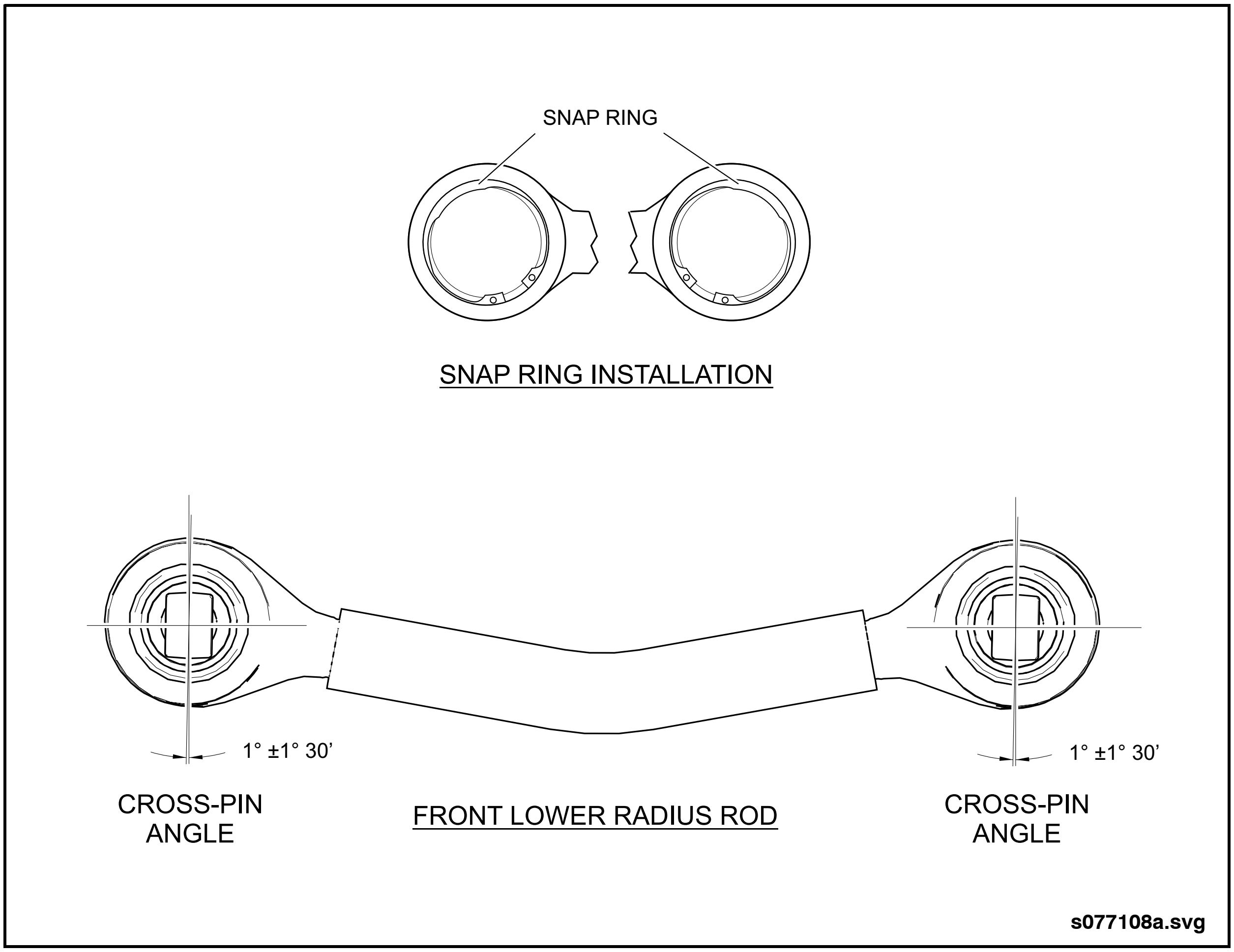


Fig. 1-38: Front Lower Radius Rod Bushing Replacement

4.3.9. Installation

NOTE:

Refer to 4.5. "Front Suspension Torque Specifications" on page 45 *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 43 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

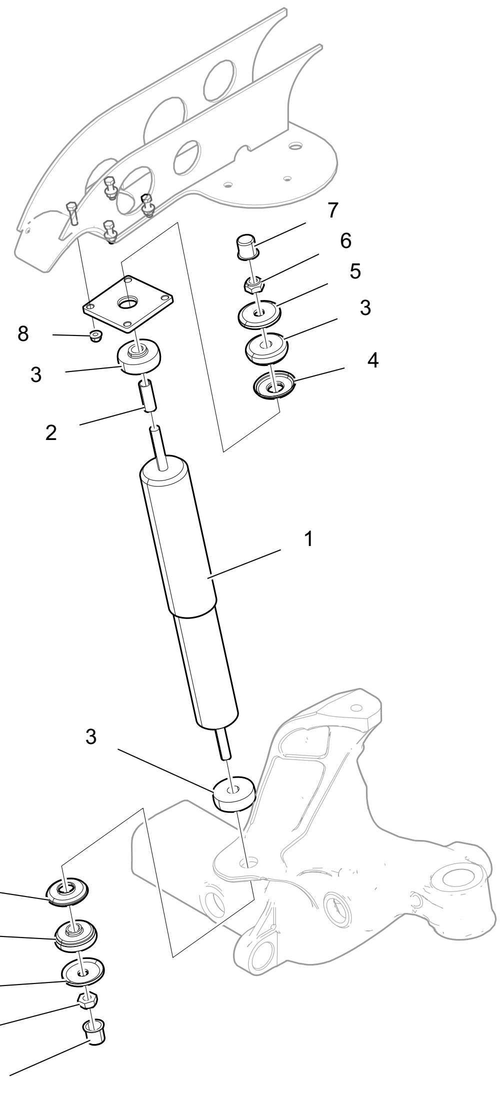
ALWAYS support the weight of the axle when replacing shock absorbers.

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. 1-39: Shock Absorber Installation” on page 42.
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. 1-39: 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. 1-40: Front Suspension Torque Points” on page 47.

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.

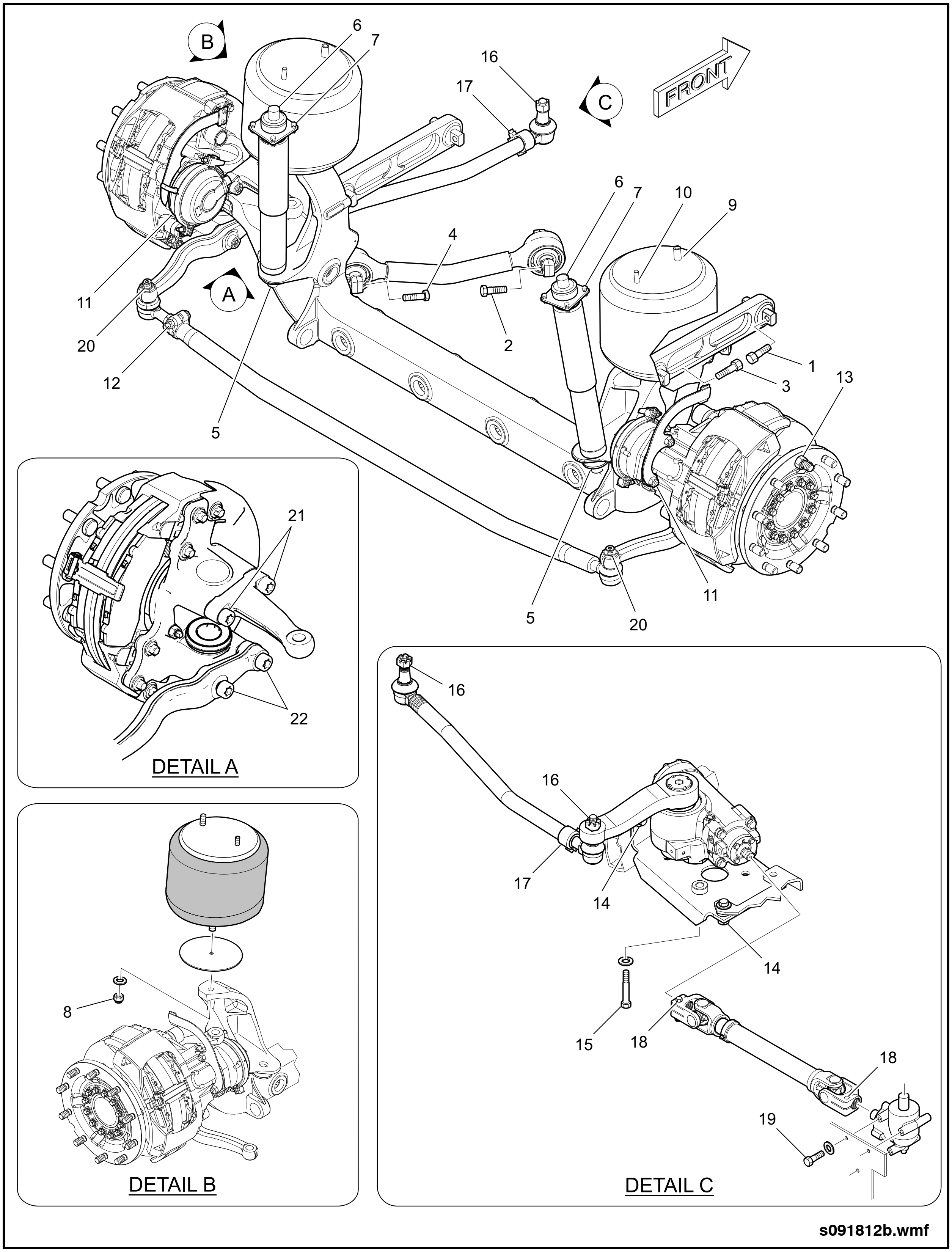


Fig. 1-40: Front Suspension Torque Points

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 48 in this section for information on the disc brakes. Refer to 5.3. “Front Brake Chambers” on page 74 in this section for information on the brake chambers. Refer to 6. “FRONT ANTI-LOCK BRAKING SYSTEM (ABS) & COMPONENTS” on page 81 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. 1-41: Disc Brake Assembly” on page 49.

5.2.2. Front Disc Brakes Specifications & Wear Limits

Manufacturer .... Knorr-Bremse

Model..SN 7000

Type.................. Air-actuated sliding caliper

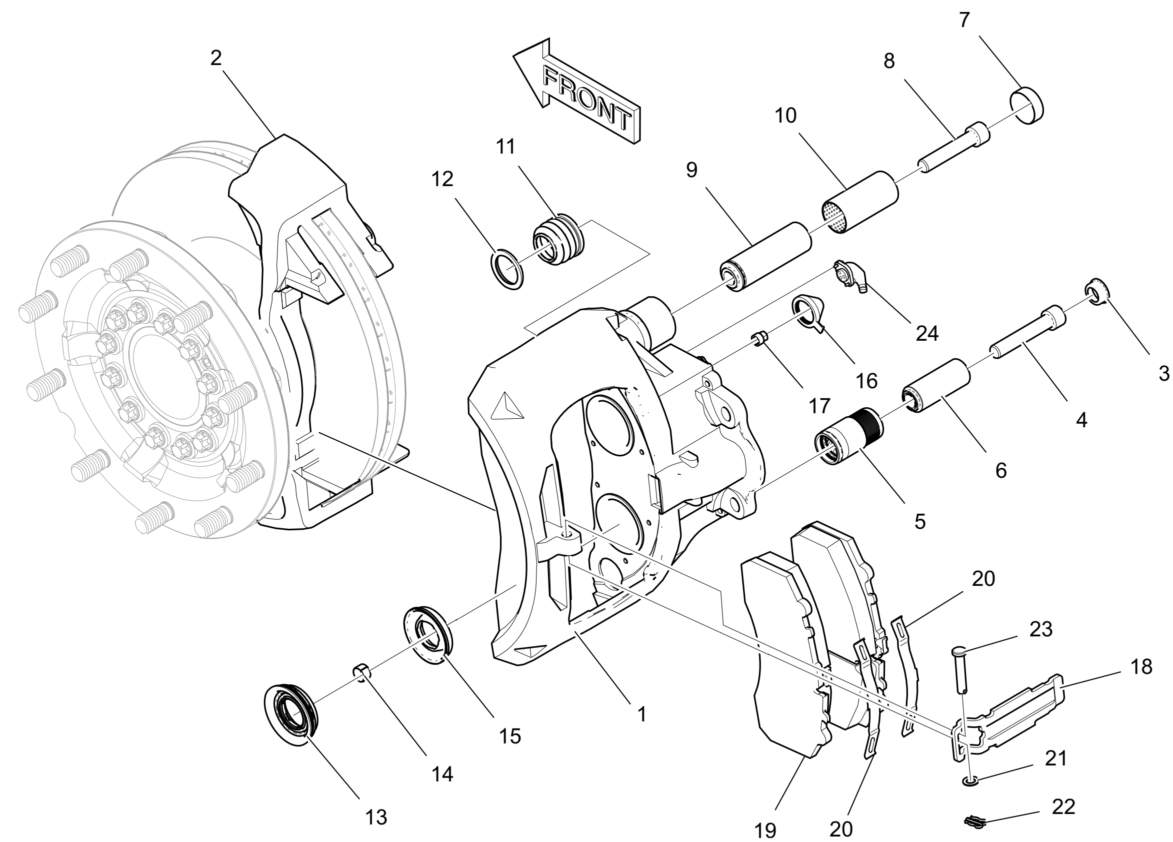
Brake pad clearance
.............0.024 to 0.043" (0.6 to 1.1 mm)

Brake pad thickness (min)
....0.08" (2.0 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. 1-41: Disc Brake Assembly

5.2.3. Operation

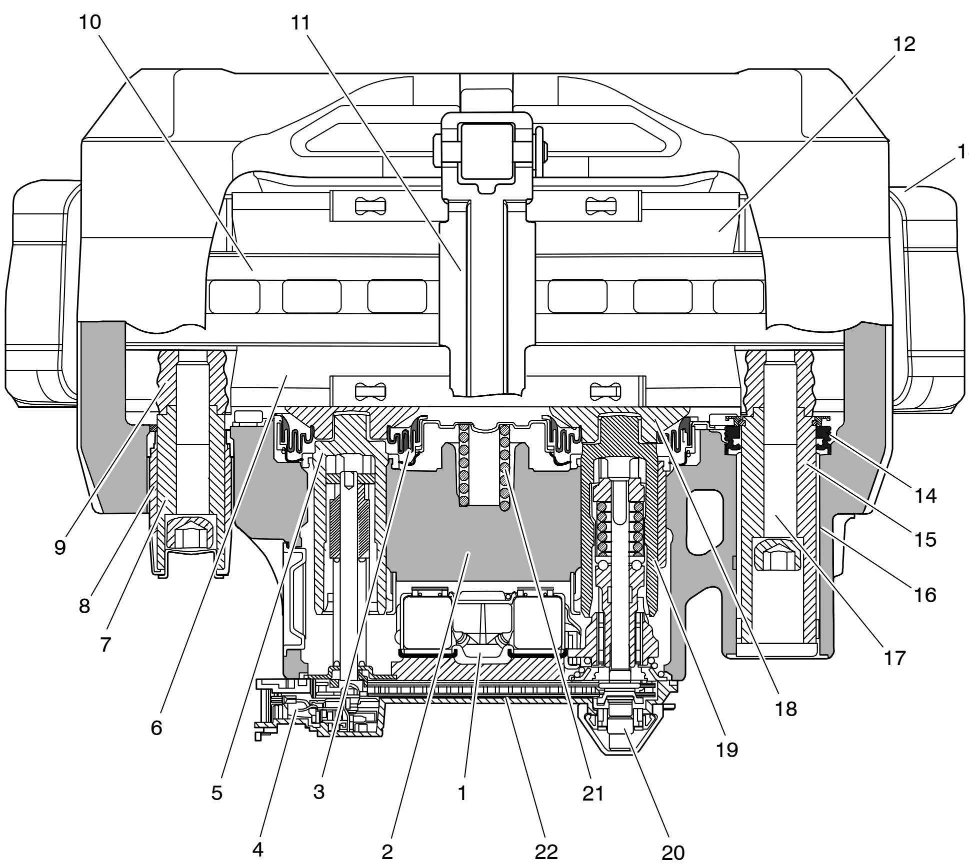
☞**NOTE:**

When reviewing the following information on operation of the disc brake assembly See “Fig. 1-42: Disc Brake Cross Section” on page 51.

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.



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. 1-42: Disc Brake Cross Section

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.

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. Jack up the axle and remove the wheel.
5. Check the brake disc temperature; it should be between 14°F and 122°F (-10°C and 50°C).
6. 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 65 in this section for procedure. Once movement is obtained, continue to step 8.
7. Pull off the adjuster cap using the tag, taking care not to lose the shear adapter.

CAUTION

Removal of the adjuster cap with a screwdriver, or similar tool, is not allowed. Damage to the seal may result.

8. Insert new brake pads. Refer to 5.2.5. “Brake Pads” on page 59 in this section for procedure.
9. 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.

10. Apply the brakes 20 times with medium pressure (approximately 30 to 40 psi (2-3 bar).
11. Check the gap between each of the tappets and inboard pad backplate. 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).
    a. If the gap difference between the two tappets is > 0.25 mm then the caliper guide pin clearance must be checked. Refer to 5.2.4.4. “Caliper Guide Pin Inspection” on page 56 in this section for procedure.
    b. In addition each gap must measure between 0.6 to 1.2 mm.

CAUTION

If the clearance is too great, there is a danger of brake failure. If the clearance is too small, there is a danger of overheating that may lead to consequential damage.

12. 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.

NOTE:

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.

13. Lightly grease the contact surface of the cap with white grease.

NOTE:

A new adjuster cap should be fitted even if the brake pads are not being replaced.

14. The tag of the adjuster cap should be positioned to ensure access is maintained for subsequent removal.

15. 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 of the brake chamber.

    b. Remove brake chamber. Refer to 5.3. “Front Brake Chambers” on page 74 for procedure.

    c. Check position of lever inside the caliper in its released state.

    d. Remove 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.

16. Check caliper running clearance. Refer to 5.2.4.4. “Caliper Guide Pin Inspection” on page 56 in this section for procedure.

17. Install the brake pads. Refer to 5.2.5. “Brake Pads” on page 59 in this section for procedure.

18. Install the brake chamber. Refer to 5.3. “Front Brake Chambers” on page 74 in this section for procedure.

19. Recheck the adjuster.

20. If the air gap is still smaller than 0.6 mm between both tappets, the brake carrier must be replaced.

21. Install the wheel.

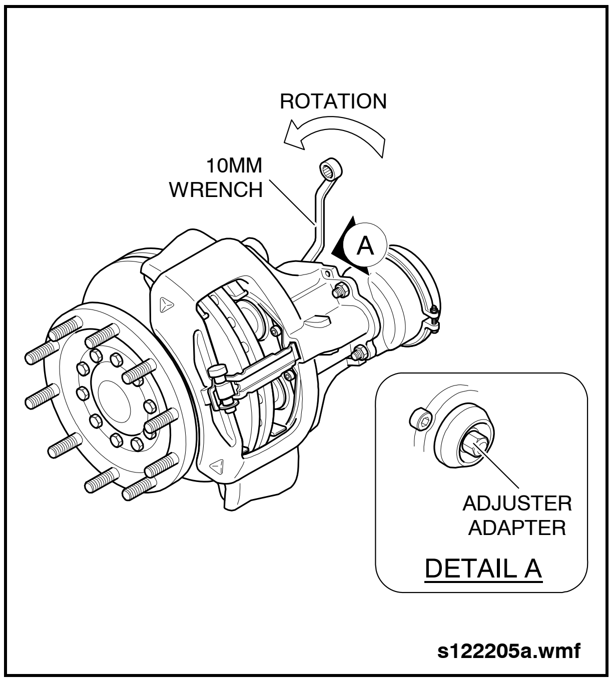


Fig. 1-43: Checking Adjuster Movement

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 indicates a worn brake pad condition. See "Fig. 1-44: Brake Pad Wear Inspection" on page 54.
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 59 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 55 in this section for procedure.

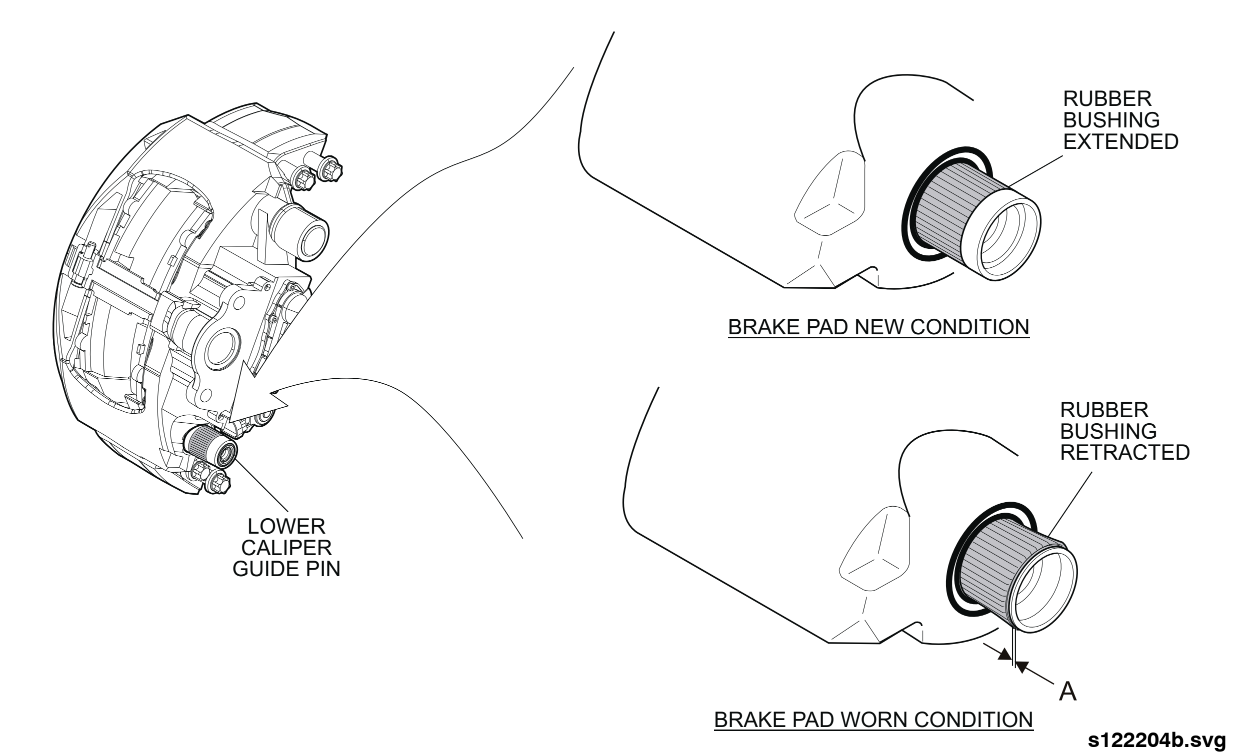


Fig. 1-44: Brake Pad Wear Inspection

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. 1-45: Rotor Run-Out Measurement Point” on page 55.

   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 72 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. 1-46: Brake Disc Condition” on page 56.

   a. Minor web-like cracks on the braking surface are acceptable. Refer to area “A” shown on illustration.

   b. Cracks less than 0.059" (1.5 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.

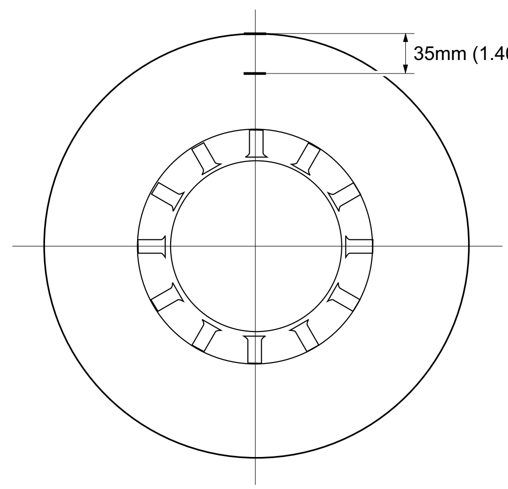


Fig. 1-45: Rotor Run-Out Measurement Point

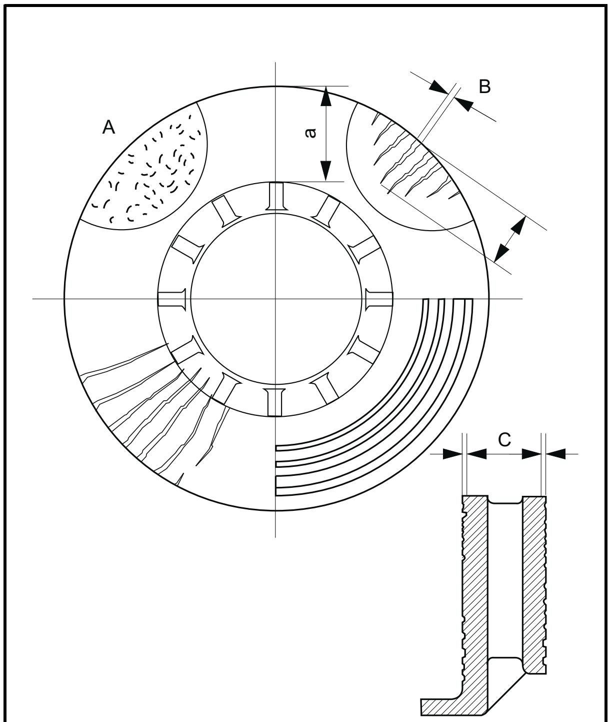


Fig. 1-46: Brake Disc Condition

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 59 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 54 *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 grease to guide pin.
4. Push the caliper inward fully the 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. Mount a dial indicator (Items 29 & 69 from special tools list) on the short bearing side of the carrier with the indicator tip resting on the brake caliper. Zero the dial gauge. See “Fig. 1-47: Measuring Guide Pin Play” on page 57.
   c. Apply pressure to the brake caliper in an upward direction and read the dial gauge. Replace guide pins if reading exceeds 0.079" (2.0 mm). Refer to 5.2.7. “Caliper Guide Pins” on page 65 in this section for replacement procedure.

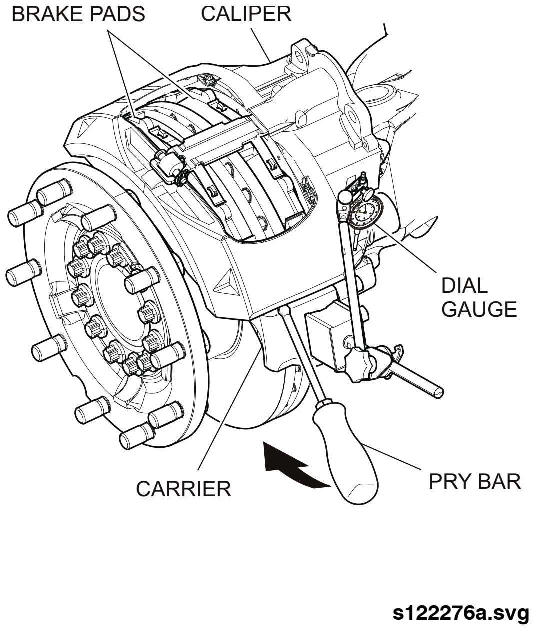


Fig. 1-47: Measuring Guide Pin Play

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 59 in this section for removal procedure
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 a proper visual inspection. See “Fig. 1-48: Tappet & Rubber Boot Inspection” on page 58.
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 69 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 69 in this section for replacement procedure.

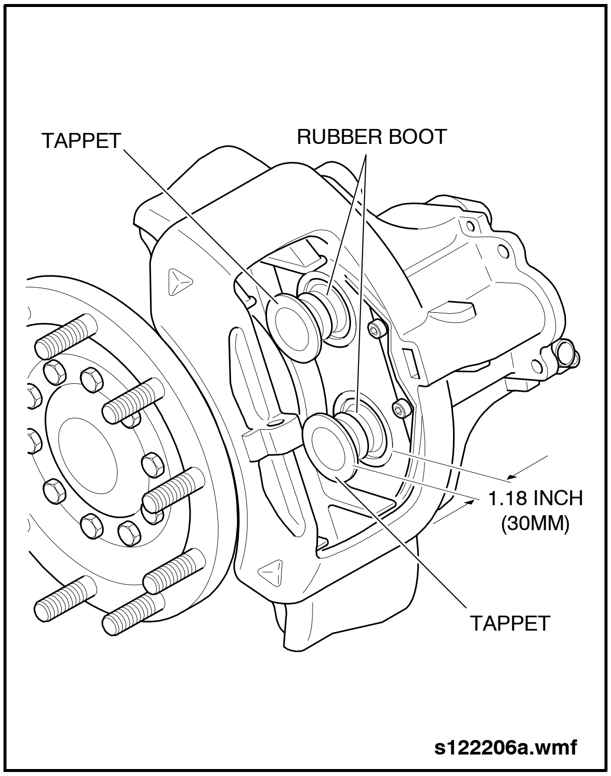


Fig. 1-48: Tappet & Rubber Boot Inspection

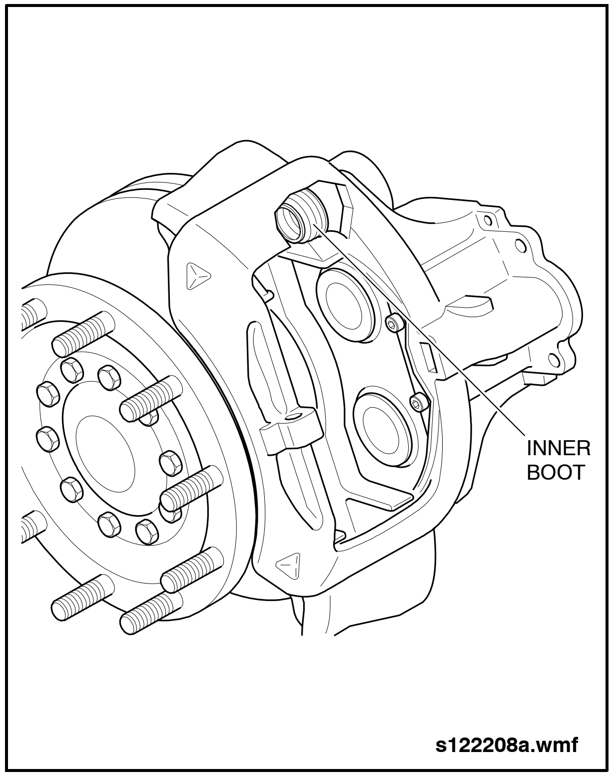


Fig. 1-49: Upper Guide Pin Inner Boot Inspection

5.2.4.6. Upper Guide Rubber Boot Inspection

1. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 59 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. 1-49: Upper Guide Pin Inner Boot Inspection” on page 58.
3. Inspect the rubber boot for cracks, tears, wear, or deterioration. Replace as necessary. Refer to 5.2.7. “Caliper Guide Pins” on page 65 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.

☞NOTE:

Each brake pad contains End Of Life (EOL) wear sensors and wiring harness. The sensor harness mounting and protection components must be removed first before removing the brake pads from the caliper.

4. Remove the wear sensor harness protection plate from the brake pad retainer. See “Fig. 1-50: Wear Sensor Harness Routing” on page 59.
5. Unclip the wear sensor harness from the guide and move harness out of the way of brake pad retainer.
6. Remove the bolt and nut holding the wear sensor cable extension to the bracket on the brake caliper. See “Fig. 1-51: Wear Sensor Cable Extension Removal” on page 60.
7. 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.

☞NOTE:

The wear sensor guide is clipped onto the brake pad retainer and may unclip during disassembly.

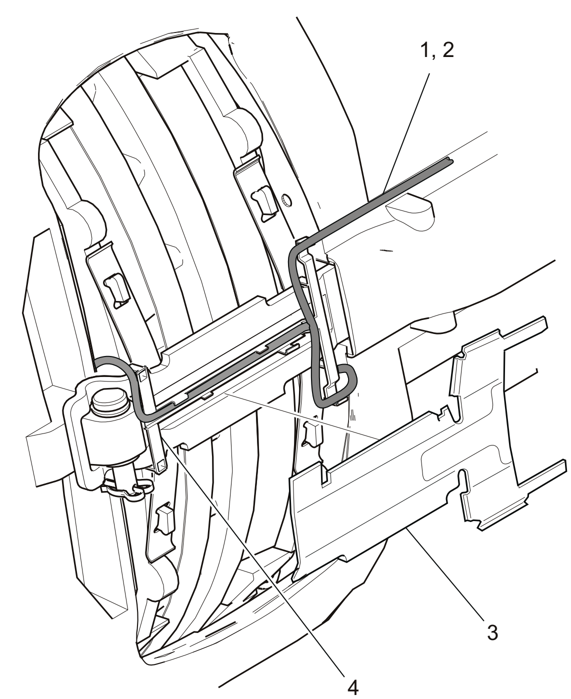
8. Carefully pry out the wear indicator from each brake pad and move wear sensor harness away from the caliper.
9. Increase brake pad clearance as follows:
   a. Remove the protective cover from the adjuster by using the pull tab. Do not use a screwdriver to pry off the cap, otherwise the seal could be damaged. See “Fig. 1-52: Brake Pad Removal” on page 60.

⚠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.

10. Remove the brake pads from the caliper.



1. Kit, Brake Pad Wear Indicator Sensor (Incl. 2...4)
2. Sensor, w/Heatshrink
3. Protection Plate
4. Guide

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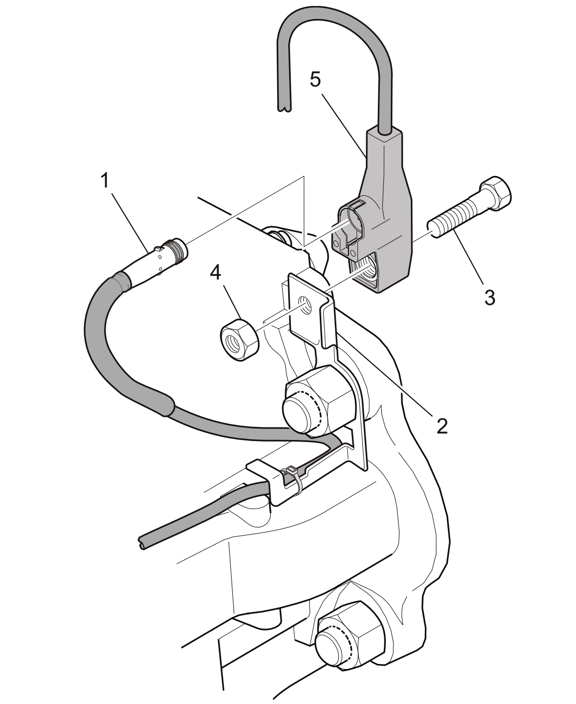
Fig. 1-50: Wear Sensor Harness Routing



1. Cable, Wear Indicator Sensor
2. Retaining Plate
3. Bolt, Hex M8
4. Nut, Hex M8
5. Cable, Extension

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Fig. 1-51: Wear Sensor Cable Extension Removal

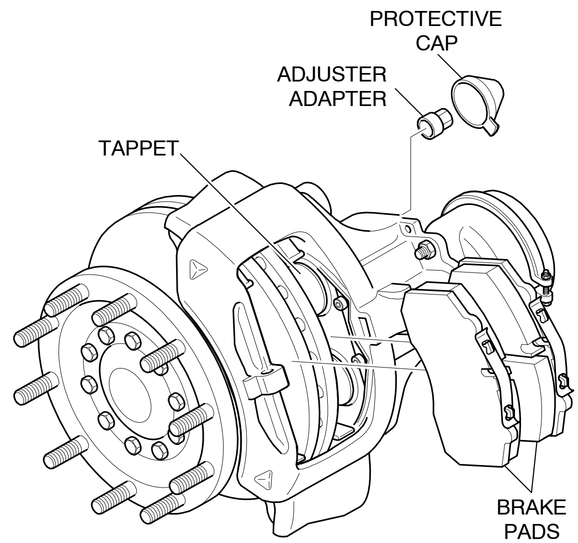

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Fig. 1-52: Brake Pad Removal

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 69 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. 1-53: Areas to Apply Lubricant" on page 61. *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. 1-54: Brake Pad Installation" on page 62.
2. Pull the brake caliper outward against the stop and insert the outboard brake pad.
3. Insert the wear sensor cable into the groove of each pad. The wear indicators snap into place in the holes in the pad material.

☞**NOTE:**

Ensure that the longer end of the wear sensor harness is inserted into the outboard brake pad.

☞**NOTE:**

The wear sensor cable should be replaced any time a brake wear condition has been detected. Typically the wear sensor will be abraded and damaged whenever it triggers a worn brake pad condition. It is also recommended that the wear sensor cable be replaced whenever the disc brake pads are renewed.

4. 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. 1-55: Brake Pad Retainer Installation" on page 62.
   b. Insert new retaining pin and secure with new washer and spring clip.
5. Attach the wear sensor harness guide to the brake pad retainer and clip the sensor harness to secure it.
6. Install the wear sensor harness protection plate onto the brake pad retainer.
7. Attach the wear sensor harness to the brake caliper using the original mounting bolt and nut. Apply medium strength threadlocker, such as Loctite242, to the threads of the nut.

☞**NOTE:**

If the round sensor connector between the wear sensor harness and the extension harness is unplugged during the removal procedure, check that the rubber seal is not damaged or deformed. Ensure the wear sensor connector is properly pushed into the cable extension connector upon re installation. The cable extension connector has locking tabs which lock in position when the sensor's plug is inserted correctly.

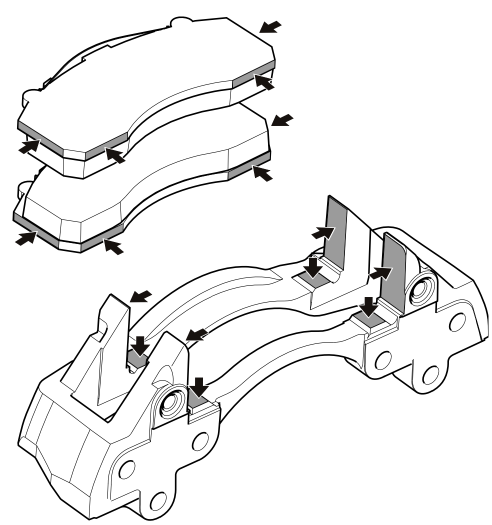

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Fig. 1-53: Areas to Apply Lubricant

CAUTION

A damaged seal or improperly seated connector will not provide a watertight seal between the sensor connector and the extension cable connector. Penetration of water can lead to corrosion on connector pins and cause sensor failure.

8. 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 0.024 to 0.047" (0.6 to 1.2 mm).
9. Lower the vehicle and perform road test to verify satisfactory operation of the brakes.

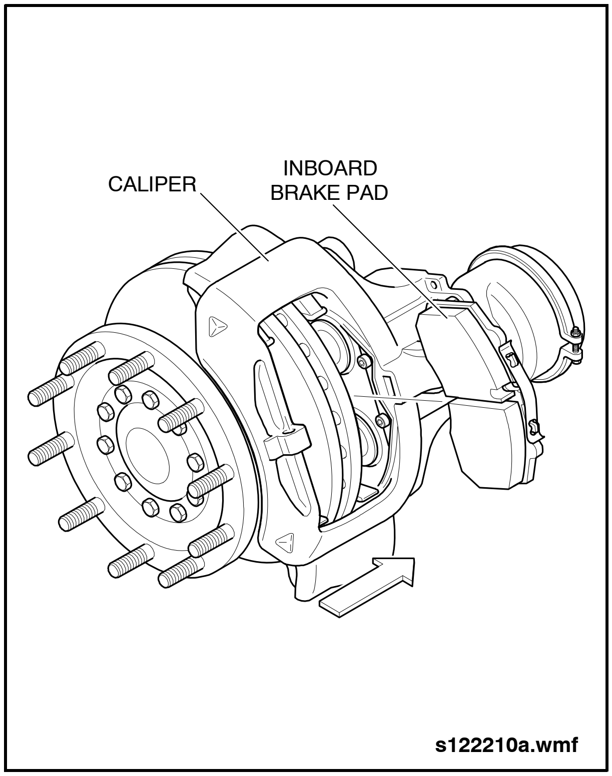


Fig. 1-54: Brake Pad Installation

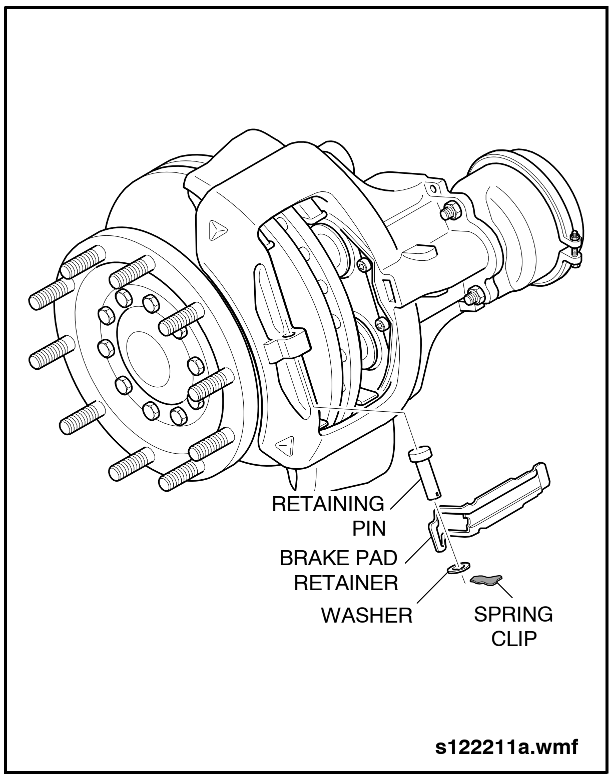


Fig. 1-55: Brake Pad Retainer Installation

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 74 in this section for removal procedure.
5. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 59 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. 1-56: Brake Caliper Removal” on page 63.
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.

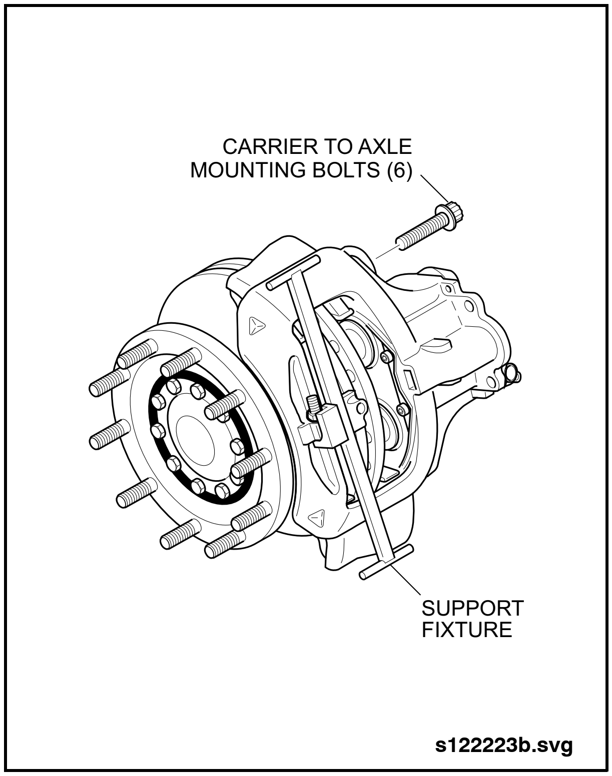


Fig. 1-56: Brake Caliper Removal

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-lbs. (250 Nm), then final torque to 288 ft-lbs. (390 Nm).
3. Remove the supporting fixture (Item 1 from special tools list).

   ☞**NOTE:**

   Reinstall tie rod arm using two new self locking 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. Install brake pads. Refer to 5.2.5. “Brake Pads” on page 59 in this section for installation procedure.
5. Install brake chamber. Refer to 5.3. “Front Brake Chambers” on page 74 in this section for installation procedure.
6. Install tire and wheel assembly
7. 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. “Front Brake Chambers” on page 74 in this section for removal procedure.
2. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 59 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. 1-57: Brake Caliper Guide Pin Removal” on page 66.
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. 1-58: Brass Bushing Removal” on page 66.
    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. 1-59: Rubber Bushing Removal” on page 66.
    b. Pull the bushing out of the caliper.

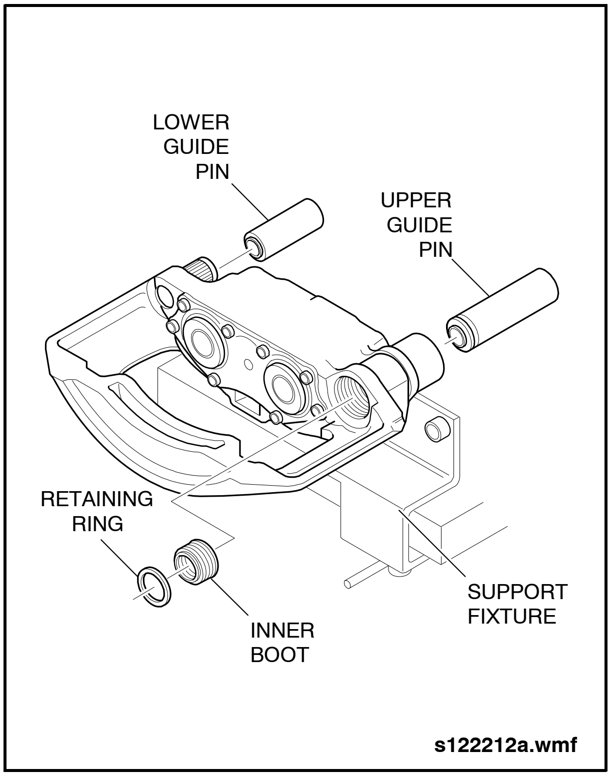


Fig. 1-57: Brake Caliper Guide Pin Removal

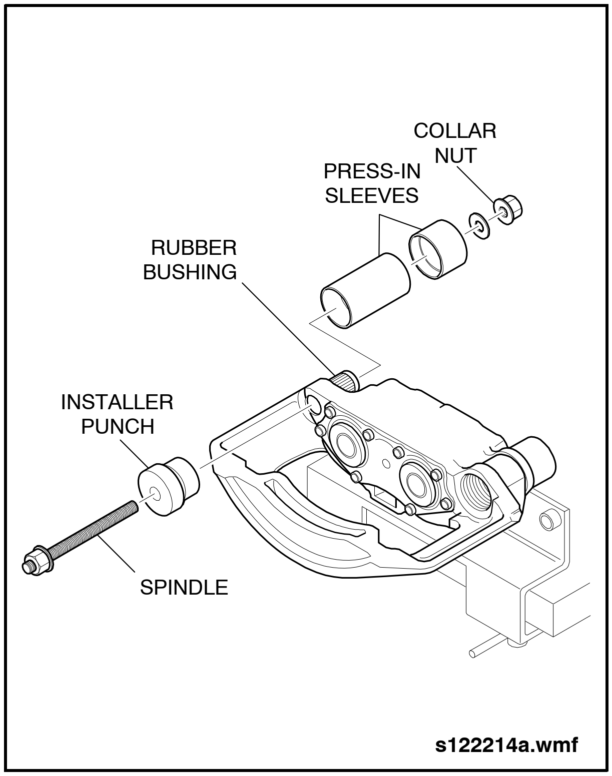


Fig. 1-59: Rubber Bushing Removal

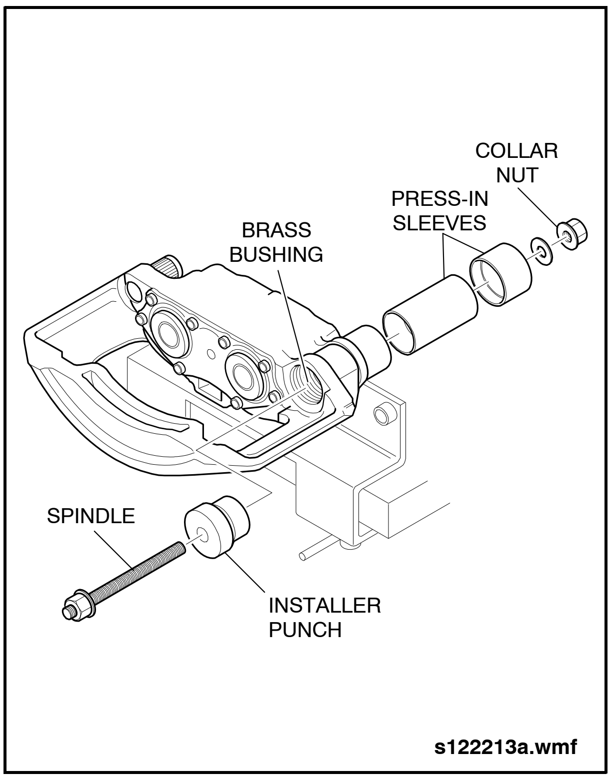


Fig. 1-58: Brass Bushing Removal

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. 1-60: Rubber Bushing Installation" on page 68.
   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. 1-61: Brass Bushing Installation" on page 68.
   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. 1-62: Indenting Tool Installation" on page 68.
   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. 1-63: Inner Boot Installation" on page 68.
   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. 1-64: Protective Cover & Cap Installation" on page 69.
11. Install the brake pads. Refer to 5.2.5. "Brake Pads" on page 59 in this section for removal procedure.
12. Install the brake chamber. Refer to 5.3. "Front Brake Chambers" on page 74 in this section for removal procedure.

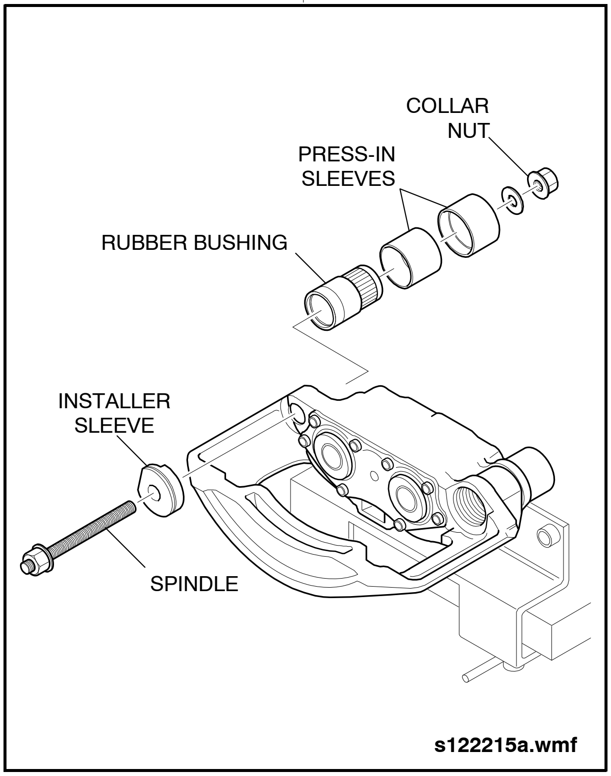


Fig. 1-60: Rubber Bushing Installation

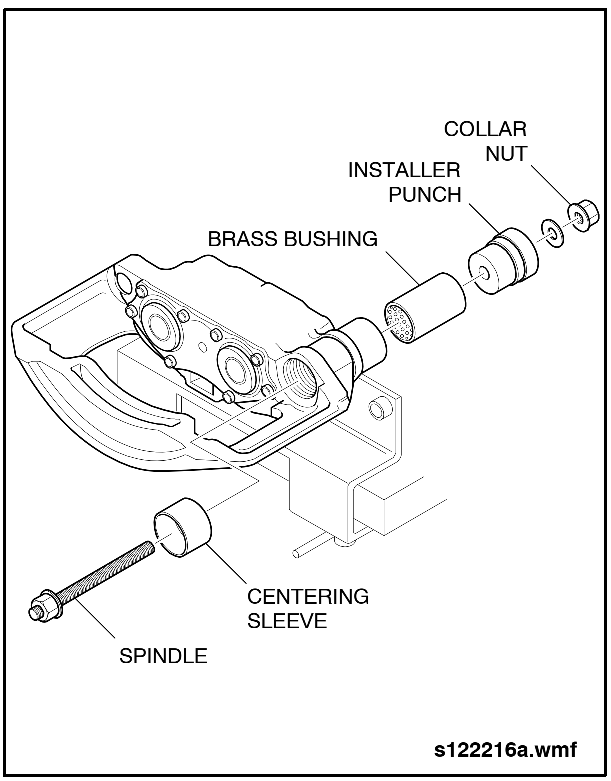


Fig. 1-61: Brass Bushing Installation

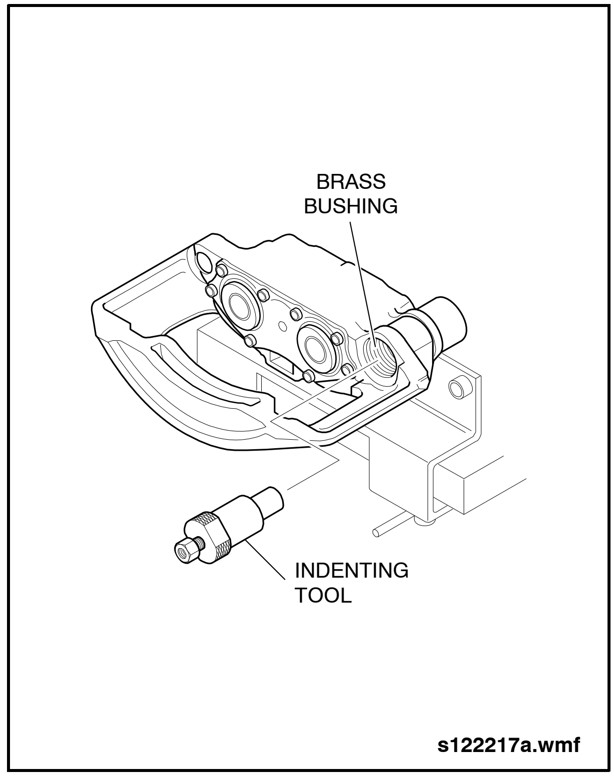


Fig. 1-62: Indenting Tool Installation

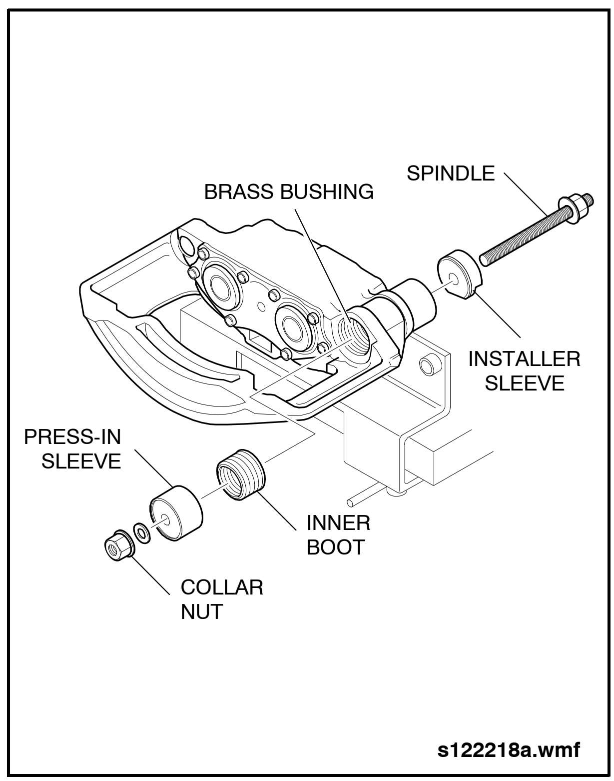


Fig. 1-63: Inner Boot Installation

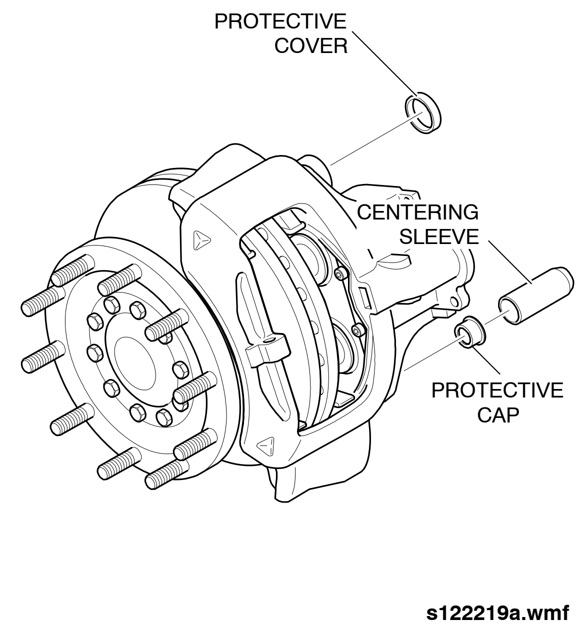


Fig. 1-64: Protective Cover & Cap Installation

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 59 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. 1-65: Unscrewing Tappets” on page 70.
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. 1-66: Removing Tappets” on page 70.
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. 1-67: Removing Inner Seal” on page 70.
8. Remove the bushing from the end of the threaded sleeve.

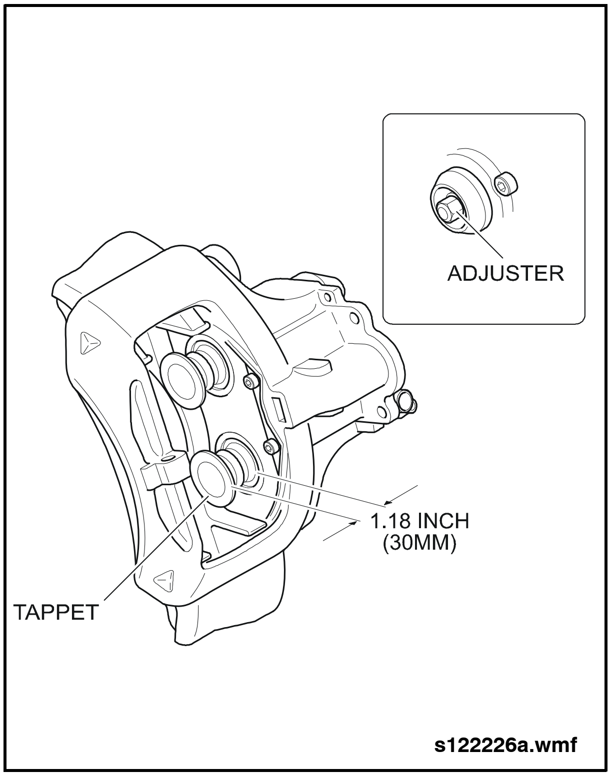


Fig. 1-65: Unscrewing Tappets

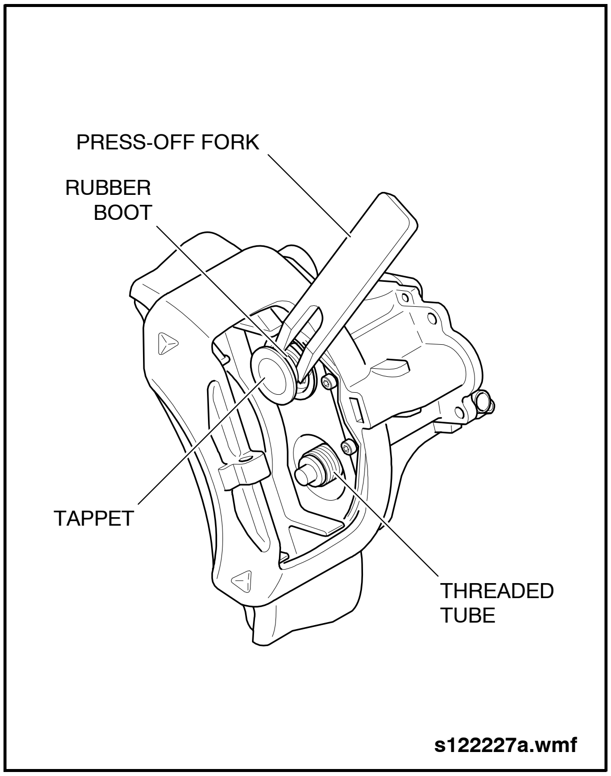


Fig. 1-66: Removing Tappets

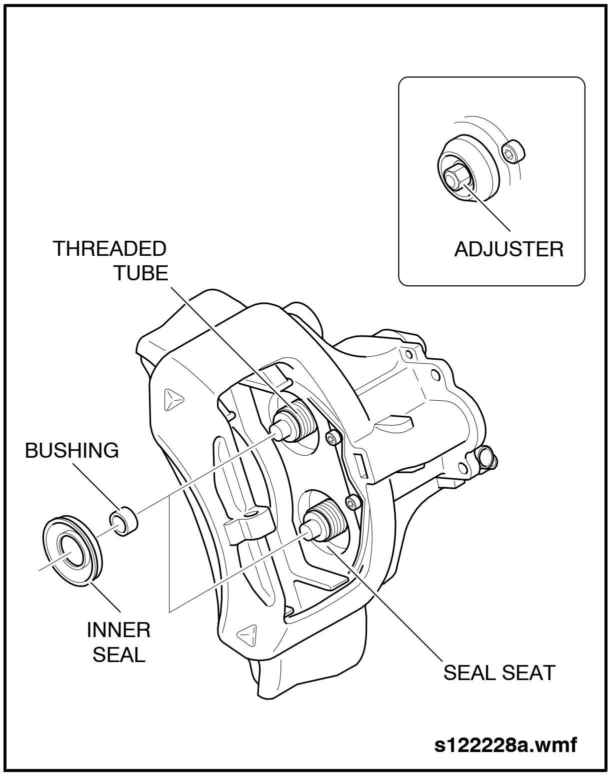


Fig. 1-67: Removing Inner Seal

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. 1-68: Inspecting Threaded Tubes” on page 71.
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.

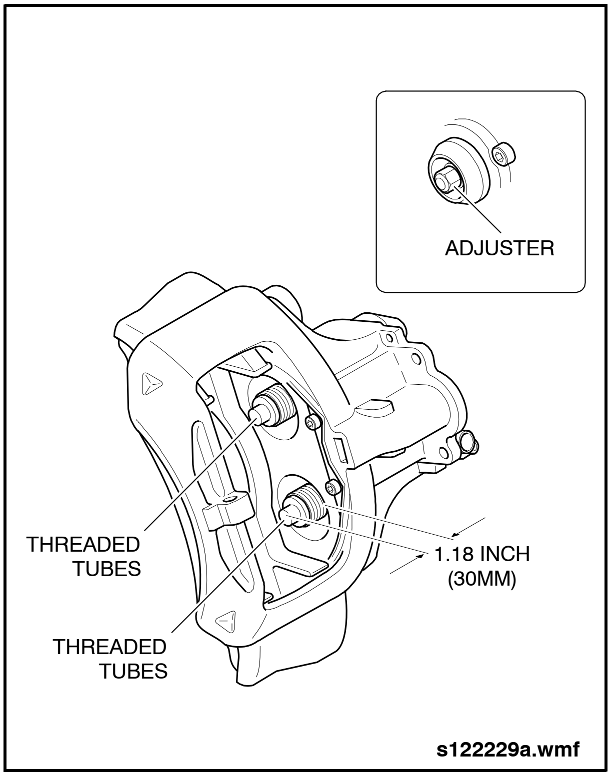


Fig. 1-68: Inspecting Threaded Tubes

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. 1-69: Installing Inner Seal” on page 72.
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:

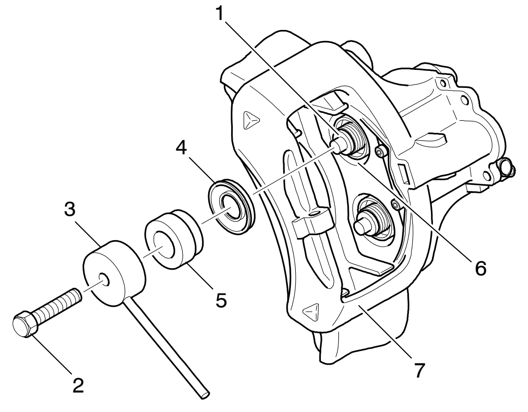
The inner seal must not turn.

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. 1-70: Installing Tappet & Rubber Boot” on page 72.
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. 1-71: Seating Tappet Against Stop” on page 72.
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 59 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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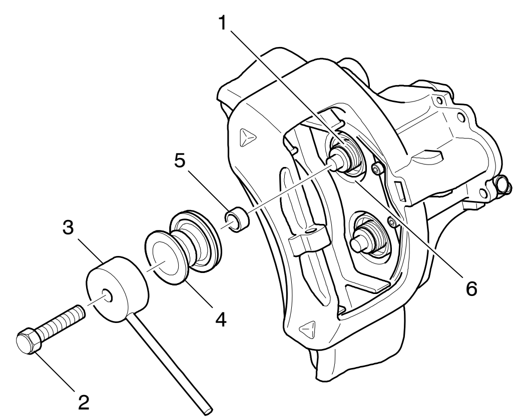
Fig. 1-69: Installing Inner Seal



1. Threaded Tube
2. Forcing Bolt
3. Installer Sleeve
4. Tappet & Rubber Boot
5. Bushing
6. Seal Seat

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Fig. 1-70: Installing Tappet & Rubber Boot

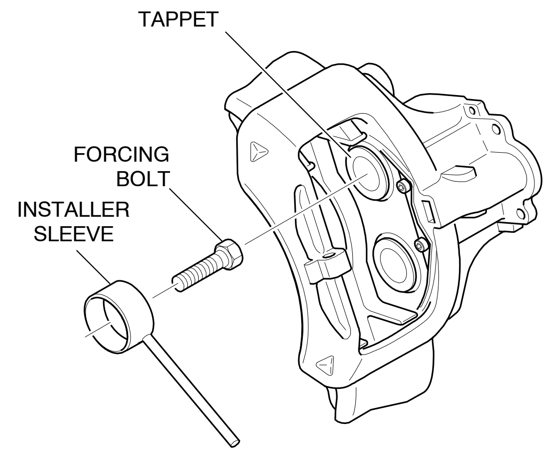

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Fig. 1-71: Seating Tappet Against Stop

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 59 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 63 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. 1-72: Brake Disc Removal” on page 73.
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.

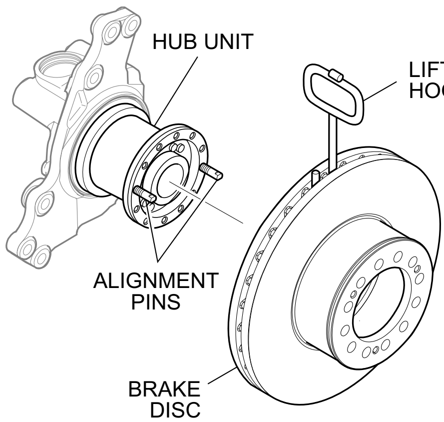


Fig. 1-72: Brake Disc Removal

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 14 in this section for procedure.

5.2.9.3. Machining

CAUTION

DO NOT machine the brake disc to less than 1.575" (40 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 59 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 1.575" (40 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.

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. 1-73: Front Brake Chamber Removal & Installation” on page 75.
7. Place a protective cover over the brake caliper to prevent entry of contaminants.

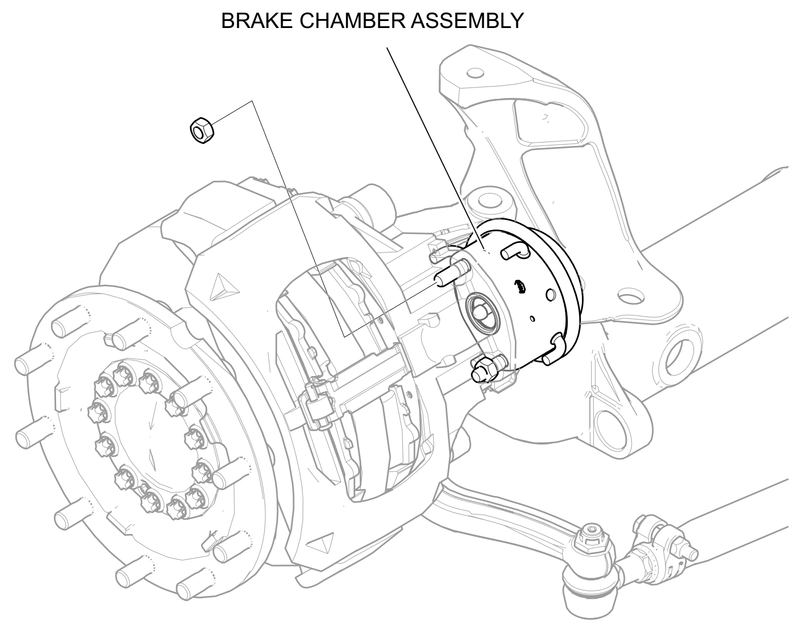


Fig. 1-73: Front Brake Chamber Removal & Installation

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. 1-74: Front Brake Chamber ESP Sensor Pack” on page 77.

   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 and ESP sensor pack must be replaced as an assembly.

   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 and caliper mounting surfaces. 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.
5. Install new M16 lock nuts and torque to specification. Refer to 4.5. “Front Suspension Torque Specifications” on page 45 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 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.

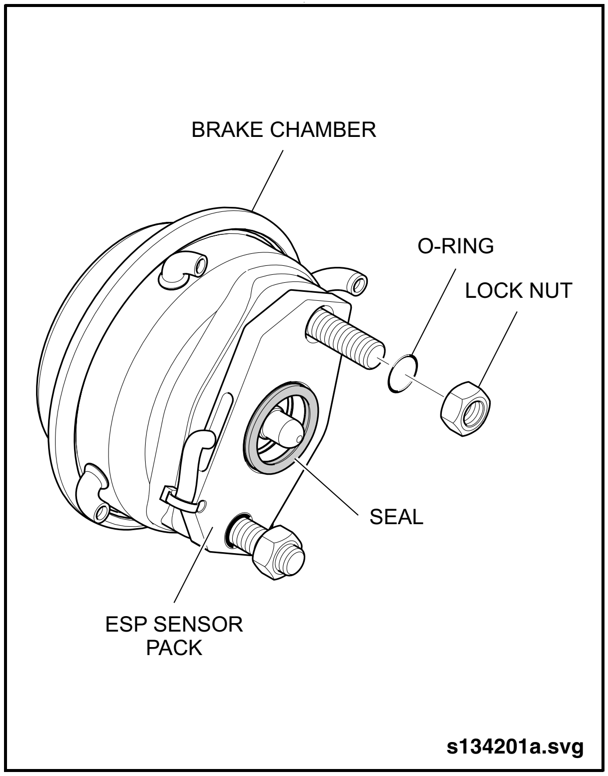


Fig. 1-74: Front Brake Chamber ESP Sensor Pack

5.4. End of Life Brake Pad Wear Sensor System

5.4.1. Description

The End of Life Brake Pad Wear Sensor system includes brake-pad mounted end-of-life (EOL) wear sensors, a resistor, software within the Vehicle Multiplexing Modules and text message indicators that appear on the instrument panel.

The engine switch box also contains Brake Worn Indicator lights. Refer to Section 4 of this manual for more information on the engine switch box.

The sensors harnesses at each caliper have a Y-shape with an electrical connector at the end to interface with the vehicle wiring harness. One sensor is connected to the inboard brake pad and one to the outboard brake pad.

5.4.2. End of Life Brake Pad Wear Sensor System Specifications

System Voltage....................................24 V

Sensors..... Normally Closed (Open at EOL)

Resistor (current limiting)
.... 1 K Ohm, 1/2 watt

5.4.3. Operation

The wear sensors on each axle are connected in series and supplied with 24 volts through a 1 K Ohm current limiting resistor.

The wear sensors are normally closed providing a path for current to flow from the 24 volt power supply to inputs on the instrument panel. The sensors will open when abraded by the brake disc due to excessive brake pad wear.

An open circuited wear sensor will be sensed by the multiplexing system and a message will appear on the message display screen in the instrument panel. The messages, Front Brake Worn or Rear Brake Worn are specific to the axle not the caliper or pad that has failed.

WARNING

It is unsafe to operate a vehicle with a worn brake pad or pads. Continued operation of the vehicle with a brake worn indicator message active could lead to brake system component failure and possible damage and loss of life. Remove a vehicle with a Brake Worn message from service and notify service personnel immediately.

If a brake worn message appears on the instrument panel, inspect the affected axle. Refer to the Preventive Maintenance Section of this manual as well as Sections 1 and 2 for more information on brake system inspections.

5.4.4. End of Life Brake Pad Wear Sensor System Troubleshooting

END OF LIFE BRAKE PAD WEAR SENSOR SYSTEM TROUBLESHOOTING		
SYMPTOM	**POSSIBLE CAUSE**	**RECOMMENDED ACTION**
Brake Worn message appears on screen	Brake pads are worn beyond safe limits	Visually inspect the brake pads. Replace brake pads and wear sensors as necessary.
Brake Worn message appears on screen and brake pads are not worn.	Failed sensor	Visually inspect the brake pads and brake pad sensors. Replace brake pads and wear sensors as necessary.
	Damaged sensor cable	Visually inspect the wear sensor harnesses and connectors. Perform vehicle wiring check. Refer to 5.4.4.2. “Vehicle Wiring Check” on page 80 in this section for procedure.
	Faulty resistor	Locate the resistor bus bar and test the resistors. Refer to 5.4.4.1. “Component Diagnosis” on page 79 in this section for procedure.
	Breaker Tripped	Check the sensor system breaker. Refer to 5.4.4.1. “Component Diagnosis” on page 79 in this section for procedure.
Brake Worn message fails to appear on screen and brake pads are worn.	Wear sensor not installed properly	Visually inspect the brake pads. Replace or reinstall wear sensors onto pads as necessary.

5.4.4.1. Component Diagnosis

Resistors

1. Locate the resistors in the side console panel harness.
2. Remove the resistor connector and test each the resistance between pin 1and 2.
3. Replace the resistor if it tests higher or lower than the specified value.

Breaker

1. Locate the brake wear system breaker. Refer to sheet AB in "ES-Electrical Schematics" in the Vehicle System Drawing Manual for information on the size and location of the brake wear system breaker.
2. Inspect the breaker for proper installation or tripped condition.
3. Reset breaker if necessary.

5.4.4.2. Vehicle Wiring Check

☞NOTE:

The following procedures are typical for the End of Life Brake Wear sensor circuits and can be performed on the axle requiring service.

Test harness continuity from sensor to instrument panel as follows:

1. Set the Battery Disconnect switch to the OFF position.
2. Block the wheels to prevent the vehicle from moving.
3. Gain access to the instrument panel and the affected axle.
4. Visually inspect all the connectors in the circuit to verify they are properly connected and free of damage or corrosion.
5. Disconnect the wiring harness connector containing the sensor inputs from the instrument panel cluster. Refer to sheet IO in "ES-Electrical Schematics" in the Vehicle System Drawing Manual for multiplexing module pin-out information.
6. Disconnect the resistor connectors in the side console.
7. Use a multimeter to test the vehicle harness for proper continuity or open circuit conditions on each wear sensor circuit. Refer to sheet AB in "ES-Electrical Schematics" in the Vehicle System Drawing Manual for circuit configuration.
8. Repair or replace any damaged harness components as necessary.
9. Reconnect all harness components and test the system before returning the vehicle to service.

5.4.5. Removal

1. Remove the brake pads and brake sensor assembly from the vehicle. Refer to 5.2.5. “Brake Pads” on page 59 in this section for procedure.
2. Remove the brake sensors from the brake pads.

5.4.6. Installation

1. Assemble new brake pads with a new brake sensor harness.
2. Align each sensor in the groove of the brake pads and press down until they lock into place. See “Fig. 1-75: Wear Sensor Installation” on page 80. .

☞NOTE:

The sensor with the long wire fits onto the outboard brake pad and the sensor with the short wire fits on the inboard brake pad.

3. Install the brake pads and brake sensor harness into the vehicle. Refer to 5.2.5. “Brake Pads” on page 59 in this section for procedure.

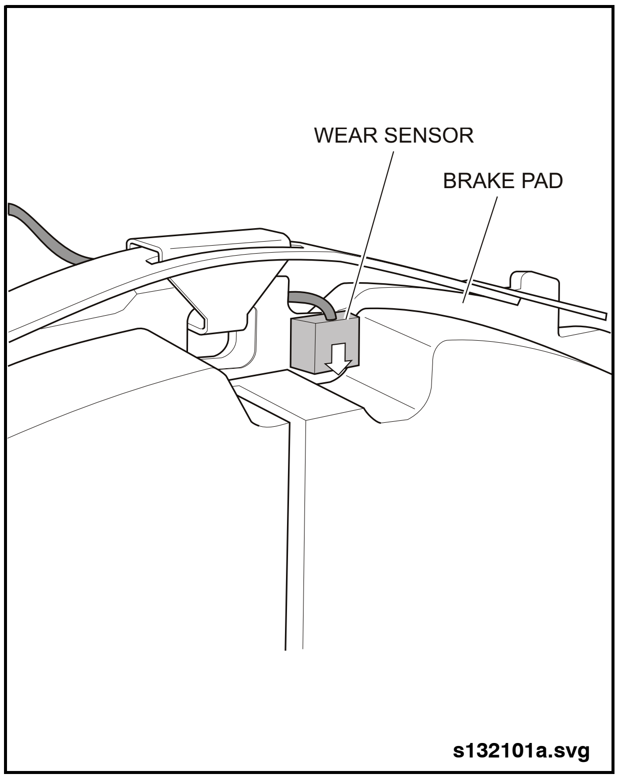


Fig. 1-75: Wear Sensor Installation

6. FRONT 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. 1-76: Front Speed Sensor Removal & Installation” on page 82.
3. Disconnect sensor cable from chassis harness.
4. Pull sleeve out of bearing bore.

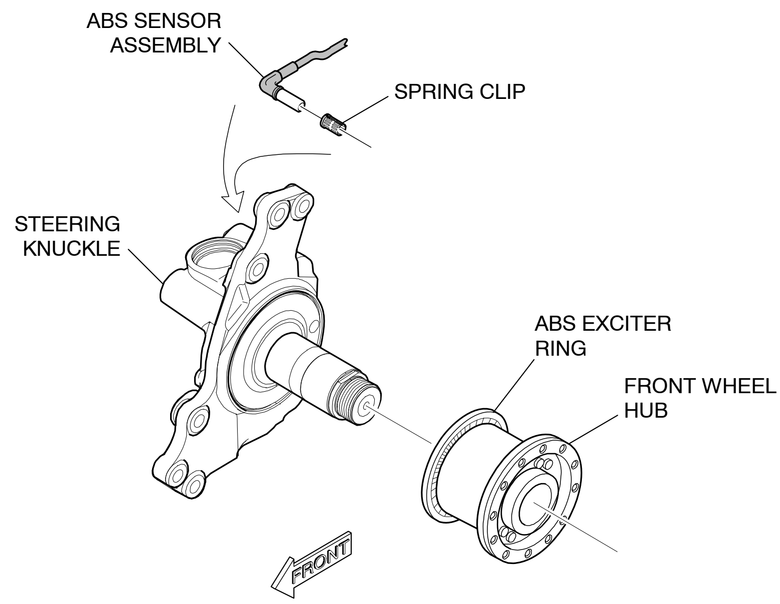


Fig. 1-76: Front Speed Sensor Removal & Installation

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.

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

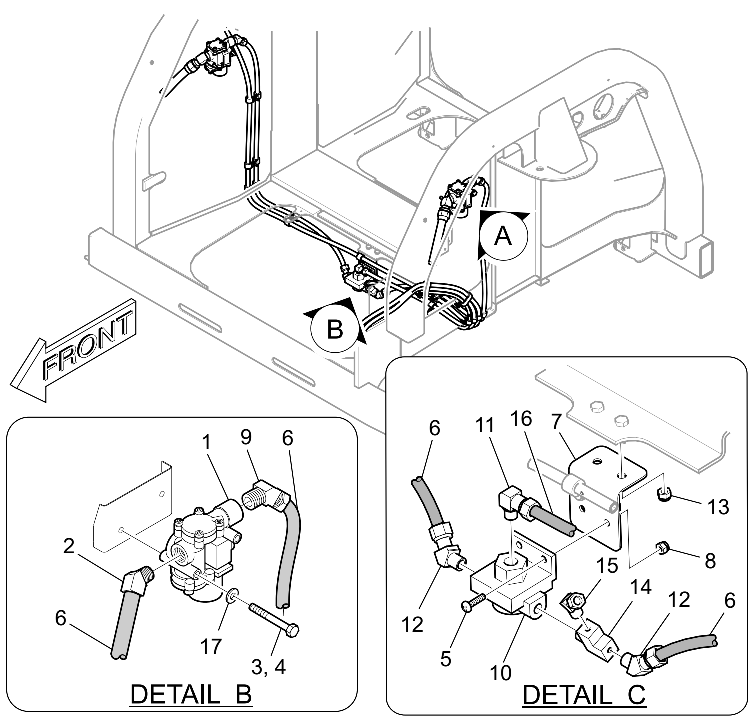
1. Set the Battery Disconnect switch to the OFF position.
2. Disconnect the wiring from the ABS valve.
3. Disconnect the air lines from ports 1 and 2 of the ABS valve. See "Fig. 1-77: Front Modulator Valve Removal & Installation" on page 84.
4. Remove the two mounting bolts and nuts.
5. Remove the ABS 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. 1-77: 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. 1-78: ABS ECU” on page 85.

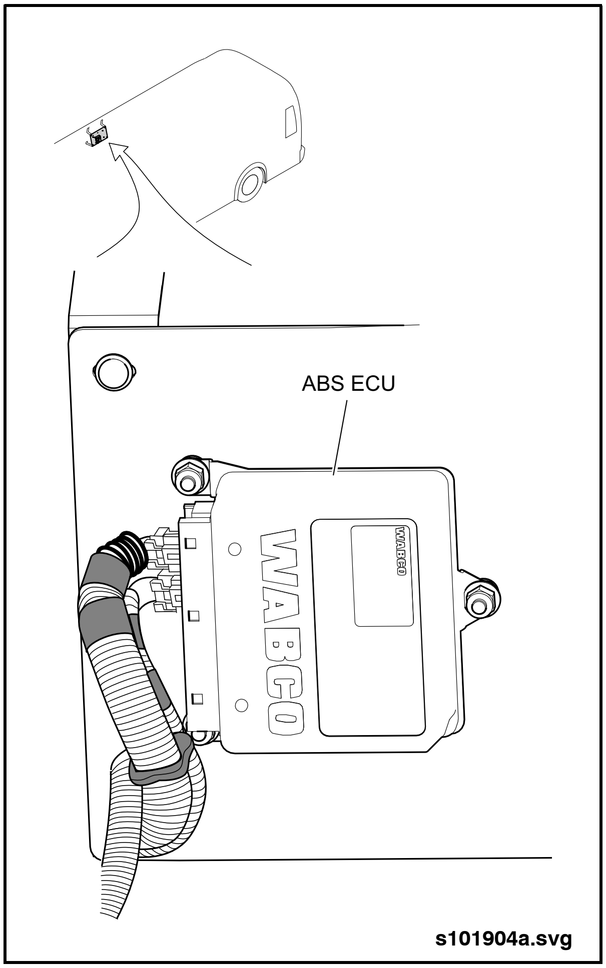


Fig. 1-78: ABS ECU

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 86 in this section for basic information on blink code troubleshooting 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 94 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. 1-79: Special Tools-1” on page 91. See “Fig. 1-80: Special Tools-2” on page 92. See “Fig. 1-81: Special Tools-3” on page 93.

SPECIAL TOOLS	DESCRIPTION
1	Supporting Fixture
2	Socket, E24
3	Retaining Bolt, M8
4	Adapter, Wrench
5	Socket Wrench, Size 22 Splined
6	Wrench Handle, Socket
7	Handle, Torque Wrench
8	Handle, Screwdriver Torque
9	Shaft, Removable Screwdriver
10	Bit, Removable Screwdriver
11	Gauge, Feeler
12	Lifting Hook
13	Callipers, Measuring
14	Pin, Centering
15	Adapter
16	Impact Tool
17	Torque Multiplier - 1:3.5
18	Socket
19	Socket - Wheel Flange Bolt
20	Support
21	Holding Tube, Socket
22	Pin, Connecting 36 mm
23	O-Ring, 42mm

SPECIAL TOOLS	DESCRIPTION
24	Screw, Cap Cylinder
25	Adapter, Tool Assembly
26	Handle, Slip On
27	Washer
28	Gauge, Dial Stand
29	Gauge, Dial
30	Slotted Nut Spanner Socket
31	Counter Holder Flange
32	Power Wrench
33	Counter Holder
34	Reaction Arm
35	Ratchet
36	Bushing, Threaded M115
37	Removal Flange, Hub Unit
38	Puller Cap, Threaded
39	Cover, Fitting
40	Spindle
41	Nut, Spindle
42	Fitting Sleeve
43	Pump, Hydraulic
44	Piston Cylinder, Hollow, 200 kN
45	Flange Extractor
46	Pressure Piece, Hub Unit Bearing, 200 kN
47	Rod, Threaded, M20 x 270
48	Nut, Collar
49	Plate, Traverse
50	Positioning Tool, Thrust Bearing Sleeve

SPECIAL TOOLS	DESCRIPTION
51	Fixture, Hydraulic Press
52	Press Hydraulic 750 kN
53	Punch, Aligning
54	Mandrel, Short W/Magnet
55	Mandrel, Pressing
56	Mandrel, King Pin Press In
57	Spacer Tube
58	Mandrel, King Pin Cap Installation
59	Tool, Cable Tie Tying
60	Pressing Adapter
61	Mandrel, Guide & Press
62	Pressing Adapter
63	Pressing Adapter
64	Joint Press
65	Flat Cylinder
66	Chain, Safety
67	Torque Adapter, TX100
68	Socket Wrench, Size 36 Splined
69	Mounting Fixture, Dial Gauge
70	Nut, Collar Trapezoidal Thd.
71	Spindle, Trapezoidal Thd.
72	Punch, Installer
73	Sleeve, Installer
74	Tool, Indenting
75	Sleeve, Press-In
76	Sleeve, Centering
77	Sleeve, Press-In

SPECIAL TOOLS	DESCRIPTION
78	Sleeve, Press-In
79	Plate, Adapter
80	Mounting Fixture
81	Fork, Press-Off
82	Sleeve Installer
83	Bushing Installer

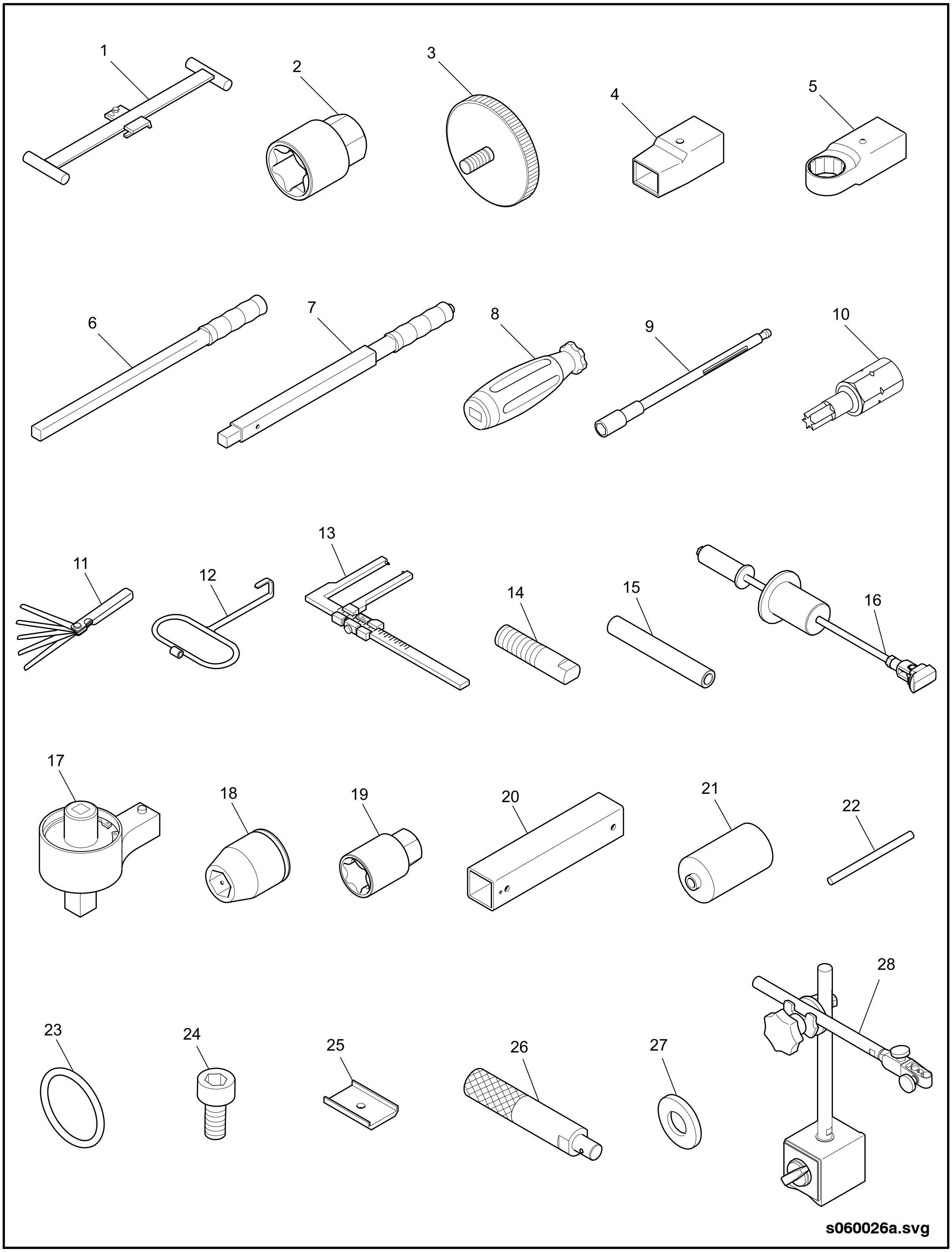


Fig. 1-79: Special Tools-1

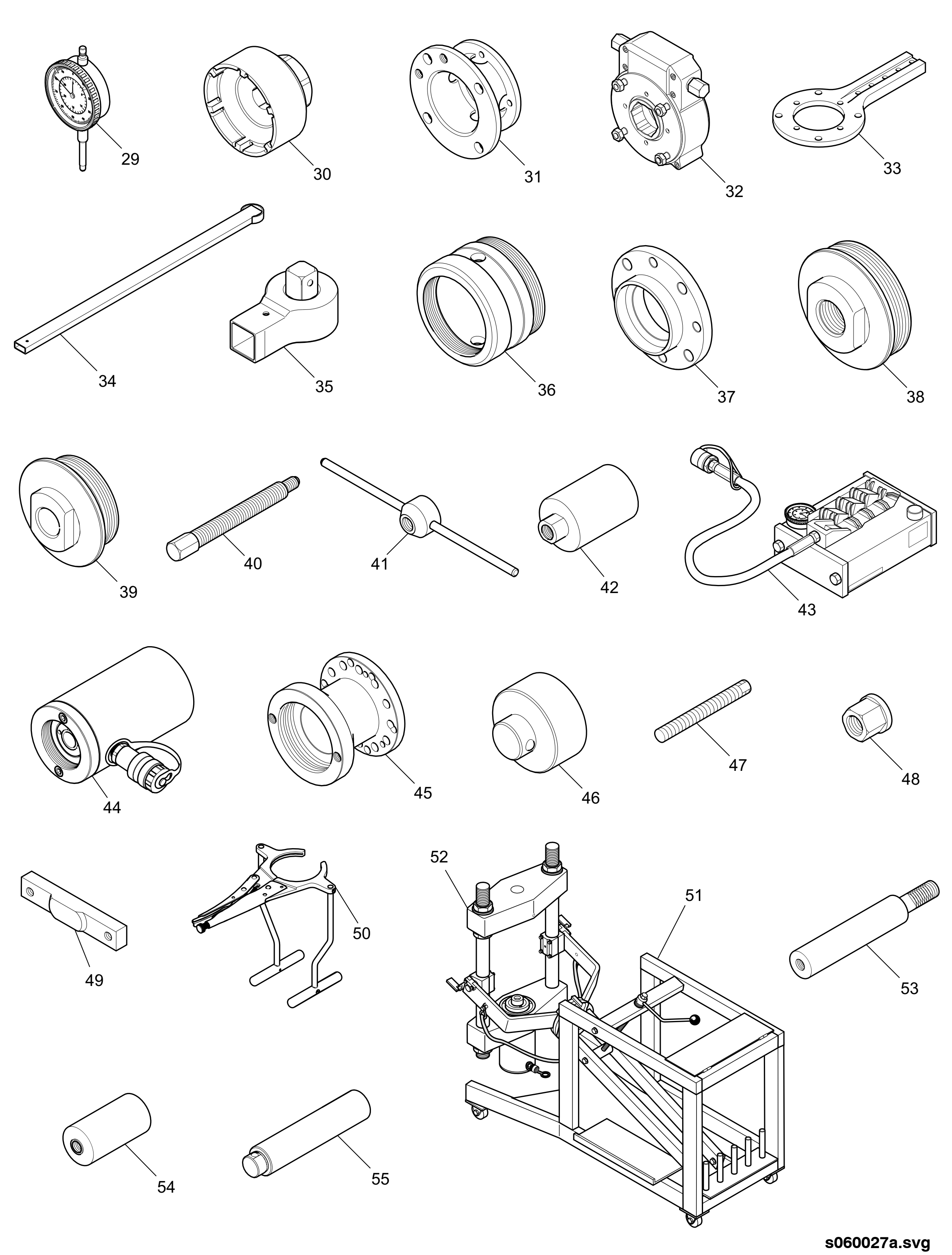


Fig. 1-80: Special Tools-2

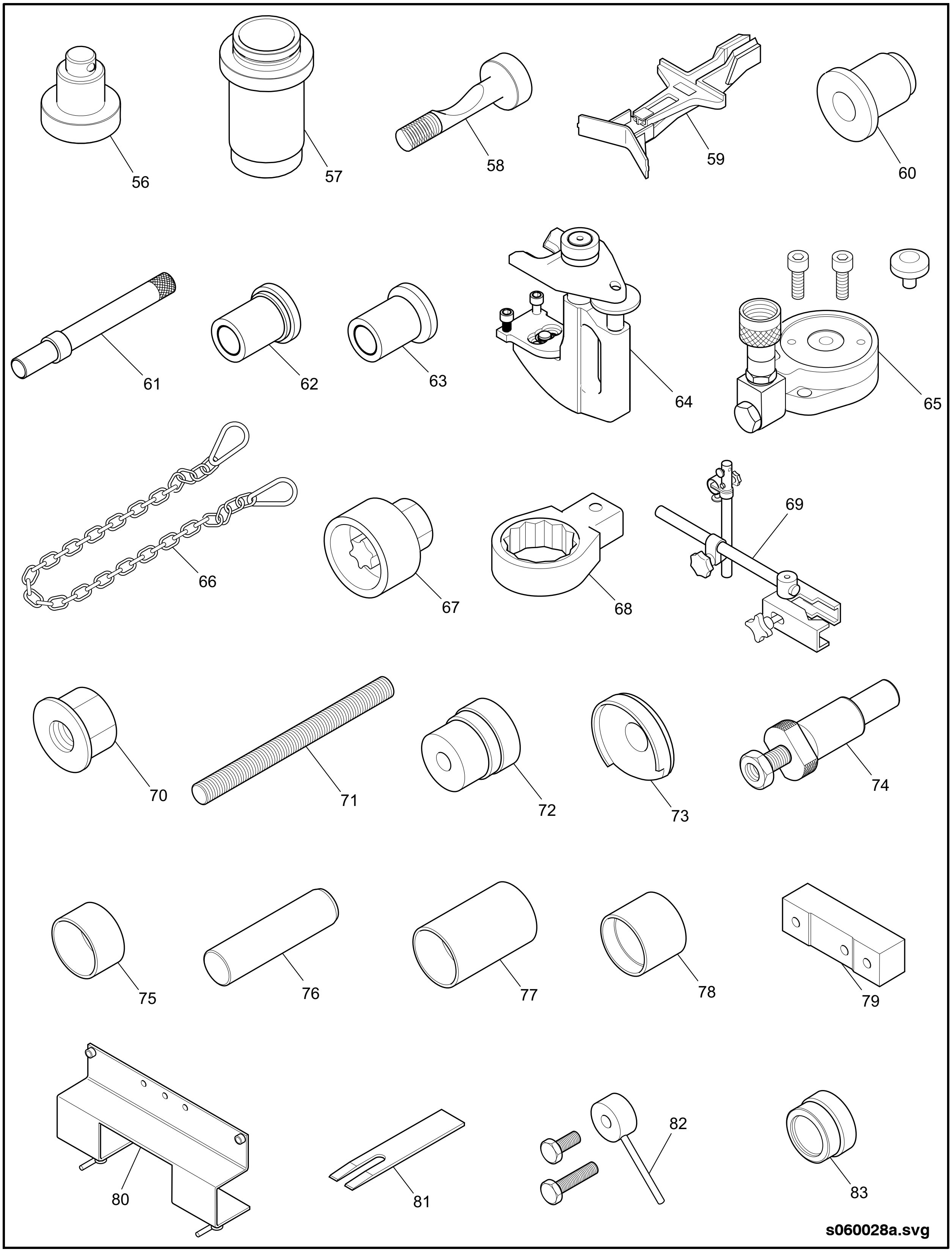


Fig. 1-81: Special Tools-3

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. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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.

1. Rear Suspension Unit
2. Air Spring
3. Shock Absorber
4. Rear Axle Assembly
5. Brake Chamber
6. U-Bolt
7. Top Radius Rod
8. Bottom Radius Rod
9. Jacking Pad Assembly
10. Washer
11. Nut

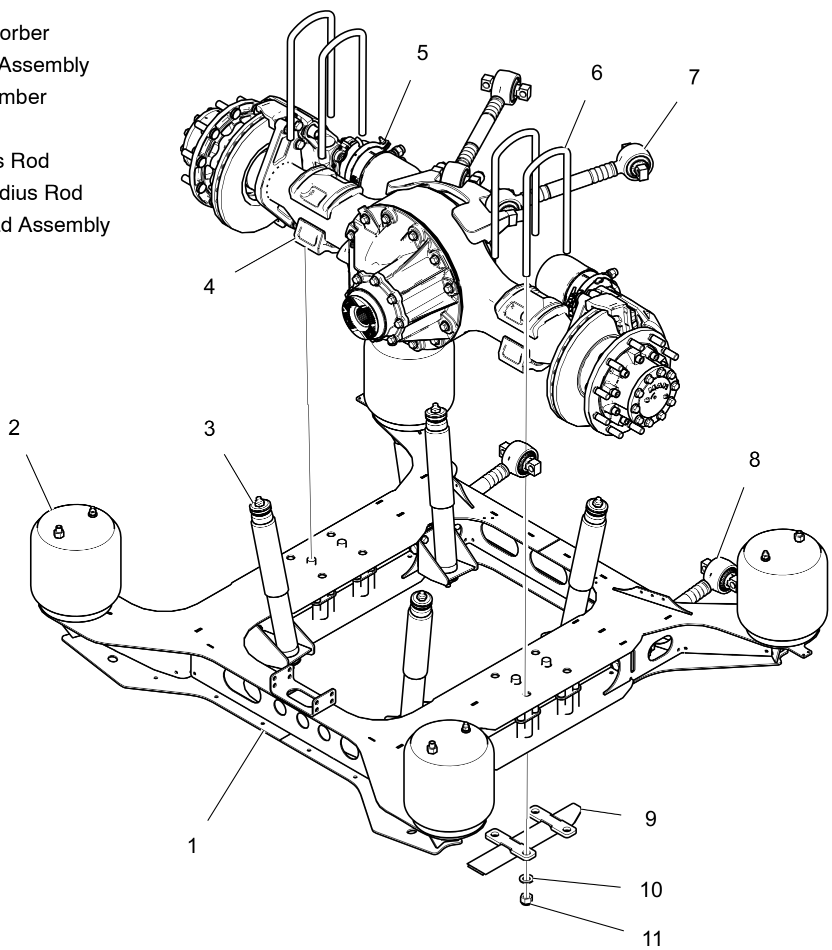


Fig. 2-1: Rear Axle & Suspension Assembly

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. Unplug brake wear sensor harness from vehicle harness.
8. Remove membrane breather from vehicle structure mounting bracket.
9. 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.
10. Disconnect upper and lower radius rods at their chassis mounting points and leave opposite end attached to axle and suspension beam.
11. Disconnect the shock absorbers from the axle suspension beam and leave upper shock mounts attached to vehicle structure.
12. Remove the center nut from the bottom of each air spring and leave air spring upper mounts attached to vehicle structure.
13. Tag and disconnect brake chamber air lines.
14. Check for and disconnect any other lines or harnesses routed to the axle or axle components.
15. 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

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 wiring harness.
10. Connect brake wear sensor harness to vehicle wiring harness.

☞**NOTE:**

If the round sensor connector between the wear sensor harness and the extension harness is unplugged during the removal procedure, check that the rubber seal is not damaged or deformed. Ensure the wear sensor connector is properly pushed into the cable extension connector upon re installation. The cable extension connector has locking tabs which lock in position when the sensor's plug is inserted correctly.

⚠CAUTION

A damaged seal or improperly seated connector will not provide a watertight seal between the sensor connector and the extension cable connector. Penetration of water can lead to corrosion on connector pins and cause sensor failure.

11. Mount membrane breather to vehicle structure mounting bracket.
12. Check for and connect any other lines or harnesses removed during the disassembly process.
13. 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.
14. Connect leveling valve links to original positions on suspension beam brackets.
15. 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

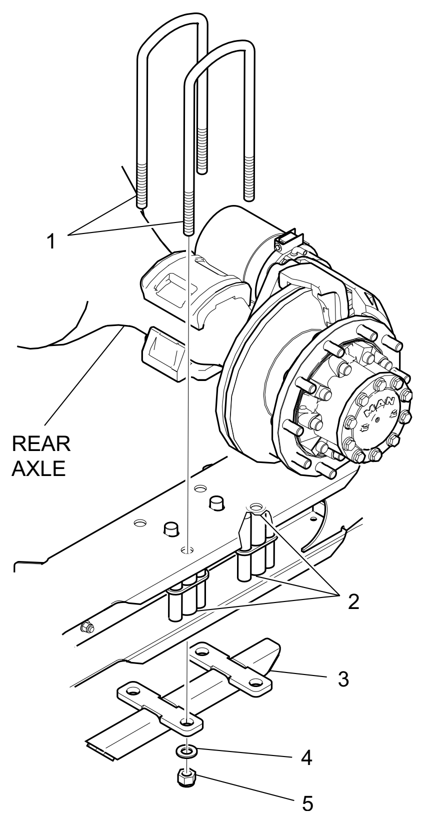


Fig. 2-2: Axle to Suspension Beam Mounting Detail

2.6. Assembly

☞**NOTE:**

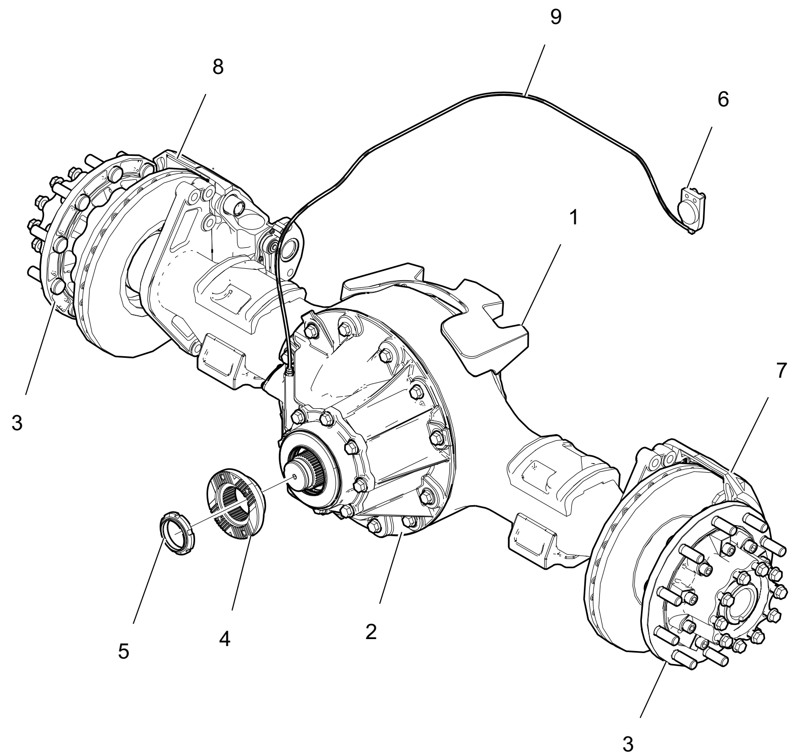
Refer to 4.5. "Rear Suspension Torque Specifications" on page 91 in this section for all assembly and installation torque values.

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 driveshaft 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 .... 130 psi

Maximum Load (dual tires)........... 7,390 lbs. @ 130 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 (EPA 2014-2016) 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 91 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.

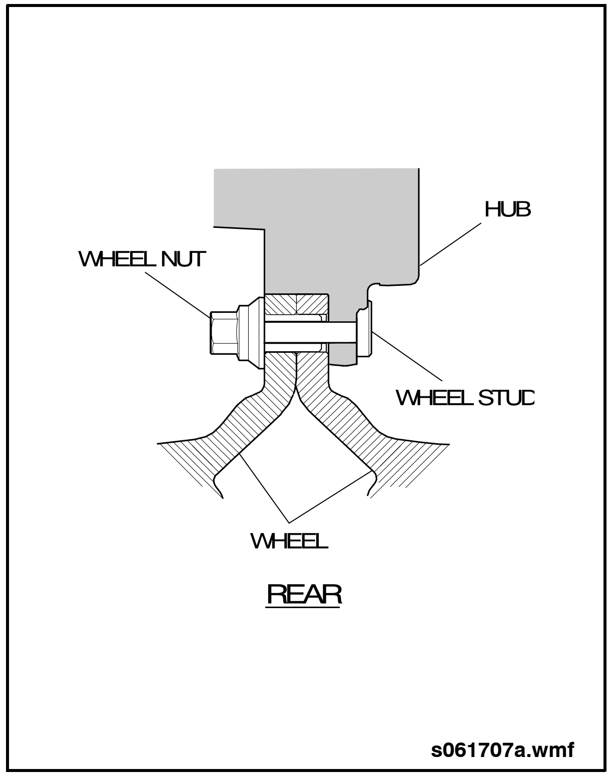


Fig. 2-4: Hub Piloted Wheels - Rear

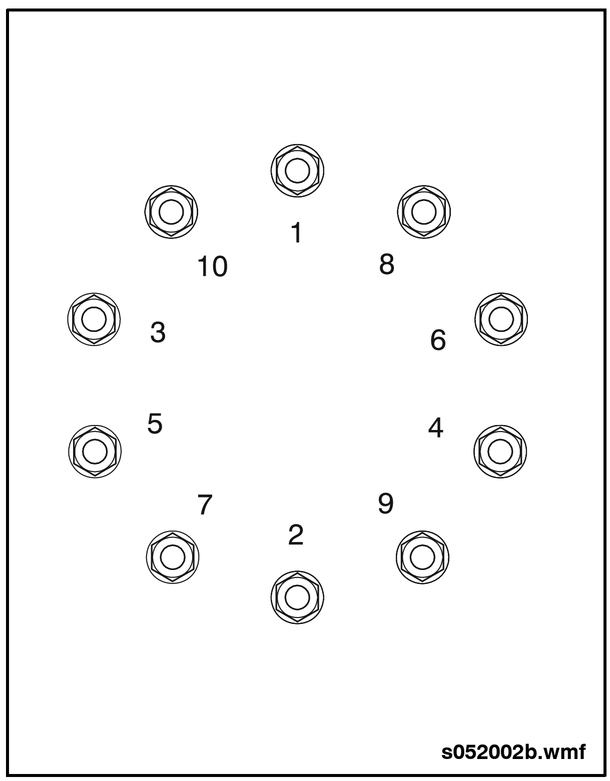


Fig. 2-5: Wheel Nut Torquing Sequence

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).

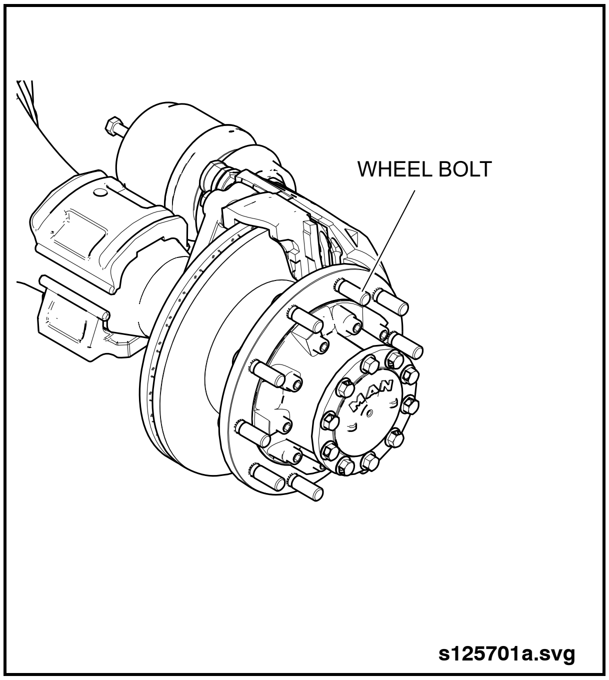


Fig. 2-6: Wheel Bolt Removal

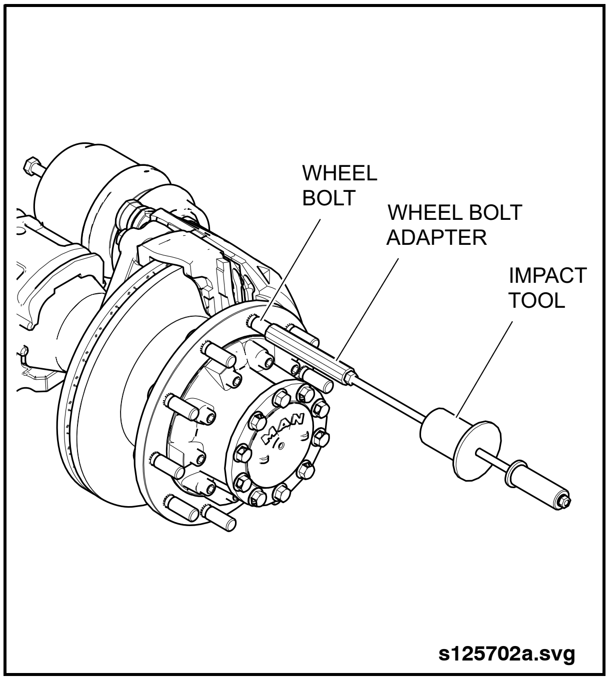


Fig. 2-7: Wheel Bolt Installation

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. 2-9: Axle Shaft Removal & Installation" on page 13.
2. Remove the axle shaft and clean the hub and shaft mating surfaces.

NOTE:

The axle shafts are of unequal length. Ensure that each axle is identified as to its location.

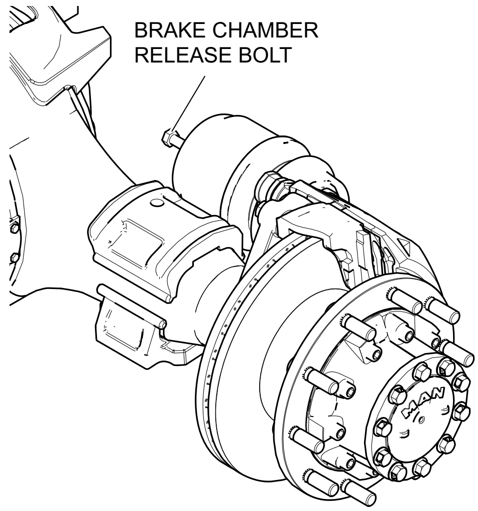


Fig. 2-8: Screwing in Release Bolt

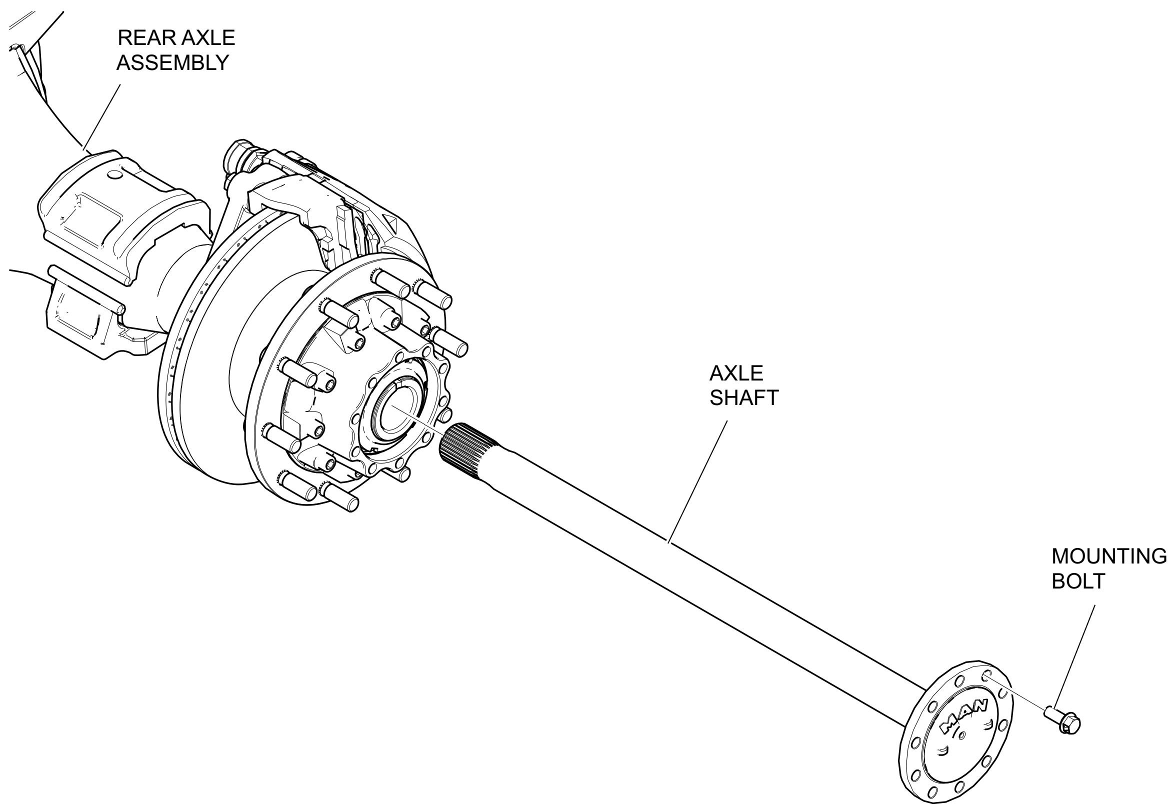


Fig. 2-9: Axle Shaft Removal & Installation

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. 2-10: Wheel Bearing Inspection” on page 15.
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.

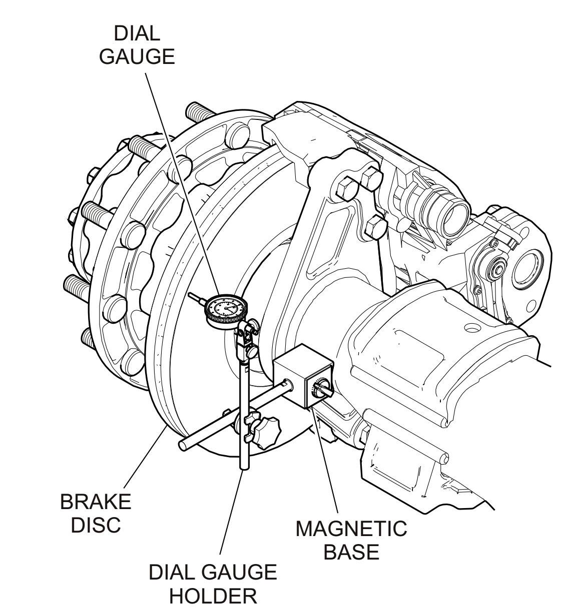


Fig. 2-10: Wheel Bearing Inspection

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. 2-11: Wheel Hub Assembly” on page 17.

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. 2-12: Unlocking Slotted Nut” on page 18.

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. 2-13: Assembling Centering Device” on page 18.

3.9.3.3. Inserting Centering Device

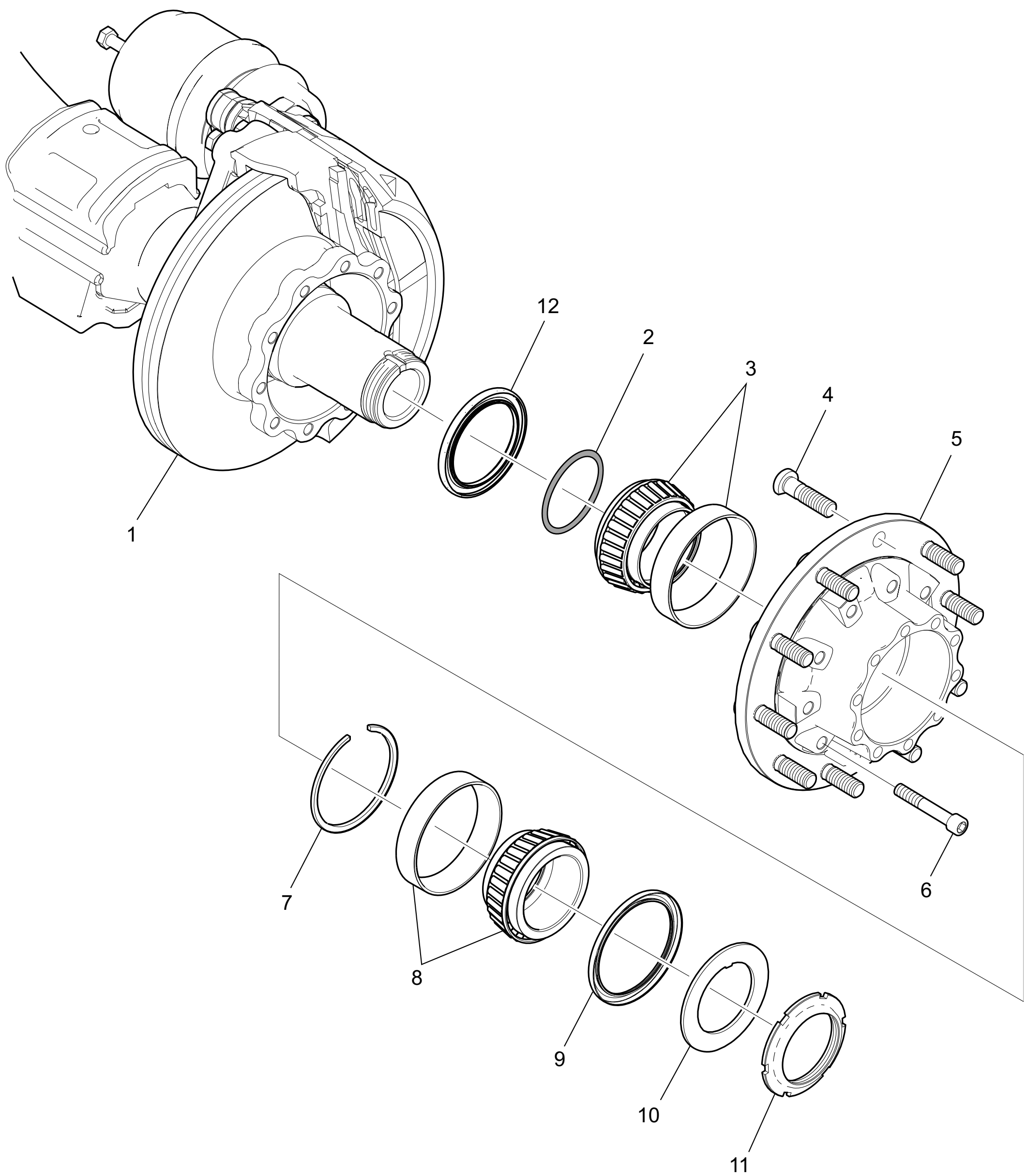
1. Insert the centering device into the axle stub until it stops. See “Fig. 2-14: Inserting Centering Device” on page 18.
2. Clamp the centering device in place by tightening the screw spindle.

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. 2-15: 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. 2-16: Loosening Slotted Nut” on page 19.
5. Remove the special tools.

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. 2-17: Removing Slotted Nut” on page 19.
3. Discard the slotted nut.



1. Brake Disc	5. Wheel Hub	9. Outer Shaft Seal
2. O-Ring	6. Socket Head Screw	10. Thrust Washer
3. Inner Bearing Assembly	7. Retaining Ring	11. Slotted Nut
4. Wheel Bolt	8. Outer Bearing Assembly’	12. Inner Radial Seal/Pulse Wheel

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Fig. 2-11: Wheel Hub Assembly

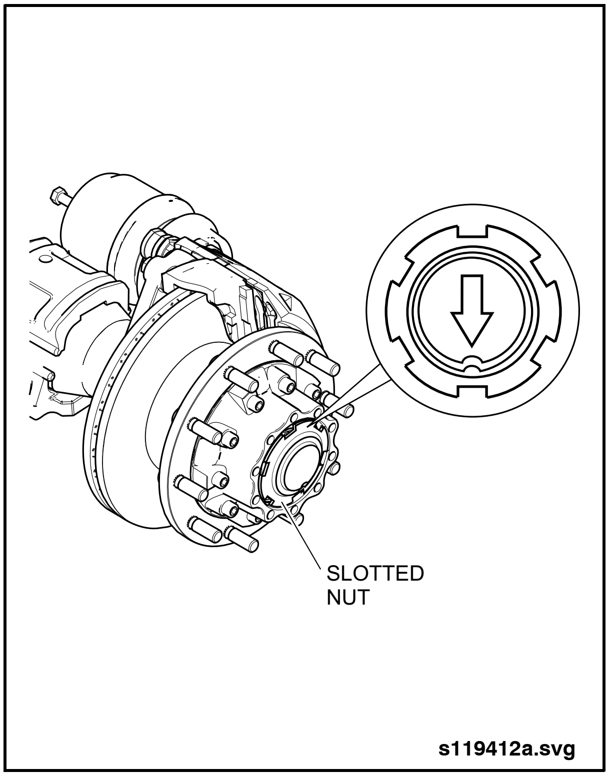


Fig. 2-12: Unlocking Slotted Nut

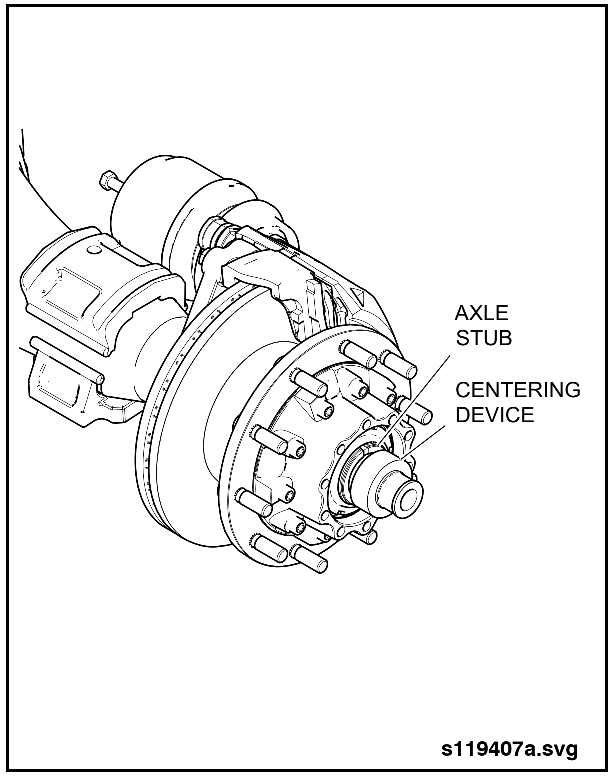


Fig. 2-14: Inserting Centering Device

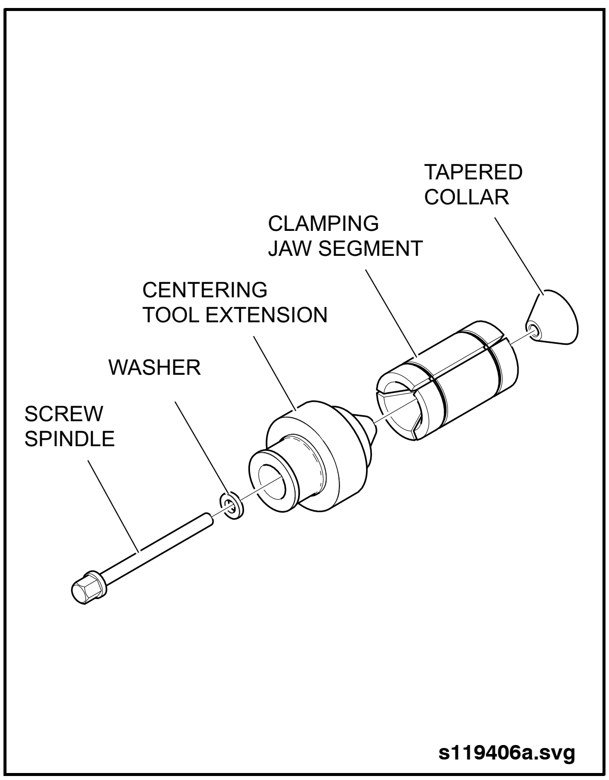


Fig. 2-13: Assembling Centering Device

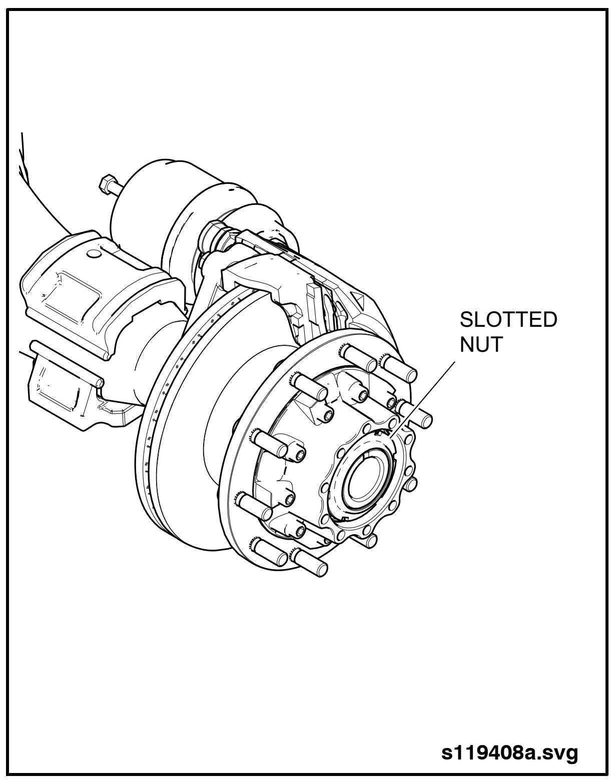
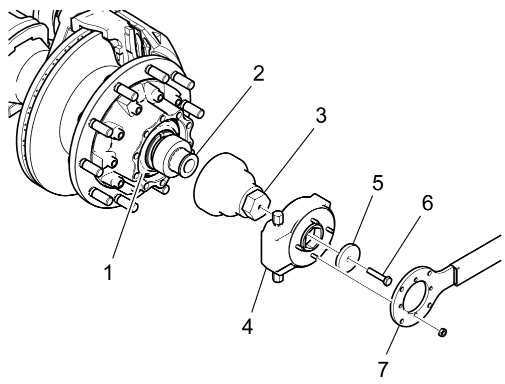


Fig. 2-15: Slotted Nut



1. Slotted Nut'
2. Centering Device
3. Slotted Nut Socket
4. Torque Multiplier
5. Washer
6. Hex Bolt
7. Counter Holder

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Fig. 2-16: Loosening Slotted Nut

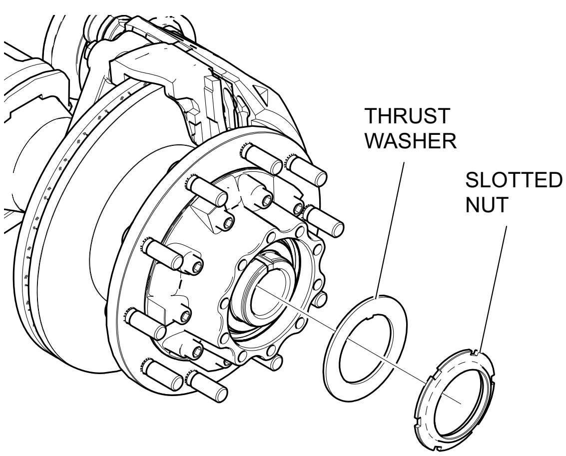

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Fig. 2-17: Removing Slotted Nut

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. 2-18: 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.

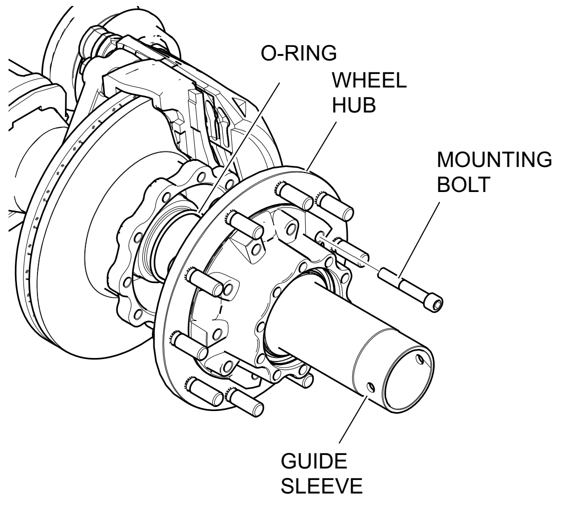


Fig. 2-18: Removing Wheel Hub

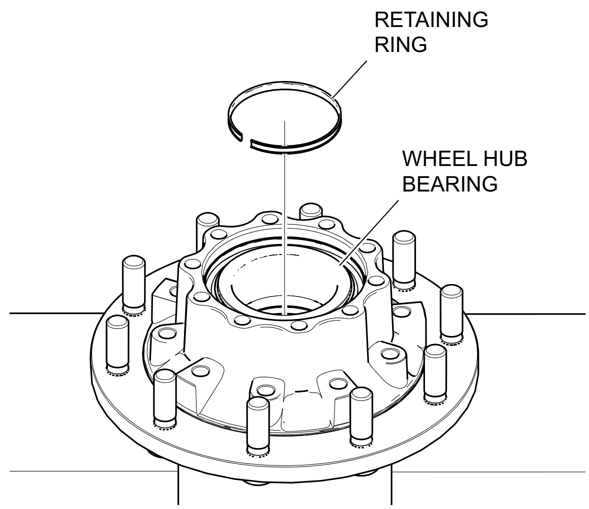


Fig. 2-19: Removing Retaining Ring

3.9.4. Disassembly

3.9.4.1. Retaining Ring Removal

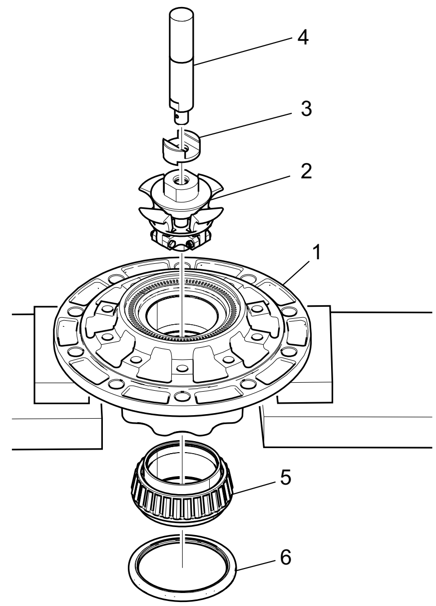
Remove the retaining ring for the wheel hub bearing. See "Fig. 2-19: Removing Retaining Ring" on page 20.

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. 2-20: Removing Outer Tapered Roller Bearing” on page 21.
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. 2-20: 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. 2-21: Removing Outer Bearing Outer Race" on page 22.
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.

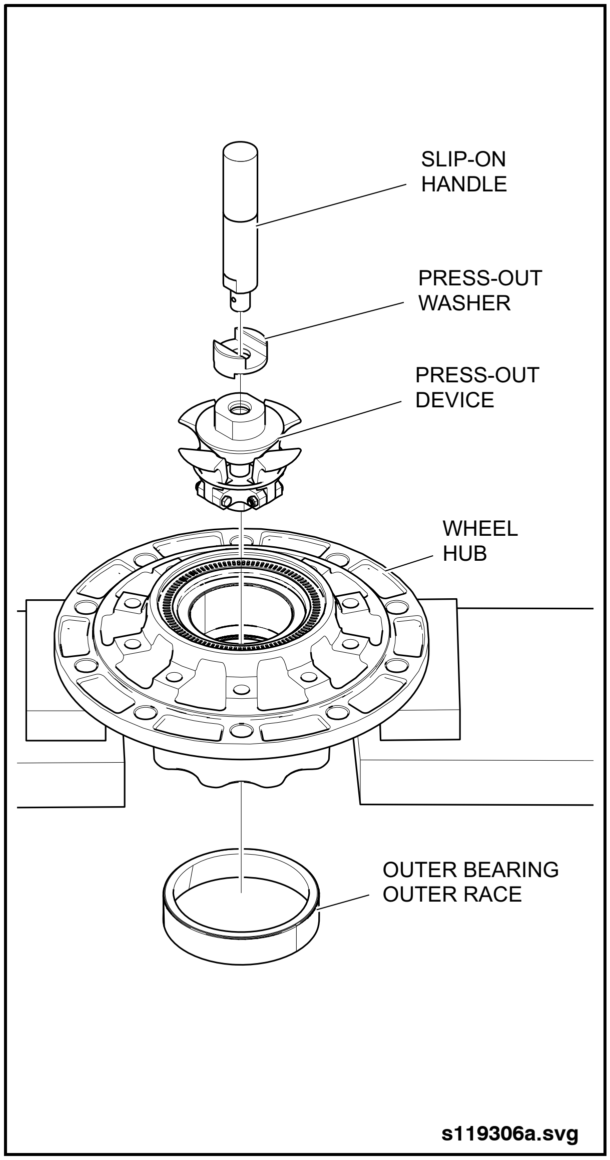


Fig. 2-21: Removing Outer Bearing Outer Race

3.9.4.4. Inner Tapered Roller Bearing Removal

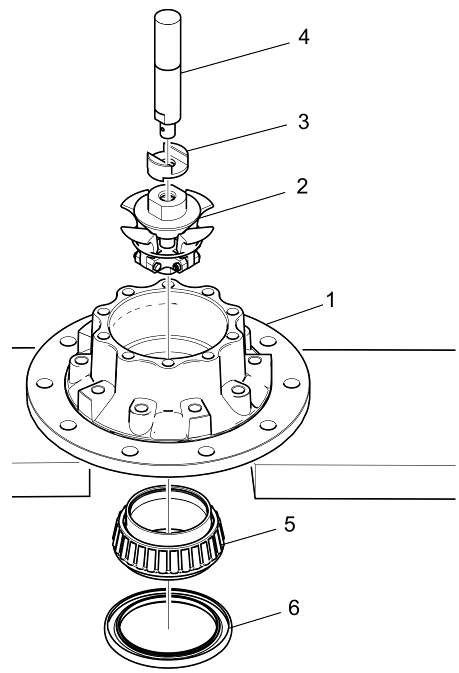
☞NOTE:

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. 2-22: Removing Inner Tapered Roller Bearing” on page 23.
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. 2-22: 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. 2-23: Removing Inner Bearing Outer Race” on page 24.
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.

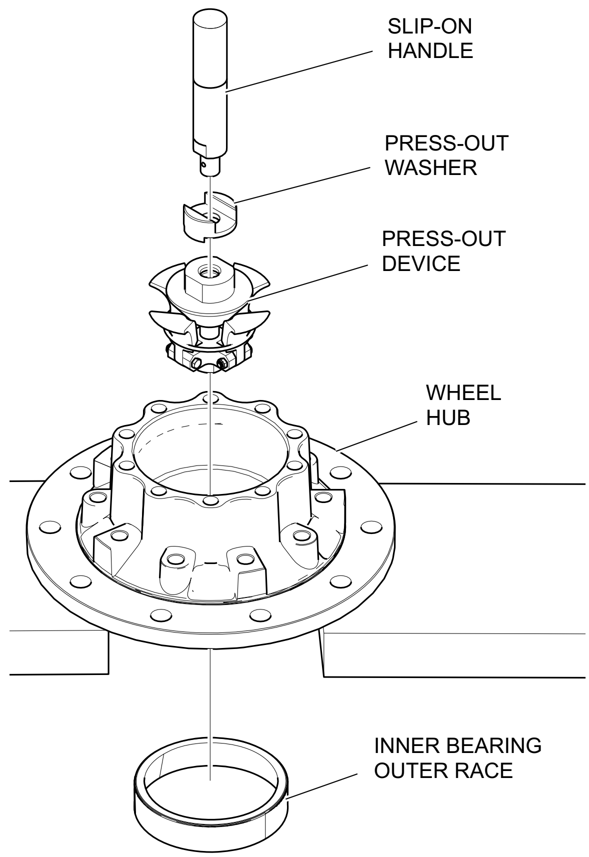

Fig. 2-23: Removing Inner Bearing Outer Race

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. 2-24: Installing Inner Bearing Outer Race" on page 25.
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.

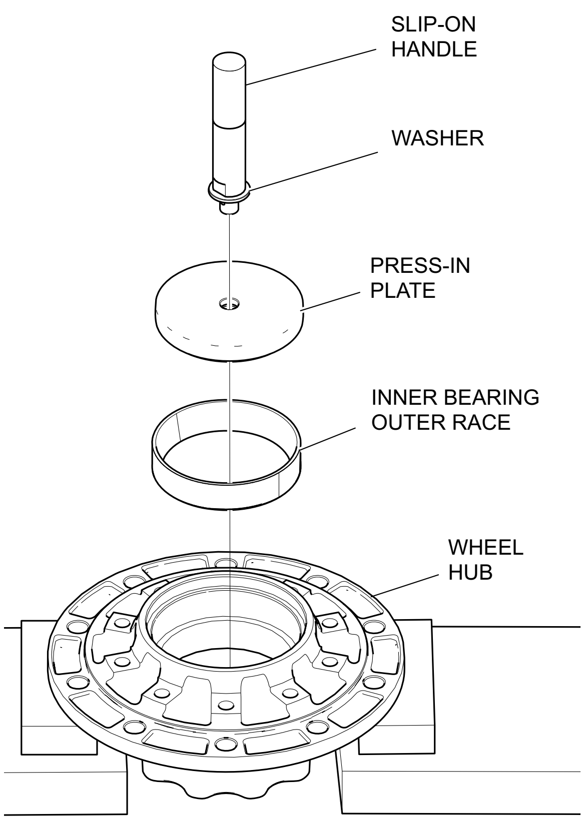

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Fig. 2-24: Installing Inner Bearing Outer Race

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. 2-25: Greasing Hub Unit Wheel Bearings" on page 25. 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.

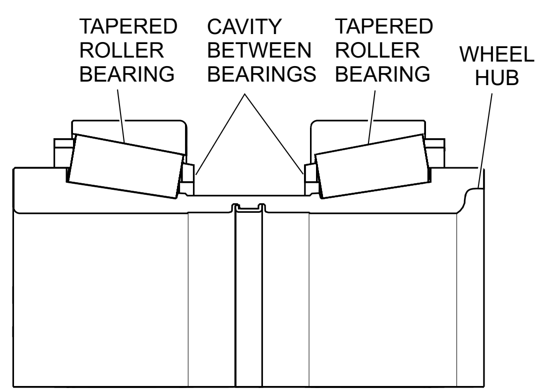

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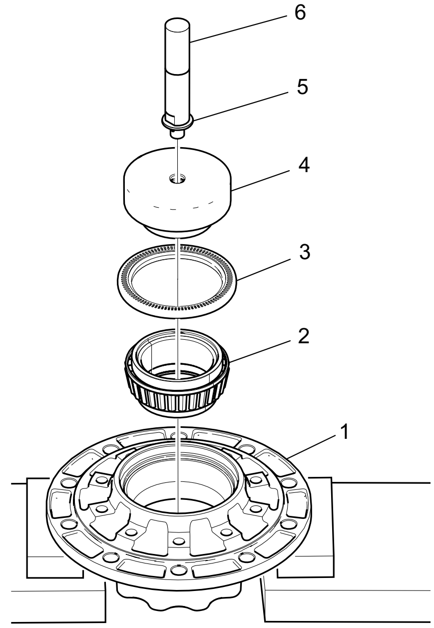
Fig. 2-25: Greasing Hub Unit Wheel Bearings

3.9.5.3. Inner Tapered Roller Bearing Installation

1. Insert the tapered roller bearing into the wheel hub. See "Fig. 2-26: Installing Inner Tapered Roller Bearing" on page 26.
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.



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. 2-26: Installing Inner Tapered Roller Bearing

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. 2-27: Installing Outer Bearing Outer Race” on page 27.

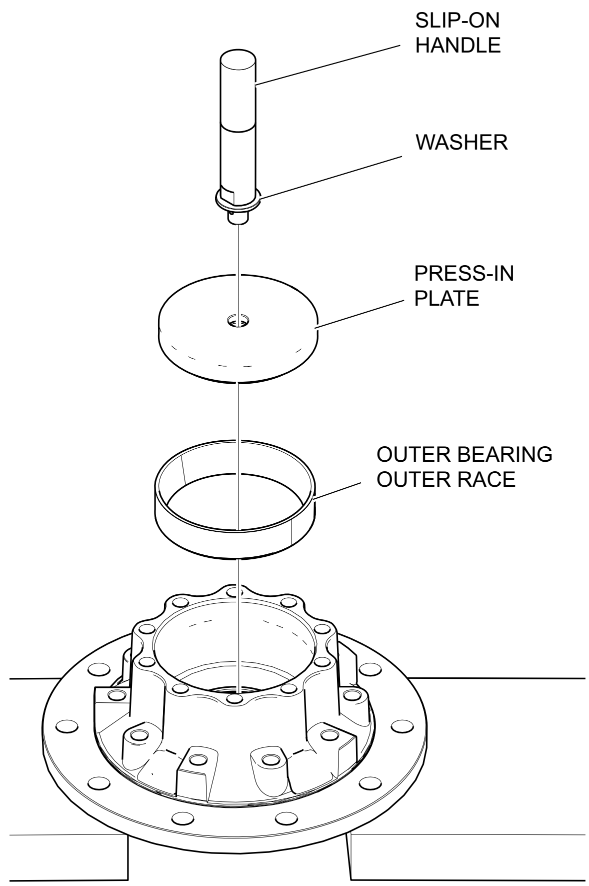


Fig. 2-27: Installing Outer Bearing Outer Race

3.9.5.5. Outer Tapered Roller Bearing Installation

1. Insert the tapered roller bearing into the wheel hub. See “Fig. 2-28: Installing Outer Tapered Roller Bearing” on page 28.
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.

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.

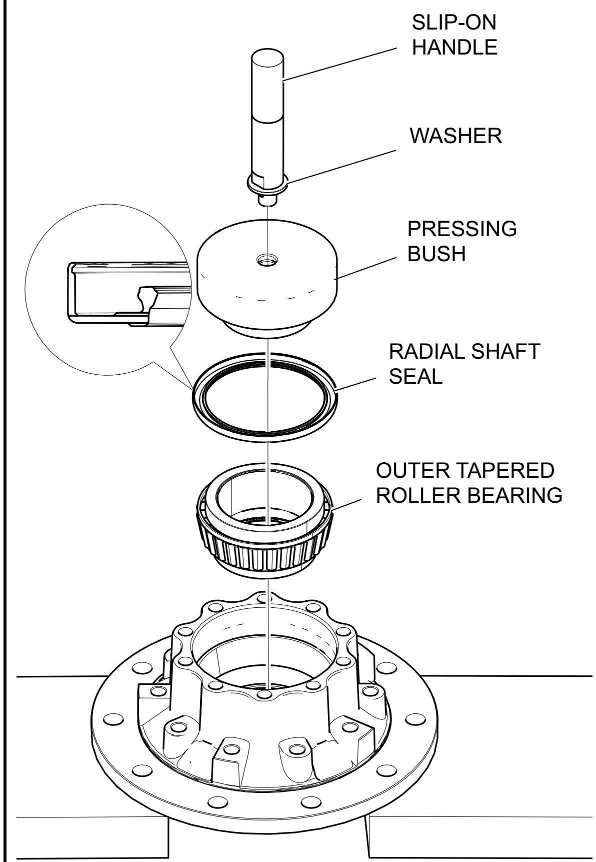


Fig. 2-28: Installing Outer Tapered Roller Bearing

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. 2-29: Locking Slotted Nut" on page 30.

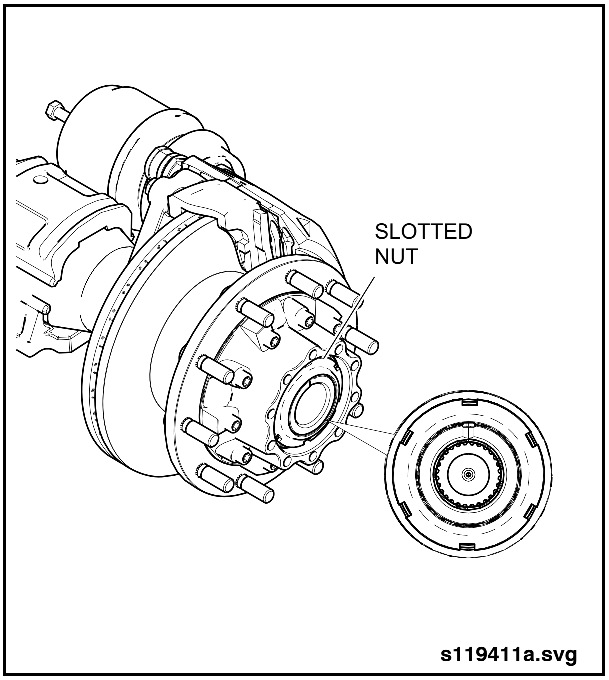
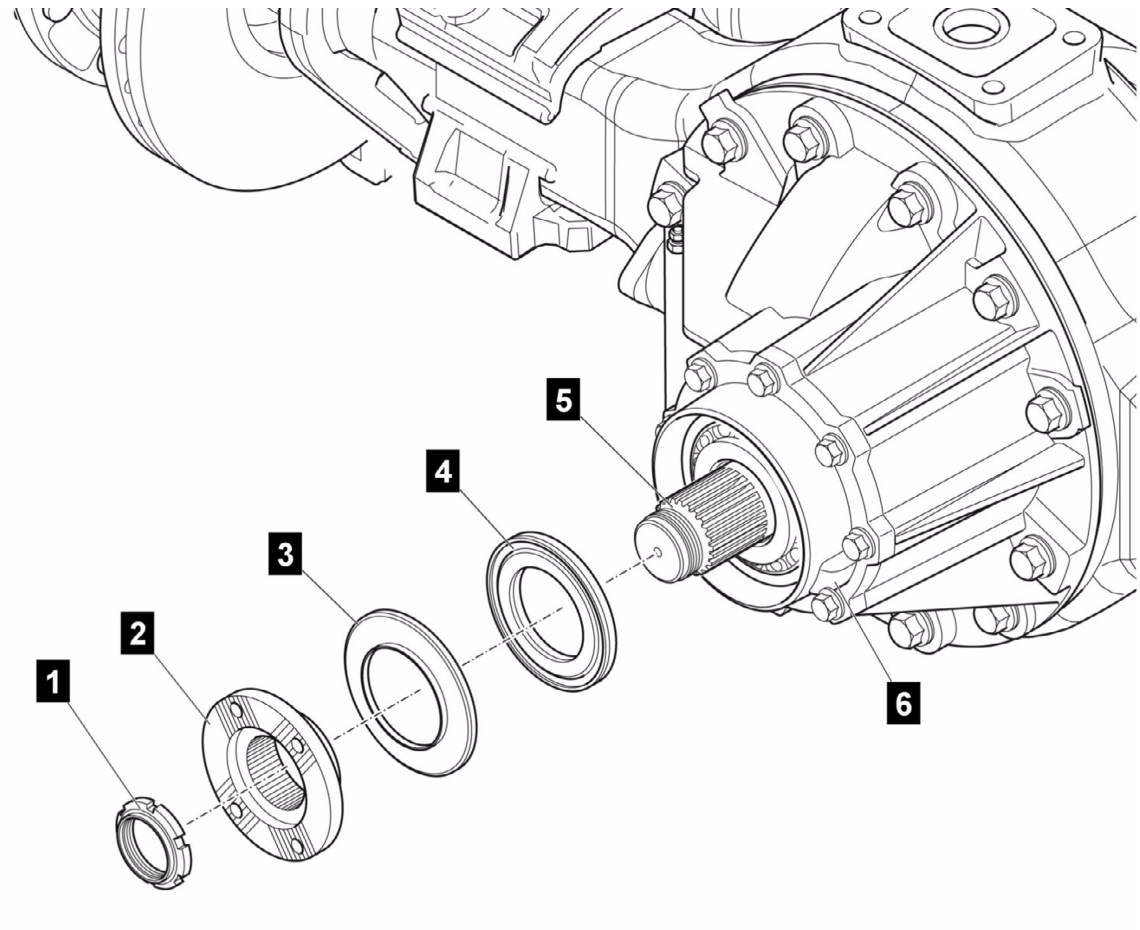


Fig. 2-29: Locking Slotted Nut

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. 2-30: Pinion Seal Replacement” on page 31.

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. 2-30: 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. 2-31: Unlocking Slotted Nut” on page 32.
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. 2-32: Mounting Input Flange Tool” on page 32.
   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.

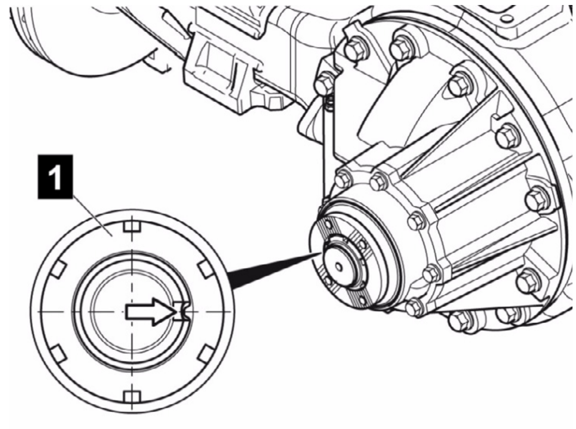


Fig. 2-31: Unlocking Slotted Nut

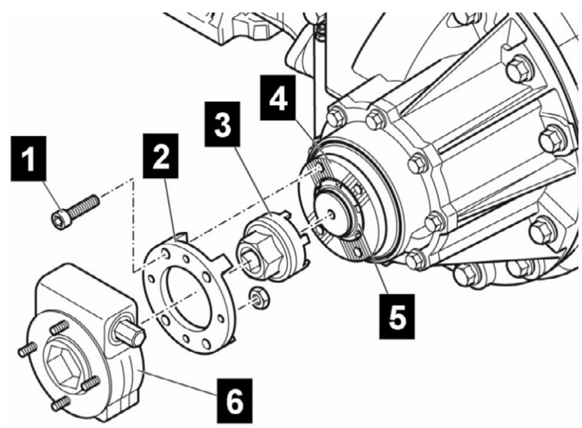


Fig. 2-32: Mounting Input Flange Tool

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. 2-33: Removing Slotted Nut” on page 33.
2. Remove the special tools.
3. Remove and discard the slotted nut.

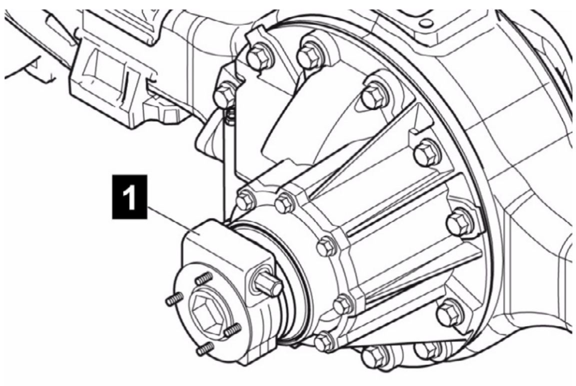


Fig. 2-33: Removing Slotted Nut

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. 2-34: Pulling Off Input Flange” on page 33.

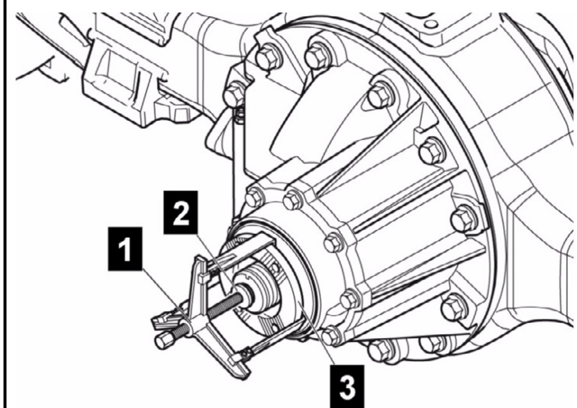


Fig. 2-34: Pulling Off Input Flange

3.10.1.4.Removing Radial Shaft Seal

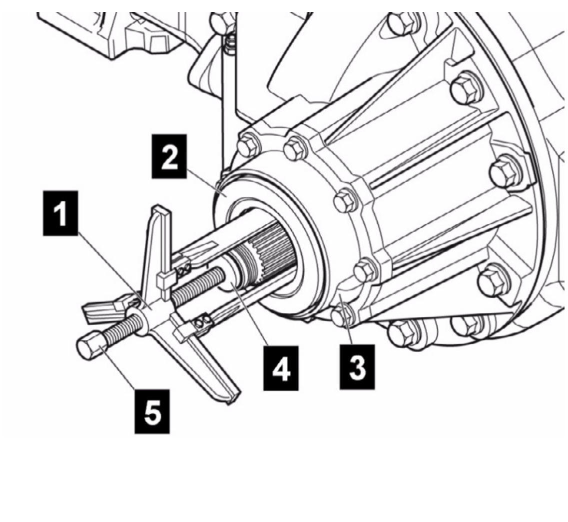
1. Insert the hooks of the 3-Arm Puller (Item 32 from Special Tools List) behind the sealing lips of the radial shaft seal.
2. Place the Spindle Adapter (Item 67 from Special Tools List) on the pinion shaft and thread in the spindle until it contacts the spindle adapter. See “Fig. 2-35: Removing Radial Shaft Seal” on page 34.
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.

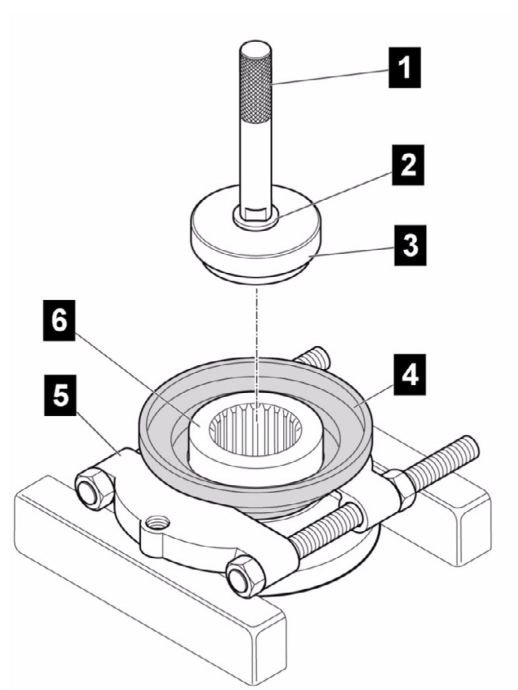
1. Fit the Separator (Item 75 from Special Tools List) under the shield. See “Fig. 2-36: Removing Input Flange Shield” on page 34.
2. Place the Separator and input flange on a press and support with suitable blocks.
3. Assemble the Pressing Plate (Item 74 from Special Tools List) with Detachable Handle (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

s132206a.jpg

Fig. 2-35: Removing Radial Shaft Seal



1. Detachable Handle
2. Thrust Washer
3. Pressing Plate
4. Input Flange Shield
5. Separator
6. Input Flange

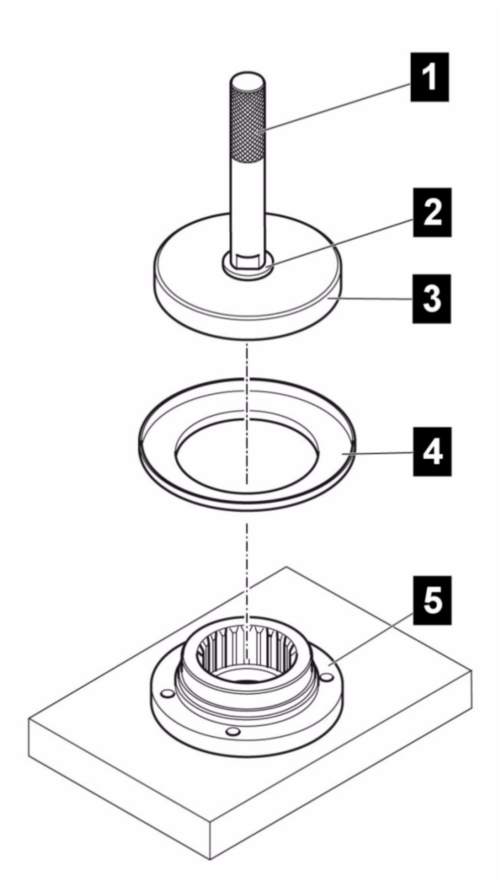
s132207a.jpg

Fig. 2-36: 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. 2-37: Installing Input Flange Shield” on page 35.



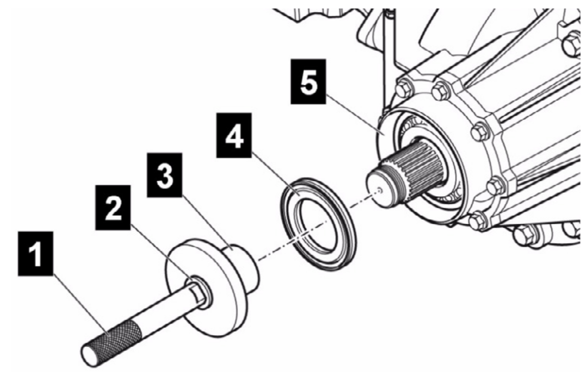
1. Detachable Handle
2. Thrust Washer
3. Pressing Plate
4. Input Flange Shield
5. Input Flange

s132208a.jpg

Fig. 2-37: 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. 2-38: Installing Radial Shaft Seal” on page 35.



1. Detachable Handle
2. Thrust Washer
3. Pressing Adapter
4. Radial Shaft Seal
5. Drive Pinion Gear Housing

s132209a.jpg

Fig. 2-38: 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

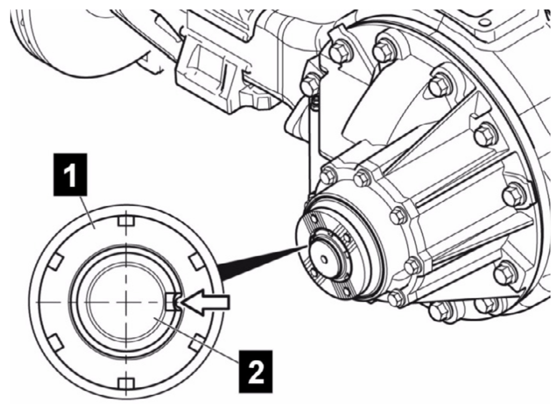
⚠CAUTION

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. 2-39: Locking Slotted Nut” on page 36.



1. Slotted Nut Collar
2. Input Shaft Groove

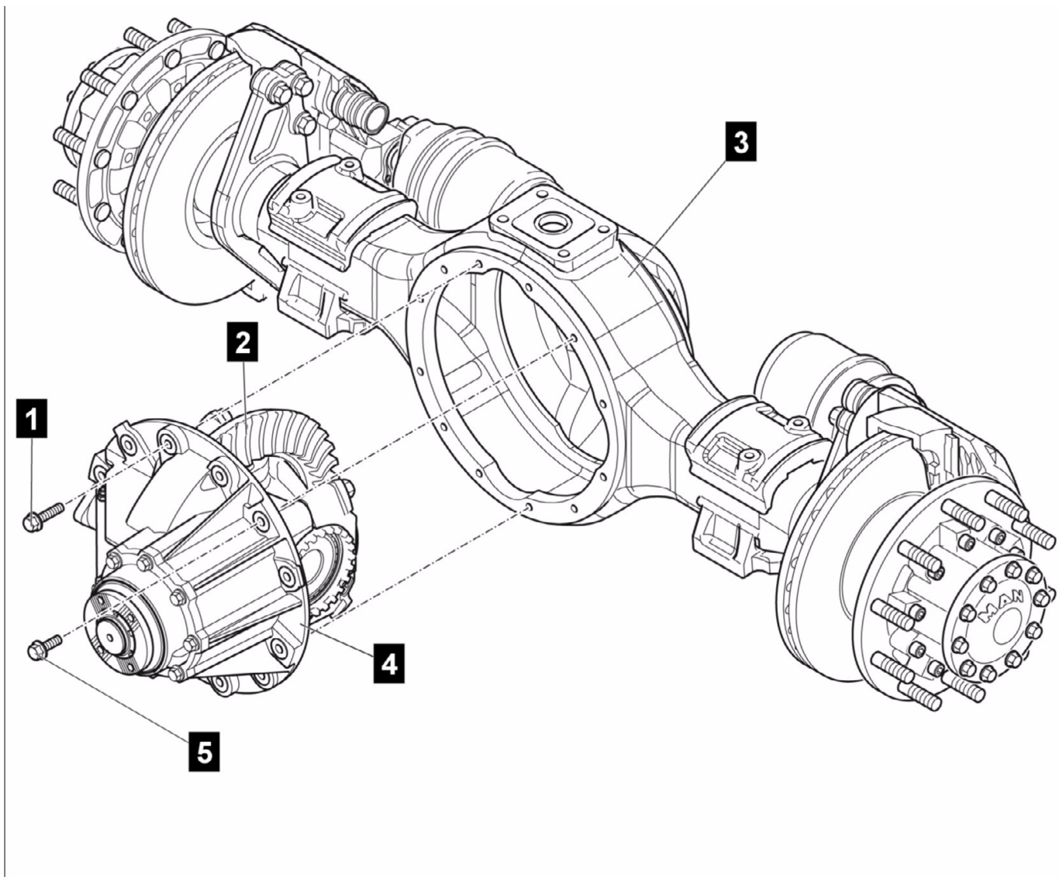
s132210a.jpg

Fig. 2-39: 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. 2-40: Differential Carrier Removal" on page 37.



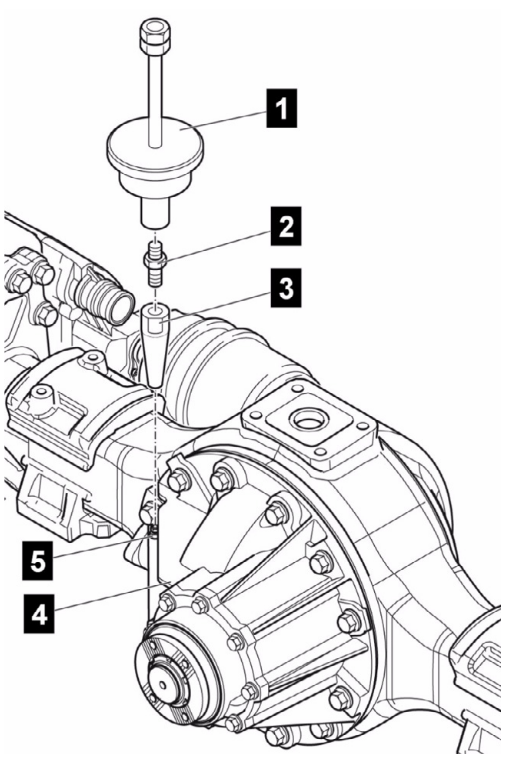
1. Mounting Bolt, M16 x 60 mm
2. Differential
3. Axle Housing
4. Differential Carrier
5. Mounting Bolt, M16 x 50 mm

s132211a.jpg

Fig. 2-40: 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. 2-41: Removing Axle Breather Connection" on page 38.
3. Thread the puller attachment onto the breather connection and use the slide hammer action to extract the breather.



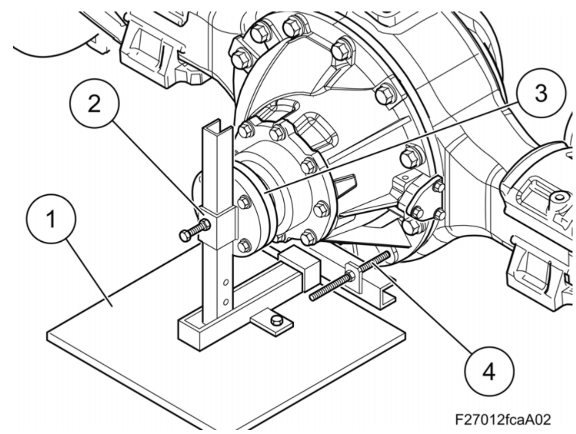
1. Extractor
2. Threaded Adapter
3. Tapered Adapter
4. Breather Pipe
5. Axle Gear Housing

s132212a.jpg

Fig. 2-41: 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. 2-42: Differential Carrier Lifting Device" on page 38.
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.jpg

Fig. 2-42: Differential Carrier Lifting Device

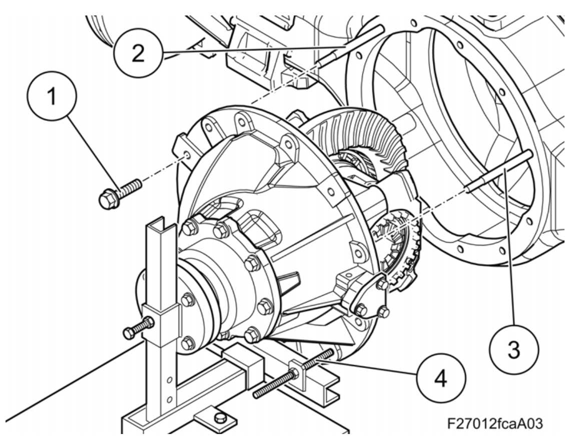
3.11.1.3.Removing Differential Carrier

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. 2-43: Differential Carrier Removal” on page 39.
3. Remove the remaining mounting bolts.
4. Use the lifting device to carefully slide the 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.jpg

Fig. 2-43: 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. 2-44: Axle Housing Oil Filter” on page 40.
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.

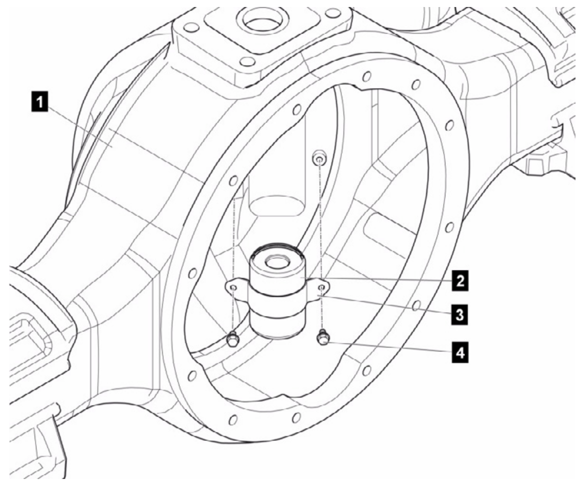
3. Mount the Lifting Device and Assembly Crown (Items 36 & 37 from Special Tools List) to the differential and secure it in place with the Support Screw (Item 38 from Special Tools List).
4. Use the hydraulic lift and adapter to position the lifting equipment and differential carrier assembly in line 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 273 ft-lb. (370 Nm).
11. Remove the support screw from the lifting device and install the last remaining bolt in its place and torque to 273 ft-lb. (370 Nm).
12. Remove the lifting equipment from the input flange.



1. Axle Housing
2. Oil Filter
3. Bracket
4. Mounting Bolt

s132213a.jpg

Fig. 2-44: Axle Housing Oil Filter

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.

3.12. Differential

3.12.1. Removal

The following procedure describes separating the differential from the differential carrier assembly. See “Fig. 2-47: Differential Carrier Assembly” on page 42.

3.12.1.1. Placing Differential Carrier in Stand

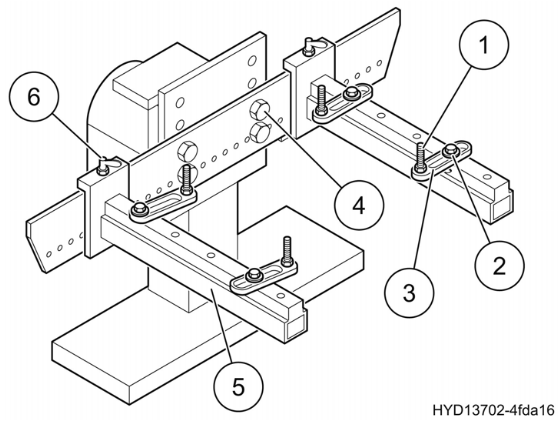
1. Install the Universal Support (Item 48 from Special Tools List) on the Engine Stand (Item 79 from Special Tools List) and tighten the mounting bolts. See “Fig. 2-45: Universal Support” on page 41.

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 41.

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.

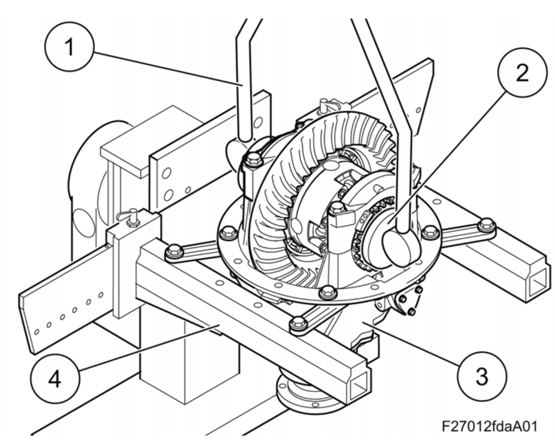
4. Remove lifting equipment from differential carrier.



1. Stud Bolts
2. Mounting Bolts
3. Sliders
4. Mounting Bolts
5. Universal Support
6. Cotter Pin

s126211a.jpg

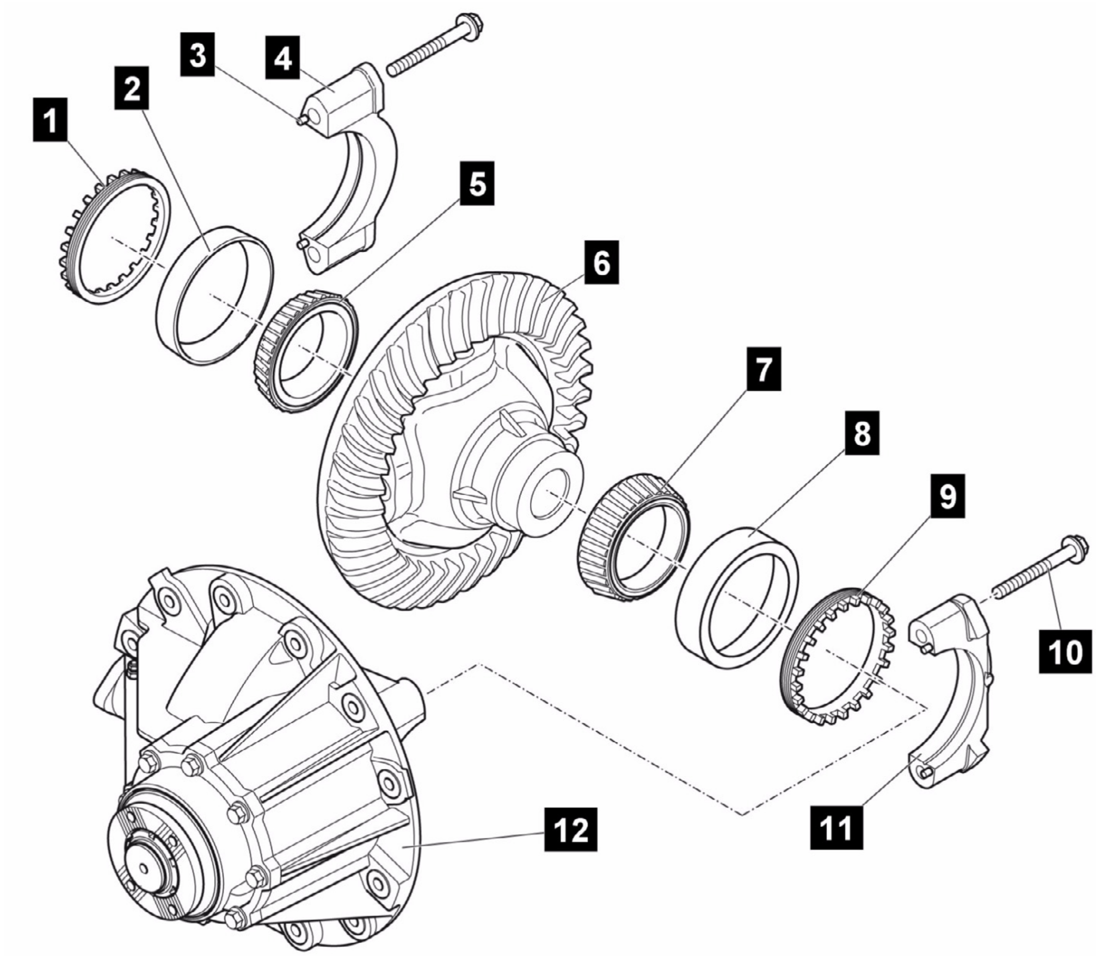
Fig. 2-45: Universal Support



1. Lifting Device
2. Attachment Plates
3. Drive Axle Housing
4. Universal Support

s126212a.jpg

Fig. 2-46: Positioning Differential Carrier in Stand



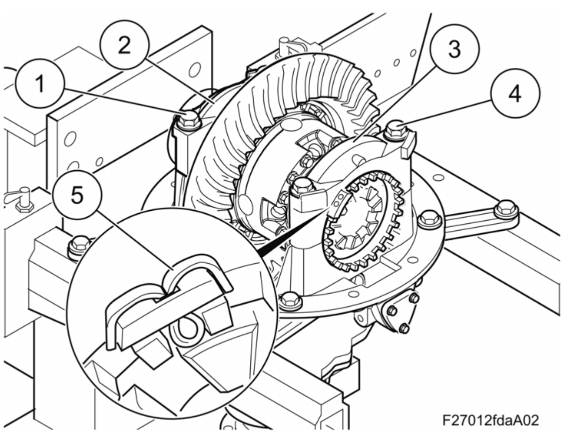
1. Threaded Bearing Adjuster
2. Bearing Outer Race
3. Locating Pin
4. Bearing Cap
5. Tapered Roller Bearing
6. Differential
7. Tapered Roller Bearing
8. Bearing Outer Race
9. Threaded Bearing Adjuster
10. Mounting Bolt
11. Bearing Cap
12. Axle Gear Housing

s132214a.jpg

Fig. 2-47: Differential Carrier Assembly

3.12.1.2.Removing Bearing Caps & Adjusters

1. Remove the split locking pins for the bearing adjusters on both sides. See “Fig. 2-48: Removing Bearing Caps” on page 43.
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.



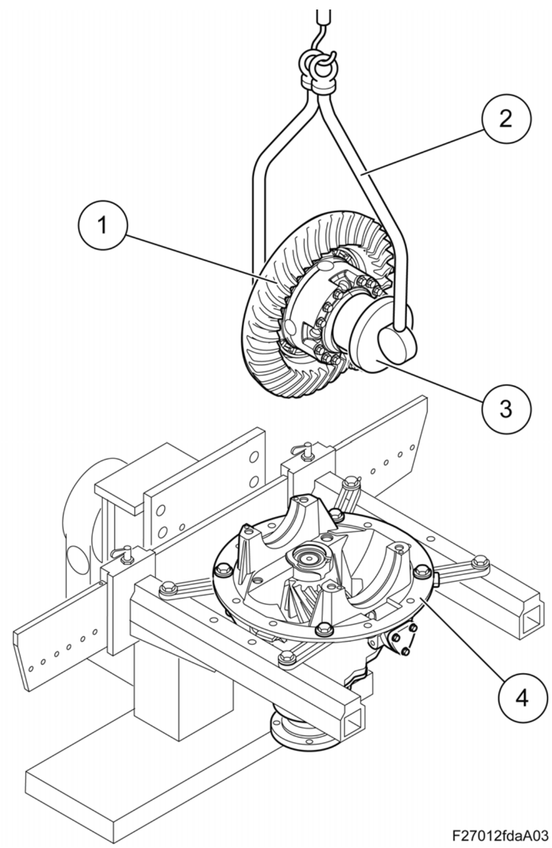
1. Bearing Cap Bolt
2. Bearing Cap
3. Bearing Cap
4. Bearing Cap Bolt
5. Split Locking Pin

s126213a.jpg

Fig. 2-48: Removing Bearing Caps

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. 2-49: Removing Differential Assembly” on page 43.
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. Differential Assembly
2. Lifting Device
3. Attachment Plates
4. Drive Axle Housing

s126214a.jpg

Fig. 2-49: Removing Differential Assembly

3.12.2. Installation

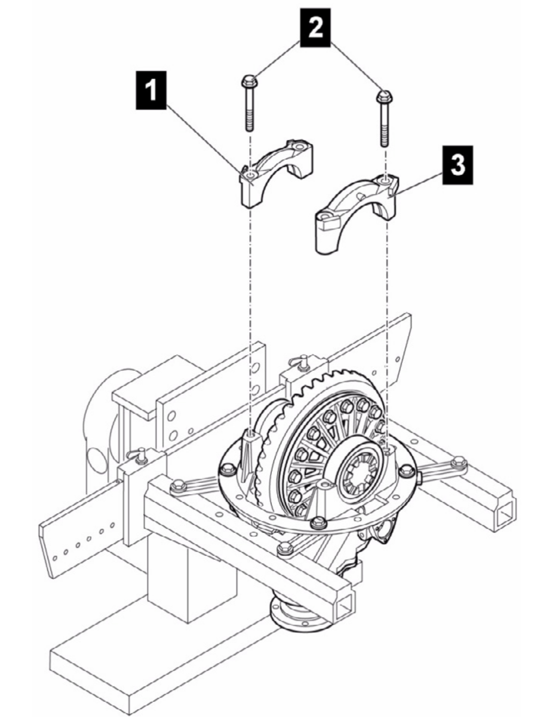
The following procedure describes installing the differential into the differential carrier assembly.

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

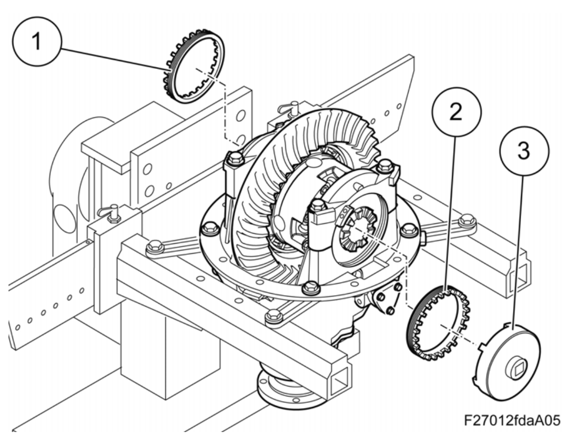
1. Refer to the markings made during removal and position the bearing caps in their original location. See “Fig. 2-50: Bearing Cap Installation” on page 44.
2. Install new mounting bolts and torque to first stage of tightening 44 ft-lbs. (60 Nm).
3. Apply a thin layer of gear oil on the threaded adjusters retainers and then thread them in until lightly seated against the bearings. See “Fig. 2-51: Bearing Adjusters” on page 44.
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 58 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

s132215a.jpg

Fig. 2-50: Bearing Cap Installation



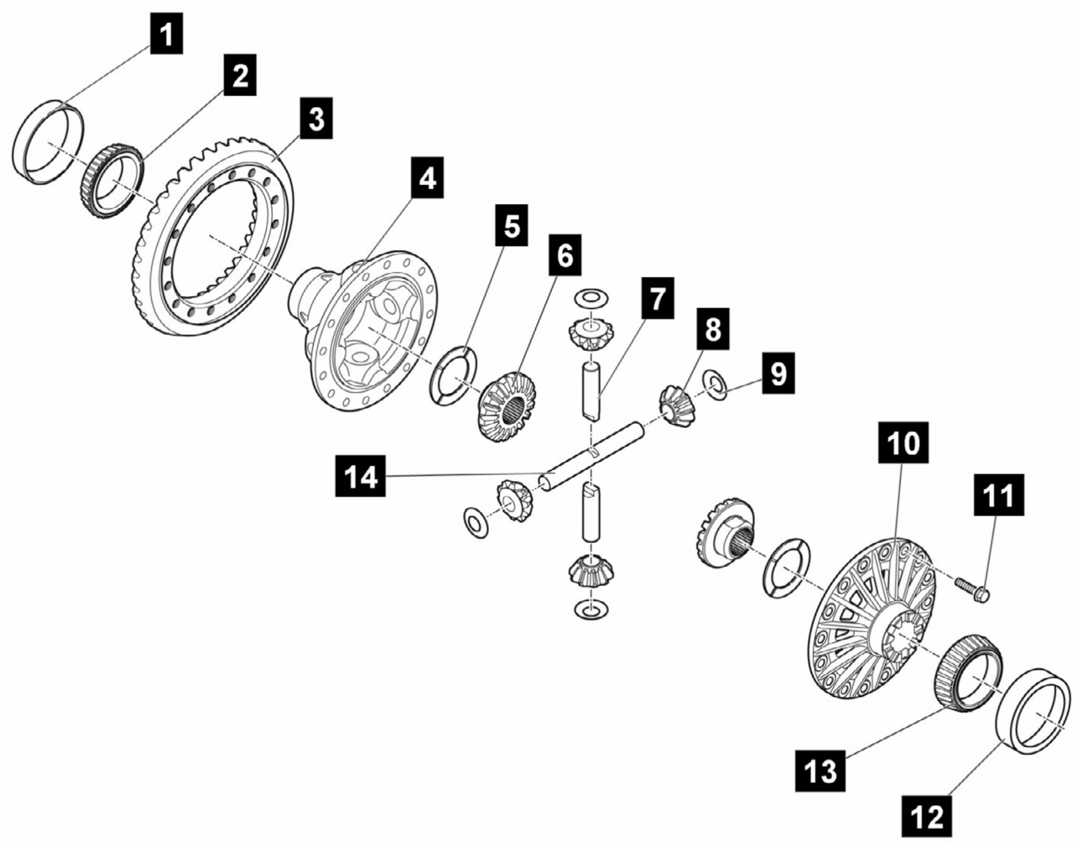
1. Bearing Adjuster
2. Bearing Adjuster
3. Slotted Nut Wrench

s126215a.jpg

Fig. 2-51: 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. 2-52: Differential Assembly” on page 45.



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.jpg

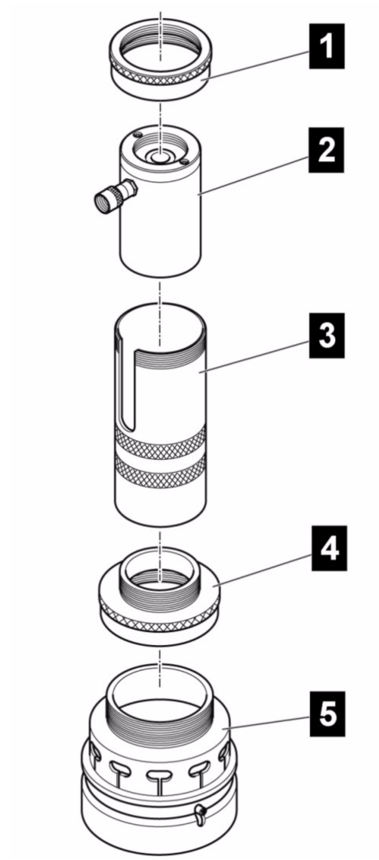
Fig. 2-52: Differential Assembly

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.

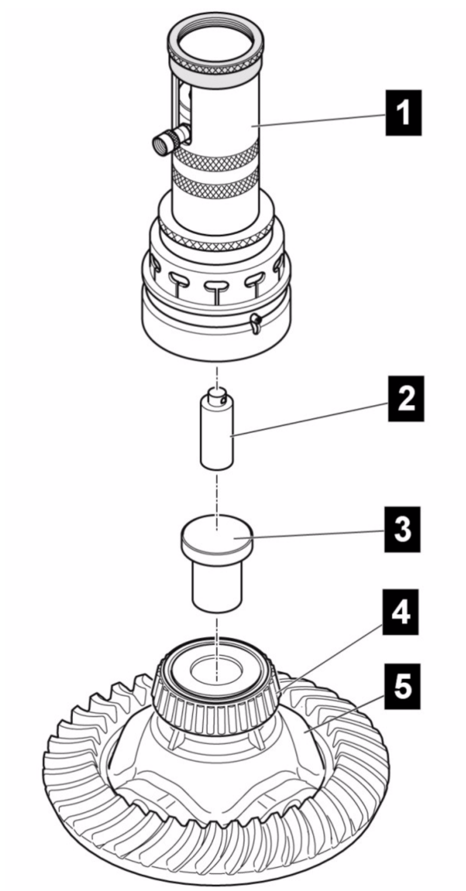
1. Assemble the hydraulic puller as follows:
   a. Install the Threaded Adapter (Item 80 from Special Tools List) onto the Bearing Gripper (Item 93 from Special Tools List). See “Fig. 2-53: Hydraulic Bearing Puller Tool Assembly” on page 46.
   b. Install the Cylinder Support (Item 81 from Special Tools 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. 2-54: Attaching Hydraulic Puller” on page 47.
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. 2-55: Attaching Hydraulic Pump” on page 47.
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.jpg

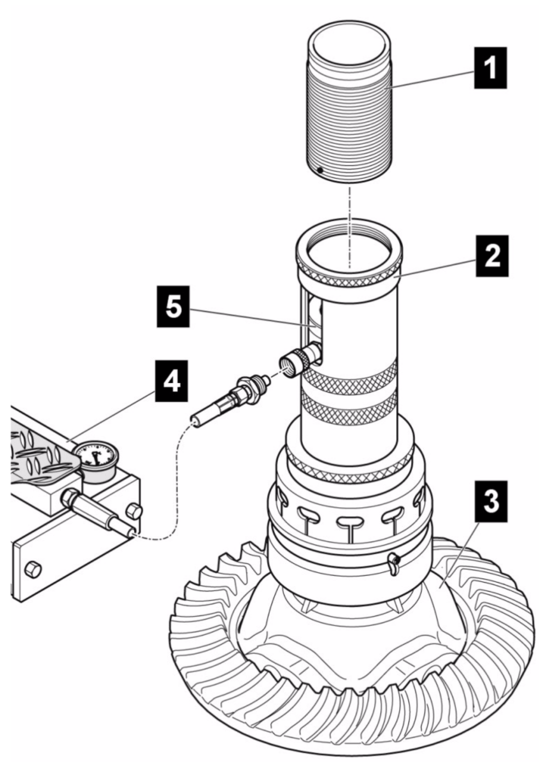
Fig. 2-53: Hydraulic Bearing Puller Tool Assembly



1. Puller
2. Thrust Piece, Hydraulic Puller
3. Thrust Piece, Differential
4. Tapered Roller Bearing
5. Differential

s132218a.jpg

Fig. 2-54: Attaching Hydraulic Puller



1. Threaded Sleeve
2. Cap
3. Differential
4. Hydraulic Pump
5. Hollow Piston Cylinder

s132219a.jpg

Fig. 2-55: Attaching Hydraulic Pump

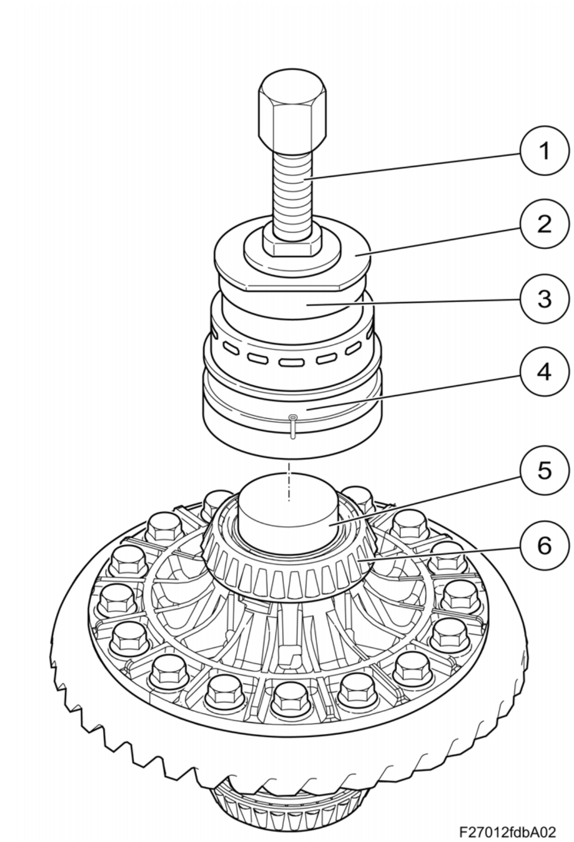
3.12.3.2. Removing Tapered Roller Bearings (Mechanical Method)

1. Insert the Differential Thrust Piece (Item 50 from Special Tools List) into differential. See "Fig. 2-56: Attaching Mechanical Puller" on page 48.
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. 2-56: Attaching Mechanical Puller" on page 48.
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.jpg

Fig. 2-56: Attaching Mechanical Puller

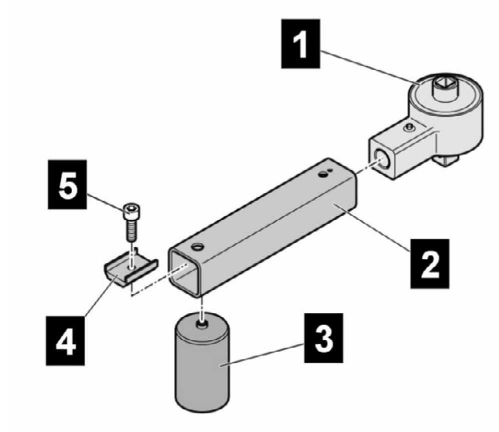
3.12.3.3.Special Tool Assembly

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. 2-57: Special Tool Assembly” on page 49.

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.jpg

Fig. 2-57: Special Tool Assembly

3.12.3.4. Removing Crown Gear & Differential Cover

CAUTION

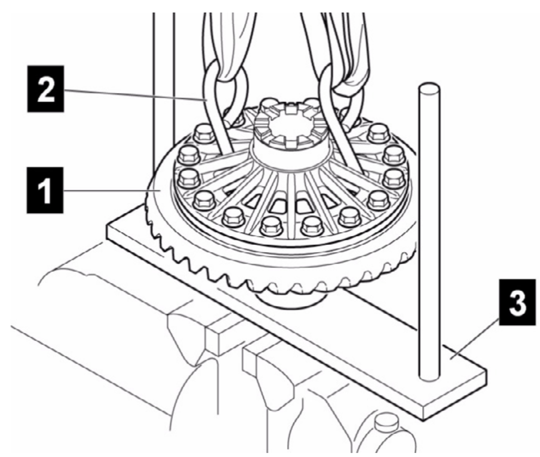
Due to the danger of injury when working with heavy components, the use of a suitable lifting device is required.

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. 2-58: Positioning Differential on Assembly Device" on page 50.
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. 2-59: Crown Gear Bolt Loosening" on page 51.
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. 2-60: Marking Crown Gear" on page 51.
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.

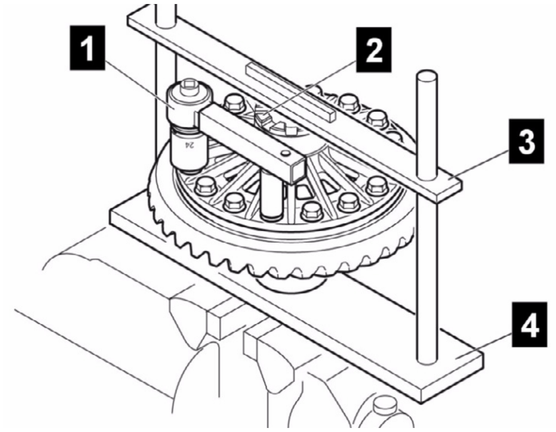
12. Remove remaining crown gear bolts.
13. Drive the crown gear off the differential housing by alternately striking each of the three securing bolts with a hammer.
14. Support the crown gear and remove the three securing bolts.
15. Separate cover from differential housing.



1. Differential
2. Lifting Hook & Strap
3. Assembly Device

s132221a.jpg

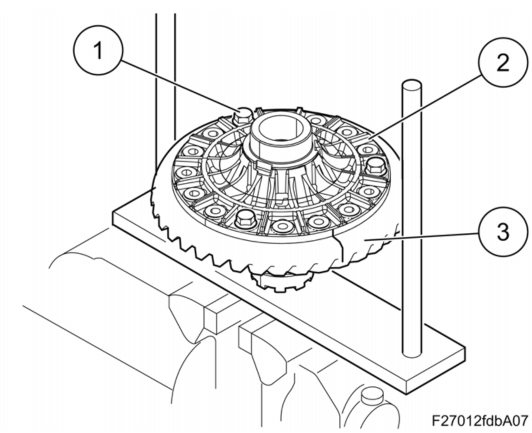
Fig. 2-58: Positioning Differential on Assembly Device



1. Special Tool
2. Lock Teeth
3. Counter Brace
4. Differential Assembling Device

s132222a.jpg

Fig. 2-59: Crown Gear Bolt Loosening



1. Securing Bolt
2. Differential Carrier
3. Crown Gear

s126228a.jpg

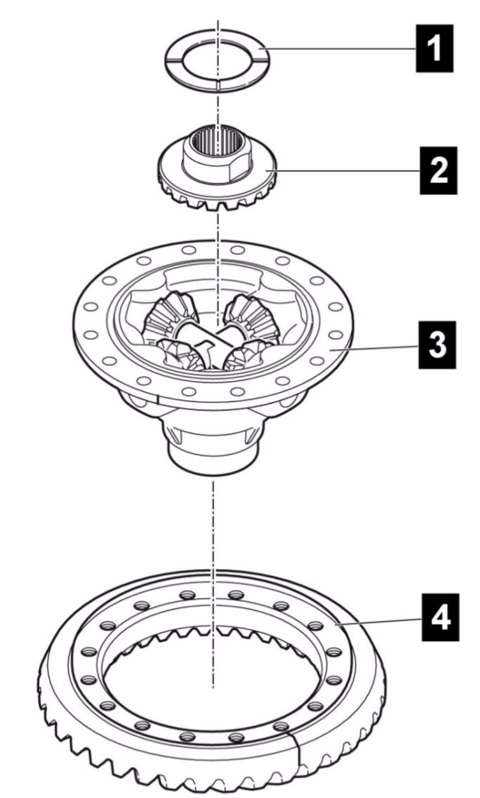
Fig. 2-60: Marking Crown Gear

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.

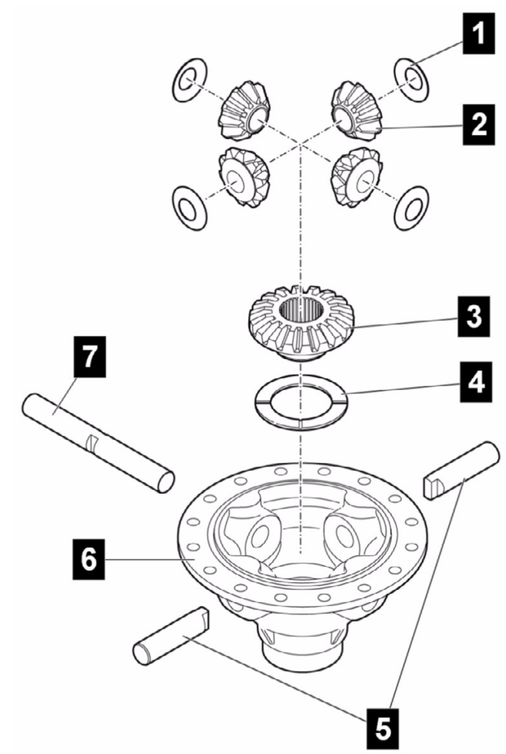
1. Remove the differential side gear and thrust washer from the differential housing. See “Fig. 2-61: Differential Side Gear” on page 52.
2. Pull the differential pins (two pieces) out of the differential housing, then pull out the single piece pin. See “Fig. 2-62: Differential Pinion Gears” on page 52.
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

s132223a.jpg

Fig. 2-61: 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

s132224a.jpg

Fig. 2-62: 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:

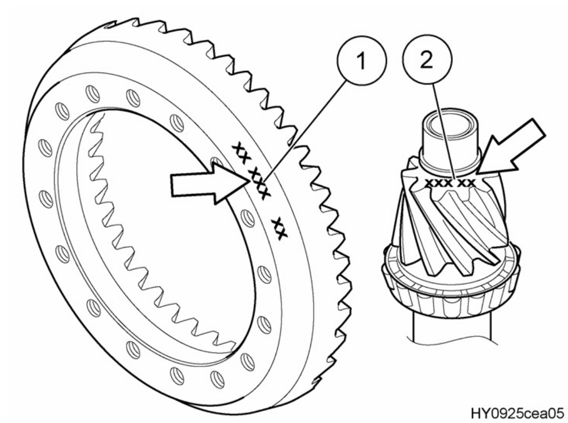
- If impact wrenches are used, these may only be used for pre-tightening to a maximum of 50% of the final torque value. Final tightening must always be performed manually using a torque wrench.
- Always replace crown gear and pinion drive gear as a set. The pairing numbers are stamped on the parts as 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. 2-63: Gear Pairing Numbers” on page 53.
2. Install the gear set in an drive axle housing corresponding to the ratio.



1. Gear Pairing Number
2. Gear Pairing Numbers

s126233a.jpg

Fig. 2-63: 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.

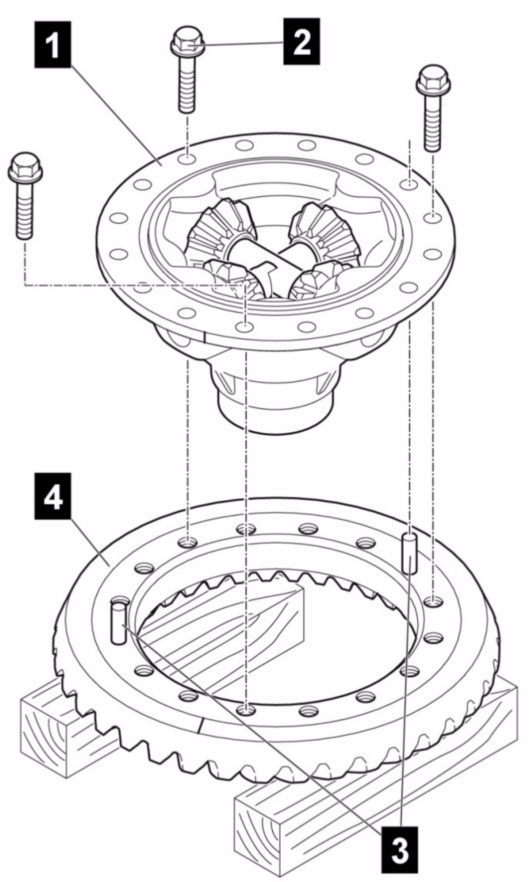
5. Insert the two-piece differential pins through the differential pinion gears and into the corresponding slot of the single-piece pin.

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. 2-64: Installing Crown Gear” on page 54.
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.jpg

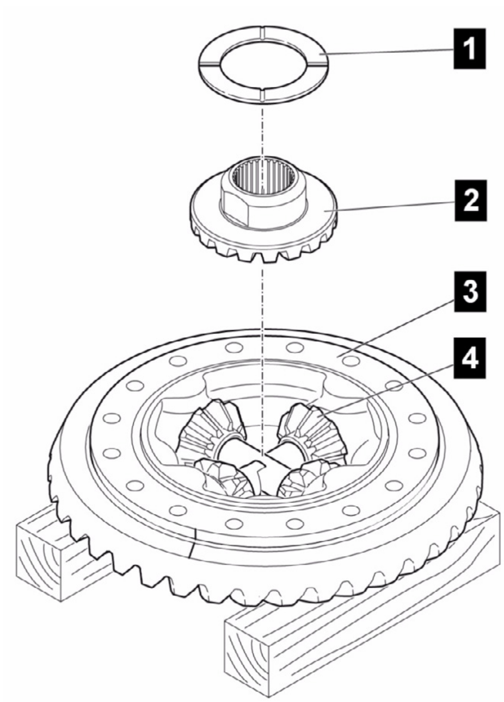
Fig. 2-64: Installing Crown Gear

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. 2-66: Installing Differential Housing Cover" on page 55.
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

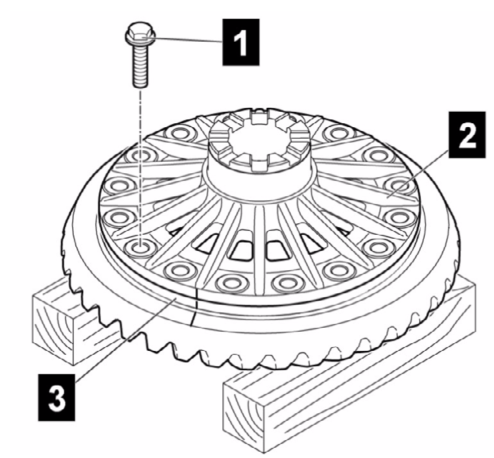
1. Install the differential housing cover on differential housing, ensuring that markings are aligned. See "Fig. 2-66: Installing Differential Housing Cover" on page 55.
2. Install new mounting bolts and hand-tighten only at this time.



1. Thrust Washer
2. Side Gear
3. Differential Housing
4. Pinion Gears

s132226a.jpg

Fig. 2-65: Installing Differential Side Gear



1. Mounting Bolt
2. Differential Housing Cover
3. Differential Housing

s132227a.jpg

Fig. 2-66: Installing Differential Housing Cover

3.12.4.6.Tightening Crown Gear Mounting Bolts

CAUTION

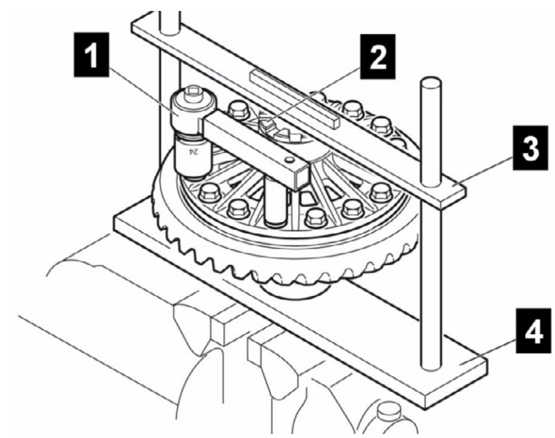
Due to the danger of injury when working with heavy components, the use of a suitable lifting device is required.

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. 2-67: Installing Special Tool” on page 56.
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.jpg

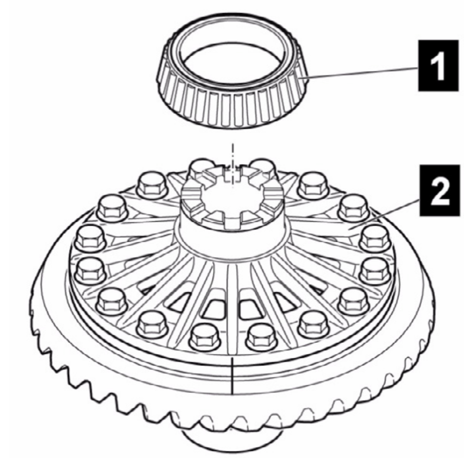
Fig. 2-67: Installing Special Tool

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.

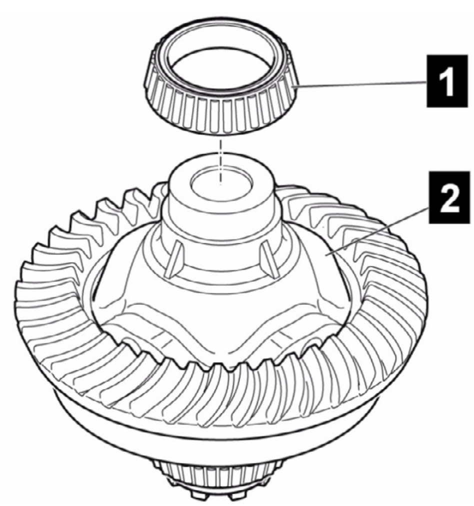
1. Lift the differential off the assembly device using Hooks and Lifting Strap (Items 84 & 62 from Special Tools List).
2. Move differential to work bench and support with crown gear teeth facing down.
3. Remove lifting equipment.
4. Heat the tapered roller bearing to 250°F (120°C).
5. Use protective gloves and install tapered roller bearing onto differential bearing journal, ensuring bearing is fully seated. See "Fig. 2-68: Installing Tapered Roller Bearing on Lock Side" on page 57.
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. 2-69: Installing Tapered Roller Bearing on Differential Side" on page 57.



1. Tapered Roller Bearing
2. Differential

s132228a.jpg

Fig. 2-68: Installing Tapered Roller Bearing on Lock Side



1. Tapered Roller Bearing
2. Differential

s132229a.jpg

Fig. 2-69: 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.

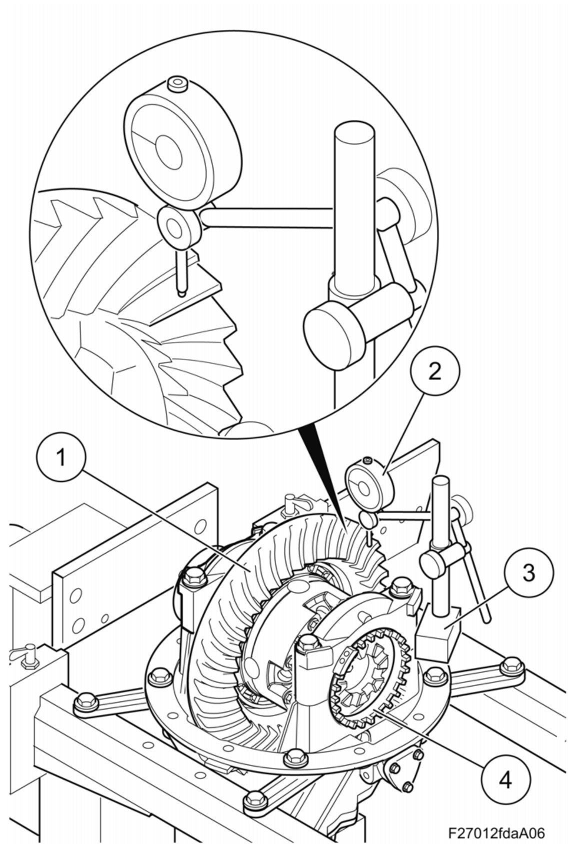
3.12.5.1. Backlash Adjustment

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. 2-70: Backlash Adjustment” on page 58.
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

s126216a.jpg

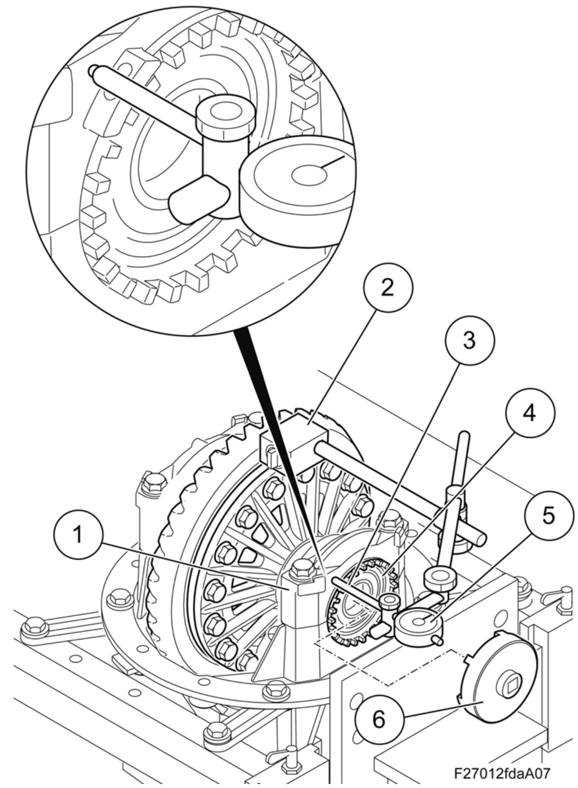
Fig. 2-70: Backlash Adjustment

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).

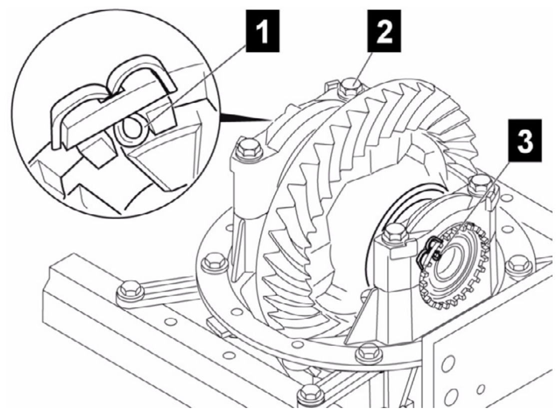
1. Torque bearing cap mounting bolts to final torque setting of 391 ft-lbs. (530 Nm) using Torque Wrench and Square Drive (Items 96 & 39 from Special Tools List).
2. Loosen the threaded bearing adjuster on the differential housing cover side using Slotted Nut Wrench (Item 46 from Special Tools List).
3. Place Dial Gauge Holder with Dial Gauge (Items 45 & 44 from Special Tools List) on the crown gear. See "Fig. 2-71: Setting Bearing Preload Adjustment" on page 59.
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. 2-72: Locking Threaded Bearing Adjusters" on page 60.



1. Bearing Cap
2. Dial Gauge Holder
3. Dial Gauge Tip
4. Bearing Adjuster
5. Dial Gauge
6. Grooved Nut Socket

s126217a.jpg

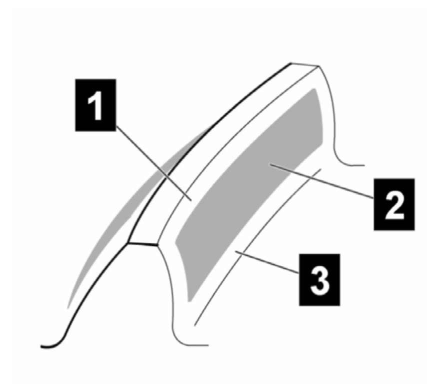
Fig. 2-71: Setting Bearing Preload Adjustment



1. Split Pin
2. Bearing Cap Mounting Bolt
3. Split Pin

s132230a.jpg

Fig. 2-72: Locking Threaded Bearing Adjusters



1. Tooth Tip
2. Correct Contact Pattern
3. Tooth Root

s132231a.jpg

Fig. 2-73: 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. 2-73: Contact Pattern on Crown Gear” on page 60.
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. 2-74: Contact on Tooth Tip” on page 61.
2. Recheck backlash and adjust as necessary. Refer to 3.12.5.1. “Backlash Adjustment” on page 58 in this section for procedure.

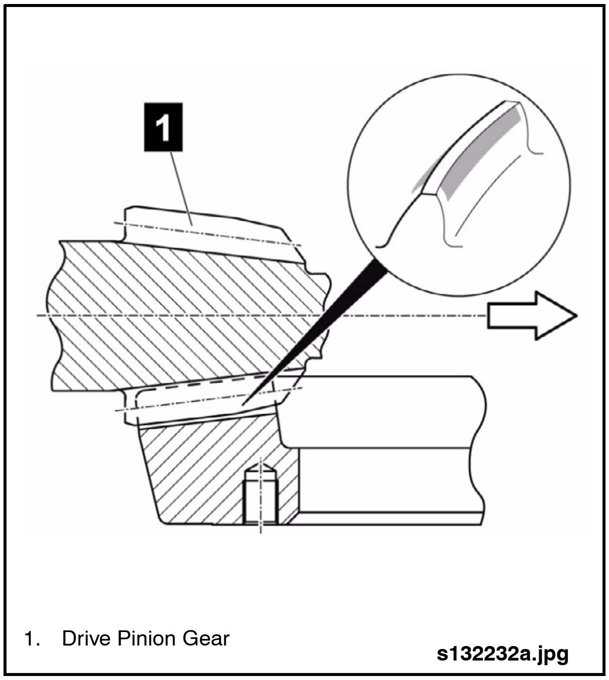


Fig. 2-74: Contact on Tooth Tip

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. 2-75: Contact on Tooth Root” on page 61.
2. Recheck backlash and adjust as necessary. Refer to 3.12.5.1. “Backlash Adjustment” on page 58 in this section for procedure.

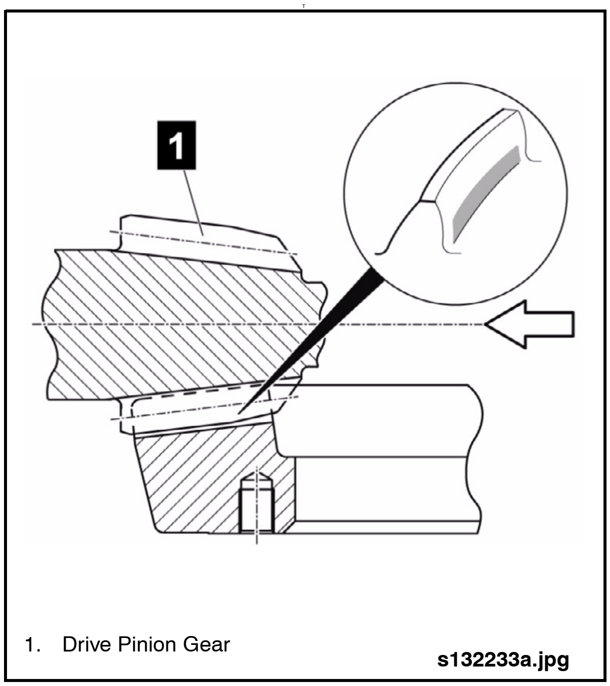


Fig. 2-75: Contact on Tooth Root

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. 2-76: Drive Pinion Gear Installation” on page 62.

CAUTION

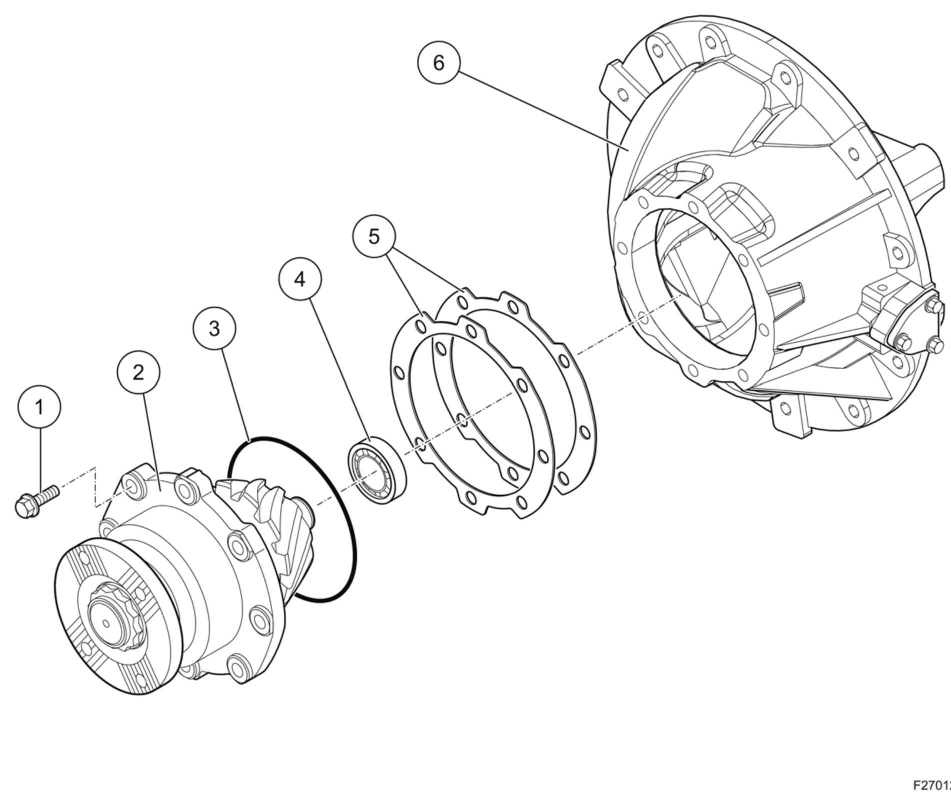
Components can be damaged due to incorrectly tightened fasteners. If impact wrenches are used, these may only be used for pre-tightening to a maximum of 50% of the specified final torque value. Final tightening must always be performed manually using a torque wrench.

☞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

s126238a.jpg

Fig. 2-76: Drive Pinion Gear Installation

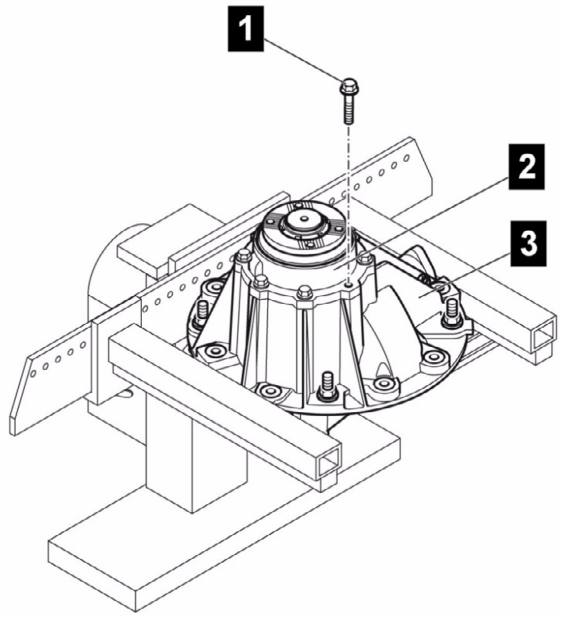
3.13.2. Removal

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. 2-77: Drive Pinion Gear Housing Removal” on page 63.
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.

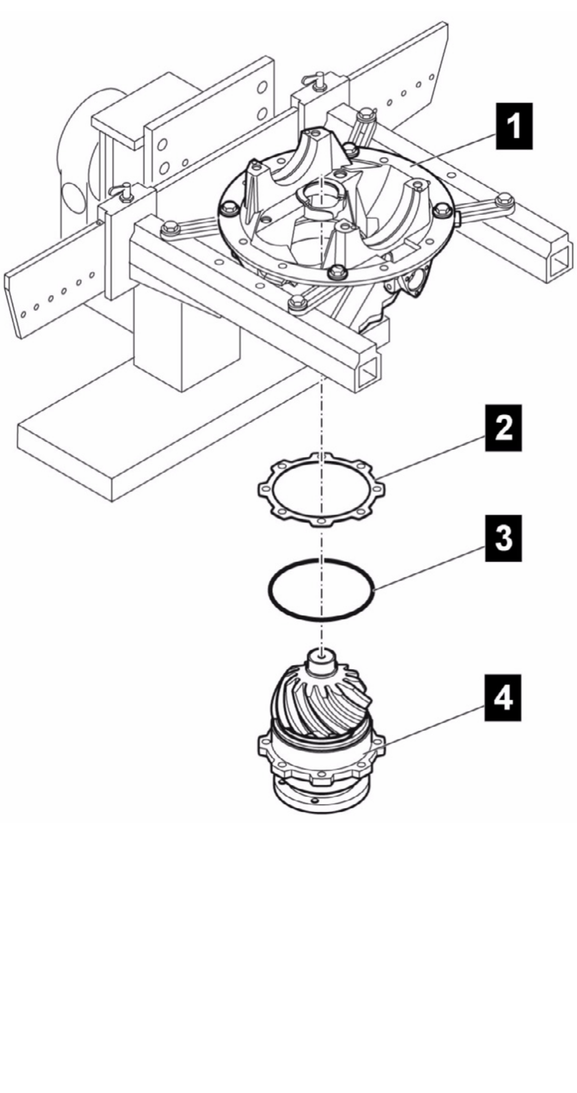
4. Rotate the axle gear housing 180° so that the input flange is facing down. See “Fig. 2-78: Pressing Out Drive Pinion Gear Housing” on page 64.
5. Place a suitable support beneath the drive pinion gear housing so that it does not fall to the floor when pressed out.
6. Press out the drive pinion gear 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

s132234a.jpg

Fig. 2-77: Drive Pinion Gear Housing Removal



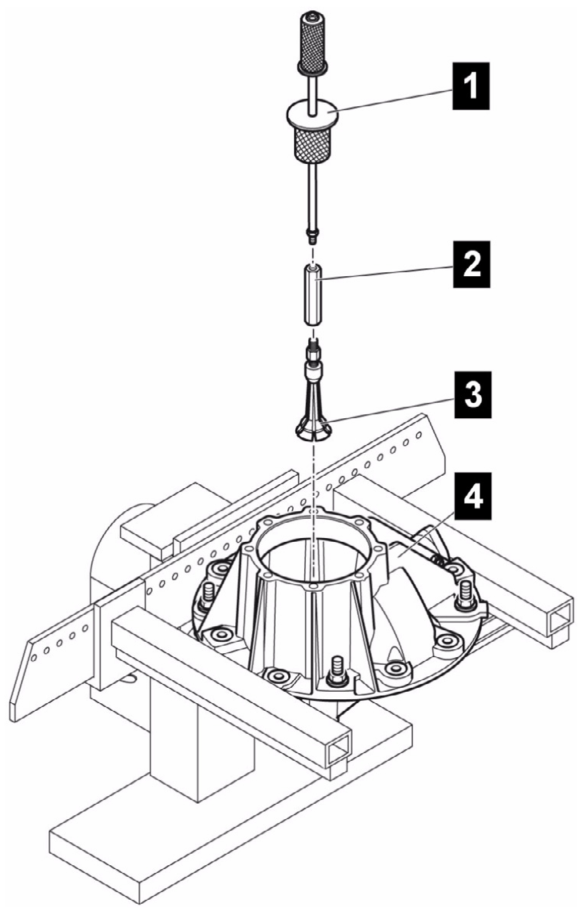
1. Axle Gear Housing
2. Shims
3. O-Ring
4. Drive Pinion Gear Housing

s132235a.jpg

Fig. 2-78: 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. 2-79: Removing Roller Bearing” on page 64.
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.jpg

Fig. 2-79: Removing Roller Bearing

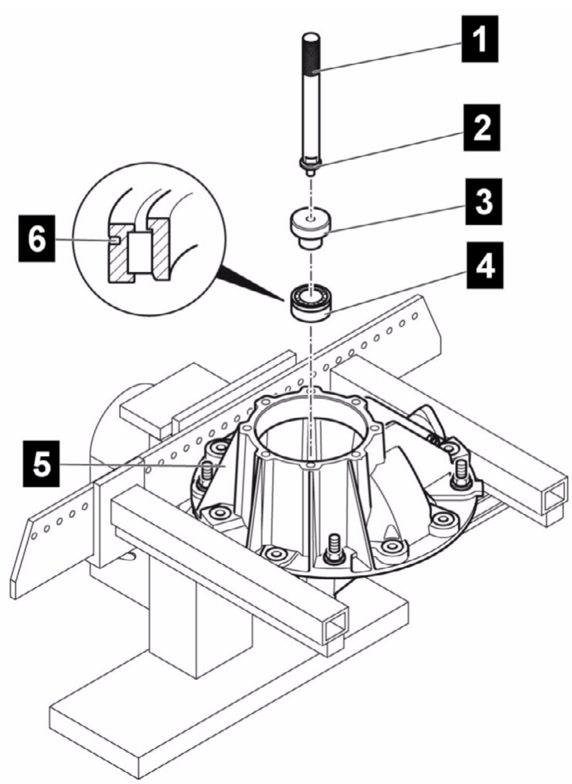
3.13.3. Installation

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. 2-80: Installing Roller Bearing” on page 65.

3.13.3.2. Installing Shims

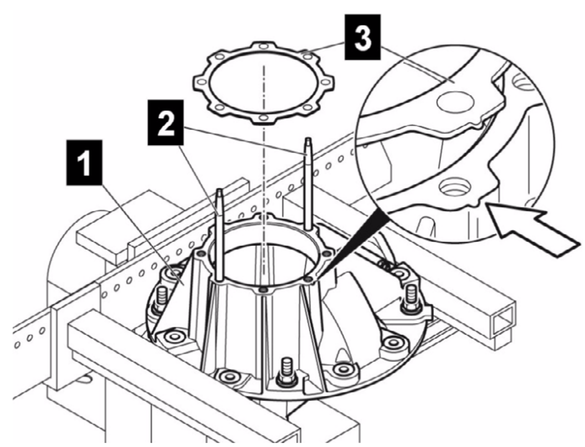
1. Thread Centering Pins (Item 78 from Special Tools List) into axle gear housing.
2. Install shims so that the lug on the shim aligns with the lug marking on the axle gear housing. See “Fig. 2-81: Installing Shims” on page 65.



1. Detachable Handle
2. Thrust Washer
3. Pressing Adapter
4. Roller Bearing
5. Axle Gear Housing
6. Roller Bearing Groove

s132237a.jpg

Fig. 2-80: Installing Roller Bearing



1. Axle Gear Housing
2. Centering Pins
3. Shim Lug

s132238a.jpg

Fig. 2-81: Installing Shims

3.13.3.3.Installing Drive Pinion Gear Housing

CAUTION

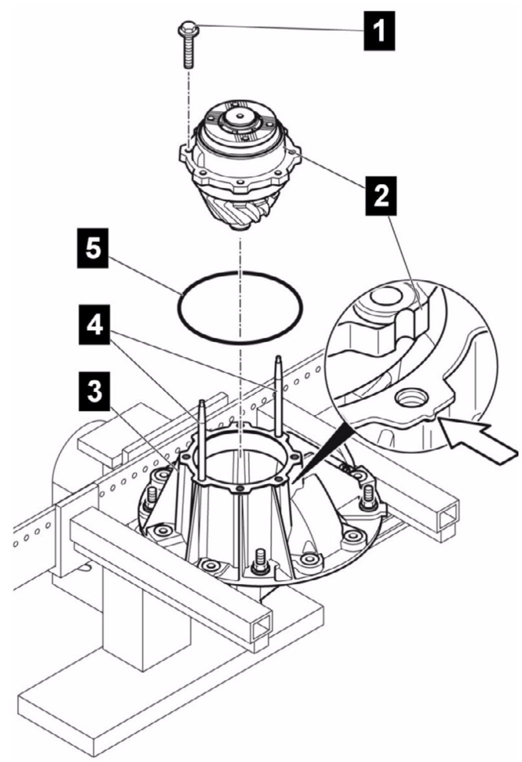
Due to the danger of injury when working with heavy components, the use of a suitable lifting device is required.

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. 2-82: Installing Drive Pinion Gear Housing” on page 66.

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.jpg

Fig. 2-82: 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. 2-83: Installing Input Flange Without Seal” on page 68.
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 36 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. 2-84: Mounting Friction Tester” on page 68.
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.

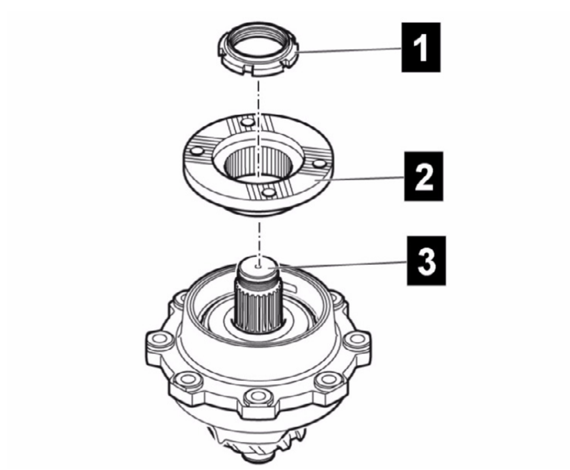


Fig. 2-83: Installing Input Flange Without Seal

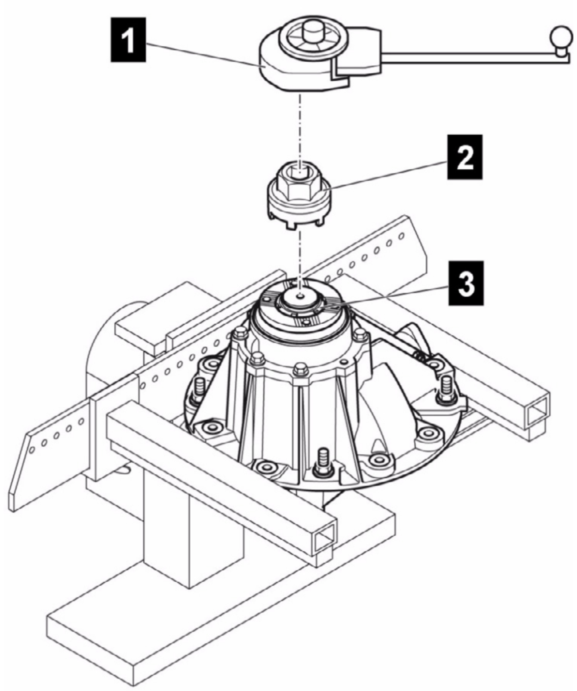


Fig. 2-84: Mounting Friction Tester

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. 2-85: Pinion Depth” on page 69.
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. 2-86: Dimension “C”” on page 69.
6. Subtract Dimension “A” from Dimension “C” and record the result as Dimension “S”.

☞NOTE:

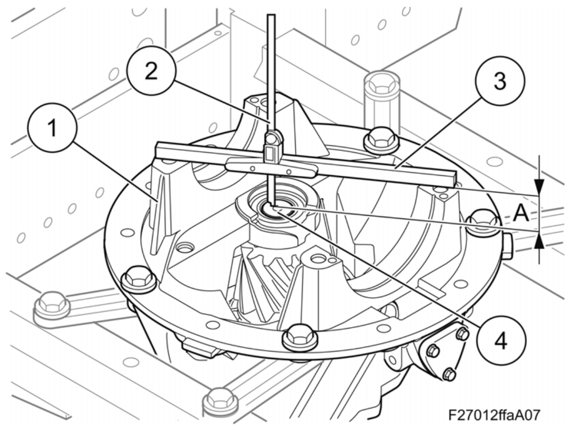
Dimension “S” is the required shim thickness.

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

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Fig. 2-85: Pinion Depth

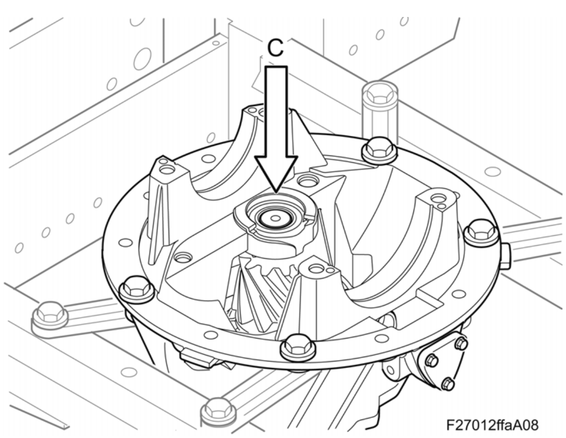

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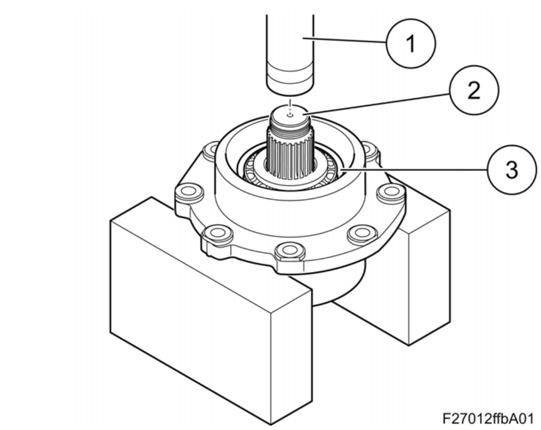
Fig. 2-86: Dimension "C"

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. 2-87: Removing Drive Pinion Gear" on page 69.
2. Remove the outer tapered roller bearing from the drive pinion gear housing. See "Fig. 2-88: Drive Pinion Gear Assembly" on page 70.
3. Remove the shim and spacer from the drive pinion gear.



1. Hydraulic Press
2. Drive Pinion Gear
3. Tapered Roller Bearing

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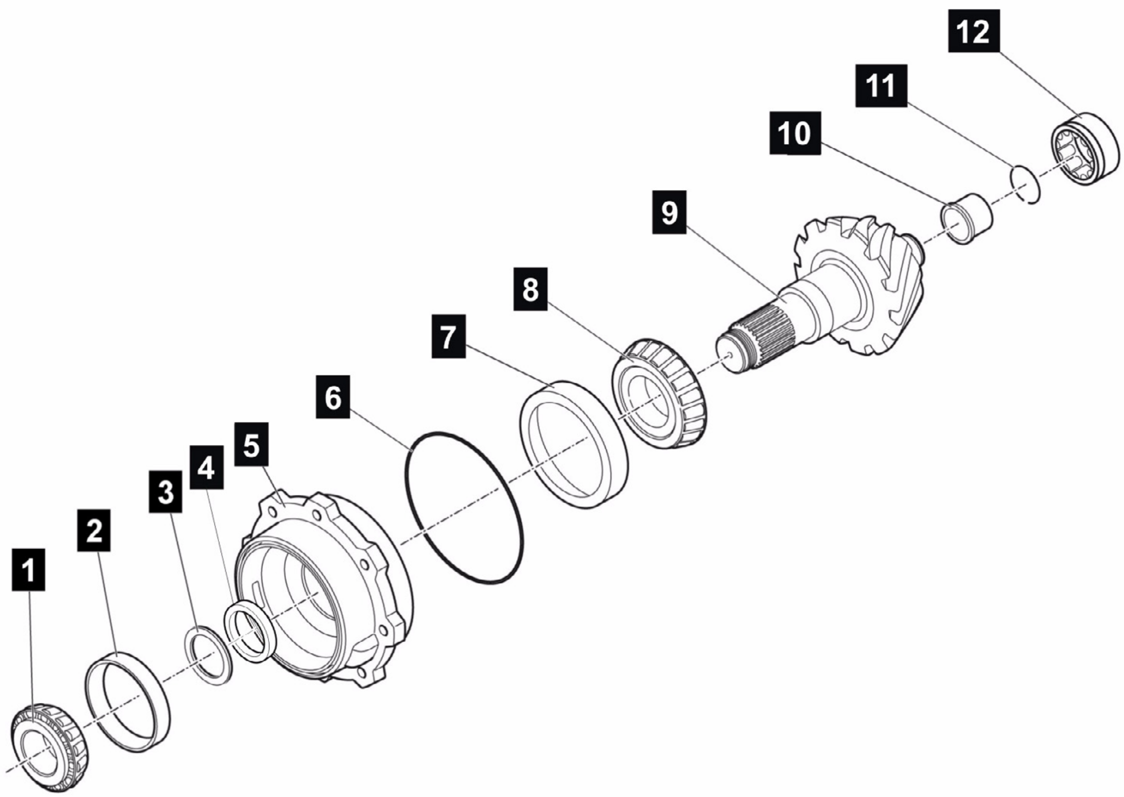
Fig. 2-87: Removing Drive Pinion Gear



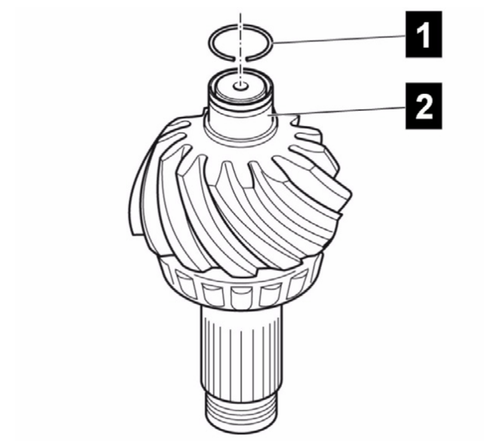
1. Outer Tapered Roller Bearing
2. Outer Bearing Outer Race
3. Shim
4. Spacer
5. Drive Pinion Gear Housing
6. O-Ring
7. Inner Bearing Outer Race
8. Inner Tapered Roller Bearing
9. Drive Pinion Gear
10. Roller Bearing Race
11. Circlip
12. Roller Bearing

s132242b.jpg

Fig. 2-88: 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. 2-89: Removing Bearing Circlip" on page 71.
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. 2-90: Removing Drive Pinion Inner Bearing Race" on page 71.
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

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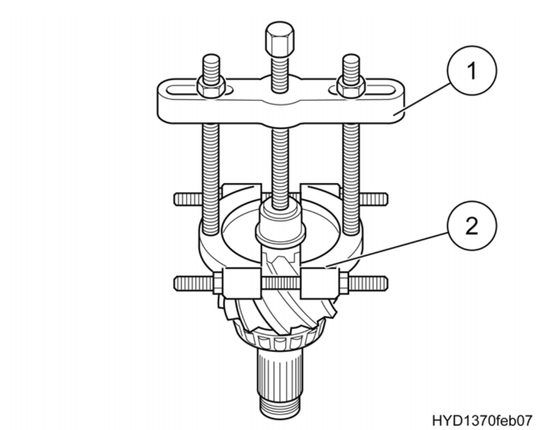
Fig. 2-89: Removing Bearing Circlip



1. Puller
2. Separator

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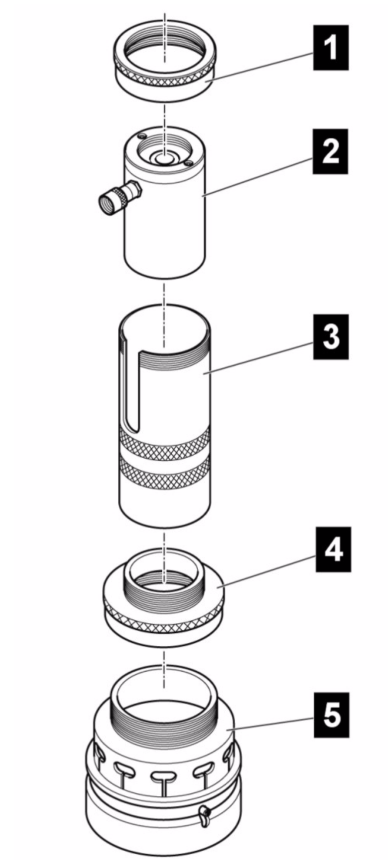
Fig. 2-90: Removing Drive Pinion Inner Bearing Race

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. 2-91: Hydraulic Bearing Puller Tool Assembly” on page 72.
   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. 2-92: Attaching Hydraulic Puller” on page 73.
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. 2-93: Attaching Hydraulic Pump” on page 73.
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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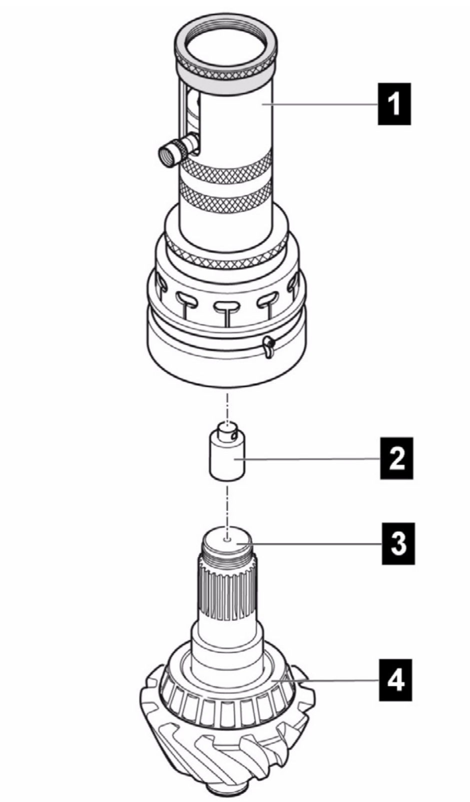
Fig. 2-91: Hydraulic Bearing Puller Tool Assembly



1. Puller
2. Thrust Piece
3. Drive Pinion Gear
4. Tapered Roller Bearing

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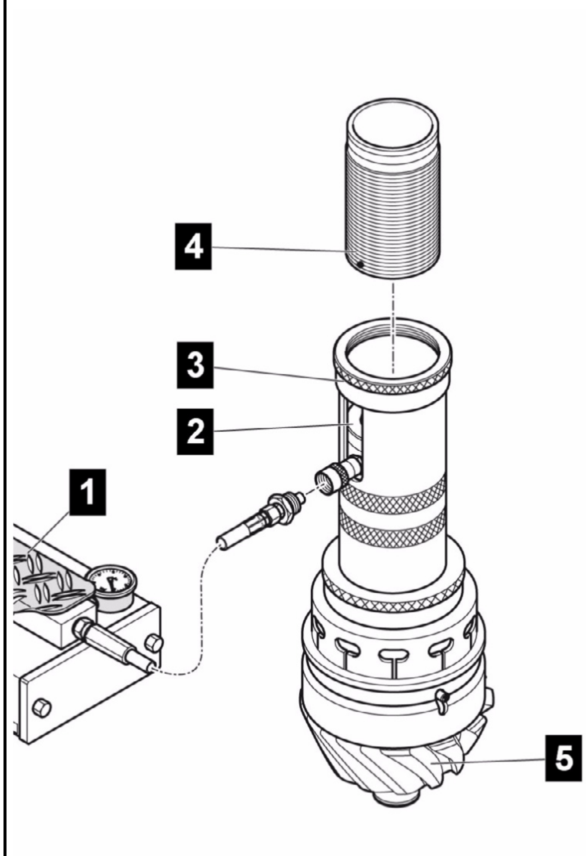
Fig. 2-92: Attaching Hydraulic Puller



1. Hydraulic Pump
2. Hollow Piston Cylinder
3. Cap
4. Threaded Sleeve
5. Drive Pinion Gear

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Fig. 2-93: Attaching Hydraulic Pump

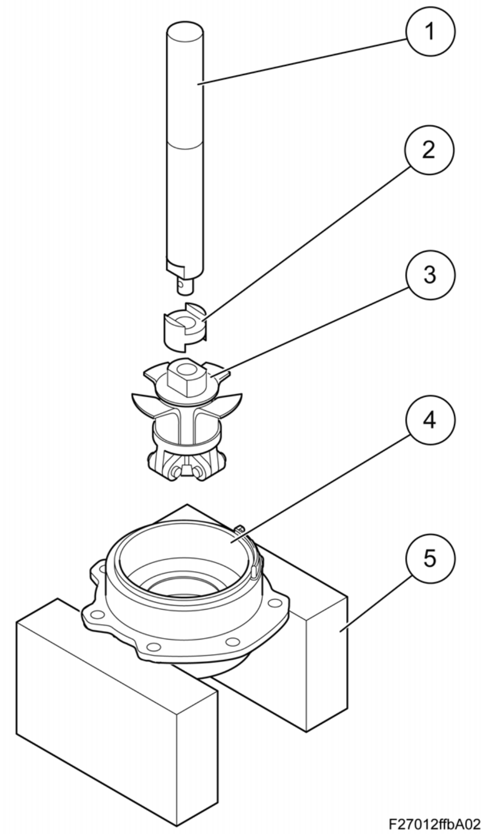
3.13.4.4.Removing Outer Bearing Outer Race

1. Position the drive pinion gear housing on support blocks with the input end facing down. See "Fig. 2-94: Removing Outer Bearing Outer Race" on page 74.
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. 2-94: Removing Outer Bearing Outer Race

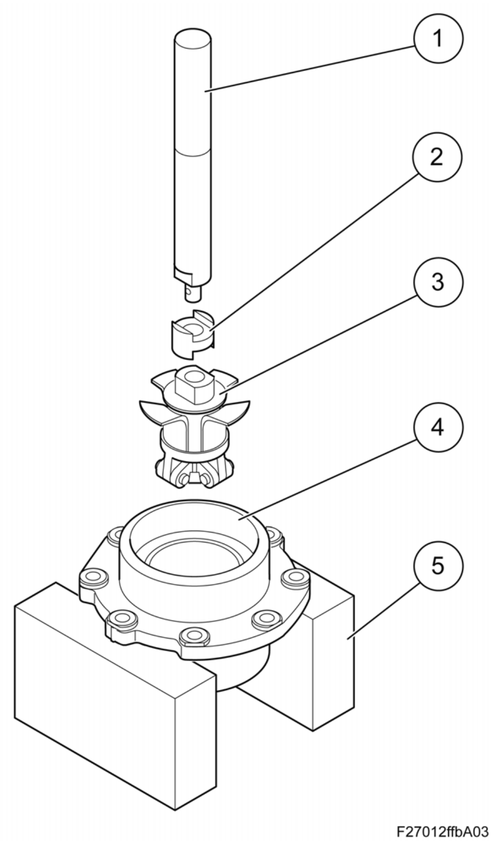
3.13.4.5.Removing Inner Bearing Outer Race

1. Reposition the drive pinion gear housing on support blocks with the input end facing up. See "Fig. 2-95: Removing Inner Bearing Outer Race" on page 75.
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

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Fig. 2-95: Removing Inner Bearing Outer Race

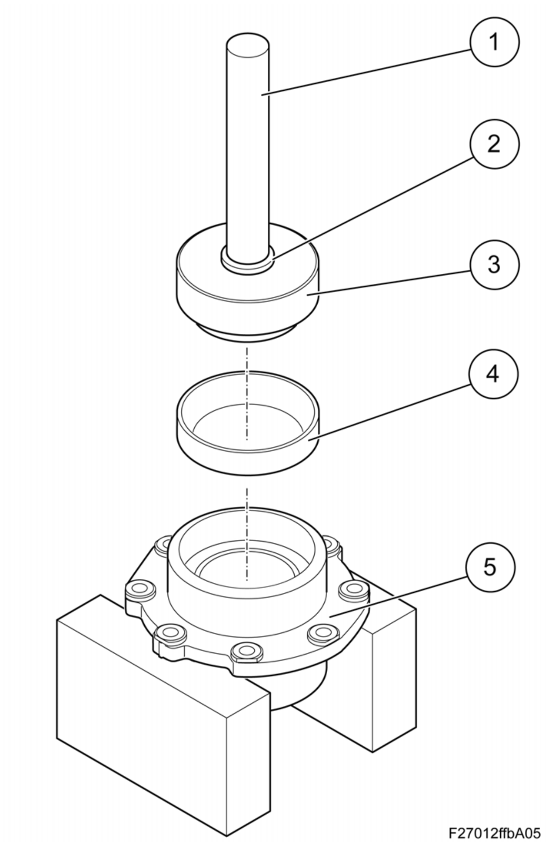
3.13.5. Assembly

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. 2-96: Installing Outer Bearing Outer Race" on page 76.
2. Press the outer bearing outer race into the drive pinion gear housing until it has seated.

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. 2-97: Installing Inner Bearing Outer Race" on page 76.
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 Plate, Outer
4. Outer Bearing Outer Race
5. Drive Pinion Gear Housing

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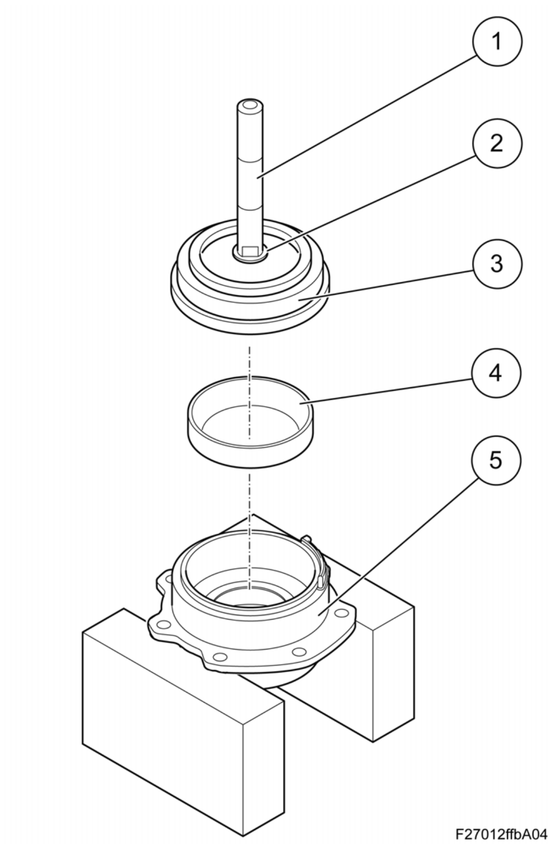
Fig. 2-96: Installing Outer Bearing Outer Race



1. Detachable Handle
2. Thrust Washer
3. Pressing Adapter, Inner
4. Bearing Outer Race
5. Drive Pinion Gear Housing

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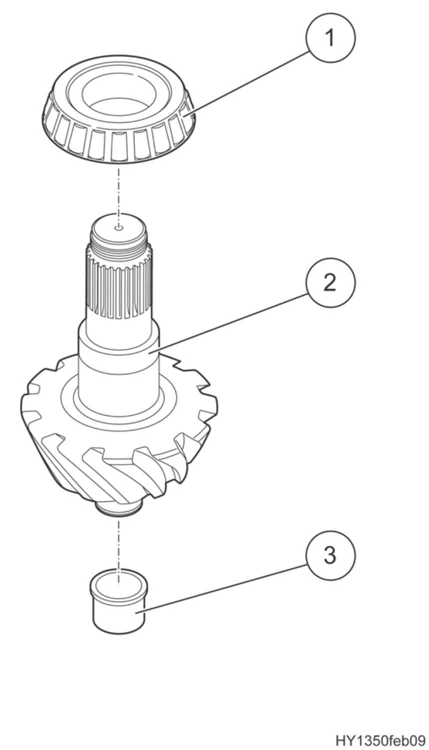
Fig. 2-97: Installing Inner Bearing Outer Race

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. 2-98: Mounting Inner Tapered Roller Bearing & Inner Race” on page 77.
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. 2-99: Installing Bearing Inner Race Circlip” on page 78.
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. 2-98: Mounting Inner Tapered Roller Bearing & Inner Race

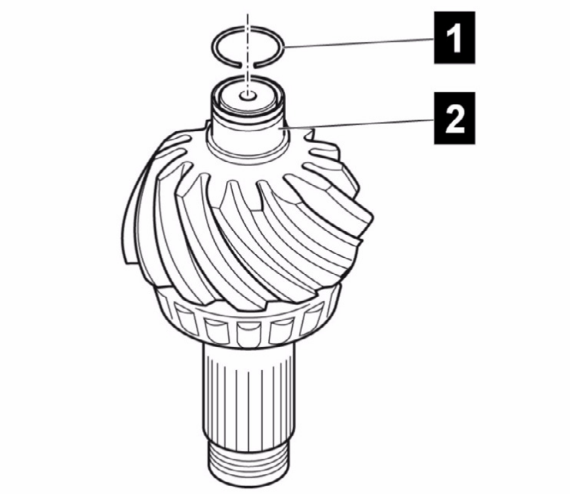


Fig. 2-99: Installing Bearing Inner Race Circlip

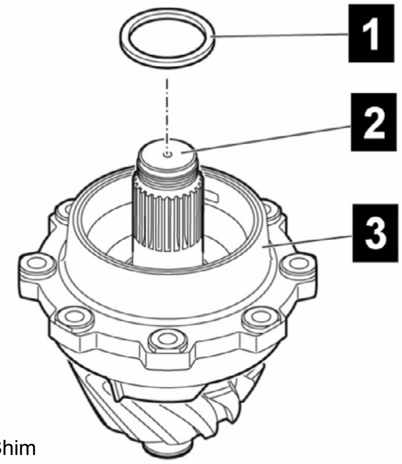


Fig. 2-100: Installing Drive Pinion Gear Housing

3.13.5.4.Installing Drive Pinion Gear Housing

1. Install the drive pinion gear housing onto the drive pinion gear. See "Fig. 2-100: Installing Drive Pinion Gear Housing" on page 78.
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 67 for checking procedure. If friction coefficient has not been determined, use a 0.157" (4.0 mm) thick shim as an initial starting point.

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. 2-101: Installing Outer Tapered Roller Bearing" on page 78.

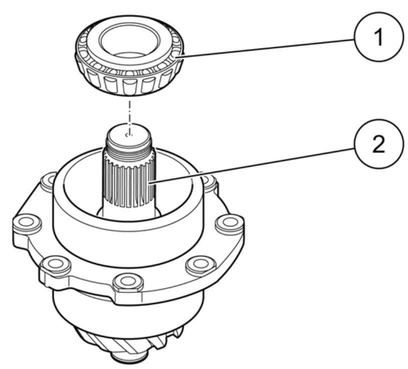


Fig. 2-101: Installing Outer Tapered Roller Bearing

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

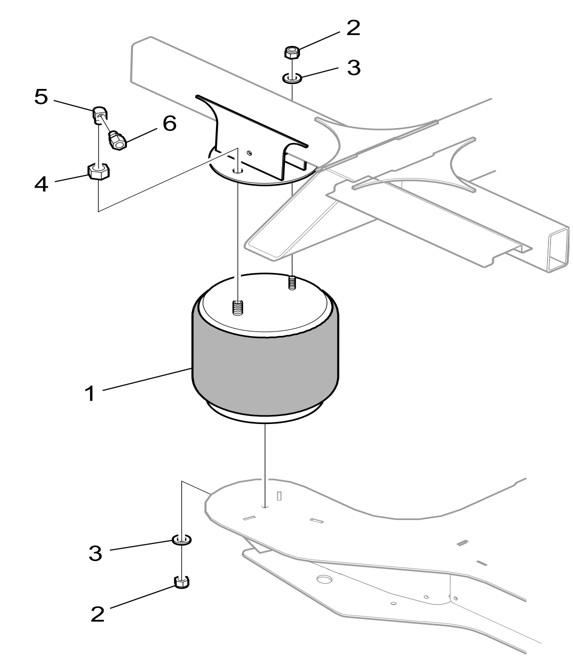
Model 1T15LP-5

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. 2-102: Rear Air Spring Removal & Installation” on page 79.
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. 2-102: 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.

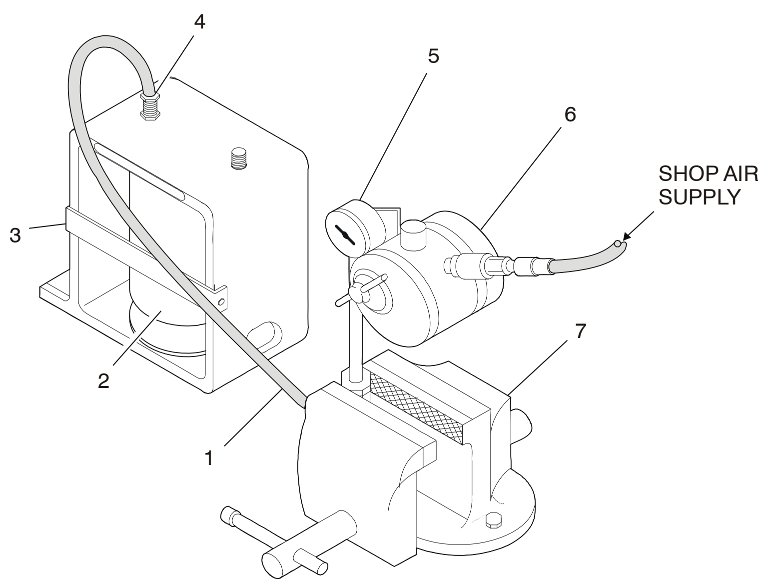
4.2.6. Cleaning & Inspection

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. 2-103: Leak Test Fixture" on page 80.

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. 2-103: Leak Test Fixture

4.2.8. Installation

☞**NOTE:**

Refer to 4.5. "Rear Suspension Torque Specifications" on page 91 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. 2-104: Upper Radius Rod Removal & Installation" on page 83. See "Fig. 2-105: Lower Radius Rod Removal & Installation" on page 84.

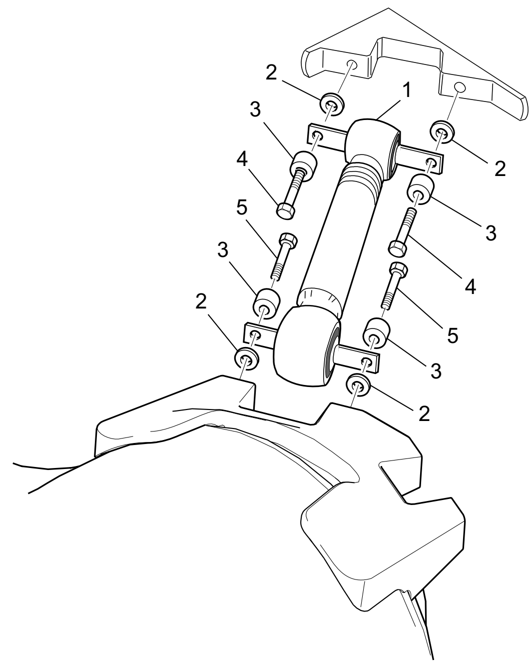
☞NOTE:

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. Spacer
4. Bolt, Hex 3/4"
5. Bolt, Hex 3/4"

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Fig. 2-104: 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.

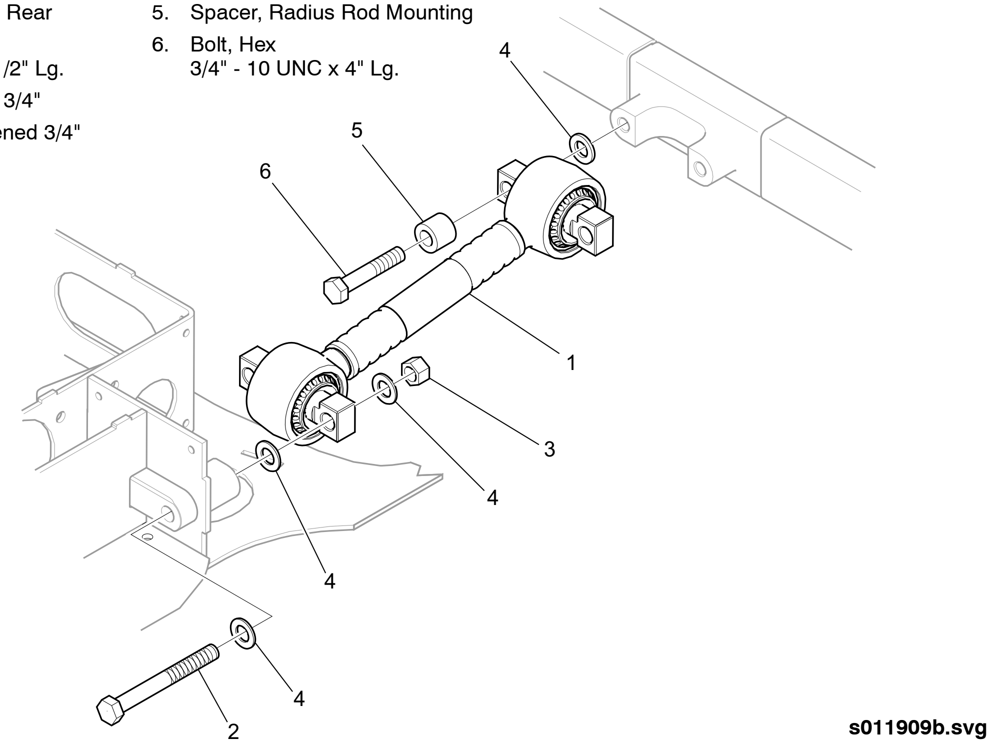


Fig. 2-105: Lower Radius Rod Removal & Installation

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. 2-106: Rear Radius Rod Bushing Replacement" on page 85.
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.

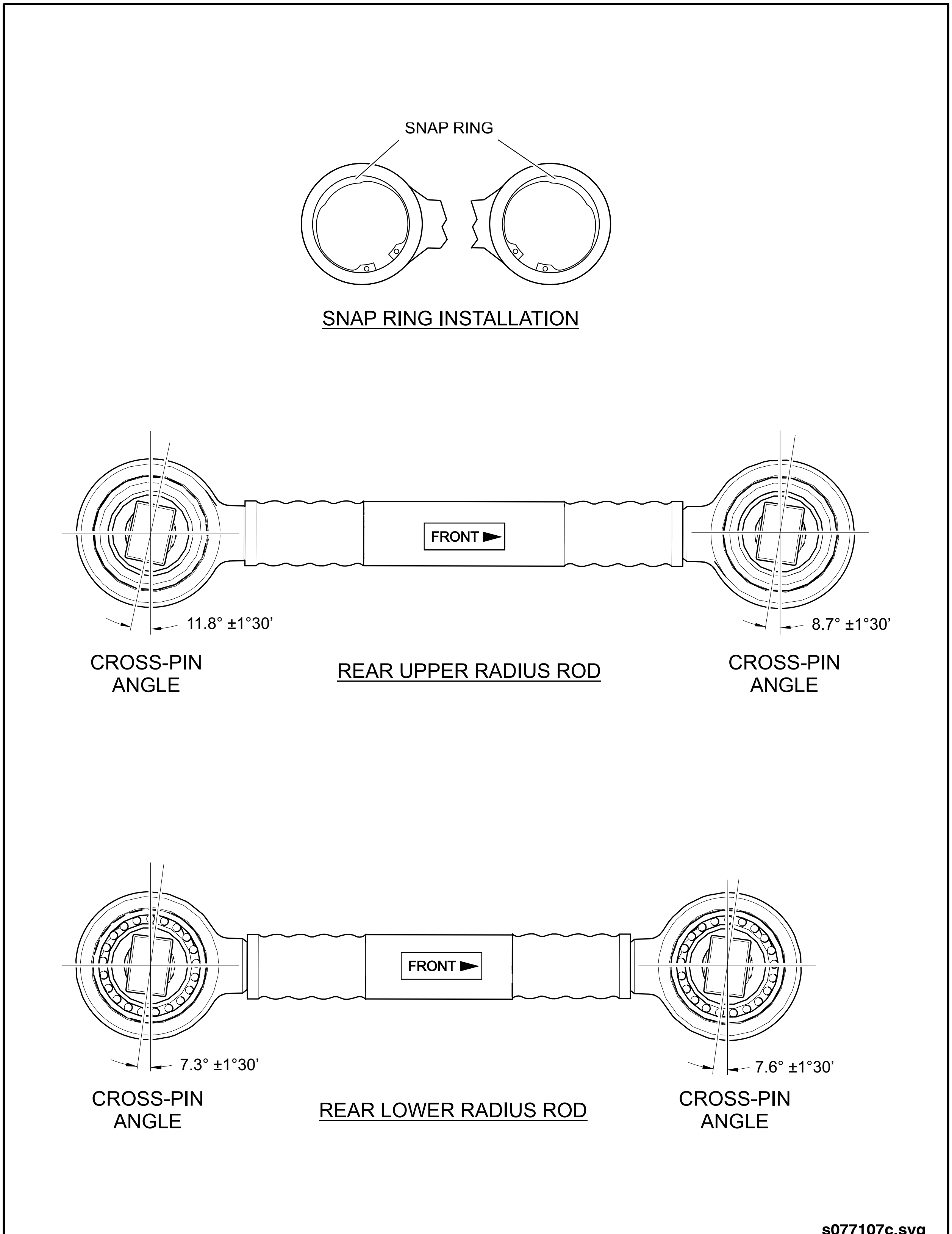


Fig. 2-106: Rear Radius Rod Bushing Replacement

4.3.9. Installation

☞**NOTE:**

Refer to 4.5. “Rear Suspension Torque Specifications” on page 91 *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. See “Fig. 2-106: Rear Radius Rod Bushing Replacement” on page 85.

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:

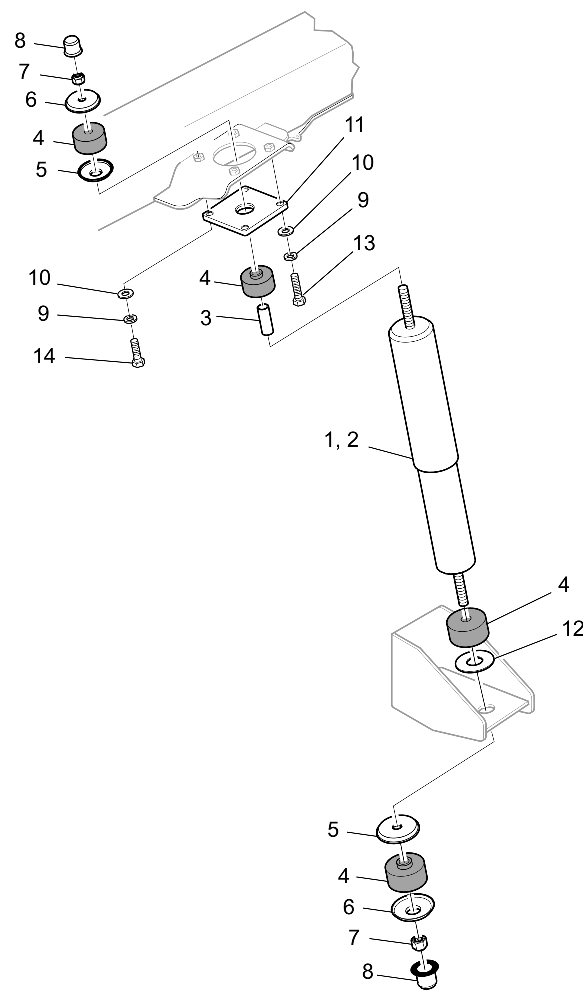
   The upper shock mount requires removal of the mounting plate in order to access the top mounting nut.

2. Remove the four bolts retaining the upper shock mounting plate to the chassis bracket. See “Fig. 2-107: Shock Absorber Removal & Installation” on page 88.

   ☞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. 2-107: 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. 2-108: Rear Suspension Torque Points” on page 92.

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.

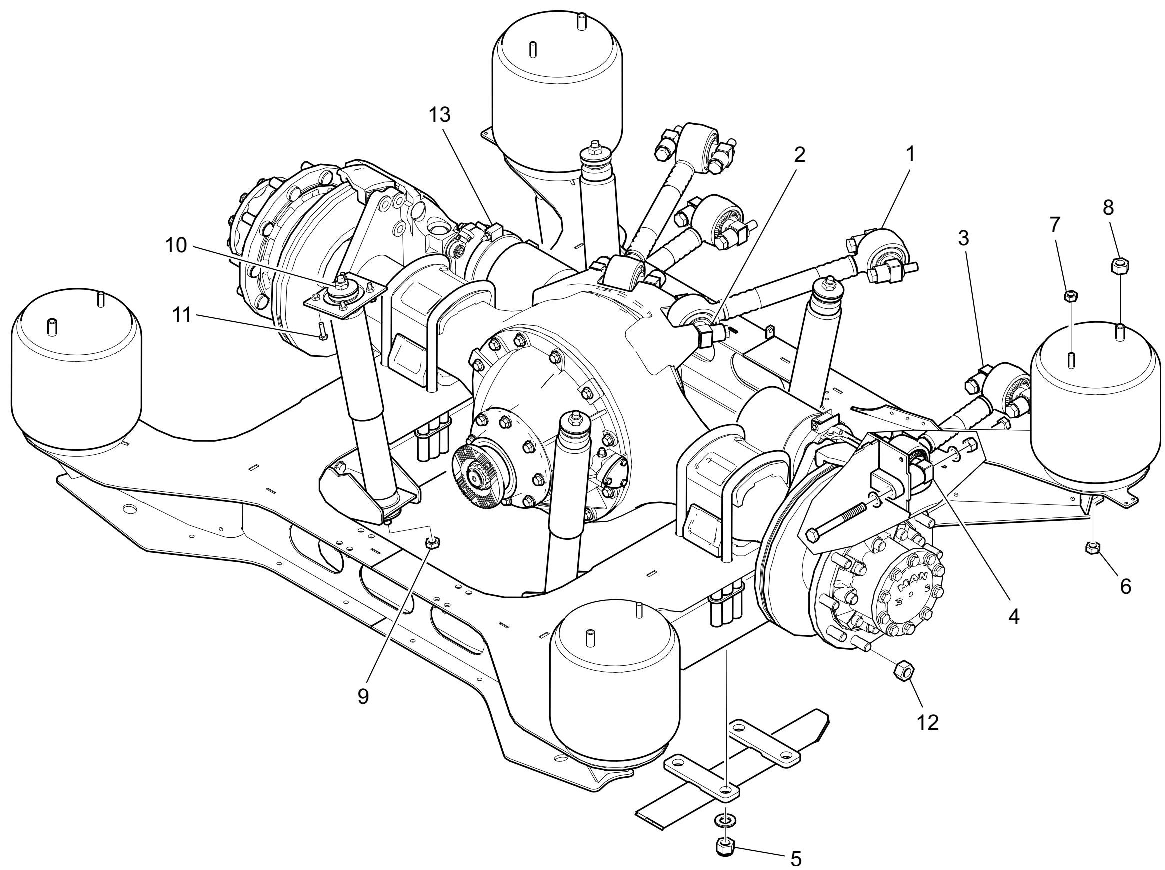


Fig. 2-108: Rear Suspension Torque Points

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 93 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 brake system includes the brake caliper, brake carrier, disc pads, brake disc, and brake chamber. See “Fig. 2-109: Disc Brake Assembly” on page 94. Refer to 5.3. “Rear Brake Chambers” on page 121 in this section for information on the brake chambers and Refer to 3.6. “Wheels” on page 9 in this section for brake disc removal and installation procedures.

5.2.2. Rear Disc Brakes Specifications & Wear Limits

Manufacturer .... Knorr-Bremse

Model..SN 7000

Type.................. Air-actuated sliding caliper

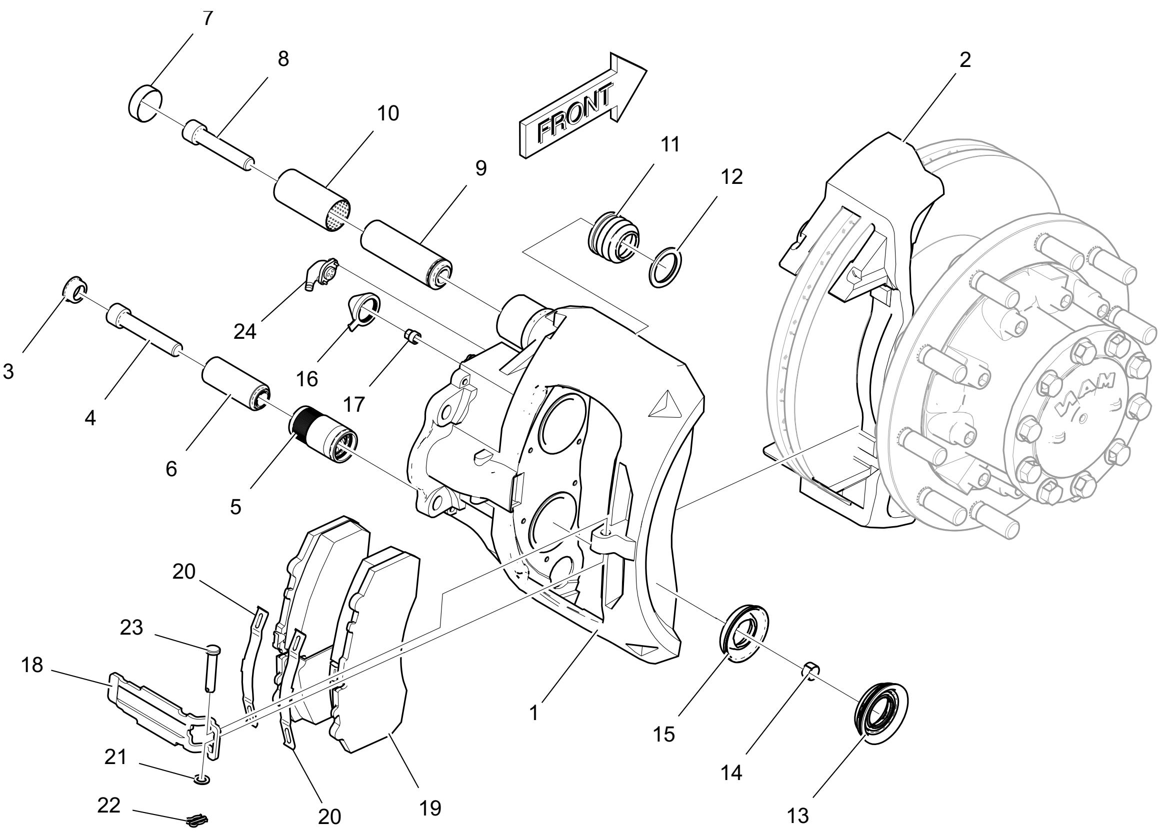
Brake pad clearance
.............0.024 to 0.047" (0.6 to 1.2 mm)

Brake pad thickness (min)
....0.08" (2.0 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
2. Disc Brake Carrier
3. Cap
4. Cap Screw, Hex Socket Head
5. Bushing
6. Lower Guide Pin
7. Cover
8. Cap Screw, Hex Socket Head
9. Upper Guide Pin
10. Bushing, Brass
11. Boot, Inner
12. Ring
13. Tapper & Boot Assembly
14. Bushing, Tappet
15. Seal, Inner
16. Cap, Adjuster
17. Adapter, Shear
18. Pad Retainer
19. Pad
20. Spring, Pad Retainer
21. Washer
22. Clip, Spring
23. Pin, Pad Retainer
24. Plug, EBS Port

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Fig. 2-109: Disc Brake Assembly

5.2.3. Operation

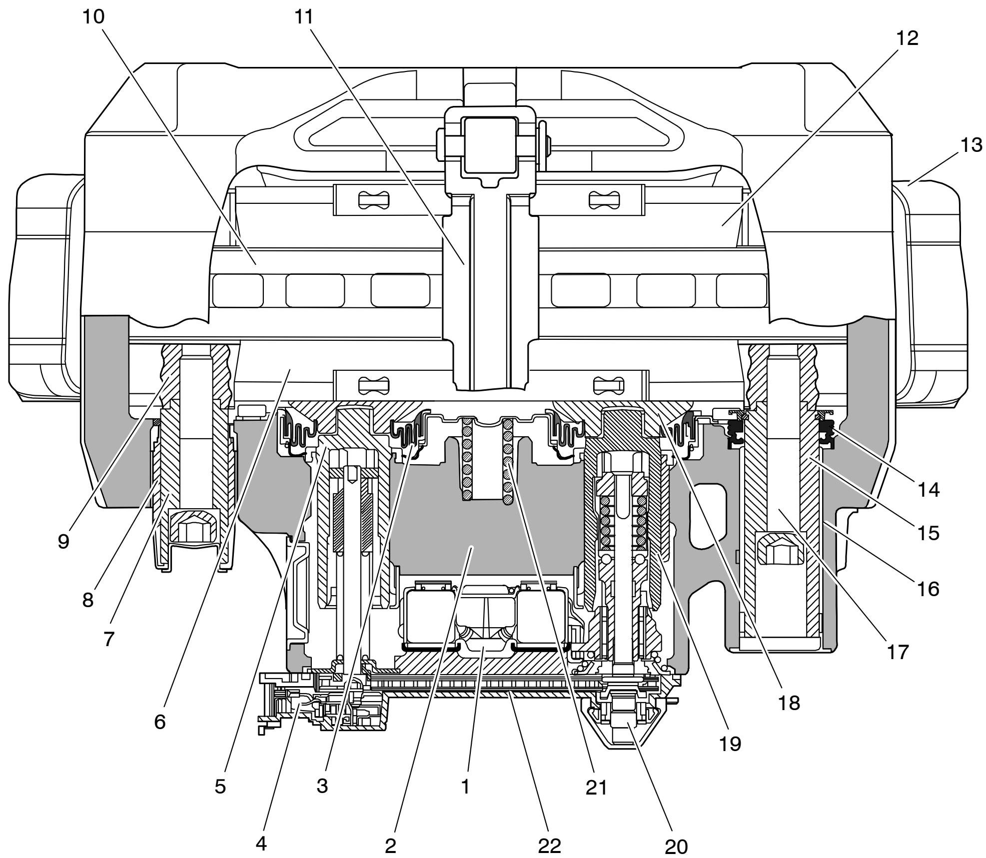
☞**NOTE:**

When reviewing the following information on operation of the disc brake assembly See “Fig. 2-110: Disc Brake Cross Section” on page 96.

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.



1. Actuator Lever
2. Brake Caliper
3. Tappet Boot
4. Wear Sensor
5. Threaded Tube
6. Inner Brake Pad
7. Lower Guide Pin
8. Rubber 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. 2-110: Disc Brake Cross Section

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.

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. Jack up the axle and remove the wheel.
5. Check the brake disc temperature; it should be between 14°F and 122°F (-10°C and 50°C).
6. 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.
7. Pull off the adjuster cap using the tag, taking care not to lose the shear adapter.

⚠CAUTION

Removal of the adjuster cap with a screwdriver, or similar tool, is not allowed. Damage to the seal may result.

8. Insert new brake pads. Refer to 5.2.5. “Brake Pads” on page 105 in this section for procedure.
9. 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.

10. Apply the brakes 20 times with medium pressure (approximately 30 to 40 psi (2-3 bar).
11. Check the gap between each of the tappets and inboard pad backplate. 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).
    a. If the gap difference between the two tappets is > 0.25 mm then the caliper guide pin clearance must be checked. Refer to 5.2.4.4. “Caliper Guide Pin Inspection” on page 102 in this section for procedure.
    b. In addition each gap must measure between 0.6 to 1.2 mm.

⚠CAUTION

If the clearance is too great, there is a danger of brake failure. If the clearance is too small, there is a danger of overheating that may lead to consequential damage.

12. 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.

NOTE:

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.

13. Lightly grease the contact surface of the cap with white grease.

NOTE:

A new adjuster cap should be fitted even if the brake pads are not being replaced.

14. The tag of the adjuster cap should be positioned to ensure access is maintained for subsequent removal.

15. 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 of the brake chamber.

    b. Remove brake chamber. Refer to 5.3. “Rear Brake Chambers” on page 121 in this section for procedure.

    c. Check position of lever inside the caliper in its released state.

    d. Remove 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.

16. Check caliper running clearance. Refer to 5.2.4.4. “Caliper Guide Pin Inspection” on page 102 in this section for procedure.

17. Install the brake pads. Refer to 5.2.5. “Brake Pads” on page 105 in this section for procedure.

18. Install the brake chamber. Refer to 5.3. “Rear Brake Chambers” on page 121 in this section for procedure.

19. Recheck the adjuster.

20. If the air gap is still smaller than 0.6 mm between both tappets, the brake carrier must be replaced.

21. Install the wheel.

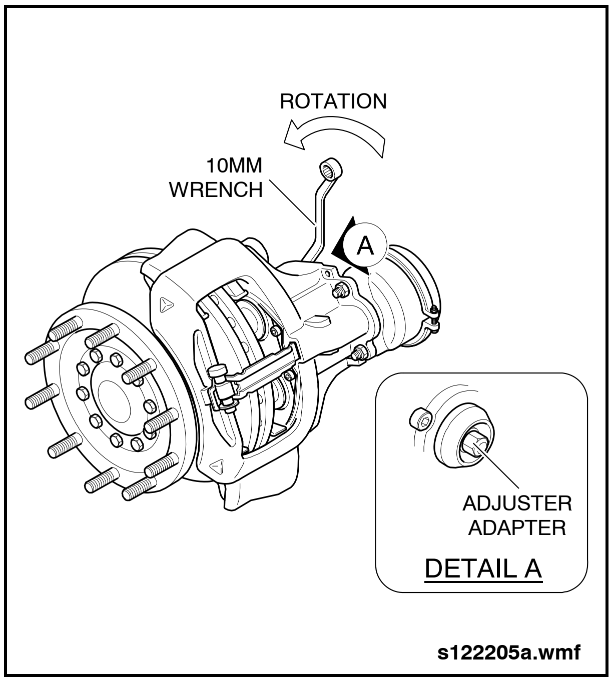


Fig. 2-111: Checking Adjuster Movement

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 indicates a worn brake pad condition. See “Fig. 2-112: Brake Pad Wear Inspection” on page 99.
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 105 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 100 in this section for procedure.

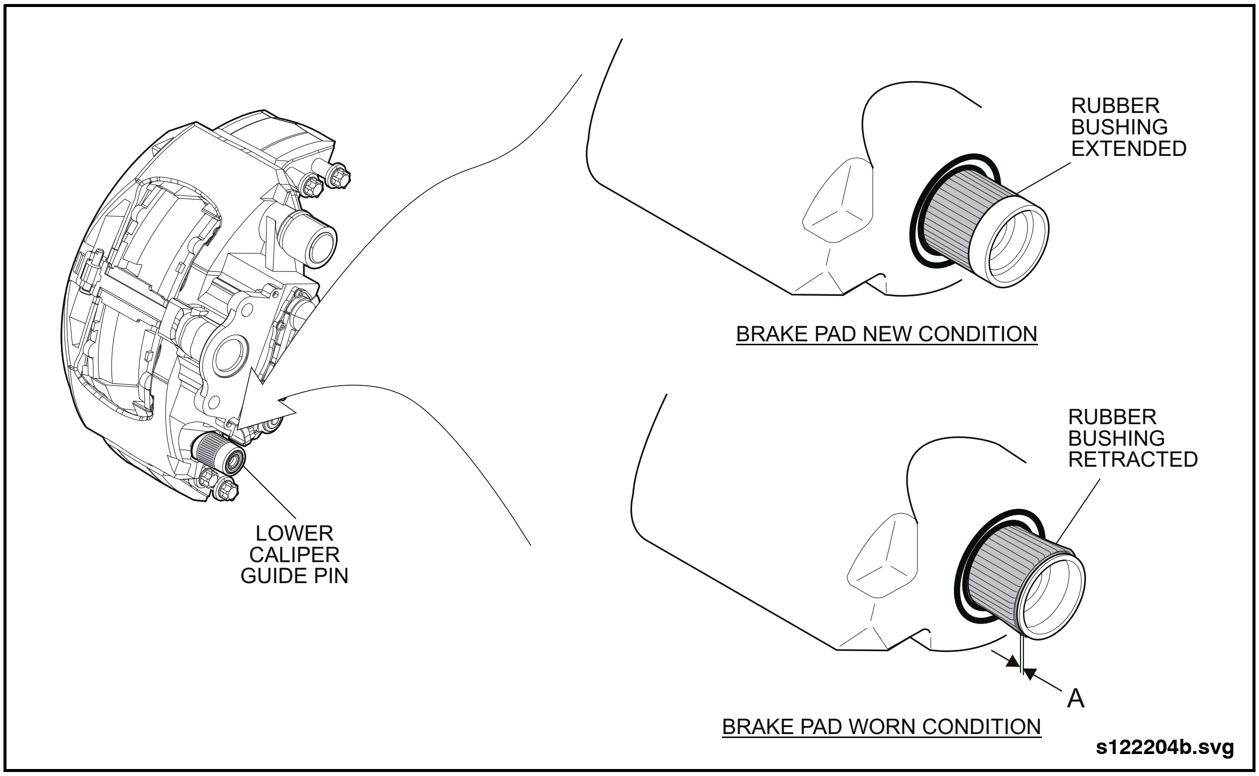


Fig. 2-112: Brake Pad Wear Inspection

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 100.

   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.

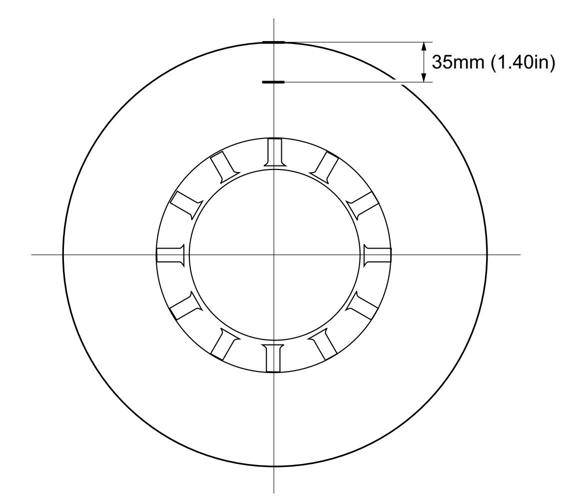


Fig. 2-113: Rotor Run-Out Measurement Point

3. Inspect the brake disc for cracks and scoring. See "Fig. 2-114: Brake Disc Condition" on page 101.

   a. Minor web-like cracks on the braking surface are acceptable. Refer to area "A" shown on illustration.

   b. Cracks less than 0.059" (1.5 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.

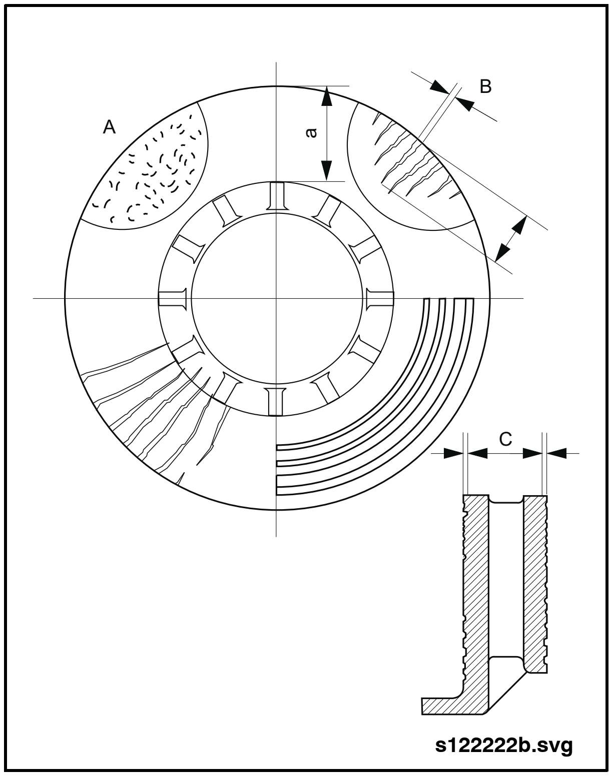


Fig. 2-114: Brake Disc Condition

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 105 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 99 *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 grease to guide pin.
4. Push the caliper inward fully the 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. Mount a dial indicator (Items 29 & 69 from special tools list) on the short bearing side of the carrier with the indicator tip resting on the brake caliper. Zero the dial gauge. See “Fig. 2-115: Measuring Guide Pin Play” on page 102.
   c. Apply pressure to the brake caliper in an upward direction and read the dial gauge. Replace guide pins if reading exceeds 0.079" (2.0 mm). Refer to 5.2.7. “Caliper Guide Pins” on page 111 in this section for replacement procedure.

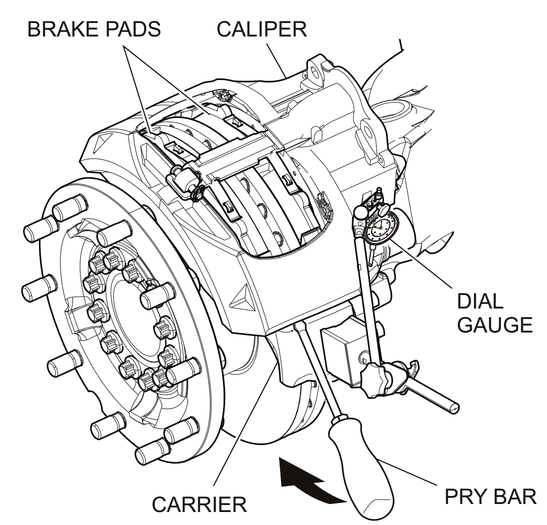


Fig. 2-115: Measuring Guide Pin Play

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 105 in this section for removal procedure
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 a proper visual inspection. See “Fig. 2-116: Tappet & Rubber Boot Inspection” on page 103.
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.

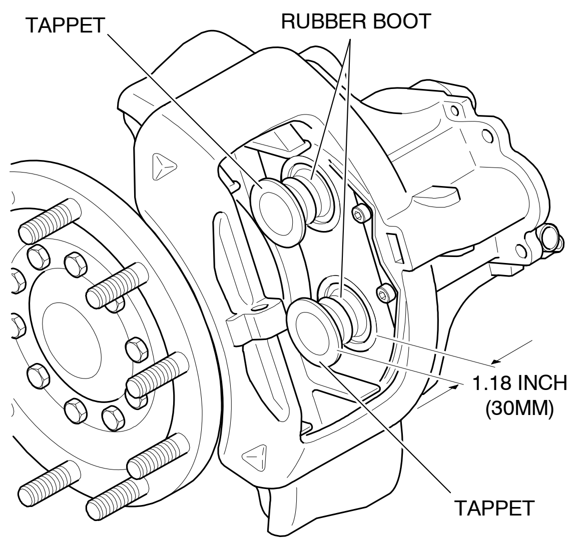


Fig. 2-116: Tappet & Rubber Boot Inspection

5.2.4.6. Upper Guide Rubber Boot Inspection

1. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 105 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. 2-117: Upper Guide Pin Inner Boot Inspection” on page 104.
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.

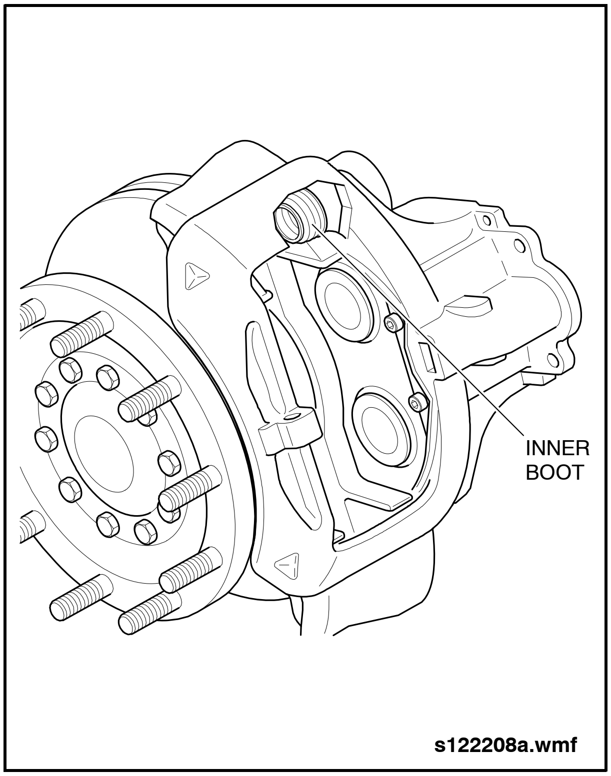


Fig. 2-117: Upper Guide Pin Inner Boot Inspection

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.

NOTE:

Each brake pad contains End Of Life (EOL) wear sensors and wiring harness. The sensor harness mounting and protection components must be removed first before removing the brake pads from the caliper.

4. Remove the wear sensor harness protection plate from the brake pad retainer. See “Fig. 2-118: Wear Sensor Harness Routing” on page 105.
5. Unclip the wear sensor harness from the guide and move harness out of the way of brake pad retainer.
6. Remove the bolt and nut holding the wear sensor cable extension to the bracket on the brake caliper. See “Fig. 2-119: Wear Sensor Cable Extension Removal” on page 106.
7. 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.

NOTE:

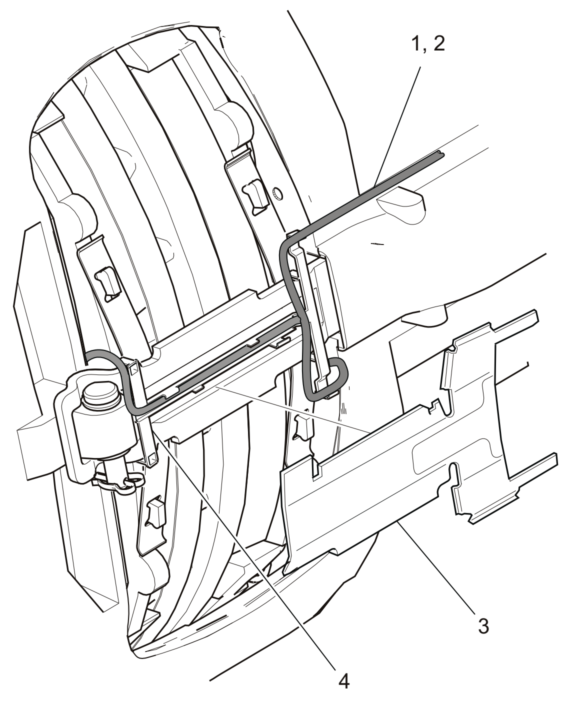
The wear sensor guide is clipped onto the brake pad retainer and may unclip during disassembly.

8. Carefully pry out the wear indicator from each brake pad and move wear sensor harness away from the caliper.
9. 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. 2-120: Brake Pad Removal” on page 106.

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.

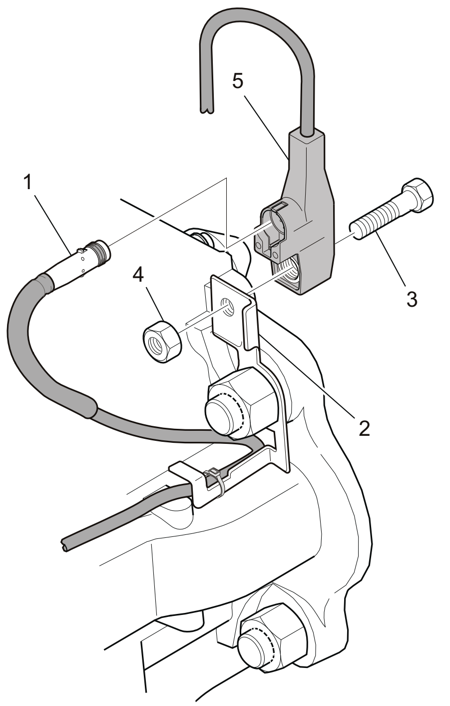
   b. Use the adjuster adapter and turn the adjuster counter-clockwise until the brake pads are free.
10. Remove the brake pads from the caliper.



1. Kit, Brake Pad Wear Indicator Sensor (Incl. 2...4)
2. Sensor, w/Heatshrink
3. Protection Plate
4. Guide

s122253b.svg

Fig. 2-118: Wear Sensor Harness Routing



1. Cable, Wear Indicator Sensor
2. Retaining Plate
3. Bolt, Hex M8
4. Nut, Hex M8
5. Cable, Extension

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Fig. 2-119: Wear Sensor Cable Extension Removal

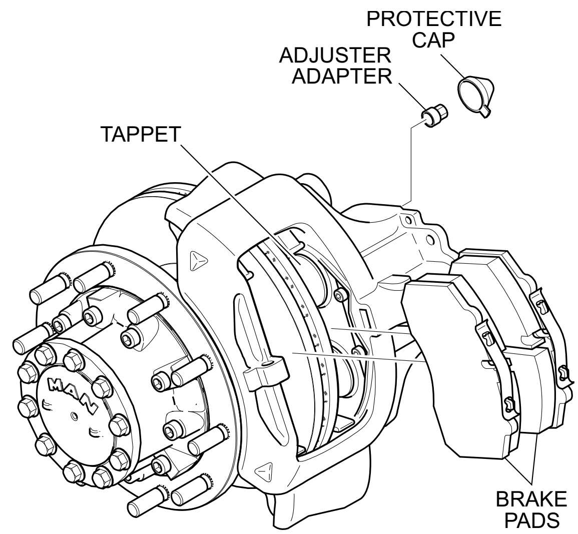

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Fig. 2-120: Brake Pad Removal

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. 2-121: Areas to Apply Lubricant” on page 107. *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. 2-122: Brake Pad Installation” on page 108.
2. Pull the brake caliper outward against the stop and insert the outboard brake pad.
3. Insert the wear sensor cable into the groove of each pad. The wear indicators snap into place in the holes in the pad material.

NOTE:

Ensure that the longer end of the wear sensor harness is inserted into the outboard brake pad.

NOTE:

The wear sensor cable should be replaced any time a brake wear condition has been detected. Typically, the wear sensor will be abraded and damaged whenever it triggers a worn brake pad condition. It is also recommended that the wear sensor cable be replaced whenever the disc brake pads are renewed.

4. 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. 2-123: Brake Pad Retainer Installation” on page 108.
   b. Insert new retaining pin and secure with new washer and spring clip.
5. Attach the wear sensor harness guide to the brake pad retainer and clip the sensor harness to secure it.
6. Install the wear sensor harness protection plate onto the brake pad retainer.
7. Attach the wear sensor harness to the brake caliper using the original mounting bolt and nut. Apply medium strength threadlocker, such as Loctite-242 to the threads of the nut.

NOTE:

If the round sensor connector between the wear sensor harness and the extension harness is unplugged during the removal procedure, check that the rubber seal is not damaged or deformed. Ensure the wear sensor connector is properly pushed into the cable extension connector upon re installation. The cable extension connector has locking tabs which lock in position when the sensor's plug is inserted correctly.

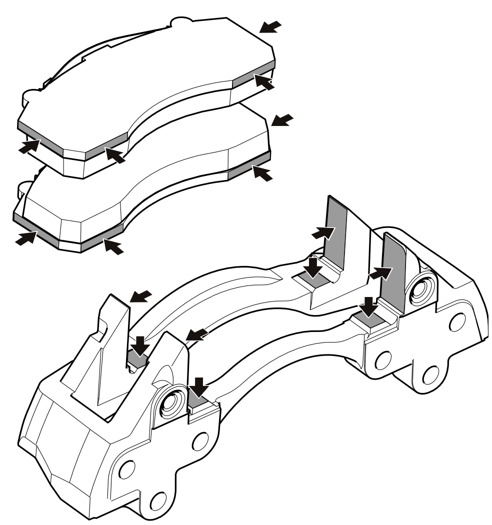

Fig. 2-121: Areas to Apply Lubricant

CAUTION

A damaged seal or improperly seated connector will not provide a watertight seal between the sensor connector and the extension cable connector. Penetration of water can lead to corrosion on connector pins and cause sensor failure.

8. 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 0.024 to 0.047" (0.6 to 1.2 mm).
9. Lower the vehicle and perform road test to verify satisfactory operation of the brakes.

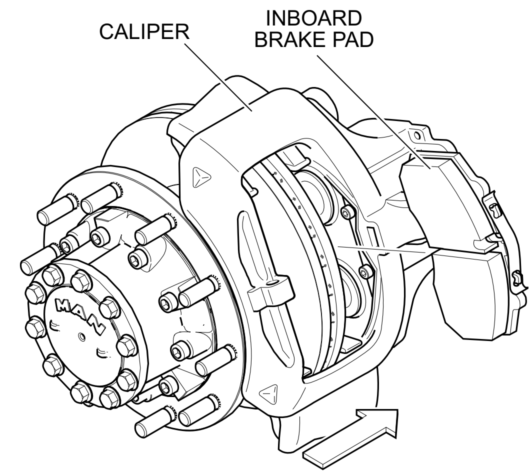

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Fig. 2-122: Brake Pad Installation

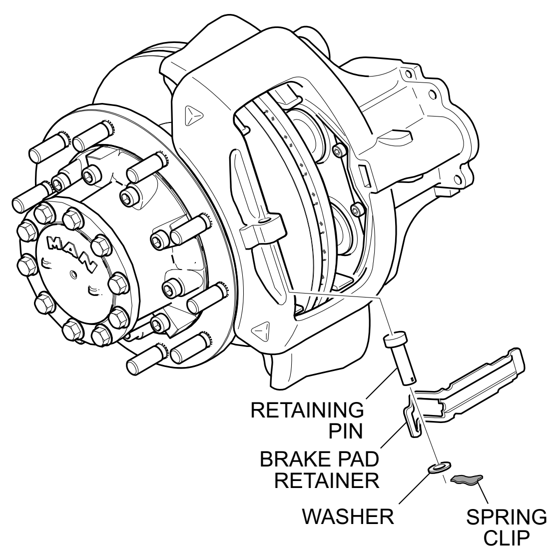

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Fig. 2-123: Brake Pad Retainer Installation

5.2.6. Brake Caliper & Carrier Assembly

☞NOTE:

The following procedure describes removal of the brake caliper and carrier as an assembly from the rear axle flange.

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 105 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.

6. Install the caliper support fixture (Item 1 from special tools list). See “Fig. 2-124: Brake Caliper Removal” on page 109.
7. Remove the six hex head bolts that retain the entire caliper and carrier assembly to the rear axle flange and remove the entire caliper and carrier assembly from vehicle. Discard the six mounting bolts.

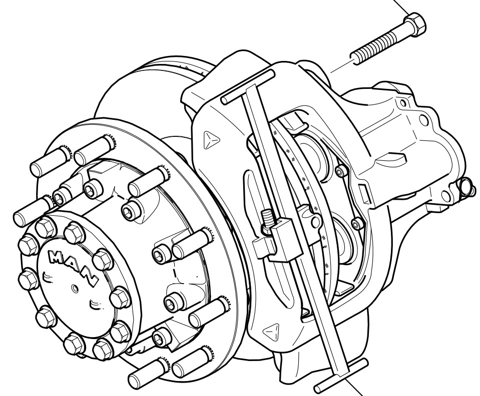


Fig. 2-124: Brake Caliper Removal

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 flange 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) has 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 105 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

☞NOTE:

Refer to the Special Tools Chart in Section 1 of this manual for the disc brake servicing tools.

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 105 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 the caliper support fixture (Item 1 from special tools list). See “Fig. 2-125: Brake Caliper Removal” on page 112.

⚠CAUTION

Support the caliper before removing the caliper mounting bolts.

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. 2-126: Brake Caliper Guide Pin Removal” on page 112.
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. 2-127: Brass Bushing Removal” on page 112.
    b. Pull the brass bushing out of the caliper.
12. Remove the bushing from the 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. 2-128: Rubber Bushing Removal” on page 112.
    b. Pull the bushing out of the caliper.

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.

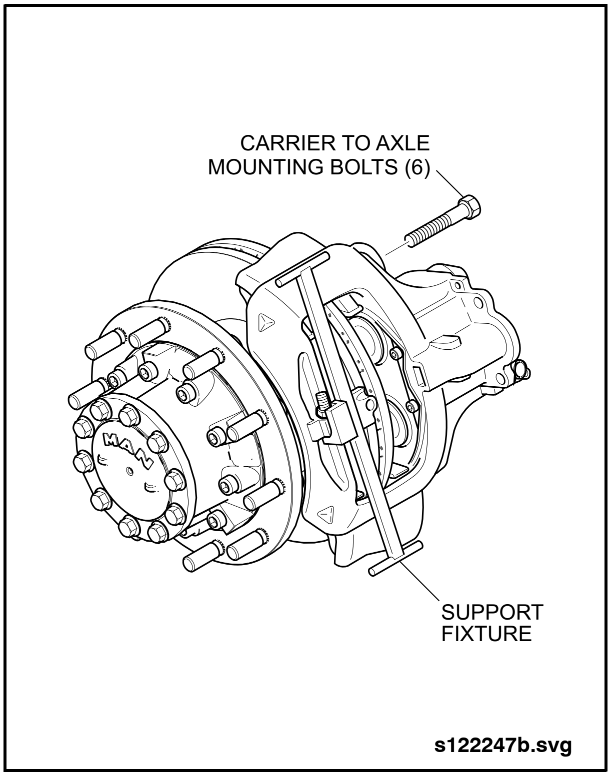


Fig. 2-125: Brake Caliper Removal

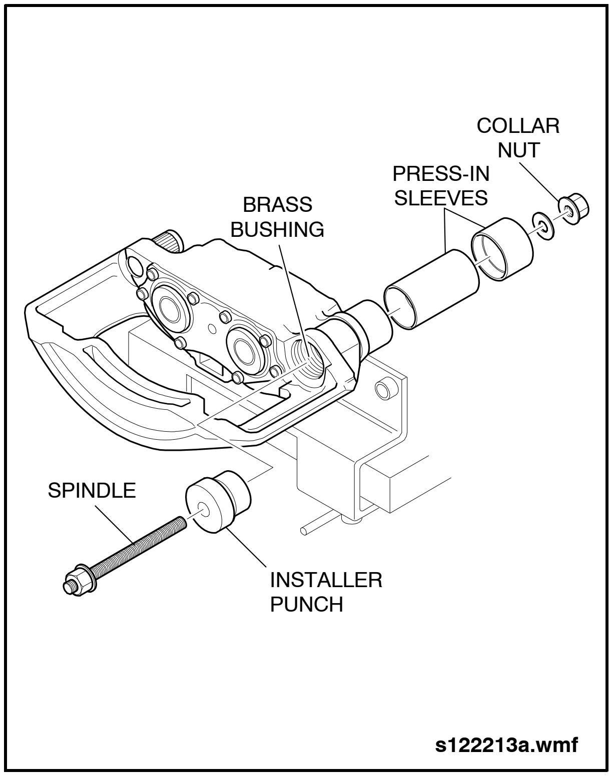


Fig. 2-127: Brass Bushing Removal

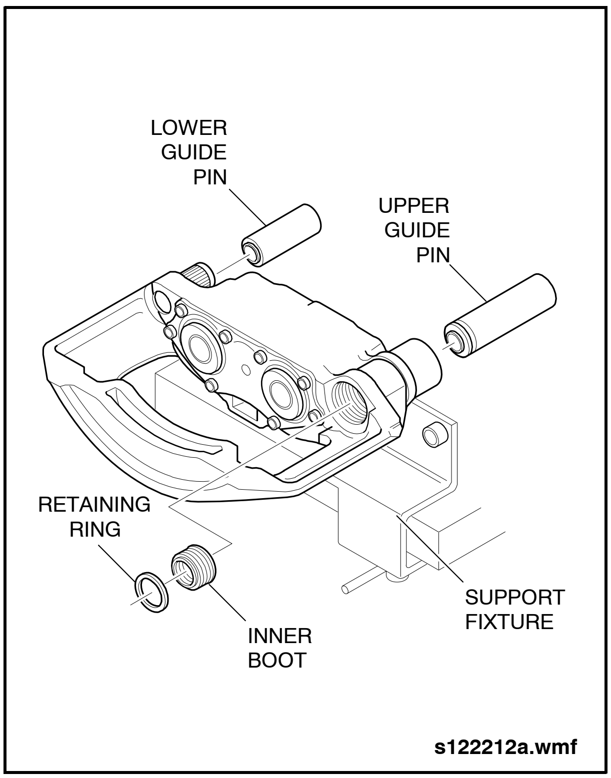


Fig. 2-126: Brake Caliper Guide Pin Removal

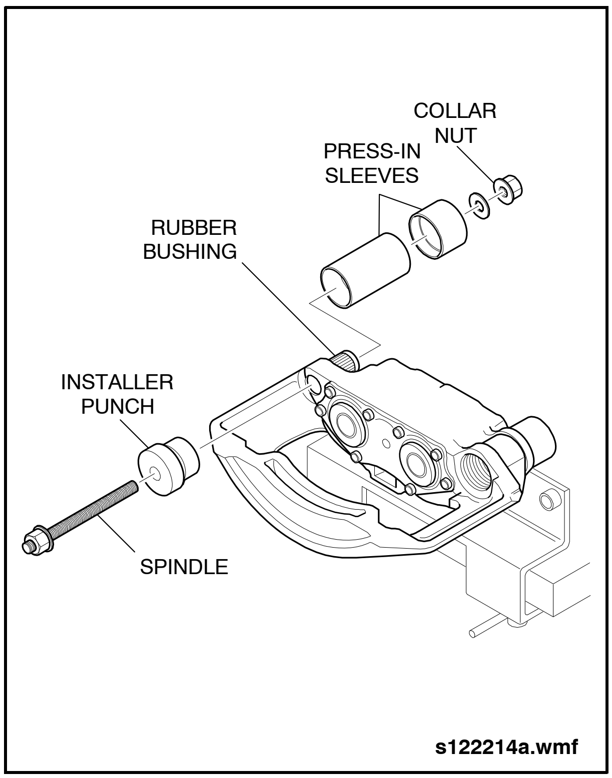


Fig. 2-128: Rubber Bushing Removal

5.2.7.3. Installation

☞NOTE:

Refer to the Special Tools Chart in Section 1 of this manual for the disc brake servicing tools.

1. Install the bushing in the lower guide pin bore as follows:
   a. Insert bushing into press-in sleeve (Item 78 from specials tool 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. 2-129: 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 specials tool list). Ensure that the open side of the centering sleeve is facing away from the caliper. See "Fig. 2-130: 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. 2-131: 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. 2-132: 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 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. Remove the supporting fixture.
10. 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.
11. 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. 2-133: Protective Cover & Cap Installation" on page 115.
12. Install brake pads. Refer to 5.2.5. "Brake Pads" on page 105 in this section for installation procedure.
13. Install brake chamber. Refer to 5.3. "Rear Brake Chambers" on page 121 in this section for installation procedure.
14. Install tire and wheel assembly
15. Lower the vehicle and road test the vehicle to verify satisfactory operation of the brakes.

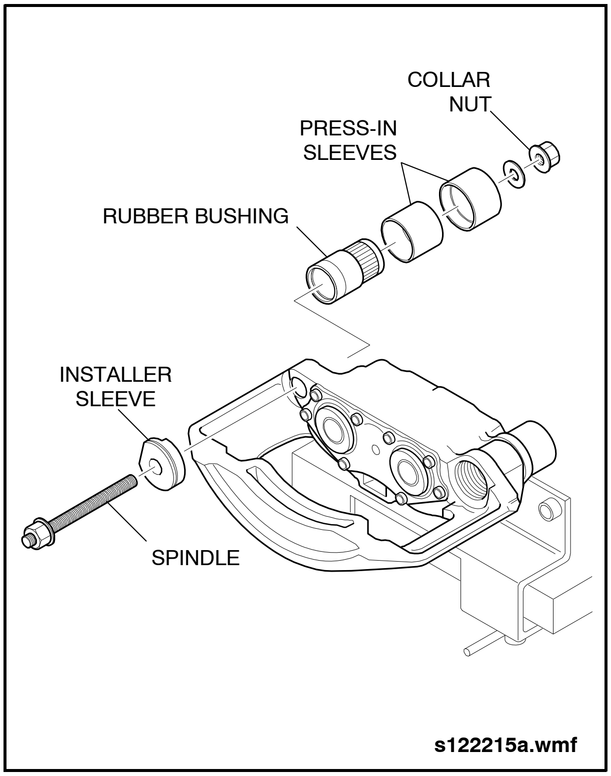


Fig. 2-129: Rubber Bushing Installation

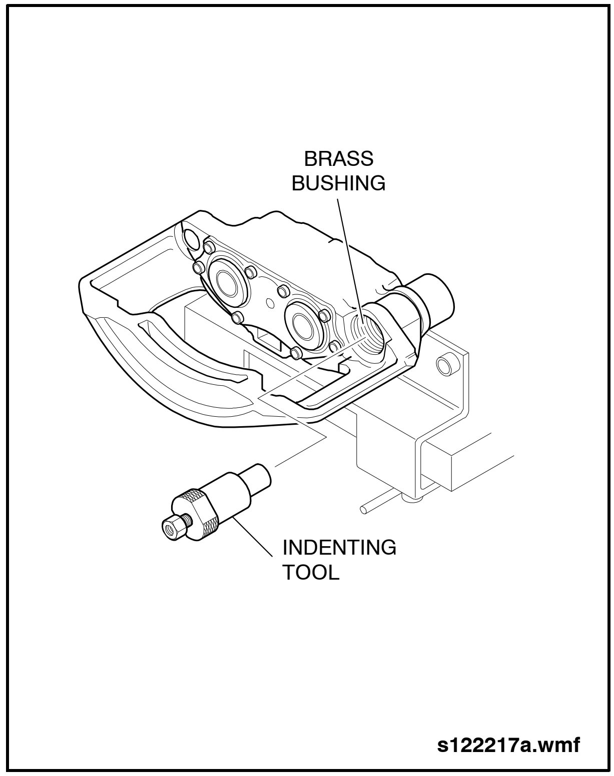


Fig. 2-131: Indenting Tool Installation

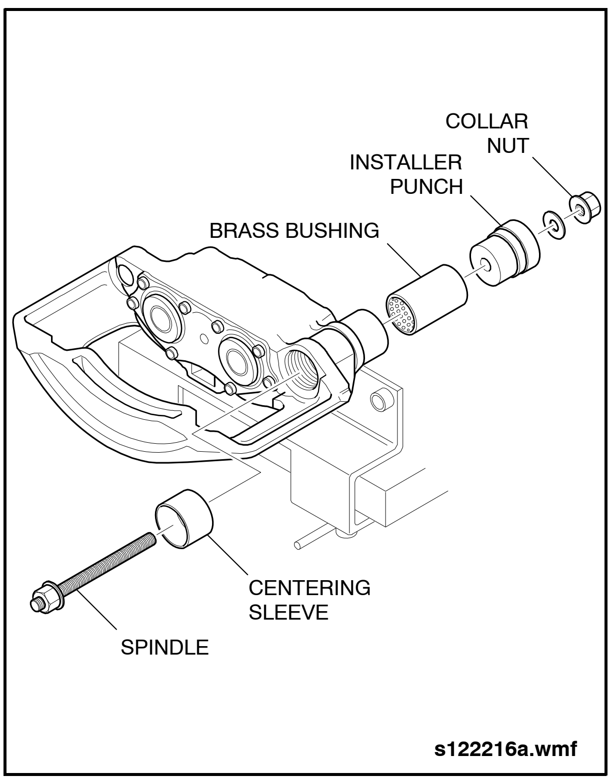


Fig. 2-130: Brass Bushing Installation

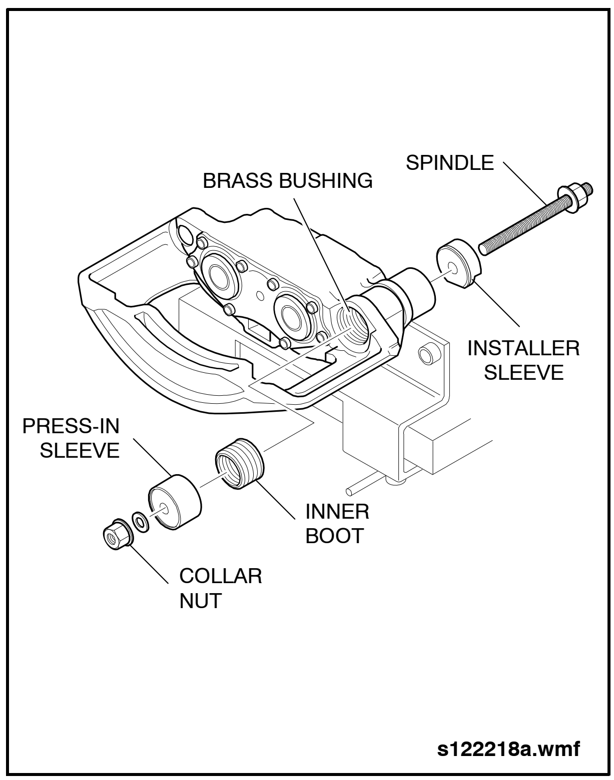


Fig. 2-132: Inner Boot Installation

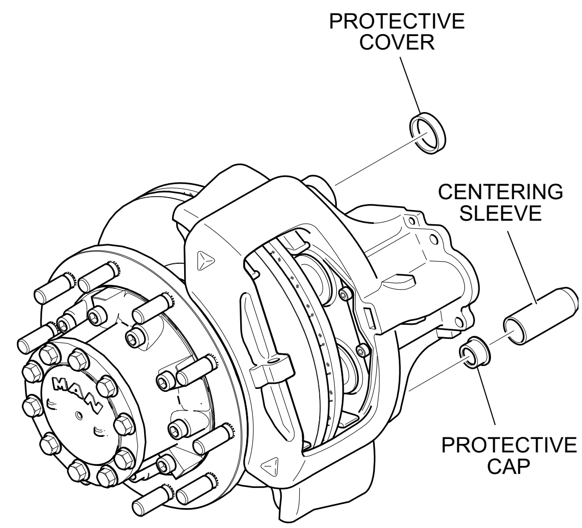


Fig. 2-133: Protective Cover & Cap Installation

5.2.8. Tappet & Rubber Boot

NOTE:

The following procedure provides removal/ installation instructions for the brake caliper tappets, rubber boots, and inner seals.

5.2.8.1. Removal

NOTE:

Refer to the Special Tools Chart in Section 1 of this manual for the disc brake servicing tools.

1. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 105 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. 2-134: 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. 2-135: 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. 2-136: 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. 2-137: 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.

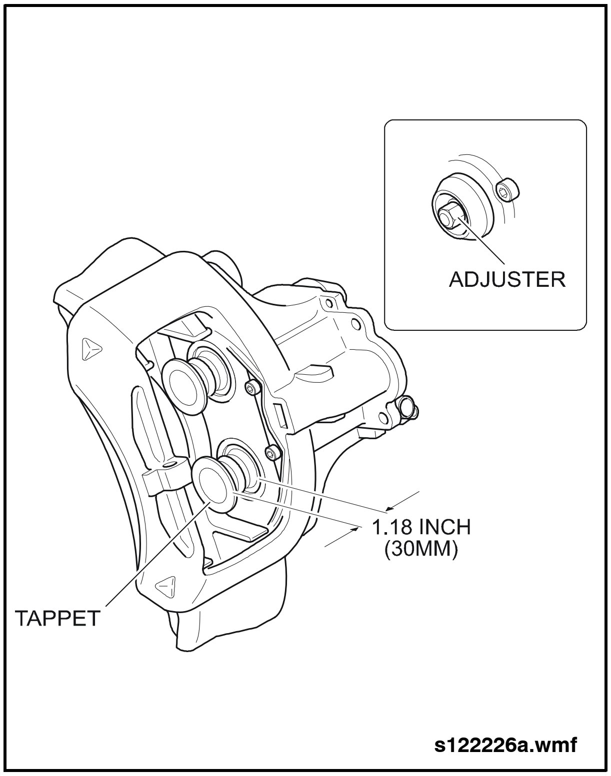


Fig. 2-134: Unscrewing Tappets

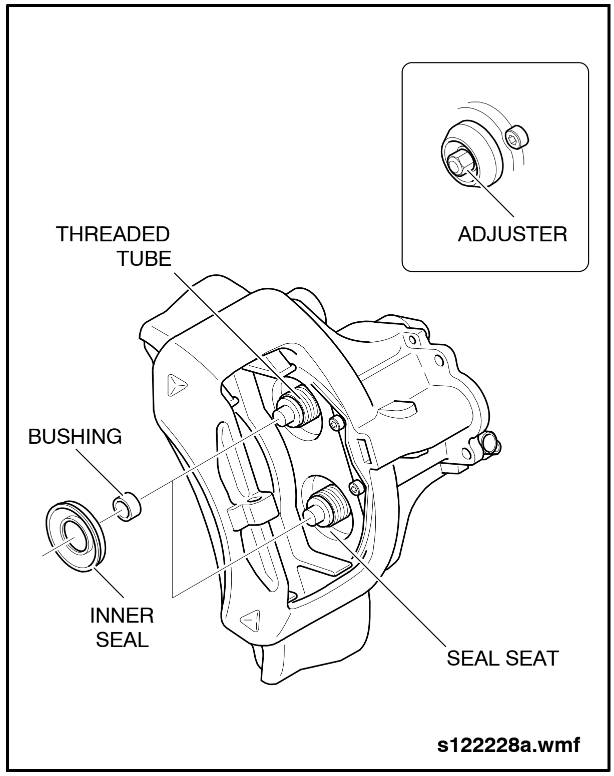


Fig. 2-136: Removing Inner Seal

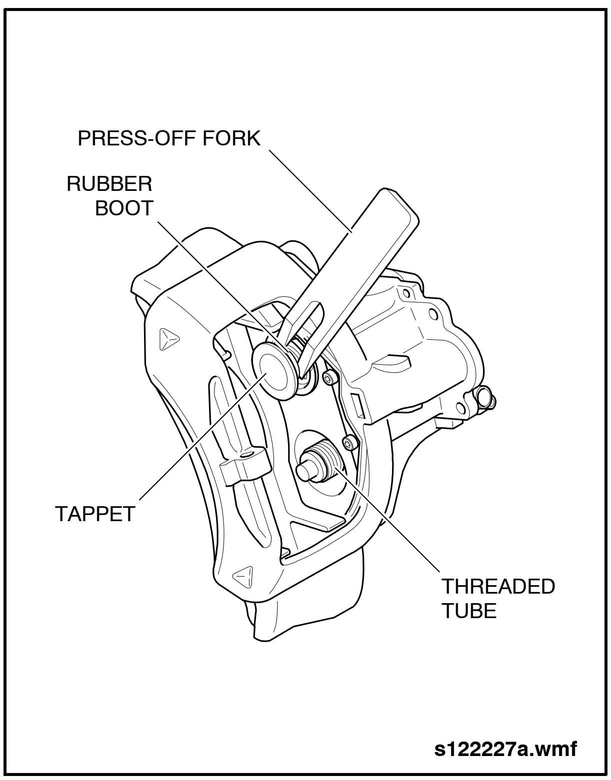


Fig. 2-135: Removing Tappets

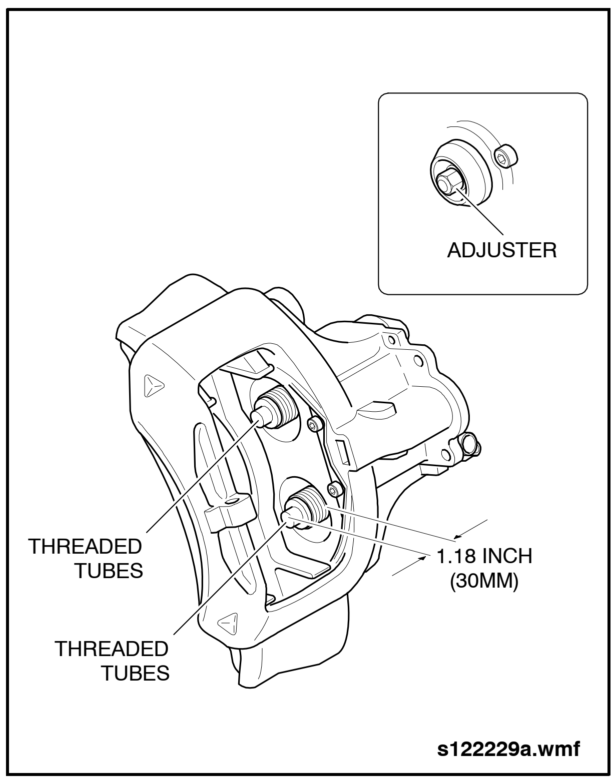


Fig. 2-137: Inspecting Threaded Tubes

5.2.8.3. Installation

☞**NOTE:**

Refer to the Special Tools Chart in Section 1 of this manual for the disc brake servicing tools.

☞**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. 2-138: 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:**

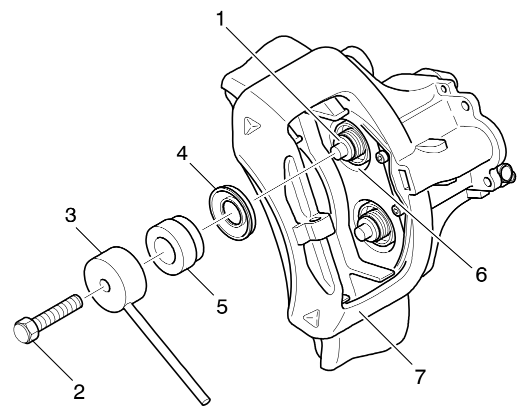
The inner seal must not turn.

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. 2-139: 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. 2-140: Seating Tappet Against Stop” on page 118.
11. Use the forcing bolt to press the tappet up against the stop on the threaded sleeve.



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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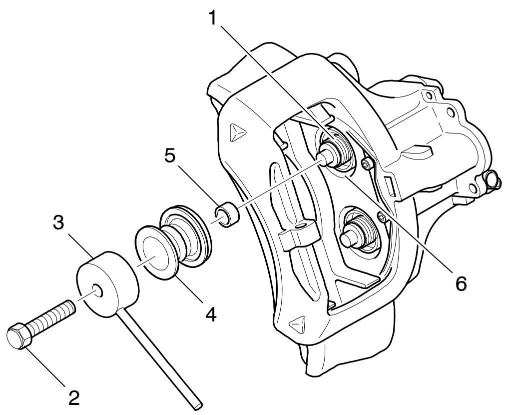
Fig. 2-138: Installing Inner Seal



1. Threaded Tube
2. Forcing Bolt
3. Installer Sleeve
4. Tappet & Rubber Boot
5. Bushing
6. Seal Seat

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Fig. 2-139: Installing Tappet & Rubber Boot

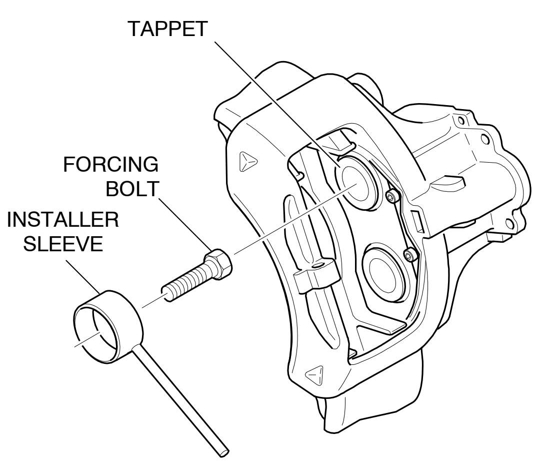

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Fig. 2-140: Seating Tappet Against Stop

5.2.9. Brake Disc

5.2.9.1. Removal

1. Remove the brake pads. Refer to 5.2.5. “Brake Pads” on page 105 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 15 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. 2-141: 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. 2-142: Separating Wheel Hub from Brake Disc” on page 119.
9. Remove wheel hub and O-ring from the brake disc.

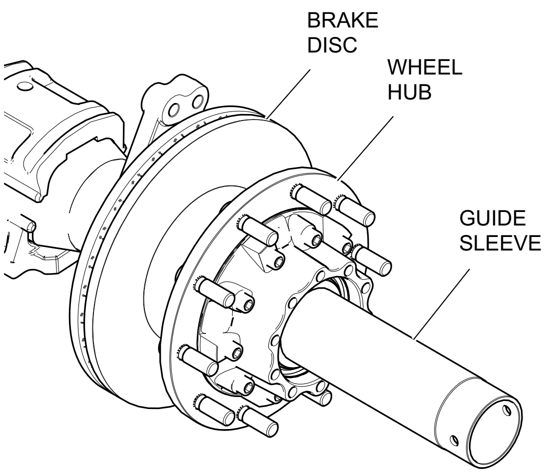


Fig. 2-141: Removing Wheel Hub & Brake Disc

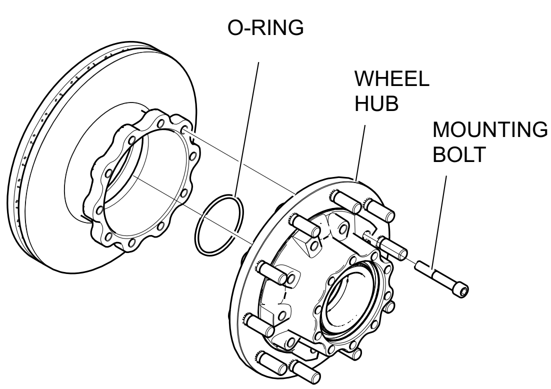


Fig. 2-142: Separating Wheel Hub from Brake Disc

5.2.9.2. 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 15 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 105 in this section for procedure.

5.2.9.3. Machining

CAUTION

DO NOT machine the brake disc to less than 1.575" (40 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 105 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 1.575" (40 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

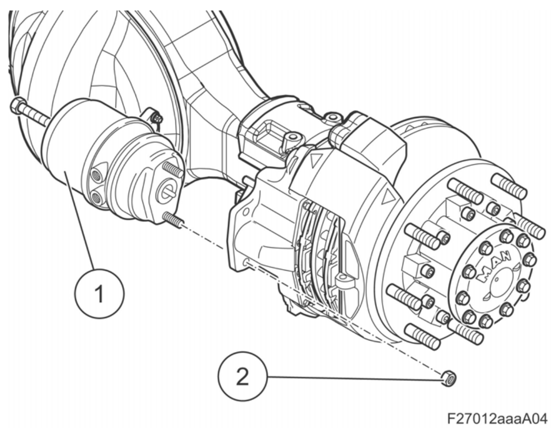
DO NOT use impact tools to cage or uncage the brake chamber.

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. 2-143: 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. 2-143: 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. 2-144: 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 and ESP sensor pack must be replaced as an assembly.
   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 and caliper mounting surfaces. 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.

CAUTION

Ensure brake chamber is properly positioned so that the breather tube is NOT facing directly downward toward the road surface.

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.
5. Install new M16 lock nuts and torque to specification. Refer to 4.5. “Rear Suspension Torque Specifications” on page 91 in this section for torque specification.
6. Connect air lines, as marked during removal, to brake chamber and torque air line fittings to 25 to 30 ft-lb. (34 to 40 Nm).
7. Connect the electrical harness to the ESP sensor pack.
8. 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.

9. Start vehicle and charge air system to normal operating pressure.

CAUTION

Ensure the vehicle wheels are chocked during the following procedure.

10. Release the parking brake.
11. Use soapy water or leak detection solution to inspect for air leaks at the spring brake air inlet fittings.
12. With parking brake still released and spring brake fully pressurized, fully apply the brake treadle (minimum 100 psi at service brake chamber).
13. Check for air leaks at the service brake air inlet fittings.
14. 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).
15. Apply parking brake and confirm that the spring brakes apply.

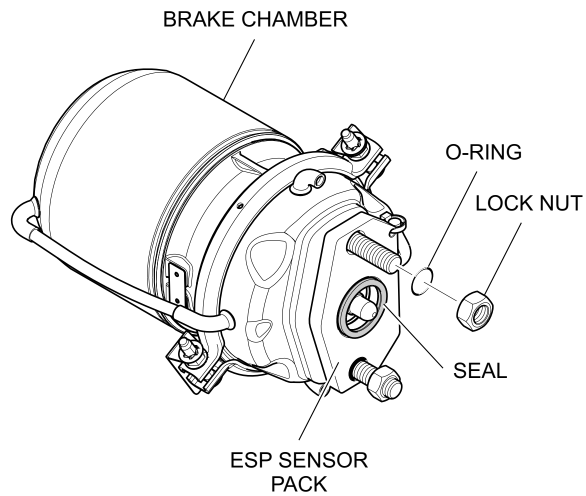


Fig. 2-144: Rear Brake Chamber ESP Sensor Pack

5.4. End of Life Brake Pad Wear Sensor System

5.4.1. Description

The End of Life Brake Pad Wear Sensor System is typical on all axles. Refer to Section 1 of this manual for information on this system.

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 15 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. 2-145: 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. 2-146: 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.

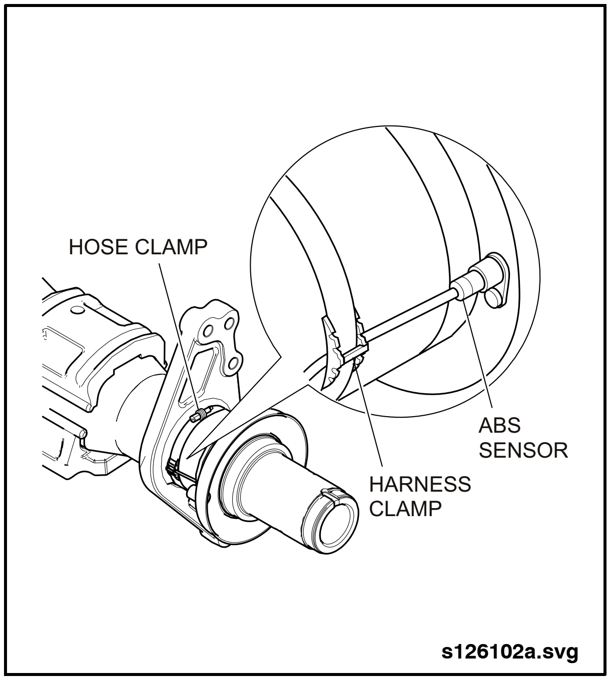


Fig. 2-145: Removing ABS Sensor Harness Clamp

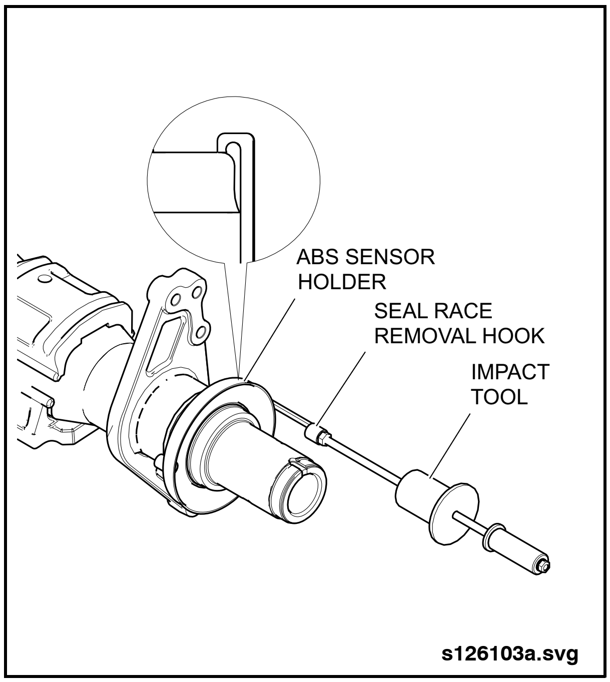


Fig. 2-146: Removing ABS Sensor Holder

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. 2-147: Installing ABS Sensor” on page 127.
3. Screw in the three pressure screws until they make light contact with the ABS sensor holder.

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. 2-148: Assembling Centering Device” on page 127.
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.

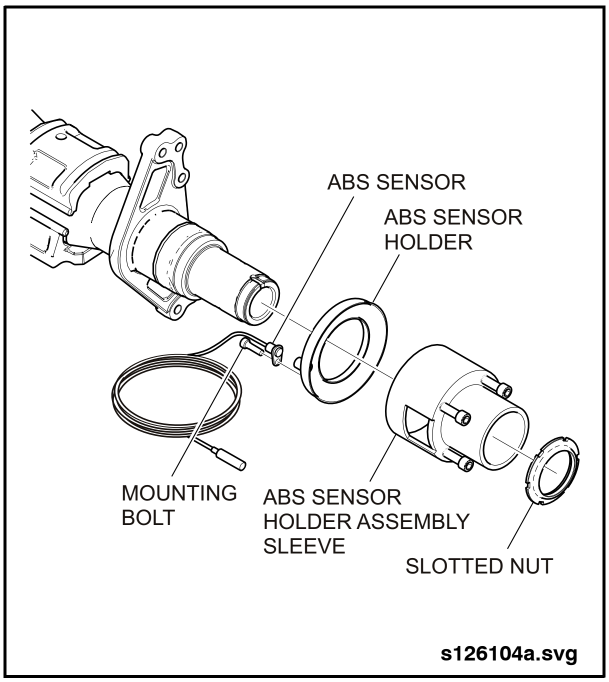


Fig. 2-147: Installing ABS Sensor

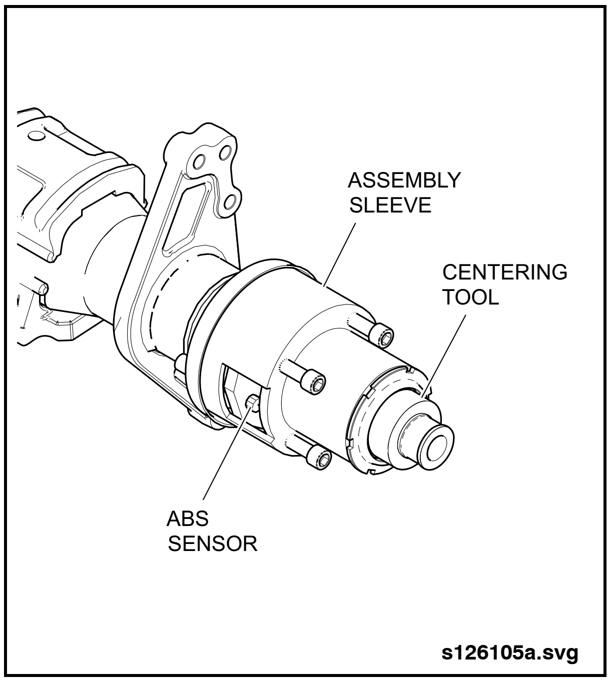
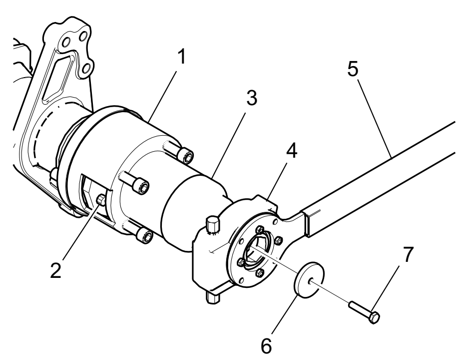


Fig. 2-148: Assembling Centering Device

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. 2-149: 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.



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. 2-149: 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. 2-150: Setting Gap Width” on page 128.
2. Adjust the gap by rotating the pressure screws evenly until the specified gap is reached.
3. Remove the assembly sleeve tool.

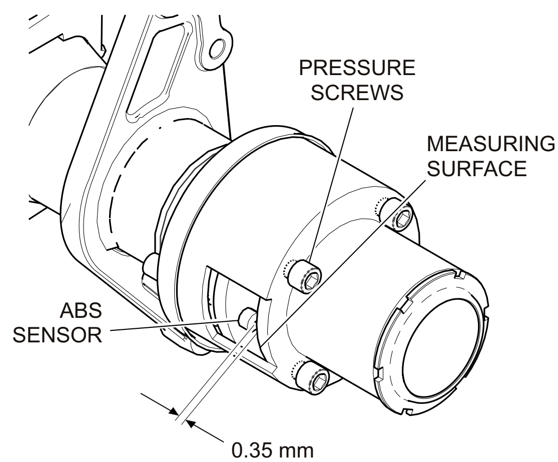

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Fig. 2-150: Setting Gap Width

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 15 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.

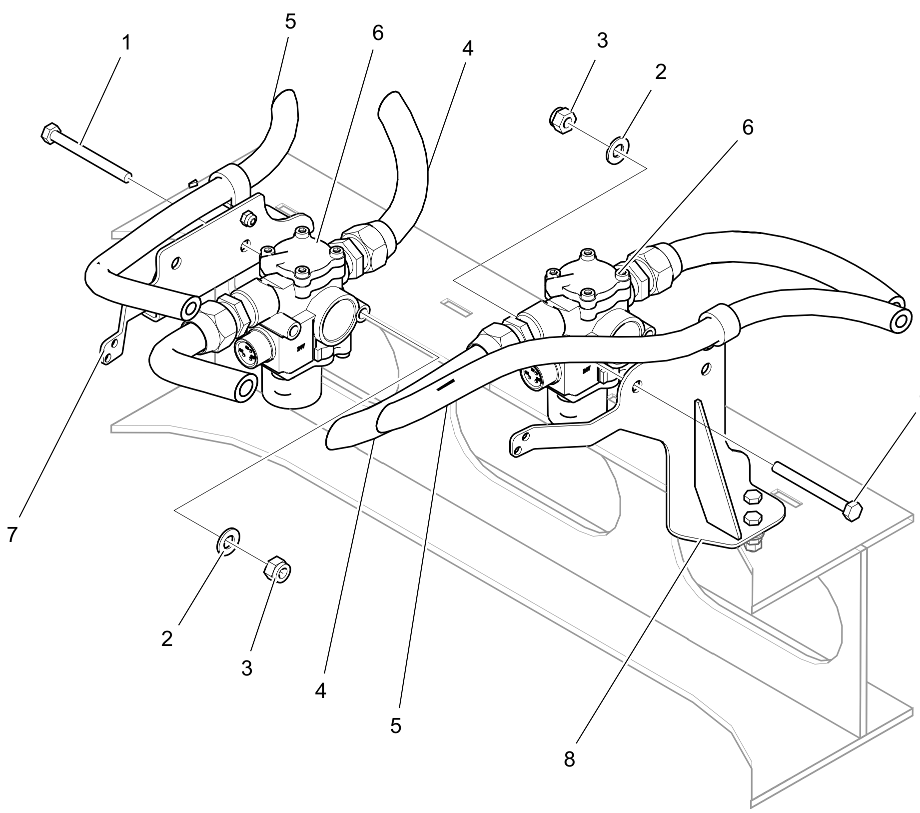
This modulation of brake application pressure will continue until the impending wheel lock-up condition is alleviated.

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. 2-151: 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.



1. Bolt, Hex 5/16" - 18 UNC x 3 " Lg.
2. Washer, Flat 5/16"
3. Nut, Lock Nylon 5/16" - 18 UNC
4. Hose, Brake 1/2"
5. Hose, Rear Brake 3/8" I.D.
6. Valve Assembly, Modulator 24V
7. Bracket, Modulator Valve Streetside
8. Bracket, Brake Modulator

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Fig. 2-151: Rear Modulator Valve Removal & Installation

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.

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. 2-152: 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.

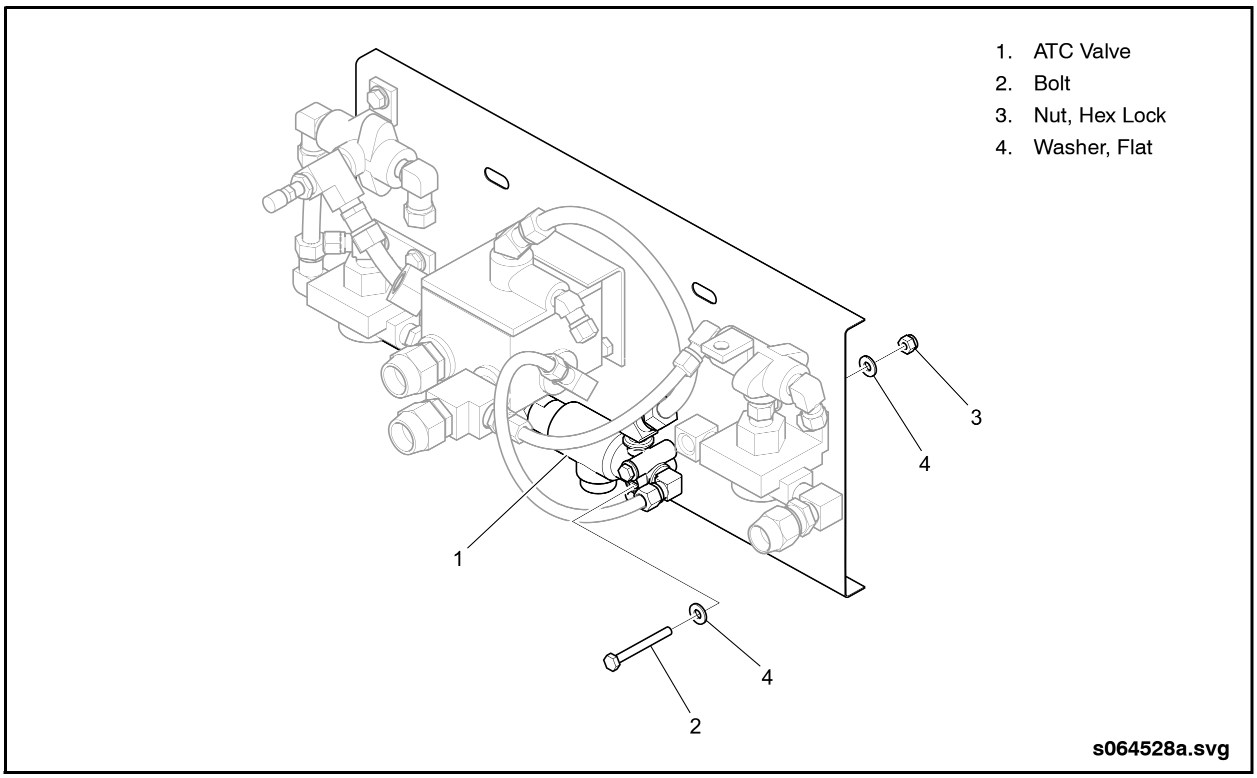


Fig. 2-152: Automatic Traction Control Valve

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. 2-153: ABS ECU” on page 133.

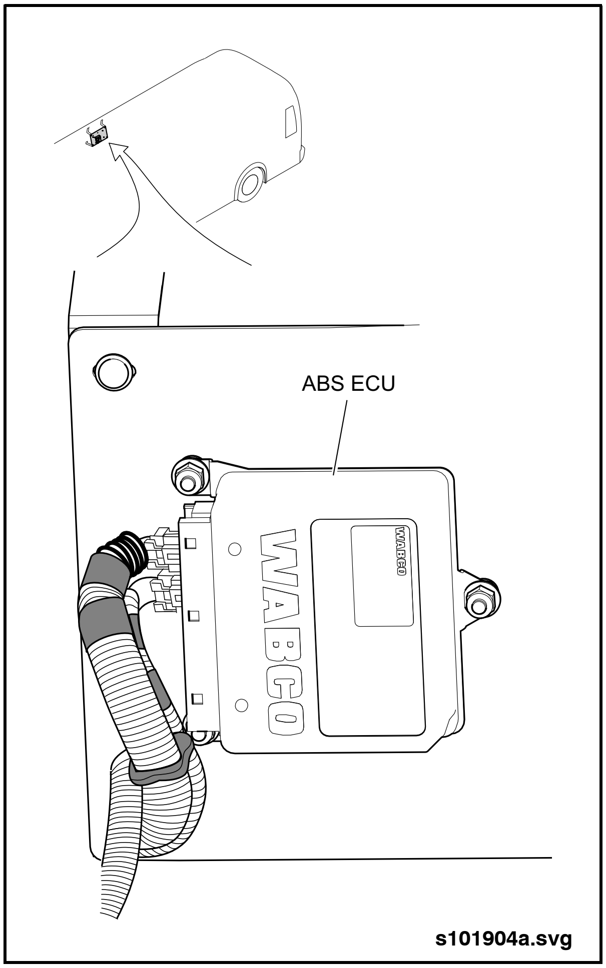


Fig. 2-153: ABS ECU

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 149 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. 2-154: Special Tools-1" on page 139. See "Fig. 2-155: Special Tools-2" on page 140. See "Fig. 2-156: Special Tools-3" on page 141. See "Fig. 2-157: Special Tools-4" on page 142. See "Fig. 2-158: Special Tools-5" on page 143.

SPECIAL TOOLS	DESCRIPTION
1	Adapter, Wheel Bolt
2	Slide Hammer
3	Tapered Collar
4	Segment, Clamping Jaw
5	Extension, Centering Tool
6	Washer
7	Spindle, Screw
8	Socket, Nut Slotted
9	Multiplier, Torque 1:8
10	Reaction Arm
11	Ratchet Insert
12	Counter Holder
13	Guide Sleeve
14	Slip-on Handle, Press-in & Press-out
15	Washer, Press-in
16	Adapter, Pressing Device
17	Press Out Device, Bearing
18	Press-in Plate
19	Pressing Bush, Inner Tapered Roller Bearing
20	Pressing Bush, Outer Tapered Roller Bearing
21	Supporting Fixture
22	Gauge, Feeler
23	Hook, Seal Race Removal

SPECIAL TOOLS	DESCRIPTION
24	Flange, 150mm - 180mm
25	Sleeve Assembly, ABS Sensor Holder
26	Slotted Nut Wrench
27	Threaded Pin, Adapter Flange
28	Cotter Pin
29	Puller, 3 Arm, Input Flange
30	Separator, Roller Bearing Inner Race
31	Puller, Bearing Separator
32	Puller, 3 Arm, Input Flange Seal
33	Detachable handle
34	Pressing Adapter, Input Flange Seal
35	Adapter Piece, 3-Arm Puller, Input Flange
36	Lifting Device, Differential Removal
37	Assembly Crown, Differential Removal
38	Support Screw, Differential Removal
39	Square Drive
40	Adapter, Axle Breather Connection
41	Threaded Adapter, Axle Breather Connection
42	Extractor, Axle Breather Connection
43	Intermediate Flange 150 mm
44	Gauge, Dial
45	Holder, Dial Gauge
46	Slotted Nut Wrench, Differential Threaded Adjusters
47	Lifting Device
48	Holder, Universal
49	Plate Attachments
50	Thrust Piece, Differential
51	Bearing Gripper

SPECIAL TOOLS	DESCRIPTION
52	Puller Sleeve
53	Spindle, Bearing Puller
54	Reducer, Rolex II
55	Assembling Device, Differential
56	Torque Multiplier - 1:3.5
57	Brace
58	Adapter Pin
59	Torque Wrench
60	Torque Wrench (80-400 Nm)
61	Feeler Gauge
62	Lifting Strap
63	Open-End Wrench
64	Pin, Connecting
65	Cable Tie Pliers
66	Screw, Socket Head
67	Spindle Adapter, Input Seal
68	Pin, Centering
69	Adapter
70	Expandable Puller
71	Pressing Plate, Input Flange Shield Installation
72	Depth Gauge, Electronic
73	Support Bar, Electronic Depth Gauge
74	Pressing Plate, Input Flange Shield Removal
75	Separator, Input Flange Shield
76	Lift Adapter
77	Tester, Friction
78	Alignment Pins
79	Engine Stand

SPECIAL TOOLS	DESCRIPTION
80	Threaded Adapter
81	Cylinder Support
82	Cap
83	Threaded Sleeve
84	Hook
85	Socket
86	Support
87	Torque Wrench
88	Pressing Adapter, Roller Bearing
89	Eyebolt
90	Lifting Chain
91	Box-End Ratchet
92	Ratchet Handle
93	Bearing Gripper
94	Pressing Adapter, Pinion Bearing Outer Race
95	Ratchet
96	Torque Wrench (160-800 Nm)
97	Handle, Screwdriver Torque
98	Shaft, Removable Screwdriver
99	Bit, Removable Screwdriver
100	Calipers, Measuring
101	Piston Cylinder, Hollow 200 kN
102	Pump, Hydraulic
103	O-Ring, 42 mm
104	Adapter, Tool Assembly
105	Adapter, Wrench
106	Thrust Piece, Hydraulic Puller

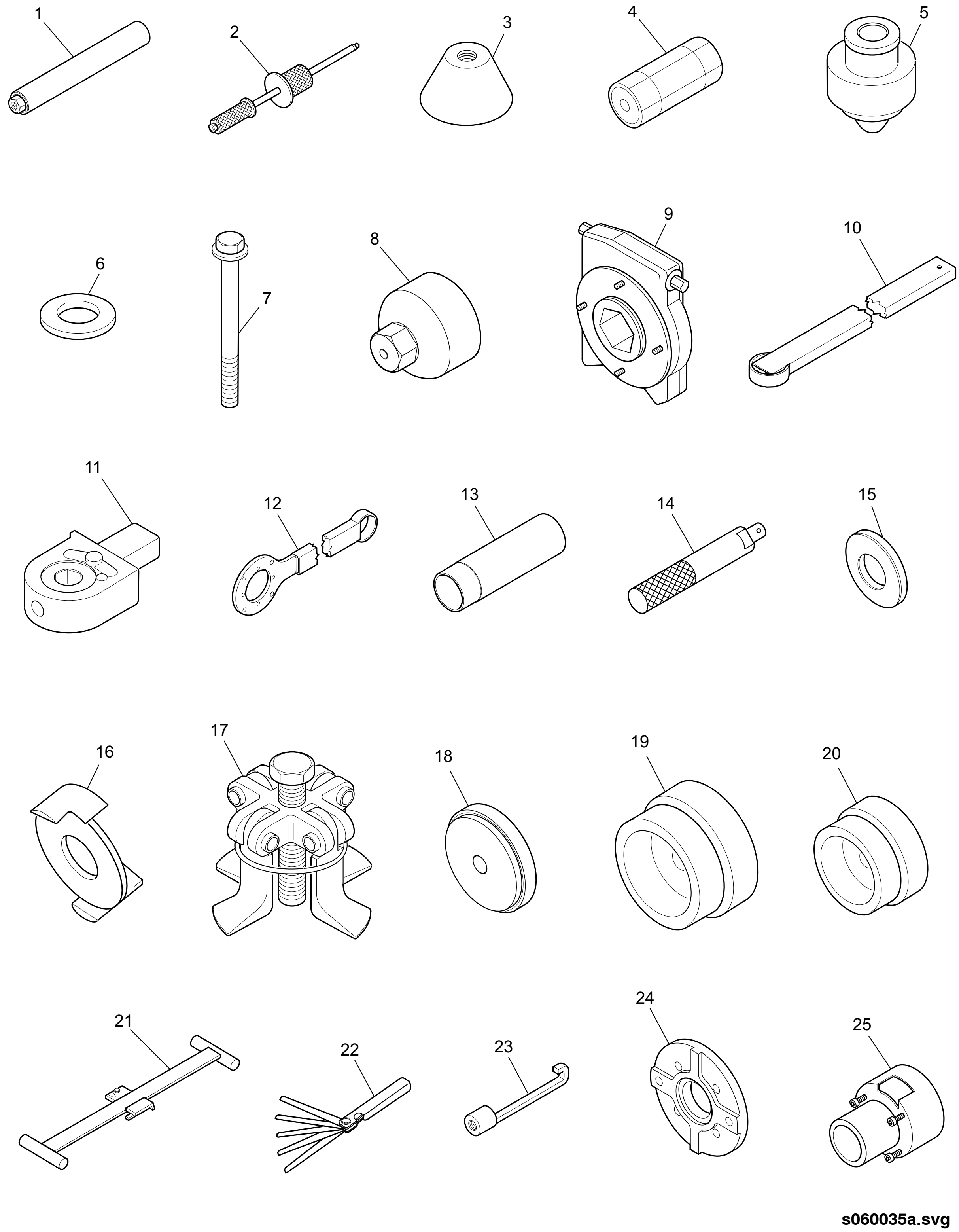


Fig. 2-154: Special Tools-1

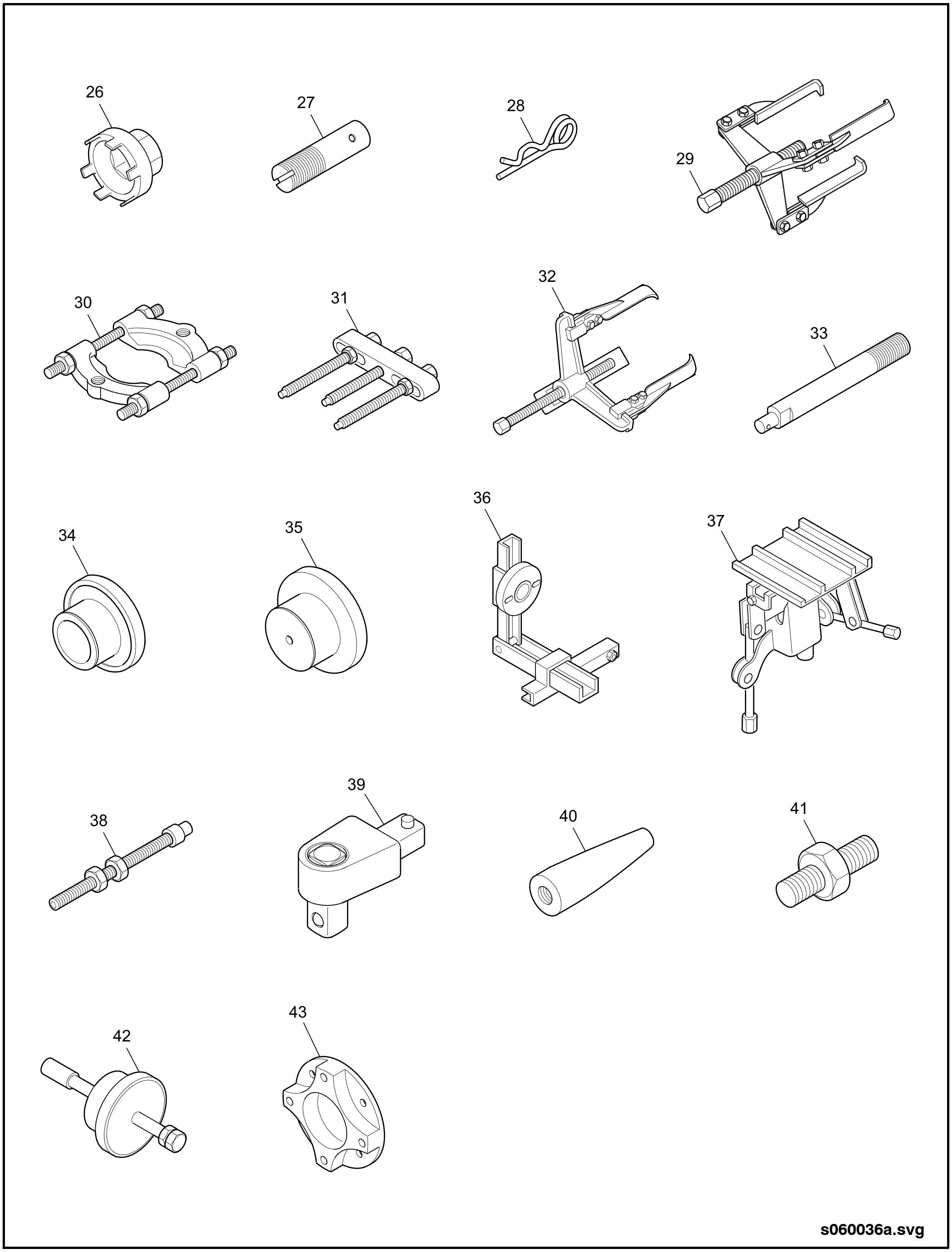


Fig. 2-155: Special Tools-2

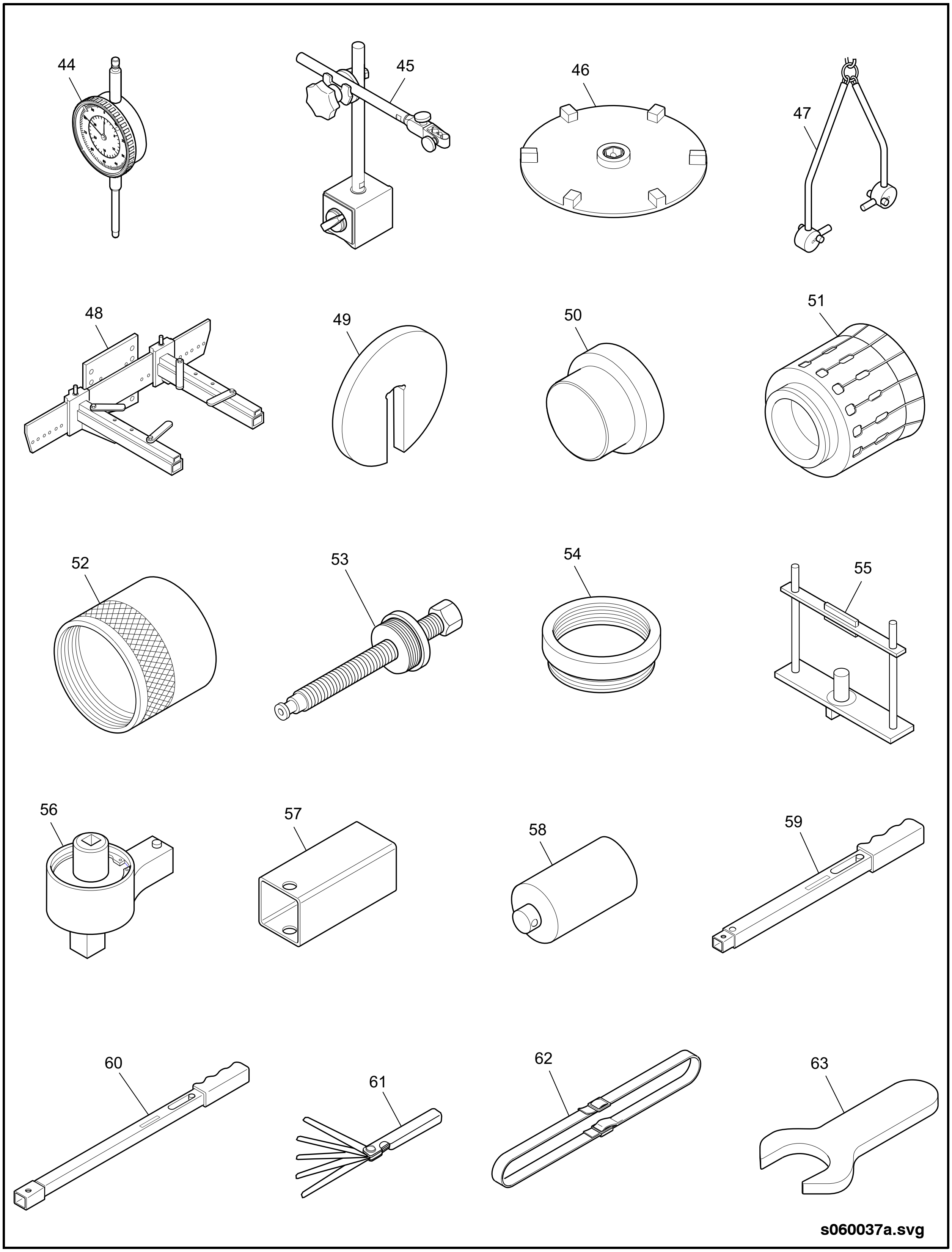


Fig. 2-156: Special Tools-3

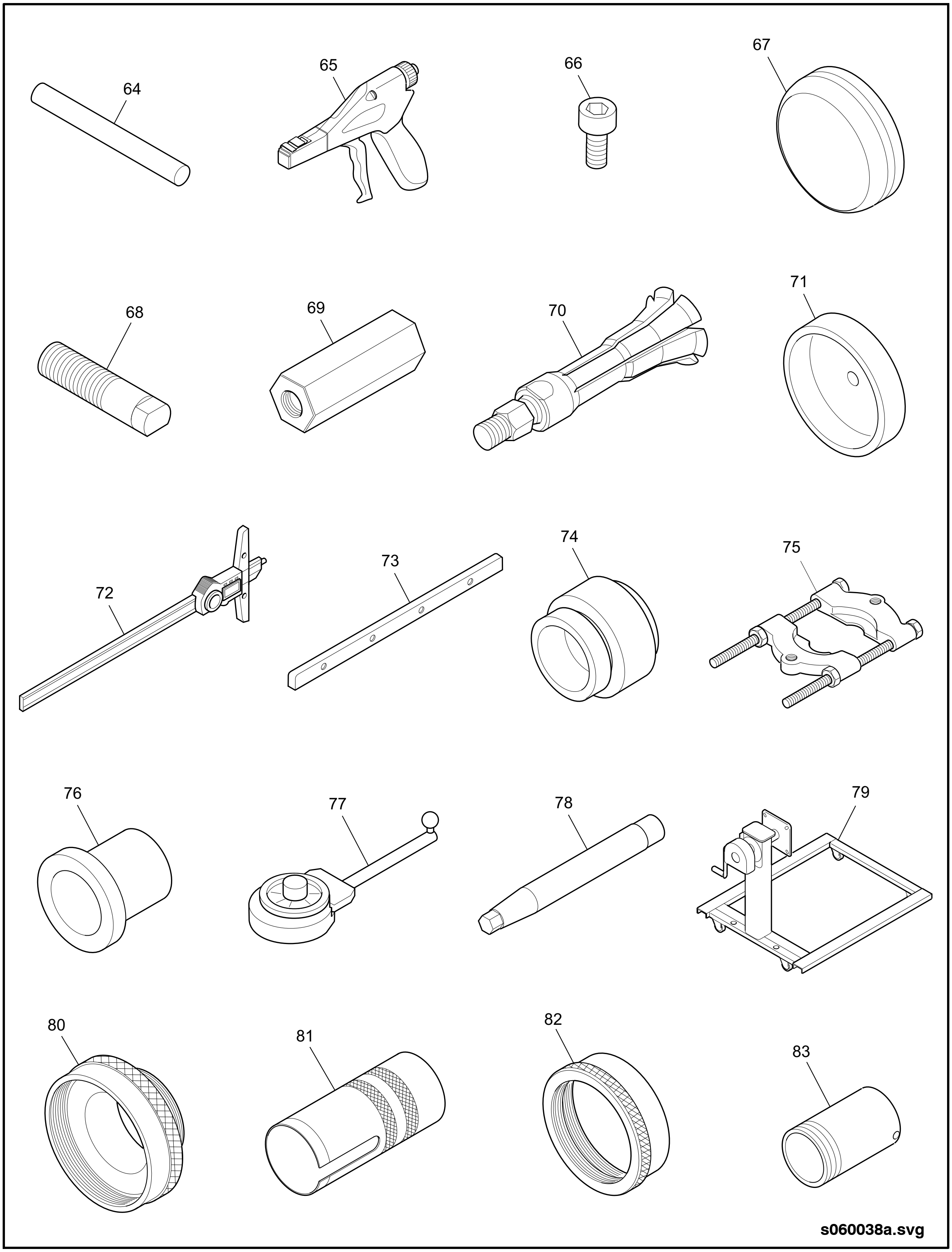


Fig. 2-157: Special Tools-4

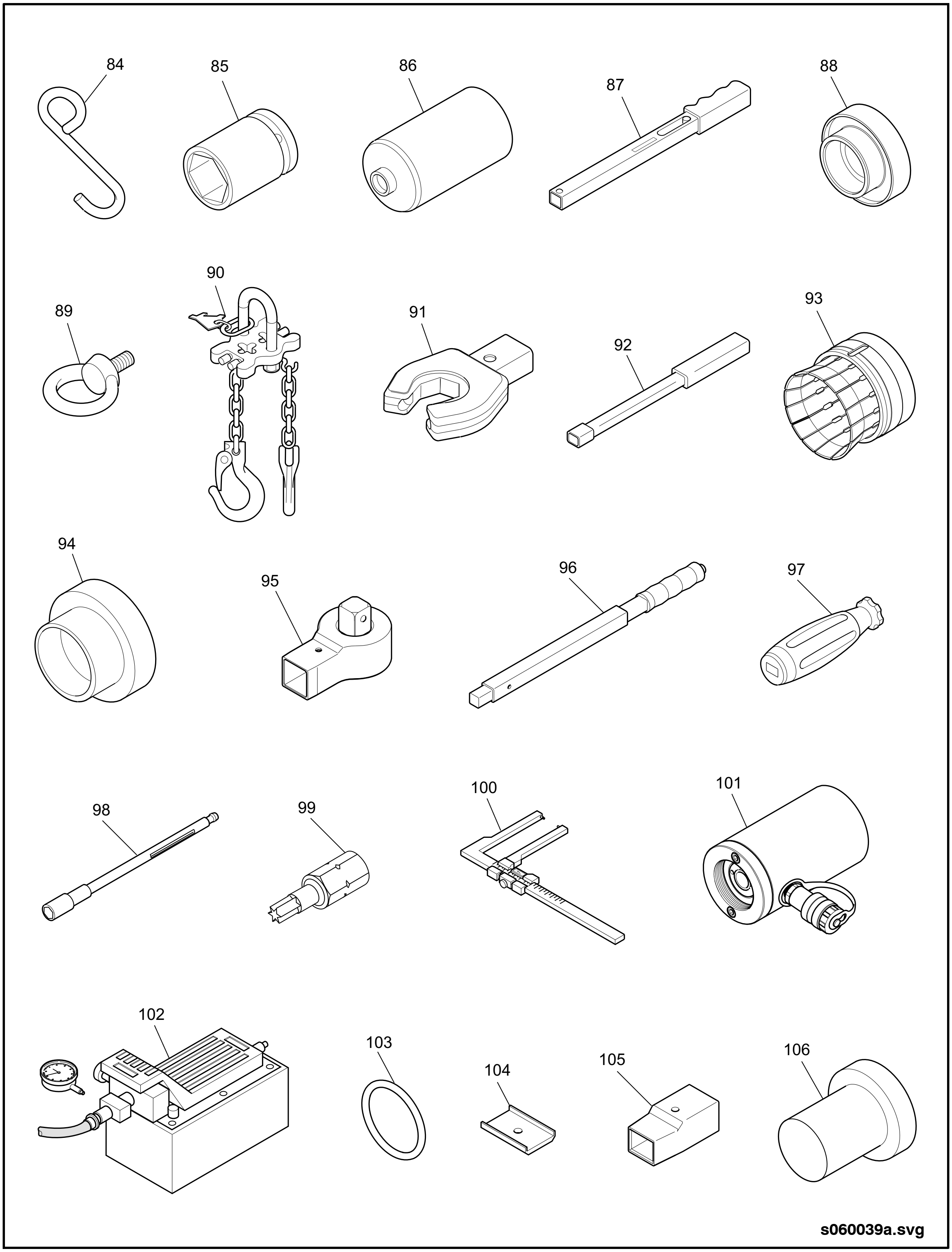


Fig. 2-158: Special Tools-5

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. 2-159: Driveshaft Removal & 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.

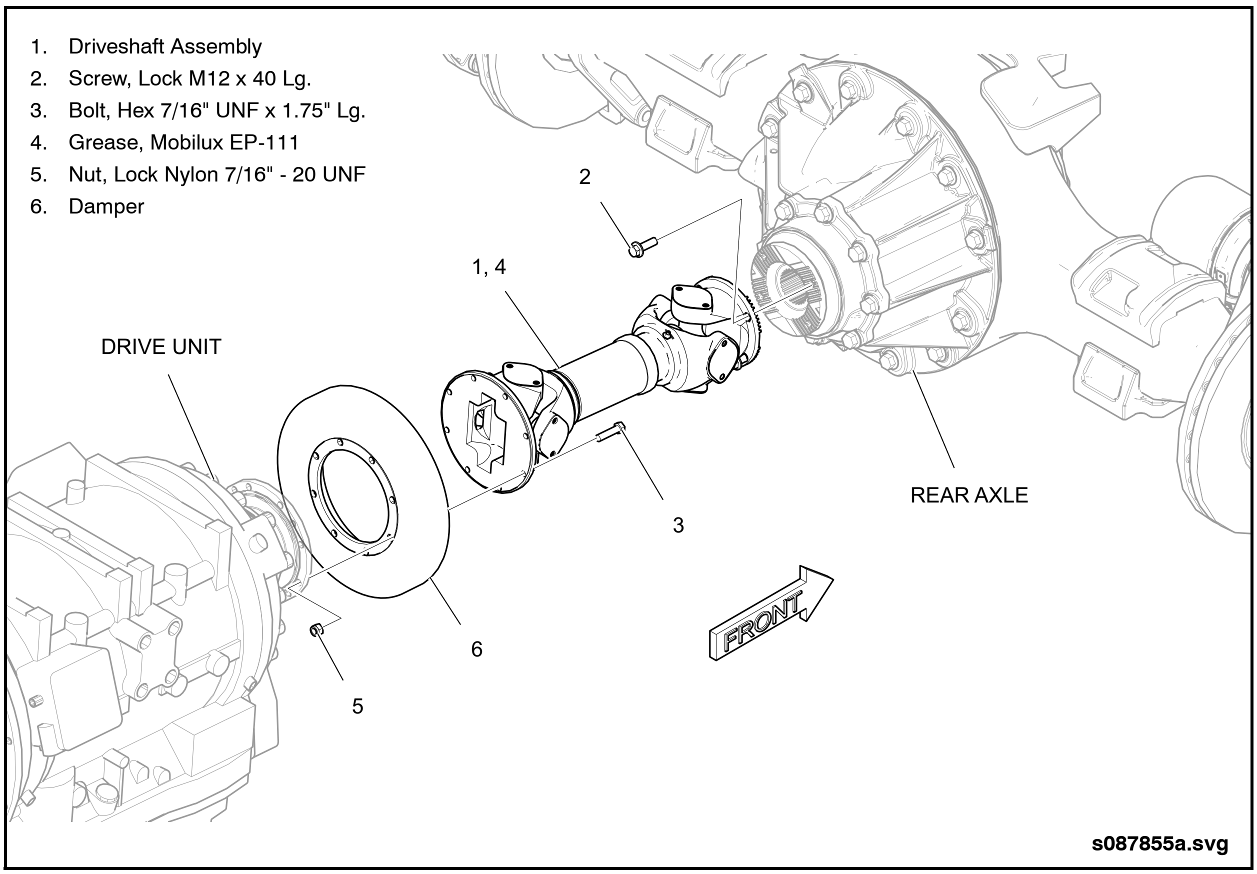


Fig. 2-159: Driveshaft Removal & Installation

8.2. Driveshaft Specifications

Manufacturer.................. Prop Shaft Supply

Model.......................................1710 Series

Angular Misalignment Capacity (bump angle)
.... 22° minimum, both ends

Balancing Requirement ....
0.31 in-oz/10 lbs of shaft weight at 3000 RPM

Extended Length (yoke center-to-center)
.... 17.88" (454mm)

Collapsed Length (yoke center-to-center)
.... 13.25" (337mm)

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

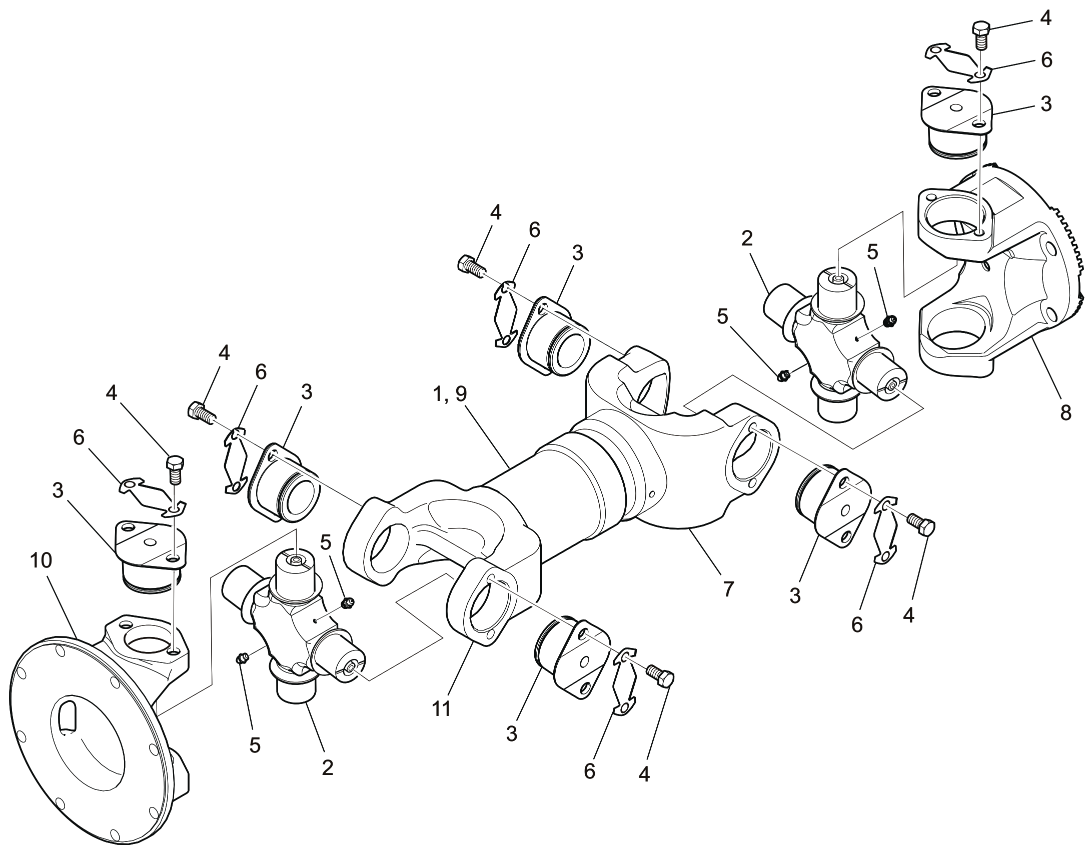
Refer to the Preventive Maintenance section of this manual for scheduled servicing procedures.

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. 2-160: Driveshaft Assembly” on page 146.
4. Remove bolts retaining driveshaft flange to drive axle and remove driveshaft assembly from vehicle.



1. Driveshaft Assembly, (Incl. 2-11)
2. Cross
3. Cup, Bearing
4. Bolt, Hex 3/8" - 24 x 9/16" UNF
5. Fitting, Grease 1/4" - 28 Taper Thread
6. Plate, Locking
7. Shaft, Yoke
8. Flange Yoke
9. Seal, Can
10. Flange Yoke
11. Slip Yoke

s012478a.svg

Fig. 2-160: 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.

☞**NOTE:**

Critical exposed surfaces of new drive shafts are protected and coated with a preservative. At installation this coating should be removed with solvent.

1. Inspect the condition of the mating flanges on the drive unit 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. Install the torsional damper on the flat flange end of the driveshaft using alignment marks made during removal.
3. Support the driveshaft and align torsional damper with flange on drive unit. Ensure marks on torsional damper and drive unit flange are aligned.
4. Install eight bolts and lock nuts and torque lock nuts to 75 to 77 ft-lbs. (102 to 104 Nm). Apply torque witness marks.
5. Align the cross-tooth flange on the driveshaft with the drive axle flange and install four new M12 capscrews.

☞**NOTE:**

The capscrews come with thread locking compound on the threads and should be used only once.

6. Ensure that cross-tooth flanges are properly seated then torque the capscrews alternately to 81± 3 ft-lb. (110 ± 4 Nm). Apply torque witness marks.
7. Remove the supporting equipment and install the driveshaft guard.

8.9. Torsional Damper

8.9.1. Description

The torsional damper is used to control vibration frequency on the driveshaft. The damper is bolted to the driveshaft through the output flange of the drive unit with eight bolts and lock nuts and is removed when the driveshaft is removed. It is critically balanced to the driveshaft assembly and must be marked for reference to the driveshaft and drive unit output flange prior to removal.

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. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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.

2.4.1.1. 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...................... 0.38"

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.

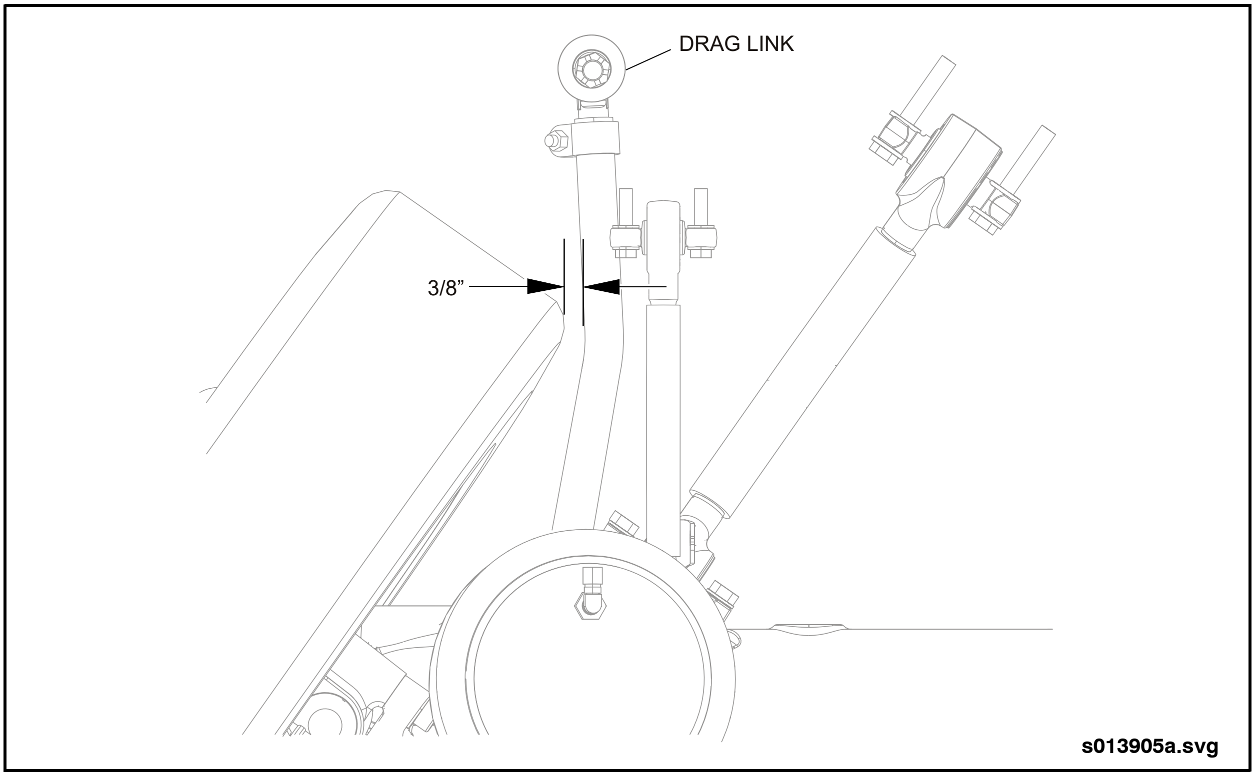


Fig. 3-1: Tire to Drag Link Clearance

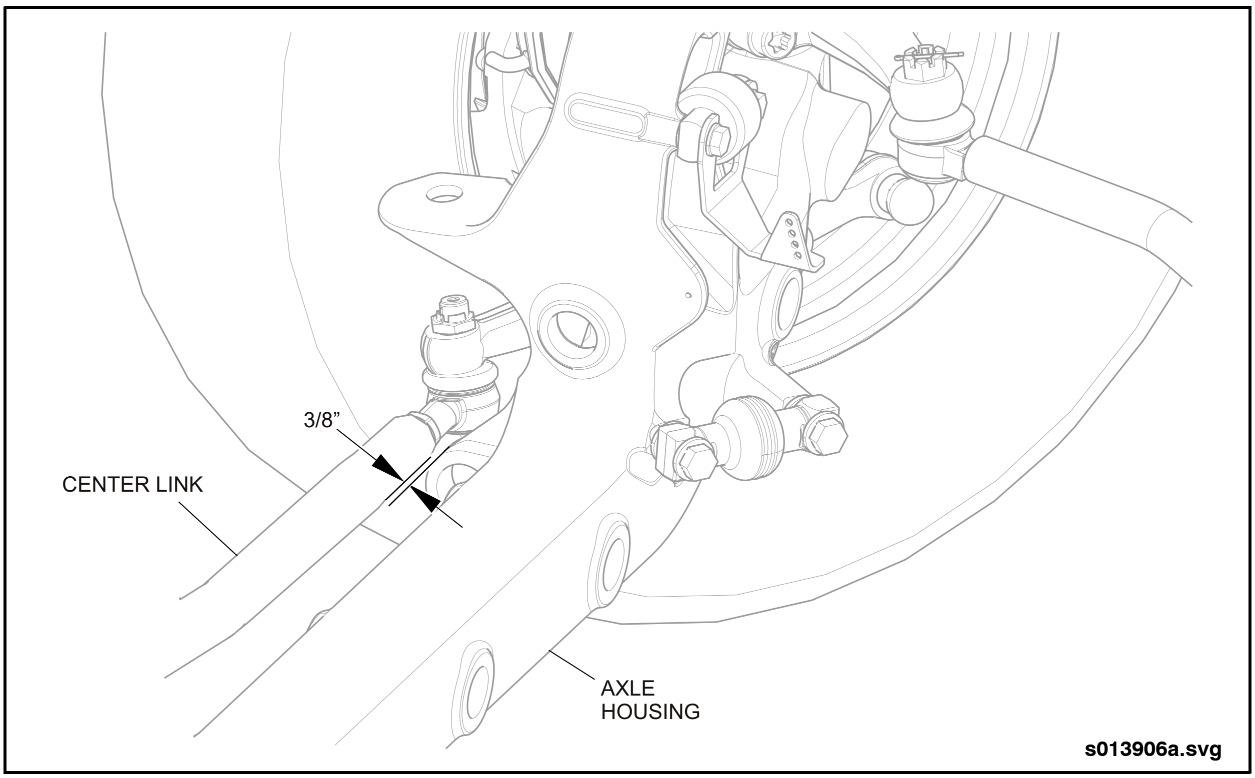


Fig. 3-2: Center Link to Axle Housing Clearance

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.

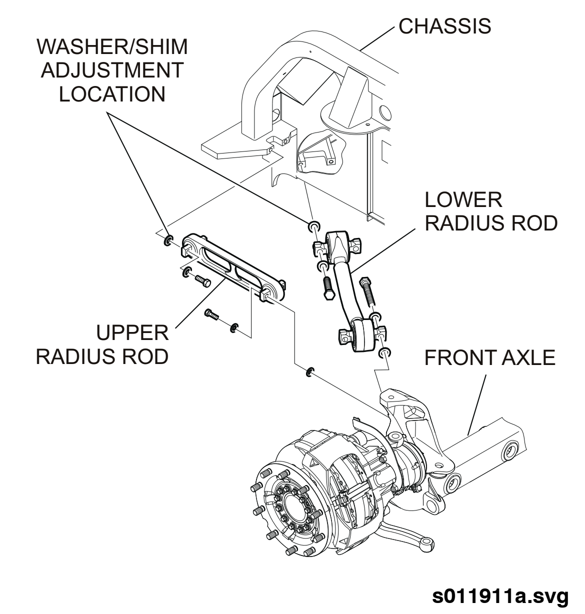


Fig. 3-3: Front Setback Angle Adjustment

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.

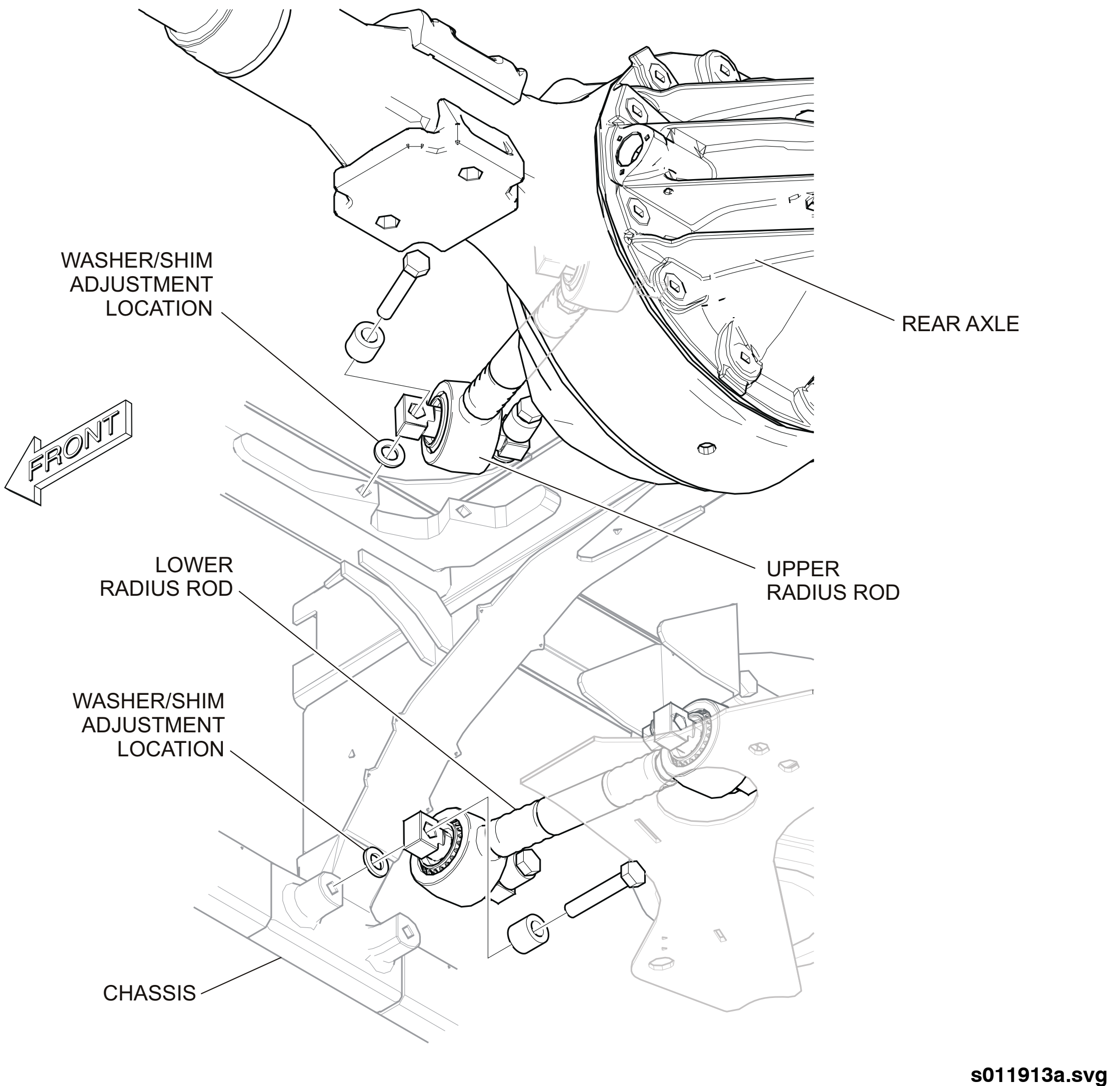


Fig. 3-4: Rear Thrust Angle Adjustment

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.

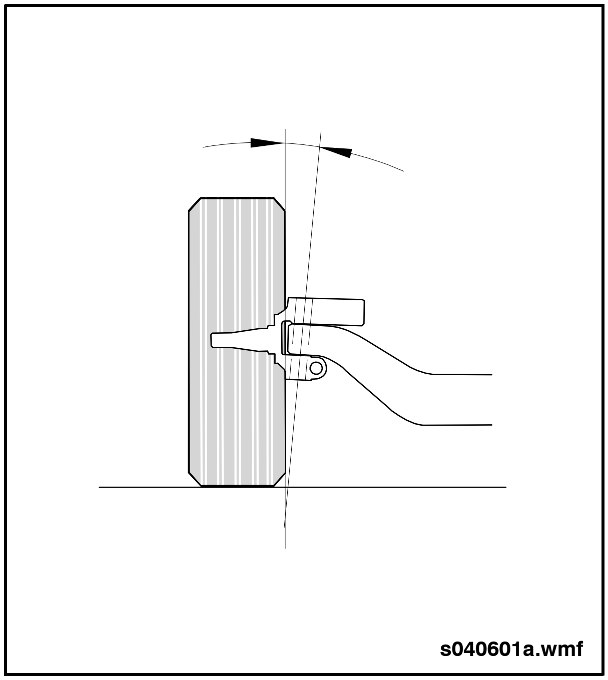


Fig. 3-5: King Pin Inclination

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.

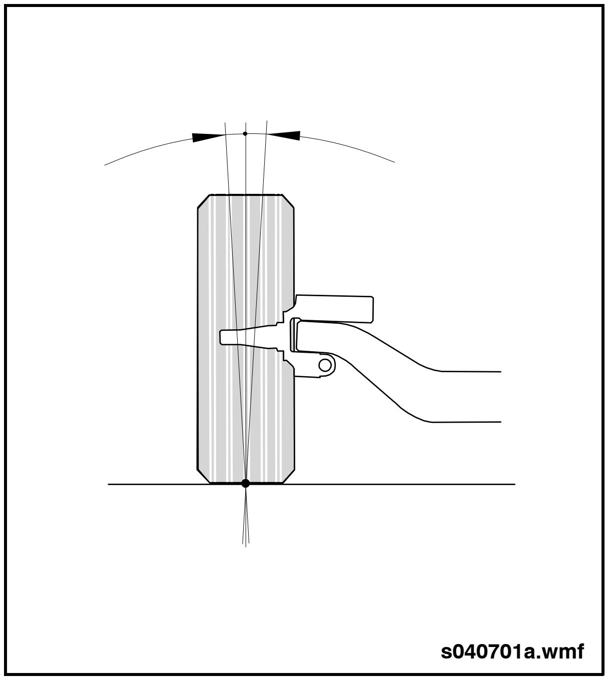


Fig. 3-6: Camber Angle

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.

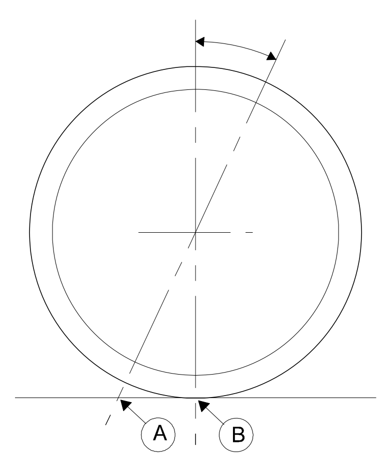


Fig. 3-7: Caster Angle

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.

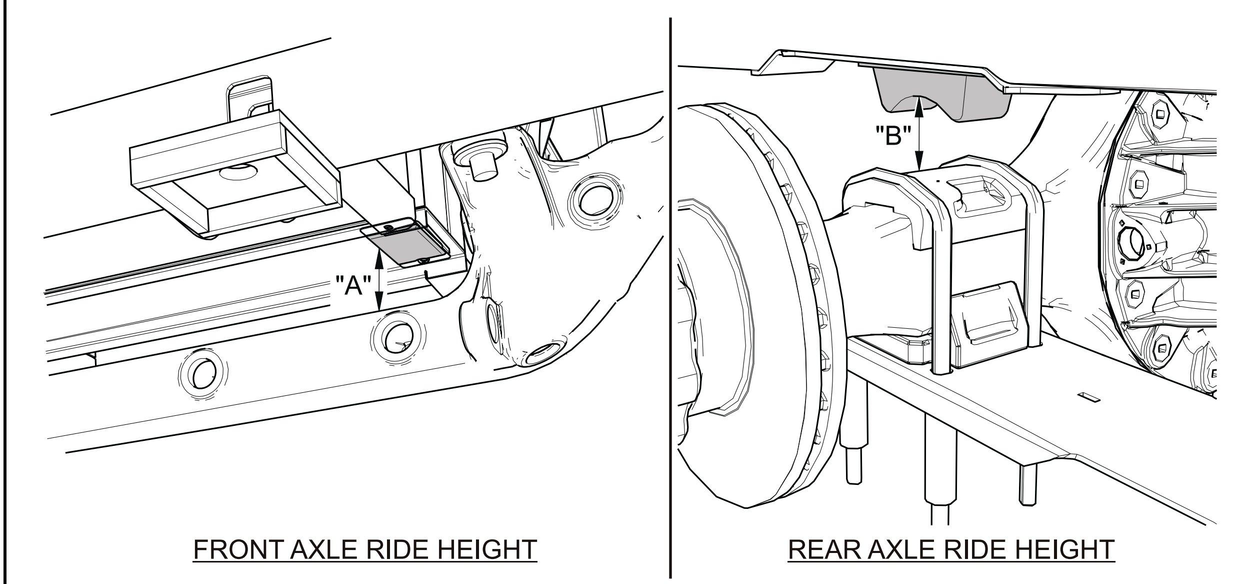


Fig. 3-8: Ride Height Adjustment

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 Head Cap 5/16" - 18 x 3/5
3. Steering Column Support Assembly
4. Bolt, Hex 3/8" - 16 UNC x 3/4" Lg.
5. Washer, Flat 3/8"
6. Loctite 272 Threadlock
7. Miter Box Assembly
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, Fore
14. Clamp, Aft
15. Screw, PH Cross Recess Tpg. Type AB 1/4" x 1" Lg.
16. Steering Wheel
17. Ground Wire Assembly
18. Button, Horn
19. Washer, Flat 5/16"
20. Bracket, Steering Column Cover

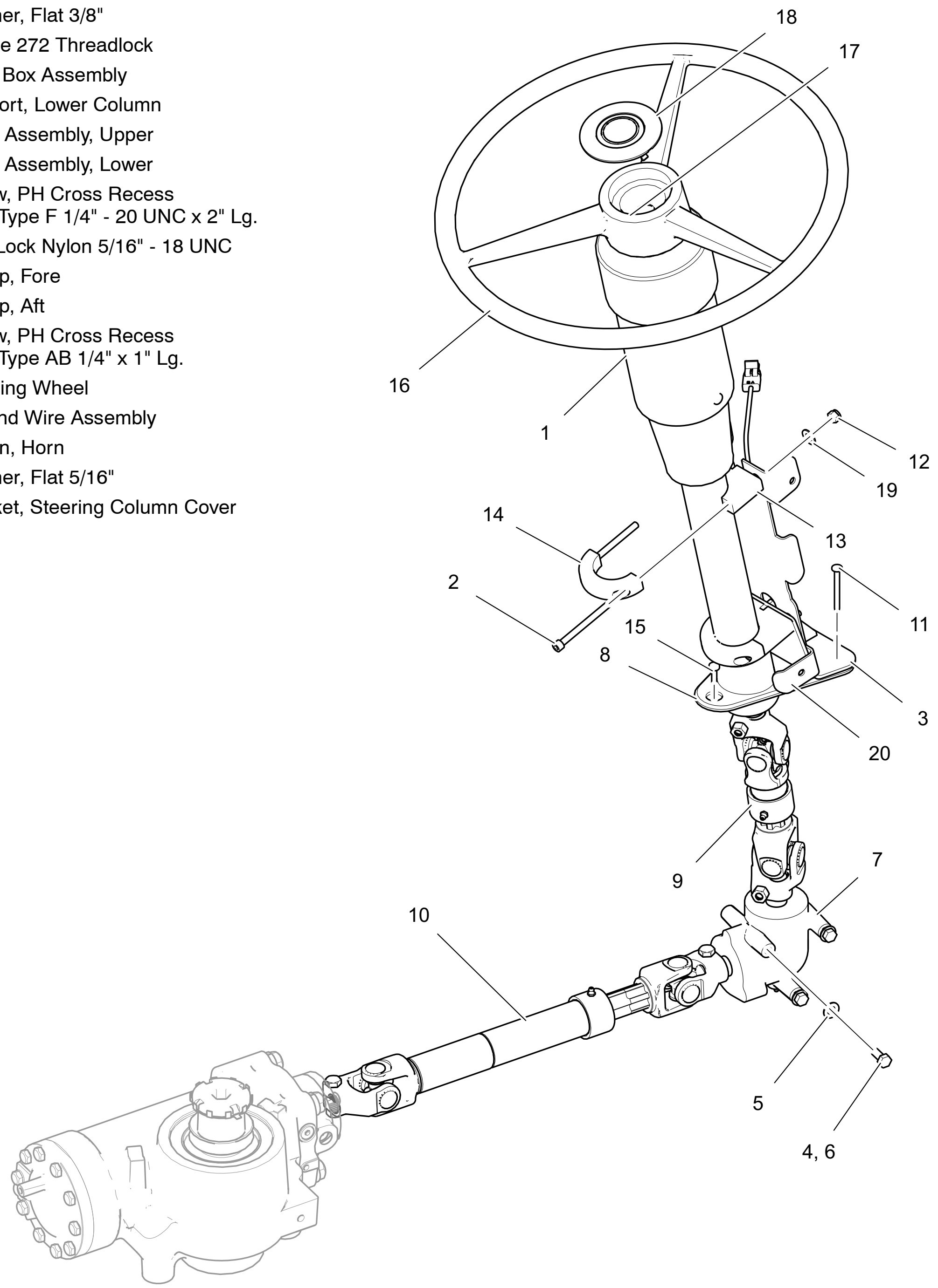
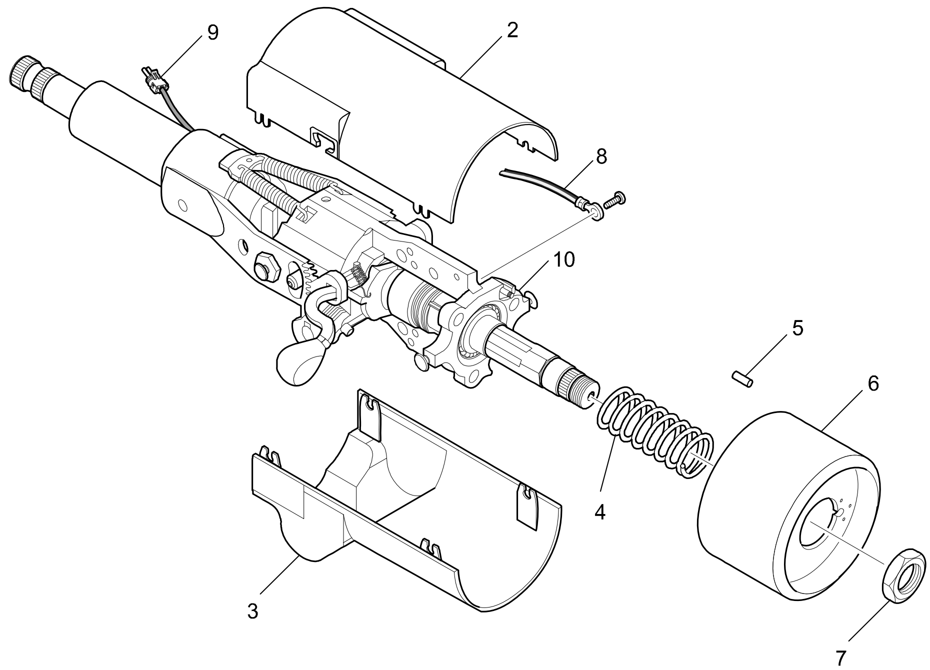


Fig. 3-9: Steering Column Installation



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

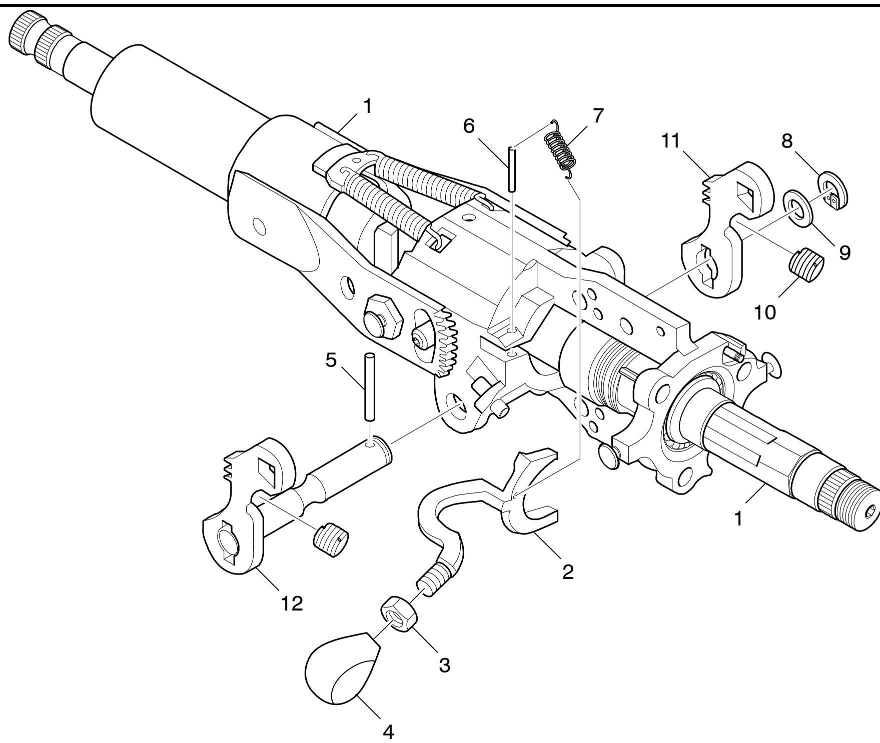
1. Telescope the column out toward the driver.
2. Tilt the column all the way down and pull the upper cover off by grasping the cover at the bottom, closest to the dash.
3. Tilt the column all the up and pull the lower cover off, similar to removing the upper cover.
4. Start the engine so the hydraulic 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)	5. Pin	9. Washer
2. Actuator	6. Pin	10. Spring
3. Nut, Lock	7. Spring	11. Pawl
4. Knob	8. Ring, Retaining	12. Rod & Pawl Assembly

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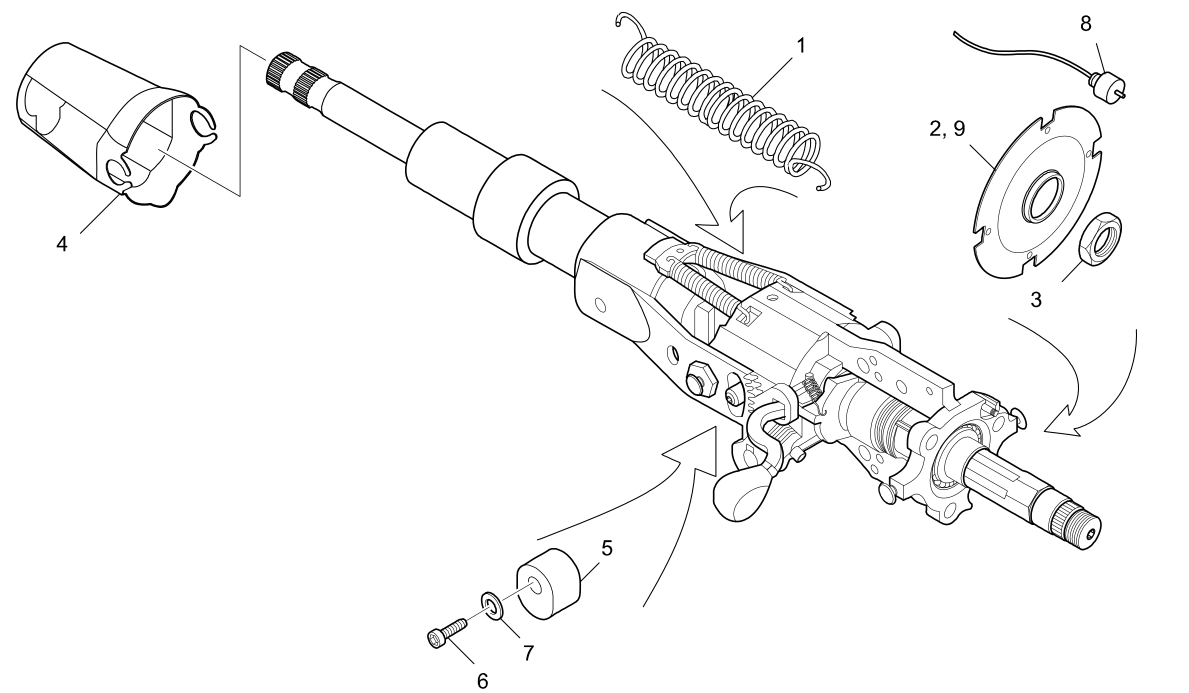
Fig. 3-11: Rod & Pawl Removal

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
2. Grease Kit
3. Nut, Hex 7/8"
4. Cover, Trough
5. Tilt Stop
6. Screw
7. Washer
8. Brush, Horn
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.

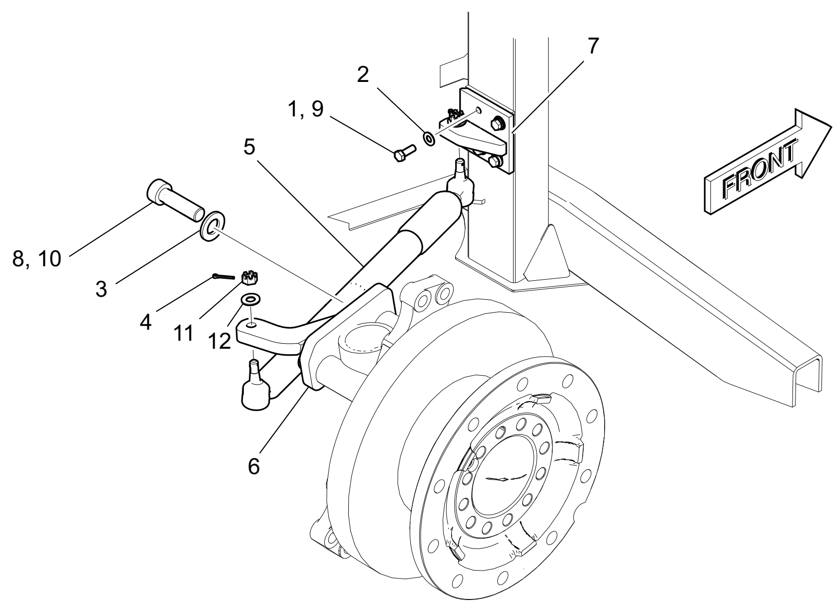
2.9. Steering Damper

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 Assembly, Steering Damper
7. Mounting Assembly, Steering Damper
8. Loctite, 263 Red
9. NEVER-SEEZ
10. Screw, Torx Cap M22 x 1.5 x 75
11. Nut, Castle M12 x 1.5
12. Washer, Flat Hardened 1/2"

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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.

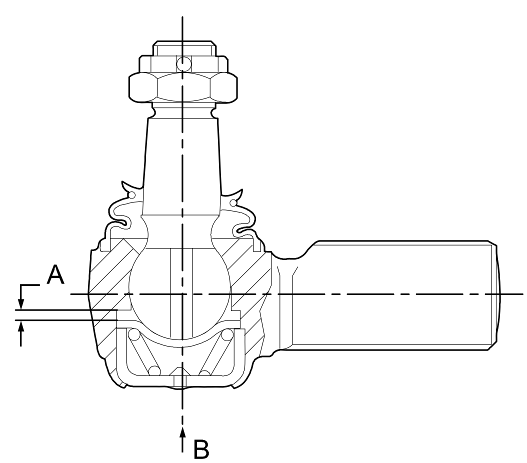


Fig. 3-14: Ball Joint End Lift Measurement

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

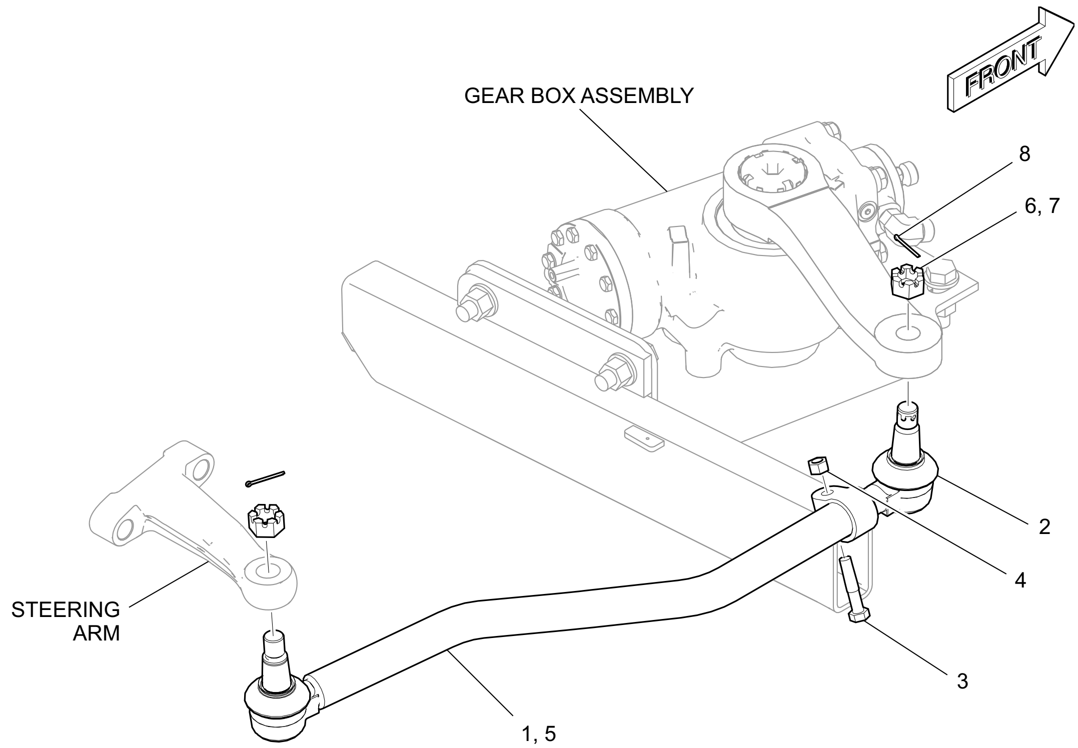
DO NOT exceed maximum checking load or damage to internal components of the ball joint could result.

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

s014644a.svg

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 to 59 to 70 ft-lb. (80 to 95 Nm).

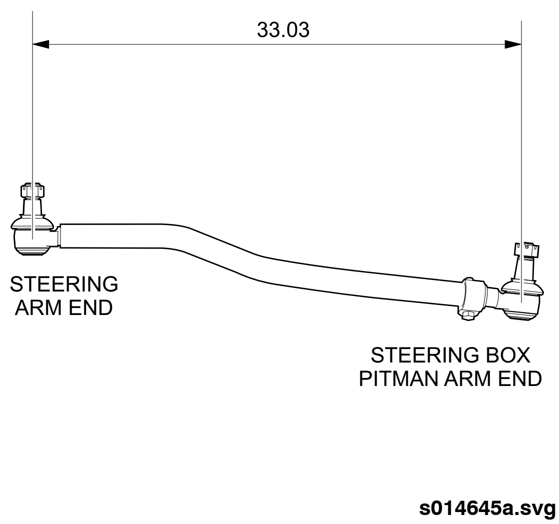


Fig. 3-16: Drag Link Adjustment

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 bolts 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. Note the installed angle of the diagnostic fitting and remove from steering gearbox.
7. 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.

8. Position lifting equipment beneath the steering gearbox support plate and support the weight of the steering gearbox.

9. 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.

10. 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.

11. Remove the five bolts and spacers that secure the support plate to the steering gearbox.

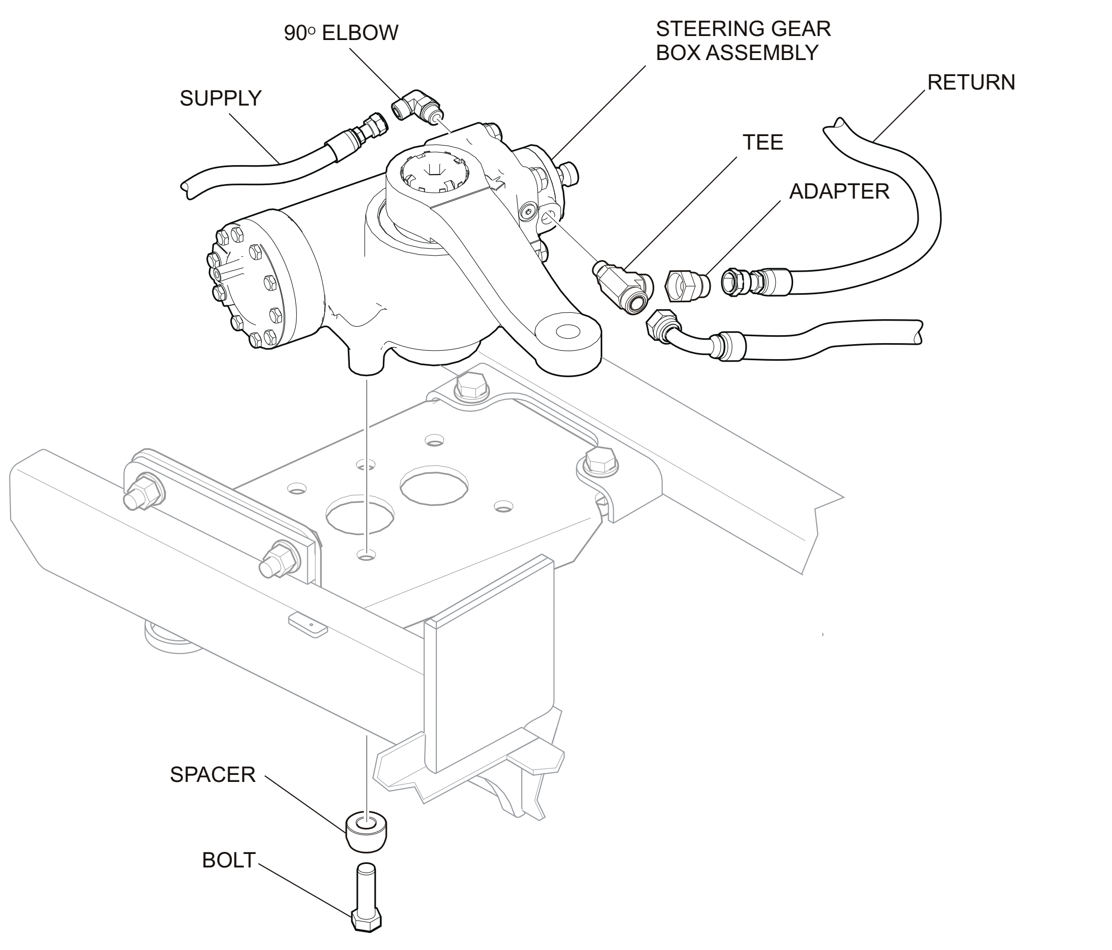


Fig. 3-17: Steering Gearbox Removal & Installation

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.

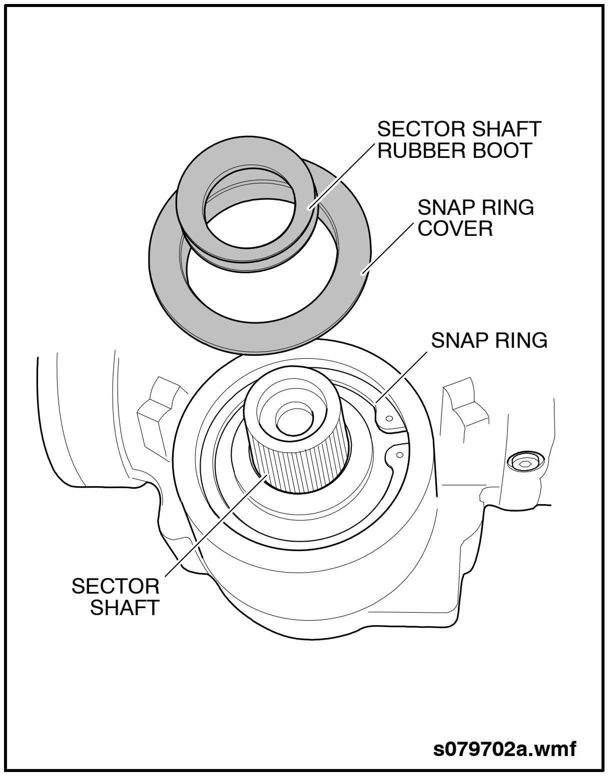


Fig. 3-18: Sector Shaft Boot & Cover Removal

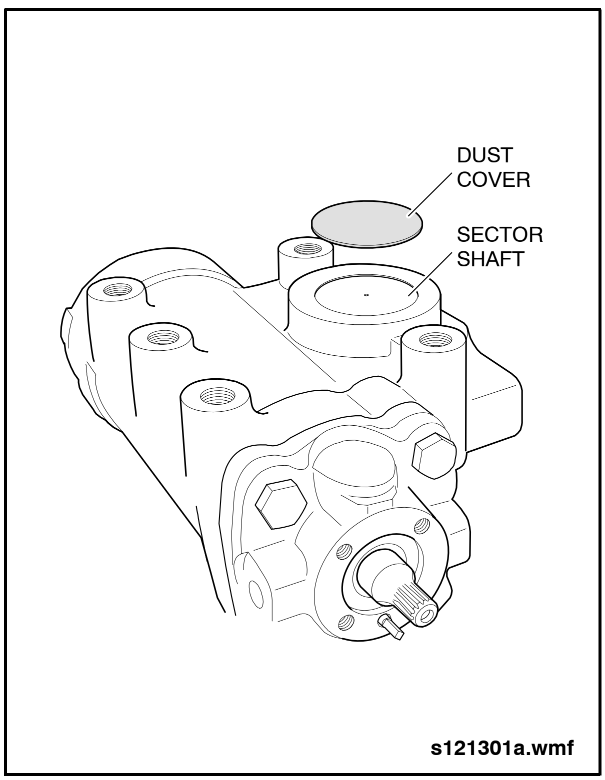


Fig. 3-19: Sector Shaft Dust Cover Removal

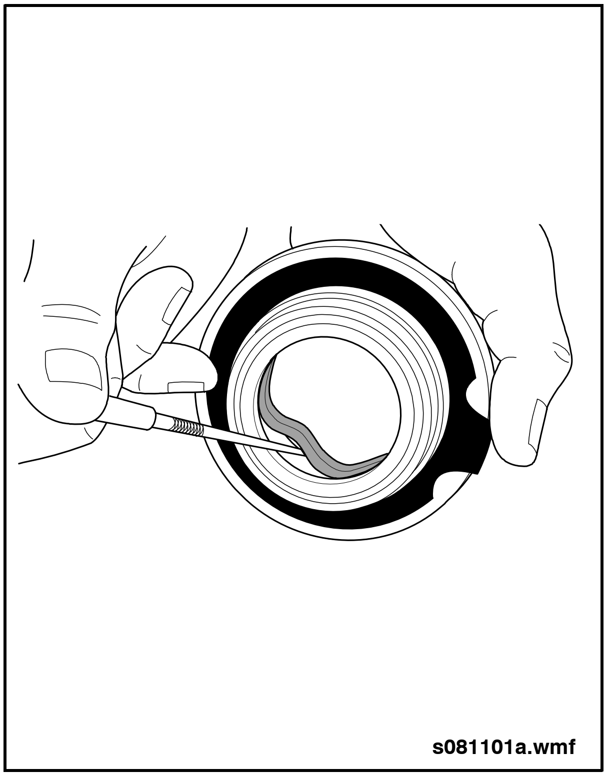


Fig. 3-20: Cover & Sector Shaft Seal Removal

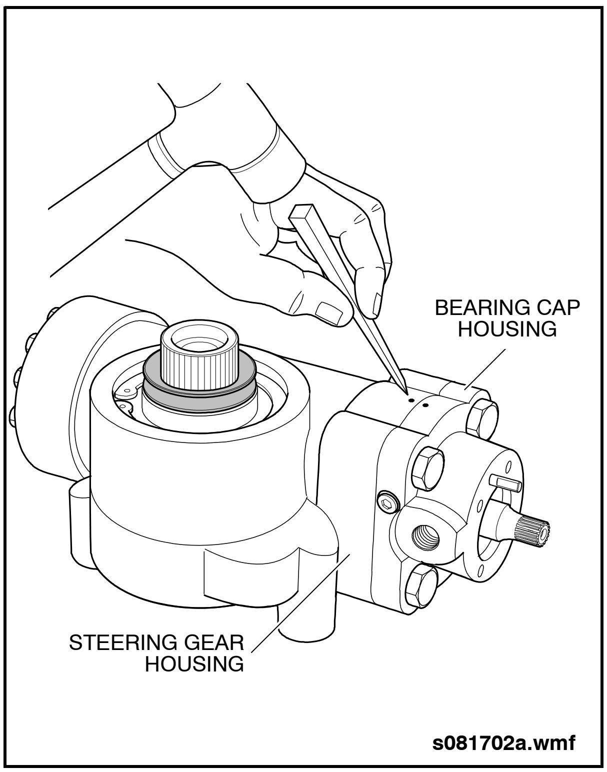


Fig. 3-21: Bearing Cap & Housing Reference Marks

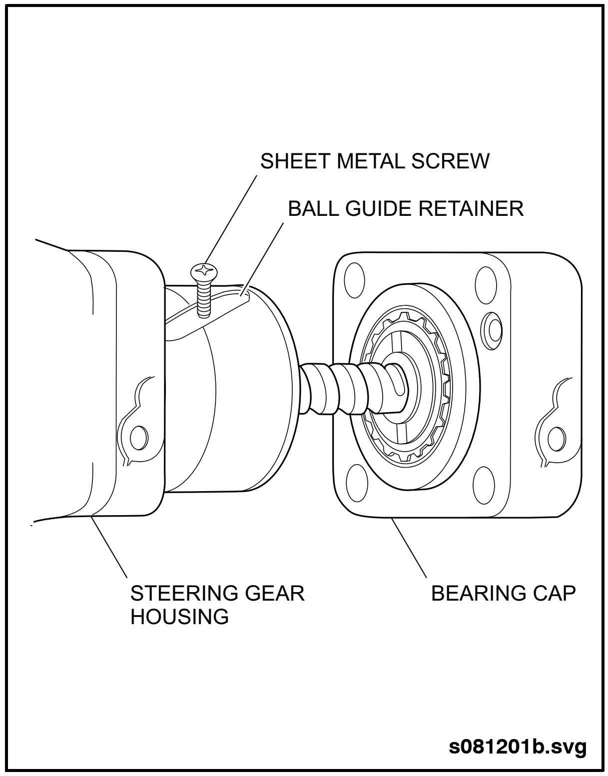


Fig. 3-22: Ball Guide Retainer Removal

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.

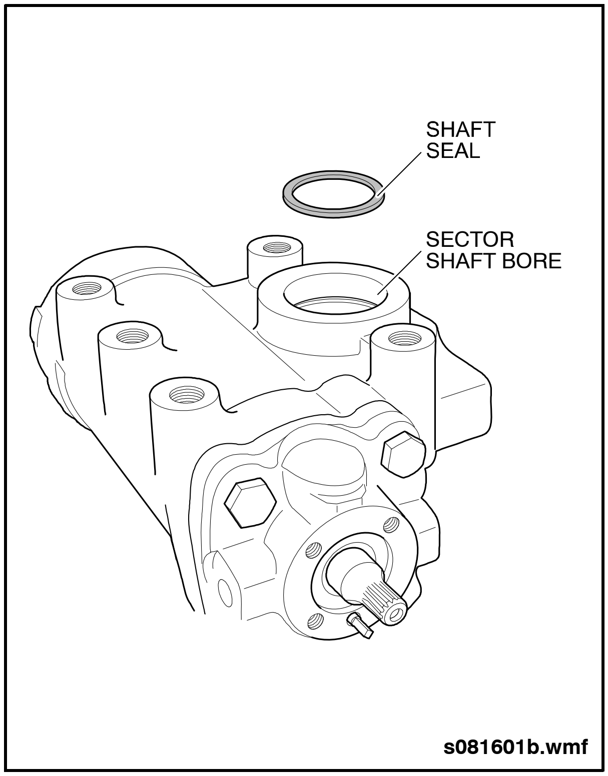


Fig. 3-23: Sector Shaft Seal Installation

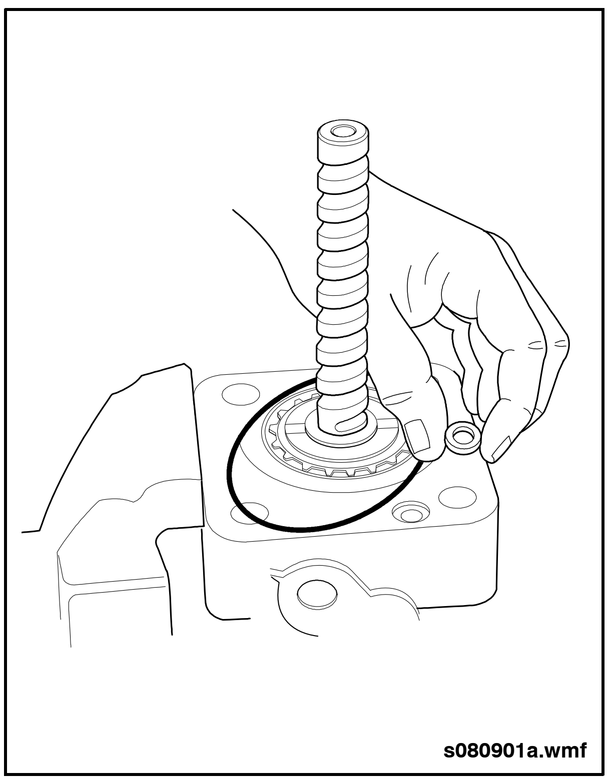


Fig. 3-24: Seal Ring Installation

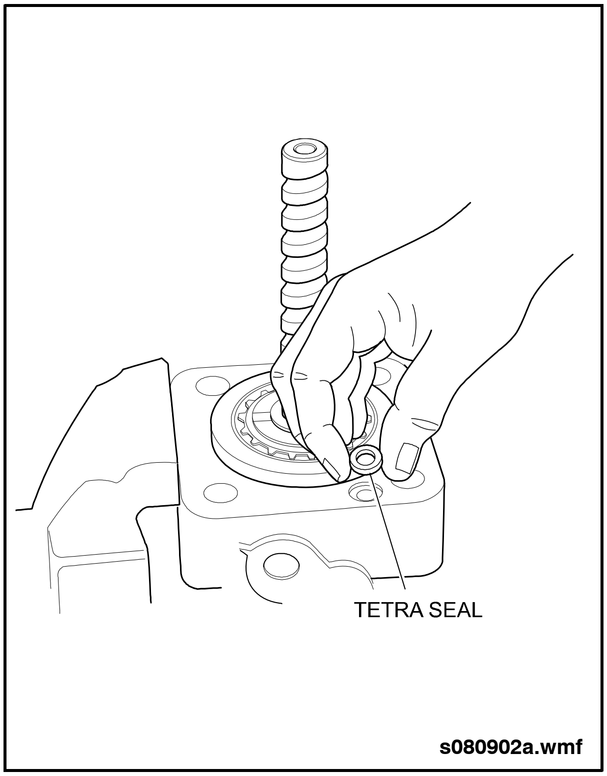


Fig. 3-25: Tetra Seal Installation

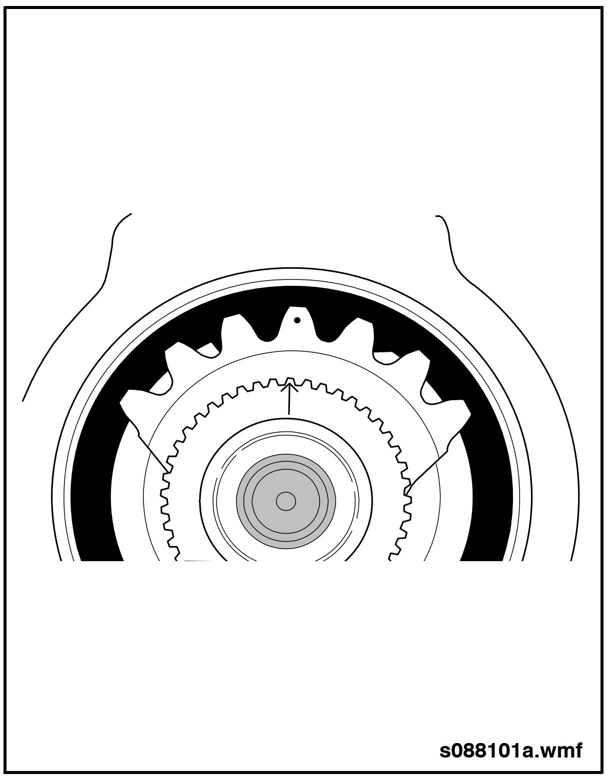


Fig. 3-26: Sector Shaft Timing Marks

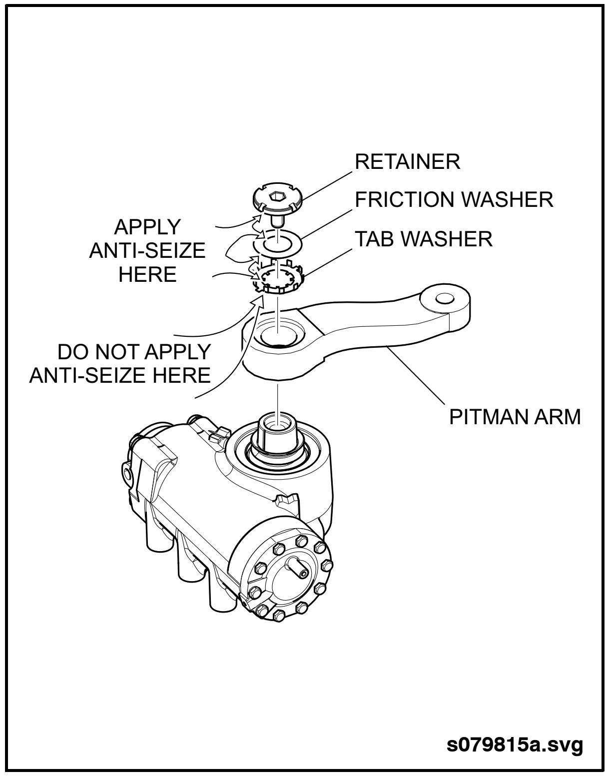


Fig. 3-27: Anti-Seize Compound Application

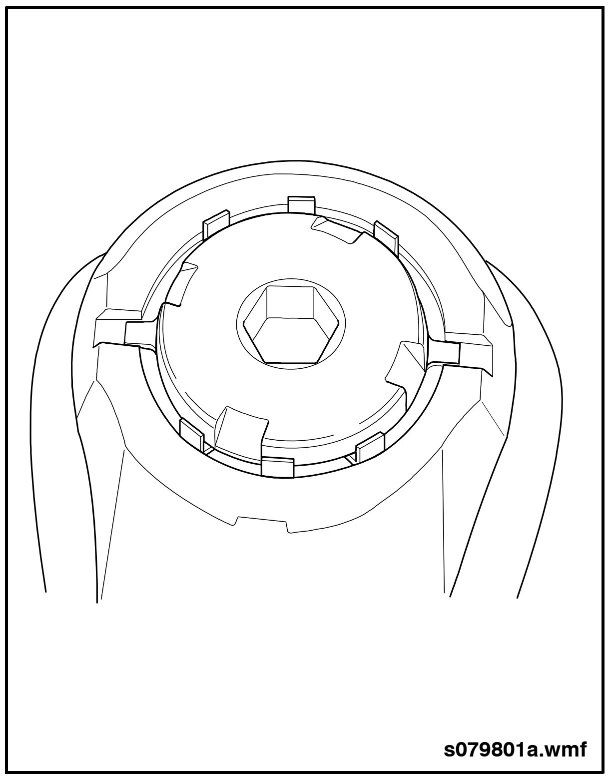


Fig. 3-28: Locking Pitman Arm Tabs

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. Reinstall diagnostic connector at same angle noted during removal. Lubricate O-ring and torque nut to 50 to 60 ft-lb. (68 to 81 Nm).
10. Connect -08 pressure hose and torque fitting to 32 to 35 ft-lb. (43 to 47 Nm.)
11. Connect -10 return hose and torque fitting to 46 to 50 ft-lb. (62 to 68 Nm.)
12. Reinstall and close the removed access doors.
13. Lower vehicle and fill reservoir with oil.
14. Bleed the system. Refer to 2.12.11. “Bleeding Power Steering Hydraulic System” on page 43 in this section for procedure.
15. 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

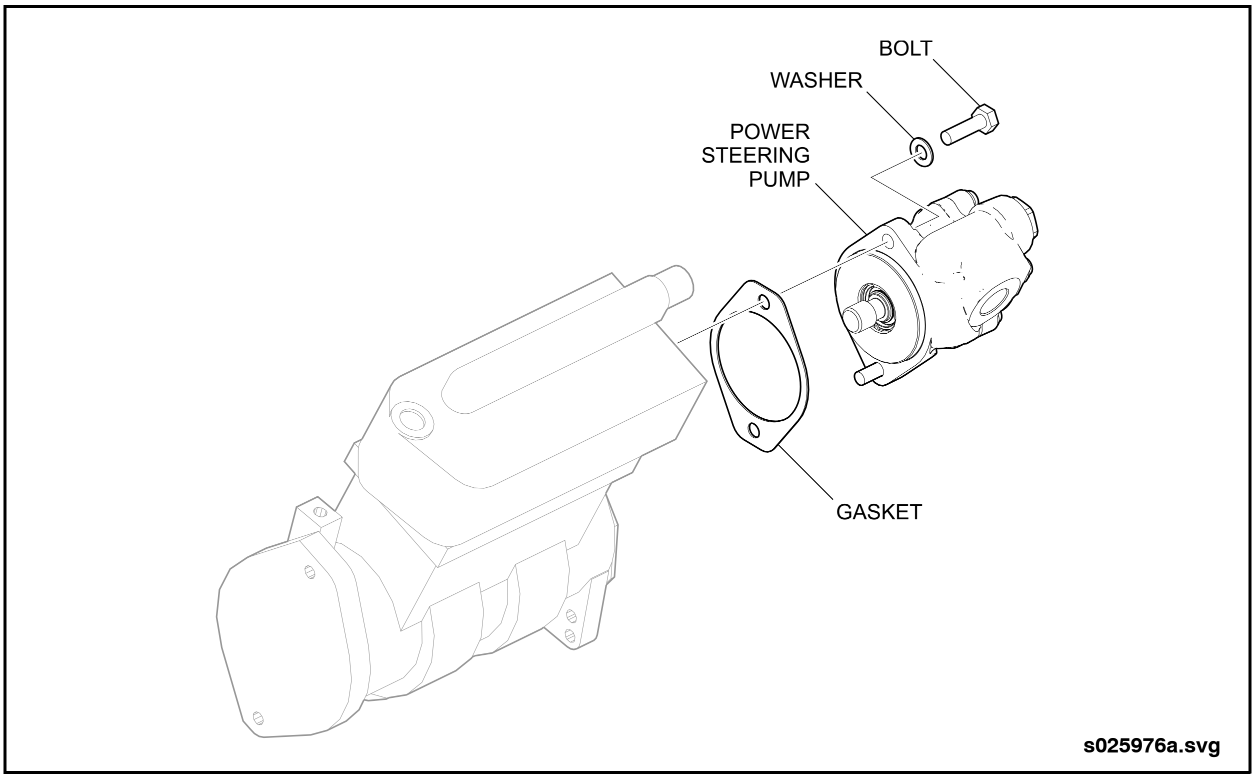


Fig. 3-29: Power Steering Pump Installation

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 “G” grease (Chevron 23003, GR-25 or equivalent).
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-242 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.

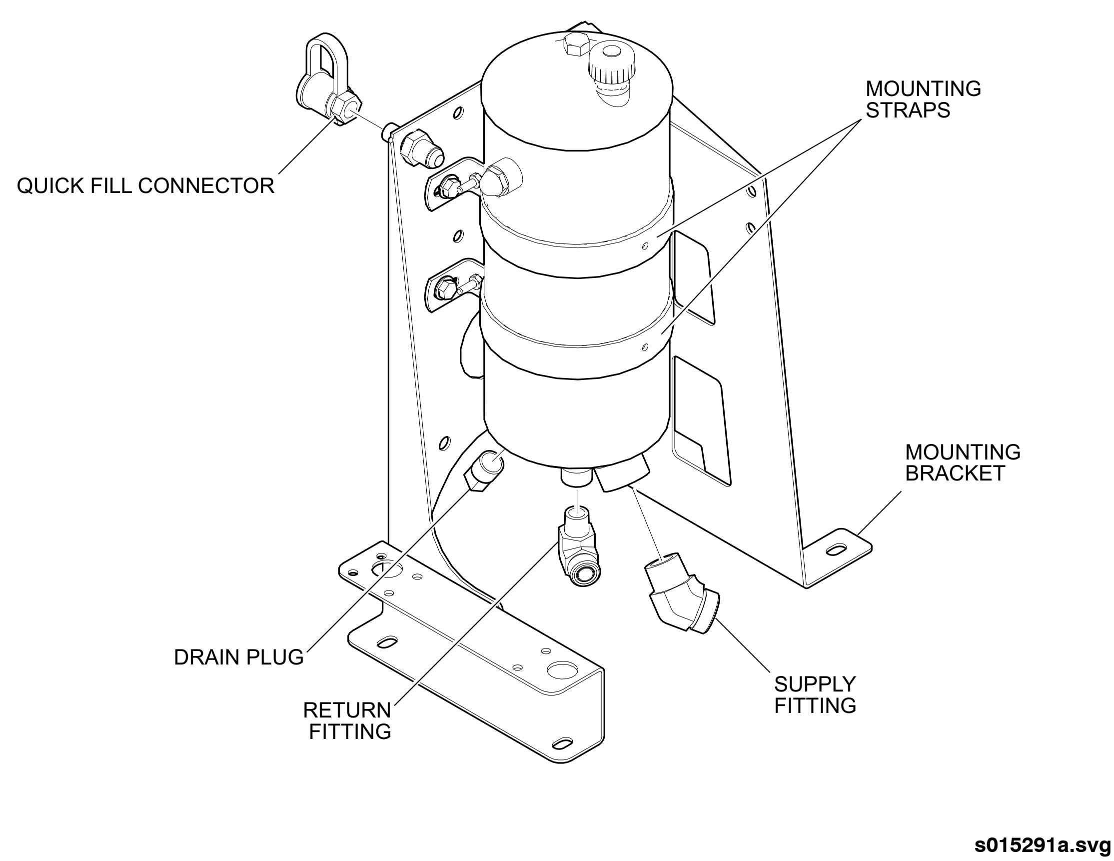


Fig. 3-30: Power Steering Reservoir Installation

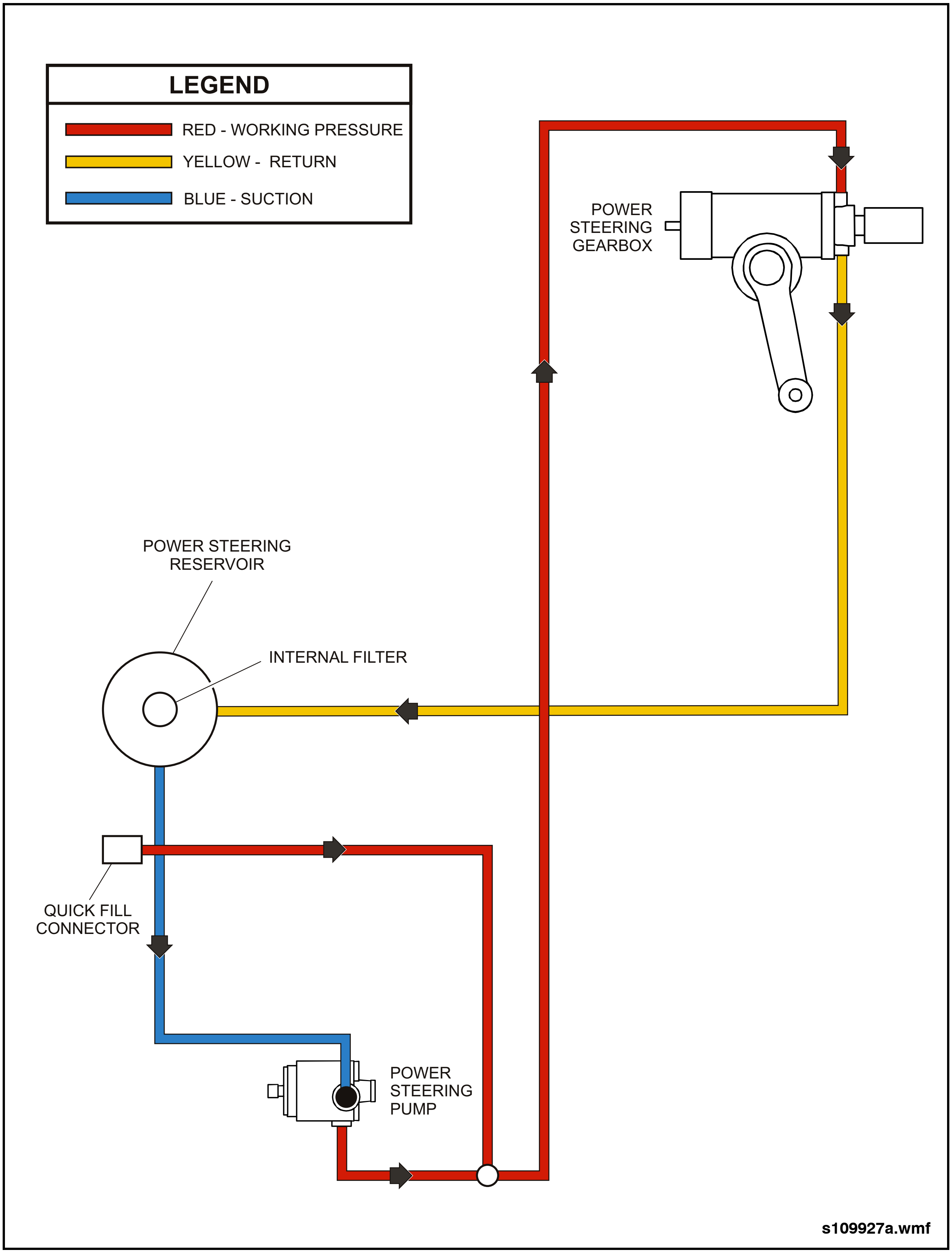


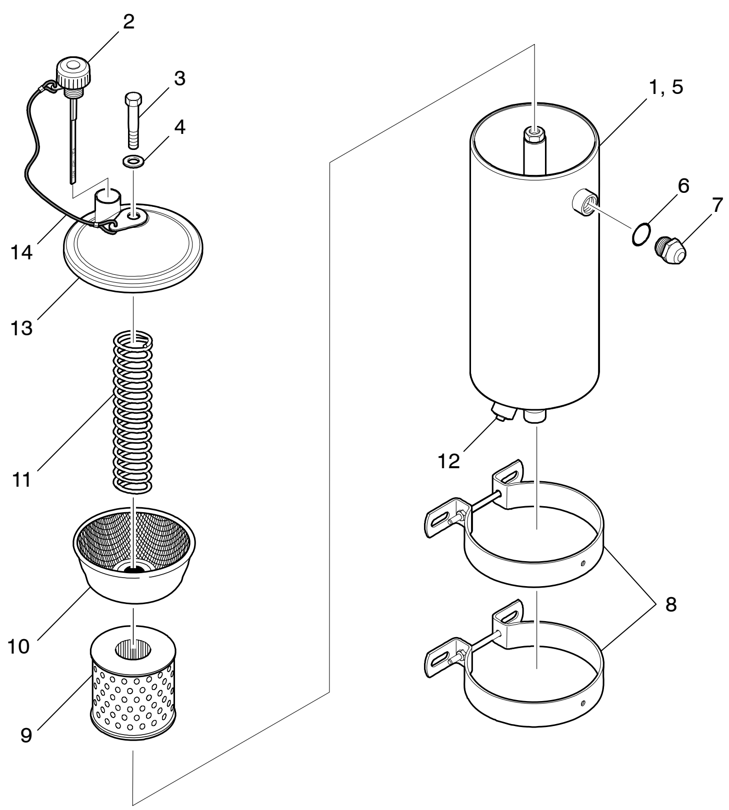
Fig. 3-31: Hydraulic Steering Schematic

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...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

s015232b.wmf

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

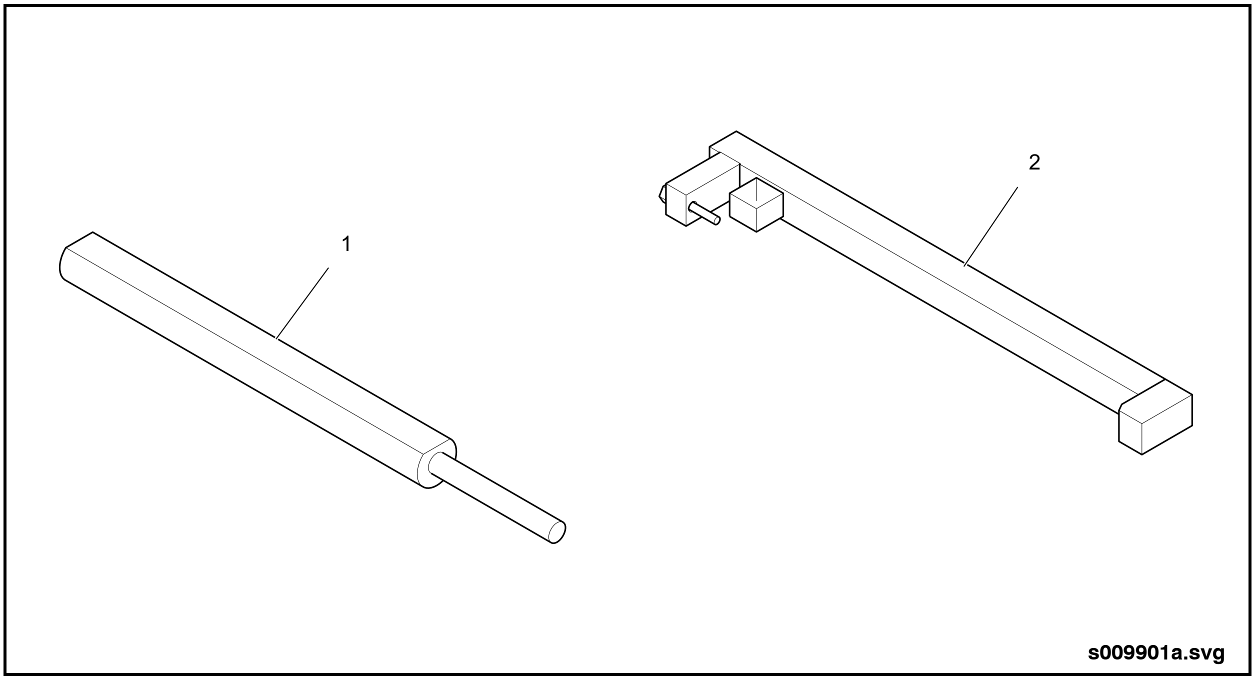


Fig. 3-33: Special Tools

Engine System

1. SAFETY

1.1. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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 ISL 9.0L (EPA 2015) Engine

2.1.1. Description

The Cummins ISL9 engine is an 8.9 liter, four-stroke, inline, six cylinder, diesel 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)

2.1.2. Engine Specifications

Rated Power..............300 HP @ 2200 RPM

Peak Torque ....1050 ft-lb. @ 1200 RPM

Displacement..............8.9 liters (540 cu. in.)

Firing Order 1-5-3-6-2-4

Aspiration ....Turbo Charge

Engine Weight (dry) ....1678 lb. (761 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.

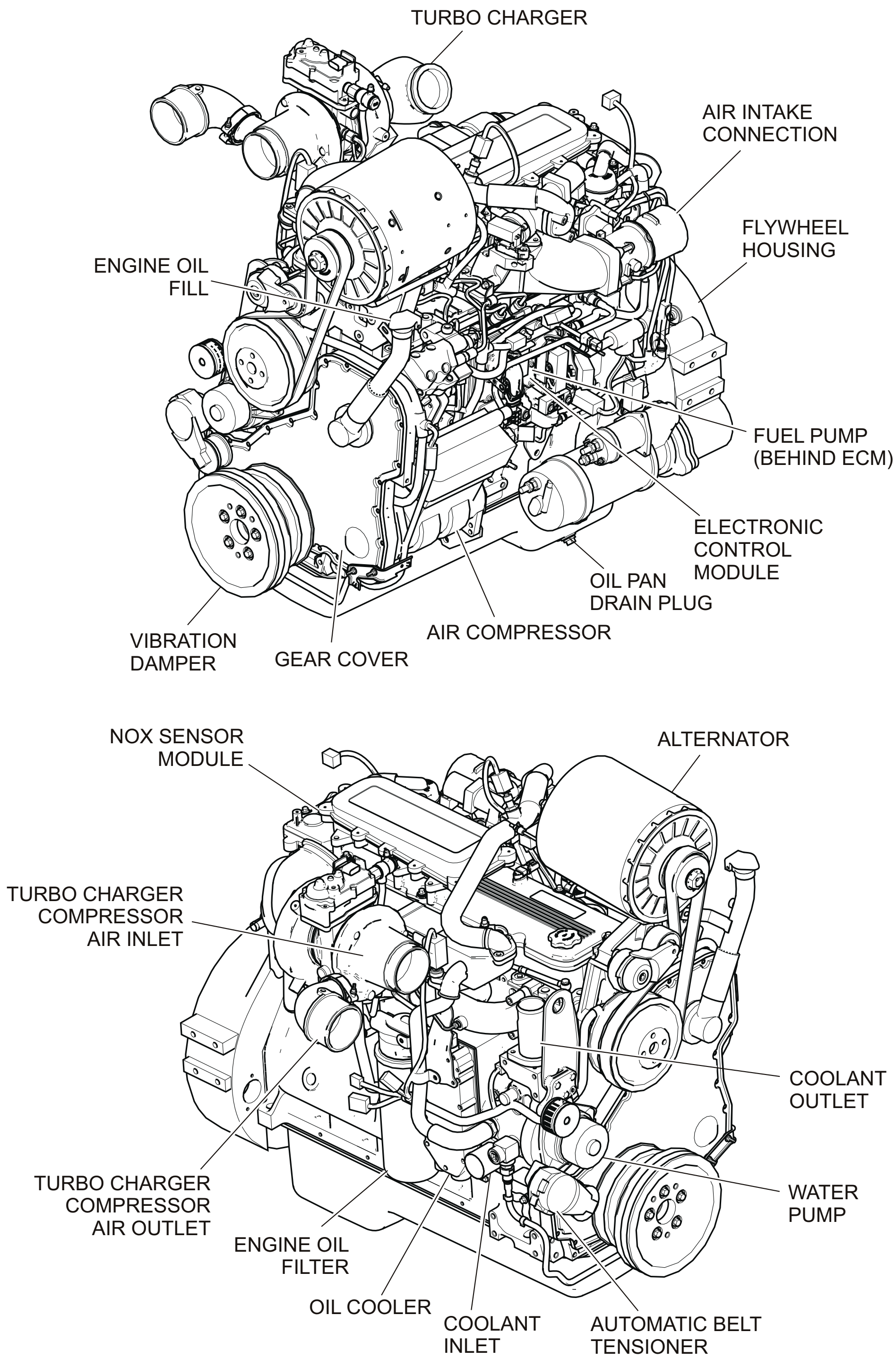


Fig. 4-1: Engine Views

2.1.3. Removal

1. Set the Battery Disconnect switch in the streetside battery compartment to the OFF position.
2. Unlatch the belt guard door and swing open. Remove cotter pins from upper and lower hinge pivots and lift off the belt guard. See “Fig. 4-2: Bumpers & Belt Guards” on page 5.
3. At the rear interior of the vehicle, raise the rear seats and set the prop rods to retain the seats in an elevated position. Remove the interior engine access door cover.

☞**NOTE:**

The engine can be removed from the vehicle without removing the engine struts. If struts are to be removed, Refer to 2.4. “Engine Struts” on page 15 *in this section for procedure.*

4. Remove the drain plug from the lower radiator tube and open the petcock drain valve at the bottom of the radiator. Drain the coolant using a suitable container to catch the fluid.
5. Support the bumper with a suitable lifting device, remove the 4 retaining bolts and remove the bumper.
6. Raise the vehicle. Refer to the General Information Section of this manual for procedure.
7. Drain the vehicle air tanks. Refer to the General Information Section of this manual for tank drain locations.
8. Relieve tension on the HVAC compressor belt using the compressor base turnbuckle and remove the HVAC compressor belt.
9. Disconnect all wire harnesses from engine switch box.
10. Pull out the battery tray.
11. Underneath the vehicle in the drive unit area, disconnect the driveshaft from the drive unit. Allow the driveshaft to hang onto the rear axle bunk. See “Fig. 4-3: Disconnecting the Driveshaft” on page 6.
12. Disconnect the drive unit main harness and speed sensor electrical connector.
13. Disconnect engine air compressor and governor lines at the compressor and the inlet hose at the engine air filter elbow.
14. Disconnect charge air tube.
15. Disconnect electrical harnesses from engine.
16. Disconnect lower coolant tube support clamps from left-hand side engine rail.
17. Disconnect fuel line from engine.
18. Remove tube between surge tank and lower coolant tube.
19. From inside of vehicle, remove air intake clamp at turbo and separate air intake tube from turbo.
20. Loosen and remove the 2 V-band clamps retaining the exhaust elbow. Unbolt the bracket from the engine and remove the elbow.
21. Disconnect the coolant bleed line at the top of the engine.
22. Disconnect coolant lines from thermostat housing.
23. Disconnect and plug the pressure and return hoses at the hydraulic pump mounted to the rear of the engine air compressor.
24. Disconnect the output hose from the muffler tank.
25. Ensure that all hoses and connectors are disconnected and out of the way.
26. Remove the 3/4" bolt, snubbing washer, flat washer, and lock nut from the rear engine mounts. See “Fig. 4-4: Engine Mounts” on page 6.
27. Break loose the four 5/8" bolts that attach the front mount bracket to the main frame rails. Do not remove bolts at this time.
28. Raise vehicle and position engine dolly. Refer to the General Information Section of this manual for information on raising the vehicle. See “Fig. 4-5: Engine Support Dolly” on page 7.

⚠CAUTION

The following procedure requires the engine dolly to support the weight of the engine sufficiently to have the rear engine mounts and front mount support bracket in a state of neutral load.

29. Lower vehicle slowly until light contact is made equally with front mount support bracket and transmission. Adjust engine dolly as necessary to support the front mount support bracket and transmission equally.

30. Continue to lower the vehicle slowly until the front engine mount support bracket is unloaded.

☞NOTE:

The bolts on the front engine mount bracket should turn easily once the mount bracket is unloaded.

31. Remove the bolts, washers, and lock nuts from the front mount support bracket.

32. Lower the vehicle slightly and just enough to clear rear mount bracket during removal of engine dolly.

☞NOTE:

Ensure that the rear engine mounts are clear of the mount support brackets but DO NOT lower the vehicle more than necessary, otherwise clearance between the air intake tube and the engine door opening will be compromised.

33. Perform a final inspection to ensure all lines, hoses and electrical harnesses have been disconnected and safely tied out of the way.

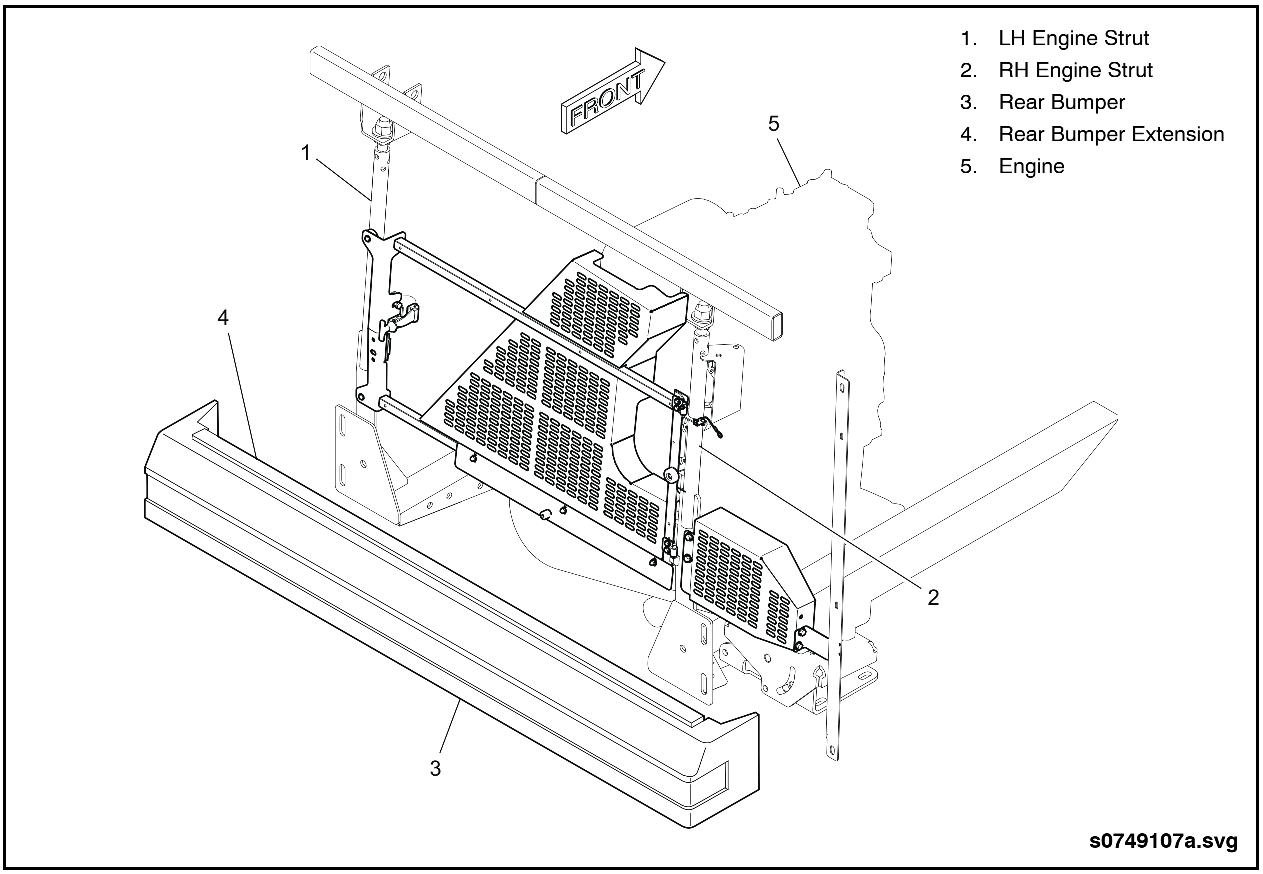


Fig. 4-2: Bumpers & Belt Guards

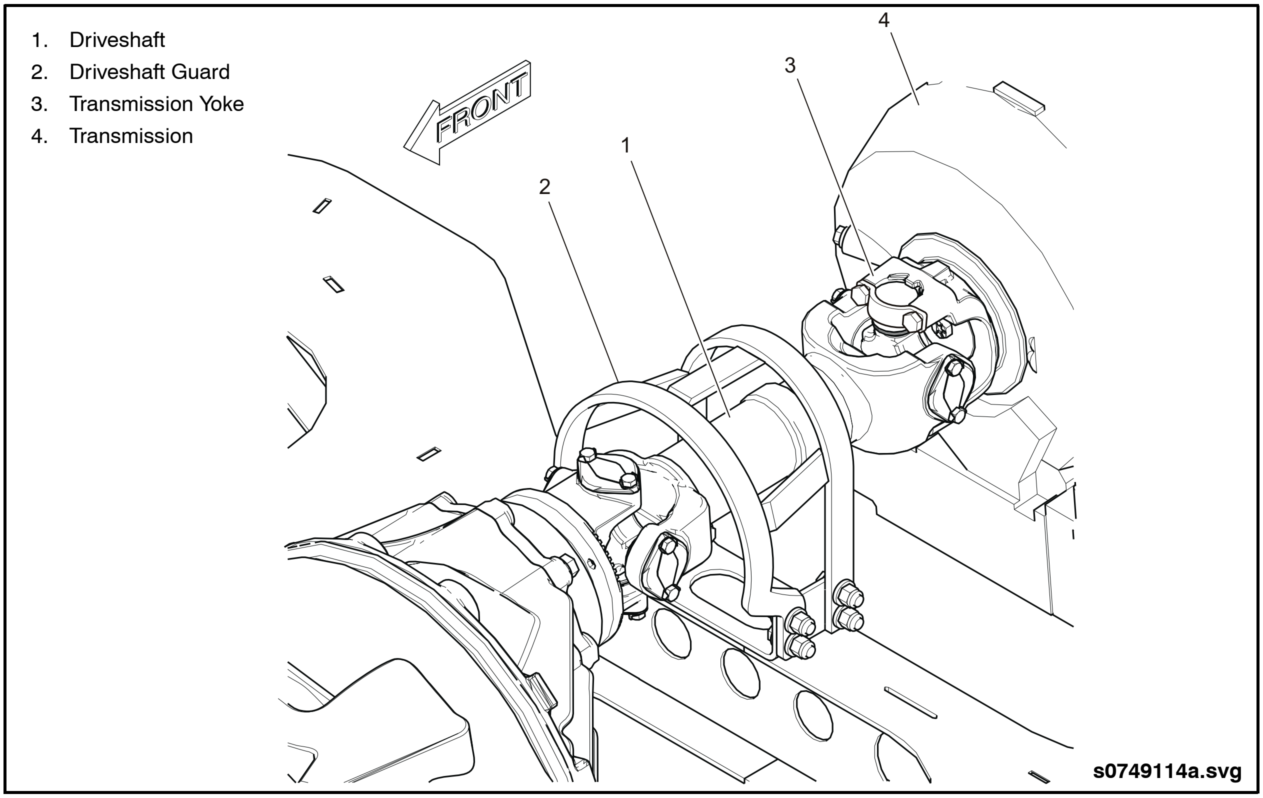


Fig. 4-3: Disconnecting the Driveshaft

34. Carefully pull the engine dolly out from the engine compartment.

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.

35. Install lifting brackets on the engine if the engine is to be removed from the dolly. Remove the existing brackets from the engine that are used to support the CAC tubes and exhaust tubes. Install approved engine lifting brackets at these locations. Retain original brackets for reinstallation.

☞ **NOTE:**

The original Cummins engine brackets were supplied loose with the vehicle at time of delivery.

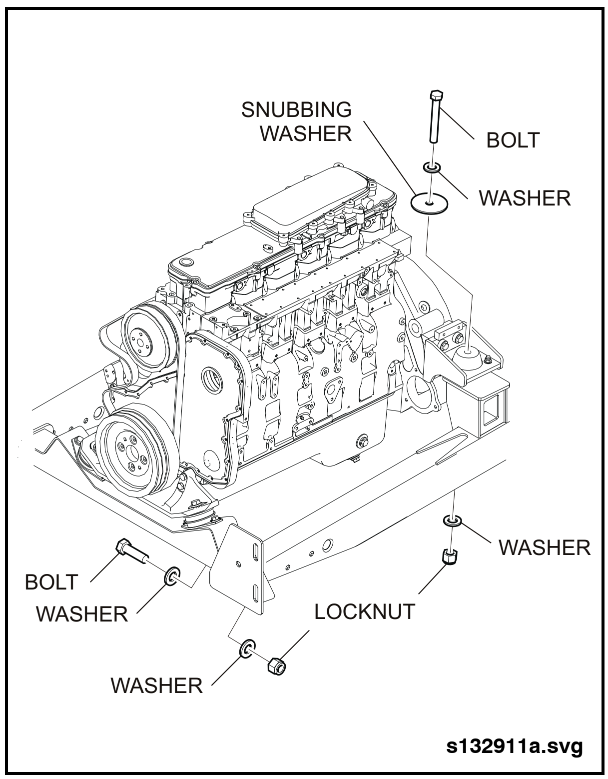


Fig. 4-4: Engine Mounts

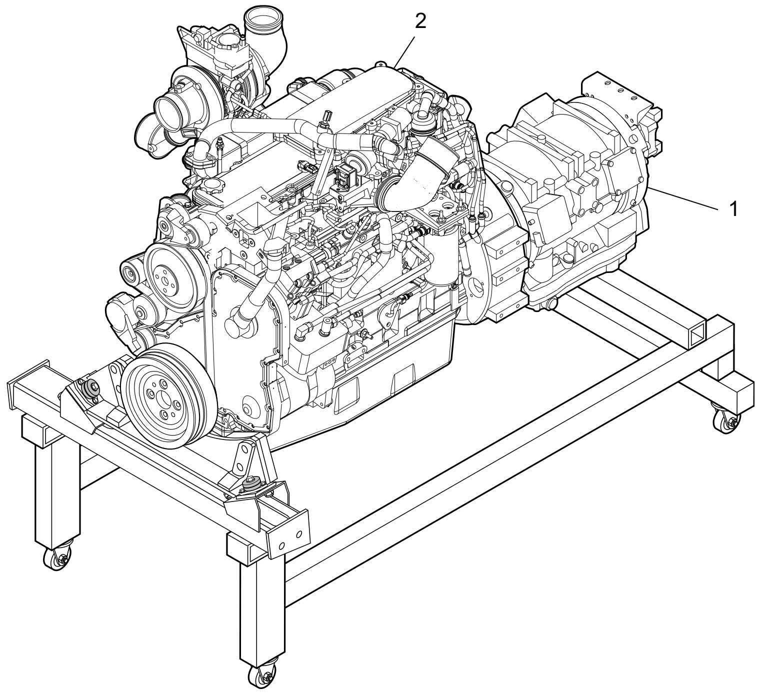


Fig. 4-5: Engine Support Dolly

2.1.4. Installation

☞**NOTE:**

If engine was fitted with lifting brackets during removal from engine dolly, replace lifting brackets with original CAC and exhaust tube mounting brackets.

1. Slide the engine dolly into position and align the engine mounts with the chassis mounting brackets.
2. Raise the vehicle slightly to align the holes in the front mount support bracket with the corresponding holes in the vehicle frame.
3. Insert front mounting bolts.

☞**NOTE:**

Use an alignment punch, if necessary, to aid insertion of mounting bolts. DO NOT force or hammer bolts into place.

4. Use a separate wrench to hold lock nuts and torque front mounting bolts to 160 ft-lb. (215 Nm).
5. Insert rear mounting bolts with flat washer and snubbing washer.

☞**NOTE:**

Use an alignment punch, if necessary, to aid insertion of mounting bolts. DO NOT force or hammer bolts into place.

6. Install lock nuts and flat washer and tighten until snug only.
7. Raise vehicle slightly to ensure full weight of engine is taken by rear mounts.
8. Torque rear mounting bolts to 250 ft-lb. (339 Nm).
9. Raise vehicle slightly to allow removal of engine dolly.
10. Connect coolant hoses disconnected during removal.
11. Connect engine air compressor, governor pressure and air inlet hoses.
12. Connect the muffler tank outlet hose.
13. Connect wires to starter motor.
14. Connect engine ECU connectors.
15. Connect alternator electrical connections.
16. Connect hydraulic pump pressure and return hoses at the pump.

17. Install exhaust elbow to turbo and to exhaust outlet.
18. Connect fuel line to engine.
19. Install charge air cooler intake lines.
20. Install HVAC compressor drive belt. Adjust belt tension using mounting base turnbuckle. Refer to Section 10 of this manual for further information on compressor installation.
21. Install lower radiator tube drain plug and shut radiator petcock drain valve.
22. From underneath vehicle, attach driveshaft to drive unit. Install driveshaft guard.
23. Attach drive unit 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. Connect all wire harnesses to the engine switch box.
27. Check to ensure that all hoses and connectors are connected, properly routed, and secured
28. Fill hydraulic reservoir.
29. Lift the bumper in place with a suitable lifting device. Install and tighten the 4 mounting bolts.
30. Top up coolant level in surge tank.
31. Check engine and drive unit fluid levels.
32. Slide the battery tray back into position. Set the Battery Disconnect switch in the battery compartment to the ON position.
33. Run the engine at idle and check for leaks.

2.2. A/C Pulley Replacement

☞**NOTE:**

The following procedure is provided in the event the engine-mounted A/C compressor drive pulley needs to be replaced. The A/C drive pulley is a 3-piece assembly that bolts to the engine crankshaft pulley and must be installed according to the instructions provided to ensure that it is properly assembled and securely mounted.

2.2.1. Removal

1. Remove the A/C drive belt as follows:
   a. Loosen the 3/4" pivot bolt on the A/C compressor tensioner plate.
   b. Loosen the two 5/8" lock nuts at the adjustment slot on the tensioner plate.
   c. Loosen the turnbuckle and adjust until there is enough slack to allow the drive belt to be removed.
2. Remove the six M8 x 16 mm socket head cap screws that retain the pulley to the damper and remove the pulley.
3. Remove the six M8 x 35 mm socket head cap screws that retain the damper to the adapter flange and remove the damper. See “Fig. 4-6: A/C Pulley Assembly” on page 9.
4. Remove the four M12 x 40 mm hex head bolts that retain the adapter flange to the engine crankshaft pulley and remove the adapter.

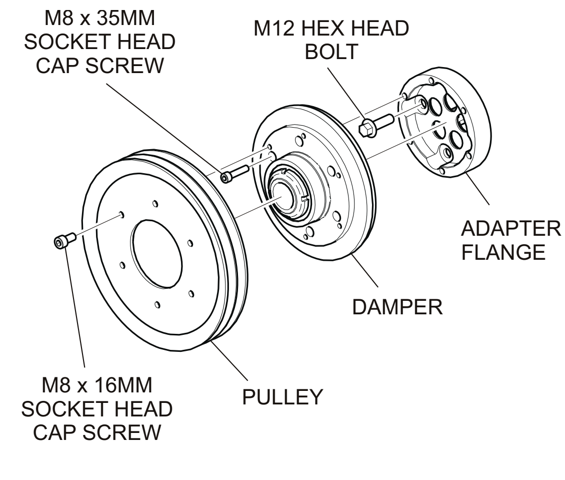


Fig. 4-6: A/C Pulley Assembly

2.2.2. Installation

☞NOTE:

The following procedure assumes that a new pulley assembly is being installed complete with new hardware. The new pulley assembly is comprised of three components which are assembled for shipping purposes and must be dismantled before being installed on the engine.

1. Remove the two M8 x 16 mm socket head cap screws and separate the pulley from the damper.
2. Mark the assembled relationship between the damper and the adapter flange, then remove the two M8 x 35 mm socket head cap screws and separate the damper from the adapter.
3. Install the adapter flange on the engine crankshaft pulley using four new M12 x 40 mm hex head bolt and torque to 80 to 85 ft-lbs. (108 to 115 Nm.).

☞NOTE:

Refer to your New Flyer Parts Manual to ensure that the correct bolts are being used for installation.

⚠CAUTION

Ensure that the damper is properly oriented with the adapter flange in the following step. Incorrect installation of the damper can lead to bolt failure and subsequent engine damage.

4. Note the assembly marks previously made on the damper and adapter flange. Four relief cutouts are machined into the backside of the damper and these reliefs must align with the four M12 bolt heads. See “Fig. 4-7: Damper Alignment” on page 10.
5. Secure the damper to the adapter flange using the six M8 x 35 mm socket head cap screws that were provided with the pulley assembly. Apply medium strength thread locker to the screws and torque screws to 22 ft-lbs. (30 Nm).
6. Align the through-holes on the pulley with the threaded holes on the damper and secure with six M8 x 16 mm socket head cap screws. Apply medium strength thread locker to the screws and torque screws to 18 ft-lbs. (25 Nm).
7. Install the A/C belt. Refer to Section 10 of this manual for belt installation and tensioning procedures.

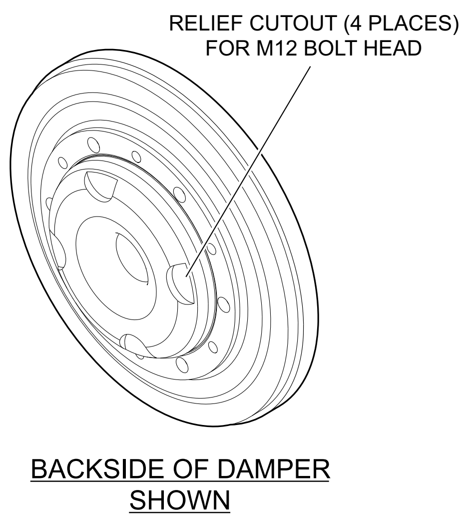


Fig. 4-7: Damper Alignment

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. 4-8: Front Engine Mounts” on page 11.
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

Assess whether raising the engine will have any affect on components directly attached to the engine or components in the immediate area of 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.

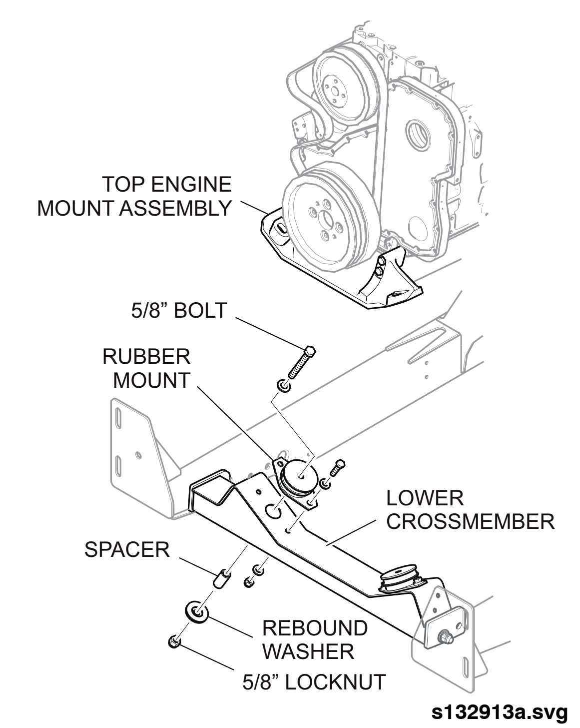


Fig. 4-8: Front Engine Mounts

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. 4-9: Front Engine Mount Cross-Section" on page 12.

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.

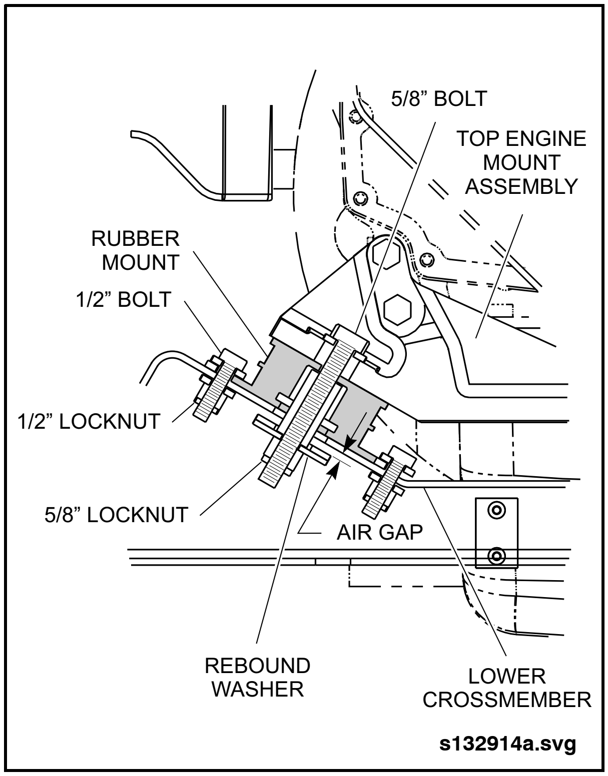


Fig. 4-9: Front Engine Mount Cross-Section

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. 4-10: Rear Engine Mount” on page 14.
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.
10. Loosen the clamps that secure the SCR coolant supply and return lines that run above and across the rear of the engine.

⚠**CAUTION**

Assess whether raising the engine will have any affect on components directly attached to the engine or components in the immediate area of 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.

11. 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.
12. 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.

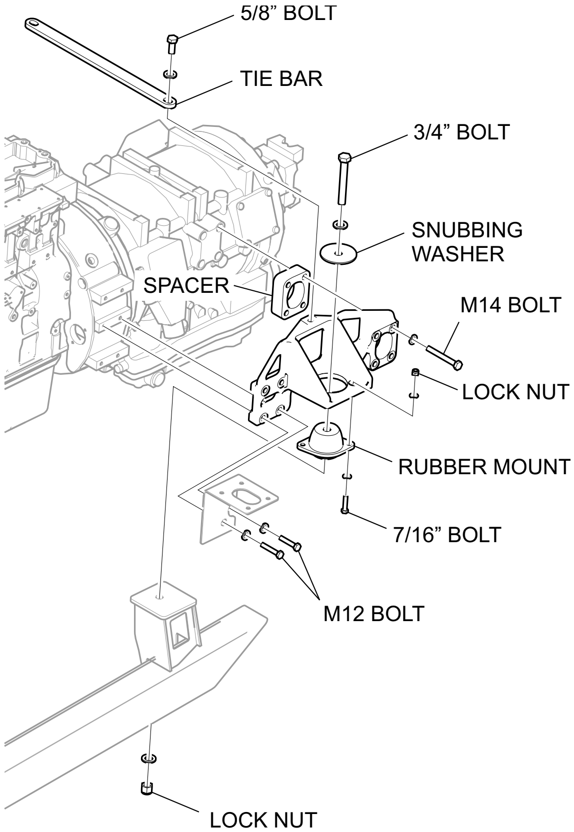


Fig. 4-10: Rear Engine Mount

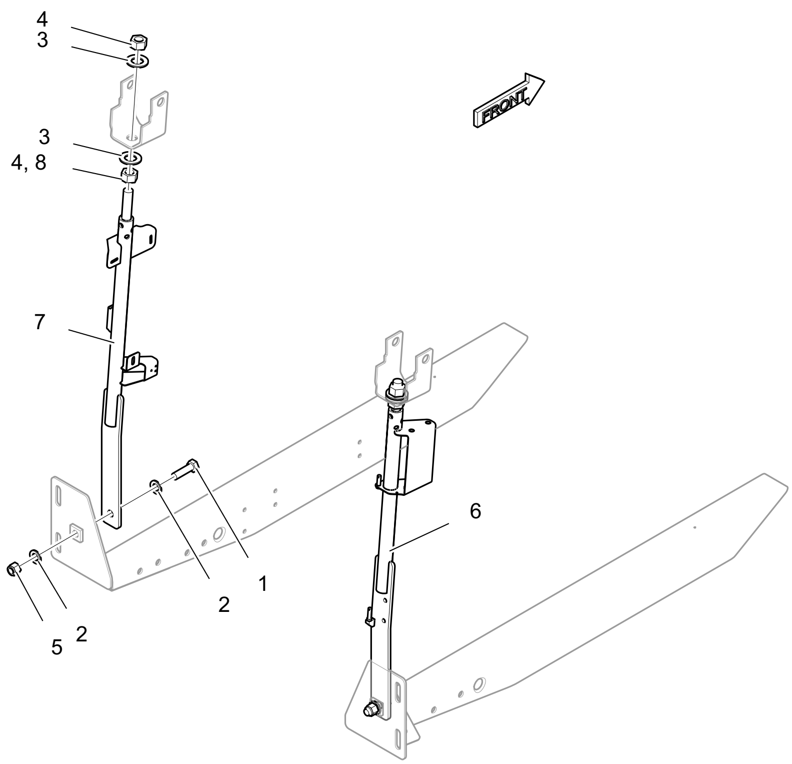
2.3.5. Rear Mount Installation

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.
8. 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. 4-11: Engine Struts" on page 15.



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 Seez

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Fig. 4-11: 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 336 ft-lb. (456 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. 4-12: Engine Strut Tensioning” on page 16.
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).

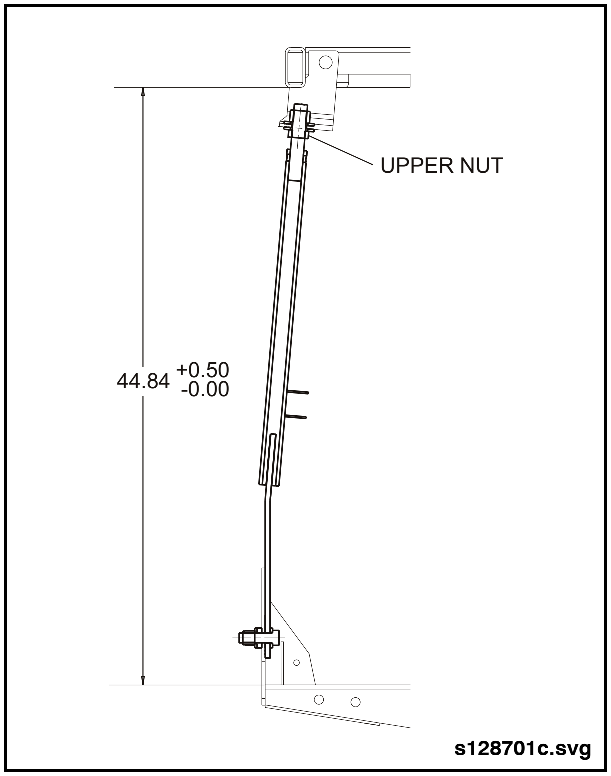


Fig. 4-12: Engine Strut Tensioning

2.5. Air Intake & Air Cleaner Assembly

2.5.1. 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. 4-13: Engine Intake System" on page 18.

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.

2.5.2. 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.

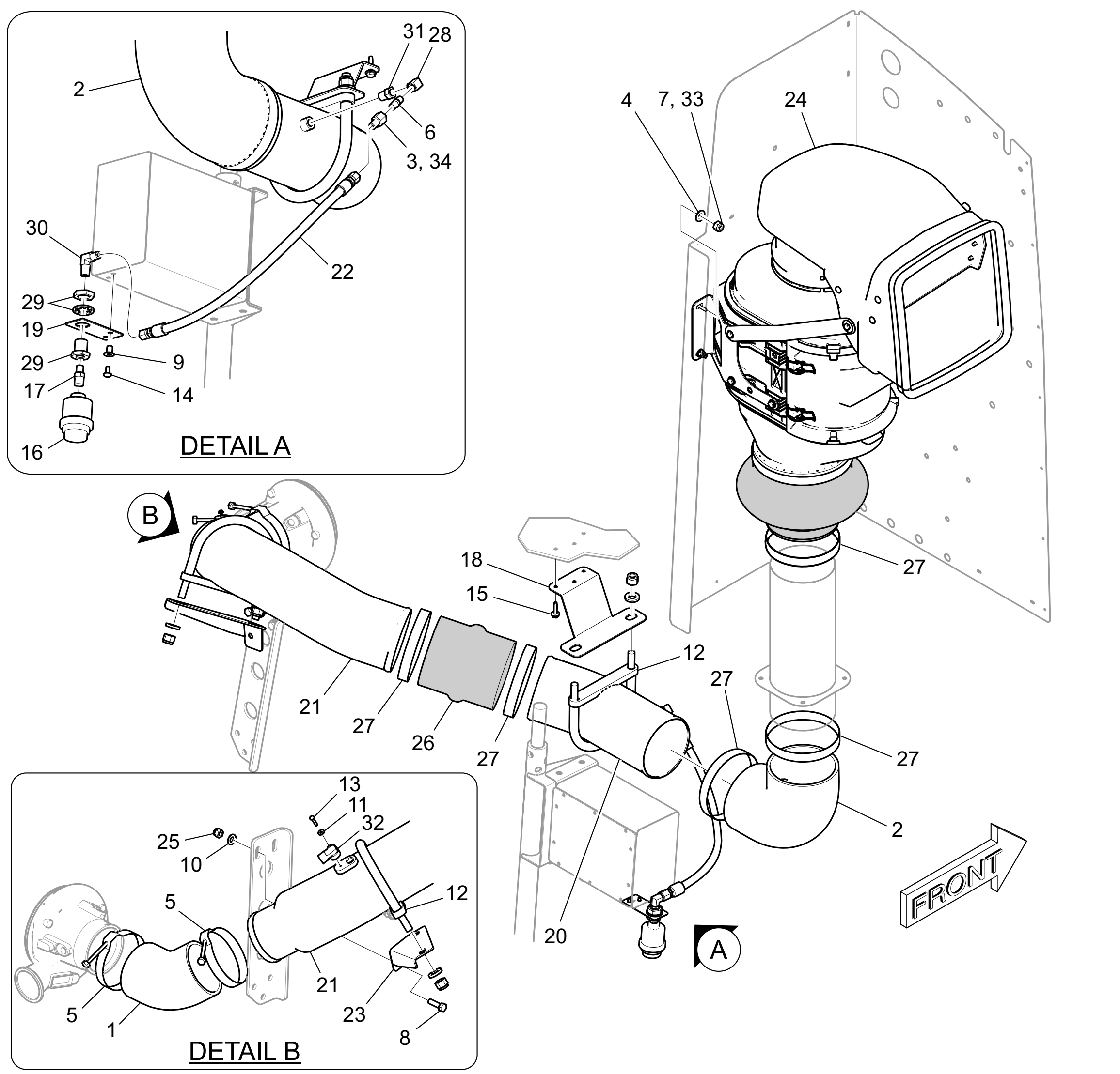
2.5.3. Maintenance

Refer to the Preventive Maintenance section of this manual for scheduled inspections on the air filter restriction indicator and air filter element replacement procedures.

2.5.4. 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.



1. Elbow, Rubber 4"
2. Elbow, Rubber 5"
3. Adapter, intl Pipe to
4. Washer, Flat 1/4"
5. Clamp, T-Bolt w/Spring
6. Filter, 1/8 PT
7. Nut, Lock Nylon 1/4" - 20 UNC
8. Bolt, Hex 3/8" - 16 UNC x 1 1/4" Lg.
9. Insert, Monel #10 - 32 UNF x .020" - .130"
10. Washer, Flat 3/8"
11. Washer, Flat #6
12. Clamp, Air Tube
13. Screw, PH Cross Recess SST #6 - 32 UNC x 5/8" Lg.
14. Screw, PH Cross Recess SST #10 - 32 UNF x 3/4" Lg.
15. Screw, Hex SST #10 - 24 UNC x 1" Lg.
16. Indicator, Air Restriction
17. Nipple, Reducing
18. Bracket, Air Intake Tube
19. Bracket, Air Filter
20. Tube, Air Intake ISL
21. Air Intake Tube
22. Hose Assembly, EQ1 - 4 FL20.0
23. Bracket, Air Intake Tube
24. Air Cleaner & Intake Box Assembly
25. Nut, Lock Nylon 3/8" - 16 UNC
26. Hose, Hump 5.0" I.D.
27. Clamp, Hose 5 1/2"
28. Elbow, Street 1/8"
29. Connector, Bulkhead 1/4"
30. Elbow, 90°
31. Bushing, Reducer
32. Sensor, TBAP
33. Loctite, 242
34. Loctite, PST

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Fig. 4-13: Engine Intake System

2.5.5. 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 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.

2.5.6. Disassembly

1. Remove the support bracket that attaches the air intake box to the air cleaner assembly. See “Fig. 4-14: Air Intake Box/Cleaner Assembly” on page 19.
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.

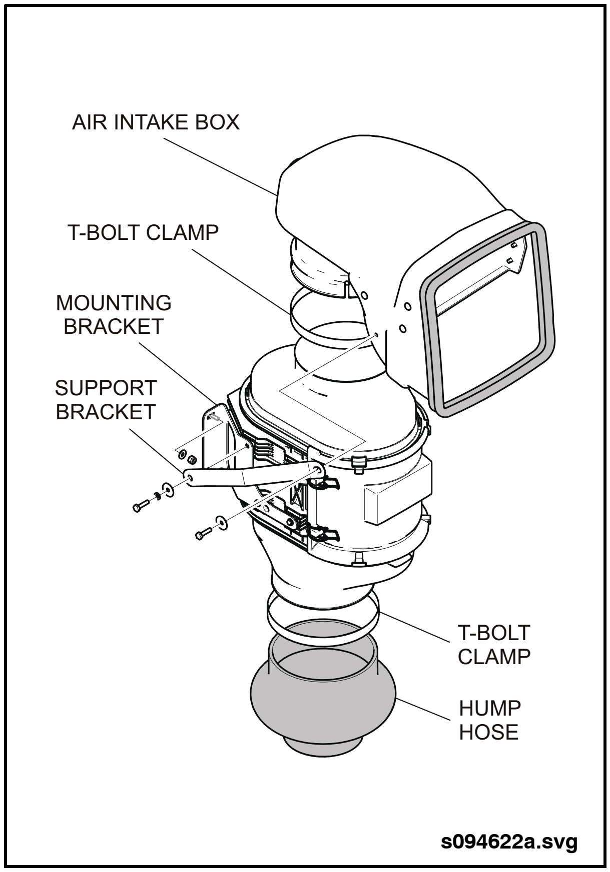


Fig. 4-14: Air Intake Box/Cleaner Assembly

2.5.7. 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.

2.5.8. 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.
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. Remove the protective cover from the horizontal air intake tube and install the lower rubber elbow and torque T-bolt clamps to 85 in-lb.
7. 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.

2.6. Exhaust & Aftertreatment System

2.6.1. Description

The exhaust and aftertreatment system processes the gaseous waste products from engine combustion to ensure the chemical composition being released into the atmosphere complies with established environmental regulations. The exhaust system consists of the following components:

- ❒ Diesel Particulate Filter (DPF)
- ❒ Exhaust Tubes, Blankets, & Bellows
- ❒ Selective Catalytic Reduction (SCR) Unit including supply module
- ❒ Decomposition Reactor with dosing module
- ❒ Diesel Exhaust Fluid (DEF) Tank
- ❒ Nitrogen Oxide (NOx) Sensors (2)
- ❒ Tailpipe

The exhaust system is mounted using mounting brackets, DPF clamps, V-bands, and U-clamps.

2.6.2. 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 DPF. Damaged parts should be replaced and loose clamp should be tightened securely.

☞**NOTE:**

When installing new parts into the exhaust system, leave the clamps loose until the 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. Replace U-clamps and V-band clamps at the same time as the connecting component.

2.6.3. Diesel Particulate Filter (DPF)

2.6.3.1. Description

The DPF consists of three segments: a diesel oxidation catalyst in the inlet section, a particulate filter, and an outlet section. The particulate filter is constructed of a chemically coated ceramic material. The particulate filter removes particles from the exhaust. An ash deposit forms from this process. This deposit must be periodically removed by cleaning.

The DPF also incorporates three temperature sensors and two differential pressure sensors. One temperature sensor is mounted in the DPF diesel oxidation catalyst inlet section; the second and third are mounted in the fore and aft portions of the particulate filter segment. The differential pressure sensors are mounted in the fore and aft portions of the particulate filter segment. A sensor table, mounted on the side of the DPF, provides a stable platform for the electrical connectors that interface with the engine harness.

2.6.3.2. Operation

The engine ECM monitors the outputs from the sensors. The pressure sensor output is used to determine the ash or soot content of the particulate filter portion. Filter regeneration or filter maintenance will occur dependent on this signal.

2.6.3.3. Removal

⚠CAUTION

Diesel oxidation catalyst elements used in the DPF are made from brittle material. DO NOT drop or strike the DPF; damage to the diesel oxidation catalyst element may result.

1. Set the Battery Disconnect switch to the OFF position.
2. Open the DPF access door to gain access to the DPF.
3. Remove the P-clips that attach the SCR harness to the muffler and disconnect the harness from the DPF sensor table. See “Fig. 4-15: Diesel Particulate Filter Removal & Installation” on page 23.
4. Remove the V-clamp connector from the DPF inlet and discard the gasket.

⚠DANGER

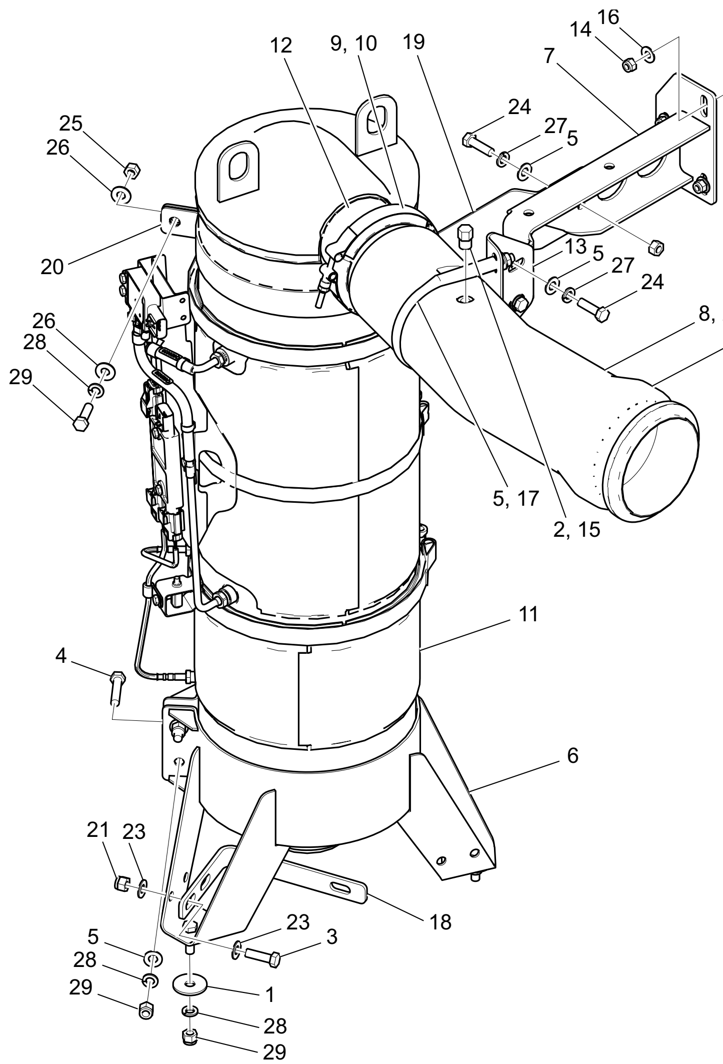
Use work platforms or scaffolding whenever working on the vehicle rooftop. Ensure maintenance personnel use an approved safety harness.

5. Gain access to the rooftop and remove the fasteners that attach the roof exhaust plate to the rear crown. Slide the exhaust plate over the tailpipe.
6. Remove the tailpipe U-clamp and note the location and quantity of washers.
7. Loosen the tailpipe seal clamp and remove the tailpipe from the SCR unit.
8. Remove the V-clamp connector from the DPF outlet and discard the gasket.
9. Locate the DPF upper support clamp and remove the fasteners in order to separate the upper clamp from the plate and bracket assembly.
10. Mark the position of the DPF relative to the lower support clamp.
11. Loosen the 3/8" fasteners on the base support clamp.
12. Attach lifting equipment to the lift eyes on the DPF and carefully remove the DPF from the vehicle.

☞NOTE:

If the base support clamp requires replacement, proceed with the following steps.

13. Remove the 1/4" fasteners that attach the L-shaped exhaust tube support bracket to one of the legs on the base support clamp.
14. Remove the 3/8" fasteners that attach the base support clamp to the vehicle structure. Note the location and quantity of washers.



1. Washer, Lower Rad 1.5" O.D.
2. Plug, 1/4"
3. Bolt, Hex 1/4" - 20 UNC x 1" Lg.
4. Bolt, Hex 3/8" - 16 UNC x 1 3/4" Lg.
5. Washer, Flat 3/8"
6. Clamp Assembly, Support
7. Bracket, DPF/Tail Pipe Support
8. Blanket, Ancillary Exhaust Tube
9. Clamp, Spherical 4"
10. Gasket, Spherical 4"
11. DPF Assembly
12. Ancillary Spherical Tube Assembly
13. Bracket, Ancillary Tube Support
14. Nut, Lock Nylon 5/16" - 18 UNC
15. Never Seize
16. Washer, Flat SS 5/16"
17. Clamp, 4"
18. Bracket, Exhaust Tube Support
19. Bracket Assembly, Support
20. Clamp, DPF Support
21. Nut, Lock Nylon 1/4" - 20 UNC
22. Wire, SS Exhaust Tubing
23. Washer, Flat 1/4"
24. Bolt, Hex 3/8" - 16 UNC x 1" Lg.
25. Bolt, Hex SS 3/8" - 16 UNC x 1 1/4" Lg.
26. Washer, Flat SS 3/8"
27. Washer, Lock Spring Type 3/8"
28. Washer, Lock Spring Type SS 3/8"
29. Nut, Hex SS 3/8" - 16 UNC

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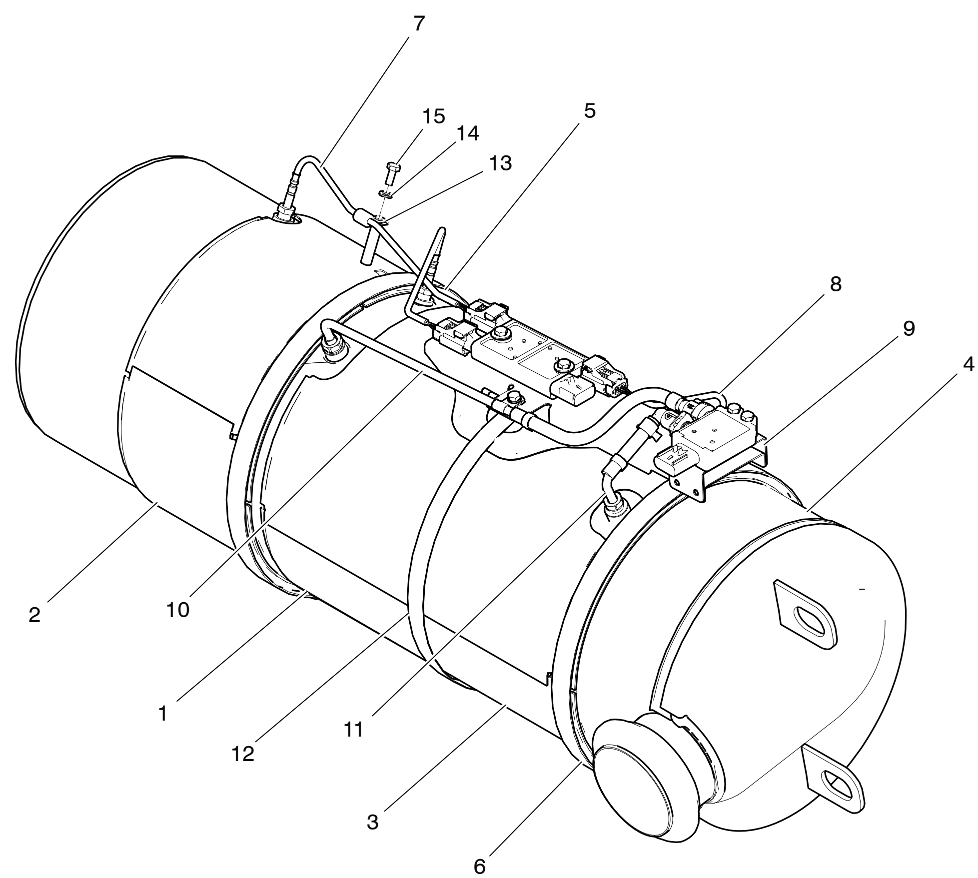
Fig. 4-15: Diesel Particulate Filter Removal & Installation

2.6.3.4. Disassembly

1. Disconnect the aftertreatment exhaust gas inlet temperature sensor connector from the sensor interface module. See "Fig. 4-16: Diesel Particulate Filter Assembly" on page 24.
2. Remove the V-band clamps from the inlet and outlet flanges of the DPF. Separate the flanges by 1/2" to allow removal of the gaskets. Discard the gaskets.
3. Mark the direction of the exhaust flow, and draw an orientation reference line across each segment and V-band clamp, to aid in reassembly.
4. Remove the exhaust gas temperature sensors from the DPF.
5. Remove the differential pressure sensor tubes from the DPF.
6. Remove the sensor table from the DPF.



1. DPF Assembly, (Incl. 2...15)
2. Module, Aftertreatment Inlet
3. Module, Particulate Filter
4. Module, Aftertreatment Outlet
5. Gasket, Circular
6. Clamp, V Band
7. Sensor, Temperature
8. Sensor, Temperature
9. Bracket, Support
10. Tube, Formed
11. Tube, Formed
12. Clamp, Band
13. P-Clip
14. Washer, M6 x 1.0 x 12
15. Screw, M6 x 1.0 x 15

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Fig. 4-16: Diesel Particulate Filter Assembly

2.6.3.5. Inspection

☞NOTE:

If the muffler particulate filter is being replaced, clean the exhaust tube from the turbocharger outlet to the muffler catalyst section, including the muffler inlet.

⚠CAUTION

DO NOT use a grinder to remove residual gasket material. Damage to muffler flanges may result.

DO NOT use an open flame to burn off accumulated muffler soot residue.

DO NOT scrape accumulated soot residue from the face of the muffler.

1. Use a scraping tool to remove any gasket material which has stuck to the muffler.
2. Inspect V-band clamps and straps for over-extension, bends, and damage to clamps or strap threads. Replace clamps and straps which exhibit any damage.
3. Replace particulate filters which exhibit any of the following conditions:
   a. Shifting, moving or looseness of filter in canister
   b. Cracking or damage of canister
4. Send particulate filters to an authorized Cummins repair location for cleaning or replacement. Specialized cleaning equipment is required for the cleaning procedure.

2.6.3.6. Assembly

1. Install new gaskets into inlet and outlet segments of the DPF.
2. Install new (or cleaned) particulate filter and attach to DPF sections using V-clamps. Do not tighten V-clamps until final installation to allow section rotation and alignment of differential pressure sensor tubes.
3. Install the sensor table onto the DPF.
4. Install differential pressure sensor tubes into the DPF.
5. Install exhaust gas temperature sensors into the DPF and connect electrical connectors to the senor table.

2.6.3.7. Installation

☞NOTE:

If the base support clamp was removed, follow step1; otherwise proceed to step 2.

1. Place base support clamp into position and loosely install 3/8" fasteners. Final tighten lock nuts once DPF is installed and aligned with exhaust tube.
2. Use lifting equipment, carefully lower DPF assembly into the base support clamp, ensuring DPF is aligned with clamp as marked during removal.

☞NOTE:

It may be necessary to loosen the lower exhaust pipe support bracket and U-clamp to accommodate exhaust pipe alignment with DPF inlet.

3. Install V-clamp with new gasket on DPF inlet. Torque clamp to 10 ft-lb. (14 Nm).
4. Tighten the 3/8" fasteners on the base support clamp.
5. Install V-clamp with new gasket on DPF outlet. Torque clamp to 10 ft-lbs. (14 Nm).
6. Position the DPF upper support clamp so that it aligns with the plate and bracket assembly. Torque clamp fasteners to 20 ft-lb. (28 Nm).
7. Install tailpipe with seal clamp onto SCR unit. Do not tighten seal clamp at this time.
8. Install tailpipe U-clamp with same quantity washers as noted during removal. Ensure tailpipe is properly positioned, and then tighten seal clamp and U-clamp.
9. Slide the exhaust plate over the tailpipe and secure to rear crown panel with original fasteners.
10. Connect SCR harness to the DPF sensor table and secure harness to muffler with P-clips.
11. Set the Battery Disconnect switch to the ON position and start engine.
12. Check the exhaust system for proper operation and ensure there are no leaks.
13. Close and latch the DPF access door.

2.6.4. Muffler Filter Regeneration

Regeneration is the process by which soot is removed from the muffler particulate filter. This regeneration can be automatic or stationary.

2.6.4.1. Automatic Regeneration

WARNING

If the Exhaust High Temp indicator on the instrument panel illuminates, ensure the exhaust outlet is not located where it could cause damage to persons or any materials which could melt or explode and that nothing is within 2 feet of the outlet. Ensure no combustible materials are within 5 feet of the outlet. Exhaust outlet temperatures can reach 1500°F (800°C) during regeneration.

Passive regeneration occurs during vehicle operation when exhaust temperatures are naturally high enough to oxidize the soot collected in the muffler particulate filter. If the exhaust temperatures are not high enough to oxidize the soot, then the engine ECM will increase the exhaust temperature by typically injecting a small amount of diesel fuel into the exhaust system. This additional fuel is oxidized by the muffler catalyst which creates the heat necessary to regenerate the muffler particulate filter. No operator intervention is required during this automatic regeneration mode (also referred to as active regeneration). Although high exhaust temperatures occur during active regeneration, the High Exhaust Temp indicator on the instrument panel is programmed not to illuminate during the process. This indicator will illuminate as a warning that exhaust temperatures are excessive during normal, non-regeneration operation. The indicator will also illuminate during forced stationary regeneration.

2.6.4.2. Stationary Regeneration

Stationary regeneration is performed when the vehicle duty cycle is not sufficient for automatic regeneration to occur. If the Exhaust Regen Needed indicator on the instrument panel illuminates, the vehicle operator should immediately change to a more challenging duty cycle, or maintenance personnel should perform stationary regeneration. Refer to Section 19 of this manual for information on this indictor. Stationary regeneration is performed as follows:

WARNING

During the stationary regeneration process exhaust gas temperatures can reach 1500°F (800°C) and exhaust system component temperatures can reach 1300°F (700°C). These temperatures can cause severe burns to persons and damage to property. Engine speed will also increase during this process.

1. Park the vehicle in a secure and safe location on a stable surface which will not burn where nothing is within 2 feet of the exhaust outlet and no combustible materials are within 5 feet of the outlet.
2. Apply the parking brake.
3. Press the Neutral button on the transmission shift selector.
4. Place wheel chocks in front of the front tires and behind at least one rear tire.
5. Place barriers at the rear of the vehicle which will keep persons at least 5 feet from the exhaust outlet region of the vehicle.
6. If the vehicle is located indoors, attach an exhaust outlet tube rated to at least 1500°F (800°C).
7. Ensure a fire extinguisher is located nearby.
8. Inspect exhaust system surfaces to ensure nothing is interfering with them.
9. Start the engine.
10. Locate the Exhaust Filter switch inside the front destination sign compartment. Set the switch to the REGEN position. Engine speed and exhaust temperatures will increase while the muffler regenerates.
11. Monitor the area surrounding the vehicle to ensure nothing and no one interferes with the exhaust system components during the regeneration process. If required, shut off the engine to stop the process. Engine speed will return to low idle once the process is complete. Once the process is complete, exhaust system components will remain excessively hot for three to five minutes. The Exhaust High Temp indicator on the instrument panel will remain illuminated during the regeneration process.
12. Return the Exhaust Filter switch to the NORMAL position once the regeneration process is complete.

2.6.5. Selective Catalytic Reduction Unit (SCR)

2.6.5.1. Description

The Selective Catalytic Reduction Unit (SCR) is an assembly of two major components:

- ❒ An aftertreatment device similar to the Diesel Particulate Filter
- ❒ A Decomposition Reactor.

Both are horizontally mounted on a support cradle which is mounted in the rear ceiling area of the roof. Access to the SCR can be gained through the rear roof grill access panel and side access doors.

2.6.5.2. Operation

SCR systems inject urea (known as a reducing agent) and water, into the exhaust stream. In this first stage, the urea is converted into ammonia. In the second stage, which takes place in the SCR, the nitrous oxide combines with the ammonia to produce water and harmless nitrogen.

⚠ WARNING

During regeneration, exhaust gas temperature can reach 800 °C [1500°F], and exhaust system surface temperature can exceed 700 °C [1300°F], which is hot enough to ignite or melt common materials, and to cause serious personal injury. The exhaust and exhaust components can remain hot after the vehicle has stopped moving. To avoid the risk of fire, property damage, burns or other serious personal injury, allow the exhaust system to cool before beginning this procedure or repair and make sure that no combustible materials are located where they are likely to come in contact with hot exhaust or exhaust components.

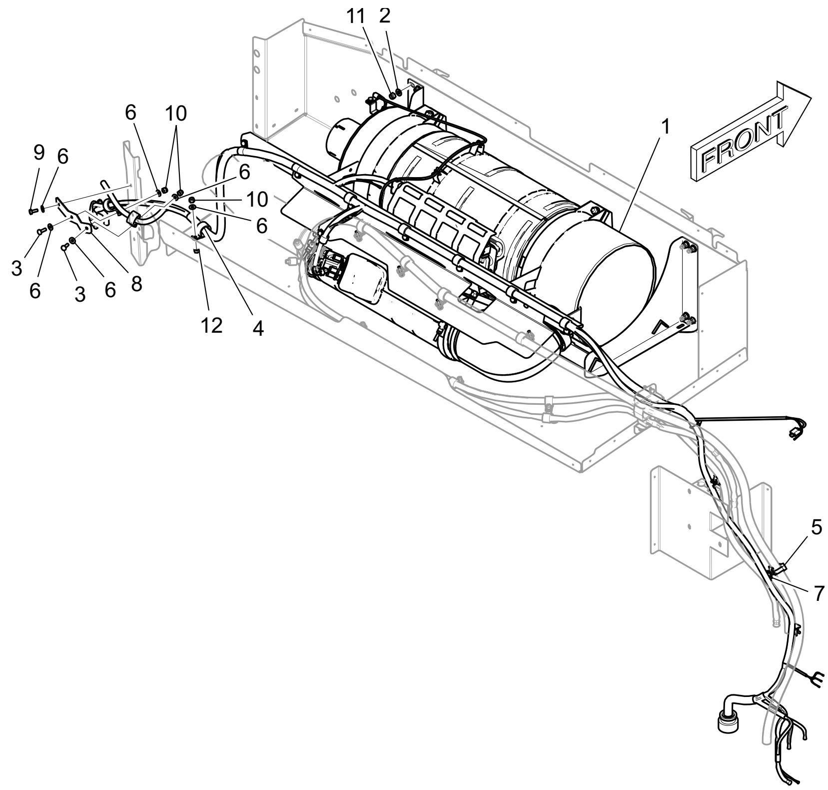
2.6.5.3. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Remove the rear roof grill access panel and roof exhaust plate.
3. Open the DPF access door.
4. Disconnect the electrical connectors from the SCR electronic control module and the dosing valve. See “Fig. 4-17: Selective Catalytic Reduction Removal & Installation” on page 29.
5. Remove the tail pipe U-clamp and loosen the exhaust seal clamp, then remove the tailpipe.
6. Remove the V-clamp at the decomposition reactor inlet and outlet. Discard the gaskets.
7. Disconnect DEF supply hose and coolant supply/return lines at the dosing module on the Decomposition Reactor.

☞**NOTE:**

It is acceptable to remove the dosing valve without removing the DEF and coolant lines. Always support the DEF dosing valve. Do not let it suspend freely, for it may damage the fluid connectors and lines.

8. Remove the clamps securing the SCR electronic control module wiring and remove the NOx sensor mounting bolts.
9. Remove the U-clamp securing the decomposition reactor and remove the decomposition reactor from the vehicle.
10. Remove the bolts, washers and nuts from the securing straps holding the SCR catalyst.
11. Attach lifting equipment to the SCR catalyst and remove from the vehicle.



1. SCR Assembly
2. Washer, Flat 5/16"
3. Screw, PH Cross Recess SST 1/4" - 20 UNC x 3/4" Lg.
4. Clamp, "P" 1" SST/HT
5. Cable Tie, 4/5" W x 8 6/7" Lg.
6. Washer, Flat SST 1/4"
7. Spacer, Dual Swivel Saddle
8. Bracket, Mounting
9. Bolt, M6 x 1.5 mm x 16 SST
10. Nut, Lock Nylon 1/4" - 20 UNC
11. Nut, Lock Nylon 5/16" - 18 UNC
12. Nut, Hex SST 1/4" - 20 UNC

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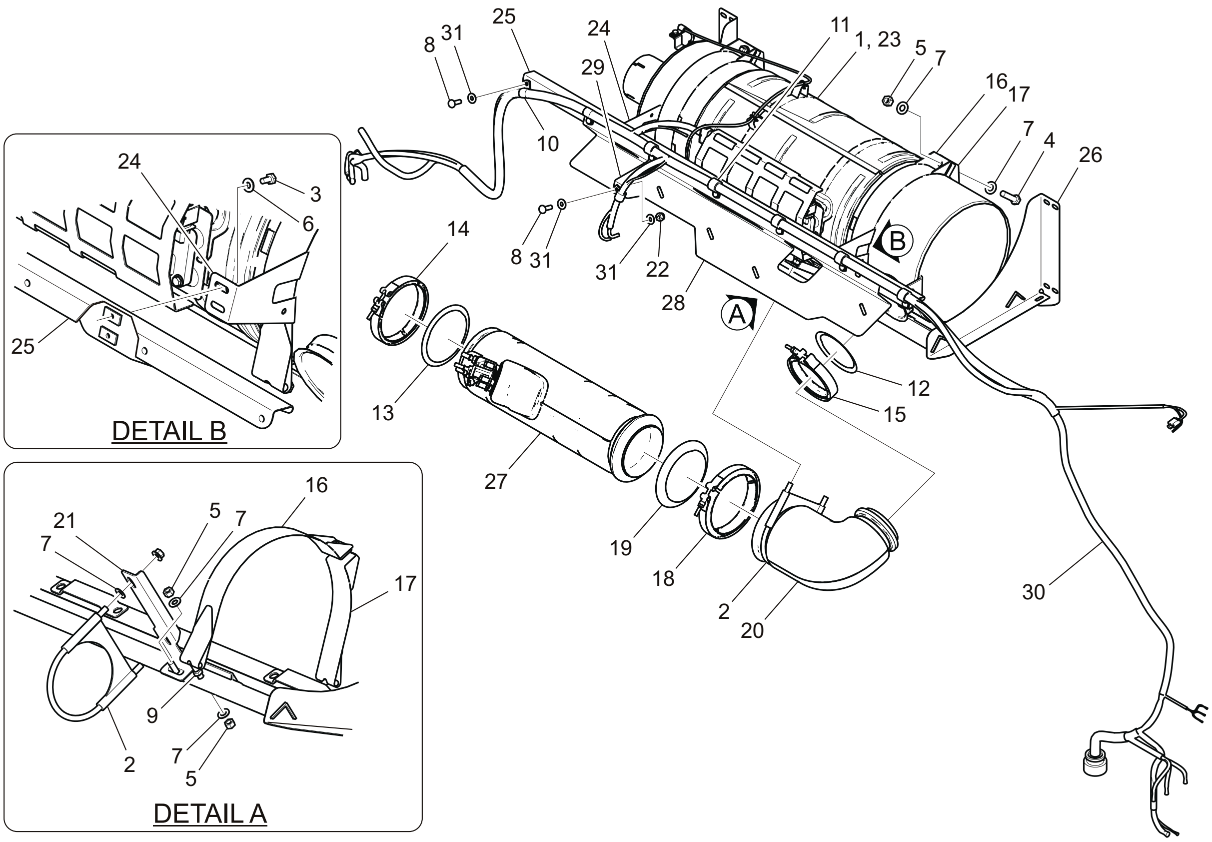
Fig. 4-17: Selective Catalytic Reduction Removal & Installation

2.6.5.4. Disassembly

1. Disconnect the SCR temperature sensors from the SCR catalyst temperature sensor interface module. See “Fig. 4-18: Selective Catalytic Reduction Assembly” on page 30.
2. Remove the SCR temperature sensors from the SCR catalyst.
3. Remove the SCR temperature sensor interface module.
4. Remove the SCR catalyst temperature sensor interface module mounting bracket.



1. SCR Assembly, (Incl. 2…31)
2. Clamp, U-Bolt 5"
3. Bolt, Hex 1/4" - 20 UNC x 1/2" Lg.
4. Bolt, Hex 3/8" - 16 UNC x 1 1/2" Lg.
5. Nut, Hex 3/8" - 16 UNC
6. Washer, Flat 1/4"
7. Washer, Flat 3/8"
8. Screw, PH Cross Recess SST 1/4" - 20 UNC x 3/4" Lg.
9. Nut, Hex Jam 3/8" - 16 UNC
10. Clamp, "P" 1/2" SST/H
11. Clamp, "P" 3/4" SST/HT
12. Gasket, Marmon 4"
13. Gasket, Marmon 5"
14. Clamp, Marmon 5"
15. Clamp, Marmon 4"
16. Strap Assembly
17. Strap Assembly
18. Clamp, Spherical Marmon 5"
19. Gasket, Spherical Marmon 5"
20. Elbow, Exhaust Spherical Marmon
21. Support, Elbow/Reactor
22. Nut, Lock Nylon 1/4" - 20 UNC
23. SCR Unit Assembly
24. Bracket, Harness Support
25. Channel, Harness Support
26. Bracket, Support
27. SCR Decomposition Reactor Assembly
28. Panel Assembly, Heatshield
29. Bracket, Harness Support
30. Harness, SCR Engine X40/60
31. Washer, Flat SST 1/4"

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Fig. 4-18: Selective Catalytic Reduction Assembly

2.6.5.5. Inspection

1. Inspect the SCR catalyst for cracks or puncture holes especially around the weld areas. Replace the aftertreatment SCR catalyst if it is damaged.

CAUTION

DO NOT use a metallic object to clean the SCR catalyst. This will scratch the surface of the SCR catalyst which may cause future excessive DEF crystallization build up.

2. Inspect the SCR catalyst inlet for diesel exhaust fluid deposits. If buildups are present carefully scrape with a non-metallic object to clean the majority of the build-up.

WARNING

DO NOT use a pressure washer to remove diesel exhaust fluid deposits from the SCR catalyst.

☞**NOTE:**

If crystallization buildup is found, be sure to complete a stationary regeneration once the exhaust system is reassembled. This will ensure the remaining diesel exhaust fluid crystallization has been removed from the SCR catalyst.

3. Inspect the exhaust flanges for corrosion or other damage.
4. Use a putty knife to remove any residual gasket material from the flanges on the SCR catalyst.

CAUTION

Avoid dropping fragments of gasket material into the SCR catalyst.

Do not grind on the flange surface, as this can damage the flange and cause the connection to leak.

5. Inspect the v-band clamps and mounting straps for signs of over-extension. The band must not be bent or damaged.
6. Inspect the v-band clamp and mounting strap threads for damage. Replace v-band clamps if necessary.

2.6.5.6. Assembly

1. Install the SCR catalyst temperature sensor interface module mounting bracket.
2. Install the SCR temperature sensor interface module.
3. Install the SCR temperature sensors to the SCR catalyst.
4. Connect the SCR temperature sensors to the SCR catalyst temperature sensor interface module.

2.6.5.7. Installation

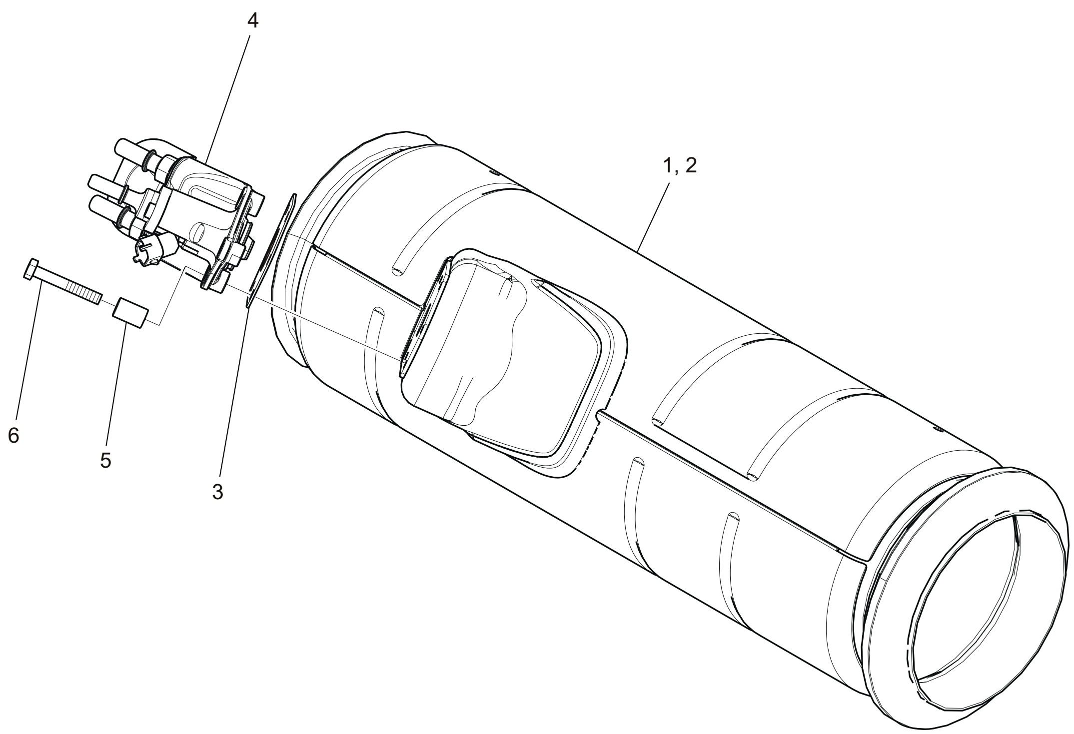
☞**NOTE:**

The decomposition reactor is installed as part of the Selective Catalytic Reduction (SCR) Unit. Refer to 2.6.6.4. “Installation” on page 34 *in this section for procedure.*

2.6.6. Decomposition Reactor

2.6.6.1. Description

The Decomposition tube is composed of a DEF dosing valve mount and decomposition tube mixer. The valve mount is where the DEF dosing valve is mounted to allow DEF spray into the exhaust stream. The decomposition tube mixer creates a swirl pattern exhaust stream to help mix the DEF and engine exhaust. See "Fig. 4-19: Decomposition Reactor Assembly" on page 32.



1. SCR Decomposition Reactor Assembly, (Incl. 2...6)
2. Reactor, Decomposition'
3. Gasket, Irregular
4. Injector
5. Spacer
6. Screw, M6 x 1.0 x 40

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Fig. 4-19: Decomposition Reactor Assembly

2.6.6.2. Cleaning & Inspection

1. Inspect all the joints for any signs of leaks. Leaking DEF will leave white deposits.
2. Inspect the DEF dosing valve mount for a buildup of crystallized DEF.
3. Inspect the DEF dosing valve mount for a buildup of crystallized DEF.
4. Check the inlet of the SCR catalyst for buildup.
5. Inspect the outlet of the diesel particulate filter (DPF) for crystallization.
6. Inspect the elbow and exhaust pipes connected to the decomposition tube for DEF buildups.

☞**NOTE:**

If the crystallization is excessive and blocking a majority of the exhaust passages, there may be a problem with the DEF dosing valve. Refer to OEM information for complete fault code troubleshooting procedure.

7. If buildups are present, carefully scrape with a non-metallic object to clean the majority of the build-up. Use a pressure washer to dissolve the remaining crystallization.
8. Inspect the exhaust flanges for corrosion or other damage.
9. Use a putty knife to remove any residual gasket material from the flanges on the decomposition tube.

⚠**CAUTION**

DO NOT grind on the flange surface, as this can damage the flange and cause the connection to leak.

10. Inspect the DEF dosing valve mounting area.
11. Check the threaded capscrew holes for damaged threads.
12. If the threads are damaged, the decomposition tube can be repaired using M6 x 1.0 helicoil inserts.
    a. Bore out the hole down 12 mm and install the threaded coil. Use only the wire type coil inserts, since the amount of material around the threaded capscrew hole is limited.
    b. Follow the manufacturer's recommended guidelines to install the coiled threaded insert.

2.6.6.3. Final Inspection

☞**NOTE:**

The decomposition tube should be smooth and free of scratches or other damage. If the decomposition tube has any structural defects or material degradation, replace the decomposition tube.

Check the following areas carefully:

- ❒ Aftertreatment dosing valve mount
- ❒ Mixer
- ❒ Insulation
- ❒ Welded joints.

2.6.6.4. Installation

1. Attach lifting equipment to the SCR device and install it onto its support cradle.
2. Secure the SCR device with the securing straps. Torque bolts which secure straps to 20 ft-lb. (27 Nm).
3. Install the decomposition reactor and ensure the dosing module is rotated and aligned 60 +/- 10° from the vertical. See "Fig. 4-20: Decomposition Reactor Alignment" on page 34.
4. Secure the decomposition reactor in the proper position with a U-clamp.
5. Mount the SCR electronic control module and secure that NOx sensor cable with clamps.
6. Connect DEF supply hose and coolant supply/return lines at the dosing module on the Decomposition Reactor.
7. Install new gaskets and install the V-clamps at the Decomposition Reactor inlet and outlet.
8. Install the tailpipe and secure it in place with the U-clamp.
9. Check alignment of all components and tighten all camps including the seal clamp on the tailpipe.
10. Reinstall rear roof grill access panel and roof exhaust plate.
11. Set the Battery Disconnect switch to the ON position.
12. Start the vehicle and check for leaks. Check for active fault codes.
13. If DEF buildups where present, complete a stationary regeneration to make sure that any of the remaining diesel exhaust fluid crystallization has been removed from the SCR catalyst.
14. Continue to monitor for leaks at the exhaust joints.

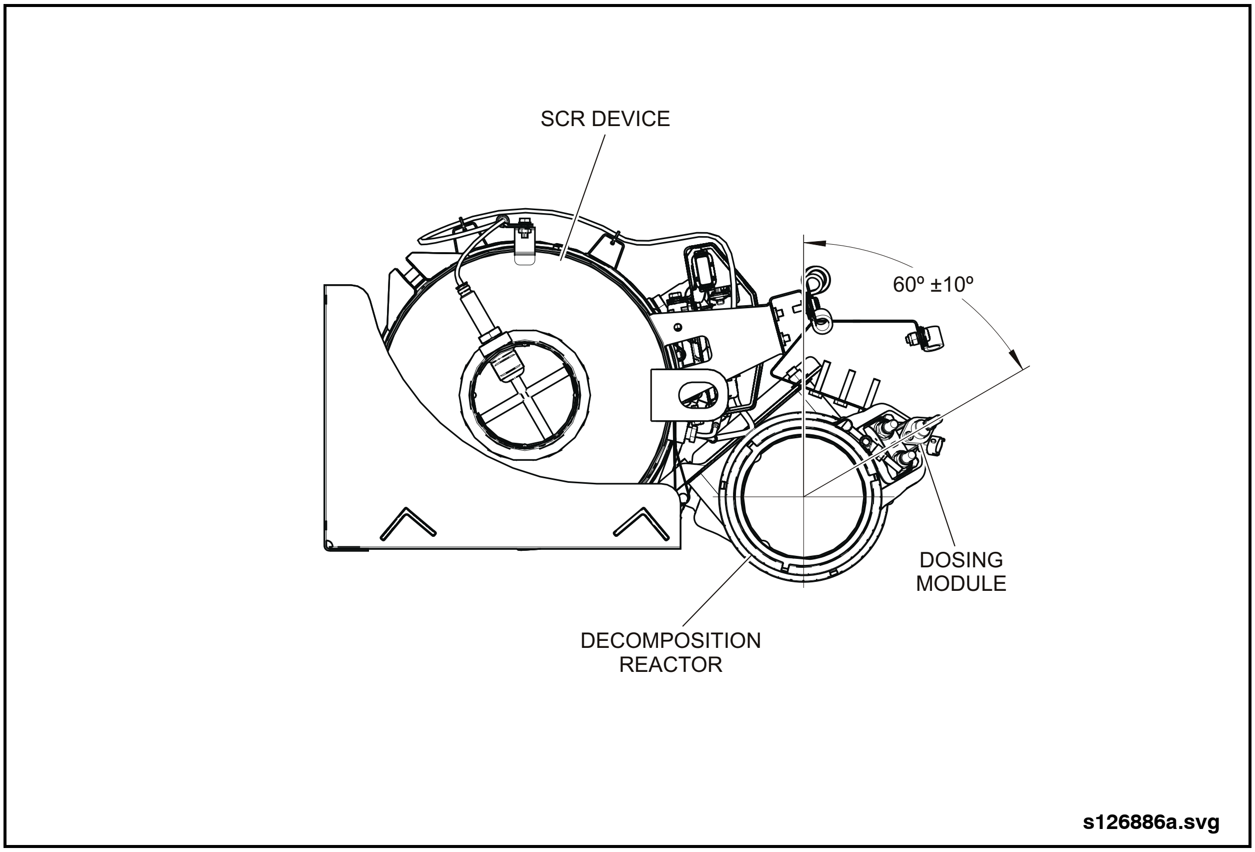
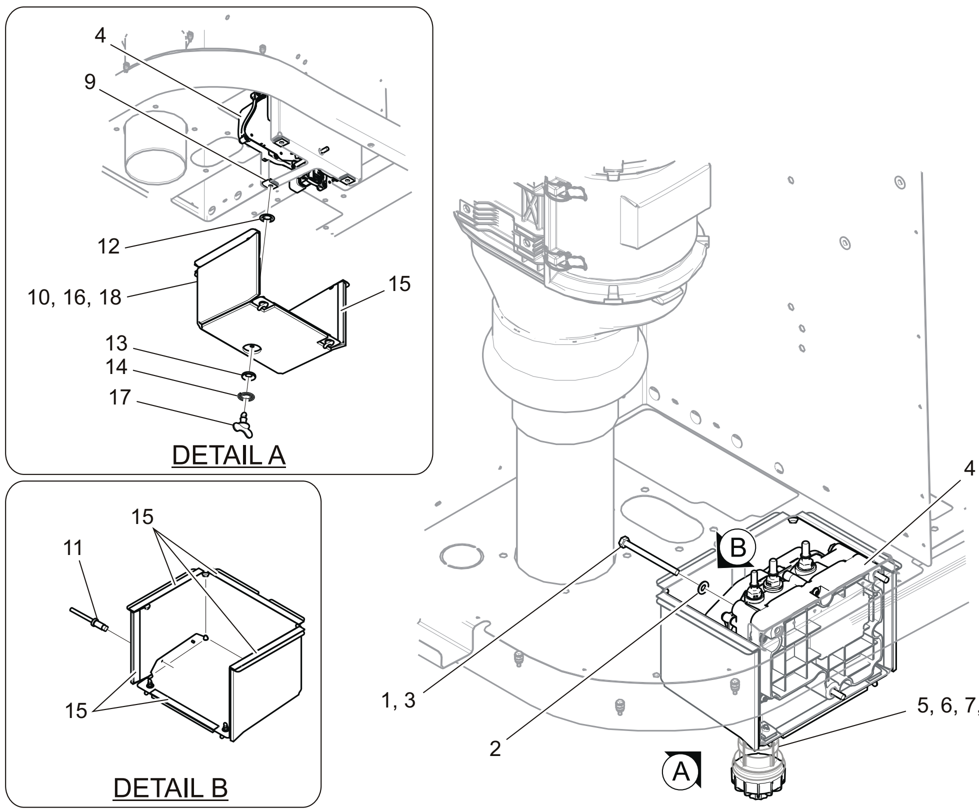


Fig. 4-20: Decomposition Reactor Alignment

2.6.7. SCR Dosing Supply Unit

2.6.7.1. Description

The SCR dosing supply unit consists of a pump, filter, inlet, outlet, and backflow ports, and an electrical connector. The dosing supply unit is mounted on the curb-side in the engine compartment. See “Fig. 4-21: SCR Supply” on page 35.



1. Bolt, Hex
   5/16" - 18 UNC x 3 3/4" Lg.
2. Washer, Flat 5/16"
3. Loctite, 242
4. SCR Supply Module (Incl. 5)
5. Kit, Filter (Incl. 6...8)
6. O-Ring
7. Filter
8. Equalizing Element
9. Receptacle, 1/4" Turn #85
10. Cover Assembly, (Incl. 11...18)
11. Rivet, Steel Plated 1/8"
12. Retainer, 1/4" Turn Stud
13. Washer, Wear #85 Cupped
14. Spring, Ejector #85
15. Tape, Foam
16. Cover, SST
17. Stud, 1/4" Turn Wing #85
18. Insulation, .25" Neoprene

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Fig. 4-21: SCR Supply

2.6.7.2. Operation

The dosing supply unit is controlled by the engine ECM and draws diesel exhaust fluid from the DEF tank, pressurizes the fluid, and delivers the fluid through a filter to the dosing valve located on the decomposition reactor. Unused diesel exhaust fluid is returned to the DEF tank.

2.6.7.3. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance requirements and intervals.

2.6.7.4. Removal

WARNING

Wear eye protection when servicing the SCR supply module. Do not open any SCR fittings for five minutes after the engine has been turned off to allow the automatic purge cycle to complete.

1. Set the Battery Disconnect switch to the OFF position.
2. Label each DEF line and its mating parts prior to removal to ensure correct reinstallation.
3. Remove the DEF lines in the following order:
    a. Backflow - return line to the DEF tank.
    b. Inlet - supply line from the DEF tank.
    c. Outlet - delivery line to the dosing valve.
4. Cap all open lines and fittings to prevent contamination.
5. Disconnect the 12-pin electrical connector from the dosing supply unit by sliding the yellow portion of the connector outward and lifting the connector straight upwards.
6. Remove the three mounting bolts and remove the dosing supply unit from the vehicle.
7. Inspect the supply module for damage or corrosion.

2.6.7.5. Cleaning & Inspection

1. Inspect for signs of leakage as evidenced by a white residue around fittings, connections, and the filter cap. Examine these areas carefully for damaged connection fittings or sealing surfaces.
2. Use only a clean damp cloth to wipe down the unit. Do not immerse the unit in any type of cleaning solution and do not wash the unit with any detergents.

2.6.7.6. Installation

1. Position the dosing supply unit on the upper rear panel and secure with three bolts, flat washers, and lock washers. Torque bolts to 14 ft-lbs. (19 Nm).
2. Insert the 12-pin electrical connector into the socket and slide the yellow portion of the connector inward.
3. Install the DEF lines in the following order, ensuring the lines snap and lock in place:
    a. Backflow - return line to the DEF tank.
    b. Inlet - supply line from the DEF tank.
    c. Outlet - delivery line to the dosing valve.

2.6.8. Diesel Exhaust Fluid (DEF) Tank

2.6.8.1. Description

The DEF tank is a molded polyethylene tank. It is mounted at the rear curbside of the vehicle and accessed through the rear curbside access door. The tank consists of the following components:

- ❒ Tank sensor assembly
- ❒ Float switch (normally closed)
- ❒ Filler neck with cap

2.6.8.2. DEF Tank Specifications

Fluid Capacity
.... 10.64 usable gallons (40 litres)

2.6.8.3. Operation

The engine ECU control module determines when and how much diesel exhaust fluid will be injected into the Decomposition Reactor. The SCR supply module pumps the fluid to the dosing module which then injects the fluid into the Decomposition Reactor.

2.6.8.4. Removal

1. Turn the main Battery Disconnect switch to the OFF position. Open the fusebox access door and the rear engine access door.
2. Close the engine coolant valves.
3. Remove the fill cap and drain plug from the DEF tank and drain it into a clean, properly labeled container.

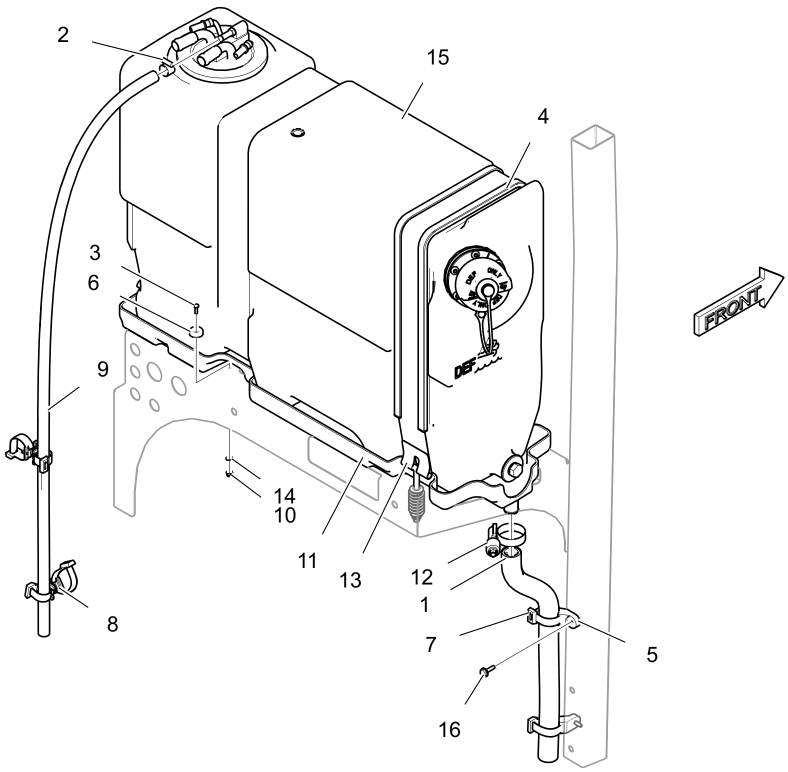
⚠ WARNING

Use eye protection and protective clothing.

☞**NOTE:**

Refer to 2.7. “Diesel Exhaust Fluid” on page 47 *in this section for proper handling procedures.*

4. Mark, disconnect and plug hoses from the multi-function head unit assembly.
5. Disconnect electrical connector from the multi-function head unit assembly See “Fig. 4-22: Diesel Exhaust Fluid Tank Removal & Installation” on page 38.
6. Remove the mounting clamp from the tank.
7. Use lifting equipment or the assistance of another person to remove the tank from the vehicle.



1. Hose, Silicone 3/4" I.D.
2. Clamp, Gear .56" - .87"
3. Screw, PH Cross Recess SST #6 - 32 UNC x 1/2" Lg.
4. Channel, Rubber
5. Mount, Cable Tie 3/16" Eye
6. Bumper, Rubber
7. Cable Tie, 4/5" W x 8 1/2" Lg.
8. Spacer, Dual Swivel Saddle
9. Hose, Rubber 5/16" I.D.
10. Nut, Lock Nylon #6 - 32 UNC
11. Tray, DEF Tank
12. Clamp, Breeze .81" Dia. - 1.5" Dia.
13. Screw, PH Cross Recess SST #10 - 24 UNC x 1 1/4" Lg.
14. Washer, Flat SST #6
15. DEF Tank Assembly
16. Screw, Hex HD #10 TRI-LOB

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Fig. 4-22: Diesel Exhaust Fluid Tank Removal & Installation

2.6.8.5. Disassembly

1. Mark the position of the Multi-Function Head Unit (MFHU) relative to the DEF tank.
2. Remove the two T25 Torx screws securing the retaining ring to the tank and remove the retaining ring.

CAUTION

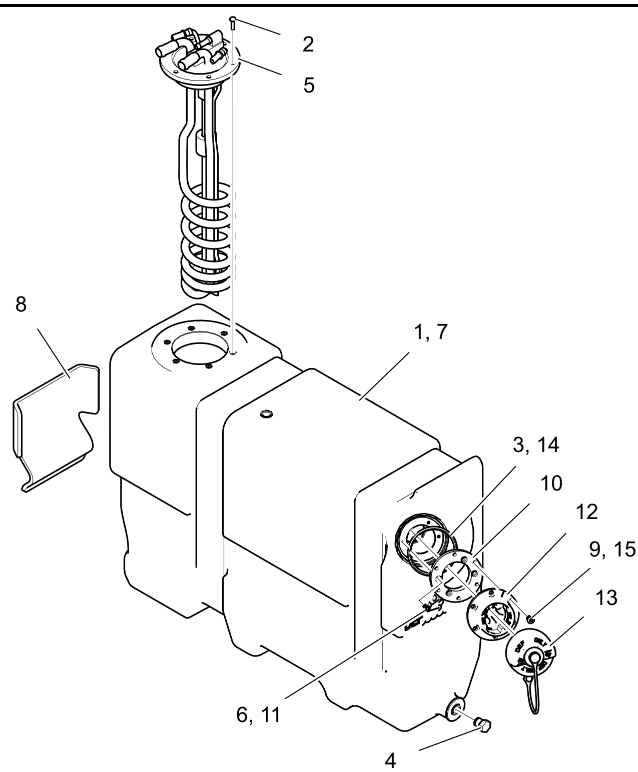
DO NOT pull on wiring harnesses or fittings when trying to remove filter head from tank.

3. Use a flat head screwdriver to gently pry under the head unit while simultaneously pulling on the top of the unit. Continue prying and pulling until the mounting base is free from the tank.

CAUTION

DO NOT pull directly upward on MFHU when removing it from the tank as this might damage the head unit and seal bore. ALWAYS angle the unit out of the tank to prevent damage.

4. Pull the MFHU out of the tank until the inlet filter approaches the opening in the tank. Angle the MFHU and fold the filter element upwards. Continue to carefully remove the MFHU until completely free of the tank bore. See “Fig. 4-23: DEF Tank Assembly” on page 39.



1. DEF Tank Assembly, (Incl. 2-15)
2. Screw, PH Cross Recess SST #10 - 24 UNC x 3/4" Lg.
3. Oil, 15W40
4. Plug, -6 ORB SST EPDM
5. Sensor, DEF Tank
6. Sealant
7. Tank, 10 Gal.
8. Insulation, .25 Neoprene
9. Loctite, 425 Threadlocker Blue
10. Adapter, DEF Tank Filler Neck
11. Screw, Socket Head M5 x 0.8 x 14 Lg.
12. Adapter, DEF Tank Filler Neck
13. Cap, DEF Tank Filler Neck
14. O-Ring, DEF Tank Filler Neck
15. Screw, Socket 1/4" - 20 UNC x 9/16" Lg.

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Fig. 4-23: DEF Tank Assembly

2.6.8.6. Assembly

1. Clean and inspect the tank and all sealing surfaces.
2. Clean and install the drain plug. Torque to 40 to 60 in-lb. (4.5 to 6.7 Nm). dry.
3. Service the multi-function head unit as follows:
   a. If the level sensor needs to be replaced, remove the focus tube by hand, turning counter-clockwise until free. Then snip the ties holding the wire harness. Next, grip the sensor with a pair of pliers below its head and turn it counter clockwise.
   b. Lubricate the gasket of a new level sensor with a thin layer of DEF compatible petroleum jelly or oil. Screw the new level sensor into place until the bottom lip of the level sensor is touching the top of the head unit.
   c. Reinstall the focus tube tightening until hand snug. Resecure the wire harness.
4. Replace the suction filter on the multi-function head unit by removing the screw securing the filter. Install a new filter and align the screw hole in the multi-function head unit. Secure the filter with the screw.
5. Install a new O-ring on the MFHU.
6. Install the MFHU as follows:
   a. Apply a thin layer of O-ring lubricant to the bore seal O-ring.

   ⚠CAUTION

   DO NOT push the MFHU directly into the tank as this could damage the unit.

   b. Fold the filter element upward and position the bottom of the MFHU inside the tank bore at an angle. Carefully work the unit through the bore until the bottom of the unit and filter are inside the tank.

   ⚠CAUTION

   DO NOT press directly on the fittings when installing the MFHU into the tank.

   c. Position the MFHU as marked during removal and press on the top of the blue mounting base until completely seated in the tank bore.
   d. Replace the retaining ring on the MFHU and install the two T25 Torx screws. Torque the screws 20 to 30 in-lb. (2 to 3 Nm).
7. Reinstall the filler cap on the tank.

2.6.8.7. Installation

1. Use lifting equipment to place the tank in the DEF tank tray.
2. Install mounting clamp onto the tank.
3. Tighten the tank straps until the strap springs are compressed to 1.4".
4. Route the vent and drain hoses so that there is a continuous slope for draining. Torque the hose clamps to specifications. Refer to Section 6 of this manual for specification.
5. Connect the hoses onto the tank sensor assembly.
6. Connect the electrical connector to the tank sensor assembly.

2.6.9. DEF Tank Filling

The Diesel Exhaust Fluid (DEF) tank can be filled manually at the fill location in the fusebox access door.

2.6.10. Nitrous Oxide (NOx) Sensors

2.6.10.1.Description

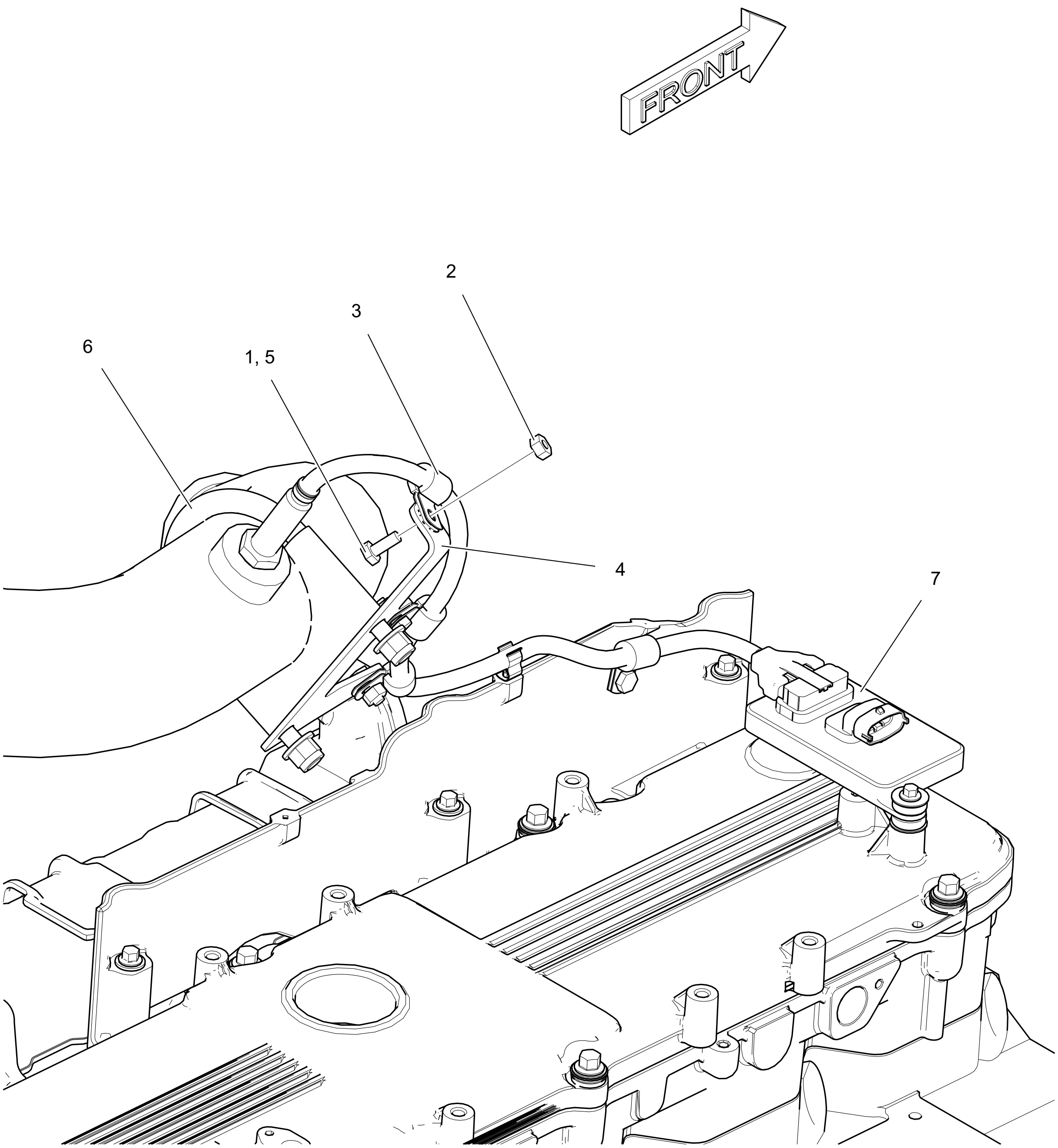
Two NOx sensors are mounted in the exhaust system piping. One is located after the turbocharger, the other is located after the SCR catalyst. Both NOx sensors are made up of a small electronic module with a wired connection to the sensor body that is installed in the exhaust system. These two parts are permanently connected and can not be separated. The wiring harness connector on the intake NOx sensor is keyed differently from the outlet NOx sensor.

2.6.10.2.Operation

The NOx sensors monitor the level of nitrous oxide in the exhaust system. This information is used to control the regeneration cycles and the amount of Diesel Exhaust Fluid that gets injected into the exhaust stream.

2.6.10.3.Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Disconnect the vehicle harness from the electronic control module. See “Fig. 4-24: NOx Sensor Removal & Installation” on page 42.
3. Disconnect any wire clips that are securing the cable between the sensor body and the electronic module.
4. Remove the mounting hardware from the sensor electronic control module.
5. Remove the NOx sensor from the exhaust system piping.
6. Remove the sensor.



1. Bolt, Hex 1/4" - 20 UNC x .63" Lg.
2. Nut, Hex 1/4" - 20 UNC
3. Clamp, "P" .375" SST/HT
4. Bracket, Cable Support
5. Never Seize
6. U-Clamp, 3 1/2"
7. NOx Sensor

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Fig. 4-24: NOx Sensor Removal & Installation

2.6.10.4. Cleaning & Inspection

⚠CAUTION

DO NOT clean the NOx sensor with any kind of fluid. Damage to the sensor can occur.

DO NOT immerse the NOx sensor in water or any kind of chemical wash. Damage to the sensor can occur.

DO NOT jet wash or steam clean the NOx sensor. Damage to the sensor can occur.

1. Inspect the NOx sensor for damage to the wiring or to the body of the sensor.
2. Inspect the electrical connector pins in the sensor and in the engine wire harness for signs of corrosion.
3. Replace the intake NOx sensor if any damage is found.
4. Inspect the engine NOx mounting hardware and replace any damaged isolator mounts.

   ☞**NOTE:**

   This sensor is placed before the diesel particulate filter. It is not uncommon to have soot on the tip of the sensor. Do not try to clean the intake NOx sensor tip unless directed by fault codes or other troubleshooting symptoms. Refer to Cummins OEM information for fault code troubleshooting procedures.

5. Inspect the tip of the NOx sensor for damage. Replace the NOx sensor if any damage is found.

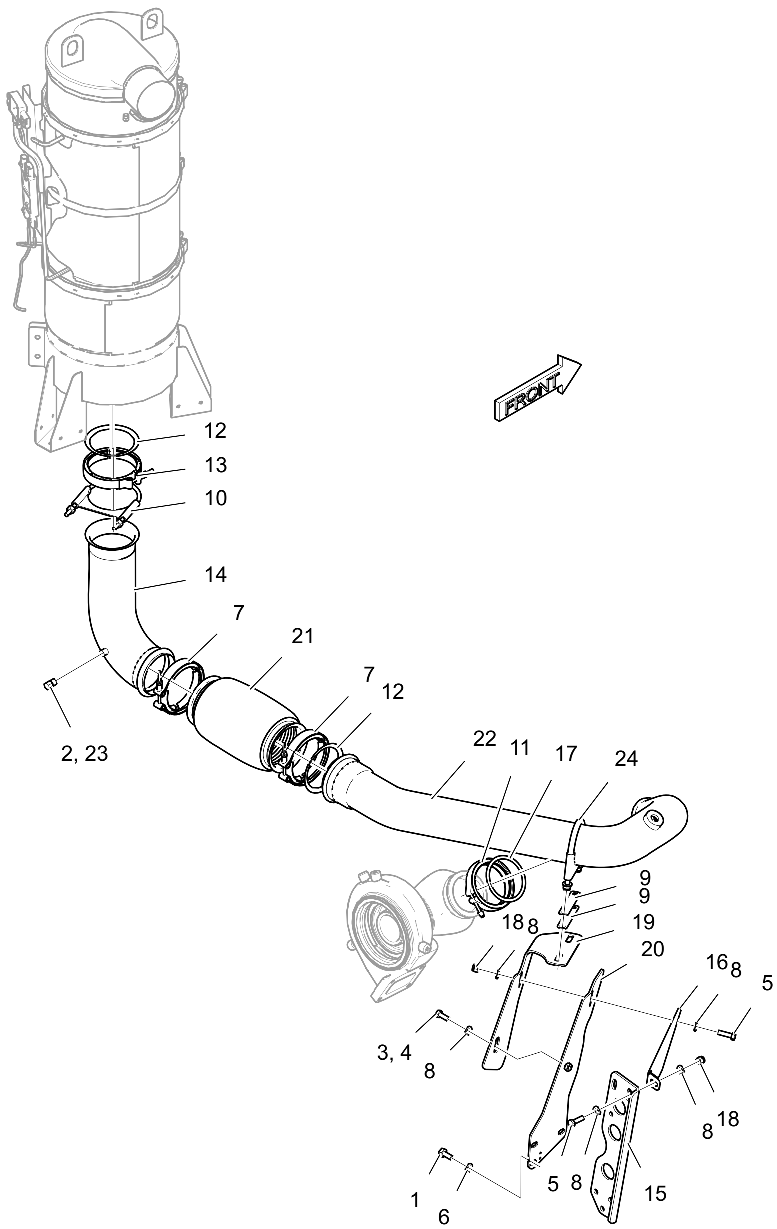
2.6.10.5. Installation

1. Apply a light coating of never-seez to the threads of the NOx sensor.
2. Install the NOx sensor in the exhaust system and tighten the retaining nut. Torque to 37 ft-lb (50Nm).
3. Route the sensor wire in the same orientation as removed and clamp in place.
4. Install the NOx sensor electronic module using the original mounting hardware. Torque the mounting screws to 39 in-lb (4.4 Nm).
5. Connect the vehicle wire harness to the NOx sensor electronic module.
6. Switch the battery disconnect switch on.
7. Run the engine and check the exhaust system to ensure no leaks.

2.6.11. Exhaust Tubes, Exhaust Flex Connector & Exhaust Blankets

2.6.11.1. Removal

1. Unclip the spring retainers.
2. Remove exhaust blankets.
3. Cut the stainless steel wire using side cutters and unlace the exhaust blankets. Remove exhaust blankets.
4. Remove the V-band clamps from the exhaust tube at the muffler inlet and from one end of the exhaust connector. Remove exhaust tube. See “Fig. 4-25: Exhaust Tube Removal” on page 44.
5. Remove V-band clamp from other end of exhaust connector and remove exhaust connector.
6. Remove U-clamp from mounting bracket and V-band clamp from turbo outlet. Remove the exhaust tube.



1. Bolt, M10 x 25
2. Plug, 1/4"
3. Loctite, 243
4. Bolt, Hex 3/8" - 16 UNC x 1" Lg.
5. Bolt, Hex 3/8" - 16 UNC x 1 1/4" Lg.
6. Washer, Flat 3/8"
7. Clamp, Exhaust 4.75" I.D.
8. Washer, Flat Hardened 3/8"
9. Spacer, Exhaust Tube
10. Clamp, 4"
11. Clamp, Exhaust 4" V-Band
12. Gasket, Marmon 4"
13. Clamp, Marmon 4"
14. Tube, Exhaust Flex/DPF ISL
15. Bracket, Air Intake Tube Support
16. Brace, Exhaust/ Air Intake Tube Support
17. Gasket, Marmon 3.5"
18. Nut, Lock Nylon 3/8" - 16 UNC
19. Bracket, Exhaust Tube Support
20. Bracket Assembly, Exhaust Tube Support
21. Connector, Flex
22. Tube, Exhaust Turbo/Flex ISL
23. Never Seize
24. U-Clamp, 3 1/2"

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Fig. 4-25: Exhaust Tube Removal

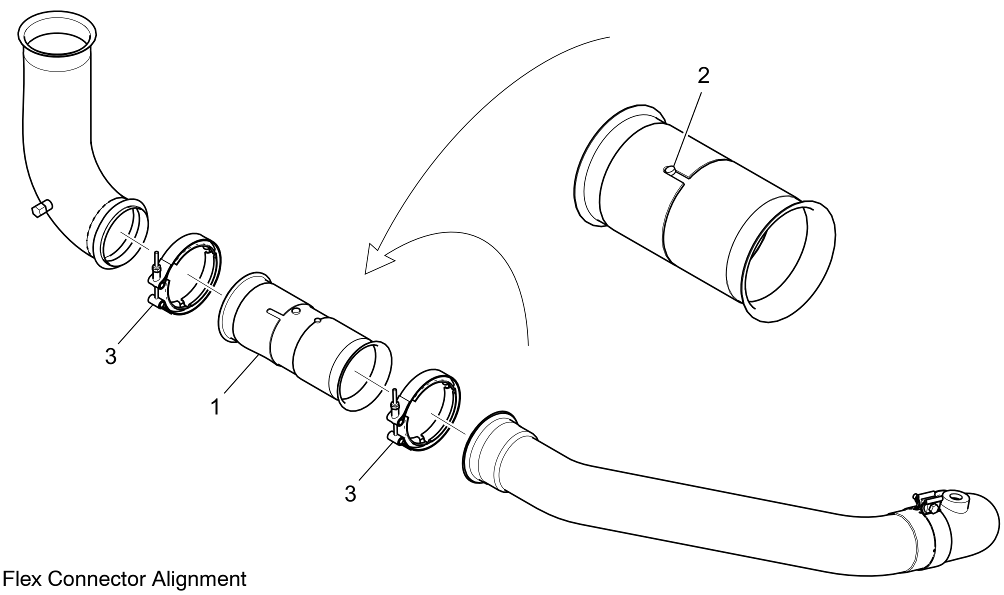
2.6.11.2. Installation

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 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. 4-26: Flex Connector Alignment Tool" on page 46.

   ☞**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 75 in-lb (8.5 Nm). Tighten U-clamp.Tighten V-band clamp on the muffler connection to 75 in-lb (8.5 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 10.00 ± 0.18" when measured between the crimping rings on either end. Adjust muffler exhaust tube as required to achieve this dimension. See "Fig. 4-27: Exhaust Flex Connector Installation" on page 46.
   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 to the rear. Compress the blanket sufficiently so that the seam is closed with ends of the insulation butting together.
12. Secure the blanket using the spring retainers provided.



1. Tool, Flex Connector Alignment
2. Locating Pin
3. V-Band Clamp

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Fig. 4-26: Flex Connector Alignment Tool

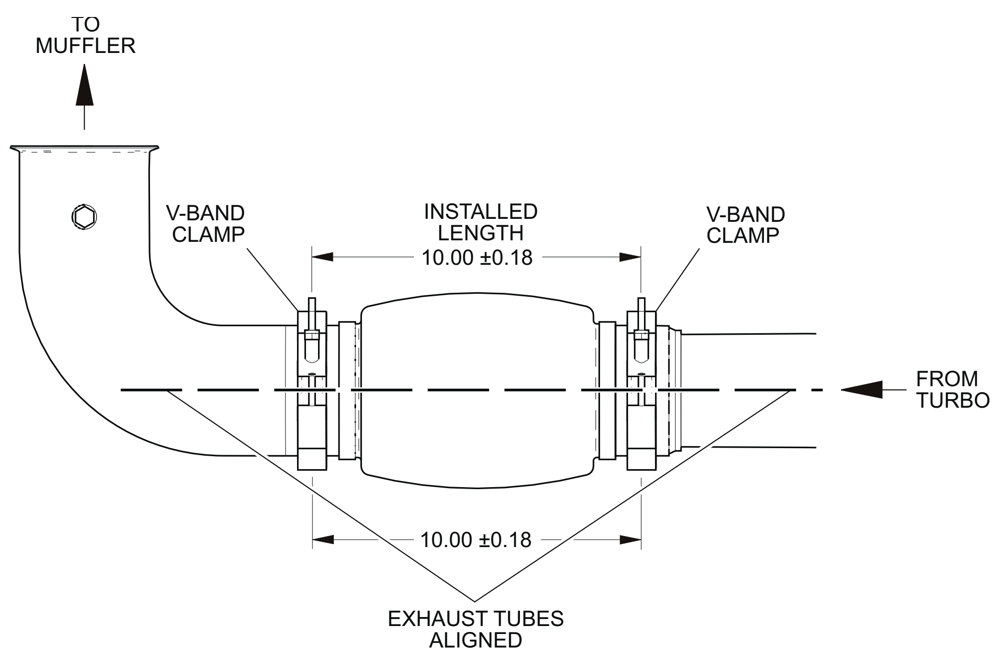

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Fig. 4-27: Exhaust Flex Connector Installation

2.7. Diesel Exhaust Fluid

2.7.1. Description

Diesel Exhaust Fluid is a urea-based chemical reactant designed specifically for use in Selective Catalytic Reducing (SCR) systems to reduce Nitrous Oxide (NOx) emissions. The raw materials used to produce DEF include natural gas, coal or other petroleum products. DEF is prepared by dissolving solid high purity urea in deionized water to create a 32.5% solution in water.

Urea is:

- ❒ Nontoxic and nonpolluting
- ❒ Nonflammable
- ❒ Stable and colorless
- ❒ Composed of urea and water.

Diesel Exhaust Fluid may be called by other names, including:

- ❒ Urea
- ❒ AUS 32 (Aqueous Urea Solution 32)
- ❒ AdBlue™
- ❒ NOx Reduction Agent
- ❒ Catalyst Solution
- ❒ Stableguard 32.

⚠ CAUTION

Any Diesel Exhaust Fluid used in this vehicle must meet the requirements as outlined in the specifications section.

2.7.2. Diesel Exhaust Fluid Specifications

The urea content of the solution must be 32.5 percent ± 0.7 percent by weight and must meet the International Standard ISO 22241-1 for diesel engines. There is no acceptable substitute.

Diesel exhaust fluid should be certified by the American Petroleum Institute (API), Indicated by the symbol on the container/dispensing system. See “Fig. 4-28: Diesel Exhaust Fluid Certification Symbol” on page 47.

⚠ CAUTION

NEVER add water or any other fluid to the diesel exhaust fluid tank. Damage to the aftertreatment system may result. Adding water to the diesel exhaust fluid tank:

- ❒ **Will change the diesel exhaust fluid concentration levels, which may affect SCR efficiency.**
- ❒ **May add contaminates and/or affect the chemical properties of the diesel exhaust fluid, which may damage the aftertreatment system.**
- ❒ **Will alter the freeze point and characteristics of the diesel exhaust fluid solution, potentially leading to damaged diesel exhaust fluid dosing system components during cold weather operation.**

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Fig. 4-28: Diesel Exhaust Fluid Certification Symbol

2.7.3. Operation

Diesel Exhaust Fluid is injected into the exhaust stream where the urea is converted into ammonia. Nitrous oxide in the exhaust gasses combines with the ammonia to produce water and harmless nitrogen. Refer to 2.6.4. “Muffler Filter Regeneration” on page 26 and Refer to 2.6.6. “Decomposition Reactor” on page 32 in this section for more information on the components involved in this process.

WARNING

It is unlawful to tamper with or remove any component of the aftertreatment system. It is also unlawful to use diesel exhaust fluid that does not meet the specifications provided or to operate the vehicle/equipment with no diesel exhaust fluid.

WARNING

Diesel exhaust fluid contains urea. Do not get the substance in your eyes. In case of contact, immediately flush eyes with large amounts of water for a minimum of 15 minutes. Do not swallow internally. In the event the diesel exhaust fluid is ingested, contact a physician immediately.

2.7.4. Handling

Diesel exhaust fluid is not harmful to handle, but can be reactive and/or corrosive to the following materials over time:

- ❒ Carbon steels, zinc coated carbon steels, and mild iron
- ❒ Nonferrous metals and alloys: copper, copper alloys, zinc, and lead
- ❒ Solders containing lead, silver, zinc, or copper
- ❒ Aluminum and aluminum alloys
- ❒ Magnesium and magnesium alloys
- ❒ Plastics or metals coated with nickel.

If diesel exhaust fluid comes in contact with any of these materials, clean immediately. Refer to 2.7.8. “Disposal & Cleaning” on page 49 in this section.

2.7.5. Shelf Life

The following conditions are ideal for maintaining diesel exhaust fluid quality and shelf life during prolonged storage:

- ❒ Storage temperature between -5°C to 25°C [23°F to 77°F]
- ❒ Storage in sealed containers to reduce the possibility of contamination
- ❒ Storage in an area that avoids direct sunlight.

In these conditions, diesel exhaust fluid has a minimum expected shelf life of 18 months. However, each 5°C [9°F] increment above recommended temperatures reduces shelf life by 6 months (for example 30°C [86°F] = 12 month shelf life, 35°C [95°F] = 6 month shelf life, etc.).

2.7.6. Storage

Long term storage in a vehicle (in excess of 6 months) is **not** recommended. If long term storage is necessary, periodically test the diesel exhaust fluid to make sure the concentration does **not** fall out of specification. Refer to 2.7.10. “Testing” on page 49 in this section for procedure.

Refer to ISO 22241-3 for detailed information on handling, transportation, and storage of Diesel Exhaust Fluid.

2.7.7. Cleanliness Practices

Materials that come into contact with diesel exhaust fluid **must** be free from any contamination, oil, fuel, dust, detergents, and any other chemicals.

☞**NOTE:**

Spilled DEF, if left to dry or wiped away with a cloth only, will leave a white residue. Failure to clean the spilled diesel exhaust fluid from a surface may result in an incorrectly diagnosed leak of the diesel exhaust fluid dosing system.

Thoroughly wash any containers or funnels that will be used to dispense, handle, or store diesel exhaust fluid. Wash them thoroughly to remove any contaminants and then rinse with distilled water.

⚠ **CAUTION**

DO NOT use tap water to rinse components that will be used to deliver diesel exhaust fluid. Tap water will contaminate the diesel exhaust fluid. If distilled water is not available, rinse with tap water and then rinse with diesel exhaust fluid.

2.7.8. Disposal & Cleaning

Transfer spilled DEF into a suitable container or cover the spill using an absorbent material. Disposed of DEF according to local environmental regulations.

⚠ **CAUTION**

Containers used to store disposed DEF must be labeled correctly. DO NOT empty waste DEF into the drainage system. DO NOT empty/release waste DEF into surface water.

2.7.9. First Aid

In case of contact with eyes, immediately flush eyes with large amounts of water for a minimum of 15 minutes.

In the event that diesel exhaust fluid is ingested, contact a physician immediately.

2.7.10. Testing

Having the correct concentration of Diesel Exhaust Fluid is critical for proper engine and aftertreatment system performance. Test the concentration of the Diesel Exhaust Fluid using a Diesel Exhaust Fluid Refractometer. See "Fig. 4-29: Diesel Exhaust Fluid Refractometer" on page 50. Refer to your New Flyer Parts Manual for tool part number. Follow the instructions provided with the service tool.

Correct urea concentration level is 32.5 ± 1.2%

☞**NOTE:**

The specification listed above is from the ISO 22241-1 standard. When measuring the Diesel Exhaust Fluid concentration, consideration of the tool tolerances, variability and calibration should be factored before condemning the diesel exhaust fluid.

If the DEF concentration is outside of this specification, drain the DEF tank, flush it clean with distilled water and fill with new or known good Diesel Exhaust Fluid, then recheck the Diesel Exhaust Fluid concentration.

The concentration of the DEF should be checked when:

- ❒ The vehicle has been stored for an extended period of time.
- ❒ It is suspected that water has been added to the Diesel Exhaust Fluid tank

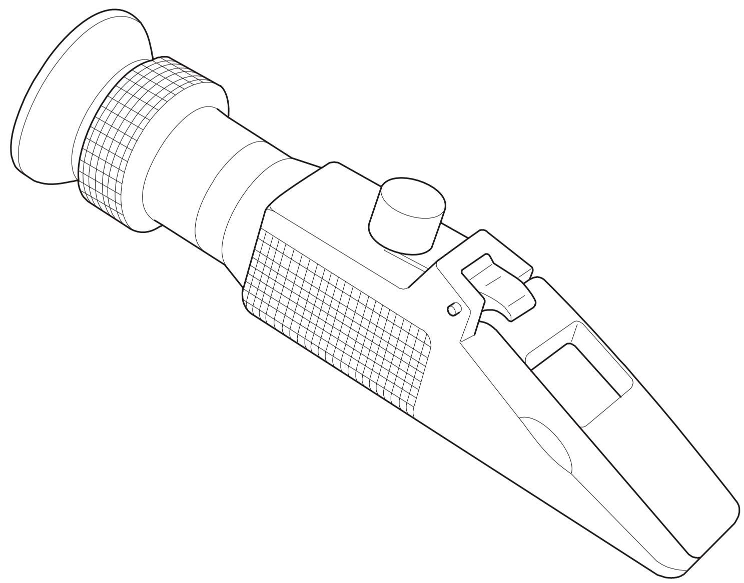

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Fig. 4-29: Diesel Exhaust Fluid Refractometer

2.7.11. Contamination/Incorrect Fluid

CAUTION

NEVER add water or any other fluid to the Diesel Exhaust Fluid (DEF) tank. Damage to the aftertreatment system may result.

In the event that the incorrect fluid is added to the Diesel Exhaust Fluid tank, contact a local Cummins Authorized Repair location to determine the appropriate repair. If only water has been added to the Diesel Exhaust Fluid tank, drain the tank, flush with distilled water and refill with new Diesel Exhaust Fluid. Check the concentration after completing the refill.

2.7.12. Freezing

CAUTION

DO NOT add any chemicals/additives to the diesel exhaust fluid in an effort to prevent freezing. If chemicals/additives are added to the diesel exhaust fluid, the aftertreatment system may be damaged.

Diesel exhaust fluid freezes at approximately 12°F (-11°C). The diesel exhaust fluid system on the vehicle is designed to accommodate this and does not require any intervention by the vehicle operator.

2.8. Front Onboard Diagnostic Connector

2.8.1. Description

The Onboard Diagnostic Connector is located under the dash next to the outboard side of the steering column. The connector is labeled "OBD" for easy identification. See “Fig. 4-30: Onboard Diagnostic Connector” on page 51.

This connector is a standard 9-pin diagnostic connector containing diagnostic drops for the engine J1939/J1708 and the vehicle Multiplexing system J1939 networks.

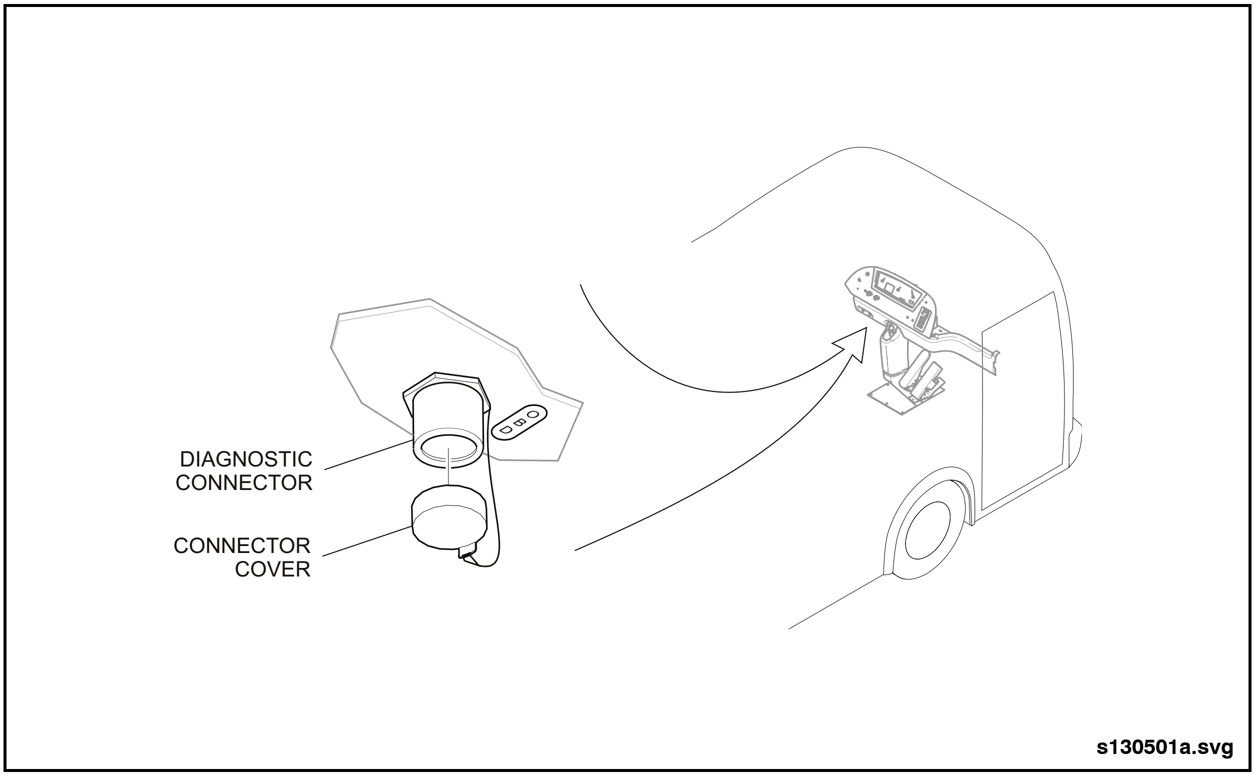


Fig. 4-30: Onboard Diagnostic Connector

2.9. Engine Switch Box

2.9.1. 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. 4-31: Engine Switch Box” on page 53.

- ❒ Rear 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.
- ❒ Wait To Start lamp - indicates when the engine is ready to start.
- ❒ Engine Coolant Fill Mode switch - used during coolant filling process to open all heating system solenoid valves.
- ❒ Engine Diagnostic Connector - used for connecting diagnostic hardware during service.
- ❒ CAN Communicator - used to display engine data and diagnostic information.
- ❒ Aux Heater switch - used to operate the engine auxiliary coolant heater.
- ❒ Idle Speed switch - used to select either NORMAL or FAST engine idle speed.
- ❒ Exhaust Filter switch - used to select either REGEN, INHIBIT, or NORMAL modes of diesel particulate filter regeneration operation.
- ❒ Hybrid Fan Fault indicator - illuminates if a fault is detected with the rooftop fan controller for the hybrid oil cooler.
- ❒ EMP Fan Reverse Switch - used to clear debris from the radiator core.
- ❒ EMP Diagnostic Light - used to display radiator diagnostic fault codes.

2.9.2. Operation

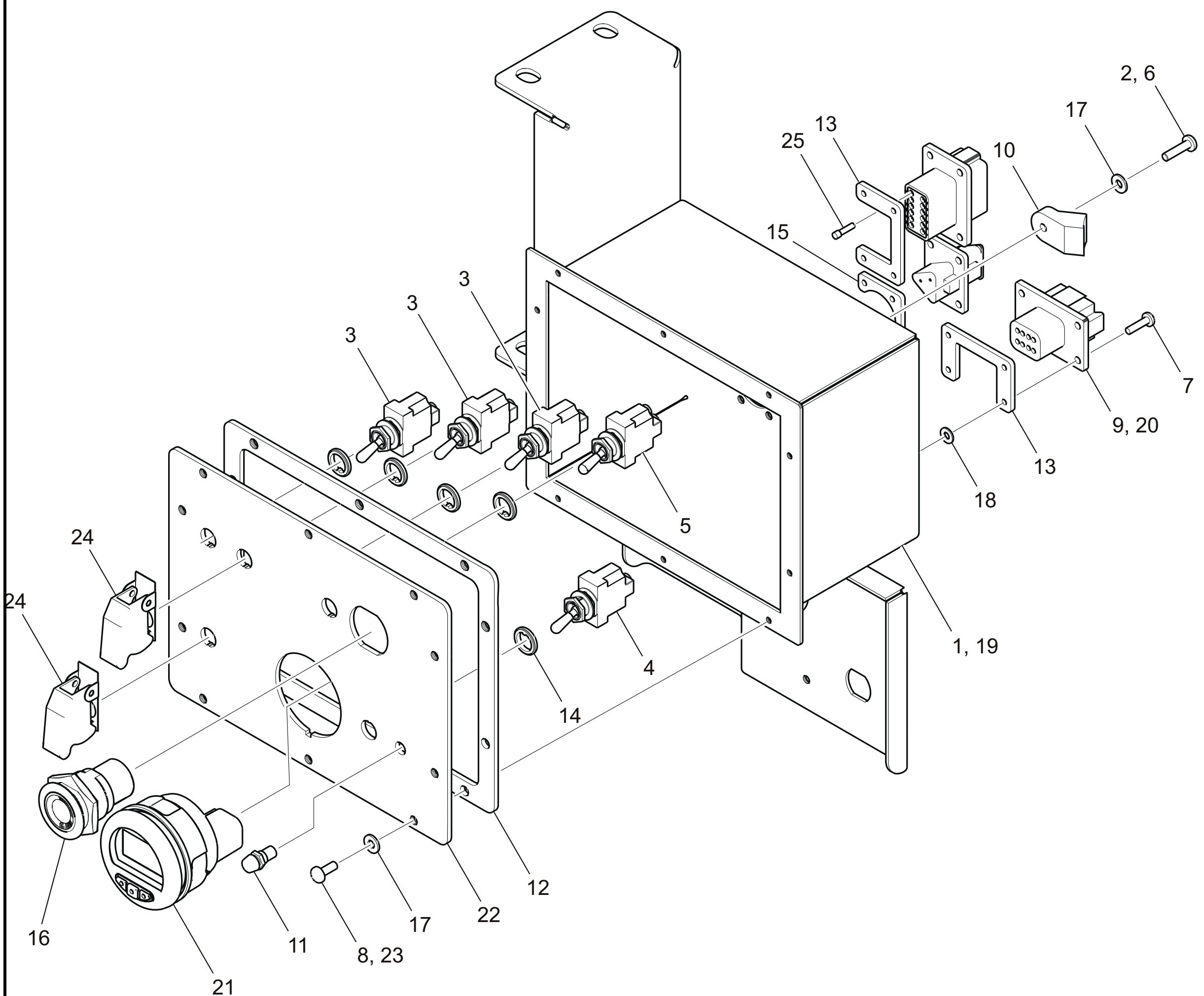
Before attempting to start the engine from the engine compartment make certain that:

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, (Incl. 2-26)
2. Screw, PH Cross Recess SST #10 - 24 UNC x 3/4" Lg.
3. Switch, SPST WP Maintain
4. Switch, Toggle SPDT Maintained On-Off-On
5. Screw, PH Cross Recess SST #8 - 32 UNC x 5/8" Lg.
6. Screw, PH Cross Recess SST #10 - 32 UNF x 1/2" Lg.
7. Harness, Engine Compartment Switch Box
8. Adhesive, SIKA 221 White
9. Lamp, LED Amber 12V
10. Gasket, Switch Box
11. Mount, Cable Tie 3/16" Eye
12. Switch, Push Button
13. Bracket, Switch Box Side
14. Washer, SST Cup .664" O.D. x .466" I.D.
15. Guard, Toggle Switch
16. Bracket, 3 Pin Connector
17. Gauge, Can Communicator
18. Switch Box Assembly
19. Plate, Switch Box
20. Washer, Flat SST #8
21. Washer, Flat SST #10
22. Pin, #18 - 16 AWG
23. Never Seize
24. Loctite, 243 Blue
25. Switch, SPST Moment
26. Guard, Switch

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Fig. 4-31: Engine Switch Box

2.9.3. CAN Communicator

2.9.3.1. 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.

2.9.3.2. 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.

2.9.3.3. 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

2.9.3.4. 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 3. “VENDOR SERVICE INFORMATION” on page 70 in this section for more information on this device.

2.10. Engine Oil Diagnostic Fitting

2.10.1. 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 oil sampling push-button fitting is connected to a tee fitting on the bypass oil filter supply line on the streetside of the engine.

2.11. Engine Fire Detectors

2.11.1. Description

The Engine Fire Detection system consists of four normally closed thermocouple-type probes mounted to brackets in the engine compartment. The probes are connected, in series, between the vehicle's 24 volt electrical system and an input on the vehicle multiplexing system. The probe's open set-point rating is 280°F (138°C).

2.11.2. Operation

The thermocouple probes monitor engine ambient temperature. An elevated temperature, indicative of a potential engine fire, will cause one or more of the thermocouple's to open, breaking the voltage signal to the vehicle Multiplexing System. The multiplexing system will respond by activating a red Eng Fire indicator on the driver's instrument panel.

2.12. Engine Bypass Oil Filter

2.12.1. Description

The Spinner II engine bypass oil filter is designed to extend the engine life by removing soot particles from the oil. The bypass oil filter is remotely mounted in the engine compartment. See “Fig. 4-32: Engine Bypass Oil Filter Installation” on page 56. The bypass oil filter is a centrifugal type which consists of a cover assembly, rotor, housing assembly, air valve assembly and float mechanism.

2.12.2. Engine Bypass Oil Filter Specifications

Manufacturer .... T.F. Hudgins Inc.

Model......No. 576HE (with disposable rotor)

Rating ....1 gpm centrifuge

Air Pressure...................36 psi cut-out valve

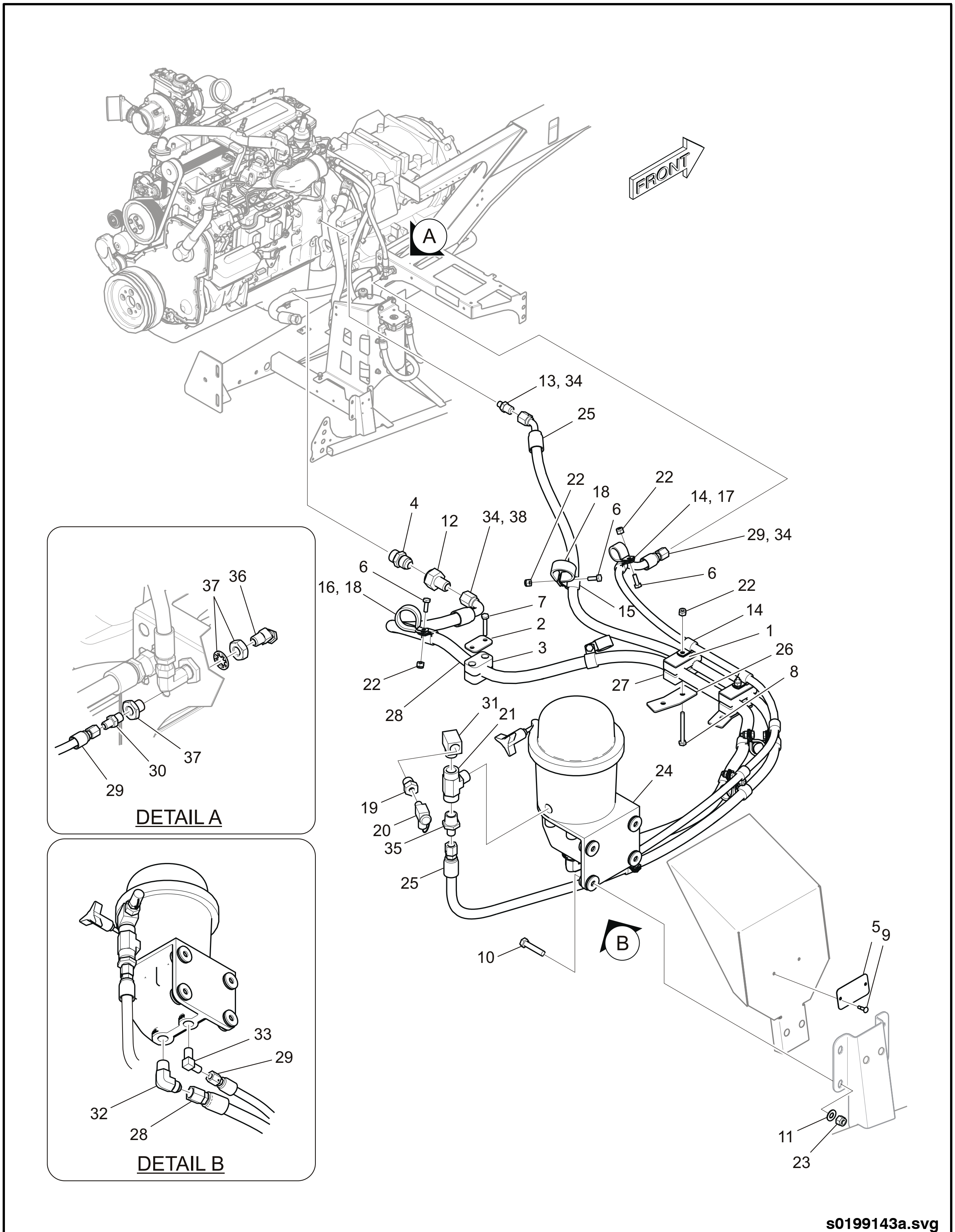

Fig. 4-32: Engine Bypass Oil Filter Installation

1. Plate, Twin Cover	20. Valve, Oil Sampling Push Button
2. Plate, Cover 3/4" Tube	21. Tee, Male 1/2" NPT
3. Clamp, Single 3/4" Tube	22. Nut, Lock Nylon 1/4" - 20 UNC
4. Adapter, M22 x -10 JIC	23. Nut, Lock Nylon 3/8" - 16 UNC
5. Tag, Engine Oil	24. Oil Filter Assembly, Bypass
6. Bolt, Hex 1/4" - 20 UNC x 3/4" Lg.	25. Hose Assembly, EQ1 - 06 FL 69.0
7. Bolt, Hex 1/4" - 20 UNC x 1 1/2" Lg.	26. Bracket, Hose Support
8. Bolt, Hex 1/4" - 20 UNC x 2 1/2" Lg.	27. Clamp, Twin 20/17.2mm Dia.
9. Rivet, Mono Blind SST 3/16" x .064/.270"	28. Hose Assembly, EQ1 - 08 FL 64.0
10. Bolt, Hex 3/8" - 16 UNC x 1 3/4" Lg.	29. Hose Assembly, EQ1 - 04 FL 46.0
11. Washer, Flat 3/8"	30. Adapter, ext Pipe to 37° Flare
12. Adapter, 7/8" x 3/4" JIC	31. Adapter, Elbow 90° ext Pipe to intl Pipe
13. Connector	32. Elbow, 90°
14. Clamp, "P" 1/2" SST/HT	33. Adapter, Elbow 90° ext Pipe to 37° Flare
15. Clamp, "P" .625" SST/HT	34. Loctite, 567 White
16. Clamp, "P" 3/4" SST/HT	35. Adapter, ext Pipe to 37° Flare
17. Clamp, "P" .875" SST/HT	36. Elbow, 45° 3/8" O.D. x 1/4" NPT
18. Clamp, "P" 1.375" SST/HT	37. Connector, Bulkhead 1/4"
19. Reducer, 1/2" Male NPT x 1/8" Female NPT	38. Gasket, Permatex

Engine Bypass Oil Filter Installation (parts list)

2.12.3. Operation

Oil supplied by the engine oil pump enters the rotor which causes the rotor to rotate at a high speed. The centrifugal force separates the contaminants from the oil. The contaminants are collected on the interior wall of the rotor. The cleaned oil returns to the engine crankcase. The air line supplies a small volume of air to prevent a vacuum forming inside the bypass filter. As the oil spins inside the rotor, a funnel effect is created at the surface of the oil. The float mechanism and an air valve located at the bottom of the bypass filter control the amount of air required so that the rotor spins at high speed. The float mechanism turns off the air supply when the engine stops.

2.12.4. Functional Test

With the engine running at operating temperature and at normal engine operating speed, check for excessive vibration, excessive noise or a humming sound, or oil leaks. Shut down the engine and listen immediately for the sound of spinner rotation. If it is working properly the filter rotor can be heard spinning. Refer to "Troubleshooting" in this section for possible causes of any abnormal conditions noted during the functional test.

☞**NOTE:**

The filter rotor does not operate at idling speed, when oil pressure is below 20 psi. A moderate sound or vibration level is normal as the rotor rotates at high speed.

2.12.5. Bypass Oil Filter Troubleshooting

BYPASS OIL FILTER TROUBLESHOOTING		
PROBLEM	**POTENTIAL CAUSE**	**RESOLUTION**
Excessive vibration or noise	Damaged bearings	Replace upper and lower bearings
	Damaged noise insulators	Replace noise insulators at mounting screws and torque to 23 ft-lb.
Humming noise - rotor is not turning	Insufficient air supply	Replace air valve cartridge, float mechanism and cut-out valve
	Clogged rotor	Replace rotor
Oil leaks	Damaged O-rings	Replace upper and lower O-rings
	Damaged cut-out valve	Replace cut-out valve
External air leaks	Damaged air hose connection	Replace air hose and air valve cartridge
Air tank drains over night	Damaged air valve	Replace air valve cartridge and float mechanism

2.12.6. Servicing

1. Follow proper engine shut-down procedures. Allow the rotor to come to a complete stop before opening the bypass filter.

WARNING

Wear eye protection and protective gloves when servicing the bypass oil filter. Avoid touching hot internal parts.

2. Loosen the handle on band clamp, disengage tee bolt and separate cover assembly from body assembly. See “Fig. 4-33: Engine Bypass Oil Filter Assembly” on page 60.
3. Remove the rotor and allow it to drain. The rotor is not serviceable and must be replaced at the recommended intervals. Refer to the Preventive Maintenance Section of this manual for scheduled maintenance intervals.
4. Inspect the cover assembly which contains the upper bearing. Clean the upper bearing and O-ring contact. Check the upper bearing for wear and proper rotation.

☞NOTE:

The upper bearing is not serviceable. If the bearing is damaged the cover assembly must be replaced.

5. Clean the lower bearing which is located in the body assembly. Check it for wear and proper operation. If it needs replacing do the following:
   a. Using a 29 mm socket, remove the bearing housing. The steel sleeve insert and spacer washer needs to be removed if these did not come out of the housing.
   b. Once all parts are removed, clean the recess.
   c. Insert a new bearing into the bearing housing from the threaded side and press it until seated.
   d. Rotate the brass bearing until the hole is aligned with the hole in the housing.
   e. Insert the steel sleeve into the brass bearing.
   f. Place a new washer into the body assembly and thread the other three parts back into the housing using Loctite No. 648. Torque to 11 ft-lb.
6. Check the float mechanism for proper operation as follows:. See “Fig. 4-34: Float Assembly” on page 62.
   a. Form a small hook on a stiff wire approximately 9 in. long.
   b. Insert the hook end of the wire into body assembly and lift the float arm which is visible in the drain body. A bubbling action or hissing sound should be noted when the air is on.
   c. Push the float arm down to stop the air flow.

1. Oil Filter Assembly, Bypass (Incl. 2-14, 16-18)
2. Clamp, Band
3. O-ring Viton
4. Rotor
5. Bolt, M10 x 35
6. Body Assembly
7. Valve, Idle Cut Out
8. Seal, Idle Cut Out Valve
9. Bearing, Lower
10. O-ring Viton
11. Control Float Mechanism
12. Body Assembly, Drain
13. Noise Isolator, c/w Washers
14. Cartridge, Air Valve Assembly (Incl. 15)
15. Seal, Air Valve Cartridge Viton
16. Cover Assembly
17. Spring
18. Plug

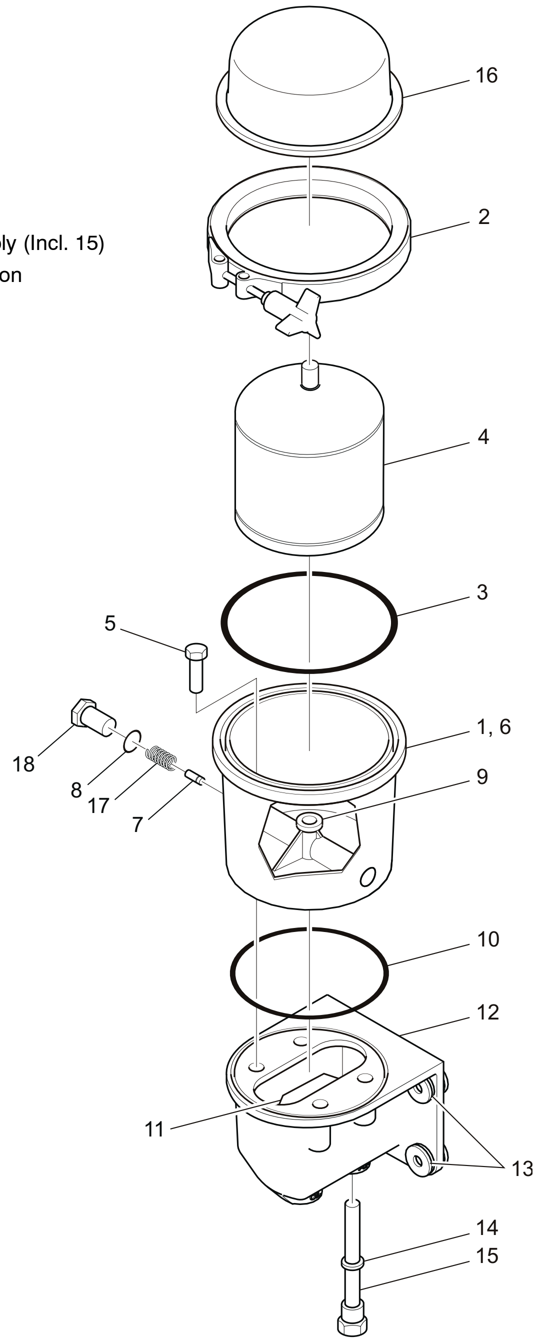

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Fig. 4-33: Engine Bypass Oil Filter Assembly

7. If the float mechanism needs replacing, use the following procedure:

WARNING

Drain the air system before proceeding.

a. Disconnect the air supply to the body assembly and drain the oil out of the drain body.

b. Remove the bolts inside the body assembly and lift the body assembly off the drain body.

c. Remove the two bolts that hold the float mechanism. Make sure that the screw driver is sitting firmly in the screw head before turning. Thread adhesive was used during assemby. Remove the float mechanism.

d. Place a new float mechanism into the drain body. Apply Loctite No. 71211 onto the threads of the replacement screws and install them. Center the float mechanism on the sump pocket before tightening the screws.

e. Reconnect the air system and check the float for proper operation. Lift the float to turn on the air. Push the float down to stop the air.

f. Remove the old O-ring from the drain body and clean the O-ring groove.

g. Install a new O-ring onto the body assembly. Place the body assembly on the drain body. Apply Loctite No. 71211 onto the threads of the bolts and torque to 35 ft-lb. (47Nm).

h. Reconnect the air supply to the body assembly if the air cut-out valve does not need replacing.

8. If the air cut-out valve needs replacing, use the following procedure:
   a. Disconnect the air supply to the body assembly if it is not already done.
   b. Remove the air cut-out valve located on the drain body assembly and clean the valve seal area.
   c. Install a new air valve cartridge with a new seal.
   d. Reconnect the air supply to the body assembly if it is not already done.

   ☞**NOTE:**

   Viton seals are required as these are able to endure the hot operating conditions. A cartridge installed without a seal will be damaged.

9. Insert a new rotor into the cover assembly and firmly press it until seated.
10. Remove the old O-ring from the drain body and groove. Install a new O-ring onto the body assembly.
11. Align the rotor inlet with the lower bearing in the body assembly and press the two pieces together. The cover assembly has to be seated on the O-ring.
12. Reinstall the band clamp uniformly over cover and body assemblies and tighten the clamp handle securely by hand.
13. Start the engine and check for leaks and proper operation. Refer to 2.12.4. “Functional Test” on page 57 in this section for procedure.

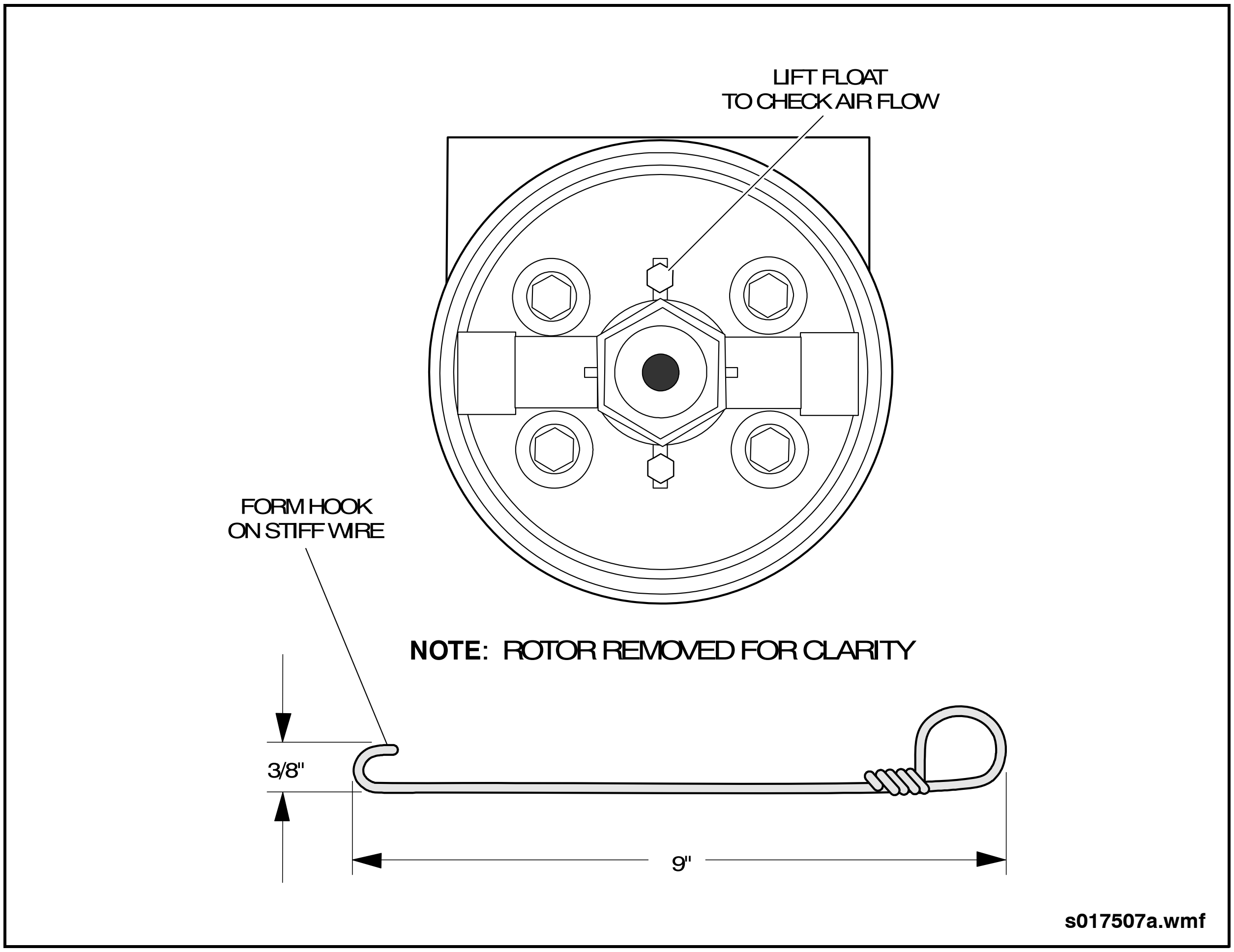

Fig. 4-34: Float Assembly

2.13. Fire Suppression System

2.13.1. Description

This vehicle is equipped with a Dual Spectrum Fire Suppression System. See “Fig. 4-35: Fire Suppression System” on page 64. The system consists of the following components:

- ❒ Linear Thermal Detector (LTD) - The linear thermal detector is a heat sensing coil which is bracket-mounted above the engine. The coil is sensitive along its entire 20 ft. length and reacts when temperatures in the engine compartment reach 350°F. The entire coil assembly must be replaced if it operates and sets off the fire suppression system. An end-of-line plug is installed in the end of the coil and is used to complete the coil circuit.
- ❒ Thermostat - A 450°F spot thermostat is located in the muffler compartment.
- ❒ Optical Flame Detectors - three detectors are located in the engine compartment.
- ❒ Fire Extinguisher - A fast opening valve is mounted on a DOT certified cylinder which contains 22 lbs. of BC-rated Purple-K Dry Chemical agent. The extinguisher is installed horizontally in the bottle mounting bracket.
- ❒ Battery Backup Module - located in the driver’s overhead compartment.
- ❒ Battery Backup - located below the steering column, accessible from under the vehicle through the steering box access panel.
- ❒ An access panel is provided on a rear lighting panel on the streetside of the vehicle.
- ❒ Control Panel - The control panel is located in the driver’s area and displays the current system status.

  The control panel contains System OK, FIRE ALARM, FIRE TROUBLE and Fire Alarm indicators for both Zones #1 and #2, the Audio Alarm, the TEST/RESET switch and the ALARM SILENCE switch. If a fire sensor detects a fire, the FIRE ALARM indicator and audio alarm immediately activate. Engine shutdown output is a normally open contact (1 Amp maximum) which shorts to ground when engine shutdown should occur. The Stop Engine Override switch on the driver's side console can be used to delay engine shutdown and extinguisher discharge an extra 15 seconds. The SYSTEM OK indicator indicates power is on to the system and the system is connected correctly. The TROUBLE idicators illuminate if there is a fault in the detection circuitry. The control panel's indicators and audio alarm are tested by depressing the TEST/RESET switch. The ALARM SILENCE switch will disable the audible alarm. See “Fig. 4-36: Fire Suppression Control Panel” on page 65.

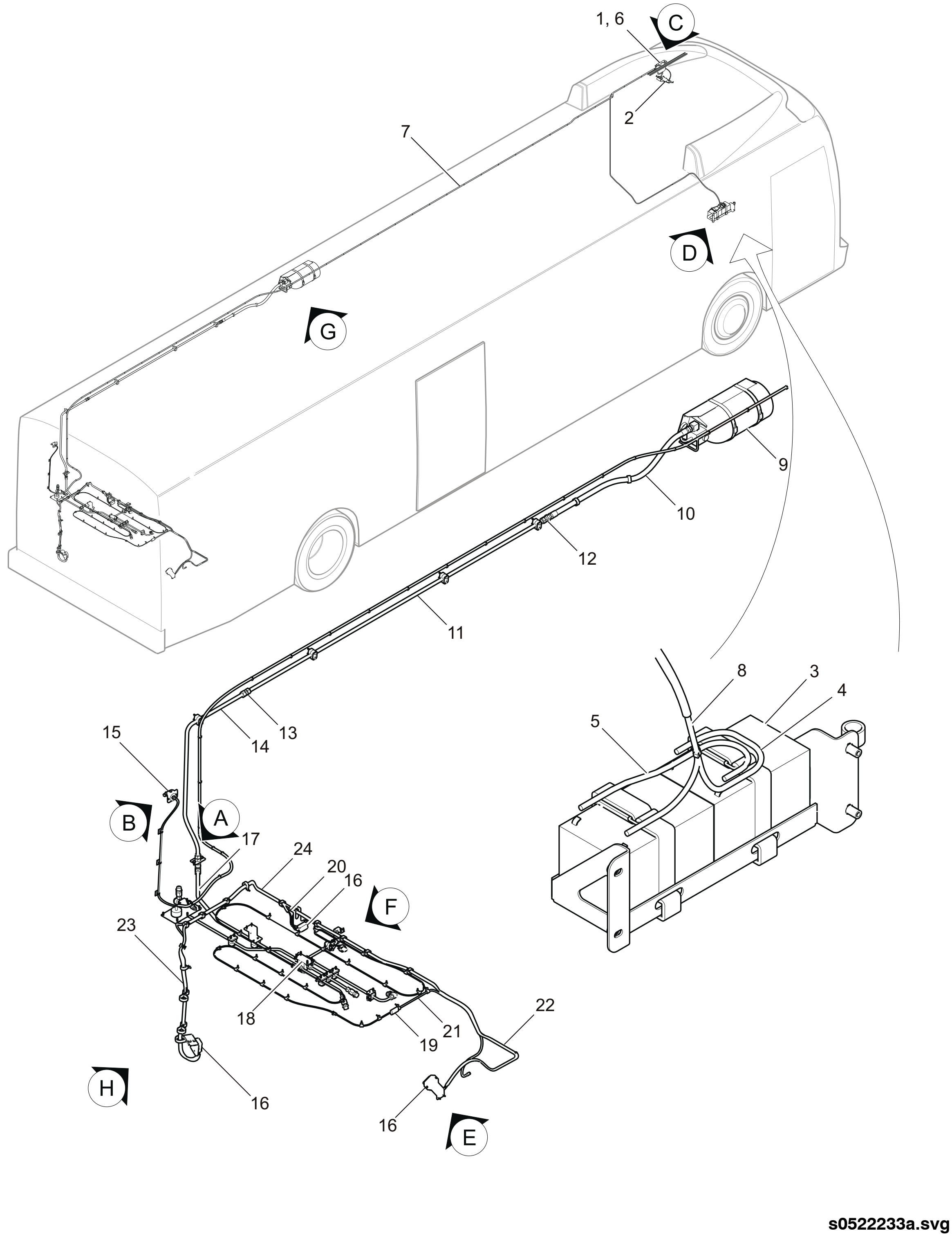

Fig. 4-35: Fire Suppression System

1. Module Battery Backup Assembly	13. Union, .75" Tube to 0.75" Tube
2. Display Panel Assembly	14. Tube, Agent Cylinder SST
3. Battery Backup Assembly	15. Thermostat, Spot 450° F
4. Harness, Battery Backup to Battery	16. Sensor, Fire & Heat
5. Harness, Battery Backup	17. Tube Assembly, Discharge
6. Harness, Battery Backup Module to Battery	18. Nozzle Assembly, Fire Suppressant
7. Harness, Main Fire Suppression	19. Harness, Linear Fire Detection 20'
8. Harness, Main to Battery Backup Module	20. Harness, Sensor 2'
9. Cylinder Assembly, Extinguisher Horizontal	21. Harness, Sensor 8'
10. Hose Assembly, -12 FS	22. Harness, Sensor 9'
11. Tube, Agent Cylinder SST	23. Harness, Engine Compartment
12. Union, .75" Tube to -12 AN	24. Harness, Sensor 9'

Fire Suppression System (parts list)

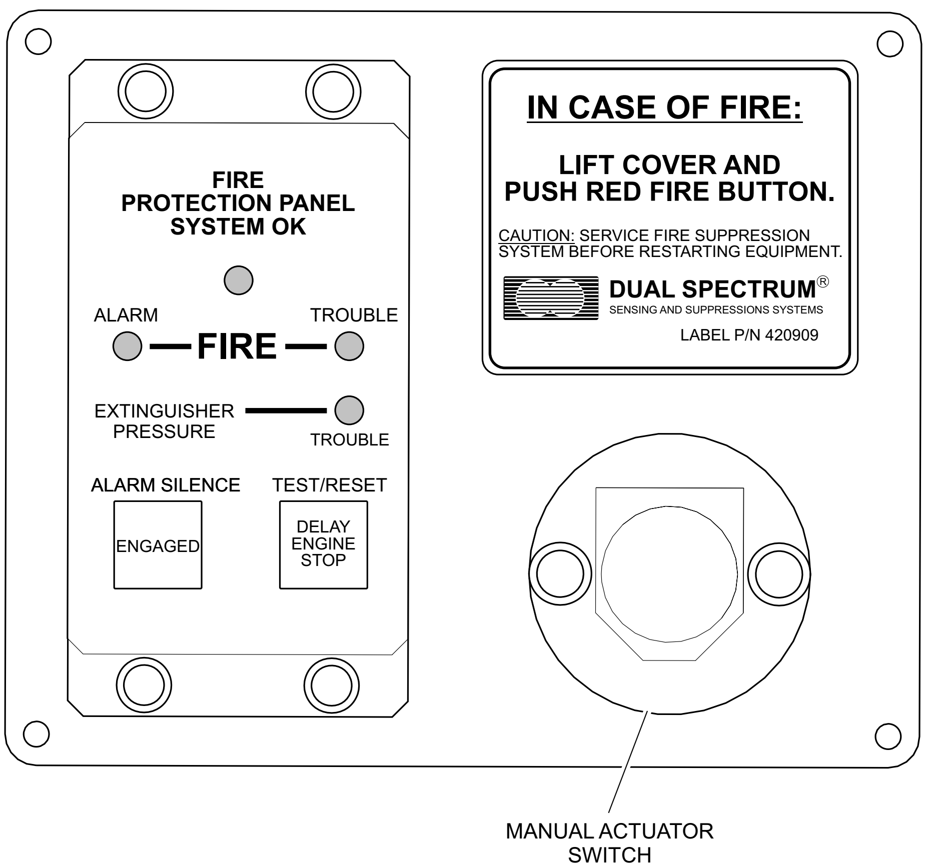

Fig. 4-36: Fire Suppression Control Panel

2.13.2. Operation

When a fire is detected inside the engine compartment, the system sends a fire warning signal to the control panel located in the driver's area. The control panel immediately turns on the Fire Alarm lamp and sounds the audio alarm. After a 15 second time delay the engine is automatically shut down. The fire extinguisher is released coincidentally with engine shutdown.

The Fire Suppression System operates as follows:

1. System detects a fire.
2. System illuminates the FIRE ALARM indicator and sounds the audible alarm.
3. The driver brings vehicle to a safe stop. The system automatically shuts down the engine 15 seconds after the fire alarm starts, (unless delayed by the driver's using the Stop Engine Override switch on the side console).
4. The system discharges the fire extinguisher into the engine compartment (unless delayed by emergency driver override).
5. FIRE ALARM and audible alarm warnings remain illuminated.
6. Maintenance turns power OFF at the battery disconnect switch.
7. Extinguisher is replaced (if required).
8. Maintenance turns power on.
9. System is READY and is indicated by SYSTEM OK LED on the control panel.

2.13.3. Maintenance

After extinguishing a fire, the system is restored to operational status in the following sequence:

⚠ CAUTION

DO NOT chafe, kink, cut or paint Linear Thermal Detector (LTD) cable.

1. Replace linear thermal detector.
2. Replace the spot thermostat.
3. Refer to 2.13.4. “Fire Extinguisher Replacement” on page 67 in this section for procedures.
4. The Battery Disconnect switch is then turned ON.
5. The Test/Reset switch on the control panel is pressed to restore normal system operation.

⚠ CAUTION

DO NOT reset the system until the extinguisher is replaced.

2.13.4. Fire Extinguisher Replacement

WARNING

The extinguisher is pressurized! DO NOT loosen bracket clamps or handle a fire extinguisher unless the anti-recoil plug is installed in the valve outlet port and the squib lead is shunted.

1. Set the Battery Disconnect switch to the OFF position. Disconnect power to the system by disconnecting the 15 amp fuse leading to the J16 connector for the system. Refer to the FIRE SUPPRESSION electrical schematic for fuse location.
2. Obtain access to extinguisher in rear streetside light panel.
3. Disconnect the electrical connector on the extinguisher valve from the wiring harness.
4. Install a shorting plug into the electrical connector on the extinguisher.
5. Remove the hose from the valve outlet port and install the anti-recoil plug.
6. Loosen the mounting clamps and remove the extinguisher.

CAUTION

DO NOT attempt to recharge fire extinguishers. Take the extinguishers to a local fire protection equipment company.

7. Remove the cone nozzles from the distribution tubing for inspection and cleaning.
8. Blow out the distribution tubing with dry compressed air to ensure the tubing is dry and free of residual extinguishing agent.
9. Use a wrench to reinstall the cone nozzles tightly.

☞**NOTE:**

DO NOT use pipe dope or Teflon tape on the nozzle threads. Replace any damaged or missing nozzle caps.

10. Inspect the new extinguisher. Ensure the anti-recoil plug is installed.

CAUTION

Ensure extinguisher is correctly oriented in bracket. Otherwise it may not function as designed.

11. Install the extinguisher in its mounting bracket and tighten the clamps. Do not connect the valve wiring harness at this time.

WARNING

DO NOT stand in front of or look into the outlet port when the anti-recoil plug is removed.

12. Keep clear of the outlet port while unscrewing the anti-recoil plug. Store it in the mounting point provided.
13. Immediately install the fittings and hose. If necessary, the clamps maybe loosened slightly to reposition the bottle, then retighten the clamps.

CAUTION

If the fire suppression control panel is in alarm condition (red ALARM light illuminated) the extinguisher may discharge if it is connected to the system. Ensure this red ALARM light is NOT illuminated before continuing with this procedure.

14. Connect power to the system by connecting the 15 amp fuse. Confirm the red ALARM light on the control panel is NOT illuminated. The yellow TROUBLE light will be illuminated solid as the extinguisher valve electrical connector is not connected.
15. Set the Battery Disconnect switch to the ON position.
16. Remove the shorting plug from the electrical connector on the extinguisher.
17. Attach the wiring harness to the cylinder connector.
18. Confirm the SYSTEM OK light on the control panel illuminates solid green.

2.13.5. Fire Suppression System Troubleshooting

FIRE SUPPRESSION SYSTEM TROUBLESHOOTING		
SYMPTOM	**PROBABLE CAUSE**	**CORRECTIVE ACTION**
All control panel lamps off	No power to system	Check connections to & voltage of vehicle batteries.
		Check system fuse (15A).
		Below 9 volts the system will not function.
Control panel green SYSTEM OK lamp blinking	Low battery voltage	Check connections to & voltage of vehicle batteries.
		Below 11 volts the system will provide low voltage indication.
Control panel green SYSTEM OK lamp off, yellow fire TROUBLE lamp on, red fire ALARM lamp on solid & audible alarm on	System automatically discharged	Correct the cause of the fire & reset the system. Refer to 2.13.4. “Fire Extinguisher Replacement” on page 67 in this section for procedure.
Control panel green SYSTEM OK lamp off, yellow fire TROUBLE lamp on, red fire ALARM lamp on blinking & audible alarm on	System manually discharged	Correct the cause of the fire & reset the system. Refer to 2.13.4. “Fire Extinguisher Replacement” on page 67 in this section for procedure.
Control panel green SYSTEM OK lamp off, yellow fire TROUBLE lamp on, solid & audible alarm beeping	Component not connected or damaged harness in the extinguisher circuit	Check harness connections at extinguisher.
		Check electrical interconnections. Refer to Fire Suppression Electrical Schematic.
Control panel green SYSTEM OK lamp off, yellow fire TROUBLE lamp on, blinking & audible alarm beeping	Component not connected or damaged harness in the fire detection circuit	Check harness connections at Linear Thermal Detector (LTD).
		Check connection at end of line plug on LTD.
		Check electrical interconnections. Refer to Fire Suppression Electrical Schematic.
Vehicle will not start. Control panel red fire ALARM lamp on solid & audible alarm on	System not reset after fire	Correct the cause of the fire & reset the system.Refer to 2.13.4. “Fire Extinguisher Replacement” on page 67 in this section for procedure.

FIRE SUPPRESSION SYSTEM TROUBLESHOOTING		
SYMPTOM	**PROBABLE CAUSE**	**CORRECTIVE ACTION**
Extinguisher pressure gauge reading is low	Extinguisher cold	Let extinguishers warm up to room temperature (approx. 70°F 21°C) & recheck the gauge. If the pointer is then within the green arc, no corrective action is required.
	Extinguisher leaking or discharged	Have the fire extinguisher serviced by a fire protection equipment company familiar with Dual Spectrum equipment.

3. VENDOR SERVICE INFORMATION

The following supplier manuals contain additional reference information.

3.1. Cummins ISL (2015) Manuals

- ❐ Custom Parts Manual
- ❐ Troubleshooting Manual
- ❐ Service Manual
- ❐ Operation & Maintenance Manual
- ❐ Owner's Manual

3.2. Forster Manual

- ❐ Can-Communicator User Guide

3.3. Dual Spectrum Fire Suppression Manuals

- ❐ Kidde Operation & Maintenance

Hybrid Drive System

1. SAFETY

☞**NOTE:**

Consult Allison Electric Drive Field Engineering before performing any work on the vehicle which involves the drive unit.

1.1. High Voltage Safety

DANGER

The Allison E^P System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Normal operating conditions:

ESS Voltage Range ....432 to 780 VDC

DPIM DC Current Range ..... -350 to +350 A

WARNING

All persons working with potentially hazardous electrical energy should familiarize themselves with safe electrical work practices. Refer to 1.1.6. "Electrical Safe Work Practices" on page 5 **in this section for procedure.**

1.1.1. High Voltage Interlock Loop (HVIL)

DANGER

DO NOT rely solely on the HVIL system to de-energize the electric drive system. Always perform the appropriate voltage checks and use lockout energy control techniques to ensure the system is de-energized. DO NOT attempt to bypass the HVIL system for any reason. Serious personal injury or death may result if proper safety procedures are not followed.

The Propulsion System uses a High Voltage Interlock Loop to attempt to prevent access to energized potentially hazardous electrical circuits. HVIL switches are located on the high voltage AC connectors on the drive unit and DPIM and on the high voltage DC connectors on the ESS and DPIM. Opening the covers on any of these connectors will cause the HVIL switch to open and mechanically disconnect high voltage energy from the system.

1.1.2. High Voltage Isolation Fault Detection

The Propulsion System uses Isolation Fault Detection to identify a short to the vehicle chassis on the high voltage circuit. The Check System indicator on the instrument panel will illuminate if this fault condition occurs and will automatically shutdown the vehicle.

1.1.3. General High Voltage Precautions

Always treat electrical systems as if they are powered ON. Make sure Master Run switch is in the STOP-ENGINE position. Set the Battery Disconnect switch to OFF. Always follow the High Voltage Disconnect Verification procedure before performing any work on the system.

1.1.4. High Voltage Disconnect Verification

DANGER

ALWAYS wear high voltage (Class 0 isolation) protective gloves when working on high voltage equipment (Item 11, 12, or 13 from Special Tools list).

1. Set Master Run switch to the STOP-ENGINE position.
2. Set the Battery Disconnect switch to the OFF position. Use a lockout device to prevent unauthorized access to the Battery Disconnect switch.
3. Remove connector PI120 (low voltage 24-pin connector) from the DPIM. See “Fig. 51: DPIM Low Voltage Connections” on page 3.
4. Remove connector PB140 (low voltage 31-pin connector) from the ESS. See “Fig. 52: ESS Low Voltage Connections” on page 3.
5. Remove both HVIL covers on the ESS. See “Fig. 53: ESS HVIL Cover Removal” on page 3.
6. Remove the positive and negative connectors from the ESS. See “Fig. 54: ESS High Voltage Connections” on page 3. Use a lockout device to prevent unauthorized reinstallation.

CAUTION

Use a voltmeter, such as a Fluke 87, that is UL Listed E59794 and CSA Certified LR44340, IEC-1010-1, 1000V Category III input protection.

7. Measure the following voltages using an approved voltmeter.
   a. ESS positive to negative terminals. See “Fig. 55: ESS Voltage Check Between HV Terminals” on page 4. Voltage reading must be less than 3VDC before work can continue.
   b. ESS positive terminal to chassis ground. See “Fig. 56: ESS Voltage Check Between HV Terminals & Ground” on page 4. Voltage reading must be less than 3VDC before work can continue.
   c. ESS negative terminal to chassis ground. Voltage reading must be less than 3VDC before work can continue.
8. Remove the AC and DC lug access covers from the DPIM. Use an approved voltmeter to perform the following measurements:
   a. DC positive to negative terminal. See “Fig. 57: Voltage Check Between DPIM DC HV Terminals” on page 4. Voltage reading must be less than 3VDC before work can continue.
   b. DC positive terminal to chassis ground. See “Fig. 58: Votlage Check Between DPIM DC HV Terminals & Ground” on page 4. Voltage reading must be less than 3VDC before work can continue.
   c. DC negative terminal to chassis ground. Voltage reading must be less than 3VDC before work can continue.
   d. AC phase to phase; A-B, A-C, B-C. Voltage reading must be less than 3VDC before work can continue.
   e. AC phase to chassis ground. See “Fig. 59: Voltage Check Between Each DPIM AC Phase & Ground” on page 5. Voltage reading must be less than 3VDC before work can continue.
   f. Work can now be performed on the high voltage system.

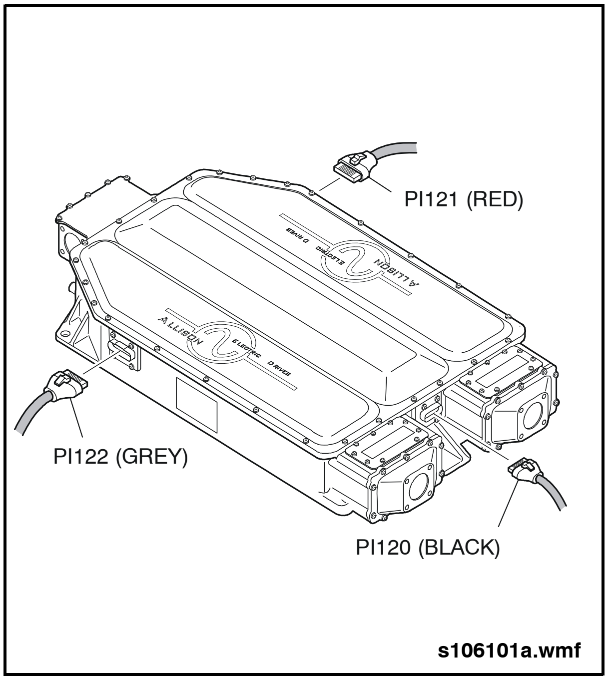

Fig. 51: DPIM Low Voltage Connections

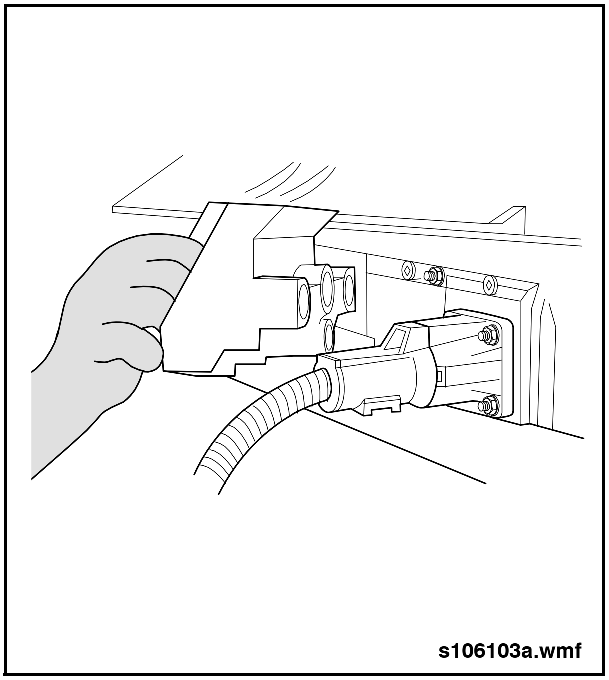

Fig. 53: ESS HVIL Cover Removal

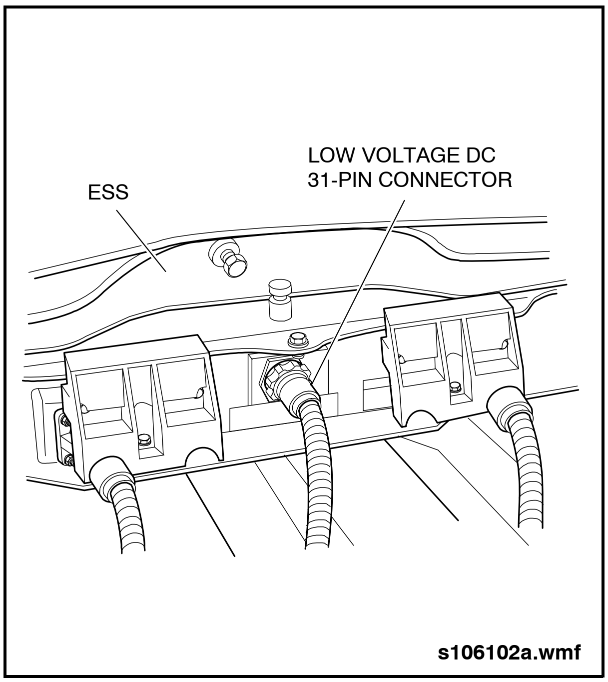

Fig. 52: ESS Low Voltage Connections

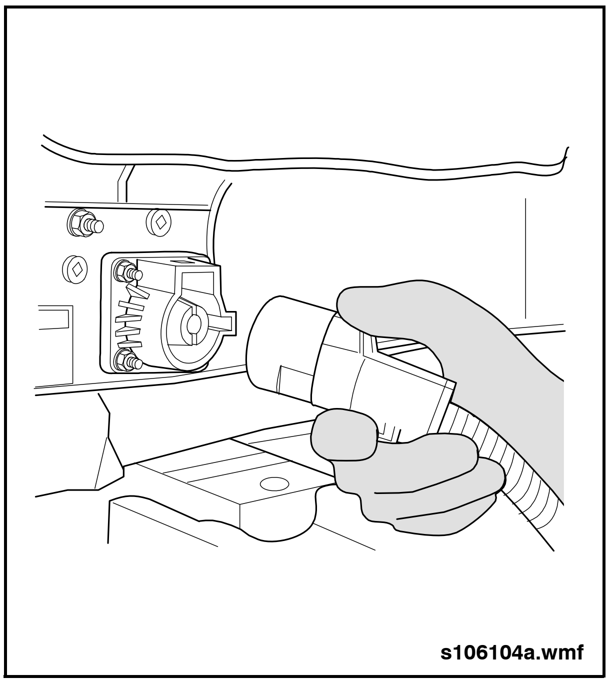

Fig. 54: ESS High Voltage Connections


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Fig. 55: ESS Voltage Check Between HV Terminals

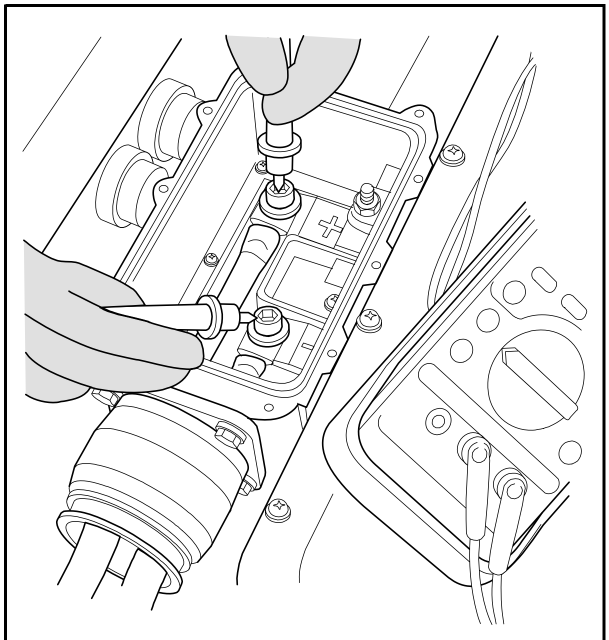
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Fig. 57: Voltage Check Between DPIM DC HV Terminals

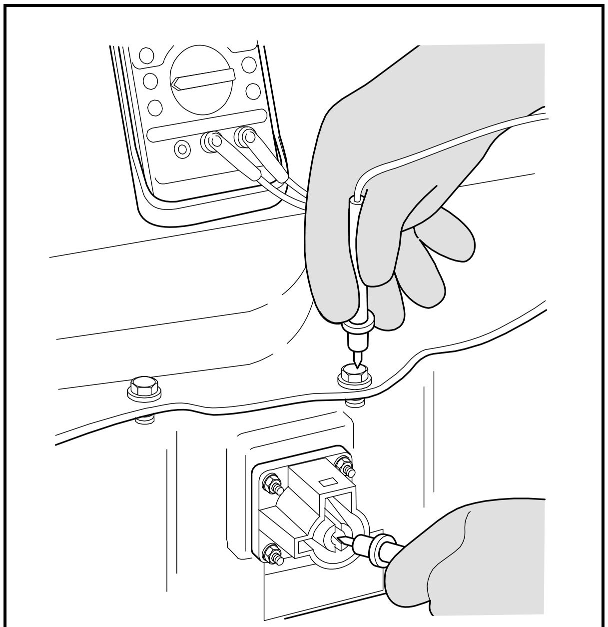
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Fig. 56: ESS Voltage Check Between HV Terminals & Ground

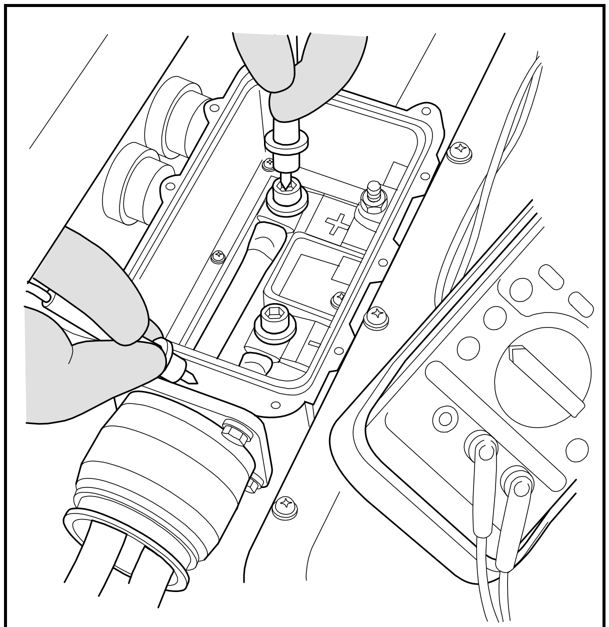
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Fig. 58: Votlage Check Between DPIM DC HV Terminals & Ground

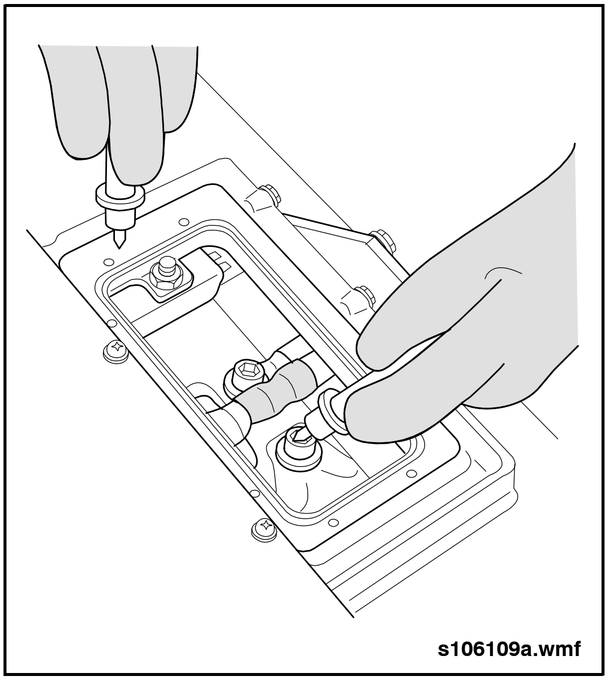


Fig. 59: Voltage Check Between Each DPIM AC Phase & Ground

1.1.5. Energy Storage Lockout

Use lockout devices to prevent installation of the ESS DC connectors during service. Refer to Allison Electric Drive System Service Manual for acceptable devices.

1.1.6. Electrical Safe Work Practices

Reference the following sources to obtain more information on establishing safe electrical work practices:

- www.OSHA.gov, 29CFR 1910 Subpart S
- www.NFPA.org, NFPA 70E-2004

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. HYBRID DRIVE SYSTEM

2.1. Description

The Hybrid Drive System consists of:

- ❒ Drive Unit
- ❒ Dual Power Inverter Module (DPIM)
- ❒ Energy Storage System (ESS)
- ❒ Transmission & Vehicle Control Modules (TCM/VCM)
- ❒ Pushbutton Shift Selector (PBSS)

2.2. Operation

This vehicle is powered by a parallel hybrid system that blends both mechanical and electrical power paths to drive the vehicle. The system consists of a diesel engine, drive unit, Energy Storage System (ESS), Dual Power Inverter Module (DPIM), and electronic controls. See “Fig. 5-10: Hybrid Drive System Layout” on page 7.

The diesel engine is conventionally mounted and coupled to the drive unit. The drive unit is an arrangement of three planetary gearsets, two clutches, and two motor/generators that work together with an electronic control unit to provide two continuously variable operating ranges.

Diesel engine torque is blended with the drive unit’s electric motors to propel the vehicle. The motors primarily accelerate the vehicle from a standstill to about 12 mph. At cruising speeds the vehicle is propelled primarily by the diesel engine.

The Energy Storage System (ESS) is a modular roof-mounted battery pack. It stores the AC energy provided by the motor/generators which has been converted to DC energy by the DPIM unit. The DPIM unit also converts the stored DC energy back to AC in order to drive the motor/generators when required.

The electric motors in the drive unit can be driven by the weight of the vehicle, through the driveline, during deceleration and create electrical energy generation. This process, known as “regenerative braking”, also slows the vehicle by imposing a drag on the driveline.

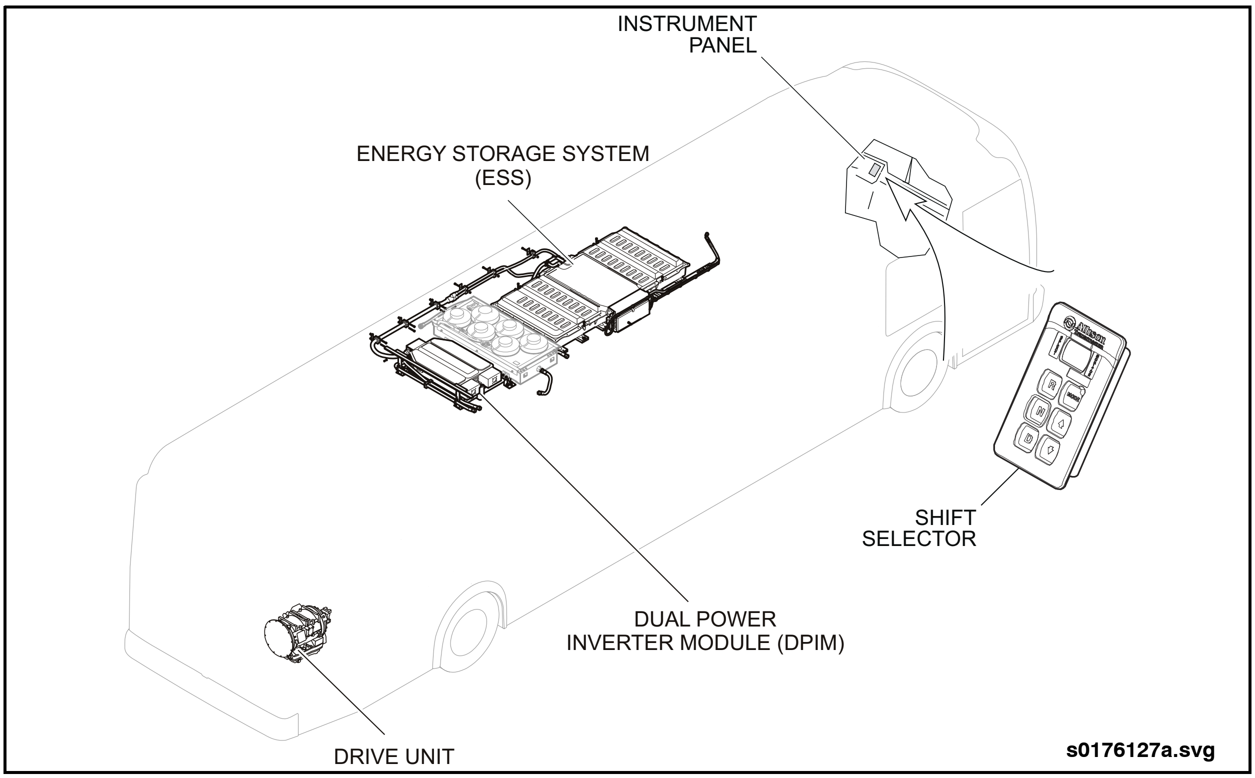
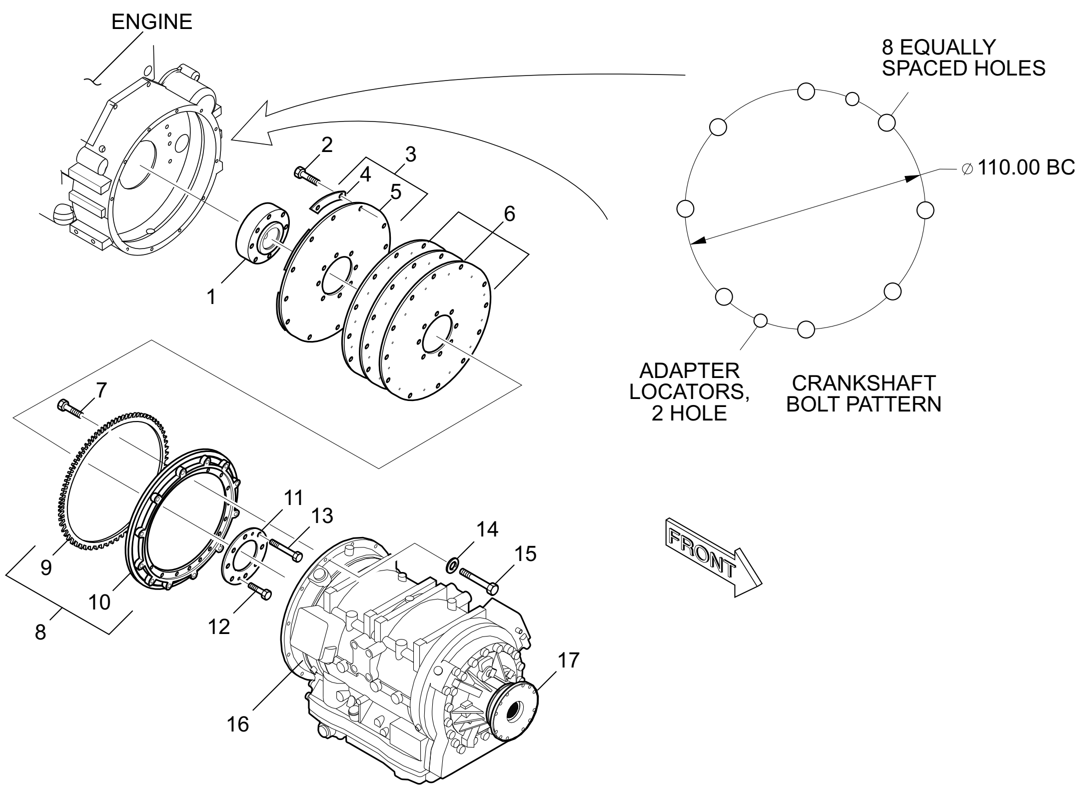


Fig. 5-10: Hybrid Drive System Layout

2.3. Drive Unit

2.3.1. Description

The drive unit is mounted to the vehicle engine and coupled to the driveline in the same manner as a transmission. The unit contains two concentric electric motors that, in combination with planetary gearing and rotating and stationary clutches, provide infinitely variable forward and reverse speeds. See “Fig. 5-11: Drive Unit Removal & Installation” on page 8.



1. Hub, Adapter
2. Bolt, M10 x 1.5 x 30
3. Flex Plate Assembly, (Incl. 4 & 5)
4. Plate, Bolt
5. Flex Plate
6. Flex Plate
7. Bolt, M8 x 1.25 x 25
8. Adapter Assembly, Gear (Incl. 9 & 10)
9. Gear, Ring
10. Adapter, Flex Plate
11. Plate, Wear
12. Bolt, M6 x 1.0 x 16
13. Bolt, Crankshaft C 8.3
14. Washer, Flat
15. Bolt, M10 x 1.5 x 35
16. Drive, Unit EV40 (Incl. 17)
17. Flange, Output

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Fig. 5-11: Drive Unit Removal & Installation

2.3.2. Operation

The drive unit is used to turn the engine flywheel during vehicle starting. The engine does not require a starter motor. During vehicle operation, power from the roof-mounted Electrical Storage System is combined with engine power within the drive unit to accelerate the vehicle. This process is called torque blending.

2.3.2.1. Regenerative Braking

Regenerative braking is an energy recovery process that occurs whenever the throttle is not applied and the vehicle is moving forward. During this process a drive unit motor is electrically switched from motor operation to generator operation. The vehicle's rotating driveshaft then turns the motor/generator. The electrical energy produced is routed through the roof-mounted Dual Power Inverter Module (DPIM) to the Energy Storage System. This interaction of the magnetic fields within the motor/generator also produces drag on the vehicle driveline and slows the vehicle. Braking force increases when the service brakes are applied.

Pressing the DOWN (⇓) arrow while moving forward increases the regenerative braking effect of the drive unit. The Push-button Shift Selector (PBSS) displays [F] or [L] to identify the level of regenerative braking in use. Increasing regenerative braking does not limit forward speed to a particular range. The drive unit remains in the selected regenerative braking mode until the Master Run switch is set to the STOP-ENGINE or NIGHT-PARK position, the UP (⇑) or DOWN (⇓) arrows are used, or Neutral [N] is selected. Following any of these conditions, the system returns to the default regenerative braking level.

2.3.2.2. Auto-Neutral

The drive unit uses a multiplexing output and an external relay to automatically select neutral whenever the parking brake is applied. The vehicle multiplexing is also programmed to select auto-neutral whenever the entrance door is open. Auto-neutral is sometimes referred to as "forced neutral" because the drive unit 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].

2.3.2.3. Drive Unit Fluid Level Check

⚠DANGER

Ensure the following conditions are met prior to conducting a fluid level check:

- ❒ **Vehicle is brought to a complete stop on a level surface.**
- ❒ **Drive unit is in neutral [N].**
- ❒ **Parking brake is applied.**
- ❒ **Vehicle wheels are chocked.**

The drive unit is equipped with an electronic Oil Level Sensor (OLS). The OLS provides a means to check the drive unit fluid level. To display fluid level, simultaneously press the UP (⇑) and DOWN (⇓) arrow keys on the push button shift selector (PBSS) for five seconds. The vehicle must meet the following conditions for two minutes before readings can be obtained:

- ❒ Engine at idle (750 to 850 RPM)
- ❒ Sump fluid at operating temperature of 68° to 176°F (20° to 80°C).
- ❒ Drive unit output shaft stopped.
- ❒ Drive unit in neutral [N].
- ❒ Oil level sensor functioning properly.

Fluid level condition will be displayed instantly if the above conditions have been met for a two-minute period prior to the request. However, if the two-minute period has not been met, a countdown display will be shown during the two-minute period. An invalid for display code will be shown if an operational condition has not been met. Refer to 2.3.2.5. "Invalid for Display Codes" on page 10 in this section for display codes and their meaning. The countdown is restarted when the condition causing the invalid for display code is corrected.

2.3.2.4. Drive Unit Oil Sampling Pushbutton

The drive unit is equipped with an oil sampling pushbutton fitting to allow quick oil diagnostics, such as checking for presence of metallic particles in the oil. The oil sampling pushbutton fitting installed on the streetside engine strut and is accessible through the engine access door.

2.3.2.5. Invalid for Display Codes

INVALID FOR DISPLAY CODES	
DISPLAY SEQUENCE	**INTERPRETATION OF DISPLAY**
oL,- -,50	Engine RPM too low, below 750 RPM
oL,- -,59	Engine RPM too high, above 850 RPM
oL,- -,65	Neutral [N] not selected
oL,- -,70	Sump fluid temperature too low
oL,- -,79	Sump fluid temperature too high
oL,- -,89	Output shaft rotation
oL,- -,95	Sensor failure*
* Report sensor failure to a distributor or dealer in your area.	

2.3.2.6. Shift Selector Display Codes

☞**NOTE:**

The fluid level information is displayed one character at a time. Press the neutral [N] button once to exit the Fluid Level mode.

SHIFT SELECTOR DISPLAY CODES	
DISPLAY SEQUENCE	**DISPLAY MEANING**
oL, oK	Fluid level correct
oL, Lo, 1	Fluid level is 1 quart low
oL, HI, 1	Fluid level is 1 quart high

2.3.3. Removal

DANGER

Refer to 1.1. “High Voltage Safety” on page 1 in this section and familiarize yourself with the safety requirements before performing any maintenance or repair on the Allison E^P System™. Refer to Allison E^P Systems™ Service Manual.

☞**NOTE:**

The following procedure describes removal and installation of the drive unit without removing the engine from the vehicle. Refer to Section 4 of this manual for the removal and installation procedure of the engine and drive unit as an assembly. Further information on the drive unit can be obtained from Allison Electric Drive Field Engineering.

1. Park vehicle on level surface with parking brake applied and wheels chocked.
2. Set Battery Disconnect switch to OFF position.
3. Perform high voltage disconnect verification. Refer to 1.1.4. “High Voltage Disconnect Verification” on page 2 in this section for procedure.
4. Drain fluid from drive unit.
5. Remove clamp securing dipstick tube to mounting bracket. Remove dipstick tube from grommet in drive unit housing.
6. Disconnect the DPIM oil lines and oil cooler lines from the drive unit.
7. Disconnect all electrical connectors from drive unit including main harness, A and B motor speed sensors, output speed sensors, and HVIL switches.
8. Remove high voltage covers and disconnect lugs retaining HV wiring.

☞**NOTE:**

If there is insufficient clearance to access high voltage covers at this time, this procedure can be performed when the drive unit has been separated and lowered from the engine. Ensure adequate cable slack is provided. DO NOT stretch HV cables.

9. Disconnect vehicle driveshaft from the drive unit output yoke. Position the disconnected driveshaft to avoid interference when removing the drive unit.
10. Securely support the drive unit with a hoist, jack, or other suitable removal equipment.
11. Remove engine flywheel access cover. Rotate the engine flywheel until a flexplate-to-ring gear bolt is centered in the opening of the viewing hole. See “Fig. 5-12: Flexplate Access Cover” on page 12.
12. Remove the bolt and rotate the engine until the next bolt is centered in the opening. Repeat this process until all six M10 bolts are removed.

☞**NOTE:**

In order to ease the removal/installation process it is recommended the rear mounts be loosened from the engine mounting pads.

13. Use a suitable jack to support the weight of the engine.
14. Loosen the 3/4" isolator mount bolt on each rear mount. Loosen, but do not remove, the M12 bolts that attach each rear mount to the engine. Remove the 5/8" nut, bolt, and washer from one end of the tie bar that connects the two rear mounts together.
15. Remove the four M14 bolts that attach each rear mount to the drive unit.

16. Loosen but do not completely remove four equally spaced drive unit to flywheel housing M10 bolts.

☞ **NOTE:**

These bolts will act as guides when the drive unit is initially separated from engine and help prevent misalignment damage to the torque converter.

17. Remove the remaining eight M10 bolts.

18. Carefully separate the drive unit from the engine and pull straight back until the drive unit contacts the heads of the four bolts that were previously loosened.

⚠ **CAUTION**

Ensure that the drive unit is properly aligned and supported so that it will not roll or slip when the final four bolts are removed.

19. Remove the final four M10 bolts and move the drive unit away from the engine.

20. Ensure that all items and electrical connectors have been disconnected before lowering drive unit.

21. Lower the drive unit and hoist to a work stand or bench. Use Stator Housing Fixture (Item 1 from Special Tools List).

☞ **NOTE:**

If a replacement drive unit is being installed, it will be necessary to transfer the ring gear and flexplate adapter assembly to the new unit. Proceed with following step:

22. Remove ten M8 bolts that retain the ring gear and flexplate adapter assembly to the damper assembly and remove ring gear and flexplate assembly from drive unit.

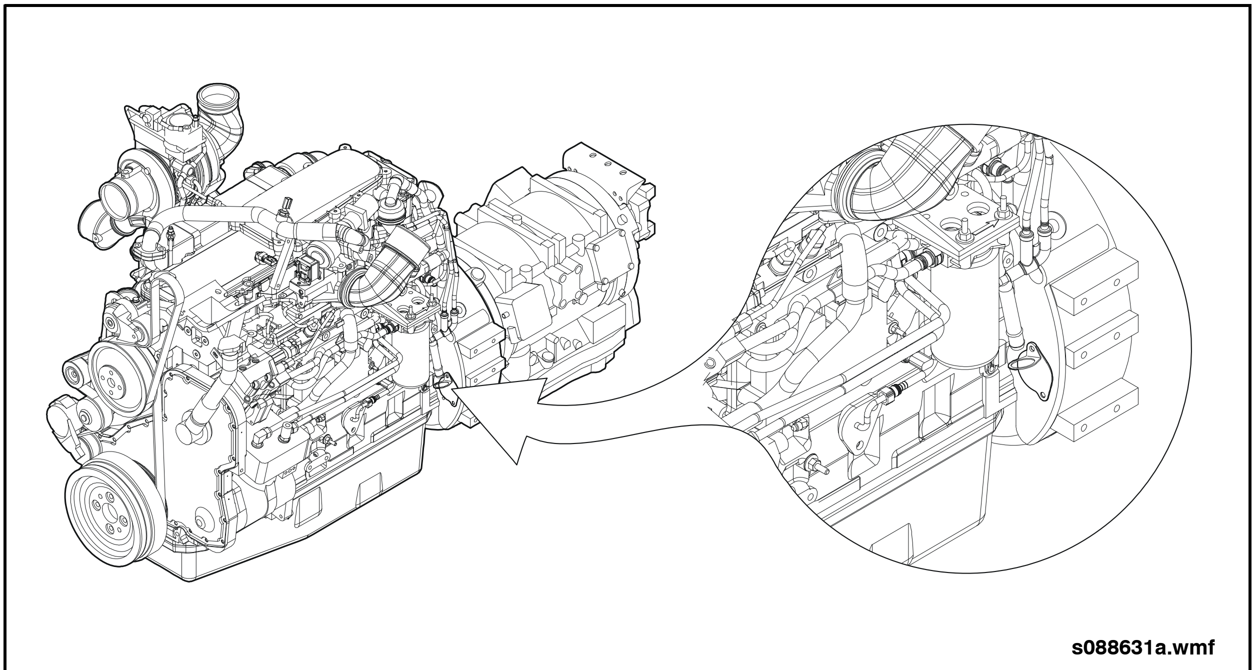


Fig. 5-12: Flexplate Access Cover

2.3.4. Installation

1. Transfer the ring gear and flexplate assembly to the new drive unit, if required, and fasten in place with ten M8 bolts. Torque to 25 ft-lb. (34 Nm).
2. Install headless guide pins at four equally spaced locations on the engine flywheel housing to help align drive unit during installation.
3. Install a headless guide pin into one of the threaded holes in the flexplate adapter to help align flexplate with drive unit flexplate adapter during installation. Ensure that this guide pin is positioned so as to be centered within the engine access opening when the drive unit is joined to the engine.
4. Apply molybdenum-disulfide (Molykote) grease on the pilot boss of the damper assembly.

CAUTION

Ensure that the drive unit is properly aligned and supported so that it will not roll or slip as the drive unit is being moved into position.

5. Carefully push the drive unit towards the engine while guiding the pilot boss on the damper assembly into the engine flywheel hub adapter and also aligning the flexplate guide bolt into a bolt hole on the flexplate.
6. Seat the drive unit squarely against the engine flywheel housing. Install eight M10 bolts and washers and finger tighten only at this time.

CAUTION

The drive unit must seat flush with the engine flywheel housing before mounting bolts are tightened. DO NOT use mounting bolts to draw mating flanges together. If interference is experienced, move the drive unit away from the engine and investigate the cause.

7. Remove the four guide bolts and install the remaining four M10 bolts and washers. First, torque these four equally spaced bolts 38 to 45 ft-lb. (51 to 61 Nm), then torque remainder of bolts using a criss-cross pattern.
8. Remove the flexplate guide bolt from the engine flywheel access opening and replace with an M10 bolt. Hand tighten only at this time.
9. Rotate the flexplate to the next hole and install another M10 bolt. Repeat this process until all bolts are installed hand tight.
10. Torque the M10 flexplate bolts to 50 ft-lb. (68 Nm).
11. Install the engine flywheel access cover.
12. Install the four M14 bolts that attach each rear mount to the drive unit. Torque 95 ft-lb. (129 Nm).
13. Torque the four M12 bolts that attach each rear mount to the engine to 75 ft-lb. (102 Nm).
14. Install the 5/8" bolt, nut, and washer that attaches the tie bar to the rear mounts. Torque bolt to 70 ft-lb. (95 Nm).

15. Lower the engine and drive unit assembly to allow the rear mounts to take the weight of the assembly. Torque the isolator mount 3/4" bolt to 250 ft-lb. (339 Nm).

16. Connect driveshaft to output yoke of drive unit. Refer to Section 2 of this manual for procedure.

17. Connect lugs that retain high voltage wiring to drive unit. Install high voltage covers with new Electromagnetic Interference (EMI) gasket and torque cover bolts to 21 ft-lb. (28 Nm). See “Fig. 5-13: High Voltage Cable EMI Gaskets” on page 15.

☞NOTE:

Electromagnetic interference (EMI) gaskets are required on the high voltage cables to suppress EMI emissions and avoid possible interference with the vehicle electronic components. The EMI gaskets are not reusable and must be replaced each time the high voltage cables are reconnected.

18. Connect all electrical connectors to drive unit including main harness, (A) and (B) motor speed sensors, output speed sensors, and HVIL switches.

19. Connect the DPIM oil lines and oil cooler lines to the drive unit.

☞NOTE:

If drive unit was removed due to internal failure, the oil cooler, hydraulic cooler, DPIM, and interconnecting hoses will have to be cleaned and flushed.

20. Install dipstick tube into grommet in drive unit housing, ensuring beaded portion of tube compresses grommet against housing. Secure tube to mounting bracket using clamp.

21. Fill drive unit with fluid. Refer to the Preventive Maintenance Section of this manual for fluid specification.

22. Set the Battery Disconnect switch to the ON position.

23. Start engine and check for leaks. Top up fluid level if necessary. Refer to 2.3.2.3. “Drive Unit Fluid Level Check” on page 9 in this section for fluid level checking procedure.

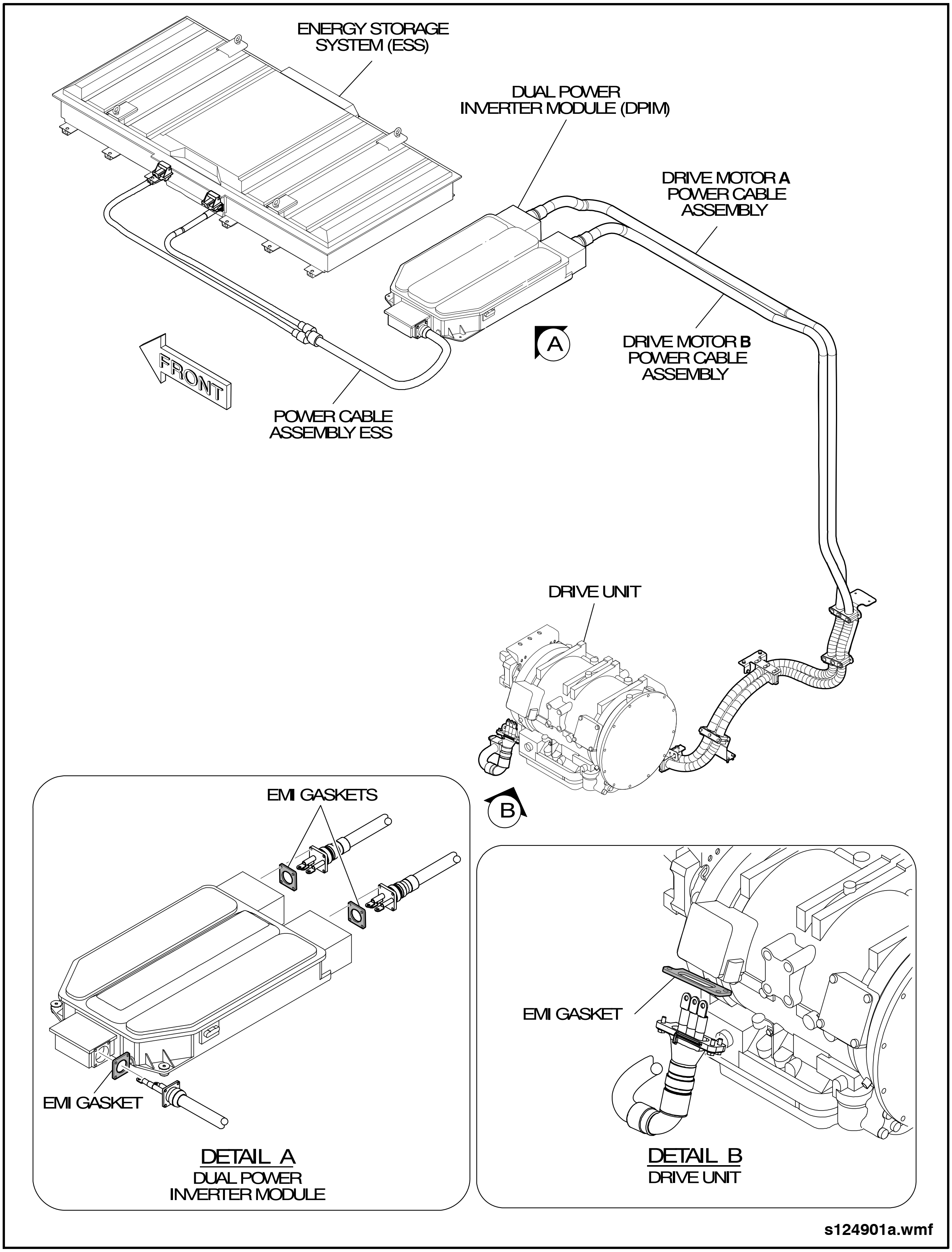


Fig. 5-13: High Voltage Cable EMI Gaskets

2.4. Dual Power Inverter Module (DPIM)

2.4.1. Description

The DPIM is located in the DPIM/Hydraulic Cooler rack enclosure on the roof of the rear section of the vehicle. The DPIM consists of two inverters that are enclosed in a common housing and are capable of producing 160 kW continuous 3-phase AC output. The DPIM is electrically-connected to the drive unit using two high voltage AC connectors located at one end of the unit. The DPIM is electrically-connected to the ESS using a high voltage DC connector located at the opposite end of the unit. Three low voltage DC multi-pin connectors are also provided. The module is oil-cooled and is connected to the drive unit oil system using flexible hoses. See "Fig. 5-14: ESS & DPIM Installation" on page 16.

2.4.2. Operation

The DPIM converts AC electricity to DC electricity and vice-versa. During regenerative braking, AC electricity generated by the drive unit is converted to DC electricity by the DPIM and stored in the Energy Storage System (ESS). During the run mode, the DPIM utilizes the stored DC electricity and converts it to AC electricity to power the drive unit. The DPIM receives a torque command from the Transmission Control Module (TCM) and controls the magnitude and frequency of the phase currents to meet the required demand.

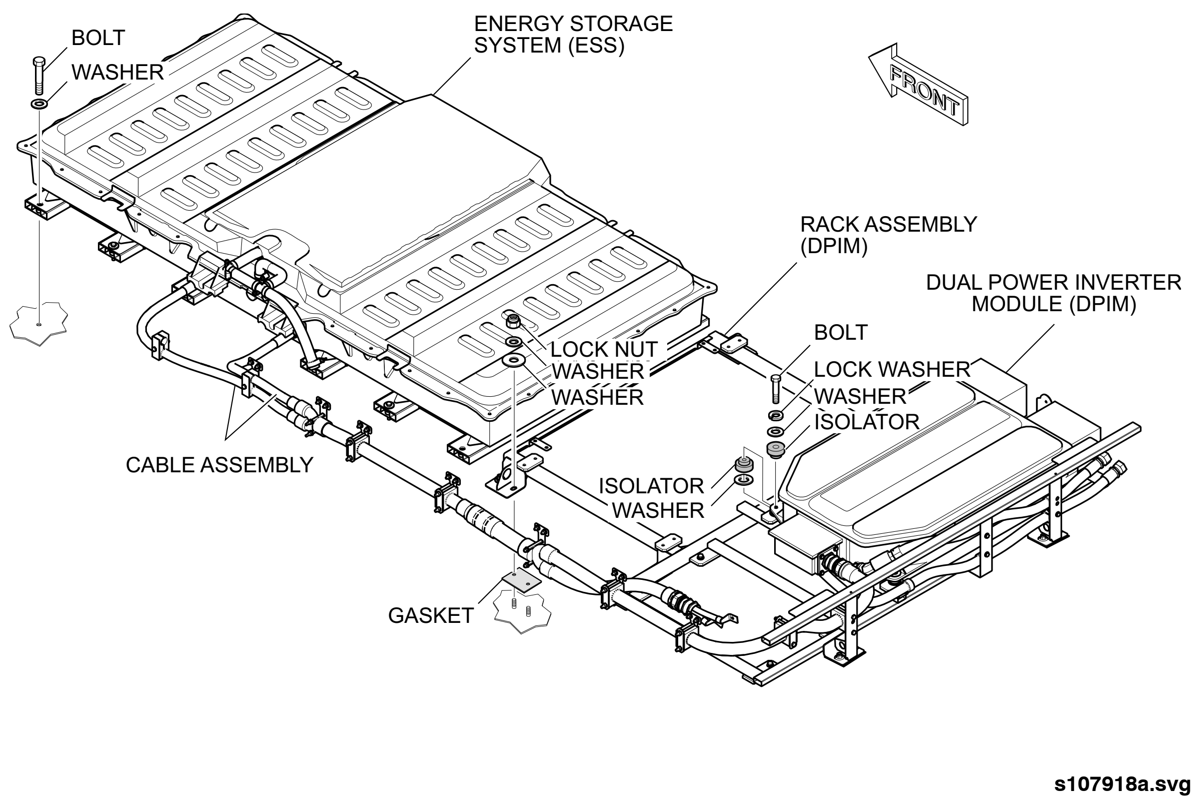


Fig. 5-14: ESS & DPIM Installation

2.4.3. Removal

DANGER

Refer to 1.1. “High Voltage Safety” on page 1 **in this section and familiarize yourself with the safety requirements before performing any maintenance or repair on the Allison E^{P} System™. Refer to Allison E^{P} Systems™ Service Manual.**

1. Park vehicle on level surface with parking brake applied and wheels chocked.
2. Set Battery Disconnect switch to OFF position.
3. Perform high voltage disconnect verification. Refer to 1.1.4. “High Voltage Disconnect Verification” on page 2 in this section for procedure.
4. Drain fluid from drive unit.
5. Disconnect the three low voltage DC multi-pin connectors (PI120, PI121, and PI122) from the DPIM.
6. Remove the cover from the high voltage DC connector box and disconnect the negative and positive lugs. Ensure wires are properly identified before removing wire pass-through assembly from lug box assembly.
7. Remove the cover from each high voltage AC connector box and disconnect the three phase lugs. Ensure wires are properly identified before removing wire pass-through assembly from lug box assembly.
8. Remove oil cooler lines from DPIM housing. Identify and mark location of oil cooler lines.
9. Remove the three bolts and vibration isolation mounts that retain the DPIM housing to the rack structure. Remove DPIM from vehicle.

2.4.4. Installation

⚠CAUTION

The low voltage system control wiring must be tested before being connected to the DPIM. DO NOT make connections to DPIM if any test results exceed the test fail voltage, as damage to the DPIM may result.

1. Confirm vehicle low voltage wiring integrity using the DPIM Installation Protection Device. Refer to 2.4.5. "DPIM Installation Protection Device (DIPD)" on page 19 in this section for procedure.
2. Install the DPIM into vehicle rack structure and secure with three bolts and isolation mounts. Torque bolts to 30 ft-lb. (41 Nm) maximum.
3. Install oil cooler lines as marked during removal
4. Install the AC high voltage cabling and wire pass-through assemblies with new EMI gasket. Torque pass-through connector 47 to 53 in-lb. (5 to 6 Nm).

   ☞NOTE:

   Electromagnetic interference (EMI) gaskets are required on the high voltage cables to suppress EMI emissions and avoid possible interference with the vehicle electronic components. The EMI gaskets are not reusable and must be replaced each time the high voltage cables are reconnected.

5. Ensure the phase connections are correctly installed as noted during removal. Install both AC cover plates and torque cover screws 11 to 13 in-lb.
6. Install the DC high voltage cabling and wire pass-through assembly with new EMI gasket. Torque pass-through connector 47 to 53 in-lb. (5 to 6 Nm).

   ☞NOTE:

   Electromagnetic interference (EMI) gaskets are required on the high voltage cables to suppress EMI emissions and avoid possible interference with the vehicle electronic components. The EMI gaskets are not reusable and must be replaced each time the high voltage cables are reconnected.

7. Ensure the negative and positive lugs are correctly installed as noted during removal. Install cover plates and torque cover screws 11 to 13 in-lb.
8. Install the three low voltage DC multi-pin connectors (PI120, PI121, and PI122) to the DPIM.
9. Reinstall the positive and negative high voltage DC cables that were disconnected from the ESS during the High Voltage Disconnect Verification Procedure. Reinstall the protective covers over the cable connectors.
10. Fill the drive unit with fluid. Refer to the Preventive Maintenance Section of this manual for fluid specification.
11. Set the Battery Disconnect switch to the ON position.
12. Start engine and check for oil leaks.
13. Allow the drive unit fluid to come up to operating temperature and perform fluid level check. Refer to 2.3.2.3. "Drive Unit Fluid Level Check" on page 9 in this section for procedure. Top up fluid level as necessary.

2.4.5. DPIM Installation Protection Device (DIPD)

☞**NOTE:**

Use the DPID whenever the DPIM is replaced or whenever connecting wire harnesses have been replaced or repaired.

2.4.5.1. Description

The DPIM Installation Protection Device (DIPD) (Item 9 from Special Tools List) is used to test for the presence of any potentially damaging voltages prior to installation of the DPIM. The DIPD will interface to the system by way of the same low voltage connectors and harnesses the DPIM will utilize when installed. The DIPD will be temporarily connected to the low voltage control system wiring in place of the DPIM. The system low voltage supply will be energized, and the vehicle ignition will be turned on to establish the initial conditions necessary for the installation protection check.

☞**NOTE:**

This device does not prove a wiring installation is correct for proper DPIM operation. The DIPD will only provide a visual indication (illuminated LEDs) to verify that there are no potentially damaging voltages applied to the DPIM low voltage system interconnection points.

The DIPD will detect the presence of voltage levels, above the maximum allowed on any single pin, or combination of pins associated with the DPIM low voltage system interconnections. In some instances, voltages significantly lower than the maximum allowable will be considered a failure if it has been determined that voltage level is indicative of improper wiring.

The following table lists the low voltage connections available for DPIM operation and the maximum allowable voltage that may be applied to each pin without risking damage to the DPIM internal circuitry. This table provides a listing of the (nominal/maximum) voltage failure set point for each interconnection point.

2.4.5.2. Maximum Allowable Voltage

MAXIMUM ALLOWABLE VOLTAGE								
PI120 Pin	Maximum Allowable Voltage	Test Fail Voltage (Max)	PI121 Pin	Maximum Allowable Voltage	Test Fail Voltage (Max)	PI122 Pin	Maximum Allowable Voltage	Test Fail Voltage (Max)
1	7 Volts	5 Volts	1	7 Volts	5 Volts	1	32 Volts	18 Volts
2	7 Volts	5 Volts	2	7 Volts	5 Volts	2	32 Volts	18 Volts
3	7 Volts	5 Volts	3	7 Volts	5 Volts	3	25 Volts	18 Volts
4	7 Volts	5 Volts	4	7 Volts	5 Volts	4	25 Volts	18 Volts
5	No Connection	N/A	5	No Connection	N/A	5	32 Volts	18 Volts
6	25 Volts	5 Volts	6	25 Volts	5 Volts	6	32 Volts	18 Volts
7	14 Volts	14 Volts	7	14 Volts	14 Volts	7	32 Volts	5 Volts
8	32 Volts	3 Volts	8	32 Volts	3 Volts	8	25 Volts	5 Volts
9	25 Volts	5 Volts	9	25 Volts	5 Volts	9	25 Volts	5 Volts
10	14 Volts	14 Volts	10	14 Volts	14 Volts	10	No Connection	N/A
11	25 Volts	5 Volts	11	25 Volts	5 Volts	11	No Connection	N/A
12	14 Volts	14 Volts	12	14 Volts	14 Volts	12	32 Volts	5 Volts
13	32 Volts	5 Volts	13	32 Volts	5 Volts	13	32 Volts	3 Volts
14	No Connection	N/A	14	No Connection	N/A	14	18 Volts	18 Volts
15	10 Volts	5 Volts	15	10 Volts	5 Volts	15	18 Volts	18 Volts
16	No Connection	5 Volts	16	No Connection	5 Volts	16	32 Volts	N/A
17	32 Volts	3 Volts	17	32 Volts	3 Volts	17	32 Volts	N/A
18	32 Volts	3 Volts	18	32 Volts	3 Volts	18	32 Volts	N/A
19	7 Volts	5 Volts	19	7 Volts	5 Volts	19	32 Volts	N/A
20	7 Volts	5 Volts	20	7 Volts	5 Volts	20	32 Volts	N/A
21	32 Volts	3 Volts	21	32 Volts	3 Volts	21	32 Volts	N/A

MAXIMUM ALLOWABLE VOLTAGE								
PI120 Pin	Maximum Allowable Voltage	Test Fail Voltage (Max)	PI121 Pin	Maximum Allowable Voltage	Test Fail Voltage (Max)	PI122 Pin	Maximum Allowable Voltage	Test Fail Voltage (Max)
22	32 Volts	8 Volts	22	32 Volts	8 Volts	22	32 Volts	3 Volts
23	14 Volts	5 Volts	23	14 Volts	5 Volts	23	18 Volts	18 Volts
24	32 Volts	3 Volts	24	32 Volts	3 Volts	24	18 Volts	18 Volts
25	32 Volts	8 Volts	25	32 Volts	8 Volts			
26	14 Volts	5 Volts	26	14 Volts	5 Volts			
27	32 Volts	8 Volts	27	32 Volts	8 Volts			
28	14 Volts	5 Volts	28	14 Volts	5 Volts			
29	32 Volts	3 Volts	29	32 Volts	3 Volts			
30	32 Volts	3 Volts	30	32 Volts	3 Volts			
31	10 Volts	5 Volts	31	10 Volts	5 Volts			
32	32 Volts	5 Volts	32	32 Volts	5 Volts			

The DIPD will simulate the 12V sensor supply voltages normally supplied by the DPIM internal circuitry and make appropriate measurements to ensure this power has not been inadvertently routed to another interconnection point on the DPIM which could be damaged by the application of 12VDC.

The following conditions will cause the DIPD LED's to illuminate:

❐ Proper low voltage supply and ground connections to the system.

❐ Supply power within proper voltage range.

❐ Proper system initial conditions met.

❐ No improper voltage applied to any applicable pin(s).

☞**NOTE:**

If any of the previous test results are not satisfactory, the associated indicating lamp will turn off or blink depending upon the location and type of fault.

The DIPD will perform a short (approximately 5 second) test of all indicating lamps when power is applied to the device, (PI122 connector mated with vehicle). All five lamps (the indicating lamps and the test lamp on the DIPD) should illuminate during this time.

2.4.5.3. Operation

The DIPD connects to any system designed to utilize a DPIM by way of three low voltage connectors that are mated to the system harnessing in the same manner as a DPIM. These connectors are designated as PI120 (Red, 32-pin), PI121 (Gray, 32-pin) and PI122 (Black, 24-pin)

It is imperative that all wiring installation and any other construction efforts which could potentially damage system wiring, are completed throughout the entire vehicle prior to execution of the DIPD test procedure. This ensures meaningful results while testing with the DIPD.

The vehicle low voltage harness installation should be retested with the DIPD following any maintenance or modification that affects the DPIM low voltage interface wiring.

2.4.5.4. Functional Test

☞**NOTE:**

This test procedure assumes that a DPIM has not been connected to the low voltage harnessing system prior to testing with the DIPD. If this is not the case, the DPIM must be fully de-energized and the low voltage harnessing system connectors (PI120, PI121 and PI122) disconnected from the DPIM prior to continuing with the following steps.

1. Establish proper initial system conditions for testing as follows:

   ☞**NOTE:**

   Various DIPD display combinations may exist as proper initial system conditions for testing are being established in the steps below. These displays are evaluated in subsequent operations and may be ignored until Step 1 is fully completed.

   a. Ensure all 12VDC and/or 24VDC power interrupting devices are configured for normal operation of the system to be tested. Set Battery Disconnect switch to the ON position and set the Master Run switch to STOP-ENGINE.

   b. Connect the DIPD to each of the DPIM low voltage harness connectors (PI120, PI121 and PI122) of the system to be tested. (The DIPD connectors are color coded and keyed to assist proper connection.)

   c. Set the Master Run switch to the DAY-RUN position.

2. Summary of DIPD Test Result:

   a. If all four DIPD display lamps are illuminated continuously, the low voltage harness does not contain wiring errors that could potentially damage a DPIM when installed.

   ☞**NOTE:**

   This testing does not verify that the vehicle wiring is correct for proper DPIM operation. It only verifies that potentially damaging voltages will not be applied to the device through the low voltage interface.

   b. If any of the four DIPD display lamps are not illuminated or flashing, then the vehicle low voltage wiring interface contains errors which could potentially damage the DPIM if installed. Under this condition, the low voltage wiring harness errors must be located and corrected before attempting to install the DPIM.

3. Detailed evaluation of DIPD displayed test result:

   a. The Power Circuits OK lamp should be illuminated indicating that each of the 12V supply and ground pins are properly connected.

   b. The Power Circuits OK lamp will not be illuminated if any of the following improper conditions exist:

      i. Any one of the four 12V supply pins are not connected (or improperly connected to another electrical point within the system).

      ii. Any one of the four Ground pins are not connected (or improperly connected to another electrical point within the system).

      iii. 12V supply voltage is less than 10VDC.

      iv. 12V supply voltage is greater than 18VDC.

☞**NOTE:**

The DIPD will function with any one 12V supply and any one Ground pin connected correctly.

   c. The Supply Voltage OK lamp should be illuminated indicating that the supply voltage is within acceptable voltage limits.

   d. The Supply Voltage OK lamp will not be illuminated if any of the following improper conditions exist:

      i. 12V supply voltage is less than 10VDC.

      ii. 12V supply voltage is greater than 18VDC.

   e. The Setup OK lamp should be illuminated indicating the vehicle Ignition signal is properly applied.

   f. The Setup OK lamp will not be illuminated if any of the following improper conditions exist:

      i. Master Run switch not ON (DAY or NIGHT-RUN).

☞**NOTE:**

The vehicle ignition power is applied to Pins PI122-16 and PI122-17. The DIPD must detect 12V (nominal) at either pin for the Setup OK lamp to be illuminated.

      ii. No 12V supply pin is connected.

   g. The Test Result OK lamp should be illuminated (continuously) indicating that no potentially damaging voltages have been detected on any DPIM low voltage pin.

☞**NOTE:**

Two separate, repeating tests are performed alternately by the DIPD. The low voltage interface is tested with and without simulated DPIM 12V sensor supply outputs. If either test fails, the Test Result OK lamp will be extinguished during that specific test. Therefore, a flashing Test Result OK lamp indication is to be interpreted as an indication of an improper wiring condition.

   h. The Test Result OK lamp will not be illuminated (or flash) if any of the following improper conditions exist:

      i. An improper (potentially damaging to the DPIM) voltage is detected at any low voltage interface pin.

      ii. 12V supply voltage is less than 10VDC.

      iii. 12V supply voltage is greater than 18VDC.

2.5. Energy Storage System (ESS)

2.5.1. Description

The ESS consists of a nickel metal hydride battery pack and connecting electrical cables. The ESS battery pack is located in the Battery Rack Enclosure on the roof of the vehicle. The battery pack is connected to the DPIM with high voltage DC cables and to the vehicle system wiring with a low voltage DC multi-pin connector. Cooled air is ducted around the battery pack to cool the unit. Refer to Section 10 of this manual for information on the Battery Cooler.

2.5.2. Operation

The ESS stores energy generated by the drive unit and captured during regenerative braking. This energy is available on demand to the drive unit. The battery pack is non-serviceable and does not require off-vehicle charging.

2.5.3. Removal

DANGER

Refer to 1.1. "High Voltage Safety" on page 1 **in this section and familiarize yourself with the safety requirements before performing any maintenance or repair on the Allison E^{P} System™. Refer to Allison E^{P} Systems™ Service Manual.**

1. Park vehicle on level surface with parking brake applied and wheels chocked.
2. Set Battery Disconnect switch to OFF position.
3. Perform High Voltage Disconnect Verification Procedure as described in this section.
4. Remove steel braided hose from hydrogen vent.
5. Remove 12 mounting bolts, nuts, and washers.
6. Attach lifting fixture (Item 10 from Special Tools List) to the four lifting eyes on the battery pack and lift battery pack from vehicle.

2.5.4. Installation

CAUTION

The low voltage system control wiring must be tested before being connected to the ESS. DO NOT make connections to ESS if any test results exceed the test fail voltage, as damage to the battery pack may result.

1. Confirm vehicle low voltage wiring integrity using the Battery Pack Installation Protection Device. Refer to 2.5.5. "Battery Pack Installation Protection Device (BIPD)" on page 25 in this section for procedure.
2. Install the battery pack into vehicle rack structure using lifting rig. Secure with 12 bolts, nuts, and washers. Torque bolts 38 to 45 ft-lb. (51 to 61 Nm).
3. Attach hydrogen vent tubing.
4. Reinstall the positive and negative high voltage DC cables that were disconnected from the ESS during the High Voltage Disconnect Verification Procedure. Reinstall the protective covers over the cable connectors.
5. Connect low voltage DC multi-pin connector.
6. Set Battery Disconnect switch to the ON position.
7. Start engine and verify systems operation.

2.5.5. Battery Pack Installation Protection Device (BIPD)

☞**NOTE:**

Use the BIPD whenever the ESS is replaced or whenever connecting wire harnesses have been replaced or repaired.

2.5.5.1. Description

The Battery Pack Installation Protection Device (BIPD) (Item 8 from Special Tools List) is used to test for the presence of any potentially damaging voltages prior to installation of the ESS. The BIPD will interface to the system by way of the same low voltage connectors and harnesses the ESS will utilize when installed. The BIPD will be temporarily connected to the low voltage control system wiring in place of the ESS. The system low voltage supply will be energized, and the vehicle ignition will be turned on to establish the initial conditions necessary for the installation protection check.

☞**NOTE:**

This device does not prove a wiring installation is correct for proper ESS operation. The BIPD will only provide a visual indication (illuminated LEDs) to verify that there are no potentially damaging voltages applied to the ESS low voltage system interconnection points.

The BIPD will detect the presence of voltage levels, above or below those allowed on any single pin, or combination of pins associated with the ESS low voltage system interconnections. The following table provides a listing of the maximum, minimum, and failure voltages for each interconnection point.

2.5.5.2. Maximum/Minimum Allowable Voltage

MAXIMUM/MINIMUM ALLOWABLE VOLTAGE				
CONNECTOR PIN	SIGNAL NAME	MAXIMUM ALLOWABLE VOLTAGE	MINIMUM ALLOWABLE VOLTAGE	TEST FAIL VOLTAGE
A	CAN HI	18VDC	N/A	17VDC
B	CAN LO	18VDC	N/A	17VDC
C	CAN Shield	0VDC	N/A	2VDC
D	ES Relay Closed	N/A	N/A	N/A
E	Ignition	N/A	N/A	N/A
F	+12V Battery Supply	18VDC	9VDC	17VDC/10VDC
G	+12V Battery Return	N/A	N/A	N/A
H	+12V Battery Return	N/A	N/A	N/A
J	No Connection	N/A	N/A	N/A
K	No Connection	N/A	N/A	N/A
L	ES Wake-Up	N/A	N/A	N/A
M	No Connection	N/A	N/A	N/A
N	No Connection	N/A	N/A	N/A
P	+12V Battery Supply	18VDC	9VDC	17VDC/10VDC
Q	No Connection	N/A	N/A	N/A
R	+12V Battery Return	N/A	N/A	N/A
S	No Connection	N/A	N/A	N/A
T	No Connection	N/A	N/A	N/A
U	No Connection	N/A	N/A	N/A
V	No Connection	N/A	N/A	N/A
W	No Connection	N/A	N/A	N/A
X	No Connection	N/A	N/A	N/A

MAXIMUM/MINIMUM ALLOWABLE VOLTAGE				
CONNECTOR PIN	**SIGNAL NAME**	**MAXIMUM ALLOWABLE VOLTAGE**	**MINIMUM ALLOWABLE VOLTAGE**	**TEST FAIL VOLTAGE**
Y	No Connection	N/A	N/A	N/A
Z	+24V Battery Return	N/A	N/A	N/A
a	+24V Battery Supply	N/A	18VDC	18VDC
b	+24V Battery Supply	N/A	18VDC	18VDC
c	+24V Battery Supply	N/A	18VDC	18VDC
d	No Connection	N/A	N/A	N/A
e	+24V Battery Return	N/A	N/A	N/A
f	+24V Battery Return	N/A	N/A	N/A
g	No Connection	N/A	N/A	N/A

The BIPD provides a visual indication of the following:

- ❒ Proper low voltage supply and ground connections to the system.
- ❒ Supply power within proper voltage range.
- ❒ Proper system initial conditions met.
- ❒ No improper voltage applied to any applicable pin(s).

☞**NOTE:**

If any of the test results are not satisfactory, the associated indicating lamp will turn off or blink depending upon the location and type of fault.

The BIPD will perform a short (approximately 2 second) test of all indicating lamps when power is applied to the device.

2.5.5.3. Operation

The BIPD connects to a system designed to utilize an Energy Storage System by way of the low voltage connector that is mated to the system harnessing in the same manner as a battery pack.

It is imperative that all wiring installation and any other construction efforts that could potentially damage system wiring, are completed throughout the entire vehicle prior to execution of the BIPD test procedure. This ensures a meaningful test result.

It is recommended that the vehicle low voltage harness installation be re-tested with the BIPD following any maintenance or modification that affects any Energy Storage System low voltage interface wiring.

2.5.5.4. Functional Test

☞**NOTE:**

This test procedure assumes that a battery pack has not been connected to the low voltage harnessing system prior to testing with the BIPD. If this is not the case, the low voltage harnessing system connector must be disconnected from the Energy Storage System prior to continuing with the following steps.

1. Establish proper initial system conditions for testing as follows:

   ☞**NOTE:**

   Various BIPD display combinations may exist as proper initial system conditions for testing are being established in the steps below. These displays are evaluated in subsequent operations and may be ignored until Step 1 is fully completed.

   a. Ensure all 12VDC and/or 24VDC power interrupting devices are configured for normal operation of the system to be tested. Set Battery Disconnect switch to the ON position and set the Master Run switch to STOP-ENGINE.

   b. Connect the BIPD to the ESS low voltage harness connector of the system to be tested.

   c. Set the Master Run switch to the DAY-RUN position.

2. Summary of BIPD Test Result:

   a. If all four BIPD display lamps are illuminated continuously, the low voltage harness does not contain wiring errors that could potentially damage a battery pack when installed.

   ☞**NOTE:**

   This testing does not verify that the vehicle wiring is correct for proper ESS operation. It only verifies that potentially damaging voltages will not be applied to the device through the low voltage interface.

   b. If any of the four BIPD display lamps are not illuminated, then the vehicle low voltage wiring interface contains errors which could potentially damage the ESS if installed. Under this condition, the low voltage wiring harness errors must be located and corrected before attempting to install the battery pack.

3. Detailed evaluation of BIPD displayed test result:

   a. The Power Circuits OK lamp should be illuminated indicating that each of the 12V supply and ground pins are properly connected.

   b. The Power Circuits OK lamp will not be illuminated if any of the following improper conditions exist:

      i. Either of the two 12V supply pins are not connected (or improperly connected to another electrical point within the system).

      ii. Any one of the three 12V Ground pins are not connected (or improperly connected to another electrical point within the system).

      iii. Any one of the three 24V supply pins are not connected (or improperly connected to another electrical point within the system).

      iv. Any one of the three 24V return pins are not connected (or improperly connected to another electrical point within the system).

      v. 12V supply voltage is less than 10VDC.

      vi. 12V supply voltage is greater than 18VDC.

☞NOTE:

The BIPD will function with any one 12V supply and any one Ground pin connected correctly.

   c. The "Supply Voltage OK" lamp should be illuminated indicating that the 12V and 24V supply voltages are within acceptable limits.

   d. The "Supply Voltage OK" lamp will not be illuminated if any of the following improper conditions exist:

      i. 12V supply voltage is less than 10VDC.

      ii. 12V supply voltage is greater than 18VDC.

      iii. 24V supply voltage is less than 18VDC.

      iv. No 12V supply pin is connected.

   e. The "Setup OK" lamp should be illuminated indicating the vehicle ignition signal is properly applied.

   f. The "Setup OK" lamp will not be illuminated if any of the following improper conditions exist:

      i. Master Run switch not ON (DAY or NIGHT-RUN).

      ii. No 12V or 24V return pin is connected.

☞NOTE:

The vehicle Ignition power is applied to Pin E. The BIPD must detect 12V (nominal) for the Setup OK lamp to be illuminated.

   g. The Test Result OK lamp should be illuminated indicating that no potentially damaging voltages have been detected on any ESS low voltage pin.

   h. The Test Result OK lamp will not be illuminated if any of the following improper conditions exist:

      i. An improper (potentially damaging to the ESS) voltage is detected at any low voltage interface pin.

      ii. 12V supply voltage is less than 10VDC.

      iii. 12V supply voltage is greater than 18VDC.

2.6. Transmission & Vehicle Control Modules (TCM/VCM)

2.6.1. Description

The TCM/VCM consist of two panel-mounted electronic control modules. One is located behind a lighting panel near the streetside rear corner of the front section of the vehicle. The other one is mounted in the rear panel with the vehicle's multiplexing modules and other electronic components.

2.6.2. Operation

The TCM/VCM modules monitor and control system components, store system control calibrations, and perform diagnostic functions. Refer to your Allison E^P Systems™ Service and Troubleshooting Manual for more information on these components.

2.7. Push Button Shift Selector (PBSS)

2.7.1. Description

The PBSS is located on the right side of instrument panel and is used by the operator to select the direction of operation. The shift selector panel includes a display panel and six keypads. The direction of operation is shown on the display. The shift selector directional buttons are: See "Fig. 5-15: Shift Selector" on page 31.

- D - Forward, commands forward vehicle movement. [F] shown on the display.
- N - Neutral, commands neutral, no vehicle movement. [N] shown on the display.
- R - Reverse, commands rearward vehicle movement. [R] shown on display.

2.7.2. Operation

Pressing the Down (↓) arrow button while in Forward operation commands the system to increase the regenerative braking system. The display will change from [F] to [L] to indicate that increased regenerative braking has been selected. The system will return to the default regenerative braking level whenever the Master Run switch is cycled.

Simultaneously pressing the Up (↑) and Down (↓) arrow buttons for five seconds, while in neutral [N], will initiate the fluid level checking process. Refer to 2.3.2.3. "Drive Unit Fluid Level Check" on page 9 in this section for procedure.

Simultaneously pressing the Up (↑) and Down (↓) arrow buttons again, while in neutral, will activate the diagnostic mode in which diagnostic codes can be retrieved. Codes will be displayed in traditional main code/sub code format. Press the mode button to access the next code (up to nine codes can be stored). Clear codes by holding mode button for 10 seconds. Press and hold the Up (↑) and Down (↓) arrow buttons to exit the diagnostic mode.

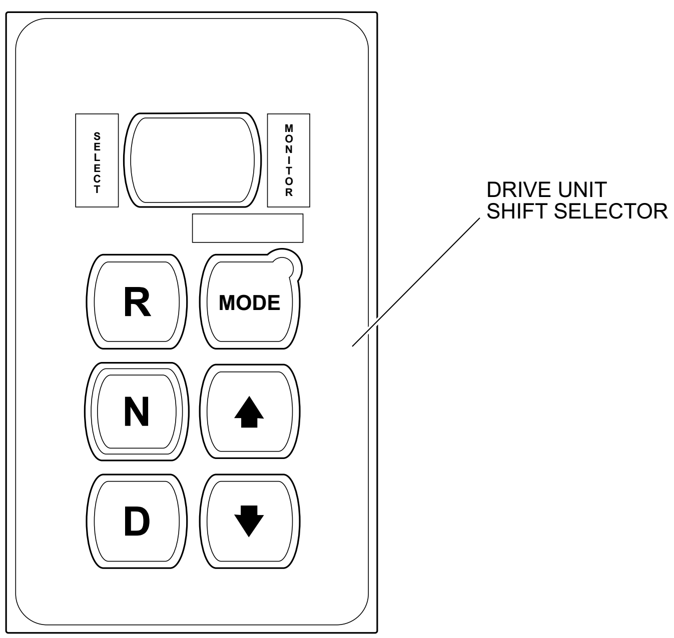


Fig. 5-15: Shift Selector

3. SPECIAL TOOLS

3.1. Special Tools Chart

Refer to your New Flyer Parts Manual for purchase part numbers. See “Fig. 5-16: Special Tools” on page 33.

SPECIAL TOOLS	DESCRIPTION
1	Stator housing fixture, lifting turnover stand
2	High Impedance Digital Multimeter set
3	Adapter to 9 pin Deutsch
4	Softing CAN card 2
5	Harness assembly, TCM/DPIM/VCM
6	Harness assembly, Drive unit/ESS
7	WTEC III universal breakout box
8	ESS installation protection device
9	DPIM installation protection device
10	Engergy Storage removal installation fixture
11	Gloves, HV large
12	Gloves, HV medium
13	Gloves, HV small

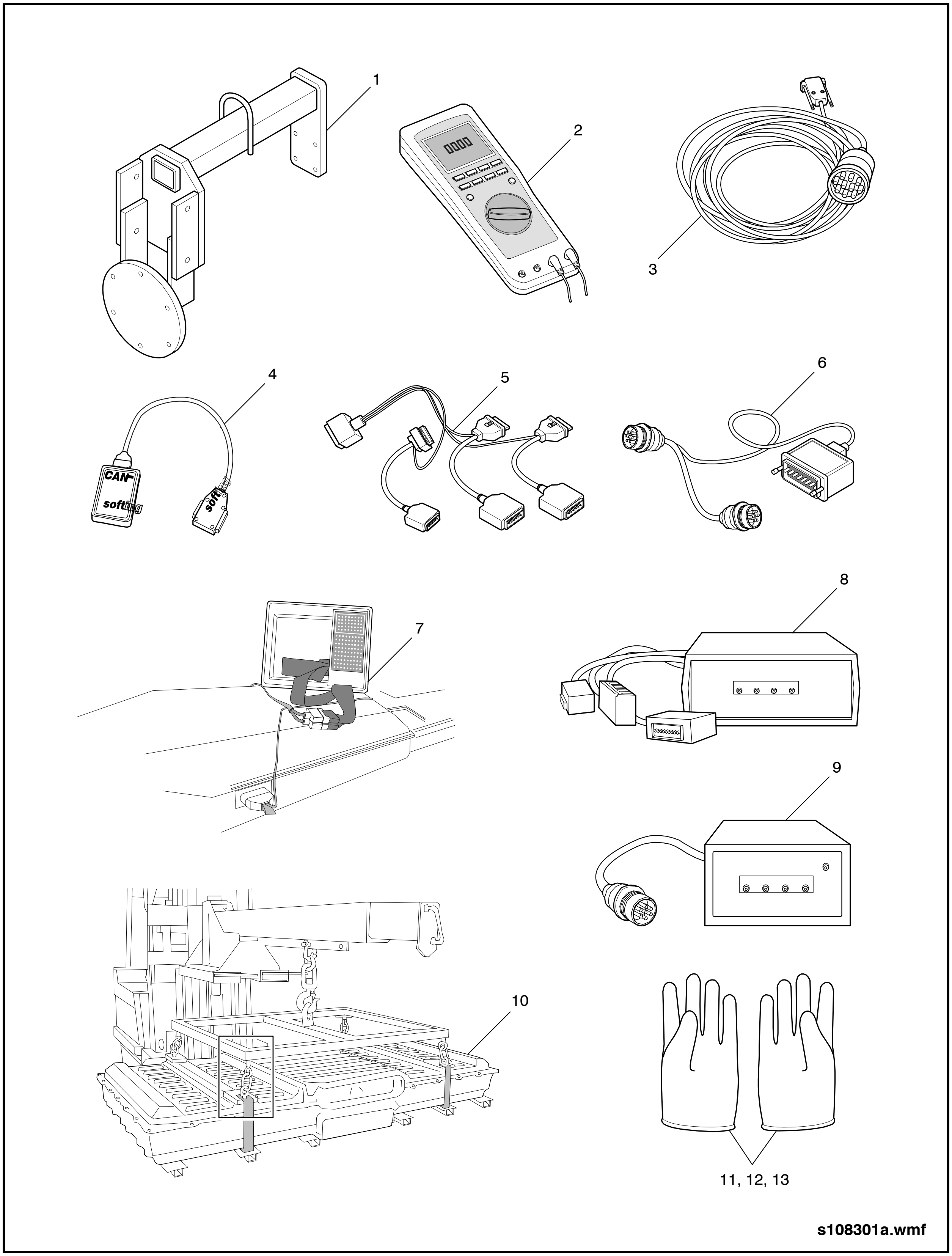


Fig. 5-16: Special Tools

4. VENDOR SERVICE INFORMATION

The following supplier manuals contain additional reference information.

4.1. Allison EP40/50 Manuals

- ❐ Parts Manual
- ❐ Service Manual
- ❐ Troubleshooting Manual
- ❐ Principles of Operation
- ❐ Operator Manual

Cooling System

1. SAFETY

1.1. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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. 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, before doing any work on the cooling system. Severe injury can occur if this is not observed.

The Mini-Hybrid electronic cooling system installed on this vehicle is an electric only fan system that replaces the traditional hydraulic driven mechanical fan. The Mini-Hybrid is electronically controlled to cool both charged intake air and engine coolant separately. The Electric fans are divided into 3 groups: Charge Air Cooler fans, Engine Coolant fans and Shared fans. The fans operate at variable speeds and intervals as dictated by the Electronic Fan Controller. The Mini-Hybrid system operates independent of engine speed and control. It is capable of providing full load cooling at engine idle speeds and it reduces thermal events by eliminating the hydraulic fan system. Maintenance is performed with the manual reverse feature. The Mini-Hybrid system comes with both a diagnostic light and service technician tool.

1. The cooling system includes the following essential components:
   - ❐ Radiator/Charge Air Cooler
   - ❐ Water Pump
   - ❐ Surge Tank
   - ❐ Coolant Recovery Tank
   - ❐ Connecting Hoses Piping
   - ❐ Heating System (Refer to Section 10 of this manual)
2. The fan system draws cooling air through the radiator/charge air cooler core.
3. 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 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
   - ❐ Is used in heating system of the vehicle.
4. Liquid coolant for the cooling system is added through surge tank filler cap and pressure within the cooling system is maintained by a pressure cap on the surge tank.
5. 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.

2.2. Coolant Circulation

Coolant circulation during warm-up differs from circulation after engine has reached normal operating temperature as explained in the following sections.

2.2.1. 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, transmission oil cooler, heater lines in vehicle body, and the surge tank.

2.2.2. 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, transmission oil cooler and vehicle heating system, and when required, surge tank.

2.3. Engine Coolant

2.3.1. Description

This vehicle has been prefilled with an anti-freeze 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.

2.3.2. 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.

2.3.3. 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.

The following procedures provide information on how to isolate and drain the engine and radiator from the entire vehicle cooling/heating system as well as how to drain the entire vehicle cooling/heating system. The method chosen will also affect the procedure to be used for filling and deaeration.

2.3.3.1. Engine & Radiator

Isolate the engine and radiator from the rest of the vehicle cooling/heating system as follows:

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. Close the coolant supply valve. This valve is located in the coolant line between the engine and the booster pump. Refer to the HVAC System Layout for valve location.
5. Close the heating system return valve. This valve is located in the heating system return line close to the lower radiator tube. Refer to the HVAC System Layout in the Vehicle System Drawings Manual for valve location.
6. Open the surge tank access door.
7. Relieve the cooling system pressure by depressing the pressure relief valve on the surge tank. Open the fill cap once the pressure has been relieved.
8. 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.
9. 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.

10. Locate and remove any drain plugs from coolant tubes and transmission oil cooler, if equipped.
11. Replace the coolant filter and record installation date and vehicle mileage.
12. Reinstall and tighten all drain plugs and close all drain cocks once engine and radiator are completely drained.

2.3.3.2. Vehicle Cooling/Heating System

Drain the entire vehicle cooling/heating system, including engine and radiator as follows:

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 defroster access door.
5. Open the surge tank access door.
6. Relieve the cooling system pressure by depressing the pressure relief valve on the surge tank. Open the fill 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 and record installation date and vehicle mileage.
11. Open the defroster access door and open the drain cock at the bottom of the driver's heater/defroster unit. Drain coolant into a suitable container.

☞**NOTE:**

It may be necessary to remove coolant hoses from vehicle heating units in order to ensure complete draining of vehicle heating system.

12. Reinstall and tighten all drain plugs and close all drain cocks once engine and radiator are completely drained.

2.3.4. Filling & Deaeration

⚠WARNING

Allow the cooling system to cool below 120°F (49°C) before servicing. Relieve system pressure using the pressure relief lever at the surge tank. Severe injury can occur from hot coolant, and surfaces.

⚠CAUTION

The following fill and deaeration procedure must be performed any time maintenance has been performed on the heating/cooling system or engine/cooling system components. It is necessary to bleed the systems of any air pockets prior to running the engine in service; otherwise damage to the engine will likely occur.

Check that the ENG CLNT FILL MODE switch is in the OFF position prior to filling the system. Otherwise damage to the booster pump will likely occur.

Keep all manual valves open if the vehicle cooling/heating system was drained. Keep all manual isolation valves closed if the engine/radiator system was drained.

☞**NOTE:**

The surge tank can be filled through the pressure fill connector at a rate of 5 gallon per minute (GPM).

☞**NOTE:**

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.

1. Check that the drain cocks are closed and the drain plugs are installed.
2. Set the driver's heater/defroster temperature to the OFF position.
3. Open the pressure relief on the surge tank pressure cap and loosen the coolant recovery tank cap.

☞**NOTE:**

A coolant pressure fill connector is located at the rear street side of the engine compartment. 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.

4. Add coolant through the pressure fill connector until the surge tank is full. Stop when the coolant starts entering the coolant recovery tank. See “Fig. 6-1: Coolant System Fill Levels” on page 7.
5. Check that all manual valves are open.
6. Set the Master Run switch to DAY-RUN, set the defroster to HOT and the defroster fan to LOW.
7. At the engine switch box set the engine run switch to REAR and turn the coolant fill mode switch to the ON position.
8. Check that the booster pump is operating.
9. Observe the fluid level gauge on the surge tank. The coolant will drop during the fill mode.
10. Keep adding coolant until the surge tank is full. Allow the fill mode to run for 5 to 7 minutes.
11. Close the pressure relief on the surge tank pressure cap.
12. Start the engine and run it at low idle for 2 minutes. Ensure that the level in the surge tank does not drop.
13. Run the engine at full RPM until the thermostat opens at approximately 180°F (82°C).
14. Continue operating the engine for 2 minutes at low idle speed.
15. Turn off the engine and the fill mode switch.
16. Keep adding coolant until the surge tank is full and the coolant level in the coolant recovery tank is between cold max and hot max level.
17. Close the coolant recovery tank cap and check that there are no coolant leaks.
18. Disconnect the pressure fill equipment.
19. Allow the engine to cool below 120°F (49°C).
20. Check that the surge tank is full and the coolant level in the coolant recovery tank is above the cold minimum level.

2.3.5. 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.

2.4. Maintenance

☞**NOTE:**

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance procedures and intervals.

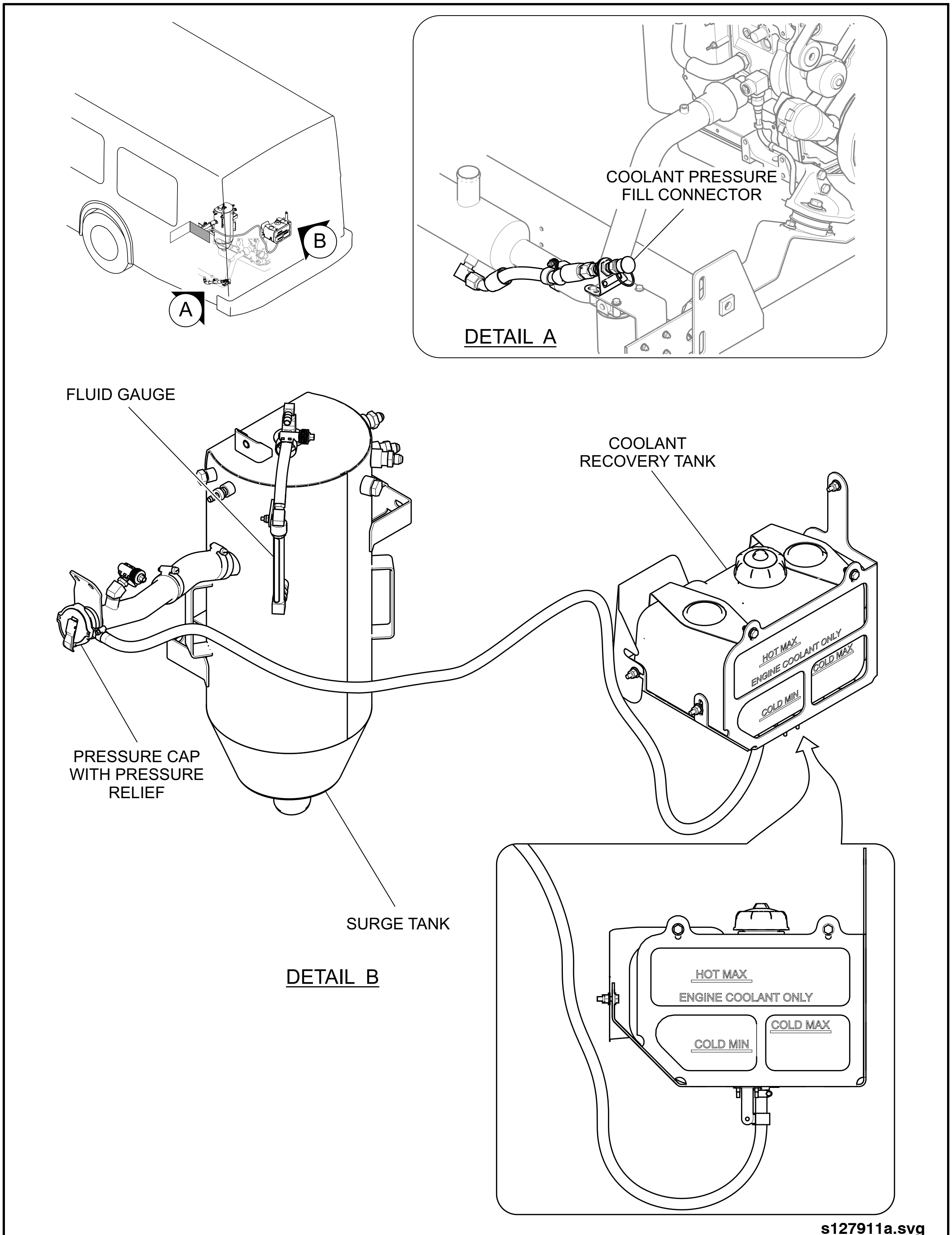


Fig. 6-1: Coolant System Fill Levels

2.5. 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.

2.5.1. Description

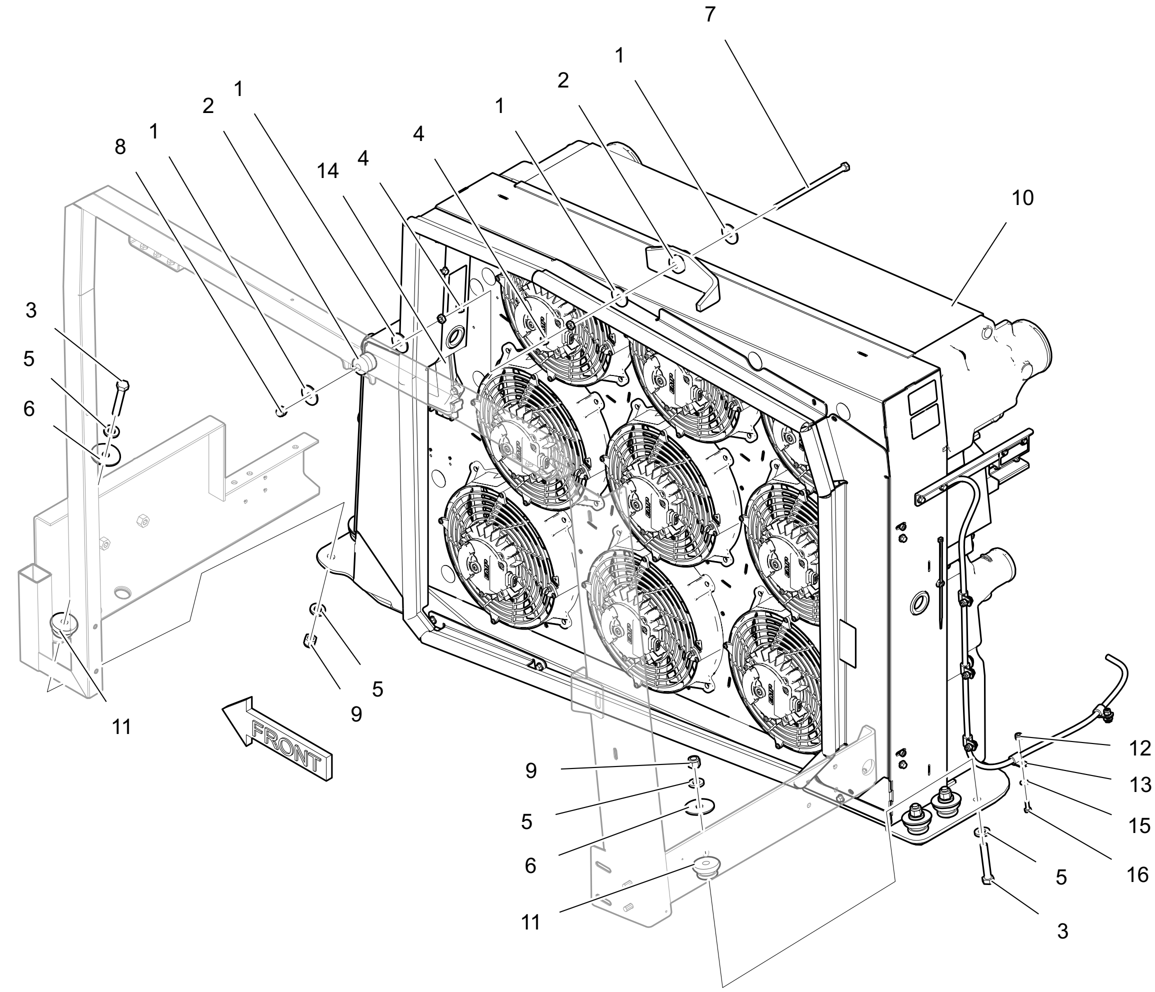
☞**NOTE:**

For orientation purposes, the left and right sides of the radiator/charge air cooler unit are determined by standing on the street-side of the vehicle and facing the electric cooling fans.

This vehicle is equipped with an EMP M9 combined radiator/charge air cooler assembly. The assembly includes the following major components:

- ❒ Radiator
- ❒ Charge air cooler
- ❒ Nine electric fans
- ❒ TMC system controller
- ❒ Wiring harness
- ❒ J1939 CAN vehicle interface cable
- ❒ Power and ground studs
- ❒ LED diagnostic lamp
- ❒ Fan reverse button
- ❒ Grounding wire

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 radiators and are enclosed by a fan shroud which provides a mounting location for the electric cooling fans. The system controller is bracket-mounted to the left side of the radiator/ charge air cooler assembly. See “Fig. 6-2: Radiator/Charge Air Cooler Installation” on page 9.



1. Washer, Lower Rad
2. Mount, Rubber
3. Bolt, Hex 1/2" - 13 UNC x 2 3/4" Lg.
4. Nut, Hex Jam 3/8" - 16 UNC
5. Washer, Flat Hardened 1/2"
6. Washer, Snubbing
7. Bolt, Hex 3/8" - 16 UNC x 7.0" Lg. Fully Threaded
8. Nut, Lock Nylon 3/8" - 16 UNC
9. Nut, Lock Nylon 1/2" - 13 UNC
10. Radiator/Charge Air Cooler Assembly
11. Mount, Center Bonded
12. Nut, Lock Nylon 1/4" - 20 UNC
13. Clamp, "P" .375" SST/HT
14. System Controller
15. Washer, Flat 1/4"
16. Bolt, Hex 1/4" - 20 UNC x 3/4" Lg.

s0197152a.svg

Fig. 6-2: Radiator/Charge Air Cooler Installation

2.5.2. Radiator/Charge Air Cooler Specifications

Manufacturer
.... Engineered Machined Products (EMP)

Model XPL2D-M9

Lower Radiator
.........Aluminum tanks and bar/plate core with 8.5 fins/inch & 36 Hot Row Core

Upper Radiator
.........Aluminum tanks and bar/plate core with 10 fins/inch & 16 Hot Row Core

Charge Air Cooler
.........Aluminum tanks and bar/plate core with 8.5 fins/inch & 16 Hot Row Core

Cooling Fans
...............Nine EMP FiL-11 11" diameter electric fans (pusher type)

Fan Speed
.................Variable speed 0 - 5500 RPM (default ON @ 4000 RPM)

Current draw @28 VDC
....225 amps max

CAN Communication
.... SAE J1939 protocol with diagnostic system reporting

Fan Control
.... Independent temperature control for coolant and charge air via J1939

2.5.3. Operation

The radiator consists of an upper and lower section and is 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 upper and lower sections, 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 FiL-11 fans are individually controlled by the TMC system controller. The TMC system controller commands fan speed by referencing the charge air cooler and radiator temperatures 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 radiator 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 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.

2.5.4. Maintenance

☞**NOTE:**

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance intervals and requirements.

2.5.5. Radiator/Charge Air Cooler Troubleshooting & Repair

☞**NOTE:**

Refer to 3. "VENDOR SERVICE INFORMATION" on page 25 *in this section for further information.*

2.5.6. 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.

2.5.7. 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.
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 2.3.4. “Filling & Deaeration” on page 5 in this section for procedure. Also refer to the Preventive Maintenance Section of this manual for fluid specification.

2.6. Hybrid Oil Cooler Assembly

2.6.1. Description

The hybrid oil cooler assembly consists of an oil cooler, a shroud and four electrically operated fans mounted to the shroud. The unit is roof-mounted behind the hybrid drive system's Dual Power Inverter Module on the rear section of the vehicle.

2.6.2. Oil Cooler & Fan Shroud Specifications

Maximum Current Draw
.... 120 amps @ 28 VDC

Operating Voltage .... 18 - 32 VDC

2.6.3. Operation

The primary function of the assembly is to cool the oil from the drive unit.

A temperature sensor is located in the outlet line of the drive unit and provides a signal to the system controller located on the oil cooler and fan shroud assembly. The system controller will command the individual fan controllers to drive the fan motors at a speed proportional to temperature input.

Oil cooler outlet temperature is the temperature of the oil being returned to the sump of drive unit and needs to be regulated between 131 to 154°F (55 to 68°C). The six electric fans on the rooftop oil cooler will begin to operate at 131°F (55°C) and increase linearly in speed as the temperature increases. The fans will reach maximum speed when the oil temperature is at 154°F (68°C).

The electric fans are defaulted to the high speed setting if an open circuit fault should be detected in the temperature sensor circuit. If the oil being returned to the drive unit is not able to be cooled sufficiently, then the drive unit self-protection system will initiate a shutdown procedure.

2.6.4. Hybrid Oil Cooler Troubleshooting & Repair

☞**NOTE:**

Refer to EMP OK4 Oil Cooler Service Manual for troubleshooting, diagnostic, and repair procedures. Refer to 3. “VENDOR SERVICE INFORMATION” on page 25 *in this section for further information.*

2.6.5. Removal

WARNING

Use work platforms or scaffolding whenever working on roof-mounted components. Ensure maintenance personnel use an approved safety harness.

NOTE:

The following procedure describes removing the oil cooler and fan shroud assembly as a unit from the vehicle and then disassembling the components in a work area. Individual fan units can be replaced without removing the entire unit from the rooftop of the vehicle.

1. Set the Battery Disconnect switch to the OFF position.
2. Disconnect the main 16-pin connector from the cooling fan harness. See “Fig. 6-3: Hybrid Oil Cooler Installation” on page 15.
3. Use a backup wrench on the fittings and remove oil cooler supply and return lines. Install protective plugs in the oil cooler ports and oil lines.
4. Remove bolts attaching cooler and fan shroud assembly to roof mounts.
5. Attach lifting equipment to cooler and fan shroud assembly and remove from vehicle.

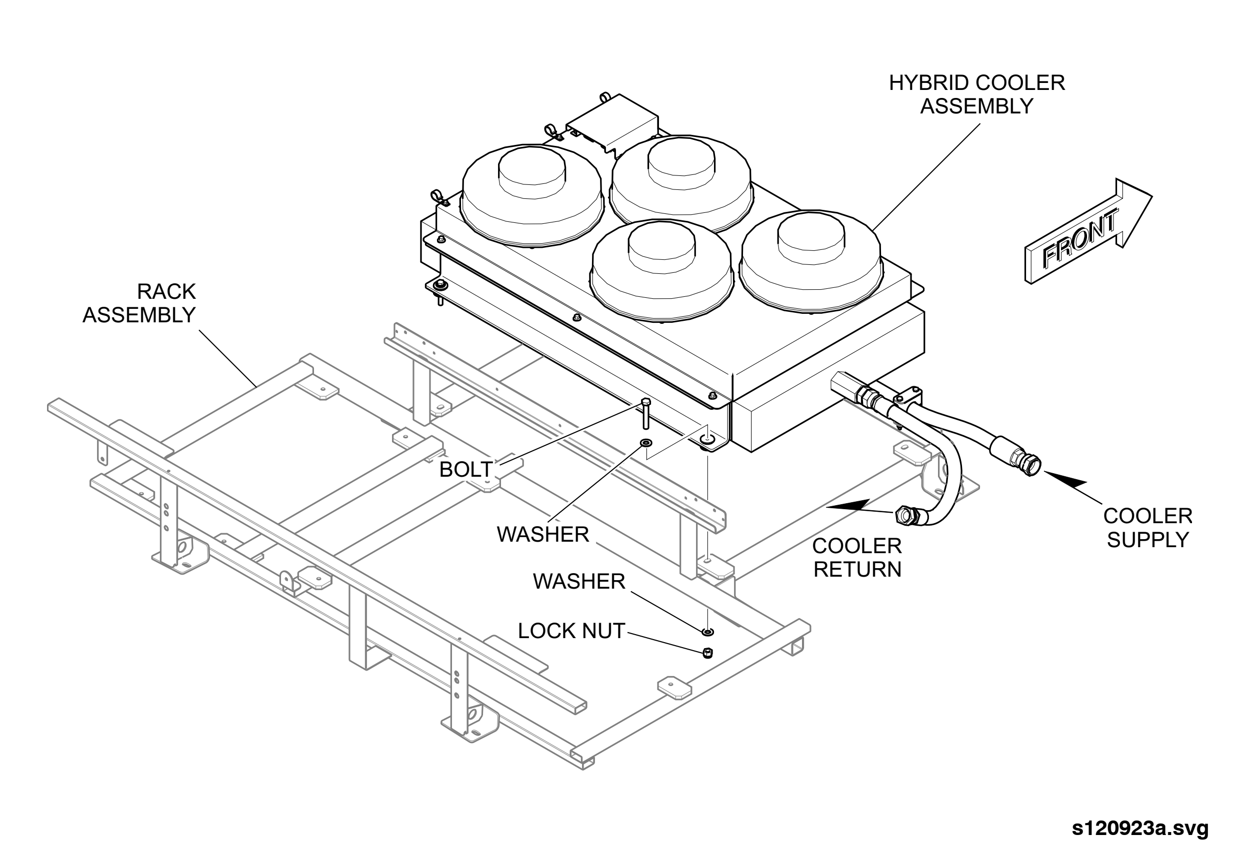


Fig. 6-3: Hybrid Oil Cooler Installation

2.6.6. Installation

1. Use suitable lifting equipment and carefully position the oil cooler and fan shroud assembly onto the rooftop DPIM/Cooler rack assembly.
2. Align the holes in the oil cooler brackets with the rack mounting plate and install four 3/8" bolts, flat washers, and lock washers. Torque bolts to 25 to 30 ft-lbs. (34 to 41 Nm).
3. Remove the protective covers from the oil cooler ports and oil lines and install supply and return oil lines to oil cooler. Use a backup wrench on the fittings when tightening the oil lines.
4. Connect the 16-pin main electrical harness from the fan assemblies to the vehicle harness.
5. Set Battery Disconnect switch to ON position.
6. Start vehicle and check for any oil leaks at oil cooler.
7. Check that fans begin to operate as oil temperature reaches 131°F (55°C) and linearly increase in speed until maximum speed is reached at 154°F (68°C).

2.7. Surge Tank

2.7.1. Description

The surge tank is located in the engine compartment on the streetside of the vehicle, adjacent to the radiator. The surge tank includes the following components:

- ❒ Filler Cap with Pressure Control & Relief Valve
- ❒ Coolant Level Sensors
- ❒ Fluid Level Gauge
- ❒ Pressure Test Valve

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. 6-4: Surge Tank Assembly” on page 18.

2.7.2. Surge Tank Specification

Type.................... Welded steel construction

Size .... 9.5" Dia. x 23.50" high

Capacity .... 4.6 gal.

Tank Pressure Rating ....
..............25 psi (172 kPa) with water test

Filler Cap with Relief Valve
............pressure rating 16 psi (110 kPa)
..................operating range 14 to 18 psi
.... (97 to 124 kPa)

2.7.3. 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.

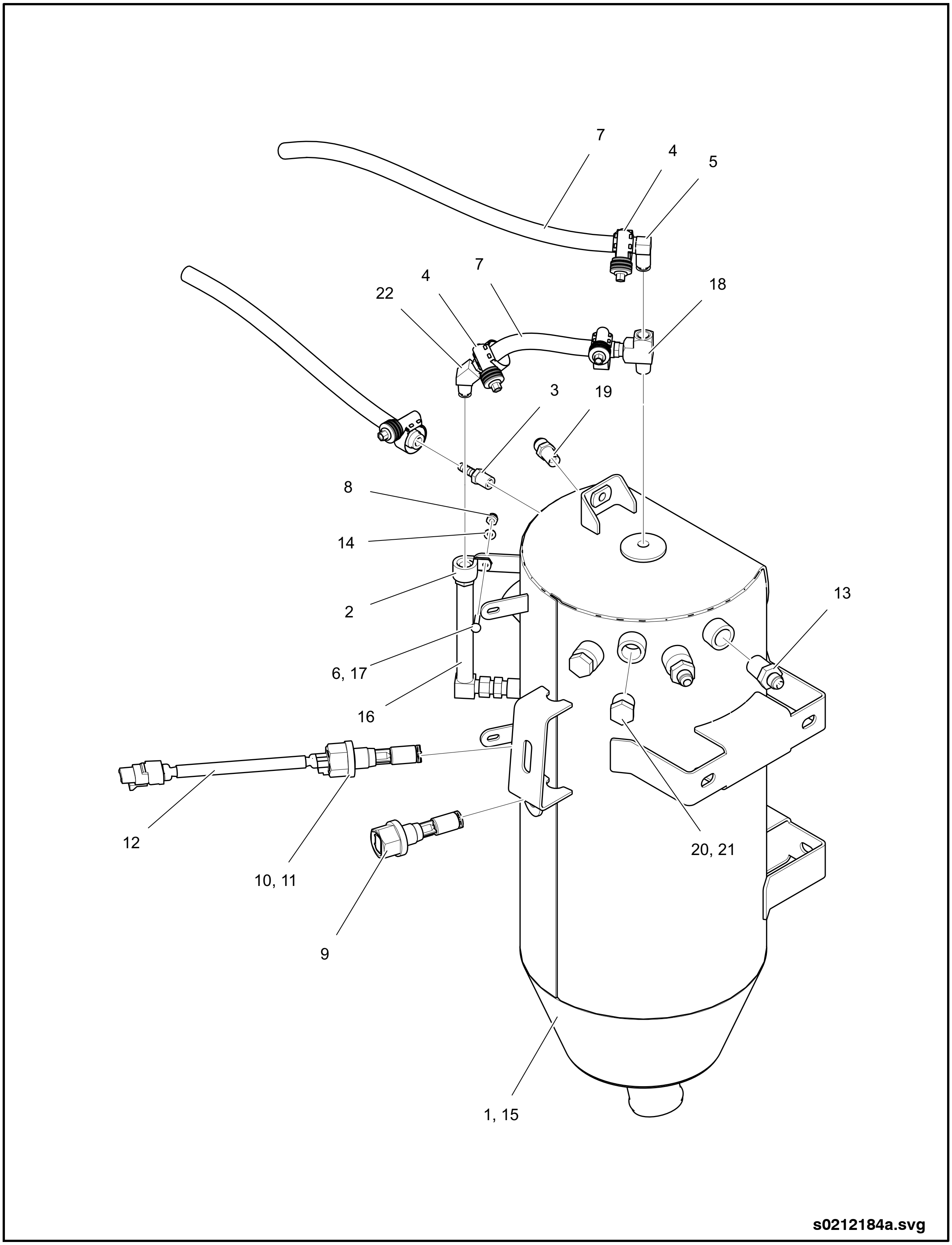


Fig. 6-4: Surge Tank Assembly

1. Surge Tank Assembly, (Incl. 2-10, 13-22)	12. Sensor Assembly, Coolant Level
2. Clamp, "P" .625" SST/HT	13. Adapter, 1/2" NPT x 6 JIC Brass
3. Fitting, Barbed 1/4" MPT x 3/8" I.D. Barb	14. Washer, Flat SST #10
4. Clamp, Flexgear .56" Dia. - 1.06" Dia.	15. Surge Tank, Welded
5. Fitting, Barb Hose 1/4" x 3/8" I.D.	16. Gauge, Coolant Level
6. Screw, PH Cross Recess #10 - 24 UNC x 3/4" Lg.	17. Never Seize
7. Hose, Silicone Rubber 9mm I.D. 13' Long	18. Tee, Street 1/4" PT
8. Nut, Lock Nylon #10 SST	19. Adapter, 1/4" NPT x 3/8" JIC Brass
9. Sensor, Low Coolant Level	20. Loctite, PST
10. Sensor, Low Fluid Assembly (Incl. 11-12)	21. Plug, Pipe 1/2" - 14 Brass
11. Sensor, Low Coolant Level	22. Elbow, 45° 1/4" NPT

Surge Tank Assembly (parts list)

2.7.3.1. Filler Cap with Pressure Control & 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 filler 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.

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:**

Use a commercially available cooling system pressure tester to pressurize and test both the cooling system and pressure control cap.

2.7.3.2. 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.

2.7.3.3. 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. The fluid level gauge is graduated with a cold and a hot mark.

2.7.3.4. Pressure Test Valve

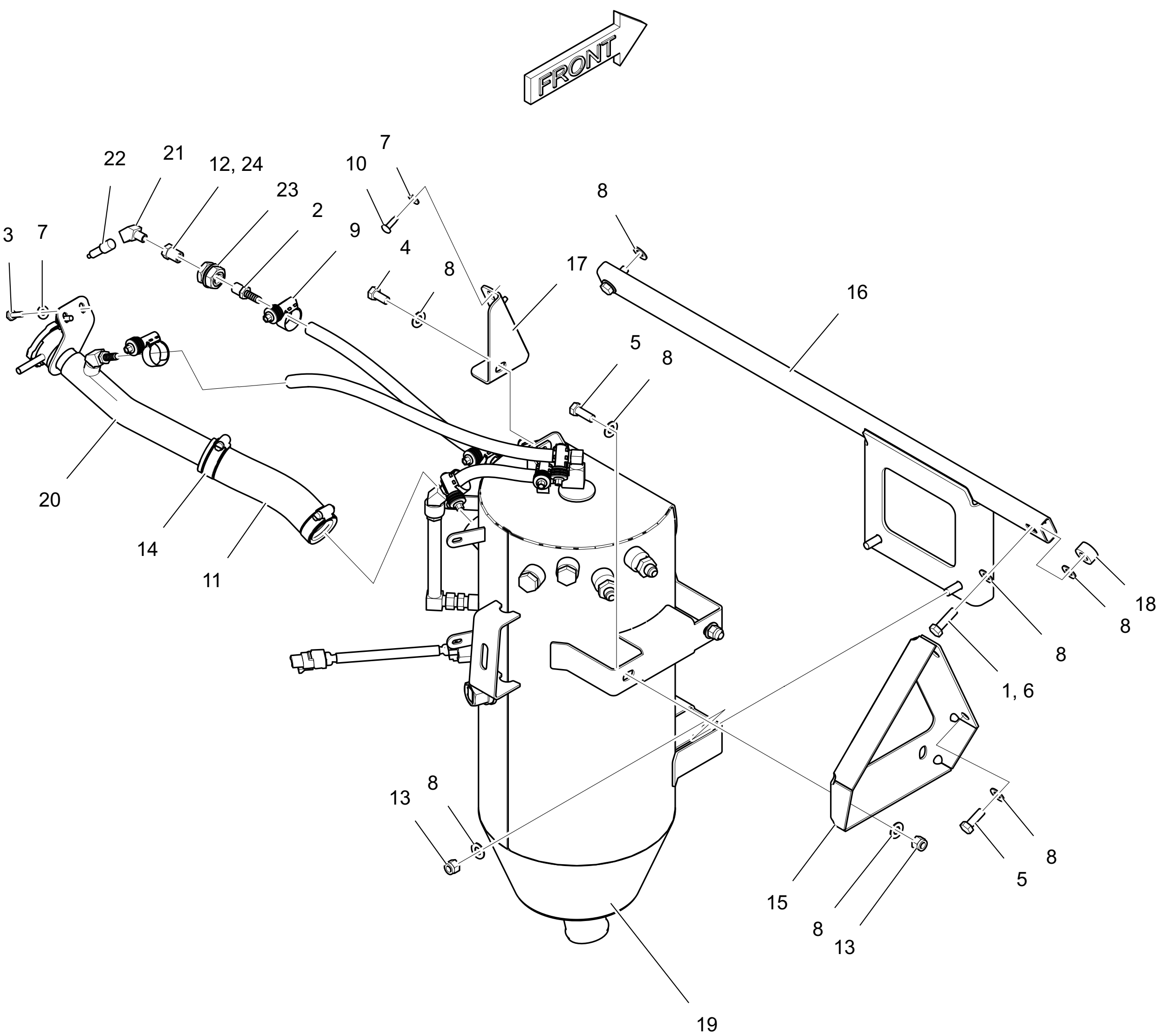
The pressure test valve, mounted near the surge tank fill tube, is used to check the cooling system operating pressure.

2.7.4. Removal

1. Relieve system pressure using the manual pressure relief valve on the filler cap. Remove the filler cap. See “Fig. 6-5: Surge Tank Installation” on page 21.
2. Close manual shutoff valves located in the supply and return lines.
3. Drain the cooling system until the coolant fluid is below the level of the surge tank.
4. Disconnect and tag all hoses and electrical connections from the surge tank.
5. Remove the fastener securing the surge tank to the top mounting bracket.
6. Remove the fasteners securing the surge tank to the middle bracket.
7. Remove the fasteners securing the surge tank to the bottom bracket.
8. Remove the surge tank from the vehicle.
9. Clean the surge tank and inspect it for damage.

2.7.5. Installation

1. Install the surge tank in reverse order using Loctite-243 on the screw threads.
2. Reconnect all hoses and electrical connectors to the surge tank.
3. Add coolant to the cooling system. Refer to 2.3.4. “Filling & Deaeration” on page 5 in this section for procedure.



1. Clamp, "P" .625" SST/HT
2. Clamp, "P" 3/4" SST/HT
3. Clamp, "P" Cushion SST/HT 1.313"
4. Bolt, Hex 1/4" - 20 UNC x 3/4" Lg.
5. Bolt, Hex 1/4" - 20 UNC x 1" Lg.
6. Bolt, Hex 1/4" - 20 UNC x 1 1/4" Lg.
7. Washer, Flat #10
8. Washer, Flat 1/4"
9. Screw, PH Cross Recess SST #10 - 24 UNC x 3/4" Lg.
10. Loom, Therm-L 1" Dia. 36" Lg.
11. Screw, PH Cross Recess Tpg. Type F #10 - 24 UNC x 3/4" Lg.
12. Screw, PH Cross Recess Tpg. Type F #10 - 24 UNC x 1 1/2" Lg.
13. Hose, Silicone 5/16" I.D. Drain
14. Spacer, .5" O.D. x .75" Thk.
15. Nut, Lock Nylon #10 - 24 UNC
16. Nut, Lock Nylon 1/4" - 20 UNC
17. Bracket
18. Bracket
19. Rivet, Mono Blind SST 3/16" x .064/.270
20. Bracket
21. Shield, Heat Coolant Recovery
22. Tank Assembly, Coolant Recovery
23. Clamp, Hose 5/16"
24. Tag, Coolant Recovery Tank

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Fig. 6-5: Surge Tank Installation

2.8. Coolant Recovery Tank

2.8.1. 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 vented to the atmosphere and graduated with COLD FULL and HOT FULL marks for servicing.

2.8.2. Coolant Recovery Tank Specifications

Type .... Molded Translucent Plastic

Capacity................................2.5 gal. (9.5 L)

Cap .... Top Vented, Nylon

2.8.3. 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.

2.8.4. Removal

⚠ WARNING

Allow engine cooling system to cool before servicing.

⚠ WARNING

Relieve pressure in cooling system before servicing. Open pressure cap slowly.

1. Remove the remote pressure cap.
2. Disconnect the hose from the coolant recovery tank and drain the coolant into a suitable container.
3. Remove the two bolts securing the tank clamp to the tank mounting bracket at the front of the tank. See “Fig. 6-6: Coolant Recovery Tank” on page 23.
4. Remove the bolt securing the tank clamp to the tank mounting bracket at the rear of the tank and remove the clamp portion of the bracket.
5. Remove the coolant recovery tank from the mounting bracket.
6. Clean the coolant recovery tank and inspected it for damage.

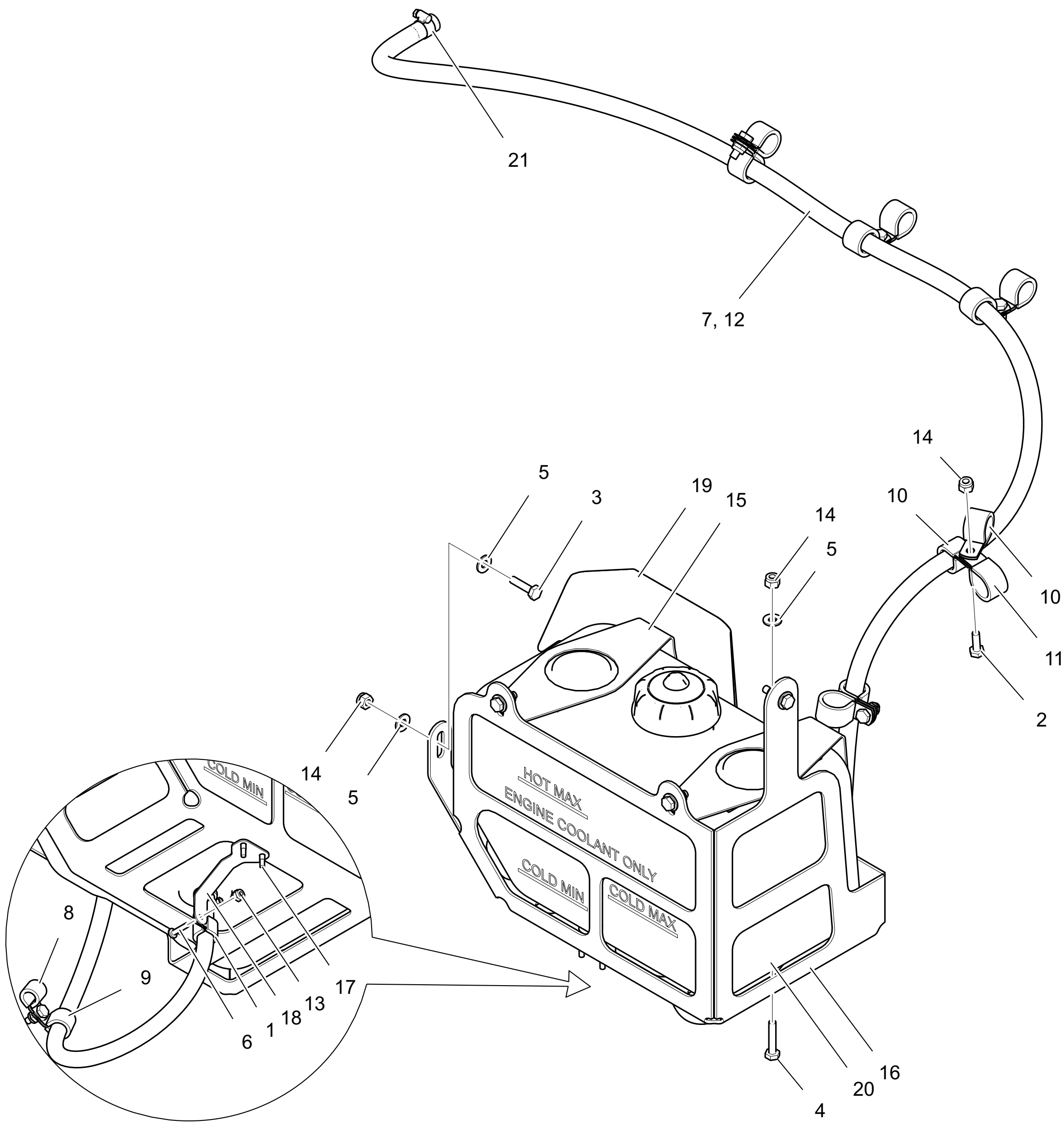
2.8.5. Installation

1. Position the coolant recovery tank on the vehicle-mounted support bracket.

☞NOTE:

The tank has raised circular surfaces that must clear the circular openings in the tank clamp. The clamp should sit flat on the top of the tank without causing any deformation to the tank.

2. Align and install the tank clamp. Install and tighten the front two bolts, washers and lock nuts.
3. Install the bolt washer and lock nut at the rear of the tank clamp. Tighten the nut until it contacts the clamp and then tighten three more turns.
4. Connect the hose to the fitting on the bottom of the coolant recovery tank.
5. Install the pressure cap.
6. Add coolant to cooling system. Refer to 2.3.4. “Filling & Deaeration” on page 5 in this section for procedure.



1. Clamp, "P" .625" SST/HT
2. Bolt, Hex 1/4" - 20 UNC x 3/4" Lg.
3. Bolt, Hex 1/4" - 20 UNC x 1" Lg.
4. Bolt, Hex 1/4" - 20 UNC x 1 1/4" Lg.
5. Washer, Flat 1/4"
6. Screw, PH Cross Recess SST #10 - 24 UNC x 3/4" Lg.
7. Loom, Thermal L-Wrap 1"
8. Clamp, "P" 1/2" SST/HT
9. Clamp, "P" .625" SST/HT
10. Clamp, "P" 3/4" SST/HT
11. Clamp, "P" .875" SST/HT
12. Hose, Silicone 5/16" I.D. Drain
13. Nut, Lock Nylon #10 - 24 UNC
14. Nut, Lock Nylon 1/4" - 20 UNC
15. Bracket, Coolant Recovery Tank
16. Bracket, Coolant Recovery Tank
17. Rivet, Mono Blind SST 3/16" x .064/.270"
18. Bracket, Hose Coolant Recovery Tank
19. Shield, Heat Coolant Recovery Tank
20. Tank Assembly, Coolant Recovery
21. Clamp, Hose 5/16"

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Fig. 6-6: Coolant Recovery Tank

2.9. Hose Clamp Torque Specifications

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.

HOSE CLAMP TORQUE SPECIFICATIONS

Item	Description	Application	Clamp Width	Torque (in-lb.)
1	Ideal Smartseal Stainless Steel Clamp	Rad Hoses (large) & Surge Tank Drop Tube	0.625	125 in-lb.
2	Ideal Waveseal Stainless Steel Clamp	Rad Hoses (small) & Heater Lines, Surge Tank & DEF Tank	0.562	80 in-lb.
3	Ideal Flexgear Stainless Steel Clamp	Surge Tank & Coolant Filter Hoses	0.562	50 in-lb.
NOTE: Retorque surge tank hose clamps after 30 minutes.				

3. VENDOR SERVICE INFORMATION

The following supplier manuals contain additional reference information.

3.1. Engineered Machined Products (EMP) Manual

- ❐ MH9 Cooling System Service Manual
- ❐ MH9 Cooling System Troubleshooting Manual
- ❐ OK4 Oil Cooler Service Manual

Fuel System

1. SAFETY

1.1. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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. FUEL SYSTEM

2.1. Description

The fuel system includes the fuel tank, a primary fuel filter, a secondary fuel filter, lift pump, fuel pump, fuel manifold, and fuel lines.

The fuel tank is mounted in the vehicle chassis, forward of the rear wheels. Supply and return fuel lines run between the tank and the engine at the rear of the vehicle. Engine-mounted fuel components include a lift pump, main fuel pump and the injection system. Refer to the OEM Engine Maintenance Manual for further information on the engine fuel system.

2.2. Operation

On engine start-up the lift pump draws fuel from the fuel tank, through a primary fuel filter. The low pressure side of the fuel pump discharges fuel through the fuel manifold, the secondary fuel filter and to the inlet of the high pressure fuel pump. High pressure fuel is delivered through a common fuel rail to the fuel injectors. Surplus fuel returns to the fuel tank through a return line.

2.3. Fuel Tank

2.3.1. Description

A single fuel tank is mounted transversely in the vehicle chassis, forward of the rear axle. A fuel filler neck assembly is bolted to the tank and provides mounting locations for the fuel filler adapter, pressure relief valve, and fuel level control valve. Fuel tank fill access is provided through a hinged door on the curbside of the vehicle. Supply and return fuel hoses connect the fuel tank with the engine. The fuel tank is equipped with the following components:

- ❒ Pressure Relief Valve
- ❒ Fuel Level Control Valve
- ❒ Whistle Valve
- ❒ Fuel Level Sending Unit

2.3.2. Removal

⚠ WARNING

Diesel fuel is flammable. Keep open flames and sparks away from work area. Work in a well ventilated area. Wear proper eye protection and protective clothing.

1. Set the Battery Disconnect switch to the OFF position.
2. Remove the fuel filler adapter from the fill tube and remove adapter through the fuel filler access door. Plug the filler tube to prevent debris from entering. See “Fig. 7-1: Fuel Tank Installation” on page 4.
3. Disconnect the pressure relief vent hose and tie it away from the fuel tank.
4. Raise the vehicle. Refer to the General Information Section of this manual for lifting procedures.
5. Remove the drain plug from the bottom of the fuel tank and drain the fuel into a clean container. Temporarily plug the drain port to prevent contamination.

☞**NOTE:**

The fuel tank capacity is 125 U.S. gal.

6. Disconnect the fuel supply and return lines from the fuel tank and tie them away from the fuel tank. Plug all fuel lines to prevent contamination.
7. Disconnect the fuel tank ground cable from the vehicle structure.

⚠ WARNING

Use proper lifting equipment and procedures when removing the fuel tank. The fuel tank weighs approximately 255 lbs and the center support frame weighs approximately 60 lbs.

8. Position a lift table or similar lifting device beneath the fuel tank center support frame. Arrange wood blocks on the lift so that the weight of the center support frame is taken by the lift.
9. Remove the fasteners holding the center support frame, lower the frame and move away from the vehicle.

☞**NOTE:**

Record quantity and position of any shims installed between support frame and vehicle structure. Retain shims for reassembly.

10. Reposition the lift under the fuel tank. Place wooden blocks under the streetside and curbside tank support channels so that the weight of the fuel tank is evenly distributed and taken by the lifting equipment.
11. Check that the fuel tank is properly supported, and then remove the fasteners holding the streetside and curbside supports.
12. Carefully lower the fuel tank and move it to a clean work area.

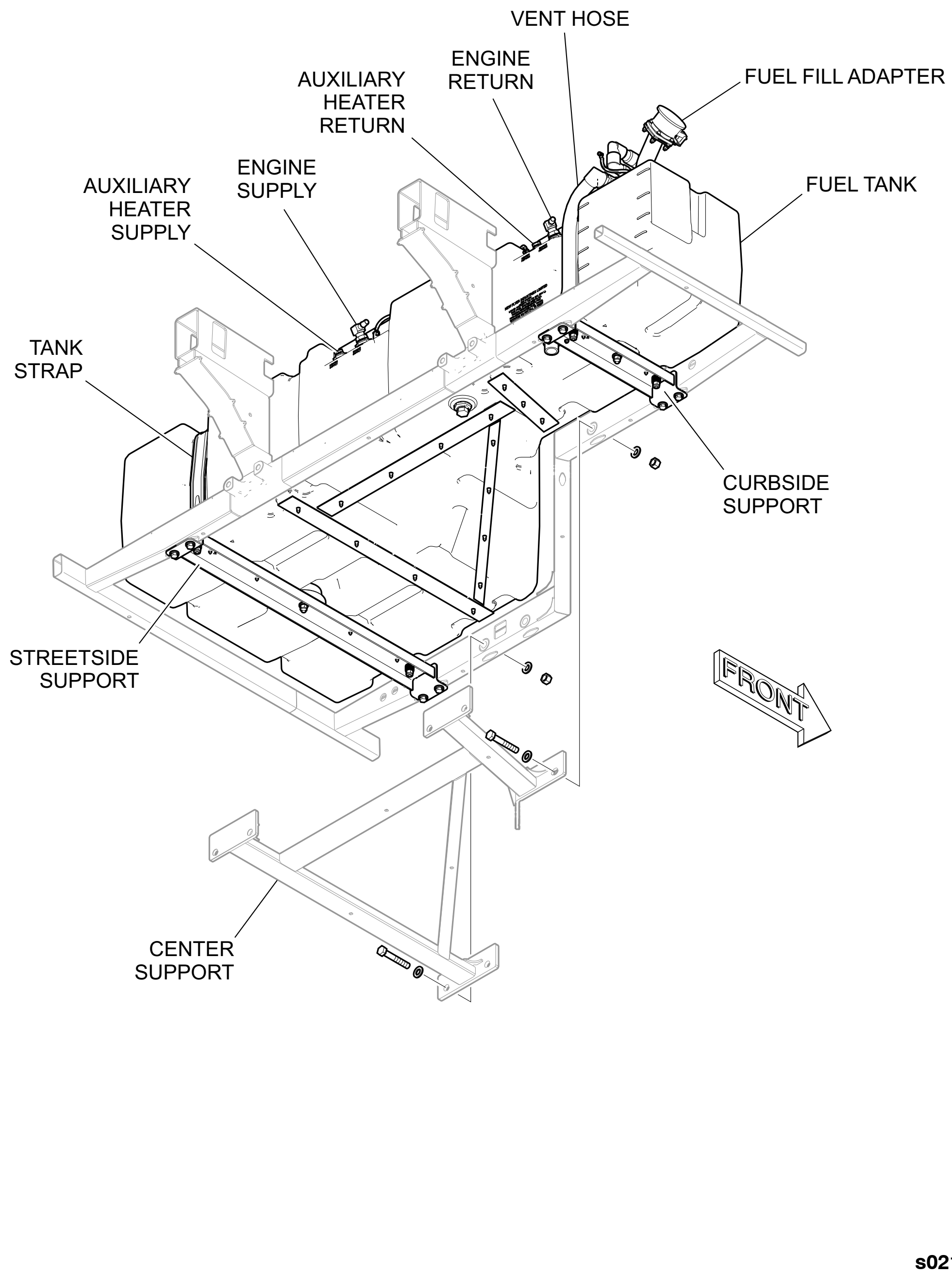


Fig. 7-1: Fuel Tank Installation

2.3.3. Disassembly

1. Mark the position of the streetside and curbside support channels to ensure proper location during assembly.
2. Remove the support channels from the bottom of the fuel tank by removing the lock nuts, and spring washer stack from each strap T-bolt. Remove straps and supports from fuel tank.
3. Remove fuel tank components. See “Fig. 7-2: Fuel Tank Accessories” on page 5.

☞NOTE:

Refer to specific replacement instructions in this section for information on replacing fuel tank mounted components.

4. Remove the filler neck assembly from the fuel tank by removing the eight bolts from the mounting plate. Remove and discard gasket.

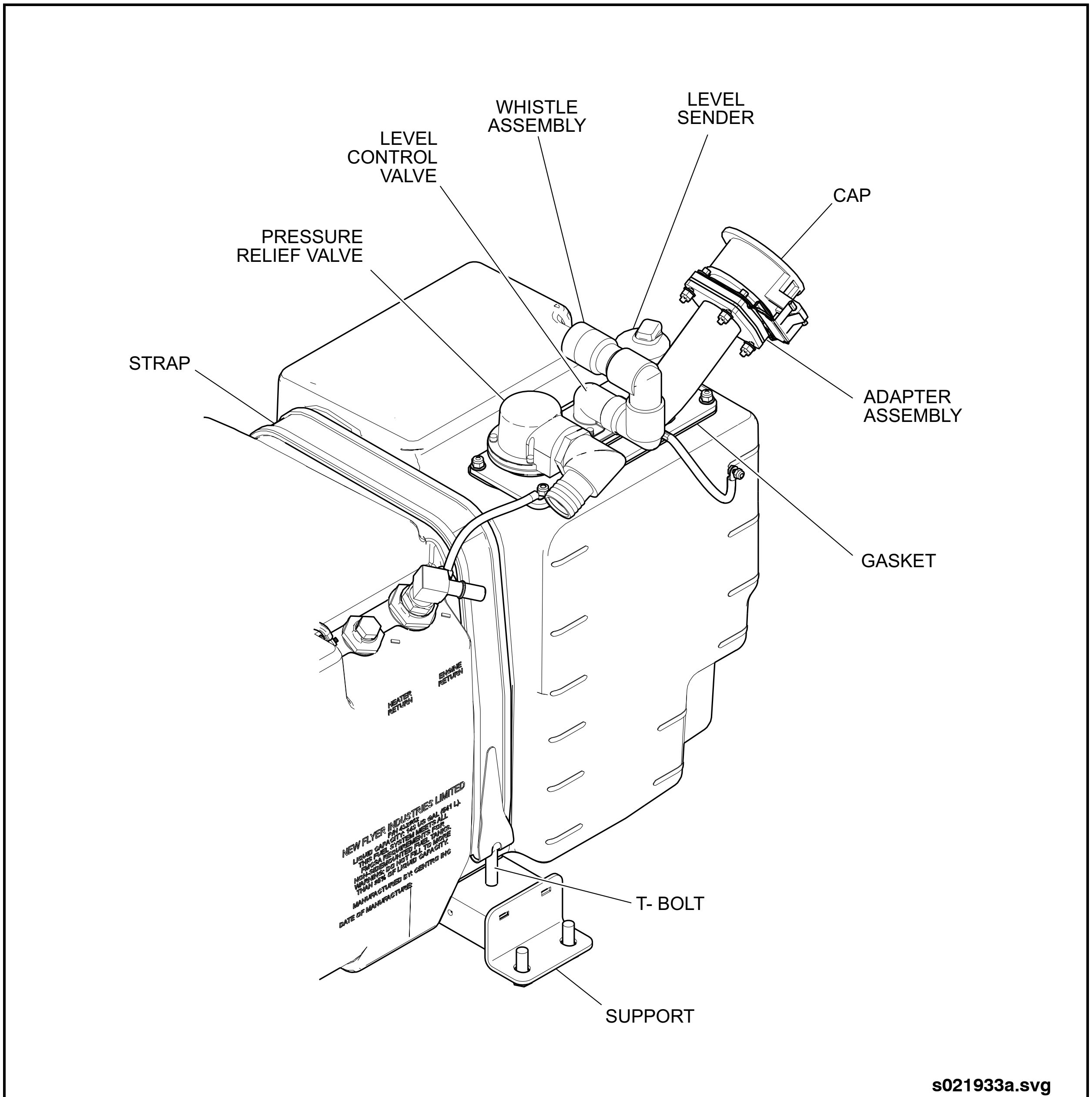


Fig. 7-2: Fuel Tank Accessories

2.3.4. Cleaning & Inspection

1. Inspect fuel tank for dents, cracks, corrosion, or other damage.
2. Clean all threaded fittings and ports of any thread sealant or thread locking residue.
3. Inspect all fittings and ports for thread damage.
4. Inspect filler neck welded joint at mounting plate for cracks.
5. Inspect all mounting flanges and sealing surfaces for flatness, scoring, corrosion, or other damage.
6. Inspect all neoprene isolator strips located on the side and center support channels and tank straps. Replace damaged or worn neoprene strips using 3M Fastbond 30H adhesive.
7. Inspect interior of tank for rust particles, sludge, water, or microbial growth. Clean and flush tank as required.

2.3.5. Assembly

1. Install drain plug using Loctite 567 thread sealant.
2. Install filler neck assembly onto tank with new gasket. Apply Loctite 222 to eight mounting bolts and tighten.
3. Install fuel tank mounted components.

☞NOTE:

Refer to specific replacement instructions in this section for information on replacing fuel tank mounted components.

☞NOTE:

Perform a fuel tank pressure test if any components were replaced or repairs undertaken. Refer to 2.7. "Fuel System Leak Test" on page 14 *in this section for test procedure.*

4. Position streetside and curbside support channels on underside of fuel tank at locations marked during disassembly. Ensure neoprene isolator strips are in good condition and properly bonded to the support channels.
5. Attach the tank straps to the fuel tank support channels using T-bolt, washer stack, and lock nut. Ensure the washer stack is assembled in the correct pattern. See "Fig. 7-3: Washer Stack Assembly" on page 6.
6. Tighten nuts until the washer stack is fully compressed.

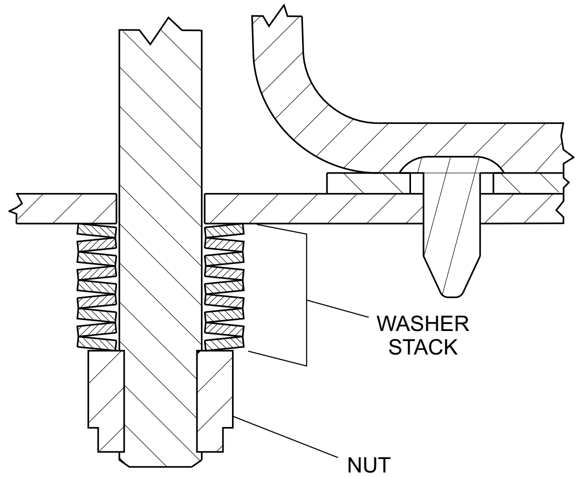


Fig. 7-3: Washer Stack Assembly

2.3.6. Installation

1. Raise fuel tank into position, aligning streetside and curbside support channels with threaded mounting holes in vehicle structure.
2. Secure support channels to vehicle structure by applying Loctite 272 thread locker to mounting bolts and installing with washers. Torque bolts 82 to 90 ft-lbs (111 to 122 Nm).
3. Use lifting equipment to raise the center support frame into position. Ensure that the neoprene isolator strips are in good condition and properly bonded to the underside of the support frame.
4. Replace shims, if applicable, in quantity and locations noted during removal. Do not exceed two shims per location.
5. Secure center support frame to vehicle structure using original fasteners. Torque fasteners 155 to 175 ft-lbs. (210 to 237 Nm).
6. Connect fuel supply and return lines to tank.
7. Connect vent hose to pressure relief valve.
8. Connect the fuel tank ground cable to the vehicle structure.
9. Attach pressure-fill adapter to fuel filler pipe using a new gasket. Torque fasteners 75 to 85 in-lbs.
10. Fill the fuel tank.
11. Set the Battery Disconnect switch to the ON position.
12. Purge the fuel system, start the vehicle, and check for leaks.

2.3.7. Anti-Spill System

The fuel tank has a Emco anti-spill filler system. The system prevents the fuel from spilling during fuel filling. The Emco system allows for fast pressure filling.

The anti-spill system is mounted on the fuel tank. It consists of a filler neck adapter, level control valve, a whistle valve, and a pressure relief valve.

The fueling nozzle is mechanically locked to the filler neck adapter during fueling, but is easily removed when the tank has been filled to 95% of its maximum capacity.

☞**NOTE:**

To engage or disengage the nozzle from the adapter, rotate the nozzle approximately 30° clockwise to engage and counter-clockwise to disengage.

A whistle valve, attached to the level control valve, emits a whistle sound when the tank is being filled. The whistling sound continues until the level control valve automatically shuts off the whistle valve.

When the fuel level approaches 95% of the tank capacity, the level control valve shuts off the air vent and whistle valve, allowing a slight pressure build-up in the tank. This results in back pressure on the trip mechanism in the nozzle, causing the nozzle to shut off the fuel flow.

☞**NOTE:**

The shut-off pressure is approximately 0.7 to 1.1 psi.

The pressure relief valve functions if the nozzle fails to shut off and fuel continues to fill the tank. When the pressure reaches 3.1 to 3.3 psi in the tank, it causes a spring-loaded poppet in the pressure relief valve to lift off its seat. This allows pressure and fuel to escape via a fuel discharge hose.

Once the flow is shut off, the operator pulls the disconnect handle on the side of the nozzle, thereby activating the pressure relief valve. The pressure relief valve vents the pressure build up in the tank to the atmosphere.

☞**NOTE:**

The pressure relief valve activates at 3.1 psi.

When the venting “hiss” has stopped, the operator keeps the disconnect handle pulled out and rotates the nozzle to disengage it from the adapter.

2.3.8. Level Control Valve Replacement

1. Unscrew the whistle valve from the level control valve.
2. Remove screws securing the control valve to the fuel tank. Disconnect the overflow hose and remove from the level control valve. Remove control valve and gasket.
3. Clean mounting surface of the control valve.
4. Position a new gasket and control valve on the fuel tank, install mounting screws to tighten them. Connect overflow hose to control valve.

☞NOTE:

DO NOT exceed 10 to 15 in-lb. (1.1 to 1.7 Nm) torque when installing gasket mounting screws. DO NOT use power tools to install these screws.

5. Clean the whistle valve in a suitable solvent. Replace the internal spring in the valve if necessary. Make sure to place the seal, float, and ball in proper positions. See "Fig. 7-4: Level Control Valve" on page 8.
6. Install whistle valve by screwing it into control valve and tightening it securely.

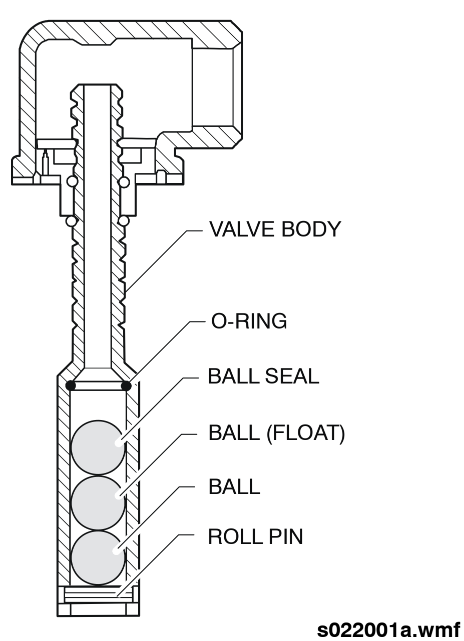


Fig. 7-4: Level Control Valve

2.3.9. Pressure Relief Valve Replacement

1. Disconnect hose and remove from relief valve.
2. Remove screws securing the pressure relief valve to the fuel tank.
3. Remove the relief valve and its gasket from the fuel tank.
4. Clean mounting surface of the relief valve.
5. Position a new gasket and relief valve on the fuel tank, install mounting screws and tighten.

☞NOTE:

DO NOT exceed 10 to 15 in-lb. (1.1 to 1.7 Nm) torque when installing gasket mounting screws. DO NOT use power tools to install these screws.

6. Connect hose to relief valve.

2.3.10. Fuel Level Sending Unit

2.3.10.1.Description

The fuel level sending unit consists of a liquid level sensor which provides a continuous output of tank contents in voltage format. The sensor is threaded into the fuel tank near the fuel filler and pressure relief valves.

2.3.10.2.Fuel Level Sending Unit Specifications

Probe Length .... 17.51" (445mm)

Supply Voltage .... 7 - 35 VDC

Supply Current ....15 - 30 mA

Output .... 0 - 5 VDC

Linearity 1%

Accuracy .... ± 2% of Depth at 68°F (20°C)

Connection
.... 4 way Delphi Packard connector

Operating Temperature
.......................-40 to 185°F (-40 to 85°C)

2.3.10.3.Operation

The fuel level sending unit has no moving parts and is mounted vertically to cover the whole depth of the tank. The fuel level sender's output voltage will vary with the level of fuel in the fuel tank. This output voltage is connected to the input of a fuel gauge which provides a corresponding level reading. The fuel gauge is mounted on the fuel filler behind the fuel filler access door.

2.3.10.4.Removal

☞**NOTE:**

Fuel tank must be removed from vehicle to replace fuel level sending unit.

1. Clean accumulated debris from around fuel level sending unit.
2. Mark the position of the fuel level sending unit connector relative to the fuel tank.
3. The fuel level sending unit is threaded into an adapter in the fuel tank. Use a wrench to remove sending unit only.
4. Clean mounting surface on fuel tank of any excess sealant

2.3.10.5.Installation

1. Apply Teflon tape thread sealant to the sending unit's threads, leaving the first set of threads clean.
2. Install the fuel level sending unit into the fuel tank and hand-tighten.
3. Use a wrench to tighten sending unit two full turns past the hand tightened limit.

☞**NOTE:**

During installation be sure to align the final position of the fuel level sending unit connector to the mark made during disassembly. This will ensure the harness can properly connect once the fuel tank has been reinstalled in the vehicle.

2.4. Primary Fuel Filter

☞**NOTE:**

Refer to the Preventive Maintenance Section of this manual for fuel filter replacement interval and procedure.

2.4.1. Description

The primary fuel filter is bracket-mounted on the curbside of the engine compartment. The filter assembly consists of a filter head, 30 micron replaceable spin-on filter element, a reusable see-through contaminant collection bowl, a manual priming pump, a 24V heating element, and vent plug. See “Fig. 7-5: Fuel Lines & Primary Fuel Filter Installation” on page 10.

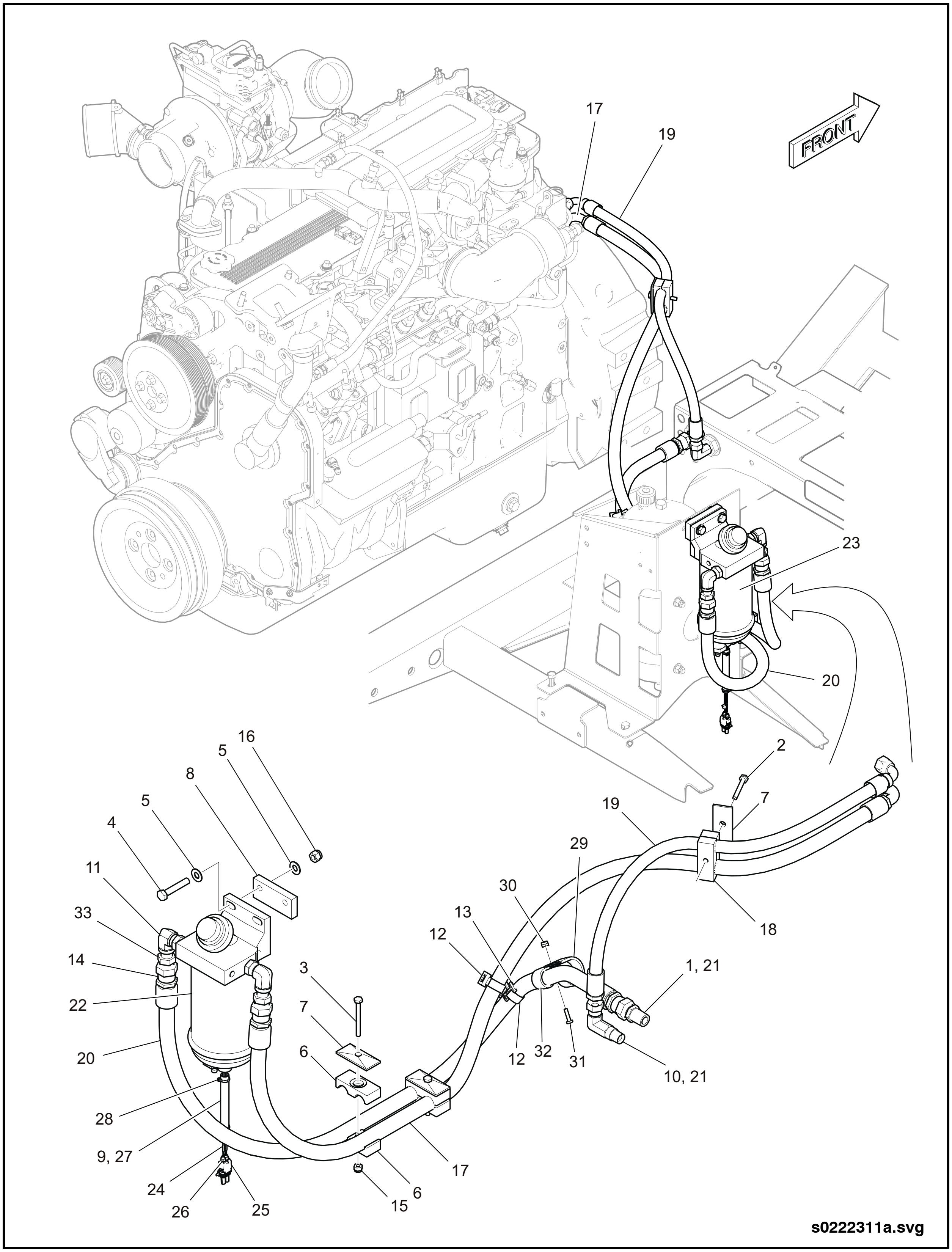


Fig. 7-5: Fuel Lines & Primary Fuel Filter Installation

1. Adapter, ext Pipe to 37° Flare	12. Cable Tie, 4/5" W x 8 1/2" Lg.	23. Filter Assembly, Primary Fuel
2. Bolt, Hex 1/4" - 20 UNC x 2 1/4" Lg.	13. Spacer, Dual Swivel Saddle	24. Socket, Female Terminal
3. Bolt, Hex 1/4" - 20 UNC x 2 1/2" Lg.	14. Adapter	25. Connector, 2-Way Tower
4. Bolt, Hex 3/8" - 16 UNC x 2" Lg.	15. Nut, Lock Nylon 1/4" - 20 UNC	26. Seal, Connector
5. Washer, Flat 3/8"	16. Nut, Lock Nylon 3/8" - 16 UNC	27. Loom, Convoluted Split .38"
6. Clamp, Twin Hose 22mm Dia.	17. Hose Assembly, GH 100-10 FL 63.0	28. Cable Tie, 4" Lg. Black
7. Plate, Clamp	18. Clamp, Twin .91 x .75	29. Clamp, "P" 1.375" SST/HT
8. Spacer, Fuel Filter	19. Hose Assembly, GH100- 8 FL 29.0	30. Nut, Lock Nylon #10 - 24 UNC
9. Water Probe Assembly	20. Hose Assembly, GH100-10 FL 47.0	31. Screw, PH Cross Recess SST #10 - 24 UNC x 3/4" Lg.
10. Elbow, 90° - 8 PT/JIC	21. Loctite, 567 White	32. Clamp, "P" .875" SST/HT
11. Elbow, 90° 3/8" NPT x 3/8" FPT Swivel	22. Fuel Filter Assembly, Primary (Incl. 23-28)	33. Valve, Check

Fuel Lines & Primary Fuel Filter Installation (parts list)

2.5. Secondary Fuel Filter

2.5.1. Description

The secondary fuel filter is bracket-mounted on the curbside of the engine compartment. The filter assembly consists of a filter head and a replaceable spin-on filter element. See “Fig. 7-6: Secondary Fuel Filter Installation” on page 12.

2.5.2. Secondary Fuel Filter Specifications

Mounting .... Spin-on

Particle Size .... 4 micron

Liquid Capacity .... 0.21 gal (0.8 L)

Rated Flow............... 1.2 gal/min (4.6 L/min)

2.5.3. Operation

The fuel filter is plumbed into the pressure side of the lift pump. Fuel from the tank enters the filter and passes through the filter media which removes contaminants. The filtered fuel is delivered to the engine high pressure fuel pump.

2.5.4. Maintenance

Refer to the Preventive Maintenance Section of this manual for filter draining, removal and installation intervals and procedures.

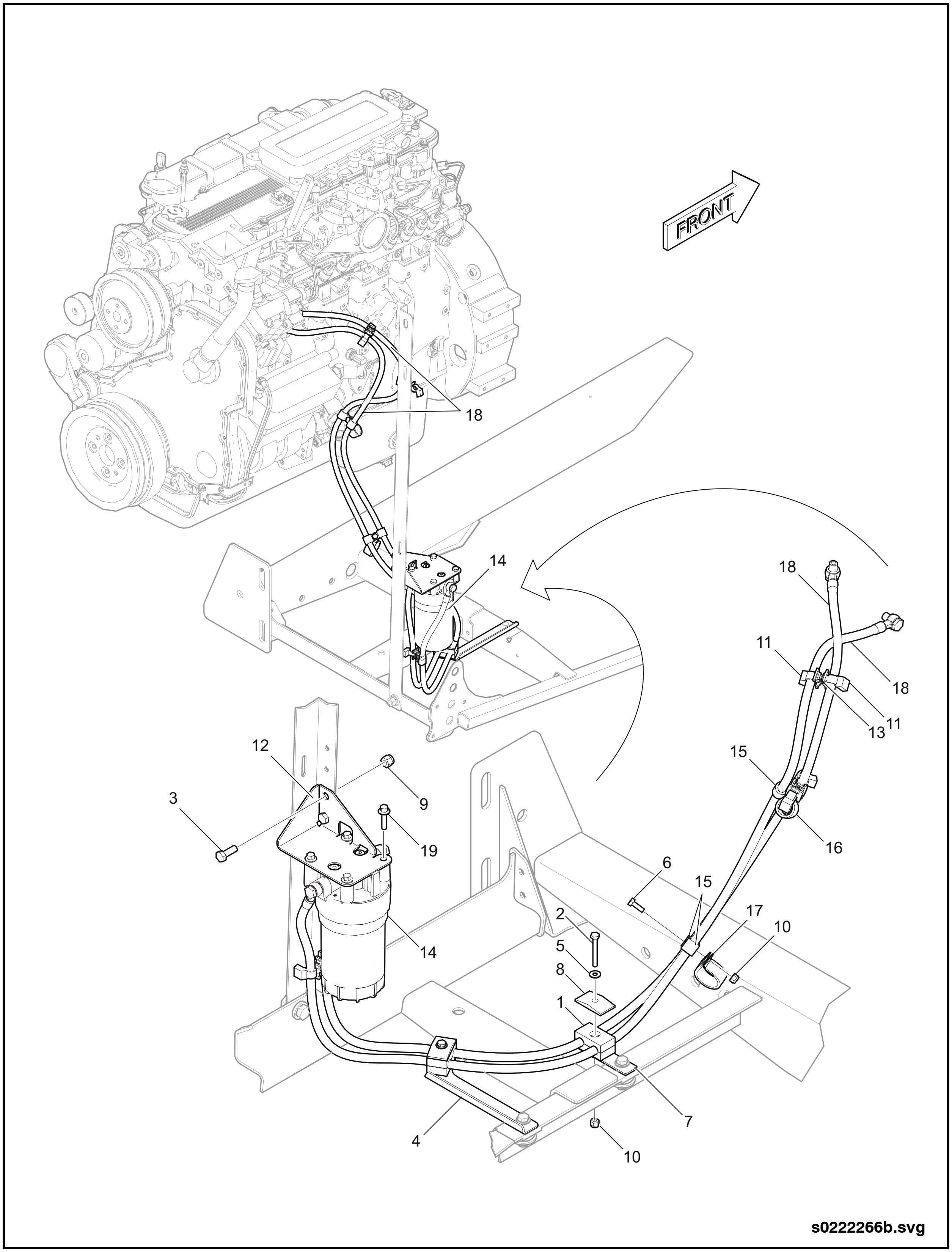


Fig. 7-6: Secondary Fuel Filter Installation

1. Clamp, Double 1/2" Tube	11. Spacer, Dual Swivel Saddle
2. Bolt, Hex 1/4" - 20 UNC x 2" Lg.	12. Bracket, Fuel Filter Secondary
3. Bolt, Hex 3/8" - 16 UNC x 1" Lg.	13. Spacer, Dual Swivel Saddle
4. Bracket, Fuel Line Support	14. Filter Assembly, Secondary Fuel
5. Washer, Flat 1/4"	15. Clamp, "P" 1/2" SST/H
6. Bolt, Hex 1/4" - 20 UNC x 3/4" Lg.	16. Clamp, "P" .875" SST/HT
7. Bracket, Fuel Line Support	17. Clamp, "P" 1.375" SST/H
8. Plate, Cover	18. Hose Assembly
9. Nut, Lock Nylon 3/8" - 16 UNC	19. Screw, M8 x 16 mm
10. Nut, Lock Nylon 1/4" - 20 UNC	

Secondary Fuel Filter Installation (parts list)

2.6. Fuel Lines & Flexible Hoses

2.6.1. Description

The performance of engine and auxiliary equipment is greatly dependent on the ability of flexible hoses to transfer lubricating oil, air, coolant, and fuel oil. Diligent maintenance of hoses is an important stop in ensuring efficient, economical and safe operation of the engine and related equipment.

Investigate leaks immediately to determine if hoses have ruptured or worn through. Take corrective action immediately. Leaks are not only potentially detrimental to machine operation, but they also result in added expense caused by the need to replace lost fluids.

⚠ CAUTION

Personal injury and/or property damage may result from fire due to the leakage of flammable fluids such as fuel or lube oil.

A hose has a finite service life. The service life of a hose is determined by the temperature and pressure of the air or fluid within it, its time of service, its mounting, the ambient temperatures, and amount of flexing and vibration it is subjected to.

2.6.2. Locating Air Leaks in Fuel Lines

Air drawn into the fuel system may result in uneven running of the engine, black or white smoking and stalling when idling, or a loss of power. Poor engine operation is particularly noticeable at the lower engine speeds. If air is found in the fuel, the source will normally be between the fuel tank and the fuel pump.

Check for loose, faulty, or improper fuel line connectors.

2.7. Fuel System Leak Test

The fuel system can be tested for leaks by attaching an Emco Wheaton P/N G2287-001 test kit and a source of shop air to the fuel tank as follows:

1. Open the fuel filler access door on the curbside of the vehicle.
2. Gain access to the fuel tank fittings on top of the fuel tank by removing the seat and fuel tank access cover in front of the riser on the streetside of the vehicle.
3. Plug the level control valve outlet with a 1" NPT plug.
4. Attach the regulator adapter to the fuel tank filler. See “Fig. 7-7: Fuel System Leak Test” on page 14.

☞NOTE:

DO NOT attach the regulator at this time.

5. Connect a supply of shop air to the regulator and open the ball valve.
6. Set the regulator to 2 psi by pulling out the regulator knob and turning it to decrease the pressure.
7. When the gauge reads 2 psi, push in the regulator knob to lock it and disconnect the shop air.
8. Connect the regulator to the adapter.

☞NOTE:

Ensure that the ball valve is closed.

9. Rotate the adapter lever to open the poppet on the tank filler.
10. Connect a supply of shop air to the regulator and open the ball valve.
11. Pressurize the tank and fuel lines. When the pressure has stabilized at 2 psi, close the ball valve and disconnect the shop air.
12. After 5 minutes check the gauge for any pressure loss.
13. If the gauge shows a pressure loss, repressurize the tank to 2 psi, soap test all fittings and repair all leaks.
14. Once all repairs have been completed, open the ball valve and drain the system of air.
15. Disconnect all test fittings, remove the level control valve plug and fit the dust cap.
16. Install the fuel tank access cover and seat.

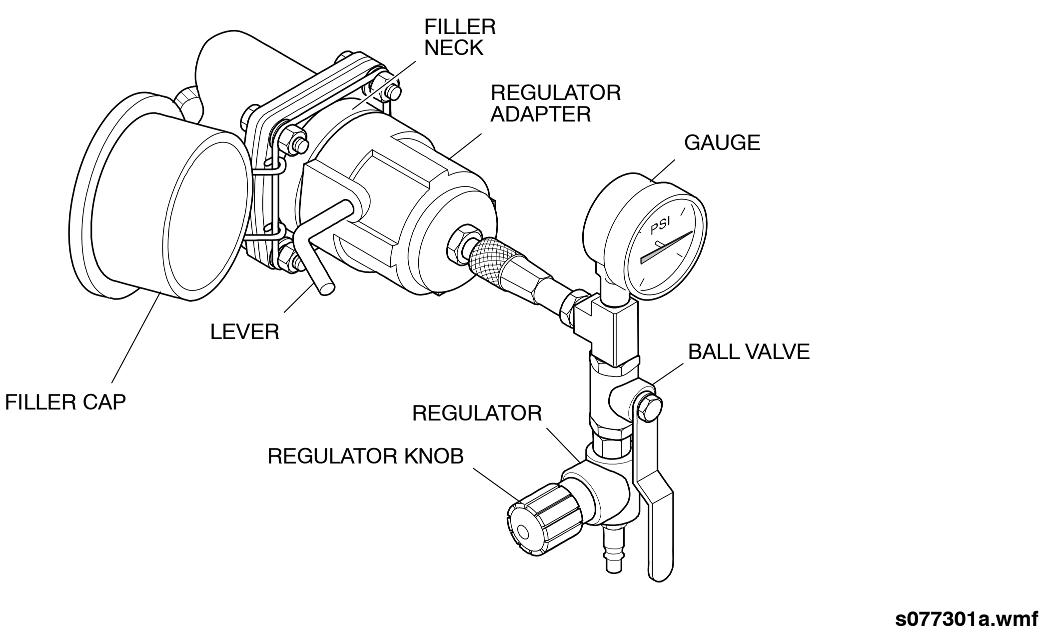
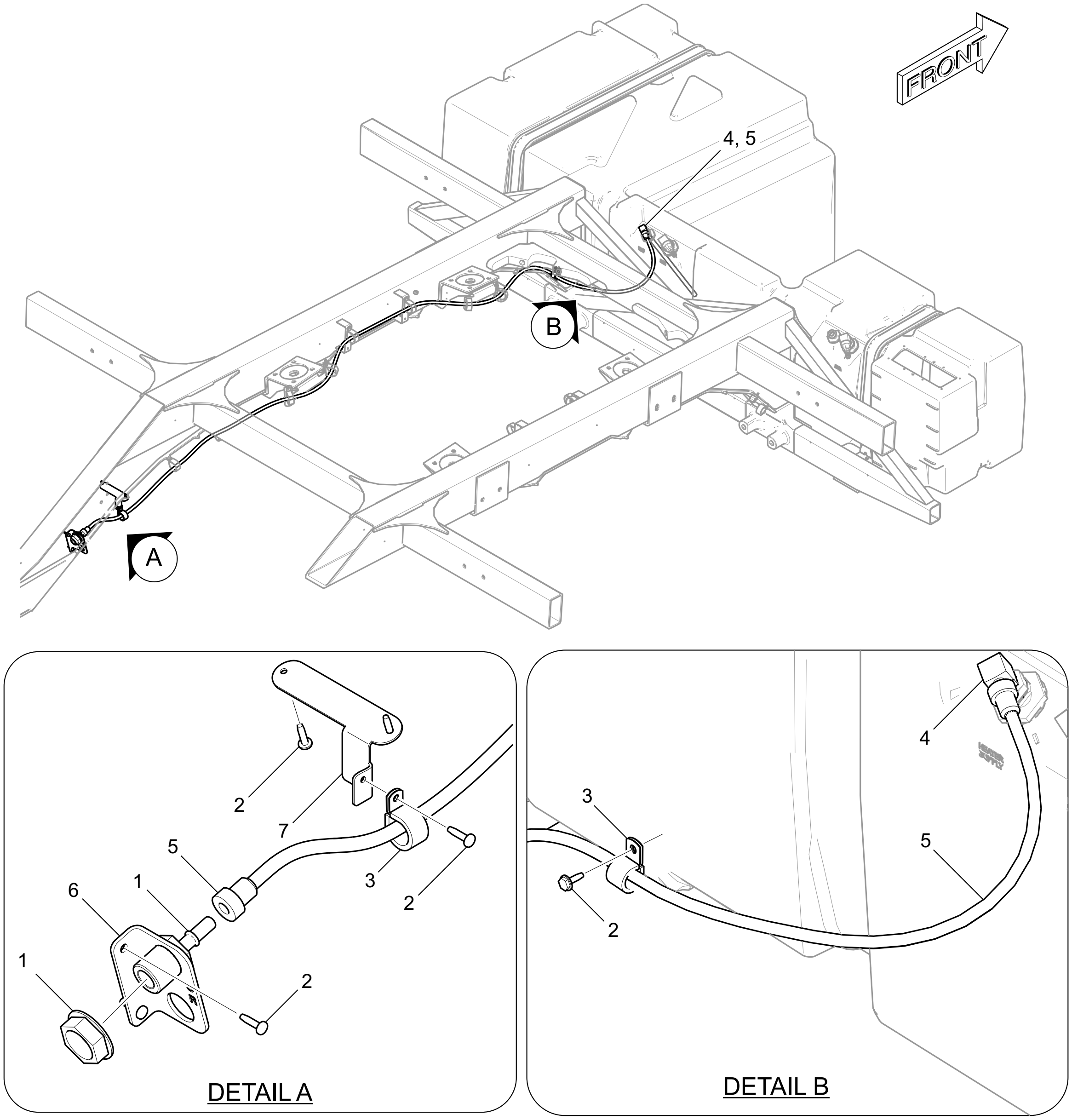


Fig. 7-7: Fuel System Leak Test

2.8. Auxiliary Coolant Heater Fuel Line

2.8.1. Description

The fuel system includes a fuel supply line for the auxiliary coolant heater which is located in the engine compartment. The coolant heater is used to pre-heat engine coolant during cold weather operation. The fuel line installation consists of a 1/2" supply nylon fuel tube connected to the main fuel tank by elbows and tube assemblies and routed to the engine compartment via thru-bulkhead connectors. See “Fig. 7-8: Auxiliary Coolant Heater Fuel Line Installation” on page 16.



1. Fitting, 3/8" J2044 x 3/8" FPT Anchor
2. Screw, PH Cross Recess Tpg. Type F #10 - 24 UNC
3. Clamp, "P" 3/4" SST/HT
4. Pick-up Tube, 3/8" Auxiliary Heater Fuel
5. Tube, Heater Fuel Supply
6. Bracket, Fuel Lines
7. Bracket, Fuel Lines

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Fig. 7-8: Auxiliary Coolant Heater Fuel Line Installation

3. DIESEL FUEL

3.1. Description

Diesel fuel performs two major functions in a diesel engine:

- ❒ It supplies all of the energy for the engine.
- ❒ It cools and lubricates the fuel pump and injectors.

☞**NOTE:**

Refer to the OEM Engine Maintenance Manual for required fuel specifications for this engine.

Wax crystals begin to form in diesel fuels at a certain cold temperature called cloud point. During cold weather operation, the selected fuel should have a cloud point at least 6°C (10°F) below the lowest expected fuel temperature. This will prevent forming of the wax crystals to clog the fuel filters.

Vehicle that operates at temperature below -29°C (-20°F) requires special attention to the cooling system, lubricating system, fuel system, electrical system, and cold weather starting aids for efficient engine starting and operation. Consult an authorized service outlet from your engine manufacturer for recommendation.

Using a lighter distillate fuels may be more practical for any one of the following operating conditions:

- ❒ Prolonged idling period.
- ❒ Cold weather below 0°C (32°F).
- ❒ Altitudes above 5,000 feet.

3.2. Storage

Fuel oil should be clean and free of contamination. Storage tanks and stored fuel should be inspected regularly for dirt, water and sludge; they should be cleaned if contaminated. Diesel fuel tanks can be made of monel, stainless steel, black iron, welded steel or reinforced (non-reactive) plastic.

⚠ **CAUTION**

DO NOT use galvanized steel or sheet metal tanks and galvanized pipes or fittings in any diesel fuel storage, delivery, or fuel system. The fuel oil will react chemically with the zinc coating, forming a compound which can clog filters and cause engine damage.

3.2.1. System Fuel Tanks

Keep the fuel tank filled to reduce the condensation to a minimum. Select the proper grade of fuel in accordance with the Fuel Specifications.

3.3. Fuel Contaminants

The most common form of diesel fuel contamination is water. Water is harmful to the fuel system in itself, but it also promotes the growth of microbiological organisms (microbes). These microbes clog fuel filters with a “slime” and restrict fuel flow.

Water can be introduced into the fuel supply through poor maintenance (loose or open fuel tank caps), a contaminated fuel supply or condensation.

Condensation is particularly prevalent on units that stand idle for extended periods or time. Ambient temperature changes cause condensation in partially filled fuel tanks.

Units in storage are particularly susceptible to microbe growth. The microbes live in the fuel-water interface. They need both liquids to survive. These microbes find excellent growth conditions in the dark, quiet, non-turbulent nature of the fuel tank.

Microbe growth can be eliminated through the use of commercially available biocides. There are two basic types on the market:

- ❐ The water soluble type treats only the tank where it is introduced. Microbe growth can start again if fuel is transferred from a treated to an untreated tank.
- ❐ The diesel fuel soluble type, such a “Biobor” manufactured by U.S. Borax (or equivalent), treats the fuel itself, and therefore, the entire fuel system.

Any units that will sit idle for extended periods, or any units being stored, should be treated as follows: add the biocide according to the manufacturer's instructions. This operation is most effective when performed as the tank is being filled. Add dry gas (isopropyl alcohol) in the correct proportions.

If the fuel tanks were previously filled, add the chemicals and stir with a clean rod.

3.3.1. Preventing Algae Contamination

Algae formation is harmful to the fuel system of a diesel engine. Algae grows and thrives on water. It multiplies rapidly and can quickly clog the fuel filters and injector nozzles, stopping fuel flow to the cylinders.

To avoid algae contamination, eliminate the presence of water in the fuel system by:

- ❐ Purchasing fuel from reputable dealers where their fuel is fresh.
- ❐ Filling up the fuel tank to prevent moisture condensation, especially if the vehicle is parked for an extended time.

Air System

1. SAFETY

1.1. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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
E6	Brake Application Valve
EBR	Emergency Brake Release
KBL	Kneeling Block
LV	Leveling Valve
LVL	Leveling Valve Left
LVR	Leveling Valve Right
MDV	Mechanical Dump Valve
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
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
PS7	Pressure Switch - Exit Door
PS8	Pressure Switch - Interlock Warning
PS15	Pressure Transducer - Brake Application
PT3	Pressure Transducer - Rear Brake Circuit
PT15	Brake Application Pressure Transducer
PTV	Pressure Test Valve
QR-1	Quick Release Valve
R	Reservoir Port
R14	Relay Valve with Double Check Valve
RDV	Rotary Dump Valve
RV3	Pressure Reducing Valve
S	Supply Port
SERV	Service Port
SR7	Spring Brake Modulating Valve
SV	Safety Valve
UNL	Unload Port - Governor
TRNSDCR	Transducer

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 supplied by an engine driven Air Compressor (1) running at engine speed. The compressor is fed air through a Tube (2) connected to the engine 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 is supplied 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 (17) and Air Towing Connector (13) are provided for towing purposes. The towing vehicle provides system air pressure through the Charge Fitting (17) and Check Valve (14). The Towing Connector (13) receives the towing vehicle's brake application pressure.

☞**NOTE:**

The front brake system is not operable during towing operations.

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 of the Rear Brake Relay Valve (5) and the supply (S1) port of the Brake Foot Valve (4). Air is also supplied to the (B) balance port of the Rear Brake Relay Valve (5) through the Automatic Traction Control (ATC) Valve (6).

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. A second pressure transducer (13) provides a signal to the regenerative braking 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.

An E-stroke Pressure Transducer (8) is also connected to the D1 port of the Brake Foot Valve (4) and is used to provide a signal to the Electronic Stroke Monitoring System.

☞**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 (5) 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 Electronic Control Unit (ECU) detects an ABS event (impending wheel lock-up) it energizes 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 energizes the inlet and outlet solenoids of the Modulator Valve (9) which closes the supply port and opens the delivery and exhaust ports. To hold brake application pressure at a given value, the ECU energizes the inlet solenoid and de-energizes the outlet solenoid of the Modulator Valve (9), which closes the supply and exhaust ports.

This modulation of brake application pressure continues 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 energizes 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 simultaneously energizes 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) pushes 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 by 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 Drain Valve (7). 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 the button down on the EBR valve (8) allows 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) results in immediate application of the Emergency Brakes (10) without modulated control.

A loss of air pressure from the Rear Brake Tank (2) disables the rear service brakes. To maintain rear brake function in this situation, the Spring Brake Modulating Valve (9) releases 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) is proportional to brake treadle application.

Lack of air pressure at the balance (B) port of the Spring Brake Modulating Valve (9) allows the pressure sensed at the control (C) port to control the rate at which air is exhausted through the exhaust port. This action results 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 80 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), through an in-line Air Strainer (9), and through Rotary Dump Valve (10) to the entrance door.

Air from the Accessories Tank (3) is also routed to the engine Spinner filter.

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 flows from the pressure (P) port to the (C1) port in the Leveling Valve (13). If the Air Springs (14) are extended (inflated), air flows 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 a 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) directs 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) continue to fill until the vehicle ride height is reached. At this point, the Leveling Valve (13) closes the connection between the pressure (P) port and delivery (C1) port and vehicle ride height is maintained.

If the vehicle should exceed the specified ride height, the Leveling Valve (13) closes the pressure (P) port and directs the delivery (C1) port to the exhaust (E) port. This reduces air volume in the Air Springs (14) and lowers vehicle suspension until the specified ride height is reached.

The Leveling Valve (13) maintains 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), and a Rotary Dump Valve (10) before being applied to the entrance door baseplate. The air passes through a baseplate mounted Rotary Dump Valve (18), a Door Control Mag Valve (19) and maintains constant pressure on both cylinder chambers of the differential Door Motor (21). A Normally Open Pressure Switch (20) provides the Multiplexing System with a signal to indicate system pressure.

When the door controller is in the OPEN position, the Door Control Mag Valve (19) is energized and air from the large cylinder chamber is released through the pressure (P) port.

3.7.3. Exit Door Operation

When the door controller is in the CLOSED position, air from the Accessories Tank (3) is routed through the Mechanical Dump Valve (22), Door Control Mag Valve (24) and maintains constant pressure on both cylinder chambers of the differential Door Motor (23). A Normally Open Pressure Switch (25) provides the Multiplexing System with a signal to indicate system pressure.

When the door controller is in the OPEN position, the Door Control Mag Valve (24) is energized and air from the large cylinder chamber is released through the exhaust (E) port.

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 4.5. “QBA15 Air Dryer” on page 35 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 4.5. “QBA15 Air Dryer” on page 35 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

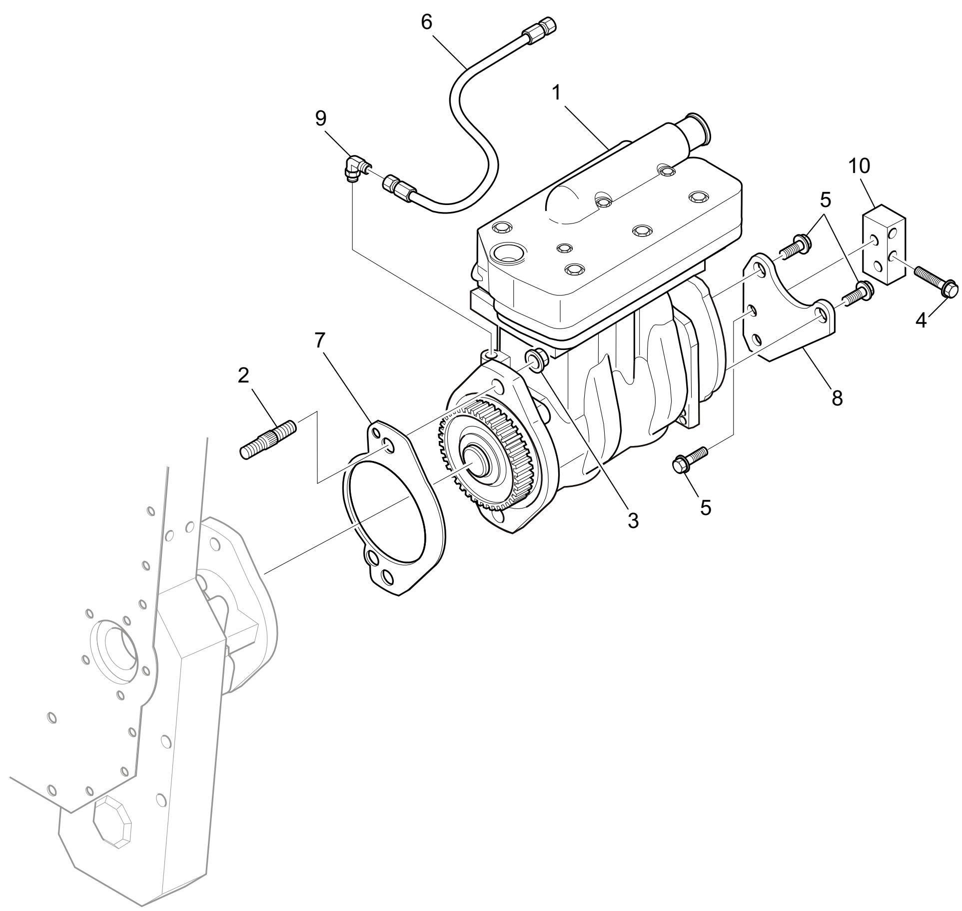
The air compressor is heavy. Use suitable lifting equipment or the assistance of another person to support the weight of the air compressor.

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:**

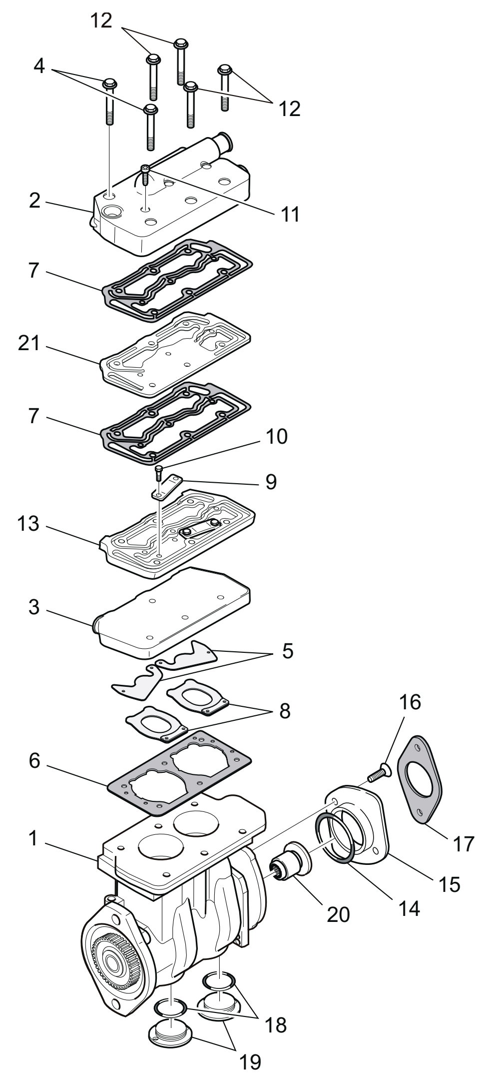
Twin cylinder air compressors do not require the piston position to be timed to the engine.

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.

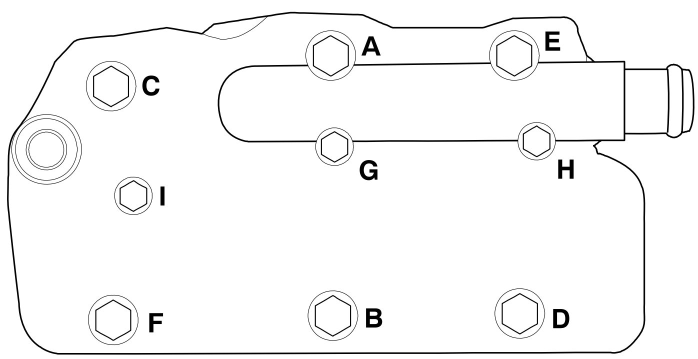


Fig. 8-3: Compressor Head Assembly Torque Pattern

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 to the hydraulic reservoir bracket.

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.

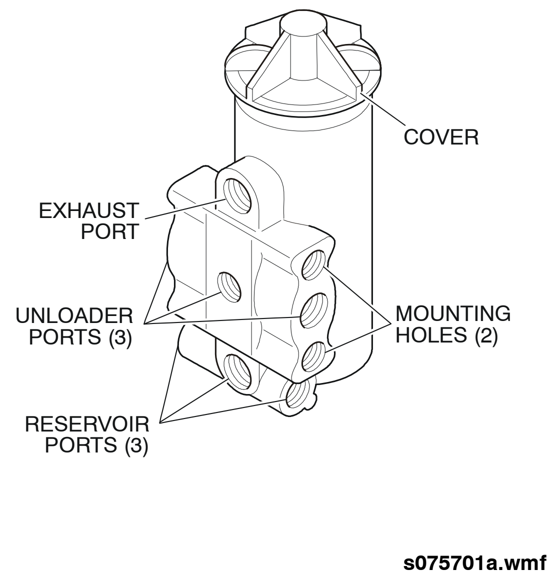


Fig. 8-4: Governor Exterior Ports

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.

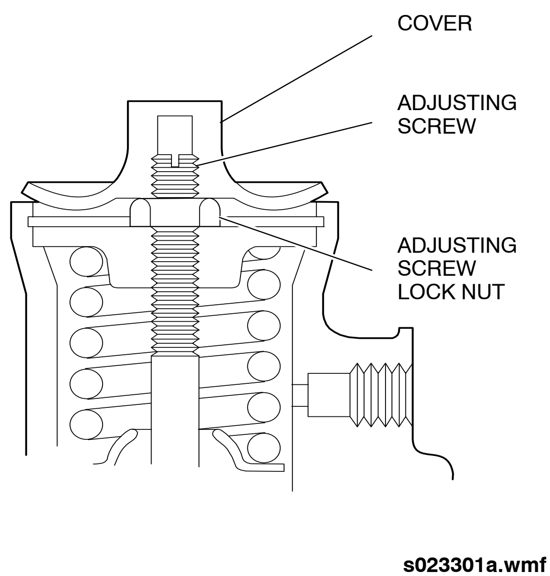


Fig. 8-5: Governor Adjustment

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.

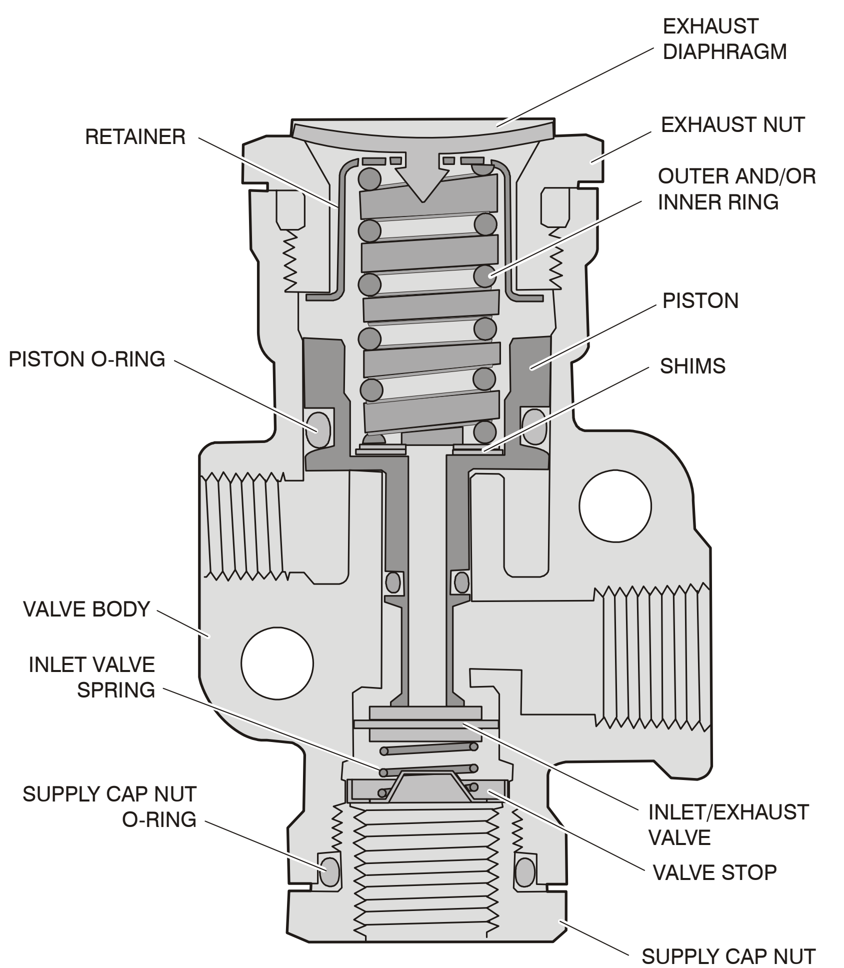


Fig. 8-6: Pressure Reducing Valve Cross Section

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. Interlock Solenoid Valve

WARNING

Refer to “WARNING” and “CAUTION” at the beginning of “Main Air Supply System Components” when performing maintenance on these components.

4.4.1. 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.

4.4.2. 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)

4.4.3. 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.

4.4.4. 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 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.

4.4.5. 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.

4.5. QBA15 Air Dryer

⚠ WARNING

Refer to "WARNING" and "CAUTION" at the beginning of "Main Air Supply System Components" when performing maintenance on these components.

4.5.1. 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.

4.5.2. 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.

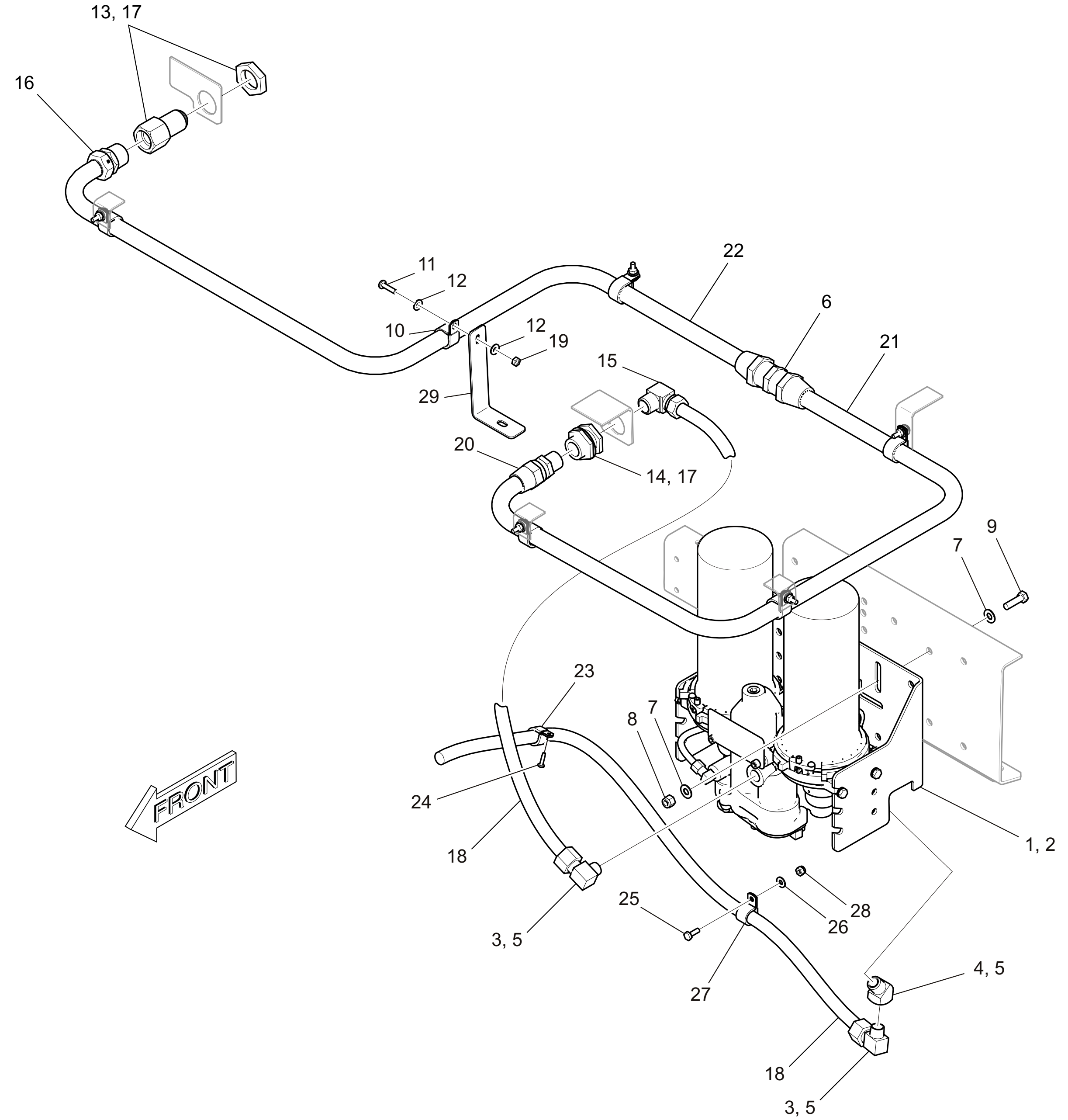
The electronic control module controls operation of the diverter valve assembly. A typical operating cycle consists of an air signal out the right-hand valve for 48 seconds, then no signal from either valve for 12 seconds, followed by a switch over to the left-hand valve for 48 seconds, then no signal 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.

4.5.3. Removal

1. Remove the three air lines from the air dryer. See "Fig. 8-7: Air Dryer Installation" on page 36.
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.



1. Air Dryer Assembly, (Incl. 2-5)
2. Air Dryer Assembly, QBA15NX5
3. Elbow, 90° 3/4" O.D. x 1/2" PT
4. Elbow, 45° Street 1/2" MPT
5. Loctite, 567 White
6. Union, 1" O.D. x 1" O.D.
7. Washer, Flat 3/8"
8. Nut, Lock Nylon 3/8" - 16 UNC
9. Bolt, Hex 3/8" - 16 UNC x 1 1/4" Lg.
10. Clamp, "P" 1" SST/HT
11. Screw, PH Cross Recess SST 1/4"
12. Washer, Flat SST 1/4"
13. Connector, 16 JIC 1 FPT Blkhd.
14. Connector, Anchor 3/4"
15. Elbow, 90° 3/4" NTA x 3/4" MPT
16. Connector, Straight 1" MPT
17. Loctite, 567 White
18. Tube, Nylon 3/4" Green
19. Nut, Hex Machine Screw 1/4"
20. Connector, 3/4" PT x 1" O.D.
21. Tube Assembly, Air Dryer
22. Tube Assembly, Air Dryer
23. Clamp, "P" 3/4" SST/HT
24. Screw, PH Cross Recess Tpg. Type F #10 - 24 UNC x 3/4" Lg.
25. Bolt, Hex 1/4" - 20 UNC x 3/4" Lg.
26. Washer, Flat 1/4"
27. Clamp, "P" 3/4" SST/HT
28. Nut, Lock Nylon 1/4" - 20 UNC
29. Bracket, Tube Support

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Fig. 8-7: Air Dryer Installation

4.5.4. 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 38.
   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.
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.

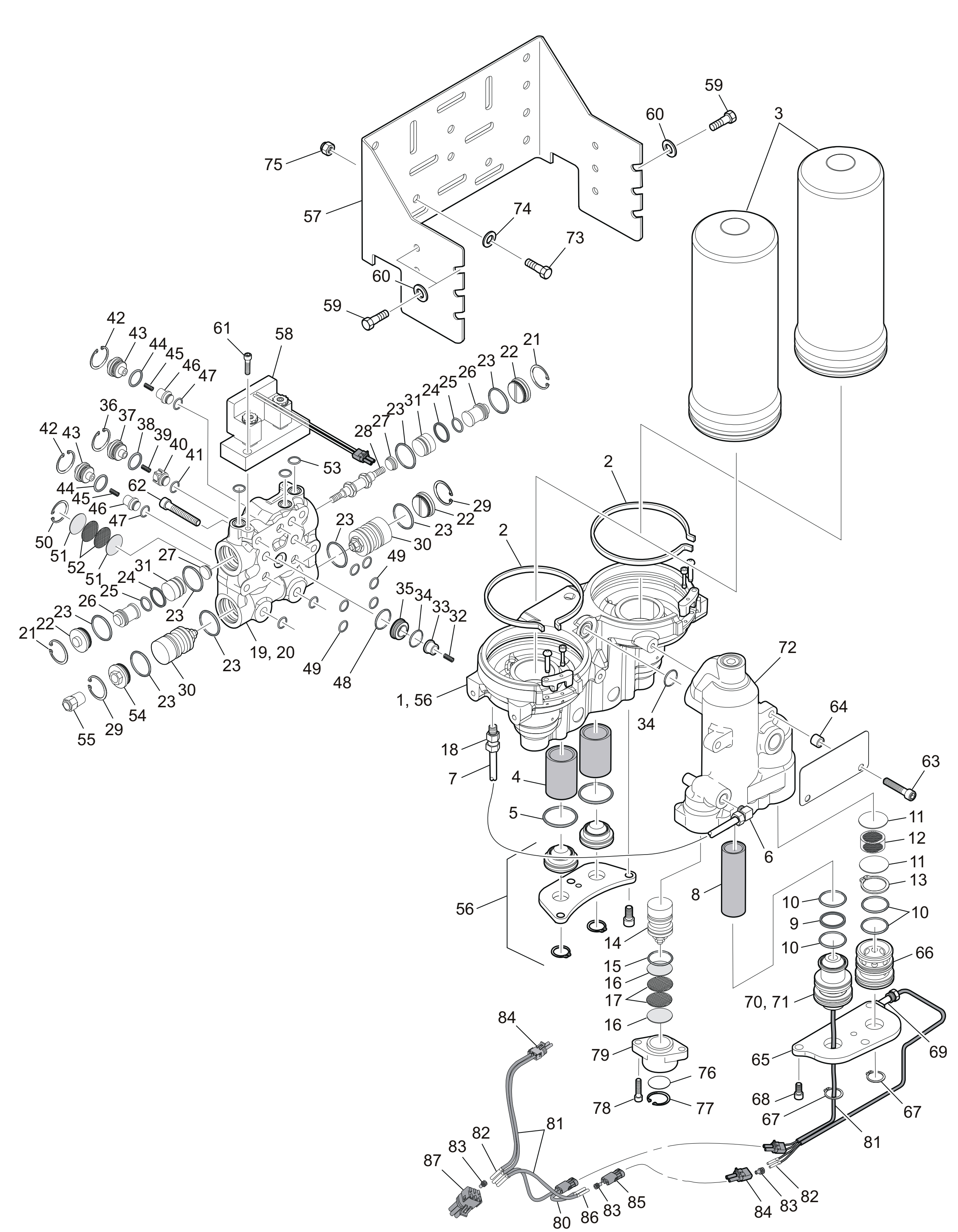


Fig. 8-8: Air Dryer Assembly

1. Air Dryer Assembly, QBA15NX5 (Incl. 2-19, 56-87)
2. Retainer
3. Canister, Desiccant Filled
4. Coalescing Element
5. O-Ring
6. Fitting Tube
7. Hose
8. Prefilter Element
9. O-Ring
10. O-Ring
11. Scrubber Disc
12. Scrubber Element
13. Retaining Ring
14. Unloader Valve
15. Crush Seal
16. Perforated Disc
17. Screen
18. Fitting Tube
19. Diverter Valve Assembly, (Incl. 20-55)
20. Housing
21. Retaining Ring
22. End Cap
23. O-Ring
24. Seal
25. O-Ring
26. Piston
27. Cap
28. Stem
29. Retaining Ring
30. Valve
31. Diverter Sleeve
32. Spring
33. Valve
34. O-Ring
35. Seat, Valve
36. Retaining Ring
37. Cap
38. O-Ring
39. Spring
40. Poppet
41. O-Ring
42. Retaining Ring
43. Cap
44. O-Ring
45. Spring
46. Poppet
47. O-Ring
48. O-Ring
49. O-Ring
50. Retaining Ring
51. Perforated Disk
52. Screen Disk
53. O-Ring
54. End Cap
55. Fitting Tube
56. Coalescer Housing
57. Bracket, Mounting
58. Electronic Control Module
59. Bolt, Hex 5/16" -18 x 5/8" Lg.
60. Washer, 5/16"
61. Bolt
62. Bolt
63. Bolt
64. Spacer
65. Plate
66. Scrubber
67. Retaining Ring
68. Bolt
69. Heater Assembly
70. Thermostat Assembly
71. Prefilter Nose
72. Body
73. Bolt, Hex 3/8" -16 x 1 1/4" Lg.
74. Washer, 3/8"
75. Nut, Hex 3/8" -16
76. O-Ring
77. Retaining Ring
78. Bolt
79. Unloader Cover
80. Wire, Exane 16 GA White
81. Cable, Exane
82. Female Terminal
83. Cable Seal
84. Connector Assembly, 2F
85. Connector Assembly, 2M
86. Male Terminal
87. Connector Assembly, 4F

Air Dryer Assembly (parts list)

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.

4.5.5. 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.

4.5.6. 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 name-plate. 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 cap-screws, 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.

4.5.7. 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.

4.5.8. 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.

4.6. Air Tanks

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

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.

4.6.2. 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.

4.6.2.1. Operation of Integral Check Valve

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.

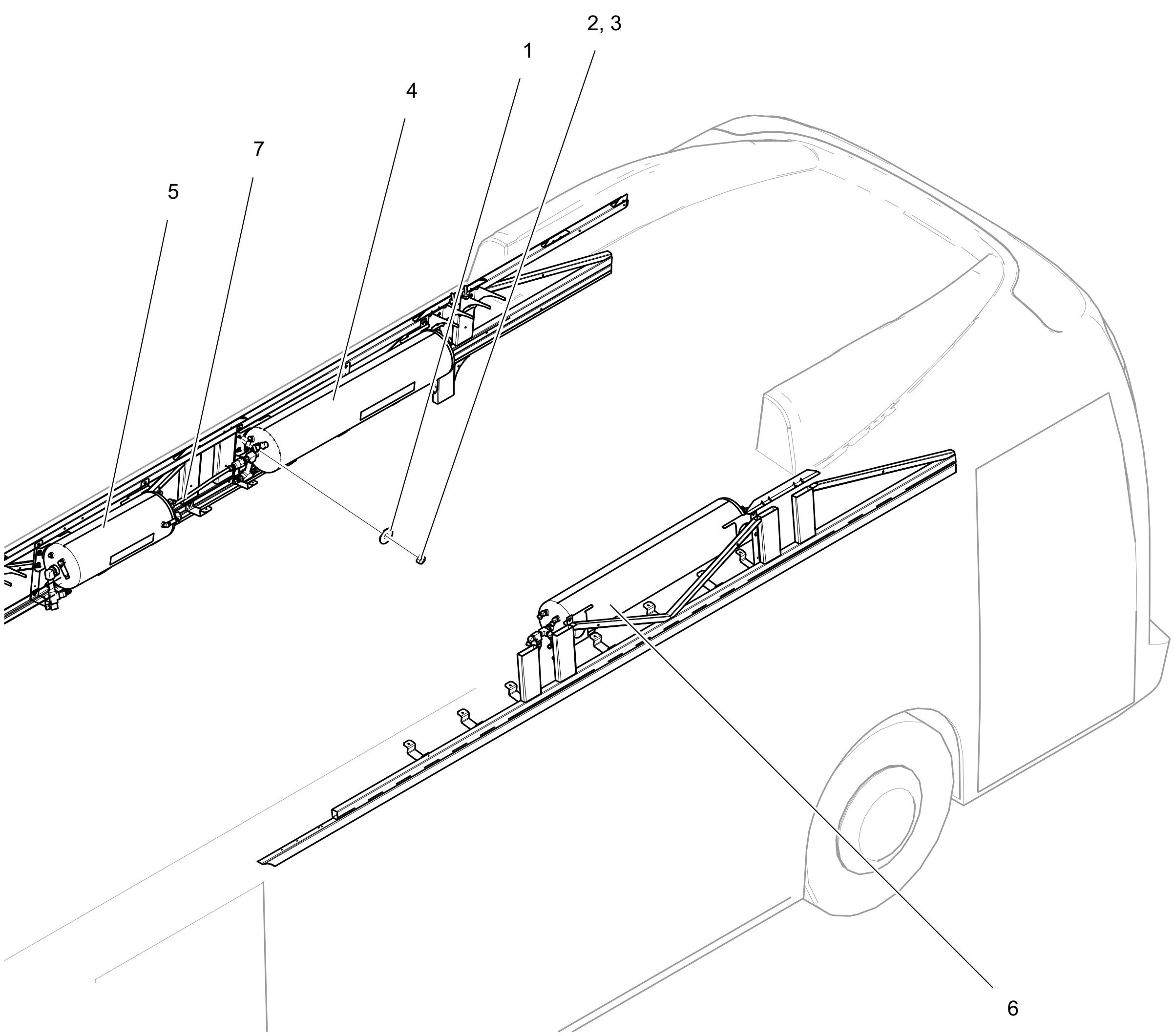
4.6.3. Cleaning & Inspection

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.

4.6.4. 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 44.
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. Washer, Large 5/16"
2. Loctite, 243
3. Nut, Hex 5/16" - 18 UNC
4. Air Tank Assembly, Front Brakes & Emergency
5. Air Tank Assembly, Wet & Rear Brakes
6. Air Tank Assembly, Kneeling & Accessories
7. Tube, Nylon 5/8" Green

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Fig. 8-9: Air Tank Locations

4.7. 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.

4.7.1. 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.

4.7.2. 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.

4.7.3. Removal

WARNING

During component removal or installation, ensure the Battery Disconnect switch is in the OFF position.

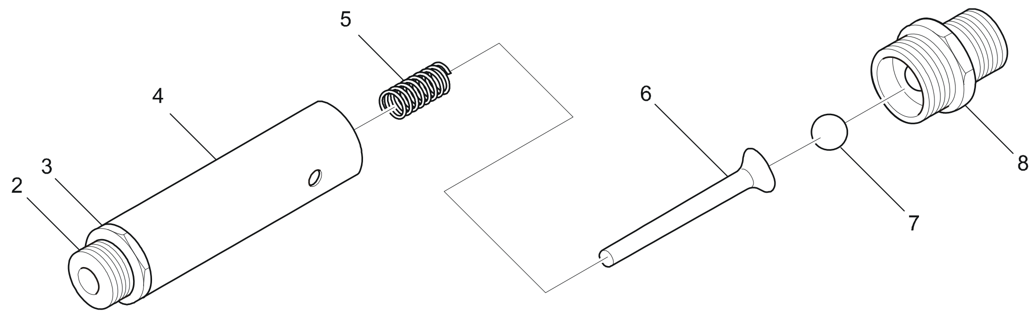
1. Block wheels or otherwise secure vehicle and drain reservoirs.
2. Using wrench flat closest to wet tank reservoir, unscrew valve from reservoir.

4.7.4. 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.

4.7.5. 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 46.
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

4.7.6. Cleaning & Inspection

Clean all parts in mineral spirits. Inspect all parts. All parts not considered serviceable should be replaced.

4.7.7. 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.

4.7.8. 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.

4.7.8.1. Raising Pressure Setting

1. Loosen lock nut.
2. Turn adjusting nut clockwise to obtain correct pressure setting.
3. Tighten lock nut.

4.7.8.2. Lowering Pressure Setting

1. Loosen lock nut.
2. Turn adjusting nut counter-clockwise to obtain correct pressure setting.
3. Tighten lock nut.

4.7.9. 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 4.7.5. “Disassembly” on page 45 and Refer to 4.7.7. “Assembly” on page 46 in this section for procedure. Refer to 4.7.8. “Adjustment” on page 46 in this section if adjustment is necessary.

4.7.10. 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 4.7.5. “Disassembly” on page 45 and Refer to 4.7.7. “Assembly” on page 46 in this section for procedure.

4.8. Air Lines & Fittings

WARNING

Refer to “WARNING” and “CAUTION” at the beginning of “Main Air Supply System Components” when performing maintenance on these components.

4.8.1. 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.

4.8.2. 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.

4.8.2.1. 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.

4.8.2.2. 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.**

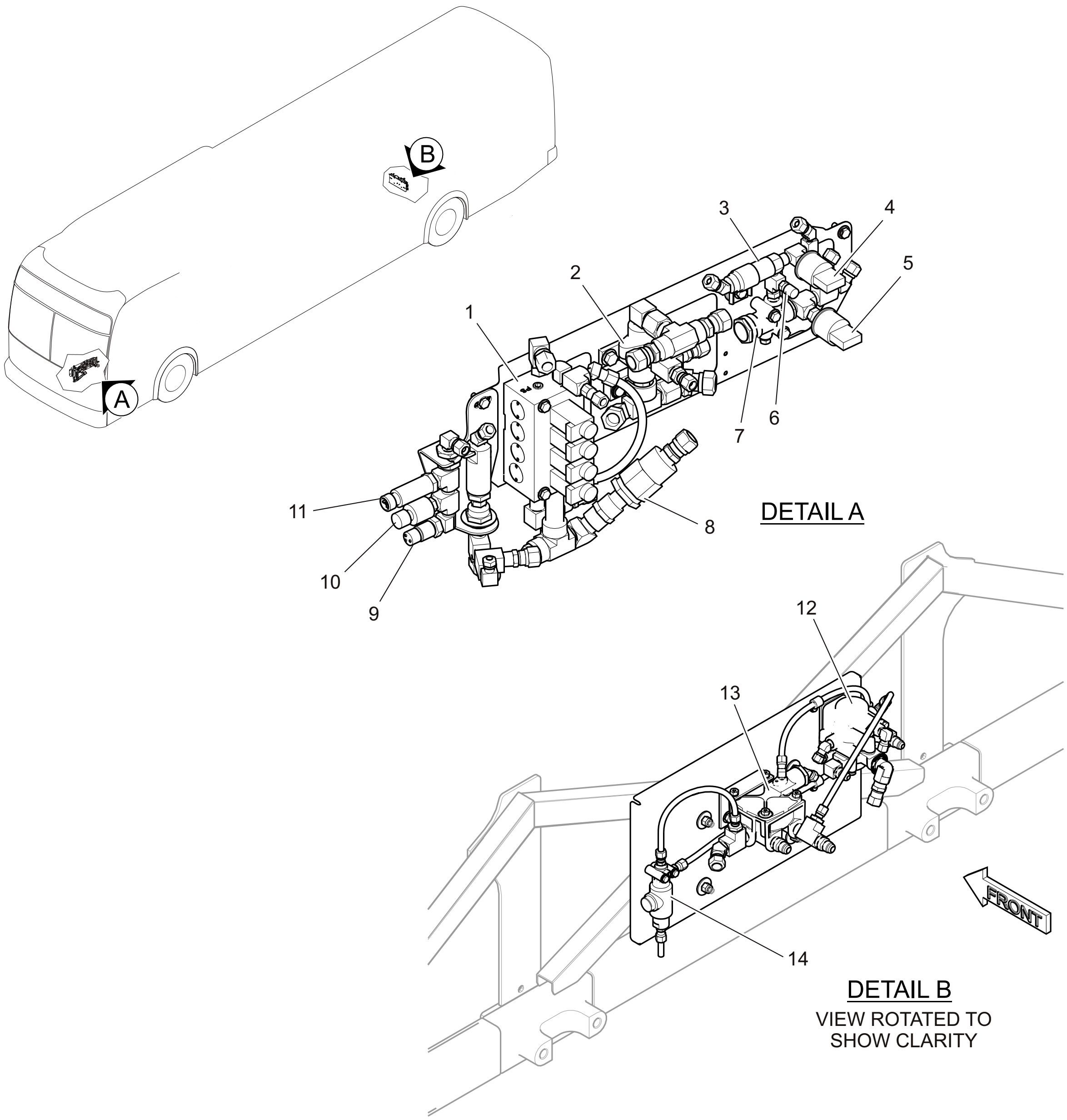
CAUTION

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 50. 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, E-Stroke
10. Pressure Transducer 250 psi
11. Pressure Transducer 150 psi
12. Spring Brake Control Valve
13. Relay Valve, R-14
14. Traction Control Valve

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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.

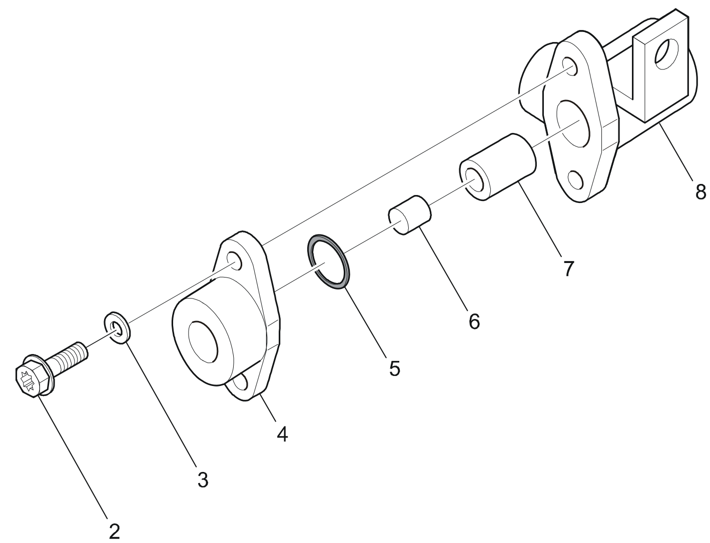
5.3.2. Operation

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 53.
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:

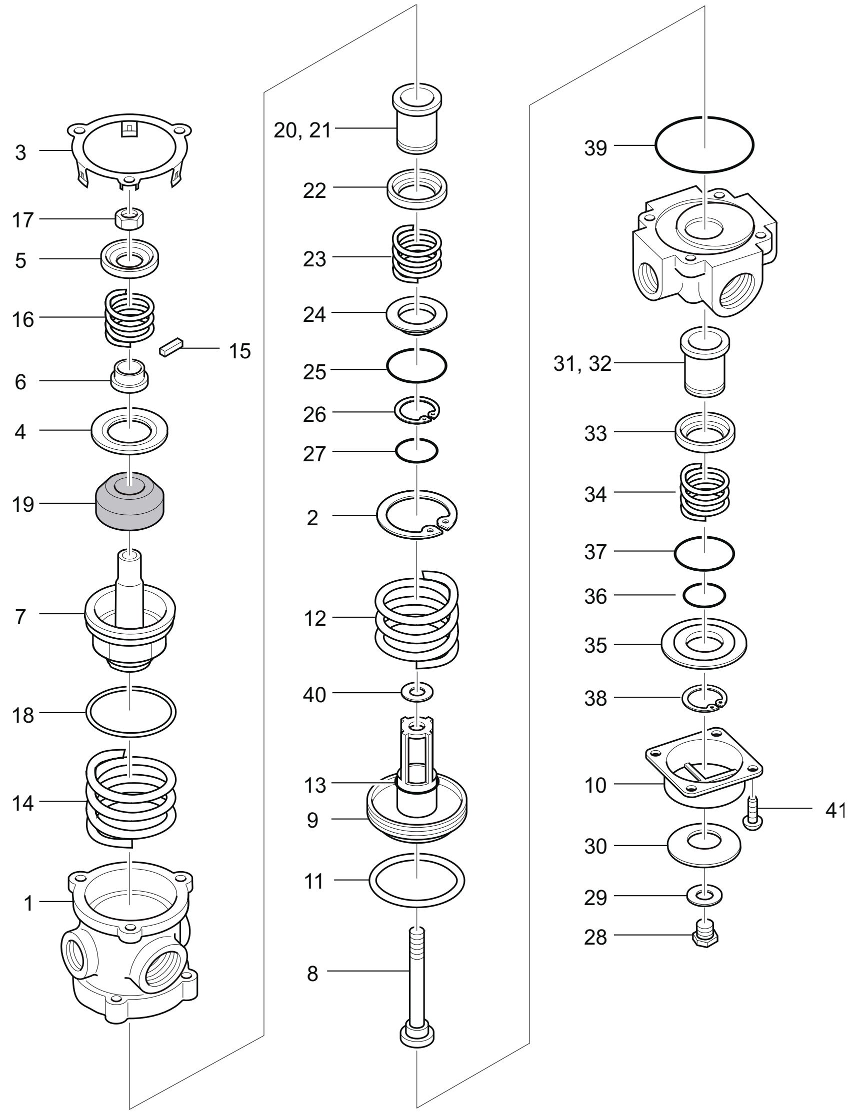
A Brake Valve Actuator (BVA) is attached to the E-6 Brake valve. See "5.5. Brake Valve Actuator" on page 61. *in this section for information on this component.*

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 55.

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 56.

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.

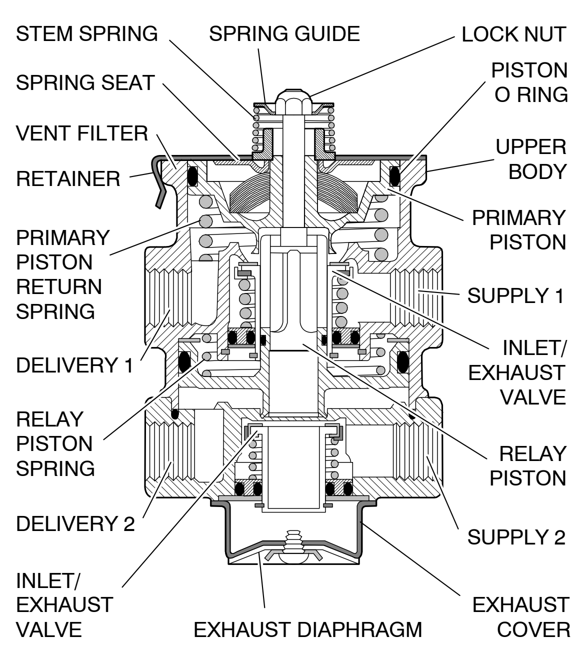


Fig. 8-14: E-6 Dual Brake Valve Cross Section

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 61 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 54 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 62.

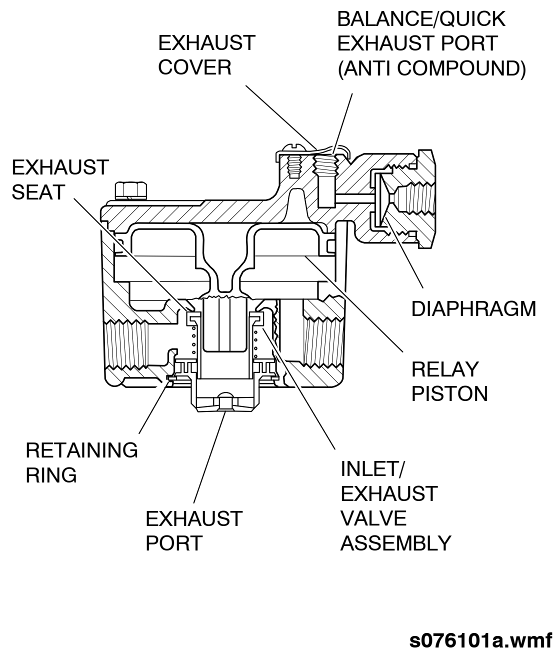


Fig. 8-15: R-14 Relay Valve Cross Section

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

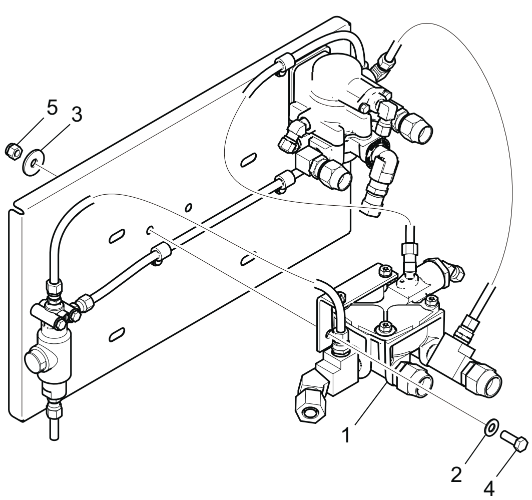
When control air pressure in the cavity above the relay piston is exhausted from the line, air pressure beneath the piston lifts the relay piston and exhaust seat away from the modulation tube opening the exhaust passage. With the exhaust passage open, the air pressure in the brake chambers is then permitted 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 63.

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.

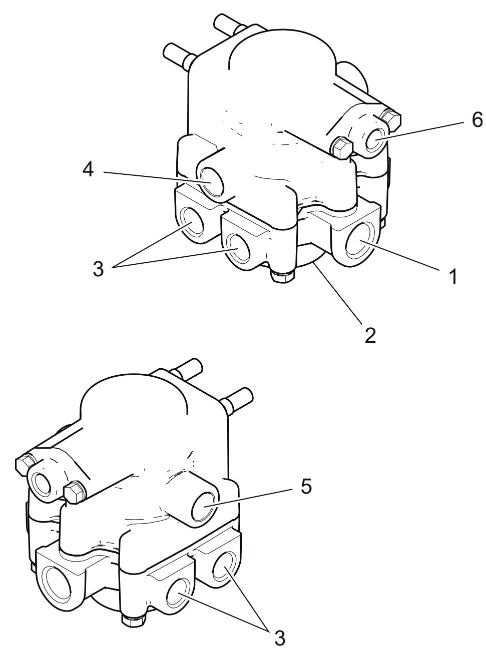
5.7.1. Description

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 64.

- 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

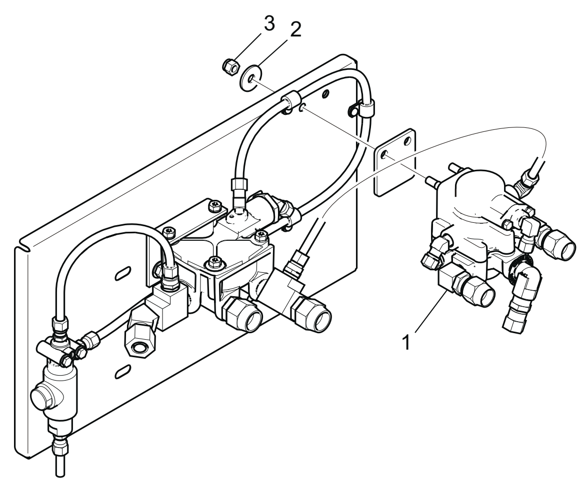
Refer to the Preventive Maintenance section of this manual for maintenance intervals and procedures.

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 66.
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

s131204a.svg

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 67. 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 67.

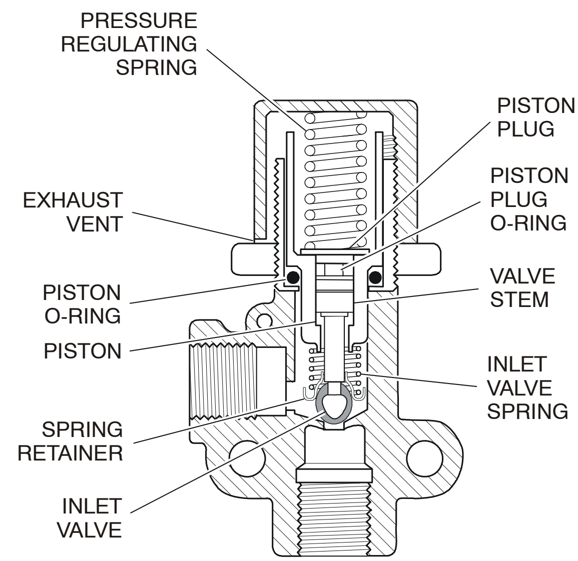
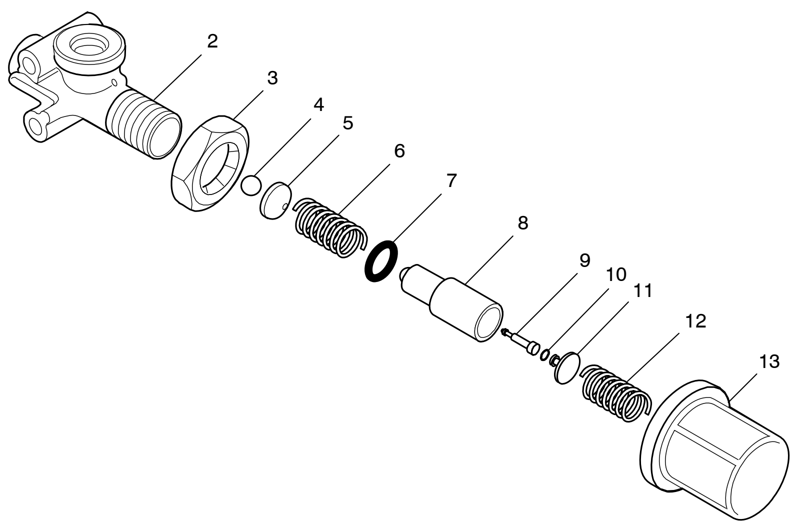


Fig. 8-19: PR-2 Pressure Protection Valve Cross Section



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.

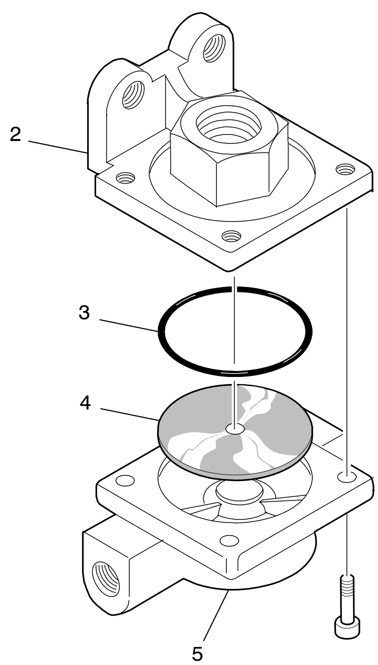
1. Block vehicle wheels and hold vehicle by means other than air brakes.
2. Drain all air brake system reservoirs.
3. Disconnect air lines from valve.
4. Remove mounting bolts, then valve.

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 71.
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 71 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 75.
4. Disconnect the electrical connector from the switch being replaced.
5. Remove the switch from the threaded fitting.

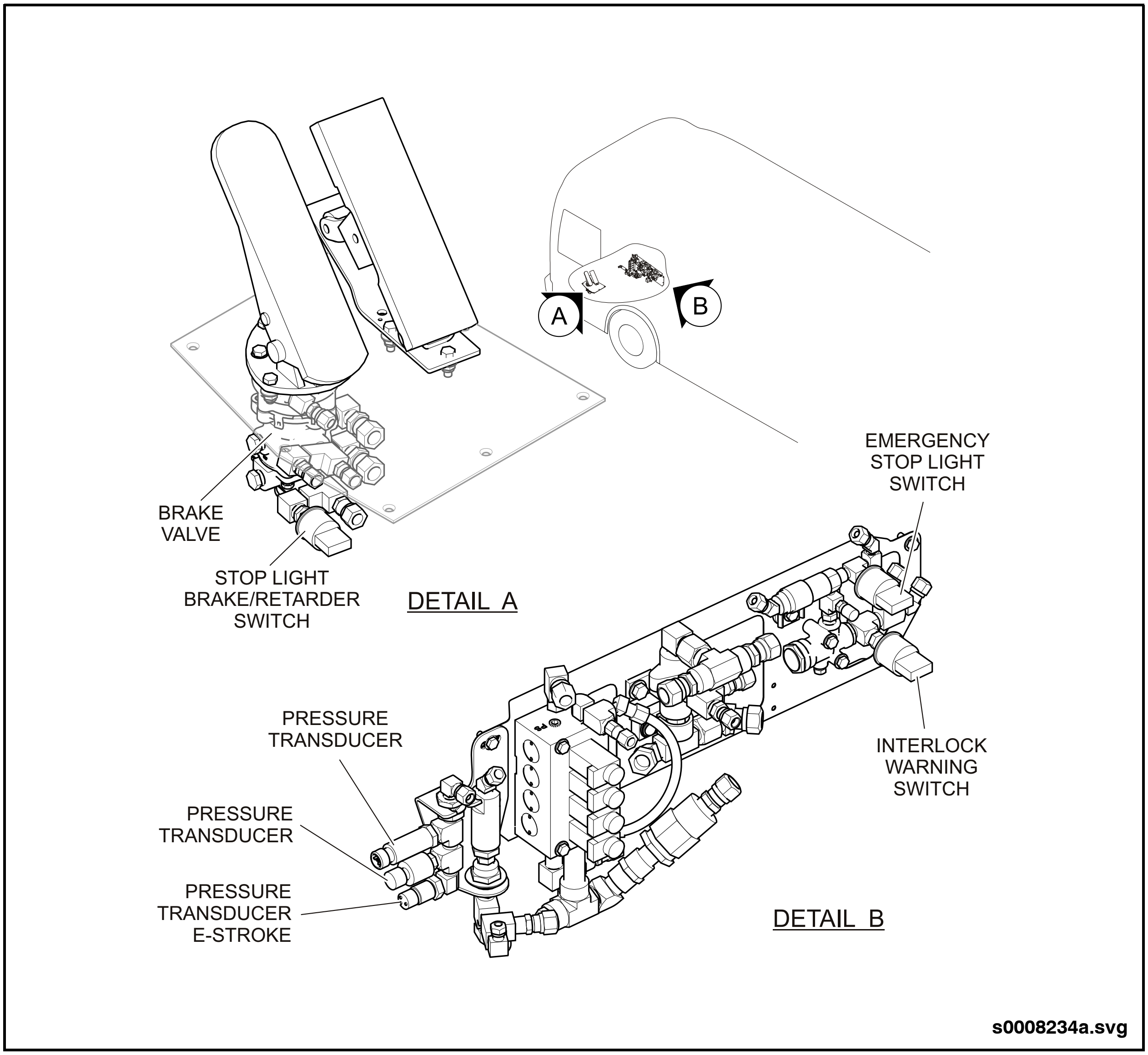


Fig. 8-22: Pressure & Stop Switches Installation

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 Application Pressure Transducer (PS15)

5.10.4.1.Description

The brake application pressure transducer is mounted on the pressure switch bracket and is teed into the Stop Light Pressure Switch (PS4) line. The brake application pressure transducer converts an air pressure input to an analog electrical output. The transducer is not a repairable item and must be replaced as an assembly if defective.

5.10.4.2.Operation

The pressure transducer senses delivery (D1) air pressure from the brake valve when the brake treadle is applied. The output signal from the pressure transducer is proportional to the applied brake pressure. This signal is used by the Drive Unit Vehicle Control Module (VCM) to control regenerative braking.

5.10.4.3.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 Brake Application Pressure Transducer.
4. Disconnect the electrical connector from the transducer.
5. Loosen the connector which retains the transducer to the tee fitting on the switch bracket and remove the transducer.

5.10.4.4.Installation

1. Install transducer onto tee fitting and tighten connector.
2. Connect electrical connector to transducer.
3. Close access door
4. Set Battery Disconnect switch to ON position.

5.10.5. Brake Tank Pressure Sending Units

5.10.5.1.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.

5.10.5.2.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

5.10.5.3.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.

5.10.5.4.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 air tank behind the aisle light panels.
4. Disconnect the electrical connector from the transducer.
5. Remove the transducer.

5.10.5.5.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.

5.10.6. Electronic Stroke Alert Pressure Transducer

5.10.6.1.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.

5.10.6.2.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.

5.10.6.3.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.

5.10.6.4.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

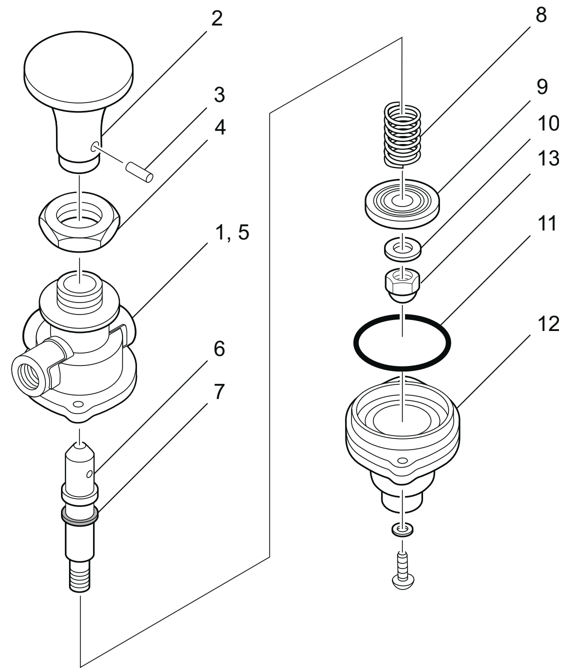
⚠ CAUTION

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 82.
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 83.

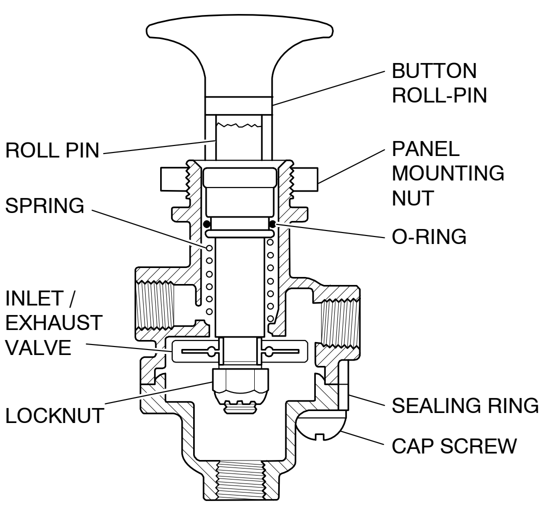


Fig. 8-24: Parking Brake Control Valve Cross Section

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 84.
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.

1. Park Brake Tower Assembly
2. Elbow, 45° 3/8" O.D. x 1/4" NPT
3. Connector, Bulkhead 1/4"
4. Grommet, .50 O.D. x .38 I.D. x .06 Thk.
5. Tube, Nylon 3/8" Brown

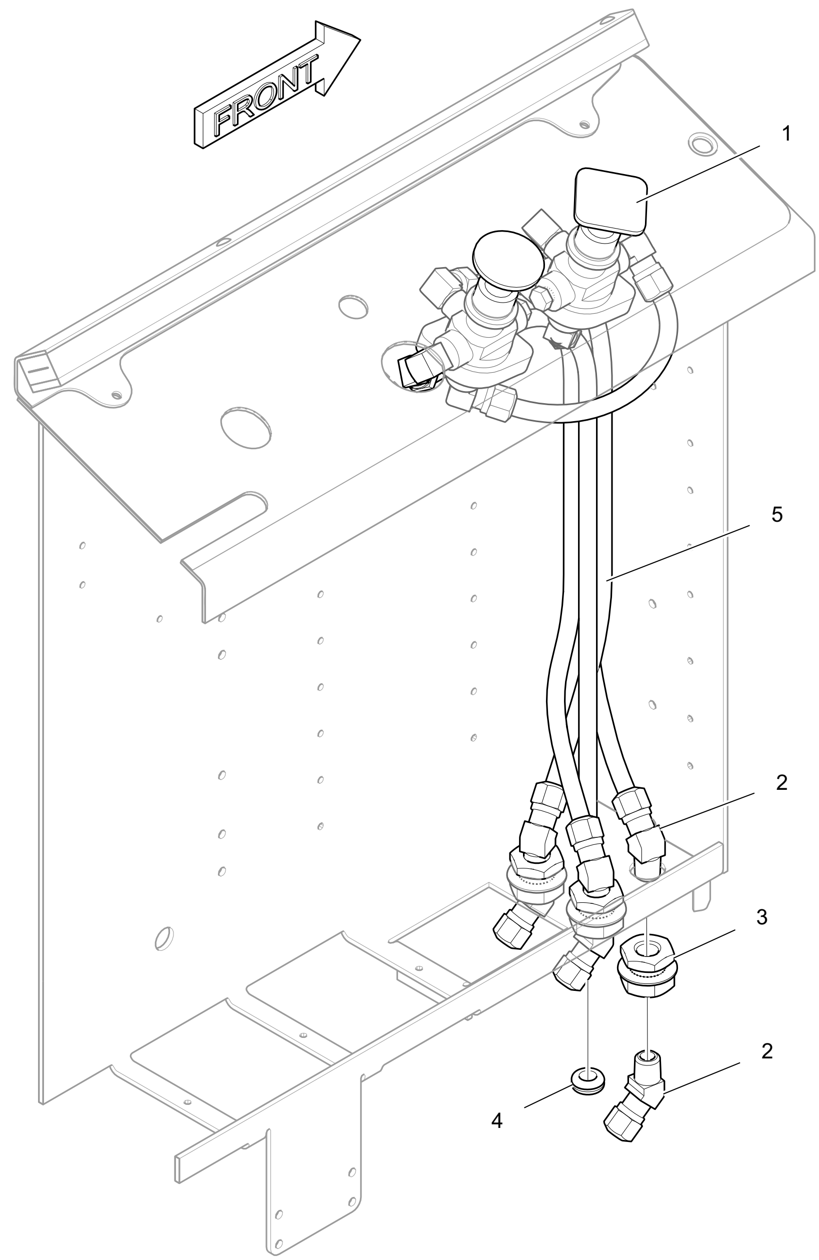


Fig. 8-25: Parking & Emergency Release Valve Installation

6.2.4. Installation

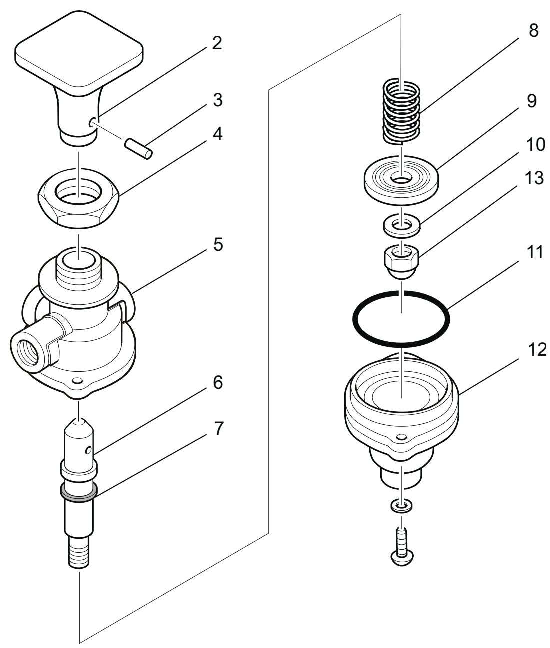
Installation is the reverse of removal. Ensure that the valve is located correctly for connection of the air lines.

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 85.
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 92 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 89. See “Fig. 8-28: Rear Leveling Valve Installation” on page 90.
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

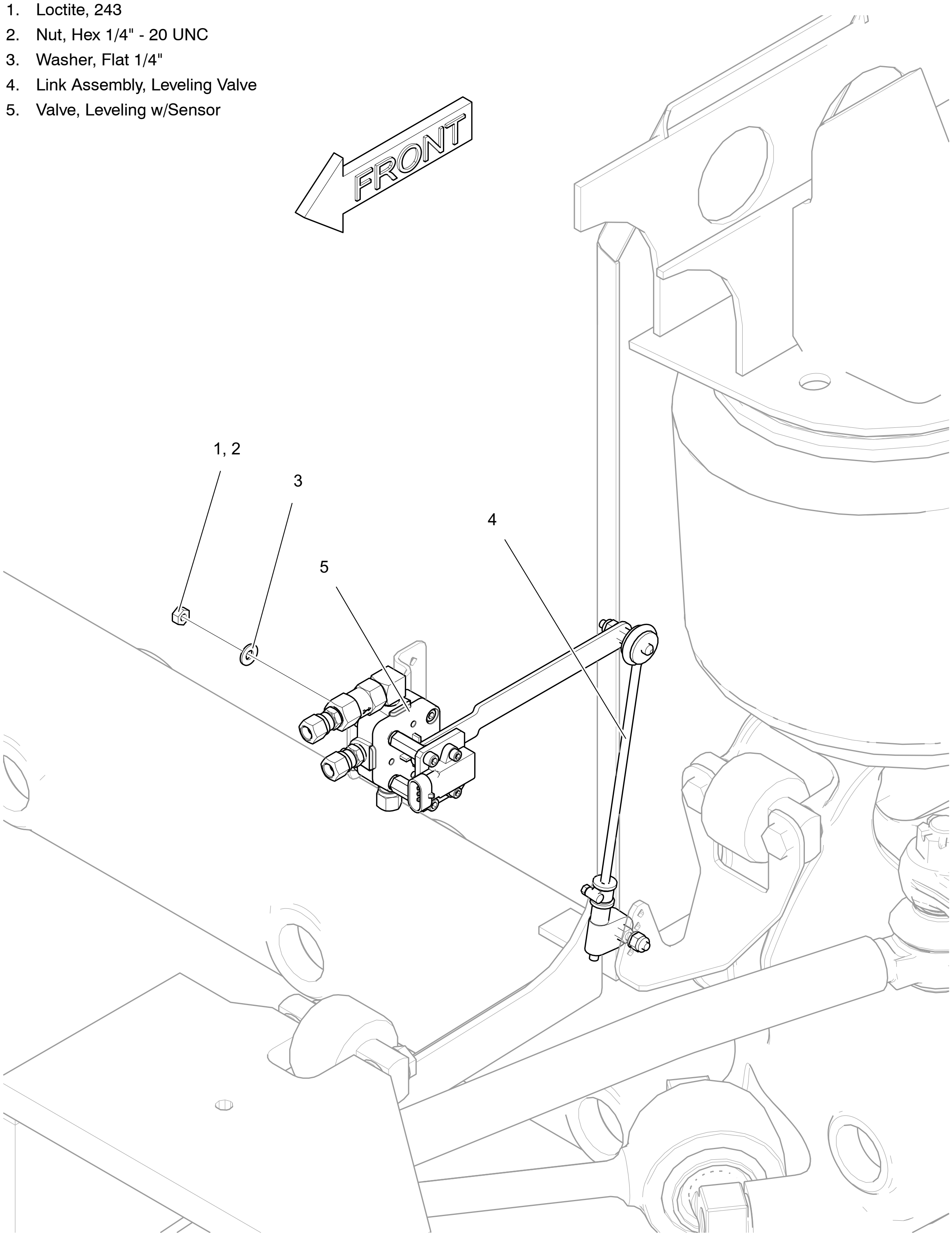


Fig. 8-27: Front Leveling Valve Installation

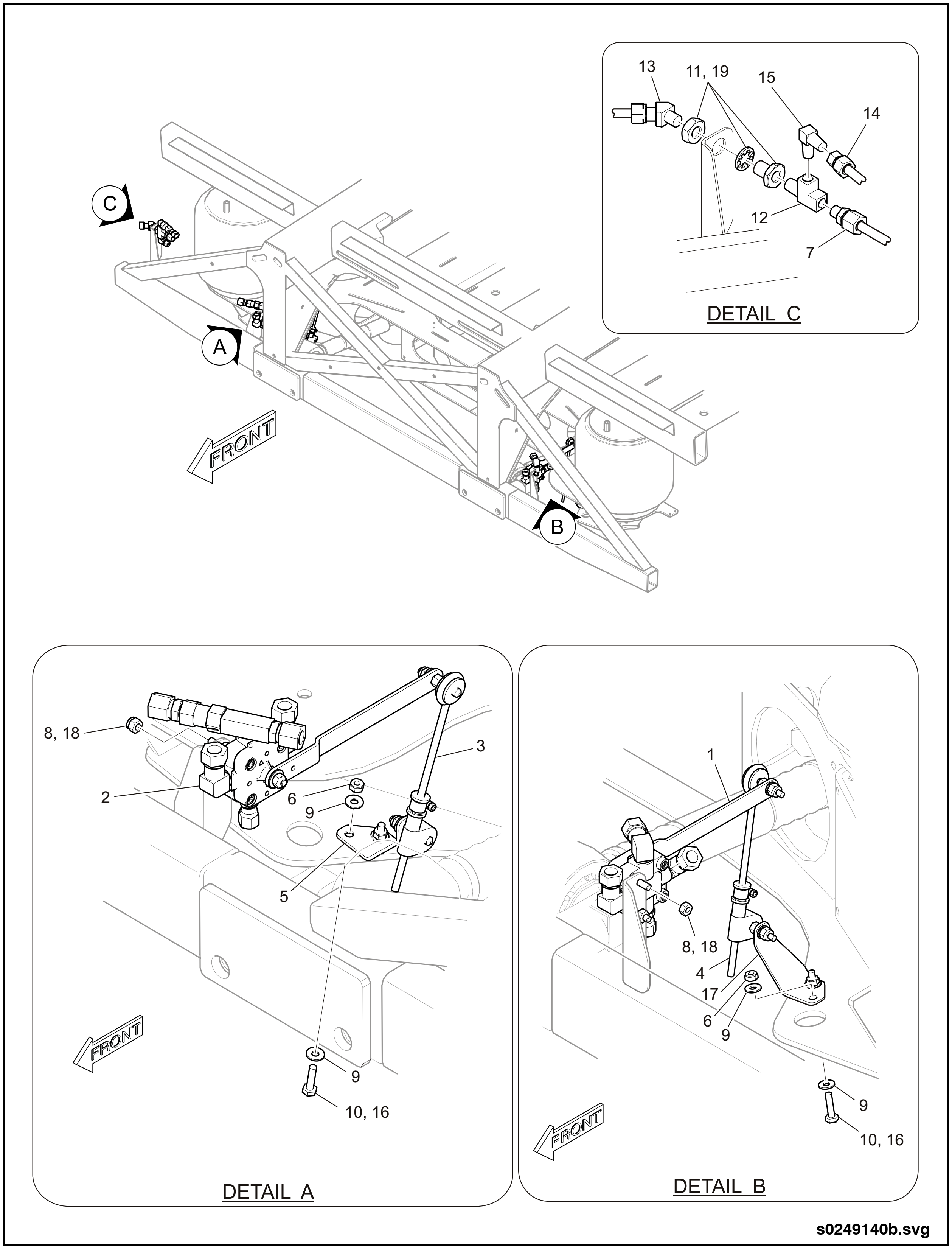


Fig. 8-28: Rear Leveling Valve Installation

1. Valve Assembly, Leveling Curbside	7. Connector, 1/2" O.D. x 1/4" PT	15. Elbow, 90° ext Pipe to ext Pipe
2. Valve Assembly, Leveling Streetside	8. Nut, Hex 1/4" - 20 UNC	16. Bolt, Hex SST 1/4" - 20 UNC x 1" Lg.
3. Link Assembly, Leveling Valve Curbside	9. Washer, Flat SST 1/4"	17. Bracket, Streetside Leveling Valve
4. Link Assembly, Leveling Valve Streetside	10. Adhesive, SIKA 221 White	18. Loctite, 243 Blue
5. Bracket, Curbside Leveling Valve	11. Connector, Bulkhead 1/4"	19. Loctite, 567 White
6. Nut, Hex Lock Steel 1/4" - 20 UNC	12. Tee, Street 1/4" PT	
	13. Elbow, 45° 1/2" O.D. x 1/4" PT	
	14. Connector, 1/4" FPT x 3/8" Syn.	

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. 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

7.2.4. 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.

7.2.5. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Drain the air system to remove pressure in the lines. See “Fig. 8-29: Front Kneeling Valve Installation” on page 94.
3. Locate the kneeling valve. Refer to 7.2.1. “Description” on page 92 in this section the for location.
4. Disconnect the three solenoid electrical connectors from the kneeling valve.
5. Disconnect and tag all air lines from the valve.
6. Remove fasteners that attach mounting bracket to vehicle and remove the kneeling valve, and bracket as an assembly from the vehicle.

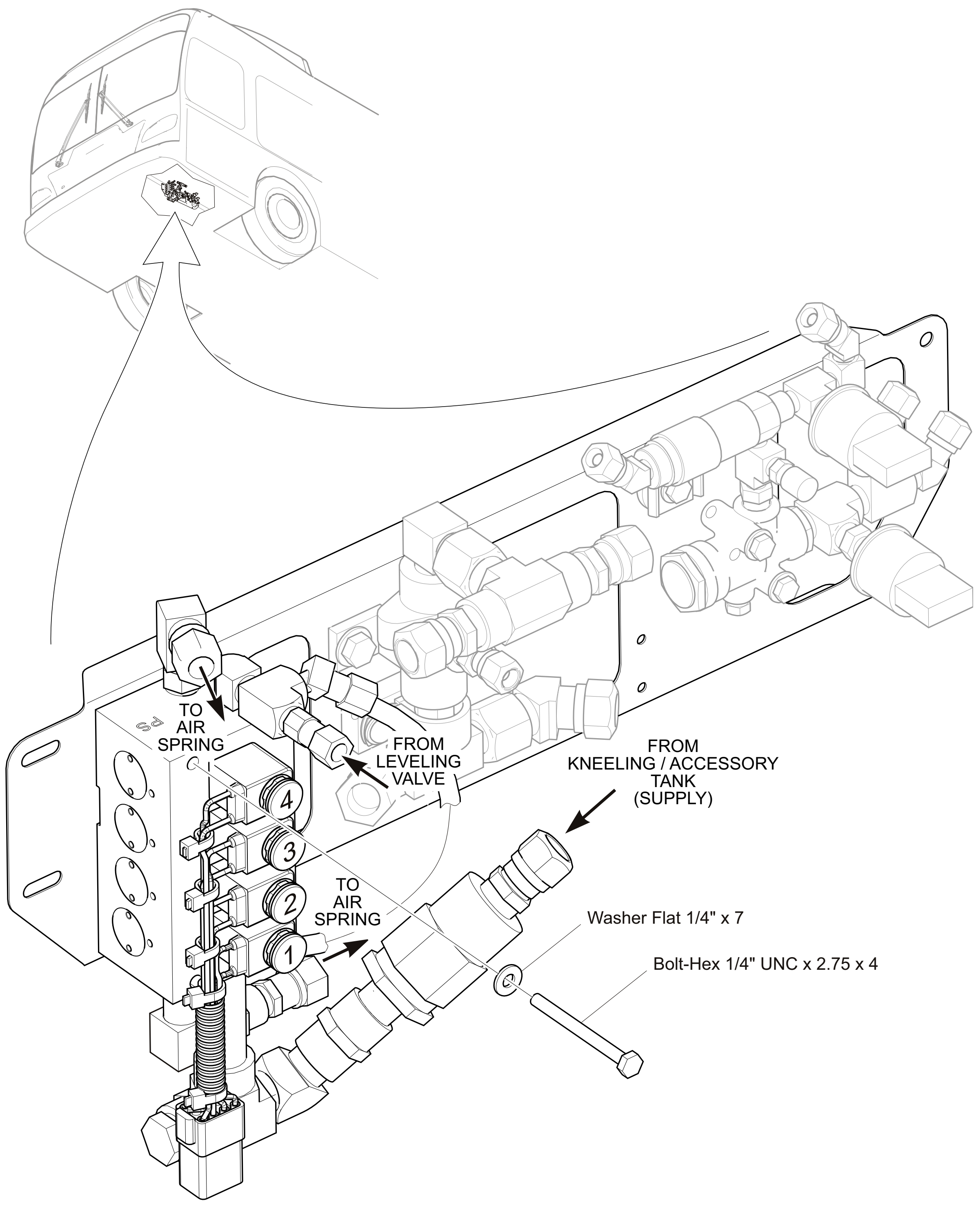
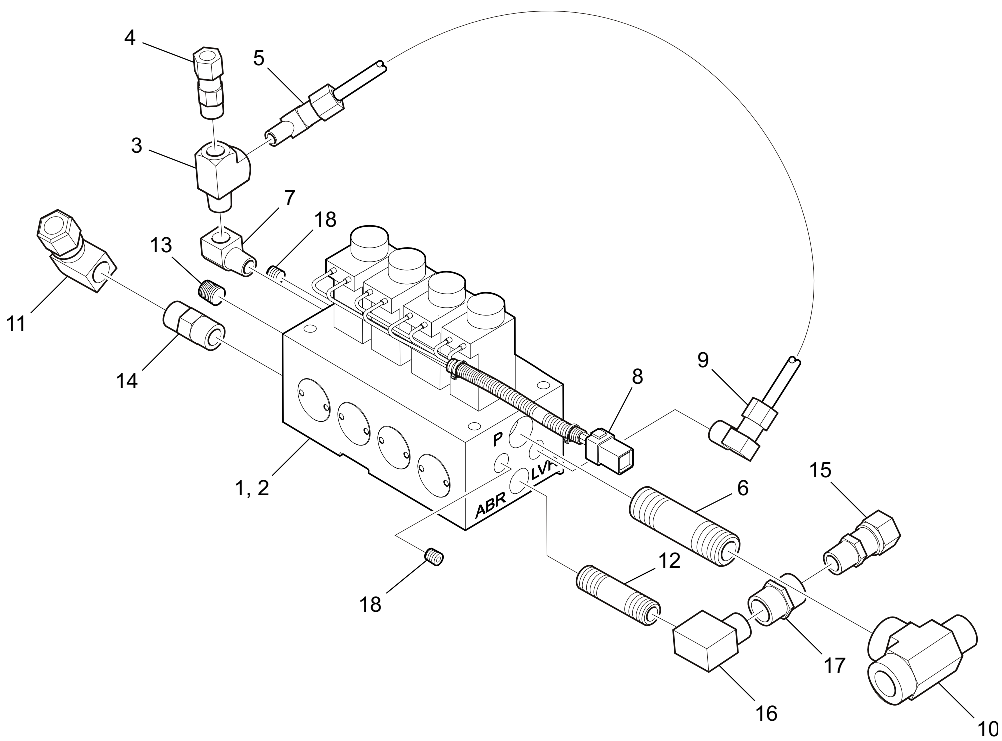


Fig. 8-29: Front Kneeling Valve Installation

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 96.
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

s035211a.svg

Fig. 8-30: Kneeling Valve Assembly

Electrical System

1. SAFETY

1.1. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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.

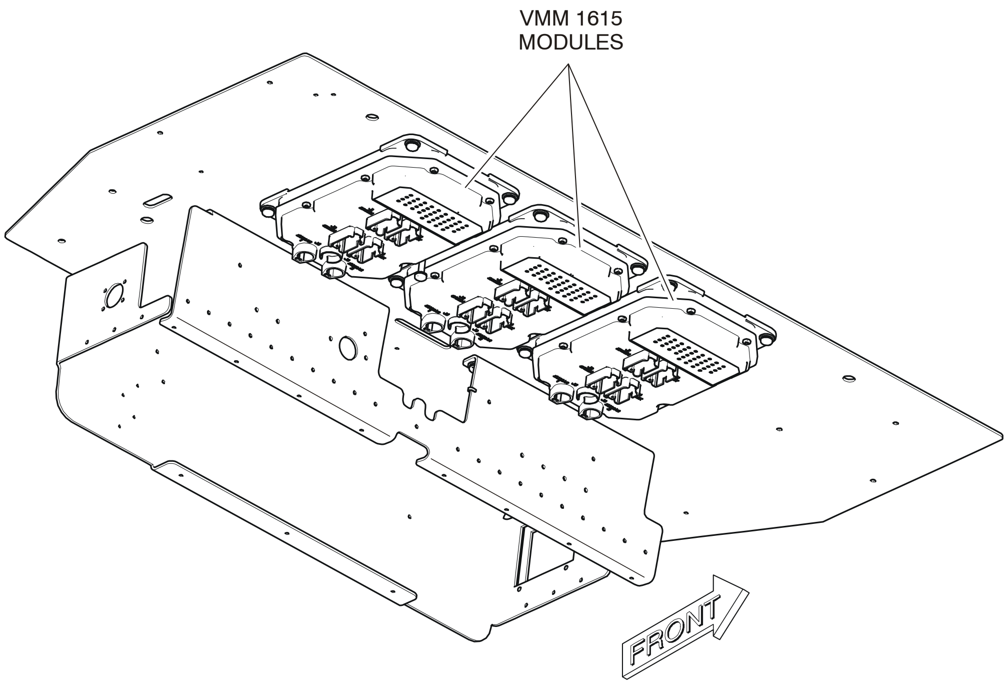


Fig. 9-1: Rear Panel

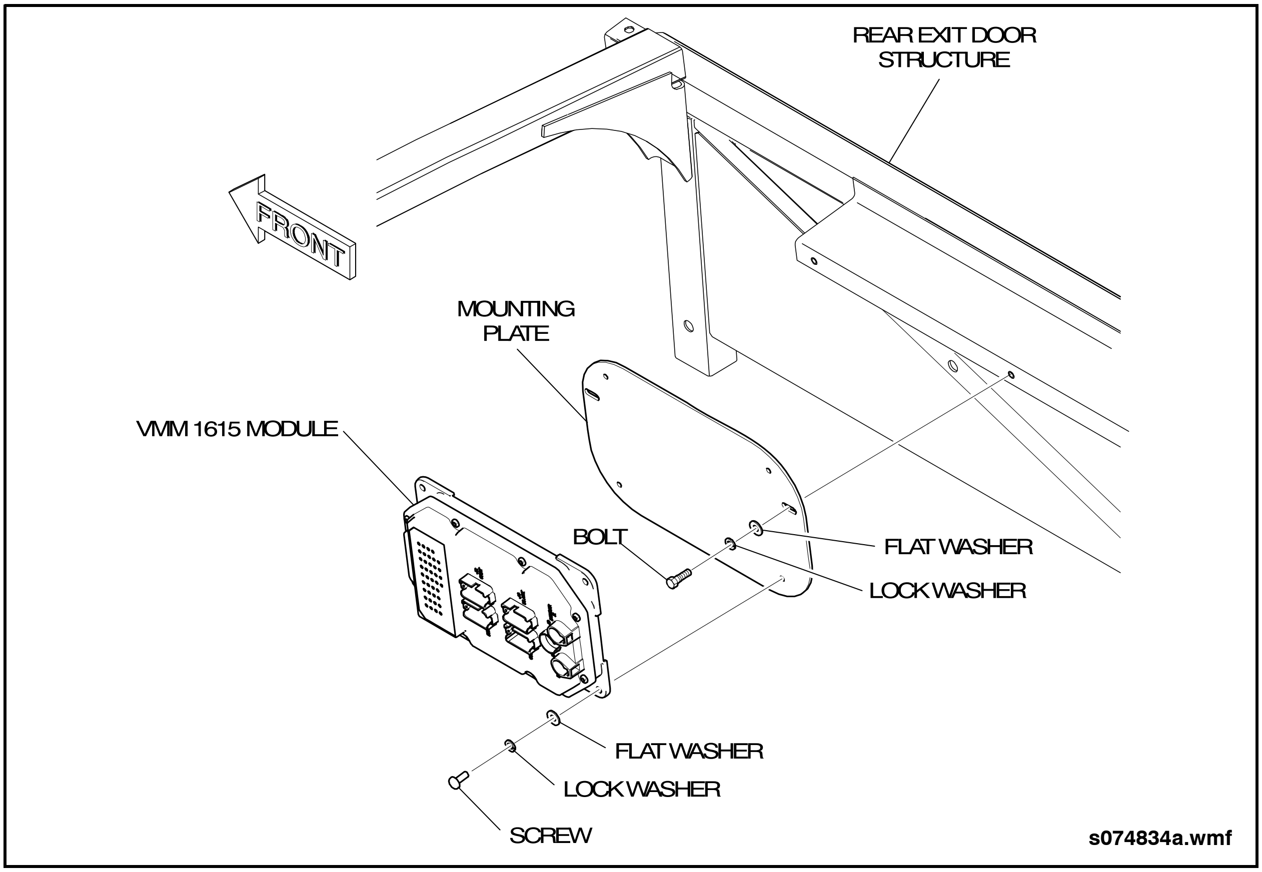


Fig. 9-2: Exit Door Module Installation

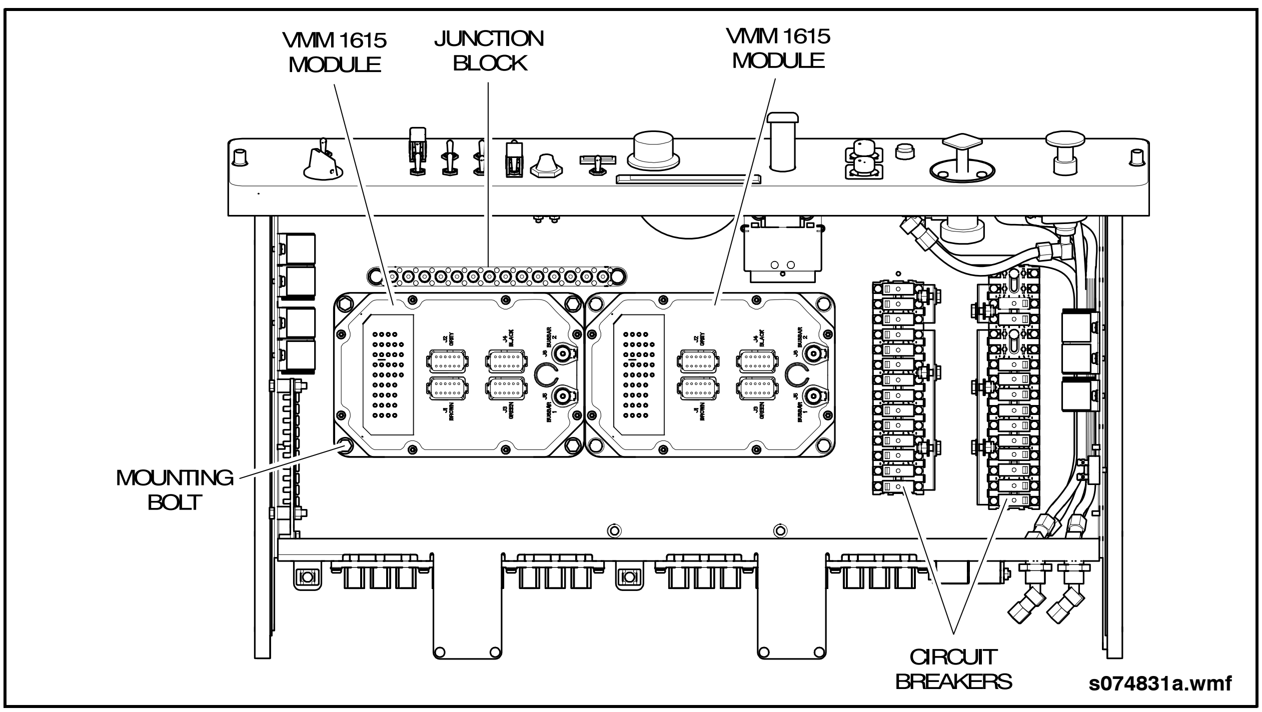


Fig. 9-3: Side Console Module Installation

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.

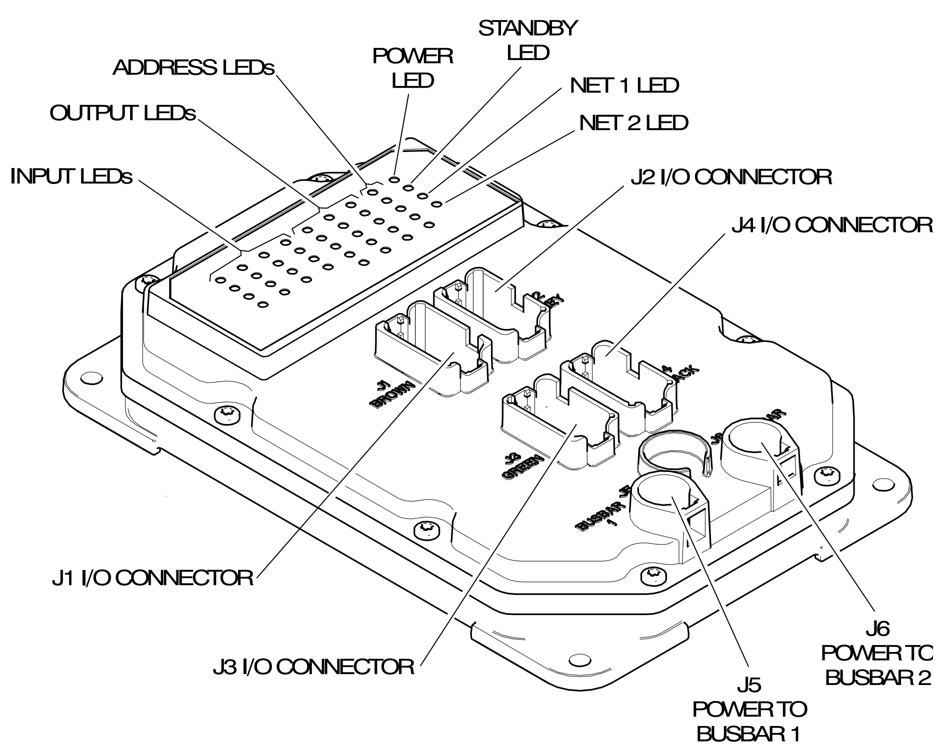


Fig. 9-4: VMM 1615 Module

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 16. “VENDOR SERVICE INFORMATION” on page 65 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, drive unit, 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 VMM's, 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 consists of a High Voltage DC to DC converter. It is mounted on the hybrid propulsion system equipment rack on the roof of the vehicle. Refer to Section 5 of this manual for information on the hybrid Propulsion System. The function of the DC to DC converter is to provide 24V to the electrical/multiplexing system and to recharge the battery system.

NOTE:

Refer to 5. “BATTERY SYSTEM” on page 14 *in this section for more information on this component.*

4.2. High Voltage DC to DC Converter

4.2.1. Description

The High Voltage DC to DC Converter (HVDC) is a roof-mounted electronic module that replaces the traditional belt-driven alternator in the vehicle's electrical system. The HVDC converts high voltage DC stored in the hybrid drive system's batteries to low voltage DC for charging the auxiliary vehicle batteries.

The HVDC is connected to the battery equalizer and the vehicle multiplexing system's node 15 via a dedicated controller area network (CAN) cable. The HVDC is connected to the hybrid drive system's high voltage interlock (HVIL) system. Removing the cover on the High Voltage Lug box will switch all high voltage power in the system off.

WARNING

DO NOT rely solely on the HVIL system to de-energize the electric drive system. Always perform the appropriate voltage checks and use lockout energy control techniques to ensure the system is de-energized. DO NOT attempt to bypass the HVIL system for any reason. Serious personal injury or death may result if proper safety procedures are not followed.

4.2.2. DC to DC Converter Specifications

Current Rating 300A

Input Voltage Range .... 500-780 VDC

Input Voltage (Full Power Out) .... 600 VDC

Output Voltage Range .... 24-30 VDC

Efficiency (At Max Power) 91%

Max Input Current .... 17 A

Standby Current .... <20 mA

Cooling Method .... Forced Air

Weight .... 75 lbs. (34 kG)

4.2.3. Operation

The converter begins operating and charging the auxiliary batteries when it receives a signal the engine is running and the input high voltage is between 500 and 800 VDC. The converter provides up to 250 amps of continuous current and shuts down when the input voltage drops below 500 volts. Once the input voltage is equal to or greater than 550 volts, the converter restarts automatically.

A soft shutdown is performed when the input voltage is above 800 volts and restarts automatically once the input voltage drops below 750 volts. If the input voltage exceeds 850 volts, the converter shuts down without restating automatically when voltage drops below 750 volts again. To restart the converter operation, the engine must be shut down and restarted.

4.2.4. Maintenance

NOTE:

The High Voltage DC to DC converter's internal components can only be serviced by the manufacturer.

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance procedures and intervals.

4.2.5. Removal

DANGER

The Hybrid Drive System and the DC to DC converter use potentially lethal voltages. Serious personal injury or death could result if proper lockout procedures are not followed prior to servicing this equipment. Refer to Section 5 of this manual for high voltage safety procedures before servicing.

ALWAYS wear fall protection equipment when working on the roof of the vehicle.

ALWAYS wear High Voltage Personal Protective Equipment when working on the high voltage electrical system.

1. Switch the battery disconnect switch to the OFF position and secure with lock-out equipment.
2. Disconnect the high voltage batteries from the hybrid drive system. Refer to “High Voltage Disconnect Verification” in Section 5 of this manual for procedure.
3. Remove the cover from the high voltage junction box. Verify that no power is present in the junction box as follows:
   a. Use a 1000 VDC voltmeter to measure the voltage between the RED and BLACK terminals. The voltage should be less than 3 VDC.
   b. Measure the voltage between the RED terminal and chassis ground. The voltage should be less than 3 VDC.
   c. Measure the voltage between the BLACK terminal and chassis ground. The voltage should be less than 3 VDC.
   d. If the voltages are not less than 3 VDC, reinstall the cover for twenty minutes and then make these same measurements again.

   ☞**NOTE:**

   If the voltage does not fall below 3 VDC, notify a specialist trained in Allison's Energy Storage System.

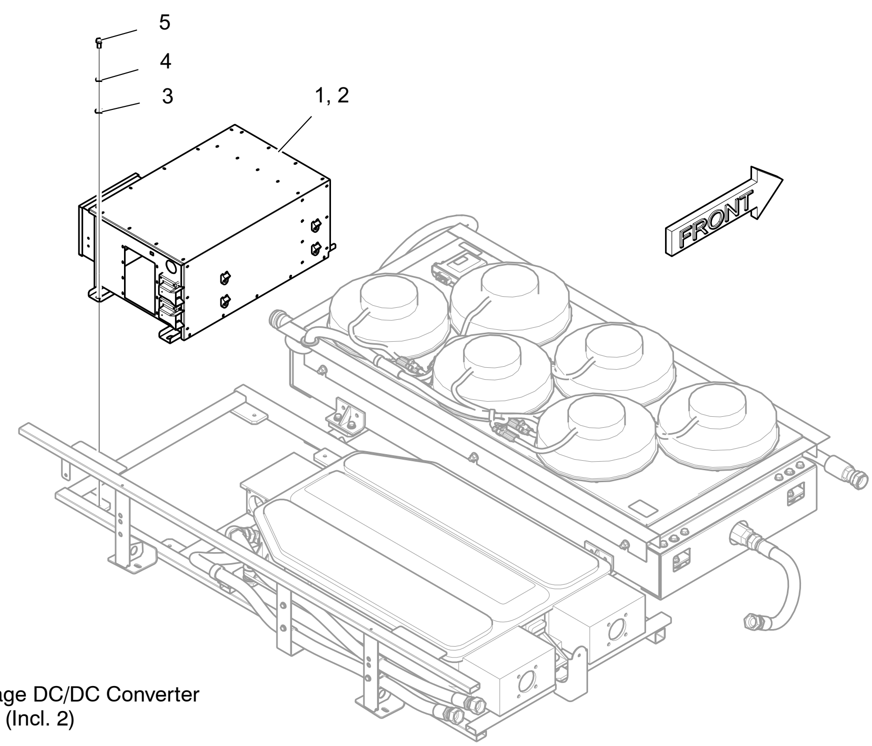
4. Once verification is complete and no high voltage is present inside the high voltage junction box, disconnect the high voltage cables from the converter. Discard the mounting hardware and wrap the cable ends with electrical tape to protect them.
5. Remove the collar nut connecting the high voltage conduit to the junction box and remove the cable assembly from the high voltage junction box.
6. Tag and disconnect the high voltage interlock harness from the converter.
7. Reinstall the cover on the high voltage junction box.

8. Verify that no power is present at the low voltage terminals as follows:
   a. Use a DC voltmeter to measure the voltage between the RED and BLACK terminals. The voltage should be less than 3 VDC.
   b. Measure the voltage between the RED terminal and chassis ground. The voltage should be less than 3 VDC.
   c. Measure the voltage between the BLACK terminal and chassis ground. The voltage should be less than 3 VDC.
   d. Do not remove the wiring if voltage is present.
9. Remove the covers from the low voltage output terminal connection points and remove the low voltage cables. Discard the mounting hardware and wrap the cable ends with electrical tape to protect them.
10. Remove the cable ties holding the low voltage wiring to the converter.
11. Tag and disconnect the CAN harnesses form the converter.
12. Remove the mounting bolts securing the converter to the DPIM equipment rack. See "Fig. 9-5: High Voltage DC to DC Converter" on page 11.

☞NOTE:

One mounting bolt also secures an equipment rack grounding wire. Note the location and orientation of all fasteners for reassembly.

13. Remove the converter form the vehicle.



1. High Voltage DC/DC Converter Assembly (Incl. 2)
2. Air Filter
3. Washer, Flat Hardened 3/8"
4. Washer, Lock Spring Type 3/8"
5. Bolt, Hex 3/8" - 16 UNC x 3/4" Lg.

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Fig. 9-5: High Voltage DC to DC Converter

4.2.6. Installation

1. Position the converter on the DPIM equipment rack.
2. Secure the converter in place with the mounting bolts washers and lock washers. Torque bolts to 25 to 30 ft-lb. (34 to 41 Nm).

☞NOTE:

Be sure to reinstall the equipment rack grounding wire under the converter's mounting bolt. Clean the ground terminal and the mounting location to bare metal prior to reassembly.

3. Remove the low voltage covers to access the cable connection studs.
4. Reinstall the low voltage negative and positive cables onto the converter. Attach the positive cable to the RED terminal and the negative cable to the BLACK terminal. Be sure the lugs sit flat on the terminal base.

⚠CAUTION

Drawing the lugs down with the mounting hardware, lug misalignment or applying excessive torque will break the terminal studs.

5. Install new hardware and torque fasteners to 100 in-lb. (11 Nm). See “Fig. 9-6: Low Voltage Lug Installation Detail” on page 13.
6. Reinstall the low voltage terminal covers and torque to 10 in-lb. (1 Nm). Do not over torque fasteners.
7. Use wide, heavy duty cable ties with a maximum width of 1/2" to secure the low voltage cables to the converter.
8. Connect the high voltage interlock harness and the CAN harness to the converter.
9. Remove the high voltage junction box cover.
10. Reinstall the high voltage power cable conduit assembly into the high voltage junction box. Slide the collar nut over the high voltage wiring and tighten the conduit to the junction box.
11. Install the high voltage wiring lugs to the high voltage studs. Attach the positive cable to the RED terminal and the negative cable to the BLACK terminal. Be sure the lugs sit flat on the terminal base.

⚠CAUTION

Drawing the lugs down with the mounting hardware, lug misalignment or applying excessive torque will break the terminal studs.

12. Install new hardware and torque fasteners to 60 to 70 in-lb. (6.8 to 7.9 Nm). See “Fig. 9-7: High Voltage Lug Installation Detail” on page 13.
13. Install the high voltage junction box cover.
14. Reconnect all high voltage systems and switch the Battery Disconnect switch to the ON position.
15. Once the hybrid drive system is started and functioning, test the vehicle and high voltage DC to DC converter operation.

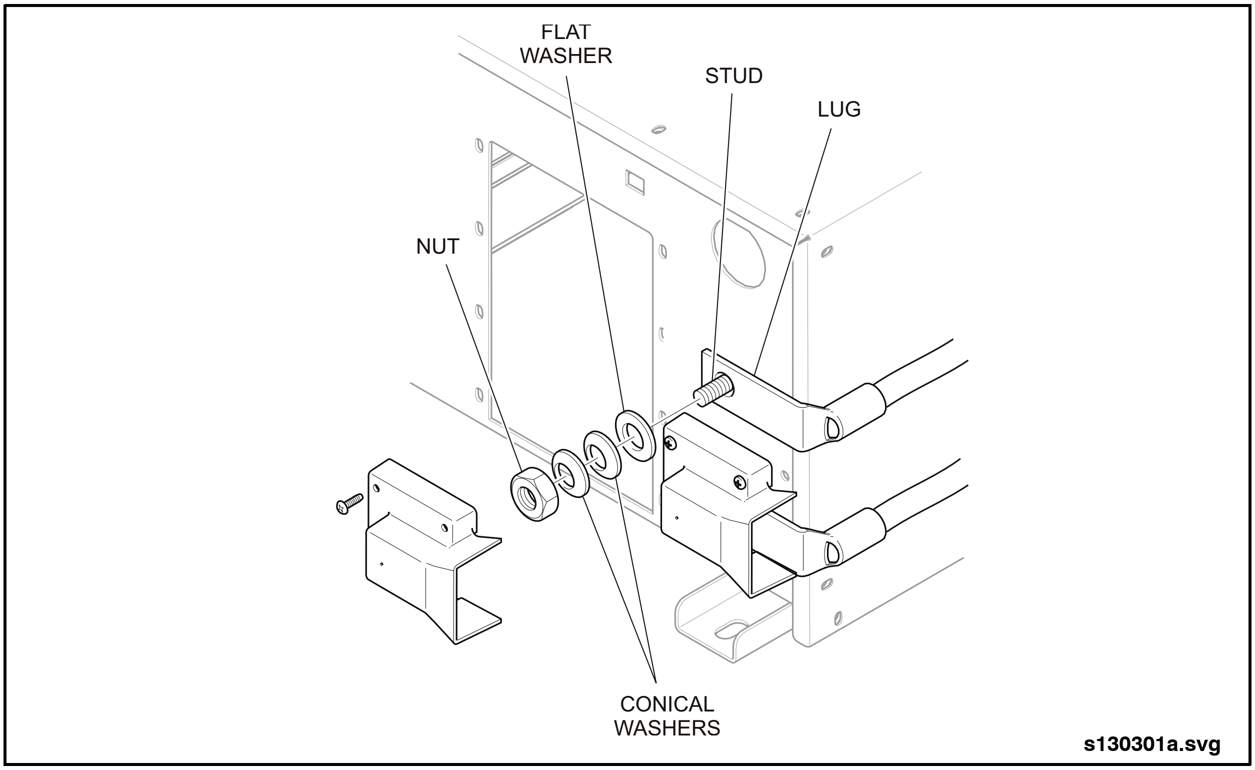


Fig. 9-6: Low Voltage Lug Installation Detail

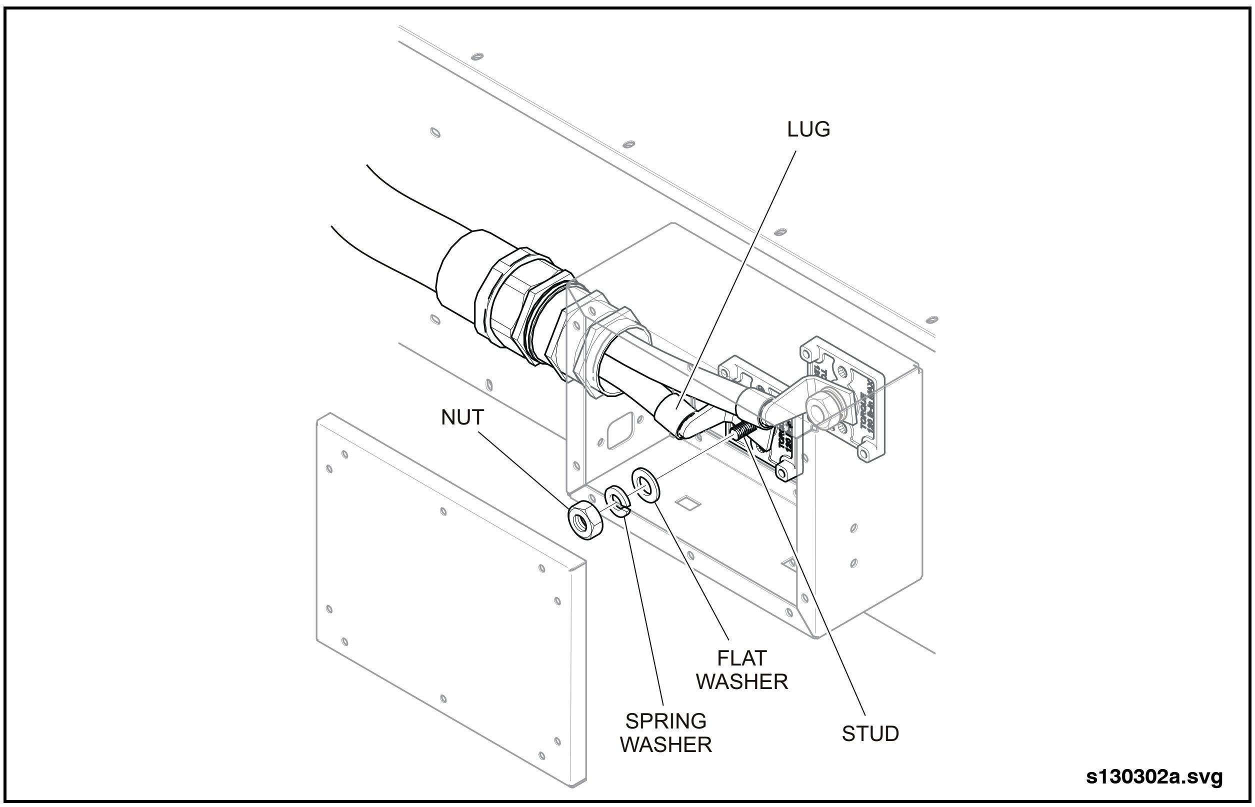


Fig. 9-7: High Voltage Lug Installation Detail

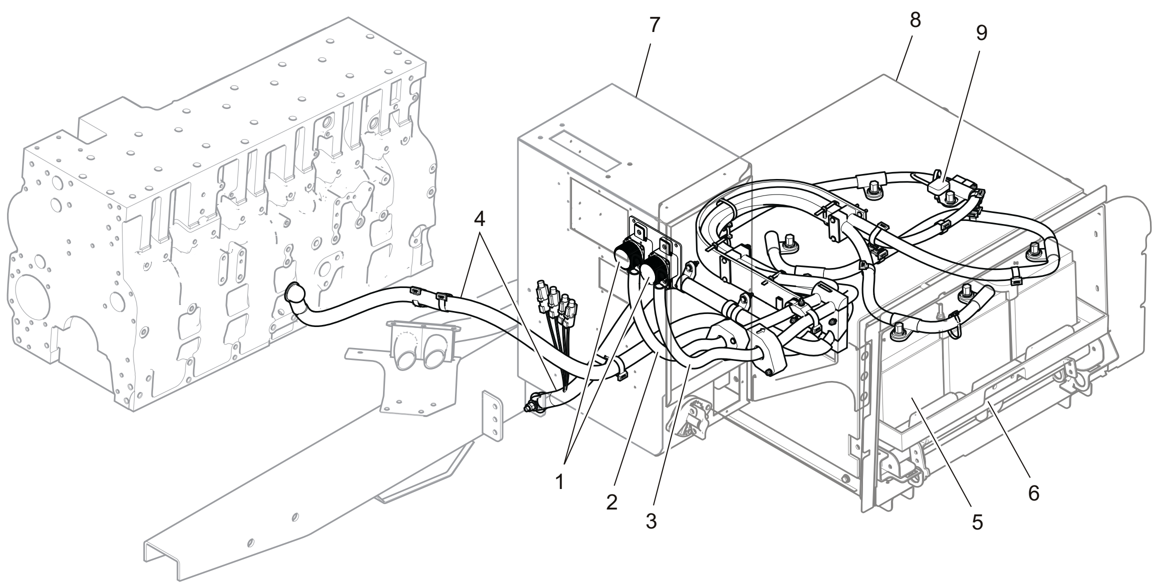
5. BATTERY SYSTEM

5.1. 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. 9-8: Battery Tray" on page 14. The battery disconnect switch is located on the fusebox, above the battery tray. See "Fig. 9-9: Battery Disconnect Switch & Fuses" on page 15. 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. Power Relay, 400A
2. Battery to Power Relay Power Cable (PS29PC)
3. Battery to Power Relay Power Cable (PS3PC)
4. Battery Ground to Groundpoint Battery (PS12PC)
5. Battery
6. Slide Tray
7. Fusebox
8. Cover
9. Temperature Sensor

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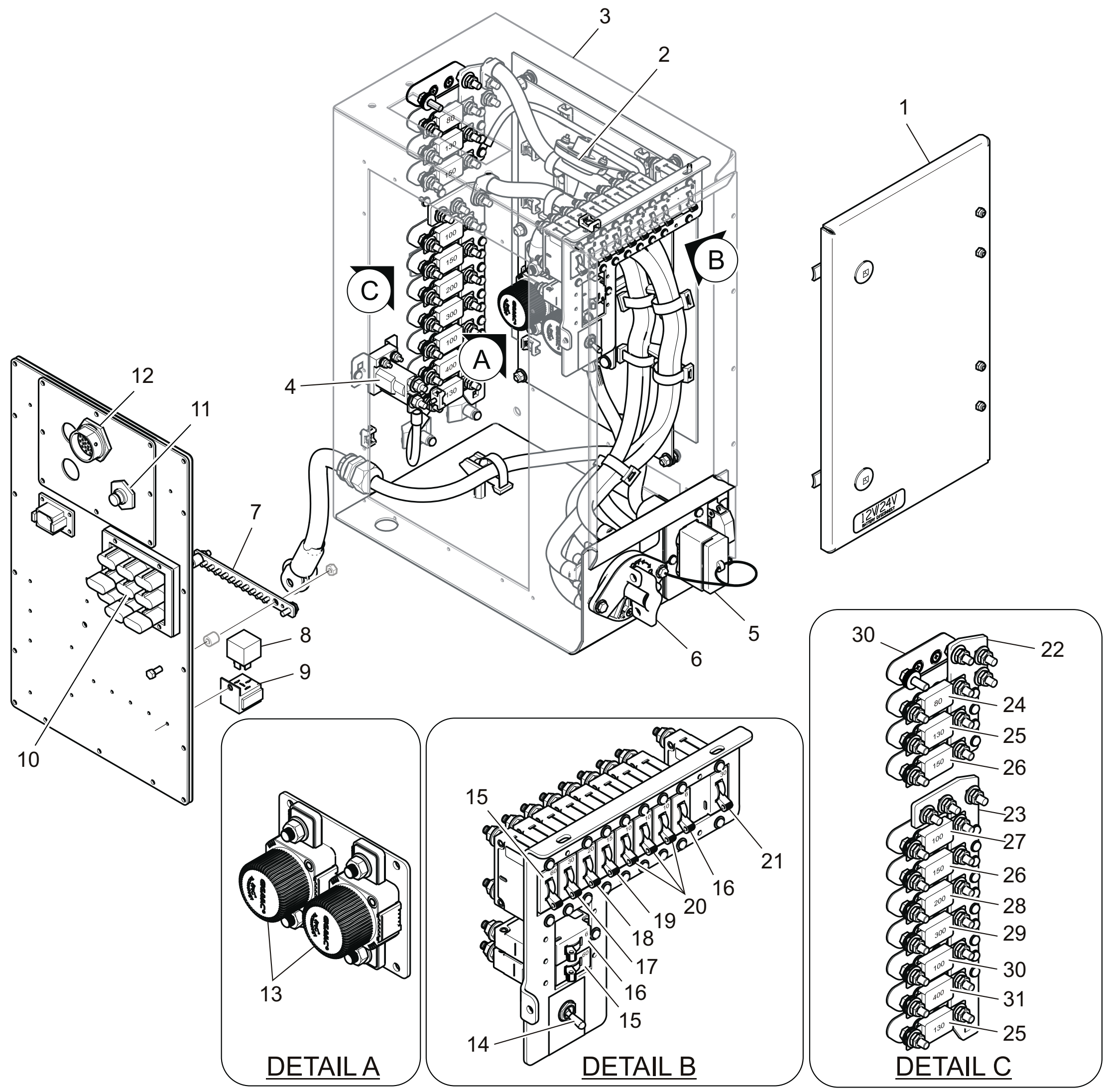
Fig. 9-8: Battery Tray



1. Fusebox Access Door
2. Fusebox Service Light
3. Fusebox Assembly
4. Relay, 24V 100 AMP
5. Jumpstart Assembly
6. Battery Disconnect Switch
7. Bus Bar, 12-Position
8. Module, Relay Socket
9. Relay, 24V SPDT
10. Connector, Packard 9-3 CCT
11. Power Lead Assembly
12. Fusebox Harness
13. Power Relays, 400A
14. Fusebox Service Light Switch
15. Breaker, 60 AMP Long Delay
16. Breaker, 6 AMP Long Delay
17. Breaker, 30 AMP Instant Trip
18. Breaker, 20 AMP Long Delay
19. Breaker, 15 AMP Long Delay
20. Breaker, 10 AMP Long Delay
21. Breaker Relay, 30 AMP Long Delay
22. Bus Bar, 12V
23. Bus Bar, 24V
24. Fuse, 80A
25. Fuse, 130A
26. Fuse, 150A
27. Fuse, 100A
28. Fuse, 200A
29. Fuse, 300A
30. Fuse Block
31. Fuse, 400A

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Fig. 9-9: Battery Disconnect Switch & Fuses

5.2. Battery Disconnect Switch

5.2.1. 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.

5.3. 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.

5.3.1. 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.

5.4. Fusebox Assembly

5.4.1. Description

The fusebox assembly is located at the rear curbside of the vehicle. The main components of the fusebox assembly include the Battery Disconnect switch, fuse panel, circuit breaker panel, and Compartment Light switch. Refer to 5.2. “Battery Disconnect Switch” on page 16 in this section for more information on this component.

5.4.2. 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
Grid Heater Relay to Power Cables	Lock Nut 5/16" - 24 UNF	9-10 ft-lb. (12.2-13.5 Nm)
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.		

5.5. 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.

5.5.1. 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.

5.5.2. Batteries Specifications

- ❒ 12 volt
- ❒ 31 group size
- ❒ 1150 cold cranking amperes
- ❒ 205 minute reserve capacity
- ❒ 100 AH battery capacity

5.5.3. 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.

5.5.4. 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.

5.5.5. 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. 9-10: Battery Charging Profile" on page 20.

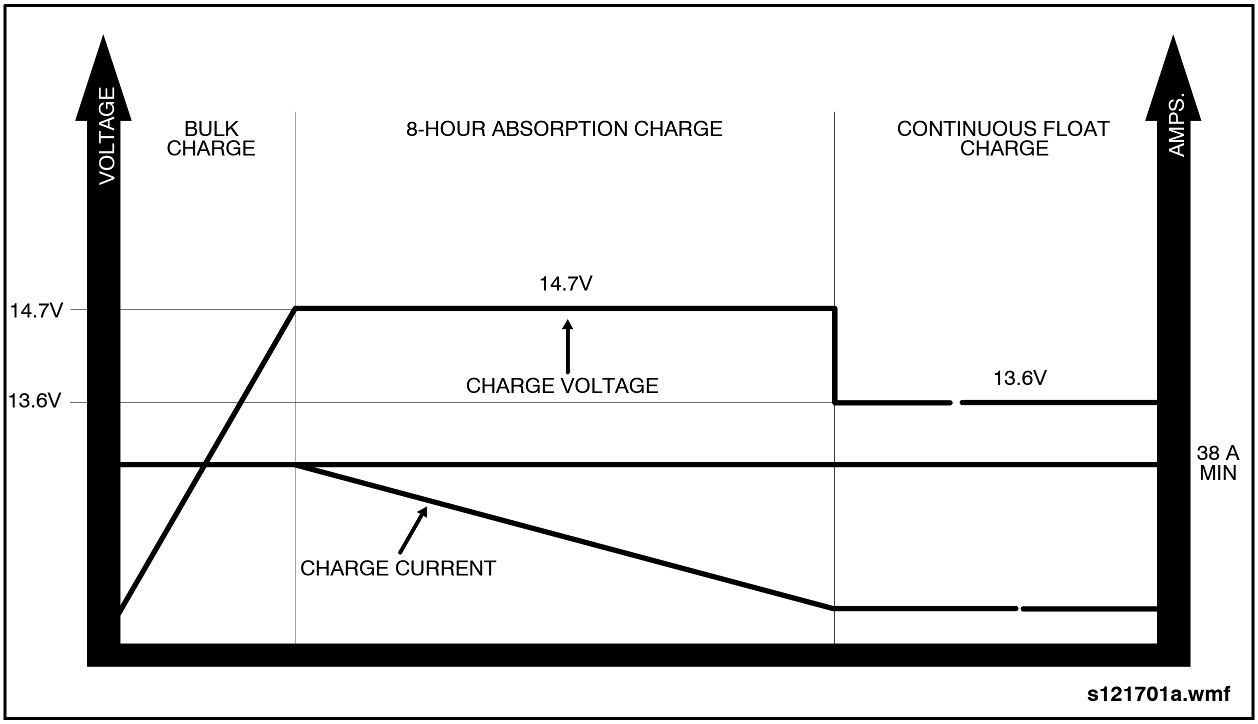


Fig. 9-10: Battery Charging Profile

5.5.6. Functional Test

5.5.6.1. 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.

5.5.6.2. 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 5.5.5. “Battery Charging” on page 19 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.

5.5.7. 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.

5.6. Temperature Indicator

5.6.1. Description

A non-reversible temperature indicator strip is installed on top of each battery for ease of temperature monitoring.

5.6.2. Temperature Indicator Specifications

Manufacturer ....Omega Engineering Inc.

Temp. Indicators (°F)
..........................140, 150, 160, 170, 180

Accuracy....................................1.8°F (1°C)

5.6.3. Operation

The indicator strip cells turn black as they are exposed to higher temperatures.

5.6.4. Removal

1. Lift a corner of the strip and remove.
2. Remove any remaining adhesive residue.

5.6.5. Installation

1. Ensure the mounting surface is clean and dry.
2. Install the strip using the adhesive backing.

5.7. Voltage Equalizer

5.7.1. 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. 9-11: Battery Voltage Equalizer Installation" on page 22.

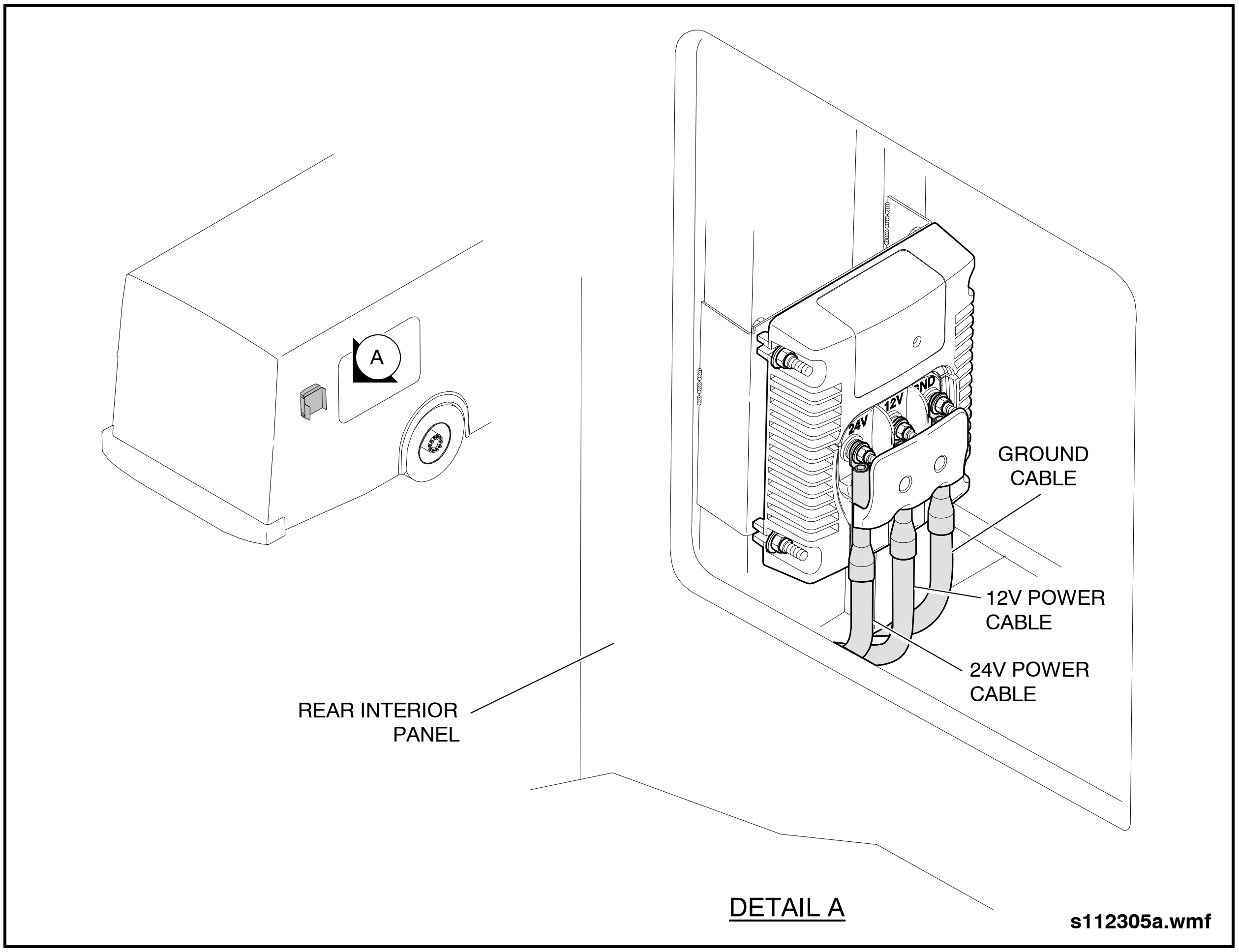


Fig. 9-11: Battery Voltage Equalizer Installation

5.7.2. 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

5.7.3. 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.

5.7.3.1. 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.

5.7.3.2. 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.

5.7.4. 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.	

5.7.5. 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.

6. EXTERIOR LIGHTS

See “Fig. 9-12: Exterior Lamps” on page 28.

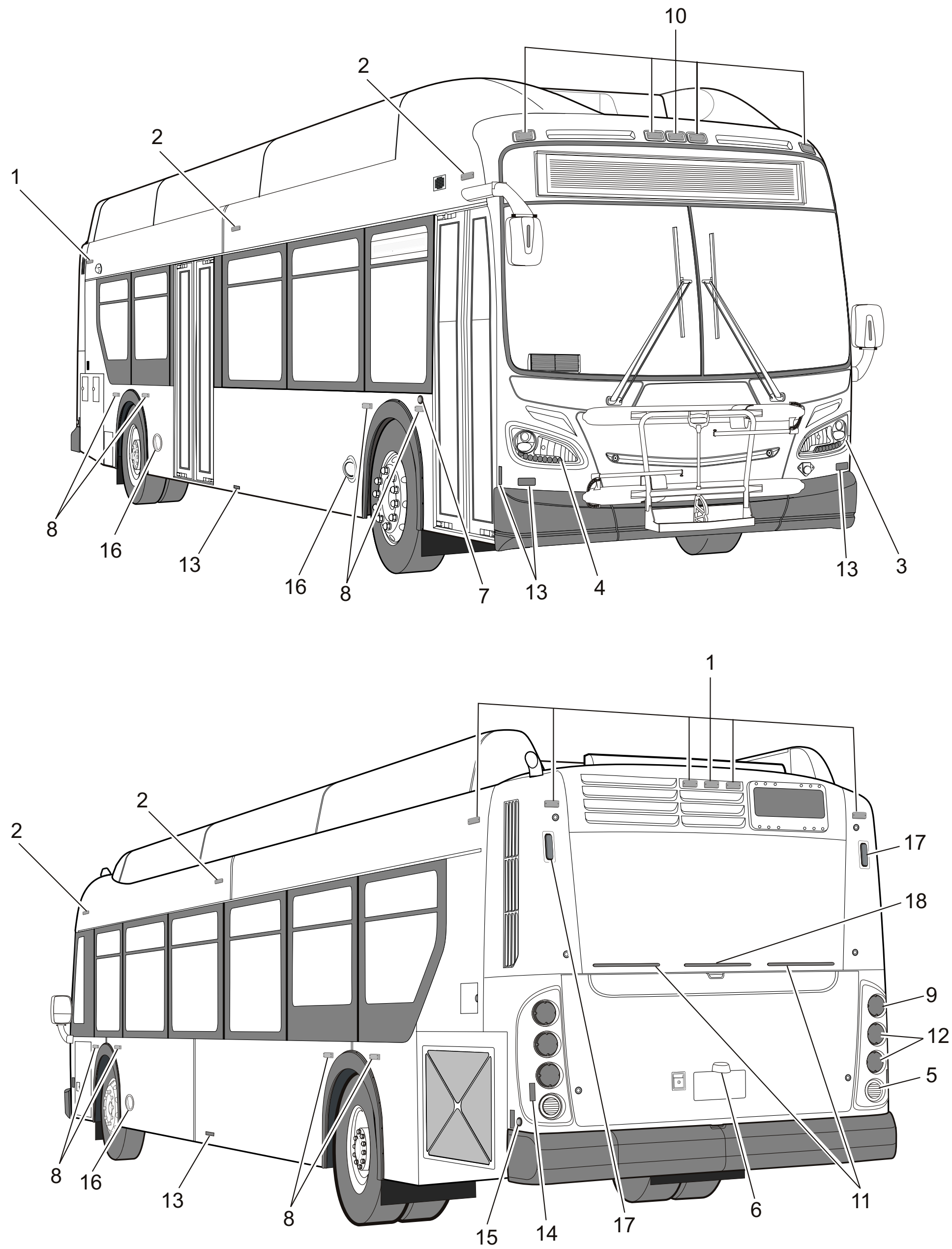
6.1. Headlights

6.1.1. Description

The headlight assemblies contain an LED low beam, an LED amber turn light and a high beam bulb. The LED lights have a 10,000 hour service life rating. The high beam has a replaceable bulb. Each headlight assembly is controlled by its own headlight module located behind the wiper motor access door.

6.1.2. 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.



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\

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Fig. 9-12: Exterior Lamps

6.1.3. Removal

☞**NOTE:**

Replacing a faulty low beam or turn signal light requires the replacement of the complete headlight assembly. The high beam bulb can be replaced separately and can be accessed from the interior of the vehicle without removing 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 doors, interior LH lower dash panel access door, and interior RH lower dash panel access door. See "Fig. 9-13: Headlight Removal & Installation" on page 30.
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.
5. Remove the high beam bulb with a 1/4 turn CCW twisting motion.

☞**NOTE:**

Determine that the problem is in the headlight and not in the module by plugging the removed headlight into the working headlight module on the opposite side. Replace the headlight assembly if it still does not function.

6.1.4. Installation

1. Install a new headlight assembly using the original washers and nuts.
2. Install a new high beam bulb with a 1/4 turn CW twisting motion, being careful not to touch the glass surface of the bulb with bare hands or any other object that could leave an oily residue on the bulb.
3. Connect the wiring harness to the headlight assembly and secure the harness with cable ties.
4. Close and secure all access doors.
5. Set the Battery Disconnect switch to the ON position and test operation of the headlight assembly.
6. Adjust the headlights if required. Refer to 6.1.5. "Headlight Aiming" on page 31 in this section for aiming procedure.

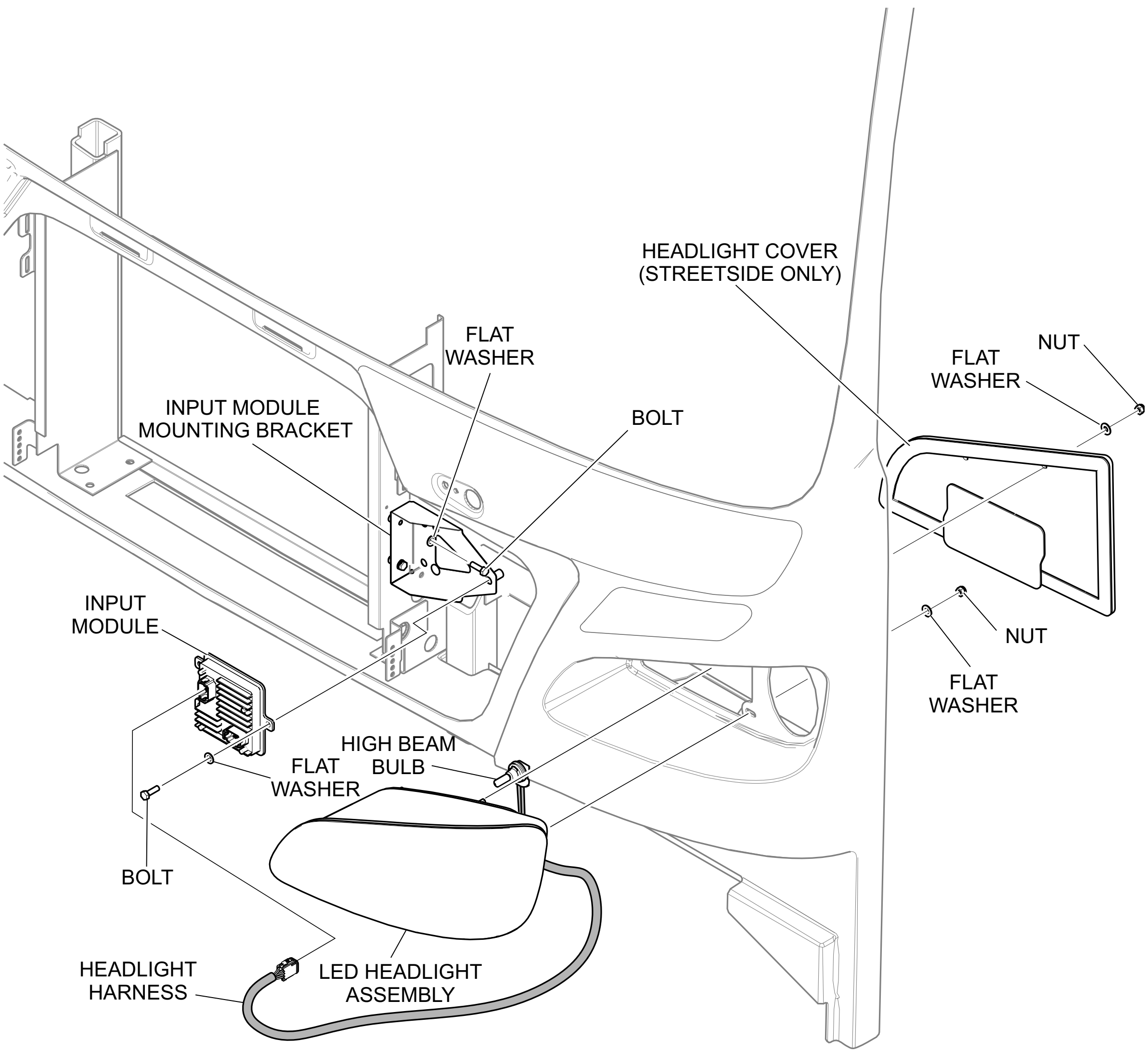


Fig. 9-13: Headlight Removal & Installation

6.1.5. 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 6.1.6. “Headlight Aiming (Alternate Procedure)” on page 34 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. 9-14: Headlight Aiming” on page 33.
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.

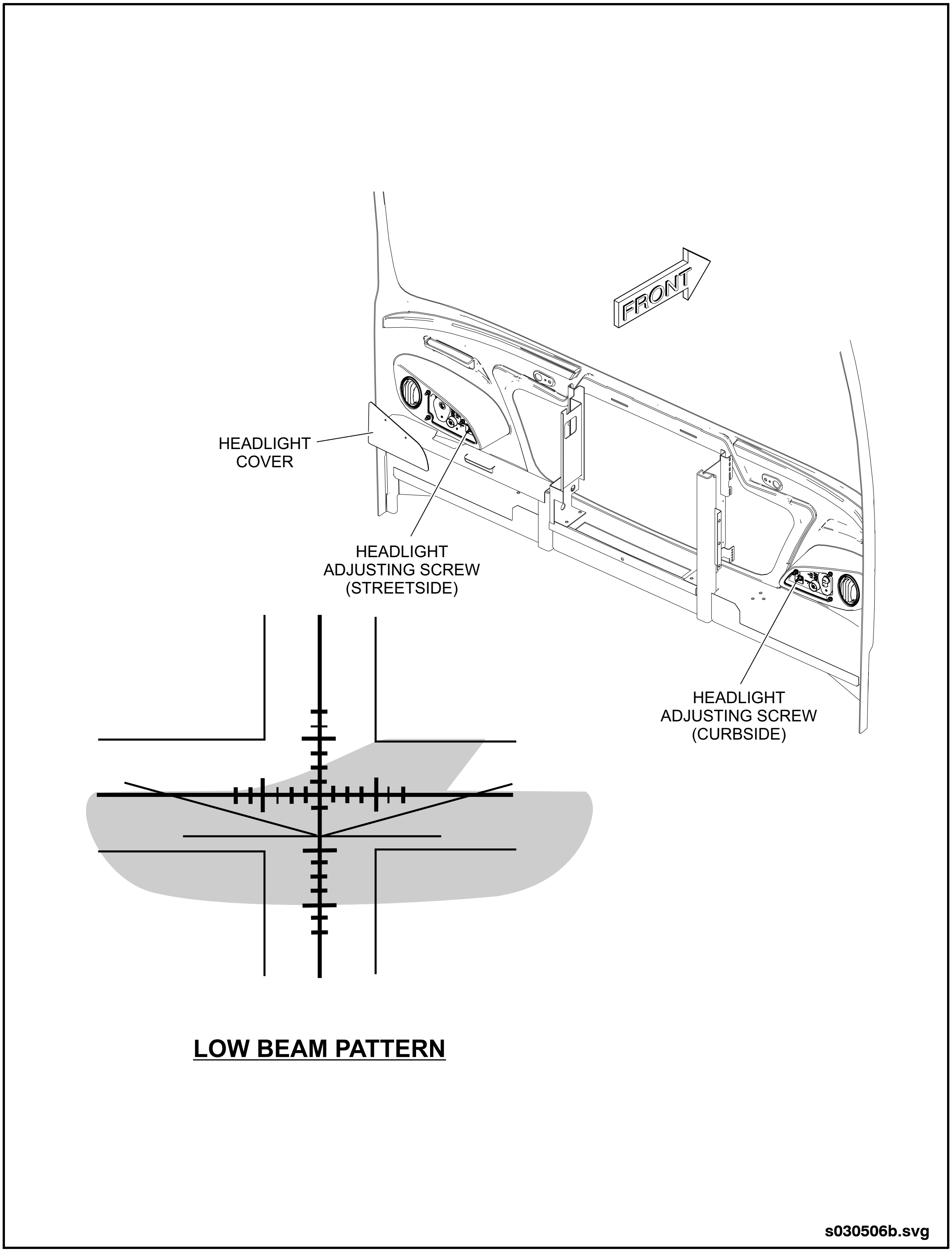


Fig. 9-14: Headlight Aiming

6.1.6. 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. 9-16: Low Beam Headlight Aiming” on page 35.
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. 9-15: Low Beam Center Location” on page 34.

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.

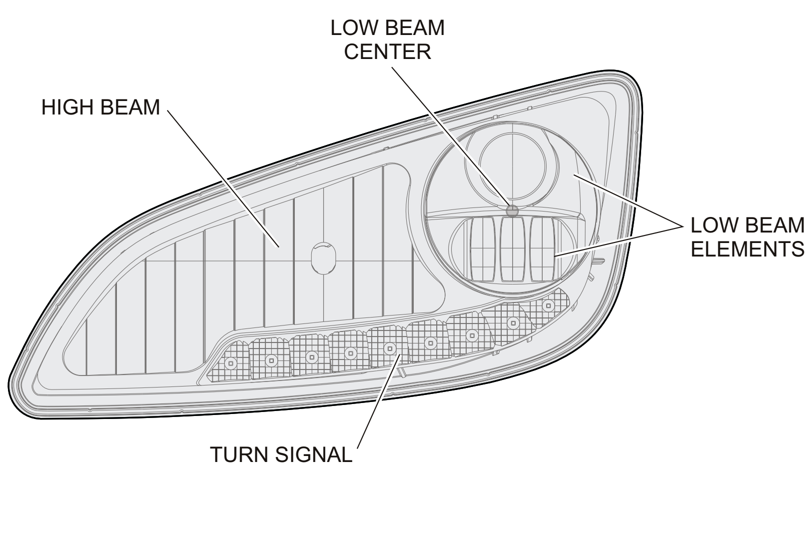
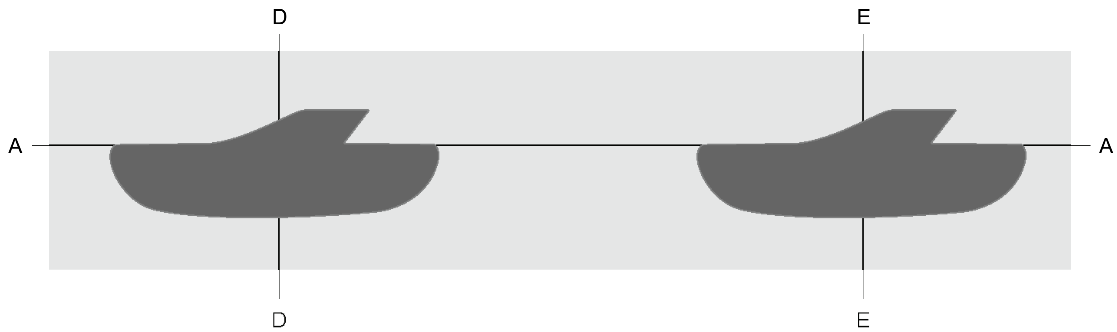
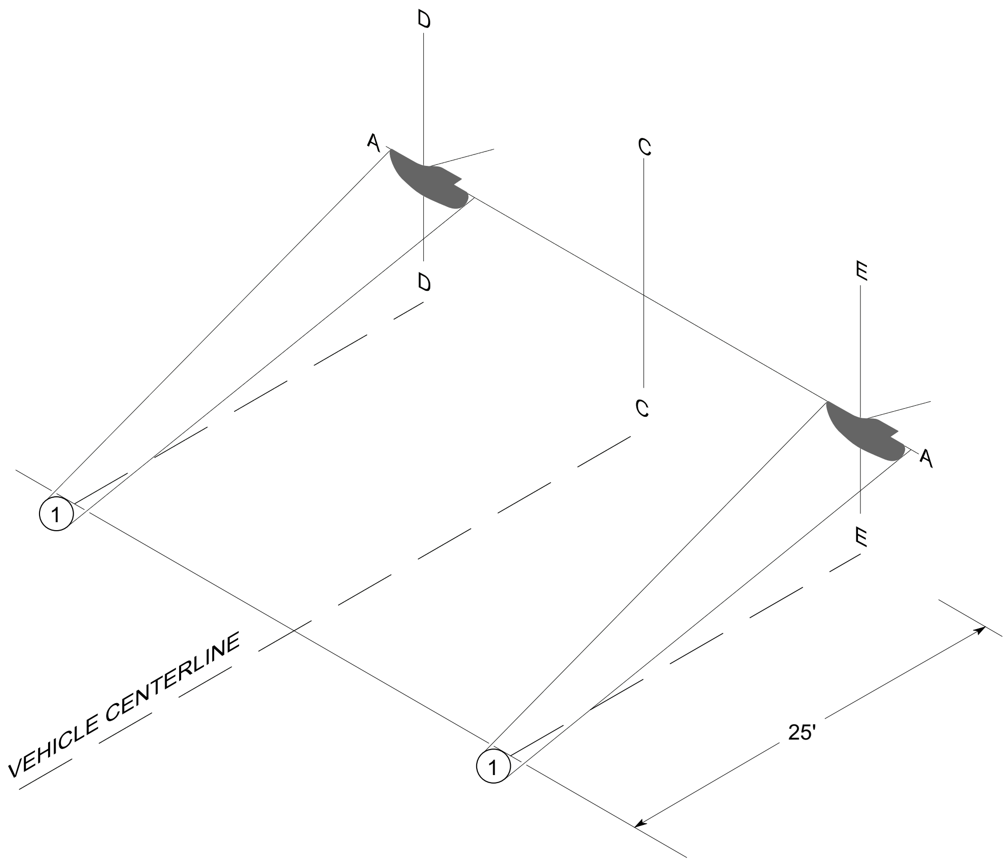


Fig. 9-15: Low Beam Center Location



CORRECTLY AIMED LOW BEAMS



LOW BEAM AIMING MARKS

LEGEND	
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. 9-16: Low Beam Headlight Aiming

7. INTERIOR LIGHTS

7.1. Aisle Lights

7.1.1. Description

The aisle light panels are located above the side windows on either side of the passenger aisle. See “Fig. 9-17: Aisle Lights Layout” on page 36.

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. 9-18: LED Aisle Lights Assembly” on page 37.

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 7.1.5. “Dimming Adjustments” on page 40 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 50%
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 50%

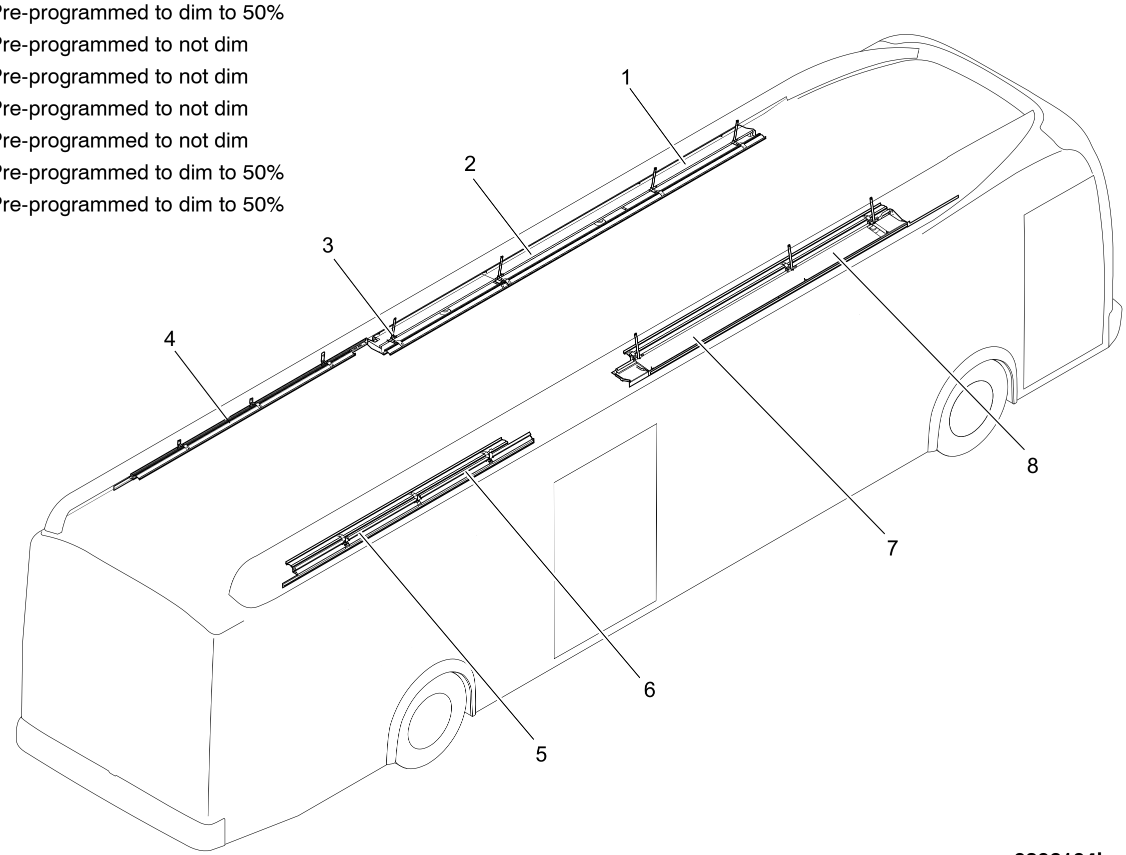


Fig. 9-17: Aisle Lights Layout

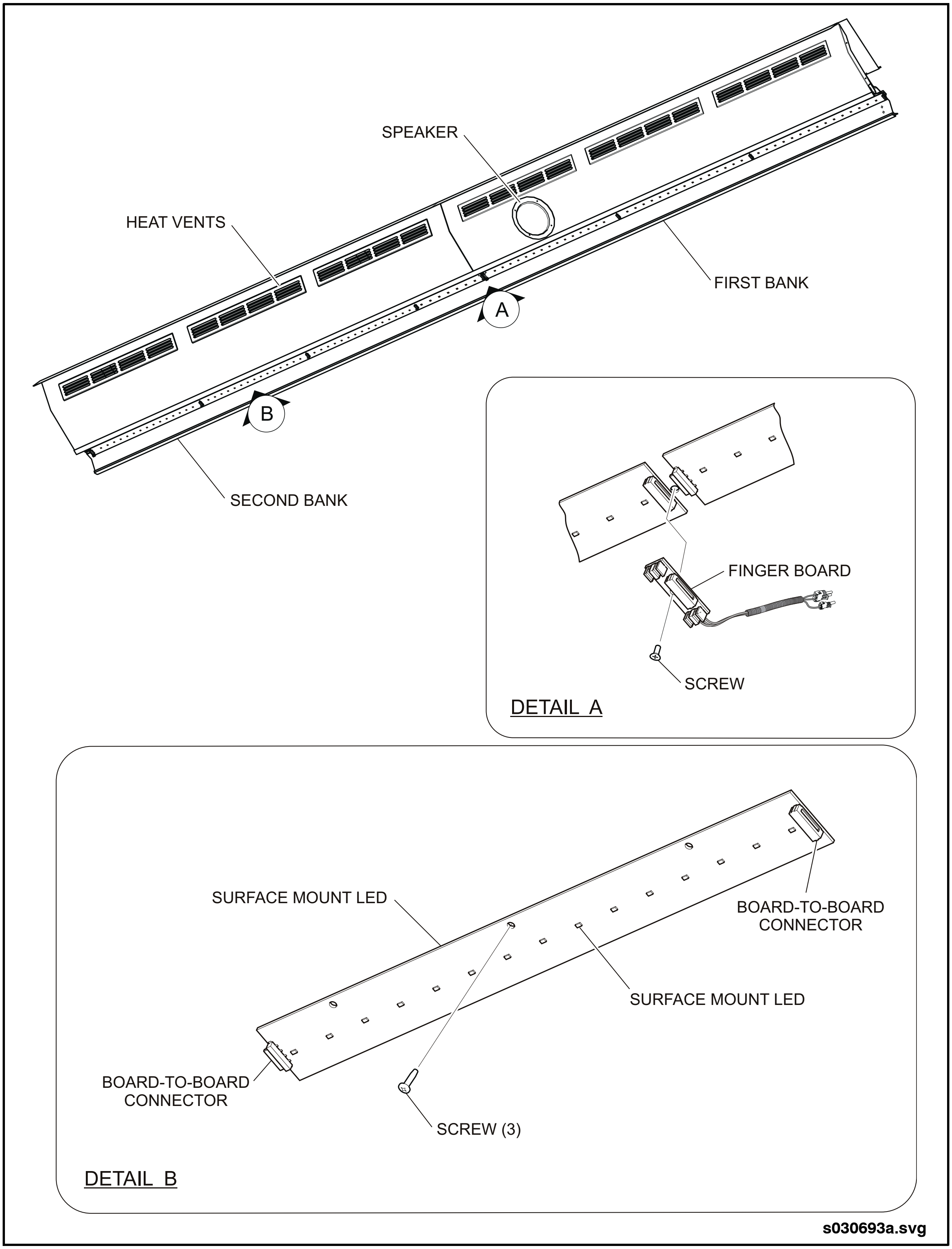


Fig. 9-18: LED Aisle Lights Assembly

7.1.2. 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

7.1.3. 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.

7.1.4. 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.

7.1.4.1. 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.

7.1.5. 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 7.1.6.1. “Lens” on page 41 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 located 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 three programming pads on the clever lighting board. The programming pads are labeled “DOWN UP” and “DIM PGM”. See “Fig. 9-19: Lighting Board Programming Pads” on page 40.
5. Place the pins of the programming fob onto the programming pads. Press the button on the DOWN side of the fob to reduce lighting intensity and press the button on the UP side of the fob to increase lighting intensity. See “Fig. 9-20: Lighting Board Dimming Adjustment” on page 40.

☞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.

6. Test the operation of aisle lights and ensure that the dimmable lighting panels increase to 100% lighting intensity when the entrance door is opened.
7. Replace the lens once all adjustments have been made.

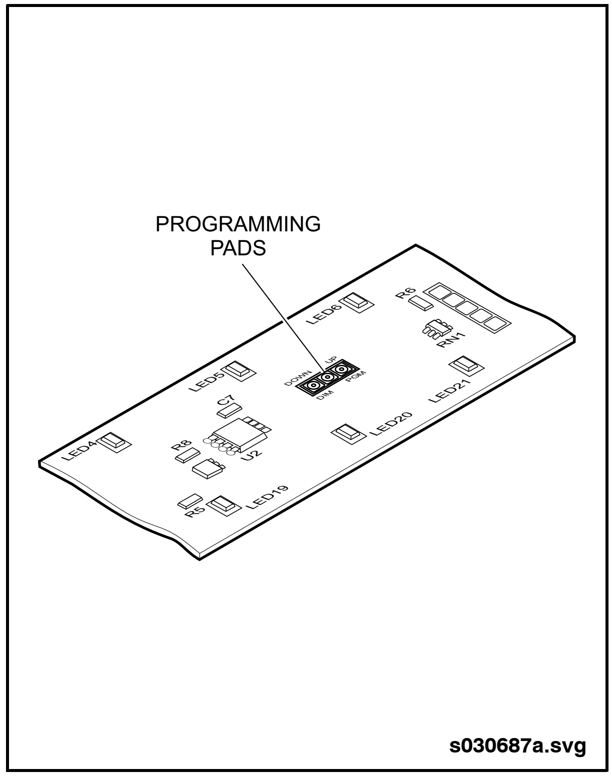


Fig. 9-19: Lighting Board Programming Pads

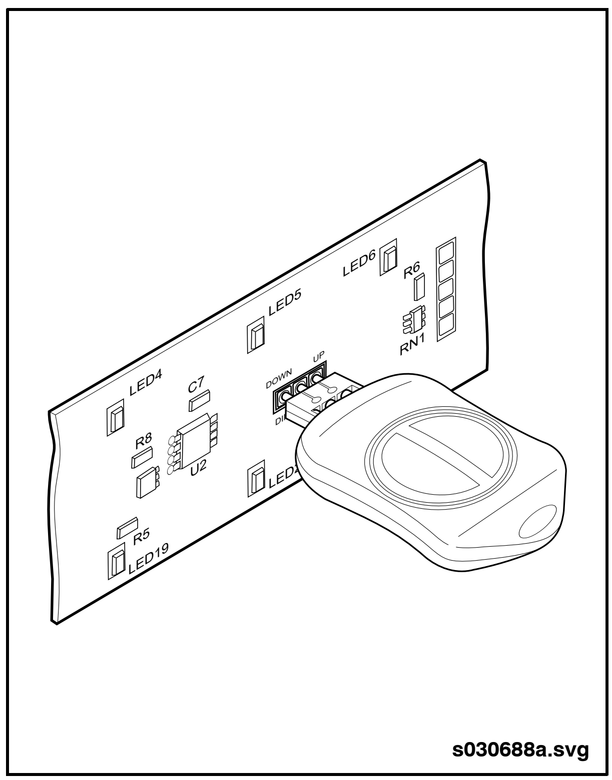


Fig. 9-20: Lighting Board Dimming Adjustment

7.1.6. Removal

7.1.6.1. 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. 9-21: Lens Removal” on page 41.

☞**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.

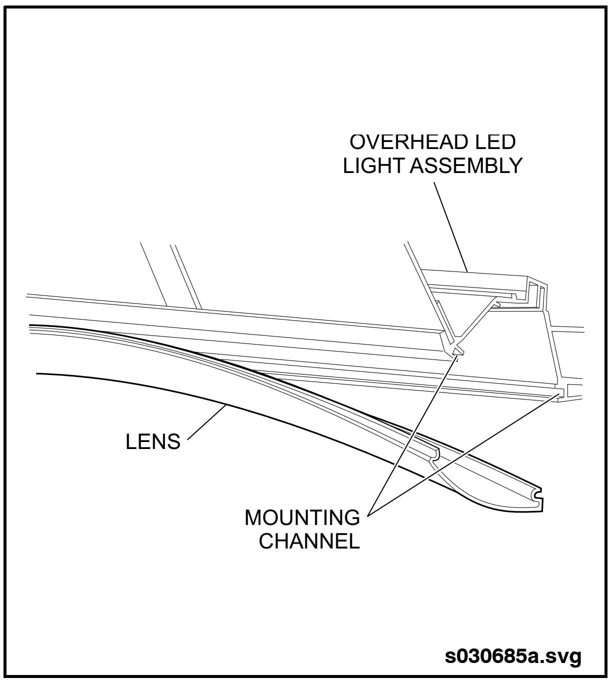


Fig. 9-21: Lens Removal

7.1.6.2. 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 7.1.6.1. “Lens” on page 41 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.

7.1.6.3. Finger Board

1. Remove the lens. Refer to 7.1.6.1. “Lens” on page 41 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. 9-22: Finger Board Assembly” on page 42.
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.

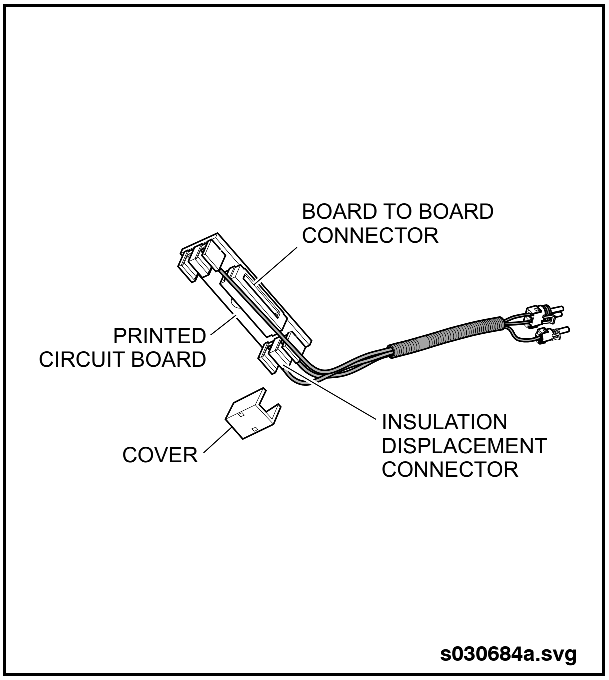


Fig. 9-22: Finger Board Assembly

7.1.7. Installation

7.1.7.1. 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.

7.1.7.2. 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.

7.1.7.3. 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.

8. DOOR MASTER SWITCH

8.1. Description

The Door Master switch is a two-position toggle switch located in the destination sign panel. The switch is labeled ON for normal operation and OFF for emergency operation.

8.2. 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 rear 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.

8.3. 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.

8.3.1. 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 set the vehicle in 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. Set the vehicle in 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. Return the vehicle to 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.

8.3.2. 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.

8.4. 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.

9. HORNS & WARNING ALARMS

9.1. Electric Horn

9.1.1. 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. 9-23: Horns Installation" on page 45.
- ❒ 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.

9.2. Warning Alarms

☞**NOTE:**

Refer to the General Information Section of this manual for information on warning alarms.

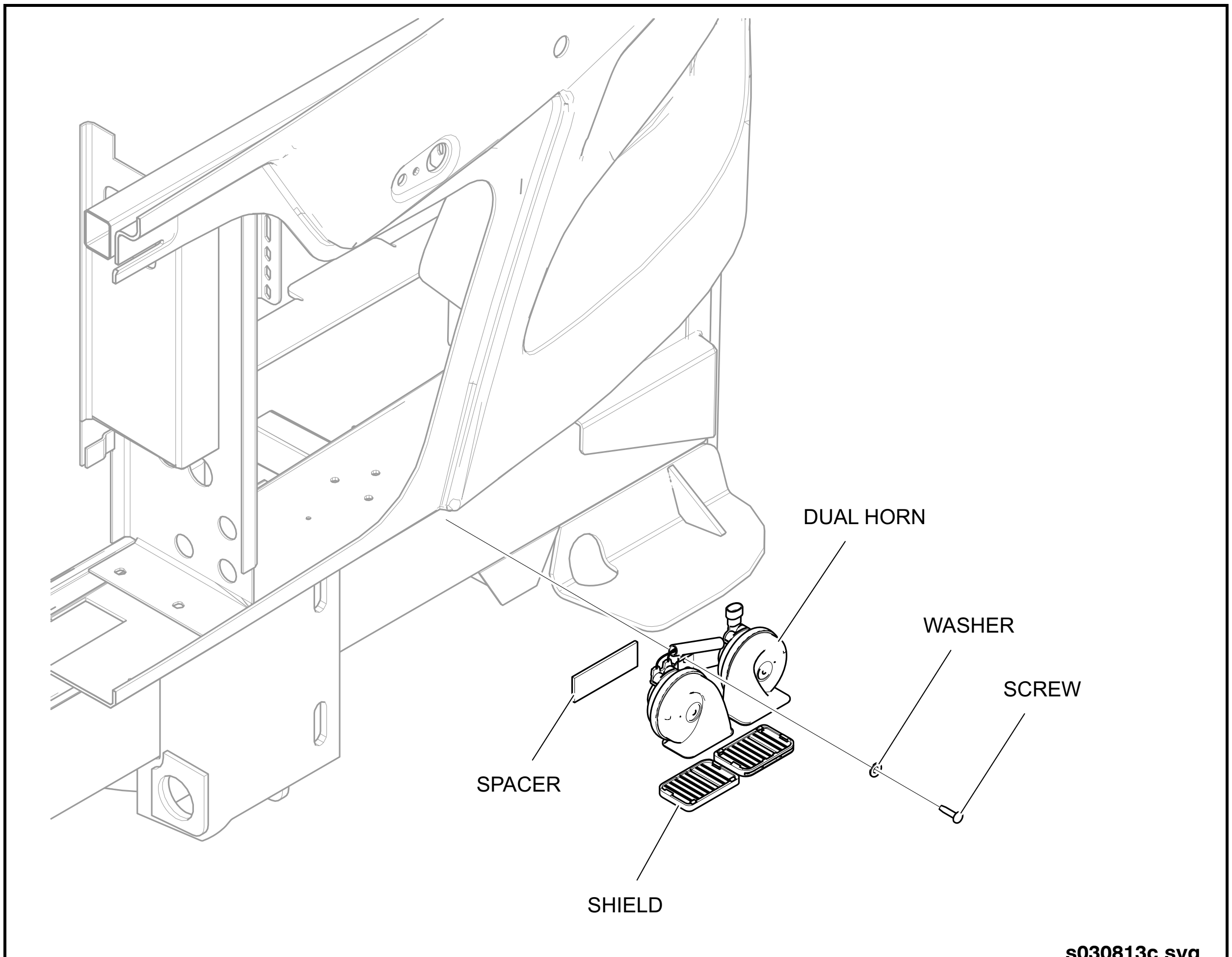


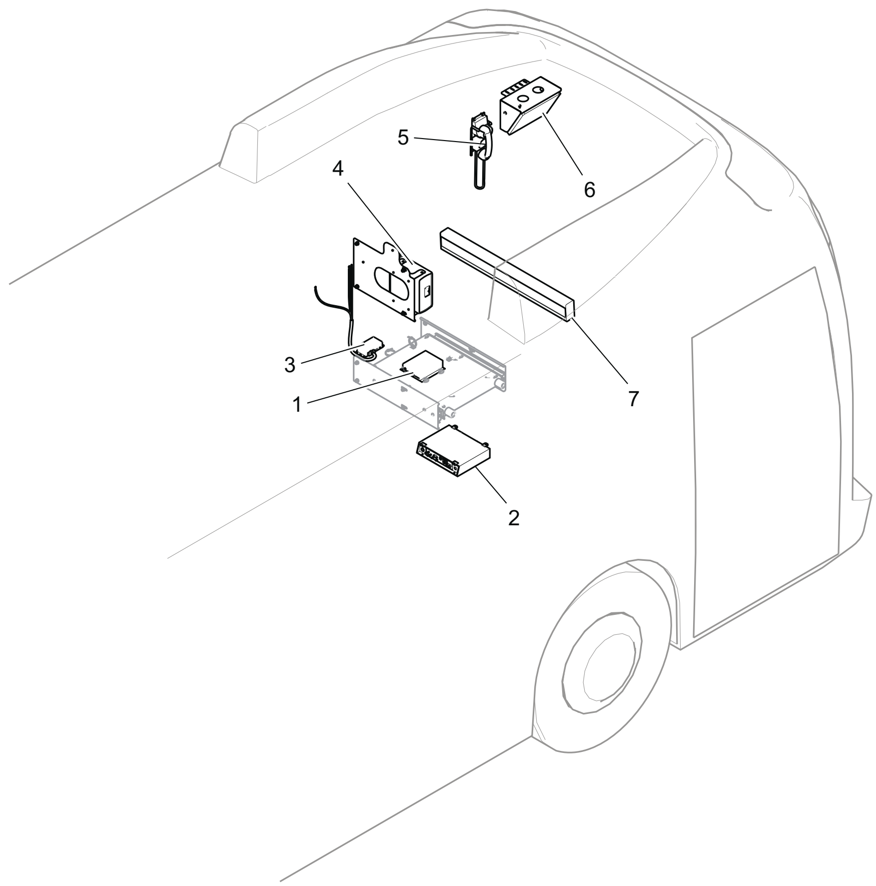
Fig. 9-23: Horns Installation

10. AUTOMATIC VEHICLE ANNOUNCEMENT (AVA) SYSTEM

10.1. 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. 9-24: AVA System” on page 47.

- ❐ IVN4 Controller - located in the electronic equipment enclosure.
- ❐ Transit Control Head - located under the driver’s overhead panel.
- ❐ WiFi Antenna.
- ❐ Wireless Router.
- ❐ Universal Radiologic Controller Module.
- ❐ Driver’s Handset.
- ❐ Public Address (PA) speakers - located in the interior and exterior of the vehicle.
- ❐ Interior LED message display signs - ceiling-mounted near the front, and rear inside the HVAC cover.
- ❐ Automatic Volume Control (AVC) microphone - mounted on the fifth bay ceiling panel.
- ❐ Quad-Band antenna - roof-mounted.
- ❐ Smartyard Vehicle Tag Connector Module - located in the electronic equipment enclosure.
- ❐ A P.A. control panel on the side console.



1. Universal Radio Logic Controller
2. Wireless Router
3. Vehicle Tag/Smartyard Module
4. IVN4 Controller
5. Radio Handset
6. Transit Control Head Module
7. LED Sign

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Fig. 9-24: AVA System

10.2. Operation

10.2.1. 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. See “Fig. 9-25: IVN Transit Control Head” on page 48.

Access to all screens and functions begins at the Main Screen. The Main Screen presents all of the necessary information for the operator to properly use the system.

- <Route> This key is used to display the route selection screen.
- <Logon> This key is used to display the operator logon screen (if function is desired)
- <P/S> This key is used to display the Public Service Announcement Screen to manually trigger Public Service announcements.
- <Audio> This key is used to manually play the current stop announcement.
- <More> This key is used to access Screen Brightness and Contrast Controls.
- <Dest> This key is used to display the Public Relations Code Entry Screen.

Refer to Clever Devices Intelligent Vehicle Network Operator’s Manual for further information on this system.

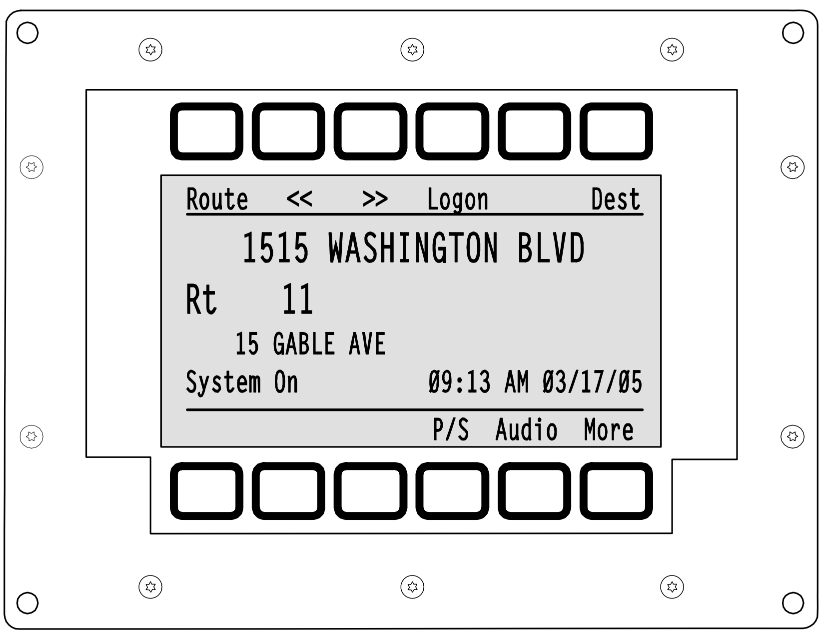

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Fig. 9-25: IVN Transit Control Head

11. AUTOMATIC PASSENGER COUNTER (APC) SYSTEM

11.1. Description

The Automatic Passenger Counter (APC) System consists of: See “Fig. 9-26: APC Installation” on page 49.

- ❒ APC controller module located in the entrance door mechanism compartment.
- ❒ APC infrared transmitters and receivers located near the entrance and exit doorways.
- ❒ APC harness assembly.

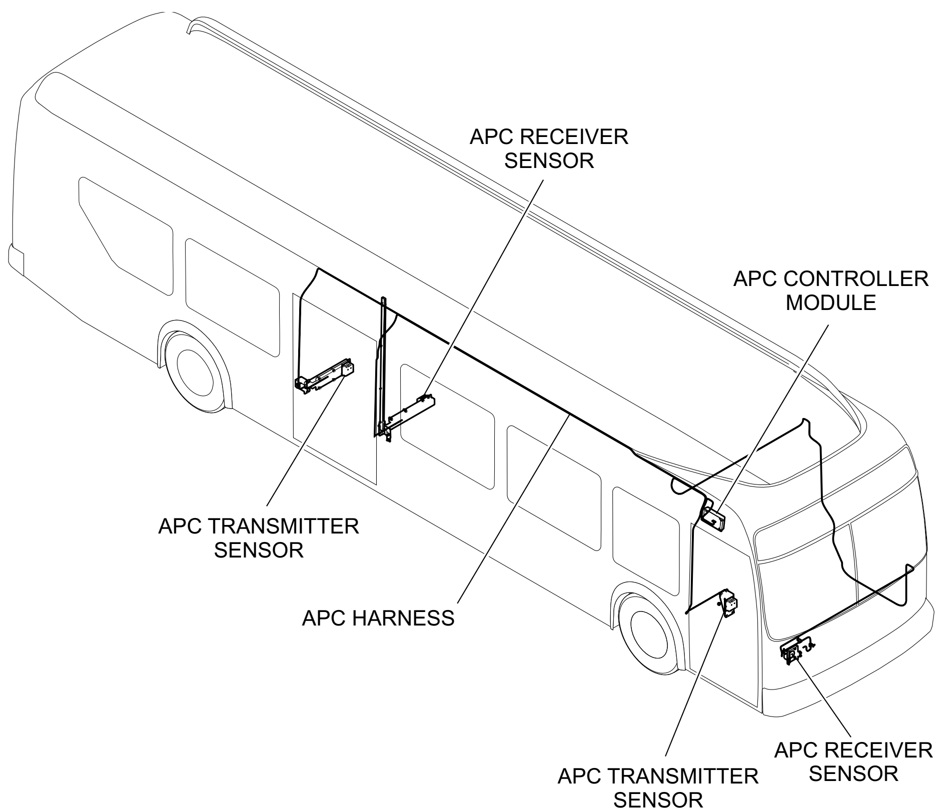


Fig. 9-26: APC Installation

11.2. Operation

The APC is a device capable of counting passengers on a transit vehicle. It uses active infrared technology to project two parallel beams of infrared energy from a transmitter module to a receiver module. The receiver/transmitter pairs are located such that boarding or disembarking passengers break the beams as they enter or exit the vehicle. The sequence in which the beams are broken allows the controller to determine the direction of travel. The APC controller is capable of communicating count and diagnostic data to the IVN Controller via J1708 cabling or to a laptop computer via an RS232 port.

The APC Controller has two LED indicators on the front panel. The bottom (green) indicator is a power indicator and is illuminated whenever power is applied to the controller. The top (red) indicator is a system status indicator. The status indicator will flash at a rate of approximately once every 2 seconds under normal conditions. The status indicator will flash quickly, approximately twice per second, if a fault is detected by the controller.

The APC system is supported by diagnostic software and can be accessed with the IVN Transit Control Head located on the front destination sign access door. Refer to Clever Devices "APC Installation Guide" for instructions on using the diagnostic screen and for APC system troubleshooting procedures.

12. VIDEO SURVEILLANCE SYSTEM

12.1. Description

The video surveillance system records events as they occur on the vehicle. See "Fig. 9-27: Video Surveillance System" on page 52. The system consists of:

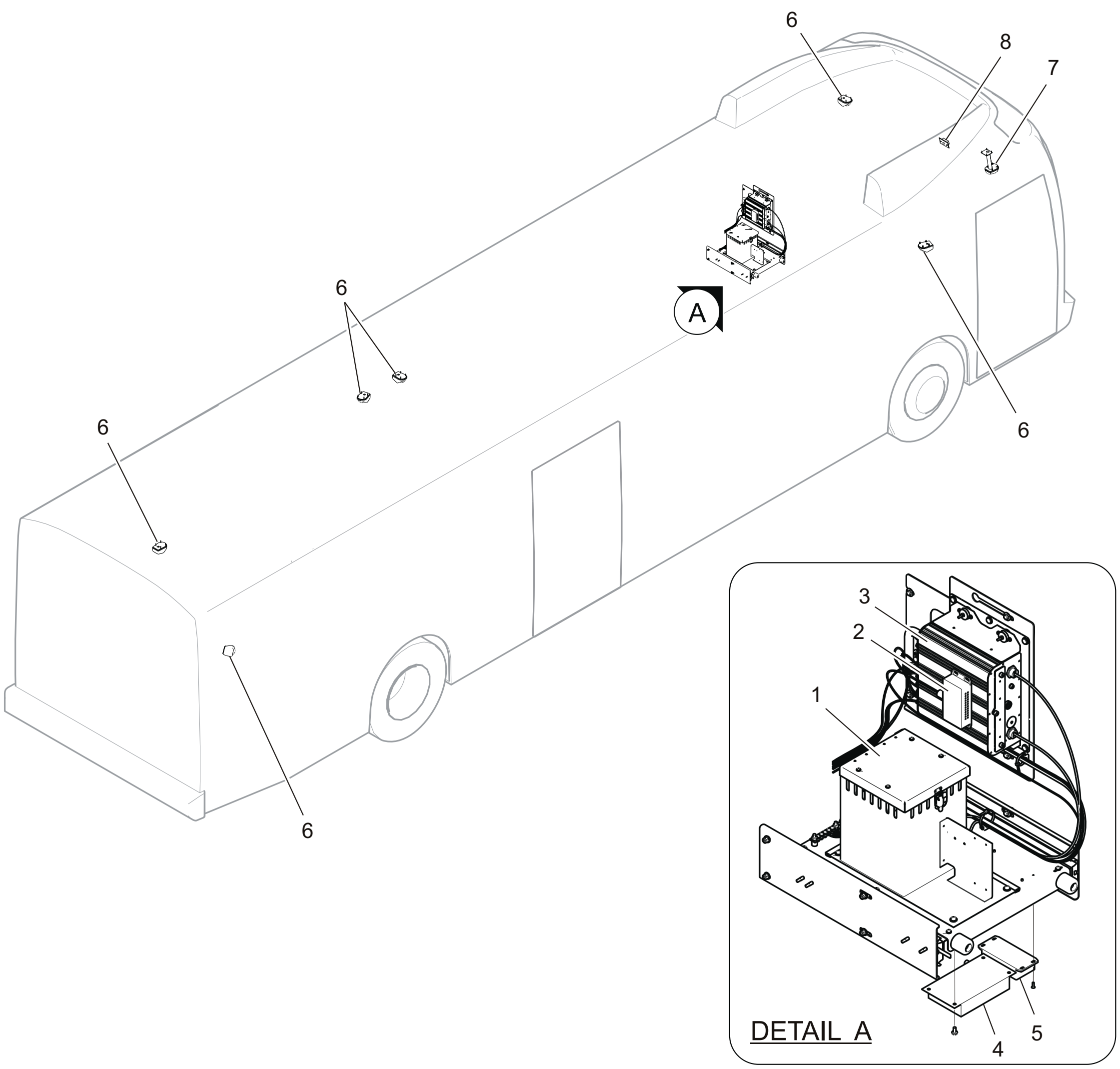
- ❒ One camera on the exterior of the vehicle at the curbside.
- ❒ Six cameras on the interior of the vehicle.
- ❒ A microphone located on the front destination sign door.
- ❒ An LED status box located in the electronic equipment enclosure
- ❒ An event marker switch located on the side console.
- ❒ A digital video recorder (DVR) with backup battery located in the electronic equipment enclosure.

12.2. 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.

Marked images (images recorded because of event switch or impact sensor activation) can be protected from being overwritten for a user-designated period of time. The video recording system can be programmed to continue recording images up to 30 minutes after the Master Run switch has been set to the STOP-ENGINE position.



1. Battery Box Enclosure
2. LED Status Display Module
3. Digital Video Recorder, 16 Channel (DVR)
4. TR-600 Wireless Radio
5. J1708 Converter Module
6. Camera, 3.6mm
7. Camera, 3.6mm Forward
8. Microphone Recorder

s0510241a.svg

Fig. 9-27: Video Surveillance System

13. FLEET MANAGEMENT SYSTEM

13.1. 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. 9-28: Fleet Management System” on page 53.

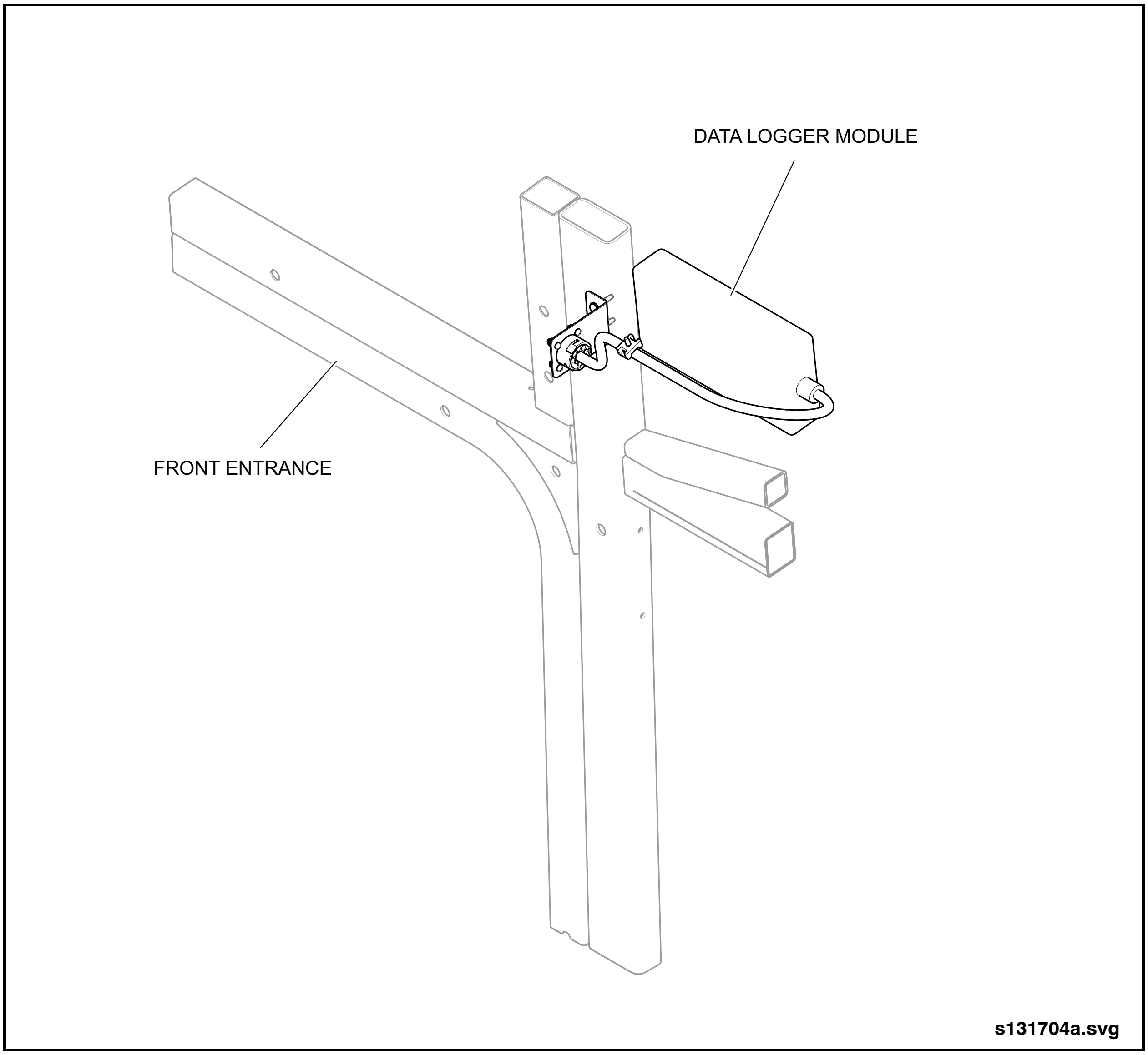


Fig. 9-28: Fleet Management System

13.2. 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.

13.3. 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.

13.4. 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).

13.5. 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.

14. ELECTRONIC STROKE ALERT (e-STROKE)

14.1. 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.
- ❒ An e-Stroke diagnostic lamp mounted in the electronic equipment enclosure, used to annunciate warning.
- ❒ 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. 9-29: E-Stroke Chassis Communication Module” on page 55.
- ❒ A Brake Alert message on the instrument panel display screen.
- ❒ Brake Lining Wear indicators in the brake lining at each wheel.
- ❒ Interconnecting wiring harness.

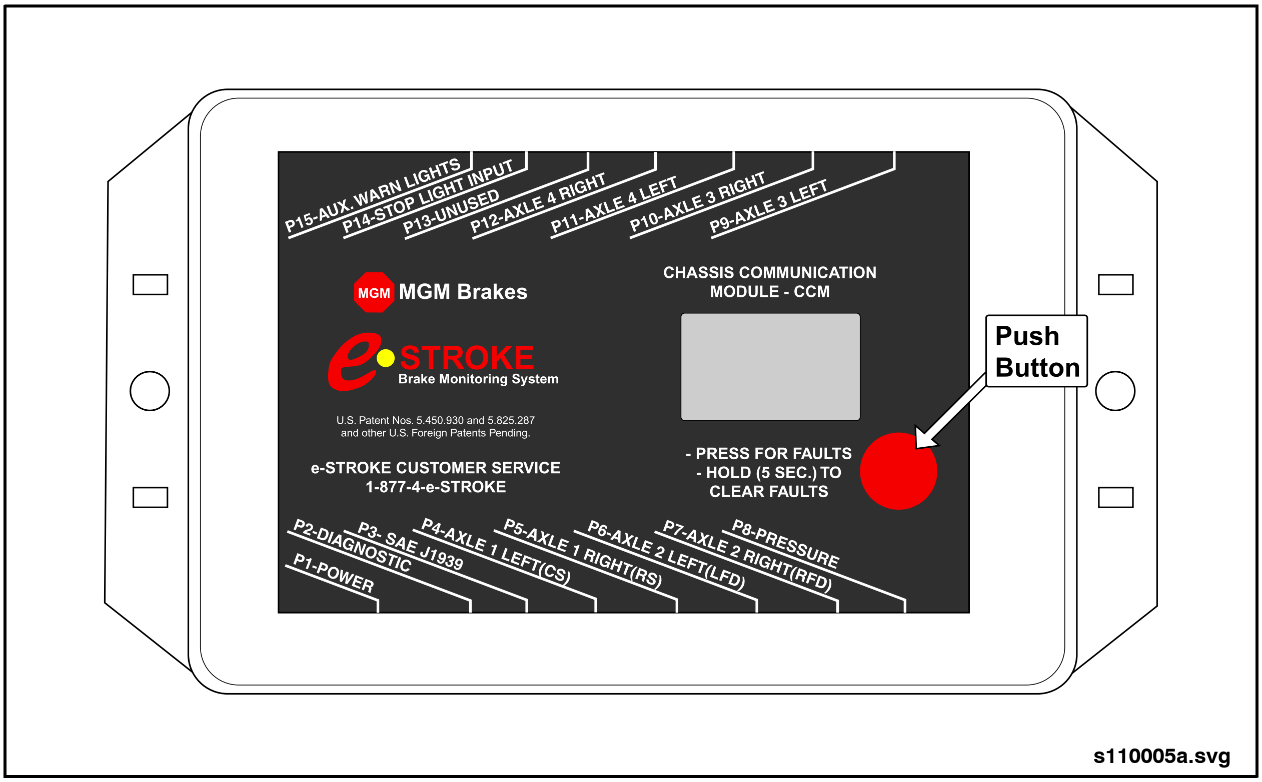


Fig. 9-29: E-Stroke Chassis Communication Module

14.2. 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 14.2.2. "Blink Code Definitions" on page 57 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.

14.2.1. 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.

14.2.2. 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		

14.2.3. 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.

14.3. 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.*

15. ELECTRICAL SYSTEM SCHEMATICS

15.1. 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. 9-30: VMM Schematic” on page 62.

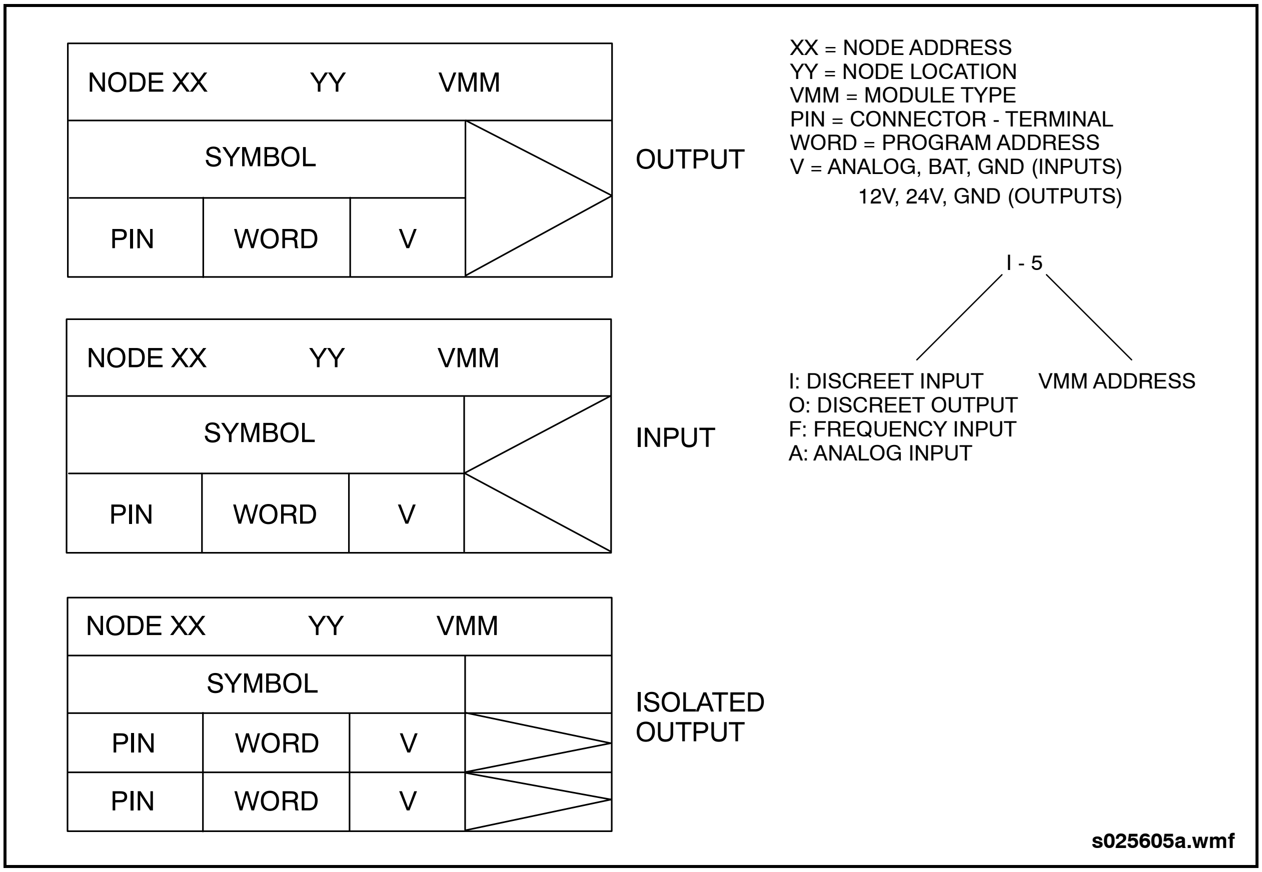


Fig. 9-30: VMM Schematic

15.2. 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.

15.3. 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.

15.4. 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.

15.5. 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
HP	Hybrid Propulsion
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

15.6. 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.

16. VENDOR SERVICE INFORMATION

The following supplier manuals contain additional reference information.

16.1. Vansco Manuals

- ❒ VMM 1210/1280/1615 Software User Guide
- ❒ VMM 1615 Hardware User Guide

HVAC System

1. SAFETY

1.1. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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

Engine damage may occur if pressure-fill and deaeration procedures are not followed. Servicing heating system components may result in air being introduced into the system. It is necessary to completely bleed any air entrapped in the vehicle heating system and the engine cooling system before starting the engine. Refer to Section 6 of this manual for 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:

- ❒ Roof-mounted HVAC unit.
- ❒ HVAC display panel located behind the ceiling-mounted access door.
- ❒ Refrigerant compressor located in the engine compartment.
- ❒ Hybrid battery cooler located on rooftop energy storage system 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.
- ❒ Auxiliary coolant heater 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 coolant booster pump draws coolant from the engine and delivers it to the HVAC unit heater coil, interior heater coils, and driver's heater/defroster unit heater coil. 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 a cable-operated coolant shutoff valve is located in the defroster compartment. Cooling system drain cocks are provided at the bottom of the radiator and in the driver's heater/defroster return line.

2.2.3. Auxiliary Coolant Heater

The auxiliary coolant heater operates whenever there is a demand for heat, as determined by the HVAC control unit or the driver's heat control switch. The booster pump delivers coolant to the auxiliary coolant heater from where it is distributed to the HVAC unit and vehicle interior heating system. Refer to 2.9. "Auxiliary Coolant Heater" on page 34 and Refer to 2.10. "Booster Pump" on page 38 in this section for more information on these units.

2.2.4. Vehicle Heating System Bypass

A solenoid-operated shutoff valve is installed in the coolant return line and is used to bypass coolant from the vehicle interior heating system and recirculate the coolant directly back to the engine to promote quick engine warmup and maintain an efficient engine operating temperature. The solenoid valve is energized open by the vehicle multiplexing system if the system detects engine coolant temperature below a preset value.

2.2.5. 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.

2.2.6. 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 engine 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.

2.3. HVAC Unit

2.3.1. Description

The RLF series is a one-piece condenser/evaporator/heater assembly located on the roof of the vehicle. The HVAC unit is designed to interface with vehicle components such as the compressor, floor heaters and booster pump.

The evaporator, heater coil, and blower motors are housed in the front section of the unit. The condenser coil and fans are housed in the aft section of the unit.

An interior HVAC access door is located in the ceiling of the vehicle. Releasing the quarter-turn latches allows the hinged door to swing downward, providing access to the return air filter.

The receiver/dryer, sight glass, Intelligaire III control module, display module, return air temperature sensor, fuses, and J1939 diagnostic connector can also be accessed from below. All other HVAC components must be accessed from the rooftop. See “Fig. 10-1: Interior HVAC Components” on page 8.

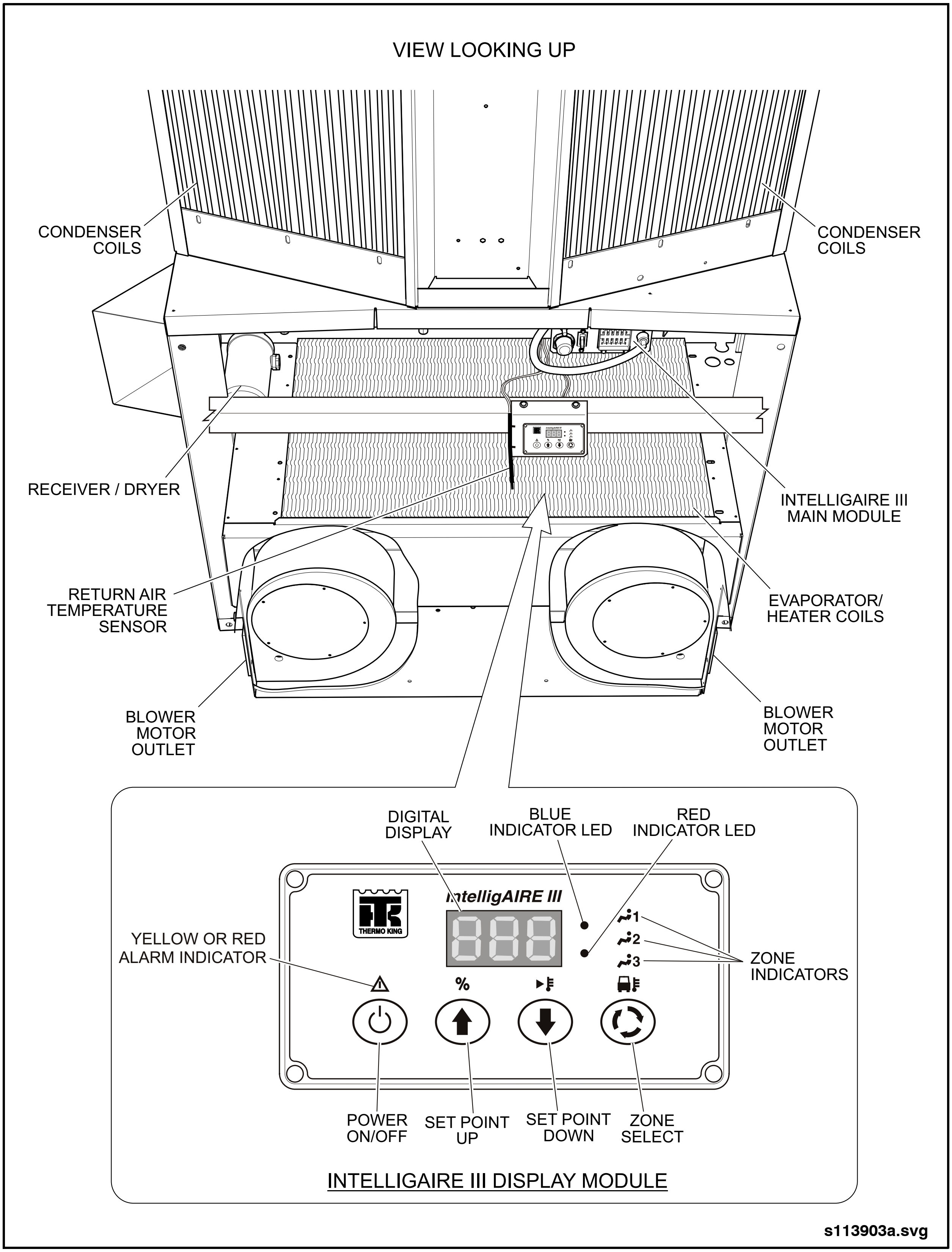


Fig. 10-1: Interior HVAC Components

2.3.2. HVAC Unit Specifications

Manufacturer..................Thermo King Corp.

Model... RLF2-M7

Condenser Motors ....Brushless 24 VDC

Blower Motors..................Brushless 24VDC

Refrigerant Type R-407C

2.3.3. Operation

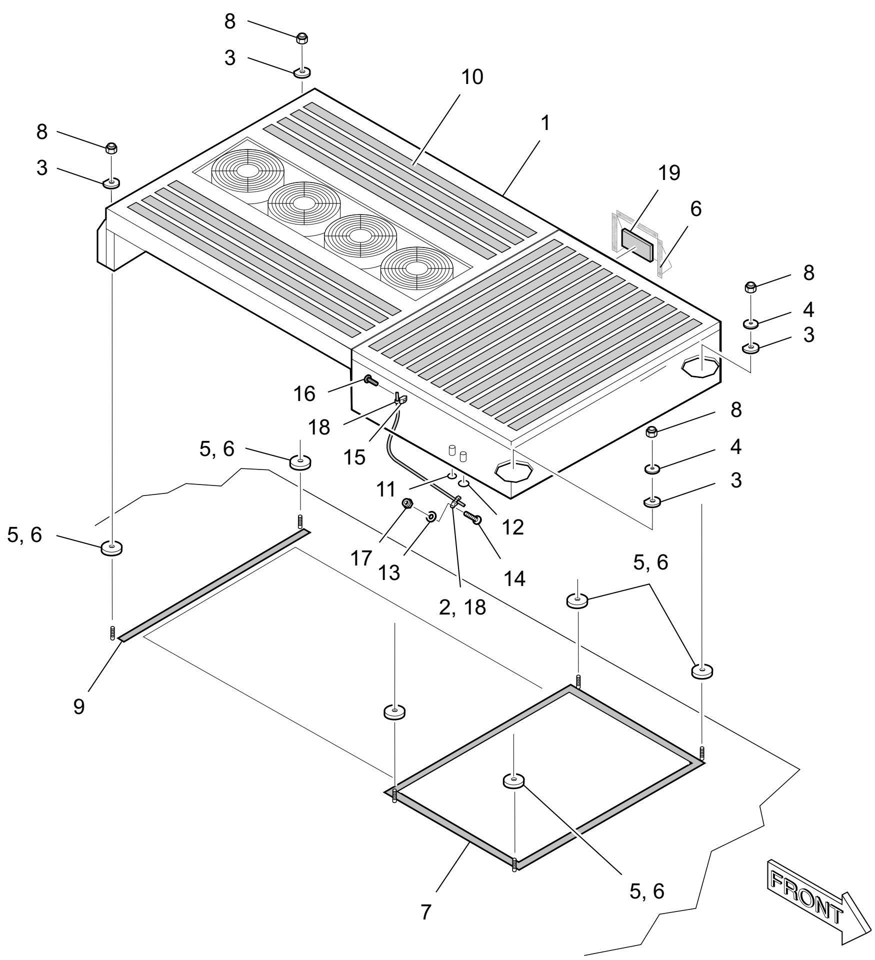
DANGER

DO NOT operate the compressor with the discharge valve closed. This conditions increases internal pressure, which can cause an explosion.

The vehicle is equipped with a Multiplexing System, which interfaces the RLF unit with the Climate Control switch on the side console. It also allows interface with other HVAC components such as the compressor, floor heater, 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. 10-2: HVAC Unit Installation” on page 10.

Refer to the Thermo King Maintenance Manual for specific details of operational mode.



1. HVAC Unit Assembly
2. Mount, Cable Tie 3/16" Eye
3. Washer, 3/8" x .19" Thk
4. Washer, Flat 3/8"
5. Spacer, 1.750" x .38" Thk
6. Adhesive, SIKA 221 White
7. Gasket, Roof HVAC Front
8. Nut, Lock Nylon 3/8" - 16 UNC
9. Gasket, Roof HVAC Rear
10. Safety Walk, 2" Wide
11. O-Ring, -20
12. O-Ring, -24
13. Washer, Flat SST #10
14. Screw, PH Cross Recess SST #10 - 24 UNC x 1" Lg.
15. Mount, Cable Tie 2-Way 1/14" Eye
16. Screw, PH Cross Recess Tpg. Type F 1/4" - 20 UNC x 1 1/4" Lg.
17. Nut, Lock Nylon #10 SST
18. Cable Tie, 4/5" W x 8 1/2" Lg.
19. Filter, Air Fresh

s0358144a.svg

Fig. 10-2: HVAC Unit Installation

2.3.4. 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 47 in this section for further detailed information on service intervals and procedures.

2.3.5. 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. Evacuate the refrigerant from the A/C system. Refer to your Thermo King Maintenance Manual for evacuation procedure.
3. Disconnect and plug refrigerant lines.
4. Drain coolant from the HVAC heater core.
5. Disconnect and plug coolant hoses.
6. Disconnect HVAC electrical harnesses that interface with vehicle wiring.
7. Remove the HVAC unit cover.
8. Remove the lock nuts, washers, and spacers that secure the HVAC unit to the roof structure mounting studs. Note the location of washers and spacers for reassembly.
9. Attach lifting equipment to the HVAC unit ensuring the load is equally distributed.
10. Remove the HVAC unit from the rooftop of the vehicle.

2.3.6. 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. Prepare the rooftop mounting surfaces and HVAC unit underside surfaces for installation as follows:.
   a. Scrape clean any existing sealant from the mounting area on the rooftop.
   b. Apply the self-adhesive gasket to the underside of the HVAC unit. Apply the gasket around the perimeter of the evaporator section and apply a single gasket strip at the aft end of the condenser section.

   ☞**NOTE:**

   Position the splice on the evaporator gasket at the aft end of the evaporator and seal joint with Sika 221.

   c. Apply a generous bead of Sika 221 sealant to the area around each roof mounting stud.
   d. Place a spacer onto mounting stud and press the spacer into the sealant until the sealant is visible around the edges of the spacer.
   e. Apply a second generous bead of Sika 221 around each roof stud and over the spacer.
2. Lift the HVAC unit into position and align the holes in the mounting brackets with the rooftop mounting studs.
3. Secure the HVAC unit with lock nuts and washers. Torque nuts to 22 ft-lbs. (30 Nm).
4. Connect HVAC electrical harnesses to vehicle wiring.
5. Connect coolant hoses.
6. Connect refrigerant lines.
7. Charge the A/C system. Refer to your Thermo King Maintenance Manual for recharging procedure.
8. Reinstall the HVAC unit cover.
9. Set Battery Disconnect switch to the ON position.
10. Top up the cooling system and perform a deaeration procedure. Refer to Section 6 of this manual for deaeration procedure.
11. Test the heating and air-conditioning systems for proper operation.

2.4. IntelligAIRE III Control System

2.4.1. 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. 10-3: HVAC Control Panel” on page 13.

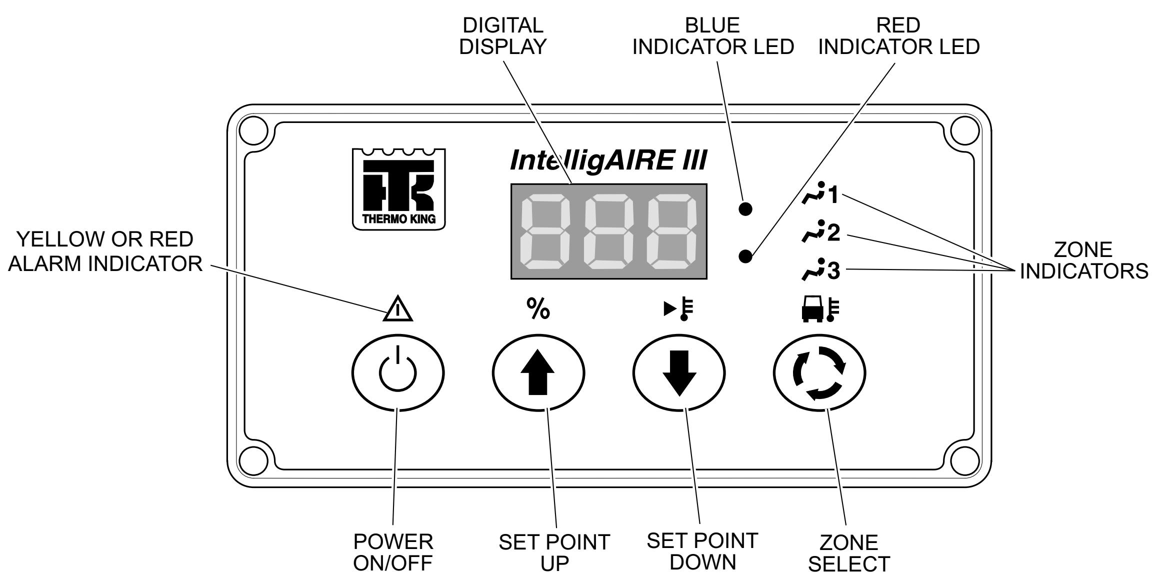


Fig. 10-3: HVAC Control Panel

2.4.2. 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 47 *in this section for further information on the Intelligaire III Control System.*

2.4.3. HVAC Display Module Controls

2.4.3.1. 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.

2.4.3.2. 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.

2.4.3.3. 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.

2.4.3.4. 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.

2.4.3.5. 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.

2.4.4. Intelligaire III Control System Diagnostics

☞NOTE:

Refer to 3. "VENDOR SERVICE INFORMATION" on page 47 *in this section for information on the Intelligaire III Control System diagnostics.*

2.5. Hybrid Battery Cooler

2.5.1. Description

The hybrid battery cooler assembly is located in the roof-mounted battery/DPIM rack enclosure. It consists of an evaporator coil, expansion valve, air filter, and connecting A/C lines and fresh air ducts. See "Fig. 10-4: Hybrid Battery Cooler Installation" on page 15.

2.5.2. Operation

The battery cooler operates when the battery pack air temperature exceeds 80°F (27°C). Internal fans within the battery pack draw air through the intake duct, across the evaporator coil, and through the hybrid battery pack. Refer to Section 6 of your New Flyer Parts Manual for details of this installation. Refer to the Preventive Maintenance Section of this manual for the hybrid battery pack air filter servicing schedule.

2.5.3. 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 47 in this section for further detailed information on service intervals and procedures.

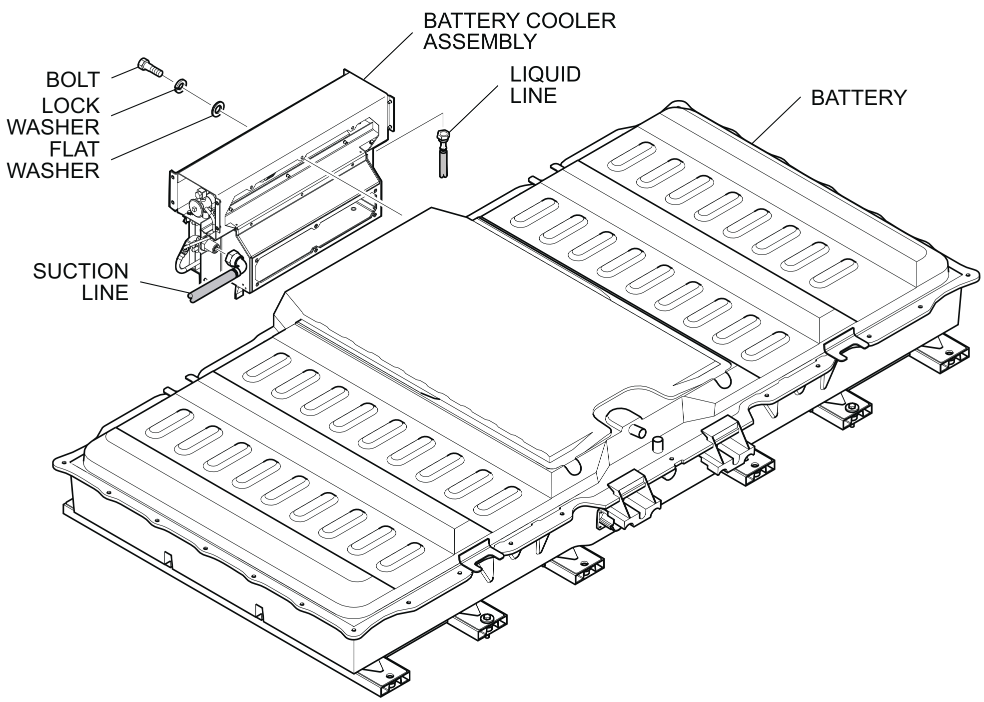


Fig. 10-4: Hybrid Battery Cooler Installation

2.5.4. 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. Set the Battery Disconnect switch to the OFF position.
2. Evacuate the refrigerant from the A/C system. Refer to your Thermo King Maintenance Manual for evacuation procedure.
3. Locate the hybrid battery cooler on the side of the Energy Storage System (ESS).
4. Disconnect and plug refrigerant lines.
5. Remove the M6 bolts and washers that attach the battery cooler outlet flange to the ESS.
6. Lift the hybrid battery cooler off the two lower locating studs and remove the battery cooler from the ESS.
7. Remove the six M6 bolts that attach the lower inlet mounting angle and gaskets if a new hybrid battery cooler assembly is being installed.

2.5.5. 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.

☞**NOTE:**

A new replacement hybrid battery cooler assembly will come with lower inlet mounting angle and gaskets. If the existing hybrid battery cooler is being reinstalled, the lower inlet mounting angle and gaskets will already be installed on the ESS.

1. Remove the bottom inlet mounting angle and gaskets from the new replacement hybrid battery cooler.
2. Use six M6 bolts to install the bottom inlet mounting angle onto the ESS.
3. Lower the battery cooler into position over the two locating studs.
4. Secure the battery cooler to ESS with six M6 bolts at the top and bottom outlet mounting angles.

☞**NOTE:**

Adjust the outlet side of the battery cooler to allow the gasket on the inlet side to form a proper seal.

5. Connect refrigerant lines.
6. Charge the A/C system. Refer to your Thermo King Maintenance Manual for recharging procedure.
7. Set Battery Disconnect switch to the ON position.
8. Test the operation of the ESS hybrid battery cooler.

2.6. Compressor

2.6.1. Description

This vehicle is equipped with a Thermo King four-cylinder, V-type reciprocating compressor. See "Fig. 10-5: Main Features of HVAC Compressor" on page 17. 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... X430

Type..................Four-cylinder Reciprocating

Displacement...................30 cu. in. (492 cc)

Maximum Speed .... 3000 rpm

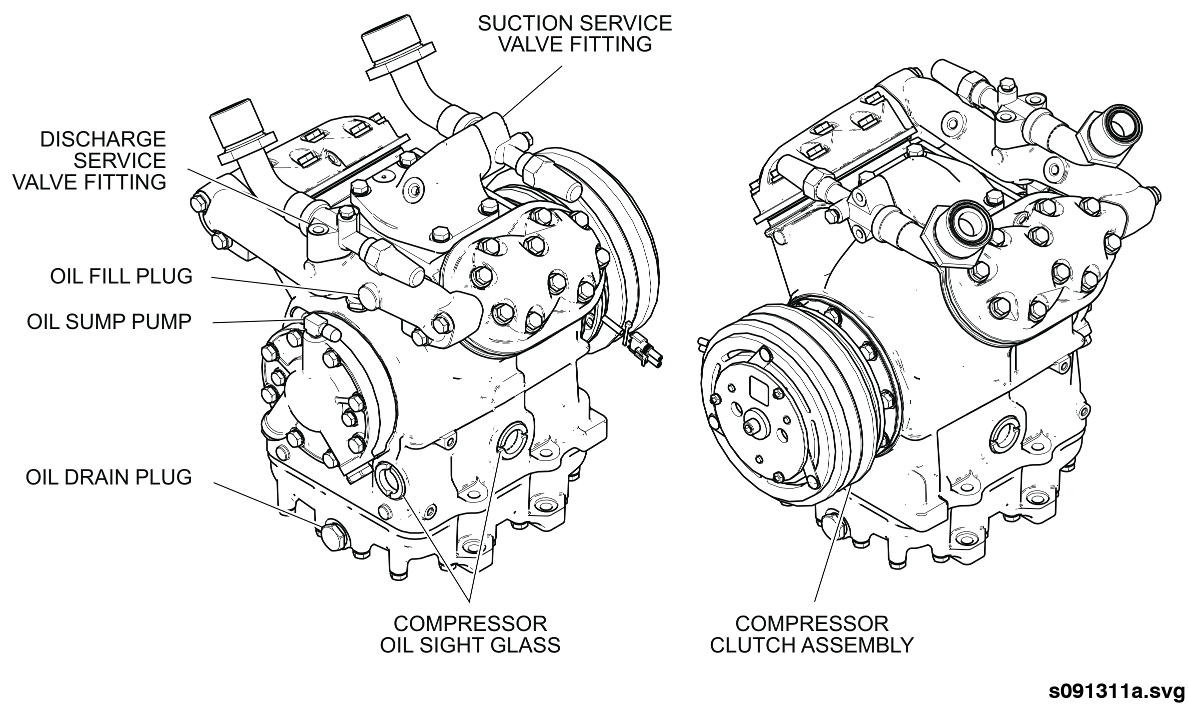


Fig. 10-5: Main Features of HVAC Compressor

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 47 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. A tensioning roller is mounted on a bracket next to the engine and dampens belt oscillations during compressor operation. See “Fig. 10-6: A/C Compressor Installation” on page 18.

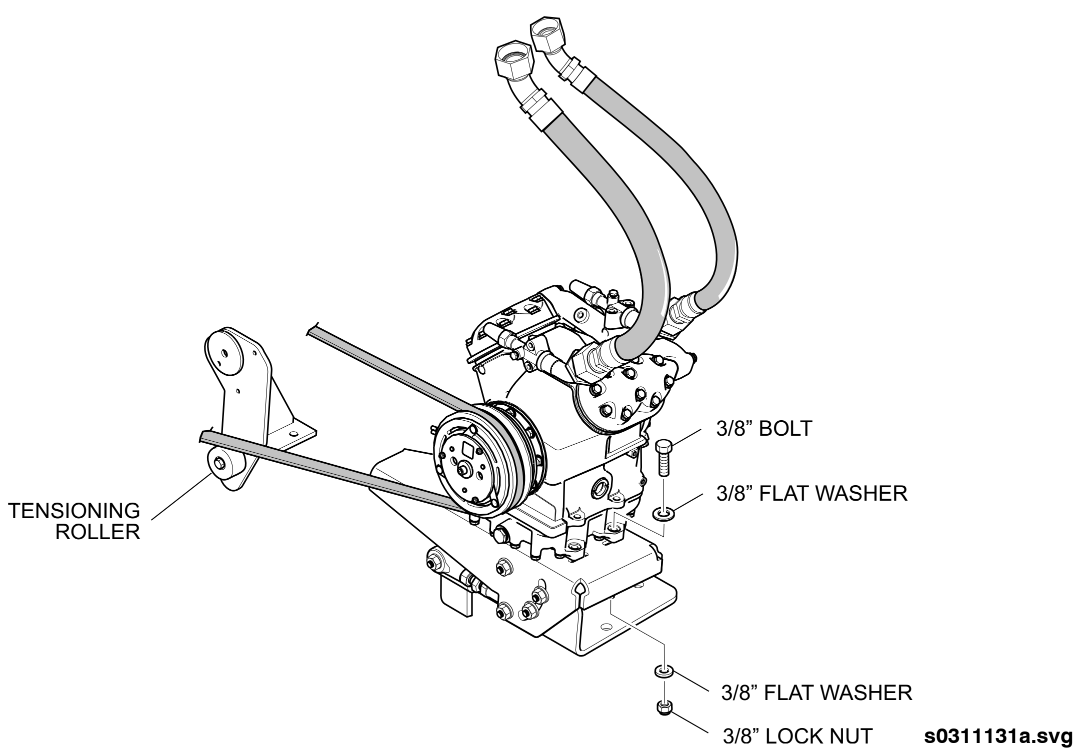


Fig. 10-6: A/C Compressor Installation

2.6.6. Compressor Removal

1. Evacuate the compressor and disconnect from system. Discard the brass washer from the discharge hose. 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. Release belt tension by leveraging the autotensioner using the 1/2" square key hole and remove belt.
5. Support compressor, remove four 3/8" bolts retaining compressor to 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.
2. Use a straightedge 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 250 lb. force on the belt.
4. Torque the 3/4" pivot bolt that retains the mounting plate to the support plate to 304 ft-lbs. (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 200 to 210 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. 10-7: Heater/Defroster Assembly” on page 22.
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.

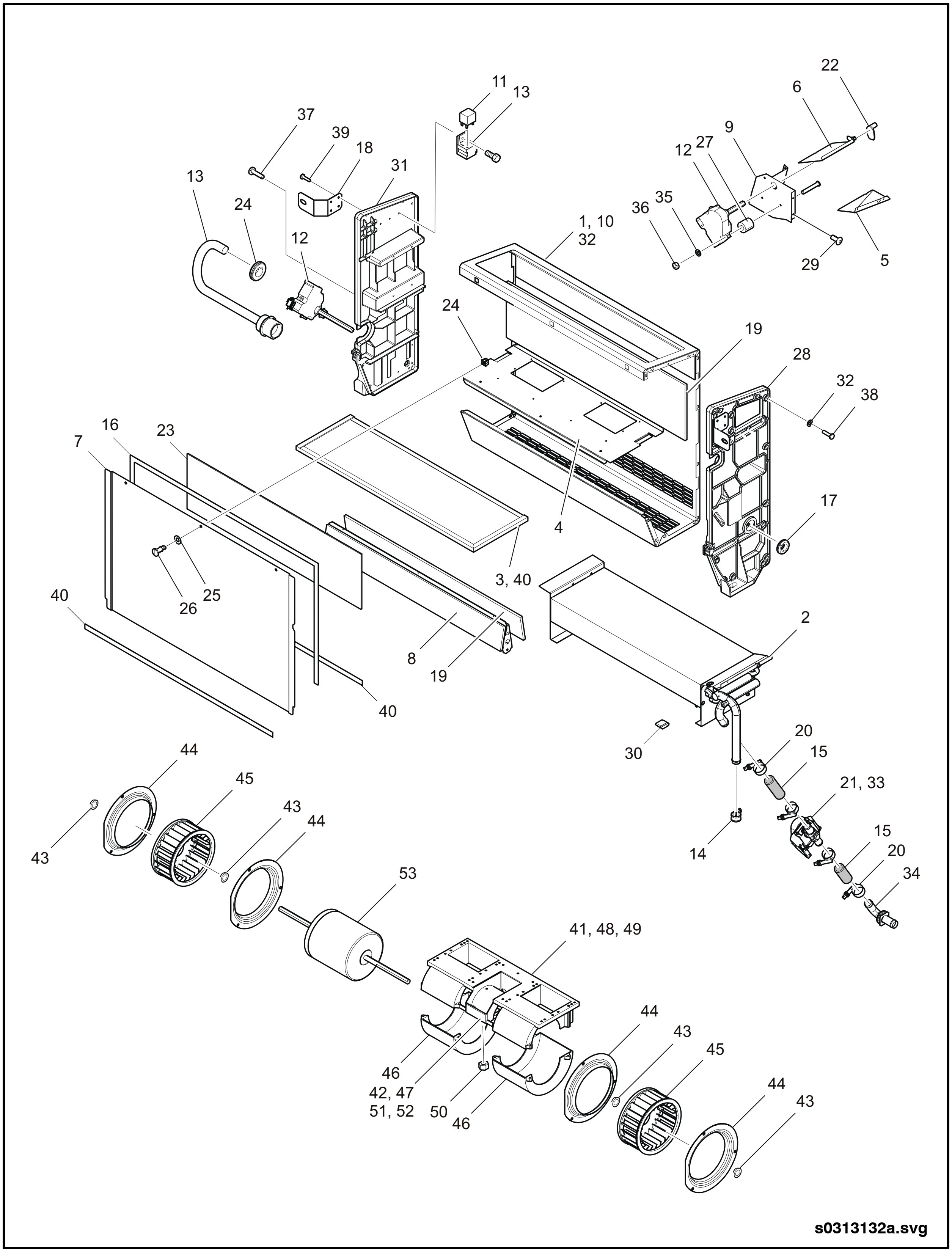


Fig. 10-7: Heater/Defroster Assembly

1. Heater/Defroster Assembly, 24V (Incl. 2-41)	18. Bracket	36. Nut, Lock #8 - 32
2. Coil, Heater	19. Seal, Foam 1/4" Thk.	37. Screw, Tpg, #8 - 32 x 1/2" Lg.
3. Filter	20. Clamp, Gear	38. Rivet, 3/16" x .44" SST
4. Plate, Blower	21. Valve Assembly, Heater Control	39. Screw, #10 - 16 x 5/8" Lg.
5. Plate	22. Bushing	40. Seal, 3/16" x 1/2"
6. Door, Flapper	23. Foam, 1/8" Thick	41. Blower Assembly, (Incl. 42-53)
7. Cover, Front	24. Receptacle	42. Bracket, Resistor
8. Door, Flapper	25. Retainer	43. Clip
9. Plate	26. Stud, Oval Slotted	44. Venturi
10. Casing	27. Spacer, Nylon 1/2"	45. Wheel, Blower
11. Relay, 24V	28. Side, RH	46. Housing, Top
12. Actuator, Motor 24V	29. Rivet, 1/8" SST	47. Resistor, 3 Speed Aluminum
13. Harness, Wiring	30. Clip, Coil	48. Pad, Motor
14. Clamp, Hose P-Type #12	31. Side, LH	49. Housing, Blower
15. Hose, Silicone	32. Washer, Flat #10 SS	50. Nut, Lock Nylon #10 - 32
16. Neoprene, 1/16" x 2"	33. Tie Wrap	51. Screw, PH #10 - 32 x 3/4" Lg.
17. Grommet	34. Tube Assembly, Copper	52. Pad, Motor
	35. Washer, Flat"	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. Top up coolant at surge tank, run engine, 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 25 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 26 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 26 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 26 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 26 in this section.
	Heat control valve actuator faulty.	Test heat control valve actuator. Refer to 2.7.5.2. "Component Diagnosis" on page 26 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 26 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 26 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 26 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 26 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. 10-8: Defroster Components" on page 26.

   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.

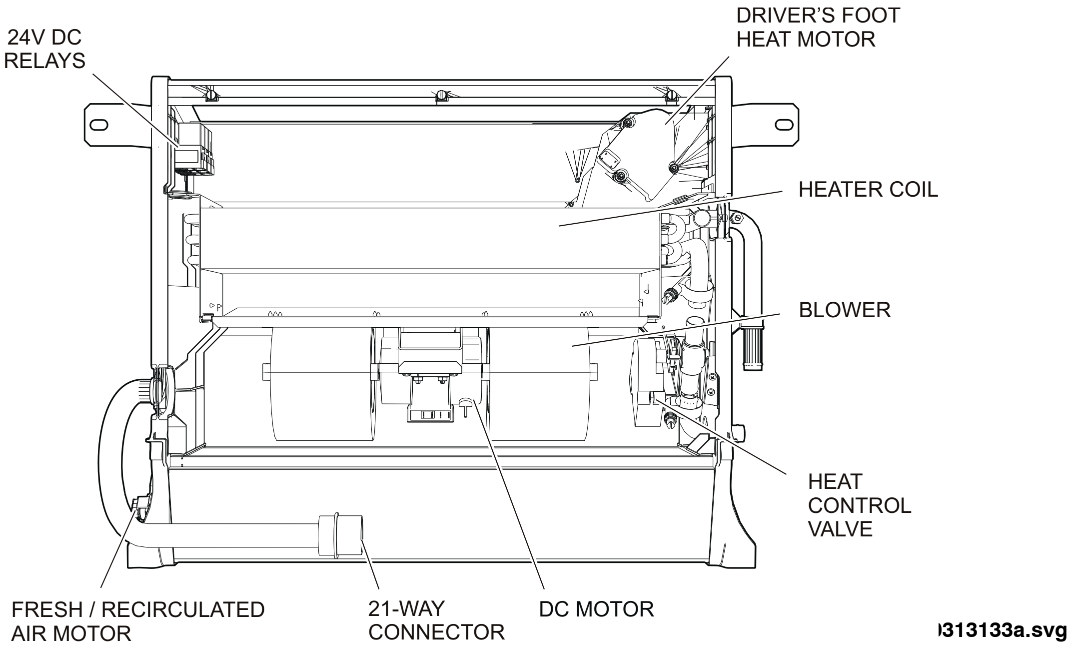


Fig. 10-8: Defroster Components

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. 10-9: Resistor Module" on page 27.

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.

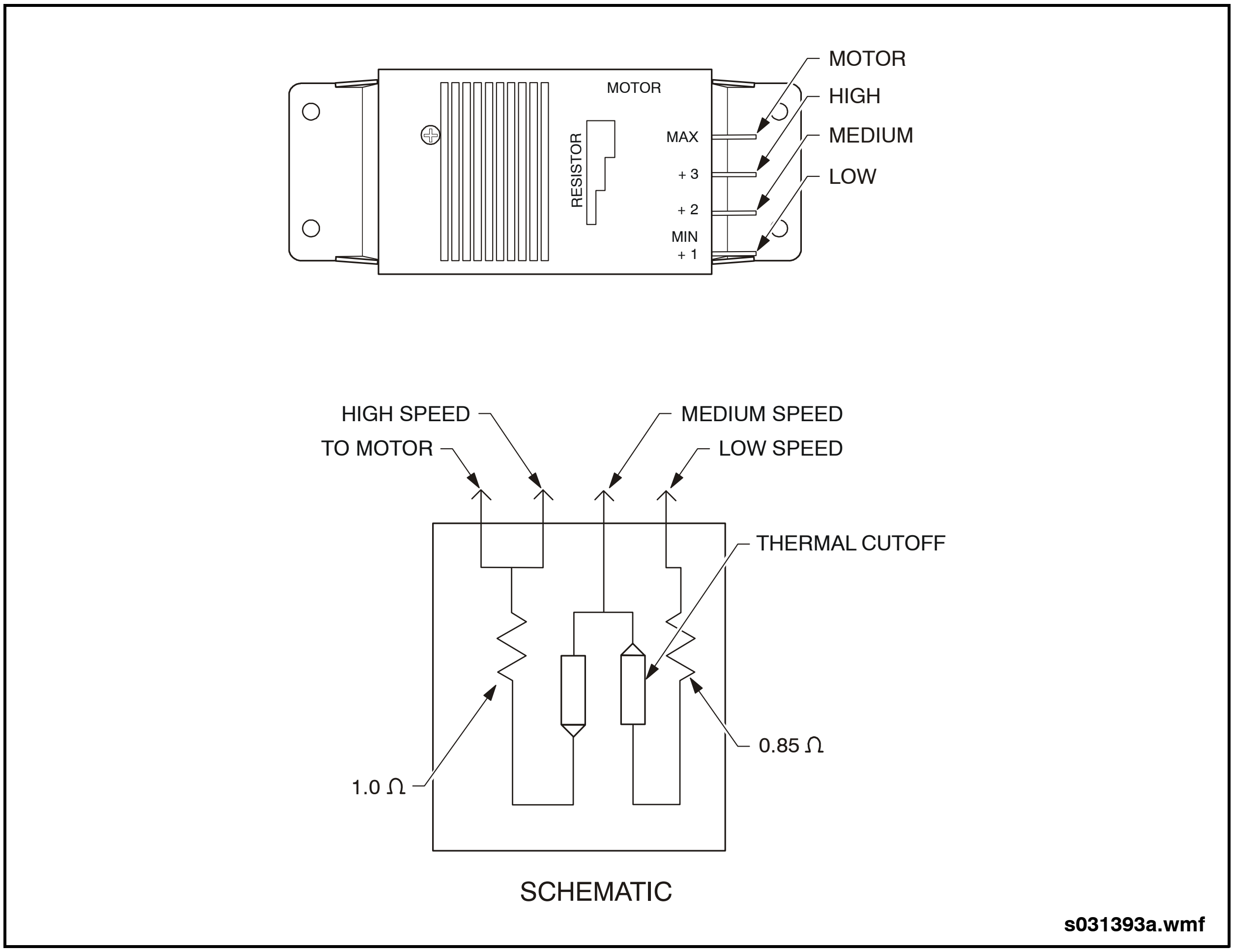


Fig. 10-9: Resistor Module

2.8. Floor Heaters

2.8.1. 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.

2.8.2. Floor Heaters Specifications

Heating .... 41,000 BTU/H (at 150°F Temperature Differential)

Air Flow .... 350 CFM (at High Speed)

Current .... 3.7 A (at 27 V High Speed)
.... 1 A (at 27 V Low Speed)

2.8.3. Operation

The floor heaters receive 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.

2.8.4. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance requirements.

2.8.5. Removal

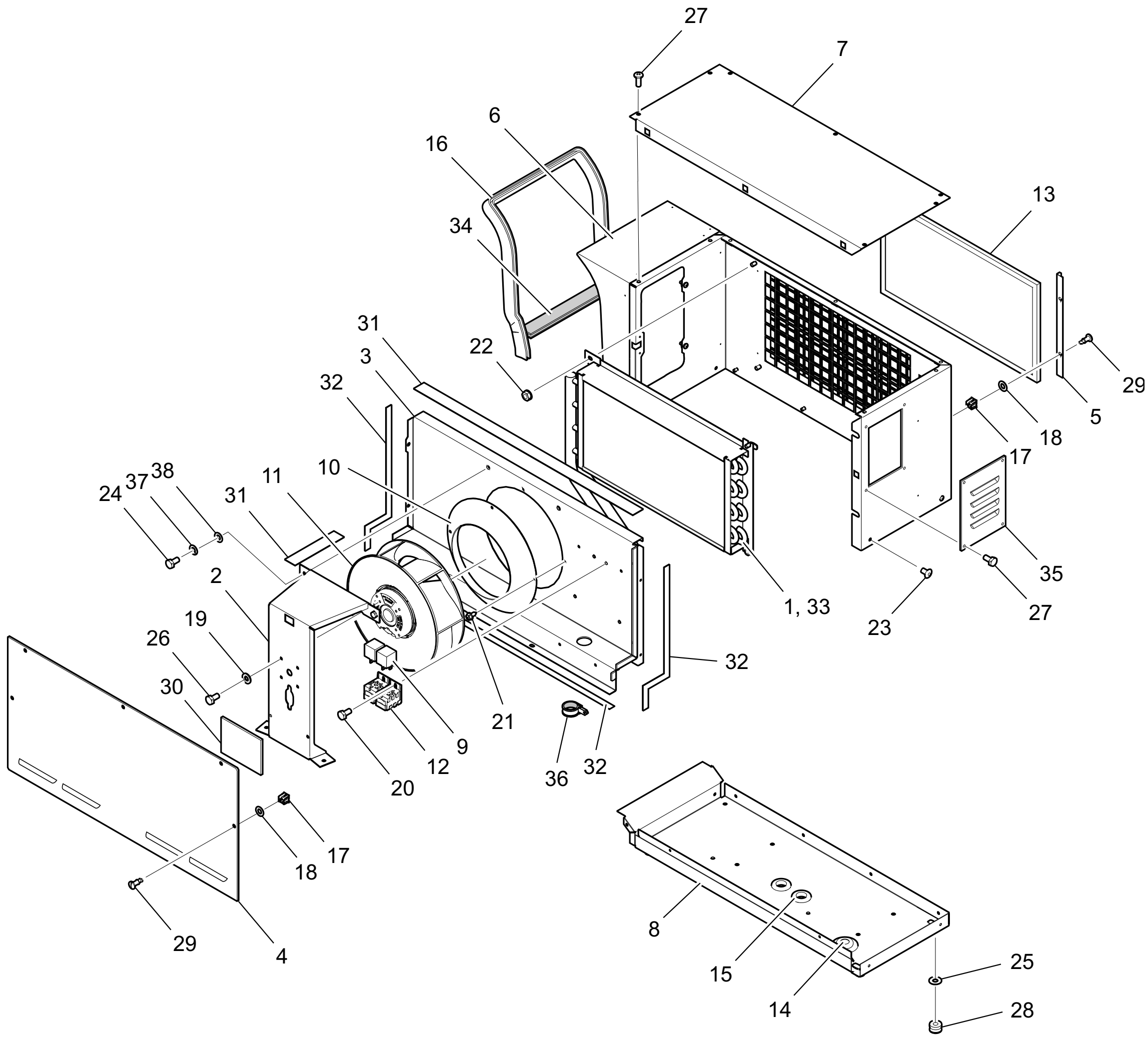
1. Shut off coolant supply and return valves to the heater system.
2. From underneath the vehicle, disconnect the coolant supply and return hoses from the heater taking care to catch any spilled coolant in an appropriate container.
3. Tag and disconnect the vehicle wiring harness from the junction block.
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.

2.8.6. Disassembly

1. Remove the filter retainer and slide the filter out. See "Fig. 10-10: Streetside Heater Assembly" on page 29. See "Fig. 10-11: Curbside Heater Assembly" on page 30.
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...38)
2. Bracket
3. Divider
4. Cover, Access
5. Retainer, Filter
6. Casing
7. Cover, Top
8. Tray, Bottom
9. Relay, 24V
10. Venturi
11. Fan Assembly, 24V
12. Wiring Harness
13. Filter, Air
14. Grommet
15. Grommet
16. Seal
17. Receptacle
18. Retainer
19. Washer, Flat M4
20. Screw, Hex Head #10 - 32 UNF x 3/8" Lg.
21. Screw, Hex Head Tapping #8 x 3/8" Lg.
22. Nut, Lock 1/4" - 20 UNC
23. Rivet, SS 3/16" x .315"
24. Capscrew, Hex Head 1/4" - 20 UNC x 1/2" Lg.
25. Washer, Flat SS 1/4"
26. Screw, Tapping M4 x 8mm Black
27. Screw, Phillips Head #10 - 32 UNF x 1/2" Lg.
28. Nut, Round Knurled Brass 1/4" - 20 UNC
29. Stud, Oval Slotted
30. Seal, 3/16" x 3"
31. Neoprene, 1/16" x 1"
32. Neoprene, 1/16" x 2"
33. Coil, Heater
34. Seal
35. Door, Access
36. Clamp. Hose
37. Washer, Lock 1/4"
38. Washer, Flat 1/8"

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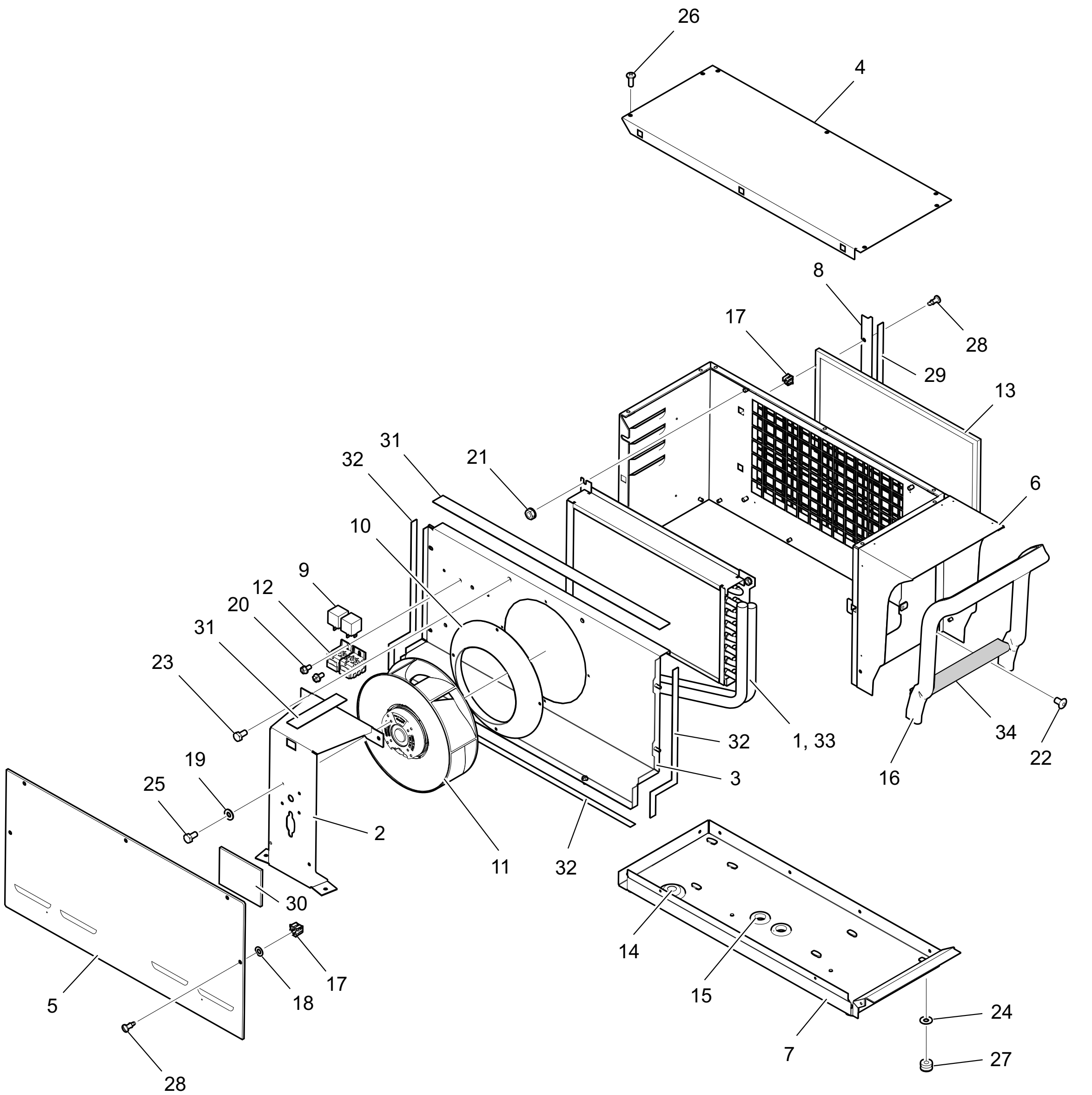
Fig. 10-10: Streetside Heater Assembly



1. Heater Assembly, Curbside (Incl. 2…34)
2. Bracket
3. Divider
4. Cover, Top
5. Cover, Access
6. Casing
7. Tray, Bottom
8. Retainer, Filter
9. Relay, 24V
10. Venturi
11. Fan Assembly, 24V
12. Wiring Harness
13. Filter, Air
14. Grommet
15. Grommet
16. Seal
17. Receptacle
18. Retainer
19. Washer, Flat M4
20. Screw, Hex Head #10 - 32 UNF x 3/8" Lg.
21. Nut, Lock 1/4" - 20 UNC
22. Rivet, SS 3/16" x 0.315"
23. Capscrew, Hex Head 1/4" - 20 UNC x 1/2" Lg.
24. Washer, Flat SS 1/4"
25. Screw, Tapping M4 x 8mm Black
26. Screw, Phillips Head #10 - 32 UNF x 1/2" Lg.
27. Nut, Round Knurled 1/4" - 20 UNC
28. Stud, Oval Slotted
29. Seal, 3/16" x 1/2"
30. Seal, 3/16" x 3"
31. Neoprene, 1/16" x 1"
32. Neoprene, 1/16" x 2"
33. Coil, Heater
34. Seal

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Fig. 10-11: Curbside Heater Assembly

2.8.7. 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.

2.8.8. 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 vehicle wiring harness to the junction block.
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.

2.8.9. Exit Door Floor Heater Troubleshooting

☞NOTE:

Ensure that all electrical connections are clean and making proper contact before conducting troubleshooting procedures. Pay particular attention to the drive module and 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.

EXIT DOOR FLOOR HEATER TROUBLESHOOTING		
SYMPTOM	**POSSIBLE CAUSE**	**RECOMMENDED ACTION**
Heater motor inoperative	No power	Perform "Vehicle Wiring Check" in this section.
	Faulty ground	Check connection to Terminal "D" on vehicle wiring harness interface. Verify that Terminal "D" is properly grounded to the vehicle.
	Motor seized	Replace motor.
	Blower wheel obstructed or damaged	Remove obstruction.
	Motor open circuit	Refer to 2.8.9.2. "Component Diagnosis" on page 33 in this section for procedure. Replace motor as an assembly if defective.
	Faulty fan speed resistor or resistors	Refer to 2.8.9.2. "Component Diagnosis" on page 33 in this section for procedure. Replace wire harness if a resistor is defective.
	Faulty fan speed relay or relays	Refer to 2.8.9.2. "Component Diagnosis" on page 33 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.

2.8.9.1. 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 "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 terminal "A".

☞NOTE:

If no power is indicated at terminal "A", check for a tripped circuit breaker or faulty ground circuit. Refer to vehicle electrical schematic.

2.8.9.2. 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 Ohm ± 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.

2.9. Auxiliary Coolant Heater

2.9.1. Description

The auxiliary heater is a diesel-fueled coolant heater. It increases the temperature of the coolant coming from the engine to ensure that as the coolant circulates, sufficient heat is transferred to the heaters located throughout the vehicle.

The auxiliary heater is mounted to a supporting cradle assembly in the engine compartment. It receives a fuel supply line from the vehicle's fuel system, and coolant supply and return lines from the coolant booster pump. Refer to Section 7 of this manual for a description of the fuel system. Refer to 2.10. “Booster Pump” on page 38 in this section for further information concerning the pump.

2.9.2. Auxiliary Coolant Heater Specifications

Model...................................... Proheat M80

Heat Output............. 80, 000 BTU/h (24 Kw)

Voltage .... 24 VDC

Current ....5.2 amps

Fuel Consumption ....0.78 US gal/hr (2.95 Liters/hr)

Ignition............................... Electronic spark

Fuel Connection ....-4 SAE 37° (J.I.C.) Swivel nut male 90° Elbow

Outlet Coolant Temperature ....185°F (85°C)

Weight (basic heater) ....53 lbs. (23.5 kg)

Network Compatibility................ J1939 CAN

2.9.3. Operation

The auxiliary coolant heater is enabled using the Aux Heater toggle switch located in the front destination sign compartment and is signaled by the multiplexing system to start once the engine is running. The auxiliary coolant heater is self-regulating and will operate within a prescribed temperature setpoint.

An internal fuel pump draws fuel from the vehicle fuel tank and supplies it to an internal fuel pressure regulator. Fuel is re-circulated within the pump, thereby negating the need for a fuel return line.

An impeller style blower, driven by the electric motor, provides compressed air for the combustion section. An aspirating type burner nozzle draws fuel from the fuel regulator and atomizes the fuel. An electronic ignition module with plug-in electrode is used to ignite the combustible fuel/air mixture.

The coolant booster pump provides engine coolant to the inlet port on the auxiliary coolant heater. Coolant circulates through the heat exchanger, where heat is transferred to the coolant, and exits through the outlet port where it is delivered to the various heating units in the vehicle. A temperature sensor, located in the outlet port, measures coolant temperature and sends this information to the Proheat Control Module (PCM).

2.9.4. Maintenance

Refer to the Preventive Maintenance Section of this manual for maintenance procedures and intervals.

2.9.5. Auxiliary Coolant Heater Troubleshooting

Refer to 3. “VENDOR SERVICE INFORMATION” on page 47 in this section for troubleshooting information.

2.9.6. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Gain access to the heater. Refer to Section 15 of this manual for access door locations.
3. Remove support brackets from cradle as required for access. See “Fig. 10-12: Auxiliary Coolant Heater Installation” on page 36.
4. Disconnect the heater electrical connections.
5. Close the coolant gate valves on the inlet and outlet side of the heater.
6. Disconnect the coolant inlet and outlet lines. Be careful to avoid spilling coolant.
7. Release the clamp from the air inlet and remove the air inlet tube.
8. Disconnect and plug the fuel supply line. Be careful to avoid spilling fuel.
9. Remove the heater support brackets.
10. Remove the bolts, washers and nuts which secure the heater to the cradle assembly.
11. Disconnect the exhaust line from the underside of the heater.
12. Remove the heater from the vehicle.

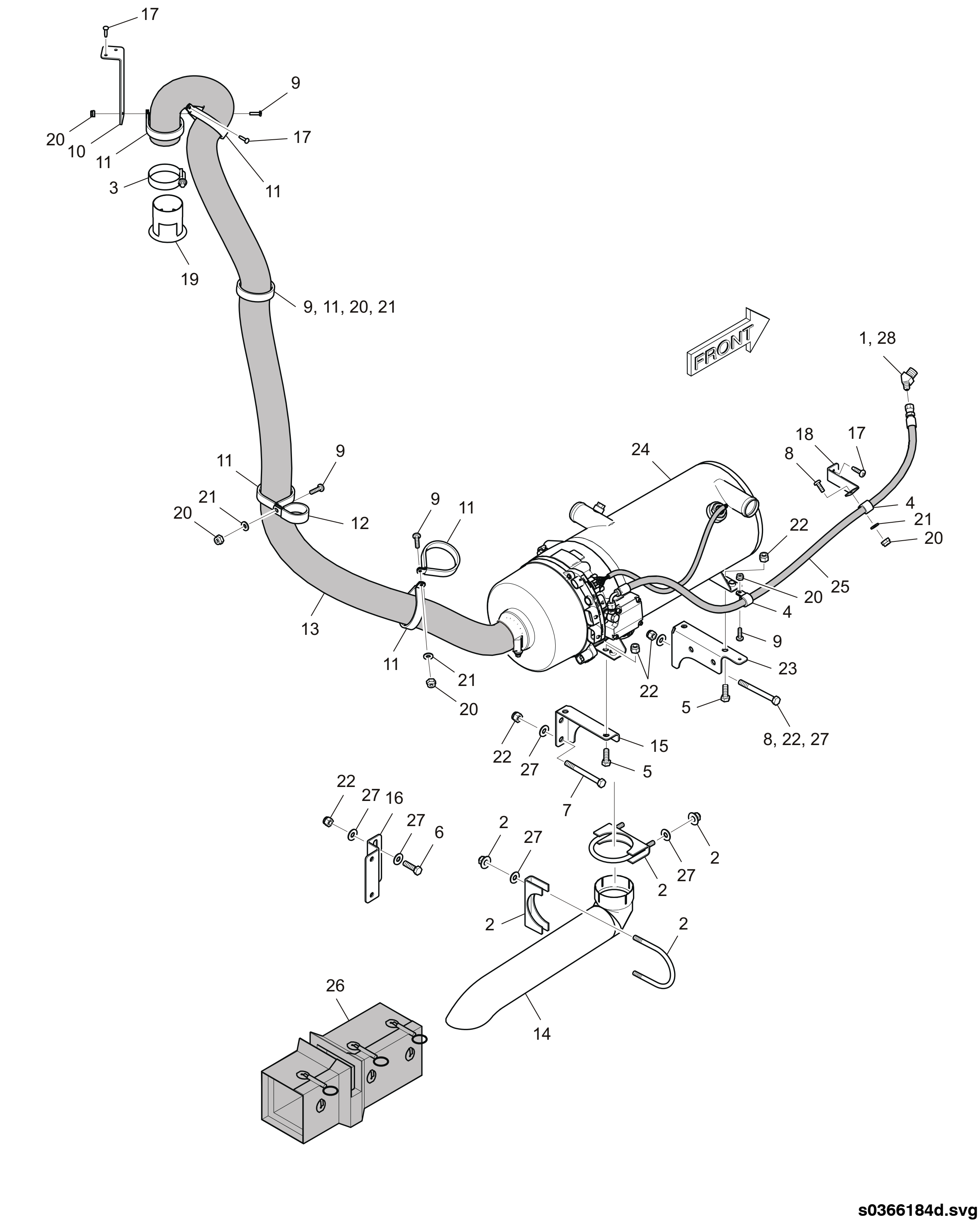


Fig. 10-12: Auxiliary Coolant Heater Installation

1. Adapter, Elbow 45° ext Pipe to 37° Flare
2. Clamp, Saddle
3. Clamp, Air Intake Hose
4. Clamp, "P" SST .500" x .2 Mtg.
5. Bolt, Hex 3/8" - 16 UNC x 1" Lg.
6. Bolt, Hex 3/8" - 16 UNC x 1 1/4" Lg.
7. Bolt, Hex 3/8" - 16 UNC x 5" Lg.
8. Screw, PH Cross Recess SST #10 - 24 UNC x 5/8" Lg.
9. Screw, PH Cross Recess SST #10 - 24 UNC x 3/4" Lg.
10. Bracket, Hose Support
11. Clamp, "P" 2.50" SST/HT
12. Clamp, "P" 1.50" SST/HT
13. Hose, Air Intake
14. Tube, Exhaust 2.75" O. D.
15. Bracket, Auxiliary Heater Mount
16. Bracket, Auxiliary Heater Exhaust
17. Screw, PH Cross Recess Tpg. Type F #10 - 24 UNC x 3/4" Lg.
18. Bracket, Hose Support
19. Fitting, Snorkel Diffuser
20. Nut, Lock Nylon #10 - 24 UNC
21. Washer, Flat SST #10
22. Nut, Lock Nylon 3/8" - 16 UNC
23. Bracket, Auxiliary Heater Mount
24. Auxiliary Coolant Heater Assembly
25. Hose Assembly, Fuel Heater 4
26. Blanket, Exhaust Tube
27. Washer, Flat SST 3/8"

Auxiliary Coolant Heater Installation (parts list)

2.9.7. Installation

1. Set the heater on the cradle assembly. Secure with mounting bolts, nuts and washers.
2. Connect the exhaust line to the underside of the heater.
3. Connect the fuel supply line.
4. Attach the air inlet line and secure with clamp.
5. Connect the coolant supply and return lines. Open the coolant gate valves on the inlet and outlet side of the heater.
6. Attach the electrical connections.
7. Attach the heater support brackets.
8. Set the Battery Disconnect switch to the ON position.

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 engine outlet hose 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 40 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

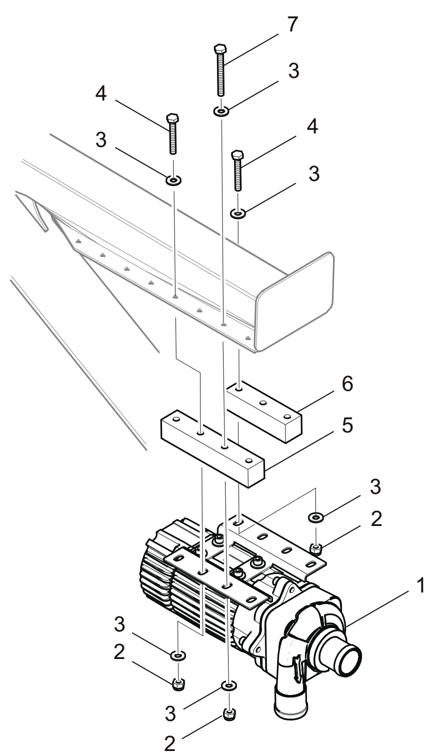
Refer to the Preventive Maintenance Section of this manual for scheduled intervals and service procedures.

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. 10-13: Booster Pump Installation" on page 40.
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
2. Nut, Lock Nylon 1/4" - 20 UNC
3. Washer, Flat 1/4"
4. Bolt, Hex 1/4" - 20 UNC
5. Spacer, Pump
6. Spacer, Pump
7. Bolt, Hex 1/4" - 20 UNC

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Fig. 10-13: 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. Run engine and check for leaks.

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. 10-14: Booster Pump Assembly” on page 42.
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.

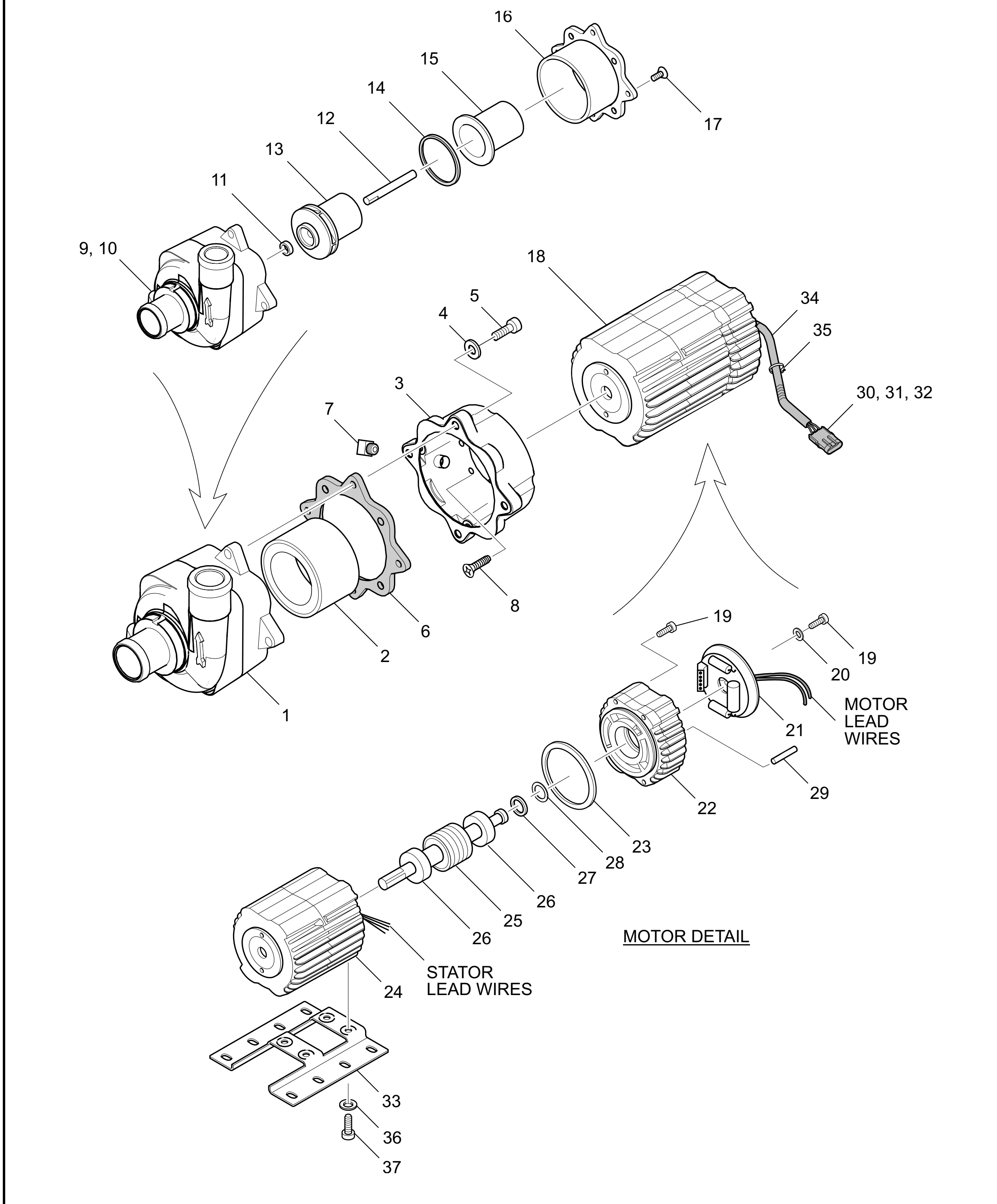


Fig. 10-14: Booster Pump Assembly

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	24. Stator & Housing Assembly
6. Gasket, Connecting Bracket	25. Shaft & Rotor Assembly
7. Plug, Plastic	26. Ball Bearing
8. Screw, Flat Head	27. Wave Washer
9. Housing Assembly, (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
16. Housing, Connector Ring	35. Ties, Cable
17. Screw, FH	36. Washer, Flat 1/4"
18. Motor, 27V (Incl. 19-37)	37. Screw, Socket Head 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 43 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 44 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 41 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 44 in this section for procedure.

3. VENDOR SERVICE INFORMATION

The following supplier manuals contain additional reference information.

3.1. Thermo King Manuals

- ❐ RLF2-M7 Maintenance Manual
- ❐ IntelligAIRE III Controller Diagnostic Manual

3.2. Proheat Manual

- ❐ Proheat M80 Operation & Maintenance Manual

Structures & Chassis

1. SAFETY

1.1. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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.**
- ❐ **Propulsion System Modules - disconnect the red and grey 32-pin connectors on each of the Vehicle Control Module (VCM) and Transmission Control Module (TCM).**
- ❐ **Dual Power Inverter (DPIM) - disconnect 24-pin connector (P1120 black) and both 32-pin connectors (P1121 red, P1122 grey).**
- ❐ **Energy Storage System (ESS) - disconnect the round 31-pin connector (PB140).**
- ❐ **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 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 video recorder.**
- ❐ **Fleetwatch Data Logger Module - disconnect the vehicle interface connector from the data logger.**

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 using the following products:

- ❒ Chemkleen CL90 - to clean structure.
- ❒ Urethane Zinc Rich Primer - consisting of S28079 catalyst and S28080 zinc powder.
- ❒ Corashield™ 7972 - undercoating compound
- ❒ Coratube™ - used as an internal structural tube coating

All of these products are available from PPG Industries.

3.2.2. Surface Preparation

The vehicle frame and chassis must be prepped through several processes to adequately protect the structure and chassis from premature corrosion.

3.2.3. 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 primer and undercoating with a damage area not more than 1/8" in width may be repaired by applying undercoating 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.

3.2.4. 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.

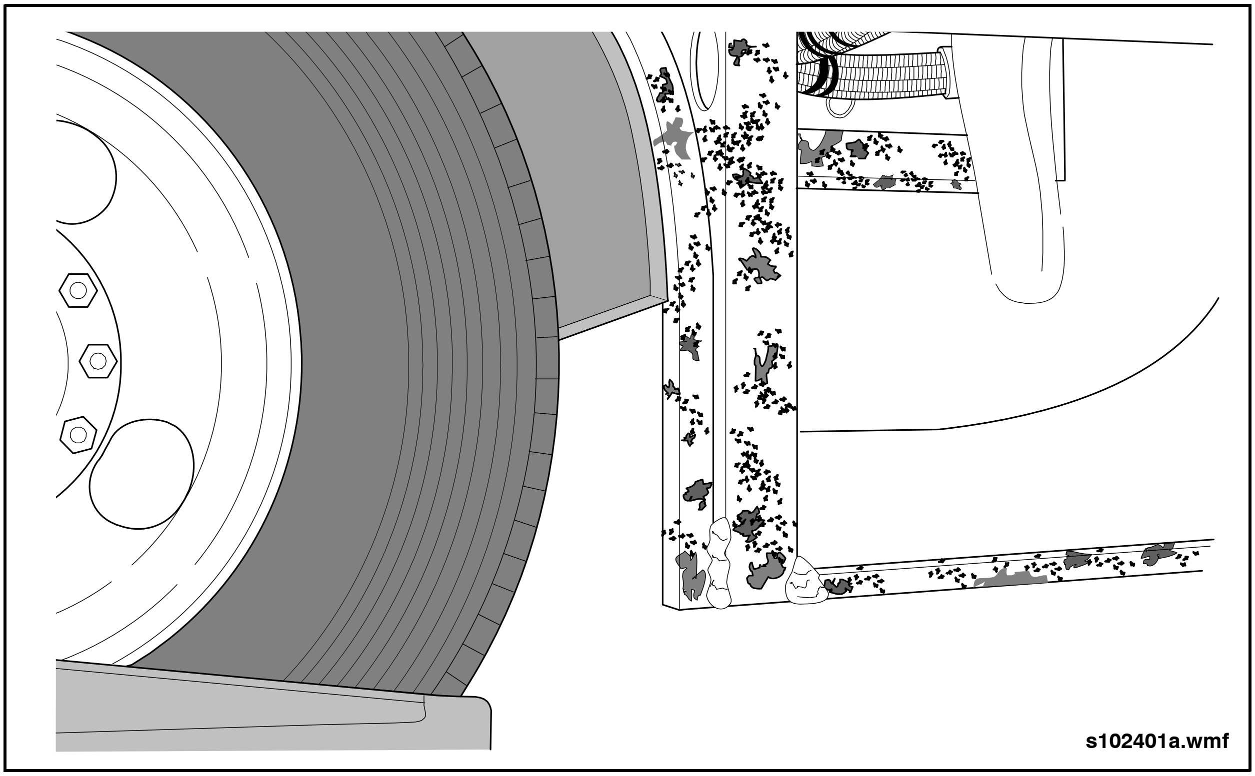


Fig. 11-1: Untreated Repair Area

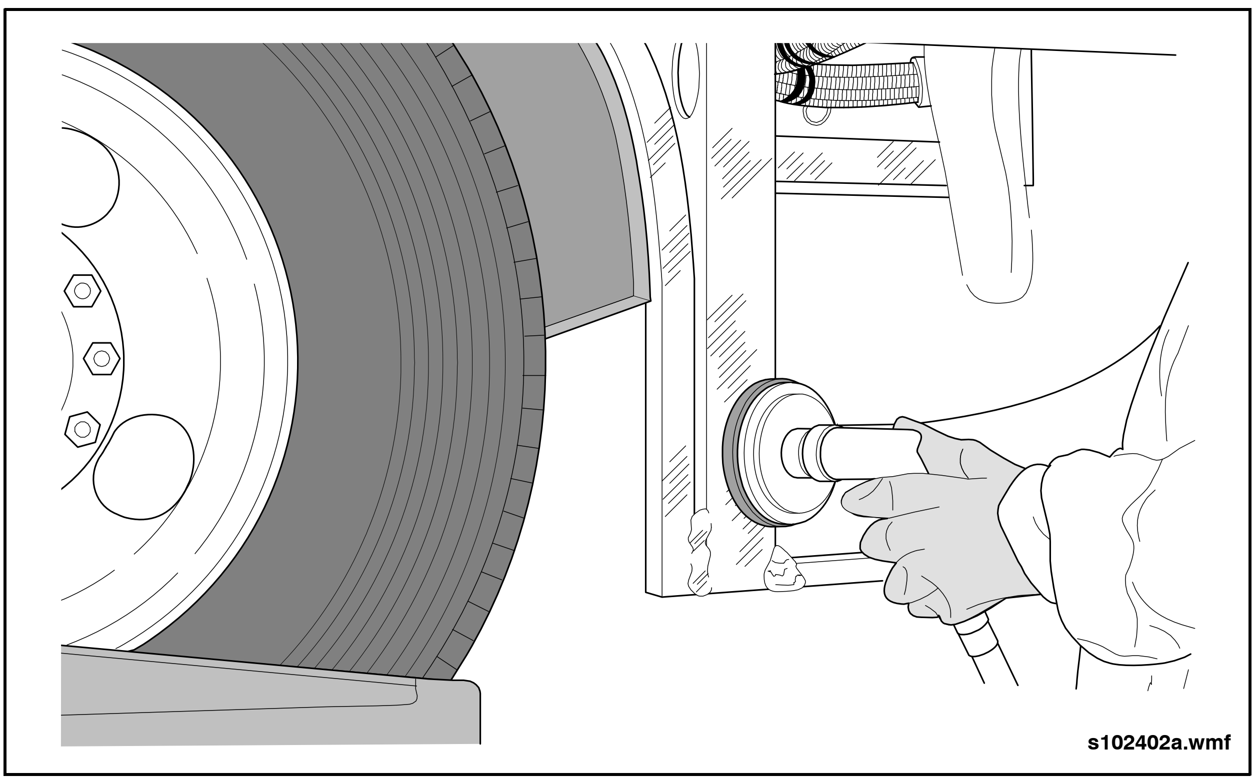


Fig. 11-2: Surface Cleanup

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.

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 primer by combining one gallon of S28079 liquid to 29 lb. of S28080 zinc powder as per instructions. Mix thoroughly and use immediately.

☞**NOTE:**

DO NOT apply primer if ambient temperature is below 40°F (5°C) or if humidity is less than 12% or above 90%. Primer cannot be applied over undercoating material.

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 13.

☞**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.

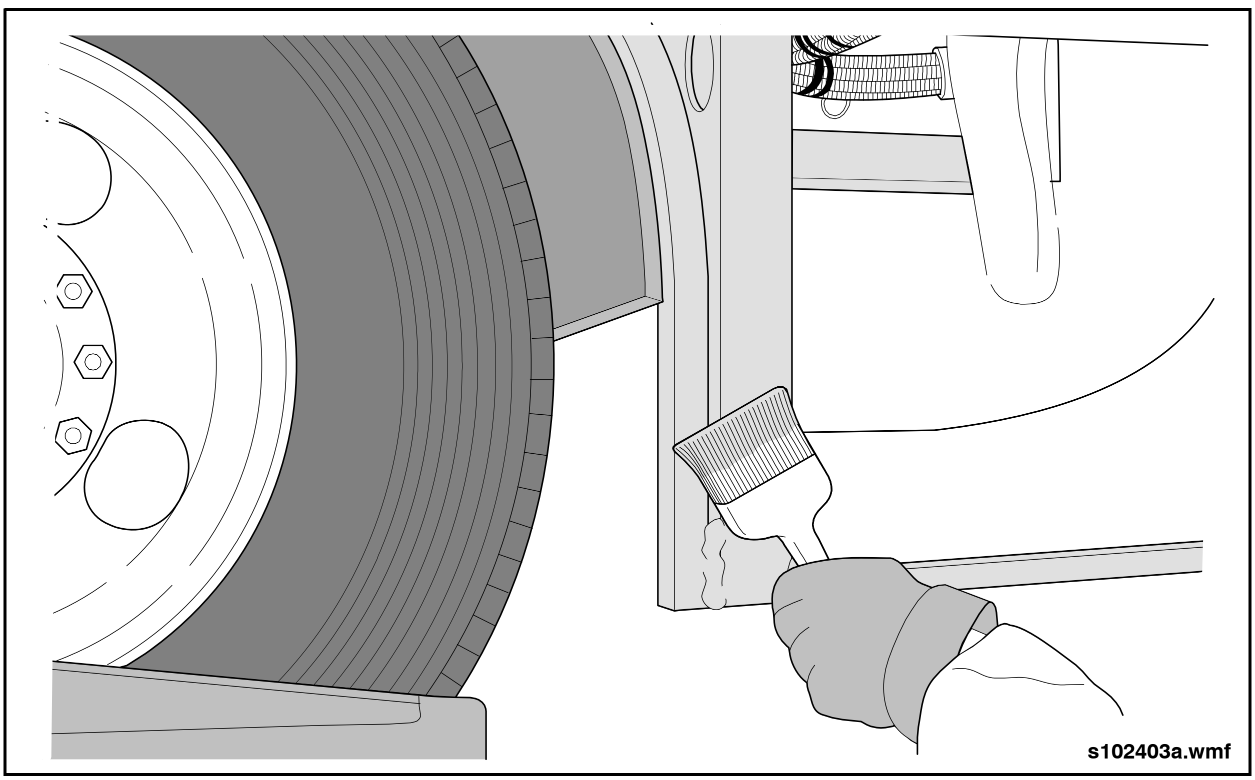


Fig. 11-3: Primer Application

3.4. Undercoating Application

Undercoating is factory applied to all the under chassis areas exposed to road spray.

NOTE:

DO NOT apply undercoat 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. Mix undercoating compound (Corashield™ 7972) and thin to required consistency.
2. Ensure ambient temperature is between 50 and 90°F (10 and 32°C) and humidity is under 80%. Substrate temperature cannot exceed 212°F (100°C).
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: Corashield Application” on page 14.
4. If undercoating will not adhere properly, wash area with appropriate solvent and allow to dry for 5 to 10 minutes. Repeat spraying process and allow undercoating 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 minutes, dry hard in 24 hours and fully cured in 72 hours.

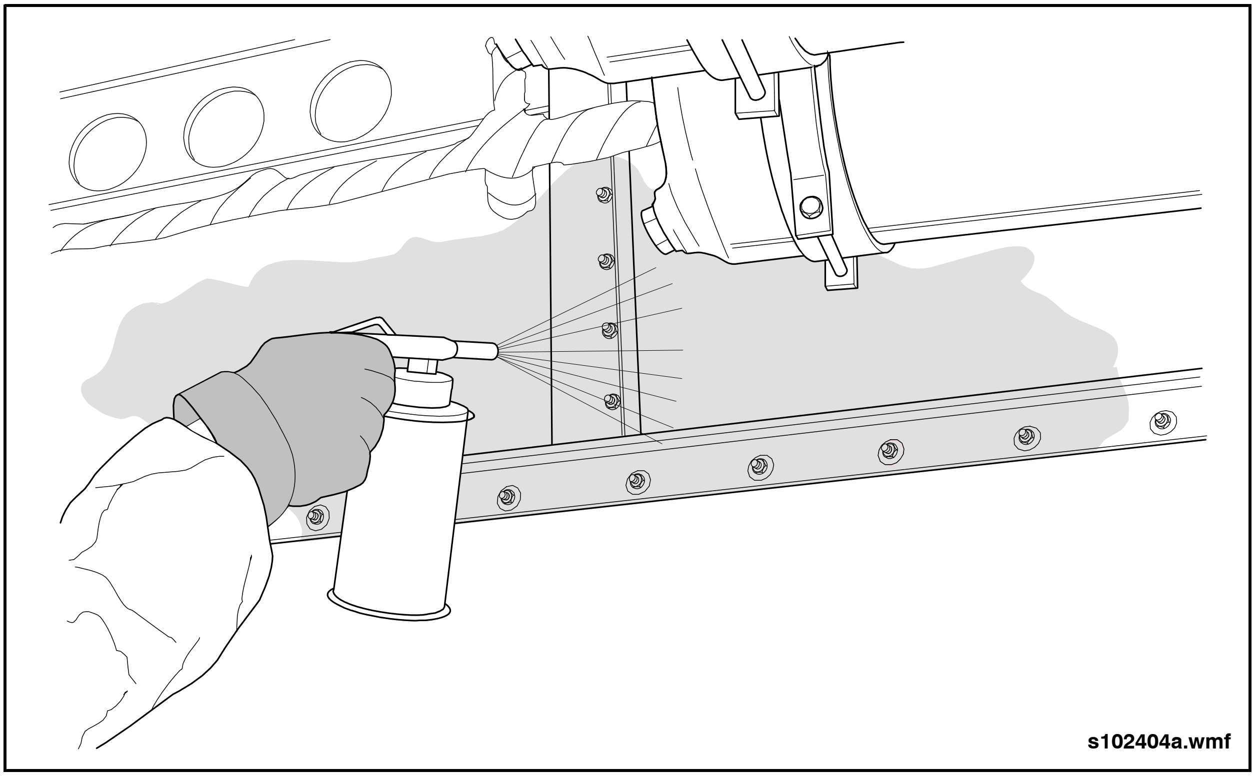


Fig. 11-4: Corashield Application

3.5. Frame Tubing Internal Coating

Any tubing that is being replaced must be internally coated with Coratube.

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: Coratube Application” on page 15.
2. Remove spray nozzle and install sealing plugs.

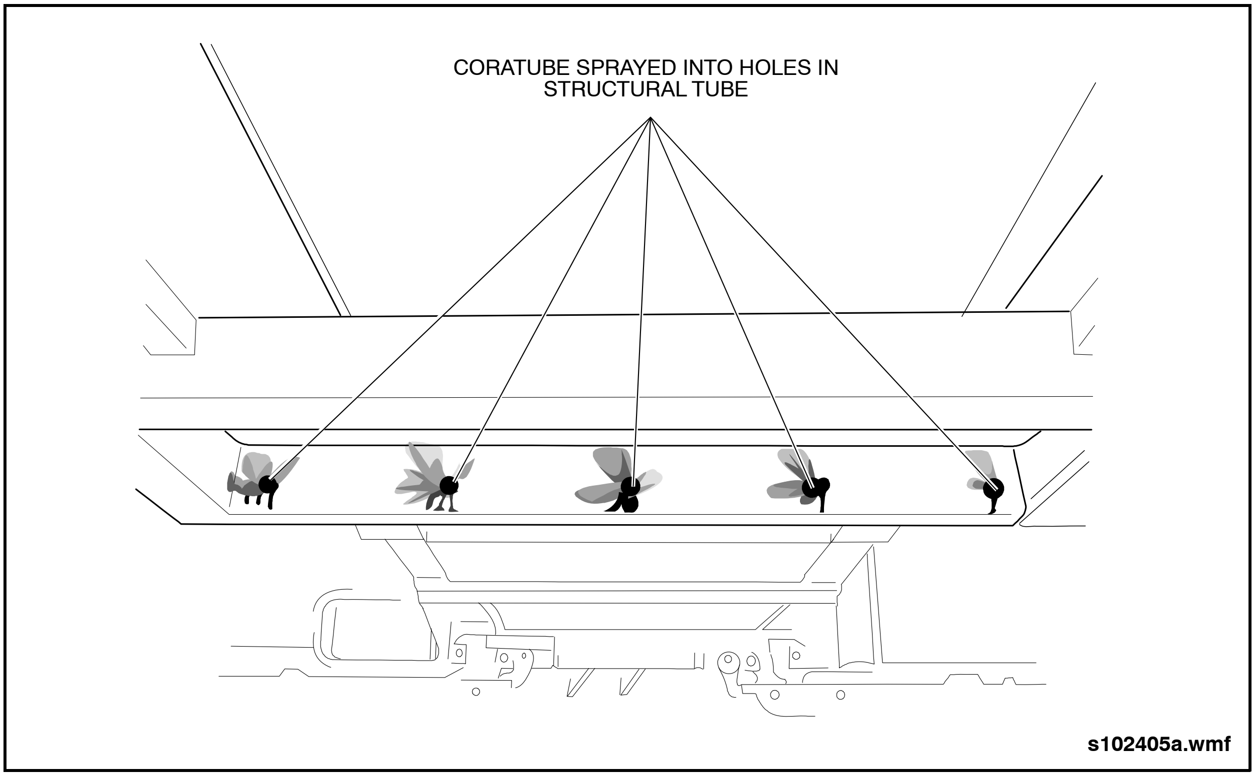


Fig. 11-5: Coratube Application

3.6. 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.

3.6.1. 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.

3.6.2. 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 3.6.1. "Frequency of Inspection" on page 16 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.

3.6.2.1. 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 undercoating. 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.

3.6.3. Repairs for Undercoated Areas

1. Any scratches, gouges or cracks found in the undercoating 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 Coraprime (available from the New Flyer Parts Division). If the undercoating 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 Corashield undercoating can then be applied to the required thickness. Corashield is available from the New Flyer Parts Division.

3.6.4. Repairs for Non-Undercoated Areas

1. Any area which does not have the undercoating must be repaired by grinding the area and the 1/4" around the damaged area. The bare metal must be primed with Coraprime.
2. Corashield must be applied to the determined thickness. This product is available from the New Flyer Parts Division.

3.6.4.1. 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 Coratube™ available from the New Flyer Parts Division.

3.6.5. 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. at:

- ❒ tel: (204) 934-4874
  fax: (204) 224-0248

Interior Panels & Applied Parts

1. SAFETY

1.1. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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.

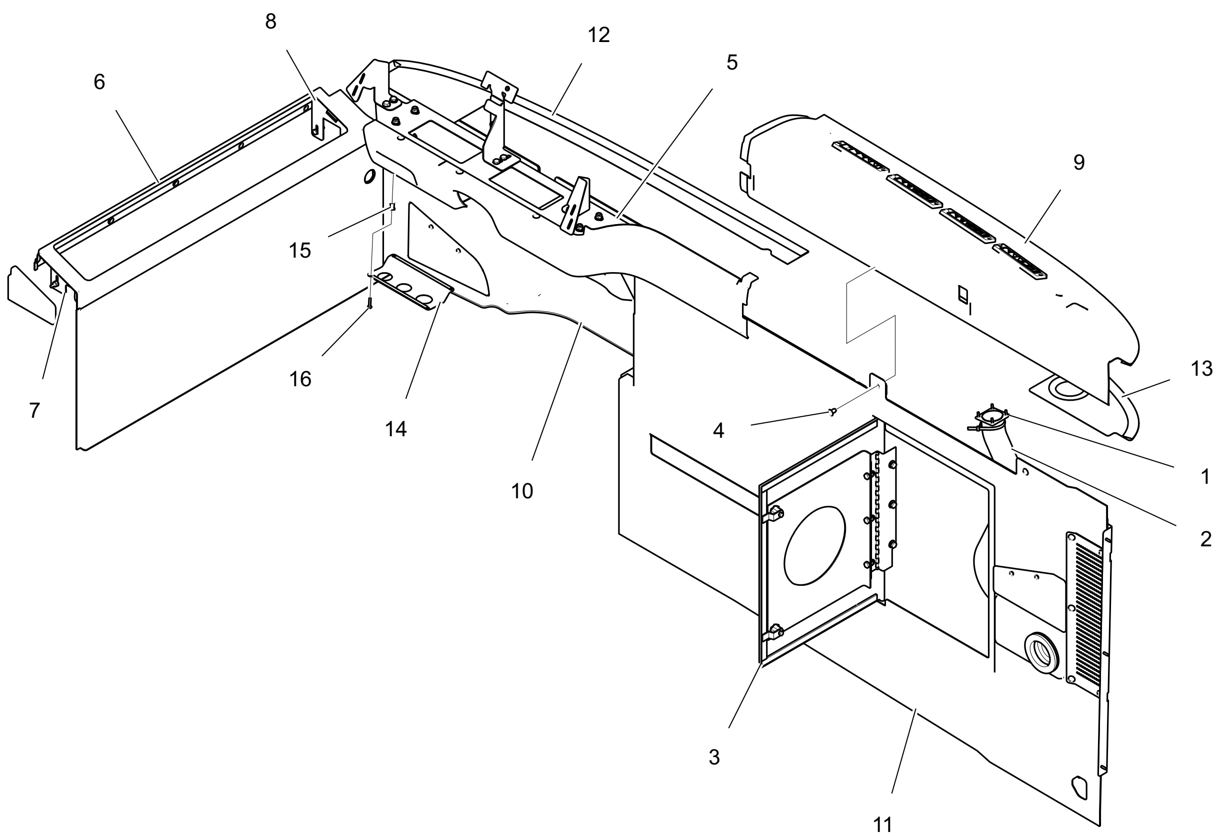
2.3. Interior Panel Replacement

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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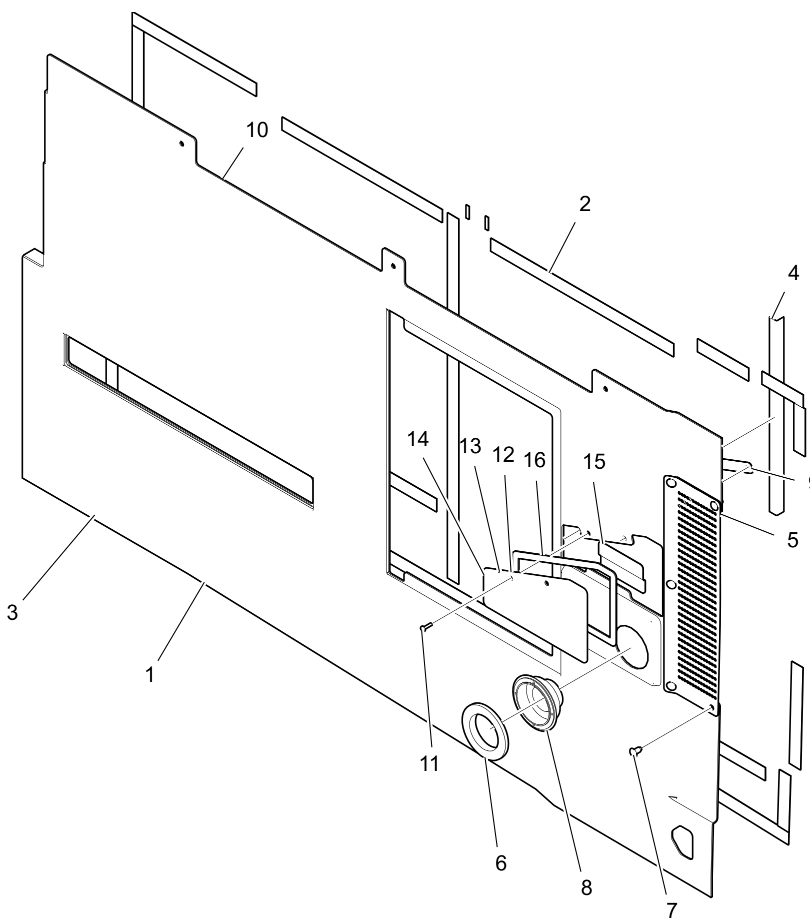
Fig. 12-1: Dash Panels Installation

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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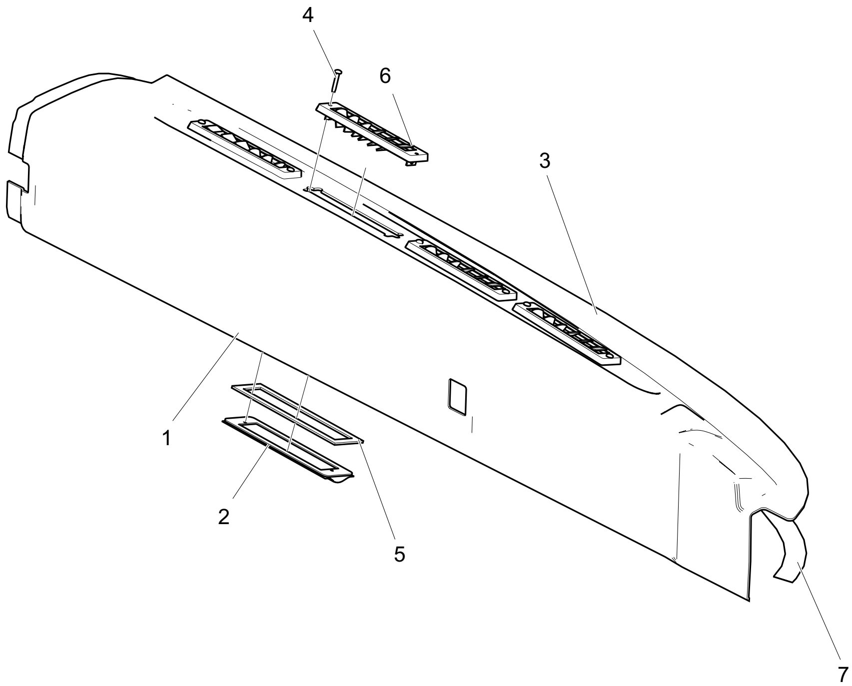
Fig. 12-2: Lower RH Dash Panel Installation

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.

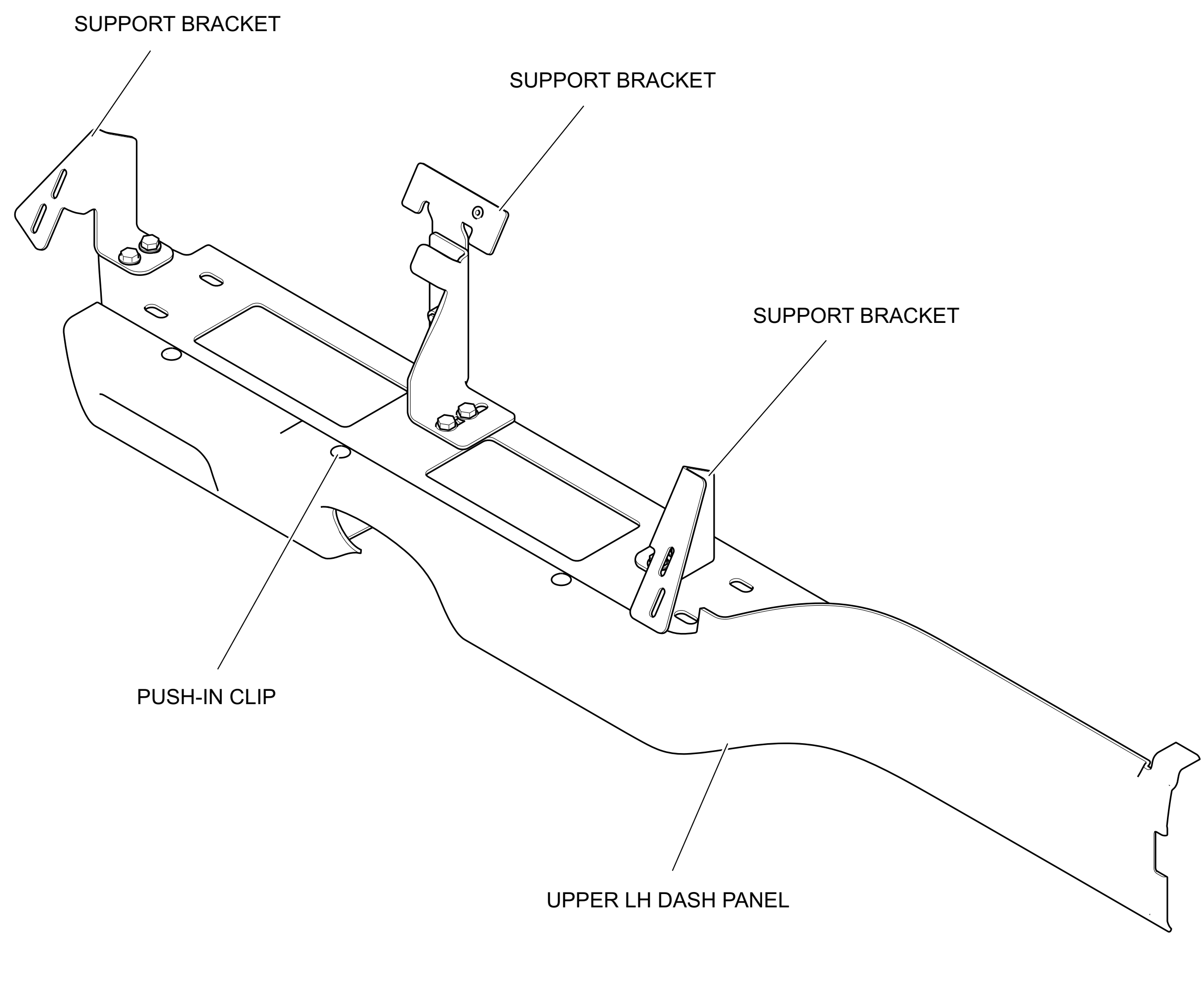
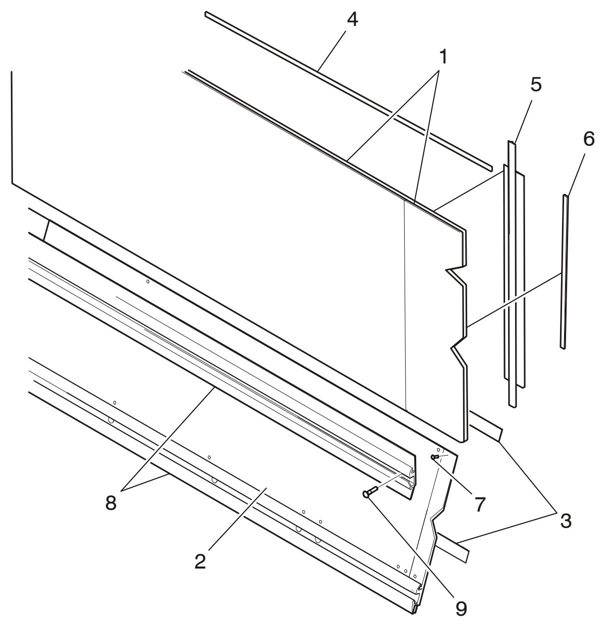


Fig. 12-4: Upper LH Dash Panel Installation

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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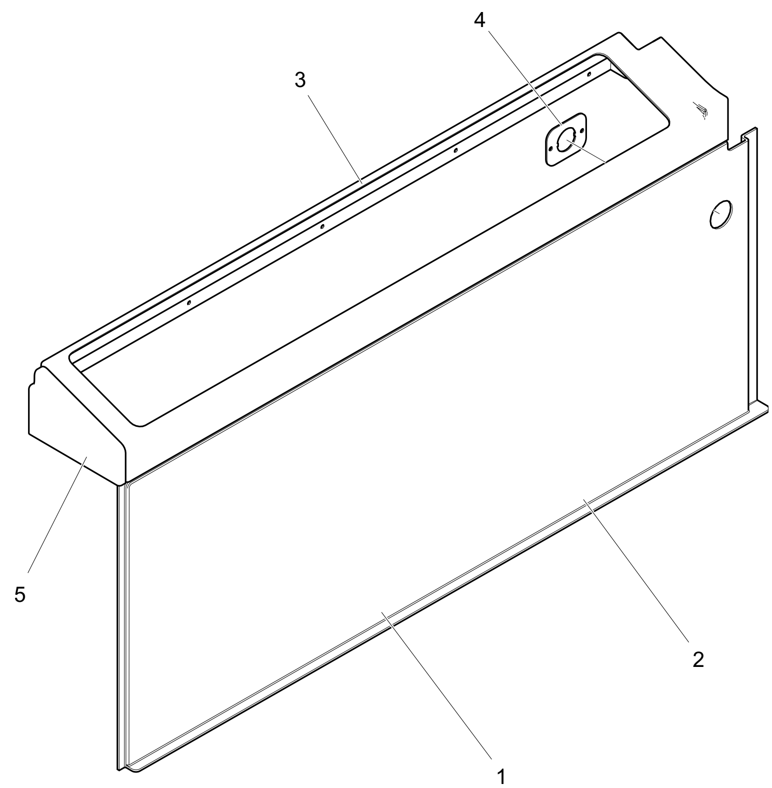
Fig. 12-5: Side Wall & Kick Panel Assembly

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

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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.

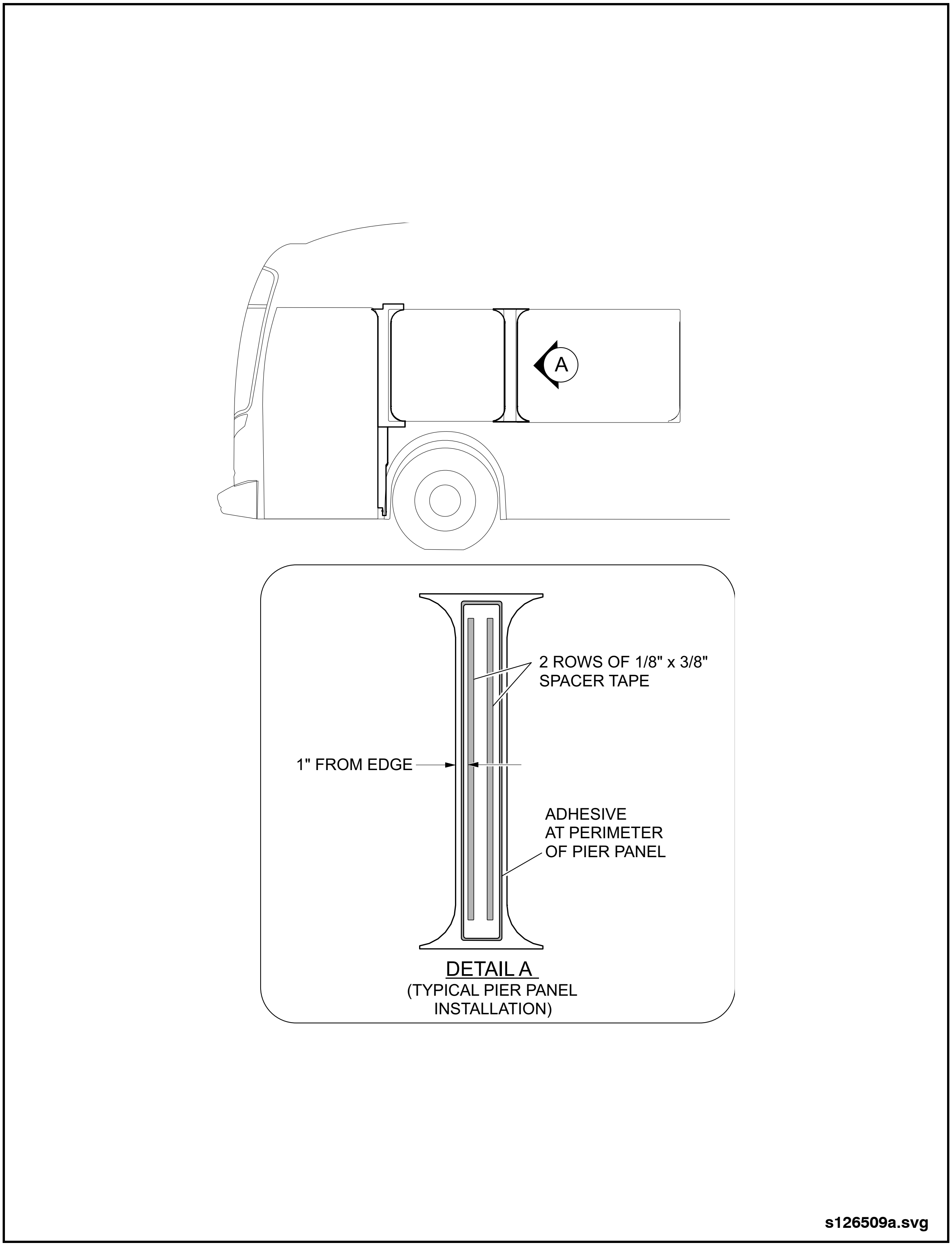


Fig. 12-7: Pier Panel Installation

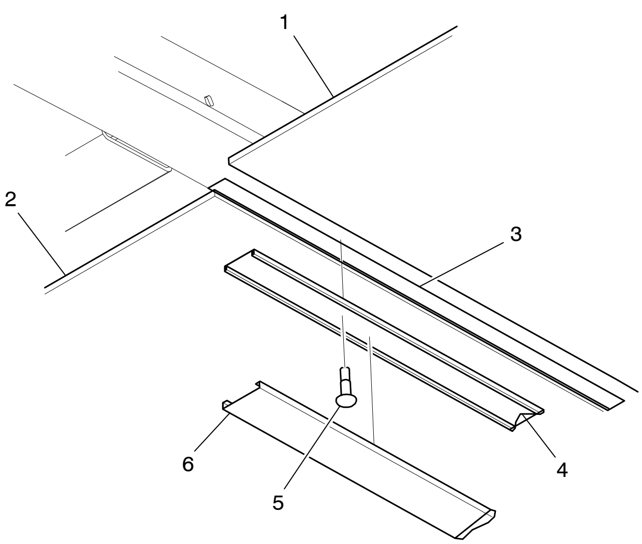
2.7. Ceiling Panels

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 in the center for accessing the rear shelf area. 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.

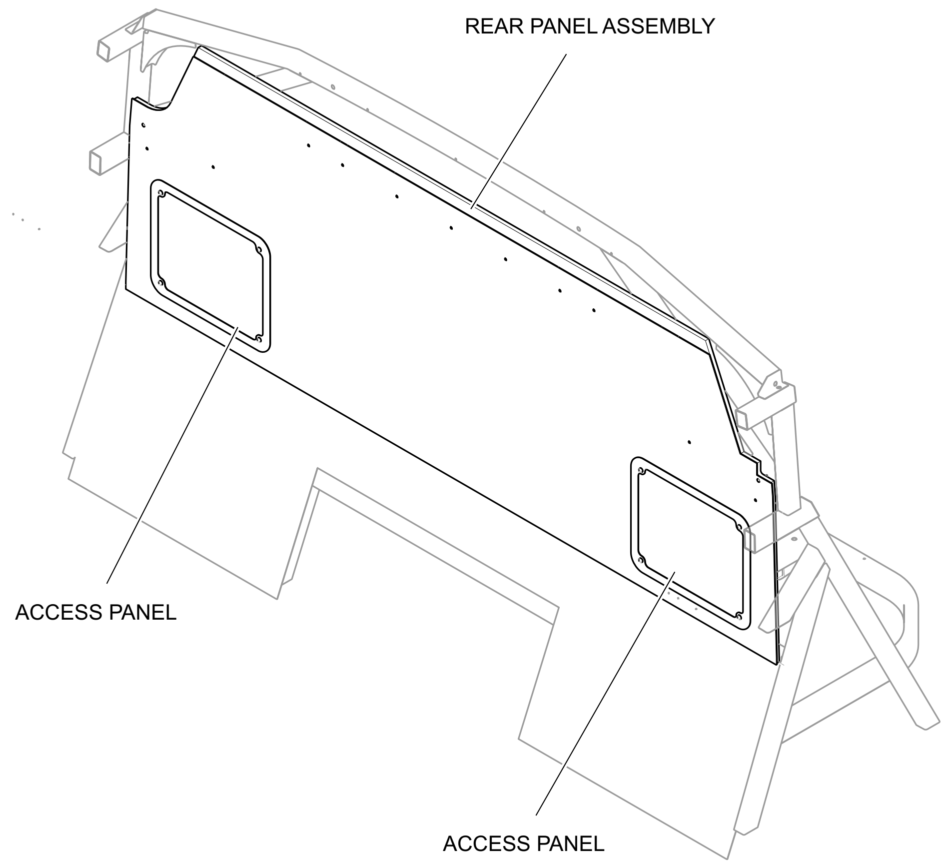


Fig. 12-9: Rear Panel Installation

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

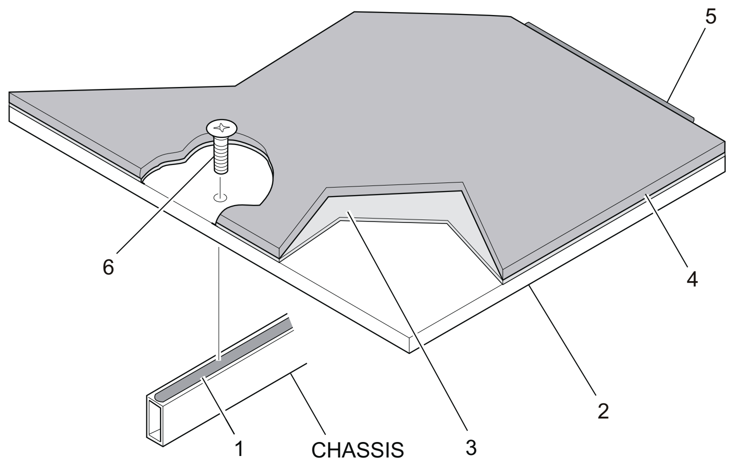


Fig. 12-10: Flooring Material

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

Adhesive
.......3M Fastbond Contact Adhesive 30H

Sealant.............................. Altro Blue No. 73

Weld Thread ....Altro WR231, 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.

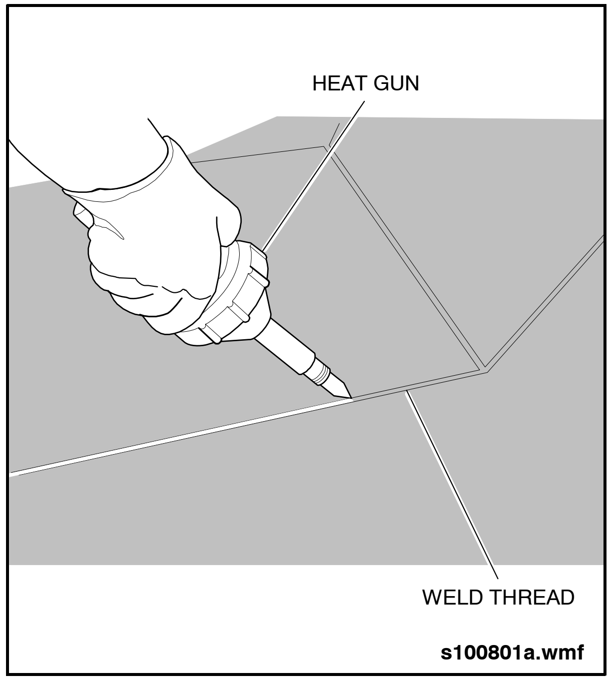


Fig. 12-11: Floor Welding Thread Installation

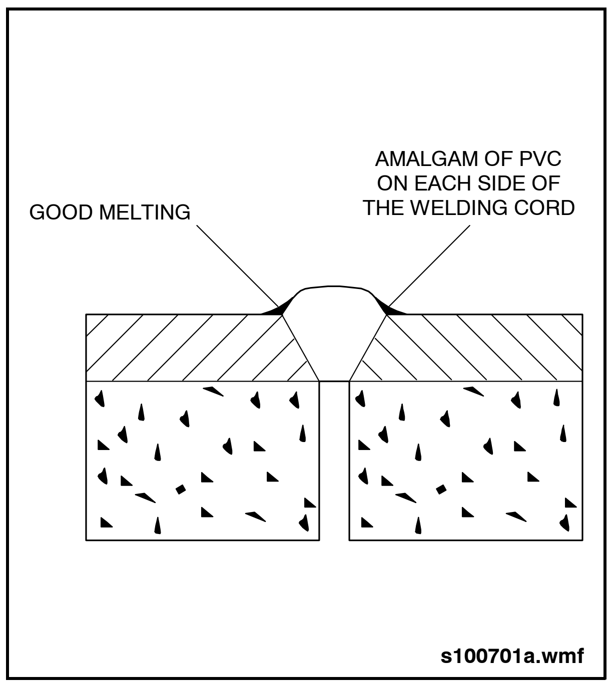


Fig. 12-12: Correct Floor Weld

4. SAFETY EQUIPMENT

4.1. Fire Extinguisher

4.1.1. Description

The fire extinguisher is a 5 lb. multi-purpose dry chemical fire extinguisher. It is located inside the equipment box on the curbside luggage rack.

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.

4.2. Safety Triangle

4.2.1. Description

The safety triangles, located inside the equipment box on the curbside luggage rack, are used to warn oncoming traffic of a potential hazard should the vehicle be out of service on the roadside. See “Fig. 12-13: Safety Equipment Installation” on page 21.

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.

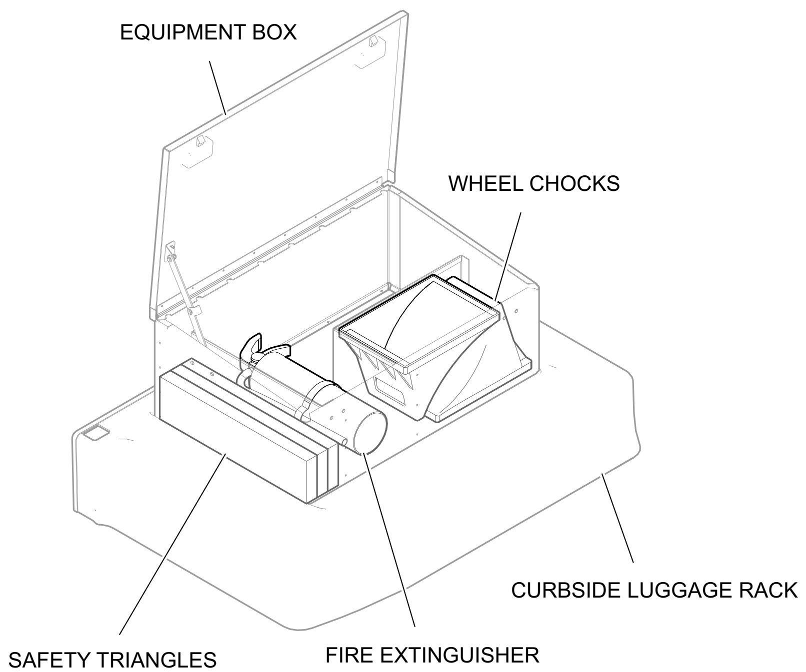


Fig. 12-13: Safety Equipment Installation

Exterior Panels & Applied Parts

1. SAFETY

1.1. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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

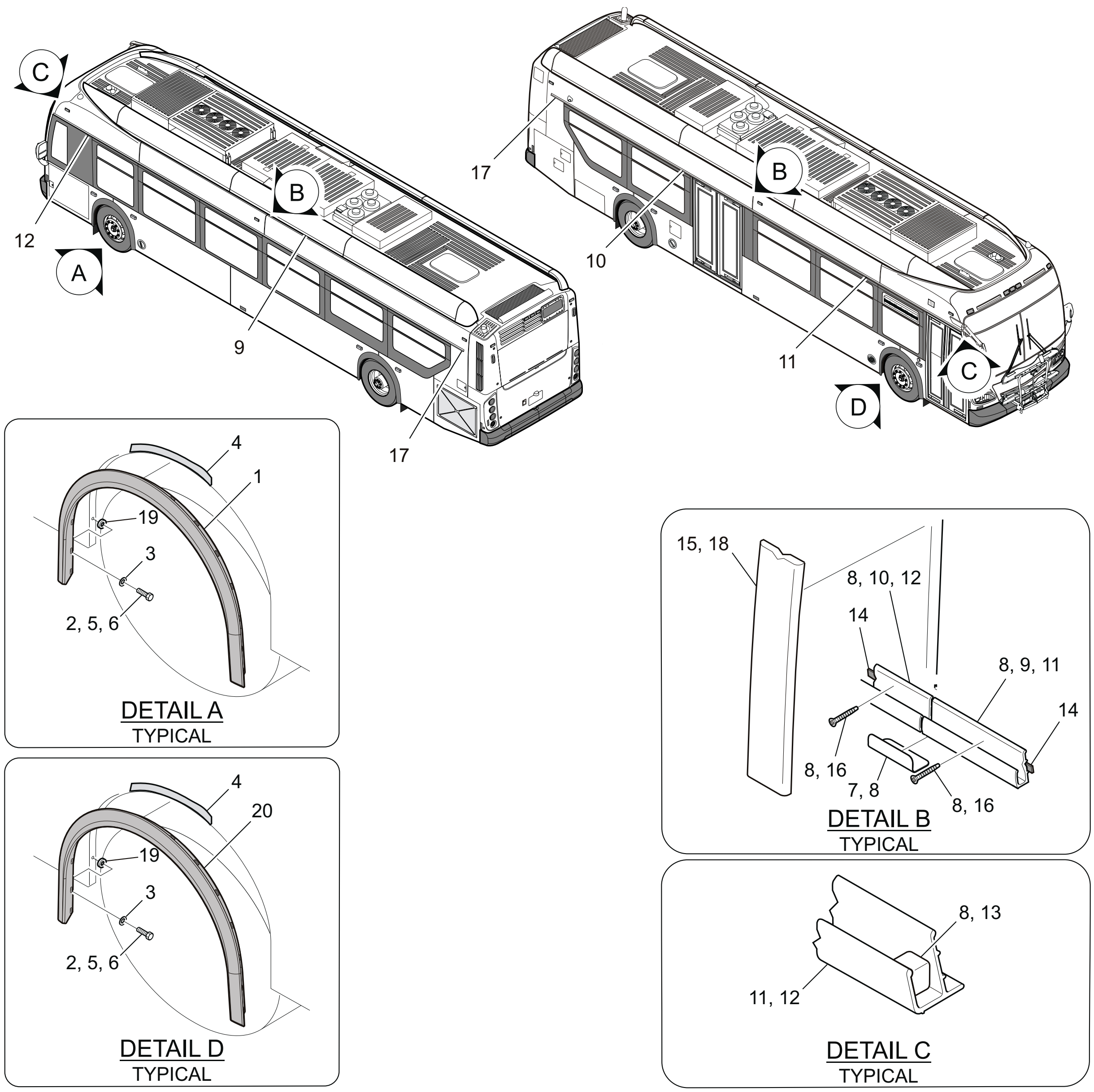
1. In thick material, drive out the rivet stem using a tapered steel drift pin. In thin material, drill the tapered portion of the stem away to destroy the lock.
2. Drill nearly through the head of the rivet using a drill the same size as the rivet shank. Break off rivet head.
3. Drive out remaining 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. Screw, Hex SST 1/4" - 20 UNC x 3/4" Lg.
3. Washer, Flat 1/4" SST
4. Tape, Butyl .12" x .50" Black
5. Adhesive, SIKA 221 Black
6. Loctite, 243 Blue
7. Expansion, Drip Rail
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, FH Thread Cutting #10 - 32 UNF
17. Molding, Trim Window
18. Panel, Roof Cap Overlap
19. Spacer, 0.281" I.D. x 1.25" O.D.
20. Fender, Polyurethane

s0322619a.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 at 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-201 Polyurethane Sealant

2.3.5.1. Description

Sikaflex-201 is a one component, flexible, polyurethane-based elastomeric sealant. It is a moisture-cured, non-sag system. 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 .... 1.23 kg/L

Tack-free time .... 8 to 5 hours

Cure Rate
.... 14 days at 41°F (5°C) 60% rel hum

(1/4" x 1/4" bead)
...... 10 days at 73°F (23°C) 50% rel hum
.... 6 days at 73°F (23°C) 90% rel hum
...... 3 days at 140°F (60°C) 40% rel hum

Shore A Hardness .... 40 to 45

Elongation at Break 700%

Application Temperature .... 5 to 40°C

Service Temperature
.......................-40 to 194°F (-40 to 90°C)
.... (briefly up to 248°F/120°C)

Colors .... White/Black

2.3.5.3. Uses

Use to waterproof rivet seams, and for sealing of exposed and concealed joints of aluminum, steel, coated metals, wood, roof rails, door hinges, as a sealant between all exterior panels, and as a general roof panel adhesive.

2.3.6. Sikaflex-252 Adhesive/Sealant

2.3.6.1. 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.

2.3.6.2. 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

2.3.6.3. Uses

Use as an external panel adhesive (except for roof panels) which is applied to the entire perimeter surface of the panel.

2.3.7. 3M-550 Fast Cure Adhesive/Sealant with Accelerator AC61

2.3.7.1. 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.

2.3.7.2. 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)

2.3.7.3. Uses

Use as an external panel adhesive, applied to the perimeter surface of the panel.

2.3.8. Sika-205 Cleaner

Sika-205 Cleaner is a special cleaner for the pretreatment of bond faces prior to bonding or sealing with Sikaflex products.

2.3.8.1. Application Method

Apply in a thin film to the bond face. Let dry 10 minutes.

2.3.9. Sika-206G&P Primer

2.3.9.1. 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.

2.3.9.2. 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

2.3.9.3. 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 15.

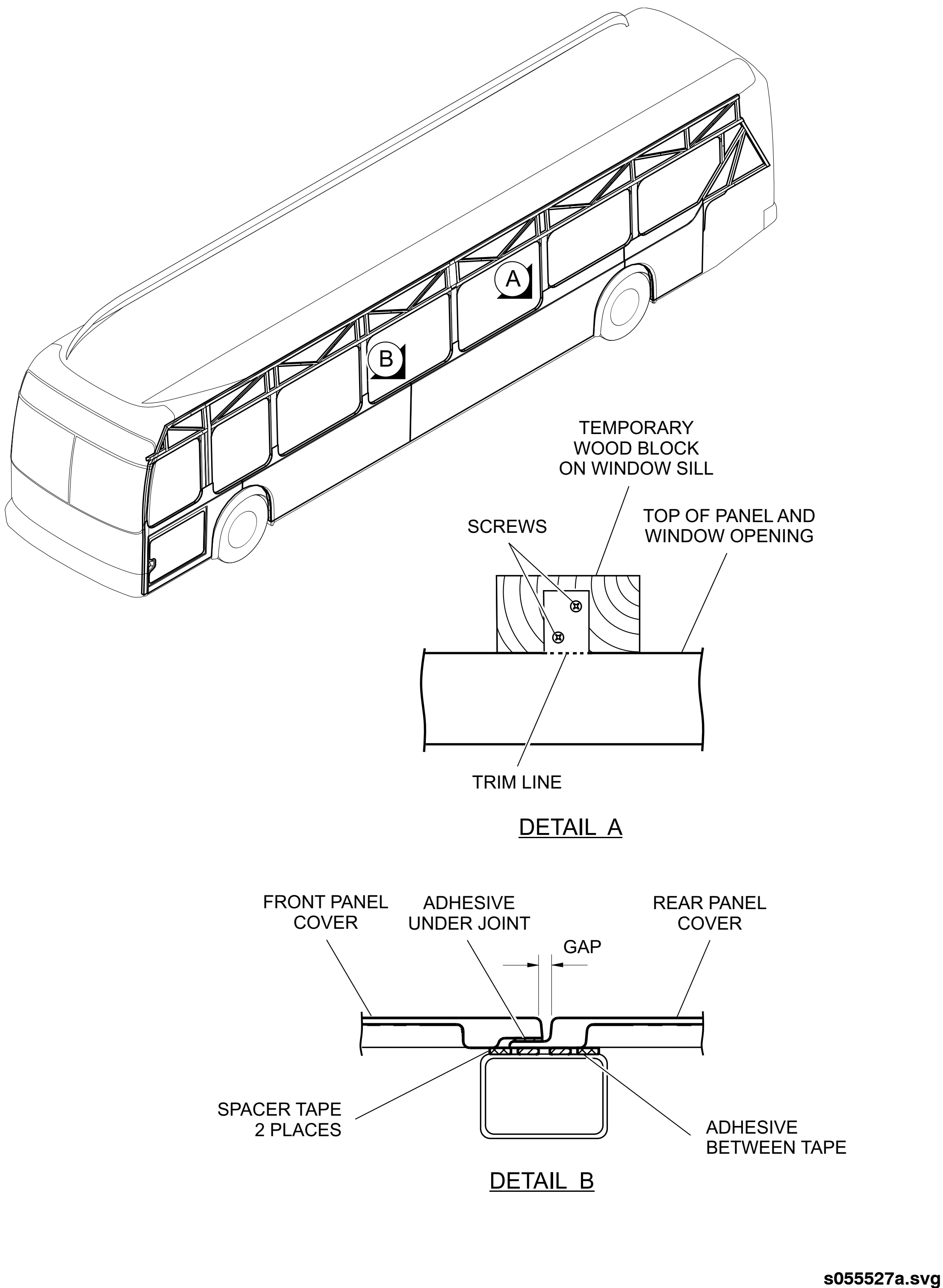


Fig. 13-2: Side Panel Application-1

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.

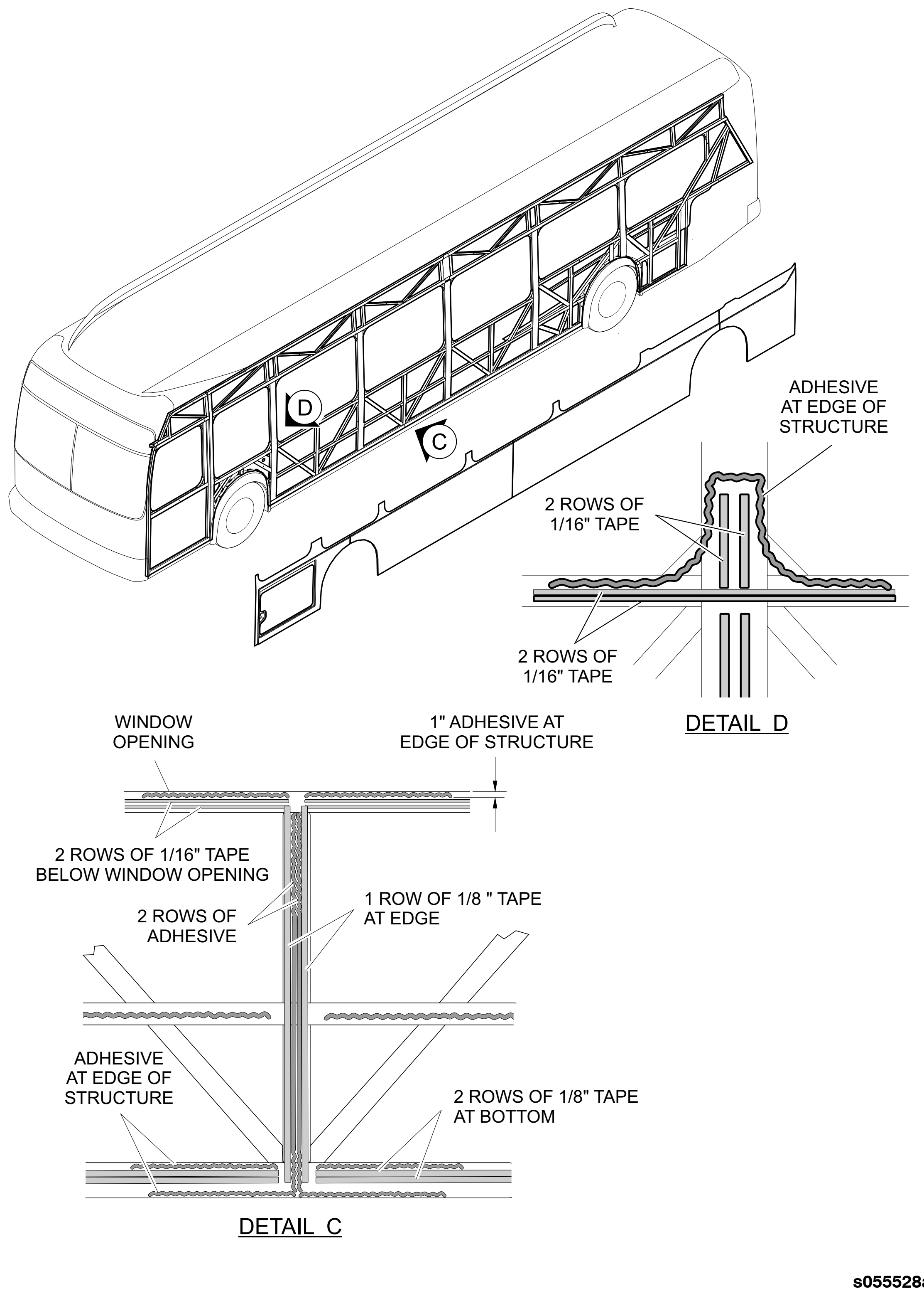


Fig. 13-3: Side Panel Application-2

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.

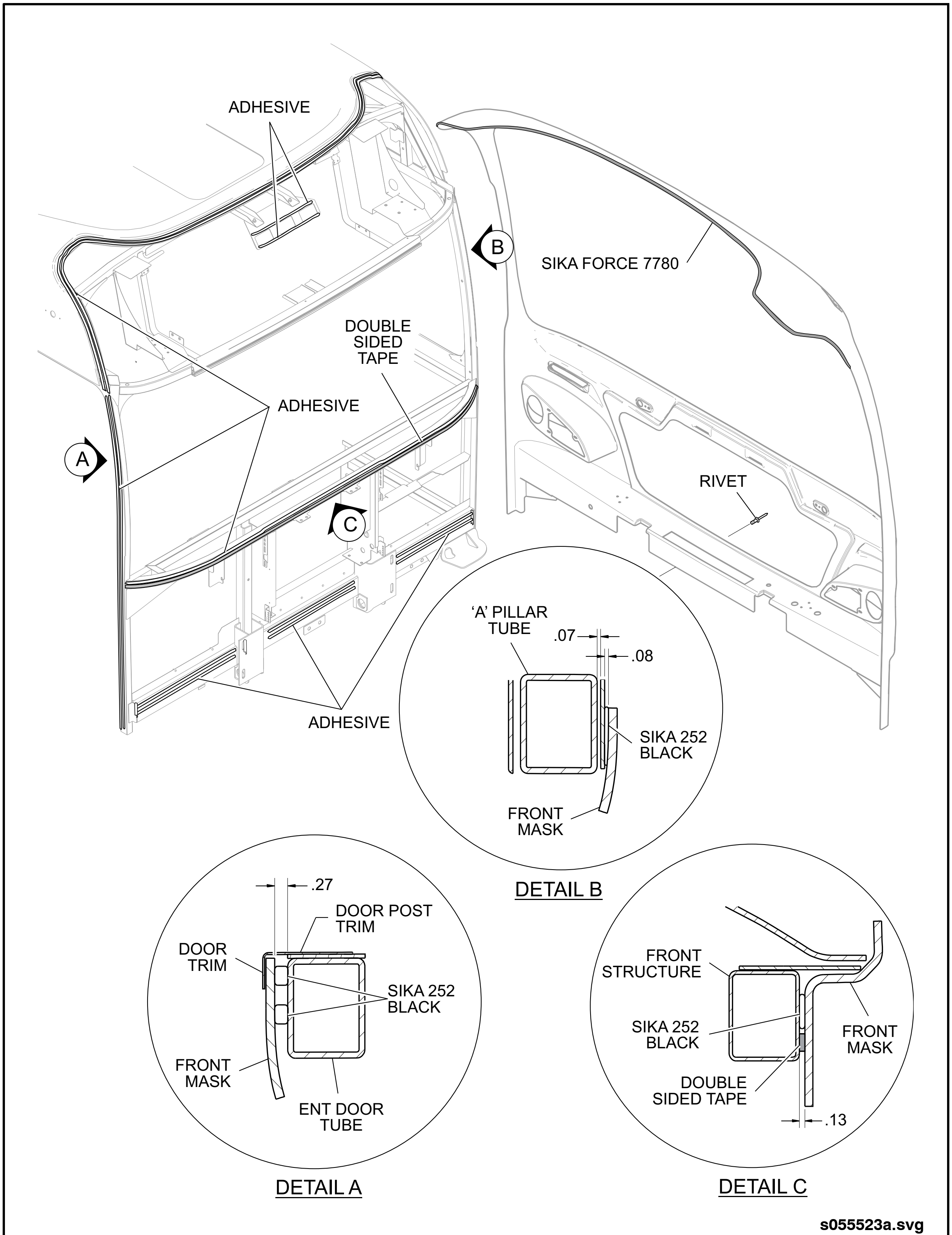


Fig. 13-4: Front Mask Panel Application

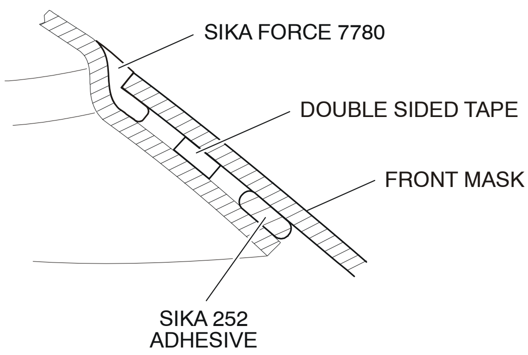


Fig. 13-5: Front Mask Lap Joint

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. Apply a stitch bead (six inches of adhesive with a 6" gap) to the area between the continuous beads. 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-201 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-201 Adhesive after front mask has been installed.
24. After painting, apply black Sika-221into the center lap joint. Do not fill the center gap, but tool a smooth radius edge along the length of the joint.

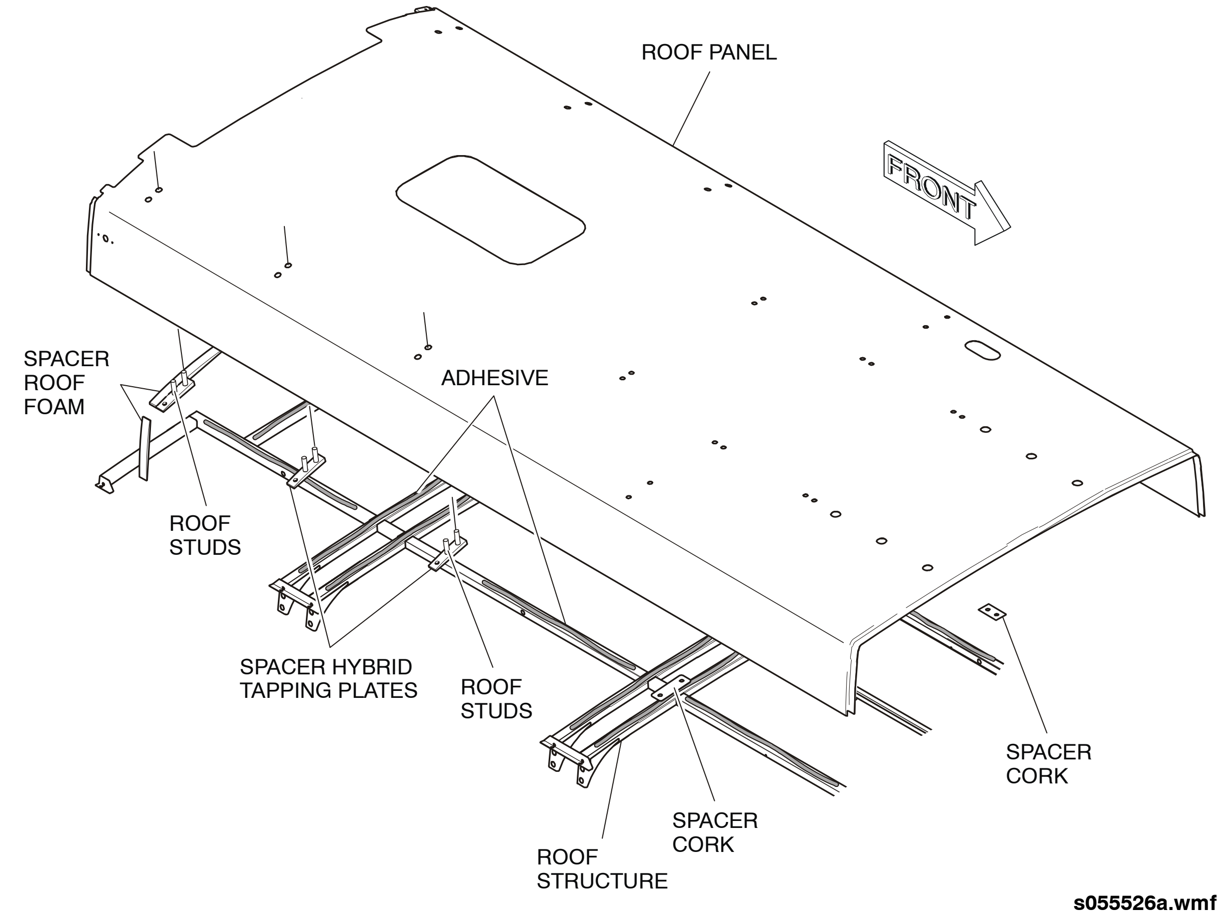


Fig. 13-6: Roof Panel Installation

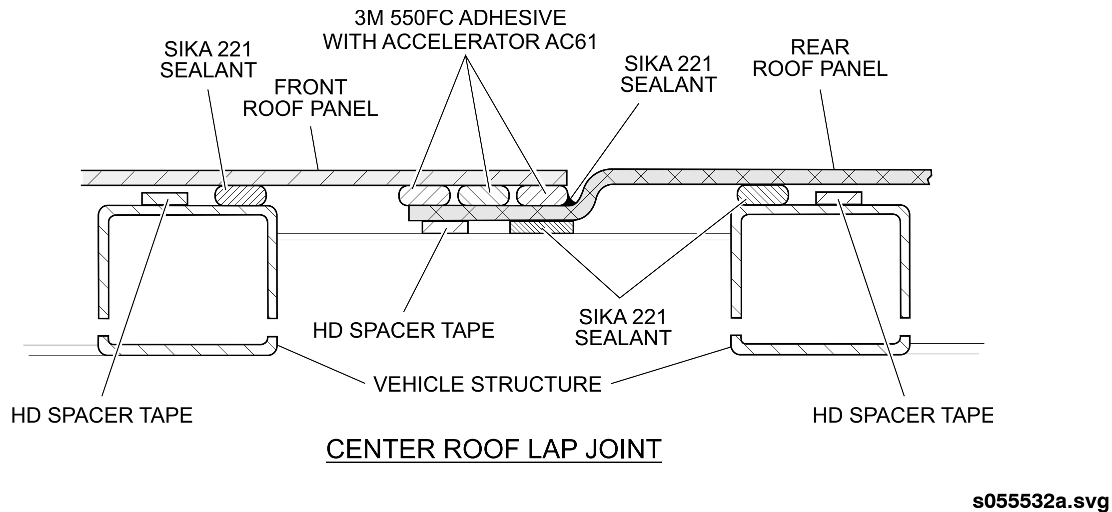


Fig. 13-7: Roof Panel Cross Section

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.

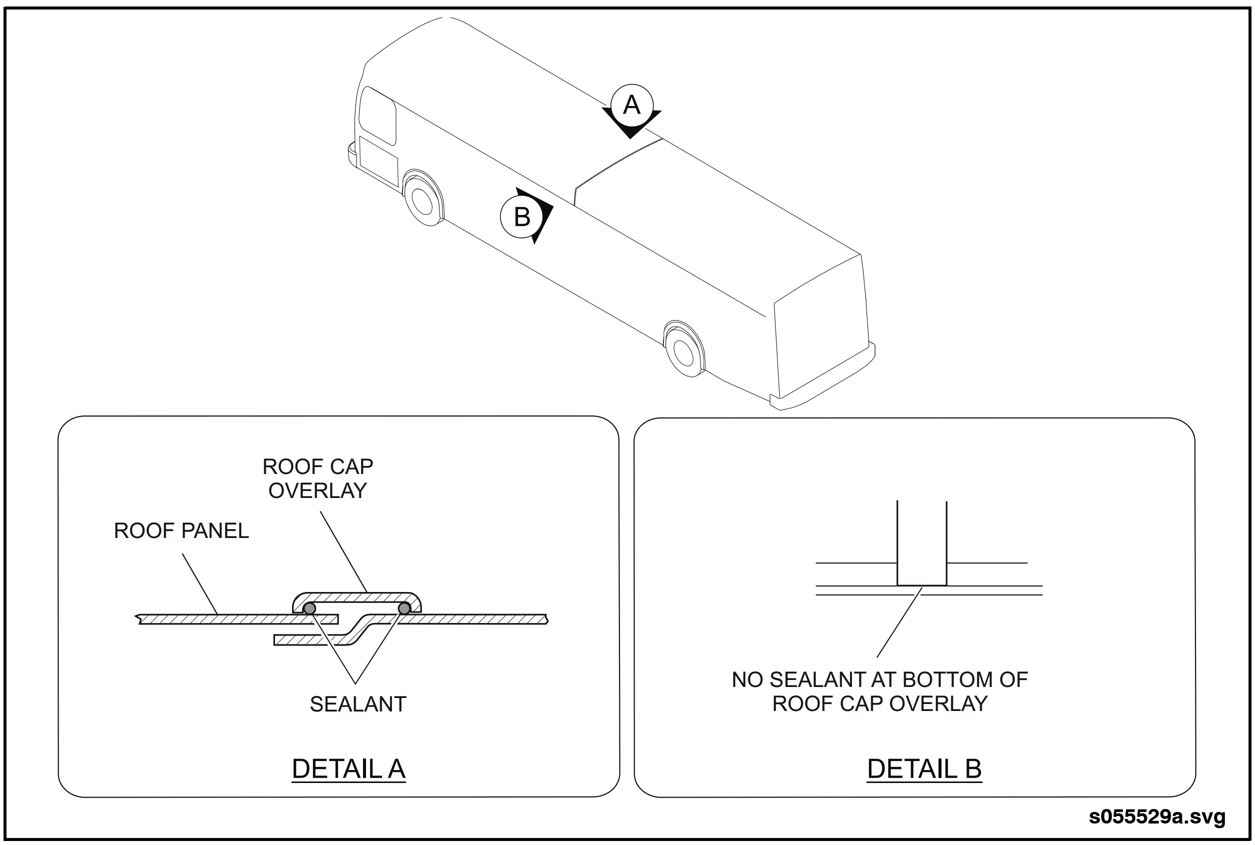


Fig. 13-8: Roof Cap Overlay Installation

2.12. Rear Crown Grille Panel

2.12.1. Description

The rear crown grille panel is manufactured from fiberglass and provides a ventilated cover for the emission control equipment located at the upper rear roof of the bus. It also houses the rear Route sign at the curb side corner. See "Fig. 13-9: Rear Crown Grille Panel" on page 24.

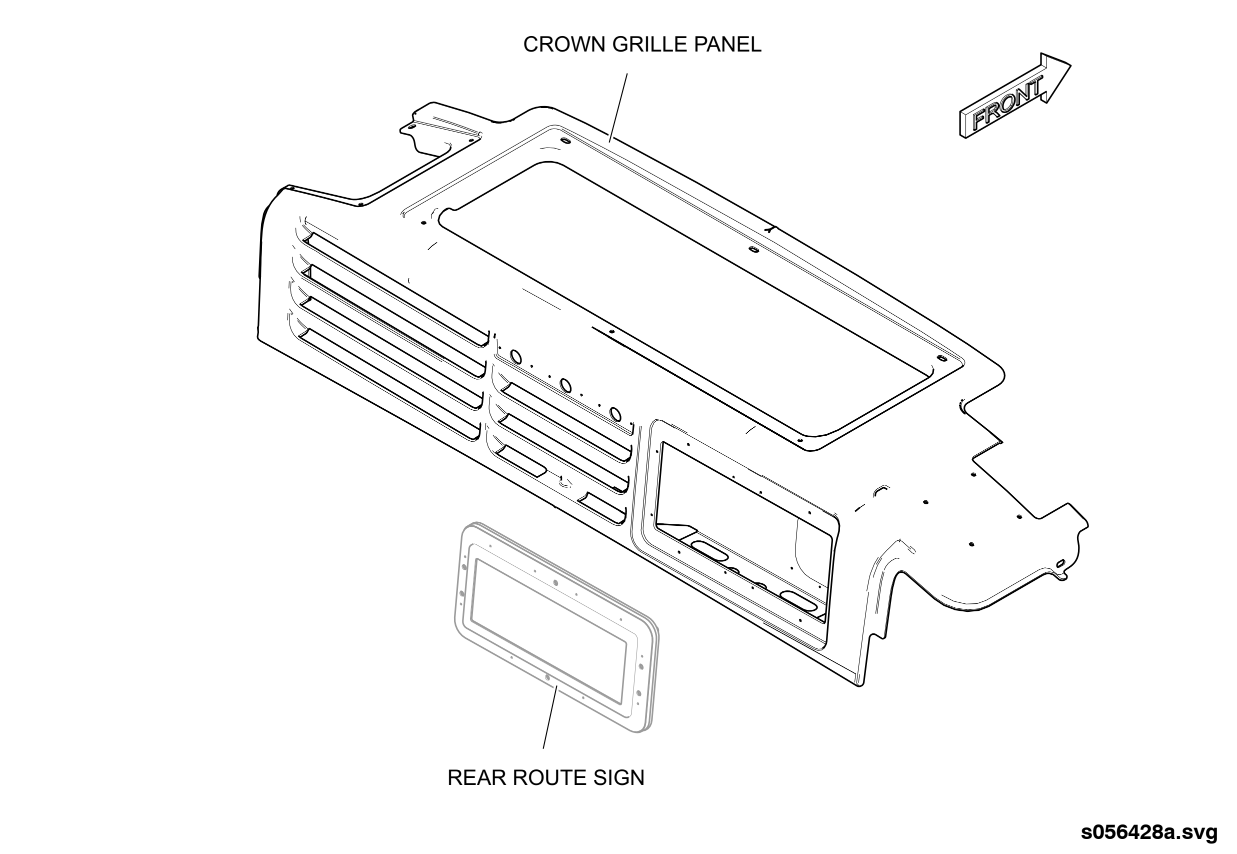


Fig. 13-9: Rear Crown Grille Panel

2.13. Fiberglass Panels

2.13.1. 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.

2.13.1.1.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 2.13.1.2. “Using Fiberglass Paste” on page 26 in this section for procedure.

2.13.1.2.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.

2.13.2. Gelcoat Finish

2.13.2.1.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 2.13.4. “Larger Fiberglass Panel Damage” on page 28 *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.

2.13.3. 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.

2.13.4. 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 2.13.2.1. "Gelcoat Surface Repair" on page 27 in this section for procedure.

2.14. Painting Procedures & Preparation

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 DX-330 wax and grease remover.
2. Alternatively, spot blast around rivet heads.
3. Scuff surface with 80 grit sandpaper, using dual action sander.
4. Clean with DX-330 wax and grease remover.
5. Apply primer. Refer to 2.14.1.4. “Primer” on page 30 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 DX-330 wax and grease remover.
4. Apply primer. Refer to 2.14.1.4. “Primer” on page 30 in this section for procedure.

2.14.1.3. Fiberglass

1. Clean surface with DX-330 wax and grease remover.
2. Scuff with Scotch Brite 7447 (red) or sand with 400 grit sandpaper by hand or 320 grit DA.
3. Clean with DX-330 wax and grease remover.
4. Apply primer. Refer to 2.14.1.4. “Primer” on page 30 in this section for procedure.

2.14.1.4.Primer

1. Blend equal parts of DP Epoxy Primer with equal parts of DP-401 catalyst, allowing for a 30 minute induction period.

☞**NOTE:**

If a reducer is desired to enhance the handling characteristics, add up to 25% of the appropriate DT Reducer to the already mixed DP primer.

☞**NOTE:**

No induction period required if using DP-402 fast catalyst.

2. Apply one full wet coat at 50 psi gun pressure to achieve recommended film build of 0.7 to 1.0 dry film thickness.
3. If a second coat is necessary, wait 10 to 15 minutes between coats.
4. Air dry primer for one hour at 75°F (24°C) or bake at 150°F (66°C) for 30 minutes.
5. Topcoat can be applied up to seven days after which either a fresh coat of DP must be applied or the entire surface must be scuff sanded.

2.14.1.5.Spot Primer

☞**NOTE:**

Small imperfections may be filled with DGP 41/42 spot putty.

1. Mix 5 parts of K-36 with 1 part K-201 with 1 part DT reducer.
2. Apply 2 to 3 full wet coats at 40 to 50 psi at the gun 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 topcoat.

2.14.1.6.Topcoat (Deltron Base Coat/Clearcoat)

1. Mix Deltron Base Coat with the appropriate DRR reducer at a mix rate for solid color at 1 part color and 1 1/2 part DRR reducer. For metallic mix 1 part color and 2 parts DRR reducer.
2. Apply medium coats until hiding is achieved. Air pressure should be 40 to 45 psi at the gun. Allow 5 to 10 minutes between coats to allow for complete solvent evaporation and a recommended film build of 0.7 to 1.5 film build.
3. Allow final coat to air dry 20 minutes by the clock prior to topcoating with clear or two-toning.

2.14.1.7.Clearcoat

1. Clearcoat with CDU 2020 by mixing 2 parts CDU 2020 with 1 part of the appropriate DT reducer and 1 part of the appropriate DU catalyst.
2. Apply 1 medium wet coat and then two full wet coats with 40 to 50 psi at the gun to achieve a recommended film thickness of 2 to 3 mils, allowing a 15 to 20 minute flash between each coat. Allow to dry for 6 hours or overnight.
3. Force drying may be achieved by baking for 30 minutes at 140°F (60°C). Accelerated drying may also be achieved by adding 1 oz. of DX-84 per gun cup.

2.14.1.8.Topcoat (DCC)

1. Mix DCC color with 2 parts color with 1 part appropriate DT reducer and 1 part appropriate DU catalyst.
2. Apply 2 to 3 wet coats with 40 to 50 psi at the gun to allow a recommended film build of 2 to 3 mils. Allow a 15 to 20 minute flash time between each coat. Allow to dry for 6 hours or overnight.
3. Force drying may be achieved by baking for 30 minutes at 140°F (60°C). Accelerated drying may also be achieved by adding 1 oz. of DX-84 per gun cup.

2.14.1.9. Epoxy Primer

⚠ CAUTION

This product is flammable. Use only with adequate ventilation systems and equipment. Keep away from heat, sparks, and open flame. Refer to and follow the safety data contained on the product labels. Read and follow any other information contained in product safety data sheets.

PPG Moisture Cure Zinc rich primer is designed to provide protection in humid and corrosive environments. It can be topcoated within four hours of application with SUPER-SHIELD®II, epoxy or polyurethane topcoats.

The specified application required to provide optimum corrosion protection is one 8 mil wet coat drying to 5 mil. This coverage must be attained to maintain corrosion warranty.

The pot life of mixed primer base (part 1) and activator (part 2) is a minimum of 8 hours. The recommended thinner and cleaner is SP05054T0.

2.14.2. Surface Preparation

1. Round off rough welds and sharp steel edges. Remove weld splatter.
2. Dry-abrasive blasting, chemical treatment or mechanical cleaning, depending on conditions and/or pertinent specifications.

2.14.3. Application Conditions

Surface temperature must be at least 5°F (3°C) above the dew point to ensure that moisture condensation does not occur during application and drying period. Apply when air and surface temperatures are between 45°F to 100°F (7°C and 38°C).

2.14.4. Application Equipment

- ❒ Electrostatic spray (GRACO pro 4500)
- ❒ Air mix spray - Fluid pressure 1,000 psi, air atomization pressure 60 lb. Use 0.013 to 0.017 orifice, 1.57 to 1.97" (40 to 50 mm) fan and 100 mesh filters.
- ❒ Airless spray - Fluid pressure 2,000 to 2,400 psi, use 0.013 to 0.019 orifice, 1.57 to 1.97" (40 to 50 mm) fan and 100 mesh filters.

☞NOTE:

Finish coat of SUPER-SHIELD®II, polyurethane or epoxy can be applied over this primer from between 1 to 24 hours. This will depend upon the primers original film build, the shop temperature, humidity and air movement conditions.

2.14.5. Recommended Drying & Curing Time

Air dry (20°C (68°F) at 50% rel hum) - dry to touch in 60 to 90 minutes at 4 mils DFT.

2.14.5.1. Force Cured

1. Primer only - allow 30 minutes flash, then dry at 140 to 176°F (60 to 80°C) for 1 hour.
2. Mono cure primer/topcoat, allow the primer to flash for 60 minutes prior to applying topcoat.

   Flash topcoat for a minimum of 30 minutes then mono cure at 140°F (60°C) max. for 1 to 2 hours.

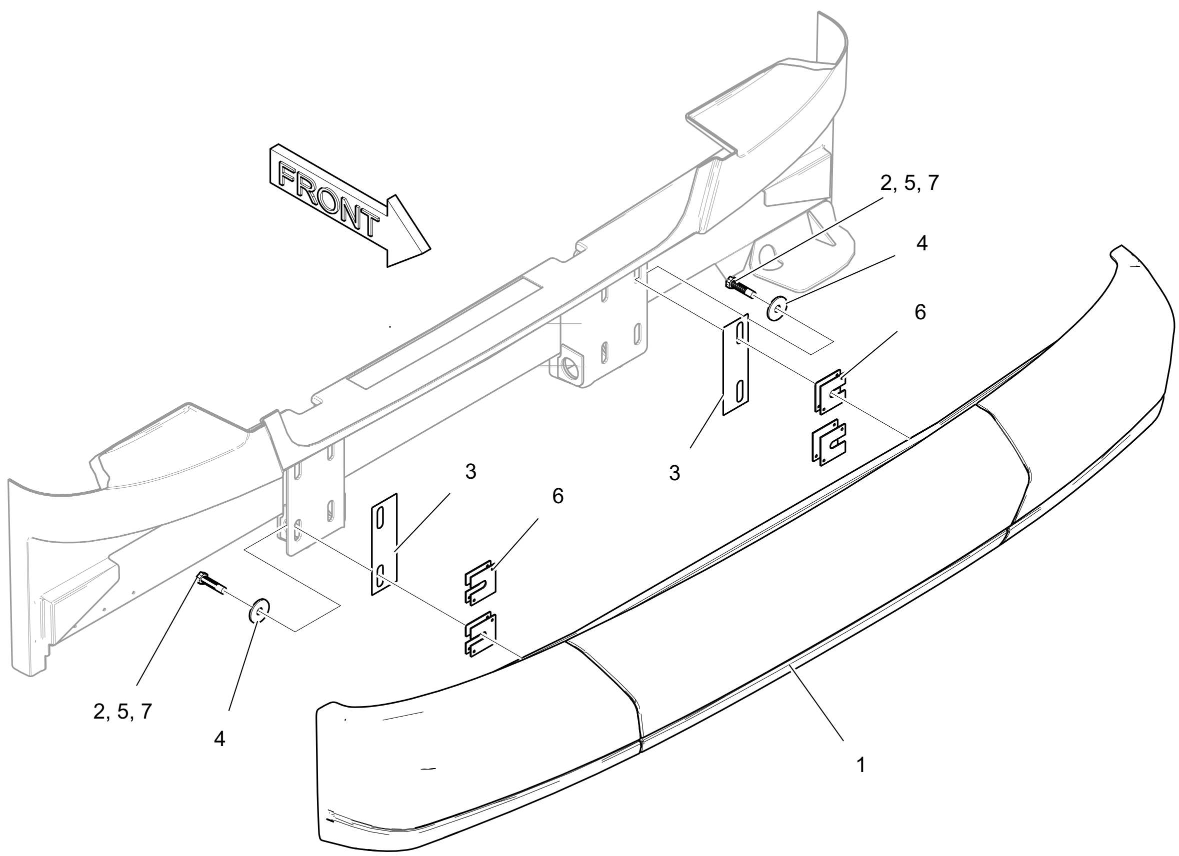
3. BUMPERS

3.1. Description

The front and rear bumpers are constructed of an extruded aluminum channel fitted with three energy-absorbing modules.

3.2. Removal

1. Support the bumper assembly and remove the four bolts, nuts, and washers securing the bumper assembly to the vehicle structure. See "Fig. 13-10: Front Bumpers Installation & Removal" on page 32. See "Fig. 13-11: Rear Bumpers Installation & Removal" on page 33.
2. Remove the bumper assembly from the vehicle, being careful not to lose the two isolator strips that are located between the bumper and the mounting bracket.



1. Bumper Assembly, Front
2. Bolt, Hex 5/8" - 11 UNC x 1 3/4" Lg.
3. Strip, Isolator
4. Washer, Special Flat 11/16"
5. Bolt, Hex 5/8" - 11 UNC x 2.50" Lg.
6. Spacer, Rear Bumper
7. Loctite, 263 Red

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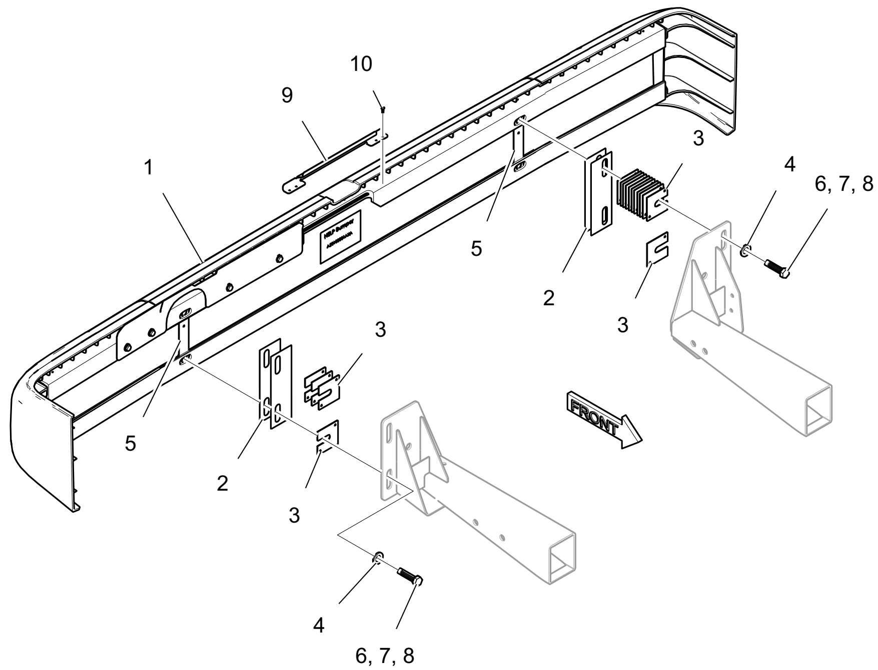
Fig. 13-10: Front Bumpers Installation & Removal



1. Bumper Assembly, Rear
2. Strip, Isolator
3. Spacer, Rear Bumper
4. Washer, Flat SST Hardened 5/8"
5. Strip Assembly
6. Bolt, Hex SST
   5/8" - 11 UNC x 2" Lg.
7. Bolt, Hex SST
   5/8" - 11 UNC x 2 1/2" Lg.
8. Loctite, 263 Red
9. Guard, Rear Bumper
10. Rivet, Low Profile Blind Alum.
    3/16" x .062/.250

s032399a.svg

Fig. 13-11: Rear Bumpers Installation & Removal

3.3. Disassembly

1. Remove the three screws that fasten each corner closeout plate to the bumper (front bumper only).
2. Pry out the four plastic clips at each end of the bumper that secure the end module to bumper channel.
3. Slide out the end modules from the bumper channel and then slide out the center module.

3.4. Assembly

1. Insert center module into grooves in bumper channel and slide into place.
2. Insert end modules into grooves in bumper channel and slide into place. Lock each end module in place using four plastic clips (Xmas tree style).
3. Install each corner closeout plate using three screws (front bumper only).

3.5. Installation

1. Support bumper and move into place, ensuring rubber isolator strips are placed between the bumper and the vehicle mounting bracket.
2. Install and tighten four mounting bolts, nuts, and washers.

3.6. 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.

3.6.1. Repair Materials

The following materials are commonly available from most automotive supply stores or automotive paint finishing suppliers:

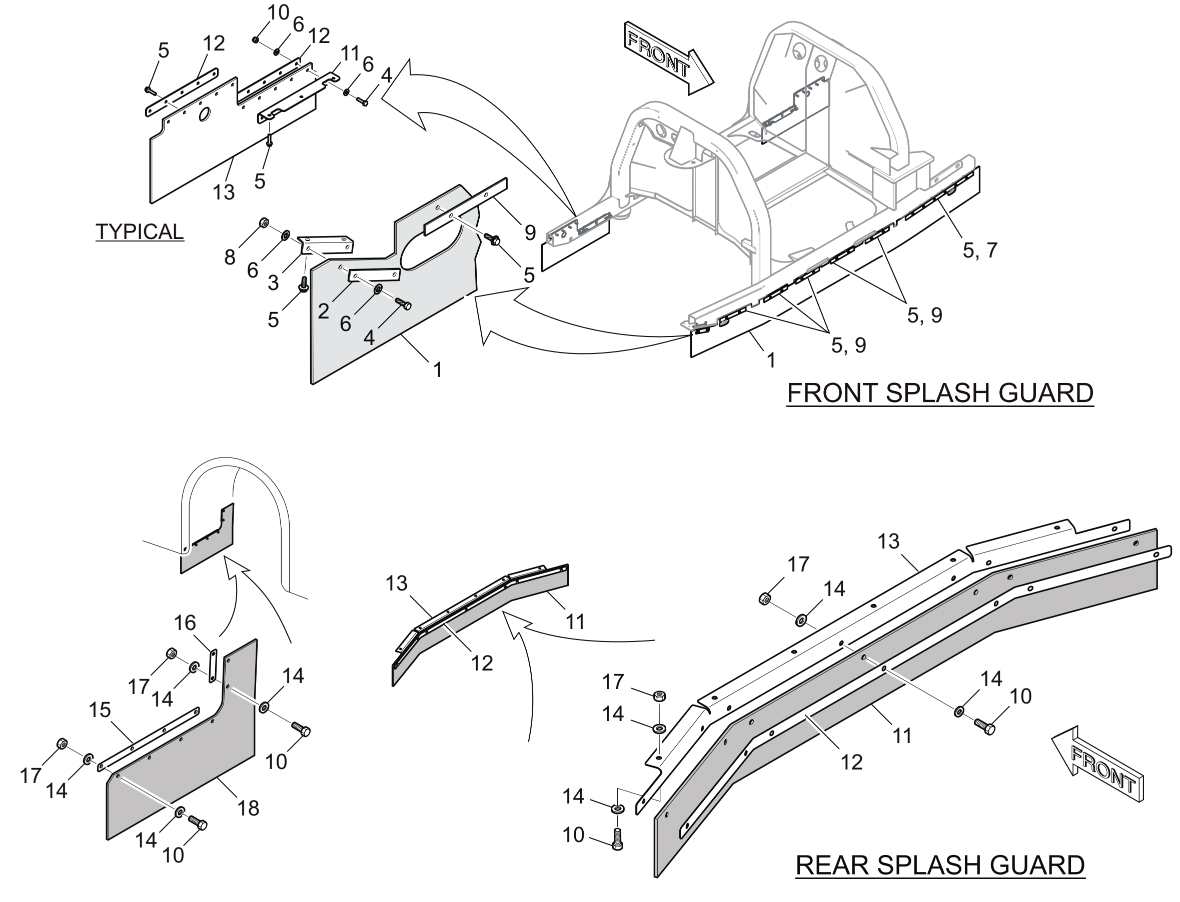
- ❒ 3M #8101 Structural Adhesive
- ❒ SEM #3835 Plastic Prep
- ❒ SEM #39927 Flexible SEM-Weld (for large areas)
- ❒ SEM #39928 Flexible SEM-Weld (10 oz. tube for small areas)
- ❒ SEM #39103 Bumper Coater (Black)
- ❒ PPG Spot Putty #DFL1 Dark Grey

4. SPLASH GUARDS

4.1. Description

Continuous rubber splash guards are mounted to the structure between the front and rear wheel wells. Mud flaps are installed to the rear of each wheel well. Front splash guards are secured with retainers and screws. Rear splash guards are secured to reinforcing brackets with screws. The brackets are bolted to mounting angles which in turn are attached to the vehicle structure. Mud flaps are secured to mounting angles which are attached to the vehicle structure with screws.

Check mounting hardware for condition and security. Replace or tighten as required. Check splash guards and mud flaps for condition. Replace if damaged or unserviceable. See “Fig. 13-12: Splash Guards Installation” on page 36.



1. Splash Guard, Front
2. Retainer, Splash Guard
3. Bracket, Retainer
4. Bolt, Hex SST 1/4" - 20 UNC x 1" Lg.
5. Screw, Tapping 1/4" - 20 x 1.00" Lg.
6. Washer, Flat SST 1/4"
7. Retainer, Splash Guard
8. Nut, Hex SST 1/4" - 20 UNC
9. Retainer, Splash Guard
10. Bolt, Hex SST 1/4" - 20 UNC x 1" Lg.
11. Mud Flap, Rear Center
12. Bracket, Mud Flap Retainer
13. Bracket, Rear Axle Mud Flap
14. Washer, Flat SST 1/4"
15. Plate, Mud Flap Retainer
16. Plate, Mud Flap Retainer
17. Nut, Lock 1/4" - 20 SST
18. Mud Flap, Rear

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Fig. 13-12: Splash Guards Installation

5. S-1 GARD

5.1. Description

The S-1 Gard is a protective molded bumper mounted in front of the rear curb-side wheels. It is designed to prevent persons from falling under the rear wheels of the vehicle. The S-1 Gard fits into a receiver channel and is retained there with two mounting bolts.

5.2. 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. Installation

1. Slide the S-1 Gard into the receiver channel.
2. Secure the S-1 Gard to the channel with 1/2" lock washers and bolts. S-1 Gard is correctly positioned when its outer edge is approximately 0.5" inboard of the first tire tread.
3. Torque bolts 117 ± 3 ft-lb. (159 ± 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 4.4".

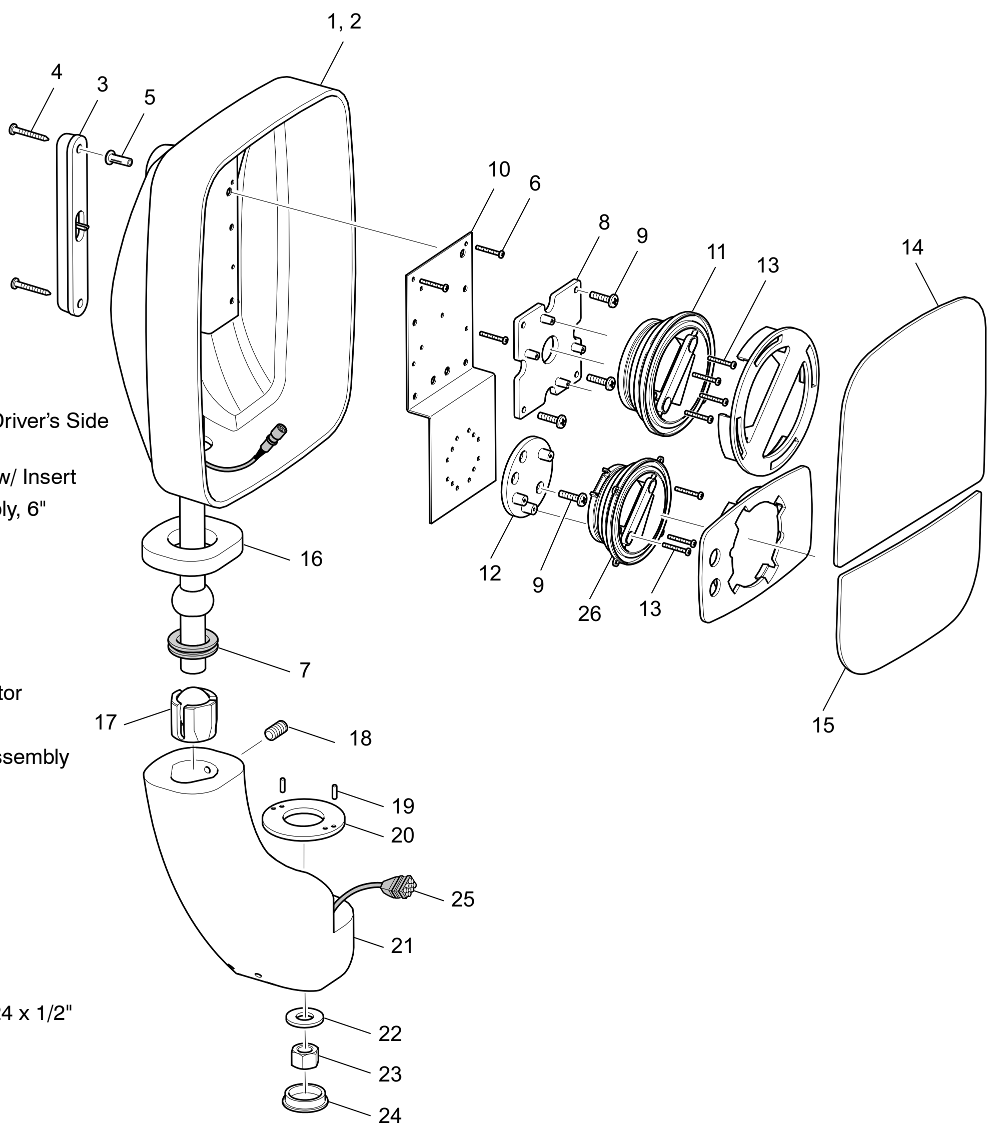
6. MIRRORS

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 is fastened to the vehicle structure above the driver's window and is positioned at the upper forward edge of the window. The mirror is equipped with a turn indicator and upper rectangular and a lower convex sections. See "Fig. 13-13: Exterior Driver's Side Mirror Assembly" on page 38.



1. Mirror Assembly, Driver's Side (Incl. 2...26)
2. Housing, 8" x 11" w/ Insert
3. LED Light Assembly, 6" (Incl. 4 & 5)
4. Screw
5. Nut
6. Screw
7. Grommet
8. Plate, Medium Motor
9. Screw, FH
10. Plate and Shaft Assembly
11. Motor, Manual
12. Plate, Small Motor
13. Screw, Mounting
14. Glass, Flat
15. Glass, Convex
16. Gasket 1/2"
17. Collet
18. Screw, Set 3/8" - 24 x 1/2"
19. Roll Pin
20. Race
21. Arm, Mirror
22. Washer, Flat SS 1/2"
23. Nut, Stover
24. Cap
25. Harness, Mirror Arm
26. Mechanism, Tip Tap

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Fig. 13-13: Exterior Driver's Side Mirror Assembly

6.1.2. Curbside Mirror

This mirror is located above and in front of the entrance door and is remotely adjusted. It is attached to a support arm connected to a chassis-mounted support bracket. The upper portion of this dual mirror is flat surfaced, the lower portion has a full face convex surface for wide-angle curbside vision.

The mirror is equipped with a turn indicator, and an upper rectangular and lower convex sections. The mirror housing is fitted with a turn signal lamp. See “Fig. 13-14: Exterior Curbside Mirror Assembly” on page 39.

1. Mirror Assembly, Curbside (Incl. 2...29)
2. Housing, 8" x 11" w/ Insert
3. LED Light Assembly, 6" (Incl. 4 & 5)
4. Screw
5. Nut
6. Screw
7. Grommet
8. Plate, Medium Motor
9. Screw, FH
10. Plate and Shaft Assembly
11. Motor, Electric w/Heat
12. Plate, Small Motor
13. Screw, Mounting
14. Glass, Flat
15. Glass, Convex
16. Gasket 1/2"
17. Collet
18. Screw, Set 3/8" - 24 x 1/2"
19. Screw, FH - 24 x 1/2"
20. Arm, Mirror
21. Harness, Mirror Arm
22. Washer, Flat SS 1/2"
23. Nut, Stover
24. Cap
25. Bolt, Hex Head 1/2" - 13
26. Locknut, Center
27. Spring
28. Nut, Acorn
29. Washer, Plastic

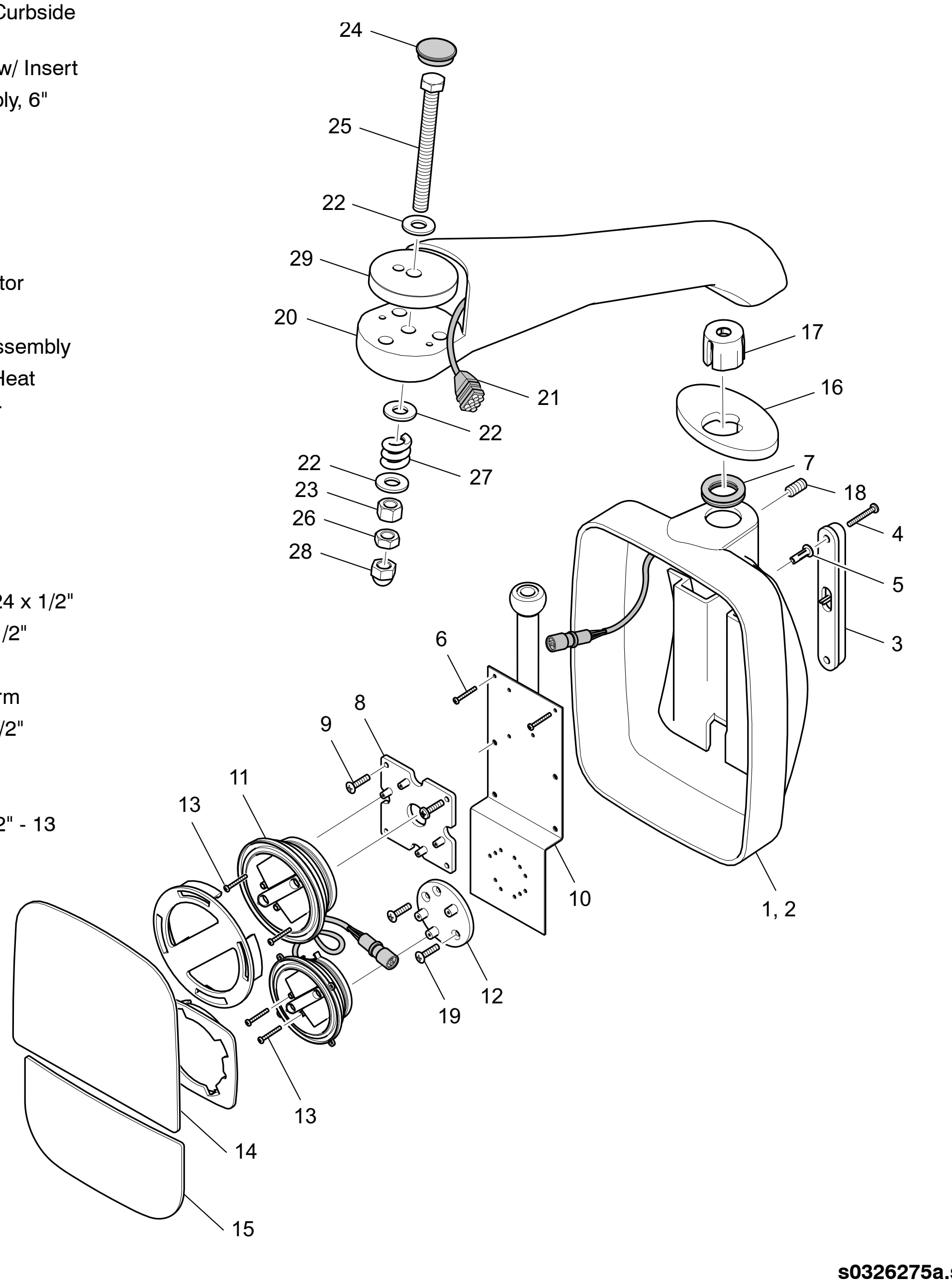


Fig. 13-14: Exterior Curbside Mirror Assembly

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.

6.3. Interior Mirrors

6.3.1. Description

The following mirrors are located throughout the vehicle interior:

- ❒ Aisle Mirror - The aisle mirror is located under the front destination sign closeout. 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 a 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 - The bike rack mirror is located to the right of the aisle mirror. Adjust this mirror to provide a view of the bike rack.
- ❒ Overhead Convex 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.

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. 13-15: Windshield Wiper & Motor Installation” on page 42.
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.

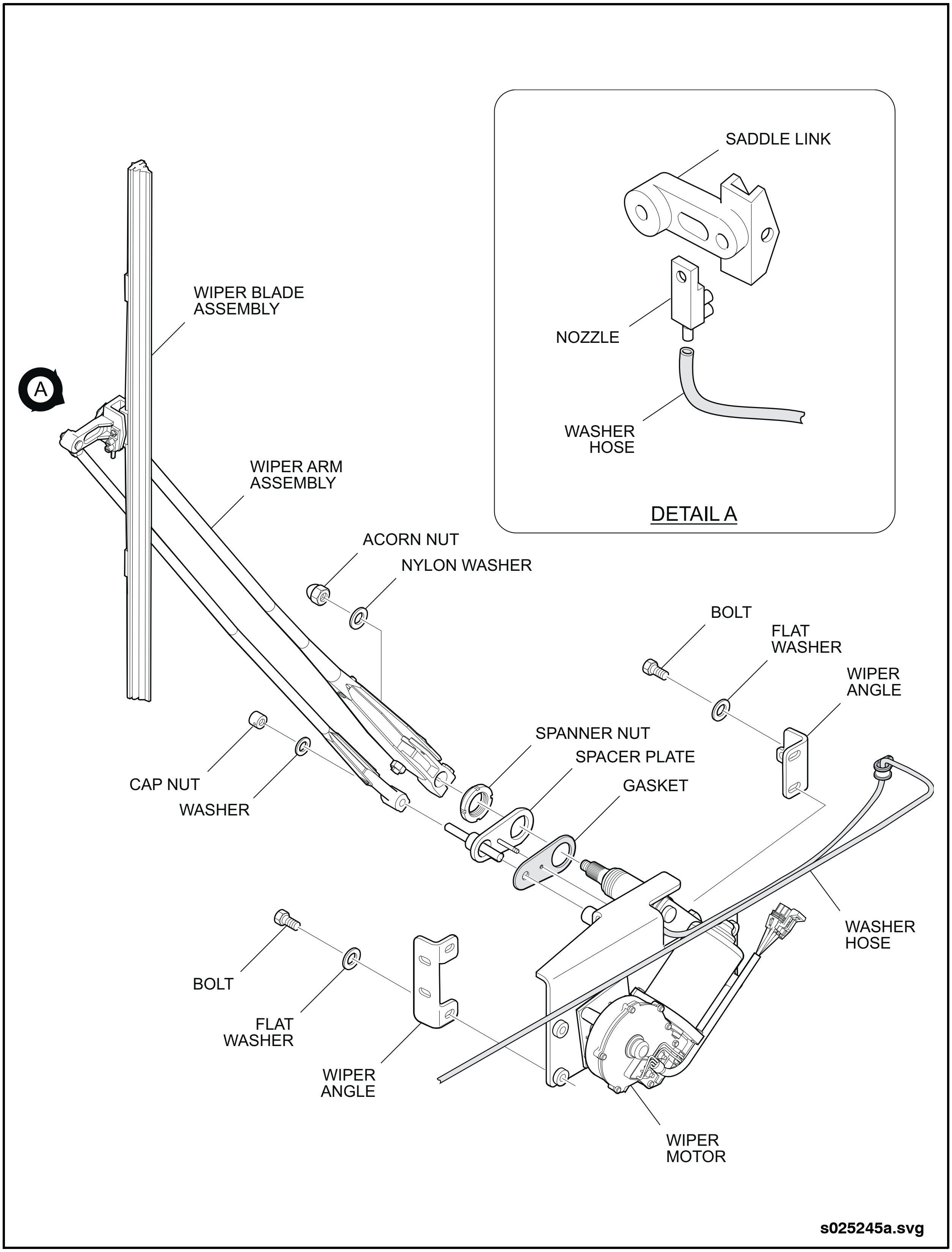


Fig. 13-15: Windshield Wiper & Motor Installation

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. Install spanner nut and tighten to 25 to 30 ft-lb. (34 to 41 Nm).
5. Install wiper operating arm in originally marked position.
6. Tighten arm clamping bolt to 155 to 165 in-lb. (17 to 18 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. 13-16: Washer Bottle Installation” on page 44.
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:**

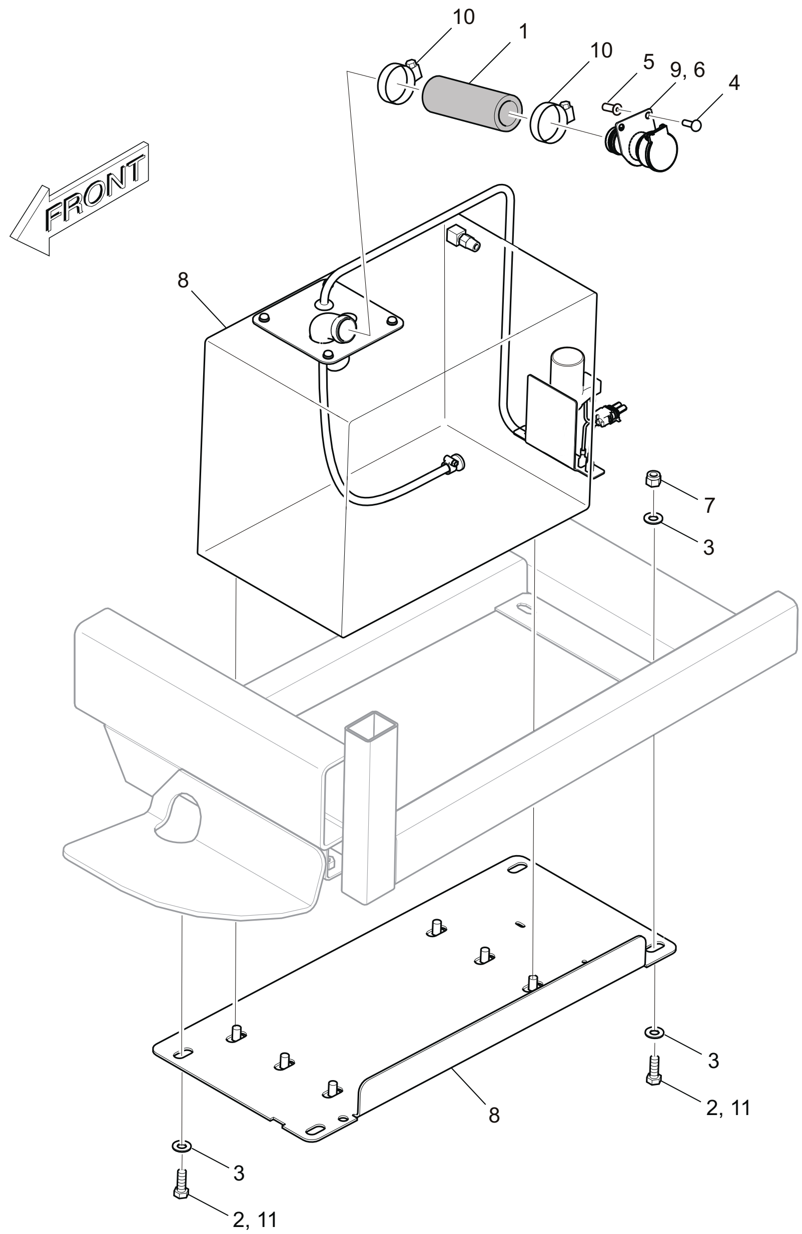
To be replaced only as an assembly.

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. 13-16: Washer Bottle Installation

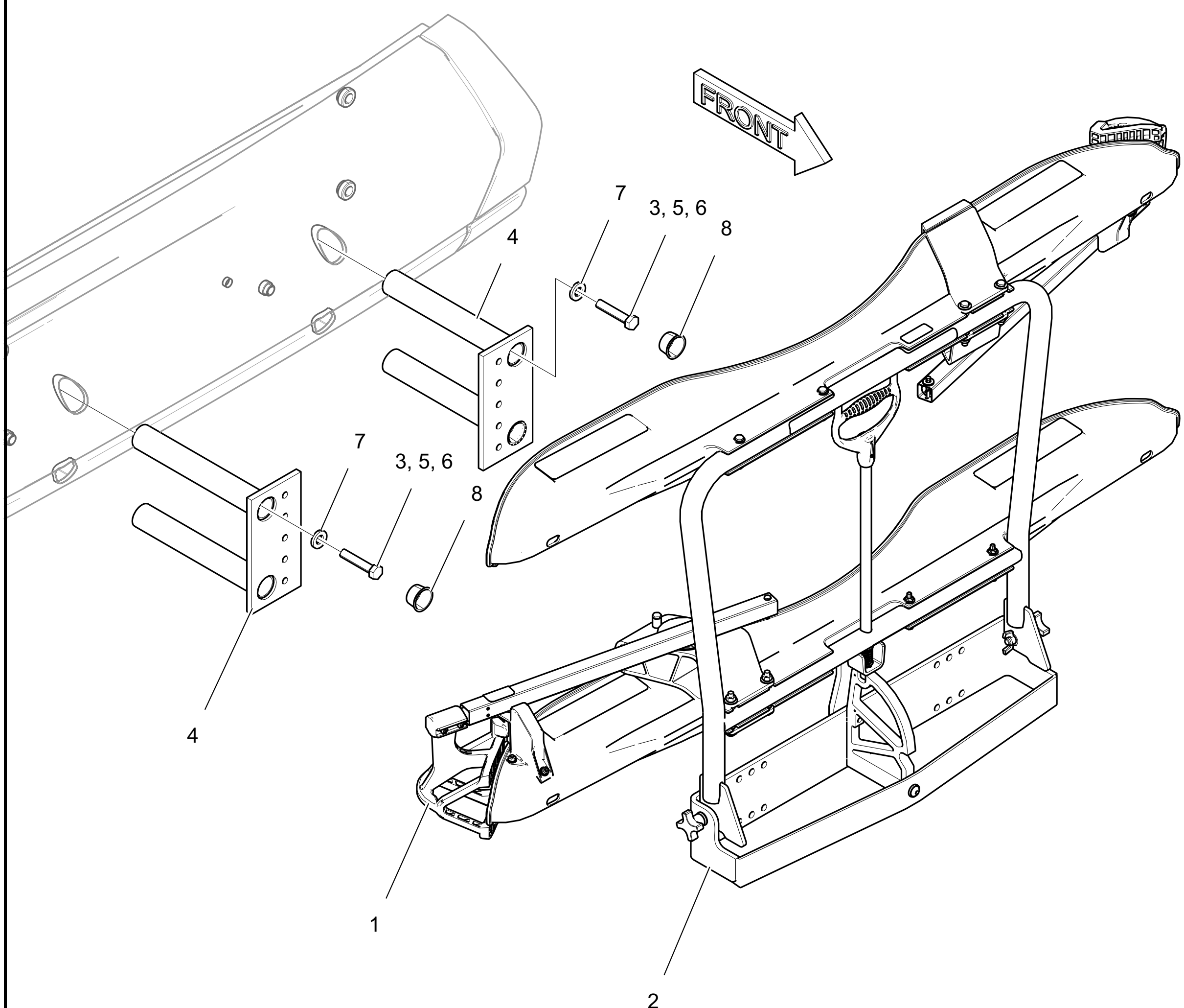
7.2.5. Washer System Troubleshooting

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. 13-17: Major Components of Bike Rack” on page 46.



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. 13-17: 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 head-lamps. ALWAYS verify that the head-lamps 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 main loops, saddle pieces, and the rectangular 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. 13-18: Latch Mechanism Servicing” on page 48.
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.

1. Latch Tube
2. Washer
3. Spring
4. Latch Pin
5. Roll Pin
6. Spring Pin
7. Latch Handle

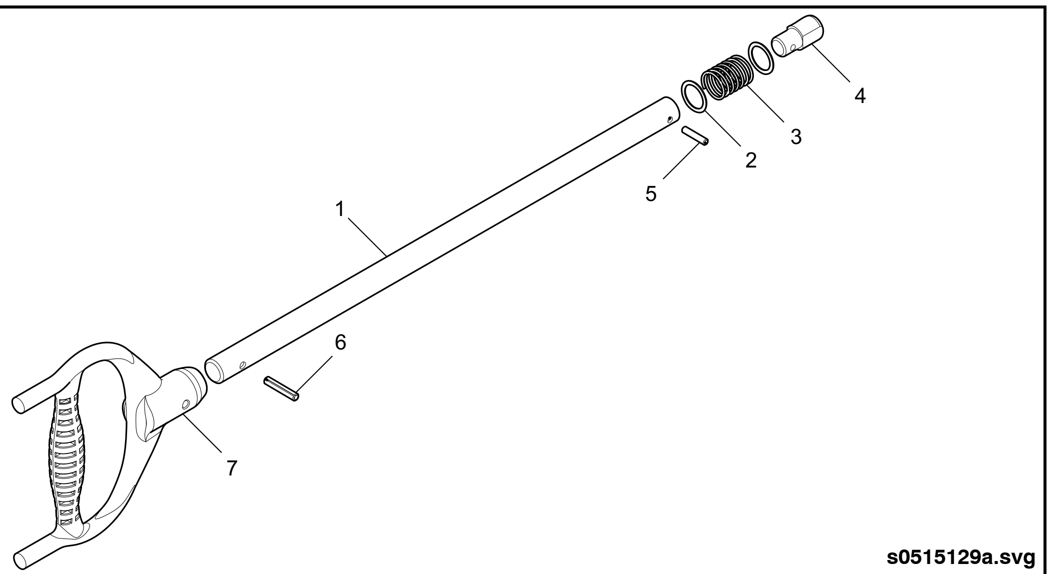


Fig. 13-18: Latch Mechanism Servicing

8.3.3. Support Arm Servicing

1. Examine components inside the support arm assembly. See "Fig. 13-19: Support Arm Servicing" on page 49.
   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 overtighten. 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. Lock Washer
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

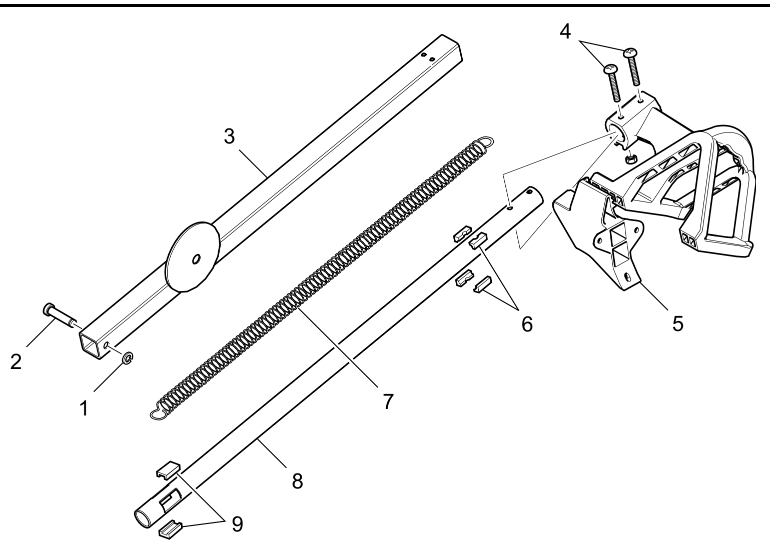


Fig. 13-19: Support Arm Servicing

Windows

1. SAFETY

1.1. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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.

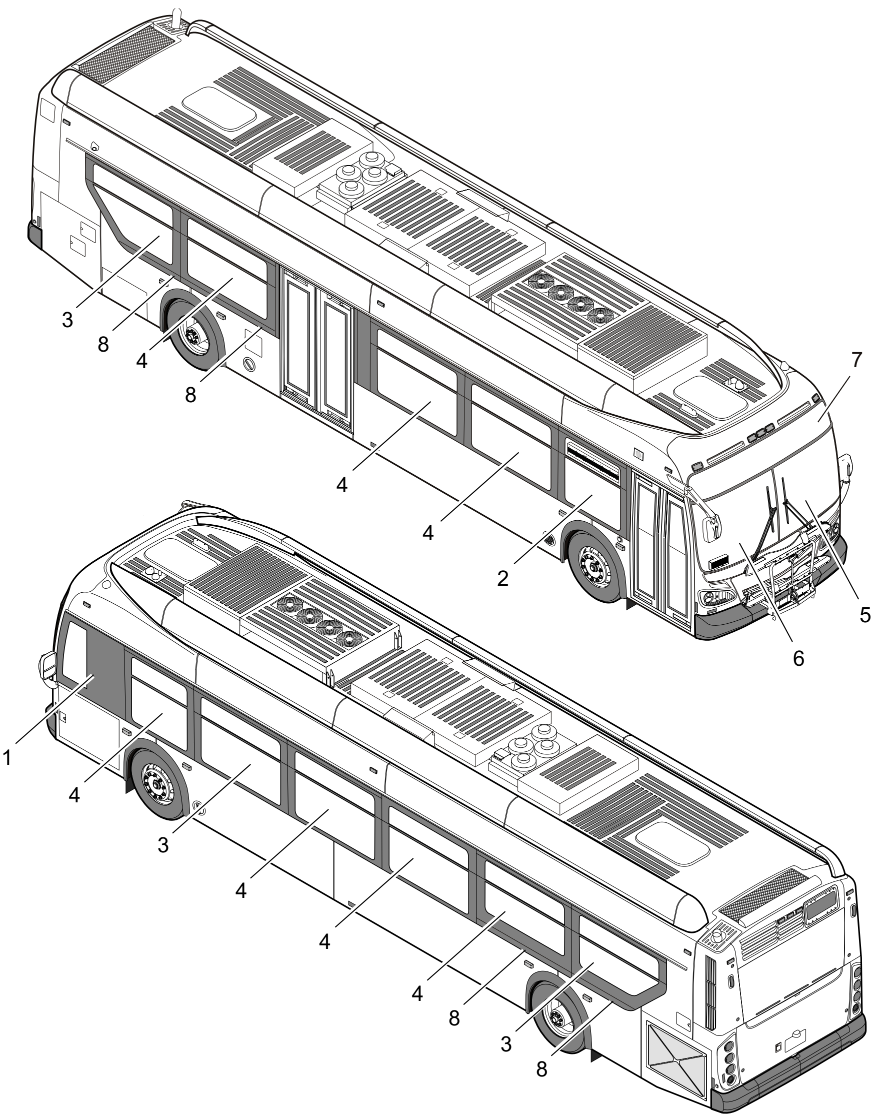
2. WINDOWS

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



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

s0327340a.svg

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.

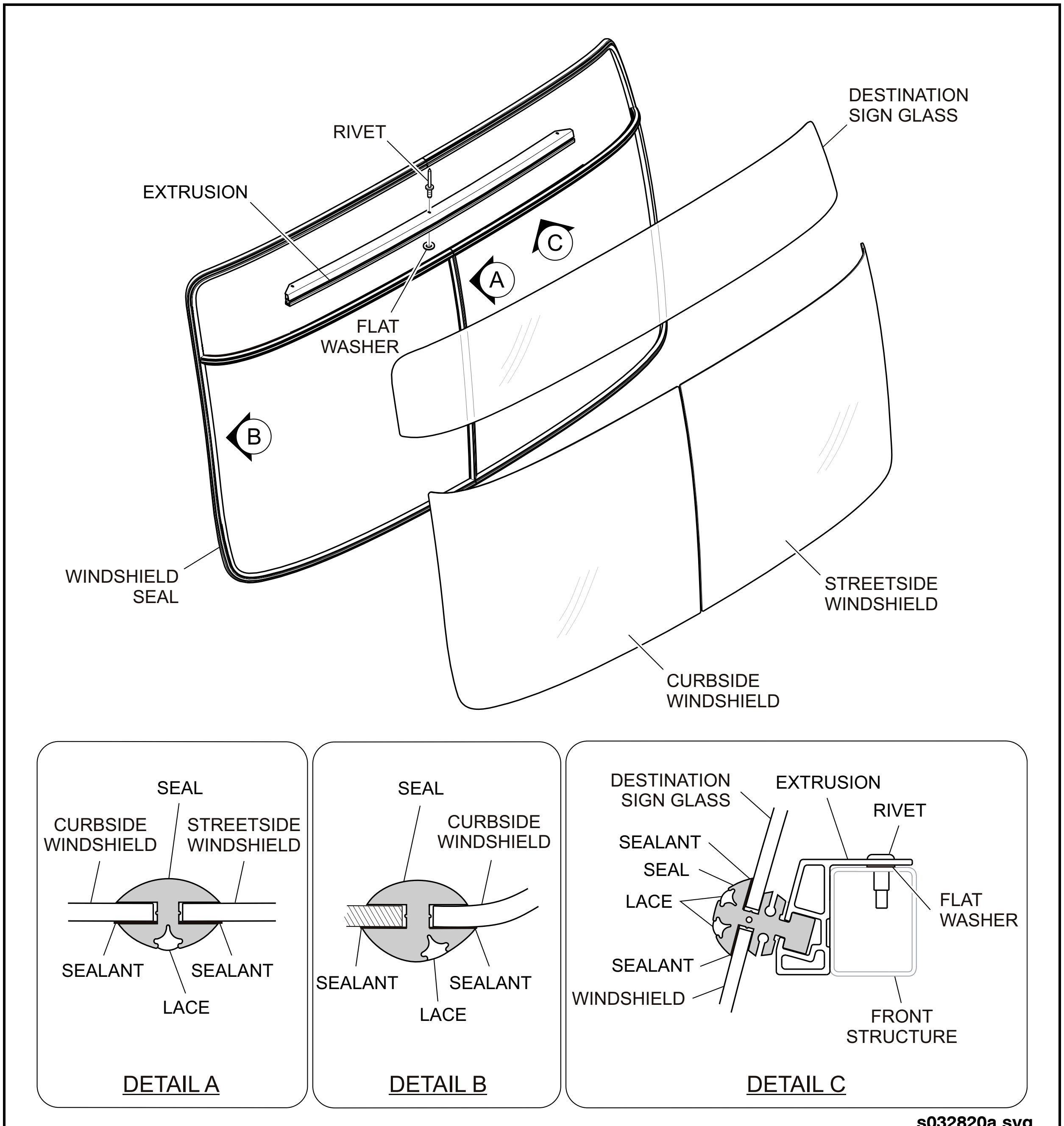


Fig. 14-2: Windshield

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.

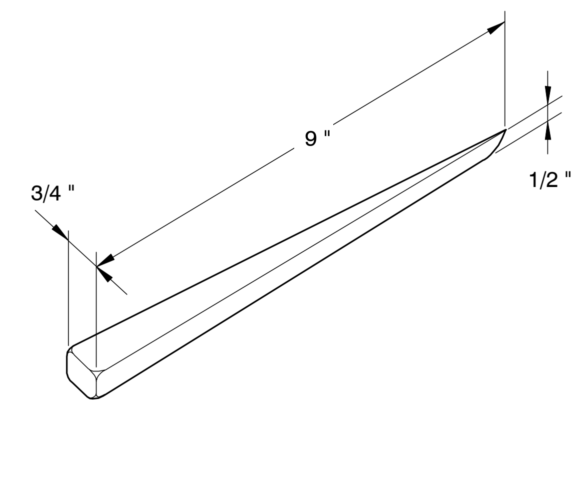


Fig. 14-3: Installation Tool

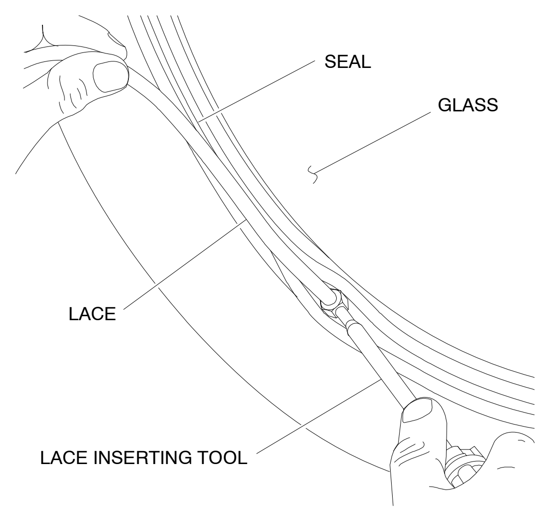


Fig. 14-4: Installing Lace

2.3. Driver's Window (MV209)

2.3.1. Description

The driver's window is a non-emergency release style window with a forward slider portion and an aft fixed portion. The window assembly consists of a frame, a sub-frame, a clamp ring, and flush mounted tempered glass sections. See "Fig. 14-5: Driver's Window Assembly" on page 6.

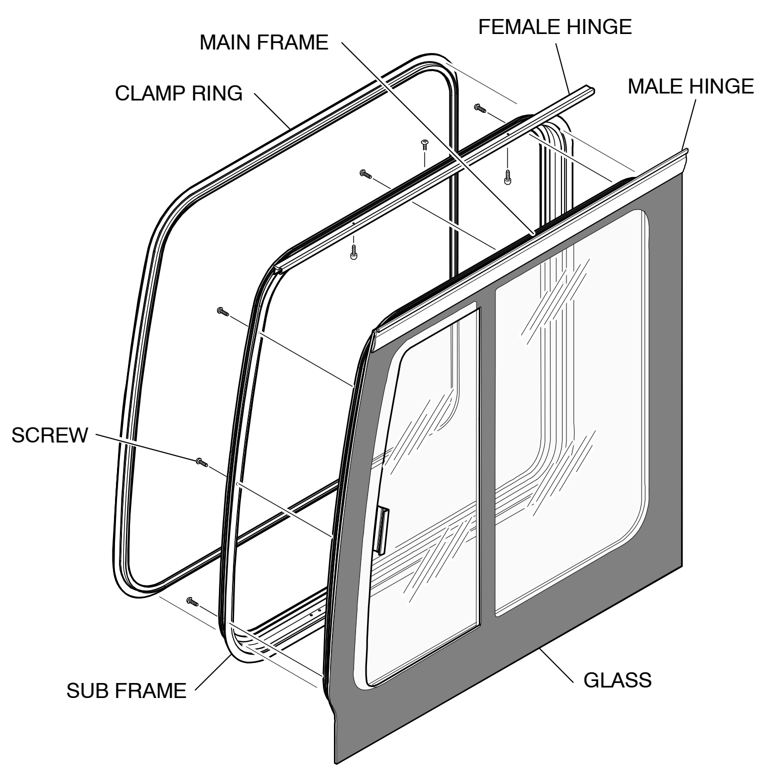


Fig. 14-5: Driver's Window Assembly

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 19 *in this section for glass replacement procedure.* Refer to 2.10. "Window Assembly Replacement" on page 34 *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.

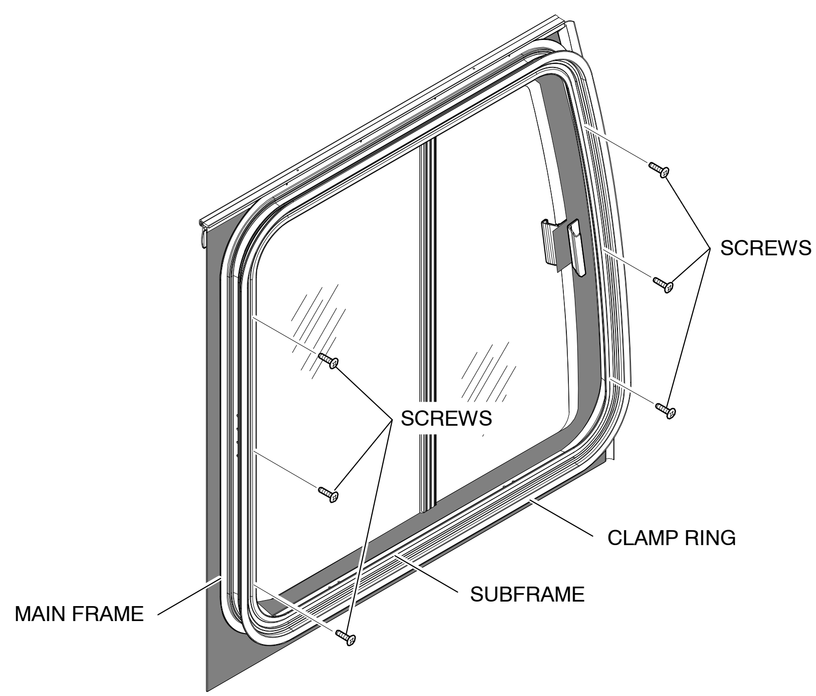


Fig. 14-6: Driver's Window Frame Removal

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 19 in this section for glass replacement procedures.

2.3.5. Driver's Fixed Meet Rail Replacement

Refer to 2.9.1. "Fixed Meet Rail Procedure" on page 33 in this section for glass replacement procedures.

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 13 and Refer to 2.4.6. “Sash Assembly Installation” on page 14 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 9.

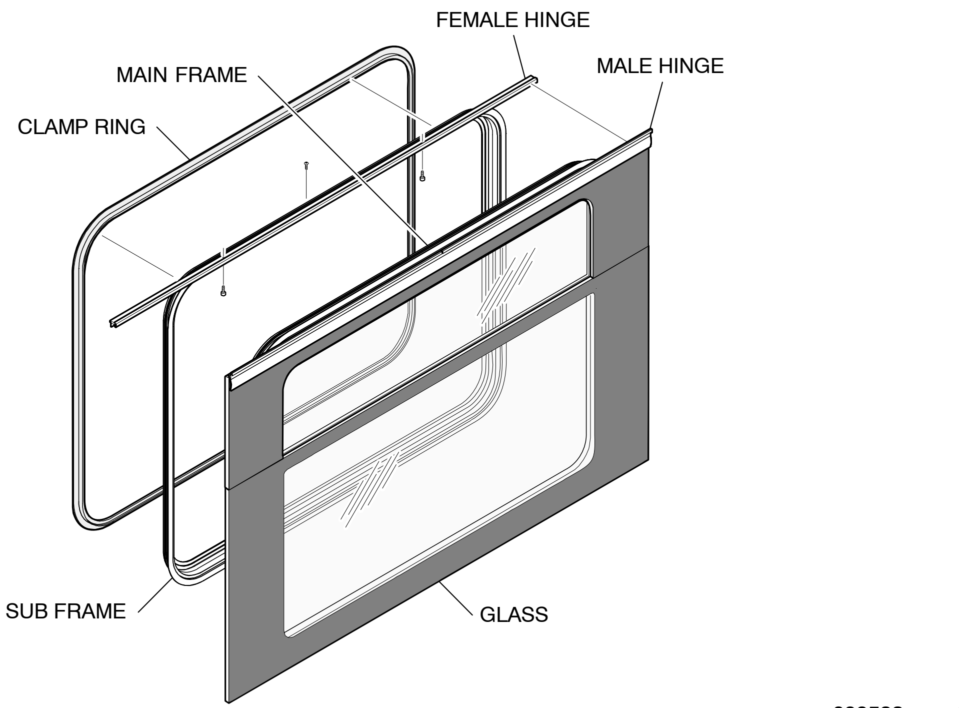


Fig. 14-7: Side Emergency Window Assembly

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 10.
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.

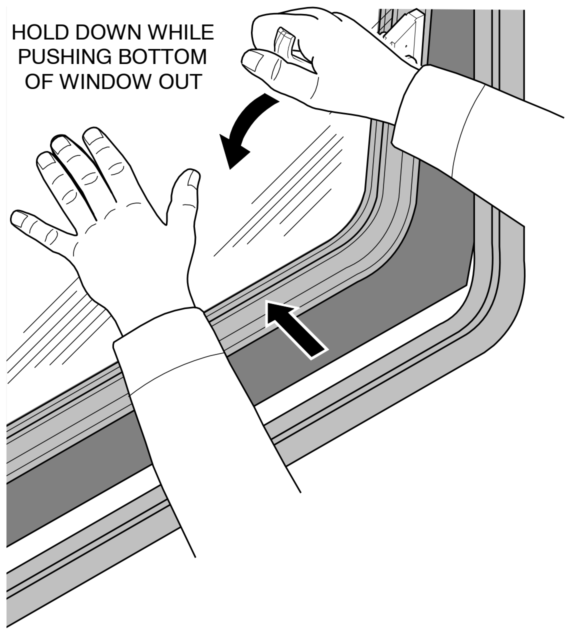


Fig. 14-8: Side Emergency Window Operation

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 19 *in this section for glass replacement procedure.* Refer to 2.10. “Window Assembly Replacement” on page 34 *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 11.

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.

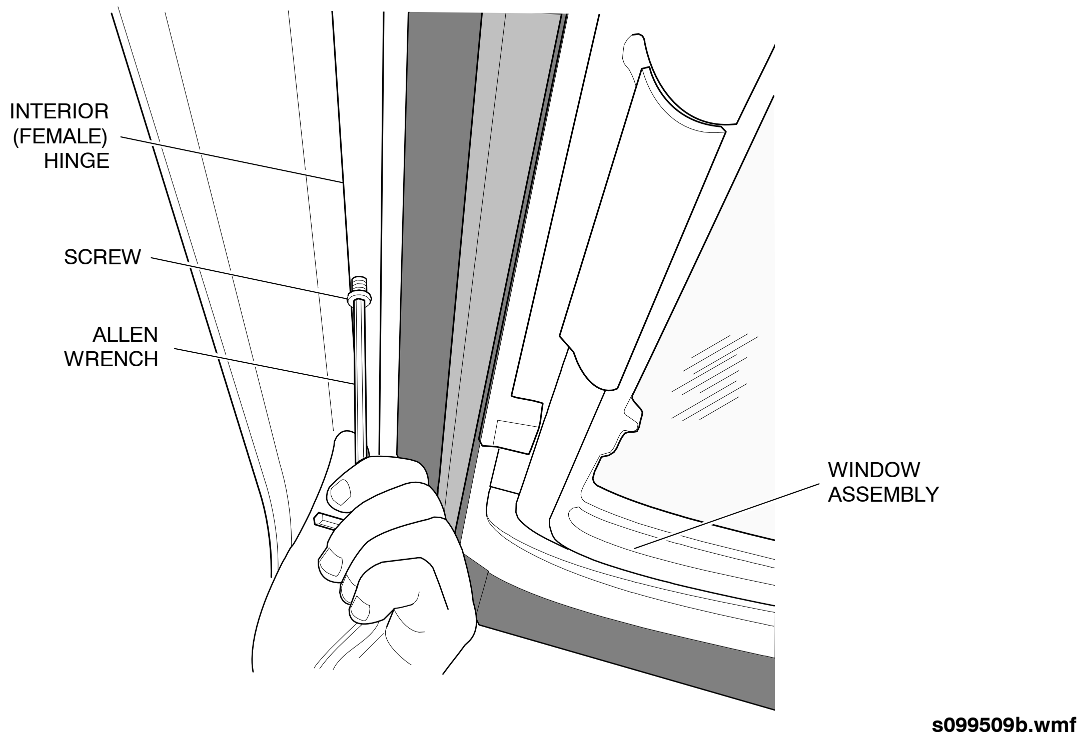


Fig. 14-9: Subframe Screw Removal

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 12.
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.

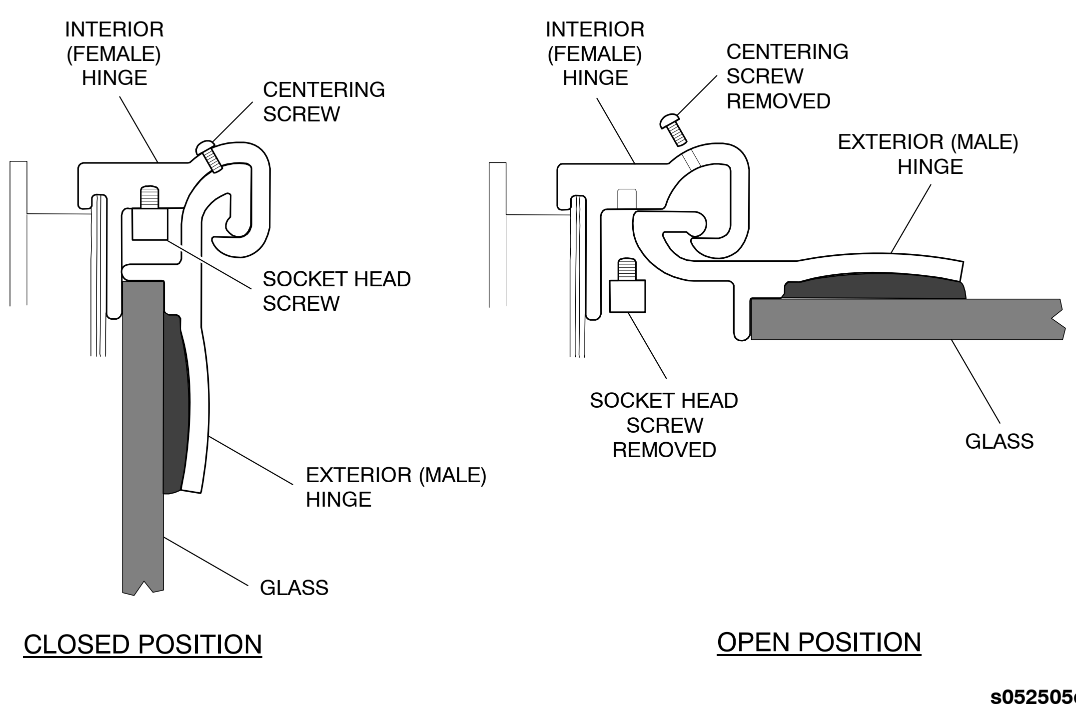


Fig. 14-10: Correct Engagement

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 13.
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.

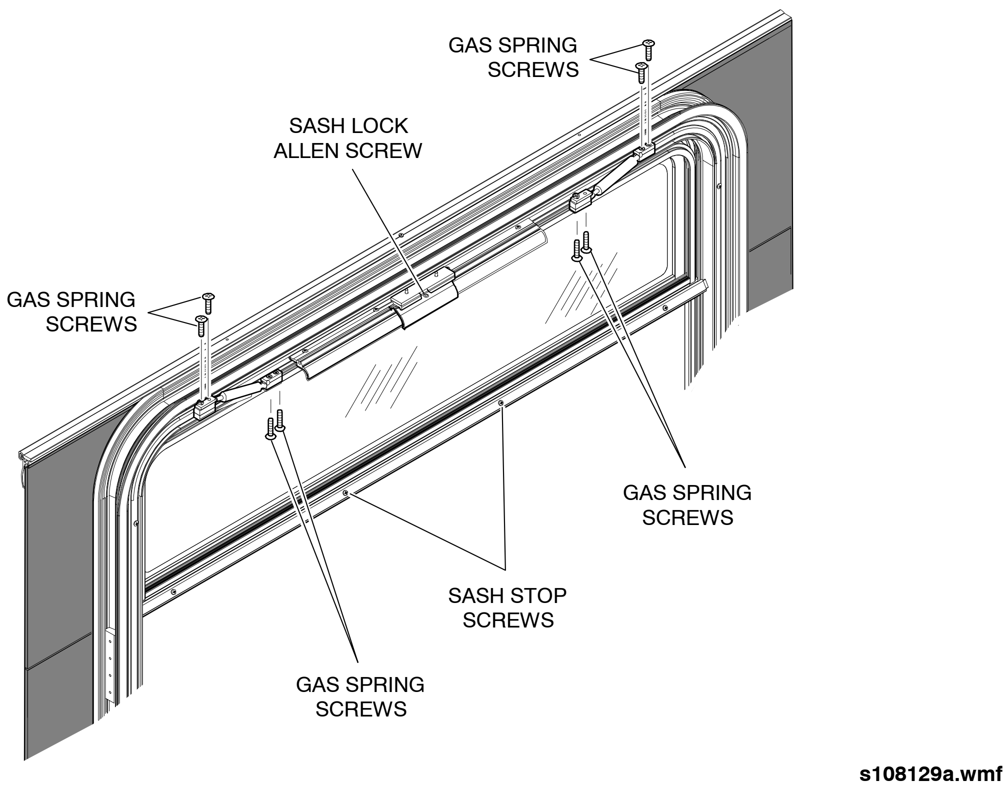


Fig. 14-11: Window Sash Removal

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 19 in this section for glass replacement procedures.

2.5. Side Non-Emergency Window (MV201 & 208)

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 15.

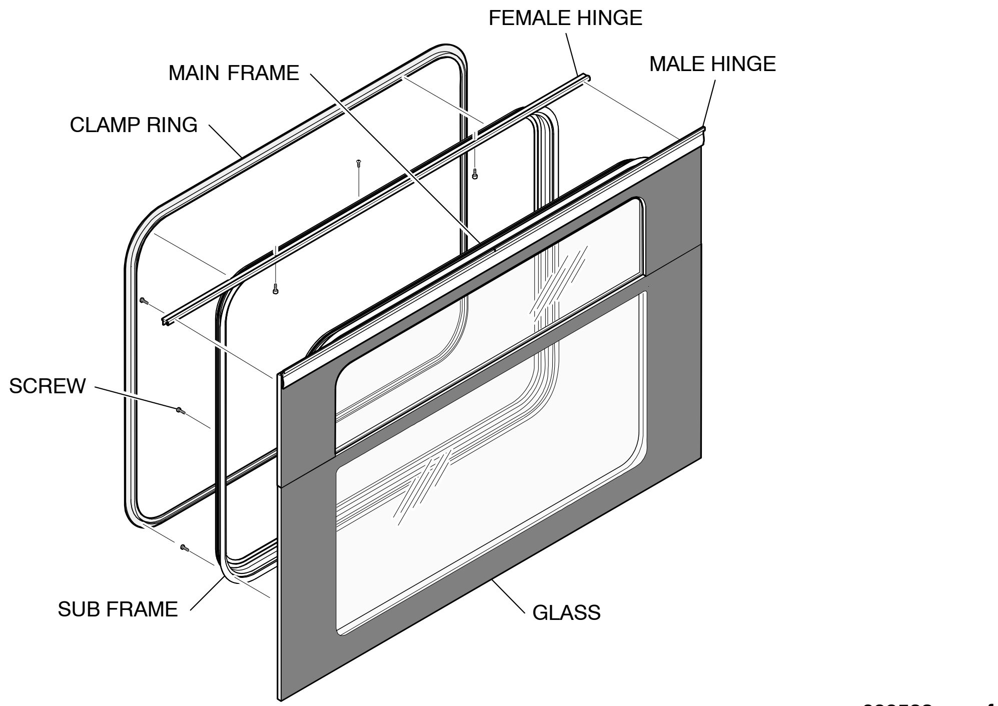


Fig. 14-12: Side Non-Emergency Window Assembly

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 19 *in this section for glass replacement procedure.* Refer to 2.10. “Window Assembly Replacement” on page 34 *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 16.
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.

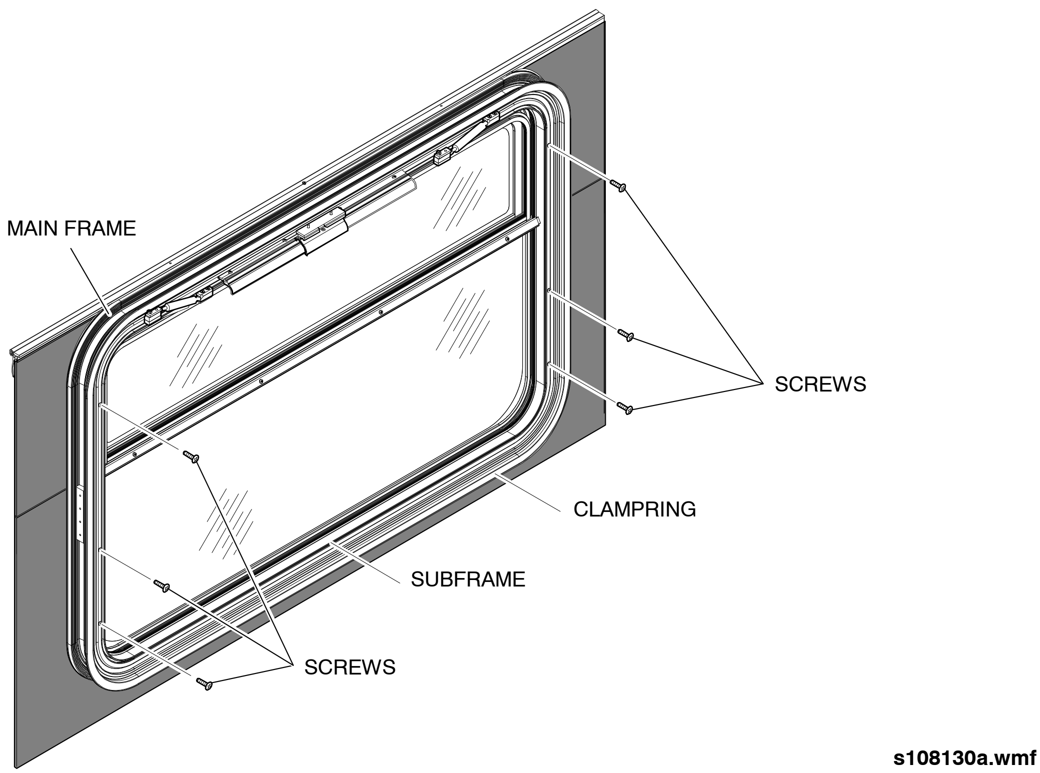


Fig. 14-13: Non-Emergency Window Frame Removal

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 13 and Refer to 2.4.6. "Sash Assembly Installation" on page 14 in this section for sash removal and installation procedures.

2.5.5. Glass Replacement

Refer to 2.7. "Flush Window Glass Replacement" on page 19 in this section for glass replacement procedures.

2.6. Side Destination Sign Window (MV207)

2.6.1. Description

One side destination sign window is installed on the curbside of the vehicle and one is installed on the streetside of the vehicle. The window assembly consists of a frame, a subframe, a clamp ring, and flush mounted glass. The side destination sign window is serviced identically to the Side Non-Emergency Window. Refer to 2.5. “Side Non-Emergency Window (MV201 & 208)” on page 15 in this section for servicing procedures. Refer to 2.7.7.3. “Fixed Over Fixed Capping the Joint Procedure” on page 26 in this section for special glass section sealing requirements. See “Fig. 14-14: Side Destination Sign Window” on page 18.

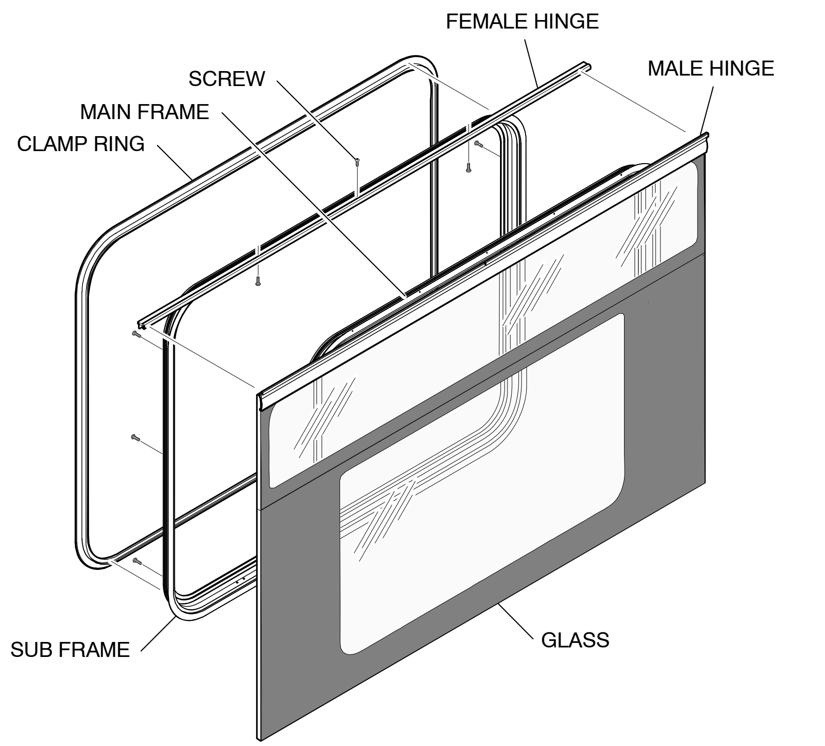


Fig. 14-14: Side Destination Sign Window

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 19. 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.

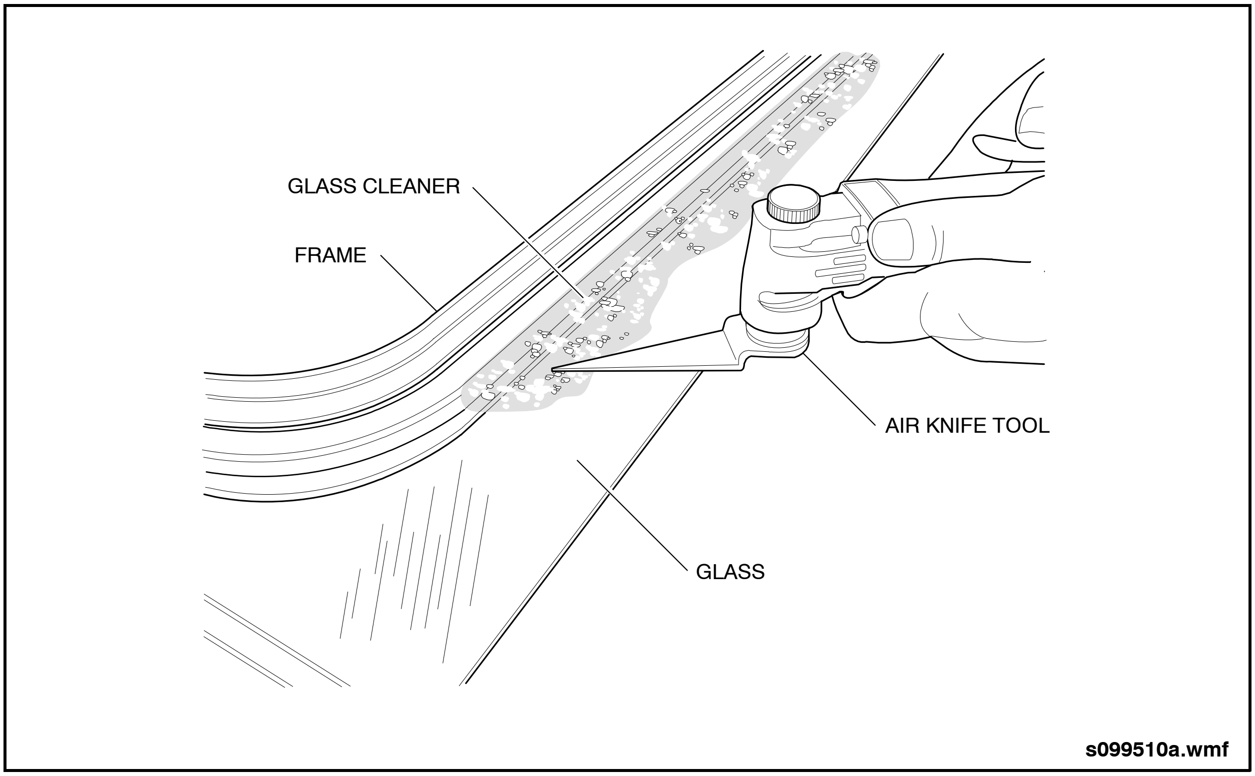


Fig. 14-15: Cutting of Bond Between Frame & Glass

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 20. Slightly lift up on the male hinge to prevent the blade from getting stuck.

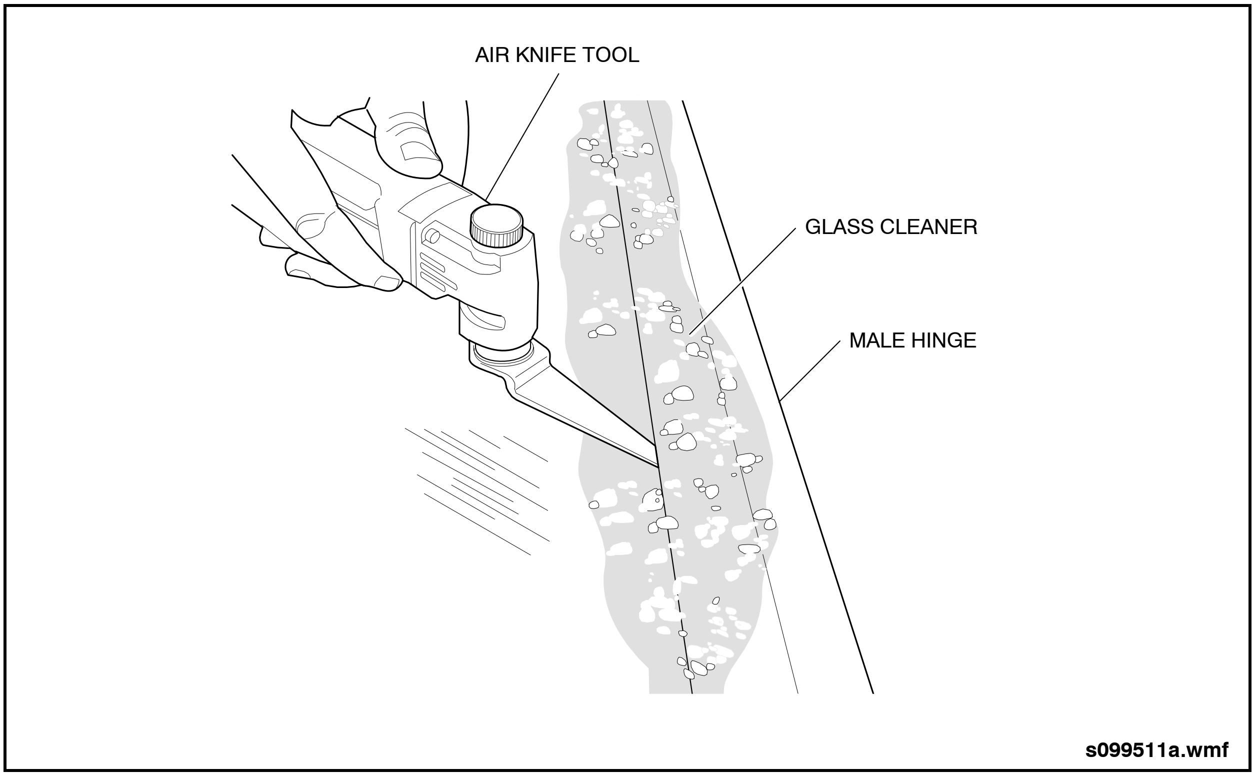


Fig. 14-16: Cutting of Bond Between Male Hinge & Glass

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 36 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 22.

☞NOTE:

For replacement of the driver’s window flush glass, Refer to 2.9.2. “Bonding Driver Frame to Glass” on page 33 *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 22.
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.

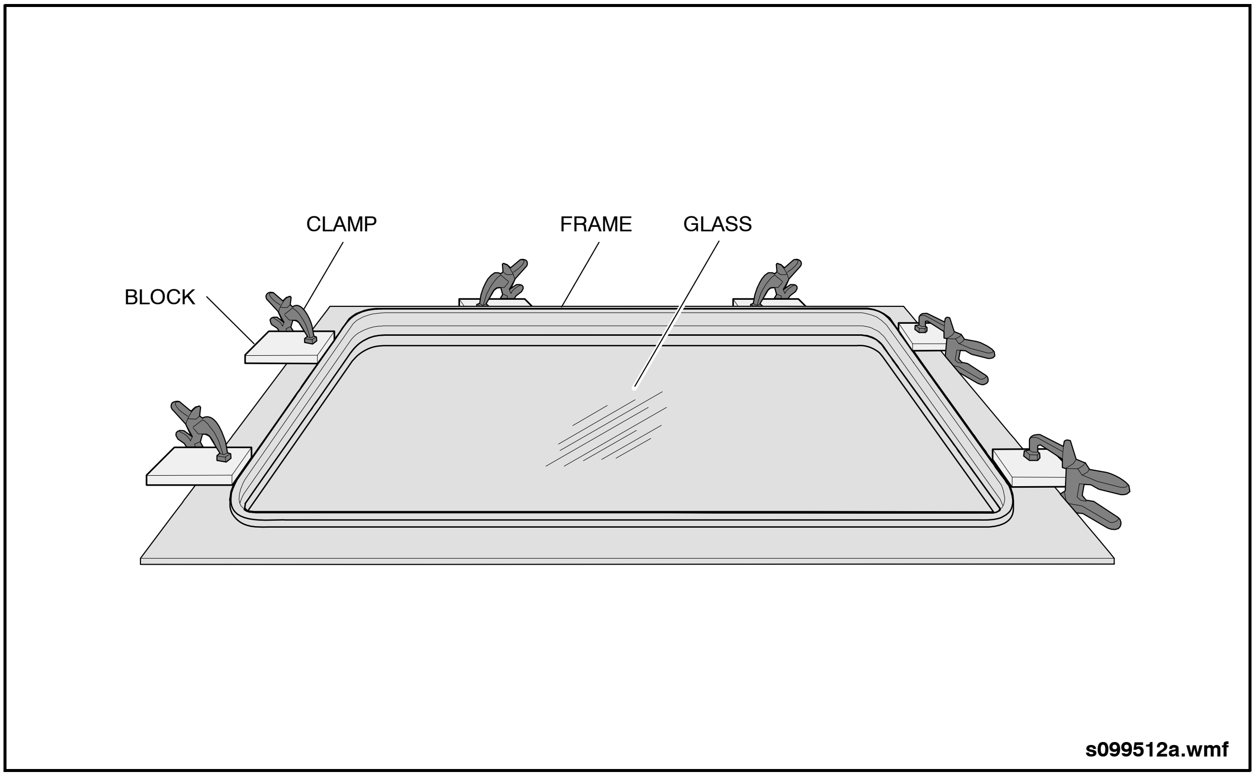


Fig. 14-17: Frame to Block Alignment

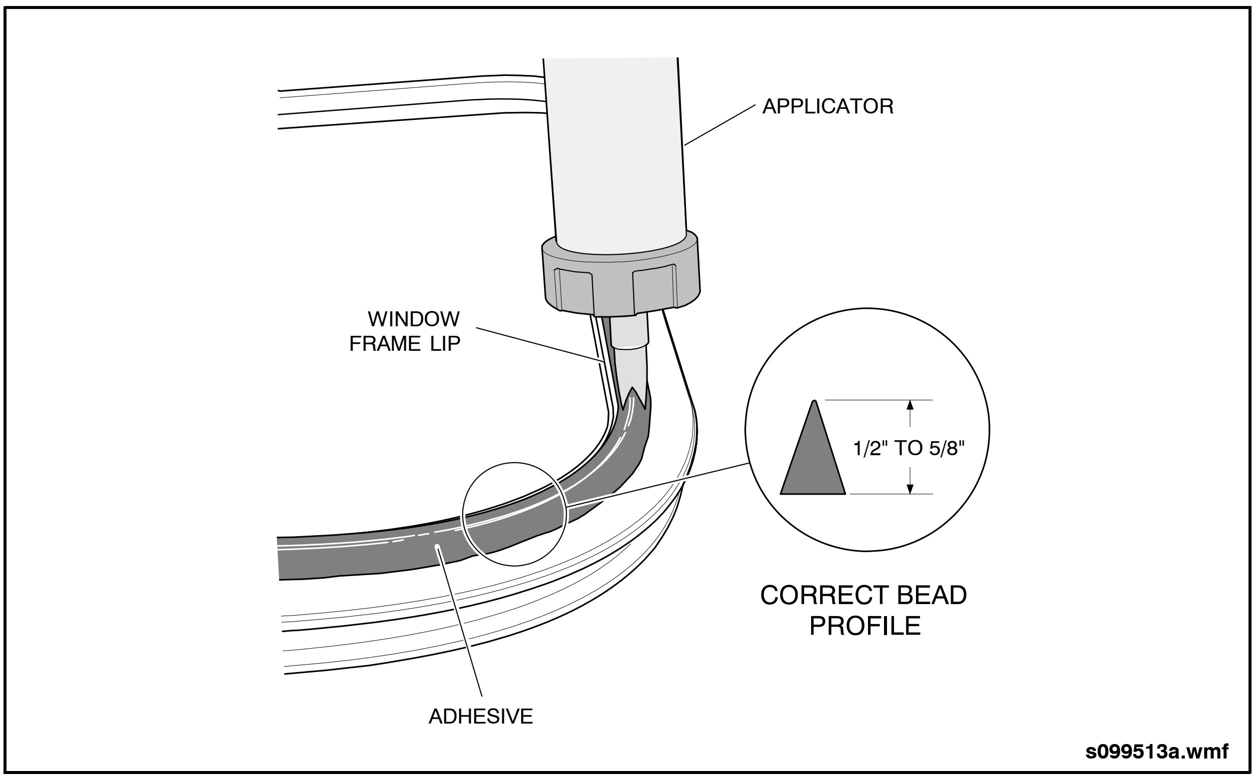


Fig. 14-18: Adhesive Application

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 23.
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 24.
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 24.
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.

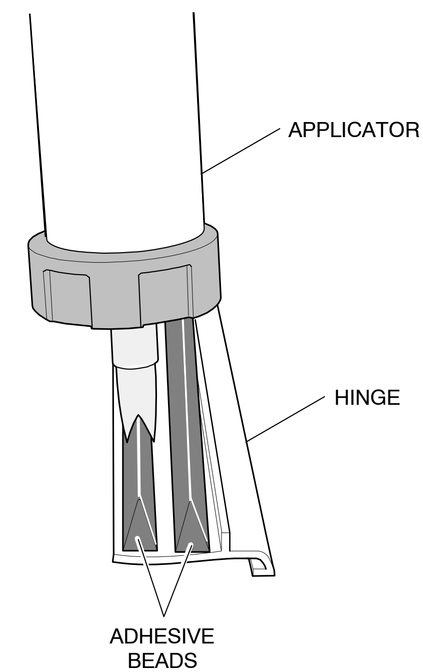


Fig. 14-19: Male Hinge Adhesive Application

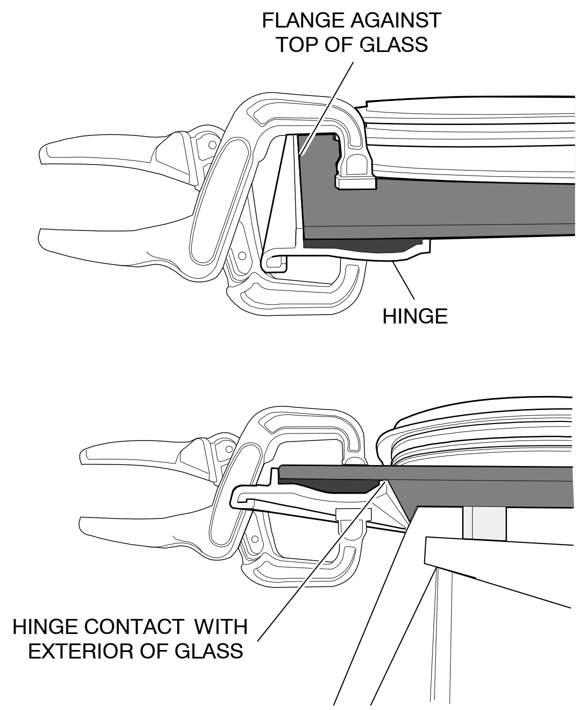


Fig. 14-20: Flange & Hinge to Glass Contact

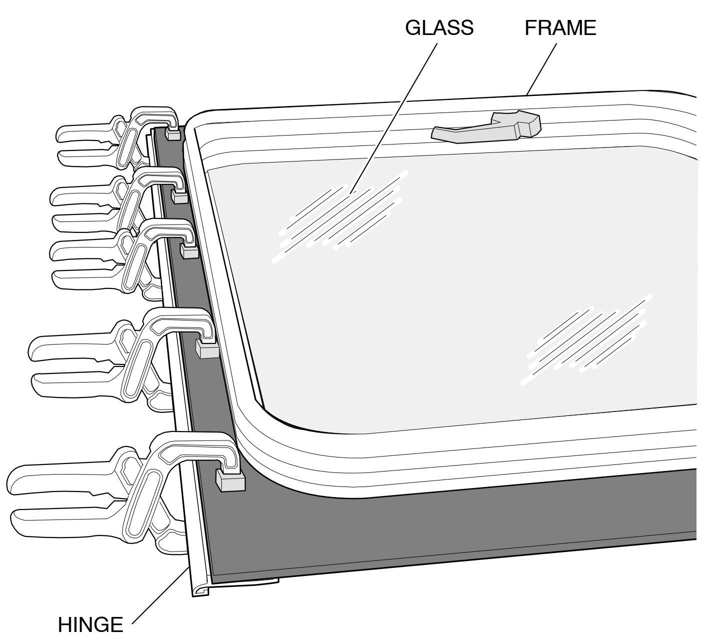


Fig. 14-21: Male Hinge Clamping

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 19 in this section for procedure.
2. Clean frame. Refer to 2.7.4. “Frame Cleaning” on page 21 in this section for procedure.
3. Refer to 3. “GLASS OFFSET GUIDE” on page 36 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 21 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 26 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 19 in this section for procedure.
2. Clean frame and hinge. Refer to 2.7.4. "Frame Cleaning" on page 21 and "Male Hinge Cleaning" in this section for procedures.
3. Refer to 3. "GLASS OFFSET GUIDE" on page 36 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 21 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 26 in this section for procedure.
14. Bond male hinge to glass. Refer to 2.7.6. "Bonding Male Hinge to Glass" on page 23 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 25 in this section for glass replacement. Refer to 2.7.8.2. "Tip-in Joint Sealing Procedure" on page 27 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 27.
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 27.
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 28.

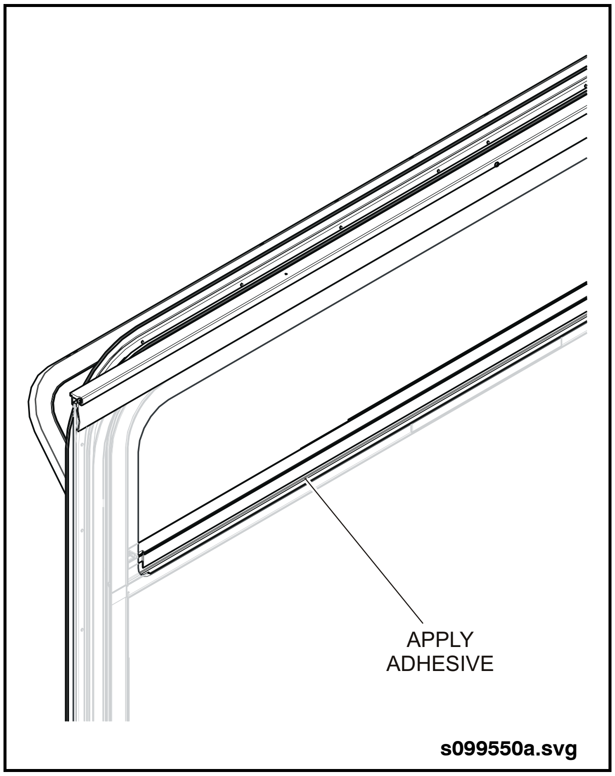


Fig. 14-22: Transom & Glass Joint

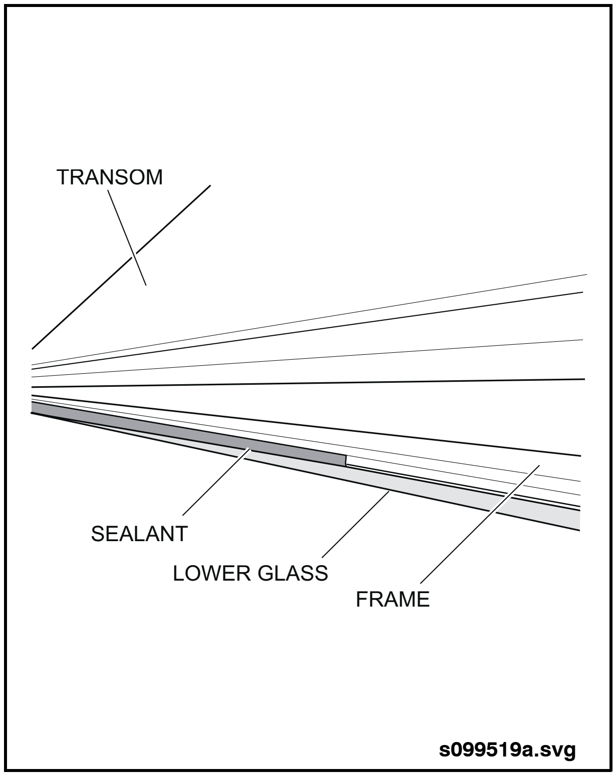


Fig. 14-23: Transom & Glass Joint Seal

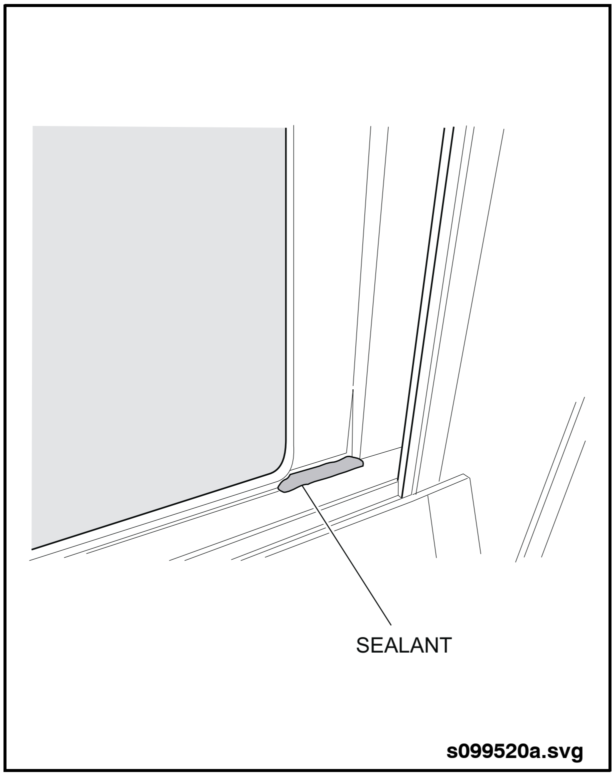


Fig. 14-24: Transom Joint Seal

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 29.
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.

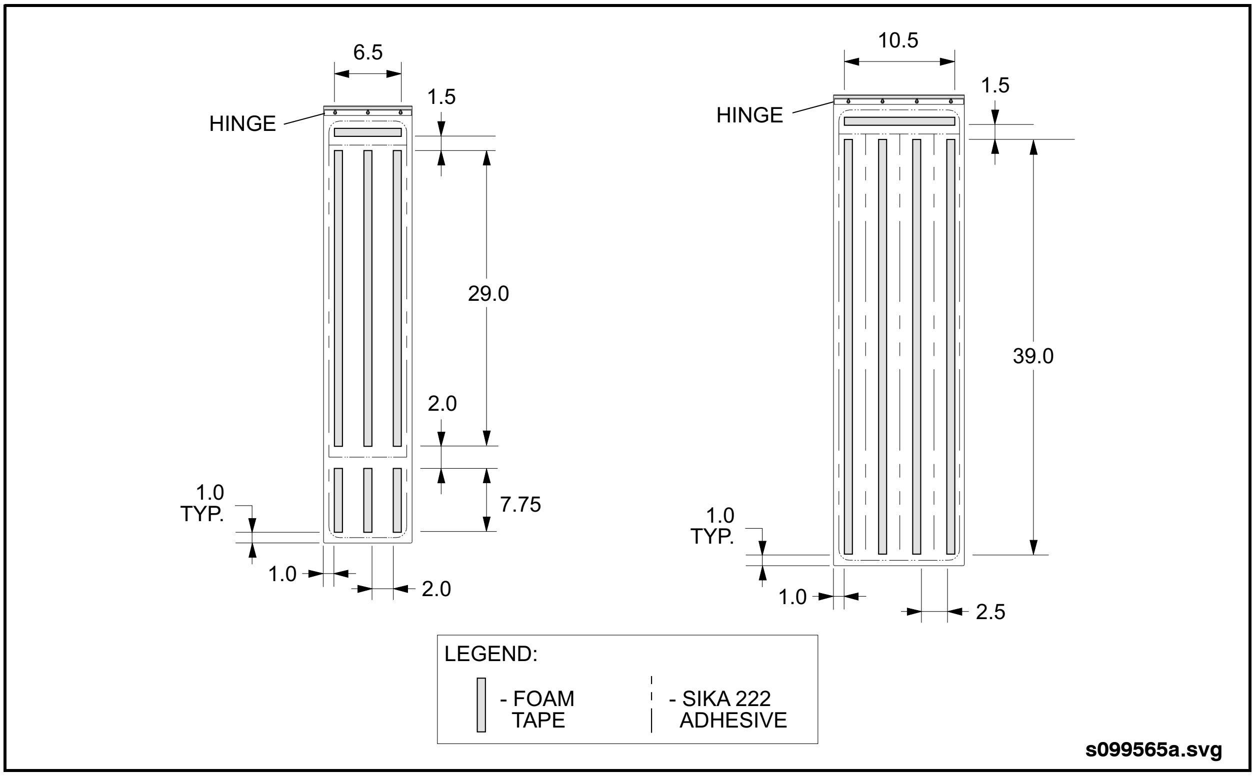


Fig. 14-25: Infill Glazing Seal Installation

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 30.
   - ❒ 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.

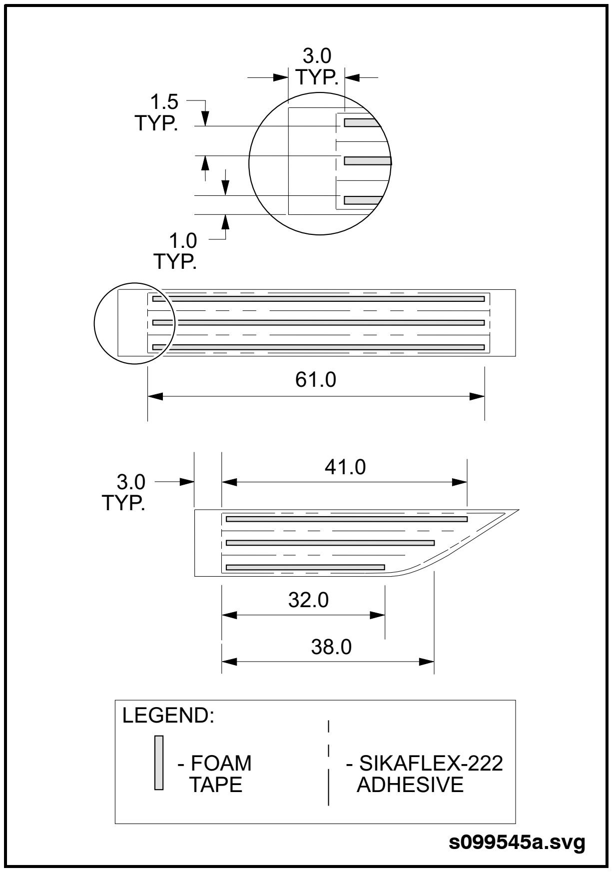


Fig. 14-26: Lower Infill Glazing Seal Installation

2.8. Vandal Shields

2.8.1. 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.

2.8.2. 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. 14-27: Acrylic Shield Removal” on page 31.

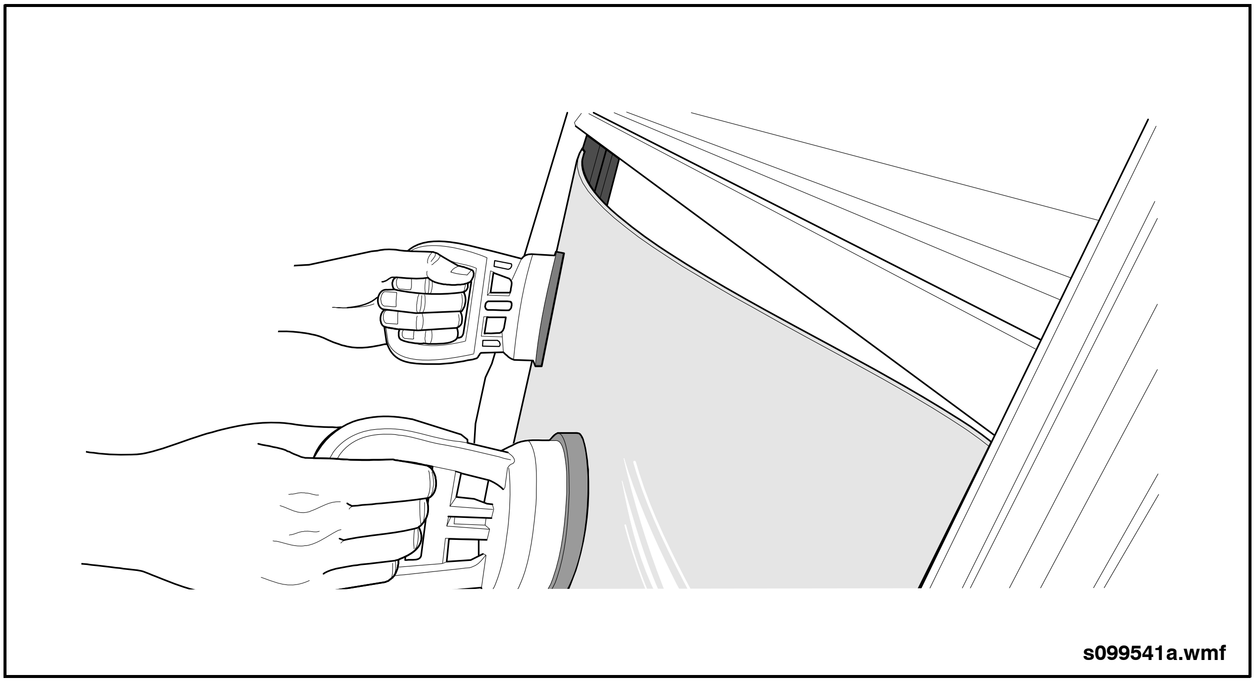


Fig. 14-27: Acrylic Shield Removal

2.8.3. 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.

2.8.4. 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. 14-28: Shield Retainer Rubber Removal" on page 32.
2. Pull the rubber out around the perimeter of the window.
3. Installation is the reverse of removal.

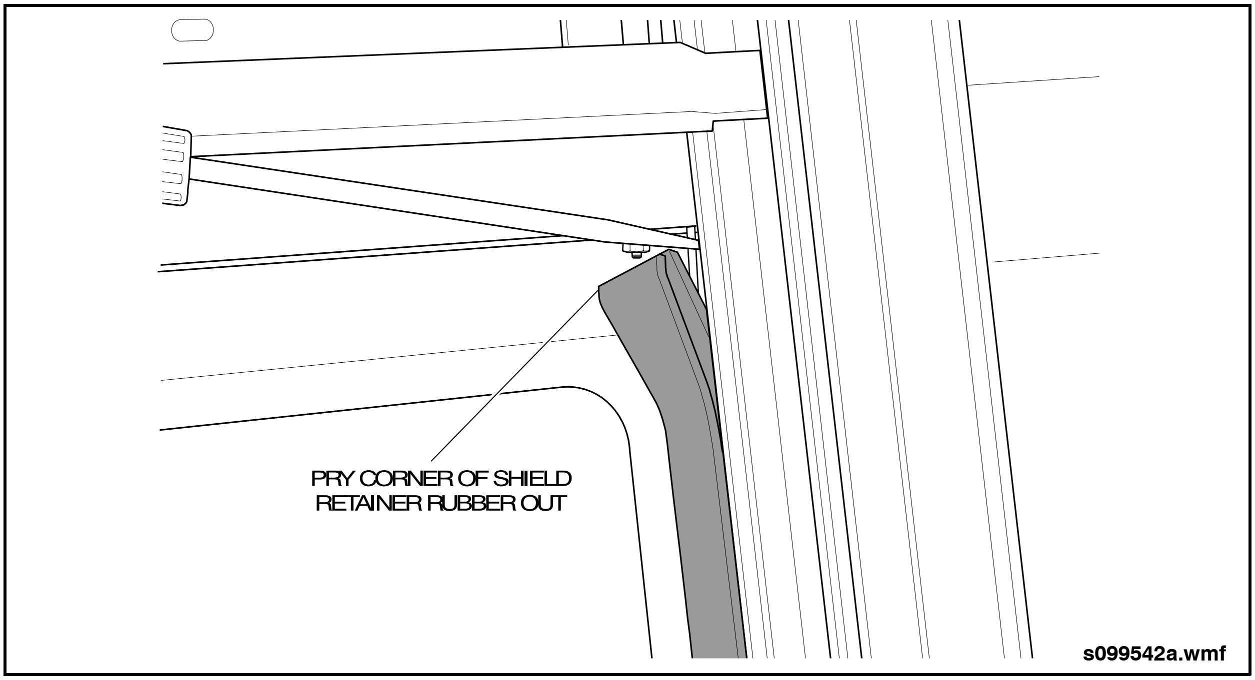


Fig. 14-28: Shield Retainer Rubber Removal

2.8.5. 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.

2.9. Driver's Window Bonding Procedure

2.9.1. Fixed Meet Rail Procedure

1. Refer to 3. “GLASS OFFSET GUIDE” on page 36 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 21 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.

2.9.2. Bonding Driver Frame to Glass

1. Remove the glass. Refer to 2.7.1. “Fixed Glass Removal” on page 19 in this section for procedure.
2. Clean frame and hinge. Refer to 2.7.4. “Frame Cleaning” on page 21 in this section for procedure.
3. Refer to 3. “GLASS OFFSET GUIDE” on page 36 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 21 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 23 in this section for procedure. Allow the hinge to cure for 48 hours.

2.10. 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.

2.10.1. 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.

2.10.2. 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. 14-29: Initial Screw Tightening Sequence” on page 35.
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. 14-30: Final Screw Tightening Sequence” on page 35.

After you complete the window installation, check the operation of window sliders. Verify function of emergency release handle and latches on egress style windows.

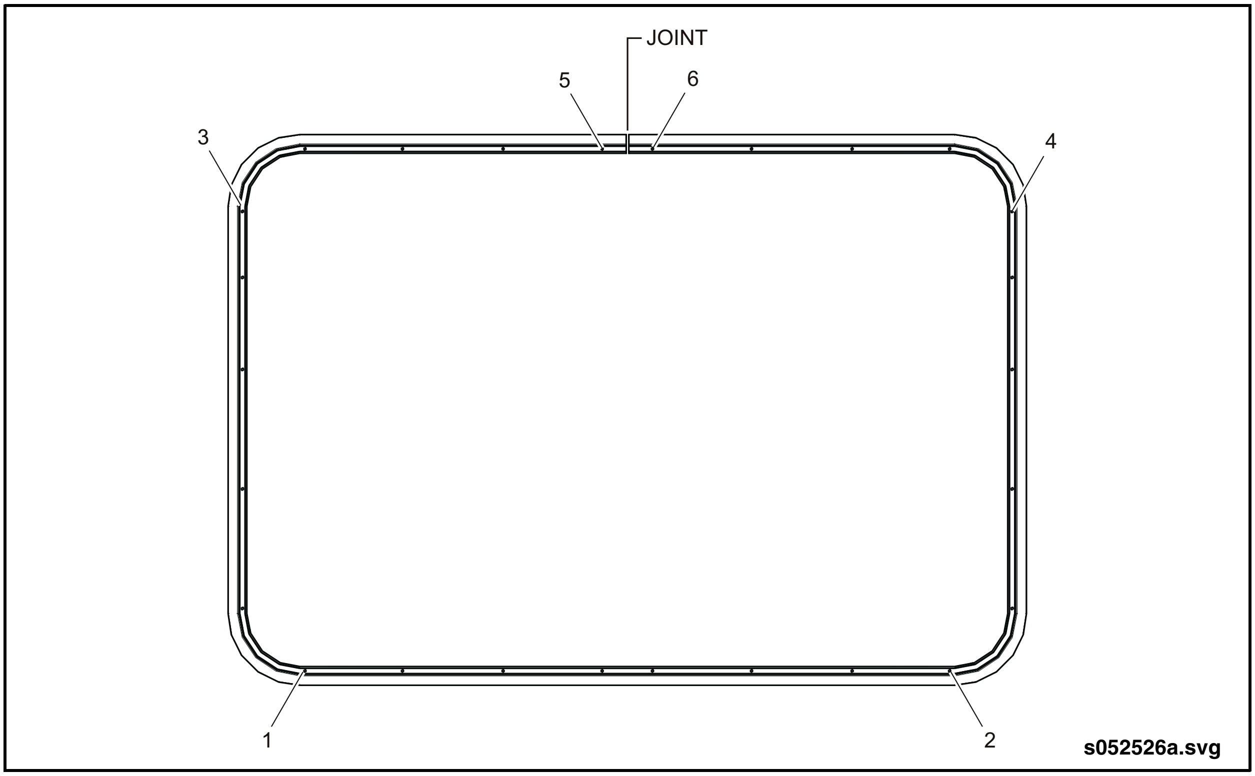


Fig. 14-29: Initial Screw Tightening Sequence

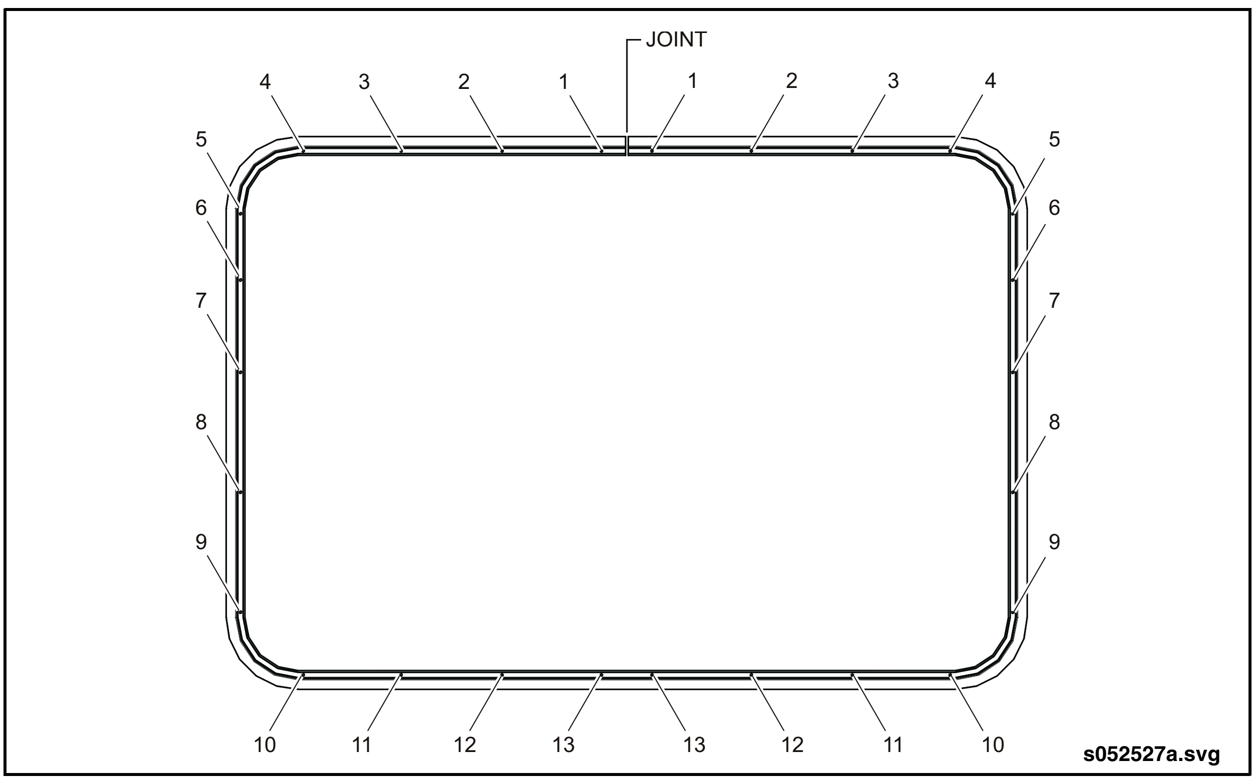


Fig. 14-30: Final Screw Tightening Sequence

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. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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

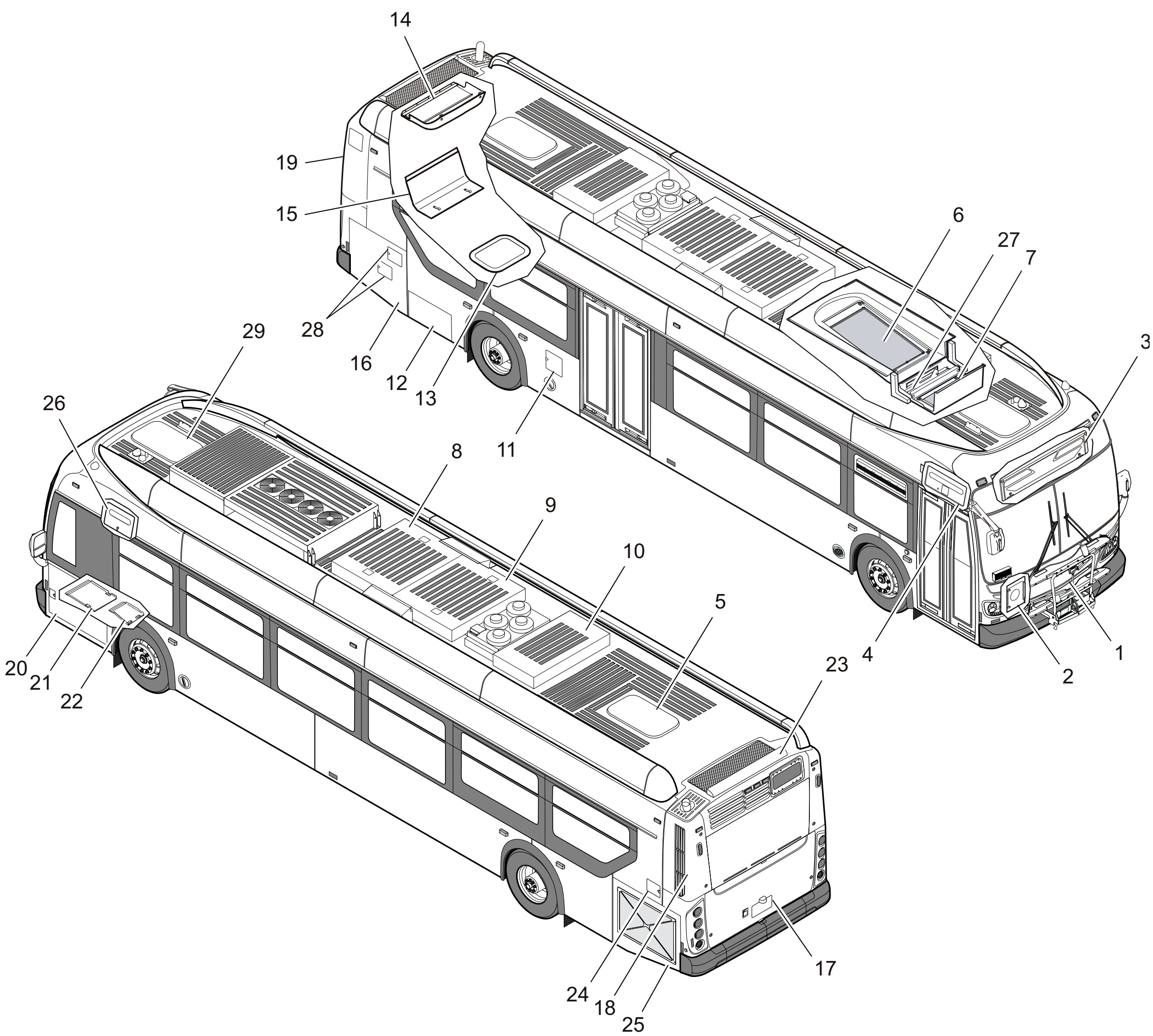
Refer to the Preventive Maintenance Section of this manual for scheduled maintenance requirements on the interior access doors.

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 a gas strut 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. Roof Hatch Assembly
6. Door Assembly, Return Air Grille & HVAC Access
7. Door Assembly, Access
8. Cover Assembly, Hybrid Battery Front
9. Cover Assembly, Hybrid Battery Rear
10. Cover Assembly, DPIM
11. Door Assembly, Fuel Filler Access
12. Door Assembly, Battery Access
13. Door Assembly, Driveshaft Access
14. Door Assembly, Rear Electronic Equipment Access
15. Door Assembly, Transmission/Drive Unit Access
16. Door Assembly, Fusebox Access
17. Door Assembly, Engine Access
18. Door Assembly, Upper Corner Pillar Streetside
19. Door Assembly, Upper Corner Pillar Curbside
20. Door Assembly, Side Console Access
21. Door Assembly, Steering Box Access
22. Door Assembly, Radius Rod Access
23. Panel Assembly, SCR Access
24. Door Assembly, Surge Tank Access
25. Door Assembly, Radiator Access
26. Door Assembly, Driver's Locker
27. Door Assembly, Stop Request Access
28. Door Assembly, Access
29. Roof Hatch Assembly

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Fig. 15-1: Access Door Locations

2.4. Engine & Drive Unit Access

The engine and drive unit 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 seat back is parallel to the floor.
3. Locate the support tube and unlatch it from its storage clip. See “Fig. 15-2: Engine & Drive Unit Access Doors” on page 5.
4. Lower the free end of the tube and index it with the peg on the vehicle structure.
5. Allow the seat to pivot down slightly so the peg engages into the open end of the support tube.
6. Install the safety pin through the cross-drilled hole in the tube and peg to safely secure the seat assembly in the raised position

⚠ WARNING

Ensure the seat assembly is properly secured with the support tube and safety pin is installed to prevent the seat assembly from being lifted further from the raised position. Improper securing of the seat assembly could allow it to fall accidentally while accessing the engine or drive unit and can cause serious personal injury.

7. 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.
8. Carefully lift the door assembly. The will pivot on the piano hinge attached to the upper part of the access opening.
9. Continue pivoting the assembly upwards until the access door back is parallel to the floor.
10. Locate the support tube.
11. Lift the free end of the tube up and index it with the peg on the bottom of the access door assembly.
12. Allow the access door to pivot down slightly so the peg engages into the open end of the support tube.
13. 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 drive unit and can cause serious personal injury.

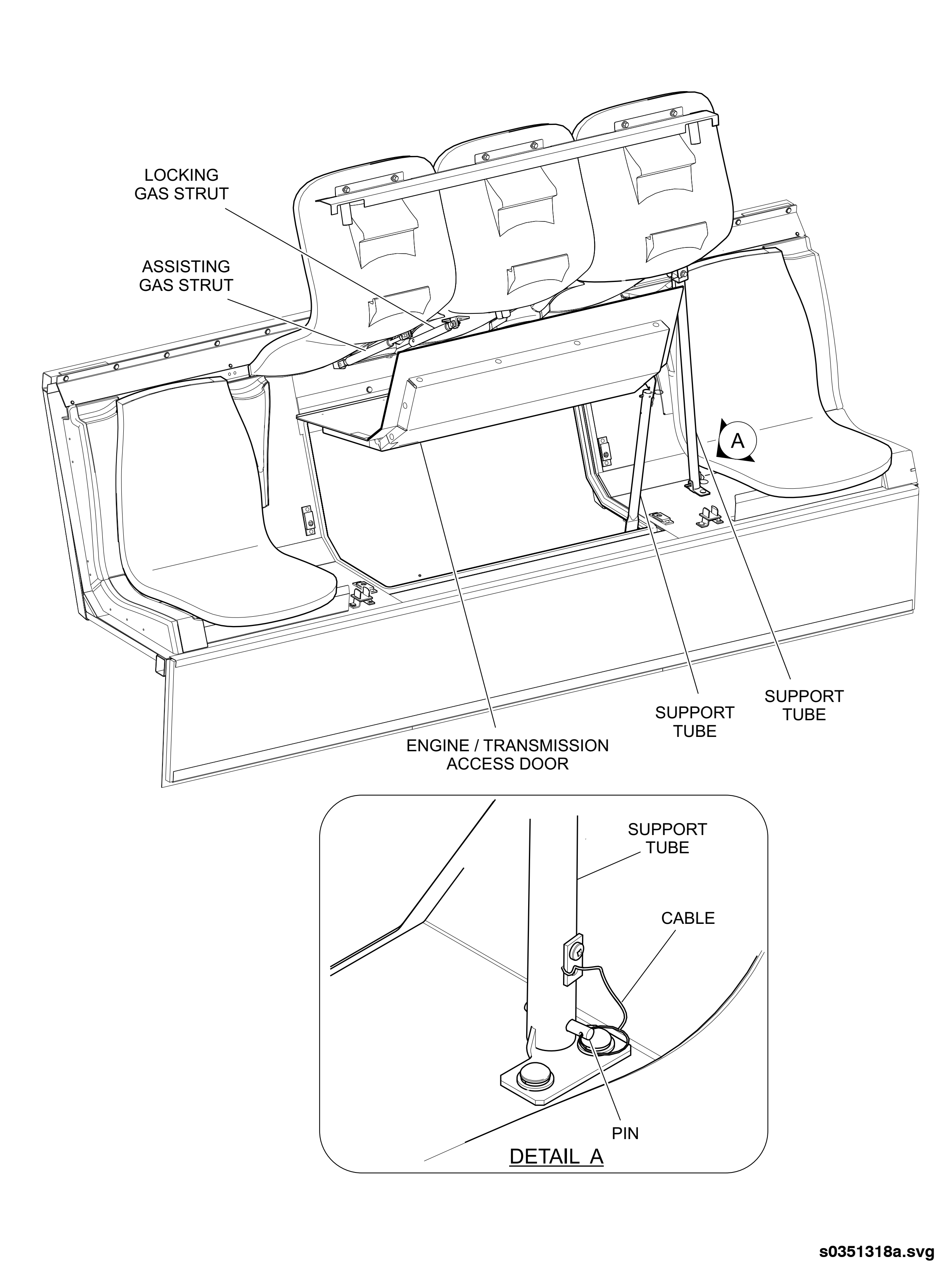


Fig. 15-2: Engine & Drive Unit Access Doors

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 sub-floor 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.

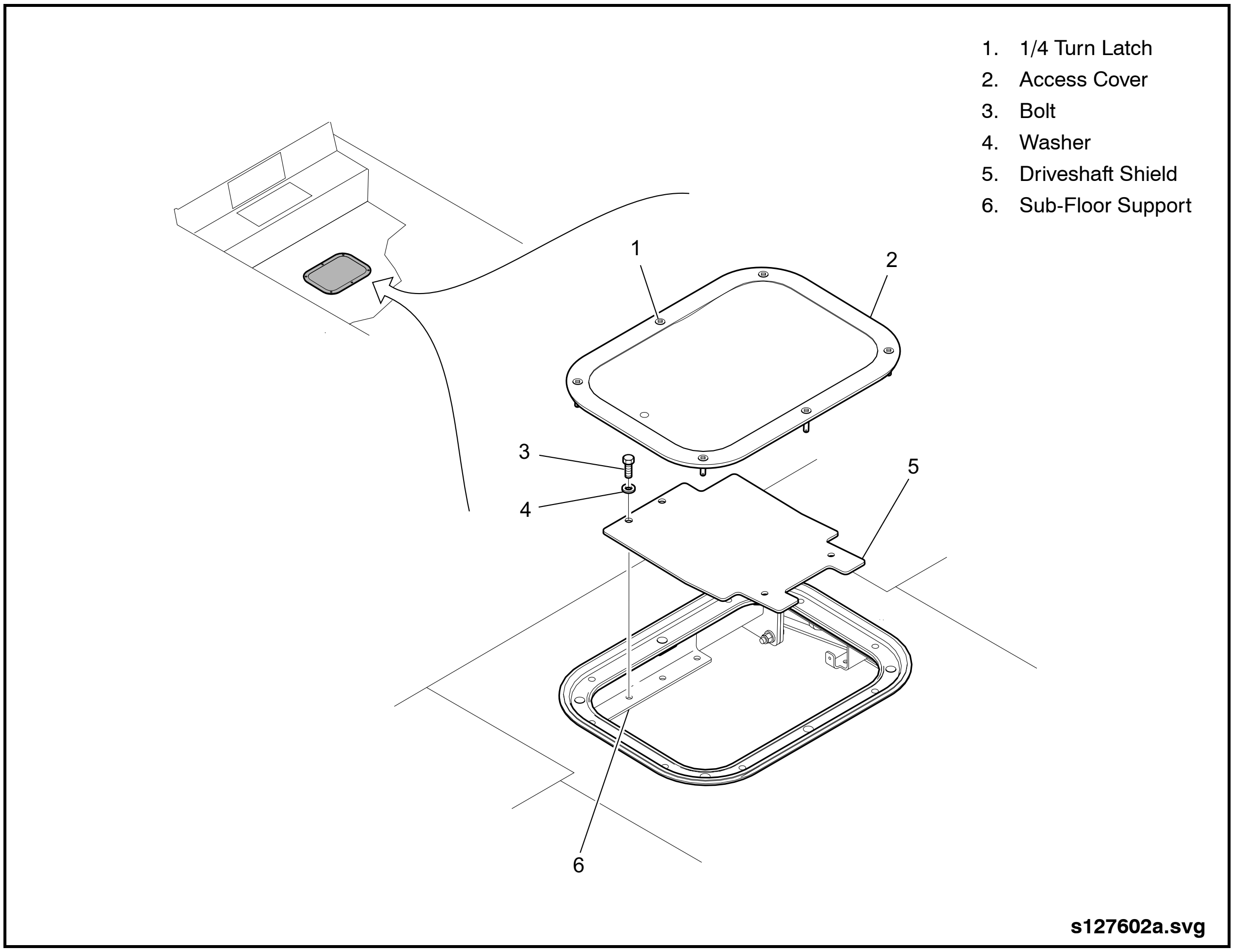


Fig. 15-3: Driveshaft Access

2.6. Return Air Grille & HVAC Access

The interior A/C access door is located in the ceiling of the vehicle. It is secured with square-key quarter-turn latches on the streetside and a concealed hinge on the curbside. See "Fig. 15-4: HVAC Interior Access" on page 7.

The door swings downward to access the HVAC unit return air filter. A detachable lanyard prevents the access door from falling open uncontrollably.

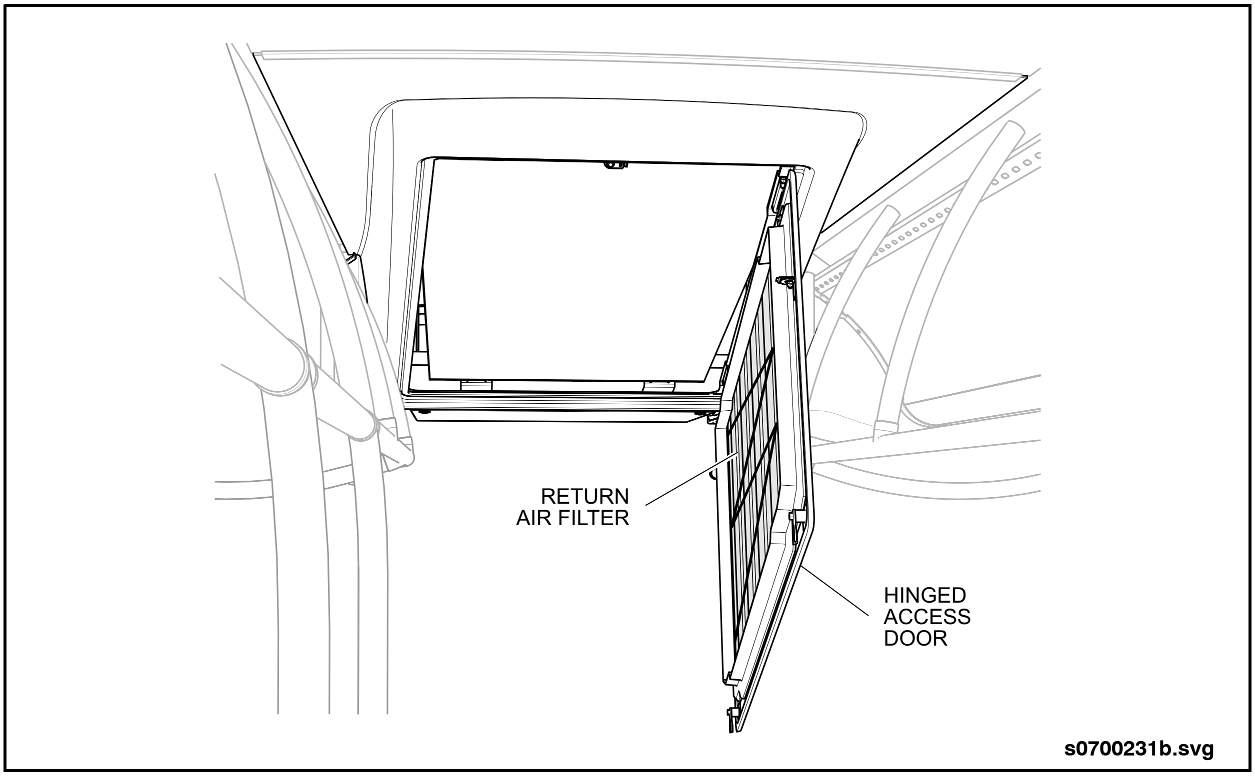


Fig. 15-4: HVAC Interior Access

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 HVAC refrigerant lines and coolant lines. 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, equipped with a quarter-turn latch, 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 back of vehicle. It serves to provide access to the hydraulic reservoir, alternator, engine assembly and engine switch panel. This door is equipped with two gas struts to support the door and is held closed with streetside paddle latch.

3.9. Fuel Filler Access

The fuel filler access door is located on the curbside near the center of the vehicle. This door allows access to the fuel tank for filling and maintenance inspection. The door is spring-loaded to remain either open or 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. Diesel Exhaust Fluid Fill Access

The diesel exhaust fluid fill door is a small hinged door mounted in the rear of the fuse box access door. It is held open and closed by a gas strut.

3.13. Selective Catalytic Reduction (SCR) Access

The SCR access is a roof mounted perforated panel at the rear of the vehicle. Removing this panel allows access to the exhaust system components and plumbing. It is held in place with bolts at the rearward edge and nuts at the forward edge. Remove the screws and bolts, retaining all fasteners for reassembly, and lift the access panel to clear the threaded studs on the vehicle structure at the forward edge.

☞**NOTE:**

The SCR access incorporates a directional contoured "Air Scoop" to provide air flow to the SCR components.

3.14. 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.

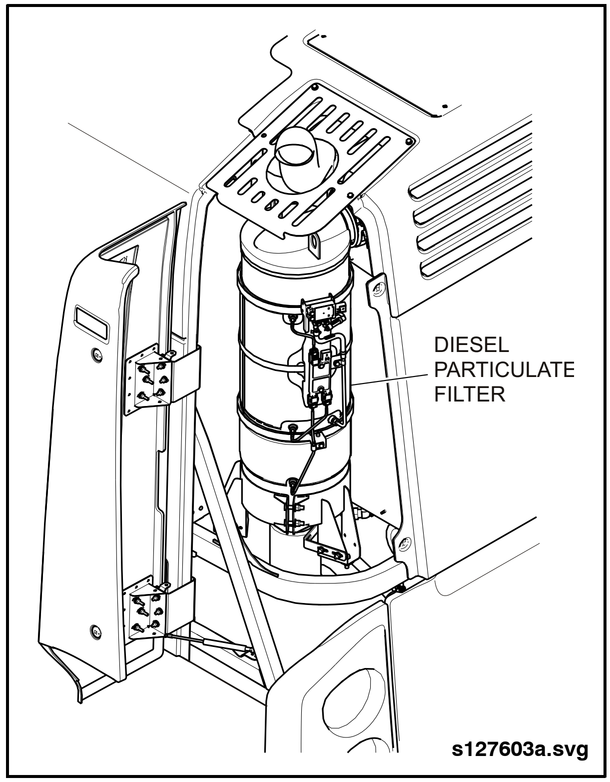


Fig. 15-5: Streetside Corner Pillar

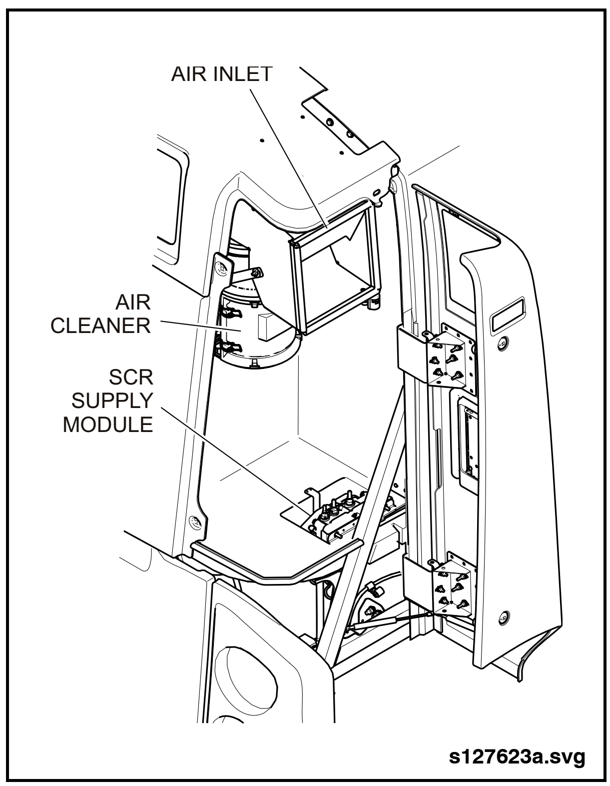


Fig. 15-6: Curbside Corner Pillar

3.15. Hybrid Battery Access

The front and rear hybrid battery access panels are located on the roof directly above the hybrid battery pack. They are fastened to the hybrid battery pack mounting structure with bolts, nuts and washers. The covers have holes to allow access to the lifting hooks.

☞**NOTE:**

It is not necessary to remove these covers during hybrid battery pack installation or removal.

To remove the covers:

1. Remove the small covers on the streetside and curbside of the hybrid battery pack, retaining all hardware for reassembly.
2. Remove the front and rear hybrid battery access covers, retaining all hardware for reassembly.

3.16. DPIM Access

The Dual Power Inverter Module (DPIM) access door is located on the roof of the vehicle directly above the DPIM. This access door is secured with square-key quarter-turn latches on the rearward edge. It is hinged and pivots upward to allow access to the DPIM.

4. ROOF VENT/HATCHES

4.1. Description

Two multi-position glass hatches are located on the roof. These hatches can be opened to allow fresh air into the vehicle and in an emergency the vents can be used as escape exits.

4.2. Operation

4.2.1. 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.

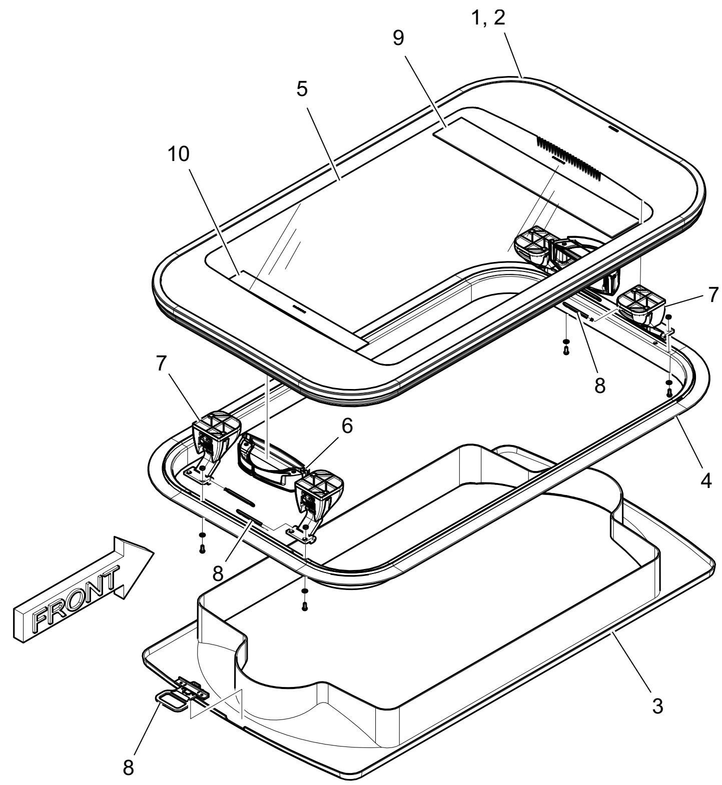
4.2.2. Emergency Exit

The roof hatch functions as an emergency exit and is identified by decals on the hatch panel. Proceed as follows to operate the emergency exit:

1. Pull the red handle at the rear of the hatch to release the locking mechanism. The handle is attached to a cable which will release the retaining pins from the rear hinge. See “Fig. 15-7: Roof Vent/Hatches” on page 13.
2. Push upward on the rear section of the hatch, allowing it to swing fully open on the front hinges.

☞**NOTE:**

If the emergency handle was activated, reinstall the retaining pins into the release hinges.



1. Roof Hatch Assembly, (Incl. 2...10)
2. Roof Hatch Assembly, (Incl. 3...8)
3. Inner Frame
4. Outer Frame
5. Glass Dome
6. Handle
7. Mechanism
8. Emergency Release Unit
9. Decal, Emergency Exit
10. Decal, Pull Red Handle

s033547a.svg

Fig. 15-7: Roof Vent/Hatches

4.3. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled maintenance requirements.

4.4. 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. Remove the interior trim ring by pulling one side in and down. Remove the screws and washers retaining the emergency release handle to its mounting bracket.
2. Use a utility knife to carefully cut through the adhesive around the perimeter of the hatch. Ensure the knife blade is parallel to the roof and extends under the mounting flange to completely break the seal.
3. Carefully pry the hatch up from the opening and remove.

4.5. 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. Clean the rooftop opening. Remove any excess sealant or other contaminants.
2. Apply Sika 221 Adhesive to the perimeter of the hatch mounting flange and press the hatch into the opening.
3. Mount the release handle to the mounting bracket.
4. Install the interior trim by clipping one side in and pushing the opposite side until it also clips into place.

☞**NOTE**

This installation requires an assistant, if sealant has not been allowed to cure. Press the hatch down from the roof side while the interior trim is being installed.

5. Allow the Sika adhesive to cure for 12 hours before placing the vehicle into service or exposing it to the elements.

Entrance & Exit Doors

1. SAFETY

1.1. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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.

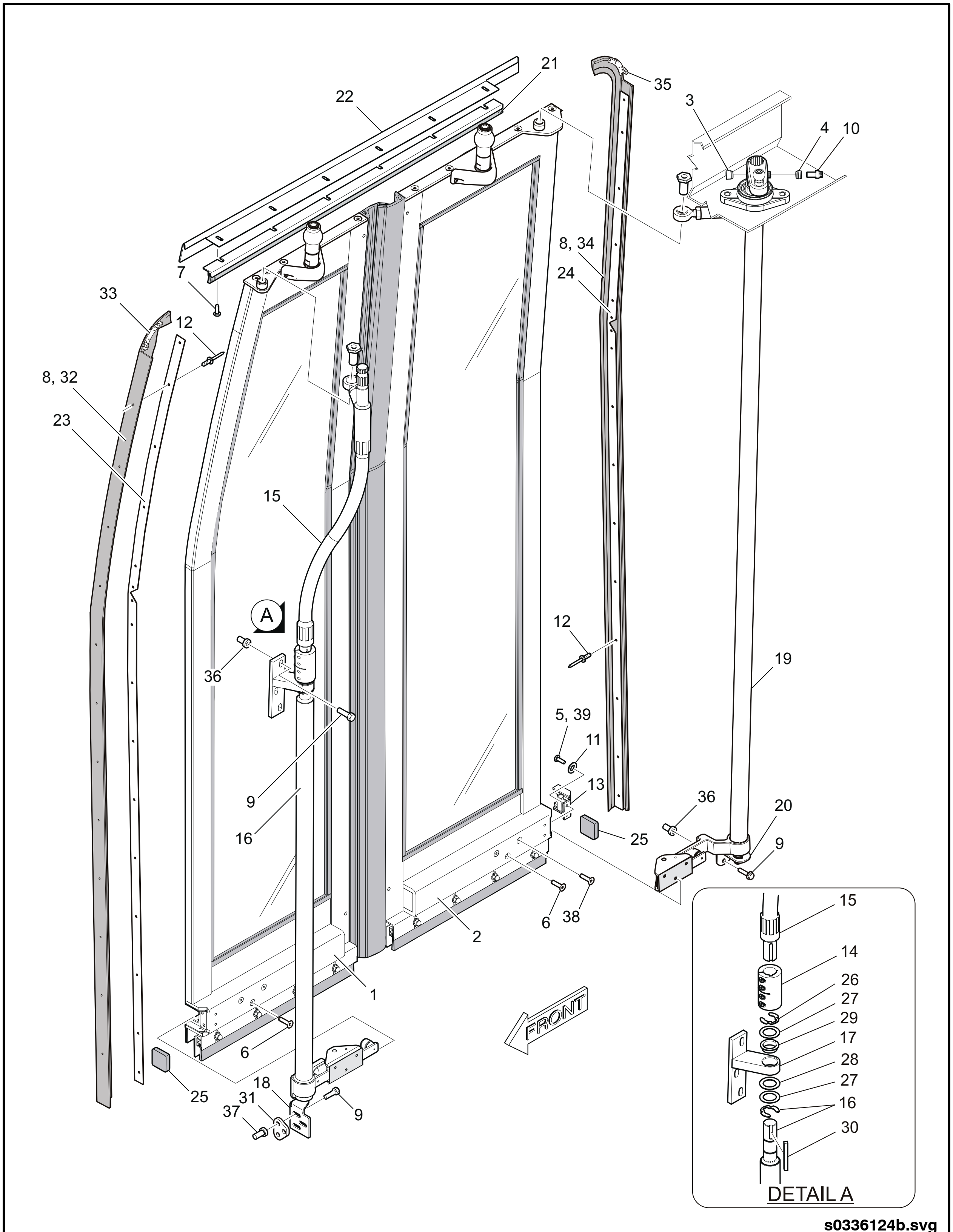


Fig. 16-1: Entrance Door

2. VAPOR/NFI SLIDE GLIDE ENTRANCE DOOR

2.1. Description

The Vapor/NFI slide glide entrance door is air operated by a minimum of 85 psi from the vehicle accessory air tank. The door system consists of a differential door motor mounted horizontally on a shelf plate above the door panels. The motor, 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 and the tops of the door panels.

The slide glide door is held in the open or closed position by means of air pressure. When air pressure is not present, the doors will remain open or closed and may be pushed to either position by hand.

Two Limit switches activated by the door cycling mechanism are used as 85° and 5° Limit switches.

A pressure switch is teed into the air supply line of the door motor and is used by the vehicle Multiplexing System to confirm operating pressure at the entrance door.

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 3/4" 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. Screw, 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 1.00" Ext
27. Washer, Special 1.50" x 1.00"
28. Washer, Thrust 1.50" x 1.00"
29. Bearing, Door Shaft Fore
30. Key, Square 1/4" SST
31. Spacer, Entrance Door Pivot
32. Seal, Door Jamb Fore (Incl. 33)
33. Bracket, Jamb Seal
34. Seal, Door Jamb Aft (Incl. 35)
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" Black
39. Loctite, 24

Entrance Door (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, or by opening the entrance door.

2.2.2. Throttle Interlock

The throttle (accelerator) interlock is activated by opening or authorizing a door 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. Opening Cycle

When the slide glide door is closed air pressure from the vehicle accessory tank maintains constant pressure to both cylinder chambers on the differential door motor. When the door control valve is placed in the open position, air pressure is allowed to bleed off the large cylinder in a controlled rate of flow through cylinder adjusting ports and back through the exhaust ports at the base of the control valve.

At a predetermined point in the opening cycle, horizontal movement of the rack and piston assembly closes off the primary air exhaust port by action of the seal cushion. The greater pressure in the smaller cylinder causes the movement of the piston in the large cylinder to compress the remaining air which is bleeding off more slowly through the cushioning speed port. This compressing action provides the means of controlling the opening action of the motor, thus preventing the door panels from slamming open. As the doors are fully opened, the remaining air pressure in the large cylinder is slowly depleted through the cushioning speed port and out through the control valve exhaust port.

As the smaller cylinder air pressure causes the piston to move, a rack gear, attached between both pistons, meshes and rotates with a gear which converts the inline piston motion into rotary motion necessary for operation of the lever/push rod assembly. Rotation of the lever causes the push rod assemblies to move against the levers splined to the top of the shaft and arm assemblies.

The door motor forces the levers to rotate the shaft and arm assemblies which are vertically mounted between the floor and shelf plate. The shaft and arm assemblies are located at the base by pivot bearings on two mounting place weldments. The splined stub shafts of the shaft and arm assemblies extends through the base plate and rotates on roller bearings housed in the plate. The roller bearings support the shaft and arm assemblies.

The door panels are each attached in three places to the door mechanism. The linkage arms of the shaft and arm assemblies are a strap hinge configuration and are attached in two places. They are attached to the outer jam edge of the fore and aft door panels. A roller guide pivot point at the top of the doors is the third attachment. As the shaft and arm assembly rotates to the open position the arms move inward pushing the trailing seal of the doors inside the vehicle. The roller guide pivot point slides inside a guide in the mechanism's base plate allowing the doors to turn 90°. The panels come to rest flat against the sides of the entrance/exit way inside the vehicle.

2.3.2. Closing Cycle

In the door closing process, air pressure is admitted through the opening speed port cavity which was sealed by the seal cushion. The cavity is opened and the main area of the large cylinder begins to fill with air. Due to the larger piston area in the cylinder, the net force difference causes the rack to move in the closing direction, thus closing the doors as described in the door opening cycle description. The door panels are held closed by air pressure.

2.4. Maintenance

2.4.1. Air Line Tubing & Fittings

Air pressure is provided to the door motor through 5/16" black flexible air brake tubing.

CAUTION

Flexible air line tubing has a nominal wall thickness of 0.040" and must not be forced into a minimum bend radius of less than 1 1/4" or kinking and damage may occur.

The air lines are fitted with compression fittings that are easily replaced as required.

The tubing is protected, where required, by a sheath of black loom. The loom is both flexible and weather resistant.

2.4.2. Air Line Replacement

The air line must be assembled by installing end fittings onto the tubing. No special tools are required.

1. Cut the 5/16" diameter tubing to the required length.
2. Place the nut and sleeve over the tubing.
3. Slide the insert inside the tubing end until flange meets the tubing.
4. Connect tubing nut to the component mating fitting and tighten.
5. Install nut, sleeve, and insert, at opposite end of line as required.

Ensure that there are no kinks in the tubing when it is installed. Avoid using welding torches in the vicinity of air line tubing. Spare tubing should be stored in clean surroundings with ends plugged.

2.5. 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. 16-2: Entrance Door Adjustment Points” on page 7.

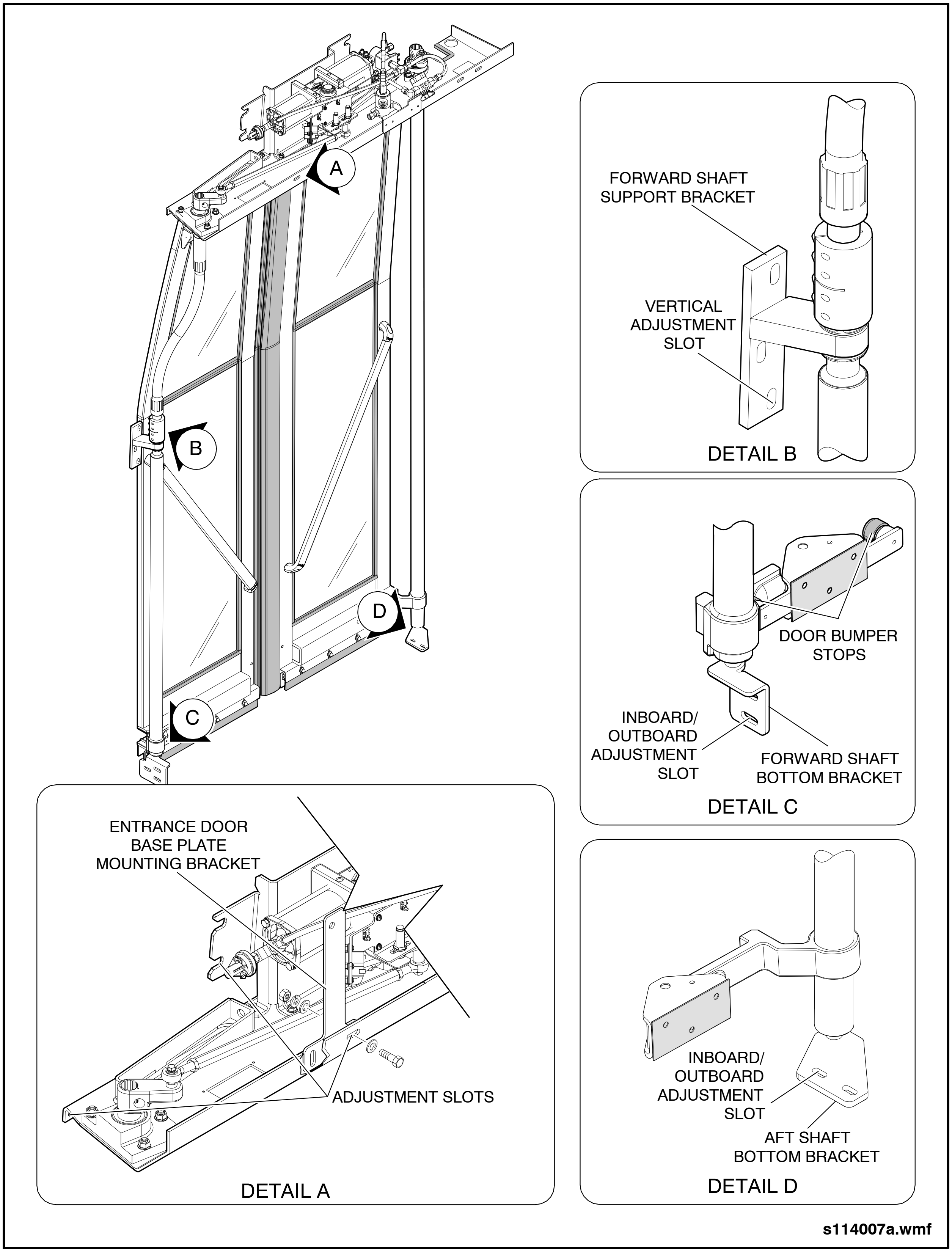


Fig. 16-2: Entrance Door Adjustment Points

2.5.1. 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. Exhaust all air from system using base plate dump valve.
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 4.12" ± 0.12" 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.

2.5.2. Door Panel Height Adjustment

The height of each panel must be adjusted to allow light contact (maximum 0.030") 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 0.030" 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. 16-3: Timing Marks” on page 9.
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.

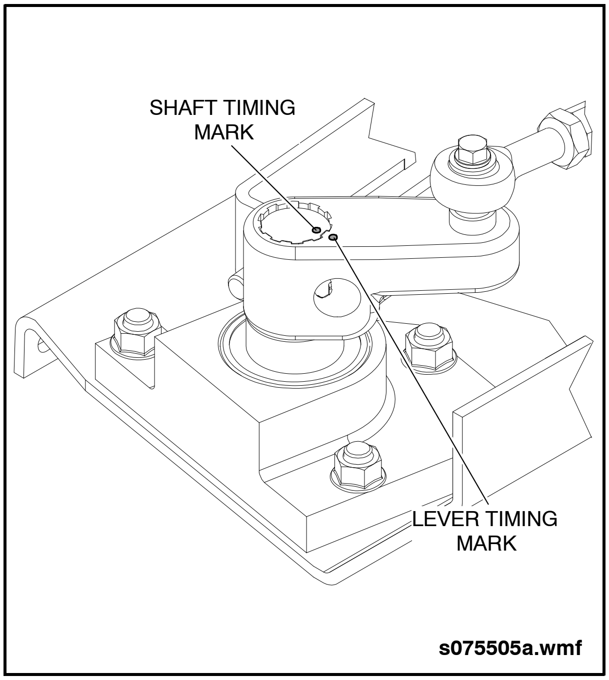


Fig. 16-3: Timing Marks

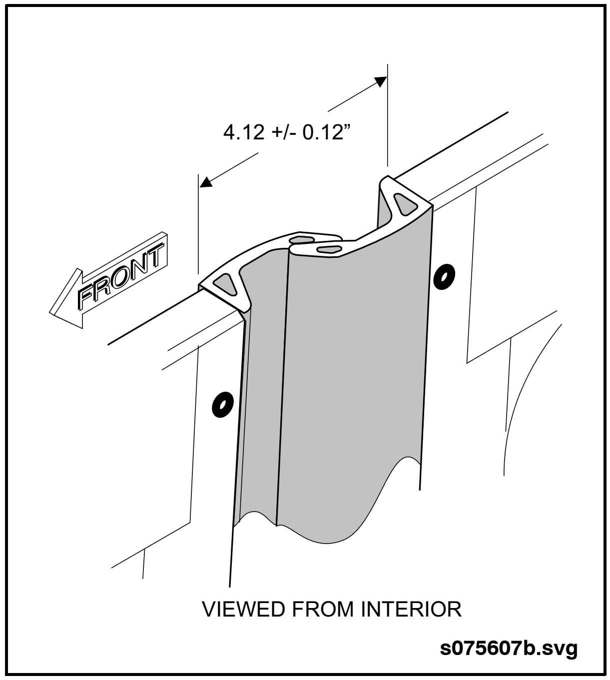


Fig. 16-4: Door Closure Adjustment

2.5.3. 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. 16-4: Door Closure Adjustment" on page 9.
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.

2.5.4. 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.

2.5.5. Connecting Rod Adjustment

1. Ensure door panels are closed.

WARNING

Make sure door operator linkage is clear. Remove hands from within door operator compartment.

2. Apply air to system by turning on the manual dump valve.
3. Verify that the door engine teeter lever is in its fully closed position.
4. Loosen connecting rod bearing locking nuts located on each end of both connecting rods.
5. Connect aft panel connecting rod to corresponding pin on teeter lever. Lengthen or shorten connecting rod to bring aft panel to its fully closed position. Shorten connecting rod by rotating it approximately one full turn to achieve an acceptable door closed preload. Ensure teeter lever has not rotated from its fully closed position during this process.
6. Connect fore panel-connecting rod to corresponding pin on teeter lever. Lengthen or shorten rod assembly to bring the fore panel to its fully closed position. Shorten fore panel connecting rod by approximately one full turn to achieve an acceptable door closed preload. Ensure teeter lever has not rotated from its fully closed position during this process.
7. Verify door panels are properly preloaded in the closed position with air pressure applied. Ensure leading edge seals mate properly with little or no gap between the overlapping edges. If necessary, make minor adjustments to the lower pivots to compensate for the affects of preload.
8. Open the doors under power. Verify that door panels open fully and are preloaded in the open position. Adjust connecting rods as required to fine tune.
9. Close the doors under power. Door panels should close smoothly without excessive rubbing or interference between leading edges. If leading edge interference occurs, lengthen fore panel rod slightly or shorten aft panel rod slightly. Reverify door opened and closed preload. Tighten connecting rod locking nuts on each end to secure adjustment.

2.5.6. 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.

2.5.7. 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.

2.5.8. Door Speed Adjustments

The pneumatic door operator is equipped with a built-in cushioning feature which produces smooth door operation in the opening direction. A speed control fitting at the end of the large cylinder regulates the speed of the operator operation and cushioning. Initially the closing speed adjusting screw is set to 0.25" ± 0.03" above the top of lock nut and the opening speed adjusting screw is set to 0.31" ± 0.03" above the top of the lock nut.

☞**NOTE:**

Initial opening and closing adjustments can also be obtained by lightly seating the adjustment screw and then backing out the screw 1 1/2 turns. Initial cushioning adjustment can be obtained by lightly seating the adjustment screw and then backing out the screw 1/2 turn.

When making adjustments, always adjust the closing speed first since this adjustment also affects the door opening speed.

⚠ **WARNING**

Closing speed should be adjusted to ensure 3 to 3.5 seconds of time between initiation of closure and full door closed position.

Door closing speed must fall between 3 seconds and 3.5 seconds during all pressure possibilities between 131 psi and 95 psi. If door is adjusted at highest normal pressure, speed will decrease when lower pressure is available. Adjustment must be made to be acceptable to individual transit authority requirements at average operating air pressure so that speed does not become faster than 3 seconds at 131 psi.

⚠ **CAUTION**

NEVER force adjusting screws when adjusting in a clockwise direction. Excessive tightening pressure (metal-to-metal) will damage the operator cylinder cap.

To increase the door closing speed, loosen the lock nut which secures the closing speed adjusting screw and turn the screw outward. To decrease the closing speed, turn the screw inward. Tighten the lock nut to maintain this adjustment.

Adjust opening speed to ensure 2.5 to 3 seconds between initiation of opening and door fully opened position.

To increase the door opening speed, loosen the lock nut which secures the opening speed adjusting screw and turn the screw outward. To decrease the speed, turn the screw inward, Tighten the lock nut to maintain this adjustment.

To adjust the cushioning during the opening cycle, loosen the lock nut and carefully adjust the opening cushion screw. Be sure to tighten the lock nut after making the adjustment.

2.6. Emergency Air Release Valve

2.6.1. Description

A red handled rotary valve is used to pressurize and vent the air supply from the lines and air cylinder of the door system. The valve can be used to quickly exhaust the air from the door circuit, should an emergency arise, or during service procedures. The entrance door valve is located above the door, behind a hinged access door and a frangible panel marked for emergency use. The exit door uses an emergency release valve which is located beside the door also behind a frangible cover. The door manual control valve located on the vertical face of the side console panel may be used by the driver or service personnel to perform the same function without necessitating the opening of the hinged access doors.

2.6.2. Operation

When handle is in the normal position, the supply air flow enters open Port No. 4, and exits out Port No. 2, to the door supply lines. When handle is turned 90° to the emergency position (1/4 turn counterclockwise) the supply air flow is blocked and the door system lines are vented to atmosphere through Port No. 1.

With air exhausted from door motor and lines, the door panel may be opened and closed manually as required.

2.6.3. Removal

1. Open accessory tank drain valve, to vent air to atmosphere.
2. Access emergency valve; mark, loosen and remove the supply lines from valve.
3. Loosen and remove the two mounting screws and nuts.
4. Lift valve away from bracket.
5. Remove fittings from supply ports to be used on replacement valve.

2.6.4. Installation

1. Position valve in place on top of bracket and secure with mounting hardware. Ensure proper orientation.
2. Connect the air line from accessory tank to Port No. 1 and air line from throttle valve to Port No. 2.
3. Ensure valve handle is in the exhaust position.
4. Close accessory tank drain valve and charge the air system.
5. When tank is fully charged, place emergency valve to the normal position; this will energize the door motor circuit.
6. Check all valve fittings for air leaks using a soap and water solution.

2.6.5. Maintenance

The emergency release valve is considered non-serviceable and cannot be adjusted. Valve must be checked regularly for proper operation and leakage. Any defect requires that the valve be replaced as a unit.

2.7. Door Manual Control Valve

2.7.1. Description

During a reduction in operating air pressure, or for servicing, the door panels may be manually opened by exhausting the air from the door motor circuit. 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.

2.8. Entrance Door Switch Plate & Proximity Switches

2.8.1. Description

The door mechanism is equipped with two proximity switches (LS1 & LS2) that are mounted on the inboard face of the door motor plate. The switches are mounted on the front of the entrance door operator.

2.8.2. Operation

Opening or closing the door causes the gear rack on the door motor piston to drive the output shaft gear and rotate the output shaft (teeter) lever. An actuating cam is attached to the output shaft lever. As the door approaches the fully opened position, the actuating cam will actuate the LS2 proximity switch. This switch is referred to as the 85° limit switch and is used by the vehicle Multiplexing System to recognize a "door open" condition. As the door approaches the fully closed position, the actuating cam will actuate the LS1 proximity switch. This switch is referred to as the 5° limit switch and is used by the vehicle multiplexing system to recognize a "door closed" condition.

2.8.3. Removal

☞**NOTE:**

The door proximity switches are non-repairable and must be replaced as an assembly.

1. Set the Battery Disconnect switch to the OFF position.
2. Open the access door to the entrance door mechanism.
3. Use the rotary dump valve to remove air pressure from the door motor.
4. Tag and disconnect the electrical leads from the switches.
5. Remove the switch from the door operator. front plate. See "Fig. 16-5: Entrance Door Base Plate" on page 14.

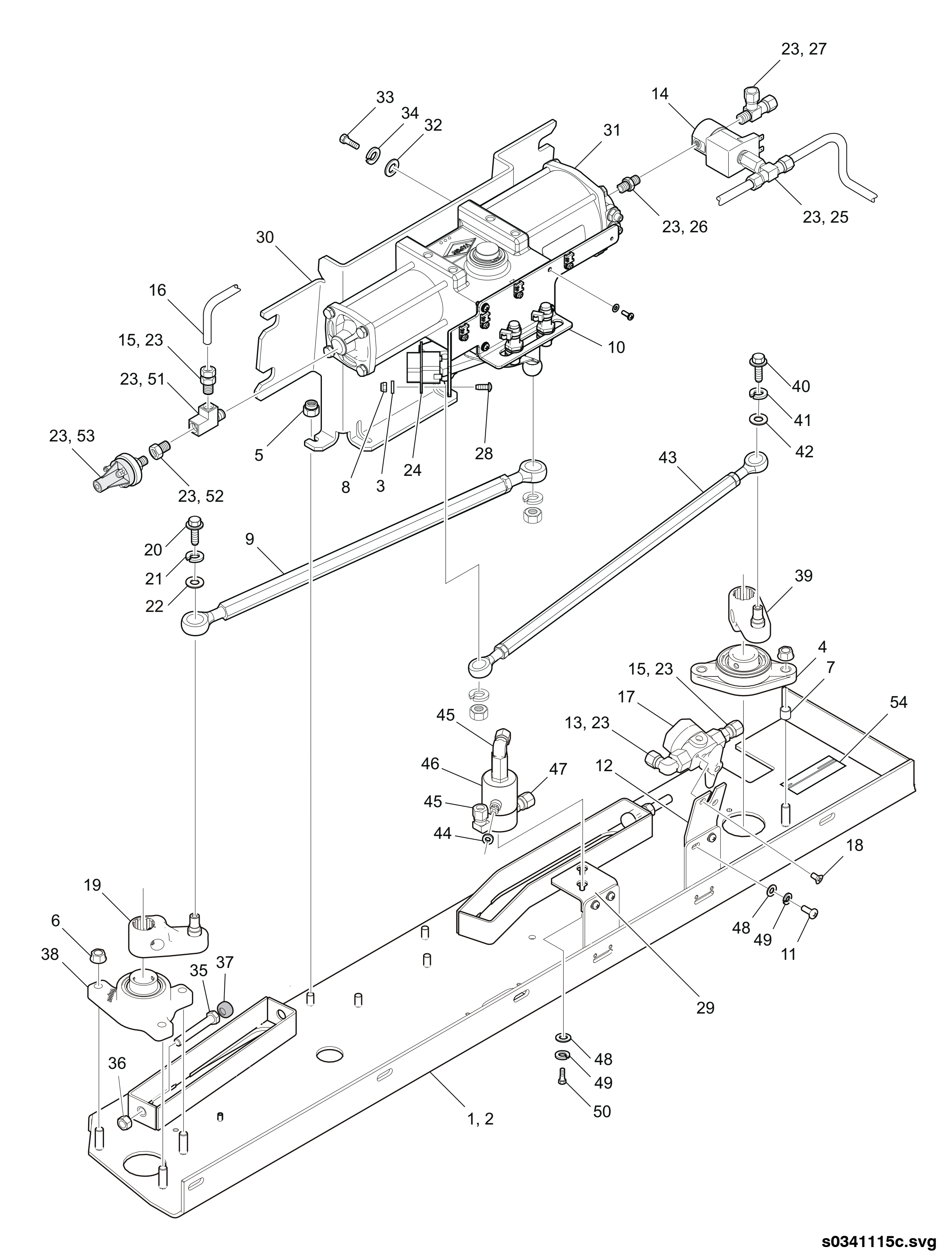


Fig. 16-5: Entrance Door Base Plate

1. Base Plate Assembly, Entrance Door (Incl. 2-19, 23-39, 43-54)	28. Screw, PH #8 - 32 x 1/2" Lg.
2. Base Plate, Welded	29. Bracket, Mag Valve
3. Washer, Plain #8 - .375" O.D. x .032" Thk.	30. Plate, Door Operator
4. Bearing, Ball	31. Door Operator Assembly
5. Nut, Hex Locking 5/16" - 18 UNC	32. Washer, Plain 3/8" - .813" O.D. x .065" Thk.
6. Nut, Hex Locking 3/8" - 16	33. Screw, Locking Torque Patch
7. Bushing, 3/8" I.D. x 1/2" O.D.	34. Washer, Lock Special 3/8" - .141" W x .094" Thk.
8. Nut, Hex Locking #8 - 32 UNC	35. Screw, Hex HD Cap 3/8"
9. Connecting Rod Assembly	36. Nut, Hex 3/8" - 16 UNC
10. Proximity and Connector Assembly	37. Cap, Neoprene
11. Screw, Pan HD Recess #10	38. Bearing, Block
12. Bracket, Rotary Valve	39. Lever Assembly, Door Shaft (Incl. 40-42)
13. Elbow, Nylon Tube Fitting Brass 3/8"	40. Screw, Locking Torque Patch
14. Mag Valve	41. Washer, Lock 1/4"
15. Connector, Nylon Tube Fitting Brass 3/8"	42. Washer, 1/4" - .562 O.D. X .049 Thk.
16. Tubing, Nylon	43. Connecting Rod Assembly
17. Air Cock Assembly	44. Washer, Lock Int. #10
18. Screw, Flt HD Rec #8 - 32 UNC x .31" Lg.	45. Fitting, Tube
19. Lever Assembly, Door Shaft (Incl. 20-22)	46. Valve, Solenoid
20. Screw, Locking Torque Patch	47. Connector, Male 3/8"
21. Washer, Lock 1/4"	48. Washer, Plain #10 - .438" O.D. x .032" Thk.
22. Washer, 1/4" - .562 O.D. X .049 Thk.	49. Washer, Lock #10
23. Sealant, Teflon	50. Screw, Hex Head TRM #10
24. Harness, Wiring	51. Tee, Pipe Fitting Brass 1/4"
25. Tee, Nylon Tube Fitting Brass 3/8"	52. Fitting, Pipe w/Brass Bushing 1/4"
26. Fitting, Pipe 1/4"	53. Switch, Pressure
27. Connector, Nylon Tube Fitting Brass 3/8"	54. Label Identification

Entrance Door Base Plate (parts list)

2.8.4. Installation

1. Install the switch into the front plate of the door operator.
2. Adjust switch position. Refer to 2.8.5. “Proximity Switch Adjustment” on page 15 in this section for adjustment procedure.

2.8.5. Proximity Switch Adjustment

Adjust the distance between the switch and the teeter plate to ensure correct actuation of the entrance door. Ensure the following conditions are met prior to proceeding with adjustments:

❒ Using a digital multimeter (DMM), verify each proximity switch is receiving power and ground.

❒ Open the hinged access panel above the entrance door and operate the emergency release control to exhaust air from the door system.

1. Manually move door panels to the fully closed position and ensure output lever is rotated fully clockwise (as viewed from the bottom looking up).
2. Use a feeler gauge to measure gap between teeter lever and bottom of the LS1 proximity switch. Loosen switch lock nuts as required and adjust switch to obtain a gap of 0.080 ± 0.010 inches (2.00 ± 0.13 mm) (Dim “A”). See “Fig. 16-6: Proximity Switch Adjustment” on page 16.
3. Manually open the door and ensure the output shaft is rotated fully counter-clockwise as viewed from the bottom looking up. The LS2 proximity switch should actuate just prior to the door being fully opened, and remain actuated with the door fully open, illuminating the LED light at the rear of the switch. This actuation point is referred to as 85° open.

4. Use a feeler gauge to measure gap between teeter lever and bottom of the LS2 proximity switch. Loosen switch lock nuts as required and adjust switch to obtain a gap of 0.080 ± 0.010 inches (2.00 ± 0.13 mm).
5. Manually close the door and ensure the output shaft is rotated fully clockwise as viewed from the bottom looking up. The LS1 proximity switch should actuate just prior to the door being fully closed, and remain actuated with the door fully closed, illuminating the LED light at the rear of the switch. This actuation point is referred to as 5° closed.
6. Manually operate the door mechanism several times between fully open and fully closed to ensure proper actuation of the switches.
7. Torque switch lock nuts to 130 in-lb.
8. Close the emergency release control to apply system air pressure to door motor.
9. Cycle door controller several times between open and closed to ensure proper operation of the door mechanism and limit switches.

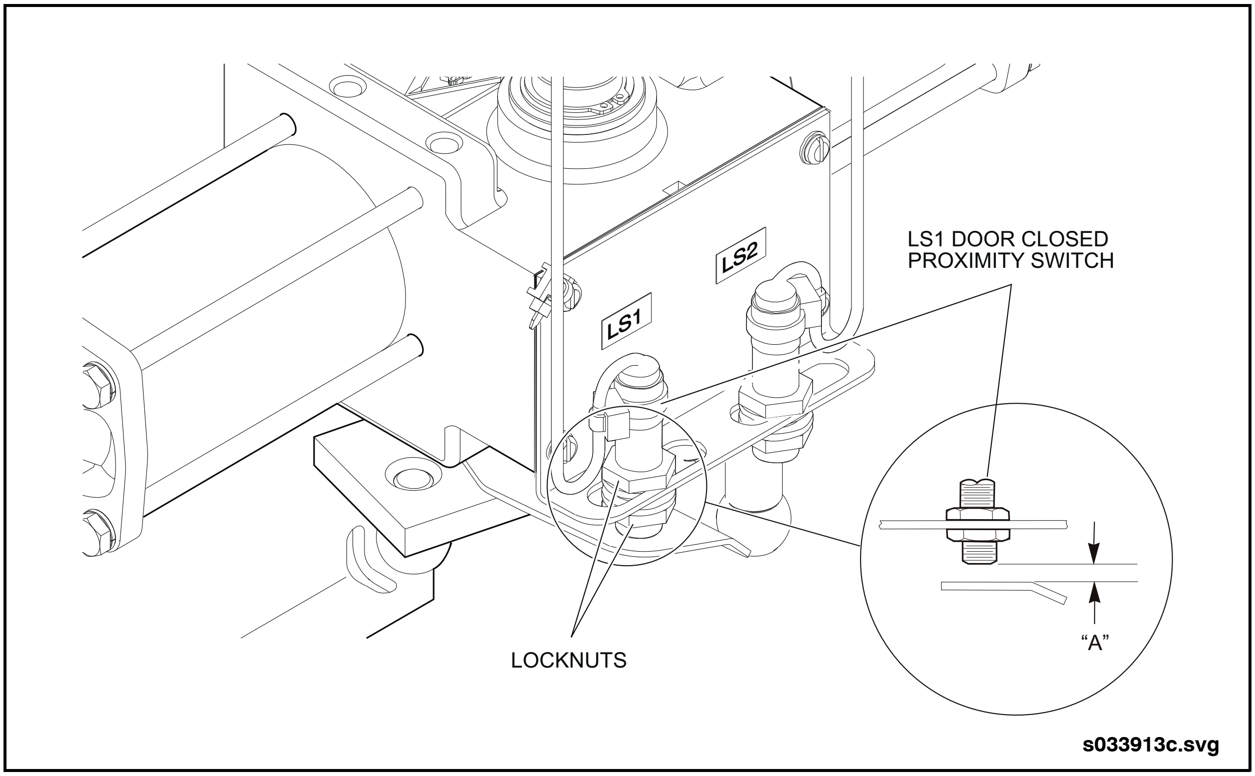


Fig. 16-6: Proximity Switch Adjustment

2.9. Entrance Door Operator

2.9.1. Description

The pneumatic door operator is a geared differential, air-operated device consisting of two horizontally opposed cylinders of different diameters. A rack gear connects the pistons which operates within the cylinders. The rack meshes with a gear which converts the straight line motion of the pistons into the rotary motion necessary for operation of the lever assembly. See "Fig. 16-7: Door Operator Cross-Section" on page 17.

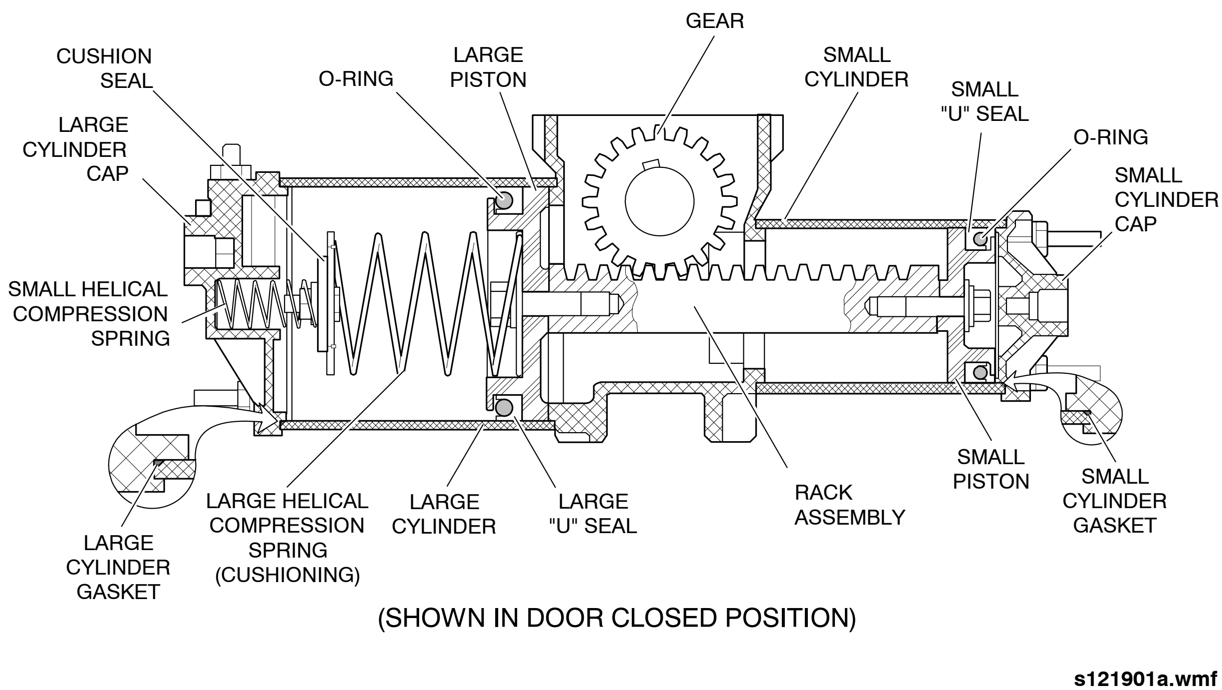


Fig. 16-7: Door Operator Cross-Section

2.9.2. Operation

During normal operation, air pressure is continually applied to both cylinders - directly to the smaller “opening” cylinder from the reservoir, and from the control valve to the larger or “closing” cylinder.

In the door opening process, air pressure to the large cylinder is shut off and permitted to bleed off at a controlled rate through adjusting ports back through the exhaust port in the control valve. At a predetermined point in the opening cycle, horizontal movement of the rack and piston assembly closes off the primary air exhaust port by action of the cushion seal. The greater pressure in the smaller cylinder causes the movement of the piston in the large cylinder to compress the remaining air which is bleeding off more slowly through the cushioning speed port. This compressing action provides the means of controlling the opening action of the operator, thus preventing the door panels from slamming open. As the doors are fully opened, the remaining air pressure in the large cylinder is slowly depleted through the cushioning speed port and out through the control valve exhaust port.

In the door closing process, air pressure is admitted through the closing speed port cavity which was sealed by the cushion seal. With the aid of the compression spring, the cavity is soon opened in the main area of the opening cylinder, the net force difference causes the rack to move in the closing direction, thus closing the doors.

2.9.3. Maintenance

☞**NOTE:**

Refer to the Preventive Maintenance Section of this manual for run-in and regularly scheduled maintenance requirements.

If the door panels operate erratically, disconnect the door from the operator assembly by detaching the connecting rods from the door shaft levers. Open and close the door panels manually to see if they operate freely. Any binding in the door action must be corrected before reattaching the connecting rods to the door shaft levers. Check for binding in the external linkage before removing the operator for internal repairs.

If door panels operate freely with the operator disconnected, check that there is sufficient air pressure to the operator and that there are no air leaks to cause improper operation. Adjust cushioning stop screw.

If no air leaks are indicated and proper air pressure is assured for normal operation, and the cushion stops have been adjusted but operation is erratic, the door operator should be removed for internal repairs.

2.9.4. Removal

1. Set the Battery Disconnect switch to the OFF position.
2. Drain all air tanks.
3. Remove connecting rods from teeter lever.
4. Disconnect air lines from door operator end caps.
5. Disconnect electrical leads from switch plate and pressure switch.
6. Remove fasteners that attach door operator to baseplate.
7. Remove door operator from vehicle.

2.9.5. Disassembly

1. Remove door engine from the vehicle and place on a clean workbench.
2. Rotate the teeter lever towards the larger cylinder, so that the large piston bottoms out against the gear housing assembly. Scribe an index mark to show the orientation of the teeter bar relative to the gear housing. See “Fig. 16-8: Teeter Shaft Index Marking” on page 19.
3. Remove and retain all tie rod nuts, lock washers and plain washers from the cylinder end caps. Remove the tie rods from the gear housing. Remove the end caps, compression spring and cushion spring assembly. See “Fig. 16-9: Entrance Door Motor Assembly” on page 20.
4. Pull the large and small cylinders away from the gear housing and off their respective pistons.
5. Place an adjustable wrench or similar tool on the flats of the rack to prevent the rack from rotating. Remove the hex head cap screw, washer and lock washer to disconnect the small piston from the rack. Retain fasteners for reassembly.
6. Pull the rack and large piston out through the large piston side.
7. Hold the rack with the adjustable wrench. Remove the hex head cap screw, washer and lock washer to disconnect the large piston from the rack. Retain fasteners for reassembly.
8. Discard the large and small plastic pistons, U-seals, and O-rings.

   ☞**NOTE:**

   Prior to discarding the large piston, make note of whether the piston has a rectangular recess at the location where the piston contacts the rack. This information will be required during assembly.

9. Remove the cushion seal from the cushion spring assembly by removing the lock nut, washer and the spring retainer. Discard the cushion seal. See “Fig. 16-10: Cushion Spring & Seal” on page 21.
10. Remove the jam nuts, washers, and O-ring seals from the speed and cushioning control screws. Do not remove the adjustment screws. See “Fig. 16-11: Adjustment Screw Location” on page 21.

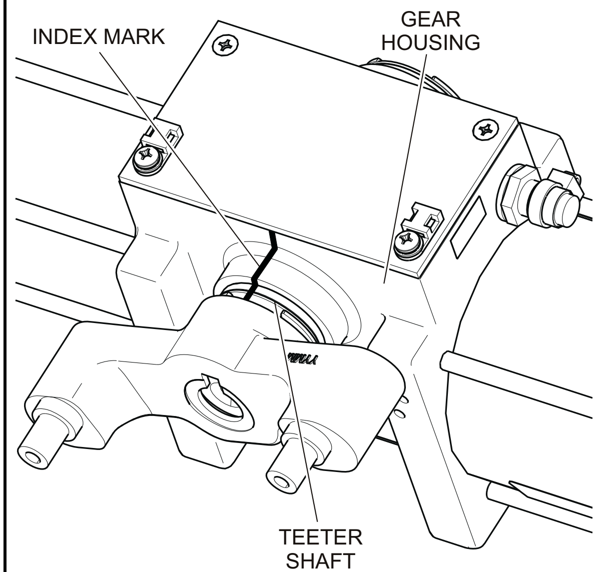


Fig. 16-8: Teeter Shaft Index Marking

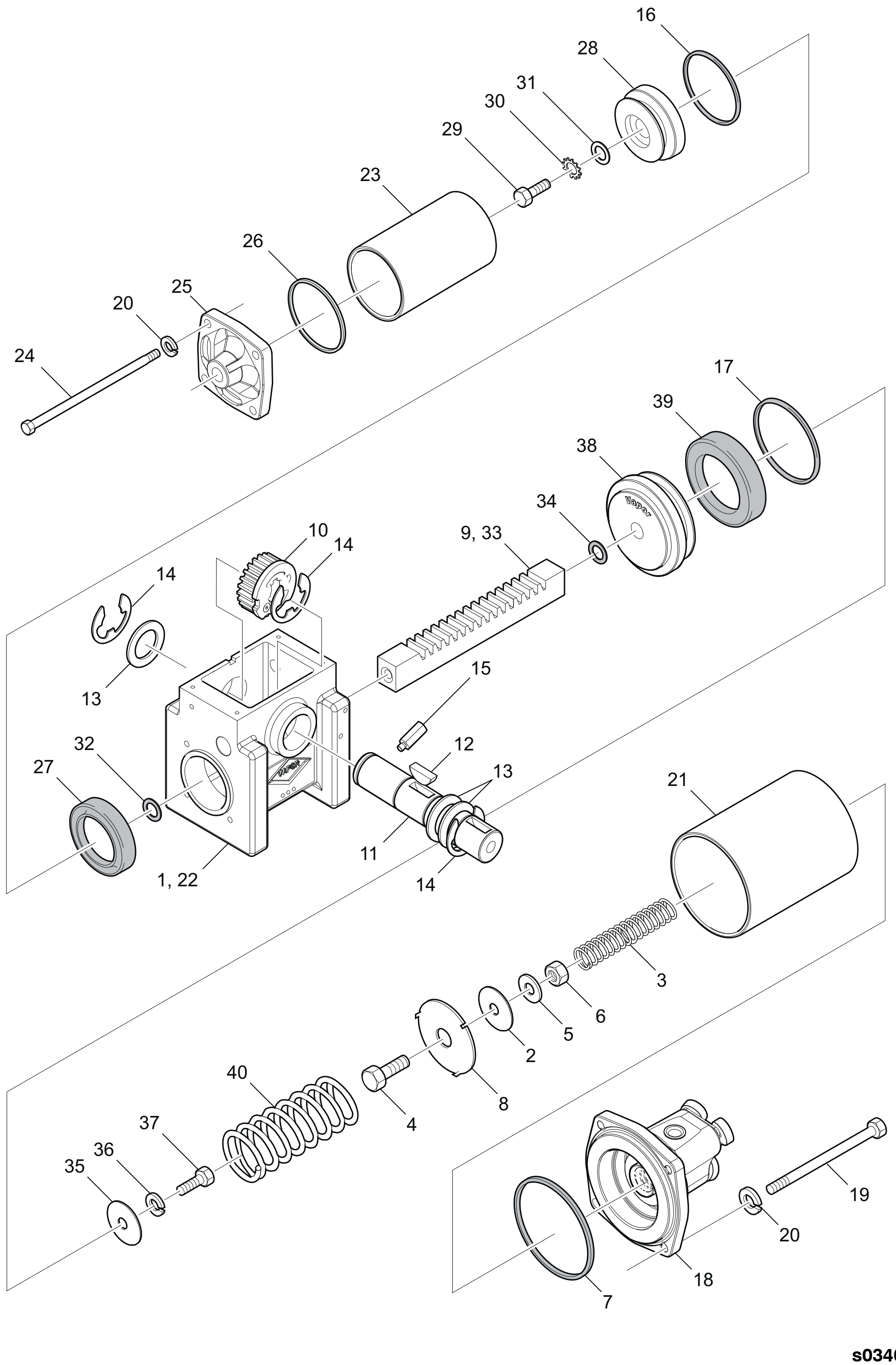


Fig. 16-9: Entrance Door Motor Assembly

1. Door Operator Assembly, (Incl. 2-40)	14. Ring Retaining Ext	28. Piston, Small
2. Seal, Cushion	15. Target	29. Screw, Hex Cap 5/16" - 18 UNC x 1" Lg.
3. Spring, Helical Compression	16. O-Ring	30. Washer, External Lock
4. Screw, Hex HD Cap 1/4" - 20 x 1" Lg.	17. O-Ring	31. Washer, Flat 5/16" ID x 3/4" O.D. x 0.06" Thk.
5. Spring, Retainer	18. End Cap Assembly, Large	32. O-Ring
6. Nut, Lock	19. Screw, Hex 1/4" - 20 UNC x 5 1/2" Lg.	33. Rack Assembly
7. Gasket, Large Cylinder	20. Washer, Lock 1/4"	34. O-Ring
8. Retainer	21. Cylinder, Large	35. Washer, Special
9. Lubricant, Grease	22. Housing Assembly	36. Washer, Lock Special 3/8"
10. Gear and Cam Assembly	23. Cylinder, Small	37. Screw, Hex 3/8" - 16 x 1" Lg.
11. Shaft Output	24. Screw, Hex 1/4" - 20 x 5" Lg.	38. Piston Large
12. Key Woodruff	25. Cap, Small Cylinder	39. Seal, U-Type 3 3/8" O.D.
13. Spacer, End Play	26. Gasket	40. Spring, Activair Engine
	27. Seal, "U" Type 2 1/4" O.D.	

Entrance Door Motor Assembly (parts list)

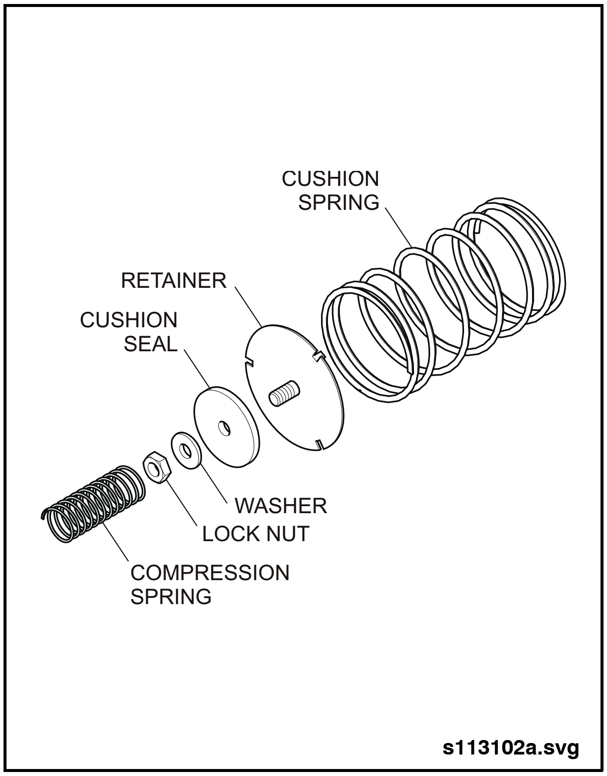


Fig. 16-10: Cushion Spring & Seal

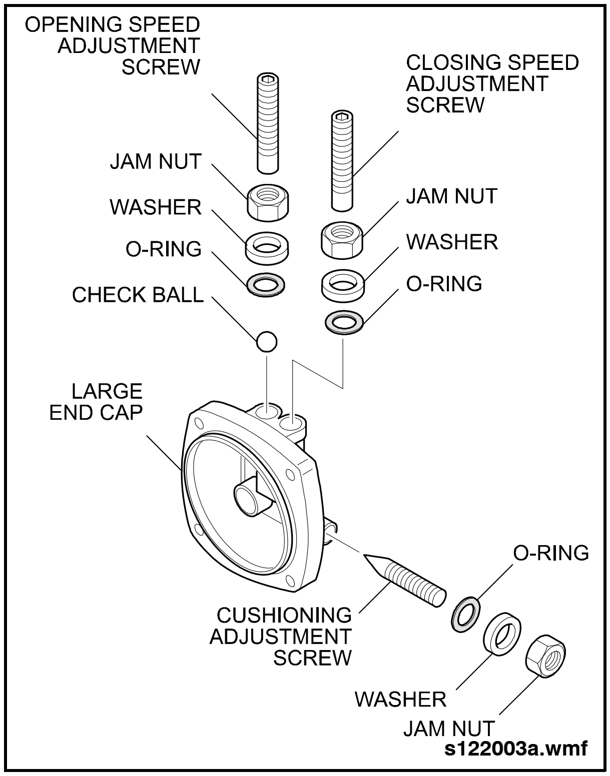


Fig. 16-11: Adjustment Screw Location

2.9.6. Cleaning & Inspection

1. Clean all parts thoroughly with mineral spirits and inspect for wear.
2. Wipe the inside of gear housing with cloth saturated with mineral spirits.

CAUTION

DO NOT use trichlorethylene or chlorinated hydrocarbon solvents. Do not soak the gear housing in solvent as this will damage the shaft bearings.

3. Wipe all components clean and dry with a lint free cloth before re-assembling.

2.9.7. Assembly

☞**NOTE:**

Use the parts retained from disassembly and the new parts provided in the repair kit for reassembly. Refer to your New Flyer Parts Manual for repair kit part number.

1. Apply a light coat of grease (Vapor P/N 67110070, Syn-Tech NS-4405-FG) to both sides of the new cushion seal and attach the cushion seal to the cushion spring assembly using the lock nut, washer and spring retainer.
2. Install new O-rings on the speed and cushion control screws.

☞**NOTE:**

The repair kit includes adjustment screw O-rings to suit different configurations. If the retaining washer is 0.490 in. O.D., use the 0.437 in. O.D. O-ring. If the retaining washer is 0.625 in. O.D., use the 0.599 in. O.D. O-ring.

3. Assemble a new large U-seal and O-ring on the large piston. Position a new 1/2" O-ring between the large piston and the rack.

☞**NOTE:**

The open side of the U-seal must face away from the rack.

4. Use the adjustable wrench to hold the rack and attach the piston to the rack using the 3/8" hex head cap screw, washer and lock washer.

☞**NOTE:**

The repair kit contains two different styles of large piston. One style features a rectangular recess where the piston contacts the rack, while as the other style has a smooth surface. Use the same style of piston as what was removed during disassembly.

5. Torque the hex head cap screw to 14 ft-lb. (19 Nm).
6. Apply a light coat of grease to the U-seal and O-ring.
7. Lubricate the rack teeth with grease.
8. Insert the rack and large piston into the gear housing through the large cylinder side.
9. Assemble a new small U-seal and O-ring to the small piston. Position a new 7/16" O-ring between the small piston and the rack.

☞**NOTE:**

The open side of the U-seal must face away from the rack.

10. Attach the piston to the rack using the 5/16" hex head cap screw, washer and lock washer.
11. Torque the hex head cap screw to 10 ft-lb. (14 Nm).
12. Apply a light coat of grease to the U-seal and O-ring.
13. Coat the interior surfaces of the large and small cylinders with a light coat of grease.
14. Bottom the large piston against the gear housing and align the teeter lever with the index mark made during disassembly.
15. Lift the small piston and the rack to mesh with the gear. While holding the large piston against the gear housing, slip the small cylinder over the small piston until the cylinder is seated onto the shoulder of the gear housing.

☞**NOTE:**

Ensure that the U-seal does not roll when installing the cylinder over the piston.

16. Place the small cylinder gasket on the small end cap and install the end cap on the cylinder.

17. Reinstall the tie rods using the washers, lock washers and hex nuts.

⚠CAUTION

Excessive or uneven tightening may damage the cylinder cap.

18. Finger tighten the hex nuts, then cross tighten the hex nuts on the tie rods equally in 10 in-lb. increments to 60 in-lb.

☞NOTE:

Keep the tie rods parallel to the cylinder while tightening.

19. Slip the large cylinder over the large piston, with the tapered edge of the cylinder facing away from the gear housing, until the cylinder is seated onto the shoulder of the gear housing.

☞NOTE:

Ensure that the U-seal does not roll when installing the cylinder over the piston.

20. Place the cushion spring assembly into the recess of the large piston.

☞NOTE:

A small amount of grease in the recess area will assist in maintaining the spring in position.

21. Position the helical compression spring on the cushion spring assembly.

22. Place the large cylinder gasket on the large end cap.

23. Position the large end cap on the cylinder. Ensure that the compression spring is seated in the recess in the center of the end cap.

24. Verify that the large piston is bottomed against the housing and the index marks are aligned.

25. Reinstall the tie rods using the washers, lock washers and hex nuts.

⚠CAUTION

Excessive or uneven tightening may damage the cylinder cap.

26. Finger tighten the hex nuts, then cross tighten the hex nuts on the tie rods equally in 10 in-lb. increments to 60 in-lbs.

☞NOTE:

Keep the tie rods parallel to the cylinder while tightening.

27. Reinstall any mounting brackets or covers.

2.9.8. Functional Test

☞NOTE:

The door operator should be given both a leakage test and an operational test following overhaul before being placed back in service.

2.9.8.1. Test Setup

1. Prior to performing test, ensure that the rack and teeter shaft are properly indexed by rotating the teeter lever and bottoming the large piston against the gear housing. Verify that the index marks made during disassembly are aligned. If the marks are not aligned, it will be necessary to disassemble and reindex the teeter shaft gear with the rack.
2. Clamp the door motor securely in place on a test bench.
3. Connect the air lines, pressure gauge, and shutoff valves as shown in the test schematic. Use an air supply regulated to 120 to 125 psi. See “Fig. 16-12: Door Operator Test Schematic” on page 24.

☞NOTE:

Air from the door closing side of the door motor must be exhausted to atmosphere when Air Valve # 2 is in the closed position.

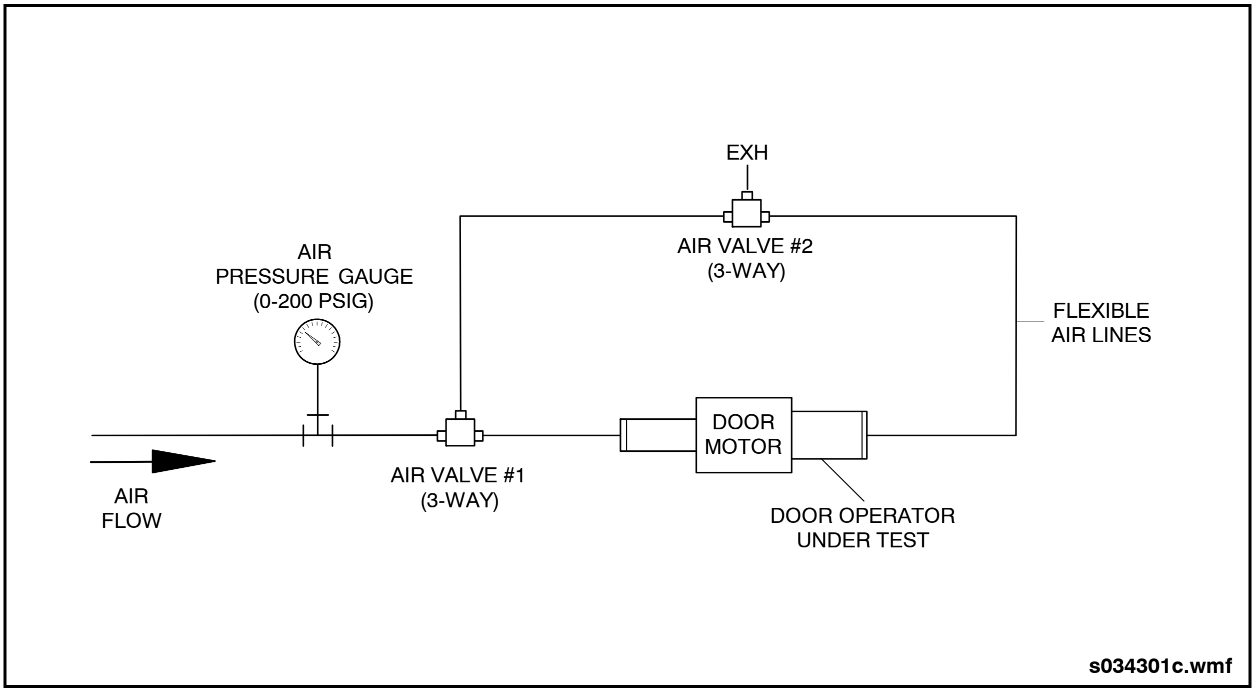


Fig. 16-12: Door Operator Test Schematic

2.9.8.2. Leakage Test

CAUTION

NEVER adjust the speed or cushioning screws more than 4-5 turns outward from the fully bottomed position. The adjustment screws are not captive and, if installed loosely, may become projectiles when air pressure is applied.

1. Loosen the jam nut and adjust the opening and closing screws to their nominal position of 1 1/2 turns from fully bottomed. Tighten jam nut.
2. Loosen the jam nut and adjust the cushion screw to its nominal position of 1/2 turn from fully bottomed. Tighten jam nut.
3. Open both air shutoff valves and apply regulated air pressure to both cylinders.

CAUTION

DO NOT submerge door operator in water during testing as some areas of the door motor are not designed to be watertight.

4. Use a brush and soapy water solution to check for leaks. Check cylinder end caps, cylinder to gear housing gasket, and adjustment screws. Repair any leaks and recheck.

2.9.8.3. Opening & Closing Speed Adjustment

1. Close both air shutoff valves and apply regulated test air pressure.
2. Manually rotate the output shaft assembly to the full extent of its travel in both directions several times. Movement should be smooth without binding or noise.
3. Use a protractor or similar measuring device to record total travel of the teeter arm/output shaft. Total shaft rotation should be approximately 155°.
4. Move the teeter arm/output shaft to the door CLOSED position. The teeter arm should be 15° ± 1.5° from door operator cylinder centerline. Measure and record this angle for future test reference.

☞**NOTE:**

The door operator will need to be disassembled and checked for proper assembly if either of the operating angles specified in steps 3 and 4 are incorrect. Verify that the gear, rack, and shaft are properly indexed. Reassemble unit when problem is corrected and perform a leakage test as described previously.

5. Open air shutoff valve #1. The door operator should move to the fully OPEN position.
6. Open air shutoff valve #2 and record the time it takes the door operator to move from the fully OPEN position to the fully CLOSED position. Door operator should fully close within 3 to 3.5 seconds at regulated supply air pressure.
7. Turn the closing speed adjustment screw clockwise until it is lightly seated. Do not force the screw.
8. Close air shutoff valve #2 and record the time it takes the door operator to move from the fully CLOSED position to the fully OPEN position. Typical opening speed should be within 2.5 to 3 second range. Record actual opening time.

☞**NOTE:**

If operating time is excessively slow, check for a jammed check ball in the opening speed adjustment port. Replace large cylinder end cap if check ball is jammed in its seat.

9. Open air shutoff valve #2 and record the time it takes the door operator to move from the fully OPEN position to the fully CLOSED position. Door operator should close very slowly, typically 10 seconds or more than that recorded previously in step #6.
10. Turn the opening speed adjustment screw clockwise until it is lightly seated. Do not force the screw.
11. Close air shutoff valve #2 and record the time it takes the door operator to move from the fully CLOSED position to the fully OPEN position. Door operator should open very slowly, typically 10 seconds or more than that recorded previously in step #8.
12. If the results of any of the previous tests are significantly out of the specified range, then replace the large cylinder end cap and adjustment screws.
13. Reset opening and closing speed adjustment screws to their original positions (backed out 1 1/2 turns from being lightly seated).

2.9.8.4. Open Cushion Adjustment

14. Open air shutoff valve #2 and allow the door operator to move to the fully CLOSED position.
15. Turn the cushioning adjustment screw clockwise until it is lightly seated. Do not force the screw.
16. Close air shutoff valve #2. The teeter arm/ output shaft should rotate toward the OPEN position and then slow down significantly. An additional 10 seconds may be required for the door operator to be in the fully OPEN position.
17. If the door operator fails to operate as described in step #16, either the cushioning seal is not seating properly on the large end cap or the cushioning screw is not closing off the corresponding port. Partial disassembly may be required to correct the problem.
18. Return the cushioning screw to its original position (backed out 1/2 turn from being lightly seated).
19. Install protective caps in any open ports if the door operator is to be stored before being installed in the vehicle.

2.9.9. Installation

1. Position door operator onto baseplate and secure with original fasteners.
2. Connect air lines to door operator end caps.
3. Connect electrical leads to switch plate and pressure switch.
4. Install connecting rods on teeter lever.
5. Set Battery Disconnect switch to ON position.
6. Start engine, operate at fast idle and charge air system.
7. Check for leaks and tighten fittings as necessary.
8. Cycle through the open and closed positions several times and check for smooth operation.
9. Perform final door opening/closing and cushioning adjustments. Refer to 2.5.8. “Door Speed Adjustments” on page 11 in this section for procedure.

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. Shut off air supply to door mechanism and ensure no pressure is at door motor.
3. 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.
4. 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.
5. 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 2.5. “Entrance Door Adjustment Procedure” on page 6 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 motor 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 (motor) 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 Panels

2.12.1. 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.

2.13. Door Glass

2.13.1. 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.

2.13.2. 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.

2.13.3. 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. 16-13: Exit Door" on page 32. The base plate assembly above the door contains the door motor, the gear and lever assembly, door shaft levers, two proximity switches which actuate the door opening and closing cycles and two pressure switches connected to the door sensitive edges. See "Fig. 16-14: Exit Door Base Plate" on page 34. Refer to the Preventive Maintenance Section of this manual for servicing procedures. Refer to 3.6. "Sensitive Edges" on page 47 in this section for information on that system.

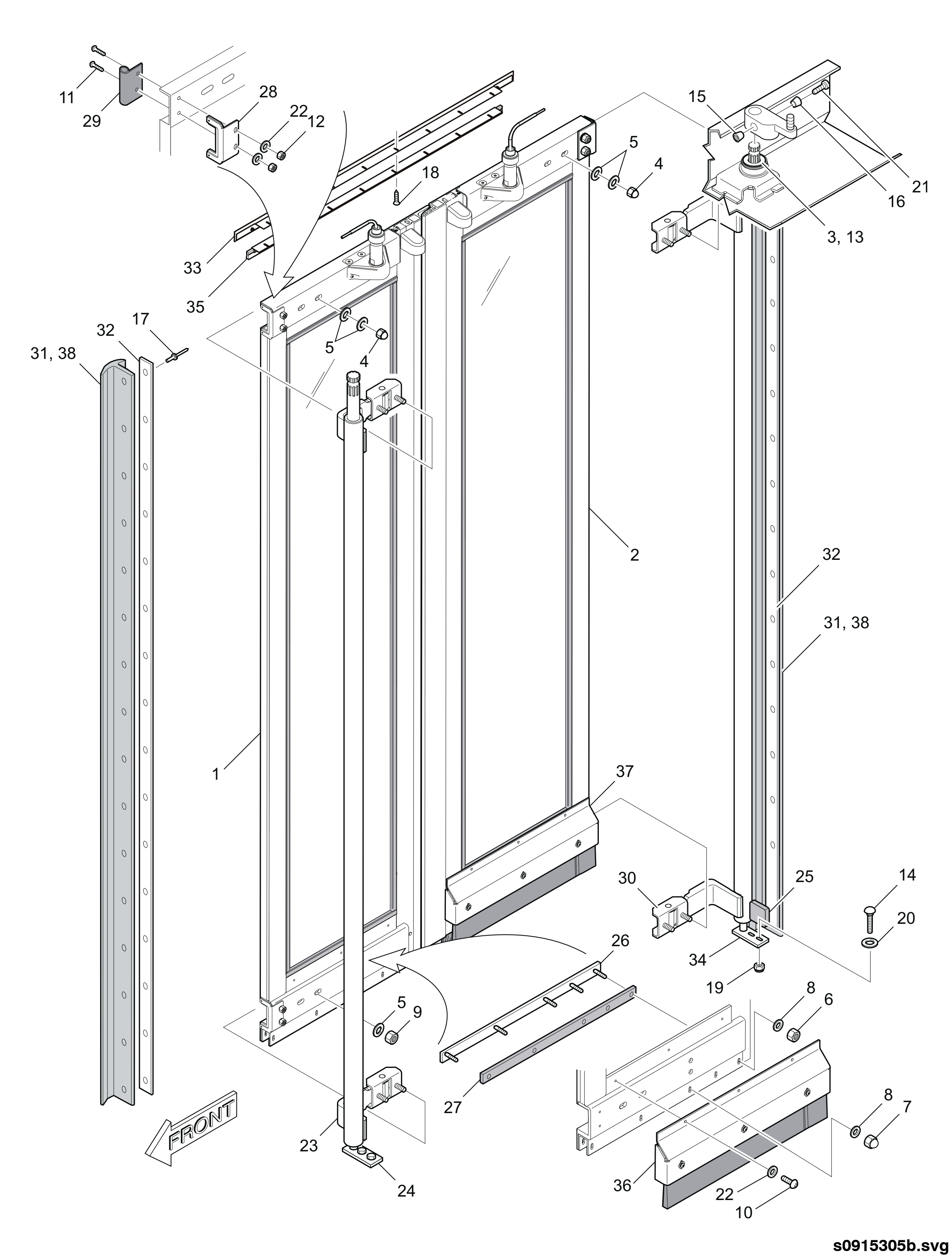


Fig. 16-13: Exit Door

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. Exit Door Adjustment Procedure

This section covers the final adjustment of rear door panels, linkage and door speed adjustments.

3.2.1. 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 bus floor. Tighten mounting hardware to secure the adjustment.
3. Manually close the doors. Check for approximately a 3/4" 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 seal with the top of the doors, with a maximum gap of 0.030". If gaps exist, install additional spacers between the door shaft lever and bearing to raise the door enough to form a seal. See “Fig. 16-15: Door Shaft Lever Shim Adjustment” on page 36.
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.

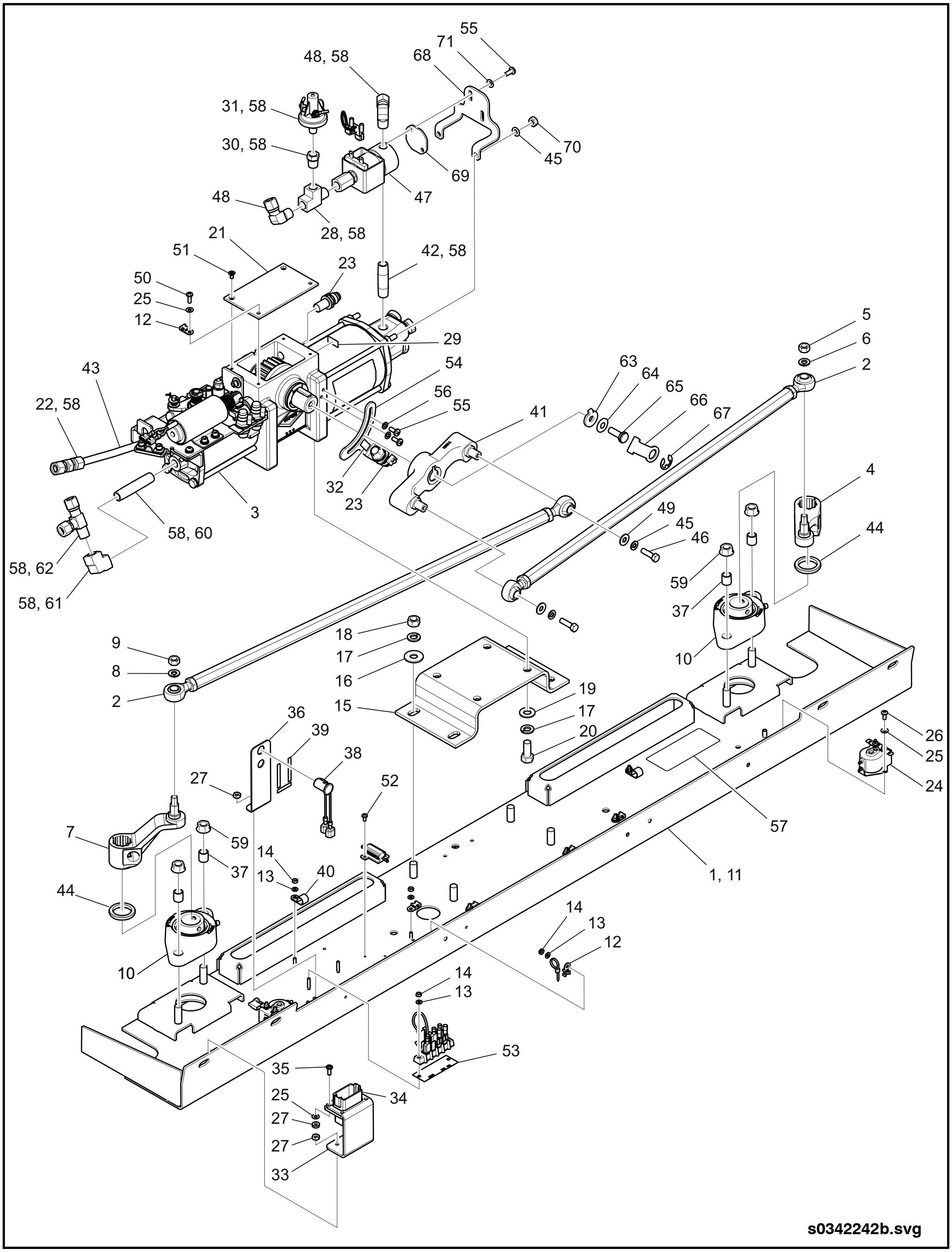


Fig. 16-14: Exit Door Base Plate

1. Base Plate Assembly, Exit Door (Incl. 2-4, 8, 11-72)
2. Connecting Rod Assembly
3. Door Operator Assembly
4. Lever Assembly, Door Shaft RH (Incl. 5-7)
5. Washer, Lock Spring 5/16"
6. Nut, Hex 5/16" - .125" W x .078" Thk.
7. Shaft Lever
8. Lever Assembly, Door Shaft LH (Incl. 9-10)
9. Washer, Lock Spring 5/16"
10. Nut, Hex 5/16" - .125" W x .078" Thk.
11. Base Plate, Welded
12. Clip, Harness
13. Washer, Flat #6 - .312" O.D. x .028" Thk.
14. Nut, Hex Keps #6 - 32 UNC
15. Plate, Engine Mounting
16. Washer, Plain 3/8" - 1" O.D. x .072"
17. Washer, Lock Special 3/8" - .141" W x .094" Thk.
18. Nut, Hex 3/8" - 16 UNC
19. Washer, Flat 3/8" - .813" O.D. x .065" Thk.
20. Screw, Locking Torque Patch
21. Cover, Gear
22. Union, Nylon Tube Fitting 3/8"
23. Proximity Switch Assembly
24. Switch, Pressure Wave
25. Washer, Flat #8
26. Screw, PH #6 - 32 x .31" Lg.
27. Nut, Hex Keps #8 - 32 UNC
28. Tee, Pipe Fitting Brass 1/4"
29. Label, Identification LS4
30. Fitting, Pipe w/Brass Bushing 1/4"
31. Switch, Pressure
32. Label, Identification LS3
33. Bracket, Harness
34. Harness, Wiring
35. Screw, PH #8 - 32 x 1/2" Lg.
36. Bracket, Mounting
37. Bushing, 3/8" I.D. x 1/2" O.D.
38. Indicator Light, 28V DC
39. Label Class Switch & Light
40. Clamp, Cable Hanger
41. Teeter Assembly
42. Nipple, Pipe Fitting 1/4"
43. Tubing, Nylon
44. Spacer, Lever
45. Washer, Lock Special 1/4" -.109 W x .062" Thk.
46. Screw, Locking Torque Patch
47. Mag Valve
48. Elbow, Nylon Tube Fitting 3/8"
49. Spacer
50. Screw, PH Rec Sem Ex #8 - 32 UNC x 1/2" Lg.
51. Screw, FH HD REC #8 - 32 x .31
52. Screw, PHD Recess Sem EX #4 - 40 x .25"
53. Strip, Marker
54. Bracket, Sensor
55. Screw, PH PN HD SEMS #10 - 32 x .50" STL ZN
56. Washer, Flat #10 - .375" O.D. x .032" Thk.
57. Label, Identification
58. Sealant, Teflon
59. Nut, Hex Locking 3/8" - 16
60. Connector, FTG Auto Brass L NIP 1/4"
61. Connector, FTG Auto Brass 90 EL 1/4"
62. Connector, Nylon Tube Fitting Brass 3/8"
63. Washer, Teeter
64. Washer, 0.324 x 0.787
65. Bolt, Teeter w/Lock
66. Lock, Teeter Bolt
67. Ring, Retaining
68. Bracket Mounting, Solenoid
69. Spacer, Solenoid
70. Nut, Hex 1/4" - 20 Steel
71. Washer, Plain #10 - .438" O.D. x .032" Thk.
72. Bearing, Ball

Exit Door Base Plate (parts list)

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. Apply air to the door motor. With the doors in the closed position, verify that the leading door edge metal to metal distance is 4.12" ± 0.12" across the entire door length. See “Fig. 16-16: Door Closure Adjustment” on page 36. 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. Remove air from the door motor before making adjustment. Tighten mounting hardware to secure the adjustment.

11. With the doors in the closed position, and air applied to the door motor, check the door closed preload. The doors should sit firmly against the jamb seals and should not exhibit any looseness or play. To increase the door closed preload, loosen the connecting rod jam nuts and shorten the connecting rod lengths approximately one turn. If a preload adjustment is made, recheck door panel phasing as described in Step 9. Tighten connecting rod jam nuts to secure the adjustment.
12. Power open the doors and check door open preload. In the fully open position, the doors should not exhibit any looseness or play. To increase door open preload, loosen the connecting rod jam nuts and lengthen the connecting rod lengths as required. If a preload adjustment is made, recheck door panel phasing as described in Step 9. Tighten connecting rod jam nuts to secure the adjustment.
13. With the doors in the CLOSED position, turn the door shaft lever stop adjustment screws on the baseplate counter-clockwise until the heads make contact with the door shaft levers. Secure adjustment of the stop screws by tightening the stop screw jam nuts.

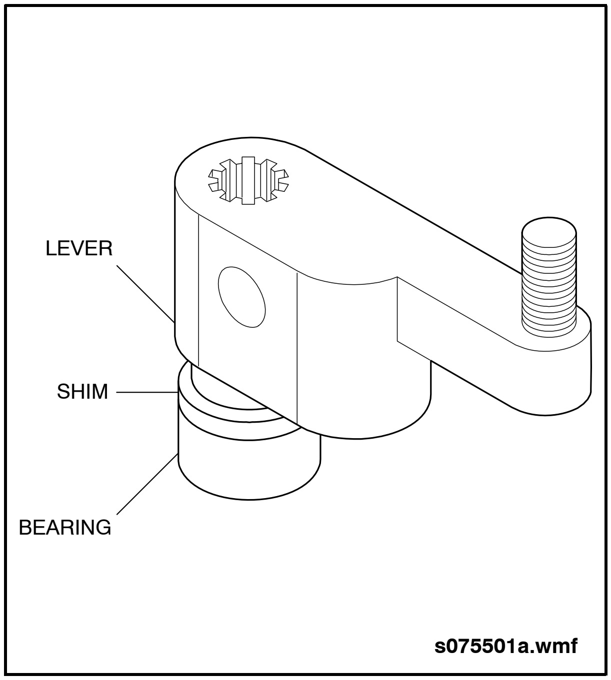


Fig. 16-15: Door Shaft Lever Shim Adjustment

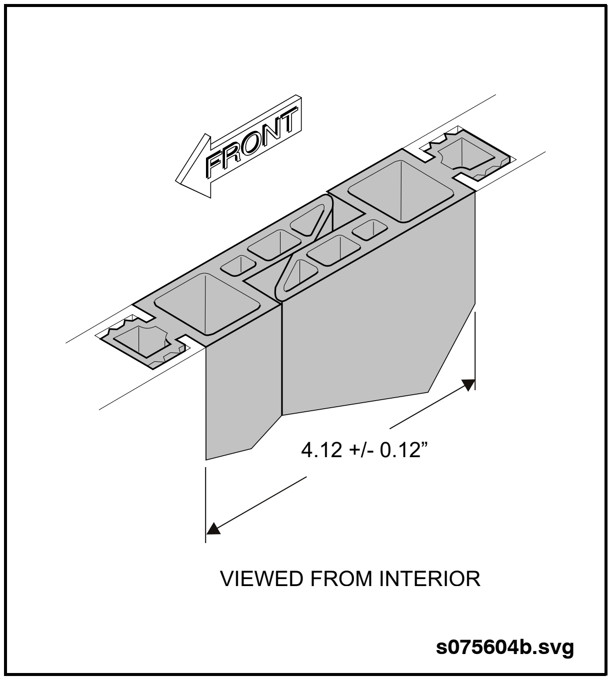


Fig. 16-16: Door Closure Adjustment

3.2.2. Door Speed Adjustments

The pneumatic door operator is equipped with a built-in cushioning feature which produces smooth door operation in the opening direction. A speed control fitting at the end of the large cylinder regulates the speed of the operator operation and cushioning. Initially the closing speed adjusting screw is set to 0.25" ± 0.03" above the top of lock nut and the opening speed adjusting screw is set to 0.31" ± 0.03" above the top of the lock nut.

☞NOTE:

Initial opening and closing adjustments can also be obtained by lightly seating the adjustment screw and then backing out the screw 1 1/2 turns. Initial cushioning adjustment can be obtained by lightly seating the adjustment screw and then backing out the screw 1/2 turn.

When making adjustments, always adjust the closing speed first since this adjustment also affects the door opening speed.

⚠WARNING

Closing speed should be adjusted to ensure 3 to 3.5 seconds of time between initiation of closure and full door closed position.

Door closing speed must fall between 3 seconds and 3.5 seconds during all pressure possibilities between 131 psi and 95 psi. If door is adjusted at highest normal pressure, speed will decrease when lower pressure is available. Adjustment must be made to be acceptable to individual transit authority requirements at average operating air pressure so that speed does not become faster than 3 seconds at 131 psi.

⚠CAUTION

NEVER force adjusting screws when adjusting in a clockwise direction. Excessive tightening pressure (metal-to-metal) will damage the operator cylinder cap.

To increase the door closing speed, loosen the lock nut which secures the closing speed adjusting screw and turn the screw outward. To decrease the closing speed, turn the screw inward. Tighten the lock nut to maintain this adjustment.

Adjust opening speed to ensure 2.5 to 3 seconds between initiation of opening and door fully opened position.

To increase the door opening speed, loosen the lock nut which secures the opening speed adjusting screw and turn the screw outward. To decrease the speed, turn the screw inward. Tighten the lock nut to maintain this adjustment.

To adjust the cushioning during the opening cycle, loosen the lock nut and carefully adjust the opening cushion screw. Be sure to tighten the lock nut after making the adjustment.

3.3. Exit Door Switch Plate & Proximity Switches

3.3.1. Description

The slide glide exit door mechanism is equipped with a switch plate and two proximity switches. The switch plate is attached to the top of the door operator assembly.

3.3.2. Operation

When the door is being closed, the piston in the door operator assembly moves toward the closed position causing the output lever to rotate clockwise and in near proximity to the lower 5° limit switch. This signal is used by the multiplexing system as a door closed input. When the door is being opened, the piston in the door operator assembly moves toward the open position causing the output lever to rotate counter-clockwise and in near proximity to the upper 85° limit switch. This signal is used by the multiplexing system as a door open input.

3.3.3. Maintenance

The proximity switches are not serviceable and must be replaced when proven defective. Two lock nuts hold them in position and allow easy adjustment or replacement of the switches. All switch settings come adjusted from the factory and only require readjustment when disturbed through door system overhaul, vehicle accident or switch replacement.

3.3.3.1. Removal

1. Open the hinged access panel above the entrance door and operate the emergency release control to exhaust air from the door system.
2. Position the door panels to allow access to switches.
3. Mark and disconnect wiring connectors from switches.
4. Remove the inner lock nut from each switch and remove the switches.

3.3.3.2. Installation

1. Rotate the output lever fully clockwise to the closed position. Slide the 5° (lower) proximity switch into position so that the head of the proximity switch is centered over the flat of the output lever and install lock nut.
2. Adjust proximity switch in or out as required to obtain a 2.0 to 2.8 mm gap between the end of the switch and the gear lever when the lever is rotated past the end of the switch.
3. Rotate the output lever fully counter-clockwise to the open position and install the 85° (upper) limit switch. Adjust proximity switch as described in the previous step.
4. Connect wiring to switches.
5. Operate the door mechanism through its full range of travel to ensure proper actuation of switches. Switches should initially actuate approximately 5° before the fully opened/closed position and remain actuated while in the fully opened/closed position. Ensure adequate clearance exists between switches and connecting rods.
6. Close the emergency release valve and functionally test operation of the door assembly and switches.

3.3.4. Proximity Switch Adjustment

Adjust the distance between the switch and the output lever to ensure correct actuation of the exit door. Ensure the following conditions are met prior to proceeding with adjustments:

- ❐ Using a digital multimeter (DMM), verify each proximity switch is receiving power and ground.
- ❐ Open the exit door emergency valve cover and operate the emergency release control to exhaust air from the door system.

1. Manually close the exit door to rotate the output lever fully clockwise to the closed position. Position the 5° (lower) proximity switch so that the head of the proximity switch is centered over the flat of the output lever and install lock nut.
2. Adjust proximity switch in or out as required to obtain a 0.080 ± 0.010 inches (2.00 ± 0.13 mm) (Dim. “A”) gap between the end of the switch and the flat of the output lever. See “Fig. 16-17: Proximity Switch Adjustment” on page 39.
3. Manually open the exit door to rotate the output lever fully counter-clock-wise to the open position. Position the 85° (upper) limit switch so that the head of the proximity switch is centered over the flat of the output lever and install lock nut.
4. Adjust proximity switch in or out as required to obtain a 0.080 ± 0.010 inches (2.00 ± 0.13 mm) gap between the end of the switch and the flat of the output lever.
5. Manually operate the door mechanism several times between fully open and fully closed to ensure proper actuation of the switches.
6. Torque switch lock nuts to 130 in-lb.
7. Close the emergency release control to apply system air pressure to door motor.
8. Cycle door controller several times between open and closed to ensure proper operation of the door mechanism and limit switches.

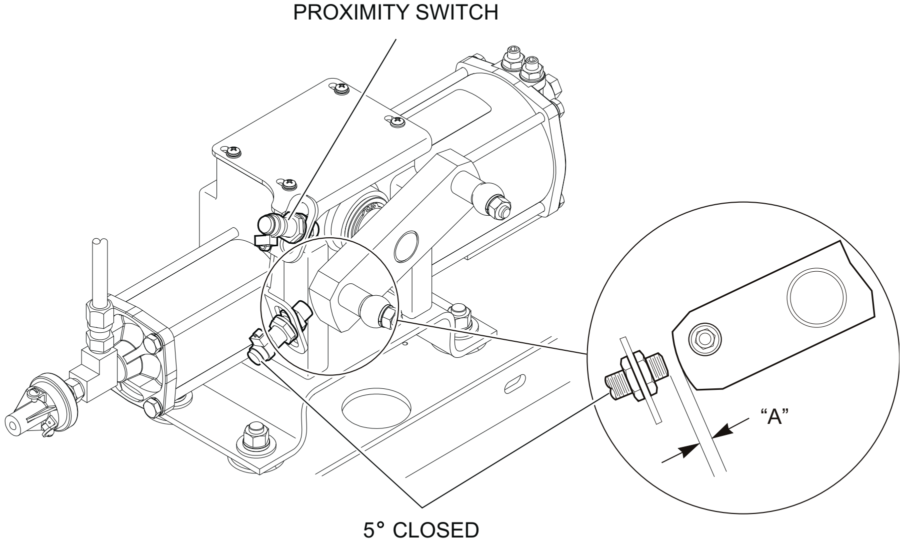


Fig. 16-17: Proximity Switch Adjustment

3.4. Exit Door Emergency Release Handle

3.4.1. Description

The exit door emergency release handle 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 handle that activates the emergency cam on the baseplate above the exit door.

3.4.2. Operation

Pulling the emergency release handle retracts the emergency cable which is attached to the emergency handle in the baseplate. This action causes the emergency cam to rotate and release the lock pawl, thereby allowing the door panels to be manually pushed open.

3.4.3. Emergency Cable Replacement

1. Set the Battery Disconnect switch to the OFF position.
2. Drain the air tanks.
3. Access the baseplate and disconnect the emergency release cable clevis at the emergency handle connection point.
4. Disconnect the emergency cable from the opposite end by opening the hinged door on the emergency release cover.
5. Loosen the upper jam nut until it slides off the control cable housing.
6. Pull the cable assembly out of the mounting bracket.
7. Installation is reverse of removal.
8. Adjust the cable length so that the emergency cam fully releases the lock pawl when the red emergency handle is pulled down.
9. Set the Battery Disconnect switch to the ON position and charge the air system.
10. Test emergency operation of the door.

3.5. Exit Door Motor

3.5.1. Description

The Pneumatic door motor is used as the basic assembly for various types of door operator assemblies. The controller is a geared differential, air-operated device consisting of two horizontally opposed cylinders of different diameters. A rack gear connects the pistons which operates within the cylinders. The rack meshes with a gear which converts the straight line motion of the pistons into the rotary motion necessary for operation of the lever assembly.

3.5.2. Maintenance

The pneumatic door motor has been designed to provide many years of trouble-free service with little or no maintenance. However, a complete inspection should be made for loose components at the end of the first thirty days after installation. At this time, all mounting and connections should be checked and tightened where required. Check for air leaks at all connections: use a soapy water solution. All adjusting screw jam nuts should be checked as well as all integral components of the motor assembly; tighten as required. Following a five or six year period of hard usage, the motor should be disassembled, cleaned and relubricated. No other maintenance is anticipated. A light coating of SAE #20 oil should be applied annually on all bearing surfaces at the door, rod and lever assemblies.

If the door panels operate erratically, disconnect the door from the motor assembly by detaching the connecting rods from the door shaft levers. Open and close the door panels manually to see if they operate freely. Any binding in the door action must be corrected before reattaching the connecting rods to the door shaft levers. Check for binding in the external linkage before removing the motor for internal repairs.

If door panels operate freely with the motor disconnected, check that there is sufficient air pressure to the motor and that there are no air leaks to cause improper operation. Adjust cushioning stop screw.

If no air leaks are indicated and proper air pressure is assured for normal operation, and the cushion stops have been adjusted but operation is erratic, the door motor should be removed for internal repairs. Shut off the air supply and disconnect the air line piping at each end of the motor. Remove the motor from its location by removing the mounting screws, nuts, and lock washers which secure the operator mounting brackets to the base plate.

3.5.3. Disassembly

Disassemble the door motor by removing 1/4" - 20 x 5" screws and 1/4" lock washers from both end caps. Next remove the rack and piston assembly by first removing the smaller piston from the assembly and pulling the rack and piston assembly out through the large piston side. The hex head cap screw and lock washer must be removed to disconnect the smaller piston from the rack. Use a new O-ring when reassembling. Clean all parts thoroughly and closely inspect for wear. Replace all worn or defective parts. See “Fig. 16-18: Exit Door Motor Assembly” on page 42.

CAUTION

DO NOT use cleaners such as trichlorethylene on the U-type seals. It is preferred that no cleaner be used on the seals, but rather they be wiped clean with a clean dry lint free cloth.

☞**NOTE:**

Be sure all components are wiped clean and dry before reassembly.

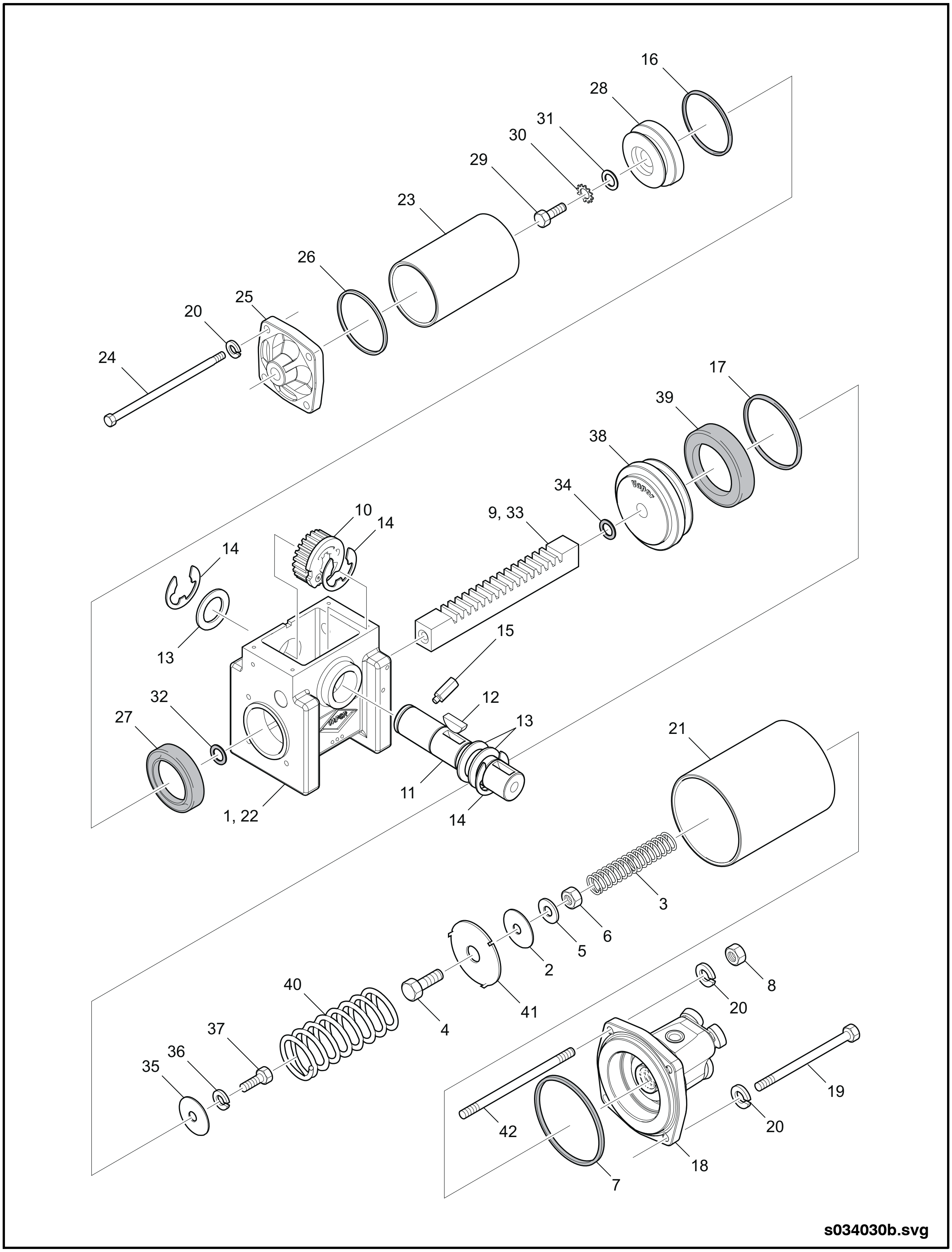


Fig. 16-18: Exit Door Motor Assembly

1. Door Operator Assembly, (Incl. 2-42)	15. Target	29. Screw, Hex Cap 5/16" - 18 UNC
2. Seal, Cushion	16. O-Ring	30. Washer, External Lock
3. Spring, Helical Compression	17. O-Ring	31. Washer, Flat 5/16" ID x 3/4" O.D.
4. Screw, Hex HD Cap 1/4" - 20	18. End Cap Assembly, Large	32. O-Ring
5. Spring, Retainer	19. Screw, Hex 1/4" - 20 UNC	33. Rack Assembly
6. Nut, Lock	20. Washer, Lock 1/4"	34. O-Ring
7. Gasket, Large Cylinder	21. Cylinder, Large	35. Washer, Special
8. Nut, Hex 1/4" - 20	22. Housing Assembly	36. Washer, Lock Special 3/8"
9. Lubricant, Grease	23. Cylinder, Small	37. Screw, Hex 3/8" - 16 x 1" Lg.
10. Gear and Cam Assembly	24. Screw, Hex 1/4" - 20 x 5" Lg.	38. Piston Large
11. Shaft Output	25. Cap, Small Cylinder	39. Seal, U-Type 3 3/8" O.D.
12. Key Woodruff	26. Gasket	40. Spring, Activair Engine
13. Spacer, End Play	27. Seal, "U" Type 2 1/4" O.D.	41. Retainer
14. Ring Retaining Ext	28. Piston, Small	42. Rod, Tie

Exit Door Motor Assembly (parts list)

3.5.4. Assembly

☞**NOTE:**

Before assembling the door motor, check that the two springs (24 & 30) conform to the following:

Spring	Load Applied	Length Loaded
24	6.0 lbs. ± 0.6 lbs. 1.10 lbs. ± 0.11 lbs.	0.625" 2.5"
30	0.81 lbs. ± 0.08 lbs. 2.14 lbs. ± 0.21 lbs.	1.805" 0.925"

☞**NOTE:**

The lubricant used during the assembly procedure is Lubriplate No. 905 or equivalent.

For reassembly, use the procedure outlined as follows:

1. Coat inside walls of cylinders with a light coating of lubricant.
2. Insert the assembled rack and piston into the large piston side of the cylinder assembly. Secure the small piston to the rack with the hex head cap screw and lock washer. Torque the screw 10 to 30 ft-lb. (13 to 40 Nm).
3. With the rack and piston assembled (approximately centered in the body, 8 full teeth toward the large cylinder side of the body center-line), place the gear on the rack with the hole in a vertical position, ± 10°, and insert the shaft through the gear.
4. Secure the gear and shaft with the spiral pin centering the pin in the assembly. The pin must not extend into the gear tooth area.
5. Liberally lubricate the rack and gear teeth.
6. Apply a light coat of lubricant to both sides of the cushion seal before assembly, then apply the hex head cap screw and locking jam nut to secure the cushion seal in place on the retainer. The chamfer on the spring retainer must face toward the cylinder cap.

⚠ **CAUTION**

DO NOT tighten cap screw and locking jam nut so as to compress the seal until it blows.

7. Secure large and small pistons, with U-seals and O-rings to the rack, then apply springs to the large piston. Use new seals if originals are worn or misshapen.

8. Assemble cylinders to body and cylinder caps using new gaskets. Coat the gaskets with lubricant prior to assembling.

CAUTION

Be sure that tapered ends of cylinders are facing the cylinder caps.

9. Install the long cap screws and cross tighten equally to 10 in-lb. increments to a total torque of 60 to 65 in-lb. Be careful to keep the shafts of the long cap screws parallel to the axis of the cylinder. When the mounting brackets are installed, the door operator must sit flat (no rocking) when placed on a flat and level surface.
10. Install the stainless steel ball in the right hand opening (as viewed from end of large cylinder). This is the door opening speed adjustment side.
11. Coat the 2 door speed adjusting screws with lubricant. Install adjusting screws and jam nuts with end play washer and O-ring, and tentatively adjust screws as follows:
    a. Closing speed adjusting screw (RH side) 0.25" ± 0.03" above nut.
    b. Opening speed adjusting screw (LH side) 0.31" ± 0.03" above nut.
    c. Tighten the nuts in place observing that the screws do not turn. If screws have a tendency to turn, hold them in place with a 5/32" Allen head wrench while tightening nuts.
12. Coat the cushioning screw with lubricant, Install this screw and jam nut with end play washer and O-ring. Adjust by seating point of screw in orifice and backing off 1/8 turn. Tighten nut in place as in Step 11.

3.5.5. Motor Testing after Assembly

To ensure proper operation of the pneumatic door motor after overhaul and/or reassembly, it should be given both a leakage test and an operational test before placing back in service.

The following equipment is required for properly testing door motors which have been disassembled for cleaning, repairing or overhauling.

3.5.5.1. Equipment

1. Pressure regulated air supply, 120 to 125 psi. See “Fig. 16-19: Piping Arrangement for Testing Door” on page 45.
2. Water tank; size suitable for partially immersing door motor.
3. Air shutoff cock.
4. Quick dump air cock with exhaust port.

NOTE:

Air in large (closing) cylinder must be exhausted to atmosphere when cock is closed.

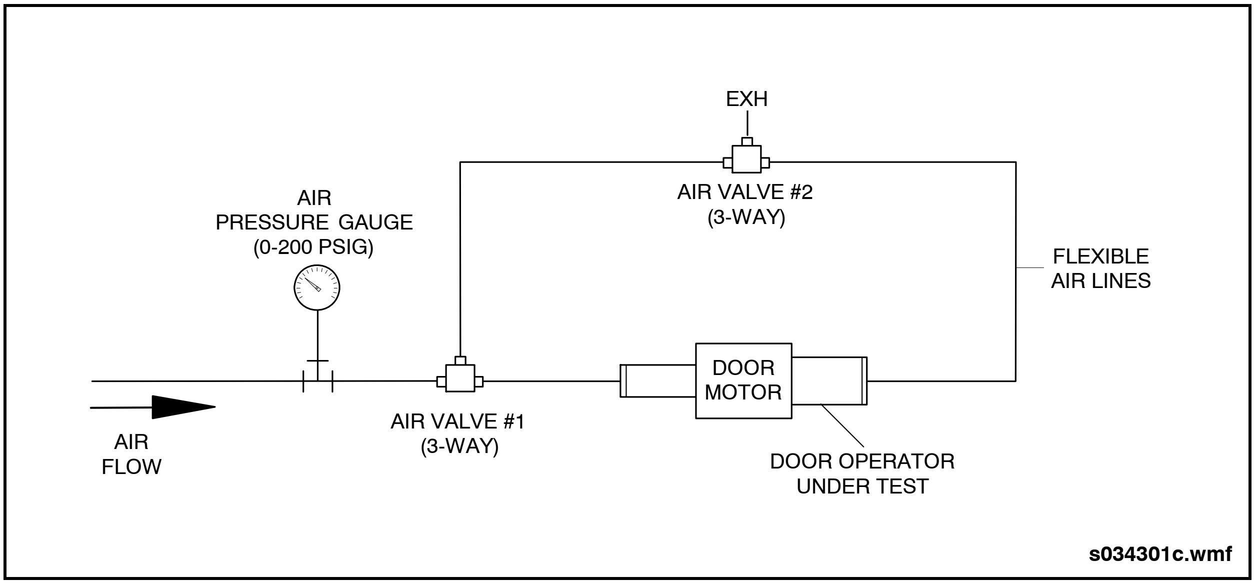


Fig. 16-19: Piping Arrangement for Testing Door

3.5.5.2. Leakage Test

1. After assembling in accordance with the instructions, turn on air supply and cycle the door motor to the CLOSED position.
2. With air supplied to both cylinders, submerge each end of the motor in the water test tank.

☞**NOTE:**

DO NOT submerge the complete door motor since the shaft bearing area is not air or water tight. DO NOT permit water to enter the motor under the coverplate. Submerge each cap end only, just above the cylinder gaskets.

3. Check entire motor-end caps, cylinder gaskets, metering screws and so forth for air leaks. All air leaks must be corrected before the door motor is given an operational test. Raise the motor from the test tank and shut off air supply. Disconnect test equipment and dry off motor. Proceed with operational test.

   However, if this test cannot be performed at this time, install thread protectors in each opening to prevent dirt and foreign objects from entering the cylinders.

3.5.5.3. Operational Test

1. Clamp the door motor securely in place on test bench.
2. Manually rotate the output shaft assembly to the full extent of its travel in both directions several times. Movement should be smooth and free of binding and without noise. Set the motor in the CLOSED position.
3. Check that the metering screws are adjusted as specified in step 11 in “Assembly”.
4. Connect the flexible air lines to both large and small cylinders with the air cocks in place. Close air cocks and turn on air pressure.
5. Open air cock No. 1 Air admitted to opening (smaller) cylinder should cause motor to rotate to the OPEN position.
6. Open air cock No. 2 Air admitted to the closing (larger) cylinder should cause the motor to rotate to the “closed” position. Cycle the motor several times by opening and closing air cock No. 2. Shaft rotation of the motor should be approximately 150° and travel should be smooth and free from noise. Check the horizontal position of the output lever according to your specific application drawing.
7. Cycle the motor several times and observe that a definite, consistent slowdown (cushioning) occurs after approximately 80° ± 5° of rotation in the opening direction. Operation should be smooth and without slamming. If cushioning occurs more then 5° late, adjust the cushioning metering screw to bring this movement to within tolerance. If the cushioning adjustment cannot be properly made, the cushioning seal is not seating properly and corrections must be made.
8. Cycle the motor to the OPEN position and shut off air supply.

3.6. Sensitive Edges

3.6.1. Description

The sensitive door edge system consists of a soft rubber edge with a sealed chamber, a PVC transfer tube, a pressure airwave switch and a set of door operator cam switches which signal door position, and interface with the electrical control system. See “Fig. 16-20: Door Edge to Panel Interface” on page 47.

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. 16-21: Switch Contacts” on page 48.

The switch is supplied with the sensitivity properly factory preset for the sensitive edge arrangement being utilized. See “Fig. 16-22: Air Wave Switch” on page 48.

Upon closure of the pressure wave switch contacts, the door control system is signaled to reverse (reopen). The door system will reopen until the 85° Limit switch is actuated. Refer to the DC (Door Controls) Electrical Schematic in Section 9 of this manual. The system will then reinitiate the closing cycle. Upon reaching a closed position, the 5° Limit switch will actuate. This switch indicates the doors are in a closed position and the sensitive edge circuit may then be deactivated.

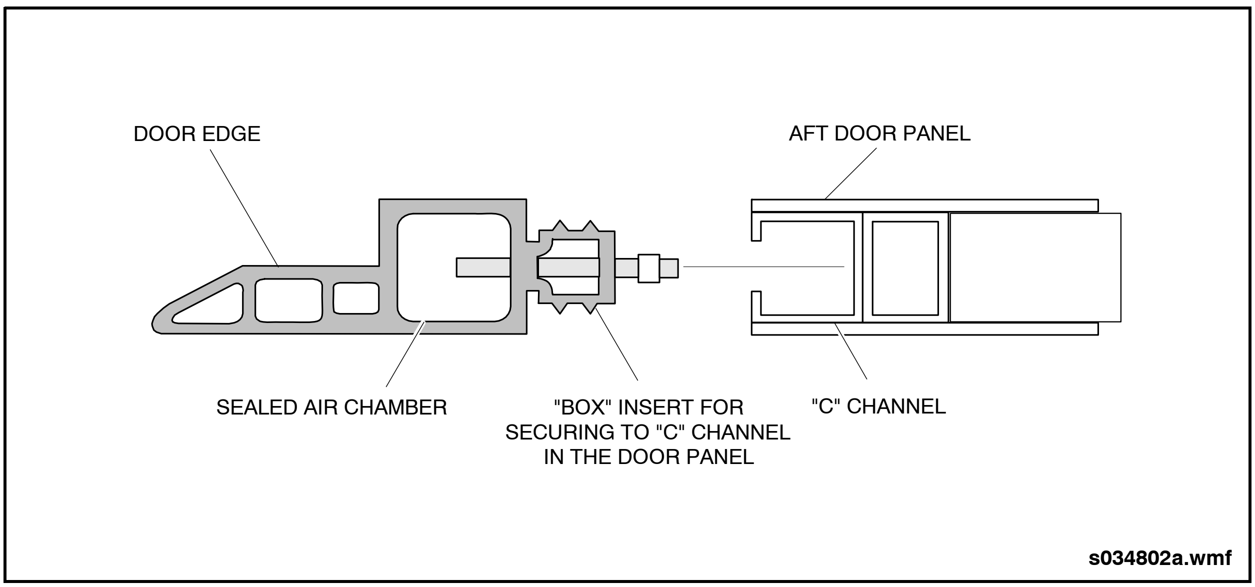


Fig. 16-20: Door Edge to Panel Interface

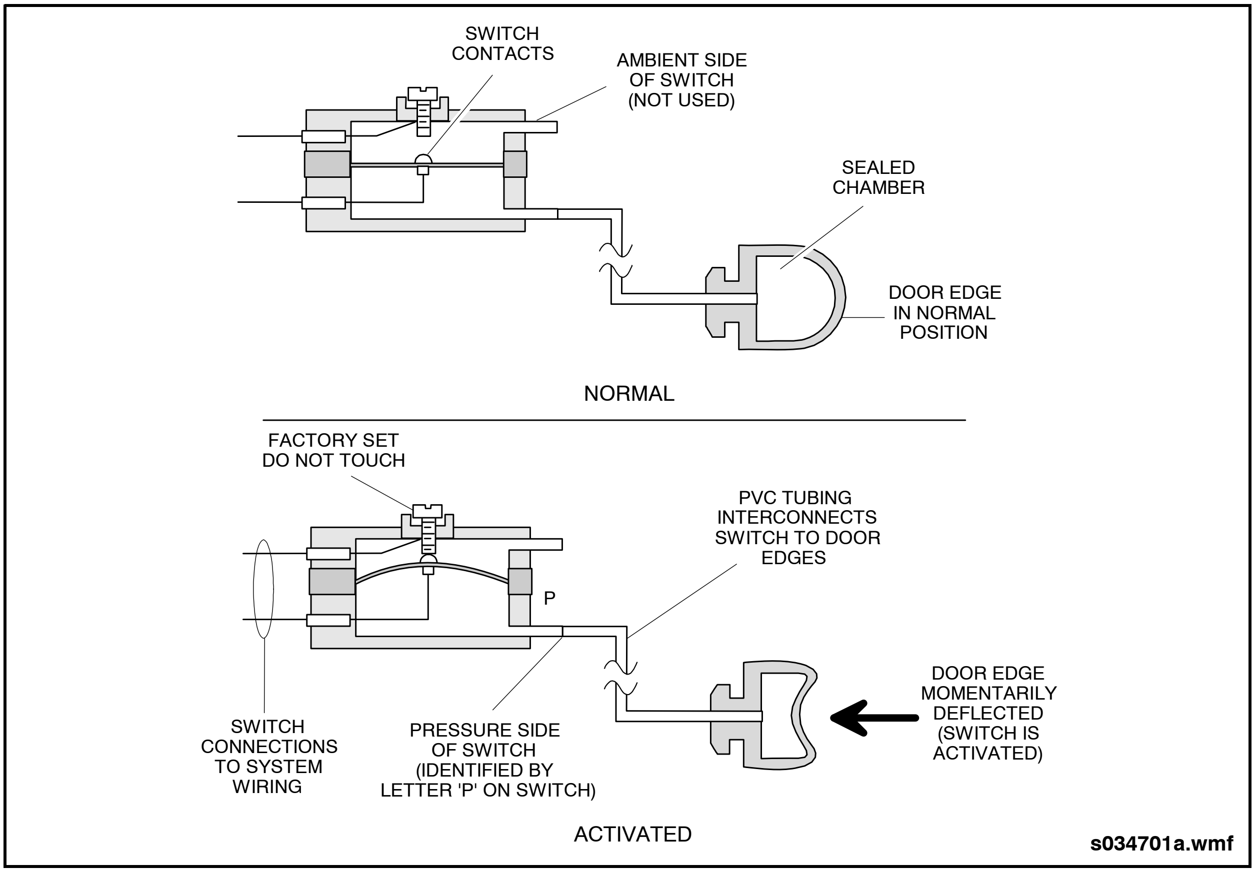


Fig. 16-21: Switch Contacts

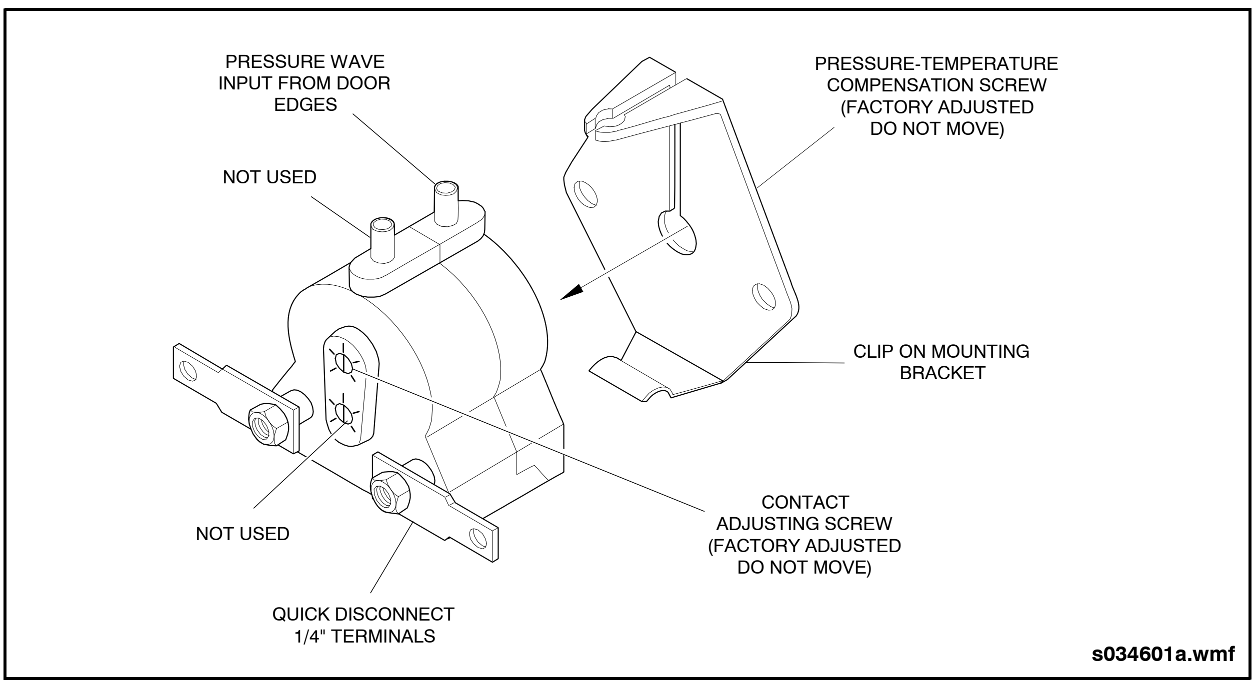


Fig. 16-22: Air Wave Switch

3.6.2. Functional Test

☞NOTE:

The following test is used to verify that the sensitive edges deactivate when the door is 5° from being fully closed. 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. 16-23: Pinch Test" on page 49.
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. 16-24: Rod Test" on page 49.
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.

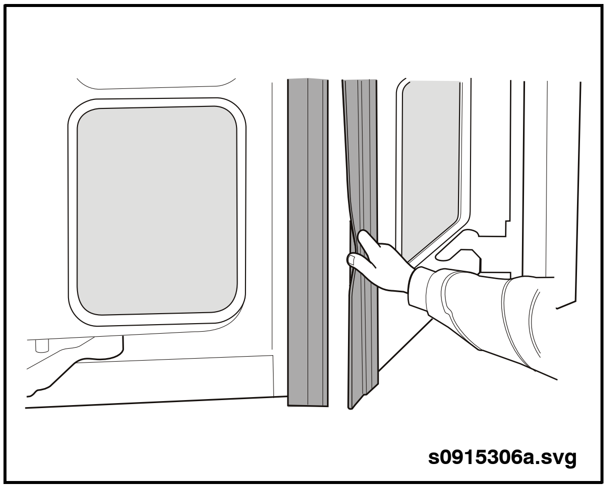


Fig. 16-23: Pinch Test

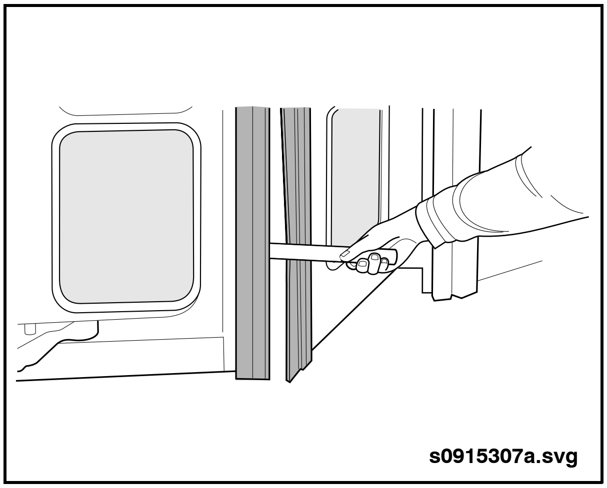


Fig. 16-24: Rod Test

3.6.3. Maintenance

Sensitive edge systems should be periodically checked following Limit 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).

3.6.4. 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. Connect the end of the tubing to the open port on the pressure wave switch.

3.7. CLASS™ Exit Door Sensing System

3.7.1. Description

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.

3.7.2. Operation

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.

3.7.3. 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.

3.7.4. 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 bus 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. 16-25: Door Controller Positions" on page 55.

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 bus and replace with a spare.

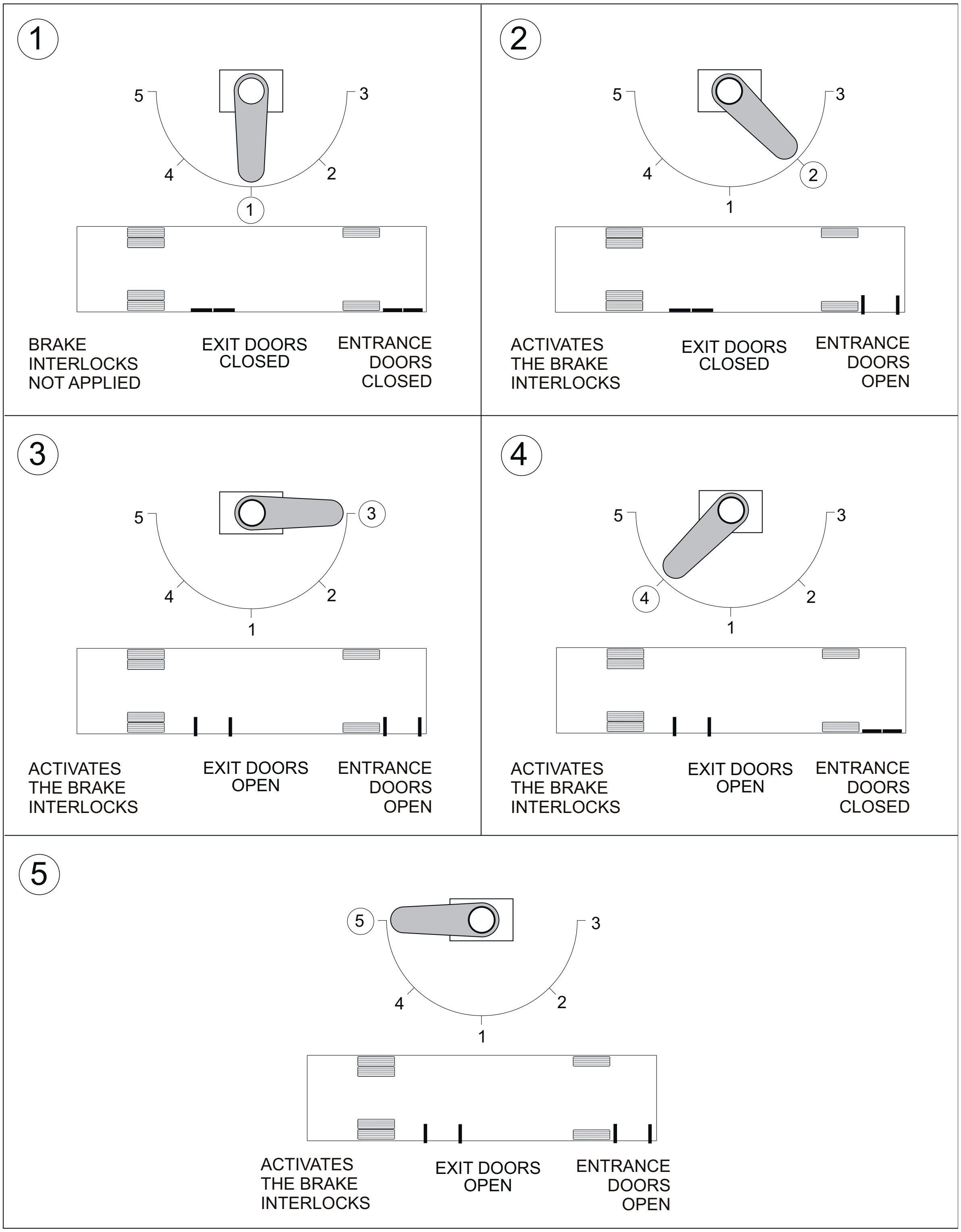


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Fig. 16-25: Door Controller Positions

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. 16-26: Door Controller Assembly” on page 57.
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 #10 split lock washer(s). Mark their location(s) for proper positioning during reassembly.
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.

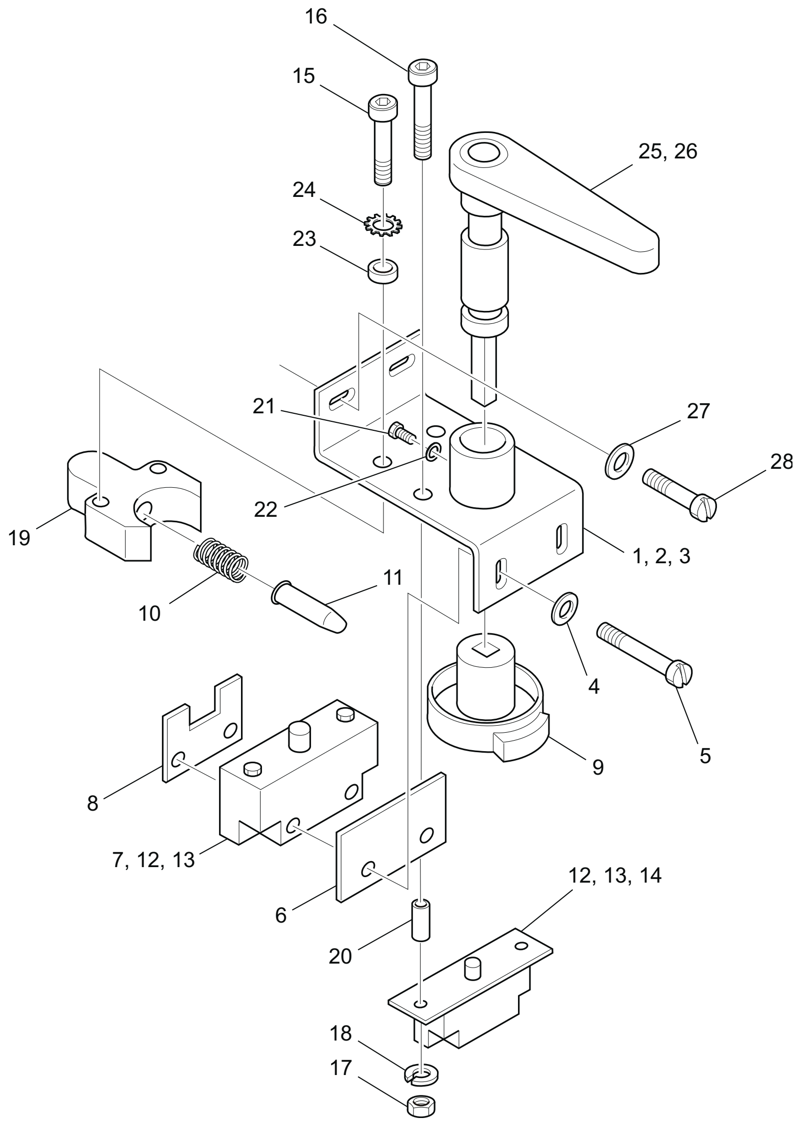
☞NOTE:

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. 16-26: 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. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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

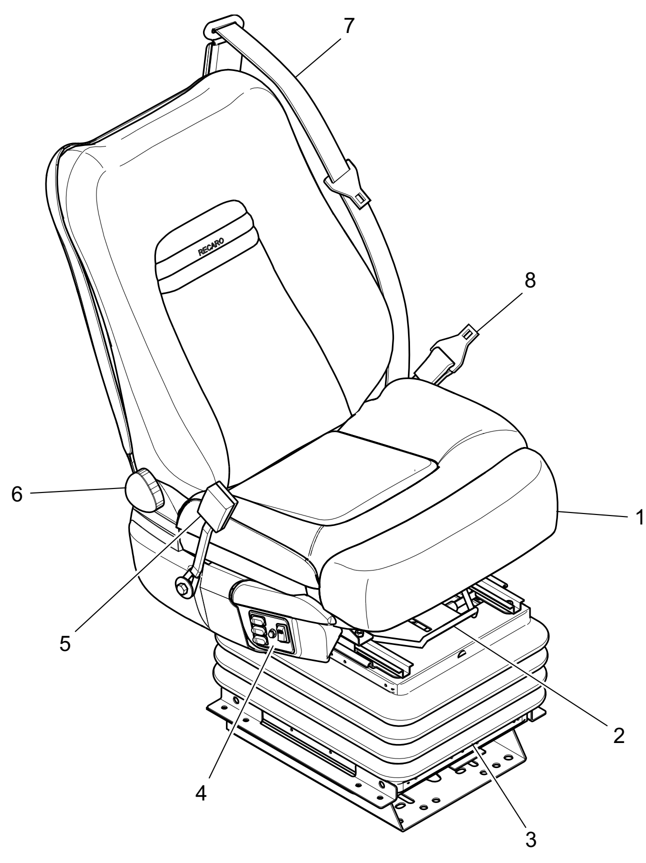
DO NOT adjust the seat while driving. Loss of control of the vehicle could result and cause an accident if attempting to adjust the seat while driving.

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.

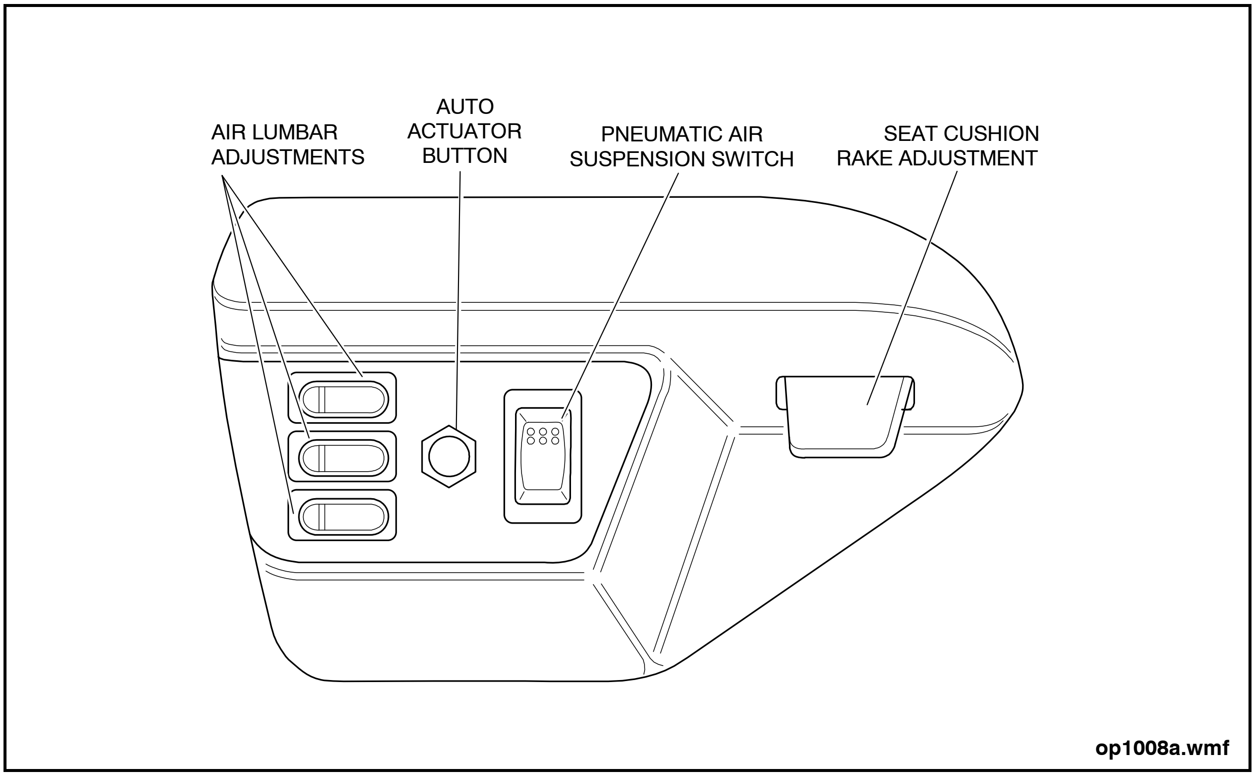


Fig. 17-2: Driver's Seat Switch Panel

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.

2.3. 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.

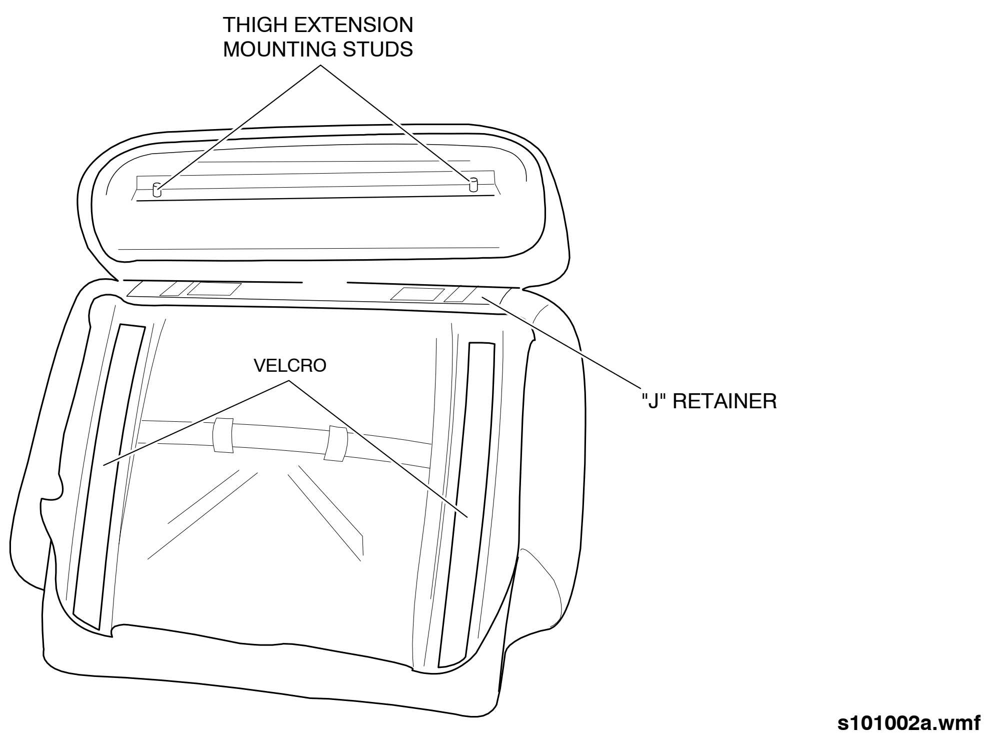


Fig. 17-3: Seat Cushion

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.

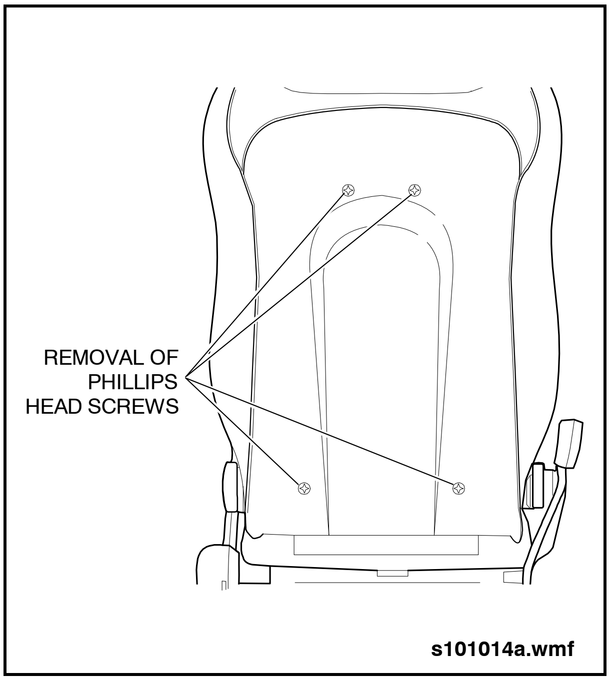


Fig. 17-4: Seat Back Cover

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.

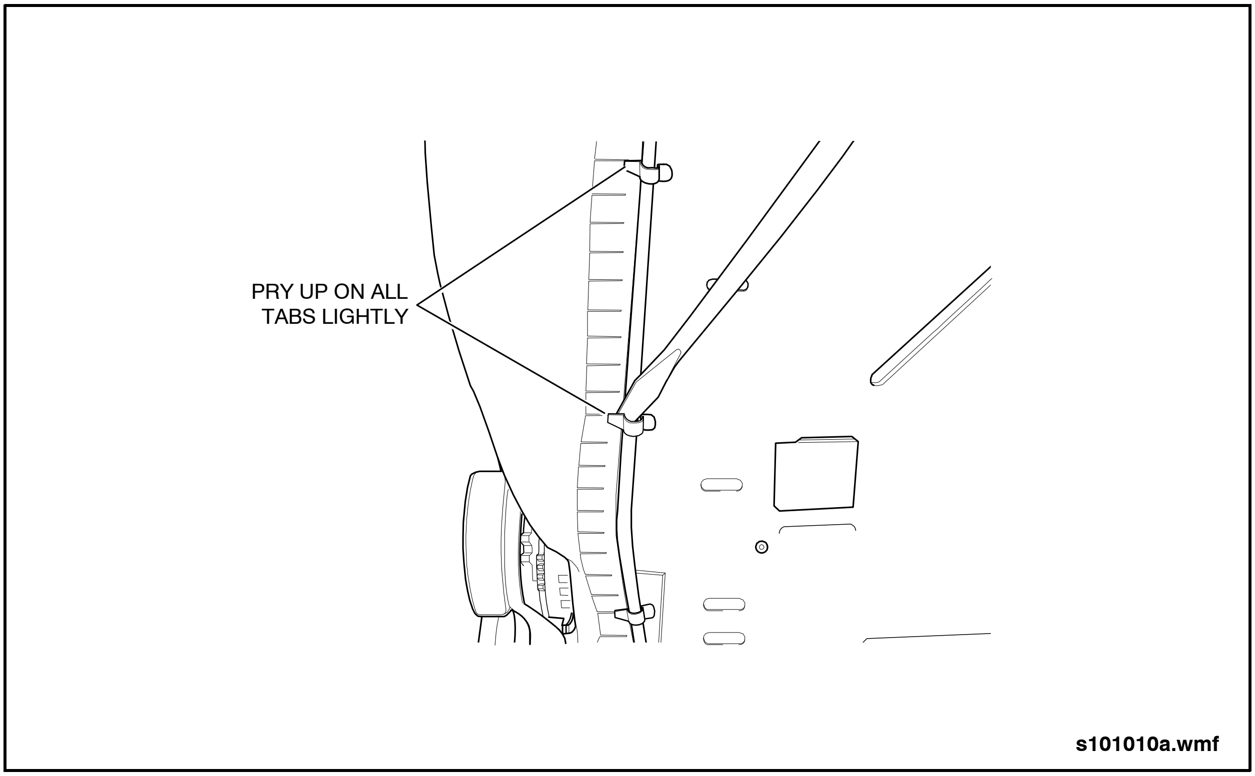


Fig. 17-5: Seat Back Cover Retaining Tabs

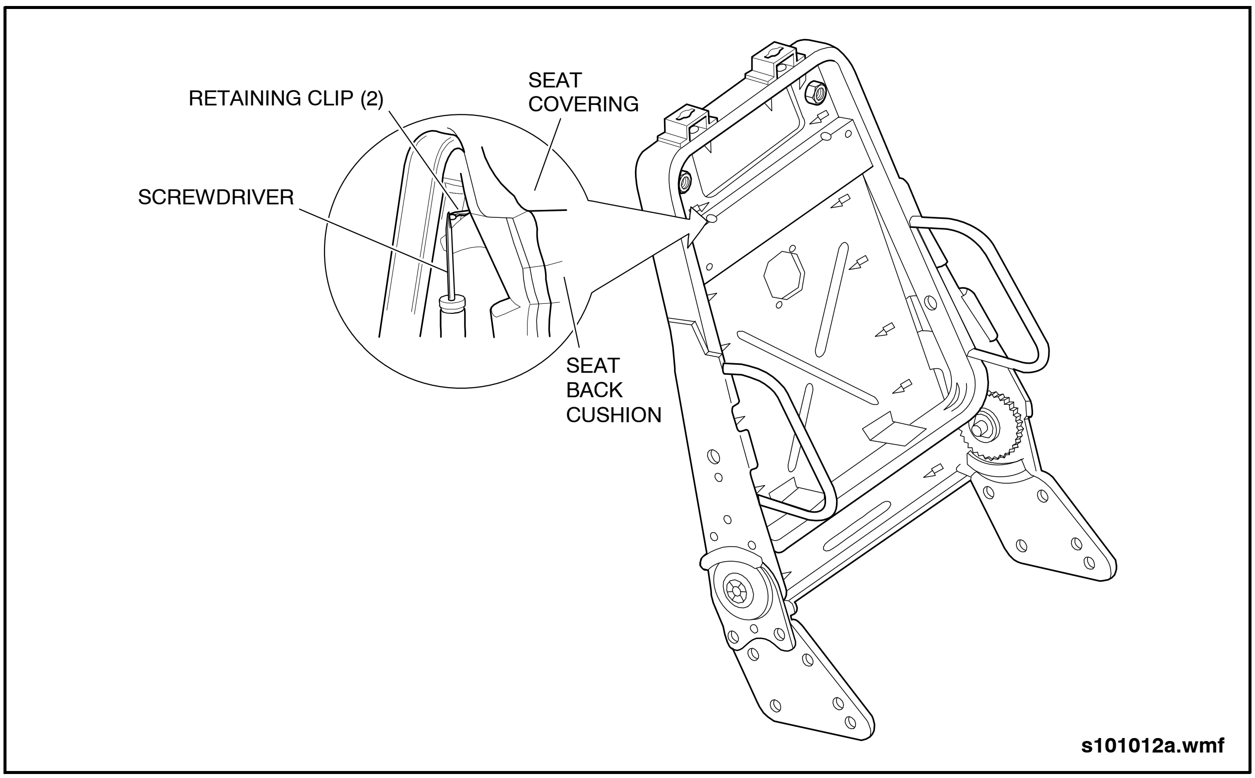


Fig. 17-6: Headrest Retaining Clips

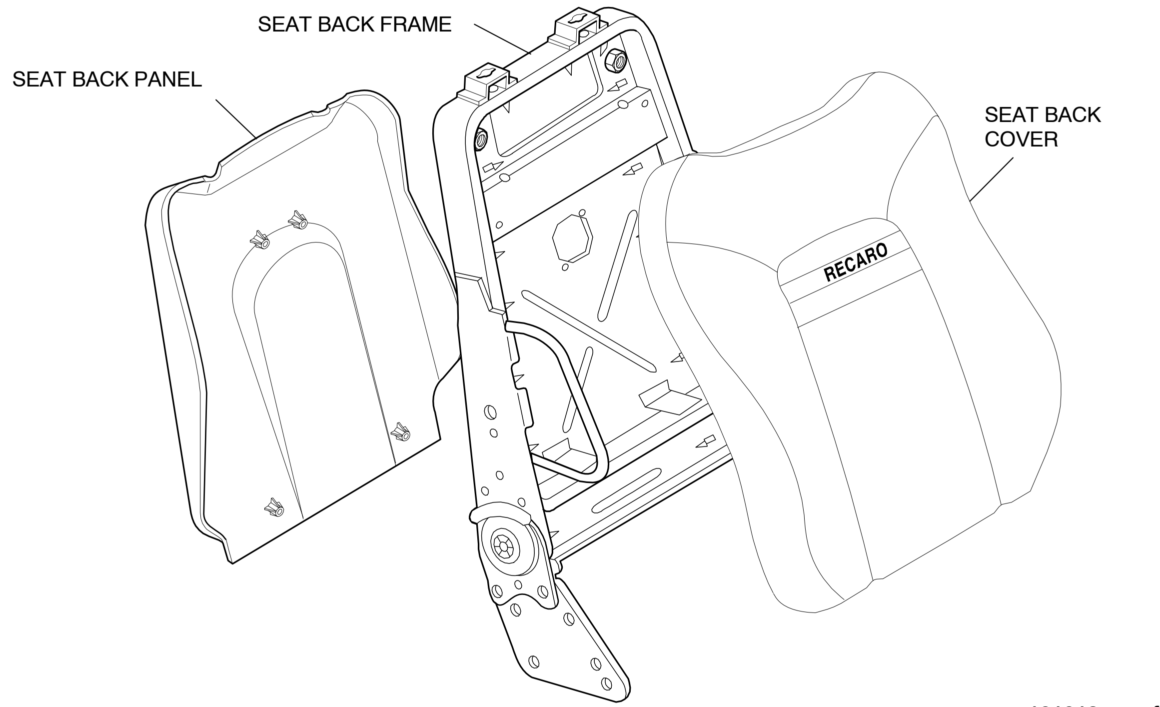


Fig. 17-7: Cover Retainer

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.

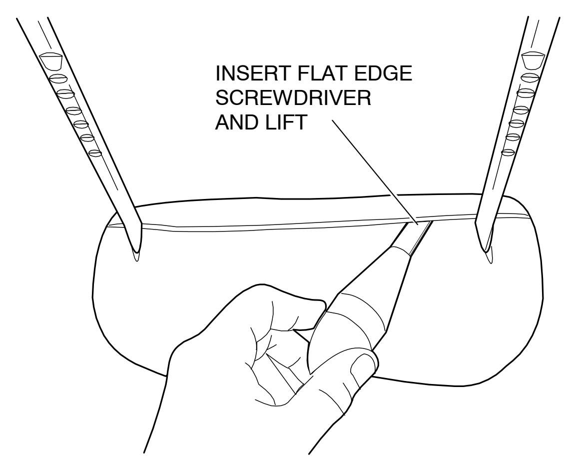


Fig. 17-8: Headrest Cover

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.

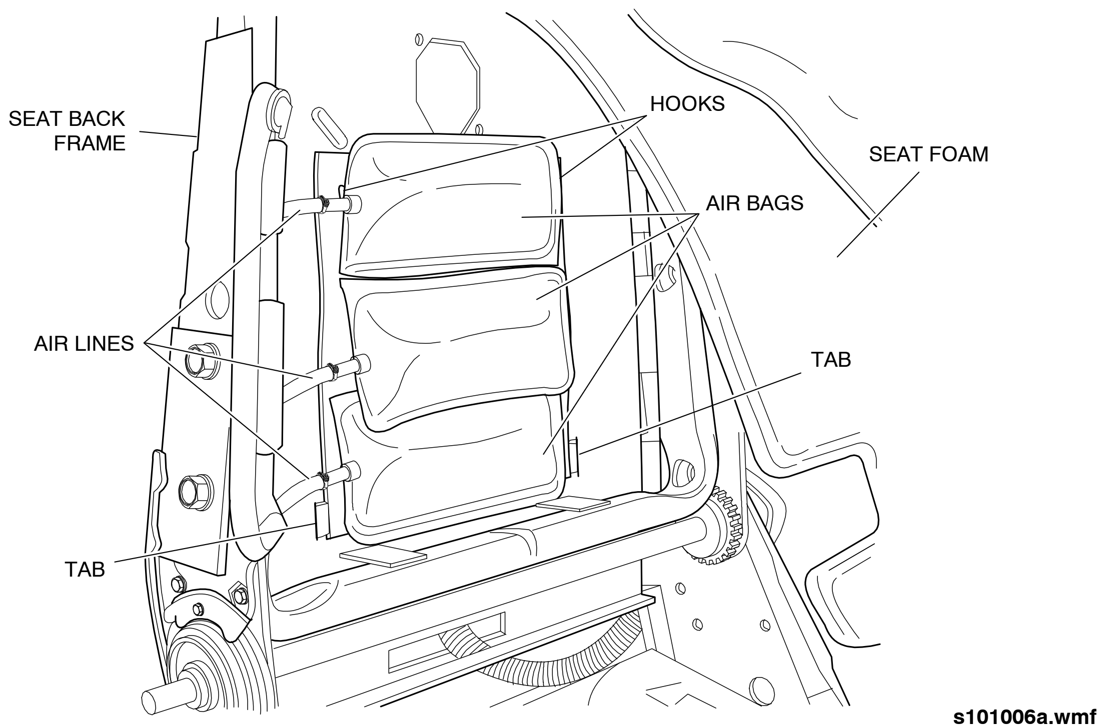


Fig. 17-9: Seat Lumbar Bags

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.

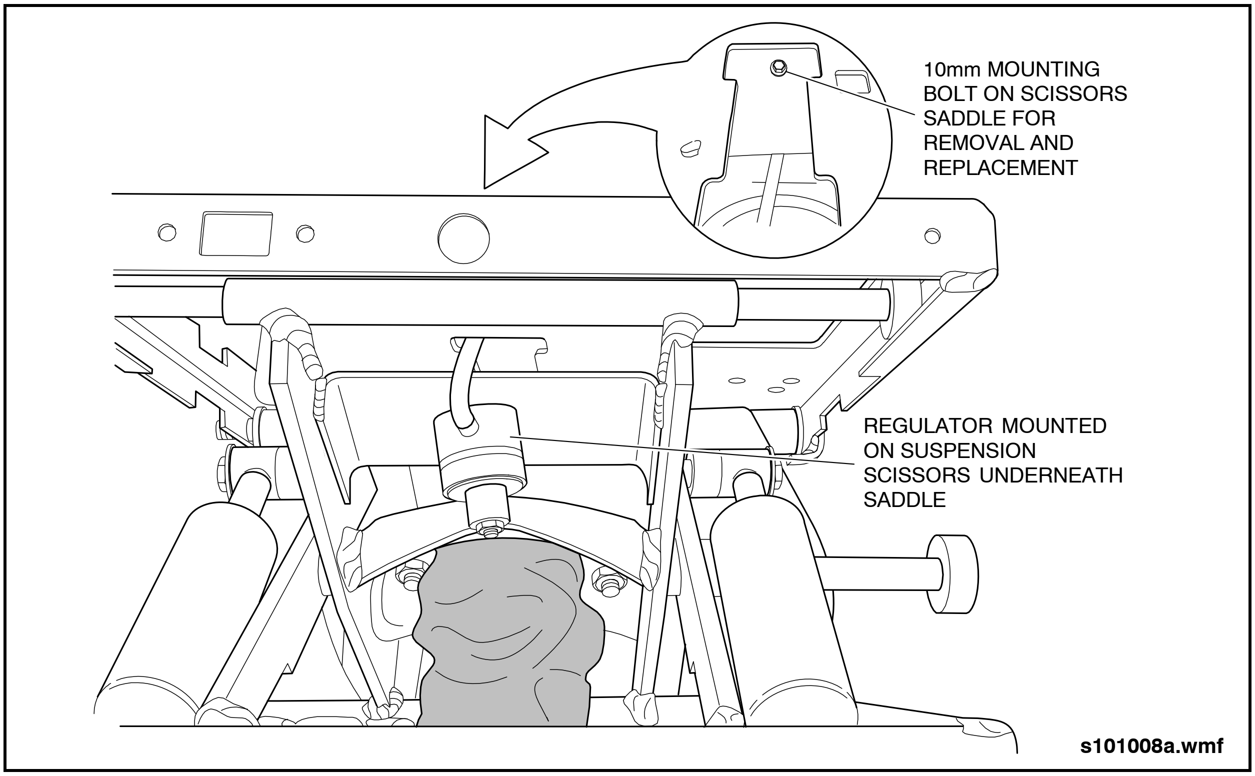


Fig. 17-10: Scissors Cross Bar Bolt

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.

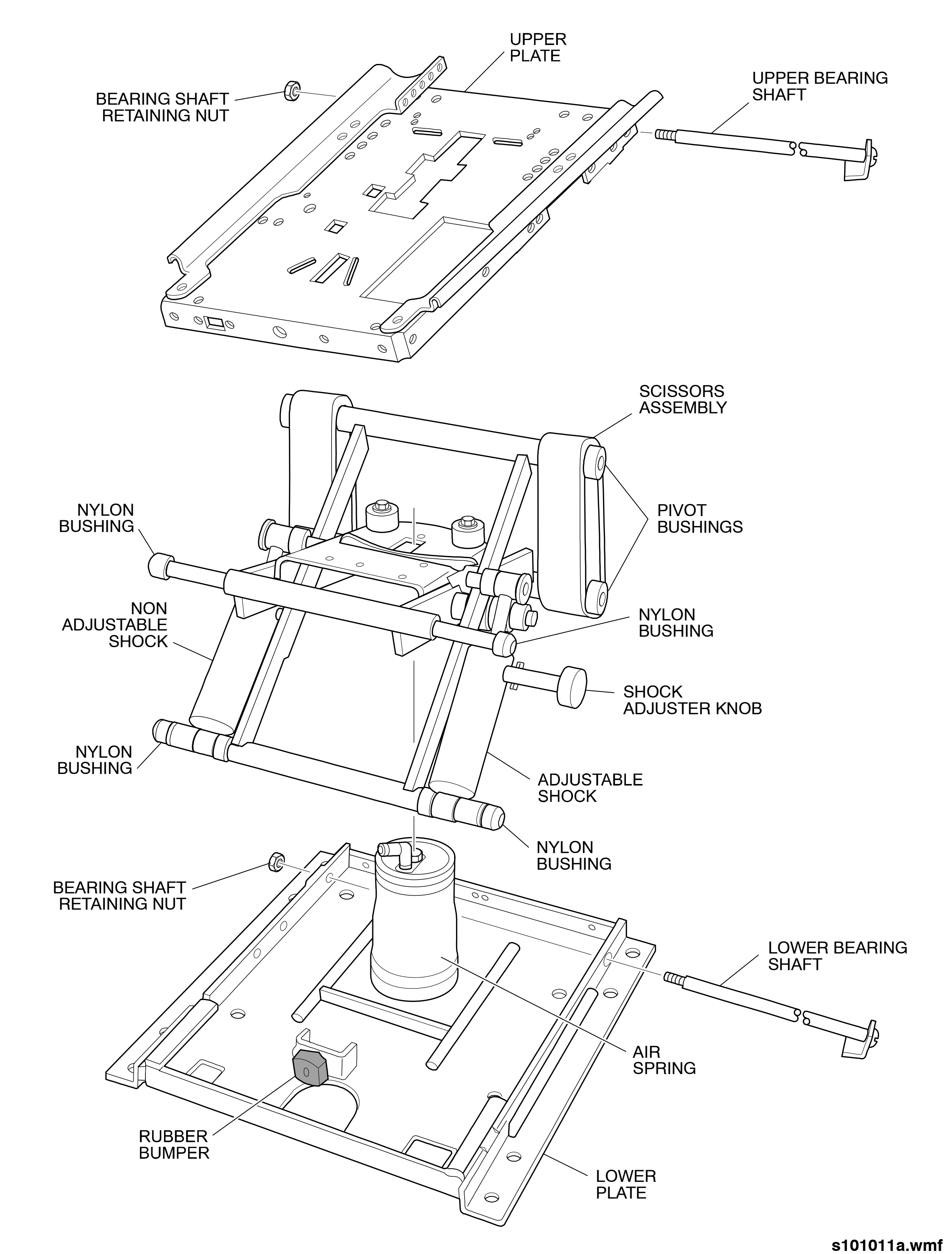


Fig. 17-11: Suspension Mounts

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

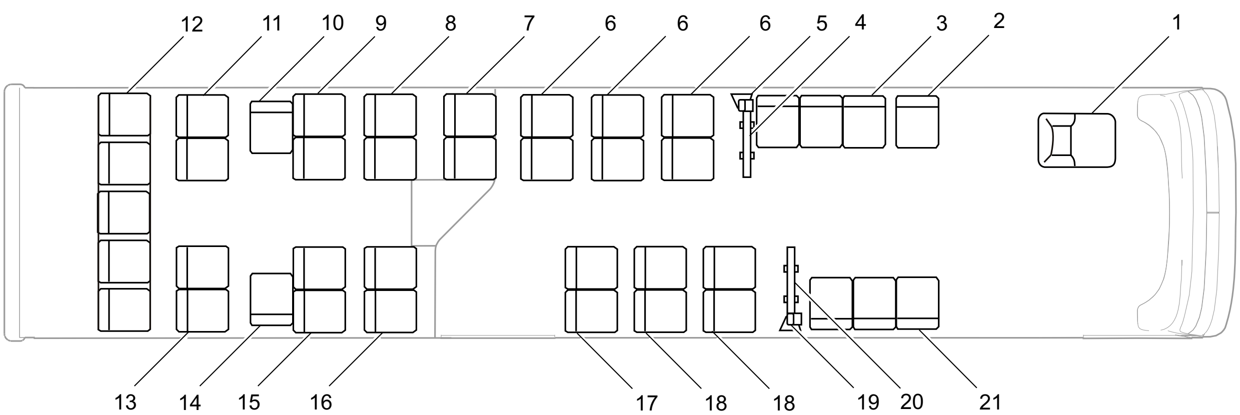
When replacing a seat-belt assembly, use all the new components in the service kit. Failure to install the seat-belt assembly to Recaro specifications could cause bodily harm in the event of an accident. Please follow and read instructions carefully and if there are any difficulties please contact Recaro 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. Tower Reliant, Barrier Streetside
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. Tower Reliant, Barrier Curbside
20. Barrier, Curbside
21. 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.

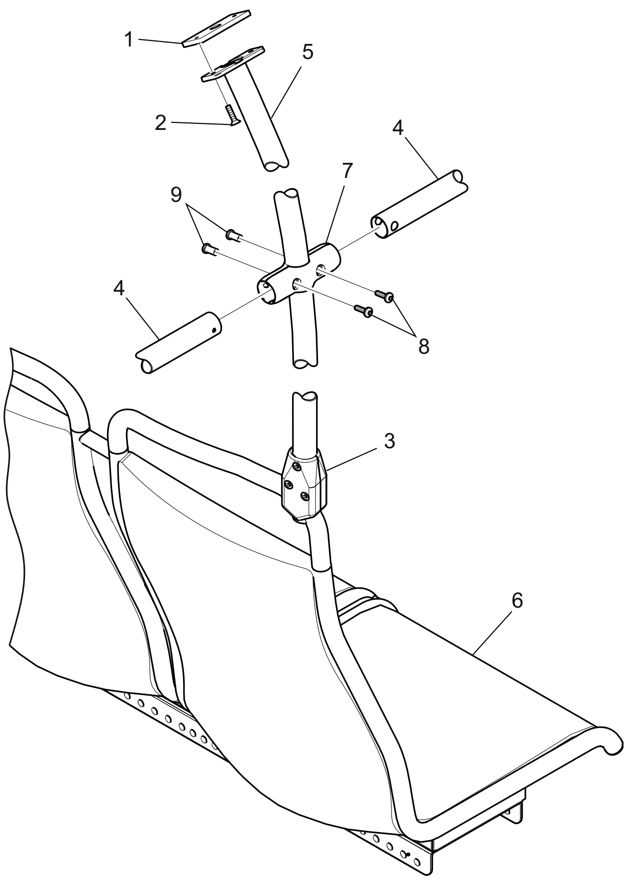
Regularly remove all dust and loose dirt from fabric with a whisk broom or vacuum cleaner. Always begin with lukewarm water and a white cloth for stain removal before applying any cleaning agent. Use foam upholstery cleaner or a mild household detergent and first testing in a small area. Flush the area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

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 16.



1. Mounting Plate
2. Screw
3. Stanchion Cup
4. Horizontal Grab Rail
5. Vertical Grab Rail
6. Passenger Seat
7. Cross Fitting
8. Screw
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 17.
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 17.
4. Remove the vertical stanchion and grabrail.

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.

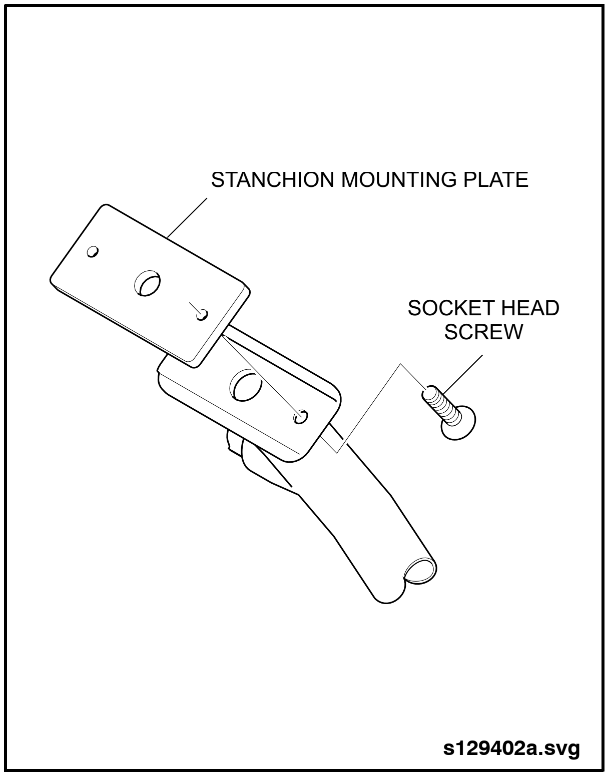


Fig. 17-14: Stanchion Upper Mounting

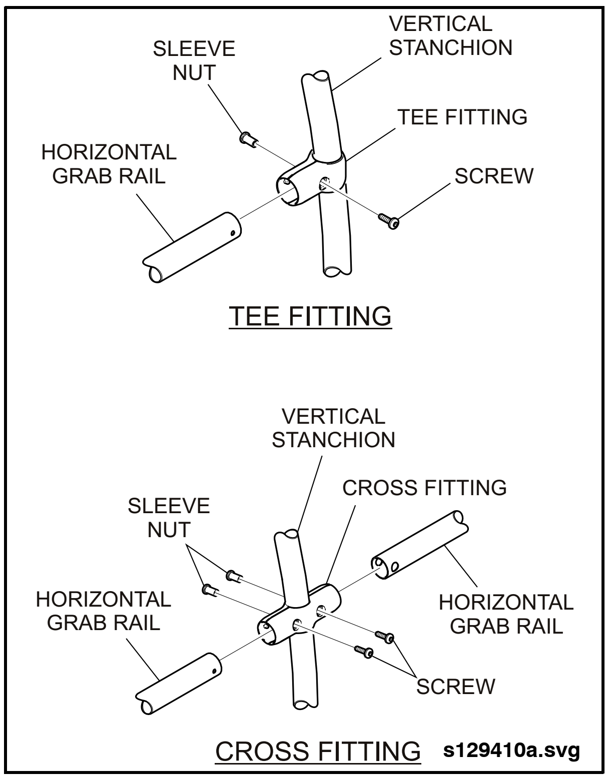


Fig. 17-15: Tee & Cross Fitting Connection

5. DRIVER’S DRAFT SHIELD DOOR

5.1. Description

The draft shield door is a two panel assembly that protects the driver's seat area. It consists of a lower door panel assembly and upper safety shield. See “Fig. 17-16: Driver’s Draft Shield Door” on page 18.

5.2. Operation

The upper safety shield can swing open independently by actuating the upper latch on the interior. The entire door can be opened by actuating the lower latch. The draft shield door can be held open by a latch mounted above the electronic equipment enclosure.

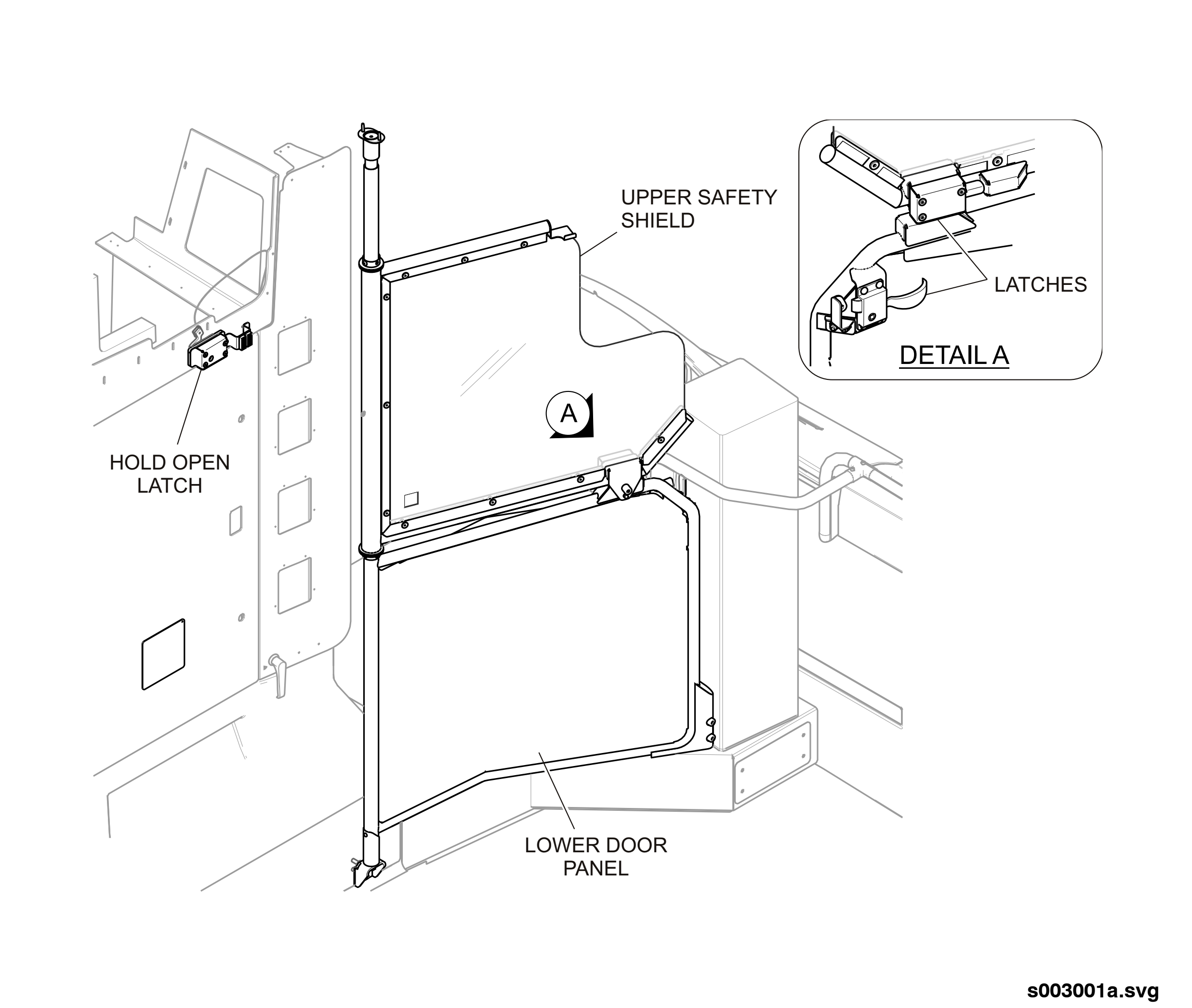


Fig. 17-16: Driver’s Draft Shield Door

6. WHEELCHAIR RESTRAINT SYSTEM

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. 17-17: Wheelchair Restraint System" on page 20.

6.1. Operation

6.1.1. 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.

6.1.2. Rear Wheelchair Restraints

Locate the two tie-down belts under the barrier and attach each belt to solid rear frame members of the wheelchair as follows:

1. Locate tie-down belt release handle on forward face of barrier.
2. Activate the belt release handle to release the tie-down belts.
3. Attach the extended end of each tie-down belt to a solid rear frame member of the wheelchair.
4. Use the belt tensioner to take up the belt slack.
5. Check belts to ensure they are secure.

6.1.3. Front Wheelchair Restraints

Attach the front tie-down belt to a solid front member of the wheelchair as follows:

1. Press the retractor release button and pull belt to extend.
2. Attach the extended end of belt to a solid front frame member of the wheelchair.
3. Take up the belt slack by pressing the release button again.
4. Turn the belt retractor knob until tight.

6.1.4. Passenger Securement

WARNING

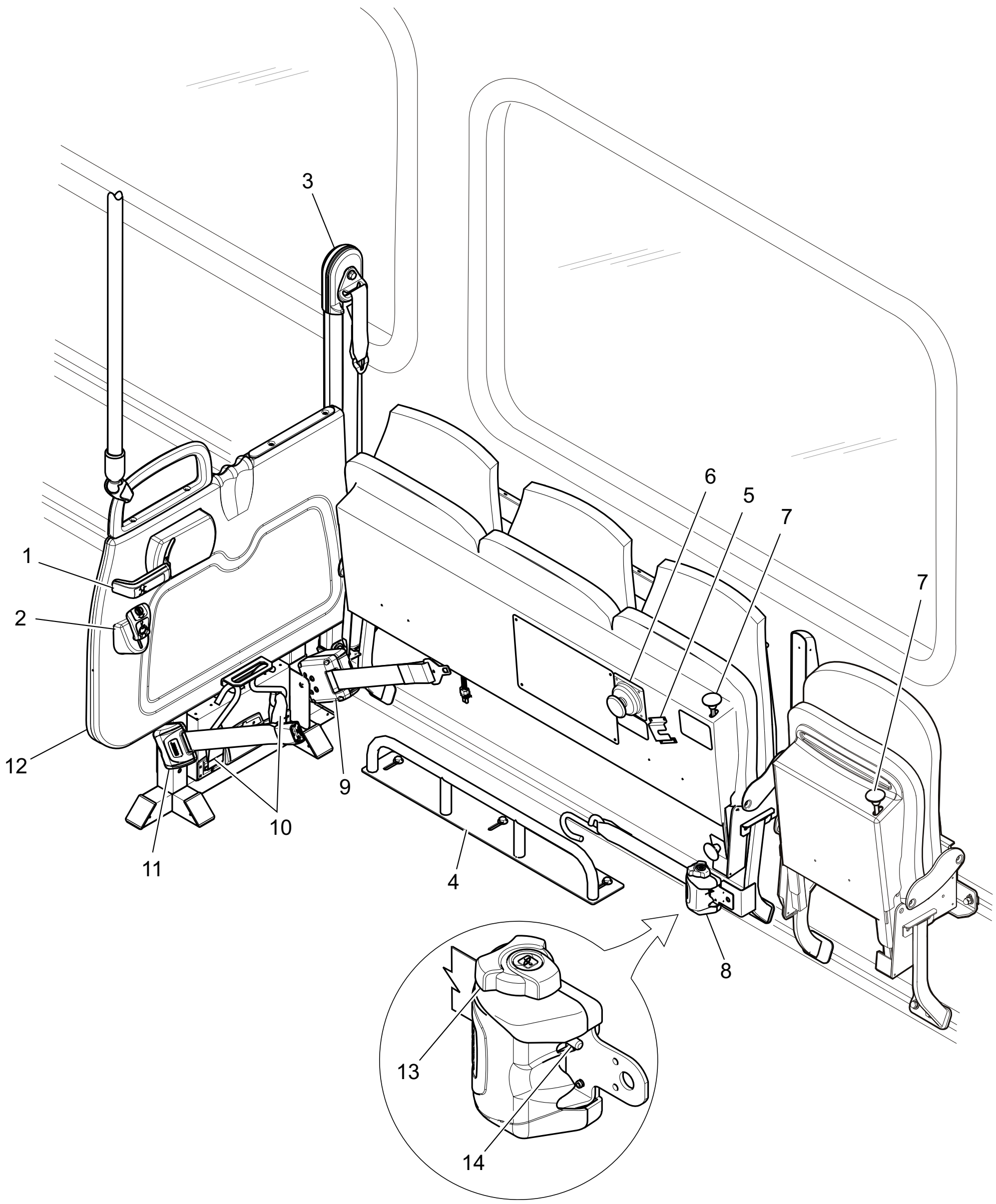
Restraints should not be held away from body by wheelchair components.

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.

6.2. Maintenance

Refer to the Preventive Maintenance Section of this manual for scheduled inspections of the wheelchair restraint system.



1. Belt Tensioner
2. Belt Release Handle
3. Shoulder Belt Height Adjuster
4. Wheelchair Guide
5. Lap Belt Hook Bracket
6. Stop Request Push Button
7. Flip-Up Mechanism Release Knob
8. Front Tie Down Belt
9. Lap Belt
10. Rear Tie-Down Belts
11. Lap Belt Clip
12. Barrier
13. Belt Retractor Knob
14. Retractor Release Button

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Fig. 17-17: Wheelchair Restraint System

Destination Signs

1. SAFETY

1.1. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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.

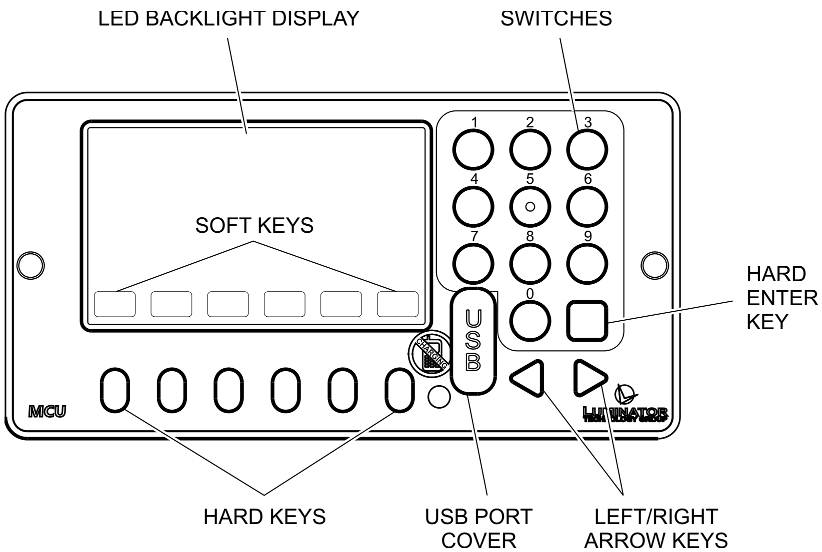


Fig. 18-1: Multi Control Unit (MCU)

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.

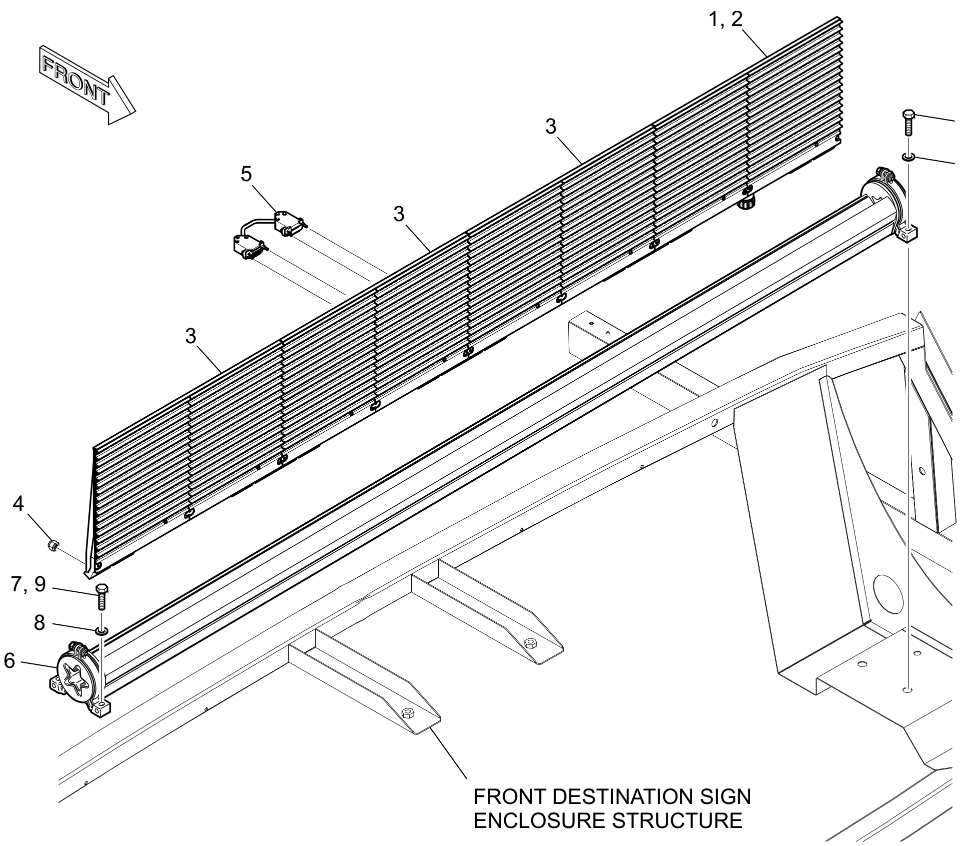
⚠ CAUTION

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 nuts and washers from either end 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 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.

s0360138b.svg

Fig. 18-2: Front Destination Sign Installation

2.3.5. Disassembly

1. Unplug the two wiring connectors from the power supply/data controller board.
2. Disconnect the power/data cable from the four display boards.
3. Remove each display board or power supply/data controller board by removing the two retaining nuts. Remove board assembly from support bar.
4. 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 four display boards and the power supply/data controller board using two retaining nuts for each board.

   ☞**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 power/data cable to the four display boards.

4. Plug the two wire connectors into the power supply/data controller board.

2.3.7. Installation

1. Align sign assembly mounts over the studs in the destination sign compartment. Secure with nuts and washers.

2. Connect vehicle wiring harness to sign.

3. Set Battery Disconnect switch to ON position.

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

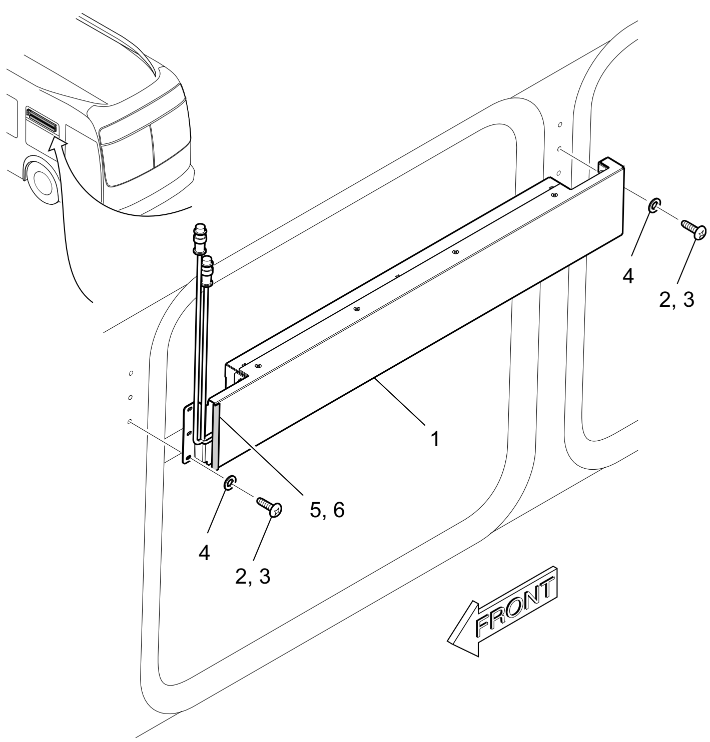
1. Set the Battery Disconnect switch to the OFF position.
2. Disconnect the electrical connections to the sign, and tag for reinstallation. See "Fig. 18-3: Side Destination Sign Installation" on page 9.
3. Remove the retaining screws holding the sign in place and remove the sign.

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

s0362100c.svg

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

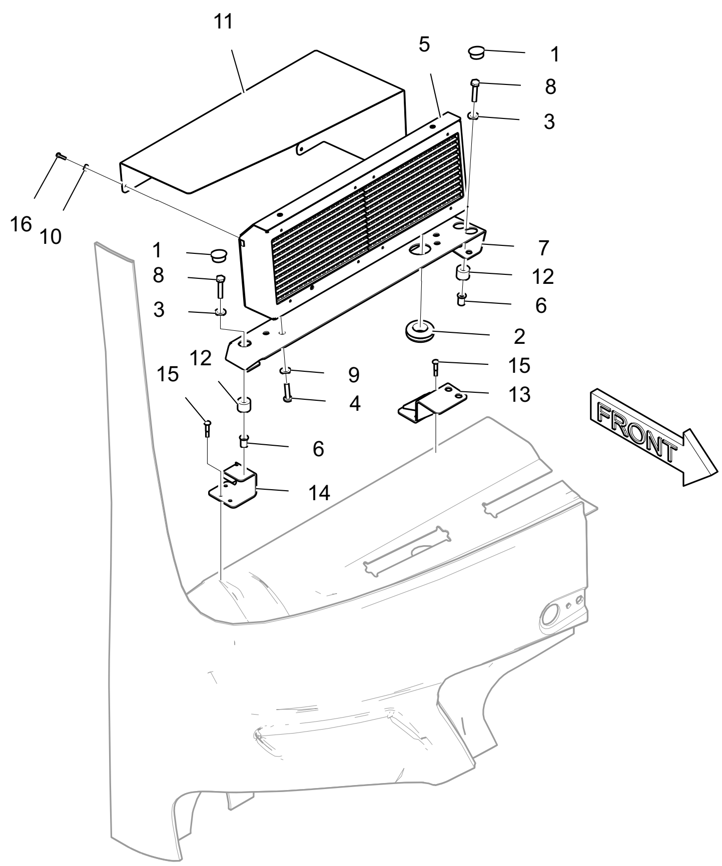
1. Set the Battery Disconnect switch to the OFF position.
2. Remove the mounting screws from the mounting bracket.
3. Raise the unit and disconnect the electrical connector.
4. Remove the unit from the vehicle.
5. Service the unit. Refer to the Luminator Service Manual for procedure.

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 on the rear exterior 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

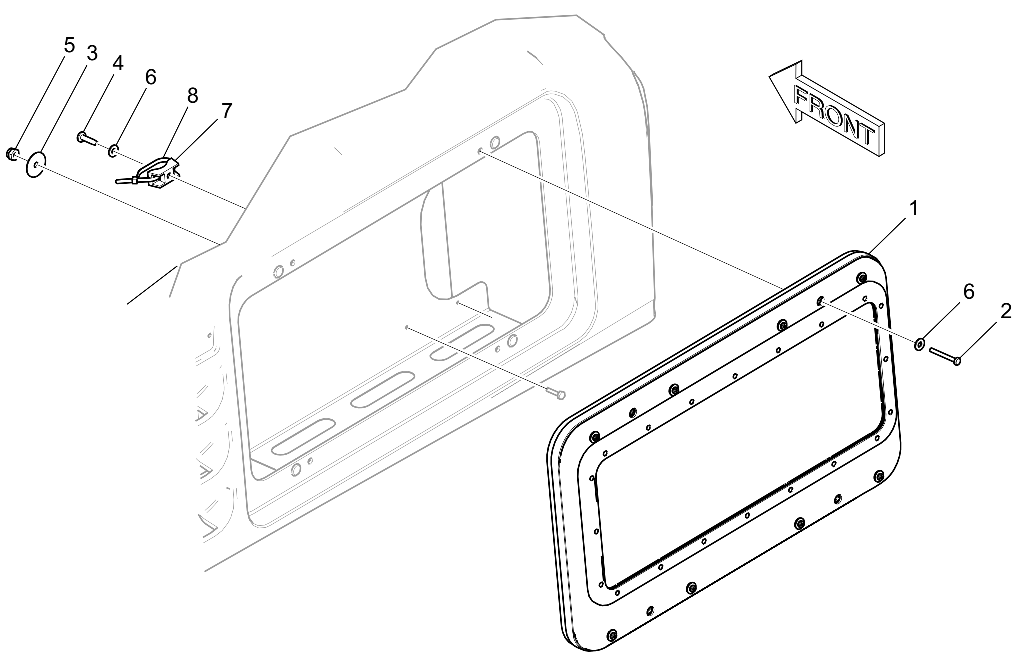
1. Set the Battery Disconnect switch to the OFF position.
2. Remove the retaining screws from the rear sign.
3. Pull the sign outward and disconnect the wiring.
4. Remove the rear sign from the vehicle.

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. Screw, PH Cross Recess SS #10 - 24 UNC x 1 3/4" Lg.
3. Washer, Flat 1/4" SST
4. Screw, PH Cross Recess SS #10 - 24 UNC x 3/4" Lg.
5. Nut, Lock Nylon #10 SST
6. Washer, Flat SS #10
7. Mounting Base
8. Cable Tie, Black 7" Lg.

s098236a.svg

Fig. 18-5: Rear Route Sign Installation

3. VENDOR SERVICE INFORMATION

The following supplier manuals contain additional reference information.

3.1. Luminator Manuals

❒ Horizon Operation & Maintenance Manual

Driver's Controls

1. SAFETY

1.1. High Voltage Safety

DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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.

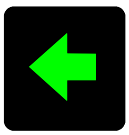
CAUTION

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.



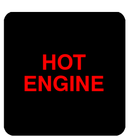
2.1.1. Turn Indicators (Green)

⚠ 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:**

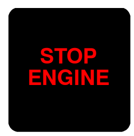
If this indicator remains illuminated, the Engine Protection System engages, initiating an automatic engine shutdown sequence.

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.



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.

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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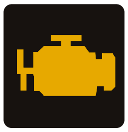
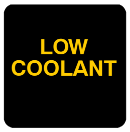
Fig. 19-1: Instrument Panel



2.1.5.Exhaust Malfunction Indicator (Amber)

The Exhaust Malfunction indicator will illuminate when a malfunction related to the Emissions Control System is detected.

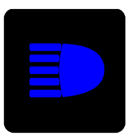


2.1.6.Low Coolant Indicator (Amber)

The Low Coolant indicator illuminates if too little coolant is in the engine to maintain normal engine operating temperature.

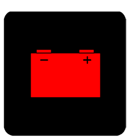
☞**NOTE:**

If this indicator remains illuminated, the Engine Protection System engages to initiate an automatic engine shutdown sequence.



2.1.7.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.

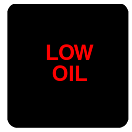


2.1.8.No Gen Indicator (Red)

⚠ **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.



2.1.9.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.

2.1.10.High Exhaust Temp Indicator (Amber)

⚠ **WARNING**

If the High Exhaust Temp indicator on the instrument panel illuminates, ensure the exhaust outlet is not located where it could cause damage to persons or any materials which could melt or explode, and that nothing is within 2 feet of the outlet. Ensure no combustible materials are within 5 feet of the outlet. Exhaust outlet temperatures can reach 1500°F (800°C) when this indicator illuminates.

The High Exhaust Temp indicator illuminates during the regeneration process when exhaust temperatures are high.

☞**NOTE:**

Illumination of this indicator does not signify the need for any kind of vehicle or engine service.

EXHAUST REGEN NEEDED

2.1.11.Exhaust Regen Needed Indicator (Amber)

This indicator will either illuminate steady or flash and may illuminate in combination with the Check Engine indicator to indicate the various stages of soot buildup in the muffler particulate filter. Refer to the following chart for a description of various conditions and actions required when this indicator illuminates.

EXHAUST REGEN NEEDED INDICATOR FUNCTION

DPF Soot Level	Exhaust Regen Needed Indicator	Check Engine Indicator	Stop Engine Indicator	Engine Derate	Procedure
Low to Medium	On	Off	Off	None	Increase vehicle duty cycle to allow mobile active regeneration.
Medium to High	Flashing	Off	Off	None	Increase vehicle duty cycle to allow mobile active regeneration.
High	Flashing	On	Off	Derate (Note 1)	Perform stationary regeneration (Note 3)
Severe	Off	Off	On	Severe Derate (Note 2)	Stop engine at earliest opportunity. (Note 3)

Note 1: Moderate derate of engine torque.
Note 2: Severe derate or engine speed.
Note 3: Stationary regeneration will be disabled.

2.1.12.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.

2.1.13.ABS Fail Indicator (Amber)

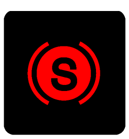
The ABS Fail indicator illuminates if the ABS System requires service. Engine start-up illuminates the indicator momentarily as part of a system check. It is also used during diagnostics to display the blink code.

2.1.14.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.



2.1.15.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 parking brake indicator will begin to flash if the E-Stroke System activates.

2.1.16.Diesel Exhaust Fluid (DEF) Indicator (Amber)

The DEF symbol will illuminate to indicate that the fluid level in the tank is low and needs to be refilled.

2.1.17.Wait to Start Indicator (Amber)

The Wait to Start indicator illuminates before engine start-up with the Master Run switch in the DAY-RUN or NIGHT-RUN position. The indicator will remain illuminated for up to 45 seconds while the intake air heater system operates.

☞**NOTE:**

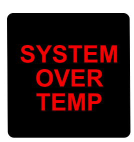
The Wait to Start indicator and the intake air heater system will only operate in temperatures below 66°F (19°C).

2.1.18.A/C Fail Indicator (Red)

The A/C Fail indicator illuminates if the heating, ventilating and air conditioning (HVAC) unit malfunctions.

2.1.19.ATC Indicator (Amber)

The ATC indicator illuminates when the Automatic Traction Control System is operating to limit drive wheel spin on slippery surfaces.



2.1.20.System Overtemp Indicator (Red)

The System Overtemp Indicator illuminates if the oil in the EV Drive System™ or Dual Power Inverter Module (DPIM) exceeds the maximum rated operating temperature. Immediately move the vehicle to a safe area and shut down the system.

2.1.21.Check System Indicator (Amber)

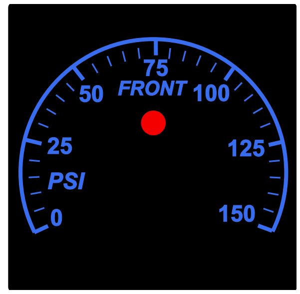
CAUTION

If the Check System indicator illuminates for more than 30 seconds, remove the vehicle from traffic to a safe location, shut the engine down and apply the parking brake.

The Check System indicator illuminates if a non-critical fault is detected in the Allison electric drive system.

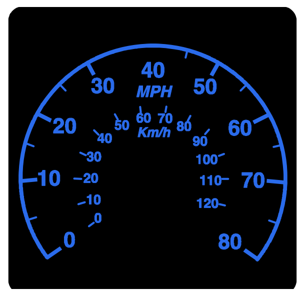
2.1.22.Stop System Indicator (Red)

The Stop System indicator illuminates if a major fault or unsafe operating condition is detected in the Allison electric drive system. Immediately move the vehicle to a safe 21area and shut down the system.



2.1.23.Air Pressure Gauges

Individual analog air pressure gauges are used to monitor the vehicle's front and rear air brake systems. An LED indicator at the bottom 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).



2.1.24.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.

2.1.25. 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 8. The screen has a trip odometer and an hour meter in the upper left hand corner.

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 8.

Reset the trip counter by pressing and holding for 1 second in the odometer. See "Fig. 19-4: Resetting the Trip Counter" on page 9.

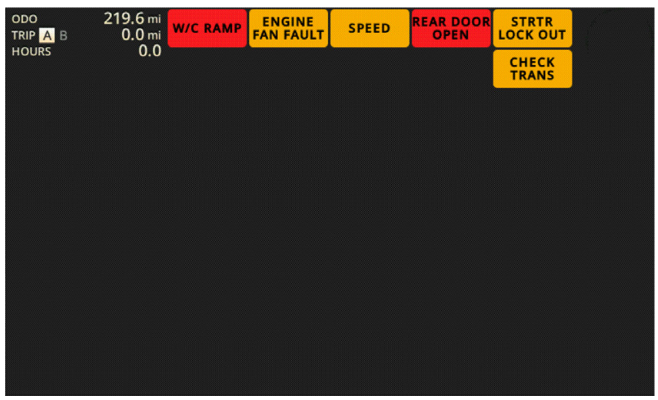


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Fig. 19-2: Operator Screen

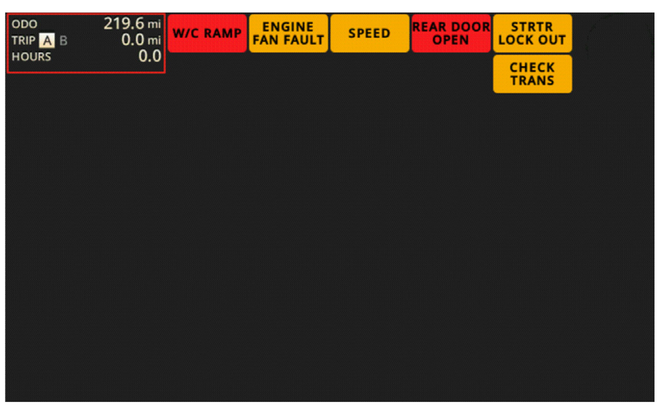

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Fig. 19-3: Changing from Trip A to B

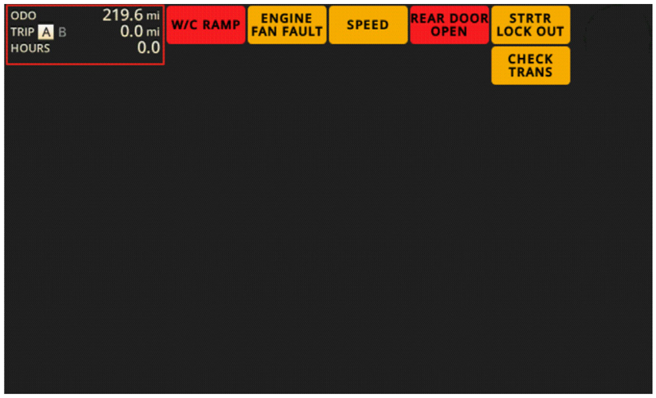

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Fig. 19-4: Resetting the Trip Counter

2.1.25.1.Password Entry Screen

- ❒ Enter PIN code and press OK or to go back, press the Exit icon. See “Fig. 19-5: Password Entry Screen” on page 9.

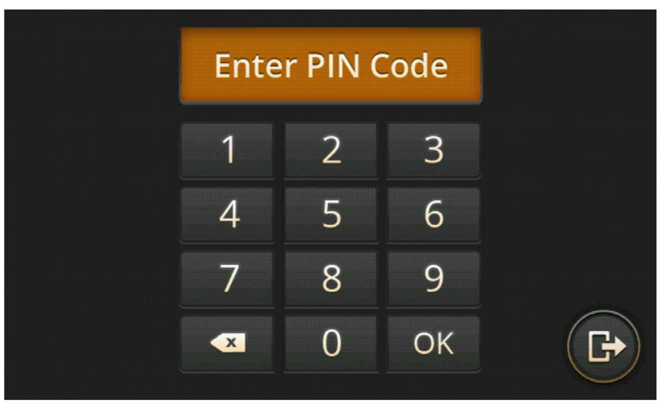

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Fig. 19-5: Password Entry Screen

2.1.25.2.Service Mode Screen

- The Service Mode screen provides access to functions shown. The Mute Speaker icon disables the alarm sounds when in Service Mode. The sound automatically reverts back to normal operation when you exit from Service Mode. Select an action by touching an icon or to go back, press the Exit icon. Touch here for the Updater access Service Mode screen. See "Fig. 19-6: Service Mode Screen" on page 10.

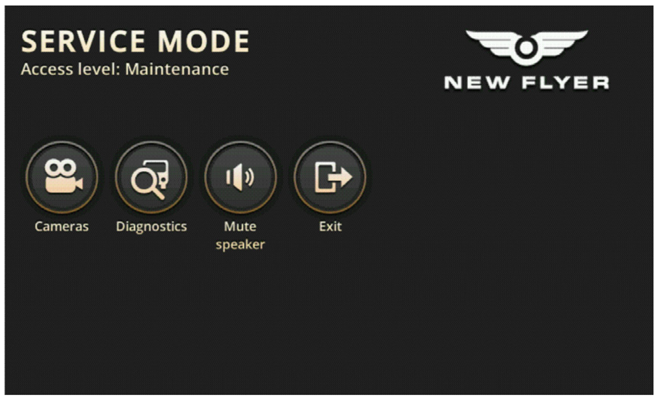

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Fig. 19-6: Service Mode Screen

2.1.25.3.Function Readout Displays

- Diesel Exhaust Fluid Level - displayed on a bar graph as percentage of fluid remaining in the tank. The low DEF indicator illuminates at 10% capacity and flashes at 5% capacity. See “Fig. 19-7: Function Readout Screen” on page 11.
- 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. The low battery indicator illuminates when the voltage is at 11 volts.
- 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. The low battery indicator illuminates when the voltage is at 23 volts.

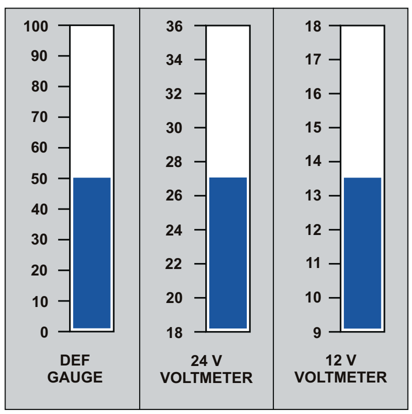

Fig. 19-7: Function Readout Screen

2.1.25.4.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.
- ❒ Starter Lockout (Amber) - This message will appear if an attempt is made to re-engage the starter within four seconds of a previous starter engagement. Allow four seconds to elapse before attempting to re-engage the starter.
- ❒ 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.
- ❒ 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.

- ❒ Rear Door Open (Red) - The Rear Door Open message appears when the exit door is open or a fault is detected in the Obstruction Detection System.
- ❒ Front Brake Worn (Amber) - The Front Brakes Worn message will appear on the LCD screen to indicate that the brake disc pads have worn to a limit where service is required.
- ❒ Rear Brake Worn (Amber) - The Rear Brakes Worn message will appear on the LCD screen to indicate that the brake disc pads have worn to a limit where service is required.
- ❒ 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.
- ❒ Stop Request (Red) - The Stop Request message will appear when the passenger signal system has been activated.
- ❒ Hybrid Initial (Amber) - The hybrid initial message advises that the hybrid drive is initiating.
- ❒ 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.
- ❒ Seat Belt (Red) - The Seat Belt message appears and a buzzer sounds when the driver's seat belt is unfastened.
- ❒ W/C Ramp (RED) - The Wheelchair Ramp message will appear any time the ramp is not fully stowed.
- ❒ Kneel (Amber) - The Kneel message will appear to indicate that the vehicle is below normal ride height.
- ❒ Engine Fan Fault (Amber) - The Engine Fan Fault message will appear if a fault is detected with the radiator electronically controlled fan system.
- ❒ W/C Stop Request (Amber) - The W/C Stop Request message appears when the wheelchair passenger signal system has been activated.
- ❒ Hybrid Fan Fault (Amber) - The Hybrid Fan Fault message will appear on the LCD screen to indicate a fault with the roof-mounted hydraulic oil cooler and fan assembly.
- ❒ Engine Fire (Red) - This message appears and a warning buzzer sounds when there is a fire in the engine compartment.

- ❒ Low Fuel (Amber) - The Low Fuel indicator illuminates when the level of diesel fuel in the tank as reached the minimum level for reliable vehicle operation.
- ❒ Interlock Fault (Red) - The Interlock fault message will appear on the LCD screen to indicate a fault has been detected with the Interlock System.
- ❒ Fuel Door Open (Red) - This message will appear if the fuel door proximity switch does not sense that the fuel filler door is closed.
- ❒ 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.
- ❒ Day Run (Amber) - This message indicates that the Master Run switch is in the DAY-RUN position.
- ❒ Regen Brake ON (Amber) - This message appears on the LCD screen when the regenerative braking system is active. The regenerative braking system can be enabled or disabled by toggling the ON/OFF REGEN BRAKE SWITCH located in the destination sign compartment.
- ❒ Aux Heater (Amber) - The Aux Heater message will appear on the LCD screen when the engine coolant heater functions. It starts automatically in cold conditions to heat the engine coolant to operating temperature.

☞**NOTE:**

The engine coolant heater operates only when the Master Run switch is in either the DAY-RUN or NIGHT-RUN position.

- ❒ Auxiliary Heater Fault (Amber) - The Auxiliary Heater Fault message will appear on the LCD screen when a fault is detected during auxiliary heater operation.

☞**NOTE:**

The engine coolant heater operates when the Master Run switch is in either the DAY-RUN or NIGHT-RUN position.

2.1.26. Drive Unit Shift Selector

⚠CAUTION

Be sure to bring the vehicle to a full stop before shifting from drive [D] to reverse [R] or vice versa.

The Drive Unit shift selector is located on the right hand side of the instrument panel. The shift selector module has six push-button switches and a green LED display. Three switches control the reverse [R], neutral [N] and drive [D] selections.

☞**NOTE:**

A back-up alarm activates when reverse [R] is selected.

The other three switches are MODE, UP arrow, and DOWN arrow. The UP and DOWN arrows initiate the drive unit diagnostics system when pressed simultaneously. Press them once for diagnostics and twice for oil level readings. The MODE switch is used in combination with the diagnostic function.

☞**NOTE:**

The drive unit auto-neutral feature will automatically select neutral if the parking brake is applied or the interlocks have been applied for five minutes.

2.1.27. 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.

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.

2.1.28. 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.

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.

☞**NOTE:**

Closing the switch guard locks the switch in the RAISE position.

HOLD

During the kneeling cycle, this position stops kneeling operations, silences the alarms and extinguishes the exterior warning light. The Kneel indicator and the interlocks remain activated.

2.1.29. Wiper/Washer Controls

The Wiper Control switch operates the left-hand and right-hand wiper motors. Rotating the control knob through the intermittent range will vary the delay of the wiper sweep for differing rain conditions. 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 in the side console access door.

2.1.30. 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. 19-8: Driver's Area Climate Controls" on page 15.

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 foot 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.

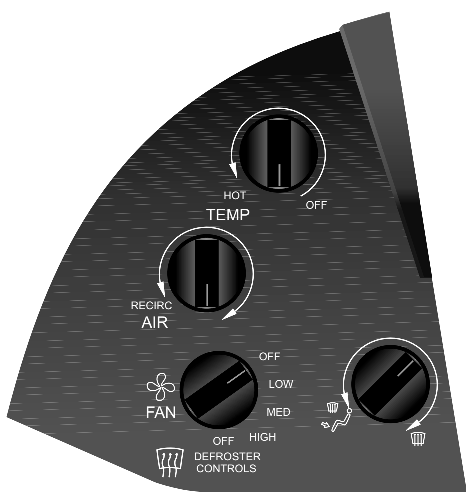

Fig. 19-8: Driver's Area Climate Controls

2.3. Side Console Switch Panel

See “Fig. 19-9: Side Console Panel” on page 17.

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.

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. 19-10: 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 (None) Curbside (None)
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 (None)
OFF	ANY POSITION	Streetside (None) Curbside (None)

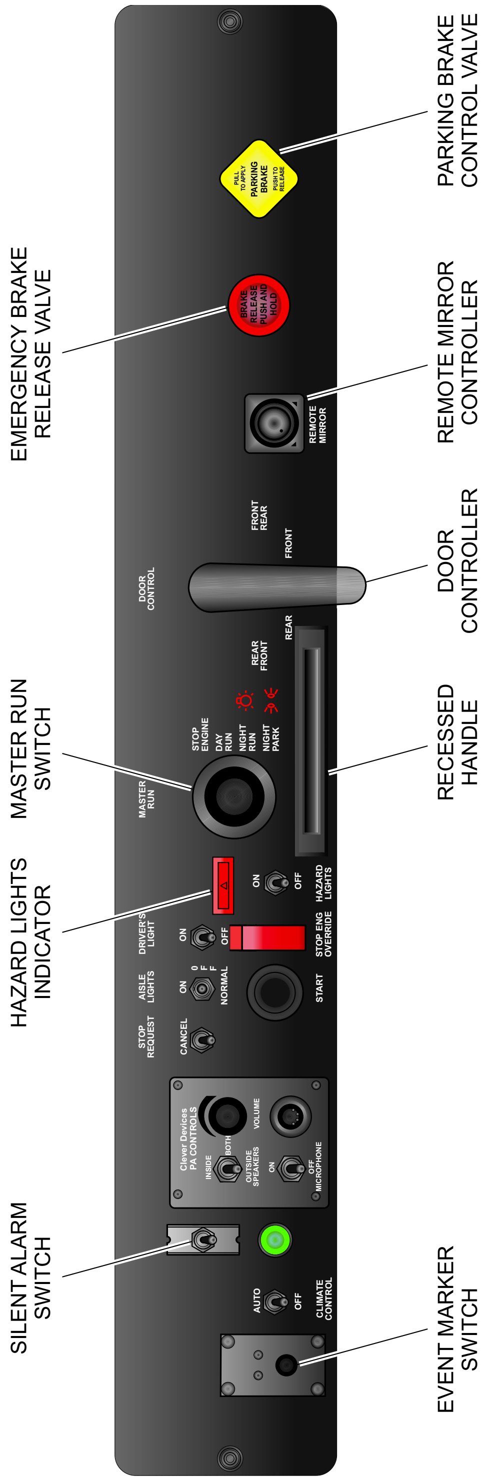

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Fig. 19-9: Side Console Panel

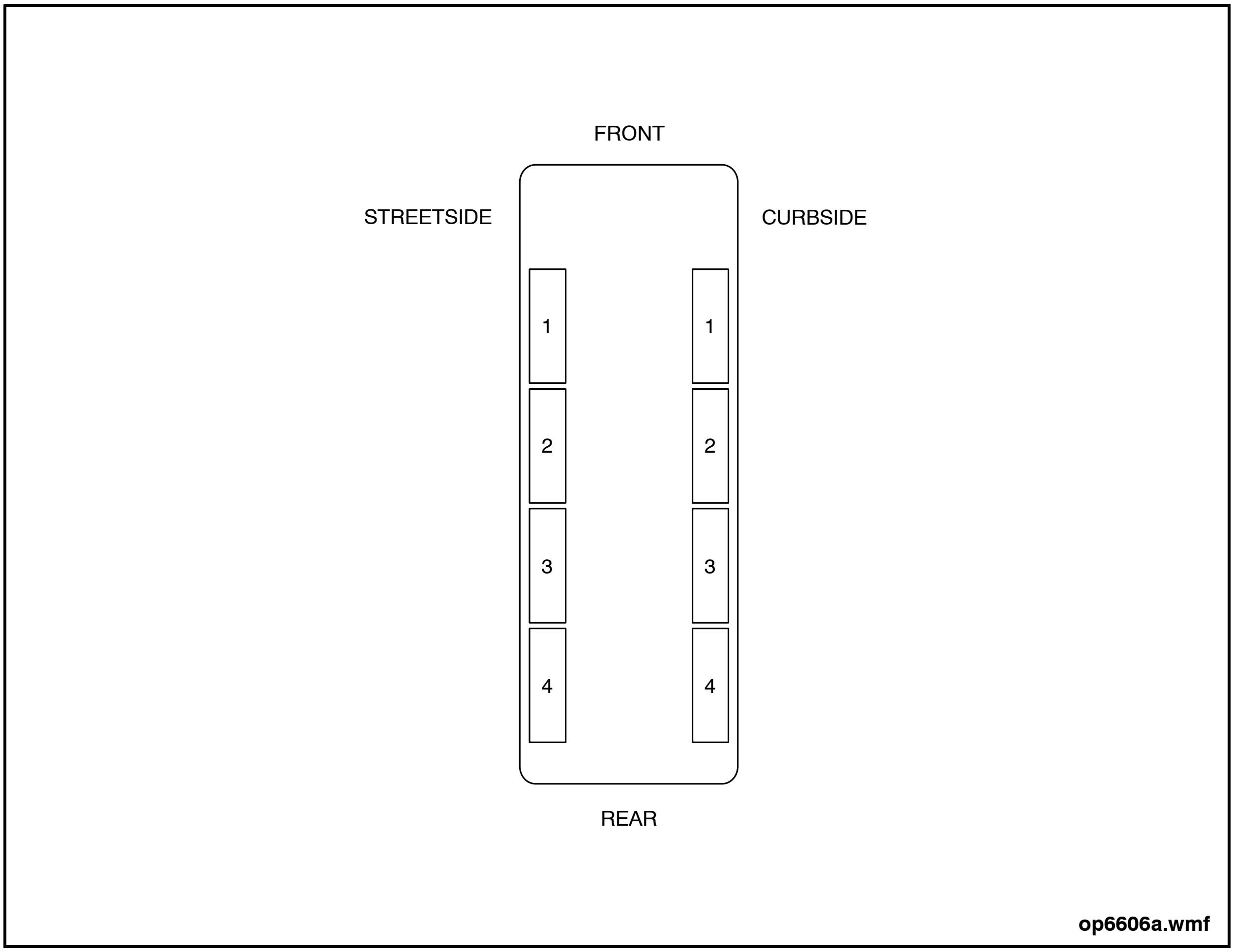


Fig. 19-10: Interior Lighting Panels

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 2)	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 2)		x	x	
Aisle lights, on (Note 2)	x	x	x	x
Instrument panel illumination			x	x
Instrument panel dimmer			x	x
Driver’s lamp (Note2)	x	x	x	x
Service compartment lights (Note 2)	x	x	x	x
Entrance & exit door lights with door open		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
Regenerative braking (Note 1)		x	x	
Driver's alarm		x	x	
Parking brake alarm (Note 2)	x			x
Fire suppression & 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: 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. 19-11: 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.

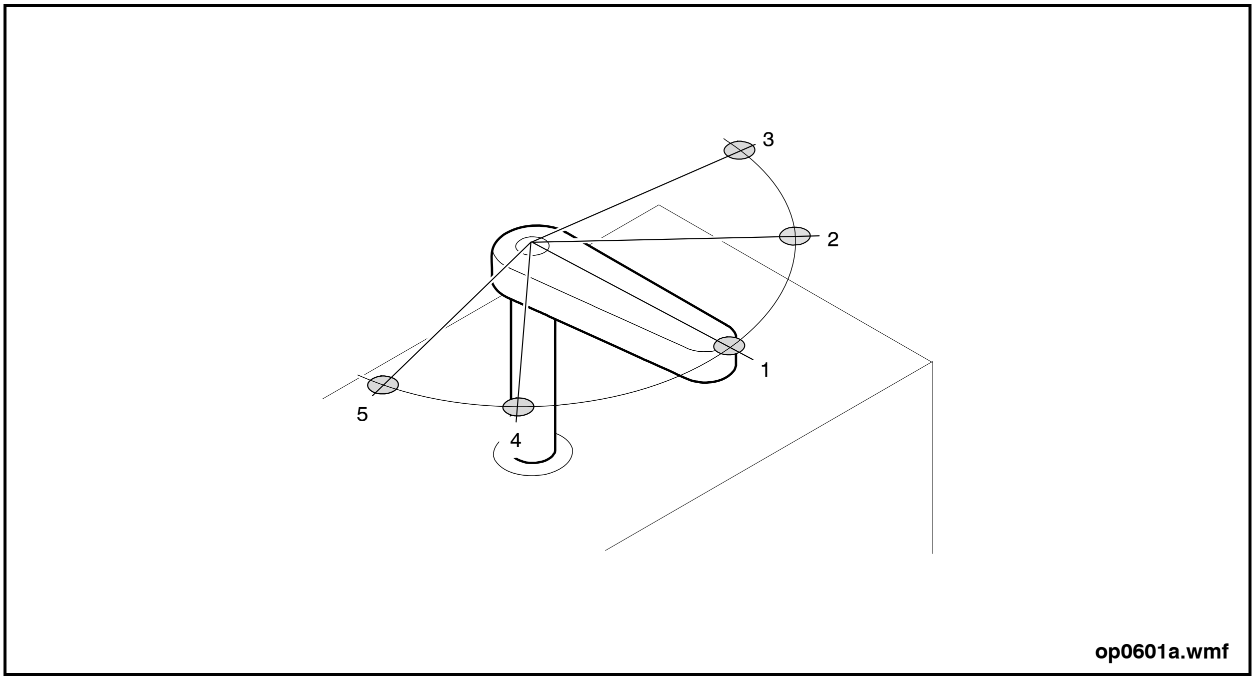


Fig. 19-11: Door Controller

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. Climate Control Switch

The Climate Control switch is a two-position toggle switch controlling the heating, ventilating and air conditioning (HVAC) system. In the normal AUTO position the HVAC System maintains a preset temperature in the vehicle interior. Position to OFF to disengage the HVAC System.

2.3.17. Event Marker Switch

This device is used to mark incidents on the Video Surveillance System for storage and subsequent playback. The green status light indicates that the system is operating normally. The red status light indicates a fault with the system.

2.4. Foot Operated Controls

See “Fig. 19-12: Driver’s Foot Controls” on page 24.

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 retarder function.

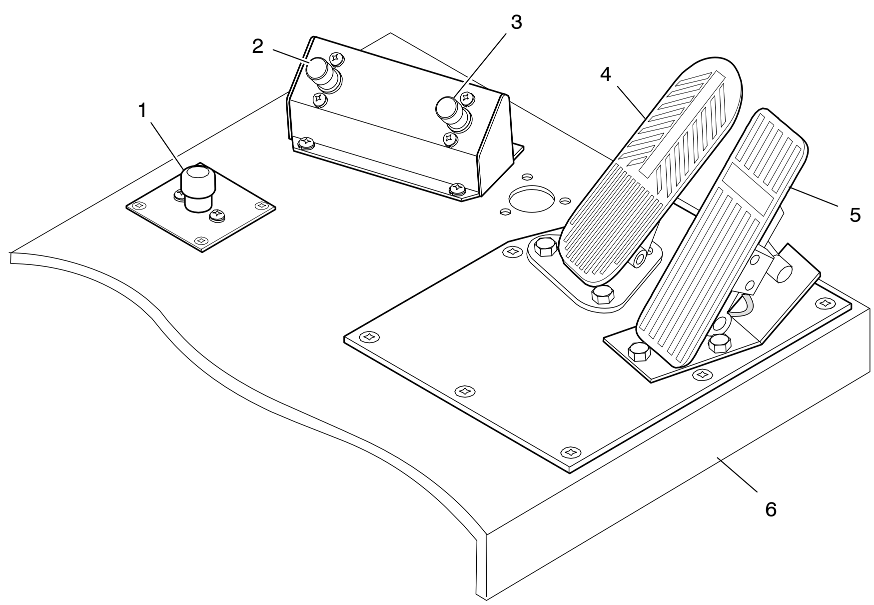
Brake application is proportional to the amount of treadle movement applied. Pressing the brake treadle illuminates the stop lights and the stop lights indicator.

☞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
3. Right Turn Signal
4. Brake Treadle
5. Accelerator Treadle
6. Driver’s Platform

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Fig. 19-12: 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 Brake Alert message on for more than a minute.

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. 19-13: Miscellaneous Switches” on page 26.

2.5.1. Service Light Switch

The Service Light switch is located behind the destination sign access door and controls the service lamp in the destination sign compartment.

2.5.2. 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.

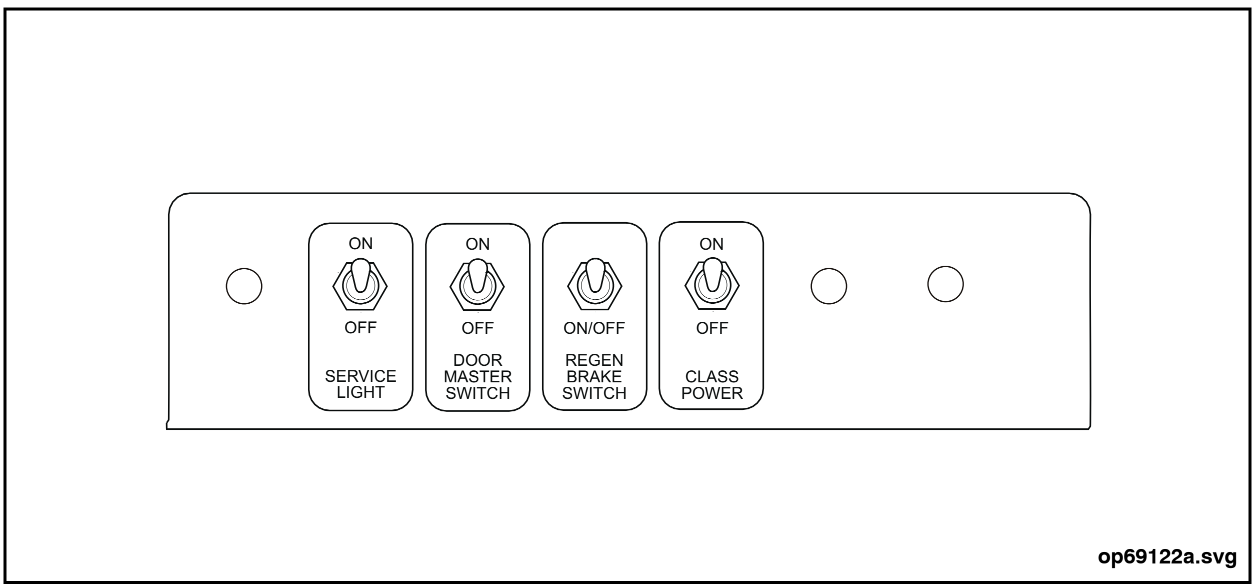


Fig. 19-13: Miscellaneous Switches

2.5.3. Regen Brake Switch

The Regen Brake toggle switch is located inside the front destination sign compartment and controls power to the regenerative braking system. Moving the switch to the OFF position will deactivate the regenerative braking system and illuminate the REGEN BRAKE OFF indicator on the instrument panel. The ON position will restore operation of the regenerative braking system.

☞**NOTE:**

Consult your transit authority for specific operating conditions during which the Regen Brake 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. 19-14: Instrument Panel Repair & Installation” on page 28.
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.

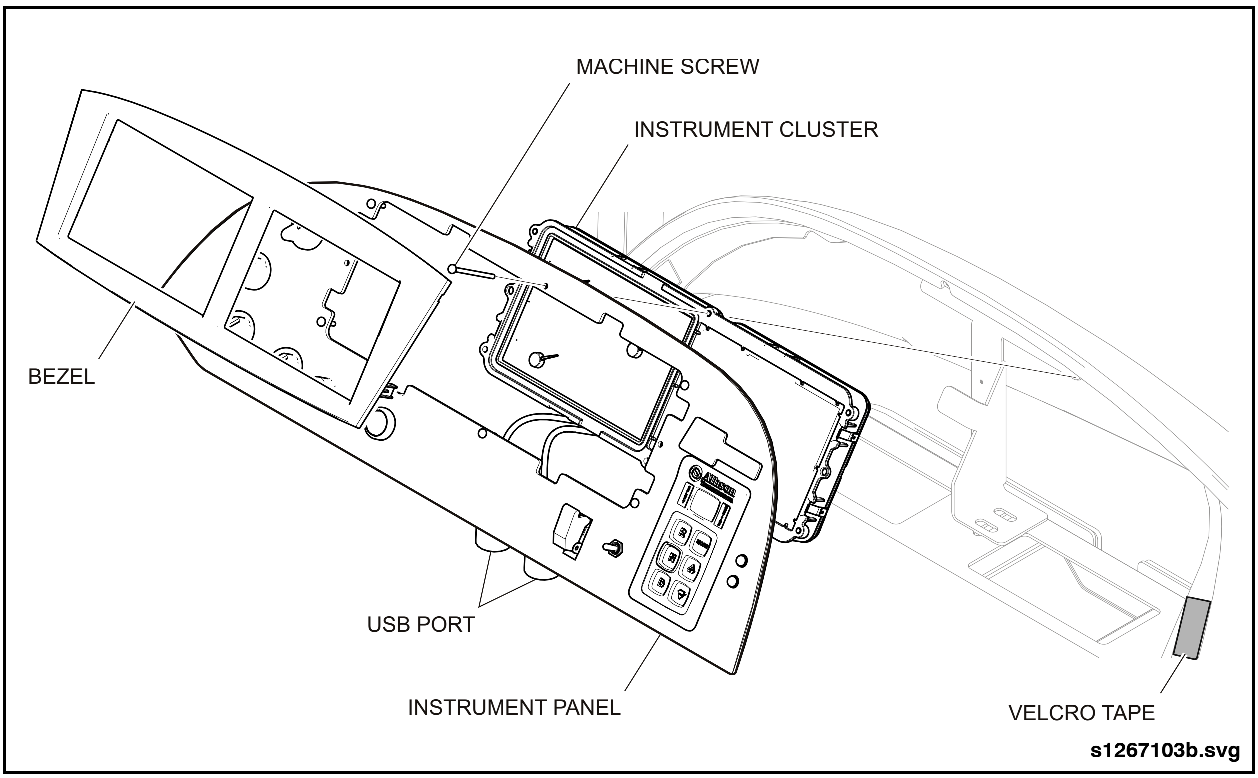


Fig. 19-14: Instrument Panel Repair & Installation

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. 19-15: Side Console Repair" on page 31.
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.

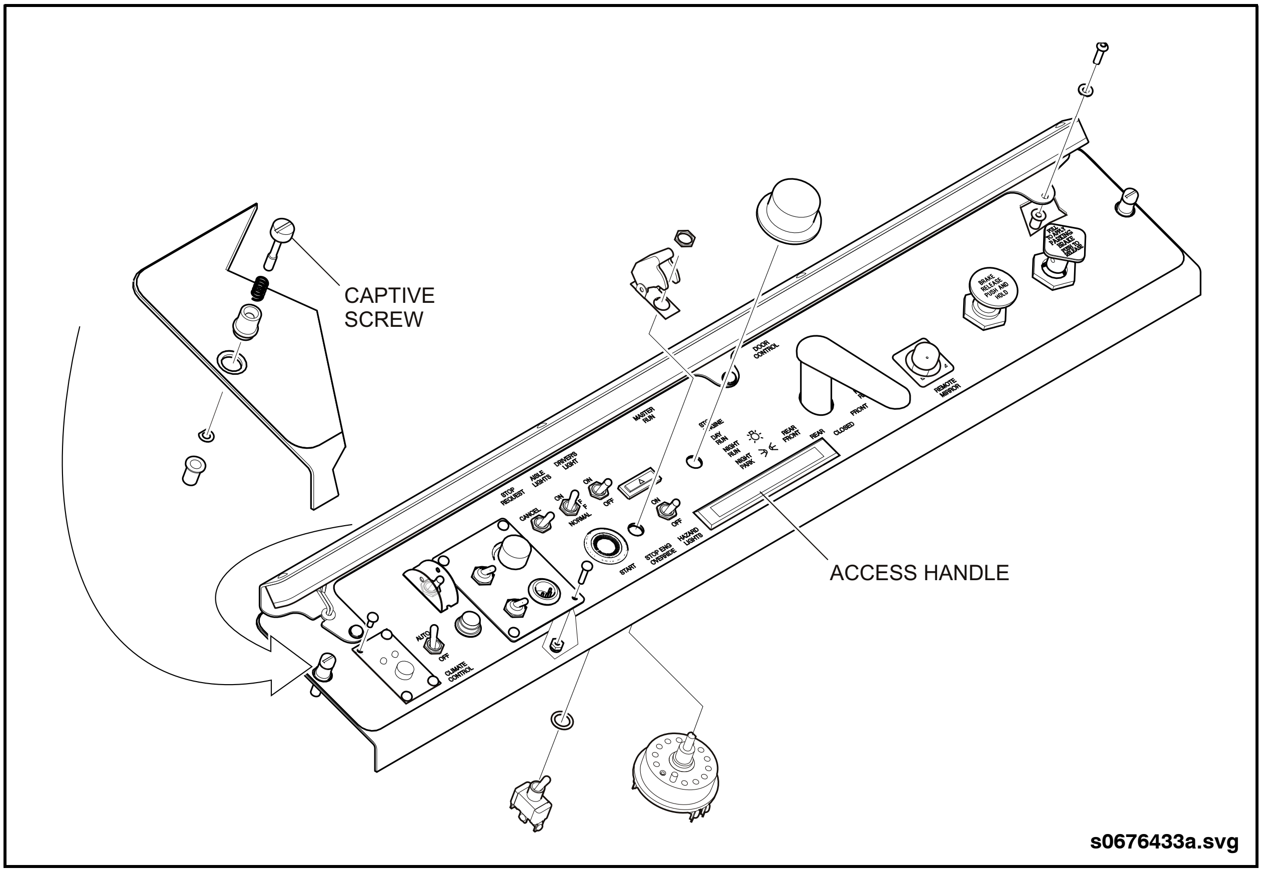


Fig. 19-15: Side Console Repair

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. 19-16: Accelerator” on page 33.
3. Lubricate pivot pins and roller with a thin layer of dry lubricant (Molykote 321 or equivalent).

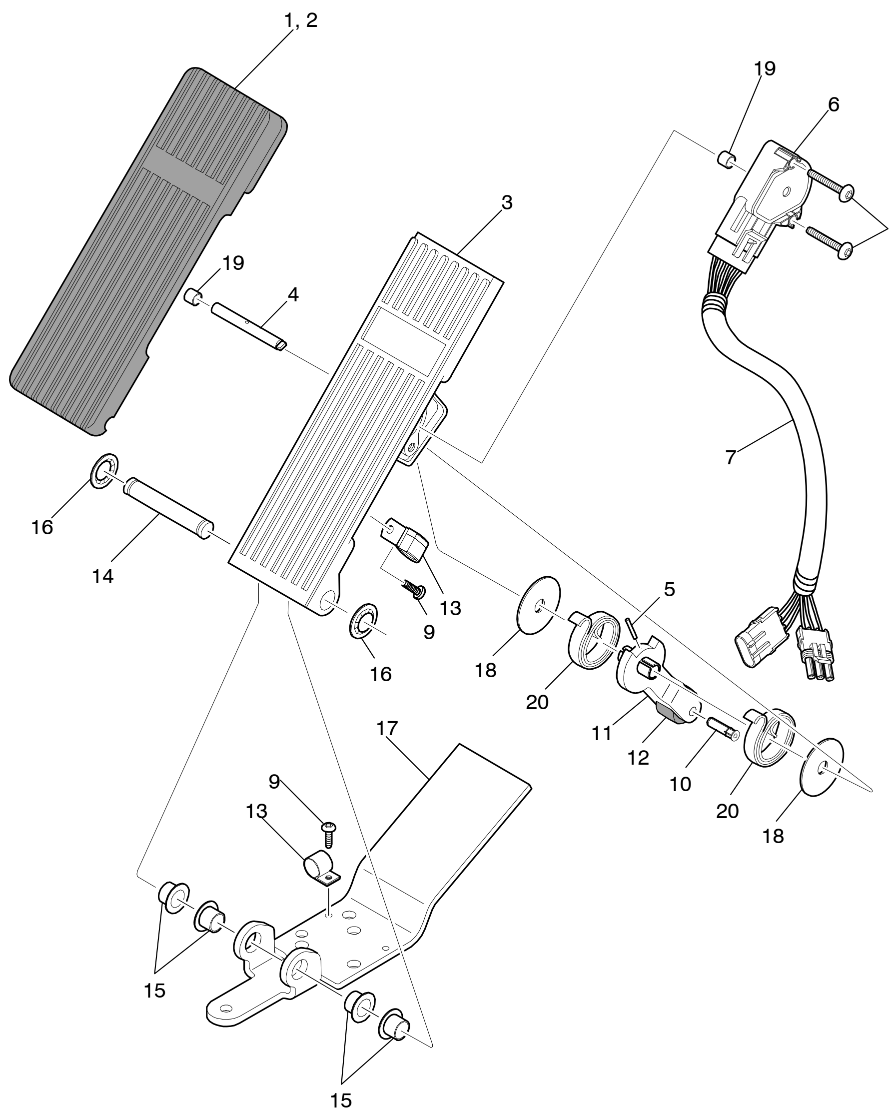
☞**NOTE:**

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

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Fig. 19-16: 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. High Voltage Safety

⚠ DANGER

The Allison H 40/50 EP System™ uses potentially hazardous electrical energy. All high voltage hybrid propulsion components are identified with High Voltage warning labels or symbols. DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

Refer to Section 5 of this manual for further information on the vehicle's high voltage 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.

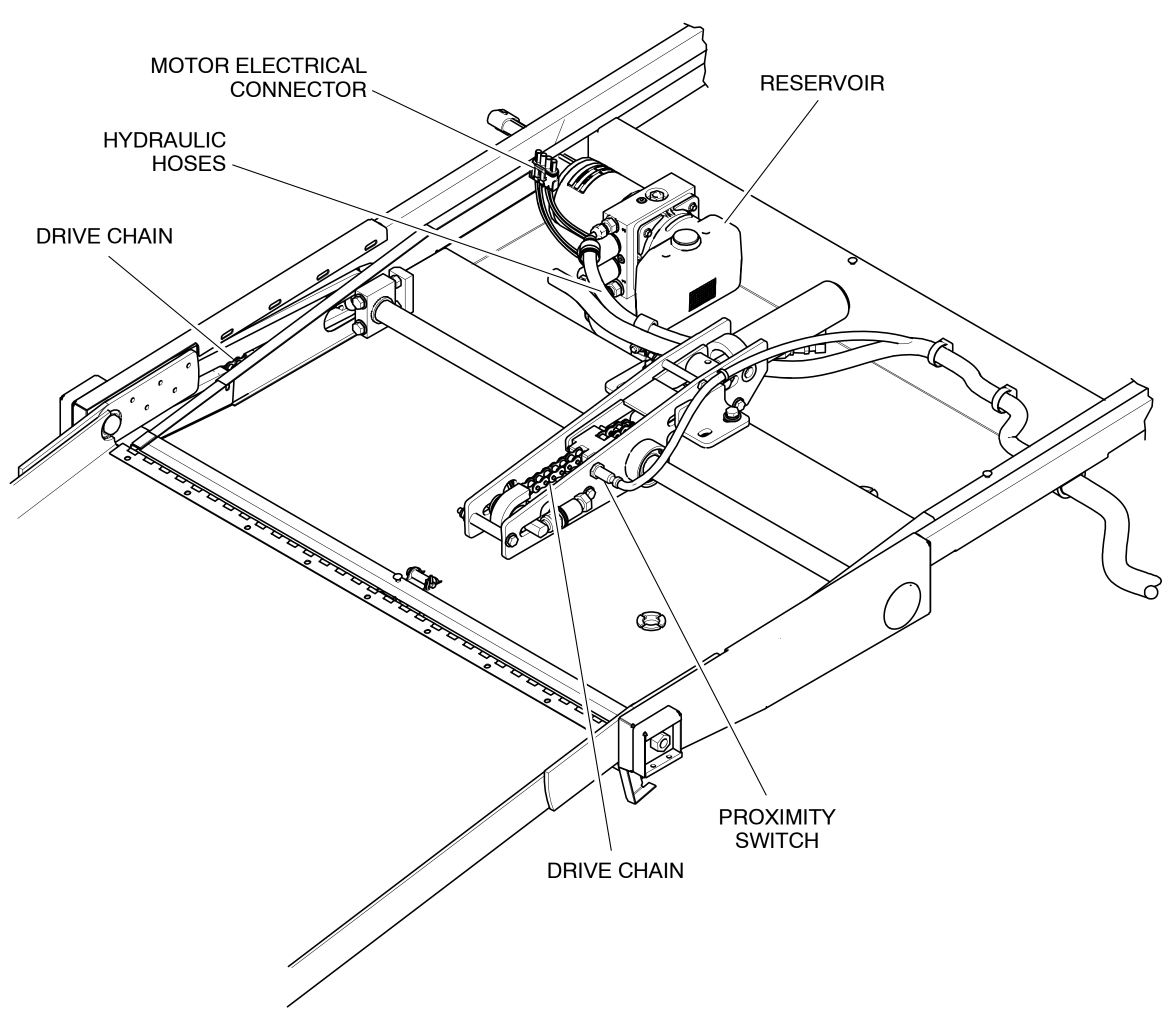


Fig. 20-1: Ramp Assembly Major Components

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.

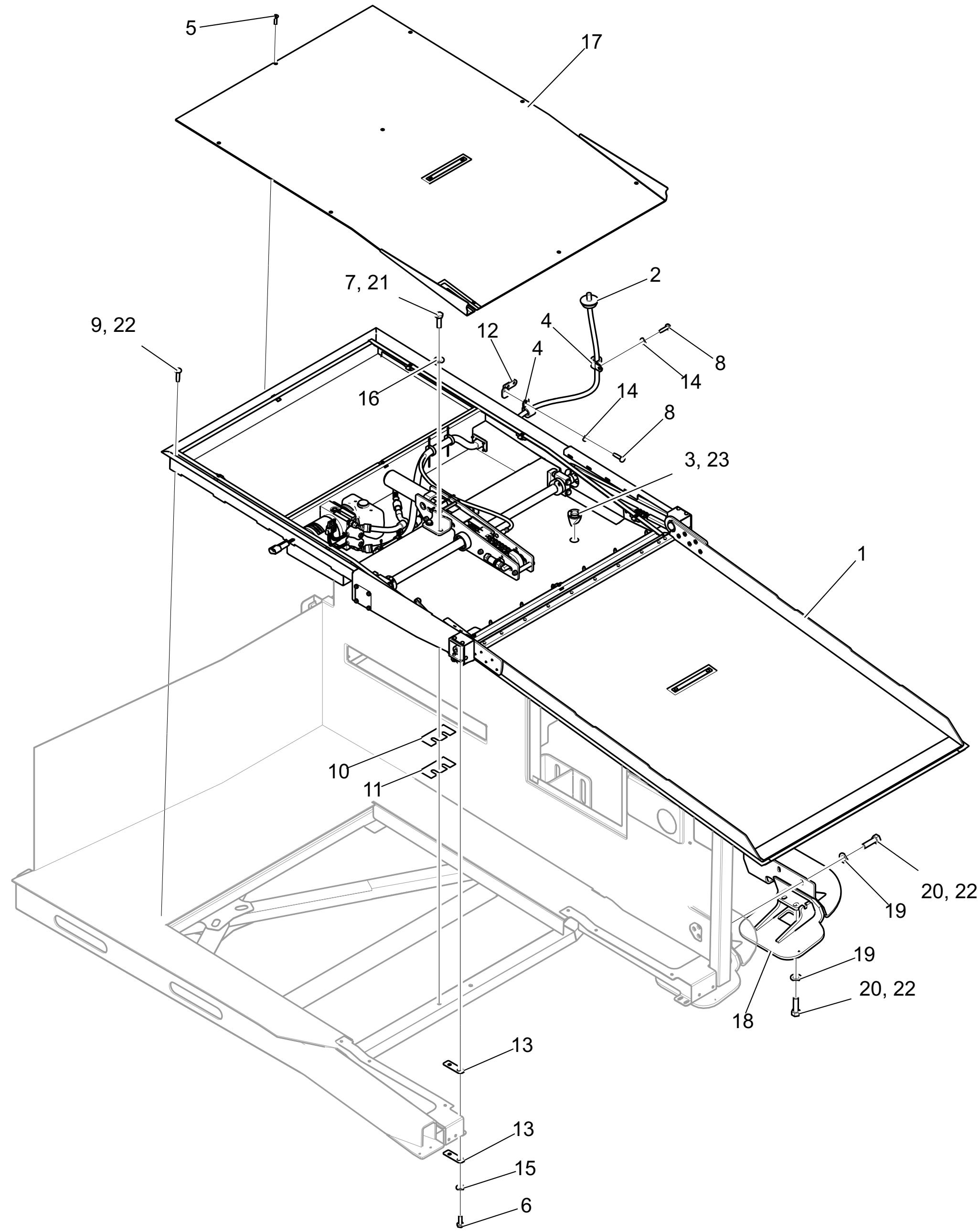
☞**NOTE:**

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, Entrance
2. Grommet, PUR .50" Tube O.D. x 1.5" Hole x .18" Thk.
3. Valve, Moisture Vacuator
4. Clamp, "P" SST .500" x .2 Mtg.
5. Screw, FH Cross Recess SST #10 - 24 UNC x 3/4" Lg.
6. Bolt, Hex SST 1/4" - 20 UNC x 3/4" Lg.
7. Bolt, Hex SST 5/16" - 18 UNC x 1" Lg.
8. Screw, PH Cross Recess Tpg. Type F #10 - 24 UNC x 3/4" Lg.
9. Screw, SST Cross Recess Tpg. Type F 1/4" - 20 UNC x 1" Lg.
10. Spacer, .050 Thk
11. Spacer, .037 Thk
12. Bracket
13. Spacer, .063 Thk
14. Washer, Flat SST #10
15. Washer, Flat SST 1/4"
16. Washer, Flat SST 5/16"
17. Cover Assembly, 32"
18. Skid Plate Assembly
19. Washer, Flat 3/8"
20. Screw, Hex SST 3/8" - 16 UNC x 1 1/4" Lg.
21. Loctite, 271 Thread Locker
22. Loctite, 242
23. Adhesive, SIKA 221 Black

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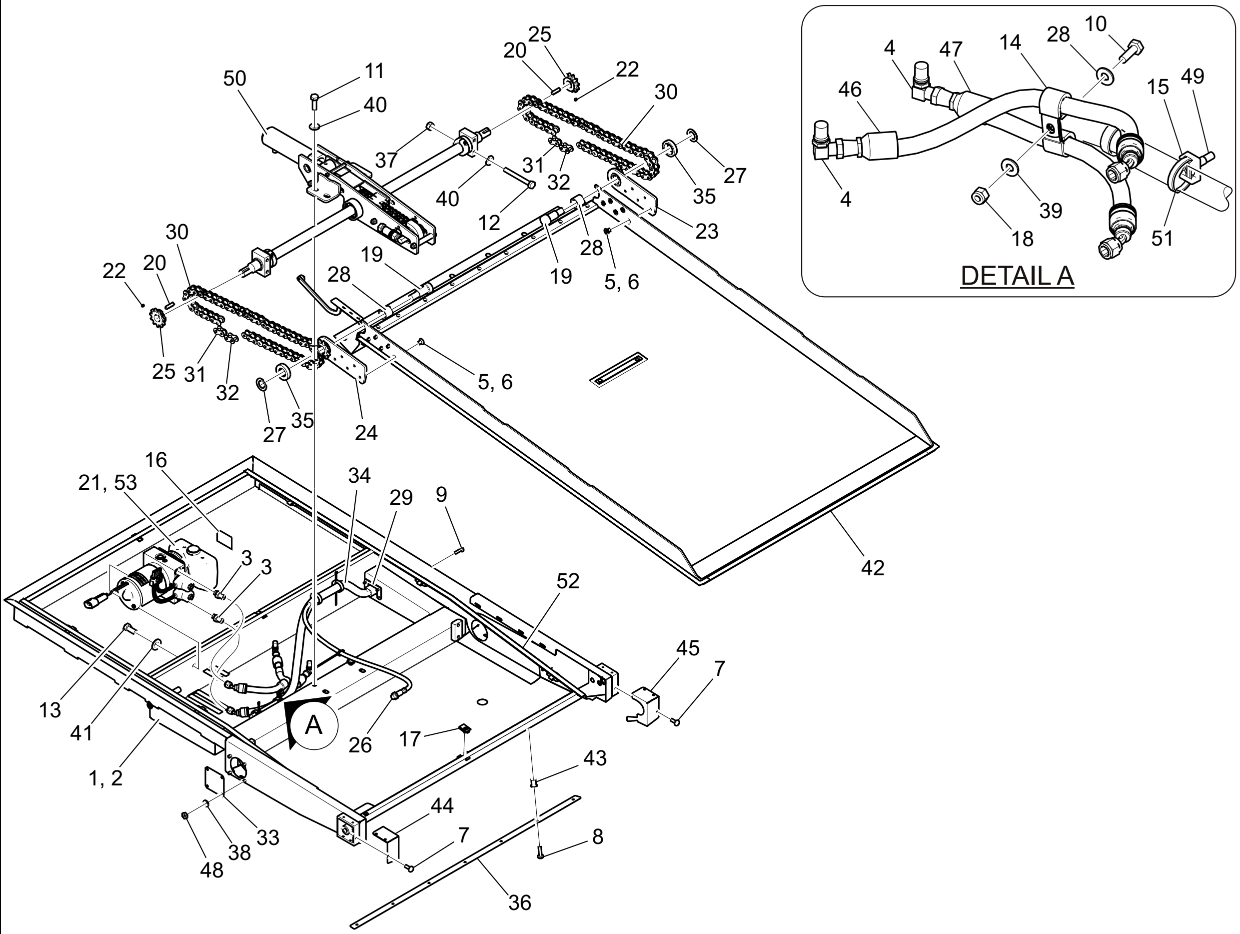
Fig. 20-2: Ramp Installation



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

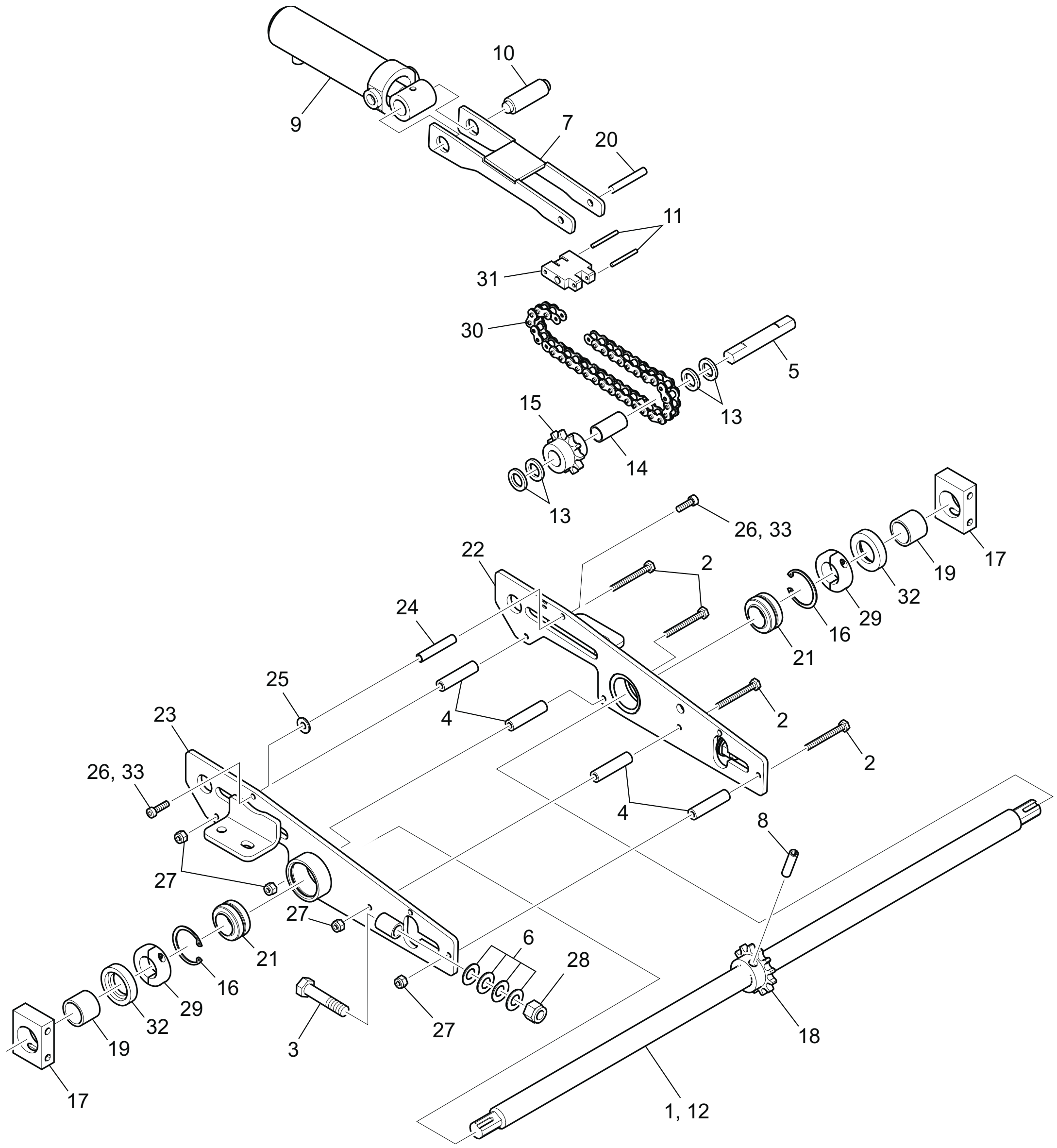
The maximum gap of 5/8" (16mm) is an American Disabilities Association (ADA) specification. This gap dimension MUST NOT be exceeded around the perimeter of the cover plate.

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

s0364116a.svg

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.

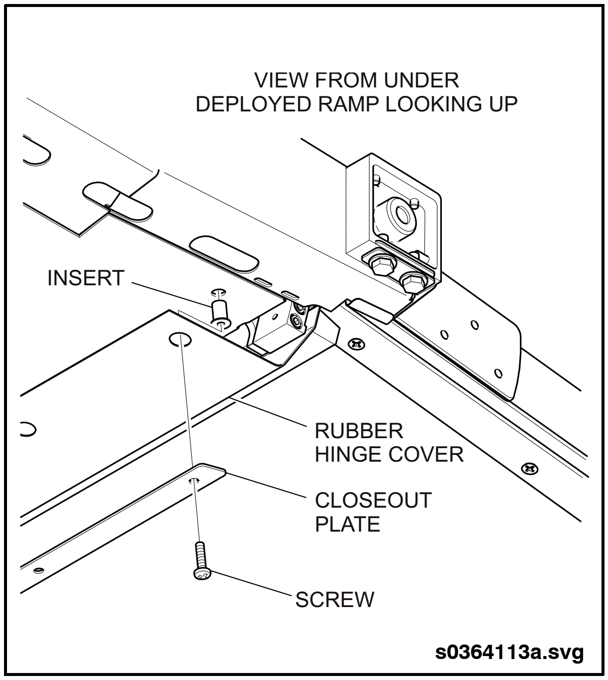


Fig. 20-5: Rubber Hinge Cover

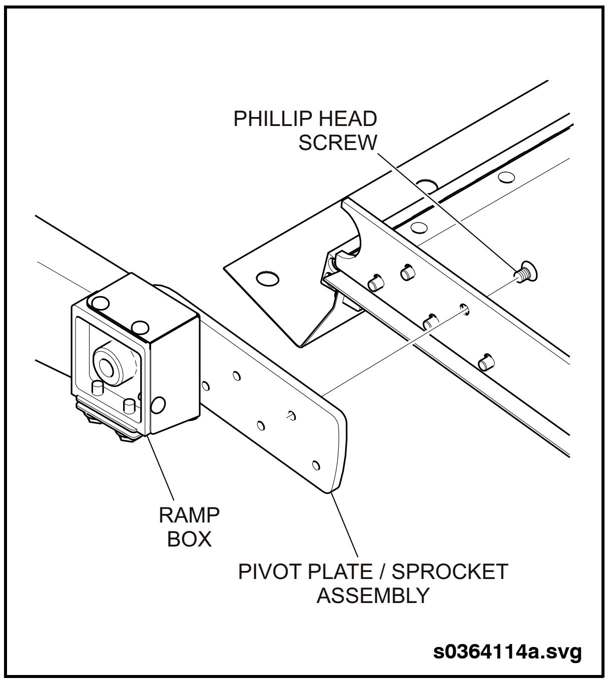


Fig. 20-6: Ramp Plate Removal

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.

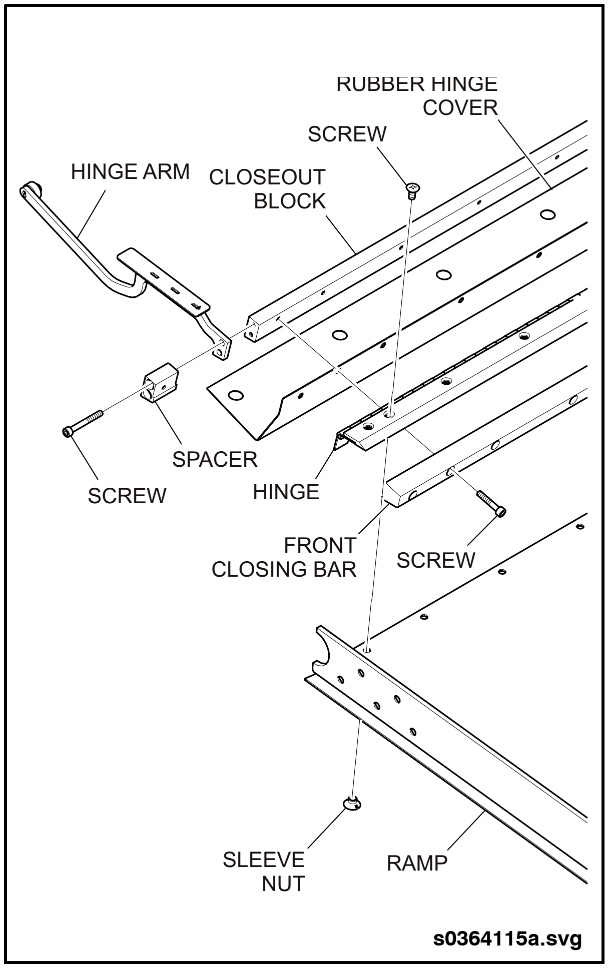


Fig. 20-7: Hinge & Cover Assembly

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.

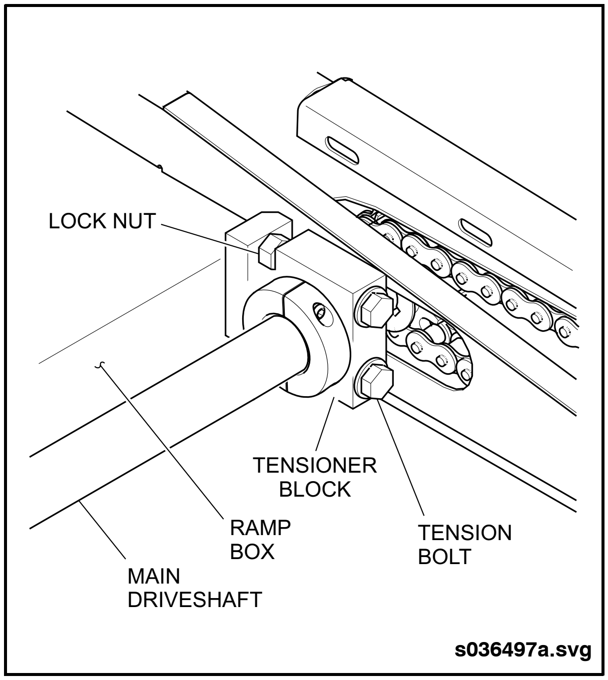


Fig. 20-8: Tensioner Block

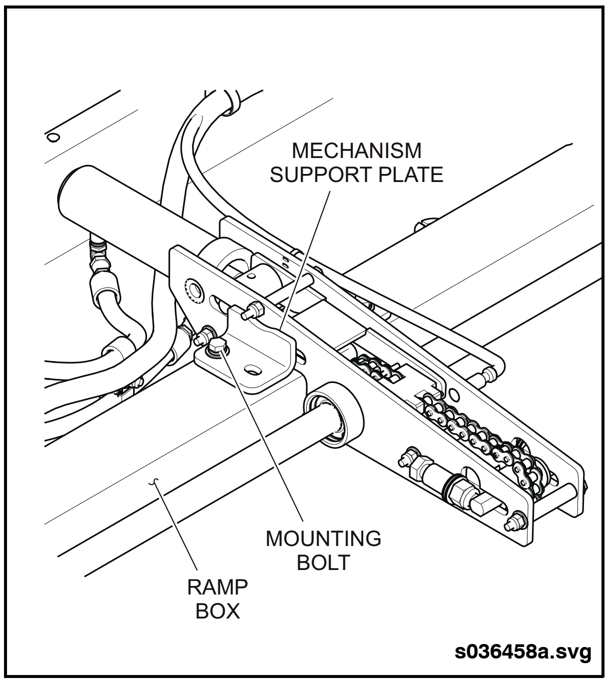


Fig. 20-9: Mechanism Mounting

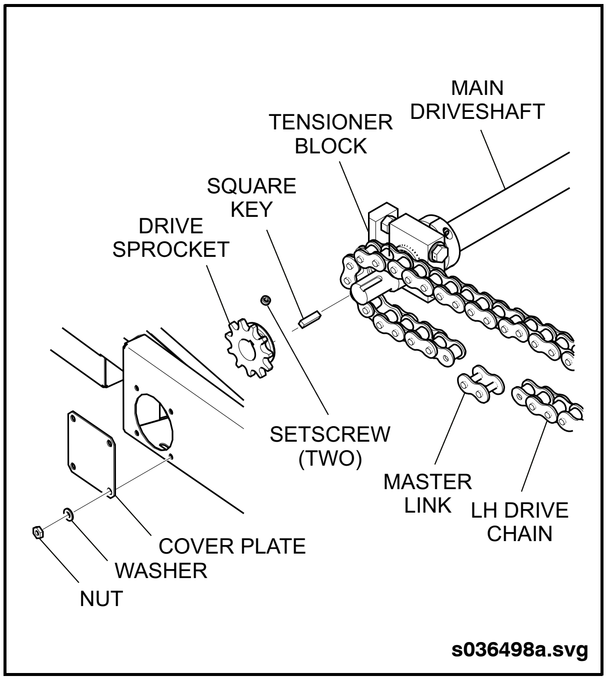


Fig. 20-10: Drive Chain & Sprocket

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.

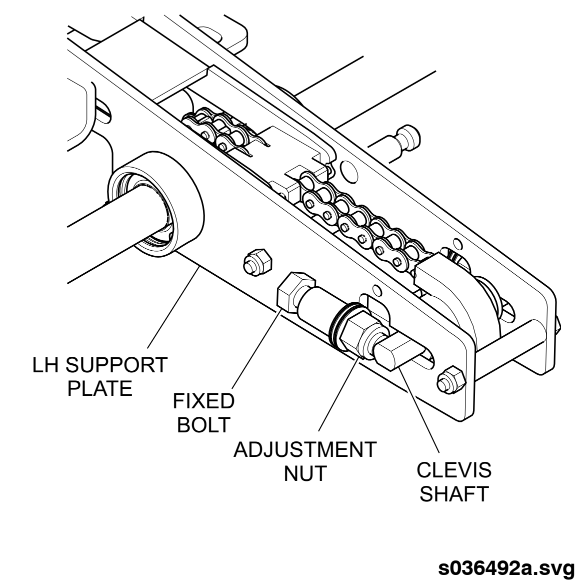


Fig. 20-11: Chain Tension Adjustment

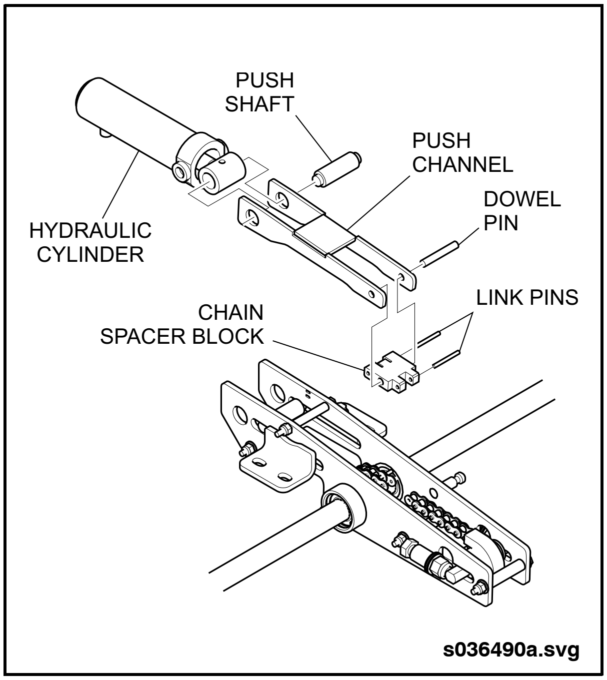


Fig. 20-12: Drive Chain & Spacer Block

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.
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.

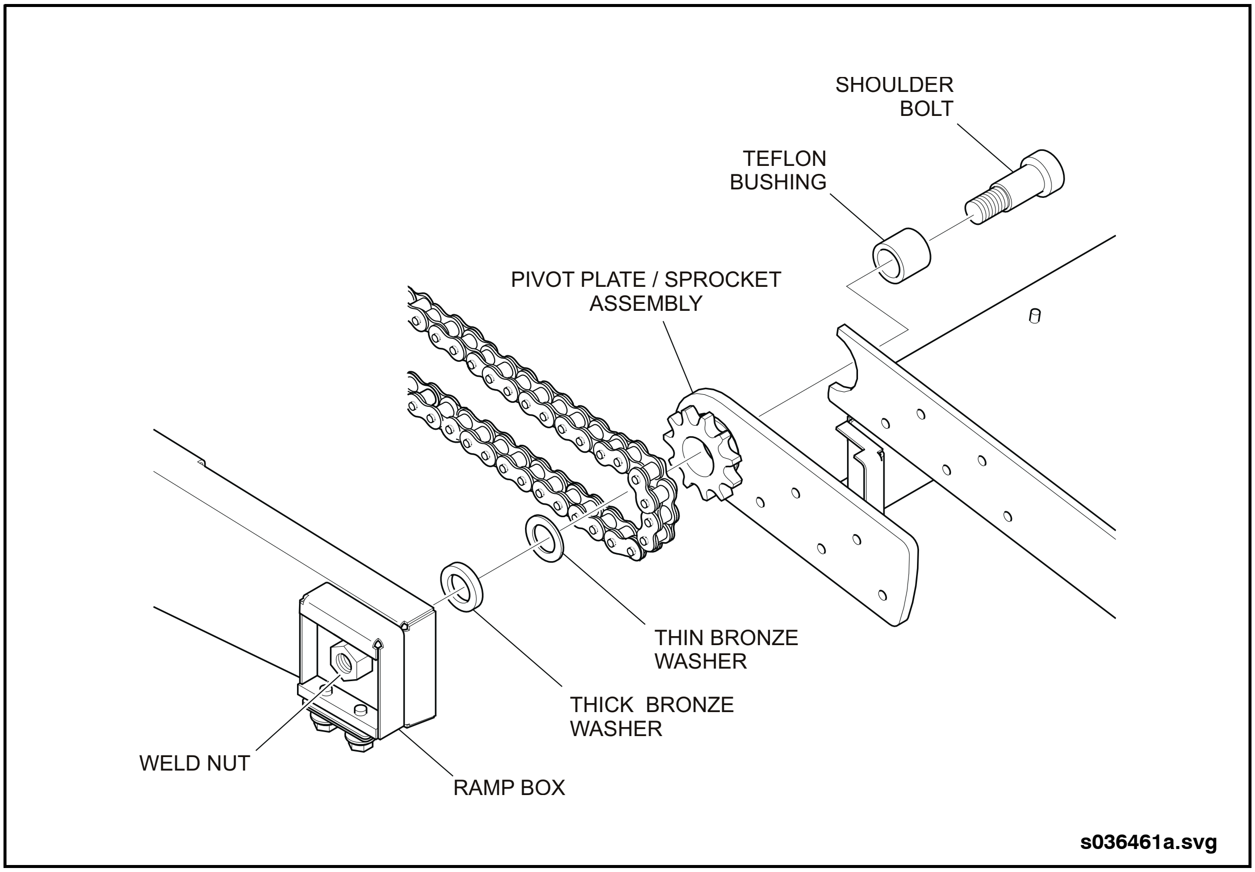


Fig. 20-13: Pivot Plate Installation

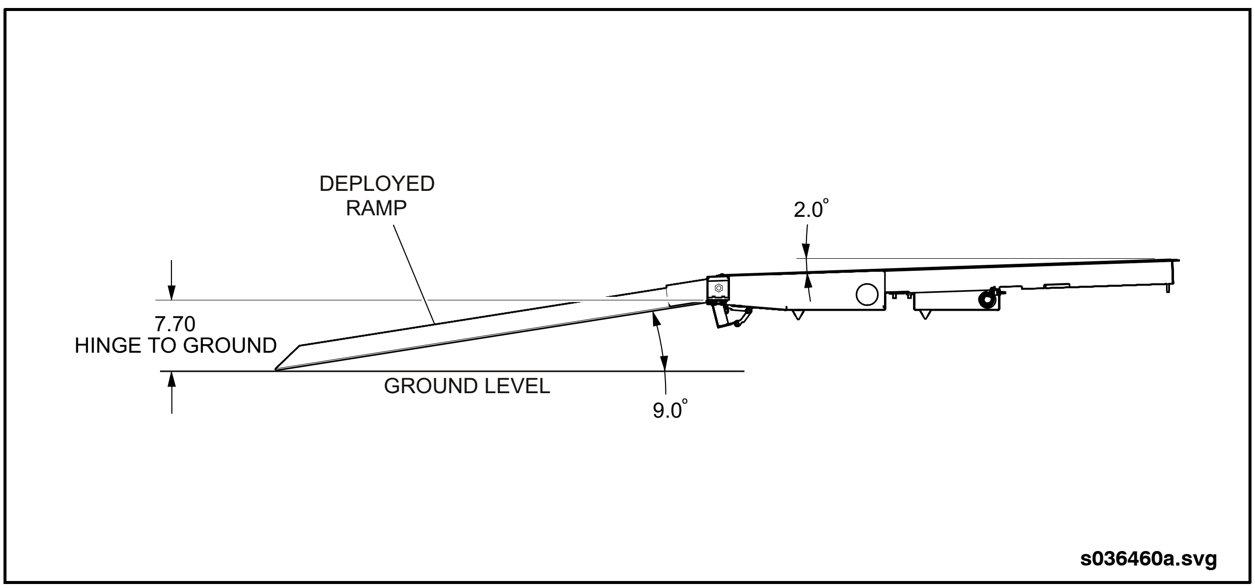


Fig. 20-14: Pivot Plate Alignment

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.

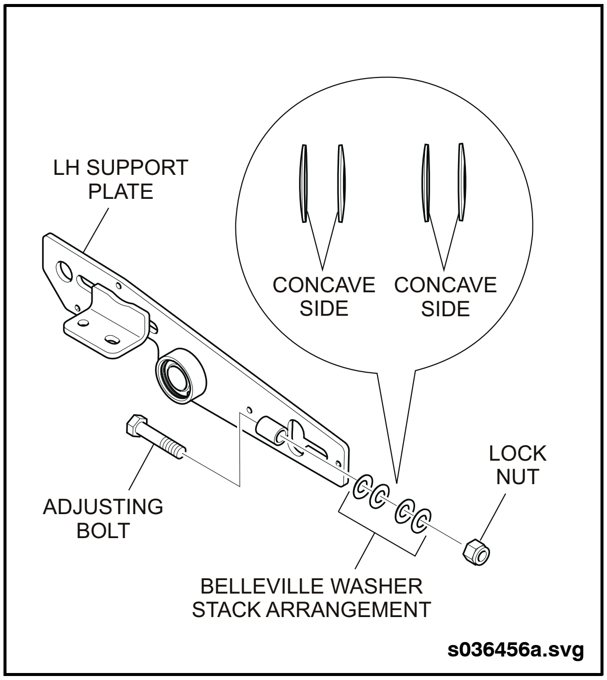


Fig. 20-15: Adjusting Bolt Installation

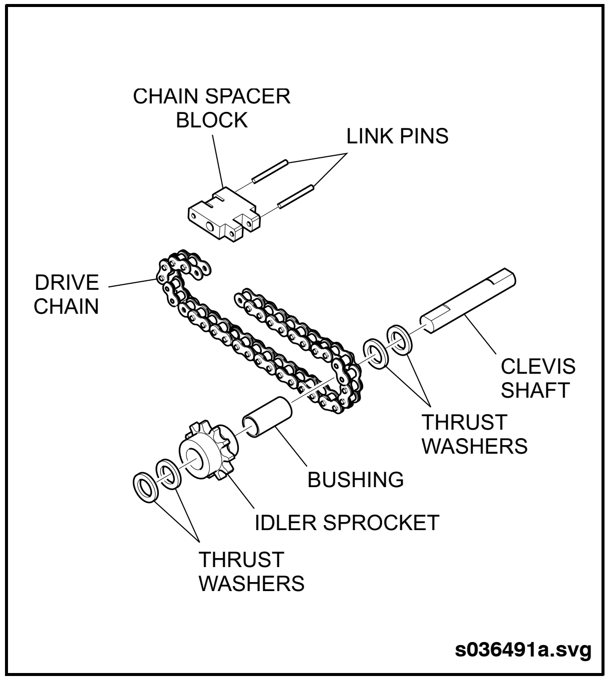


Fig. 20-16: Chain Spacer Block Installation

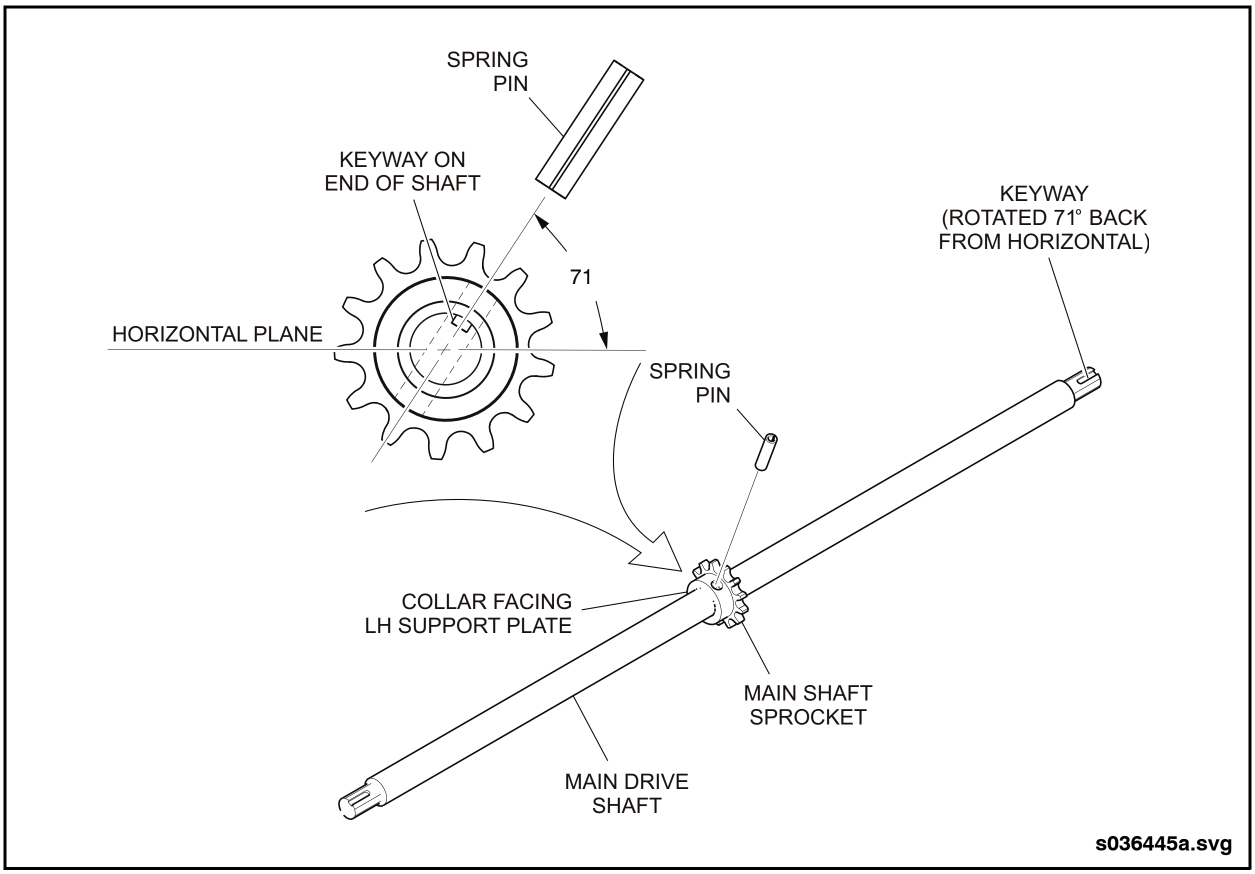


Fig. 20-17: Drive Sprocket Installation

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 drive chain tension by tightening the locknuts on the adjusting bolts equally. Continue to tension the chain until the Belleville washers are compressed nearly flat. Do not over tighten chain.

☞**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.
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.

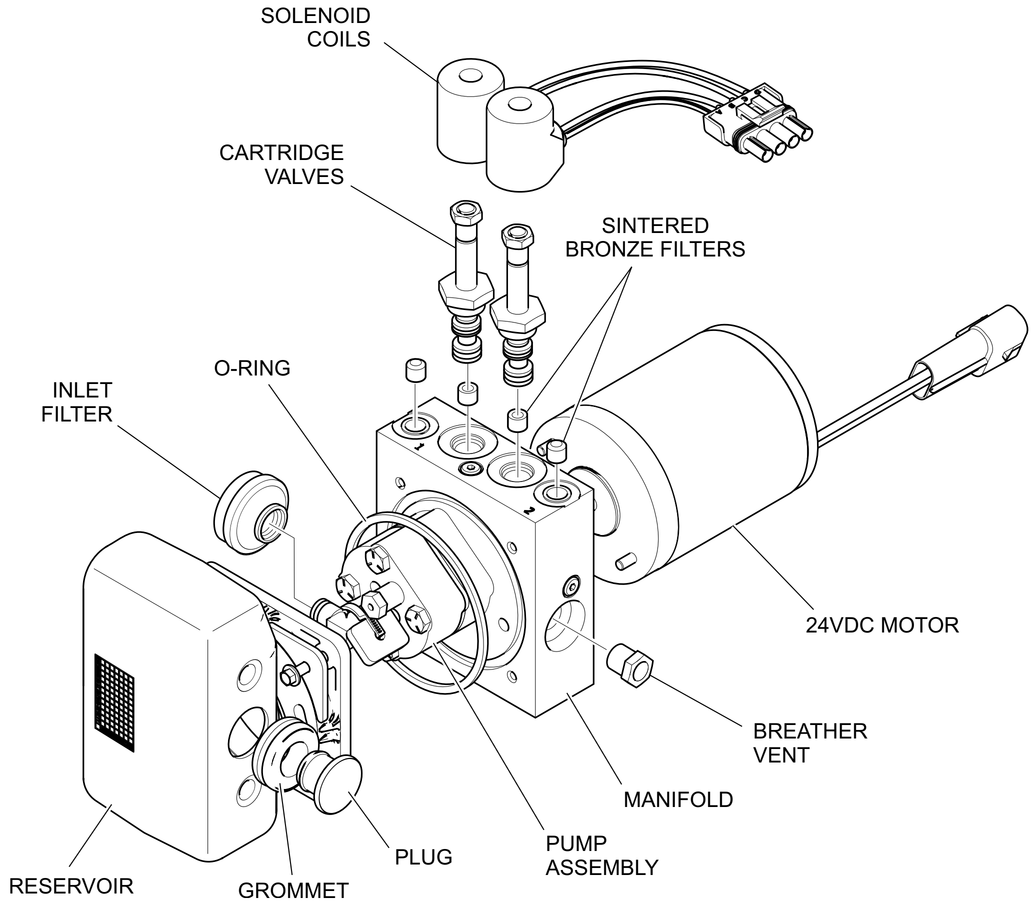


Fig. 20-18: Hydraulic Power Pack Assembly

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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